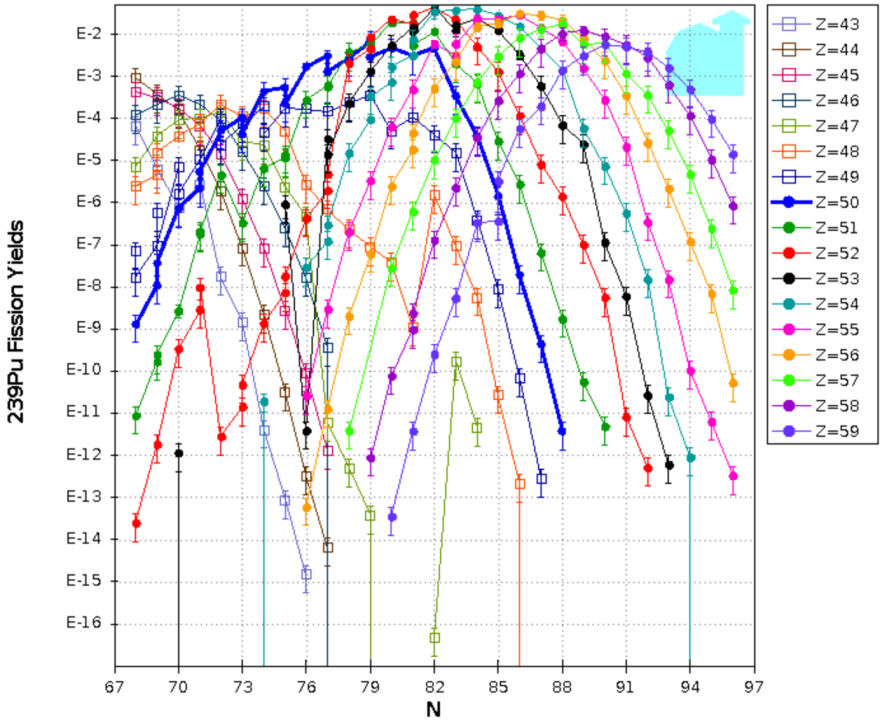
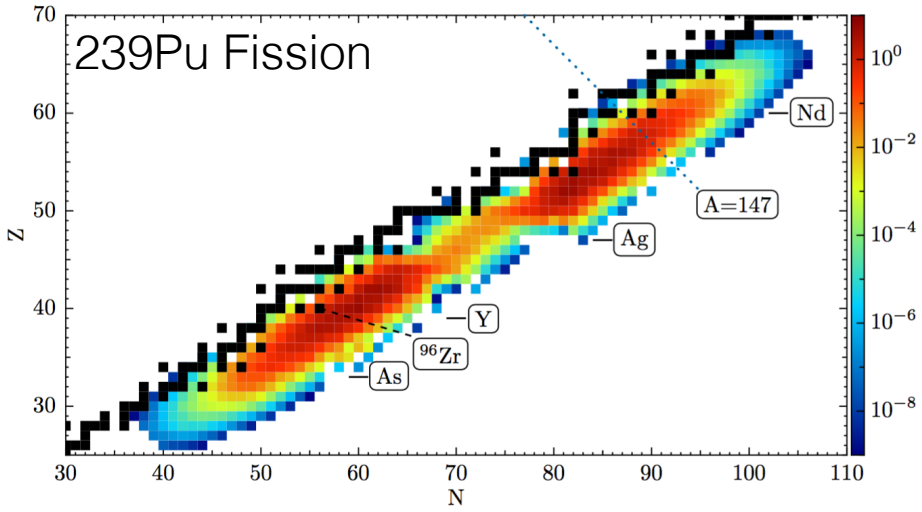
Fission Product Yields with SPIDER at LANSCE

