Geant4.10.01-cand02 : Selected Results from test19 and test47

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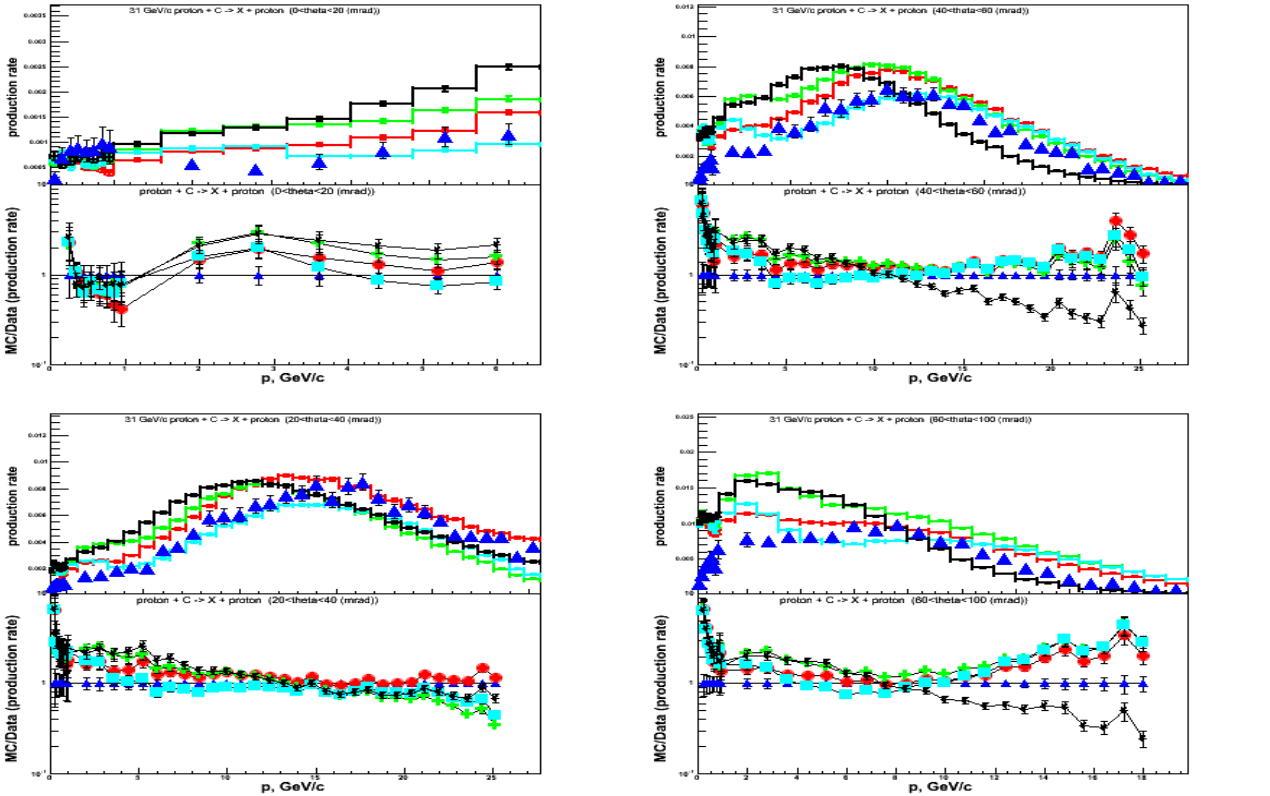
General Information

- Included releases:
  - 4.9.6.p03, 4.10.0.p02, 4.10.0-ref08
  - 4.10.1-cand02 – current
  - NOTE-1: there is no plan t re-run validation on 4.10.1-cand03 as it is my understanding that the HAD physics is substantially the same
  - Full validation will be done on geant4.10.1
- Subset of validation tests: test19 and test47
- Focus: FTF (due to many recent changes)
  - Intermediate and High energies
- Bertini and Binary (mainly a cross-check)
  - Intermediate energies

Results

- FTF
  - 4.10-cand02 shows significant improvement in several areas
    - Agreement with NA49 data is better than even 4.9.6.p03
    - Repaired modeling of pion production by pion beam at 3-12GeV/c
  - Still of concern
    - π^- production by proton beam at 3-12GeV/c on C or Be
    - Proton production in p+C at 31GeV/c is negatively affected again (was damaged throughout 4.10-cycle, then repaired in 4.10.0-ref08)
    - K+/pi+ ratio in p+C at 31GeV/c "partially" repaired but the shape is somewhat odd
  - Selected plots included
  - χ^2 tables included
- Bertini is stable through most of 4.10-cycle (diff. from 4.9.6.p03)
- Binary is stable

