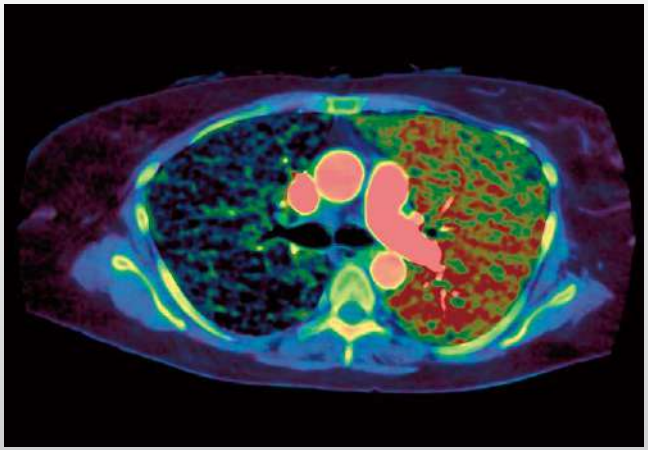
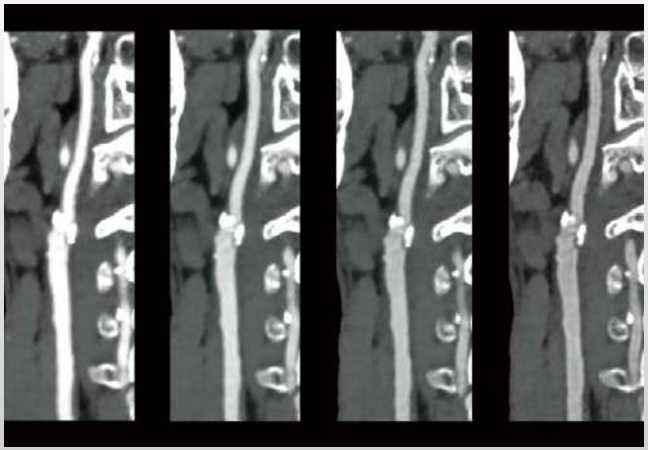
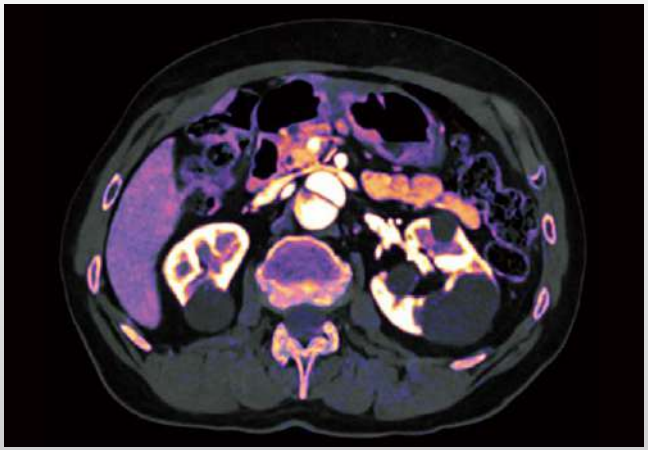
CT Clinical Brochure

Spectral Imaging







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Canon gratefully acknowledges the following sites who contributed cases to this brochure:

Fujita Health University, Japan
National Hospital of Sri Lanka
Kyorin University, Japan
NHC Strasbourg University Hospital, France
Pamela Youde Nethersole Eastern Hospital, Hong Kong
Radboud University Medical Center, the Netherlands
Kobe City Medical Center General Hospital, Japan

Spectral CT — the way it was meant to be

The key challenge to an effective Spectral solution is to acquire exposures at different energies (kV) at the same angle of rotation and the same instance of time.

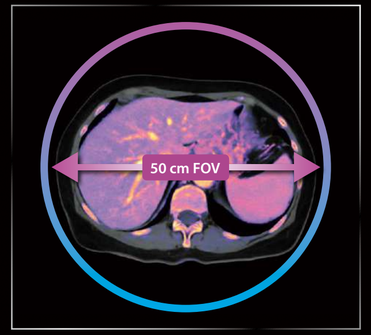
Canon have solved this challenge by utilizing a rapid kV switching method with patient specific mA modulation in combination with Deep Learning Reconstruction to perform Spectral helical and volume scanning that delivers excellent energy separation and low-noise properties.

Furthermore, the 16 cm volumetric Spectral scan and 50 cm full FOV allows for whole organ coverage for Spectral acquisition in a single rotation.

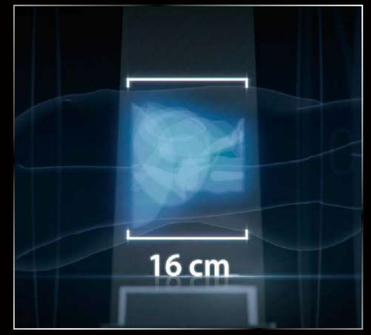
Rapid kV Switching

- Rapid kV switching for fast acquisition speed helical and volume scans can be seamlessly integrated into existing workflows and completed in the same time as a single energy scan

50 cm FOV

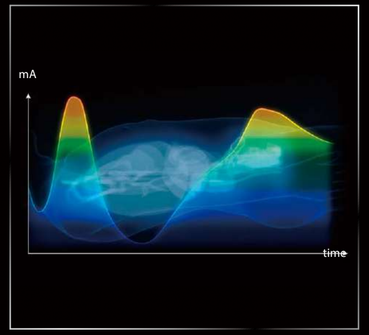


Up to 16 cm of wide z-coverage



- 50 cm FOV coverage and 16 cm whole organ coverage

Patient-specific mA modulation



- Maintain equivalent image quality for every image with patient-specific mA modulation that changes with each rotation

A smarter Spectral solution leveraging the power of Deep Learning Reconstruction

The advantage of Spectral Deep Learning Reconstruction, one of the AI technologies that make up Canon's Altivity brand, is its ability to transform multi-energy raw data sets into complete and separate high and low energy sinograms.

This provides excellent energy separation for Spectral analysis with the high resolution and low noise properties you would expect from a routine diagnostic CT exam.

Spectral DLR for energy separation and view transformation

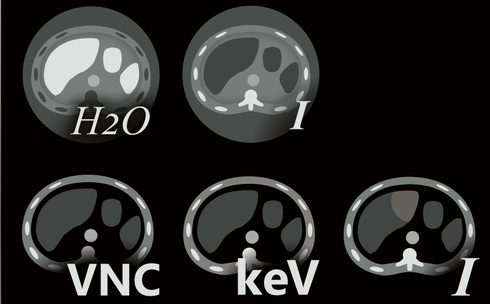
Spectral Reconstruction works by transforming energy – agnostic information from one energy to the other to create Deep Learning Views (DLVs). DLVs are generated by the trained neural network using measured data from both the opposite energy views as well as adjacent same-energy views.
The result is two full high and low energy sinograms that are precisely aligned providing excellent energy separation.

