Neutrino Scattering In Geant4

Geant4 Collaboration Meeting
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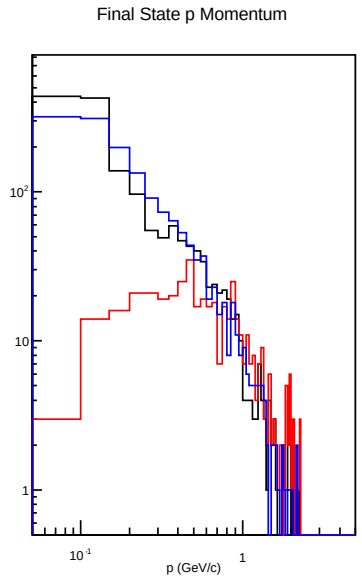
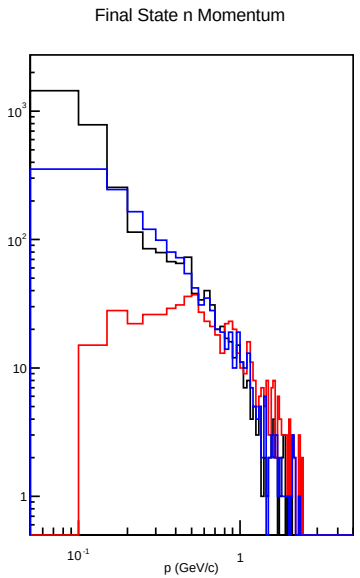
Progress So Far

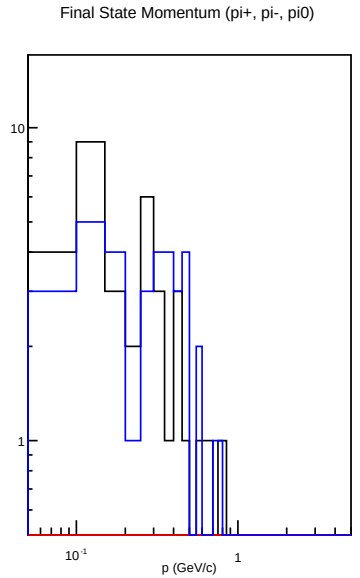
- First step: Geant4-to-GENIE interface
  - use Geant4 Bertini cascade to do final state interactions in nucleus after GENIE neutrino vertex is generated
  - complete, committed to GENIE svn
  - validation underway

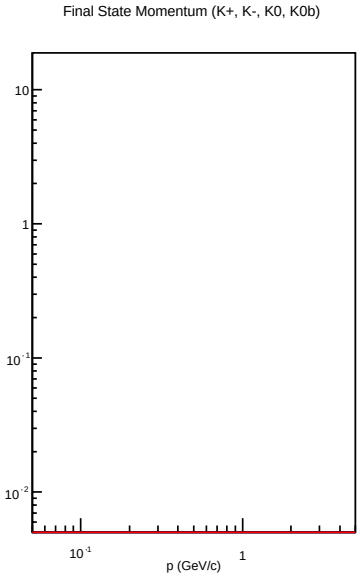
- Early results:
  - no final state nuclear interaction model (red)
  - HAIntranuke (GENIE) final state interaction model
  - Bertini cascade (Geant4) final state model

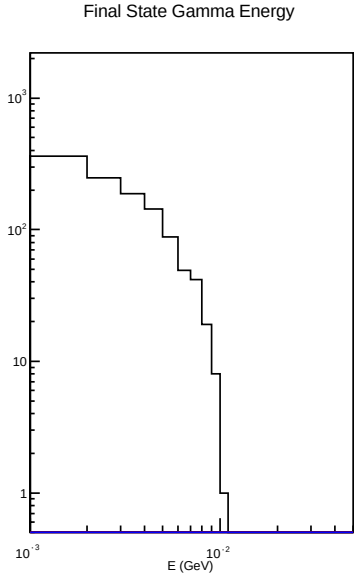
Neutrino Scattering: NCEL (black: Bertini, blue: GENIE)