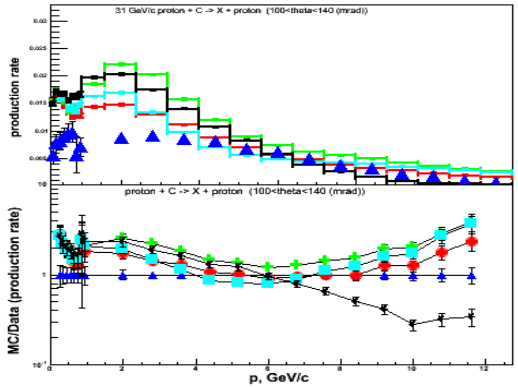
31GeV/c p+C -> p + X
FTF - regression test (I)

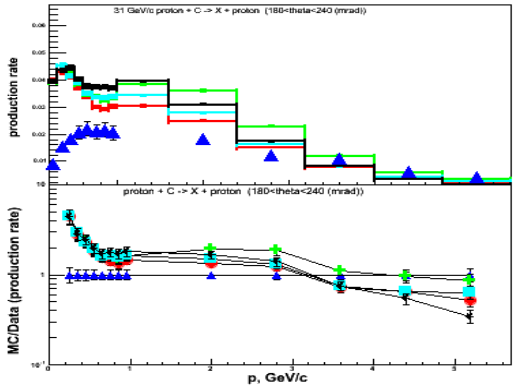


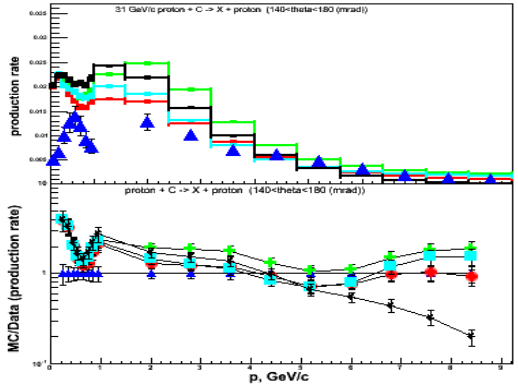
MC vs NA61 Data; χ^2/NDF calculated over ALL theta bins
χ^2/NDF = 20.6122 for geant4-09-06-p03 vs NA61 Data
χ^2/NDF = 36.8967 for geant4-10-00-p02 vs NA61 Data
χ^2/NDF = 24.4708 for geant4-10-00-ref-08 vs NA61 Data
χ^2/NDF = 32.156 for geant4-10-01-cand-02 vs NA61 Data

- geant4-09-06-p03
- geant4-10-00-p02
- geant4-10-00-ref-08
- geant4-10-01-cand-02
- exp.data

31GeV/c p+C -> p + X
FTF - regression test (II)







