Validation of Geant4.10.2.p02 and 10.3.b01
Brief Summary
based on test19, 47, 48, 75, and 23

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Geant4 Hadronic Group Meeting

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General Information

- Included:
  - AtRest processes – test48
  - Gamma-N interactions – test75
  - Baryon production by Bertini, Binary, FTF at intermediate energies – test47
  - FTFP, QGSP(+G4LundStringFragm.) at 31GeV/c or 158GeV/c – test19
  - Selected tests of Bertini, FTF, INCLXX at intermediate energies – test19
  - Tests of FTFP_BERT, QGSP_BERT, NuBeam, Shielding, ShieldingM physics lists on light and heavy (simplistic) targets – test23
- Releases:
  - Geant4.10.2.p02 and 10.3.b01; ref. 9.6.p04 and/or 10.1.p03 (if available)
- Mainly a verbal report
- Selected plots included for illustrative purpose

Validation Results Overview (I)

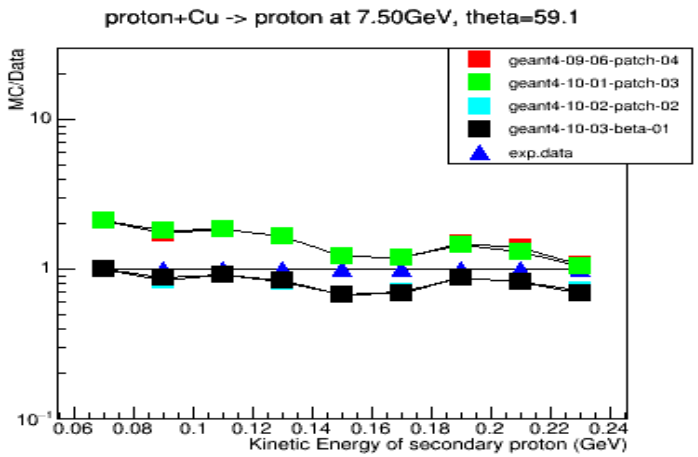
- No crashes or other unpleasant surprises in 10.2.p02 or 10.3.b01
- Rad.decay bug is fixed (problem from 10.2)
- No crashes in PreCo (problem from 10.2.p01)
- Bertini is the same between 10.1.p03 and 10.2.p02 (earlier differences from 9.6-series already discussed in previous meetings)
- No changes in INCLXX
- Minor variations in Binary, nothing statistically significant

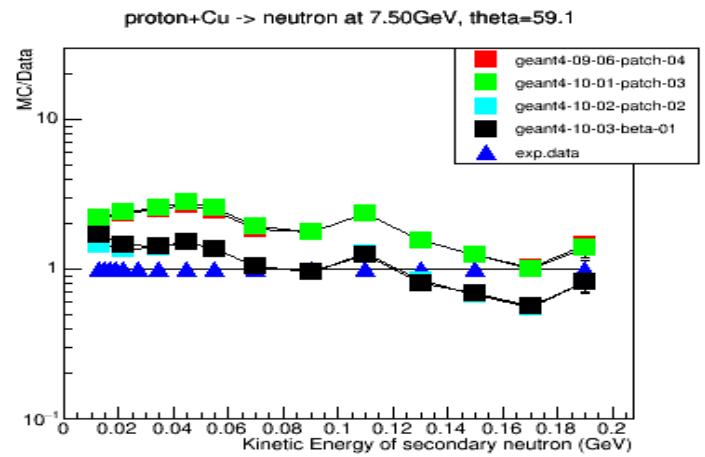
Validation Results Overview (II)

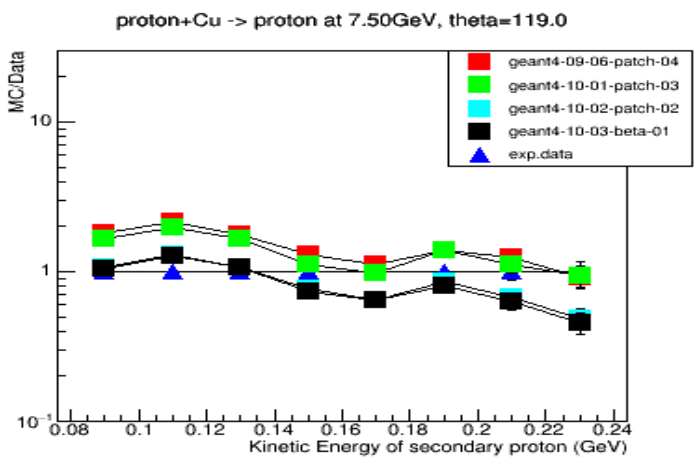
- Various changes in FTF from 9.6.p04 to 10.1.p03/10.2.p02/10.3.b01 (some already discussed in previous meetings)
- High energy end is definitely affected - FTT is best in 10.2.p02 for modeling high energy interactions
- Various changes by FTF in intermediate energy range - some good, some bad; statistically speaking, changes in the intermediate energy range are from neutral to somewhat negative
- Ongoing work on FTF in 10.2/10.3 to improve neutron production in the intermediate energy range
  - p+A -> n improved
  - pion+A -> p/n somewhat degraded
  - pion production is also affected, including for heavy targets
- p+A -> pbar - the trend is towards degradation

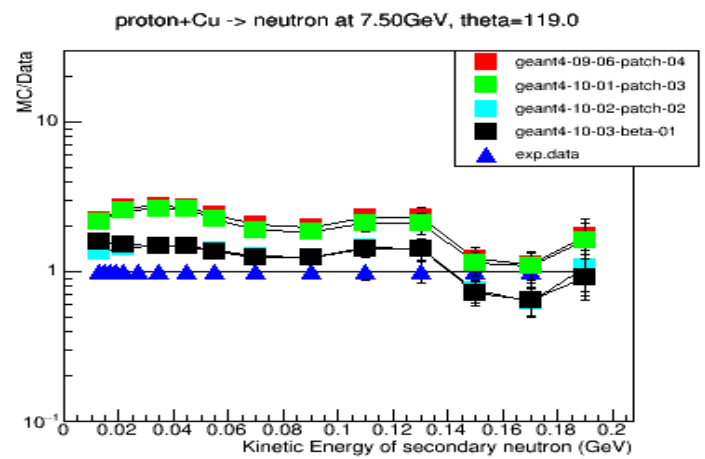
7.5GeV/c p + Cu -> p/n + X

(results produced per request from Mu2e)





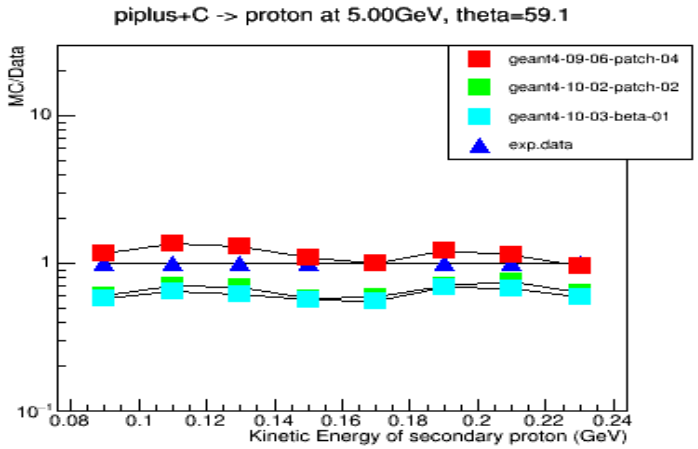




ftfp vs (ITEP) Data
χ^2/NDF = 57.1044 for geant4-09-06-patch-04
χ^2/NDF = 66.1755 for geant4-10-01-patch-03
χ^2/NDF = 10.373 for geant4-10-02-patch-02
χ^2/NDF = 10.4044 for geant4-10-03-beta-01

ftfp vs (ITEP) Data
χ^2/NDF = 167.466 for geant4-09-06-patch-04
χ^2/NDF = 168.766 for geant4-10-01-patch-03
χ^2/NDF = 14.4547 for geant4-10-02-patch-02
χ^2/NDF = 17.8176 for geant4-10-03-beta-01

