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A mammographic software phantom design to test the imaging performance of digital detectors

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1. Background-Aim

- Digital detectors could be considered the backbone of an X-Ray imaging device, since the formation of the radiographic image and hence the visualization of internal structures would be impossible without them.

- The resulting image must be of a high quality, in order to avoid hypo- or hyper-diagnosis.

- Some characteristics of the detector that affect the quality of the final image are the:
  - ✓ response curve: shows the translation of the incident KERMA to pixel values,
  - ✓ normalized noise power spectrum (NNPS): indicates the relative noise fluctuation in the spatial frequency domain, and the
  - ✓ modulation transfer function (MTF): characterizes the ability of the detector to discern small objects.

- The aim of this study was to test the usefulness of a methodology in exploring the imaging capabilities of digital detectors.

2. Materials & Methods

- ✓ MATLAB software (Version 9.12), and
- ✓ XMuDat software (Version 1.0.1).

A Novel Method to Model Image Creation Based on Mammographic Sensors Performance Parameters: A Theoretical Study

by Nektarios Kalyvas [1,*], Anastasia Chamogeorgaki [2], Christos Michail [1], Aikaterini Skouroliakou [2], Panagiotis Liaparinos [1], Ioannis Valais [1], George Fountos [1] and Ioannis Kandarakis [1]

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The Dexela 2923 CMOS X-ray detector: A flat panel detector based on CMOS active pixel sensors for medical imaging applications

