

# Testing of Advanced Scintillators for a Compton Telescope

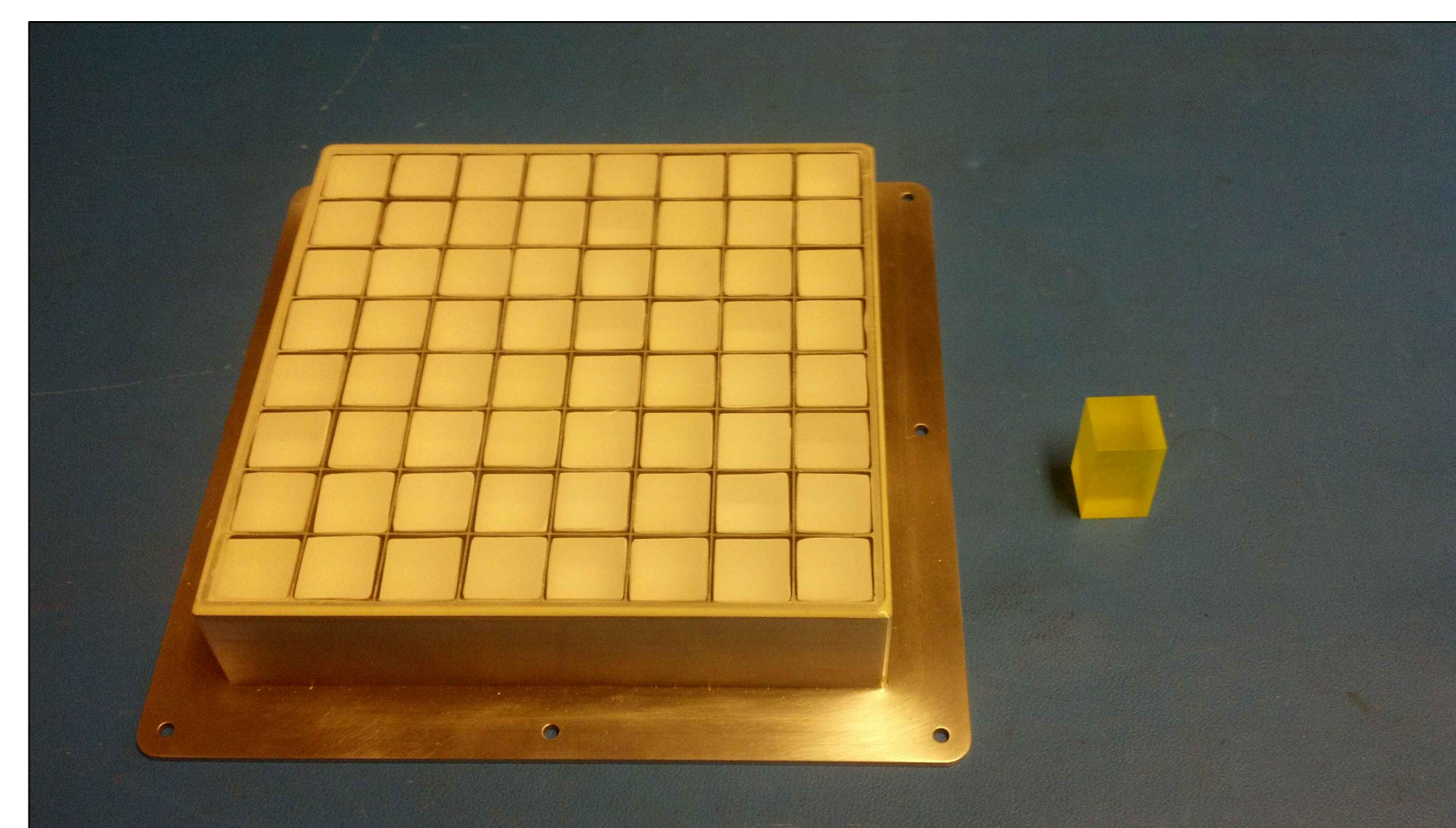
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## Experiment

Two new types of inorganic scintillators, Cerium Bromide ( $\text{CeBr}_3$ ) and Gadolinium Fine Aluminum Gallate (GFAG), were tested and compared for use in a Compton gamma ray telescope. The materials were evaluated for energy resolution and event coincidence timing (time of flight).