- Complete high and low kVp sinograms
- Temporally and spatially aligned

Spectral DLR for noise reduction

The reconstruction process is completed by taking advantage of the established noise reduction capabilities of Deep Learning to create low noise Spectral CT image data.

- 50% noise reduction compared to same dose single energy*1
- Fine grain texture monochromatic images*2

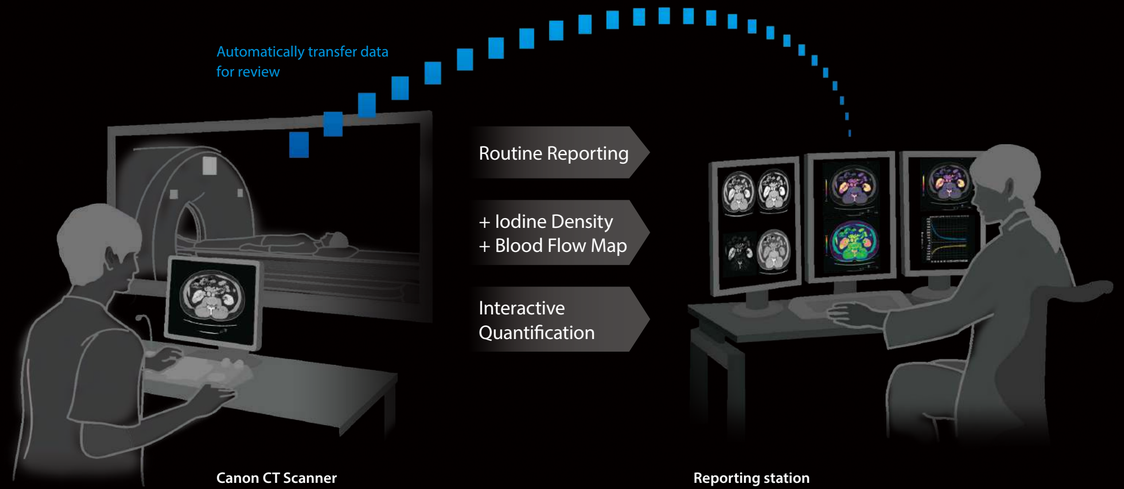


Range of spectral images generated from the CT console delivered directly to your PACS
- Monochromatic images
- Iodine maps
- VNC

*1 120 kVp equivalent monoenergetic images (70 keV) with 50% less noise than single energy with Adaptive Iterative Dose Reduction 3D (AIDR 3D).
*2 In a water phantom comparing the Spectral reference protocol for Body at 70 keV to AIDR 3D at 120 kVp.

Seamless workflow for faster results

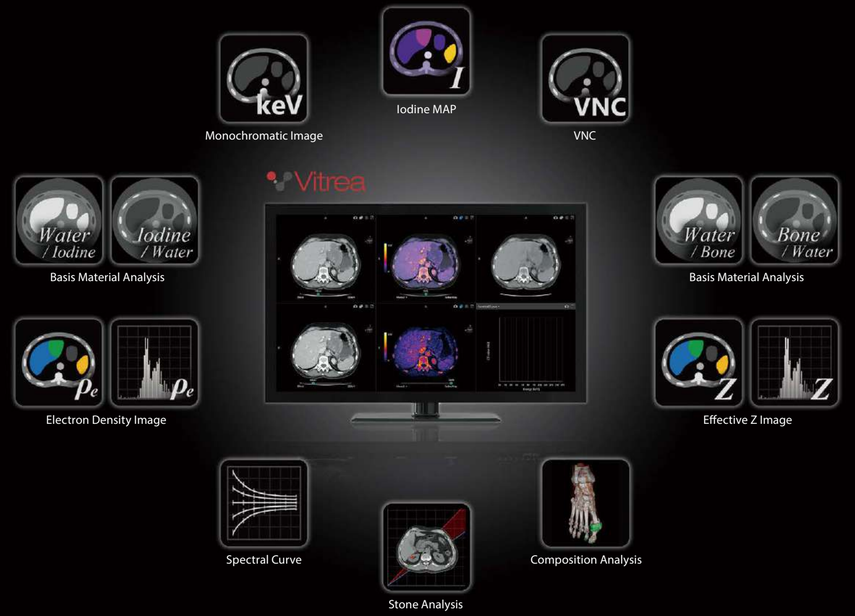
Spectral images are reconstructed and delivered directly to your reading station for quick review.



Canon CT Scanner
Spectral acquisitions require no additional training for the operator making it as easy as any routine scan, providing a consistent experience.

Reporting station
Diagnose with more confidence.
Distribute and share results with the patient's care team.

Extensive suite of Spectral applications for in-depth analysis



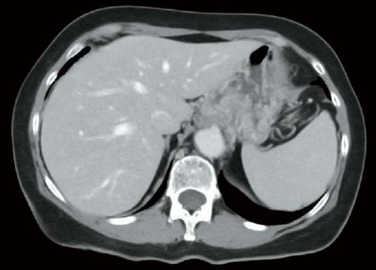
Interactive analysis including quantification of Spectral data for a more detailed and confident diagnosis is available with our range of Vitrea applications which can be integrated into most PACS.

- Create effective monochromatic images for 166 energy levels ranging from 35 keV to 200 keV
- View quantitative color-coded iodine maps
- Characterize and differentiate tissue with Effective Z and Electron density
- Differentiate between uric acid and non-uric acid urinary stones
- Visualize and quantify the presence of monosodium urate in anatomical structures
- Differentiate iodine from an intracranial hemorrhage

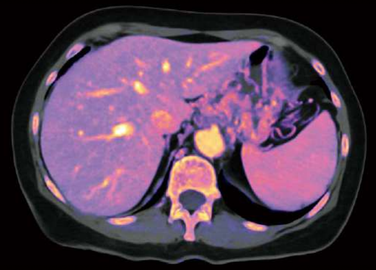
Energy separation and noise reduction to see beyond the HU spectrum

