GAMMA SPECTROSCOPY

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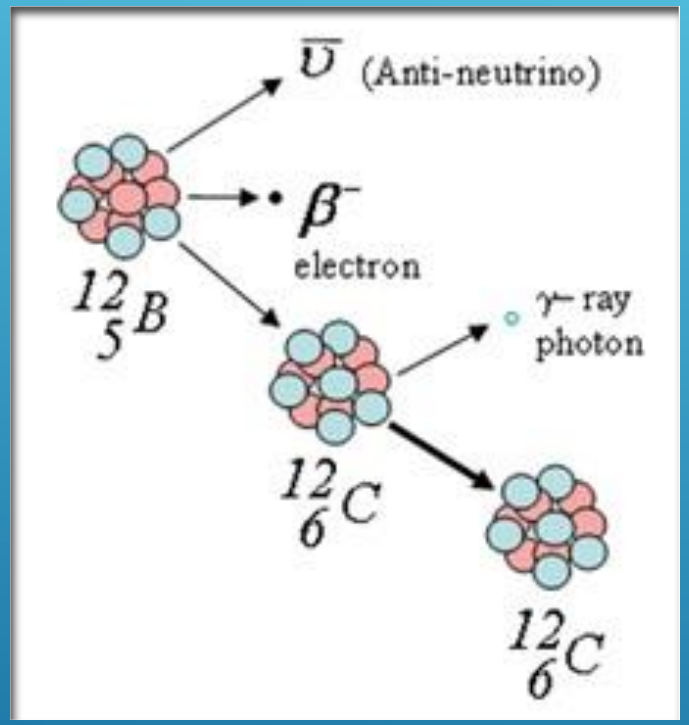
GAMMA DECAY



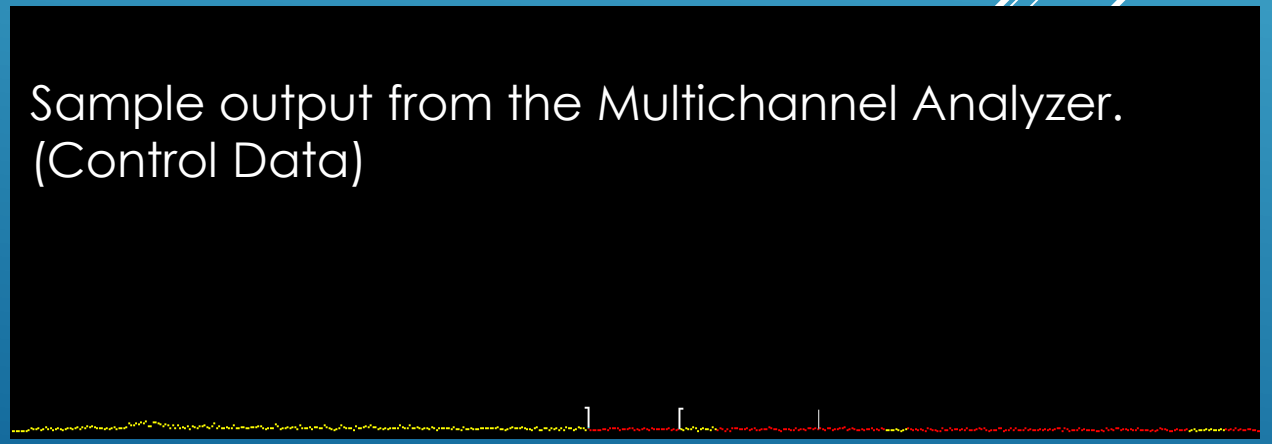
- **Gamma Decay** is the emission of a high-energy photon (O~0.01-10[MeV]) due to an excited nucleon returning to the ground state.
  - It is also possible for change in state to result in pair production if $\Delta E \geq 2m_e c^2 \cong 1[MeV]$, but the pair will annihilate.
- Excited nucleons result from other radioactive decay.
  - **Alpha Decay:** Ejection of a ^{4}He nucleus.
  - **Beta Decay:** $n \rightarrow p^+ + e^- + \bar{\nu_e}$ or $p^+ \rightarrow n + e^+ + \nu_e$.

- Isotopes have unique nucleon states and therefore gamma frequencies ($E = hf$).
  - Repulsive electromagnetic force between protons — no cutoff point.
  - Attractive strong force between nucleons – cutoff point.

