Dosepix Detector as kVp-meter in Radiology and Mammography: First steps

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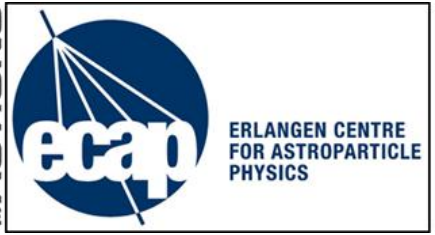
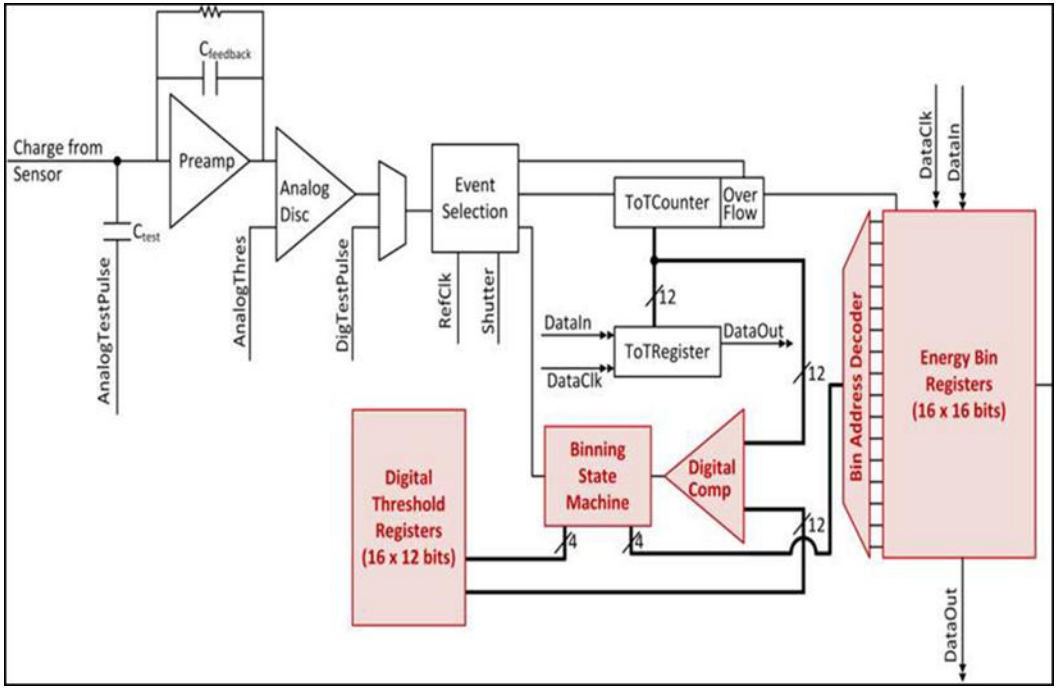


Dosepix: General overview

PARAMETER	SPECIFICATION
Pixel Pitch	220 µm x 220 µm 55 x 55 µm
No. of Pixels	16 x 16
Sensitive Area	3.52 mm x 3.52 mm



Outline

- Part I: kVp-meter in Radiology Range
- Part II: Studies on Pile-up under mammographic conditions
- Conclusions

Outline

- Definition of kVp-meter
- Why DOSEPIX?
- Experimental Results
- Conclusions

kVp-meter in Radiology

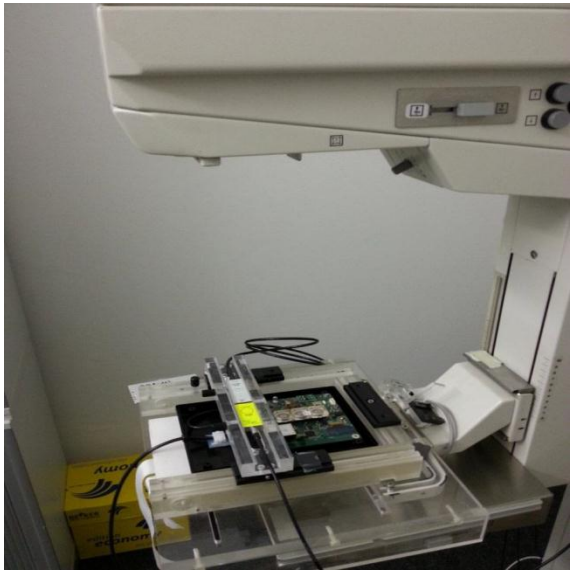
- "*One of the **most important parameters** of diagnostic X-RAY EQUIPMENT is the **voltage applied to the X-RAY TUBE**, because both the IMAGE QUALITY in diagnostic radiology and the DOSE received by the PATIENT undergoing radiological examinations are dependent on the X-RAY TUBE VOLTAGE*." (IEC 61676)

