Los Alamos NATIONAL LABORATORY

NC STATE UNIVERSITY

MUSiC: Application and Efficacy of Organic Scintillators for Leakage Multiplication Measurements of HEU Systems

Arel D'Agostino, Robert Weldon, Jesson Hutchinson, John Mattingly

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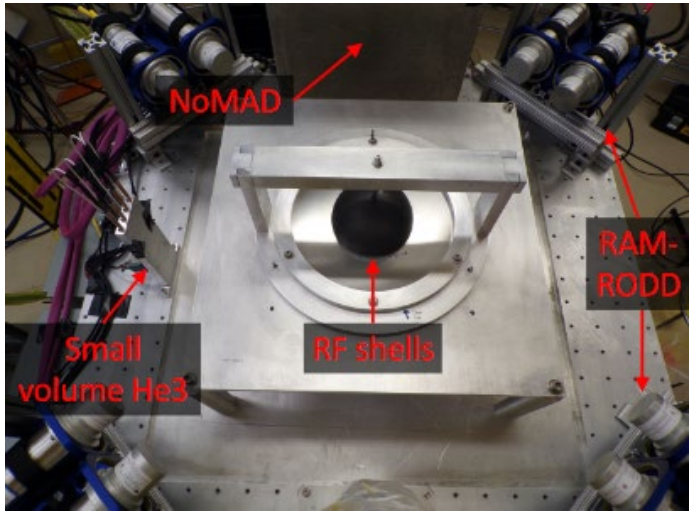
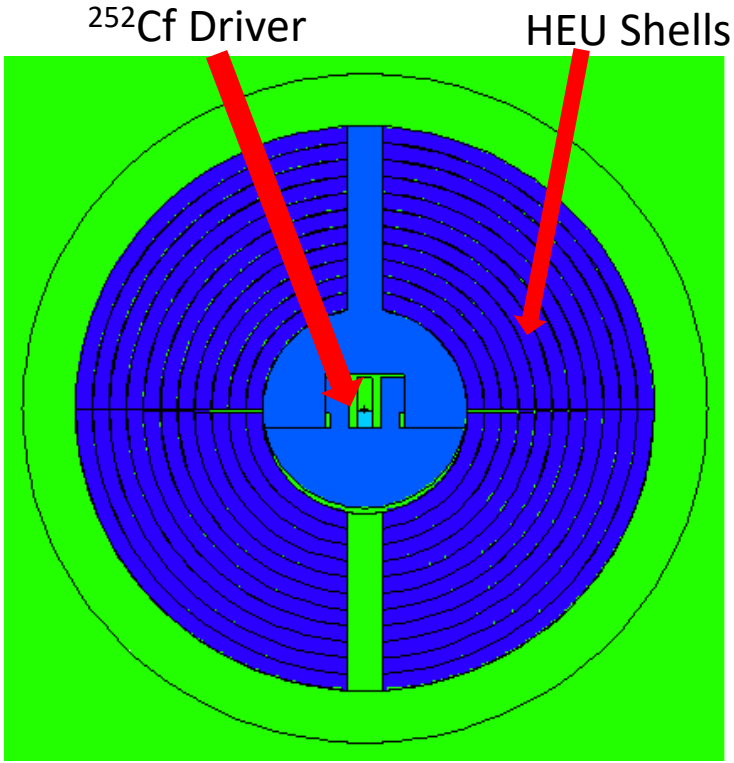
MUSiC Description

- Series of 8 subcritical and 2 critical experiments using HEU metal shells
- Mass range: ~13-43kgs
- Detectors deployed:
  - RAM-RODD: OS system of 8 Ej-309s
  - NoMAD: poly moderated ^{3}He system
  - Small volume ^{3}He



