A Field Deployable Imaging Neutron Detector (FIND) for SNM

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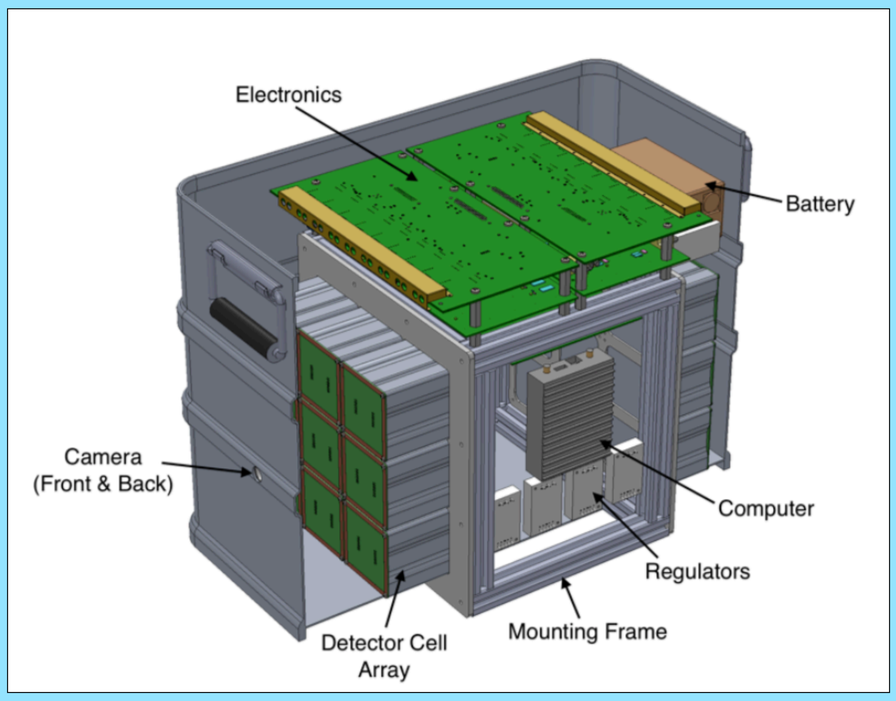
Abstract

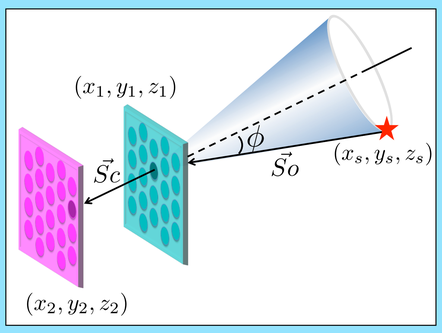
Neutron detection is of particular interest for nuclear or radiological material identification for security and proliferation deterrence, as well as for nuclear waste detection and monitoring. We present a concept for a Field-Deployable Imaging Neutron Detector (FIND) based on modern, commercially available detector technology that is compact, low-power, low-mass, and rugged. Individual detector cells are composed of stilbene 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 it to be easily transported to the field for rapid deployment. We describe the FIND instrument concept and initial tests of detector cell performance.

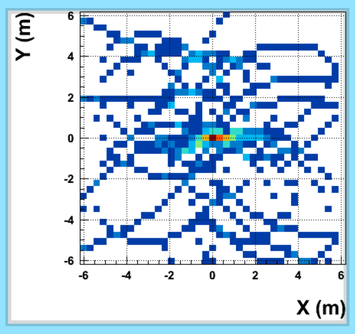
FIND Design



Technique

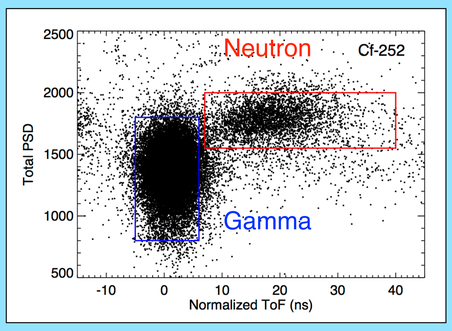
- Detect multiple n-p scattering in position-sensitive detector layers made up of individual scintillator cells
- Measure: positions, energy deposits, time-of-flight, pulse shape
- Apply n-p scatter kinematics to compute incident particle energy and direction
- Apply Compton Scattering kinematics for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

