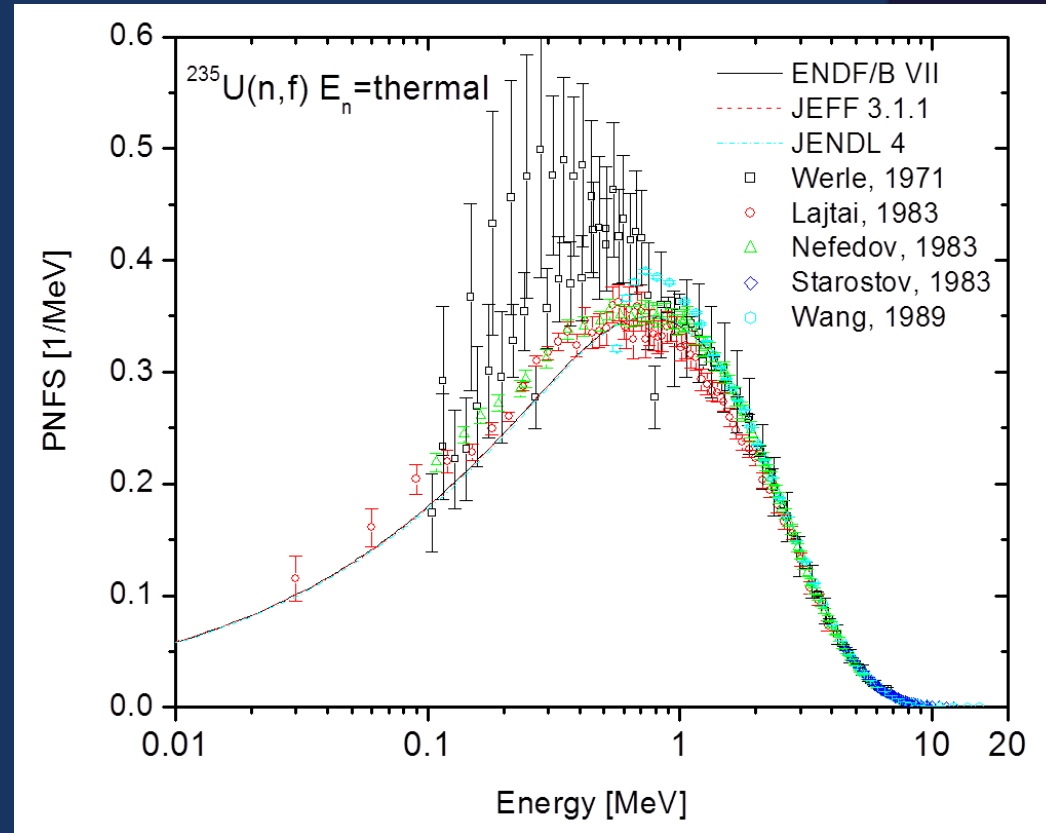# Characterization of an EJ301 Detector for Pulse Shape Discrimination of keV Neutrons

