



# Detector Mechanisms for a Portable Neutron Resonance Transmission Analysis System

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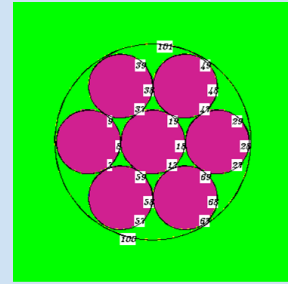
# Agenda



**Overview and  
Background**



**Work  
Accomplished**



**Research Focus  
and Ongoing  
Work**



**Applications  
and Impact**

# Thorium Fuel Cycle Safeguards

May include...

- Heterogeneous nuclear materials with different isotopes present
- Indistinguishable passive signatures
- **High gamma backgrounds**

A detection mechanism that is...

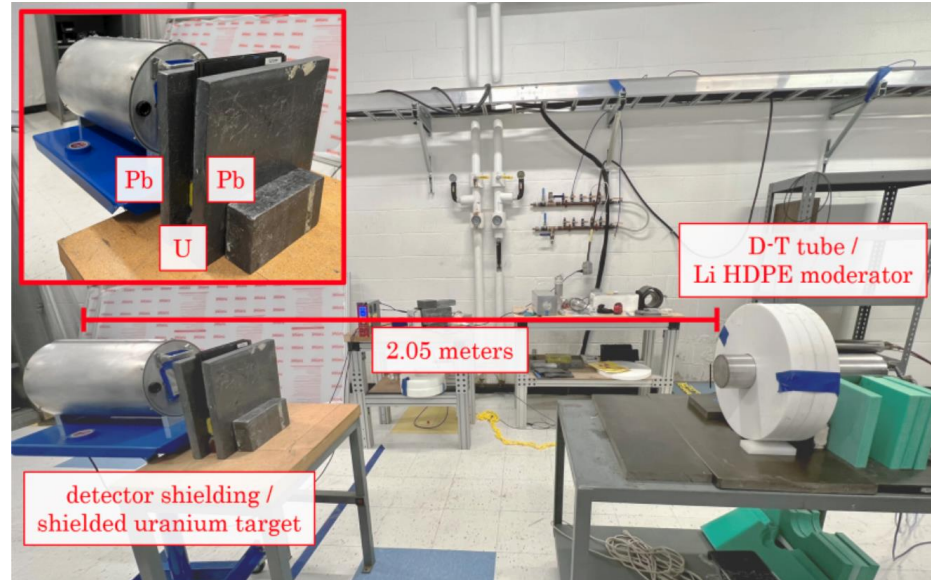
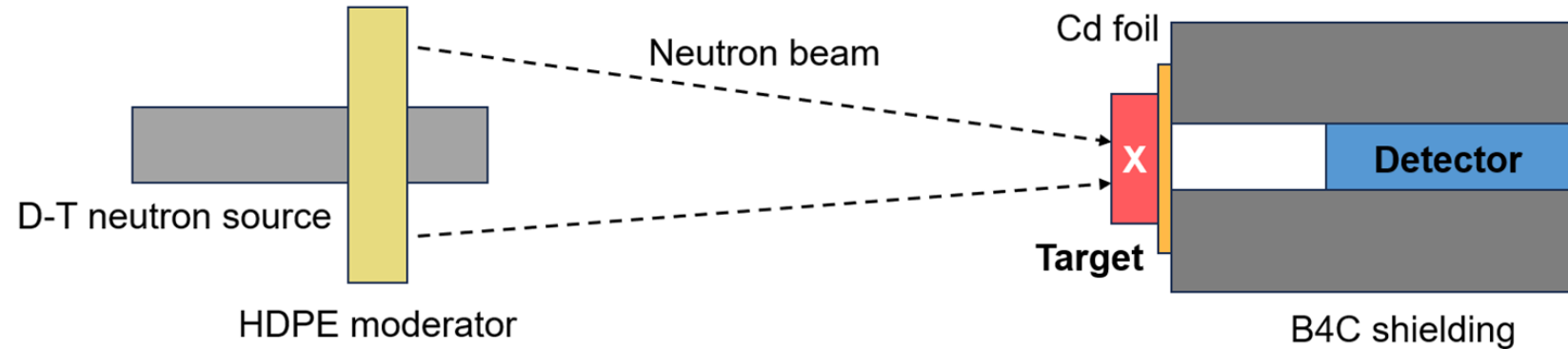
- Applicable for range of isotopes and fuel forms
- Active
- Portable and non-destructive
- **Accurate even in high gamma backgrounds?**

