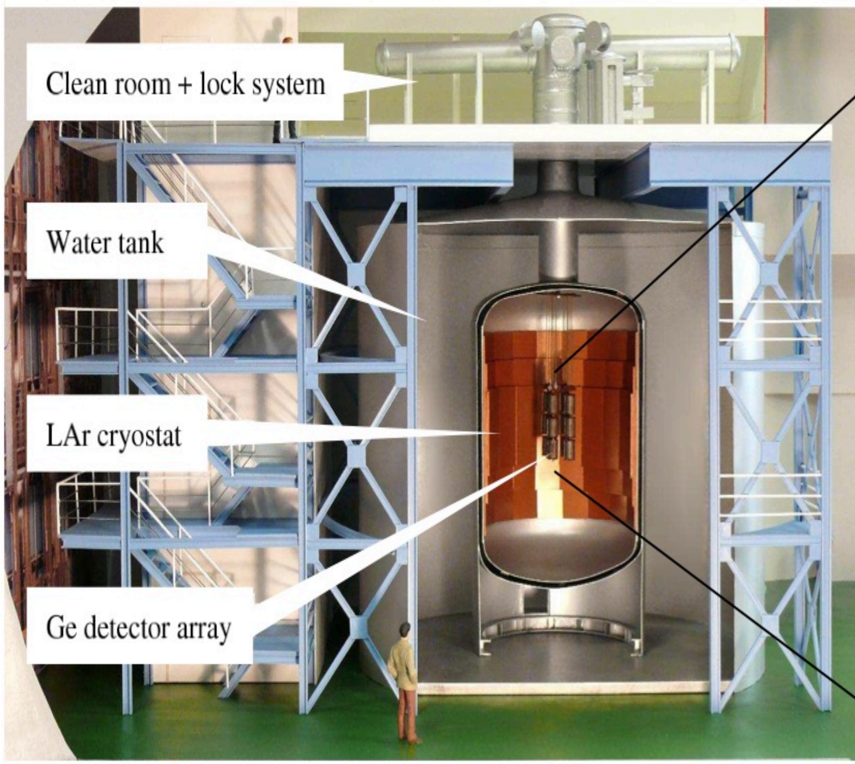
GERDA/LArGe

Detector calibration using ^{228}Th

By Dana Byram
With much assistance from Carla Macolino - GERDA
October 3, 2014

GERDA
designed for the detection of 0νββ



- Enriched ^{76}Ge crystal based detector array
- Contained inside a copper-lined steel cryostat
- Filled with LAr for cooling/shielding
- Surrounded by a copper shroud
- First phase data taking completed in 2013
- Preparing for Phase 2!

LArGe

- Being used to prepare for GERDA phase 2 (designed for the detection of $0\nu\beta\beta$)
- Similar to GERDA
  - 1 Natural BeGe detector
  - Steel cryostat w/1m^3 of LAr
  - Pb and Cu shielding instead of water
  - 9 PMT's in the LAr Cryostat to detect scintillation light - used for cooling the Ge and anti-coincidence veto.

LArGe detector on Oct. 1, 2014

Primary Goal: To calibrate the LArGe detector's energy spectrum vs fADC channel response using ^{228}Th source

<u>Calibration objectives</u>

- To characterize the detector's resolution at the ROI for 0νββ (2039 keV)
- To examine the detector resolution at all energies
- To ease peak identification by lining up the fADC channel with the peak energy.

