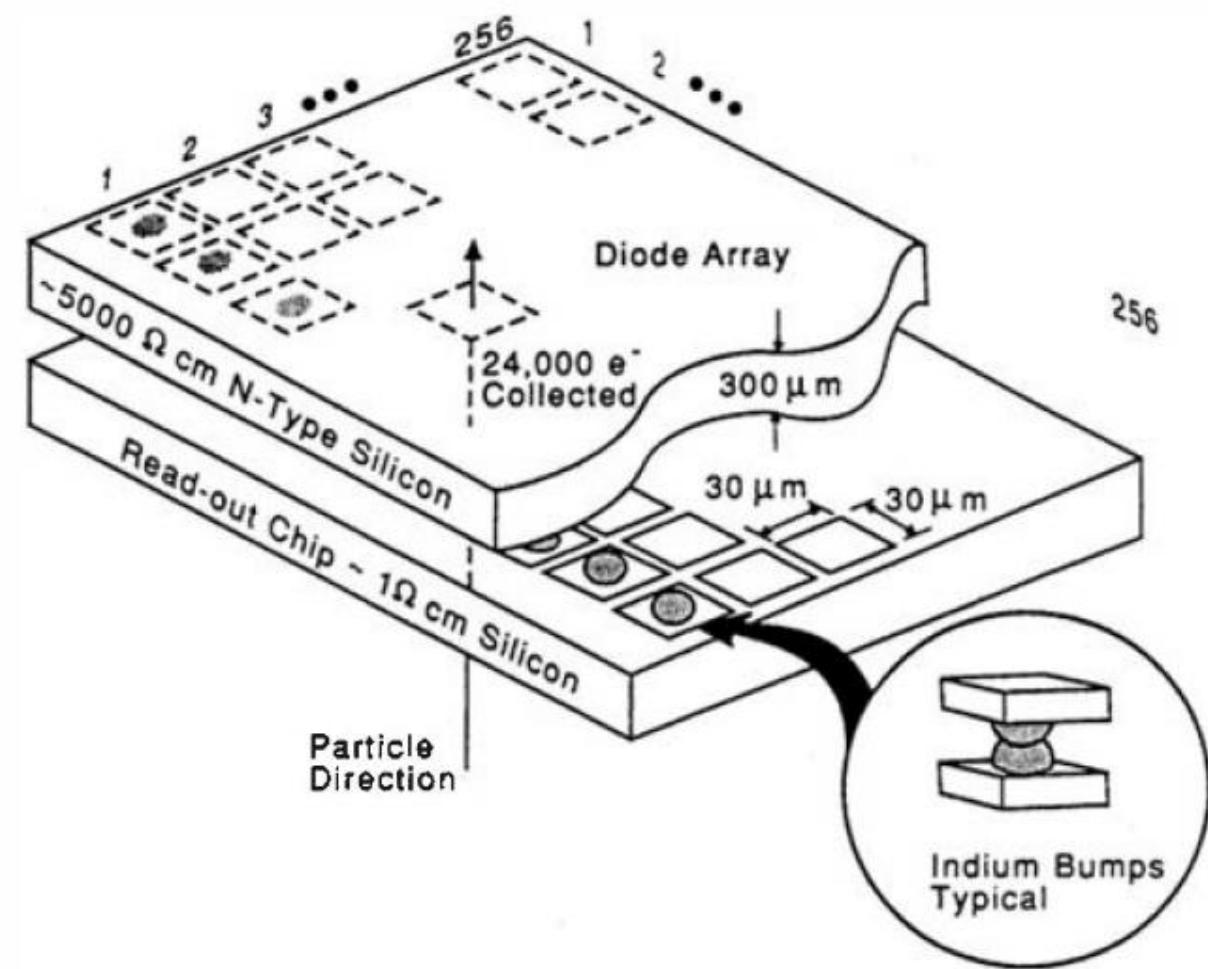
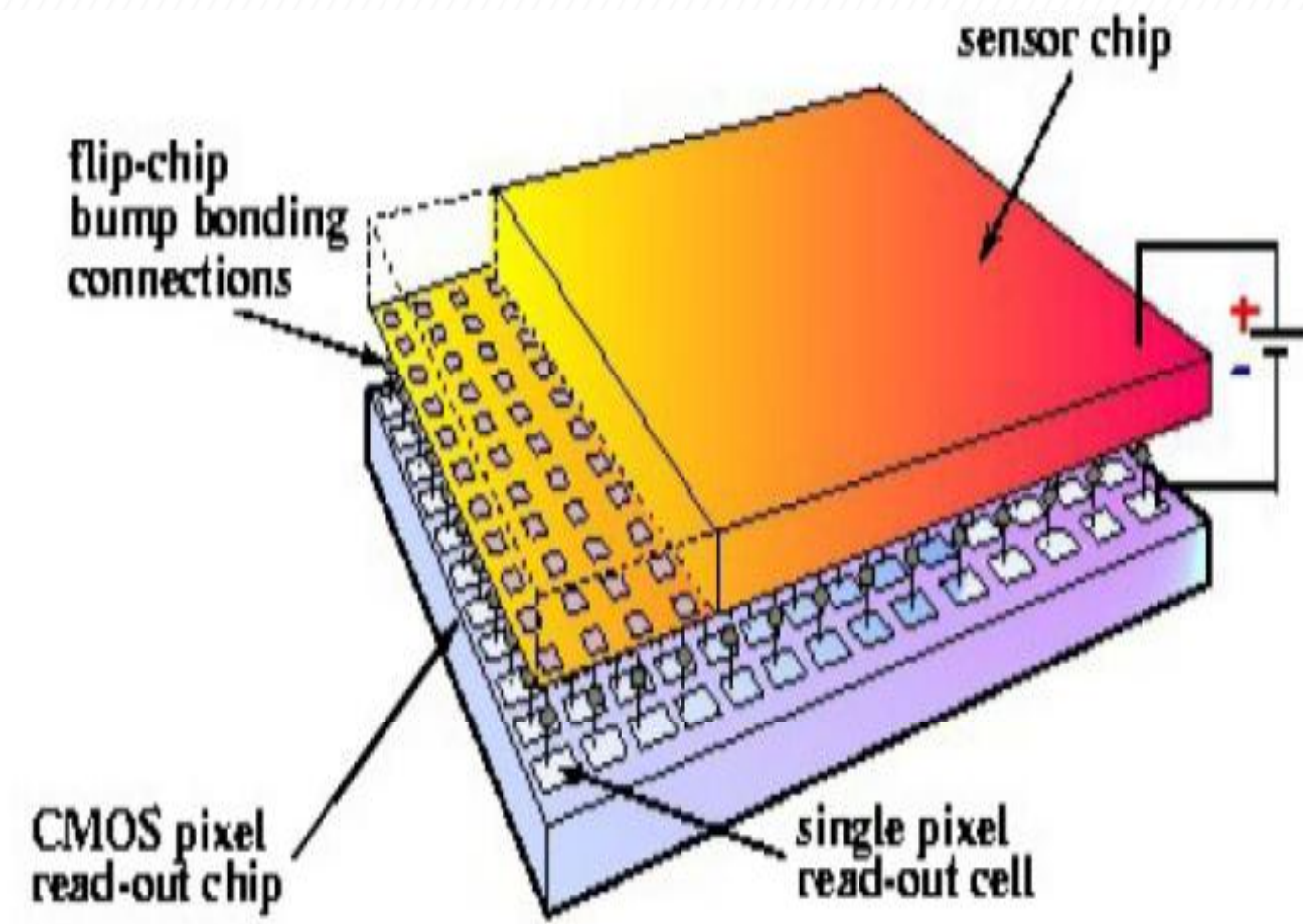
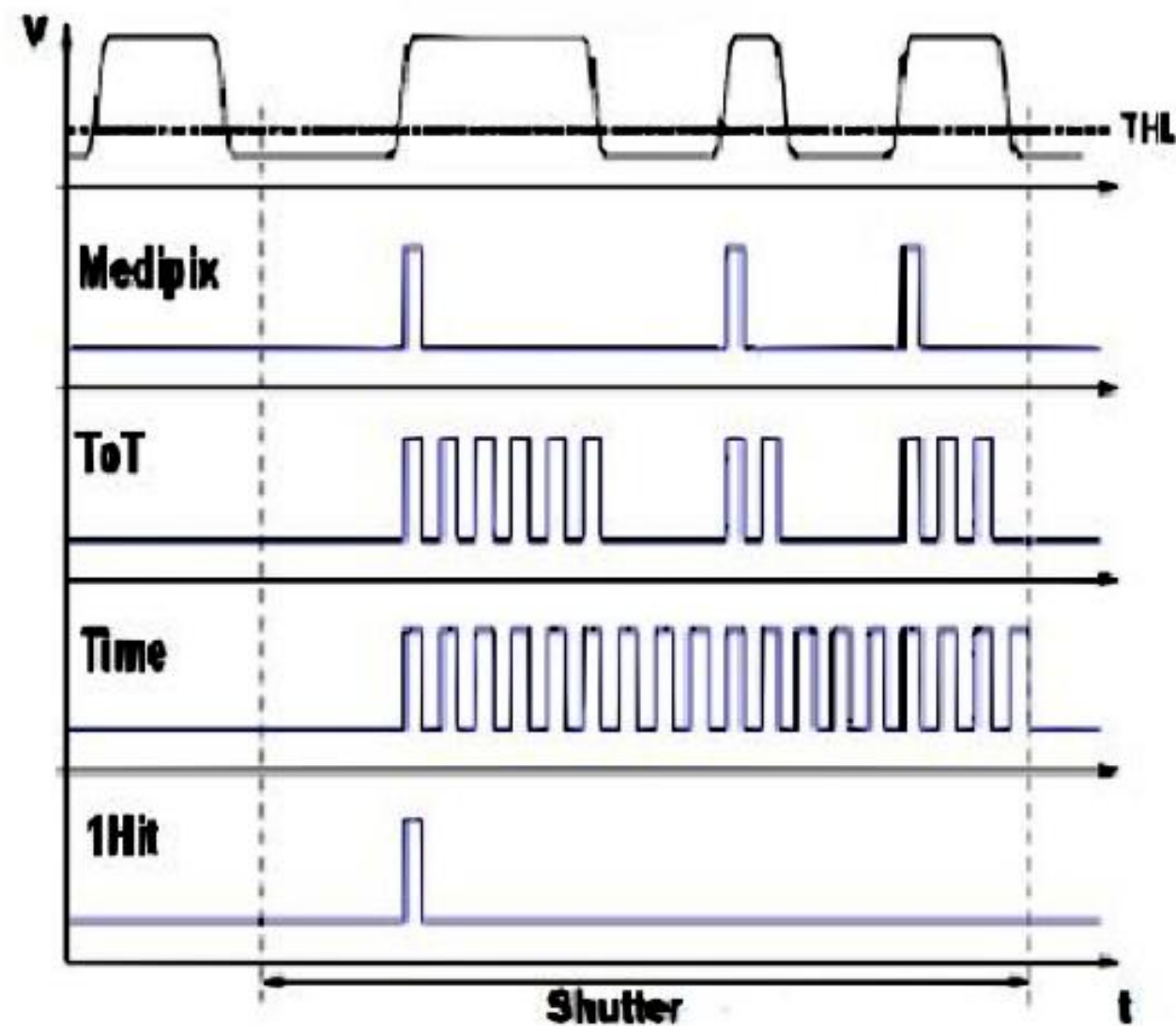


