KU LEUVEN

Neutron Pulse Shape Discrimination:

Making a discrimination line and dealing with overflow events

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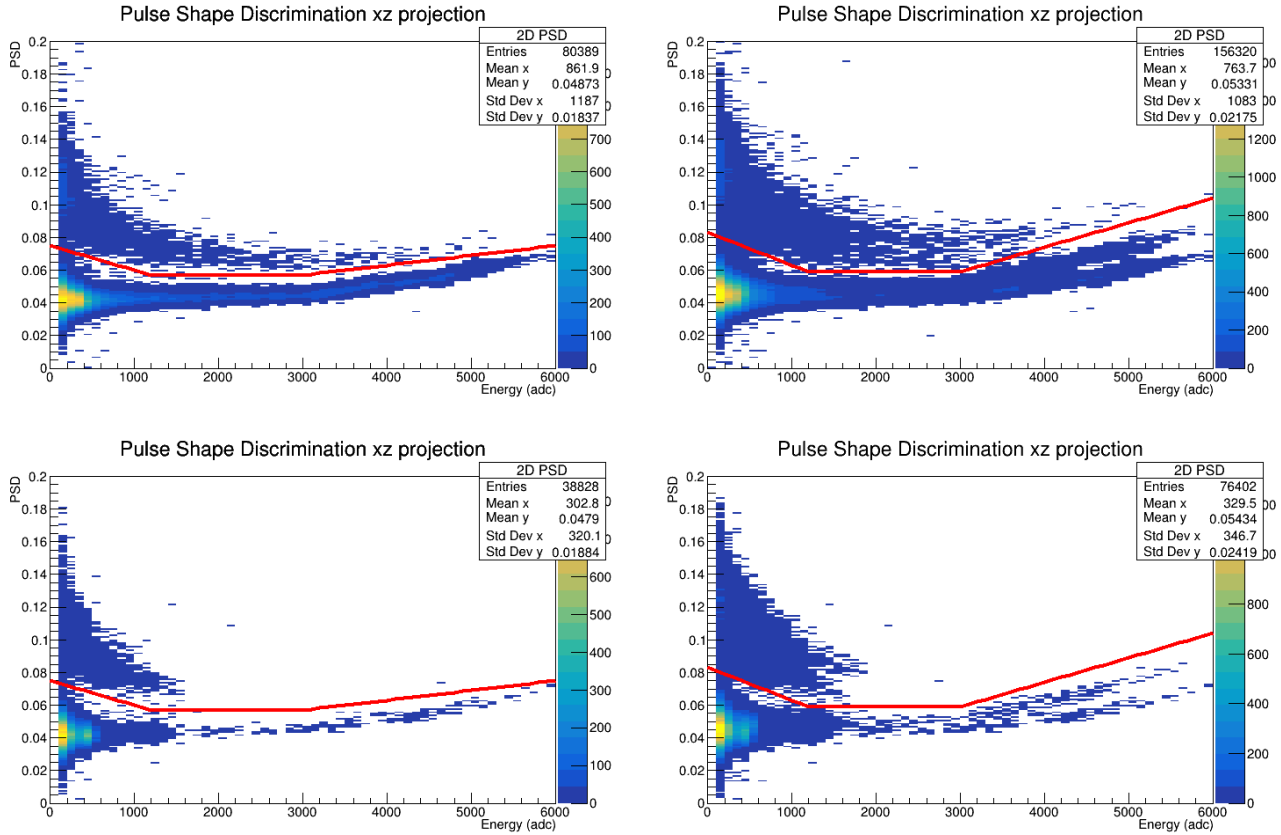
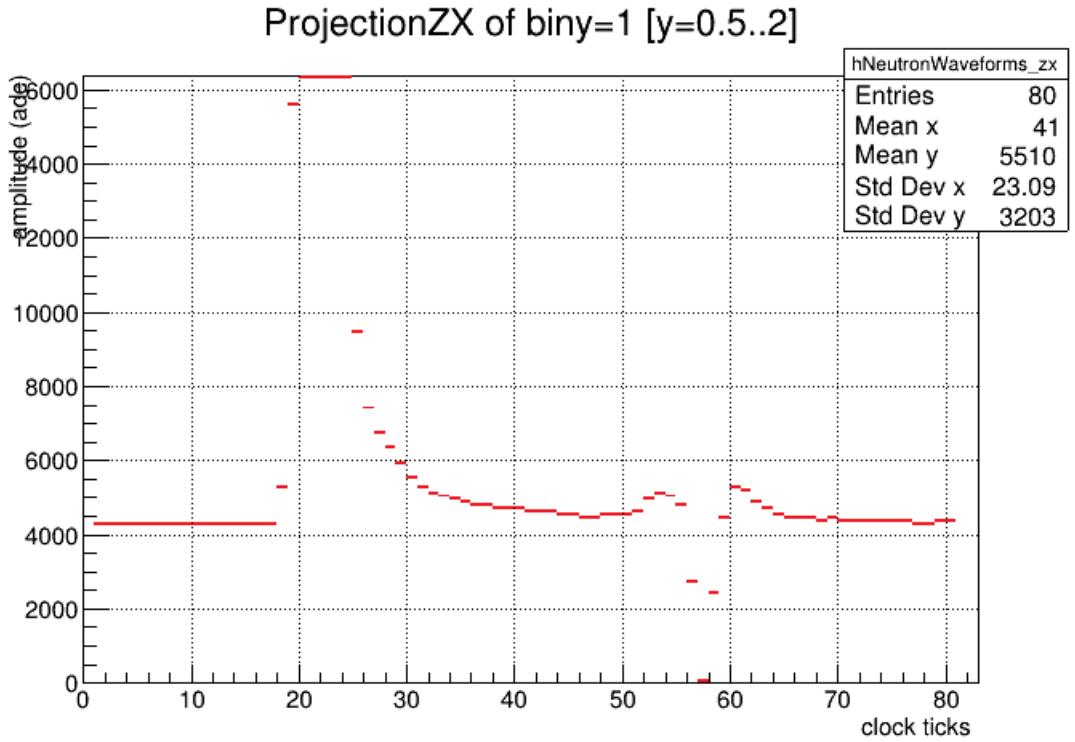
Making the discrimination line

