Preliminary Results of a 2V-2E Fission Fragment Spectrometer

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In collaboration with
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Los Alamos National Laboratories

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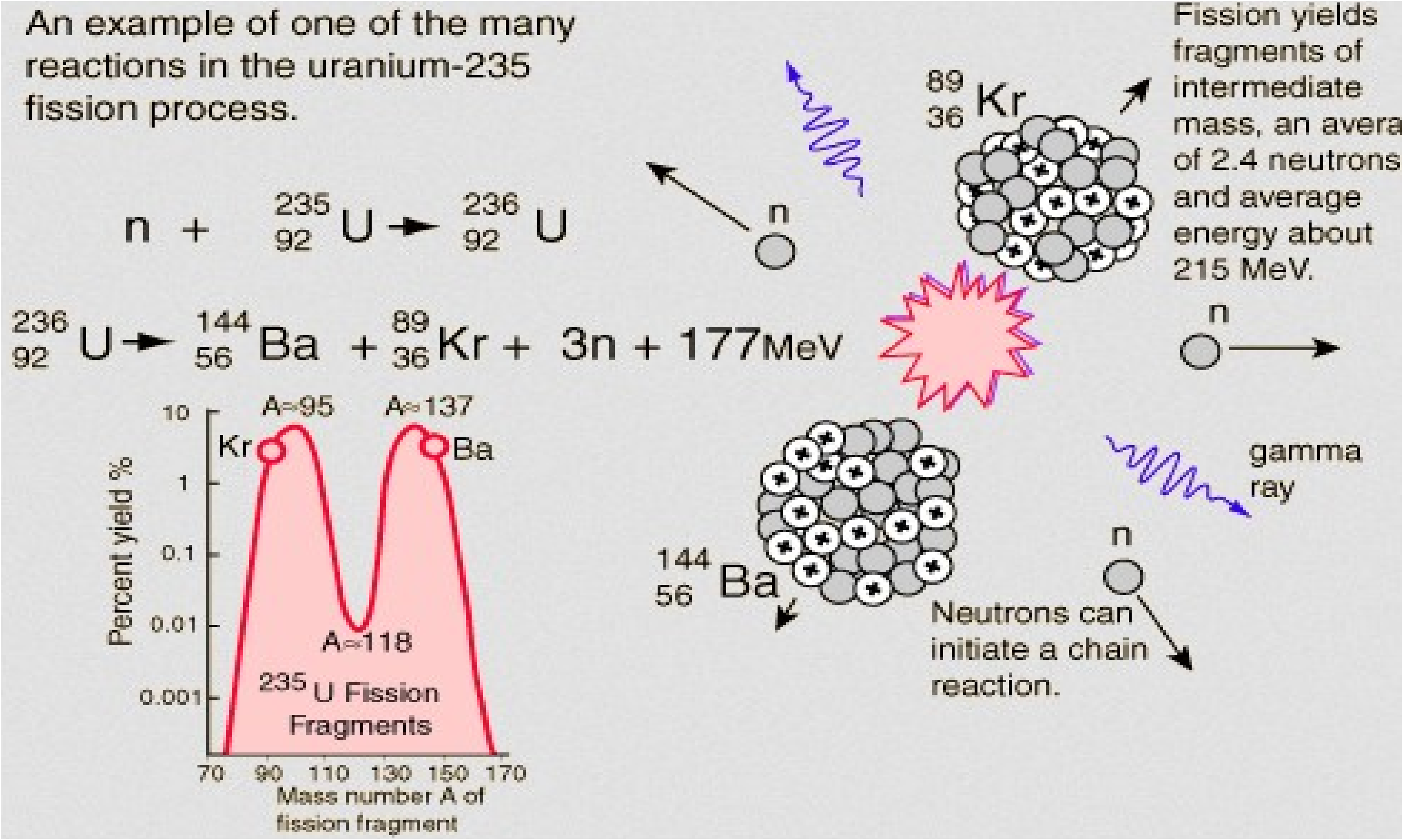
Outline

- Motivation/Introduction
- Detector Overview & Equations
- Time of Flight Detector
- Ionization Chamber
- Preliminary Results
- Conclusions & Future Work
  - Active Cathode

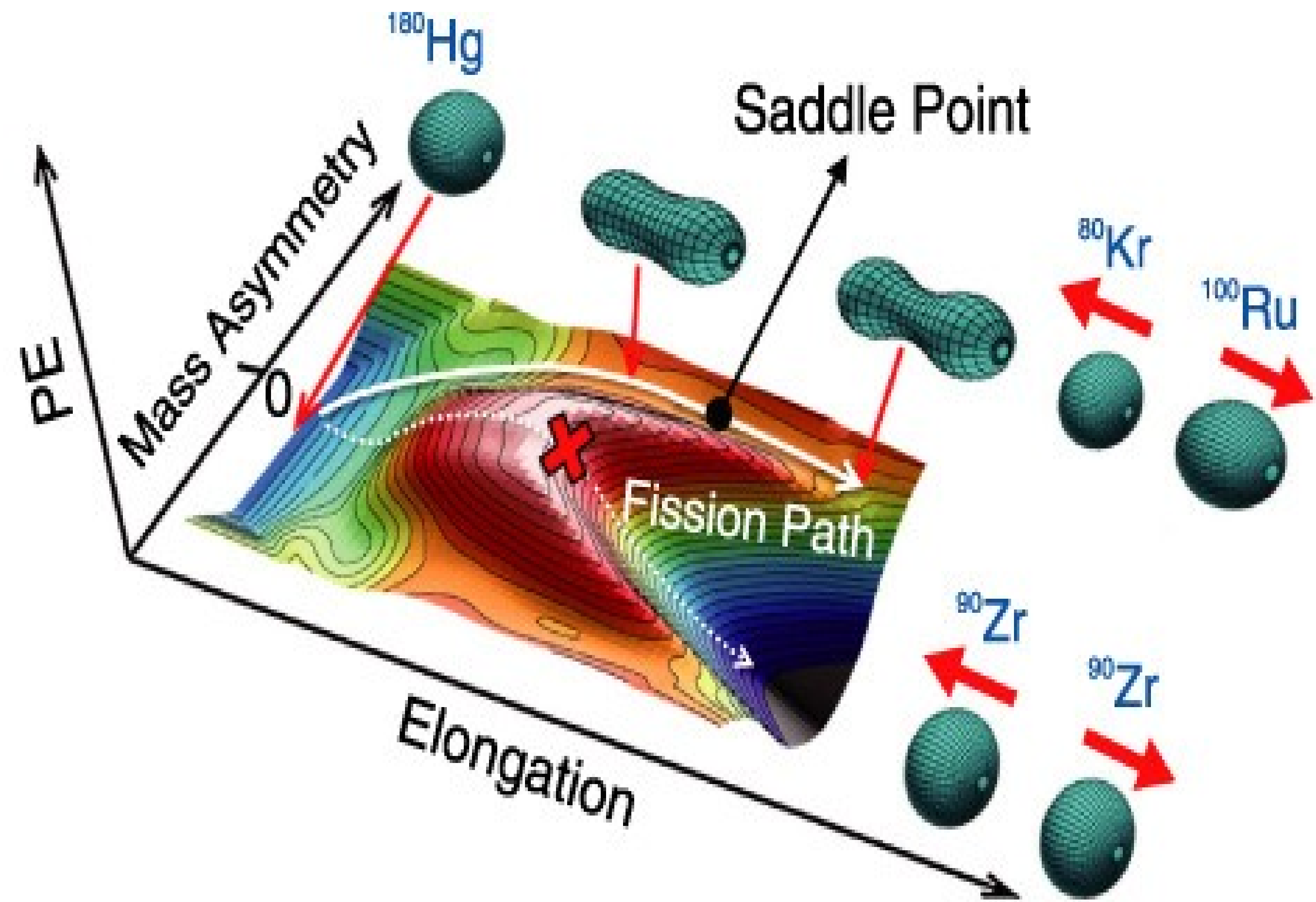
SPectrometer for Ion DEtection in fission Research (SPIDER)