5GeV/c π^+ + C -> p/n + X



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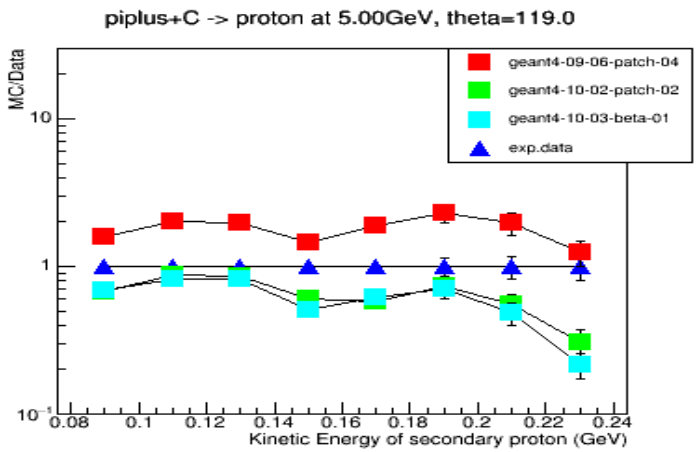
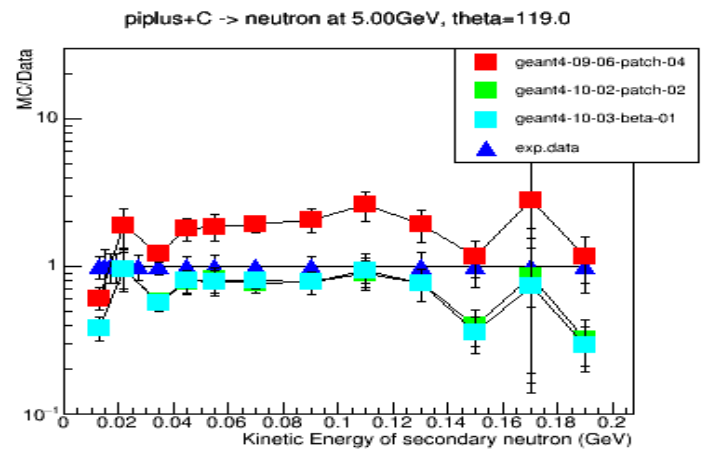
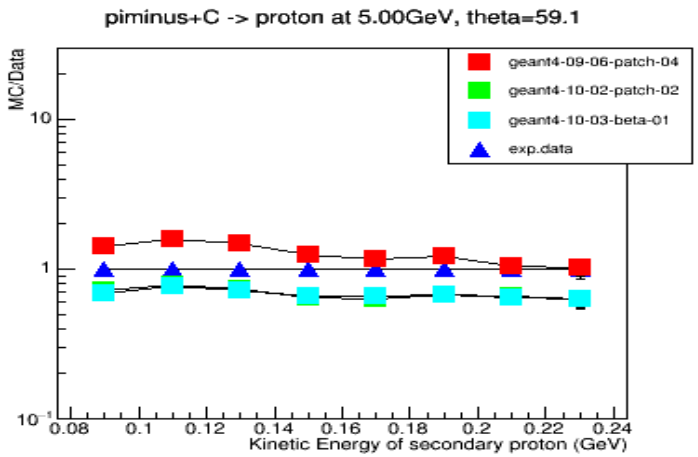


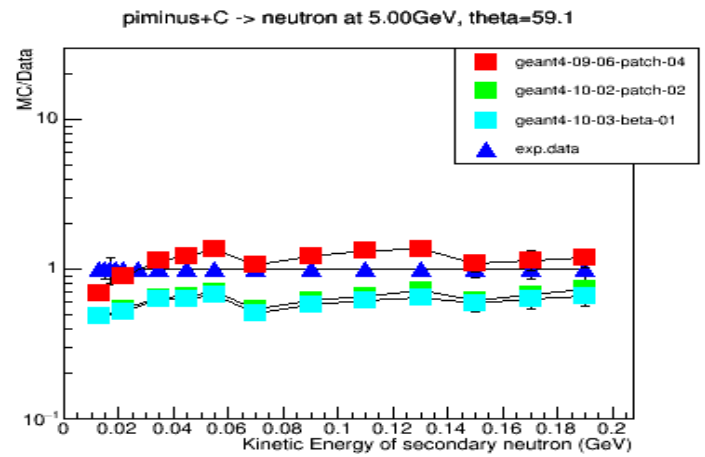
ftfp vs (ITEP) Data
χ^2/NDF = 6.29596 for geant4-09-06-patch-04
χ^2/NDF = 11.9718 for geant4-10-02-patch-02
χ^2/NDF = 14.8644 for geant4-10-03-beta-01

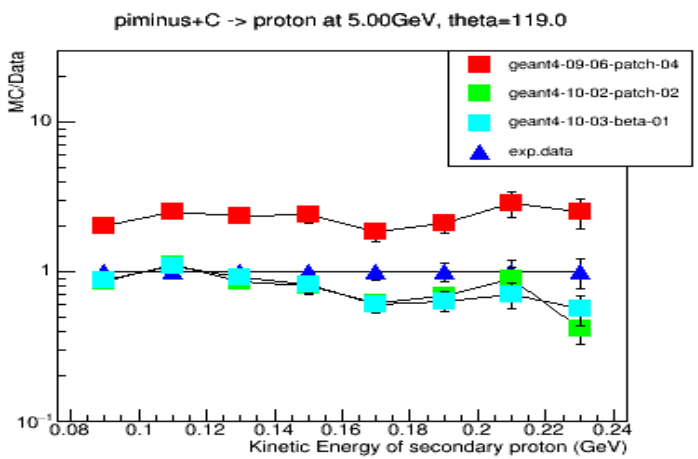


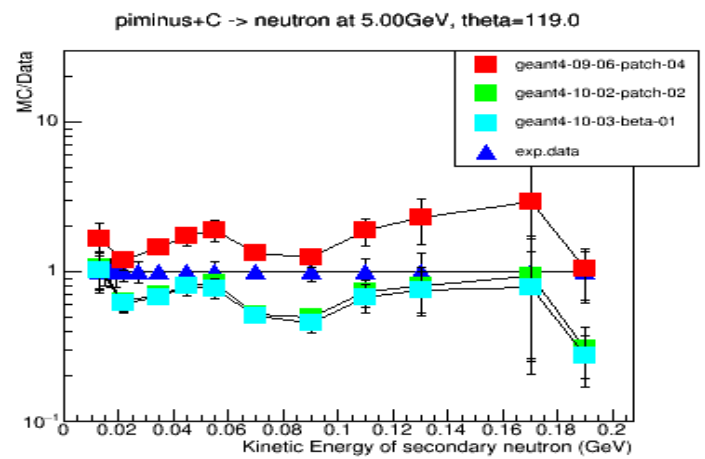
ftfp vs (ITEP) Data
χ^2/NDF = 11.3525 for geant4-09-06-patch-04
χ^2/NDF = 3.37888 for geant4-10-02-patch-02
χ^2/NDF = 3.38423 for geant4-10-03-beta-01

5GeV/c π^- + C -> p/n + X





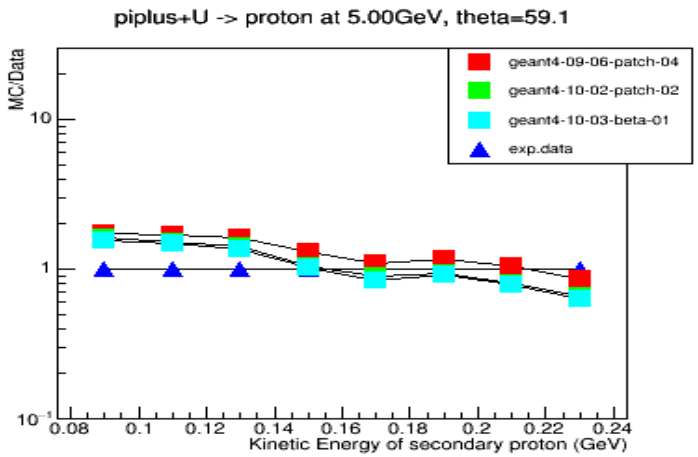




ftfp vs (ITEP) Data
χ^2/NDF = 11.4977 for geant4-09-06-patch-04
χ^2/NDF = 7.98631 for geant4-10-02-patch-02
χ^2/NDF = 8.08463 for geant4-10-03-beta-01

ftfp vs (ITEP) Data
χ^2/NDF = 6.42452 for geant4-09-06-patch-04
χ^2/NDF = 9.36376 for geant4-10-02-patch-02
χ^2/NDF = 10.8138 for geant4-10-03-beta-01

