



ADVANCED REACTOR SAFEGUARDS & SECURITY

# Nondestructive Assay of Irradiated TRISO Fuel

*Oak Ridge National Laboratory*

*Los Alamos National Laboratory*

PRESENTED BY

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# Updates and Path Forward

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- Ongoing:
  - FY25 Measurement Campaign Data Analysis
- Upcoming (as of March 2026):
  - Irradiation Experiments at HFIR

# FY25 Irradiation Experiments

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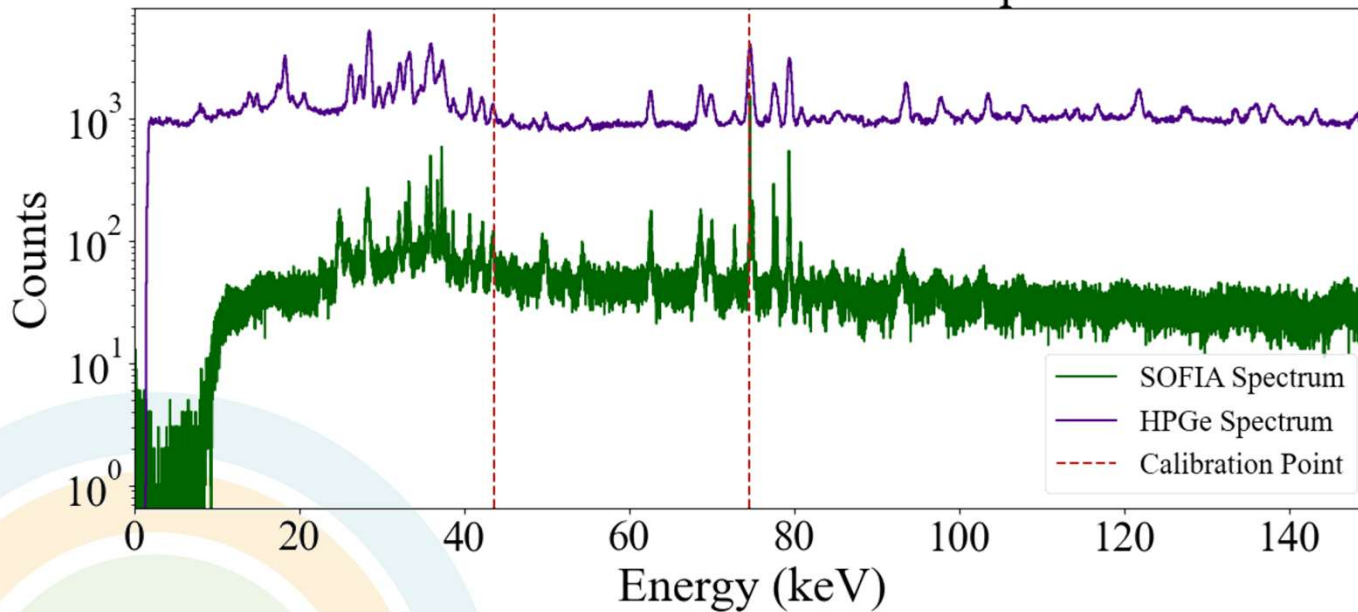


- Targets (nanograms of actinides):
  - Natural Uranium
  - Pu-239
  - Mixtures
    - 0.5% - 2% Pu to U at 19% and 15% Enriched
- Irradiated to produce  $\sim 10^9$  Fissions
  - Activity Limit for HFIR without glass sealing:  $10^{11}$
  - Target fissions informed by the SOFIA detector

