$^{68}Zn(n,\gamma)\,^{69}Zn$ Measurement: Status Update

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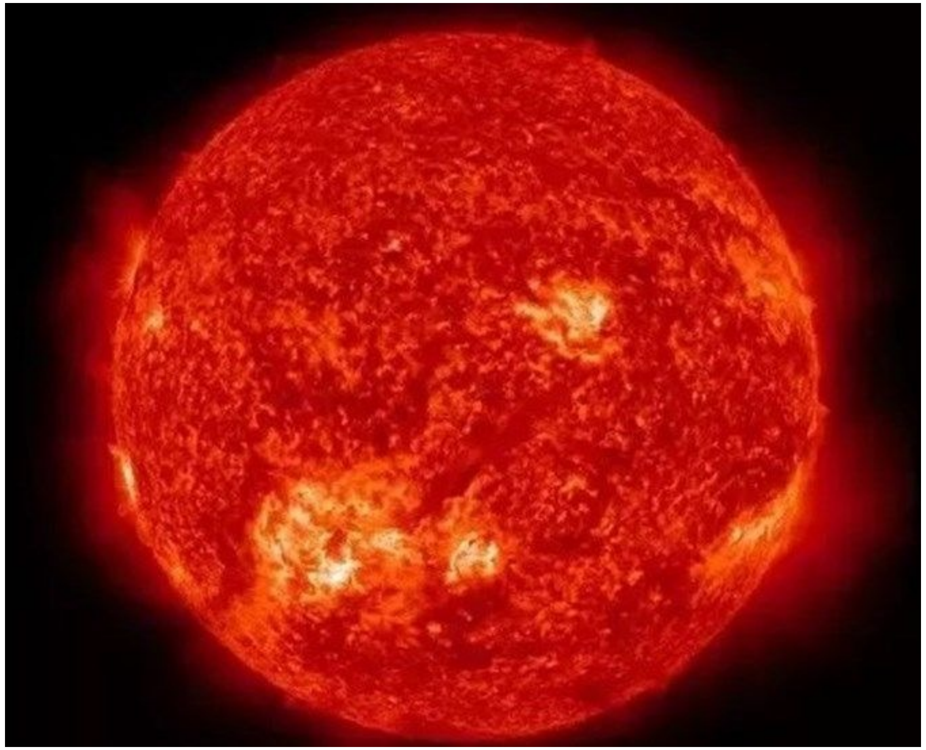
Motivation

- Nishimura *et al.* (MNRAS 469, 2017) performed a study of weak s-process uncertainties using simulations to investigate the most dominant uncertainty source on the final abundances of different isotopes.
  - ➢ Study found that existing data for ^{68}Zn(n,γ) reaction showed the uncertainties have the most impact on abundance estimates for ^{68}Zn and ^{78}Se.



Stewart, Suzy. "Red Giant Star: Journey to the Late Stages of Stellar Life". *The Planets*. Accessed on November 14, 2023. https://theplanets.org/types-of-stars/red-giant-star/.

- By investigating the ^{68}Zn(n,γ) ^{69}Zn reaction, we can:
  - ➢ Add to the scarce experimental data (improving uncertainties)
  - ➢ Get an improved understanding of the origins of ^{68}Zn.

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nTOF CERN erc European Research Council UKRI Science and Technology Facilities Council

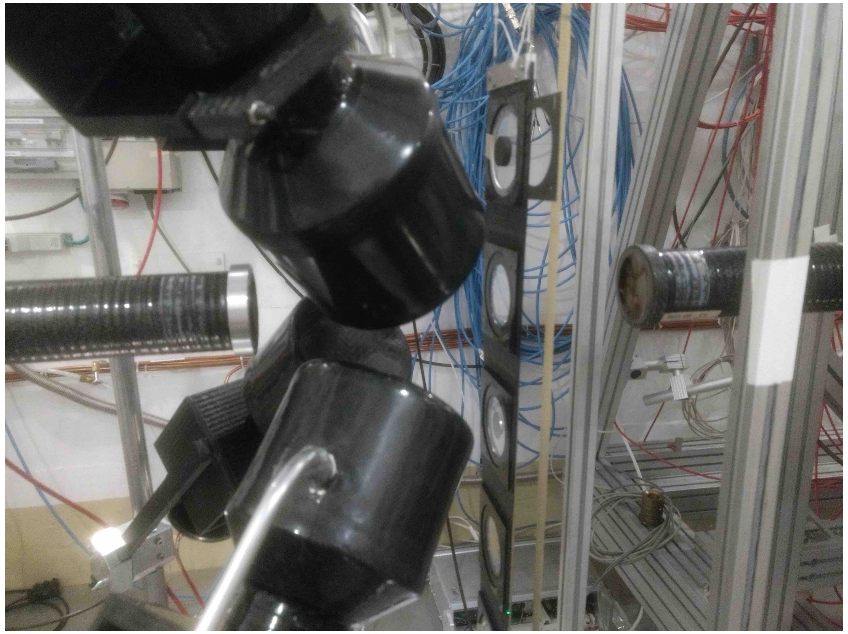
Experiment

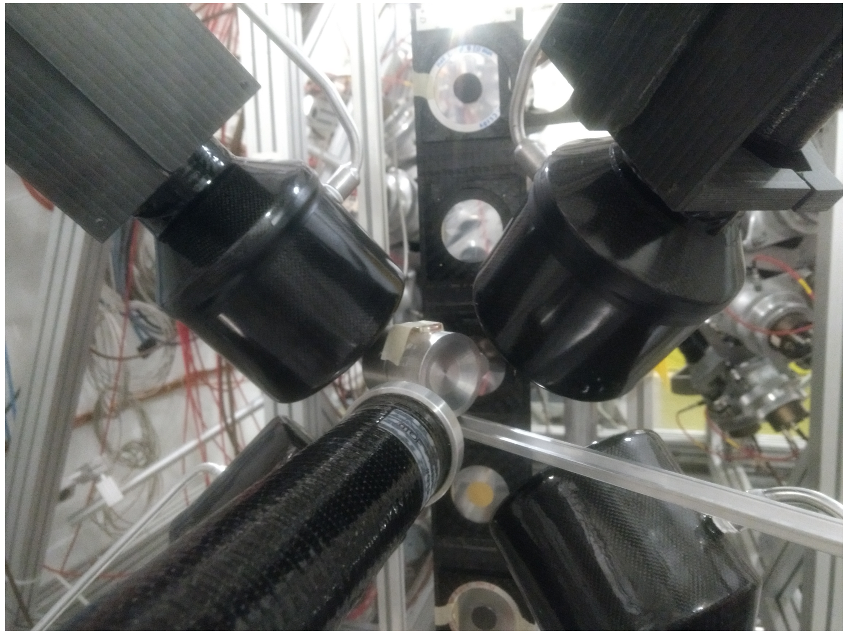
- Enriched Zinc sample produced by ISOFLEX USA.
  - Metal powder sample was pressed into cylindrical pellets at PSI.
  - Mass: 1.998/pm0.001 g
  - Diameter = 20.02mm
  - Thickness = 1.39 mm

^{68}Zn Target Composition

Isotope	Isotopic Composition (%)
^{64}Zn	0.01
^{66}Zn	0.10
^{67}Zn	0.61
^{68}Zn	99.26
^{70}Zn	0.02

