



SystemPlus EVOLUTION™

User Manual

Document Number: MSPE.EN

Document Version: 1.08

Date: 12 June 2020



MICROMED I via Giotto 2 I 31021 Mogliano Veneto I Treviso, ITALY
micromed@micromed.eu I tel. +39-041-5937000 I fax +39-041-5937011

CONTENTS

CONTENTS	2
GENERAL INTRODUCTION	10
Introduction	10
Use of the Mouse and Keyboard	11
System Requirements.....	12
General Precautions and Warnings	13
Responsibility.....	13
Indications for Use (U.S./BRAIN QUICK systems)	13
Indications for Use (EU/BRAIN QUICK and MYOQUICK systems)	14
Use Limitations	14
SystemPlus EVOLUTION Configuration.....	14
Data Protection.....	15
Data Acquisition and Analysis.....	15
Cybersecurity	16
Copyright.....	16
Archive	17
Introduction	17
Archive Window	17
Menu Bar	18
File Menu	18
Edit Menu	18
Help Menu	21
View Menu.....	21
Tools menu	21
Toolbar.....	22
Patient List	23
Exam List	23
File List	23
Resource List.....	24
Types of Resources	24
Status Bar.....	25
Custom List View and Sorting	25
Sorting.....	25
Columns View	26
Options	26

About the General Window	26
Settings	26
General	27
Key Function	28
Storage.....	28
SmartEEG	28
External DB Interface.....	29
External Programs	29
Lockdown.....	29
About the EEG Window	30
Headbox.....	30
Video Source.....	31
Video Recording	31
Video Reviewing	31
Accessing Data.....	32
Modify - New Resource	32
New/Search Patient.....	33
Patient Information - Modify.....	33
Exam Information - Modify.....	35
File Information - Modify.....	35
Property Window	36
Advanced Functions	37
Auto Archive of a Resource	37
Automatic CD/DVD Writing Procedure.....	37
Backup Properties.....	38
Backup Scheduler	39
How to Reduce an EEG File.....	40
Search for a Patient or Group of Patients.....	40
MS40 Window	42
EEG - Software	44
EEG Acquisition Window	44
Menu Bar	44
File Menu	45
Modify Menu	45
Acquire Menu	47
Analyze Menu	47
Reference Menu	49
Tools Menu.....	49
Options	49
Windows Menu	50
Help Menu	50
Toolbars	50
Status Bar.....	51
EEG Acquisition Procedure	51
EEG Review Window.....	53
Menu Bar	53
File Menu	54
Modify Menu	54
Analyze Menu	57
Reference Menu	58

Tools Menu	58
Move Menu	59
Windows Menu.....	59
Help Menu	59
Toolbars	59
Notes.....	60
Triggers	60
Status Bar.....	60
Review Procedure	61
EEG Functions.....	63
How to Print an EEG on Paper	63
How to Use the Thermal Printer	64
Modify Montage	66
User Definable Parameter Settings.....	68
Measure Cursors.....	74
Acquisition Chronometer.....	76
SLI Control.....	76
Check Impedance.....	77
View Impedance	78
Video EEG	78
Check Marker.....	78
Connection.....	78
Modify Connection Window.....	79
Particular Functions	82
Types of Connections.....	82
Data Average.....	91
Digital Trigger Insertion Parameters.....	91
Trigger Insertion on Muscular Activity.....	91
Data Average	92
Average Parameters	93
Other Controls	95
Density Spectral Array.....	96
Protocol Setup	96
EEG Analyzer.....	100
Maps	101
Introduction	101
Types of Maps.....	101
Access to the Maps Section	101
Menu, Toolbar, and Status Bar	101
Menu.....	101
Modify Menu	102
Tools Menu	102
Window Menu	103
Help Menu	103
Tool bar.....	103
Status Bar.....	103
Amplitude Maps.....	104
Amplitude Maps	104

Amplitude Map Settings	105
Frequency Maps and Spectrums	107
Frequency Maps	107
Access to the Frequency Maps and Spectrums	108
Frequency Map Settings	108
Spectral Analysis	111
Single Spectrum Analysis	111
Advanced Functions	111
Dynamic Amplitude Maps	111
Three-dimensional Maps	112
Electrode Position	112
Statistic.....	114
General Description	114
Structure of the STATISTICS Module	114
Statistic Settings	114
Statistic Settings	114
Statistic - Attributes Setup Menu	115
Options Menu	115
Construction of the Statistical Attribute Tree.....	115
Attribution of the Statistical Parameters	116
Access to the Attribution of Statistical Parameters.....	116
Review of the Group of Possible Statistical Attributes	116
Review of the Group of the Attributes Assigned to the Current File.....	117
Parameter Attributions to a Current File.....	118
Statistic Elaboration	119
Access to the Statistical Elaboration Section.....	119
Research Mask Setting	119
Result Representation of Statistical Research	122
Graphic Elaboration of the Results	123
Statistic - Glossary	124
Statistic Attributes	124
Statistic Research Mask	124
Research Modes for Statistical Attributes	124
Child Selection Mode in the Statistical Tree	124
Type of Node in the Statistical Tree.....	124
Report	126
Introduction	126
Report Templates	126
Report Window	126
Menu Bar	126
Modify Menu	127
View Menu	127
Insert Menu	128
Format Menu.....	129
Table Menu.....	129
Window Menu	129

Help Menu	129
Toolbars	130
About Microsoft Word.....	130
Report Templates.....	130
EMG - Software	132
System Description	132
Use of the Mouse and Keyboard	132
Amplifiers and stimulators	132
The Amplifiers.....	132
The Stimulators.....	133
Getting started	133
How to Create a New Exam	133
How to Review an Exam	133
Selecting an exam.....	134
Exams.....	134
Protocol Grid.....	135
Acquisition setup.....	135
General	135
Channel.....	135
Stimulator	136
Markers.....	137
Correlation	137
Average.....	138
Headbox.....	138
Cycles	138
Pressure	139
Muscles and sites.....	139
Calculation	140
Footswitch	140
MEP Setup	140
Automatic program	141
Lines.....	142
Remote Control	142
Needle EMG Report.....	142
Acquisition and review window	142
Menu bar	143
Toolbars	148
Layout setup.....	148
The tabs of parameters.....	148
General	148
Tables.....	149
Exam	149
Tables Parameters setup	149
EMG exams	150
Needle EMG - Turns & Amplitude - QEMG.....	150
MNCV and SNCV	160
Inching	162

RNS	164
H Reflex.....	166
F Wave	168
Blink Reflex	170
MEP.....	172
SSR	174
RR.....	175
SFEMG	176
Hot keys	178
Footswitch.....	179
EP - Software	180
System Description	180
Use of the mouse and the keyboard	180
Amplifiers and stimulators	180
The amplifiers	180
The stimulators	181
Getting started	182
How to Record an Exam	182
How to View a Recording	183
How to Generate a Report.....	183
How to Print a Report.....	183
Selecting an exam.....	184
Exams.....	184
Protocol Grid.....	184
Acquisition setup.....	185
The Parameter Tabs.....	185
General	185
Channel.....	185
Stimulator	186
Markers.....	189
Interpeaks.....	189
Average.....	190
Headbox.....	190
Parameters View	190
Advanced Average	191
Acquisition	191
Acquisition Window.....	191
Acquisition procedure	196
Hot keys	196
Review.....	197
Review Window	197
Multi-selection.....	205
Hot keys	206
IOM	207
Introduction	207

System Description	207
IOM hardware setup and protocol configuration	207
Main window	207
Menu bar.....	207
File Menu	207
Modify Menu	208
Acquire Menu	209
Toolbars	210
Status Bar.....	210
Window components: clock, stimulator, traces, average, trends, parameters and notes.....	210
IOM acquisition window	211
IOM review	211
Positioning the flags: the template trace.....	211
Setup.....	211
Protocol Manager	211
Protocol Setup	212
Introduction	213
Types of Maps.....	214
Access to the Maps section	214
Menu, toolbar and status bar	214
Menu.....	214
Modify Menu	214
Toolbar.....	215
Status bar	216
Amplitude Maps.....	216
Amplitude Maps	216
Amplitude Map Settings	217
Frequency Maps and Spectrums.....	220
Frequency Maps	220
Access to the Frequency Maps and Spectrums	221
Frequency Map Settings	221
Spectral Analysis	223
Single Spectrum Analysis	223
Advanced functions.....	224
Dynamic Amplitude Maps.....	224
Three-dimensional Maps	224
Electrode Position	225
General Description	226
Structure of the STATISTICS module.....	226
Statistic settings	226
Statistic settings.....	226
Statistic - Attributes Setup Menu	226
Construction of the statistical attribute tree	227
Attribution of the statistical parameters	227
Access to the attribution of statistical parameters.....	227
Review of the group of possible statistical attributes	228
Review of the group of the attributes assigned to the current file	229

Parameter attributions to a current file	229
Statistic Elaboration	230
Access to the Statistical Elaboration section	230
Research mask setting	230
Result Representation of a statistical research	233
Graphic Elaboration of the results.....	234
Statistic - Glossary	235
Statistic Attributes	235
Statistic research mask	235
Research modes for statistical attributes.....	235
Child selection mode in the statistical tree	235
Type of node in the statistical tree	235
Annex - EMG Application Note	236
Electromyography	236
SPONTANEOUS AND VOLUNTARY ACTIVITY STUDING.....	236
Work modality	237
MUAP Analysis.....	238
Electroneurography.....	244
SENSORY CONDUCTION VELOCITY	244
MOTOR CONDUCTION VELOCITY	246
H REFLEX.....	248
F WAVE	250
SSR - SIMPATIC SKIN RESPONSE	252
MUNE Motor Unit Number Estimation	254
Single fibre	256
Concentric needle Single-Fiber electromyography	261
Single-Fiber Layout and Setup	261
Annex - EP Application Note.....	264
Evoked Potentials.....	264
Synchronized average.....	264
Recording place and patient condition.....	265
Electrode application.....	265
Filters	265
Stimulation artefacts	266
Evoked Potential Types.....	266
SOMATOSENSORY EVOKED POTENTIALS – UPPER LIMB.....	267
SOMATOSENSORY EVOKED POTENTIALS – LOWER LIMB.....	269
BRAINSTEM EVOKED POTENTIALS.....	271
VISUAL EVOKED POTENTIALS	273
LASER EVOKED POTENTIAL.....	275
Cognitive Evoked Potentials	277

GENERAL INTRODUCTION

Introduction

SystemPlus EVOLUTION is the software that handles all Micromed acquisition and review systems for EEG and PSG, EMG and EP, which means that according to the enabled key options, SystemPlus EVOLUTION integrates all types of exams into a single application, such as:

- EEG
- Video EEG
- Long term monitoring of Epilepsy - Stereo EEG
- Ambulatory EEG / PSG
- EEG Recording during functional MRI
- Electromyography
- Evoked Potentials
- Intra-Operative Monitoring

The configurations are open towards external systems and are organized according to the criteria of maximum working flexibility. The single archive and project design guarantee is that all standard activities of Acquisition, Review, Analysis, Report, and Archive of all exams can be managed in a single unit or on several systems distributed over a network.

The program has been designed to be offered in various performance / feature levels.

Some SW features could be not available in all countries.

Product availability varies by market:

Product	Markets Available*
Routine EEG, VideoEEG	EU, PAC-ASIA, MIDDLE EAST, USA
Long Term Monitoring	EU, PAC-ASIA, MIDDLE EAST, USA
Ambulatory EEG	EU, PAC-ASIA, MIDDLE EAST, USA
PSG (ambulatory and fixed)	EU, PAC-ASIA, MIDDLE EAST
Electromyography (EMG)	EU, PAC-ASIA, MIDDLE EAST
Evoked Potentials (EP)	EU, PAC-ASIA, MIDDLE EAST
Intra-Operative Monitoring	EU, PAC-ASIA, MIDDLE EAST

*Based on Regulatory clearance of each country

Therefore, some of the features described in the present manual cannot be available on the software installed on your system.

This document includes updated features available in SystemPlus EVOLUTION version 1.04.0215.

Use of the Mouse and Keyboard

The application program is based on the Windows[®] operative system and shares some user interface techniques and software characteristics that are common to the more popular software: use is more intuitive and familiar. Many program operations can be performed independently via the keyboard or the mouse. To make the use of the system more accessible, our company has provided some key functions called Quick Keys that allow the user to directly access the acquisition and view an exam (some of these keys are user definable, see the Archive section).

It is recommended that you familiarize yourself with the mouse for the Windows operative system functions. The program uses many typical techniques, for example, the click of the left and right mouse button, double click of the left mouse button, or the pressure of the left button while moving the mouse in order to drag and drop an object.

ADVICE: Do not forget to use both mouse keys; they could have different internal functions.

HINTS: Have you forgotten the settings for the function keys? During exam acquisition or review, it is possible to activate a window with a menu of function keys by pressing the F12 key on the keyboard.

System Requirements

PROCESSOR: Intel® Core™, 3.30GHz

MEMORY: 256 MB of RAM minimum

HARD DISK: 40 GB minimum

OPERATING SYSTEM: Windows XP Professional, Windows Vista, Windows 7, Windows 8.1 or Windows 10

Output Devices: Any IEC 60950 compliant monitor and printer supported by the installed operating system

Network: Systems intended to be connected to a LAN need an Ethernet 10/100 card with a RJ45 connector or a **BQ NET POE M/BQ NET POE 2** interface.

Separation Devices: Parts of the system that are in the “Patient Area” or are electrically linked (i.e. data cable, network, or triggers) to devices in the patient area need proper isolation from the mains voltage and measure to lower leakage currents on the enclosures of IT-devices included in the system. Therefore, the use of a separation transformer on their mains connection, or the use of proper separation devices between devices in the patient area and devices outside it (e.g. **BQ USB**, **BQ NET POE** interfaces) is mandatory. The system configuration set by authorized technicians at installation must not be modified by the user.

Failure to use Separation Transformer Units or complete systems from our company will void any declaration of compliance with the standards from our company.

On Acquisition Systems*

Micromed INTERFACE CARDS

1. BQ USB (for amplifiers SAM FC1, MORPHEUS, MATRIX, MATRIX LIGHT)
2. BQ USB EXPRESS (for amplifiers SD LTM EXPRESS, SD PLUS)
3. BQ PCI PLUS, BQ PCI PLUS FO (for amplifiers SAM FC1, MORPHEUS, MATRIX, MATRIX LIGHT)
4. BQ NET POE M (for amplifiers SAM FC1, MORPHEUS)
5. BQ NET POE 2 (for amplifiers SD LTM EXPRESS, SD PLUS)
6. BQ PCI EXPR LTM (for amplifiers SD LTM EXPRESS, SD PLUS)
7. BQ PCI EXPR MX (for amplifiers MATRIX, MATRIX LIGHT)
8. BQ USB PLUS (for amplifiers SD LTM PLUS)
9. BQ USB MULTI (for amplifiers SD LTM PLUS)
10. BOX TERMINAL MULTI (for amplifiers SD LTM PLUS)

Micromed AMPLIFIERS and STIMULATORS

1. SD LTM EXPRESS (on interface cards BQ USB EXPRESS, BQ PCI EXPR LTM, BQ NET POE 2)
2. SD LTM EXPRESS in combination with SD LTM STIM stimulators (on interface cards BQ USB EXPRESS, BQ PCI EXPR LTM, BQ NET POE 2)
3. SD PLUS (on interface cards BQ USB EXPRESS, BQ PCI EXPR LTM, BQ NET POE 2)
4. MORPHEUS (on interface cards BQ USB, BQ PCI PLUS, BQ PCI PLUS FO, BQ NET POE M)
5. SAM FC1 (on interface cards BQ USB, BQ PCI PLUS, BQ PCI PLUS FO, BQ NET POE M)
6. SAM FC1 in combination with ENERGY stimulators (on interface cards BQ PCI PLUS, BQ PCI PLUS FO and BQ USB)

7. MATRIX and MATRIX LIGHT (on interface cards BQ USB, BQ PCI PLUS, BQ PCI EXPR MX)
8. MATRIX in combination with ENERGY stimulators (on interface cards BQ USB, BQ PCI PLUS, BQ PCI EXPR MX)
9. SD LTM PLUS (on interface cards BQ USB PLUS, BQ USB MULTI, BOX TERMINAL MULTI)
10. SD LTM PLUS in combination with SD LTM STIM stimulator (on interface cards BQ USB PLUS, BQ USB MULTI, BOX TERMINAL MULTI)

Micromed AMBULATORY RECORDERS

1. MORPHEUS
2. BRAIN SPY PLUS
3. SD LTM EXPRESS

* some hardware devices might not yet be available

General Precautions and Warnings

Read this section carefully:

Warnings are identified with the word “WARNING” before the text. The remaining statements must be considered cautions.

Responsibility

Micromed can only be held responsible for the accuracy of signals recorded under the circumstances described in this user manual. The collected data is not a substitute for the interpretation and clinical conclusions by a physician.

Micromed cannot be held responsible for data generated by misuse of the equipment from its operators.

Indications for Use (U.S./BRAIN QUICK systems)

SystemPlus EVOLUTION is the software included in BRAIN QUICK systems.

The Micromed BRAIN QUICK system is intended to acquire and store physiological signals for EEG and/or polysomnography (PSG) and to transfer data to separate PSG analysis software.

The system includes:

- Hardware recorders intended to acquire and temporarily store physiological signals for EEG and/or PSG and to transfer the data to separate polysomnographic analysis software, and
- Software which is used for the signal acquisition, display, storage, process, and measure of biologic signals.

The hardware recorders (amplifiers) are **BRAIN SPY PLUS**, **MORPHEUS**, **SD LTM 32 EXPRESS**, and **SD LTM 64 EXPRESS**. They acquire the same kind of signals by using the SystemPlus EVOLUTION software. The recorder models essentially differ on the number of available EEG channels (16 in the **BRAIN SPY PLUS**, 24 in the **MORPHEUS**, 32 in **SD LTM 32 EXPRESS**, and 64 in **SD LTM 64 EXPRESS**). A system with up to 256 channels can be obtained by cascading 4 **SD LTM 64 EXPRESS** amplifiers.

The system is intended to be used by physicians, technicians, and other medical professionals that are trained in EEG and/or PSG.

Caution: U.S. Federal Law restricts this system to sale by, on the order of, a physician.

Indications for Use (EU/BRAIN QUICK and MYOQUICK systems)

The SystemPlus EVOLUTION software is explicitly designed to help physicians in recording, archiving and reviewing data coming from Micromed digital acquisition systems.

The software can be used for EEG, EMG and EP exams and other neurophysiologic studies based on the data recorded from the patient through Micromed acquisition devices. The software could also be used for cortical stimulation during electroencephalography examinations (i.e. stereoEEG) in combination with specific stimulators.

Use Limitations

- SystemPlus EVOLUTION is intended for the signal acquisition, display, storage, process, and measure of biologic signals. SystemPlus EVOLUTION software can be used for EEG and PSG exams based on the data recorded from the patient.
- SystemPlus EVOLUTION software is explicitly designed to help physicians record, archive, and review data from Micromed digital acquisition systems.
- Some analysis functional tools (time, amplitude and frequency measurements and their representation) are provided as default or software options. Results from these tools must never substitute the critical interpretation and the clinical conclusions that pertain only to the physician.
- **WARNING:** SystemPlus EVOLUTION software is not intended to continuously monitor central nervous system functionality in conditions where a warning on the change of patient condition is essential (e.g. OR and ICU automatic monitoring without the presence of the physician), since it is not equipped with the proper alarms that substitute continuous medical surveillance. The use of SystemPlus EVOLUTION must always be carried out under the supervision of a physician or a qualified technician.

SystemPlus EVOLUTION Configuration

- Micromed SystemPlus EVOLUTION software installation must always be carried out by authorized technicians. Deep knowledge of the inside software structure and of the hardware system is needed.
- To solve any problems that can arise during the use of software, contact your Micromed representative and the Micromed Service department.
- **DO NOT ATTEMPT TO MODIFY THE SYSTEM CONFIGURATION BY YOURSELF** (including the parts of software that manages hardware setup and that are highlighted and described in the user manual as reserved to the technicians). For any needs, contact Micromed Service Department or a Micromed authorized technician.
- The configuration of the resource list must only be performed by authorized personnel, since a wrong or incomplete configuration of resources can lead to data loss. Ask for Technical Assistance if you need to modify your system: the best software and hardware configuration according to your new exigencies will be suggested.
- Moreover, it is strongly suggested not to install other software on the PC. Any additional software you install is at your own risk and Micromed cannot be held responsible for any problems from that installation. Intervention for resuming a situation where an additional installation has led to a problem will incur a charge by Micromed according to the standard Service Price List.

Data Protection

- Micromed SystemPlus EVOLUTION software's advanced storage and data management features work properly ONLY if the user does not copy or move data without using the proper archive function, see the Archive section of the user manual. This function allows the software archive references to always be synchronized with the current situation. OPERATIONS PERFORMED ON DATA FILE WITHOUT USING THE SystemPlus EVOLUTION ARCHIVE COMMANDS CAN LEAD TO TEMPORARY OR PERMANENT PATIENT DATA, EXAM, OR FILE LOSS.
- It is highly recommended to never access the SystemPlus EVOLUTION work directories (defined in the path selection box of the installation setup, the database and resources setup screens) by using the operating system functions (Windows Explorer, the desktop My Computer, or Network Neighbourhood icons) to avoid any possible damage to the files.
- Trace data and database backup can be stored on external supports when using SystemPlus EVOLUTION.
- Periodic backup of the database on external supports is available by setting the "Database Backup Scheduler" properties. If these are already set, you should only modify the time interval between two backups while other configurations (e.g. the path) should only be changed under Micromed technician instructions. Refer to the related chapter of the user manual for detailed instructions.
- IT IS RECOMMENDED TO PERFORM BOTH DATA AND DATABASE BACKUPS REGULARLY to prevent data loss due to physical support damage (e.g. scratches on CD-ROM surfaces), due to a problem with an incorrect linkage in the database management, or due to interference with some other running software.
- Trace data and database backup can be performed on a similar or different type of support than the original. Considering the particular critical operation, BACKUP MUST BE PERFORMED ON DEVICES NOT CONNECTED TO THE NETWORK (or temporarily disconnected) in order to avoid accidental access to the data during the copy operation.

Data Acquisition and Analysis

- Since SystemPlus EVOLUTION widely uses PC resources (memory and CPU), it is recommended to close other running applications, especially when performing operations that require the management of a great amount of data (e.g. video acquisition, 32 channel acquisition at high sampling rate, and so on) otherwise, a message "SPEED ERROR" could appear and the acquisition could be stopped.
- During data acquisition, it is recommended that the user checks the quality of the resulting traces, keeping them displayed on the monitor. No other operation should be performed during acquisition in order to minimize error probability.
- During review of the traces for interpretation, it is recommended to check the correspondence of the traces displayed with those desired (patient data, trace parameters, montage).
- The measures automatically performed (e.g. nervous conduction velocity calculation) by EMG and EP software, according to the settings chosen by the user, display the numerical results on the side of the related trace. The flags on the trace indicate the calculation points. The physician that performs the exam should always check if the points selected by the software are the most significant ones from a clinical point of view, and should eventually correct them manually.

- In all the software features, any automatic analysis tool always has to be considered as a help in interpreting traces, and not as the interpretation itself.

Cybersecurity

Micromed systems should comply with the following recommended cybersecurity controls:

- The PC should have an antivirus installed, Micromed recommends Symantec antivirus
- User passwords have to be private and follow the recommended password policy listed below:
 - o They have to be renewed every six months
 - o They have to be at least 8 characters long
 - o They have to contain both upper-case and lower-case letters (case sensitivity)
 - o They have to include special characters, such as @, #, \$
 - o Passwords that match the format of calendar dates, license plate numbers, telephone numbers, or other common numbers are not allowed should be avoided
- If the system is connected to a computer network (intranet and/or internet), the firewall must be active and properly configured by technical personnel to allow Micromed software network services
- Usage of USB media devices should be limited
- Only a limited set of users should access shared folders and disk resources – sharing of resources by several people should be avoided
- It is also recommended to install the most important Windows updates and patches as soon as they are available on Microsoft update center.

Copyright

All information in this document can be modified without notice. Names of companies, people, and data mentioned are fiction and do not in any way represent people, companies, or products unless clearly specified. No part of this document can be reproduced or transmitted in any format or in any manner, electronically or mechanically, for any aim without Micromed S.p.A. written consent.

© 2019 Micromed S.p.A. All rights reserved. SystemPlus EVOLUTION is a Micromed S.p.A. product Micromed S.p.A. via Giotto 2 31021 Mogliano Veneto - Treviso - Italy

Microsoft, MS, MS-DOS, ActiveX, Internet Explorer, Visual Basic, Visual C++, Windows, Windows NT, Win32, and Win32s are registered marks of the Microsoft Corporation of the United States and other countries.

Other mentioned products and company names can be owner register marked.

Archive

Introduction

The program is a standard Windows Application and the archive is an ODBC: any interrogations can be performed as SQL server.

Improvements have been studied and developed to make the interface user-friendly: from one unique screen, it is possible to manage all archives and transfer functions.

The Archive program has two different levels:

1. **Standard:** this program allows the user to have a separate Database for each station without a central one.
2. **Advanced:** this program allows the user to have a centralized Database that each station refers to. This Database keeps count of all file transferrals that happen in the system. This way the position of each file or exam can always be individualized at any moment by any user.

Archive Window

This is the main section of the program. When the program is booted, this is the first screen that the user sees and it always remains available until the program. The archive manages the files, the exams, the patients, and the files already memorized in the same computer and those memorized in network connected computers.

The archive window is sub-divided into three parts:

- At the top of the screen, the menu bar and the toolbar are present.
- In the centre of the screen, three columns include patient list (left), exam list of a patient (centre), and file exam of an exam (right). An identification string is present over each list.
- On the bottom of the screen, the resource list and the status bar are present.

Clicking with the right mouse button on the lists of Patients, Exams, Files, and Resources activates a pop-up menu s that makes the available functions of the archive active for the user's needs.

NOTE: the same functions are accessible via the Edit menu: clicking the right mouse button in the list is a very quick way to perform the same operations.

- when the user uses a standard database, all defined resources can be destinations for copies. In any case, the standard database does not keep trace of where the files have been copied.
- when an advanced database is used, only the auxiliary resources and archive resources can be destinations for copies of files. The copy function does not allow the data to send to another type of local resource or remote resource as it is not possible to have coexistence of two copies located in the same file in a system with a database in network. If the user wants to copy something, in a different local station or a remote station, the user must use the Send to function. At the end of the copy function, in an archive resource in the file column, the number of the destination disk appears corresponding with the archived item. Vice-versa is true for the copy function in an auxiliary resource: in the file column, no indication appears as the advanced database does not keep trace of any transferrals within an auxiliary resource.

Move To	Sends a single patient with all exams in a particular resource that have been defined in the resource section. When the patient is sent to another resource, this is automatically removed from the local patient list. It is not possible to send a patient in an auxiliary resource; for this type of operation, the function <i>Copy To</i> must be used
Modify	Allows the user to see and eventually modify the information on the patient selected by opening the window Patient Information - Modify
Delete	Removes the patient from a local resource. If the exams or files have not been archived, the program asks the user for a double confirmation before irreversibly deleting them
Properties	For further details, also see "Patient List" Opens the Properties window, that provides information on the Patient

Exam:

This function is also accessible via the toolbar. From the sub- menu, the user can select the items **EEG, EP, EMG, IOM, Report, and Anamnesis**

View	Only available in the exam and file lists. If the user selects an exam, the program opens (in review phase) the primary file associated with that exam (highlighted in the file list). The same thing happens when the user double clicks the left mouse button on the selected exam.
------	---

NOTE: the primary file is not always the first on the top of the list. It depends on the type of order set in the list of the file.

Search	Disabled
Copy To	Copies the selected exam on a particular resource that has been defined in the resource section. The list of possible resource destinations appears in a sub-menu on the right

Join

Only works with EEG exams: joins more traces belonging to the same exam or more EEG exams. In the first instance, if an EEG exam has more than one file (instance of interrupted acquisition and reboot), this function joins all EEG files found in the file list that belong to the same exam. In the second case, it is

possible to join more exams: the user selects a series of contiguous EEG exams (keeping the CAPS buttons pressed) or single exams (keeping the CTRL button pressed) by clicking the mouse at the same time. By recalling this function, all the exams are united into one exam with a time limit of 24 hours of trace duration

NOTE: a small window shows the progress of this operation, and allows the user to cancel it if necessary

ATTENTION: if only one exam is selected with only one trace, an error message is shown (at least two traces are needed for the Join function)

Modify the	Allows the user to view and eventually modify the information from selected exam by opening the Exam Information- Modify window
Delete	Removes the exam from a local resource. If it has not been archived, the program asks the user for double confirmation before deleting it in an irreversible way
Properties	Opens the Properties dialog window that provides information on the exam and on the Patient. For further details see "Exam List"

File:

New	Also accessible via the toolbar: from the sub-menu, the user can select the items EEG, EP, EMG, IOM, Report, and Anamnesis
View	Only available in the exam and file lists. If the user selects a file, the program opens it in review phase. The same thing happens when the user double clicks the left mouse button on the selected file.
Copy To	Copies a single file on a particular resource that has been defined in the resource section. The list of possible resource destinations appears in a sub-menu on the right
Reduce	Reduces the EEG file (trace). For further information, refer to section "EEG file Reduction"
Statistic	Provides access to "Statistics Assignment"

Items

Analyze	Provides access to other configured programs for further analysis
Export Viewer	Export the current file into the viewer format
Modify	Allows the user to view and eventually modify the information of the selected file by opening the File Information - Modify window
Delete	Removes the files from a local resource. If this has not been archived, the program asks
Amount	Allows the user to view a temporal layout of the files
Delete/Modify	
Archive Data	Allows the user to modify or delete some archive data. A window is shown and the user has to select the archived data to prepare as well as the desired value for data revision

Help Menu

Contents	Opens an online guide of the program to the page relative to the archive window
About	Opens a dialogue window with all information about the program and the operative system
Properties	Opens the Properties window that provides all information of a file, exam, or Patient

View Menu

Refresh

Refreshes the archive screen by adding all modifications that have been performed since the last update

Tools menu

Import

allows the user to import an exam or a file from a different source:

Exam - File

opens a dialog window that asks the user to specific the path and name of the file to be imported. Once localized, press OPEN and the file is imported. The files can be imported are EEG Trace file, EP Trace file, EMG Trace file (all with extensions .TRC), or reports in Rich Text Format (.RTF) or in High Edit Format (.HED).

NOTE: if the patient that the file or exam belongs to imported is not present in the destination archive (the current resource), a corresponding record is created in the patient list. The import of an exam creates a new exam in the exam list of the selected patient: the imported file is associated to the new exam; instead the import of a file adds this files to the file list of the selected exam

EDF File Format

allows the user to import and EDF file format into our program file format.

Aux Disk System2

allows the user to import the System 2 archives; opens a window where the user is asked to specific an archive path. Once the patient importation has been started the patients and exams are added to the selected resource. Two indicators show the operation progress while it is possible in any moment to stop the operation

Options

opens a dialog window where the user sets various parameters of general type and other regarding program section more in details.

NOTE: the Options function is exclusively reserved by our technicians and must not be in any way modified by the user. Please consult your zone representative for information about the program configuration.

For further details see section Options.

Brain Spy 2100/3100

allows the user to enter the configuration program of the BS2100 or BS3100 recorder. For further information please refer to the User Manual of the BS2100 and see the section BS2100. The following functions are available:

Read

reads the memory card

Direct

starts a new EEG recording with the recorder device

Direct Bluetooth

views the EEG recording via Bluetooth

Bluetooth COM

sets the Bluetooth COM port

BS 2100 Utility

opens a dialog window which allows to set the BS2100 parameters

Ambulatory recorder

allows the user to enter the configuration program of the Ambulatory recorder (SD LTM family and Morpheus)

The following functions are available:

Memory card reader

reads the memory card (reads and saves into a file)

Direct acquisition

starts a new EEG recording with the recorder device

Setup

sets the interface, the Bluetooth COM port and the device to use as ambulatory recorder

EMG Quick Key

allows the user to access to the configuration of the hot keys for exams of EMG and EP. A window is shown with the hot keys that are default configured, but the user can modify them according to his needs. To do this the user must position the cursor in the appropriate space in correspondence to the key and having highlighted it, inserts a letter or number chosen from the keyboard. Modifications take place by pressing the function key **OK**.

NOTE: the hot keys are the same for exams of EMG & EP

Open / New Report Model

allows the user to create or modify a report model. See the section Report Model

Backup Scheduler

allows the user to set the backup properties of the database in use. For further information please refer to the section Backup Scheduler

Statistic

allows the user to access and prepare statistics elaboration.

The following functions are available:

Set

sets the structure of Statistics Tree

Search

starts the Statistics Search and Elaboration section

Amount

allows the user to view a temporal lay-out of the files.

Delete/Modify Archive Data

allows the user to modify or delete some archive data. A window is shown and the user has to select the archive data to prepare and the desired value for the data revision.

Toolbar

The toolbar's buttons are (from left):

- **Add a patient (F2)**: opens the New/Search Patient window in which the user can add or search a new patient.
- **Refresh**: refreshes the Archive screen by adding all modifications performed since the latest refresh.
- **HIS Integration**: manages the integration of the program with the Hospital

Information System.

- **Filter:** opens the Patient Search window.
- **Auto Archive:** Auto Archives patients with a specific marker from the source resource to a destination storage resource. For more information, please refer to the section “Auto Archive function.”
- **Add an EEG exam (F3):** adds a new EEG exam to the selected patient.
- **Add an EMG exam (F5):** adds a new EMG exam to the selected patient.
- **Add an EP exam (F6):** adds a new EP exam to the selected patient.
- **Add an IOM exam (F7):** adds a new IOM exam to the selected patient.
- **Add an Info (F8):** adds a new anamnesis exam to the selected patient.
- **Add an EEG file (F9):** adds a new EEG file to the selected exam.
- **Add an EMG file (F10):** adds a new EMG file to the selected exam.
- **Add an EP file (F11):** adds a new EP file to the selected exam.
- **Add a Report (F12):** adds a new report to the selected exam.

Patient List

In this list, all patient records are shown in detail.

Above the list is an indication of the name of the selected resource and if the patient is filtered or not (icon of a funnel = filter present, icon funnel cancelled = filter disabled). The **Patient Filter On/Off** function allows the user to only view those that satisfy a certain criteria. The research criteria are defined using obstacles on fields present on the patient card (for example, the *initials of the Surname and Name*, a certain *date of birth or recording date*, etc.)

By double clicking one of the records present in the patient list, a window “Information Patient - Modify” opens, allowing the user to access and eventually modify information relative to that patient.

Exam List

In this list, all details of the exam records are shown. Above the list the selected patient's name is shown.

By double-clicking the left mouse button on one of the records in the exam list, the primary file belonging to that exam is opened and highlighted in the file list.

Clicking the right mouse button over the exam, a pop-up menu appears that shows all available functions for exam management. See menu section, “Edit - Exam.”

File List

In this list, all details of the file records are shown. Above the list, the type of the selected exam is shown.

By double clicking on the left mouse button on one of the records present in the file list, the user opens it in review mode.

By clicking the right mouse button over the file, a pop-up menu appears that shows all available functions for file management. See menu section, “Edit - File.”

Patient, Exam, and File List Common Properties

If the option *Show Record Navigator* is enabled, in the lower part of each list, the user will see a record navigator that allows them to select the records of the patients, exams, or files in an alternative way.

Each list is subdivided into one or more columns, each showing a record field. This subdivision can be personalized by the user. After clicking the right mouse button over the list header, the following items appear in a menu:

Column...: one of the following items can be selected

Personal: a dialog window opens allowing the user to add or cut the columns to view and determine the order in which the columns are shown in the current list. See “Custom list View and Sorting.” NOTE: it is possible to change the order in which columns are shown in the list by dragging and dropping the header to the destined spot highlighted by two red arrows.

All: ALL the columns in the current list are shown.

Standard: a collection of standard fields are shown.

Column Order: a dialog window opens in which it is possible to set the order criteria of the records shown in the current list. See “Custom list View and Sorting.”

An order criteria can therefore be based on one or more fields (columns) of the list: if the column is used to order the record, a triangle appears in the header, indicating top direction (ascending order) or bottom direction (descending order). Clicking on the header with the left mouse button, the user alternatively passes from ascending order to descending order. Clicking the left mouse button instead, the dialog window of the **Column Order** is shown on the header of a column that is not used for column order (and does not have a triangle).

Resource List

In the lower part of the archive screen, the user finds the resource section that defines the work space.

When the user left-clicks on a resource, the resource is selected and the patient list contained in it becomes visible.

NOTE: if the resource contains many records or it is a resource non-local where the access happens via network, it is possible that a time lapse occurs before the record of the patients and the exams appear in the respective lists; during this operation the mouse becomes an hour-glass.

Right-clicking on a resource, a menu appears with the resource management functions. These functions are described in the menu “Edit - Resource.” On the right of the resource section, there is a grid that shows the amount of available disk space in respect to (/) total disk space.

Each resource can be shown/hidden by right-clicking on the white area and selecting its name from the popup menu.

Types of Resources

Each resource in the list has a specific name configured by the technician during installation; this indication can vary from user to user. In any case, each resource is defined by one of the following types:

- **Local Resource:** this type of resource is typically a working station of the system. A local disk for acquisition or the review of data is intended. This resource can be selected in order to obtain a patient list.

- **Auxiliary Resource:** this type of resource is typically a temporary archive resource. This resource can be selected to obtain a patient list.
- **Storage Resource:** this type of resource is usually an optic disk or a CD-ROM where the patient data is archived (i.e. Archive resource). This resource cannot be selected by the user to obtain a patient list, as this operation is automatically managed by the Database.
- **Remote Resource:** this type of resource defines all the other local units of the systems, in which the user can simply read the data without giving modifications. This resource can be selected to obtain a patient list from within it.
- **Database:** this type of resource represents the core of the entire system in which all information is passed and recorded. From this resource, data can be seen, data can be assigned to another resource (for modifications), or it is possible to delete all the data relative to a patient in a definite way.
- **MultiStorage Resource:** this type of resource represents a set of storage resources referred to the same Database (i.e. a collection of Archive resources). This resource cannot be selected by the user to obtain a patient list, as this operation is automatically managed by the Database.

Status Bar

In the lower part of the Archive screen, a status bar is present that indicates:

- On the right, the type of resource in which the user is working (Local or Database Zone).
- On the left, the status of the resource (Read Only or Read/Write).

Custom List View and Sorting

After right-clicking on the headers of the columns in patient list, exam list, and file list, a popup menu appears which allows the user to set columns visibility and order criteria.

Sorting

After left-clicking on the headers of the columns or right-clicking on the headers of the columns and then selecting **Column Order**, a dialog window appears which allows the user to set the sorting key. This is valid for each archive list (patient list, exam list, and file list).

In the dialog window, there are four popup menus in which the first top (**Sort Items by**) indicates which column to use as the principal order criteria. Obviously there are two options: **A...Z** (ascending order) and **Z...A** (descending order); if *None* is selected, the order options are deactivated and this indicates that the records are not in order (they are seen in the order the database loaded them).

It is possible via the other popup menu "**Then by**," to match up to four order criteria in a cascade way. Each time one of them is selected, an item different from *None* is viewed, the options near are activated relative to that field.

The button **Clear All** disables all the order criteria (select *None* in every popup menu).

At the end, by pressing **OK** the user exits and saves the modifications. By pressing **Cancel** the user exits without saving modifications.

Columns View

By right-clicking on the headers of the columns, a popup menu appears that allows the user to set the columns visibility. This is valid for each archive list (patient list, exam list, and file list).

By selecting **Column... – Personal**, a dialog window appears.

In the dialog window, there are two lists of fields: on the left, the fields that are available and on the right, the fields to display. With the left and right arrows at the center, it is possible to move the fields between the two lists. With the up and down arrows on the right, it is possible to change the order of the columns in the specific archive list (patient, exam or file list). The fields that appear on the top represent the fields starting from the far left columns in the specific archive list.

In the dialog window, it is possible to move the fields from one list to another simply by double-clicking on them.

At the end, by pressing **OK**, the user exits and saves the modifications. By pressing **Cancel**, the user exits without saving modifications.

Options

This dialog window is accessed by clicking **Options** (from the menu **Tools** in the archive window) and then **General** or **EEG**.

In this window, several parameters can be modified by the user:

Other parameters, marked in red, are fundamental for the correct functionality of the program: they are reserved only for technicians and must not be modified by the user.

NOTE: a password is requested to access to the Options section.

The **General** section refers to general parameters and the **EEG** section refers to Headbox, EEG, and Video parameters.

About the General Window

Settings

The Settings tab displays the software program version installed on the unit.

On the left, a list of parameters is shown (with the title **Item Name**) and on the right, a textbox is shown (with the title **Current Setting**). For each parameter selected in the list on the left, the textbox on the right shows the corresponding value.

List of Parameters (Under Item Name)

Local Settings: indicates the directories containing the local settings used by the program; to modify them, just type the path into the textbox on the right.

Language: indicates the language in which the program has been set. The language setting can be modified by pressing the **Modify** key, select the desired language from the popup menu and press **OK**. **NOTE:** to make the new settings effective, the program must be rebooted.

Notch: it is possible to set the Notch filter at **50Hz** (Europe) or **60Hz** (United States) by pressing the **Modify** key.

Key Function: can be **enabled/disabled**; status changes by pressing the **Modify** key and

pressing **OK**. If enabled, a set of key function buttons appear at the bottom of the screen. Each time the cursor passes over a key of the toolbar, a string appears that describes the function of that particular key.

General

There are five sections of parameters:

Windows

Display New Exam Information Form: allows the user to insert information regarding the exam upon execution, in the event some information is not present.

Display New File Information Form: allows the user to insert information regarding the file upon execution, in the event some information is not present.

Database

Show Empty Patient: if selected, allows the user to individualize patients without an exam or file attached.

Link External Database: optional feature: allows the program to link to an external database for patient and exam data. Please refer to t assistance to use this option.

Layout

Large Buttons: this function allows the user to improve the visibility of the functions of the keys in the archive toolbar by making the dimensions bigger.

Show Patient List Above Exam and File Lists (Next Time): this function allows the user to position the list of patients, the file list, or the exam list so they horizontally overlap. Modifications will be effective upon the first program.

Show Record Navigator (Next Time): this function allows the user to view the record navigator or not. Modifications will be effective upon the first program reboot.

Row Exam Comment / Row File Comment: this function selects if the comments at the exam or file level in the relative lists must be displayed as a Preview column between an exam and another one.

Show the Right Side to the Left and Left Side to the Right in the Impedance Check window: if selected, this function inverts the horizontal visualization in the Impedance Check window (for EEG exams during acquisition) in respect to the natural orientation (right to the right and left to the left).

Network

Enable Resource Menu Functions for Remote Desktop (UltraVNC): this function allows the display of, the functions for Remote Desktop management in the resource menu of the Archive windows.

Enable Resource Menu Functions for Remote Acquisition & Review: this function allows the display of the functions for Remote Acquisition & Review management in the resource menu of the Archive windows.

Editor

Editor Word: this function allows setting Microsoft Word as the default editor for reporting.

Editor HighEdit: this function allows setting HighEdit as the default editor for reporting.

Editor ODT: this function allows setting ODT as the default editor for reporting. This is the default option when you install a new Windows 10 machine.

Key Function

The settings of this tab are reserved only for technicians and must not be modified by the user.

There are two sections:

List Functions Enable: shows the installed hardware keys on the unit.

Multi-Licence Network Key: manages the network hardware key for Multi-license use.

Month/Year: shows the date (month and year) of production of the installed hardware key.

Storage

The settings of this tab are reserved only for technicians and must not be modified by the user.

There are three sections:

Auto Storage: the reports can be archived separately from the exams. In this case, two storage resources have to be defined, one for the reports and one for the exams. Once these storage resources have been configured, they will be viewed in this section of the Storage tab.

In the Archive windows, when the user accesses the moving functions (Copy or Move), the menu item "Auto Storage" is shown, which allows the user to position the reports directly in the appropriate resource.

Auto Archive: for the resources linked to a Database, it is possible to define a procedure that moves all the patients with a particular marker to an archive resource. This section of the Storage tab allows the user:

- To enable the Auto Archive option
- To define the Source Resource for Auto Archive procedure
- To define the Auto Archive Setting for each Source Resource (define the storage for reports, define the destination storages that will be used in cyclic mode, set disk full alarm)
- To define the Video EEG Automatic Reduction criteria (Disabled, Reduce Video Only, Reduce EEG and Video, Reduce EEG Only)

For further details, see "Auto Archive."

Copy to Multi Storage: allows the user to decide when to copy into the Multi Storage Resource (Disabled/Enabled after the Storage Resource is full/enabled after burning the Storage Resource).

SmartEEG

There are three sections of parameters:

SmartEEG Analysis

Analysis starts automatically during acquisition: if selected, SmartEEG starts to analyze the EEG trace during the acquisition.

SmartEEG Result

Extract the result into a report document: if selected, when the EEG acquisition has finished a report, a file is generated and stored along with the EEG file.

SmartEEG Online Analysis

Settings: displays the Online Setup window, which allows the user to select online analysis methods.

External DB Interface

The integration of the program with the Hospital Information System is managed. There are three sections of parameters:

Exchange SQL Database: allows the user to set the SQL parameters to identify the exchange database.

Linked Resource: allows the user to select the resource used for HIS Integration

External Interface Program Location: allows the user to edit the name of the computer where the External Interface Program is installed.

External Programs

There are three sections of parameters:

Program for Remote Machine: sets the path of the program for Remote view and control.

Analysis Manager: sets the path for the SleepView program.

Acquisition List Remote Control: when this function is active, the computer can be controlled from another or can control other computers.

Control this machine: set machine IP address and communication port

Enable Control of Remote machines: enable setup button where it is possible to see the list of machines to be controlled

Lockdown

Here you can define the following settings of the lockdown:

Automatic Lockdown: the checkbox must be selected to activate the lockdown for this system.

Lockdown Idle Time Value (ms): This field defines the amount of idle time required before the screen is locked.

AutoHide Credential Time Value (ms): If the screen is locked, the login window appears by clicking the mouse or using the keyboard. If there is no interaction afterwards, the login window will be hidden after a certain time. This time can be set in the field **Autohide credentials time value (ms)**.

Lockdown screen opacity value(%): This field defines the opacity of the lockdown screen. The higher the value, the lower the transparency.

Screen saver image name (*.bmp; *jpg, *.ico): With the browse button you can select an image to display on review stations, while on acquisition stations the trace will remain visible.

About the EEG Window

Headbox

The Headbox tab shows the user how the headbox is connected to the unit. These connections can be modified via the arrows near the corresponding description.

The following items appear:

Check Headbox: allows the user to verify if the headbox is correctly connected.

NOTE: some headboxes cannot be checked (the button appears disabled).

Headbox: there are two popup menus that allow the user to select the interface (below) and the type of headbox (above) used within the system.

NOTE: first of all, the user must select the interface and then the headbox.

The following interfaces in theory are available: **BQ PCI**, **BQ PCI + Bluetooth**, **BQ USB** Interface Card, **BQ USB** Interface Card + Bluetooth.

The list of headboxes in the above popup menu depends on the selected interface in the below popup menu.

Interrupt: these two popup menus indicate the IRQ number and the device address used by the unit for headbox management. With some systems, they may appear disabled or not visible.

On the right, a popup-menu may appear to select the used COM port.

Upgrade Firmware: in this section, the current version and the available version of firmware are shown. If they do not correspond, the user can decide to upgrade the firmware of the headbox by pressing the appropriate button. A password is requested to confirm that the technician wants to upgrade the firmware.

Impedance Check: shows the right side to the left and the left side to the right in the Impedance Check window.

EEG Recording

There are three sections of parameters:

Trace Length: sets some ties about the trace length and the recording. The following options are available about the length:

No Limit: no ties about the trace length.

Close Trace File Every: the period of time has to be set.

Close Trace File At Time: the time has to

be set. About the recording:

Make a Single Trace and Stop Recording: toggles on or off for this function.

Background Transfer: sets the Background Copy Mode, the Destination Resource, and/or the Security Resource to use in the transfer of data.

Network Warning Messages: provides the option to enable the warning text messages function to send messages to Network Resources chosen from available ones.

Video Source

Setting the type of video card is an operation only reserved for the technician and should not be modified in any way by the user.

There are three sections of parameters:

Video Acquisition Input Type

Video Capture Source

Video Acquisition Control:

provides the options to enable VISCA, Pelco-D, Sony SNC controls. Enabling the option "Use External Camera Control (over IP)" you will be able to use advanced camera controls through IP

Video Recording

Setting of the type of video card is an operation only reserved for the technician and should not be modified in any way by the user.

There are two sections of parameters:

Software Compression

Video File Length

Video Reviewing

Setting of the type of video card is an operation only reserved for the technician and should not be modified in any way by the user.

There are two sections of parameters:

Information regards the Video player

Video Reduce

Accessing Data

Modify - New Resource

This dialog window appears when the user wants to define a new resource (with the title “New Resource”) or when the user wants to modify an existing resource (with the title “Modify Resource”).

NOTE: the resource list can be configured, but this operation must be performed exclusively by authorized personnel, as the description is reserved for technicians only and all functions are protected by a password.

Controls found here, from top to bottom:

Option: section that includes the following

- **Type:** popup menu that allows the user to select the type of resource between **Local Resource, Auxiliary Resource, Storage Resource, Remote Resource, Database Resource, and Muti Storage Resource**. For a more detailed description, refer to “Resource List.”
 - Types of Resources
- **Read/Write - Read Only:** for some resources, it is possible to create a type of access even in Read Only to protect data.
- **Removable:** type of disk (removable support).
- **Double Sided:** double sided Read/Write support

Description: name of resource that appears in the resource list. The left and right arrows allow the user to choose resource icons.

Path: path of database that makes the used resource.

Browse: use to obtain the path. This control is disabled in case of a Database type resource.

Enable Linked Database: check box that enables the connection of the local resource to the central working database. The data is acquired in the local disk while the patient information, the exam information, and the file information are in the central database. Performing this connection enables the following controls:

JET - SQL: allows the user to select between two different types of database, JET motor or SQL server.

ADO - JET: if the JET motor is selected the following controls are enabled

- **Path:** path of the database to which the user connects.
- **Browse:** to obtain a path.

ADO - SQL: if the SQL server is selected, the following controls are enabled

- **Server Name:** name of the SQL server.
- **Database:** name of the database where the user is connected
- **User Name - Password:** user name and password to create connection **Refresh:** rewrites the original path that the user had upon opening the window.
- **Test Connection:** tests the connection to the SQL server.

New/Search Patient

It is possible to insert a new patient via this window, but it is also possible to search for an already existing one. This means that while the user is typing in the patient's data, the system looks for all the patient in the database shares with all inserted data. In this way, if a patient has already done an exam and it is physically present in the database, patient information is automatically viewed. On the contrary, (if a patient is not yet present in the database) insert all the fields and press **New**.

NOTE: while the user is inserting the patient data, the user can check if the patient is already present in the list, and in this case, select the patient and click on the Open key.

NOTE: many things occur when the exams are performed in clinics. One of the most common situations is when two patients have the same name and are born on the same day. If this were to happen, the user must simply select New and insert the new patient's data. The system automatically sees this as a new patient.

In the upper part of the window, there are five textboxes where the user can insert patient data and items for research: LastName, FirstName, Birthdate, ID1, ID2.

At the center, there is a patient directory that is divided into five columns that correspond with the textboxes for data insertion.

NOTE: if the user searches for a patient by simply inserting the first letter of a surname, for example Z, and there is no patient in the list with a surname beginning with a Z, the list will appear empty. Instead, if there are patients whose surnames begin with a Z or who have the same surname, they will be shown in the list.

In the lower part of the window, the following buttons are:

- **New:** opens a window Patient Information - Modify (with the title Patient Information - New), even if the patient has not yet been inserted in this window. Here, the user can insert all patient data and not only for research.
- **Open:** once the patient has been selected, the Patient Information - Modify window opens (with the title Patient Information - Modify).
- **Cancel:** returns to the window of the archive section without saving modifications.

Patient Information - Modify

In this window, there are the following sections:

- Identification:
- **ID1:** identification primary to the patient. This could be the hospital code or the tax file number for example.
- **ID2:** identification secondary to the patient. This could be configured by the user.
- Name:
- **Last - First:** patient's last name and first name.
- **Maiden:** patient's maiden name, where females keep their surname.
- Address:
- **Street- City - Province - Zip:** street, city, province, and postal code of the residing address.
- **Country:** Patient nationality in the event the patient does not live in the same country where the exam is performed.
- Birthdate:

- **Day - Month -Year** : day, month, and year of the patient date of birth. The user can type in the numbers on the keyboard or select them from the popup menus.
- Gestation Days
- Telephone:
- **Home - Work**: patient residential and work telephone numbers.
- Sex:
- **Male - Female**: patient's sex.
- Physical Data:
- **Height - Weight**: patient's weight and height.
- Insurance:
- **Number - Company**: number and name of patient's insurance company.
- Others:
- **Doctor**: popup menu that allows the user to insert or choose the doctor that treats the patient.
- **Hospital**: popup menu that allows the user to insert or choose the hospital or clinic in which the patient is undergoing the exam. This field can be used to specify the ward where the patient is hospitalized.
- **Marker**: popup menu that allows the user to insert or choose a free field.
- **Comment**: in this field, the user can insert a free comment relative to the patient. This is a general comment referred to the patient and should not be referred to a single exam from the moment a specific field for each exam exists.

NOTE: in the dialog window, colored fields are compulsory.

With the **OK** key, the user exits from the window saving all the modifications. With the **Cancel** Key, the user exits without saving anything.

NOTE: if the user inserts new data (for example a new doctor or hospital), a window appears in which the user is asked to add information into the current database. By pressing **YES**, another window appears in which the user has the possibility of inserting a new value (for example the name of the doctor, the hospital, or a new name for the marker).

The window of new value inserts can contain other information. For example: in the event of a new medical name alias doctor, the user can insert various information such as (Title, Position) relative to the doctor in question and this information is added to the database when the modification confirmation appears via the **OK** key. The values added to the database are then available at any moment for modifications. If, for example, a new patient is inserted into the patient tab, the available names of doctors will be shown.

Exam Information - Modify

The field <xxx> in the title bar shows the type of exam selected for modification. In this window, the following sections are present:

Exam: the following controls are found here

- **Code:** textbox where the user can directly type an identification code for the exam.
- **Doctor:** popup menu that allows the user to insert or choose the doctor from the list that treats the patient.
- **Technician:** popup menu that allows the user to insert or choose a technician from the list that performs the exams.
- **Hospital:** popup menu that allows the user to insert or choose the hospital or the clinic in which the patient is undergoing the exam from the list. This function can be used to specify the ward of the hospital where the patient is hospitalized.
- **Requesting Doctor:** a popup menu that allows the user to insert or choose a doctor from the list.
- **Marker:** popup menu that allows the user to insert or choose a free field from the list.

Flags: composed of eight check boxes.

- **Quick Search 0 - 7:** under development.

Comment: textbox where the user can type a free comment about the exam. This comment is generic and refers to the exam.

Don't Show This Form Next Time: allows the user to decide if this window will appear at the start of the next acquisition.

The buttons in the window are:

OK: exits and saves all the newly inserted information.

Cancel: exits without saving or inserting new information.

NOTE: if the user has enabled this window from the Tools - Option - General menu, this window opens each time the user begins to acquire any type of exam. The window allows the user to insert the information relative to the exam in question that was not completely available beforehand.

File Information - Modify

The field <xxx> in the title bar shows the type of file selected for modification. In this window, the following sections are present:

Exam: the following controls are found here

- **Code:** textbox where the user cannot directly type, the exam identification code is visualized.
- **Doctor:** popup menu that allows the user to insert or choose the doctor from the list that treats the patient.
- **Technician:** popup menu that allows the user to insert or choose a technician from the list that performs the file.
- **Hospital:** popup menu that allows the user to insert or choose the hospital or the clinic

in which the patient is undergoing the exam from the list. This function can be used to specify the ward of the hospital where the patient is hospitalized.

- **Requesting Doctor:** popup menu that allows the user to insert or choose a doctor from the list.
- **Marker:** textbox where the user cannot directly type, the marker of the exam is visualized.

Flags: composed of eight check boxes.

- **Quick Search 0 - 7:** under development.

Comment: textbox where the user can type a free comment about the file. This comment is generic and is referred to the file.

Don't Show This Form Next Time: check box that allows the user to decide if this window will appear at the start of the next acquisition.

The keys in the window are:

OK: exits and saves all the newly inserted information.

Cancel: exits without saving or inserting new information.

NOTE: if the user has enabled this window from the Tools - Option - General menu, the window opens each time the user begins to acquire any type of exam. This window allows the user to insert the information relative to the file in question that was not completely available beforehand.

Property Window

In the Property window, there is a tabs option divided into:

- **Patient:** that contains information relative to the selected patient.
- **Exam:** that contains the information relative to the selected exam.
- **File:** that contains the information relative to the selected file.

In each tab the **Modify** key is present, which allows the user to add or modify the information relative to the patient level, exam level, or file level (see Patient Information - Modify, Exam Information - Modify, File Information - Modify).

NOTE: if the Properties function has been called at the file level, all three tabs are available (Patient - Exam - File). If the function has been called at the exam level only, the following tabs are available: Patient – Exam. If instead, it is called at the patient level, only the Patient tab is available.

Advanced Functions

Auto Archive of a Resource

For the resources linked to a Database, it is possible to define a procedure that moves all patients with a particular marker to an archive resource. The destination resource is usually a virtual disk, where data are moved before CD/DVD burning.

About the destination archive resource: it is possible to fix a specific destination storage resource otherwise to define a collection of destination storage resources that will be used in cyclic mode. The use of at least two destination storage resources assures that the procedure is not interrupted when the first destination resource is full: data will be moved into another destination resource belonging to the collection.

ATTENTION: if all destination storage resources are full, an error message will appear and it is recommended to burn the storage resources.

About the destination storage resource list: at most, four resources may be chosen and used in cyclic mode.

Furthermore, it is possible to select that a destination storage resource be applied to report type file, where the report files are moved because of the Auto Archive procedure calling.

Automatic CD/DVD Writing Procedure

This procedure is used for burning storage resources by using a specific external writing program. Before the use of this procedure, some parameters must be set:

- Path name of the CD/DVD Writing Program
- Command Line Syntax
- CD/DVD Writer Drive Letter
- Number of CD/DVD Copies
- Storage Resource to be Written (Only in Standard Mode)

About the Storage Resource to be Written: the Standard mode has to be discriminate from the Auto Archive one.

In Standard mode (Auto Archive option is disabled):

- If the system can manage a unique Database, a specific storage resource (to be written) has to be set.
- If the system can manage more than a Database (MultiDatabase system), a specific storage resource (to be written) has to be set for each Database.

After calling the Automatic CD/DVD Writing Procedure, a dialog window appears to confirm the selection of the storage resource to be written.

In Auto Archive mode (Auto Archive option is enabled):

- If the system can manage more than an Auto Archive Source Resource, a dialog window appears to select the Source Resource.

Among the destination storage resources belonging to the same group, it is suggested to burn the storage resource that was initialized in order before. If it is not accepted, a dialog window appears for the selection of the storage resources to be written.

NOTE: in Auto Archive mode and in Standard mode with the MultiDatabase system, the external writing program must be Nero.

Backup Properties

When the user presses the "New" or "Modify" keys in the Backup Scheduler window, a screen appears that shows the backup property, as described below:

Task Name: this string allows the user to identify the operations that the software performs as a consequence of the window settings. The default name is "New backup," but it is better to indicate a name that identifies the corresponding database (e.g. "backup <Name of resource>").

Type of Source: this section displays and sets the type of source of the backup operation, allowing the choice between the Directory of the data and SQL Database. With a SQL Database, the SQL Server name is asked to be set, as well as the name of the database and the temporary backup path, specified forward.

Backup Path: this section assumes a different aspect according to the Type of Source.

In case the *Type of Source* of the backup operation is the *Data Directory*, the user can view and set:

1. *The data source*, that is the completed path of the directory or file that is the object of the backup
2. *The data destination*, that is the directory in which a copy of the selected item in Step 1 is saved

Click on the option **Include Sub-Directory**, even the sub-directories will be copied.

The paths can be changed by clicking the **Browse** key and choosing the appropriate source and the destination directory.

ATTENTION: if the user chooses a directory that does not contain a database, the unit displays the message error, "*Backup Error*," when the backup is performed.

In case the *Type of Source* of the backup operation is Database SQL, in the section **Backup Path** view and set:

1. *The name of the Server SQL*
2. *The name of the database*, that the user desires to create a backup
3. *The data destination*, that is the directory in which a copy of the selected database is saved
4. The option SQL Server installed locally or in a remote unit
5. *Temporary memorized* (coming from the Server SQL). Before that, the database backup is available in the destination directory set in Step 3. The temporary choice of the temporary backup path is subject to some restrictions, including:
 - If the SQL Server is installed in a remote unit, it is necessary to specify the SAME path, first under a local form (type "C:\Path\") and then as a network path (using the UNC convention, specifying the path in the form "\\ComputerName\ResourceName\Path\")
 - If the SQL Server is installed locally, specify a local path (type "C:\Path\"). In this case, two temporary paths coincide

The paths can be changed by clicking the **Browse** key and choosing the source, the destination, and the appropriate and temporary directory. The user must edit, in the case of a remote SQL Server, the temporary path under a local form to the Server. Keep in mind that the edited path must identify the same path indicated in the same network temporary

path box (chosen with **Browse**).

Perform the Backup: this section allows the user to choose the frequency of the backup operation.

It is recommended to set an adequate frequency for database use: if a great deal of patients and exams are added, removed, and copied (e.g. in the central database of a system network), a **daily** backup is the best choice. For less intensive use, a **weekly** backup or a **monthly** backup should be considered. The **Backup Activated** option allows the user to activate the backup.

Last Schedule/Next Schedule: in the text boxes, the dates of the last backup and the next backup are shown.

The **OK** key allows the user to exit from the screen. The **Cancel** key allows the user to exit from the screen without saving modifications.

Backup Scheduler

This function is strictly correlated with data security. The settings of these parameters must be performed by authorized personnel (experts or qualified technicians) and must not for any reason be modified.

The main screen of the backup scheduler shows the backups that have already been done, with the date of the last backup and the next backup scheduled. The description viewed here, derive from the text box "name of backup" in the property window, that must be set when a new operation is added and can be modified.

New: this function allows the user to program the backup of a new database. Also see "Backup Property."

Delete: this function allows the user to delete the selected schedule (highlighted in blue) from the backup list.

Modify: this function allows the user to modify the parameters of the backup of the selected schedule (highlighted in blue). Also see "Backup Property."

Backup Now: immediately performs the backup of the selected database.

Create Backup List: this function allows the user to add (asking confirm) all existing databases to the list of the backup viewed in the window.

Exit: exits from the backup scheduler window and returns to the main Archive screen.

How to Reduce an EEG File

An important function of the system, exclusively for EEG exams, is the reduction of a file. File reduction allows the user to keep only the important segments selected from an acquired EEG trace in the memory. The result of this operation is different depending on if it is only an EEG trace or an EEG trace with a digital video connected to it.

- If it is just an EEG trace, the reduced file will appear under a new file and under the same exam. In fact, an exam can be composed of more EEG segments.
- If it is an EEG trace connected to a digital video, each segment selected appears, after reduction, as a new exam. An EEG trace can only have a digital video connected to it, while an EEG video trace can contain more consecutive segment selections.

To perform a file reduction, the user must select the segments of the trace during the reading phase of an EEG exam. To select the segments of the EEG trace, the user must insert a pair of "Reduction Flags," (red), marking the desired segments.

To perform the EEG file reduction, the user must select the desired file from the column of the file list, click the right mouse button, select the item **Reduce**, and a new window will be shown.

At this point the user can select one of the following options:

1. **On different trace** means the result of the reduction operation of the file is put in a new file that is different from the original file (that eventually can be cancelled in a second time).
2. **On the same trace** means the result of the reduction file is put on the same file and, in this way, the original file is lost. This means that only the EEG selected segments are kept in memory, while the remaining parts of the EEG trace are lost.

There is another option the user can select that is active only when the user has a digital video connected to an EEG file. The option **Reduce link video file** allows the user to decide whether or not to reduce the video digital file. If this option is selected, every EEG segment becomes a new exam for the patient with the video digital connected. If this option is not selected, only the EEG file will be reduced, while the entire digital video remains and the user will see a new file for the EEG exam.

Pressing the **OK** key, starts the file reduction and a bar indicates the progress of this operation.

NOTE: this operation can take some time especially if the user is reducing a digital video file.

Search for a Patient or Group of Patients

The research function can be performed on a single patient or on a group of patients. This is done by positioning the cursor on the patient list columns and clicking the right mouse button and choosing the **Search** option. Alternatively, the user must select the **Edit-Patient- Search** option from the Archive window in order to open the Patient Search window. In this window, the user has the possibility to set some search parameters listed below.

Below is a brief description of the fields relative to Patient Information.

Identification:

- **ID1 - ID2:** these fields allow the user to perform a search via primary and secondary identification codes.

Name:

- **Last:** this field allows the user to insert the patients surname in order to search patients whose surnames begin with the same letter or all patients with the same surname.
- **First:** this field allows the user to insert the patients name in order to search patients whose names begin with the same letter or all patients with the same name.
- **Maiden** this field is for females only. Here, the user inserts the woman's pre-martial surname in order to search patients whose surnames begin with the same letter or all patients with the same surname.

Address:

- **City - Province - Country - Zip:** these fields allow the user to insert some specifications to find a patient or a group of patients that live in the same city or province or country or have the same postal code.

Insurance:

- **Number - Company:** this field allows the user to search a patient or a group of patients that have the same letters of their insurance number or that use the same insurance company.

Birthdate:

- this field allows the user to find a patient or group of patients born in the same time interval. This particular function is performed when the user sets the date of birth **from** (inserting the **year, month, and day**) and the date of birth **to** (inserting the **year, month, and day**) in the specific fields. After the search, all patients that were born during this time interval will be shown in the patient list of the archive window. If the start date of birth and the end date are the same, only patients born on that exact day will be shown.

Recording Date:

- this field allows the user to find a patient or group of patients recorded in the same time interval. This particular function is performed when the user sets the start recorded date **from** (inserting the **year, month, and day**) and the date of recording **to** (inserting the **year, month, and day**) in the specific fields. After the search, all patients that were recorded during this time interval will be shown in the patient list of the archive window. If the start recording date and the end date are the same, only patients recorded on that exact day will be shown.

Sex:

- **Male - Female - Both:** this field allows the user to find a group of patients with the same sex. If the option *Both* is selected, both sexes (male and female patients) will appear in the patient list of the archive window. **NOTE: the patient's sex must be set.**

Other:

- **Doctor:** this field allows the user to specify the doctor's name as a criteria for the patient search.
- **Hospital:** this field allows the user to specify the hospital as a criteria for the patient search.
- **Marker:** this field allows the user to specify the value of the marker, from the memorized list, as a criteria for the patient search.

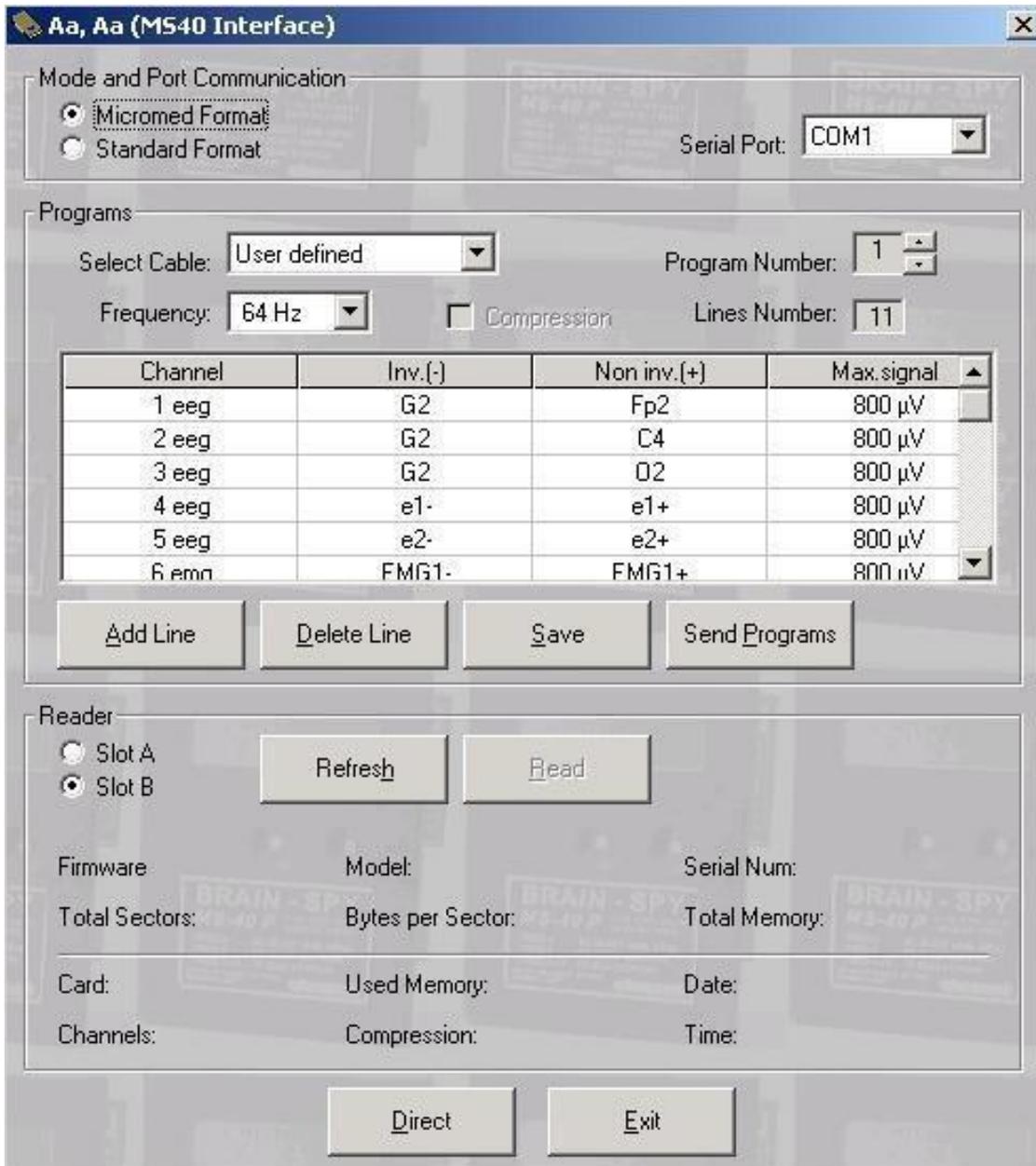
These buttons are present:

- **OK** starts the patient search
- **Cancel** closes the search function
- **Clear** sets null values into all fields relative to Patient Information

MS40 Window

This dialog window is accessed by clicking the item *MS40* from the menu *Tools* in the archive window.

It allows the user to set all communication parameters for MS40 holter. Please refer to the MS40 manual for all operating instructions about this device.



Mode and Port Communication

Micromed Format
 Standard Format

Serial Port: COM1

Programs

Select Cable: User defined Program Number: 1

Frequency: 64 Hz Compression Lines Number: 11

Channel	Inv.(-)	Non inv.(+)	Max. signal
1 eeg	G2	Fp2	800 µV
2 eeg	G2	C4	800 µV
3 eeg	G2	O2	800 µV
4 eeg	e1-	e1+	800 µV
5 eeg	e2-	e2+	800 µV
6 emn	FMG1-	FMG1+	800 µV

Add Line Delete Line Save Send Programs

Reader

Slot A
 Slot B

Refresh Read

Firmware Model: Serial Num:

Total Sectors: Bytes per Sector: Total Memory:

Card: Used Memory: Date:

Channels: Compression: Time:

Direct Exit

Mode and Port Communication - Reader

At the top of the window, the user can set the communication mode between *Our Company Format* (that is, directly access the memory slots) and *Standard Format* (that is, to see the memory slots as hard disk devices and access them through the standard file system). It is also possible to select the communication serial port by choosing it from the

popup menu to the right.

When the user selects a specific communication mode, the lower part of the window (the frame *Reader*) changes. In *Our Company Format*, two slot selectors are visible (**Slot A** and **Slot B**), and the button *Refresh* performs a check of the card searching it inside the two slots; in *Standard Format* a popup menu allows the user to select the drive letter to associate with the device. When the device has been scanned, some fields are filled with data statistics, like card model, serial number, total sectors and bytes per sector, total memory, etc.

Clicking the button *Read* makes the card being read and data be stored a new EEG file, linking it to the file list of the selected patient.

Clicking the button **Direct** opens a new EEG acquisition window, ready to start a new acquisition based on the MS40 device. Refer to section “EEG Acquisition” for details on EEG recording.

Programs

The central part of the window houses a frame called *Programs* where the user can set the recording protocol. Up to 8 setups can be selected (*Program Number*); it is possible to select the kind of connection cable (*Select Cable*) and the sample frequency for each of them. It is also possible to add or delete lines (*Add Lines* and *Delete Lines*) and change the parameters of each line by clicking inside the cells of the grid; when the program is ready, it can be saved (button *Save*) and sent to the MS40 device (*Send Programs*).

