Development of a planar germanium double-sided strip detector for beta-decay spectroscopy

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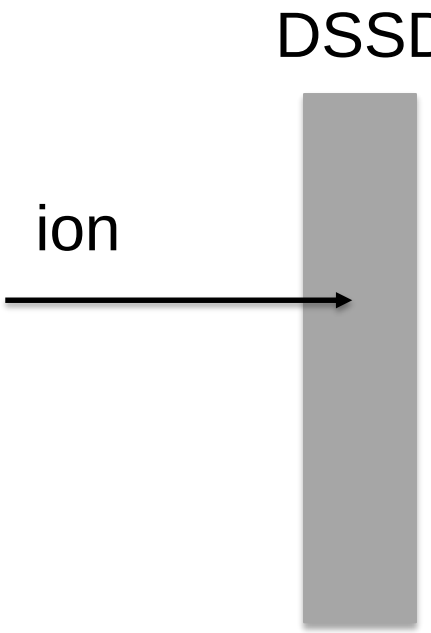
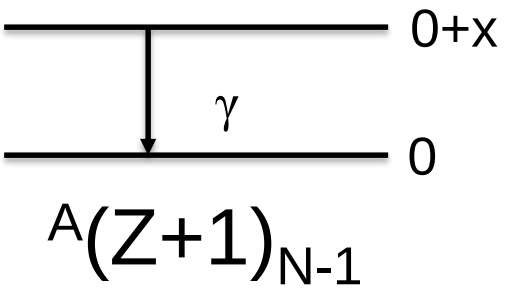
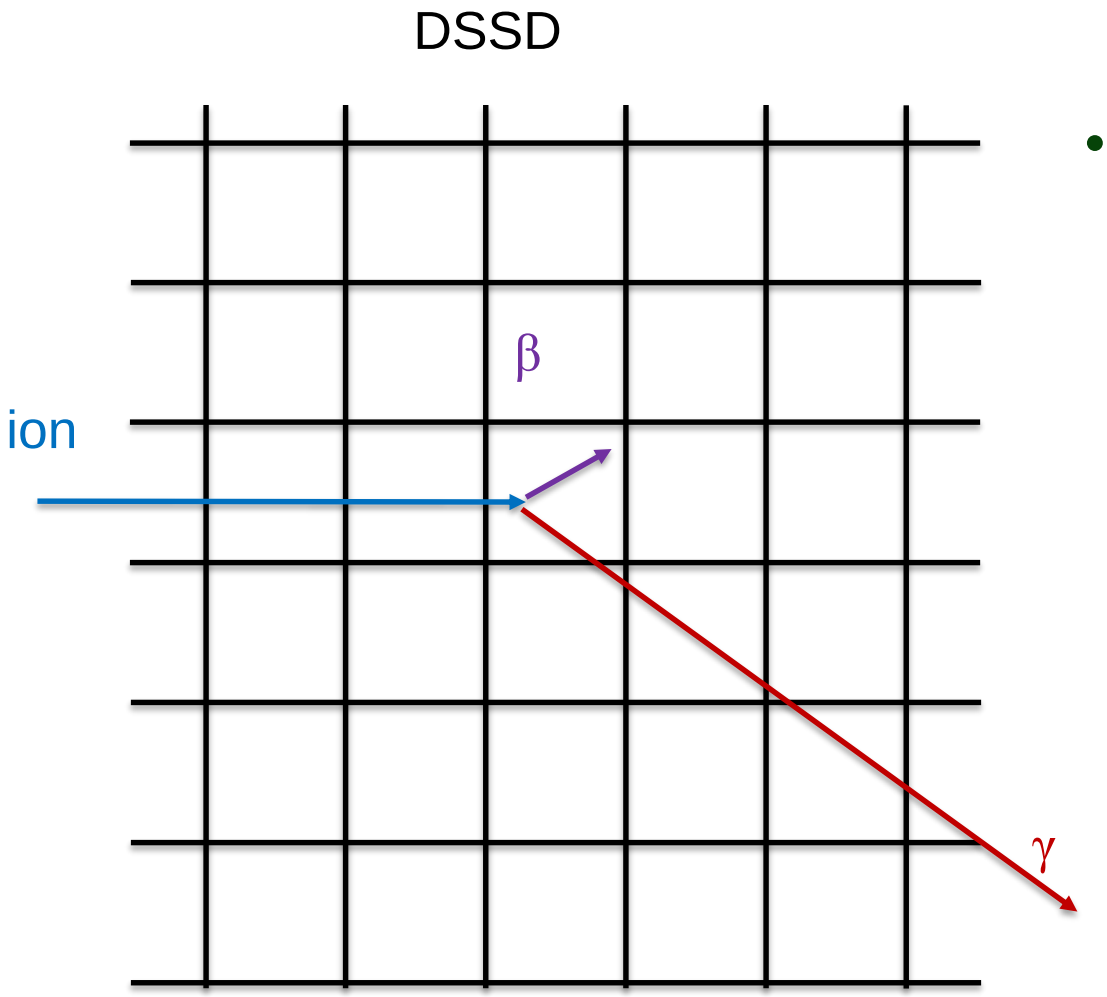
Beta-Decay Spectroscopy