# Calibration procedure of hybrid pixel detector with GaAs(Cr) sensor and Timepix readout chip

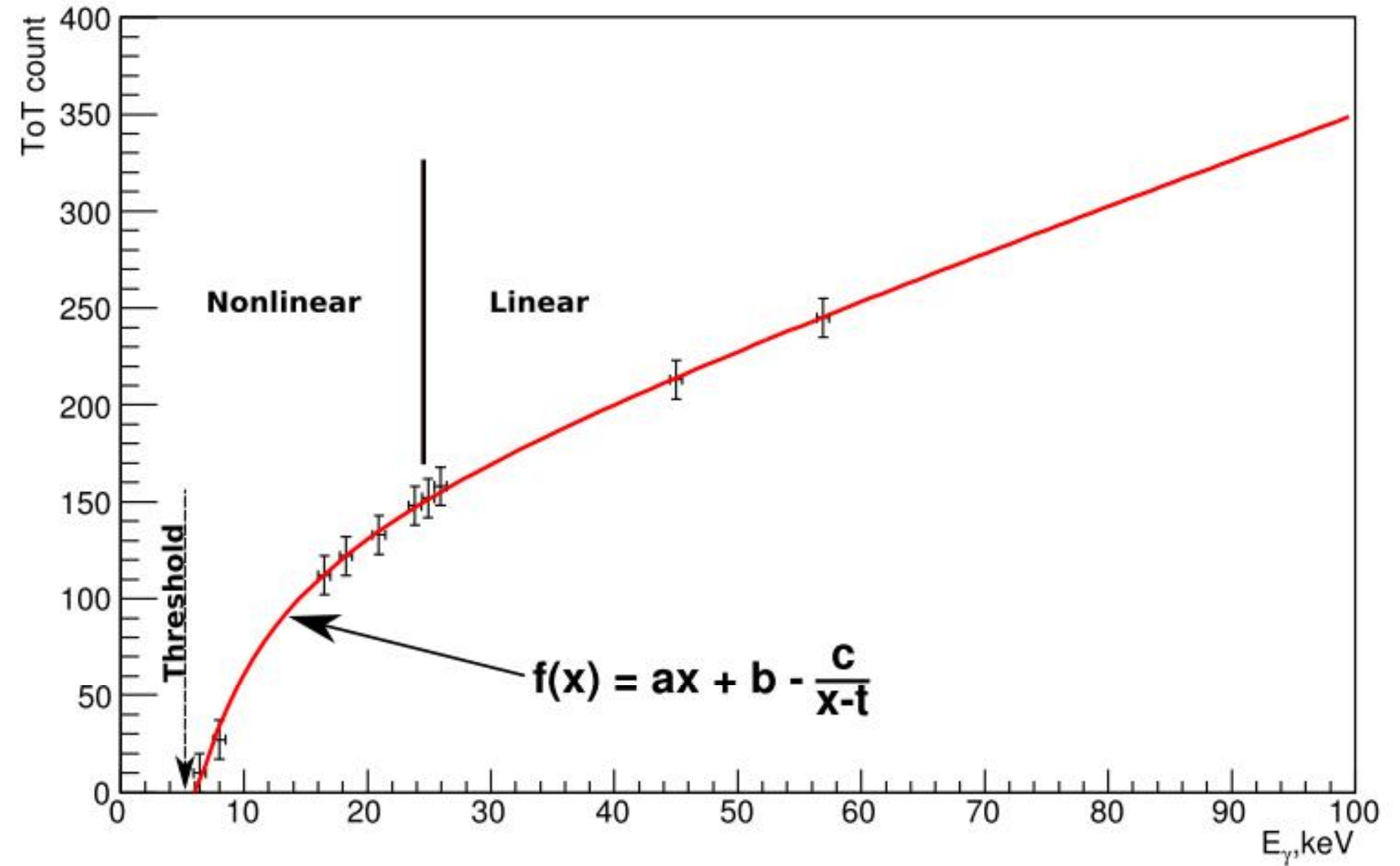
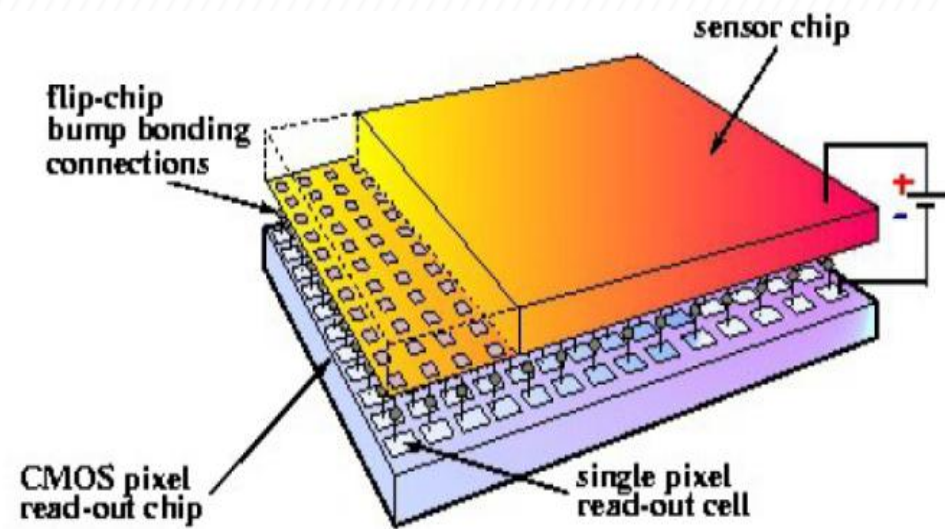
Ibrahim Hany (ibrahim.m.hany@ieee.org)  
B.Sc. Graduate - Nuclear and Radiation Engineering Department  
Alexandria University