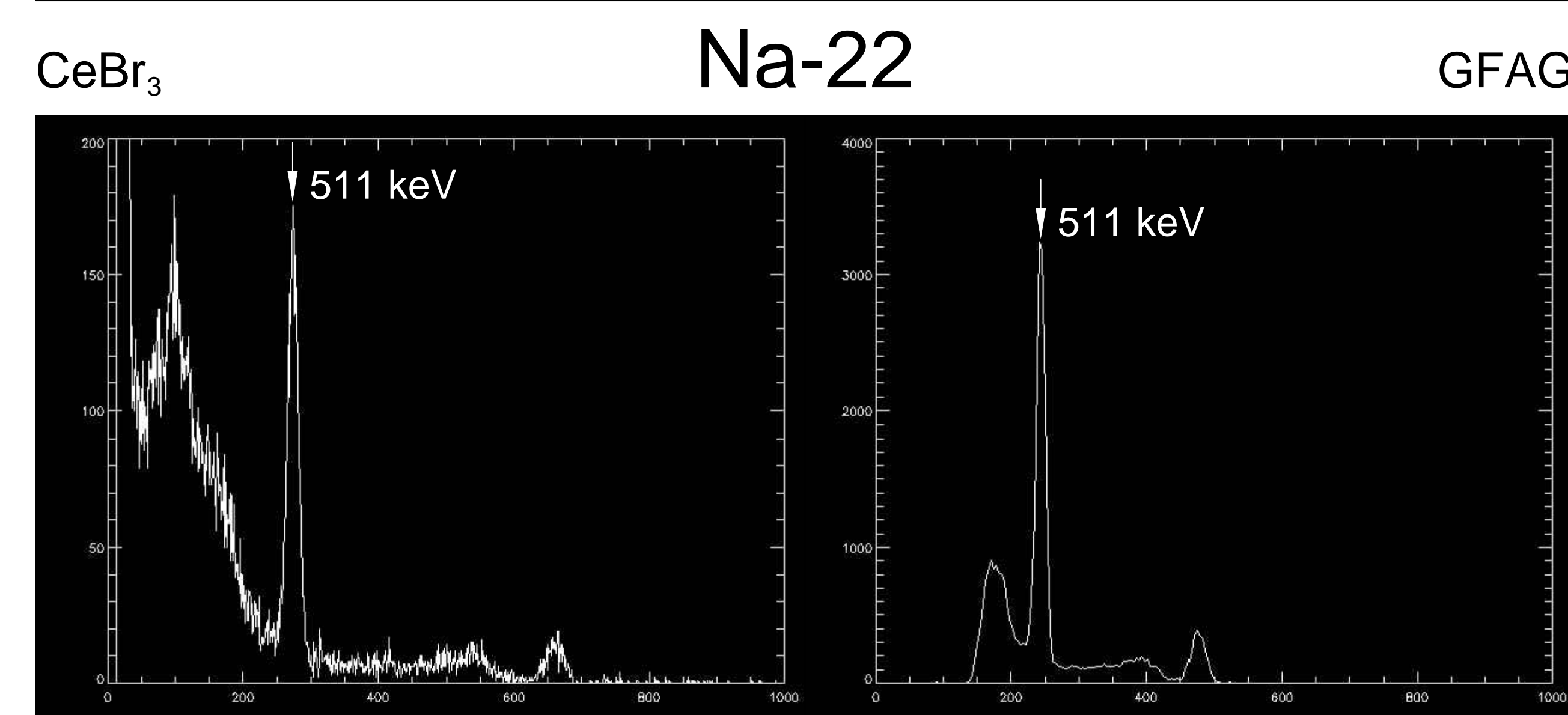