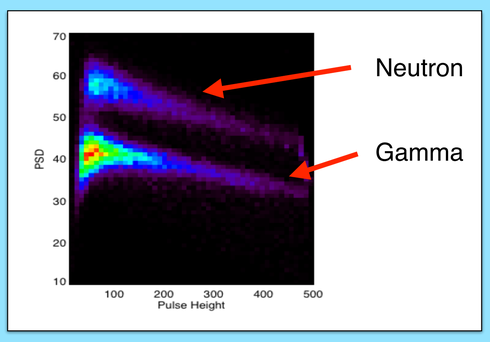




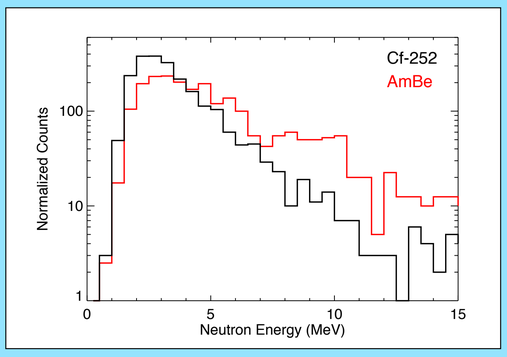
20 events

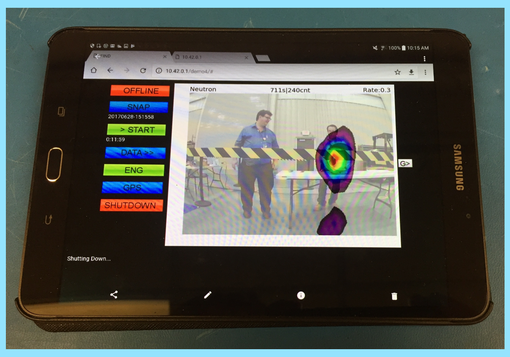
- Discriminate between neutron and gammas using TOF & PSD



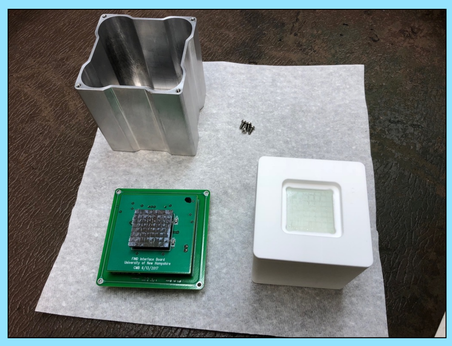


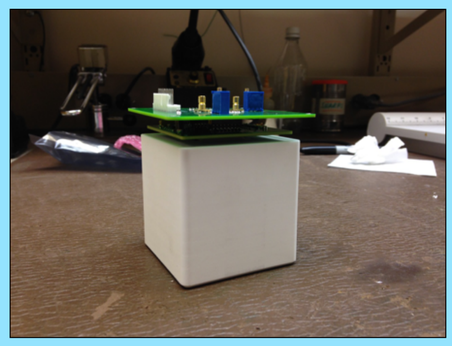
- Constructed image is overlaid on camera image for source location
- Display is done through a Web-page-based GUI via WiFi



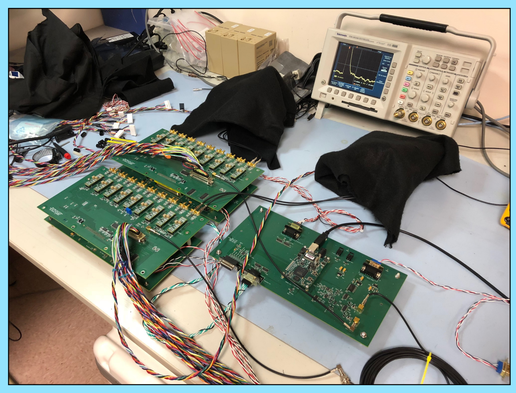


FIND Construction

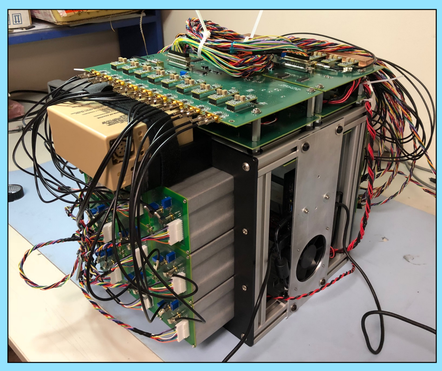


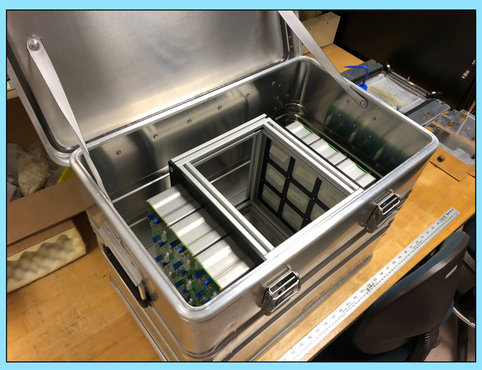


- Detector cells constructed with single crystal stilbene scintillator and J-series SiPM arrays



- Each detector layer is independently controlled by analog and digital electronics. A main digital board records data, resets layers and communicates to the onboard computer.





- The FIND instrument is self contained in a single container. The case is 24 in x 16 in x 16 in and weighs ~50 lbs. Battery runtime of ~8 hours with 24 VDC input option.

SWORD Simulations

- SWORD mass model of the 2nd generation FIND instrument has been created
- Simulations performed of the response to the UNH Cf-252 source last a distance of 4m, 20deg off axis
- More than a factor of 2 efficiency improvement over the 1st generation prototype