Qualitative

Monochromatic 75 keV



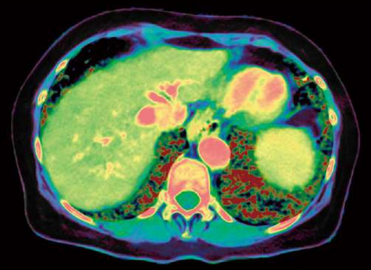
Iodine map



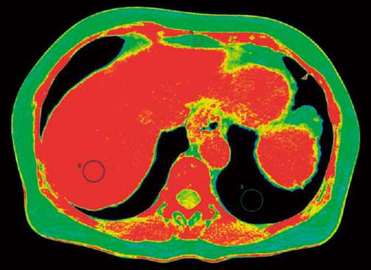
Virtual Non-Contrast

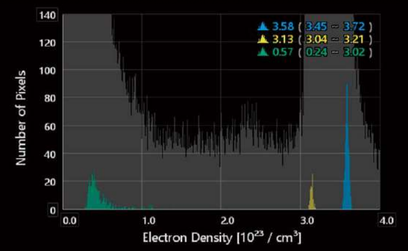
Quantitative

Effective atomic number



Electron density



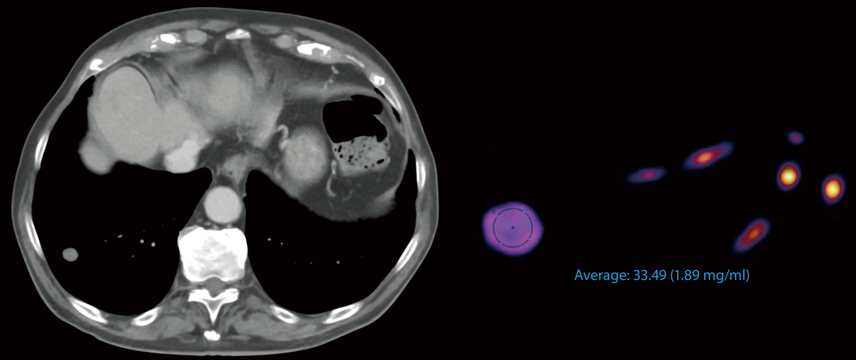


ROI 1 (blue) Liver. ROI 2 (yellow) Peritoneal fat.
ROI 3 (green) Lung.

The power to characterize different materials

Materials exhibit different attenuation profiles at different energy levels providing a unique Spectral signature, which can be identified and classified.

Spectral DLR combined with powerful Spectral analysis tools allow you to define more accurate treatment plans based on quantitative material classification.



Enhancing lung nodule with iodine uptake of 1.89 mg/ml

Rule out uric acid in kidney stones

Determine the presence of MSU in tophi

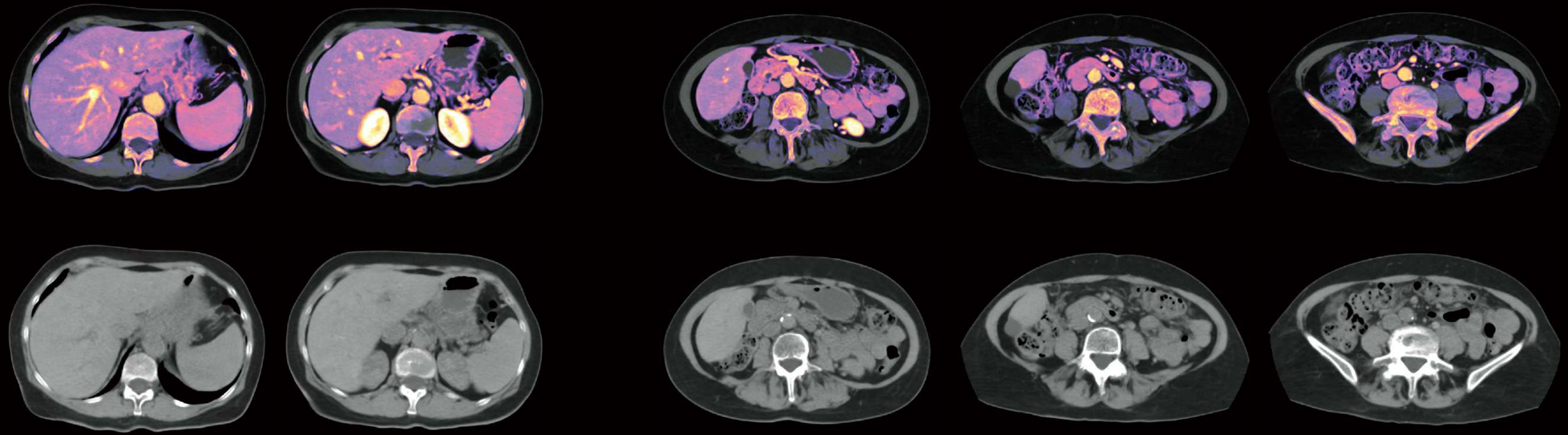
Easy visualization of iodinated contrast media

Make regions of clinical interest standout with color blood flow maps that highlight hyperperfused lesions.

Quickly evaluate whole organ perfusion to help visualize regions of lower blood flow or generate virtual non-contrast images.

Iodine map

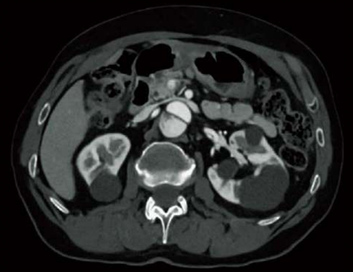
Virtual Non-Contrast



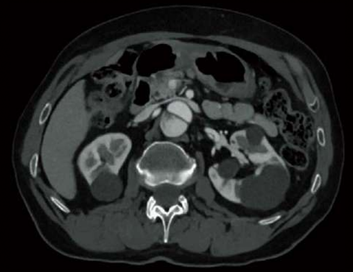
Optimize the use of iodinated contrast media

Spectral offers the ability to optimize iodinated contrast media usage.*
Low keV imaging provided by Spectral enables the opportunity to reduce the total iodine contrast load to the patient while maintaining excellent contrast conspicuity.

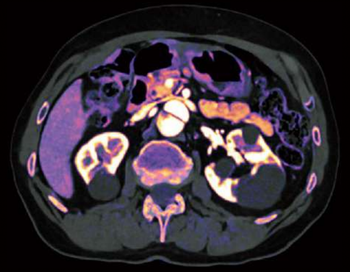
60 keV



70 keV



Iodine map



A word from the expert

Spectral CT has proven to be a very useful addition in our routine workflow, particularly for patients with known renal insufficiency.

This acquisition protocol allows us to confidently reduce the contrast dose in these patients, in some cases we see a contrast reduction up to 60% even with a slow flow rate up to 1 ml/s. This is only possible by relying on low keV imaging to enhance the iodine conspicuity if necessary.

Professor Catherine Roy, MD
Radiologist
Strasbourg University Hospital, France

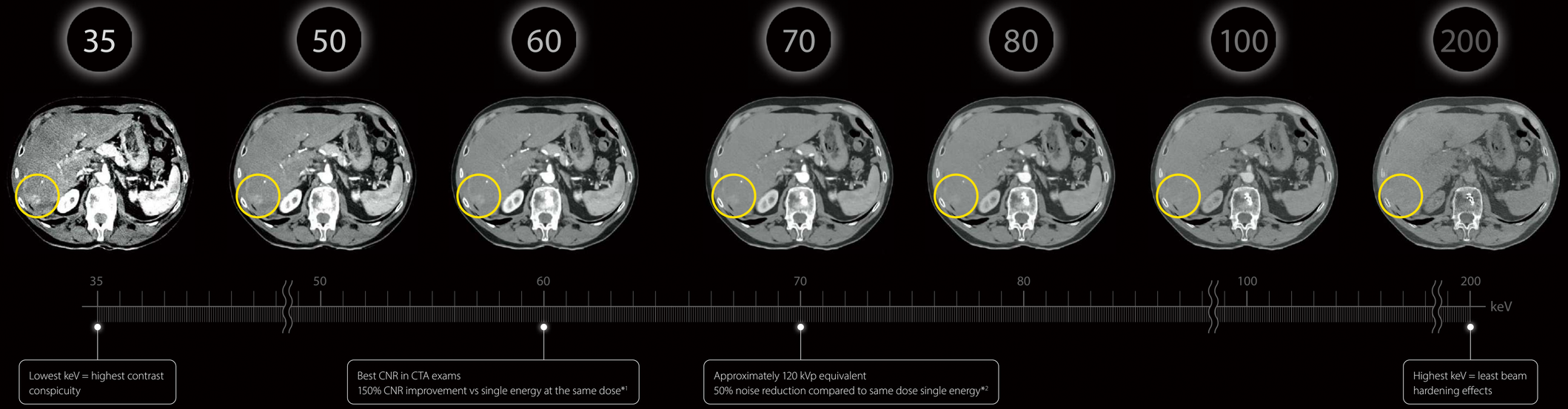
* Optimization of contrast usage is only recommended within the dosing ranges that appear in approved iodinated contrast drug labeling.

