

Validation of Geant4 Hadronic Physics, with the Focus on the FNAL Intensity Frontier Program

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Note: Results included in this
report have been obtained
with Geant4.9.6.p01





General Information

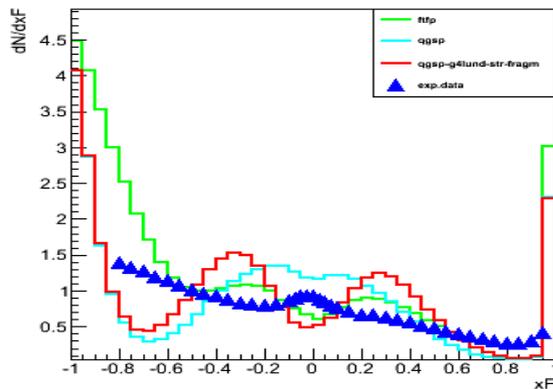
- Scope of the task and general information introduced in the talk at the May 9 meeting:
<https://indico.fnal.gov/conferenceDisplay.py?confId=6808>
- Since then, we attended several NuMI-X meetings and gathered information on topics of interest
- More work invested:
 - test19 (HE, process level)
 - useful testbench that allowed to recombine components (string fragm.) in HE models (QGS & FTF) for a better fit with p+C HE exp.data (see following slides)
 - Results/options presented at the NuMI-X on 7/11/2013
 - test23 (physics lists, IE and HE)
 - tests the 1st interaction of a beam in a realistic target
 - added several HARP datasets (Be, Ta), improved analysis routines (see following slides)
 - started initial work on composing experimental physics list for NuMI-X
 - hosts common-use code/infrastructure (test23/CommonSW) - more on this later

High Energy Validation (I)

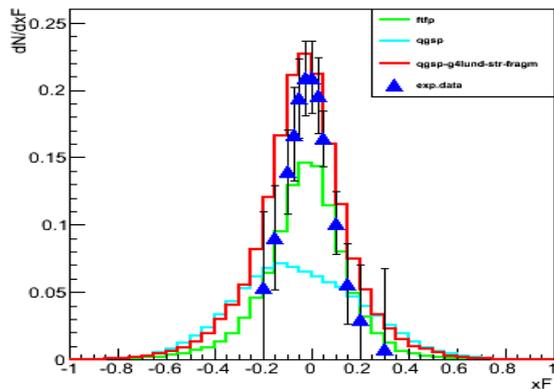
test19: FTF, QGS models & NA49 exp.data (158GeV/c p on C)

