

Subsolid Nodule Detection in Low-Dose Photon-Counting CT of the Chest

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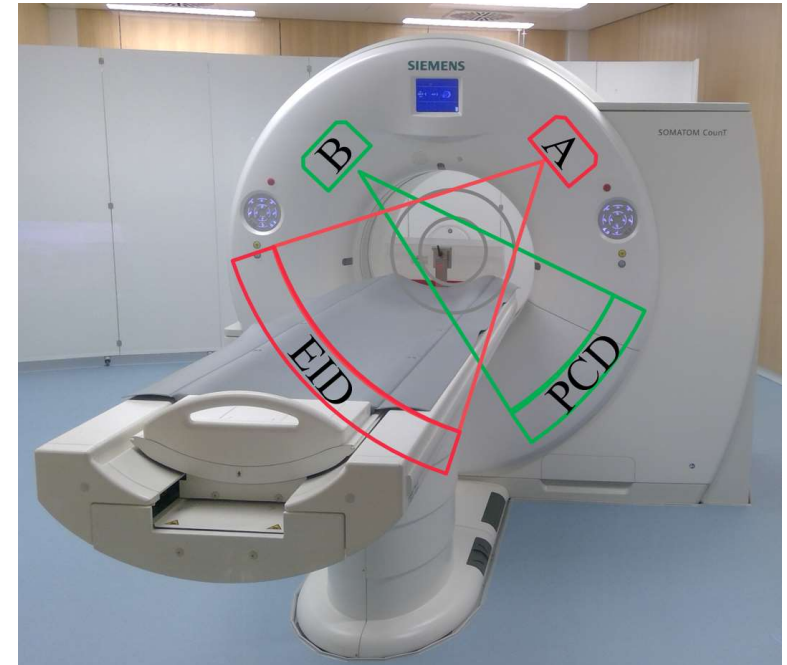
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- Photon-Counting Detector (PCD) CT in Ultra-High Resolution (UHR) mode demonstrates
 - increased signal-to-noise ratios¹
 - higher spatial resolution¹
 - higher HU accuracy for lung parenchyma and ground glass densities²when compared to Energy-Integrating Detector (EID) CT
- How is the detection of subsolid nodules in low dose acquisitions affected by PCD?

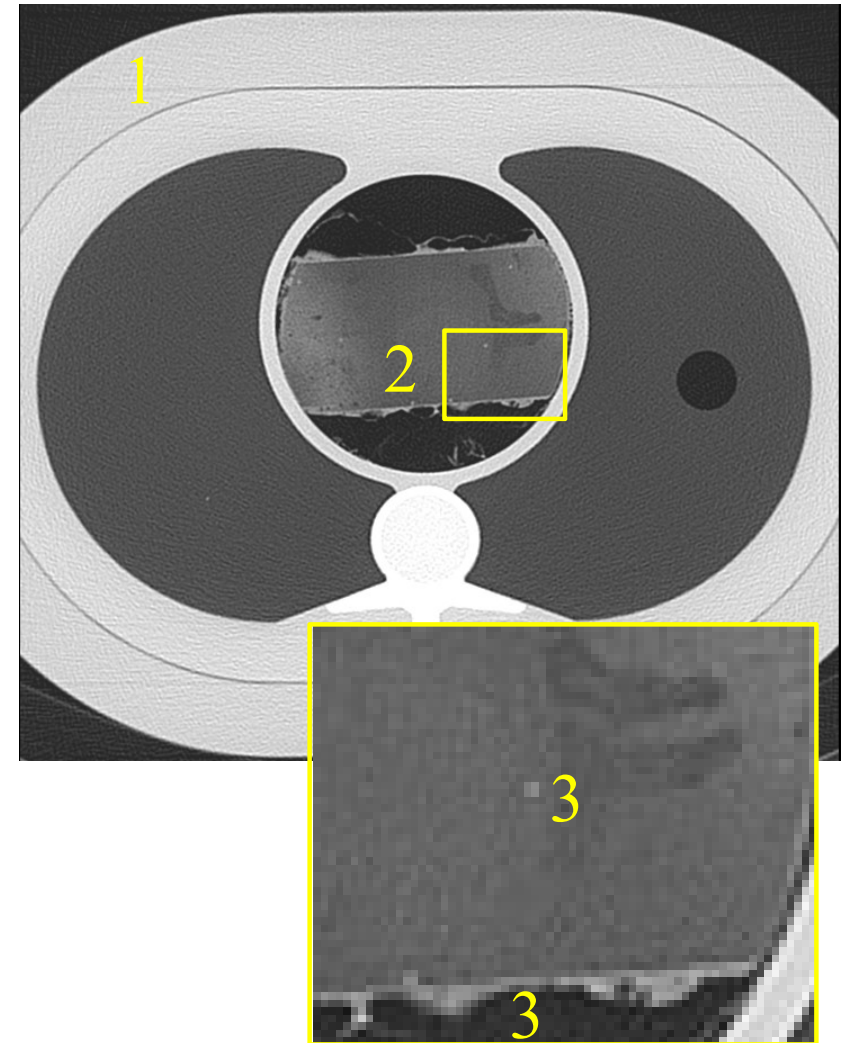
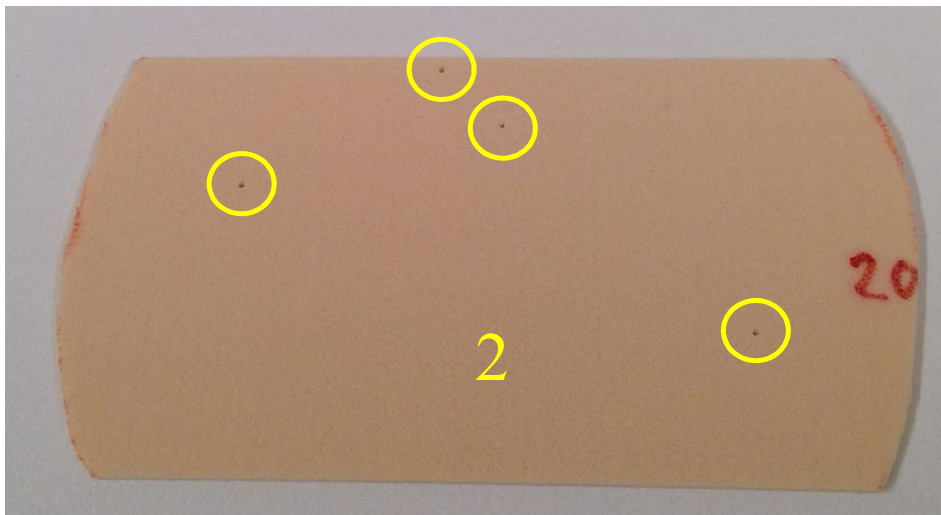