- Applications
  - Nuclear Structure
  - Nuclear Astrophysics
- Ions from fragmentation facility internally deposit on semi-conductor detector





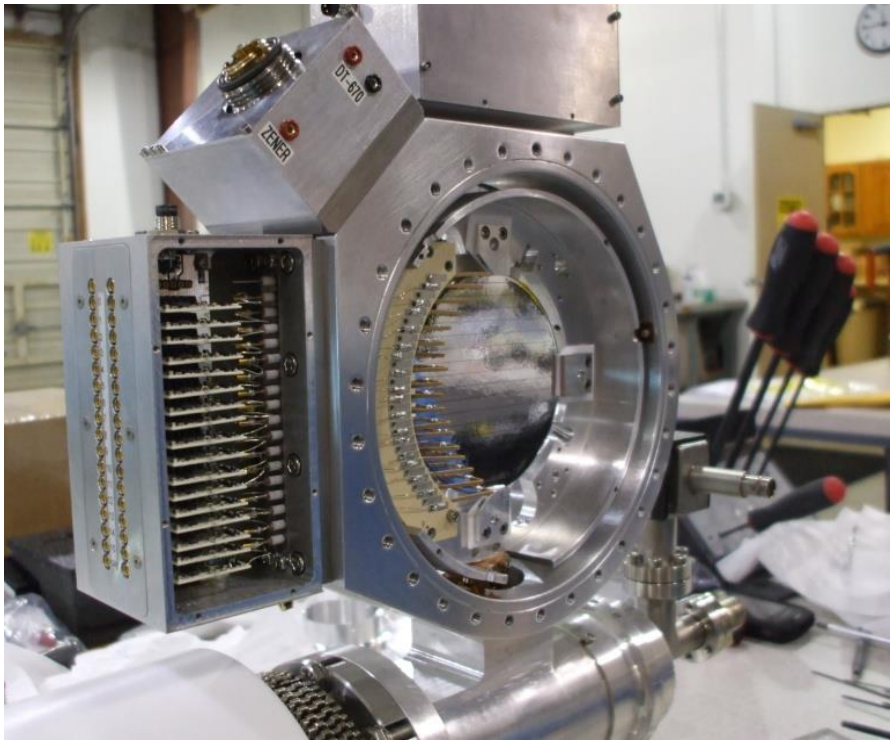
Beta-Decay Detection Efficiency



- Two sets of orthogonal strips with two gain ranges
- Correlate heavy ion energy deposits to subsequent decay events based upon timing and position information
  - Location: strip with maximum energy deposition
  - Time: timing difference between ion and decay events within user-specified window

Beta-Decay Electron Detection Efficiency

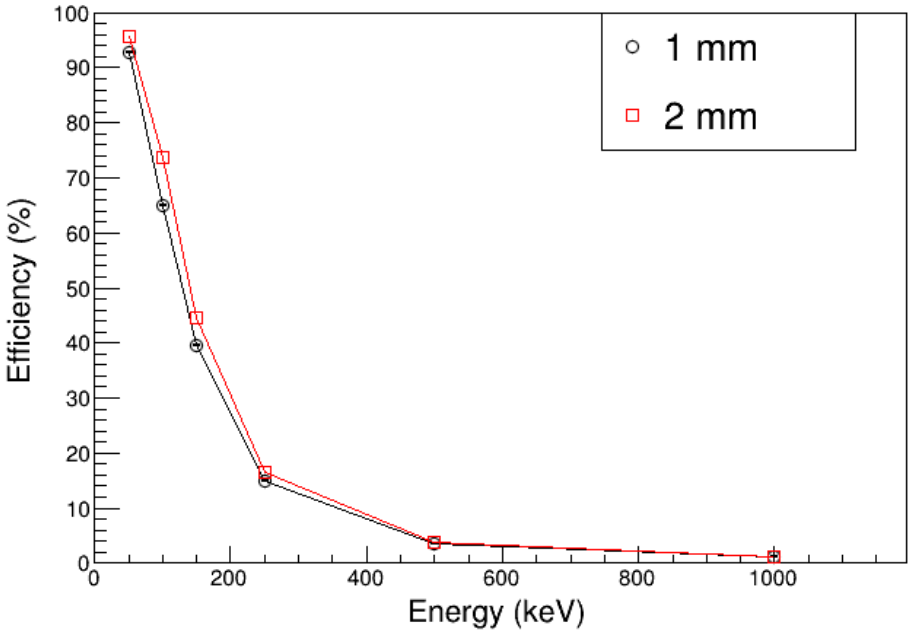
- Previously, Beta Counting System consisted of thin Si DSSD
- Beta detection efficiency of Si setup 35-40% at best
- Planar GeDSSD greatly increases detection efficiency
  - Higher Z of Ge
  - Greater thicknesses available



Prisciandaro, J. I. *et al.,* Nucl. Instr. Meth. A, **505**, 140 (2003)
Larson. N. *et, al.*, Nucl. Instr. Meth. A, **727**, 59 (2013).