- Piecewise defined line
  - Linear decreasing
  - Constant
  - Linear increasing
- Find good parameters visually and put into config file
- Above line: Most likely neutron
- Below line: Most likely photon



Recap - Overflows

- Overflow events → “Take away fraction of the integral”
- PSD value is increased → Curved lines at higher energies
- Find a method to improve the discrimination for overflows



Finding a good interpolation

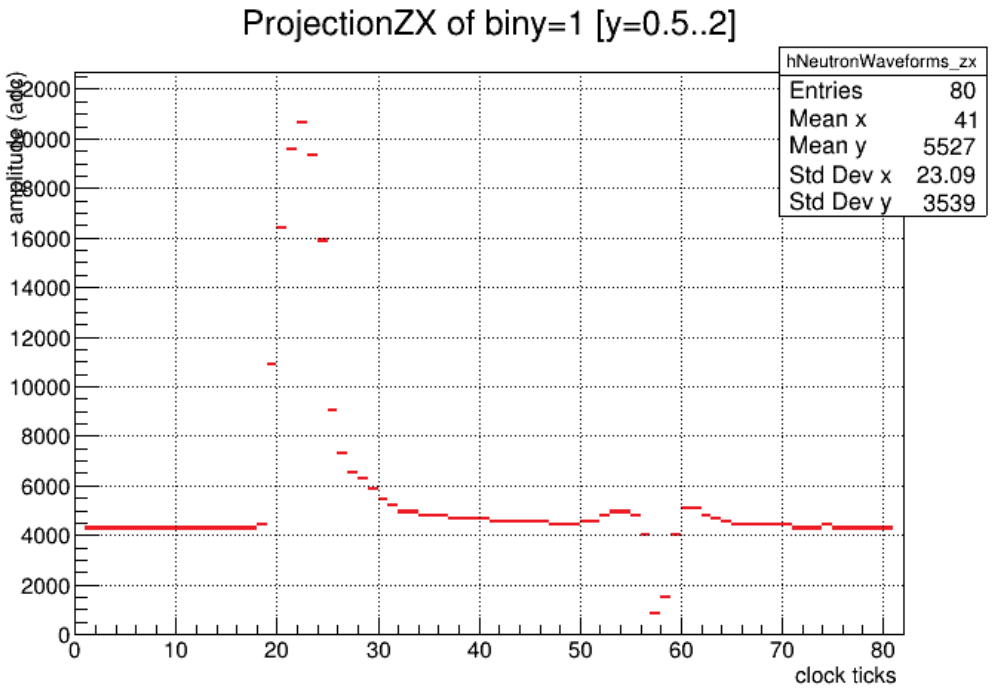
- Curve that goes through $(a, f(a))$ and $(b, f(b))$:

$$f(t) = x\,[-(t-a)(t-b)] + f(a) + (t-a)\frac{f(b)-f(a)}{b-a}$$

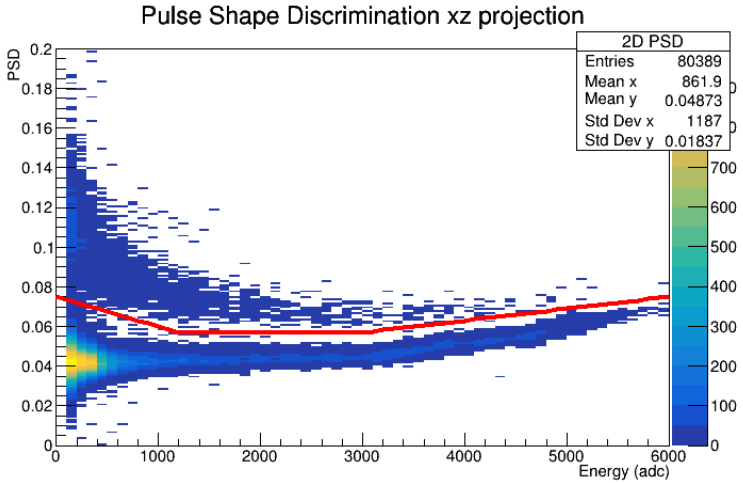
- First term: zero in a and b; second term: line between $(a, f(a))$ and $(b, f(b))$
- x determines how high the maximum lies
- Use point $(a-1, f(a-1))$ to determine x