MC vs NA61 Data; χ^2/NDF calculated over ALL theta bins
χ^2/NDF = 20.6122 for geant4-09-06-p03 vs NA61 Data
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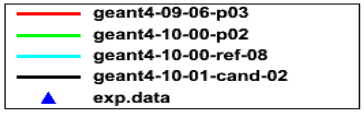
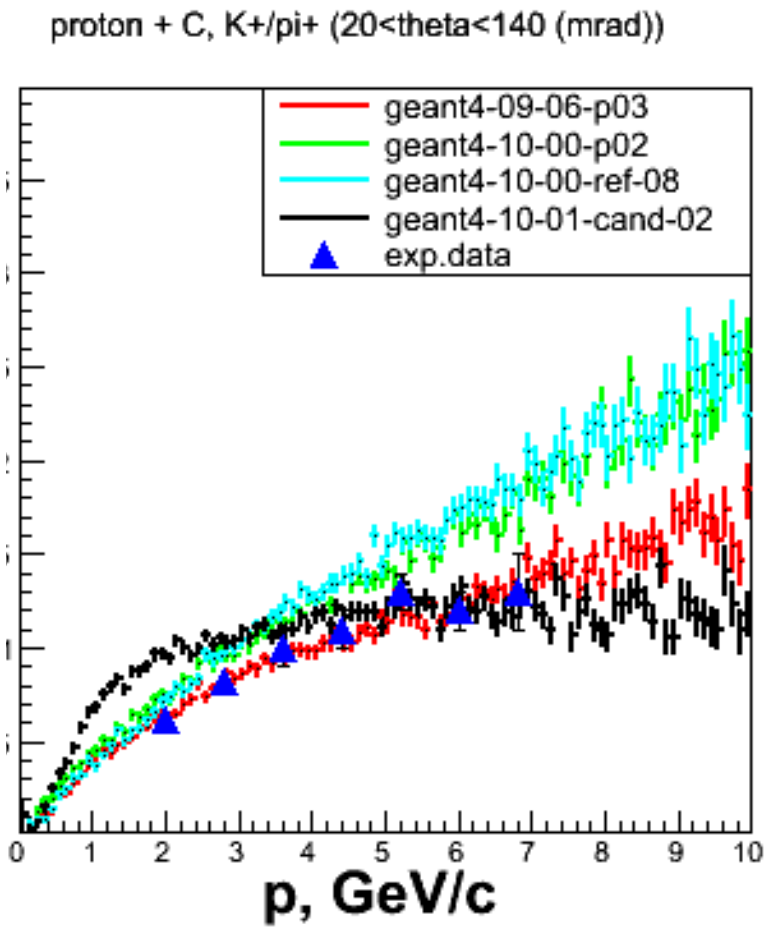
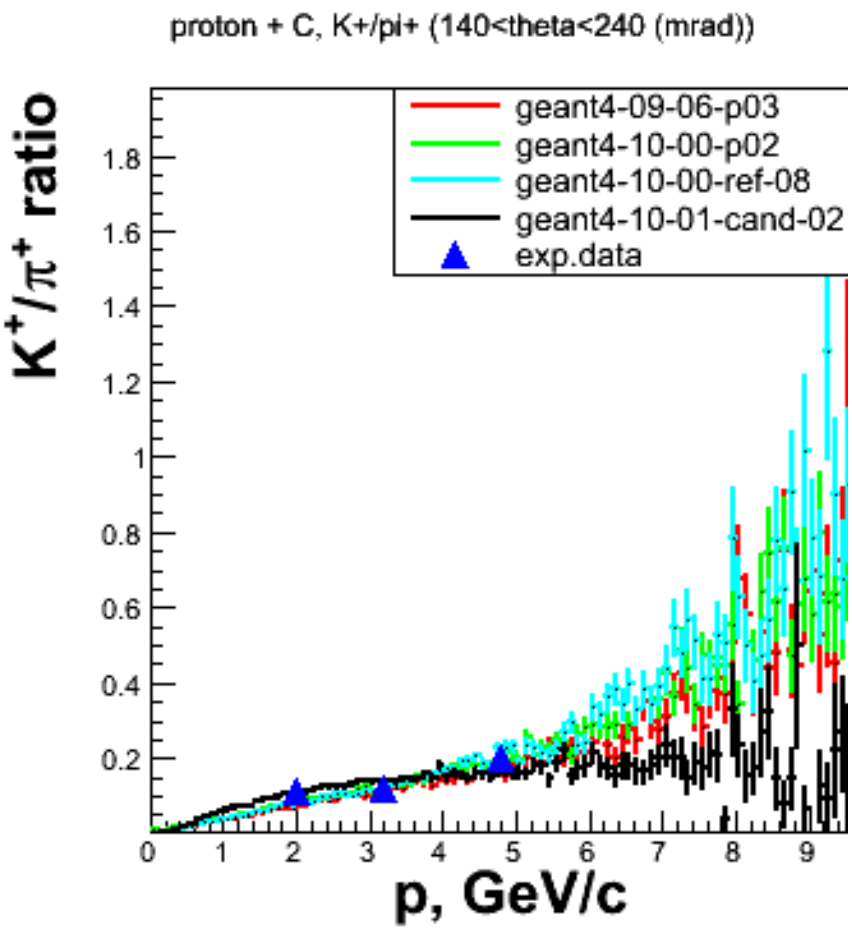
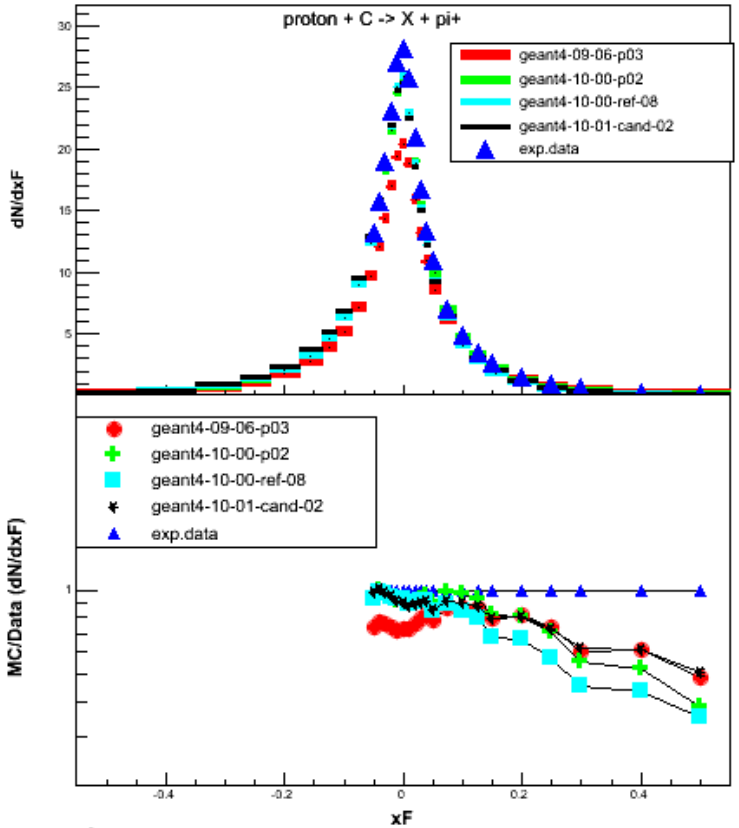