Amanda Lewis

Motivation

- Improve accuracy of neutron detection in the keV range

- Reduced uncertainties will benefit
  - non-proliferation
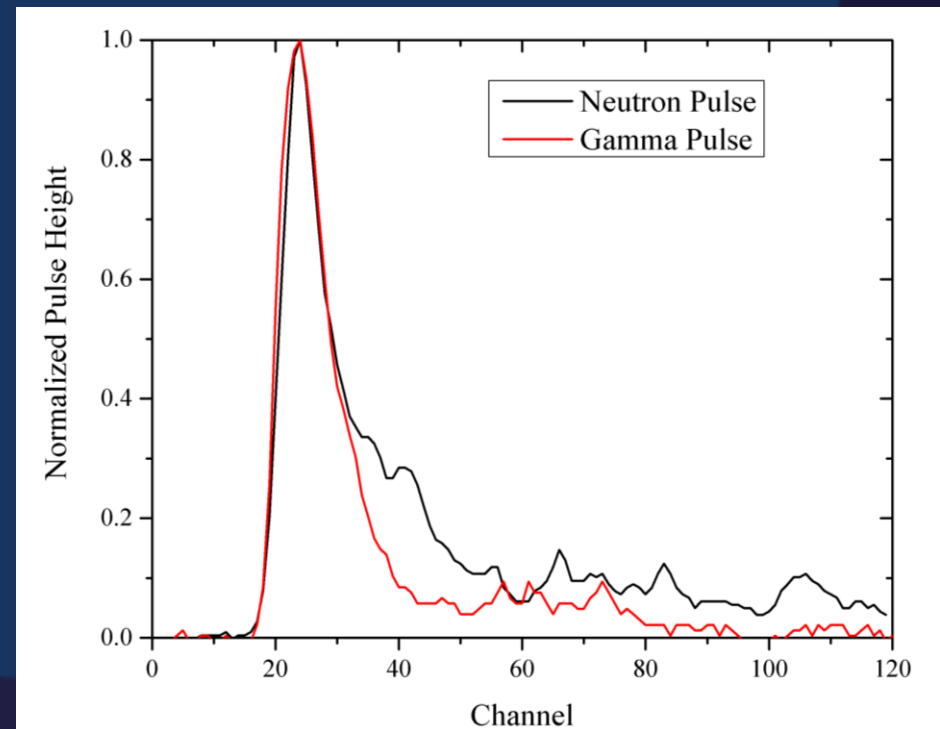 - reactor safety applications

Detection of keV Energy Neutrons

- Plastic Scintillators
  - No PSD
  - Low signal to background

- Lithium Glass
  - Low efficiency

Pulse Shape Discrimination

- A very accurate method for neutrons above 500 keV to distinguish gamma events from neutron events in liquid scintillators

