Implementation of an optimized non-contrast chest CT protocol for all patient sizes

Photon-counting CT uses a fundamentally different detector design than energy-integrating detector CT

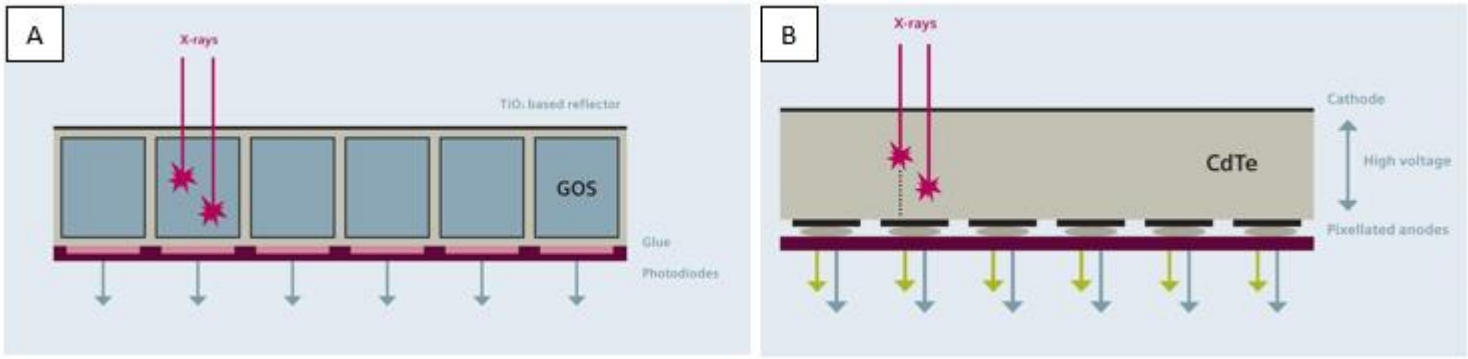

Illustration of the current energy integrating detector (A) and a photon counting detector (B) with improved detector efficiency and more detailed information thanks to direct conversion of the radiation signal, smaller detector elements, and spectral information (intensity and energy) obtained by counting the number of incoming photons.

Images adapted from Siemens Healthineers https://www.siemens-healthineers.com/nl/computed-tomography/news/mso-photon-counting-detectors.html

Photon-counting detector (PCD) CT *versus* Energy-integrating detector (EID) CT

Identify the differences between your available CT scanners and protocols

Use a reference scanner as standard

Make dose adjustments for comparison

Column1	Edge	Edge Plus	Force	Alpha
Ref kV	120	Sn 100	Sn 100	Sn 100
Quality ref mAs	85	500	500	277
Kernel	BI57	BI57	BI57	BI56
Slice/increment	1.0/1.0	1.0/1.0	1.0/1.0	1.0/1.0
CTDIvol	5.75	2.02	2.53	1.94
Pitch	0.85	0.6	0.6	0.6
Rotation time	0.33	0.5	0.5	0.5

Example of non-contrast chest CT protocols of different CT scanners.

EID-CT PCD-CT

Column1	Edge	Edge Plus	Force	Alpha
Tube	Straton MX	Straton MX Sigma	Vectron	Vectron
kV	CARE kV	CARE kV	CARE kV	CARE KeV
mA	CARE Dose4D	CARE Dose4D	CARE Dose4D	CARE Dose4D
Tin filter	n.a.	Sn 0.6 mm	Sn 0.6 mm	Sn 0.4 mm
Flash mode	n.a.	n.a.	Yes	Yes
Collimation	0.6 mm	0.6 mm	0.6 mm	0.4 mm
Iterative reconstruction	ADMIRE 3	ADMIRE 3	ADMIRE 3	QIR 4
Matrix	512 x 512	512 x 512	512 x 512	768 x 768

Example of differences in scan and reconstruction parameters of CT-scanners with own specifications, applied to the adult non-contrast enhanced chest protocol.

RSNA 2023
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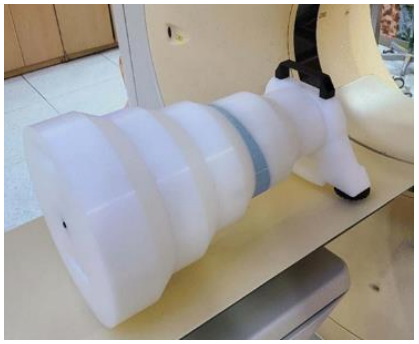
Image quality (IQ) determination

Objective IQ:

Use the detectability index (d'): a task-based signal-to-noise ratio (SNR) image quality methodology that combines spatial resolution, noise properties, observer filter. The phantom allows for evaluation of different patient sizes.