↓

IEC 61676: ***Practical Peak Voltage***

The equivalent value of X-Ray tube voltage of a constant potential waveform which produces the same image contrast

- PPV can be deduced with an ***invasive measurement*** by the waveform of the signal at the oscilloscope

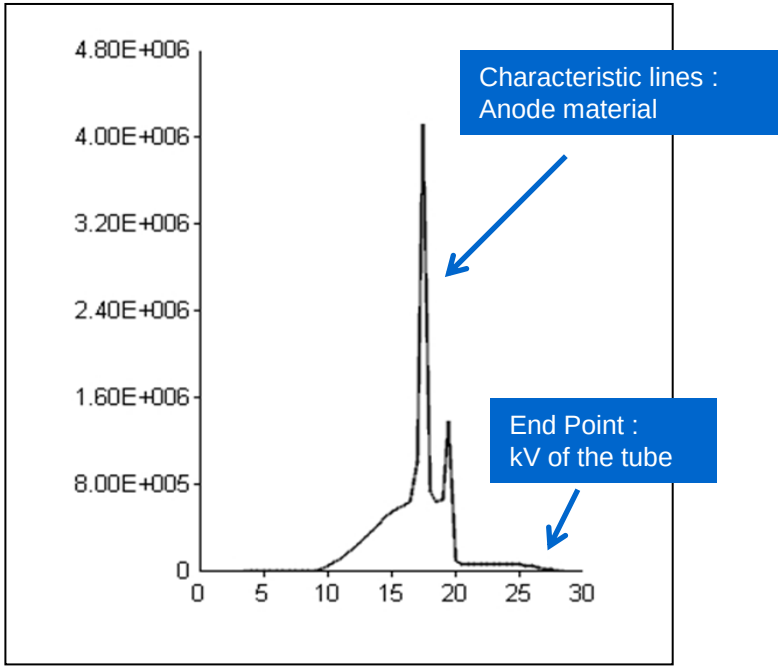


Mammography Unit, IBA Dosimetry

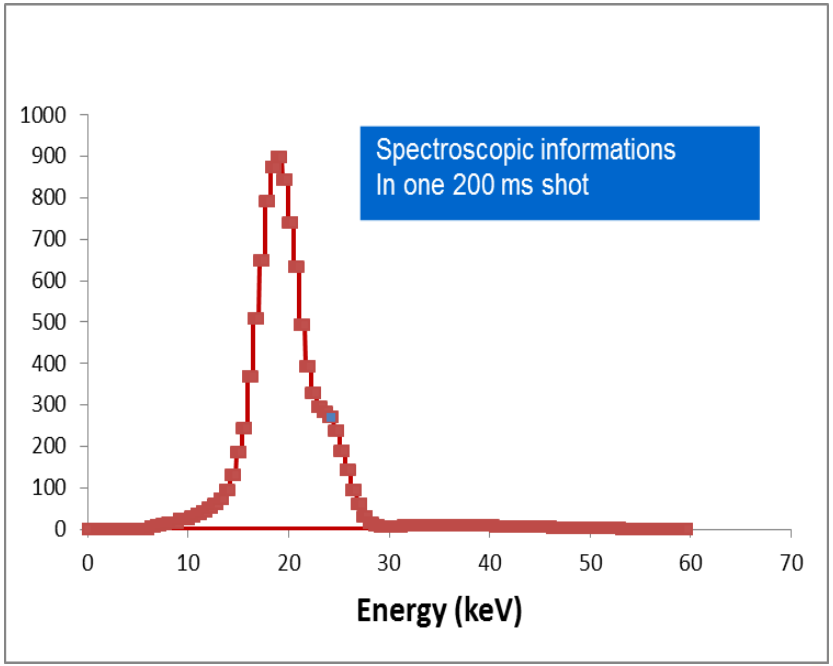
Part I: kVp-meter in Radiology Range

Why Dosepix?