Jack Winkelbauer

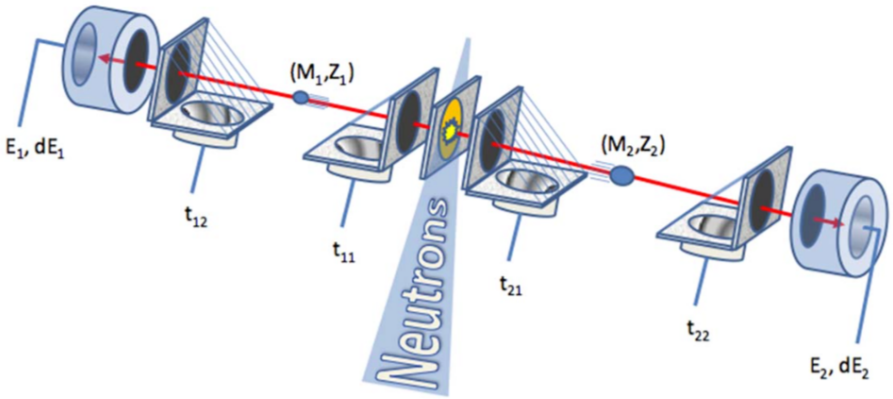
Fission Product Yields

- Fission modeling
- Radiochemical diagnostics
- Weapons simulations





Precision Independent FPY's



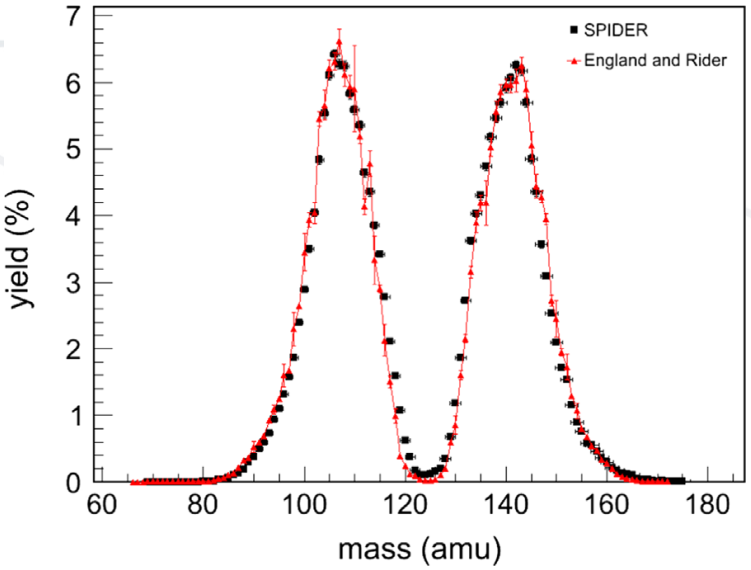
$$M = \frac{2Et^2}{l^2}$$

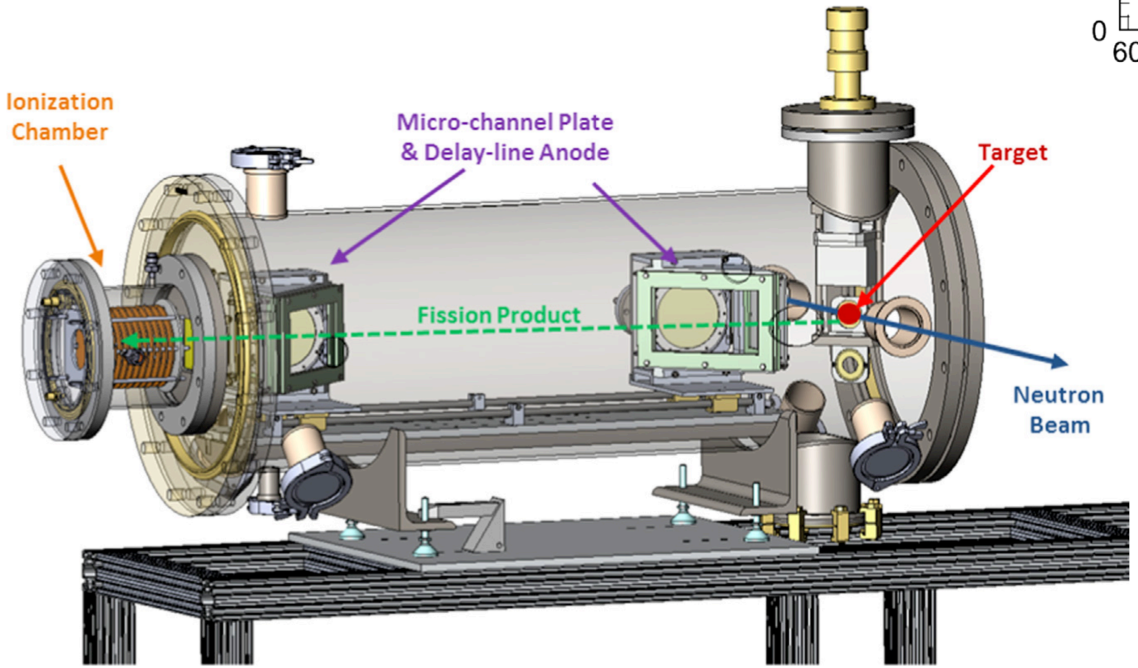
$$\frac{\delta M}{M} = \sqrt{\left(\frac{\delta E}{E}\right)^2 + \left(2\frac{\delta t}{t}\right)^2 + \left(2\frac{\delta l}{l}\right)^2}$$

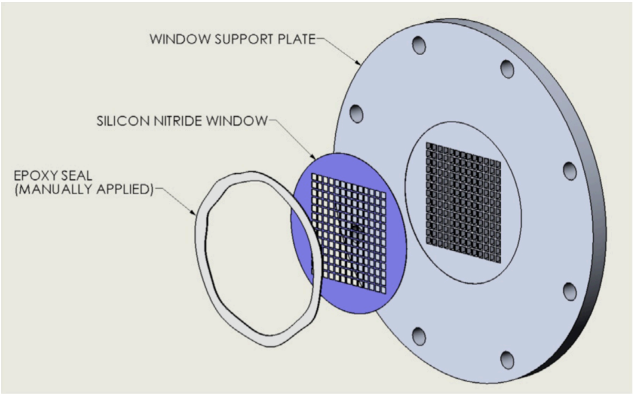
- 2E-2v Method
  - 100 ps timing measurement
  - 0.5% energy measurement
  - 1mm position(s) measurement
- Measure velocity with MCP's, energy with ionization chambers
- Bragg-curve spectroscopy for Z-ID
- Scalable to increase efficiency
- Objective: <1 AMU mass resolution, 1% efficiency
- **TKE and neutron emission as a function of A and E_n**

