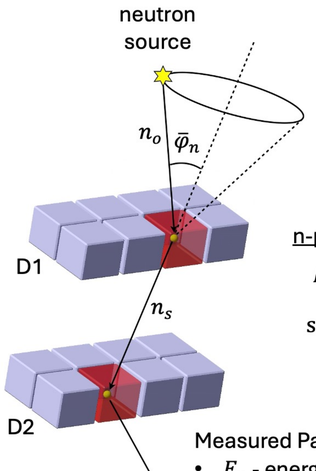
Imaging Neutron / Gamma-Ray Detector Development

Initially motivated by COMPTEL studies of solar flare neutrons, a series of detector designs have been developed for applications in homeland security, to provide simultaneous neutron and gamma-ray imaging. Development work focused on solar flares and studies of lunar regolith have also continued.

Detection Principles

The same instrumentation can be used for imaging both neutrons and gamma-rays.



Neutron Imaging

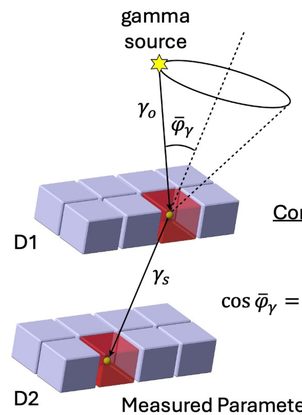
n-p scattering in D1

$$E_{n_o} = E_p + E_{n_s}$$

$$\sin^2\bar{\varphi}_n = E_p/E_{n_o}$$

Measured Parameters:

- E_p - energy of scattered p in D1
- E_{n_s} - energy of scattered n (ToF)
- locations in D1 and D2



Gamma-Ray Imaging

Compton scattering in D1

$$E_{\gamma_o} = E_e + E_{\gamma_s}$$

$$\cos\bar{\varphi}_\gamma = 1 - \left(\frac{m_e c^2}{E_{\gamma_s}}\right) + \left(\frac{m_e c^2}{E_e + E_{\gamma_s}}\right)$$

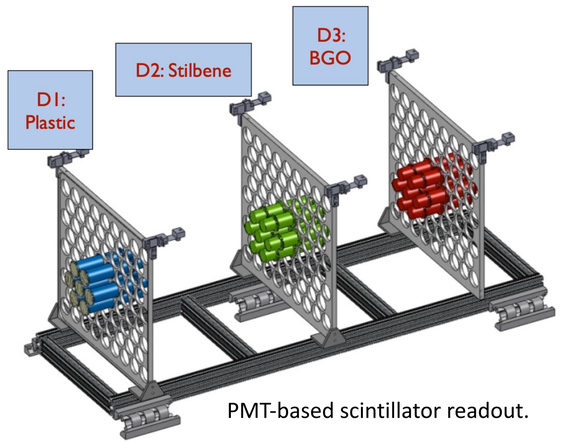
Measured Parameters:

- E_e - energy of scattered e^- in D1
- E_{γ_s} - energy of scattered gamma
- locations in D1 and D2

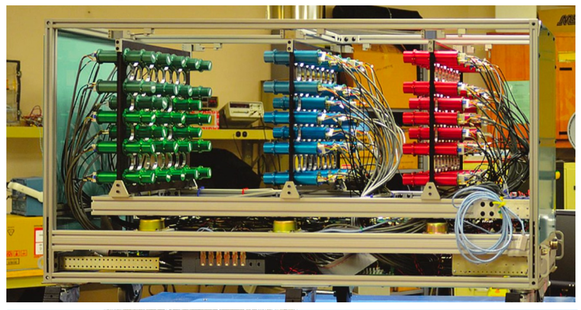
Measurements of both pulse-shape and time-of-flight are used to more efficiently identify both neutrons and gamma-rays.

