

Validation of Hadronic Models using BNL E802 and MIPP data

Geant4 Hadronic Working Group Meeting
August 16, 2017

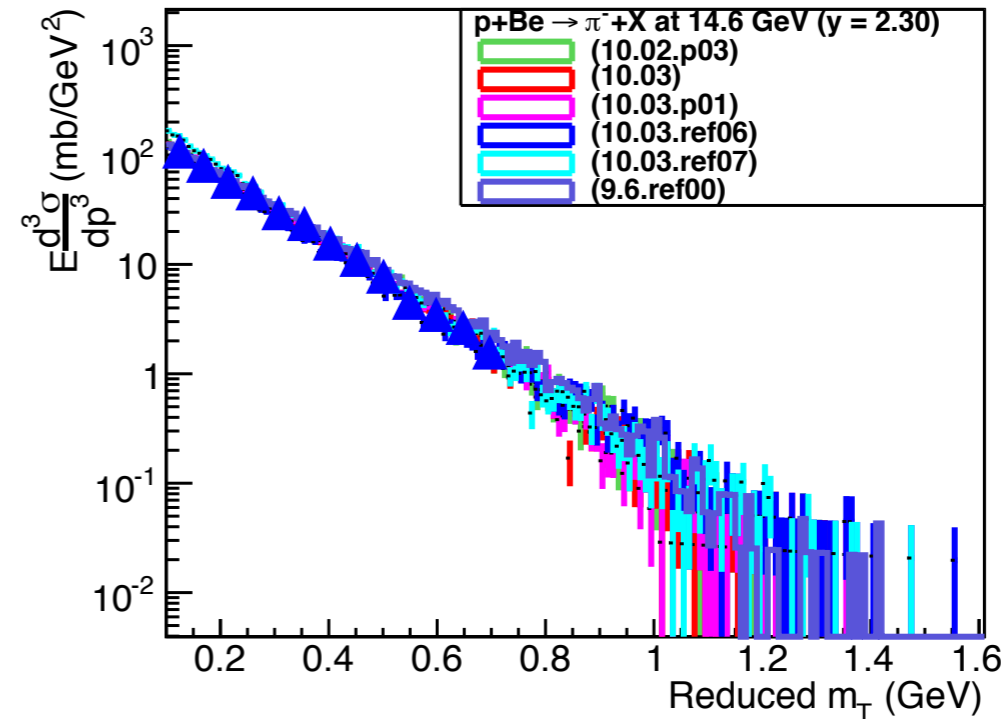
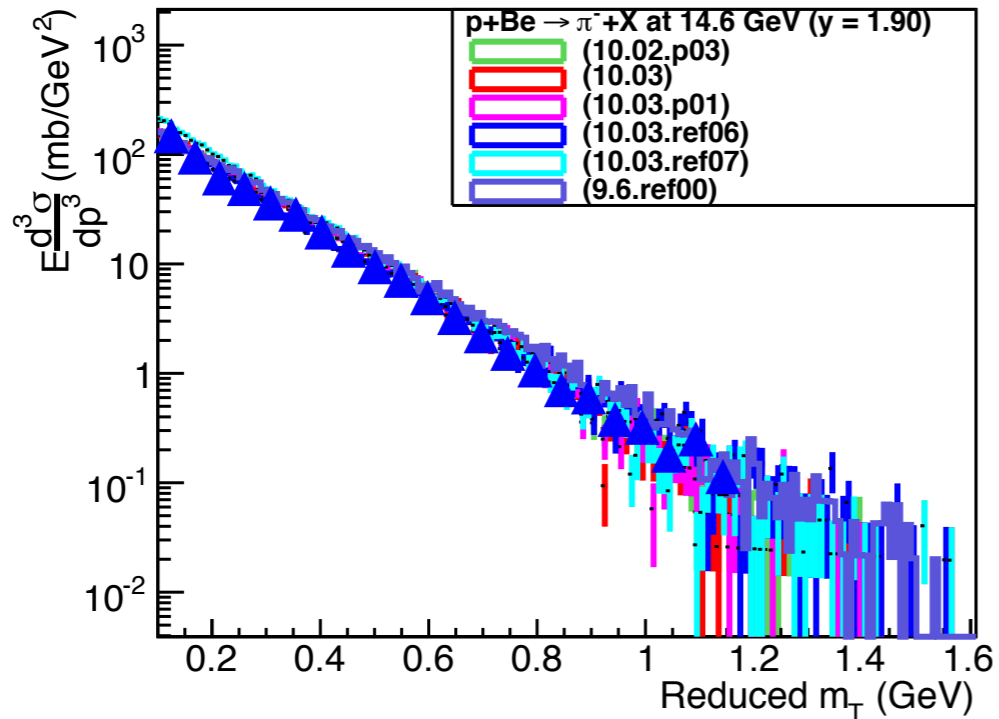
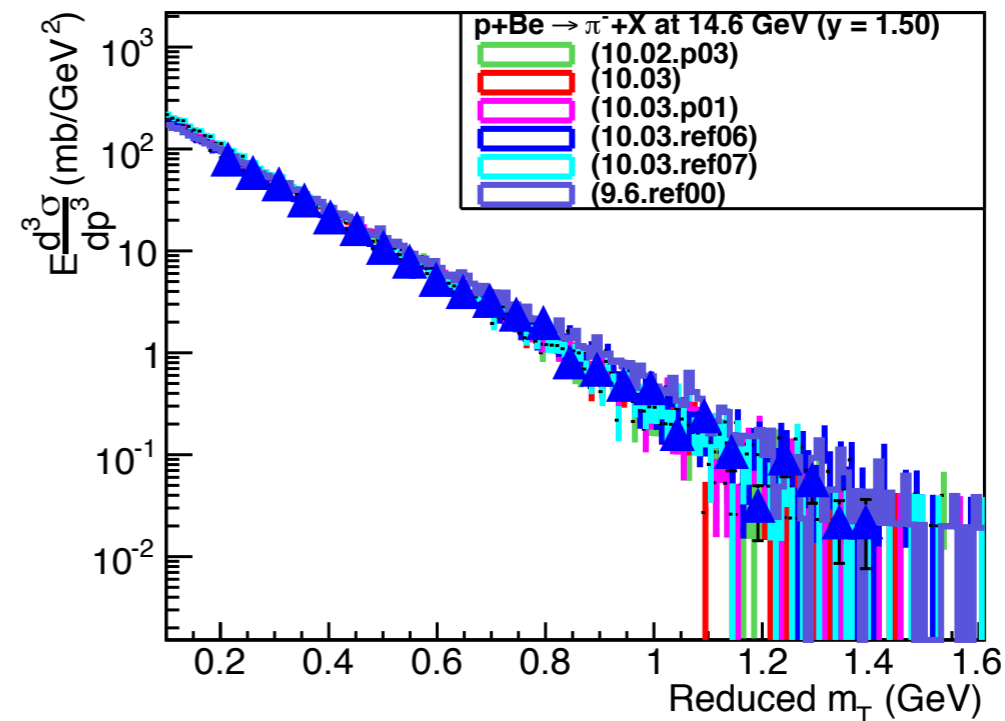
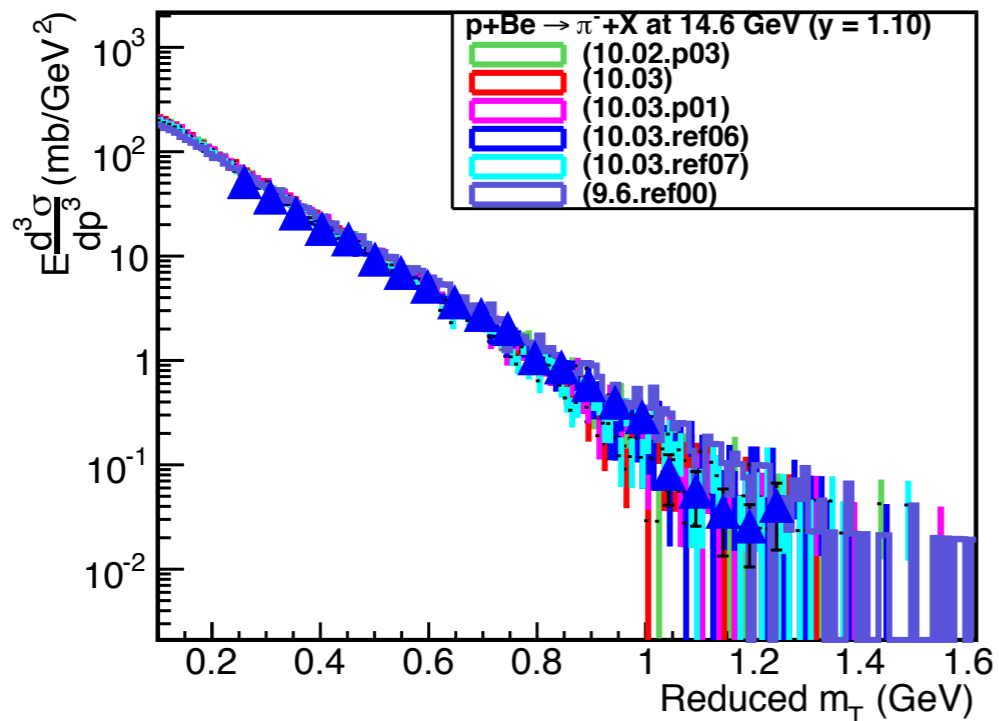
S. Banerjee
Fermilab



