

Characterization of a new photon counting detector with X-ray fluorescences

*F. Bisello^{1,2}, I. Ritter², F. Tennert², A. Zang², T. Gabor^{2,5}, M. Campbell³, W.S. Wong³, N. Michel⁴
S. Wölfel¹, G. Anton², and T. Michel²*

1- IBA Dosimetry GmbH, Bahnhofstraße 5, 90592 Schwarzenbruck, Germany

2-Erlangen Centre for Astroparticle Physics, Radiation and Detector Physics, Erwin-Rommel-Str. 1, 91058 Erlangen, Germany

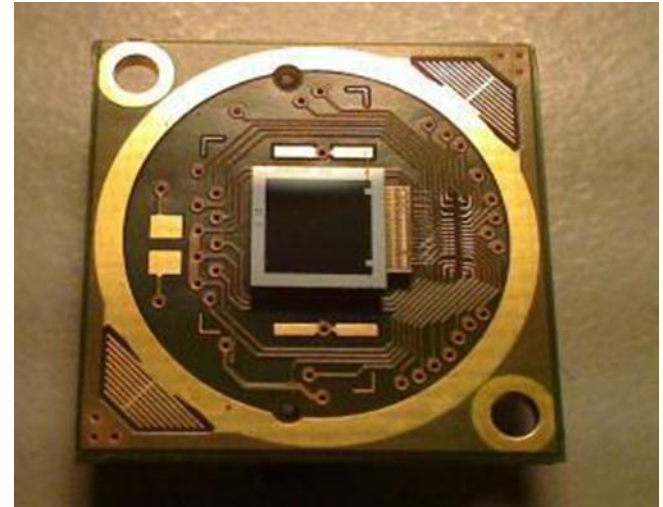
3- CERN, Medipix Team, Microelectronics Group, 1211 Geneva, Switzerland

4- Customized Microelectronic Solutions, Bruckwiesenstr. 3,91220 Schnaittach, Germany

5- Fraunhofer Institute for Solar Energy Systems ISE, Heidenhofstraße 2, 79110 Freiburg im Breisgau , Germany

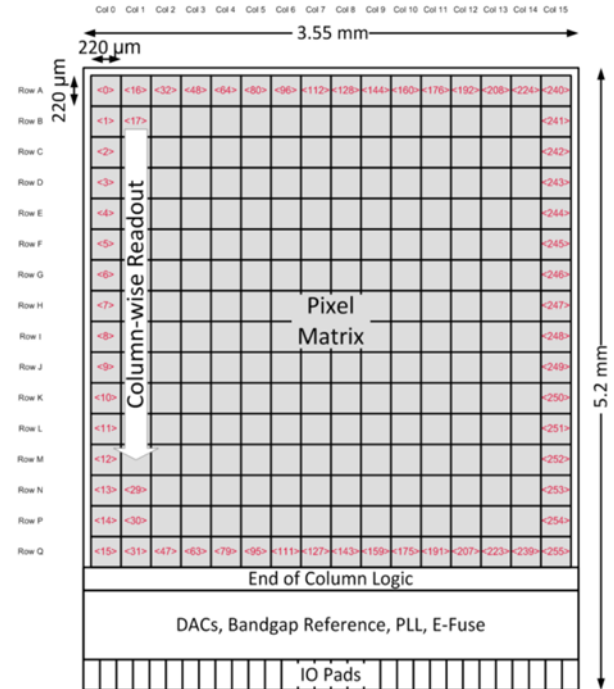


- General overview of the detector
- Comparison of the calibration methods
- Measurements of X-ray spectra



A Hybrid Pixel Detector for photon counting

PARAMETER	SPECIFICATION
Pixel Pitch	220 μm x 220 μm
No. of Rows	16
No. of Columns	16
Sensitive Area	3.52 mm x 3.52 mm
Sensor Material	Silicon



