From Diagnosis to Prevention: Opportunistic Screening with Photon-Counting CT?

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CT Examinations in Numbers

- In 2023 approximately 14 million CT examinations were performed in Germany (and about 70 million in the EU, 93 million in the US).
- Body regions:
  – Head ~ 30 %
  – Chest/thorax ~ 25 %
  – Abdomen/pelvis ~ 35 %
  – Other ~ 10 %
  – Use of contrast media ~ 40 %

Definitions

- Incidental findings = unexpected discoveries
- Opportunistic screening = systematic, intentional extraction of (preventive) health information
- Both are obtained from CT scans acquired for other indications.
- However, both require additional reading time.

Opportunistic Screening in MRI

- **Opportunistic detection of osteoporosis using vertebral bone quality (VBQ) score from routine spine MRIs.**
- **Muscle/fat segmentation from abdominal or whole body MRI datasets (e.g. for sarcopenia or metabolic risk).**
- **Limitations:**
  - **lack of standardized protocols, less quantitative**
  - **higher cost and scan time**

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https://doi.org/10.1007/s00198-021-06129-5

ORIGINAL ARTICLE

Opportunistic Use of Lumbar Magnetic Resonance Imaging for Osteoporosis Screening

A. Kadri[1] · N. Binkley[2] · D. Hernando[3] · P. A. Anderson[1]

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https://doi.org/10.1210/clinem/dgad082
Advance access publication 17 February 2023
Clinical Research Article

ENDOCRINE SOCIETY

OXFORD

Opportunistic Evaluation of Trabecular Bone Texture by MRI Reflects Bone Mineral Density and Microarchitecture

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Opportunistic Screening in PET

- Opportunistic assessment of osteoporotic activity via ^{18}F-FDG or ^{18}F-NaF.
- Whole-body cancer screening via ^{18}F-FDG.
- Limitations:
  - High cost
  - Lower availability
  - Lower patient numbers

Current Osteoporosis Reports (2024) 22:553–560
https://doi.org/10.1007/s11914-024-00887-x

REVIEW

PET/CT for the Opportunistic Screening of Osteoporosis and Fractures in Cancer Patients

Peter Sang Uk Park[1,2] · Thomas J. Werner[1,2] · Abass Alavi[1,2]

Accepted: 6 September 2024 / Published online: 14 September 2024

Japanese Journal of Radiology (2025) 43:266–281
https://doi.org/10.1007/s11604-024-01659-4

ORIGINAL ARTICLE

Applicability and performance of ^{18}F-FDG PET-based modalities for whole-body cancer screening: a systematic review and meta-analysis

K. J. Das[1] · J. K. Meena[2] · D. Kumar[3]

Received: 23 April 2024 / Accepted: 8 September 2024 / Published online: 20 September 2024

CT

- **Osteoporosis screening**
  - Uses trabecular attenuation (e.g., at L1) to estimate bone mineral density (BMD)
  - Detects vertebral compression fracturesComparable to DXA; applicable to abdominal or chest CT scans (e.g., CT colonography)
  - Automated and manual quantitative CT (QCT) methods
- **Sarcopenia screening**
  - Quantifies skeletal muscle mass and quality (myopenia, myosteatosis)
  - Linked to frailty, aging, postoperative complications, and cancer outcomes
  - Combined muscle and fat metrics identify “sarcopenic obesity”
- **Adiposity and fat distribution**
  - Measures visceral and subcutaneous fat areas and ratios
  - Visceral/subcutaneous fat ratio used as a cardiometabolic risk marker
  - Related to metabolic syndrome and diabetes
- **Cardiovascular screening**
  - Quantifies: Coronary artery calcium (CAC)
  - Abdominal aortic calcification
  - Aortic aneurysms
  - Cardiac size and valvular calcifications
  - Predicts future cardiovascular events and mortality
- **Liver screening**
  - Opportunistic quantification of hepatic fat (steatosis), iron overload, and fibrosis
  - Liver attenuation, volumetry, and surface nodularity as biomarkers
  - Automated Couinaud segment analysis and spleen volume for cirrhosis assessment
- **Metabolic syndrome and overall body composition**
  - Combines bone, muscle, fat, and liver parameters for cardiometabolic risk stratification
  - AI-based integration provides estimates of “biologic age” and health status
- **Other emerging AI-based markers**
  - Opportunistic assessment of pancreas, kidneys, adrenal glands, bowel, lungs, and lymph nodes
  - Oncologic incidental findings
  - Detection of extracolonic cancers and other early malignancies during CT colonography

Radiology
REVIEWS AND COMMENTARY • REVIEW

Value-added Opportunistic CT Screening: State of the Art

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Conflicts of interest are listed at the end of this article.

Radiology 2022; 303:241–254 • https://doi.org/10.1148/radiol.211561 • Content codes: CT AI

Opportunistic CT screening leverages robust imaging data embedded within abdominal and thoracic scans that are generally unrelated to the specific clinical indication and have heretofore gone largely unused. This incidental imaging information may prove beneficial to patients in terms of wellness, prevention, risk profiling, and presymptomatic detection of relevant disease. The growing interest in CT-based opportunistic screening relates to a confluence of factors: the objective and generalizable nature of CT-based body composition measures, the emergence of fully automated explainable AI solutions, the sheer volume of body CT scans performed, and the increasing emphasis on precision medicine and value-added initiatives. With a systematic approach to body composition and other useful CT markers, initial evidence suggests that their ability to help radiologists assess biologic age and predict future adverse cardiometabolic events rivals even the best available clinical reference standards. Emerging data suggest that standalone “intended” CT screening over an unorganized opportunistic approach may be justified, especially when combined with established cancer screening. This review will discuss the current status of opportunistic CT screening, including specific body composition markers and the various disease processes that may be impacted. The remaining hurdles to widespread clinical adoption include generalization to more diverse patient populations, disparate technical settings, and reimbursement.

An earlier incorrect version appeared online. This article was corrected on March 18, 2022.

Cross-sectional imaging displays anatomic structures beyond the strict clinical indication for performing the examination. Radiologists, in turn, must process and manage this additional data responsibly. For example, an abdominal CT examination for suspected diverticulitis will not only address the focused clinical query but will also include comprehensive imaging of the entire abdomen and pelvis. This has raised appropriate concern for unnecessary subsequent work-up related to “incidentalomas.” In con-

any nontransparent “black box” uncertainty. Finally, the clear and appropriate shift from volume-based practice toward value-added approaches makes opportunistic screening highly attractive, enhancing both quality and service at little or no additional cost but also with downstream potential for increased revenue.

“Opportunistic Screening” in Medicine and Radiology

Technical and methodological aspects
- **Abdominal and thoracic CT scans as data sources**
- **No extra scan time or radiation exposure**
- **Fully automated AI analysis**

Why Photon-Counting CT (PCCT)?

Why not conventional CT or MRI or PET or …?

- PCCT retrospectively allows for a variety of different reconstructions
  - Ultra high, high, standard, and low spatial resolution
  - VMI = standardization
  - A wide range of energy (keV) levels
  - Spectral analysis (material decomposition, iodine maps, virtual non-XX images, …)
  - Reconstruction settings appropriate for the patient‘s indication
  - Reconstruction settings appropriate for the desired screening
  - …
- One scan fits all.*
- No additional scan time or x-ray dose or contrast injection required.

*As long as it is not too noisy.

Diagnosis

Prevention

Standard PCCT Scan
according to clinical indication

Diagnosis

Reconstruction
according to clinical indication

Systematic Review
focussing on the clinical indication

Structured Report
to be sent to the referring physician

Radiologist (+ AI)

Prevention

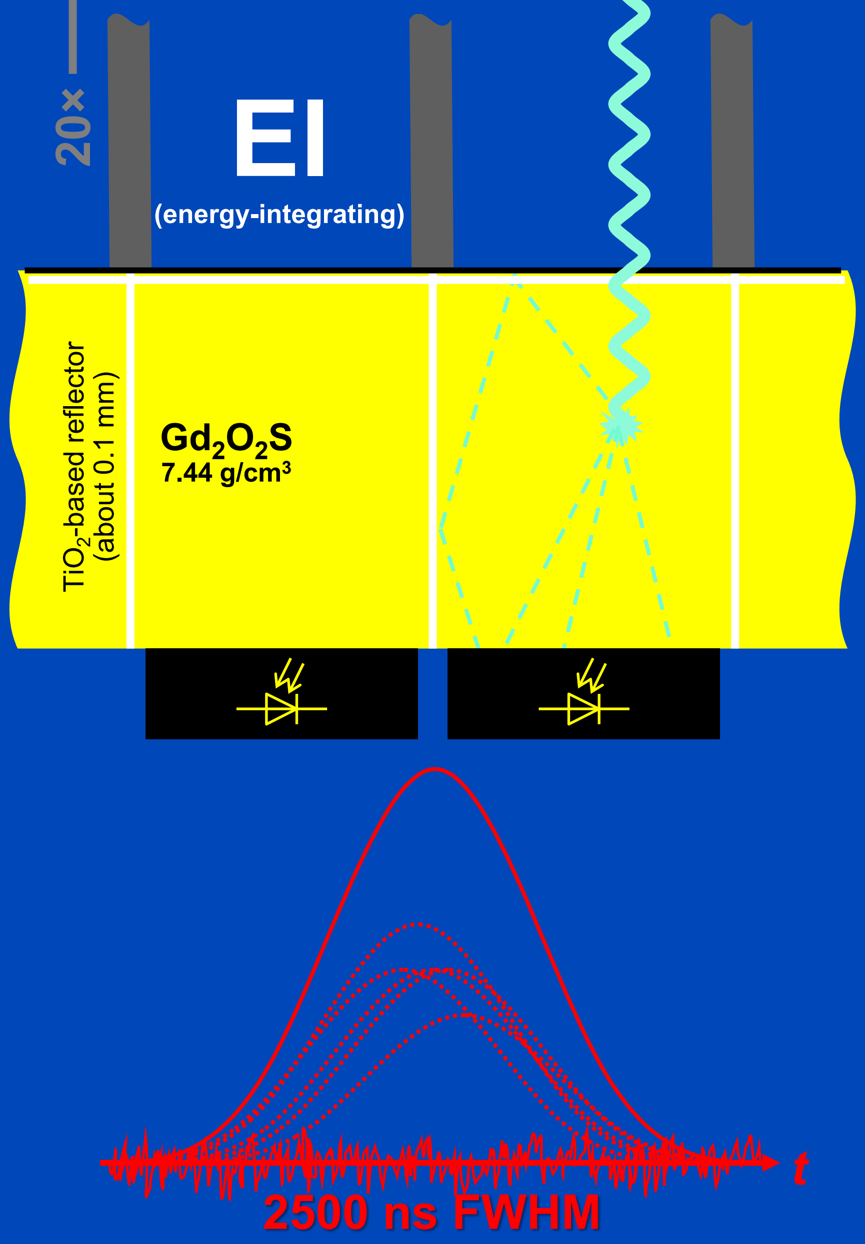
Reconstruction(s)
according to screening task(s)

Opportunistic Screening
and (more) incidental findings

Screening Report
if abnormal send to radiologist

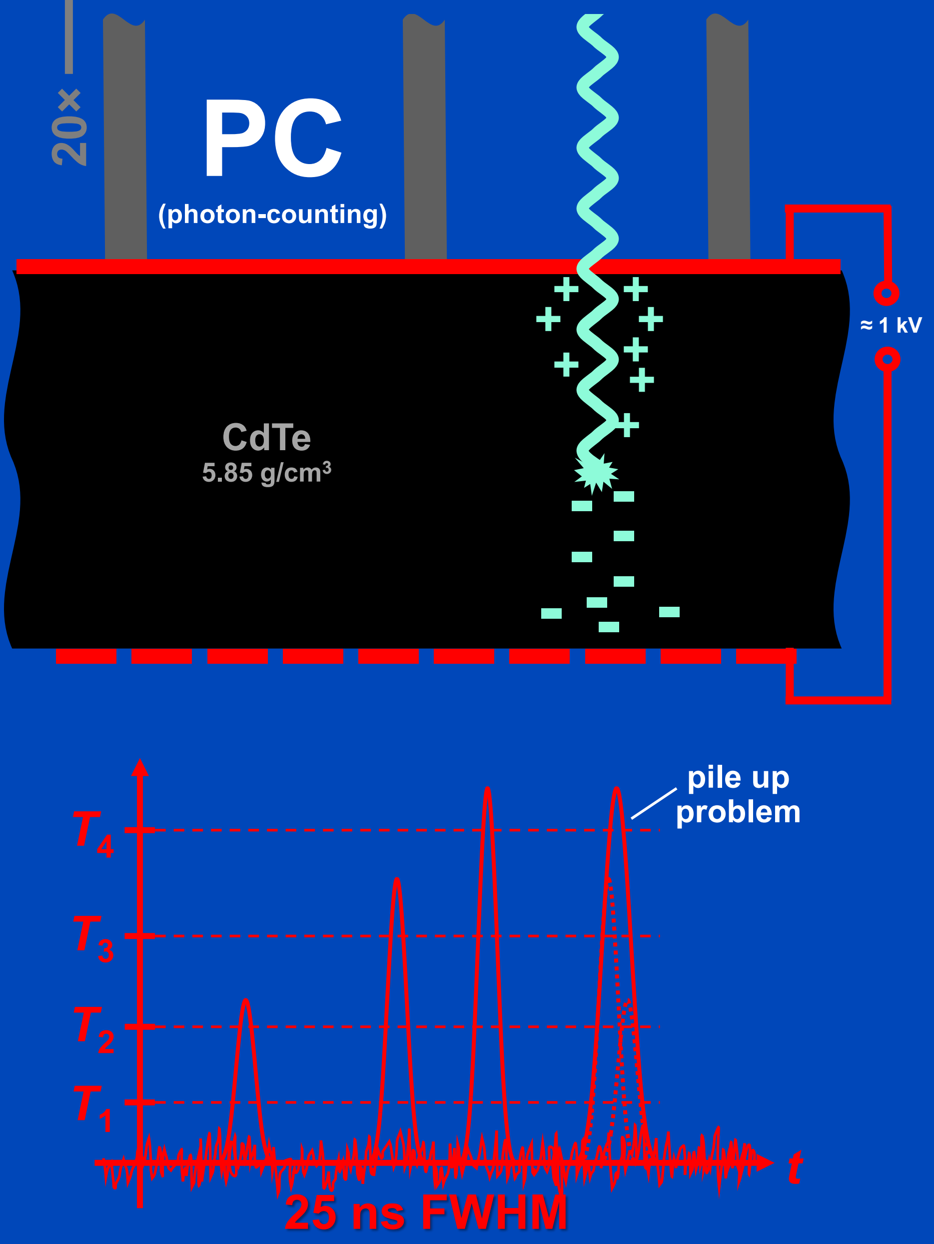
AI only

Indirect Conversion



i.e. max O(40·10³) cps

Direct Conversion



i.e. max O(40·10⁶) cps

Requirements for CT: up to 10^9 x-ray counts per second per mm^2. Hence, photon counting currently only achievable for direct converters.

