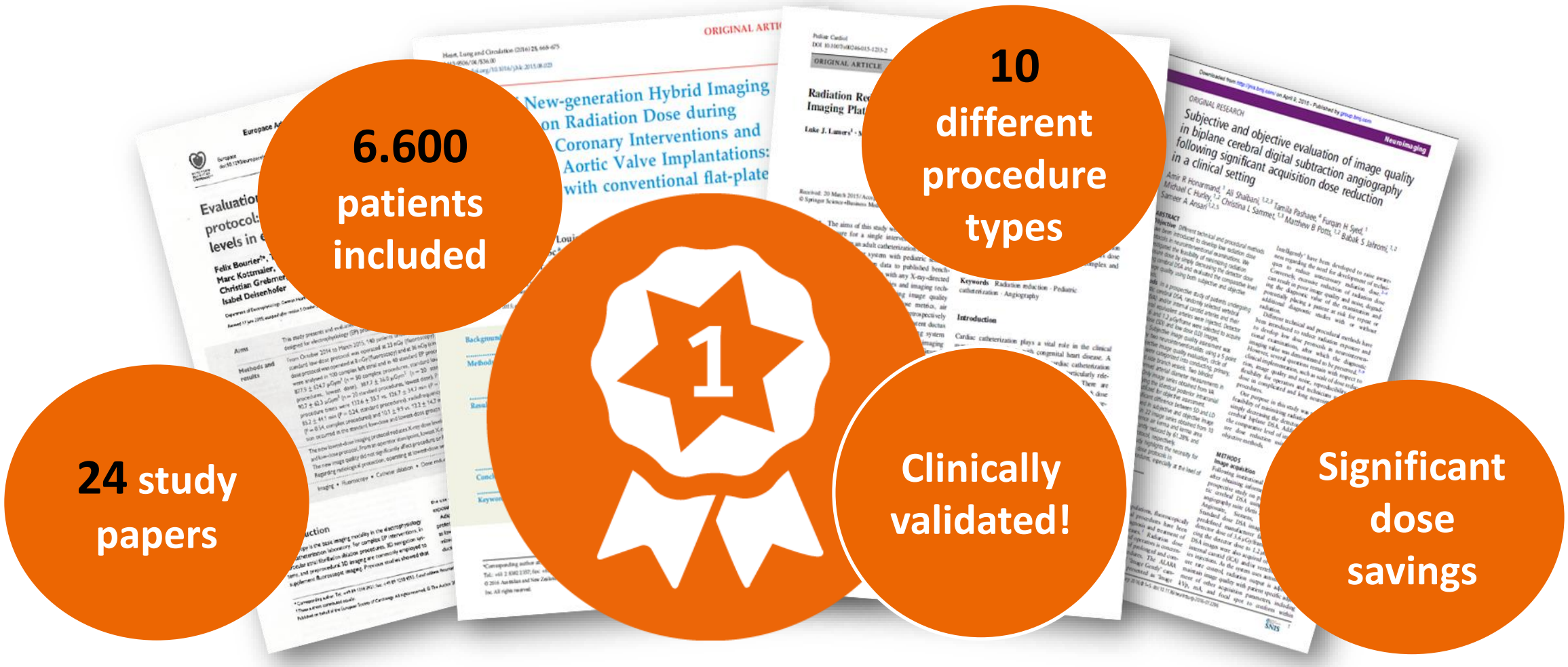
Dose saving in Angiography

February 2020

Innovation Leader in Dose Management
Clinically proven by various studies



SIEMENS Healthineers

Dose saving in

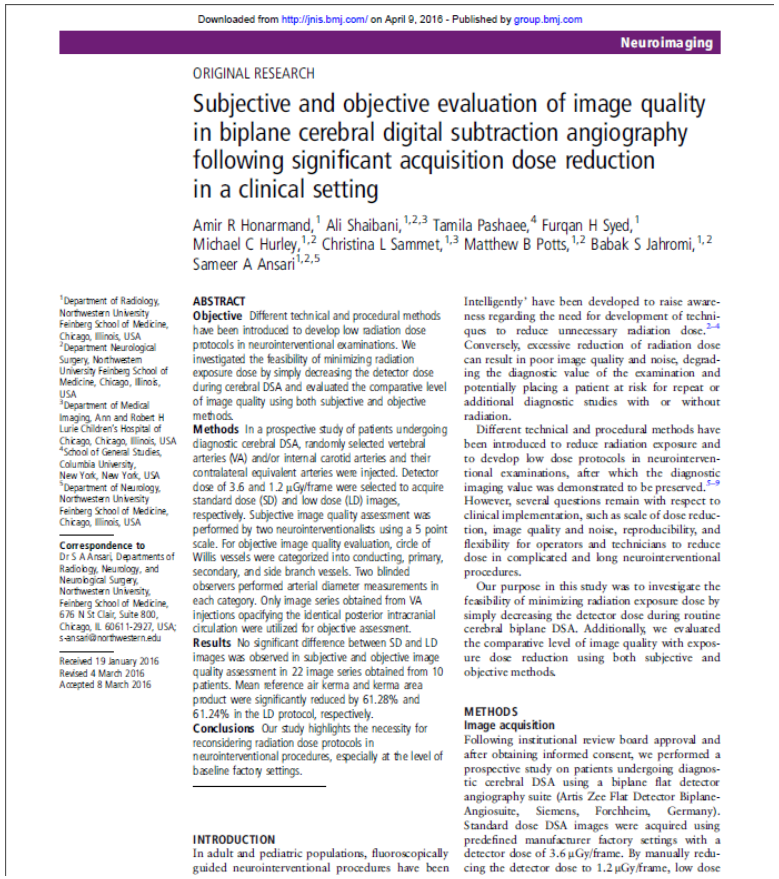
Interventional Radiology

Artis zee in Neuro interventions
Significant dose reduction with low dose protocol

NORTHWESTERN UNIVERSITY
FEINBERG SCHOOL OF MEDICINE

DAP per low dose procedure

420 µGym²



ORIGINAL RESEARCH

Subjective and objective evaluation of image quality in biplane cerebral digital subtraction angiography following significant acquisition dose reduction in a clinical setting

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ABSTRACT

Objective Different technical and procedural methods have been introduced to develop low radiation dose protocols in neurointerventional examinations. We investigated the feasibility of minimizing radiation exposure dose by simply decreasing the detector dose during cerebral DSA and evaluated the comparative level of image quality using both subjective and objective methods.

Methods In a prospective study of patients undergoing diagnostic cerebral DSA, randomly selected vertebral arteries (VA) and/or internal carotid arteries and their contralateral equivalent arteries were injected. Detector dose of 3.6 and 1.2 µGy/frame were selected to acquire standard dose (SD) and low dose (LD) images, respectively. Subjective image quality assessment was performed by two neurointerventionalists using a 5 point scale. For objective image quality evaluation, circle of Willis vessels were categorized into conducting, primary, secondary, and side branch vessels. Two blinded observers performed arterial diameter measurements in each category. Only image series obtained from VA injections opacifying the identical posterior intracranial circulation were utilized for objective assessment.

Results No significant difference between SD and LD images was observed in subjective and objective image quality assessment in 22 image series obtained from 10 patients. Mean reference air kerma and kerma area product were significantly reduced by 61.28% and 61.24% in the LD protocol, respectively.

Conclusions Our study highlights the necessity for reconsidering radiation dose protocols in neurointerventional procedures, especially at the level of baseline factory settings.

INTRODUCTION

In adult and pediatric populations, fluoroscopically guided neurointerventional procedures have been Intelligently' have been developed to raise awareness regarding the need for development of techniques to reduce unnecessary radiation dose.[3–4] Conversely, excessive reduction of radiation dose can result in poor image quality and noise, degrading the diagnostic value of the examination and potentially placing a patient at risk for repeat or additional diagnostic studies with or without radiation.

Different technical and procedural methods have been introduced to reduce radiation exposure and to develop low dose protocols in neurointerventional examinations, after which the diagnostic imaging value was demonstrated to be preserved.[5–9] However, several questions remain with respect to clinical implementation, such as scale of dose reduction, image quality and noise, reproducibility, and flexibility for operators and technicians to reduce dose in complicated and long neurointerventional procedures.

Our purpose in this study was to investigate the feasibility of minimizing radiation exposure dose by simply decreasing the detector dose during routine cerebral biplane DSA. Additionally, we evaluated the comparative level of image quality with exposure dose reduction using both subjective and objective methods.

METHODS

Image acquisition

Following institutional review board approval and after obtaining informed consent, we performed a prospective study on patients undergoing diagnostic cerebral DSA using a biplane flat detector angiography suite (Artis Zee Flat Detector Biplane-Angiosuite, Siemens, Forchheim, Germany). Standard dose DSA images were acquired using predefined manufacturer factory settings with a detector dose of 3.6 µGy/frame. By manually reducing the detector dose to 1.2 µGy/frame, low dose

Honarmand et al. J Neurointerv Surg. 2017 Mar;9(3):297-301.

- Standard vs. low dose protocol
- Diagnostic cerebral DSA
- 10 patients
- DAP with standard dose protocol:
- 1 083 µGym²

Artis zee in Neuro interventions
Less dose than other vendors

7.03 µGym²/ frame

DAP Siemens

Diagnostic neuro DSA Michigan

50 µGym²/ frame

DAP other vendors

Diagnostic neuro DSA‘s for conventional systems

* Source: Söderman et al., Radiation dose in neuroangiography using image noise reduction technology: a population study based on 614 patients, Neuroradiology (2013).

Artis Q in Neuro interventions
Improved image quality at comparable dose

SIEMENS Healthineers

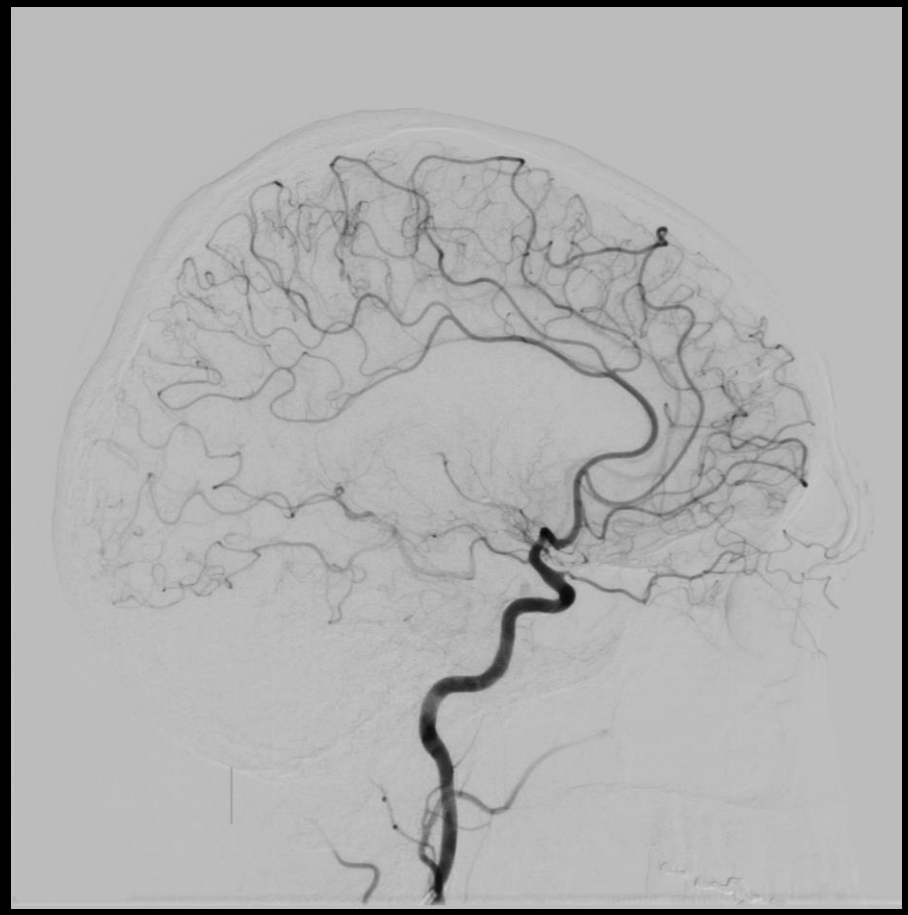
Artis Q

Visionary intervention

Severe stenosis of the left middle cerebral artery.

Tube voltage:	69 kV
FOV:	42 cm
Frames:	24 cm
DAP:	5.65 µGym²/f
Detector dose:	0.8 µGy/f

www.siemens.com/artis-q-masterpieces



Prof. Dr. med. Martin Skalej, University of Magdeburg, Germany

Artis zee in TACE
Low dose levels in complex procedures

GOOD SCIENCE
BETTER MEDICINE
BEST PRACTICE

Total DAP per procedure

13 689 µGym²

Average value in TACE
DAP: 19 943 µGym² *

ECR 2016 / C-1983

Radiation dose tracking for patients undergone to high-dose procedures in Interventional Radiology in a Hospital with a Medical Physic Unit (MPU) and in one without it

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Congress: ECR 2016
Poster No.: C-1983
Type: Educational Exhibit
Keywords: Cancer, Aneurysms, Stents, Physics, Chemoembolisation, Fluoroscopy, Catheter arteriograp Radioprotection / Radiation dose, Radiation physics, Interventional vascular
Authors: A. Masarà[1], G. LAURICELLA[2], E. De Bellis[1], A. Triannì[1]; [1]Udine/IT, [2]Pordenone/IT
DOI: 10.1594/ecr2016/C-1983
DOI-Link: http://dx.doi.org/10.1594/ecr2016/C-1983

Learning objectives

Aim of this study is to evaluate patient dose in two common endovascular interventional procedures and to compare the different practice in two different hospitals (Udine University Hospital and Pordenone Hospital). The selected procedures are the Transarterial Chemoembolization (TACE) and Endovascular Aortic Repair (EVAR) for Abdominal Aortic Aneurysm (AAA). We investigated all the factors that could affect patient dose (systems' performances, procedure's complexity, workflow, etc)...

Read more

Fig. 1: EVAR

Background

TACE and EVAR are two of the most common endovascular interventional procedures. They are both considered high dose procedures, because of their high complexity which is often related to long exposure times and, consequently, to high levels of radiation dose to the patient. TACE is considered the standard treatment for intermediate-stage Hepatocellular carcinoma (HCC) , which is defined as an extensive multifocal disease without vascular invasion in patients with preserved liver functions and...

Fig. 3: TACE

Masarà et al. ECR 2016 / C-1983.

- High complexity TACE procedures with rather high fluoro time
- 129 patients
- Total DAP values:
  2 321 µGym² to
  83 723 µGym²

* Literature-based review of 6 multi-vendor publications. Data on file.

Artis Q in UFE
Unique dose saving possibilities

Klinikum Stuttgart

DAP per procedure

1 444 µGym²

EPOS™ Electronic Presentation Online System — ESR European Society of Radiology

Uterine Fibroid Embolization (UFE) and Radiation Exposure in the year 2015: The potential for dose-reduction applying the new Siemens Artis Q technology.

Poster No.:	C-0159
Congress:	ECR 2015
Type:	Scientific Exhibit
Authors:	C. M. Sommer, M. Klapp-Oliger, A. Hatopp, S. Erpenbach, K. Thomas, P. Kurz, G. M. Richter; Stuttgart/DE
Keywords:	Pelvis, Genital / Reproductive system female, Interventional vascular, Catheter arteriography, Fluoroscopy, Percutaneous, Embolisation, Radiation safety, Technical aspects, Dosimetric comparison, Neoplasia
DOI:	10.1594/ecr2015/C-0159

Aims and objectives

To evaluate the potential for dose-reduction of uterine fibroid embolization (UFE) applying the new Siemens Artis Q technology.

Methods and materials

From 02/2014-11/2014, all patients undergoing UFE applying the new Siemens Artis Q technology were included. Artis Q technology is an angiography system consisting of a powerful X-ray tube and a high-dynamic range detector. Indications for UFEs were obtained after interdisciplinary consultation and informed consent. All UFEs were performed as standardized bilateral embolization procedures according to a specific treatment plan (e.g. "low-dose pelvis" angiography preset, specified image frames for angiography and stasis in the uterine artery as embolization endpoint) from experienced interventional radiologists (>10 years experience). Patient demographics and radiation exposure (using the automatically generated examination protocol) were analyzed. For classification of our data, a systematic review of published data was performed (search strategy: MEDLINE as database and "uterine fibroid embolization" as search term for primary selection, reference list of relevant articles for additional selection).

Sommer et al. ECR 2015 / C-0159.

- Standard bilateral embolization procedures
- 24 patients
- Average DAP of comparable studies (literature reviewed in this study): 15 327 µGym²

Artis Q in UFE

Dose values significantly below expert proposals

EPOS™ Electronic Presentation Online System — ESR European Society of Radiology

Uterine Fibroid Embolization (UFE) and Radiation Exposure in the year 2015: The potential for dose-reduction applying the new Siemens Artis Q technology.

Poster No.:	C-0159
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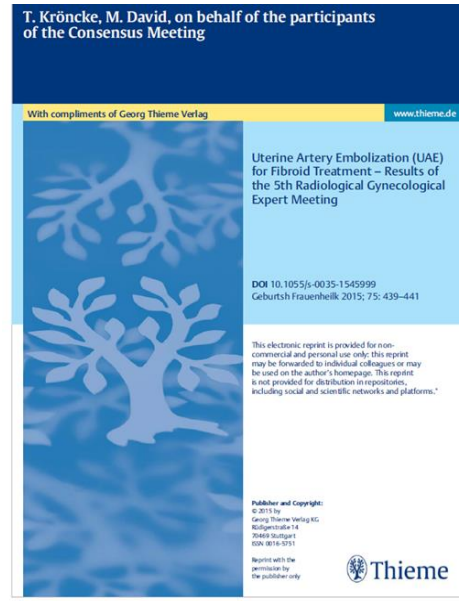
Klinikum Stuttgart

Median DAP per procedure

1 444 µGym²

Sommer et al. ECR 2015 / C-0159.

Recommendations of the 5th Radiological Gynecological Expert Meeting



Average DAP per procedure

< 5 000 µGym²

Kröncke et al. Geburtshilfe Frauenheilkd. 2015 May; 75(5): 439–441.

Artis zee in PAE
Dose clearly below average values

Total DAP [µGy·m²]	With syngo DynaCT	Without syngo DynaCT
Axiom Artis dTA	27 002	20 985
Artis zee	16 609	12 683
Dose reduction with Artis zee	↓	↓

Nigel Hacking et al., ESIR 2016, oral presentation.

Typical value in PAE

DAP: 76 345 µGym² *

Dr. Nigel Hacking (UK) at ESIR (European School of Radiology) in November 2016

* Literature-based review of 6 multi-vendor publications. Data on file.

Dose saving in

Cardiology

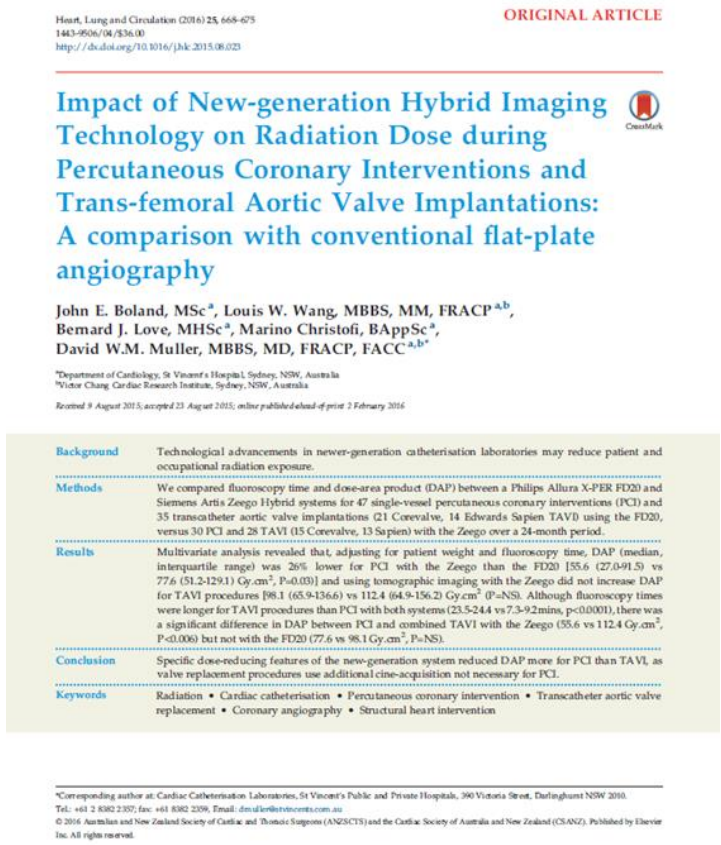
Artis zee in Coronary Artery Disease
Less dose compared to other vendor (intra-study)

ST VINCENT'S HOSPITAL SYDNEY

Median DAP per procedure

5 560 µGym²

Literature-based average
DAP: 12 200 µGym² *



Heart, Lung and Circulation (2016) 25, 668–675
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2015.08.023

ORIGINAL ARTICLE

Impact of New-generation Hybrid Imaging Technology on Radiation Dose during Percutaneous Coronary Interventions and Trans-femoral Aortic Valve Implantations: A comparison with conventional flat-plate angiography

John E. Boland, MSc[a], Louis W. Wang, MBBS, MM, FRACP[a,b], Bernard J. Love, MHSc[a], Marino Christofi, BAppSc[a], David W.M. Muller, MBBS, MD, FRACP, FACC[a,b,*]

[a]Department of Cardiology, St Vincent's Hospital, Sydney, NSW, Australia
[b]Victor Chang Cardiac Research Institute, Sydney, NSW, Australia

Received 9 August 2015; accepted 23 August 2015; online published-ahead-of-print 2 February 2016

Background Technological advancements in newer-generation catheterisation laboratories may reduce patient and occupational radiation exposure.