- Motivation
  - More information for fission fragment inventories
    - Current data limited to ~thermal & 14MeV (DT)
    - Waste, reactors, nonproliferation, stockpile stewardship
    - Verification of simulation and theory regarding fundamental fission processes
  - Goal: less than or equal to 1 amu mass resolution

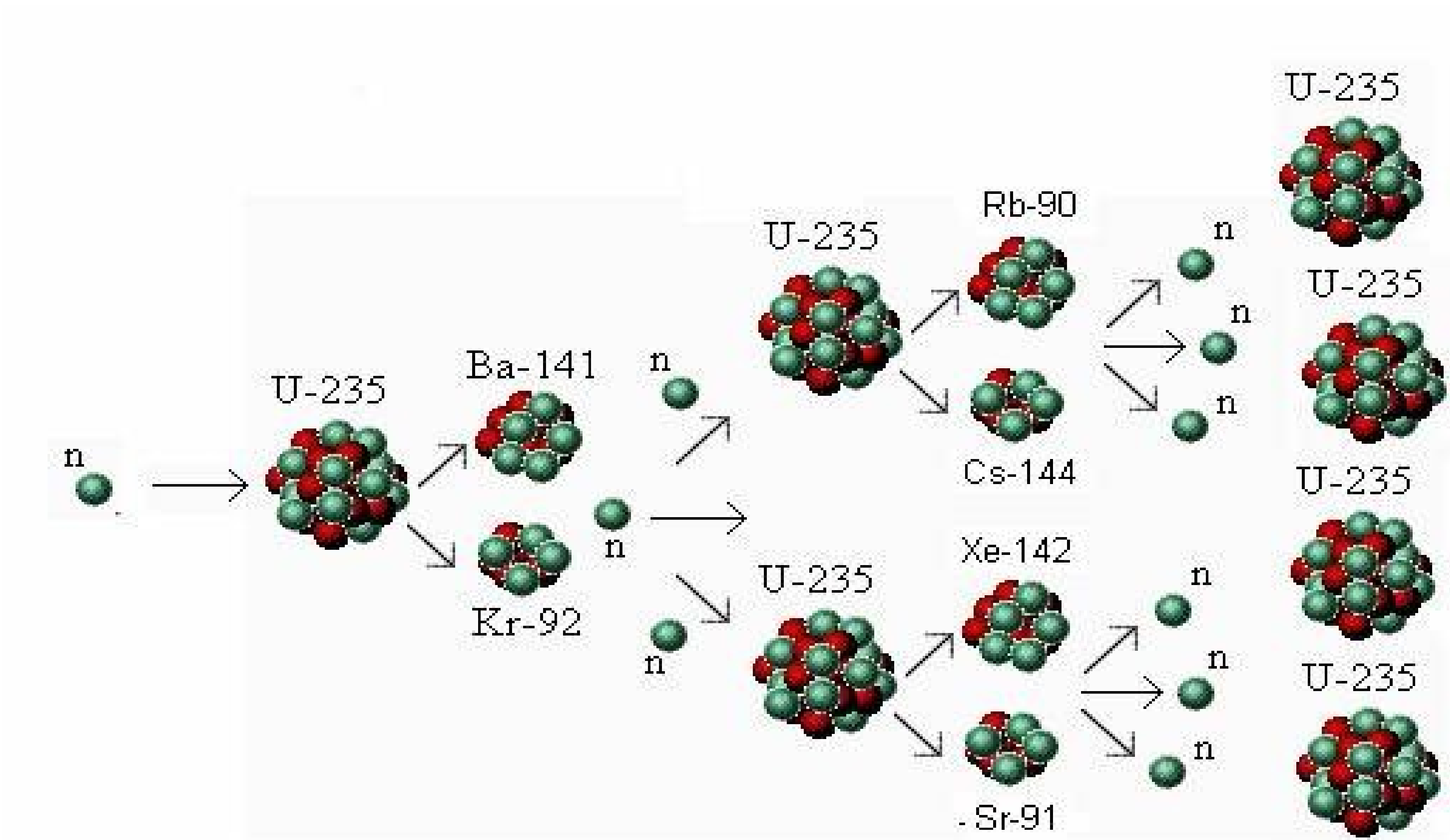
Fission Fragments



Fission Fragments: Nuclear Peanuts



Fission Fragments



