

Introduction

The detection of the characteristic 1.809 MeV γ -ray line from the decay of long lived radioisotope ^{26}Al ($t_{1/2} = 7.17 \times 10^5$ yrs) in the interstellar medium has demonstrated that nucleosynthesis is an ongoing process in the Galaxy, confirming earlier measurements of excess ^{26}Mg in meteorites and presolar dust grains.

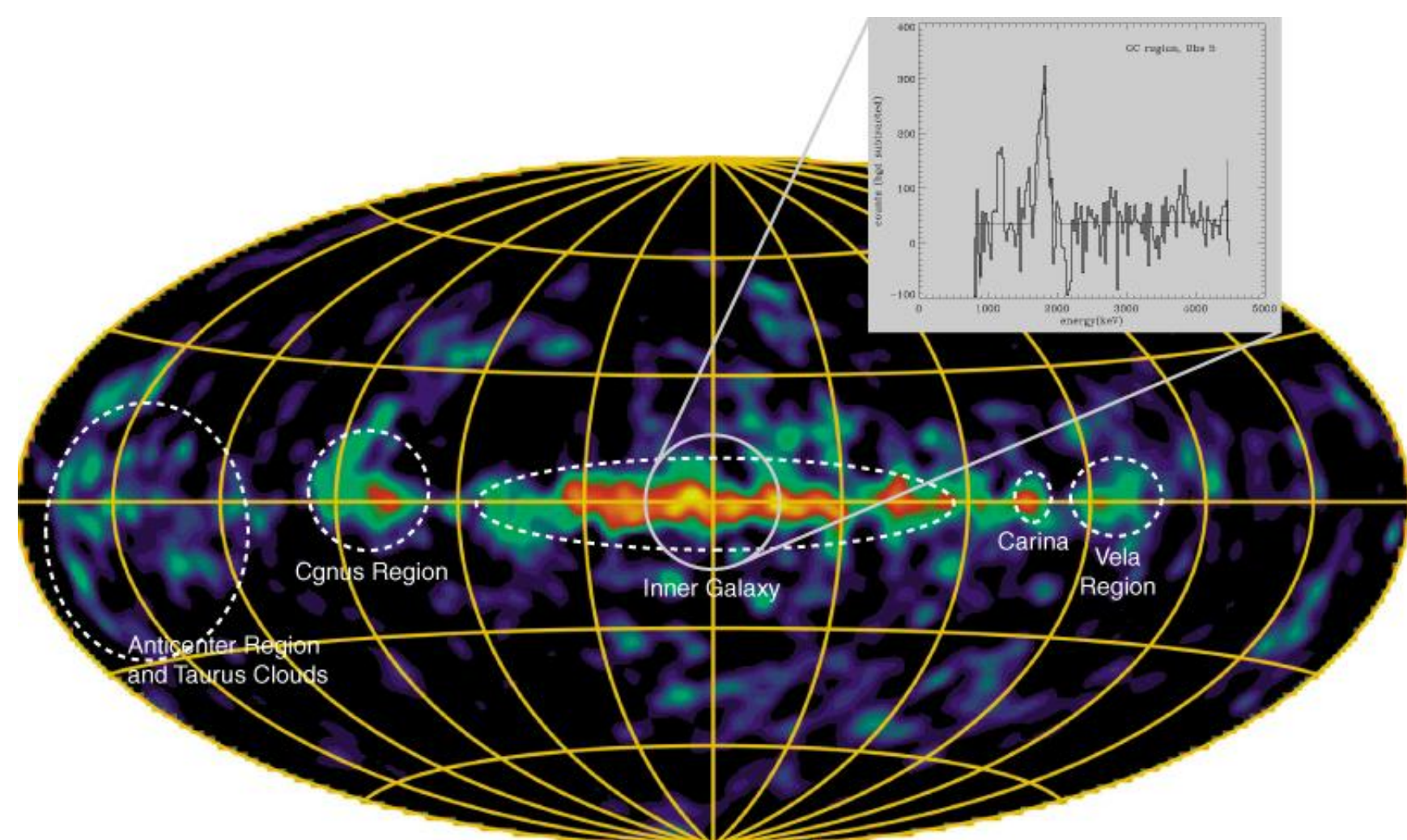


Fig 1: Galactic ^{26}Al map [Taken with the COMPTEL Telescope]

