



R3 FLASHTALK - FASTPAC -- July 2022

July 2022

Changing the World's Energy Future

David L Chichester



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Fieldable Alpha Spectrometry

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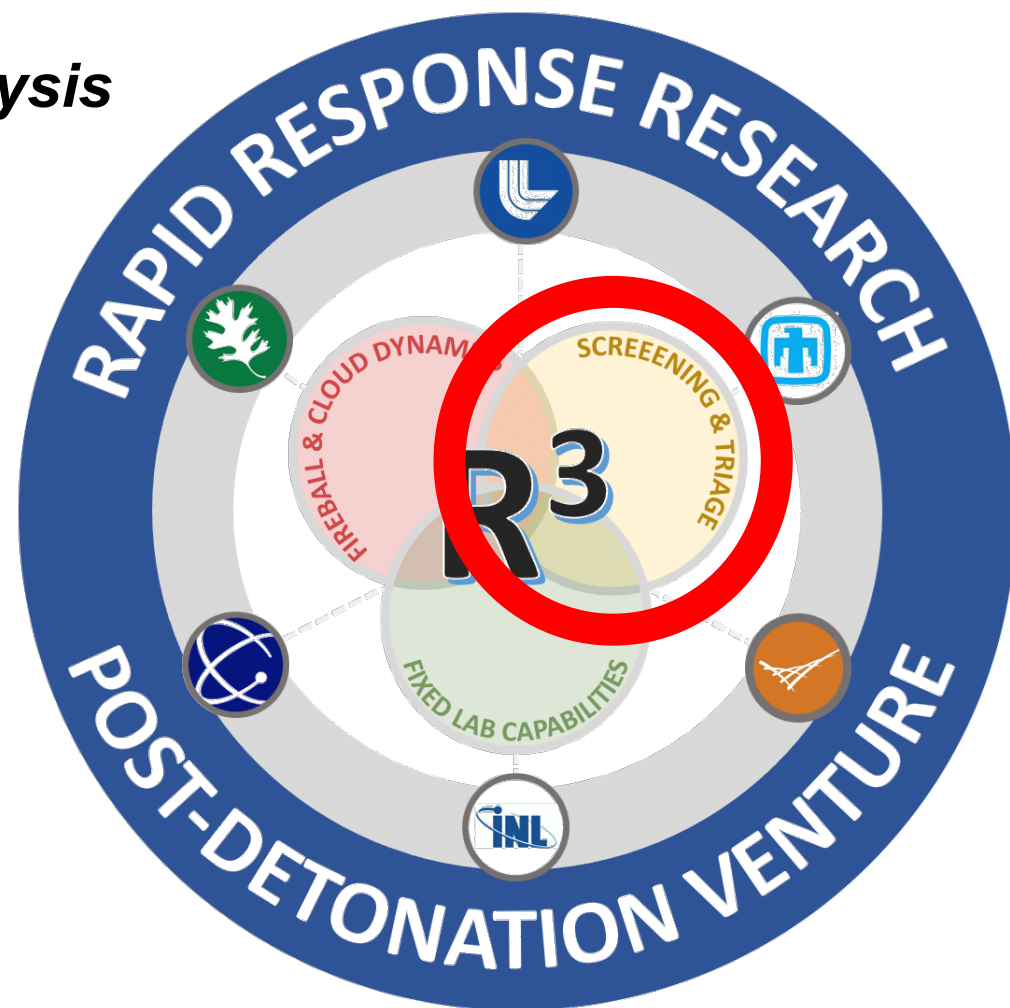
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Department of Energy review required before public release
Name/org: D. Chichester, INL Date: 5 July 2022
Guidance (if applicable): NA

TA2: Advances in Screening and Triage Analysis

... to develop, test and evaluate the fieldability of a suite of analytical methods that could significantly accelerate the timeline required to obtain insights into key nuclear device characteristics.