31GeV/c p+C – K+/pi+ ratio vs momentum
FTF - regression test (III)

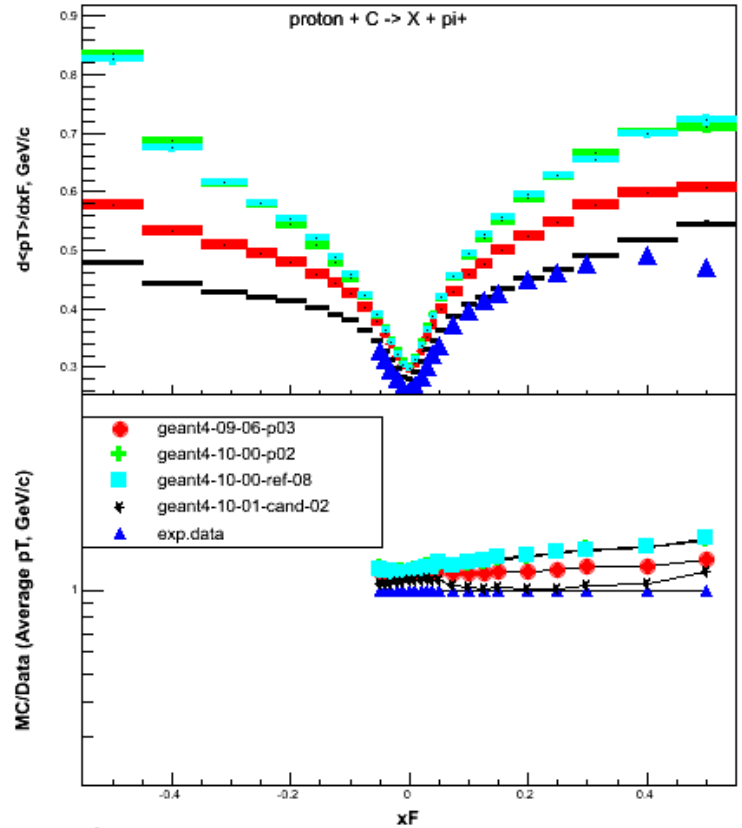




158GeV/c p+C -> pi+ + X
FTF - regression test (I)

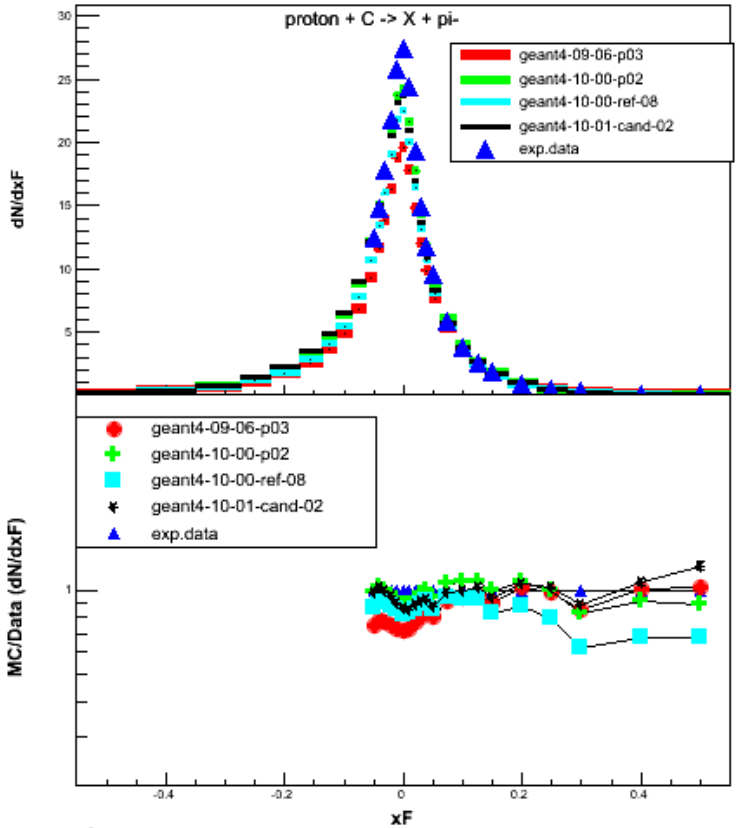


χ^2/NDF = 101.638 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 67.1446 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 108.57 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 54.2288 for geant4-10-01-cand-02 vs NA49 Data