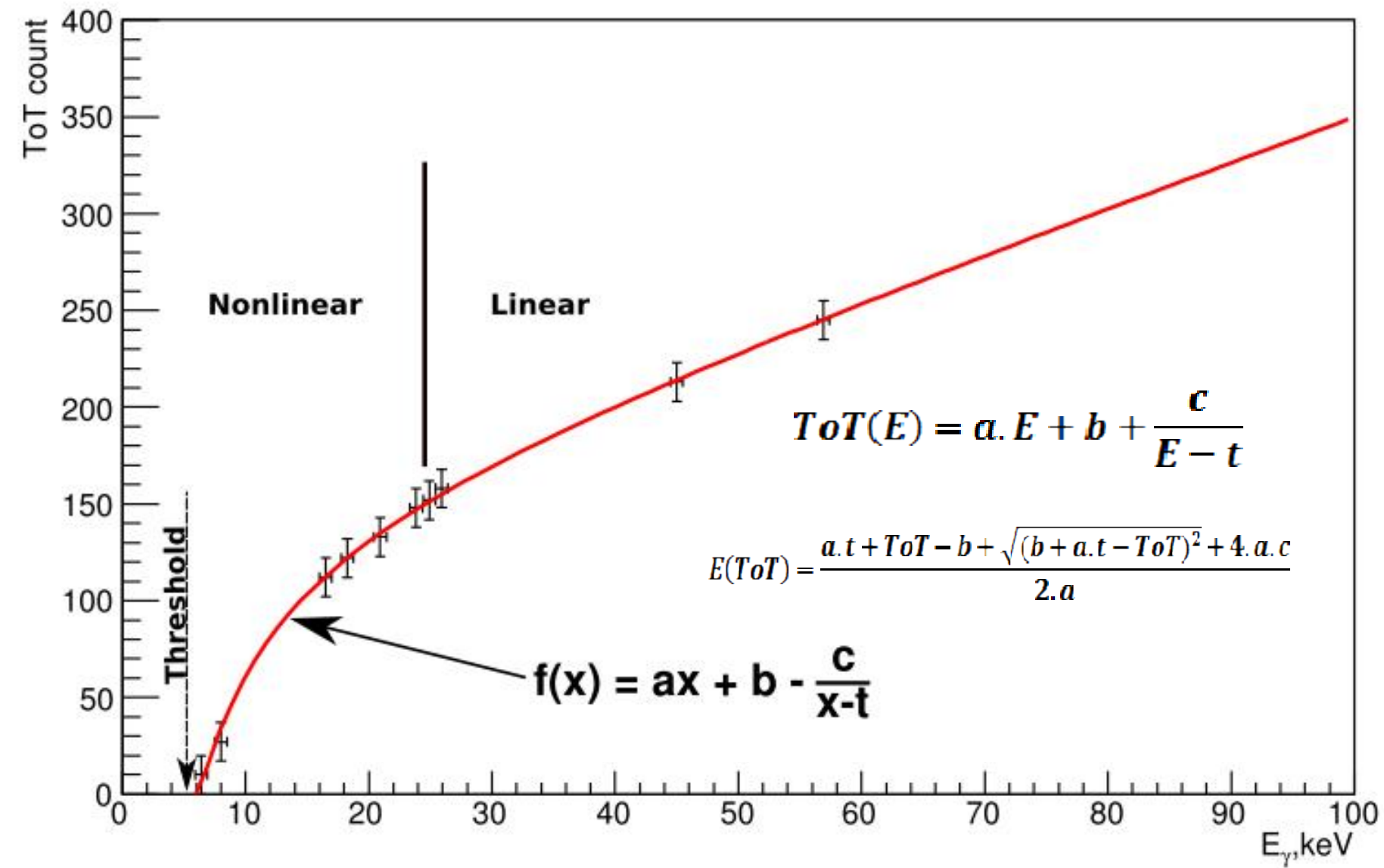


- **Medipix (counter) mode:** the chip counts how many times during the open shutter the signal exceeds a certain threshold;
- **Time-over-Threshold (ToT) mode:** the chip measures for how long the signal stays above the threshold;
- **Time-of-arrival (ToA) Mode:** the chip measures time from the moment when the signal crosses the threshold until the shutter is closed;
- **OneHit mode:** the chip checks if the signal exceeds the threshold at least once during the open shutter.





# Energy Calibration (Per Pixel/Generalized)



256\*256 = 65,536 Pixels  
 65,536 Pixels = 65,536 Calibration Curves  
 65,536 Calibration Curves = 65,536\*4 = 262,144 Parameters

Calibration of the pixel detector is carried out in two stages.

The first stage is the pixels threshold equalization.