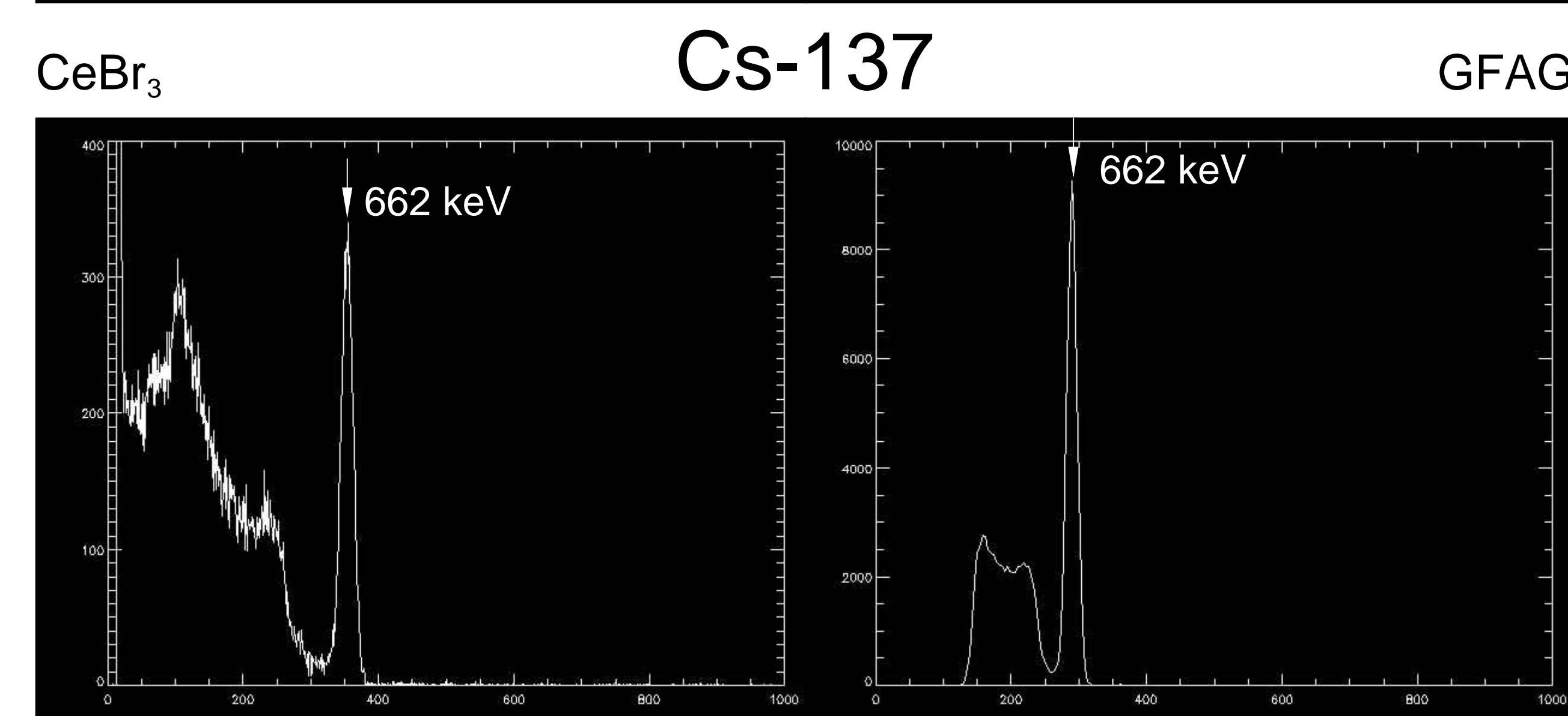
