



Preliminary characterization of a pixelated CZT gamma ray spectrometer

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Introduction

- ▶ Dual detection device using CdZnTe (CZT) sensor:
 - ▶ Neutrons - detection
 - ▶ Gammas - spectrometer + imaging
- ▶ Use in nuclear decommissioning, nuclear safety, environmental radioprotection
- ▶ Lightweight (200 g) & rugged
 - ▶ Use in harsh environments
 - ▶ Possibility of mounting on UAV

SRE3020 Overview

Gamma Ray Spectroscopy Module

Camera module for gamma ray spectroscopy

Provides data from gamma radiation sensed in the built-in CZT crystal

Contains CZT, biasing, readout circuitry and digital processor

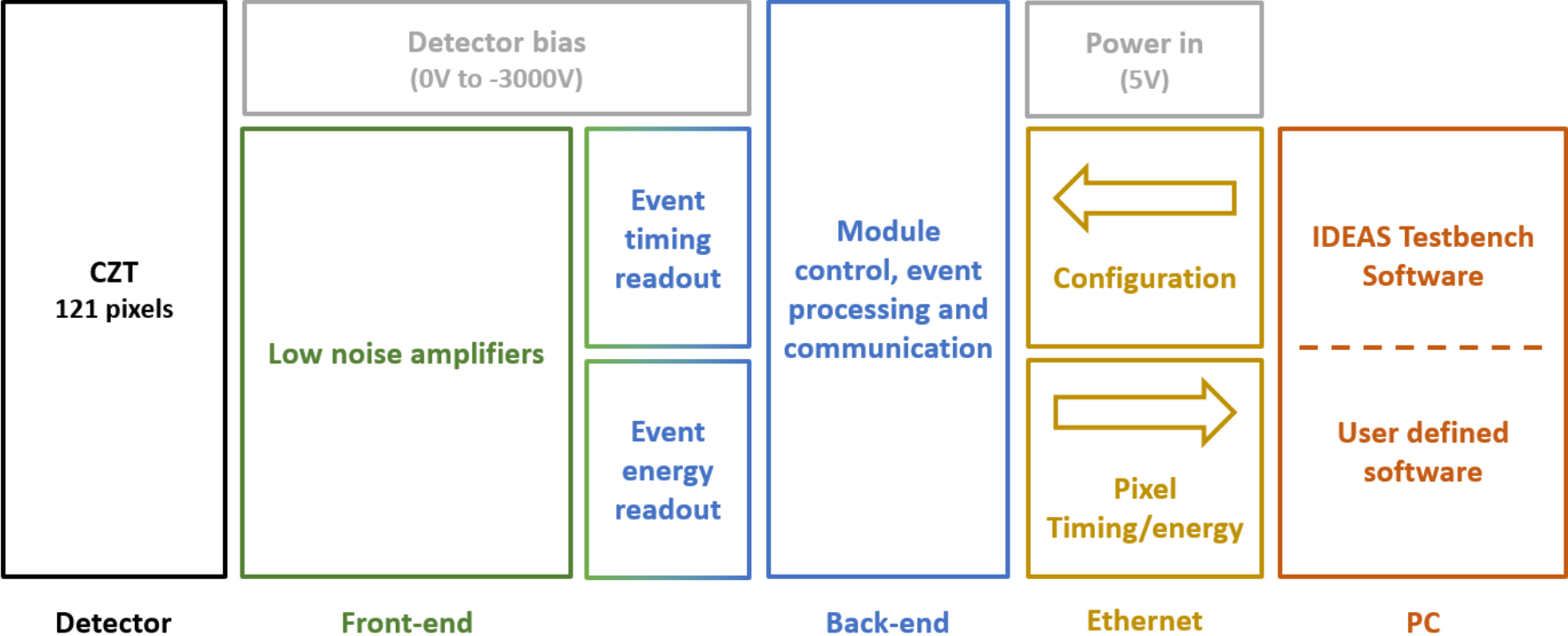
CZT crystal: Redlen, $2 \times 2 \times 1.5 \text{ cm}^3$