# Simultaneous Measurement with uCal and HPGe



Calibrated SOFIA and HPGe Spectra

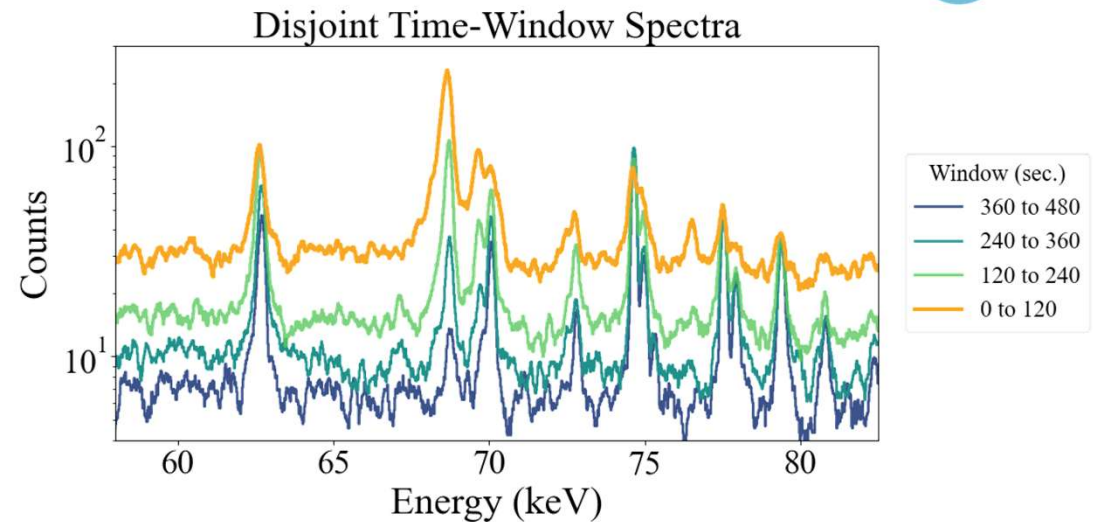
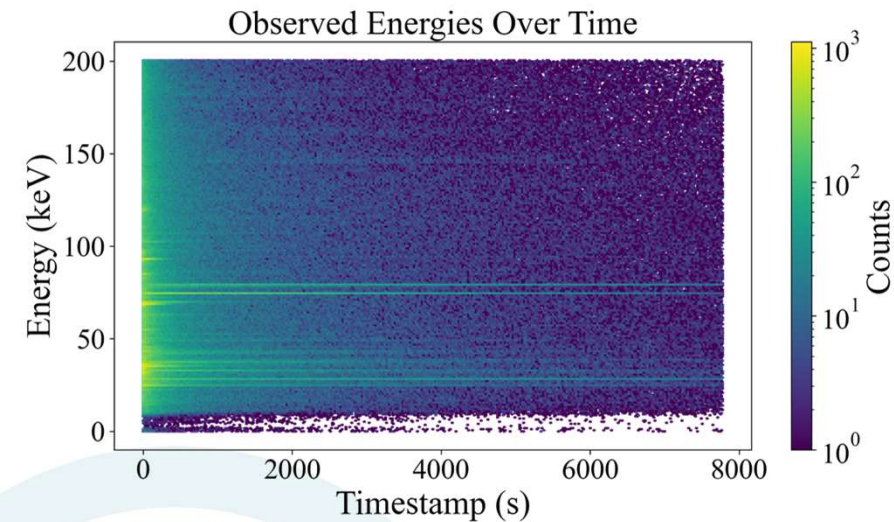


**14.9% Enrichment; 2% Pu to U by weight**

We used the HPGe for a two-point energy calibration using U-239 peaks at 43.5 keV and 74.6 keV

