Calibration of a Passive REM Counter with Monoenergetic Neutrons

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1) Context

Rem counters are the most used instruments for neutron survey for radiation protection purpose. Most of them are active instrument using a proportional counter as thermal neutron detector. A dual detector extended range rem counter, being both active and passive, was recently proposed. The work described herein focuses on the characterization of the passive version of the rem counter.

The irradiation to monoenergetic neutron beams were performed at PTB (Germany) with the following energies: 0.565 MeV, 8.08 MeV, 14.8 MeV and 19 MeV.

2) The Passive REM Counter

The passive rem counter hosts as inner detector two CR-39 PADC track detectors coupled with an enriched boron converter. The track detectors are supplied by Intercast (Parma - Italy). Tracks on the detectors are produced by alpha particles and ^{7}Li nuclei obtained via interaction of thermal neutron with 10B. The detectors were etched in a 6.25 mol aqueous NaOH solution at 98 °C for 40 minutes. Under these etching conditions the bulk attack velocity, measured with the fission fragments technique, is V_B = 10±0.2 µm/h.

Fig 1. Picture of the rem counter.

The rem counter (Figure 1) consists of a polythene spherical shell, 25 cm in outer diameter, inside which is placed a concentric inner lead shell along with cadmium insets to respectively extend and tune the response function to high energy neutrons so that it is as close as possible to the fluence to H*(10) conversion coefficients.