Methods We compared fluoroscopy time and dose-area product (DAP) between a Philips Allura X-PER FD20 and Siemens Artis Zeego Hybrid systems for 47 single-vessel percutaneous coronary interventions (PCI) and 35 transcatheter aortic valve implantations (21 Corevalve, 14 Edwards Sapien TAVI) using the FD20, versus 30 PCI and 28 TAVI (15 Corevalve, 13 Sapien) with the Zeego over a 24-month period.

Results Multivariate analysis revealed that, adjusting for patient weight and fluoroscopy time, DAP (median, interquartile range) was 26% lower for PCI with the Zeego than the FD20 [55.6 (27.0-91.5) vs 77.6 (51.2-129.1) Gy.cm², P=0.03)] and using tomographic imaging with the Zeego did not increase DAP for TAVI procedures [98.1 (65.9-136.6) vs 112.4 (64.9-156.2) Gy.cm² (P=NS). Although fluoroscopy times were longer for TAVI procedures than PCI with both systems (23.5-24.4 vs 7.3-9.2 mins, p<0.0001), there was a significant difference in DAP between PCI and combined TAVI with the Zeego (55.6 vs 112.4 Gy.cm², P<0.006) but not with the FD20 (77.6 vs 98.1 Gy.cm², P=NS).

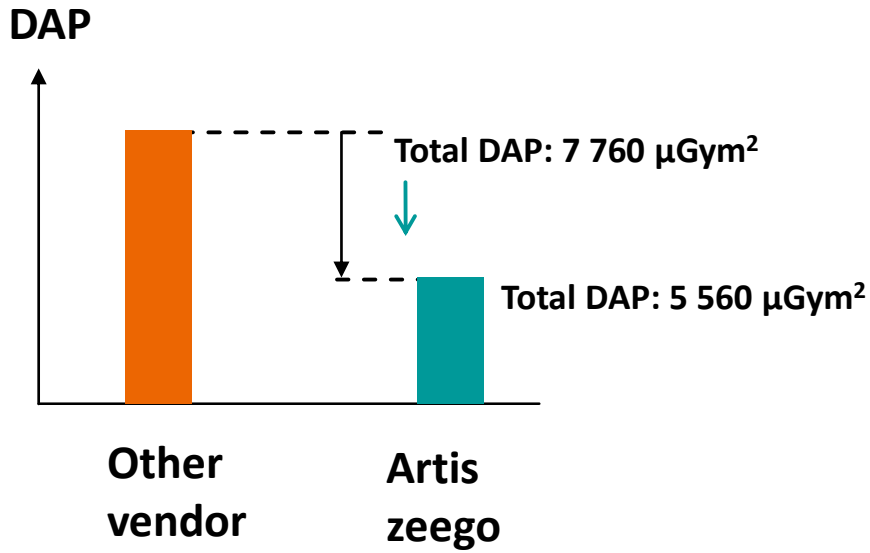
Conclusion Specific dose-reducing features of the new-generation system reduced DAP more for PCI than TAVI, as valve replacement procedures use additional cine-acquisition not necessary for PCI.

Keywords Radiation • Cardiac catheterisation • Percutaneous coronary intervention • Transcatheter aortic valve replacement • Coronary angiography • Structural heart intervention

*Corresponding author at: Cardiac Catheterisation Laboratories, St Vincent's Public and Private Hospitals, 390 Victoria Street, Darlinghurst NSW 2010.
Tel.: +61 2 8382 2357; fax: +61 8382 2356; Email: dmuller@stvincents.com.au

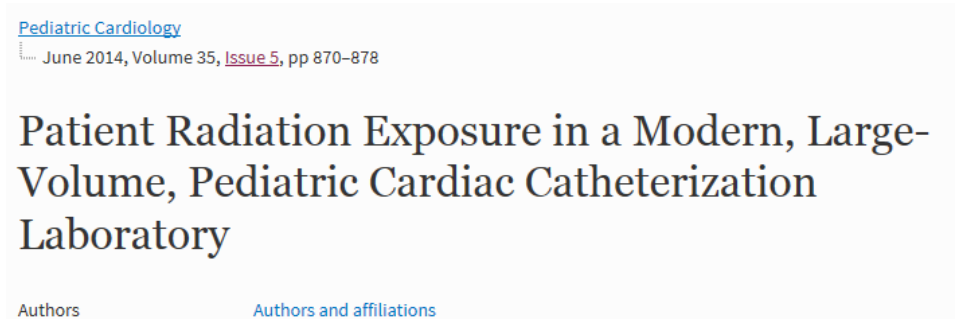
Boland et al. Heart Lung Circ. 2016 Jul;25(7):668-75.

- Siemens vs. other vendor
- Single-vessel percutaneous coronary interventions (PCI)
- 47 patients



*Comparable procedures. Data on file.

Artis zee in Congenital Heart Disease
Less dose compared to other vendors


Pediatric Cardiology
June 2014, Volume 35, Issue 5, pp 870–878

Patient Radiation Exposure in a Modern, Large-Volume, Pediatric Cardiac Catheterization Laboratory

Authors Authors and affiliations


JACC: CARDIOVASCULAR INTERVENTIONS VOL. 7, NO. 9, 2014
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RADIATION SAFETY

Radiation Dose Benchmarks During Cardiac Catheterization for Congenital Heart Disease in the United States

Sunil J. Ghelani, MD,* Andrew C. Glatz, MD, MSCE,† Sthuthi David, BS,* Ryan Leahy, MD, MS,‡ Russel Hirsch, MD,§ Laurie B. Armsby, MD,‖ Sara M. Trucco, MD,¶ Ralf J. Holzer, MD, MSc,# Lisa Bergersen, MD, MPH*

DAP [mGy·m²]	PDA closure	ASD closure	Pulmonary valvuloplasty	Aorta coarctation
Other vendors (average value)	700	2100	700	2900
Artis zee	352	1038	405	484
Dose reduction with Artis zee	↓	↓	↓	↓

Ghelanie et al. JACC Cardiovasc Interv. 2014 Sep;7(9):1060-1069.

Glatz et al. Pediatr Cardiol. 2014 Jun;35(5):870-878.

Artis zee in Arrhythmias
Significant dose savings with ultra-low dose protocol

Deutsches Herzzentrum München
des Freistaates Bayern
Klinik a. d. Technischen Universität München

Europace Advance Access published November 20, 2015

CLINICAL RESEARCH

Evaluation of a new very low dose imaging protocol: feasibility and impact on X-ray dose levels in electrophysiology procedures

Felix Bourier[1]*, Tilko Reents[1], Sonia Ammar-Busch, Alessandra Buiatti, Marc Kottmaier, Verena Semmler, Marta Telishevska, Amir Brkic, Christian Grebmer, Carsten Lennerz, Christof Kolb, Gabriele Hessling, and Isabel Deisenhofer

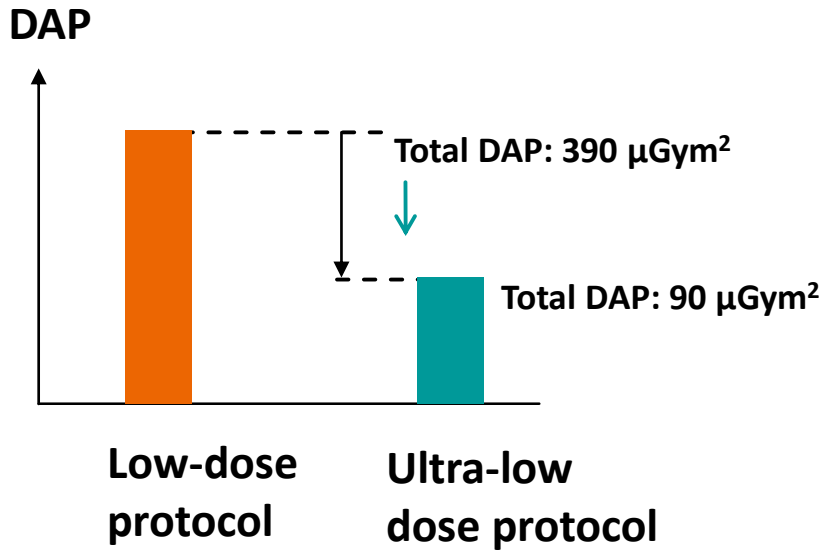
Bourier et al. Europace. 2016 Sep;18(9):1406-10.

- Low-dose protocol vs. ultra-low dose protocol
- Standard left atrial procedure
- 140 patients

Total DAP per procedure

90 µGym²

Other vendor
DAP: 880 µGym²*



*Comparable procedures. Data on file.

Artis zee in Arrhythmias
Significant dose savings with ultra-low dose protocol

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

Total DAP per procedure

199 µGym²

Other vendor
DAP: 568 µGym²

Pediatr Cardiol
DOI 10.1007/s00246-015-1233-2

ORIGINAL ARTICLE

Radiation Reduction Capabilities of a Next-Generation Pediatric Imaging Platform

Luke J. Lamers[1] · Martine Moran[1] · Jenna N. Torgeson[1] · John S. Hokanson[1]

Received: 20 March 2015 / Accepted: 9 July 2015

Abstract The aims of this study were to quantify patient radiation exposure for a single interventional procedure during transition from an adult catheterization laboratory to a next-generation imaging system with pediatric settings, and to compare this radiation data to published benchmarks. Radiation exposure occurs with any X-ray-directed pediatric catheterization. Technologies and imaging techniques that limit dose while preserving image quality benefit patient care. Patient radiation dose metrics, air kerma, and dose–area product (DAP) were retrospectively obtained for patients <20 kg who underwent patent ductus arteriosus (PDA) closure on a standard imaging system (Group 1, $n = 11$) and a next-generation pediatric imaging system (Group 2, $n = 10$) with air-gap technique. Group 2 radiation dose metrics were then compared to published benchmarks. Patient demographics, procedural technique, PDA dimensions, closure devices, and fluoroscopy time were similar for the two groups. Air kerma and DAP decreased by 65–70 % in Group 2 (p values <0.001). The average number of angiograms approached statistical significance (p value = 0.06); therefore, analysis of covariance (ANCOVA) was conducted that confirmed significantly lower dose measures in Group 2. This degree of dose reduction was similar when Group 2 data (Kerma 28 mGy, DAP 199 µGy m²) was compared to published benchmarks for PDA closure (Kerma 76 mGy, DAP 500 µGy m²). This is the first clinical study documenting the radiation reduction capabilities of a next-generation pediatric imaging platform. The true benefit of this dose reduction will be seen in patients requiring complex and often recurrent catheterizations.

Keywords Radiation reduction · Pediatric catheterization · Angiography

Introduction

Cardiac catheterization plays a vital role in the clinical management of patients with congenital heart disease. A known risk of any X-ray-directed cardiac catheterization procedure is radiation exposure which is particularly relevant in vulnerable pediatric patients [3, 7]. There are increasing numbers of reports documenting benchmark dose exposure for pediatric interventional catheterization procedures [4, 6]. Imaging techniques and protocols are being studied to obtain optimal image quality at the lowest possible X-ray dose [10, 12, 13], and several quality initiatives have been instituted to better understand the scope of radiation exposure and consequences in pediatric interventional cardiology. Any technology shown to improve image quality at lower X-ray dose is beneficial to patients with congenital heart disease (CHD) undergoing cardiac catheterization and to staff routinely performing these procedures.

Recent years have seen concerted efforts by manufacturers to reduce the interventional radiation exposure through technological process. In this regard, systems have moved from image intensifiers (II) to flat panel detectors (FD). Within the recent year, novel imaging systems became available with FDs that increase the acquired image bit depth from 14 bit to 16 bit, as well as employing crystalline silicone instead of amorphous silicon. Both improvements offer

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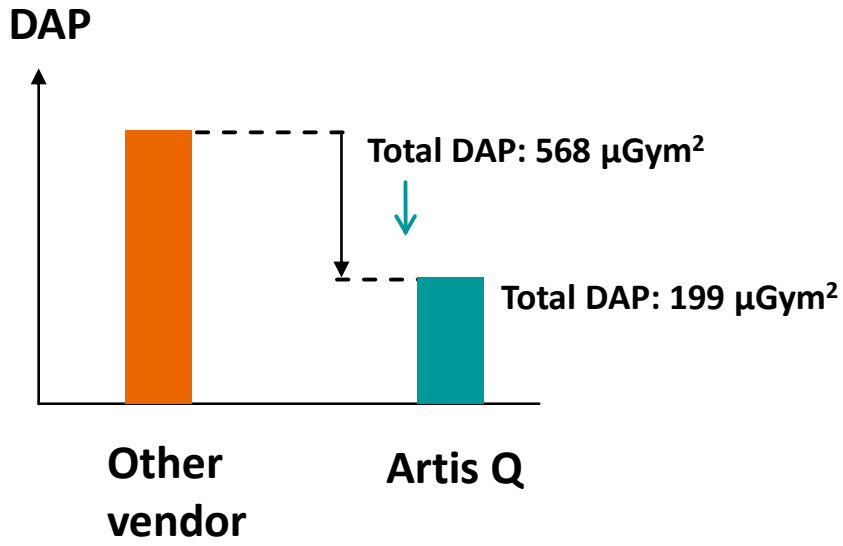
Lamers et al. Pediatr Cardiol. 2016 Jan;37(1):24-9.

- Siemens vs. other vendor
- Patent ductus arteriosus (PDA) closure procedures
- 21 patients



Artis Q in Coronary Artery Disease
Clear operator dose savings compared to other vendor

The Prince Charles Hospital Foundation
Finding cures. Saving lives.

Median Operator dose

3 µSv

Other vendor
Median Operator dose: 10 µSv

Head-to-Head Radiation Dose and Image Quality Comparison of Two State-of-the-Art Cardiac Catheter Lab X-ray Systems

J. Crowhurst [1,2,*], M. Whitby [1], M. Savage [1,2], D. Walters [1,2]

[1] *The Prince Charles Hospital, Brisbane, Australia*
[2] *University of Queensland, Brisbane, Australia*

Introduction: X-ray systems used for cardiac catheterisation aim to optimise image quality and radiation dose. This study compared two of the latest systems.

Methods: Both biplane X-ray systems (Siemens Artis Q and Philips' AlluraClarity FD10) in a single tertiary facility were compared for diagnostic coronary catheterisation procedures ± left ventriculography/ aortography over 30 days. Operators performed procedures with both systems. Procedural radiation data, patient BMI, contrast media and operator dose were collected. Image quality tests were performed with a Westmead test tool and a 200 mm Perspex phantom.

Results: See table.

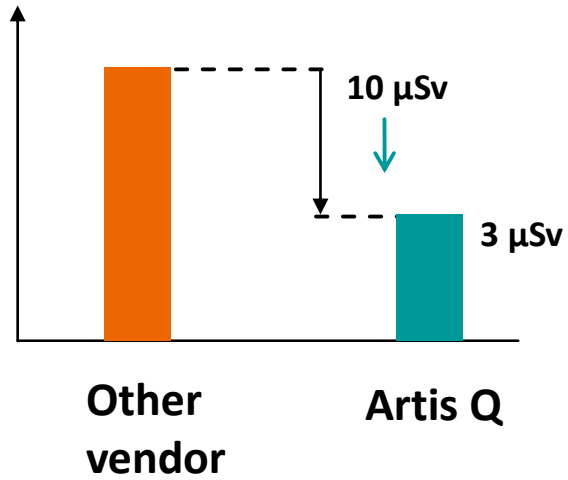
Conclusion: At this centre a lower skin dose and operator dose was achieved with the Siemens system. All other measures were not significantly different. Image quality tests demonstrated better high contrast resolution with the Philips system, whilst Siemens demonstrated better low contrast detectability.

Measure	Siemens Artis Q	Philips Allura	P =
N =	76	99	-
BMI	28.4 (25.5-34.1)	28.7 (24.6-34.7)	0.931
Median fluoro time (minutes)	3.4 (2.1-5.7)	4.0 (2.6-5.5)	0.486

Walters et al. Heart Lung and Circ. 2017;26(2):209..

- Siemens vs. other vendor
- Diagnostic coronary catheterisation procedures

Operator dose



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- Sommer et al. ECR 2015 / C-0159.
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- Walters et al. Heart Lung and Circ. 2017;26(2):209.

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The keys to successful procedures

SIEMENS Healthineers

Better image quality

ALARA

Confident decisions in diagnosis and treatment

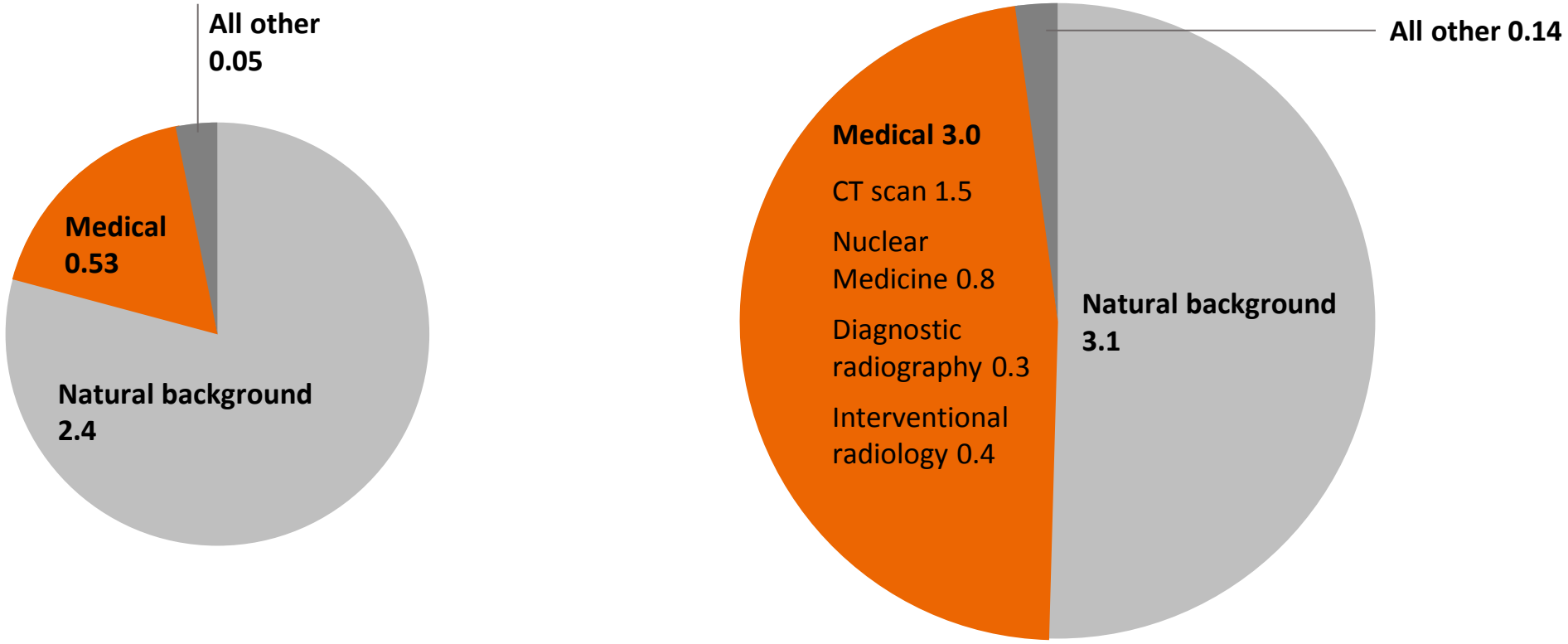
Reduce dose for patient and clinical staff

Standard with every Artis system

Certainty

Increased safety

Radiation dose in medical imaging has become the focus



Distribution and development of annual per capita dose in mSv to the population from 1980 to 2006 in the USA as an example for the development in industrialized countries.

Sources and Effects of Ionizing Radiation, UNSCEAR 2008 Report. United Nations Scientific Committee on the Effects of Atomic Radiation, New York, 2010.