uCal spectra had to be calibrated at the pixel-level to aide in co-adding

# Half-Life Estimation

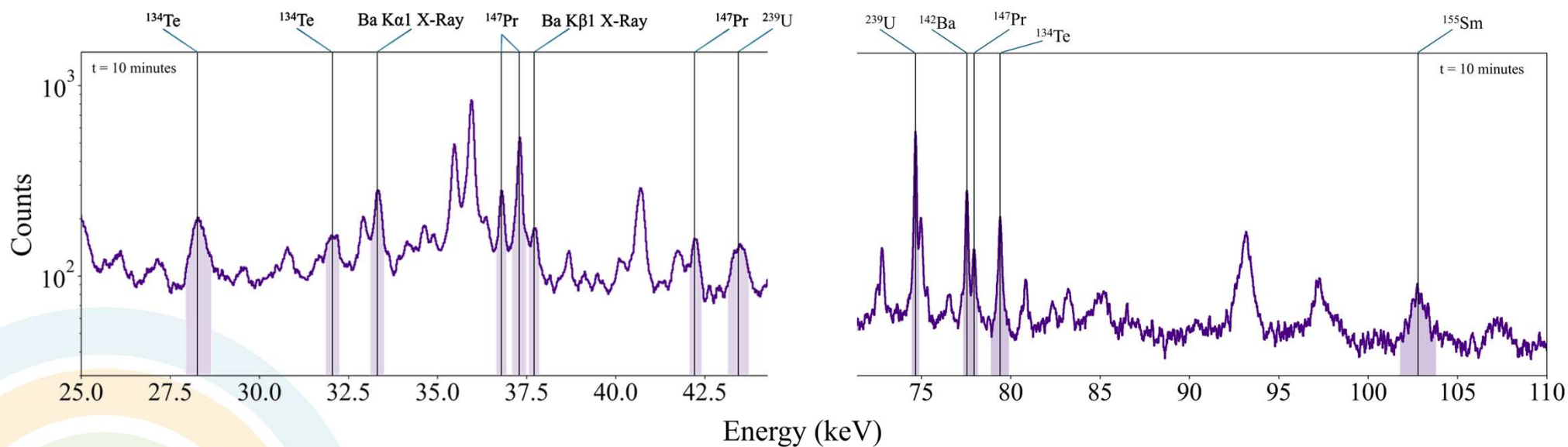


We used three different methods to calculate the half-life from the uCal list mode data including Los-Linear Regression, Iteratively Reweighted Least Squares, and Piecewise Regression

We did see a bias on the half-life estimation, but they allowed for the identification of peaks that came from the same isotope



# Peak Identification based on Half-Life



# Dissemination of the Results



- Report uploaded to PICS:NE
- Manuscript ready for submission

## Half-Life Measurements of Short-Lived Fission Products Using an Ultra-High-Resolution Microcalorimeter

Stefania Dede<sup>1</sup>, Hyrum J. Hansen<sup>1</sup>, Matthew H. Carpenter<sup>1</sup>, David C. Glasgow<sup>2</sup>, Craig Gray<sup>2</sup>, Jianwei Hu<sup>2</sup>, Katrina Koehler<sup>1,3</sup>, Donald Kovacic<sup>2</sup>, Daniel G. McNeel<sup>1</sup>, Robert D. McElroy, Jr.<sup>2</sup>, David J. Mercer<sup>1</sup>, Rico U. Schoenemann<sup>1</sup>, Katherine A. Schreiber<sup>1</sup>, Mark P. Croce<sup>1</sup>, Kathleen C. Goetz<sup>2</sup>, and Emily N. Stark<sup>1</sup>

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# Improvements for the Next Campaigns

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- Separate acquisitions were low-statistics at the pixel-level
  - Solution 1: one long acquisition and “hot swapping” the samples
  - Work towards the solution:
    - Mimicked this measurement at LANL with a SOFIA system
  - Solution 2: use pre-computed pulse filters to get an energy-calibrated spectrum
  - Work towards the solution:
    - Pre-computed filters have been developed through other uCal projects and will be adapted for this specific detector system
    - This will also allow us to re-analyze the data that was coadded manually

# FY26 Irradiations

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- Using simulated TRISO fuel:
  - Similar targets to FY25
  - Dialing in the “hot swapping” of samples
  - This can be done using the operational reactor

# FY26 Irradiations



- Re-irradiating TRISO fuel:
  - Re-irradiating the TRISO particles in the “sleeping reactor” does not require sealing in quartz ampules
  - While this decreased the administrative burden, it does require a well-coordinated team
  - We anticipate getting 4-8 hours of measurement time

## **“Sleeping reactor” irradiations: The use of a shut-down reactor for the determination of elements with short-lived activation products**

**E. A. Jerde,<sup>1,2</sup> D. C. Glasgow<sup>2</sup>**

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<sup>2</sup> *Chemical and Analytical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

(Received June 28, 1999)

# FY26 Re-Irradiated TRISO

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- Particles from the AGR2 Experiments at Idaho National Lab:
  - 7.46 %FIMA
  - 8.22 %FIMA
  - 9.26 %FIMA
  - 10.42 %FIMA
  - 12.05 %FIMA
- Different particles than were previously measured but from the same samples
  - In addition to measuring the particles right after re-irradiation, we will measure them when they are no longer re-activated

# Sleeping Reactor Irradiation Experiments

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- Cycle 515: Approximately April 24<sup>th</sup>, 2026
- Cycle 516: Approximately June 5<sup>th</sup>, 2026