Boost contrast and reduce artifacts with 166 monochromatic energy levels

With a simple slider bar control, users can select a spectrum of virtual monochromatic keV settings with all Spectral scans.

Higher energy levels show less beam hardening effects, which may help reduce metallic artifacts.

Lower energy levels show increased HU density of iodinated contrast media which may help to increase the conspicuity of subtle enhancing lesions.



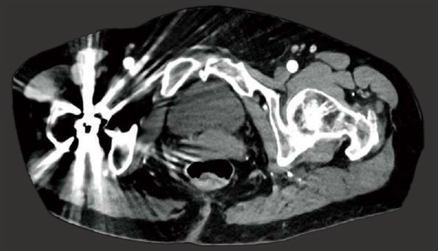
*1 136-168% CNR improvement for iodine at 70 keV relative to single energy with AIDR 3D 120 kVp. In a Gammex phantom, model 471, comparing the Spectral reference protocol for Body to AIDR 3D at 120 kVp.
*2 120 kVp equivalent monoenergetic images (70 keV) with 50% less noise than single energy with AIDR 3D.

The power of Spectral and Single Energy Metal Artifact Reduction (SEMAR) combined for metal artifact reduction and increased iodine conspicuity

Deep Learning Spectral CT, in combination with SEMAR, substantially reduces metal artifacts in all Spectral reconstructions. This allows clinicians to fully benefit from the increased iodine conspicuity in the low keV ranges (35-65 keV).

Low keV

- Increase iodine conspicuity
- Increase in low contrast resolution
- Increase low contrast detectability



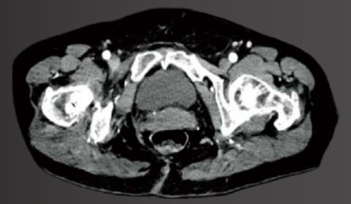
55 keV without SEMAR

High keV

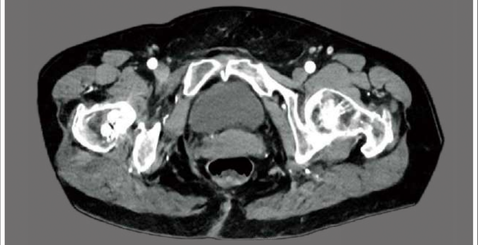
- Beam hardening reduction
- Calcium blooming reduction
- Metal artifact reduction

low keV

high keV



35 keV with SEMAR



55 keV with SEMAR

200 keV with SEMAR

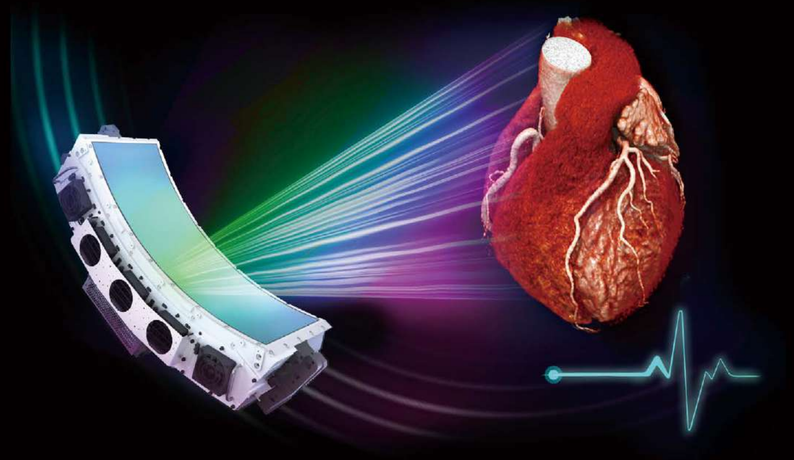
ECG gated volumetric Deep Learning Spectral cardiac CT

Technological Advantages

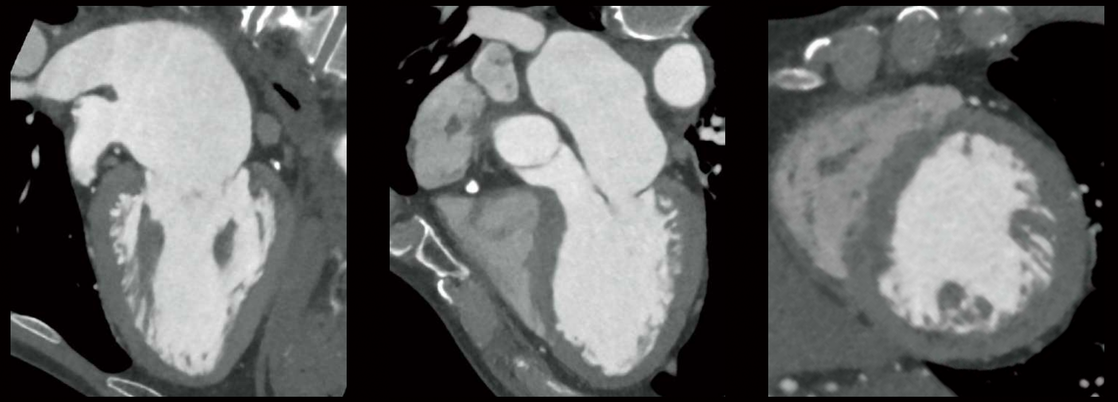
- 16 cm volumetric coverage
- One beat cardiac acquisition
- SEMAR
- Temporal congruency
- Spatial alignment

Clinical advantages

- Low keV to improve iodine conspicuity and reduce iodine contrast load
- Myocardial perfusion analysis
- Delayed enhancement analysis



70 keV



Spectral brain

Spectral brain leverages the advantages of full volumetric acquisition and Advanced intelligent Clear-IQ Engine (AiCE) Deep Learning Reconstruction to provide excellent, low noise iodine/water basis material images calculated in the raw data domain.