NuMI case

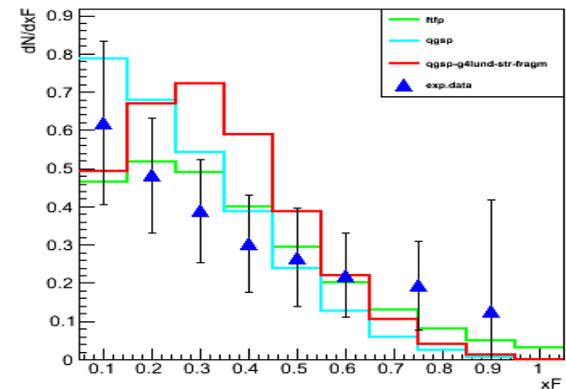
proton + C -> X + proton



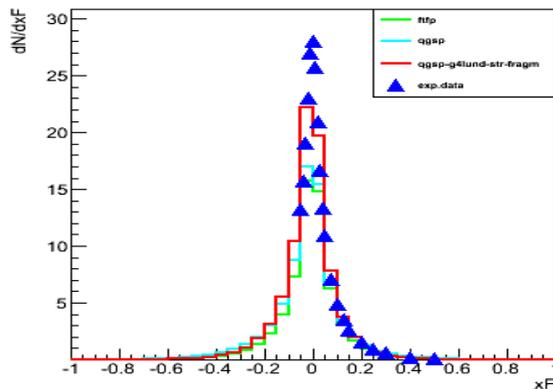
proton + C -> X + antiproton



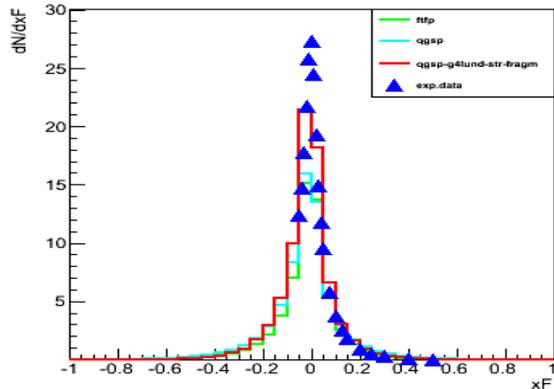
proton + C -> X + neutron



proton + C -> X + pi+



proton + C -> X + pi-



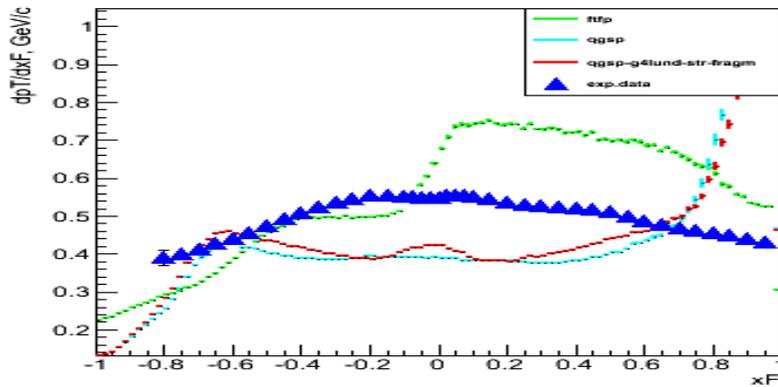
In these plots and next:
Green = standard FTFP
Light Blue = standard QGSP
Red = QGSP
+G4LundStringFragmentation

High Energy Validation (II)

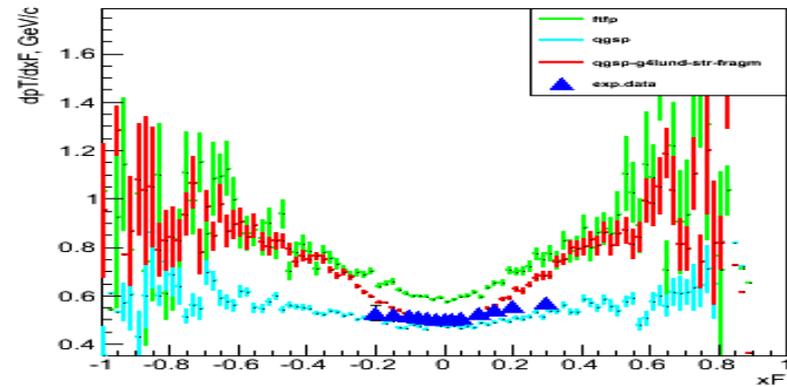
test19: FTF, QGS models & NA49 exp.data (158GeV/c p on C)