- At low energy, noise becomes an issue

- This project aims to push that limit down below 200 keV
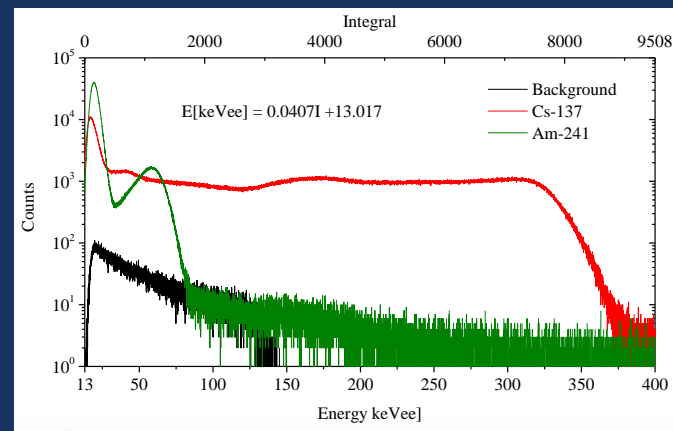
Detector System

- EJ301 organic scintillation detector
    - 0.5 in thick
    - 5 in diameter
- Bias voltage of 2200V
- 1 ns resolution
- 120 ns pulse length
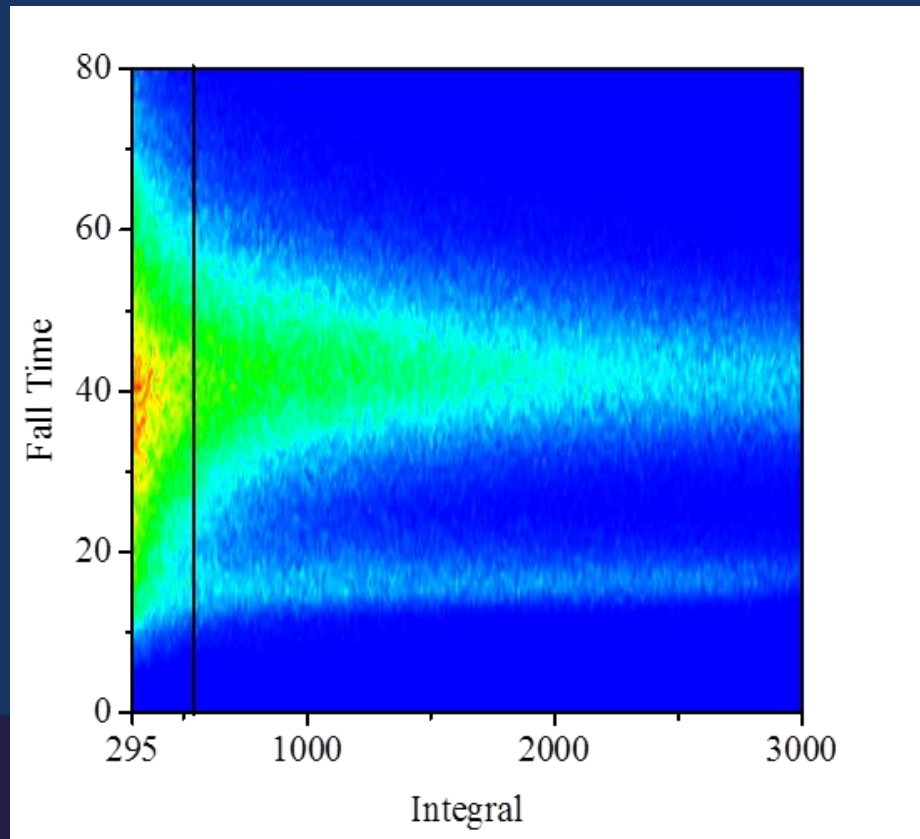- Lowest detectable deposition is 13 keV