Theoretical Mammography spectrum: Mo-Mo , 28 kV, 2mGy



Dosepix spectrum: Mo-Mo , 28 kV, 2mGy, 200 ms

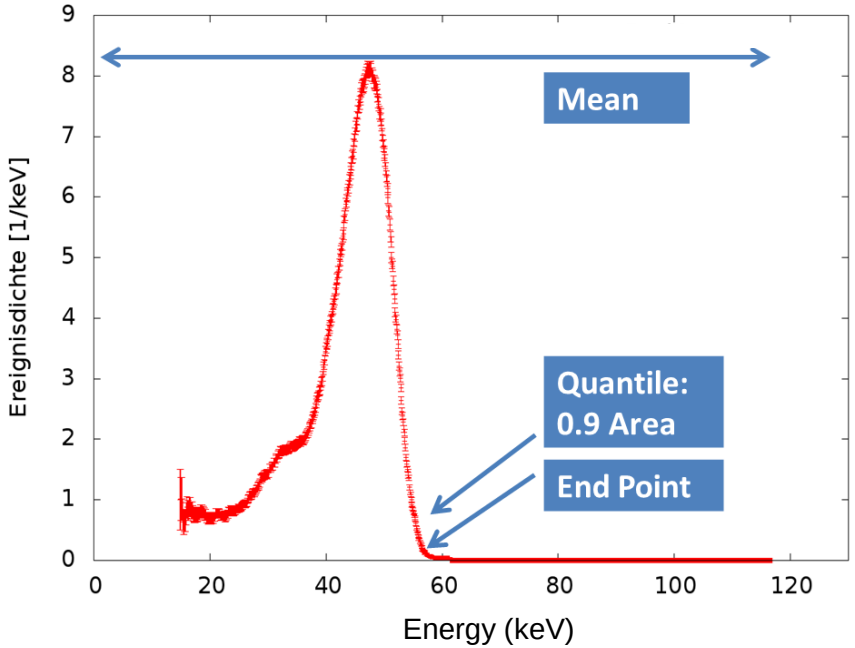


Materials and Methods

Tube Anode	W
Tube Energy	40 – 120 kV
Tube Current	5 – 50 mA
Distance	100 cm
Filter Materials	1.5mm Cu 0.72mm Sn

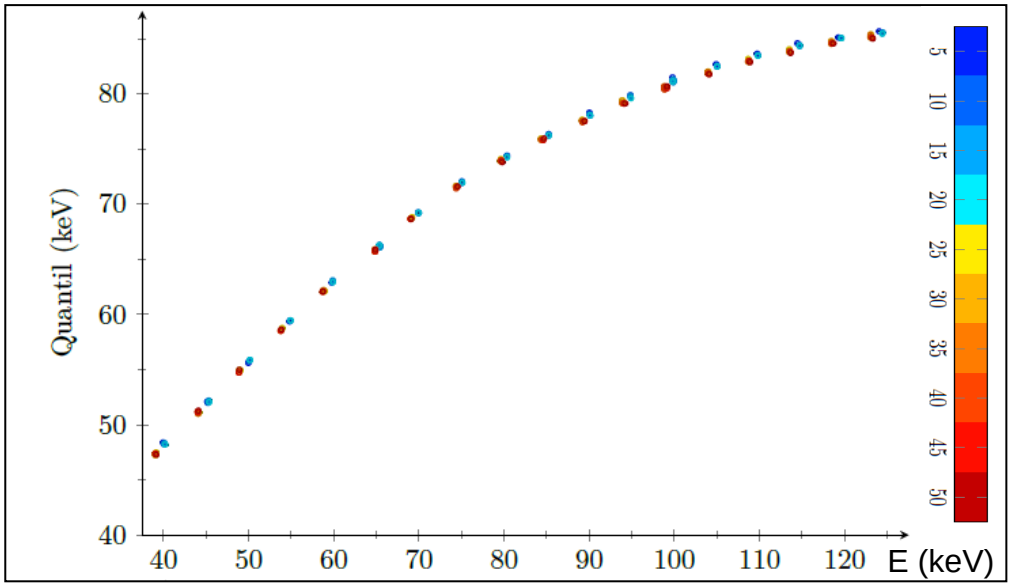
Features:
- Mean
- Quantile (0.9 of the area)
- End Point