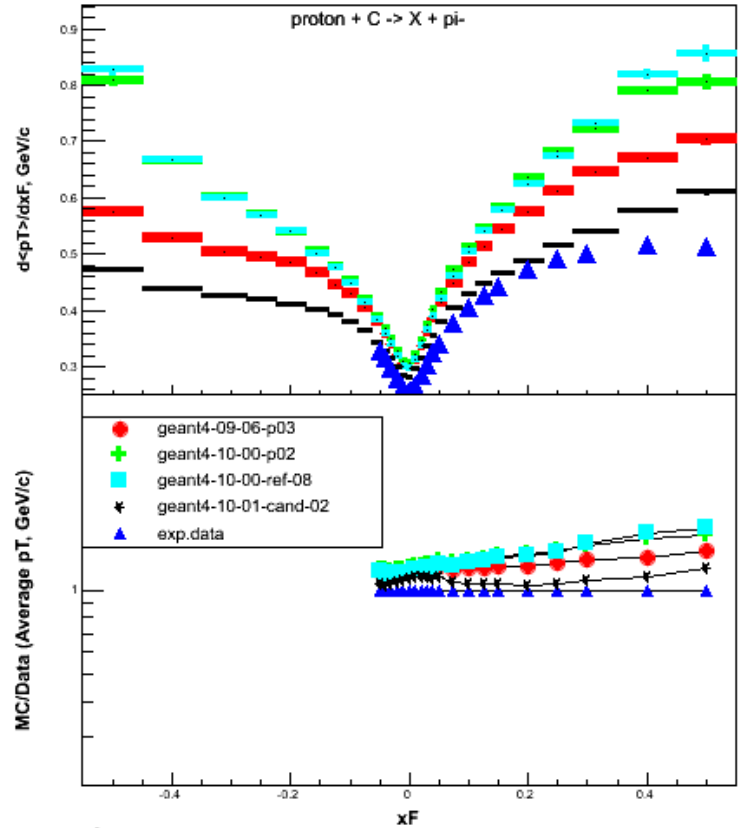


χ^2/NDF = 44.0521 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 104.664 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 100.958 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 7.05326 for geant4-10-01-cand-02 vs NA49 Data

158GeV/c p+C -> pi- + X
FTF - regression test (II)

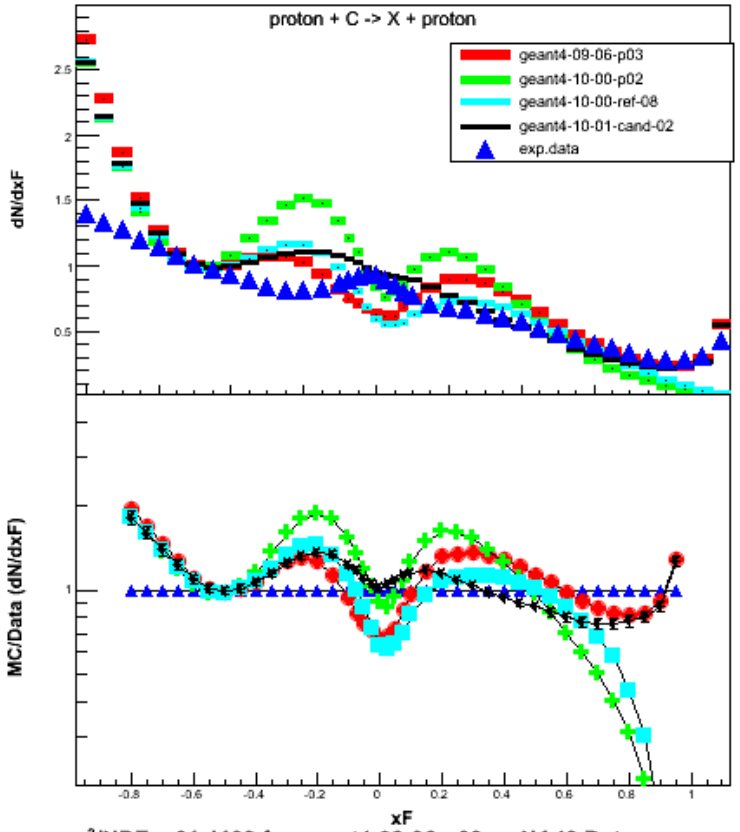


χ^2/NDF = 49.9851 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 7.61099 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 42.355 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 10.4652 for geant4-10-01-cand-02 vs NA49 Data

