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Compact Neutron Scatter Camera Search Applications

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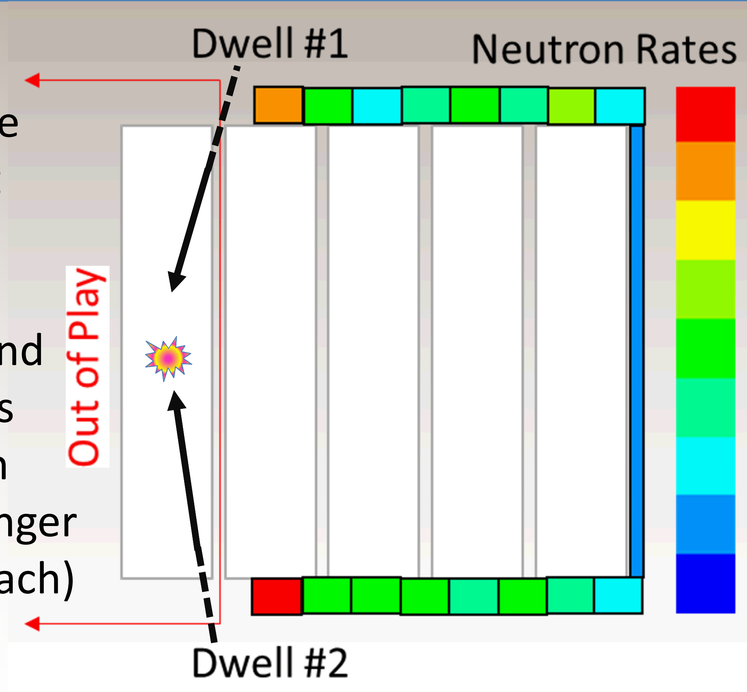
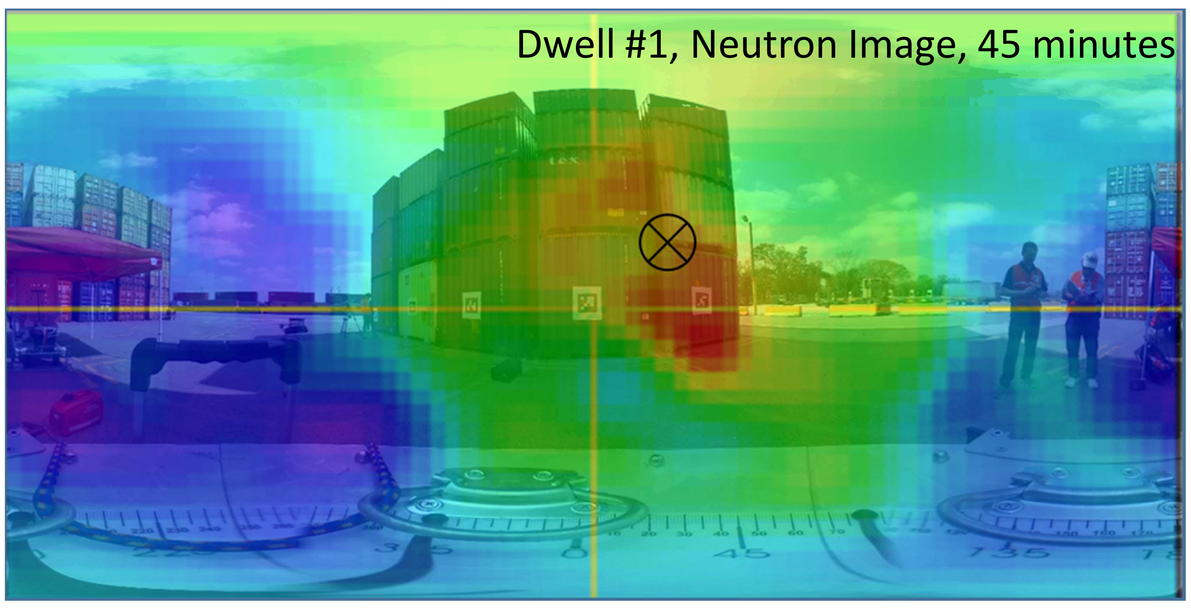
Mobile Imager of Neutron for Emergency Responders (MINER):