Prototype SPIDER

- 2 arm (~3e-4/arm)
- 200 nm SiN window array







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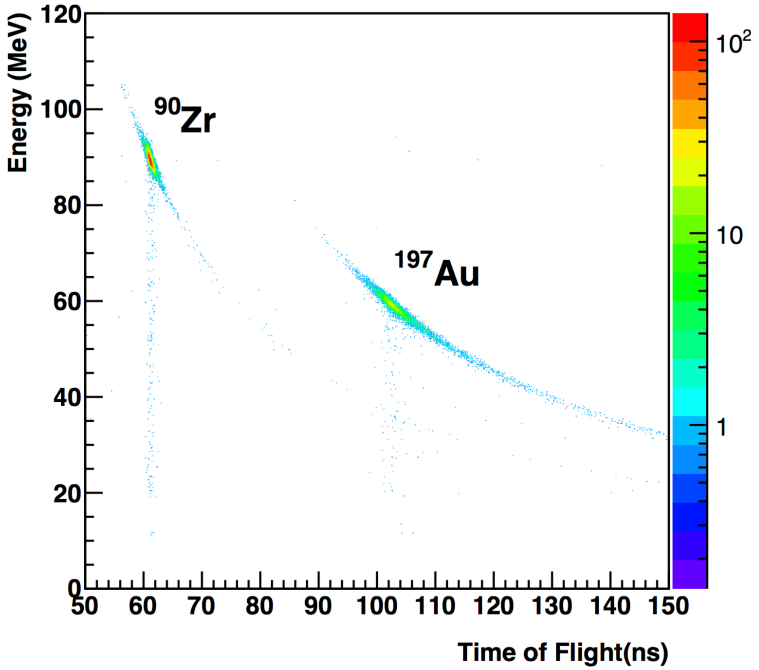
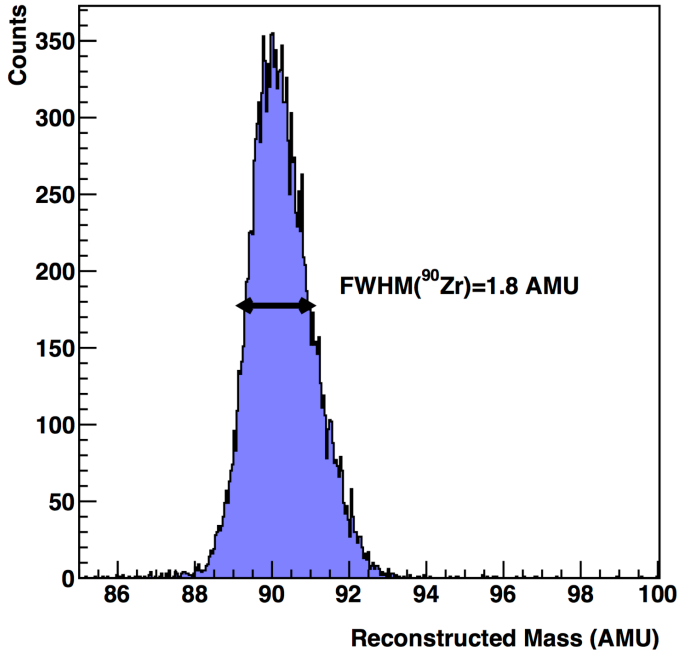
Notre Dame (Dec. 2017)

- 90 MeV 90Zr beam
- Scatter Zr ions from Au foil
- SPIDER arm at 45 degrees

Prototype SPIDER Performance (Notre Dame)



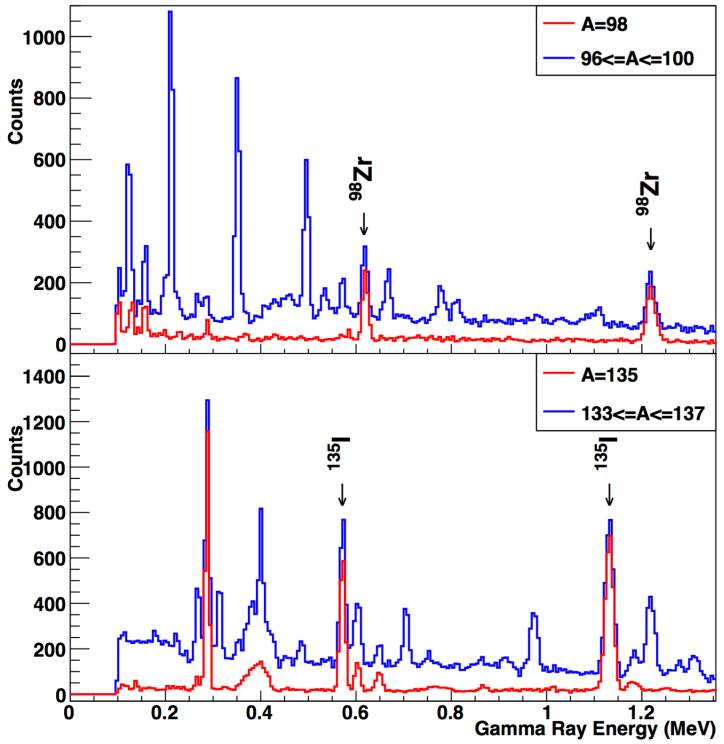


Planned Improvements to SPIDER

- Redesign IC Window
- MCP Position Readout
- Frisch Grid (Z ID)
- MCP timing signals from sample, IC window
- *Gamma-ray Detection*

