Simulation BSM

Vladimir Grichine (LPI)

Geant4 simulation R&D beyond the standard model (BSM) is discussed. First results with neutrino interactions as background for BSM events are shown.

Motivation

- The number of experiments (NA64, SHiP, CERN NP, LHC, etc) directed to the registration of physics beyond the standard model is growing up.
- Simulation of new particles and processes is needed for the optimization of the experiment design as well as for reconstruction validation.
- Here the first requirements concerning mediator and hidden particles as well as neutrino background are discussed.

Particles

- Intermediate vector massive gammas (VMG) introduced similar to vector dominance in strong interactions.
- Hidden scalar particles (HSP).
- Other 'dark matter' particles, depending on models (there is degree of freedom in langranjian selection)

Processes

- VMG is assumed to be created in the bremsstrahlung of proton (electron) beam dumped in the experiment target. Meson decays are also under consideration.
- VMG in turn can create pairs of hidden scalar particles.
- HSPs can be involved in scattering on nucleons and nuclei.
- Background processes like neutrino-nucleus interactions (NNI) should be considered in details as well. The NNI final state kinematics is similar to events with HSP.

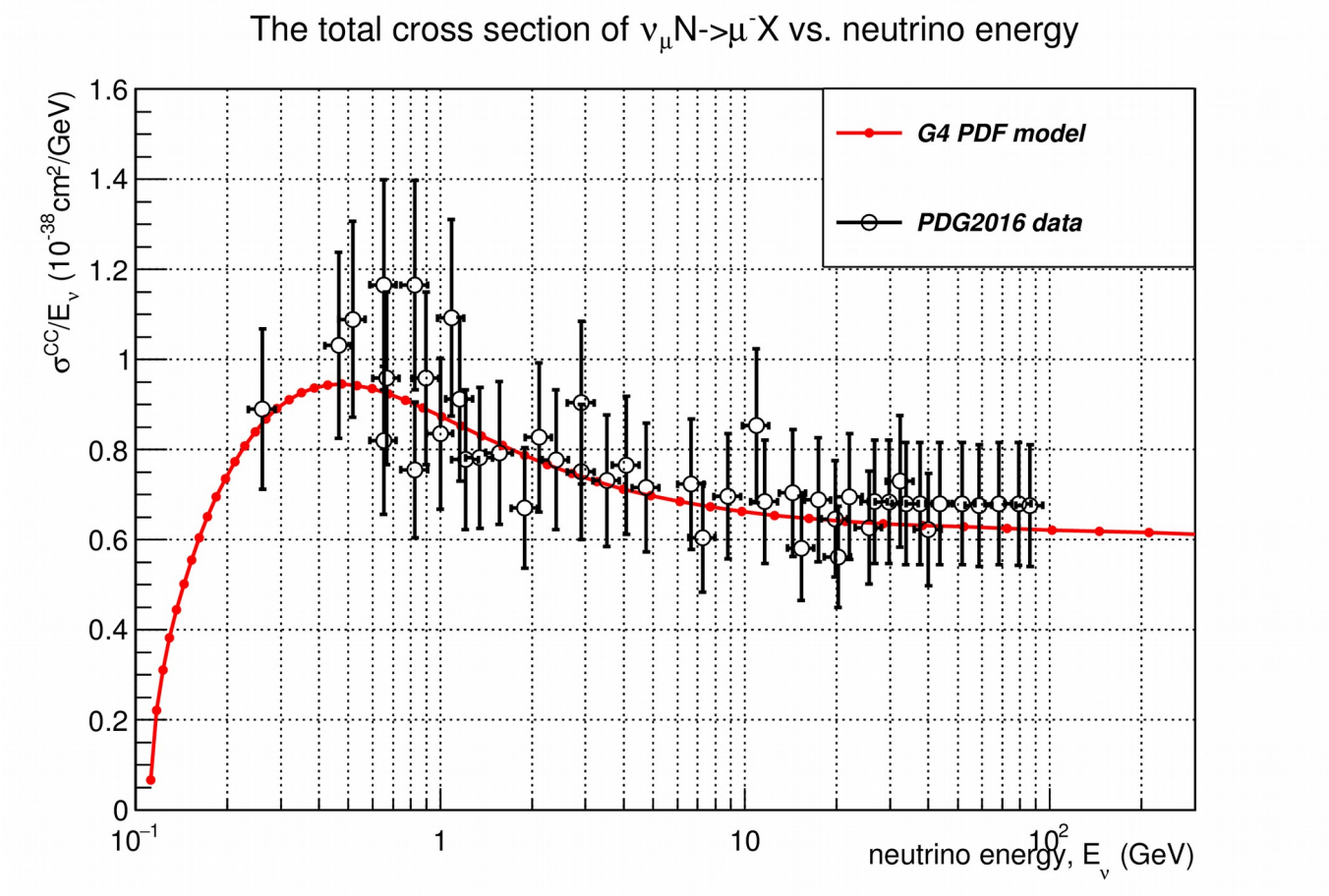
Implementation

- The BSM bremsstrahlung can be inherited from G4hBremsstrahlung model. The SampleSecondaries and ComputeDMicroscopicCrossSection methods, etc …, are modified to provide VMGs in the final state.
- The HSP pair creation can be inherited from standard pair production model.
- New particles and processes as well as PLs (constructors) can be implemented as Geant4 'extended/exotic/TestDm1' example (similar to the monopole example).

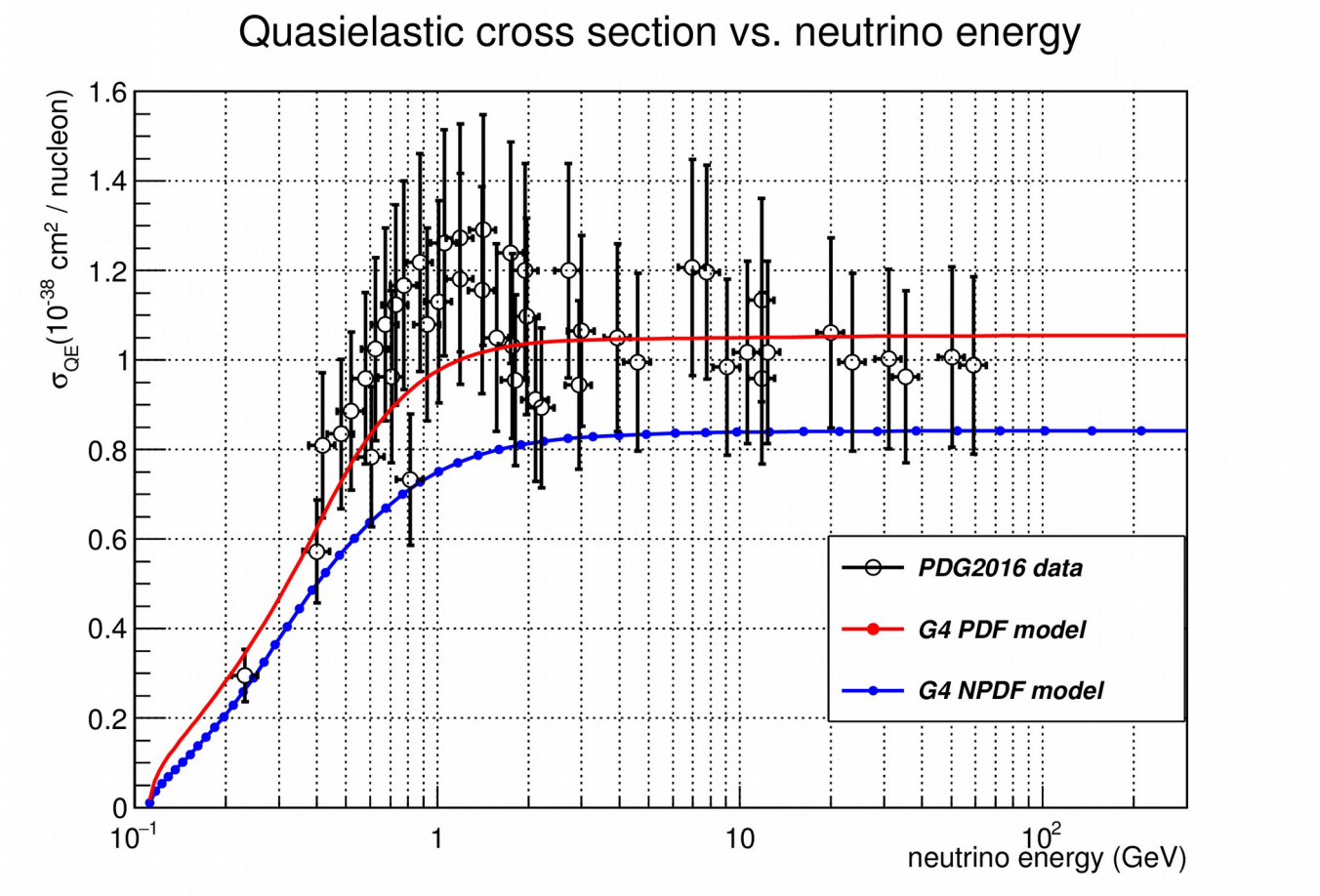
Status and plans

- The neutrino-nucleus interaction final state generator is under discussion. It could be implemented as modification of the Geant4 particle gun or via interface with existing neutrino event generators.
- Both neutrino integral cross sections and kinematical distributions were implemented as test application (see below).
- The first models with VMG and HSP processes are planned to be implemented in the framework of TestDm1