Task 2.1: Enhanced Techniques for In-field Screening and Measurements

Subtask 2.1.1: Counting capabilities for early-time analyte quantification and screening



Thrust Area Review

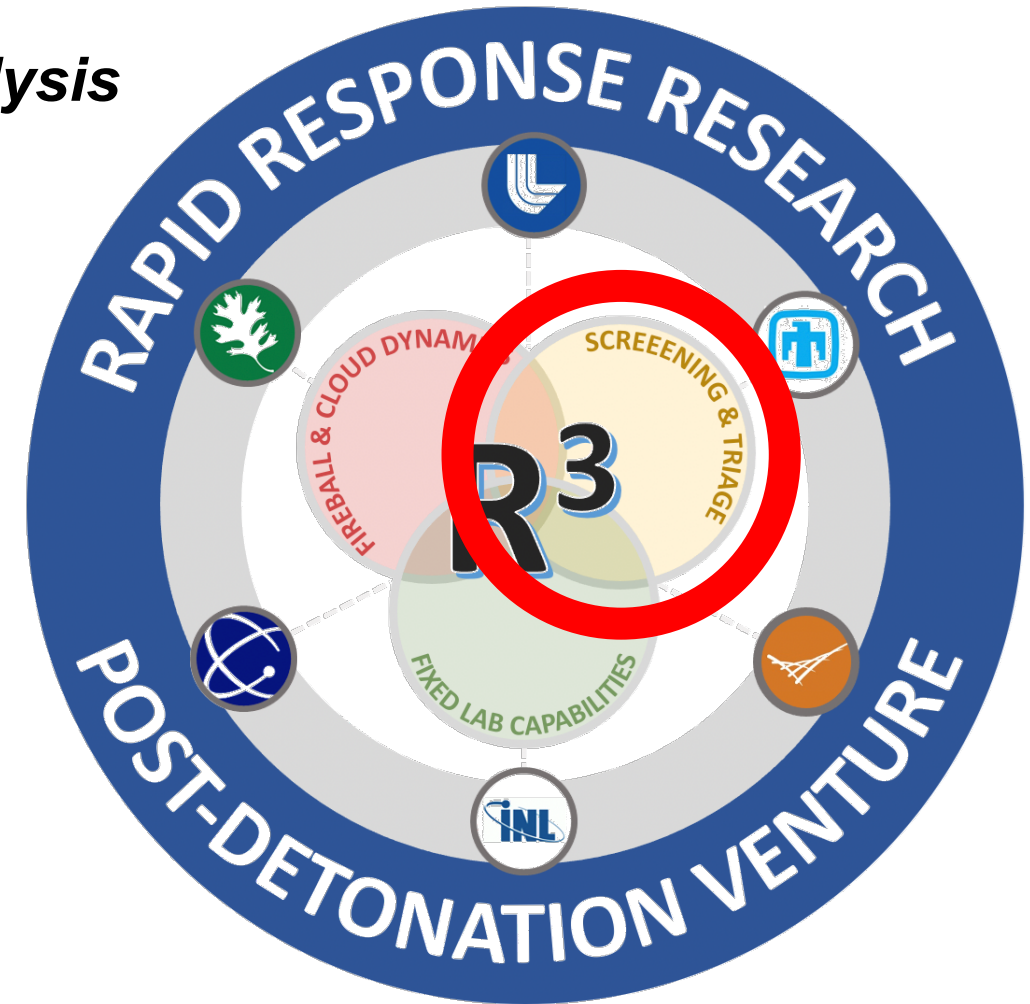
TA2: Advances in Screening and Triage Analysis

... to develop, test and evaluate the fieldability of a suite of analytical methods

Fieldable Alpha Spectrometry

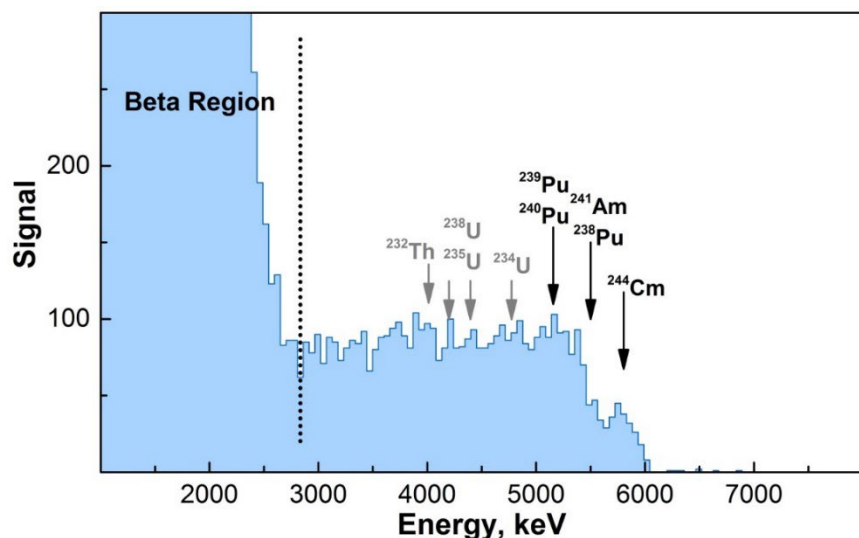
Developing alpha spectrometry instruments and methods that can be forward deployed to allow immediate post-detonation actinide characterization of nuclear fallout.