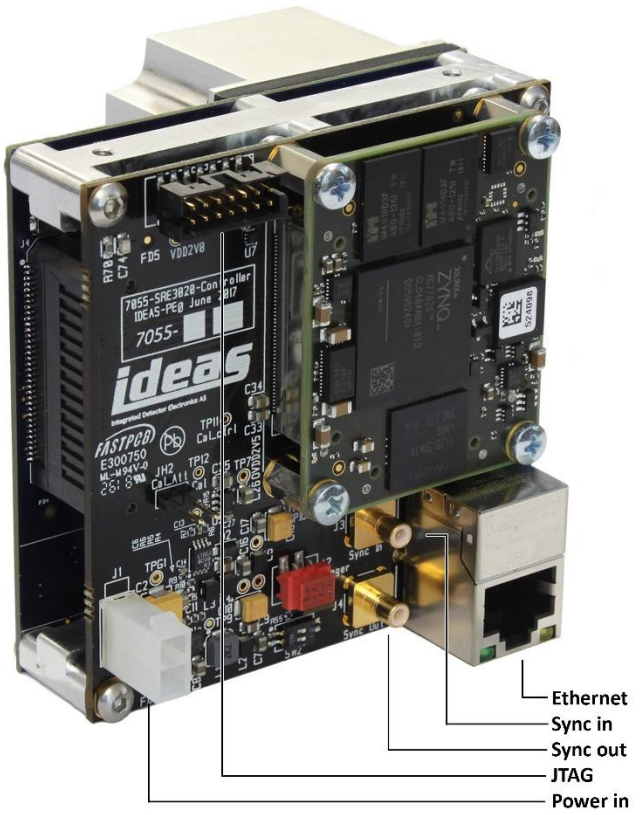
122 charge sensitive amplifiers – 1 cathode, 121 anodes

Timer (40 MHz) and signal for each channel



Block scheme





Back-end interface



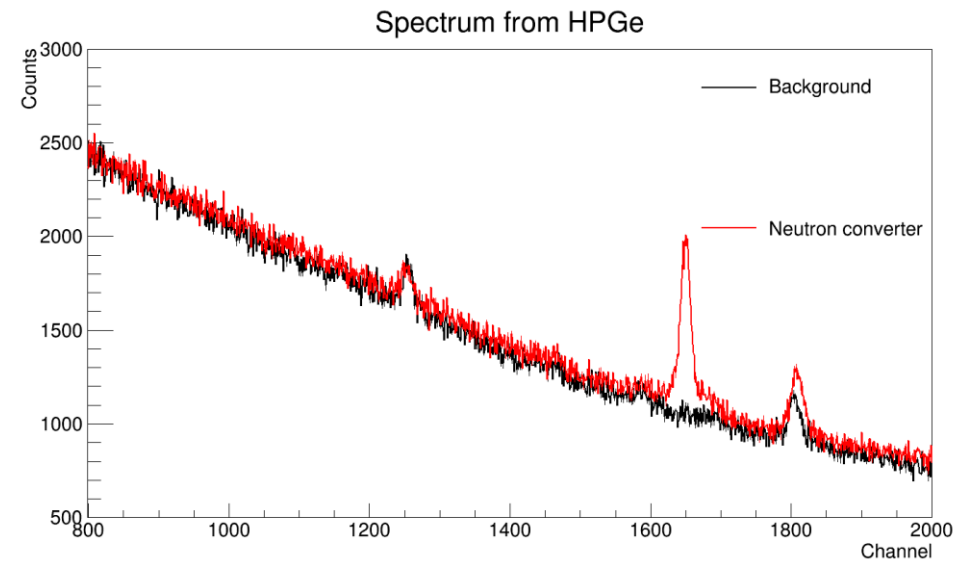
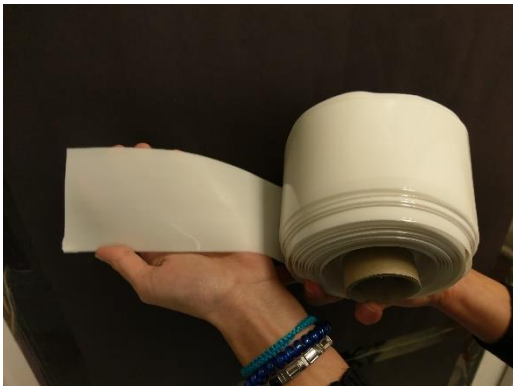
CZT pixel locations