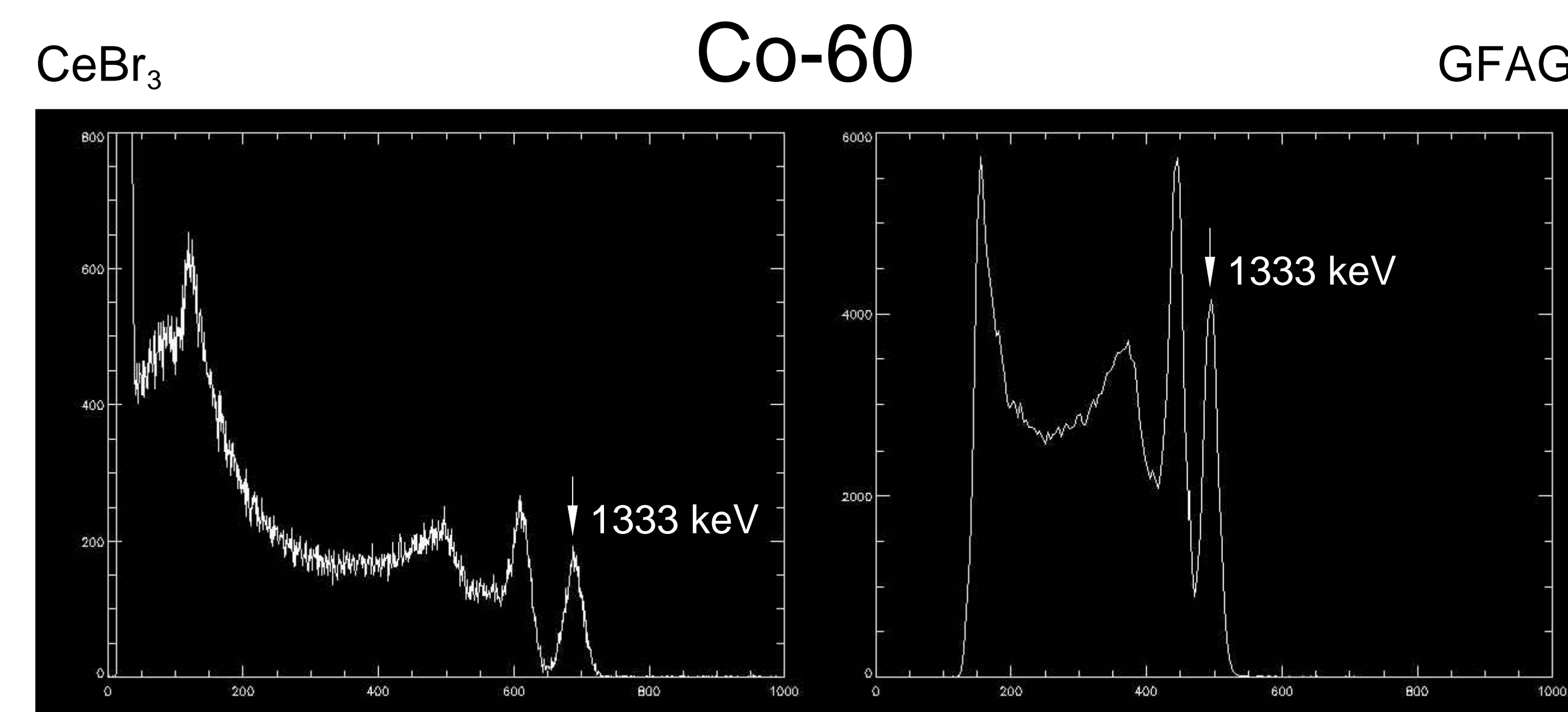