Data Acquisition

- Pure Gamma sources
- Mixed neutron/gamma sources
  - ^{252}Cf spontaneous fission source
    - with and without lead shielding
  - Neutron beam created at Gaerttner Linear Acceleration Facility at Rensselaer Polytechnic Institute
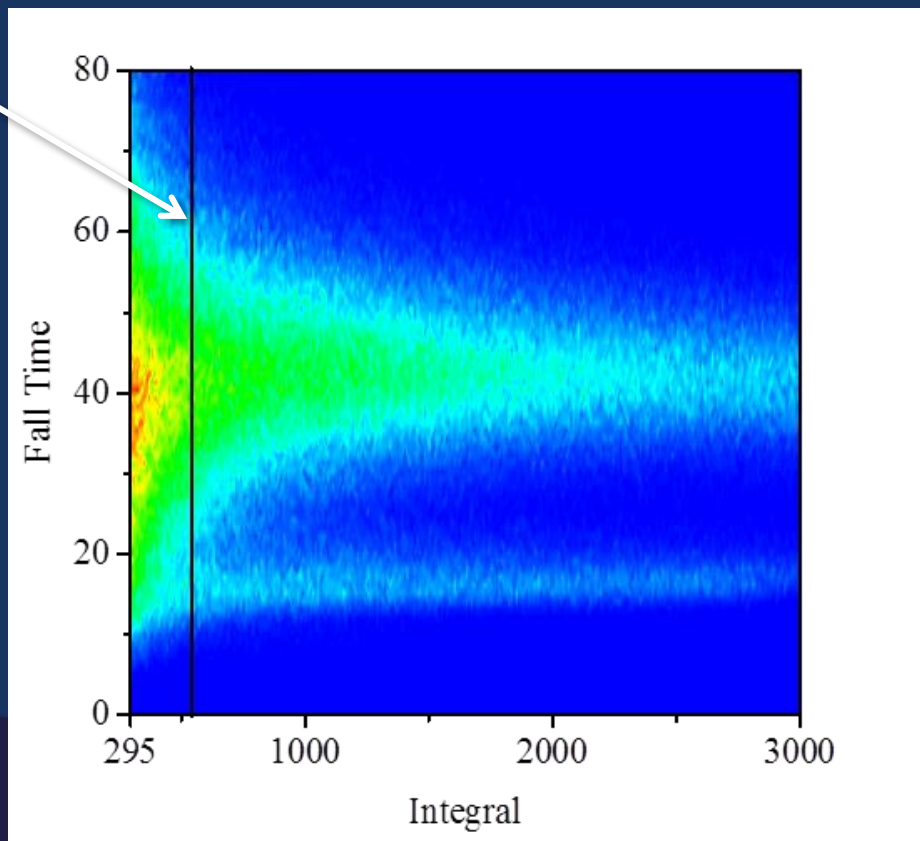
Average Pulse Shapes

