Preparations for Measuring the Gamma Ray Strength Function of ^{60}Fe using $^{59}Fe(d,p)^{60}Fe$

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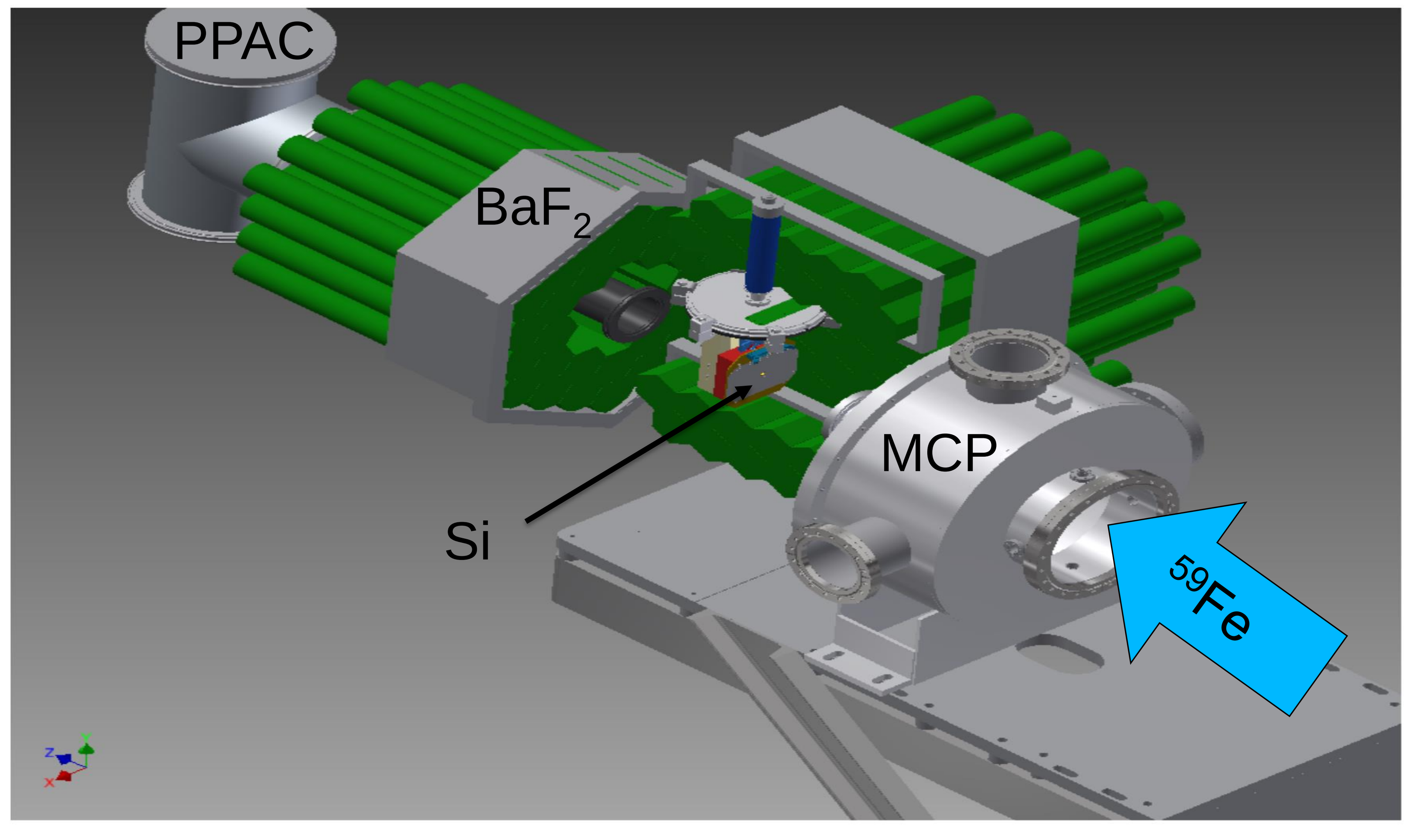
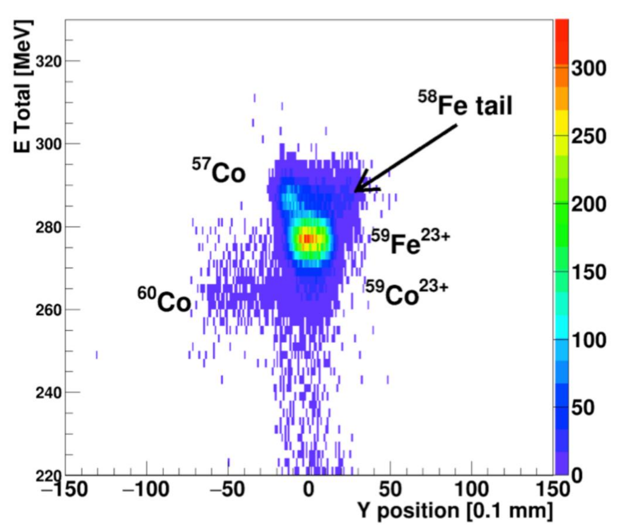
Introduction