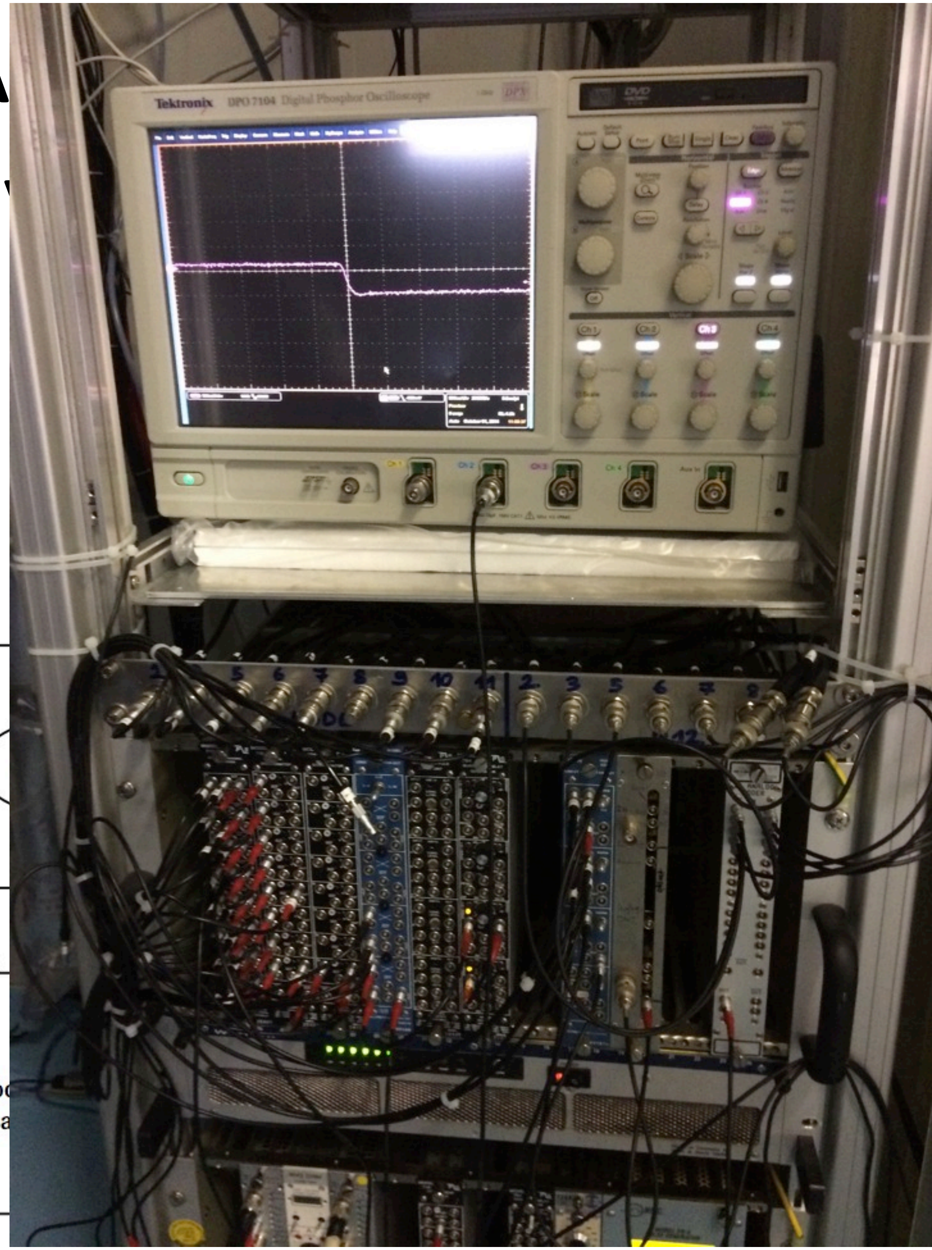
Source tube on the LArGe Detector

GELA… data anal… tors

…the Ge and LAr

…standardized

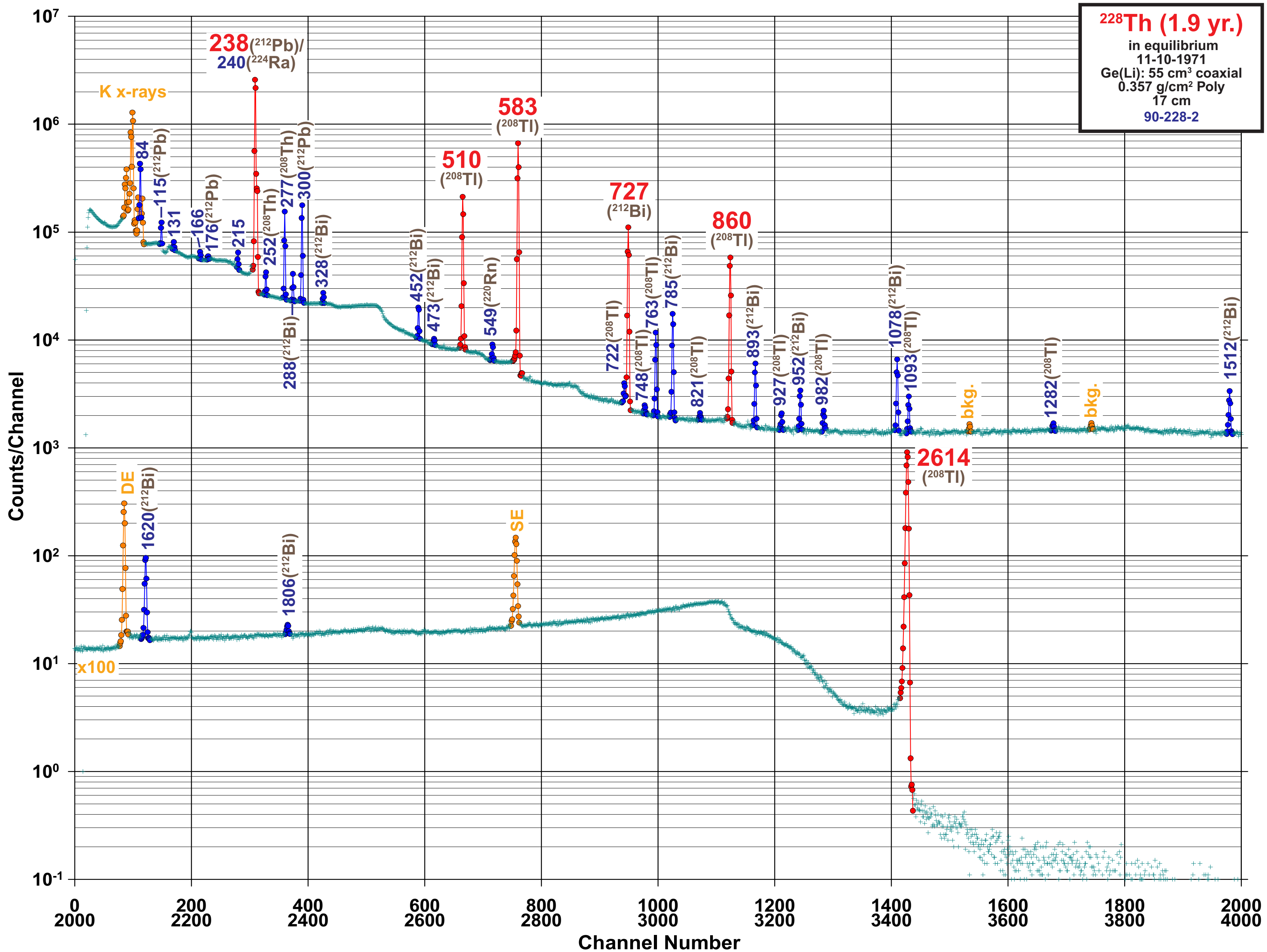
…ation results,
…gy spectrum
…results, e.g.,
…trum
…s, e.g., cuts