Future YSO/SiPM (70 ns) or $LaBr_3$/SiPM (16 ns) indirect converters may also enable photon-counting CT.

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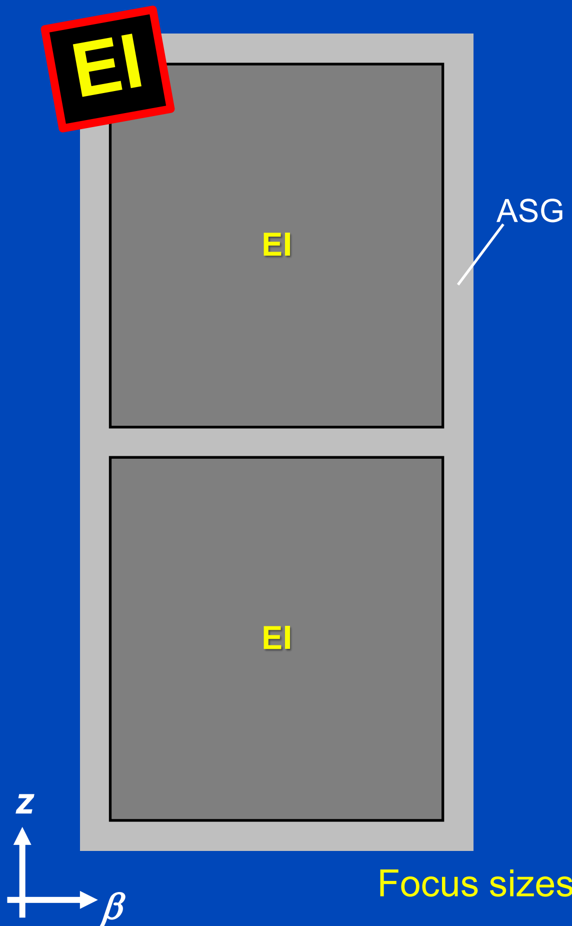
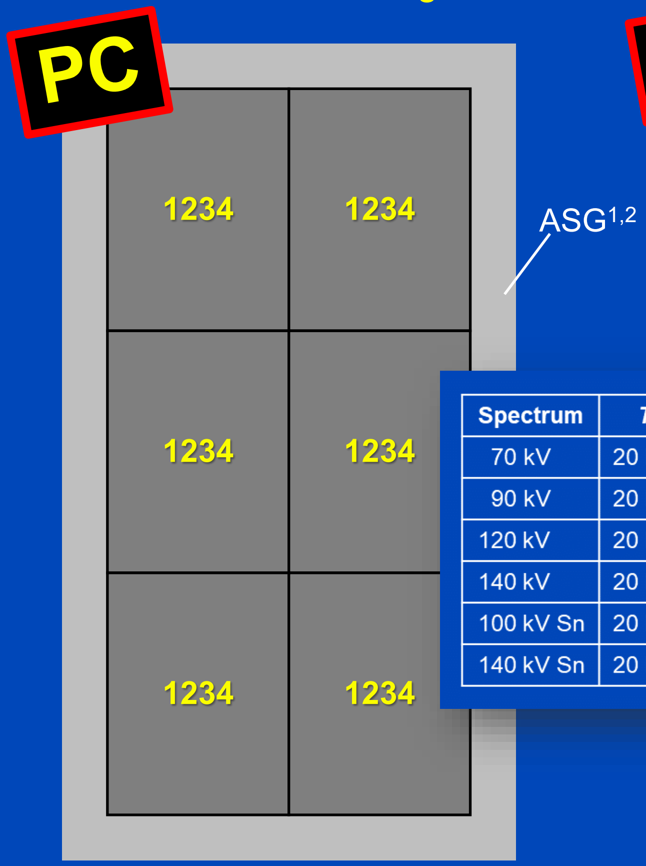
Detector Pixel Force vs. Alpha

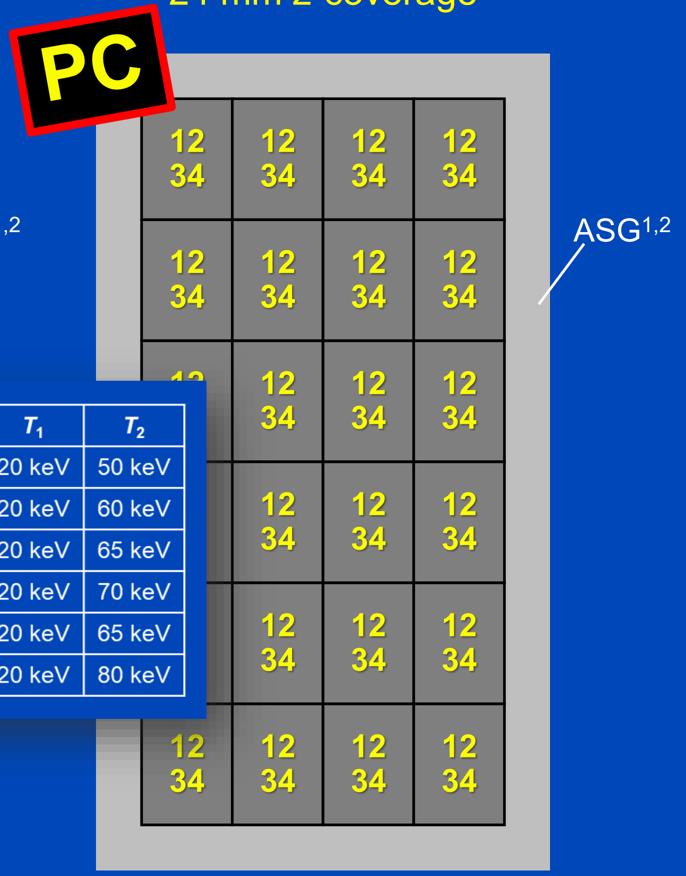
Force
920 × 96 detector pixels
pixel size 0.52 × 0.56 mm at iso
avg. sampling 0.56 × 0.6 mm at iso
57.6 mm z-coverage



Alpha (Std, Quantum Plus)
1376 × 144 macro pixels
pixel size 0.3 × 0.352 mm at iso
avg. sampling 0.344 × 0.4 mm at iso
57.6 mm z-coverage



Alpha (UHR, QuantumHD)
2752 × 120 pixels
pixel size 0.151 × 0.176 mm at iso
avg. sampling 0.172 × 0.2 mm at iso
24 mm z-coverage



Spectrum	T_1	T_2
70 kV	20 keV	50 keV
90 kV	20 keV	60 keV
120 kV	20 keV	65 keV
140 kV	20 keV	70 keV
100 kV Sn	20 keV	65 keV
140 kV Sn	20 keV	80 keV

Focus sizes (Vectron): 0.181×0.226 mm, 0.271×0.7316 mm, 0.362×0.497 mm at iso
which are 0.4×0.5 mm, 0.6×0.7 mm, 0.8×1.1 mm at focal spot

[1]J. Ferda et al. Computed tomography with a full FOV photon-counting detector in a clinical setting, the first experience. European Journal of Radiology 137:109614, 2021
[2]Rajendran et al. Full field-of-view, high-resolution, photon-counting detector CT: technical assessment and initial patient experience. Phys. Med. Biol. 66:205019, 2021

dkfz.

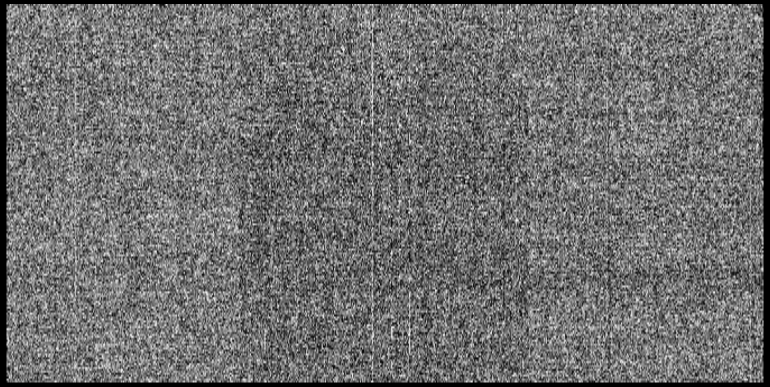
Siemens Naeotom Alpha.Peak
The World‘s First Photon-Counting CT

- **Tubes**
  - tube A: 120 kW ⎫ ≈ ¼ MW
  - tube B: 120 kW ⎭
  - Focal spot size down to 181 µm
- **Detectors**
  - pixel size down to 150 µm
  - 288 detector rows
  - 2752 detector columns
- **Speed**
  - up to 4 rotations per second
  - up to 737 mm/s scan speed
  - down to 66 ms native temporal resolution
- **50 cm FOM**
- **Spectral**
  - VNC, VNCa (pure lumen), VMI
  - Z_{eff}, electron density, …

Advantages of Photon-Counting CT

- No reflective gaps between detector pixels
  - Higher geometrical efficiency
  - Less dose
- No electronic noise (every photon counts)
  - Less dose for infants
  - Less noise for obese patients
- Counting
  - Swank factor = 1 = maximal
  - “Iodine effect“ due to higher weights on low energies
- Energy bin weighting
  - Lower dose/noise
  - Improved iodine CNR
- Smaller pixels (to avoid pileup)
  - Higher spatial resolution
  - “Small pixel effect” i.e. lower dose/noise at conventional resolution
- Spectral information on demand
  - Dual Energy CT (DECT), Multi Energy CT (MECT)
  - Standardization (e.g. VMI)

EI (Dexela)



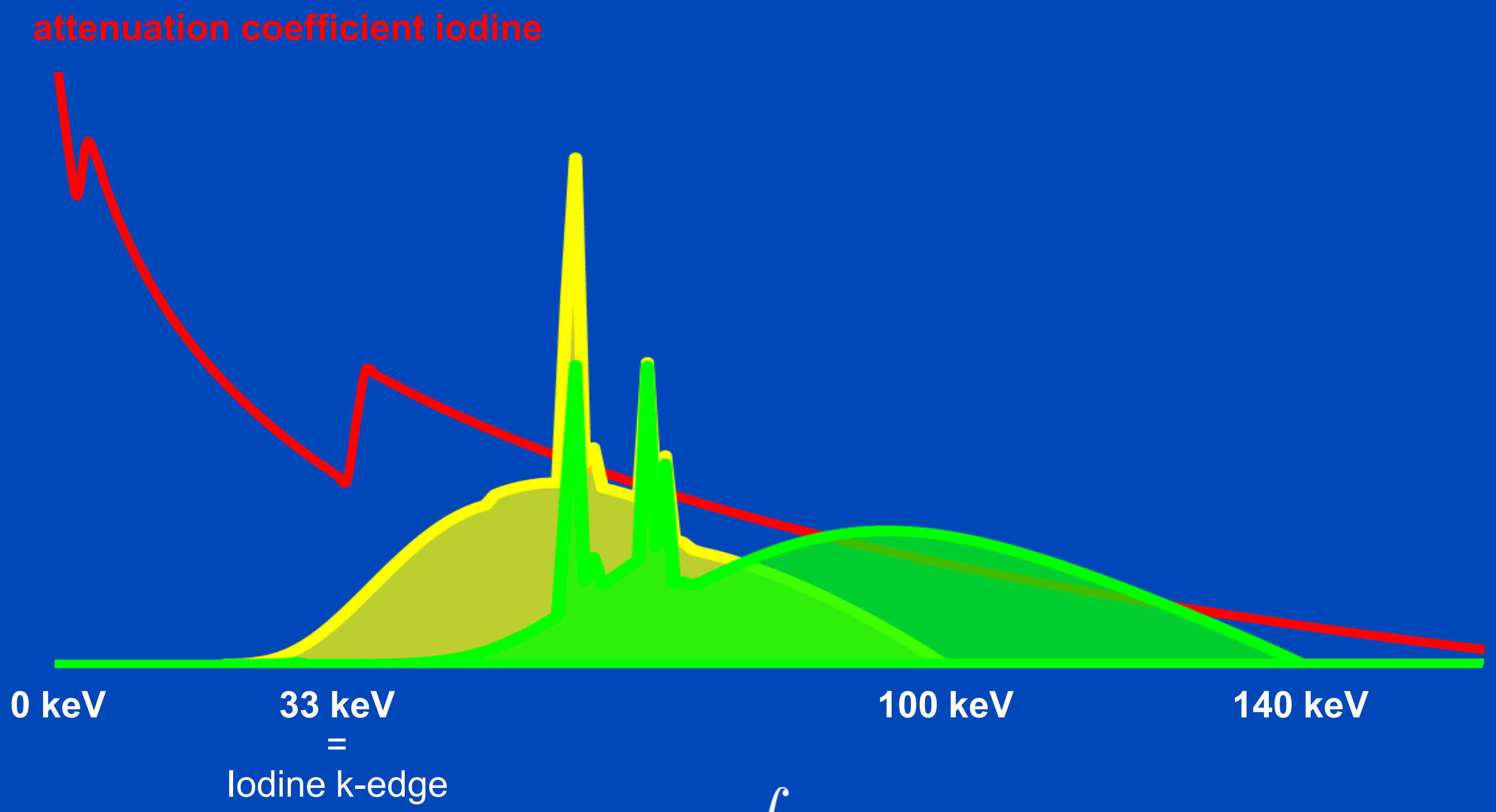
Readout noise only. Single events hidden!