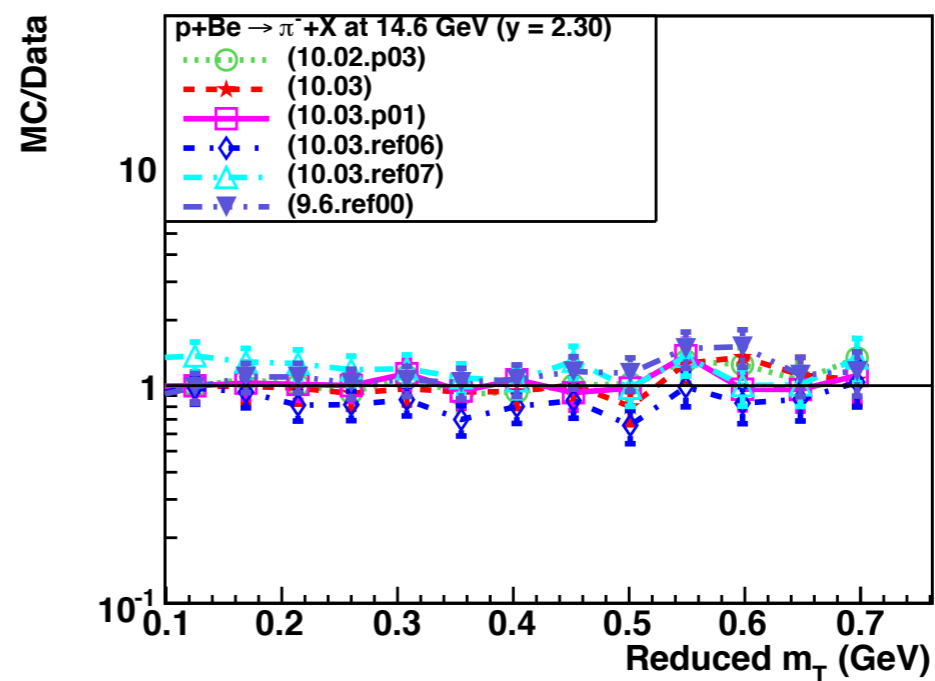
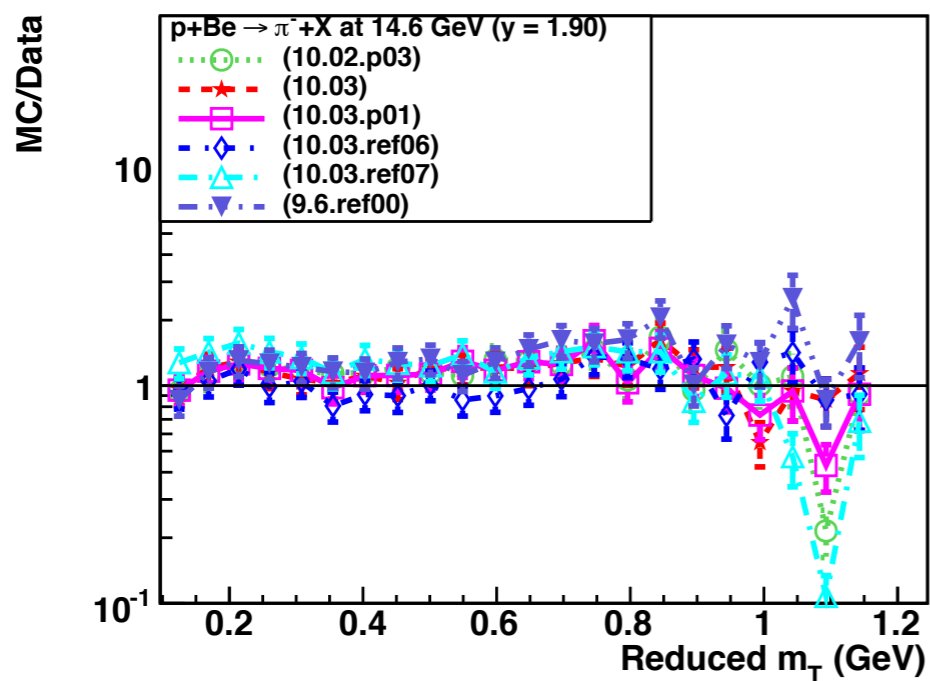
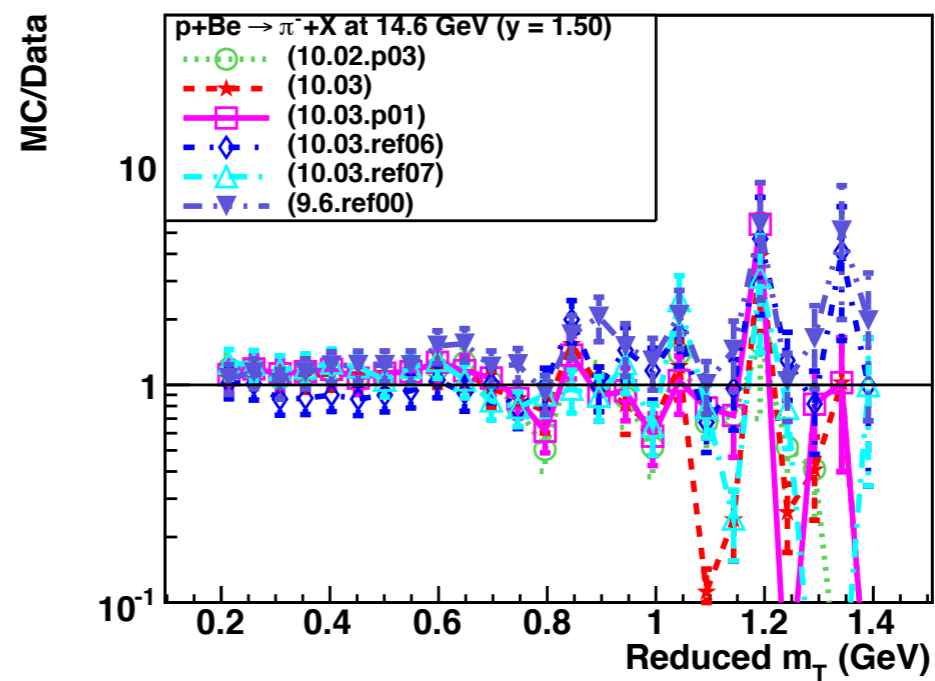
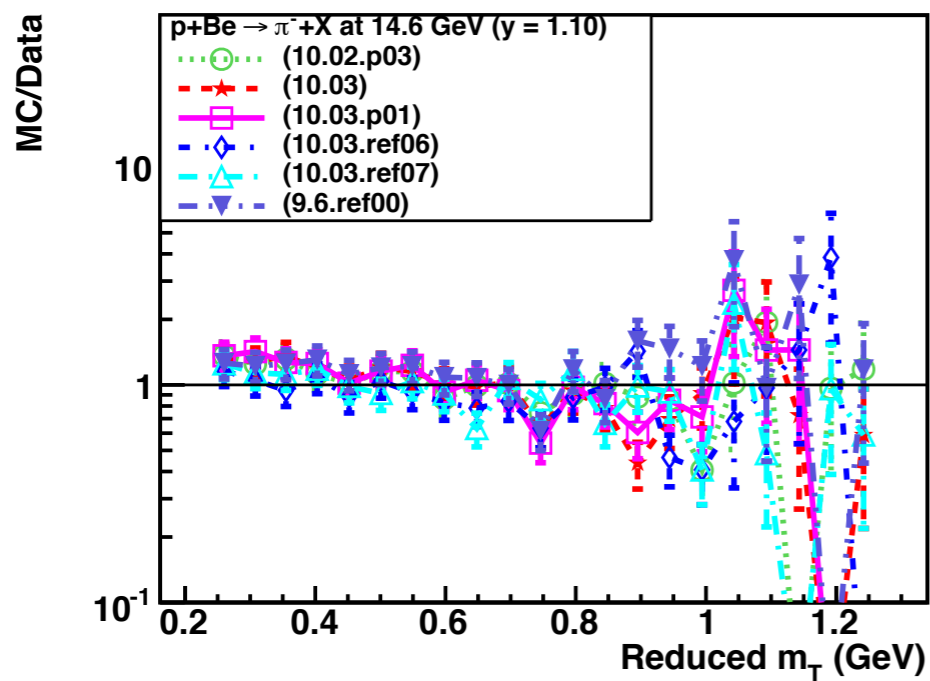
- **Data set from BNL E802:** (T. Abbott *et al.*, Phys. Rev. D45, 3906)
 - Inclusive π^\pm , K^\pm and proton production from p beams at 14.6 GeV/c on a variety of nuclear targets
 - Quantities measured are Lorentz invariant differential cross sections as a function of transverse mass (m_T) in bins of rapidity (y)
 - Data quality: statistical error 5-30%; systematic uncertainty 10-15%
 - Targets studied Be, Al, Cu, Au for all the final states available
- **Data set from Fermilab E907:** (T.S. Nigmanov *et al.*, Phys. Rev. D83, 012002)
 - Inclusive neutron production with proton beams at high energies on a number of nuclear targets
 - Targets used: Hydrogen, Beryllium, Carbon, Bismuth, Uranium
 - Projectile: proton beam at: 56.8, 57.3, 82.6 and 120 GeV/c. Beam momentum and impact point at the target are measured using an upstream spectrometer
 - Neutrons detected in the hadron calorimeter and its energy is measured by subtracting energies of charged particles within the geometric acceptance of calorimeter
 - Inclusive neutron momentum distribution and Lorentz invariant cross section for neutron as a function of x_F without any geometric acceptance correction