HPGe data

Ro…
sa…

Tier4
PSD, delayed coincidence, veto…



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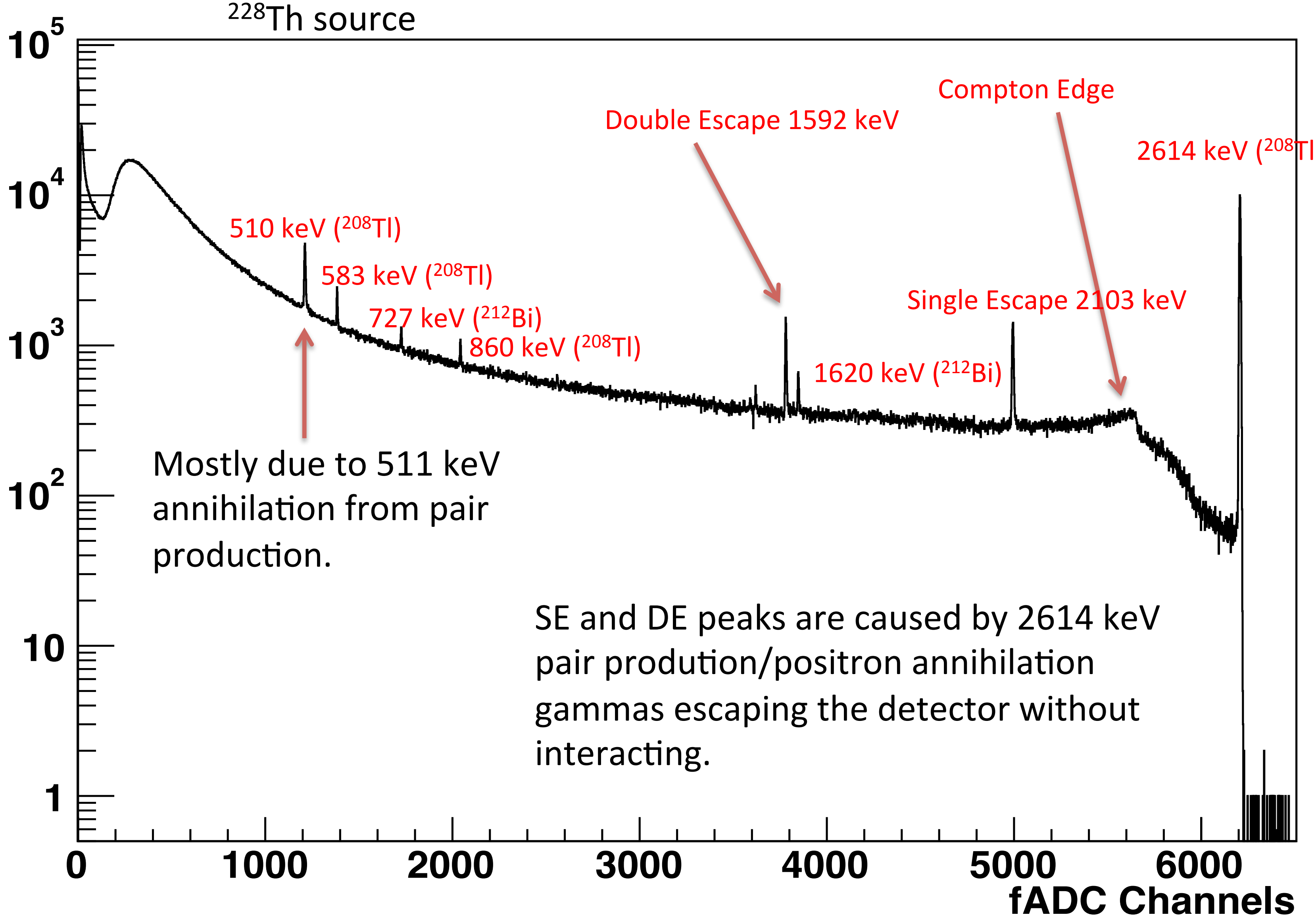
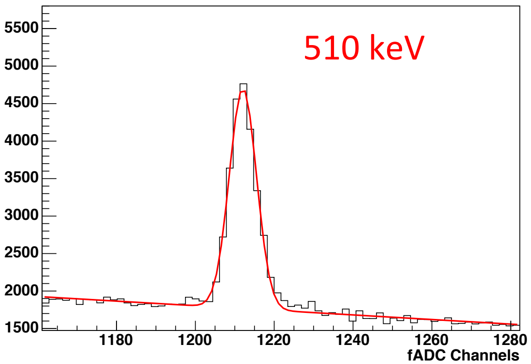
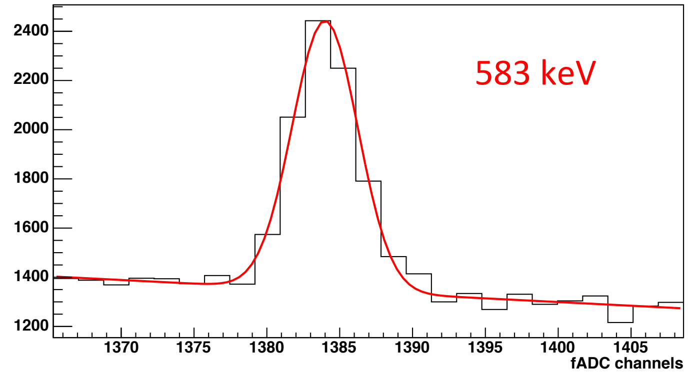
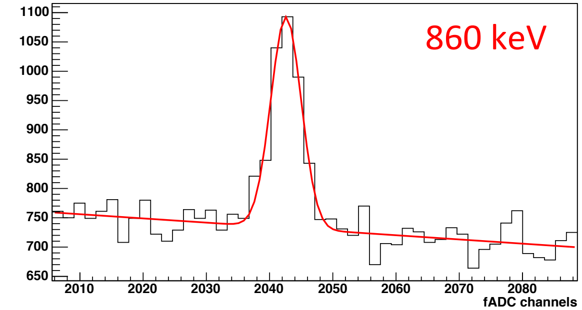
Smoothed uncalibrated energy spectrum obtained from ^{228}Th source