The existence of a low-lying isomeric states in ^{26}Al complicates the calibration of its nucleosynthesis. One of main sources of uncertainties in understanding ^{26}Al comes from the neutron destruction channels. Specifically the $^{26}\text{Al}(n,p)^{26}\text{Mg}$ reaction rate has strong discrepancies at the temperatures around 1GK. We will investigate the neutron destruction channels in ^{26}Al via the $^{26}\text{Al}(d,p)^{27}\text{Al}^* \rightarrow ^{26}\text{Mg} + p$ reaction with Helios at ANL. First, we developed a beam ^{26}Al with enough energy to populate states above the neutron threshold in ^{27}Al , and measured its isomer content.

Fig 2: Decay scheme of ^{26}Al

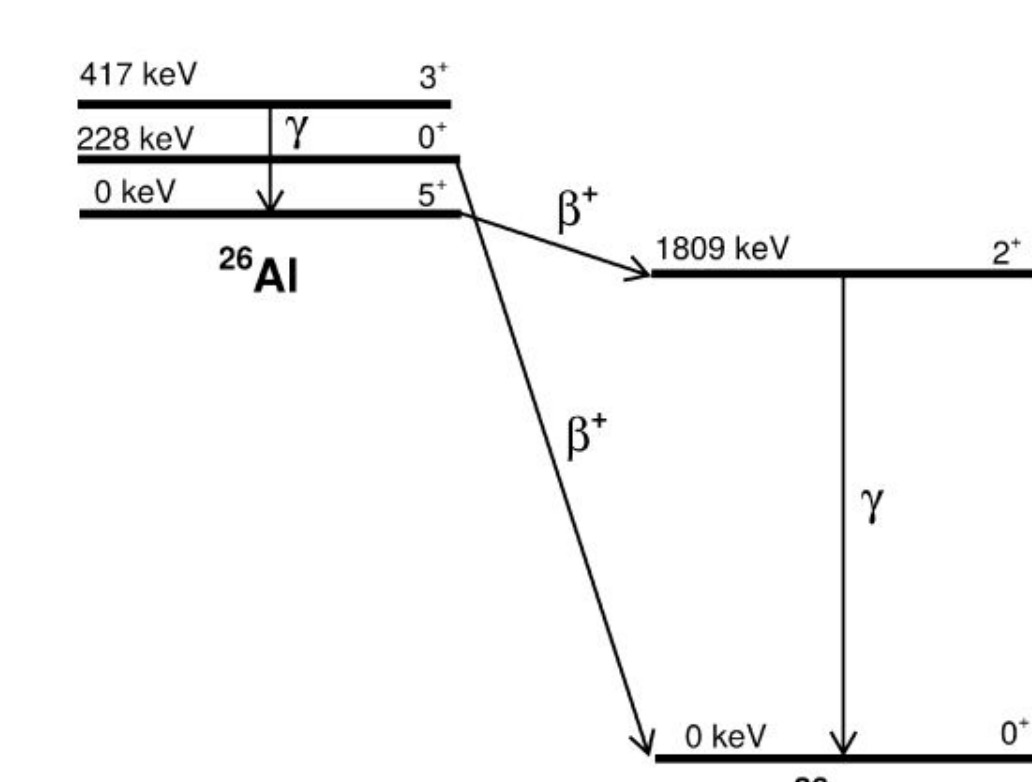


Fig 3: Current status of $^{26}\text{Al}(n,p)^{26}\text{Mg}$ reaction rate[1]

Beam Development

A ~ 9.5 MeV/u ^{26}Al beam was developed via the in-flight method at Argonne national laboratory. A primary ^{26}Mg beam with 11.5 MeV/u bombarded a hydrogen filled production gas target. The beam was delivered to the SPS area for characterization. The total ^{26}Al was measured by a silicon detector while the isomer content was measured using a Au-beam stopper and two NaI detectors. From these γ -rays associated with the stopped beam, the half-life of the decay was obtained, confirming the presence of the isomer in ^{26}Al . By using a calibrated ^{23}Na radioactive source placed at the beam stopper position, the total efficiency of the detectors was estimated.

