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Compact scintillator-based neutron spectrometers for use in aviation and space applications

Cosmic radiation, composed of Galactic Cosmic Rays (GCRs), Solar Energetic Particles (SEPs), and their associated secondary particles, represents a recognized radiation risk to space missions, satellites, and air travel. To improve risk assessment models in these contexts, it is essential to measure the various components of the radiation environment at the specific location of interest, particularly during unexpected high-energy space weather events. Secondary neutrons, with characteristic spectral features around 1 MeV and 100 MeV, are produced by cosmic ray interactions with matter and contribute substantially to overall radiation exposure at flight altitudes and in space. Neutrons pose a particular hazard to biological tissue because they interact directly with atomic nuclei, producing energetic, densely ionizing recoil particles that induce DNA damage. Continuous monitoring of radiation environments aboard aircraft and spacecraft using active radiation detectors would provide key data for improved risk assessment.

Current neutron spectrometry technologies, such as Bonner sphere systems or liquid organic scintillators coupled to photomultiplier tubes, are not well suited for use outside the laboratory. This work aims to develop a compact detector system based on plastic scintillators and silicon photomultipliers that is robust, portable, and suitable for non-expert use. A prototype spectrometer has been constructed for operation in high-energy neutron fields. Accurate spectrometry using unfolding techniques relies on well-characterized detector response functions covering the full energy range of interest. The high-energy neutron facility at iThemba LABS in Cape Town, South Africa, provides a unique opportunity to directly measure detector response functions up to 200 MeV.

We present progress toward the development of a novel detector system for high-energy neutron spectrometry in aviation and space environments, as well as in accelerator facilities such as proton therapy centres. Detector design, calibration methodology, and planned field testing are discussed.

Primary authors: KIDSON, Miles (University of Cape Town); BUFFLER, Andy (UCT); HUTTON, Tanya (University of Cape Town); Dr TROMPIER, Francois (ASNR)

Presenter: KIDSON, Miles (University of Cape Town)

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