- Average pulse shapes using fall time and integral cuts

Average Pulse Shapes

- Average pulse shapes using fall time and integral cuts
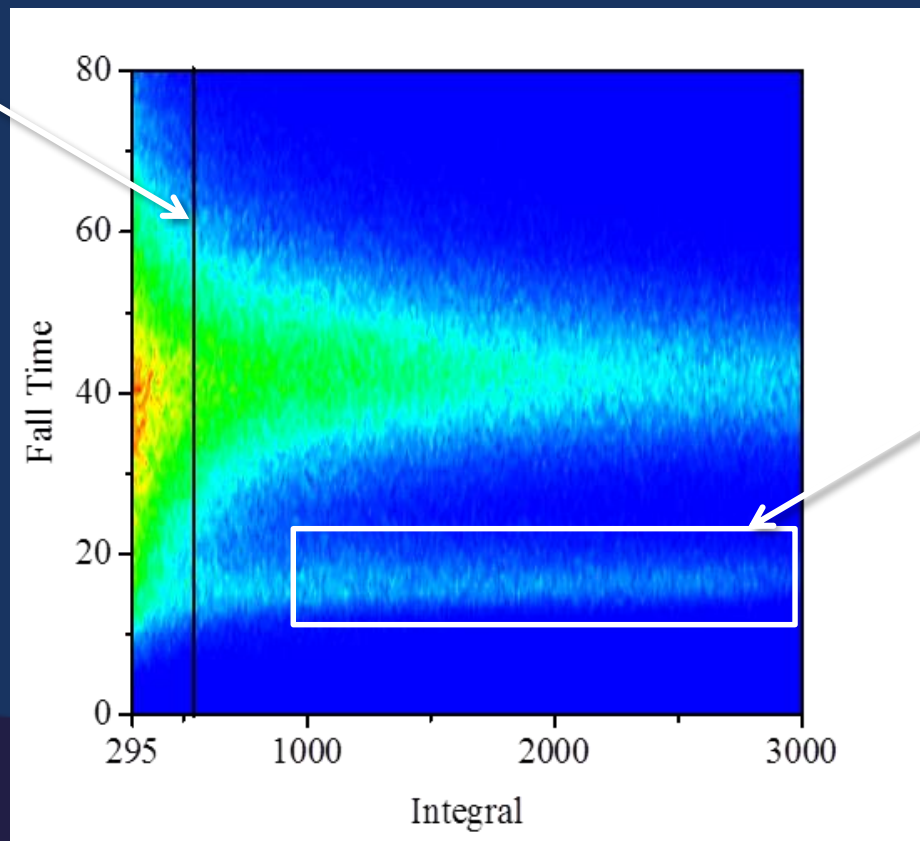
Discriminator

Average Pulse Shapes

- Average pulse shapes using fall time and integral cuts
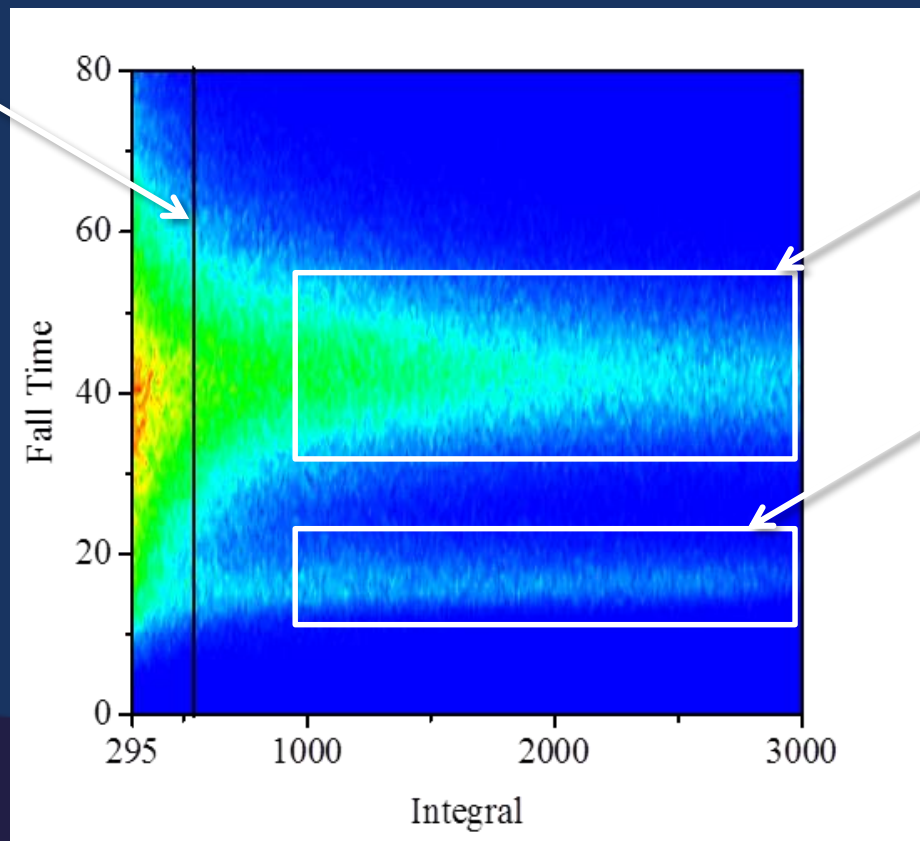
Average Pulse Shapes