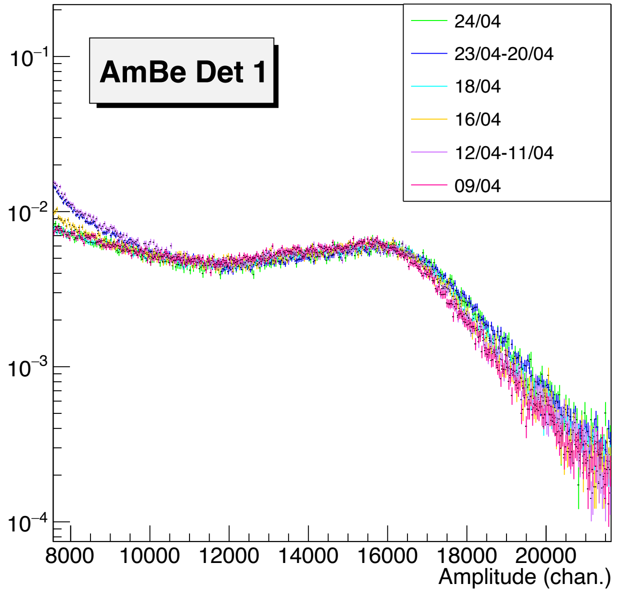
- 4 C6D6 detectors at EAR 1
- Sample runs taken:
  - Carbon
  - Gold
  - 68Zn
  - Zn + Filter
  - Empty
  - Empty + Filter

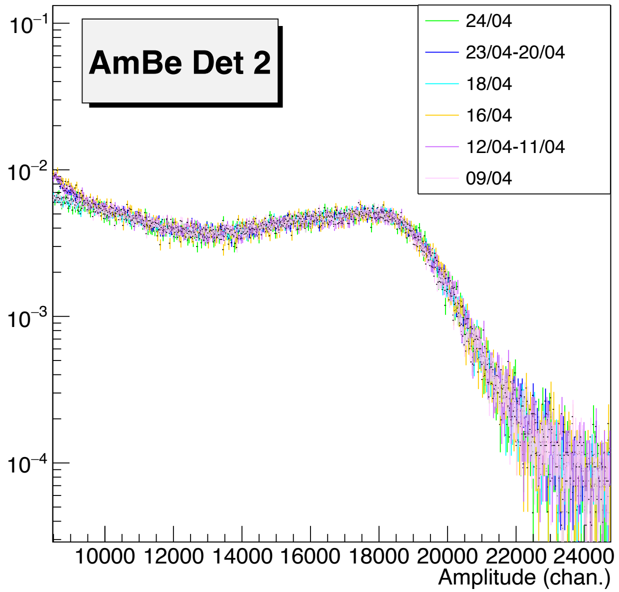


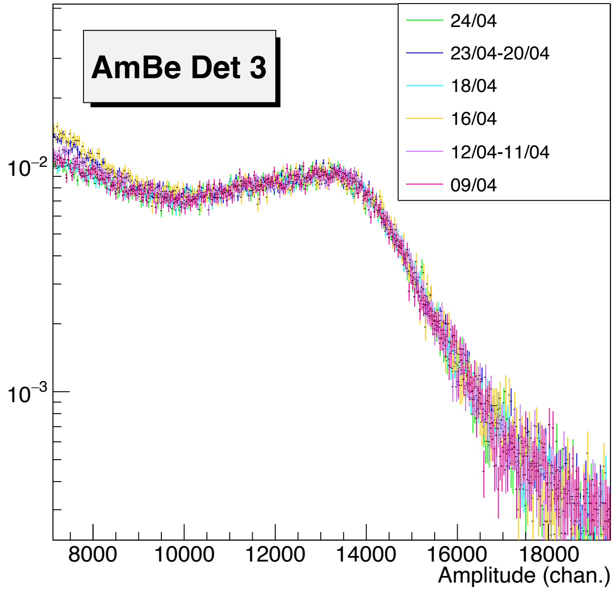


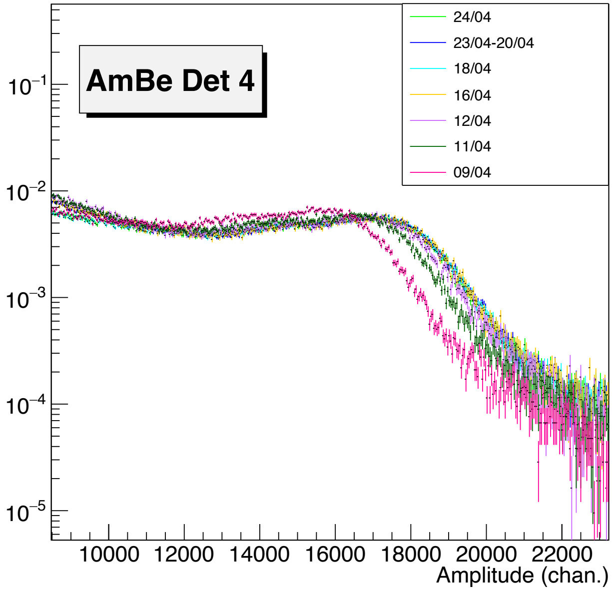
Calibration

- Four calibration sources used:
  - AmBe, 88Y, Cm-C, 137Cs
- Runs split into dates for easier analysis
- Detectors 1 & 4 were found to be unstable
  - Detector 4 is the most unstable
  - Detector 1 slightly more stable so all runs were salvageable
    - Requires three separate calibration functions due to fluctuations

