Hadronic Validation – Geant4.10.0.b01 & Geant4.9.6.ref07

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General Remarks

- Included tests: test48 (capture), test47 (intermediate E), test19 (high E), test75 (gamma-N)

- Included releases: 4.9.6.ref07, 4.10.0.b01, 4.9.6.ref03, 4.9.6.p01 (reference, no significant HAD changes in p02)

- Detailed results reported only if significant changes observed

- All plots will be uploaded to G4 Validation Repository

Test48 (partial)

- Only pi- capture tested (pbar, K, Sigma will be done later)
- Substantial difference between 4.9.6.p01/4.9.6.ref03 and 4.10.0.b01/4.9.6.ref02 (apparently started ~4.9.6.ref05 ?)
- Some "funny bumps", especially for lighter targets
- See following plots
- Exp.data used for comparison:

  R.Madey et al., Phys.Rev.C25, 2050 (1982)
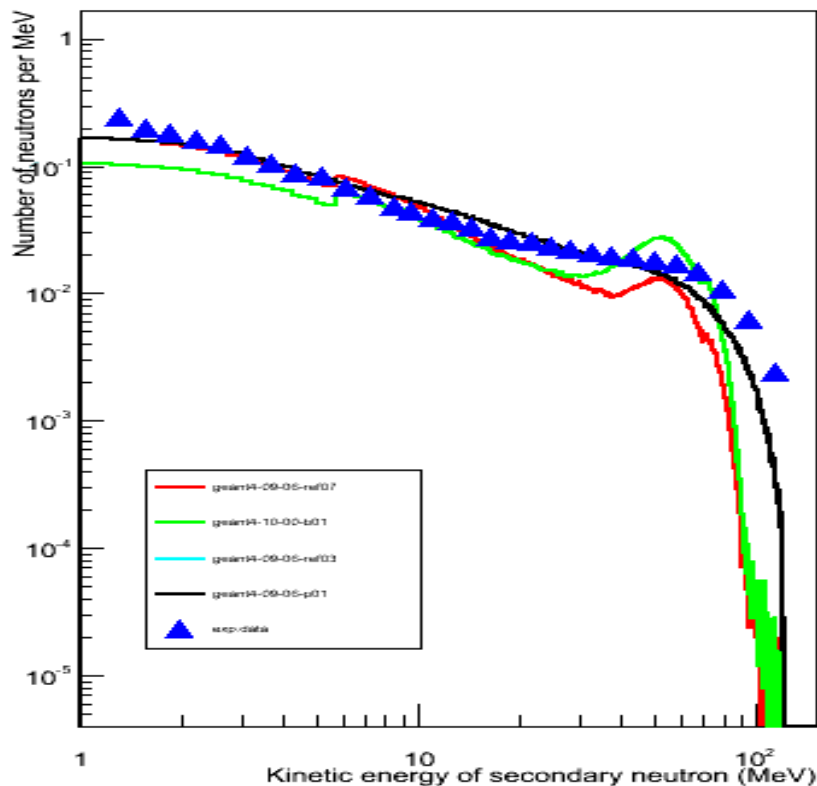
Test48: pi- capture on C -> n + X
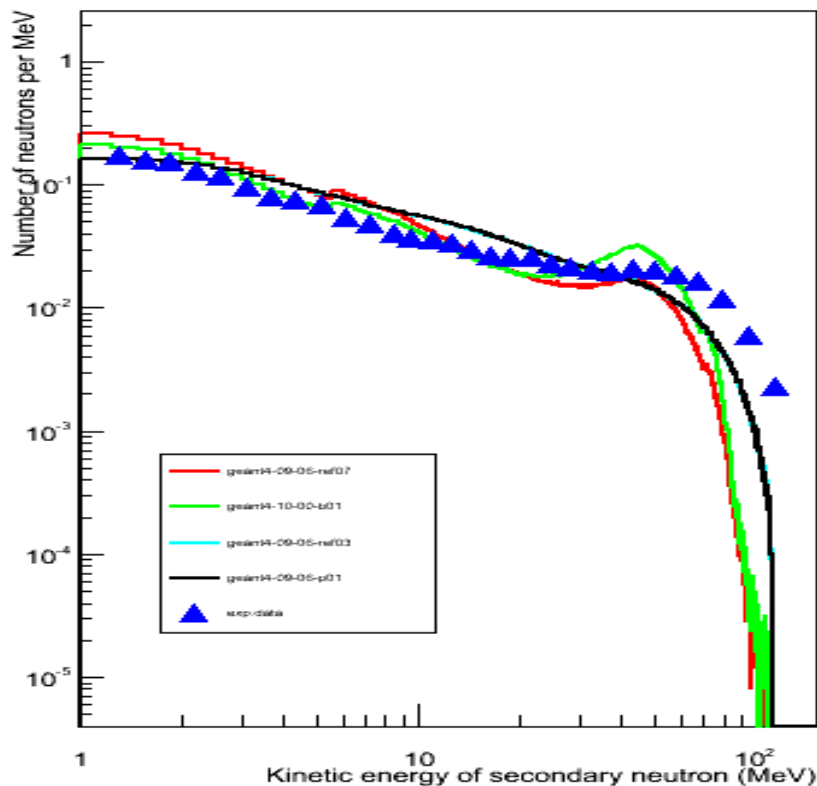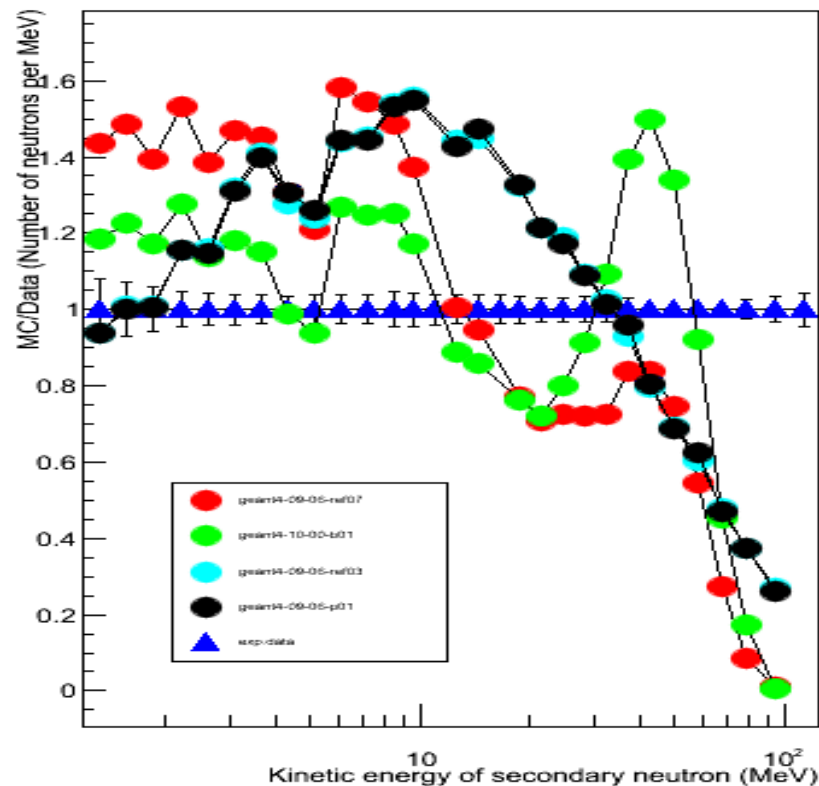
Test48: pi- capture on N -> n + X
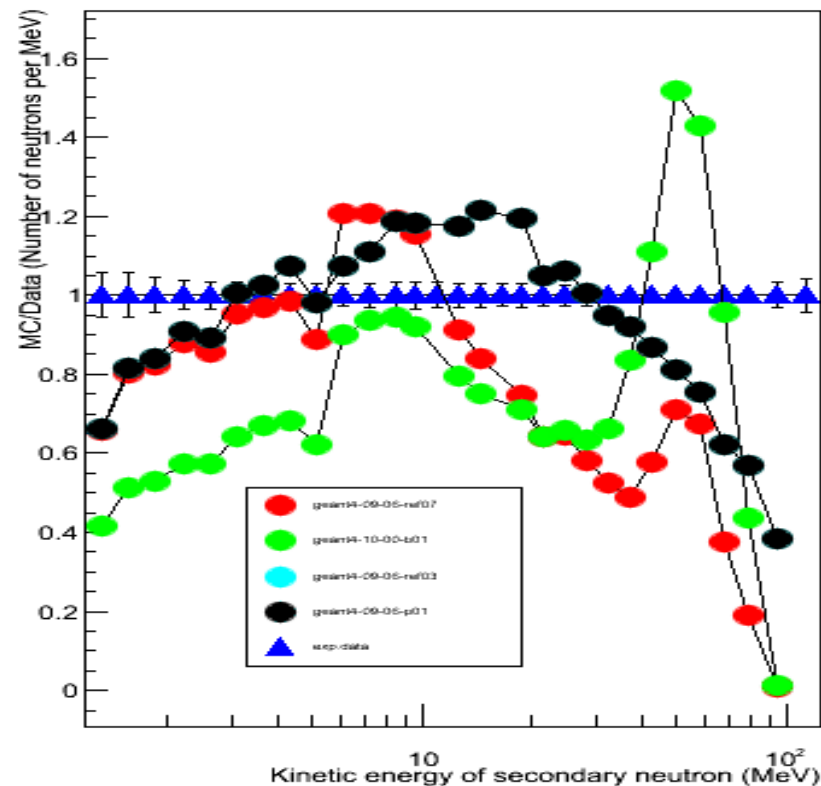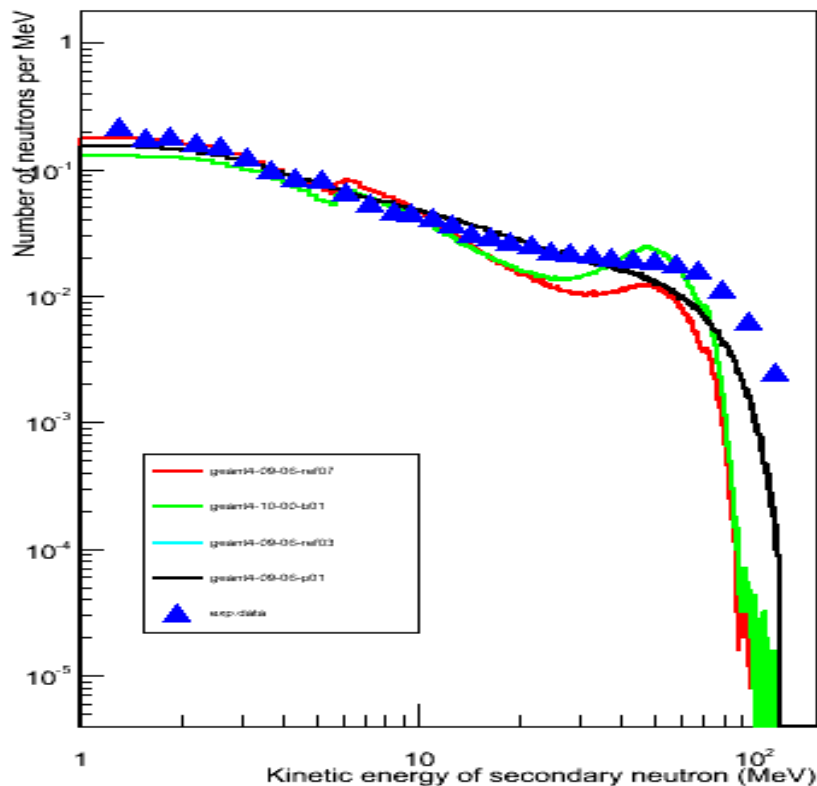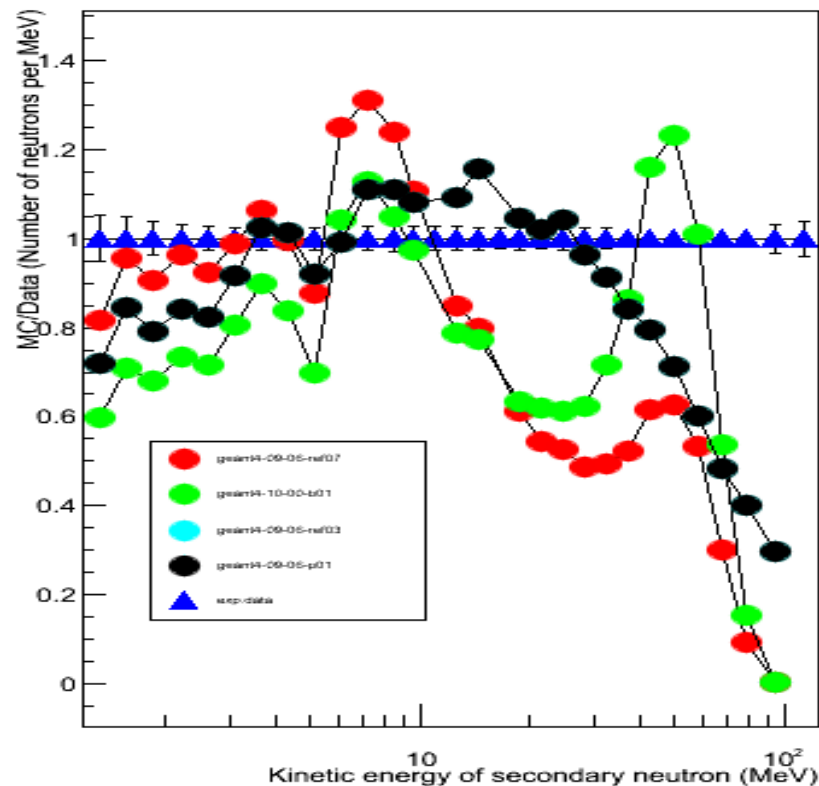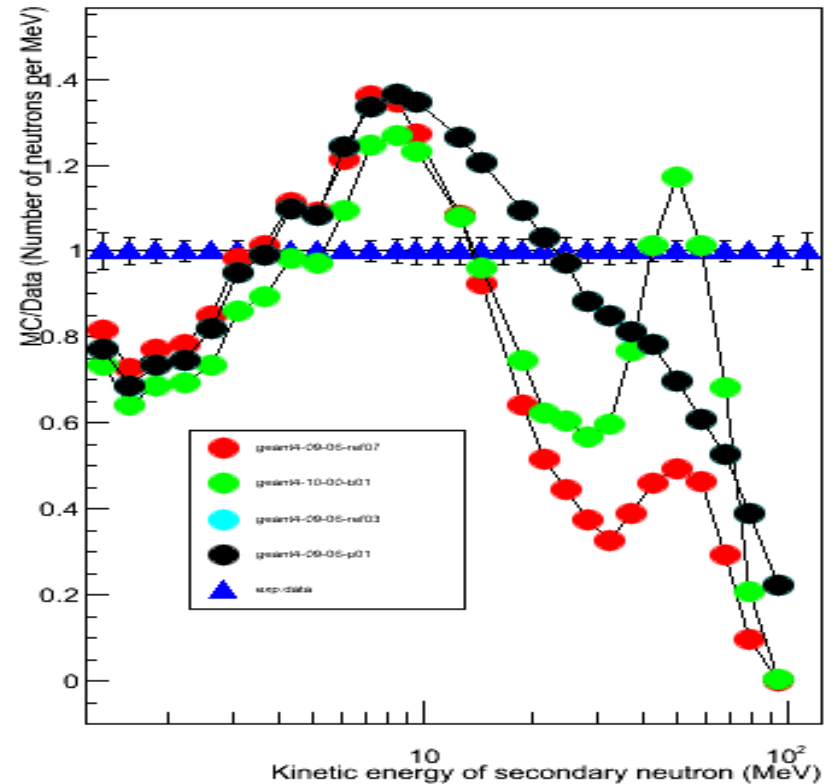
Test48: pi- capture on O -> n + X