PC (Dectris)

No readout noise. Single events visible!

18 frames, 5 min integration time per frame, x-ray off

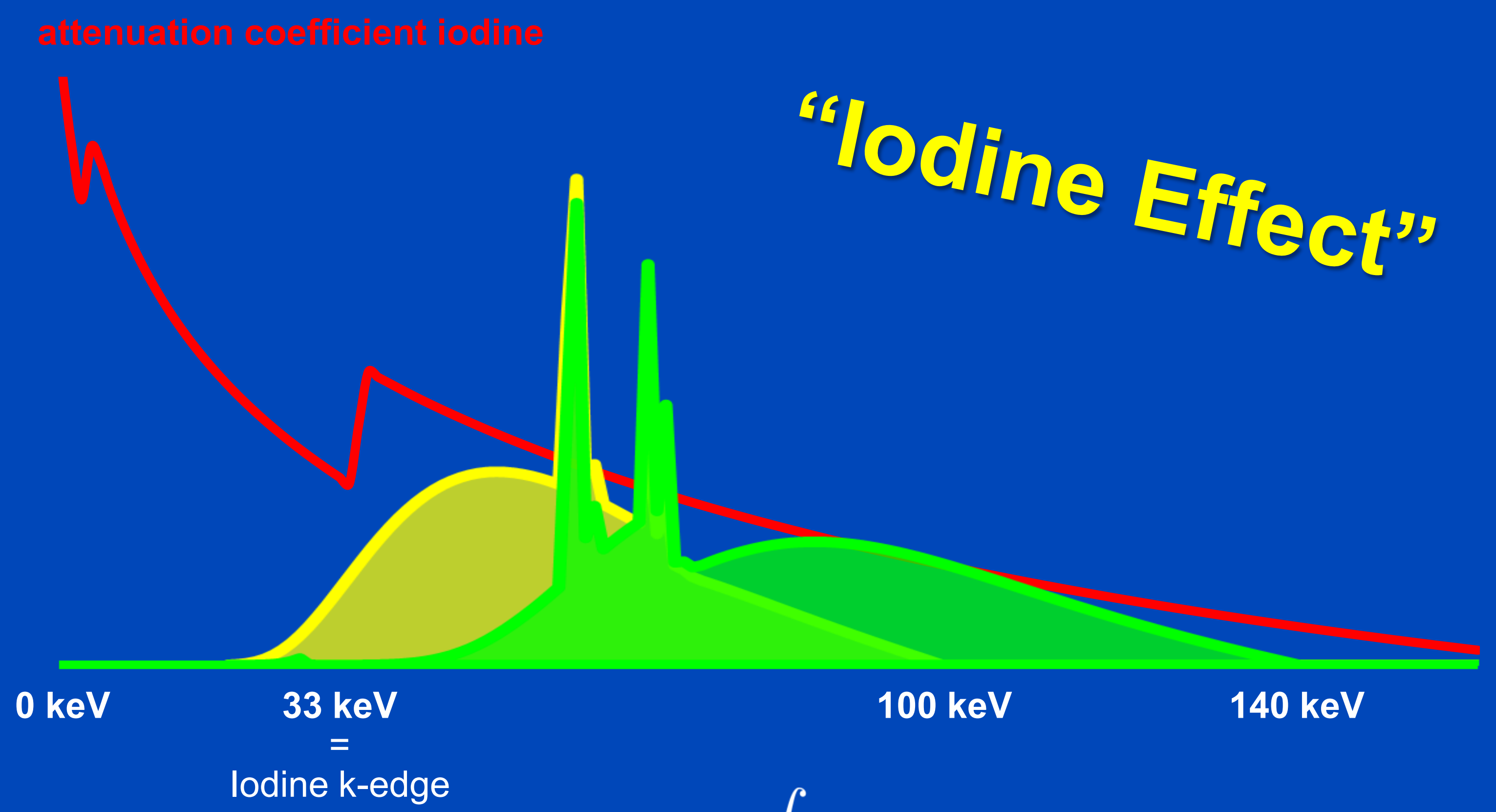
Energy-Integrating
(Detected Spectra at 100 kV and 140 kV)



$$\text{Signal}_{\text{EI}} = \int dE\, E\; N(E)$$

100 kV and 140 kV EI spectra as seen after having passed 32 cm of water.

Photon-Counting
(Detected Spectra at 100 kV and 140 kV)

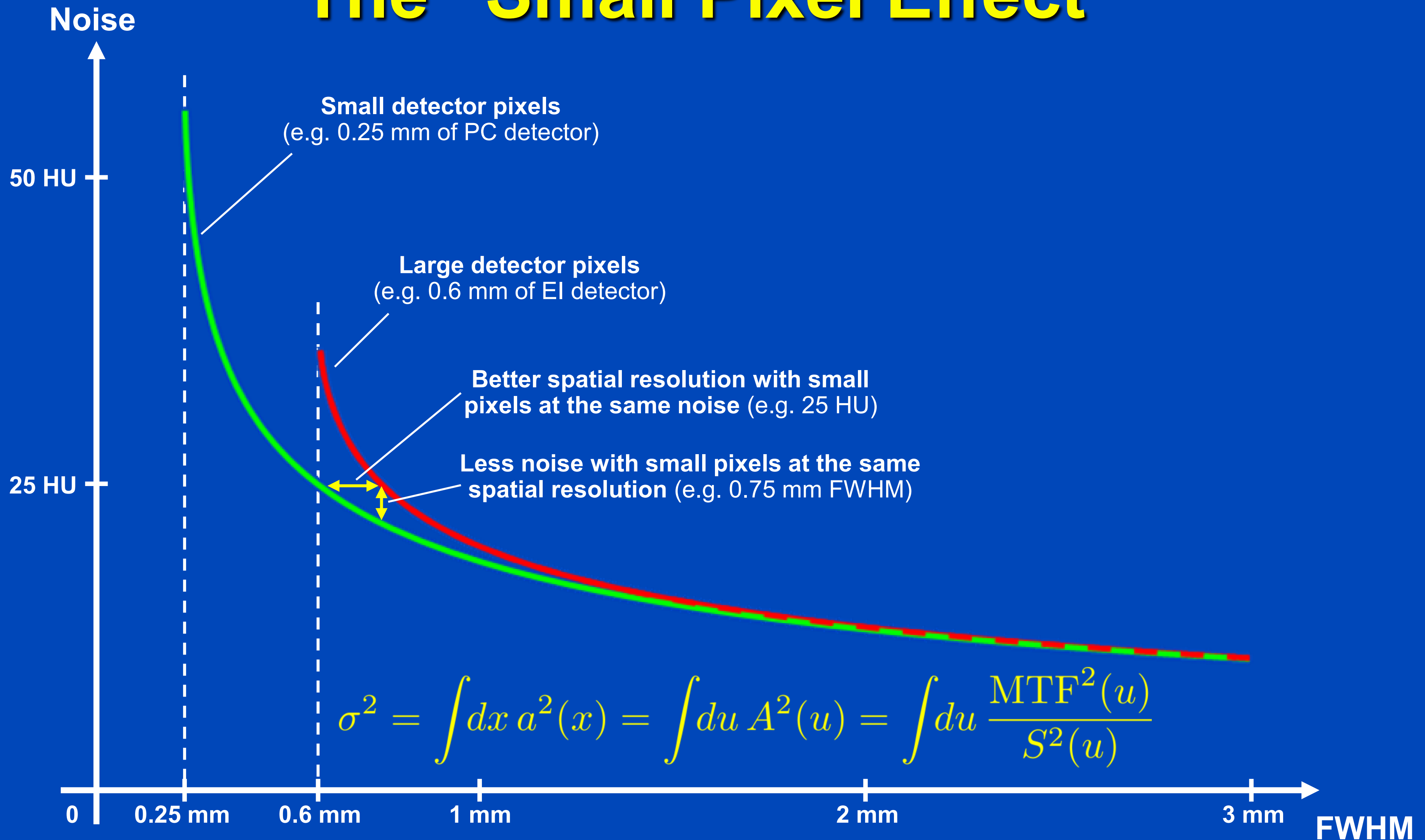


$$\text{Signal}_{\text{PC}} = \int dE\, 1\; N(E)$$

100 kV and 140 kV PC spectra (one bin) as seen after having passed 32 cm of water.

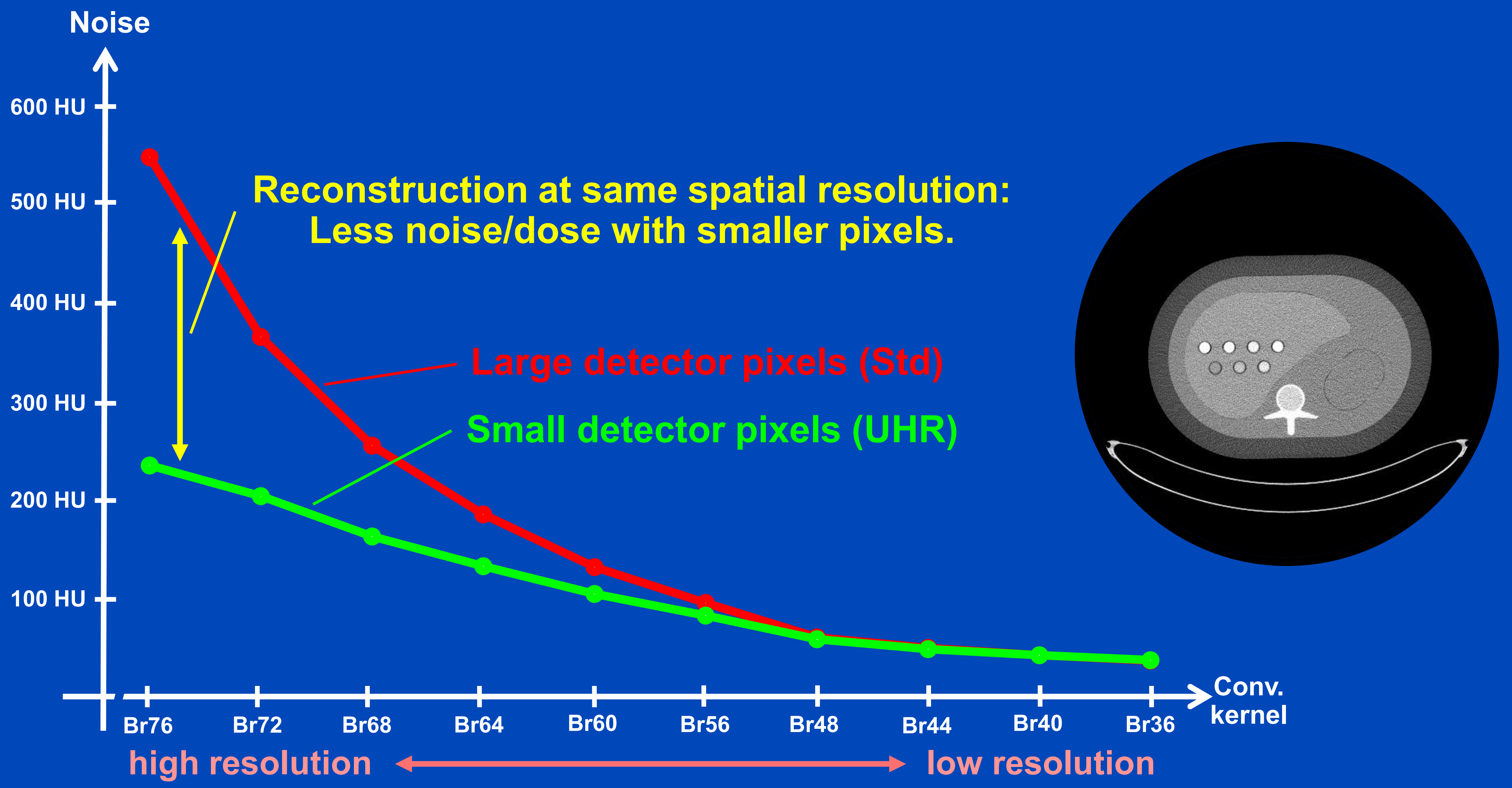
dkfz.