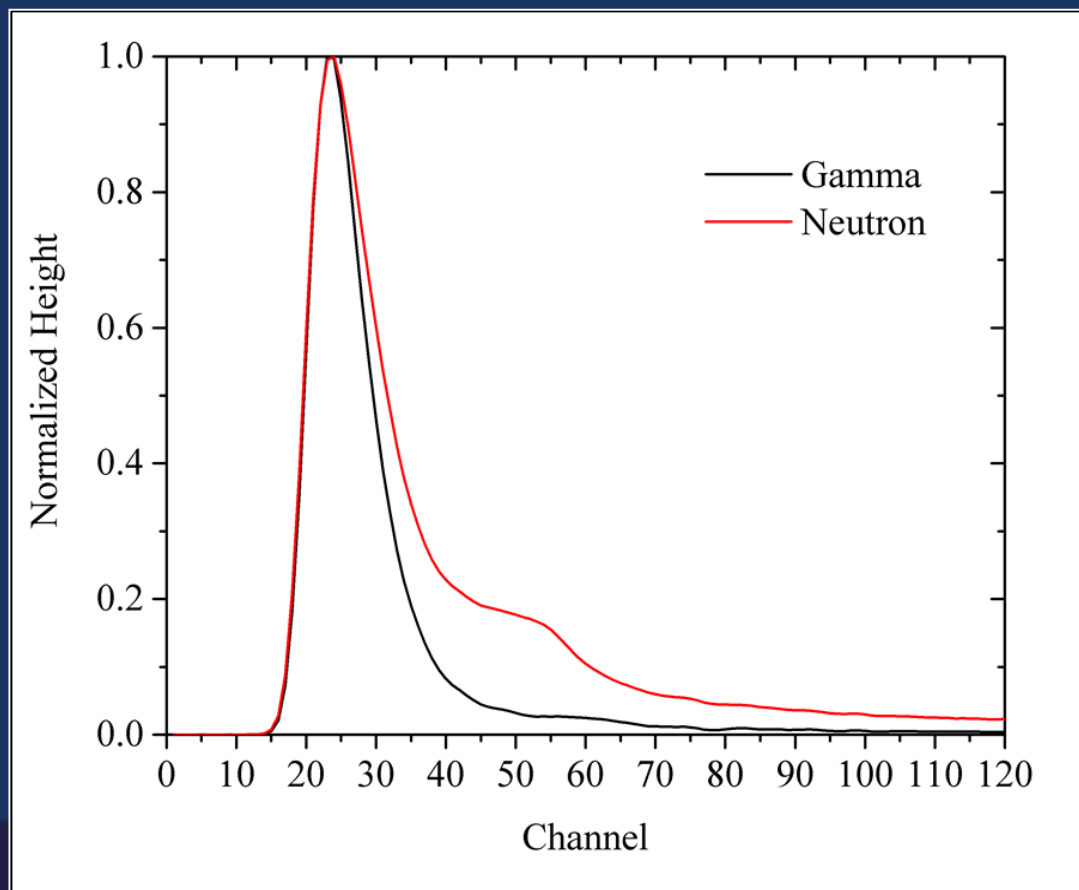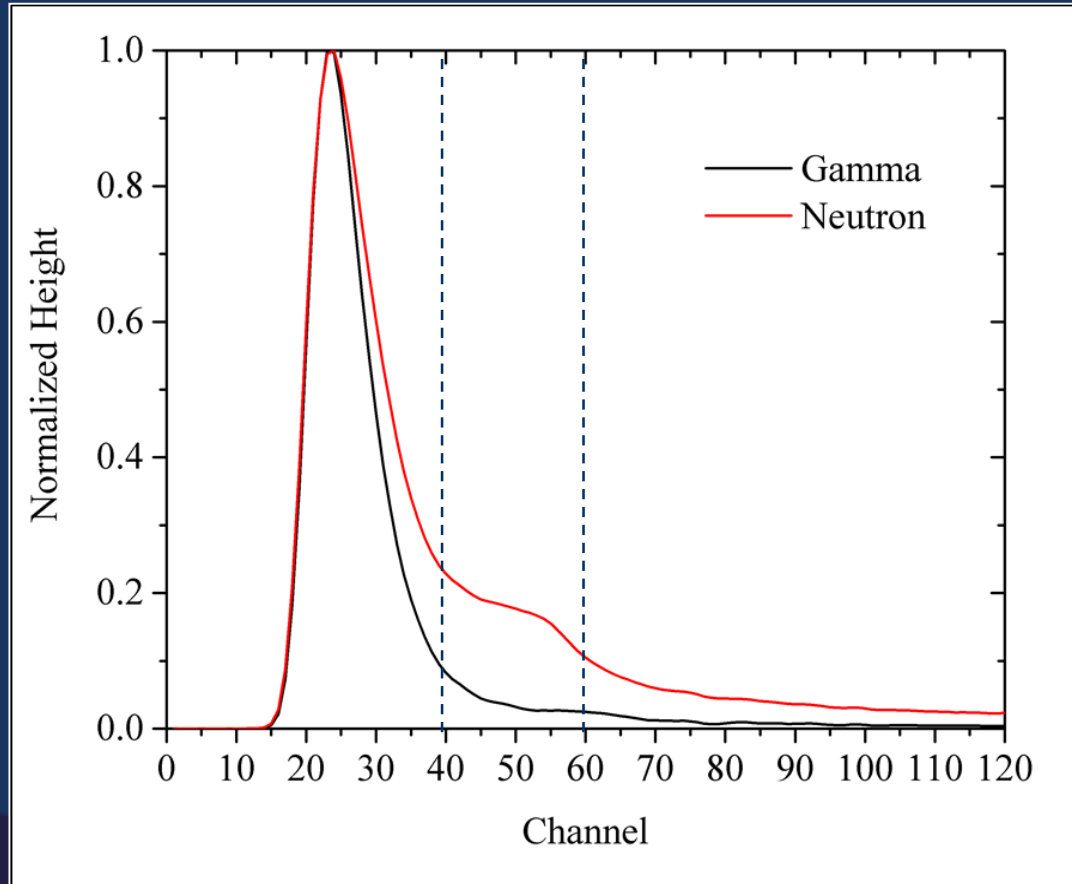- Average