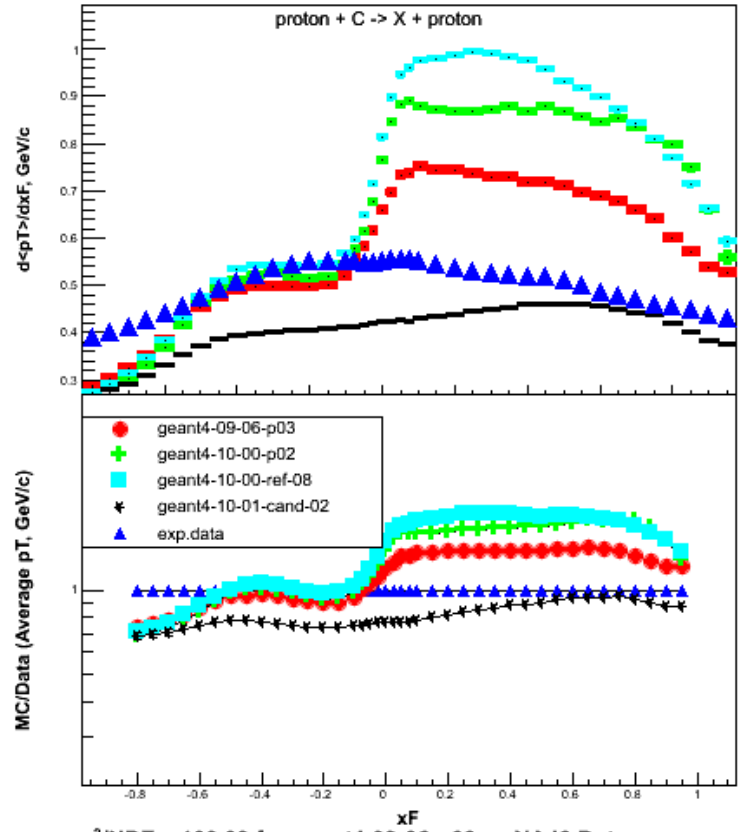


χ^2/NDF = 64.9376 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 126.062 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 114.644 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 12.4329 for geant4-10-01-cand-02 vs NA49 Data

158GeV/c p+C -> p + X
FTF - regression test (III)

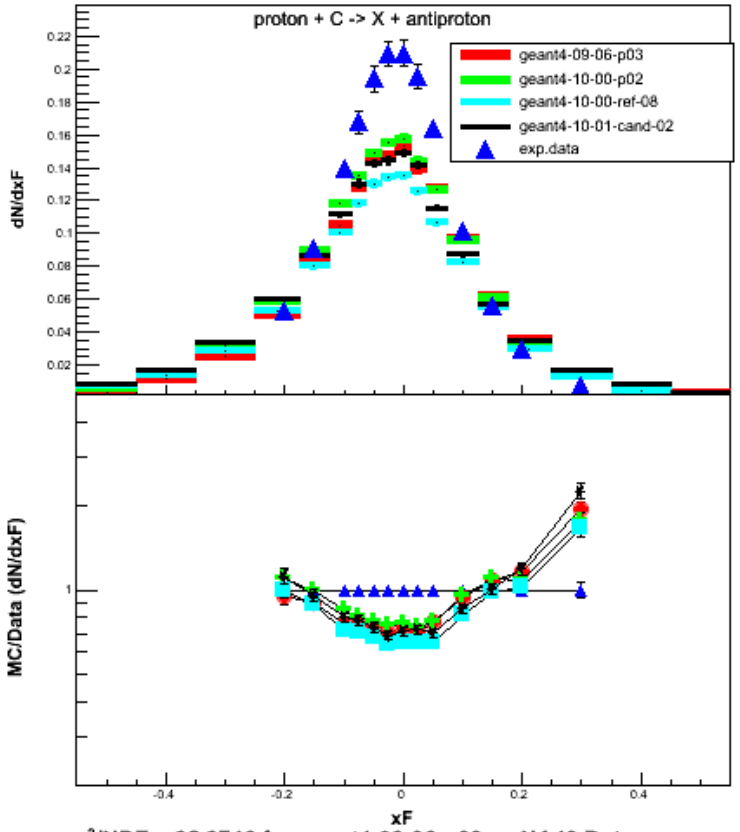


χ^2/NDF = 61.4103 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 191.987 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 85.9099 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 38.3927 for geant4-10-01-cand-02 vs NA49 Data