Procedures are getting more complex, longer and more frequent

SIEMENS Healthineers

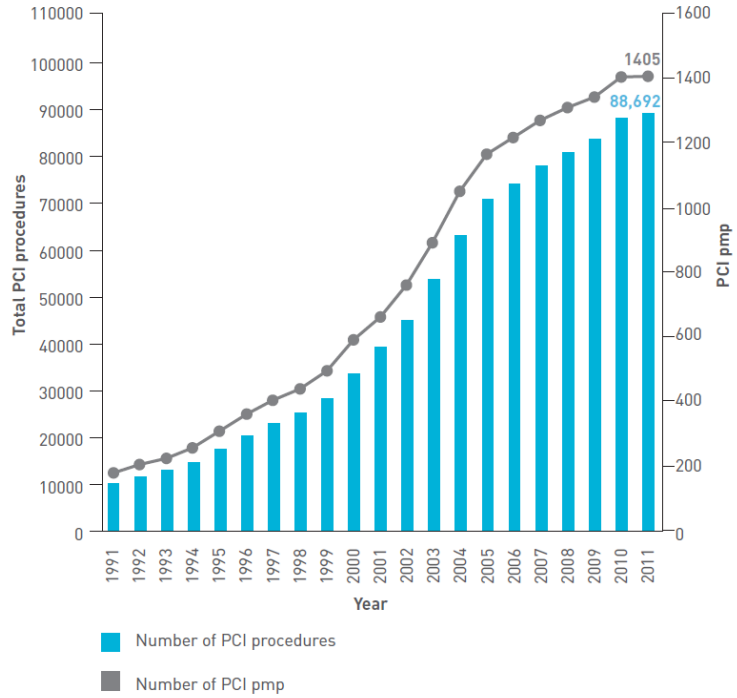
Table 3. IO Procedere Utilization and CAGR for 2002-2008

Procedure	2002	2003	2004	2005	2006	2007	2008	CAGR (%)
Liver percutaneous RF ablation	2.3	3.4	3.6	4.2	4.4	4.3	4.6	12
Liver transarterial embolization	5.5	7.7	7.5	10.9	10.3	11.6	13.7	16
Kidney percutaneous RF ablation	ND	ND	ND	ND	2.6	3.2	3.3	13
Kidney percutaneous cryoablation	ND	ND	ND	ND	0.4	0.7	2.7	153
Kidney transarterial embolization	0.8	0.9	1.3	1.1	0.7	0.7	0.7	−2.0
Lung percutaneous RF ablation	ND	ND	ND	ND	ND	2.4	3.0	26
Bone percutaneous RF ablation	ND	ND	0.2	0.3	0.4	0.5	0.8	41
All	8.5	12.1	12.7	16.5	18.8	23.5	28.8	22

Note.—Numbers are procedure performed per 100,000 Medicare enrollees. CAGRs are calculated for the period from the first year for which data are available to 2008. ND = no data.

Source; Sharon W. Kwan, MD, Robert K. Kerlan Jr, MD, Jonathan H. Sunshine, PhD, Utilization of Interventional Oncology Treatments in the United States Journal of Vascular and Interventional Radiology, Vol 21, Issue 7, Pages 1054-1060, July 2010

Fig 8. Increase in PCI activity 1991-2011



Source; British Cardiovascular Intervention Society; National Audit of Percutaneous Coronary Interventional Procedures Public Report; Annual Public Report January 2011 – December 2011

Potential effects on skin from interventional procedures

Effect	Threshold dose (Gy)	Minutes fluoro at 0.02 Gy/min	Minutes fluoro at 0.2 Gy/min
Transient erythema	2	100	10
Permanent epilation	7	350	35
Dry desquamation	14	700	70
Dermal necrosis	18	900	90
Telangiectasia	10	500	50
Cataract	> 5	> 250 to eye	> 25 to eye
Skin cancer	Not known	Not known	Not known

J. Cardella, K. Faulkner, J. Hopewell, H. Nakamura, M. Rehani, M. Rosenstein, C. Sharp, T. Shope, E. Vano, B. Worgul, M. Wucherer: "Avoidance of Radiation Injuries from Medical Interventional Procedures", ICRP publication 85

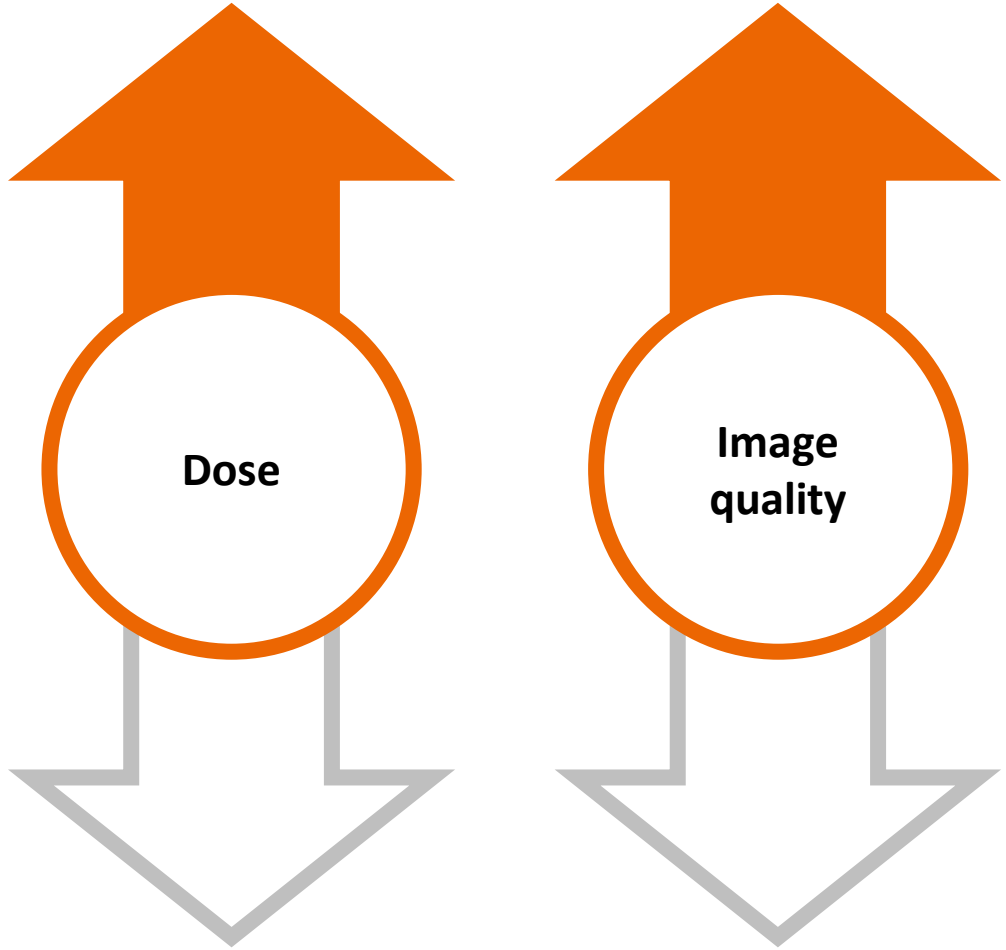
CARE+CLEAR strives to change the game

Because the general rule of X-ray says:

The higher the dose = The better the image quality

- Reducing radiation dose compromises image quality
- Improving image quality requires more powerful X-ray

What if we could lower radiation dose and get better image quality at the same time?



CARE+CLEAR strives to change the game

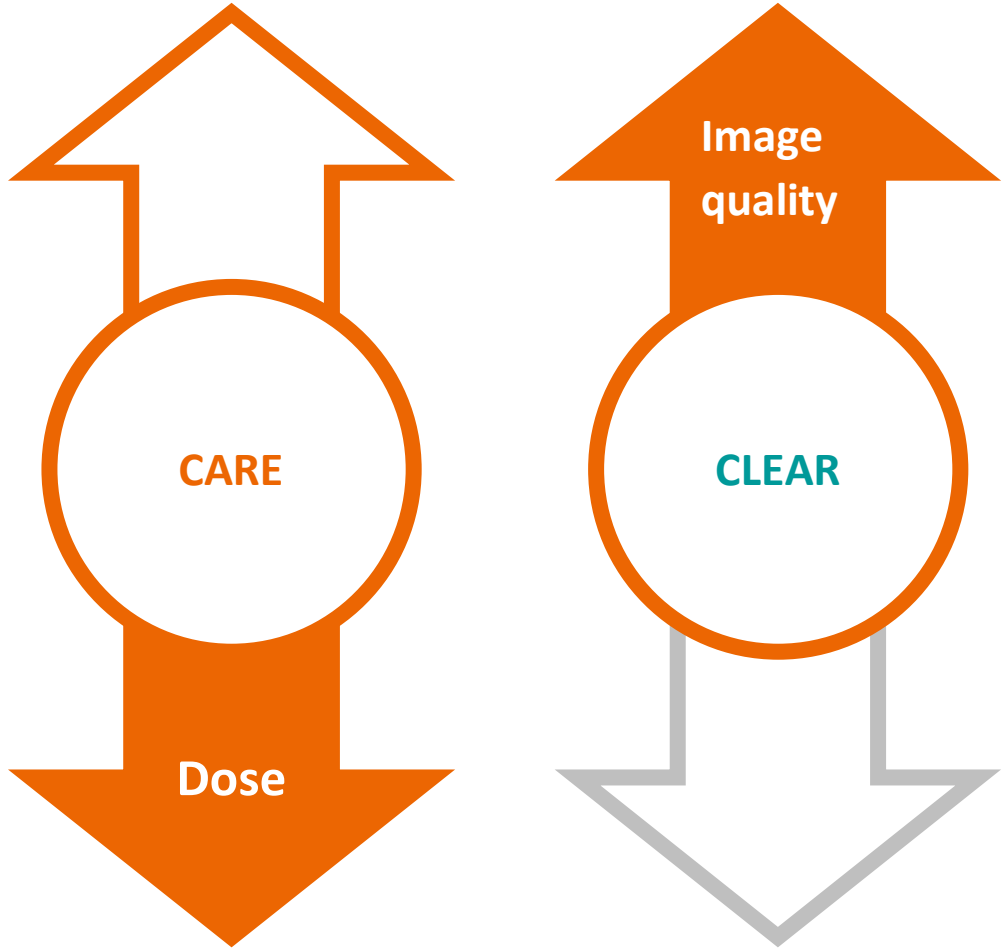
SIEMENS Healthineers

CARE+CLEAR technology takes **CARE** of all dose-saving, monitoring and reporting methods, and all technologies to make your images **CLEAR**.

CARE+CLEAR is our comprehensive portfolio of image-quality and dose-saving tools.

It is a standard with every Artis angiography system.

Unmatched since 1994.

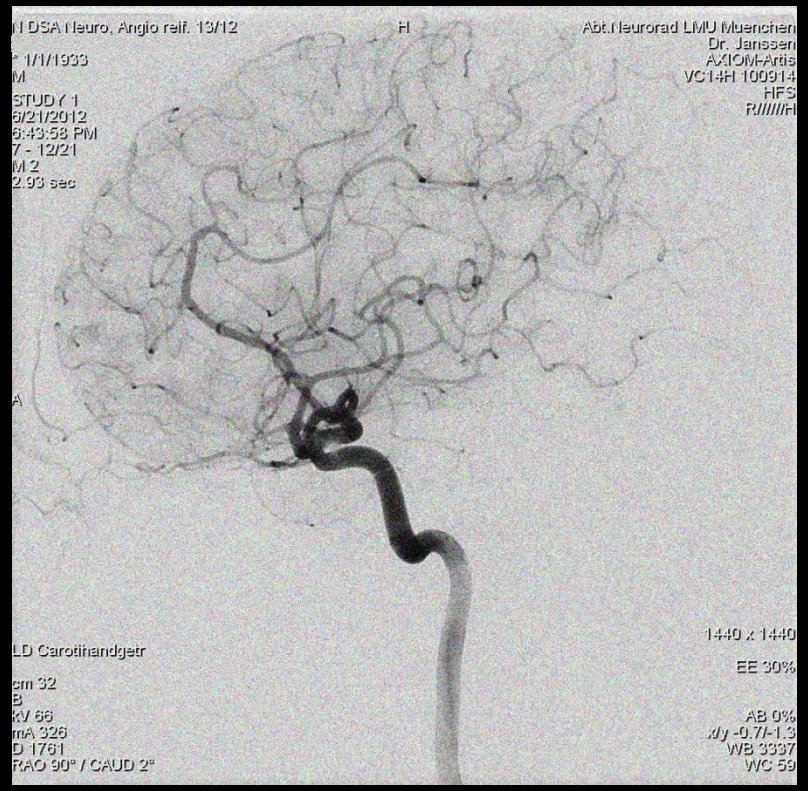


CARE+CLEAR: unmatched since 1994

CARE+CLEAR brings you …

SIEMENS Healthineers

Artis zee biplane w/o CLEARview

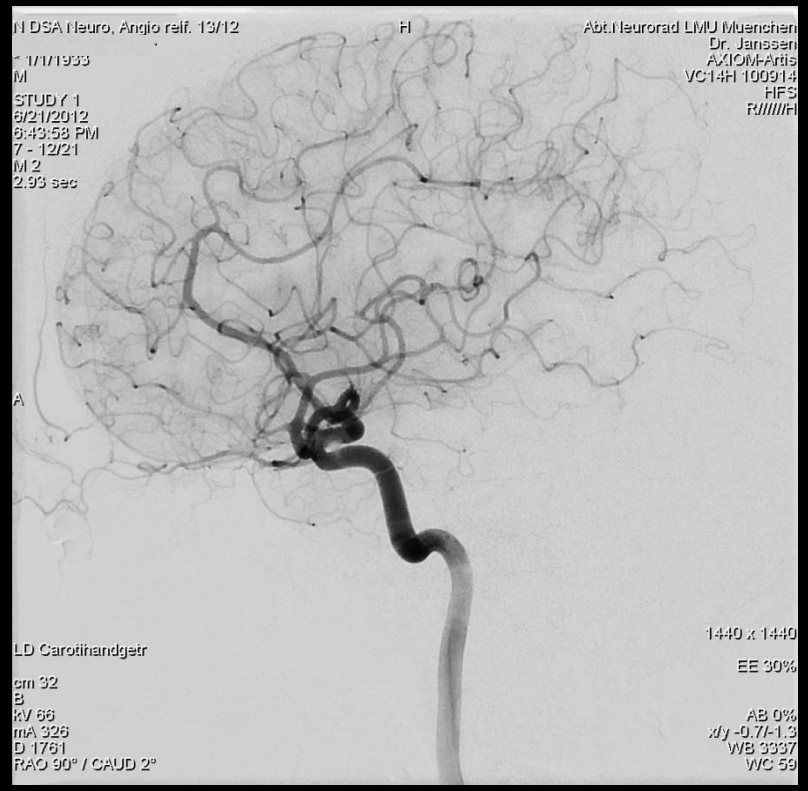


1.761 µGy

Same DOSE

Better IQ

Artis zee biplane with CLEARview



1.761 µGy

Prof. Dr. med. Brückmann, University of Munich, Germany

CARE+CLEAR
answers your challenges

- I want to **reduce dose** for patients, my team and myself
- I need to **monitor dose** during procedures in an easier way
- I need **excellent sharpness and contrast** even if objects are moving
- I need **dose reports** to manage my patient dose more easily
- Whether my patients are tall or short, obese or slender – I need to **see**
- I need image quality that fits **my preferences**

CARE+CLEAR

The optimal image quality at the lowest reasonable dose with CARE+CLEAR

SIEMENS Healthineers

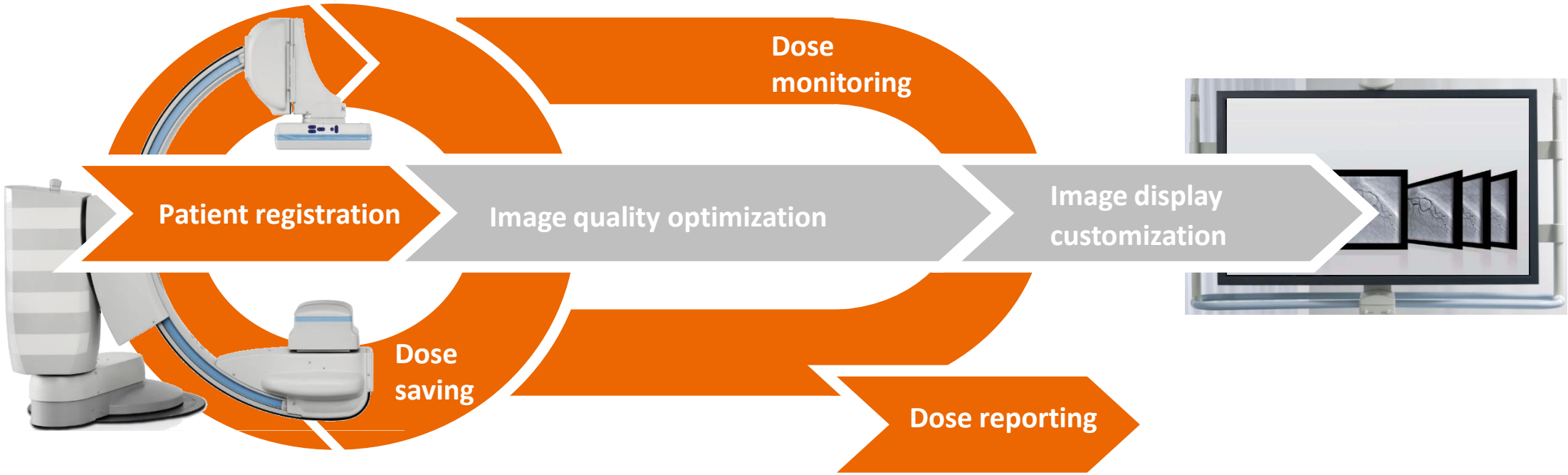
CARE

- **Reduces dose** to a minimum
- Provides **dose monitoring** during the procedure
- Makes **dose reporting** easy and structured

CLEAR

- Achieves optimized **image acquisition** with all patients
- Applies comprehensive **image processing** for excellent sharpness and contrast
- Allows **image display** customization

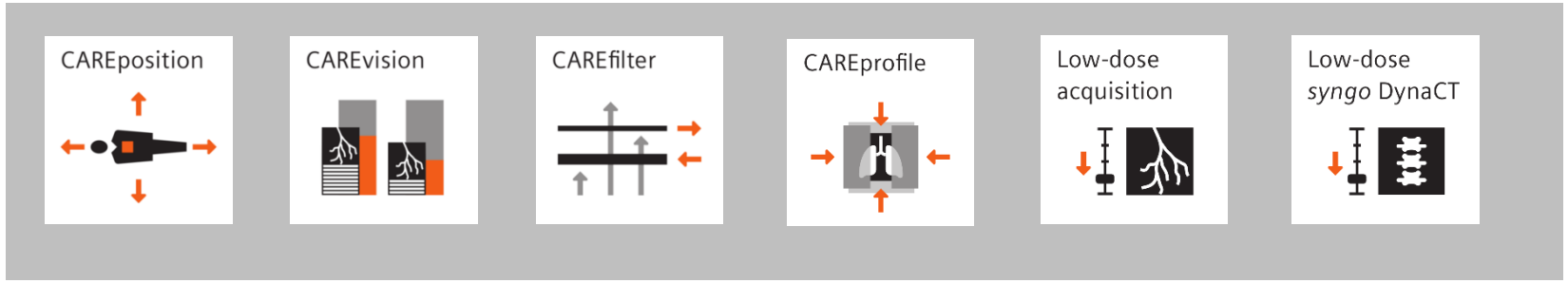
The optimal image quality at the lowest reasonable dose with CARE+CLEAR



CARE
Combined Applications to Reduce Exposure

SIEMENS Healthineers

Dose saving



Dose monitoring

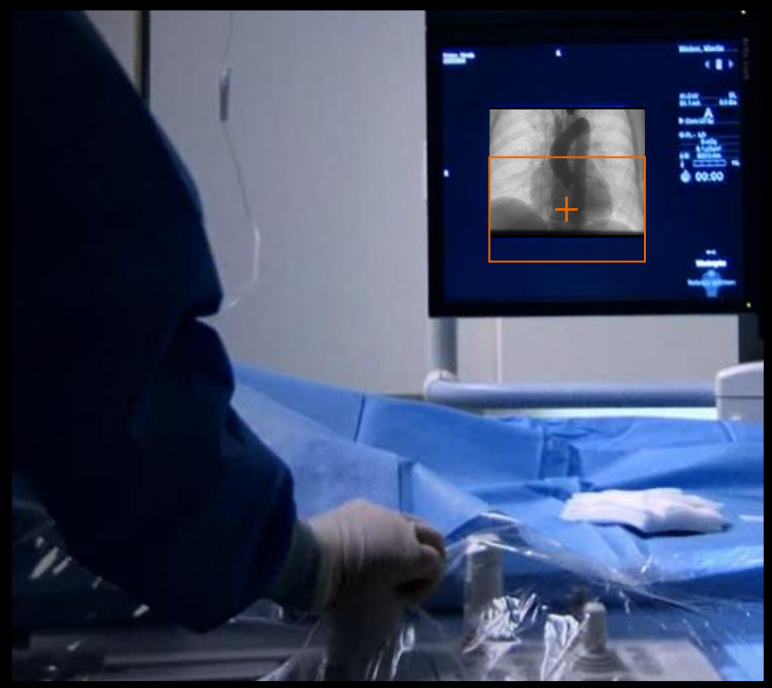
Dose reporting

Our philosophy to deliver better care at the lowest reasonable dose.

