The Frontiers of Geant4 Hadronic Physics

Dennis Wright
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Where Do We Go From Here?

- Most Geant4 hadronic models are mature
  - maintenance, validation, tuning still required
  - clean-up, extensions and speed optimizations remain important

- Physics of the LHC seems well-covered by Geant4 up to about 1 TeV
  - unless higher energy running turns up some surprises
  - generators cover the very high energies and the new particles

- So what physics should we add?

Neutrino Scattering (1)

- Needed for:
  - next generation dark matter experiments (e.g. SuperCDMS)
  - high-intensity experiments (LBNE)
  - Hyper-Kamiokande
  - any experiment for which the irreducible neutrino background is a concern

- Geant4 currently not equipped to do this
  - FLUKA is
 - GENIE already has an extensive code base for this

Neutrino Scattering (2)

- Options:
  - write an interface to GENIE
    - GENIE is a C++ neutrino scattering code
    - currently used as a generator
    - Fermi gas model of nucleus
    - approached GENIE people to see if they agree
  - write native Geant4 code
    - better nuclear models
    - already have a virtual photon interface – can be generalized to W and Z
    - substantial amount of work

Nucleus-nucleus Elastic Scattering

- Geant4 has never had this in a physics list

- Code exists now for a few years

  - model : G4NuclNuclDiffuseElastic (50 MeV < E < TeV)

  - cross sections: G4GGNuclNuclCrossSections (0.1 MeV < E < TeV)

  - could add to physics list

- What do we gain?

  - is there much data ?

  - do physics results change much?

  - need validations, sanity checks

- Look at cross sections vs. energy compared to inelastic

Pb-Pb nuclear cross-sections vs.$\sqrt{s}$/nucleon
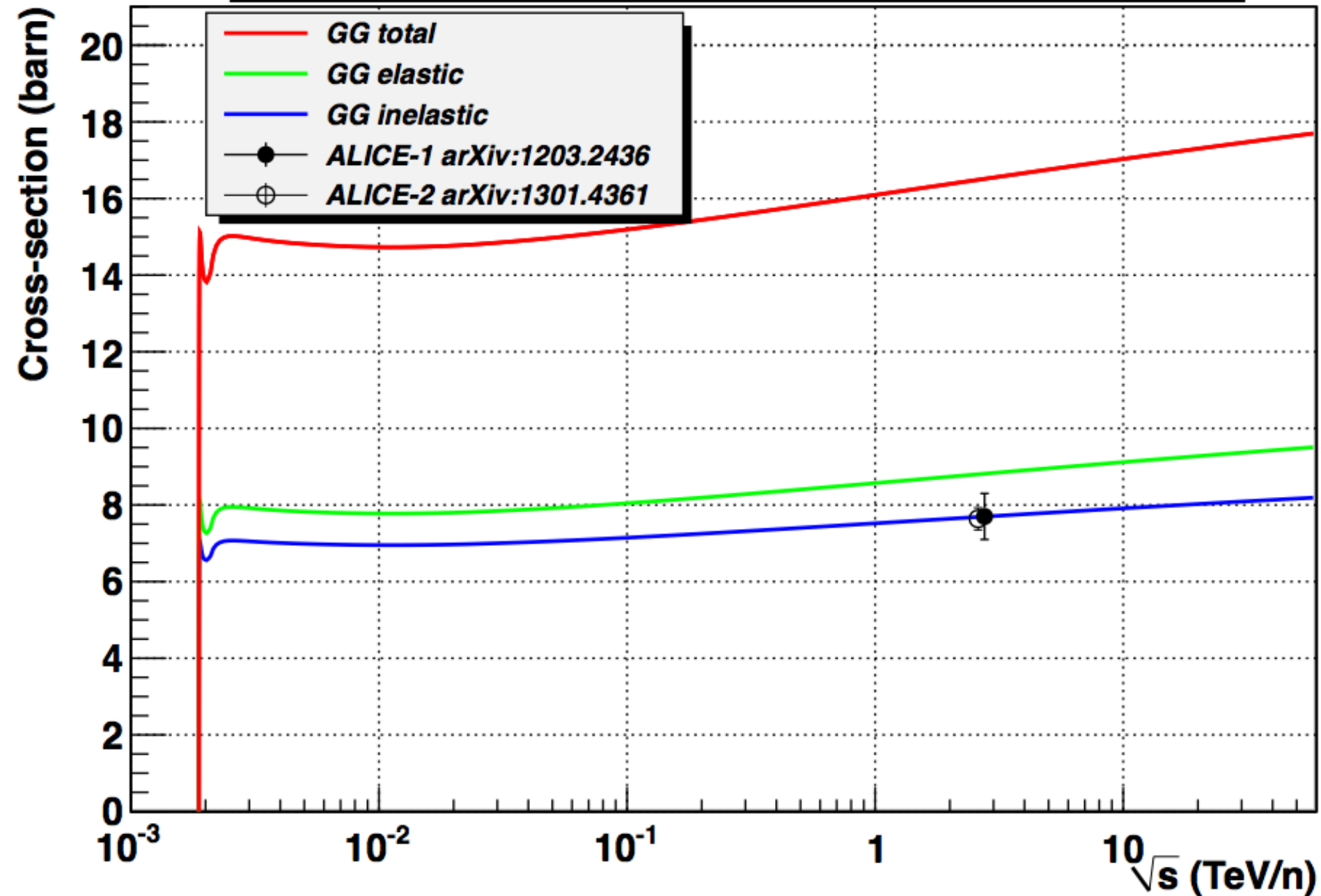
Nuclear Physics

- Huge area of physics

- Untouched in Geant4

  - except for RDM, neutronHP, photon evaporation

  - mainly because it's not important for HEP

  - what about other user communities?

- Many requests for specific reactions

  - precompound, deexcitation and cascade models can "fake it" but can't do precise work

- Can implement as theory- or data-driven

  - help from nuclear theorist would be nice

What Else ?

- spin physics
- interactions of c- b-mesons with nuclei
- hyper-nuclear physics