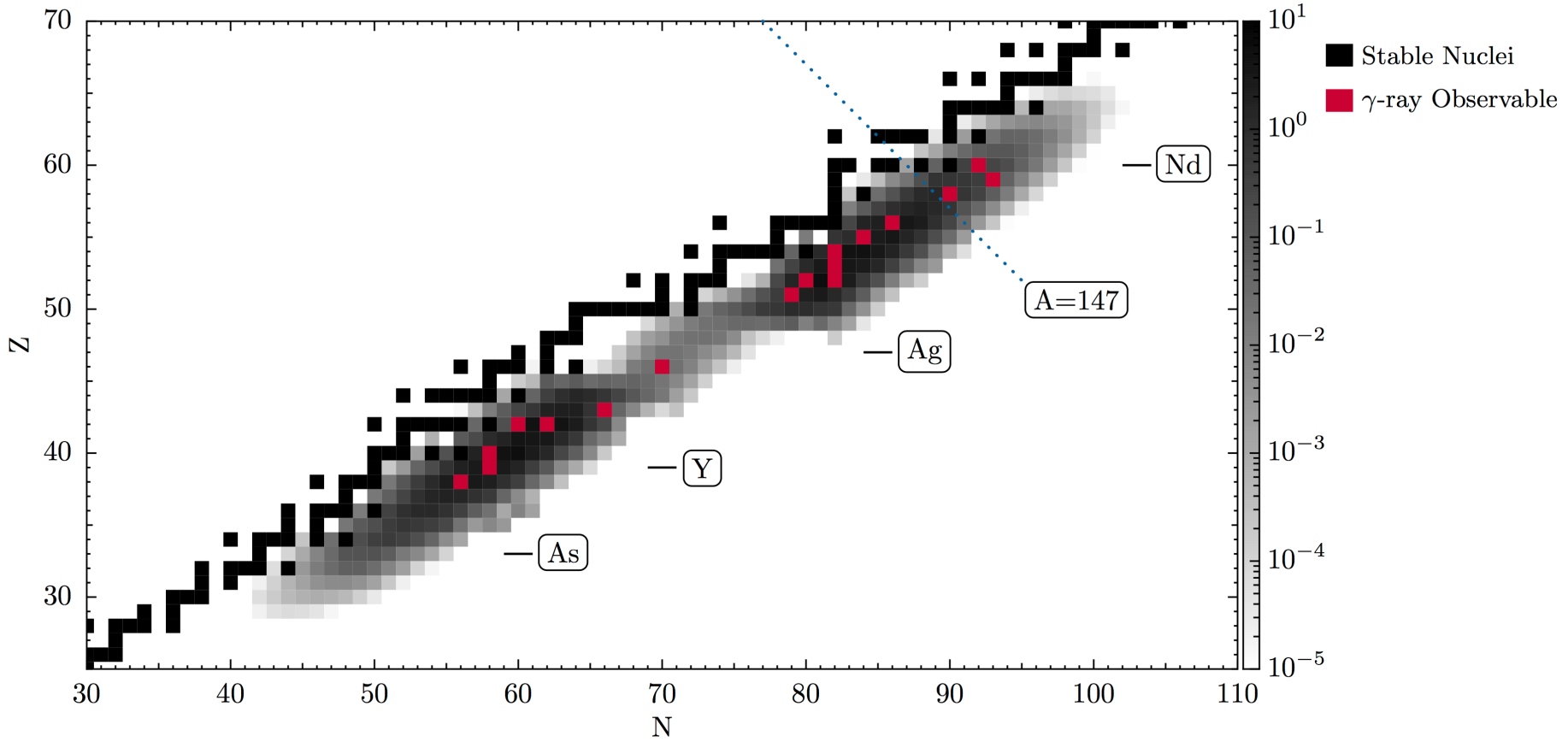
Gamma-ray tagging with SPIDER

- In-situ Mass calibration
- Calibration of Energies (TKE)
- Detector Response
- Mass dependent gamma-ray spectra



CGMF, 252Cf(sf)