- ^{60}Fe has been observed nearby in the galaxy [1], in lunar soil samples [2], in oceans worldwide [3], and in Antarctic snow[4]
- Important isotope in nucleosynthesis; branch point in the s-process
- We will measure the gamma ray strength function in order to obtain a constraint for astrophysical models
- ^{59}Fe beam, produced using the TAMU MARS line at the Cyclotron Institute, impinging on a CD_2 target
- Proton emitted at backward angles from $^{59}Fe(d,p)^{60}Fe$ reaction will be detected in a silicon detector
- Gamma rays will be detected in packs of BaF_2 crystals coupled to photomultiplier tubes.

Experimental Setup



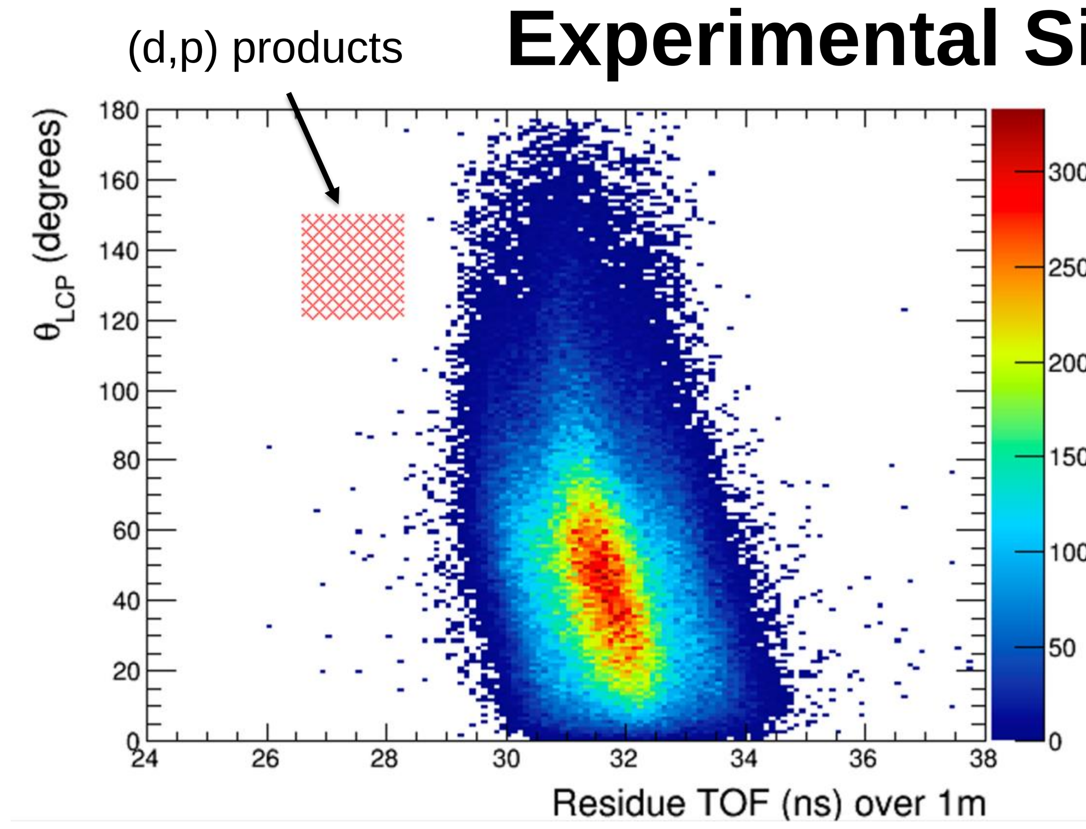
CAD drawing of anticipated final experimental setup

