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Compact detectors for high energy neutron spectrometry

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There continues to be a growing need for new compact neutron spectrometers, driven mainly by the requirements for dosimetry in hadron therapy, aircraft, spacecraft, future extra-terrestrial bases, and around high energy accelerator facilities. For dosimetry in the upper atmosphere and in space, neutrons in the energy range exceeding 100 MeV need to be measured. Since neutrons are seldom present without gamma rays, any useful detector is required to be able to discriminate between the two radiation types.

Three technological developments have reinvigorated the deployment of hydrocarbon-based detectors in non-laboratory environments. The advent of solid ("plastic") polyvinyltoluene-based detectors, which exhibit pulse shape discrimination (PSD) capabilities, remove many practical challenges and hazards associated with traditional liquid scintillators. Furthermore, the emergence of the small form-factor and low voltage silicon photomultiplier (SiPM) facilitates the design of compact devices, and digital data acquisition and processing systems allows PSD and spectrometry to be implemented in dynamically optimised software or firmware.

Neutron spectrometry outside of accelerator facilities is realised through unfolding, where the energy spectrum is deconvolved from the measured light output spectrum using a set of mono-energetic detector response functions. For neutron energies below 20 MeV, a detector response matrix can reliably be produced using Monte Carlo radiation transport codes. Due to insufficient data regarding the neutron interaction cross sections above 20 MeV the detector response can only be measured directly at reference neutron facilities such as iThemba LABS (South Africa), where nanosecond pulsed neutron beams are produced in the energy range of 30-200 MeV.

We present characterisations of newly developed compact neutron spectrometers based on EJ-276 plastic scintillators, coupled to one or more SiPMs, and illustrate the use of various designs of these detectors for spectrometry based on the unfolding of light output spectra using both simulated and measured response matrices.

Attendance Type

Remote

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