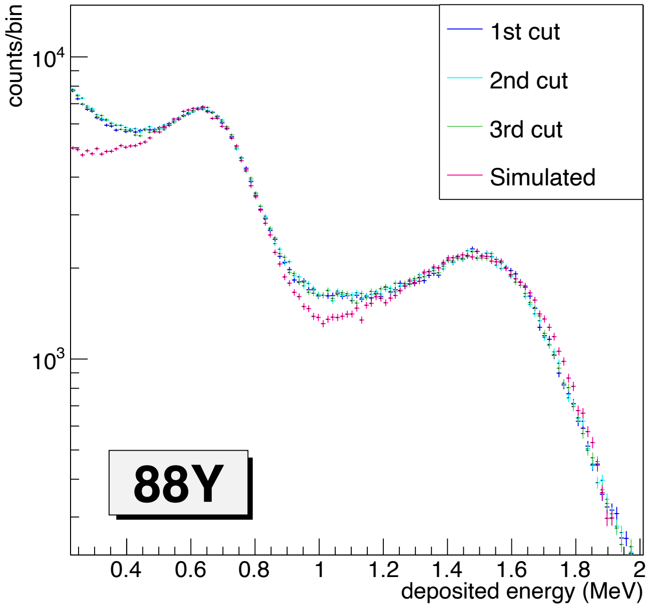


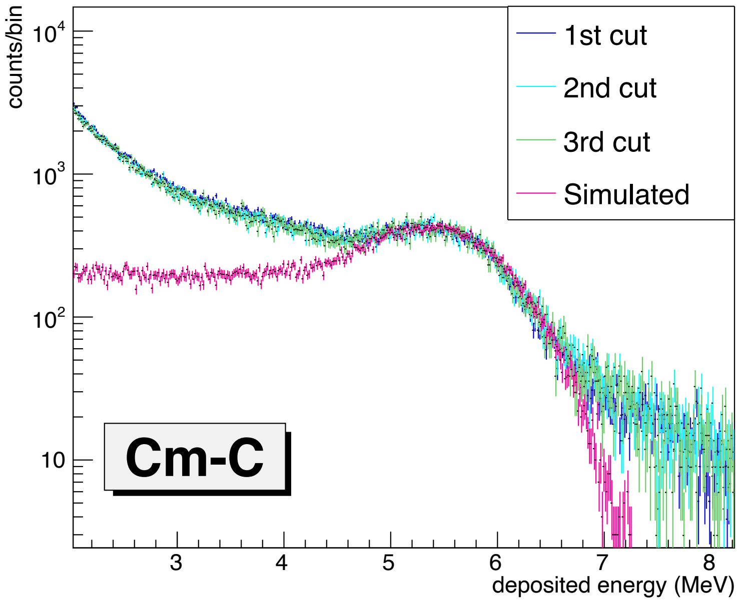




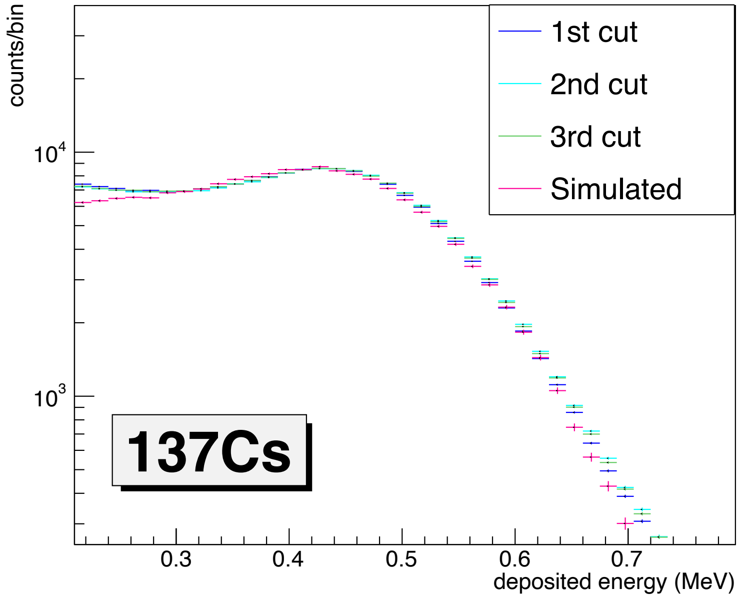


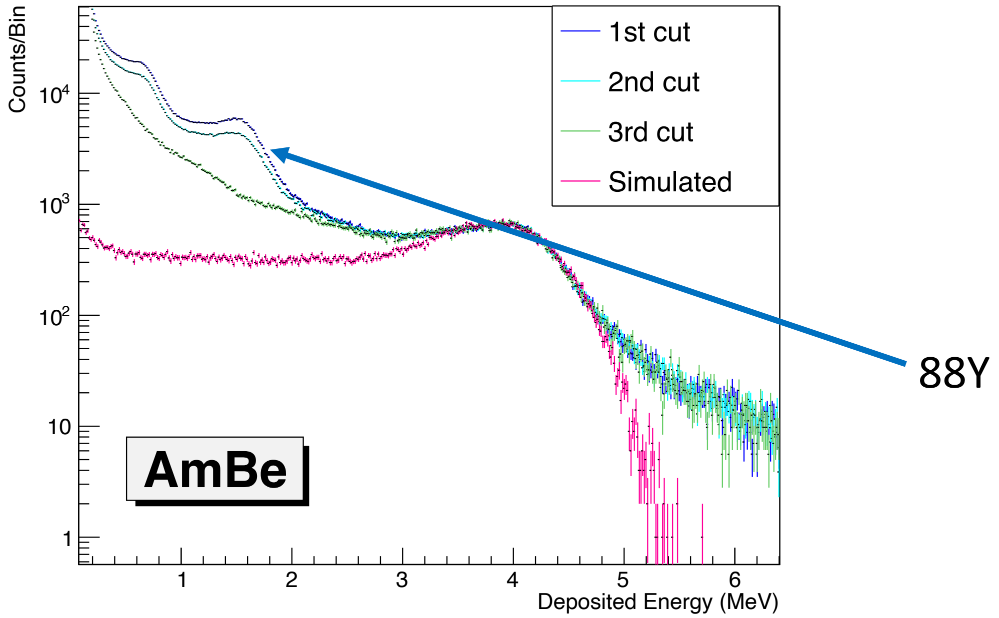
- C6D6 detectors response was simulated with GEANT 4 (thanks Nick!).
  - ➢ Fitted to produce linear calibrations
  - ➢ Compared with calibrated data
- Cuts matched up well for Detectors 2, 3 & 4