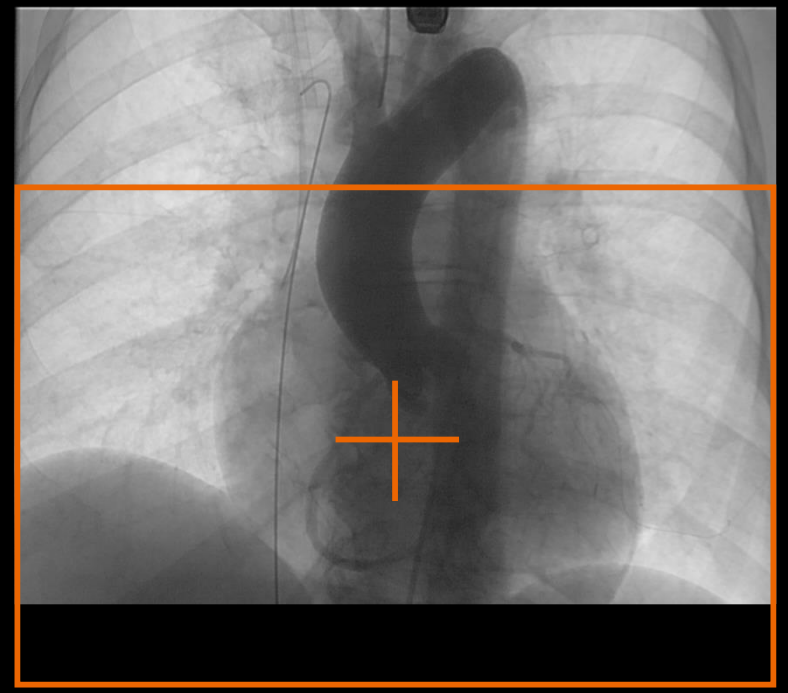
CAREposition

SIEMENS Healthineers

CAREposition allows patient positioning without fluoroscopy while moving the table or C-arm.



LIH



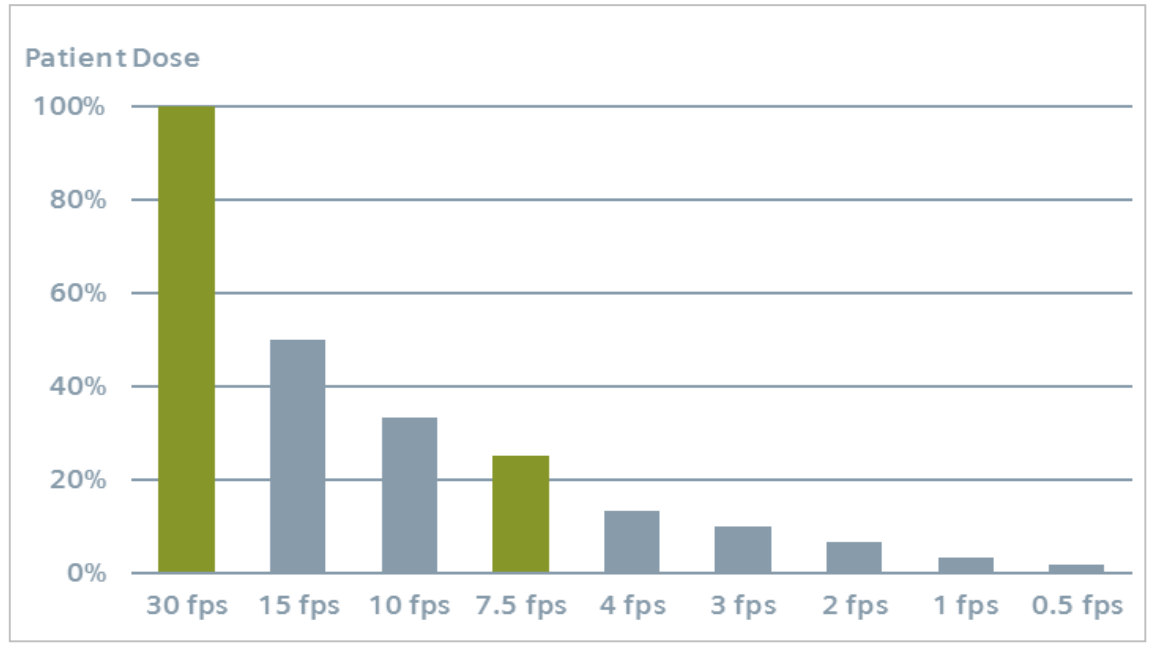
Dr. med. Philipp Kiefer, Heart Center Leipzig, Germany

CAREposition provides radiation-free patient positioning

CAREvision

- Variable fluoro pulse rates
- From 30 p/s down to 0.5 p/s
- Low frequencies to meet individual dose-saving targets
- Patient dose reduction by lowering pulse rate during fluoroscopy

E.g. the reduction from 30 p/s to 7.5 p/s at 70 kV results in a dose savings up to 75%



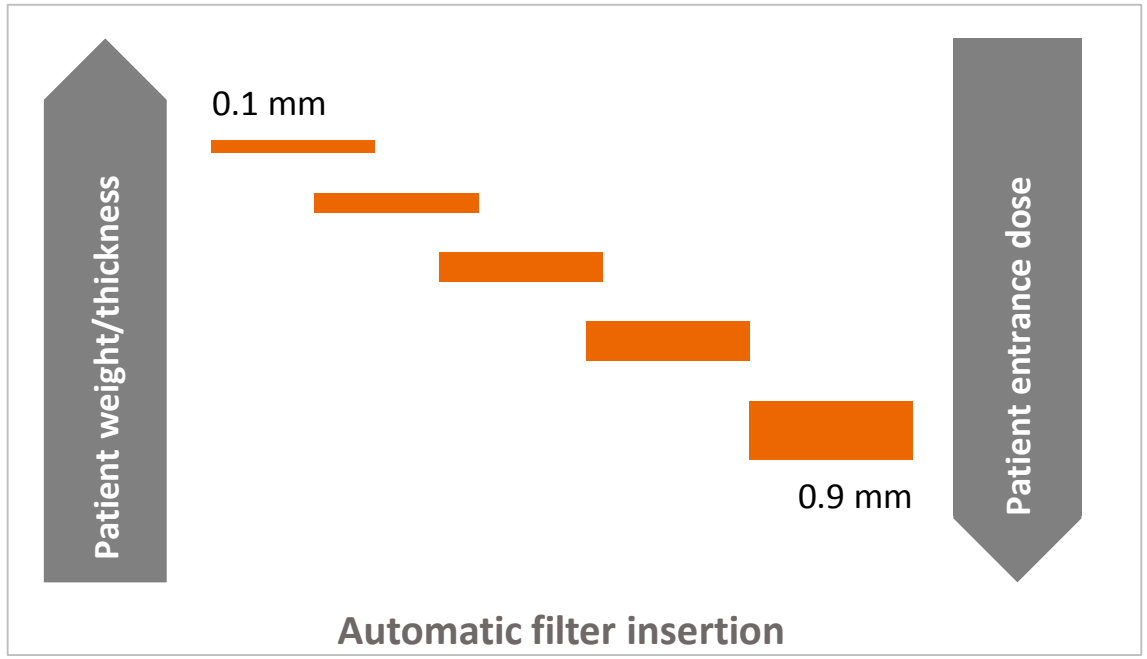
Dose savings up to

75%

CAREvision

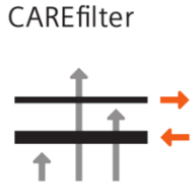
CAREfilter

- Variable copper pre-filtration (0.1 mm – 0.9 mm)
- Automatically set according to the absorption of the X-ray beam by the patient
- Always maintain the lowest reasonable patient entrance dose without degrading image quality
- No user interaction required



Dose reduction up to

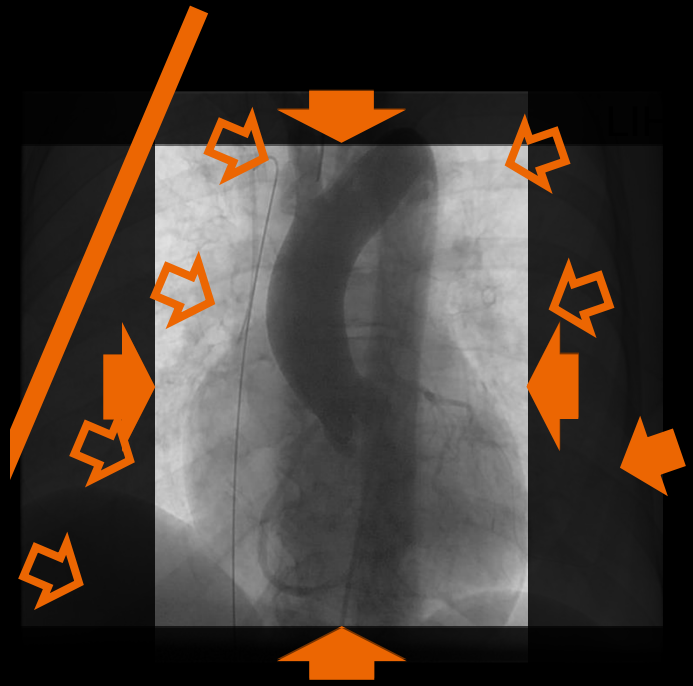
50%



CAREprofile

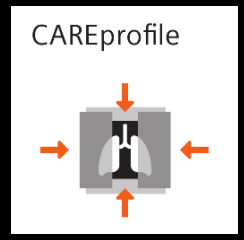
On the last image hold (LIH) screen,

- Radiation-free adjustment of collimators
- Radiation-free semitransparent filter position setting



Dr. med. Philipp Kiefer, Heart Center Leipzig, Germany

Radiation-free collimation and filter setting



Low-dose acquisition

- Low-dose protocols
- Reduced radiation during acquisition
- Can be selected from the footswitch

Dr. Niall McEniff, St. James's Hospital, Dublin, Ireland

Dose savings up to

67%

Low-dose acquisition

Low-dose *syngo* DynaCT

SIEMENS Healthineers

- 3D imaging for especially radiosensitive patients
- Reduced dose in comparison to regular 3D protocols
- 5 sec protocol at 0.1 µGy/frame instead of 0.36 µGy/frame
- Excellent imaging results at only 0.1 mSv

Dr. med. Martin Glöckler, Pediatric Cardiology Erlangen, Germany

Dose savings up to

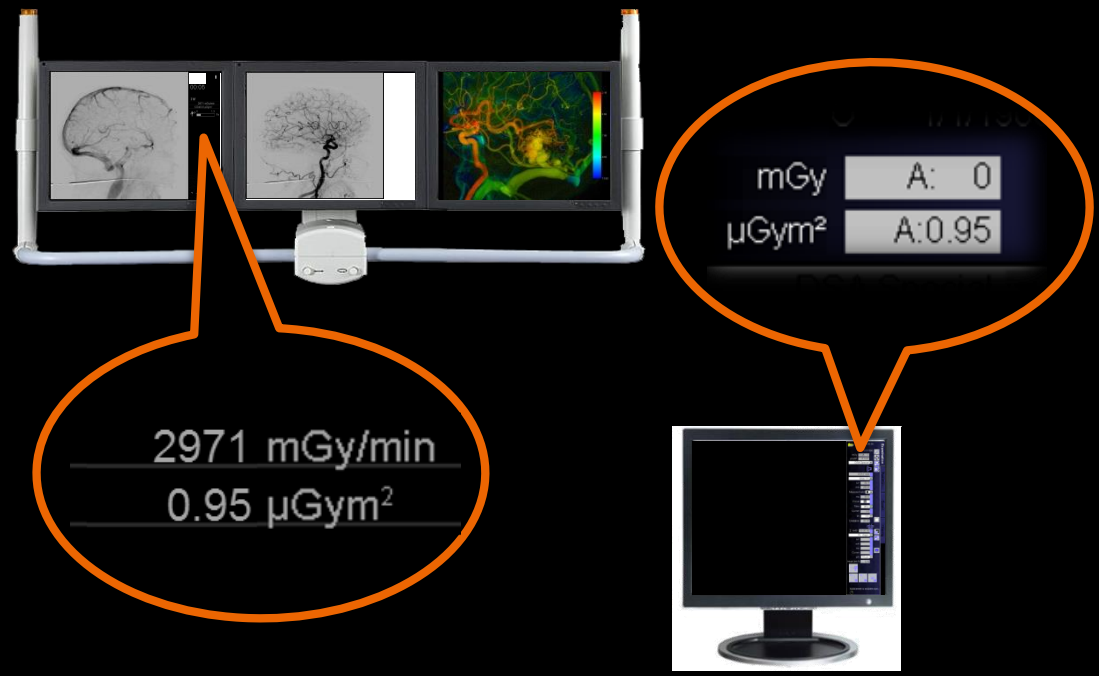
72%

Low-dose *syngo* DynaCT

CAREwatch

CAREwatch displays the dose area product (DAP) the air kerma rate or the air kerma[1)] at the interventional reference point on the live display in the examination and control rooms.

During fluoroscopy/acquisition	Without radiation
Current value of the reference air kerma rate in mGy/min	Accumulated value of the reference air kerma in mGy
Accumulated value of the reference air kerma in mGy	Accumulated dose area product in µGym²



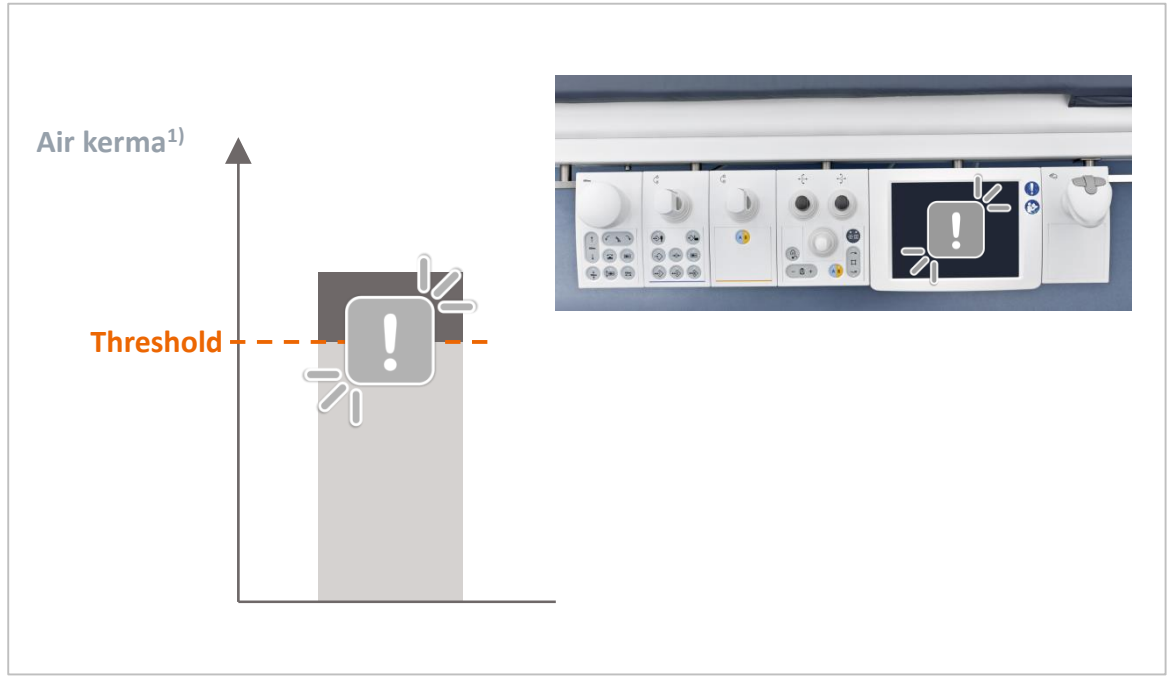
CAREwatch makes dose visible

[1)] Air kerma rate = patient entrance dose rate; air kerma = patient entrance dose

CAREguard

Three thresholds can be defined;
when one threshold exceeded

- A dose skin indicator on the live display flashes
- A warning pop-up is displayed on the tableside touch screen controller (TSC)



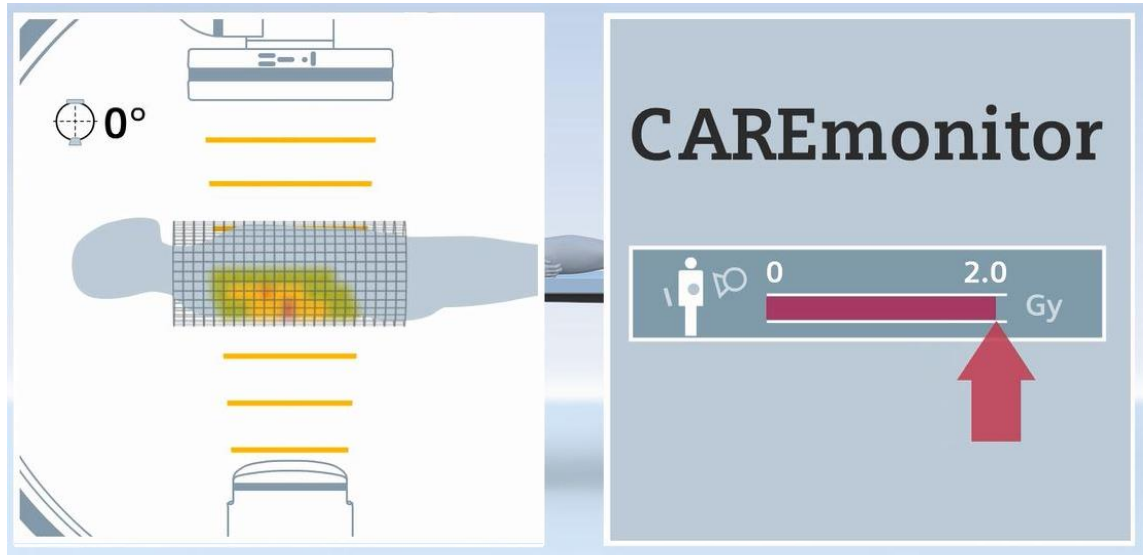
CAREguard

CAREguard provides effective patient entrance dose[1)] control

[1)] air kerma = patient entrance dose; air kerma rate = patient entrance dose rate

CAREmonitor

- Real-time visualization of accumulated peak air kerma[1)] according to current projection
- Automatic update of accumulated air kerma calculation upon every system change
- Warning message is displayed if the configured threshold has been reached in the current projection



Real-time patient entrance dose[1)] monitoring

CAREmonitor

[1)] air kerma = patient entrance dose; air kerma rate = patient entrance dose rate

CAREreport

CAREreport provides detailed information on the dose applied in a case in a DICOM structured overview

- Review and optimize your dose
- Be prepared for dose reporting requests
- Easily obtain base data for more detailed analysis
  → e.g. teamplay, CAREanalytics

CAREreport provides a DICOM structured dose report

CAREreport

New EU-wide dose directive effective February 2018

EU countries introduce national reference levels for X-ray dose.

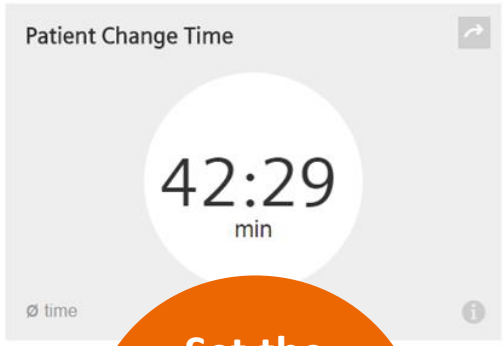
Challenges for interventionalists:

- Match **national benchmark** for dose
- Need for **regular review** and **corrective action**
- In **need of services** to fulfill the new directive

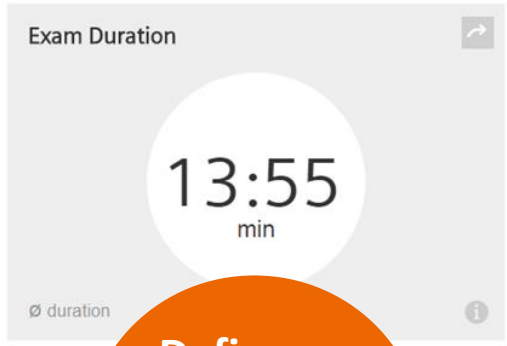
EURATOM

Defines EU-wide basic safety standards for protection against ionizing radiation.

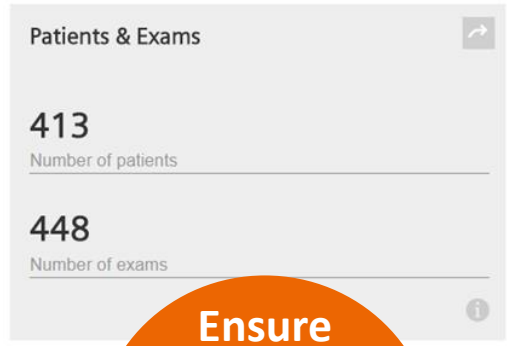
teamplay Dose and AT – the perfect match to optimally adhere new guidelines



Set the national reference value



Define an internal reference value

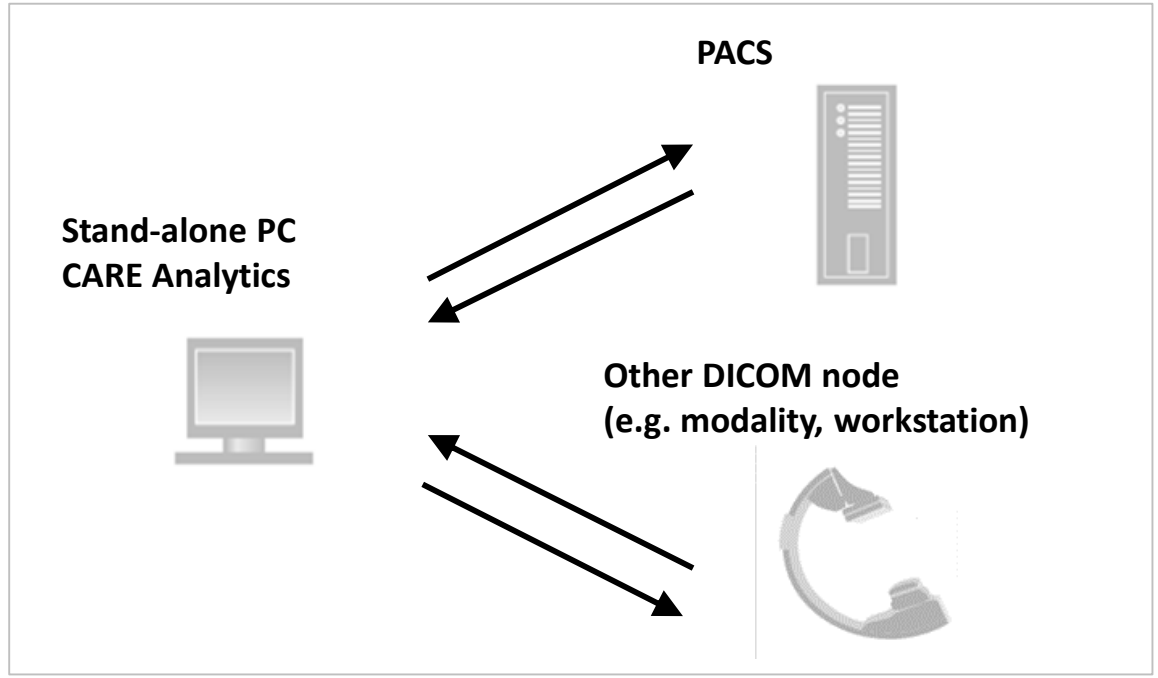


Ensure dose values are within the pre-set target

Application free of charge!

