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Measurements of neutron response functions for a BC-501A liquid organic scintillator between 5 – 66 MeV at the iThemba LABS fast neutron beam facility

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The fast neutron beam facility at iThemba LABS (D-line) offers ns-pulsed neutron fields in the range 5-200 MeV, typically produced via the 7Li(p,xn) or 9Be(p,xn) reactions [1-3], using proton beams from the separated sector cyclotron (SSC). The D-line is currently undergoing a major upgrade and redevelopment towards ISO/IEC 17025 accreditation, including physical modifications of the vault, new instrumentation for neutron metrology and improved beam monitoring and control systems. At present, the standard procedure for characterising the neutron beams and measuring spectral neutron fluence involves a 2" x 4" BC-501A liquid scintillator and a parallel-plate 238U fission chamber (FC) [2,4]. Neutron energy spectra may either be determined directly from time-of-flight measurements using the BC-501A detector, or by unfolding methods if the detector response functions are known sufficiently well over the energy range of interest. The quality of the unfolded neutron energy spectrum is directly related to the knowledge of the detector response to monoenergetic neutrons. For neutron energies below 20 MeV, a detector response matrix can reliably be produced using Monte Carlo radiation transport codes. However, above 20 MeV there are insufficient data regarding the neutron interaction cross sections, and the detector response matrix can only be measured directly.

We report on measurements of response functions in the energy range 5-66 MeV for the BC-501A detector, derived from neutron time-of-flight for the neutron field produced by a 66 MeV proton beam irradiating an 8 mm Li target. Tests of unfolding measured pulse height spectra were undertaken using the unfolding package MAXED [5]. The unfolded neutron energy spectra were experimentally validated by comparing directly with those derived from time-of-flight. The aim is to develop a portable, scintillator-based neutron detector system for measurements of spectral fluence up to 200 MeV outside of the laboratory environment where time-of-flight is unavailable, whilst maintaining the required standards and traceability.

[1] S. Pomp et al., EURADOS Rep. 2013-02, May 2013.
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[4] Z. Ndlovu et al, JACoW Cyclotrons 2019, TUP012, pp. 182 – 185, 2019.
[5] M. Reginatto, P. Goldhagen, and S. Neumann, Nucl. Instr. Meth. A476 (2002) 242

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

Primary author: MAIBANE, Kutullo (University of Cape Town)

Co-authors: BUFFLER, Andy (University of Cape Town); HUTTON, Tanya (University of Cape Town); MALEKA, Peane (iThemba LABS); NDABENI, Zina (University of Cape Town)

Presenter: MAIBANE, Kutullo (University of Cape Town)

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