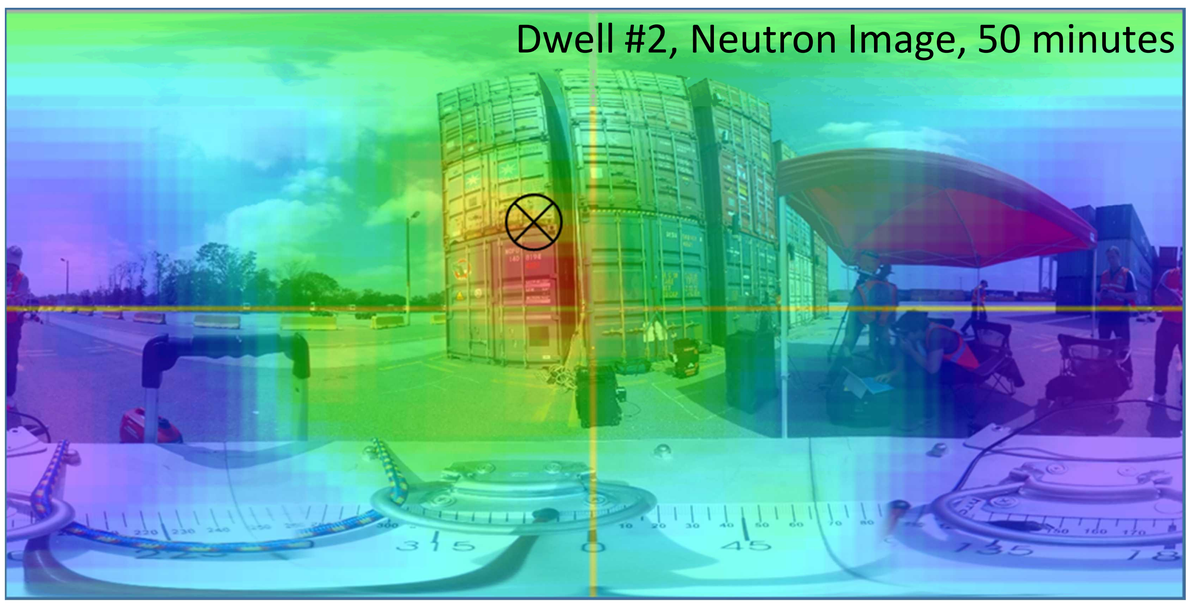
A recent campaign in Savannah demonstrated the ability of MINER to discover SNM in a realistic environment consisting of several container stacks. The stack had a mix of cargo (assorted) and empty containers (in which sources were hidden). MINER utilized single interactions in order to localize hot spots, and double scatter events in order to further image and characterize fission-energy neutrons. Gamma imaging was also demonstrated, including the ability to localize multiple sources based on their energy. Bi-modal imaging and neutron spectroscopy greatly increase the utility of the system.

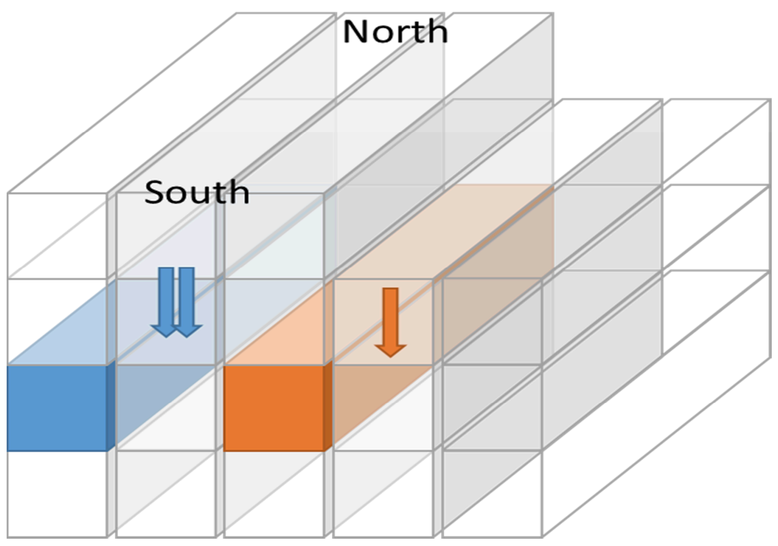
Blind Tests:

Determination of source presence through short counting scans before dwelling to develop an image for localization and spectrum. Counting was done for ~30 seconds in each location before longer dwells (up to an hour each) were performed.