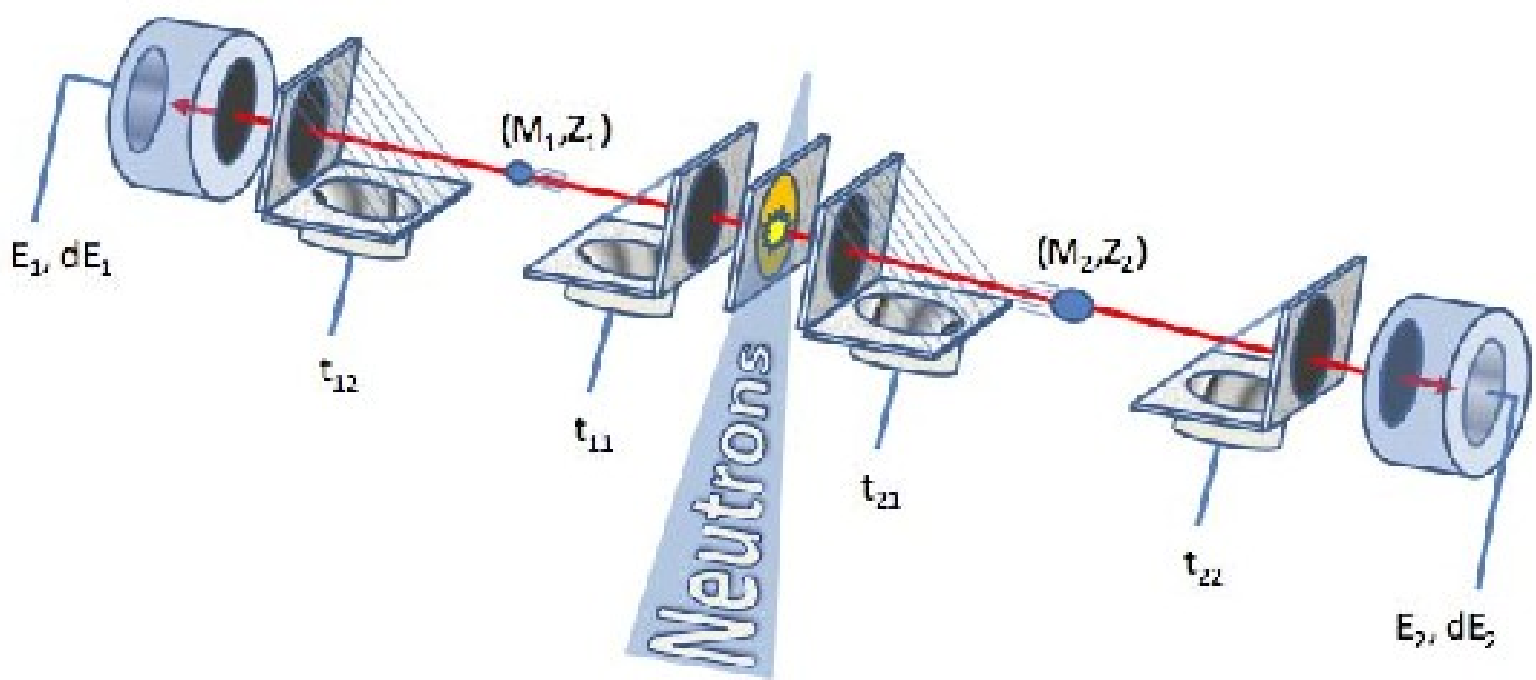
Spectrometer Overview

- 2V-2E

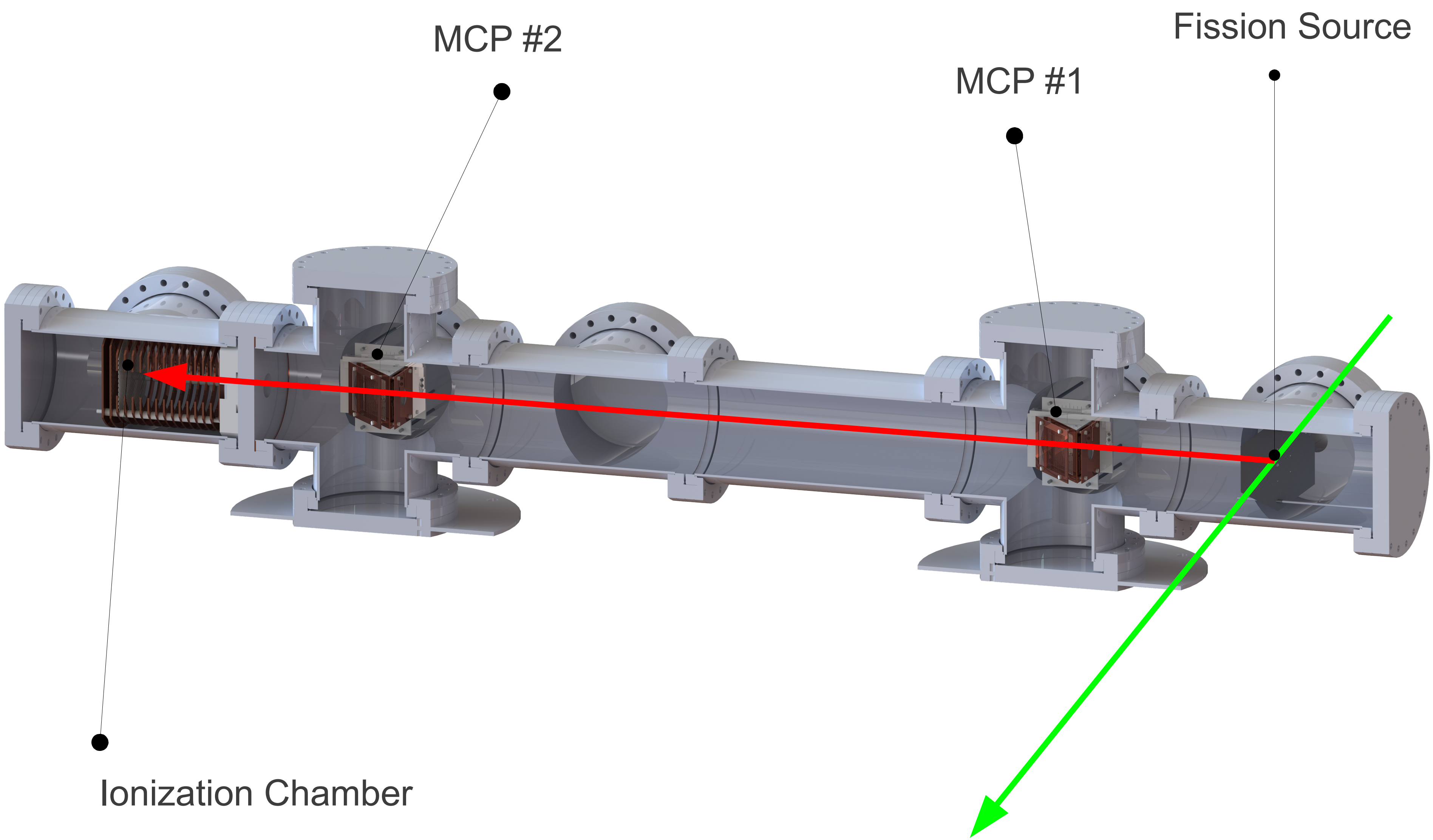
$$KE_f = \frac{1}{2} m_f v_f^{\,2} = \frac{1}{2} m_f \left(\frac{l}{t}\right)^2$$

$$m_f = \frac{2\mathrm{KE}_f}{v_f^{\,2}} = \frac{2\mathrm{KE}_f}{\left(\frac{l}{t}\right)^2}$$

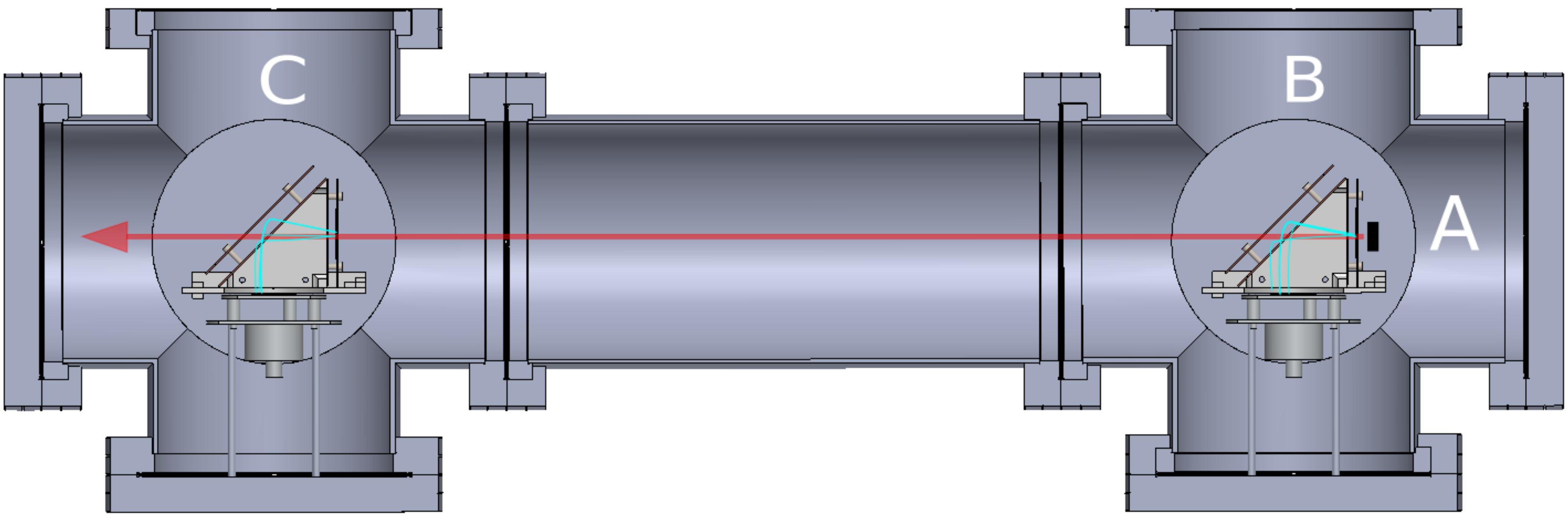
$$\delta_m^{\;2} = \left(\frac{dm}{dE}\delta_E\right)^2 + \left(\frac{dm}{dl}\delta_l\right)^2 + \left(\frac{dm}{dt}\delta_t\right)^2$$