pi- on O, BertiniPreCo
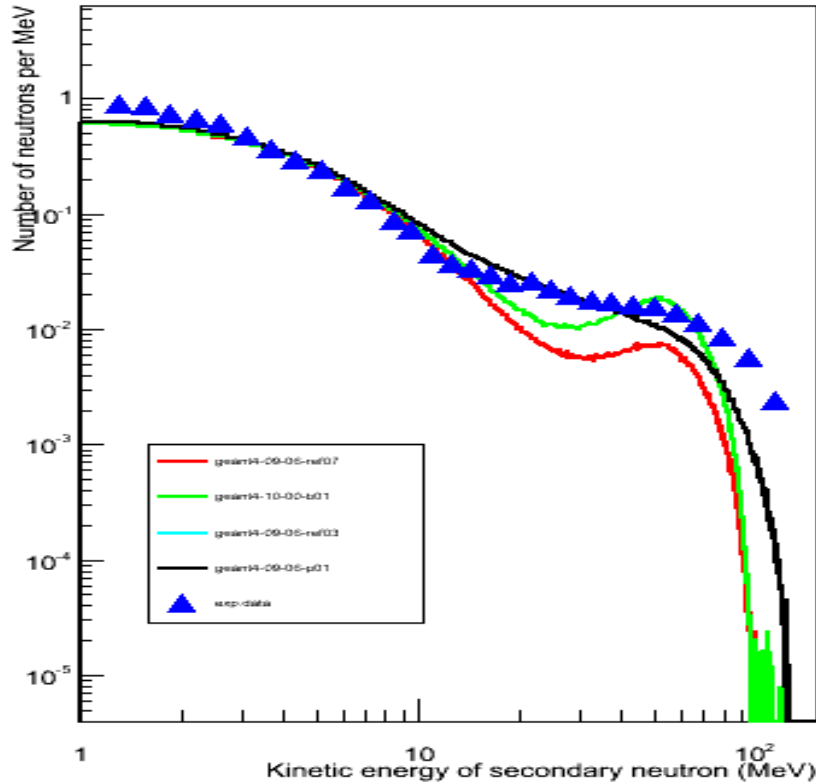

pi- on O, BertiniPreCo

Test48: pi- capture on Al -> n + X
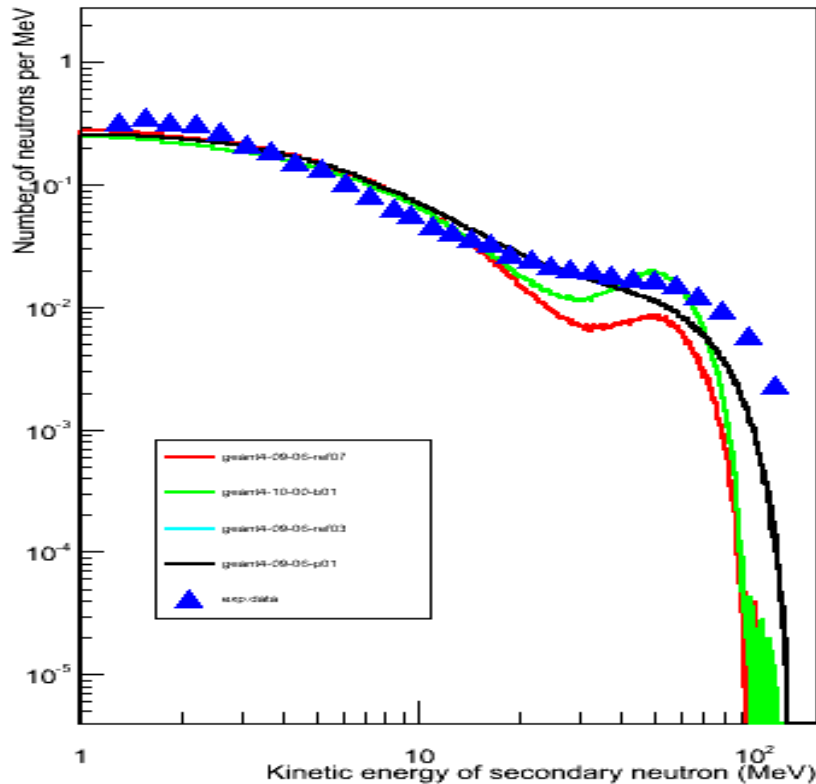
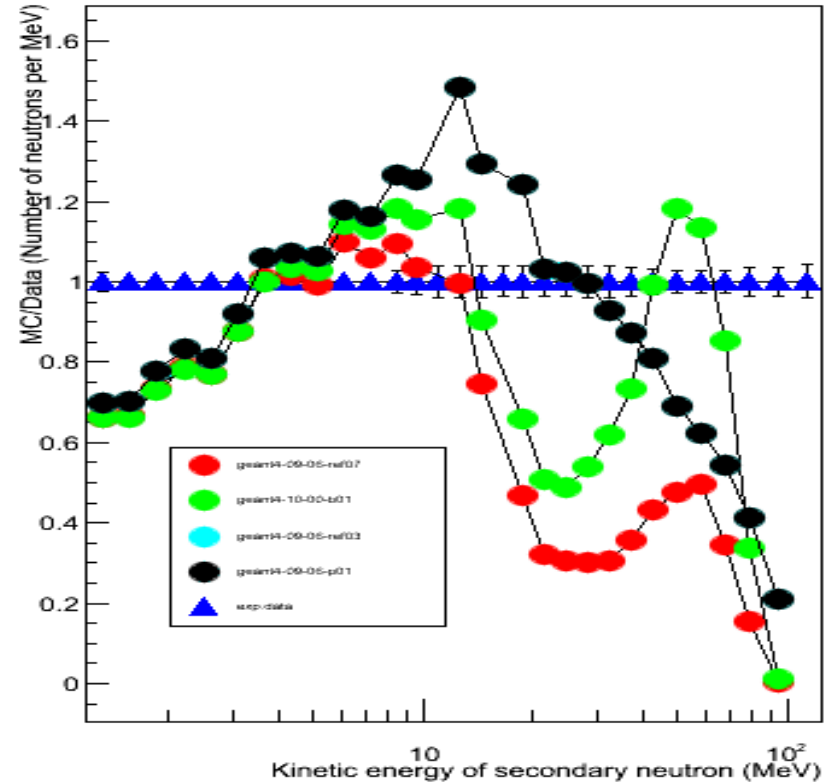# Test48: pi- capture on Cu -> n + X