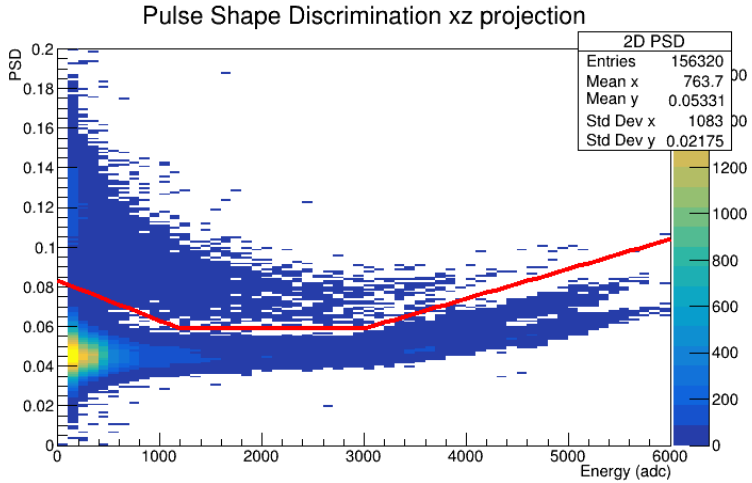
$$x = \frac{f(a) - f(a-1) - slope}{b-a+1}$$

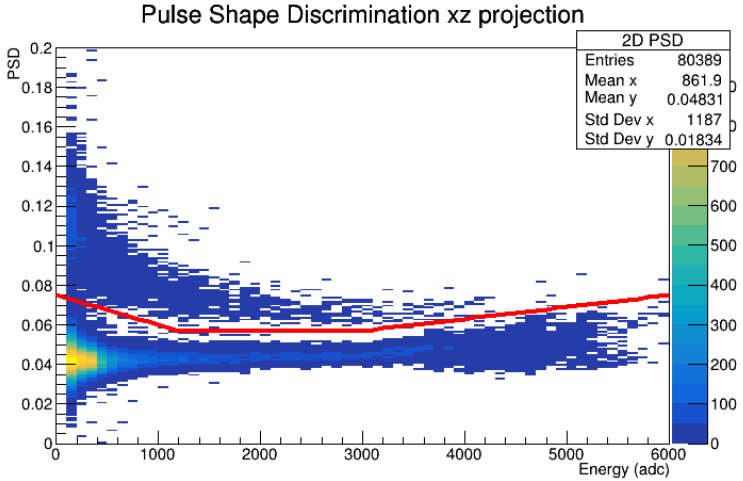
- Use for all points between a and b

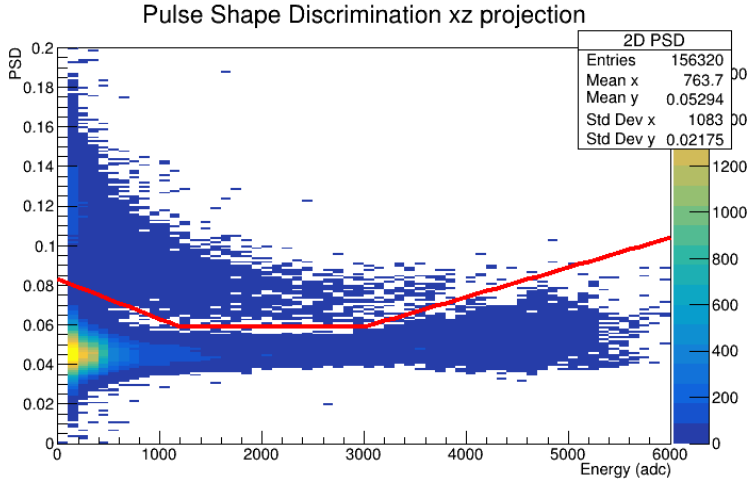


Corrected PSD plots (beam on)