Key Technologies

- 16 cm volumetric brain acquisition
- Basis material raw data processing
- AiCE Deep Learning Reconstruction

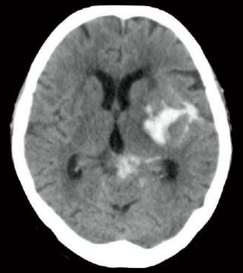
Clinical Benefits

- Vitrea Spectral analysis post processing
- Differentiate iodine from an intracranial hemorrhage
- Characterize and quantify iodine to help identify underlying tumors

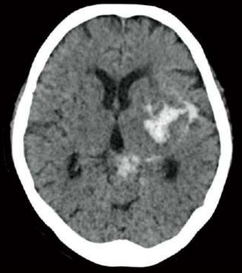
The iodine/water pair provide the full range of Spectral analysis and image re-formats including monochromatic keV (35 – 200 keV) and quantitative color iodine maps.

ICH post interventional treatment

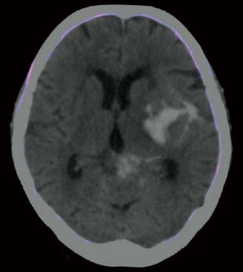
Best CNR 65 keV



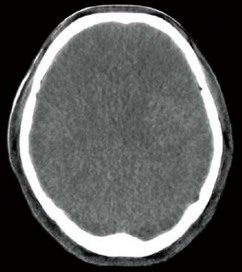
VNC



Iodine map



Iodine (Water)



This patient underwent a routine non contrast Spectral brain scan immediately after an interventional procedure to check for intracranial hemorrhage.

The monochromatic 65 keV image shows a hyperdense area.

Using Spectral analysis, the VNC image shows the hyperdense area still present indicating this area has no iodine, confirming an intracranial hemorrhage.

The iodine map fusion image and Iodine (Water) basis material image confirms the result seen in the VNC image.

Metastatic schwannoma

Best CNR 61 keV

VNC

Iodine map

Iodine (Water)

This 65-year-old woman with a known lingual pharyngeal schwannoma tumor underwent a Spectral brain CTA scan as a part of routine staging.

There is a mass seen in the right posterior fossa.

The iodine map and basis material images show increased blood flow in the tumor.

Calcified plaque in carotid artery

Global Illumination

60 keV

70 keV

80 keV

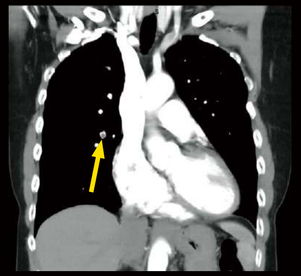
90 keV

Global Illumination

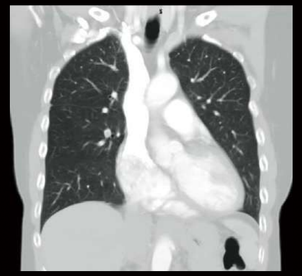
59-year-old male with BMI 19.5 was referred for a carotid CTA. A calcified plaque is seen in the left internal carotid artery.
High keV images clearly differentiate the calcification from the contrast filled lumen.

Right pulmonary embolism

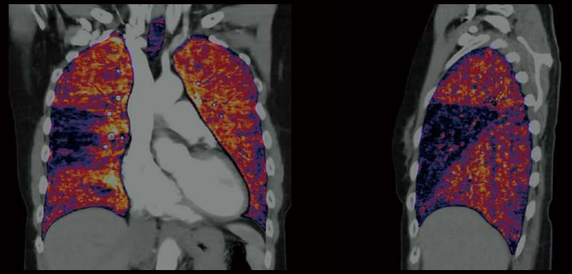
70 keV (Body window)



70 keV (Lung window)



Iodine map



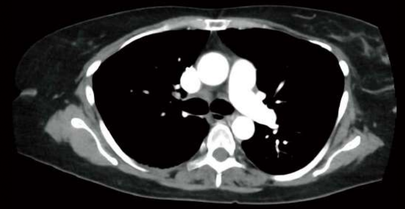
This patient presented with shortness of breath. A pulmonary embolism was suspected, and a Spectral pulmonary CTA was performed, and iodine maps were generated.

A pulmonary embolus is depicted in the 70 keV image (arrow). In the iodine map, a wedge-shaped area of hypoperfusion is depicted in the corresponding lung region.

Spectral images provide morphological and quantitative information.

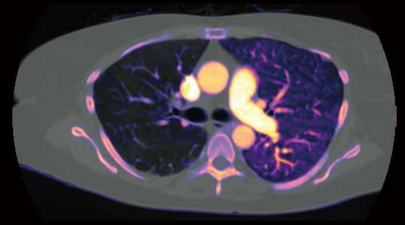
Congenital absence of right pulmonary artery

70 keV (Body window)

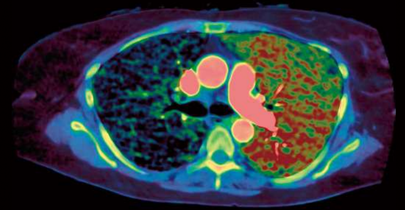


70 keV (Lung window)

Iodine map



Effective Z map

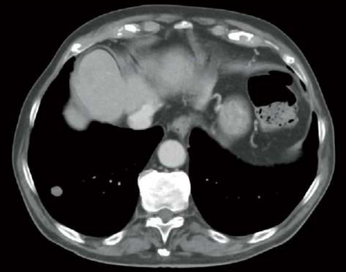


This patient presented with difficulty breathing after undergoing implantation for a cardiac pacemaker. A Spectral CTPA exam was performed to rule out pulmonary disease.

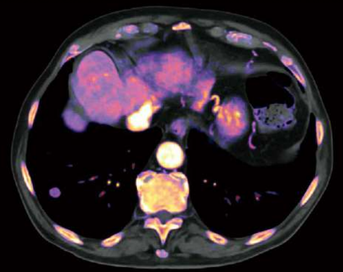
The Spectral iodine and effective Z maps show 90% reduced perfusion in the right lung due to a congenital absence of the right pulmonary artery.

Lung and vertebral metastases with iodine mapping

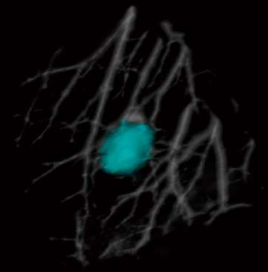
70 keV (Body window)



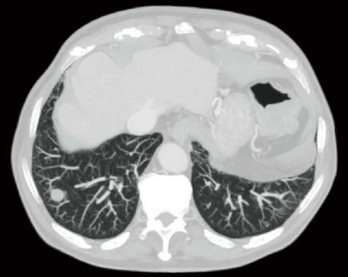
Iodine map



Nodule segmentation SVR



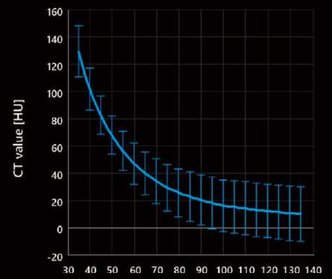
70 keV (Lung window)