pi- on Cu, BertiniPreCo

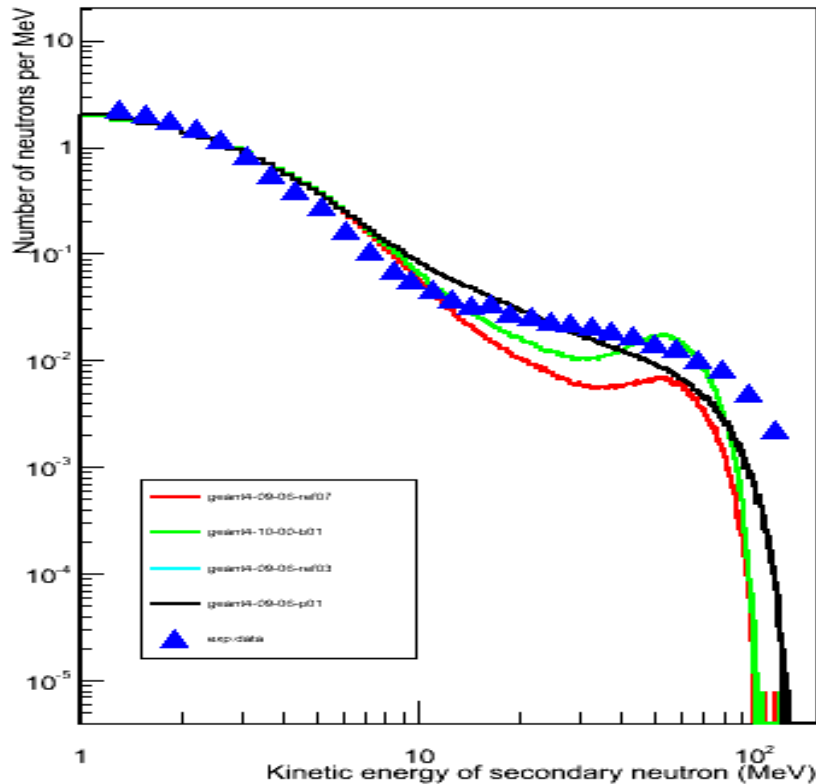pi- on Cu, BertiniPreCo

Test48: pi- capture on Ta -> n + X
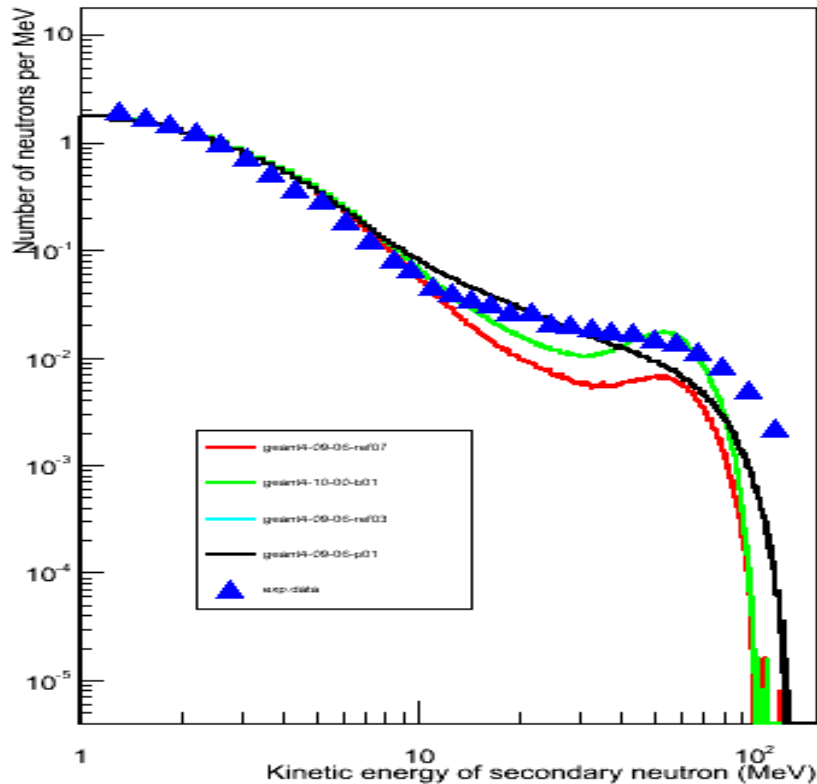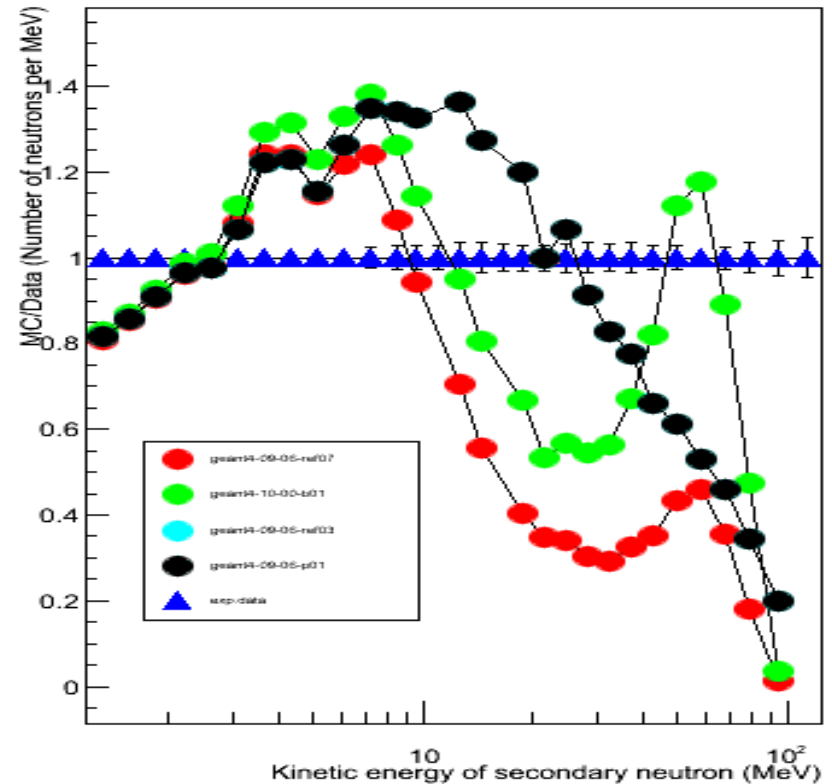
Test48: pi- capture on Pb -> n + X
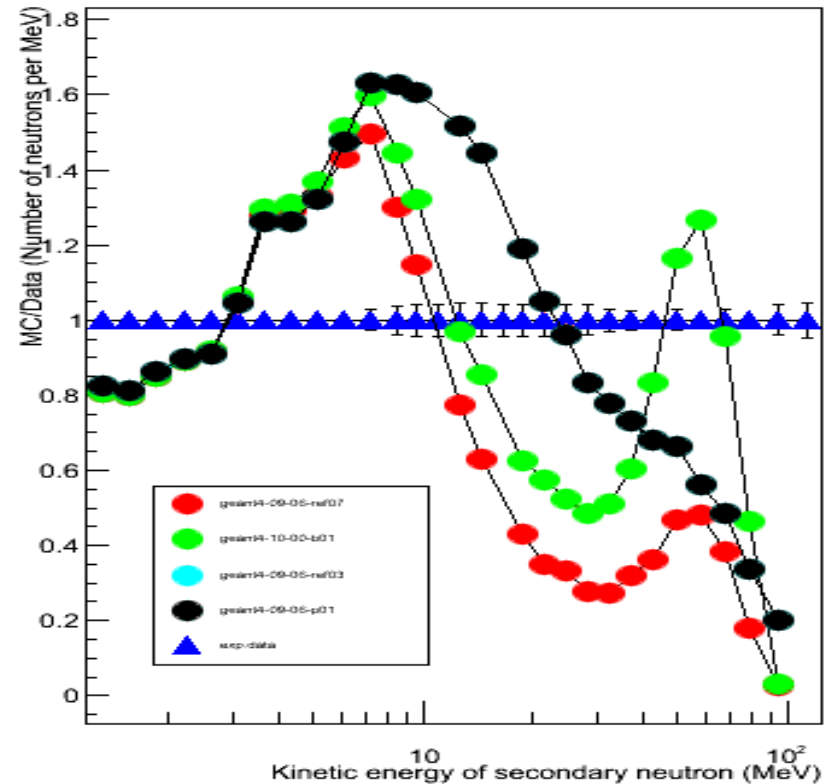
Test47: Intermediate E (up to 7.5GeV/c)

- Bertini is <u>reasonably stable</u> across 4.9.6.p01, 4.9.6.ref03, 4.10.0.b01, and 4.9.6.ref07, there're some variations but they're within errors

- FTF is stable across this group of tests
  <u>Note</u>: leading to 4.9.6.p01, non-negligible degradations
  where observed in FTF results (as compared to exp.data)
  – those are still there, as no changes vs 4.9.6.p01 observed

- Binary is stable across this group of tests

- Adding INCL++ is still in the plans – sorry for delays !