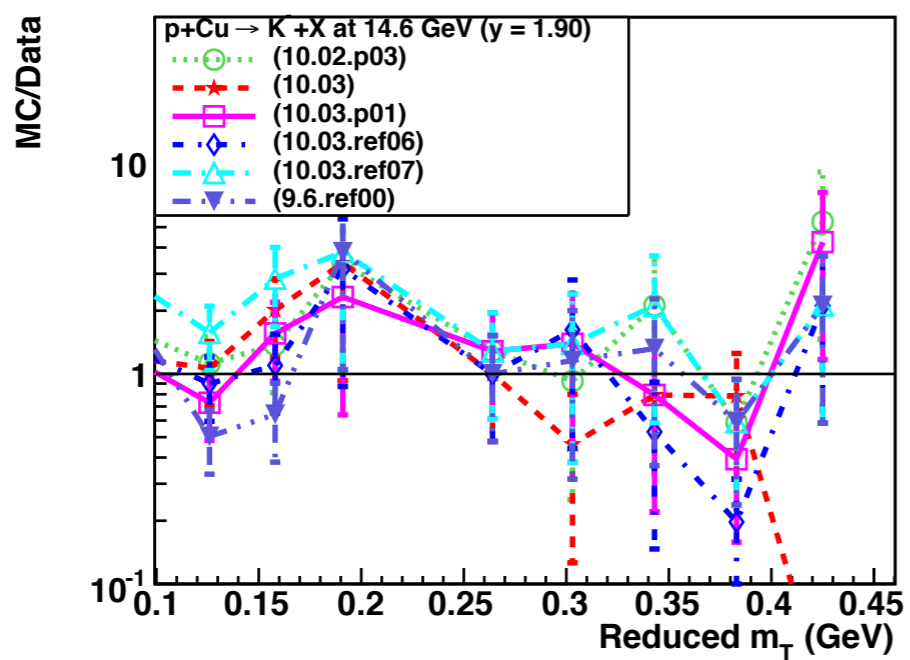
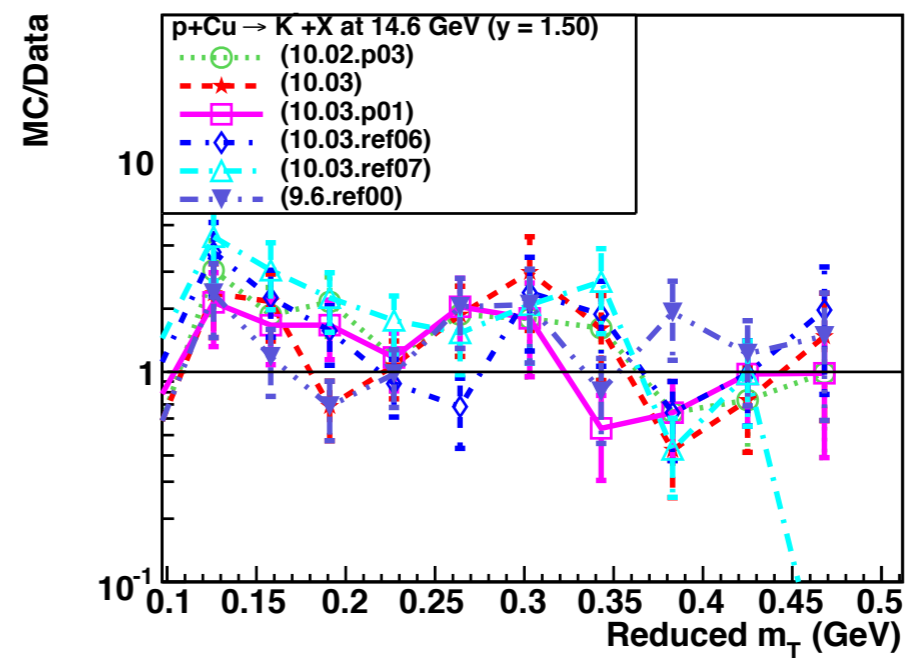
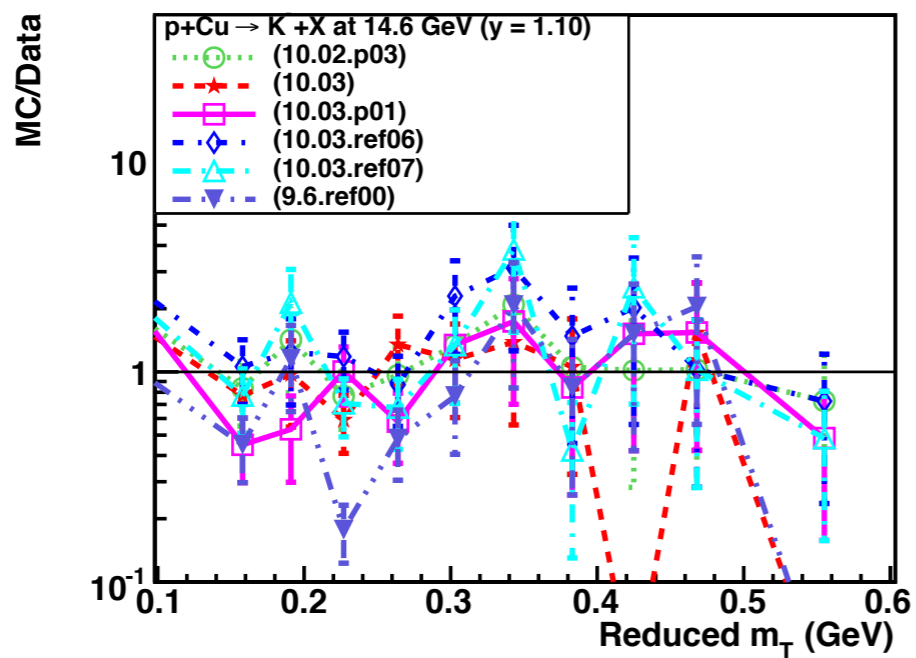
- For calculation of invariant cross sections in the BNL data **constant bin width** of ($\Delta y = \pm 0.1$) is used
- For calculation of invariant cross sections in the **MIPP** data, finite target size, beam orientation, acceptance cut of the detector, beam momentum spread, etc. are taken into account
- Three Geant4 models are considered for the comparisons:
 - Bertini cascade model for the 14.6 GeV data
 - FTFP and QGSP models for all the data sets
- Several versions of Geant4 are used:
 - 10.2.p02, 10.3, 10.3.p01, 10.3.ref06, 10.3.ref07



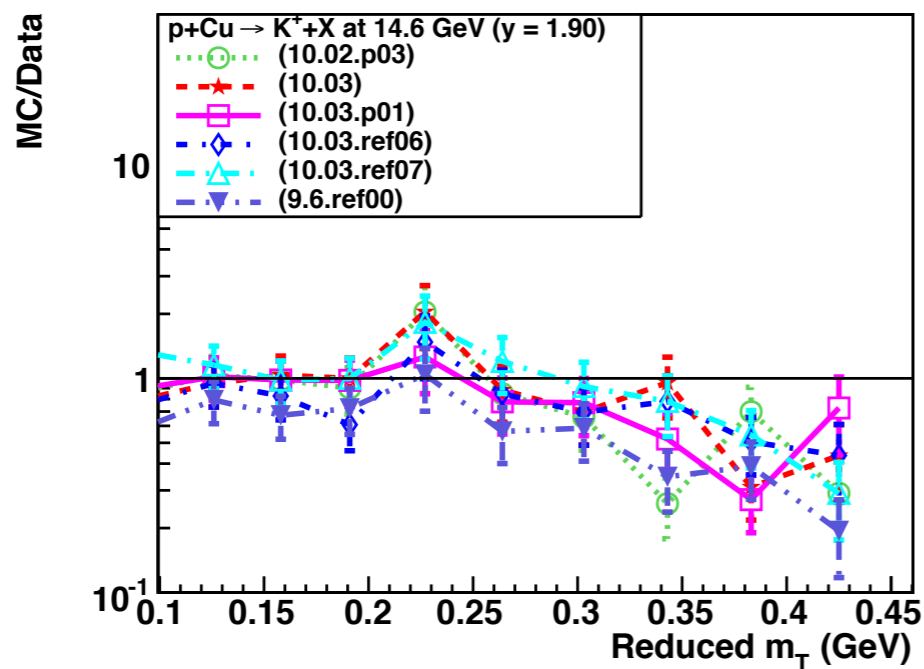
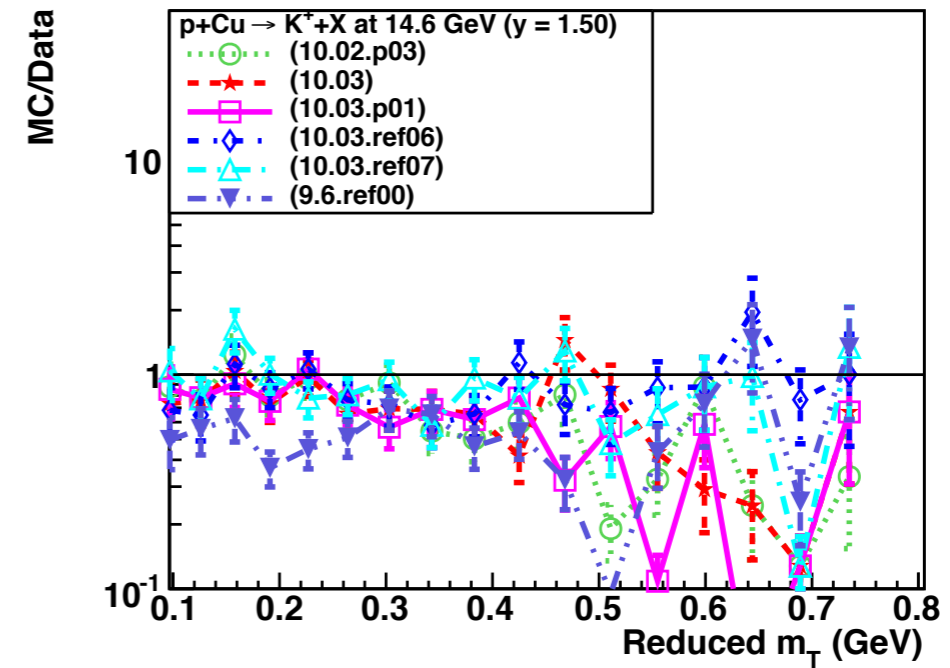
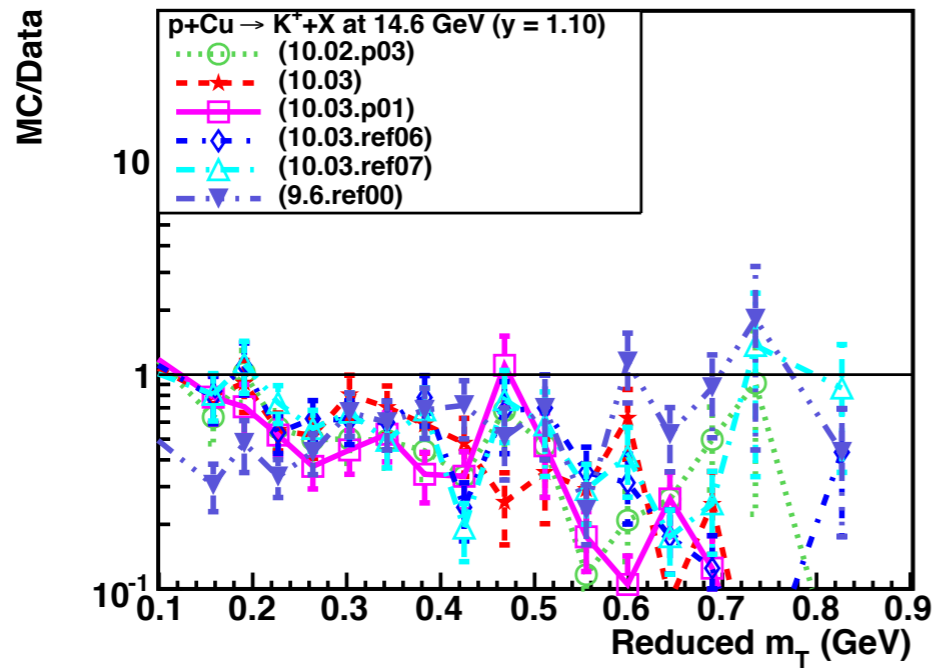
- Difficult to see the difference among different versions of FTFP model in the comparison with inclusive π spectra