ornl.gov 2011



# Neutron Resonance Transmission Analysis (NRTA)

- Neutron attenuation through sample – resonance analysis
- Previously limited to large-scale facilities
- Can be performed alongside neutron resonance *capture* analysis (NRCA)



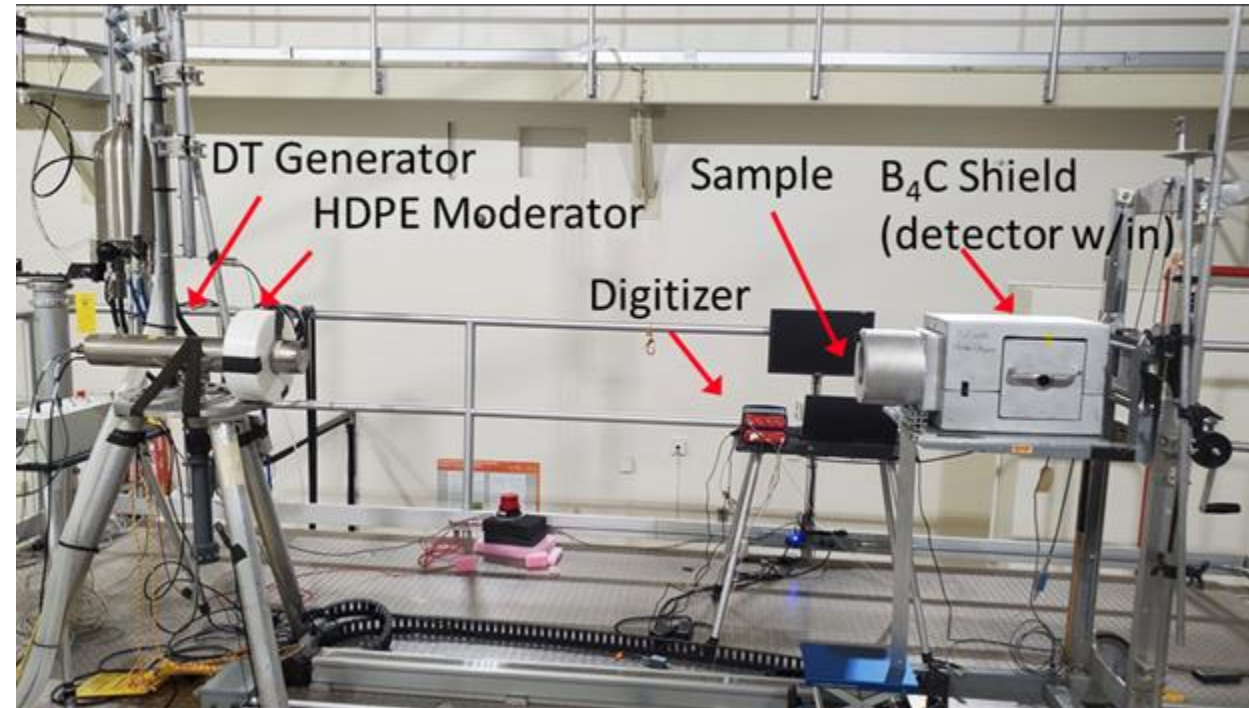
**GS20  
Scintillator**

# PNNL: NRTA for Th Safeguards

- Collaboration with PNNL
- Testing on isotopic samples
  - $^{233}\text{UO}_2$
  - $^{232}\text{Th}$  + HEU



