

Dose equivalent from 500 MeV neutrons

S. Beceiro¹, G. Fehrenbacher², F. Gutermuth², E. Kozlova², T. Radon²

¹ Universidad de Santiago de Compostela, Spain

² GSI Darmstadt, Germany

Abstract

Neutrons constitute a major component in the radiation field outside the shielding of particle accelerators. Consequently appropriate neutron dose meters are needed to survey the radiation levels.

A thermo-luminescence based neutron dosimeter is used at the UNILAC as well as at the SIS. It has been modified to improve the response for high energetic neutrons (*extended range*). We report on a test of these devices in a quasi mono-energetic field of 500 MeV neutrons.

Neutron production in Cave C

A deuteron beam with particle kinetic energy of 1 GeV impinges on a 5 cm thick lead brick. The deuterons break up into protons and neutrons mainly through Coulomb interaction (lead $Z=82$). The protons are deflected by a dipole situated downstream to the lead target (ALADIN). The remaining neutrons are employed for the dosimeter tests. The flux of the deuterons is monitored with a 1 cm thick plastic scintillator for beam intensities up to 10^5 particles per second and with a high precision ionization chamber for higher beam intensities.

Characterization of the neutron field

The neutron yield in forward direction is measured with a $2\text{m} \times 2\text{m}$ time-of-flight wall consisting of a multi-layer array of iron converters and plastic scintillators (LAND)[1]. The resulting neutron yield is 4.9 neutrons per 100 incoming deuterons. The distribution of the neutrons in energy is shown in figure 1. The most probable energy is ≈ 470 MeV which is a little lower than the 500 MeV of the primary beam revealing a small energy loss in the lead brick.

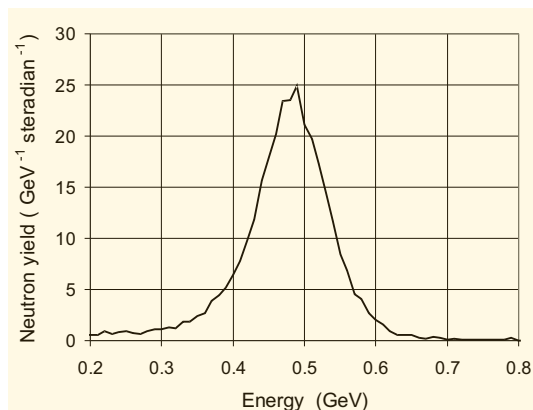


Figure 1: Energy spectrum of the neutron field as measured with LAND[1].

Neutron dose

The dose reading of the conventional TLD neutron dosimeter is 49 ± 6 pSv cm^2 which is approximately a factor of 5 lower than the result of 252 ± 47 pSv cm^2 from the extended range version (see figure 2). Both types are calibrated to the so-called ambient dose equivalent in the field of a Americium-241/Beryllium-neutron source.

FERRARI and PELLICIONI [2] report a conversion factor of 290 pSv cm^2 for neutrons of energy 500 MeV which is in good agreement with the dose reading of the extended range TLD dosimeter (see figure 2).

Conclusion

We conclude that a conventional neutron dosimeter may significantly underestimate the dose from 500 MeV neutrons whereas the extended range version yields appropriate dose readings.

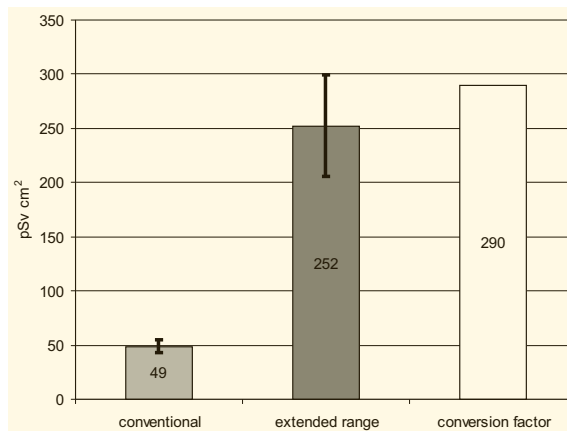


Figure 2: Dose readings of the conventional and the extended range neutron dosimeter and conversion factor from [2] for 500 MeV neutrons.

Acknowledgement

This investigation was largely supported by the LAND group which is greatly acknowledged. Work partly funded by EU grant EURONS-JRA10-SAFERIB.

References

- [1] Th. Blaich et al. *Nucl.Instr.Meth.*, A314:136–154, 1992.
- [2] A. Ferrari and M. Pellicioni. *Rad.Prot.Dosim.*, 76(4):215–224, 1998.