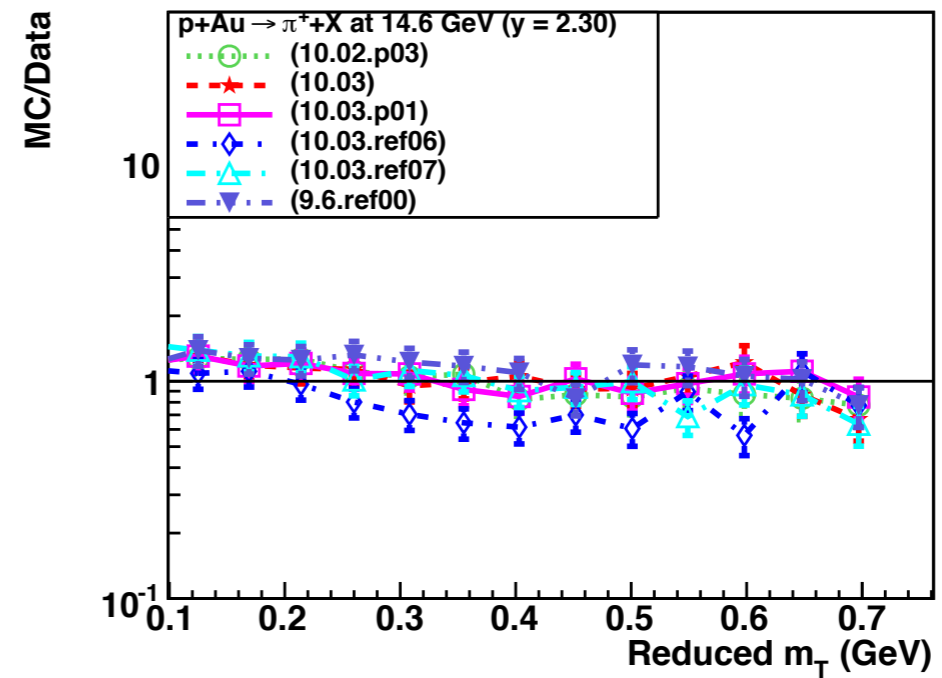
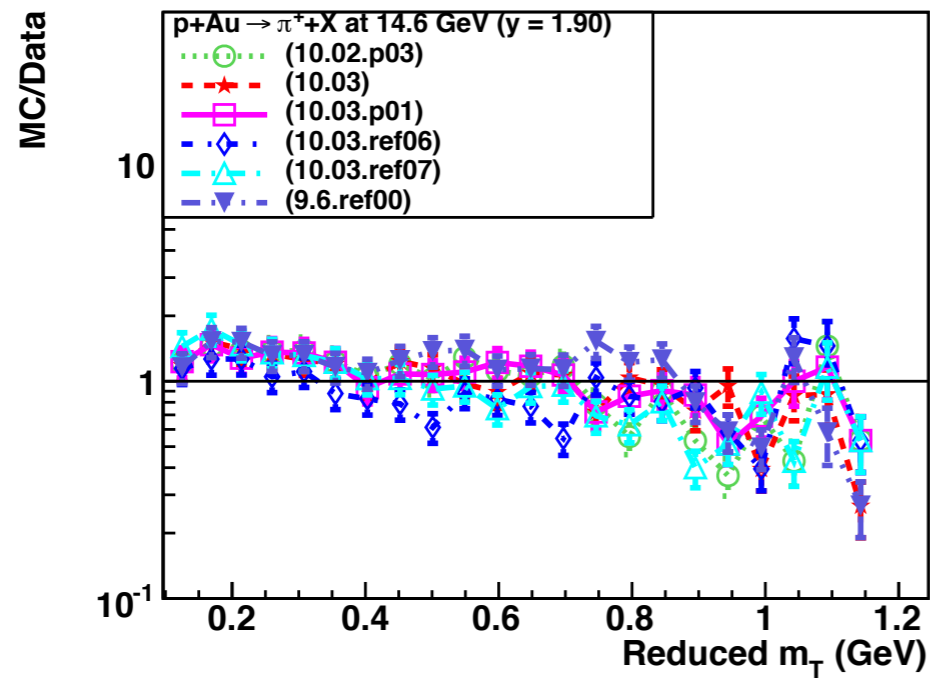
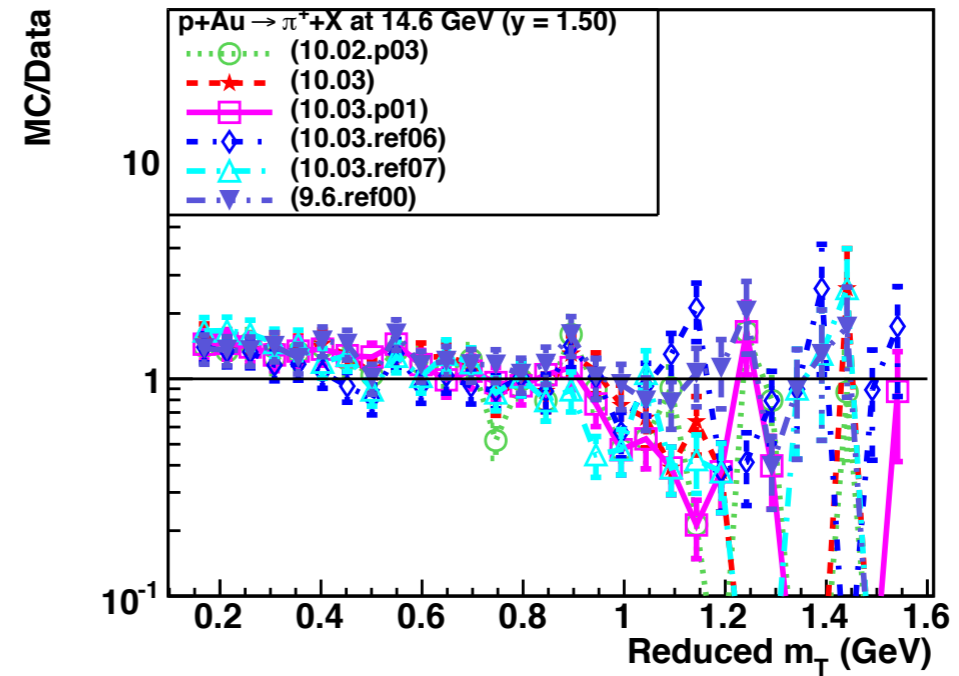
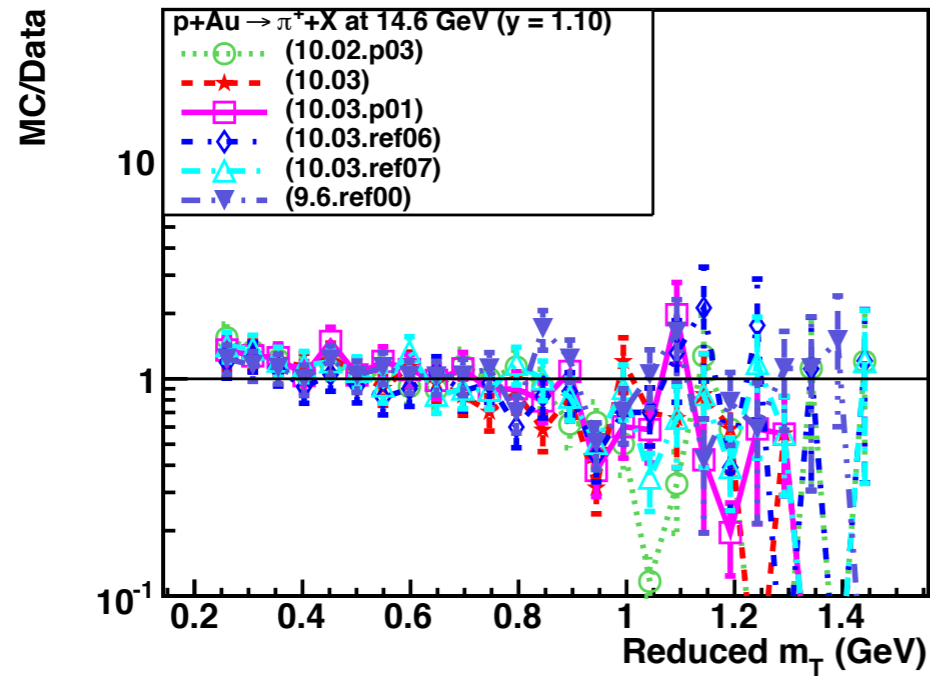
- No significant difference in the prediction of FTFP models from 9.6 till 10.4.beta



