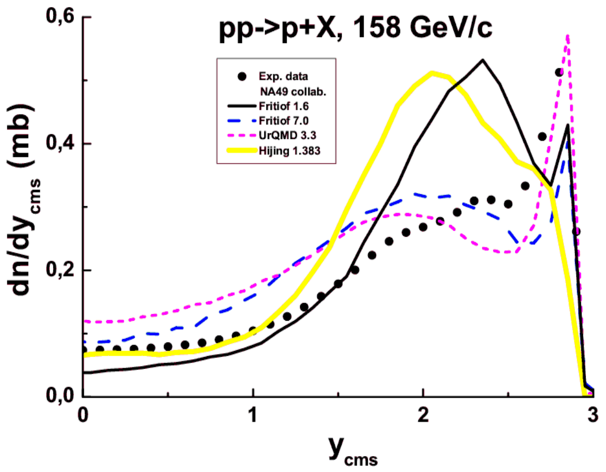
Update on hadronic string models
V. Uzhinsky, 15 September 2016

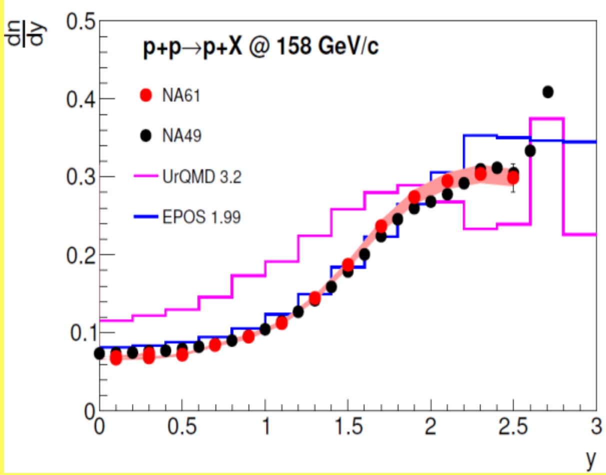
Main problem – description of baryon spectra in hadron-nucleon and hadron-nucleus interactions!

Exp. Data by NA49 Collaboration on p+p->p+X at 158 GeV/c

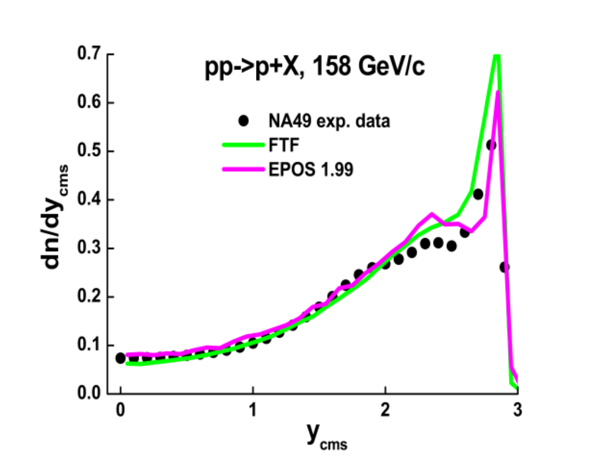
Fritiof 1.6, Fritiof 7.0, Hijing, UrQMD 3.3



EPOS 1.99 and UrQMD



EPOS 1.99 and FTF



EPOS 1.99/LHC
Tanguy Pierog and Klaus Werner
CRMC (Cosmic Ray Monte Carlo package)
https://web.ikp.kit.edu/rulrich/crmc.html