Dosepix: pixel architecture

Outline

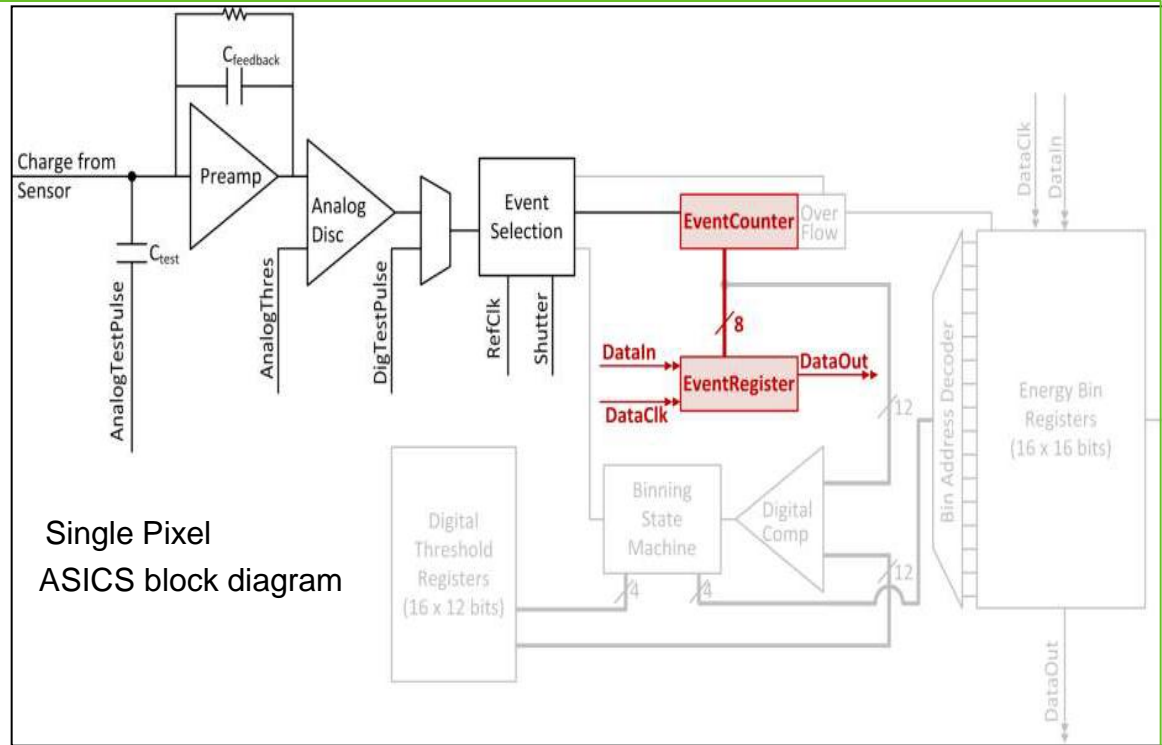
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

- Counting Mode
- Energy binning mode



* W. Wong A Hybrid Pixel Detector ASIC with Energy Binning for Real-Time, Spectroscopic Dose Measurements