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# Background Signal - GS20

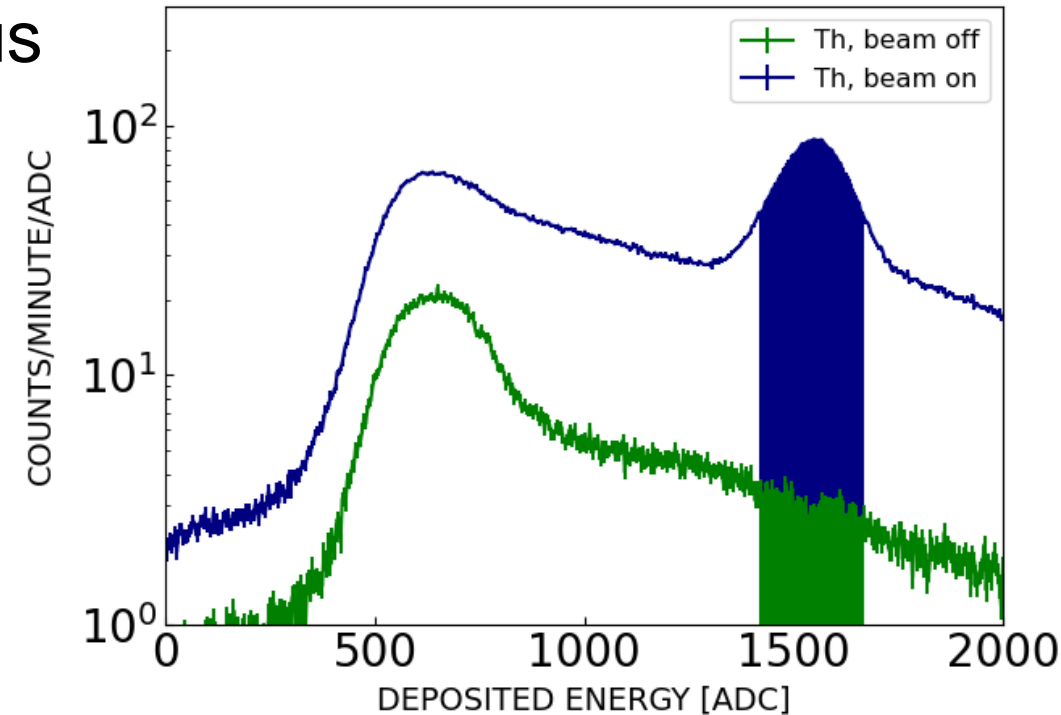
- **Background** =  
off-axis + on-axis + passive + hydrogenous