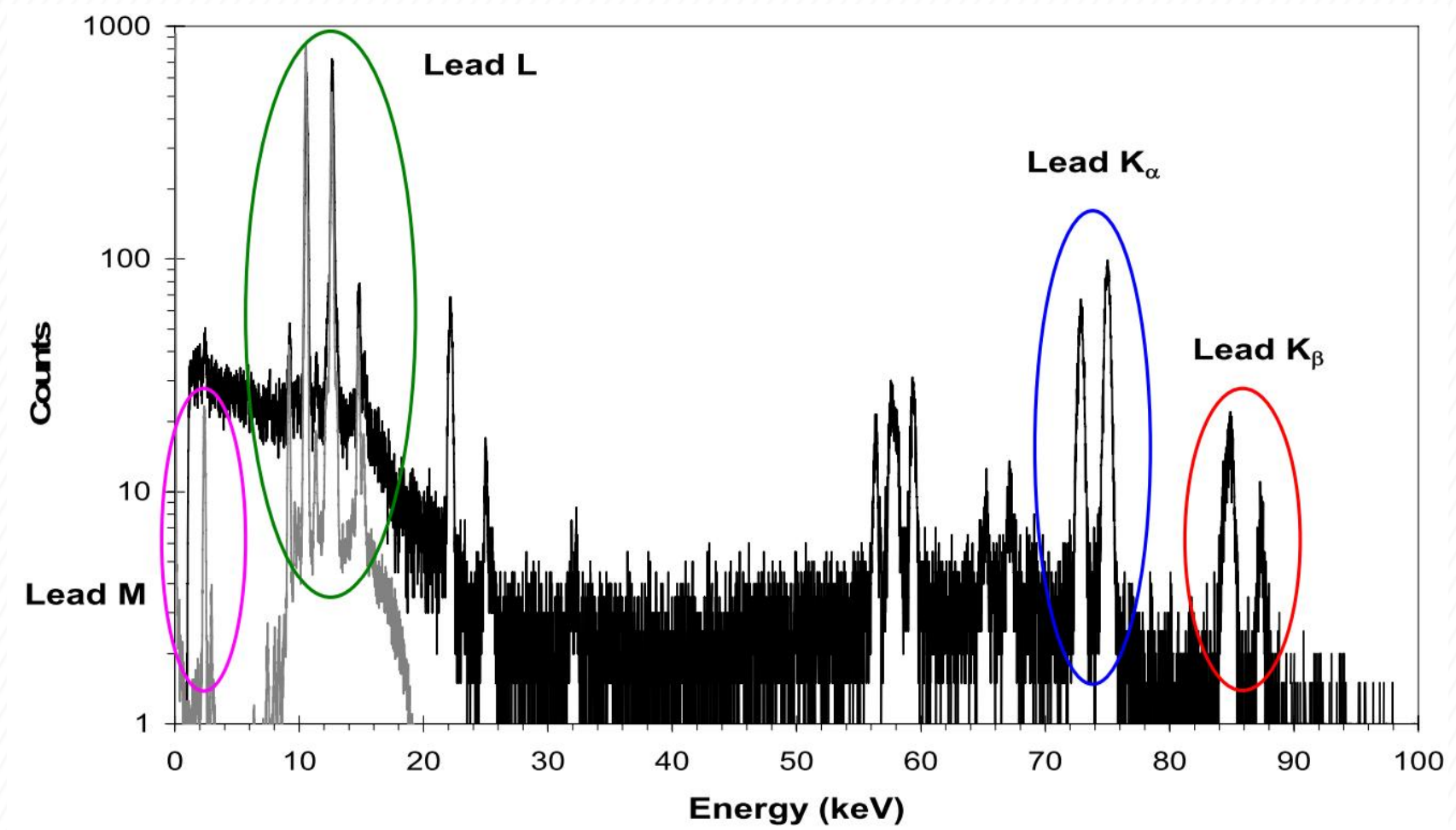
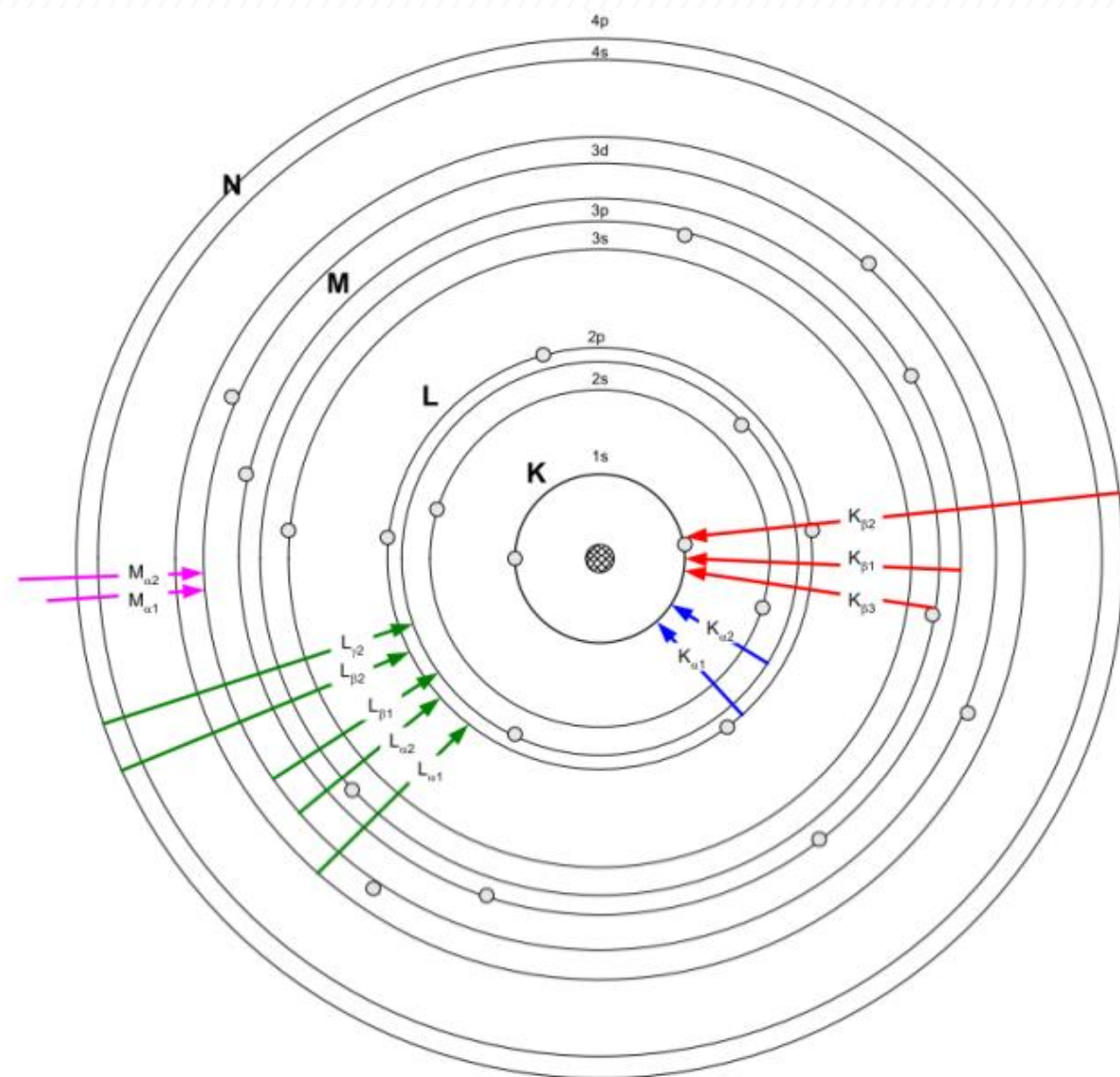
The second step is the establishment of a *one-to-one correspondence between the time length of the signal in ToT (time) and the absorbed energy.*

## Energy Calibration Experimental Steps

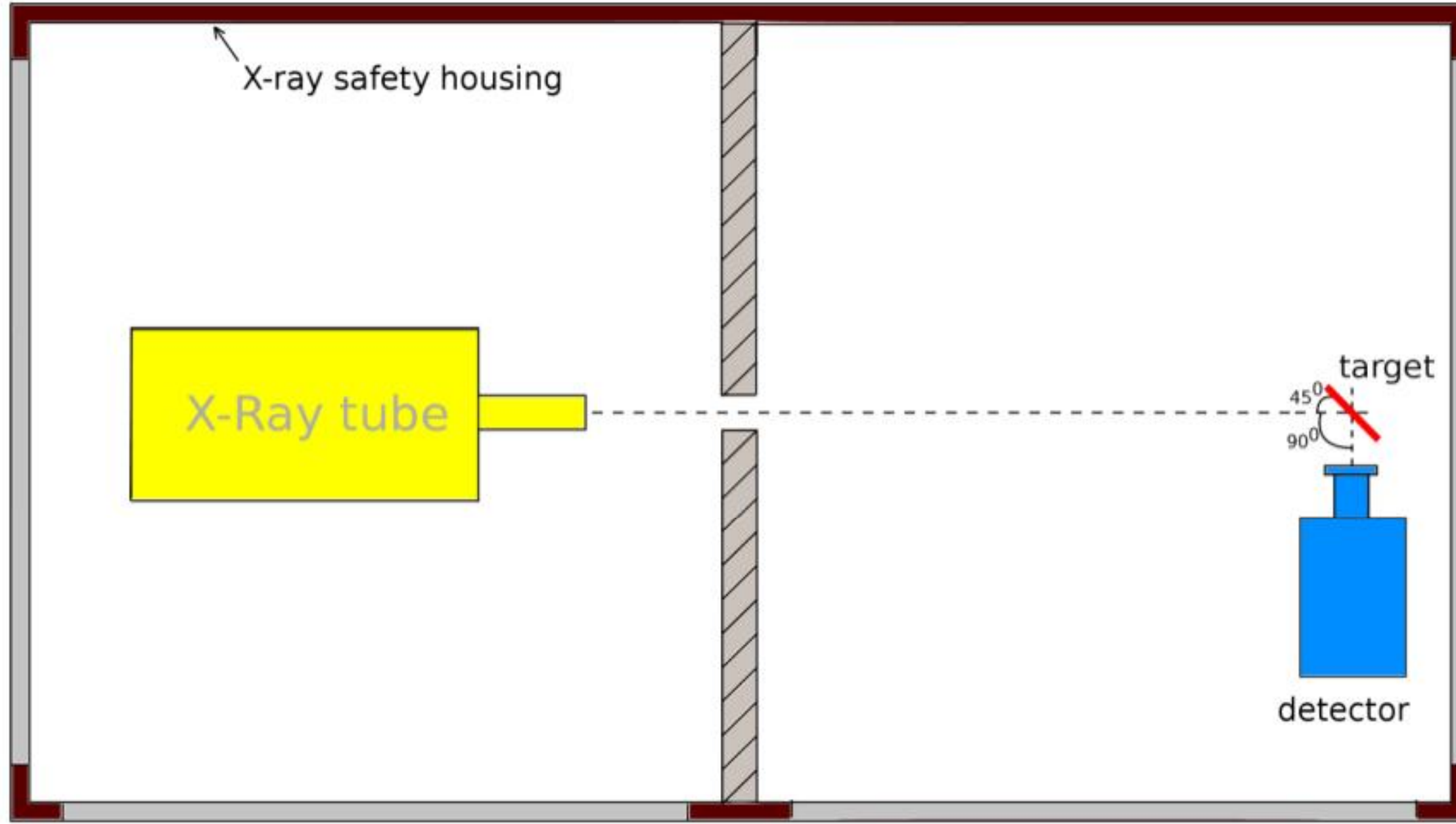
1. Measurements of X-ray spectra of known radioactive  $\gamma$ -sources or spectra of characteristic emission of selected materials in units ToT.
2. Identification of peaks in the recorded ToT-spectra with corresponding X-ray emission lines.
3. Fitting of the peaks and constructing of a ToT (E) graph (just points on the graph).
4. Fitting of the obtained ToT (E) graph with the calibration experimental function and calculation of the inverse relationship  $E(\text{ToT})$ .