The “Small Pixel Effect”



Small Pixel Effect at Naeotom Alpha

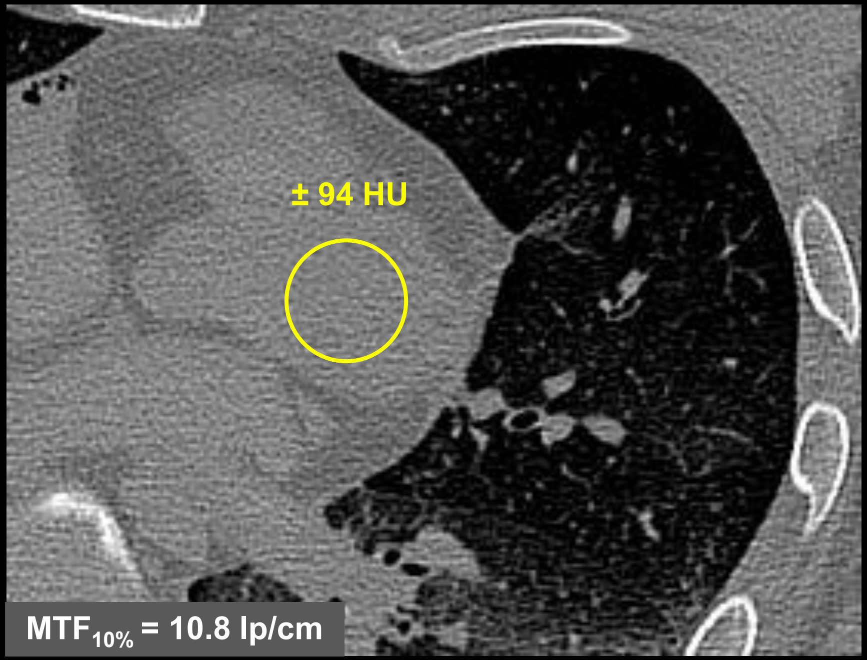
Medium Phantom, 4 mGy $CTDI_{32}$



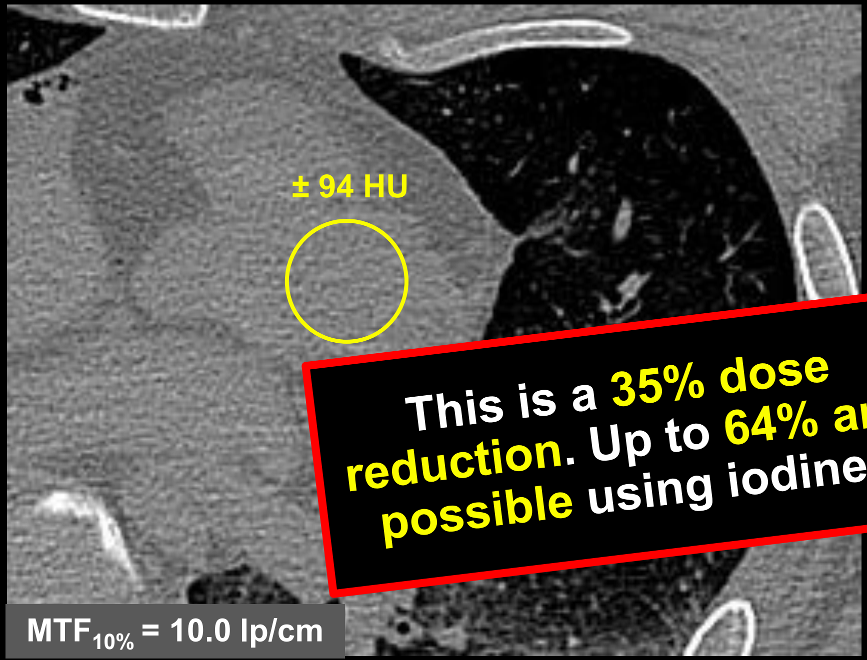
To disable the longitudinal small pixel effect, we reconstructed rather thick slices (1 mm thickness).

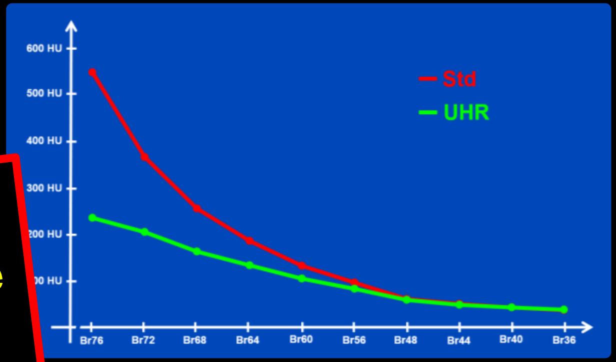
L. Klein, C. Amato, S. Heinze, M. Uhrig, H.-P. Schlemmer, M. Kachelrieß, and S. Sawall. **Effects of Detector Sampling on Noise Reduction in a Clinical Photon Counting Whole-Body CT**. Investigative Radiology, vol. 55(2):111-119, February 2020.

Energy-Integrating Detector (B70f)



Photon-Counting Detector (B70f)





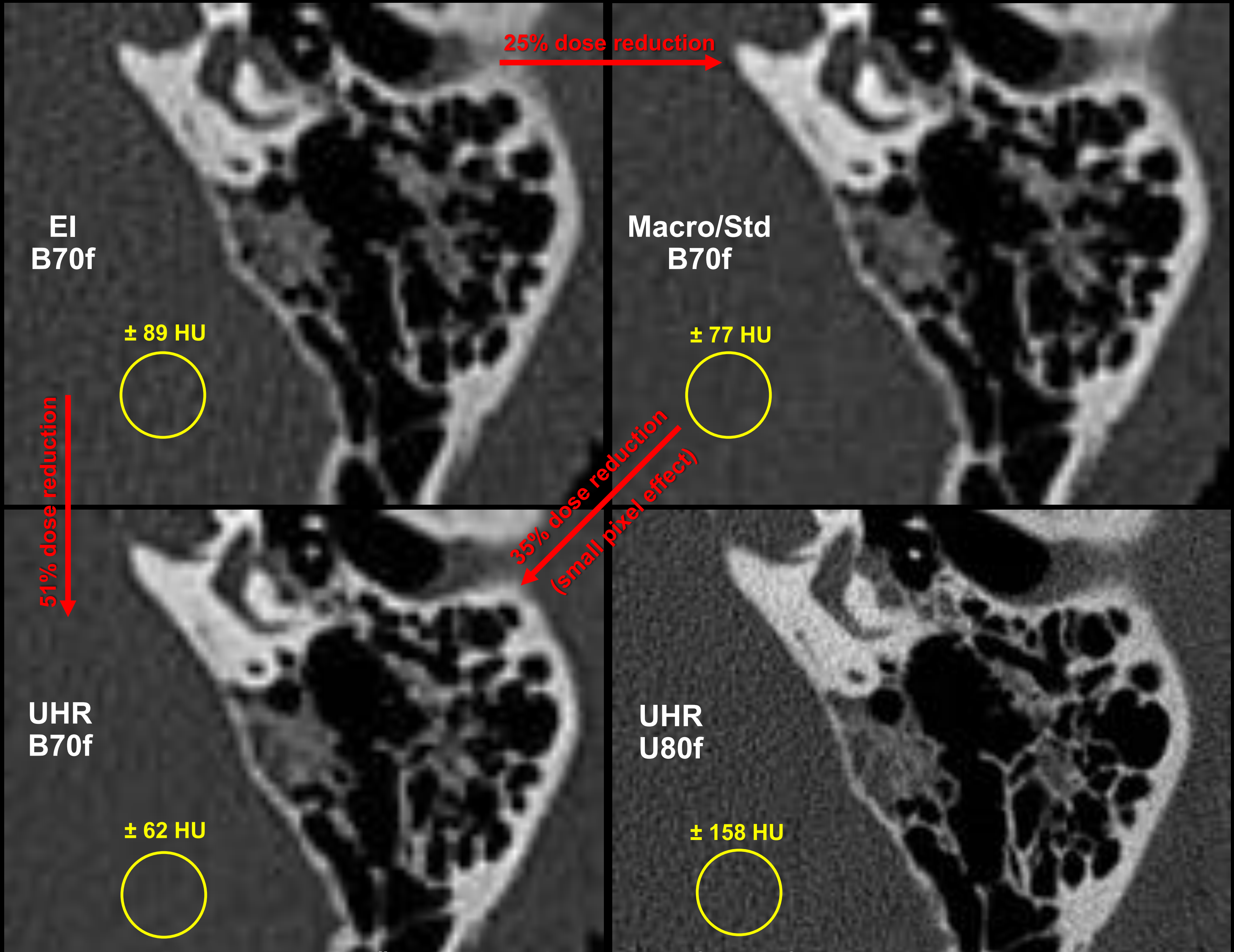
This is a 35% dose reduction. Up to 64% are possible using iodine.

Acquisition with EI:
- Tube voltage of 120 kV
- Tube current of 300 mAs
- Resulting dose of $\text{CTDI}_{\text{vol 32 cm}}$ = **22.6 mGy**

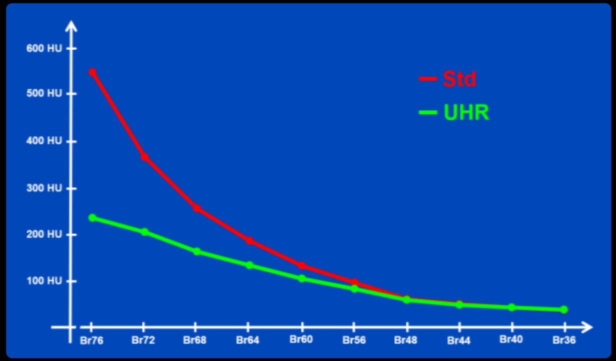
Acquisition with UHR:
- Tube voltage of 120 kV
- Tube current of 180 mAs
- Resulting dose of $\text{CTDI}_{\text{vol 32 cm}}$ = **14.6 mGy**

C = 50 HU, *W* = 1500 HU

dkfz.

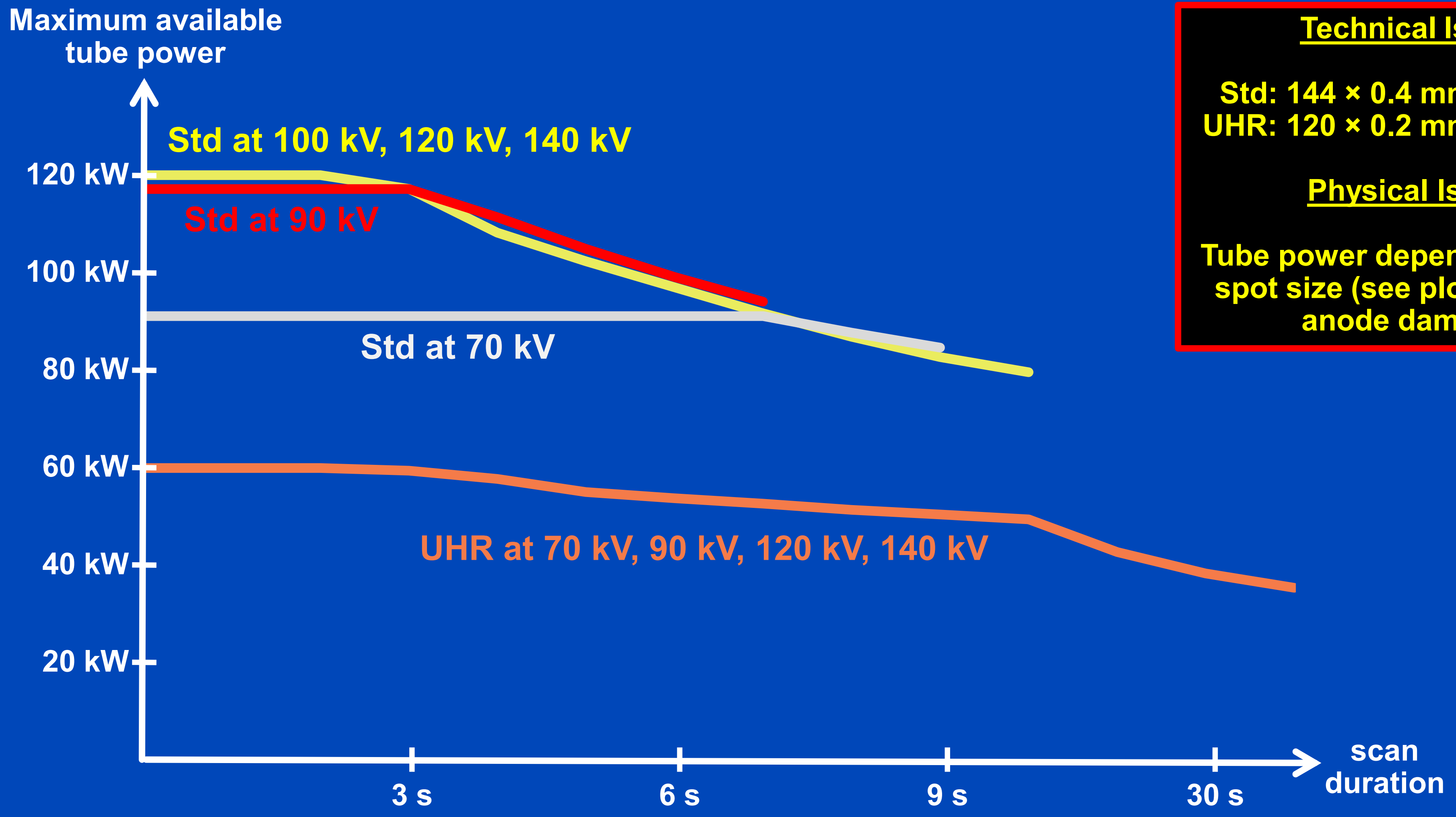


All images taken at the same dose at Somatom CounT.
C = 1000 HU, W = 3500 HU



Drawbacks of UHR?

