A Field Deployable Imaging Neutron Detector (FIND) for SNM

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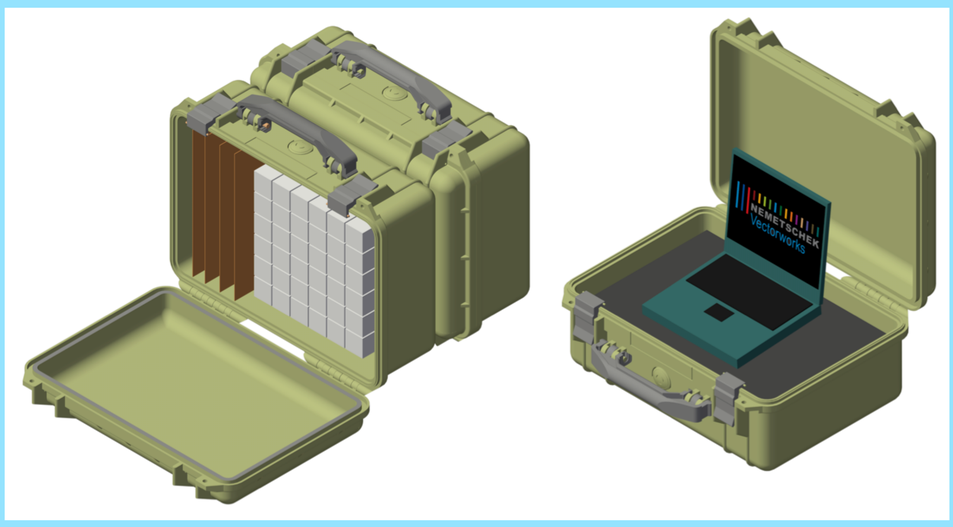
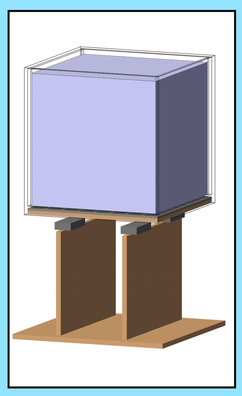
Abstract

Fast 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 and is sensitive to neutron energies roughly 1-20 MeV. 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.

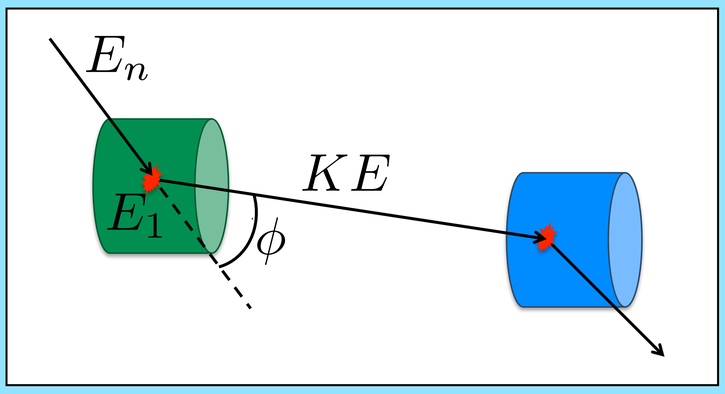
FIND Design





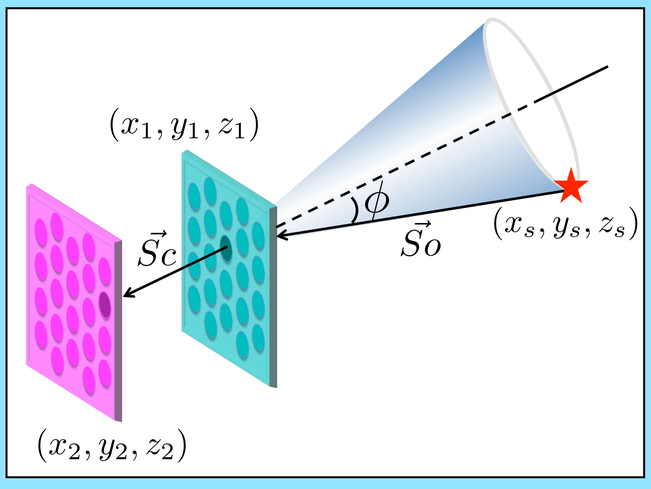
- Field Transportable System with Real Time Feedback
- Operates from on-board battery, external 12 VDC, external 120 VAC
- Operates a minimum of 8 hrs off on-board battery

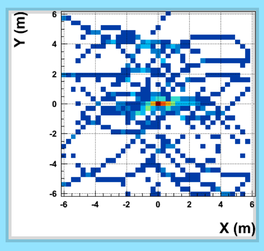
Technique



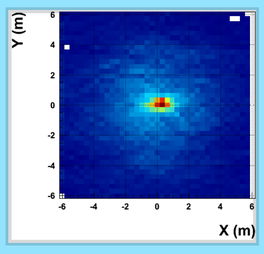
$$E_n = E_1 + K.E.$$
$$\sin^2\phi = \frac{E_1}{E_1 + K.E.}$$