- *Direct analysis of high-beta samples*
- *Sample processing*
- *High-resolution alpha spectrometry*
- *Spectral analysis*



Challenges

- Direct alpha analysis of fallout is challenging due to high beta component at early time periods ($\dot{D}_\beta \sim 150 \dot{D}_\gamma$)



Alpha spectrum from irradiated fuel, >5 y old:

- $\dot{D}_\gamma : 1 \text{ R hr}^{-1}$
- $\dot{D}_\beta : 30 \text{ R hr}^{-1}$

- Alpha spectra from thick-matrix samples lead to extreme low-energy tailing (plateaus), can improve w/ processing

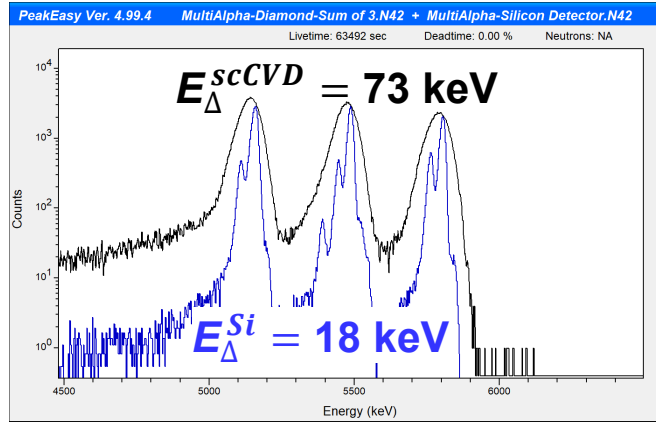
Methods and Results

- ➔ Use of single-crystal (sc) chemical vapor deposition (CVD) diamond semiconductor arrays, high-bandwidth amplifiers, high-rate digitizers
- ➔ Use of fieldable sample preparation tools and methods to reduce sample thickness and allow for better spectral quality
- ➔ Development for software tools to interpret non-ideal alpha spectra from thick samples

Motivation evolving from simple Pu detection (y/n) to actinide analysis → quantification

Fieldable Alpha Spectrometry

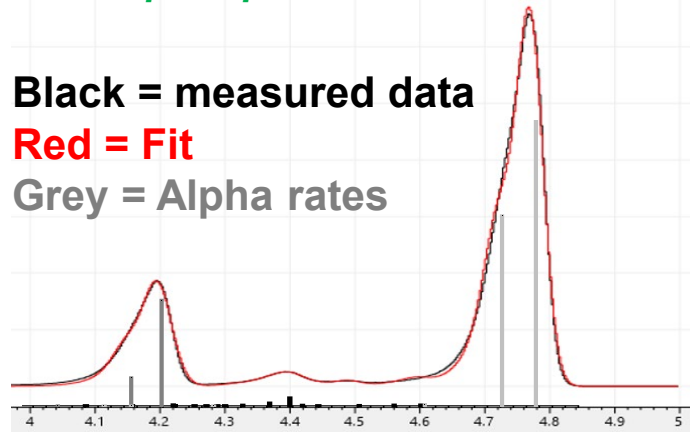
Ongoing



Array of three scCVD sensors in vacuum assembly (left) and gain-matched spectrum (right) of $^{239}\text{Pu} + ^{241}\text{Am} + ^{244}\text{Cm}$ source (black) [Si in blue]

Development of inverse solving tool to fit/deconvolve complex alpha spectra into isotopic components

Alpha spectrum for HALEU



Impacts

- Developing fieldable alpha spectrometry options for possible deployment
- Primarily focused on ground-collected samples but also exploring utility for air-filter samples
- Evolving our direction to align with requirements matrix

Next Steps

- Preparing to analyze actinide-bearing (LLNL solution) sol gel verification materials in July
- Will re-analyze these materials with sample prep afterwards
- Working with vendors on integrated 2x2 and 3x3 scCVD arrays
- Code assessment using measured spectra from sol gel work