$$C_{bg}^{tot} = C_{const} + (\omega_{trans} \cdot C_{var}) + C_{Th} + C_H$$

- Transmission

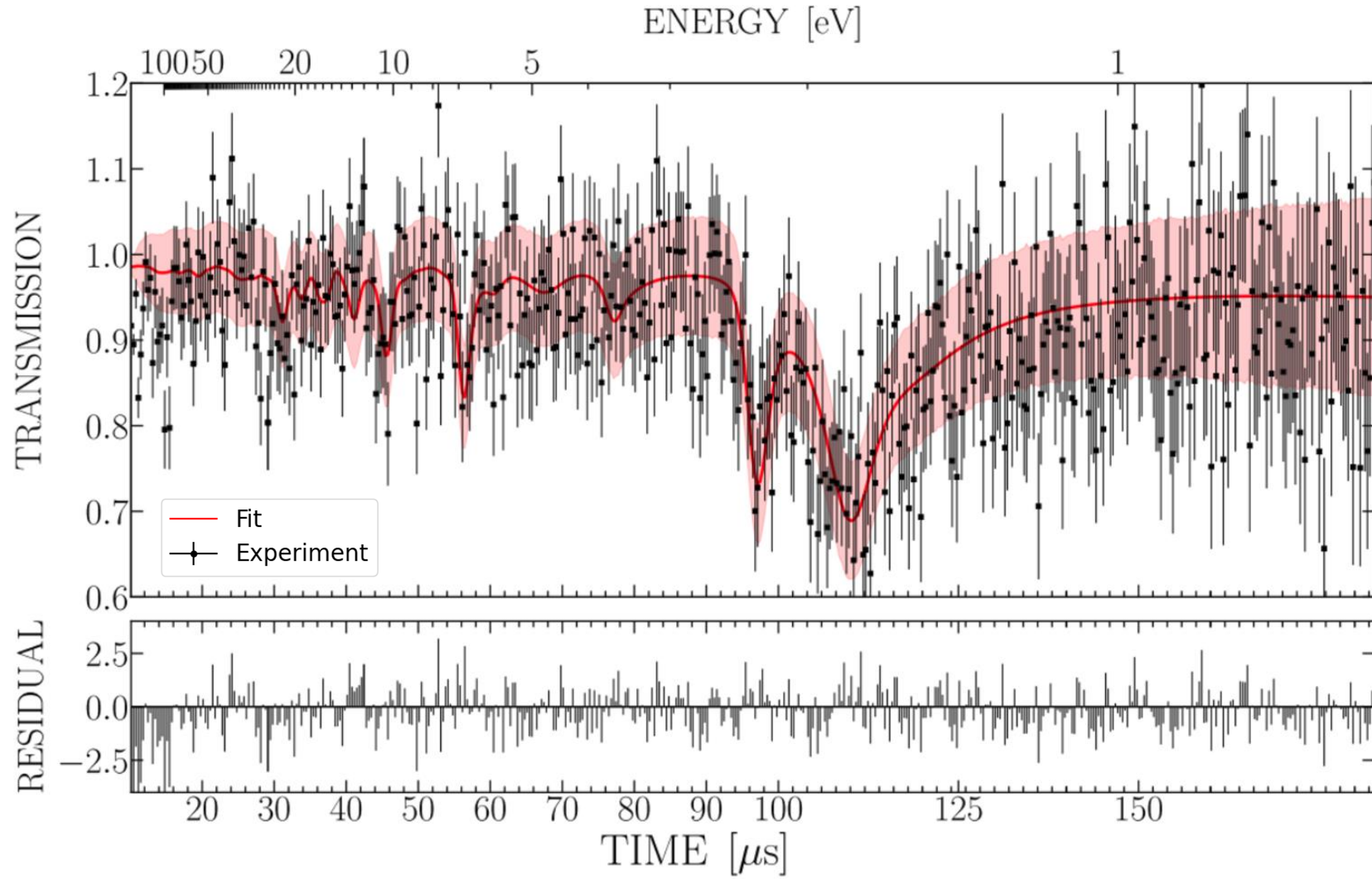
$$T = \frac{C_{target} - C_{bg, target}}{C_{open\ beam} - C_{bg, open}}$$