EEG - Software

The EEG Module section of the program regards the acquisition, review, and analysis of EEG traces.

This section has some sub-sections:

- **Connection:** describes the structure of the headbox inputs and various ways of predefined acquisition of EEG traces.
- **Data Average:** describes a powerful method to extract information from the trace using data averaging synchronizing with *triggers*.
- **Density Spectral Array:** a dedicated instrument for the analysis of EEG and polygraphic signals in the frequency domain.

EEG Acquisition Window

The acquisition window allows the user to record an EEG or video EEG exam. The acquisition is performed by technicians via the acquisition headbox that has some parameters that must be set. These parameters are grouped under **Connection**. The signal is viewed on the screen depending on other parameters that are grouped under **Montage**.

The main concept that must be kept in mind is the method by which the system works. The headbox always works with a fixed sampling frequency that only has a minimum hardware filtering. This means that the data is always saved referring to G2 and the maximum bandwidth. The data is then viewed on the screen with derivations, references, filter values, and desired gain.

Connection contains all parameters concerning the hardware (like the sampling frequency, the maximum signal input, the number of channels, and so on). All parameters regarding the review (like derivations, review filters, notch filter, gain, and reference) are contained in **Montage**. These parameters can be changed or modified at any time and the results are displayed on the screen. This is because the montages can be changed at any time during recording.

The EEG acquisition window is sub-divided into four main sections: on the top there are the menu bar and the toolbars, in the center of the window there is the display of traces, and on the bottom there is the status bar.

Furthermore, if the **Key Function** is enabled in the archive window (under Tools/Options/Settings), the Key function buttons will be shown on the bottom of the screen.

Menu Bar

When the user accesses the EEG acquisition section, the main menu changes. In the menu bar, the following items can be found:

File, Modify, Acquire, Analyze, Reference, Tools, Move (disabled during acquisition), Windows, Help

File Menu

New	Disabled
Open	Displays the archive window, making it possible to record or review another exam
Close	Closes the acquisition window and returns to the archive section
Show Report	Unavailable during acquisition
Thermal Setup	Sets parameters for the use of a thermal printer
Thermal Print	Prints the trace viewed in the EEG window with the thermal printer
Print Setup, Properties, Disk Properties	Print, Batch Print, Print Screen Unavailable during acquisition
Export	Unavailable during acquisition
Exit	Exits the EEG acquisition window and returns to the archive section

Modify Menu

Undo	Cancels all the selected lines from the current montage, keeping all other lines present. It is not possible to cancel all the lines
Cut	<p>ATTENTION: if the Cut function is enabled when all the lines are selected, a message appears saying that is impossible to cancel all lines. All the cancelled lines are kept in the memory and can be eventually inserted, in a different position or in a different montage, via the Paste function. The Cut function is only active if at least one line has been selected</p> <p>NOTE: all previously memorized lines are cancelled with functions Cut, Copy, or Keep Lines.</p>
Copy	<p>Copies all the cancelled lines that are kept in the memory, which could be eventually inserted, in a different position or in a different montage, via the Paste function. The Copy function is only active if at least one line has been selected</p> <p>NOTE: all previously memorized lines are cancelled with functions Cut, Copy, or Keep Lines.</p>
Paste	Inserts a group of lines from the memory, previously memorized using the functions Keep Lines , Cut , or Copy , on top of the first selected line. If the number of lines is more than 128, the number of lines will automatically be reduced, so that 128 lines will be shown
Select All	Selects all lines shown in the current montage. Consequently, all the names of the derivations (lines) will change color automatically
Deselect All	De-selects any active selection of the lines without changes. Consequently, no names of the derivations (lines) will be highlighted
Insert Line	Inserts a line above the first selected line
Keep Lines	Keeps only the selected lines and cancels all the others in the montage.

All the cancelled lines are kept in memory, and eventually could be inserted in a different place or into a different montage via the Paste function. The Keep Lines function is active only when at least one line has been selected

NOTE: all previously memorized lines with functions Cut, Copy, or Keep Lines are cancelled

	Set on right speaker, set on left speaker, disable sound
	About the selected lines, disables sound or activates the reproduction on the left or right speaker
Clip Line	Activates line clipping on the selected lines: clipping means that if the signal extends vertically in a space greater than is assigned to the relative trace, it is represented by a horizontal line at the maximum (or minimum) allowed value until the signal value decreases (or increases) to a representable value
Clip Amplitude	It is possible to choose the vertical extension of the lines when clipped via the popup menu; there are four options x1, x2, x3, x4. This means that the selected lines are clipped to the space required for one, two, three, or four traces respectively
Unclip Line	de-activates line clipping on the selected lines
Invert Flag Pairs	Disabled during acquisition
High Pass	Sets the cut-off frequency of the software filter high pass, lower limit of the pass band. All modifications are applied to all selected lines. If no lines are selected, the modification is applied to all EEG lines shown in the window
Low Pass	Sets the cut-off frequency of the software filter low pass, upper limit of the pass band. All modifications are applied to all selected lines. If no lines are selected, the modification is applied to all EEG lines shown in the window
Base Time	Sets the base time of the lines shown in the window. The modification is applied automatically to all lines
Gain	Sets the gain (amplification) of the selected lines. The modification is applied to all selected lines. If no line has been selected, the modification is applied to all EEG lines viewed in the window
Notch	Enables or disables the notch filter in the current montage. This type of filter can be active at the same time on all the shown lines; it cannot be applied separately on the selected lines
Invert Line	Inverts the selected lines and consequently the signal. The function Invert line is only active when at least one line has been selected
Montage	Shows a popup menu to choose the montage
Save	Saves the current montage that has been created or modified
Reload	Reloads the selected montage from the disk, exactly as it was saved the last time. All the modifications of the last save will be lost
Archive Montage	Unavailable during acquisition
Modify	Access to the EEG Montage Setup window, where it is possible to change

the relative parameters of the selected montage

Show Montage Shows the Montage View window, where the selected montage is graphically represented

Acquire Menu

Run/Stop	Starts the acquisition of the data of the patient without recording onto the hard disk. When this function is active, the trace scrolls across the window from left to right. At the same time, when this function is deactivated, the acquisition of the data stops
Save	The recording begins on the hard disk. If this function is pressed, it saves the data signals directly on the hard disk. This function is only active when the user has begun data acquisition
Pause	Pauses the recording of data onto the hard disk without interrupting data acquisition. This function is only active after the user has begun an acquisition in the event of a sudden mishap and then restarts the recording of the trace on the same exam. When this function is active, the trace continues to scroll across the window from left to right
Online Average	Activates the function of online data averaging
Online fMRI Artifact Suppression	Activates the function of online MRI artifact suppression
Review	Reviews the trace that is being acquired. This function is only active when the user has begun a data save. The EEG window is automatically split into two; on the right, there is the acquisition window, on the left there is the review window where the user can see all the acquisition up to that moment. The review window is updated every 15 seconds
Calibration	Enables/disables the visual calibration (only active after the user has started data acquisition)
NOTE: this calibration is an artificial signal (square wave) amplified and filtered by the current montage parameters	
Chronometer	Enables the chronometer for special analysis during acquisition in order to keep the trace of particular events
Check	Shows the Impedance Check window, to control the electrode impedance connected to the patient
Mode	
Connection	Shows a popup menu to set the current connection
Modify Connection	Enters the Modify Connection window where it is possible to modify the parameters for the electrode connection

Analyze Menu

Measure Cursor	Measure parameters via two cursors that are viewed on the trace
Cursor Setup	Shows the Measure Cursor and Even Detector Setup window
Measure Cursor	Disabled during acquisition
Insert Triggers	Convert events to digital triggers. Converts the events to digital triggers

with specific code

Print Note List Table Prints the table of notes

Maps allows the user to view the amplitude maps and the frequency maps described in details in their respective section

Data Average These menu items refer to the Data Average section. For details please follow each section link:

Digital Trigger Insertion Parameters

Analog Trigger Insertion Parameters

Display Trigger information opens a dialog window that displays information about inserted triggers: the user is asked to select the channel to scan and to define the search interval

Trigger Deletion opens a dialog window that makes it possible to delete inserted triggers: the user is asked to select the channel to scan and to define the search interval

Insert Trigger On Muscular Activity opens a dialog window that displays information about inserted triggers and makes it possible to insert them: the user is asked to select the channel to scan, to select the interval where to apply, to select the trigger type and other parameters.

Data Average Shows Data Average window to start the Data average

EEG Analyzer Performs analysis in the frequency and time domain of the selected data. Data can be displayed as a trend of the selected parameters or DSA (Density Spectral Array). Selected data can be exported in ASCII format

Protocol Setup Opens a dialog window where to setup all parameters of the selected analysis protocol; see "Protocol Setup"

Protocol Selection Selects the analysis protocol to be used

Start EEG Analyzer Starts analysis with the selected protocol; see EEG Analyzer

Refresh Refreshes data display

fMRI Artefact Suppression Opens a dialog window for artifact management (Gradient and Cardioballistogram Artefact)

Analysis Manager Activates online analysis with Rembrandt Analysis Manager

Reveal Detector Activates online analysis with Reveal

Reveal Event Notification Activates event notification with Reveal

SmartEEG Enables the analysis of the trace with the SmartEEG program

Export Wide Band EEG Creates a new EEG file with wide band (applying band enlarging filter)

Persyst Enable Enables Persyst Windows

Persyst Settings Enter Persyst settings (Persyst Acquisition option, Enable Seizure, Enable Spike, Enable Spike Burst)

Manual Hypnogram Creates a hypnogram manually

Crisis Sets the epileptic crisis manually

Reference Menu

Allows the user to set the type of reference that must be used for data review. Keep in mind that the data is acquired and always saved on the hard disk with the common reference; the choice of the type of reference to be used only regards the way the data is reviewed in the window.

G2

Displays the data with the common reference mode G2, the exact used electrode for the acquisition of data

AVG

Displays the data with the reference referred to the average of the recorded signals on all the electrodes

A1/A2

Displays the data with the reference referred to the average of the two signals, A1 and A2, recorded on the two earlobes (or inside the mastoids)

Source

Displays the data according the parameters of the derived reference source (called Laplaciana or Hjort derivations)

AVG Set Up

Choose the electrodes present in the calculation of AVG

Source Settings

Sets the parameters for the derivation reference source. The Source Derivation Editor window opens where the user can set the parameters for the reference

Tools Menu

Zoom, Select Disabled

Video Enable Enables analog or digital video

Video Set Up Enters the relative video parameters settings window

View Impedance, Filter Trace - Unavailable in acquisition

Archive Montage Saves the current montage with the EEG trace, in a way to associate it permanently with the trace

Options

As Recorded Unavailable in acquisition

Stimulator Control Opens the Stimulator Control window

Stimulator Program Sets the programs of the Stimulator Control Setup

LTM Cortical Stim Allows the use of Cortical Stim (with LTM headboxes)

LTM Cortical Stim Setup

EEG Sound

Windows Menu

Cascade	Displays all open windows in cascade (one on top of another horizontally or vertically)
Tile Horizontally	Displays in the open windows horizontally
Tile Vertically	Displays in the open windows vertically
List of Windows	
List of opened windows. The active window is marked with a check sign on the left	

Help Menu

Help Online	Opens this window
Hotkeys Help	Displays a window where there are two columns: the left column indicates the raid key, the right column indicates the corresponding function
About	Opens a dialogue window with all the information about the program and the operative system

Toolbars

For the acquisition of the EEG exams, five toolbars can be used.

EEG Acquire Bar

Allows the user to perform the functions tied to the acquisition operations in a rapid way. The functions are (from the left):

Check Impedance, Run/Stop, Save, Pause, Online Average, Online fMRI Artifact Suppression, Review, Chronometer

EEG Settings Bar

Allows the user to set the values of the filters, the vertical amplification, the base time, and the montage during acquisition in a rapid way. The key function are (from the left):

High Pass, Low Pass, Base Time, Gain, Montage, Notch

EEG Quick Notes Bar

Allows the user to insert a maximum of 10 predefined notes in a rapid way. The notes are defined in the section Tools - Options - Note Settings.

NOTE: this toolbar allows the user to only select notes that are defined with a number that varies between 1 and 9 (for notes 1 through 9, in the same order) and number 0 (for note 10). Moreover, the user presses the corresponding rapid key (numbered 1 through 9 or 0) and obtains the same effect of pressing the corresponding key on the toolbar.

Notes that do not have rapid keys cannot be inserted by pressing this bar.

EEG Toolbar

Allows the user to perform some functions in a rapid way. The function keys are (from the left):

Measure Cursor (active only in review), Video Enable, As Recorded (active only in review), Stimulator Control, Start EEG Analyzer, Reload, Duplicate and Lock, Event

Manger Alert, EEG Sound, LTM Cortical Stim

“Event Manger Alert” button allows to send a message to the Event Manger software, in the same PC or in an other correctly configured.

SD Toolbar

The only key present, only active if the system is connected to a **SD type headbox**, performs the SD Lock function: every positive input of the headbox is guided to G2 (with a hardware connection, via a resistance of appropriate value).

Status Bar

The acquisition status bar, that is found on the lower part of the acquisition screen, is composed of the following three sections:

- On the left, the duration of the acquisition (in hours, minutes, seconds) of the trace
- In the center, a blue bar that indicates the length of the trace in acquisition
- On the right, the type of connection being used and the available flags to mark a particular event depending on the settings

EEG Acquisition Procedure

To perform an EEG acquisition, the user must connect the electrodes to the patient, according to necessity, and follow the steps below:

1. Control the electrode impedance in order to reduce noise on the EEG trace

The impedance measure must be done:

- To verify the impedance of each electrode
- To try to reduce it as much as possible

This way, the user reduces the noise recorded on the trace.

To access to this window, the user must select the function **Acquire- Check** from the menu bar or click on the icon on the toolbar. In the Check Impedance window, each electrode value is shown corresponding to the positive and negative inputs depending on the selected key. These values are recorded along with the trace and can be verified in the reading phase of the exam via the function View Impedance (**Tools- View Impedance** in the menu bar).

NOTE: the measurement of the impedances must be done before the user begins to save data. It is possible to automatically activate an impedance check at the end of each recording session: in the EEG acquire window, select the menu **Tools- Options**, navigate to the tab **Preferences** and toggle the check-box **Check at end**.

Suggestion: lower the contact impedance value in order to obtain better trace quality.

2. Choose the type of the connection in order to have the desired parameters for acquisition

The acquisition connection contains all the parameters for the acquisition. This function should be performed before starting an exam recording. The user may access the Modify Connection window by selecting the menu bar **Acquire- Mode- Modify Connection**.

3. Enable analog or digital video if necessary

The analog or digital video can be recorded at the same time as the EEG trace recording in order to obtain a clinical correlation of the EEG trace. To start a video EEG recording

(either analog or digital), the user must select the menu bar **Tools- Video Enable** or click directly on the icon in the toolbar.

4. Start acquisition in order to verify the quality

To verify the quality of the signal, the user must start acquisition before saving the trace. From the menu bar **Acquire**, use the function **Run/Stop** or by click directly on the icon in the toolbar.

5. Enable the thermal printer if necessary

This function allows the user to print the trace with the thermal printer during exam acquisition. This is the procedure that must be done for patient brain death. To begin printing the EEG signal, the user must select **File- Thermal Print** from the menu bar.

NOTE: when the user enables the thermal printer, any modifications (montage change, filter value, or gain, etc.) on the screen is printed on the thermal paper.

6. Choose the montage for the review of the trace on the screen

The way in which the signal is viewed on the screen depends on the selected montage. The montage is composed of a group of parameters: derivations, base time, gain, high pass filter, low pass filter, and notch filter. To choose the montage, the user must access **Modify- Montage** via the menu bar or directly select the icon on the toolbar. An easier way to directly select the montage is typing in the corresponding number on the keyboard (for the first 10).

7. Start recording, saving the data on a determined resource

After having verified the quality of the signal, the user can start the recording of the EEG exam by selecting the items **Acquire/Save** from the menu bar or by clicking on the icon found on the toolbar.

8. Insert a note during a recording

During recording, the user has the possibility to insert notes to distinguish some particular events that could occur during the exam. This can be done by clicking directly on the **Quick EEG Notes** on the toolbar or by clicking the right mouse button on the EEG window. In this way, the white string is viewed on the screen where the user can select a note from the list or insert a free text and confirming it with the ENTER key.

9. Change review montage during recording

During registration, the user has the possibility to change the view montage in order to see the EEG signal with different derivations. To choose the montage, the user must access **Modify- Montage** via the menu bar or directly select the icon on the toolbar. An easier way to directly select the montage is typing in the corresponding number on the keyboard (for the first 10).

10. Mark an event during recording

According to the EEG parameter settings, via the function **Chrono/Events** in the menu bar **Tools- Options**, the user has the possibility to mark a piece of trace as an event by clicking the left mouse button on the blue or green flag icon present to the right of the status bar. During the insertion of the event, the red check symbol flashes on the icon. When reviewing the trace, the user will find a blue or green bar on the trace that indicates the insertion of the note.

11. Measure the time intervals using the chronometer during recording

During the exam, the user has the possibility to measure the time duration of a particular

event as hyperventilation or photo-stimulation. The user enables this function with the help of the chronometer by selecting it from the menu bar **Acquire- Chronometer** or by clicking on the icon on the toolbar.

12. Pause the recording

If, during the recording, something happens that disturbs the signal (for example a movement, artifact, or a momentary electrode disconnection), the user has the possibility to pause the signal recording via the **Pause** function. This allows the user to continue saving data on the same file until the user restarts the exam recording again. The user can perform the same pause function via the toolbar.

NOTE: this function is unavailable when the user is performing a digital video EEG recording.

13. Stop the recording

The user can stop acquisition at the end of the exam via **Run/Stop** in the menu bar **Acquire** or via the icon present on the toolbar.

14. Exit from the EEG acquisition window

After the recording has stopped, the user can exit from the EEG acquisition window and return to the Archive section. Upon exit, all the windows (that were opened during acquisition) are closed automatically, such as digital video, chronometer, etc. Exit from the acquisition window via the menu bar **File - Exit** or by clicking directly on the x at the top right hand corner of the window (like in all Windows standard applications).

EEG Review Window

To access the EEG review window, the user must select a patient from the patient list in the Archive section and choose the exam from the exam list and follow the procedures below:

- Click twice directly on the exam icon in the exam list column
- Or click twice on the file icon (trace) in the file list column
- Or click the right mouse button on the exam icon or file icon (respectively on the exam or file columns) and select the **View** function from the menu bar

This way, the user enters the EEG review screen, which is very similar to the acquisition screen. The EEG review screen is the part of the program that is used to review and analyze EEG exams. In the review section, it is possible to review more than one trace at the same time and this allows the user to compare different exams of the same patient or of different patients.

The EEG review screen is sub-divided into four main sections. On the top, there are the menu bar and the toolbars; in the center of the window, there is the display of traces; on the bottom, there is the status bar. Furthermore, if the **Key Function** is enabled (under Tools/ Options/ Settings) in the Archive window, the Key function buttons are shown on the bottom of the screen.

Menu Bar

When the user accesses the EEG review section, the main menu changes. The following items can be found in the menu bar:

File, Modify, Acquire (disabled), Analyze, Reference, Tools, Move, Windows, Help

File Menu

New	Disabled
Open	Displays the Archive window, making it possible to record or to review another exam
Close	Closes the Review window and returns to the Archive section
Show Report	Displays the report when this has already been generated or allows direct access to the program report program
Thermal Setup	Sets the parameters for the use of a thermal printer
Thermal Print	Prints the trace viewed in the EEG window with the thermal printer
Print Setup	Sets the parameters for the use of a laser printer or ink-jet printer
Print	Prints the trace viewed in the EEG window with a laser or ink-jet printer
Print Screen	Prints the EEG window with a laser or ink-jet printer
Batch Print, Properties, Disk Properties - Disabled	
Export	Exports the acquired signal data in a ASCII, EDF, EP or EEG format file. Exports specific flags for the management of the integration of the program with the Hospital Information System
Exit	Exits from the EEG Review window and returns to the Archive section

Modify Menu

Undo	Disabled
Cut	Cancels all the selected lines from the current montage, keeping all the other lines present. It is not possible to cancel all the lines

ATTENTION: if the **Cut** function is performed when all the lines are selected, a message appears saying that is impossible to cancel all lines.

All the cancelled lines are kept in the memory and can be eventually inserted, in a different position or in a different montage, via the **Paste** function. The **Cut** function is active only if at least one line has been selected

NOTE: all previously memorized lines are cancelled with functions **Cut**, **Copy**, or **Keep** .

Copy	Copies all the cancelled lines that are kept in memory and could be eventually inserted, in a different position or in a different montage via the Paste function. The Copy function is active only if at least one line has been selected.
------	---

NOTE: all previously memorized lines are cancelled with functions **Cut**, **Copy**, or **Keep Lines**.

Paste	Inserts a group of lines from the memory, previously memorized using the functions Keep Lines , Cut or Copy , on top of the first selected line. If the number of lines is more than 128, the number of lines will automatically be reduced, so that 128 lines will be shown
Select All	Selects all the shown lines of the current montage. Consequently all the names of the derivations (lines) will change colour automatically
Deselect All	De-selects any selection active of the lines without changes. Consequently, no names of the derivations (lines) will be highlighted

Insert Line	Inserts a line above the first selected line
Keep Lines	Keeps only the selected lines in the montage and cancels all others. All the cancelled lines are kept in the memory, and eventually can be inserted in a different place or in a different montage via the Paste function. The Keep Lines function is only active when at least one line has been selected

NOTE: all previously memorized lines are cancelled with functions Cut, Copy, or Keep Lines.

Set on right speaker, Set on left speaker, Disable sound	For the selected lines, disables sound or activates the reproduction on the left or right speaker
Clip Line	Activates line clipping on the selected lines: <i>clipping</i> means that if the signal extends vertically in a space greater than is assigned to the relative trace, it is represented by a horizontal line at the maximum (or minimum) allowed value until the signal value decreases (or increases) to a representable value
Clip Amplitude	It is possible to choose the vertical extension of the lines when clipped via the popup menu; there are four options x1, x2, x3, x4: it means that the selected lines are clipped to the space required for respectively one, two, three, or four traces
Unclip Line	De-activates line clipping on the selected lines
Invert Flag Pairs	Disabled during EEG review
High Pass	Set the cut-off frequency of the software filter high pass, lower limit of the pass band. All modifications are applied on all selected lines. If no lines are selected, the modification is applied to all EEG lines shown in the window
Low Pass	Set the cut-off frequency of the software filter low pass, upper limit of the pass band. All modifications are applied on all selected lines. If no lines are selected, the modification is applied to all EEG lines shown in the window
Base Time	Set the base time of the lines shown in the window. The modification is automatically applied to all lines
Gain	Set the gain (amplification) of the selected lines. The modification is applied on all selected lines. If no line has been selected, the modification is applied on all EEG lines shown in the window
Notch	Enables or disables the notch filter in the current montage. This type of filter can be active at the same time on all the shown lines; it cannot be applied separately on the selected lines
Invert Line	Inverts the selected lines and consequently, the signal. The function Invert line is only active when at least one line has been selected
Change Colors, Negative Input, Positive Input, Line Number	Disabled

Montag:

Montage	Shows a popup menu to choose the montage
Save	Saves the current montage that has been created or modified
Reload	Reloads the selected montage from the disk, exactly as it was saved the last time. All the modifications of the last save will be lost
Archive Montage	Archives the current montage
Modify	Accesses the EEG Montage Setup window, where it is possible to change the relative parameters of the selected montage
Show Montage	Shows the Montage View window, where the selected montage is graphically represented

Analyze Menu

Measure Cursor	Measures parameters via two cursors that are viewed on the trace
Cursor Setup	Shows the Measure Cursor and Event Detector Setup window
Measure Cursor	Shows the Measure Cursor window
Insert Triggers	Inserts trigger
Convert Events to Digital Triggers	Converts the events to digital triggers with specific code
Print Note List Table	Prints the table of notes
Maps	Allows the user to view the amplitude maps and the frequency maps described in detail in their respective section
Data Average	These menu items refer to the Data Average section. For details, please follow each section link Digital Trigger Insertion Parameters, Analog Trigger Insertion Parameters
Display	Opens a dialog window that displays Trigger information about inserted triggers: Information the user is asked to select the channel to scan and to define the search interval
Trigger Deletion	Opens a dialog window that makes it possible to delete inserted triggers: the user is asked to select the channel to scan and to define the search interval
	Insert Trigger Opens a dialog window that displays on Muscular information about inserted triggers Activity and makes it possible to insert them: the user is asked to select the channel to scan, to select where to apply the interval, to select the trigger type, and other parameters
Data Average	Shows Data Average window to start the data average
EEG Analyzer	Performs analysis in frequency and time domain of the selected data. Data can be displayed as a trend of the selected parameters or DSA (Density Spectral Array). Selected data can be exported in ASCII format
Protocol Setup	Opens a dialog window where to setup all parameters of the selected analysis protocol; see “Protocol Setup”
Protocol Selection	Selects the analysis protocol to be used
Start EEG Analyzer	Starts analysis with the selected protocol; see “EEG Analyzer”
Refresh	Refreshes data display
fMRI Artefact Suppression	Opens a dialog window for artefact management (Gradient and Cardioballistogram Artefact)
Check Marker	Performs a marker research of the created events in acquisition with the event key on the Headbox
Sleep View	Enables the analysis of the trace with the Sleep View. For further

	information, please refer to the User Manual of the Sleep View
Reveal Detector	Enables the analysis of the trace with Reveal
Reveal Event Notification	Activates the event notification with Reveal
SmartEEG	Enables the analysis of the trace with the SmartEEG program
Export Wide Band EEG	Converts the traces, applying band enlarging filter (to EEG traces only or to all traces, excluding Marker)
Manual Hypnogram	Creates a hypnogram manually
Crisis	Sets the epileptic crisis manually
External Programs	Enables the analysis of the trace with the external programs. For more information, please refer to the specific User Manual
External Program Setup	Sets some parameters to interface the program with some external analysis programs

Reference Menu

Allows the user to set the type of reference that must be used for data review. Keep in mind that the data is acquired and always saved on the hard disk with the common reference; the choice of the type of reference to be used only regards the way the data is reviewed in the window.

G2	Displays the data with the common reference mode G2, the exact electrode used for the acquisition of data
AVG	Displays the data with the reference referred to the average of the recorded signals on all the electrodes
A1/A2	Displays the data with the reference referred to the average of the two signals, A1 and A2, recorded on the two earlobes (or inside the mastoids)
Source	Displays the data according to the parameters of the derived reference source (called Laplaciana or Hjort derivations)
AVG Setup	Chooses the electrodes present in the calculation of AVG
Source Settings	Sets the parameters or the derivation reference source. The Source Derivation Matrix Editor window opens where the user can set the parameters for the reference

Tools Menu

Zoom, Select	Disabled
Video Enable	Enables analog or digital video
Video Setup	Enters the relative video parameters settings window
View Impedance	
Filter Trace	Unavailable during review
Archive Montage	Saves the current montage with the EEG trace, to associate it permanently with the trace
Options	Accesses the EEG configuration parameters

As Recorded

Stimulator Control Opens the Stimulator Control window

Stimulator Program

Setup Sets the programs of the stimulator control

LTM Cortical Stim Allows the use of Cortical Stim (with LTM headboxes)

LTM Cortical Stim Setup

EEG Sound

Move Menu

Begin Trace	Moves the cursor to the beginning of the trace
Previous Note	Moves the cursor to the previous note
Auto Left	Displays the trace with tautomatic scrolling of the bar left (backwards)
Previous Page	Takes the trace to the beginning of the previous page
Next Page	Takes the trace to the beginning of the next page
Auto Right	Displays the trace with the automatic scrolling of the bar right (forwards)
Next Note	Moves the cursor to the next note
End Trace	Moves the cursor to the end of the trace
Time Search	Moves the cursor to a specific time
Note/Event Search	Displays the trace via the list of notes/events

Windows Menu

Cascade	Puts all open windows in cascade (one on top of another horizontally or vertically)
Tile Horizontally	Puts in the open windows horizontally
Tile Vertically	Puts in the open windows vertically
List of Windows	List of opened windows. The active window is marked with a check sign on the left

Help Menu

Help Online	Opens Help window
Hotkeys Help	Displays a window where there are two columns: the left column indicates the raid key, the right column indicates the corresponding function
About	Opens a dialogue window with all the information about the program and the Operating System

Toolbars

For the review of the EEG exams, the user can use various toolbars. During the review phase and via the toolbars, the user can set the parameters of the filters and can organize the acquired traces.

EEG Move Trace Bar

Allows the user to scroll the trace rapidly and access the points marked by the notes. The

function keys are (from the left):

Begin Trace, Previous Note, Auto Left, Previous Page, Next Page, Auto Right, Next Note, End Trace

EEG Setting Bar

Allows the user to set the values of the filters, vertical amplification, time base, and montage in a rapid way during reviewing. The functions are (from the left):

High Pass, Low Pass, Base Time, Gain, Montage, Notch

EEG Toolbar

Allows the user to perform some functions in a rapid way. The functions are (from the left):

Measure Cursor, Video Enable (active only in acquisition), As Recorded, Stimulator Control (active only in acquisition), Start EEG Analyzer, Reload, Duplicate and Lock, Event Manger Alert, EEG Sound, **LTM** Cortical Stim (active only in acquisition).

“Event Manger Alert” button allows to send a message to the Event Manger software, in the same PC or in an other correctly configured.

Notes

To insert a note, just right-click over the traces; a box appears that allows the user to type a custom note or to select it from the list by clicking on the down arrow on the left. To delete a note, drag it to the recycle bin in the status bar. To move a note, drag it to the new position inside the trace display.

Triggers

Triggers are synchronizing events introduced on the recorded EEG either during acquisition or during review. There are two types of triggers:

Digital Triggers

Digital triggers are constituted by a numeric value that is stored within the trace and adds information to the trigger itself. In fact, a numeric value can inform what kind of event has generated the trigger. By default, a digital trigger is represented by a vertical line followed by a number, which is the trigger value.

Analog Triggers

Analog triggers are spikes introduced on the signal of a particular trace. They contain only timing information, that is, they are positioned on the sample in correspondence with the instant when the trigger is generated.

Status Bar

The review status bar is found on the lower part of the window. It is composed of more sections described in detail below (from left to right).

Timer Section

Timer: indicates the length in hours, minutes, and seconds that correspond with the beginning of the beginning of the trace.

Hour: indicates hours, minutes and seconds that correspond with the beginning of the trace.

NOTE: each time the user moves along the trace, these values are refreshed at once.

Flags and Triggers: Insertion and Deletion Tools

The user can insert flags, events, and triggers by dragging the respective icon from here to

the EEG recorded trace: the insertion point is where the user releases the mouse button. It is also possible to delete single flags or flag couples, events, triggers, and notes by following the reverse procedure, that is by dragging them from the trace to the icon of recycle bin: again the deletion is completed when the user releases the mouse button.

Red Flag: allows the user to select segments of the trace for the reduction of the EEG file and for the frequency maps.

Blue Flag - Green flag: indicates the segments of the trace marked as events. The trace selected segments are indicated from a bar in the same color of the flag placed on the trace according to the EEG parameter settings set by the user.

Trigger: it is possible to manually insert the trigger on a predefined line of the trace by clicking on the icon and dragging it on the trace in correspondence with the insertion point.

Recycle Bin: it is possible to remove the flags and trigger by dragging them to the bin. When the cursor passes over the indicator placed on the trace (flag or trigger), it becomes a hand.

Also see “Chrono – Events”

Scroll Bar and Indicator

Scroll Bar: allows the user to scroll the trace.

Yellow Bar: indicates the total length of the trace. The vertical lines on the yellow bar indicate the insertion of a note on the trace. Clicking twice on the yellow bar a grid shows the list of notes and events inserted on the trace. The colored bars (red, blue, or green) indicate the presence of trace segments marked as events. By double-clicking on the yellow bar, it opens a docked window which shows all the **notes**, the digital **triggers**, and the **events** on the recorded trace and the events found by other analysis programs and stored in support files (**External**). For each item in the list, the time and the item description (e.g. the trigger value for digital triggers) are shown. It is also possible to print the list by clicking the button with the icon of a printer.

Review Procedure

The review window allows the user to review the EEG exam and the video EEG previously acquired from a patient. Usually the review of an exam is performed by medical personnel using different parameters to review the EEG in different ways. The configuration of these parameters is found under **Montage** and these can be prepared and saved to have them available for a trace reading.

To review an EEG exam or video EEG, the user must choose the exam from the exam list column in the Archive section and follow these steps:

1. Scrolls the EEG trace page by page

This function allows the user to scroll the EEG trace page by page via the left-right arrows of the keyboard, by using the icon in the toolbar, or the user can directly enter in the function of the menu bar **Move- Previous Page** or **Next Page**.

2. Scrolls the EEG trace automatically

This function allows the user to scroll the EEG trace automatically page by page, from the beginning of the trace to the end: via the up-down arrows of the keyboard, by using the icon in the toolbar, or the user enters directly in the function on the menu bar **Move- Auto Left** or **Auto Right**.

3. Synchronizes the digital video EEG

To view the digital video EEG exam, after having loaded the EEG to be seen, the user must select **Tools- Video Enable** from the menu bar or click directly on the icon found on the toolbar (when the “digital” option has been set).

4. Synchronizes the analog video EEG

To view the analog video EEG exam, after having loaded the EEG to be seen, the user must select **Tools- Video Enable** from the menu bar or click directly on the icon found on the toolbar (when the “analog” option has been set).

5. Choose the review montage

The way the signal is viewed on the screen depends on the current montage selected. The montage is composed by a group of review parameters: derivations, base time, gain, high pass filter, low pass filter, and notch filter. To select the montage, the user must select **Modify - Montage** from the menu bar or select directly from the list of montages present on the toolbar. A simpler way to choose the montage is to type the corresponding number directly from the keyboard (for the first 10).

6. Find or jump to a particular note

This function allows the user to find, jump, and scroll through the trace from one note (when these have been obviously inserted) to another. This is done by using the icon found on the toolbar or the user can select the functions from the menu bar, **Move - Previous Note** or **Next Note**.

7. Find or jump to a particular event

This function allows the user to find, jump, or scroll through the trace from one event (when it has been obviously inserted) to another. This can be done by clicking twice on the yellow bar present in the status bar or if the user directly accesses the function **Move - Note/Event Search** of the menu bar. In this way, a window is shown, where all the inserted notes/events are given in chronological order. Positioning the cursor over the text or the event automatically moves the trace to the corresponding position of the note.

8. Insert or modify a note

During the exam review, the user has the possibility to insert notes to distinguish particular events. This can be done via the right mouse button on the EEG window. In this way, a white string is viewed on the screen where the user can select a note from the popup menu or insert a free text. The note insertion must be confirmed via the ENTER key. The user also has the possibility to remove the already inserted notes or move them by clicking on them (with the left mouse button) and dragging them to the bin or to a different position of the trace.

9. Modify the montage parameters directly on the display

NOTE: this function is only available in the CLINIC version of the EEG Module.

This function allows the user to modify some parameters of the EEG signal directly on the display.

The main concept to keep in mind is the multi-selection of the derivations. The user can select the derivations viewed on the display by clicking directly with the left mouse button over the derivation. When the selection is active, the description is viewed with a different color. To de-select an already selected derivation, the user must click directly on it with the left mouse button and the derivation will return to its original color. To select a group of consecutive derivations, the user must keep the "Shift" key pressed and select them

with the left mouse button. For a non-consecutive selection, instead press "Ctrl" and use the left mouse button to select.

The EEG signal parameters can be changed directly on the display relative to a single derivation or a group of derivations.

Number of derivations: to cut a single selected derivation or a group of derivations selected from the current montage, the user must select the function **Modify - Cut** from the menu bar or click directly on the icon on the toolbar.

Position of the derivation: to move a single derivation or a group of derivations to a different position, the user must drag it/them using the left mouse button to a new destination position.

10. Measure the signal with the cursor

This function allows the user to measure the exact value of the amplitude and the latency in any trace position. Use the icon on the toolbar or directly enter the function **Analyze - Measure Cursor** via the menu bar for the measurement of the signal.

11. Print one or more EEG pages

This function allows the user to print one or more pages of the EEG trace during exam review. The user can use indifferently the thermal printer (continuous module) or a standard printer single sheet (laser or ink-jet).

12. Access to Report

This function allows the user to generate a report for the current exam or, if the report is already present, to view it for consultation and eventual modifications. For more information, please refer to the report chapter in the Archive section.

13. Exit from the EEG review window

This function allows the user to exit from the EEG review window and return to the Archive section. It is possible to exit from the EEG review window either by accessing **File - Exit** via the menu bar or by clicking on the icon X present in the upper right corner of the window.

EEG Functions

How to Print an EEG on Paper

This function allows the user to print the trace with a standard printer during the review of an EEG exam. To print the EEG signal, the user must select **File - Print** from the menu bar or click on the icon present on the toolbar.

The **Printer Setup** function allows the user to set the parameters for the standard printer:

Printer: indicates the name of the printer in which the trace is printed.

Reference Gain

All Same: prints the trace with a fixed value for the reference that can be chosen by a popup menu.

From montage: prints the trace with the gain read by the current montage.

Seconds to Print

Print Whole Trace: prints the whole trace.

Current Page: prints the currently selected trace page.

Seconds sets the number of seconds to be printed from the beginning of the current page, using the arrows.

Truncate Page if Under 50% Full: if enabled, then the trace on the last page is lower than 50% and this page is not printed.

Other Parameters Waveform Style: Resolution:

Print Grid: if enabled, then prints the trace with the grid.

Darkness: indicates the intensity of the line of the seconds of the chosen grid by a popup menu.

Style: indicates the style of the grid in seconds of the line (always continuous line)

Darkness (1/5 sec): indicates the intensity of the line of the fifth of a second of the chosen grid by a popup menu.

Style: indicates the style of the grid of a fifth of a second of the line (hyphen line or continuous)

Paper Speed

As On Screen: prints the trace occupying a page for each video screen.

1.5 cm/sec: prints the trace occupying 1.5cm of the sheet per second.

3.0 cm/sec: prints the trace occupying 3.0cm of the sheet per second.

Print Heading sets the header to be used for the print.

No: no header is printed.

Small: prints the trace with a brief description on the derivations of the current montage.

Large: prints the trace with a full description on the derivations and the values of the filters for each derivation of the current montage.

On First Sheet Only: if enabled, then only prints the header on the first sheet.

Left Margin: prints the header and the trace while leaving a certain left margin, chosen via the popup menu for eventual binding.

The functions keys are:

O.K.: this key allows the user to exit while saving all the modifications to the parameters.

Cancel: this key allows the user to exit without saving modifications made.

Change Printer:

IMPORTANT: this parameter for the printer configuration is exclusively reserved for technicians. This value must not be modified by the user.

How to Use the Thermal Printer

This function allows the user to print the trace with the thermal printer during the exam acquisition. This is a procedure that must be done for the knowledge of the brain death. To begin the printout of the EEG signal in a direct way, the user must select the menu bar, **File - Thermal Print.**

NOTE: when the user enables the thermal printer, any modification (change of montage, value of filter, or gain, etc. ..) on the screen is printed on the thermal paper.

The **Thermal Setup** function allows the user to set parameters for the thermal printer.

Montage

Current Montage (Fixed): the trace will be printed with the currently selected montage (and the gain read from the montage).

Current Montage (Fixed) with all same EEG Reference Gain: the trace will be printed with the currently selected montage. The user can also specify to print the trace with a fixed gain value for all channels of EEG that can be selected via the popup menu.

Montage (Fixed): the trace will be printed with the fixed montage that can be selected via the popup menu.

Seconds to Print

Print Whole Trace: prints the whole trace.

Seconds: sets the number of seconds of the trace to be printed from the beginning of the current page.

Paper Speed

Specifies the velocity of the paper scrolling via the popup menu.

Form Feed

FF at the Beginning: at the beginning of the print, it is given a page forward.

FF at the End: at the end of the print, it is given an advancement of the page.

Print Heading sets the header to be used for the printout.

No: no header is printed.

Small: prints the trace with a brief description on the derivations of the current montage.

Large: prints the trace with a full description on the derivations and filter values for each derivation on the current montage.

Other Parameters

Print Grid: if enabled, then prints the trace with the grid.

Waveform Style: selects the type of line to be used for the trace printout via a popup menu.

Output Port:

IMPORTANT: this parameter for the configuration of the thermal printer is exclusively reserved for technicians. This value must not be modified by the user.

The two function keys are:

OK: exits saving all the parameter modifications.

Cancel: exits without saving modifications.

Modify Montage

This dialog window is accessed by clicking the item **Modify - Montage - Modify** in the EEG window (both acquisition and review).

The EEG Montage Setup window allows the user to set and modify all the parameters regarding the trace review. The user may access this window during acquisition and during trace review. Keep in mind that any modifications made in this window have no effect in the acquisition section, but only in the review of acquired data.

The window is divided into two sections. On the right the standard electrodes scalp are represented with electrode description. On the left there are two tables, one for the Montages list and one for the description of all the parameters of each derivation of a specific montage. Furthermore, if (and only if) the Modify Montage window is accessed from the Acquisition window, the Related Connects table is represented.

Montages

In the table representing the montages list, the parameters for each montage are:

#: indicates the number of the current montage. It is automatically associated with the montage and cannot be modified by the user. There are 30 available montages by default, but the user has the possibility to archive up to another 30 extra montages for each trace. The arrows allow the user to change the current montage.

Montage Description: assigns a descriptive name to the montage. This can be done by clicking on the description with the left mouse button so the user can edit or modify it. This name can be viewed in the list of montages on the EEG parameters section in the toolbar of the Acquisition or Review windows.

Lines: total number of lines of the montage. Clicking with the left mouse button on the lines number, the user can set the number of lines via the popup menu.

Base Time: indicates the value of the base time (in sec) used with the current montage. Clicking with the left mouse button on the base time, the user can set it via the popup menu.

Reference: indicates the type of reference used for the trace review in the current montage. Clicking with the left mouse button on the reference, the user can set (via the popup menu) the type of reference that must be used for data review, choosing between G2, AVG, A1A2, or SRC.

Archive: toggles on/off the automatic archiving of the selected montage inside the trace header.

Lock/Unlock: locks or unlocks the montage by double clicking on the icon. Before locking the montage, it will be saved on disk; every future change made during acquisition or review will not be saved until the montage will be unlocked again.

NOTE: if the montage is locked, any parameters of the montage can be modified.

Clicking with the right mouse button on the **Montages** table, a popup menu is shown. These functions are improved:

Copy: copies the selected montage into memory.

Paste: pastes a previously copied montage over the selected one. A confirmation is requested from the user.

Archive: archives the selected montage. In the **Montages** table, the archived montages are highlighted at the button of the table (during the trace review).

Export: exports the current montage into a Montage file (*.mon).

Import: imports a montage from a Montage file (*.mon).

Montage # ...

In the table representing the selected montage, the relative parameters are:

#: indicates the line number (the progressive number of the derivations of the current montage).

Label -: indicates the inverting input label for the current derivation. The user can set it via the popup menu that appears and clicking with the left mouse button. The new value is inserted confirming the choice always and clicking with the left mouse button.

Label +: indicates the non-inverting input label for the current derivation. The user can set it via the popup menu that appears and clicking with the left mouse button. The new value is inserted confirming the choice always and clicking with the left mouse button.

Hi Pass: indicates the high pass filter cutoff frequency for the current derivation. The user can set it via the popup menu that appears and clicking with the left mouse button.

Low Pass: indicates the low pass filter cutoff frequency for the current derivation. The user can set it via the popup menu that appears and clicking with the left mouse button.

Notch Filter: enables the notch filter. When this filter is active, it has an effect on all the lines of the current montage. This filter should clean and delete all the signal components that could create an artifact from electric current derogation.

Gain: indicates the graphic amplification (value of the gain used for the current derivation). The user can set it via the popup menu that appears and clicking with the left mouse button.

Selection Status: selects the current derivation for subsequent operations (such as **Cut**, **Copy**, or **Keep Lines** functions).

Trace Color: changes the color of the trace of the current derivation. This can be done by clicking with the left mouse button on the derivation color, selecting another color from the available ones, and confirming it with the left mouse button.

Sound: sets on the right or the left speaker for the trace of the current derivation.

Trace Format: sets the format of the trace of the current derivation via the popup menu that appears and clicking with the left mouse button. Lines, Number, or Lines+Numbers can be chosen.

Clipping: activates line clipping on the trace of the current derivation. *Clipping* means that if the signal extends vertically in a space greater than is assigned to the relative trace it is represented by a horizontal line at the maximum (or minimum) allowed value until the signal value decreases (or increases) to a representable value.

A simpler way to build the montage and enable it is to click the left mouse button in the cell of the negative input of the first derivation. The user can insert the desired derivations

by selecting them directly in the headbox displayed on the left window. Subsequently, the user can insert the positive input of the first derivation, the negative input of the second derivation, the positive input of the second derivation, and so on, always by clicking in the headbox.

In the **Montage # ...** table, the user can make multiple selections of the lines by clicking with the left mouse button on the lines when the Ctrl button is pressed.

Clicking with the right mouse button on the **Montage # ...** table, a popup menu is shown. These functions are improved:

Cut: cancels all the selected lines from the current montage.

Copy: copies the selected lines into memory.

Paste: inserts a group of lines into the current montage from the memory.

Remove: removes the selected lines from the current montage.

Insert one line: inserts one line into the current montage.

Insert multiple lines: adds a requested number of lines into the current montage. Lines can be added until the montage becomes filled.

Invert: inverts the inverting and non-inverting inputs for each of the selected lines. On the top of the Modify Montage window, there is a toolbar with the functions:

Exit: exits saving changes only for the current session and then returns to the acquisition window or the EEG review window.

Save: saves all the montages.

Cancel: exits without saving any changes (since last save).

Undo: undoes the previous action.

Option:

Show All Labels: set to show all labels or only the available ones in the labels list.

List Depth: sets the depth of the labels list (10, 20, 30, or 40 labels).

User Definable Parameter Settings

The acquisition and review EEG Module has many parameters that can be set by the user. Micromed always supplies the default values for these parameters.

The user can access the **Settings** window from the menu **Tools- Options** (a password is requested).

The **Settings** window contains some tabs. In each tab, the user can move to different fields to modify or set personalized values.

IMPORTANT: The modification of any of these parameters is exclusively reserved for technical personell; these parameters should not be modified in any way by the user to prevent an alteration of the correct working mode of the program.

The following tabs can be found:

Appearance allows the user to configure the EEG window.

Item: a popup menu that consists of:

Trace Background: allows the use to choose the background color of the trace using the color window by clicking over the key of the selected field.

Labels: allows the user to choose the color of the derivations by using the color window that is opened by clicking on the key of the selected field. Via the key **Change Font**, the user enters the **Character** window, where the type of font for the derivations can be changed and set.

Notes: allows the user to choose the color of the note by using the color window that is opened by clicking over the selected field. Via **Change Font**, the user enters the **Character** window, where the type of font for the notes can be changed and set.

Grid: allows the user to choose the color of the grid by using the color window that is opened by clicking the corresponding field.

Horizontal Grid: when this checkbox is enabled, a horizontal grid is shown on the EEG window.

Vertical: when this checkbox is enabled, a vertical grid is shown on the EEG window.

200mSec: option under development.

Trace Over Labels: when this check-box is enabled, the trace is shown over the derivations.

Not Recording warning: when this check-box is enabled, the message *"Not Recording"* flashes on the EEG acquisition until the user does not begin to save data.

Not Recording Video warning: when this check-box is enabled, the message *"Not Video Recording"* flashes on the EEG acquisition when the video is not enabled.

Show message in the middle of the window

Scroll trace speed: a popup menu to set the scroll velocity of the trace in the EEG review section. The available values are:

Max. Speed: sets the trace scroll velocity in the EEG review section at maximum velocity.

4 pages per sec: sets the trace scroll velocity in the review EEG section at 4 pages per second, relatively even the value set for the base time of the current montage.

3 pages per sec: sets the trace scroll velocity in the review EEG section at 3 pages per second, relatively even the value set for the base time of the current montage.

2 pages per sec: sets the trace scroll velocity in the review EEG section at 2 pages per second, relatively even the value set for the base time of the current montage.

A page per sec: sets the trace scroll velocity in the review EEG section at 1 page per second, relatively even the value set for the base time of the current montage.

A page per 2 sec: sets the trace scroll velocity in the review EEG section at 1 page per every 2 seconds, relatively even the value set for the base time of the current montage.

A page per 3 sec: sets the trace scroll velocity in the review EEG section at 1 page

per every 3 seconds, relatively even the value set for the base time of the current montage.

Digital Trigger View Mode: this control is active both in acquisition and in review. In review, this can be recalled by selecting the item **Digital trigger view mode** from the menu **Analyze –**

Synchronized Average. The following options are available: *None* (no type of sign on the trace for the trigger event), *Vertical bar* (vertical line), *Description* (numerical code), and *Vertical bar and description* (vertical line and numerical code).

Oximeter View Mode: allows the user to set the mode of representation of the oximeter values (**Graphical, Numerical, or Graphical and numerical**)

Preferences

Allows the user to set the EEG parameters as preferred values. The popup menu needs the following fields for the selection: **High Pass Filter, Low Pass Filter, Gain, and Base Time.** For each of these the user can choose the values.

In the two columns, different corresponding values are show in the selected field. In the column on the left all the possible values for selection are shown, while in the right column all the values chosen by the user as preferences are shown. This can be done by clicking with the left mouse button over

the desired value (highlighted) in the left column and clicking on the left arrow: the value is moved to the right column. These values will be shown in the EEG window (both acquisition and review) in the popup menu of the EEG properties. To de-select the value (already chosen), the user must click the left mouse button over the desired value (highlighted) in the left column and click on the right arrow: the value is moved back to the left column.

Check at End: enables the automatic control of the impedance of the electrode at the end of the exam recording.

Enable Check: enables the button for the Impedance Check.

Repeat Acq. when Error: allows the user to automatically repeat the exam in case of error.

Display Line Tooltip: enables the review of the tooltip at each EEG line.

Convert Trace from Type 4 to 3: to assure compatibility with some releases of the program.

Open Video Automatically After Trace: automatically opens the Video window after opening of trace window.

Acquisition Mode: allows to choose the windows visualizazion. The options are "Standard", "Two Windows" and "Three Windows" and the user can choose them alternately.

Calibration

Allows the user to perform a calibration via the ruler to view the trace correctly in accordance with the monitor type in use. This can be done via the Up/down arrows regulating the length of the ruler to 5cm.

Note Setup

Allows the user to set a list for rapid note insertion during the exam acquisition. The table has two columns:

Note: the list of notes that can be inserted during exam acquisition.

Key: the list of numerical keys or letters associated with the corresponding note for insertion.

Notes associated with numerical keys are viewed even in the corresponding icons **Quick Keys Notes** on the toolbar during exam acquisition.

To insert a note, the user must position the cursor in the desired NOTE column and type the description. In the KEY column, the user can insert a numerical key or letter. The current notes are registered by exiting the table.

NOTE: if the user desires to insert a particular note that is not present in the list of the notes during acquisition clicking the right mouse button in the EEG window enables a cursor on a string where the user can digit freely. The note is inserted upon confirmation with the ENTER key.

Chrono/Events

Allows the user to set the parameters for chronometer use. The popup menu contains the list of notes that can be associated (in an automatic way) respectively at the start and at the stop of the chronometer. The user has the possibility to highlight the trace segment as events using blue and green flags during acquisition.

The following items are present:

Start Chrono: sets the note associated with the start of the chronometer.

Stop Chrono: sets the note associated with the stop of the chronometer.

Event:

None: if the notes of the start and stop are associated with the chronometer use, this option (when active) does not mark the trace in any way.

Flag Blue: if the notes at the start and stop are associated with the chronometer use, this option (when active) marks the trace with a blue bar event.

Flag Green: if the notes at the start and stop are associated with the chronometer use, this option (when active) marks the trace with a green bar event.

Description: specifies the descriptive name for the event. This name is displayed during the exam acquisition each time the user positions the mouse over the corresponding flag in the status bar.

Start Note: sets the associated note to the start of the event.

Stop Note: sets the associated note to the stop of the event.

COM Port Settings

IMPORTANT: The modification of any of these parameters is exclusively reserved for technical personnel; these parameters should not be modified in any way by the user to prevent the alteration of the correct working mode of the program.

Digital Trigger: selects the COM port used to receive digital triggers.

Oximeter: sets the necessary parameters to perform the exam acquisition recording the signal of saturation from the Micromed **OXY40** device.

Video VISCA Commands : sets the parameters that are necessary to perform the exam acquisition with the Video VISCA.

VISCA Port 1: sets the COM port for the video synchronism device.

VISCA Port 2 : sets the COM port for the VCR bidirectional control device.

Video Setup

Allows the user to set the parameters of the analog or digital video.

IMPORTANT: The modification of any of these parameters is exclusively reserved for technical personnel; these parameters should not be modified in any way by the user to prevent alteration of the correct working mode of the program.

General Settings:

Video Display: this window appears when the user clicks on the Video Image function, verifying the settings of the Video Image.

Video Format: this window appears when the user clicks on the Video Format function, verifying the settings of the Video Format.

Video Source: this window appears when the user clicks on the Video Source function, verifying the settings of the Video Source.

Audio Source:

Digital Video Source:

Video

Audio

Capture Audio: enables the audio acquisition.

Digital Video Settings:

Make New File after Frames: the number of Maximum Frames per File: specifies the number of frames for the automatic cut of the digital EEG video file. The value depends on the size of the file. For more information as in how to calculate the number of frames to set, refer to the table below:

MJPEG* Compression, High Rate (Low Quality), with Audio					
Image	Frame Rate	Space/sec	Space/mi	Space/hou	Max. Frame
QCIF	5 frame/sec.	48 Kb	2.8 Mb	169 Mb	45000 =422 Mb = 2h 30m
176x144	12.5	120 Kb	7.0 Mb	422 Mb	45000 =422 Mb = 1h 00m
Pixel	25 frame/sec.	240 Kb	14.1 Mb	844 Mb	45000 =422 Mb = 0h 30m
CIF	5 frame/sec.	96 Kb	5.6 Mb	338 Mb	22500 =422 Mb = 1h 15m
352x288	12.5	240 Kb	14.1 Mb	844 Mb	22500 =422 Mb = 0h 30m
Pixel	25 frame/sec.	480 Kb	28.1 Mb	1.65 Gb	22500 =422 Mb = 0h 15m

Ask New Video Confirm: enables the confirm request for the creation of a new file. If not enabled, the system creates a new file automatically, according to the number of frames set by the user.

Video Compression: sets the type of software compression by choosing it from the available ones.

Audio Compression: sets the type of software compression.

Trigger Settings

This option tab allows the user to set the parameters used by the program for trigger insertion during an acquisition. In particular, it is possible to choose between analog trigger and digital trigger and according to the selected trigger to set the channel where the trigger is to be positioned or their visual aspect on the trace. Analog and digital triggers cannot be simultaneously enabled: one of the two excludes the other.

Analogical Trigger: active only in acquisition. Allows the user to select the channels where the analog triggers are inserted coming from an external unit. One or more input triggers are available depending on the acquisition headbox and interface.

The controls **Insert trigger In on channel**, **Insert trigger In 2 on channel**, and **Insert trigger In 3 on channel** address the analog triggers on different channels of the trace in an independent way.

Insert Trigger Out on channel: a channel where triggers produced by the EEG acquisition program during SLI stimulation and sent via the Trigger Out jack towards the visual stimulator are inserted.

Patient Button On: Digital Trigger:

Port COM Used: a popup menu that allows the user to select the communication serial port between *COM1*, *COM2*, *COM3*, and *COM4*. This parameter can be modified even in the options grid Com port settings.

Trigger In Used: a popup menu that allows the user to select the physical input of the analog trigger, which synchronizes the digital trigger.

Advanced stimulator control: toggles on/off the use of advanced stimulator control.

Measure Cursors

Measure Cursor Setup

The user can set various checkboxes regarding these functions:

General Settings

- Enable Measure Cursor only when the icon is active
- **Draw Vertical Line for Selected Interval:** displays, in the position of the grey vertical bar, two lines that indicate the position of the right and left cursors.
- **Automatic Position on the Screen:** when this option has been set, the user has an automatic movement of the window "Measure Cursor" out of the zone of the selected trace (indicated by a gray vertical bar).
- **Fix Interval to 1 Second:** when this option has been set, the user has an automatic selection of a trace segment (indicated by a vertical gray bar) equal to a second.
- Drag & Drop to Select
- Flags Visible
- Color of Captured Trace
- Hold Selection

Spectrum Settings

- Activate Cursor
- Detrending
- Show Spectrum

Measure Cursor

A window appears that shows some values of the amplitude and latency of the selected derivation. For the measurement of such values, only one derivation at a time can be selected.

In the upper left corner of the **Measure Cursor** window, the name of the selected derivation is shown.

In a table there are two values (Amplitude and Latency) for the left and right cursors (Difference, Max. and Min.) corresponding to the selected derivation:

Left Cursor: indicates the value of the amplitude (in microVolt) and the latency (in seconds) from the beginning of the page up to the left cursor.

Right Cursor: indicates the value of the amplitude (in microVolt) and the latency (in seconds) from the beginning of the page up to the right cursor.

Difference: indicates the value of the difference (in seconds) between the latency of the right cursor and the latency of the left cursor.

Max.: indicates the maximum value of the latency in microVolt (of the selected piece of the current derivation) and the corresponding value of the latency in seconds.

Min.: indicates the minimum value of the latency in microVolt (of the selected piece of the trace of the current derivation) and the corresponding value of the latency in seconds.

Difference: indicates the value of the difference (in microVolt) between the amplitude of the right cursor and the amplitude of the left cursor.

Under the table, a Zoom window is shown.

Under the Zoom window, these command buttons are shown:

Find: finds waves like the selected one on the trace. **Add Event:** adds the selected event to the events file.

Cancel:

Capture: saves the Zoom windows in background mode for successive comparison

Spectrum Analysis

NOTE: this function is available only in the CLINIC version of the EEG Module.

In the **CLINIC** version, the part underneath the window contains the drawing of the potential spectrum. The values of the potential and frequency under the spectrum are relative to the position of the red cursor, which can be moved to see other values.

Peak At: indicates the frequency of the maximum value of the spectrum.

Cursor: indicates if the red cursor is visible.

Detrending: indicates if the user performs detrending (allow to remove the lower components

resulting from analysis).

Acquisition Chronometer

During the exam registration, the user has the possibility to measure the time duration of particular events as hyperventilation or photo-stimulation. Clicking on the icon on the toolbar causes a small display with the chronometer controls to appear.

The blue arrows allow the user to start the chronometer. Once the user has started the chronometer, the blue arrows become active as the function key for the pause.

The pause key allows the user stop the chronometer. The time lapsed is shown on the display, while the key on the right of the display allows the user to reset the chronometer.

SLI Control

The user has the possibility to program the stimulator control during the exam recording.

Stimulator Control

This window is used to set the program and to start the stimulation.

Start: starts the stimulation.

Keys -/+: decreases or increases the stimulation frequency. They are only active if the program "Manual" is chosen.

Program: a popup menu to choose the program to use. If the choice is "Manual," the stimulation occurs with a selected frequency on the text box, otherwise with the parameters that are set in the **Stimulator Program Setup** window.

Stimulator Program Setup

This window contains two sections: **Manual Settings** and **Program Settings**

In the **Manual Settings** section it is allowed to enable or not the time limit for the stimulation (hh:mm:ss).

The **Program Settings** section contains a table with four columns:

Freq. (Hz): selects the stimulation frequency.

Length (sec): selects the duration of the stimulation in seconds.

Pause (sec): selects the duration of the pause before the next stimulation.

Note: selects the note to be written at the beginning of the stimulation.

Program Description: is the name of the program in which the user wants to save the data. The name will then be shown in the **Stimulator Control** window.

In the lower part of the window, there are two buttons:

Save: saves the program on file.

Exit: exits the settings window.

Check Impedance

This window is used to view the impedance values during EEG acquisition in order to check cable connections and to trim the impedance between each electrode and the skin of the patient. Following the window title, there is a string that identifies the connected headbox. These values may be collected into the recorded file and read again during exam review. This window only appears to check the impedances during EP exam acquisition if it is selected in the **SAM32FC1** headbox.

The appearance of the window depends on which type of headbox is connected and reflects the headbox upper mask.

There are two main mask types: those with the standard patient head (**SAM25FO**, **SAM32FO**, **SD** with jackbox **JB21P**, **SD32** with integrated jackbox, and their "reverse" versions) and those with a matrix of electrodes (**SD** with jackbox **JBMini**, **JBM12**, **JBBip**, and all multi-channel headboxes **SD64**, **SD96**, **SD128**, **SD64c**, **SD128c**, **SD256**); **SD32MRI**, **SD64MRI**; **LTM** family (**SDLTM32**, **SDLTM64**, **SDLTM128**, **MORPHEUS**); **EMBLA**.

When multi-channel headboxes are connected (number of electrodes greater than 32), the headboxes are shown in blocks of max 32 electrodes and the user can select the block of interest with buttons.

In the upper side of the window, there is a toolbar in which the buttons **Positive Inputs**, **Negative Inputs**, and **Exit** are always present. Other buttons (**I**, **II**, **III**, **IV**) are displayed when multi-channel headboxes are connected to show each block of 32 channels and allow switching from one block to another.

NOTE: there are some "quick keys." The spacebar toggles between checking positive inputs and negative inputs; when there are multiple blocks of 32 channels the numbers 1, 2, 3, 4 (both in the keyboard and in the numeric keypad) allow the user to read the values in the first, second, third, and fourth block of 32 channels.

The window is divided vertically into two parts. To the left, there is a graphic display where each electrode is represented by a circle with a diameter proportional to the impedance value: the more the impedance the larger the circle. When the impedance exceeds 20K Ω the circle appears empty. To the right of the window, there is a grid which reports the values of all the electrodes.

When the standard patient head is displayed, only the activated electrodes are visible in it; with multi-channel headboxes all the electrodes are displayed instead, independently of their connection. Moving the mouse over the shapes of the electrodes, a label appears displaying the actual value of the impedance.

A status bar at the bottom of the window shows the operation status and, if necessary, the range of the displayed electrodes when viewing a multi-channel headbox.

NOTE: in the standard patient head, the user can see a correct or reverse view of the headbox (left to the left and right to the right or vice-versa). To change the horizontal disposition of the electrodes, the user has to select the menu **Tools - Options...** from the archive window, navigate to the tab **General**, and toggle the check-box **Invert Left and Right** in the **Impedance Check** window. With headboxes, **SDMRI** is only possible in the correct view.

View Impedance

To review the impedance values that were used on the EEG exam recording, the user must select the function **Tools- View Impedance** from the menu bar in the EEG Review window. The Impedance Check window is opened where the recorded impedance values are shown with the trace (if the user has controlled the impedance before the trace recording).

Two options are available:

Starting Impedance: when this option is activated via the symbol, the values of the impedance recorded before the EEG exam recording are viewed in the Value fields.

Ending Impedance: when this option is activated via the symbol, the values of the impedance recorded at the end of the EEG exam recording are viewed in the Value fields.

Positive: displays the values of the impedance of the electrode positive inputs of the headbox. **Negative:** displays the values of the impedance of the electrode negative inputs of the headbox. **Value:** indicates the numerical value of the impedance of the corresponding electrodes.

Video EEG

When the user is performing an EEG recording, the user has the possibility to enable the recording of patient video to obtain a correlation (important for the study of epilepsy) between the events of the EEG signal and the corresponding video signal. The patient video is recorded such a **Digital** registration, as explained below.

The acquisition of a **Digital Video EEG** is composed of saving the trace and the video image, both in a digital format MJPEG and in a synchronized way directly on the hard disk of the computer.

The user can enable the video when in the EEG acquisition window via the menu **Tools- Video Enable** or by clicking directly on the **Video Enable** icon present on the EEG toolbar before starting acquisition.

Check Marker

This function is only allowed during review of the EEG files.

This function performs the search of the events created on the marker via the note key of the acquisition Headbox (that takes the frequency of this signal from 1Hz to 8Hz). When the procedure has began, a window is displayed with a bar that indicates the progress of the operation and the number of variations found (that is, the number of events).

Apply: associates each variation with a note type "mrk #," where # is the number of the note. The number limit of the notes is 200. This button only appears enabled if variations are found.

Cancel: exits without performing any operation.

Connection

The connection indicates the structure of the acquisition input of the headbox for EEG traces.

In other words, the connection indicates **which input channels are active** for acquisition and their **settings** that comprehend:

- The positive input, that is, the jack on the headbox that corresponds to the channel with a determined name
- The type of electrode, if common reference or bipolar, or if there are other electrodes relative to other units, for example, the oximeter
- The positive input labels (non-inverting) and negative input labels (inverting)
- Sampling frequency
- The number of resolution bits in analog-digital signal conversion
- The quantization window
- The input hardware filters
- A string with eventually added descriptions

The user can control the actual settings, select other settings from a database with 20 possible configurations, or modify each one of the parameters and save the changes.

Access to modifications of the connection is possible only from the **Acquire** menu of the Acquisition window.

IMPORTANT: every modification drastically influences the functionality of the entire acquisition system and must be performed with the assistance of a qualified technician.

It is possible to restore the default settings; these are given during the first software installation. For more information, call our service department.

Access to the Modify Connection Window

It is possible to access the Modify Connection window by selecting **Acquire - Mode - Modify Connection** from the menu bar when in acquisition of a new EEG exam (before starting the acquisition).

It is possible to change the connection without entering in the Modify Connection window by selecting the desired connection between the 20 available ones listed in the popup menu that is found under the item **Mode** in the **Acquire** menu.

Modify Connection Window

This is a dialog window containing 3 sections:

- On the top, a toolbar that allows all the operations relative to connection modification to be performed
- At the center, a grid that shows all the input electrodes of a determined headbox (or a combination headbox plus jackbox for SD amplifiers that allow it)
- On the bottom, a status bar that shows some parameters of the current connection

When it is open, this window presents the current connection, that is, the connection chosen between 20 available possibilities in the database of the connections correctly used in acquisition.

The Toolbar

The buttons are (from the left):

Exit: closes the window; if settings are changed and the user did not press the **Save** button, then a message asks the user for a confirmation.

Save: saves changes; only enabled if settings are changed.

Print: prints the grid with the current connection and eventual settings of the jackbox.

Help: opens the help page.

Default Labels: automatically restabilizes the default names for EEG channels. When a connection is changed, the labels of the channels of polygraph are changed automatically, while the EEG channels remain those that were selected by the user. For example, if the user has selected the free label *eIA01* instead of the fixed label *Fp1* and the user changes the connection, the first channel remains labeled *eIA01*. This button is needed to restore, in a simple and fast way (instead of manually), all the default labels for a determined acquisition modality.

Electrodes Position: recalls the dialog window that allows a custom regulation of the electrode position on the patient's head. For further details, see the “Electrode Position” section.

Connection Description: a control type popup menu in which the following the possibilities can be performed:

1. The choice of one of 20 available connections in the database relative to the current headbox
2. Renaming the current connection, which occurs by typing in the name in the textbox that is shown in the status bar (at the bottom of the window)

Acquisition Mode: a control type popup menu in which it is possible to modify the acquisition mode for the current connection. This control presents the current possible acquisition modes with the type of headbox connected to the system. For the **SD** amplifier types **SD**, **SD64c**, or **SD128c**, the possible acquisition modes depend on the type of jackbox connected to the headbox.

Jackbox: this control type popup menu is present only for the **SD** amplifier types **SD**, **SD64c**, or **SD128c**. When the user changes the jackbox must be correctly set via this control type jackbox connected the amplifier. A change front physical of the jackbox connected to the amplifier must be performed on the user's behalf, the correct user settings. The change of the jackbox is technically analog to a headbox change: consequently the Acquisition Mode is refreshed; this operation is indicated by a message that allows the user to cancel or confirm the operation. The first new acquisition modes from the list is chosen.

Pre-Filter: a control type popup menu in which it is possible to set the filter that is applied to the recorded EEG.

Oximeter: enables/disables the oximeter; when the oximeter is enabled, the three channels relative to it (**Puls**, **Beat**, and **SpO2**) appear active.

NOTE: this function is disabled for SD type amplifiers when the selected sampling frequency is at 128Hz.

DC module: enables/disables the DC Module for **SD** amplifiers; for the other headboxes, this control is not available. When enabled, the channels relative to it appear active.

DC calibration: calibrates the DC signals connected to a sensory device. A dialog box appears, that allows selection of a measure unit and to insert the measured values and the real ones.

Electrode Grid

The Lines of the Electrode Grid

The electrode grid contains as many lines as there are possible input selections for the headbox. For each acquisition modality, there can be **active** and **non-active** inputs.

The active inputs (lines with a light background) are those effectively recorded in the files during acquisition. Their visibility in acquisition phase during review (see “EEG Review” section) depends from the montage. The settings of the active inputs are user-modifiable by clicking on the cells of the corresponding lines.

The non-active inputs (lines with a gray background and barred parameters) are not acquired and the settings are not user modifiable.

NOTE: In some of the acquisition headboxes, in the modes C19 and C21, the electrode corresponding to the marker is written in green with a yellow background. This means that the marker is active (20 active channels for C19 and 22 active channels for C21), but the user cannot modify the settings (for example, it is not possible to change the label).

Another kind of acquisition channel is a bipolar input transformed into an EEG channel by short-circuiting the negative input to G2: they are explained by a different colored line and by a dedicated icon.

The Columns of the Electrode Grid

The columns are (from the left):

#: physical position of the input on the acquisition headbox. This number is found on the label, next to input jack.

Ref.: icon that indicates the type of channel or reference. The following possibilities exist:

	EEG input type, common reference with respect to electrode G2
	Bipolar input: polygraph and 16DC inputs for the SD headbox
	Bipolar input transformed into a common reference EEG channel; the operator must recognize the electric connection between the negative input and the G2 channel
	Marker input
	DC input
	Oximeter input

Input + : name of the positive input. The user can change this name by clicking the left mouse button in the cell and then selecting a free label from the popup menu. The blue labels are free, the fixed ones are black. After selecting a free label, it can be changed by typing in the new label directly from the keyboard (max 5 characters).

Input - : name of the negative input. If the input is common reference (EEG), this label is G2 and cannot be modified. If the input is another type (bipolar, marker, oximeter), the user can change this name by clicking the left mouse button in the cell and selecting a free label from the popup menu. The blue labels are free, the fixed ones are black. After selecting a free label, it can be changed by typing in the new label directly from the keyboard (max 5 characters).

Sample f(Hz): a popup menu that allows the user to select a sampling frequency from available options. Then all the inputs have the same sampling frequency and new entries are refreshed in all lines of the grid.

Bits: a popup menu that allows the user to select a resolution from available options. All the inputs have the same resolution and new entries are refreshed in all lines of the grid. In the popup menu, other parameters as well as the number of bits are highlighted. A maximum logical value, a minimum logical value, and a logical value corresponding to ground are involved in the popup menu.

Phys.max: a popup menu to select the physical value that corresponds with the maximum of the window quantization.

Phys.min: a popup menu to select the physical value that corresponds with the minimum of the window quantization.

Measure Unit: this column shows the measure unit.

HP Filter (Hz): a popup menu to select the value of the cut-off frequency of the pre-filter high-pass hardware, in Hz.

AVG: checkbox by which the user can select/de-select the EEG electrodes that will be used to compose the averaged trace for EEG reference (AVG). It is possible to make the same modifications by selecting the menu **Reference - AVG setup** from EEG acquisition window.

NOTE: it is not possible to select polygraphy electrodes for AVG.

Map: only active for the EEG electrodes; appears if electrode is present in map. If the user clicks on it, the Electrode Position window is opened.

Latitude: only active for EEG electrodes; displays the latitude of the electrode in map. If the user clicks on it, the Electrode Position window is opened.

Longitude: only active for EEG electrodes; displays the longitude of the electrode in map. If the user clicks on it, the Electrode Position window is opened.

Electrode Description: field where the user can freely type a comment (max 31 characters).

The Status Bar

On the bottom of the Modify Connection window, the status bar shows some information about the current connection: number and name of the connection, status of the oximeter (on or off), and status of the 16 DC module (on or off).

Particular Functions

Auto-Name: only available for EEG channels. Holding the CTRL key while left-clicking on the positive free label of an EEG channel opens a window with two textboxes. Type the prefix for the labels (0 to 3 characters maximum) and the number of labels to be involved, press OK, and a specific number of labels will be automatically introduced starting from the selected label; they are named xxx01 and xxx02, where xxx are the typed characters. The function will interrupt at the first occurrence of a non-EEG channel.

Label Cancellation: only available for EEG channels with a free label. The user selects a label and then presses CTRL+CANC: the label will be cancelled and all the subsequent labels will be shifted upwards by one place. The function stops when it finds a EEG label that is not free or a polygraphy label. The last EEG free label will be substituted with the string " ," or indeterminate label.

Types of Connections

For types of connections are intended for the acquisition modes that depend on the type of headbox used, and in the case of some SD amplifiers, even depend on the jackbox connected to the headbox.