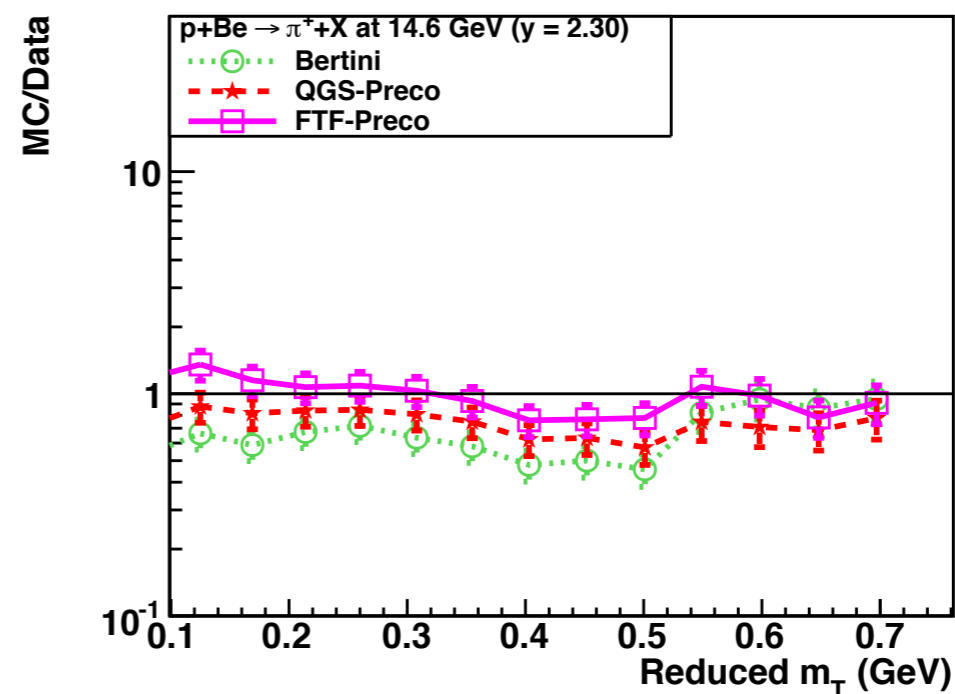
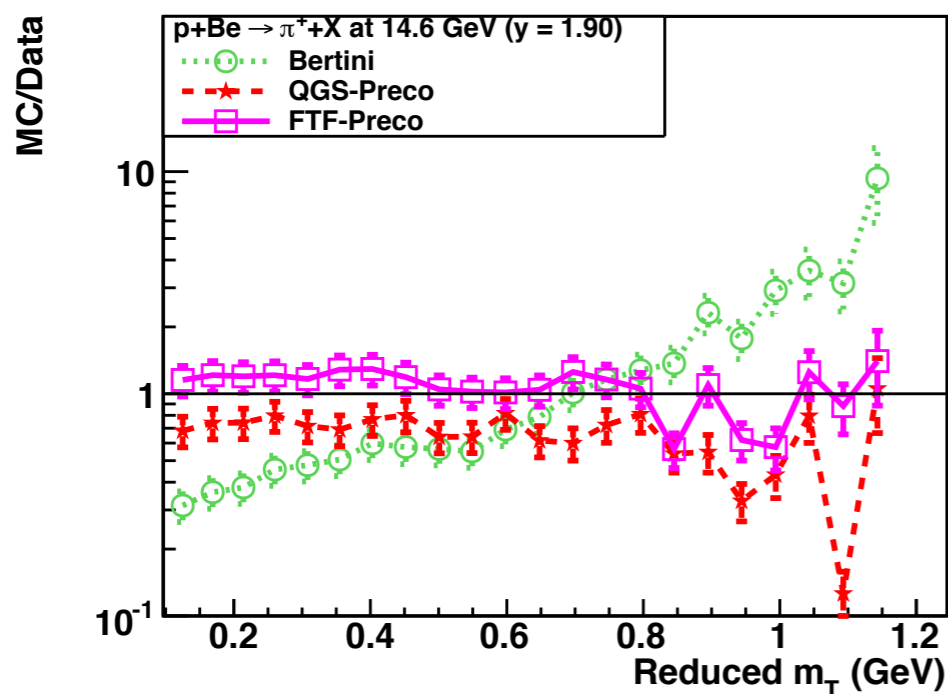
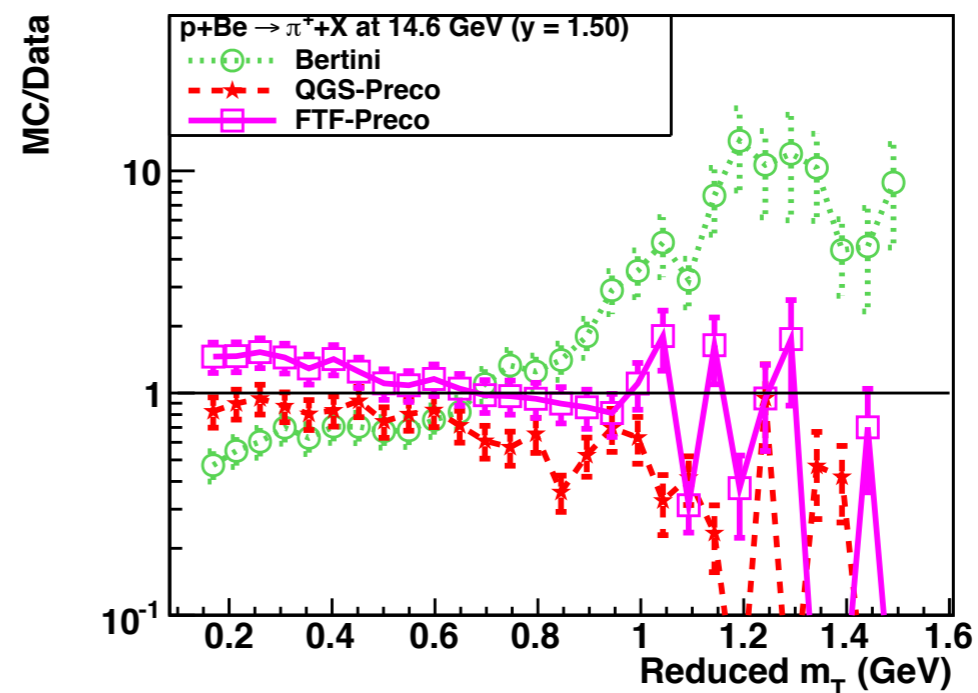
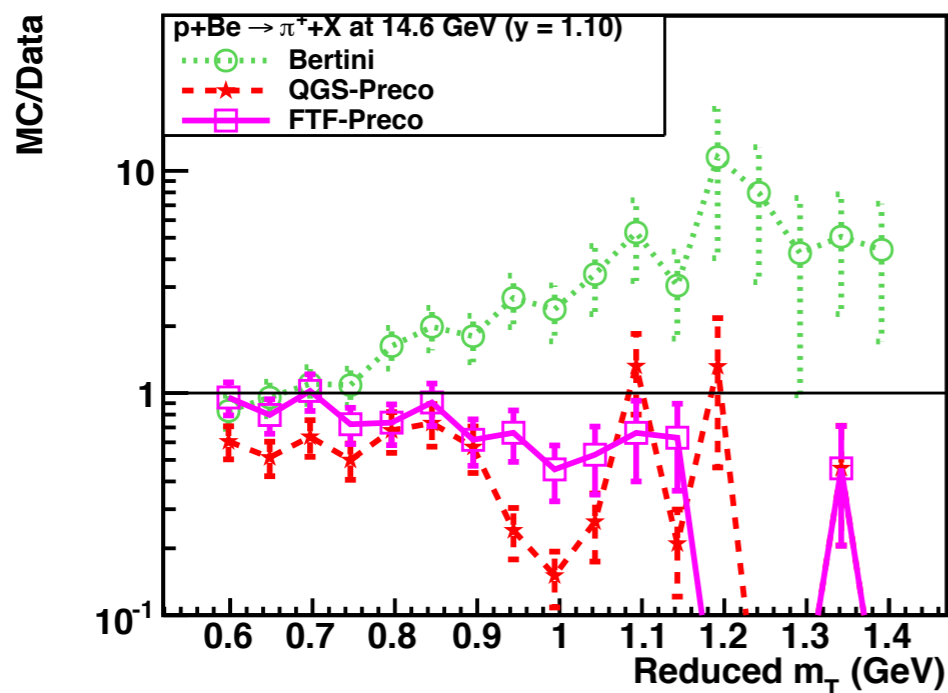
- FTFP models provide reasonable predictions for K^- production



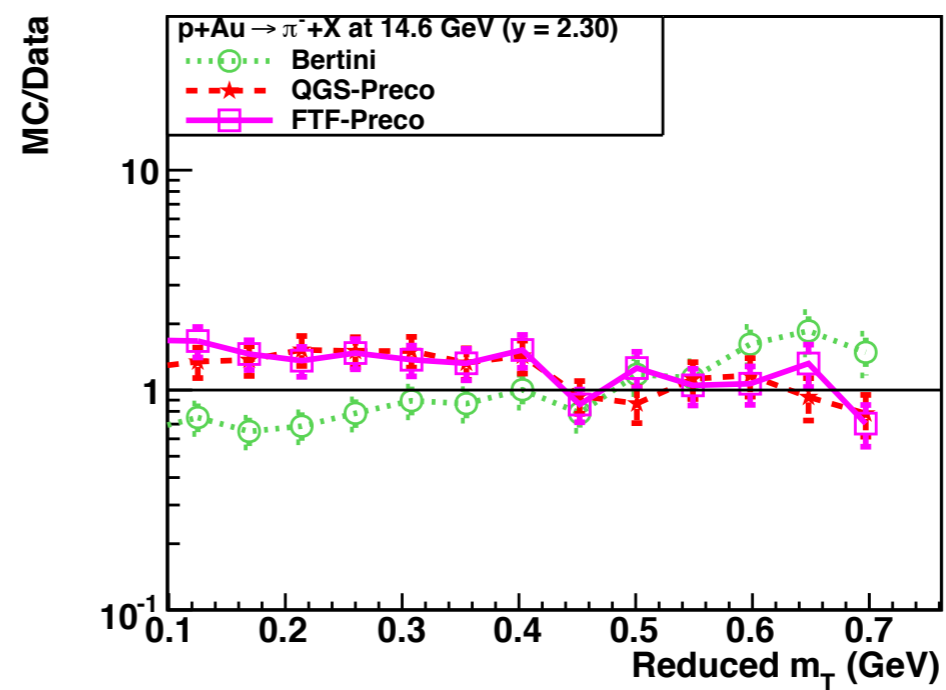
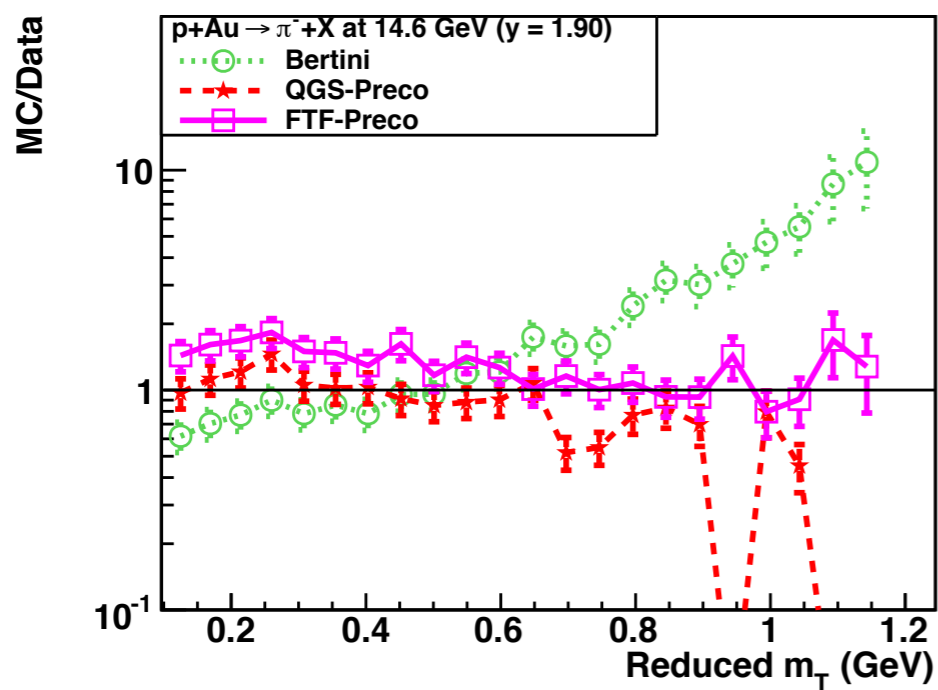
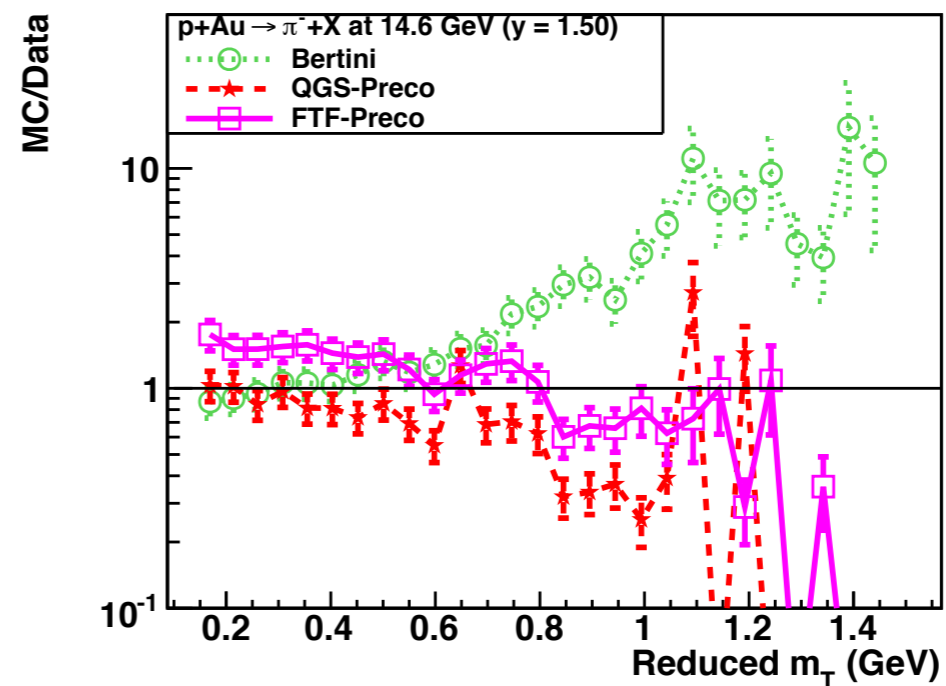
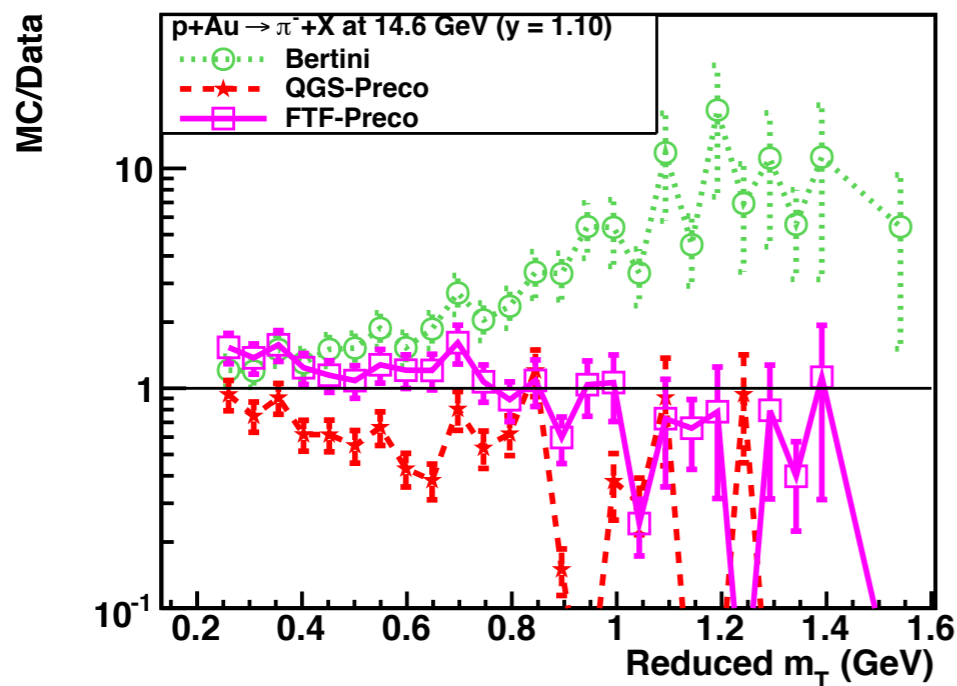
- FTFP model predictions for K^+ production are similar between 9.6 and 10.4.beta