¹ Symons, R., Pourmorteza, A., Sandfort, V., Ahlman, M. A., Cropper, T., Mallek, M., ... & Bluemke, D. A. (2017). Feasibility of dose-reduced chest CT with photon-counting detectors: initial results in humans. *Radiology*, 285(3), 980-989

² Symons, R., Cork, T. E., Sahbaee, P., Fuld, M. K., Kappler, S., Folio, L. R., ... & Pourmorteza, A. (2016). Low-dose lung cancer screening with photon-counting CT: a feasibility study. *Physics in Medicine & Biology*, 62(1), 202.




- 1) Thorax phantom without mediastinum insert, with fat mantle
- 2) Polyurethane foam (-760 HU at 120 kV)
- 3) Model for Subsolid Noduli (SN): mixture of a water-based gel and palmitic-acid-based foam

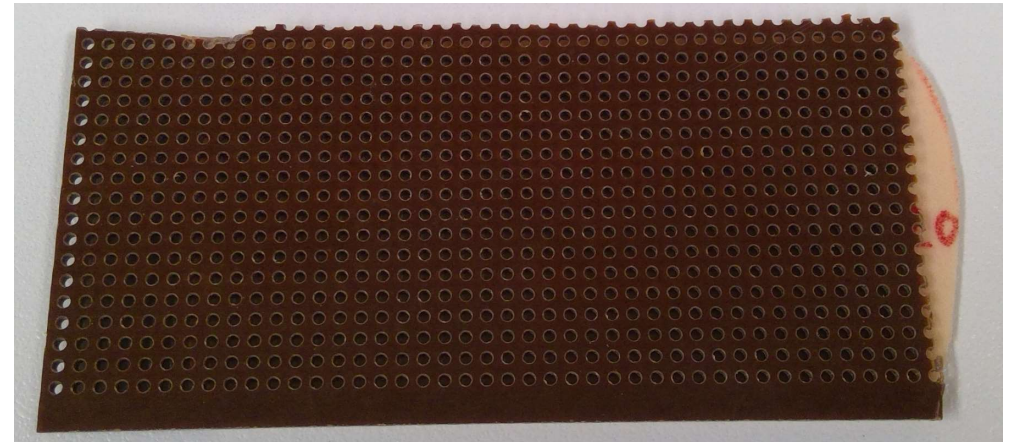



C= -500 HU, W=1500 HU
400 mAs (used as reference)



Positioning of Nodules+ Reader Study

- 20 slices 
- Number of SN for each sample equally distributed between 0 and 9
- Column and Row of each SN equally distributed (600 possible positions)
- Diameter of drill: 0.7 mm



- In total, 2×10^3 SN to detect (EID and PCD)
- 5 readers:
 - Two board-certified radiologists
 - Three residents
- SN was considered correctly identified if the user clicked within 2.5 mm of the correct nodule position (according to reference image) 

Scan Protocol

- Topogram + Data Completion Scan (DCS)
- LUSI-Protocol¹: Thorax, 128x0.6mm, 120kV, Pitch 0.8, 40 mAs
- Counting Abd UHR, 32x0.25mm, 120 kV, Pitch 0.6, 34 mAs
- CTDI₃₂ 2.7 mGy