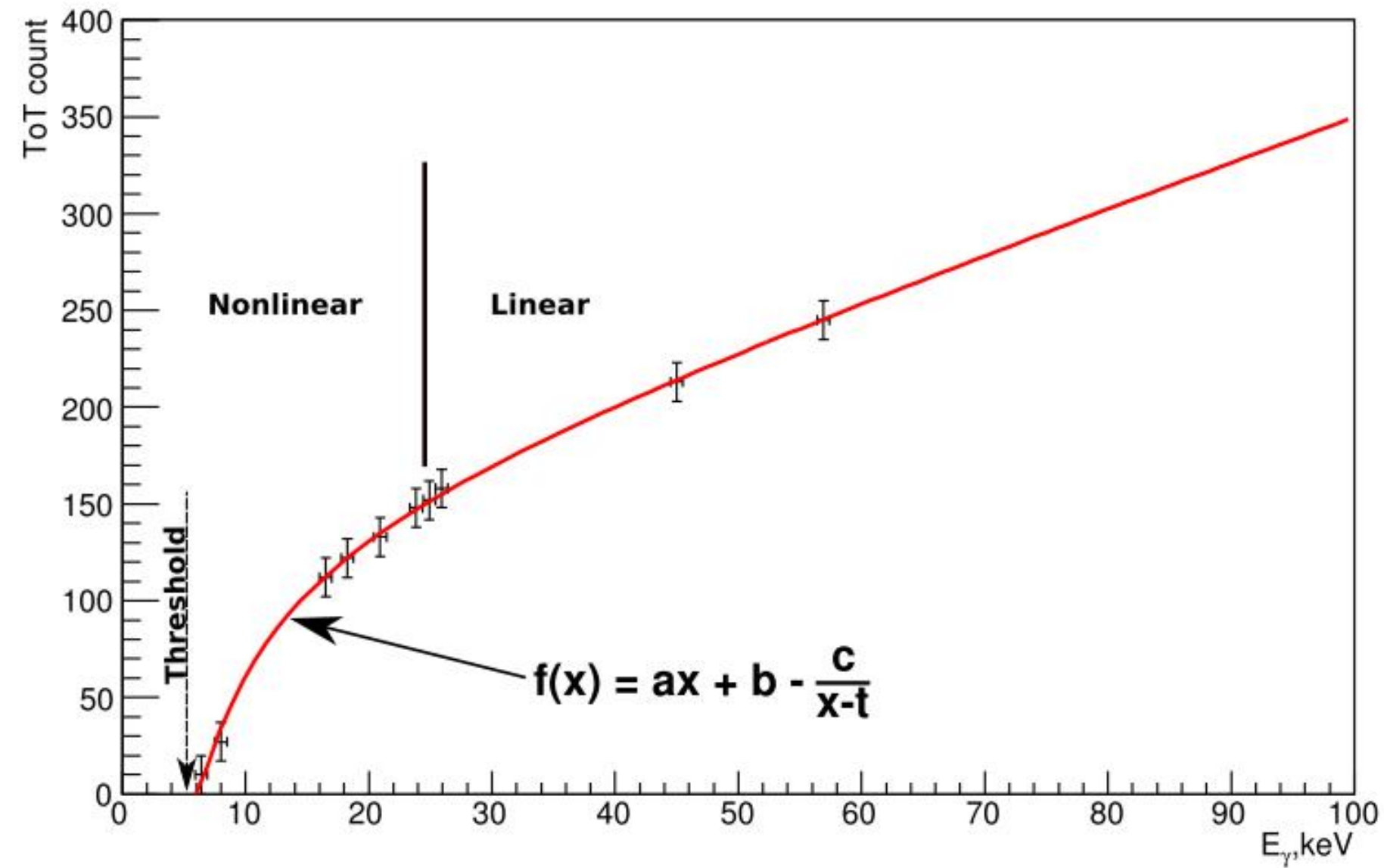
## **Energy Calibration experimental Steps (cont'd)**





<b>Foil (Element)</b>	<b><math>K_{\alpha}</math> in eV</b>
Ni	7,478.15
Cu	8,047.78
Zn	8,638.86
Zr	15,775.1
Mo	17,479.34
Rh	20,216.1
Cd	23,173.6
In	24,209.7
Sn	25,271.3
Ta	57,532