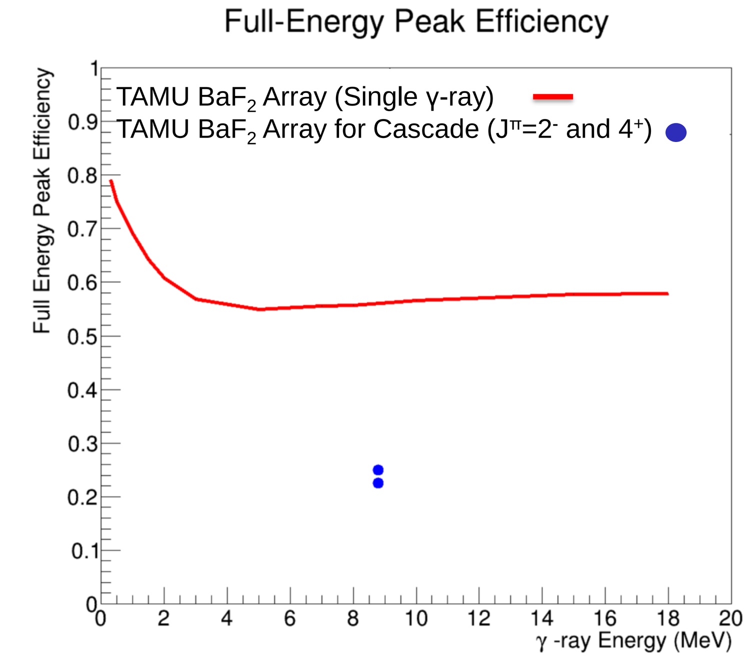


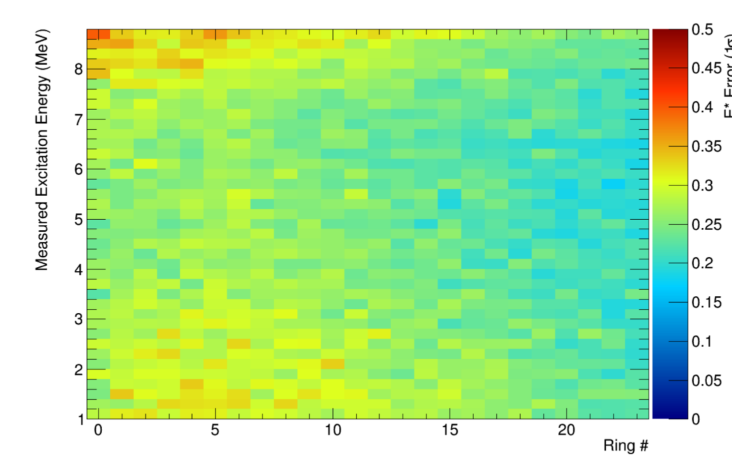
79% ^{59}Fe, 13% ^{57}Co, 7% ^{59}Co

- Coincidence of MCP and PPAC give TOF of residue
- Silicon rings give angular resolution for proton
- Purity detector for beam impurities event by event
- $\sim 10^5$ pps