CARE Analytics

- Enhanced in-house dose reporting and assessment
- Enhanced transparency regarding dose per case
- Improved reporting on patient dose history
- Improved cross-institutional reporting



CARE Analytics

CARE Analytics provides cross-institutional dose reporting

CLEAR – A standard in all Artis systems since 1994

SIEMENS Healthineers

Optimizing image quality

Image Acquisition

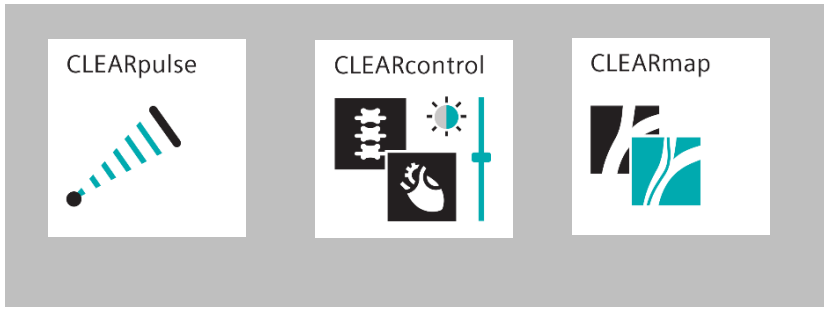
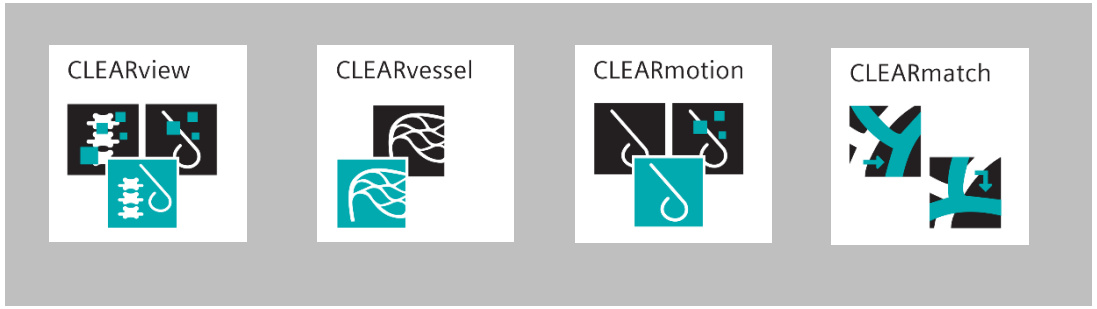


Image Processing



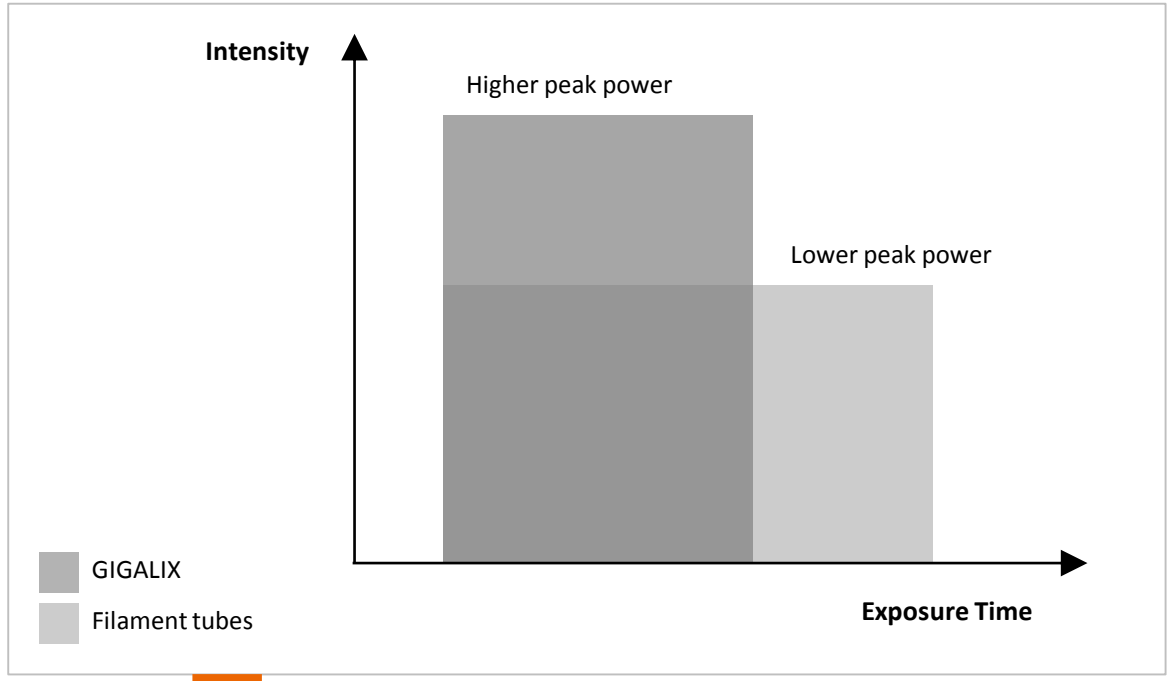
Customizing image quality

Provides optimal image quality to help increase certainty during interventions.

[1] Available for Artis Q/Artis Q.zen

CLEARpulse

- The new, grid-pulsed flat emitter technology allows short pulses with steep edges
- Moving objects can be visualized with fewer blurring artifacts
- Sharper images and optimized dose



Shorter pulses up to

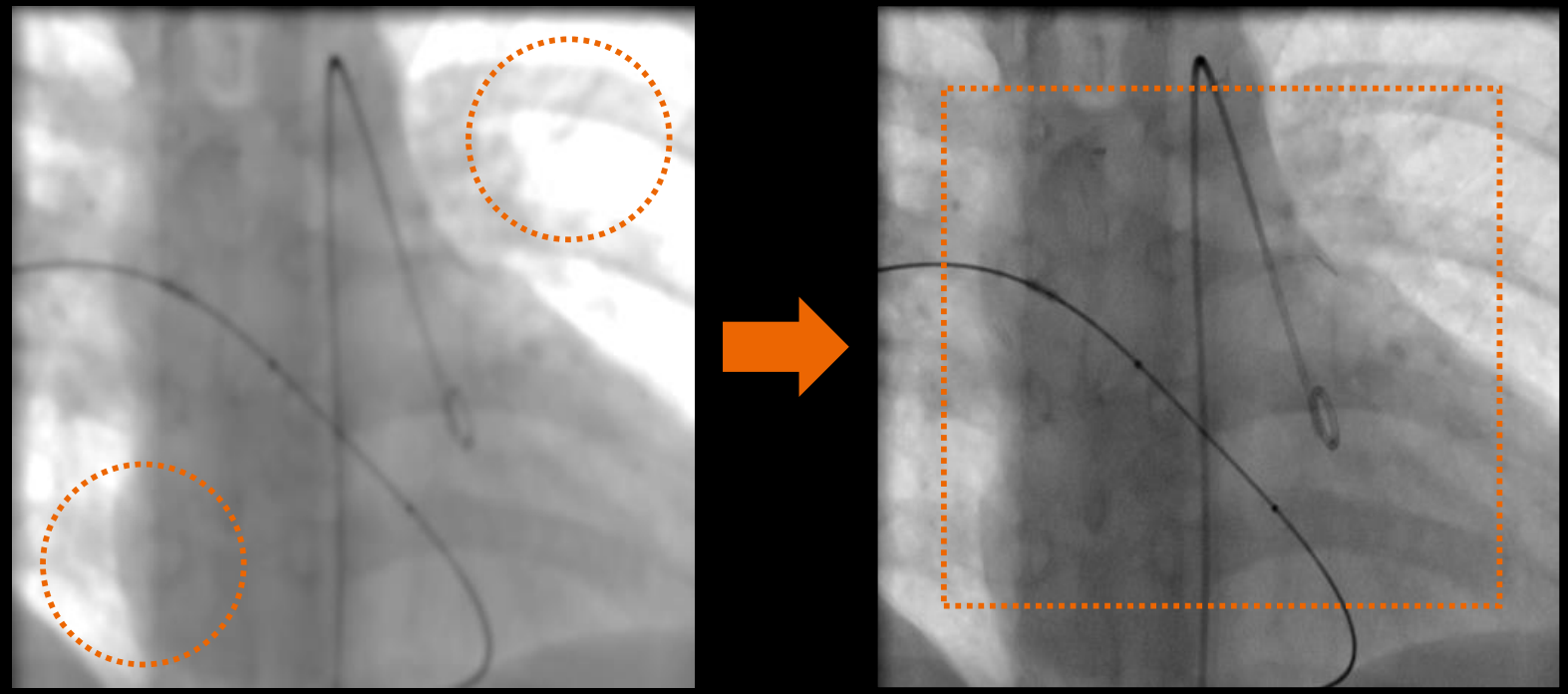
43%[1)]

CLEARpulse

[1)] Product Claims for Artis Q/Q.zen

CLEARcontrol

- Enhanced image creation process with unique histogram analysis
- Optimized contrast and brightness throughout the entire image
- Improved structure visualization near the diaphragm

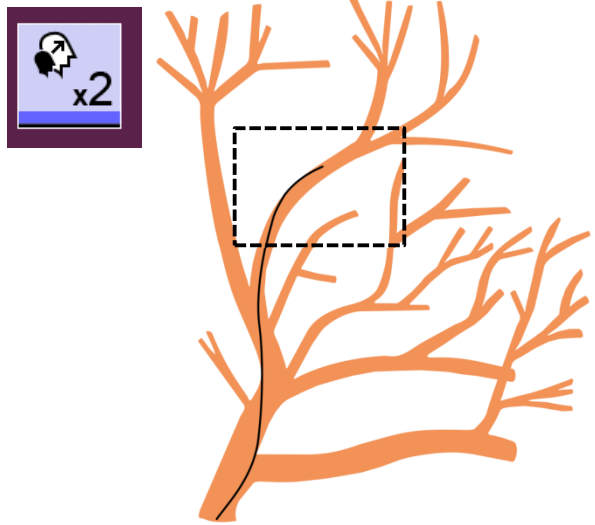


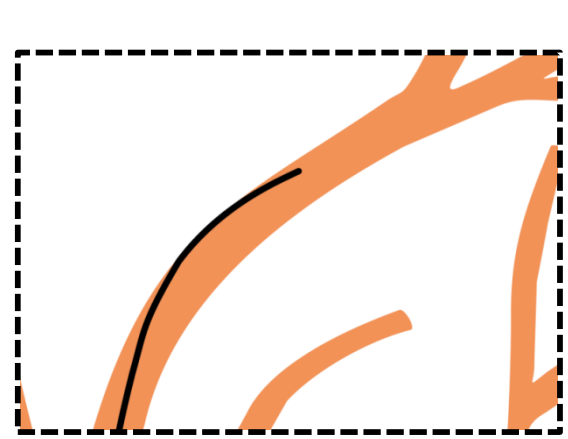
Dr. med. Andreas M. Zeiher, University Hospital Frankfurt, Germany

CLEARcontrol optimizes image brightness and contrast

CLEARmap[1)]

- Individual windowing of tools and vessels
- Select any DSA reference image as Roadmap Mask with one click
- Save dose and contrast by zoom&pan during Roadmap
- Optimized AVM treatment with Show Progress





Enabled by PURE®

CLEARmap provides fast and easy access to enhanced image quality in Roadmap

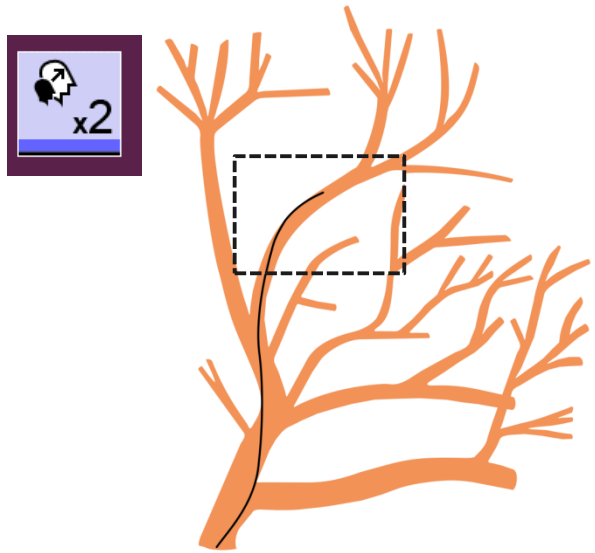
CLEARmap

[1)] Available on Artis with PURE®

Save dose & contrast with zoom & pan in RDMP

- Individual windowing of tools and vessels
- Select any DSA reference image as Roadmap Mask with one click
- Save dose and contrast by zoom&pan during Roadmap
- Optimized AVM treatment with Show Progress

Live image



Electronic zoom to target area

Enabled by PURE®

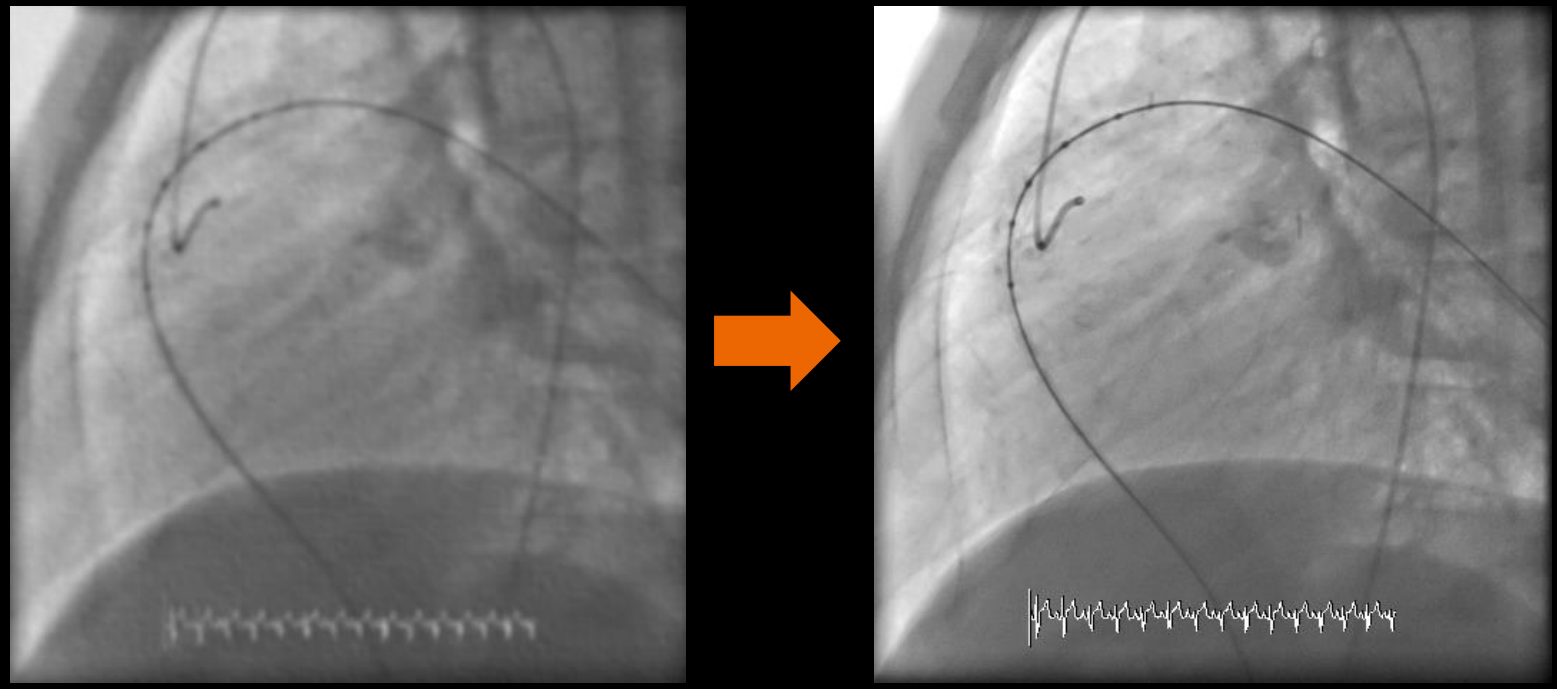
CLEARmap

CLEARmap provides fast and easy access to enhanced image quality in Roadmap

[1] Available on Artis with PURE®

CLEARview

- Enhances overall image quality, especially when using low-dose imaging protocols
- Dose-adaptive noise reduction

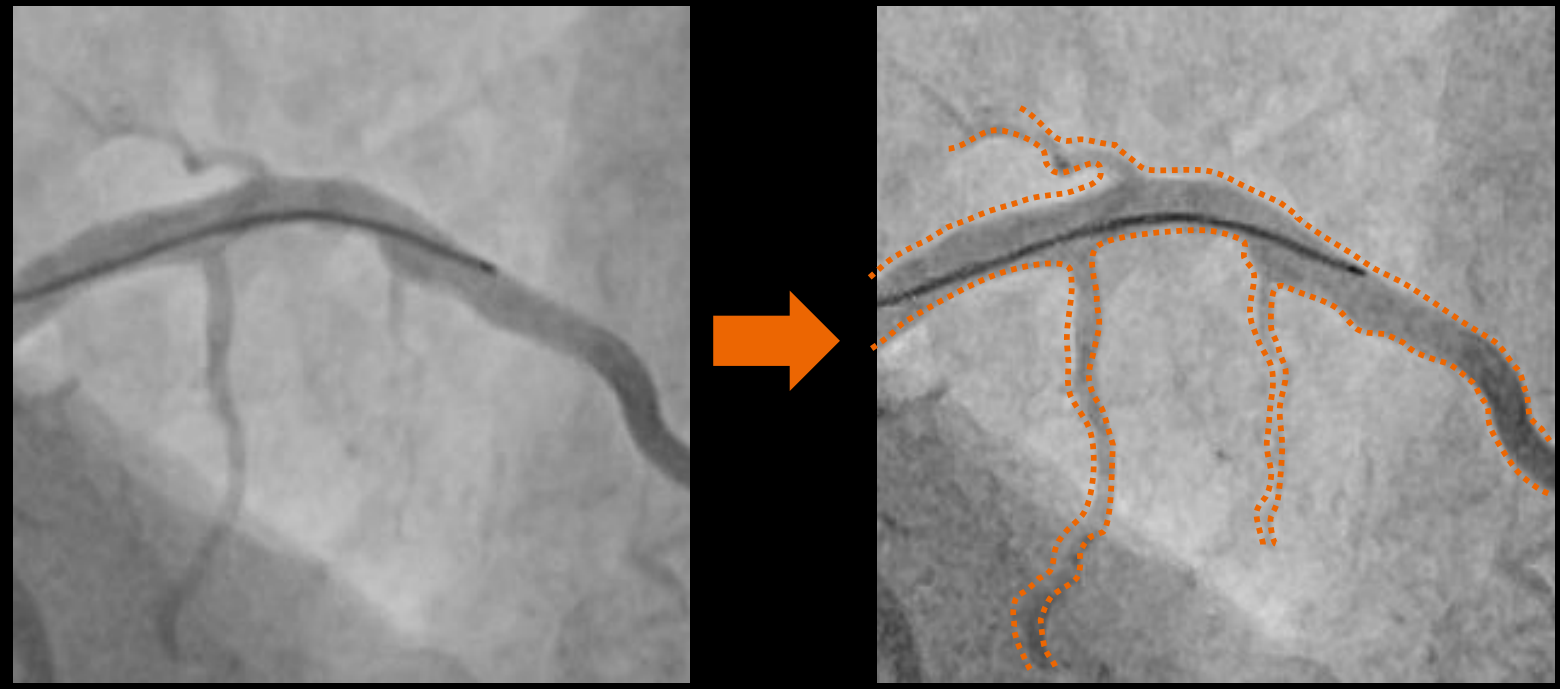


Prof. Dr. med. Andreas M. Zeiher, University Hospital Frankfurt, Germany

Enhanced image quality in low-dose

CLEARvessel

- Automatic detection of vessel edges
- Enhanced contrast and visibility of vessel edges without increasing the noise