Neutron detection

- ▶ Detection of thermal neutrons
- ▶ Two possibilities:
 - ▶ Neutron capture in cadmium
 - ▶ Detection of neutrons in the sensor itself
 - ▶ Capture gamma ray energy of 558.32 keV & 651.19 keV
 - ▶ Cross section for ^{113}Cd is 20600 b
 - ▶ Neutron capture in gadolinium
 - ▶ Wrapping the sensor with Gd containing tape
 - ▶ ^{155}Gd : 199.21 keV & 88.97 keV
 - ▶ ^{157}Gd : 181.93 keV & 79.51 keV & 944.17 keV
 - ▶ Cross section for ^{155}Gd is 60900 b, for ^{157}Gd it is 254000 b

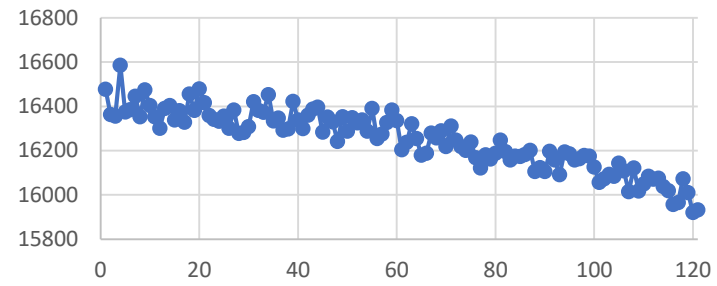
Gadolinium tape

- ▶ Manufactured by the Institute of Macromolecular Chemistry, Czech Academy of Sciences
- ▶ 20% of Gd_2O_3 on LDPE tape
- ▶ Thickness of 0.3 mm; width of 87 mm