Plots for Detector 3





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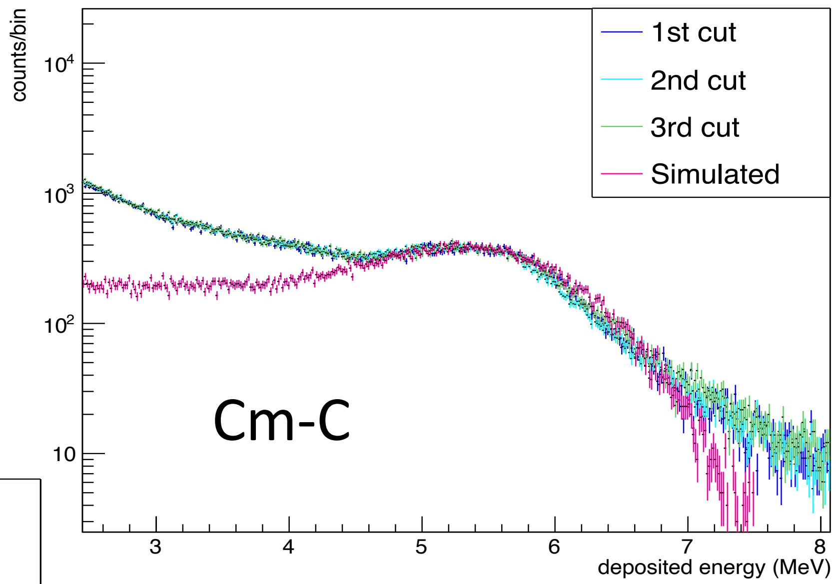
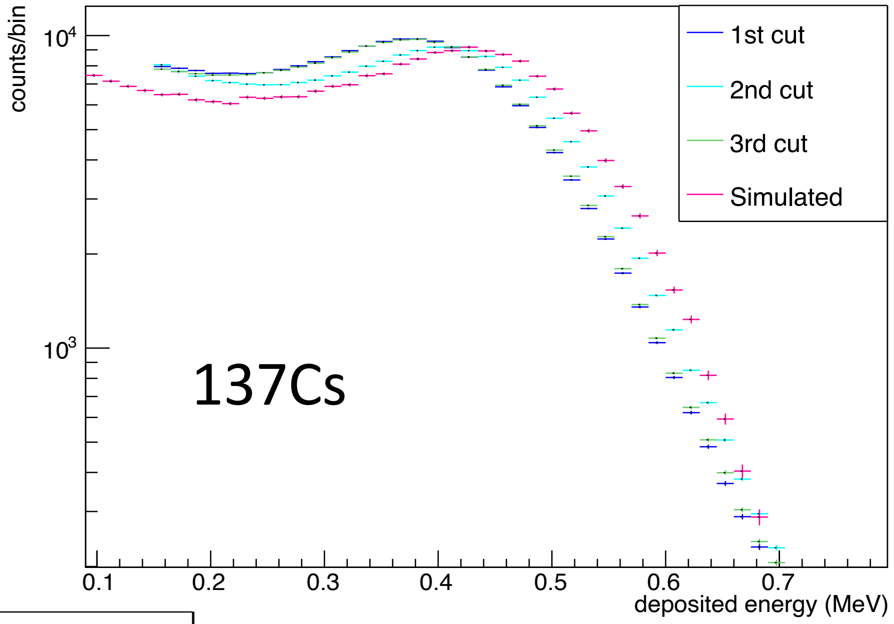
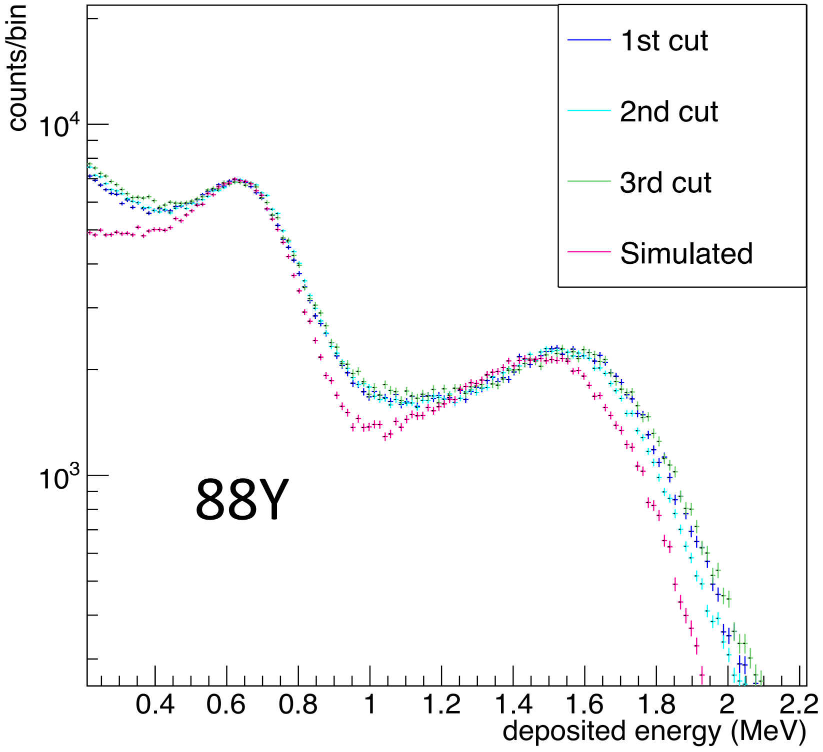
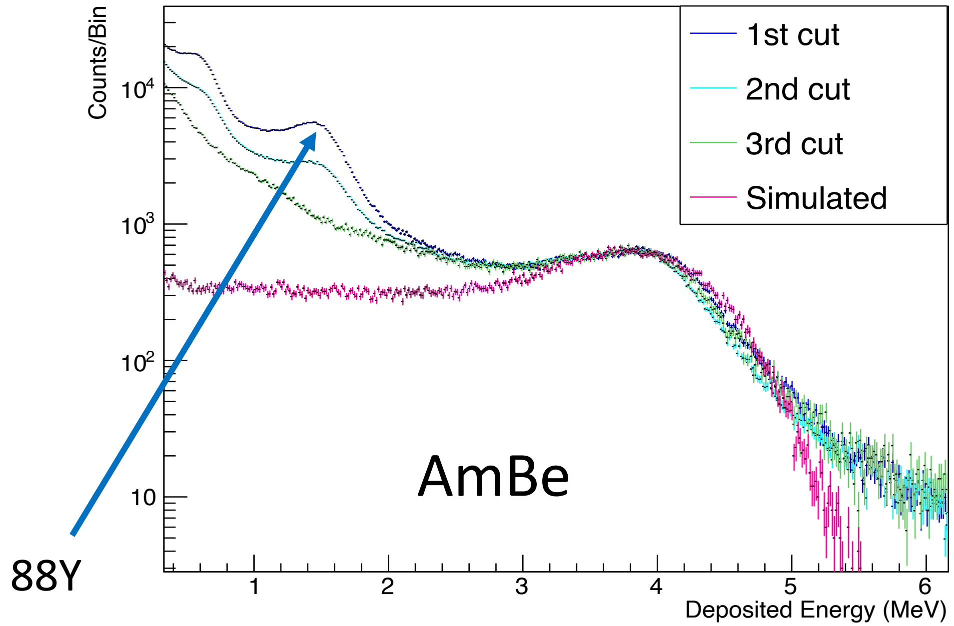
- Cuts didn't match up great for Detector 1
  - ➢ Analyse detectors separately