NuMI case

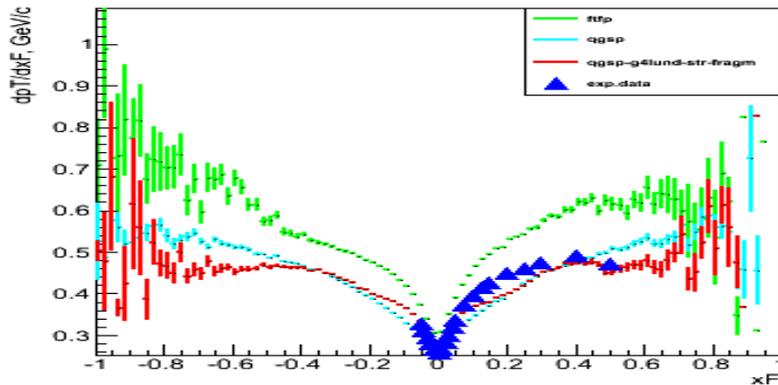
proton + C \rightarrow X + proton



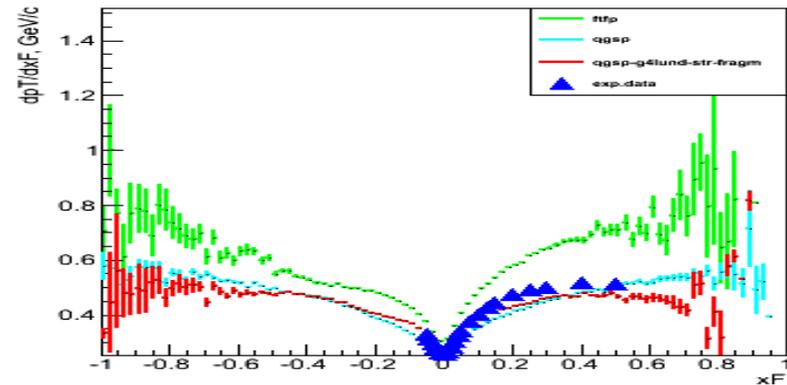
proton + C \rightarrow X + antiproton



proton + C \rightarrow X + pi+

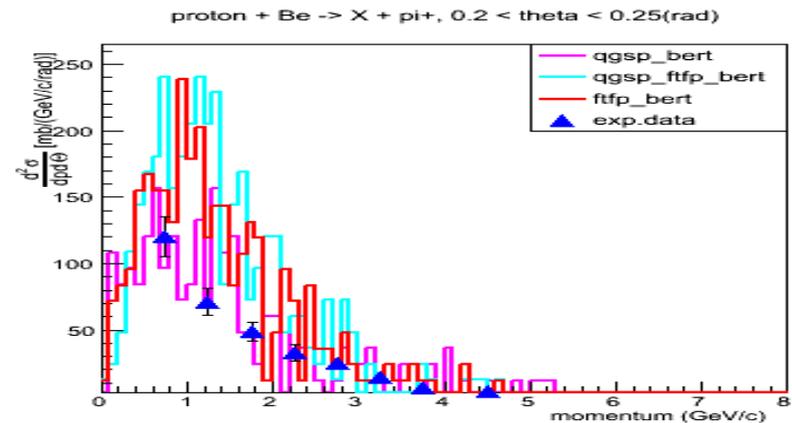
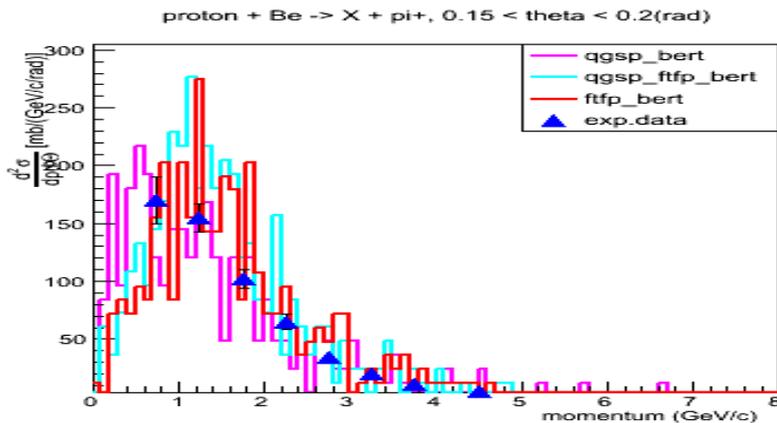
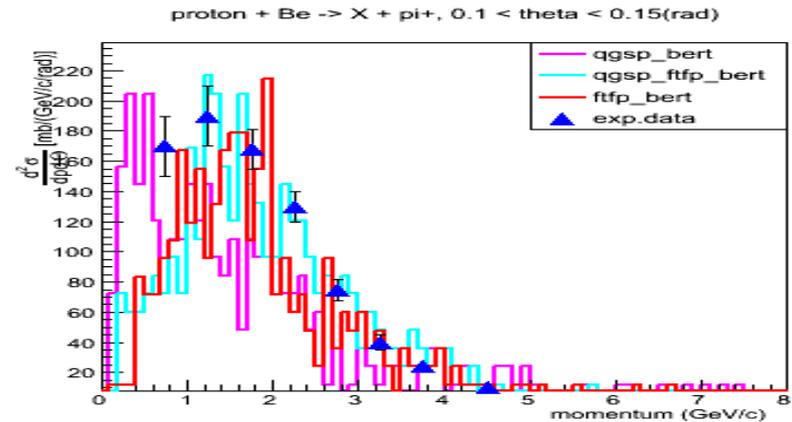
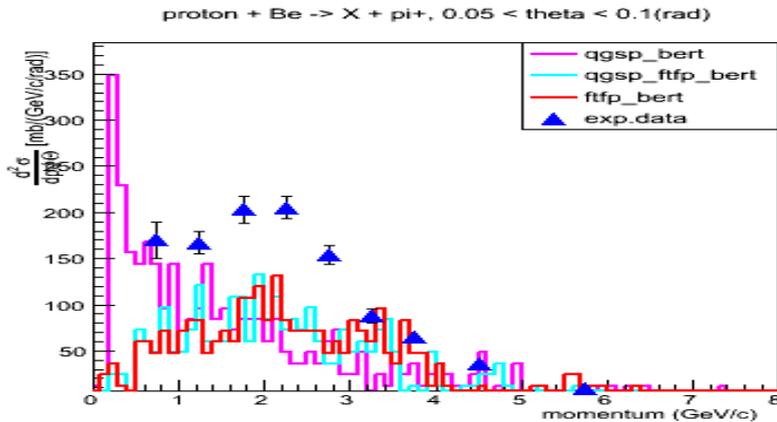


proton + C \rightarrow X + pi-



Intermediate Energy Validation (I)

test23: QGSP_BERT, QGSP_FTFP_BERT, FTFP_BERT, HARP data (8.9 GeV/c p on Be)
Booster/MiniBooNE case