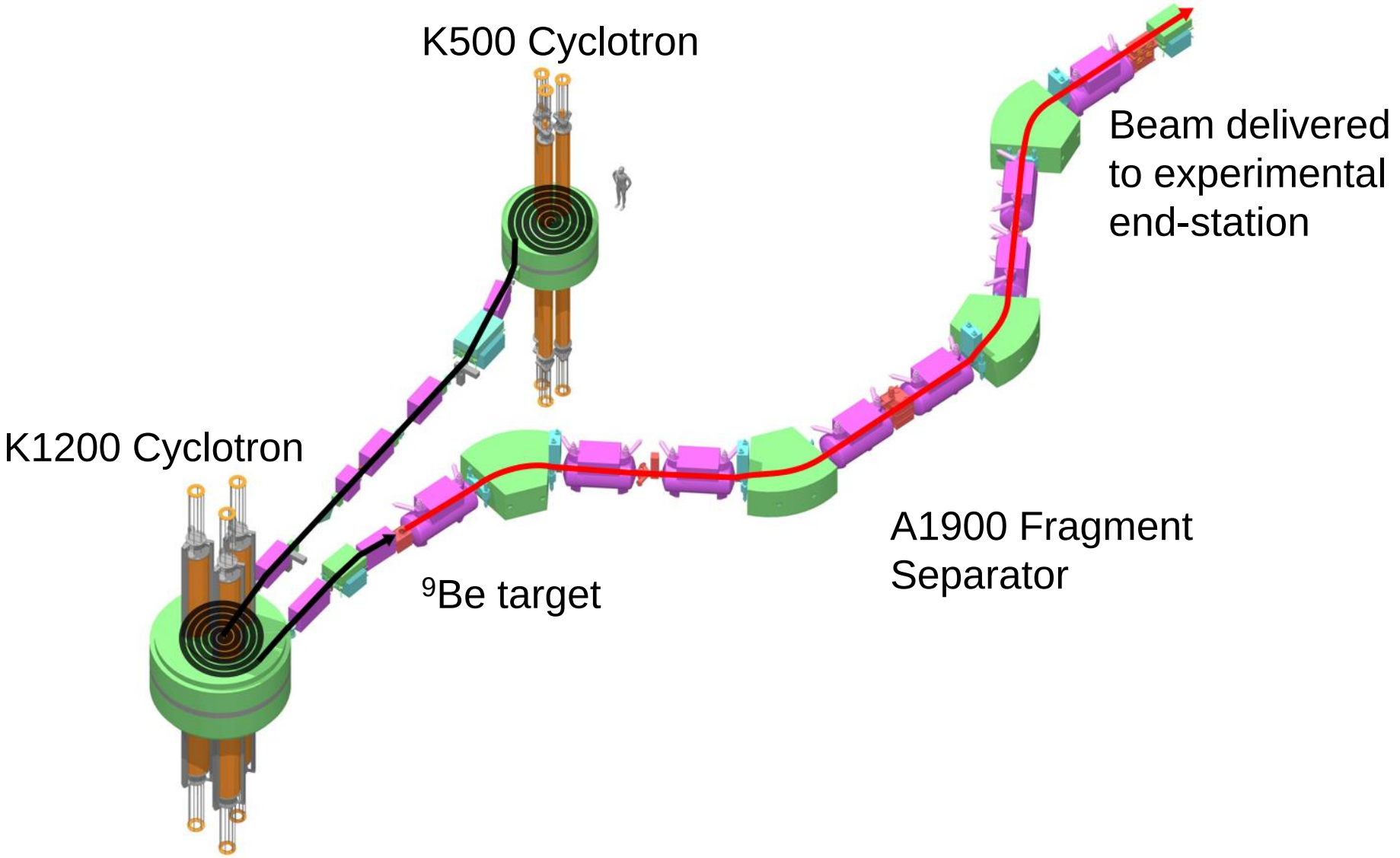
Beta-Gamma Summing

- High efficiency for low-energy gamma-ray
- If a beta-decay electron and a beta-delayed gamma-ray deposit energy at the same location at the same time, the energy depositions will sum (beta-gamma summing)
- Need techniques to separate gamma-rays from electrons

