A Field Deployable Imaging Neutron Detector (FIND) for SNM

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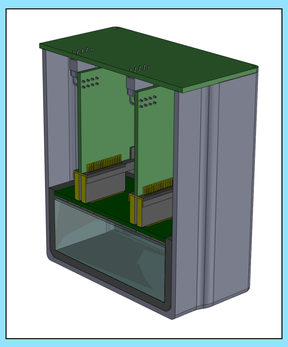
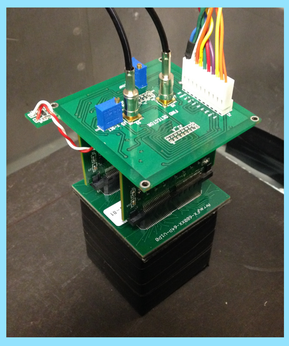
Abstract

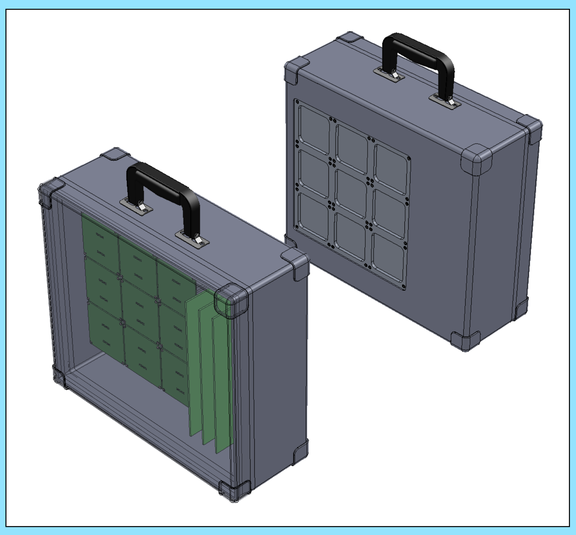
Neutron detection is of particular interest for nuclear or radiological material identification for security and proliferation deterrence, as well as for nuclear waste detection and monitoring. We present a concept for a Field-Deployable Imaging Neutron Detector (FIND) based on modern, commercially available detector technology that is compact, low-power, low-mass, and rugged. Individual detector cells are composed of plastic scintillator with pulse-shape discrimination (PSD) ability read out by arrays of silicon photomultipliers (SiPMs). A double-scatter neutron camera is formed by two layers of such detector cells. The compactness, ruggedness, and low weight of this technology allows these layers to be easily transported in standard portable containers for rapid deployment and assembly in the field. We describe the FIND instrument concept and initial tests of detector cell performance.

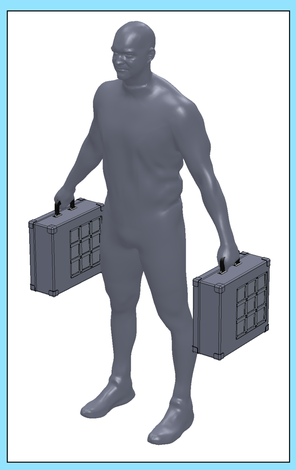
FIND Design





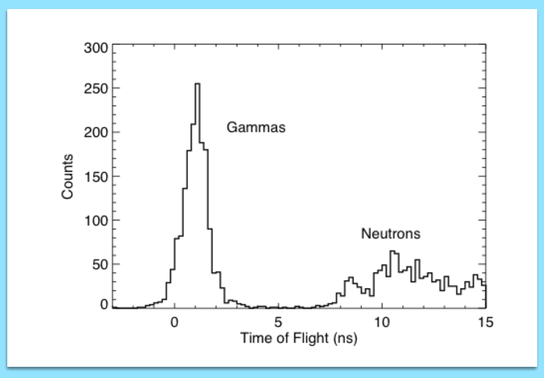
- Field Transportable System with Real Time Feedback
- Operates from on-board battery (8 hrs), external 12 VDC, external 120 VAC
- Modular design allows for the two layers to be contained in cases for compact transport (17 lb each).
- **Cases can be arrayed together to increase full instrument sensitivity.**