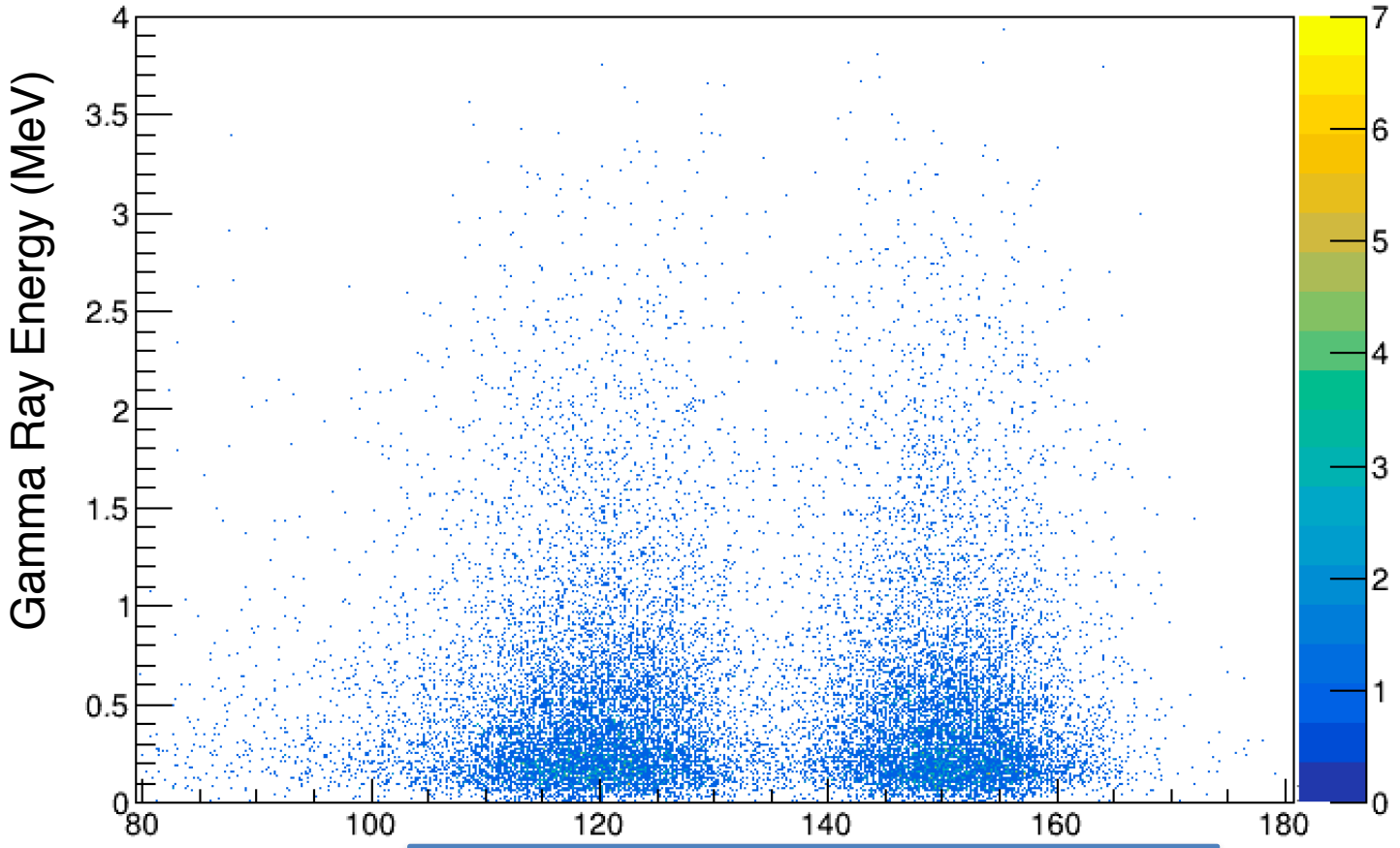
Gamma-ray tagging with SPIDER



Gamma-ray tagging with SPIDER

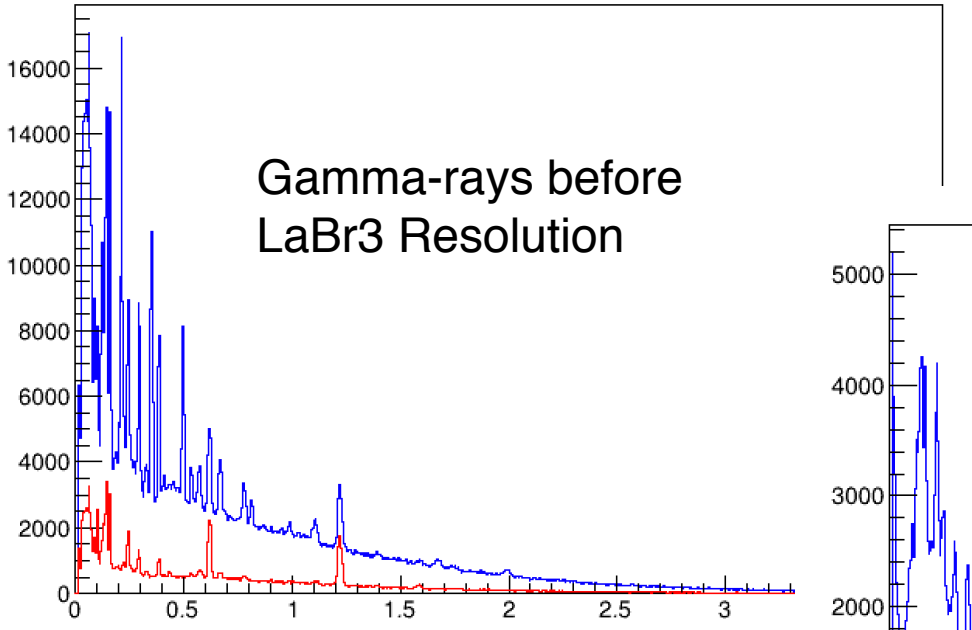
Iteration 1: LaBr3

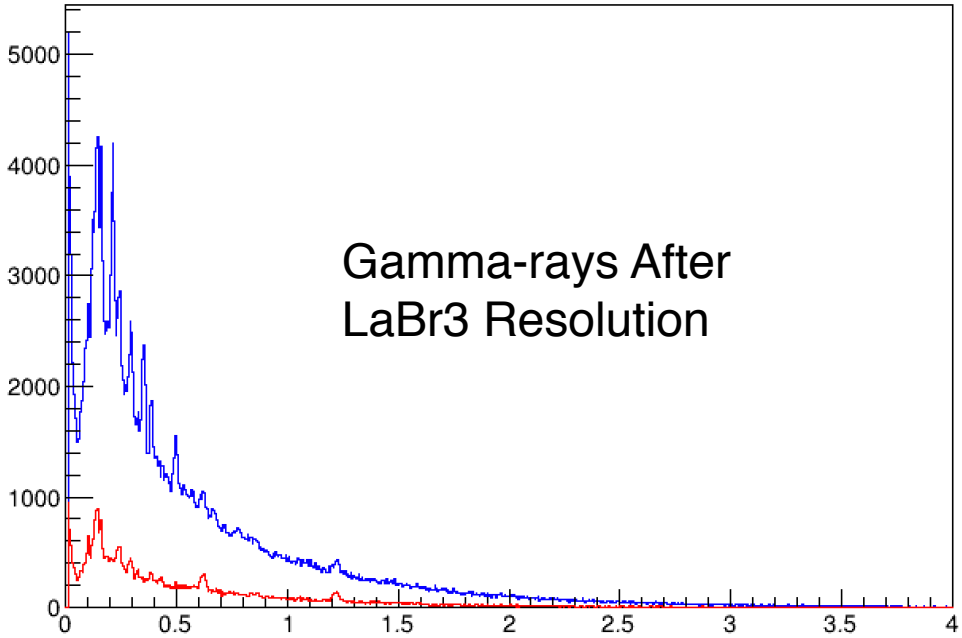
- Good Efficiency, good timing, moderate resolution
- Not adequate-> hpGe
- ~3 weeks, 1 uCi, 1/4 array



