AARM Proposal Spring 2012

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1 Cross Sections

1. AARM progress
2. future plans

The muon-nucleus interaction is an important ingredient in cosmogenic simulations which track individual interactions. It was shown that this interaction underproduced neutrons by a factor of $\sim$5 in light materials compared to FLUKA. After an upgrade to the Geant4 cross section for this process the large discrepancy is no longer present.

2 FLUKA and Geant4

1. muon induced neutron comparisons
2. future plans

Direct comparisons between FLUKA and Geant4 have confirmed (after the above modification to the muon-nucleus) that for simple liquid scintillator (C_9H_{12}; 0.877 g/cm^3) the neutron yeild and energy distributions are consistent between the two packages. However, this agreement does not appear to scale to high mass targets, giving a discrepancy by which Geant4 underproduces neutrons compared to FLUKA in ^{208}Pb. Further study is needed in this area to be sure that the cross sections applied to muon interactions (and other neutron-producing interactions in the shower) are the correct ones as dictated by experimental data.

3 Comparing to Data

1. NMM and USD with Soudan Veto

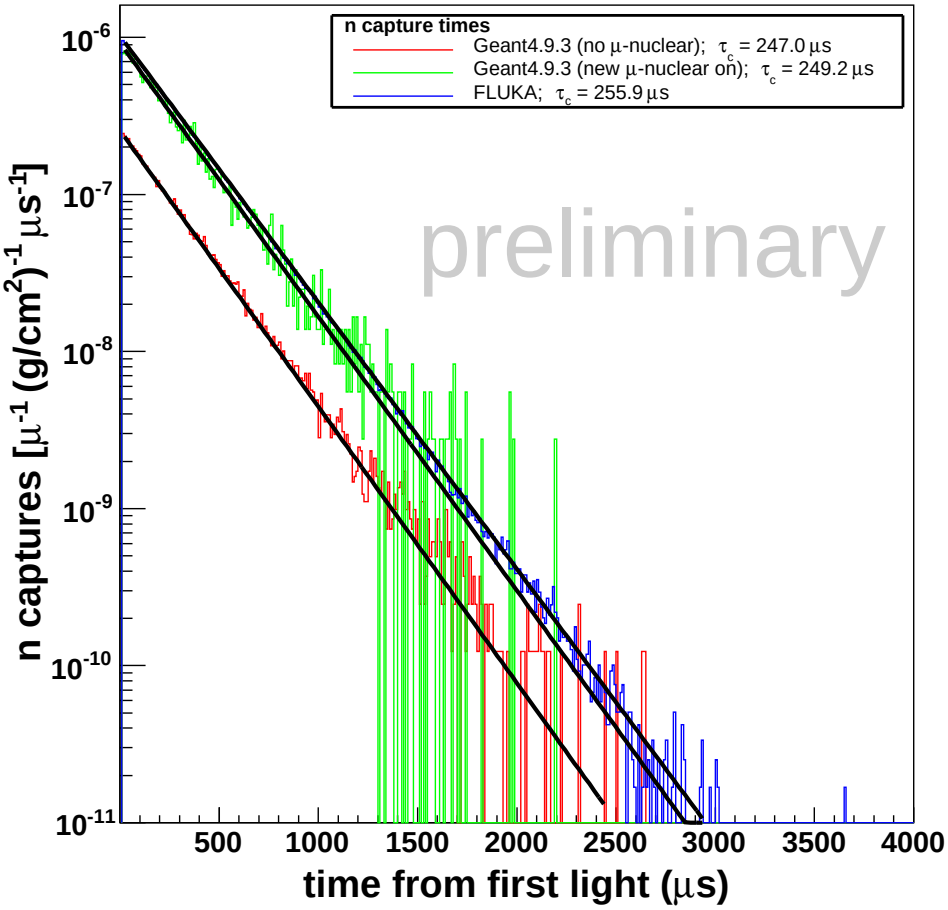

Figure 1: Without the modified muon-nuclear interaction the Geant4 simulation underproduces capturing neutrons.