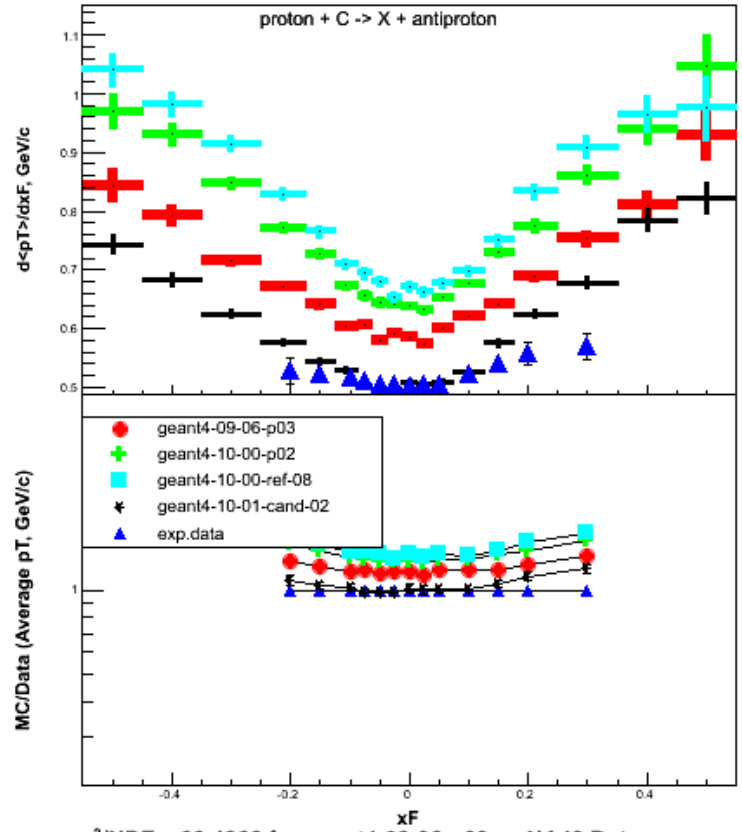


χ^2/NDF = 100.03 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 297.034 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 411.073 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 58.277 for geant4-10-01-cand-02 vs NA49 Data

158GeV/c p+C -> pbar + X
FTF - regression test (IV)

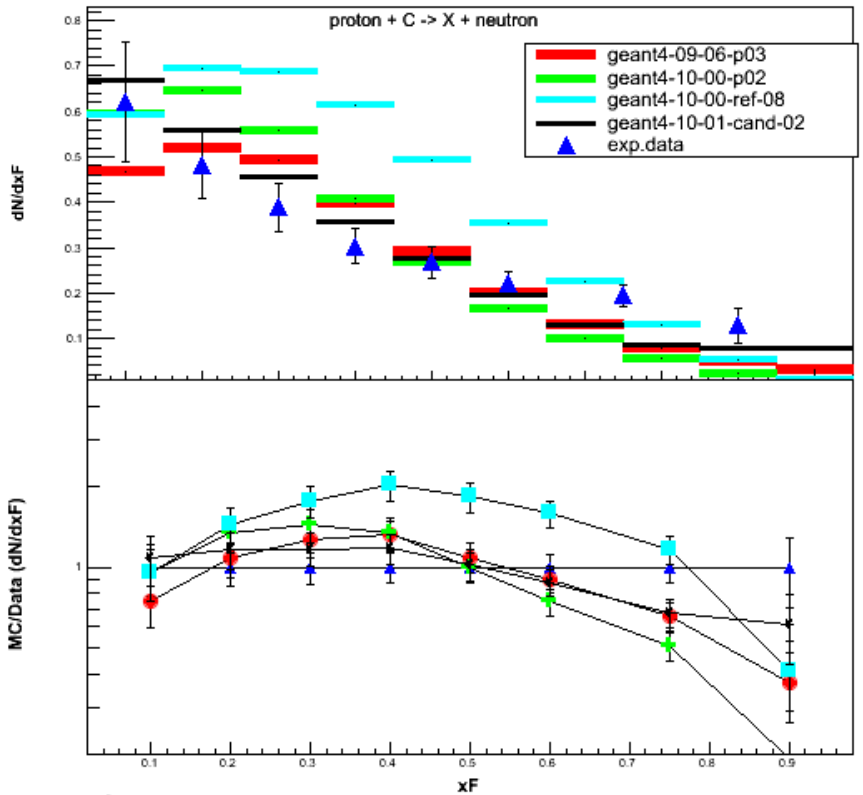


χ^2/NDF = 35.3746 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 26.3837 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 47.2234 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 45.3211 for geant4-10-01-cand-02 vs NA49 Data



χ^2/NDF = 33.4866 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 88.2401 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 117.557 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 3.4163 for geant4-10-01-cand-02 vs NA49 Data

158GeV/c p+C -> n + X
FTF - regression test (V)



χ^2/NDF = 3.1366 for geant4-09-06-p03 vs NA49 Data
χ^2/NDF = 6.45001 for geant4-10-00-p02 vs NA49 Data
χ^2/NDF = 22.0337 for geant4-10-00-ref-08 vs NA49 Data
χ^2/NDF = 1.86951 for geant4-10-01-cand-02 vs NA49 Data

Results from Statistical Tests (chi2) of FTF in the 3-158GeV/c Range of Beam Momenta

- In the next several slides there are table that show results of FTF regression testing from the statistical point of view, i.e. χ^2/NDF calculated over FTF predictions vs exp. spectra
- Results are shown only for light targets (C or Be)
- The χ^2/NDF values are integral, i.e. calculated over groups of distributions:
  - Momentum spectra in all θ–bins at 3-31GeV/c
  - Double diff. pt-spectra at 158GeV/c
  - Note-1: χ^2/NDF can be calculated for each individual distribution
  - Note-2: plots for double diff. pt-spectra are not yet included in standard validation output
- Similar numbers exist for other models; just not included here