MUSiC Description and Simulation

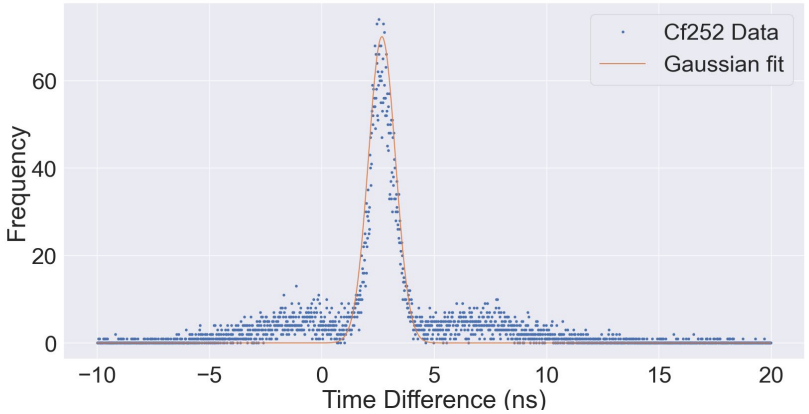
- Driven internal and external and, undriven configurations
- Simulation values from model of the shells, source holder, and ^{252}Cf source
- Significant multiplication impact from room
- Comparison to updated models to come as they are completed



Advantages of Organics

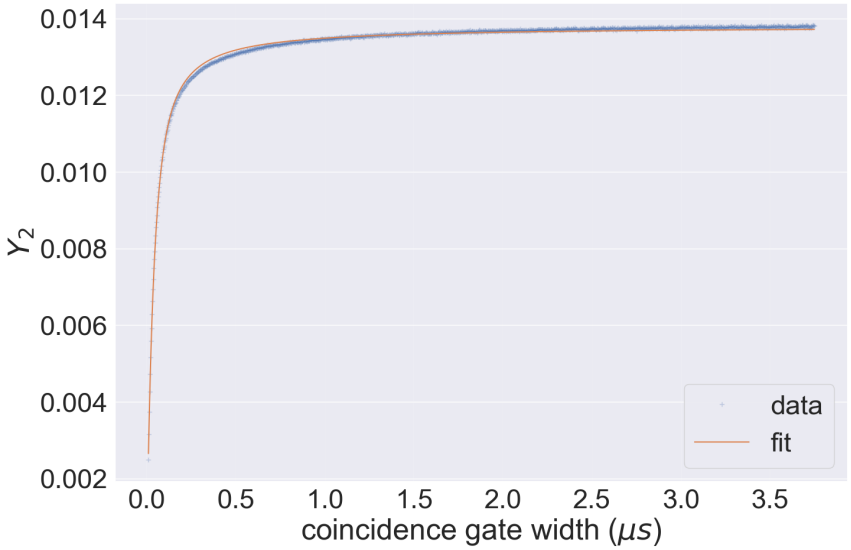
- Very fast
  - Fast response
  - No moderation
- Sensitive to neutrons and gammas and can discriminate
- Relatively cheap
- Retain spectroscopic information