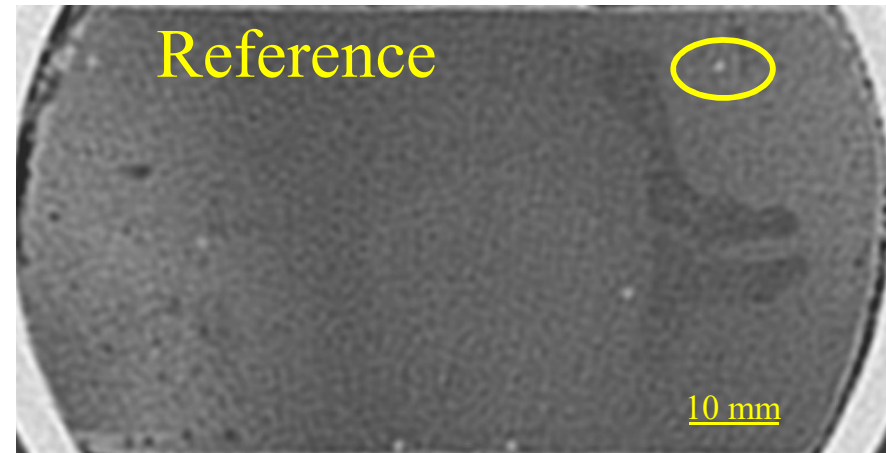
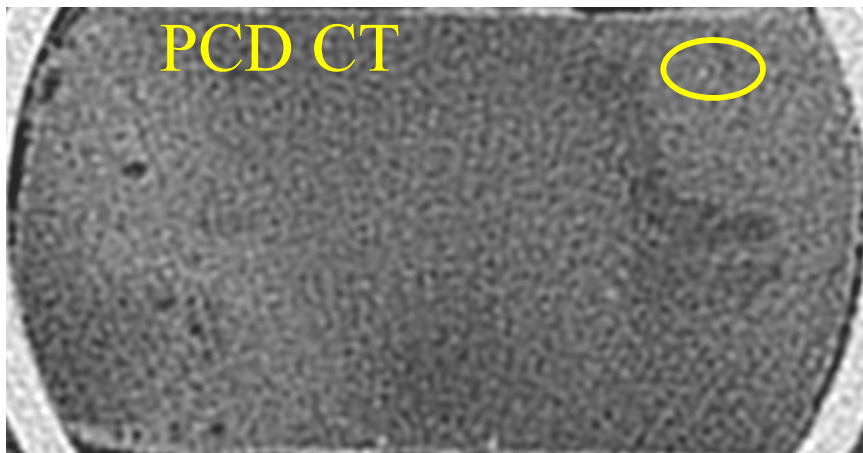
Reconstruction parameters

- Slice thickness 1mm
- B70f (both EID and PCD)
- FOV: 275mm
- Matrix size 1024²
- Window can be set by reader

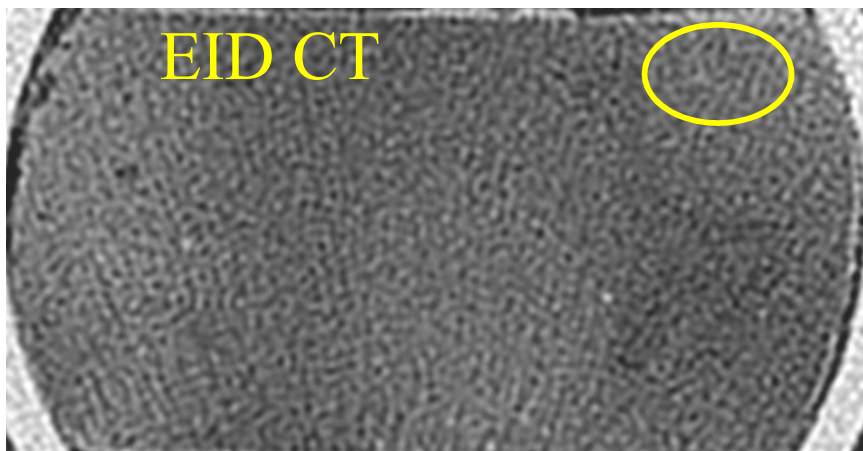
¹ Becker, N., Motsch, E., Trotter, A., Heussel, C. P., Dienemann, H., Schnabel, P. A., ... & Delorme, S. (2020). Lung cancer mortality reduction by LDCT screening—Results from the randomized German LUSI trial. *International journal of cancer*, 146(6), 1503-1513.



- Image noise (SD) in lung parenchyma was 85 HU in PCD and 120 HU in EID images
- CT-values of SNs were -340 HU (SD 120 HU)



C=-500 HU,
W=1500 HU



Results (2)

Sensitivity:

Reader	EID	PCD
1	38 %	69 %
2	56 %	67 %
3	40 %	48 %
4	41 %	51 %
5	10 %	26 %

False positives ratings summed up over all readers:

- 83 for EID
- 62 for PCD



Conclusion

PCD CT demonstrates

- lower noise-levels
- higher contrast-to-noise ratios

at constant dose, when compared to EID CT

This translates into an increase of accuracy in the detection of SN in low-dose chest CT.



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