3) Results

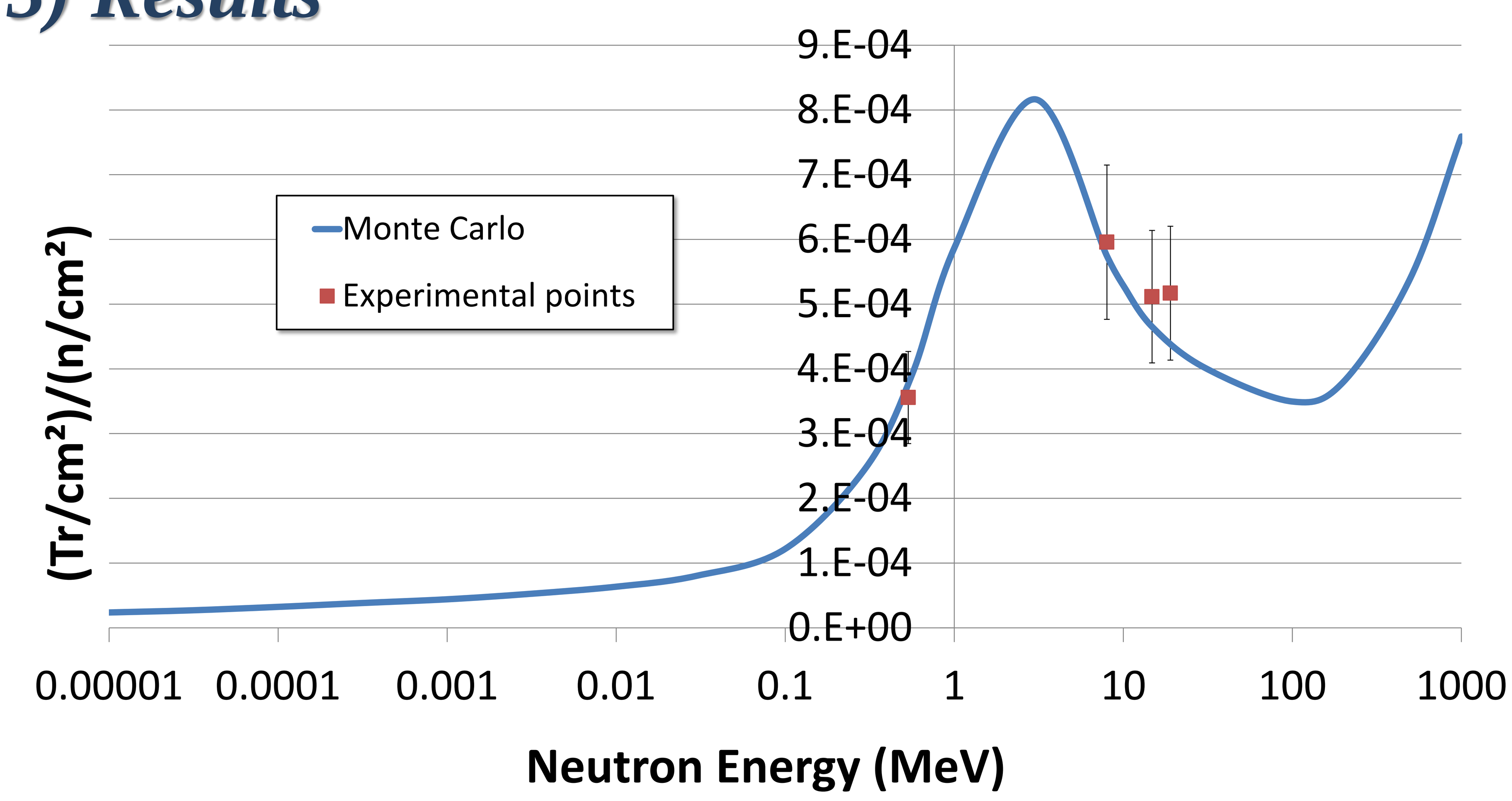

Fig 2. Comparison between experimental results and MCNP simulation

The data point corresponds to the neutrons energies of 0.565 MeV, 8.08 MeV, 14.8 MeV and 19 MeV.