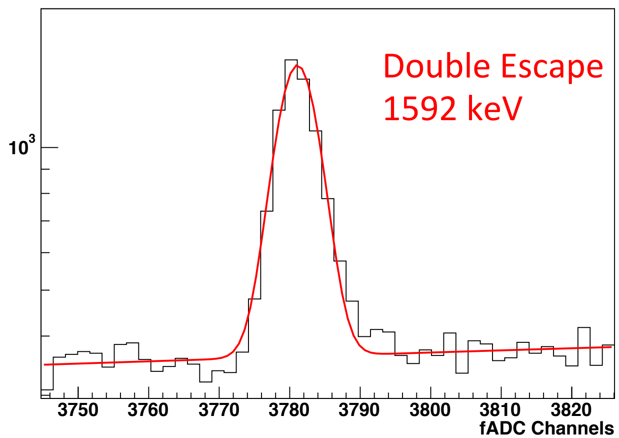


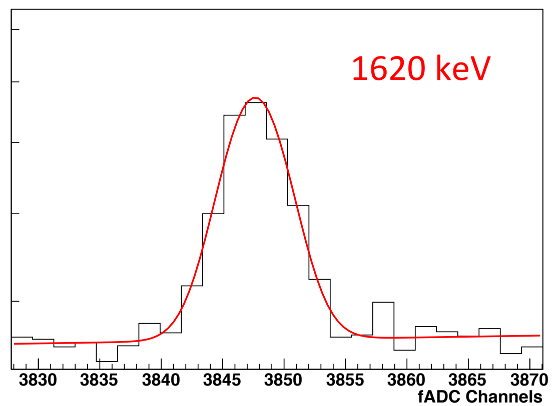
- Need to generate a function to shift the uncalibrated spectrum. Then, apply the function to all data points.
  - Perform a curve fit on gamma peaks using ROOT to find the mean channel value for the peak
  - Plot the mean channel values w.r.t. the nominal energy of the gamma peak given in literature
    - Perform a curve fit to generate a function we can use to translate the spectrum