Each acquisition mode is identified by a code (that the user cannot modify). Some of the codes are easy to interpret:

- The letter C as a prefix indicates the number of channels to a COMMON reference, that is, the EEG channels that have negative input in common called G2. For example, C21 indicates 21 EEG channels
- The letter P as suffix indicates the presence of polygraph channels; the number of these channels depend on the type of headbox (generally it is the difference between the total number of channels and the maximum number of EEG channels). For example, a SAM25 headbox: the C21P indicates 21 EEG channels and 4 polygraph channels, and the C8P indicates 8 EEG channels, but has always 4 polygraph channels

The following grid shows the available acquisition modes for each headbox and its description.

SAM25FO - SAM25FOrev

C21P	21 EEG channels, 4 polygraph channels
C21	21 EEG channels, 1 marker channel (not user modifiable)
C19P	19 EEG channels, 4 polygraph channels
C19	19 EEG channels, 1 marker channel (not user modifiable)
C12	12 EEG channels
C8P	8 EEG channels, 4 polygraph channels
C8	8 EEG channels

SAM32FO - SAM32FOrev

C21P	21 EEG channels, 11 polygraph channels
C21	21 EEG channels, 1 marker channel (not user modifiable)
C19P	19 EEG channels, 11 polygraph channels
C19	19 EEG channels, 1 marker channel (not user modifiable)
C12	12 EEG channels
C8P	8 EEG channels, 11 polygraph channels
C8	8 EEG channels (the first jackbox is active only)
C24P	24 EEG channels, 8 polygraph channels. This acquisition mode requires an external intervention added to the electrode connections. In fact, it derives from C21P, in the sense that the first 21 electrodes are real EEG electrodes and the rest are all polygraph electrodes, but the first 3 polygraph electrodes follow the EEG ones (electrodes from 22 to 24) and are treated in acquisition as in review as common reference electrodes. This reference must be performed by the operator via the electrical connection of the negative input of these channels with the input channel called G2. This operation is of fundamental importance to a correct acquisition from signals coming from these electrodes, and is highlighted by a different background color of the electrodes and by the script "connect negative input to G2" in the description field.

SD Amplifiers

The **SD** amplifiers are divided into two categories:

- Amplifiers with jackbox: **SD, SD64c, SD128c.**
- Amplifiers without jackbox: **SD64, SD96, SD128. SD32Compact**

SD with JB 21P - JB 21P Rev Jackboxes

C32	32 EEG channels. This acquisition mode requires an external intervention added to the electrode connections. In fact, it derives from C21P, in the a sense that the first 21 electrodes are real EEG electrodes and the rest are all polygraph electrodes, but they are all treated in acquisition as in review as common reference electrodes. This reference must be performed by the operator via the electrical connection of the negative input of these channels with the input channel called G2. This operation is of fundamental importance to a correct acquisition from signals coming from these electrodes, and is highlighted by a different background color of the electrodes and by the script "connect negative input to G2" in the description field.
C21P	21 EEG channels, 11 polygraph channels
C21	21 EEG channels
C19P	19 EEG channels, 11 polygraph channels
C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 11 polygraph channels
C8	8 EEG channels
C25P	25 EEG channels, 7 polygraph channels. This acquisition mode requires an external intervention added to the electrode connections. In fact, it derives from C21P, in the sense that the first 21 electrodes are real EEG electrodes and the rest are all polygraph electrodes, but the first 4 of polygraph electrodes follow the EEG ones (electrodes 22 to 25) are treated in acquisition as in review as common reference electrodes. This reference must be performed by the operator via the electrical connection of the negative input of these channels with the input channel called G2. This operation is of fundamental importance to a correct acquisition from signals coming from these electrodes, and is highlighted by a different background color of the electrodes and by the script "connect negative input to G2" in the description field.
C27P	27 EEG channels, 5 polygraph channels. Like C25P, there are 6 modifiable channels instead of 4
C31P	31 EEG channels, 1 polygraph channel. Like C25P, there are 10 modifiable channels instead of 4

SD with JBMini Jackboxes

C26P	26 EEG channels, 6 polygraph channels
C32	32 EEG channels
C19	19 EEG channels

C12	12 EEG channels
C8	8 EEG channels

NOTE: to switch from the C26P mode to the others, the user must be sure to set the knob on the front panel of the jackbox correctly, that commutes the connection of the input channels 27, 28, 29, 30, 31, and 32 from bipolar to common reference.

SD with JBBip Jackbox

32P	32 polygraph channels
-----	-----------------------

SD with JBM12 Jackbox

C16P	16 EEG channels, 16 polygraph channels
C12P	12 EEG channels, 20 polygraph channels

NOTE: to switch to another mode, the user must be sure to set the knob on the front panel of the jackbox correctly, that commutes the connection of the input channels 13,14,15, and 16 from bipolar to common reference.

SD64c with JBMini Jackbox

C64	64 EEG channels
C58P	58 EEG channels, 6 polygraph channels (the last 6 channels depend on the jackbox)
C52P	52 EEG channels, 12 polygraph channels
C26P	26 EEG channels, 6 polygraph channels (the first jackbox is active only)
C32	32 EEG channels (the first jackbox is active only)
C19	19 EEG channels (the first jackbox is active only)
C12	12 EEG channels (the first jackbox is active only)
C8	8 EEG channels (the first jackbox is active only)

NOTE: to switch to the acquisition modes that provide polygraph channels to those with only EEG channels, the user must be sure to set the knob on the front panel of the jackbox correctly, that commutes the connection of the input channels 27, 28, 29, 30, 31, and 32 from bipolar to common reference.

SD64c with JBBip Jackbox

64P	64 polygraph channels
32P	32 polygraph channels (the first jackbox is active only)

SD128c with JBMini Jackbox

C128	128 EEG channels
C122	122 EEG channels, 6 polygraph channels (the last 6 channels of the fourth jackbox)
C116	116 EEG channels, 12 polygraph channels (the last 6 channels of the third and fourth jackboxes)

C110	110 EEG channels, 18 polygraph channels (the last 6 channels of the second, third, and fourth jackboxes)
C104	104 EEG channels, 24 polygraph channels (the last 6 channels of each jackbox)
C96	96 EEG channels (only active for the first three jackboxes)
C64	64 EEG channels (only active for the first two jackboxes)
C26P	26 EEG channels, 6 polygraph channels (the first jackbox is active only)
C32	32 EEG channels (the first jackbox is active only)
C19	19 EEG channels (the first jackbox is active only)
C12	12 EEG channels (the first jackbox is active only)
C8	8 EEG channels (the first jackbox is active only)

NOTE: to switch to the acquisition modes that provide polygraph channels to those with only EEG channels, the user must be sure to set the knob on the front panel of the jackbox correctly, that commutes the connection of the input channels 27, 28, 29, 30, 31, and 32 from bipolar to common reference.

SD128c with JBBip Jackbox

128P	128 polygraph channels
96P	96 polygraph channels (only active the first three jackboxes)
64P	64 polygraph channels (only active the first two jackboxes)
32P	32 polygraph channels (active only the first jackbox)

SD64

C64	64 EEG channels
C56P	56 EEG channels, 8 polygraph channels (the last 8 of the second headbox)
C48P	48 EEG channels, 16 polygraph channels
C32	32 EEG channels (active the first headbox)
C24P	24 EEG channels, 8 polygraph channels (active only the first headbox)
C19	19 EEG channels (active only the first headbox)
C12	12 EEG channels (active only the first headbox)
C8	8 EEG channels (active only the first headbox)

NOTE: to switch to another acquisition mode, the user must be sure to set the knob on the front panel of the headbox correctly, that commutes the connection of the input channels from bipolar to common reference: channels 25 to 32 for the first headbox, and 57 to 64 for the second headbox.

SD96

C96	96 EEG channels
-----	-----------------

C88P	88 EEG channels, 8 polygraph channels (the last 8 of the third headbox)
C80P	56 EEG channels, 16 polygraph channels (the last 8 of the second and third headboxes)
C72P	72 EEG channels, 24 polygraph channels (the last of every headbox)
C64	64 EEG channels (active only the first two headboxes)
C32	32 EEG channels (active only the first headbox)
C24P	24 EEG channels, 8 polygraph channels (active only the first headbox)
C19	19 EEG channels (active only the first headbox)
C12	12 EEG channels (active only the first headbox)
C8	8 EEG channels (active only the first headbox)

NOTE: to switch to another acquisition mode, the user must be sure to set the knob on the front panel of the headbox correctly, that commutes the connection of the input channels from bipolar to common reference: channels 25 to 32 for the first headbox, 57 to 64 for the second headbox, and 89 to 96 for the third headbox.

SD128

C128	128 EEG channels
C120	120 EEG channels, 8 polygraph channels (the last 8 of the fourth headbox)
C112	112 EEG channels, 16 polygraph channels (the last 8 of the third and fourth headboxes)
C104	104 EEG channels, 24 polygraph channels (the last 8 of the second, third, and fourth headboxes)
C96P	56 EEG channels, 16 polygraph channels (the last 8 of each headbox)
C96	96 EEG channels (active only the first three headboxes)
C64	64 EEG channels (active only for the first two headboxes)
C32	32 EEG channels (active only the first headbox)
C24P	24 EEG channels, 8 polygraph channels (active only the first headbox)
C19	19 EEG channels (active only the first headbox)
C12	12 EEG channels (active only the first headbox)
C8	8 EEG channels (active only the first headbox)

NOTE: to switch to another acquisition mode, the user must be sure to set the knob on the front panel of the headbox correctly, that commutes the connection of the input channels from bipolar to common reference: channels 25 to 32 for the first headbox, 57 to 64 for the second headbox, 89 to 96 for the third headbox, and 121 to 128 for the fourth headbox.

SD32 Compact

This headbox is similar to the 32 channel **SD**, but it has no jackbox. 25 EEG channels are put on a head shaped panel while 7 polygraph channels are put on a matrix below. The

inverting input of the 7 polygraph channels can be internally switched to common reference G2 so they can be managed as EEG channels.

C32	32 EEG channels
C31P	31 EEG channels, 1 polygraph channel
C27P	27 EEG channels, 5 polygraph channels
C25P	25 EEG channels, 7 polygraph channels
C21P	21 EEG channels, 7 polygraph channels
C21	21 EEG channels
C19P	19 EEG channels, 7 polygraph channels
C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 7 polygraph channels
C8	8 EEG channels
CFRE	

SD LTM 32 with JB LTM 32P8 Jackbox

C32	32 EEG channels
C24P	24 EEG channels, 8 polygraph channels
C21P	21 EEG channels, 8 polygraph channels
C21	21 EEG channels
C19P	19 EEG channels, 8 polygraph channels
C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 8 polygraph channels
C8	8 EEG channels
CFRE	

SD LTM 64 with JB LTM 32P8 Jackbox

C32	32 EEG channels
C24P	24 EEG channels, 8 polygraph channels
C21P	21 EEG channels, 8 polygraph channels

C21	21 EEG channels
C19P	19 EEG channels, 8 polygraph channels
C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 8 polygraph channels
C8	8 EEG channels
CFRE	

SD LTM 64 with JB LTM 64P6 Jackbox

C64	64 EEG channels
C58P	58 EEG channels, 6 polygraph channels
C32	32 EEG channels
C26P	26 EEG channels, 6 polygraph channels
C21P	21 EEG channels, 6 polygraph channels
C21	21 EEG channels
C19P	19 EEG channels, 6 polygraph channels
C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 6 polygraph channels
C8	8 EEG channels
CFRE	

SD LTM 128 with JB LTM 64P6

C128	128 EEG channels
C116	116 EEG channels, 12 polygraph channels
C96	96 EEG channels
C64	64 EEG channels
C58P	58 EEG channels, 6 polygraph channels
C32	32 EEG channels
C26P	26 EEG channels, 6 polygraph channels
C21P	21 EEG channels, 6 polygraph channels
C21	21 EEG channels
C19P	19 EEG channels, 6 polygraph channels

C19	19 EEG channels
C12	12 EEG channels
C8P	8 EEG channels, 6 polygraph channels
C8	8 EEG channels
CFRE	

SD MRI, SD MRI 3KHz

C19	19 EEG channels
C19P	19 EEG channels, 2 polygraph channels
C30	30 EEG channels
C30P	30 EEG channels, 2 polygraph channels
C31	31 EEG channels
C31P	31 EEG channels, 1 polygraph channel
C32	32 EEG channels
CFRE	

SD MRI 64

C19	19 EEG channels
C19P	19 EEG channels, 2 polygraph channels
C30	30 EEG channels
C30P	30 EEG channels, 2 polygraph channels
C31	31 EEG channels
C31P	31 EEG channels, 1 polygraph channel
C32	32 EEG channels
C59	61 EEG channels
C59P	61 EEG channels, 1 polygraph channel
C61	61 EEG channels
C61P	61 EEG channels, 2 polygraph channels
C64	64 EEG channels
CFRE	

MORPHEUS

C19P	19 EEG channels, 10 polygraph channels, 2 DC inputs
------	---

CFRE	
------	--

Data Average

Digital Trigger Insertion Parameters

In this dialog window, the user can modify the way in which the triggers on the trace in review are inserted. The settings for digital triggers depend on the type of file and may appear disabled.

The following controls can be found in the window:

Value trigger: numerical value that will be assigned to the digital trigger inserted manually. Values 0 to 255 are accepted.

Show textbox at every manual trigger insertion: activating this option makes it possible to view every time the user manually inserts a digital trigger on the trace in a textbox. In the textbox, the numerical value is set in **Value trigger**.

OK: exits, confirming the settings.

Cancel: exits without saving settings.

Information about Trigger

This dialog window appears after the user has selected the item **Show information on trigger** from the menu **Analyze - Data average** and has begun the search by pressing OK in the dialog window that asks to specify the type of trigger, channel, and search interval.

In this window, the research result is viewed: in the top part of the window both the number of analog triggers found in the interval and the user specified channel appear. If the type of file supports the digital trigger in the bottom part of the window, a grid appears indicating the numerical value of the triggers found (**Value trigger**) and the quantity (**# trigger found**).

Delete Trigger

This dialog window appears after the user has selected the item **Delete trigger** from the menu **Analyze - Data Average** and has begun the search by pressing OK in the dialog window that asks to specify the type of trigger, the channel, and search interval.

This window is similar to those with information about trigger, the difference being that the controls for the deletion of triggers are present: in the case of analog triggers, just press the right button; the operation must be confirmed by the user. If the type of file supports digital triggers, another column appears in the relative grid, on the right, that allows the user to select which triggers to delete in base of belonging numerical value. Only selected triggers with a "seen" will be cancelled; this operation also requests user confirmation.

Trigger Insertion on Muscular Activity

This dialog window is accessible selecting the item **Trigger Insertion on Muscular Activity** from the menu **Analyze - Data Average**. The user can set the parameters for the automatic event search recognizable to muscular activity on a particular channel of the trace and, once the search is terminated, confirm the automatic insertion of the trigger in correspondence with the found events.

In the window, the following controls are found:

Trace to Analyze: via this popup menu, the user selects which trace must be examined by the search of events recognizable by muscular activity.

Type of Trigger:

Analog: selecting this option in correspondence with the event an analog trigger is inserted.

Trigger Channel: a channel where analog triggers are positioned.

Digital: selecting this option in correspondence with the event a digital trigger is inserted.

Trigger Value: value of digital triggers inserted. Values 0 to 255 are accepted.

Select Application Interval:

Pre-analysis Parameters: a pre-conditioning of the signal is performed on the trace to be analyzed. The controls that follow allow the user to set the parameters of such an operation.

High Pass Filter: a popup menu that allows the user to select the cut-off frequency of the high pass filter; the values listed are the same that appear in the EEG window.

Low Pass Filter: a popup menu that allows the user to select the cut-off frequency of the low pass filter; the values listed are the same that appear in the EEG window.

Notch: enables/disables the notch filter.

Rectify: enables/disables the rectification of the signal: if enables the negative part of the signal, it is inverted before analysis.

Threshold Value (µV): the determination is an event that leads to muscular activity that is based on the surpass of the threshold on behalf of the signal. In this control, the user can set the value in µV.

Inhibition Time (msec): inhibition time in the event search of muscular activity, in milliseconds, after the revelation of an event.

Data Average

The synchronized average, here called "data average," is a particular procedure that uses the trigger events positioned in an automatic way or manually on the trace during acquisition or review. The program in a second moment can perform a trace scan in search of such events to obtain the average of channel per channel periods of trace delimitation from such events, which is set by the user (from 10 msec to 10 sec). Both analog and digital triggers can be placed on the trace; the two types of triggers are generated automatically from different units (stimulators) and synchronized with particular events. The following grid indicates the main differences between the two types of triggers:

Analog Trigger	Digital Trigger
Positioned on one channel only (it is possible to position the analog trigger on different channels in the same trace)	Appears as an event and does not interest a single channel

Appears as a variation of level of the signal (vertical peak)	The instant and numerical code is memorized
The triggers cannot distinguish one from the other (apart from the channel where they are positioned)	The triggers are distinct from a numerical value; it is possible to perform a synchronized average on groups of trigger with the same code
The number of triggers that can be inserted is limited only by the length of the file (continued)	Maximum 8192 triggers can be inserted
Two triggers must be distant at least a minimum of three samples one from the other)	

NOTE: it is not possible to perform the data average using digital triggers and analog triggers at the same time.

The window of synchronized average is accessible by selecting the item **Data Average** from the menu **Analyze - Data Average**.

Window Description

At the top of the window, two tabs are visible: *Average Parameters* and *Calculation Report*.

Inside the first tab, there are all the parameters set by the user to perform the data average. Inside the second tab, there is a list of the operations which are done during calculation (report) and can be printed or saved into a log file. When the user starts Data Average, the report list is obviously empty.

Average Parameters

This tab is subdivided into various sections that are listed from top to bottom.

Trigger Selection

Two options are visible, *Digital triggers* and *Analog triggers*.

NOTE: if there are not any digital triggers present on the file, upon opening the window of the synchronized average, the part of the controls relative to the digital triggers appears disabled.

Digital Triggers: enables the use of digital trigger for the synchronized average and excludes analog trigger. The following controls become visible:

Trigger Type: opens a dialog window that allows the user to select which triggers to consider for the trace scan to perform the data average. In the grid, three columns appear: *Value trigger* that indicates the value of the triggers found, *#found trigger* that indicates how many triggers in which values were found, and the third column is used to select the triggers in base of value. The selected triggers will be used in the data average.

Total Trigger Selected: in this textbox, the total number of selected digital triggers are shown.

NOTE: if the option *Digital Triggers* is enabled and this number is zero, the average cannot be performed.

Enable Condition: if this option is checked, then the user can set a "condition," that

is how to consider the different triggers as they are disposed on the recorded trace. For example, a particular trigger can be considered a *response trigger* and has to follow another trigger (the *stimulus trigger*) before a specified interval of time; if the stimulus trigger is followed by a different response trigger, then it can be considered a "wrong response" and rejected from the calculation of data average.

Trigger Condition: opens a dialog window where the following values can be set:

Correct Answer Trigger Value: from the popup menu, the user can select the value of trigger that has to be considered as the "correct response" of the patient who receives the stimulus.

Correct Answer Interval: the max time interval (in milliseconds) from the "correct answer" trigger and the previous trigger (the stimulus trigger).

Wrong Answer Trigger Value: the value of triggers that have to be rejected and not considered in the calculation of data average.

Analog Triggers : enables the use of analog triggers for the synchronized average and excludes the use of digital triggers.

Channels Trigger: a popup menu where the user selects the channels of trace in which the scanning of the analog triggers is performed.

NOTE: if this field appears blank, the user cannot proceed with the calculation of the synchronized average.

Select the Interval Where to Apply

A popup menu allows the user to select the interval to find both digital and analog triggers. Underneath, there is a yellow bar that indicates the trace in its full extension, Internally, there is a blue rectangle that indicates the selected interval. If the user has placed a pair of flags on the trace, the choices *Pair of flags*, *All the pair flags*, *All of the traces excluding flags*, etc. appear in the menu. If the interval choice is *Pair of flags* and there are more pairs of flags on the trace, the user can select one of these by clicking on the red rectangles that appear on the yellow bar below. The selected pair then change to blue. As default, the first on the left is selected. If the interval choice is *Specific Interval*, two textboxes appear on the right of the menu where the user can set the beginning time and the end of the application interval.

General Parameters

Analysis Title: the text of the note that will be placed on the trigger event in the file of averages.

Maximum Number of Triggers: maximum number of triggers used in the creation of a single file of averages. Rejected triggers are not counted.

Maximum Number of File: maximum number of averaged files to be created. The number of files created depend on the number of triggers found (and not rejected) divided by the maximum number of triggers used for each file.

Pre-trigger Interval (msec): interval (in milliseconds) of considered trace in the construction of the average PRMA of the trigger event.

Post-trigger Interval (msec): interval (in milliseconds) of trace considered in the construction of the AFTER trigger event.

Total (msec): sum of the time of pre-trigger and post-trigger, in milliseconds.

Output Signal Window: after which the operation of the average increases the resolution (number of bit), in presence of signals particularly weak it is possible to *increase*, in the output file, *the number of bits used in the quantization of the EEG signal*. This operation

reduces but the amplitude size of the quantization window, and in the popup menu are listed on the contrary the amplitude results from the operation increase of the resolution: more is the increase of the resolution and lower is the amplitude of the quantization window. This parameter is critical: in fact an excessive increase in the resolution can create an overflow of the signal if this were to surpass the amplitude of the quantization window.

Apply Signal Window to Polygraphy Channels: if checked, this option allows the user to apply an increment of the resolution bit even to polygraph channels.

Analysis Parameters

During the trace scanning, a pre-analysis on the channels can be performed. Before this can be used for the average, the signal can be conditioned with the correction offset (based on the average of the internal of the window, Interval pre-trigger + post-trigger), filters (high-pass, low-pass and notch), rectification (the negative part of the signal is inverted), and rejected the window of the trace is used (only if the channels for which the rejection does not surpass the pre-stabled threshold).

Offset Correction : a popup menu that allows the user to select the interval used for the offset correction (channel per channel, the calculated average in which the interval is subtracted from all pre-trigger + post-triggers). The following options are available: *None, Pre-trigger, Post-trigger, All interval, and Specific Interval*; in this last on the right horizontal blue bar on the yellow background that indicates the extension of the interval of the offset correction in respect to the intervals pre-trigger + post-trigger; the red vertical line indicates the position relative to the trigger, the two textboxes above the bar allow the user to specify an interval of interest, in the limits set by the extension interval pre-trigger + post-trigger.

Select Channels for Offset Correction: it is possible to exclude some channels from the offset correction. By pressing this button, the user opens a dialog window that allows them to select which channels are excluded from the offset correction.

NOTE: to exclude all channels from the offset correction, the user must select *None* from the popup menu *Offset Correction* .

Enable Filters and Rectification: enables/disables the pre-analysis of the signal based on the high pass, low pass, notch, and rectification filters.

Set Filter and Rectification Parameters: opens a dialog window that allows the user to set the parameters of the high pass, low pass, notch, and rejection filters. The parameters in question are applied simultaneously to all EEG channels, while polygraph channels can be different channel by channel.

Enable Rejection: enables/disables rejection.

Set Rejection Parameters: opens a dialog window that allows the user to set the parameters for the rejection. In a grid, all the channels of the trace appear. It is possible to enable/disable the rejection to set the threshold intervention channel by channel (in μV). It is possible to restore the default values by pressing the **Reset** key.

Other Controls

Start: executes the trace scan and the creation of the averaged EEG file. The created file automatically appears in the window of the EEG archive immediately under the original file.

Stop: interrupts the calculation.

Preview: starts calculation without creating the averaged EEG file, so the user can review

which triggers are rejected and other parameters before performing the final calculation.

Save and Exit: exits the synchronized average program.

Density Spectral Array

Protocol Setup

This window allows the user to set up all the parameters necessary to perform the EEG analysis program. The protocols are chosen in the EEG review window via the popup menu **Protocol Selection** under the menu **Analyze - EEG Analyzer**.

The protocol name (e.g. "New Protocol - 01") is displayed at the top of the window.

There are two kinds of parameters: Calculation parameters and Elaboration parameters. By clicking on the tabs, the user can access the respective sections and modify all parameters.

Calculation Parameters

These parameters are accessible from the **Calculation** tab.

These parameters have an influence on the creation of the file containing the spectral analysis results. Note that the Filtering and Reference have been included in the calculation (even if they are linear parameters) to speed up the display process.

The following items are present:

Overlapping: part of each 2 sec sweep to overlap; the options are **No Overlapping** and **50% Overlapping**.

Tapering: tapering function to be used for FFT calculation; the options are **No Tapering** and **Cosine Tapering**.

Detrending: sweep detrending to remove slopes; the options are **Detrending OFF** and **Detrending ON**.

Reference: EEG Data Reference; the options are Common - **G2**, Average - **AVG**, Biauricular - **A1A2**, Source - **SRC**.

High Filter: the options are **Filter OFF** (see "Hardware Characteristics"), **0.53Hz**, **1.6Hz**, **2.0Hz**.

Low Filter: the options are **Filter OFF**, **15Hz**, **70Hz**.

Notch: notch filter; the options are **Notch OFF**, **Notch 50Hz**, **Notch 60Hz**.

Anti-artefact: here, the user can select the type of algorithm to suppress artefacts.

Period of Calculation: seconds of each Spectrum, from 2 seconds upwards.

Display Base Time: total base time of a display cell, from 2 seconds upwards.

Interval Type: specifies the interval of trace to be analyzed; the options are **All Trace** or **All Selection Trace**, that is only the trace between flags.

Elaboration Parameters

These parameters define the type of elaboration to be performed on data to obtain the desired value. These parameters can be modified at any time during the analysis process, since they only affect the calculation previous to data display. They are accessible from all other tabs.

Derivations

Selection of EEG Bipolar channels to be analyzed; the user can select any recorded EEG channel from the popup menu which appears by clicking on the grid cells.

Groups

Selection of groups of EEG channels to be analyzed.

About the use of a group: the analysis will be performed on the averaged signal of the channels belonging to the group.

The user can define up to 16 groups:

- Selecting one of them from the popup menu on the top
- Typing the group name in the textbox below
- Adding channels by clicking on the grid, inside the cells of the column named **Pos.Input**, and selecting a recorded EEG channel from the available popup menu

Bands

Five frequency bands are always active (1 to 4: **Delta**, **Theta**, **Alpha**, **Beta1**, and one **Extra Band**), plus two optional bands that can be activated by clicking the respective checkbox on the left (band 5 is **Beta2**, and band 6 is **Gamma**).

Each frequency band can be renamed, and its frequency limits can be changed by choosing them from the popup menu on the right. For the first band, it is possible to change both the starting and the ending frequency. For the next bands, this is only possible for the ending frequency because the starting frequency is fixed at 0.5Hz over the ending frequency of the previous band (e.g. if the ending frequency of band 1, named *Delta*, is 3.5Hz then the starting frequency of band 2, named *Theta*, is fixed to 4Hz).

- Band1 up through Band6 limits are contiguous, while Extra Band specifies an interval that can overlap any other band range

-
- Contiguous bands automatically define the Usable Band, which ranges from the lower limit of band 1 to the upper limit of band 4 (or band 5 or band 6, depending on the maximum number of defined bands)
 - Total Band is automatically set to 128Hz.

Index

The user can define and use up to 16 indexes.

An index is defined by the formula $K \times \text{Num} / \text{Den}$, where K, Num e Den have to be set by the user.

The following items are present:

Index: selection of the index (1 to 16) from the popup menu

K: set the K factor by typing the value in the textbox or by changing the actual value using the up/down arrows.

Num Oper: selection of the numerator operator from the popup menu. The numerator, Num, is composed of two parts, A and B, that are related through a multiplication, addition, or subtraction operator. Then the numerator, Num, may be $A \times B$, $A + B$, or $A - B$.

Den Oper: set the denominator operator from the popup menu. The denominator Den is composed of two parts, C and D, that are related through a multiplication, addition, or subtraction operator. Then the numerator, Den, may be $C \times D$, $C + D$, or $C - D$.

There is a table with 5 columns, used for the definition of the factor A, B, C, and D. In particular, for each factor, the user has to select:

Channel Type: the channel type (Monopolar, Bipolar, Group) from the selection in the popup menu.

Channel Name: the channel name from the selection in the popup menu.

Data Type: the data type from the selection in the popup menu.

Data Index: the data index from the selection in the popup menu.

Layout

In this tab, the user can define the graphic layout of the EEG Analyzer form. By dragging the items from the left to the cells of the grid, the user can dispose which item to display and its position. To remove an item just drag the trash bin over it.

Ascii

In this tab, the user can set which parameters are available for display and have to be exported to the ASCII file.

The user can set the source (*Channel Name*) and the type of data (*Data Type*) inside the grid:

Channel	Description	Possible Value
Monopolar	Channel raw data (Common reference EEG or Polygraphy Channels)	Any recorded channel
Bipolar	Selection of EEG Bipolar channels to be analyzed	Any recorded EEG channel
Group	Selection of group of EEG channels to be analyzed	Any recorded EEG channel
Data Type	Description	
Numerical Value		
Absolute Power	Calculated in ALL available bands (Band 1...Band 6, Extra, Useful, Total)	
Relative Power	Calculated in ALL available bands (Band 1...Band 6, Extra)	
SEF = Spectral Edge Frequency	Calculated in ALL available bands (Band 1...Band 6, Extra, Useful, Total)	
PF = Peak Frequency	Calculated in ALL available bands (Band 1...Band 6, Extra, Useful, Total)	
MDF = Main Domain Frequency	Calculated in ALL available bands (Band 1...Band 6, Extra, Useful, Total)	
MF = Median Frequency	Calculated in ALL available bands (Band 1...Band 6, Extra, Useful, Total)	
User Index	Combination of the calculated data	
Signal Value	Mean, Max, or Min value of a channel in Time	
BSR = Burst Suppression Ratio	Index of Suppression of the trace	
Average Coherence		
Integrated Amplitude		
Tachogram in bpm		
Tachogram in s		

NOTE: the analysis of polygraphic channels is always performed on raw data, which are directly recorded in bipolar.

General

In this tab, there are three sections:

Acoustic Alarm: can be activated or not. If it is activated, the user can set the volume (Mute, or a progress value between Min and Max).

Adapt Time Base to Trace: can be activated or not.

Cell Background Color: by clicking on the colored cell, a table with colored cells appears. Click on a cell to fix the corresponding color.

Smart Easy

In this tab, there are three sections:

Choose Smart Easy Method: select a method between available options (Adult, Dinamics Adult, Dinamics Children, NewBorn Children). For each method, a brief description is included with the requirements.

File: the user can choose whether or not to create the File Inf.

Smart Easy Method Time Control: the user can choose whether or not to disable Time Control.

Advanced

In this tab, there are two sections:

BSR Settings: the user can set the Burst Suppression Ratio parameters. Use the up/down arrows to set the BSR Threshold (in microV) and the BSR Duration (in ms).

Select ECG Label: select the option "Not present" or choose between the available labels on the list.

EEG Analyzer

The "EEG Analyzer" software is a dedicated instrument for the analysis of EEG and Polygraphic signals. It provides quantitative analysis of data both in frequency and in time domain, with the display of evolution of any of the calculated parameters over time.

The EEG Analyzer program let the user configure the type of analysis to be performed, the kind of display to be used, and the kind of data to be exported to the Text file. The text file can be easily imported in EXCEL.

To start EEG Analyzer, the user must open an EEG file in review mode and choose **Start EEG Analyzer** from the **Analyze - EEG Analyzer** menu. The other menu items (**Protocol Setup, Protocol Selection, and Refresh**) are functional to set all program parameters and to force screen refresh. All user definable parameters are stored in a configuration file ("EA_Analyzer.prg") and can be recalled at any time.

The kinds of data display available are:

DSA (Density Spectral Array) and **Trend**.

Calculation Scheme

Data elaboration always starts from the EEG raw data, which also includes the polygraphic data recorded into the ".trc" file. The analysis is then divided into:

Linear Parameters: the results of the calculation of these parameters (complex DT and others) are stored in the ".fft" file that is created the first time the analysis is performed. The file must be recalculated if any of the analysis parameters are changed. Data is then taken from this file any time its display is requested.

Non-Linear Parameters: these parameters are calculated any time their display is required.

Maps

Introduction

This section describes the functions and the commands of EEG and EP software that characterizes SystemPlus Maps Analysis. The user's minimum requirements are a good knowledge of clinical meaning and exam methods.

Types of Maps

Two types of maps exist:

- Amplitude Maps
- Frequency Maps

Together with frequency maps, it is possible to conduct spectral analysis viewed in the same way where the electrodes are placed on the patient's head.

Access to the Maps Section

To access the Maps section, the user must first open the review section of an EEG or EP trace and then select the sub-menu, "MAPS," from the Analyze menu. Here, the user will find two items that permit access to the Amplitude maps or Frequency maps and spectrums sections. It is possible to accomplish the same thing by pressing one of the two keys present on the toolbar, if visible.

When the map windows are active, the main menu changes and the keys that are present on the eventual toolbars can be activated or deactivated according to the functions forecasted for that type of analysis.

Menu, Toolbar, and Status Bar

Menu

When the user accesses one of the two sections, Amplitude Maps or Frequency Maps and Spectrums, the main menu changes.

The Map menu has the following items: File Menu, Modify Menu, Tools Menu, Window Menu, Help Menu. Below that, is the map toolbar and at the bottom of the window, there is the map status bar.

File Menu

Open	Opens another exam of file choosing from the archive screen
Save	Disabled
Print Screen	This function allows the user to print what is shown on the monitor
Print Setup	Sets the printer parameters
Properties	This function allows the user to access the properties of the map program. Refer to Amplitude Map Settings" or "Frequency Map Settings"

Disk Properties	Disabled
Export	This function allows the user to export the data of the signal in ASCII format or export a graphic file
Exit	This function allows the user to return to the Archive section

Modify Menu

Copy	This function allows the user to copy the maps of the relative trace onto the clipboard for an eventual insertion into the comment section
Electrode Position	Gives access to the electrode position window. Please refer to the "Electrode Position" section
Show Info	
Electrodes	Allows the user to view the electrodes on the map. If they are shown, it is possible, by moving the cursor over these, to read the name (label) and the value of the signal at that point (time instant of the corresponding map)
Description	Allows the user to view the textbox that is shown under the map, where the position of the map is rendered in distance per second from the beginning of the trace
Cursor Band	This function is only active when there are a lot of maps. If the background is light blue and the button appears pressed, this indicates that the cursors are joined. This is represented by a vertical gray bar that joins the blue cursors on the EEG trace regarding the maps. When the icon is gray, the cursors are free and can be moved one at a time on the trace
Step	Indicates the distance between every cursor and the following (in milliseconds for EEG and in pixels for EP) and is only active if the cursors are joined. It is possible to change the interval by typing a new value and pressing ENTER. If the maps are not immediately refreshed, select REFRESH from the same menu, or press the relative key on the toolbar
Draw Mode	When selected, this function allows the user to move the cursors without recalculating the maps each time; in that case refresh has to be called manually as required
Refresh	Refreshes the screen and recalculates the maps

Tools Menu

It is possible to access two advanced functions regarding amplitude amps and frequency maps via this menu.

Dynamic Maps	This item allows the user to access the section Amplitude Dynamic Maps
3D Maps	This item allows the user to access the section Three- dimensional Maps

Window Menu

Cascade	Displays all open windows in cascade (one on top of another horizontally or vertically)
Tile Horizontally	Displays in the open windows horizontally
Tile Vertically	Displays in the open windows vertically
List of Windows	List of opened windows. The active window is marked with a check sign on the left

Help Menu

Help Online	Opens Help window
Hotkeys Help	Opens a panel to the right that shows all defined hotkeys
NOTE: there are no hotkeys defined for the report window.	
About	Disabled

Tool bar



The toolbar contains the main items of the Maps menu grouped and easily reachable via keys. These functions are:

- **Property** (File Menu)
- **Cursor Band** (Modify Menu)
- **Interval** (Modify Menu)
- **Draw Mode** (Modify Menu)
- **Refresh** (Modify Menu)
- Dynamic Maps (Tools Menu)
- Amplitude Maps
- Frequency Maps

The last two buttons on the right are to recall the amplitude maps window and the frequency maps window, which appear disabled when the map window is active and enabled if the trace window is active.

Status Bar

The status bar of the maps program presents various settings for the maps themselves.

From left: the type of reference (G2 indicates common reference), the cut-off frequency of the high pass filter and the low pass filter, the notch filter presence and the type of scale applied to the map. The same settings are found when the user sets the maps.

When working with frequency maps, the type of interval on the trace is indicated in the position where the calculation is made (see the "Frequency Map" section).

Amplitude Maps

Amplitude Maps

Amplitude maps are a graphic view of the signal amplitude according to the position of the electrodes on the patient's head.

The Window

The window is made up of various components: one or more circles indicate the patient's head and the colors indicate the distribution of the amplitude (one color corresponds to a signal value) to a determined instant of the EEG or EP trace. Each circle is a map.

The Cursors on the Trace

Cursors are positioned on the EEG or EP trace and each one represents a temporary interval that corresponds with a relative map. More precisely, the map on the top left corresponds with the first left cursor, the map on the top right corresponds with the second cursor, the map in the middle left with the third map and so on.

Before calculating the maps of a trace, the user must open it for review (as explained in the introduction). Once the option "Amplitude Maps" has been selected, the two windows can be put side by side, the one with the trace and the one with the maps. On the trace, the cursors are visible (joined or free).

The cursors can be moved by dragging them with the mouse (drag & drop) and the maps are recalculated every time. The cursors can be free or joined. In the first case (free cursors) it is possible to move them one at a time, in the second case (joined) they are grouped together in a gray band; it is possible to move them together by dragging the gray band. With joined cursors it is possible to move the first and the last of these. The in-between cursors are automatically moved in a way to keep a constant interval between themselves.

Other Graphic Symbols

Next to the maps there are other indications used to define the images and the calculation parameters better. Nearby, there is a correspondence scale between color and amplitude, and the corresponding minimum and maximum values are at the extremities of the two scales. Under the map, there is a textbox that indicates the cursor position in seconds from the beginning of the trace page. On the top right and left of each map there are two textboxes labeled **L** and **R** that indicate the left side or the right side of the patient's head.

The user will find symbols (squares or black circles) on the map that indicate the electrodes. The name of the corresponding electrode appears by moving the cursor over these symbols. These are the only points where a correct correspondence of the measured signal is effective. The amplitude value of all the points between the electrodes is calculated with an interpolation algorithm where the parameters are set via an actual window (see "Algorithm" section). The electrodes shown on the maps can be in a different position than the actual physical position on the patient's head (electrode position can be modified by the user, see the "Electrode Position" section). It is the user's responsibility to keep the correct correspondence between the two.

Electrodes

Default electrodes are:

8 channels: Fp1, Fp2, C3, C4, T3, T4, O1, O2

12 channels: Fp1, Fp2, F7, Fz, F8, C3, C4, T5, Pz, T6, O1, O2

19 channels: Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2

21 channels: Fp1, Fpz, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2, Oz

Amplitude Map Settings

A dialog window allows the user to set the calculation parameters and visual appearance of the amplitude maps. The following options are found within:

- **Algorithm:** to define the algorithm calculation parameters.
- **Scale:** to define graphic parameters in which the maps are designed.
- **Appearance:** complete appearance of the map window.

On the lower part of the screen, the following buttons are found: pressing **OK** allows the user to exit from the screen and save all the modifications made in the map setup, while pressing **Cancel** allows the user to exit WITHOUT saving the modifications (the same thing happens when the user closes the window by pressing X on the right of the title bar).

Algorithm

These are the parameters for the calculation of the amplitude maps.

Interpolation

In the popup menu, the user may select three different types of interpolation:

K-*nn*: interpolation method of the number of electrodes nearer to the calculation point.

Spline *pl*: spline plane type of interpolation.

Spline *sf*: spline spherical type of interpolation.

Other parameters intervene in the interpolation algorithm:

M: grade of the interpolation polynomial.

K: number of electrodes considered in the interpolation of the value at any point.

These two parameters are optimized and it is recommended to leave the default values.

Resolution: a type of popup menu. The resolution is the number of internally interpolated points on the maps and indicates the calculation matrix dimension.

Interpolation Time for Each Map: this function indicates the time that is needed to calculate each map. The total time is shown in the yellow textbox. The time only appears when the **ESTIMATE!** key is pressed.

Common Filter for All Channels

The following filters are common to all channels and their values are shown on the status bar from left to right.

High Pass Filter: a popup menu where the user chooses the value of the cut-off frequency of the high pass filter.

Low Pass Filter: a popup menu where the user chooses the value of the cut-off frequency of the low pass filter.

Notch Filter: control of the type of checkbox that allows the user to choose whether or not to enable the Notch filter. The two values near the filter indicate two possible choices. The selected value must correspond to the frequency of the network voltage.

NOTE: the values of the filters (high pass, low pass, and notch) are taken from the settings of

the first channel of the EEG or EP trace.

Scale

Scale Colors: is a colored vertical bar that indicates the correspondence between a color and the signal amplitude. One extremity of the scale corresponds with the minimum value of amplitude and the other to the maximum value, while the in between colors corresponds with the in-between values (according to a linear scale). The user can select different color scales by using the nearby arrows.

Amplitude Map Scale

Balanced: a balanced color scale that has minimum and maximum symmetrical amplitudes, with respect to zero. The values can be set using the nearby textbox. Use the nearby arrows to increase and decrease the values of intervals 1- 100 $\mu\text{V}/\text{mm}$ by $10\mu\text{V}$.

Distributed: the highest and lowest values of all the maps are automatically calculated and the color extremes are assigned to the scales.

Special: different values can be assigned via the nearby textboxes via the arrows, with intervals of $10\mu\text{V}$, or by typing the desired value in the textbox and pressing the ENTER key.

NOTE: the user can automatically switch from the balanced, to distributed, to special scales by double-clicking on the color scale near each map.

Appearance

In this sub-section, the user can change the visual appearance of the window, according to the following parameters:

Map Number: a popup menu that allows the user to set the number of maps to be viewed, this can be **1, 4, 8, 32**. A cursor on the EEG or EP trace corresponds to a map. The order for the maps goes from left to right and from top to bottom, that is, the first map on the top left corresponds to the first cursor. The map on the bottom right corresponds to the last cursor on the right. All the other maps in the middle represent the in-between cursors.

Graphic Filter

Modifies the singular appearance of every map:

Circular: this popup menu allows the user to choose the head shape. For the moment, the only possibility is circular.

Electrode Presence: the user has the possibility to make the electrodes visible or not by clicking on the checkbox. The user can choose the appearance of the electrodes by selecting one of the two nearby choices.

Description: the user has the possibility to make the yellow textbox (under the map where the distance in seconds from the start of the page to the relative cursor is shown) visible or not by clicking on the checkbox.

NOTE: if 32 maps are viewed, it is recommended to deactivate the Description option because it is easier to see the maps.

Cursor Movement

Fixed Interval Cursors: this function is only available when a lot of maps are viewed. The cursors at fixed intervals are a togetherness of cursors, one for each map, indicated on the trace by a blue vertical line grouped by a gray band. The user can set the distance between the cursors (indicated in milliseconds) in a nearby textbox. The band between the cursors allows the user to move all the cursors at the same time along the trace. On the toolbar,

this is indicated by a grooved icon with vertical blue lines on a light blue background, while the un-grooved icon with gray lines indicates the possibility to move a cursor at a time. The interval can be changed by moving the first or the last cursor on the trace (joined cursors) and dragging them with the mouse (drag & drop method). The interval represents the distance between the first cursor and the second, between the second and third, and so on. For EEG trace, the unit measure is milliseconds while for EP traces ,pixels are used.

Single Cursor: the free cursor mode is used when selecting Single Cursor, each time that the map window is opened.

Frequency Maps and Spectrums

Frequency Maps

Frequency maps allow analysis of the topographic distribution on the patient's head of the original signal transformed in the frequency domain and divided into spectral bands, each one covering a determined frequency range. From the original data, we can obtain the spectrums of the signal of each channel (linear scale or logarithmic), the maps of absolute power spectrums (linear scale or logarithmic), or relative power maps.

Analysis is average type and therefore we need to define the interval where it is performed. The user can analyze different parts of the EEG trace, but it is necessary to mark the initial points and end points of every interested part via the insertion of a pair of flags on the trace.

Flags

Flags are placed on the trace by the user. The user needs a pair of flags to define an interval of trace where to calculate the maps. The trace can have more than one pair of flags. The analysis of the maps will keep in count of the average of the spectrums calculated on all the selected intervals.

According to Fourier analysis methods, spectral analysis happens when dividing the data of the trace into intervals of two seconds (considered interval "acceptable" in order to have a stabile). This time results as a minimum interval that the user can analyze; in other words, it is not possible to analyze parts of trace less than two seconds in length. The transformation results of all the intervals of the selected signal are elaborated to obtain an average signal spectrum, in which maps can be extracted.

Therefore, the interval defined by the flags must be a multiple of two seconds. For example, if we insert a pair of flags with the first at 10.8 seconds from the beginning of the trace and the second at 47.2 seconds, the frequency analysis in this period starts from 12.0 seconds until 46.0 seconds from the beginning of the trace, for a complete interval of 34 seconds.

Other Graphic Symbols

Next to the maps, there are other indications used to define the images and the calculation parameters better. Nearby, there is a correspondence scale between color and amplitude, and the corresponding minimum and maximum values at the extremities of the two scales. Under the map, there is a textbox that indicates the cursor position in seconds from the beginning of the trace page. On the top right and left of each map, there are two textboxes labeled **L** and **R** that indicate the left side or the right side of the patient's head.

The user will find symbols (squares or black circles) that indicate the electrodes on the map. The name of the corresponding electrode appears by moving the cursor over these symbols. These are the only points where a correct correspondence of the measured

signal is effective. The amplitude value of all the points between the electrodes is calculated with an interpolation algorithm, where the parameters are set via an actual window (see “Algorithm” section). The electrodes shown on the maps can be in a different position than the actual physical position on the patient's head (their initial setting can be modified by the user, see the “Electrode Position” section). It is the user's responsibility to keep the correct correspondence between the two.

Electrodes

Default electrodes are:

8 channels: Fp1, Fp2, C3, C4, T3, T4, O1, O2

12 channels: Fp1, Fp2, F7, Fz, F8, C3, C4, T5, Pz, T6, O1, O2

19 channels: Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2

21 channels: Fp1, Fpz, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2, Oz

Access to the Frequency Maps and Spectrums

To access the Frequency maps, the user must open an EEG trace in review. From the **Analyze** menu and the sub-menu **Maps** choose the item **Frequency Maps**. A dialog window appears that allows the user to choose the type of maps and the calculation interval.

Below the title bar, there is a toolbar with two icons. The icon with a circle represents the frequency maps while the other one with a graphic indicates spectrums; the corresponding windows open by pressing this.

The blue textbox below the toolbar shows the patient's name, the data, and hour of recording.

The yellow textbox indicates the traces in length and red horizontal rectangles appear on it or blue that indicate the defined parts from the pair of flags. The blue parts are those selected for the calculation, the red ones are de-selected.

To select the data for analysis, five possible options include:

- **Flag pairs:** this option allows the user to choose one pair of flags only as markers of the part to be analyzed.
- **All the Flag pairs:** analysis on the parts of the traces delimited by all the present pairs of flags.
- **Whole Trace:** analysis is done on the whole trace.
- **From/To:** the two textboxes are enabled where the user types the values of the initial instant and of the final instant of the analysis.
- **All trace apart the flag pairs:** the selection is inverted in respect to the second possibility.

IMPORTANT: the flag pairs must be placed on the trace before performing a frequency analysis.

Frequency Map Settings

A dialog window allows the user to set the calculation parameters and visual appearance of the amplitude maps. The following options are found within:

- **Algorithm:** to define the algorithm calculation parameters.

- **Scale:** to define graphic parameters in which the maps are designed.
- **Appearance:** complete appearance of the map window.
- **Frequency Bands:** every map is calculated in a determined frequency band that can be modified.

On the lower part of the screen, the following buttons are found: pressing **OK** allows the user to exit from the screen and save all the modifications made in the map setup, while pressing **Cancel** allows the user to exit WITHOUT saving the modifications (the same thing happens when the user closes the window by pressing X on the right of the title bar).

Algorithm

These are the parameters for the calculation of the Frequency maps:

Interpolation

The user may select three different types of interpolation in the popup menu:

K-nn: interpolation method of the number of electrodes nearer to the calculation point.

Spline pl: spline plane type of interpolation.

Spline sf: spline spherical type of interpolation.

Other parameters intervene in the interpolation algorithm:

M: grade of the interpolation polynomial.

K: number of electrodes considered in the interpolation of the value in any point.

These two parameters are optimized and it is recommended to leave the default values.

Resolution: a type of popup menu. The resolution is the number of internally interpolated points on the maps and indicates the calculation matrix dimension.

Interpolation Time for each map: this function indicates the time that is needed to calculate each map. The total time is shown in the yellow textbox. The time only appears when the **ESTIMATE!** button is pressed.

Common Filter for All Channels

The following filters are common to all channels and their values are shown on the status bar from left to right.

High Pass Filter: a popup menu where the user chooses the value of the cut-off frequency of the high pass filter.

Low Pass Filter: a popup menu where the user chooses the value of the cut-off frequency of the low pass filter.

Notch Filter: control of the type of checkbox that allows the user to choose whether or not to enable the notch filter. The two values near the filter indicate the two possible choices. The selected value must correspond to the frequency of the network voltage.

IMPORTANT: the values of the filters (high pass, low pass, and notch) are taken from the settings of the first channel of the EEG or EP trace.

FFT Parameters

Tapering: this option allows the user to reduce the leakage of spectral components.

Detrending: this option allows the user to remove slopes (slow components) of the signal to be analyzed.

Scale

Scale Colors: is a colored vertical bar that indicates the correspondence between a color and the signal amplitude. One extremity of the scale corresponds with the minimum value of amplitude and the other one with the maximum value, while the in-between colors correspond with the in-between values (according to a linear scale). The user can select different color scales by using the nearby arrows.

Frequency Map scale

Balanced: a balanced color scale that has minimum and maximum symmetrical amplitudes, with respect to zero. The values can be set using the nearby textbox. Use the nearby arrows to increase and decrease the values of intervals by $10\mu\text{V}$.

Distributed: the highest and lowest values of all the maps are automatically calculated and the color extremes are assigned to the scales.

Special: different values can be assigned via the nearby textboxes via the arrows with intervals of $10\mu\text{V}$, or by typing the desired value into the textbox and pressing the ENTER key.

NOTE: the user can automatically switch from the balanced, to distributed, to special scales by double-clicking on the color scale near each map.

Appearance

In this sub-section, the user can change the visual appearance of the window, according to the following parameters:

Number of Maps: a popup menu that allows the user to set the number of maps to be viewed, this can be **1, 4, 8, 32**. A cursor on the EEG or EP trace corresponds with a map. The order for the maps goes from left to right and from top to bottom, that is, the first map on the top left corresponds with the first cursor. The map on the bottom right corresponds with the last cursor on the right. All the other maps in the middle represent the in-between cursors.

Graphic Filter: modifies the singular appearance of every map.

Circular: this popup menu allows the user to choose the head shape. For the moment, the only possibility is circular.

Electrode Presence: the user has the possibility to make the electrodes visible or not by clicking on the checkbox; the user can choose the appearance of the electrodes by selecting one of the two nearby choices.

Description: The user has the possibility to make the yellow textbox (under the map where the distance in seconds from the start of the page to the relative cursor is shown) visible or not by clicking on the checkbox.

NOTE: if 32 maps are viewed, it is recommended to deactivate the Description option because it is easier to see the maps.

Frequency Bands

This option grid is only active for frequency maps, and not for amplitude maps.

The four pairs of textboxes indicate the lower and upper frequency threshold value for each map: **Delta, Theta, Alpha, and Beta**. The user can set the values of each band or leave the default settings, which are always available. To set new values, the user can either click on the arrows or type in the new values and press ENTER.

Restore Defaults: the default values are restored by pressing this button.

Spectral Analysis

Spectral analysis is a window containing many graphics as well as electrodes on the patient's head. Each graphic represents a spectral power in function of the data frequency analysis conducted on the relative signal to that electrode, in the interval defined by the user. The relative electrode names appear by moving the mouse over the graphics.

Below the title bar the user will find the frequency bands indicated: **Delta**, **Theta**, **Alpha**, and **Beta** with values set previously from the maps setup window.

The textbox on the top left indicates the maximum value of the Y-Axis coordinate. The user can modify this value by using the arrows near the box.

The status bar has various other indications (see "Status Bar" section) and shows the type of interval selected for analysis in the last textbox on the right.

Single Spectrum Analysis

It is possible to enlarge the window by clicking on one of these spectrums, permitting the user to observe the spectral analysis of the relative electrode in detail.

The indications of the four bands are always present **Delta**, **Theta**, **Alpha**, and **Beta**, and are the same set by the user in the map properties window.

The textbox on the top left indicates the maximum value for the Y-Axis coordinate. The user can modify this value by using the arrows near the textbox.

The name of the electrode appears by moving the cursor over the spectrum.

If the user moves the vertical yellow bar horizontally, the values of the two textboxes on the top left change automatically and indicate the values of the ordinate and the axis of the graphic in that point respectively from the left.

To return to the main spectral analysis window, click anywhere in the internal part of the window.

Advanced Functions

Dynamic Amplitude Maps

The video of the evolution in time of the amplitude maps of the trace is dealt with.

To see the dynamic amplitude maps, the user must select the item "Dynamic Maps" from the tools menu or click on the corresponding icon on the toolbar.

"Dynamic Maps" are represented by a circle that indicates the patient's head. The squares (or little black circles) indicate the electrode position, symbols **L** and **R** respectively indicate the left and right sides. The color scale is present on the right side of each map. Under the map, there is a textbox with the distance in seconds from the beginning of the trace page.

NOTE: the function of the movement maps uses the same parameters present in the amplitude maps setup. When the user enters the map movement section, the maximum



and minimum values of the scale are calculated starting from the position of the first cursor on the trace.

There is a toolbar composed of eight command keys on the upper part of the map window, from left these are:

- **Start:** moves the cursor from the beginning of the trace.
- **Backwards:** automatically moves the cursors backwards on the trace.
- **Left:** moves the cursor left with an interval step indicated in the textbox on the right.
- **Stop:** stops the video maps.
- **Right:** moves the cursor right with an interval step indicated in the textbox on the right.
- **Forwards:** automatically moves the cursor forward along the trace.
- **End:** moves the cursor to the end of the trace.
- **Steps:** in this textbox, the user can set the interval by directly typing a value between 1 and 9999 (units are in milliseconds for EEG, pixels for EP).

Script appears describing the commands by moving the mouse over the commands on the toolbar.

Three-dimensional Maps

This supplies a three-dimensional display of the amplitude and frequency maps.

This function is only available when the user has set **spline spherical** interpolation in the algorithm grid in the map setup window.

To see the three-dimensional maps, the user must select **3D Maps** from the tools menu or double-click on the left mouse button on one of the maps.



On the upper part of the three-dimensional map, there is a toolbar composed of six keys, from left they are:

- **Backwards:** rotates the head counter-clockwise with intervals of 5°.
- **Stop:** stops rotation.
- **Forwards:** rotates the head clockwise with intervals of 5°.
- **Start:** makes the head return to the start position.
- **Electrodes:** can display the electrodes on the patient's head.
- **Grid:** can display the latitude-longitude grid of the patient's head. Other functions present on the window are:

Color Scale: The color scale is the same set previously in the setup window.

Vertical Scroll Bar: this function allows the user to slant the patient's head on a horizontal level from 0° (flat view) to 90° (side view).

Horizontal Scroll Bar: this function allows the user to rotate the patient's head manually from right to left, from -180° to 180°.

Electrode Position

At times, the user moves one or more electrodes from their default position on the patient's head deliberately. To reflect this change on the analysis maps and given the possibility to update the electrode position manually memorized in the program.

The window of the electrode position can be recalled before trace acquisition by pressing

the **Electrode Position** button when the user is in the Modify Connection window (EEG acquisition) or in review phase of the maps (both amplitude and frequency maps) by selecting the item “Electrode Position” in the Modify menu.

The screen is divided into three sections: the **grid** on the left, the **head** on the right, and the **electrode position database** below.

The Grid

The grid is composed of four columns called: **Active, Electrode, Latitude, Longitude.**

- **Active:** indicates if the electrode is enabled or not. The user can activate the electrodes by clicking the left mouse button on the corresponding checkbox, which makes a symbol appear. The symbol disappears and the electrode is disabled if the left mouse button is pressed again.
- **Electrode:** indicates the electrode name. The EEG channels visible here are selected in the "Modify Connection" window, in acquisition; (recallable only in the acquisition phase of EEG traces.) Refer to the “EEG” section.
- **Latitude:** indicates the latitude of the electrode and can be modified by the user. Click the left mouse button on the desired electrode cell and type the new value.
- **Longitude:** indicates the longitude of the electrode and can be modified by the user. Click the left mouse button on the desired electrode cell and type the new value.

The Head

The head is shaped like the scalp with squares that represent the electrodes. If the electrode that corresponds with a square is active on the map, a black circle appears in the square. These squares can be moved inside the red circle by dragging them with the mouse; in the latitude and longitude columns, the values change automatically. The name of the electrode appears when the user moves the mouse over each square.

Electrode Position Database

Description: if the user wants to vary the electrode position they can choose between a series of available settings. A list of settings appears by clicking on the popup menu, where some are default and others are user-built. It is possible to create a new setting by starting from the initial setting,

modifying the electrode position and their status (active - inactive), and typing a new name in the **Description** field and pressing the **Save** button.

Save: pressing this button makes a new setting in the database of the available settings. If a save of settings with the same name is attempted, the system will produce an error message.

Delete: a selected setting is deleted by pressing this button. Default settings cannot be cancelled. These two functions are present:

Apply: all the modifications applied to the maps are made by pressing this button. If the button is not pressed, the modifications will be lost (even if they are saved in a new database).

Exit: the user presses this button to exit from this window.

NOTE: if modifications have been made and are not saved, they will be lost upon exit.

Statistic

This section describes the functions and commands of the Statistic software.

General Description

The STATISTICS module was developed to provide a program of statistical catalog and elaboration, that is used to:

- Classify, according to the desired group of attributes, every file of the archived patients that are present in the referring database
- Individualize, between the classified files, a group with common characteristics

In a preliminary catalog and statistics elaboration phase, the user must program a togetherness of possible attributes, sub-dividing them into various groups (called classes), each one containing one or more parameters, even organized on different levels (items and sub-items).

Once the attributes have been set, the files are then cataloged, giving them the right attributes of the various classes, items, and sub-items.

The purpose of the statistical elaboration program is to shed light on eventual correlations (both negative and positive) between the available parameters.

Structure of the STATISTICS Module

The STATISTICS software is composed of three functions:

- Statistic Set, for the definition of the togetherness of possible attributes (the statistic tree with its class, items, sub-items)
- Statistic Items, for classification of the pointed file according to the desired group of attributes
- Statistic Search, for statistic elaboration

Statistic Settings

Statistic Settings

This section describes the functions and commands of the software used for the creation of the statistical tree and for the definition and structure of the togetherness of possible attributes, sub-divided into classes, items, and sub-items.

Access to the Statistic Attributes Settings

To access to the **Attributes Settings** section, the user must start from the main Archive window where the list of patients can be seen. There the user must select STATISTIC - SET from the TOOLS menu.

When the window of the **Attributes settings** is active, a main menu is given where the various functions are found. The menu consists of a tree structure, that allows the user to define and build a togetherness of possible statistic attributes, sub-divided into 3 levels (classes, items, and sub-items).

Statistic - Attributes Setup Menu

When accessing the Statistics - Attributes settings section, a main menu appears. Below the Statistics Menu – Setup, the user finds:

File, Options

File Menu

Exit This function allows the user to return to the Archive section

Options Menu

View Title of Memo Node

This function regards the type of representation of the nodes of memo type in the screen of Attributions, statistic parameters, and of Statistical Elaboration. The function allows the user to choose to view the title (fixed part) of the node of memo type as set by the description (a variable part typed by the user)

View Recording Data in Statistics

This function regards the type of representation of the selected attributes for the current file in the Attribution of statistic parameters phase. The function allows the user to choose to view the data that each statistic parameter was attributed to the current file

Construction of the Statistical Attribute Tree

The functions listed here build and modify the tree structure of the statistical attributes. With respect to the current node:

- Press the left mouse button and enter the writing phase of the descriptive string of the node
- Press the right mouse button to pull up a menu that groups the functions for the structure of the possible statistical attributes

The items in the menu are:

Insert Child: this function allows the user to insert a child to the pointed node

Delete Node: this function deletes the pointed node and its attached children

Type of Node: this function allows the user to define the type of pointed node, choosing between:

- **Yes/No**, for a leaf node that can be alternatively selected or not
- **Memo**, for a leaf node that can contain a variable description written by user
- **With Children**, for a node that can have children

Child Selection Node: this function allows the user to define, for the pointed node, the child selection mode, choosing between:

- **Single**, one child at a time can be selected, in Attribution of statistic parameters phase
- **Multiple**, more children can be selected, in Attribution of statistic parameters phase

NOTE: the choice of the child selection mode is active only for nodes with a child. The nodes at the third level are obligatory leaf nodes, therefore it is not possible to set type of node 'with children' or the child selection mode. Functions Insert child and Child selection mode are allowed only for the type of nodes with child.

Attribution of the Statistical Parameters

This section describes the functions and commands of the software used to classify a pointed file according to a desired group of attributes.

Access to the Attribution of Statistical Parameters

To access the **Parameter Attribution** section, the user must begin from the main review window of the patient list and relative exams and file, point to a file (to be cataloged according to the group of attributes) and select STATISTIC ITEMS from the menu that appears after pressing the right mouse button.

When the **Parameter Attribution** window is active, the user is asked to review the *group structured from all the possible statistical attributes* and to review the *attributes already assigned to the current file*.

Keep in mind that the attributes belong to one of the 3 possible levels, called classes, items, and sub-items. Consequently, both the review of the possible attributes and the review of the attributes already assigned to the current file represent a sub-division in levels. In particular:

- All the possible attributes are recalled and reviewed in a list, sub-divided according to the level of belonging (1 list for each of the 3 possible levels). Pointing to an element in the list if the classes (first level of the tree), the items, and sub-items lists (second and third levels of the tree) are updated to view all the children of the pointed element in the list of the classes
- The attributes assigned to the current file are represented in a grid, the first 3 columns represent the 3 possible levels. An option makes it possible to see a fourth column in the grid, where the dates of attribution are shown of the various parameters of the current file

Review of the Group of Possible Statistical Attributes

Keep in mind that the attributes belong to one of 3 possible levels, called classes, items, and sub-items.

In the Parameter Statistical Attribution phase, all possible attributes are recalled and viewed in a list, sub-divided according to the belonging level (1 list for every one of the 3 possible levels). Consequently, in the window of Parameter Statistical Attribution, 3 lists appear with useful things:

- A list that represents the classes (first level of statistics tree). Use the mouse and the keyboard with the arrows to select a class
- A list that represents the items (second level of statistics tree) that belongs to the selected class. Use the mouse and the keyboard with arrows to select an item
- A list to represent the sub-items (third level of the statistics tree) that belongs to the selected item. Use the mouse and the keyboard to select a sub-item

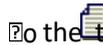
Scrolling the list if the items, automatically is refreshed the list of the sub-items, that views the attributes of a third level that belongs to the selected item. Scrolling the list of classes, automatically are refreshed the lists of the items, sub-items, viewing the attributes of the second and third level that belong to the pointed class.

Symbols

Every element in the list of classes, the list of the items, and in the sub-items list has a symbol that characterizes the type of node, the selection mode, if the type of node is

yes/no or memo, and if it is assigned to the current file or not.

The following symbols are used:

- 
 to characterize the nodes in which the type is **with children** and the possibility of **multiple selection** of children
- 
 to characterize nodes in which the type is **with children** and obstacle of **single selection** of children
- 
 to characterize nodes in which the type is **yes/no** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is not attributed* to the current file
- 
 to characterize nodes in which the type is **yes/no** and obstacle of **single selection** between nodes that belong to the same group; the node *is not attributed* to the current file
- 
 to characterize nodes in which the type is **yes/no** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is attributed* to the current file
- 
 to characterize nodes in which the type is **yes/no** and obstacle of **single selection** between nodes that belong to the same group; the node *is attributed* to the current file
- 
 to characterize the node in which the type is **memo** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is not attributed* to the current file
- 
 to characterize the node in which the type is **memo** and obstacle of **single selection** between nodes that belong to the same group; the node *is not attributed* to the current file
- 
 to characterize the node in which the type is **memo** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is attributed* to the current file
- 
 to characterize the node in which the type is **memo** and obstacle of **single selection** between nodes that belong to the same group; the node *is attributed* to the current file

Review of the Group of the Attributes Assigned to the Current File

Keep in mind that the attributes belong to one of the 3 possible levels, called classes, items, and sub-items.

In the Statistical Parameter attribution phase, the attributions assigned to the current file are summed in a grid of 3 or 4 columns, where:

- The first 3 columns represent respectively the classes, items, and sub-items
- One option makes it possible to see a fourth column of the grid, where the dates of attribution of various parameters to the current file are shown

In the 3 lists that represent the group of possible attributes, the parameters assigned to the current file are highlighted, following these criteria:

- In every one of the 3 lists, the attributes that do not have children in the levels below are signaled in *red* (that is, in the tree structure corresponding to leaf nodes) and have been assigned to the current file

- In the list of classes and of items, attributes that have at least one child is signalled in *green* and has been assigned to the current file.

For example:

- If there has been a sub-item assigned to the current file, this sub-item appears in red in the list of the sub-items, while the items and classes that contain it are shown in green in their respective lists
- If there has been an item assigned to the current file, naturally the list of the sub-items will be empty, the item appears written in red in the item list, while the class that contains it is shown in green in the class list
- If there has been a class assigned to the current file, naturally the items and sub-items list will both be empty, and the class will be written in red in the class list

Parameter Attributions to a Current File

Remember that it is possible to assign the current mask only to attributes that have children, or that the tree structure corresponds to leaf nodes. Therefore:

- Scrolling through the class list, it is possible to attribute the parameters of type class (first level of the tree of the statistics) that do not have children and where the type is yes/no or memo
- Scrolling through the list of the classes and relative items, it is possible to attribute the parameters of item type (second level of the statistics tree) that do not have children and where the type is yes/no or memo.
- Scrolling the list of the classes, the items, and the relative sub-items, it is possible to attribute all the parameters sub-item type (third level of the statistics tree), that do not have children and where the type is yes/no or memo

Choose in the group of possible attributes those to be assigned to the current mask, or scroll through the class list, scroll through the item list, and eventually scroll through the sub-items list in a way to find the corresponding element without children and the yes/no or memo types. Use the left mouse button and with a double-click, the following results are obtained:

- For yes/no nodes, alternatively the pointed attribute is inserted or removed from the togetherness of attributes assigned to the current mask
- For memo nodes, the user enters the script phase of the description. According to the end of the description it is void or no, the pointed attribute is respectively removed or inserted in the group of attributes assigned to the current mask

Statistic Elaboration

This section describes the functions and commands of the software used for Statistical Elaboration, in particular, to individualize a group of common characteristics between files or patients.

Access to the Statistical Elaboration Section

To access the **Statistical Elaboration** section, the user must directly enter it from the Archive section, where the list of patients is present, and select STATISTIC-SEARCH from the TOOLS menu.

When the window of **Statistical Elaboration is active**, some option grids are shown, each one has been designed to group and manage a group of functions (settings of the research masks, filters, representation of the results and elaboration).

Research Mask Setting

Once the user has:

- Programmed the group of possible statistic attributes, sub-divided into various groups (called classed), each one containing 1 or more parameters, even organized into different levels (items and sub-items)
- Classified the archived patient files according to a desired group of attributes, that is those present in the database

-it is possible to individualize a group with common characteristics between the classified files. This function is managed by the Statistical Elaboration module, with the aim to highlight eventual correlations (both positive and negative) between available parameters.

To individualize a group of files (between those classified) with common characteristics, the user must build masks, intended as folders that memorize search criteria, that is in which file conditions it must satisfy to enter the group of interest.

This section describes the functions and commands of the software used for building such research masks.

Filter Settings

Once the user points to the tab called **Filters**, the following will be shown in the window:

- A popup menu that allows the user to choose a search mask between those available, or create a new mask. It is possible to type in the textbox to attribute a title to the pointed mask
- Two checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the date of birth of the patient
- Two checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the recording data of the file
- A popup menu that allows the user to limit the search to only particular types of files
- A checkbox that allows the user to choose to manage the search at a patient or file level as explained previously

In the window there are some buttons associated with the following functions:

- **Research:** starts the search of the all the cataloged files, using the pointed mask and the current settings regarding the attributes, the search modes, and the filters.
- **New Mask:** loads a new mask, it must be configured by the user (regarding the attributes, search modes, filters) before starting the search.
- **Reload Mask:** maintains the original configuration of the mask without saving any modifications made to the current mask.
- **Delete Mask:** deletes the current mask.
- **Cancel:** exits the Statistical Elaboration.

Filter Settings for the Current Mask

For the current mask, it is possible to implore limits regarding the research dominion, introducing one or more of the following restrictions:

- Limit the patient's date of birth inferior
- Limit the patient's date of birth superiorly
- Limit the date of file recording inferior
- Limit the date of file recording superior
- Limit the search to only particular types of files
- Do not allow patient duplication in the result list of the search, as stated previously

If the user introduces one of the four limits, they must select the corresponding checkbox and set the desired data.

If the user would like to limit the search to only particular types of files, they must select the items (one or more than one) corresponding to the types of files interest from the corresponding popup menu.

Regarding the duplication of the patient in the result list:

The aim of the search is to individualize a togetherness of files with common characteristics, between those that are cataloged. In particular, if more files of the same patient have been cataloged and satisfy the search criteria, this patient appears in the results list as many times as the files are cataloged that satisfy the research criteria (search *file level*, is allowed the *duplication of patients* in the result list). If the user wishes that every patient appear more than once in the results list, the user must disable the corresponding checkbox (search *patient level* and the *duplication of patients* is not allowed in the result list).

Search Mode Settings

Once the user points to the tab called **Research**, the Attribution parameter statistic window appears with the following options:

If the user focuses on the popup menu that allows them to choose the search mode for the current grouping, that is for all the attributes that have the same parent of the current node.

The research mode defines, for each group of attributes, the characteristics that the attributes assigned to a file must have to satisfy research criteria (that is if, for every group of attributes, a file can have *only an attribute* between those set, or if it must have them *all*, or if they have *all or no other*, or if they do not have *any of the attributes* set).

There are four available research modes:

- **At Least One:** satisfies all the cataloged files that have, for the current grouping, *at least one attribute* between those set for the search

- **All or More:** satisfies all the files cataloged that have, for the current grouping, *all the attributes* between those set for the search. Keep in mind that the files can also have other attributes belonging to a grouping not set in the search
- **Only:** satisfies all the cataloged files that have, for the current grouping, *all and only the attributes* between those set by the search, in particular such files do not have other attributes belonging to the current grouping and not set for the search (different from the **All or More** mode)
- **None:** satisfies all the files cataloged that do not have, for the current grouping, *any of the attributes* between those set by the search

Research Mode Settings for the Current Mask

Once one or more of the attributes belonging to the same group, or having the same parent, have been assigned to the current mask. Select one of these attributes in the corresponding list (of classes, items, or sub-items) and then choose the search mode using the appropriate popup menu.

Repeat this operation for all the groups of attributes involved in the current mask settings.

Filter Settings

Once the user points to the tab **Filters**, the following will be shown in the window:

- A popup menu that allows the user to choose a search mask between those available, or create a new mask. It is possible to type directly in the textbox to attribute a title to the pointed mask
- Two checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the date of birth of the patient
- Two checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the recording data of the file
- A popup menu that allows the user to limit the search only with particular types of files
- A checkbox that allows the user to choose to manage the research at a patient or file level as explained previously

In the window, some buttons are present that are associated with the following functions:

- **Research:** starts the search of the all the cataloged files, using the pointed mask and the current settings regarding the attributes, the research modes, and the filters.
- **New mask:** loads a new mask that must be configured by the user (regarding the attributes, search modes, and filters) before starting the search.
- **Reload mask:** maintains the original configuration of the mask without saving any modifications made to the current mask.
- **Delete mask:** deletes the current mask.
- **Cancel:** exits the Statistical Elaboration.

Filter Settings for the Current Mask

For the current mask, it is possible to implore limits regarding the search dominion, introducing one or more of the following restrictions:

- Limit the patient's date of birth inferior
- Limit the patient's date of birth superiorly
- Limit the date of file recording inferior
- Limit the date of file recording superior

- Limit the search only to particular types of files
- Do not allow patient duplication in the result list of the research, as stated previously

If the user introduces one of the four limits, select the corresponding checkbox and set the desired data.

If the user would like to limit the search only to particular types of files, select the items (one or more than one) that correspond with the types of files interest from the corresponding popup menu.

Regarding the duplication of the patient in the result list:

The aim of the search is to individualize a togetherness of files, between those cataloged with common characteristics. In particular, if more files of the same patient have been cataloged and satisfy the research criteria, this patient appears in the results list as many times as the files are cataloged that satisfy the research criteria (*search file level*, the *duplication of patients* is allowed in the result list). If the user wishes that every patient appear more than once in the results list, the user must disable the corresponding checkbox (*search patient level* and the *duplication of patients* is not allowed in the result list).

