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Development of neutron detectors for key astrophysical nuclear reactions

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Many experiments operate detectors that are susceptible to fast neutron-induced backgrounds [1]. To decrease these backgrounds many collaborations, including the nuclear astrophysics community, operate their experiments in deep underground laboratories. But even in such low background environments it is critical to accurately know the environmental neutron flux.

One way to measure this is the capture-gated neutron spectrometry [2,3], which has in the last years been extended to setups based on hybrid 3He- Liquid/Plastic scintillator detection systems [4,5].

The very early stages of such developments rely on Monte Carlo simulations that can predict the number of interactions, deposited energies and time-correlations. These simulations require precise moderation models for the different materials. At very low neutron energies the data-driven Geant4 NeutronHP physics are required for the most reliable results, and optimally one should include the molecular corrections to the scattering cross sections in various materials. These corrections are currently only implemented for a few materials such as polyethylene and water.

In order to better investigate the possible effects on simulations with and without molecular corrections we have studied the neutron moderation process for a EJ309 detector using GEANT4 and compared it to the results of simulations, where the scintillator was replaced by polyethylene and water, with and without molecular corrections. We will present these comparisons and preliminary results of measurements using a hybrid liquid scintillator-He3 detector.

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