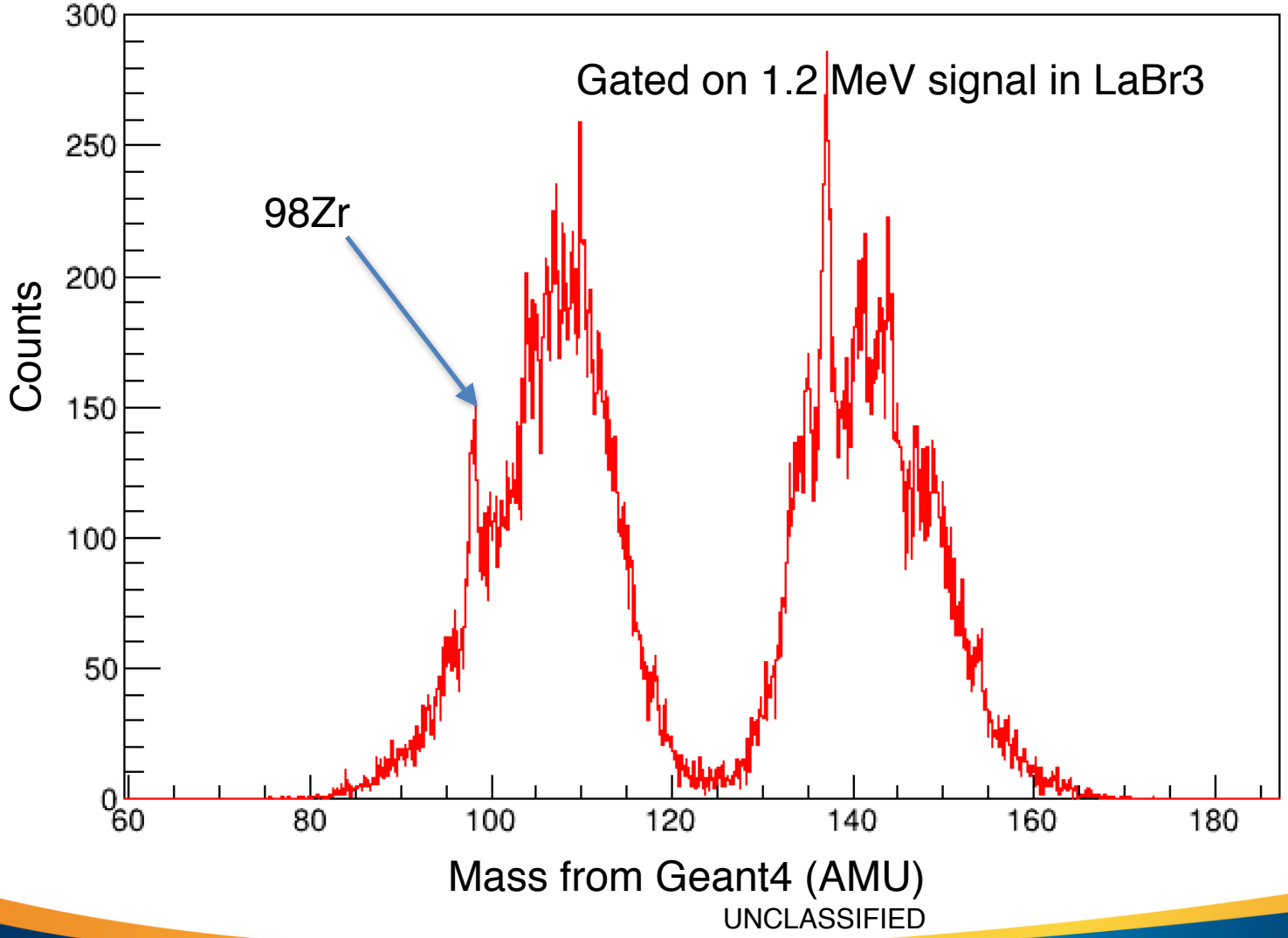
Iteration 1a: LaBr3 Geant4

10 days, 10 uCi, 8 detectors





Iteration 1a: LaBr3 Geant4

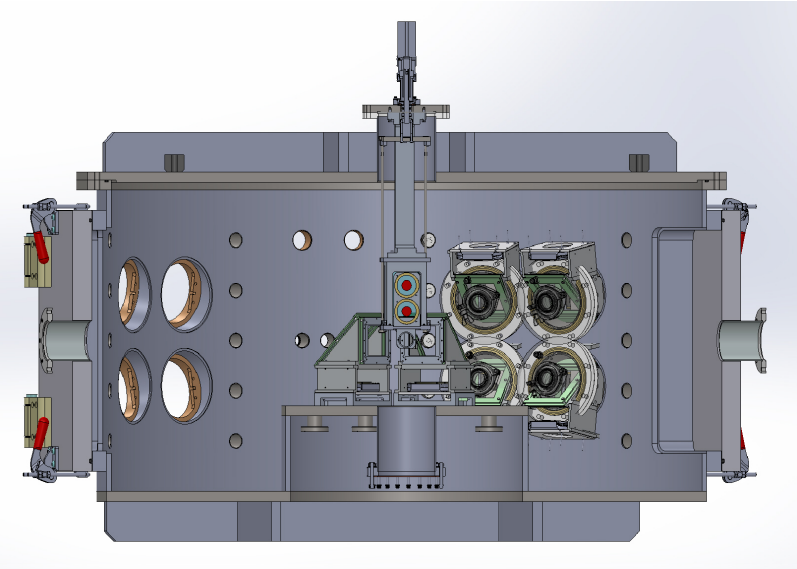


Iteration 2: hpGe

- moderate efficiency, moderate timing, great resolution
- More 252Cf
-

Full Scale SPIDER (In Progress)