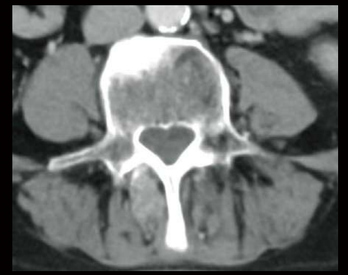
Quantitative analysis

Average: 33.49 (1.89 mg/ml)

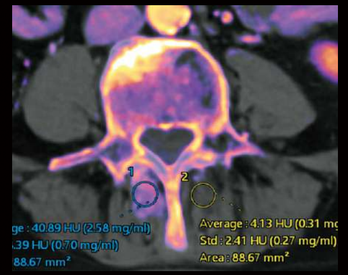
Spectral curve



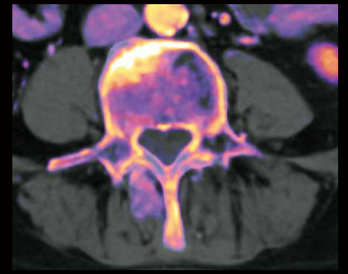
70 keV (Body window)



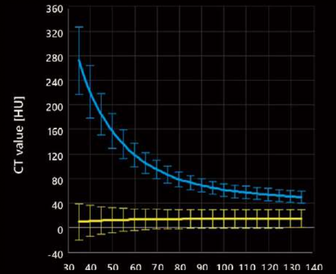
Iodine map



Iodine map



Spectral curve



A 66-year-old male with a history of renal cell carcinoma with pulmonary and bone secondary lesions presented for a follow up scan. A Spectral scan was performed of the chest and abdomen.

Lung reconstructions demonstrate a lung metastasis. Spectral curves confirm the iodine uptake in the lesion.

Reconstructions of the spine demonstrate a vertebral metastasis. Spectral curves confirm the iodine uptake in the lesion.

Spectral SEMAR no compromise on contrast conspicuity

A word from the expert

Deep Learning Spectral CTA offers state-of-the-art image quality and improves the conspicuity and characterization of arterial structures.

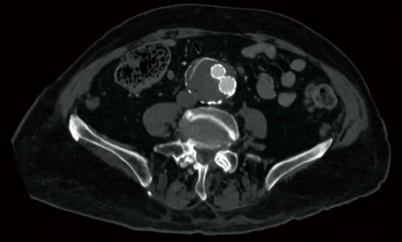
For patients with endovascular aortic stent grafts, SEMAR in addition to a Spectral DLR protocol will substantially reduce metal artifacts, and is beneficial for low keV monochromatic imaging.

This protocol provides excellent depiction of the EVAR, with efficient assessment of endoleaks and graft integrity.

Prof. Mickaël Ohana MD, PhD
Nouvel Hôpital Civil,
Strasbourg University Hospital, Strasbourg,
France

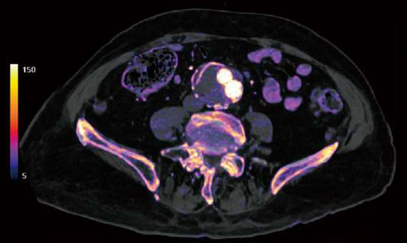
50 keV
SEMAR

70 keV
SEMAR

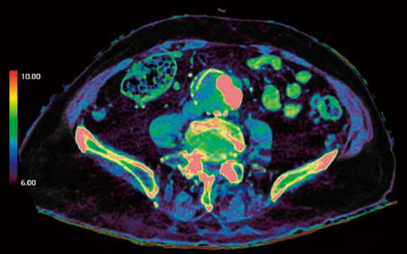


75 keV CPR
SEMAR

Iodine map



Effective Z map



Spectral SEMAR
Global Illumination

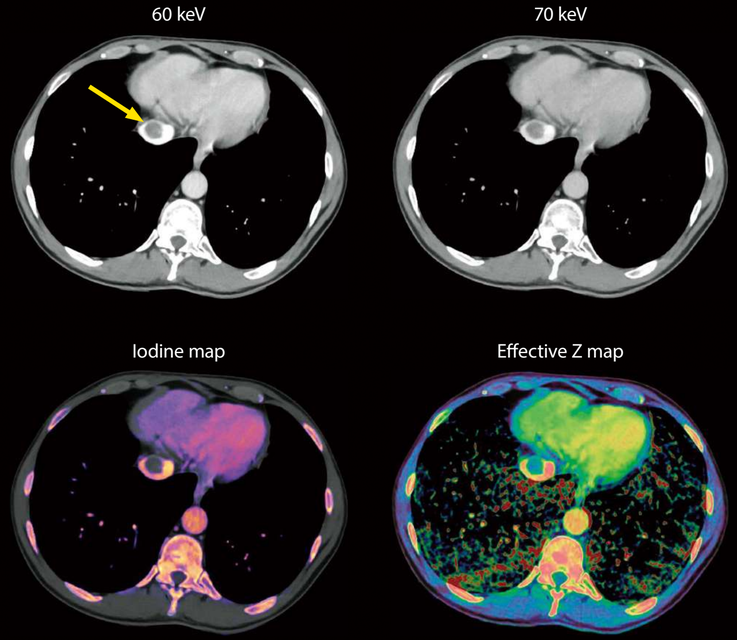
An elderly patient with impaired renal function presented for a routine follow-up CT after placement of an endoluminal stent graft.

To minimize the amount of iodinated contrast administered a Spectral CT scan was performed.

Utilizing the low keV range of Spectral energy to increase iodine conspicuity allowed a 32.5% reduction of iodine load compared to the single energy equivalent.

This in combination with SEMAR allows physicians to fully benefit from the increased iodine conspicuity in the low keV ranges, to identify subtle endoleak with greater confidence.

Filling defect in inferior vena cava

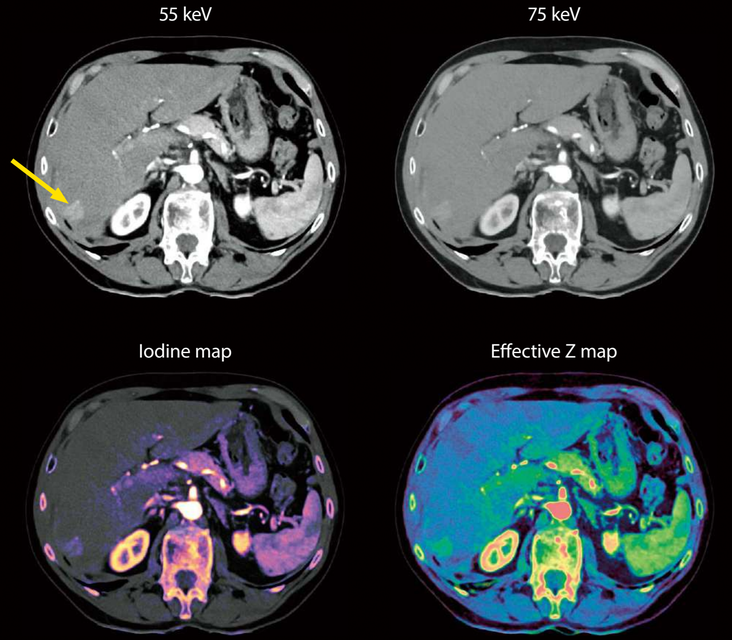


A 54-year-old male with a recurrence of liver cancer and pulmonary metastasis underwent a Spectral venous scan.

