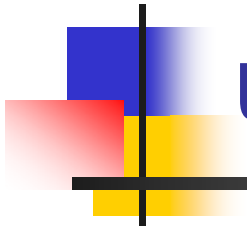

Geant4 issues relevant to underground physics experiments

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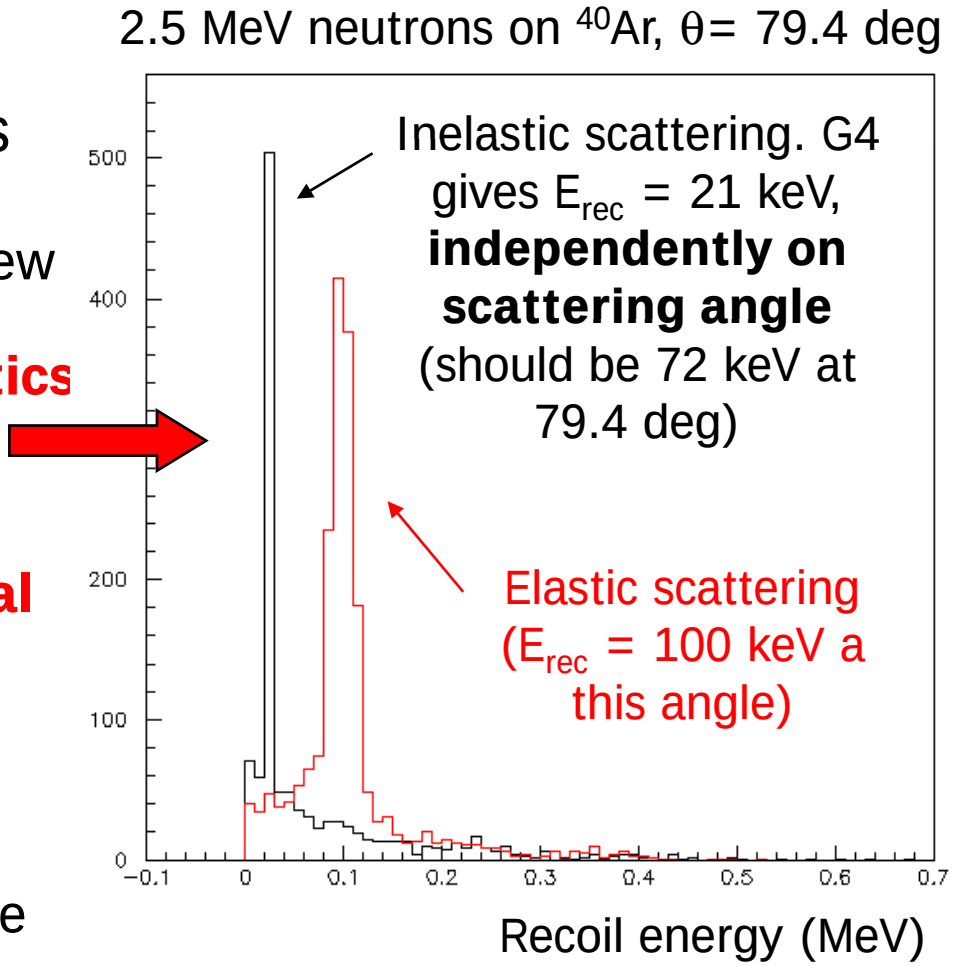
Geant4 Technical Forum
17 July 2007

Geant4 for underground physics applications

- Most critical parts for Geant4-based applications in underground and low-background physics are:
  - Precise tracking of thermal and fast neutrons (NeutronHP models) → dark matter search and ββ-decay experiments
  - Low-energy electromagnetic physics for e^-,γ-rays and ions (including fluorescence and Auger effect)
  - Production of neutrons and isotopes from μ-induced showers → **very hot topic** for most Monte Carlo groups (comparison of simulations with data)
  - Radioactive decay and branching ratios (precise simulation of spectra in ultra-low background Ge spectrometers, including *summing effect*)

NeutronHP

- A few long-standing bugs have been reported on this part of code:
  - Bug #526: **fixed** with the new G4NDL3.11 database
  - Bug #675: **wrong kinematics** of the recoil nucleus after **inelastic interactions** (missing Lorentz boost)
  - Bug #821: **missing residual nucleus** after inelastic scattering
  - Potential non-energy conservation in G4NeutronHPCapture (recoil nucleus generated if only one γ-ray is emitted)



Muon-induced showers

- Production of neutrons and radioactive isotopes from **μ-induced showers** is a very hot topic → critical background, especially for dark matter experiments. Explored extensively within the **EU ILIAS project** (a network of EU underground laboratories)
- A few papers in the literature, comparing Geant4 and other codes with experimental data (NIM A 505, 688; NIM A 545, 398; PRD 64,013012): **good agreement for light targets** (e.g. liquid scintillator), but probably under-production (factor > 2) for heavier targets (e.g. lead)
- This is **being explored** within ILIAS with dedicated simulations and new experimental data.

Radioactive decay

- For the precise simulation of spectra in ultralow-background Ge γ-ray spectrometers, it is crucial to take into account **summing effects**
- Nucleus at rest as “primary”: **G4 simulates the final state** using G4RadioactiveDecay database
- **Very precise for most nuclei**. A difference in branching ratios showed up from G4 7.x to G4 8.x for some nuclei. This worsens the agreement with the Table of Isotopes (bug #952); being checked systematically. **Investigated** by INFN-LNGS group and (partially) traced back to G4VGammaDeexcitation. Interface to AtomicDeex can be improved