Dosepix: pixel architecture

Outline

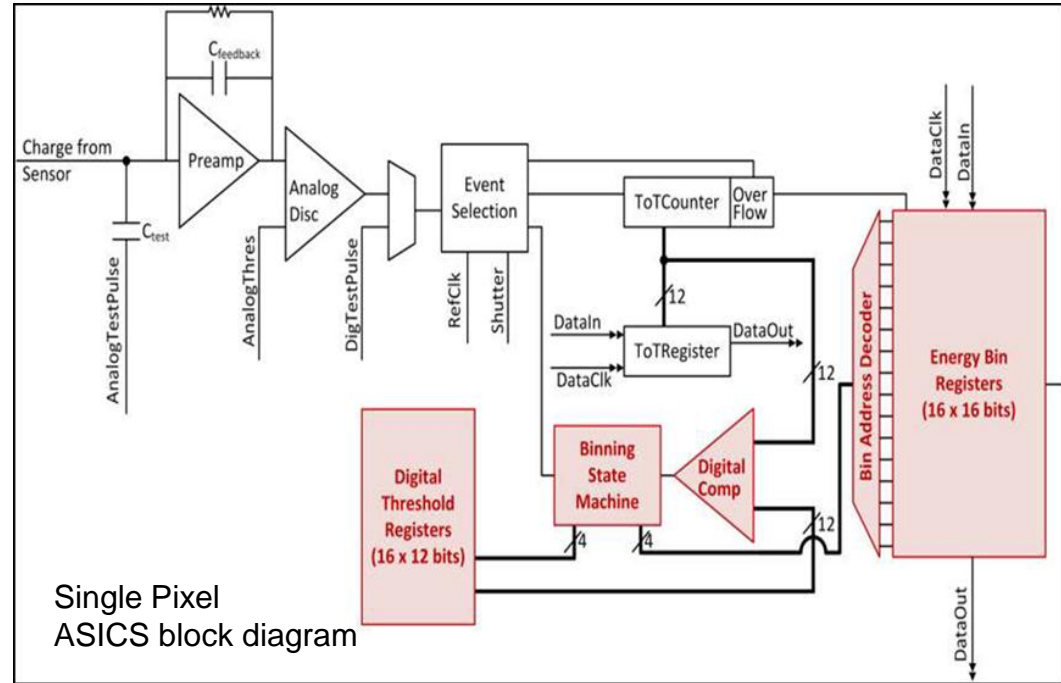
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

- Counting Mode
- Energy binning mode



* W. Wong A Hybrid Pixel Detector ASIC with Energy Binning for Real-Time, Spectroscopic Dose Measurements

Calibration Methods I: Analog Test Pulse method

Outline

Dosepix

Calibration Methods

X-ray Spectra

Conclusion

- Pixel wise calibration
- Analog test pulse

The test pulse is driven in the matrix column wise.

The ToT value for each test pulse is recorded

Test Pulse method

Outline

Dosepix

Calibration Methods

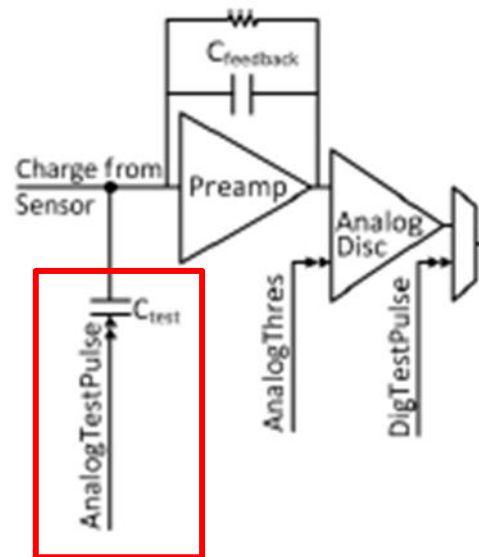
X-ray Spectra

Conclusion

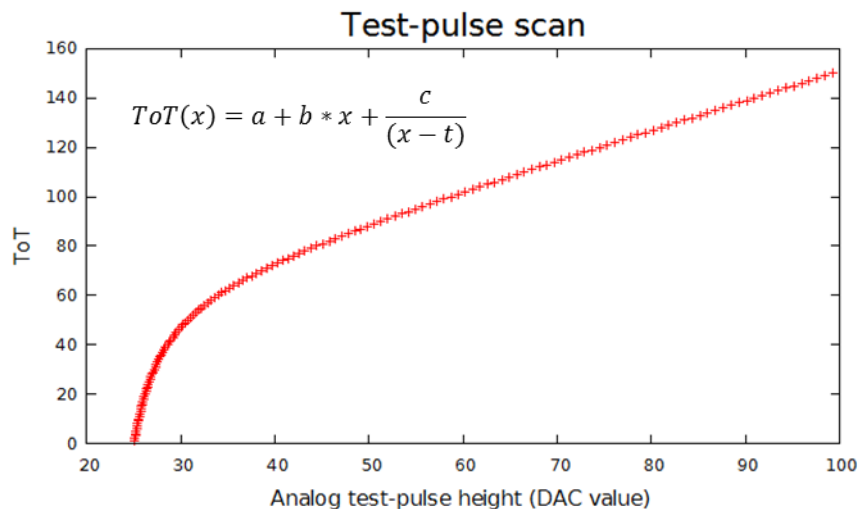
- Pixel wise calibration
- Analog test pulse

