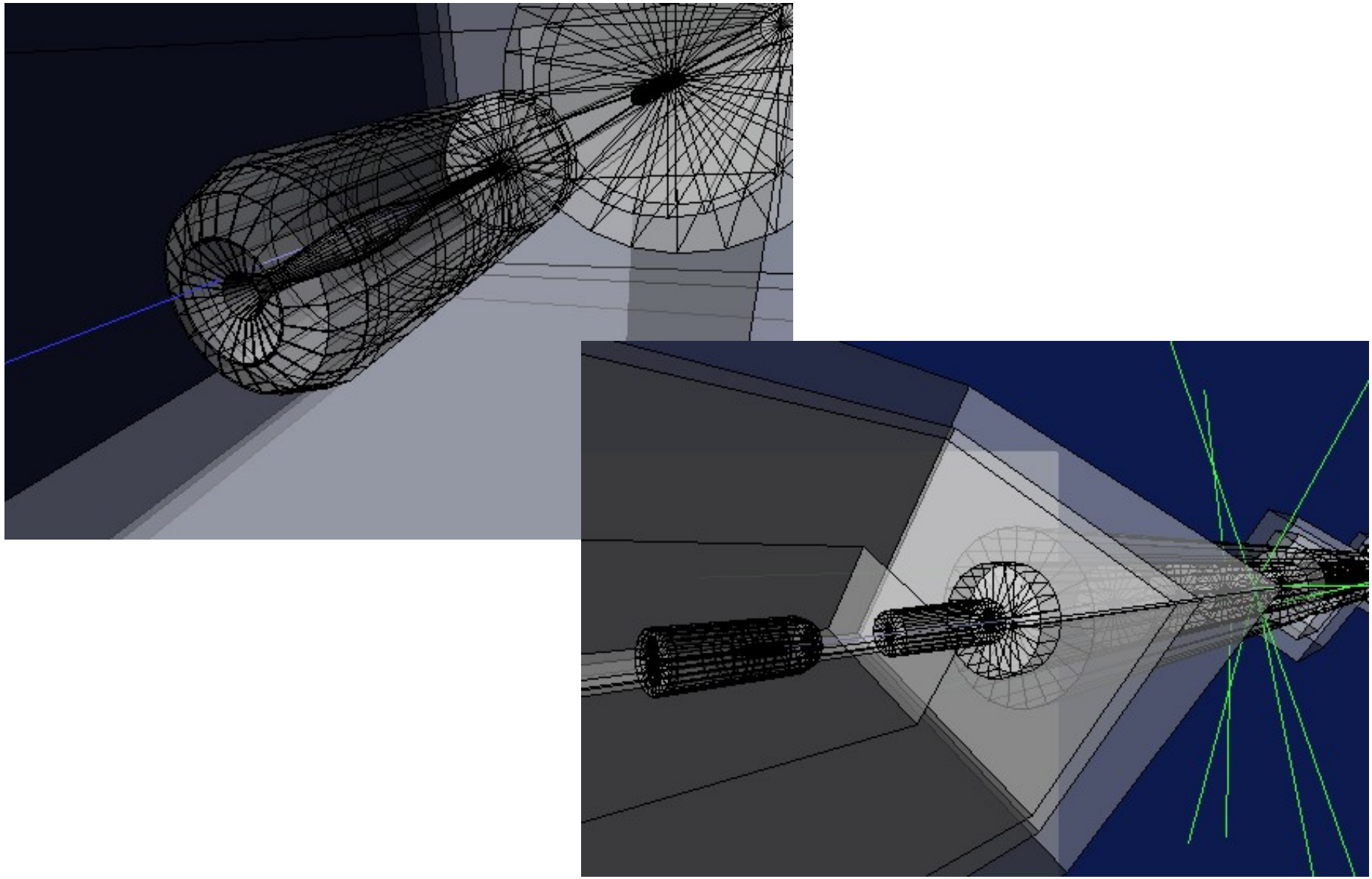
GEANT4 Beam MC



Motivations

1. Need to rely on physics models/external data for hadron production, since we probably won't be able to fix it by just looking at the neutrino fluxes at the detector and at the muon fluxes in the LMC and muon monitors;

2. We're analyzing important external data from CERN HARP and BNL E910. We should use it, and in the right way;

3. The current beam MC has only two physics models, MARS and GFLUKA. It is likely that none of the two can be used "as-is" for our final results. We should add more predictions from other commonly-used MC simulations.

Cross-section interface

- Basic idea: interface several models for primary protons interacting in Beryllium to one MC, directly at the cross-section level;

- To implement a production model for a secondary, say π^+, need as input:

1. total p-Be inelastic cross-section
2. double-differential inclusive π^+ production cross-section in p-Be

- Get as output:

1. the average π^+ multiplicity per inelastic collision, from inputs 1 and 2;
2. the π^+ 3-momentum distribution, from input 2 and primary proton direction

- For each inelastic collision in Be, throw dices accordingly;

- Use standard G4 tools to simulate all other physics processes (decays, energy loss, etc.), and transportation in the geometry/magnetic field.