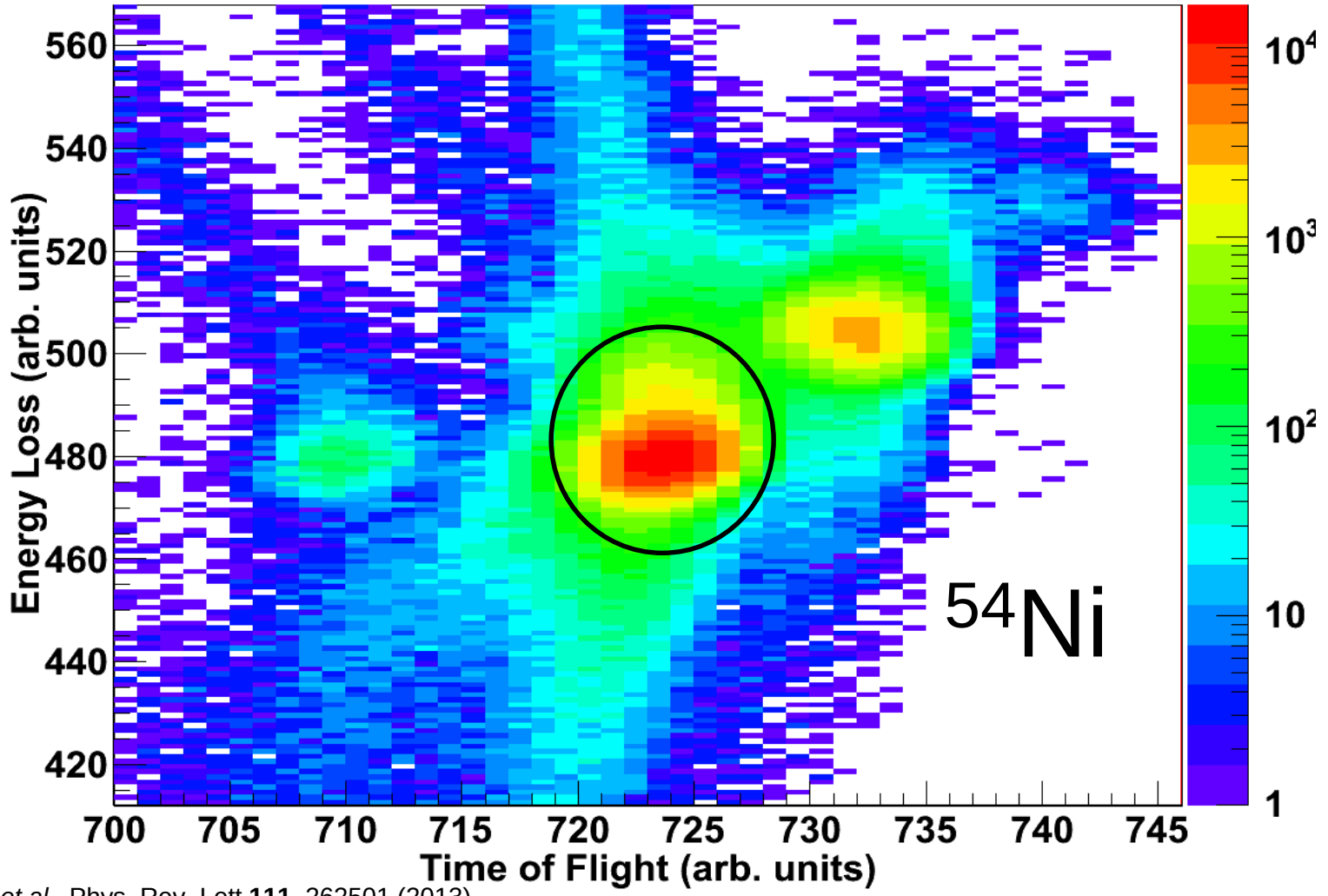


Larson. N. *et, al.*, Nucl. Instr. Meth. A, **727**, 59 (2013).
S. Agostinelli, *et al*., Nucl. Instr. and Meth. A, **506,** 250 (2003).