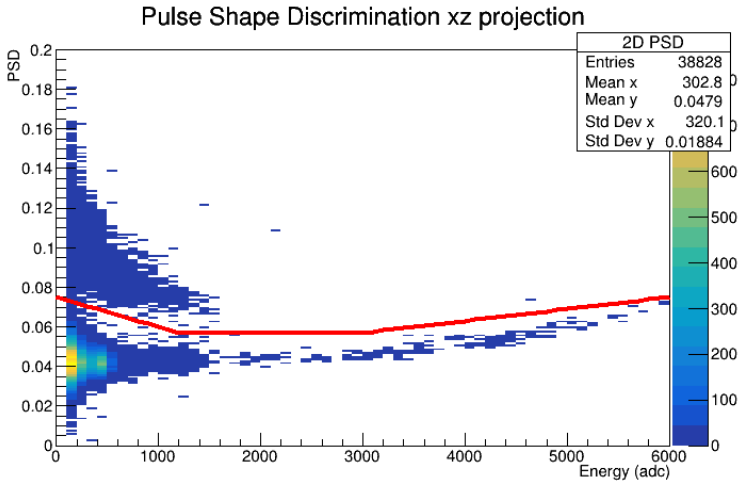


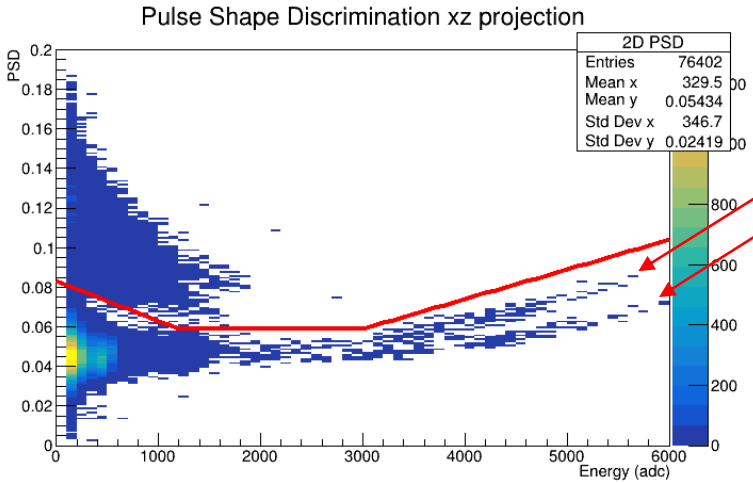




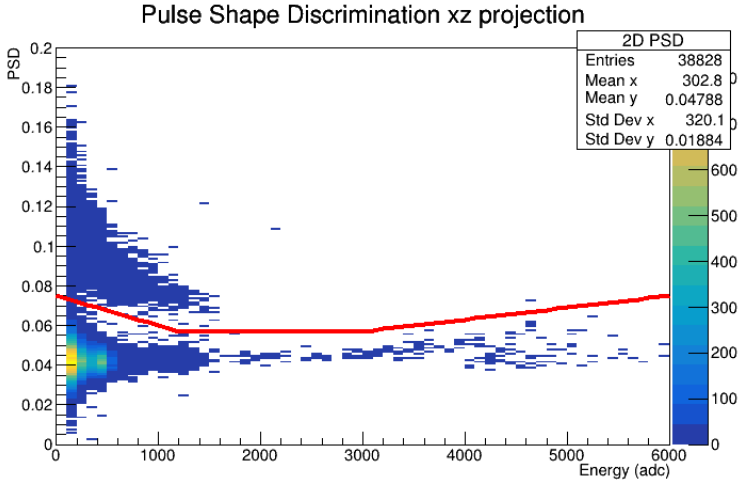


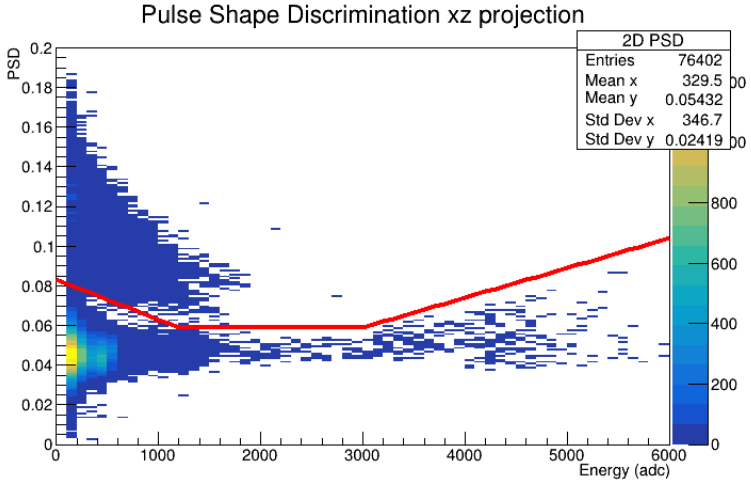
Corrected PSD plots (calibration)





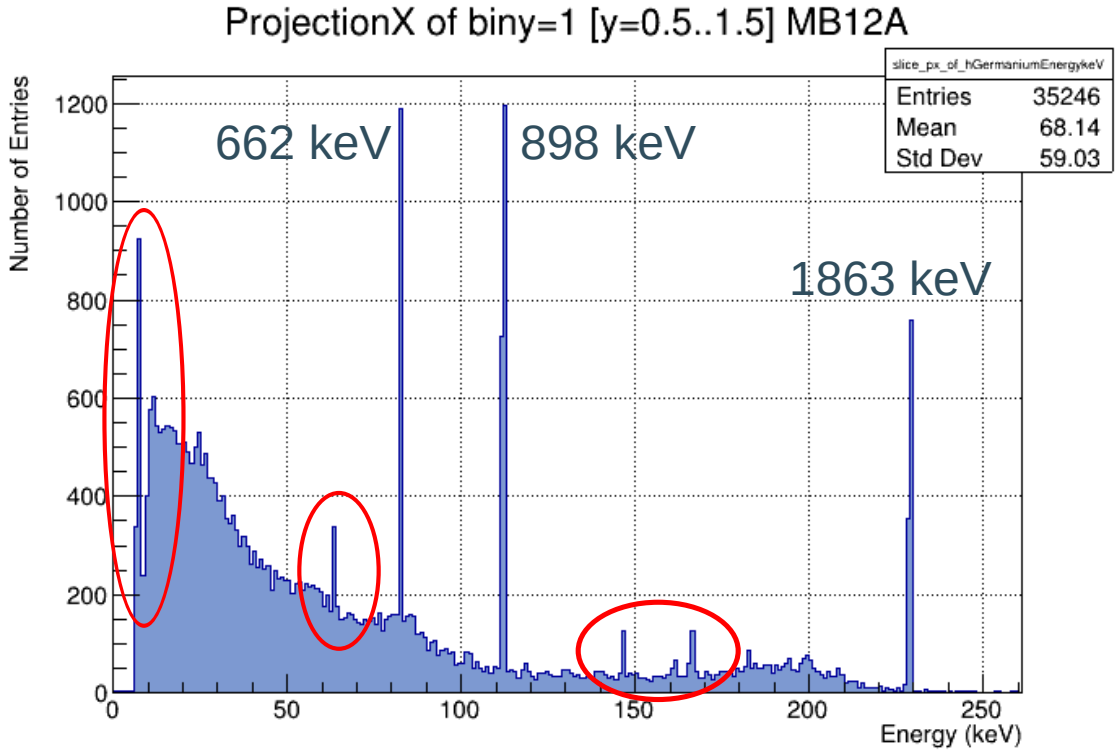
Overflow/pile-up?