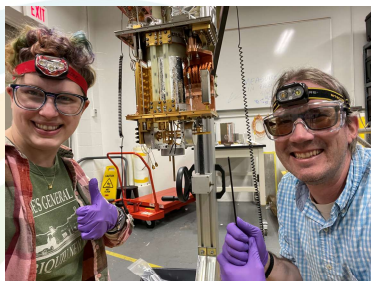
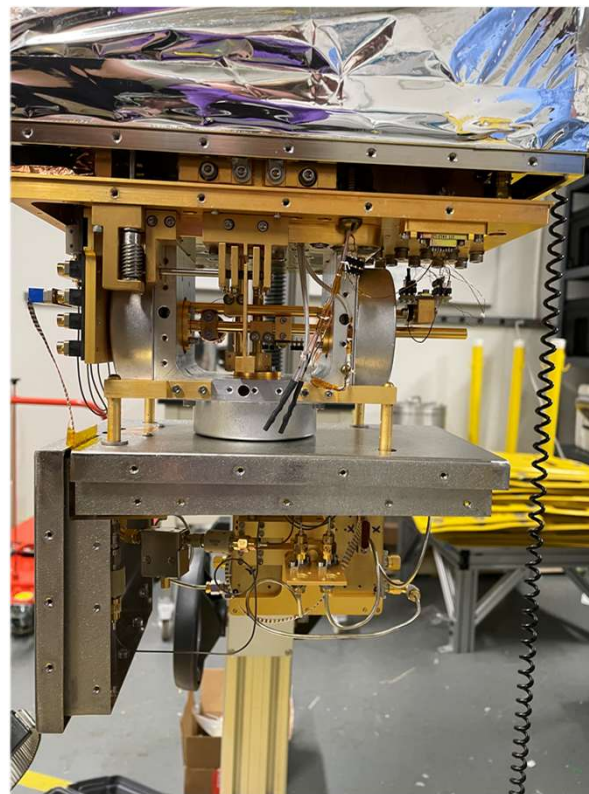
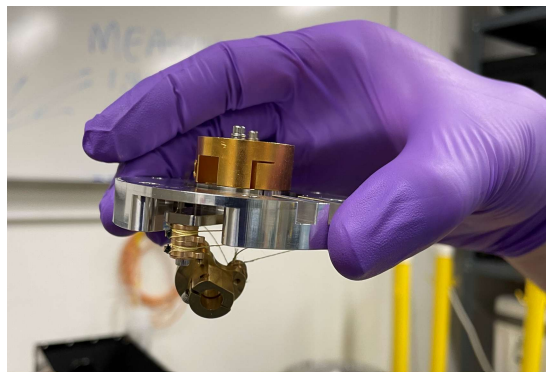
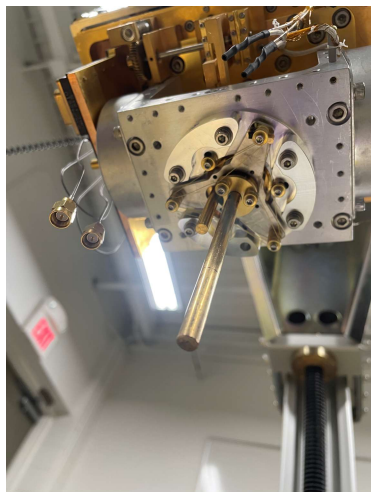
# Reinstall SOFIA at HFIR

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- SOFIA had been moved back to LANL to support other uCal measurements
- SOFIA did the 2800 mile round trip between LANL and ORNL between October 2025 and March 2026
- During the March 2026 install we identified an issue that required replacing an internal component of the cryostat
- April 2026 we transported a service stand from LANL to ORNL and back to perform the repair
- The repair was successful and only possible due to the coordination and support of both the ORNL and LANL teams
- The measurement campaign can continue ***on-schedule***

# Field-Repair Operations



**Successful Repair Thanks To:**  
ORNL Riggers  
(Moving SOFIA to and from the HFIR Lab)  
ORNL RCTs  
(Surveying in and out equipment between rad areas)  
ORNL Lab Space Use  
(SEL Lab for Repairs;  
Escorts in the Lab)  
LANL Microcal Team  
(Service Stand;  
Remote Support)

# Plans for the Data

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- Compare data re-analysis of FY25 data
- Analyze the TRISO re-irradiation data and look for fission product signatures of burnup and enrichment
- Leverage this dataset for potential future ML work out of BNL
  - Discussions following WANDA 2026



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# Thank You