Statistic Search

Once the user has completed setting the search mask and they have:

- Chosen the mask to be used (between those available or pointing to a new mask) from the **Research**, **Filters**, or **Results** option tab
- Set the needed attributes from the **Research** option tab
- Set the search mode for each group of attributes from the **Research** options tab
- Set eventual obstacles regarding the patient date of birth, the data of file recording, the type of file, and the duplication of patients in the results list from the **Filters** options tab

-the search between all cataloged files can be started by pressing the **Research** button in the **Research** or **Filters** options tab and using the pointed masks and the current settings

regarding the attributes, the search modes, and the filters. The settings of the mask are saved and are proposed each time the user recalls the masks.

The search results are shown in a grid of the **Results** options tab.

Result Representation of Statistical Research

When the user points to the **Results** option grid, the following appears in the window:

- A popup menu that allows the user to choose a search mask between those available, or to create a new mask. It is possible to directly type in the internal part of the textbox to attribute a title to the pointed mask
- A list that displays the results obtained with the current mask following a search
- The following buttons are present in the window, associated with the following functions:
 - **Research**: starts the search between all the cataloged files, using a pointed mask and the current settings regarding the attributes, the research, and filter manners.
 - **New Mask**: loads a new mask, which must be user-configured (regarding the attributes, the search, and filter modes) before starting the search.
 - **Reset Mask**: this function resets the new modifications to the present mask and

maintains the original configuration of the mask.

- **Delete Mask:** deletes the current mask.
- **Export:** exports the list of the results in a test file.
- **Cancel:** exits the Statistical Elaboration.

Result Representation of Statistical Research

The results are grouped in a grid of three or five columns, depending on if duplicate patients are allowed, as described in the Filter Settings section.

If the search was performed on the patient level, or if patient duplication is not permitted on the result list, three columns show the last name, the name, and the data of patient birth as long as the cataloged file satisfies the search criteria.

If the research was done on a file levels, or the duplication of the patients in the result list is permitted, the 5 columns show the last name, name, the patient's date of birth, the recording date and the type of file cataloged that satisfies the research criteria.

Graphic Elaboration of the Results

Once that the user points to the **Elaboration** option tab, the window shows three framed structures:

- **Statistical Mask:** a list of available masks for eventual elaboration.
- **Statistical Graphs:** displays the graph representation and comparisons between the masks.
- **Exportation:** allows the user to export any information (contained in the search masks) in a text file or Excel. The user must choose which fields of interest are to be exported.

In the window, other buttons are present:

- **Export:** exports (in a text file or Excel file), the information the mask level said to be interesting (for example the mask title, limitations on the date of birth, the recording date of the file , etc...).
- **Draw:** traces a graph (correlation between the masks selected for statistical elaboration).
- **Copy:** copies the graph in the notes and data it represents.

Selection of the Mask for Statistical Elaboration

The available masks for an eventual elaboration are displayed in the list. Each line of the list shows the title of the mask and the number of patients or files found (depending on the type of search held, either at the patient level or file level, as described in the "Filter Settings" section) on a total (respectively to patients or files).

Select from the mask list by clicking on the corresponding line. The selected masks in this list are the base of the graphic representation of the results and the exportation operation of the information described in the following two paragraphs:

Statistical Graphs

Select the mask that the user would like to put in correlation (as described in the previous paragraph), choose the type of graph the user intends to trace (histogram, pie chart, etc...) in the correct popup menu, and press **Draw** to start the graph construction.

The **Copy** function allows the user to copy in another application, the graph and the data represented in it. The data and the graph are then copied on the clipboard, whatever is imported in the other application depends on the application itself (e.g. only the data in

the Excel sheet is copied by recalling *Paste* from Excel; the graph is copied by recalling *Special Paste* from Excel).

Exportation of the Information Contained in the Masks

Select items of interest from the mask list. Choose the information to be exported from the list of possible information on the mask level. This choice occurs by clicking on the line that corresponds with the desired information (e.g. the mask title, the limits on the dates, the number of records found, etc...). Therefore, the user must choose whether or not to export all the information on the text file or Excel file by clicking in the corresponding checkbox. Press **Export** to execute exportation.

Statistic - Glossary

Statistic Attributes

Statistical attributes allow the user to catalog the characteristics of every file of the archived patients.

In a preliminary phase to cataloging and statistical elaboration, the user must program the group of possible statistical attributes, which sub-divides them into various groups (called classes), each one can contain one or more parameters, organized on different levels (items and sub-items).

Statistic Research Mask

In the statistical elaboration phase, the user can build and memorize search masks, moreover, folders that contain a series of general information that define search criteria.

Every mask memorizes information regarding the attributes to individualize, filters on recorded data and the type of file, the filters on the patient date of birth, etc.

Research Modes for Statistical Attributes

All the attributes have the same parent and are defined by the same group.

The search mode defines, *for each attribute group* (that is, attributes with the same parent), the characteristics that the *assigned attributes to a file* must have to satisfy the search criteria (that is, for every group of attributes, a file can only have an attribute between those set, or it must have them all or none, or it does need any of the set attributes).

Child Selection Mode in the Statistical Tree

In the attribute settings phase, for each node of the statistical tree where the type is *with children*, the user defines the child selection mode by choosing between:

- *Single*: more than one child at a time can be selected in Statistical Parameter attribution.
- *Multiple*: more than one child can be selected at the same time in Statistical Parameter attribution.

Type of Node in the Statistical Tree

For each node of the statistical tree, in the Attribute settings, its type is defined by choosing between:

- **Yes/No:** for a leaf node that, in Statistical Parameter attribution, alternatively chooses between yes or no.
- **Memo:** for a leaf node that can contain a variable description, written by the user in the phase of Statistical Parameter attribution. In Attribute settings, the *title* is defined, that represents the fixed part and can be seen, in the Statistical Parameter attribution and Statistical Elaboration, as prefixed to the description set by the user.
- **With Children:** for a node that can have children. The definition of children occurs in the Attribute settings phase. Three levels for the statistical tree, it is not possible to define this type for the nodes at the third level.

Report

Introduction

The report is a particular text document that shows all the information about the patient and the exam diagnosis.

The user can assign a report for each exam. There are various ways to assign a report:

- When in exam review phase, choose **File - Show Report**
- From the Archive window, press the right mouse button when it is positioned on the exam list or file list and choose the items **New - Report** from the popup menu
- Via the toolbar of the Archive window, select the report icon or use the appropriate key function button
- From the Edit menu of the Archive window, select the items **Exam - New - Report** or

File - New - Report.

A dialog window will appear that asks the user to specify the type of model to be used for the report.

Report Templates

The model is a pre-built document that can contain information, headers, etc... This information can be modified by the user so that the report model adapts to the user (doctor, lab, or hospital) needs; to create different models, see the section "Report Models."

NOTE: the model can also be an empty document.

The model can contain automatic fields, that is, referrals to record fields of the patient. When the report of an exam of a determined patient is created, instead of the referrals, the patient data automatically appears. Also see **Fields** in the **Insert Menu** section.

Report Window

The report window appears like a text document.

On the top of the window, there are the menu bar and the Standard and Format toolbars. In the center of the window, there is the body of the text document, where the user can type his own comment to the exam.

Menu Bar

File, Modify, View, Insert, Format, Table, Windows, Help

File Menu

New	Disabled
Open	Opens another exam file by selecting it from the Archive window
Save	Saves all information in the report or in the report model
Save As	Saves all the information of the report or the report model in a particular

	directory with a different name (and/or with a different format)
Previous Comment, Next Comment	Disabled
Page Setup	Shows all the parameters relative to the format of the page
Print Preview	Shows the preview before printing the report
Print	Prints the report
Print Setup	Sets the printer parameters
Properties, Disk Properties, Export	Disabled
Exit	Exits the Report section and returns to the Archive window. The system requests a confirmation whether to save new modifications when exiting this window

Modify Menu

Undo	Cancels the previous operation
Cut	Cuts the selected part of the report (keeps it in the clipboard, a following operation of Cut or Copy replaces the previously memorized data)
Copy	Copies the selected part of the report (keeps it in the clipboard, a following operation of Cut or Copy replaces the previously memorized data)
Paste	Pastes the cut or copied part previously in report
Clear	Disabled
Select All	Selects all the contents of the report to cancel or modify them
Find	Finds a word or a phrase of the text quickly without scrolling through the entire text
Find Next	Finds the next occurrence of a word or a phrase of text quickly without scrolling through the entire text
Replace	Changes the word or phrase in the text by automatically substituting it with another word or phrase
Copy to Block	Copies the selected text in a note block (.HED file). This block of text can be inserted into other reports via the function Block present in the Insert menu
General	Specifies a directory where the text blocks are recorded for general use
EMG	Specifies a directory where the text block of specific use for EMG are recorded (... \EMGBlocks)

View Menu

Hidden Characters	Shows/hides all the spaces, tabs, and line-feed between lines and words
Fields	
Visible	The data is highlighted (all information relative to the patient, exam) with a gray background

Codes	The name of the field is shown in braces
Update	Refreshes the archive data
Background	
Standard	The background is shown in white
System Colours	The background is shown with the operative system colors
Gridlines	Shows the grid of the table (invisible in the printing phase)
Units	Unit measure of the ruler, selectable between Cm and
Inches	Header and Footer
Disabled	

Insert Menu

Objects can be inserted into the position indicated by the cursor in a document.

File	A dialog window opens to specify the path and name of the file to be inserted. Files with extensions ".hed" (default), ".txt," or ".rtf" are excepted
Picture	The same as file insertion Default extension ".bmp"
Fields	The model of the report can be configured with some "automatic fields" that are automatically updated by the program with patient relative information during a report generation. This information is typically the patient's name, date of birth, and all the other items relative to the patient or the exam correlated with the patient. A dialog window is opened, on the left, there is a list of possible fields to be inserted in the report. On the right, a textbox shows the contents of the selected field for that particular patient or exam. By pressing Insert , the selected field is inserted into the pre-chosen position and the window closes
Symbol	Disabled
Block	Lets the user insert preset blocks of text. It opens a dialog window that asks the user to specify the path and name of the block to insert (that is a file with extension .HED)
Exam List	For EP or EMG reports, this function inserts a bookmark that identifies the position where a list of all performed exams is printed in the report

Date	Inserts the current data in the cursor position
Time	Inserts the current time of the cursor position
Page Break	Inserts a page separator in the cursor position

Format Menu

Characters	Allows the user to set the type of fonts used in the report
Paragraph	Allows the user to set the characteristics of every paragraph and the contents of the paragraph (paragraph is every string of text contained between one paragraph and another)

Table Menu

Contains the typical management functions of the tables. When a table is created, the user must specify the number of lines and columns.

The following functions are present – all of which have the same functionality as MS Word

- Insert Table
- Select table
- Insert Row
- Delete Row
- Select Row
- Insert Column
- Delete Column
- Insert Cell
- Delete Cell
- Merge Cells
- Split Cells
- Cell Height and Width
- Borders and Shading

Window Menu

Cascade	Displays all open windows in cascade (one on top of another horizontally or vertically)
Tile Horizontally	Displays in the open windows horizontally
Tile Vertically	Displays in the open windows vertically
List of Windows	List of opened windows. The active window is marked with a check sign on the left

Help Menu

Help Online	Opens Help window
Hotkeys Help	Opens a panel to the right that shows all defined hotkeys
NOTE: there are no defined hotkeys for the report window	
About	Disabled

Toolbars

Below the menu bar are two toolbars, **Standard** and **Format**.

The Standard one contains the typical commands that manage the file (from the left):

Open - Save - Print - Print Preview | Cut - Copy - Paste

The Format toolbar contains the typical commands that manage the document (from the left):

Font

- Font dimension | Align Left - Center - Align Right - Justify | Bold - Italic - Underline

Text Color

NOTE: along with these two bars, there are other toolbars that are used by the exam window; these bars will be disabled.

About Microsoft Word

NOTE: in the Editor section under Tools - Options – General, the user can set Microsoft Word as the default editor.

The user can use Microsoft Word as an editor, to generate reports or model.

In this case, the typical toolbars of Microsoft Word appear in the Report window, above the text area. Most of the functions of the menu bar and of the primitive toolbars are disabled. The available functions substantially regard the **Fields** management.

Report Templates

Different doctors or different types of exams can have different templates for the creation of a report.

To create a new template or to modify an existing one, the user must select the item **Open/New Report Model** from the **Tools** menu, in the menu bar of the Archive window.

The New Report window is shown, where more than one report model is present. To create a new model, the user must select an EMPTY DOCUMENT and then double-click the left mouse button or the **OK** key. To modify an already existing template, the user must select the desired template and then double-click the left mouse button or the **OK** key.

When a new model is created, the user can insert a lot of information, for example the patient's name, the hospital, the street, the telephone number, etc. This can be done by simply typing the text and modifying it: in dimension, font, position. Also see **Insert Fields**.

.

Below is an example of the type of information that the user can insert in a report model:

Sacred Heart Nursing Home for children
52760 lindley drive, London
Tel:00 44 1 79879900
fax: 00 44 1 79879900

Patient: <<LastName>> <<FirstName>>
Birth Date: <<Birthday>>
Exam: <<ExamCode>><<ExamCode>>
Recording Date: <<RecordingDate>>□

EMG - Software

NOTE: this feature could be not available in your country.

System Description

The standard configuration of an EMG system is composed of the following elements:

Amplifiers
Stimulators
Personal computer
Monitor and speakers
Printer

The system can include other components, upon user requirements. The specified components compose a typical system configuration. For further details of the system see the Archive section.

Use of the Mouse and Keyboard

The program is based on the Windows operative systems and shares some user interfaces and software characteristics that are common to most popular software; this makes it more familiar and intuitive in its use. Many program operations can be performed indifferently via the use of the keyboard or the mouse. To make easier the use of the system, our company has defined some key functions (alias Hot Keys) that allow the user to access in a direct way to the functions and commands that are necessary during acquisition and exam review (some of these functions can be user defined, see the Archive section).

It is recommended to familiarize with the use of the mouse for the normal Windows® operative system functions. The software for EMG uses many typical techniques as for example the click of the left and right mouse buttons, double-click of the left mouse button, or keeping the left mouse button pressed while moving the cursor (drag and drop method).

ADVICE: do not forget to use both the mouse keys; they could have different internal functions.

RECOMMENDATION: have you forgotten the settings for the Function keys? During exam acquisition or view, pressing the F12 key from the keyboard, it is possible to activate a window with a menu of function keys.

Amplifiers and stimulators

The Amplifiers

Our company supplies the following amplifier models: Matrix Light 1002, 1002EP, 1005, 1009, 1013, 1017.

Headbox model 1002 has two acquisition channels, the 1005 has five, the 1009 has nine, the 1013 has 13, 1017 has 17. All the headboxes have an incorporated electric stimulator. Headboxes with an EP suffix are especially for evoked potentials but those regarding EMG are like normal stimulators. The outputs on the stimulators are on the front panel of the device.

Amplifiers have three types of inputs:

- 4 amplifiers (in Matrix version) has Lemo type connector 3-pin for electrodes with a shielded cable
- Connectors type "touch proof" for positive inputs, negative and ground
- DIN 5-Pin connectors

The ground electrode is common to all amplifier channels.

The user of good quality electrodes and an accurate connection technique is very important in order to acquire a good signal.

The Stimulators

This section regards the Headbox models Matrix Light 1002, 1002EP, Energy, Energy Twin. Electric, auditory, visual, and magnetic stimulators can be used for the evoked potential exams. Our company's electric stimulator used for EP is a current controlled generator. This generator has the following parameters:

- **Current intensity (mA):** the user can vary the intensity via the knob on the front panel of the Headbox, or in the exam protocol settings or during acquisition via the mouse or the keyboard.
- **Stimulus duration (μ s):** the user can vary the duration in the exam protocol settings or during acquisition via the mouse or the keyboard.
- **Stimulus frequency (Hz):** the user can vary the frequency in the exam protocol settings or during acquisition via the mouse or the keyboard.

Accessories with type mini-DIN input connectors or with standard touch-proof input connectors can be connected to the stimulator (for further information consult your distributor).

ADVICE: connecting the ground electrode to the patient, always try to place it between the acquisition electrode and the stimulation one; this should decrease the stimulus artefact. Use preferably shielded quality cables.

Getting started

How to Create a New Exam

To access to the EMG section, the user can insert a new patient or add an exam to a patient already present in the database, following the modality indicated in detail in the Archive section.

NOTE: the creation of a new patient record requires the insertion of the patient's surname, name, and date of birth.

To obtain a new EMG recording, you have to follow these steps:

- When you are in the Archive window, click the new EMG exam button on the toolbar above the columns of exams (or press the key F5). The same can be done by clicking the menu **Edit -> Exam -> New -> EMG**

or

If an EMG exam already exists and you want to have another EMG recording within the same exam, you can start a new EMG file by clicking the new EMG file button on the toolbar above the columns of files (or press the key F10). The same can be done by clicking the menu **Edit -> File -> New -> EMG**

- Select the available exam type from the option tab; this can be done by clicking on the mouse on the label of the tab or using the quick keys from the keyboard. For further details see section "Selecting an Exam."
- Select a protocol from the grid. For further details see section Acquisition setup
- There are two possible ways to begin an acquisition:
 1. Click the **Acquire** key directly on the bottom left
 2. Press the numerical key indicated next to the protocol on the first column of the grid

How to Review an Exam

To see an EMG recording or a report, the following steps are taken:

1. Using the mouse select a patient in the left column (list of patients) of the Archive section
2. Select the exam of interest, checking the creation date on the middle column (list of exams)

3. Double-click on the icon on the right column that corresponds to the file that is wished to be seen, always checking the file creation date

Alternatively, instead of using the double-click of the left mouse button, the user can use the right mouse button, with just a click on the icon of the exam or the file of interest. A popup menu opens where the possible operations appear: in this case, choose **View**.

Selecting an exam

When the user accesses a new EMG exam, a dialog window opens allowing the choice of the type of exam to be performed and the protocol setup. The window has several exam tabs, each of them contains a grid with protocols; at the top there is a menu with many items to be used to manage the protocols:

- **Exit**: to exit from the dialog window.
- **Help**: to open this window.
- **New**: to create a new protocol.
- **Duplicate**: to create a copy of the protocol.
- **Delete**: to remove a protocol.
- **Move Up\Move Down**: to move up\down a protocol in the list.
- **Setup**: to enter in the setup of the protocol.
- **Tables**: to enter in the setup of the tables parameters.
- **Tools**: to enter in the Tools section.
- **Acquire**: to start the selected exam.

Below the list of the protocols there is a table that specifies the type of headbox used and the hardware connection card.

Exams

The available exams are present in the grid in the middle of the window. In order to choose the exam type, the user must click on the label on the grid using the left mouse button. The exams types available are:

EXAM	ABBREVIATION	HOT KEYS
Needle EMG, spontaneous activity/voluntary activity	EMG - SPO/EMG - VOL	F1
Motor Unit Action Potentials	MUAP	F2
Motor Nerve Conduction Velocity	MNCV	F3
Motor Sensory Conduction Velocity	SNCV	F4
Repetitive Nerve Stimulation	REP	F5
H Reflex	H REFLEX	F6
F Wave	F WAVE	F7
Blink Reflex	BLINK REFLEX	F8
Magnetic Evoked Potentials	MEP	F9
Sympathetic Skin Response	SSR	F10
RR Interval	RR	F11
Single Fibre	SFEMG	F12
Mune	MUNE	

NOTE: depending on the package purchased by the user, not all of the above exams may be available.

Protocol Grid

The middle grid has the list of the protocol for the exam that is selected on the column on the left. Each line corresponds to a protocol. To start an acquisition the user must select a protocol between those enabled and press the **Acquire** button, or press the number on the keyboard that appears in the first column. To add a new protocol the user has to press the "NEW" button and then the button Setup.

NB: the lock on the right column indicates whether the protocol can be modified or not. The protected protocols cannot be modified; the user can only create a copy and then modify the copy.

Pressing the **Exit** button, the user exits from the dialog window without creating any exam.

EPILOG: the exam selection can be made from the keyboard by pressing the hot keys F1 - F12, while pressing the number of the protocol that is viewed on the first left column in the protocols grid, the acquisition begins using that specific protocol.

Acquisition setup

The exam protocol contains all the specific settings for that type of exam, that is the settings of all parameters necessary to correctly record and view the signals according to the nerve and site chosen.

The settings of all these parameters is via the "Acquisition Program Setup" window with several tabs, each of them containing specific parameters, and three buttons above:

- **Save and Exit:** closes the window and saves modifications.
- **Save:** temporarily saves the settings without closing the window.
- **Cancel:** closes the window without memorizing the modifications made.

The protocols are memorized in the .PRG file and can be saved, cancelled, copied, and pasted as described in "Selecting an Exam."

IMPORTANT: to enable a protocol the user needs to have at least one trace active, as explained in the hardware settings. It is recommended to also type in a title (section Software), in order to avoid confusion with protocols without names.

General

In this section there is a summary with the most important information of the protocol:

Exam: the name of the exam.

Protocol: the name of the protocol.

Headbox: name of the headbox used for the exam.

Interface Card: name of the acquisition interface used for recording.

Number of Channel:

Acquisition Time: the length of the sweep acquired in the protocol.

Sample Rate: the sampling rate used to acquire the signal. The sampling rate changes with the length of the sweep acquired.

Acquisition Mode: gives the number of channels enabled.

Stimulator: the type of stimulation used in the protocol.

Channel

This section regards the conditioning via software and hardware of the acquired signal in order to optimize both the acquisition and the viewing. Practically here the user can regulate parameters such as filters, gain, base time, trace color etc. and select which channel using, which sampling rate etc.

In the first part of the menu the user can set the hardware parameters:

Acquisition Mode: allows the user to select the number of channels to use in the protocol: changing the number of channel, the window with the list of the channels will change

Sample Rate: this menu is to select the sampling rate

After selecting the Acquisition Mode, the window containing the list of the channels will change.

Label (+ or -): identification string of the positive/negative input; up to 5 characters are accepted.

Input (+ or -): the user can select which input associate to the different channels. Each input will be associates to a different color in order to be recognized easily.

Status: to select the status of the channel; OFF (disabled), Bipolar, DC, DIN.

PreFilter: high pass hardware pre-filter setting; this is a quite touch and critical parameter for acquisition and it is recommended to leave the default values.

Signal Max: working window of the analog/digital convertors; signals that are wider than those set saturate the inputs while smaller signals risk not to be converted with sufficient resolution. This parameter remains the same for all traces. For needle EMG exams (EMG SPO-VOL), this value is automatically set by the program (the label **Auto** appears) and the user cannot modify this value.

Memorization Time: time of total recording (length of trace). This parameter remains the same for all the traces and influences the sampling frequency directly, that is set automatically basing itself on it.

About the **Software Setup**:

NOTE: the original signal IS NOT modified, what changes is the signal representation on the screen.

Artefact Suppression: suppresses the initial samples for a time indicated by the popup menu, to view on the traces a horizontal line instead of the artefact. *This control is only available for some EMG exams.*

Notch Filter: suppresses the components of the signal having the frequency equal to that of the network (50Hz in Europe, 60Hz in USA).

Type of Filter: allows the user to choose between different software filters; choice can be IIR, FIR, Butterworth, or Identity (that is no filter applied).

In the grid in the middle of the window there can be various parameters in an independent way for each active trace. The default parameters viewed depend on the type of protocol selected. To change the parameters just click on the corresponding cell with the left mouse button. A menu appears (or a window for the trace color) where the user can choose one of the possible valid values for that parameter. These parameters are:

- **High Pass, Low Pass Filters**: values of their cut off frequency of the software filter; in case of Identity filter they are not considered.
- **Time base**: time interval that corresponds to the width of the scanning window.
- **Gain**: value of the signal that corresponds to the height of a square of the grid in the scanning window. For the exams Needle EMG, it is possible to set independently the gain for each of them by selecting the value from the columns **Gain SPO** and **Gain VOL**.

Stimulator

Regarding the stimulator settings it is necessary to keep two things in mind:

- The EMG system can have up to four stimulators connected, while the software pilots only two at the same time.
- For the MEP exam a not owner magnetic stimulator is used (an external Trigger is used)

The lower part of the grid is always present. The following parameters are found:

Stimulator Type: enables the checkbox the upper part of the grid appears (Electric Stimulator) that allows the user to set the parameters in which the first stimulator pilots. At the same time the options that allow to set the Stimulus Origin (in fact with a our stimulator it is possible only the internal trigger generation) and the options to set the checkbox for the second stimulator are disabled.

Enable Stimulator 2: enables the checkbox the lower part of the grid appears (Electric Stimulator) that allows the user to set the parameters that pilot the second stimulator. This checkbox is active only if stimulator 1 is present.

When one or two stimulator are enabled, automatically a grid will appear with the following parameters:

Parameter grid for the stimulators
<p>Electric Stimulator (MNCV, MSCV, REP, H REFLEX, F WAVE, BLINK-REFLEX, SSR)</p> <ul style="list-style-type: none"> • Side: can be Left, Right, Bilateral • Repetition Rate: the maximum frequency of stimulation available is 300 Hz but if the frequency of stimulation is higher then the inverse of the mem. time, an error message will appear and the user will have to decrease the frequency (a warning if the Stimulation time is less than the Acquisition time) • Stim Intensity: current intensity of the electric stimulus; that goes from 0 to 99.9 mA, with increment steps of 0.1mA. • Stim Duration: stimulus duration that goes from 50µsec to 1000µsec with steps of 25µsec. • Stim Delay: delay between the acquisition start and the stimulus application; the applicable delay goes from 0 to 25msec with increment steps of 0.1msec. • Stim Polarity: to set the shape of the stimulus (Positive, Negative) • Stim 2nd Phase Duration: to set the stimulus as biphasic, the duration of the second phase has to be set. • Stimulator N.: if there are more then one stimulator connected, there is the need to select the stimulator <p>Output: for model Twin is to select which electrical stimulator using for the electrical stimulation</p>

Markers

In this section there are two tables: in the first one there is the list of the flag enabled for each channel, the second one (Markers List) is to memorize new flags. The active channels are shown using a green symbol and those not active with a red symbol (State column). Every channel can have up to eight flags. To insert the flag you just need to click on the cell with the mouse and a popup menu will appear. To insert the flag the user will only need to press ENTER.

Correlation

This section is available only for MNCV and SNCV exams. The user has the possibility to set the correlations between various acquisition sites (stimulation) for the automatic calculation of the velocity value. There are two types of correlation:

- **Absolute:** the ratio of the distance between the stimulation site and the acquisition site and the latency time of the acquired potentials is calculated (absolute conduction velocity of the potential).
- **Relative:** the ratio between the distance of the two acquisition sites and the latency differences of the acquired potentials is calculated (relative velocity of the conduction potential).

At the center of the window there is a grid with 4 columns and many line, these are defined sites in section Muscles and sites of the EMG exam Protocol. The columns indicate, from left:

Segment: indicates the type of correlation, that can be **Absolute** or an indication type **2->1** or **3->2** that represents the acquisition sites for which the relative correlation are calculated. In this column the user cannot perform any action.

Trace1: name of the correlation start site. In this column the user cannot perform any operation. The third column has no indication.

Trace2: name of the correlation destination site. The user can modify it clicking on the left mouse button: a popup menu appears in which the user chooses between one of the predefined sites.

The first line (empty) of the menu represents the stimulation site; choosing this, in the first column of the grid the indication **Absolute** appears.

Distance: distance between the two destination sites can be set as a pre-defined distance.

Average

In this section the parameters are set in order to obtain a correct average of the signal.

Number of Stimulations: in this textbox it is possible to set the number of responses to the stimulation that are considered for the calculation of the signal average. The responses over the rejection threshold are automatically rejected and are not counted. The number can be typed directly or by increasing or decreasing via the arrows on the slider.

Rejection Level: the window where the response must be kept in order to be considered can be smaller than the window set as Signal Max in the Hardware section. The value in the cell indicates the maximum value the signal can have in order to be accepted in the average.

Start: the threshold control is performed only after the "start" value. This is useful if there is a stimulus artefact: sometimes if the stimulus artefact is really high, all the traces in the average could be rejected.

For the F WAVE exam this check is present:

Duration zone M: controls the type of slider that allows the user to vary the duration of the zone M from 0 to 100 milliseconds.

Headbox

This section allows the user to verify the type of Headbox, Stimulators and Interfaces configured at the system installation. It is also possible upgrade the firmware of the units installed.

IMPORTANT: modifications to the settings of this tab are reserved to authorized technicians.

Access to the parameter configuration is protected by the Unlock function and asks for a confirmation. To exit from this section without modifying the properties (event considered potentially dangerous for the system) just press the Cancel button.

Cycles

This section is available for RR exams only. Below the methods of exam testing are given.

Default: allows the user to select the type of test to be performed.

The test can be composed of more consecutive phases, called cycles. At the center a grid allows the user to set the parameters of the cycles. The grid has these columns:

Name: title given to the cycle. To modify this field click on the left mouse button, type the name and press ENTER.

Duration: duration of the cycle. To modify this field click on the left mouse button, type the name or use the arrow keys to increase or decrease and press ENTER.

Measure: unit of measure of the duration of the cycle. Clicking the left mouse button it is possible to choose between **sec**, **beat** (heartbeats), **resp** (breath cycles), **keyboard** (the user changes the cycle pressing on the bar of the keyboard).

Alarm: sound that warns the end of a cycle. Clicking the left mouse button it is possible to choose between **null** (no sound), **beep** (predefined sound), **msg** (warning window), **beep+msg** (sound and window together).

Waiting Measure and Waiting Alarm: these column are relative to the waiting phase that is between a cycle and the next one and are analog to the previous property of the active phase of the test.

Waiting Duration: duration of the pause between a cycle and another. To modify this field click on the left mouse button, type the name or use the arrow keys to increase or decrease and press ENTER.

The table below is to do the calculation of the parameters recorded in the cycles. The result of these formulas is calculated in an automatic way at the end of the test. Clicking on the checkbox

nearby the user can select the formula, that in this case appears on the left side of the acquisition-review exam window, under the cycle grid. All the parameters of these formulas can be user modifiable, via a popup menu that allows the user to choose between the various options available.

They are:

1. **Description:** there is the description of the line of the table (in the line there can be the parameters of the Numerator and Denominator of the formula n.1 or formula n.2).
2. **First and second addend:** these are the addend of the formula.
3. **Operation:** this is the type of operation applied between the factors. The functions available are + (addition), - (subtraction), * (multiplication).

In the **Frequency Analysis** box (typically used for the Malliani exam), the following controls:

Band1 - Band4 (Hz): via the checkbox on the left the frequency band where the spectrum signal is examined is activated; once the respective band has been activated the textboxes are enabled where the user types the band extremities (in Hz); the arrows nearby allow the user to increase/decrease the value with steps of 0.1Hz.

NOTE: to obtain correctness, the second extremity must always be higher than the first, otherwise the value set is not accepted; therefore it is suggested to set the maximum limit first (right textbox) and then the minimum (left textbox).

The factors are taken from the results of the operations on the acquired signal, listed below:

RR (x)	Interval between the beat number x and the beat number x-1
RR Max	Maximum Interval between beats
RR Min	Minimum Interval between beats
RR Med	Average Interval between beats
VAR RR	Variation of the Interval
SD RR	Standard Deviation of the Interval
FC (x)	Beats per minute (in bpm) x
FC Max	Maximum beats per minute
FC Min	Minimum beats per minute
FC Med	Average beats per minute
VAR FC	Variation of the beats per minute
SD FC	Standard Deviation of the beats per minute
0	No operation
1	Numeric factor is 1
Band1	Spectral Power calculated in Band 1
Band2	Spectral Power calculated in Band 2
Band3	Spectral Power calculated in Band 3
Band4	Spectral Power calculated in Band 4

Pressure

There are these two controls:

Device Type: allows the user to select the acquisition device for the bloody pressure between Vasotrac and FinaPres.

Serial Port: allows the user to select the serial COM number to receive the data from the device.

Muscles and sites

In this section the user can set the names of the body location where the acquisition are performed.

The table represents information about muscles and sites.

About the management:

- To insert a new site: press the **New** button on the left top, types the name directly from the keyboard and then press ENTER.
- To delete a site: selects the site to be eliminated and then press the **Delete** button.
- To change the name of a site: click the left mouse button over the site name, type in the new name and then press ENTER.
- To change the name of the nerve, click the left mouse button over the site name, type in the new name and then press ENTER.

Calculation

In this section the velocity calculation, amplitude and acquired trace area parameters are set (exams MNCV, SNCV, SSR).

Velocity Calculation Point: here the user sets the marker considered as the point of the calculation velocity.

- **Onset:** considers as latency the beginning point of the potential (first figure).
- **Peak -:** considers as latency the negative peak point of the potential (second figure).
- **OCross:** considers as latency the zero crossing of the potential with the base line (third figure).
- **Peak +:** considers as latency the positive peak point of the potential (4th figure).

Amplitude Calculation Limits: it is possible to choose between the peak to baseline or peak-to-peak amplitude.

Area Calculation Limits: it is possible to choose between the area of the negative wave and the total area of the wave.

Duration Calculation Limits: it possible to select the calculation of the duration between Onset and 0Crossing or between Onset and End of the wave.

Footswitch

In this section it is possible to set the operation held by the two-foot switches, always depending on the type of the selected exam:

Exam	START Button	STORE Button
EMG - SPO, EMG - VOL	Starts/Stops acquisition	<ul style="list-style-type: none"> • Saves 5 seconds Saves continuously
MNCV, SNCV	<ul style="list-style-type: none"> • Single stimulation Starts/Stops Average	Following site
REP, H REFLEX, F WAVE	<ul style="list-style-type: none"> • Starts/Stops trend Single stimulation	Following site
BLINK REFLEX	Single stimulation	Left/Right
RR	Starts/Stops acquisition	Save
SFEMG	Starts/Stops acquisition	Following site

NOTE: exams MEP and SSR do not use the footswitch.

MEP Setup

This section is available only for MEP exams and is needed to program of representation mode of the curves obtained by magnetic stimulation. Generally in the review panel of the traces, up to seven types of sites are present. The first six are fixed and show the trace recorded, while the seventh, relative to peripheral stimulation, is able to be set by the user and can be of two types: MAP (that is single curve) and F Wave (that is a group of 10 curves used for the research of the F Wave).

The fixed sites are:

1. Relaxed Cortical
2. Averaged Relaxed Cortical
3. Cortical Contract
4. Averaged Cortical Contract
5. Radicular
6. Averaged radicular

The seventh site is user selectable between **MAP** and **F WAVE**.

Zone M duration: if the F WAVE is selected for the seventh site, a slider is enabled and allows the user to set the M zone Duration in *ms*.

Automatic program

Trend Setup for exams REP-AC, F-WAVE, H-REFLEX

Via the programming section of the trend, the user can define real acquisition sequences. This type of setting is especially used during the research of the repetitive response when the patient undergoes stimulation trends interval by sequences of fatigue and muscle recovery.

In the setup screen the user has the possibility to define a series of parameters (grid columns) that characterize every sequence (every line of the grid):

- **Number of Stimulations:** number of stimulation to be distributed, and therefore the number of curves to be recorded.
- **Frequency:** stimulation frequency.
- **Delay:** time of delay before the beginning of another sequence (if 0, means that a following acquisition).
- **Note:** generic title to assign to a group of acquired curves.

Such parameters can be modified by clicking with the right mouse button on the desired textbox and typing in the value to be set.

Each time that **New Line** button is pressed, a new line on the grid is added to make a new sequence possible. The maximum number of sequences definable by the user and working from the purchased version is 50.

Trend Setup BLINK-REFLEX

The protocol for the Blink Reflex is protected and can't be changed. To perform some changing the protocol the user has to duplicate the protocol and open the copy.

Via the programming section of the trend, the user can define real acquisition sequences. This type of setting is especially used when the user desires to stimulate at fixed intervals and eventually using a pre-stimulus to inhibit some components.

Type of exam: allows the user to choose between normal Blink Reflexes or inhibited reflexes.

In the setup screen, the user has the possibility to define a series of parameters (columns of the grids) that characterize each sequence (every line of the grid):

- **Number of Stimulations:** number of stimuli to be distributed, and therefore the number of curves to record for every side of stimulation (maximum of 10).
- **PreStimulus:** indicates how much time before the acquisition of the signal the user must derogate the pre-stimulus (if put at 0ms indicates the absence of the pre-stimulus).
- **PostStimulus:** indicates how much time the user must attend before acquiring the following response.
- **Note:** generic title to assign to a group of acquired curves.

Such parameters can be modified by clicking with the left mouse button on the textbox and type in the value to be set.

Each time that **Add Line** button is pressed a new line on the grid is added to make a new sequence possible. The maximum number of sequences definable by the user and working from the purchased version is 50.

Lines

The section is available only for SFEMG exams.

Number of Visualization: number of lines in cascade to be viewed from each page during the review phase.

Number of Acquisition lines: number of traces to be memorized for each SFEMG acquisition (variable from 1 to 128).

Fiber Density: allows the user to enable or disable the research of the fiber density.

Remote Control

This menu enables the Remote Control of the Stimulator. The only button with a multiple choice is the "OK\SAVE" button in which the user can choose between Single Shock (save a trace for every stimulation) and Start\Stop Average.

Needle EMG Report

This is the setup window for the advanced Needle EMG Report. This function allows an easier and faster construction of a needle EMG Report.

In the first table there is the list of the different Field to be Analyzed during the Needle EMG (in the column "Properties"), while the column "Function Keys" is the list of the fast buttons associated to the different field. Each "property" has different values associated, all these values has to be inserted in the table on the right. To insert the values you just need to do a single click with the left button of the mouse and then type the word. The Value in the list "Normal" will be highlighted in Green in order to be better displayed in the list, and will be the value considered by the system as Normal. To set a value "As Normal", the user has to select with the mouse the value and click on the "Set As Normal" icon in the top right of the window.

The Value in the list "Set as Default" will be highlighted in Black in order to be better displayed in the list, and will be the value automatically pre-selected by the system once the report is started. To set a value "As Default" the user has to select with the mouse the value and click on the "Set As Default" icon in the top right of the window.

Acquisition and review window

The appearance of this window depends on the selected exam. The window is usually divided into two: on the left there is a panel for the acquired traces (averaged or not) while on the right there are various indications and controls and, on the lower part, there is a trace panel that shows the traces in real time during acquisition. This window is associated with a menu bar and many toolbars. On the lower part of the window a status bar shows further indications and controls. Furthermore, if in the Archive window the **Key Function** is enabled (under Tools/ Options/ Settings), on the bottom of the screen the Key function buttons are shown.

The following are the various acquisition windows for the various types of exams

Exam	Quick Access Key
Needle EMG, Turns & Amplitude, QEMG	F1
MUAP	F2
MNCV	F3
SNCV	F4
RNS	F5

H Reflex	F6
F Wave	F7
Blink Reflex	F8
MEP	F9
SSR	F10
RR	F11
SFEMG	F12
MUNE	

Menu bar

When the user accesses the EMG acquisition section, the main menu changes. The following items appear:

File, Modify, Acquire, Tools (disabled during acquisition), Analyze Menu (disabled), Move (disabled during acquisition), Windows, Help

File Menu

New	Opens the dialog window for the choice of the type of exam to be performed and the protocol setup
Open	Displays the archive window, making it possible to review another exam
Close	Closes this section
Add to Report	Unavailable during acquisition. During review, it adds the acquired traces and the grid with the calculated parameters to the report. If the report doesn't exist, it creates a new report and asks the user to specify a report model
Print	Prints the acquired traces and the grid of calculated parameters
Print Screen	This function allows the user to print what it is shown on the monitor
Export	Exports the traces in various formats; the following items appear: ASCII File Is needed to export the data of the exam in ASCII format. A window opens asking the user the export parameters: <ul style="list-style-type: none"> • Export Traces, with options Selected Traces or All traces • Exported data, with options Filtered or Not filtered • Scale, with options Digit, microvolt or millivolt The Export key completes the operation asking for further source information and suggesting a name. The Cancel key allows the user to exit without completing any

	operation
	EDF file, Export Trace, Export to EP file, Export to EEG file Disabled
Exit	Exits from the EMG section closing all the open windows and returning to the Archive section

Modify Menu

Undo, Copy, Paste	Disabled												
Cut	Cuts the selected traces												
Select All	Selects all the traces currently visualised, available only during review												
Deselect All	De-selects all the traces currently visualised, available only during review												
Invert Selection	Inverts the trace selection, available only during review												
Filter	<p>Allows the user to choose the type of software filters and their settings:</p> <p>Type</p> <ul style="list-style-type: none"> Identity: the signal is not filtered. Two Poles IIR: software filter - Infinite Impulse Response at 2 poles; <i>NOTE: in Needle EMG and MUAP only the IIR-2 Poles filter is used. The user cannot modify this setting.</i> FIR: software filter Finite Impulse Response. Butterworth: software Butterworth filter. <table border="1"> <tr> <td>High Pass</td> <td>Sets the cut off frequency of the high pass software filter</td> </tr> <tr> <td>Low Pass</td> <td>Sets the cut off frequency of the low pass software filter</td> </tr> <tr> <td>Notch</td> <td>Enables/disables intervention of the software filter that suppresses the disturbances of the electric network</td> </tr> <tr> <td>Smoothing Up</td> <td>Increases smoothing by increments of 1</td> </tr> <tr> <td>Smoothing</td> <td>Value of smoothing filter</td> </tr> <tr> <td>Smoothing Down</td> <td>Decreases smoothing filter by increments of 1</td> </tr> </table>	High Pass	Sets the cut off frequency of the high pass software filter	Low Pass	Sets the cut off frequency of the low pass software filter	Notch	Enables/disables intervention of the software filter that suppresses the disturbances of the electric network	Smoothing Up	Increases smoothing by increments of 1	Smoothing	Value of smoothing filter	Smoothing Down	Decreases smoothing filter by increments of 1
High Pass	Sets the cut off frequency of the high pass software filter												
Low Pass	Sets the cut off frequency of the low pass software filter												
Notch	Enables/disables intervention of the software filter that suppresses the disturbances of the electric network												
Smoothing Up	Increases smoothing by increments of 1												
Smoothing	Value of smoothing filter												
Smoothing Down	Decreases smoothing filter by increments of 1												
Time Base	Time interval that corresponds the width of the review window. This can be changed on all the traces or only for those selected. If the traces visualised have different base time, this textbox appears white, that is without any												

	indication, and on the grid a column appears that shows the base time trace per trace
Amplification	Signal amplitude per vertical square of the grid in the review window. It can be changed on all the traces or only for those selected. If the traces visualised have different amplifications, this textbox appears white, that is without any indications, and on the grid a column appears showing the amplification trace per trace
Artef. Reject	Enables/disables the intervention of an algorithm that resets on video the first samples of the signal affected by a stimulus artefact. The intervention interval is set via the popup menu. If the first option is chosen (Disable) the suppression algorithm is disabled
Correction	Enables/disables the intervention of a particular algorithm that suppresses the stimulus artefact in the sensory (MSCV correcting and unremitting) the first instances of the trace after stimulation. In sensory acquisition this algorithm is enabled as default
Stimulation Side	These two options are present: Left, Right
Invert Lines	Inverts the polarity of the selected traces; not available in acquisition

Acquire Menu

Run/Stop	Starts or stops the acquisition from the Headbox. Attention: this does not coincide with the data saved in permanent memory (on disk)
Stimulation	Starts or stops the stimulation
Single Shock	Acquires the signal of the single stimulus response; this technique is used for MNCV above all
Average	Activates/deactivates the average. When the average has been activated, the acquisition starts like the average of different traces; deactivating the average function, the acquisition is automatically turned off as the average of more traces
View Montage	Shows the Montage View window
Start/Stop Trend	Starts or stops the acquisition of the responses in cascade for the number of pre-set stimuli in the protocol
Save All	This function is available during acquisition of the EMG Needle exams. Enabling this function the user has the possibility to save everything that the signal has acquired without time limits (up to an eventual saturation of the hard disk memory)
Save	This function is available during the acquisition of the exams in Needle EMG. Enabling this operation the user has the possibility to save segments of trace of 5 seconds: the program automatically saves 3 seconds prior to and 2 seconds afterwards the instant of the save function
Pause	
Clear Exam	Deletes the acquired response. If the user is acquiring in the Average mode, the function deletes the averaged

	trace (without no confirmation request) and the acquisition restarts averaging automatically the new response
QEMG	
Turns Amplitude	Available during the acquisition of Needle EMG exam; please refer to the section Turns and Amplitude
Trigger	This function is available during the acquisition of Needle EMG exam. Enabling this function the base program Trigger is activated. The program is synchronized on a threshold trigger (configurable by the user as a gain level and delay using the respective arrows of the keyboard) and view in the Motor Unit Action Potentials (MUAP). This program allows the user to view the MUAP but not their save
MUAP	This function is available during Needle EMG exam. Enabling this function the advanced Trigger program is activated with the automatic capture of the MUAP. The program synchronizes on a trigger threshold (configurable by the user as the gain level and delay using the respective arrows from the keyboard) and views the Motor Unit Action Potential window (MUAP)
MUAP Capture	This function is available during MUAP exams; it allows the user to acquire up to 20 trends saving up to 10 unit for each trend (for a total of 200 MUAP). These responses are saved in a file called MUAP, accessible from the archive screen
Add site	
Overload Rejection, Check, Temperature	Disabled

Tools Menu

View Average	Shows a single trace that the average of a group of traces overlapped instead of the group
Rectification	Inverts the negative part of the signal
Measure Cursors	Activates the measure cursor for Needle EMG exam
Overlap	Regards the trace overlapping; the following sub-menu opens
	Derivation Overlaps traces having the same name belonging to more acquired averages (verification of the exam)
	Selection Overlaps only the selected traces; the traces must not be overlapped in derivation
	Reset Shows all the traces with overlapping
Calculation Algorithms	
Default Flags	If the item is pressed a flag shows, otherwise they have a cross shape that intersects with the trace
Color Settings	Opens a window that allows the user to set the background color, the grid color, the color of the trace

	etc. Two default color options are available. Colors for every option are fixed
--	---

Move Menu

The items of this menu are active only for the Needle EMG exam. The commands are the following:

Begin Trace	Moves the display to the trace beginning
Previous Page	The display passes directly to the previous page. If the user is already on the first page, this command is ignored
Next Page	The display passes directly to the following page. If the user is already on the last page, this command is ignored
End Trace	The display is positioned at the end of the trace
Auto Right	Forwards the trace performing a replay

Windows Menu

Cascade	Puts all open windows in cascade (one on top of another horizontally or vertically)
Tile Horizontally	Puts in the open windows horizontally
Tile Vertically	Puts in the open windows vertically
<i>List of Windows</i>	List of opened windows. The active window is marked with a check sign on the left

Help Menu

Help on line	Opens this window
Hotkeys help	Displays a window where there are two columns: the left column indicates the raid key, the one on the right indicates the corresponding function. Refer to Hot Keys section
About	Opens a dialogue window with all the information about the program and the operative system

Toolbars

For acquisition and review of the EMG exams three toolbars are used: one that holds the acquisition buttons, one for the filter parameters settings, and one with the keys for the organization of the acquired traces during review.

Acquisition Toolbar

The acquisition toolbar has both keys for EMG and EP; depending on the type of exam the keys can be deactivated or activated.

The corresponding functions to the items present in the Acquisition toolbar are, from the left:

Run/Stop, Stimulation, Average;

Go to Linked Program: active only for EP;

Save, Save All, Pause, Single Shock, Start/Stop Trend, Turns Amplitude, Trigger, MUAP, MUAP Capture, Clear Exam, Check, Temperature.

Parameter Toolbar

The parameter bar has keys and popup menus that allow the settings of the software filter and other trace review parameters. These parameters are some of those present in the Modify Menu, from the left:

High Pass, Low Pass, Base Time, Amplification, Notch, Smoothing Up, Smoothing, Smoothing Down.

Review Toolbar

The toolbar for the review of EMG has the keys for EP as well, the items of the EP are deactivated. The active keys correspond to some of the items present in the Modify Menu, in the Tools Menu and in the File Menu. These keys are, from the left:

Invert Lines, Measure Cursor, Select All, Deselect All, Invert Selection;

Addition, Average, Subtraction, P300 traces automatic subtraction, Overlap separately P300 traces, P300: all active only for EP;

View Average, Derivation, Reset, Selection, Rectification, Add to Report.

Layout setup

This section regards the user settings of the parameters necessary to compile the final report. The settings of all these parameters is via the "Layout" window with several tabs, each of them containing specific parameters, and two buttons above:

- **Exit**: closes the window and eventually requests to save the variations made.
- **Save**: temporarily saves the settings without closing the window.

The tabs of parameters

The tabs of parameters contain various items, click to open their respective topics:

General

In this tab the user sets the **Current Layout** and the **First Page Setup**.

About the **Current Layout**, the user is allowed:

- To create a new layout or to duplicate an existing one (using the **New** and **Duplicate** buttons). In both cases, the user sets the name of the layout
- To delete a layout (using the **Delete** button)
- To select a layout from the list of the available ones

About the **First Page Setup**, the user can select:

- The Font and Color
- The Report Model

- To insert the Exam List (ordered by acquisition) or not
- To insert the Page Break or not

Tables

In this tab the user sets how to insert the tables in the report. The settings refer to the current layout.

In the **Tables** section, the user decides to insert in the report:

- One table for each acquisition: for each acquisition, a table is inserted in the report
- or
- One table for each exam: data of acquisition of the same type is grouped in a unique table in the report

In the **Tables Order** section, the user decides to:

- Insert tables by the acquisition order

or

- Insert tables by an order chosen by the user, using the below list and the arrow keys

Exam

In this tab the user sets how to insert numerical data and traces graph in the report. The settings refer to the current layout.

On the grid the following columns are found:

Exam: in this column are listed the various EMG exam types

Left Right Comparison: for the current exam type, the comparison between the left and right side is managed using one of the following mode:

- Vertical alignment
- Horizontal alignment
- With different color

Left Color, Right Color: for the current exam type and if the comparison between the left and right side is managed using different color, the user can select here the color for left side and right side.

Print traces: for the current exam type and if a unique table for each exam is inserted in the report, the user can select to print traces below the exam or below the table. Otherwise, if for each acquisition a table is inserted in the report, each table is followed by the traces.

Grid square size: the user can set the size of the grid square.

Tables Parameters setup

This section regards the user settings of the parameters necessary:

- To view the signals according to the nerve and site chosen
- To compile the final report.

The settings of all these parameters is via the "Tables" window with several tabs, each of them containing specific parameters, and two buttons above:

- **Exit:** closes the window and eventually requests to save the variations made.
- **Save:** temporarily saves the settings without closing the window.

View

In this tab the user sets which parameters to view during Acquisition and Review section, their font, bgcolor, and forecolor.

A pair of tables is represented:

- On the left, the table of available parameters

- On the right, the table of selected parameters. Using the left mouse button, click on the cell of the actual parameter to select the measure unit

For some exams (MNCV, SNCV, H-REFLEX, F-WAVE, BLINK-REFLEX) two pairs of tables are shown. Use the left and right arrows that are set between the two tables, to move the actual parameter from a table to the other one.

On the right of the table of selected parameter there are some buttons:

- Use the two arrows to move up or down the actual parameter
- Use the appropriate buttons to set the font, bgcolor, and forecolor for Header and Value

Report

In this tab the user sets which parameters to view during Report section, their font, bgcolor, and forecolor.

A pair of tables is represented:

- On the left, the table of available parameters
- On the right, the table of selected parameters. Using the left mouse button, click on the cell of the actual parameter to select the measure unit

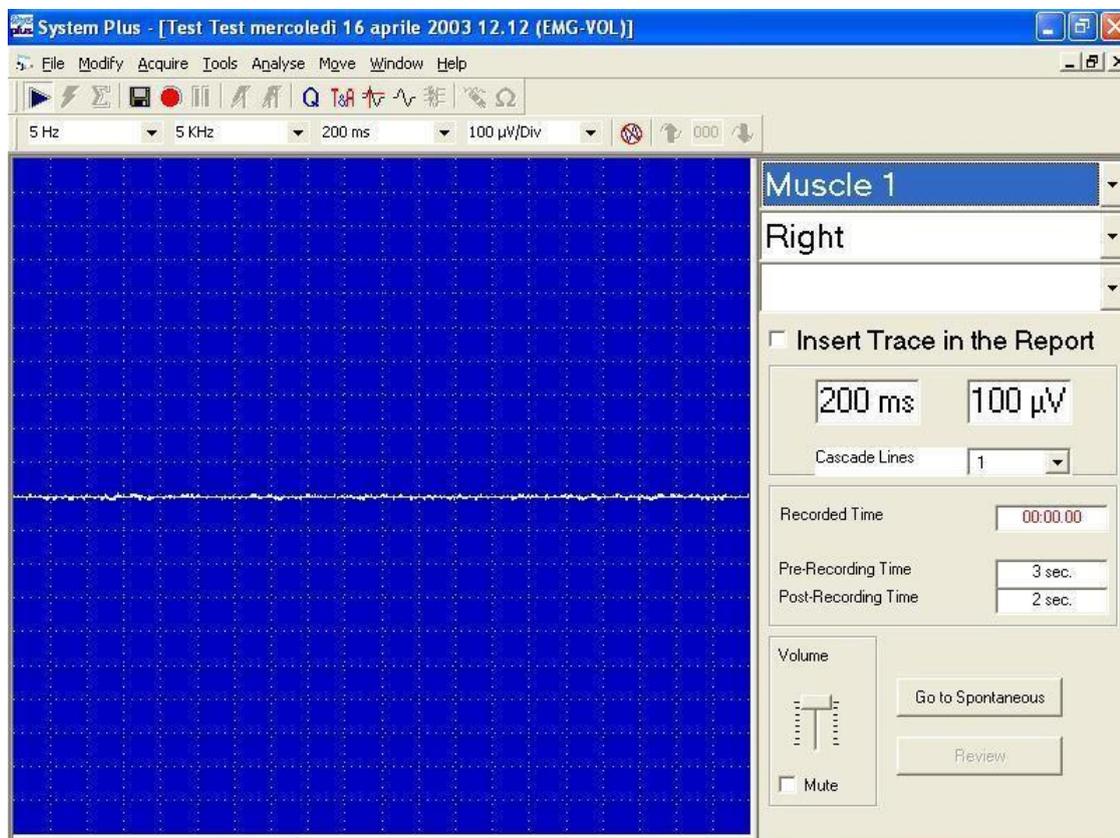
Use the left and right arrows that are set between the two tables, to move the actual parameter from a table to the other one.

On the right of the table of selected parameter, there are some buttons:

- Use the two arrows to move up or down the actual parameter
- Use the appropriate buttons to set the font, bgcolor and forecolor for Header and Value

EMG exams

Needle EMG - Turns & Amplitude - QEMG



The user can enter this program by pressing the New EMG Exam button (key **F5**) or New EMG File (key **F10**) from the archive window, then selecting the Needle EMG tab (key **F1**) from the EMG setup window and then pressing the Acquire button.

Upon acquisition screen opening, a dialog box appears asking to specify the side of acquisition, *Left or Right*.

The acquisition program begins immediately. First, the Base Time and signal Amplification are to be fixed, after which it is possible to begin, if necessary the recording on disk via the hot keys or the keys of the toolbar or via the items under the Acquire menu.

The window of Needle EMG exam is divided into two main parts: on the right there are the commands and the parameter indications of the exams, on the left a panel with all the acquired traces in real time. The window changes if the user selects an optional program of analysis: MUAP, Turns & Amplitude or QEMG.

Controls (right side of the acquisition window)

In the first popup menu on the top it is possible to select the name of the muscle site or nerve from the list of defined names in the Muscles and sites EMG exam protocol section.

In the second popup menu it is possible to set the acquisition side, Left or Right.

In the third popup menu it is possible to select the comment blocks memorized in the files build by the user: these files are found in the "...\\Settings\\Blocks\\EMGBlocks" directory. If this directory is empty (no comment file has been created), the popup menu remains empty.

Insert Trace in the Report: controls the type of checkbox; if it has been selected, a graph of the acquired traces is automatically shown in the report when it is generated.

NOTE: pressing the **F8** key or the Add to Report key on the toolbar or selecting **Add to report** from the EMG Tools menu a dialog window opens with a textbox that makes it possible to introduce a comment in the report when it is generated. This option can be disabled (see Options - EMG in the Archive section)

In the box below the present command two textboxes appear and a popup menu: on the left the time base is indicated, on the right the vertical amplitude is shown; both are modifiable from the keyboard via the Hot Keys.

Cascade Lines: a popup menu where the user may select the number of lines on the monitor during acquisition. These are not acquired at the same time, however each line is the continuation of the last on that precedes it (in a vertical way, it is the first on the top is the continuation of the last on the bottom).

Other controls and indications:

Save: a textbox that indicates the time save; when saving for a prefixed time of 5 seconds (pressing the space bar or the function key F5) the "SAVE" string flashes.

Recorded Time: amount of recording time.

Pre/Post Recording Time: these two textboxes indicate the pre/post time intervals of recording. Remember that when saving 5 seconds of trace segments (pressing the space bar or the key function F5) the program automatically saves 3 seconds prior to acquisition automatically and 2 seconds after the trace in respect to the save command.

Volume: regulates the output volume. Remember that the amplitude of the output volume is proportional to the amplitude of the video signal.

Mute: deactivates the sound.

The button **Go to Voluntary/Go to Spontaneous** allows the user to switch alternatively to the two EMG acquisition programs in an automatic way and directly.

Review: this button switches to the review mode for the last recorded trace.

Measure Cursor

When acquisition stops, the machine automatically switches over to review and the measure cursor appears: which is a band overlapping a trace, re-sizeable and moveable by the user, in which the peak-to-peak and signal area are calculated and spectral analysis is shown. The calculated values appear in a small window on the side. The measure cursor option can be activated or deactivated via the Tools menu or via the relative key present on the review toolbar.

Turns & Amplitude

The Turns & Amplitude program is an (optional) analysis program available during acquisition and review sessions of the EMG Needle exam. The user enters this program via the item Turns and Amplitude from the Acquire menu or by clicking on the relative button found on the toolbar.

The Turns & Amplitude analysis depends on the subdivision of the signal in epochs of equal duration (1 second). In every epoch the number of oscillations of the wider signals of a certain threshold (100 μV); this number is called **Turns**. In the same epoch the average amplitude of the signal is calculated, called **Amplitude**. These two values compose a pair of coordinates of a point of the Turns & Amplitude diagram.

The trace panel therefore is divided vertically in two parts: in the upper part the trace runs in real time, while in the lower panel the diagram of the Turns & Amplitude appears having turns like axis and amplitude as coordinates (in μV). As the acquisition continues red squares appear on the diagram that indicate the measures of the turns & amplitude done on the epochs of the acquired signal. Pressing the **F2** key function all the points of the diagram are cancelled and a new analysis restarts.

During acquisition a pause button is enabled: it allows the user to pause and restart the parameters extraction routine.

Between the two panels a popup menu appears in which the user can choose the normative data relative to a particular muscle; these data represent the normal area that is indicated by a closed line above the diagram.

On the left of the panel containing the diagram there are two popup menu that allow the user to size the diagram in a way to highlight the zone near the origin or vice versa better:

Max. Turns: number of maximum turns in axis.

Max. Amplitude: maximum amplitude in coordinate.

In the **Number Epochs** textbox the number of epochs of 1 second considered at the start of an acquisition is indicated.

How to Create Normative Data

In the popup menu mentioned above, normative data of a standard series of muscles are present:

Biceps Male above 60
Biceps Male below 60
EDC Male above 60
EDC Male below 60
Quadriceps Male above 60
Quadriceps Male below 60
Tibialis Male above 60
Tibialis Male below 60

These data are memorized in other text files (with extension **.txt**) present in the directory **..\NormativeTA.** The names of these files are shown in the popup menu without extension. The user can build their own files of normative data or modify those present with any Text-Editing program, following these simple notes:

- Uses as name of file a string type: **[muscle name] [sex] [age]**
- The file contains the pair of coordinates of points expressed in turns (axis) and amplitude (ordinate, in μV) separated by a space, a pair per line; the program reads the coordinate and uses them to design a polygon having the points as data referrals. A maximum of 100 pairs of co-ordinates are considered, but a number that goes from 10 to 20 is already sufficient. An example of normative data files is the following "*Tibial Male below 60.txt*":

```

0                200
90               300
200              350
400              450
    
```

600	550
732	550
732	2250
600	2200
400	1850
200	1400
90	1000
0	200

Take note that the last pair of coordinates coincide with the first and this makes the polygon closed.

MUAP

In this test, Motor Unit Action Potentials are recorded from the needle electrode inserted in a muscle. The patient is instructed to perform a slight contraction of the examined muscle and the system records predefined number of MUAPs from different insertions.

Four windows can be displayed in the MUAP mode of operations:

1. Raw EMG signal window. This window is used to set the trigger level and display the free running EMG signal with slow time base. Detected MUAPs are displayed in distinguished color and are also shown in the Detected MUAP window. Vertical cursor in this window is used to point to the MUAP that can be manually modified

2. Detected MUAP window. Up to 10 detected MUPs can be shown sequentially. Time base, amplitude scale and delay can be independently set for this window. The onset and the end of each potential are marked with color boxes. MUAP duration is measured between the right edge of the onset box and the left edge of the end box. The height of boxes is equal to V_p and the length is equal 3ms which means that MUAP must be stable for at least 3ms before it starts and 3ms after it ends. Clicking on the onset or end box invokes MUAP modification dialog. Two vertical and two horizontal cursors are available for amplitude and duration measurements

3. MAP window. It can be alternatively displayed instead of the detected MUAP window. It shows the MUP amplitude as a function of MUP duration. All MUPs are divided into two categories: simple (≤ 4 phases) and polyphasic (> 4 phases). MUPs that are simple and their amplitude and duration are identical (within function resolution) and these MUPs are scored at least four times - are marked as simple. MUPs that are polyphasic and their amplitude and duration are identical (within function resolution) and these MUPs are scored at least four times - are marked as polyphasic. Other MUPs (all MUPS that have less than 3 resembling MUPs) are marked as variable

4. Histograms window. Histograms are displayed for MUP amplitude, duration and phases. The histograms are automatically scaled. The values displayed to the right of histograms are:

- MIN – minimal value (5% off all MUPS have amplitude (duration or phases) less than MIN)
- MAX – maximal value (5% off all MUPS have amplitude (duration or phases) grater than MAX)
- MEAN – mean value
- SD – standard deviation

Program can work either in online or in offline mode.

Online Mode

In this mode EMG signals are recorded and analyzed online. This is the standard mode when the patient is being examined.

To acquire the data follow these steps:

- Insert the needle electrode into the examined muscle and instruct the patient to perform weak contractions of the muscle so that few Motor Unit potentials are generated
- Press the New Ins button to start the examination. EMG signals from the needle electrode in the tested muscle are displayed as they are acquired. The triggered potentials are displayed

in the MUAP window. If the trigger cursor in the Raw EMG window is switched on, it can be used to set the MUAP trigger level

- Press the Acquire button (or the Space Bar) to start automatic MUAP detection. Program automatically classifies MUAPs and when the pre-programmed number of MUAPs is detected or after the predefined time period the program stops. The data is automatically stored. Reposition the needle and perform other recordings
- Repeat this procedure to record data from several insertions

Offline Mode

In the offline mode you select previously recorded data to be re-analyzed. Most of commands are the same for both online and offline modes.

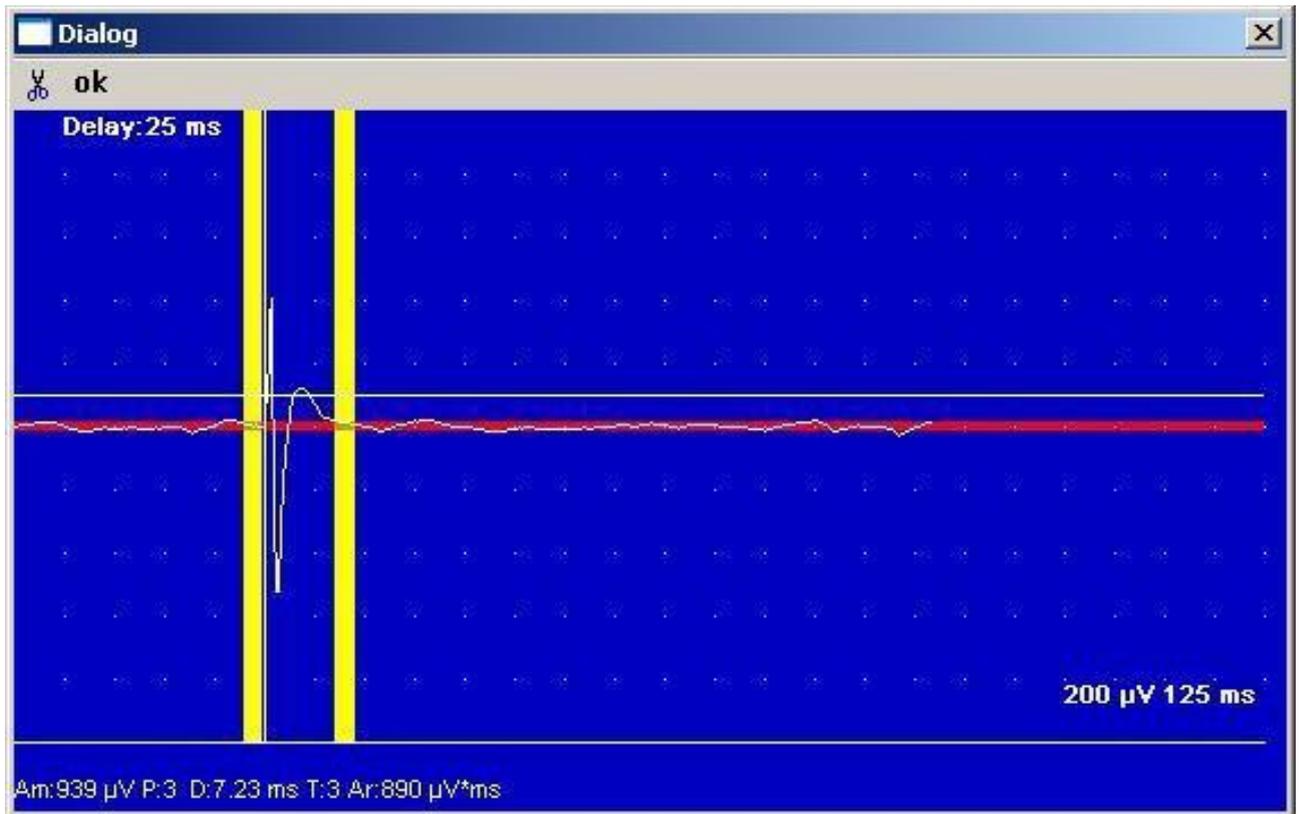
In the Auto-Level mode, the trigger level is by default set to value that is equal to $\frac{1}{2}$ of one amplitude scale division. Other detection parameters are also firmly dependant on the amplitude sensitivity.

If the Auto-Level is switched off the user is responsible for setting the MUAP detection criteria.

After the data from several insertions has been recorded one can switch from insertion to insertion with Previous or Next buttons. The Mean button displays mean results screen where all histograms show summed data from all accepted results. In this mode the MUAP window is switched off and the MAP window is displayed.

When you scroll the recorded EMG signal in the upper window, the first N detected MUAPs (that can be seen in the upper window) are also shown in the MUAP window. As you point to the selected MUAP with the mouse cursor, a tool-tip showing the MUAP parameters is displayed. Manual modification of MUAP onset and end can be invoked easily by clicking that MUAP.

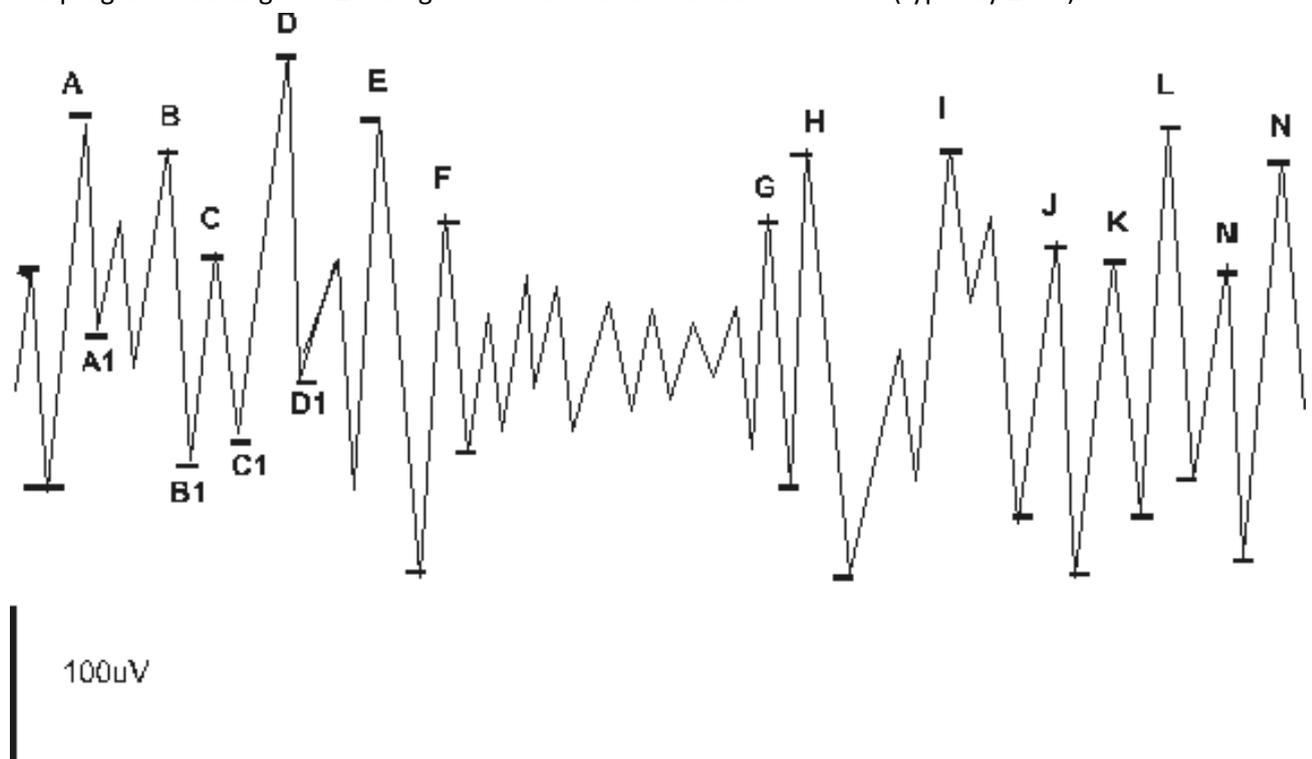
MUAP modification. The MUAP modification dialog enables to change positions of the onset and end markers. As these markers are repositioned, the MUAP parameters are recalculated. To change the onset or the end of the MUAP you must drag the corresponding vertical marker to desired position. A thin vertical cursor (trigger delay) in the modification dialog is used to separate the area where onset and end markers can be moved. Press the OK button to accept the entered modifications or press the Scissors button to delete the MUAP completely.



IPA

Interference Pattern Analysis module records the EMG signal during maximum voluntary contraction and performs Turns and Amplitude analysis.

Pre-programmed length of EMG signal can be recorded for each insertion (typically 1 sec).



Turns are defined as reversals in slope that are separated from previous and next turns by amplitude change higher than 100μV. Turns are marked with letters (A, A1, B, B1, etc.).

Negative turns are marked with A, B, C ... while positive turns are marked with A1, B1...etc.

- Intervals are calculated as distances between successive negative turns.
- Turns amplitudes are measured between successive negative and positive turns (for example A-A1, B-B1...)

Acquiring Data

To perform the IPA test in the online mode, follow the steps below:

- Press the New Ins button and have the patient perform muscle contraction
- Now press the Acquire button to record the predefined epoch of EMG signal. The raw signal is displayed in cascade mode on the left side. When the recording is done, the histograms are calculated and displayed. The EMG signal is frozen. The acquired data is automatically accepted but can be later rejected with the Reject command
- Repeat above steps for other insertions if necessary
- The raw EMG data can be scrolled if the time base is short. Two horizontal cursors are available to measure the signal amplitude
- Two histograms are constructed for the IPA data:
 - Turns Amplitude
 - Turns Intervals. The interval histogram is constructed from intervals between those negative turns that have amplitude higher than the average turn amplitude

When data from multiple insertions has been recorded you can switch among insertions with Previous or Next buttons. The Mean button is used to display the mean results from all recorded insertions.