pulse shapes using fall time and integral cuts
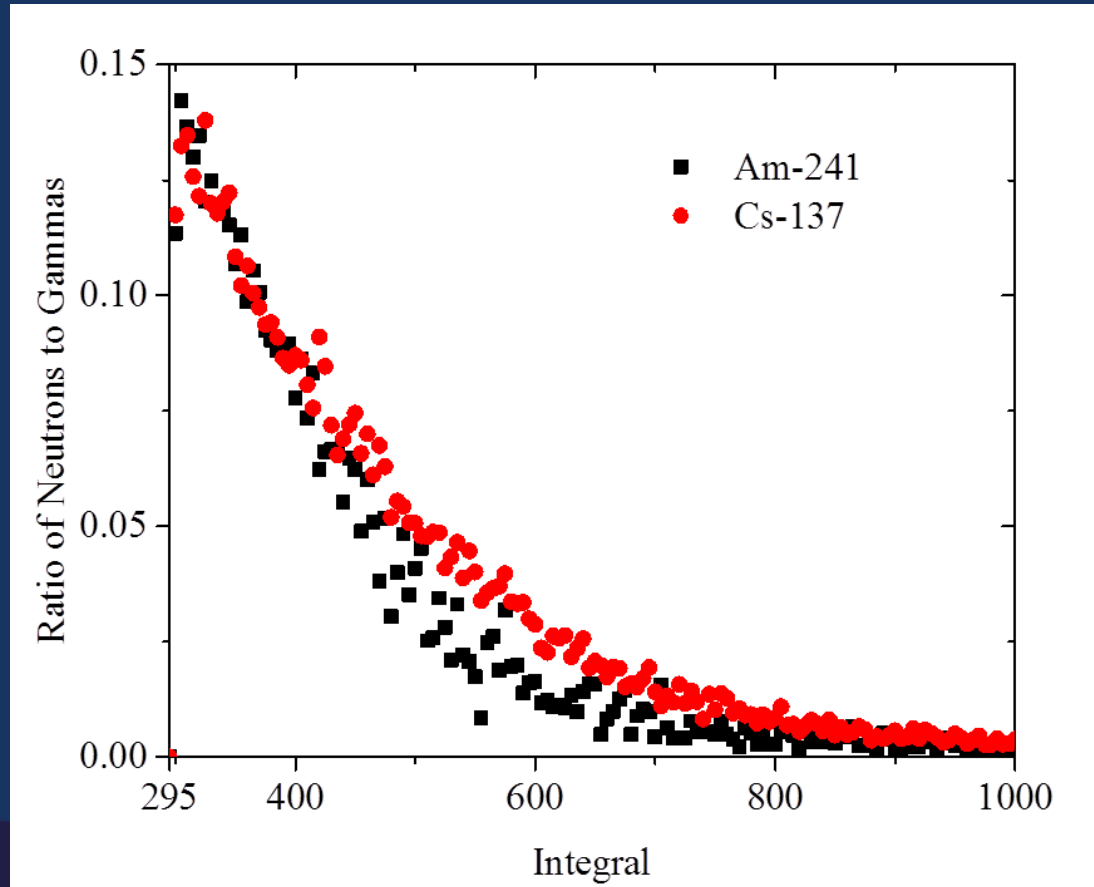