Status of code development

- Code is in CVS (`BooNEG4Beam`). New version last Monday;
- What is implemented:

1. three models for p, π^+, $K^\pm$ secondary production in p-Be collisions;
2. same geometry, magnetic field, and primary beam description as G3;
3. similar physics list, for physics processes other than p-Be interactions;
4. same HBOOK ntuple output format as G3, compatible with existing redecay routine.

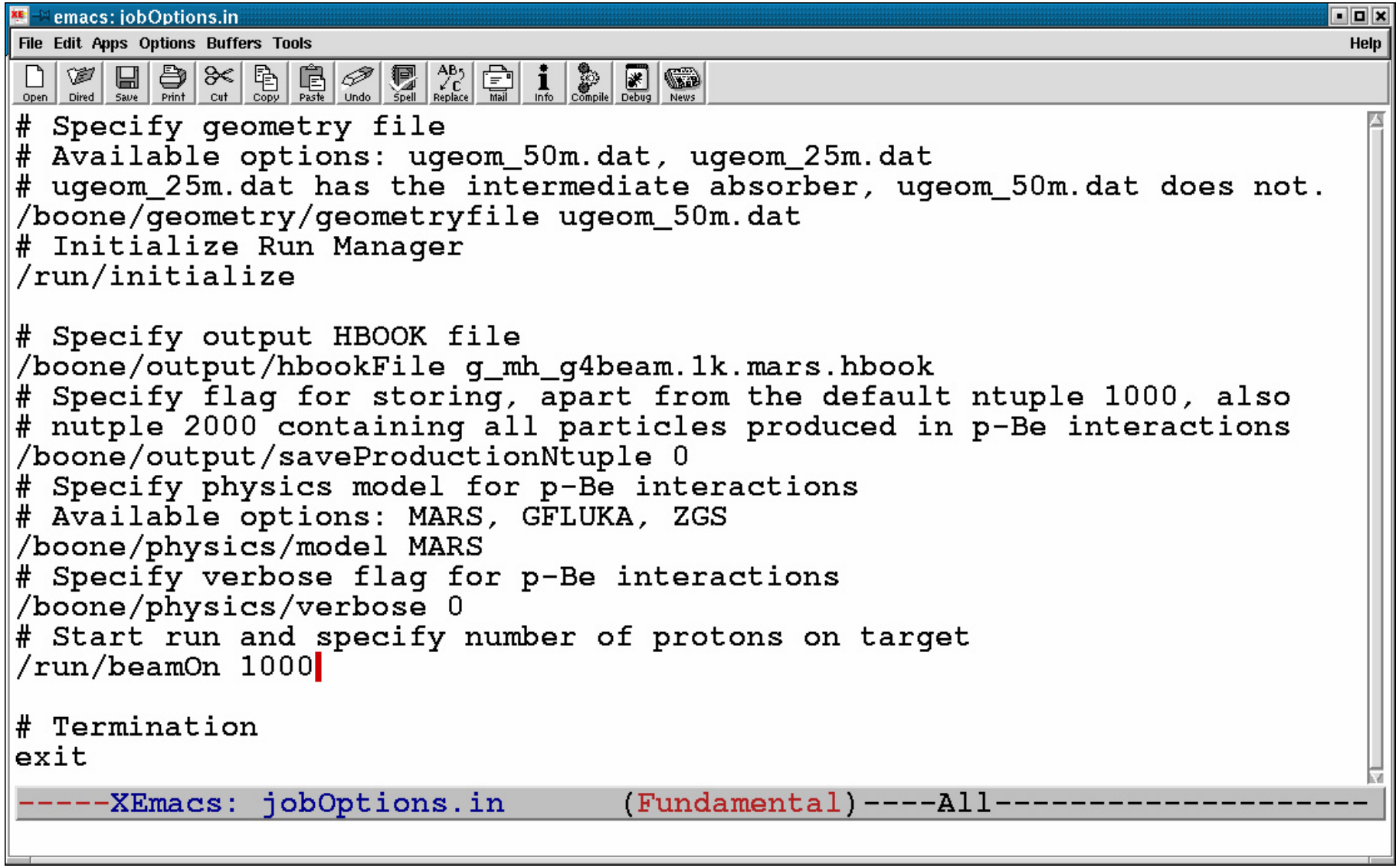
- What is not yet implemented:

1. K^0 production;
2. muon polarization effects in muon decays.

- What is implemented, but wrong:

1. muon decays at rest;
2. something else, affecting the normalization of the neutrino flux

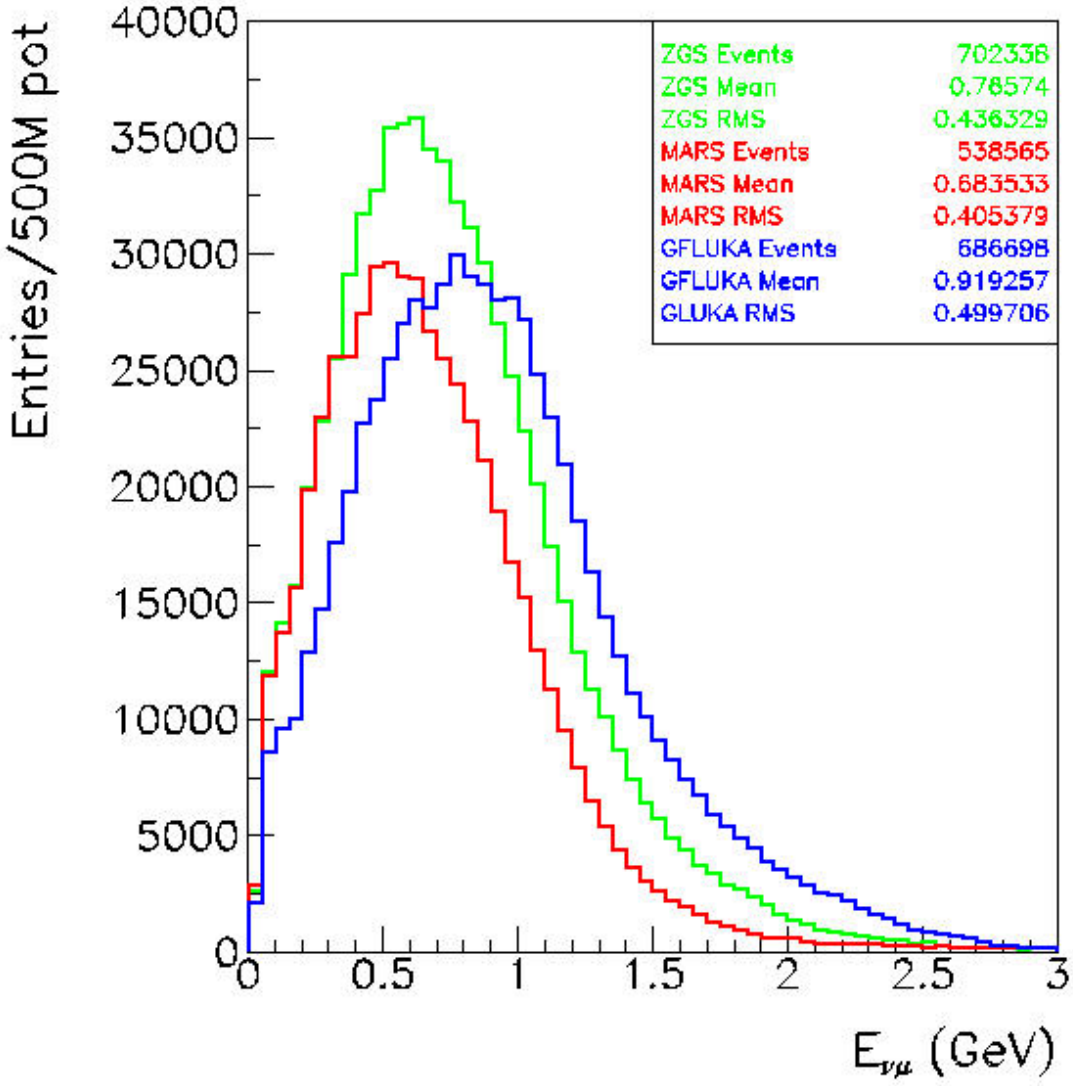
How to run: jobOptions file



G4 results for the neutrino flux at the detector

Three physics models present so far:

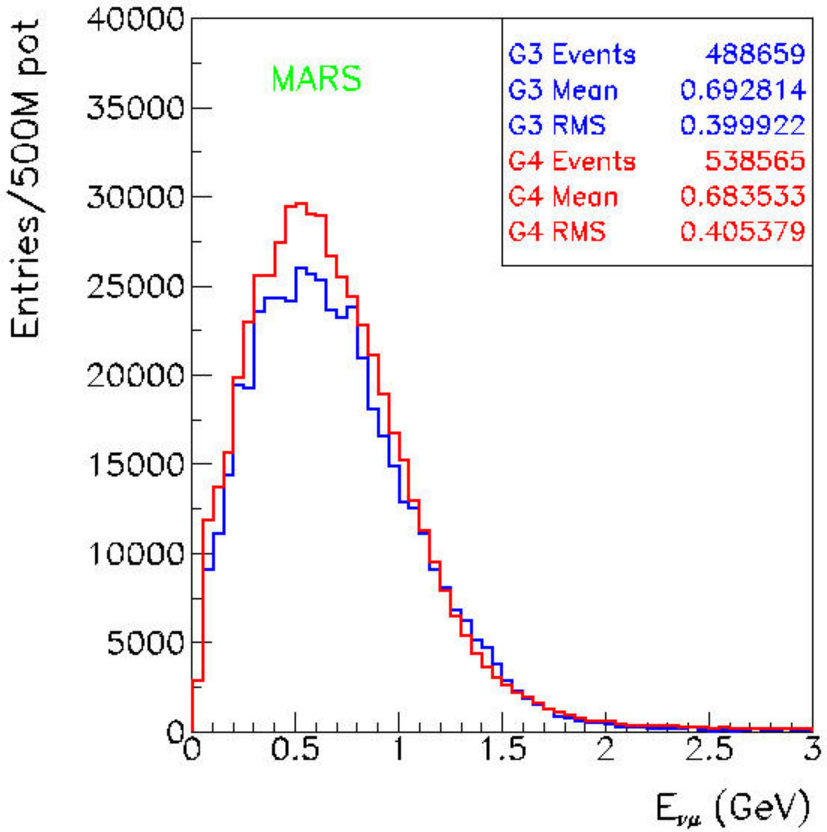
1. MARS;
2. GFLUKA;
3. Sanford-Wang fit to Argonne's ZGS data. Interesting because similiar approach to K2K one.

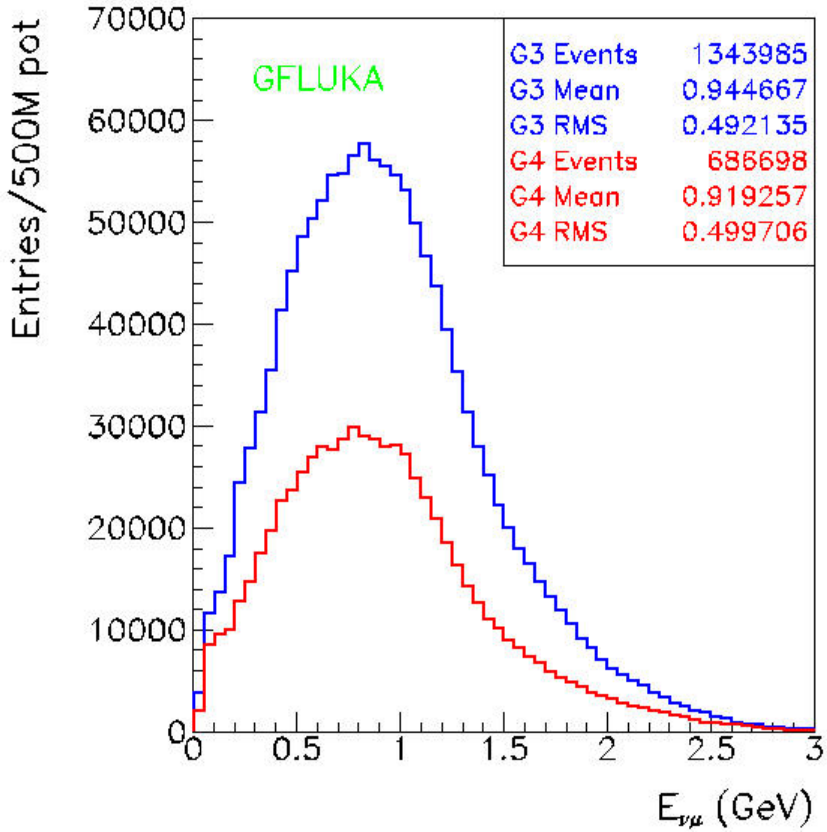


- Statistics: 500k pot for each physics case, then neutrino parents redecayed 1000 times by `BooBeamNT` and ν's transported to MiniBooNE detector

G4 validation (G3-G4 comparisons)

- `BoobeamNT` output for the neutrino flux for both MARS and GFLUKA, in both G3 and G4;
- agreement on the shapes of the distributions; discrepancies in the overall normalization: 10% in MARS, factor of 2(!!) in GFLUKA:





- CPU time on Condor batch system, for 500k pot: 8-12 hours G4, 8-17 hours G3
- Many more plots at:
  `http://www-boone.fnal.gov/software_and_analysis/beam_group/software/links/geant4/`.

Coming soon

- better input for GFLUKA model;
- add K^0 for all models;
- fix muon polarization and decay at rest problems;
- add BNL E910 model;
- Later: DPMJET, FLUKA, HARP.