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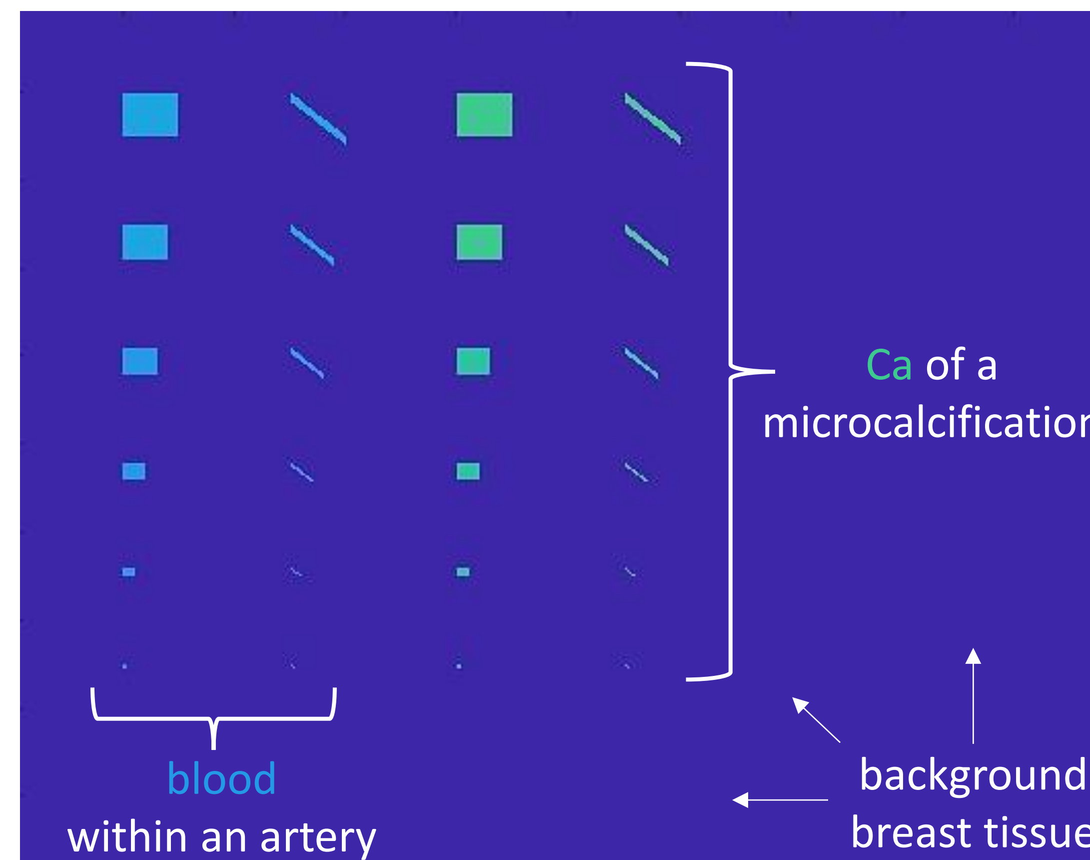
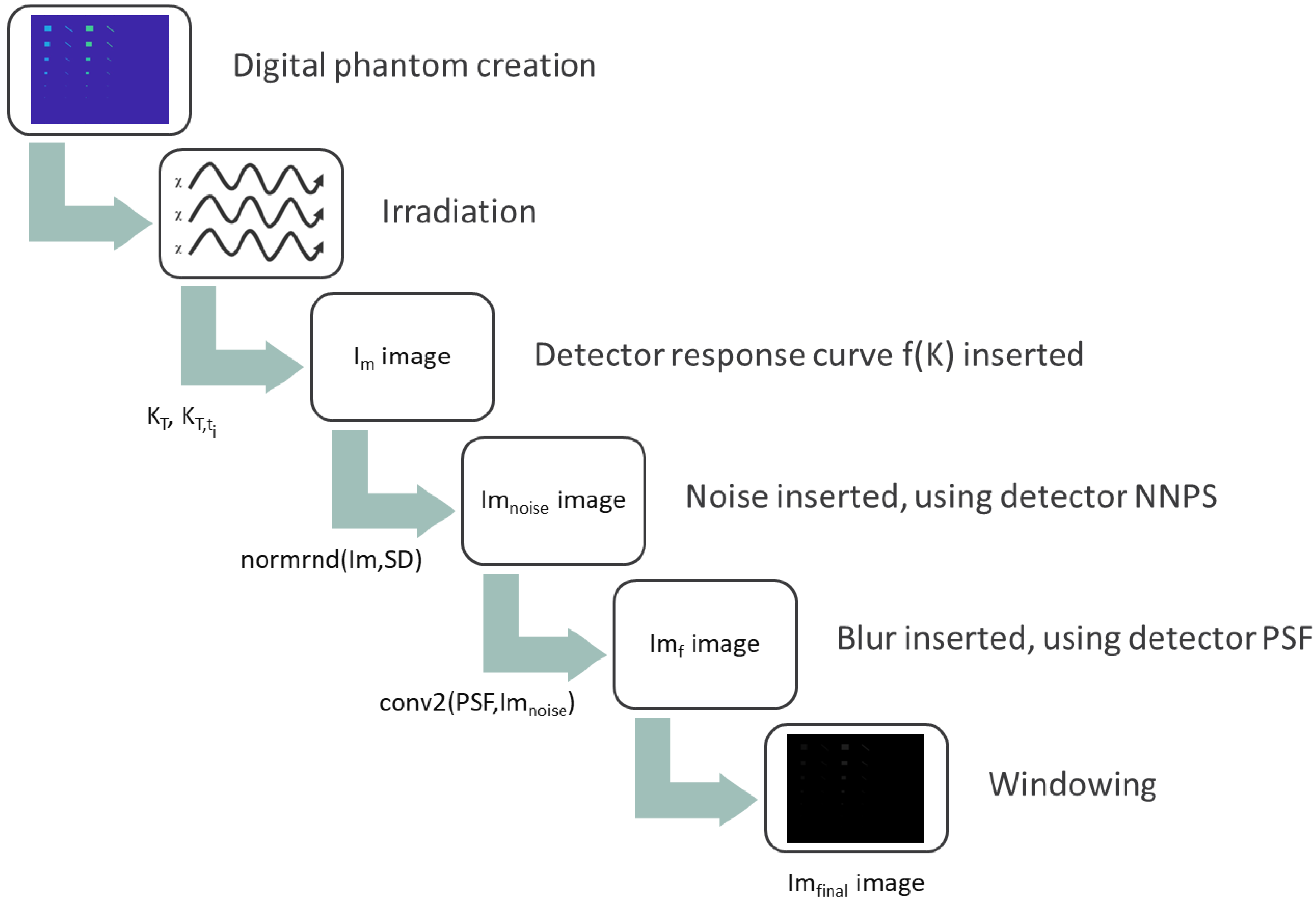


2. Materials & Methods



3. Results

f = 1500000 photons/mm^2

f = 4500000 photons/mm^2

E	23 keV
$t_{compressed\_breast}$	4.5 cm
t_{thick_artery}	0.5 cm
t_{medium_artery}	0.4 cm
t_{thin_artery}	0.3 cm
t_{thick_calc}	0.01 cm
t_{medium_calc}	0.0075 cm
t_{thin_calc}	0.005 cm