Power of Vectron X-Ray tube in Naeotom Alpha



Technical Issue

Std: 144 × 0.4 mm = 57.6 mm
UHR: 120 × 0.2 mm = 24.0 mm

Physical Issue

Tube power depends on focal spot size (see plot) to avoid anode damage.

Wu et al. European Radiology (2025) 35:2287–2295
https://doi.org/10.1007/s00330-024-11046-2

EUROPEAN SOCIETY OF RADIOLOGY
European Radiology

MUSCULOSKELETAL

Artificial intelligence assisted automatic screening of opportunistic osteoporosis in computed tomography images from different scanners

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Abstract

Objectives It is feasible to evaluate bone mineral density (BMD) and detect osteoporosis through an artificial intelligence (AI)-assisted system by using quantitative computed tomography (QCT) as a reference without additional radiation exposure or cost.

Methods A deep-learning model developed based on 3312 low-dose chest computed tomography (LDCT) scans (trained with 2337 and tested with 975) achieved a mean dice similarity coefficient of 95.8% for T1–T12, L1, and L2 vertebral body (VB) segmentation on test data. We performed a model evaluation based on 4401 LDCT scans (obtained from scanners of 3 different manufacturers as external validation data). The BMD values of all individuals were extracted from three consecutive VBs: T12 to L2. Line regression and Bland–Altman analyses were used to evaluate the overall detection performance. Sensitivity and specificity were used to evaluate the diagnostic performance for normal, osteopenia, and osteoporosis patients.

Results Compared with the QCT results as the diagnostic standard, the BMD assessed had a mean error of (− 0.28, 2.37) mg/cm^3. Overall, the sensitivity of a normal diagnosis was greater than that of a diagnosis of osteopenia or osteoporosis. For the diagnosis of osteoporosis, the model achieved a sensitivity > 86% and a specificity > 98%.

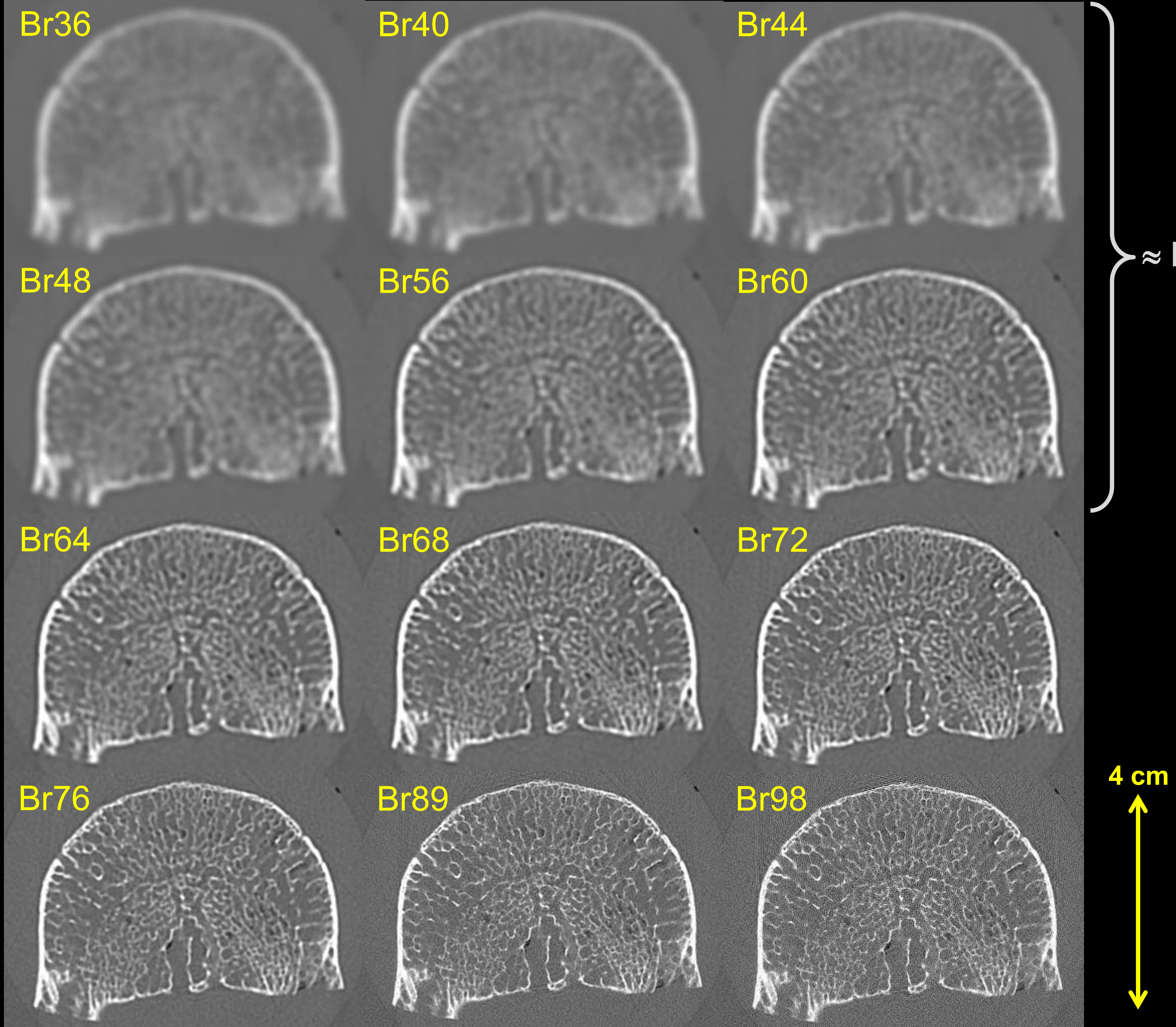
Conclusion The developed tool is clinically applicable and helpful for the positioning and analysis of VBs, the measurement of BMD, and the screening of osteopenia and osteoporosis.

Clinical relevance statement The developed system achieved high accuracy for automatic opportunistic osteoporosis screening using low-dose chest CT scans and performed well on CT images collected from different scanners.

Key Points

- *Osteoporosis is a prevalent but underdiagnosed condition that can increase the risk of fractures.*
- *This system could automatically and opportunistically screen for osteoporosis using low-dose chest CT scans obtained for lung cancer screening.*
- *The developed system performed well on CT images collected from different scanners and did not differ with patient age or sex.*

dkfz.



Vertebra at Naeotom Alpha.Peak in UHR mode.

C = 500 HU
W = 3000 HU

dkfz.

Prevalence of Osteoporosis

- According to the World Health Organization (WHO) osteoporosis is among the ten most common diseases worldwide.
- Impacting over 200 million women all over the world
- Germany: 5.87 million people are affected of which around 82% are women
- Less than 25% of all cases are detected and treated early enough.

https://www.osteoporose-deutschland.de/osteoporose/ (Accessed on 24.10.2025) Peyman Hadji, Elizabeth Esterberg, Dominik Obermüller, and Robert Bartsch. Bone evaluation study-2: Update on the epidemiology of osteoporosis in Germany. Archives of Osteoporosis, 19(1):26, 2024

Osteoporosis

- Common metabolic bone disease
  - Characterized by reduced bone mineral density (BMD) and deterioration of bone microarchitecture.
- Leads to increased bone fragility and higher fracture risk
  - Mainly affecting the spine, hip, and wrist.
- Often asymptomatic until the first fracture occurs.
- With an aging global population, the number of osteoporotic fractures and associated economic costs are expected to rise.
- Early diagnosis is crucial for effective treatment and prevention.
  - After the first fragility fracture, there is a significantly increased risk of subsequent fractures.

Tilman D Rachner, Sundeep Khosla, and Lorenz C Hofbauer. Osteoporosis: now and the future. The Lancet, 377(9773):1276–1287, 2011.

Screening Methods

- The current gold standard for BMD measurement is dual-energy X-ray absorptiometry (DEXA)
  - Standardized but limited in availability and use in certain clinical settings.
- CT with a calibration phantom often referred to as qCT
  - Cannot be applied retrospectively.
  - Adds to patient dose.
- Opportunistic osteoporosis screening
  - Not implemented in clinical routine.

Glen M Blake and Ignac Fogelman. Technical principles of dual energy x-ray absorptiometry. In Seminars in nuclear medicine, volume 27,pages 210–228.Elsevier, 1997.
Joseph J Schreiber, Paul A Anderson, and Wellington K Hsu. Use of computed tomography for assessing bone mineral density. Neurosurgical Focus, 37(1):E4, 2014.

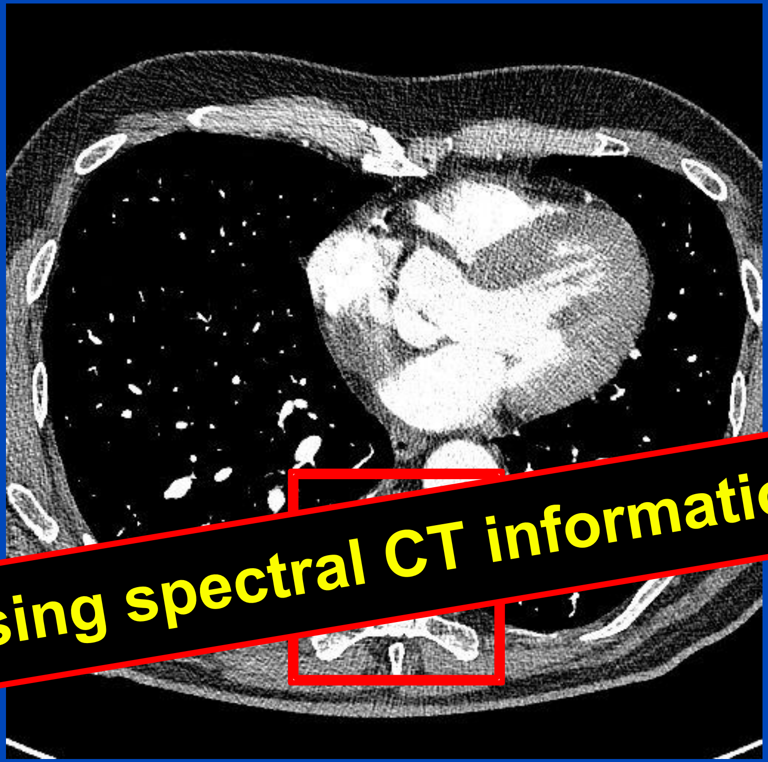
Challenges

- Approximately 400 million CT scans are performed worldwide each year.
- Around 40% of all CT scans are contrast-enhanced scans.
- Contrast uptake also occurs in spongy bone and may interfere with accurate BMD measurements.

Dominika Sabiniewicz-Ziajka, Arkadiusz Szarmach, Malgorzata Grzywi´nska, Pawel Ga´c, and Maciej Piskunowicz. Redefining radiation metrics: evaluating actual doses in computed tomography scans. Biomedicines, 12(3):600, 2024.
Risa Kanatani, Takashi Shirasaka, Tsukasa Kojima, Toyoyuki Kato, and Masateru Kawakubo. Influence of beam hardening in dual-energy CT imaging: phantom study for iodine mapping, virtual monoenergetic imaging, and virtual non-contrast imaging. European radiology experimental, 5:1–8, 2021.