A filling defect is seen in the IVC. Monochromatic images do not show clear evidence if this lesion is an organized thrombus or a tumor.

The iodine map and effective Z images show no iodine uptake confirming this is a thrombus rather than a tumor inside the IVC.

Subtle enhancing liver lesion



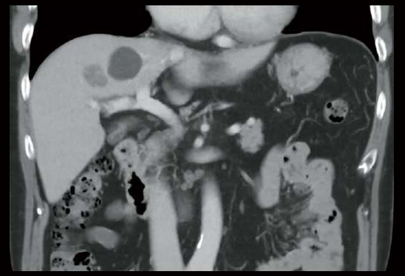
A 56-year-old male presented for pre-transplant liver assessment. A Spectral arterial scan was performed.

A small subtle enhancing lesion is difficult to see in the 75 keV image but can be more easily seen in the 55 keV image. The lesion is easily seen in the iodine map and effective Z images.

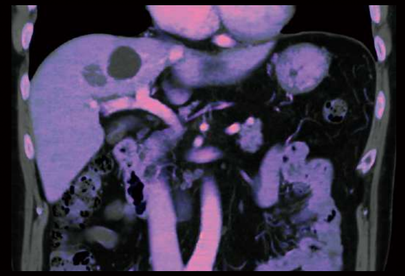
Using the suite of images available with Spectral analysis this lesion can be identified with confidence.

Liver lesions with Spectral curve analysis

70 keV

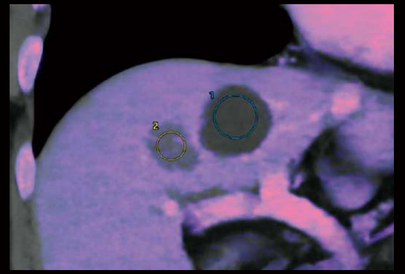


Iodine map

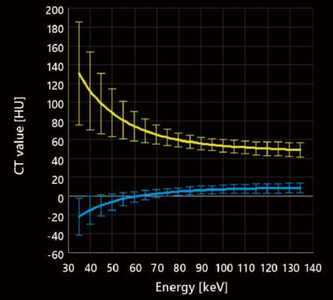


This patient with BMI 21 was referred for a scan of the liver.
A Spectral scan was performed with quantitative analysis.
The cyst was confirmed to contain water while the lesion contains both iodine and fat confirming the diagnosis of hepatocellular carcinoma. The iodine maps provide additional information for tissue characterization.

Iodine map

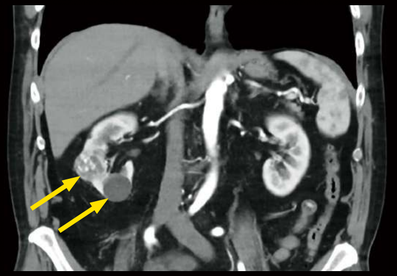


Spectral curve

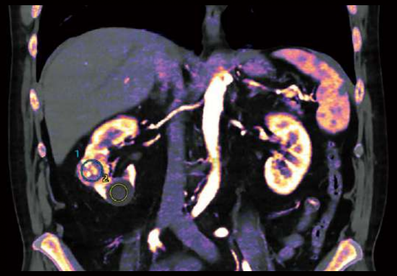


Renal lesions with Spectral curve analysis

70 keV



Iodine map

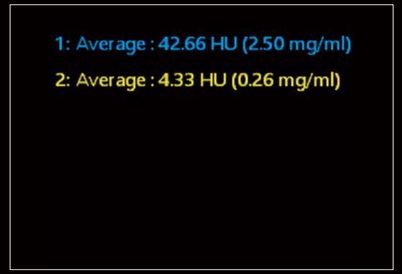


This patient was referred for a scan of the kidneys. An arterial phase Spectral scan was performed.

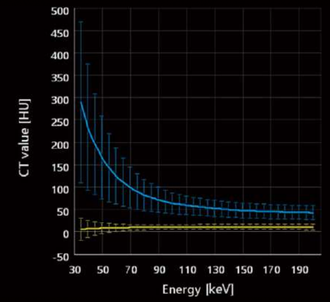
Two lesions in the right kidney are demonstrated. The iodine map shows the superior lesion to be enhancing and the inferior lesion has no enhancement.

This is confirmed with quantitative analysis using ROIs showing iodine mg/ml and the Spectral curve.

Quantitative analysis

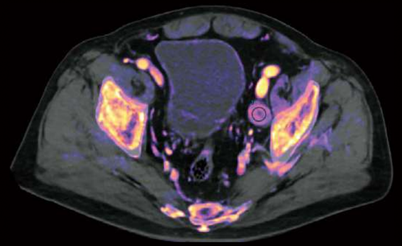


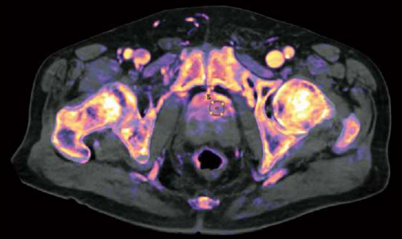
Spectral curve

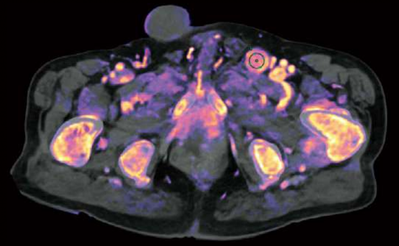


Prostate cancer and metastases with iodine mapping

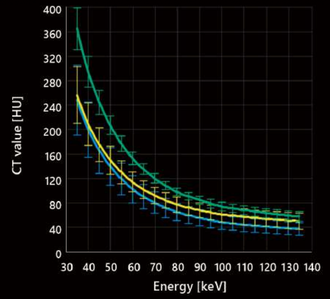
Iodine map







Spectral curve

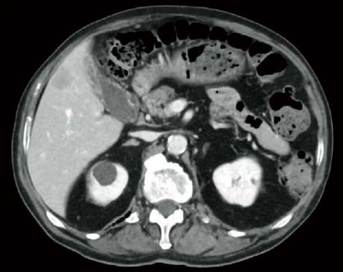


This 86-year-old male was referred for a scan of the chest and abdomen to follow up prostate cancer. A venous phase Spectral scan with iodine quantification was performed.

ROI 1 (blue) is placed in a left internal iliac lymph node. ROI 2 (yellow) is placed in the prostate mass. ROI 3 (green) is placed in a left superficial femoral lymph node.

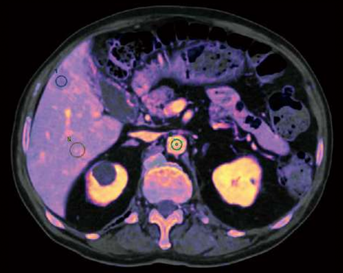
Spectral curve analysis show iodine uptake in the mass and lymph nodes.