Test75: gamma-N

- **No changes across 4.9.6.ref03, 4.10.0.b01, 4.9.6.ref07**

- **Some earlier changes, in gamma-Cu at 668MeV and gamma-Pb at 668MeV, between 4.9.6.p01 and 4.9.6.ref03 are already known; uploaded to G4 Val Repository**

Test19: High E – 31GeV/c(NA61) & 158GeV/c(NA49)

- QGS(P) – stable from 4.9.6.p01 through 4.9.6.ref07
  <u>Note</u>: QGSP+G4LundStringFragmentation is still the most promising option for modeling highE p+C interactions

- FTF(P) – SURPRISE !!! (but not always a delight…)
  - SIGNIFICANT changes in 4.9.6.ref07, at 31GeV/c & 158GeV/c
  - Some of the changes are good, and some are not

- See following plots
  Note: latest release 4.9.6.ref07 is color-coded RED

- Remark on pi production: tests do not account for decays of such resonances as eta, eta_prime, etc. - ~6.5% effect

- Last but not least: FTF seems to be <u>leaking memory</u>

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Test19: 158GeV/c p on C (NA49 – I) Improvements in dN/dxF spectra for pions, no change for pbar, "no opinion" on p and n
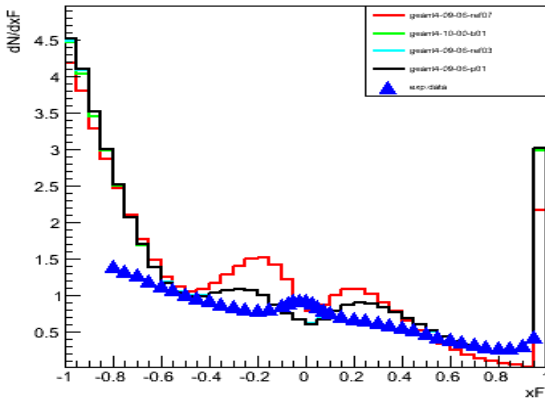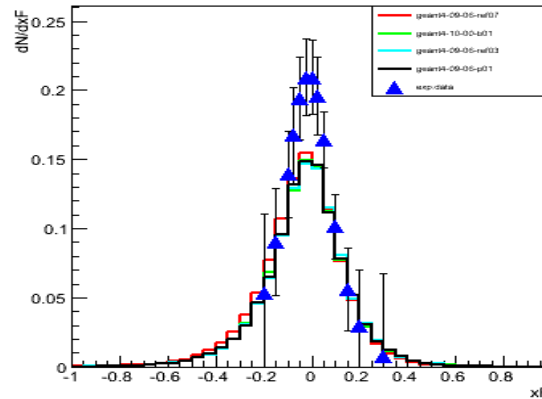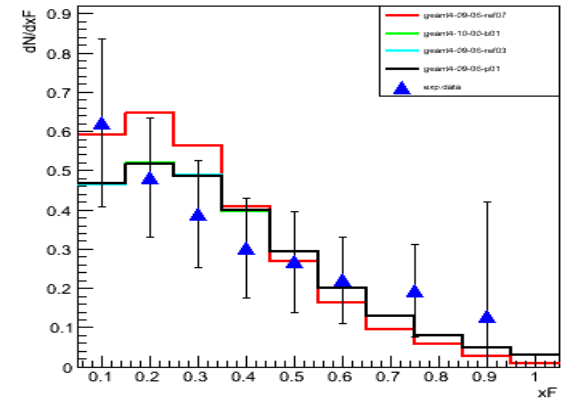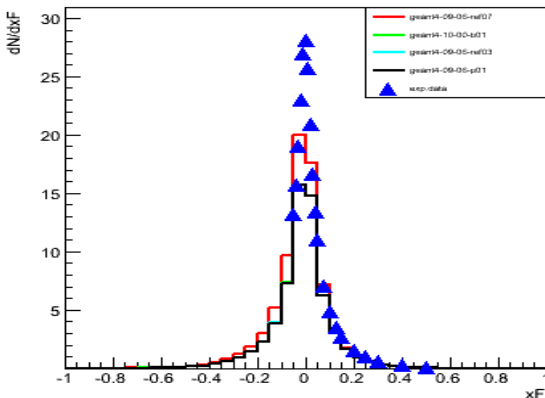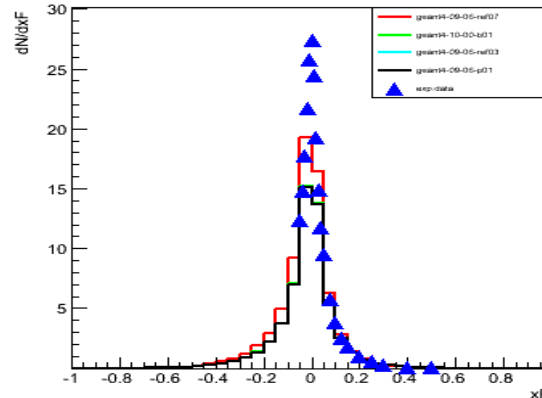
Test19: 158GeV/c p on C (NA49 – II) <u>Degradation</u> in all <pT> vs xF spectra
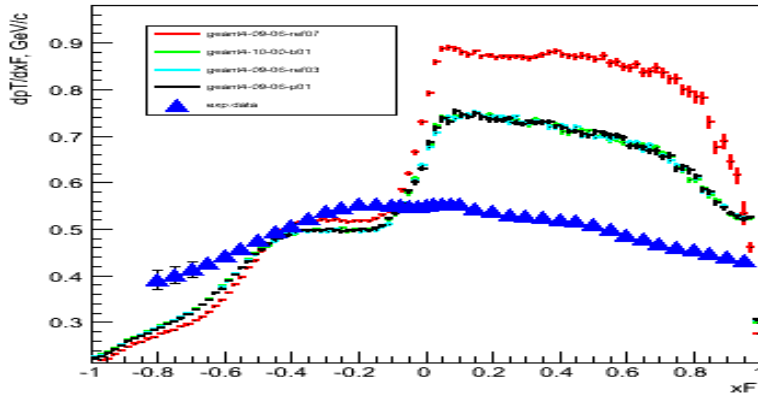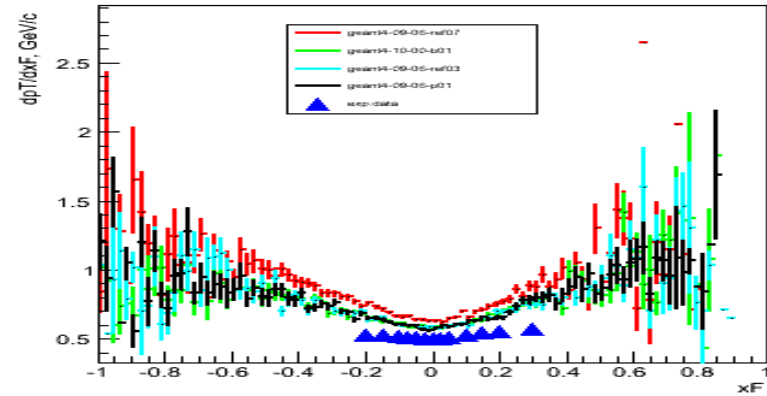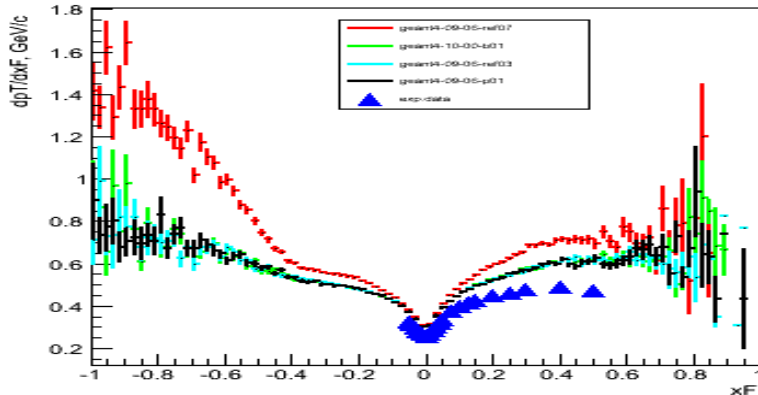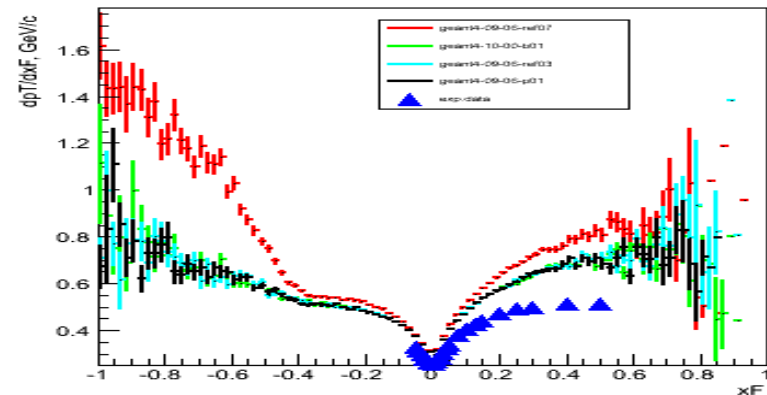
Test19: 31GeV/c p on C (NA61 – I)
Improvements in pi- spectra at small(er) theta