$\text{CeBr}_3$  array (left) and GFAG (right)

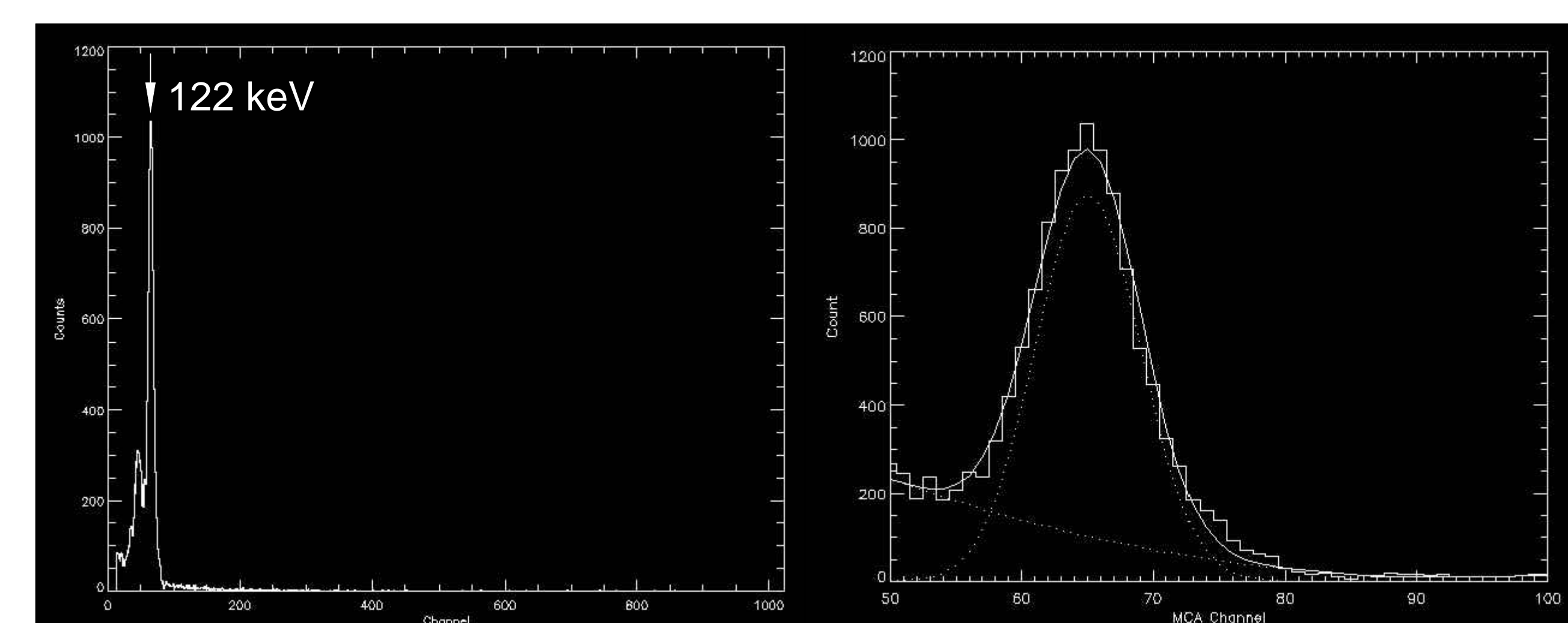
## Energy Resolution

Four radioactive sources were used to compare the energy resolution. The events were measured using a silicon photomultiplier (SiPM). The pulse height of the light emitted by the scintillators was measured and plotted. The peaks for energy lines of the sources were measured. A higher channel value for the centroid corresponded to a better response from the scintillator.

Source	Energy (keV)	Resolution (FWHM)	
		$\text{CeBr}_3$	GFAG
Co-57	122	16.35%	N/A
Co-60	1333	4.56%	5.60%
Cs-137	662	5.69%	8.60%
Na-22	511	6.84%	9.23%