1-Arm SPIDER

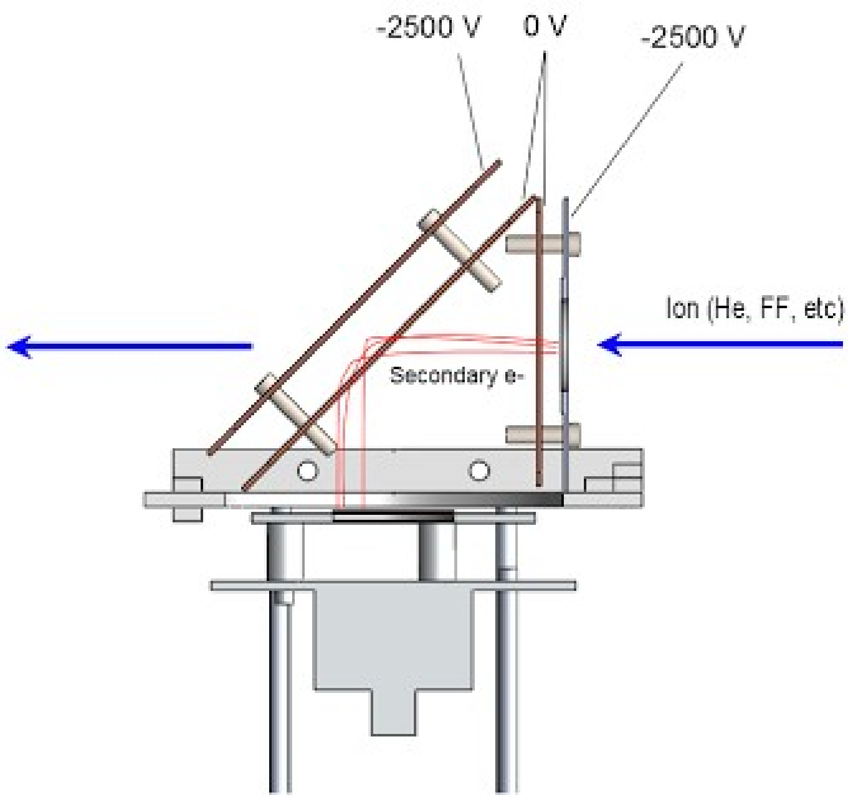


Time of Flight

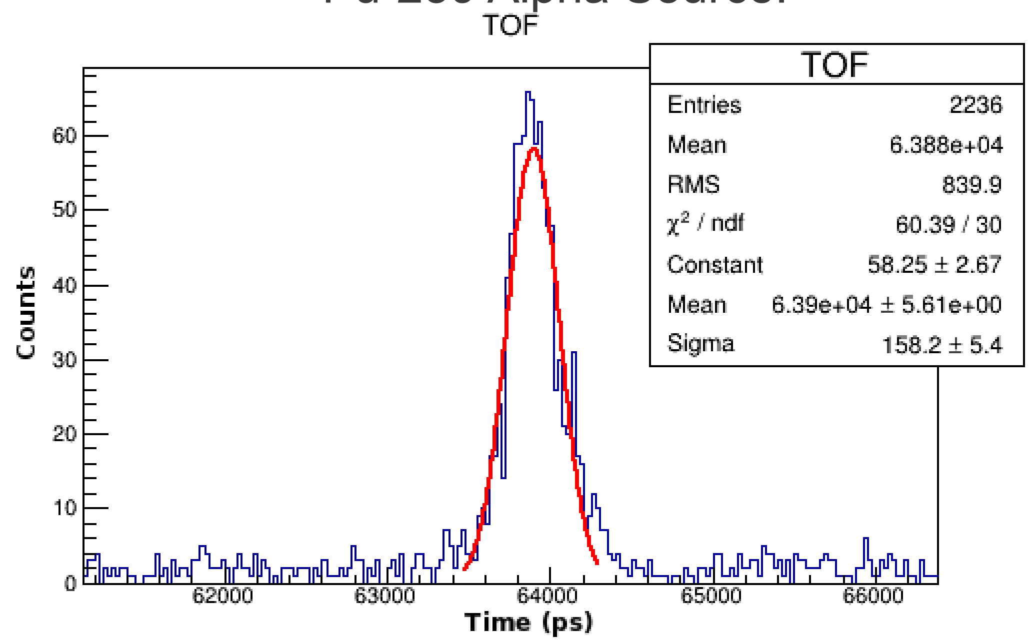


A: Source
B: Timing signal #1
C: Timing signal #2

Time of Flight