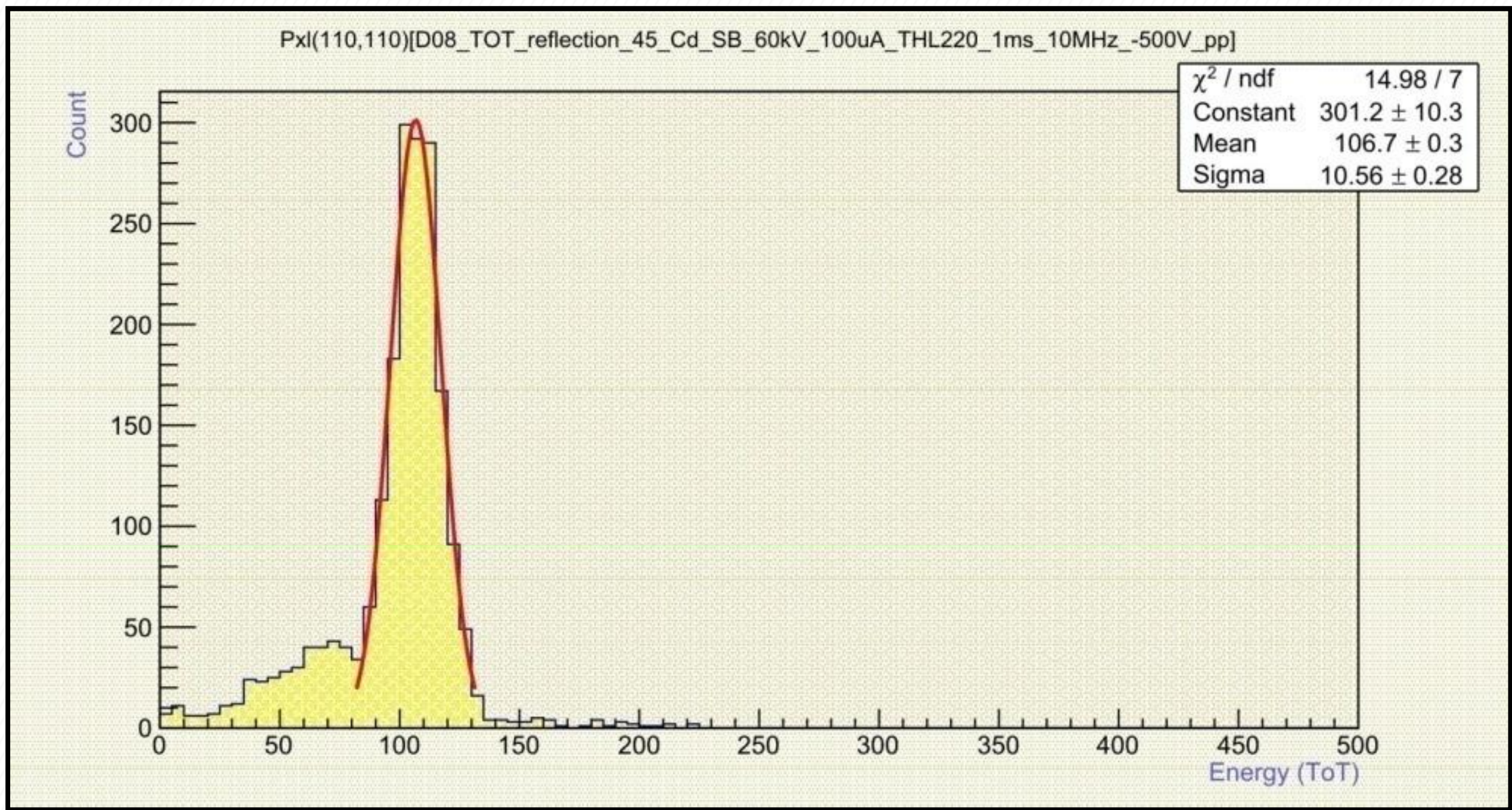
256\*256 = 65,536 Pixels

65,536 Pixels = 65,536 Calibration Curves

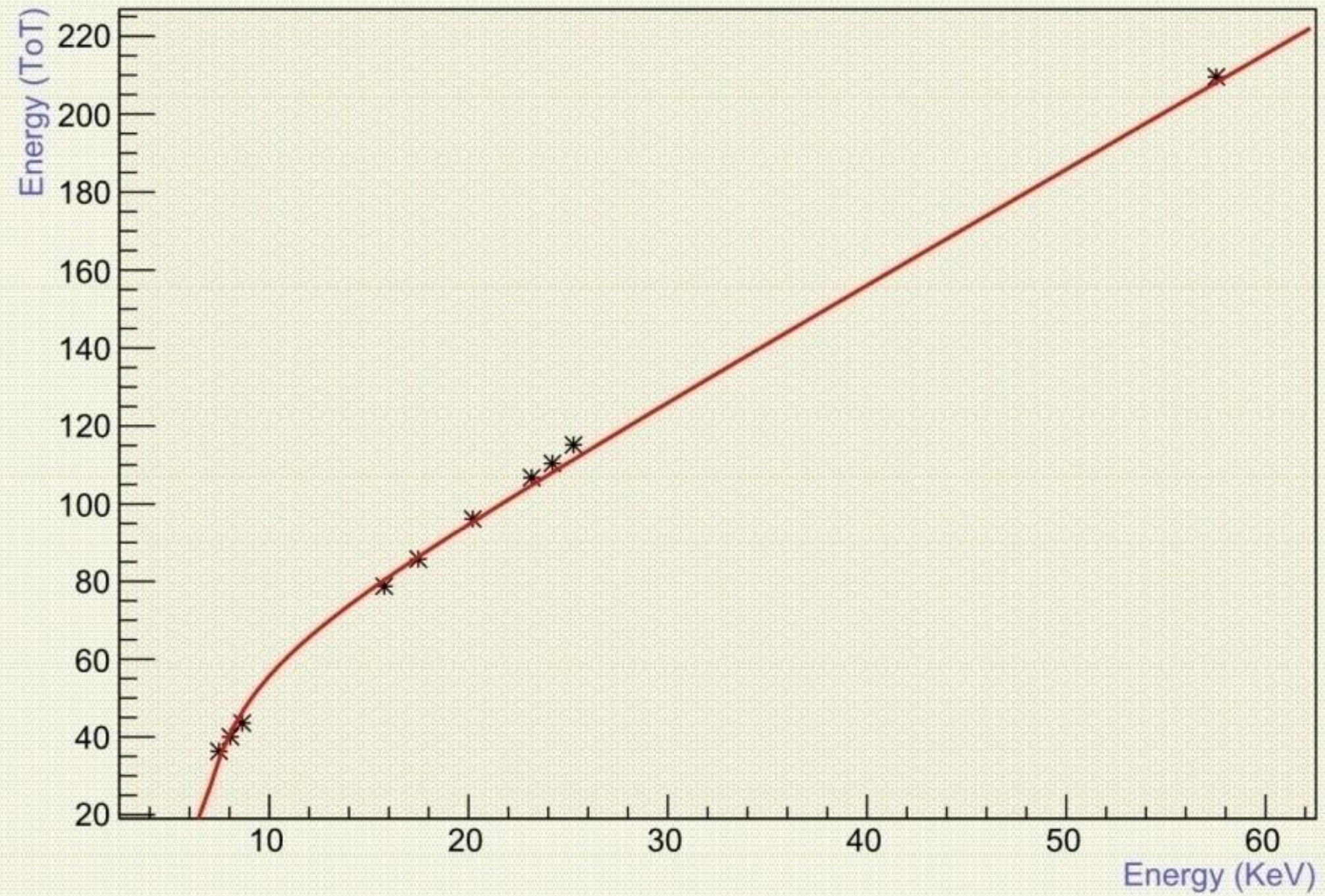
65,536 Calibration Curve\*10 Foils= 655,360 Curve