Below the histograms window the following numerical parameters are also displayed:

- Mean amplitude: mean turns amplitude
- Mean density: reciprocal of the mean interval (in Hz units)
- Activity:

$$Activity = \frac{Total_measurement_time - Silence_time}{Total_masurement_time} * 100\%$$

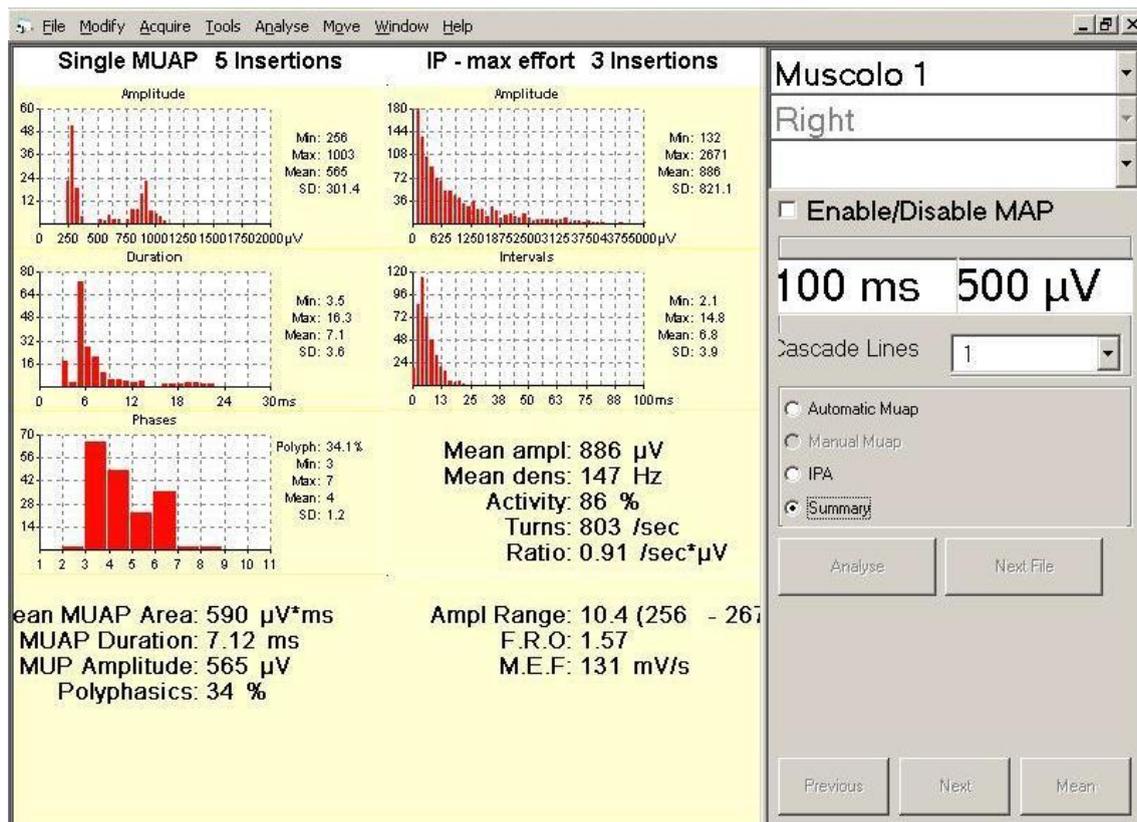
where:

Total_measurement_time is user defined (usually 1 second)
 Silence_time is calculated as a sum of those intervals that are longer than 5ms.

- Turns: number of turns per second
- Ratio: Turns per second/Mean turns amplitude

Summary

When both AMUP and IPA data have been recorded you can switch to the summary page, which shows the most important mean results for these two examinations.



Additional numerical parameters are shown in the lower window:

- Ampl range (minimal MUAP amplitude – maximal IPA amplitude)
- Mean density 100/mean IPA interval
- F.R.O Functional Recruitment Order
- F.R.O = mean IPA amp/mean MUAP amp
- M.E.F Maximal Electrical Force
- M.E.F = (mean IPA amp) * (mean density)

MUAP

The MUAP program is an analysis program (optional) of Motor Unit Action Potentials available during the acquisition sessions and review session of EMG spontaneous and voluntary activity.

During acquisition phase, the user can enter this program by:

- Pressing the New EMG Exam button (key **F5**) or New EMG File button (key **F10**) from the archive window, then selecting the MUAP tab (key **F2**) from the EMG setup window, selecting the protocol and then pressing the Acquire button

or

- When in Needle EMG by selecting MUAP from the Acquire Menu, or via the function key **F4** MUAP or clicking on the MUAP button on the toolbar.

Note: the function key F4 toggles from Needle EMG to MUAP. Pressing it twice will reload the same exam window.

During review phase, the user can enter this program by:

- Selecting MUAP from the Acquire Menu or via the function key **F4** MUAP or clicking the MUAP button on the toolbar.

The MUAP Analysis Program

The acquisition window is divided into at least two main parts:

- On the left, there is at least a panel traces

- On the right section, there are the controls and the parameter indications of the exam

Parameters

In the first popup menu, it is possible to select the **name** of the muscle or nerve site in the list of defined names.

In the second popup menu, it is possible to set the acquisition side: **Left** or **Right**.

The two labels below indicate the selected **Time Base** and **Amplification** for the current trace panel.

The three buttons **MANUALMUP**, **SINGLEMUP**, and **MULTIMUP** permit to choose the more suitable technique and analysis program.

The **Analysis Time** indicates the duration (in second) of the acquired trace that is automatically Analyzed (MultiMup).

It is possible to set the volume or to disable the **speaker sound** (Mute).

When enabled, the **Review** button permits to review the analysis results: MUAPs and their parameters.

The SingleMup Technique

This is an online analysis procedure that permits, during acquisition, the user to identify and classify the MUAPs.

An advanced Trigger program is activated with the automatic capture of the MUAP. The program synchronizes on a trigger threshold (configurable by the user as the gain level and delay using the respective arrows from the keyboard) and views the MUAP window.

The acquisition window is divided into three main parts:

- On the left, there are two panels traces, one above and one below; on the top the acquired trace is represented in real time and is present on the panel a horizontal red line that represents the trigger threshold. In the lower panel the triggered MUAP trace and a red line appears (horizontal trigger line). The trigger line of the upper panel and those lower are synchronized, and are moved up and down by the user via the up - down arrows of the keyboard. When the trigger starts to work on the signal, in the lower panel the MUAP appears. Pressing the left - right arrows the user can move the trace horizontally to the point of synchronism

NOTE: the trigger line can be moved by clicking over it and dragging it.

Below the two trace panels the following indications can be found, starting from the left:
Trigger: value of the trigger threshold, in *mV*; this is updated when the user moves the trigger line.

Trigger2: this is a popup menu that allows the user to select the threshold level of a second trigger; this value is dependent on the first trigger value.

Delay: value of the delay, in *ms*; this is updated when the user moves the trigger.

Base Time: changes the Base Time of the MUAP window.

- The middle section of the window archives up to 10 MUAP responses, each trend in a cascade way. See below about the MUAP's acquisition

- When a MUAP cell is available, in the right section there is a grid where for each trace the following parameters are shown (or eventually the averaged values of each trend):

Duration: duration (in *ms*) of the MUAP.
Amplitude: peak-to-peak amplitude (in μV) of the MUAP.
Turns: number of turns of the MUAP
Area: area (in $\mu V \times s$) of the MUAP.
Phases: number of phases of the MUAP.
Traces: number of traces overlapped.

In the last lines of the grid, the averaged values of each column (Mean MUAP n.x) and the averaged values of all MUAPs (Mean all MUAPs) are shown.

MUAP Exam Acquisition Mode

Once the user has triggered on the MUAP regulating the levels of the threshold trigger and of the delay (that is, the trigger has been fixed), automatic MUAP acquisition can be activated by choosing **MUAP Capture** from the Acquire menu or pressing the **space bar** of the keyboard or clicking the **MUAP Capture** button on the toolbar. In this way the first 10 MUAPs are acquired similar for morphology and typical of those triggered in the MUAP window. The acquisition of the 10 MUAPs can be memorized by selecting **Save** from the Acquire menu or pressing the **Save** button on the toolbar; in this way the user archives an acquisition trend and passes to the following acquisition trend. Up to 20 trends can be acquired archiving a total of 200 MUAPs. These responses are saved in a file called MUAP, accessible from the archive screen.

The program calculates in an automatic way the values of all the parameters for each trace (or the respective averaged values for each trend), viewing them on the grid on the right of the window as soon as the **Begin** and **End** flags have been correctly positioned for every captured MUAP.

Working on the panel of the MUAP acquired traces (in the middle): the Begin and End flags are represented on each MUAP of the current trend. To move a flag just select it clicking on it (becomes green) and drag it or click again in another point.

The MultiMup Technique

This is an analysis procedure that permits, during acquisition or review, the user to identify and classify the MUAPs.

The acquisition window is divided into two main parts:

- On the left, there is a panel where the acquired trace is represented in real time
- On the right, there are the controls and the parameter indications of the exam, in particular the **Analysis Time** indicates the duration (in second) of the acquired trace that is automatically Analyzed

The automatic MUAP acquisition can be activated by choosing **MUAP** and then clicking the **MultiMup** button on the toolbar. In this way the acquired trace is automatically Analyzed and the first 10 MUAPs of each trend are organized in a MUAP cell.

The results of the automatic analysis are represented in the MUAP window divided into four main parts:

- On the left, there is a panel where the acquired trace and the MUAPs classification are represented. A number above the red trace identifies the various MUAPs
- The middle section archives up to 10 MUAP responses, each trend in a cascade way
- In the right section, there is a grid where for each trace the following parameters are shown (or the averaged values of each trend):
 - Duration:** duration (in *ms*) of the MUAP.
 - Amplitude:** peak-to-peak amplitude (in μV) of the MUAP.
 - Turns:** number of turns of the MUAP.
 - Area:** area in ($\mu V \times s$) of the MUAP.
 - Phases:** number of phases of the MUAP.
 - Traces:** number of traces overlapped.

In the last lines of the grid, the averaged values of each column (Mean MUAP n.x) and the averaged values of all MUAPs (Mean all MUAPs) are shown.

- In the lower part on the window, there is a panel containing the various MUAP cells produced by the automatic analysis

The user can modify the automatic results, for example:

- Moving the Begin or End flags

- Clearing acquired MUAPs
- Activating the Measure Cursor and then using the Modify/Capture function

The ManualMup Technique

This is a procedure that permits, during acquisition or review, the user to identify and classify the MUAPs exclusively in manual mode.

The manual MUAP acquisition can be activated by choosing **MUAP** on the toolbar. In this way the MUAP window is shown, divided into four main parts:

- On the left, there is a panel where the acquired trace is represented and where the user has to work to classify the MUAPs.
- The middle section archives up to 10 MUAP responses, each trend in a cascade way.
- In the right section, there is a grid where for each trace the following parameters are shown (or the averaged values of each trend):
 - Duration:** duration (in *ms*) of the MUAP.
 - Amplitude:** peak-to-peak amplitude (in μV) of the MUAP.
 - Turns:** number of turns of the MUAP
 - Area:** area in ($\mu V \times s$) of the MUAP.
 - Phases:** number of phases of the MUAP.
 - Traces:** number of traces overlapped.

In the last lines of the grid, the averaged values of each column (Mean MUAP n.x) and the averaged values of all MUAPs (Mean all MUAPs) are shown.
- In the lower part on the window, there is a panel containing the various MUAP cells produced by the manual MUAP acquisition.

To proceed with the manual MUAP acquisition, the user has:

- To activate the **Measure Cursor** from the Tools menu or clicking the **Measure Cursor** button on the toolbar
- To drag the cursor on the trace, fixing the point of interest
- To press the function key **F4 Modify/Capture**

The Modify/Capture window appears. Now the user can move the Begin and End flags and then press:

- **F5 OK:** to archive the resulting MUAP.
- **F2 Cut:** to clear the acquired MUAP.
- **Search:** to search the first 10 MUAPs similar for morphology of those present in the window.

The user can append the resulting MUAPs to the selected cell or produce a new MUAP cell.

The program calculates in an automatic way the values of all the parameters for each trace (or the respective averaged values for each trend), viewing them on the grid on the right of the window.

MNCV and SNCV

The window of the MNCV and SNCV exam is divided in three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is a panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.)

invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the grid on the top the following columns are found:

Site: name of acquisition site.

Duration: duration of the response (temporary distance between start flag and end flag) in *ms*.

Amplitude: peak-to-peak amplitude of the response in *mV*.

Area: area of the response in $\mu V \times s$.

In the second grid in the center the following columns are found:

Segment: type of calculated correlation, see section "Correlation of the EMG Exam Protocols."

Latency: latency of the response, in *ms*. This is calculated as soon as the corresponding flag is positioned on the trace.

Distance: distance between acquisition site and stimulation site (absolute) or between two acquisition sites (relative), in *cm*; in this field the user must set the value clicking with the mouse, typing in the value from the keyboard and pressing ENTER. The value of the velocity (absolute and relative) is then automatically calculated.

NOTE: when the field Distance is empty, it is sufficient to type in a number from the keyboard and press ENTER.

Velocity: velocity in *m/s* calculated automatically once the necessary parameters have been set (latency of the response and distance).

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned the fields of these parameters remain empty.

Stimulator Bar

Below the grid, there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Avg** and indicates the number of responses from stimulus that have been accumulated in the average of the signal, once the user has selected this type of acquisition, the number of acquired traces when the acquisition has started.

MNCV - SNCV Exams Acquisition Modes

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The following steps are:

1. Regulate the stimuli intensity and acquire a single curve (via the space bar) or calculate the average (F6 key) of an group of analog response. The average is automatically

interrupted once it has reached the programmed number of stimuli or by pressing F6 key again

2. Verify the response obtained and pass to the following site and repeat step 1
3. Verify the correct insertion of the flags and the distances are introduced
4. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Acquisition End

NOTE: when the user stops the acquisition, the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped, the panel of the traces in real time and the stimulator bar disappear and the grids are enlarged in order to use all the leftover space.

Flag Insertion

Once acquisition has stopped, the flags **Onset** and **End** are automatically inserted; however it is possible to move them by clicking and dragging to the desired position.

To add a flag the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present on the status bar on the left of the flags. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

Inching

The window of the Inching exam is divided in three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the grid on the top the following columns are found:

Site: name of acquisition site.

Duration: duration of the response (temporary distance between start flag and end flag) in *ms*.

Amplitude: peak-to-peak amplitude of the response in *mV*.

Area: area of the response in $\mu V \times s$.

In the second grid in the center the following columns are found:

Segment: type of calculated correlation, see section Correlation of the EMG exam Protocols.

Latency: latency of the response, in *ms*. It is calculated as soon as the corresponding flag is positioned on the trace.

Distance: distance between acquisition site and stimulation site (absolute) or between two acquisition sites (relative), in *cm*; in this field the value is set to 2.5cm (1 inch). The value of the velocity (absolute and relative) is then automatically calculated.

Velocity: velocity in *m/s* calculated automatically once the necessary parameters have been set (latency of the response and distance).

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned the fields of these parameters remain empty.

Stimulator Bar

Below the grid, there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Avg** and indicates the number of response from stimulus have been accumulated in the average of the signal, once the user has selected this type of acquisition, the number of acquired traces when the acquisition has started.

Inching Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The following steps are:

1. Regulate the stimuli intensity and acquire a single curve (via the space bar) or calculate the average (F6 key) of an group of analog response. The average is automatically interrupted once it has reached the programmed number of stimuli or by pressing F6 key again
2. Verify the response obtained and pass to the following site and repeat step 1
3. Verify the correct insertion of the flags and the distances are introduced
4. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Acquisition End

NOTE: when the user stops the acquisition, the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped, the panel of the traces in real time and the stimulator bar disappear and the grids are enlarged in order to use all the leftover space.

Flags Insertion

Once acquisition has stopped, the flags **Onset** and **End** are automatically inserted; however it is possible to move them by clicking and dragging to the desired position.

To add a flag the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present on the status bar on the left of the flags. The names

of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

RNS

The window of the RNS exam is divided in three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the first grid on the top, the following columns are found:

Amplitude Ratio: ratio between the amplitude of two specific responses.

Area Ratio: ratio between the area of two specific responses.

Amplitude Variation (%): percentage of the ratio between the amplitude of two specific responses.

Area Variation (%): percentage of the ratio between the area of two specific responses.

Frequency:

These parameters are calculated for the 5th and 1st response and for the 9th and 5th response.

NOTE: the 1st, 5th, and 9th responses are taken as default for the calculation of the ratios; the user can set the responses clicking column.

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned the fields of these parameters remain empty.

Stimulator Bar

Below the grid there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Trc** and indicates the number of acquired traces when the acquisition has started.

Grid of Trends

In this grid the user can set new trends or select those present. By double-clicking over on the

trends present immediate performance starts. To modify the parameters just right-click over the fields in the grid, type in the value from the keyboard and press ENTER (or click another part). The grid columns are:

Num. Stim.: number of consecutive stimuli (a maximum of 32).

Frequency: stimulation frequency (variable from 0 to 20Hz).

Delay: delay of the beginning of the following trend respect to the one selected. A void value interrupts the stimulation sequence.

Note: description of the trend.

RNS Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The user may choose between an automatic program or manual one:

Manual procedure:

1. Regulate the stimuli intensity and acquire a curve trend pressing the space bar or the relative button on the toolbar or selecting Acquire Trend from the Acquire menu

NOTE: this is the most common way for the manual procedure. Whenever the user desires to acquire a curve of the cascade one at a time, the user must activate the Space bar of the Tools menu that allows the user to use the space bar to acquire a single curve instead of an entire cascade.

2. Verify correct flag insertion
3. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Automatic Procedure:

1. Regulate the stimuli intensity and acquire a cascade of curves selecting a trend from the grid and pressing the space bar; it is possible to start a trend by double-clicking on it
2. Wait for the end of performance of the automatic procedure
3. Pass to the following exam (with the F7 key taking the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of the corresponding exam) inserting automatically or upon request, the results in the report

NOTE: it is possible to set an automatic default program (trend) in the Automatic Program section in the EMG exam Protocols.

Acquisition End

NOTE: when the user stops the acquisition the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped, the panel of the traces in real time and the stimulator bar disappear and a graph that represents the M Amplitude of the traces appears.

Flag Insertion

Once acquisition has stopped, the flags **Onset** and **End** are automatically inserted; however it is possible to move them by clicking and dragging to the desired position.

To add a flag the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button. The selected flag is then inserted automatically on all the traces.

To remove a flag just drag it in the bin present on the status bar on the left of the flags. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

H Reflex

The window of the H Reflex exam is divided in three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key, the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the grid on the top, the following lines are found:

H Lat: latency of the H response, that coincides with the position of the **H-Beg** flag.

H Amp: H Reflex amplitude, measured as the peak-to-peak value of the response between the **H-Beg** and **H-End** flags.

M Amp: amplitude of the M response, measures as the peak-to-peak value of the response between flags **M-Beg** and **M-End**.

Amp H/M: ratio between averaged amplitude of the H and M responses.

For each parameter, the first column shows the minimum value and the third column shows the maximum found between all the traces, the second column shows the averaged value.

The second exam parameters grid shows:

M Latency: latency of the M response.

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned, the fields of these parameters remain empty.

Stimulator Bar

Below the grid there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Trc** and indicates the number of acquired traces when the acquisition has started.

Grid of trends

In this grid the user can set new trends or select those present. By double-clicking over on the

trends present immediate performance starts. To modify the parameters just right-click over the fields in the grid, type in the value from the keyboard and press ENTER (or click another part). The grid columns are:

Num. Stim.: number of consecutive stimuli (a maximum of 32).

Frequency: stimulation frequency (variable from 0 to 20Hz).

Delay: delay of the beginning of the following trend respect to the one selected. A void value interrupts the stimulation sequence.

Note: description of the trend.

H Reflex Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The user can choose between an automatic procedure and a manual procedure.

Manual procedure:

1. Regulate the stimuli intensity and acquire a curve trend pressing the space bar or the relative button on the toolbar or selecting Acquire Trend from the Acquire menu

NOTE: this is the most common way for the manual procedure. Whenever the user desires to acquire a curve of the cascade one at a time, the user must activate the Space bar of the Tools menu that allows the user to use the space bar to acquire a single curve instead of an entire cascade.

2. Verify correct flag insertion
3. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Automatic Procedure:

1. Regulate the stimuli intensity and acquire a cascade of curves selecting a trend from the grid and pressing the space bar; it is possible to start a trend by double-clicking on it.
2. Wait for the end of performance of the automatic procedure
3. Pass to the following exam (with the F7 key taking the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of the corresponding exam) inserting automatically or upon request, the results in the report

NOTE: it is possible to set an automatic default program (trend) in the Automatic Program section in the EMG exam Protocols.

Acquisition End

NOTE: when the user stops the acquisition, the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped the panel of the traces in real time and the stimulator bar disappear and on the left a graph appears that represents the amplitude of the M and H response working with the current stimulator.

Flag Insertion

Once acquisition has stopped, the flags **M-Beg**, **M-End**, **H-Beg** and **H-End** are automatically inserted; however it is possible to move them by clicking and dragging to the desired position.

To add a flag, the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present in the status bar on the left of the flags. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

F Wave

The window of the F Wave exam is divided in three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears.

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

The review area of the traces are divided in a horizontal way in two zones:

- On the left, the **M Wave zone**: the portion of the curve viewed has an amplification equal to that indicated in the popup menu on the toolbar.
- On the right, the **F Wave zone**: the portion of the curve viewed has an amplification equal to 10 times that is indicated in the popup menu on the toolbar.

These two zones are divided from a dotted vertical line that can be moved pressing the right mouse button on the destination point.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the grid on the top, the following lines are found:

F: latency of the F response, that coincides with the position of the **F-Beg** flag.

F-M: difference between the latency of the F response and the latency of the M response, that coincides with the distance between **F-Beg** and **M-Beg** flags.

F Ratio: result of the $(F + M - 1)/2$ calculation.

F Velocity: F Wave conduction velocity; this field remains empty until the user does not type in the value in the cell of the second grid below the Distance column.

F Amp: F Wave amplitude, measured as the peak-to-peak value of the response between the **F-Beg** e **F-End** flags.

For each parameter, the first column shows the minimum value and the third column shows the maximum found between all the traces, the second column shows the averaged value.

On the grid in the center the following parameters are found:

F Presence: ratio between the number of acquired traces and the number of F responses found, expressed in percentage.

F Distance: distance used for the calculation of the F Wave. This is set when the user clicks on the cell, types in the value (in *cm*) from the keyboard, and presses ENTER.

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned, the fields of these parameters remain empty.

Stimulator Bar

Below the grid there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the

front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Trc** and indicates the number of acquired traces when the acquisition has started.

Grid trends

In this grid the user can set new trends or select those present. By double-clicking over the trends present immediate performance starts. To modify the parameters just right-click over the fields in the grid, type in the value from the keyboard and press ENTER (or click another part). The grid columns are:

Num. Stim.: number of consecutive stimuli (a maximum of 32).

Frequency: stimulation frequency (variable from 0 to 20Hz).

Delay: delay of the beginning of the following trend respect to the one selected. A void value interrupts the stimulation sequence.

Note: description of the trend.

F Wave Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The user can choose between an automatic procedure or a manual procedure.

Manual procedure:

1. Regulate the stimuli intensity and acquire a curve trend pressing the space bar or the relative button on the toolbar or selecting Acquire Trend from the Acquire menu
NOTE: this is the most common way for the manual procedure. Whenever the user desires to acquire a curve of the cascade one at a time, the user must activate the Space bar of the Tools menu that allows the user to use the space bar to acquire a single curve instead of an entire cascade.
2. Verify correct flag insertion
3. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Automatic Procedure:

1. Regulate the stimuli intensity and acquire a cascade of curves selecting a trend from the grid and pressing the space bar; it is possible to start a trend by double-clicking on it.
2. Wait for the end of performance of the automatic procedure
3. Pass to the following exam (with the F7 key taking the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of the corresponding exam) inserting automatically or upon request, the results in the report

NOTE: it is possible to set an automatic default program (trend) in the Automatic Program section in the EMG exam Protocols.

Acquisition End

NOTE: when the user stops the acquisition, the program enters automatically in the review section and does not allow the

user to perform a new amplifier turn on.

Once the acquisition has stopped, the panel of the traces in real time and the stimulator bar disappear and on the left a pie diagram appears showing the percentage of the F Wave found respect to the number of trace and on the right a graph that shows the advancement of the F Wave latency for all the traces where it is present.

Flag Insertion

Once acquisition has stopped, the flags **M-Beg** and **M-End** are automatically inserted; however it is possible to move them by using the drag and drop method via the mouse to the desired position. The flags **F-Beg** and **F-End** must be placed one by one manually by the user.

To add a flag, the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present on the status bar on the left of the flags. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

Blink Reflex

The Blink Reflex exam window is divided in three main parts:

1. On the top right, there are controls (grids) with indication of the exam parameters
2. On the bottom right, there is a panel with traces acquired in real time
3. On the left of the panel, there are acquired traces and memorized on disk

Always at the center, on the bottom, an arrow indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed the parameters modifications (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical keys the amplification of the traces change, but only in the indicated panel indicated by the arrow. The parameters of the two panels are independent and can be different. The system keeps in memory the different settings.

NOTE: if the user uses, at the same time, on different traces different values for the gain, the base time or the filters, the corresponding values in the fields of the EMG toolbar are not seen (until the respective values do not coincide for all the traces). This happens for any EMG exam.

Parameters

On the top there is a textbox with a yellow background that shows the side of acquisition and the title of the acquisition protocol.

In the first grid on the top the values of the flag latency R1, R2, R3 and the duration of the response R2, R3 are shown:

Left Ipsi: ipsilateral left

Left Contra: contralateral left

Diff: difference between contralateral and ipsilateral response of the left side

Right Ipsi: ipsilateral right

Right Contra: contralateral right

Diff: difference between contralateral and ipsilateral response of the right side.

In the second middle grid the flag amplitude R1, R2, R3 values are shown and area of R2, R3 for responses **Left Ipsi**, **Left Contra**, **Right Ipsi** and **Right Contra**.

NOTE: the parameters are calculated with the flag insertion (both automatically and manually); they are updated automatically after a movement. If the flags are positioned, the fields change and these parameters remain empty.

Stimulation Bar

Below the exam parameters grids there is a control bar that regards the **Intensity**, **Duration** and **Frequency** parameters of the stimulator: these can be changed by the user clicking on the arrow nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed even by turning the knob on the front panel of the acquisition Headbox; the modifications made are in this way automatically indicated even by the **Intensity** control present on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is the **Trc** and indicates the number of acquired traces when the acquisition has been started.

Grid of Trends

In this grid the user can set new trends or select those present. By double-clicking over on the trends present immediate performance starts. To modify the parameters just right-click over the fields in the grid, type in the value from the keyboard and press ENTER (or click another part). The grid columns are:

Num Stim: number of stimuli to be distributed, and therefore the number of curves to record for every side of stimulation (maximum of 10).

Time Pre: indicates how much time before the acquisition of the signal the user must derogate the pre-stimulus (if put at 0ms indicates the absence of the pre-stimulus).

Time Post: indicates how much time the user must attend before acquiring the following response.

Note: generic title to assign to a group of acquired curves.

Blink Reflex Exam Acquisition Mode

Upon the opening of the acquisition window, the user is asked to choose the acquisition side either Left or Right. The user clicks the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button appears highlighted) and press ENTER.

The program starts the acquisition. The user can choose between the automatic procedure and the manual procedure.

Manual Procedure:

1. Regulate the stimuli intensity
2. Pressing the space bar or the relative key on the toolbar or selecting Single Shock from the Acquire menu, two curves are memorized (those relative to the two channels used)
3. The procedure is repeated twice up to a maximum of ten times, the new traces appear overlapped to those previously acquired
- 4.** The flags are manually inserted **R1-Beg, R1-End, R2-Beg, R2-End, R3-Beg, R3-End**
5. Via the slider (or the up - down arrows of the keyboard) the user passes to the other stimulation side and repeat the steps 1 through 4
6. Switch to the following exam (or with the F7 key that takes the user to the EMG exam selection, or via the F1 or F9 keys in which the user enters directly into a new acquisition window) automatically inserting or upon request the report results

Automatic Procedure:

1. Regulate the intensity of the stimulus and acquire a series of curves selecting a trend from the grid by pressing the space bar; it is possible to start a trend by double-clicking it as well
2. Wait for the end of the automatic procedure
- 3.** Insert flags manually **R1-Beg, R1-End, R2-Beg, R2-End, R3-Beg, R3-End**
4. Via the slider (or the up - down arrows of the keyboard) switch to the other stimulation side and repeat steps 1 through 3

5. Pass to the following exam (or with the F7 key that takes the user to the EMG exam selection, or via the F1 or F9 keys in which the user enters directly into a new acquisition window corresponding to the highlighted one) automatically inserting or upon request the report results

Note: it is possible to set an automatic program (trend) of default in the Automatic Program section in Acquisition setup.

Acquisition End

Note: when the user stops the acquisition, the program automatically reviews it and does not allow a new amplifiers turn on.

Once the acquisition has stopped the panel with the traces in real time and the stimulator control bar disappears and a graphic representation appears that represents the trace area.

Flag Insertion

To add flags the user needs to first click on the corresponding flag present of the status bar below (the flag becomes green) and then click on a trace, with the left mouse button. The selected flag is then inserted automatically on all of the overlapped traces.

To delete a flag just drag it in the recycle bin present on the status bar on the left. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocol.

MEP

The window of the MEP exam is divided into three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Trace View

In the panel of the traces on the left, the results of the muscle cortical magnetic stimulation relaxed and contracted, radicular and peripheral are memorized. For each one of these a memory area of 10 viewed curves is foreseen; the average of each block of overlapped curves is represented.

NOTE: the parameters indicated in the grids refer to the flags inserted on the traces corresponding to the averages.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the first grid on the top the following lines are found:

Cortical MEP (Relaxed Muscle): result for the cortical stimulation with a relaxed muscle.

Cortical MEP (Contracted Muscle): result for the cortical stimulation with a contracted muscle (facilitation).

Radicular MEP: result of the radicular stimulation.

(Fmin + M - 1)/2: information relative to the time of conduction via the study of the F Wave.

MAP: result of peripheral stimulation.

For each of these responses the **Onset** (begin of response) **Amplitude** and **Area** are calculated. In the second grid in the center the following lines are found:

Relaxed Muscle: stimulation with relaxed muscle.

Contracted Muscle: stimulation with contracted muscle.

(Fmin + M - 1)/2:

For each of these responses, these parameters are calculated:

TMCT: Total Motor Conduction Time.

PMCT: Peripheral Motor Conduction Time.

CMCT: Central Motor Conduction Time.

If the F Wave is present, the motor conduction time data for magnetic stimulation is compared to the extracts of the F Wave.

In the third grid on the bottom the following lines are found:

Ratio (MEP Contracted/MAP): ratio between the amplitudes of the MEP contracted muscle response and of the peripheral stimulation response.

Ratio (MEP Relaxed/MEP Contracted): ratio between the amplitude of the relaxed muscle and a contracted muscle MEP responses.

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned the fields of these parameters remain empty.

Stimulator Bar

Below the grid, there is a bar with controls that regards the following parameters, **Intensity**, **Duration** and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)
- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Avg** and indicates the number of response from stimulus have been accumulated in the average of the signal, once the user has selected this type of acquisition, the number of acquired traces when the acquisition has started.

MEP Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The following steps are:

1. Regulate the stimuli intensity and acquire a single curve (via the space bar). This step can be repeated up to 10 times
2. Verify the response obtained and pass to the following site and repeat step 1
3. Verify the correct insertion of the flags.
4. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

NOTE: this exam foresees the use of an external magnetic stimulator; often the acquisition of every single curve is generated by the stimulator and substitutes the use of the space bar.

Acquisition End

NOTE: when the user stops the acquisition the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped, the panel of the traces in real time and the stimulator bar disappear and the grids are enlarged in order to use all the leftover space.

Flag Insertion

Once acquisition has stopped, the flags **Onset** and **End** are automatically inserted; however it is possible to move them by using the drag and drop method via the mouse to the desired position. To add a flag the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present on the status bar on the left of the flags. The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

SSR

The window of the SSR exam is divided into three main parts:

1. On the top right, there are some controls (grids) with the exam parameter indications
2. On the bottom right, there is panel with acquired traces in real time
3. On the left, a panel of the acquired traces and those memorized on disk appears

On the dividing central division, there are as many buttons as the memorized traces and a slider that indicates where the trace is saved via the save command. Always in the lower center, an arrow that indicates with its orientation which trace panel is selected; this is needed to know which of the two are directed with the modify operations parameters (amplification, filters, etc.) invoked by the user via the menu or the hot keys. For example, pressing the keys "+" and "-" of the numerical key the trace amplification will automatically change, but only in the panel indicated via the arrow. The parameters of the two panels are independent and can be even different. The system keeps memory of the different settings.

NOTE: if, at the same time, different values for the gain, base time, or filters on different traces are used, the corresponding values are not viewed in the toolbar of the EMG properties (until the respective values do not coincide for all the traces). This happens for nearly all EMG exams types.

Parameters

On the top, there is a textbox with a yellow background that shows the acquisition side and the title of the acquisition protocol.

On the grid on the top the following columns are found:

Site: name of acquisition site.

Latency: latency of the response, in *ms*. This is calculated as soon as the corresponding flag is positioned on the trace.

Duration: duration of the response (temporary distance between the start flag and the end flag), in *ms*.

Amplitude: peak-to-peak amplitude of the response, in μV .

Area: area of the response in $\mu V \times s$.

NOTE: the parameters are calculated with the insertion of the flags (either automatically or manually); they are updated automatically after a manual movement. If the flags are not positioned the fields of these parameters remain empty.

Stimulator Bar

Below the grid there is a bar with controls that regards the following parameters, **Intensity**, **Duration**, and **Frequency** of the stimulator: these can be user modifiable clicking on the arrows nearby. The button near the Intensity control allows the user to choose the step for the intensity variation (step 1 or 0.1). Take note that the intensity can be changed by turning the knob on the front panel of the acquisition Headbox; the modifications made are automatically indicated even by the **Intensity** control on the stimulator bar.

There are 3 buttons that allow the user:

- To choose the stimulator output connector (A or B)

- To set the stimulator pulse (positive or negative)
- To enable/disable the use of remote control (probe used to start/stop the stimulation and to change the intensity)

The last field on the right is **Avg** and indicates the number of responses from stimulus has been accumulated in the average of the signal, once the user has selected this type of acquisition.

SSR Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The following steps are:

1. Regulate the stimuli intensity of the stimuli and acquire or a single curve (via the space bar). Electric stimulation must be sudden and unexpected on the patient's behalf, after having press the space bar for stimuli distribution, it is not immediate, instead there is a delay variable
2. Verify the response obtained and pass to the following site and repeat step 1
3. Verify the correct insertion of the flags and introduce the distances
4. Pass to the next exam (or with the F7 key that takes the user to the EMG exam selection window, or via the keys F1 or F9 in which the user enters directly in a new acquisition window of a corresponding exam) automatically inserting or upon request, the results in the report

Acquisition End

NOTE: when the user stops the acquisition, the program enters automatically in the review section and does not allow the user to perform a new amplifier turn on.

Once the acquisition has stopped the panel of the traces in real time and the stimulator bar disappear and the grids are enlarged in order to use all the leftover space.

Flag Insertion

Once acquisition has stopped, the flags **Onset** and **End** are automatically inserted; however it is possible to move them by clicking and dragging to the desired position.

To add a flag, the user needs first of all to click on the corresponding flag present on the status bar below (the flag becomes green) and then click on a trace, with the left mouse button.

To remove a flag just drag it in the bin present on the status bar on the left of the flags.

The names of the flags present on the status bar are set in the Markers section of the EMG exam protocols.

RR

The RR exam window is divided into three main parts:

1. On the top right, there is a grid with test indications (cycles) to be performed
2. On the top left, there is a panel that shows both the traces acquired in real time, during acquisition, and those effectively recorded on disk, during review
3. On the bottom left, the tachogram relative to the acquired signal; this represents the beats per minute of the time spent

Parameters

On the top right, there is a textbox with a yellow background that show the acquisition protocol title.

Below this, there is a grid in which the first three columns on the left contain the parameters of the acquisition cycles (**name**, **test** and **waiting**), and the remaining three columns contain the measured values **RR min**, **RR max.**, **RR avg**.

The grid can contain up to eight cycles, described in the first eight lines. The ninth line shows, in the corresponding cell of the three columns on the far right, the average value of the corresponding values of the RR obtained on all the cycles.

These parameters are not user modifiable during the acquisition phase and are set in the Cycles section of the EMG exam Protocols.

On the middle right there are the calculation formulas and the respective results for the current test. These formulas can be one, two or null, depending on the parameters set in the Cycles of the EMG exam protocols. The result is updated only at the end of the test, when all the available parameters are used by the formula.

On the bottom right, the user finds the following information:

Absolute and Relative: parameters for the three bands.

Elapsed Time: indicates the time passed (in *seconds*) from the test start.

Beats: indicates the number of heartbeats found. This value is updated during the test.

Mean RR: RR average. This value is calculated only at the end of the test.

Variance RR: this value is calculated only at the end of the test.

Sys:

Dia:

RR Exam Acquisition Mode

Once acquisition has began (pressing the space bar or the Save key on the toolbar or selecting the Save item from the Acquire menu) the program performs, in an automatic way, the cycles described in the grid on the right, respecting the delay intervals between each cycle and the next. During performance the cycle is highlighted in red in the test grid.

On the bottom the tachogram is, at the same time, updated during the acquisition. All the values are automatically updated. At the end of the test the program automatically finishes the acquisition, turns off the amplifiers and enters directly in review phase.

RR Exam Review Mode

In the review phase, between the upper panel and the tachogram, a horizontal scroll bar (that allows the user to scroll the entire acquired trace) and the **Trigger** and **Bin** icons appear. Near these, there is a textbox that indicates the instant of the beginning of the page of the trace shown. On the upper part of the trace, arrows appear facing downwards that indicate the QRS recognition points. These are automatically set by the program and can not be moved, although they can be cancelled or added by the user, in case of wrong insertion.

To remove the QRS indicator just click on the indicator and drag it to the bin, to add a QRS indicator just click on the trigger icon on the point of insertion. The mouse cursor changes shape as soon as it passes over the QRS indicator. Every variation performed on the QRS indicators is automatically updated on all the fields where the value is connected to the RR parameter.

In the tachogram, a red vertical bar appears indicating the correspondence of the tachogram with the trace shown on the upper panel. Clicking on the left mouse button on the tachogram the bar moves to that point and the trace is moved automatically in the corresponding zone.

SFEMG

The SFEMG exam window is divided into two main parts: on the right there are the controls and the parameter indications of the exam, on the left there is a panel with the traces acquired in real time.

Acquired Trace Panel

A certain amount of number of lines in cascade with crosses are viewed, in which they identify the reference points used for the recognition of the single components.

On the bottom of the panel, the overlapping curves are shown, where the temporary selection areas of each single component is identified, the trigger line and the edge (positive & negative) used for the recognition of the same component.

This type of review is active only in case in which the number of lines viewed on screen is less than 21, otherwise the curves without any indication are shown.

Parameters

In the first popup menu it is possible to select the name of the muscle or nerve site in the list of defined names from the Muscles & sites section in the EMG exam Protocols.

In the second popup menu it is possible to set the acquisition side: **Left** or **Right**.

Site: available in review, allows the user to select, via the popup menu, the site to be shown between those acquired.

Page: available in review, allows the user to select, via the popup menu, which page to be shown.

Line: available in review, allows the user to select, via the popup menu, the number of lines viewed at the same time (however if the number of lines is more than 20, the indications disappear for each single line).

Depending on the type of research the user wants to do (Jitter or Fibre Density), a grid is present where the results of the calculations are present.

In case of the Jitter research the results of all the measurements done on every site, that is the average of all the results, is shown.

The grid is composed of the following lines:

Responses: number of acquired traces.

MCD: value of the MCD (Mean Consecutive Difference) calculated.

MSD: value of the MSD (standard MCD deviation).

MIPI: value of the MIPI (Mean Inter Potential Interval).

SD IPI: value of the standard IPI deviation.

MIDI: value of the MIDI (Mean Inter Discharge Interval).

SD IDI: value of the standard IDI deviation.

Blocking: value of the block percentage on the total curve.

MCD/MSD: value of the ratio between MCD and MSD.

Each column on this grid (part from that with the average values) highlights the calculated values of each component recorded and associated to a specific site.

In the case of the fibre density research on each site, the number of components recognized and the calculation of the fiber density appear. To insert the number of components recognized the user must press a number (1 through 9) and forward to the next site.

Trigger and Delay Indications

Trigger: indicates the trigger value used for the capture curve

Delay: indicates the value in ms of the delay line

Site Movement buttons

Previous Site: passes to the previous site (if present).

Next Site: passes to the next site (if the site does not exist, the program goes directly into acquisition of an new site).

All Sites: expands the parameter grid on the whole screen in a way to view all the results without having to perform the scroll of the grid.

Available Single line controls

Selection key: indicates the number of the trace shown beside and allows the user to select (hold key) the trace for eventual modifications.

Block: button, if red, indicates that a block has been recognized.

Excluded: button if when selected becomes light blue and indicates if the curve which it refers to is excluded from any type of calculation, but not cancelled.

Exclude all Blocks: button that allows the user to exclude/activate all those traces recognized as blocks.

NOTE: the color of each curve viewed shows the status of the trace and that is red = block, light blue = excluded.

SFEMG Exam Acquisition Mode

Upon acquisition screen opening, the user is asked to choose the acquisition side either Left or Right. The user clicks on the relative mouse button or selects a button via the left - right arrows of the keyboard (the selected button is highlighted) and presses ENTER.

The acquisition program automatically begins. The far left side of the screen shows the trace in which the user is working and is present (about the center of this area) there is a trigger level indicator.

The following steps are:

1. Regulate the trigger level with the arrows slowly or via the mouse clicking on the area of the screen where the user wants to position it
2. Verify that the triggered response is steady therefore go ahead memorising (space bar or MUAP capture key)
3. During capture phase if the program loses focus, the system automatically enters in the trigger modify phase and as soon as the program is steady the program continues memorization
4. If the user wants to end the capture before the number of steady curves press the space bar again or the MUAP capture key
5. If the end of the capture is forced by the user, a confirm message is asked to accept or not the sequence of memorized traces otherwise they are saved permanently as acquired curves and the program enters into review mode
6. Define the identification areas, the trigger level and the recognition edges of the present components in the memorized site
7. Pass to the next site and repeat all steps or in case of exam termination insert the obtained results in the report

Components Identification Procedure

To identify a new component, just click and drag it from the status bar, the "component" icon on the trace area as a new component.

Once a new component has been inserted, it is possible to fix the extremities moving them (red cursors) with the drag & drop method.

To vary the edge, just click on the descriptive icon, while to fix the trigger level always use the drag & drop method.

The effect of each variation of the extremities as well as the trigger level is shown on the curves of the cascade via the identification crosses.

Hot keys

The hot keys available for the EMG acquisition and review windows represent a common and quick way of handling functions from the keyboard, allowing a real time saver. The common operations are:

- Amplifier turn on and off
- Stimulation start and stop
- Start and stop of the single curve recording or group recording (trend)
- Start of more complex procedures of automatic acquisitions
- Changing of parameters such as base time and amplification of the traces and stimulation parameters
- Add trace to reports
- Quick passage from a session of an exam to a just performed one.

EMG exams are different between themselves and therefore the definition of the hot keys depends on the type of the selected exam. Some hot keys are default set, others are user definable, as explained in the Archive section under the menu **Tools - EMG Quick Key**.

To obtain further information on how to define the hot keys for each exam, in the EMG section just press the operational key **F12** (or select the items **HotKeys Help** in the Help menu). The Hot Keys grid appears: in this grid on the left, a key appears and on the right is the corresponding function. In the lower part of the Hot Keys grid, there is a more detailed description of the current key.

NOTE: double-clicking the key is the same as pressing the corresponding hot key.

Footswitch

The use of the footswitch allows a rapid and easy access to some functions during EMG exam acquisitions, instead of using the same functions found on the Menu Bar or the Toolbar or the hot keys of the keyboard.

The functions done by the two pedals present on the footswitch can be set according to the type of EMG exam. See the “Footswitch” section in the EMG exam protocols.

EP - Software

NOTE: this feature could be not available in your country.

This section describes the functions and commands of the software for Evoked Potentials (EP). A good knowledge of the clinical meaning and exam methods are assumed.

System Description

The standard configuration of an EP system is composed of the following elements:

Amplifiers

Stimulators

Personal Computer

Monitor and Speakers

Printer

The system can include other components, having been specified by the user. The components specified compose a typical system. For further information on system configuration, see the "Archive" section.

Use of the mouse and the keyboard

The program is based on the Windows operative systems and shares some user interfaces and software characteristics that are common to most popular software; this makes it more familiar and intuitive in its use. Many program operations can be performed indifferently via the use of the keyboard or the mouse. To make the use of the system easier our company has defined some key functions (alias Hot Keys) that allow the user to access in a direct way to the functions and commands that are necessary during acquisition and exam review (some of these functions can be user defined, see the Archive section).

It is recommended to familiarize with the use of the mouse for the normal Windows® operative system functions. The software for EP uses many typical techniques as for example the click of the left and right mouse buttons, double-click of the left mouse button, or keeping the left mouse button pressed while moving the cursor (drag and drop method).

ADVICE: do not forget to use both the mouse keys; they could have different internal functions.

RECOMMENDATION: have you forgotten the settings for the Function keys? During exam acquisition or view, pressing the F12 key from the keyboard, it is possible to activate a window with a menu of function keys.

Amplifiers and stimulators

The amplifiers

Our company supplies the following amplifier models: Matrix Light 1002, 1002EP, 1005, 1009, 1013, and 1017.

Headbox model 1002 has two acquisition channels, the 1005 has five, the 1009 has nine, the 1013 has 13, the 1017 has 17 channels. All the headboxes have an incorporated electric stimulator. Headboxes with an EP suffix are especially for evoked potentials but those regarding EMG are like normal stimulators. The outputs on the stimulators are on the front panel of the device.

Amplifiers have three types of inputs:

- 4 amplifiers (in Matrix version) has Lemo type connector 3 pin for electrodes with a shielded cable
- Connectors type, "touch proof" for positive inputs, negative and ground
- DIN 5-Pins connectors

The ground electrode is common to all amplifier channels.

The user of good quality electrodes and an accurate connection technique is very important in

order to acquire a good signal.

The stimulators

This section regards the Headbox models Matrix Light 1002, 1002EP, Energy, Energy Twin. For evoked potential exams the electric, auditory, visual, and magnetic stimulators can be used. Our company's electric stimulator used for EP is a current controlled generator. This generator can has the following parameters:

- **Current intensity (mA):** the user can vary the intensity via the knob on the front panel of the Headbox, or in the exam protocol settings or during acquisition via the mouse or the keyboard.
- **Stimulus duration (μ s):** the user can vary the duration in the exam protocol settings or during acquisition via the mouse or the keyboard.
- **Stimulus frequency (Hz):** the user can vary the frequency in the exam protocol settings or during acquisition via the mouse or the keyboard.

Accessories with type mini-DIN input connectors or with standard touch-proof input connectors can be connected to the stimulator (for further information consult your distributor).

There are different kinds of auditory stimulation: click, beep, or external stimulation. All these different kind of stimulation can be selected in the popup menu "Stimulator Type." Selecting different stimulations, different parameters will appear:

a) Click stimulator

- **Side:** side of stimulation (left, right, bilateral).
- **Stim Frequency:** frequency of stimulation.
- **Volume:** sound stimulus intensity expressed in dB; from 0 to 110 dB with increase steps of 5 dB.
- **Click Type:** the user can choose between: Compression, Rerefaction, Alternate.
- **Stimulus Duration:** like the electric stimulator.
- **Stim-delay:** like the electric stimulator.
- **Noise:** pressing the On button the masking noise is enabled.
- **Bind Noise:** pressing the On button the level of the noise is linked to the volume of the click. Increasing the level of the Click, the level of the Noise will be automatically increased.
- Headphones:
 - **Type:** allows the user to choose between different types of headphones.
 - **Scale:** allows the user to choose between different scales SPL, HL.

b) Beep Stimulator

- **Play:** to have a preview of the sound.
- **Side:** side of stimulation (left, right, bilateral).
- **Stim Frequency:** frequency of stimulation.
- **Volume:** sound stimulus intensity expressed in dB; from 0 to 110dB with increase in increments of 5dB.
- **Rise Time, Fall Time and Duration:** rise time, fall time and duration of the envelope of the beep. All the values are in ms.
- **Envelope:** kind of envelope used (trapezoidal, rectangular, or Gaussian).
- **Stim-delay:** like the electric stimulator.

- **Noise:** pressing the On button the masking noise is enabled.
- **Bind Noise:** pressing the On button, the level of the noise is linked to the volume of the click. Increasing the level of the Click, the level of the Noise will be automatically increased.
- **Headphones:**
 - **Type:** allows the user to choose between different types of headphones.
 - **Scale:** allows the user to choose between different scales SPL, HL.

c) Generic Stimulator: this is to interface an external stimulator to our system and application. Our visual stimulator is a flash generator and so the following parameters can be modified:

- **Visual stimulus intensity (lumen):** the user can vary the intensity via the knob found on the front of the Headbox, or in the exam protocol settings during acquisition via the mouse or the keyboard.
- **Stimulus duration (µs):** the user can vary the duration, or in the exam protocol settings during acquisition via the mouse or the keyboard.
- **Stimulus frequency (Hz):** the user can vary the frequency, or in the exam protocol settings during acquisition via the mouse or the keyboard.

Accessories with connectors of type mini-DIN inputs or with standard touch-proof inputs can be connected to the stimulator (for further information, consult you zone representative).

SUGGESTION: always connect the ground electrode to the patient making sure to place it between the acquisition electrode and the stimulation electrode, as this decreases the stimulus artefact. Use quality cables, preferably shielded ones.

Getting started

How to Record an Exam

To access to the EP section, the user can insert a new patient or add an exam to a patient already present in the database, following the modality indicated in detail in the “Archive” section.

NOTE: the creation of a new patient record requires the insertion of at least the patient's surname, name, and date of birth.

To obtain a new EP recording, you have to follow these steps:

- When you are in the Archive window, click the new EP exam button on the toolbar above the columns of exams (or press the key F6); the same can be done by clicking the menu **Edit -> Exam -> New->EP**

or

If an EP exam already exists and you want to have another EP recording within the same exam, you can start a new EP file by clicking the new EP file button on the toolbar above the columns of files (or press the key F11). The same can be done by clicking the menu **Edit -> File -> New -> EP**

- Select the available exam type from the option tab; this can be done by clicking on the mouse on the label of the tab or using the quick keys from the keyboard. For further details, see the section “Selecting an Exam.”
- Select a protocol from the grid. For further details see the section Acquisition setup
- To begin an acquisition there are two possible ways:
 - Clicking the **Acquire** key directly on the bottom left
 - Pressing the numerical key indicated next to the protocol on the first column of the grid

At this point, the acquisition screen opens; traces are visible flowing in real time.

- Control the stimulation parameters and then begin stimulation via the hot key, or by pressing the icon Stimulation on the toolbar, or selecting the item Stimulation from the Acquisition menu
- Begin the average of the traces with the relative hot key, or pressing the icon Average on the toolbar, or selecting the item Average from the Acquisition menu
- To save the average of the traces press the relative hot key, or the icon Save on the toolbar, or select Save from the Acquisition menu

NOTE: the user can start a new acquisition even during view of an already recorded one. From the **File** menu the item **New** is selected and the procedure begins from the second step mentioned above.

IMPORTANT: the new exam will be assigned to the patient for whom the exam is currently being viewed.

For detailed information about EP recording, please refer to EP - Acquisition procedure and EP - Acquisition window.

How to View a Recording

To see an EP recording or a report, the following steps are taken:

1. Using the mouse select a patient in the left column (list of patients) of the Archive section
2. Select the exam of interest, checking the creation date on the middle column (list of exams)
3. Double-click on the icon on the right column that corresponds with the file to view, always checking the file creation date

The software for EP shows the desired exam with the settings chosen in the protocols before acquisition.

Alternatively, instead of double-clicking the left mouse button, the user can use the right mouse button, with just a click on the icon of the exam or the file of interest. A popup menu opens where the possible operations appear: in this case, choose **View**.

For detailed information about EP recording please refer to EP - Review procedure and EP - Review window.

How to Generate a Report

Follow the procedure used to view a EP recording, therefore:

- When you are in the Archive window right-click inside the Exam column or inside the File column and select **New -> Report** from the popup menu

or

- When you are in the EP review window and some traces have been saved, choose **Add to report** from the **File** menu; the selected traces are added to the report
- Eventually a dialogue window appears that asks the user to choose the type of report to generate (if it is the first request of a report for that exam). The user can choose between the already existing models (the EMG-EP model is recommended) and an empty file. Select the model and press the OK button, or double-click the left mouse button over the chosen model

How to Print a Report

The printout of a report is very easy and reminds the user that it is like any other text document:

- Select the report from the archive window and open it with a double-click of the mouse
- Controls the page settings, selecting the same item from the File menu
- If needed, set the printer settings, under the item Printer setup from the File menu

- Control the print before are printing
- Select the item "Print" from the File menu

Selecting an exam

When the user accesses a new EP exam, a dialog window opens allowing the choice of the type of exam to be performed and the protocol setup. The window has several exam tabs, each of them contains a grid with protocols; on the top there is a menu with many items to be used to manage the protocols:

- **Exit**: to exit from the dialog window.
- **Help**: to open this window.
- **New**: to create a new protocol.
- **Duplicate**: to create a copy of the protocol.
- **Delete**: to remove a protocol.
- **Move Up\Move Down**: to move up\down a protocol in the list.
- **Setup**: to enter in the setup of the protocol.
- Tables
- **Tools**: to enter in the Tools section.
- Layout
- Batch Report
- **Acquire**: to start the selected exam.

Below the list of the protocols, there is a table that specifies the type of headbox used and the hardware connection card.

Exams

The available exams are present in the grid in the middle of the window. In order to choose the exam type, the user must click on the label on the grid using the left mouse button. The exams types available are:

EXAMS	ABBREVIATION	HOT KEY
Superior Limbs - Somatosensory Evoked Potentials	SEP - SL	F1
Inferior Limbs - Somatosensory Evoked Potentials	SEP - IL	F2
Visual Evoked Potentials	VEP	F3
Auditory Evoked Potentials	AEP	F4
Auditory Brainstem Evoked Potentials	BAEP	F5
Magnetic Evoked Potentials	MEP	F6
P-300 Evoked Potentials	P-300	F7

NOTE: depending on the package purchased by the user, all the above exams may not be available.

Protocol Grid

The middle grid has the list of the protocol for the exam that is selected on the column on the left. Each line corresponds with a protocol. To start an acquisition the user must select a protocol between those enabled and press the **Acquire** button, or press the number on the keyboard that appears in the first column. To add a new protocol the user has to press the "NEW" button and then the button Setup.

NB: the lock on the right column indicates whether the protocol can be modified or not. The protected protocols cannot be

modified; the user can only create a copy and then modify the copy.

Pressing the **Exit** button, the user exits from the dialog window without creating any exam.

EPILOG: the exam selection can be made from the keyboard by pressing the hot keys F1 - F12, while pressing the number of the protocol that is viewed on the first left column in the protocols grid, the acquisition begins using that specific protocol.

Acquisition setup

The exam protocol contains all the specific settings for that type of exam, that is the settings of all parameters necessary to correctly record and view the signals according to the nerve and site chosen.

The settings of all these parameters is via the "Acquisition Program Setup" window with several tabs, each of them containing specific parameters, and three buttons above:

- **Save and Exit:** closes the window and saves the variations made.
- **Save:** temporarily saves the settings without closing the window.
- **Cancel:** closes the window without memorizing the modifications made.

The protocols are memorized in the PRG file and can be saved, cancelled, copied and pasted as described in "Selecting an EP Exam."

IMPORTANT: to enable a protocol, the user needs to have at least one trace active, as explained in the Channel settings. It is also recommended to type in a title (section General), in order to avoid confusion with protocols without names.

The Parameter Tabs

The tabs of parameter contain various items, click to open their respective topics:

General

In this section there is a summary with the most important information of the protocol:

Exam: the name of the exam.

Protocol: the name of the protocol.

Linked Protocol: it is used to link the protocol with other protocols.

Headbox: name of the headbox used for the exam.

Interface Card: name of the acquisition interface used for recording.

Number of Channel:

Acquisition Time: the length of the sweep acquired in the protocol.

Sample Rate: the sampling rate used to acquire the signal. The sampling rate changes with the length of the sweep acquired.

Acquisition Mode: gives the number of channels enabled.

Stimulator: the type of stimulation used in the protocol.

Channel

This section regards the conditioning via software and hardware of the acquired signal in order to optimize both the acquisition and the viewing. Practically here the user can regulate parameters such as filters, gain, base time, trace color, etc. and select which channel using, which sampling rate etc.

In the first part of the menu the user can set the hardware parameters:

Acquisition Mode: allows the user select the number of channels to use in the protocol: changing the number of channel, the window with the list of the channels will change.

Sample Rate: this menu is to select the sampling rate.

After selecting the Acquisition Mode, the window containing the list of the channels will change.

Label (+ or -): identification string of the positive/ negative input; up to 5 characters are accepted.

Input (+ or -): the user can select which input associate to the different channels (for example a channel can set Fpz as positive input and Fz as negative). Each input will be associates to a different color in order to be recognized easily.

Status: to select the status of the channel, OFF (disabled), Bipolar, DC, DIN.

PreFilter: high-pass hardware pre-filter setting; this is a quite touch and critical parameter for acquisition and it is recommended to leave the default values.

Signal Max: working window of the analog/ digital converters; the signals that are wider than those set saturate the inputs while smaller signals risk not to be converted with sufficient resolution. This parameter remains the same for all traces.

Memorization Time: time of total recording (length of the trace). This parameter remains the same for all the traces and influences the sampling frequency directly, that is set automatically basing itself on it.

About the **Software Setup:**

High Pass, Low Pass Filters: values of the cut off frequency of the software filters; in case of Identity filter they are not considered.

Notch Filter: suppresses the components of the signal having the frequency equal to that of the network (50Hz in Europe, 60Hz in USA).

Time Base: time interval that corresponds to the width of the scanning window.

Gain: value of the signal that corresponds to the height of a square of the grid in the scanning window.

Time Base Avg.: time interval that corresponds to the width of the building average window.

Gain Avg.: value of the signal that corresponds to the height of a square of the grid in the building average window.

Filter Type: allows to choose between different software filters; choice can be IIR, FIR, Butterworth or Identity (that is no filter applied).

Smoothing: algorithm that "sweetens" the bitterness of the signal interrupted by noise and artefacts of any kind. Higher the number set and higher is the smoothing intervention. In the grid in the middle of the window there can be various parameters in an independent way for each active trace. The default parameters viewed depend on the type of the selected protocol. To change the parameters just click on the corresponding cell with the left mouse button. A menu appears (or a window for the colored trace) where the user can choose one of the possible valid values for that parameter.

Inversion: inversion of the traces, if the checkbox is enabled, the trace is inverted.

Auto-Gain: automatic regulation of the gain, if the checkbox is enabled, the gain assumed the indicated values default in the column called "Gain" of the grid below. If the value is not correct, it will be automatically increased or decreased according to the necessities during an acquisition.

Artefact Suppression: suppresses the initial samples for a time indicated by the popup menu, to view on the traces a horizontal line instead of the artefact.

Stimulator

Regarding the stimulator settings, it is necessary to remember that:

- The EP system can have up to five stimulators connected, while the software pilots only two at the same time
- Various types of stimulators exist: electric, auditory, visual, etc. The items regarding the stimulation parameters and the trigger direction (Internal or External) depend on the type of the selected exam

There different kinds of stimulators depending on the different kind of protocols (in protocols for VEP there will be only Visual Stimulators, for SEPs only Electric etc.)

The following parameters are found:

Stimulator Type: enabling the checkbox the upper part of the grid appears (for ex. Electric Stimulator) that allows the user to set the parameters in which the first stimulator pilots. At the same time the options that allow the user to set the Stimulus Origin (in fact with an our stimulator it is possible only the internal trigger generation) and the options to set the checkbox for the second stimulator are disabled.

Enable Stimulator 2: (present only for SEPs) enabling the checkbox, the lower part of the grid

appears (Electric Stimulator) that allows the user to set the parameters that pilot the second stimulator. This checkbox is active only if stimulator 1 is present.

Stimulation Frequency

Depending on the type of exam, one (**Stimulation Frequency**) or two textboxes (**Min. Stimulation Frequency** and **Max. Stimulation Frequency**) can appear where the user types in the stimulation frequency.

Stimulator Parameter Grid

<p>Electric Stimulator (PES - AS, PES - AI)</p> <ul style="list-style-type: none"> • Side: side of stimulation (left, right, bilateral). • Repetition Rate: the maximum frequency of stimulation available is 300Hz but if the frequency of stimulation is higher then the inverse of the mem. time, an error message will appear and the user will have to decrease the frequency. • Stim Intensity: current intensity of the electric stimulus; that goes from 0 to 99.9mA, with increment steps of 0.1mA. • Stim Duration: stimulus duration that goes from 50µsec to 1000µsec with steps of 25µsec. • Stim Delay: delay between the acquisition start and the stimulus application; the delay applicable goes from 0 to 25msec with increment steps of 0.1 msec. • Stim Polarity: to set the shape of the stimulus (Positive, Negative). • Stim 2nd Phase Duration: to set the stimulus as biphasic, the duration of the second phase has to be set. • Stimulator N.: if there is more than one stimulator connected, there is the need to select the stimulator. <p>Output: for model Twin is used to select which electrical stimulator using for the electrical stimulation.</p>
<p>Visual Stimulator (VEP)</p> <ul style="list-style-type: none"> • Side: side of stimulation (left, right, bilateral). • Google Signal: gives the indication of the side of stimulation. • Stim Duration: like the electric stimulator. • Stim Delay: like the electric stimulator. • Stim Intensity (lumen): luminous stimulus intensity expressed in Lumen; can vary from 0 to 8 Lumen with increment steps of 1 Lumen. <p>Stim Frequency: frequency of the visual stimulation.</p>
<p>Auditory Stimulator (AEP - BAEPs)</p> <p>There are different kinds of auditory stimulation: click, beep, or external stimulation. All these different kind of stimulation can be selected in the popup menu "Stimulator Type." Selecting different stimulations, different parameters will appear:</p> <p>a) Click Stimulator</p> <ul style="list-style-type: none"> • Side: side of stimulation (left, right, bilateral). • Stim Frequency: frequency of stimulation. • Volume: sound stimulus intensity expressed in dB; from 0 to 110dB with increment steps of 5dB • Click Type: the user can choose between Compression, Rarefaction, Alternate. • Stimulus Duration: like the electric stimulator. • Stim-delay: like the electric stimulator.

- **Noise:** pressing the On button the masking noise is enabled.
- **Bind Noise:** pressing the On button the level of the noise is linked to the volume of the click. Increasing the level of the Click, the level of the Noise will be automatically increased.
- **Headphones:**
 - **Type:** allows the user to choose between different types of headphones.
 - **Scale:** allows the user to choose between different scales SPL, HL.

b) Beep stimulator

- **Play:** it is to have a preview of the sound.
- **Side:** side of stimulation (left, right, bilateral).
- **Stim Frequency:** frequency of stimulation.
- **Volume:** sound stimulus intensity expressed in dB; from 0 to 110 dB with increment steps of 5dB.
- **Rise Time, Fall Time and Duration:** rise time, fall time and duration of the envelope of the beep. All the values are in ms.
- **Envelope:** kind of envelope used (trapezoidal, rectangular or Gaussian).
- **Stim-delay:** like the electric stimulator.
- **Noise:** pressing the On button the masking noise is enabled.
- **Bind Noise:** pressing the On button the level of the noise is linked to the volume of the click. Increasing the level of the Click, the level of the Noise will be automatically increased.
- **Headphones:**
 - **Type:** allows the user to choose between different types of headphones.
 - **Scale:** allows the user to choose between different scales SPL, HL.

c) Generic Stimulator: this is to interface an external stimulator to the program.

P-300

In P-300 exams two electric stimulus or two auditory stimulus are used. If two electric stimulus are used, the second stimulator is always enabled. As well as the parameters for the Stimulus duration, the pre-stimulus and the current intensity, the following parameter also appears:

- **Ratio. (%):** indicates the percentage on a total number of stimulations, a certain number is performed (casually) from that stimulator other than the other. Modifying this parameter on one stimulator the user will notice that the analog parameter of the other stimulator changes also, in a way that their sum is always 100 (%).

For the auditory stimulations the user has to select Beep Stimulator as stimulation type. A grid will appear with a row for each kind of stimulus (NB: to disable the rare sound the user has to check the box "No Rare Sound"):

- **Sound Type:** it's to select between the Rare sound and the Frequent sound.
- **Play:** pressing this button the user can hear the stimulus sounds as they were set.
- **Side:** it's to select the side of stimulation (Left, Right, Bilateral).
- **Volume:** the volume in dB of the sound.
- **Frequency:** sound stimulator frequency.
- **Envelope:** what kind of envelope is used (Trapezoidal, Rectangular, Gaussian).

- **Rise Time, Fall Time and Duration:** rise time, fall time and duration of the envelope of the beep. All the values are in ms.
- **Duration:** like the electric stimulator.
- **Stim-delay:** like the electric stimulator.
- **Ratio. (%):** the same as electric stimulators.
- **Headphones:**
 - **Type:** allows the user to choose between different types of headphones.
 - **Scale:** allows the user to choose between different scales SPL, HL.

Markers

In this section there are two tables: in the first one there is the list of the flag enabled for each channel, the second one is to memorize new flags. In the State column of the first table, the active channels are shown using a green symbol and those not active with a red symbol. Every channel can have up to eight flags. To insert the flag the user just need to click on the text box with the mouse and a popup menu will appear. To insert the flag the user will only need to press ENTER.

Interpeaks

In this section the user can find the settings of the interpeaks. After having positioned the flags on the traces, as explained in the section Markers, special calculations are made, based on relations that occur between themselves.

There are three types of relations between *different flags on the same channel* or between *flags either the same or belonging to different channels*:

1. **Time Interpeak (Difference):** temporary distance between selected flags.
2. **Amplitude Interpeak + (Difference):** difference between the amplitude of the trace on the point indicated by the flags.
3. **Amplitude Inter-peak/(Ratio):** ratio between the amplitude of the trace on the point indicated by the flags.
4. **Peak to Peak (Ratio):** perform the ratio between the difference of the flag1 and flag1' and the difference of flag2 and flag2.'

On the first grid there is a list of the flags, which can be inserted in each channel. To add an additional flag, the user has to enter in the Marker section.

Interpeak Description Grid

If there is no interpeak, the grid with the list of the interpeaks will be completely empty.

The grid has five columns: the first on the left shows the type of interpeak; the other four columns show the name of the trace and the selected flags contained on it.

Create An Interpeak

To create an interpeak follow the steps below:

1. Select two flags from the columns on the first grid: the box will be highlighted in green. Different flags can be selected for the same channel or different flags on different channels
2. Press one of the four buttons that corresponds to the desired interpeak

Cancel An Interpeak

To cancel an interpeak, just select it in the Interpeak Description Grid and press the **Cancel** key.

Average

In this section the parameters are set in order to obtain a correct average of the signal.

Stop Stimulation at the end of the programmed stimulus: it is possible to activate or not this option, via the checkbox.

Number of Stimulations: in this textbox it is possible to set the number of responses to the stimulus that are considered for the calculation of the signal average. The responses over the rejection threshold are automatically rejected and are not counted. The number can be typed directly or by increasing or decreasing via the arrows on the slider.

In the table the following columns are present:

State: the active channels are shown using a green symbol and those not active with a red symbol.

Channel:

Signal Max:

Mem Time:

Rejection Level: the window where the response must be kept in order to be considered can be smaller than the window set as Signal Max in the Hardware section. The value in the textbox indicates the maximum value the signal can have in order to be accepted in the average

Start: the threshold control is performed only after the "start" value. This is useful if there is a stimulus artefact: sometimes if the stimulus artefact is really high, all the traces in the average could be rejected.

Duration:

Headbox

This section allows the user to verify the type of the Headbox, Stimulators and Interfaces configured at the system installation. It is also possible to upgrade the firmware of the units installed. It is possible to decide to always copy in all acquisition programs.

IMPORTANT: modifications to the settings of this tab are reserved for authorized technicians.

Access to the parameter configuration is protected by the Unlock function and asks for a confirmation. To exit from this section without modifying the properties (event considered potentially dangerous for the system) just press the Cancel button.

Parameters View

This section allows the user to select which properties to make available during trace viewing. The properties are indications (flags) that appear on a grid shown on the right of the EP review window, relative to the traces shown on the left.

There is a list of all the available parameters for all the traces in viewing mode. Their description and properties are listed in the grid below.

To choose the viewing parameters, the user must select the list on the left and click on the right arrow button. The parameter will be viewed in the right list (Selected Parameters). To remove a parameter it is necessary to select it from the right column and click on the left arrow button.

To modify the order in which the properties are visible in review, it is necessary to select the items in the right column and click the up arrow button or down arrow button until the desired order position is reached.

NOTE: it is recommended to set the trace properties before beginning an acquisition, to obtain the correct settings immediately once the user accesses in the review mode.

Type of Properties	Description
Flag (from 1 to 8)	Name of flag
Flag Latency (from 1 to 8)	Name of flag and latency time, that is the distance in milliseconds between the position indicated by the flag and the stimulation instant
Flag Latency Amplitude (from 1 to 8)	Like the previous flag, with more trace amplitude indication

Reject Number	Number of single acquisitions rejected in the construction of the averaged trace
Stimulation Side	side of stimulation
Average Number	Number of single acquisitions accepted in the construction of the averaged trace
Filter Band	High-pass and Low-pass software filter settings
Trace Title	Not available
Time Base	Base time
Gain	Gain
Interpeaks (from 1 to 8)	Described in detail in the Interpeak section
Comment	
Stim Intensity	Stimulus Intensity (in mA or dB or LUMEN)
Stim Duration	Stimulus Duration (in μ s)
Stim Delay	Pre-Stimulus (in ms)
Noise Masking Level	Only for Audio Potentials, expressed in dB
Exam-Specific Parameters	Stimulation parameters specific to the type of exam set
Recording Date/Time	Date/time recording
Recording Time	Recording Time
Average Reaction Time	Only for P-300: time of average reaction to the auditory stimulus
Number of Reactions	Only for P-300: number of stimuli in which the patient actually reacted
Amplitude	Maximum peak-to-peak amplitude of the signal in the interval indicated by the first two flags (flag1 and flag2) in a trace
Curs. Area	
Fibers	
Flag Latency Amplitude Peak to Peak (from 1 to 8)	Name of flag, latency time, that is the distance in milliseconds between the position indicated by the flag and the stimulation instant and peak to peak amplitude
Envelope, Burst Frequency, Rise Time, Fall Time	These are the parameters for the shape of the sound

Advanced Average

This setup is specific of IOM acquisition software.

By using this setup you can define two average memory areas where to copy the result a particular stimulation: for example if a two electrical stimulator system is used, you can assign the averaged response obtained by stimulator 1 to Average A and the averaged response obtained by stimulator 2 to Average B. When the IOM acquisition section is entered, the stimulation starts automatically and the two stimulators will alternate.

In **Average Blocks** you can define the stimulator and the stimulation side by choosing them from the popup menus.

Via the grid below you can assign each trace to one or both memory bank, just right-clicking on the columns **Average A** and **Average B**.

Acquisition

Acquisition Window

When accessing the EP acquisition section a main window opens. In this large window there are another **two windows** whereas the left one is the review window and contains a single panel of acquired traces and the right one is the acquisition window, divided in two panels of vertical traces.

NOTE: in this section the manual always refers to the acquisition screen. For the review screen refer to the Review section

of the EP software.

According to which window is active, (this is understood from the title bar) the window menu of the main window changes, making the commands and items available and deactivating the others. For example, by clicking of the acquisition window the "Acquire" menu becomes active and the "Analysis" menu is deactivated.

Acquisition Window

This window is divided vertically in two panels where the traces are viewed. The lower panel to the right shows the signal acquired in real time, as the upper panel shows the averaged traces memorized in a temporary buffer; these are the traces that are recorded on disk when the **Save** function is given via the menu bar or with the mouse on the toolbar or via the Hot Keys on the keyboard.

Of the two panels, **the active one is highlighted by two thin red vertical lines** (said to be "focused"). By clicking the mouse over the panel, the "focus" changes on the clicked one.

IMPORTANT: the focus position influences the action of the Quick Keys; when the user presses a quick key the corresponding action is executed on the focused panel.

For acquisition there are a menu bar dedicated to specific EP functions and two toolbars.