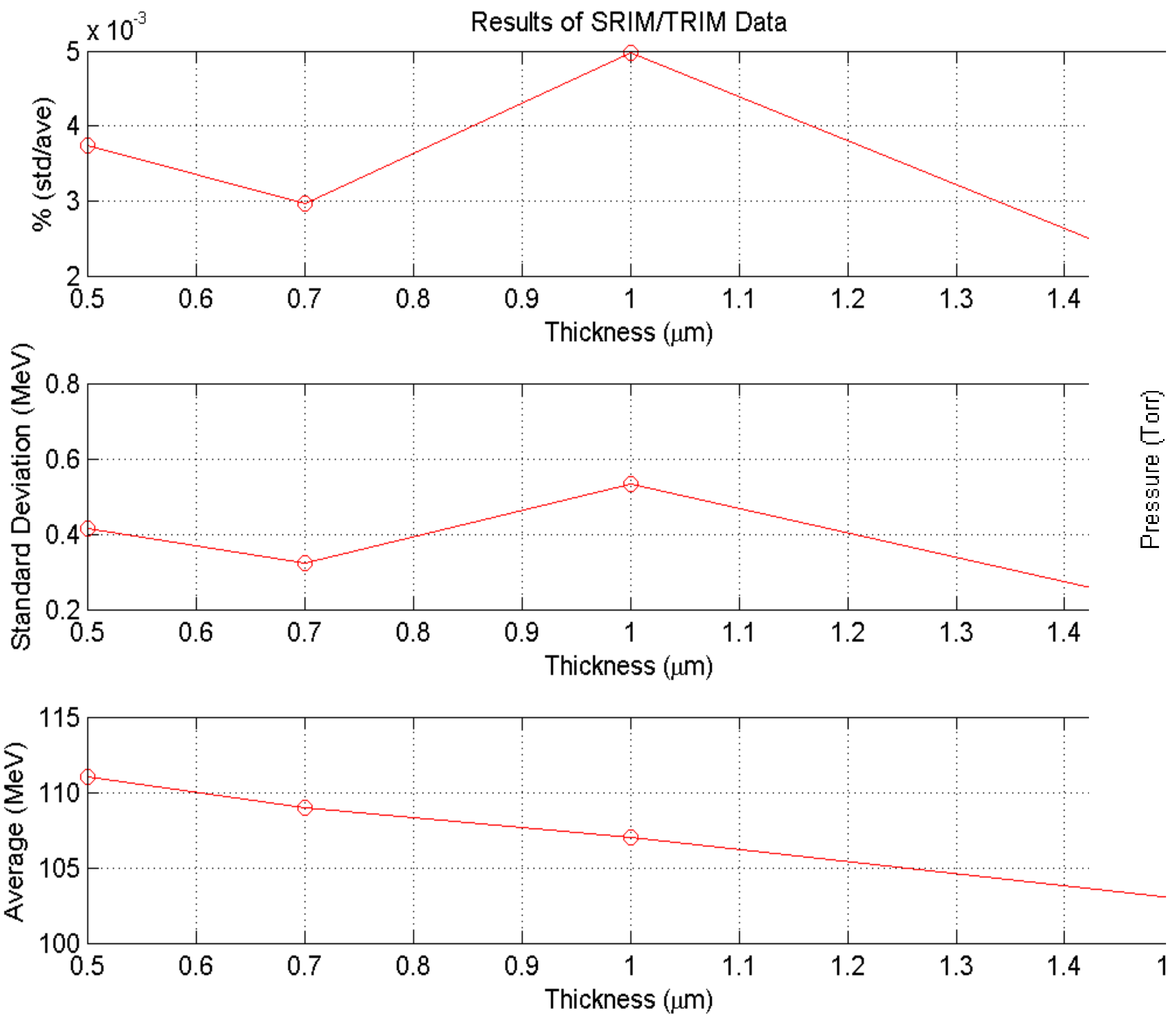


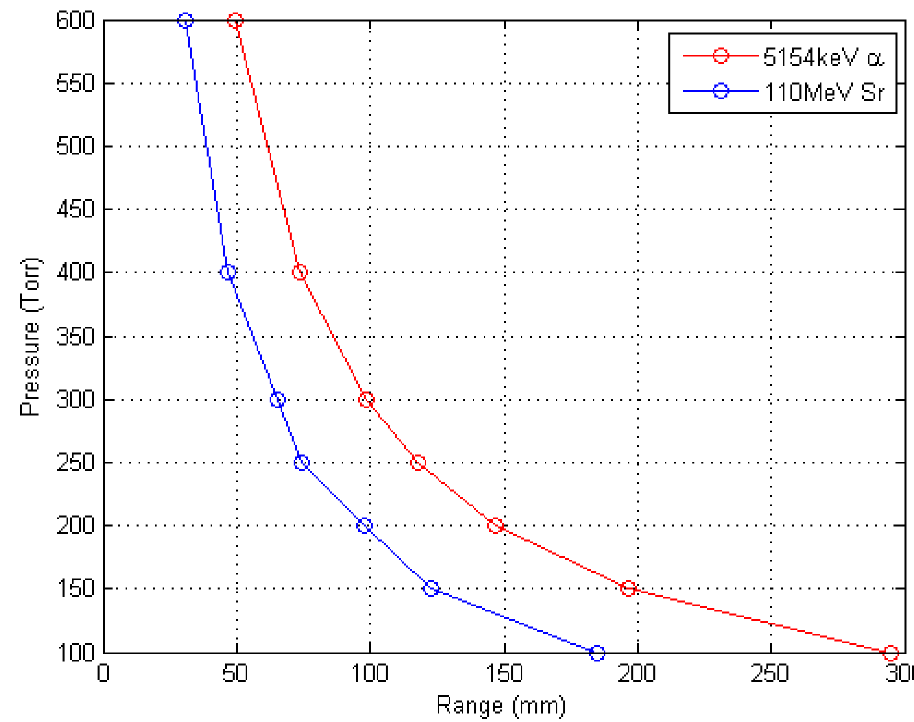
Pu-239 Alpha Source:



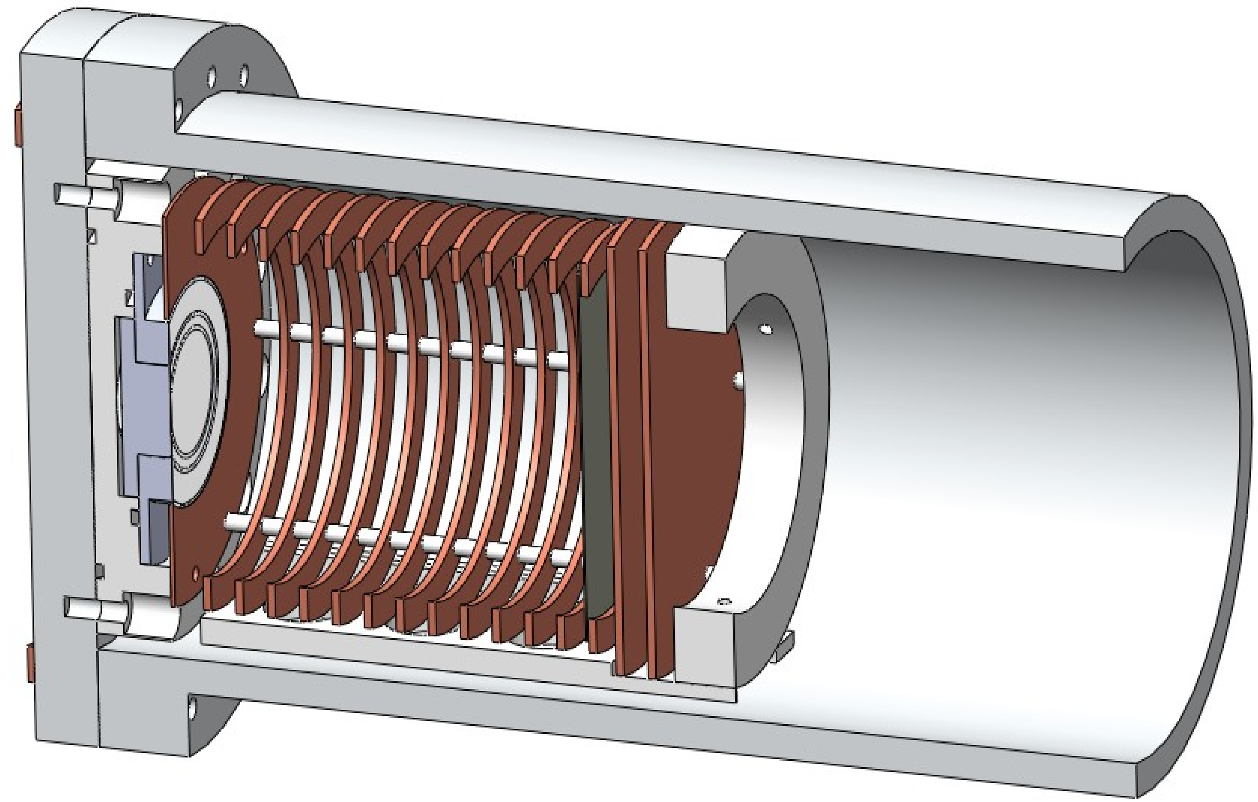
MCPs:
- Fast timing signal
- Similar to proportional counters