Experimental Simulations



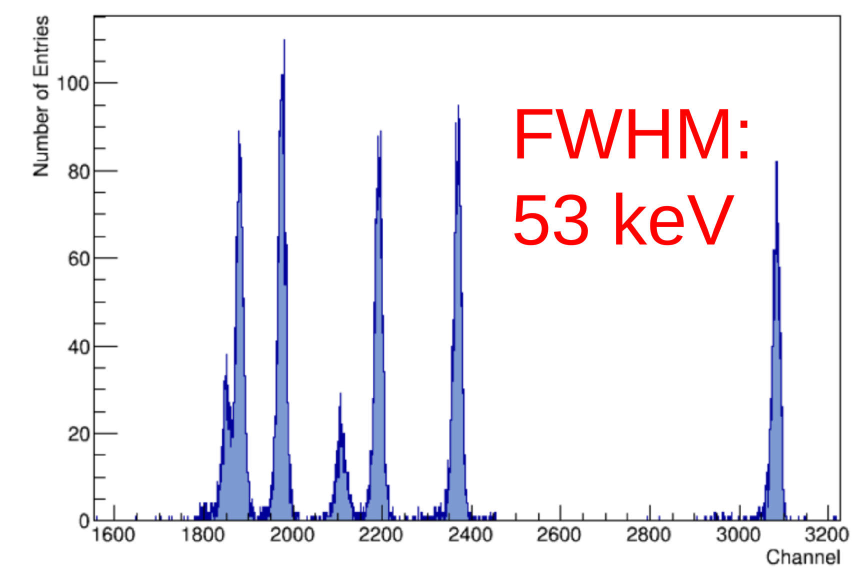


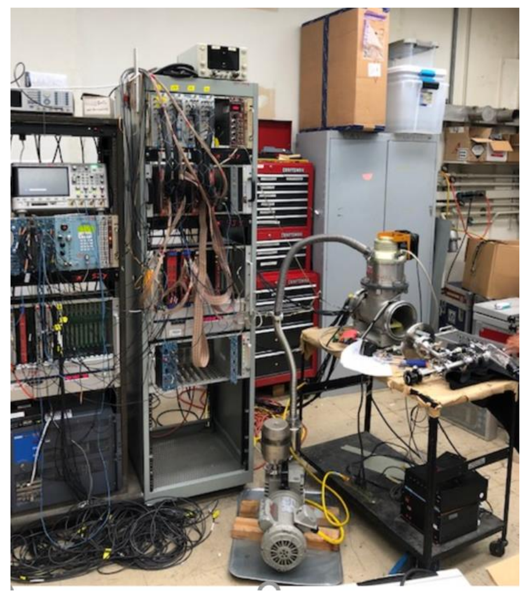


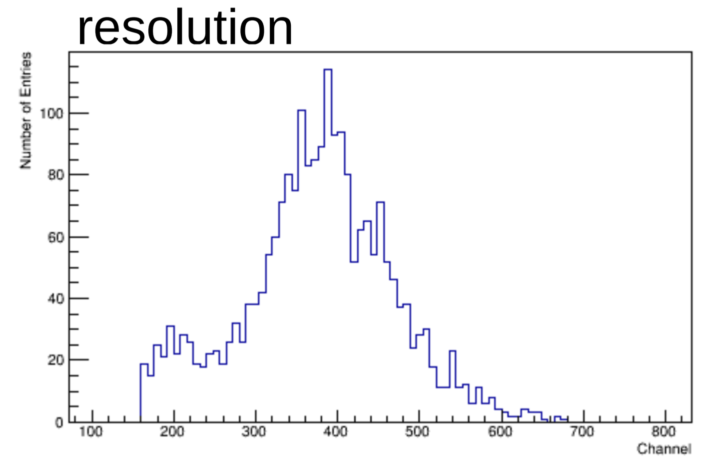
Top Left: GEANT simulation of the complete fusion between $^{59}Fe+^{12}C$. Red box shows angular range of silicon and TOF for residue of interest.
Top Right: GEANT simulation for BaF_2 array efficiency for single photons and gamma cascades.
Bottom Left: Std. Dev. of E* error for measured E* as a function of silicon ring.

Silicon Testing

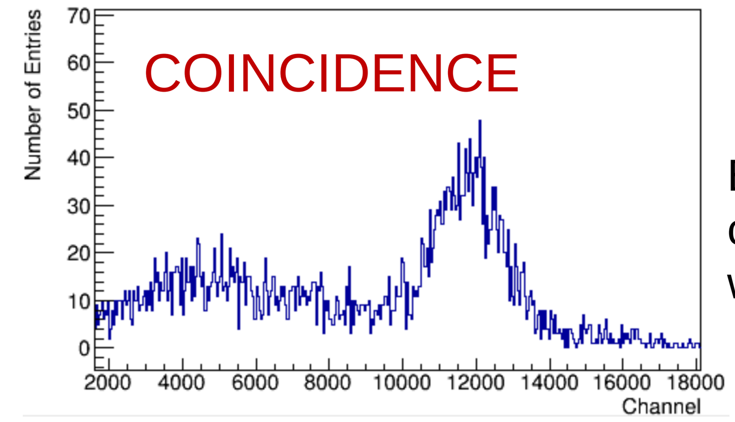
- 24 rings and 32 pies
- Currently triggering on the fast out of rings
- Tested with ^{228}Th alpha source and can achieve 53 keV (0.6%) resolution