5GeV/c π^+ + U -> p/n + X



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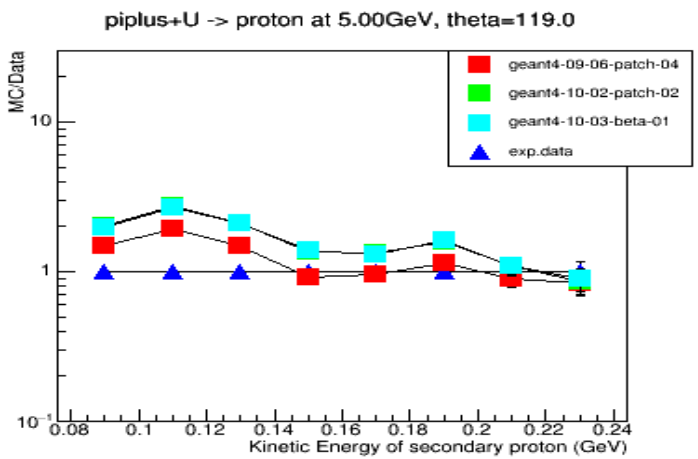
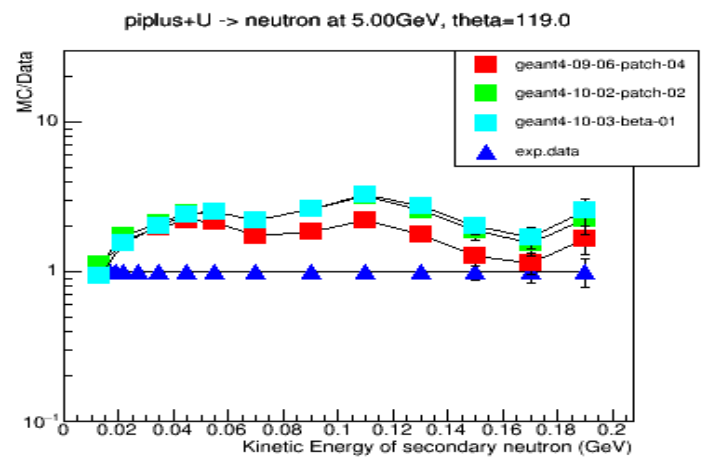
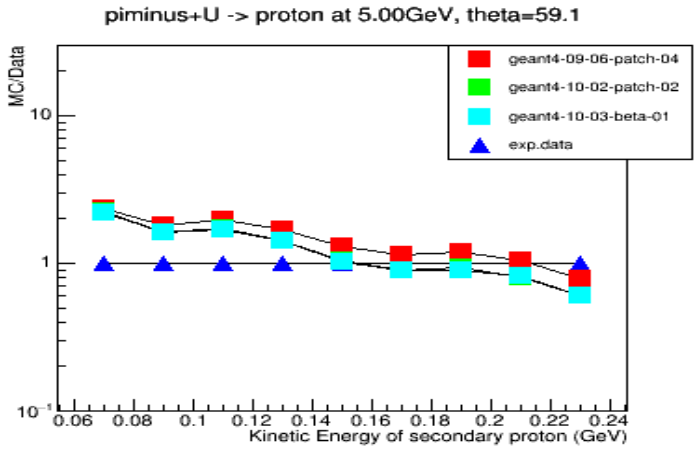


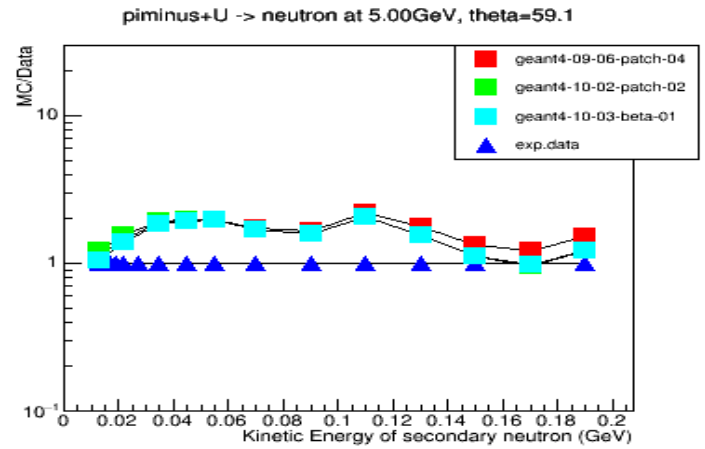
ftfp vs (ITEP) Data
χ^2/NDF = 31.8619 for geant4-09-06-patch-04
χ^2/NDF = 75.0576 for geant4-10-02-patch-02
χ^2/NDF = 72.0234 for geant4-10-03-beta-01

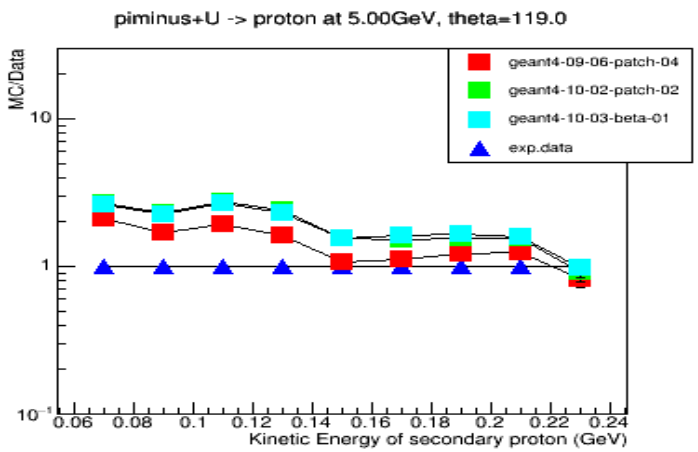


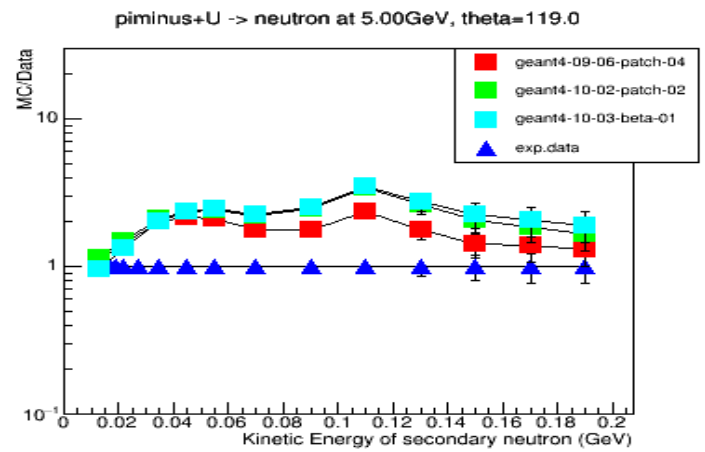
ftfp vs (ITEP) Data
χ^2/NDF = 128.747 for geant4-09-06-patch-04
χ^2/NDF = 269.987 for geant4-10-02-patch-02
χ^2/NDF = 271.675 for geant4-10-03-beta-01