FTF(P): χ^2/NDF for p + C $\longrightarrow$ π^+ + X

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c	31 GeV/c	158 GeV/c
9.6.p03	4.27	6.82	7.97	9.71	18.06	43.33
10.00.p02	6.04	9.93	8.89	11.65	4.84	51.67
10.00-ref08	15.53	18.52	13.10	14.42	5.85	54.88
10.01-cand02	3.20	9.51	11.55	14.86	5.00	22.04

FTF(P): χ^2/NDF for p + C $\longrightarrow$ π^- + X

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c	31 GeV/c	158 GeV/c
9.6.p03	3.36	4.20	5.42	5.64	12.83	40.23
10.00.p02	6.57	19.10	28.29	29.16	3.37	48.63
10.00-ref08	6.48	14.58	19.24	17.69	3.11	40.65
10.01-cand02	3.59	15.05	27.47	31.73	2.57	16.55

For 3-31GeV/c range, χ^2 is calculated over momentum spectra in all θ-bins
At 158GeV/c, χ^2 is calculated over double diff. pt-spectra in all xF-bins

FTF(P): χ^2 /NDF for $\pi^+ + C \rightarrow \pi^+ + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	17.28	15.53	18.09	3.71
10.00.p02	21.59	16.63	21.40	4.50
10.00-ref08	18.55	15.87	22.20	4.94
10.01-cand02	13.06	10.17	13.93	4.15

FTF(P): χ^2 /NDF for $\pi^+ + C \rightarrow \pi^- + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	11.62	15.81	9.91	2.66
10.00.p02	17.51	18.32	10.72	2.80
10.00-ref08	21.10	21.35	12.86	3.77
10.01-cand02	9.41	13.84	9.18	2.79

χ^2 is calculated over momentum spectra in all θ-bins

FTF(P): χ^2/NDF for $\pi^- + C \rightarrow \pi^+ + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	28.57	14.87	16.28	18.70
10.00.p02	38.45	18.92	19.40	22.63
10.00-ref08	29.64	16.47	19.71	25.29
10.01-cand02	18.21	13.82	14.51	15.64

FTF(P): χ^2/NDF for $\pi^- + C \rightarrow \pi^- + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	25.11	22.12	22.53	15.45
10.00.p02	28.59	21.32	21.51	15.42
10.00-ref08	30.61	24.32	24.53	19.42
10.01-cand02	18.00	15.15	24.78	23.43

χ^2 is calculated over momentum spectra in all θ-bins

FTF(P): χ^2 /NDF for p + Be → π^+ + X

	3 GeV/c	5 GeV/c	8 GeV/c	8.9GeV/c	12 GeV/c
9.6.p03	3.80	5.93	8.76	13.09	9.93
10.00.p02	6.49	8.14	12.02		14.67
10.00-ref08	14.04	13.72	16.04	23.89	18.44
10.01-cand02	2.76	9.12	17.44		22.40

FTF(P): χ^2 /NDF for p + Be → π^- + X

	3 GeV/c	5 GeV/c	8 GeV/c	8.9 GeV/c	12 GeV/c
9.6.p03	5.07	7.82	10.19	17.08	13.74
10.00.p02	13.11	33.20	51.20		58.36
10.00-ref08	12.83	25.77	35.39	51.89	33.68
10.01-cand02	6.70	24.55	47.12		59.56

χ^2 is calculated over momentum spectra in all θ-bins

FTF(P): χ^2/NDF for π^+ + Be $\rightarrow$ π^+ + X

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	18.42	12.10	8.55	3.68
10.00.p02	22.30	12.58	8.62	4.10
10.00-ref08	19.63	12.45	9.00	4.64
10.01-cand02	14.43	8.75	10.99	6.17

FTF(P): χ^2/NDF for π^+ + Be $\rightarrow$ π^- + X

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	11.79	13.15	10.74	3.16
10.00.p02	17.42	15.01	9.50	3.13
10.00-ref08	19.07	13.93	8.33	3.50
10.01-cand02	9.81	11.26	7.71	3.22

χ^2 is calculated over momentum spectra in all θ-bins

FTF(P): χ^2/NDF for $\pi^- + Be \rightarrow \pi^+ + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	25.74	14.06	14.55	10.68
10.00.p02	33.78	16.81	17.42	13.53
10.00-ref08	28.53	15.61	18.58	14.97
10.01-cand02	15.88	12.31	13.96	8.96

FTF(P): χ^2/NDF for $\pi^- + Be \rightarrow \pi^- + X$

	3 GeV/c	5 GeV/c	8 GeV/c	12 GeV/c
9.6.p03	31.27	24.19	23.14	19.90
10.00.p02	37.25	22.60	20.37	18.26
10.00-ref08	39.42	25.27	22.20	20.73
10.01-cand02	26.88	16.64	30.95	25.17

χ^2 is calculated over momentum spectra in all θ-bins