The test pulse is driven in the matrix column wise.

The ToT value for each test pulse is recorded



- Pixel Wise Calibration
- Test Pulse



Threshold of the pixel:
~ 62.5 mV (~ 2000e⁻)

* Jan Jakubek, Precise energy calibration of pixel detector working in time-over-threshold mode.

Energy Calibration with Fluorescence Lines

Outline

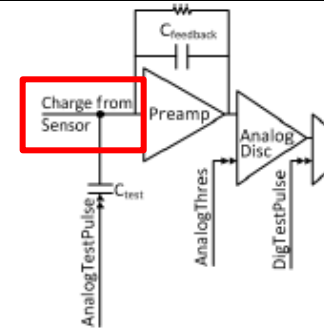
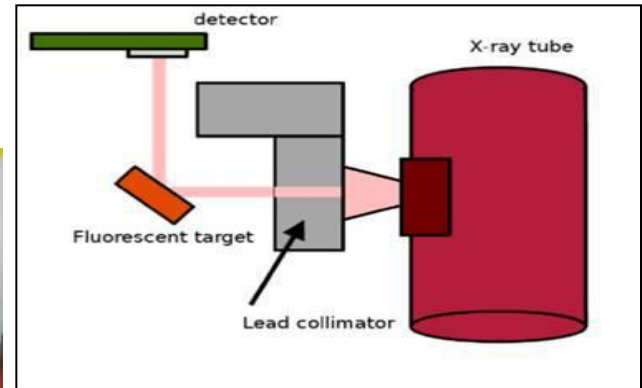
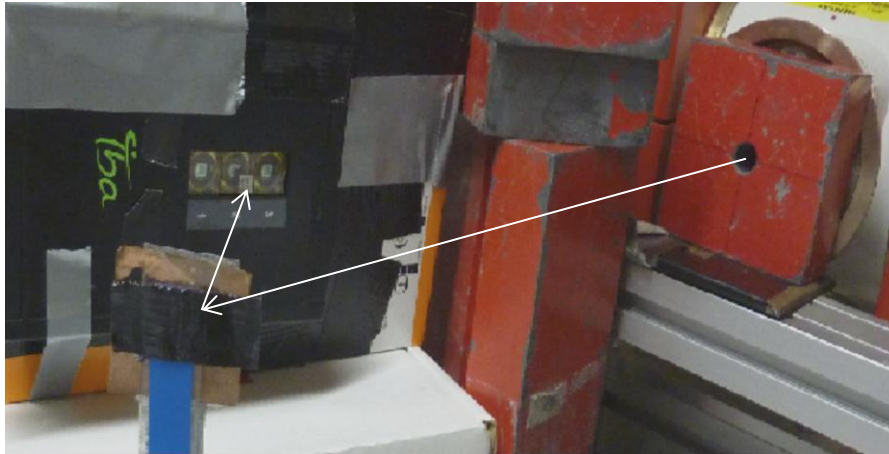
Dosepix