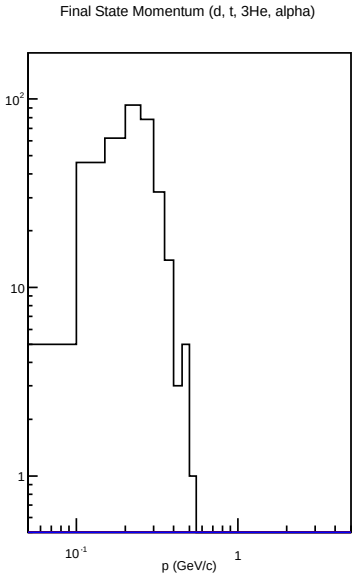




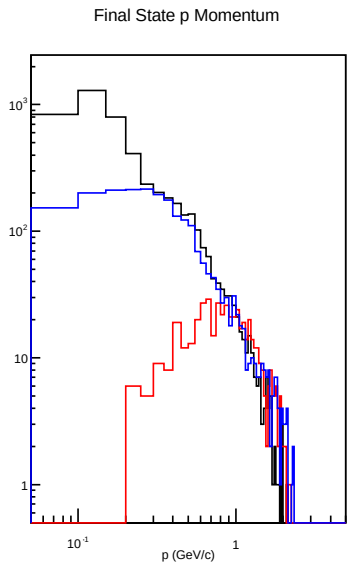


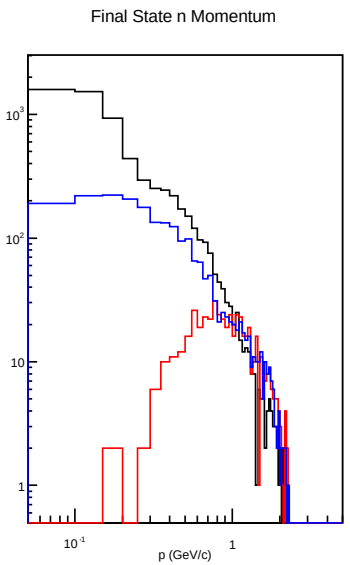


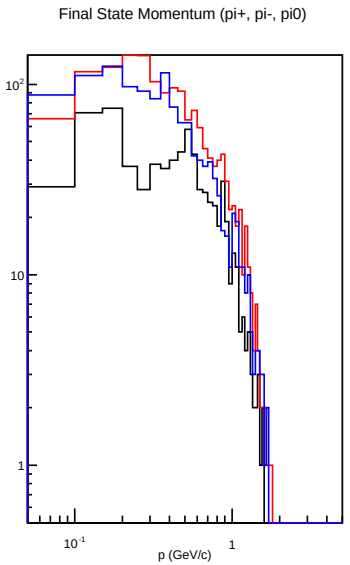


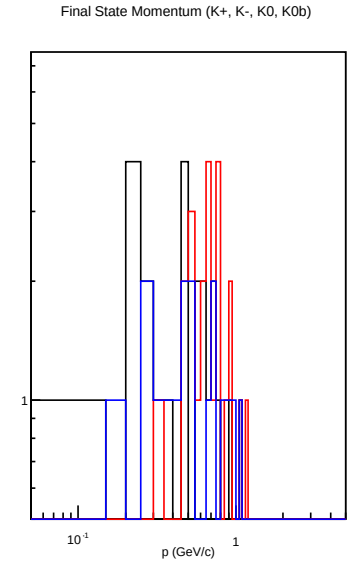


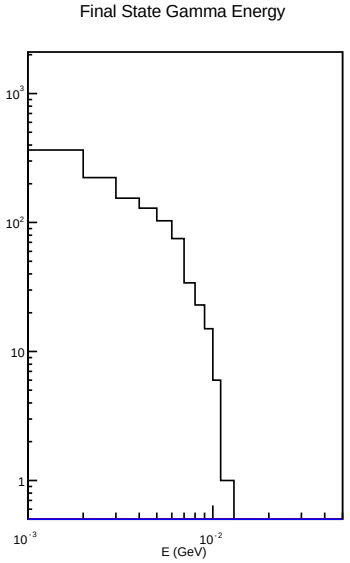
Neutrino Scattering: DIS (black: Bertini, Blue: GENIE)

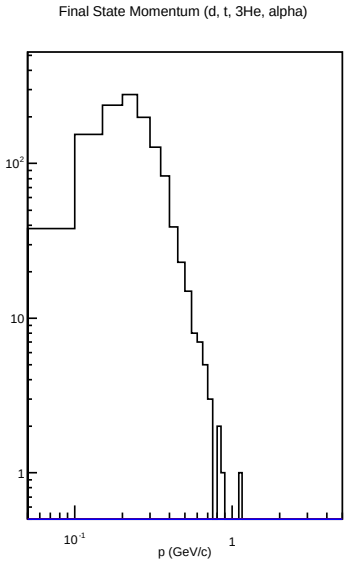












Next Steps

- GENIE-to-Geant4
  - use GENIE neutrino generators to initiate neutrino interactions in Geant4
  - need wrapper code which calls GENIE to generate neutrino vertex and converts GENIE secondaries to Geant4 particle types
  - pass these secondaries to a Geant4 hadronic code to perform final state interactions within nucleus
    - will use Bertini to start, but could be others
  - will need to extract, build and maintain minimal GENIE libraries on Geant4 side
    - Dennis

Next Steps

- Geant4 neutrino classes
  - some native Geant4 neutrino cross section classes already exist (V. Grichine)
  - need elastic and inelastic processes
    - coherent elastic does not exist in GENIE
  - problem: no one-to-one correspondence between Geant4 neutrino processes and GENIE processes
    - elastic, quasi-elastic processes in GENIE refer to neutrino-nucleon collision and not neutrino-nuclear as in Geant4
    - do we follow GENIE philosophy by treating neutrino reaction types separately (NCEL, CCQE, DIS, …) or lump these all together as one inelastic Geant4 process?

Next Steps

- Biasing
  - GENIE takes care of very small interaction cross sections by a detailed scan of the detector geometry
    - maximum neutrino cross section in that scan used to set sampling scale
    - interaction point in detector chosen based on scan
  - In Geant4 attempt to track neutrinos like any other particle → no initial scan of detector
    - therefore must do track biasing
    - can use recently added Geant4 biasing techniques to do this
    - events can then be run in natural Geant4 way