Discriminator
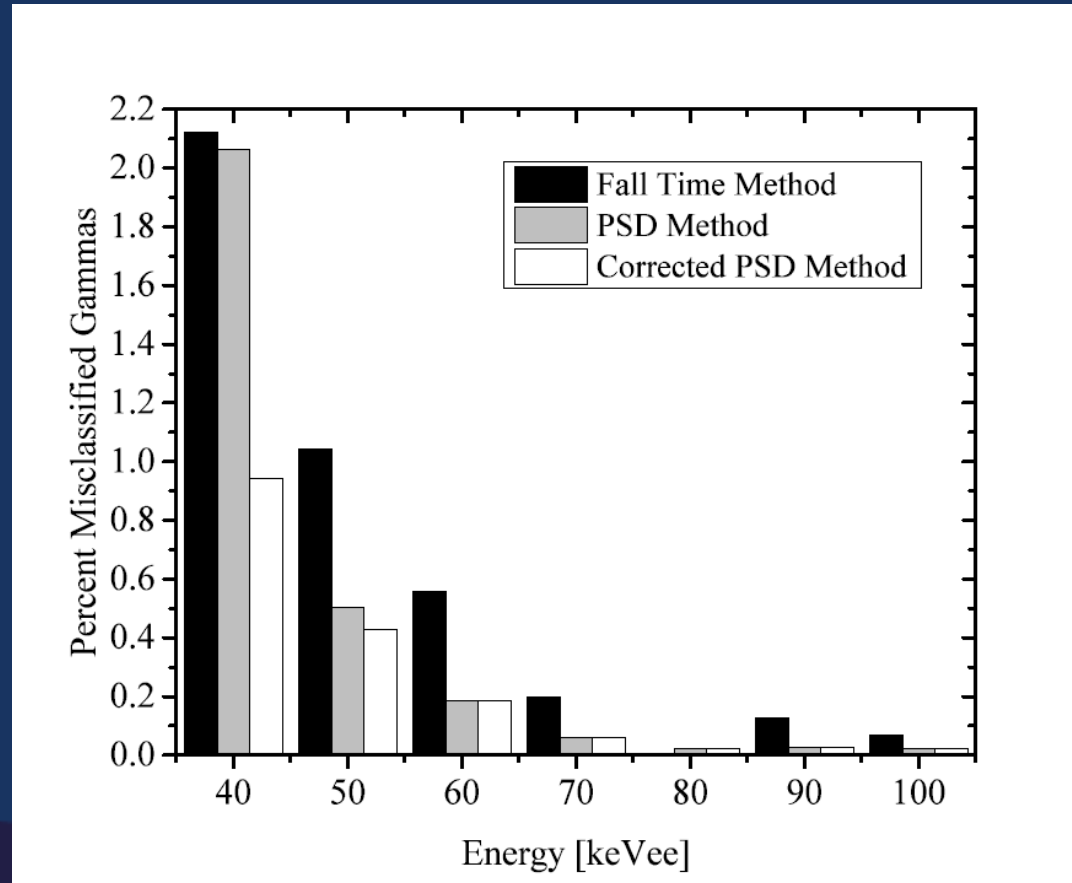
Neutron Pulses

Gamma Pulses

Average Pulse Shapes

Region of Comparison

Gamma Misclassification Correction

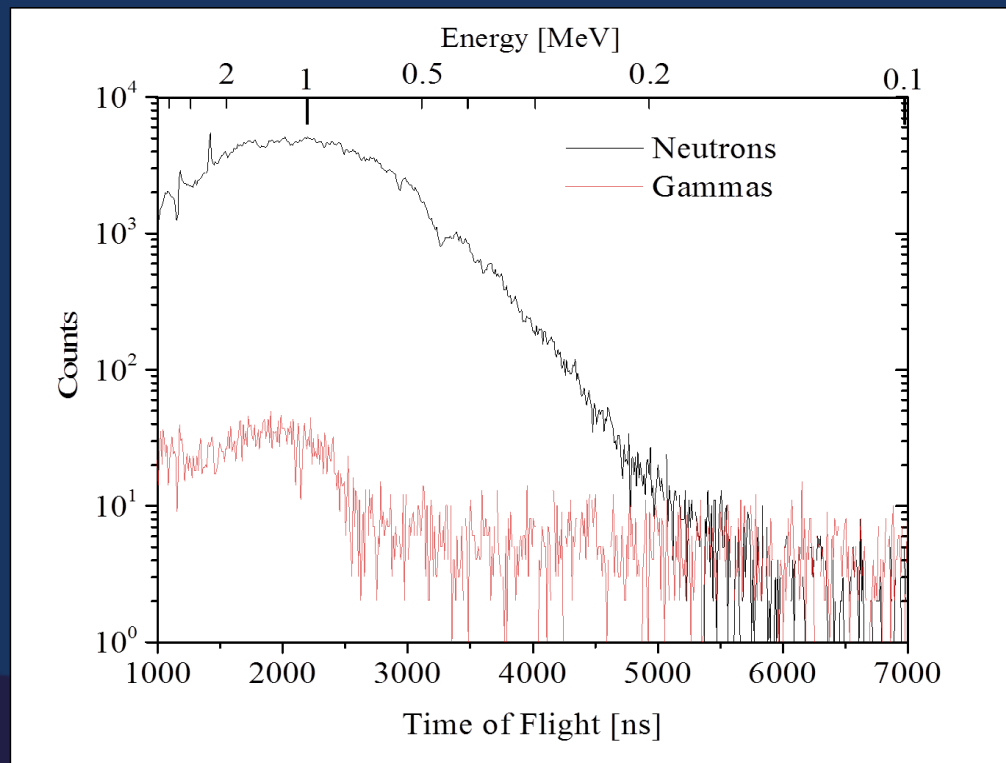# ¹³⁷Cs Source Classification

Neutron Classification

- Neutrons of known energy from LINAC were used to determine lowest detectable neutron energy, 135 keV

Summary

- Goal: push PSD capabilities below 200 keV

- Thin liquid organic scintillator used a high voltage

- Gamma discrimination was more accurate than any other work in this energy region

- Result: pushed PSD down to 135 keVee

- Future work includes looking into classifiers as a replacement for the correction factor

Acknowledgments

- E. Blain and Y. Danon for their support
- The LINAC staff for their expertise and diligent work
- The Stewardship Science Academic Alliance for their funding of this research