70 keV

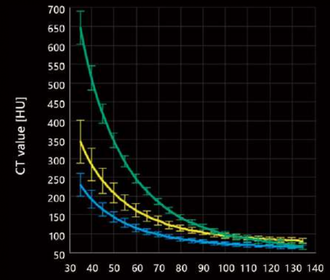


55 keV

Iodine map



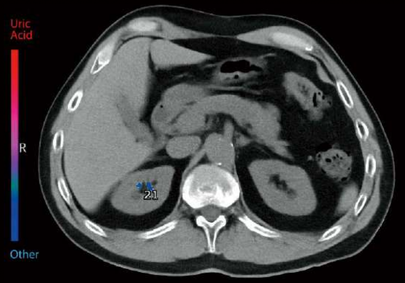
Spectral curve

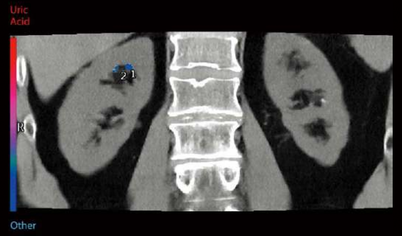


ROI 1 (blue) is placed in the liver metastasis. ROI 2 (yellow) in the aorta and ROI 3 (green) in normal liver tissue. All 3 ROI's show typical upslope towards the lower energy range typical of iodine.

At the time of the scan the metastatic lesion showed less iodine uptake than normal liver tissue.

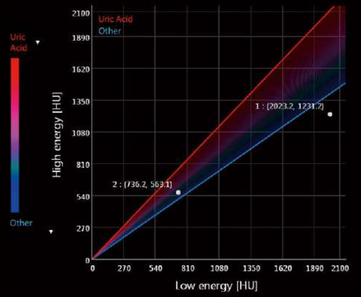
Kidney stone analysis





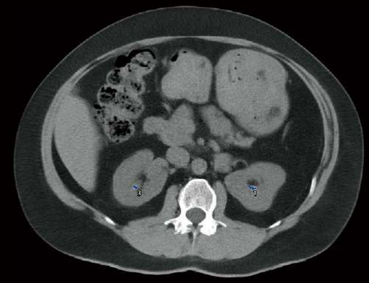
This 57-year-old male presented with flank pain. A Spectral CT of the kidneys was performed.

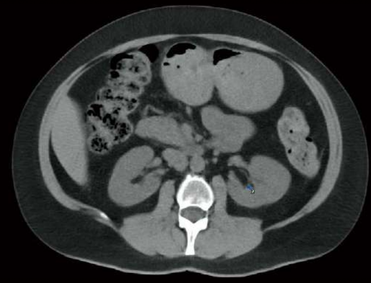
Two renal stones are demonstrated. The graph indicates they do not contain uric acid.



#	Low energy image Mean (HU)	SD (HU)	Vol. (ml)	High energy image Mean (HU)	SD (HU)	Vol. (ml)
1	866.0 (2009.9)	548.6	0.1162	606.8 (1225.0)	346.7	0.0955
2	326.3 (728.2)	164.3	0.0595	323.6 (557.3)	121.1	0.0381
3						
4						
5						

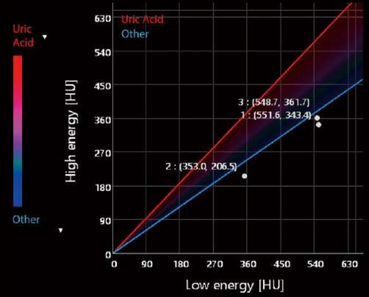
The value inside of ( ) is mean of 10% voxels from upper side in the region.





This 45-year-old female presented with flank pain. A Spectral CT of the kidneys was performed.

Two renal stones are demonstrated. The graph indicates they do not contain uric acid.

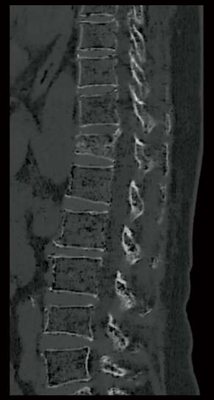


#	Low energy image Mean (HU)	SD (HU)	Vol. (ml)	High energy image Mean (HU)	SD (HU)	Vol. (ml)
1	282.1 (551.6)	103.5	0.1792	240.4 (343.4)	44.2	0.0391
2	208.1 (353.0)	54.5	0.0265	148.4 (206.5)	31.0	0.0099
3	271.6 (548.7)	112.2	0.1009	239.8 (361.7)	60.9	0.0309
4						
5						

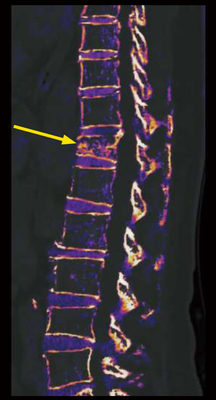
The value inside of ( ) is mean of 10% voxels from upper side in the region.

Acute compression fracture with bone marrow mapping

VNCa



VNCa map



T1WI

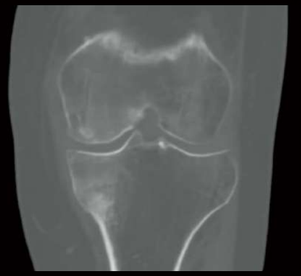
Water Dixon

This patient presented with mid-lower back pain.
A Spectral scan of the thoracic-lumber spine was performed for evaluation.
Spectral Analysis shows an acute compression fracture of T12.
Spectral bone marrow mapping shows increased density of the T12 marrow in the VNCa (virtual non calcium) image, which is associated with an acute fracture. An MRI scan was performed the T1WI and the Dixon's Water image confirmed the Spectral CT findings.

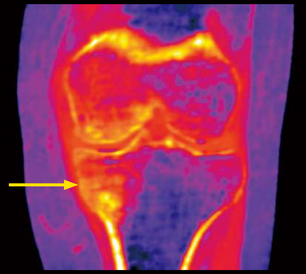
Acute knee fracture with bone marrow mapping

70 keV (Body)

70 keV (Bone)



VNCa map



T2

This patient presented at the ER with an acute knee injury.

A Spectral CT was performed, and bone marrow mapping analysis showed increased density in the right lateral femoral condyle and tibial plateau suggesting an underlying fracture.

The fractures can be seen in the monochromatic images and the associated increased bone marrow edema was confirmed by MRI.

Gout analysis

SVR MSU overlay

70 keV MSU overlay

A patient presented with a large tophus in the left olecranon fossa.

Spectral analysis confirmed the presence of MSU in the tophus. The total MSU was 21.20 cm^3.

70 keV (Body window)

70 keV MSU overlay

A patient presented with several tophi in the left knee.

Spectral analysis confirmed the presence of MSU in the tophi. The total MSU was 26.49 cm^3.

SVR tendon view MSU overlay

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MCACT0348EAB 2026-04 Published in Japan

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