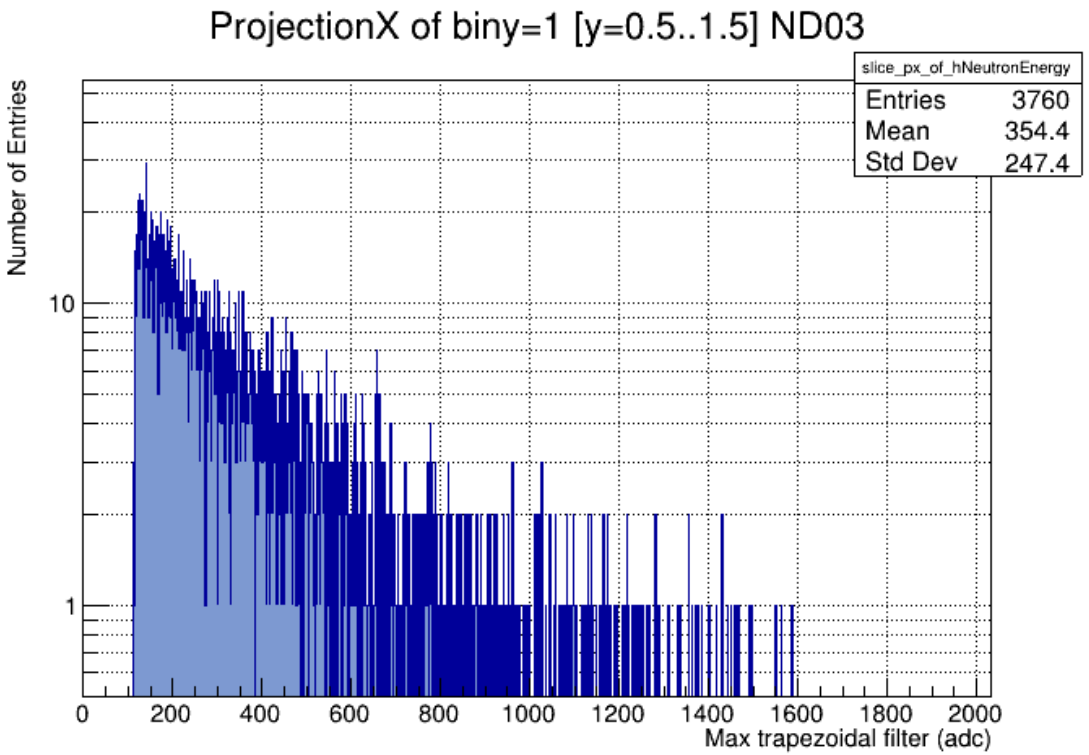


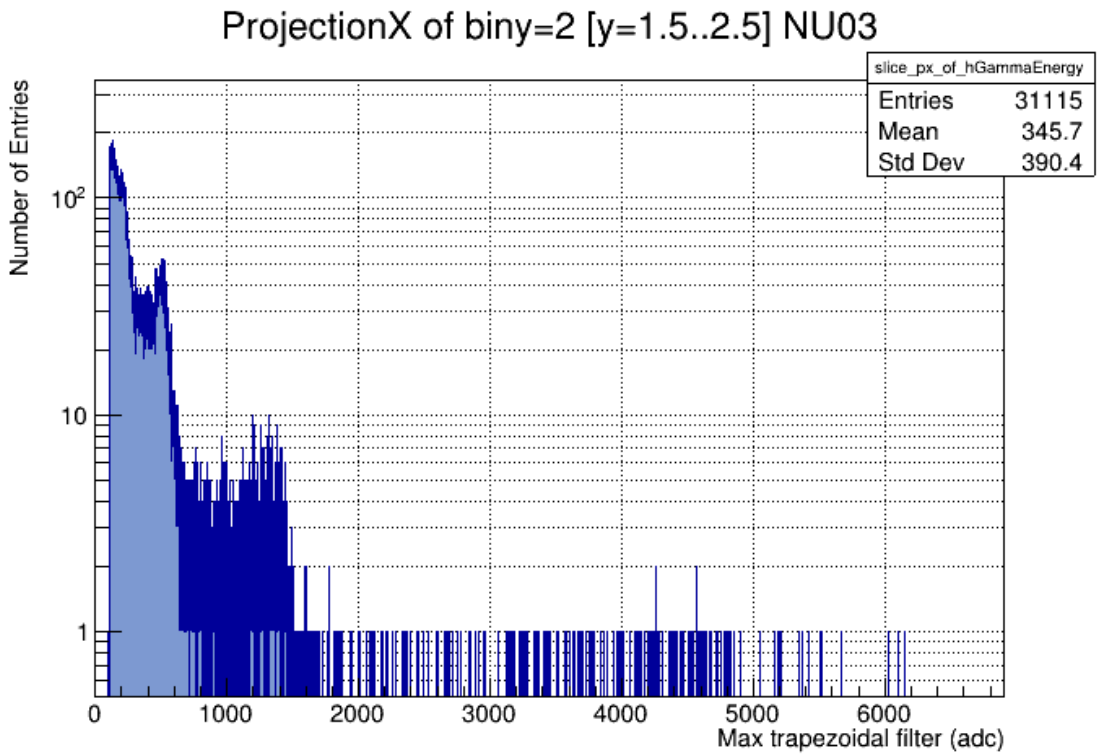
HPGe energy spectrum

- Calibrate neutron detectors with Compton continua
- Low Co-60 activity → not in spectra from neutron detectors
- Y-88
  - 1863 keV
  - 898 keV
- Cs-137
  - 662 keV