Error:
- Statistical
- Pile up (Systematic)



Experimental Results

Quantile (0.9) 1.5mm Cu



Features	Statistical Error (%)	Systematic Error (Pile up) (%)
Mean	< 1%	< 1%
Quantile	< 1%	<1%
End Point	< 1%	< 1%

Conclusion

- Result @65 kV 40 mA 1mm Cu < 4% difference from the nominal value
- Test the algorithm with other filters and in clinical situations (higher currents)

Outline

- Clinical Situation and Experimental Setup
- Using DOSEPIX: Small and Big Pixels
- Experimental Results
- Conclusion

Clinical Situation and Methods

Mammography	
Energy Range	22-35 kVp
Current	50-100 mA
Exposure time	70-400 ms
SID (Source Image Distance)	60 cm
Flux at SID	10^6 photons/mm^2/s

↓

BigPixel	$5 \cdot 10^4$ photons/BigPixel/s
SmallPixel	$3 \cdot 10^3$ photons/SmallPixel/s

Experimental Setup

Tube Anode	Mo
Tube Energy	22 – 35 kV
Tube Current	50 – 100 mA
Distance	60 cm
Exposure time	300 ms
Additional tube filtration	0.03 mm Mo

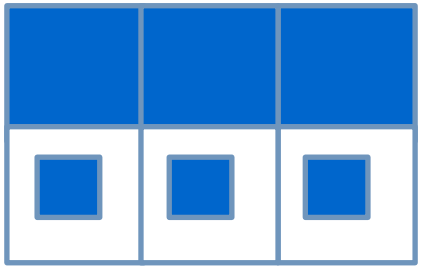
Goal:
Find the appropriate filtration which can reduce the pile up and use just the end point of the spectrum as kVp-meter
The end point is independent from anode material or additional filtration

Materials and Methods

Methods:

- Use the ratio between counts in small and big pixels to control the pile up during the shot

- Additional filtrations used to reduce the flux impinging the detector:
  - 0.03mm Mo
  - 0.06mm Mo
  - 0.3mm Cu



Big Pixels

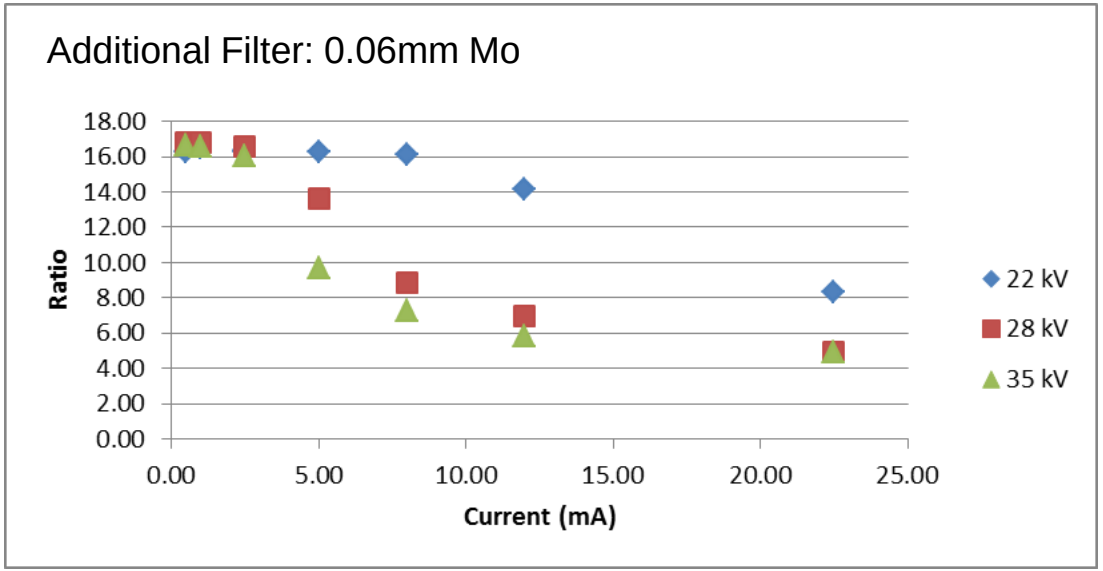
Small Pixels

Ratio (designed value): 16
simulation and measurements show energy dependent effective pixel size