- GS20 sensitive to gammas, no signal differentiation



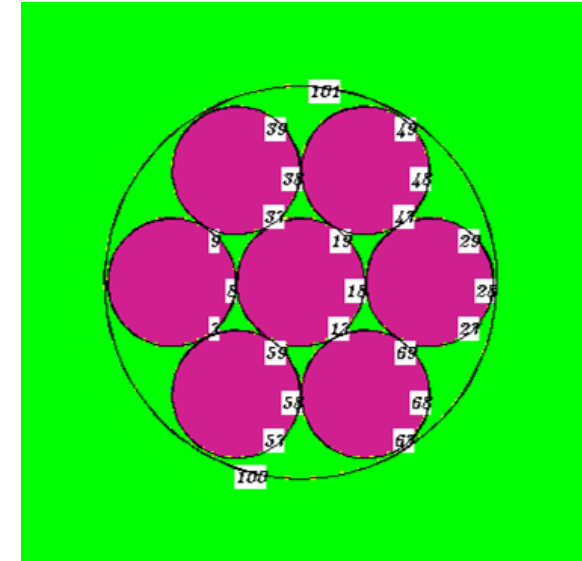
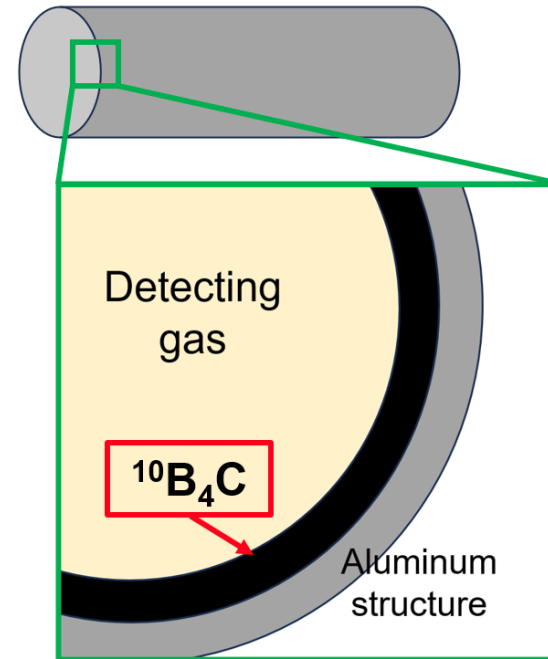
# High Gamma Background Detection Difficulties

- Effective for  $^{233}\text{Th}$
- $^{233}\text{U}$ : Pb shielding for gammas, which results in...
  - Greater noise
  - Blurring of neutron resonance
  - Requires longer measurement times



# Detection amid High Gamma Backgrounds

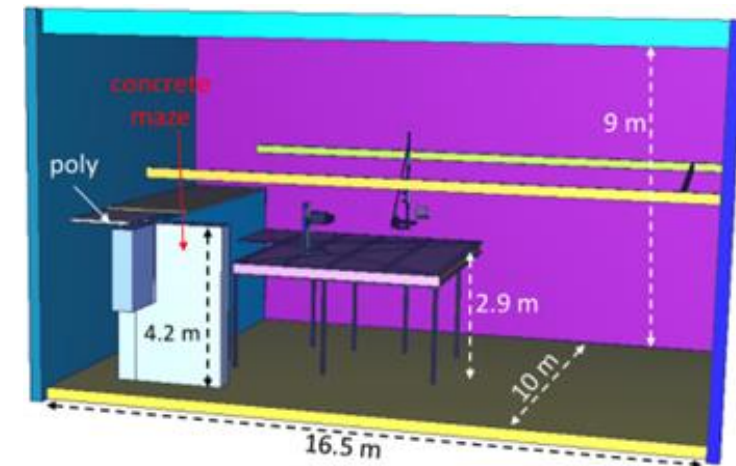
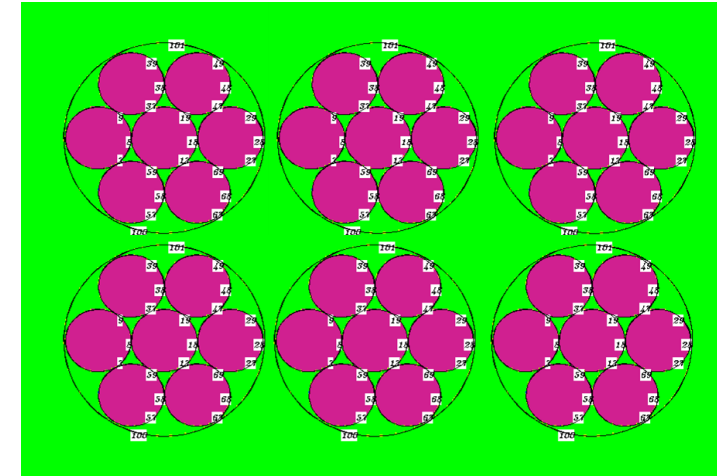
- Analysis of other detection mechanisms
- $^{10}\text{B}$ -coated straws
  - Gas ionization detector
  - Effective n-gamma discrimination
  - Can provide position information
- Packed into bundles