5GeV/c π^- + U -> p/n + X







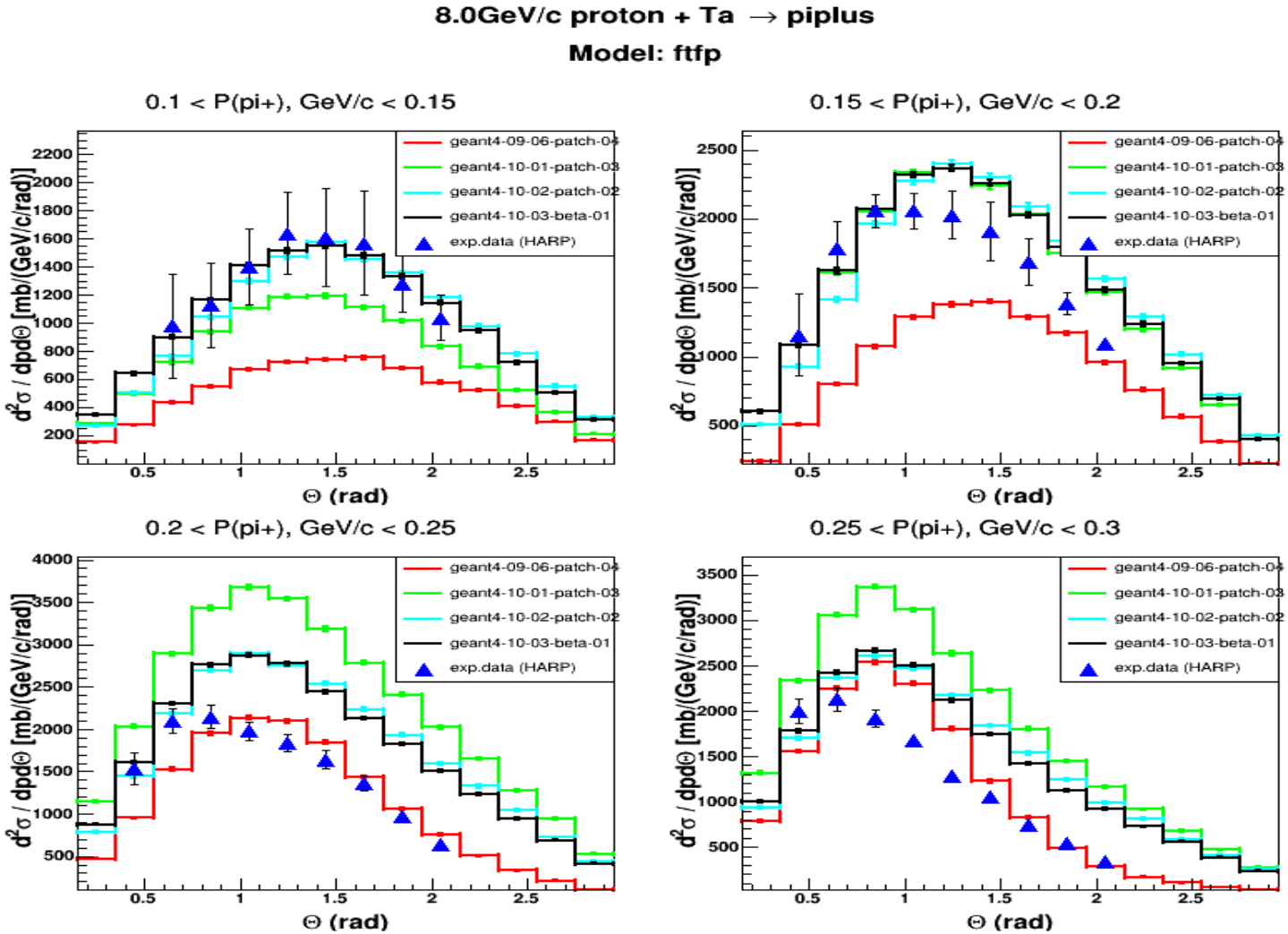


ftfp vs (ITEP) Data
χ^2/NDF = 69.0527 for geant4-09-06-patch-04
χ^2/NDF = 128.6 for geant4-10-02-patch-02
χ^2/NDF = 119.815 for geant4-10-03-beta-01

ftfp vs (ITEP) Data
χ^2/NDF = 110.843 for geant4-09-06-patch-04
χ^2/NDF = 154.304 for geant4-10-02-patch-02
χ^2/NDF = 150.151 for geant4-10-03-beta-01

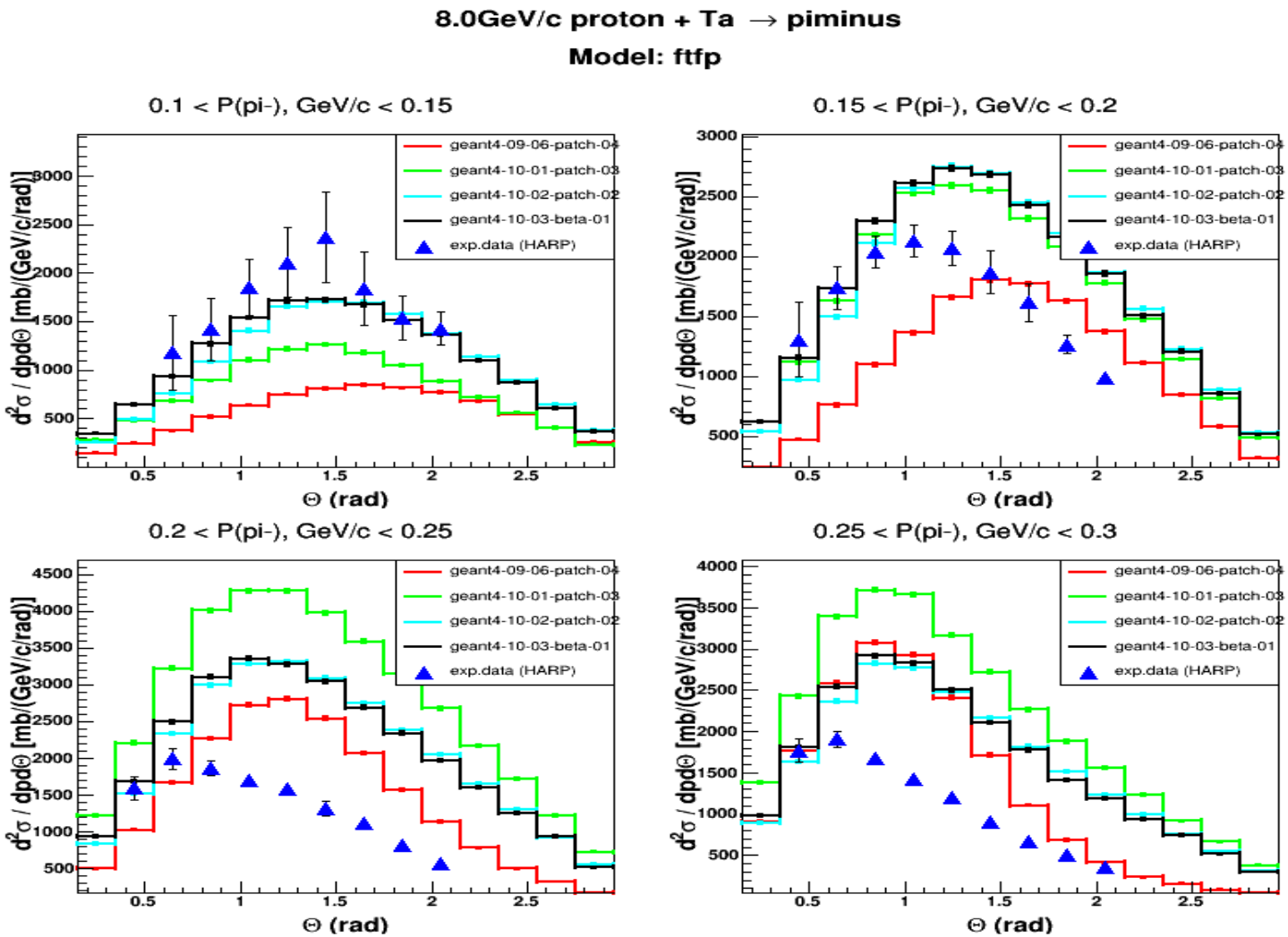
8GeV/c p + Ta -> π^+ + X

(results produced per request of Mu2e – data from HARP; additional example plots in backup)