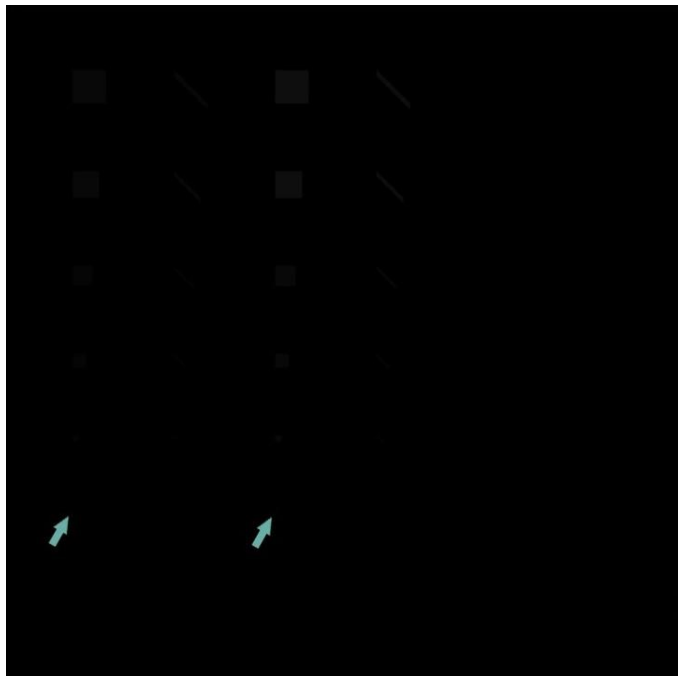
*Note: Findings marked with blue arrows were the same for all cases of photons per mm^2.

f = 6000000 photons/mm^2

f = 9000000 photons/mm^2

3. Results

f = 1500000 photons/mm²



f = 4500000 photons/mm²

E	23 keV
$t_{compressed\_breast}$	4.5 cm
t_{thick_artery}	0.3 cm
t_{medium_artery}	0.2 cm
t_{thin_artery}	0.1 cm
t_{thick_calc}	0.005 cm
t_{medium_calc}	0.003 cm
t_{thin_calc}	0.001 cm

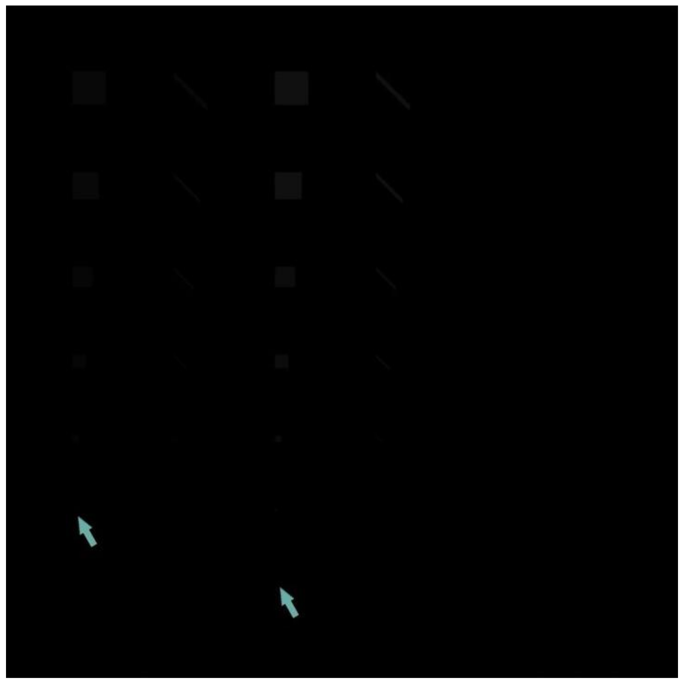
*Note: Findings marked with blue arrows were the same for all cases of photons per mm².

f = 6000000 photons/mm²

f = 9000000 photons/mm²

3. Results

f = 1500000 photons/mm^2



f = 6000000 photons/mm^2

E	28 keV
$t_{compressed\_breast}$	4.5 cm
t_{thick_artery}	0.5 cm
t_{medium_artery}	0.4 cm
t_{thin_artery}	0.3 cm
t_{thick_calc}	0.01 cm
t_{medium_calc}	0.0075 cm
t_{thin_calc}	0.005 cm

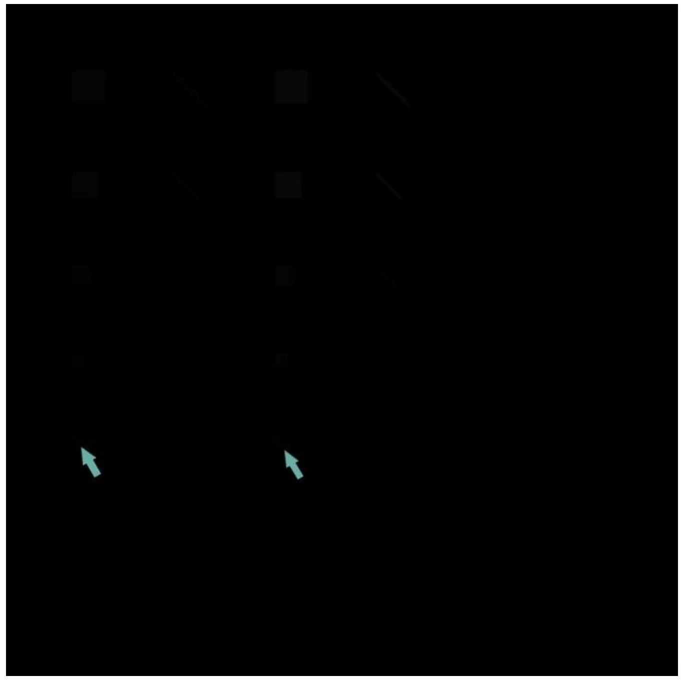
*Note: Findings marked with blue arrows were the same for all cases of photons per mm^2.