Calibration Methods

X-ray Spectra

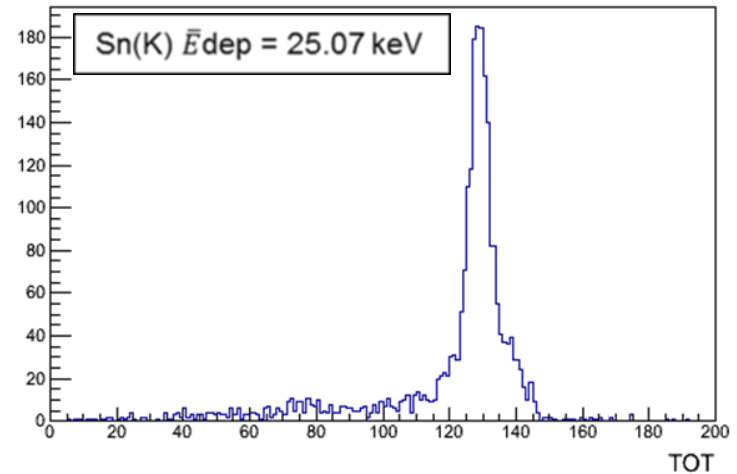
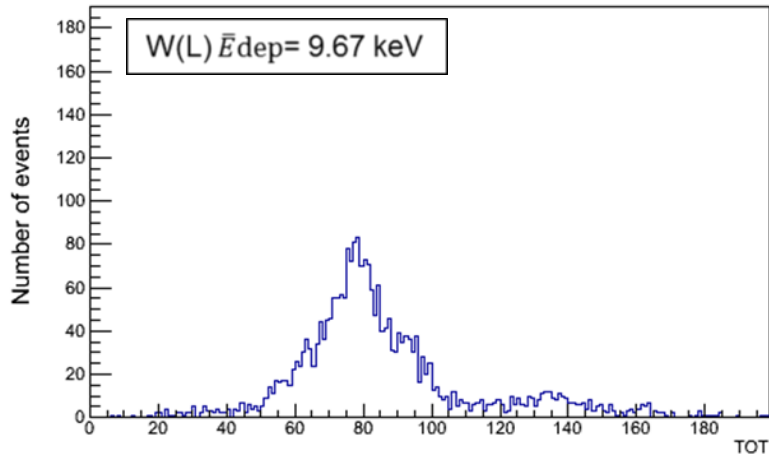
Conclusion

➤ Set-up



Calibration Methods III: Energy Calibration with Fluorescence lines

- Response of one pixel at XRF- lines of different elements



Determination of DOSEPIX ToT-Energy response

Outline

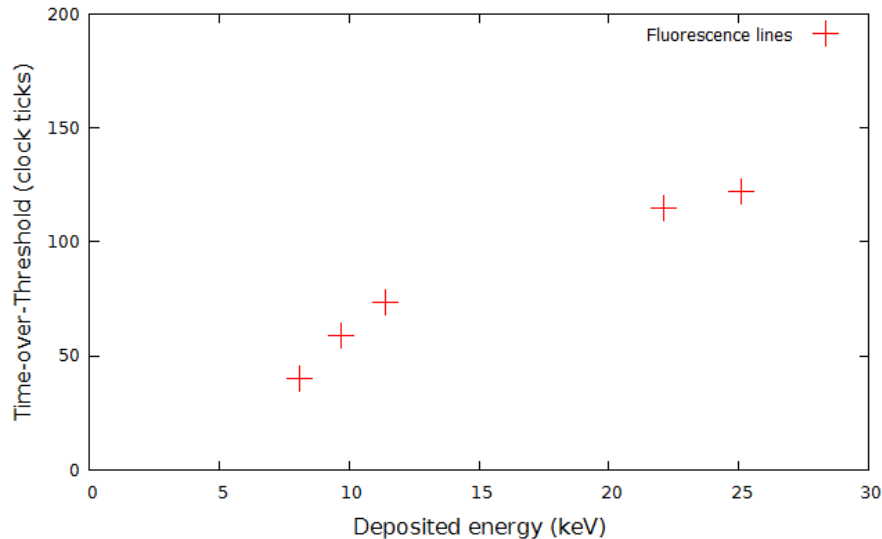
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