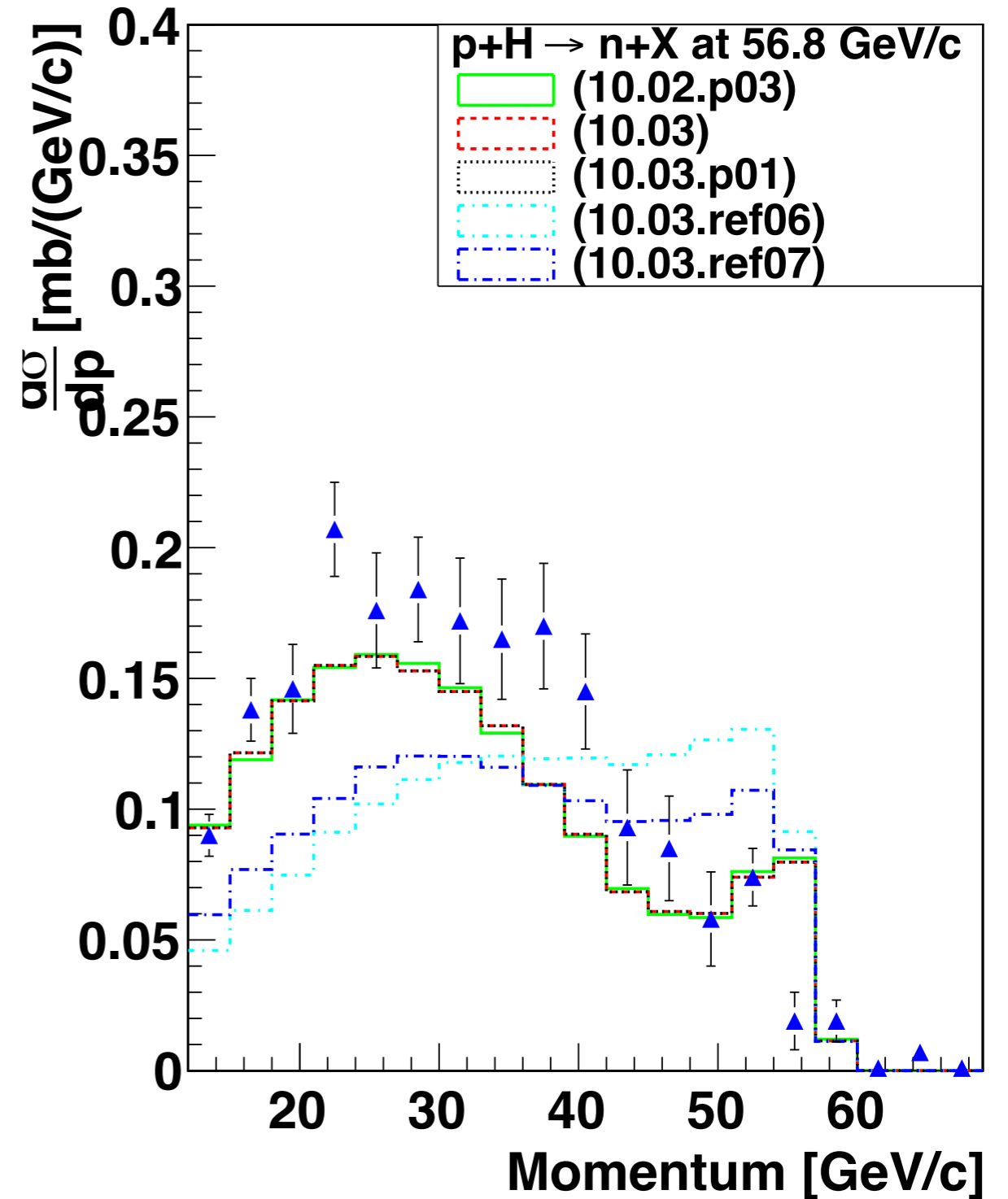
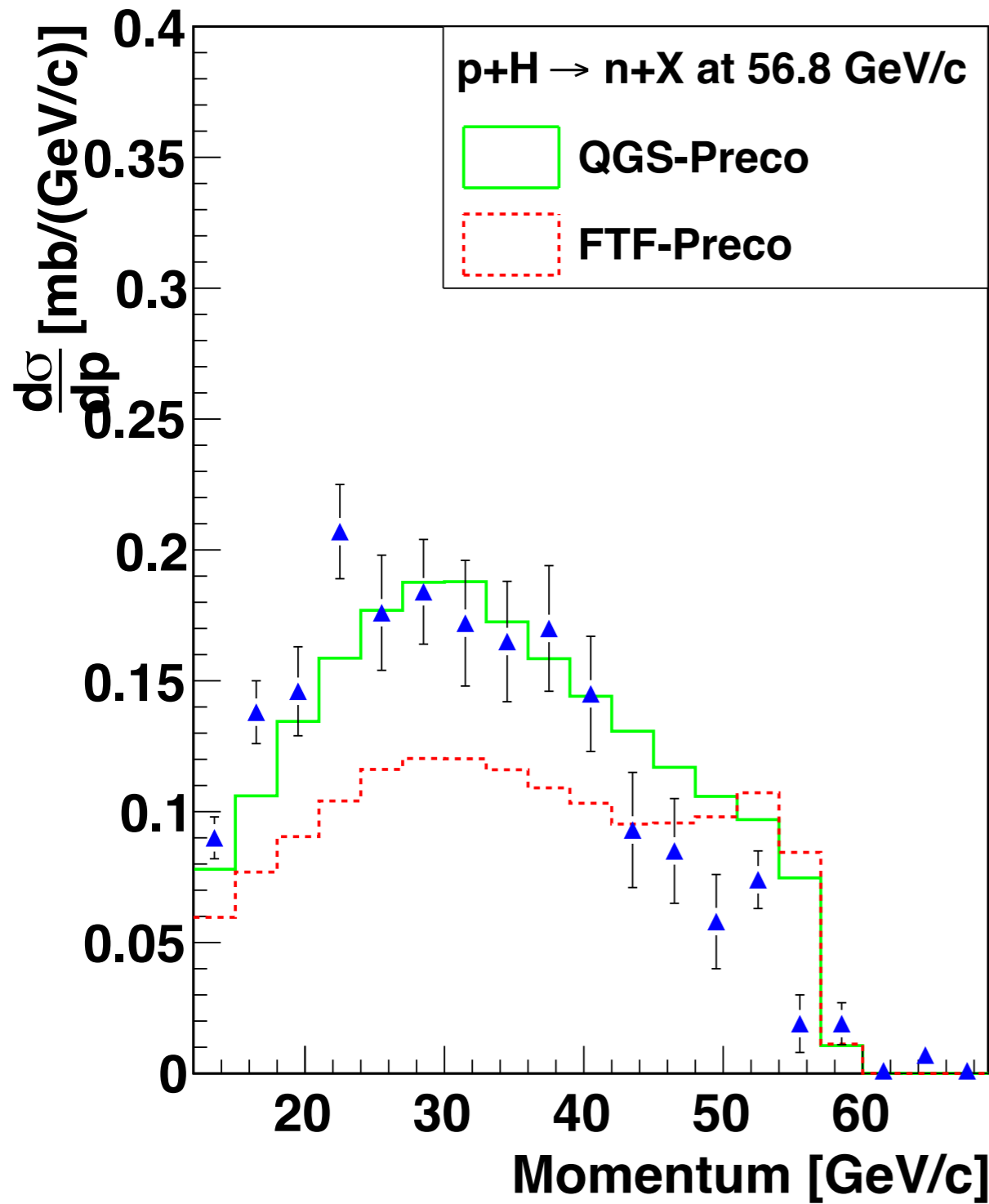
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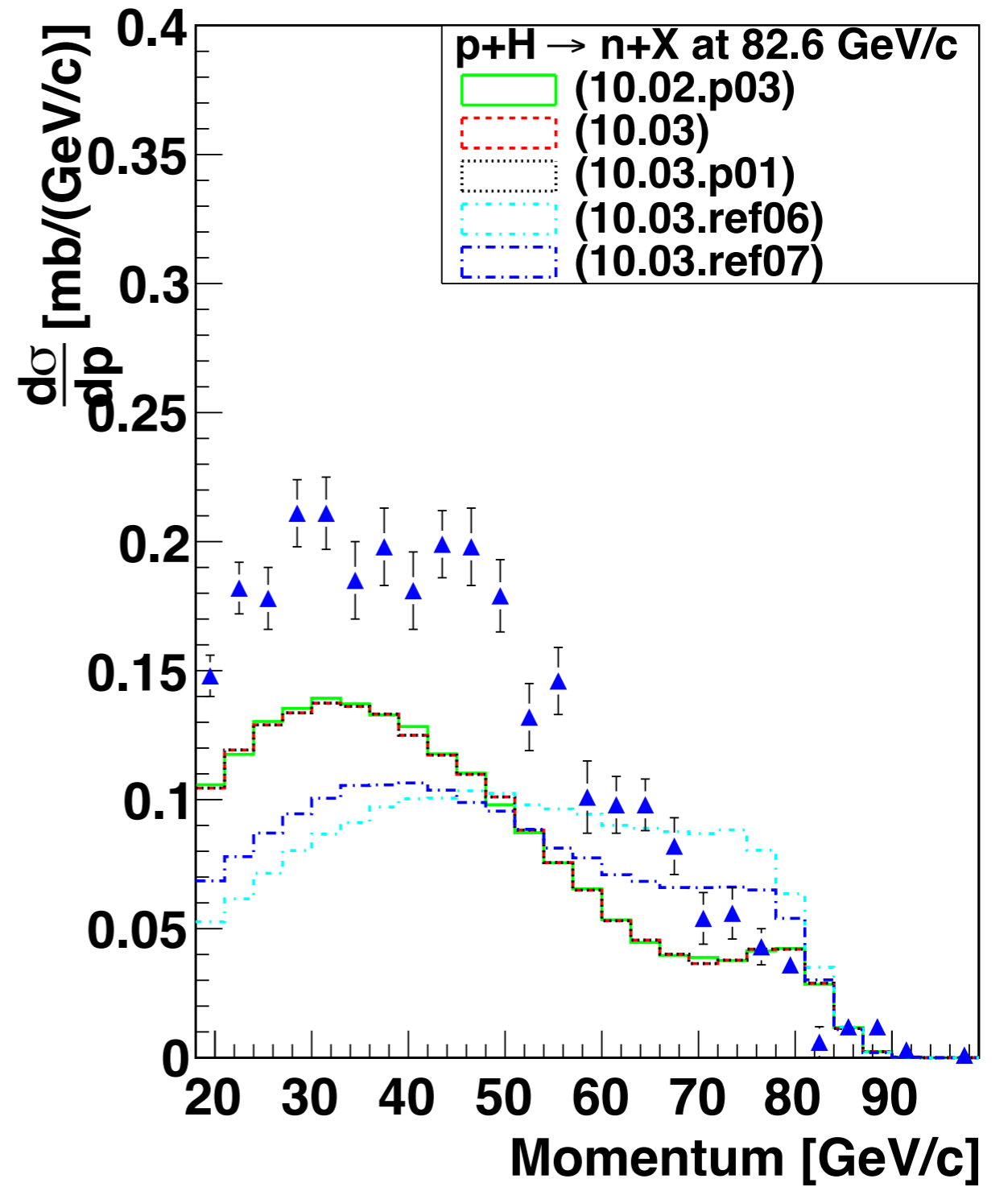
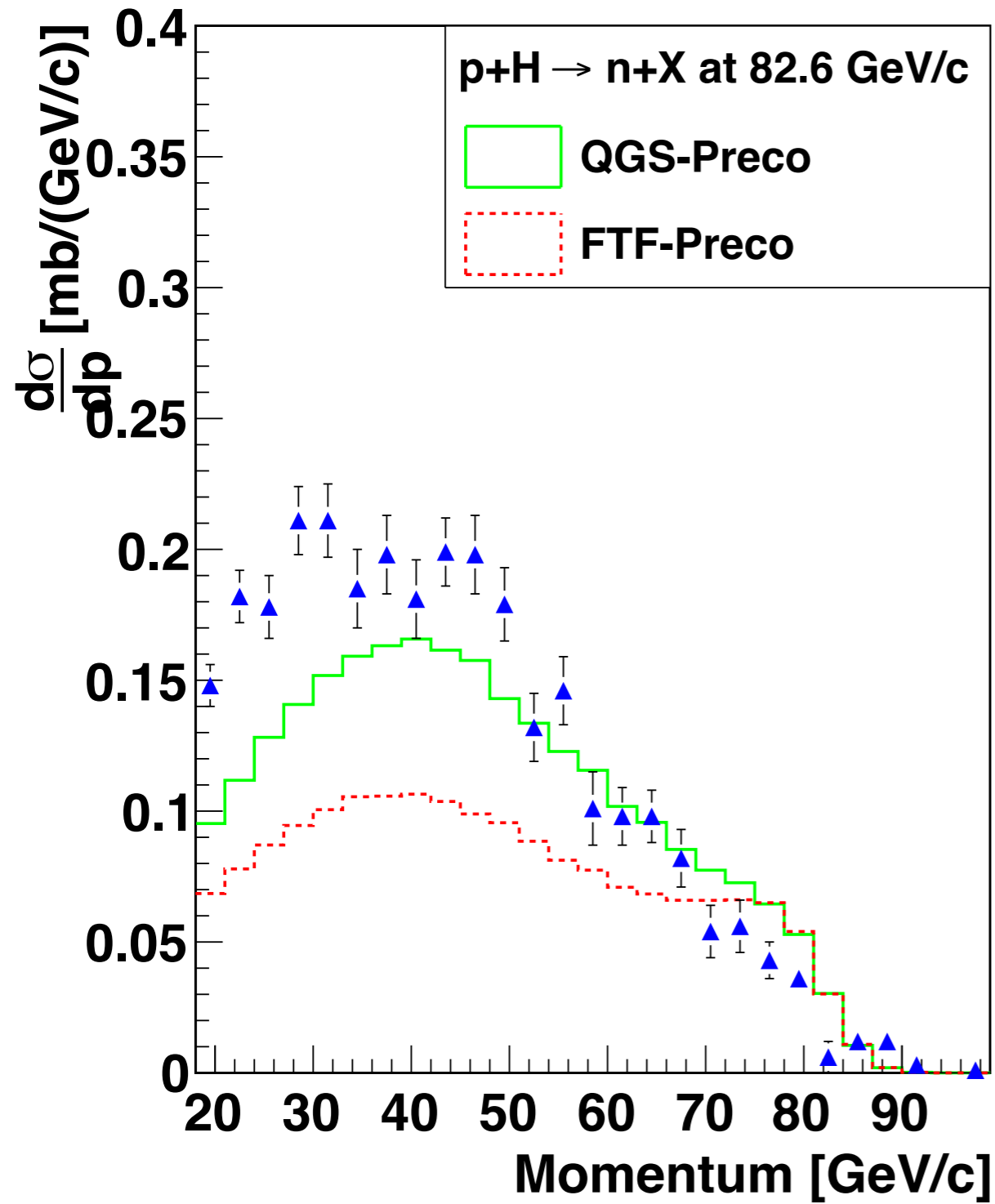
- Bertini Cascade model needs an improvement (?) - particularly in the backward hemisphere