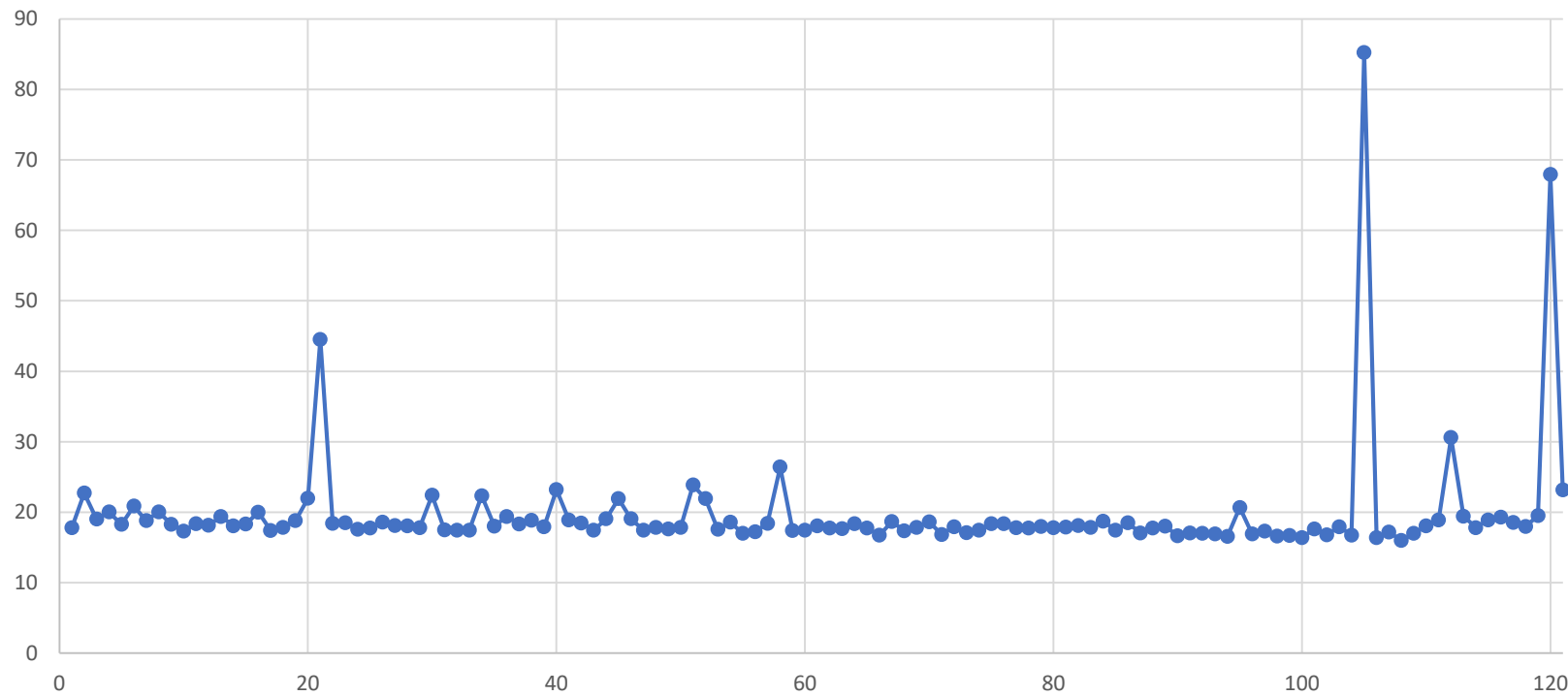


Pedestals

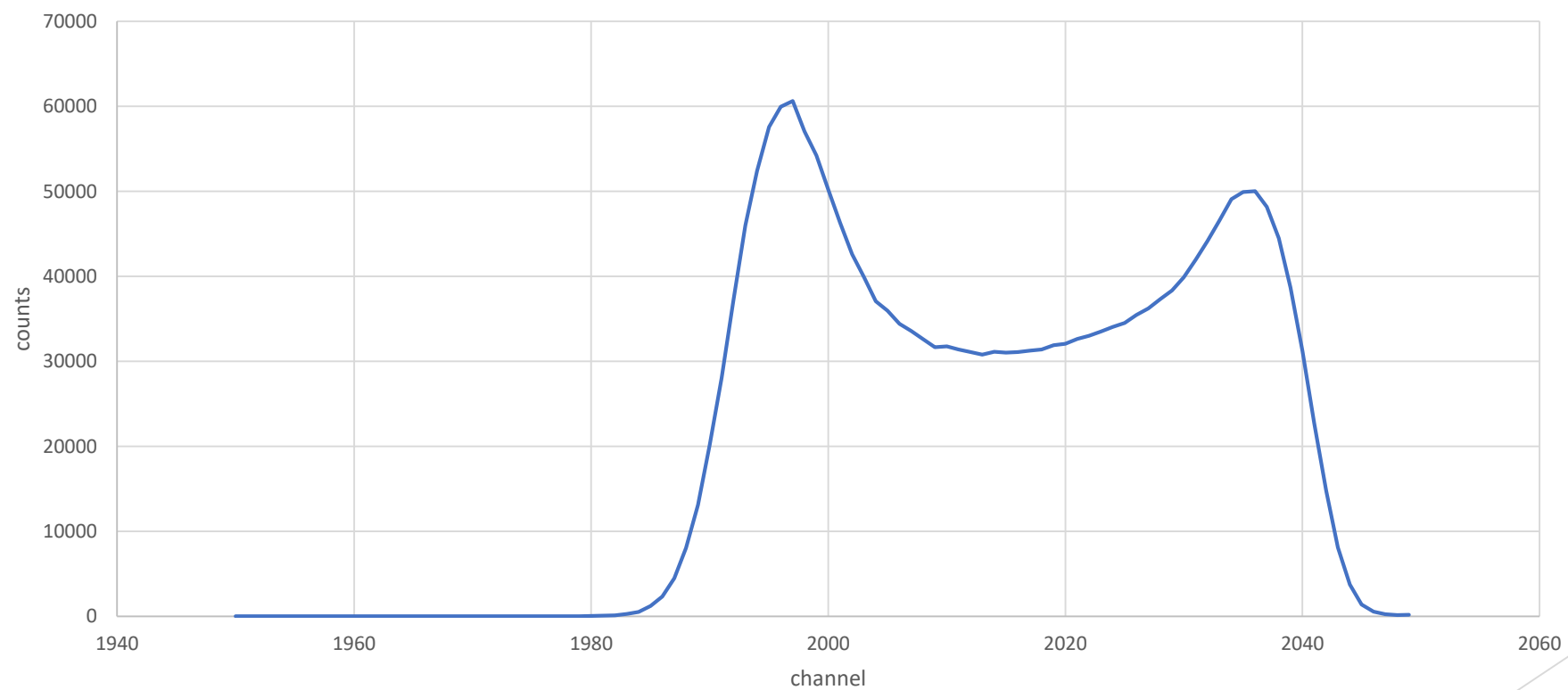
Baseline value [LSB]