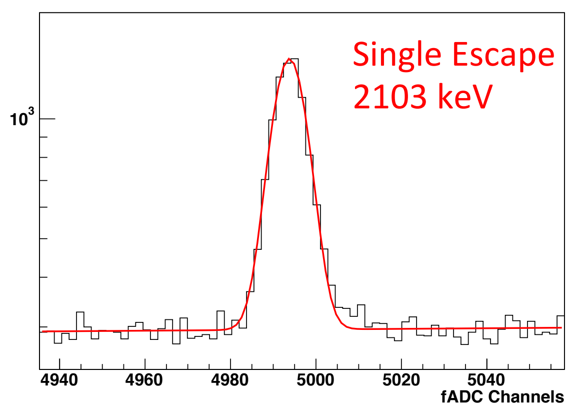


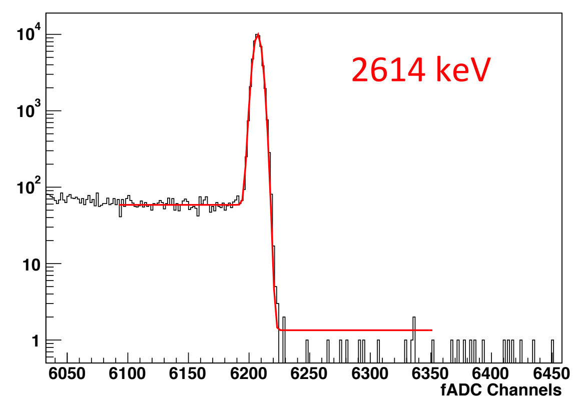




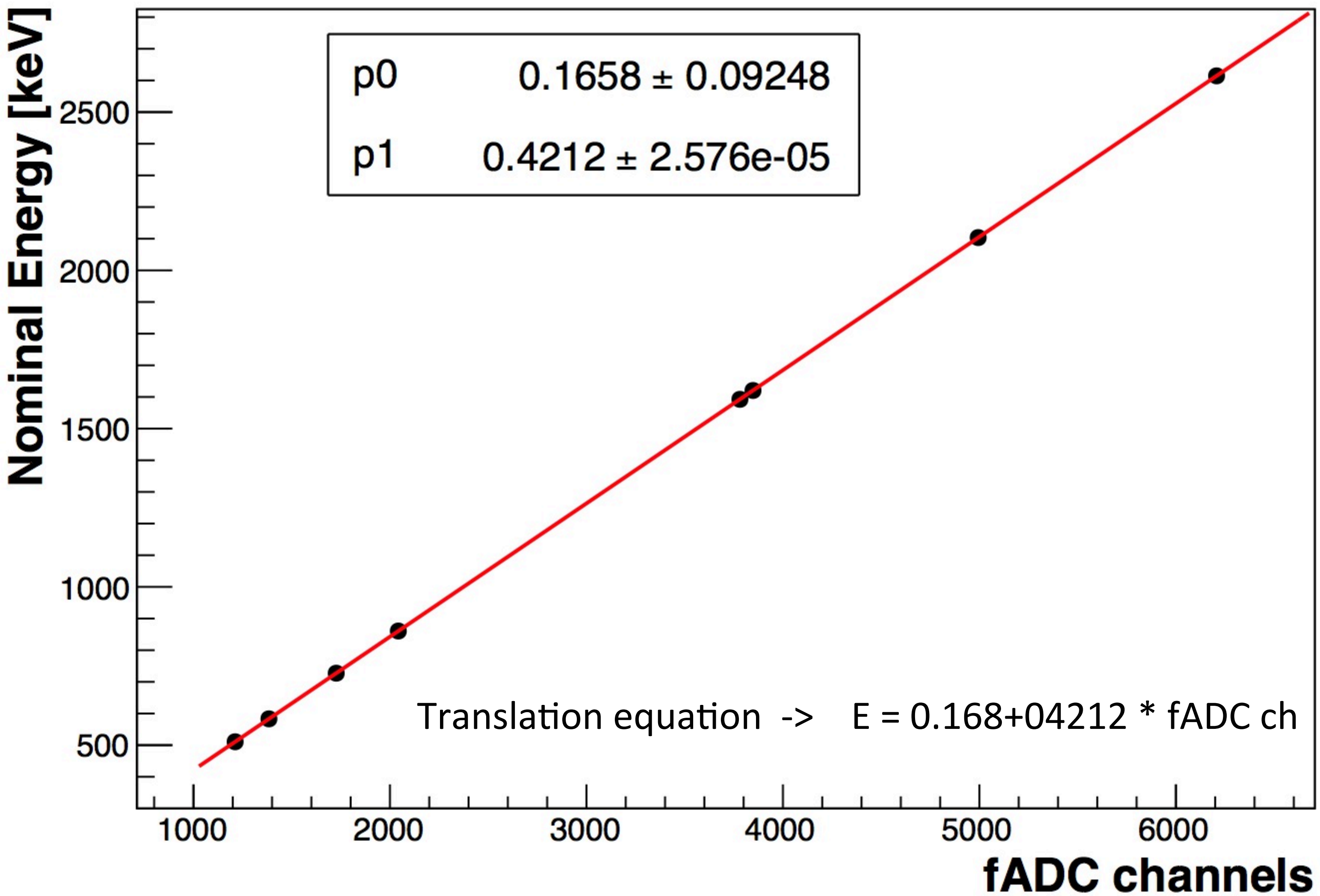


- Most peaks fitted with a gaussian+pol1
- 2614 peak required const +gauss+step function+tail
- Use peak fits to find:
  - mean channel value
  - FWHM (via σ)