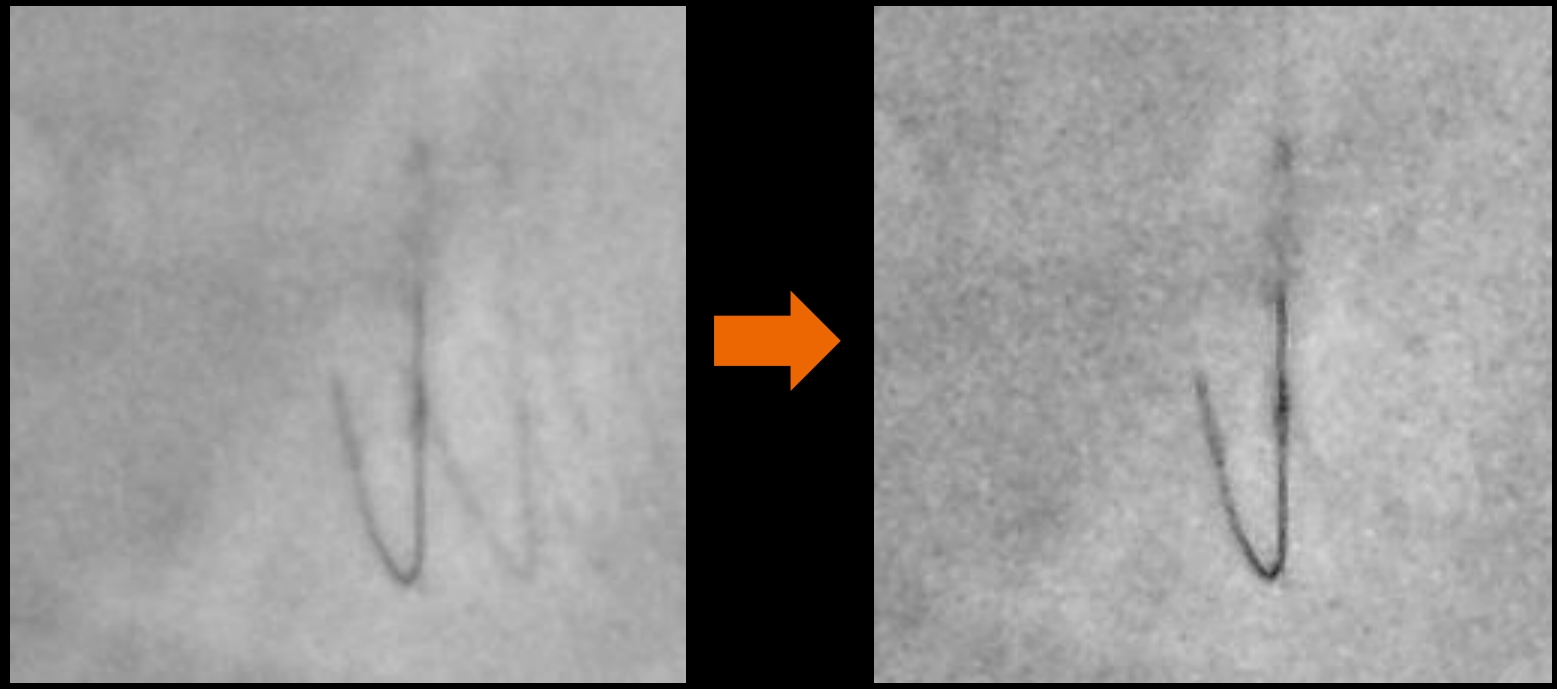


Prof. Dr. med. Andreas M. Zeiher, University Hospital Frankfurt, Germany

CLEARvessel provides sharp vessel edges

CLEARmotion

- Automatic detection of small structures
- Efficient compensation of motion artifacts
- Optimal visualization of small vessels and guidewires in the beating heart

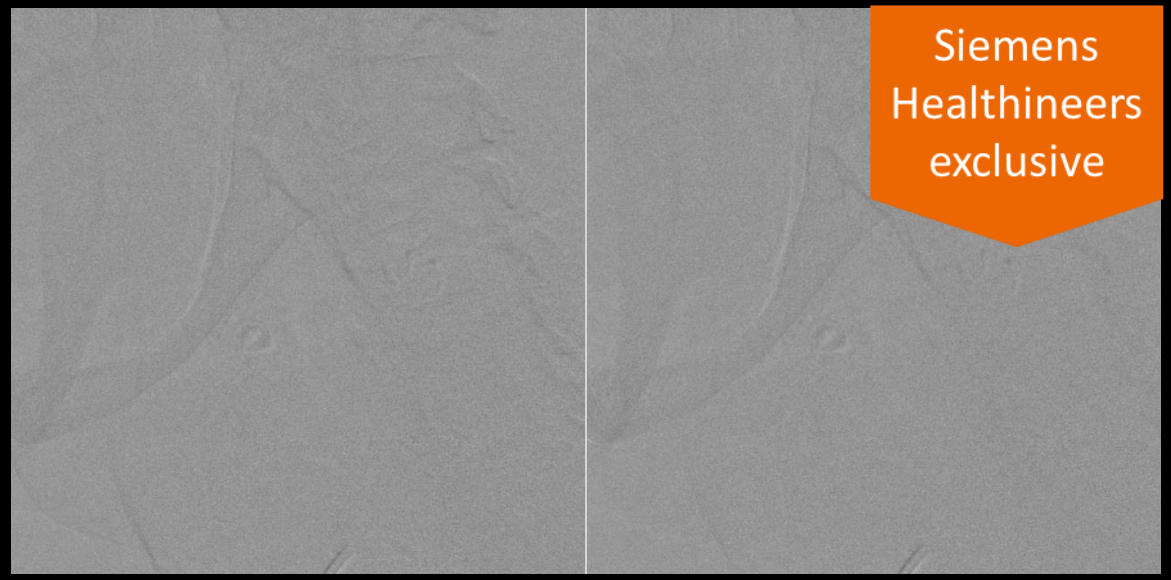


Prof. Dr. med. Chapot, Alfred Krupp Hospital Essen, Germany

CLEARmotion provides efficient motion artifact compensation

CLEARmatch[1)]

- Optimized image-quality by next generation real-time pixel shift
- Compensation of motion with unique, industry-leading pixel-shift in six dimensions



w/o CLEARmatch **with CLEARmatch**

Enabled by PURE®

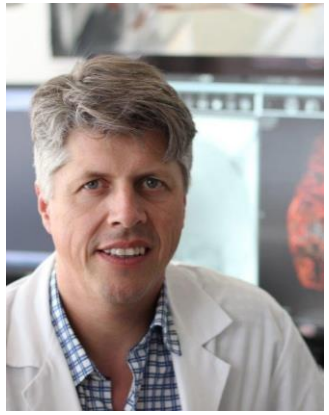
CLEARmatch compensates for patient movement with next generation real-time pixel-shift

CLEARmatch

Prof. Dr. med. Chapot, Alfred Krupp Hospital Essen, Germany

[1)] Available on Artis with PURE®

New on Artis with PURE:
CLEARmatch & CLEARmap



"CLEARmatch provides crystal-clear images; this saves a lot of time."

Johannes Weber, MD

Advanced Therapies of Diagnostic and Interventional Neuroradiology

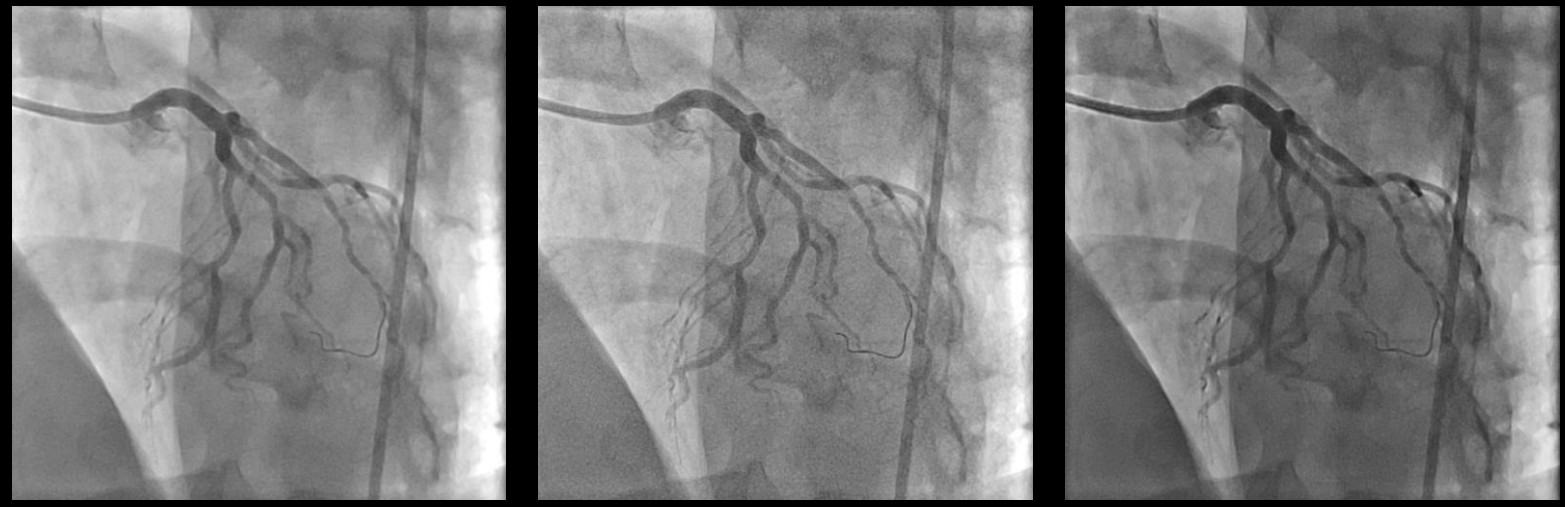
Kantonsspital St. Gallen

Switzerland

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.

CLEARchoice

- Customized image quality to your individual preferences
- Preferred image quality selection during application



Dr. med. Andreas M. Zeiher, University Hospital Frankfurt, Germany

CLEARchoice provides customized image quality

CARE+CLEAR – The optimal image quality at the lowest reasonable dose

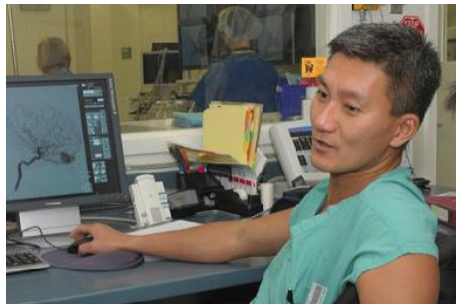
SIEMENS Healthineers

- **Reduces dose** to a minimum
- Provides **dose monitoring** during the procedure
- Makes **dose reporting** easy and structured
- Achieves optimized **image acquisition** with all patients
- Applies comprehensive **image processing** for excellent sharpness and contrast
- Allows **image display** customization

CARE+CLEAR: Improving image quality and optimizing dose in every Artis system

"We should be concerned about everyone's well-being. And if we can generate better images using less radiation, then it makes sense for us to do so."

Prof. Ansgar Berlis, Klinikum Augsburg



"Despite the lower dose there has been no change in the excellent quality of the angiography."

Henry Woo, M.D., Stony Brooke Medical Center, New York

„The image quality and image resolution are very good even when using the low-dose acquisition protocols."

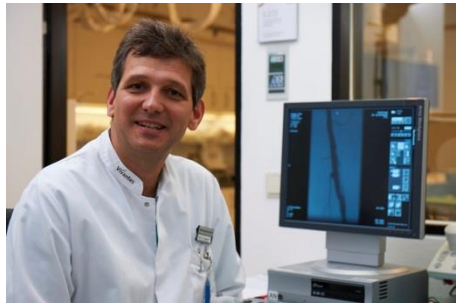
Elisa Ciceri, M.D., Neurological Institute Besta, Milano

"The biggest surprise was that Siemens is making this upgrade available gratis across the whole world. This initiative tells me that Siemens are a company unafraid to show leadership in a critical area."

David Lord, M.D., Westmead Children´s Hospital, Sydney

"These days, when we have a better understanding of the connections between radiology dose and potential illness than we did previously, I think that features that enable us to reduce the dose of radiation should be provided as a matter of course. There should not even be the possibility of choosing differently just to cut costs."

Olaf Göing, M.D., Sana-Klinikum Lichtenberg



"Many interventions these days take several hours, with correspondingly long periods of x-ray exposure. Reducing the dose is essential in these cases, especially for the staff."

Prof. Thomas Albrecht, FRCR, Vivantes Klinikum Neukölln, Berlin

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.

CARE+CLEAR
standard in all Artis systems for your clinical fields

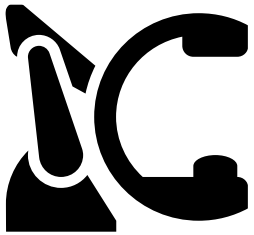
The key to lowest reasonable dose

Automatic Exposure Control

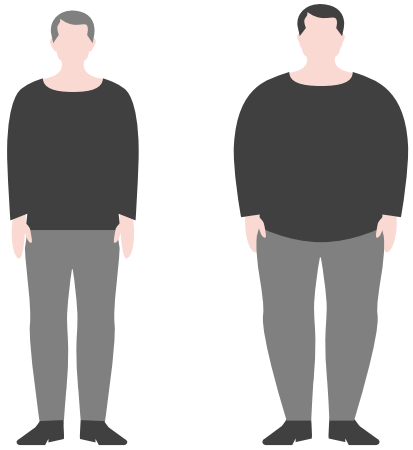
Healthcare provision in interventional angiography is changing…

SIEMENS Healthineers

More complex procedures



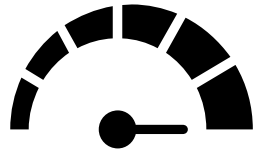
Heavier patients



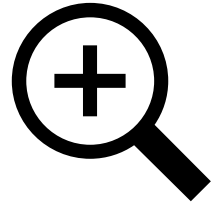
1960 2013

+ 24 lbs.

Longer exposure times



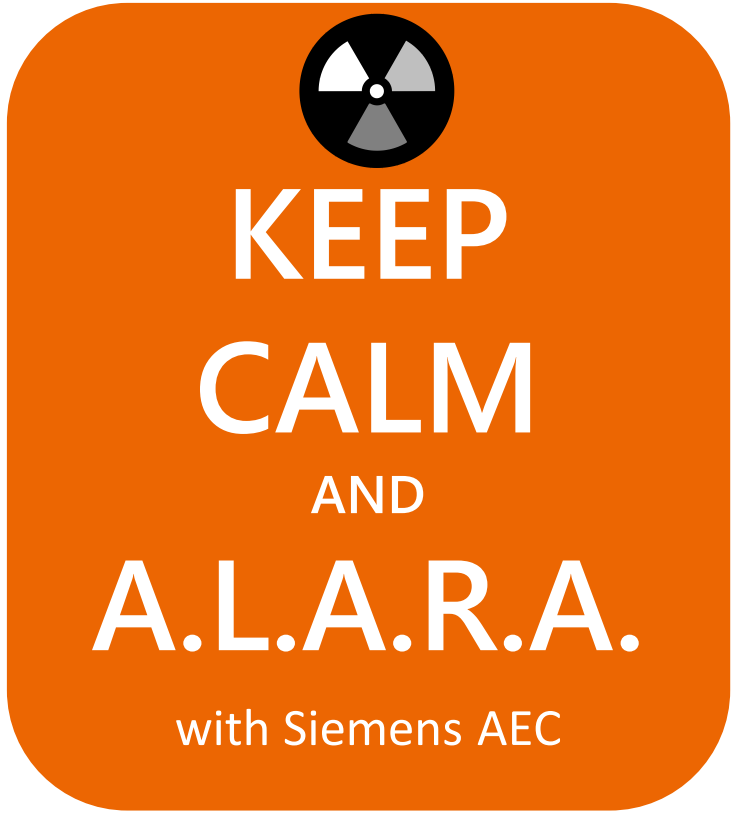
Smaller devices



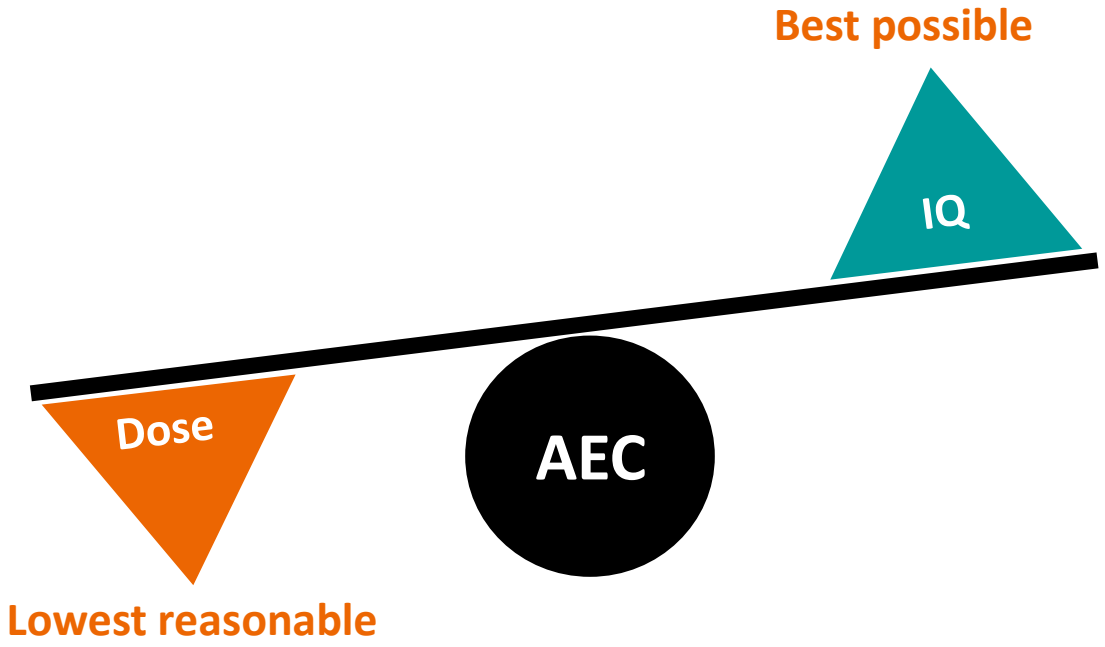
… and sticking to the A.L.A.R.A. principle is more important than ever

SIEMENS Healthineers

Reducing dose and optimizing image quality



Siemens Automatic Exposure Control helps you find the right balance



Siemens-unique five parameter Automatic Exposure Control

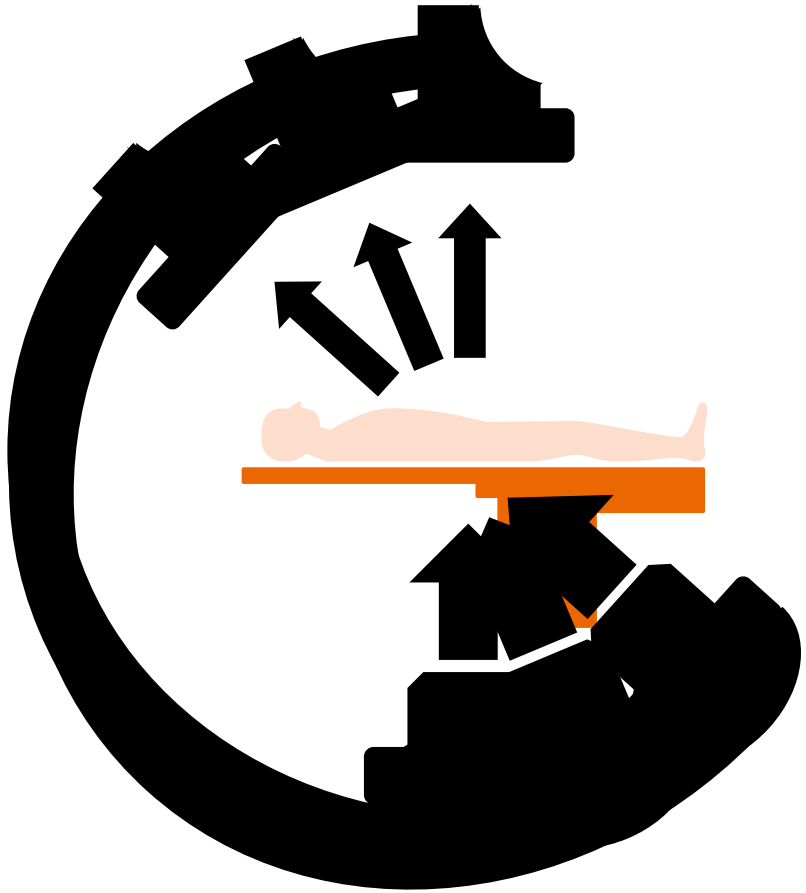
As in a classical quintet, it‘s all about harmonic interaction…