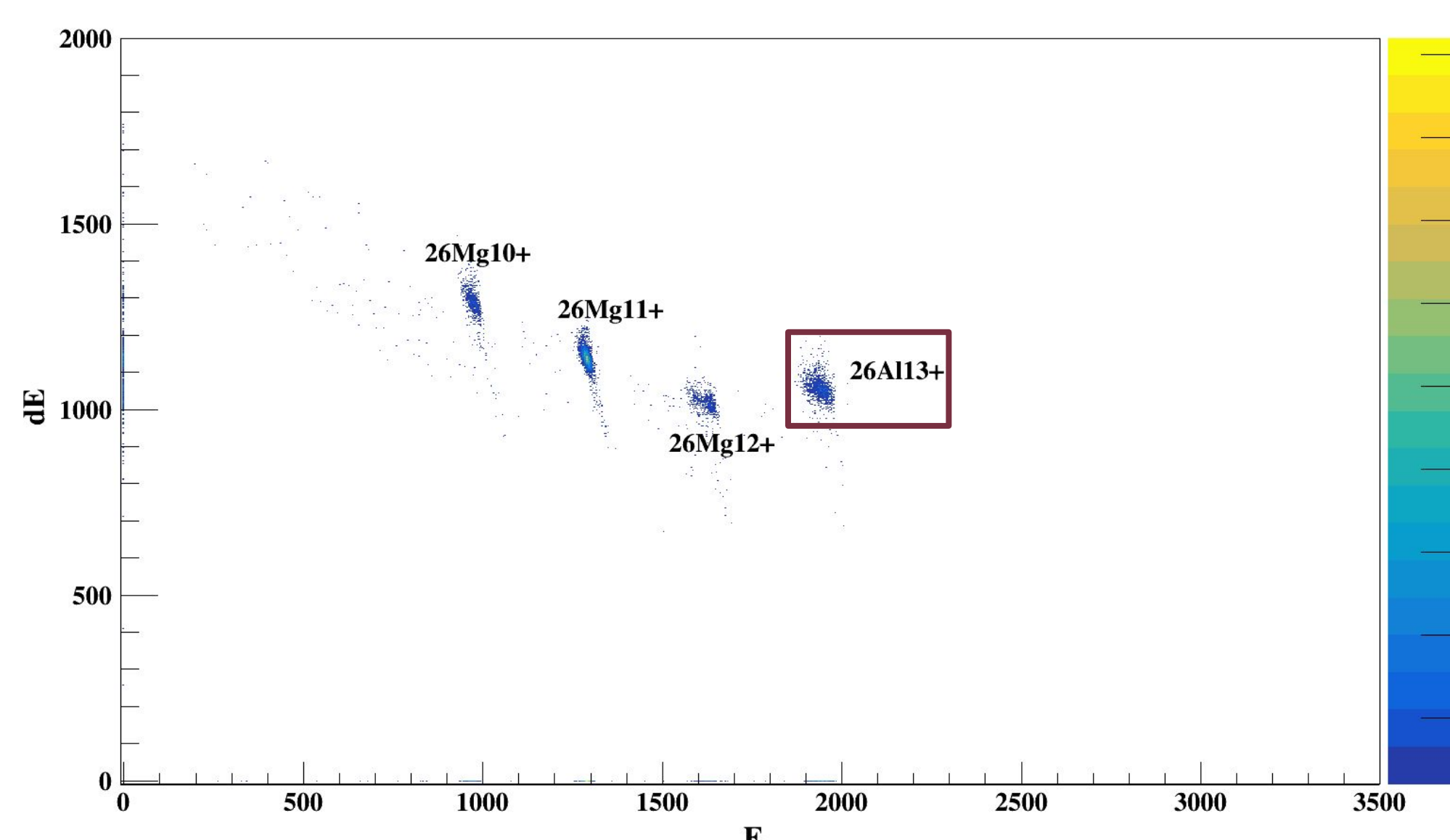


Fig 4: Particle Identification used to determine the components in the beam.