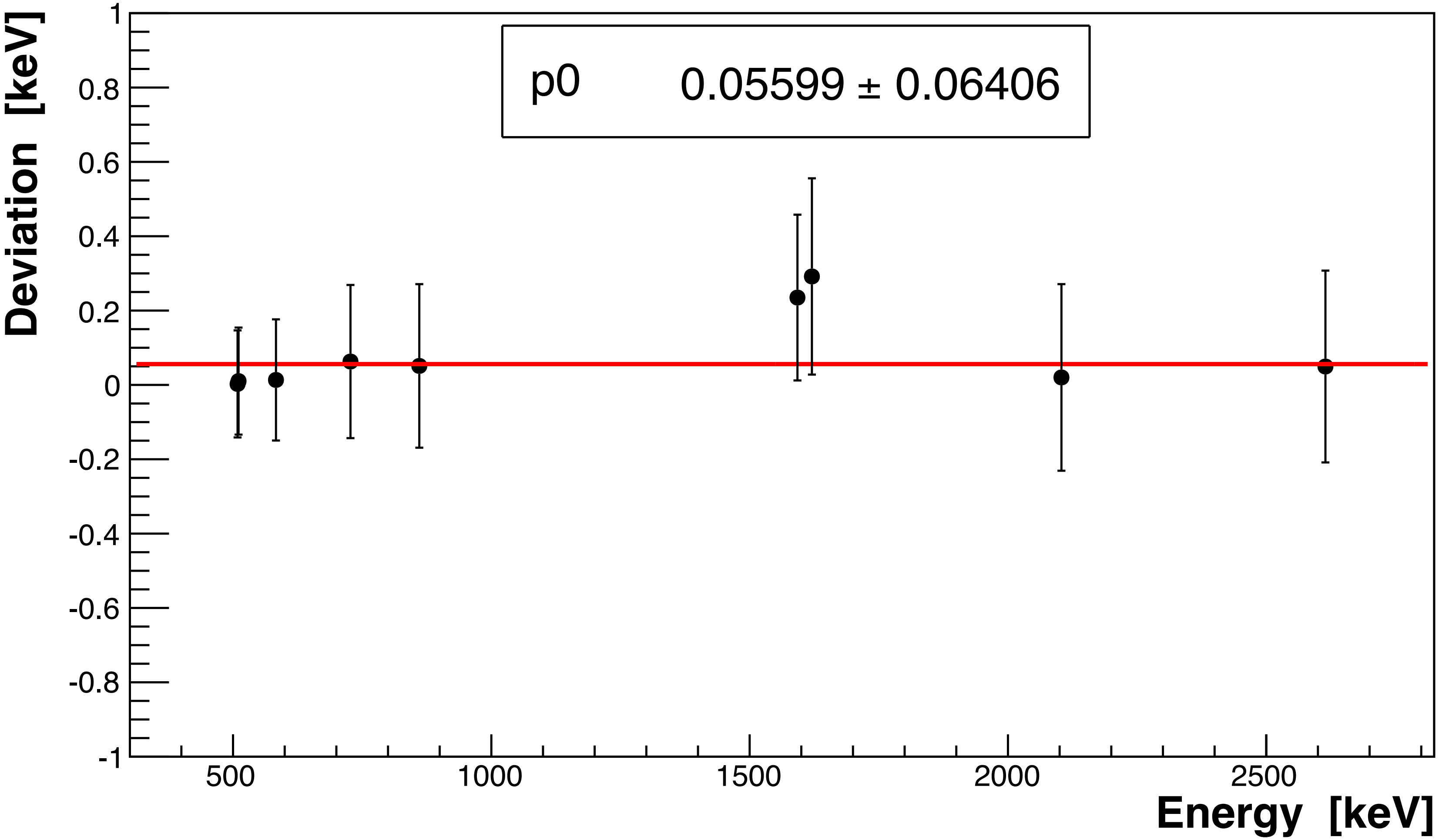




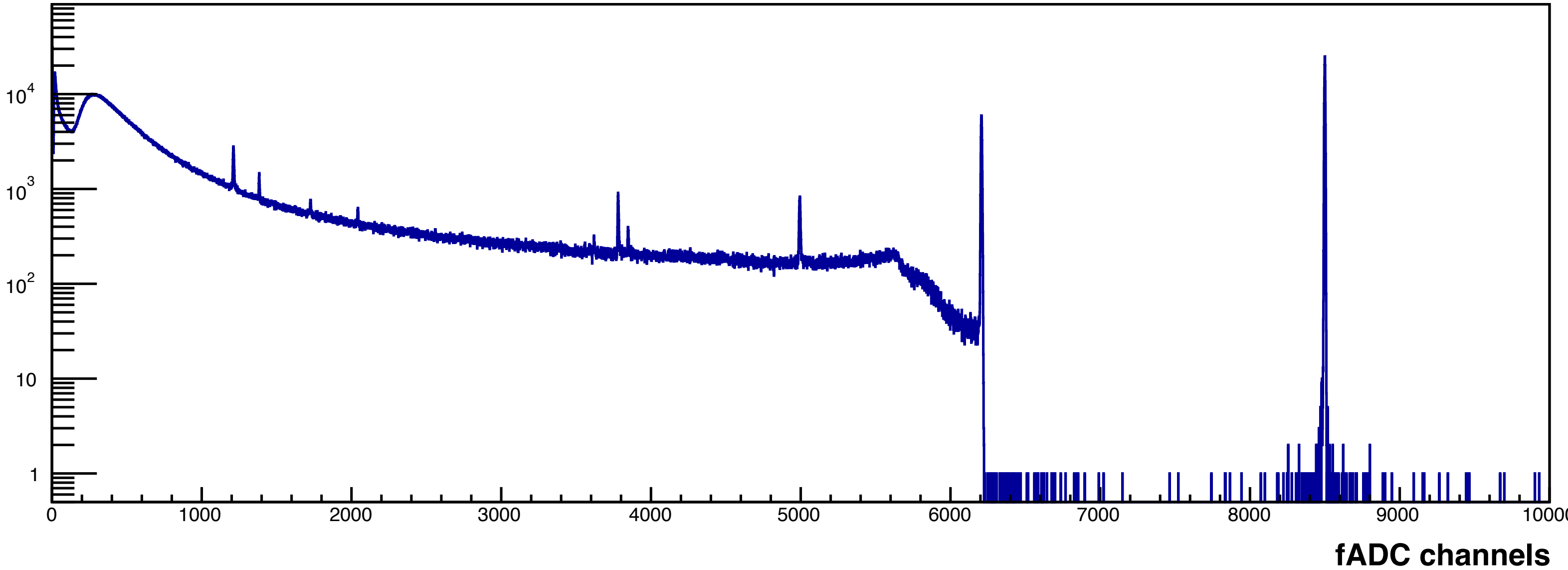
Linear fit of mean channel value vs nominal energy of the peak (from literature)