➤ Fitting of the response of **one pixel**



Element	Deposited Energy * (keV)
Sn	25.07
Ag	22.10
Pb	11.41
W	9.67
Cu	8.06

*T.Gabor, Personendosimetrie mit einem pixelierten Halbleiterdetektor, Diploma Thesis, Erlangen University

Determination of DOSEPIX ToT-Energy response

Outline

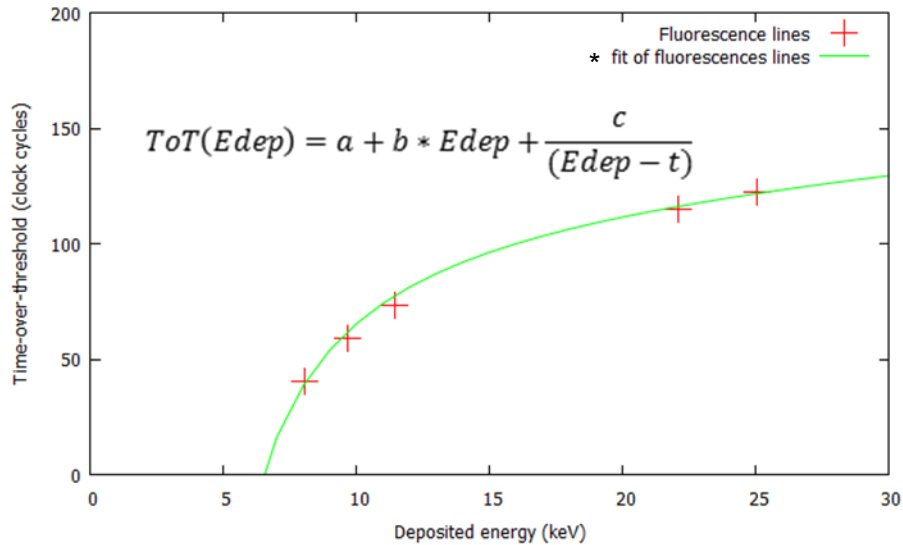
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

➤ Fitting of the response of **one pixel**



Element	Deposited Energy (keV)
Sn	25.07
Ag	22.10
Pb	11.41
W	9.67
Cu	8.06

* I.Ritter, Characterization of the Dosepix Detector with XRF and Analog Test pulses, IWORID 2013

Calibration Methods V : From Test Pulse to Energy Calibration

Outline

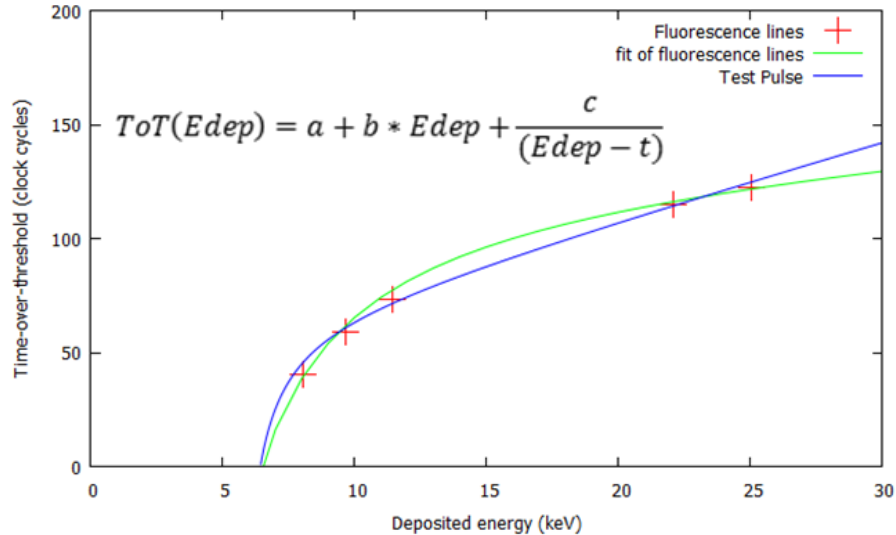
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

