Contribution ID: **125** Type: **Oral Presentation**

Neutron Detection with Sodium Iodide

Wednesday 5 March 2025 10:45 (15 minutes)

Sodium iodide is one of, if not the, most ubiquitous radiation detection materials deployed in the world today. It is favoured for its good light yield, good density and gamma detection efficiency, and its relative low cost of production to large (16”) crystal sizes. It is not widely recognised as one of the so-called dual-mode, or gamma-neutron, radiation detectors. That is both a disservice to a long-standing workhorse material, and potential source of significant error in measurements.

Sodium iodide is a thermal neutron detector…

Using advanced pulse processing techniques, it is possible to take advantage of the relatively small neutron cross section of 127I, 6.2 barns at thermal energies. Neutron captures on 127I result in subsequent de-excitations and cascade release of gamma rays. With a neutron separation energy of almost 7 MeV for 128I and primary gamma rays of 4 MeV and above, there is a low probability of interaction even for the largest sodium iodide crystals. However, this de-excitation also occurs through a complex cascade of lower energy gamma ray transitions, many of which are available for re-absorption in the scintillator. In particular, there exists a long-lived (845 ns) isomeric state in 128I at 137.9 keV which can be exploited [1]. By utilising coincident measurements of this isomeric state with the prompt gamma emission we can gain access to an efficient mechanism for the detection of thermal neutrons.

While it is unlikely that sodium iodide will become the detector of choice for neutron spectroscopy, developing a reliable thermal neutron detection mechanism on an already widely deployed piece of equipment could provide an essential additional utility.

[1] E. Yakushev et al., NIM A, 848, 2017, 162-165

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Session Classification: Session 1: Source Location and Tracking