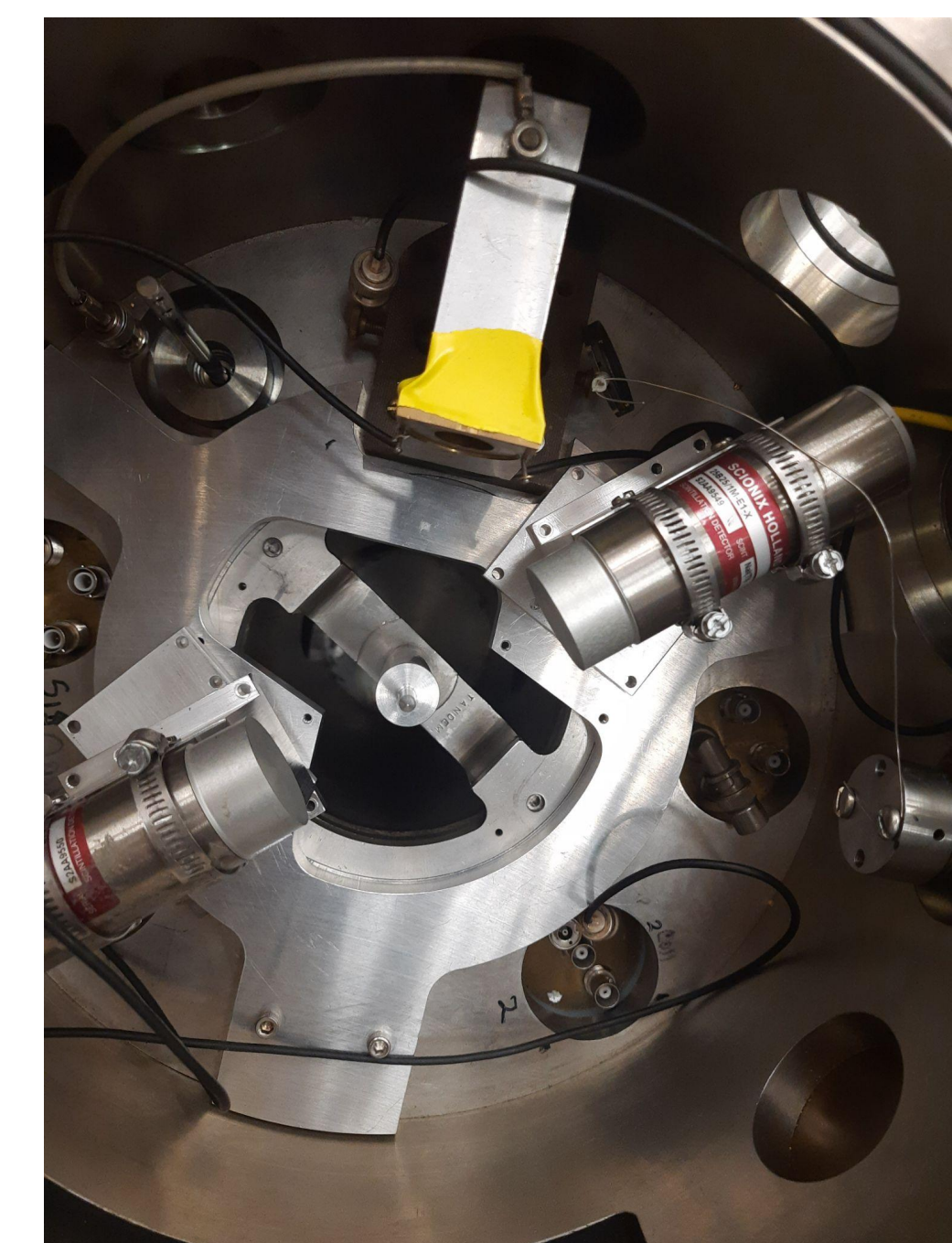


Fig 5: Experimental setup used to measure the γ -rays from the stopped beam.

