# Atlas MDT Chambers in Neutron Background

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High energetic neutrons are a major component of background for MDT muon detectors in the ATLAS experiment. The important mechanisms of neutron production in ATLAS are: Primary events causing hadronic showers in the forward calorimeter and minimum bias events producing hadronic showers either in the TAS collimators or in the beampipe. The expected neutron flux in the barrel region of the MDT muon spectrometer is between 2.7 and 4.0 $\frac{\text{kHz}}{\text{cm}^2}$. The neutron energy spectrum covers many orders of magnitudes.

To study the effect of neutrons it is important to know the neutron efficiency of the MDT chambers. A high efficiency could result in a high occupancy of the MDT chambers, thus decreasing efficiency and precision of the muon reconstruction of the spectrometer.

Two simulations [1] of the neutron efficiency are shown in Fig.2. They differ by a factor of 4 in the neutron energy range around 11 MeV where no experimental measurement existed up to now.

Our experimental setup is shown in Fig. 1 of Ref. [2]. To produce neutrons we used the $^{11}$B($^1$H,$^{11}$C)n reaction in inverse kinematics. It yields nearly mono-energetic neutrons of 11 MeV energy into a 40° cone. We used a gas target filled with hydrogen at 3 bar. The stainless steel target cell was 3 cm long and 2 cm in diameter. The $^{11}$B beam entered the target cell through a 3.5 $\mu$m thick molybdenum foil which was selected for low background neutron production. The noninteracting $^{11}$B beam was dumped in a 2 mm thick beamstop of gold. The beamstop was electrically insulated against the target cell to allow monitoring of the beam current.

Gammas created in the target cell or in the beamstop were absorbed in 9 cm of lead sitting between the $H_2$ target cell and the MDT test chamber. This eliminated nearly all gamma background, but also reduced the neutron flux by 56%.

The 15 cm long MDT test chamber with 9 tubes was equipped with the same kind of drifttubes and readout electronics as used for the muon spectrometer in the ATLAS detector. Also the same operating conditions were chosen: 3080 V for the drift field and a gas mixture of 93% Ar and 7% $CO_2$ at 3 bar absolute pressure. The chamber was placed about 15 cm away from the $H_2$ target.

To measure the energy and angular distribution of the neutrons four NE213 liquid scintillators were used. Those counters allow to distinguish gamma from neutron induced signals by a pulse-shape-discrimination (PSD) technique.

The neutron flux through each of the nine tubes was simulated as follows: The beam current measured by the insulated beamstop was combined with the differential cross section of the $^{11}$B($^1$H,$^{11}$C)n reaction from the code DROSG2000 [3]. Then a Geant4 simulation [4] was used to determine the influence of the lead absorber in front of the MDT chambers. The results of those simulations were compared with the measurement from the NE213 counters. Fig. 1 shows the nice agreement between simulation and measurement.

The total flux of up to 5.6 $\frac{\text{kHz}}{\text{cm}^2}$ agrees within the errors with the measurement of the $BF_3$ counter placed 2.6 m away from the target cell.

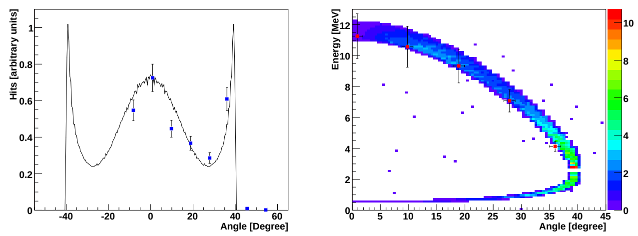


Fig. 1: Comparison of simulated and measured angular distributions of the produced neutrons.

To determine the overall neutron efficiency the MDT chamber readout was randomly triggered. The known time window for a random neutron interaction to be recorded together with the total flux of neutrons, allowed to calculate the total efficiency. In order to subtract background of neutrons produced e.g. in the entrance foil or in the beamstop we compared measurements at 3 bar of $H_2$ pressure with those with evacuated target cell.

The efficency of $(4.0^{+1.6}_{-0.3}) \cdot 10^{-4}$ is indicated in Fig. 2. This measurement favors the FLUKA simulation [5].

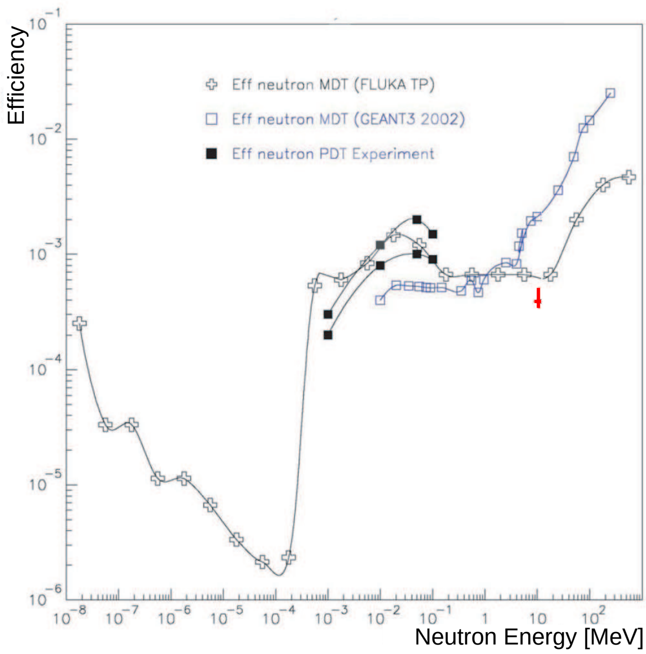


Fig. 2: Different simulations of neutron efficiency. This measurement is marked in red

## References

[1] S. Baranov *et al.*: ATL-Gen-2005-001
[2] A. Mlynek *et al.*, this report, p. 88
[3] M. Drosg: IAEA-NDS-87 Rev. 9, May 2005
[4] http://geant4.web.cern.ch/geant4/
[5] http://www.fluka.org