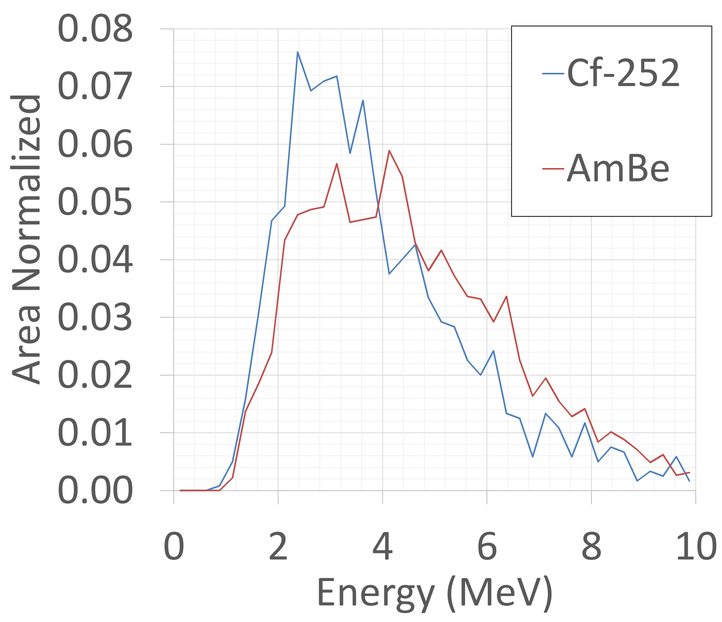




Neutron source (blue arrow) was in the middle of the 40 ft container. Measurements were conducted ~10 ft. from stack for a total standoff of ~30 feet.

Hardware:

MINER utilizes 16 each 3” liquid scintillator cells, read out by 3” PMT’s. The signals are digitized by a Struck 3316 module attached to the outside of the case, powered by a wall plug, car battery, or (here) a small generator. Processing occurs through the on-board computer, which is remotely controlled over WiFi via a tablet. Camera images were obtained using a Ricoh Theta 4Pi camera.

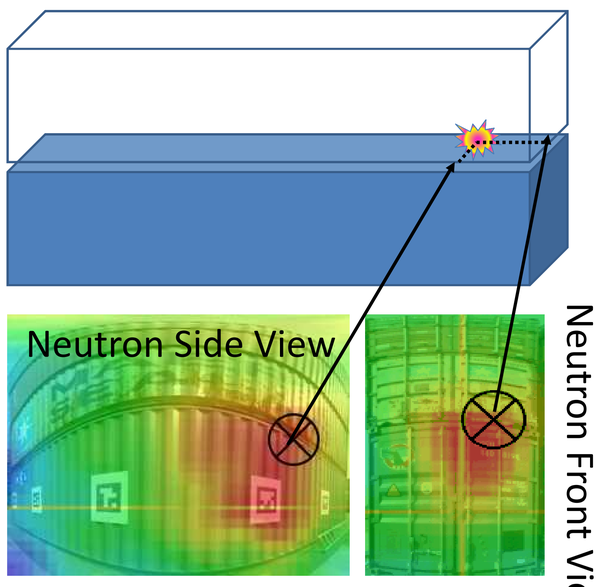


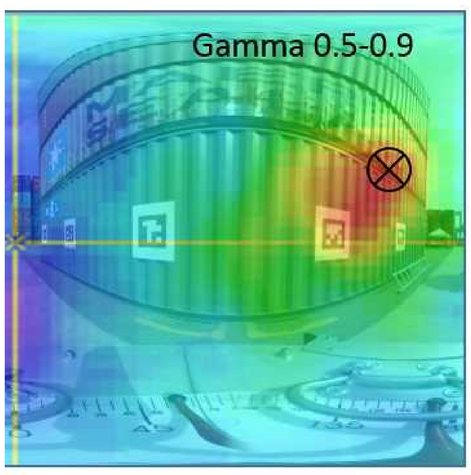
Characterization:

Information from the double scatter neutrons can be used to generate neutron energy spectra. Left: measurement in Savannah showing the difference between fission (Cf-252) and alpha-neutron (AmBe).

Triangulation:

Using multiple viewing angles, imaging allows better localization inside containers or access denied locations. Here two different views point towards a single source.





Gamma Imaging:

Liquid scintillator allows us to select for gammas for additional information. Here we imaged the same neutron source as above but using gammas. This is also useful for filtering out norm gamma sources which may be nearby.

U.S. DEPARTMENT OF ENERGY

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