Hypothesis: at low flux condition, the ratio between the counts is constant and approximately 16

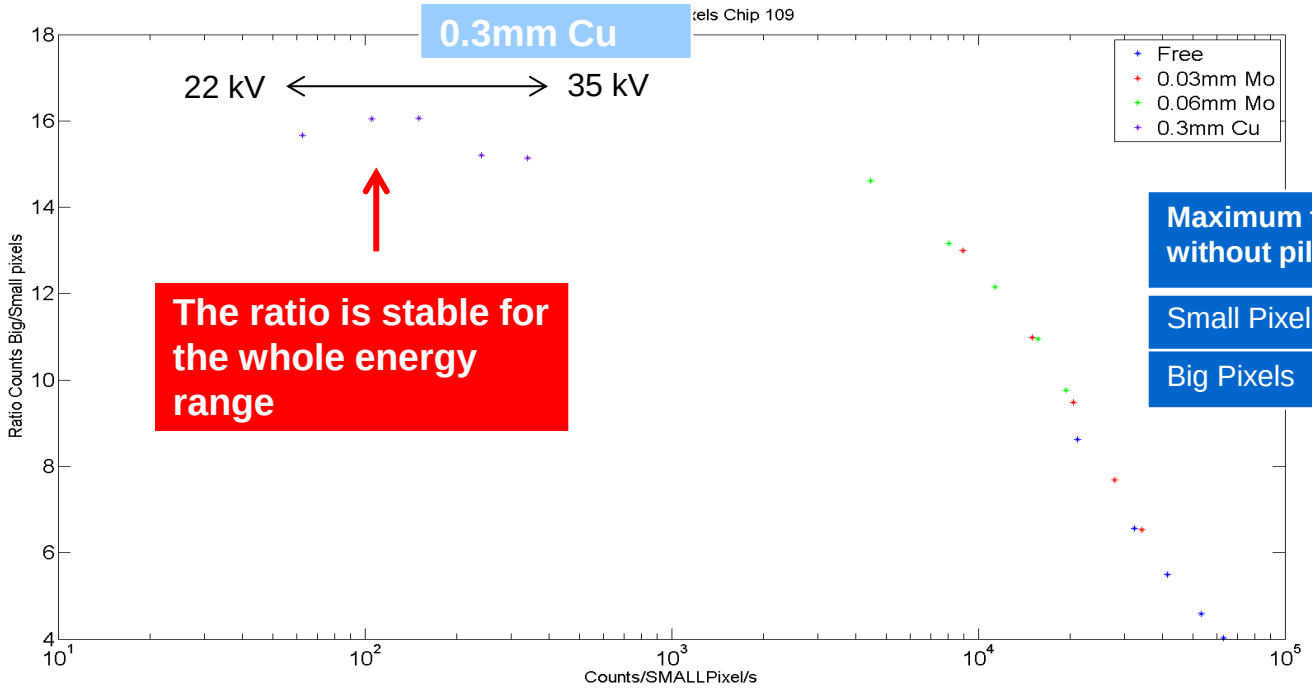
Hypothesis verification

Tube Anode	W
Tube Energy	22 – 35 kV
Tube Current	0.5 – 22.5 mA
Distance	60 cm
Exposure time	10 ms



Part II: Studies on Pile-up under mammographyc conditions

Experimental Results



The ratio is stable for the whole energy range

Maximum flux without pile-up	
Small Pixels	9.3·10^2
Big Pixels	1.5· 10^4

Conclusions

- Additional filter: 0.3mm Cu , Ratio = 15.62 ± 0.43 in the whole energy range (22-35 kV)

- Next step:
  - Verification of the same filter for other clinical situations
  - Spectra acquisition to apply the method before described

Summary

- The algorithm promises good results (at 65 kV, < 0.4%)
- Filter could be a solution to reduce the flux at the limit in which the spectrum is not affected by pile-up

Thank you for your attention

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