- 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



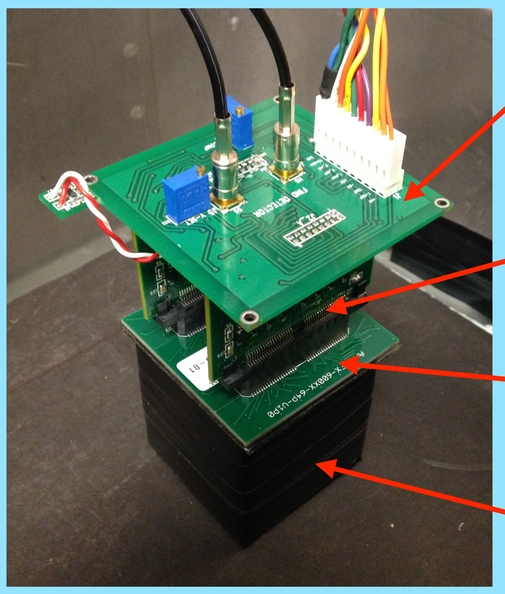


20 events



1000 events

Laboratory Results



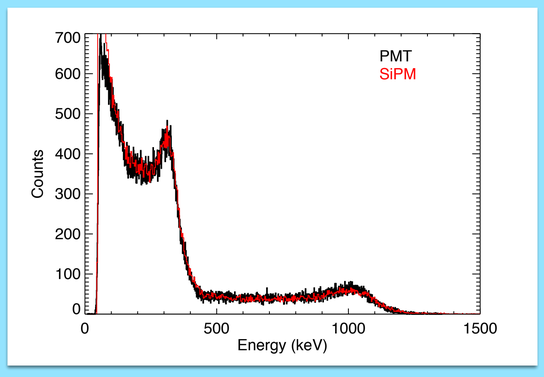
Power Supply and Temperature Compensating Board

Signal Summing Boards

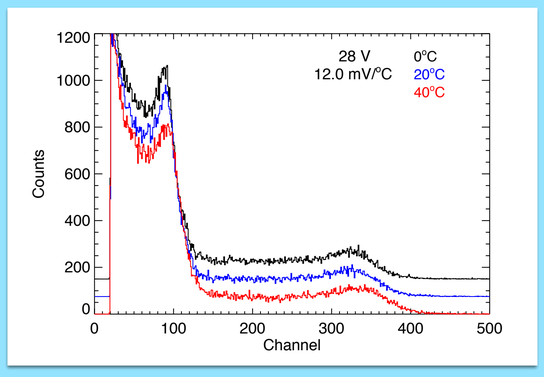
SiPM Array Board ArrayC-60035-64P-PCB

EJ-299-33A PSD Plastic Scintillator

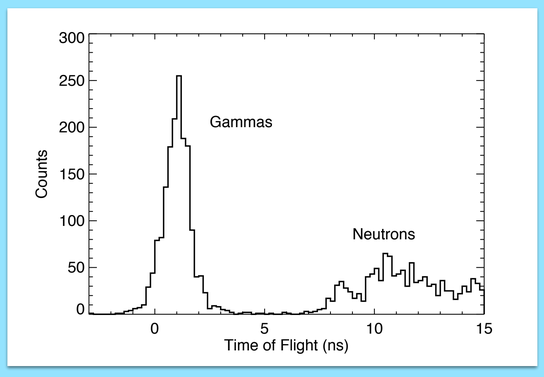
Spectroscopy Performance



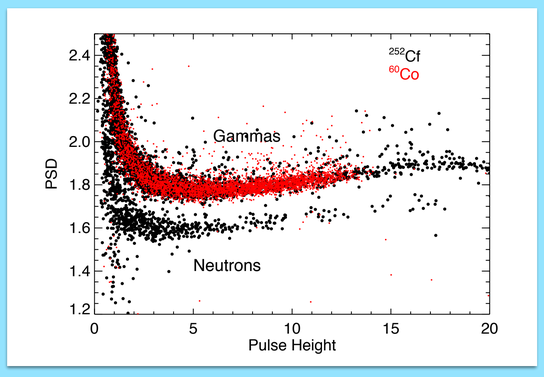
Gain Control vs. Temperature



Time of Flight Performance

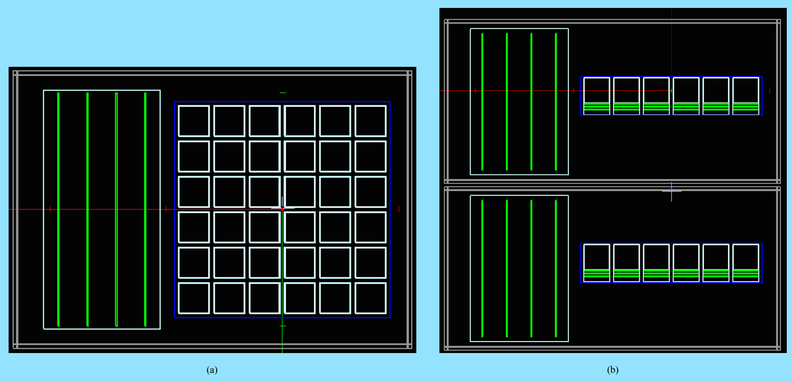


PSD Performance



Clear gamma/neutron discrimination achieved with PSD and TOF electronics.

Instrument Modeling



Mass model of the proposed instrument has been created using the SWORD simulation package

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