In the lower part of the window, the trace rejection commands, the stimulation bar and the status bar appear

Menu Bar

When the user accesses the Evoked Potentials acquisition section the main menu changes. The menu bar is composed of the following items:

File, Modify, Acquire, *Tools, Analyze, Reference* (all disabled in acquisition), Windows, Help

File Menu

New	Disabled
Open	Displays the archive screen, making the opening of another exam possible. This operation consumes a lot of the system's resources and is not recommended during acquisition
Close, Add to report, Show report, Print	Disabled
Print Screen	This function allows the user to print what it is shown on the monitor
Print Setup	Sets the printer parameters
Properties, Disk Properties, Export	Disabled
Exit	Disabled during acquisition, enabled when acquisition is stopped: closes the window

Modify Menu

Undo, Cut, Copy, Paste, Select All, Deselect All, Invert Selection	Disabled
Reload all Traces	Allows the user to reload all the traces
Filter	Allows the user to choose the type of software filters and

	<p>their settings:</p> <p>Type</p> <ul style="list-style-type: none"> • Identity: the signal is not filtered. • IIR - 2 Poles: software filter - Infinite Impulse Response at two poles. • FIR: software filter Finite Impulse Response. • Butterworth: software Butterworth filter
	<p>High Pass Sets the cut off frequency of the high pass software filter</p>
	<p>Low Pass Set the cut off frequency of the low pass software filter</p>
	<p>Notch Enables/disables the intervention of the software filter that suppresses the disturbances of the electrical network</p>
	<p>Smoothing Up Increases the smoothing filter by steps of 1</p>
	<p>Smoothing Value of smoothing filter</p>
	<p>Smoothing Down Decreases the smoothing filter by steps of 1</p>
Time Base	Time interval that corresponds to the width of the acquisition window
Amplification	Signal width per vertical square of the grid in the acquisition window
Artef. Reject	Enables/disables the intervention of an algorithm that resets on video the first samples of the signal effected by a stimulus artefact. The intervention interval is set via the popup menu. If the first option is chosen (Disable) the suppression algorithm is disabled
Stimulation Side	The following options are present: Left, Right, Bilateral, Central
Base Line Correction, Parameters, Invert Lines	Flag Disabled
Line Number	Allows the user to choose the number of traces to be viewed at the same time in the two panels of the acquisition window. The minim number is one, the maximum number is equal to the number of channels active in acquisition. When the user chooses to view less traces in respect to the number of active channels, the scroll bars present on the left of the two panels change aspect, and allows the user to select the trace of interest; these move in a synchronized manner (by moving one, the other automatically moves)
Acquire Menu	
Run/Stop	Starts or stops the acquisition from the Headbox.

	Attention: this does not coincide with the data save in permanent memory (on disk)
Stimulation	Starts or stops stimulation
Average	Starts or stops the mechanism of the trace average (temporarily memorized with the togetherness of each non rejected trace). When active, the number of the averages increases, in the lower bar of the acquisition window (with the same frequency as stimulation) and at the same time the averaged traces changes on the upper part of the acquisition window
View Montage	
Go to linked program	If a linked program is selected in the setup of the protocol selecting this option is possible to switch directly to the protocol linked
Save	Saves on disk the averaged data stored in temporary memory
Clear Exam	Deletes the averaged data from temporary memory and resets the traces present on the upper panel of the acquisition window
Overload Rejection	Enables/disables trace rejection that surpasses the set threshold (refer to the EP Exams Average Protocol). The rejected traces are not accumulated in the average calculation
Check	Stops acquisition and opens the check impedance window
Trace Controls	<p>Enables/disables the view of acquisition parameters trace by trace. Next to the trace panel in the acquisition window the following commands appear:</p> <ul style="list-style-type: none"> • lower panel, trace in real time <ol style="list-style-type: none"> 1. A textbox surrounded with four arrows, high-low and left-right, that allows the user to modify the time base and gain for every single trace; 2. Three buttons which are to select controls for the rejection of the traces. The first one is to select the threshold level for the artefact rejection, the second to select the rejection start and the third to select the rejection end. Pressing the buttons the user will have to work on the text box below (the text box on the right) to change the parameters of rejection of the different channels; • upper panel, averaged traces <ol style="list-style-type: none"> 1. a textbox surrounded by four arrows, high-low, left-right, that allows the user to modify the time base and gain for every single trace. <p>The number of commands viewed near each panel is equal to the number of traces viewed. NOTE: this function is not available in all software packages</p>
Grid Refresh	redesigns the grid; select this function if by chance there are some old traces remain in the acquisition window

Windows Menu

Cascade	puts in cascade (one on top of another horizontally or vertically)all open windows.
Tile horizontally	puts in the open windows horizontally
Tile vertically	puts in the open windows vertically
<i>List of windows</i>	List of opened windows. The active window is marked with a check sign on the left.

Help Menu

Help on line	Opens this window
Hotkeys help	Opens a panel to the right that shows all defined hotkeys
Lock toolbars	if selected, it prevents the user from moving the toolbars

Toolbars

For EP acquisition two toolbars can be used; the acquisition toolbar and the parameter toolbar.

EMG-EP Acquisition Bar

The acquisition toolbar is composed of both EP and EMG keys. The EMG keys are disabled. The enabled keys correspond to some items present in the Acquire Menu and from the left are: Run/Stop, Stimulation, Average, Go to linked Program, Save, Save All, Pause, Single Shock, Start/Stop Trend, Turns Amplitude, Trigger, MUAP, MUAP Capture, Clear Exam, Check, Temperature.

EMG-EP Parameter Bar

The parameter bar is composed of the keys and popup menus that allow the user to set the software filters and other viewing parameters of the trace. These parameters are some of those present in the Modify Menu and from the left are: High Pass Filter, Low Pass Filter, Base Time, Amplification, Notch, Smoothing Up, Smoothing, Smoothing Down

Stimulation Bar

In the lower part of the acquisition window, below the traces being acquired in real time, the user will find the average and the stimulation bar.

The average bar indicates three textbox, from the left they are:

Average: once the stimulator and the averages of the traces have been started, the number of acquisitions that satisfy the requisites of this exam type are indicated here and therefore are used to calculate the average.

Rejected: the acquisitions that do not satisfy the requisites for this exam type and surpass the set rejection level are rejected at the end of the average calculation; this counter indicates the number of rejected acquisitions. When a trace is rejected, in the last textbox on the right an error script appears "Reject".

The stimulation bar contains the following functions:

Frequency: by clicking on the arrows it is possible to modify the stimulus frequency with steps of 0.1Hz.

Intensity: by clicking on the arrows it is possible to modify the stimulus intensity with steps of 0.1mA or 1 mA. To change the step for the stimulation the user need to press the green button on the left of the intensity box.

Duration: by clicking on the arrows it is possible to modify the stimulus duration with steps of 25µs.

On the right of the Duration box there are two buttons: the first one is to select which stimulator using for the electrical stimulation, the second one is to select the polarity of the stimulation (positive or negative).

In this bar, on the left part, there is the battery icon: this is to know the level of batteries of the

stimulator.

NOTE: to change the initial parameters of the stimulation, that is, those that the user set at the start of every acquisition, it is sufficient to modify the exam protocol, in the part which regards the Stimulator.

Status Bar

The acquisition status bar is composed of the following indications, from the left they are:

- type of software filter and frequency band
- stimulation side
- rejection state indication, either active or inactive; to change to state just click in the corresponding textbox with the right mouse button.

Acquisition procedure

When the user enters in the EP acquisition, the acquisition screen is enabled. If the EP acquisition toolbar is visible, the key Run/Stop appears pressed and the lower panel shows traces running in real time acquired from the Headbox.

To perform a EP recording, follow these steps:

1. Activate Stimulation; control the exact settings of the parameters relative to stimulation, especially the stimulus current on the stimulator bar
2. Activate Average: the traces on the upper panel show the average of the traces that change at each not rejected acquisition. These traces are memorized in a temporary memory location (volatile).
3. The calculation of the average can stop automatically once the maxim number of average has been reached according to the protocol parameters set (See Stimulation stop after average). Stimulation can also cease or continue once the fixed number of averages has been reached.
4. Save the averaged traces on disk pressing the corresponding key on the toolbar, or with the hot key or from the Acquire menu.
5. If the averaged traces do not satisfy the exam requite they can be cancelled instead of being saved by pressing the corresponding button on the toolbar, or with the hot key or from the Acquire menu.
6. The user can add the exam to the report.
7. In order to close the acquisition window, the user needs to stop the acquisition. this operation should be ALWAYS done. At this point, the user may close the acquisition window only by clicking on the close button (the X present on the title bar) and the view window extends automatically until it fills the entire available space and shows the parameter grid. Otherwise the user can close the entire exam window by clicking on the close button on the title bar of the main window, the one present on both the acquisition window and the review window.
NOTE: if the data of the averaged traces have not been saved yet, when closing the acquisition screen, a message appears asking the user if the data would like to be saved, these data are in the temporary memory (not on disk). If the user does not save them, they are automatically deleted.
8. From this point onwards, the acquired exam is found in review.

Hot keys

The available quick access keys in the acquisition window for an Evoked Potential exam are the following:

Key	Description	User Modifiable
F2	Cancels the calculated average	NO
F3	Starts/ Stops acquisition	NO

F4	Starts/Stops stimulation	NO
F5	Saves the average and passes to the acquisition panel	NO
F6	Starts/Stops the average	NO
F7	Passes to a new test selection window	NO
F8	Adds the exam to the report	NO
F9	Passes to the archive window	NO
ALT+F4	Exits from the acquisition window	NO
F12	Views/ Hides the quick key window	NO
+	Increase the trace amplification	YES
-	Decreases the trace amplification	YES
*	Increases the Base Time	YES
/	Decreases the Base Time	YES
Ins	Increases the Stimulus Intensity	YES
Del	Decreases the Stimulus Intensity	YES
Page Up	Increases the Stimulation Frequency	YES
Page Down	Decreases the Stimulation Frequency	YES
Home	Increases the Stimulus Duration	YES
End	Decreases the Stimulus Duration	YES
O	Enables/Disables Rejection	YES
S	Alternates Stimulation Side	YES

Using the mouse, clicking it over the key, on the bottom left grey zone a more detailed description of the corresponding function appears.

NOTE: by double-clicking over the key, the same result as the pressure of the corresponding quick key is obtained.

To personalise the hot keys see section Archive window - menu Tools - EMG Quick Keys.

Review

Review Window

The review window of the EP software is divided in two parts: on the left a panel with acquired traces and on the right a grid containing relative flag parameters, interpeaks and other properties described more in detail in the Properties, in the protocol settings.

For a correct view of the exam, the steps to follow are:

1. trace overlapping (verification of the exam) relative to more acquired averages; this is obtained via the **Overlap** -> **Derivation** from the Tools menu.
2. manual insertion of the flags (drag & drop technique); the columns relative to the flags show latency, amplitude of the trace in certain points indications, those relative to the interpeaks show automatically the calculated result.
3. insertion of the review window into the report (traces and properties); see **Add to report** via the File menu.

The review window of the EP software has its own menu bar, toolbars and status bar as explained below.

Menu bar

When the user accesses in the Evoked Potentials view section, the main menu changes. In the menu bar the following items are:

File, Modify, Acquire (disabled), Tools, Analyze, Reference (enabled only for traces acquired in C32 modality), Windows, Help

File menu

New	opens the window for a new exam acquisition for the
------------	---

	same patient
Open	views the archive screen, making it possible to review another exam
Close	closes the active window
Add to report	adds the acquired traces to the report as shown on monitor. Adds the right grid as well (if visible) but with a limit of the printable column numbers
Show report	disabled
Print	
Print Screen	this function allows the user to print what it is shown on the monitor
Export	<p>exports the traces in various formats:</p> <p>ASCII File is needed to export the data of the exam in ASCII format. A window opens asking the user the export parameters:</p> <ul style="list-style-type: none"> • Traces to Export, with options Selected Traces or All traces • Data to Export, with options Filtered or Unfiltered • Scale, with options Digit, microvolt or millivolt <p>The Export key completes the operation asking for further source information and suggesting a name. The Cancel key allows the user to exit without completing any operation</p>
	<p>EDF file does nothing (used only for EEG traces)</p>
	<p>Export Trace creates a new file of the current one open with all the current settings</p>
	<p>Export to EP file does nothing (used only for EEG traces)</p>
	<p>Export to EEG file creates a new EEG file, converting traces from EP format to EEG format; there are some limits on sample frequency (max 4096 Hz)</p>
Exit	exits from the EP software closing all the open windows and returning to the Archive section
Modify menu	
Undo, Copy, Paste	disabled
Cut	cuts the selected traces

Reload All Traces	
Select All	selects all the traces currently visualised
Deselect All	de-selects all the traces currently visualised
Invert Selection	inverts the trace selection
Filter	<p>opens a sub-menu that allows the user to choose the type of software filters and their settings, with the following items:</p> <p>Type</p> <ul style="list-style-type: none"> • Identity: the signal is not filtered • Two Poles IIR: software filter - Infinite Impulse Response at 2 poles • FIR: software filter Finite Impulse Response • Butterworth
	<p>High Pass set the cut off frequency of the high pass software filter</p>
	<p>Low Pass set the cut off frequency of the low pass software filter</p>
	<p>Notch enables/disables intervention of the software filter that suppresses the disturbances of the electric network</p>
	<p>Smoothing Up increases smoothing steps of 1</p>
	<p>Smoothing value of smoothing filter</p>
	<p>Smoothing Down decreases smoothing filter by steps of 1</p>
Time Base	time interval that corresponds the width of the review window. This can be changed on all the traces or only for those selected. If the traces visualised have different base time, this textbox appears white, that is without any indication, and on the grid a column appears that shows the base time trace per trace
Amplification	signal amplitude per vertical square of the grid in the review window. It can be changed on all the traces or only for those selected. If the traces visualised have different amplifications this textbox appears white, that is without any indications, and on the grid a column appears showing the amplification trace per trace
Artef. Reject	enables/disables the intervention of an algorithm that resets the monitor to the first samples of effected signals from artefact stimulus
Stimulation Side	four present options are Left, Right, Bilateral, Central
Baseline Correction	<p>the base line of the trace is corrected trace by trace averaging the data. The interval of the average calculation is user selectable. The following options are present:</p> <ul style="list-style-type: none"> • Entire Track: the average is done on all trace.

	<ul style="list-style-type: none"> • Pre-Stimulus: the average is done on the samples before stimulus; this item is active only for those exams acquired with a pre-stimulus time more than zero. • Between cursors: the average is done taking all the samples between the red cursor and the green cursors. Each time that the user moves the cursors this option must be selected until the window is redesigned and the trace gets used to the changing of the base time.
Flag Parameters	opens the Flag Setup window. See the Markers protocol EP exam section
Invert Lines	inverts the polarity of the selected traces
Line Number	allows the user to choose the number of traces to be seen at the same time. The minimum number is one, the maximum is equal to the number of acquired channels. When the user decides to view less traces in respect to the number of acquired channels, the scroll bar present on the left changes aspect, allowing the user to select which trace to view. The grid on the right changes too, showing only the parameters of the trace viewed

Tools menu

Average	creates a new trace with an average of the selected traces
Addition	creates a new trace with the sum of the selected traces
Subtraction	creates a new trace with the difference of the two selected traces

For all these three functions, once the user has chosen them, a window appears with a textbox script with relative number to the traces (or groups of traces) selected, separated by commas. If no trace has been selected, the textbox appears empty. The user can modify the number of the selected traces by clicking the mouse on the cells of the grid that show the trace names. Pressing the **OK** key the operation finishes, while the **Cancel** key does not finish anything.

NOTE: the operation is finished if the rules are not violated; for example it is not possible to see the difference between more than two traces, otherwise an error message appears.

These three functions can be applied to a group of traces via the multi-selection, that has as a result a group of traces instead of one only

Measure Cursor	
P300 traces automatic subtraction	This option is to perform a subtraction between frequent and rare traces
Rare Traces	views the rare traces (only for P300)
Frequent Traces	views the frequent traces (only for P300)

NOTE: the buttons above can be both pressed

View Options	<p>Default Flags if the item is pressed, a flag is shown, otherwise they have a cross shape that intersects with the trace</p> <p>Grid Visible shows/ hides the grid in background of the</p>
--------------	---

	<p>Magnetic Grid traces if this function is selected, during the vertical dragging the traces are hooked to the horizontal lines of the grid when they are near them</p> <p>Shows Baseline shows/ hides the base line</p> <p>Shows Flag Label shows/ hides the flag names near the trace</p> <p>Shows Num trace shows/ hides the trace number near the trace (to the left)</p>
Trace Parameters	<p>Show Grid shows/ hides the parameter grid</p> <p>Show All shows all the property column of the grid</p> <p>Hide All hides all the property columns of the grid</p> <p>Monitoring Grid hides all the property apart from the ones regarding the Comment and Recording Hour</p> <p>Choose opens a windows that allows the user to modify the number of columns visible in the parameter grid. See Select number of visible columns</p>
View Average	when trace are overlapping shows only the average of them
Rectification	inverts the negative part of the signal
Overlap	Derivations overlaps the traces of more than one acquired averages (verification of exam)
	Selection overlaps only the selected traces; the trace must not be already overlapped in derivation
	Overlap Separately P300 Traces works only for P300 exam
	P300 works only for P300 exam; similar to derivation, overlaps the rare traces with the frequent ones
	Reset shows all the traces without overlapping
Join Cursor	joins the cursors together so that their distance stays the same when they are moved

Color Settings	opens a window that allows the user to set the background color, the grid color, the color of the trace etc. Two default color options are available. Colors for every option are fixed
-----------------------	---

Analyze menu

Amplitude Map	available only for exam using C21P or C32 acquisition modes. Allows the viewing of amplitude maps, described in detail
Display Frequency Analysis	This option is to visualize the spectrum of the selected trace
Display Coherence Analysis	This option is to visualize the coherence between two selected traces
ASCII Export Frequency Analysis	It's to export the spectrum of the selected channel in a TXT file
ASCII Export Coherence Analysis	It's to export the coherence analysis between two channels in a TXT file
Display Wavelet Analysis	It's to perform the wavelet analysis
ASCII Export Wavelet Analysis	It's to export the wavelet analysis in a TXT file
External Program, External Program Setup	disabled

Reference menu

This menu is enabled only for traces in C21P or C32 acquisition modalities

G2	all channels have the G2 channel as the common electrode
AVG	all the channels consider the average AVG as it were the common electrode
A1/A2	referred to the averaged of the two electrodes, A1 and A2
Source, Source Settings	disabled

Windows Menu

Cascade	puts in cascade (one on top of another horizontally or vertically)all open windows.
Tile Horizontally	puts in the open windows horizontally
Tile Vertically	puts in the open windows vertically
List of windows	List of opened windows. The active window is marked with a check sign on the left.

Help Menu

Help on line	Opens this window
Hotkeys help	Opens a panel to the right that shows all defined hotkeys
Lock toolbars	if selected, it prevents the user from moving the toolbars

Toolbars

For EP review two toolbars can be used; the review toolbar and the parameter toolbar.

EMG-EP Review Bar

The review toolbar is composed of both EP and EMG keys. The EMG keys are disabled.

The active keys corresponds to some items present in the Modify menu, in the Tools menu and in the File menu and from the left are:

Invert Lines, Measure Cursors, Select All, Deselect All, Invert Selection, Addition, Average,

Subtraction, P300 traces automatic subtraction, Overlap separately P300 traces, P300, View Average, Derivation, Reset, Selection, Reset, Rectification, Add to report.

EMG-EP Parameter Bar

The parameter bar is composed of the keys and popup menus that allow the user to set the software filters and other viewing parameters of the trace. These parameters are some of those present in the Modify menu and from the left are:

High Pass Filter, Low Pass Filter, Time Base, Amplification, Notch, Smoothing Up, Smoothing, Smoothing Down.

Status bar

On the Status bar, the indications from the left are:

- first cursor position (red) from the beginning of the trace, in msec.
- second cursor position (green) from the beginning trace, in msec.
- distance between the two cursors, in msec.
- the following textbox is not used.
- the last textbox on the right shows the pointed trace values.

The trace panel

The trace panel shows the acquired traces in various modes, according to the settings of a series of parameters such as filters, derivations etc. and the flags placed over the traces in order to calculate the interpeaks and other properties.

Cursors

On the trace panel two cursors are present, a red one on the left and a green one on the right. Upon the review window opening, these flags are positioned on the extremities of the trace panel. These are needed to give a general indication of the trace (trace synchronism) and to perform special operation such as line base correction.

Clicking the right mouse button over any trace a menu appears with the following commands, **that are applied only to the selected trace:**

Flag	Flag 1 - Flag 8: positions the selected flag where the mouse button is pressed	
Cut	deletes the trace; IMPORTANT NOTE: this operation asks for a confirmation; once confirmed the trace is cancelled definitely and irrevocable	
Select All	select the trace and the parameters on the property grid	
Filter	opens a sub-menu that allows the user to choose the type of software filters and their settings, with the following items: <ul style="list-style-type: none"> • Identity: the signal is not filtered • Two Poles IIR: software filter - Infinite Impulse Response at 2 poles • FIR: software filter Finite Impulse Response • Butterworth 	
	High Pass	set the cut off frequency of the high pass software filter
	Low Pass	set the cut off frequency of the

	low pass software filter
Notch	enables/disables intervention of the software filter that suppresses the disturbances of the electric network
Smoothing Up	increases smoothing filter by steps of 1
Smoothing	value of smoothing filter
Smoothing Down	decreases smoothing filter by steps of 1
Time Base	time interval that corresponds to the width of the review window. The time interval is changes only for the selected trace
Amplification	signal amplitude per vertical square of the review grid window. Changes only for the selected trace
Invert Lines	inverts the polarity of the selected trace
Set As Model	disabled in review, works only during acquisition. Copies the selected trace and puts it in a different color, in background in the corresponding position of the panel of the averaged traces in the acquisition window. Its aim is to be able to compare this one with the new averaged traces that are being acquired
Set Trend As Model	disabled in review, works only during acquisition. Copies the traces belonging to the same average selected and puts it in a different background color in the panel of the averaged traces in the acquisition window. The aim is to compare these with new averaged traces that are being acquired
Delete Model	

Grid

The grid can be visible or hidden (see the Tools menu).

The first grey column on the left of the grid contains the names of the traces present on the right, and it is always present when the grid is visible.

The other columns on the right contain the parameters tied to the traces, also called properties and can be personalised according to the user's needs. Their visibility depends on what is set in the sections Properties, Markers, Interpeaks in the protocol settings, before acquisition.

Trace selection techniques

Clicking on the cells of the first columns it is possible to modify the selection of the traces to perform the various functions of the menu. A single trace can be selected (blue background white script)/deselected (grey background black script) clicking on the left mouse button on the cell with traces' name. All traces can be selected at the same time clicking on the left mouse button on the first cell on the top left without name; clicking again the traces become deselected. A multi-selection of a group of traces can be performed by pressing the SHIFT (CAPS) key while clicking with the left mouse button over the trace name: all traces of determined group are selected, that is deriving from a singular acquisition (during every exam more than one acquisition can be performed of averaged traces see Acquisition section.)

Number of visible columns

It is possible to modify the number of visible columns clicking on the right mouse button on the grid header, a menu appears:

Hide this column	hides the selected column
Hide All	hides all the columns with the grid parameters, other than those with a trace name
View everything	shows all the parameters in other columns. This widens the grid and the space of the window is not enough, in the lower part a horizontal scroll bar appears that allows the user to move internally in the grid and see all the visible parameters
Select	<p>opens a dialogue window to the Properties in the protocol settings.; allowing the user to choose which properties visualize and which hide. The list indicate respectively: on the left a togetherness of the defined properties (flags, latency, interpeaks etc) and one the right those viewed. To refresh these just double-click on the list on the left hand side or by selecting one or more by clicking on the right arrow. To delete them just click on the corresponding item in the right hand column and click the left arrow. Next to the list on the right there are another two arrows that allow the user to change the visualisation of the right-left column in the properties grid. Pressing the Save and exit button the window closes and the modifications are applied.</p> <p><small>NOTE: the interpeaks must be set before acquisition to be effectively calculated in the review phase. If the user makes visible a column that had not been set previously, the corresponding cells remain empty even after having positioned the flags</small></p>

Flag

In the cell internals of the relative columns to the flags the user may find flag like icons that represent flags before the user positions them on the trace. When the flag is dragged using the drag & drop technique over the trace, in the cell an indication appears depending on the type of parameter relative to the same column: for example, if the column regards the flag name, in the cell the flag name placed on the trace appears; if the column regards the latency and amplitude in the cell the flag name appears, the distance in msec of the sample indicated by the flag respectively to the stimulation instant and amplitude in μV of the trace in that point. For further details about flags see the protocol setting Properties

Interpeaks

Once the flags have been positioned as described above, on the cell of this column with this header appear the interpeak calculation. The calculation is updated each time the user moves a pair of flags that regards the interpeak itself.

Multi-selection

Three functions Average, Addition and Subtraction are usually used on groups of single traces and give as result a new trace that is the average or the addition or the subtraction of the selected traces (maximum of two for subtraction).



It is possible to work in a different way working on groups of traces that give as result a group of traces, each having the average data or the sum or the subtraction of the traces, each of every group taken

from the same position. For example: let's say that in a exam three acquisition were done, each

one with three traces, a total of nine traces. They repeat three times over; each acquisition forms a group of three traces. Keeping SHIFT (CAPS) pressed and clicking over one of the names of the traces of a group the entire group is automatically selected; the same thing is repeated for another group and the user chooses from the tools menu the item Difference: a window opens that indicates the subtraction of trace 7 from trace 1 to form a new trace 10 having the same name *FZ-CZ*, the subtraction of trace 8 from trace 2 to form a new trace 11 having the same name *IC-L1* and the subtraction of trace 9 from trace 3 to form a new trace 12 with the same name *Knee-Knee*. The operation is finished when the user presses the **OK** button. The traces become twelve, four groups of three.

NOTE: the multi-selection indicates the (automatic) selection of a group. Hold the SHIFT down and click the left mouse button for multiple selection. Clicking on these parameters again always holding down the SHIFT the group is deselected.

Hot keys

The hot keys available for the review window for an EP exam are :

Key	Action	User Modifiable
F7	Passes to a new test selection window	NO
F8	Adds the exam to the report	NO
F9	Passes to the archive window	NO
ALT+F4	Exits from the acquisition window	NO
F12	Views/hides the quick key window	NO
+	Increases the trace amplification	YES
-	Decrease the trace amplification	YES
*	Increases base time	YES
/	Decreases base time	YES
CTRL+right arrow	Selects the following trace (for the dragging)	NO
CTRL+left arrow	Selects the next trace (for the dragging)	NO
CTRL+up arrow	Moves the selected trace up a pixel	NO
CTRL+down arrow	Moves the selected trace down a pixel	NO

Clicking on the mouse over the left key in the grey section below a more detailed description of the function appears.

NOTE: double-clicking over the key the same result appears as when pressing the corresponding hot key

To personalise the hot keys see section Archive window - menu Tools - EMG Quick Keys.

IOM

NOTE: this feature could be not available in your country.

Introduction

IOM is the acronym of Intra Operative Monitoring. This section describes the functions and commands of the Evoked Potentials (EP) IOM software in the Micromed application software. It is recommended that the user has a good knowledge of the clinical meaning and exams methods.

System Description

The standard configuration of an IOM system is composed of the following elements:

- amplifiers
- stimulators
- personal computer
- monitor and speakers
- printer

The system can include other components, upon user requirements. The specified components compose a typical system configuration. For further details of the system see the Archive section of the program.

IOM hardware setup and protocol configuration

Since IOM is a subset of EP, the settings of IOM hardware and exam protocols are the same of EP; therefore please refer to the section EP - Exam protocols.

For IOM setup instead please refer to the sections IOM Protocol Manager and IOM Protocol Setup.

Main window

IOM main window has all the components typical of an EP exam and some other components. There is a menu bar, there are four toolbars, there are panels with traces, grids with flags, panels with notes displayed inside them and a status bar at the bottom of the window.

This window is different when in acquisition or in review. In particular, the review window shows only a part of the controls that belong to the acquisition window. Each section is described accurately here.

A particular feature of IOM is the automatic positioning of the flags through a template trace.

Menu bar

When the user accesses the IOM section, the main menu bar is composed of the following items: File Menu, Modify Menu, Acquire Menu, Tools Menu, View Menu, Window Menu, Help Menu

File Menu

New, Open, Close	
Add to Report	This menu is active only in review. Adds to the report the traces visible on the screen. If the report doesn't exist yet, the user is asked to choose the model of report

Show report, Print	disabled
Print screen	This menu is active only in review. Sends to the printer a picture that corresponds to an area of the screen (buttons are excluded)
Export	disabled
Exit	Closes window

Modify Menu

Undo	disabled
Cut	This menu is active only in review. Removes the selected trace. Be careful because there is no confirm message and the trace cannot be restored.
Copy, Paste, Reload all traces, Select all, Deselect all, Invert selection	
Filter	Type The user can select these options: <ul style="list-style-type: none"> • Identity: the output is identical of the input • Two pole IIR: digital filter that behave like an analogic filter with two poles • FIR: digital filter with linear phase • Butterworth
	High Pass set the cut off frequency of the high pass software filter
	Low Pass set the cut off frequency of the low pass software filter
	Notch enables/disables intervention of the software filter that suppresses the disturbances of the electric network
	Smoothing up, Smoothing, Smoothing down disabled
Time Base	x axis scale
Amplification	y axis scale
Artef. reject	Selects the type of artefact reject to apply, or the time slot where to apply after the beginning of the trace
Stimulation side	This menu is active only in acquisition. Selects the side of stimulation between Left, Right, Bilateral, Central
Baseline correction, Flag parameters, Invert lines, Line number	

Acquire Menu

All these commands are available only during acquisition.

Run/Stop	Starts/stops acquisition
Stimulation	Starts/stops stimulation
Average	Starts/stops averaging
View Montage	
Save	Stops averaging and stores all averaged traces
Clear exam	Clears the traces that have been just acquired
Automatic	<p>Start Starts automatic IOM</p> <p>Pause Pauses automatic IOM: clicking again this menu restart IOM from the point where it was paused</p> <p>IOM step Selects the IOM step from which to begin IOM acquisition</p>
Overload rejection	
Check	Starts impedance check
Trace Controls, Grid Refresh	disabled

Tools Menu

Average, Addition, Subtraction, Measure cursor, Rare traces, Frequent traces	disabled
View Options	<p>Default flags, Grid visible, Magnetic grid, Show baseline, Show Num Trace disabled</p> <hr/> <p>Show flag label shows flag labels</p>
Trace parameters, View Average, Rectification	disabled
Overlap	<p>Opens a sub menu with these items:</p> <p>Derivation overlaps the traces</p> <hr/> <p>Selection, P300, Reset disabled</p>
Join cursor, Color settings	disabled

View Menu

Show/Hide Traces	Shows or hides the traces panel
Show/Hide Trend	Shows or hides the trend panel
Show/Hide Note	
Show/Hide Parameter	Shows or hides the parameter panel
Show/Hide Acquisition	This menu is active only in acquisition. Shows or hides the entire acquisition panel that includes the traces acquired

	in real time, the averaged ones and the clock
Show/Hide Direct	This menu is active only in acquisition. Shows or hides the panel of the traces acquired in real time
Show/Hide Clock	This menu is active only in acquisition. Shows or hides the clock

Window Menu

Cascade	puts in cascade (one on top of another horizontally or vertically) all open windows.
Tile horizontally	puts in the open windows horizontally
Tile vertically	puts in the open windows vertically
List of windows	List of opened windows. The active window is marked with a check sign on the left.

Help Menu

Help On Line	Opens this window
Hotkeys Help	Opens a panel on the right that shows all defined hotkeys for IOM
Lock toolbars	

Toolbars

There are four toolbars defined for IOM.

Filters toolbar, by which you can set (from left) **High pass filter**, **Low pass filter**, time base, vertical **amplification** and toggle **notch** filter status.

Acquisition toolbar, where there are all the standard manual acquisition commands: **Run/Stop**, **Stimulation**, **Average**, **Save**, **Clear Exam** and **Impedance check**, which opens the impedance check window.

Automatic IOM acquisition, where there are all the automatic acquisition commands (from left): **Start/Stop**, **IOM step chooser**

Review toolbar, with only two enabled commands (from left): **Derivation**, which overlaps the traces, and **Add to report** which add the traces to the report.

Status Bar

At the bottom of the window is located the status bar which shows (from the left): the name of the patient and the date of the exam, the rejection threshold, the max number of averages to accept and the x/y position of the cursor when it is moved upon the panel of averaged traces.

During review only the first panel (the one with the patient name) is visible.

During acquisition you can change the rejection threshold and the max average number by clicking on the respective status bar panel: a text appears which allows you to edit a new value. By clicking again inside the acquisition window, this new value is entered.

Window components: clock, stimulator, traces, average, trends, parameters and notes

When the acquisition starts, the window is split into two main parts: on the right there are the **clock panel** (which shows the actual time and the time difference from the last averaging action) and below it there are the **panel of stimulator parameters**, the **panel of the traces acquired in real time** and below again the **panel of averaged traces**. You can move the focus between these two last panels by clicking inside them, the selected one has two red lines to the left and the right borders. Below the panel of averaged traces there are two boxes that show the number of averaged and rejected traces during acquisition.

On the left there are the as many IOM cells as it is defined in the selected IOM acquisition protocol. The cells may be composed by **traces** (by default with a blue background), **trends** (white

background) and **parameters** (grid with flags).

The **Note** cell is always present on the right of all the other cells.

IOM acquisition window

When you enter in the IOM acquisition window, the headbox is on and you can see the traces running inside the real time panel; if the clock is visible, you can see also the clock running. There are two ways to perform IOM acquisition: manual or automatic.

Manual acquisition

Manual acquisition perform like a standard EP exam: you can start stimulation, then start averaging and save traces at the right moment. See EP Acquisition Procedure for further information.

Automatic acquisition

Automatic acquisition can be started by clicking on the Start button of Automatic IOM toolbar and then the program automatically follows the IOM protocol that was selected. The program can stop automatically when finished or run indefinitely (if IOM protocol is defined to do this) until the users stops it by clicking again the Start button. Once running, the program can be paused and restarted by clicking on the Pause button. When not running, you can select the starting step (that is EP exam protocol) via the popup menu from those defined in the current IOM protocol.

IOM review

When acquisition window is closed and some traces are saved, you can close the window and see the new exam inside the archive. By double-clicking on it you can open the IOM review window, that is similar to the acquisition one, except that the panels on the right are not visible: the clock, the stimulation, the real time acquisition, and the averaged traces.

Positioning the flags: the template trace

Either during acquisition or review it is possible to set manually the position of some flags on a trace inside a cell (a registered trace) and make this trace to be kept as "template": the algorithm for the automatic positioning will take the template trace as a guide for the insertion of the flags on all the other traces.

To make a trace as template you can:

1. re-position manually the flags by clicking and dragging them to adjust the position;
2. right-click on the trace and choose "Set as template" from the popup menu.

The trace color changes to green color to show that it is the template trace. To choose another template trace repeat the steps 1 and 2.

After the automatic positioning, it is always possible to adjust manually the position of the flags on every trace.

Setup

Protocol Manager

This is a dialog window where the user can add, remove, copy and modify IOM protocols. Once selected a specific protocol, the user can start a new IOM acquisition too.

On the left there is a list in which the defined protocols are shown: on the left column there is the "Protocol Name" as defined by the user and on the right the number of iterations. By pressing the other buttons on the window the user can do the specified action.

New: add an IOM protocol. First a dialog window is opened, that allows to input the IOM protocol name and the number of iterations. Once the user presses the OK button, a new standard protocol is created with default values (only one step, with only one cell and one active trend); then

automatically the program enters the "Settings" section for modifying these default parameters as the user's needs.

Remove: removes the selected protocol. This action has to be confirmed and cannot be undone. So be careful in order not to lose important setting data.

Duplicate: opens a dialog window that prompts the user for an IOM protocol name; this name will be used for a copy of the selected protocol (Copy the selected protocol as...). NB: duplicate names are allowed; therefore the user is responsible about the confusion caused by protocols copies which have the same name but contains different parameters. For this reason this window prompts the default name "Copy of ...".

Settings...: opens the dialog window called "IOM Protocol Setup" where the user can modify all the parameters of the selected protocol.

Acquire: starts a new IOM acquisition with the selected IOM protocol.

Help: opens this window.

Exit: closes the IOM Protocol Manager window.

Protocol Setup

This is a dialog window where the user can modify the IOM protocols.

On the top of the window there are two controls where the user can edit the protocol name and the number of protocol iterations (the same reported in the IOM Protocol Manager list).

Then there is a large box where the components of the protocol are shown: steps, cells and trends. They are organized in a tree form, which explains the structure of the protocol: steps include cells, that include trends.

Each node of the tree displays a little box on the left with a plus or minus sign inside: a plus sign means that the node is collapsed, a minus sign means that the node is expanded. Clicking on it toggles the state of the node; the same is achieved by double-clicking over the node text.

When the node is expanded, its content becomes visible. Also clicking on a node will show a series of controls inside a frame (located under the tree-box), which allow the user to modify all the parameters that belong to the selected node. These controls are different each time because step parameters are different from cell parameters, which are different from trend parameters too.

Steps

The step node is characterized by a text in bold format. The text contains these informations:

- step number, that is its position in the list (steps are executed sequentially).
- the name of the selected exam. It can be selected from a popup menu called [Select exam](#) (located in the frame under the tree-box) that displays only the available exams. NB: each exam has its own traces which may be different from one exam to another; for this reason changing the exam will prompt a message which advises the user that all trace parameters will be modified.
There is another popup menu called [Select protocol](#) that displays all the EP protocols available for the selected exam. As it has just been explained, this popup menu changes when the user select a different exam.
- number of step repetitions. The user can modify this number by clicking on the up/down arrows of the control named [Step repetition](#); when this number is greater than one it appears a text [Delay \(hh:mm:ss\)](#) where the user can input the time delay between two repetitions of the selected step (in the format hours:minutes:seconds).
- information about the application or not of moving average. The user can activate/deactivate the use of moving average by clicking on the checkbox [Apply moving average](#). When the use of moving average is activate, the [Stimuli/Block](#) popup menu appears (to select how many stimuli before recalculate the average) and the [Wiener Filter](#) popup menu appears (to activate or not a time-frequency algorithm).
- waiting parameters: the user can set how much long has to be the step duration. The frame [Wait till exam reaches](#) contains two options: [End](#) and [Specific interval time \(hh:mm:ss\)](#). The

first option indicates that the step duration depends on its parameters; the second option lets the user to specify a maximum duration time for the selected step (in the format hours:minutes:seconds).

- next action: it is explained in a message inside the frame called **Next action**. For default, at the end of a step the programs automatically jumps to the next step in the list (after waiting the specified delay). If it is an internal step in the list then the only possible action is to jump to the next step; if it is the only step defined for the selected protocol then the only possible action is to stop the IOM exam. Otherwise, if it is the last step in a list of more than one step, two options appear in the frame: **Stop IOM** and **Restart from step**. By the first the program will be terminated, by the second the user can specify the number of the step to jump to.

Cells

The cell node contains these informations:

- **Cell name**, which can be typed in the box below.
- Selected trace, which can be **All traces** or a single trace between the ones defined for the actual EP protocol.
- what to show in the IOM window: the user can select/de-select the three checkboxes **Show Traces**, **Show Trends**, **Show Parameters** to show/hide traces, trends and parameters. Notes are always visible.

Other controls are:

- **Set cell positions**, which opens a dialog window through which it is possible to change the position of all the cells defined for the selected IOM protocol
- on the left there is a custom control which can show from one to three colored rectangles: the blue rectangle indicates traces and appears if traces are selected, the yellow rectangle indicates trends and appears if trends are selected, the grey rectangle indicates parameters and appears if parameters are selected. The user can click and drag the separators between the rectangles to change their horizontal width. The **Reset** button restore the default width which is equal for each one.

Trends

The trend node contain only its name; by clicking on it, some other controls appear that allow the user to set these parameters:

- **Activate trend**. By clicking on the checkbox, the trend status will be toggled between active and not active. The same can be done by double-clicking on the trend node.
- **Trend name**, which can be typed in the apposite text box.
- **Trend formula**: this is the formula used to calculate the trend that will be shown in the apposite panel. The formula can be defined by clicking on the numerator or denominator; a popup menu appears, from which the user can select between various parameters. It is possible to define up to two numerators and two denominators. To add a second numerator or denominator, click on the "..." button and select the appropriate parameter (... means **No Operator** and if the user selects it, then the second numerator/denominator will disappear).

NOTE: if the denominator is set to zero (for example $1 - 1$) the formula will be ignored and the trend value set to zero.

Introduction

This section described the functions and the commands of EEG and EP software that characterises SystemPlus Maps Analysis. The user's minimum requirements are a good knowledge of the clinical meaning and exam methods.

Types of Maps

Two types of maps exist:

- Amplitude Maps
- Frequency Maps

Together with frequency maps, it is possible to conduct spectral analysis viewed in the same way where the electrodes are placed on the patient's head.

Access to the Maps section

To access the Maps section, the user must first open the review section of a EEG or EP trace and then select the sub-menu MAPS from the Analyze menu. Here the user will find two items that permit access to sections Amplitude maps or section Frequency maps and spectrums. It is possible to do the same thing by pressing one of the two keys present on the toolbar, if visible.

When the map windows are active, the main menu changes, and the keys are present on the eventual toolbars can be activated or deactivated according to the functions forecasted for that type of analysis.

Menu, toolbar and status bar

Menu

When the user access to one of the two sections: Amplitude Maps or Frequency Maps and Spectrums the main menu changes.

The Map menu has the following items: File Menu, Modify Menu, Tools Menu, Window Menu, Help Menu. Below there is the map toolbar and at the bottom of the window there is the map status bar.

File Menu

Open	opens another exam of file choosing from the archive screen
Save	disabled
Print Screen	this function allows the user to print what is shown on monitor
Print Setup	set the printer parameters
Properties	this function allows the user to access to the properties of the map program. Refer to the section Amplitude Map Settings or to the section Frequency Map Settings
Disk Properties	disabled
Export	this function allows the user to export the data of the signal in ASCII format or export a graphic file
Exit	this function allows the user to return to the Archive section

Modify Menu

Copy	this function allows the user to copy the maps of the relative trace on the clipboard for an eventual insertion in the comment section
Electrode Position	gives access to the electrode position window. Please refer to the Electrode Position section
Show Info	Electrodes allows the user view or not the electrodes on the map. If they are shown, by moving the cursor over

	these it is possible to read the name (label) and the value of the signal in that point (time instant of the corresponding map)
	Description allows the user to view or not the textbox, that is shown under the map, where the position of the map as distance in seconds from the beginning of the trace
Cursor Band	this function is active only when there are a lot of maps. If the background is light blue and the button appears pressed this indicates that the cursors are joined, in which it is represented by a vertical grey bar that joins the blue cursors on the EEG trace that regards the maps. When the icon is grey the cursors are free and can be moved one at a time on the trace
Step	indicates the distance between every cursor and the following, in milliseconds for EEG and in pixels for EP, and is active only when the cursors are joined. It is possible to change the interval by typing a new value and pressing ENTER. If the maps are not immediately refreshed, select REFRESH from the same menu or press the relative key on the toolbar
Draw Mode	when selected allows the user to move the cursors without re-calculating the maps each time; in that case refresh has to be called manually when required;
Refresh	refreshes the screen and re-calculates the maps

Tools Menu

Via this menu it is possible to access two advanced functions regarding amplitude amps and frequency maps.

Dynamic Maps	this item allows the user to access to the section Amplitude Dynamic Maps
3D Maps	this item allows the user to access the section Three-dimensional Maps

Window Menu

Cascade	puts in cascade (one on top of another horizontally or vertically)all open windows.
Tile horizontally	puts in the open windows horizontally
Tile vertically	puts in the open windows vertically
<i>List of windows</i>	List of opened windows. The active window is marked with a check sign on the left.

Help Menu

Help on line	Opens this window
Hotkeys help	Opens a panel to the right that shows all defined hotkeys; <i>NOTE: there are no hot keys defined for the report window</i>
About	disabled



The toolbar contains the main items of the Maps menu grouped and easily reachable via keys. These functions are:

- **Property** (File Menu)
- **Cursor Band** (Modify Menu)
- **Interval** (Modify Menu)
- **Draw Mode** (Modify Menu)
- **Refresh** (Modify Menu)
- **Dynamic Maps** (Tools Menu)
- Amplitude Maps
- Frequency Maps

The last two buttons on the right are to recall the amplitude maps window and the frequency maps window appearing disabled when the map window is active, enabled if the trace window is active.

Status bar

The status bar of the maps program presents various settings of the maps themselves.

From left: the type of reference (G2 indicates common reference), the cut off frequency of the high-pass filter and the low-pass filter, the Notch Filter presence and the type of scale applied to the map. The same settings are found when the user sets the maps.

When working with Frequency maps the type of interval on the trace is indicated in the position where the calculation is made (see the Frequency Map section).

Amplitude Maps

Amplitude Maps

Amplitude maps are a graphic view of the signal amplitude according to the position of the electrodes on the patient's head.

The window

The window is made up of various components: one or more circles indicate the patient head and the colors indicate the distribution of the amplitude (one color corresponds to a signal value) to a determined instant of the EEG or EP trace. Each circle is a map.

The cursors on the trace

On the EEG or EP trace, cursors are positioned, each one represents a temporary interval that corresponds to a relative map; more precisely, the map on the top left corresponds to the first left cursor, the map on the top right corresponds to the second cursor, the map in the middle left to the third map and so on.

Before calculating the maps of a trace the user must open it for review (as explained in the introduction). Once the option "Amplitude Maps" has been selected, the two windows can be put side by side, the one with the trace and the one with the maps. On the trace the cursors are visible (joined or free).

The cursors can be moved by dragging them with the mouse (drag & drop) and the maps are recalculated every time. The cursors can be free or joined. In the first case (Free cursors) it is possible to move them one at a time, in the second case (joined) they are grouped together in a grey band; it is possible to move them together dragging the grey band. With joined cursors it is possible to move the first and the last of these and the in-between cursors are automatically moved in a way to keep a constant interval between themselves.

Other graphic symbols

Next to the maps there are other indications used for define the images and the calculation parameters better: nearby there is a correspondence scale between color and amplitude, and at the extremities of the two scales the corresponding minimum and maximum values; under the map there is a textbox that indicates the cursor position in seconds from the beginning of the trace page; on the top right and left of each map there are two textboxes written **L** and **R** that indicated the left side or the right side of the patient's head.

On the map the user will find symbols (squares or black circles) that indicate the electrodes. Moving the cursor over these the name of the corresponding electrode appears. These are the only points where a correct correspondence of the measured signal is effective. The amplitude value of all the points between the electrodes is calculated with a interpolation algorithm where the parameters are set via an actual window (see Algorithm section). The electrodes shown on the maps can be in a different position in respect to the actual physical position on the patient's head (electrode position can be modified by the user, see Electrode Position section). It is the user's responsibility to keep the correct correspondence between the two.

Electrodes

Default electrodes are:

8 channels: Fp1, Fp2, C3, C4, T3, T4, O1, O2

12 channels: Fp1, Fp2, F7, Fz, F8, C3, C4, T5, Pz, T6, O1, O2

19 channels: Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2

21 channels: Fp1, Fpz, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2, Oz

Amplitude Map Settings

Dialog window that allows to set the calculation parameters and visual appearance of the amplitude maps. The following options are found within:

- Algorithm: to define the algorithm calculation parameters;
- Scale: to define graphic parameters in which the maps are designed;
- Appearance: complete appearance of the map window.

On the lower part of the screen, the following buttons are found: pressing **OK** the user exits from the screen saving all the modifications done in the map setup, pressing **Cancel** the user exits WITHOUT saving the modifications (the same thing happens when the user closes the window by pressing X on the right of the title bar).

Algorithm

These are the parameters for the calculation of the amplitude maps.

Interpolation

In the popup menu the user may select three types of different interpolation:

K-nn: interpolation method of the number of electrodes nearer to the calculation point.

Spline pl: spline plane type of interpolation.

Spline sf: spline spherical type of interpolation.

Other parameters intervene in the interpolation algorithm; they are:

M: grade of the interpolation polynomial.

K: number of electrodes considered in the interpolation of the value in any point.

These two parameters are optimised and it is recommended to leave the default values.

Resolution: type of popup menu. The resolution is the number of interpolated points internally on the maps and indicates the calculation matrix dimension.

Interpolation Time for each map: this function indicates the time that is needed to calculate each map. The total time is shown in the yellow textbox. The time appears only when the **ESTIMATE!** key is pressed.

Common Filter for all channels

The following filters are common to all channels and their values are shown on the status bar from left to right.

High Pass Filter: popup menu where the user chooses the value of the cut off frequency of the high pass filter.

Low Pass Filter: popup menu where the user chooses the value of the cut off frequency of the low pass filter.

Notch Filter: control of the type of checkbox that allows the user to enable or not the Notch filter. The two values near the filter indicate the two possible choices. The selected value must correspond to the frequency of the network voltage.

NOTE: the values of the filters (high-pass, low-pass and Notch) are taken from the settings of the first channel of the EEG or EP trace.

Scale

Scale colors: is a colored vertical bar that indicates the correspondence between a color and the signal amplitude. One extremity of the scale corresponds to the minimum value of amplitude and the other one to the maximum value, while the in between colors corresponds the in-between values (according to a linear scale). The user can select different color scales using the arrows near by.

Amplitude Map scale

Balanced: balanced color scale, that is with minimum and maximum symmetrical amplitudes respect to zero. The values can be set using the nearby textbox. Use the arrows near by to increase and decrease the values of intervals by 10 μ V.

Distributed: the highest and lowest values of all the maps are automatically calculated and the color extremes are assigned to the scales.

Special: different values can be assigned via the textboxes near by; it can be done via the arrows, with intervals of 10 μ V, or by typing the desired value in the textbox and pressing the ENTER key.

NOTE: the user can automatically switch from the balanced to distributed to special scales by double-clicking on the color scale near each map

Appearance

In this sub-section, the user can change the visual appearance of the window, according to the following parameter:

Map number: popup menu that allows the user to set the number of maps to be viewed, this can be **1, 4, 8, 32**. A cursor on the EEG or EP trace corresponds to a map. The order for the maps goes from left to right and from top to bottom, that is the first map on the top left corresponds to the first cursor. The map on the bottom right corresponds to the last cursor on the right. All the other maps in the middle represent the in between cursors.

Graphic Filter

Modifies the singular appearance of every map:

Circular: this popup menu allows the user to choose the head shape. For the moment the only possibility is circular.

Electrode Presence: clicking on the checkbox the user has the possibility to make the electrodes visible or not; the user can choose the appearance of the electrodes by selecting one of the two choices near by.

Description: clicking on the checkbox the user has the possibility to make visible or not the yellow textbox under the map where the distance in seconds from the start of the page to the relative cursor is shown.

NOTE: if 32 maps are viewed it is recommended to deactivate the Description option because it is easier to see the maps.

Cursor Movement

Fixed Interval Cursors: this function is available only when a lot of maps are viewed. The cursors

at fixed intervals are a togetherness of cursors, one for each map, indicated on the trace by a blue vertical line grouped by a grey band; The user can set the distance between the cursors (indicated in milliseconds in a textbox near by). The band between the cursors allows the user to move all the cursors at the same time along the trace. On the toolbar this is indicated by an grooved icon with vertical blue lines on a light blue background, while the un- grooved icon with gray lines indicates the possibility to move a cursor at a time. The interval can be changed by moving the first or the last cursor on the trace (joined cursors), dragging them with the mouse (drag & drop method). The interval represents the distance between the first cursor and the second, between the second and third and so on. For EEG trace the unit measure is milliseconds while for EP traces pixels are used.

Single Cursor: selecting single Cursor, each time that the map window is opened the free cursor mode is used.

Frequency Maps and Spectrums

Frequency Maps

Frequency maps allows to analyze the topographic distribution on the patient's head of the original signal transformed in the frequency domain and divided in spectral bands, each one covering a determined frequency range. From the original data we can obtain the spectrums of the signal of each channel (linear scale or logarithmic), or the maps of absolute power spectrums (linear scale or logarithmic) or relative power maps.

Analysis is average type and therefore we need to define the interval where it is performed. The user can Analyze different parts of the EEG trace but it is necessary to mark the initial points and end points of every interested part via the insertion of a pair of flags on the trace.

Flags

They are flags placed on the trace by the user. To define an interval of trace where to calculate the maps the user needs a pair of flags. The trace can have more than one pair of flags. The analysis of the maps will keep in count of the average of the spectrums calculated on all the selected intervals.

According to the Fourier analysis methods, spectral analysis happens when dividing the data of the trace in intervals of 2 seconds (considered interval "acceptable" in order to have a stable). This time results as a minimum interval that the user can analyze; in other words, it is not possible to analyze parts of trace less than 2 seconds in length. The transformation results of all the intervals of the signal selected are elaborated to obtain a average signal spectrum, in which maps can be extracted.

The interval defined by the flags therefore must be a multiple of 2 seconds. For example, if we insert a pair of lags with the first at 10.8 seconds from the beginning of the trace ad the second at 47.2 seconds, the frequency analysis in this period starts from 12.0 seconds until 46.0 seconds from the beginning of the trace, for a complete interval of 34 seconds.

Other Graphic symbols

Next to the maps there are other indications used for define the images and the calculation parameters better: near by there is a correspondence scale between color and amplitude, and at the extremities of the two scales the corresponding minimum and maximum values; under the map there is a textbox that indicates the cursor position in seconds from the beginning of the trace page; on the top right and left of each map there are two textboxes written **L** and **R** that indicated the left side or the right side of the patient's head.

On the map the user will find symbols (squares or black circles) that indicate the electrodes. Moving the cursor over these the name of the corresponding electrode appears. These are the only points where a correct correspondence of the measured signal is effective. The amplitude value of all the points between the electrodes is calculated with a interpolation algorithm where the parameters are set via an actual window (see Algorithm section). The electrodes shown on the maps can be in a different position in respect to the actual physical position on the patient's head (their initial setting can be modified by the user see the Electrode Position section). It is the user's responsibility to keep the correct correspondence between the two.

Electrodes

Default electrodes are:

8 channels: Fp1, Fp2, C3, C4, T3, T4, O1, O2

12 channels: Fp1, Fp2, F7, Fz, F8, C3, C4, T5, Pz, T6, O1, O2

19 channels: Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2

21 channels: Fp1, Fpz, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2, Oz

Access to the Frequency Maps and Spectrums

To access to the Frequency maps the user must open an EEG trace in review. From the menu Analyze and the sub-menu Maps choose the item Frequency Maps. A dialog window appears that allows the user to choose the type of maps and the calculation interval.

Below the title bar there is a toolbar with two icons. The icon with a circle represents the frequency maps while the one with a graphic indicates spectrums; pressing this the corresponding windows open.

The blue textbox below the toolbar shows the patient's name, the data and hour of recording. The yellow textbox indicates the traces in length and on it appear red horizontal rectangles or blue that indicate the defined parts from the pair of flag. The blue parts are those selected for the calculation, the red ones are de-selected.

To select the data for analysis, five possible ways are:

- **Flag pairs:** this option allows the user to choose one pair of flags only as markers of the part to be Analyzed.
- **All the Flag pairs:** analysis on the parts of the traces delimited by all the pair of flags present.
- **Whole Trace:** analysis is done on the whole trace.
- **From/To:** the two textboxes are enabled where the user types the values of the initial instant and of the instant final of the analysis.
- **All trace apart the flag pairs:** the selection is inverted respect to the second possibility.

IMPORTANT: the flag pairs must be placed on the trace before performing a frequency analysis.

Frequency Map Settings

Dialog window that allows to set the calculation parameters and visual appearance of the amplitude maps. The following options are found within:

- **Algorithm:** to define the algorithm calculation parameters;
- **Scale:** to define graphic parameters in which the maps are designed;
- **Appearance:** complete appearance of the map window.
- **Frequency Bands:** every map is calculated in a determined frequency band that can be modified.

On the lower part of the screen, the following buttons are found: pressing **OK** the user exits from the screen saving all the modifications done in the map setup, pressing **Cancel** the user exits WITHOUT saving the modifications (the same thing happens when the user closes the window by pressing X on the right of the title bar).

Algorithm

These are the parameters for the calculation of the Frequency maps

Interpolation

In the popup menu the user may select three types of different interpolation:

K-nn: interpolation method of the number of electrodes nearer to the calculation point.

Spline pl: spline plane type of interpolation.

Spline sf: spline spherical type of interpolation.

Other parameters intervene in the interpolation algorithm; they are:

M: grade of the interpolation polynomial.

K: number of electrodes considered in the interpolation of the value in any point.

These two parameters are optimised and it is recommended to leave the default values.

Resolution: type of popup menu. The resolution is the number of interpolated points internally on the maps and indicates the calculation matrix dimension.

Interpolation Time for each map: this function indicates the time that is needed to calculate each map. The total time is shown in the yellow textbox. The time appears only when the **ESTIMATE!** button is pressed.

Common Filter for all channels

The following filters are common to all channels and their values are shown on the status bar from left to right.

High Pass Filter: popup menu where the user chooses the value of the cut off frequency of the high pass filter.

Low Pass Filter: popup menu where the user chooses the value of the cut off frequency of the low pass filter.

Notch Filter: control of the type of checkbox that allows the user to enable or not the Notch filter. The two values near the filter indicate the two possible choices. The selected value must correspond to the frequency of the network voltage.

IMPORTANT: the values of the filters (high-pass, low-pass and Notch) are taken from the settings of the first channel of the EEG or EP trace.

FFT Parameters

Tapering: this option allows the user to reduce the leakage of spectral components.

Detrending: this option allows the user to remove slopes (slow components) of the signal to be Analyzed.

Scale

Scale colors: is a colored vertical bar that indicates the correspondence between a color and the signal amplitude. One extremity of the scale corresponds to the minimum value of amplitude and the other one to the maximum value, while the in between colors corresponds the in-between values (according to a linear scale). The user can select different color scales using the arrows near by.

Frequency Map scale

Balanced: balanced color scale, that is with minimum and maximum symmetrical amplitudes respect to zero. The values can be set using the nearby textbox. Use the arrows near by to increase and decrease the values of intervals by 10 μ V.

Distributed: the highest and lowest values of all the maps are automatically calculated and the color extremes are assigned to the scales.

Special: different values can be assigned via the textboxes near by; it can be done via the arrows, with intervals of 10 μ V, or by typing the desired value in the textbox and pressing the ENTER key.

NOTE: the user can automatically switch from the balanced to distributed to special scales by double-clicking on the color scale near each map

Appearance

In this sub-section, the user can change the visual appearance of the window, according to the following parameter:

Number of Maps: popup menu that allows the user to set the number of maps to be viewed, this can be **1, 4, 8, 32**. A cursor on the EEG or EP trace corresponds to a map. The order for the maps goes from left to right and from top to bottom, that is the first map on the top left corresponds to the first cursor. The map on the bottom right corresponds to the last cursor on the right. All the other maps in the middle represent the in between cursors.

Graphic Filter: modifies the singular appearance of every map:

Circular: this popup menu allows the user to choose the head shape. For the moment the only possibility is circular.

Electrode Presence: clicking on the checkbox the user has the possibility to make the electrodes visible or not; the user can choose the appearance of the electrodes by selecting one of the two choices near by.

Description: clicking on the checkbox the user has the possibility to make visible or not the yellow

textbox under the map where the distance in seconds from the start of the page to the relative cursor is shown.

NOTE: if 32 maps are viewed it is recommended to deactivate the Description option because it is easier to see the maps.

Frequency Bands

This option grid is active only for frequency maps, and not for amplitude maps.

The four pairs of textboxes indicate the lower and upper frequency threshold value for each map: **Delta, Theta, Alpha** and **Beta**. The user can set the values of each band or leave the default settings, always available. To set new values the user can either click on the arrows or type in the new value and press ENTER.

Restore Defaults: pressing this button the default values are restored.

Spectral Analysis

Spectral analysis is a window containing many graphics as well as electrodes on the patient's head. Each graphic represents a spectral power in function of the data frequency analysis conducted on the relative signal to that electrode, in the interval defined by the user. Moving the mouse over the graphics the relative electrode names appear.

Below the title bar the user will find the frequency bands indicated: **Delta, Theta, Alpha** and **Beta** with values set previously from the maps setup window.

The textbox on the top left indicates the maximum value of the Y co-ordinate Axis. Using the arrows near the box the user can modify this value.

The status bar has various other indications (see Status Bar section) shows the type of interval selected for analysis in the last textbox on the right.

Single Spectrum Analysis

By clicking on one of these spectrums it is possible to enlarge the window, permitting the user to observe the spectral analysis of the relative electrode in detail.

The indications of the four bands are always present **Delta, Theta, Alpha** and **Beta**, and are the same set by the user in the map properties window.

The textbox on the top left indicates the maximum value for the Y Axis co-ordinate. Using the arrows near the textbox the user can modify this value.

Moving the cursor over the spectrum the name of the electrode appears.

If the user moves the vertical yellow bar horizontally the values of the two textboxes on the top left change automatically, and indicate respectively from left the values of the ordinate and the axis of the graphic in that point.

To return to the main spectral analysis window click anywhere in the internal part of the window.

Advanced functions

Dynamic Amplitude Maps

Practically the video of the evolution in time of the amplitude maps of the trace is dealt with. To see the dynamic amplitude maps the user must select the item "Dynamic Maps" from the tools menu, or click on the corresponding icon on the toolbar.

Dynamic Maps are represented by a circle that indicates the patient's head. The squares (or little black circles) indicate the electrode position, symbols **L** and **R** indicate respectively the left and right sides. The color scale is present on the right side of each map. Under the map there is a textbox with the distance in seconds form the beginning of the trace page.

NOTE: the function of the movement maps uses the same parameters present in the amplitude map s setup. When the user enters in the map movement section the maximum and minimum values of the scale are calculated starting from the position of the first cursor on the trace.



On the upper part of the map window there is a toolbar composed of eight command keys, from left these are:

- **Start:** moves the cursor from the beginning of the trace.
- **Backwards:** automatically moves the cursors backwards on the trace.
- **Left:** moves the cursor left with an interval step as indicated in the textbox on the right.
- **Stop:** stops the video maps.
- **Right:** moves the cursor right with an interval step as indicated in the textbox on the right.
- **Forwards:** automatically moves the cursor forward along the trace.
- **End:** moves the cursor to the end of the trace.
- **Steps:** in this textbox the user can set the interval by directly typing a value between 1 and 9999 (unit are in milliseconds for EEG, pixel for EP).

Moving the mouse over the commands of the toolbar a script appears describing them.

Three-dimensional Maps

This supplies a three-dimensional vision of the amplitude and frequency maps.

This function is available only when the user has set **spline spherical** interpolation in the algorithm grid in the map setup window.

To see the three-dimensional maps the user must select 3D Maps from the tools menu or double-click on the left mouse button on one of the maps.



On the upper part of the three-dimensional map, there is a toolbar composed of six keys, from left they are:

- **Backwards:** rotates the head anti-clockwise with intervals of 5°.
- **Stop:** stops rotation.
- **Forwards:** rotates the head clockwise with intervals of 5.
- **Start:** makes the head return to the start position.
- **Electrodes:** views or not, the electrodes on the patient's head.
- **Grid:** views or not the latitude-longitude grid of the patient's head.

Other functions present on the window are:

Color Scale: The color scale is the same set previously in the setup window.

Vertical Scroll Bar: this function allows the user to slant the patient's head on a horizontal level from 0° (flat view) to 90° (side view).

Horizontal Scroll Bar: this function allows the user to rotate the patient's head manually from right to left, from -180° to 180°.

Electrode Position

At times the user moves one or more electrodes from their default position on the patient's head deliberately. To reflect this change on the analysis maps and given the possibility to update the electrode position manually memorized in the program.

The window of the electrode position can be recalled before trace acquisition pressing the **Electrode Position** button when the user is in the modify connection window (EEG acquisition) or in review phase of the maps (both amplitude and frequency maps) selecting the item Electrode Position in the Modify menu.

The screen is divided in three sections: the **grid** on the left, the **head** on the right, and below the **electrode position database**.

The grid

The grid is composed of four columns called: **Active, Electrode, Latitude e Longitude**.

- **Active:** indicates if the electrode is enabled or not. The user can activate the electrodes by clicking the left mouse button on the corresponding checkbox, making a symbol appear. Repeating the left mouse button, the symbol disappears and the electrode is disabled.
- **Electrode:** indicates the electrode name. The EEG channels here visible are selected in the "Modify Connection" window, in acquisition; (recallable only in the acquisition phase of EEG traces.) Refer to the EEG section.
- **Latitude:** indicates the latitude of the electrode and can be modified by the user. Click the left mouse button on the interested electrode cell and type the new value.
- **Longitude:** indicates the longitude of the electrode and can be modified by the user. Click the left mouse button on the interested electrode cell and type the new value.

The head

The head is shaped like the scalp with squares that represent the electrodes. If the electrode that corresponds to a square is active on the map a black circle appears in the square. These squares can be moved inside the red circle dragging them with the mouse; in the latitude and longitude columns the values change automatically. The name of the electrode appears when the user moves the mouse over each square.

Electrode position database

Description: wanting to vary the electrode position the user can choose between a series of available settings. Clicking on the popup menu a list of settings appears, where some are default and others user built. It is possible to create a new setting starting from the initial setting, modifying the electrode position and their status (active - inactive), typing a new name in the field **Description** and press the **Save** button.

Save: pressing this button a new setting in the database of the available settings. If a settings with the same name is tried to be saved the system will give out an error message.

Delete: pressing this button the setting selected is deleted. Default settings can not be cancelled. These two functions are present:

Apply: pressing this button all the modifications applied to the maps are made. If the button is not pressed the modifications will be lost (even if they are saved a new database).

Exit: press this button, the user exits from this window.

NOTE: naturally if the modifications have been made and are not saved, they will be lost upon exit. Statistic
 This section describes the functions and commands of the Statistic software.

General Description

The STATISTICS module was developed to provide a program of statistical catalog and elaboration, that allows:

- to classify, according to the desired group of attributes, every file of the archived patients, that is present in the referring database
- to individualise, between the classified files, a group with the common characteristics.

In a preliminary catalog and statistics elaboration phase, the user must program a togetherness of possible attributes, sub-dividing them in various groups (called classes), each one containing 1 or more parameters, even organized on different levels (items and sub-items).

Once the attributes have been set, the files are then cataloged giving them the right attributes of the various classes, items and sub-items.

The purpose of the statistical elaboration program is to put light on eventual correlations (both negative and positive) between the available parameters.

Structure of the STATISTICS module

The STATISTICS software is composed of three functions:

- Statistic Set, for the definition of the togetherness of possible attributes (the statistic tree with its class, items, sub-items)
- Statistic Items, for classification, according to the desired group of attributes, of the pointed file
- Statistic Search, for statistic elaboration

Statistic settings

Statistic settings

This section describes the functions and commands for the software used for the creation of the statistical tree, better said.. for the definition and structure of the togetherness of possible attributes, sub-divided in classes, items and sub-items.

Access to the Statistic Attributes Settings

To access to the **Attributes Settings** section, the user must start from the main Archive window where the list of patients can be seen. There the user must select STATISTIC-SET from the TOOLS menu.

When the window of the **Attributes settings** is active, a main menu is given where the various functions are found. The menu consists of a tree structure, that allows the user to define and build a togetherness of possible statistic attributes, sub-divided in 3 levels (classes, items and sub-items).

Statistic - Attributes Setup Menu

When accessing the Statistics - Attributes settings section a main menu appears. Below the Statistics menu - Setup the user finds:

File, Options

File menu

Exit	this function allows the user to return to the Archive section
-------------	--

Options menu

View title of memo node	this function regards the type of representation of the nodes of memo type in the screen of Attributions of statistic parameters and of Statistical Elaboration. The function allows the user to choose if to view the title (fixed part) of the node of memo type as set by the description (variable part typed by the user) or not
View recording data in statistics	this function regards the type of representation of the selected attributes for the current file in Attribution of statistic parameters phase. The function allows the user to choose if to view the data that each statistic parameter was attributed to the current file

Construction of the statistical attribute tree

The functions here listed are to build and modify the tree structure of the statistical attributes. Respect to the current node:

- press the left mouse button and enter in the writing phase of the descriptive string of the node
- press the right mouse button, a menu appears that groups the functions for the structure of the possible statistical attributes

The items in the menu are:

Insert child: this function allows the user to insert a child to the pointed node

Delete node: this function deletes the pointed node and its children attached

Type of node: this function allows the user to define the type of pointed node, choosing between:

- **yes/no**, for a leaf node that can be alternatively selected or not
- **memo**, for a leaf node that can contain a variable description written by user
- **with children**, for a node that can have children

Child selection node: this function allows the user to define, for the pointed node, the child selection mode, choosing between:

- **single**, one child at a time can be selected, in Attribution of statistic parameters phase
- **multiple**, more children can be selected, in Attribution of statistic parameters phase

NOTE: the choice of the child selection mode is active only for nodes with a **child**.

The nodes at the third level are obligatory leaf nodes, therefore it is not possible to set **type of node 'with children'** or the **child selection mode**.

Functions **Insert child** and **Child selection mode** are allowed only for nodes of type **with child**.

Attribution of the statistical parameters

This section describes the functions and commands of the software used to classify, according to a desired group of attributes, of the pointed file.

Access to the attribution of statistical parameters

To access to the **Parameter Attribution** section, the user must begin from the main review window of the patient list and relative exams and file, point to a file (that desires to be catalogued according to the group of attributes) and therefore select STATISTIC ITEMS from the menu that appears pressing the right mouse button.

When the **Parameter Attribution** window is active, the user is asked to review the *group structured of all the possible statistical attributes* and the review of the *attributes already assigned to the current file*.

Keep in mind that the attributes belong to one of the 3 possible levels, called classes, items and sub- items. Consequently both the review of the possible attributes and the review of the attributes already assigned to the current file, represent a sub-division in levels. In particular:

- all the possible attributes are recalled and reviewed in a list, sub-divided according to the level of belonging (1 list per each of the 3 possible levels). Pointing to an element in the list if the classes (first level of the tree), the items and sub-items lists (second and third levels of the tree) are updated to view all the children of the pointed element in the list of the classes.
- the attributes assigned to the current file are represented in a grid, the first 3 columns represent the 3 possible levels. On option, it is possible to for see a fourth column in the grid, where the dates of attribution are shown of the various parameters of the current file.

Review of the group of possible statistical attributes

Keep in mind that the attributes belong to one of 3 possible levels, called classes, items and sub-items.

In phase of Parameter Statistical Attribution, all the possible attributes are recalled and viewed in a list, sub-divided according to the belonging level (1 list for every one of the 3 possible levels). Consequently, in the window of Parameter Statistical Attribution, 3 lists appear with useful things:

- a list that represents the classes (first level of statistics tree). Use the mouse and the keyboard with the arrows to select a class
- a list that represents the items (second level of statistics tree) that belongs to the selected class. Use the mouse and the keyboard with arrows to select an item
- a list to represent the sub-items (third level of the statistics tree) that belongs the selected item. Use the mouse and the keyboard for select and sub-item

Scrolling the list if the items, automatically is refreshed the list of the sub-items, that views the attributes of a third level that belongs to the selected item. Scrolling the list of classes, automatically are refreshed the lists of the items, sub-items, viewing the attributes of the second and third level that belong to the pointed class.

Symbols

Every element in the list of the classes, in the list of the items and in the sub-items list has a symbol that characteries the type of node, the selection mode and, if the type of node is yes/no or memo, if it is assigned to the current file or not.

The following symbols are used:

-  to characterize the nodes in which the type is **with children** and the possibility of **multiple selection** of children
-  to characterize nodes in which the type is **with children** and obstacle of **single selection** of children
-  to characterize nodes in which the type is **yes/no** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is not attributed* to the current file
-  to characterize node in which the type is **yes/no** and obstacle of **single selection** between nodes that belong to the same group; he node *is not attributed* to the current file
-  to characterize nodes in which the type is **yes/no** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is attributed* to the current file

-  to characterize nodes in which the type is **yes/no** and obstacle of **single selection** between nodes that belong to the same group; the node *is attributed* to the current file
-  to characterize the node in which the type is **memo** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is not attributed* to the current file
-  to characterize the node in which the type is **memo** and obstacle of **single selection** between nodes that belong to the same group; the node *is not attributed* to the current file
-  to characterize the node in which the type is **memo** and the possibility of **multiple selection** of nodes that belong to the same group; the node *is attributed* to the current file
-  to characterize the node in which the type is **memo** and obstacle of **single selection** between nodes that belong to the same group; the node *is attributed* to the current file

Review of the group of the attributes assigned to the current file

Keep in mind that the attributes belong to one of the 3 possible levels, called classes, items and sub-items.

In the phase of Statistical Parameter attribution, the attributed assigned to the current file are summed in a grid at 3 or 4 column, where

- the first 3 columns represent respectively the classes, items and sub-items
- on option, it is possible to for see a fourth column of the grid, where the dates of attribution of various parameters to current file are shown

In the 3 lists that represent the group of possible attributes, the assigned parameters to the current file are highlighted following these criteria:

- in every of the 3 lists, the attributes that do not have children in the levels below are signaled in **red** (that is in the tree structure corresponding to leaf nodes) and that have been assigned to the current file
- in the list of classes and of the items, attributes that have at least one child is signalled in **green** and has been assigned to the current file.

For example:

- if there has been a sub-item assigned to the current file, such sub-item appears in red in the list of the sub-items, while the items and classes that contain it are shown in green in their respective lists
- if there has been assigned an item to the current file, naturally the list of the sub-items will be empty, the item appears written in red in the item list, while the class that contains it is shown in green in the class list
- if there has been assigned a class to the current file, naturally in the items and sub-items list both will be empty and the class will be written in red in the class list.

Parameter attributions to a current file

Remember that it is possible to assign the current mask only attributes that have children, or that in the tree structure correspond to leaf nodes. Therefore:

- scrolling the class list, it is possible to attribute the parameters of type class (first level of the tree of the statistics) that do not have children and where the type is **yes/no** or **memo**.
- scrolling the list of the classes and relative items, it is possible to attribute the parameters of type item (second level of the statistics tree) that have not got children and where the type is **yes/no** or **memo**.