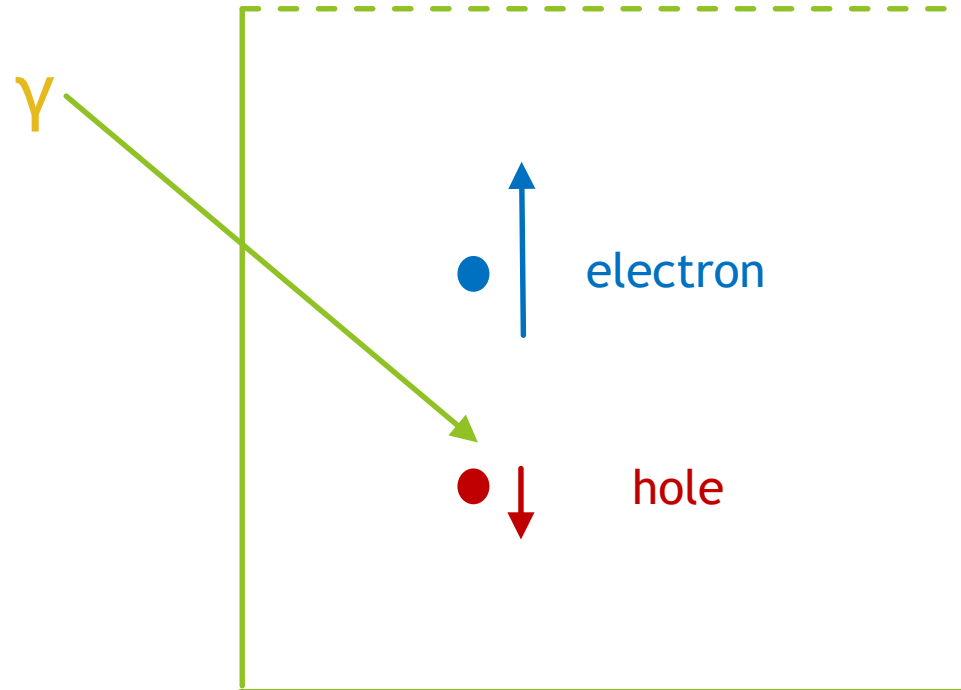
Standard deviation [LSB]