Energy spectra from neutron detector



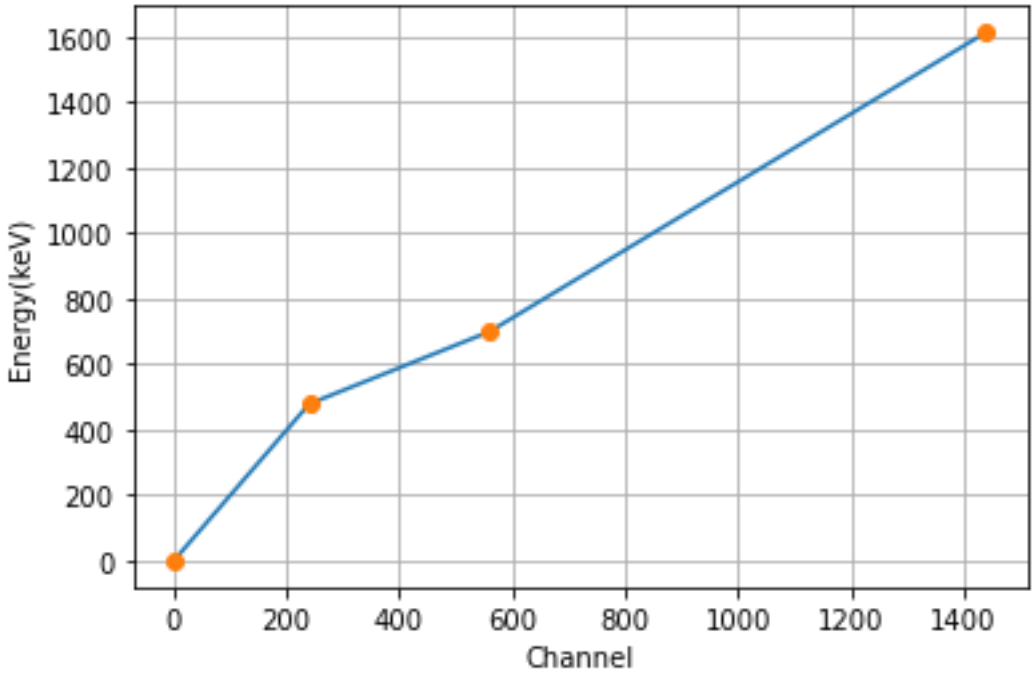


Calibrating the detector

- Compton edge:

$$\Delta E = E_0 - \frac{2E^2}{2E - m_e c^2}$$

- Y-88:
  - 1612 keV
  - 699 keV
- Cs-137:
  - 478 keV



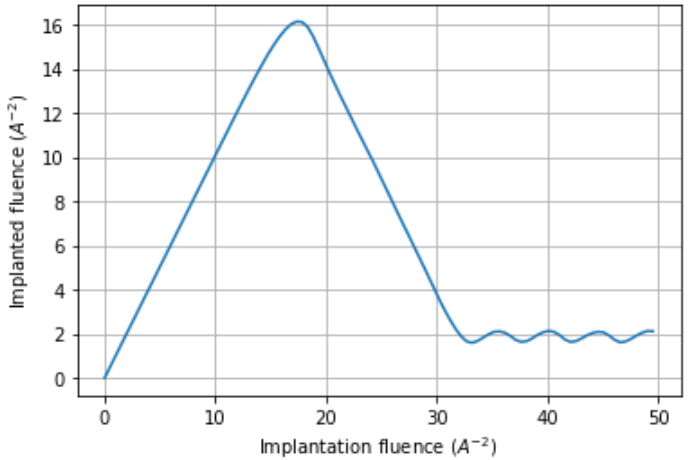
- Only done with estimated edges!