Isotope Production

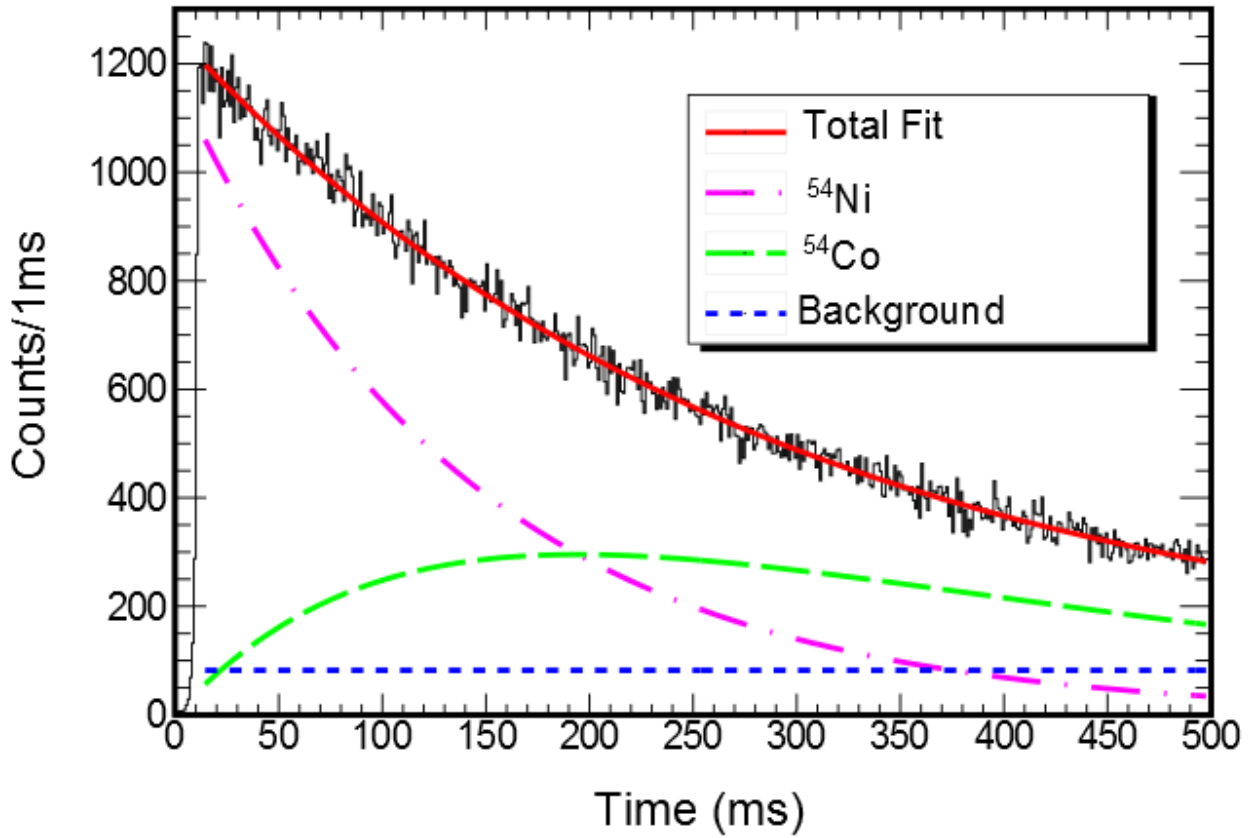


Particle Identification



Tripathi, Vandana., *et al.,* Phys. Rev. Lett **111**, 262501 (2013).