Test19: 31GeV/c p on C (NA61 – II) Improvements in pi- spectra at large theta

Test19: 31GeV/c p on C (NA61 – III)
Small improvements in pi+ spectra at small(er) theta

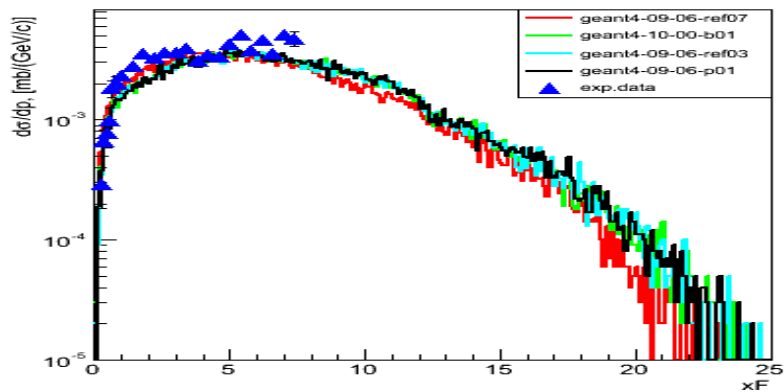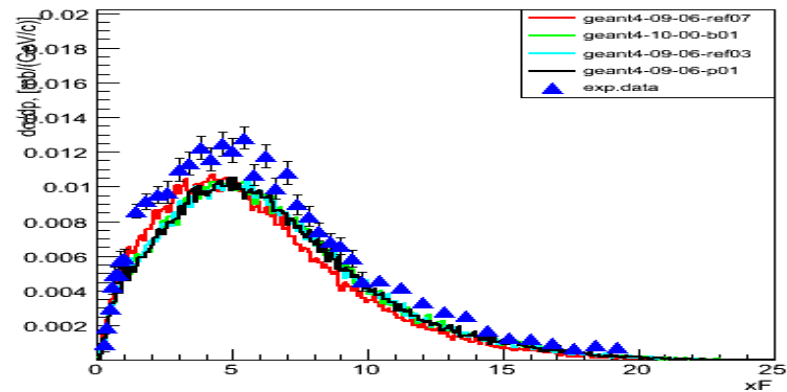

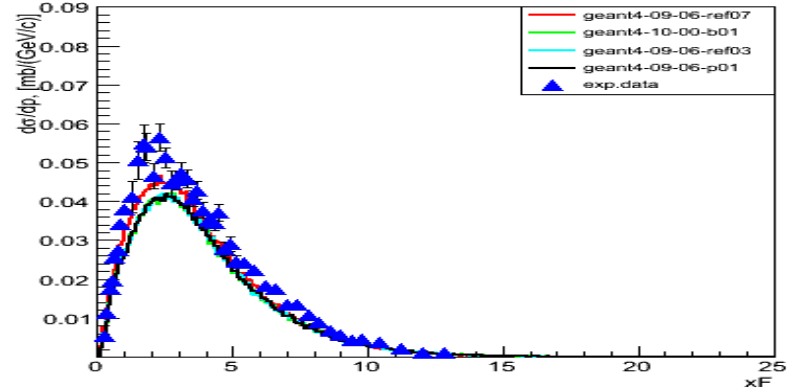proton + C -> X + pi+   (0<theta<20 (mrad))
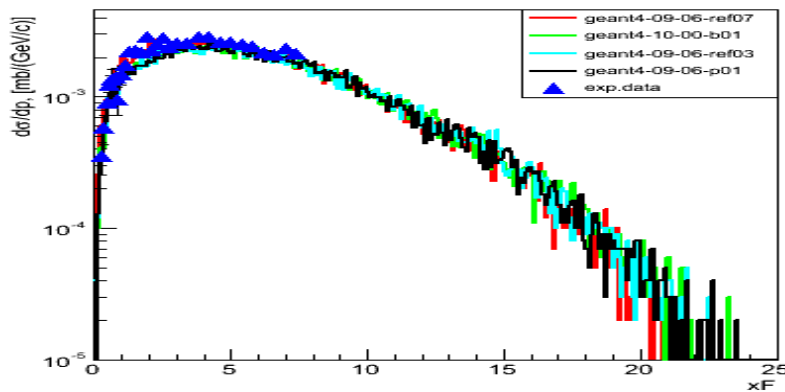
proton + C -> X + pi+   (20<theta<40 (mrad))

proton + C -> X + pi+   (40<theta<60 (mrad))
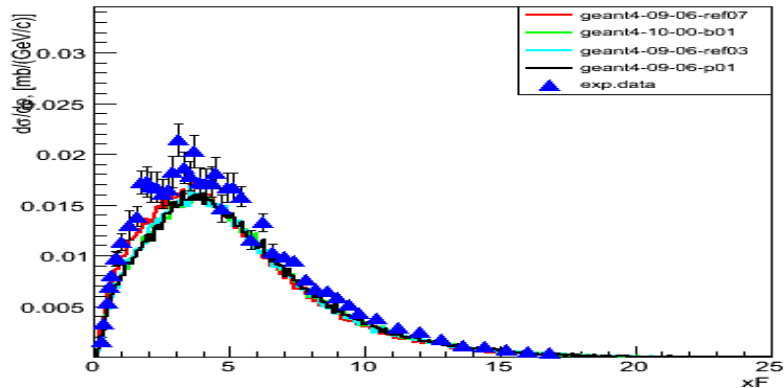
proton + C -> X + pi+   (60<theta<100 (mrad))