- scrolling the list of the classes, the items and the relative sub-items, it is possible to attribute all the types of parameters type sub-item (third level of the statistics tree), that do not have children and where the type is yes/no or memo.

Choose in the group of possible attributes that to be assigned to the current mask, or scroll the class list, eventually scroll the item list, eventually scroll the sub-items list in a way to find the corresponding element without children and types yes/no or memo. Using the left mouse button and with a double-click, the following results are obtained:

- for yes/no nodes, alternatively the attribute pointed is inserted or removed from the togetherness of the attributes assigned to the current mask
- for memo nodes, the user enters in the script phase of the description. According to the end of the description it is void or no, the pointed attribute is respectively removed or inserted in the group of attributes assigned to the current mask

Statistic Elaboration

This section describes the functions and commands of the software used for Statistical Elaboration, in particular, to individualise, between files or patients, a group of common characteristics.

Access to the Statistical Elaboration section

To access to the **Statistical Elaboration** section, the user must enter directly from the Archive section, where the list of patients is present and select STATISTIC-SEARCH from the TOOLS menu. When the window of **Statistical Elaboration is active**, some option grids are shown, each one that has been designed to group and manage a group of functions (settings of the research masks, filters, representation of the results and elaboration).

Research mask setting

Once the user :

- has programmed the group of possible statistic attributes, sub- dividing in various groups (called classed), each one containing 1 or more parameters, even organized in different levels (items and sub-items)
- has classified. according to a desired group of attributes, the patient files archived, that is those present in the database

it is possible to individualise, between the classified files, a group with common characteristics. This function is managed by the Statistical Elaboration module, with the aim to highlight eventual correlations (both positive and negative) between parameters available.

To individualise a group of files (between those classified) with common characteristics, the user must build masks, intended as folders that memorize research criteria, that is in which file conditions it must satisfy to enter in the group of interest.

This section describes the functions and commands of the software used for the building of such research masks.

Filter Settings

Once that the user points to the tab called **Filters**, in the window the following are shown:

- a popup menu that allows to choose a search mask between those available, or create a new mask. It is possible to type in directly in the text box internally, to attribute a title to the pointed mask.
- 2 checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the date of birth of the patient

- 2 checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the recording data of the file
- a popup menu that allows to limit the research only with particular types of files
- a checkbox that allows the user to choose if to manage the research at a patient or file level as explained previously

In the window there are present some buttons, associated to the following functions:

- **Research**, starts the research of the all the cataloged files, using the pointed mask and the current settings regarding the attributes, the research modes and the filters
- **New mask**, loads a new mask, it must be configured by the user (regarding the attributes, research modes, filters) before starting the research
- **Reload mask**, maintains the original configuration of the mask without saving any modifications made to the current mask,
- **Delete mask**, deletes the current mask
- **Cancel**, to exit from the Statistical Elaboration

Filter Settings for the current mask

For the current mask, it is possible to implore limits regarding the research dominion, introducing one or more of the following restrictions:

- limit the patient's date of birth inferior
- limit the patient's date of birth superiorly
- limit the date of file recording inferior
- limit the date of file recording superior
- limit the research only to particular types of files
- do not allow, in the result list of the research, the patient duplication, as said previously

If the user introduces one of the 4 limits, select the corresponding checkbox and set the desired data.

If the user would like to limit the research only to particular types of files, select the corresponding popup menu the items (one or more than one) corresponding to the types of files interest.

Regarding the duplication of the patient in the result list:

the aim of the research is to individualise a togetherness of files, between those cataloged, having common characteristics. In particular, if more files of the same patient have been cataloged and satisfy the research criteria, in the list of the results this patient appears more than once, as many times as the files are cataloged that satisfy the research criteria (*research file level*, is allowed the *duplication of patients* in the result list). If the user wishes that every patient appears more than once in the results list, the user must disable the corresponding checkbox (*research patient level* the *duplication of patients* is not allowed in the result list).

Search mode settings

Once that the user points to the tab called **Research**, the Attribution parameter statistic window appears having the following options:

If the user focuses on the popup menu that allows to choose the research mode for the current grouping, that is for all the attributes that have the same parent of the current node.

The research mode defines, for each group of attributes, the characteristics that the attributes assigned to a file must have to satisfy research criteria (that is if, for every group of attributes, a file can have *only an attribute* between those set, or if it must have them *all*, or if they have *all or no other*, or if they do not have *any of the attributes* set).

The 4 research modes available are:

- **at least one**, satisfy all the files cataloged that have, for the current grouping, *at least and attribute* between those set for the research
- **all or more**, satisfy all the files cataloged that have, for the current grouping, *all the attributes* between those set for the research, keeping in mind that the files can have even other attributes belonging to a grouping and not set in the research
- **only**, satisfy all the cataloged files that have, for the current grouping, *all and only the attributes* between those set by the research, in particular such files do not have other attributes belonging to the current grouping and not set for the research (different from the **all or more mode**)
- **none**, satisfy all the files cataloged that do not have, for the current grouping, *any of the attributes* between those set by the research

Research mode settings for the current mask

Once one or more of the attributes belonging to the same group, or having the same parent, have been assigned to the current mask, selecting one of these attributes in the corresponding list (of classes, items or sub-items) and then choose the research mode using the appropriate popup menu.

Repeat the operation for all the groups of attributes involved in the current mask settings.

Filter Settings

Once that the user points to the tab called **Filters**, in the window the following are shown:

- a popup menu that allows to choose a research mask between those available, or create a new mask. It is possible to type in directly in the text box internally, to attribute a title to the pointed mask.
- 2 checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the date of birth of the patient
- 2 checkboxes that allow the user to set eventual limits (lower and/or higher) regarding the recording data of the file
- a popup menu that allows to limit the research only with particular types of files
- a checkbox that allows the user to choose if to manage the research at a patient or file level as explained previously

In the window there are present some buttons, associated to the following functions:

- **Research**, starts the research of the all the cataloged files, using the pointed mask and the current settings regarding the attributes, the research modes and the filters
- **New mask**, loads a new mask, it must be configured by the user (regarding the attributes, research modes, filters) before starting the research
- **Reload mask**, maintains the original configuration of the mask without saving any modifications made to the current mask,
- **Delete mask**, deletes the current mask
- **Cancel**, to exit from the Statistical Elaboration

Filter Settings for the current mask

For the current mask, it is possible to implore limits regarding the research dominion, introducing one or more of the following restrictions:

- limit the patient's date of birth inferior
- limit the patient's date of birth superiorly
- limit the date of file recording inferior

- limit the date of file recording superior
- limit the research only to particular types of files
- do not allow, in the result list of the research, the patient duplication, as said previously

If the user introduces one of the 4 limits, select the corresponding checkbox and set the desired data.

If the user would like to limit the research only to particular types of files, select the corresponding popup menu the items (one or more than one) corresponding to the types of files interest.

Regarding the duplication of the patient in the result list:

the aim of the research is to individualise a togetherness of files, between those catalogued, having common characteristics. In particular, if more files of the same patient have been catalogued and satisfy the research criteria, in the list of the results this patient appears more than once, as many times as the files are catalogued that satisfy the research criteria (research *file level*, is allowed the *duplication of patients* in the result list). If the user wishes that every patient appears more than once in the results list, the user must disable the corresponding checkbox (research *patient level* the *duplication of patients* is not allowed in the result list).

Statistic search

Once the user has completed the setting of the research mask, such as:

- in the option tab **Research, Filters** or **Results** has chosen the mask to be used (between those available or pointing to a new mask)
- in the option tab **Research** has set the attributes needed
- in the options tab **Research** has set the search mode for each group of attributes
- in the options tab **Filters** has set eventual obstacles regarding the patient date of birth, the data of file recording, the type of file and the duplication of the patients in the results list

pressing the **Research** button in the options tab **Research** or **Filters**, starts the research between all the catalogued files, using the pointed masks and the current settings regarding the attributes, the research modes and the filters. The settings of the mask are saved are proposed again each time that the user recalls the masks.

The research results are shown in a grid of the options tab **Results**.

Result Representation of a statistical research

When the user points to the option grid called **Results**, in the window the following appears:

- a popup menu appears that allows the user to choose a search mask between those available, or to create a new mask. It is possible to directly type in the internal part of the textbox, in order to attribute a title of the pointed mask.
- a list, that views the results obtained with the current mask following a research

In the window the following buttons are present, associated to the following functions:

- **Research**, starts the research between all the files catalogued, using a pointed mask and the current settings regarding the attributes, the research and filter manners
- **New mask**, loads a new mask, where this must be user configured (regarding the attributes, the research and filter modes) before starting the research
- **Reset mask**, this function resets the modifications just done to the present mask and maintains the original configuration of the mask.
- **Delete mask**, deletes the current mask
- **Export**, exports the list of the results in a test file
- **Cancel**, to exit from the Statistical Elaboration section

Result Representation of a statistical research

The results are grouped in a grid, of 5 or 3 columns, depending whether or not duplicate patients are allowed described in the Filter Settings section.

If the research was done on the patient level, or the patient duplication is not permitted on the result list, the 3 columns show the last name, the name and the data of patient birth as long as the file catalogued satisfies the research criteria.

If the research was done on a file level, or the duplication of the patients in the result list is permitted, the 5 columns show the last name, name, the patient's date of birth, the recording date and the type of file catalogued that satisfies the research criteria.

Graphic Elaboration of the results

Once that the user points to the option tab called **Elaboration**, the window shows 3 framed structures:

- **Statistical Mask**, seen as a list gives the available masks for eventual elaboration
- **Statistical Graphs**, views the graph representation and comparisons between the masks.
- **Exportation**, allows the user to export any information (contained in the research masks) in a text file or Excel. The user must choose which are the fields of interest to be exported.

In the window other buttons are present: there are :

- **Export**, to export (in a text file or Excel file) the information the mask level said to be interesting (for example the mask title, limitations on the date of birth and recording date of the file , etc.)
- **Draw**, to trace a graph (correlation between the masks selected for statistical elaboration)
- **Copy**, to copy the graph in the notes and data that it represents

Selection of the mask for statistical elaboration

In the list the available masks for an eventual elaboration are viewed. Each line of the list shows the title of the mask and the number of patients or files found (depending on the type of research held, either patient level or file level as described in the Filter Settings section) on a total (respectively to patients or files).

Select from the mask list, by clicking on the corresponding line. The selected masks in this list are the base of the graphic representation of the results and the exportation operation of the information described in the following 2 paragraphs.

Statistical Graphs

Select the mask that the user would like to put in correlation (as described in the previous paragraph), choose in the correct popup menu the type of graph the user tends to trace (histogram, pie chart, etc.) and therefore press **Draw** to start the graph construction.

The **Copy** function allows the user to copy in another application, the graph and the data represented in it. The data and the graph are then copied on the clipboard , whatever is imported in the other application depends on the application itself (for example, recalling *Paste* from Excel only the data in the Excel sheet are copied; recalling *Special Paste* from Excel the graph is copied).

Exportation of the information contained in the masks

Select from the mask list those on interest. In the list of the possible information the mask level, choose which information to be exported. This choice occurs by clicking on the corresponding line to the desired information (for example the mask title, the limits on the dates, the number of records found, etc). Therefore the user must choose to export all the information on the text file or Excel file or not, by clicking in the corresponding checkbox. Press **Export** to execute exportation.

Statistic - Glossary

Statistic Attributes

Statistical attributes allow the user to catalogue the characteristics of every file of the archived patients.

In a preliminary phase to cataloguing and statistical elaboration, the user must program the group of possible statistical attributes, sub-dividing them in various groups (called classes), each one can contain 1 or more parameters, organized on different levels (items and sub-items).

Statistic research mask

In the statistical elaboration phase, the user can build and memorize research masks, moreover, folders that contain a series of general information that define research criteria.

Every mask memorizes information regarding the attributes to individualise, filters on recorded data and the type of file, the filters on the patient date of birth., etc.

Research modes for statistical attributes

All the attributes have the same parent and they are defined to the same group.

The research mode defines, *for each attribute group* (that is attributes with the same parent), the characteristics that the *assigned attributes to a file* must have to satisfy the research criteria (that is if, for every group of attributes, a file can have only an attribute between those set, or if it must have them all or none, or if does need any of the set attributes).

Child selection mode in the statistical tree

In the attribute settings phase, for each node of the statistical tree where the type is *with children*, the user defines the child selection mode choosing between:

- *single*, moreover more than one child at a time can be selected in Statistical Parameter attribution
- *multiple*, moreover more than one child can be selected at the same time in Statistical Parameter attribution .

Type of node in the statistical tree

For each node of the statistical tree, in the Attribute settings its type is defined, choosing between:

- *yes/no*, for a leaf node that, in Statistical Parameter attribution alternatively choosing between yes or no
- *memo*, for a leaf node that can contain a variable description, written by the user in the phase of Statistical Parameter attribution . In Attribute settings the *title* is defined, that represents the fixed part and can be seen, in the Statistical Parameter attribution and Statistical Elaboration, as prefixed to the description set by the user
- *with children*, for a node that can have children. The definition of children occurs in the Attribute settings phase. Three levels for the statistical tree, it is not possible to define this type for the nodes at the third level.

Annex - EMG Application Note

Electromyography

NOTE: this feature could be not available in your country.

SPONTANEOUS AND VOLUNTARY ACTIVITY STUDING

Clinic indications

This exam is used to study a muscle, we execute the exam with completely relaxed muscle and in a maximum contraction state.

In the first case we find the muscle cell spontaneous electrical activity, in the second case during their activations.

In non pathologic patient we never found electrical activity when muscle is completing relaxed.

In case of partial relaxation we can find some oscillation for motor unit; instead of this case we can find a lot of electrical activity in case of maximal contraction. Gradual is the step between electric silent and maximum electrical activity and this is an important element for pathologic diagnosis.

For example in muscle disease (primary, independent of nerve disease) we can found a lot of electrical activity also in little muscular contraction, while in nerve disease with secondary muscular suffering we have an electrical situation so poor also in maximal contraction endeavour. During voluntary activity studying is so important motor unit flash-over and there electric pattern morphology. For this reasons we develop a dedicated software that we illustrating later call Quantitative EMG and Motor Unit.

In complete relaxed muscle the spontaneous electric activity mean the patients have a muscular disease dependent of its nerve disease.

Typically this activity is low voltage and have two oscillation type, one biphasic and fast (Fibrillation) and the second slow and single phase (Jasper slow peak).

There are another type of activity we muscle is relaxed; the most characteristic is the myotonic flash-over call "Dive Bomber" for the particular sounds.

We have to talk about another type of muscular spontaneous activity, that depends by the activation of nerve fibre of the same muscle, it is called "fasciculation" and it depends by the flash-over of one or few motor unit together.



Voluntary activity recorded from triceps muscle and represented at 1mV/Div in 10ms/div

Acquisition parameters of spontaneous activity

- Channel numbers: 1-2
- Low filter: 16 Hz
- High filter: 5000 Hz
- Base Time: 100 msec -10 sec
- Signal Max: 3.2 mV
- Gain/Div: 50-100 microV/div

Acquisition Parameters of voluntary activity

- Channel numbers: 1-2
- Low filter: 16 Hz
- High filter: 5000 Hz
- Base Time: 100 msec – 10 sec
- Signal Max: 25.6mV
- Gain/Div: 1-5 mV/div

Acquisition Parameters of maximum effort activity

- Channel numbers: 1-2
- Low filter: 16 Hz
- High filter: 5000 Hz
- Base Time: 100 msec – 10 sec
- Signal Max: 25.6mV
- Gain/Div: 1-5 mV/div

Work modality

We execute the exam with the parameters above and using needle electrodes. Concentric needle electrodes have the derivation point consistent by external cannulae and another by an internal thread, isolated by cannulae and with the termination facing the needle point level.

The electrode point have oval surface where the circumference is constitute by the external cannulae and internal thread. The recording zone depends by the size of this surface; it is very restricted and limited at few motor unit space.

This is very important because if needle isn't accuracy insert in the muscle you haven't got a correct acquisition of it's activity.

We can recording voluntary muscle activity also with surface electrode but we must positioning it in precise zone above the muscle.

In this case we record the electrical activity of a large part of the muscle but this is reduce in amplitude and filtering by the distance between the source of signal (muscular cell) and recording area (electrode). We have to remember that between source and active electrodes we have a conduction with low impedance but with an elevate volume licage. We can't record complete spontaneous activity with surface electrode because it have low voltage and the signal is to much low to be recorded.

In addition to needle electrode or a couple of surface electrode to have to connect to the patient also a ground electrode. It' s important that the impedance between the skin and the electrodes or ground tape is much low as possible, especially when we record spontaneous activity with needle electrode.

Needle electrode is one of the most sensitive point out device because it present an high impedance input constituting by the thread and the cannulae.

MUAP Analysis

MUAP analysis is an extension needle EMG examination, this functions allows users to Analyze Motor Unit Action Potentials. The application software allows users to perform this kind of examination in a full range way, manual, semiautomatic and full automatic.

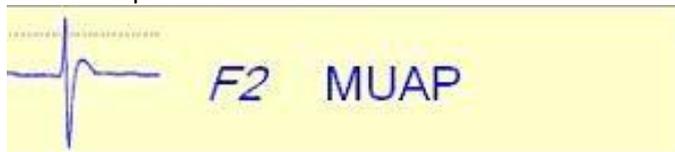
Acquisition Parameters

- Channel numbers: 1
- Low filter: 5 Hz
- High filter: 5000 Hz
- Base Time: 200 msec
- Signal Max: Auto
- Gain/Div: 150 μ V/div

Work modality

MANUAL MUP

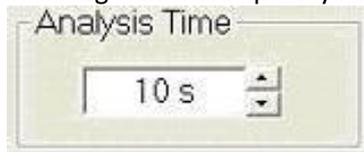
This function allows users to select by himself all the motor unit want to Analyze. To perform this examination you can run Needle EMG exam than select MUAP analysis or directly by MUAP dedicated protocol.



You have to select the side and the muscle you are about to record. Select Manual MUP analysis by pressing dedicated button

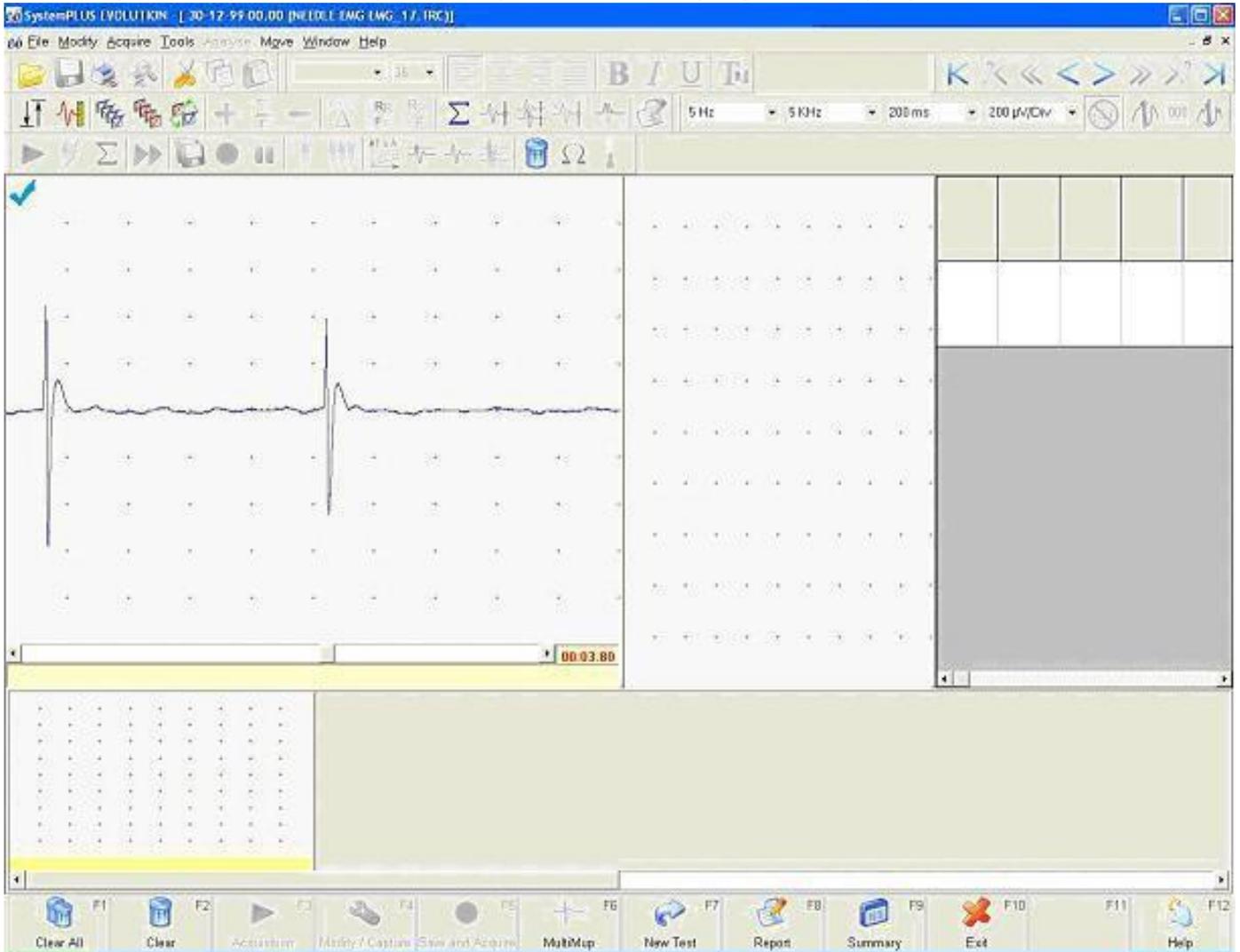


The length of trace epoch you will Analyze is settable by following field

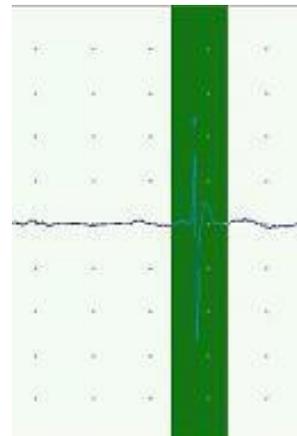


To start recording, press space bar or acquisition button on the keypad-10, when 5/10 seconds

epoch is acquired, the acquisition stop and automatically begin the analysis process



to select MUAP you want to Analyze activate measure cursor by pressing dedicated icon

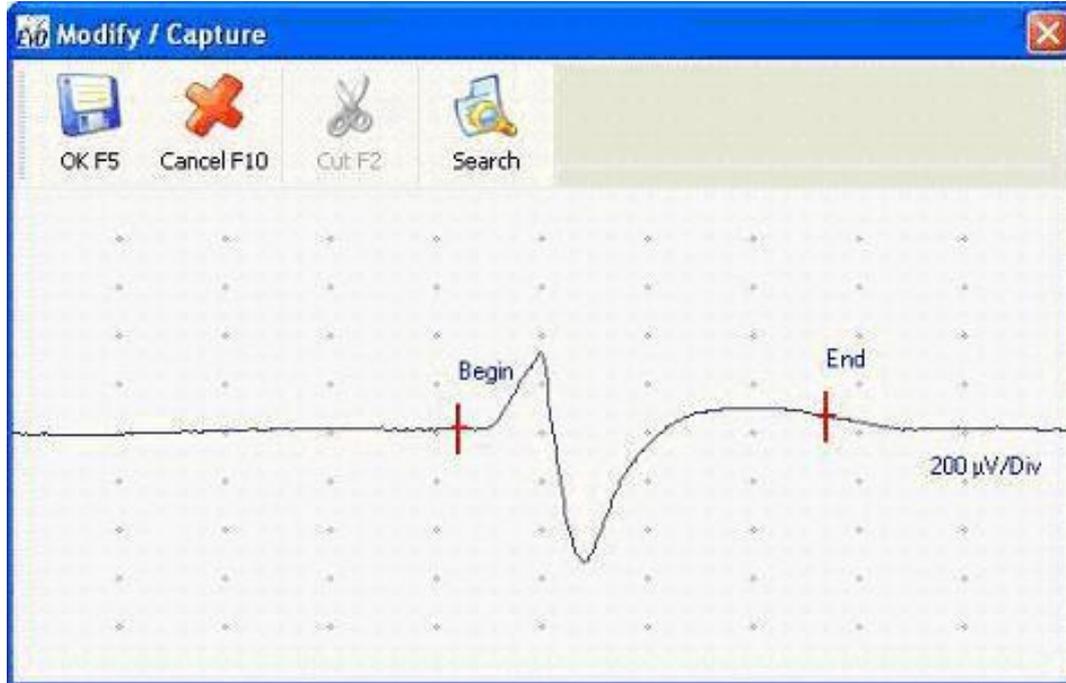


a green band identify the portion of trace you want to Analyze,



Now by pressing **Modify / Capture** button you will open a new windows that zoom on the MUP

where you can adjust the begin and the end of the potential.



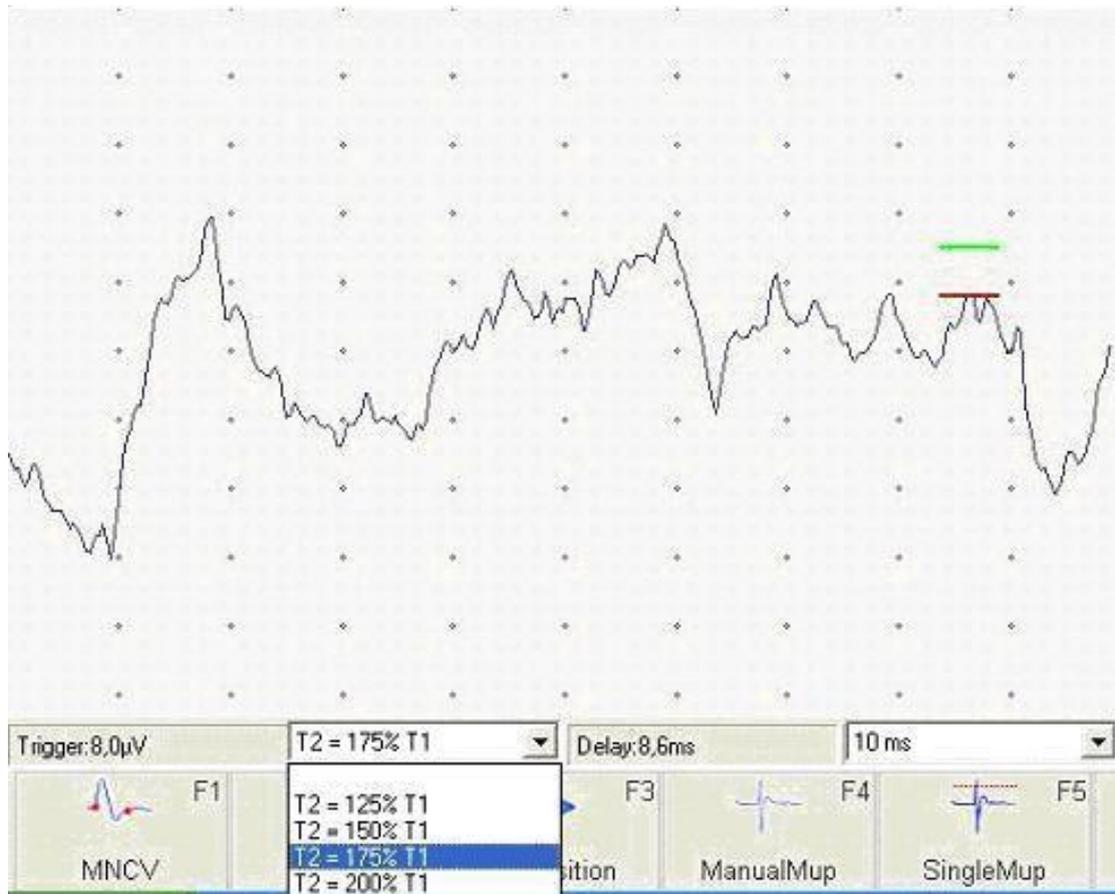
Users have now three different options:

- **Search:** system automatically looking for all action potential, similar to the selected one, present in the trace saved and store and measure all
- **Cut:** system delete the potential selected
- **Ok:** system save and measure only the potential selected

SINGLE MUAP

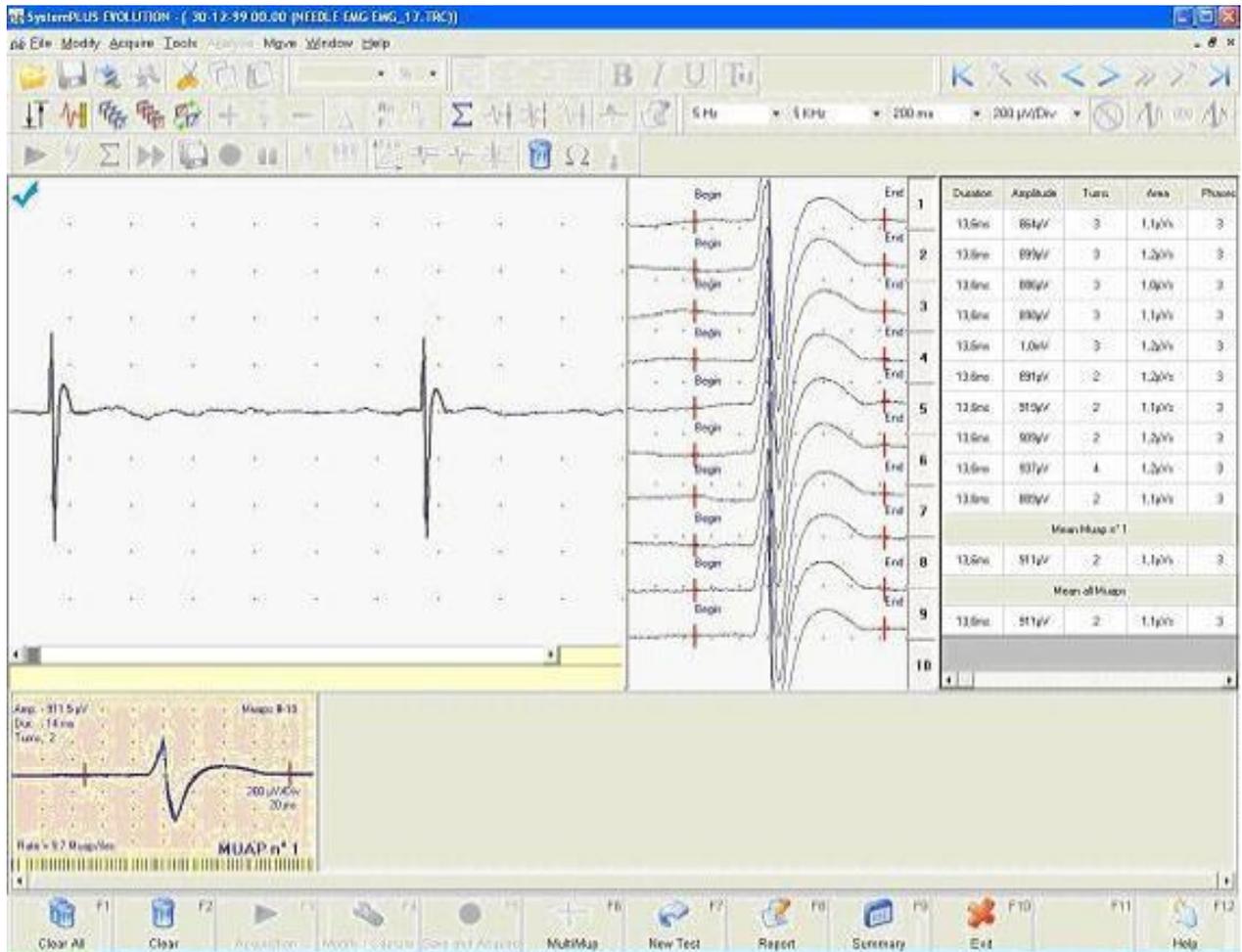


To perform this kind of analysis you have to press on Single MUAP button and system set a new windows with a trigger threshold to triggering potential you want to capture. You can chose same different kind of trigger, the default one it' s just a threshold, in the way show below you can choose



a double trigger and system capturing the 10 MUAP between the green and the red trigger threshold, MUAPs that do not fullfit trigger criteria are excluded from the capture.

To capture the MUAPs triggered press space bar or acquire button on the keypad-10, and appear the following windows



To go back on the acquisition windows to perform a new capture press F5 save button



Repeat the procedure for all potential you want to acquire.

MULTIMUP



To perform this analysis press MultiMUP function button **MULTIMUP**, system automatically detect and select all MUAP that find out in the trace, in any case user can add MUAP did' t find by the MULTIMUP analysis using the same instruction explained in Manual MUP function.

MUAP RESULT TAB

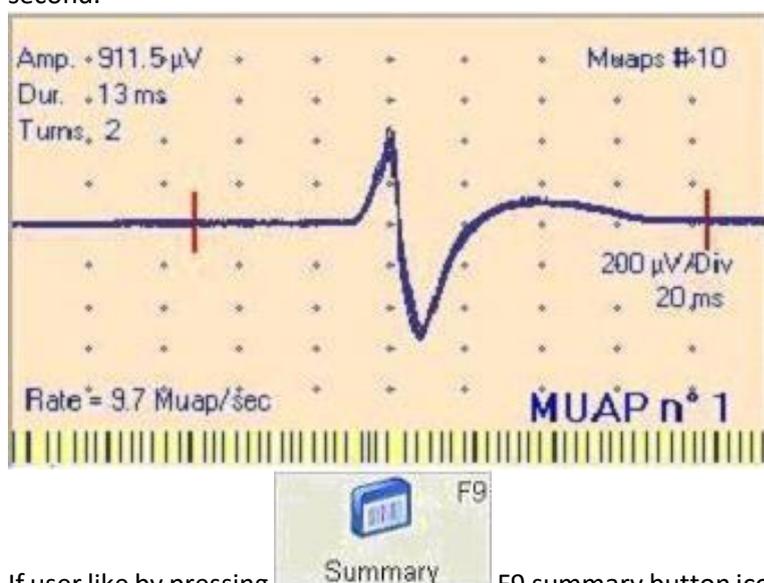
Following is showing the tab that report the result of MUAP analysis, with the mean of the MUAP selcted and the mean of all MUAP captured.

On the tab below is reported all data user need to evaluate the MUAP characteristics.

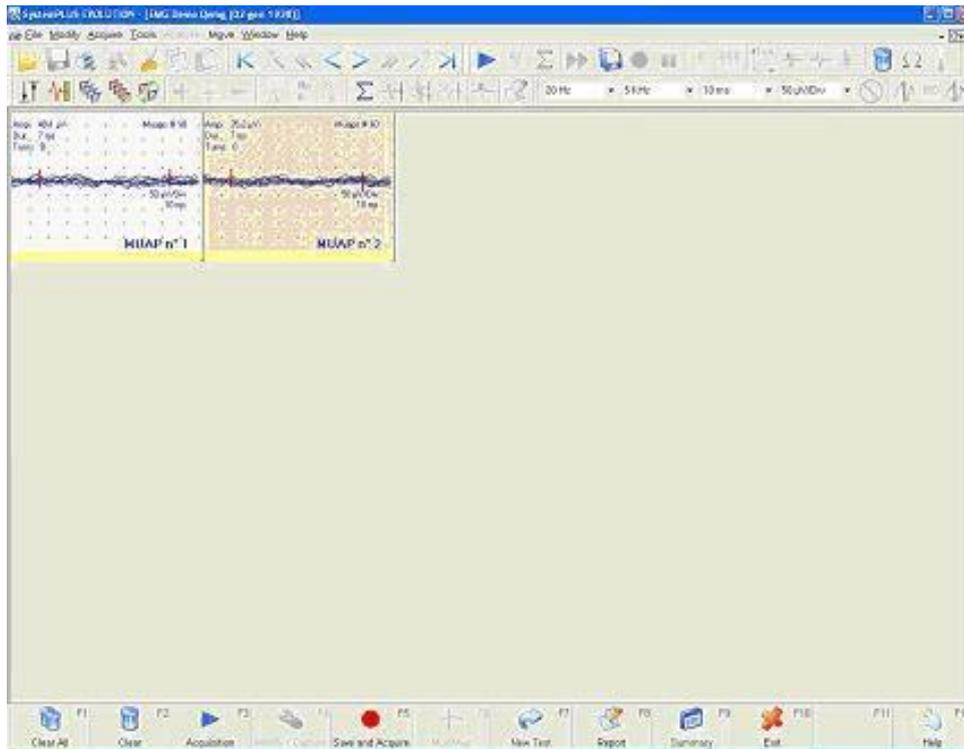
Duration	Amplitude	Turns	Area	Phases	Traces
13,6ms	864µV	3	1,1µVs	3	1
13,6ms	899µV	3	1,2µVs	3	1
13,6ms	886µV	3	1,0µVs	3	1
13,6ms	898µV	3	1,1µVs	3	1
13,6ms	1,0mV	3	1,2µVs	3	1
13,6ms	891µV	2	1,2µVs	3	1
13,6ms	919µV	2	1,1µVs	3	1
13,6ms	909µV	2	1,2µVs	3	1
13,6ms	937µV	4	1,2µVs	3	1
13,6ms	889µV	2	1,1µVs	3	1
Mean Muap n° 1					
13,6ms	911µV	2	1,1µVs	3	10
Mean all Muaps					
13,6ms	911µV	2	1,1µVs	3	10

On analysis windows you can also view a dedicated windows that show the single group of MUAP acquired, you have a different windows for any group acquired.

On the cell you have also reported Amplitude, duration, number of turns and rate of MUAP per second.



If user like by pressing Summary F9 summary button icon you have a panoramic view that allows user to see all MUAP captured in the same windows.



Electroneurography

NOTE: this feature could be not available in your country.

SENSORY CONDUCTION VELOCITY

Clinic Indication

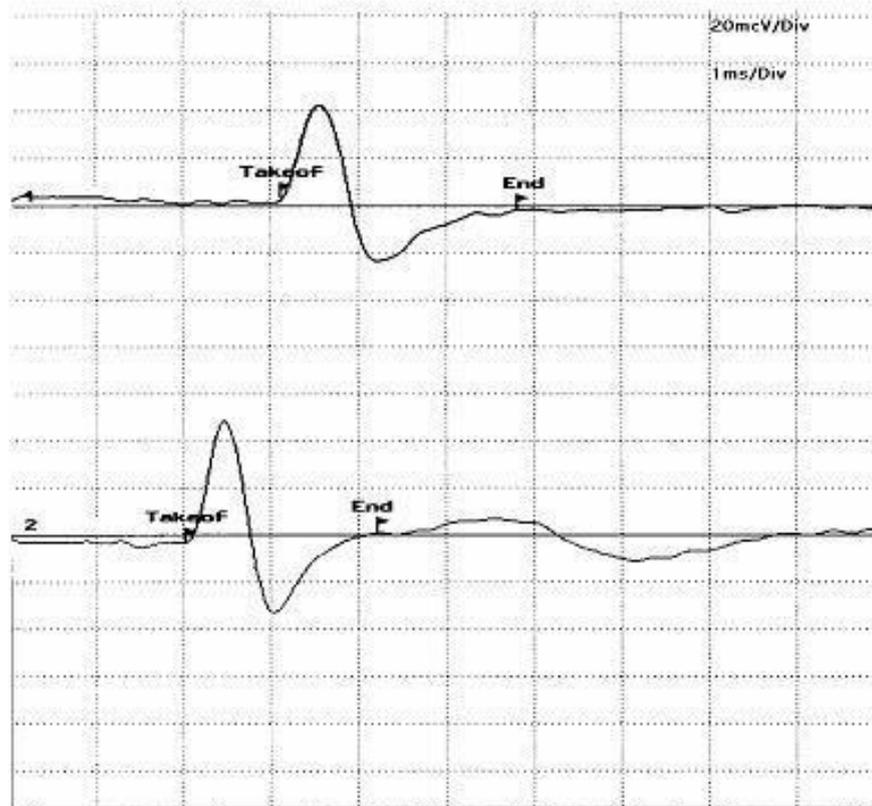
In electromyography chapter an important section is neurography, the most important, and essential aspect is the studying of nerve function with sensory conduction velocity (SCV).

To calculate SCV you need to be able to record electric potentials generated by signal transit through the nerve .

The nerve is constituting by a lot of filament (axons) along each of these ones can propagate an electric impulse (Action Potential). The action potential has a low voltage and can be recorded only with electrodes directly positioned on the nerve. In order to don't damage the nerve using needle electrodes, to record the action potential signal, are used cup electrodes but stimulating more axons to potentiate the signal and cleaning the base activity potential (noise) with the synchronized average technique.

Stimulating the nerve in a point and recording the signal in another point distal or proximal indifferently, after a latency time, the nerve potential is derived as described above. Now, knowing the distance between the stimulating and the derivation point, and knowing the transmission time, we can obtain the SCV only assuming the absence of a delay time between the stimulation time and the activation of the nerve action potential. This isn't absent but it's relatively low to be neglected for every SCV. It couldn't be neglected if the distance is small.

Usually SCV is calculated on short nerve paths; frequently it's executed stimulating on a finger and recording on the wrist, with a distance of about 9-12 cm. The two stimulation and the two derivation electrodes have a distance of 2-3 cm. So it's important to know the point of stimulation and to which derivation point is referred a point on the signal response. Usually the stimulation is near the cathode area and the first peak on the response, typically biphasic, is referred to the electrode nearest to the stimulation area. The distance has to be calculated between cathode and the derivation electrode nearest to this one, and the propagation time is measured between the beginning of the trace and the first peak of the sensitive response.



VSC in the median nerve stimulating on the wrist and derivating on the III and I finger.
VSC calculated 41.7m/s e 52.1m/s.

Anti-dromic stimulation

Orto-dromic stimulation

Electrodes positioning

The S response (sensitive) can be recorded in several nerves. The recording electrodes have to be positioned over the nerve to be Analyzed.

This response must be studied in an orthodromic sense depending if the stimulation is distal or proximal to the derivation point (see the pictures). On the orthodromic response you stimulate in a nerve point and you record in a proximal position along the usual direction of sensitive fibres.

It's preferable to place the ground near the stimulating point, between the stimulating and the recording area, but there can't be a direct connection between this one and the other electrodes. Because of the small distance between the electrodes and the ground, there can be a short circuit caused by the presence of water or conductive paste, generating artefacts.

To have a high signal quality the electrodes impedance should be less than 5 K Ω and balanced between the different electrodes. In order to have a small stimulus artefact it's important to have a low contact impedance of stimulation electrodes too.

Stimulation

The stimulation intensity is regulated to be felt by the patient without pain, but it can't be too low especially if you have to evaluate the response. So you have to stimulate with an intensity sufficient to have a maximal response without activating other nervous structures different to the nerve examined.

The stimulus duration can be short (100 micros), but not shortest if you don't want to increase the stimulation intensity. Average intensity of the fingers stimulation are 8-12mA, for the wrist nerves (median and ulnar) 6-10 mA, for the sural nerve 30-40mA.

Acquisition positioning

Number channels: 1

Low filter: 20 Hz

High filter: 2000 Hz

Base Time: 10 - 50 msec

Max Signal: 400 microV

Gain/Div: 20-100 microV/div

Averaging: 20-40 means

Work modality

On the VSC plan, after the electrodes application, and after inviting the patient to be relaxed in order to avoid the generation of electromyographic activity, you begin the stimulation with a low intensity (4-5 mA) increasing the intensity until the impulse is felt by the patient and the sensitive response is clear on the trace. Then begin the average calculation, that let to have a sharp signal. Usually are sufficient 20-40 averages to have a good signal. The absence of the sensitive response isn't a safe index of a nerve alteration. Another cause of failure in the recording, is the incorrect derivation end/or stimulation electrodes positioning. It's sufficient not to be perfectly over the nerve area to haven't any response or to have a small signal, so it's important to know the anatomy.

MOTOR CONDUCTION VELOCITY

Clinic indication

The motor nerve study is simplified by the presence of a physiologic signal amplifier of this nerve: the muscle. We can stimulate a motor nerve and see its response without using the electromyograph. Until a few years ago tests were executed using stimulators and were created signals analysing the response in its muscle with different stimulation intensity, signals very important to estimate the presence of nervous alterations.

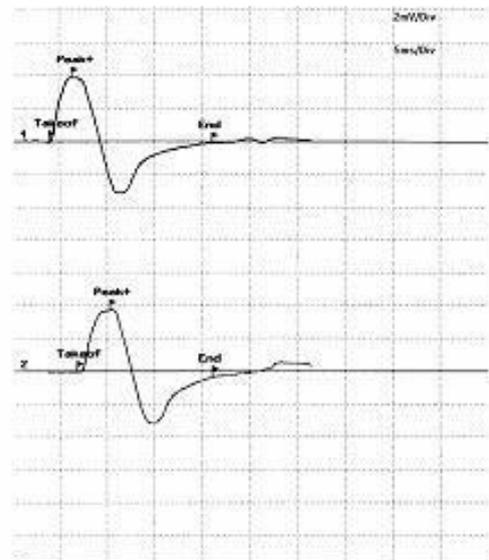
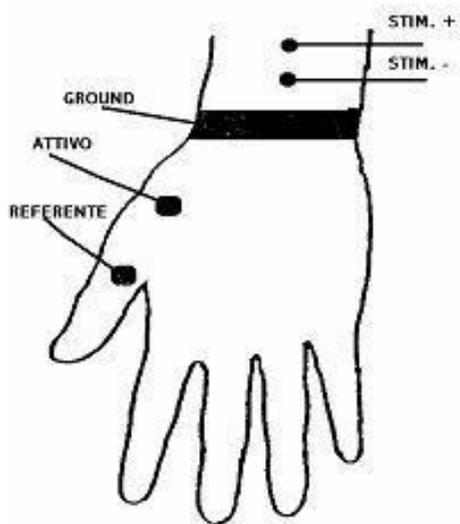
Stimulating and recording the response in a muscle we can notice a latency time which depends to two factors: the action potential propagation on the nerve and the signal diffusion from nerve to the muscle. The first one depends to the conduction velocity and to the nerve length, the

second one is constant for every nerve-muscle pair. This second time is about of 3-4 msec. It isn't impossible measure the motor speed conduction (VCM) stimulating only in one point because we don't know the latency time in the neuro-muscular transmission.

To have a good motor speed conduction estimate, the nerve must be stimulated in two points. The distance to be measured is between the two stimulation points, while the propagation time is obtained by the latency time difference of the two motor response. The distance-propagation time ratio give VCM between two stimulation points in the nerve considered. This operation can be made in more point through the nerve, so it can be explored from the spinal marrow to the periphery.

This exam is useful to have other clinic information as the distal latency time, the motor response amplitude and duration, that give some indications about the condition of the motor nerve local branches, of the neuromuscular plate, and of the muscle.

VCM can be calculated recording with cup electrodes end also with needle ones. With the first one, muscular response are with a high voltage and a simple morphology (bi or tri-phasic), with the second one, voltage is low and morphology is more complex. This difference is caused by the different electrodes position and this observation can be made for the voluntary activity observation too. If we want to have a general estimation about the muscle we'll use cup electrodes, while if we need to have a more detailed knowledge of the motor conduction, we use needle electrodes.



*VCM in two points applied on median nerve stimulating on the wrist and on the elbow
VCM calculated 51.3m/s*

Electrodes positioning

M wave can be recorded in several muscles. The recording electrodes have to be positioned so that the active one is placed on the center of the muscle and the reference on a remote area, far from the muscle.

It's preferable to place the ground near the stimulating point, between the stimulating and the recording area, but there can't be a direct connection between this one and the other electrodes. To have a high signal quality the electrodes impedance should be less than 5 KΩ and balanced between the different electrodes.

It isn't important to take particular devices to have a good signal because M wave has a high

amplitude.

Stimulation

Electrodes have to be positioned on the motor nerve with the negative one placed near the recording point.

The stimulation intensity has to be supra-maximal (just over the response stabilization level), and the duration has to be short, at most 100 micros. The intensity values are about 10-15mA for the wrist nerves (median, ulnar), 40-50 mA for the same nerves on the elbow and on the armpit, 60-70 mA for the nerves on the supraclavicular and 20-40 mA for the nerves on the foot and on the poplite (sciatic, internal and external poplite).

Acquisition parameters

Number channels: 1

Low filter: 20 Hz

High filter: 2000 Hz

Base time: 50 msec

Signal max: 25.6 mV

Gain/Div: 1-5 mV/div

Average: you need a single shock

Work modality

Once about motor conduction studies, the nerve is stimulated in two or more places. The patient must be in a relaxed and comfortable position and will be advised that he will feel only a shock not dolorous, but a little tiresome. Then you begin analysing the nerve, beginning with the place nearest to the stimulation point with a stimulation intensity that generate a supra-maximal motor response. You continue recording the signal (knowing the signal amplitude it isn't necessary doing averages of more signals), then you continue recording in the next point.

About every response are measured these parameters:

- Latency calculated on the deflection point of the base line.
- Amplitude measured peak to peak, or from positive peak to base line;
- Response area;
- Duration from the initial deflection point to the point of coming back to the base line;
- Morphology, that can be polyphasic in some pathological situations.

Watching the picture above, stimulating the nerve in two different points (wrist and elbow) we'll have two different latency times. Both values will have two components: the conduction time of the signal from the stimulation point to the end of the nerve, and neuromuscular transmission time. The difference between the value of the latency nearest to the recording point (proximal) and the latency value of the more distant one (distal) is the time spent by the stimulus to run the nerve path between the two stimulation points. If we measure the distance between the two stimulation point and we divide it with the time already calculated, we'll find the maximal signal conduction velocity in the Analyzed path. The formula used is:

$VCM (point\ 2 - point\ 1) = \frac{Length\ path\ point2 - point1}{(time\ of\ beginning\ point2 - time\ of\ beginning\ point1)}$

H REFLEX

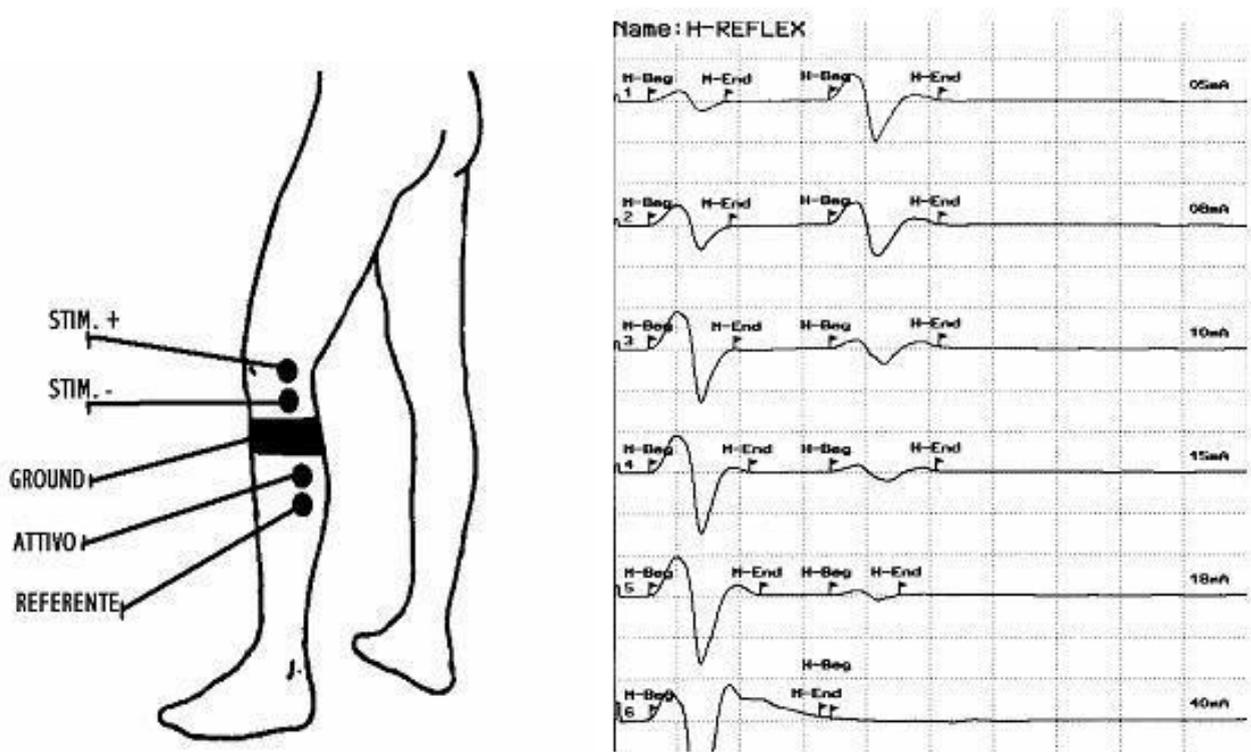
Clinic indication

This exam has a specific indication for the study of the first sacral root sufferance. H reflex (Hoffman reflex) consists of recording the motor reflex response (H) from soleus or gastrocnemius muscle by stimulating the nerve in the popliteal fossa. In this muscle the M response appear with a latency of 4-5 msec, as in other muscles when you stimulate the corresponding motor nerve. Then, after 32-38 msec, appears another motor response, which is the consequence of the muscle contraction caused by a reflex mechanism. After an initial stimulation of sensitive axons of sciatic nerve, there is an activation of nervous cells and its axons

create the motor contingent of sciatic nerve.

The sciatic nerve in the popliteal fossa has both sensitive and motor fibres. Sensitive fibres have a stimulation threshold lower than motor one. So if we stimulate this nerve with a low intensity and we gradually increase it, we'll have initially a stimulation only of sensitive fibres and then of motor ones too.

With low stimulation intensity we usually have only H reflex, because through the sensitive fibres and its indirect connection with motor cells, we activate the motor axons and the muscle connected. In this case the stimulus path is long: from poplite to back at lumbar level and then to poplite and sural muscle. The time to run this path is long. If we stimulate the motor fibres too, we have a rapid response, which is the direct motor response. With high stimuli intensity we have only the M wave and not the H one, because of the reflex suppression. In each sufferance of root S1 (through S1 pass a lot of the fibres that take part of sciatic nerve) the consequences are disappearing of H response or a decreasing in the prevalence of H wave with low stimulation



H reflex obtained with derivation in soleus muscle

intensity.

Electrodes positioning

H reflex can't be recorded in every muscle. The point in which it's easier to have this response is the soleus muscle as represented in the previous picture. The recording electrodes have to be positioned so that the active one is placed on the center of the muscle and the reference on a remote area, far from the muscle.

It's preferable to place the ground near the stimulating point, between the stimulating and the recording area, but there can't be a direct connection between this one and the other electrodes.

To have a high signal quality the electrodes impedance should be less than 5 KΩ and balanced between the different electrodes.

Stimulation

The stimulation electrodes must be positioned on the nerve that innervate the muscle. On the popliteal fossa you have to find the exact stimulation point of sciatic nerve with the lower current intensity. It's sufficient a little lateral electrode shifting to lose the stimulation.

Acquisition parameter

Number channels: 1
Low filter: 20 Hz
High filter: 2000 Hz
Base time: 100 msec
Max Signal: 25.6 mV
Gain/Div: 1 - 5 mV/div

Work modality

You begin with a zero stimulation and you increase it until the disappearing of H reflex that has a lower threshold than M wave. At this time you acquire about ten waves fixing a stimulation rate of 0.5 Hz and increasing the stimulation intensity of 1 mA until the disappearing of H reflex and the identification of M wave.

After the acquisition ending it's important to study the variation of H reflex and M wave amplitude, with the variation of stimulation intensity.

F WAVE

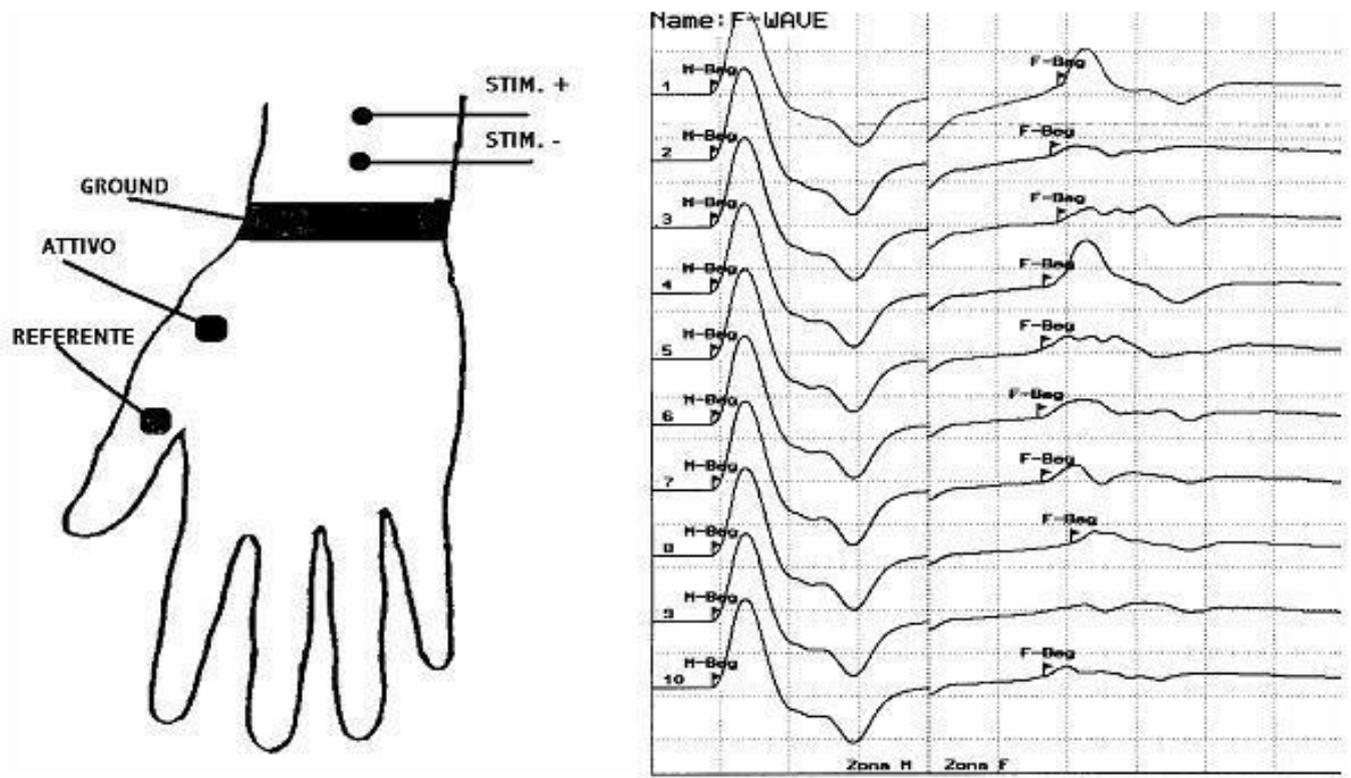
Clinic Indication

This valuation is a part of the VCM study, because it let us to have its estimate in nerve segments that usually aren't explorables with a classic VCM. F wave is a motor response (linked to the muscle stimulation) and is caused by an action potential feedback on the nervous fibre with a mechanism like an eco.

Stimulating the motor nerve in a random point we have two action potential series, one that goes from stimulus point to the muscle and the other from the stimulation point to the nervous cell positioned in the spinal marrow. The first one generates the M response; the second one dies in the spinal marrow and doesn't generate any evident effect. If any action potential directed to the cell succeed in to excite again the motor axon, we have a new muscle stimulation with a latency time that is bound by the time spent by potential to run the path from stimulation point to the marrow and then to the muscle.

The F wave absence isn't a pathology sign. About sharp F wave, that are with a lower voltage than M response, is important to calculate its temporal dispersion. A temporal dispersion or a latency increasing is the signal of a VCM slowing down. We have to compare the latency time obtained with the normal ones, that are different depending to the muscle examined, to the stimulation point and to the patient height, indeed, depending to the distance from the stimulation point and the motor spinal center on a side, and to the muscle on the other one.

To calculate the proximal VCM, that is from the stimulation point to the medullar motor center, you have to calculate the distance between this two points, and divide it with half time between the M and F wave.



F wave recorded stimulating the median nerve.

Electrodes positioning

F wave can be recorded in several muscles. The recording electrodes have to be positioned so that the active one is placed on the center of the muscle and the reference on a remote area, far from the muscle.

Is preferable to place the ground near the stimulating point, between the stimulating and the recording area, but there can't be a direct connection between this one and the other electrodes. To have a high signal quality the electrodes impedance should be less than 5 KΩ and balanced between the different electrodes.

Stimulation

Electrodes have to be positioned on the motor nerve with the negative one placed near the recording point.

The stimulation intensity has to be supra-maximal (just over the response stabilization level), and the duration has to be short, at most 100 micros. The intensity values are about 10-15 mA for the wrist nerves (median, ulnar), 40-50 mA for the same nerves on the elbow and on the armpit, 60-70 mA for the nerves on the supra-clavear and 20-40 mA for the nerves on the foot and on the poplite (sciatic, internal and external poplite).

Acquisition parameters

- Number channels: 1
- Low filter: 20 Hz

High filter: 2000 Hz
Base time: 50 – 100 msec
Max signal: 25.6 mV
Gain/Div: 1 - 5 mV/div

Work modality

Are usually acquired 10 consecutive signals and about these is important to know the M and F wave latencies.

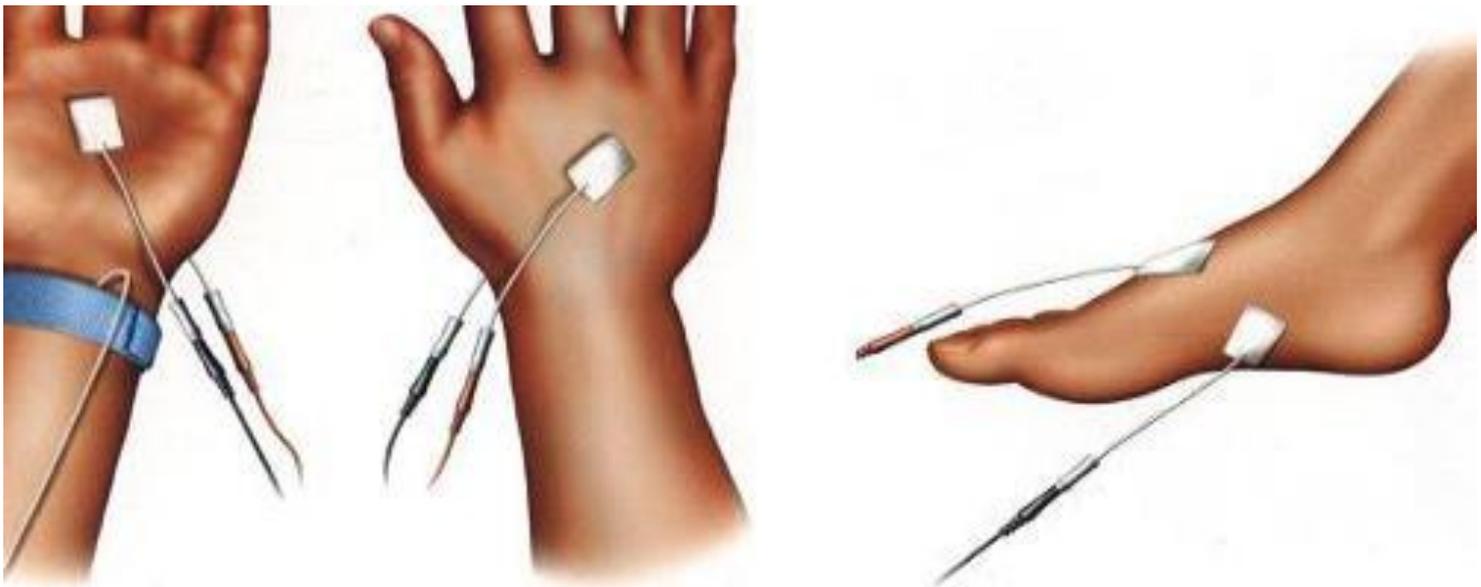
The F wave isn't always present in all the signal recorded and it's usually 10 times lower than M wave, so the two signals are presented with two different amplifications: one for the M wave zone and one for the F wave.

SSR - SIMPATIC SKIN RESPONSE

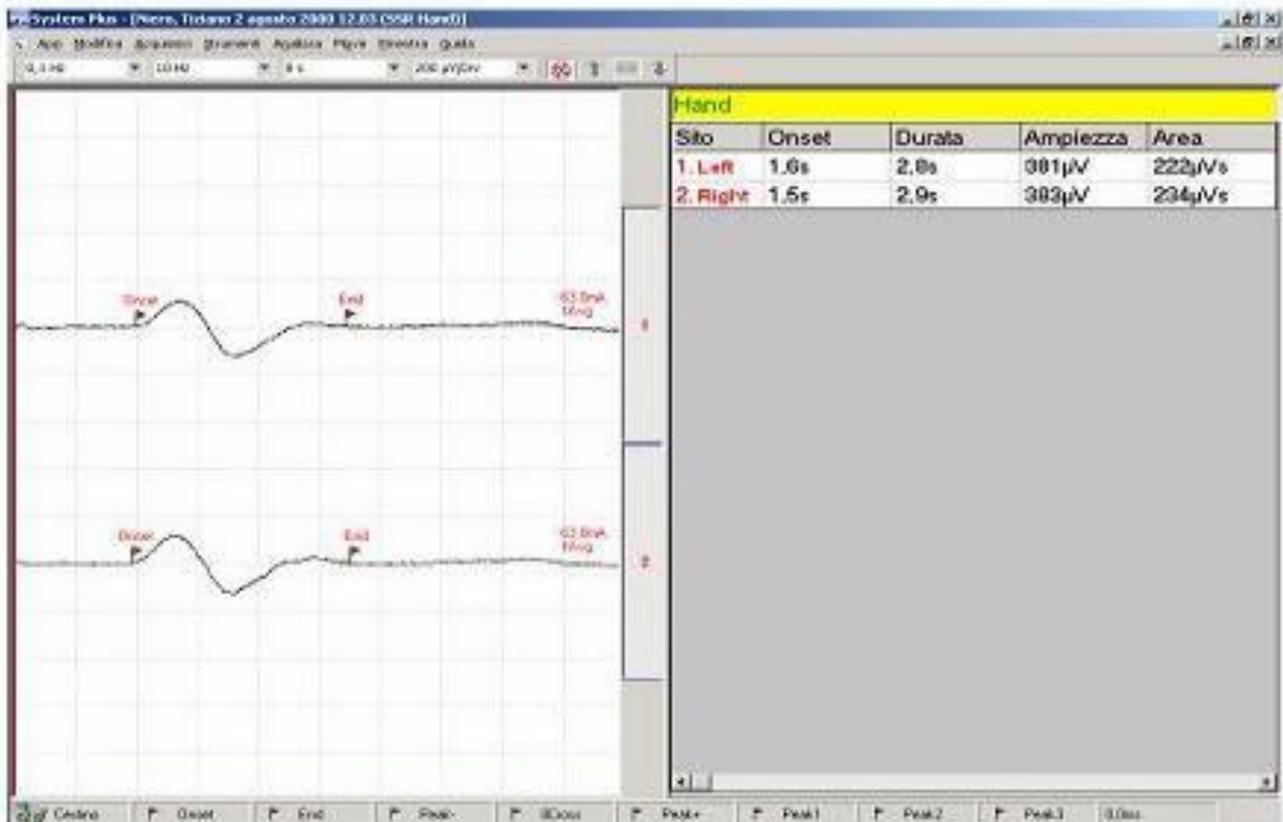
Clinic indication

It's an exam that became important about ten years ago and it's important especially for diabetic patients diagnostic.

The recorded electric response is caused by contact impedance changing after variations generated by sweat glands innervated by sympathetic nerve fibres.



Electrodes positioning for SSR on hand or on foot



SSR traces recorded on the 2 hands

Electrodes position

Response is recorded at limb extremity:

1. When you record on the hands active electrodes (Negative = Black) are placed on the palm and reference one on the dorsum of the hand.

2. When you record on the foot's active electrodes (Negative = Black) are placed on the sole of the foot and referenced against the skin or dorsum of the foot.

The ground electrode is positioned on the wrist of the hand stimulated.

Stimulation

Stimulation can be of different types: electric, auditory, visual, tactile and thermal. The most commonly used is the electric one, but auditory is frequent too.

It's important that stimulation must be unexpected by the patient in order to create a sort of "fright" and a different condition of sweat cells.

Acquisition parameters

Number channels: 1 - 4

Low filter: 0.7 Hz

High filter: 10 Hz

Base time: 8 sec.

Max signal: 25.6 mV

Gain/Div: 1 mV/div

Work modality

Observing the SSR program, after electrodes positioning and when you invited the patient to be relaxed to avoid a strong electromyography activity, you select a 30-40 mA intensity (if you use electric stimulation) and then you begin recording stimulating unexpectedly the patient on the wrist.

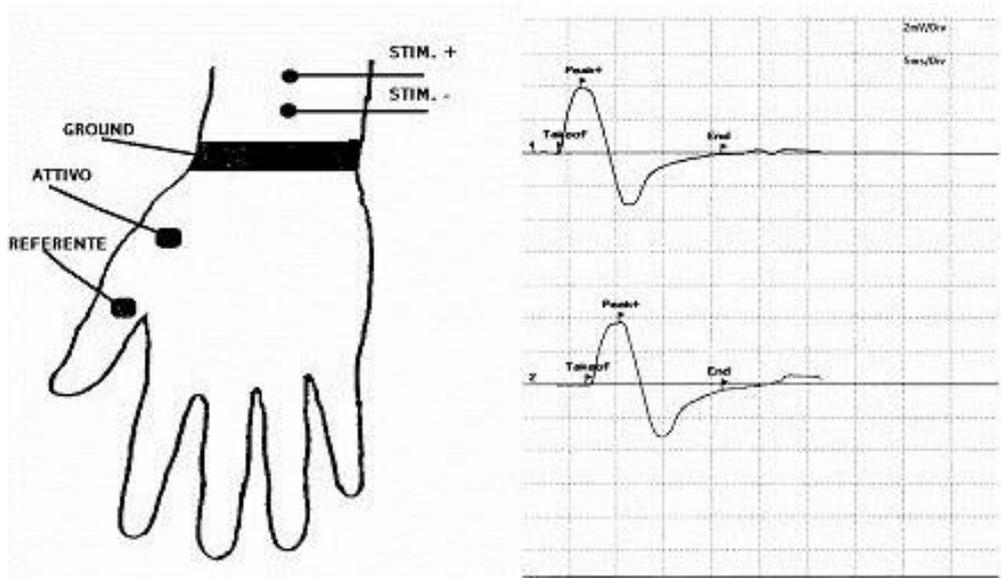
Response is a slow mono or biphasic variation with a latency time of about 1-2 seconds. Latency, amplitude and area are the most commonly used parameters.

MUNE Motor Unit Number Estimation

Clinic indication

MUNE is a non-invasive, electro physiologic method to estimate the number of motor neurons innervating a muscle or group of muscles. The relation between the size of the CMAP and the geometrical arrangement of the muscle fibers allowed you to estimate the number of motor units present. The ability to quantitatively estimate the number of surviving motor neurons is useful in the following area:

1. clinically for diagnosis of neuromuscular disorders
2. as an end point measure in clinical drug trials for lower motor neuron disorders
3. as a tool to obtain insight into the natural history and pathophysiology of lower motor neuron disorders



Motor unit number estimation of median nerve

Electrodes positioning

M wave can be recorded in several muscles. The recording electrodes have to be positioned so that the active one is placed on the center of the muscle and the reference on a remote area, far from the muscle.

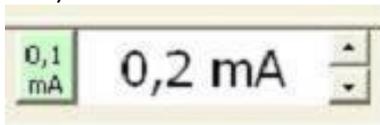
It's preferable to place the ground near the stimulating point, between the stimulating and the recording area, but there can't be a direct connection between this one and the other electrodes. To have a high signal quality the electrodes impedance should be less than 5 KΩ and balanced between the different electrodes.

Stimulation

Electrodes have to be positioned on the motor nerve with the negative one placed near the recording point.

The stimulation intensity has to be supra-maximal (just over the response stabilization level), and the duration has to be short, at most 100 micros. The intensity values are about 10-15 mA for the wrist nerves (median, ulnar), 40-50 mA for the same nerves on the elbow and on the armpit, 60-70 mA for the nerves on the supraclavear and 20-40 mA for the nerves on the foot and on the poplite (sciatic, internal and external poplite).