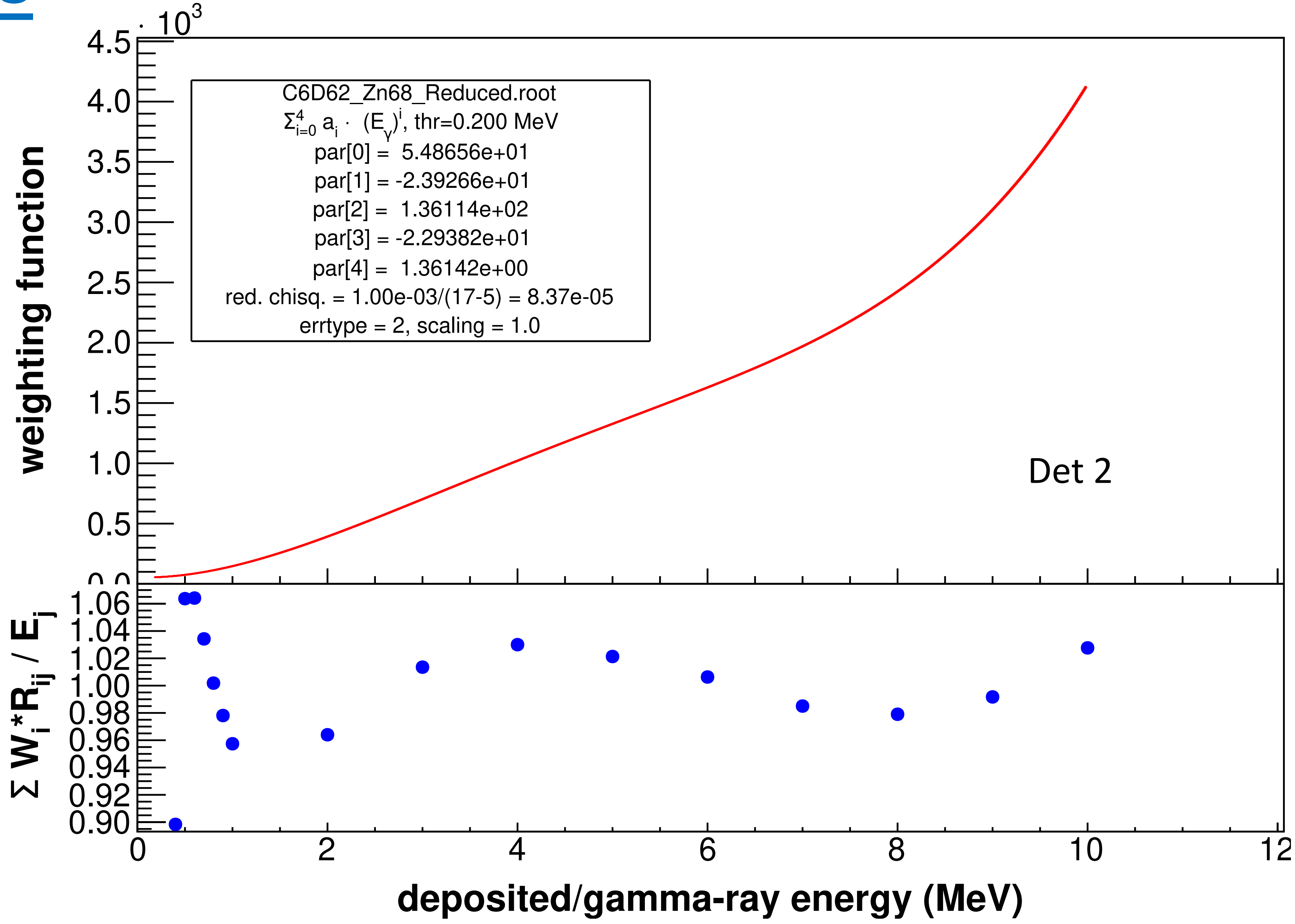




Plots for Detector 1

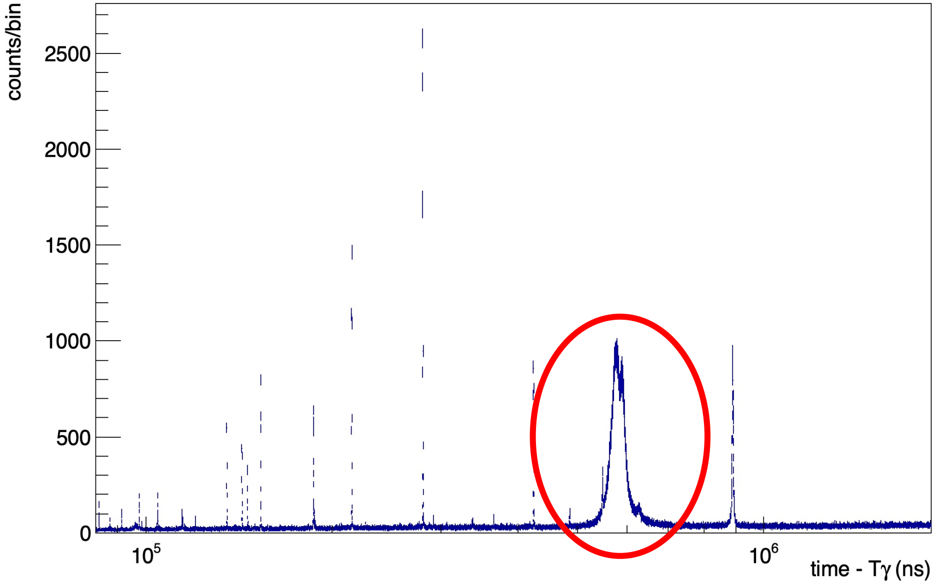
Weighting Functions

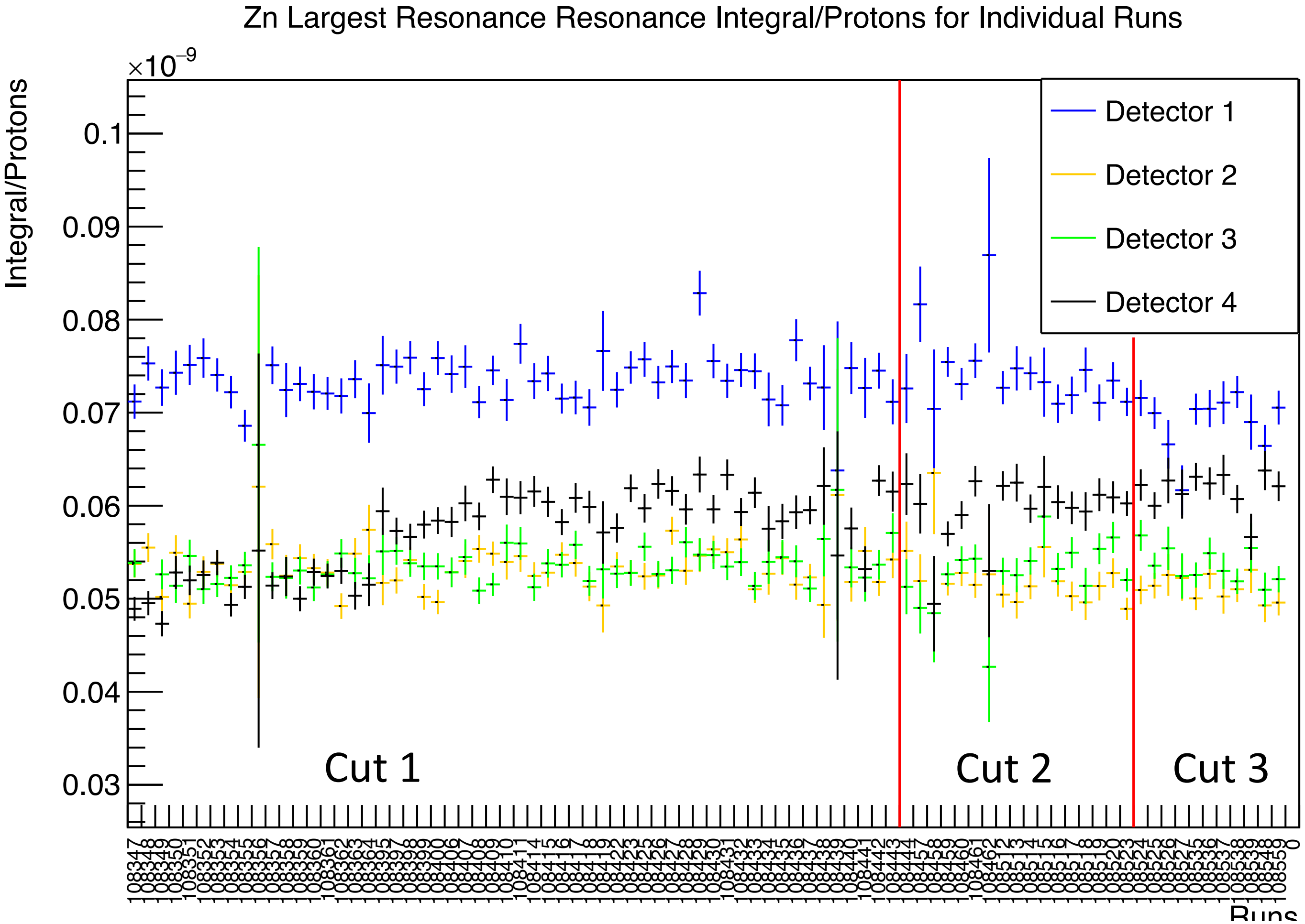
- Weighting functions were produced for Zn and Au (thanks Nick!).
- The WFs for each detector were kept separate due to the instability of detectors 1 & 4.
- 200 keV threshold