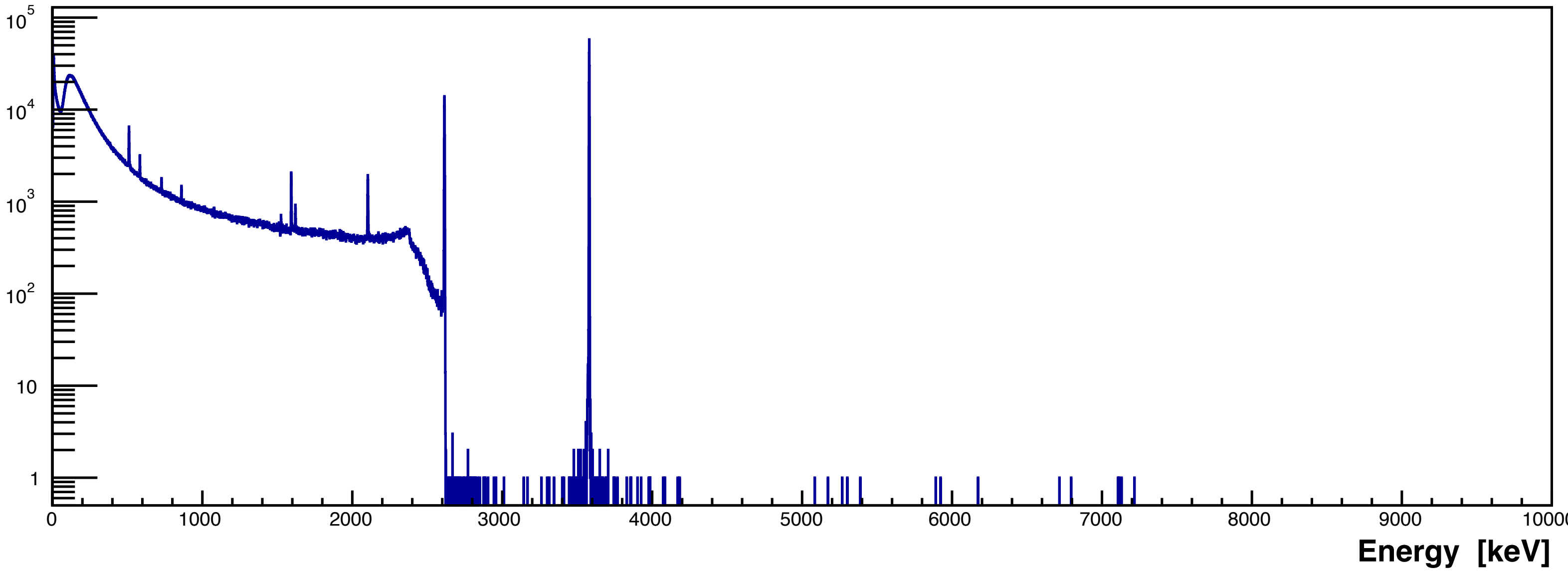
Deviation of mean channel number curve vs fit