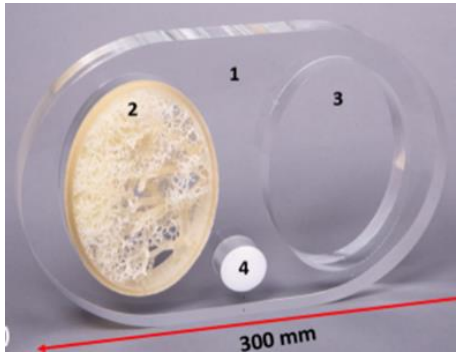
A higher d' means that the system is better able to visualize small lesions than a system with a lower d'.



Mercury 4.0 phantom Gammex™ Technology
Source:
https://www.sunnuclear.com/products/me

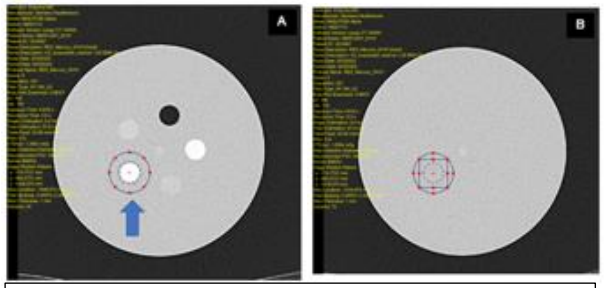
Subjective IQ:

Have Radiologists score IQ (blinded) through a 5-point Likert Scale and e.g. a 3D printed anthropomorphic lung phantom



3D printed anthropomorphic lung phantom
Source: Hernandez-Giron et al., 2019

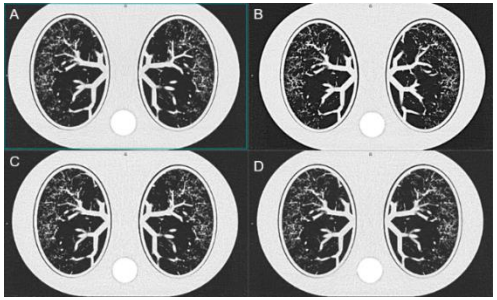
Presentation of IQ



(A) demonstrate the ROI for task-based transfer function measurement with (B) the ROI for noise power spectrum measurement.

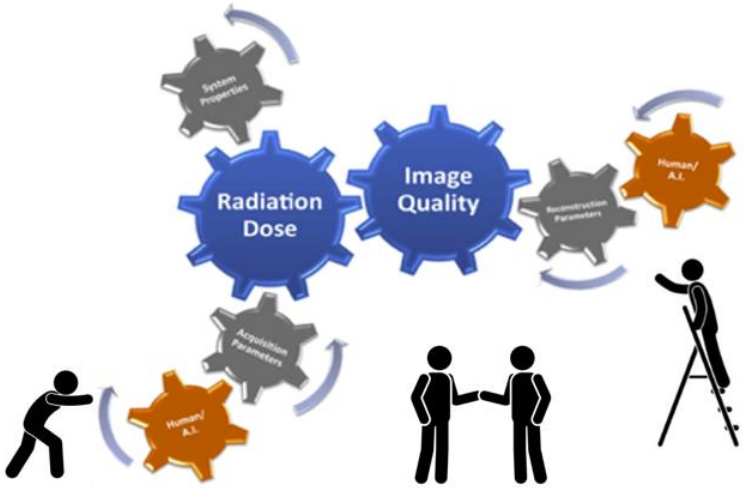
- Calculate d' with ImQuest, regarding the tasks
- Make scans and calculations for different patient sizes
- Process the results in a clear overview; e.g. excel
- Evaluate the outcomes

- Present scans together, as shown below
- Make scans and calculations for different patient sizes
- Provide a clear questionnaire with scoring list to radiologists, while scoring scans
- Process the results in a clear overview; e.g. excel
- Evaluate the outcomes



Present scans to radiologists to evaluate. A = Reference scanner (EID-CT01), B = PCD-CT, C = EID-CT02, D = EID-CT03.

And what now?



- Changing scan and reconstruction parameters has a direct influence on dose, but also (more importantly) on image quality. It is important to monitor dose and check whether image quality stays sufficient for optimal interpretation
- Adaptation of clinical scan protocols should only be done by specialized CT technicians in close collaboration with the radiologist(s) and physicists!
- Evaluation after adaptation of in-vivo is necessary

The question is if PCD-CT generates improved diagnostic image quality with lower radiation dose?