- Comparison between test pulse and fluorescences lines calibration



Threshold : 7.1 ± 1.6 keV

Future work:
Pixelwise test pulse calibration

Measurements of X-ray Spectra: Preliminary results

Outline

Dosepix

Calibration Methods

X-ray Spectra

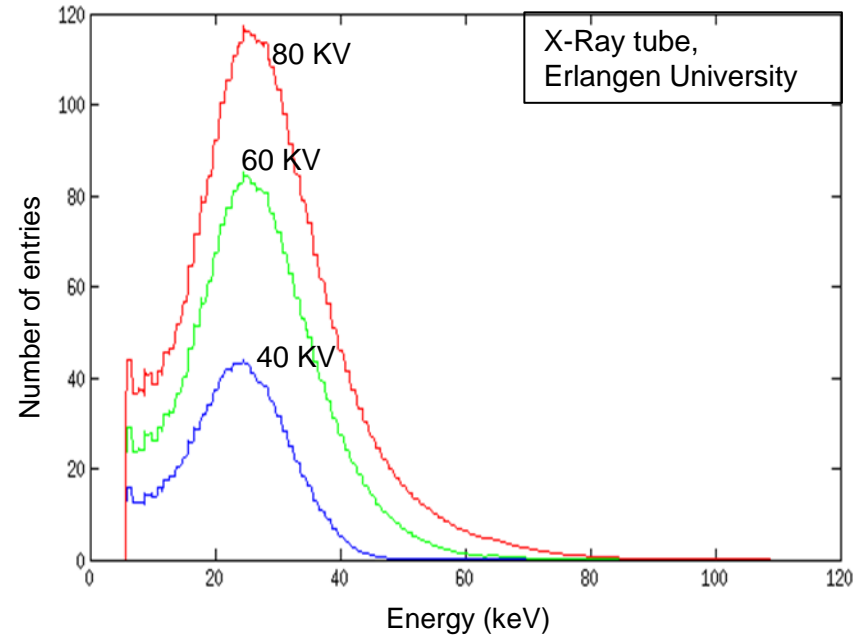
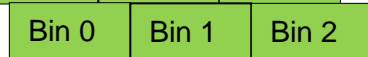
Conclusion

- Overlapping Method for Energy Binning

Pixel 1



Pixel 2



Detector Characterization:

- Threshold: 7.1 ± 1.6 keV
- Proportionality between Test Pulse (DAC Value) and Energy (keV)
- Energy Resolution: 10 % in the range of 8-25 keV

Future Work

- Analysis of impinging spectra in order to use the detector in medical application



Thank you very much for your attention

This research project has been supported by a Marie Curie Early Initial Training Network Fellowship of the European Community's Seventh Framework Programme under contract number (PITN-GA-2011-289198-ARDENT).

Backup

Calibration Methods V : From Test Pulse to Energy Calibration

Outline

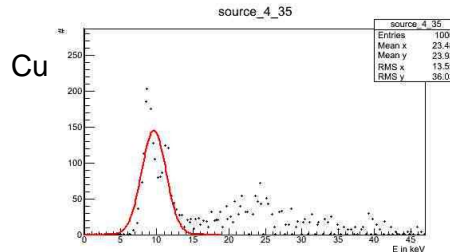
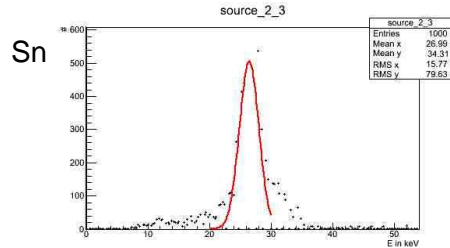
Dosepix

Calibration Methods

X-ray Spectra

Conclusion

➤ Energy Resolution



	Energy (keV)	Energy Resolution
Sn	25.07	10.91%
Ag	22.10	5.9 %
W	9.67	11.3 %
Cu	8.06	8.5%