…in order to avoid unbalanced results

Angulation-dependent AEC

SIEMENS Healthineers

The key to optimal image quality and lowest reasonable dose

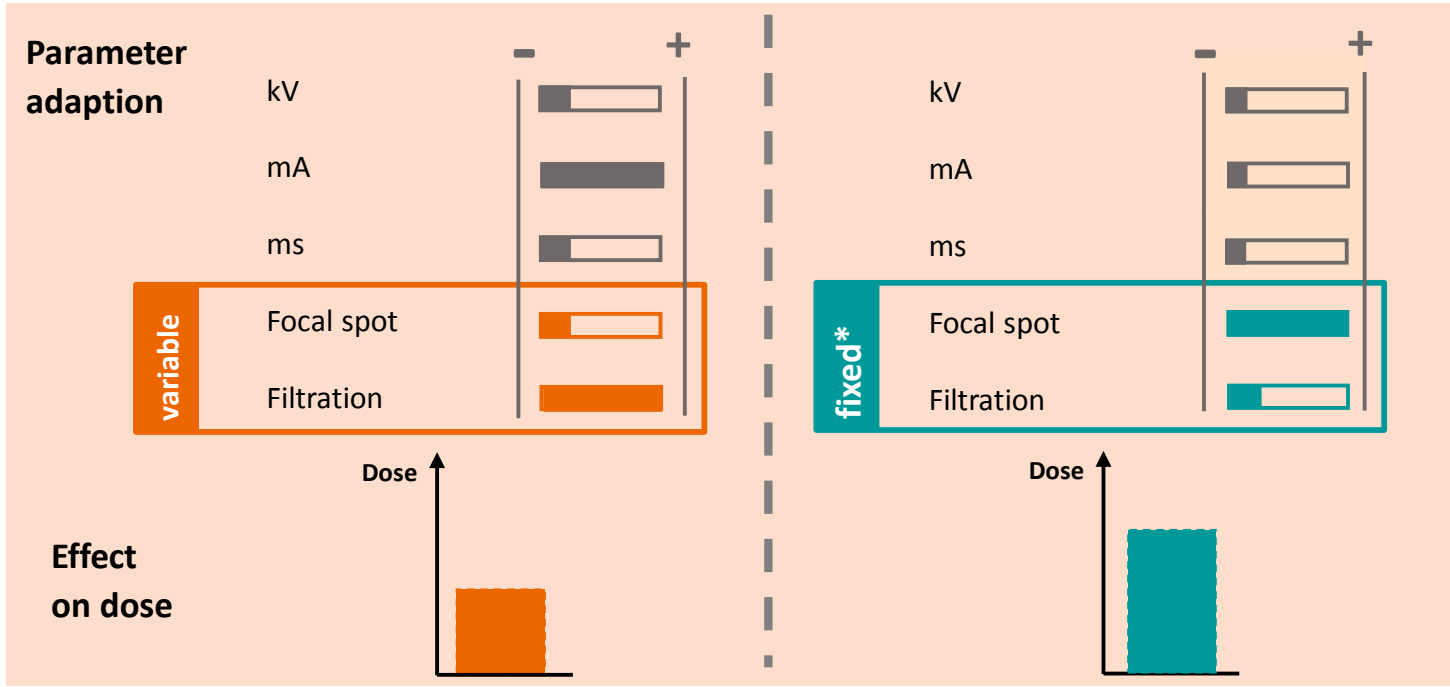


Siemens

5 variable parameters **automatically** adjustable

Other vendors

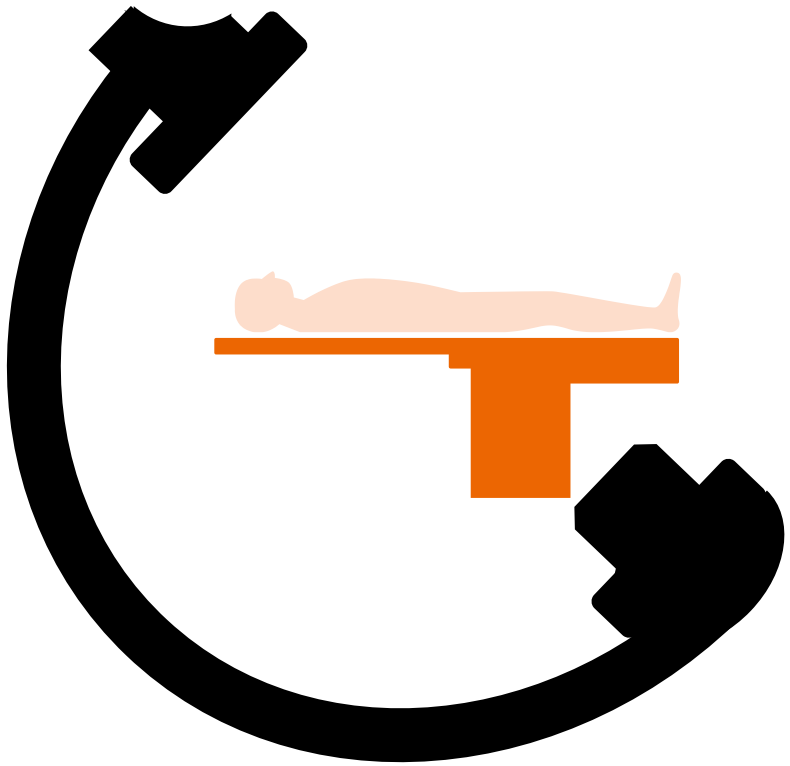
Only 3 variable parameters **manually** adjustable



*within selected organ program

Angulation-dependent AEC

Focal spot – big effect on image quality



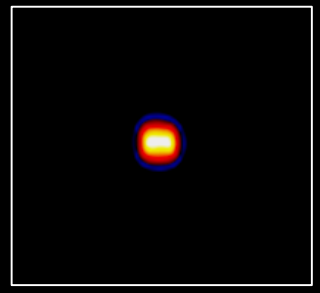
Siemens 5 parameter adaption

Selection of optimal focal spot size

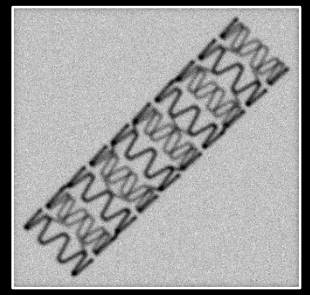
SIEMENS Healthineers

The smaller the focal spot, the lower the patient entrance dose

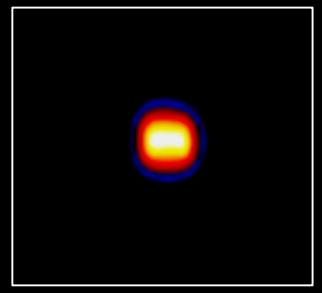
Micro focal spot



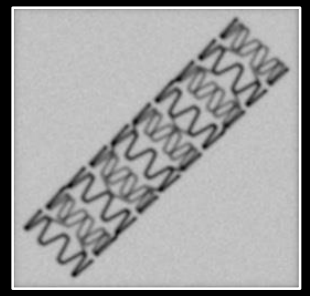
Highest spatial resolution



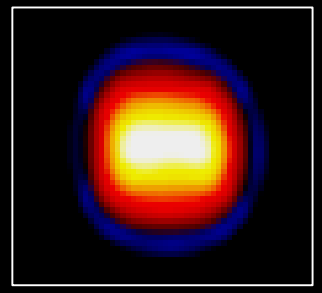
Small focal spot



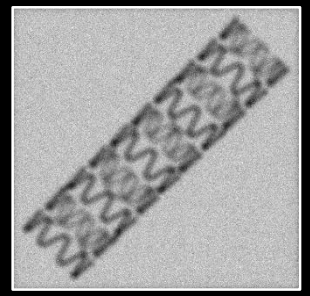
High spatial resolution



Large focal spot



Routine spatial resolution



Siemens AEC

Other vendors

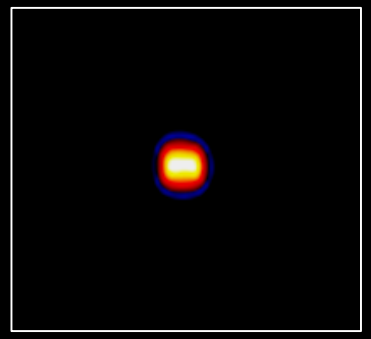
Selection of optimal focal spot size

SIEMENS Healthineers

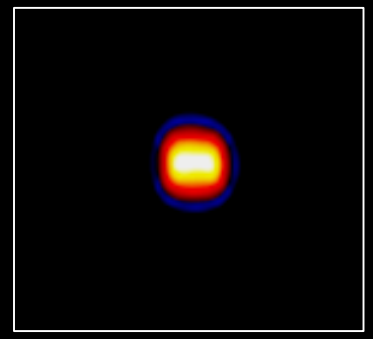
The smaller the focal spot, the lower the patient entrance dose

Spatial resolution

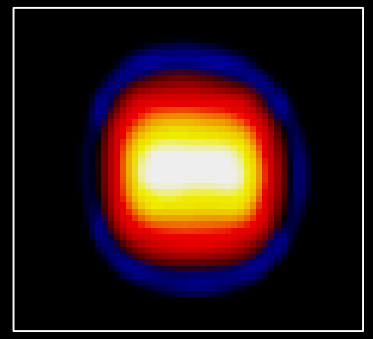
micro focal spot



small focal spot

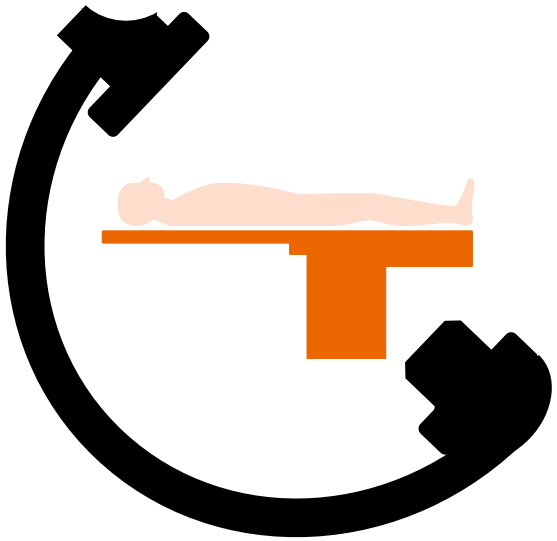


large focal spot

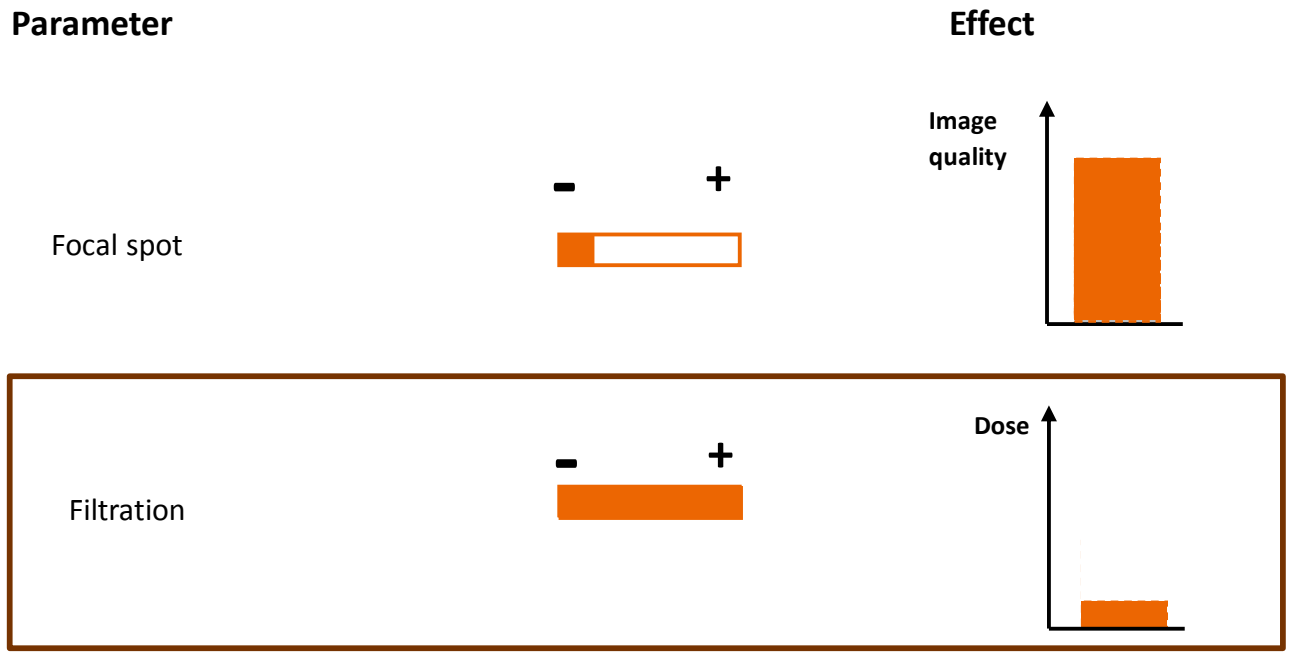


Patient entrance dose

Angulation-dependent AEC
Filtration – big effect on patient dose



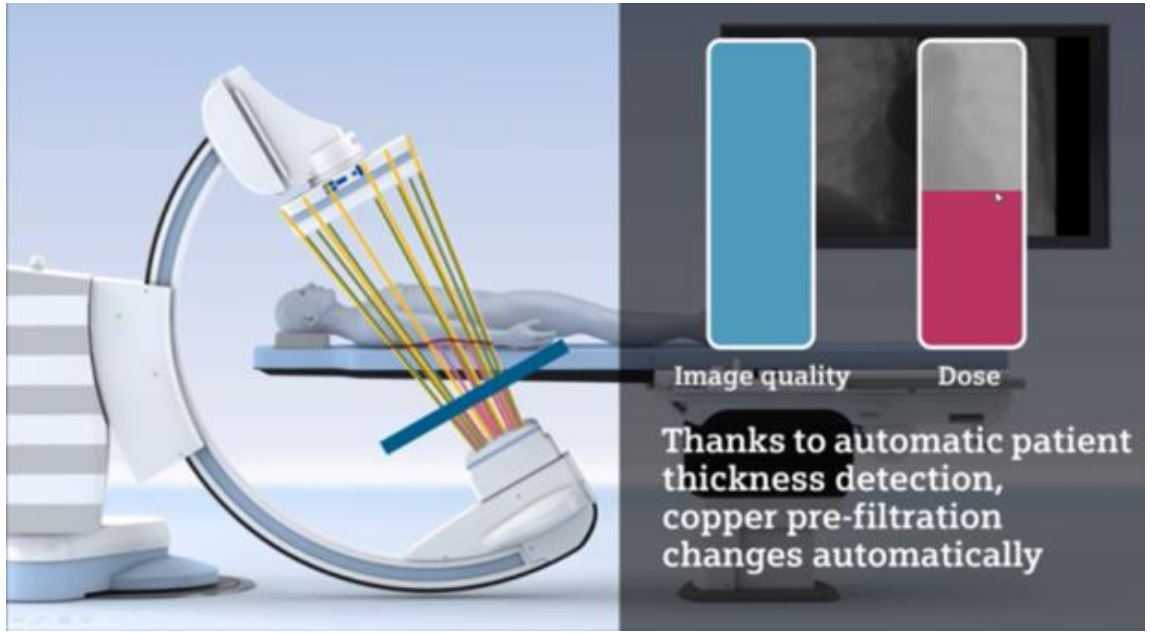
Siemens 5 parameter adaption



Angulation-dependent filtration

The key to lowest reasonable dose

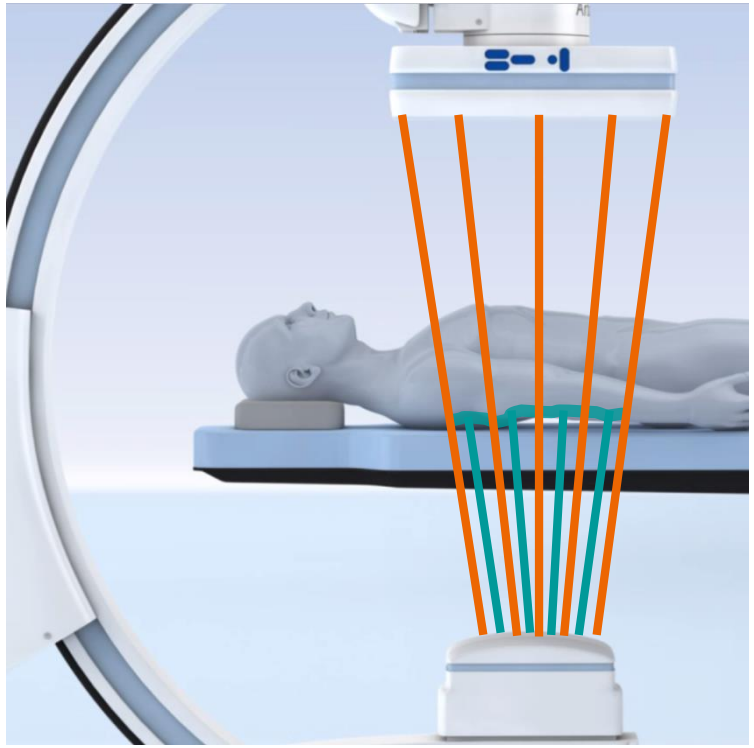
In angiography, copper filters absorb low-energy X-rays to reduce patient dose



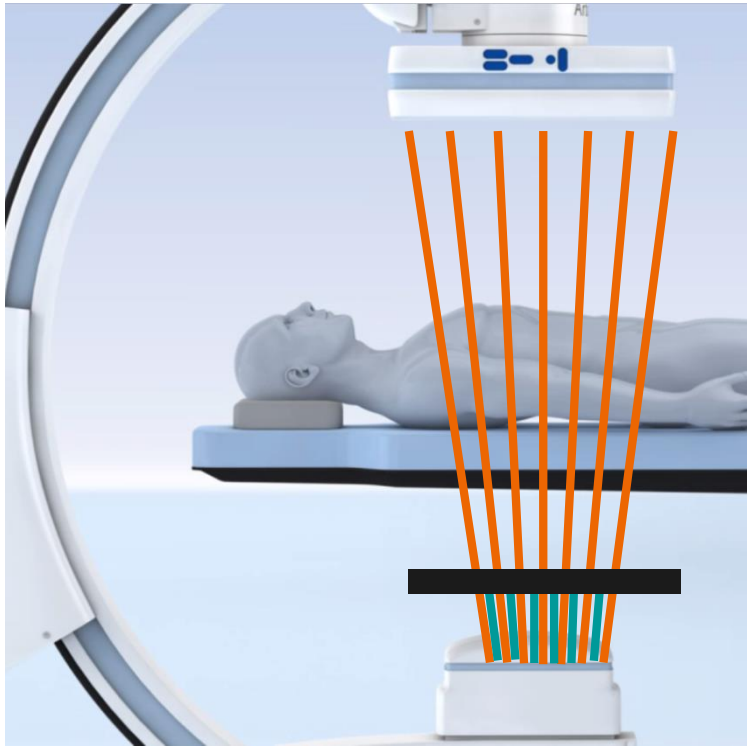
Angulation-dependent filtration

The more copper filtration, the less patient dose

Without copper filtration



With copper filtration



optimal energy X-rays

low energy X-rays

CAREfilter is the automatically adapting copper pre-filtration to the patient‘s thickness by Siemens

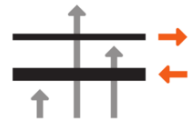
- Variable copper pre-filtration (0.1 mm – 0.9 mm)
- Automatically set according to the absorption of the X-ray beam by the patient
- Always maintain the lowest reasonable patient entrance dose without degrading image quality
- **No user interaction required**