- Measure Independent Fission Product Yields
- Important for weapons; radiochemical diagnostics
- Need High Efficiency for Fast Neutrons at WNR



Acknowledgments

Current LANL

D. Connolly, S. Mosby, C. Prokop

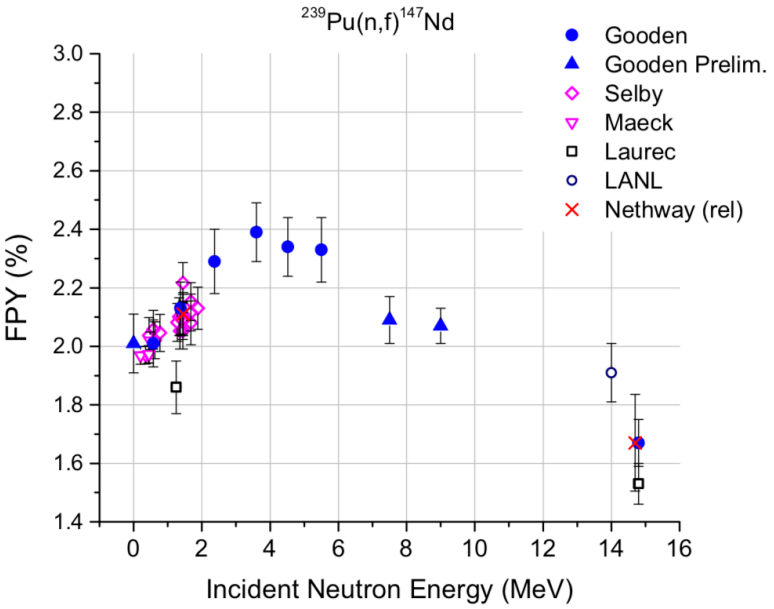
Past LANL

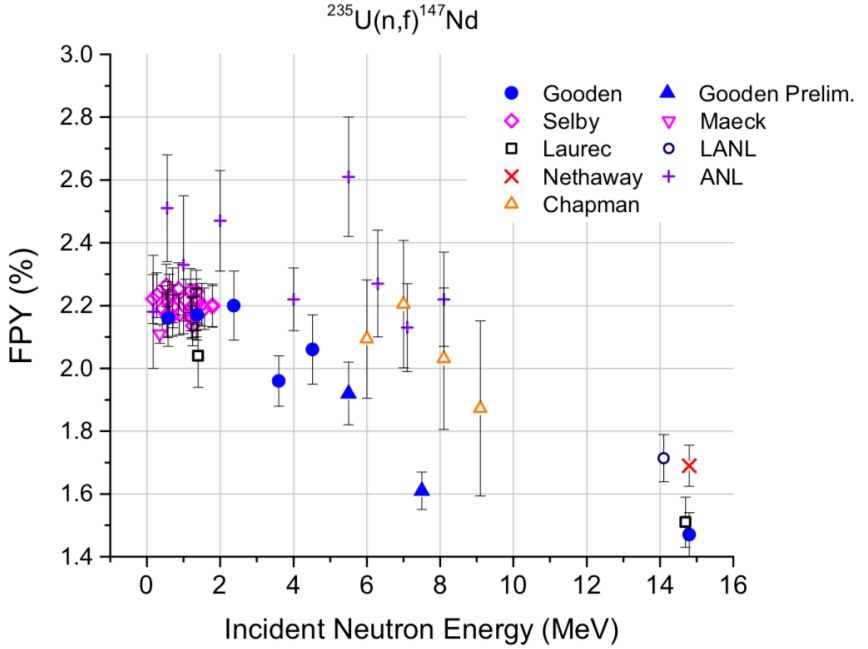
K. Meierbachtol, D. Mayorov, C.W. Arnold, F. Tovesson