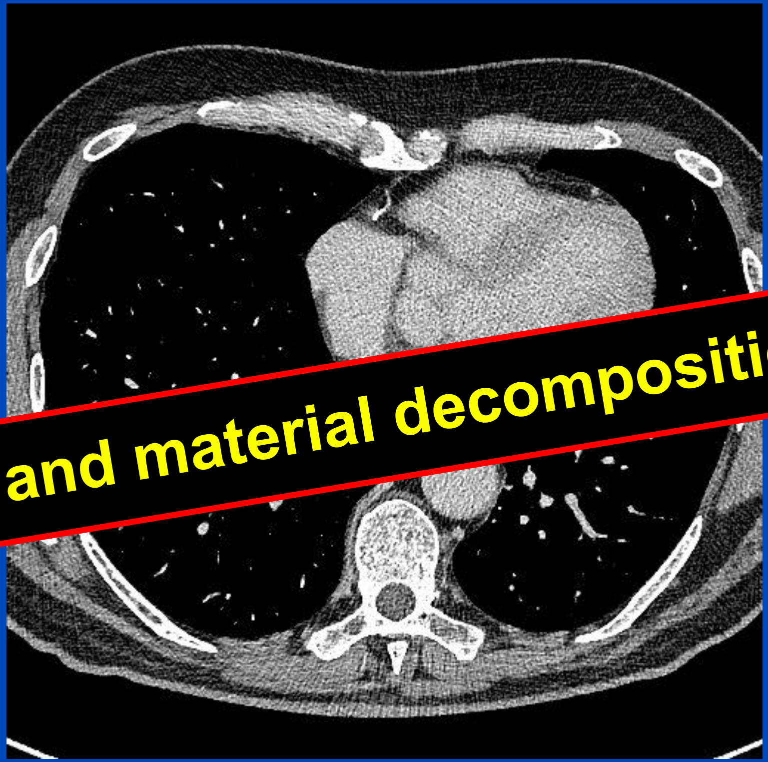
CT Values Spongy Bone Change with Contrast Agent

Unenhanced vertebra



135 HU / 1312 HU
Spongy bone / Cortical bone

Enhanced vertebra



160 HU / 1314 HU

→ Resolve using spectral CT information and material decomposition

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Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

Dental imaging in clinical photon-counting CT at a quarter of DVT dose

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[c] Department of Orthodontics, University Hospital of Schleswig-Holstein
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[e] Division of Radiology, German Cancer Research Center (DKFZ), Im N
[f] Department of Clinical Radiology and Nuclear Medicine, University H

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Photon-counting CT
Radiation dose

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Ruetters et al. International Journal of Implant Dentistry (2025) 11:51
https://doi.org/10.1186/s40729-025-00640-8

International Journal of Implant Dentistry

RESEARCH Open Access

Dental photon-counting computed tomography for the assessment of Peri-Implant structures

Maurice Ruetters[1*†], Christian Mertens[2†], Holger Gehrig[1], Sinan Sen[3], Ti-Sun Kim[1], Hans-Peter Schlem
Stefan Schoenberg[5], Matthias Froelich[5], Marc Kachelrieß[6,7] and Stefan Sawall[6,7]

Abstract

Purpose To assess the diagnostic performance of photon-counting computed tomography (PCCT) in peri-implant bone structures and to compare it quantitatively and qualitatively to cone-beam compute (CBCT).

Methods Thirty titanium implants were placed in ten porcine mandibles. CBCT and PCCT scans were a compared quantitatively regarding image noise and CT-values. Additionally bone thickness was compa standard at 60 standardized locations by one calibrated investigator in both modalities. Measurement a assessed by Bland–Altman analysis. Two experienced raters performed qualitative assessments of anat

Journal of Imaging

MDPI

Article

Opportunistic Diagnostics of Dental Implants in Routine Clinical Photon-Counting CT Acquisitions

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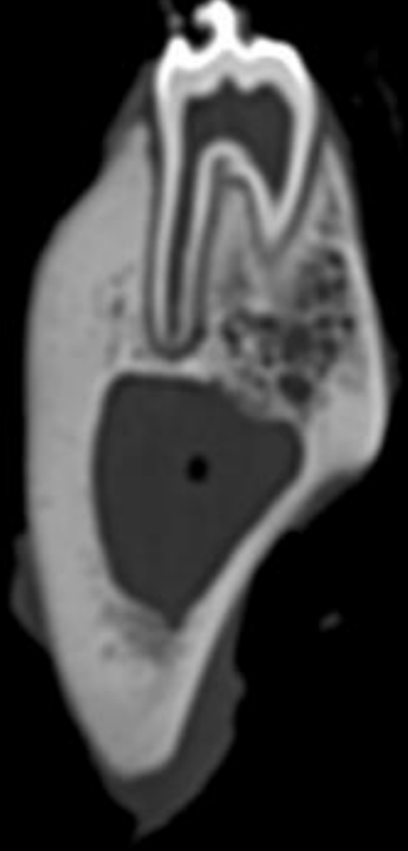
Current Status

- Approximately 1.6 million CT examinations per year in Germany incidentally include the teeth and would therefore be potentially suitable for opportunistic dental assessment.
- So far, only first feasibility or proof-of-concept studies have been published, often focusing on image quality and artifacts.
- No larger clinical studies exist yet.
- The next step would be systematic clinical validation and evaluation of diagnostic and health-economic impact.

Evolution of Spatial Resolution

Energy-Integrating

similar to
2005: Somatom Flash (B70)



Pixel size 0.181 mm
Slice thickness 0.60 mm
Slice increment 0.30 mm
$MTF_{50\%}$ = 8.0 lp/cm
$MTF_{10\%}$ = 9.2 lp/cm

10 mm

Photon-Counting

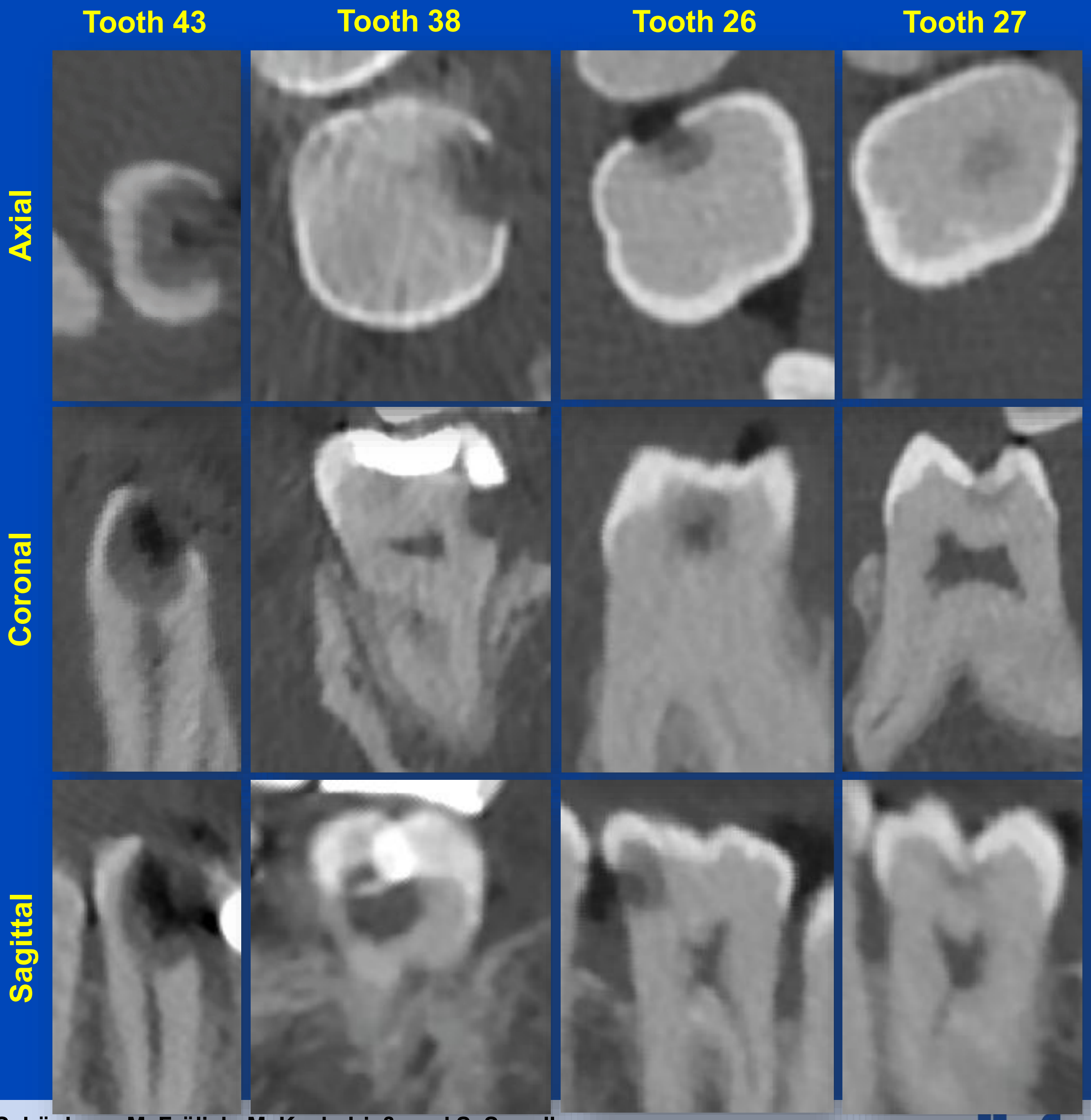
scanned at
2021: Naeotom Alpha (Br98u)

Pixel size 0.181 mm
Slice thickness 0.20 mm
Slice increment 0.10 mm
$MTF_{50\%}$ = 39.0 lp/cm
$MTF_{10\%}$ = 42.9 lp/cm

Opportunistic Diagnosis of Carious Defects in Routine Head and Neck Scans

- About 12% of all clinical CT scans include the teeth or the peridontium.
- We performed a study with 33 patients that received a routine examination of the cervical spine.
- We investigated the image quality and searched for potential pathologies.
- We found that 70% of all patients need to consult a dentist.

- Naeotom Alpha.Peak
- Br72
- $CTDI_{32\ cm}$ = 13 mGy
- C = 1300 HU, W = 6000 HU



M. Rütters, H. Gerhig, C. Mertens, S. Sen, T.-S. Kim, H.-P. Schlemmer, C. H. Ziener, S. Schönberg, M. Frölich, M. Kachelrieß, and S. Sawall. Opportunistic diagnostics of dental implants in routine clinical photon-counting CT acquisitions. Journal of Imaging 11(7):215 (11 pages), 2025.

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Lung cancer screening CT acquisition protocols for three generations of CT systems conforming to German legislation

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ARTICLE INFO

Keywords:
Lung cancer screening
Computed tomography
Image quality
Scan protocol design

ABSTRACT

Objective: Develop a computed tomography (CT) acquisition protocol for lung cancer screening compliant with German legislation across three CT system generations, addressing standardization of image quality and radiation dose amid technical variability.
Materials and methods: Three CT systems, a first-generation dual-source energy-integrating (EID) CT (Somatom Flash), a second-generation dual-source EID CT (Somatom Force), and a photon-counting CT (Naeotom Alpha), were evaluated. An anthropomorphic thorax phantom with fat rings was used to simulate small,

Lung Cancer

- Can be detected on any diagnostic scan that covers the lung.

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Original paper

Image quality of opportunistic breast examinations in photon-counting computed tomography: A phantom study

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ARTICLE INFO

Keywords:
Computed Tomography
X-Ray
Dosage
Radiation
Phantom
Imaging

ABSTRACT

Purpose: To compare the breast imaging performance of a clinical whole-body photon-counting CT (PCCT) to that of a dedicated breast CT (BCT) to determine the image quality of opportunistic breast examinations in clinical PCCT.

Materials and methods: To quantify image quality for breast cancer applications, acquisitions of a breast phantom including representations of calcifications, fibers, and masses were performed using a clinical PCCT and a dedicated BCT. When imaging with the PCCT, the phantom was also combined with a thorax phantom to simulate realistic patient positioning, while only the breast phantom was imaged in the BCT. Images in BCT were