NSPECT

Neutron SPECTrometer



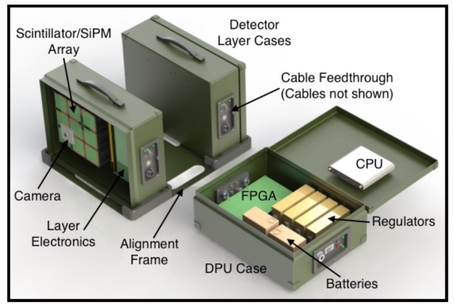
PMT-based scintillator readout.

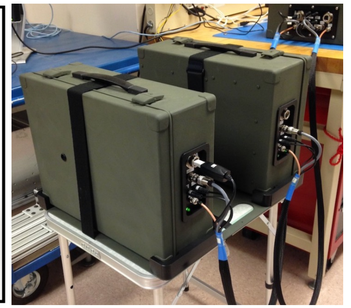


Simultaneous imaging of neutron (left) and gamma-ray (right) sources.

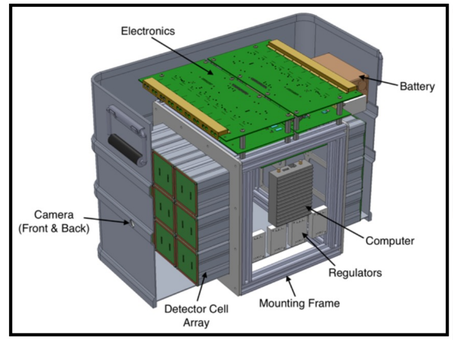
FIND

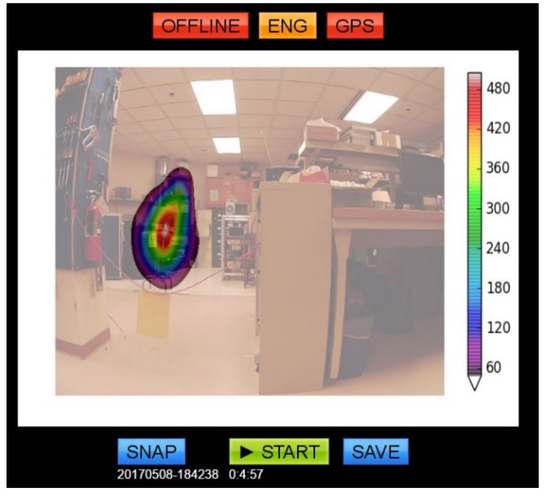
FIeld-deployable Neutron Detector





Evolution from a 3-case design (above) to a 1-case design (below)

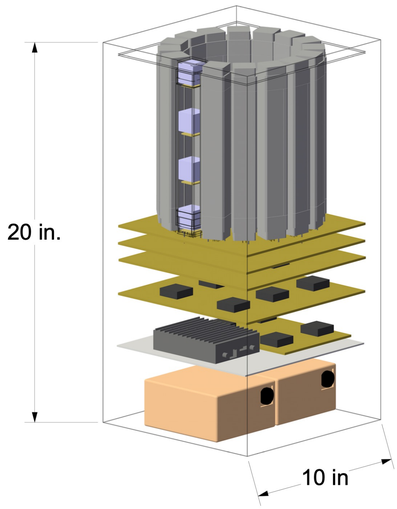


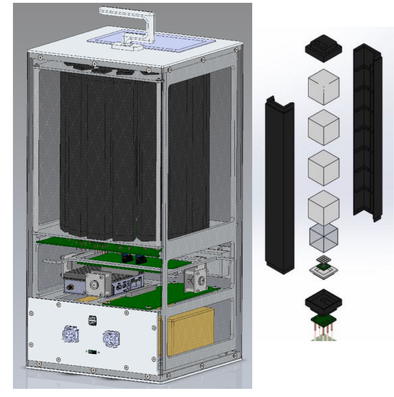


FIND's user-friendly (tablet) interface provided a neutron image overlayed on a visual image of the imaging field-of-view.

iFIND

An even more compact design that could image over a 360° FOV.





A circular arrangement of detector columns compact enough to carry in one hand. The design included a built-in touch pad interface.