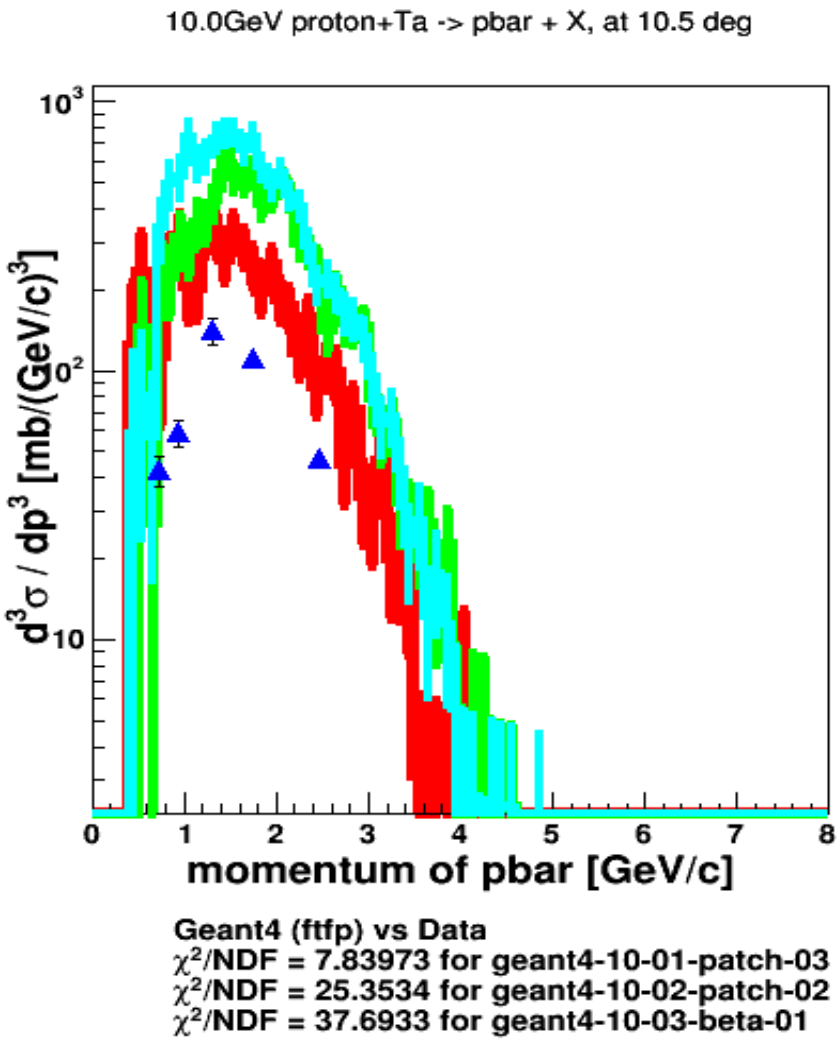


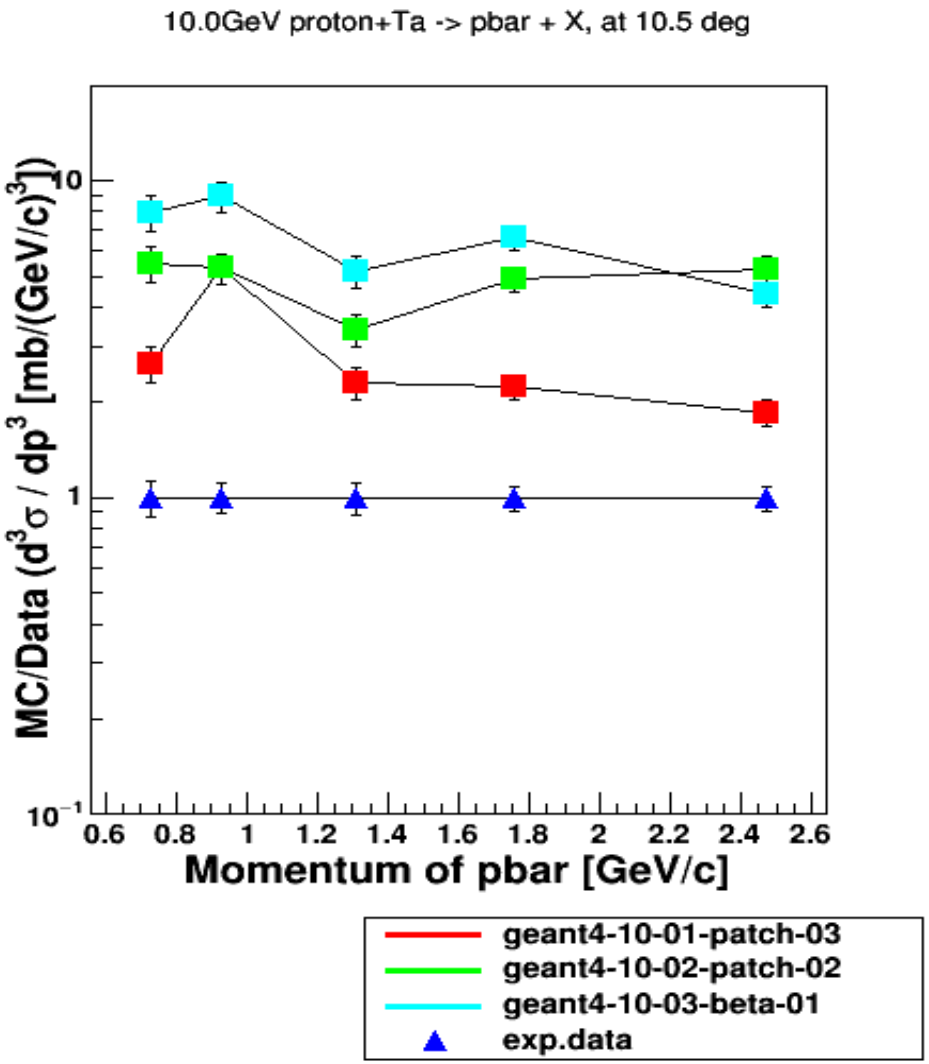
8GeV/c p + Ta -> π^- + X

(results produced per request of Mu2e - data from HARP; additional example plots in backup)



10GeV/c p + Ta -> pbar + X (at 10.5deg)