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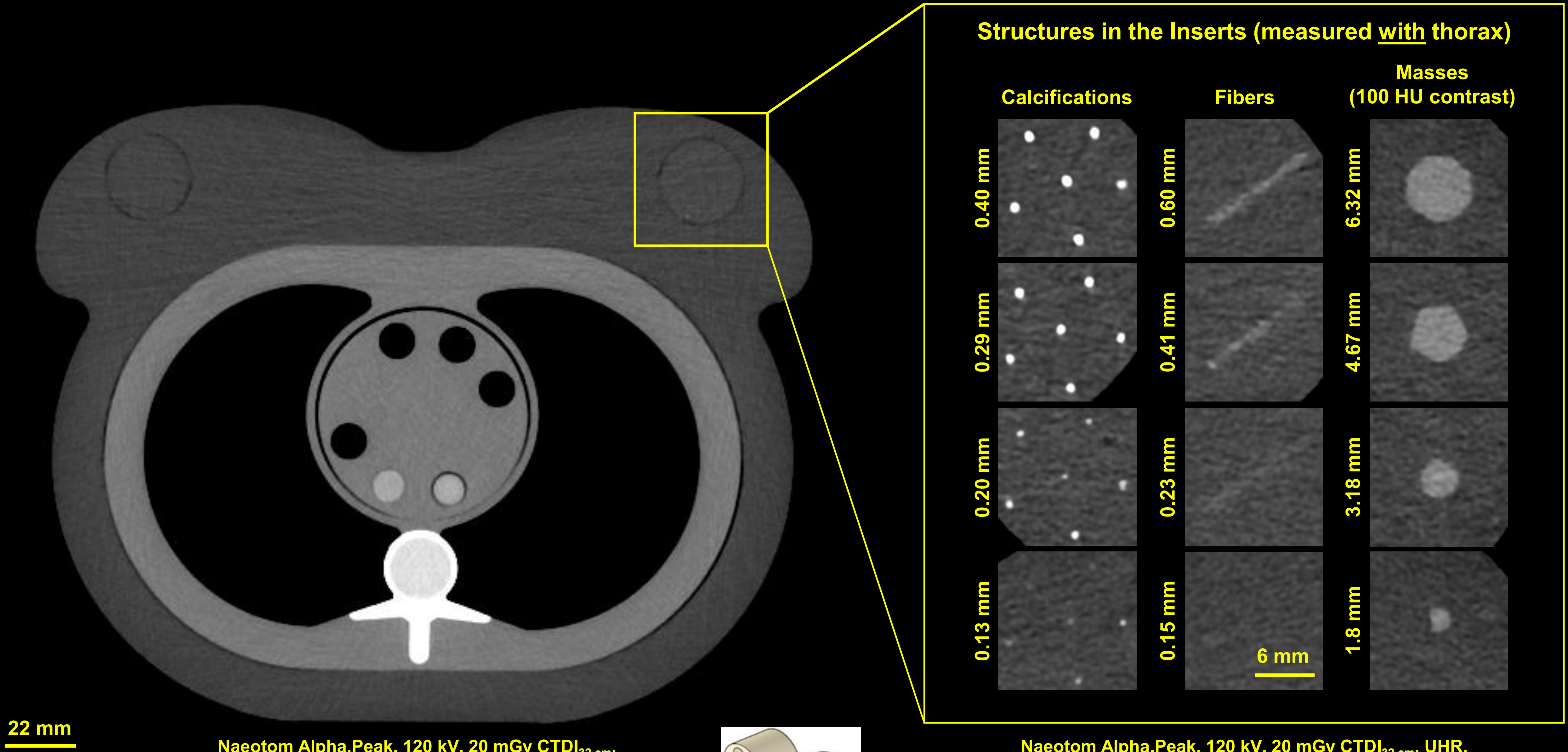
	Mammography	Tomosynthesis	Dedicated Breast CT	Dedicated PCCT	Opportunistic PCCT
Real 3D	✗	✗	✓	✓	✓
No compression	✗	✗	✓	✓	✓
Low radiation	✓	✓	?	✗	✓
Detects small tumors	✓	✓	✓	probably	probably
Low implant rupture risk	✗	✗	✓	✓	✓
Detects calcification clusters	✓	✓	✓	if UHR	if UHR
Density distribution management	✗	✗	✓	✓	✓
Low cost	✓	✓	✗	✗	✓
High throughput	✓	✓	✓	✓	✓

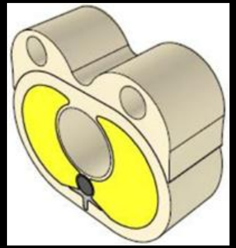
Motivation

- Mammography may be uncomfortable and painful
  - Participation rate ~ 50%
  - Has been improved by self-compression
- Mammography has no 3D information.
- Many woman undergo thoracic CT scans for other indications, e.g. cardiac CT, lung CT etc.
- The breast is often contained in the field of measurement and allows for opportunistic breast examinations.
- A total of 13.56 million CT scans are conducted annually in Germany[1]
  - 26% of all CT scans are chest CT[2] and 4% are chest & abdomen
  - 50% are female
  - 2 million scans cover the female breast.
- Photon-counting CT might provide the required spatial resolution to perform opportunistic breast examinations.

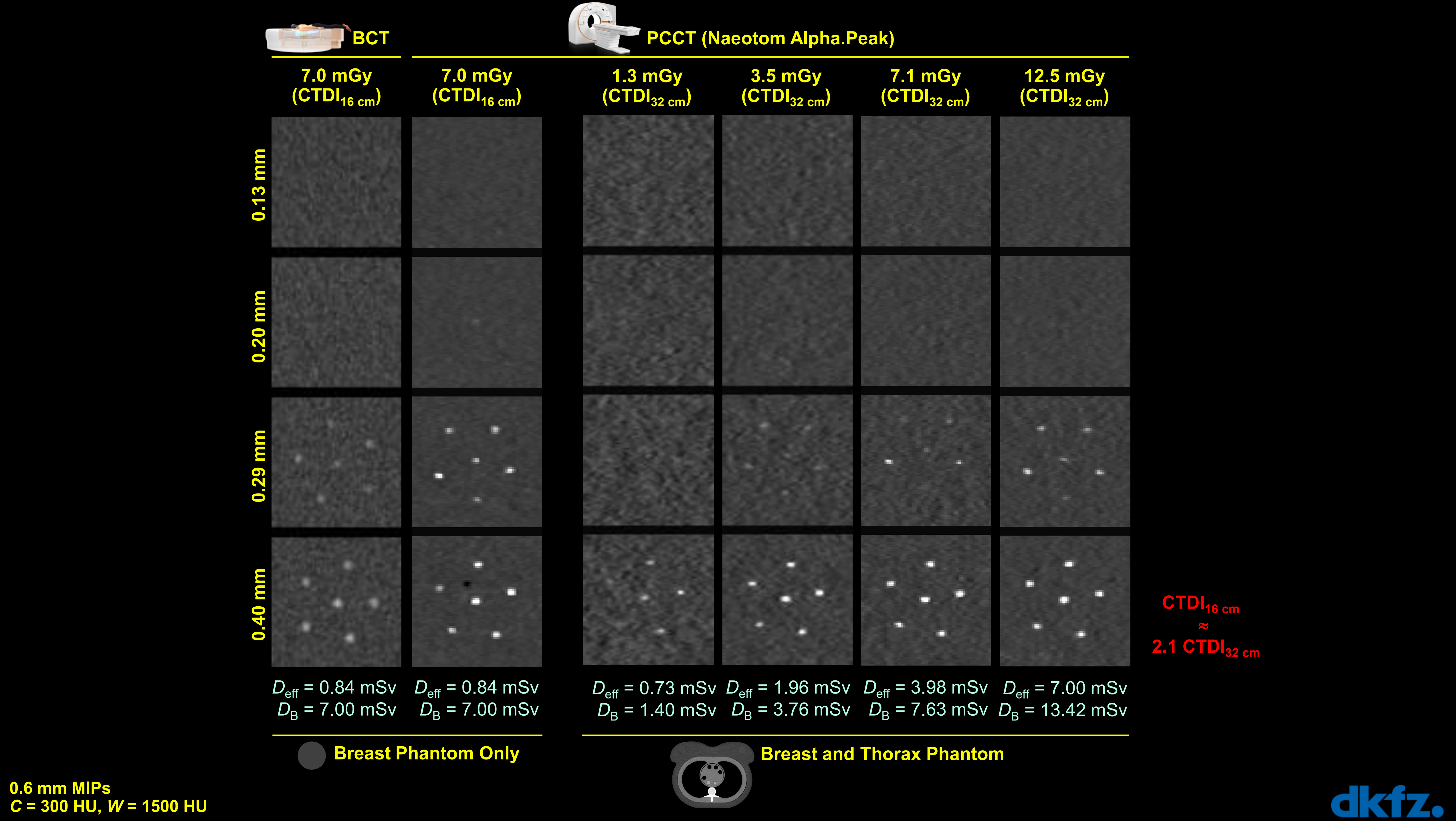
[1] https://www.statista.com/statistics/862366/computed-tomography-scan-examinations-in-Germany/
[2] https://pmc.ncbi.nlm.nih.gov/articles/PMC6314083/



Naeotom Alpha.Peak, 120 kV, 20 mGy $CTDI_{32\ cm}$,
Br40 kernel, QIR(3), pixel size 0.73 mm,
slice thickness 2.5 mm, slice increment 1.0 mm,
C = 40 HU, *W* = 400 HU



Naeotom Alpha.Peak, 120 kV, 20 mGy $CTDI_{32\ cm}$, UHR,
Br72 kernel, QIR(3), pixel size 0.097 mm,
slice thickness 0.2 mm, slice increment 0.1 mm,
C = 40 HU, *W* = 400 HU


BCT
PCCT (Naeotom Alpha.Peak)
7.0 mGy ($CTDI_{16 cm}$)
7.0 mGy ($CTDI_{16 cm}$)
1.3 mGy ($CTDI_{32 cm}$)
3.5 mGy ($CTDI_{32 cm}$)
7.1 mGy ($CTDI_{32 cm}$)
12.5 mGy ($CTDI_{32 cm}$)
0.13 mm
0.20 mm
0.29 mm
0.40 mm
D_{eff} = 0.84 mSv D_B = 7.00 mSv
D_{eff} = 0.84 mSv D_B = 7.00 mSv
D_{eff} = 0.73 mSv D_B = 1.40 mSv
D_{eff} = 1.96 mSv D_B = 3.76 mSv
D_{eff} = 3.98 mSv D_B = 7.63 mSv
D_{eff} = 7.00 mSv D_B = 13.42 mSv
Breast Phantom Only
Breast and Thorax Phantom
$CTDI_{16 cm}$ ≈ 2.1 $CTDI_{32 cm}$
0.6 mm MIPs
C = 300 HU, *W* = 1500 HU
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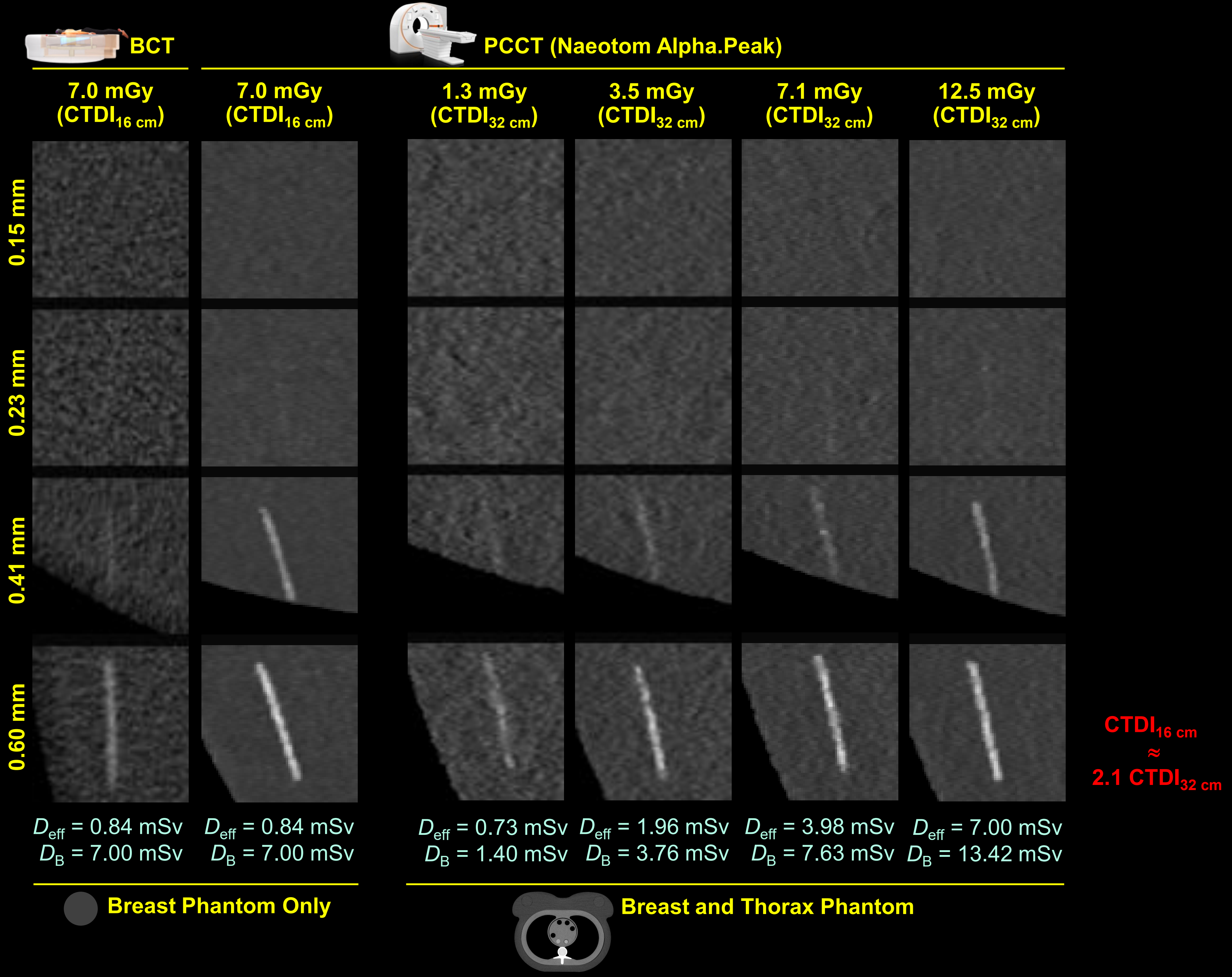
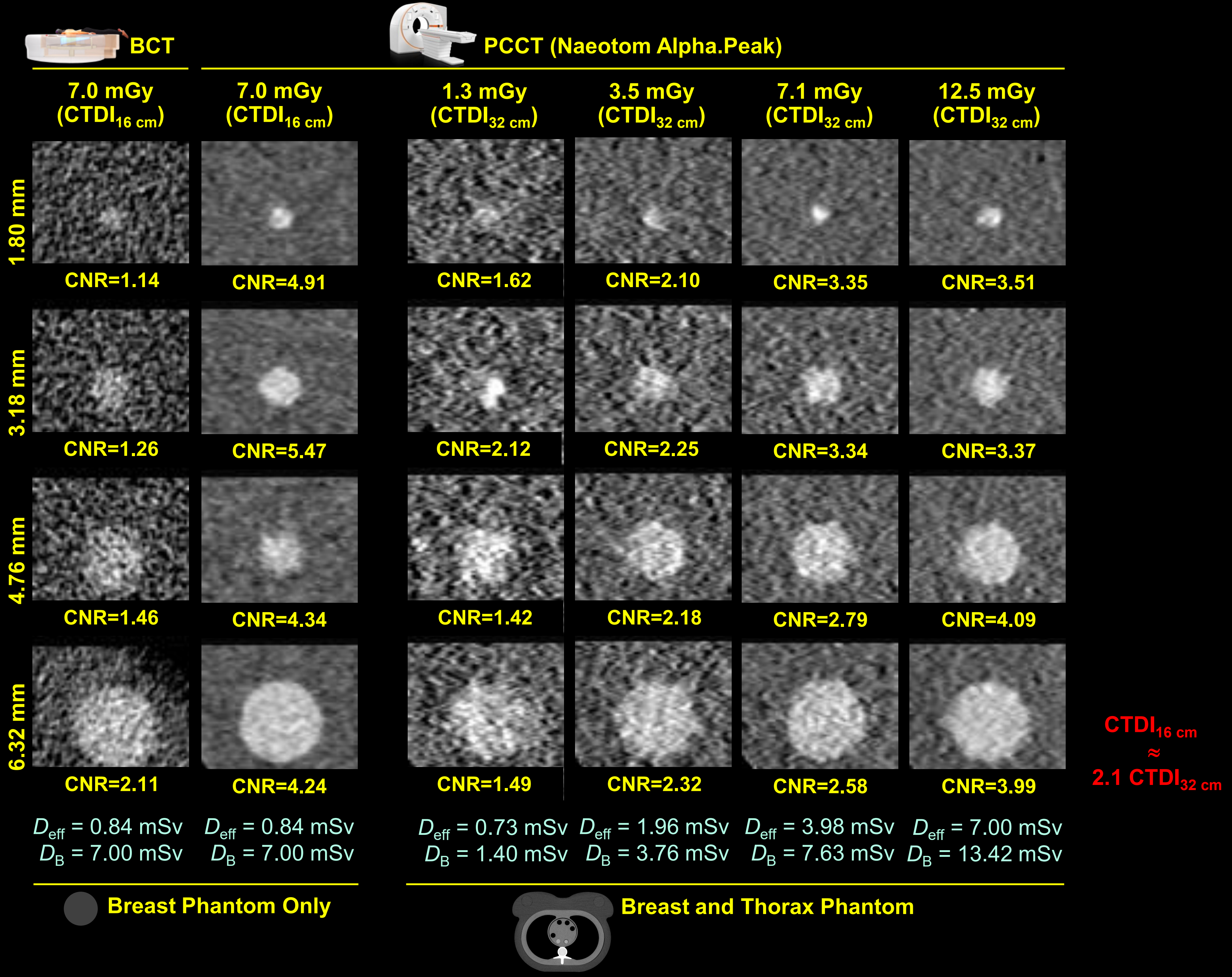