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65,536 Calibration Curves\*4 = 262,144 Parameters



Calibration Curve for Pxl (110,110)

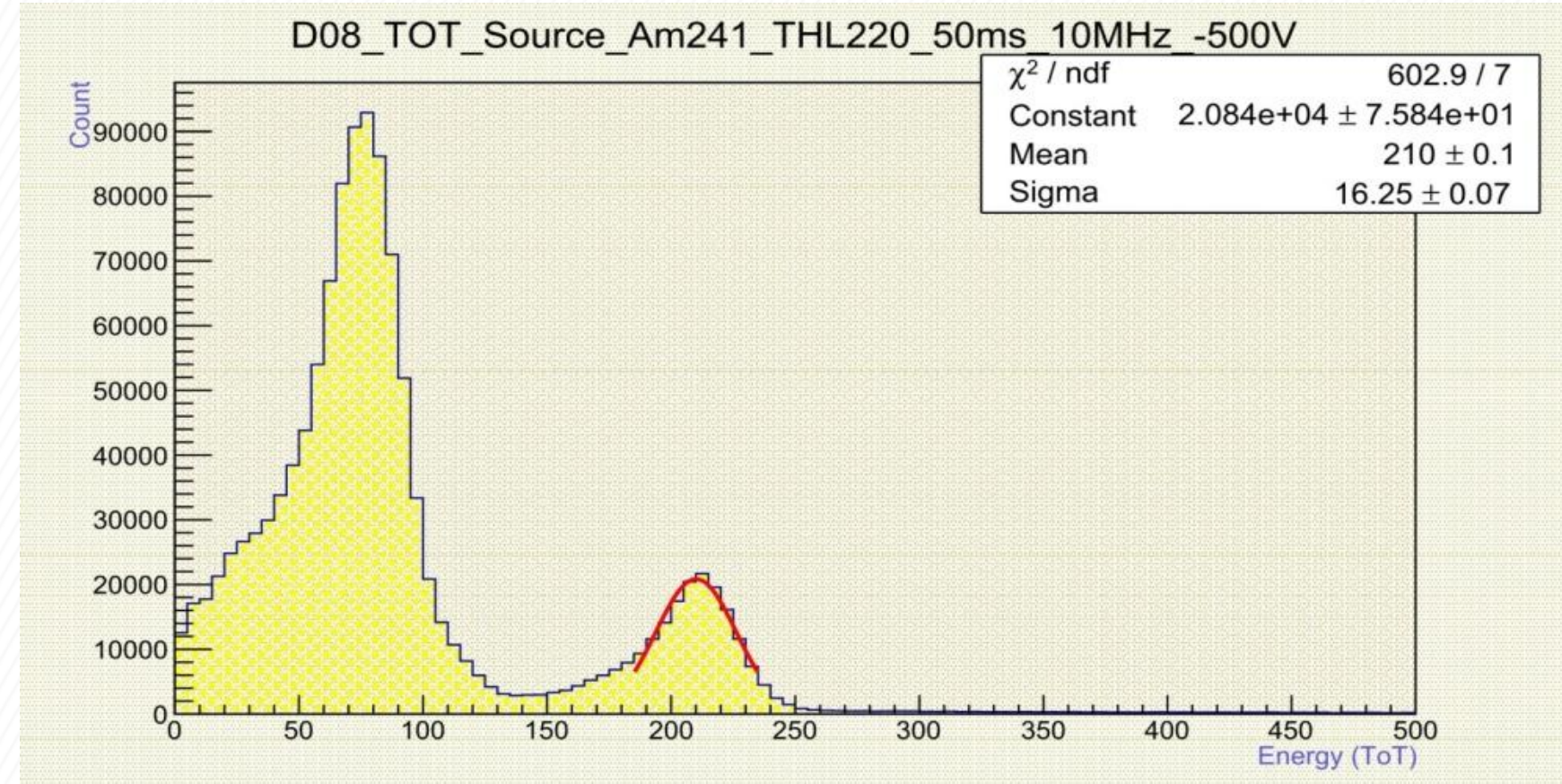


# Follow up & validation

1. Work was concentrated on the per-pixel calibration because all pixels in a hybrid pixel detector give a somewhat different response to the passage of a particle with a certain energy, which makes such method more effective than the generalized one.
2. The macros were developed for all the steps needed in the calibration; a step that was very educative.
3. I obtained the ToT spectra for each working pixel, and it was evident that around 20% of the pixels were not working well; either giving wrong signals or dead.

# Follow up and validation (cont'd)

3. To validate the results, I used a gamma emitting radioactive source: Am-241.
4. The Gaussian Mean (ToT energy peak) was equal 210.045. Using the 4 parameters ( $a=2.90578$ ,  $b=37.1093$ ,  $c=73.7067$  and  $t=4.72846$ ) and converting it to KeV energy it becomes 59.9737; a value that is very close to the 59.6 KeV (Am-241 peak)!





# Further steps

1. Convolution/Monte Carlo simulation of the Timepix detector's reading to choose the right energy peak.
2. More verification experiments.
3. Checking the validation of the energy calibration with beta-rays (after validation of the energy calibration with photons) using a beta emitting source or a magnetic electron separator would be a good step.



# Thank you !

Complete report: <http://goo.gl/fzmjKh>