^{252}Cf fission gamma coincidence

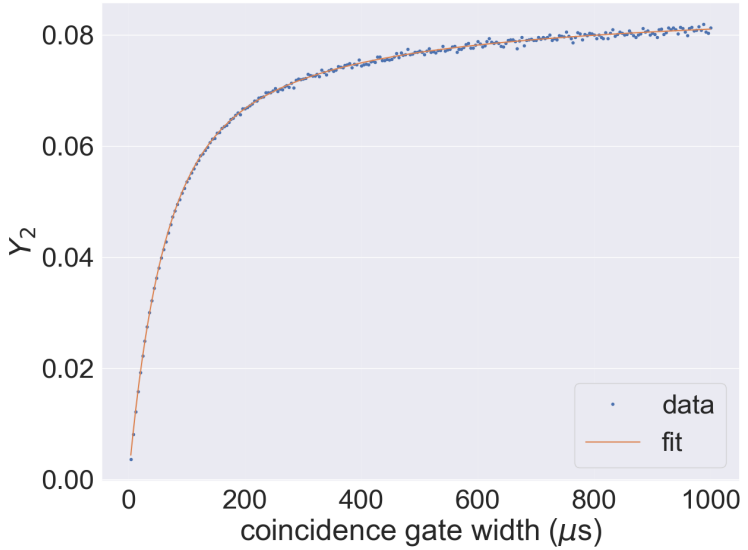


Y_2 Comparison for OS and ^{3}He for configuration 1

RAM-RODD



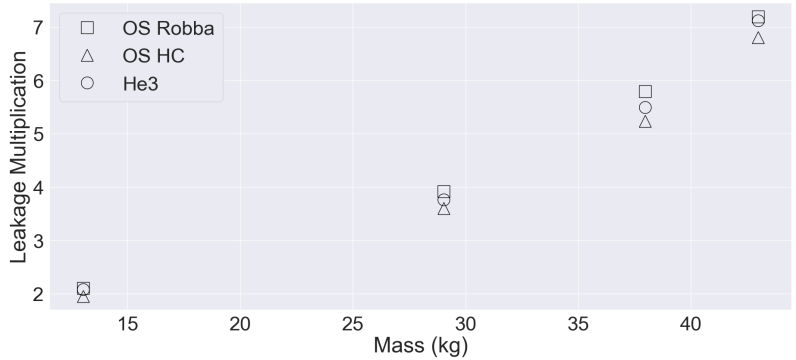
NoMAD



Results

- Analyzed OS data with Robba et al. [1] and Hage-Cifarelli [2]
- Strong agreement with He3 system
- Expect better agreement with updated simulations

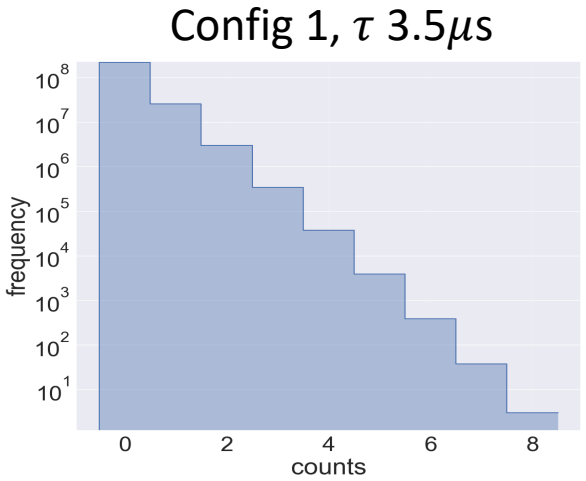
		Leakage Multiplication			
Configuration	Mass	Simulated	He3 ML	OS Robba	OS HC
1	13.0428	1.801	2.08±0.01	2.106±0.010	1.951±0.010
3	29.0415	3.301	3.76±0.02	3.912±0.019	3.603±0.019
4	37.9617	4.975	5.49±0.04	5.789±0.042	5.232±0.042
5	42.9722	6.524	7.12±0.05	7.188±0.056	6.804±0.056

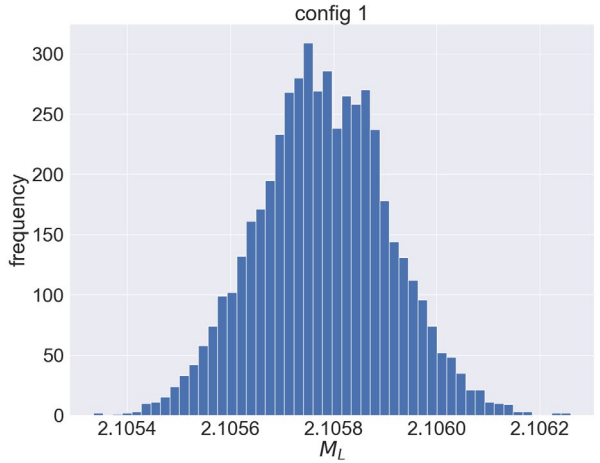


[1] Robba et al. “Neutron Multiplication Measurements Using Moments of the neutron Counting Distribution”, NIM, 1983
[2] Cifarelli, Hage, “Models for a three-parameter analysis of neutron signal correlation measurements for fissile material assay”, NIM, 1986

Uncertainty Quantification

- 1st order uncertainty propagation assumptions
  - Uncorrelated uncertainties in inputs
  - Linearly approximated measurement model
- Bootstrap the data instead to quantify uncertainty by resampling Feynman histograms





Conclusion/Summary

- Applied two methods of calculating M_L with organic scintillators on fast bare HEU systems
- Compared to ^{3}He detector results and found agreement
- Bootstrapped the data to characterize uncertainty

Acknowledgements

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