0.6 mm MIPs
C = 300 HU, W = 1500 HU



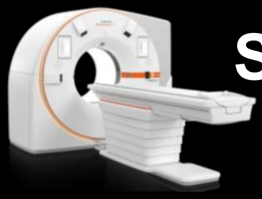
0.6 mm MIPs
C = 300 HU, *W* = 1500 HU

More on Opportunistic Screening

- While CT scans are performed for various clinical indications, potentially valuable biometric data often are unused.
- Body composition analysis (BCA) enables the quantification of biomarkers and processing of biometric data.
- Coronary artery calcium (CAC) is easily incidentally quantified on chest CT in patients imaged for noncardiac indications. However, radiologists do not routinely report the finding.
- Incidental imaging information may be beneficial to patients in terms of wellness, prevention, risk profiling, and presymptomatic detection of relevant disease.

Diagnosis

Prevention



Standard PCCT Scan
according to clinical indication

Diagnosis

Reconstruction
according to clinical indication

Systematic Review
focussing on the clinical indication

Structured Report
to be sent to the referring physician

Radiologist (+ AI)

Prevention

Reconstruction(s)
according to screening task(s)

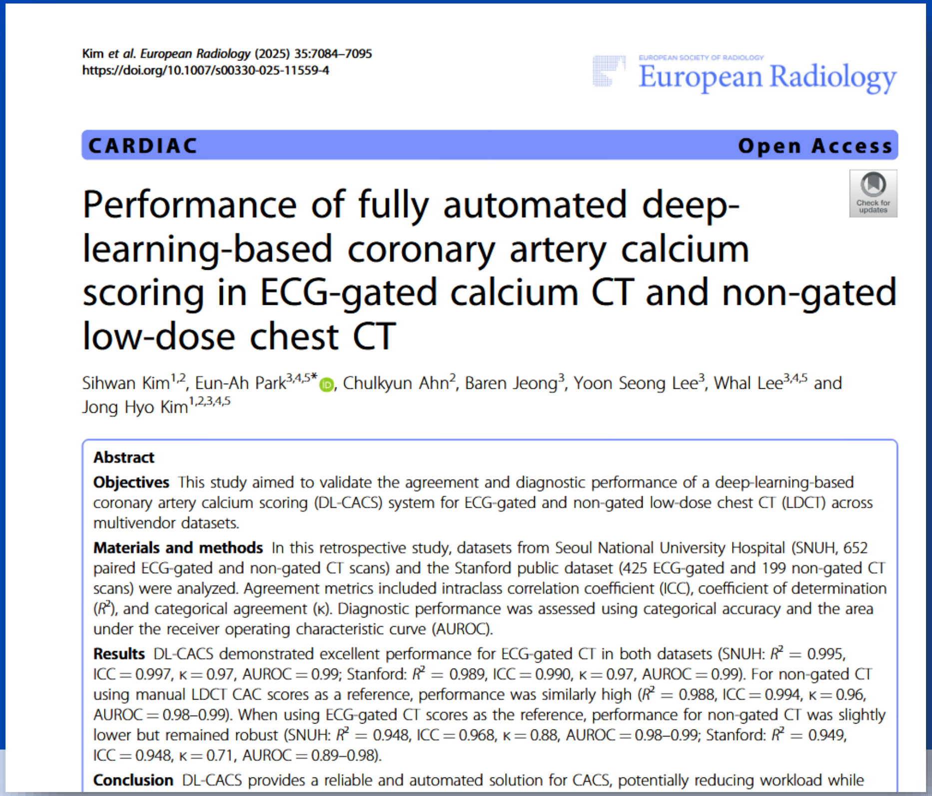
Opportunistic Screening
and (more) incidental findings

Screening Report
if abnormal send to radiologist

AI only

CT Vendor Action to Take

- Enable UHR mode as often as possible
  - Allow for UHR with full detector coverage
  - Make the use of UHR for standard protocols intransparent to the user
- Provide AI-based image reconstruction and screening workflow



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European Radiology

CARDIAC Open Access

Performance of fully automated deep-learning-based coronary artery calcium scoring in ECG-gated calcium CT and non-gated low-dose chest CT

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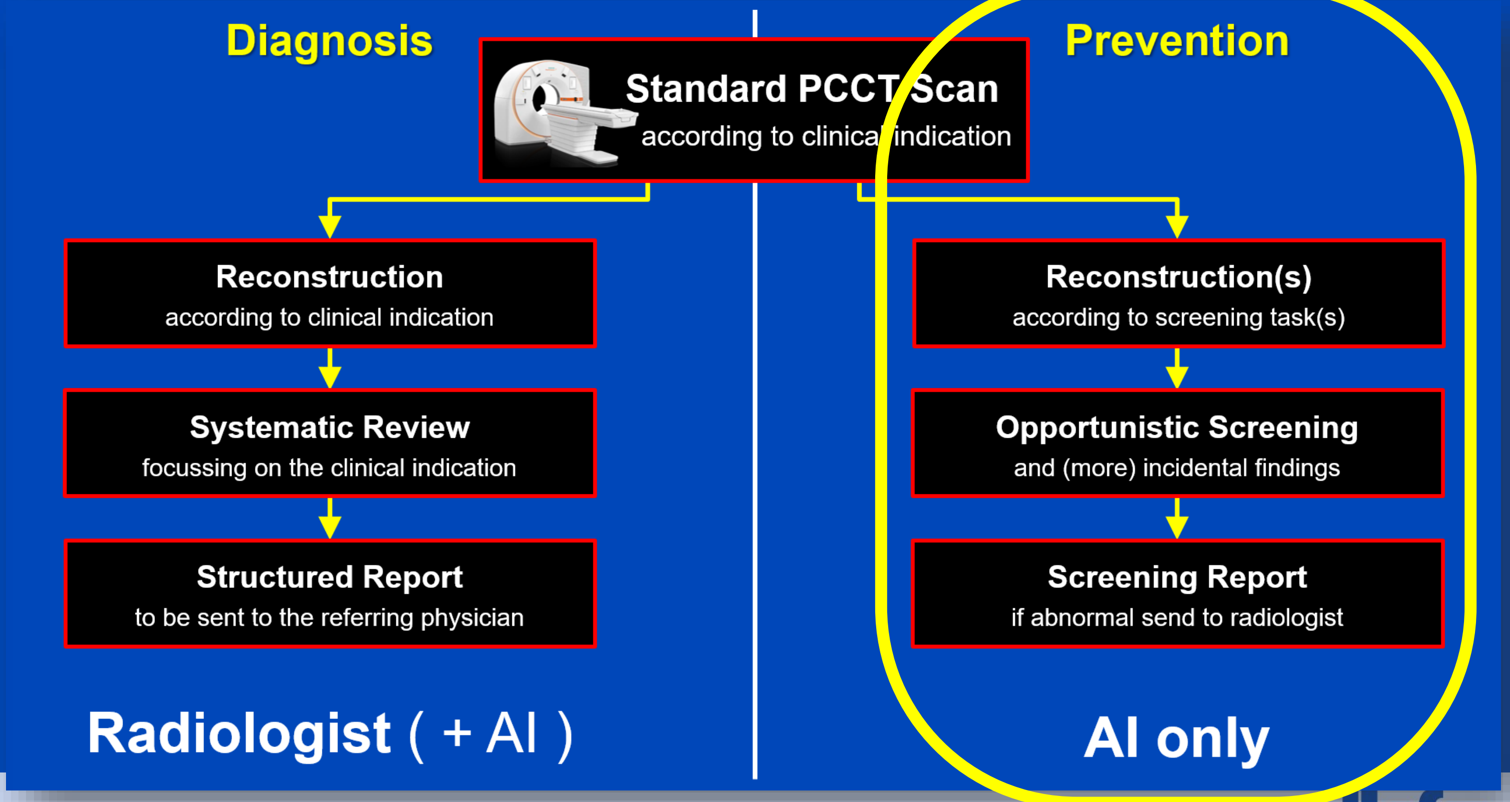
Abstract

Objectives This study aimed to validate the agreement and diagnostic performance of a deep-learning-based coronary artery calcium scoring (DL-CACS) system for ECG-gated and non-gated low-dose chest CT (LDCT) across multivendor datasets.

Materials and methods In this retrospective study, datasets from Seoul National University Hospital (SNUH, 652 paired ECG-gated and non-gated CT scans) and the Stanford public dataset (425 ECG-gated and 199 non-gated CT scans) were analyzed. Agreement metrics included intraclass correlation coefficient (ICC), coefficient of determination (R^2), and categorical agreement (κ). Diagnostic performance was assessed using categorical accuracy and the area under the receiver operating characteristic curve (AUROC).

Results DL-CACS demonstrated excellent performance for ECG-gated CT in both datasets (SNUH: $R^2 = 0.995$, ICC = 0.997, κ = 0.97, AUROC = 0.99; Stanford: $R^2 = 0.989$, ICC = 0.990, κ = 0.97, AUROC = 0.99). For non-gated CT using manual LDCT CAC scores as a reference, performance was similarly high ($R^2 = 0.988$, ICC = 0.994, κ = 0.96, AUROC = 0.98–0.99). When using ECG-gated CT scores as the reference, performance for non-gated CT was slightly lower but remained robust (SNUH: $R^2 = 0.948$, ICC = 0.968, κ = 0.88, AUROC = 0.98–0.99; Stanford: $R^2 = 0.949$, ICC = 0.948, κ = 0.71, AUROC = 0.89–0.98).

Conclusion DL-CACS provides a reliable and automated solution for CACS, potentially reducing workload while



Thank You!

This presentation will soon be available at www.dkfz.de/ct.

Job opportunities through marc.kachelriess@dkfz.de or through DKFZ's international PhD or Postdoctoral Fellowship programs.

Parts of the reconstruction software were provided by RayConStruct® GmbH, Nürnberg, Germany.