Beta-Decay Detection Efficiency



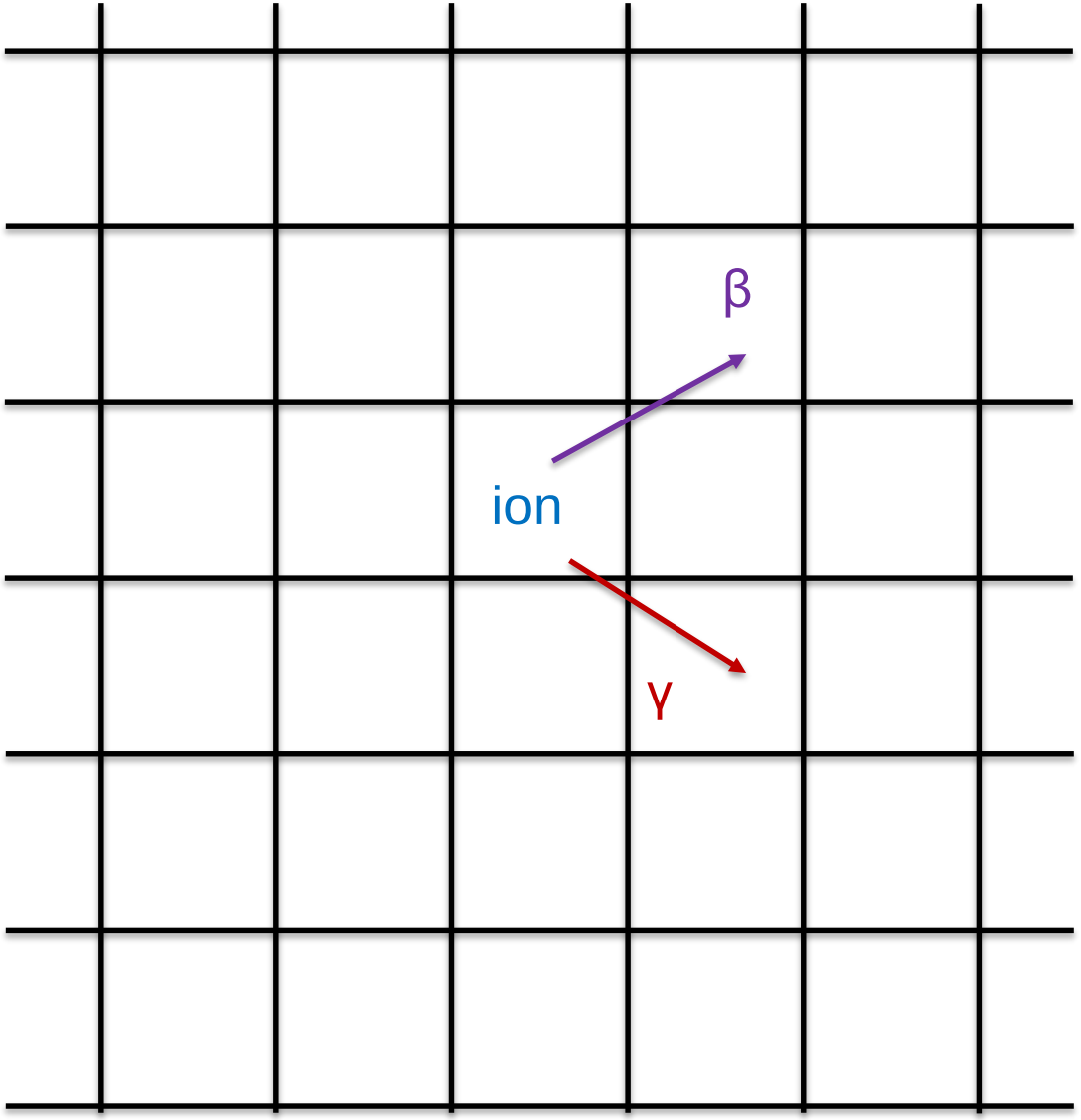
Experimental efficiency: 55(2)%

Simulated efficiency: 62%

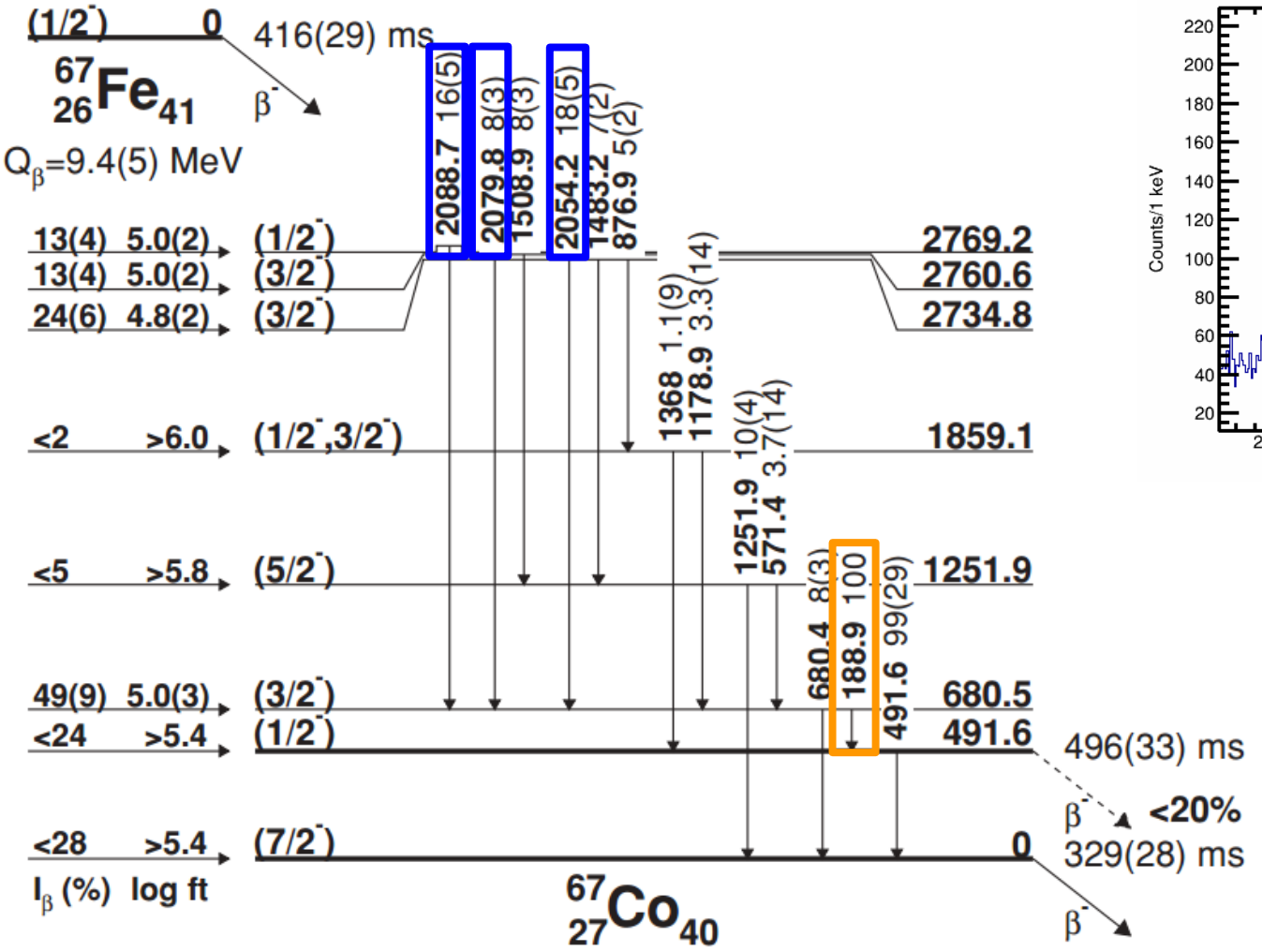
Predicted efficiency for wider correlation field: 87%