What’s next

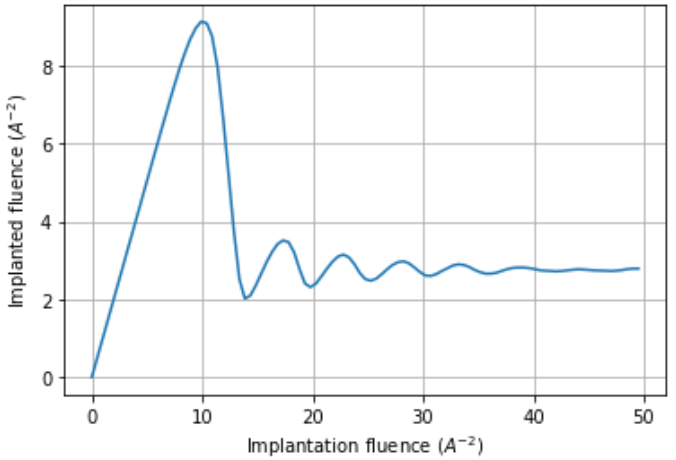
- Clean up code
- Get calibration settings (and put in config file)
- Make LikelyNeutron flag
- Geant4 simulation

Some TRIDYN results - ^{197}Au

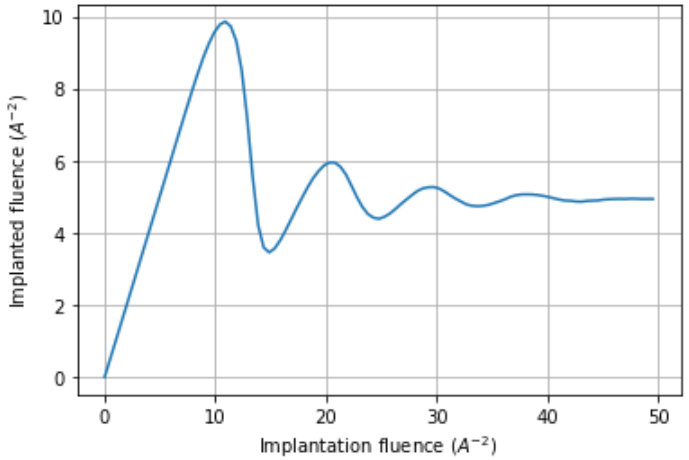
0.9 keV



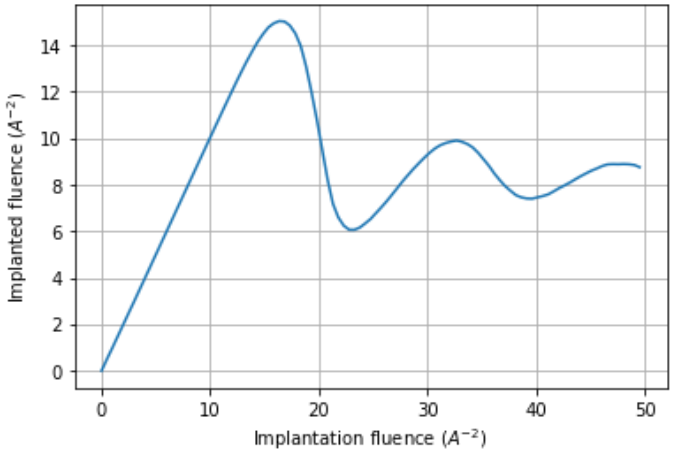