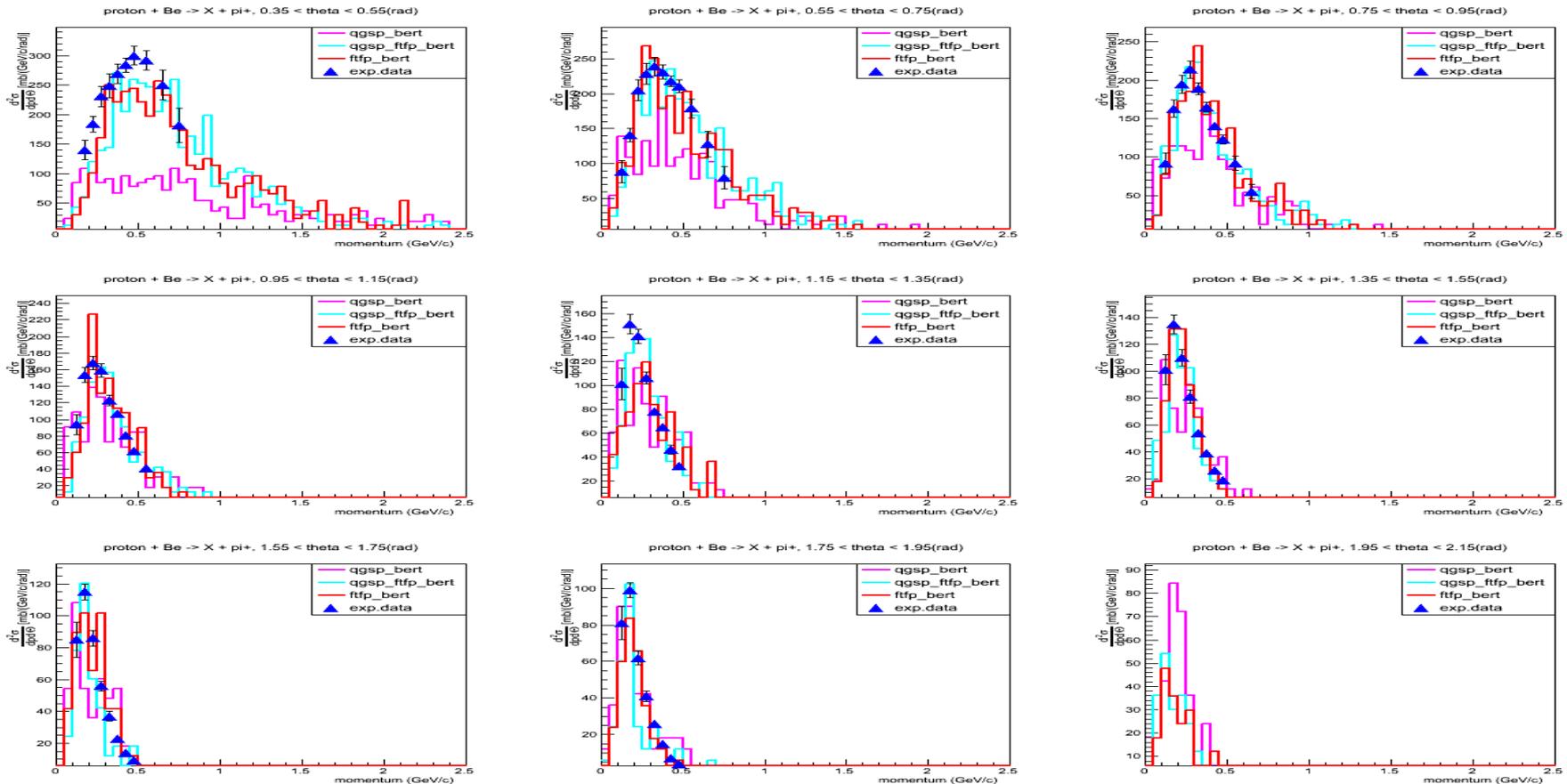




Intermediate Energy Validation (II)

test23: QGSP_BERT, QGSP_FTFP_BERT, FTFP_BERT, HARP data (8.9 GeV/c p on Be)

Booster/MiniBooNE case





Towards Future Plans

- Additional observables to look at:
 - What “bulk” comes out of realistic target ?
 - Normalization ?
 - What (other) materials are important ?
 - Additional exp.data ? Thick target data from NA61 - released ?
- A physics list is only as good as the included models are !!!