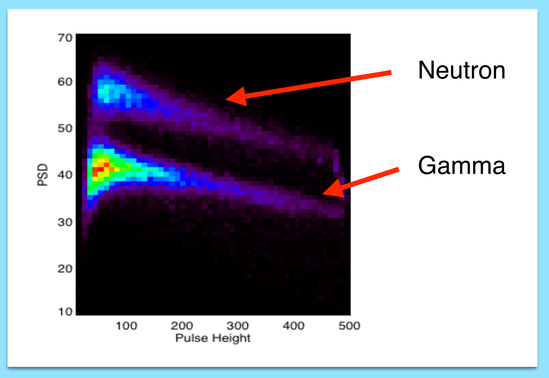


Laboratory Results

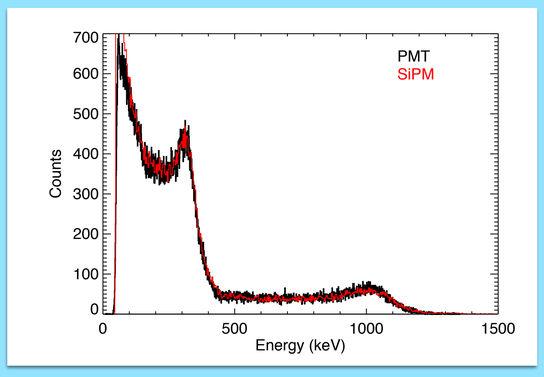
Time of Flight Performance



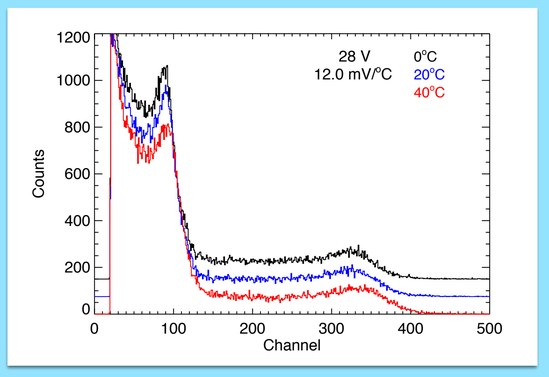
PSD Performance



Spectroscopy Performance

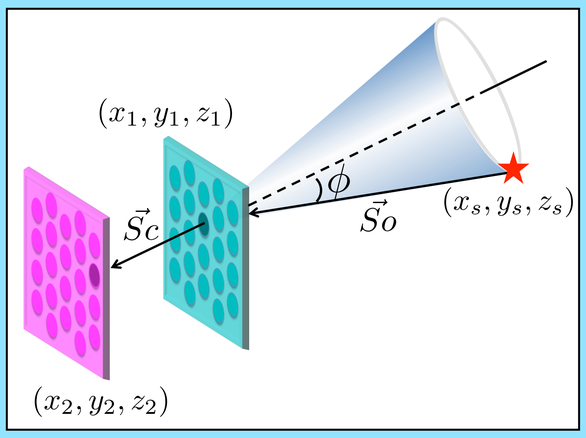


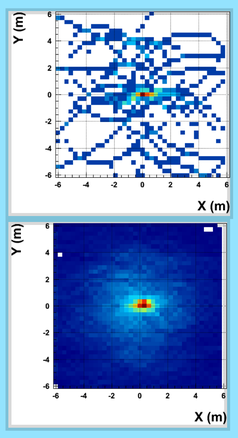
Gain Control vs. Temperature



Technique

- Detect multiple n-p scattering in position-sensitive detector layers made up of individual scintillator cells
- Measure: positions, energy deposits, time-of flight, pulse shape
- Apply n-p scatter kinematics to compute incident neutron energy and direction

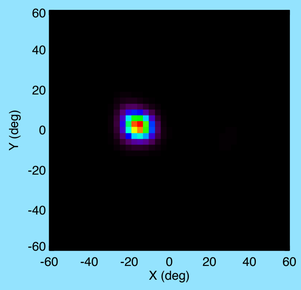




20 events

1000 events

GUI Work

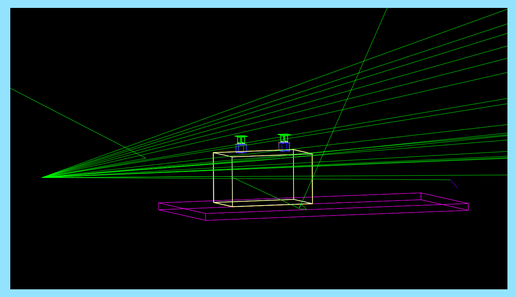


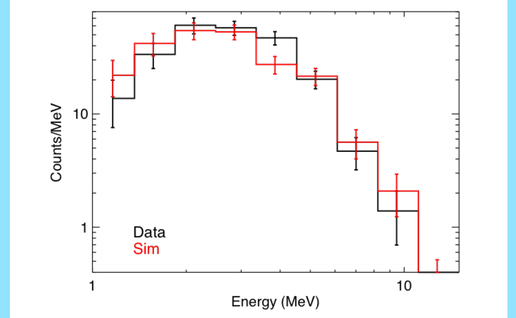
Imaging algorithms currently being refined from previous work to be implemented in the FIND prototype.

Instrument Modeling

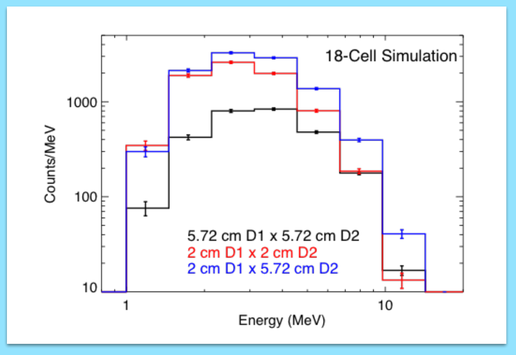
Mass model of the two-cell instrument prototype has been created using the SWORD V6 simulation package.

- Two-Cell prototype has been exposed to ^{252}Cf source in the lab.
- Recorded neutron energy spectrum is in good agreement with simulations.





- Simulations for 18-Cell prototype have been done to determine optimal thickness of scintillator in layers.
- Mass model for 18-Cell and 72-Cell system currently being updated to implement mechanical design.



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