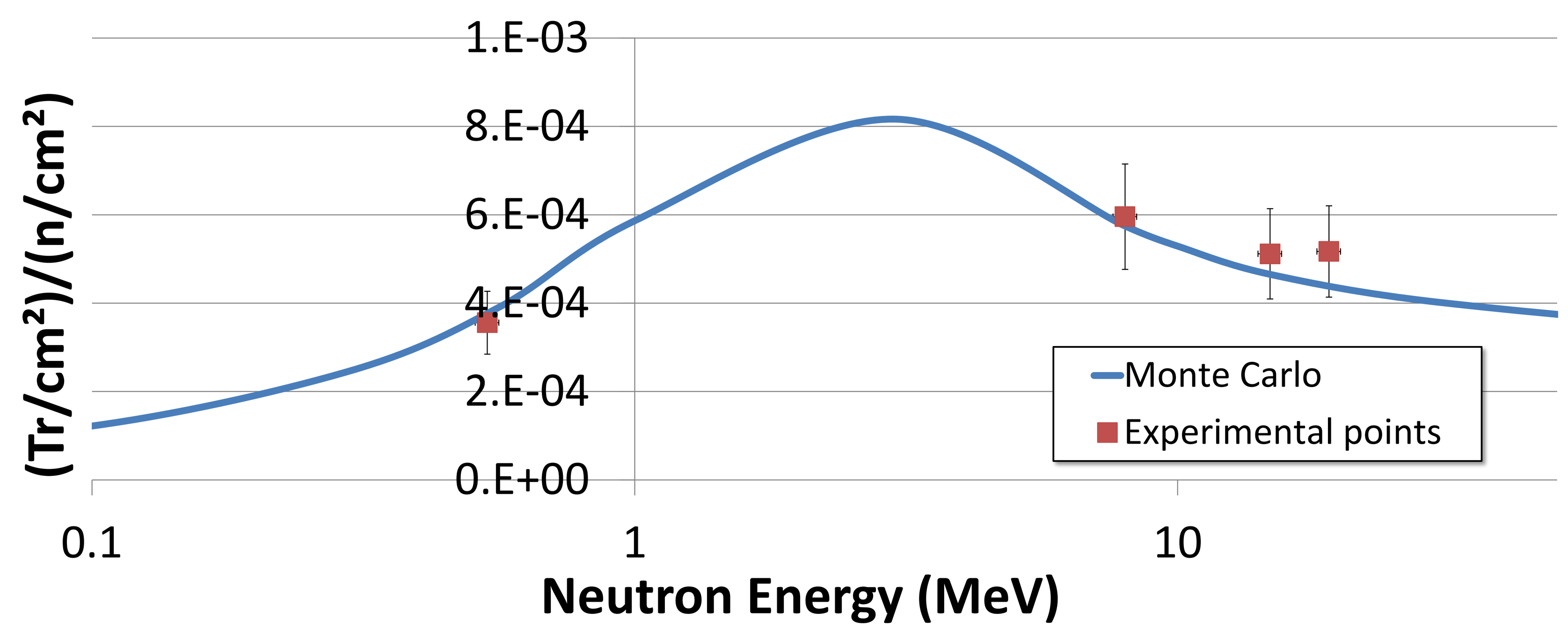

Fig 3. Close correlation between measurements and simulated values

4) Track Analysis

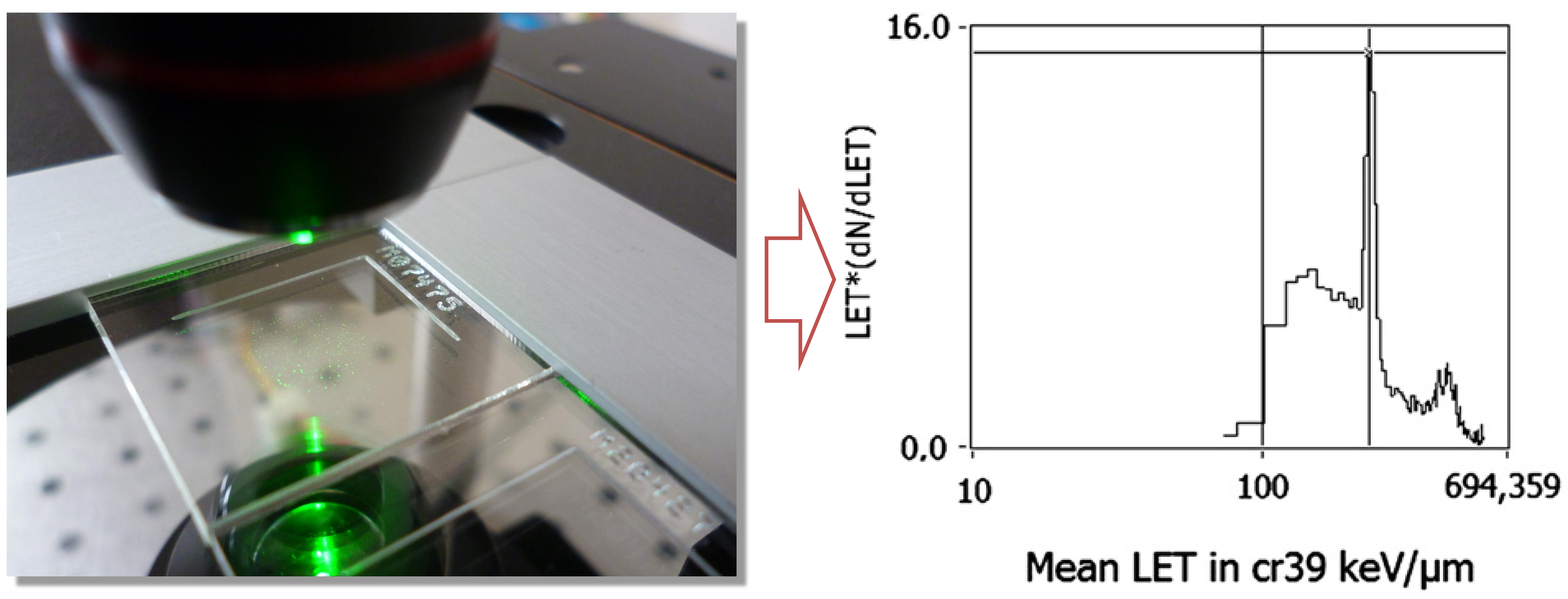

Fig 4. Mean LET distribution of particles impinging on the track detector from the POLITRACK™ SSNTD automatic detector reader.

During the on-line analysis, in order to remove the background signal, a filter is applied on the average LET. Even if some tracks are over-etched, applying a filter on the tracks' LET has a strong operational value and can be used to distinguish real tracks from noise. Tracks with an LET < 160 keV/µm are mainly due to proton background and noise (dust and scratches) on the surface.

5) Discussion

The described distribution is used to set a region of interest encompassing the signal and thus improving the signal to noise ratio. It is important to have an acceptance criterion based on a physical quantity. This filtering technique is reliable and per-mits to obtain a background signal equivalent to about 2 µSv. The calibration factor for a Pu-Be source is around 6 tracks/cm2 per µSv, corresponding to a lower limit of detection about 3 µSv.

The calibration factor was measured at the four tested energies and was compared with the response function calculated via Monte Carlo simulations.

6) Conclusion

- The track analysis procedure used is effective in rejecting tracks mainly due to proton background and noise (dust and scratches) on the surface.
- Experimental points are in good agreement with the simulated response function as shown in Figure 3.