f = 4500000 photons/mm^2

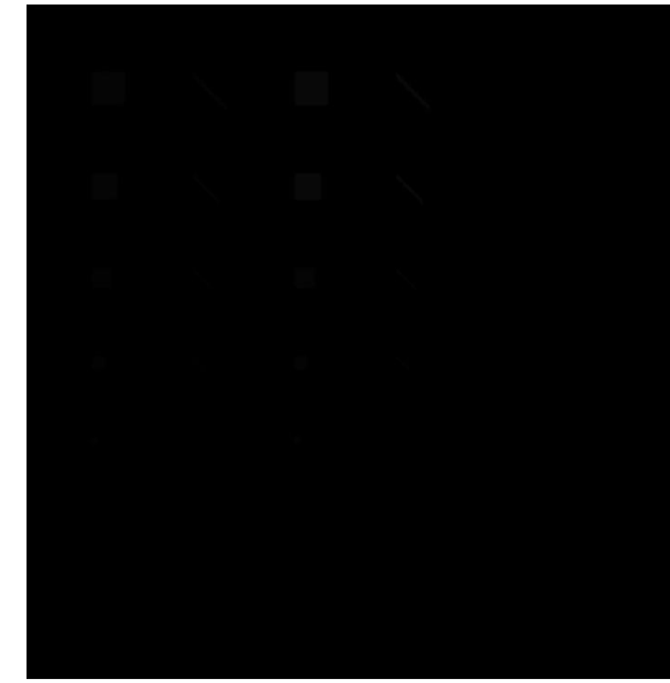
f = 9000000 photons/mm^2

3. Results

f = 1500000 photons/mm^2



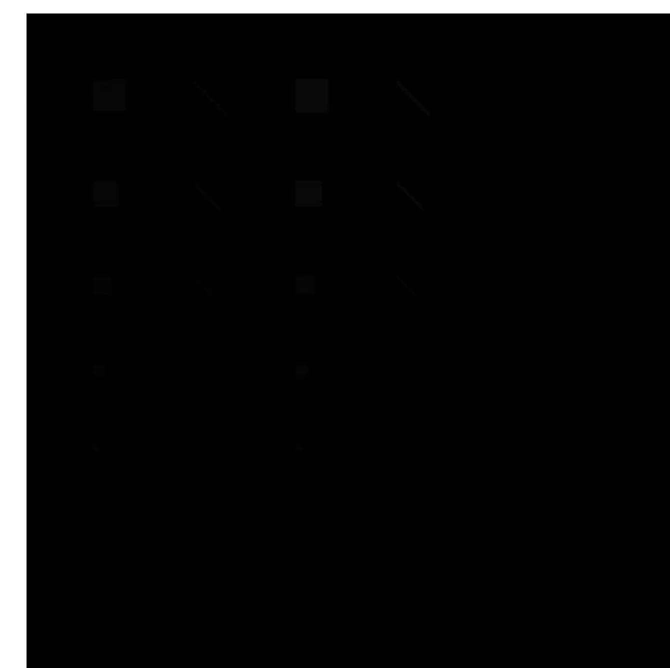
f = 4500000 photons/mm^2



E	28 keV
$t_{compressed\_breast}$	4.5 cm
t_{thick_artery}	0.3 cm
t_{medium_artery}	0.2 cm
t_{thin_artery}	0.1 cm
t_{thick_calc}	0.005 cm
t_{medium_calc}	0.003 cm
t_{thin_calc}	0.001 cm

*Note: Findings marked with blue arrows were the same for all cases of photons per mm^2.

f = 6000000 photons/mm^2



f = 9000000 photons/mm^2

4. Conclusions

- As regards the imaging capabilities of the Dexela 2923 detector (for the given experimental conditions):
  - ✓ for monoenergetic X-Rays of 23 keV, an artery up to 0.3 cm thin is visible as squares with dimensions 0.15 mm and 0.3 mm, and
  - ✓ for X-Rays of the same energy, a microcalcification up to 0.005 cm thin is visible in the same shape and dimensions,
  - ✓ if an X-Ray energy of 28 keV is considered, the 0.3 cm thin artery is visible as a square with dimensions 0.3 mm, while
  - ✓ if the same X-Ray energy is considered, the 0.005 cm thin microcalcification is visible as squares with dimensions 0.15 mm and 0.3 mm.
- The methodology applied can be useful for testing a-priori the imaging performance of digital detectors.

5. References

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