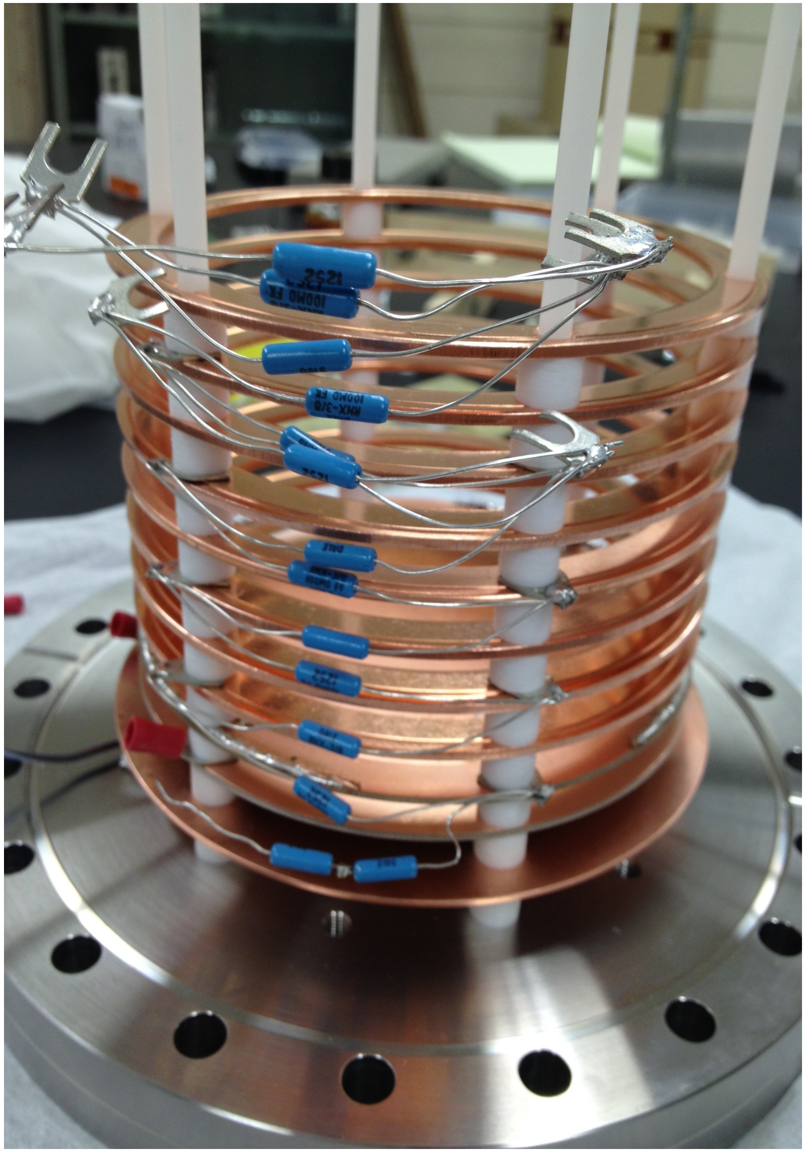
Limits of the Mylar Window



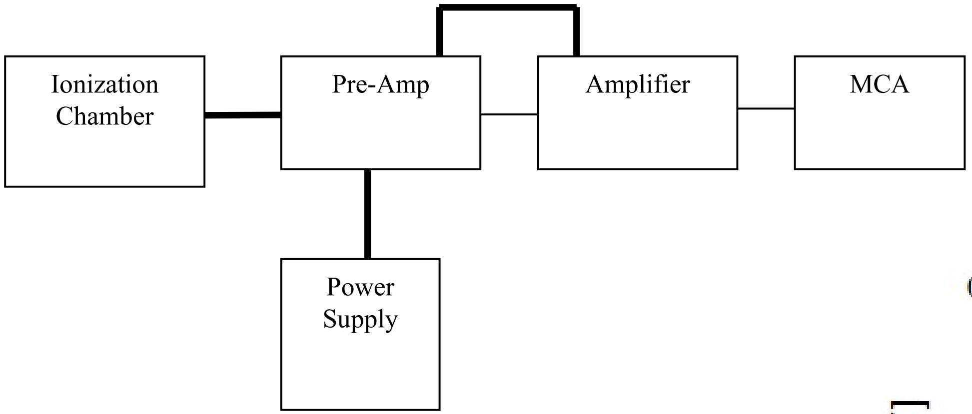


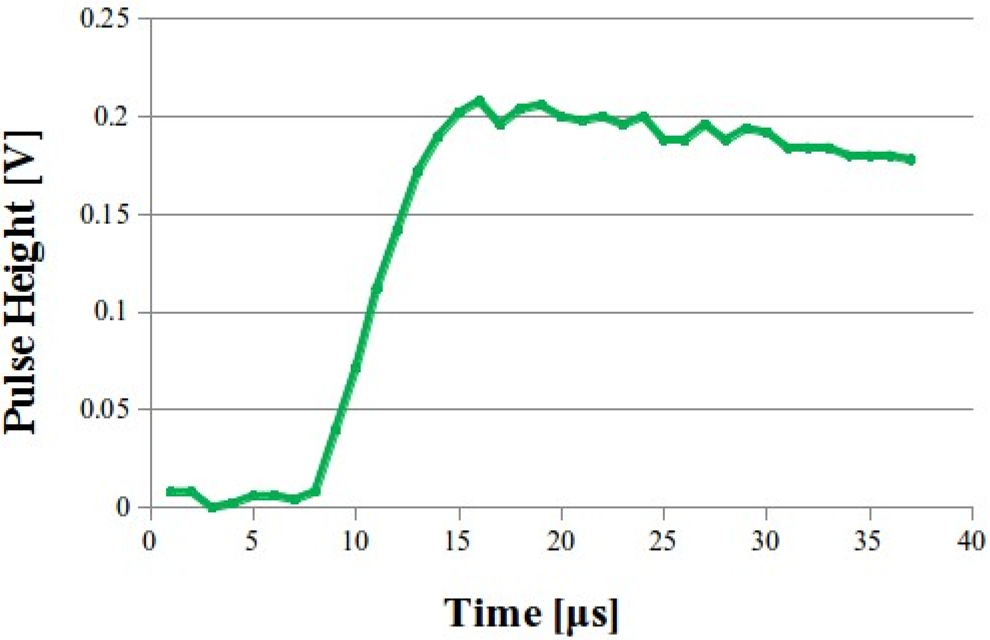
Ionization Chamber





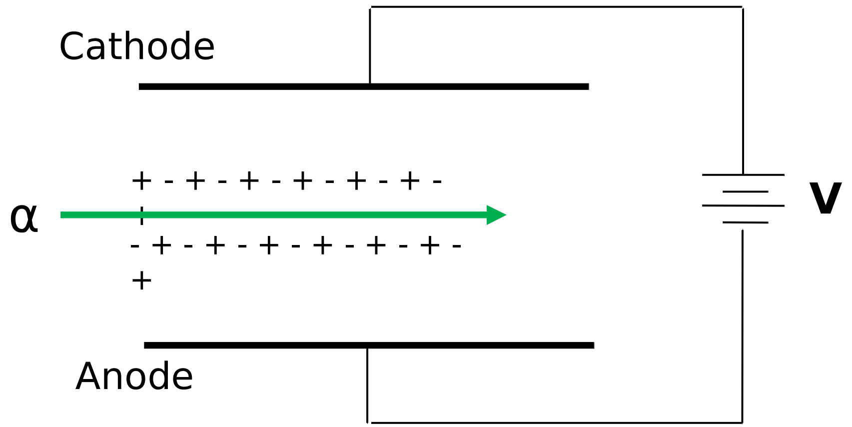
Basic DAQ

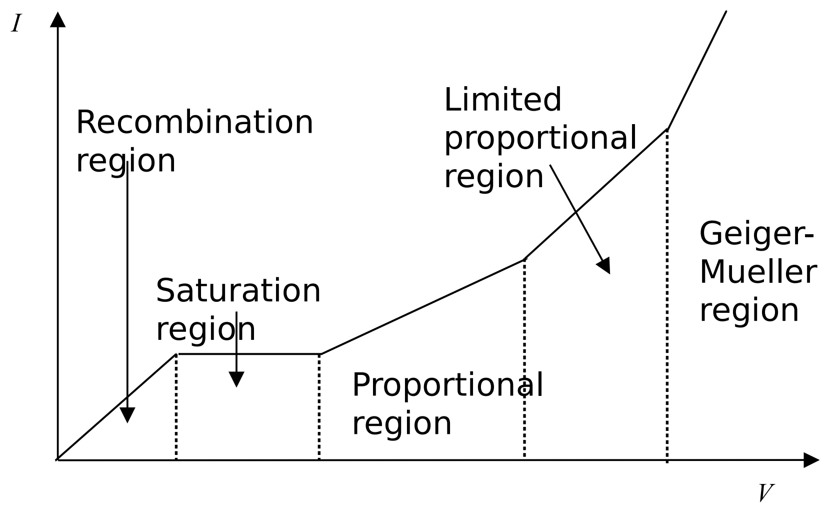

Ionization Chamber
Pre-Amp
Amplifier
MCA
Power Supply


0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
Pulse Height [V]
Time [μs]