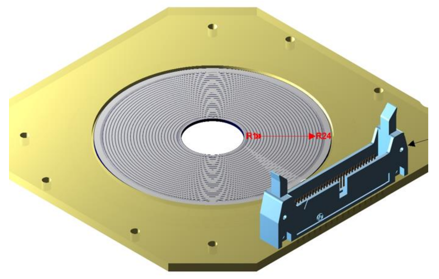




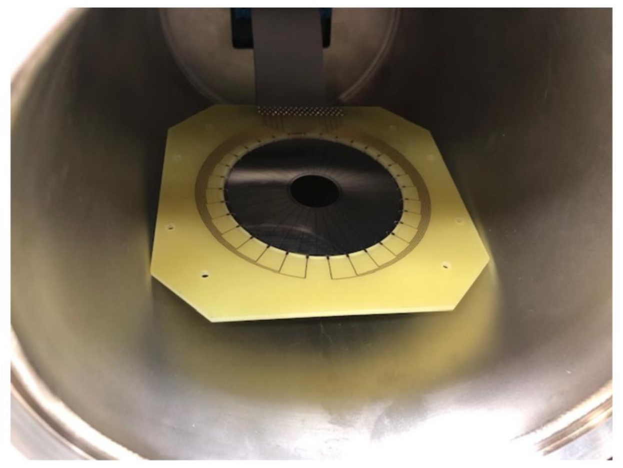
β^+spectrum from ^{68}Ge source



BaF_2 total in coincidence with Si



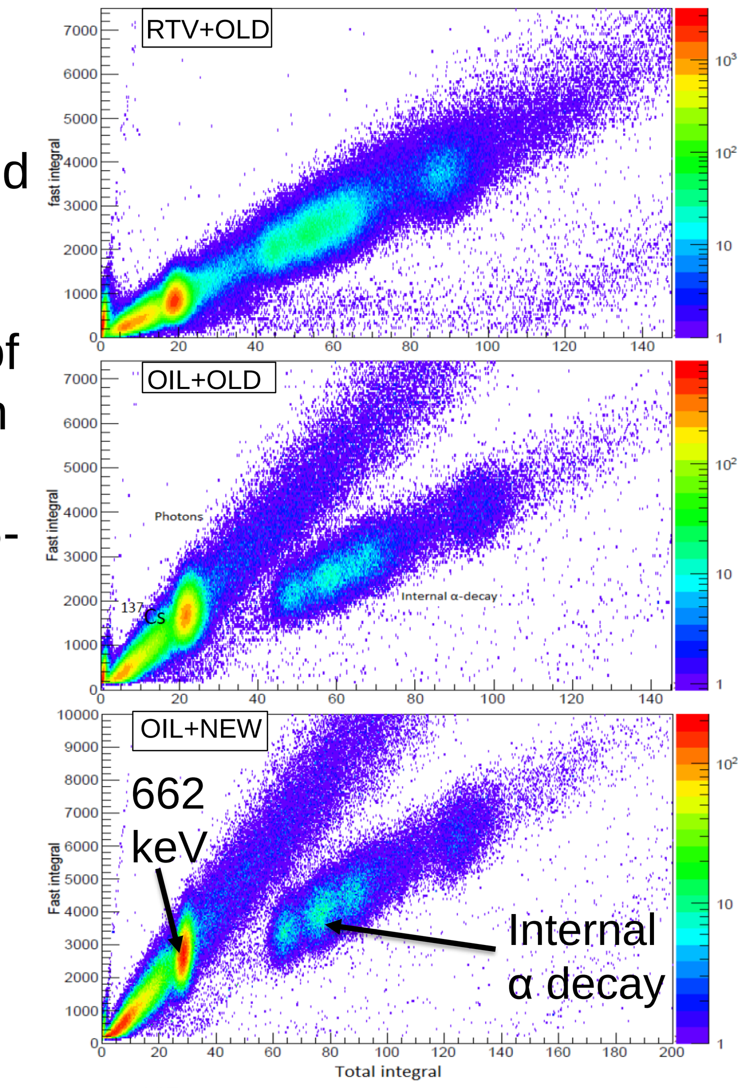
Silicon ring side



- **Top:** Current experimental setup and electronics
- **Bottom:** Silicon detector (pie side)

BaF_2 Resolution Improvement

- Decoupled to try RTV
- Initially successful but found degradation over time and uniformity issues
- Recover fast component of signal when recoupled with oil
- Resolution still between 15-25%
- New PMTs increase resolution of one detector from 17.7% to 11.6%



^{137}Cs source. Separation between internal α-decay and photons can be recovered using oil to couple.

Coming This Fall

- Measure $^{57}Fe(d,p)^{58}Fe$ reaction in order to characterize detector response
- Can check with known states of ^{58}Fe

References

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