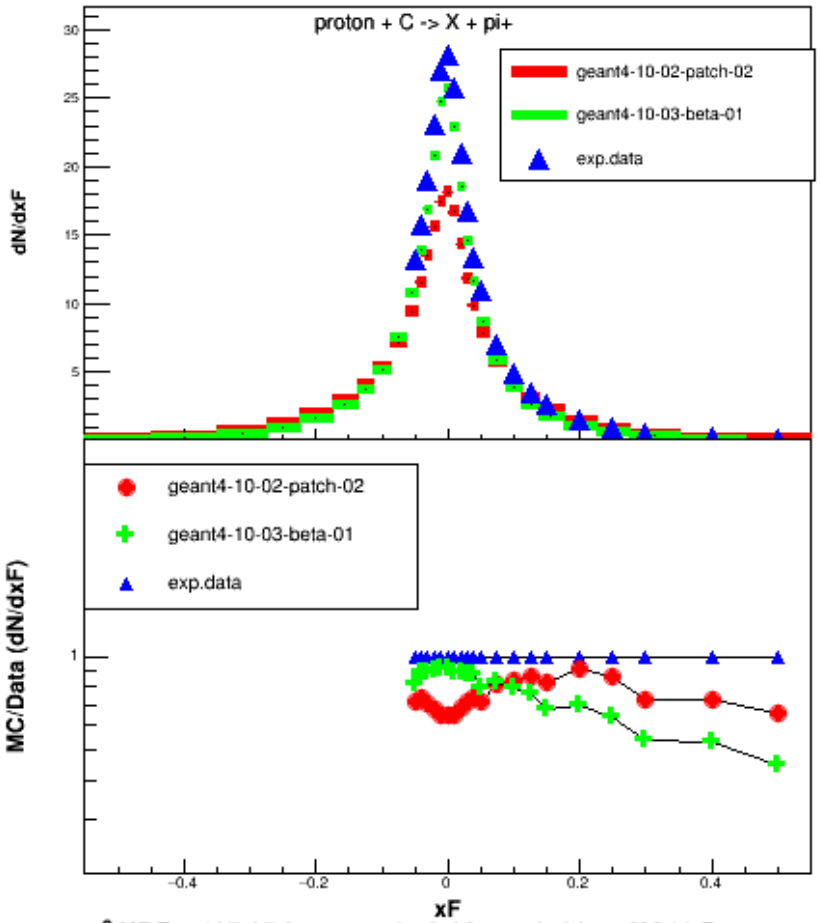




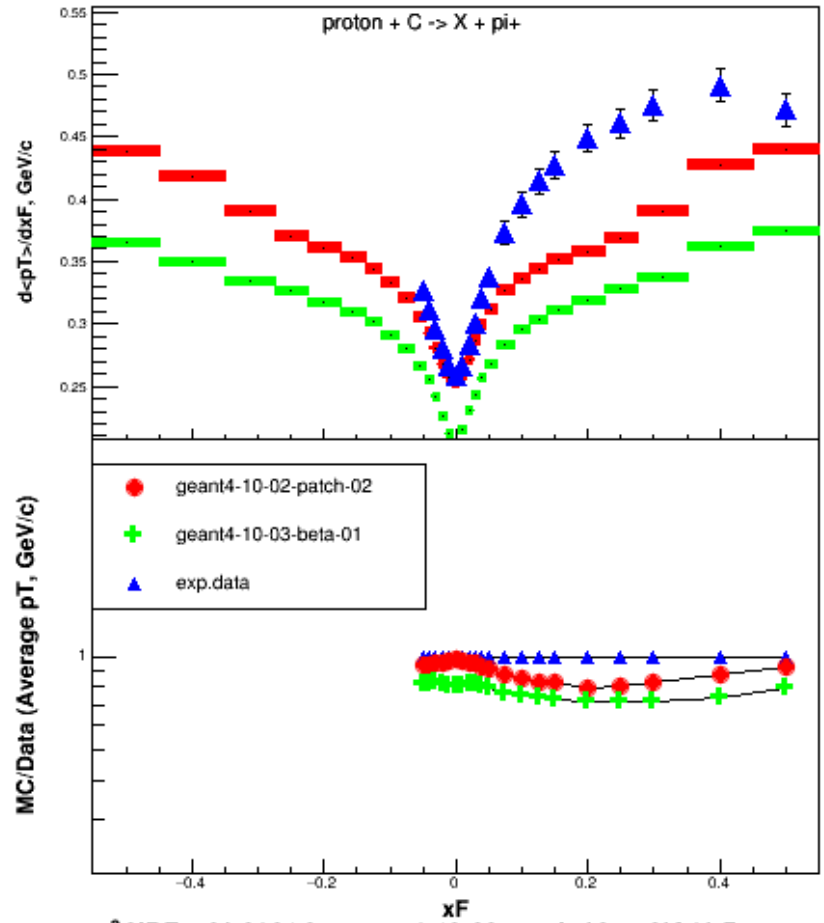
Validation Results Overview (III)

- Changes in QGS as it is undergoing major revision and re-tuning through the 4.10-series
- Too soon to say anything definite
- However, results from 10.3.b01 do show certain differences from 10.2.p02 and from earlier releases; these differences are not always good
  - NOTE: it appears that QGS in 10.3.b01 is the same code as in 10.2.b01; i.e. NO tuning yet
- Mostly, the changes were discussed already when development of QGS was re-instated n the 10.3-develpmen t cycle (10.2.refXX)
- Selected plots are included for illustrative purposes

158GeV/c p + C -> π^+ + X

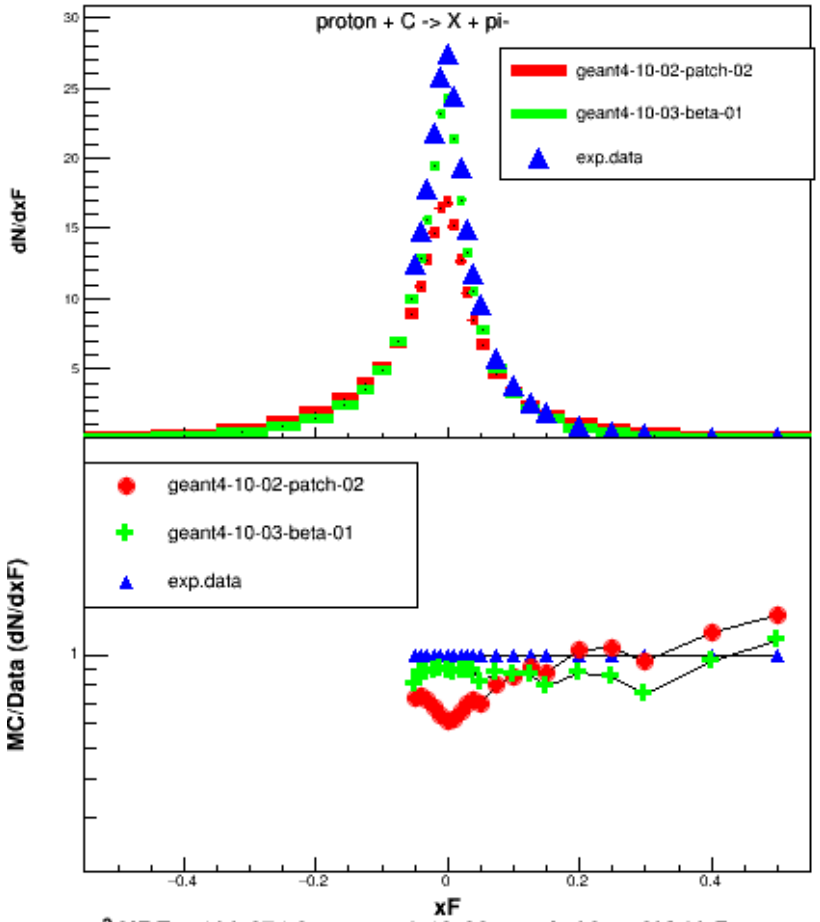


χ^2/NDF = 107.85 for geant4-10-02-patch-02 vs NA49 Data
χ^2/NDF = 94.1967 for geant4-10-03-beta-01 vs NA49 Data

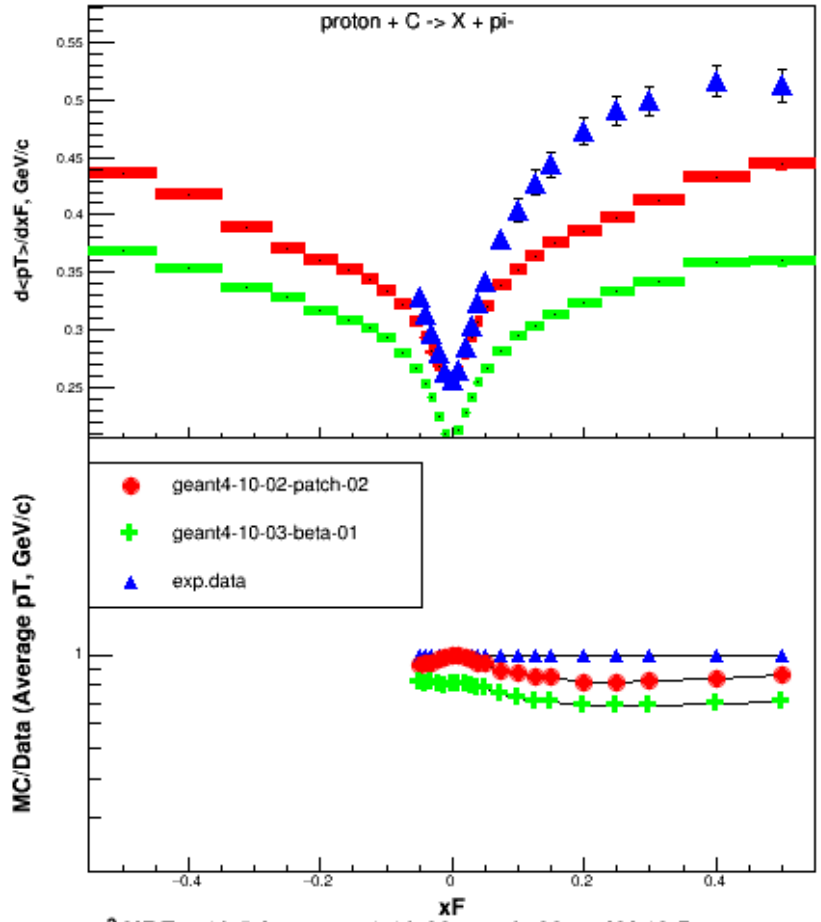


χ^2/NDF = 20.3901 for geant4-10-02-patch-02 vs NA49 Data
χ^2/NDF = 79.8267 for geant4-10-03-beta-01 vs NA49 Data

158GeV/c p + C -> π^- + X



χ^2/NDF = 100.671 for geant4-10-02-patch-02 vs NA49 Data
χ^2/NDF = 29.2947 for geant4-10-03-beta-01 vs NA49 Data