MULTICHANNEL ANALYZER

- Analyzes a signal consisting primarily of pulses
- Each channel corresponds to an incoming voltage and therefore to a given energy.
  - $E = qV$
  - Inputs are listed simply as channel numbers; outputs are counts.
  - Each count corresponds to one pulse at the associated energy.
  - Can be analog or digital. Ours uses an analog-to-digital converter.
- Most are hooked up to computers for analysis, but newer models may have their own microprocessors.

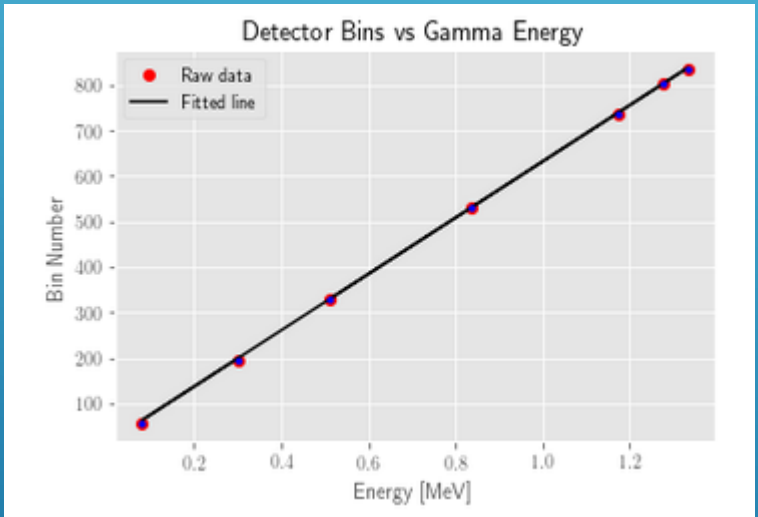
- **Pulse Height Analyzer:** Mode that sorts pulses according to amplitude
- **Multichannel Scaler:** Mode that sorts pulses by time of arrival.



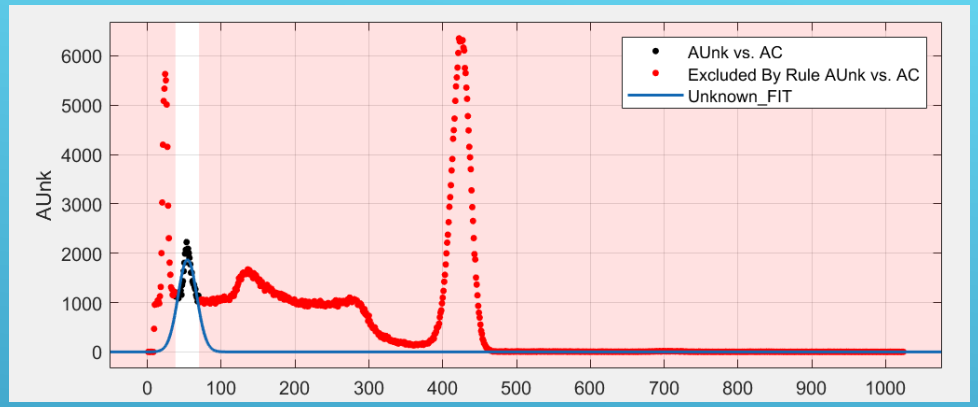
Sample output from the Multichannel Analyzer. (Control Data)

ERROR PROPAGATION

Step 1: Finding bins for known values – uncertainty is given in MATLAB based on χ^2.



$$E = 621C + 9$$



Step 2: Calibration Curve – uncertainty is given in Python by a covariance matrix based on a weighted curve fit.

Step 3: Final Value – uncertainty is calculated by hand.

$$\sigma^2 = \Sigma\left(\sigma_i \frac{df}{di}\right)^2 \qquad E = \frac{C-b}{m} \qquad \sigma_E^2 = \frac{\sigma_C^2}{m^2} + \frac{\sigma_b^2}{m^2} + \frac{\sigma_m^2}{m^4}$$

Energy [MeV]	Uncertainty [MeV]
0.670	0.007
0.024	0.007
0.072	0.007
1.16	0.01

0.662 [MeV]: ^{137}Cs. 0.511, 1.115[MeV]: ^{65}Zn

FURTHER READING

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