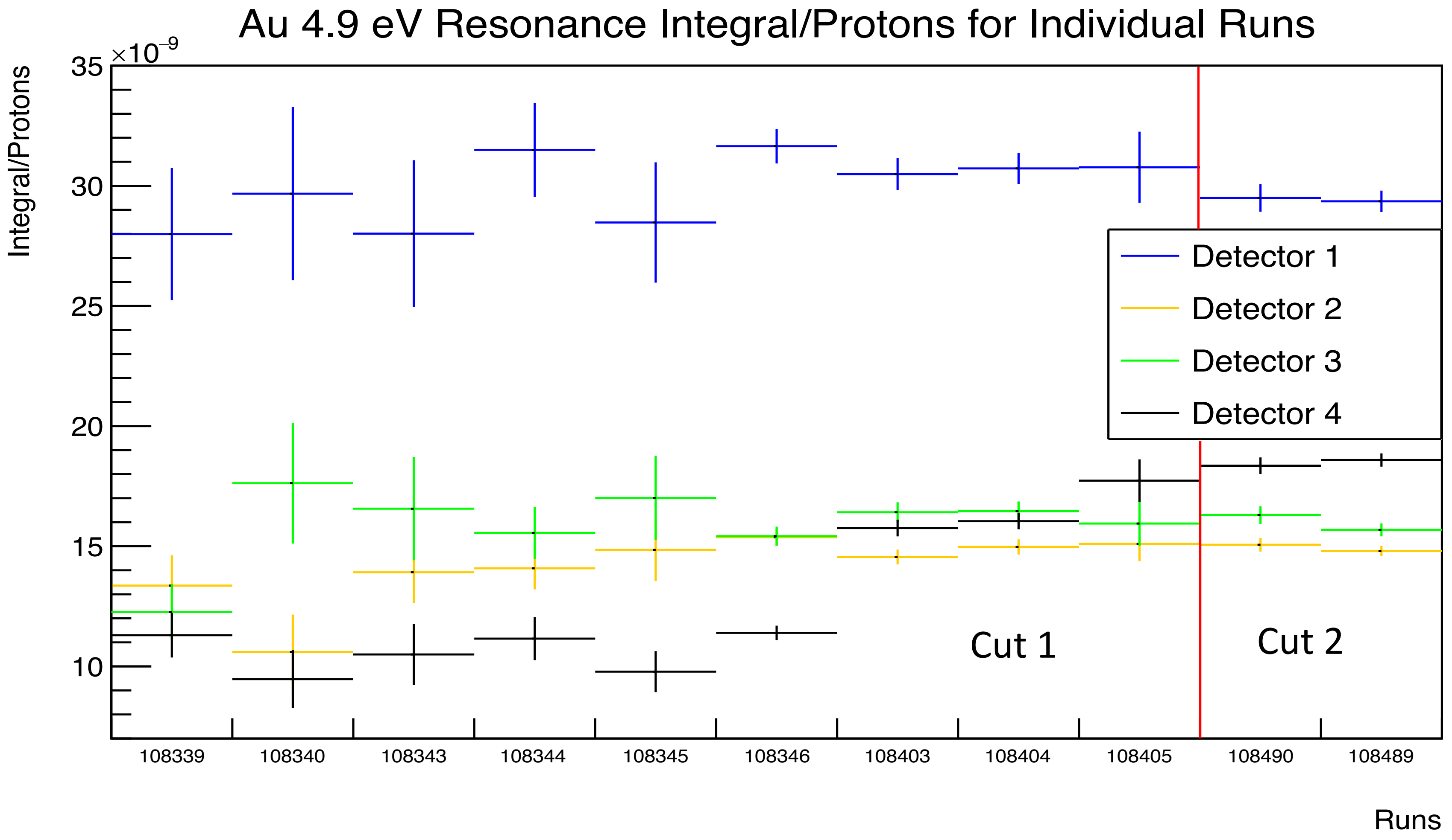
C6D6 Detector 4 Exclusion

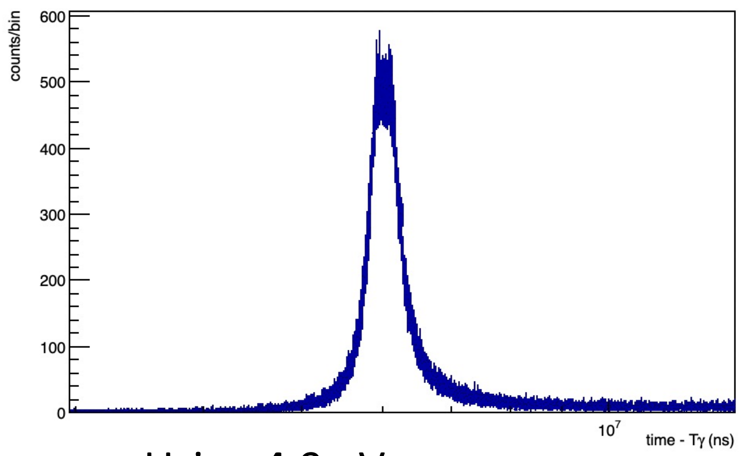
- Zn runs showed that detector 4 was more unstable than originally suspected.
- The integral/proton value for the biggest Zn resonance is relatively stable for dets 1,2 & 3 but 4 is unstable
- Results were consistent over all cuts.





- Au showed the similar results to Zn





Using 4.9 eV resonance

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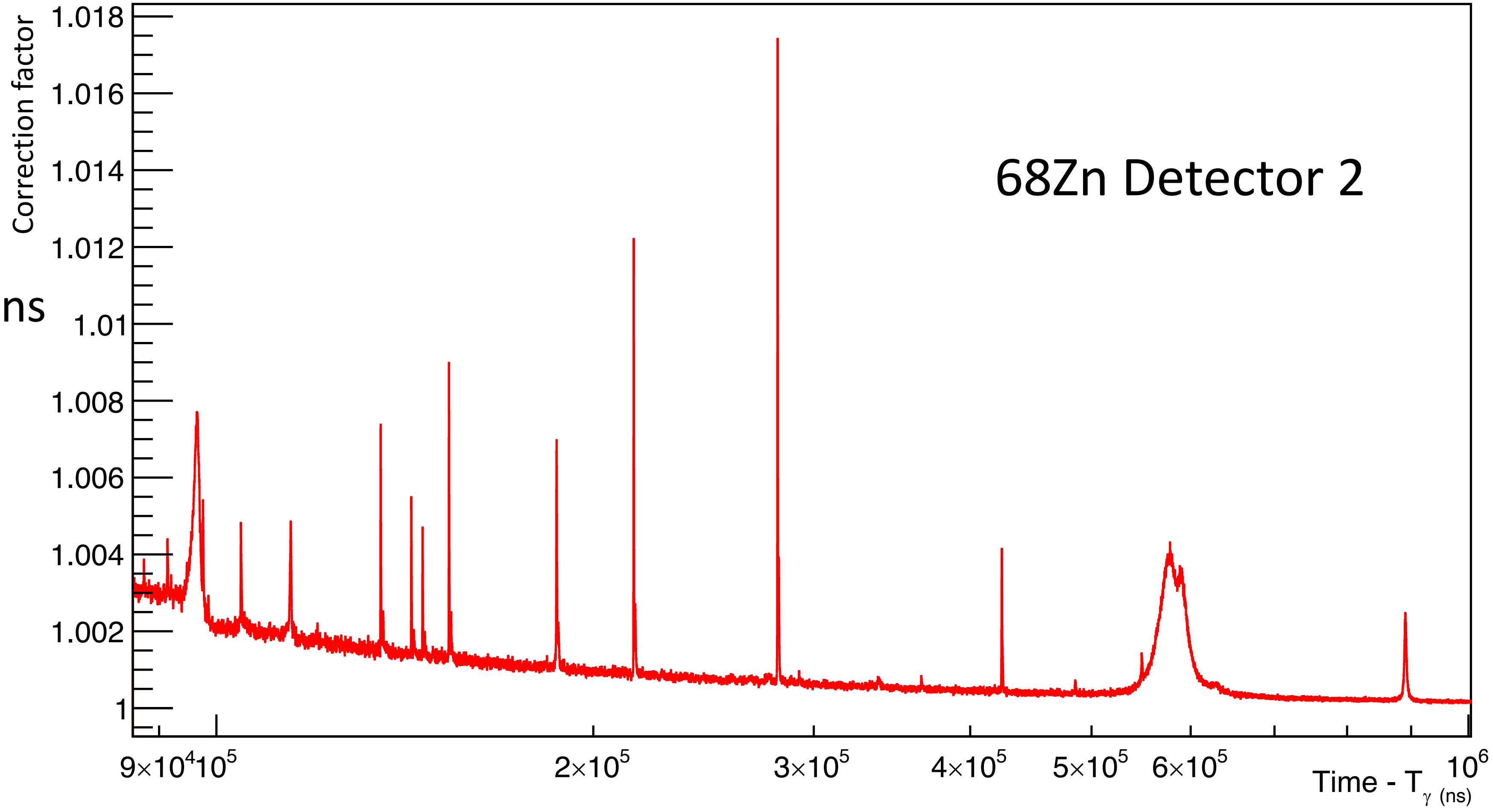
Deadtime Correction

- Deadtime correction formula:

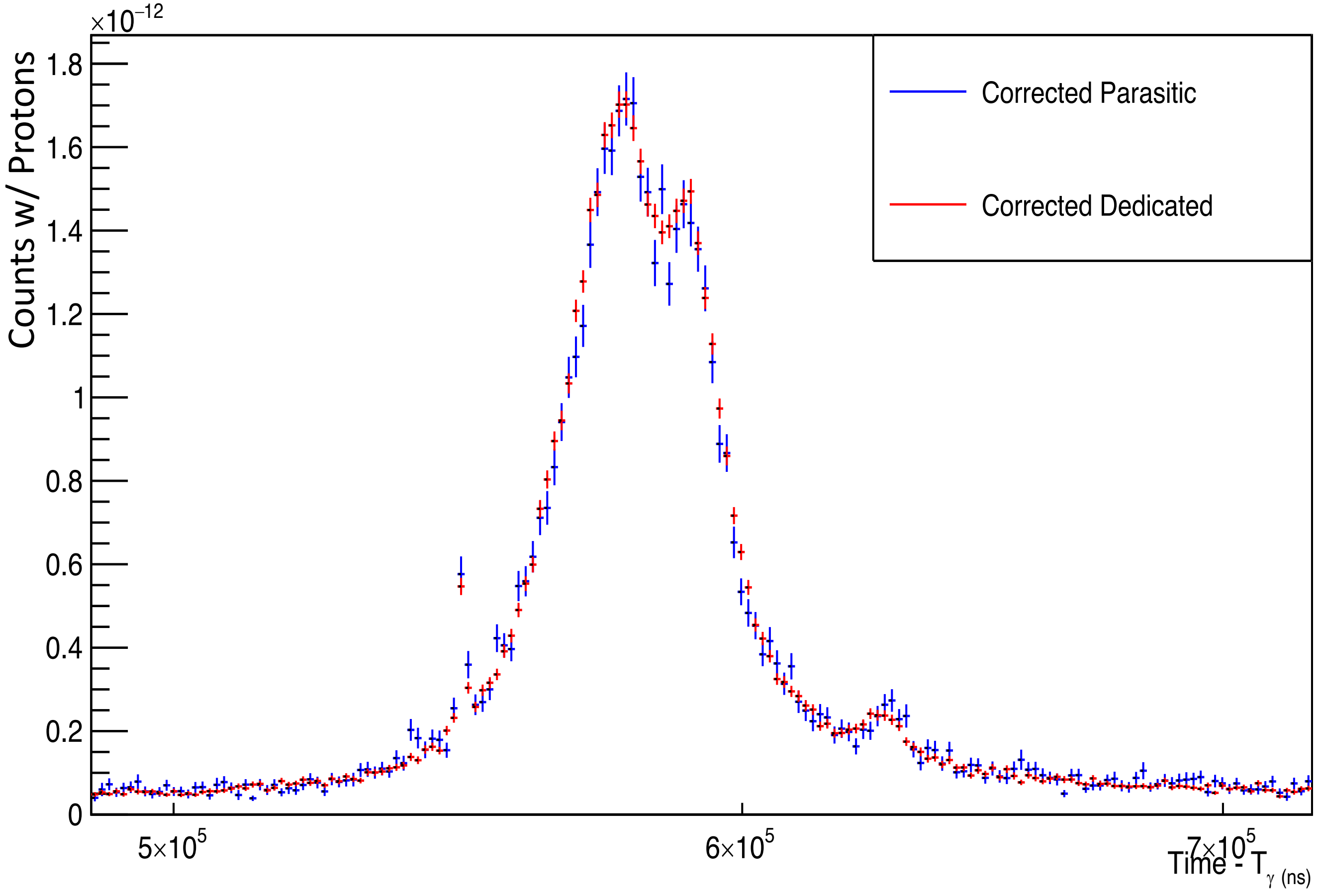
$$C' = \frac{C}{1 - C\tau_d}$$

- τ_d was estimated to be 50 ns

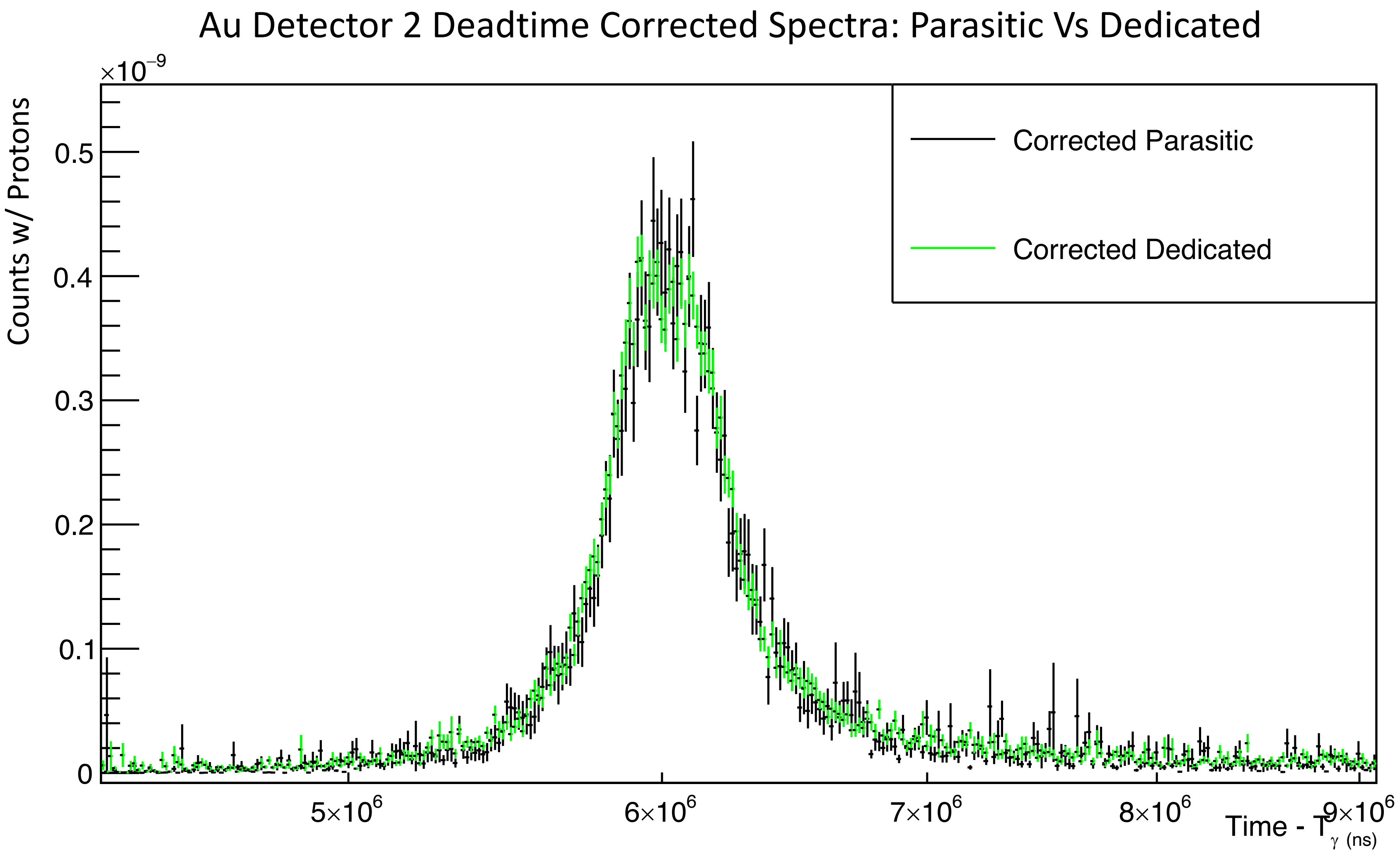


- Weighted TOF spectra was multiplied with the deadtime correction to make the “Deadtime Corrected Spectra”
  - ➢ Comparison of dedicated and parasitic pulses for all detectors are in agreement