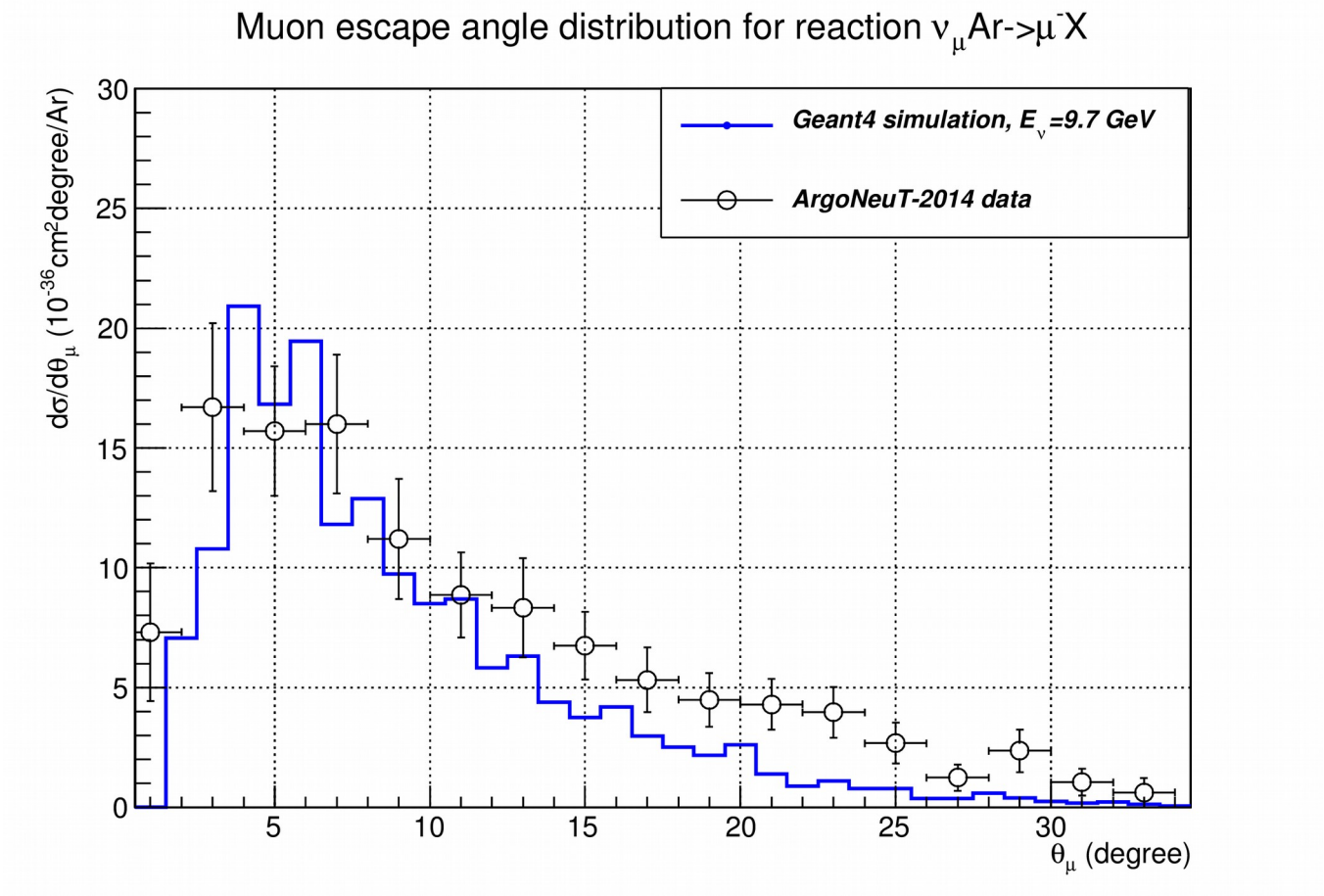
Muon neutrino total cross section divided by energy vs. the neutrino energy



Muon neutrino quasi-elastic cross section vs. the neutrino energy (nuclear PDF, nPDF, requires R&D)



The muon escape angle distribution measured in ArgoNeuT experiment (data are distributed wider due to broad neutrino spectrum, while the simulation was done for the mean neutrino energy only)



Conclusions

- Geant4 has good capabilities for the implementation of 'dark matter' and other BSM processes ('rich' EM physics, biasing).
- Geant4 has promising capabilities for the implementation of neutrino processes in terms of integral cross sections and final strate generators (existing hadronic models, biasing)