Common Use SW in G4 Validation (I)

- **Geometry**
 - “Virtual” (model/process-level) or realistic (phys.lists)
- **Physics**
 - Process level (single interaction) or Physics Lists
- **Beam definition - particle type, kinematics**
 - *G4Track* with Pre/PostStep points defined (model/process-level tests)
 - *G4VPrimaryGeneratorAction* (physics lists level tests)
- **Run Control: *G4ProcessManager* or *G4RunManager***
- **Misc. (user actions, such as stepping, etc.)**
- **Configuration/Steering**



Common Use SW in G4 Validation (II)

- Work started “locally”, to avoid code duplication across several tests in our responsibility
- Also, to allow for better structuring with every test (for example, test48 covers several almost un-related topics)
- Introduction of common-use code/library needs to blend smoothly into CTest procedure - in progress
- Question initially raised with the G4 HAD group (in first place, to address technicalities)
- Apparently, of interested to the whole group - will have a discussion at the collaboration workshop



Related Topic(s): Composition of a Physics List, etc.

- Revisited many technical details of composing physics lists
- Summarized key elements, from the “users’s point of view”, as part of Geant4-at-FNAL web materials:

<https://sharepoint.fnal.gov/project/geant4-pub/SitePages/Home.aspx>

<https://sharepoint.fnal.gov/project/geant4-pub/SitePages/ComposeG4PL.aspx>

- **Comments/suggestions welcome**
- Experiment-specific materials need to appear !!!



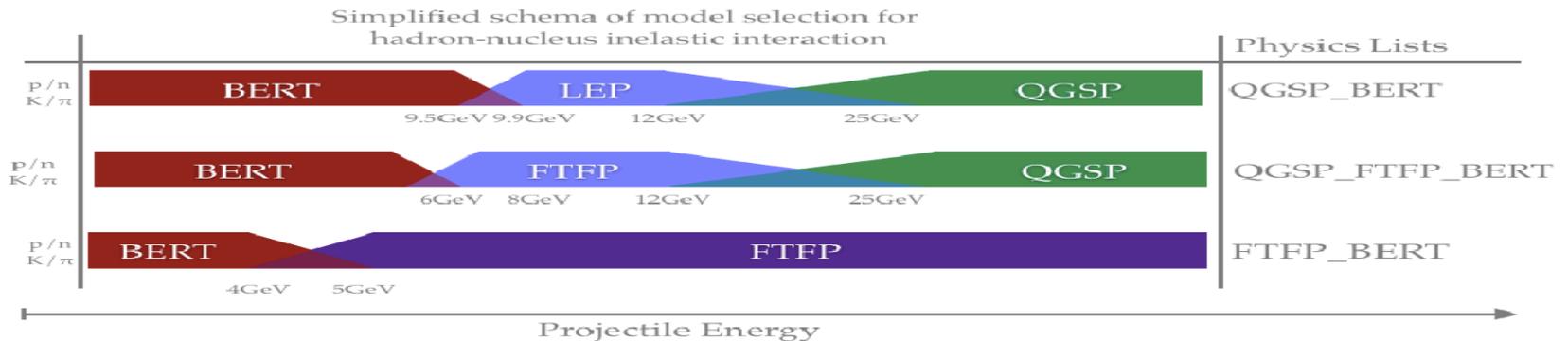
Summary

- More work has been done to expand test19 (models) and test23 (PL)
- Expanded collection of datasets
- Improved code infrastructure
- Different scenarios have been tried for composing HE models
- Relevant subset of the validation results have presented to NuMI-X
- Initial work started to gather ideas, code for NuMI physics list
- Overall improvements of the G4 validation SW will be discussed at the collaboration workshop



Physics Lists Composition and Transition Between Models

- Hadronic models may overlap in their validity range - this is also reflected in the composition of Physics Lists



- Choice is based:
 - General Validation (benchmarking vs exp.data)
 - Use-case(s)