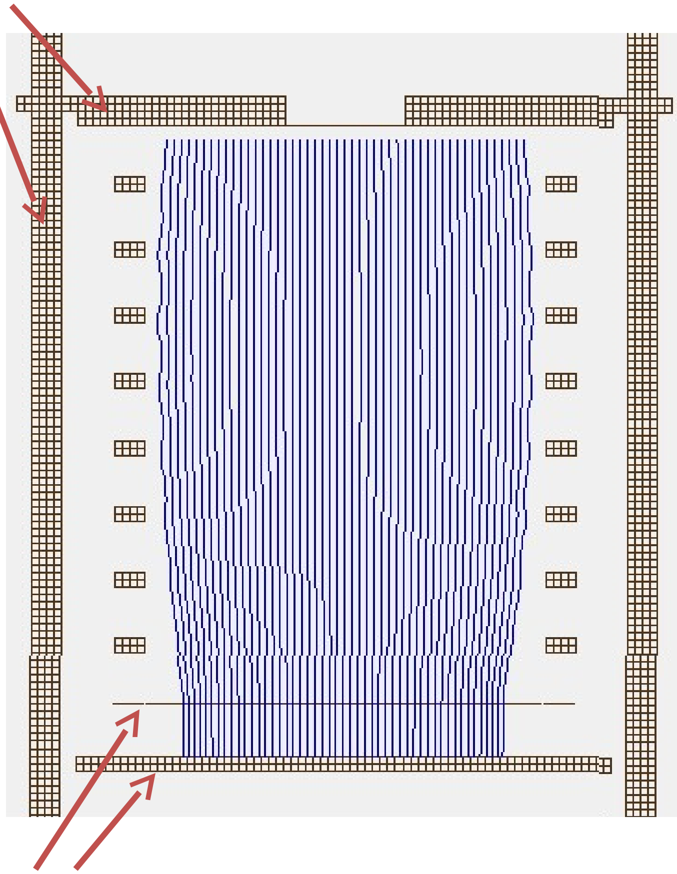
Ionization Chamber Basics

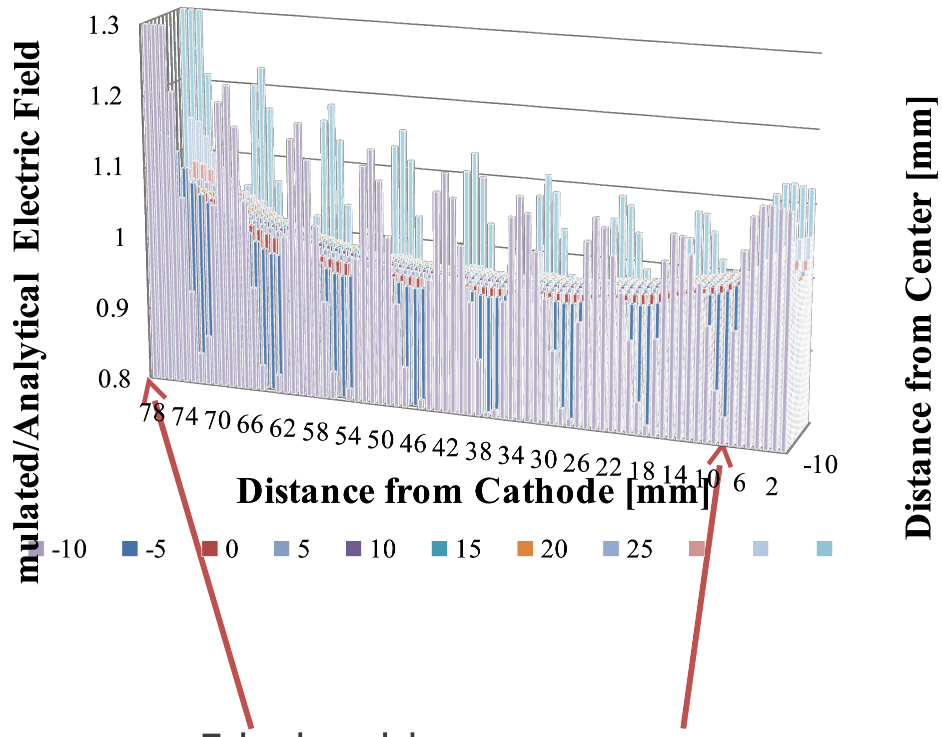
- IC's operate in the saturation region





Guard Rings





Numerical analysis of electric field within the ionization chamber using SIMION

Alpha Spectroscopy

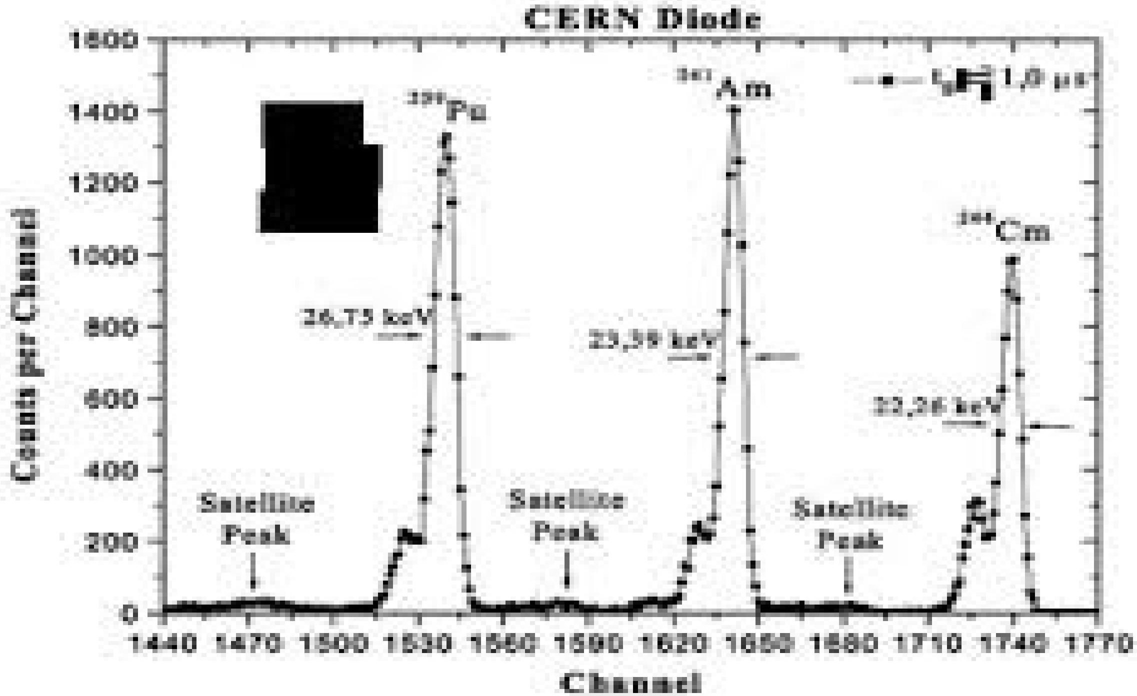
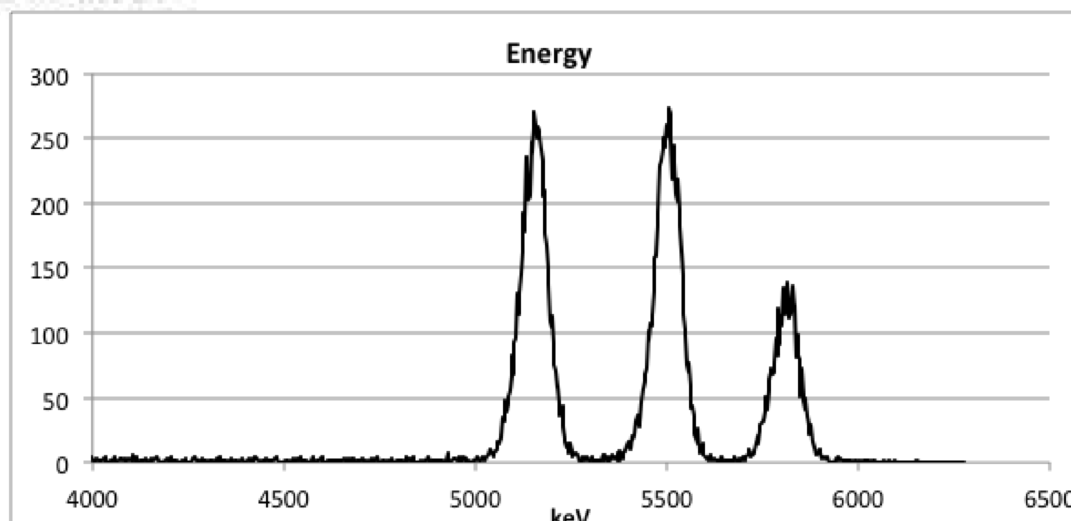


Figure 7. Alpha mixed source spectrum recorded with CERN diode at room temperature and -60 V.