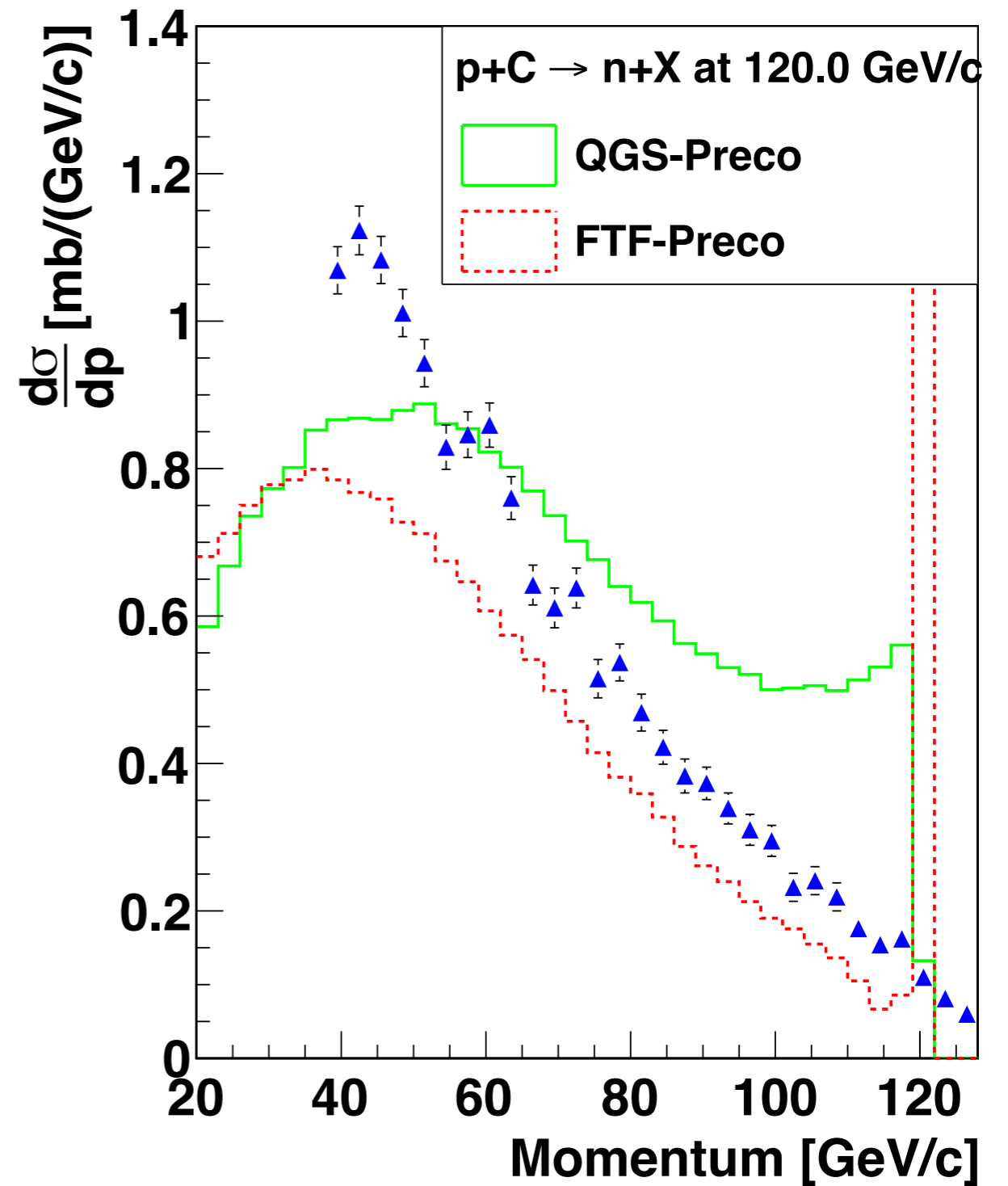
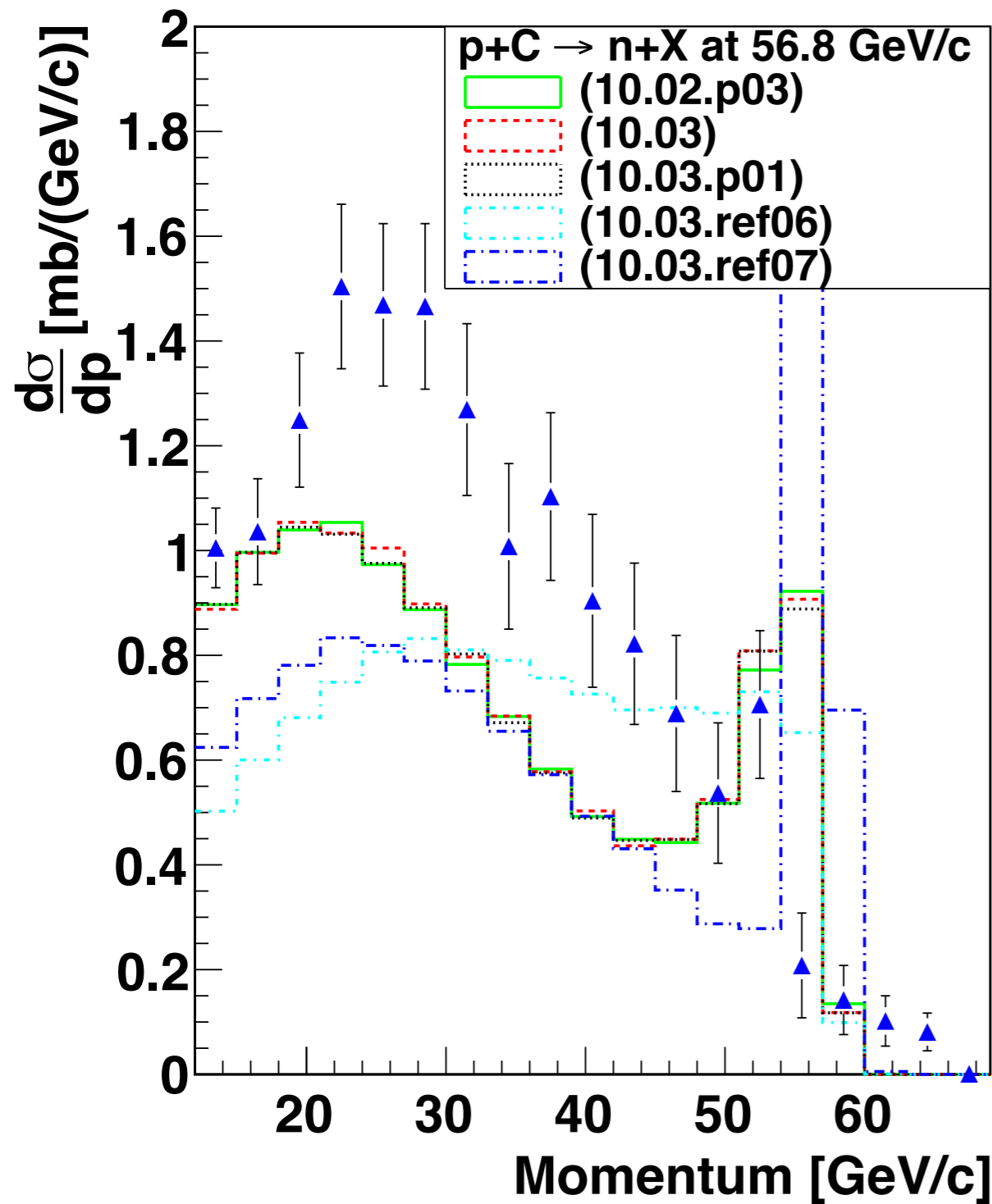
- Similar effect is observed for heavier targets