4.5 keV



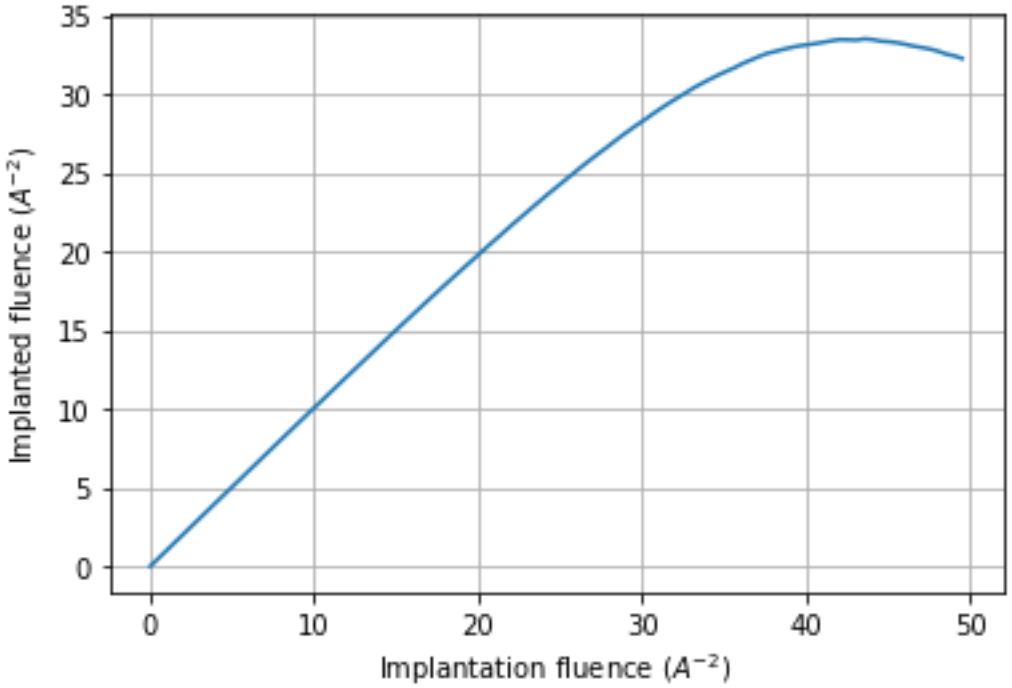
27 keV

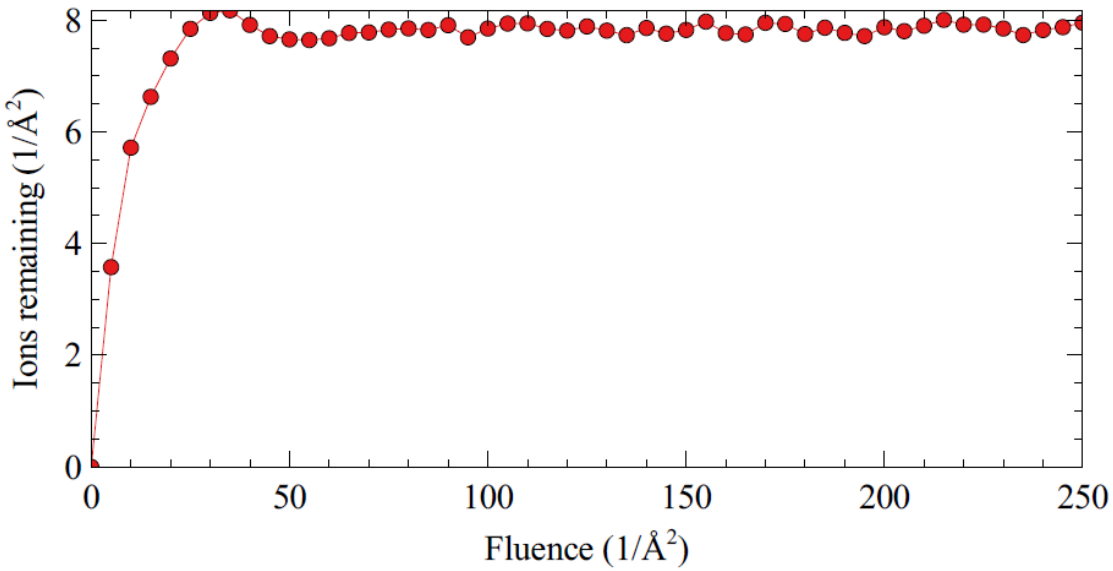


90 keV

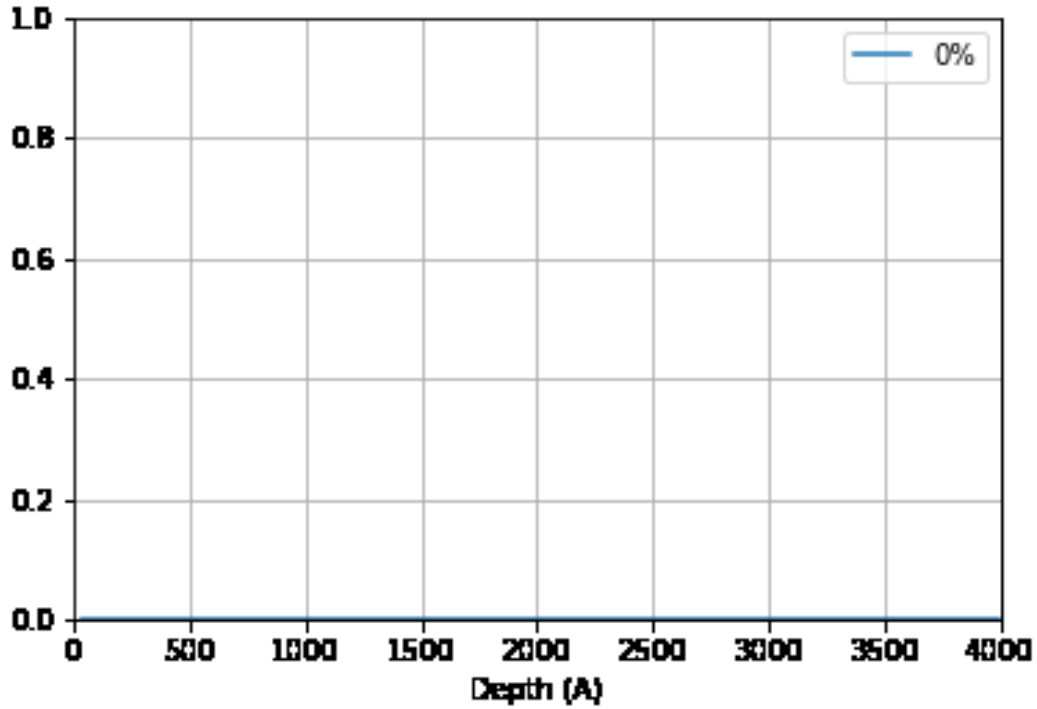


Some TRIDYN results – ^{39}K





TRIDYN ^{39}K depth profile



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