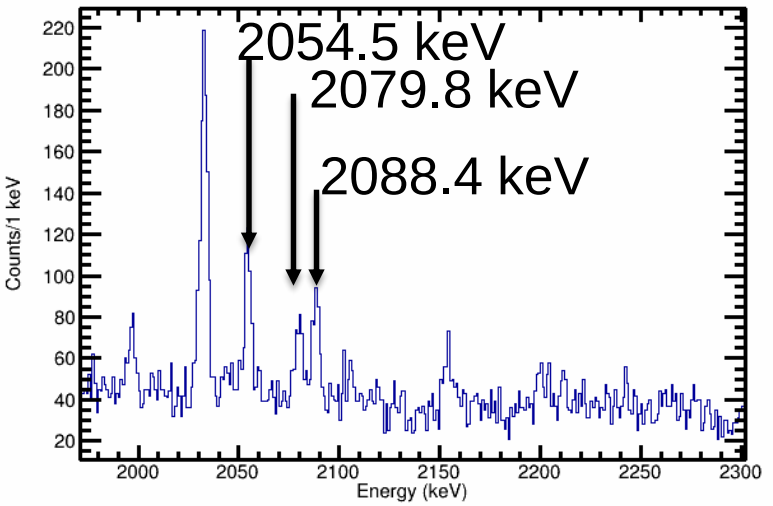
Larson. N. *et, al.*, Nucl. Instr. Meth. A, **727**, 59 (2013).

Beta-Gamma Summing Algorithm



$^{67}Fe \rightarrow {}^{67}Co$



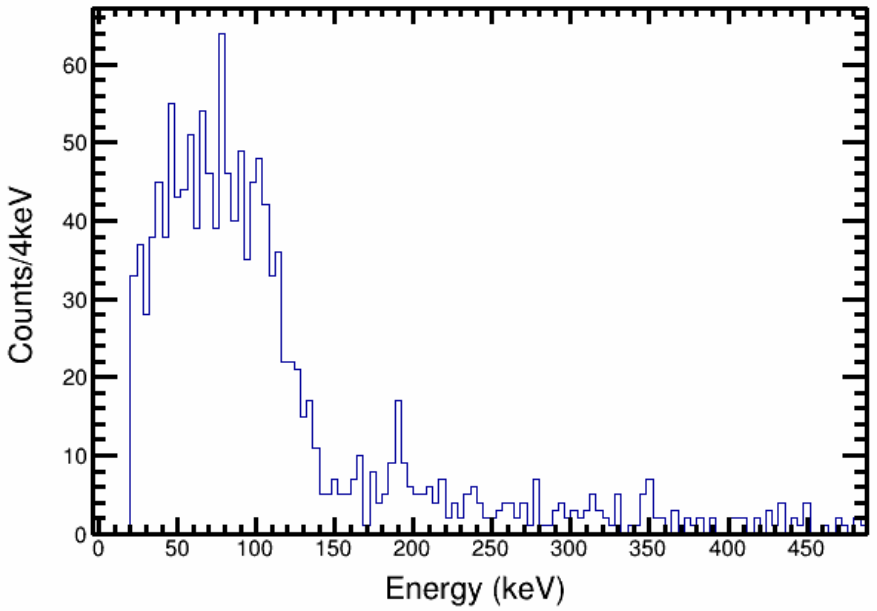


Pauwels, D., *et al.,* Phys. Rev. C **79**, 044309 (2009).