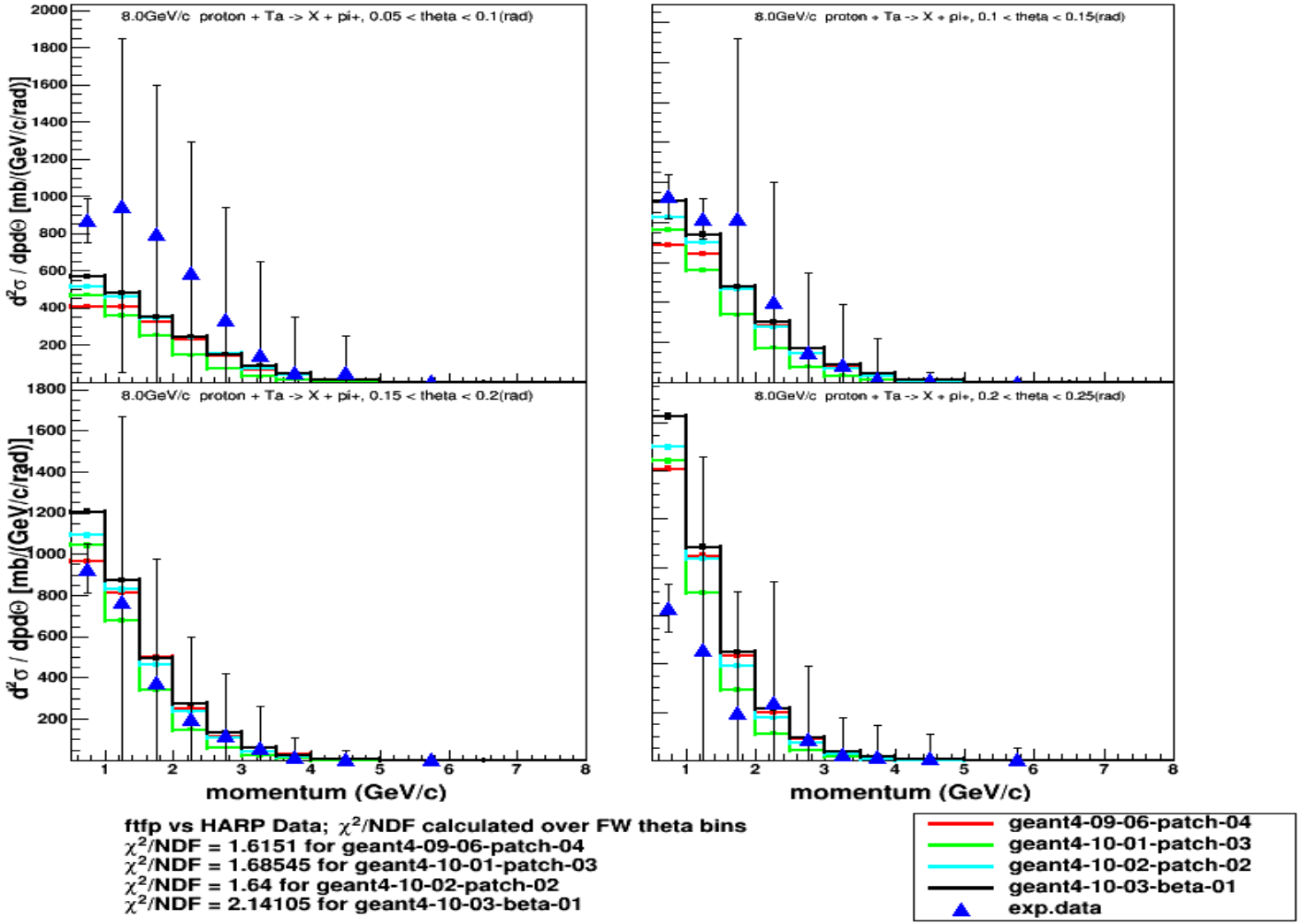
χ^2/NDF = 18.5 for geant4-10-02-patch-02 vs NA49 Data
χ^2/NDF = 94.2687 for geant4-10-03-beta-01 vs NA49 Data

Summary

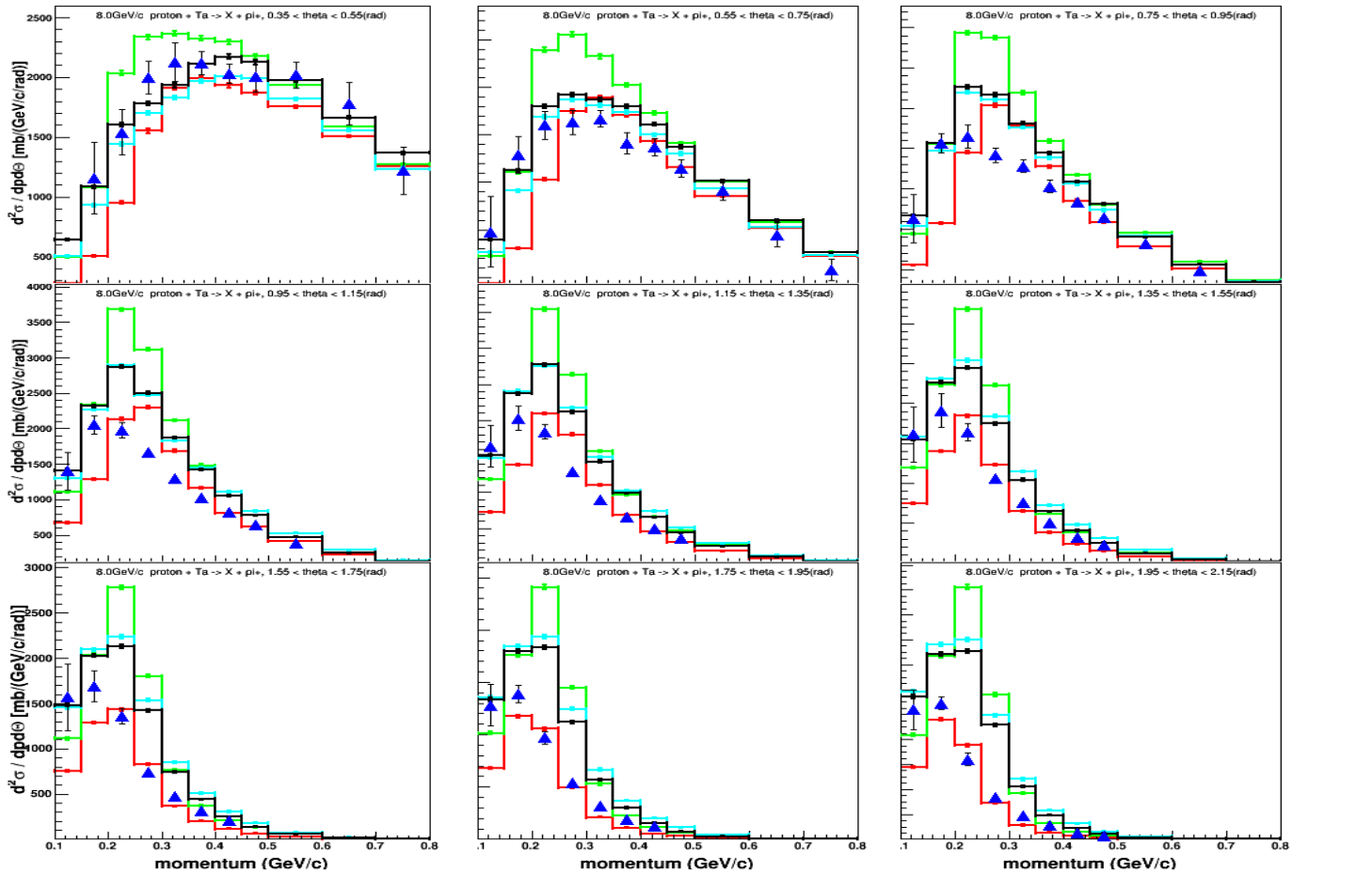
- Release 10.2.p02 is all good
  - Earlier concerns appear to be fixed
- However, users should be given explicit information about various changes, in particular in FTF since it is one of the key models
- Release 10.3.b01 is overall good
- Again, further changes in FTF should be monitored/documented
- As of now, status of QGS re-tuning remain an open question
  - NOTE: it is not a simple matter since many simulation tasks use QGS-based physics list(s)
- Full collection of results is available via Validation Repository

BACKUP SLIDES (PLOTS)

8GeV/c p + Ta -> π^+ + X (FW)