Results

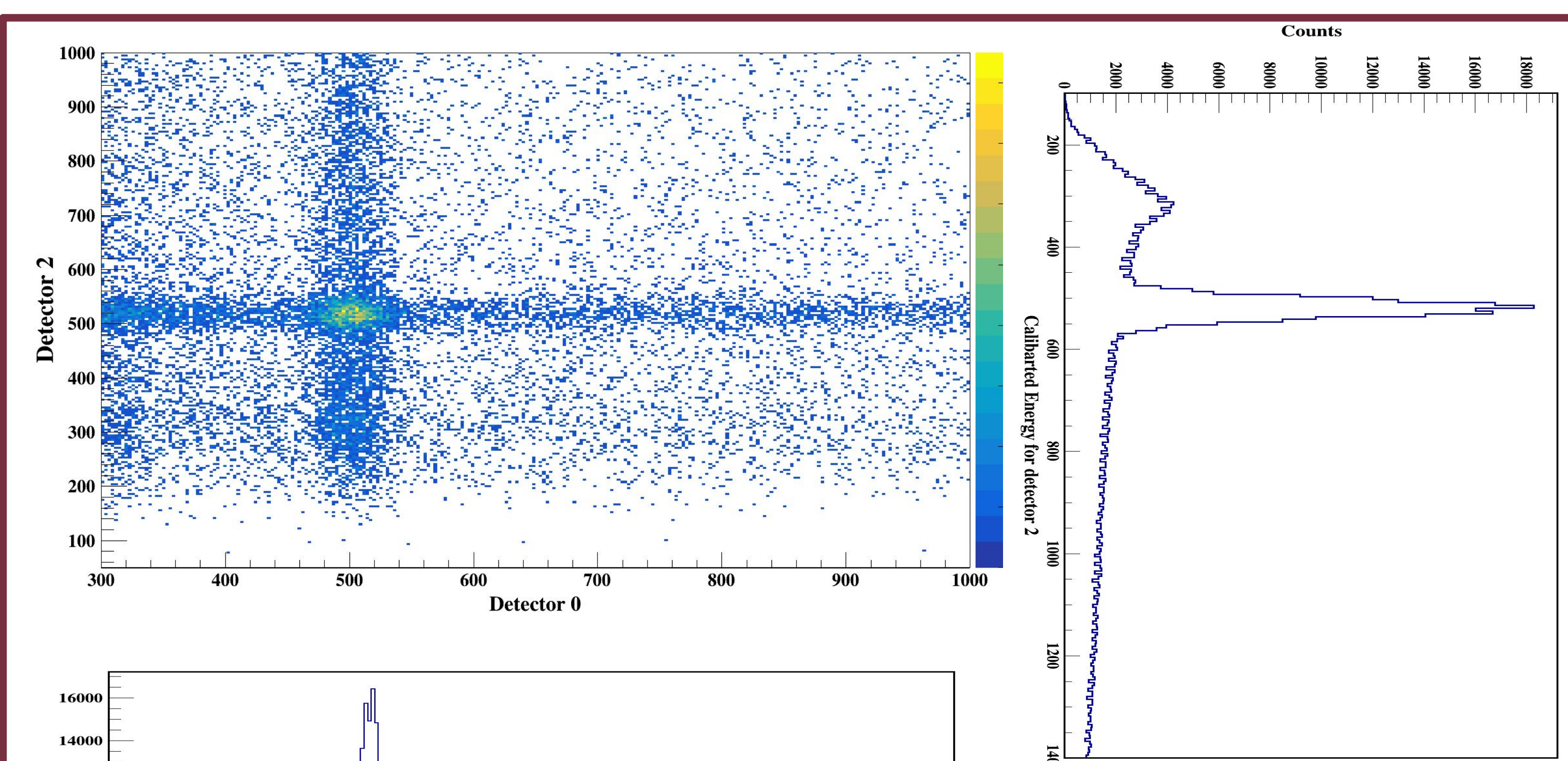


Fig 6: The 2-d Energy coincidence constructed from the calibrated detector, where the projection could be seen on x and y-axis.