A large effort has been undergone to refurbish the Soudan-II muon veto shield into a useful muon trigger and partial tracker. The shield is a C10 gas-filled detector which lines a cavern of dimensions 32.0 m $\times$ 14.5 m $\times$ 11.0 m at a depth of 2436 ft underground in the Soudan mine in northern Minnesota. The neutron detectors which sit on the interior of this shield (USD and NMM) provide a way to directly access difficult-to-study muon-neutron correlations.

- correlation data (muons for NMM)
- timing demonstration

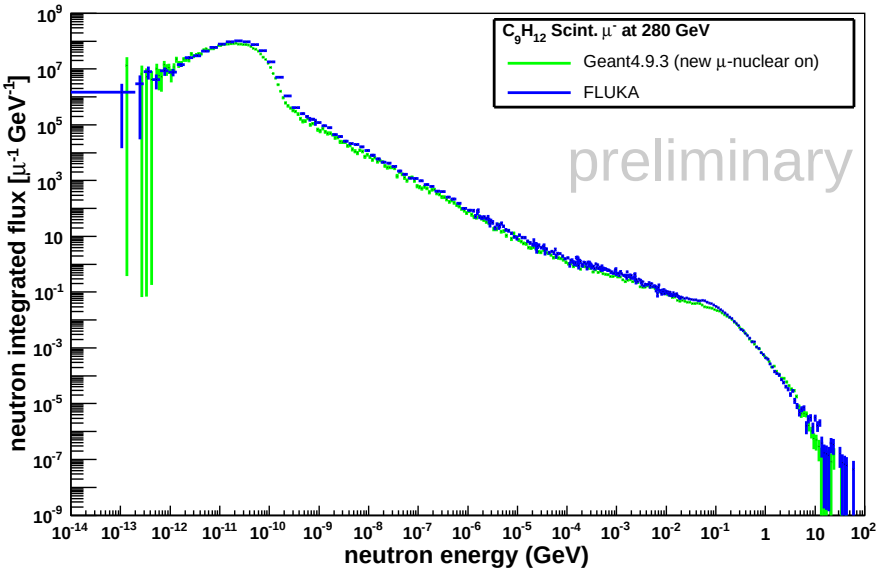

Figure 2: FLUKA and Geant4 seem to match well for the case of a simple liquid scintillator.

- simulation data

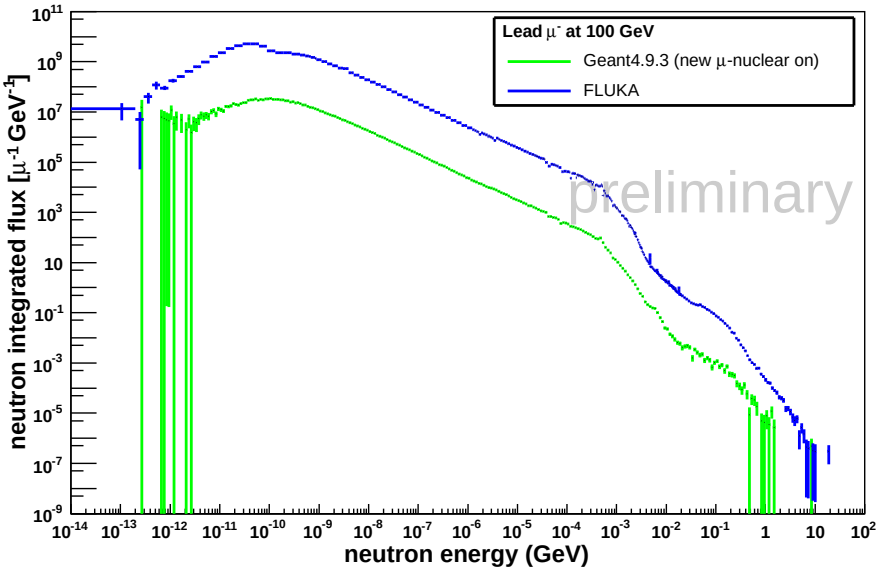

Figure 3: Compared to the FLUKA, Geant4 seems not to produce enough neutrons at most energies for muons streaming through a lead target.