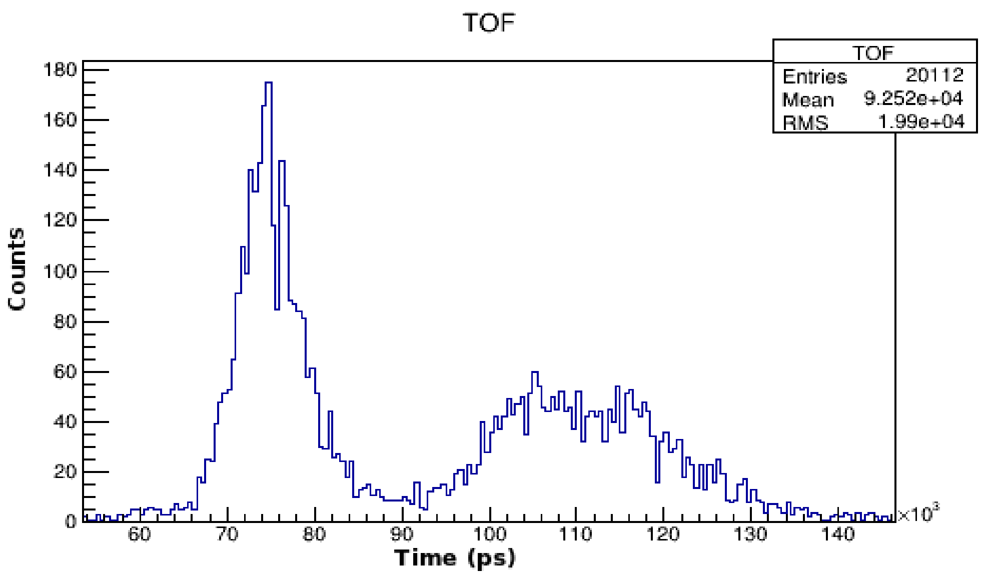
Tri-nuclide data:
Pu-239, Am-241, Cm-244

Typical ion chamber data:

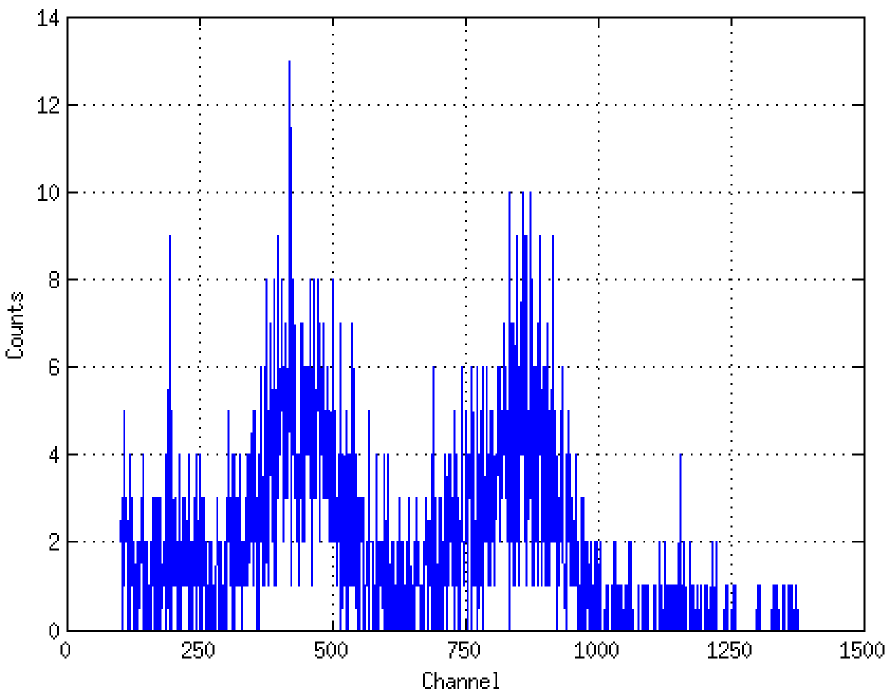


Preliminary Results

Timing histogram



Energy histogram



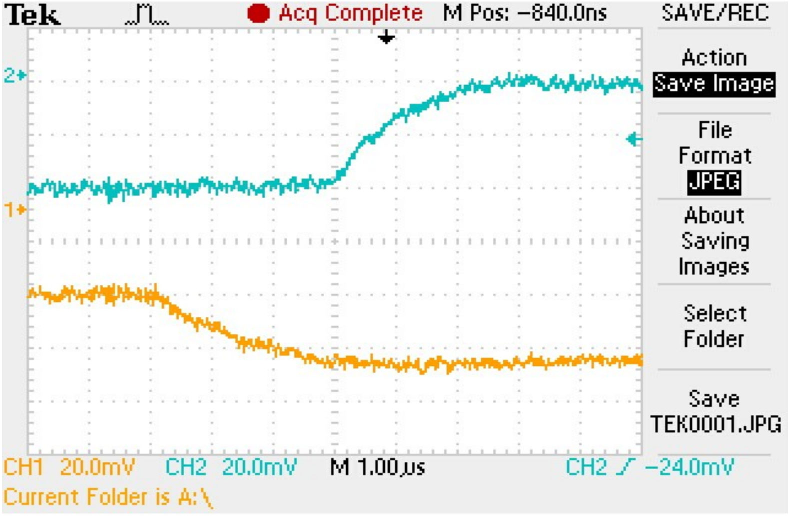
235-U(n_th ,f)X

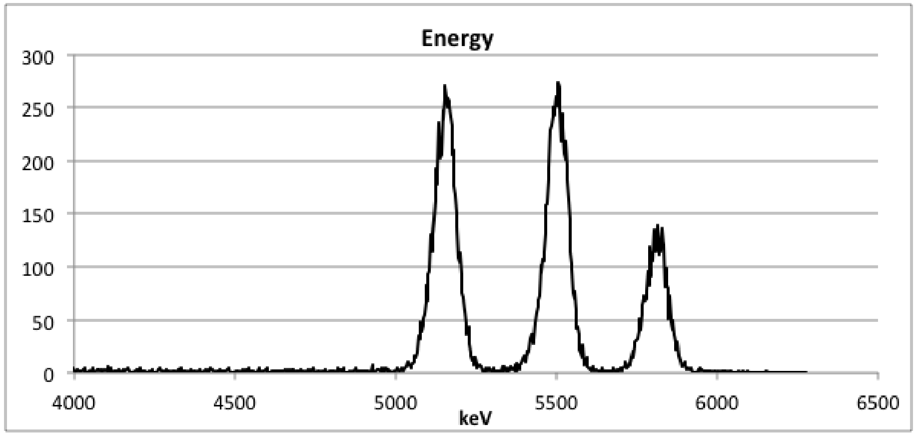
Ten hour data run, uncorrelated data

Conclusions & Future Work

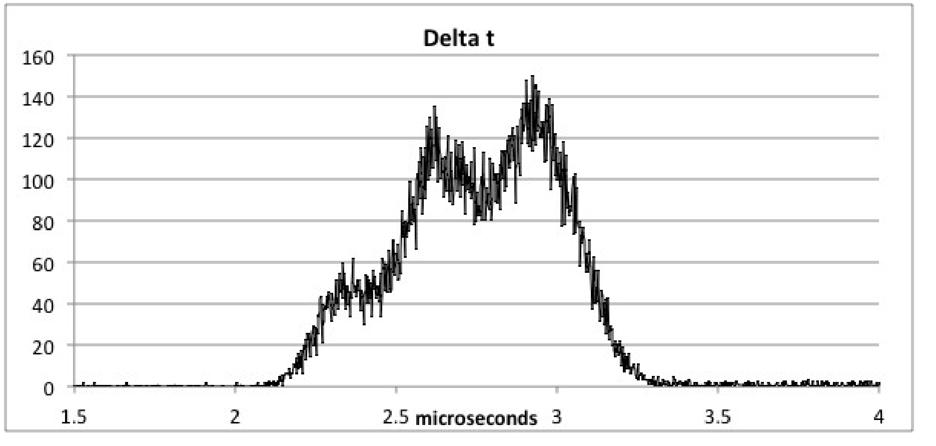
- Preliminary results were collected at the LANSCE Lujan Center
  - TOF w/ 0.5% resolution
  - IC w/ 1.5% resolution for alphas @ 600Torr
  - IC resolution @ 200Torr w/ fission fragments still under analysis (about 8% initial tests)
- Future work
  - Second Arm
  - Active Cathode design
  - Efficiency improvements
  - Window improvements

Active Cathode Design (Sanami, et. al.)





MCA energy data



MCA timing data

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  - James Cole, Paul Gilbreath, & Corey Vowell
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- The LANL SPIDER team

UNM SPIDER team

Interested in a graduate degree in nuclear engineering?
Contact Dr. Adam Hecht: hecht@unm.edu

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