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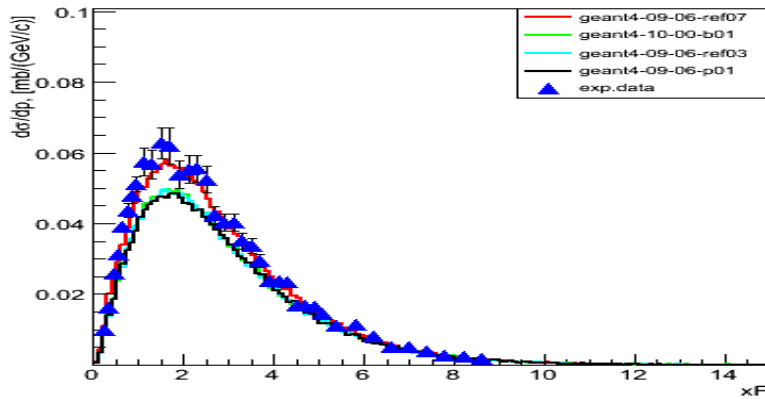
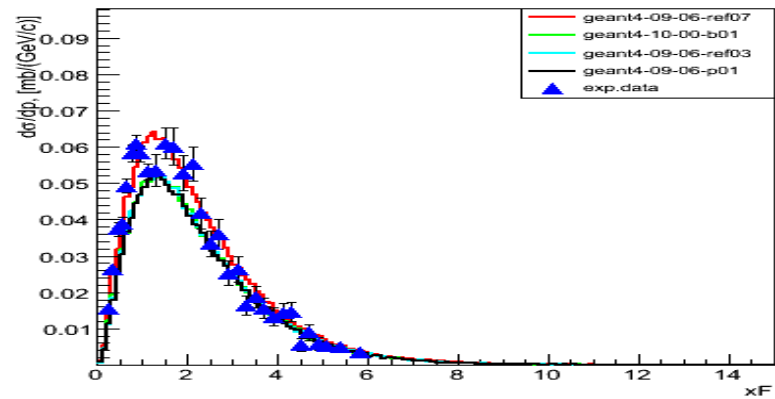# Test19: 31GeV/c p on C (NA61 – IV) Improvements in pi+ spectra at large theta
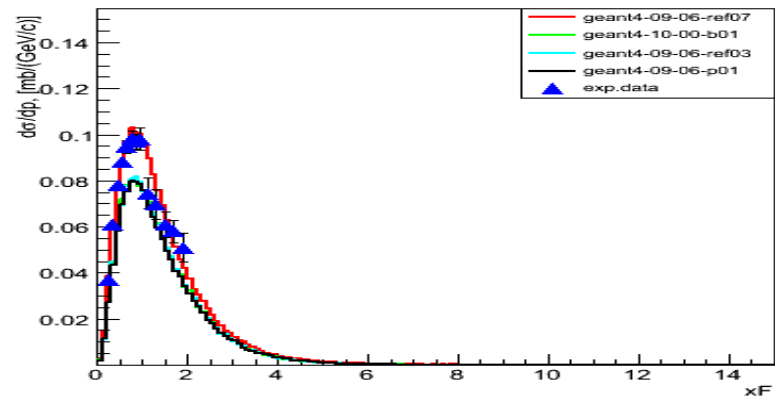

proton + C -> X + pi+ (100<theta<140 (mrad))

proton + C -> X + pi+ (140<theta<180 (mrad))

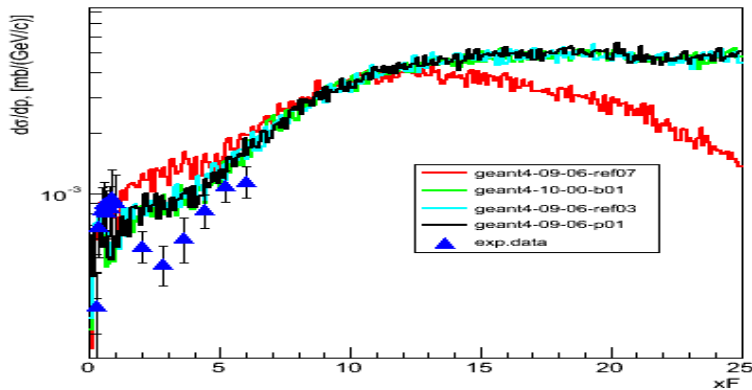proton + C -> X + pi+ (180<theta<240 (mrad))
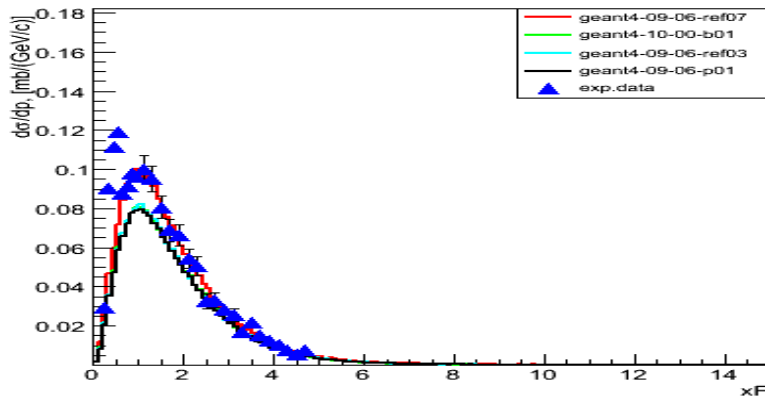
proton + C -> X + pi+ (240<theta<300 (mrad))