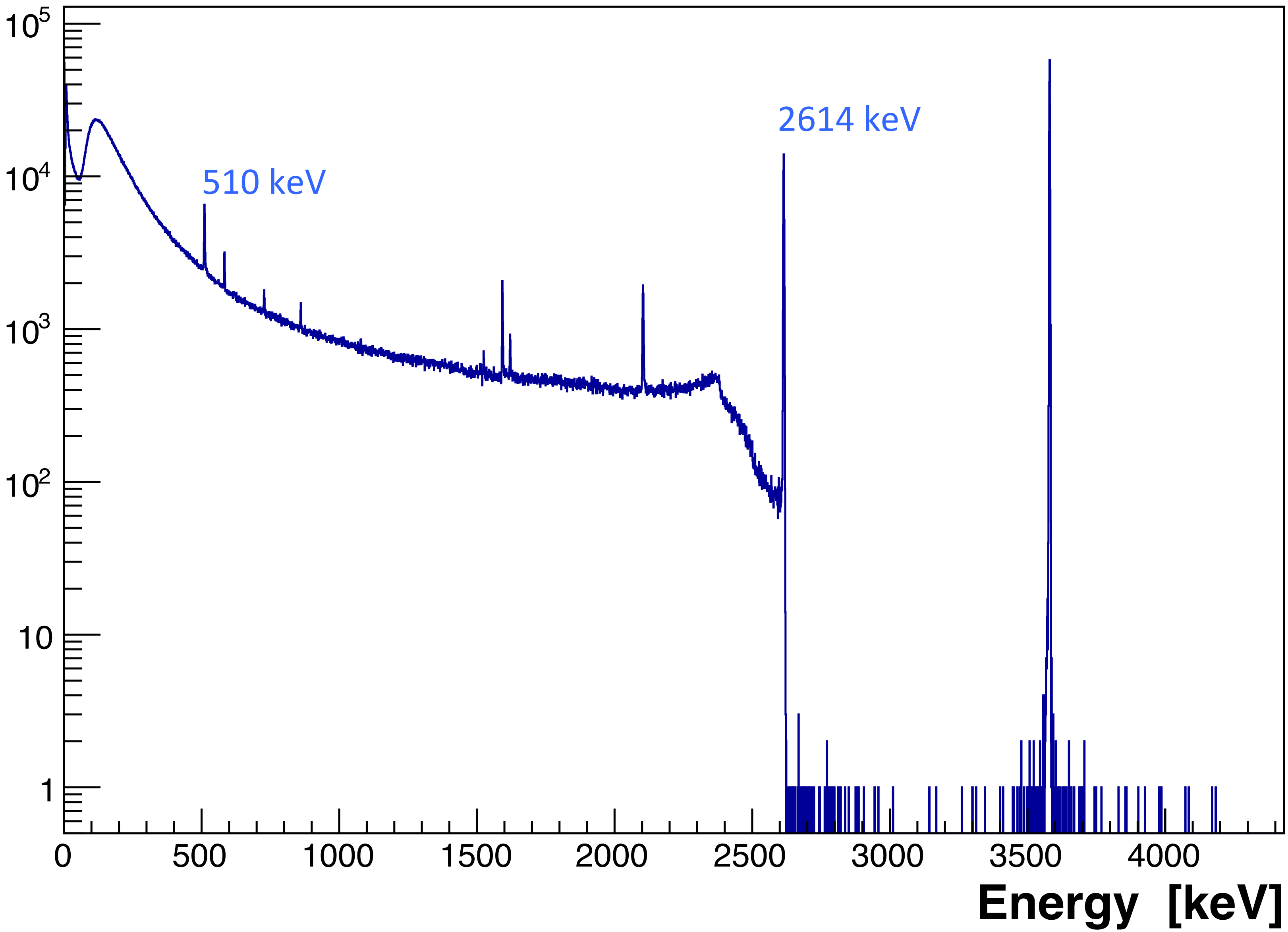


Uncalibrated Spectrum



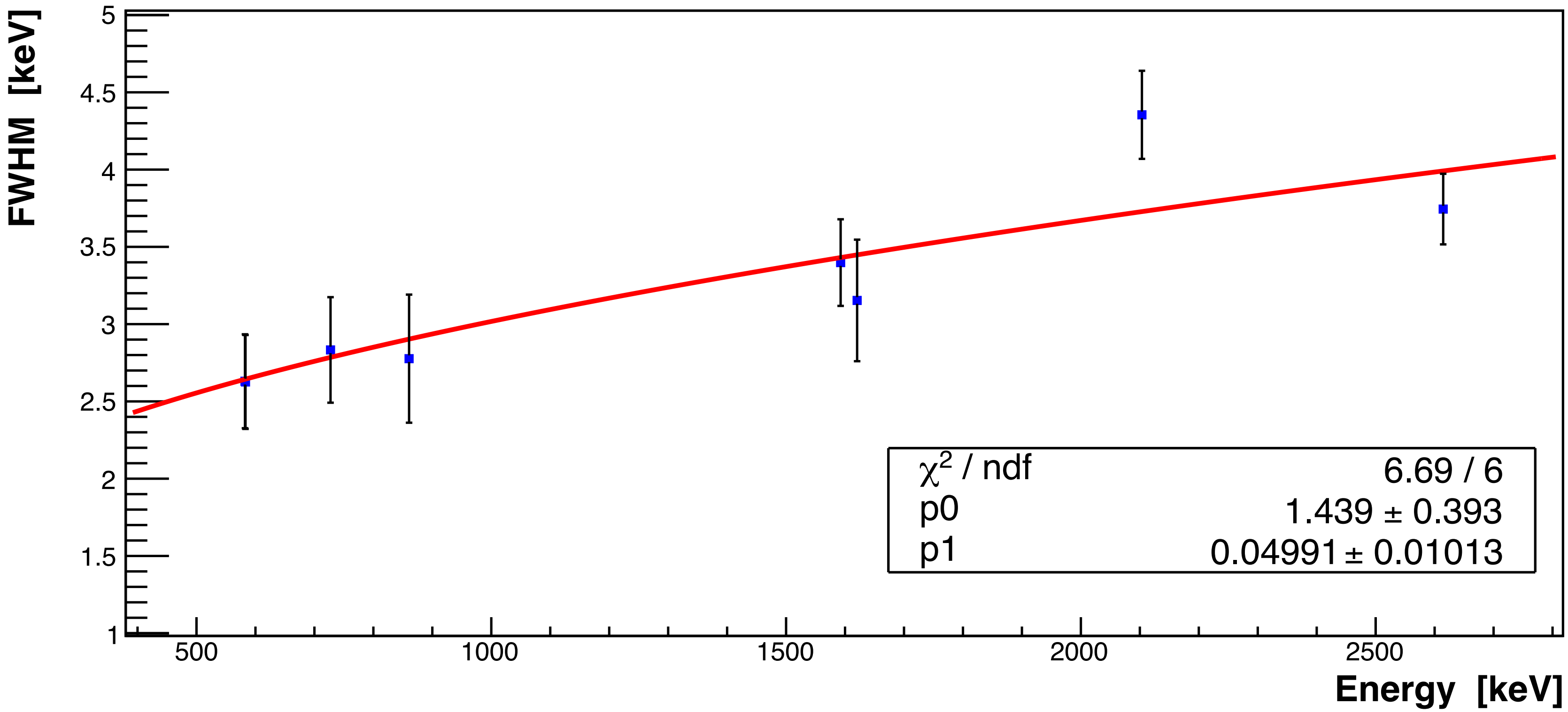
Calibrated Spectrum





2614 keV
510 keV
10^5
10^4
10^3
10^2
10
1
0
500
1000
1500
2000
2500
3000
3500
4000
Energy [keV]

Fit of FWHM points (using p0+p1*sqrt(E))



- Using these parameters and the relation FWHM = 2.355σ, we can calculate the resolution we could expect at any energy level.

THANKS!

- Thank you to the Gran Sasso Summer Institute Organizers!
  - Fausto and the LOC
- Thanks to my tutor Carla Macolino!

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