Action potentials are picked up from a muscle when stimulating its nerve at one site. The operator increase the intensity of the stimulus until a maximal response is obtained and then further increases it to assure supramaximal stimulation. This gives the maximal M-wave area, where all muscle fiber conducts. The intensity is reduced to just above threshold and the recording is stored. Increase the intensity until a slight increase in area is obtained (to perform this operation more precisely you can switch the intensity scale from 1 mA step to 0.1 mA step by clicking following icon)

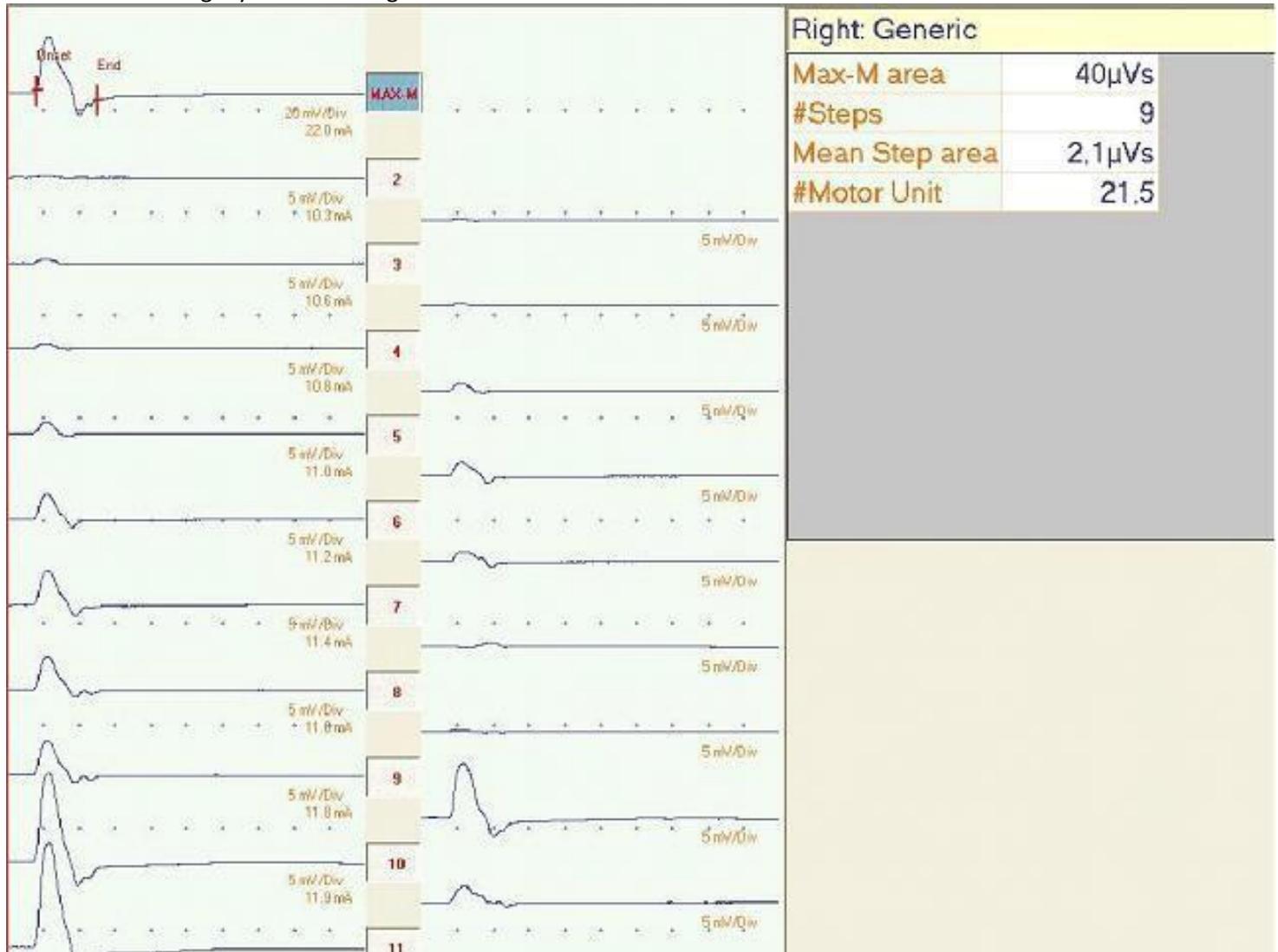


the difference from the previous AP acquired is displayed continuously in the central part of the screen, by turning the intensity down and up slightly, the increase should disappear and appear. Store the recording when it's difference. The estimated number of motor unit is displayed, base

upon the max M-wave area and the mean area increase. Continue recording bigger and bigger M-wave until the estimated number of motor units becomes constant. The result you will had it's the following in the figure below.

Acquisition parameters

- Number channels: 1
- Low filter: 20 Hz
- High filter: 2000 Hz
- Base time: 50 msec
- Signal max: 25.6 mV
- Gain/Div: 1-5 mV/div
- Average: you need a single shock



Single fibre

Single-fiber electromyography (SFEMG) is a selective EMG recording technique that allows identification of action potentials (APs) from individual muscle fibers. The selectivity of the technique results from the small recording surface (25 µm in diameter), which is exposed at a port on the side of the electrodes, which is 3mm from the tip fig. 1

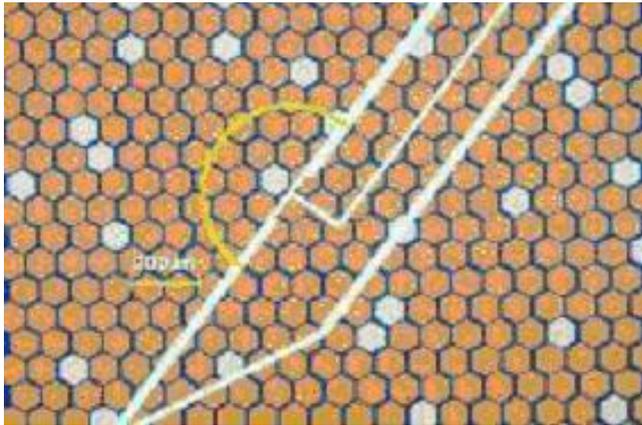


Fig. 1

The selectivity of the recording is further heightened by using a high pass filter of 500 Hz. Identification of Aps from individual muscle fibers by SFEMG uniquely allows measurement of 2 features of the motor unit: fiber density and neuromuscular jitter. The amplitude of the AP recorded with a SFEMG electrode from an average muscle fiber decreases to 200 μ V when the electrode is approximately 300 μ m from the muscle fiber. Thus, we can infer that APs greater than 200 μ V arise from muscle fiber within 300 μ m of the recording surface. By measuring in many sites within a muscle the mean number of time-locked APs that have an amplitude greater than 200 μ V and rise time of less than 300 μ s, we calculate the fiber density, which quantifies the local concentration of muscle fibers within the motor unit. This provides information that is analogous to type grouping in muscle biopsies.

As the patient voluntarily activate the muscle, the electrode is positioned to record with maximum amplitude the AP from one muscle fiber. APs are recorded in 20 separate sites within a muscle, usually via 3 separate insertion sites. The fiber density (FD) is the mean number of APs, including the triggering AP, counted in these 20 sites (Fig. 2). The normal FD is different among different muscles and increases in adult older than 60 years, especially in distal muscles.

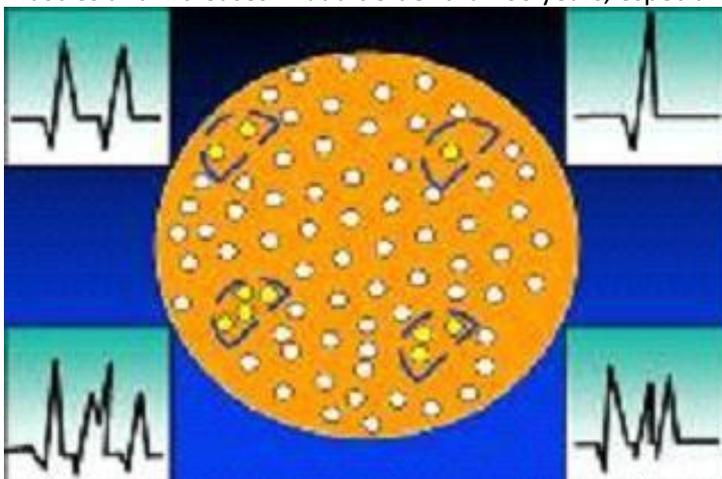


Fig.2 Diagram of single fiber density measurements in single fiber electromyography (SFEMG). Semicircle represent the recording territories of the SFEMG electrode when it is positioned to record, respectively, the signals in the adjacent outer quadrants of the figure.

When APs elicited by nerve stimulation are recorded with an SFEMG electrode, the latency from stimulus to response varies (Fig. 3). This variation is the neuromuscular jitter, most of which is produced by fluctuations in the time for end plate potentials at the neuromuscular junction to reach the AP threshold.

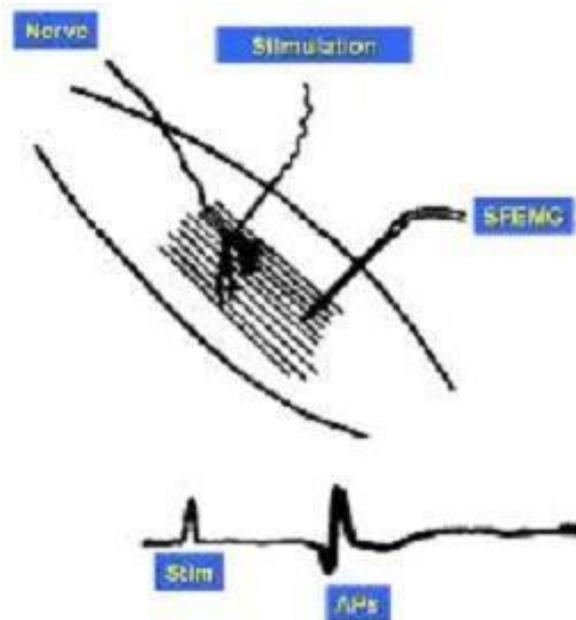


Fig. 3 Electrode setup for single-fiber electromyography (SFEMG) during intramuscular axonal stimulation. The stimulating electrode is inserted into the muscle near an intramuscular nerve fiber, and the recording electrode is inserted distally near muscle fibers innervated by this nerve. During repetitive stimulation of the nerve, the latency between stimulus and action potentials (APs) varies among successive responses (the neuromuscular JITTER).

When the SFEMG electrode is positioned to record from 2 or more muscle fibers in one voluntarily activated motor unit, the neuromuscular jitter is seen as variations in the time interval between pairs of Aps from these fibers. This paired jitter represents the combined jitter in 2 endplate.

Jitter may be measured either as the nerve is stimulated or as voluntarily activates the muscles.

AXONAL Stimulation:

- The motor nerve may be stimulated proximally to its entry into the muscle, or individual motor nerve branches may be stimulated within the muscle.
- The former technique is ideal for activating facial muscles, since individual branches of the facial nerve can be stimulated with a monopolar needle electrode.
- If a surface electrode is used for stimulation, many motor units usually are activated, making identifying the responses of single muscle fibers difficult.
- Some artefactual jitter may be introduced by variations in the intensity of the stimulus that reaches the individual motor nerve fiber, especially when surface stimulation is used.

VOLUNTARY Activation:

- Jitter measurements performed during voluntary activation if the muscle are less subject to technical problems that can lead to misinterpretation of the results. However, this technique requires more patient cooperation than stimulation jitter studies.
- As the patient slightly contracts the muscle, the SFEMG electrode is inserted into the muscle near the endplate zone; it is positioned to record 2 or more time-locked APs from the same motor unit (Fig. 4 - 5)

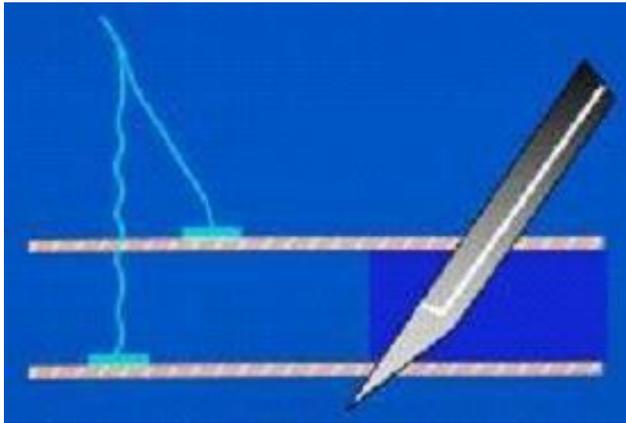


Fig. 4 Recording position of the single-fiber electromyography electrode during jitter analysis with voluntary muscle activation. The electrode is positioned to record action potentials (APs) from 2 muscle fibers that are innervated by the same motor nerve fiber.

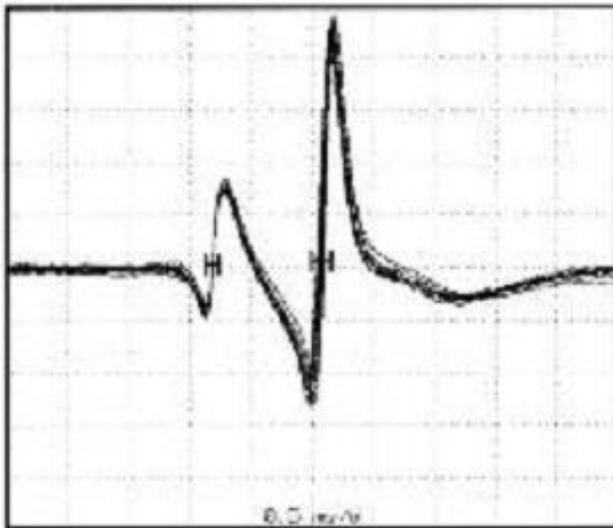


Fig. 5 Single fiber electromyography. Action potentials recorded from 2 muscle fibers with normal jitter during voluntary muscle activation. Ten consecutive discharges are superimposed. The EMG system is triggered by the rising portion of the first potential, which falls at the same position with each discharge. The second potential falls at slightly varying among successive discharges, demonstrating the neuromuscular jitter.

- The amplitude of the APs are optimized by slightly adjusting the electrode position; in the best recording position for jitter measurements, all APs of interest should have sharply rising phases and adequate amplitudes.
- APs should be measured from 20 potential pairs and recorded from different portions of the muscle, using 3-4 skin insertions.

The jitter is expressed as the mean value of consecutive differences of successive interpotential intervals (MCD) Fig. 6

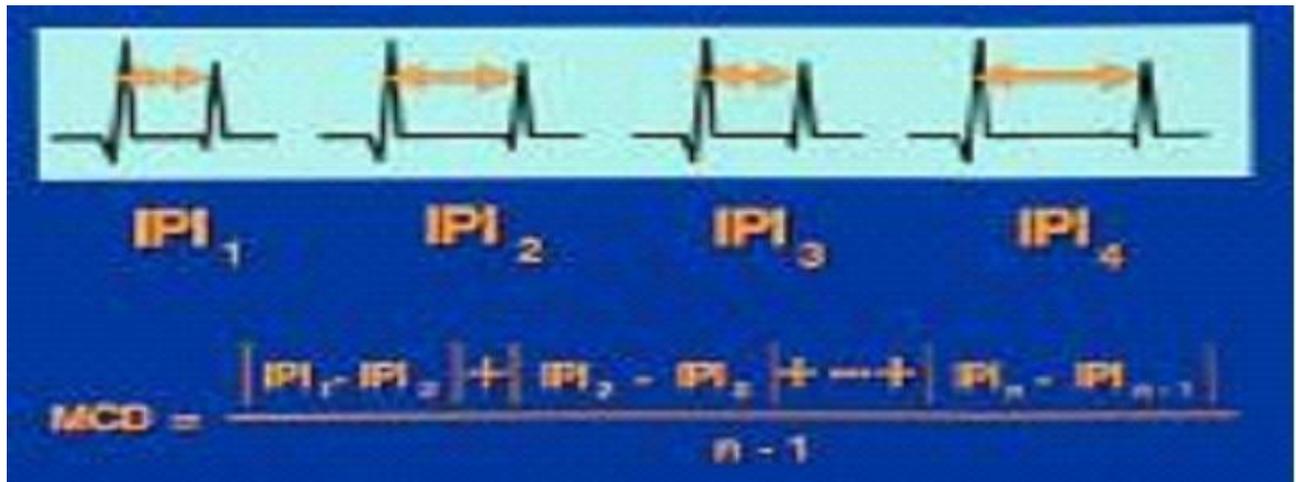


Fig. 6 Calculation of the mean difference between consecutive discharges (MCD). IPI is the interpotential interval or stimulus-to-response latency during axonal stimulation jitter analysis.

- Jitter is increased whenever the ratio between the AP threshold and the endplate potential is greater than normal; thus, it is a sensitive measure of the safety factor of neuromuscular transmission.
- The normal mean MCD value varies from 10-50 μs among different muscles.

With more pronounced disturbances, impulses to individual muscle fibers intermittently fail to occur, producing neuromuscular blocking. Only when blocking occurs is clinical weakness or a decrement on repetitive nerve stimulation tests noted. In certain situations the interpotential interval (IPI) may be influenced by the preceding interdischarge interval (IDI), which may introduce an additional variability due to the velocity of AP propagation in the muscle fibers.

- This isn't a problem with stimulation jitter studies using a constant stimulus rate, if the first 10 intervals of each train are excluded from the jitter calculation.
- The effect of preceding depolarizations becomes constant at that point, provided non impulse blocking is present to produce an irregular discharge rate.
- The effect of variable firing rates (when jitter is measured during voluntary activation) can be minimized by sorting the IPIs according to the length of the preceding IDI, than calculating the mean of the consecutive IPI differences in the new sequence. The result is called the mean sorted-data difference (MSD)
- If the MCD:MSD ratio exceeds 1.25, then variations in the firing rate have contributed to the jitter; the MSD should be used to represent the neuromuscular jitter. The MCD is used to express the jitter if the MCD:MSD ratio is less than 1.25.

There are three different way to show Jitter analysis:

- The mean or median value of the MCD values in all the pairs or endplates that are measured.
- The percentage of paired potentials or endplates in which blocking was seen.
- The percentage of pairs or endplates in which jitter exceeded the normal limit for that muscle.

The mean MCD may exceed normal limits when a few individual jitter values are extremely high.

- To avoid this, jitter values greater than 150 μs may be excluded from the mean calculation, or the median MCD may be used to express the central tendency of the data.
- In normal muscle, the mean and median MCD value are the same.

Reference jitter values have been determined for many muscles.

- Jitter increases slightly with age in normal subjects

- A study is abnormal if the mean (or median) jitter exceeds the upper limit for the muscle than 10% of pairs or endplates have increased jitter or blocking.

Jitter less than 5 μ s is seen rarely in voluntarily activated SFEMG studies in normal muscle and more often in myopathies.

- These low values probably result from recordings that are made from split muscle fiber branches of which are activated by a single neuromuscular junction.
- These value should not be included in assessments of neuromuscular transmission.

The MCD value that is measured during axonal stimulation is less than that measured during activation of the same muscle; the latter comes from only single endplates.

Reference values for jitter during axonal stimulation have been determined for the extensor communis (EDC) and orbicularis oculi muscles.

- For other muscles, the normative values for stimulation jitter can be obtained by multi values for voluntary activation by a conversion factor 0.8
- MCD values less than 5 μ s that are obtained during stimulation SFEM occur when the fiber is stimulated directly; these values should not be used for assessing neuromuscular transmission.

The electromyographer must have considerable experience with SFEMG to be able to perform studies on most patients. EMG machines incorporate automated jitter analysis technics greatly reduce analysis time.

Most adult patients can cooperate for adequate SFEMG studies. Patient discomfort rarely limits the use of this test, even when several muscle must be examined.

If the patient has a tremor, making adequate recording from distal arm muscle during voluntary activation may be impossible. In such cases recording usually can be made from facial or more proximal arm muscles. Alternatively, recordings of jitter can be made during axonal stimulation.

Concentric needle Single-Fiber electromyography

Several recent studies have examined the quantitative evaluation of neuromuscular transmission using disposable concentric needle electrodes (CNE).

- A larger recording area results in potentials that are easier to acquire.
- This larger area is more likely to produce recordings with overlapping pairs.
- The overlapping pairs, along with contributions from more distant motor units within the recording area, probably results in an underestimation of the true jitter value.
- The several studies available suggest that the specificity may be similar to recordings performed with a single-fiber electrode. However, CNE studies are a less sensitive measurements of neuromuscular transmission.
- No normative exist for this method.
- CNE studies cannot measure fiber density.

An abnormal CNE-SFEMG is useful in supporting the diagnosis of myasthenia gravis. A normal study result does not adequately reduce or eliminate the possibility of a defect in neuromuscular transmission.

Single-Fiber Layout and Setup

All parameter and value concerning Single-Fiber examination we had considered above is show in Tab in Fig. 7. The tab below is compiled automatically by the software when you insert the component of the signal acquired by drag and drop technique on clicking on component icon

	Mean	Site 3
		Comp 1
Responses	100	94
MCD	102,1µs	101,7µs
MSD	110,2µs	112,1µs
MIPI	0,8ms	0,5ms
SD IPI	104,4µs	92,8µs
MIDI	181,5ms	80,4ms
SD IDI	116,7ms	9,0ms
Blocking	4,0%	0,0%
MCD/MSD	0,93	0,91

Fig. 7 this tab showing all parameters that single-fiber program calculating.

Lines

Number of Visualization Lines:	10
Number of Acquisition Lines:	100
FiberDensity	<ul style="list-style-type: none"> Jitter Jitter Fiber Density

On single fiber–lines-protocol setup (Fig. 8) you can also chose what you want to investigate Jitter or Fiber density. Like you have read before you can't measure fiber density without a single fiber needle.

When you had chose the exam you want to execute (FD or Jitter) you will proceed to do the examination. To capture the APs you have to press SPACE BAR – PEDAL – ACQUIRE in keypad 10, and system automatically proceed to capture the potential or the stimulation triggered. Obviously the program made an Automatic comparison between the APs triggered and the other one and will make a selection based on the similitude between them. Now you will have 100 APs acquired and you need to insert the component like show in Fig. 9 for voluntary muscle activation.

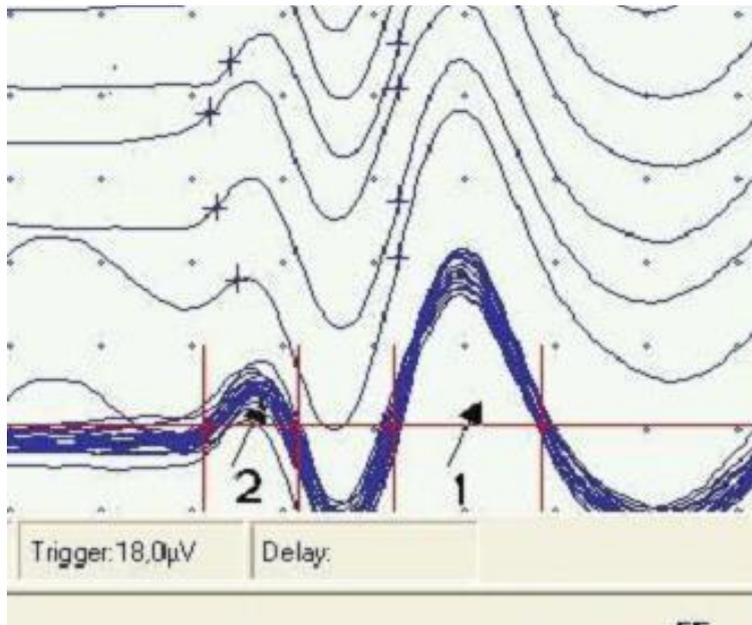


Fig. 9 In this figure you can a group of APs acquired like you can see we acquired the signal triggering the second component instead the first one because had a better definition. Triggering the first, second or third component doesn't change results of the examination. Concerning axonal stimulation (Fig. 10) you will proceed exactly in the same way except because you have to activate stimulation (pressing F4 or Stimulation Button on the keypad) to give the stimulus that generate the APs. The method it's exactly the same and in case show below we obtained 4 component.

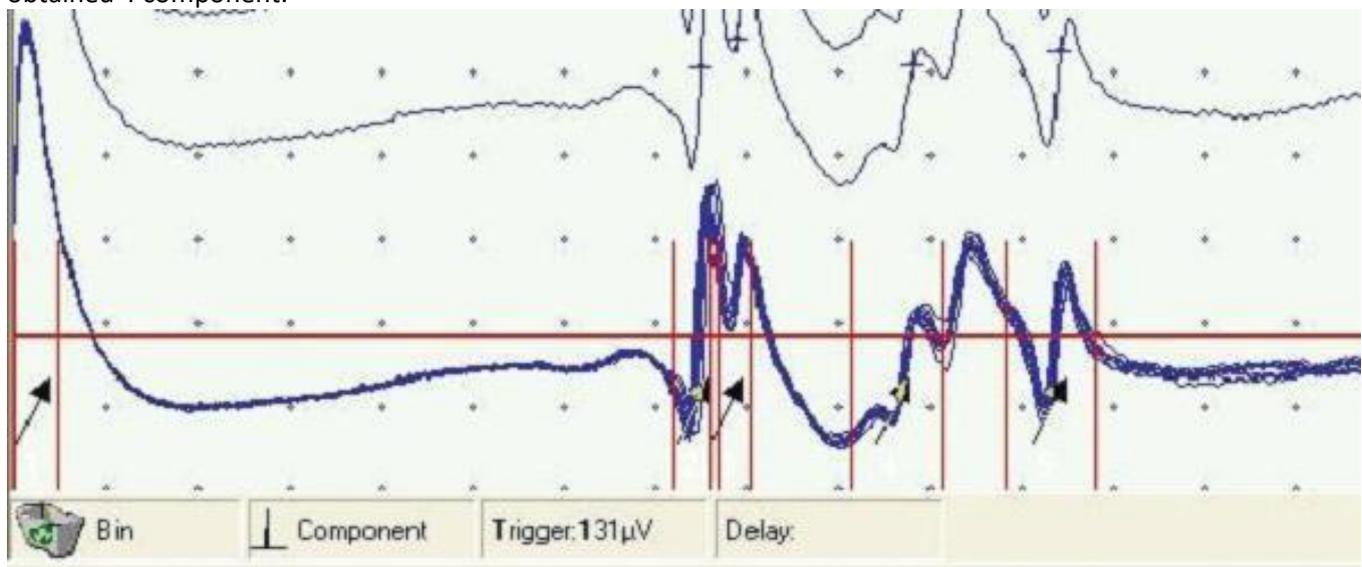


Fig. 10 The First one it's obviously is stimulus and the other 4 it's the APs we obtained. The analysis method is exactly the same and also component insertion.

Annex - EP Application Note

Evoked Potentials

NOTE: this feature could be not available in your country.

Evoked potentials (EP) are bioelectric signal generated by the activation of specific nervous paths as a consequence of a stimulation. Since nervous paths are located deeply and far from the recording points, the EP signal has a very low amplitude (few V) an it is almost covered by other bioelectric signals like EEG, ECG, muscular activity and sorrounding electromagnetic noise. In order to get the EP signal, it is very important to:

- connect the electrodes in the exact locations as defined by the literature (note the electrodes are often quite far each other in order to permit to catch the deep nervous electrical activity),
- use the synchronized average technique,
- get patient collaboration (if awake), in order to beat down artefactual activity.

Practical experience is another important factor to obtain a good signal; quality of the examination mostly depends on technician experience and patient collaboration, rather than on the quality of the recording machine.

Here below, general rules and precautions are described in order to execute different EP recordings.

Synchronized average

Synchronized average is a technique used to extract an electrophysiological signal, evoked by a stimulus, in a situation where this signal is hidden by noise or different electrophysiologic signals (electric waves with a low signal/noise ratio). The technique consist in averaging the recordings immediately following a trigger condition, often related to a stimulation. The system should know the exact times the stimulations are delivered in order to distinguish between the patient response correlated to the stimulus and the uncorrelated electrophysiological or noisy signal.

In order to improve the quality of the evoked potentials and to reduce the time requested to obtain a good evoked potential, the acquisition system does not take in consideration the slices of recording whose recorded values are higher than a defined threshold level (also called rejection level). The rejection level should be set to some V (generally from +/- 40 to +/- 80) in order to exclude artefacts caused by patient movements, eye blinking, ECG signal, and so on...

Signal/noise ratio it the parameter used to evaluate the quality of an EEG/EP recording, higher values mean the "important" signal is clearly distinct from thebackground noise. Applying the synchronized average technique, the signal/noise ratio increases following the square root of the number of averaged signals. As an example, it increases 30 times by averaging 1000 traces, it increases only 10 times more (40 times) by averaging 2000 traces. If EEG traces have a main activity at 50 microV, after 1000 averages the residual activity will be 1.6 microV, thus permitting to identify an evoked potential of 5 microV. but not sufficient to identify an brainstem evoked potential, which often has amplitudes lower than 1 microV.

Normally, for practical reasons, average is split in 2 or 3 trials (as an example: 2400 averages are divided in 3 groups of 800 stimulations each). At the end of each trial, the EP is saved and compared to the result of the other trials. All EPs obtained by the different trials must be similar each other: EP reproducibility indicates the good proceeding of the test. Take also care, the more the stimulations, the more the brain adapts to them, thus reducing the amplitude and modifying the shape of the evoked potential (adaptation).

Recording place and patient condition

The awake patient has to be relaxed and resting, in order to reduce the electrical activity caused by muscular contraction and movement artefact. Patient collaboration may be obtained by taking care of ambient conditions (like illumination, noise, comfortable position, psychologic disease, and so on...). If patient is not relaxed during the examination, it is always better to stop it; in some case, forcing a straining patient to complete the examination, will decrease the recording quality. Tests on comatose patients are easier to accomplish since there are no movement or muscular contractions (the main source of artefacts). On the other side, environment conditions in ICUs are worse than in standard laboratory examinations, because patient would probably be close to many other different monitoring or measurement instrumentations creating electromagnetic interferences.

In general it's better to keep the amplifier as far as possible from other machineries and to avoid recording cables to run close to other electrical cables. Normally, better to use electrode cables no longer than 70-80 cm; in every case, twisting the recording cables each other will decrease the noise.

An important and frequent noise source is the presence of electromagnetic interference of telecommunications devices like radio and telephones. Radio waves are often very strong in the hospitals as well as the presence of wireless telephones close to the patient or to the acquisition machine. Even when not used, radio-telephones periodically transmit acknowledgement signals to the wireless network, thus creating interference during the recording. The acquisition systems are protected from radio interferences by using special hardware filters, but filters do not erase interferences at all. Better filters against radio frequencies cause a deterioration of amplifiers Common Mode Rejection Ratio CMRR, thus not permitting to record the evoked potentials.

The complete EP recording system is constituted by the acquisition headbox with stimulator and a PC used for the data displaying and memorization. The PC itself, laptop or desktop, is a big electromagnetic noise source and it must never be positioned too close to the patient (even for safety reasons) or to the acquisition headbox.

Electrode application

Good electrode connection is very important in evoked potential recordings. Quality of an electrode connection depends on the place the electrode is placed and on the contact impedance. While electrode position varies depending on the tests, you have always to pay attention to the contact impedance which depends on the type of electrode and on the application modality. If contact impedance is low, you can easily obtain a good recording. The common mode rejection ratio (CMRR) is as high as the contact impedance is low and balanced between the two amplifier inputs. The noise from external signal are rejected well when CMRR is high and there is a low contact impedance.

Silver cup electrodes connected with conductive EEG gel, on clean and ungreased skin, have a 2-3 K Ω contact impedance. If they are positioned on a not cleaned and ungreased skin, even if using a good conductive gel, have an impedance of 20-40 K Ω . Therefore it's very important to always measure the contact impedance before to start the recording.

Needle electrodes, stuck in the skin, have a contact impedance of 3-5 K Ω independently on the skin quality (conductive gel is not used with those electrodes). Take care needle electrodes often hurt the patients in a way they could start not to collaborate (i.e. children tends to move increasing the movement artefacts). Take also care needle electrodes tend to polarize more than cup electrodes (with consequent signal deterioration) and they weaken low frequency signals (under 3-4 Hz).

Filters

The use of hardware filters is a must during EP recordings. The system has both online and offline powerful digital filters, and an hardware customizable high-pass filter. In analogue to digital

conversion theory, the lower band limit of the signal to convert has not influence on the quality of the conversion itself; only the higher band limit has to be limited to lower than half of sampling rate (sampling theorem). In practice, the opposite is much more important, because the system automatically controls the upper bandwidth limit by hardware, (in function of the sampling rate) but, since in EP we acquire short slices of EEG, the lower band limit has a greater practical importance in order to avoid offset in the amplifier and its saturation for a long time in case of low frequency artefacts.

Sometimes, in particular when recording very long latency evoked potentials, wide band (DC) amplifiers are required. Take care that the lower the band limit of the amplifier, the more difficult is to record a signal since offset potentials (mainly due to electrode polarization) saturate the amplifiers thus not permitting to record the signal for long time. Increased bandwidth also causes longer recovery times from amplifier saturation.

Hardware notch filter eliminating 50 (or 60 Hz) is not to be used since most of the times it erases important signal components of EP. It is always better to take advantage of amplifier high CMRR and take care of contact impedance and cable positions in order to lower down 50 Hz noise that can be further eliminated by synchronized average using stimulation rates not multiple of 50 Hz.

Stimulation artefacts

The mostly used EP stimulators are electric, visual and auditory. Stimulators produce electric energy thus inducing an electromagnetic field close to the patient and synchronous with the beginning of the EP; therefore stimulation artefact is not erased by synchronized average technique.

The stimulation artefact is always present in EP recordings, but its amplitude must be reduced in order not to get some interference with the evoked potential. The stimulation artefact duration is generally short and usually it finishes before the beginning of the evoked potential. However, sometimes the stimulation artefact overlap the evoked potential (as an example, the first component of the brainstem potential which has a latency of 2 ms).

Reduction of stimulation artefact can be accomplished by mean of patient skin preparation (for the electric stimulation) that reduces the contact impedance and the required voltage to produce the electric stimulation. It is also important to avoid stimulator cables are close to the electrode cables (keep always separate stimulation and recording cables) and to use the minimum stimulus duration and intensity stimulation required to excite the patient.

Evoked Potential Types

EPs are mainly divided into 3 categories depending on the latency: EP with short, mean and long latencies. EPs are defined "short term" if they appear within 10 ms after stimulus (i.e.: brainstem evoked potentials); the EPs appearing within 100 ms are defined as "mean term" latency (as the somatosensory potentials). If EPs have a latency higher than 100 ms, they are called "long term" latency (examples are the late components of every EP, which are called cortical). As a general rule, the higher the latency, the more the brain is involved in the interpretation of the stimulus. EPs can also be classified using a physical-physiological standard, depending on the kind of stimulation used or on the nervous path interested by the stimulation. The somatosensory EPs are generated by the use of electric stimulation of sensory nerves. Auditory EPs are generated by auditory stimulations. Visual EPs are generated by the retinal stimulation using short flashes. There are also many other evoked potentials obtained by complex stimulations (sounds with different tonalities, words, pictures, ...); such a kind of evoked potentials are more used in research rather than in clinical applications.

The EP morphology and its latency depends both on the kind and the place of stimulation, and on the electrode positions. The EP, actually, is the recording of the variation of dipole direction, generated by polarisation and depolarisation of axonal membranes; such a dipole is generated on the stimulation area for somatosensory EPs, on the retina for visual EPs and on the cochlea for

auditory EPs. The dipole moves along the sensitive, visual or auditory paths until the endocranic level, distributing then on the cerebral cortex areas. At this level the dipole scatters, originating many smaller dipoles in different directions, that are not recordable with precision.

If the dipole evoked by an electric stimulus on a nerve is recorded in another point along the nervous path to the brain, using two electrodes, one close to the other and positioned over a random point in this path, we obtain a biphasic action potential, with the latency depending on the distance from the stimulation site. This is what happens recording a somatosensory EP by using electrodes on the ERB and cervical points.

If electrodes are positioned far from each other (meaning we can catch electrical activity more deeper in the brain), the evoked potential has more a complex morphology, depending both on the shifting and on the changing of dipole position. A typical example is given by brainstem potentials, where you can find 5 components recording with an electrode on the vertex and another one on the mastoid. The dipole begins at the coclea, propagate along the auditory nerve, then on the bridge, then in the midbrain and finally through the temporal cortex. Such a dipole changes position many times; it runs close to the mastoideus electrode too, then it goes away and finally it returns close to the mastoideus electrode again. For this reason many waves with different amplitude and latency are recorded.

In order for the EP to be correctly evaluated, correct stimulation and recording electrode positioning are crucial. In order to obtain repetitiveness of multiple examinations on the same patient, it is essential to pay attention and keep the same recording electrode recording points during the time.

The different peaks composing the EP, have a standard naming convention composed by a letter and a number where:

- The letter (P or N) means positive or negative (where negative peaks are the ones having positive amplitudes),
- The number represents the typical latency of the peak in s.

As an example N100 means an “upper” peak at a latency of 100 s.

The electrodes used to acquire a single EP channels, also have a standard naming convention:

- Active is used to designate the negative electrode (in black),
- Reference is used to designate the positive electrode (in red).

SOMATOSENSORY EVOKED POTENTIALS – UPPER LIMB

Clinical indications

The median or the ulnar nerves are stimulated on the wrist (the anode is placed just proximal to the palmar crease, and the cathode is placed between the tendons of the palmaris longus muscle, 3 cm proximal to the anode) and the signal is recorded in several points on the neck and on the scalp. The most frequent recording points are on the supra-clavear region (ERB), on the cervical column (C5, C7) and on the scalp (Fpz, C3', Ppz, C4').

Ulnar nerve SSEPs are preferred to median nerve SSEPs for assessing the lower cervical spinal cord, especially during intraoperative monitoring when this part of the spinal cord is at risk, because the ulnar nerve originates from spinal roots C8-T1, whereas the median nerve originates from C6-T1. Ulnar nerve SSEPs will detect dorsal column damage at the C7-C8 level, but the median nerve SSEPs may persist, mediated by sensory fibers that enter the spinal cord at the C6 level.

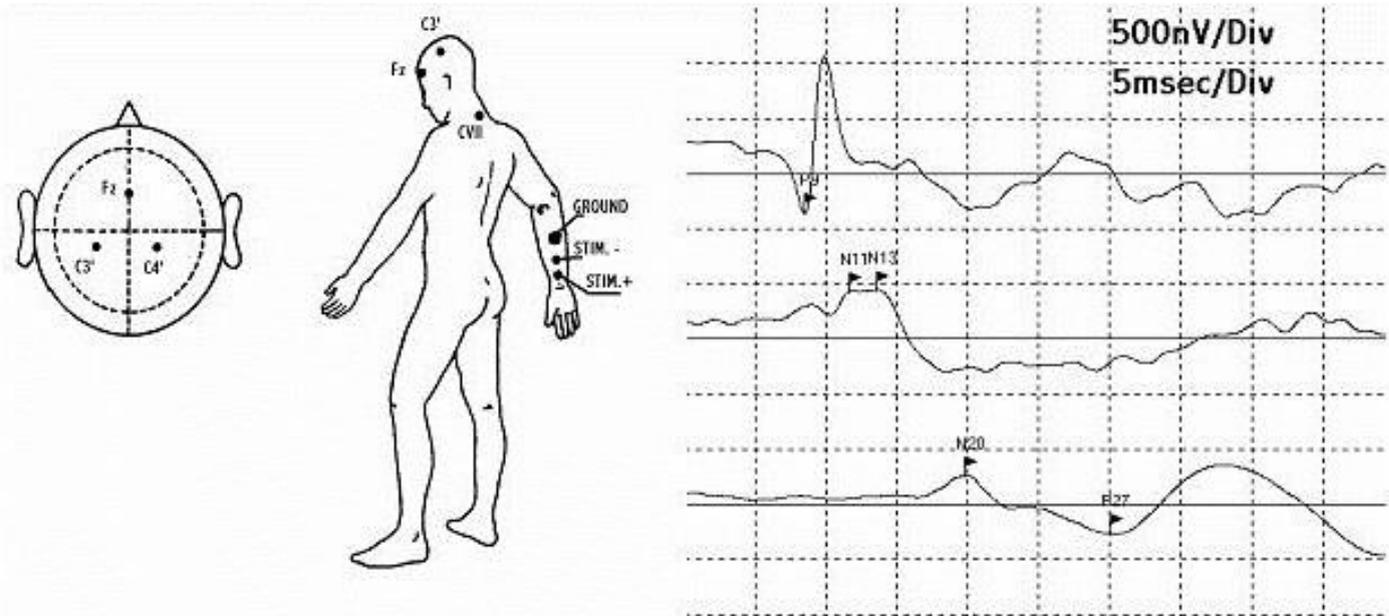
A lesion can be everywhere on the nervous system from wrist to the scalp and can take signal alterations. The signal recorded under the lesion point could be normal. For example a medullar sufferance by hernia can change potential in C5 and C7 and in the scalp without changing potential on the ERB.

Increase in latency of SSEP is very important in order to detect abnormalities in the nervous path, also signal shape alteration or its disappearance are important, even if less frequent. Since the latency time is related to the distance between recording and stimulating points, taller patients

have higher latency times than shorter ones. The normal latency times tables have to be related to the patient height.

Potentials obtained by median nerve stimulation are normally sharper and wider than the ones obtained by ulnar stimulation. Median nerve has often a common peripheral pathology (called carpal tunnel), so it is very important to proceed with ulnar stimulation before starting an evoked potential using the median stimulation.

The somatosensory potentials on the scalp have a very complex and varying morphology, so they are not described in this application note.



Electrode position

Acquisition is performed by using 3 channels :

- channel 1 acquires signal at ERB position with ERB right (active), ERB left (reference) as recording points,
- channel 2 acquires signal at C5 with Fz as reference,
- channel 3 acquires with C3' or C4' as active electrode depending if we are studying a right or left stimulation and reference at Fpz.

Ground can be positioned on the limb between the stimulator and the scalp.

Stimulation

Type: Electric

Duration: 100 microsec

Intensity: varying, the minimum value sufficient to evoke a movement on the hand when stimulation the median or the ulnar nerve (twitch)

Rate: 2.5Hz; rapid stimulus delivery rates (over 6 Hz) should be avoided, as they degrade the SSEP waveforms; always avoid stimulation rates that are subharmonics of 50 or 60 Hz since their use would lead to contamination of the averaged SSEPs by large artefacts of the line frequency (50 or 60 Hz).

Acquisition parameters

Number of channels: 3 or 4

Low Filter: 20Hz
High Filter: 500 - 1000Hz
Base Time: 50 ms
Max Signal: ± 200 microV
Gain/Div: 10 microV/div

Average

Average: 1000
Gain/Div: 1 microV/div

Working modality

Use synchronized average for 1000 times. The EP should become clearly visible after 300-400 averages. The patient has to be relaxed especially with his paravertebral and cervical muscles; so he must lie down with a lightly flexed neck on a comfortable cushion.

SOMATOSENSORY EVOKED POTENTIALS – LOWER LIMB

Clinical Indication

Two stimulation ways are normally used: posterior tibial and peroneal nerve.

For recording posterior tibial nerve SSEPs, the nerve is stimulated at the ankle, with the cathode midway between the Achilles tendon and the medial malleolus and the anode 3 cm distal to the cathode.

For recording peroneal nerve SSEPs, the common peroneal nerve is stimulated at the knee, with the cathode inferior to the leg crease just medial to the tendon of the biceps femoris muscle and the anode 3 cm distal to the cathode.

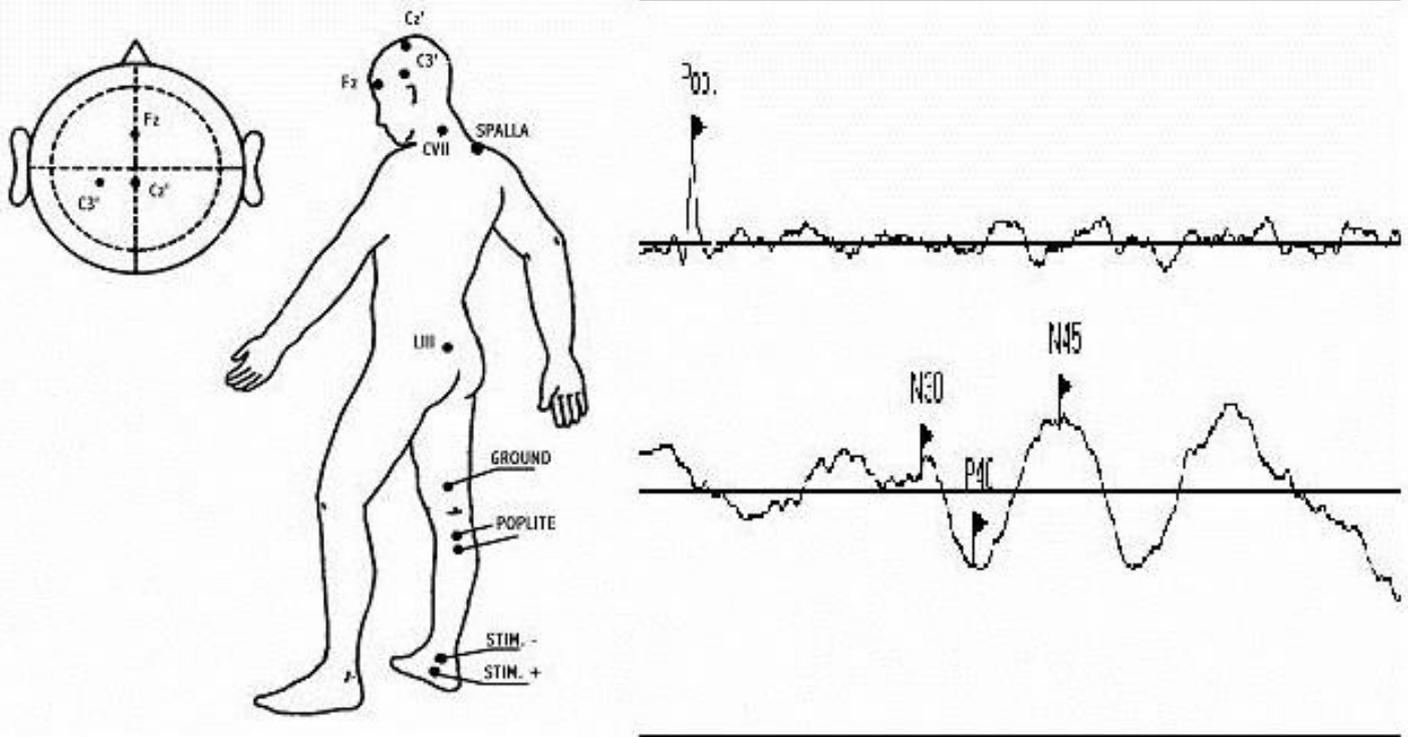
In the lower limb, posterior tibial SSEPs are generally preferred because of the following:

- in clinical diagnostic use, they are larger and display less intrasubject variability,
- in intraoperative settings, they produce less patient movement,
- in intraoperative settings, electrodes at the ankle are more accessible, and thus more easily replaced should they malfunction, than those at the knee,
- the peripheral nerve compound action potential (CAP) is easily recorded at the popliteal fossa and can be used to determine whether the nerve is being adequately stimulated. This is crucial when the rostral SSEPs deteriorate during intraoperative monitoring to indicate whether the SSEP changes are caused by spinal cord compromise or by technical problems with nerve stimulation.

However, peroneal nerve stimulation may be better in some cases because of the following:

- some patients can tolerate peroneal nerve stimulation but find posterior tibial nerve stimulation too uncomfortable,
- the posterior tibial nerve may be difficult to stimulate adequately in some patients,

- in some patients with peripheral neuropathy (which may tends to affect longer nerves more severely), peroneal nerve SSEPs may be present whereas no posterior tibial nerve SSEPs are identifiable.



SEP inferior limbs recorded in 2 channels with poplite and vertex recording points

Electrode position

When using two channels, as in the previous example, the recording channel positioned on the scalp has the active electrode in Cz and the reference in Fz, while the peripheral channel is on the popliteal muscle.

When using 4 channels, the additional two recording points are placed on the vertebral column with active electrodes in LIII and CVII and reference electrode on the shoulder or on the ears.

To have a high signal quality the electrodes impedance should be lower than 5 K Ω and should be balanced between the different electrodes.

Stimulation

Type: electric

Duration: 100 microsec

Intensity: varying, the minimum value sufficient to evoke a movement on the toes when stimulation the ankles (twitch)

Rate: 2.5Hz; rapid stimulus delivery rates (over 6 Hz) should be avoided, as they degrade the SSEP waveforms; always avoid stimulation rates that are subharmonics of 50 or 60 Hz since their use would lead to contamination of the averaged SSEPs by large artefacts of the line frequency (50 or 60 Hz).

Acquisition parameters

Channel Number: 2 or 4
Low Filter: 4 Hz
High Filter: 500 - 1000 Hz
Base Time: 100 ms
Max Signal: ± 200 microV
Gain/Div: 10 microV/div

Average

Average: 1000
Gain/Div: 1 microV/div

Working modality

Use synchronized average for 1000 times. The EP should become clearly visible after 500-600 averages.

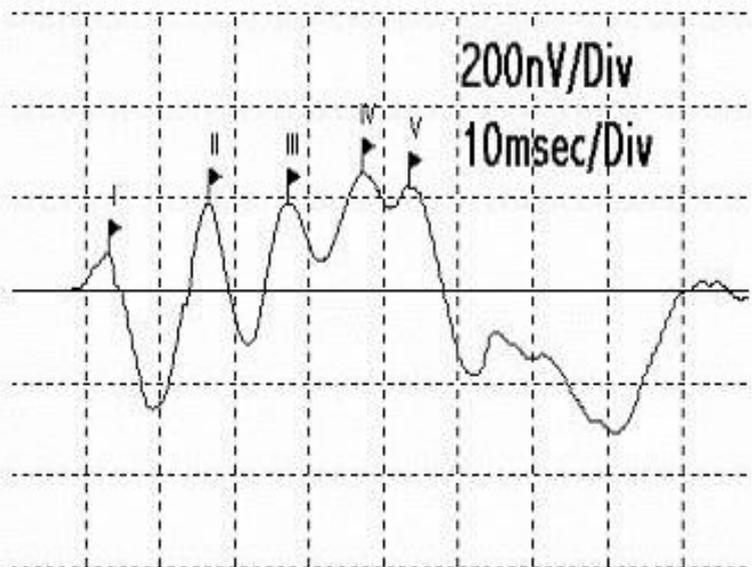
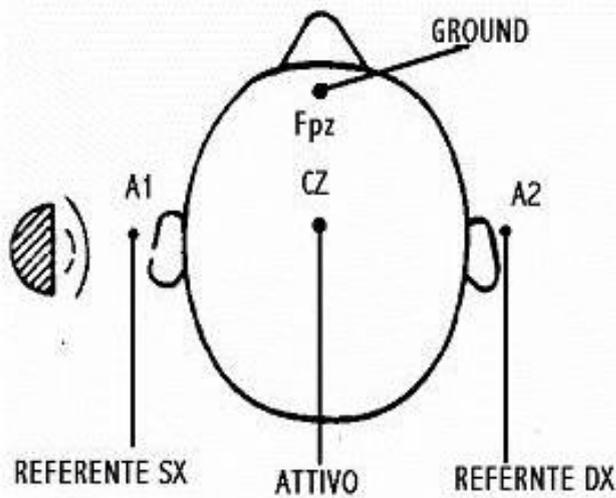
BRAINSTEM EVOKED POTENTIALS

Clinical Indication

Auditory brainstem response (ABR or BAEP) audiometry is a neurologic test of auditory brainstem function in response to auditory (click) stimuli. ABR audiometry refers to an evoked potential generated by a brief click or tone pip transmitted from an auditory transducer in the form of an insert earphone or headphone. The elicited waveform response is measured by surface electrodes typically placed at the vertex of the scalp and ear lobes. The waveform peaks are labeled I-VII. These waveforms normally occur within a 10-millisecond time period after a click stimulus presented at high intensities (70-90 dB normal hearing level [nHL]).

Auditory brainstem response (ABR) audiometry typically uses a click stimulus that generates a response from the basilar region of the cochlea. The signal travels along the auditory pathway from the cochlear nuclear complex proximally to the inferior colliculus. ABR waves I and II correspond to true action potentials. Later waves may reflect postsynaptic activity in major brainstem auditory centers that concomitantly contribute to waveform peaks and troughs. The positive peaks of the waveforms reflect combined afferent (and likely efferent) activity from axonal pathways in the auditory brain stem.

Auditory brainstem response (ABR) technology has been used in testing newborns for the past 15 years. Approximately 1 of every 1000 children is born deaf. Many more are born with less severe degrees of hearing impairment, while others may acquire hearing loss during early childhood. Several clinical trials have shown automated auditory brainstem response (AABR) testing as an effective screening tool in the evaluation of hearing in newborns, with a sensitivity of 100% and specificity of 96-98%.



BAEP with the following latencies:

I=1.31msec, II=2.66msec, III=3.71msec, IV=4.70msec, V=5.34msec

Auditory brainstem response (ABR), often used intraoperatively with electrocochleography, provides early identification of changes in the neurophysiologic status of the peripheral and central nervous systems. This information is useful in the prevention of neurotologic dysfunction and the preservation of postoperative hearing loss. For many patients with tumors of CN VIII or the cerebellopontine angle, hearing may be diminished or completely lost postoperatively, even when the auditory nerve has been preserved anatomically.

Electrode position

Two channels are normally sufficient for BAEP application.

The active electrode is positioned on Cz, the reference on the mastoid or on the lobes (A1 and A2), and the ground on the forehead in Fpz.

To have a high signal quality the electrodes impedance should be lower than 5KΩ and balanced between the different electrodes.

Stimulation

Type: Click (normally alternating compression/ rarefaction)

Mask: Sometimes pink noise is introduced on the cap contralateral to the stimulation

Duration: 100 micros

Intensity: 70 - 80dB over auditory threshold

Rate: 11Hz or slightly less

Acquisition parameters

Channel Number: 1 or 2

Low Filter: 150Hz

High Filter: 3000Hz

Base Time: 10 ms

Signal max: ±50 microV

Gain/Div: 10 microV/div

Average

Average: 2000
Gain/Div: 200 nV/Div

Working modality

Test the patient auditory threshold and add 70dB before to begin the stimulation.

Continue averaging until you reach the programmed stimulation number (normally 2000, since the evoked potential amplitude has nanoVolt amplitude).

BAEP has 7 positive waves, labelled with roman numbers from I to VII and grouped in the first 10 ms after stimulus. The first 5 ones are the most important; you can find them in almost all BAEPs.

VISUAL EVOKED POTENTIALS

Clinical Indications

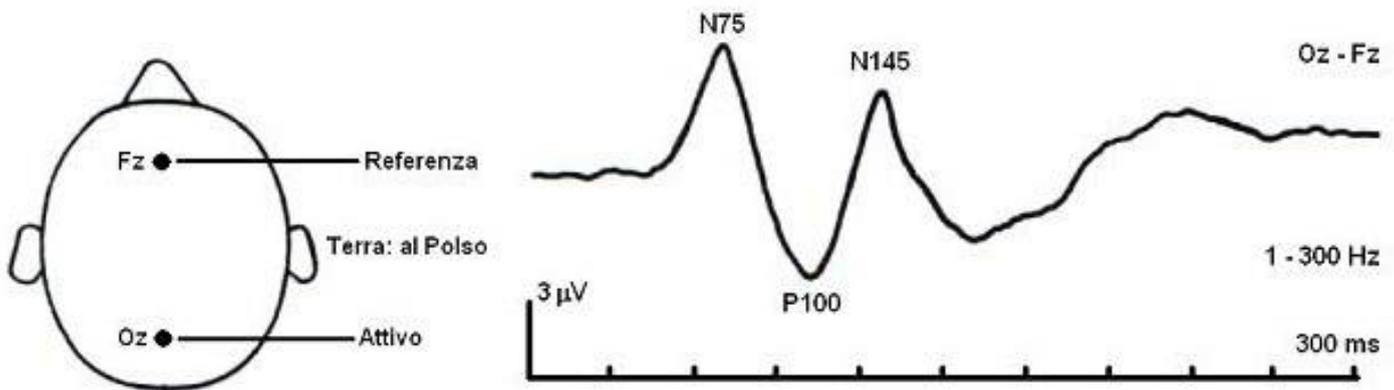
The VEP tests the function of the visual pathway from the retina to the occipital cortex. It measures the conduction of the visual pathways from the optic nerve, optic chiasm, and optic radiations to the occipital cortex. The most important fact to consider is that, although the axons from the nasal half of the retina decussate at the optic chiasm, the temporal axons do not. Therefore, retrochiasmatic lesions may not be detected by full-field checkerboard stimulation. VEPs are most useful in testing optic nerve function and less useful in postchiasmatic disorders. In retrochiasmatic lesions, the Partial field studies or MRI are a more useful test.

The VEP is very useful in detecting an anterior visual conduction disturbance. However, it is not specific with regard to etiology. A tumor compressing the optic nerve, an ischemic disturbance, or a demyelinating disease may cause delay in the P100; only additional clinical history and, often, MRI are needed to uncover the etiology.

The usual waveform is the initial negative peak (N1 or N75), followed by a large positive peak (P1 or P100), followed by another negative peak (N2 or N145). Maximum value for P100 is 115 milliseconds (ms) in patients younger than 60 years; it rises to 120 ms thereafter in females and 125 ms in males. Even though published norms are available in the medical literature, each individual laboratory should have its own norms to control for lab-to-lab variability in technique. The W morphology of the VEP is most often an individual variation, although decreasing the stimulation frequency from the ubiquitous 2 Hz to 1 Hz usually converts the W shape into a conventional P100 peak. Check size and alternation rate are factors in this; the responses can be manipulated to a W or a conventional P100 response by changing these parameters. Large checks tend to produce VEPs similar to those produced by flash stimulation.

The usual VEPs are evoked by checkerboard stimulation and, because cells of the visual cortex are maximally sensitive to movement at the edges, a pattern-shift method is used with a frequency of 1-2 Hz. The size of the checks affects the amplitude of the waveform and the latency of the P100. In addition, pupillary size, gender, and age all affect the VEP. Visual acuity deterioration up to 20/200 does not alter the response significantly; large checks may be required. In some studies, women have slightly shorter P100 latencies. Sedation and anesthesia abolish the VEP. Some subjects, by "fixating" beyond the plane of stimulation, may alter or suppress P100 altogether.

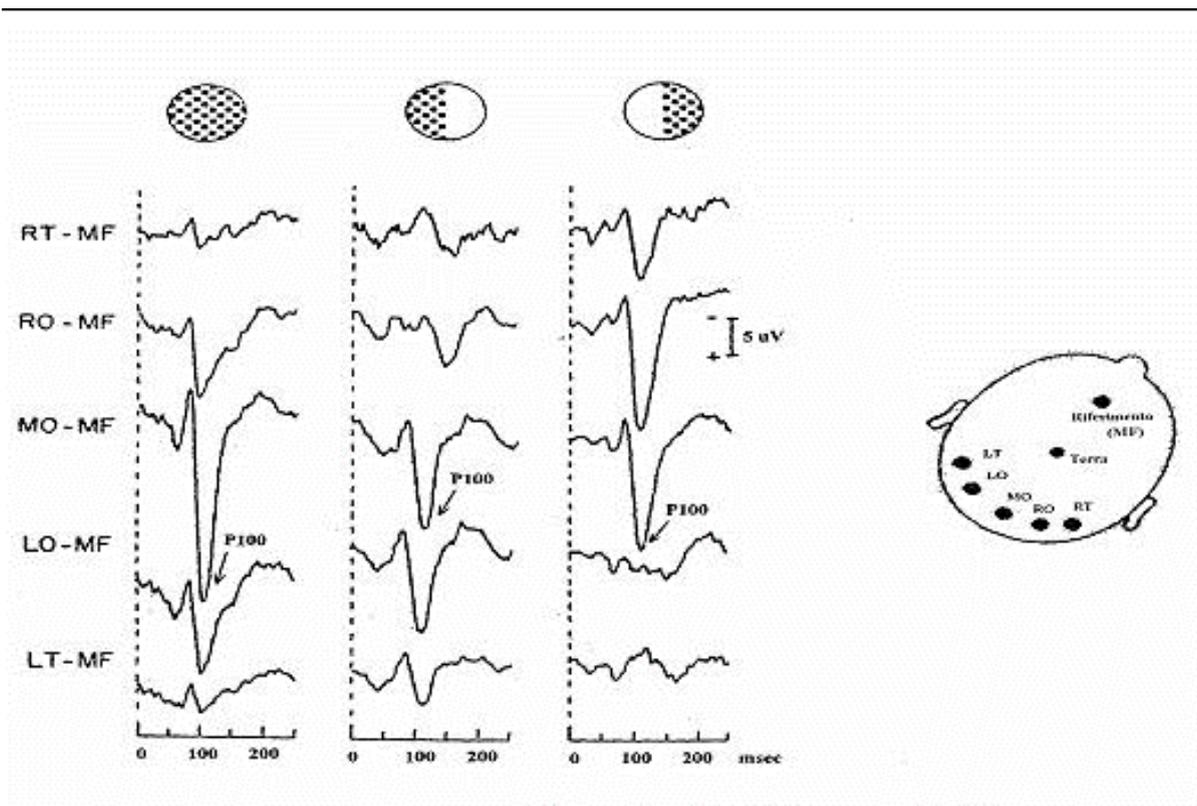
VEPs are mainly used to test sclerosis influence on visual functions and to test distribution of visual information at the very first stages of cortex elaboration. VEPs used with particular retina electrodes (ERGs) are useful to test several retinal pathologies. In general VEP gives indication about pathologies of the entire optical nerve, and pathologies of primary cortex elaboration of optical nerve information.



VEP simplest electrode position and typical evoked potential

Electrode Position

Responses are collected over Oz, O1, and O2 and with hemifield studies at T5 and T6 electrodes using the standard EEG electrode placement.



Example of Multichannel VEP

To have a high signal quality the electrode impedance should be lower than 5KΩ and it should be balanced between the different electrodes.

Stimulation

Type: Flash or Checkerboard, in case of checkerboard, 3 modes are used:

- Full screen
- Horizontal half field (4 recording channels required)
- Vertical half field (4 recording channels required)

Monocular stimulation is used to avoid masking of a unilateral conduction abnormality. Testing circumstances should be standardized, including seating distance of 70-100 cm from the monitor screen, giving a check size of approximately 30 seconds of visual angle. The vision should be corrected to the extent possible in case of a visual problem. Pupil size and any abnormality should be noted.

Visual angle: 15', 30', 60', 90' (an EP recording is mostly required for each angle)

Rate: 1 – 2 Hz

Contrast: 60% to 95% (typical)

Patient Distance: PATTERN 10 stimulator uses two standard distances for patient (called A e B) depending on the kind of monitor used:

Distance	Monitor 15"	Monitor 14"	Monitor 13"
A	130.97 cm	122.24 cm	113.51 cm
B	109.14 cm	101.87 cm	94.59 cm

NOTE. The values described refer to the stimulation using PATTERN 10 stimulator.

Acquisition Parameters

Channel Number: 1 to 5; multiple channels are used for more selective VEP recordings when partially stimulating the fovea (half or quarter field stimulations)

Low Filter: 1 Hz

High Filter: 100 Hz

Base Time: 200 – 500 ms.

Signal max: ±200 microV

Gain/Div: 20 microV/div

Average

Average: 100 - 150

Gain/Div: 2 - 5 microV/Div

Working modality

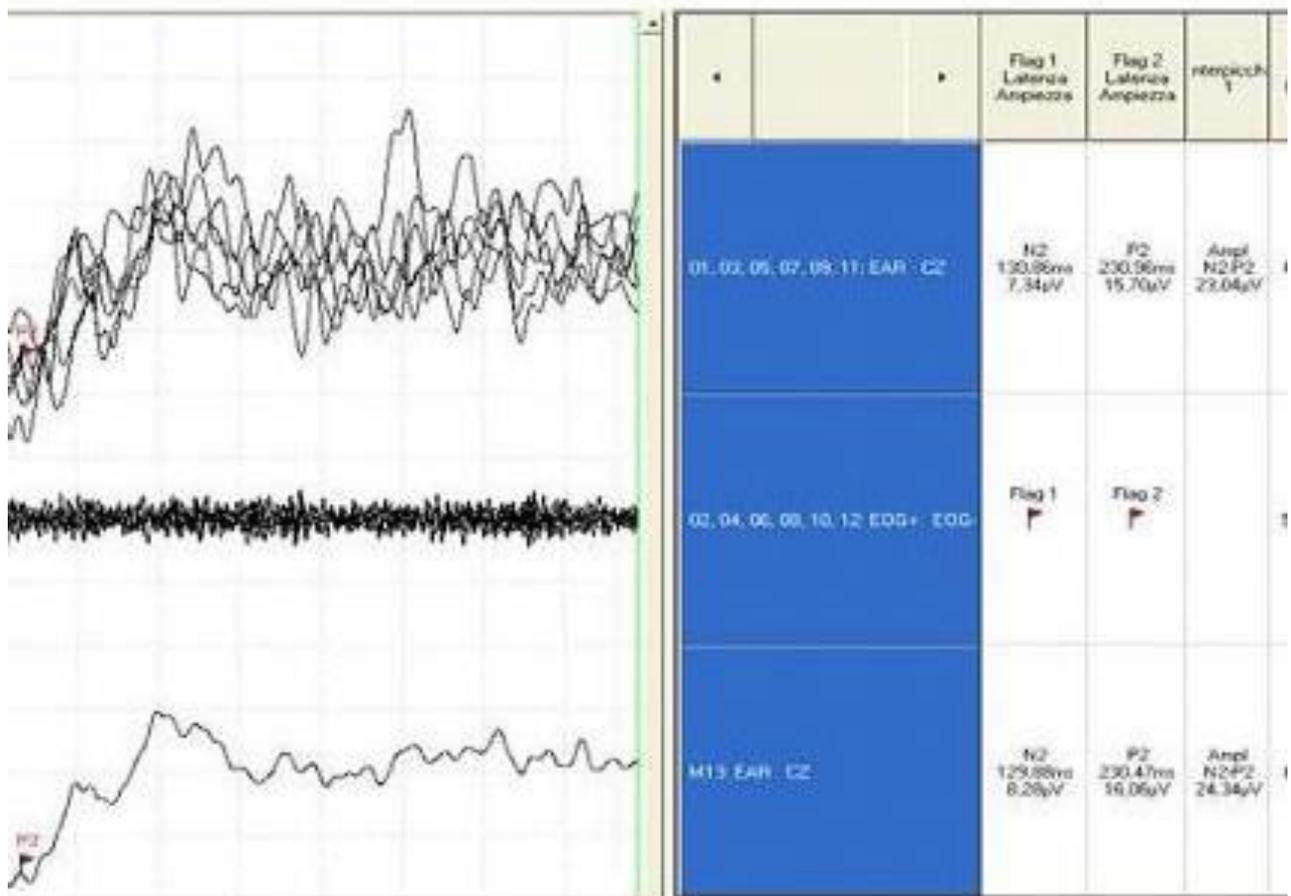
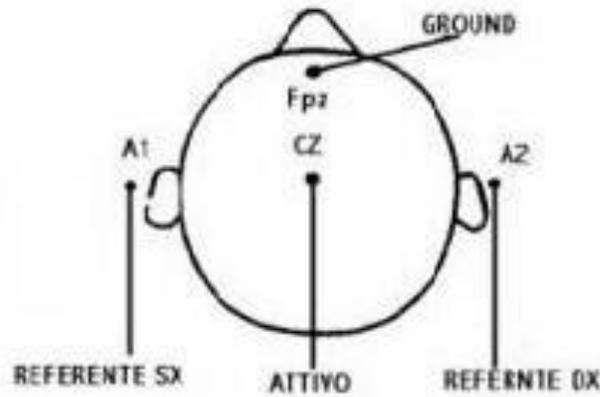
Place the patient in a coherent position in front of the stimulator (visual angle, pattern dimension), then proceed with the stimulation until the programmed number of stimulations is reached, normally 100-150. Repeat the stimulation procedure at least twice for each eye.

In the evoked potential we usually detect 3 waves: N75, the first negative deflection, N100, the greatest and most reproducible positive wave, and N145.

LASER EVOKED POTENTIAL

Clinical Indications

Laser Evoked Potentials are used to examine pain disturbances.



*2 channel LEP with latency peak:
N2=129,88msec and P2=230,47msec.*

Electrode position

One or two channels are normally used; in case of one channel applications, active electrode is positioned on the vertex Cz and reference on the nose or on the lobe A1-A2, ground is connected to the forehead Fpz. Sometimes oculars movement and contralateral temporal site (T3, T4) are recorded. To have a high signal quality the electrodes impedance should be lower than 5 KΩ and balanced between the different electrodes.

Stimulation

Type: Laser

Duration: Depending by pain patient threshold

Intensity: Depending by pain patient threshold

Rate: 0,1 Hz

Acquisition parameters

Channel number: 1 to 3

Low Pass Filter: 0,3Hz

High Pass Filter: 70Hz

Time Base: 1s

Signal Max: ± 200 microV

Gain/Div: 10 microV/div

Average

Average: 30

Gain/Div: 10 microV/div

Working modality

As a first step, you need to test the patient pain threshold, then you start the acquisition. Average the trace until you obtain a clear and well defined potential, potential has an amplitude of some microV, so to obtain a good result 30 averages are enough in most of the cases.

Repeat the examination 2 times for each side to verify the coherence of the potentials.

LEP potentials is composed by a negative peak around 120ms and a positive deflexion around 400 ms.

Cognitive Evoked Potentials

Clinical Indications

While short latency EP are generated by the «obligatory» nervous pathways (they are also called «exogenous» that means: determined outside the organism), later EP components are sensitive to changes in meaning of stimulus and information processing (for this reason, they are called «endogenous» = determined within the organism). Long latency EP, also called Cognitive Evoked Potentials (ERP), are further two classes:

- Evoked ERP, the most commonly studied, occuring in response to a physical stimulus,
- Emitted ERP occuring in absence of a physical stimulus (i.e. omission of item in a sequence).

Evoked ERP can have both exogenous and endogenous components; emitted usually have only endogenous.

Oddball stimulation paradigm is the most widely used in order to evoke ERP; oddball paradigm propose a sequence of two different stimuli called "frequent" and "rare." The frequent stimulus is given at a predefined or random rate; the rare stimulus is presented randomly in place of the frequent one (frequent to rate ratio is defined by the stimulation protocol). The rare stimulus can also be a "missed" stimulus, but in this case some problems for synchronization of the average arise. Sometimes the user is asked to perform a "cognitive" task every time a rare stimulation occurs (like to count the number of stimulations or to press a button).

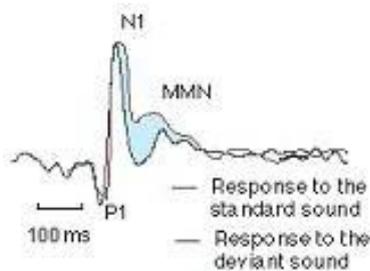
Different kind of stimulators are used; frequent and rare stimulation may vary for intensity (i.e. lower and higher volume of auditory stimulation), position (i.e. left and right hand electrical stimulation), characteristic (i.e. different tone of auditory stimulation), meaning (i.e. relaxing or tensing pictures). The most widely and documented stimulation used is auditory.

Two different Evoked Potentials, each following frequent or rare stimulations, are then calculated and Analyzed.

Mismatch Negativity

The Mismatch Negativity or MMN is a negative ERP component that is recorded between 100-200

ms in response to low-probability deviant sounds in a sequence of standard sound stimuli, when attention is directed elsewhere. The deviance between sounds can be defined by a frequency (pitch) difference or a duration difference. The MMN is considered as the 1st step in the processes leading to conscious detection of differences in auditory context, i.e. the mnemonic comparison of a given stimulus with a previous one which has already build up a trace in memory. The violation of the previously formed memory trace produces the MMN. Recently, it has been demonstrated that not only physical characteristics of the stimulus but also abstract properties can lead to the MMN. MMN has being used to study dyslexia and, since it reflects a preattentive state, it can be also elicited during sleep, moreover, it has been proposed as an index for coma prognosis. The MMN is best seen in the difference wave between the ERP in response to the standard and deviant sounds.



P300

The classical P300 deflection emerges in a time-locked record as a positivity typically appearing approximately 300 to 400 ms following stimulus presentation. Timing of this component may range widely, however, from 250 ms and extending to 900 ms, with amplitude varying from a minimum of 5 V to a usual limit of 20 V for auditory and visual evoked potentials, although amplitudes of up to 40 V have also been documented. The P300, first described by Sutton, et al., is perhaps the most-studied ERP component in investigations of selective attention and information processing, due partly to its relatively large amplitude and facile elicitation in experimental contexts.

The P300 is typically generated in an auditory 'oddball' protocol in response to attended low-probability (deviant) target stimuli requiring an overt response. Typically the P300 amplitude in response to the low-probability target stimuli will be higher relative to that in response to the standard stimuli. The P300 is considered to be related to the maintenance of working memory when the mental model of the stimulus environment is updated.

Electrode Positions

ERPs can be acquired using 2 up to 32 channels; the most used configuration for clinical purposes employs 3 recording points: Fpz, Cz, Pz, all referring to A1A2 (ground in Fz).

Stimulation

Type: Many different kind of stimulation are employed; depending on the type of stimulation different stimulators may be used (from the traditional electric stimulator, to the complex paradigm stimulators).

The most test are performed by using auditory tones as described below:

Frequency: Rare tones having lower frequencies than frequent tones (1000 Hz against 2000 Hz, trapezoidal envelope)

Duration: 50 ms or slightly higher

Intensity: 70 dB HL

Rate: Random between 0,3 to 0,8 Hz

Acquisition parameters

Channel number: 2 up to 32

Low Pass Filter: 0,5 Hz

High Pass Filter: 100 Hz
Time Base: 500 ms
Signal Max: ± 200 microV
Gain/Div: 20 microV/div

Average

Average: 60 per trial (presentation of rare sounds about 15% or 20%), 3 trials per exam
Gain/Div: 10 microV/div