1D Strip Spectra

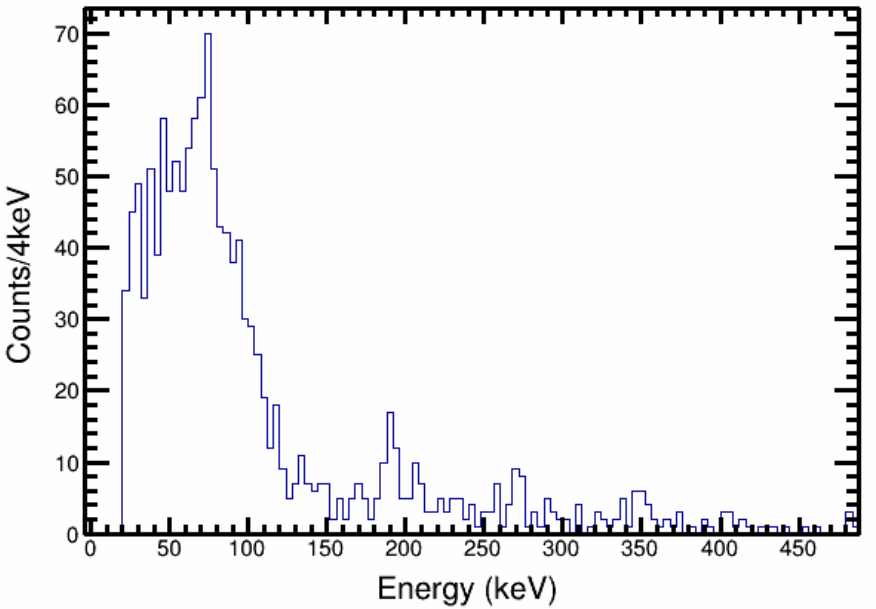
Predicted: 28±8 counts
10±1%

Back Strips



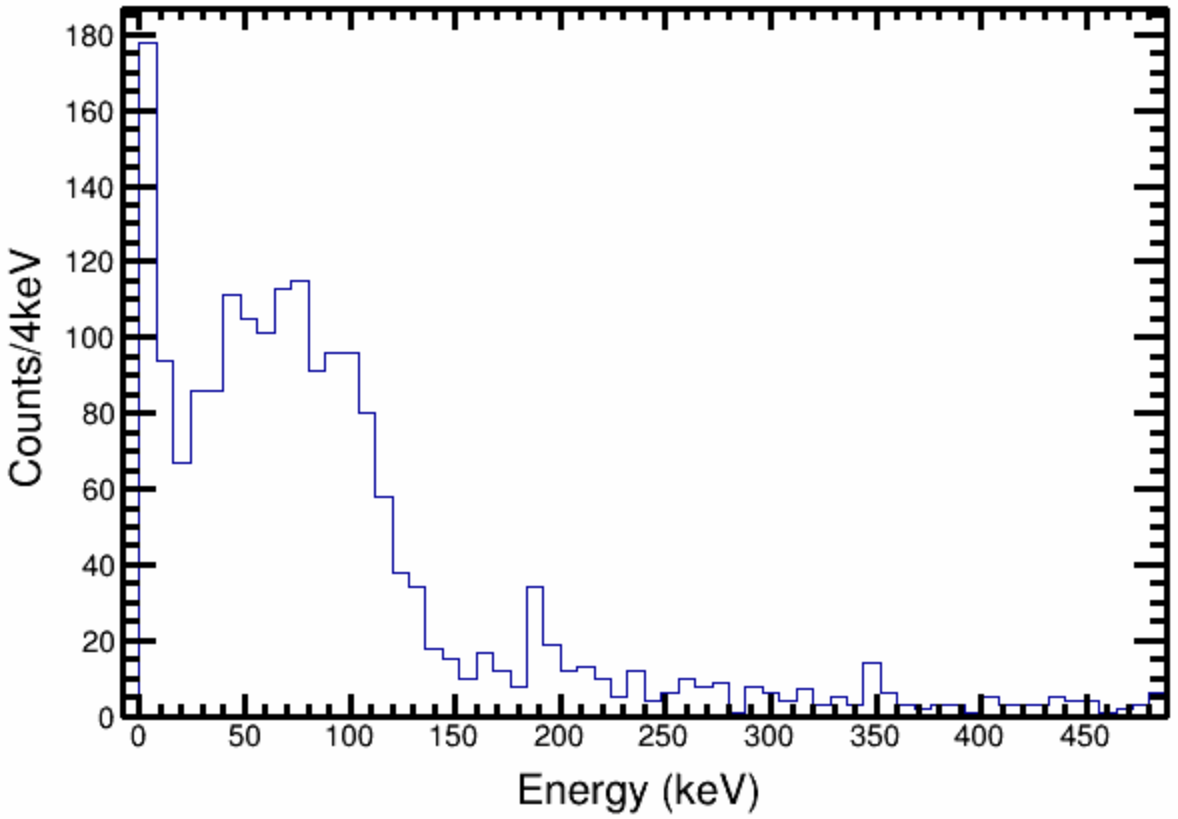
Back: 19±9 counts
7±3%

Front Strips



Front: 25±10 counts
8±4%

Algorithm Results



Predicted: 48±13 counts
17±1%

Experiment: 30±11 counts
11±4%

Conclusion and Outlook

- Demonstrated beta-decay detection efficiency of 60%, with indications of increasing to 90%
- Demonstrated beta-gamma summing algorithm can recover gamma-ray detection efficiency
- We look forward to future experimental campaigns

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