Automatic filter insertion

Dose reduction up to

50%

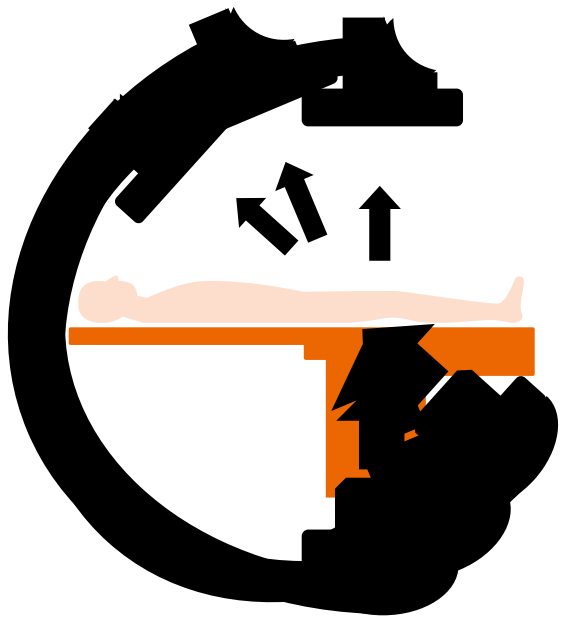
CAREfilter



Summary

SIEMENS Healthineers

The key to optimal image quality and lowest reasonable dose



Siemens AEC

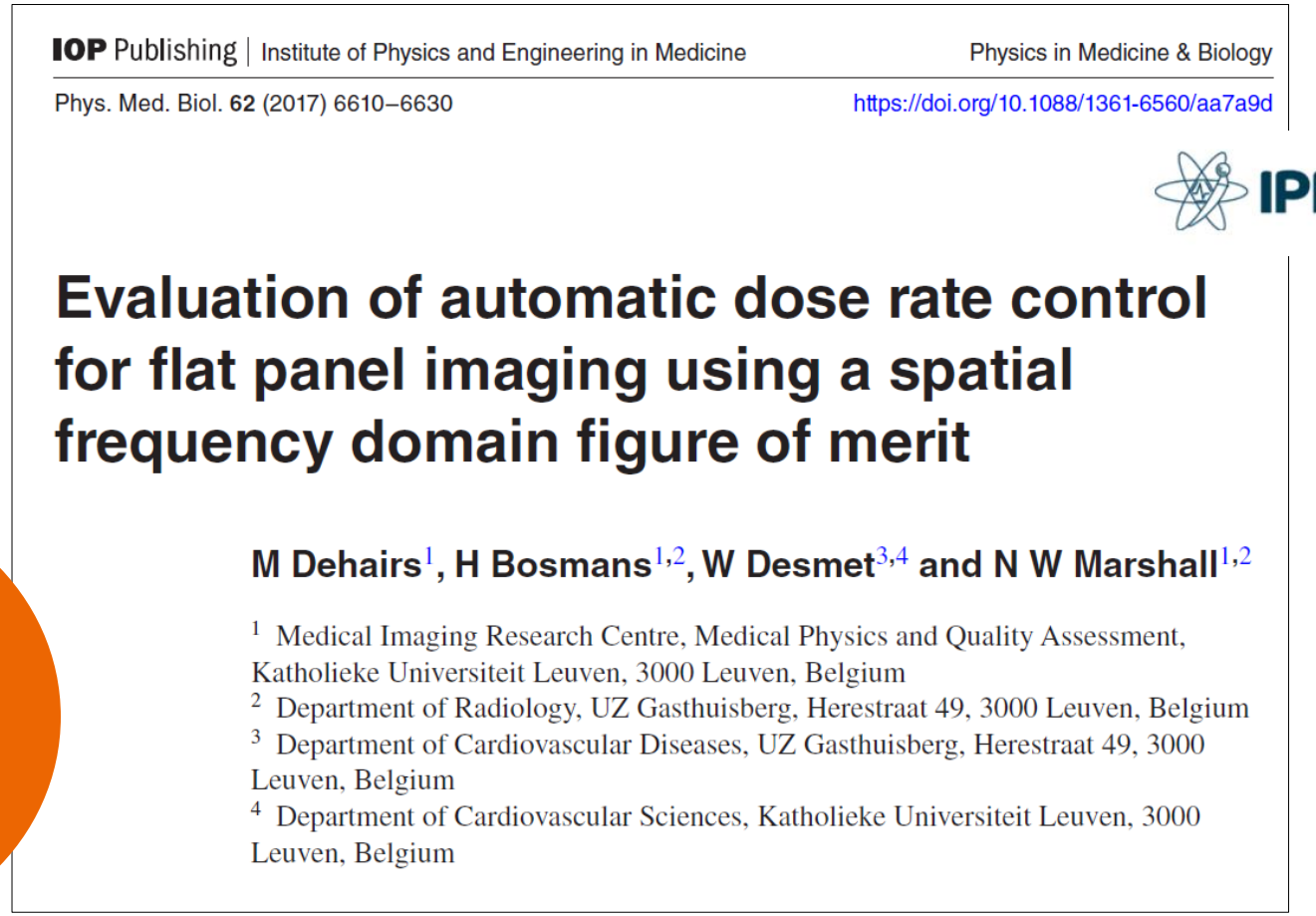
- **5** parameters **automatically** optimized
- Minimized dose **independent of angulation**
- Optimized resolution **independent of angulation**

Other vendors

- **3** parameters automatically optimzed
- **Unnecessary high dose** for thin patients
- **Loss of spatial resolution** for thin patients
- Manual adaptation of parameters necessary

Scientific study on AEC now released
Results from University of Leuven, Belgium

SIEMENS Healthineers



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Physics in Medicine & Biology
Phys. Med. Biol. 62 (2017) 6610–6630
https://doi.org/10.1088/1361-6560/aa7a9d

IPEM Institute of Physics and Engineering in Medicine

Evaluation of automatic dose rate control for flat panel imaging using a spatial frequency domain figure of merit

M Dehairs[1], H Bosmans[1,2], W Desmet[3,4] and N W Marshall[1,2]

[1] Medical Imaging Research Centre, Medical Physics and Quality Assessment, Katholieke Universiteit Leuven, 3000 Leuven, Belgium
[2] Department of Radiology, UZ Gasthuisberg, Herestraat 49, 3000 Leuven, Belgium
[3] Department of Cardiovascular Diseases, UZ Gasthuisberg, Herestraat 49, 3000 Leuven, Belgium
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Superiority now scientifically validated

M Dehairs et al 2017 Phys. Med. Biol. 62 6610

Study overview

Purpose

The work compares a 3 parameter exposure control to a more flexible 5-parameter method to investigate the possible benefits of increasing AEC parameter freedom.

Methods and materials

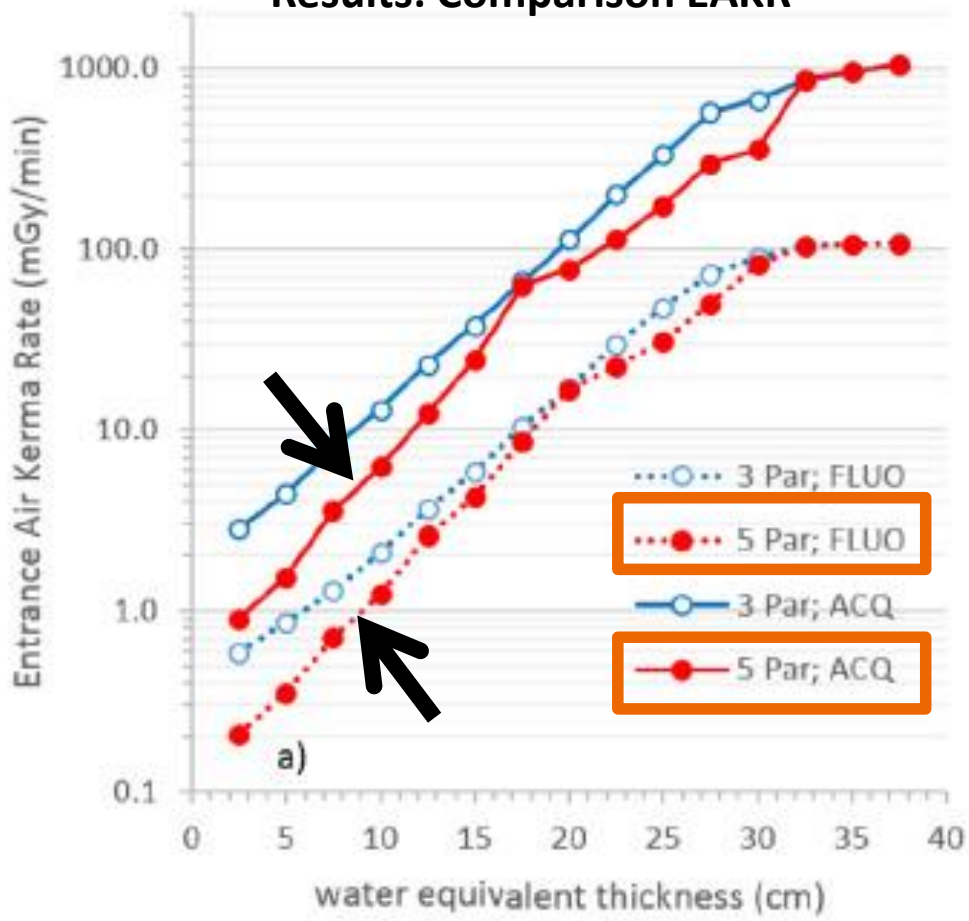
1. Use of a phantom composed of 15 PMMA/aluminium plates and an iron insert
2. Evaluation of dose with standard 3 parameter vs. 5 parameter settings in different thicknesses

Entrance Air Kerma Rate (EAKR) significantly lower thanks to 5 controlling parameters

KU LEUVEN

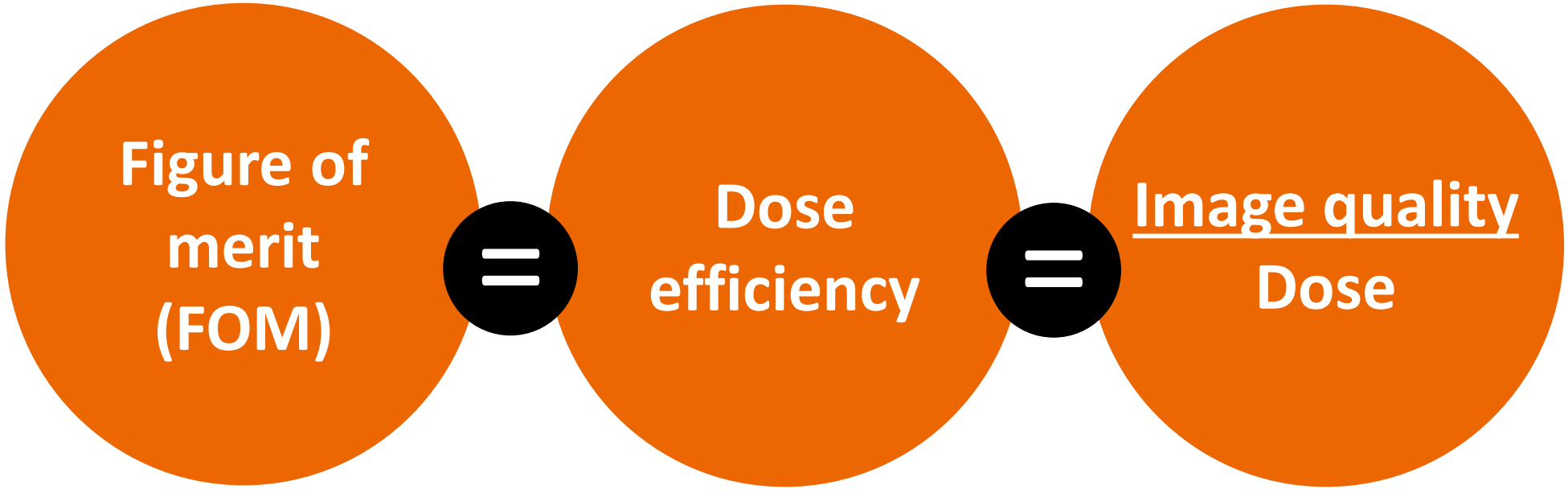
→ most benefit in dose reduction visible in smaller patient thicknesses

Results: Comparison EAKR



M Dehairs et al 2017 Phys. Med. Biol. 62 6610

Dose efficiency as an indicator for dose reduction at constant image quality

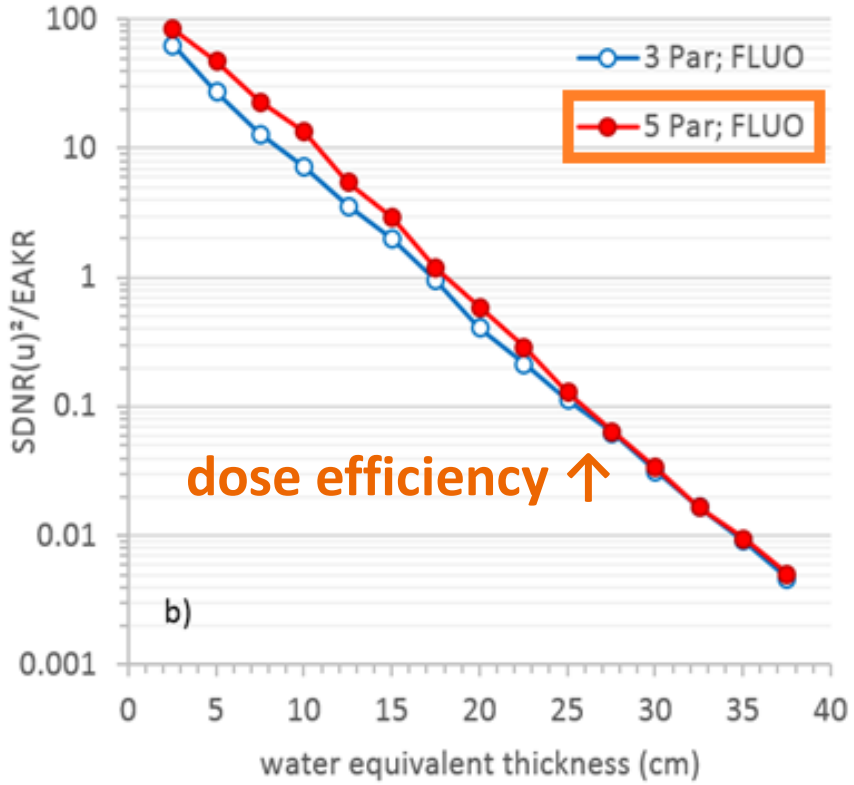


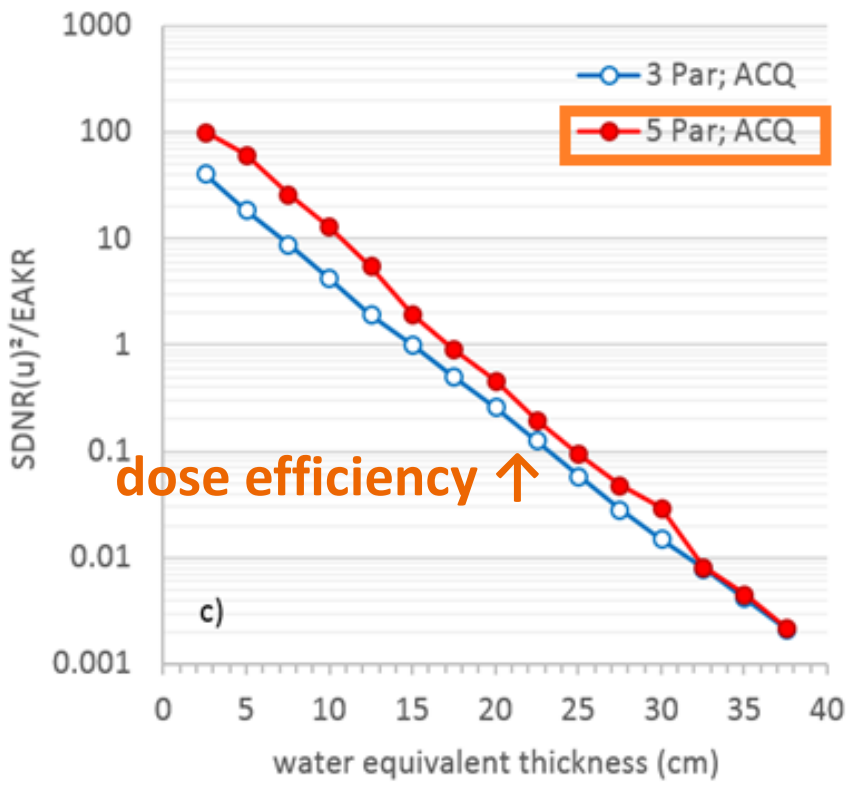
Increase of dose efficiency over all attenuations

SIEMENS Healthineers

KU LEUVEN

Results: Comparison SDNR $(u)^2$/EAKR (FOM)





→ 5 parameter more or as effective (as 3p) over all thicknesses

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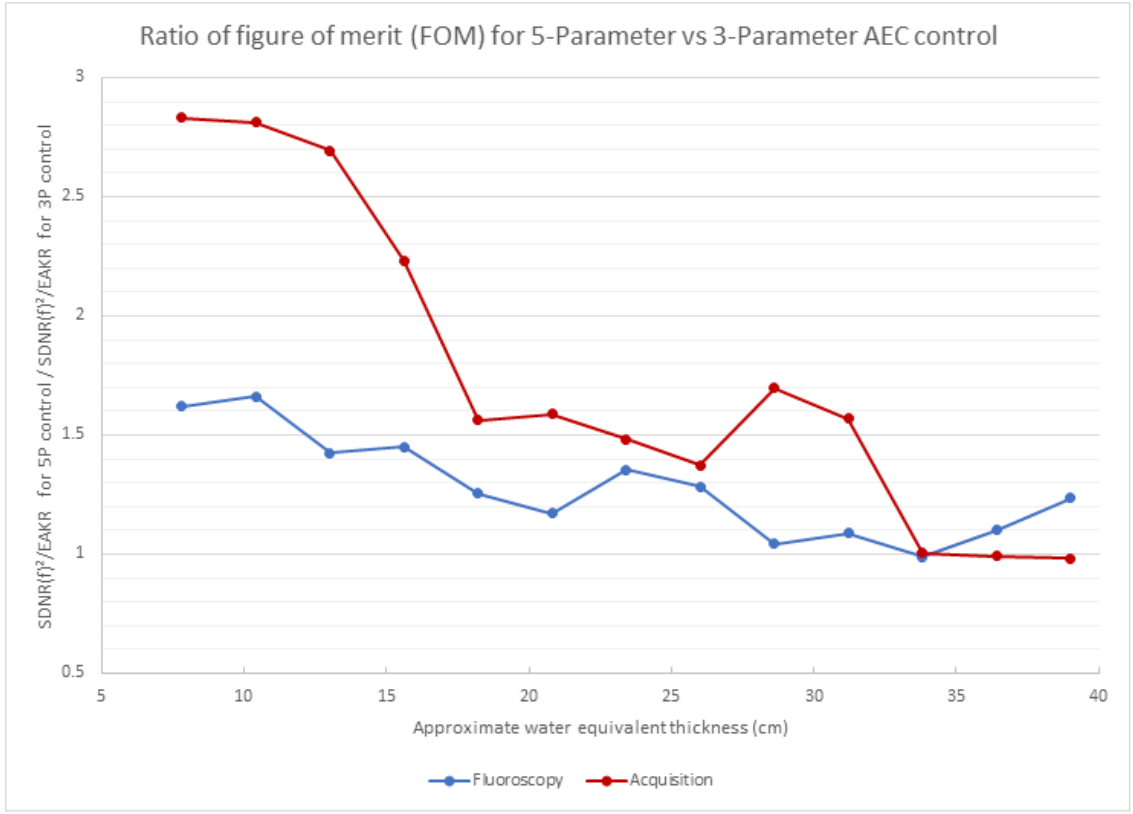
More than half the dose saved with 5 flexible parameters compared to only 3 parameters

SIEMENS Healthineers

KU LEUVEN

Results: Ratio SDNR (u)^2/EAKR (FOM))



Up to 40% less dose in fluoroscopy

Up to 65% less dose in acquisition

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Significant increase of dose efficiency over all thicknesses

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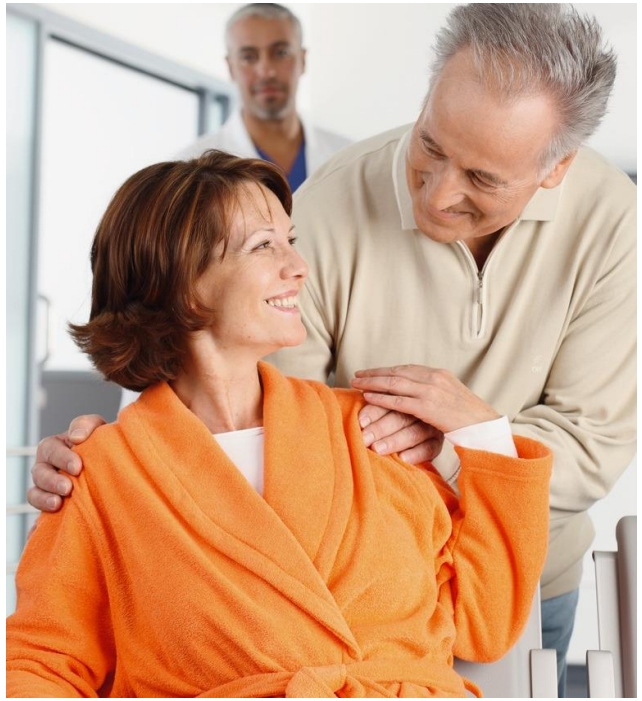
Dose efficiency increases

for all attenuations

75%
in
acquisition



28%
in
fluoroscopy

Significant increase of dose efficiency over all thicknesses

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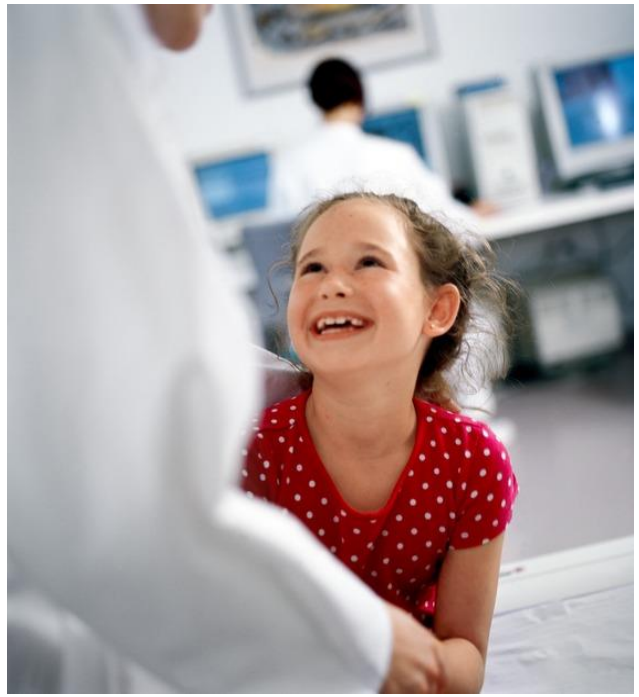
Dose efficiency increases

for small attenuations

128%
in acquisition



43%
in fluoroscopy

The benefits of a 5 parameter AEC

Prof. Hilde Bosmans, KU Leuven, Belgium

The AEC Five

A perfect team for significant dose reduction

Thank you
for your enthusiasm!

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