Common mode noise distribution

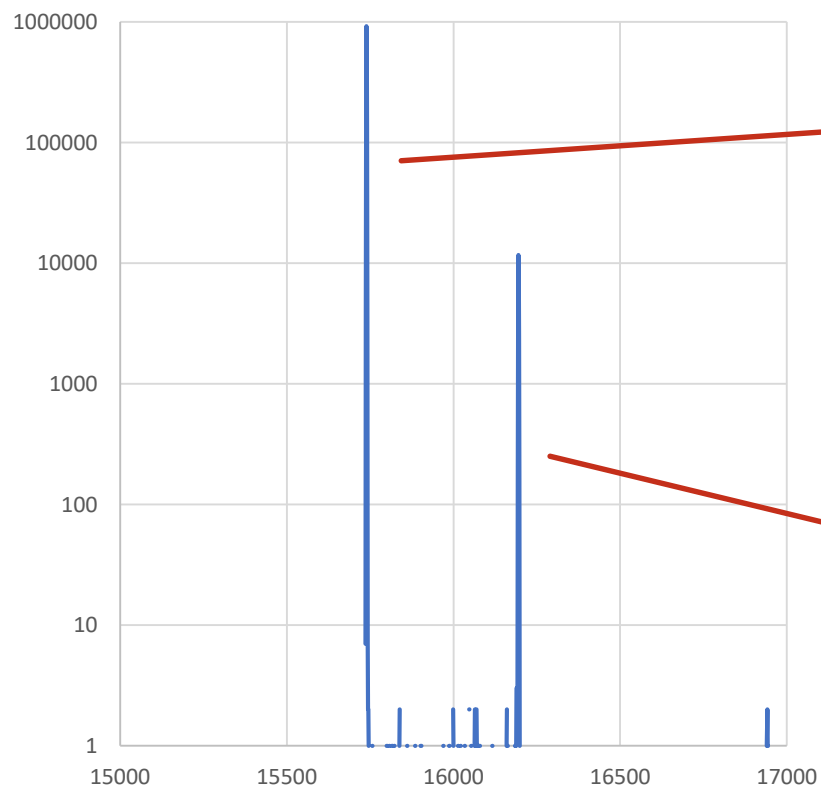


Cathode/anode timing



Cathode/anode timing

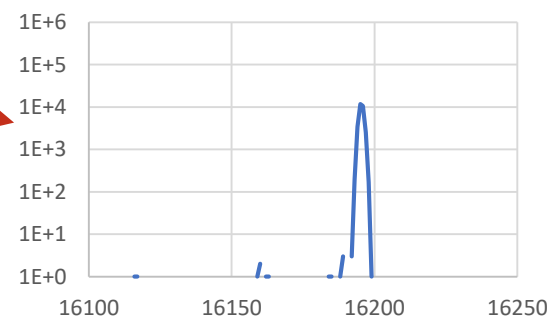
Timing data for single anode pixel



Cathode triggered events

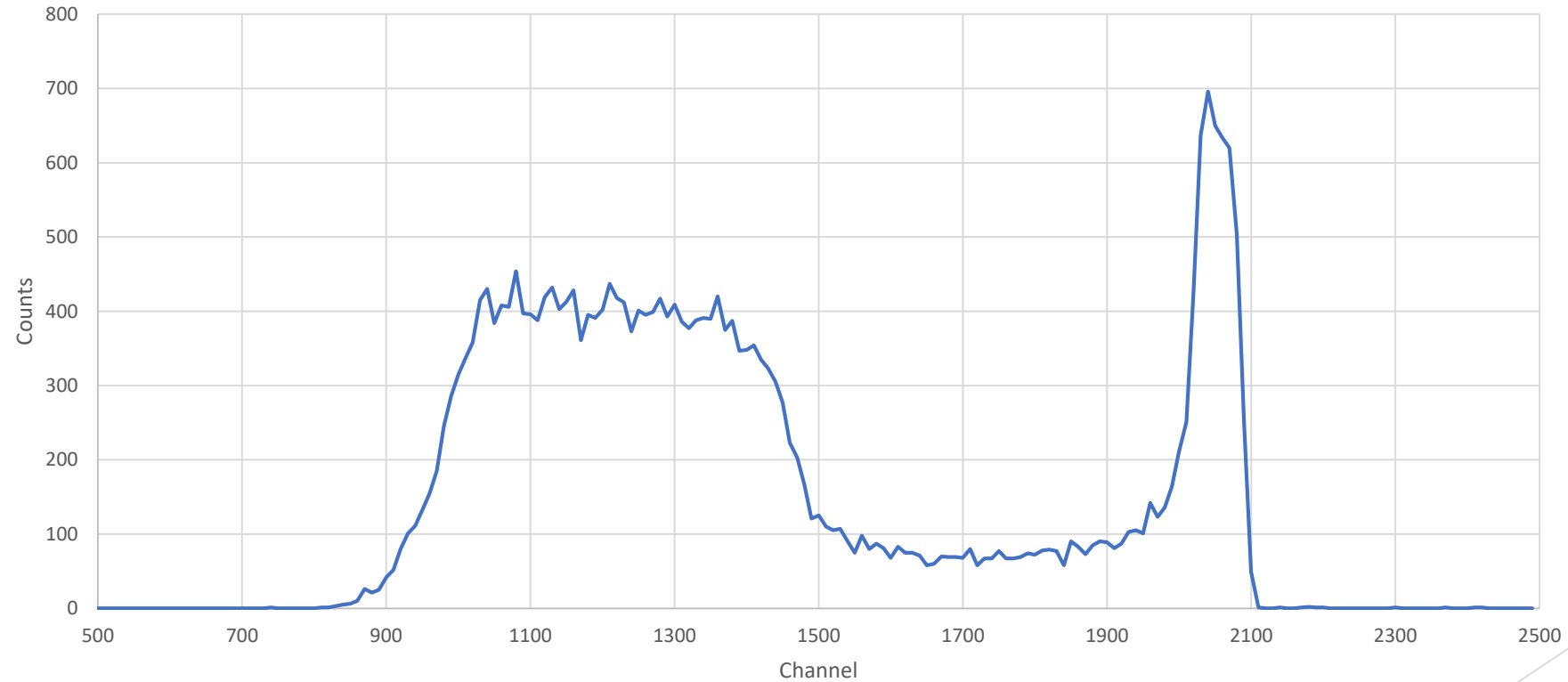


Anode triggered events

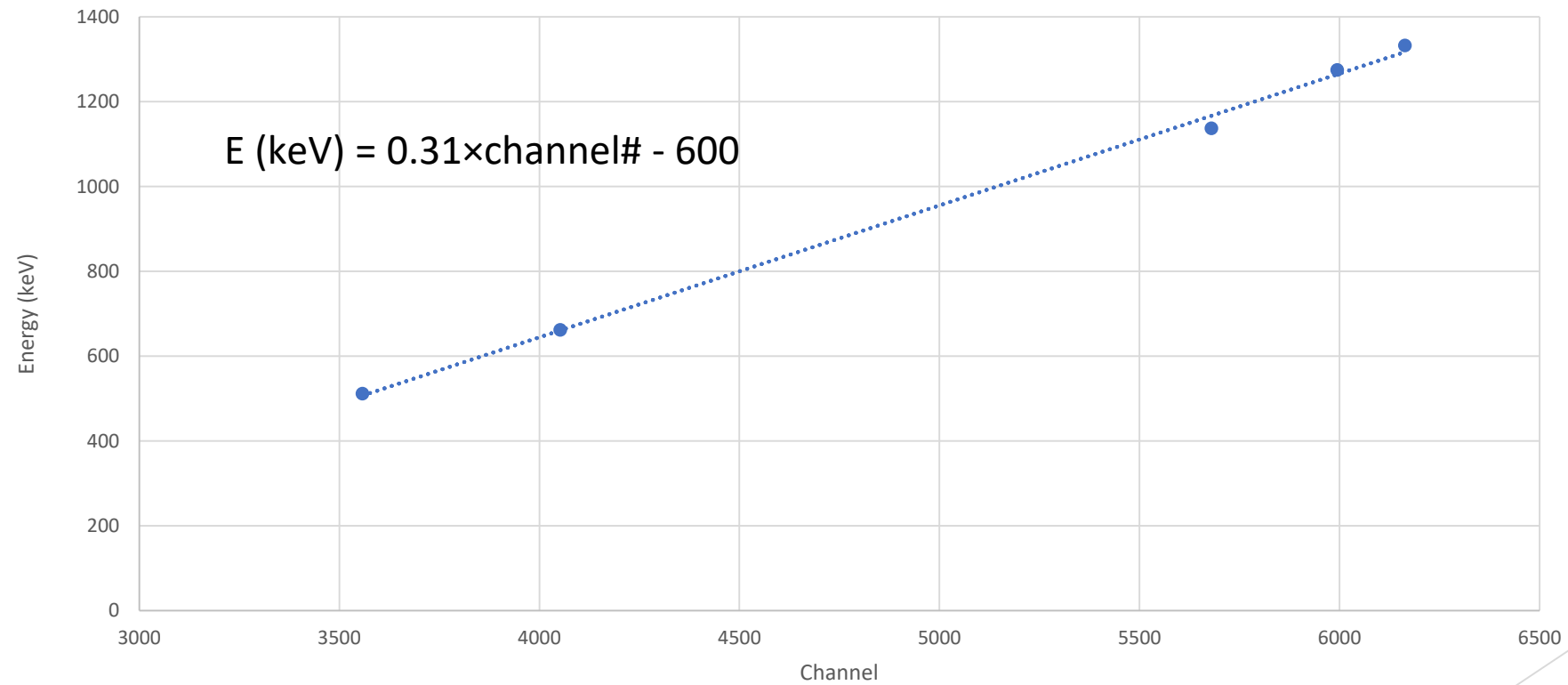


Anode triggered single pixel ^{137}Cs spectrum

FWHM 22 keV
→ Resolution of 3,3% @ 662 keV



Energy calibration



Summary & Outlook

- ▶ Gamma camera spectroscopic module capable of 3% resolution for ^{137}Cs
 - ▶ Preliminary results! 1% resolution is achievable.
- ▶ A standalone SW for Compton camera imaging is developed simultaneously by a project partner
- ▶ Measurements with thermal neutrons in 2 weeks

Thank you for your attention!

Any questions?

- ▶ The research leading to these results has received funding from the Ministry of Education, Youth and Sports of the Czech Republic and the Research Council of Norway within subprogram Eurostars-2 under Project Contract no. MSMT-8179/2017-1.