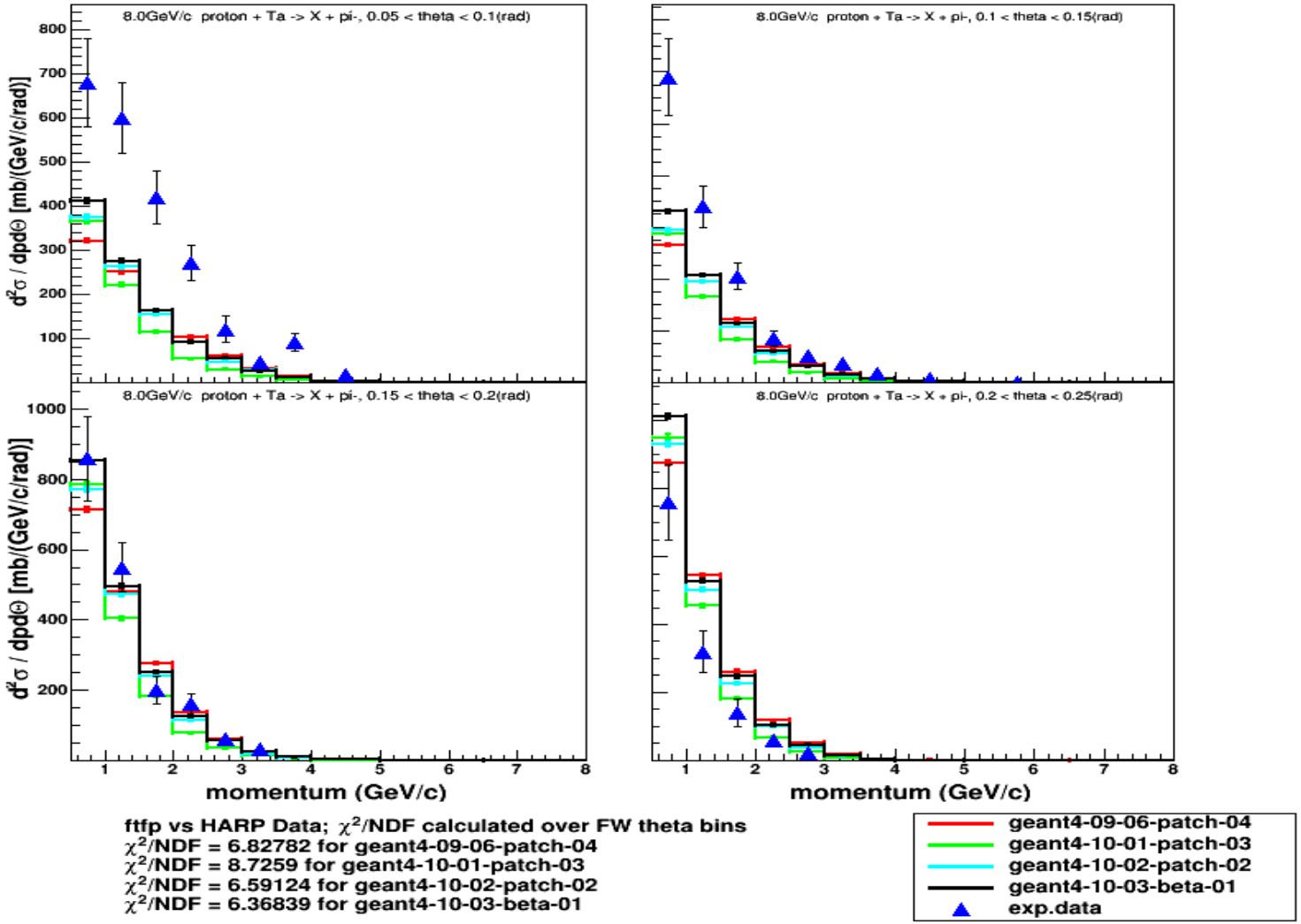


8GeV/c p + Ta -> π^+ + X (LA)

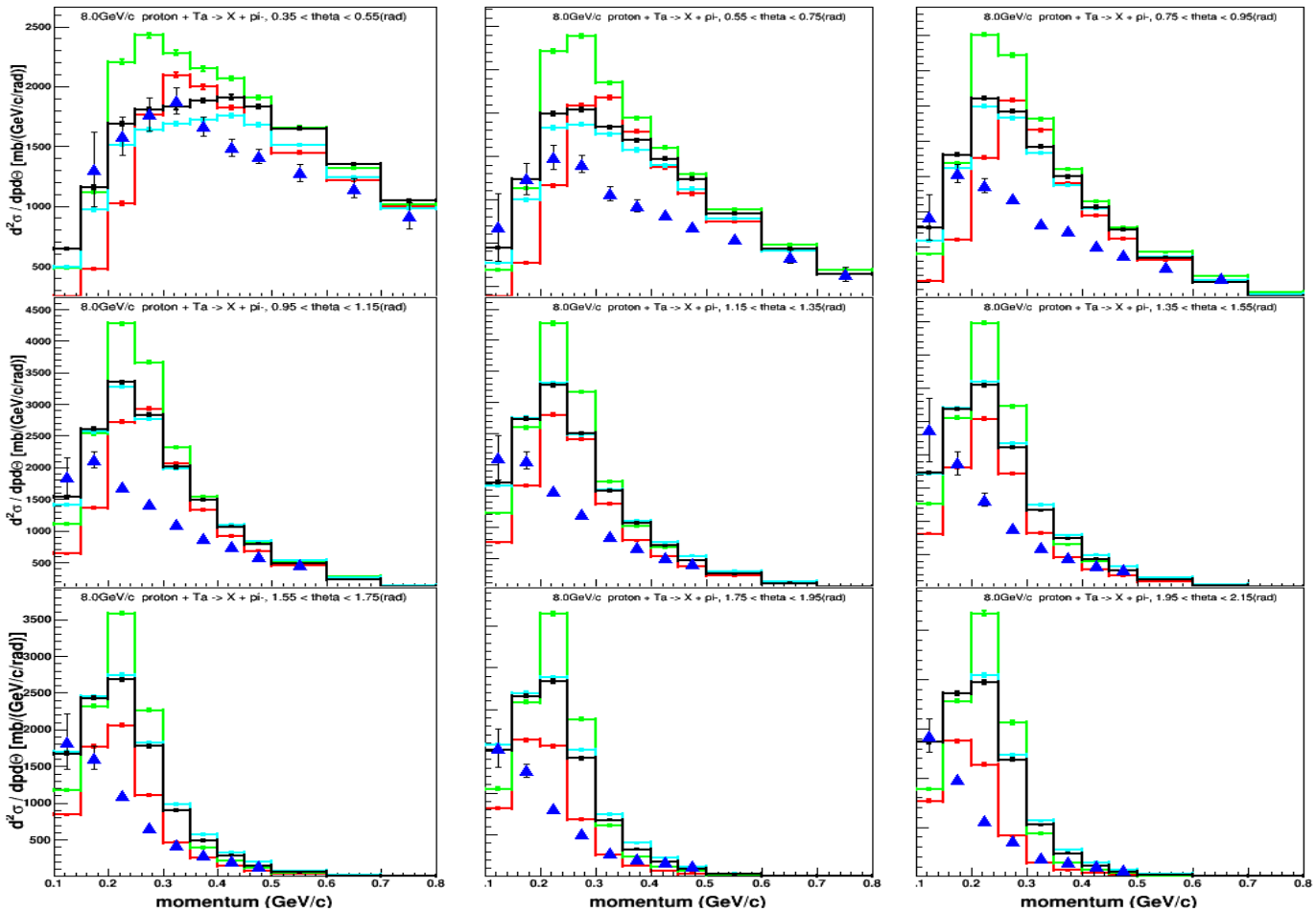


ftfp vs HARP Data; χ^2/NDF calculated over LA theta bins
χ^2/NDF = 9.69913 for geant4-09-06-patch-04
χ^2/NDF = 71.2463 for geant4-10-01-patch-03
χ^2/NDF = 43.249 for geant4-10-02-patch-02
χ^2/NDF = 32.0708 for geant4-10-03-beta-01

8GeV/c p + Ta -> π^- + X (FW)



8GeV/c p + Ta -> π^- + X (LA)



ftfp vs HARP Data; χ^2/NDF calculated over LA theta bins
χ^2/NDF = 59.7018 for geant4-09-06-patch-04
χ^2/NDF = 239.914 for geant4-10-01-patch-03
χ^2/NDF = 137.181 for geant4-10-02-patch-02
χ^2/NDF = 127.596 for geant4-10-03-beta-01

- geant4-09-06-patch-04
- geant4-10-01-patch-03
- geant4-10-02-patch-02
- geant4-10-03-beta-01
- exp.data