Zn Detector 2 Deadtime Corrected Spectra: Parasitic Vs Dedicated



- Same analysis done for Au
  - ➢ Showed similar results to Zn for all detectors



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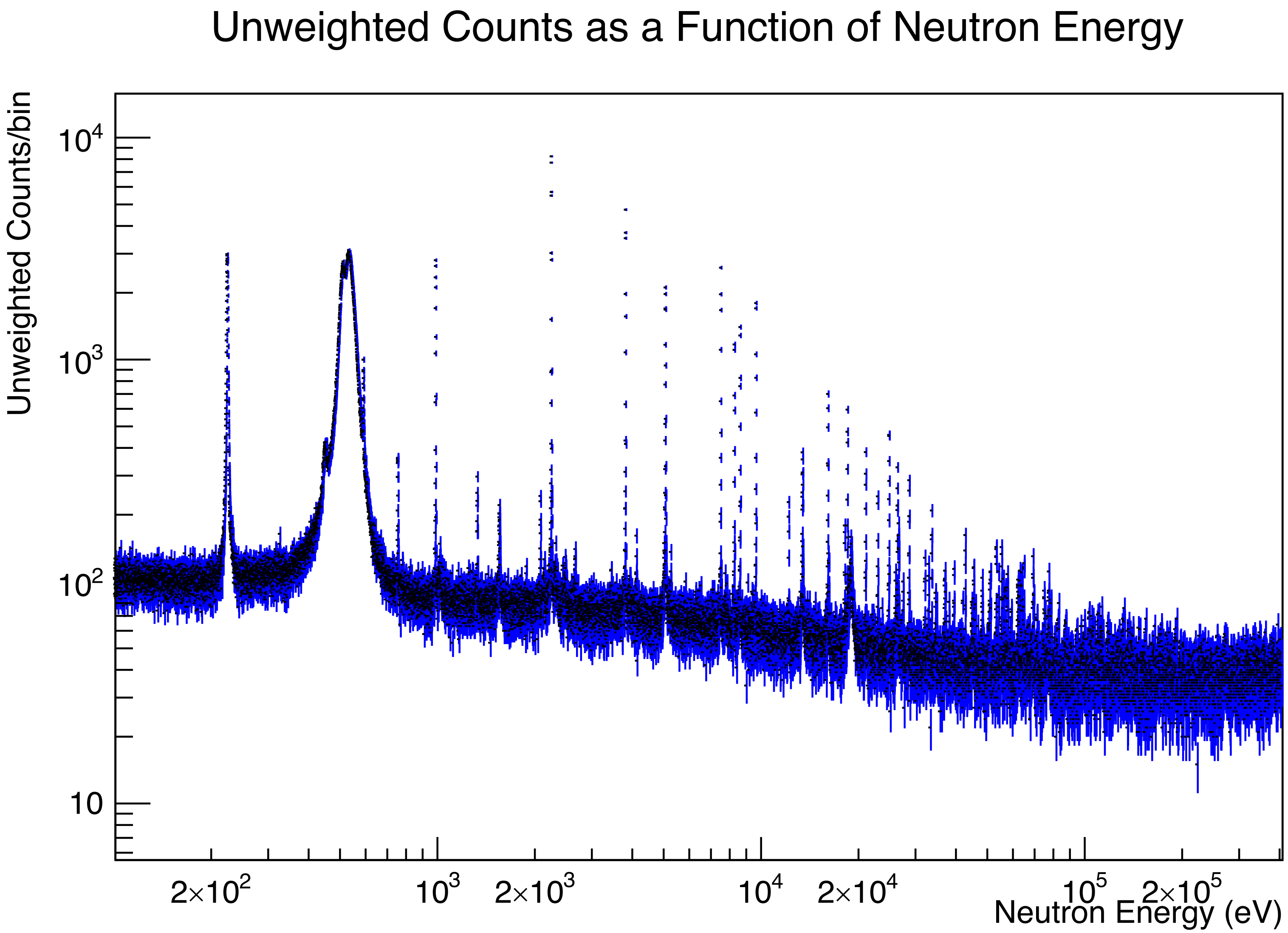
Resolvable Resonance Range

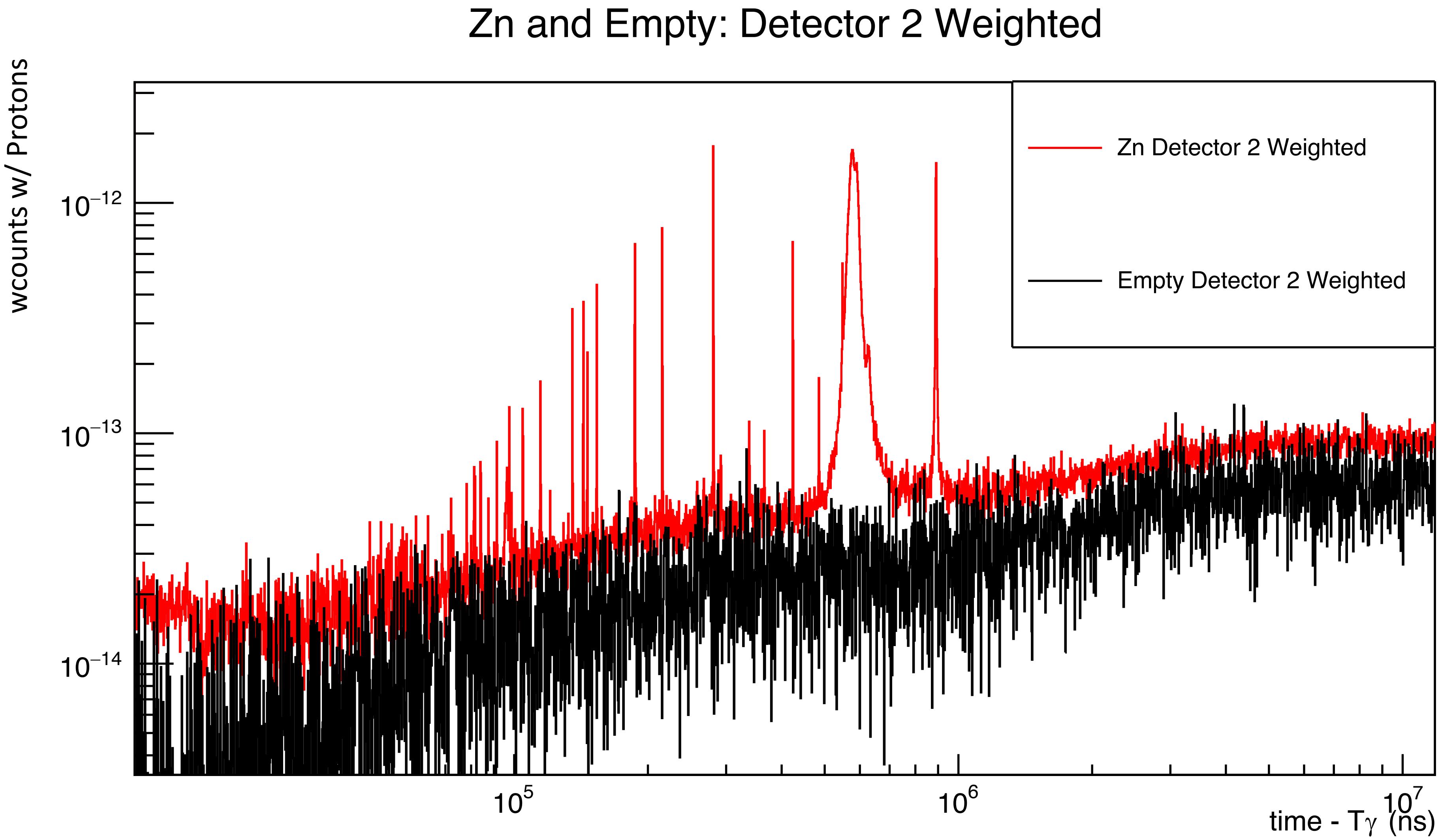
- Quick calibration of Zn data to estimate the limits of resolved resonances

  - ➢ Flight path of 185m assumed

- Hopeful to resolve resonances between 100 keV-200 keV



Background Removal



Next Steps

- Subtracting backgrounds
  - Subtracting Empty from Zn and Au

- Calculate yields from the subtracted spectra
  - Normalise detectors by Au
  - Check detectors 1, 2 & 3 are consistent after normalisation

- Combine detectors together

- Fitting resonances

Thanks for listening!