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# Detection of Prompt Photofission Neutrons from $^{238}$U with a $^{4}$He Scintillation Detector

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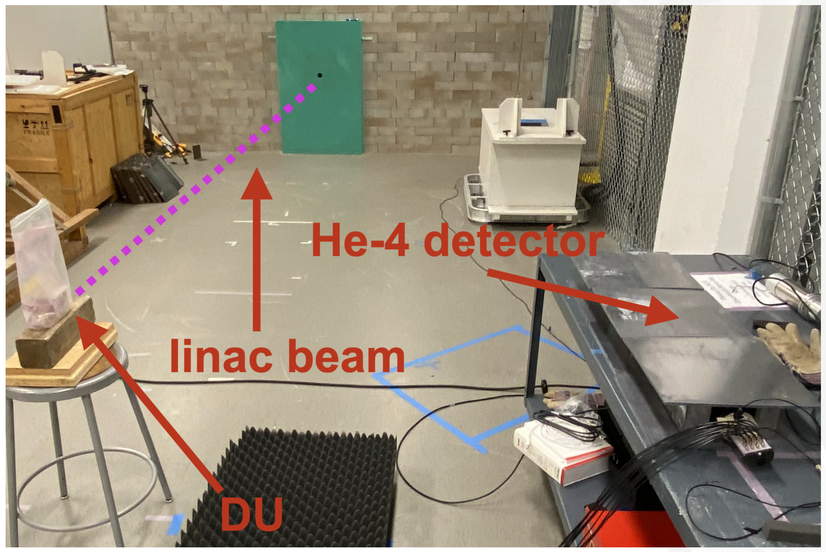
## Introduction and Motivation

- Photon active interrogation is theoretically promising for SNM detection but its use is limited by detector shortcomings:
- Thermal neutron capture-based detectors: insensitive to energy e.g., cannot distinguish fission vs (γ,n) neutrons
- Pulse-shape discrimination (PSD)-capable detectors: intense gamma fields degrade performance
- $^{4}$He scintillators:
  - Discriminate photofission neutrons from (γ,n) neutrons
  - Limited sensitivity to intense gamma fields, no PSD required

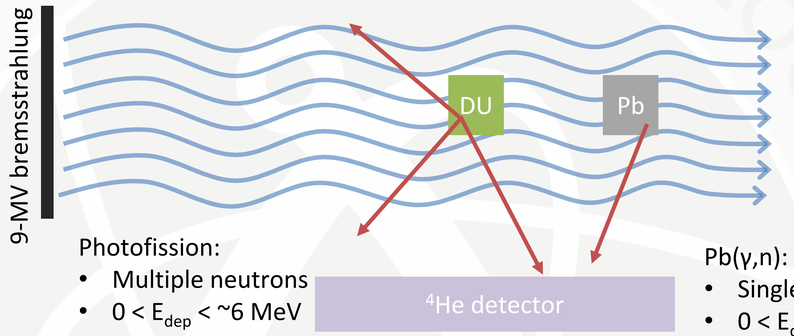



## Mission Relevance

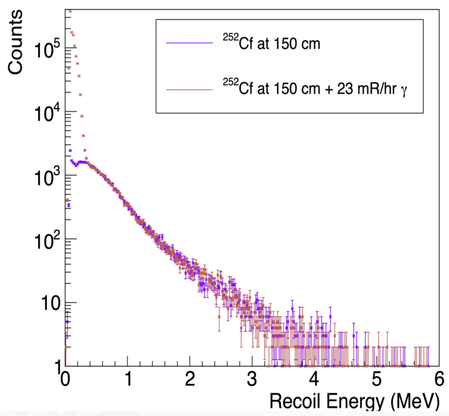
- Prompt photofission neutron detection rapidly identifies nuclear material in interdiction and verification scenarios.
- Interdiction and verification are crucial capabilities to prevent nuclear terrorism and material diversion.

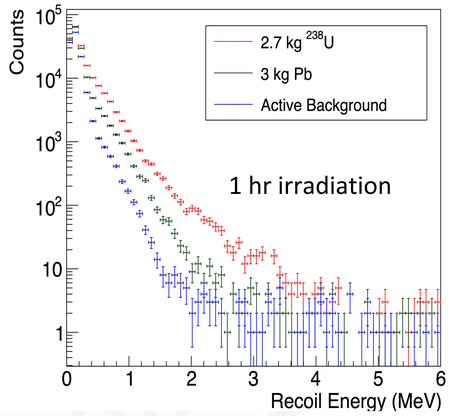
## Technical Approach

- A 9-MV linac-bremsstrahlung photon source irradiated $^{238}$U and Pb objects
  - Demonstrated photofission neutron energy discrimination
- Gamma-ray discrimination verified with a $^{252}$Cf neutron source and $^{137}$Cs, $^{60}$Co, and $^{22}$Na gamma sources (23 mR/hr on contact)




## Results




- Intense γ field does not impact neutron spectrum above ~300 keV
- High-energy tail of photofission spectrum seen above active background (linac on, no target) and Pb (γ,n)

## MTV Impact

- Networking with students through MTV produced multi-group collaboration for this project.
- Practicum at SNL-CA being planned to explore further applications of $^{4}$He neutron detector

## Conclusions

- $^{4}$He detector technology shown to be capable of operating in intense gamma-ray environments
- Feasibility of energy discrimination to verify presence of fissionable material confirmed.
- This work represents a novel means to indicate the presence of nuclear material, and significantly impacts the NNSA interdiction and verification missions

## Next Steps

- Further spectral analysis will optimize the system to quickly confirm the presence or absence of fissionable material
- Simulation framework being developed to predict response to different fissionable materials ($^{235}$U, Np)

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