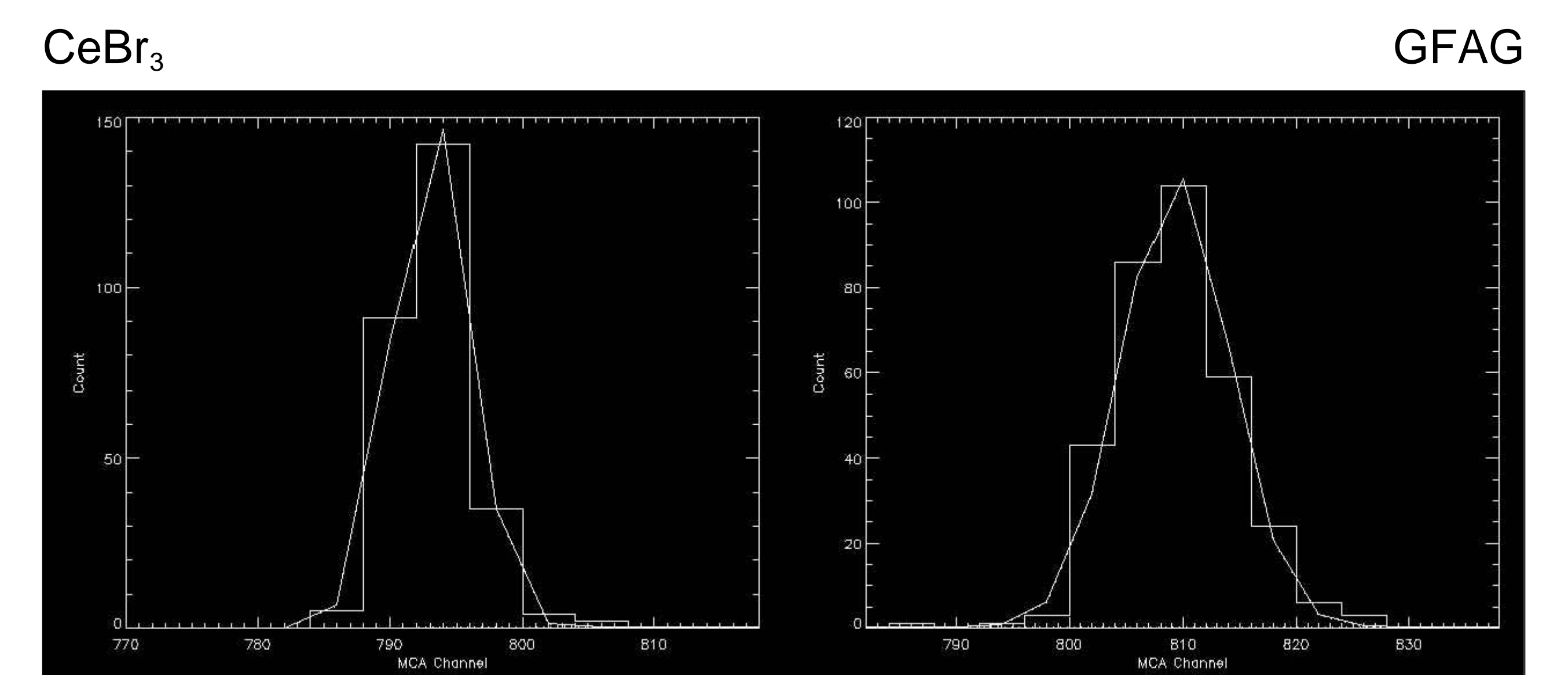
The histograms show the energy spread of registered events in  $\text{CeBr}_3$  (left) and GFAG (right). Arrows point the peaks that were measured and compared for energy resolution.



The left graph shows the events for Co-57. The peak of interest was fitted with a Gaussian (shown right). Then the centroid of the curve and standard deviation were determined.

## Time of Flight

Time of flight (ToF) measurements were taken with the Co-60 source. The events were measured in coincidence with an organic p-terphenyl scintillator. Only events that were near the Compton edge for p-terphenyl and Photopeak for  $\text{CeBr}_3$  and GFAG were considered and plotted. ToF was determined by the Full Width Half Max of the resulting curves. The lower ToF value indicates a quicker response and resolution of the event.



Time of Flight - 0.671 ns

Time of Flight - 1.12 ns

## Conclusion

The  $\text{CeBr}_3$  proved to be superior with both its energy resolution and ToF, which was almost half of GFAG. GFAG also proved to be more likely to registering background noise and so required higher threshold. Measuring Co-57 became impossible as its lines were below that threshold. Lastly, the SiPMs used had been designed for bluer light ( $\lambda \sim 400$  nm), and likely did not respond as well to GFAGs greener light output. It's possible that GFAG may have performed better with a SiPM more attuned to its light output.