# B-coated straws Ongoing/Future Work

- Means of increasing efficiency
- Arrays of straws, TOF calculated at each column
  - ~15 bundles to achieve equivalent GS20 efficiency
- Novel geometries
- MCNP simulations for modeling efficiency and signal response



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# Applications and Impact

- Range of applications, directly connected to NNSA mission
  - Safeguards technologies for fuel cycle materials
  - Increasingly important for complex novel fuel cycles, such as Th
  - Critical to global nonproliferation concerns, arms control applications
- Impact of MTV on development
  - Collaboration with PNNL
  - Use of PNNL's range of resources and materials
  - Plan for continued cooperation and experimentation



# Acknowledgements



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# Works Cited

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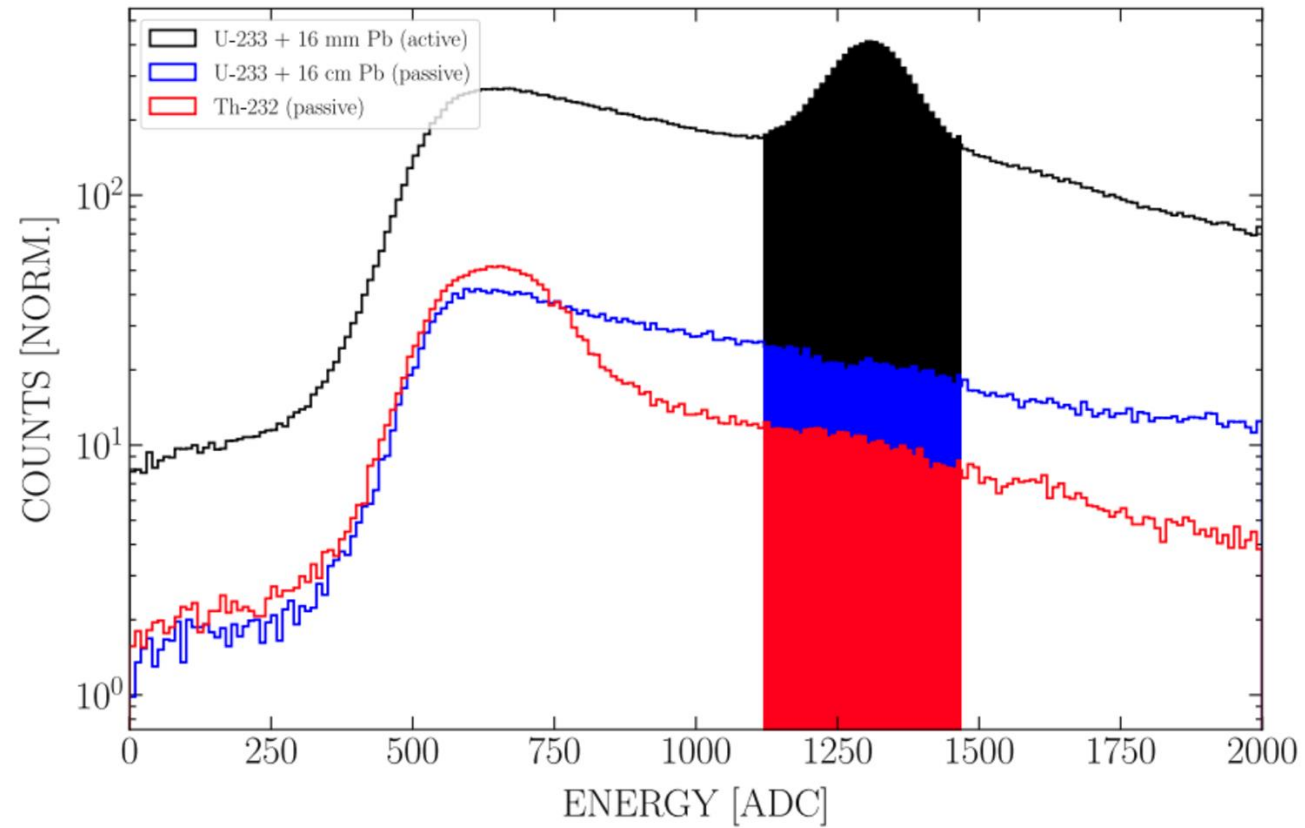
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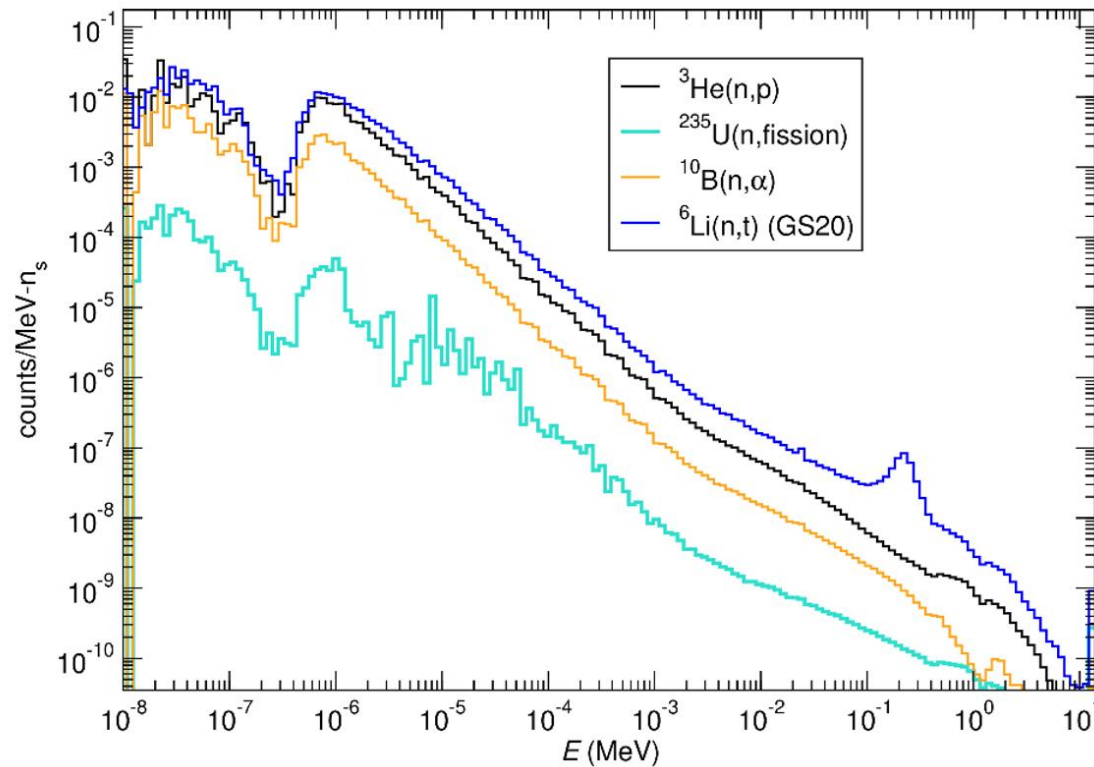
# Additional Slides

$^{233}\text{U}$  vs  $^{232}\text{Th}$  gamma background counts



# Additional Slides

## Detection efficiencies comparison



## B-coated straw orientation