UNM

A. Hecht, R. Blakeley, P. Baldez

Fission Product Yields





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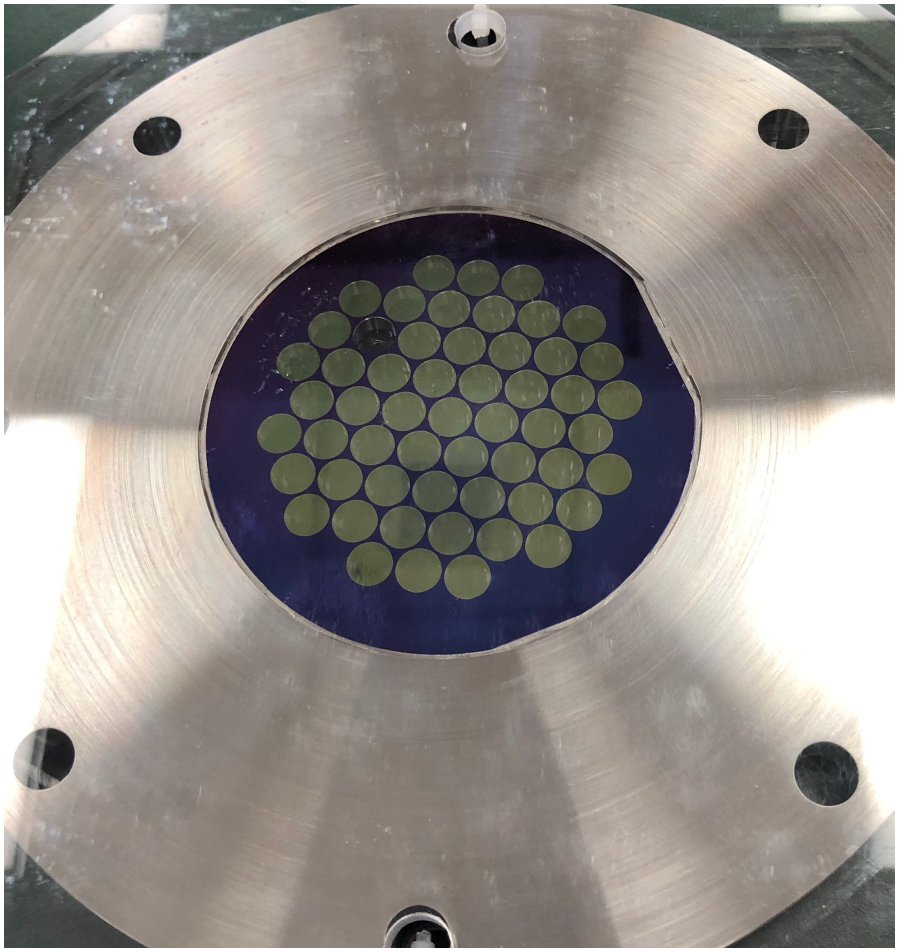
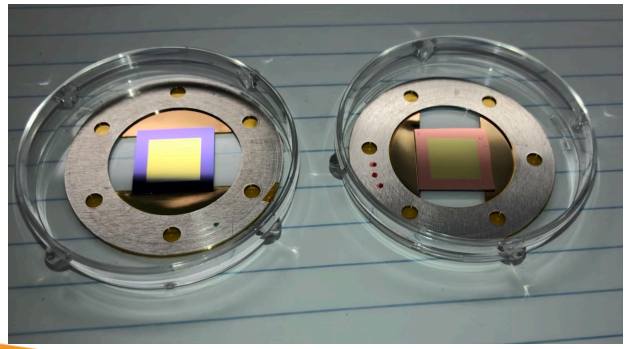
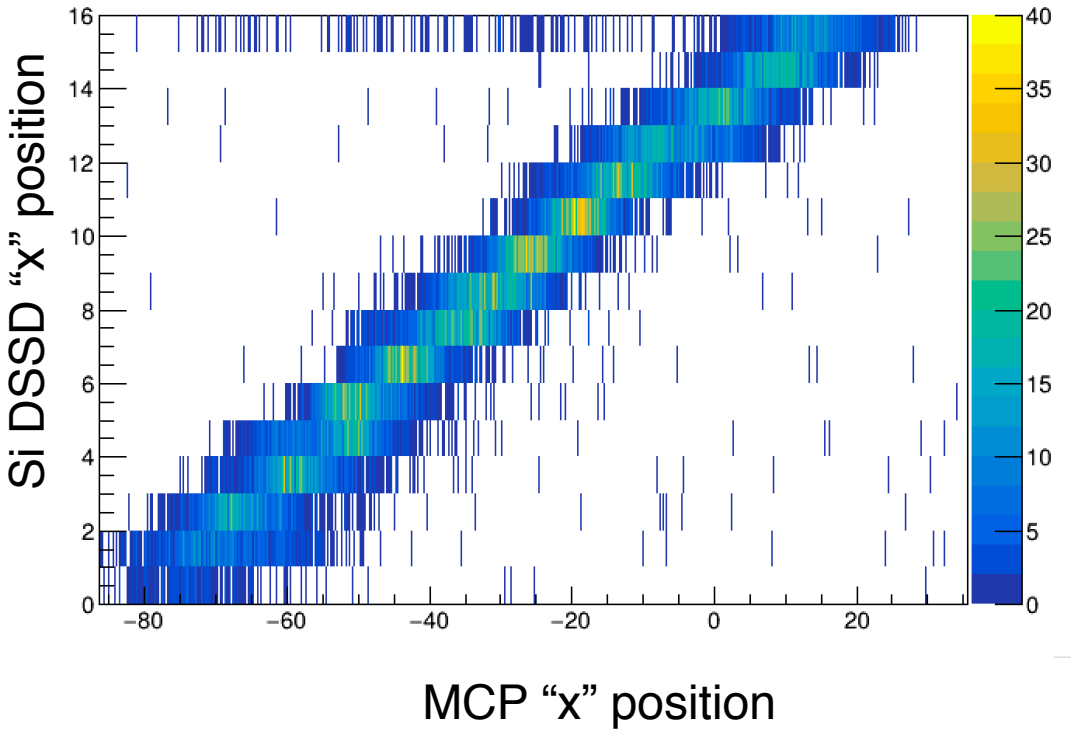
Window Redesign

- Circular window cells
- Larger (9mm vs 3.75mm)
- Complete assembly by manufacturer (Norcada)
- Secondary Electrons?





MCP Position Readout



- Delay line anode (~100 um resolution)
- Electrostatic mirrors (~1mm for FF, 5mm for alphas)
- Position dependent pulse shape (digitized DLA signals?)