Test19: 31GeV/c p on C (NA61 – V)
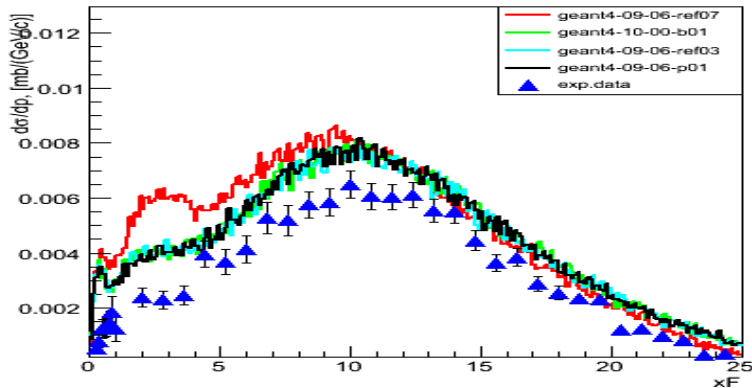# Degradation in proton spectra at small theta
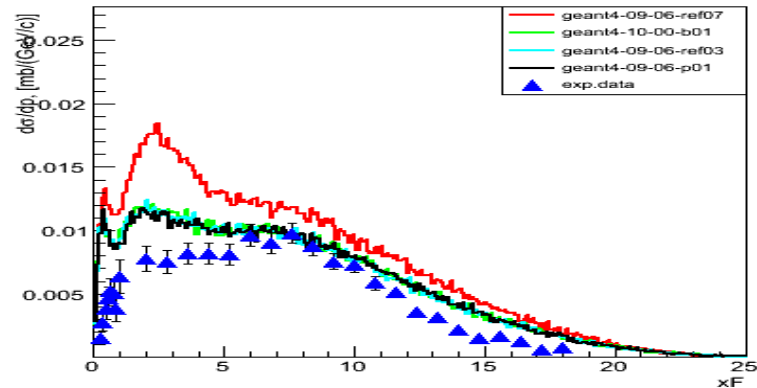
Test19: 31GeV/c p on C (NA61 – VI)
Degradation in proton spectra at large theta
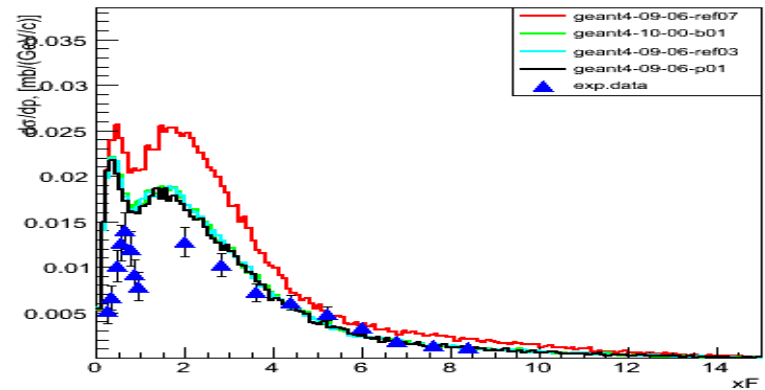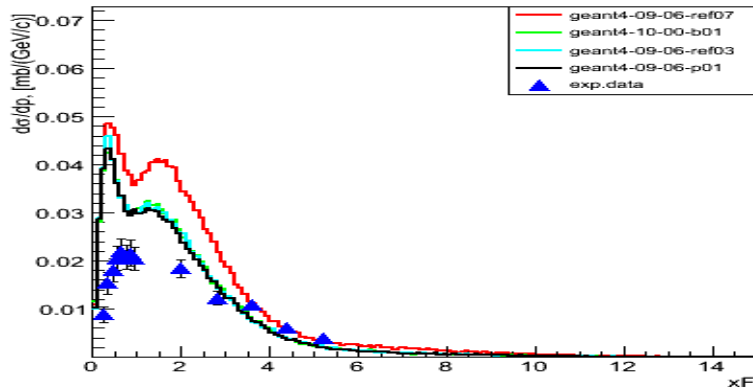
Test19: 31GeV/c p on C (NA61 – VII)
Degradation in pi+/K+ spectra

proton + C, K+/pi+ (20<theta<140 (mrad))

proton + C, K+/pi+ (140<theta<240 (mrad))
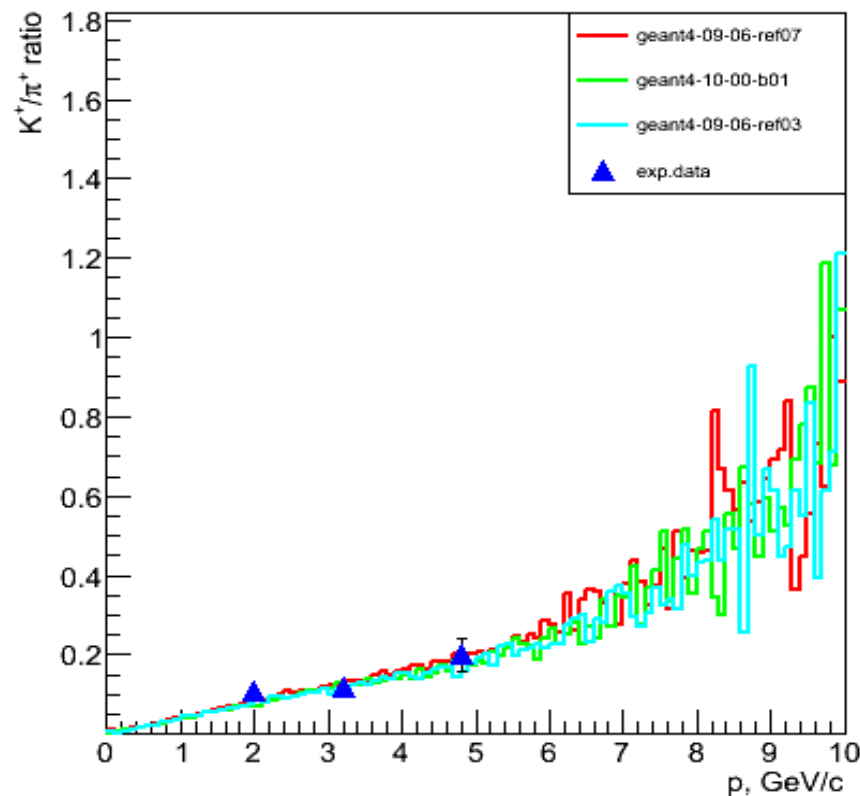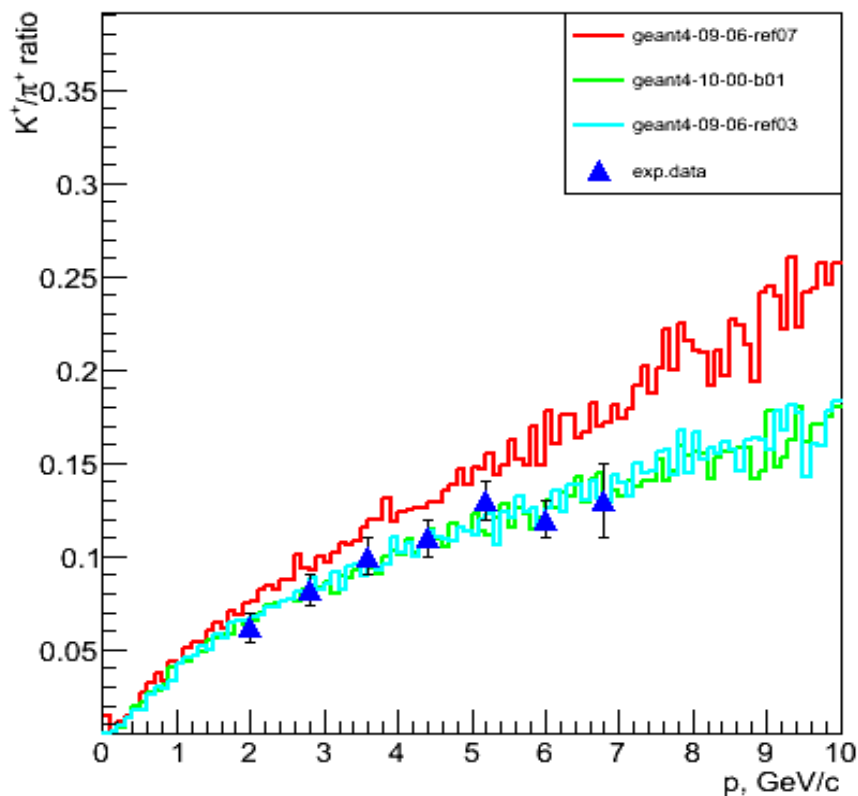
(Instead of) Summary

- For most part, key hadronic models (Bertini, FTF, QGS, Binary) are reasonably stable across the group of releases from 4.9.6.p01 through 4.9.6.ref07

- Bertini is of concern when modeling pi- capture

- FTF shows a mix of good and not so good news at higher energies

- FTF seems to be leaking memory, at least in 4.10.0.b01 and 4.9.6.ref07

- Any recent changes and possible memory issues in FTF should be (re)considered with caution since FTF is our principal HE model in production physics lists