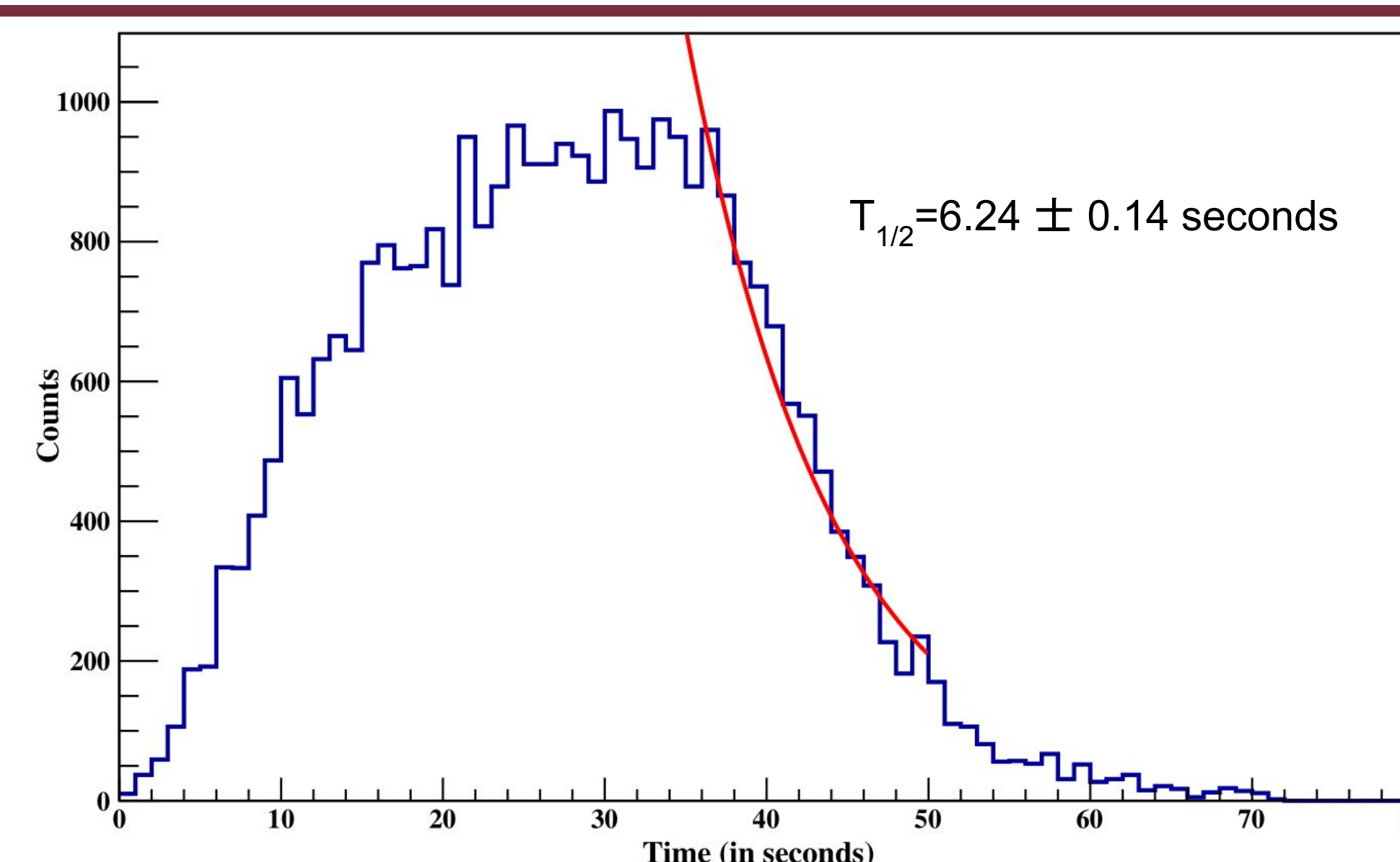
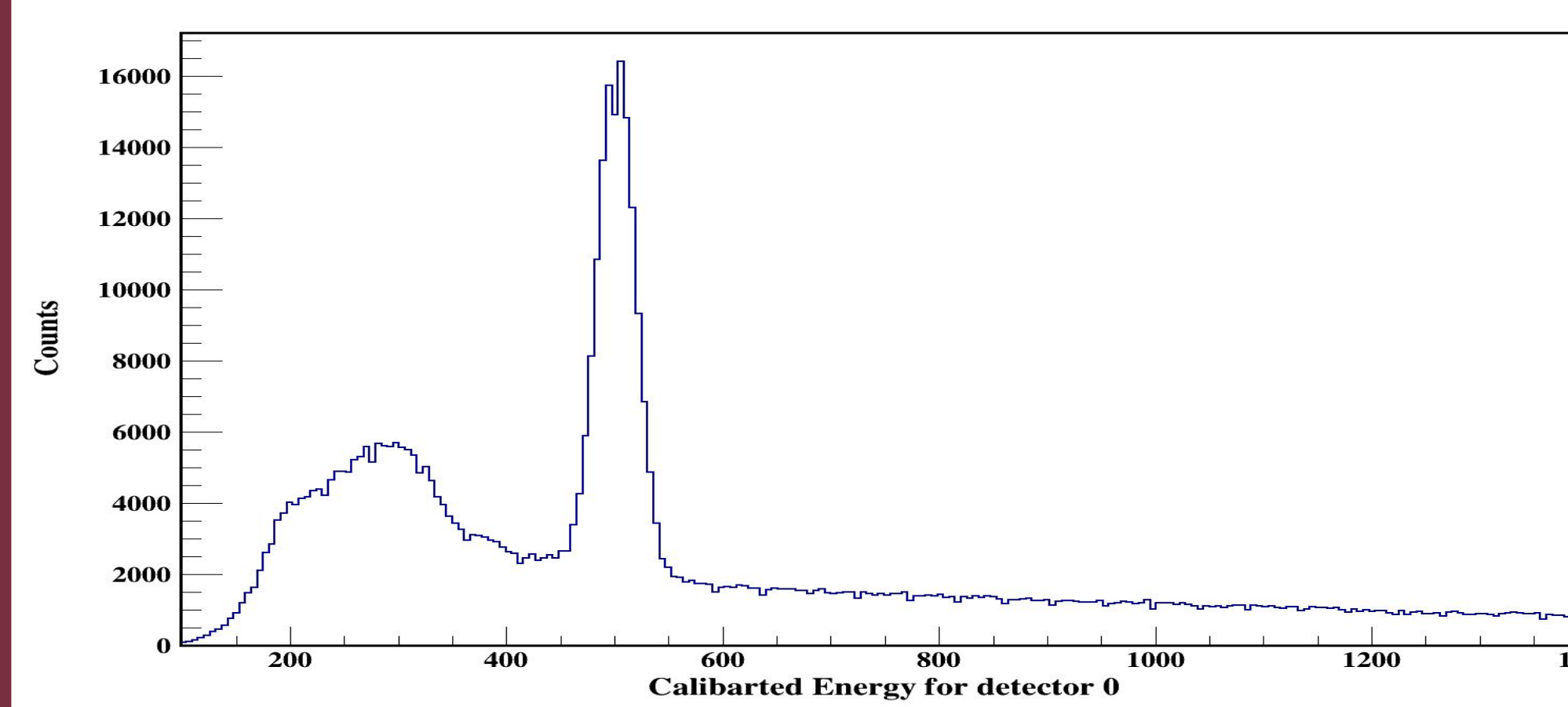


Fig 7: Time histogram gated by the above energy correlation which confirms the presence of the isomer

From the total beam and NaI measurements we estimate $\sim 1 \times 10^4$ ^{26}Al particles per 1 pA of ^{26}Mg , with $\sim 90\%$ purity and $60 \pm 5\%$ isomer content.

Future work includes to measure the $^{26}\text{Al}(d,p)^{27}\text{Al}^* \rightarrow ^{26}\text{Mg} + p$ with HELIOS. The ^{26}Al beam will populate states in ^{27}Al in a (d,p) reaction. The decays of the $^{27}\text{Al}^*$ from states above the neutron decay threshold ($S_n \sim 13$ MeV) will also be detected in coincidence with the protons from the (d,p) reaction in a two-array HELIOS configuration.[2]

References

- [1] Iliadis, C et al, AJSS 193 16,1(2011)
- [2] S.Almaraz-Calderon et. al, LOI