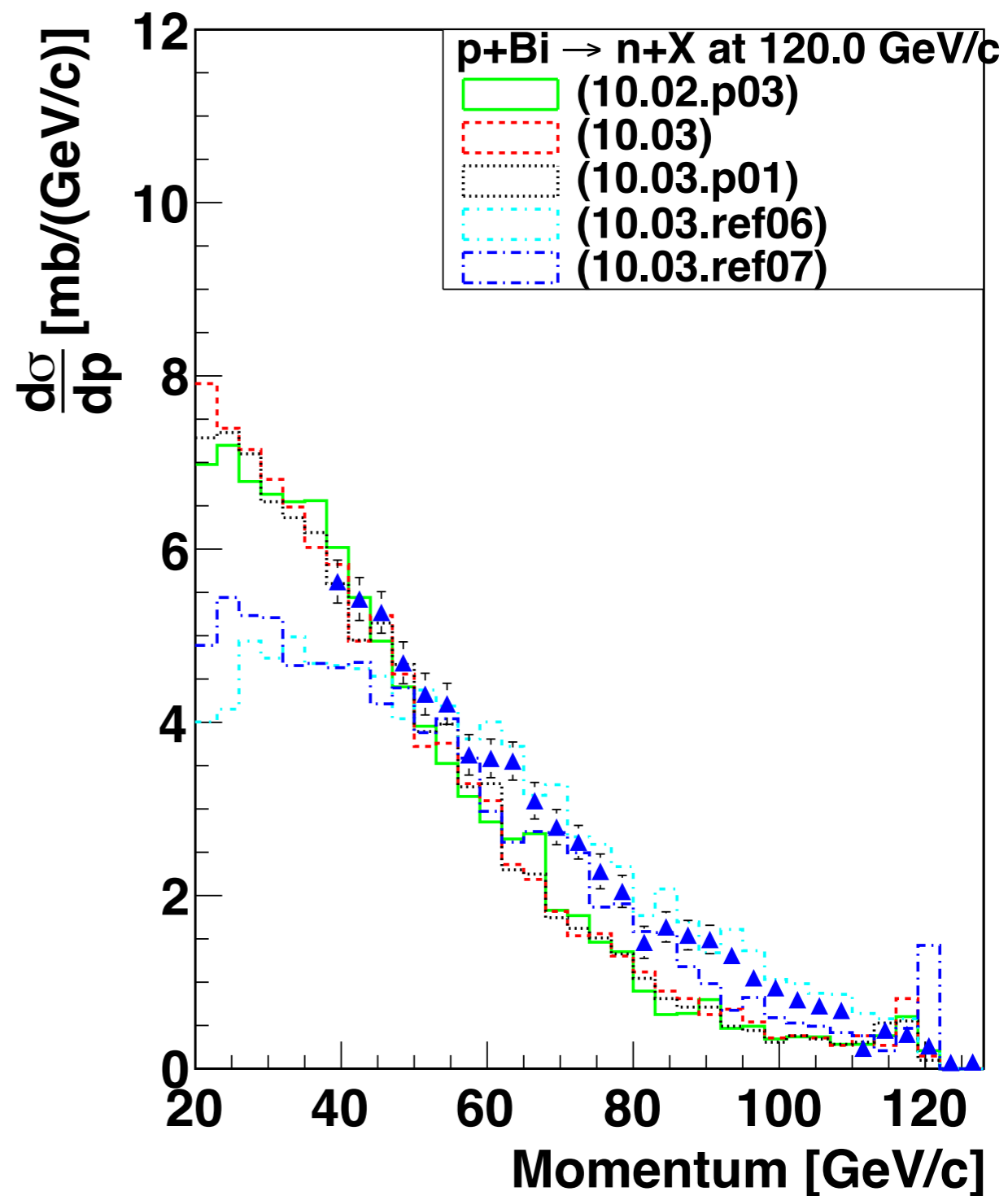
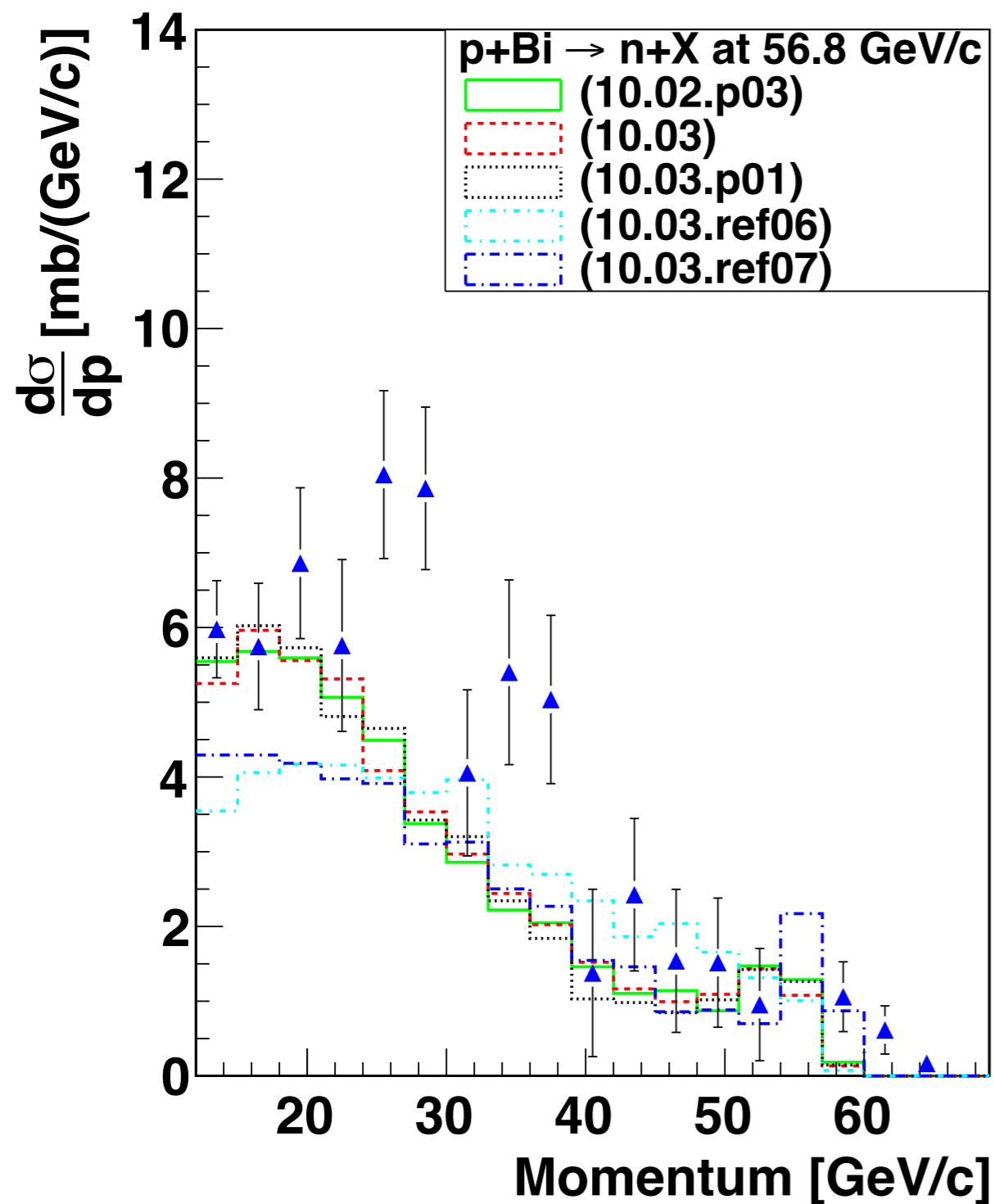
- QGSP has better agreement than FTFP.
- FTFP predictions were better in 10.2 and 10.3 versions



- QGSP is better also at this energy
- FTFP predictions were better in 10.2 and 10.3 versions



- FTFP model predictions show a spike at the highest energy which is more prominent in the most recent Geant4 version



- FTFP model provides better agreement for heavier targets.
- Prediction worsens in the most recent versions



- Validation effort has been restarted with BNL E802 and MIPP experimental data
- Predictions from FTFP model provide good agreement with the BNL data while Bertini Cascade model needs some work to provide better agreement
- FTFP model shows some short comings in predicting inclusive neutron spectrum. This is more pronounced in the most recent versions.