+ CERN

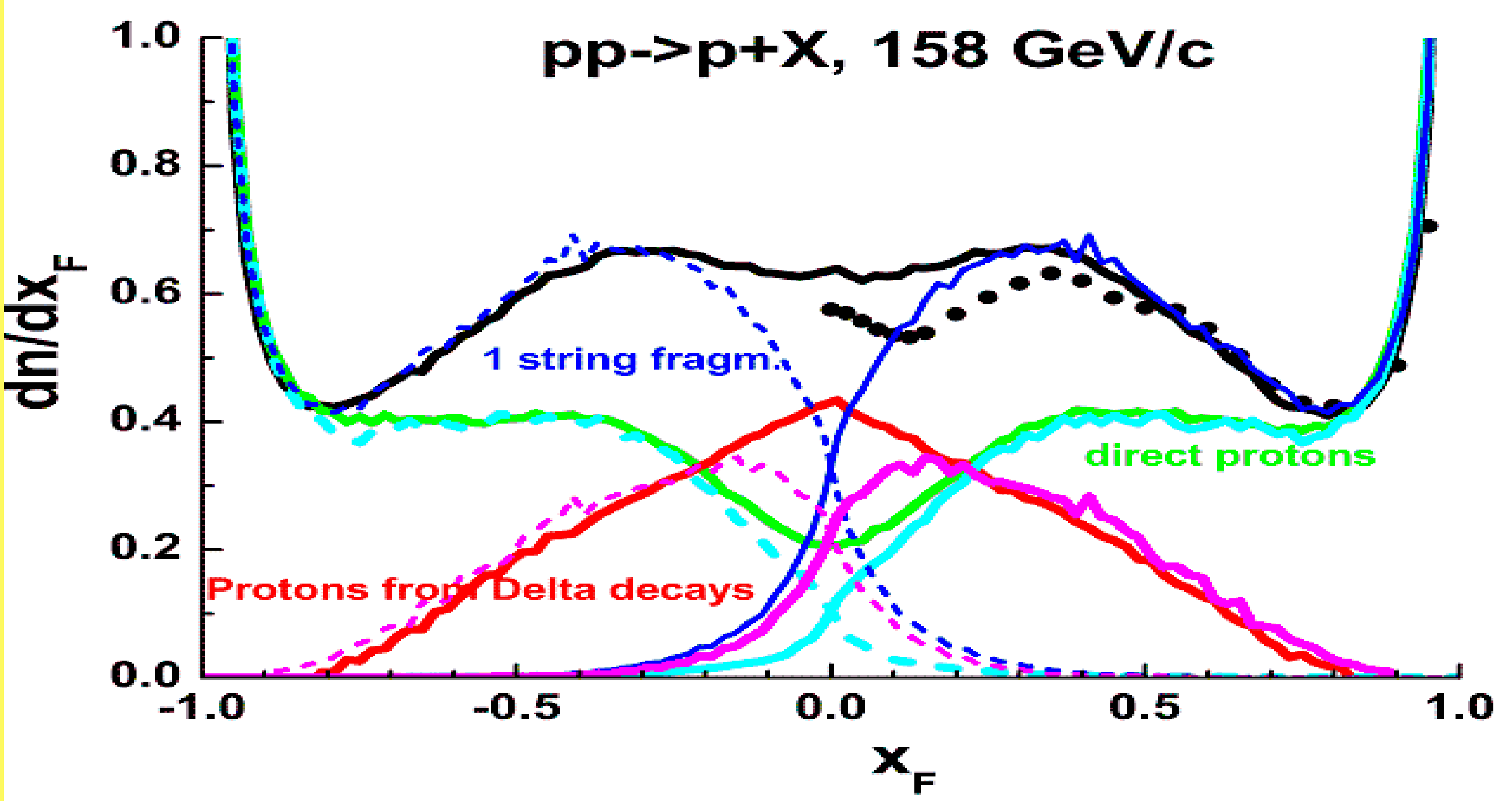
EPOS LHC: Test of collective hadronization with data measured at the CERN Large Hadron Collider (Phys.Rev. C92 (2015) 034906)
T. Pierog, Iu. Karpenko, J.M. Katzy, E. Yatsenko, K. Werner.

Parton based Gribov-Regge theory (Phys.Rept. 350 (2001) 93-289)
H.J. Drescher, M. Hladik, S. Ostapchenko, T. Pierog, K. Werner

Content

1 String fragmentation functions; 2 Pt of baryons; 3 Validation

Structure of dn/dx proton spectra



P(B 3/2): P(B 1/2) = 1:1. It cannot be changed.

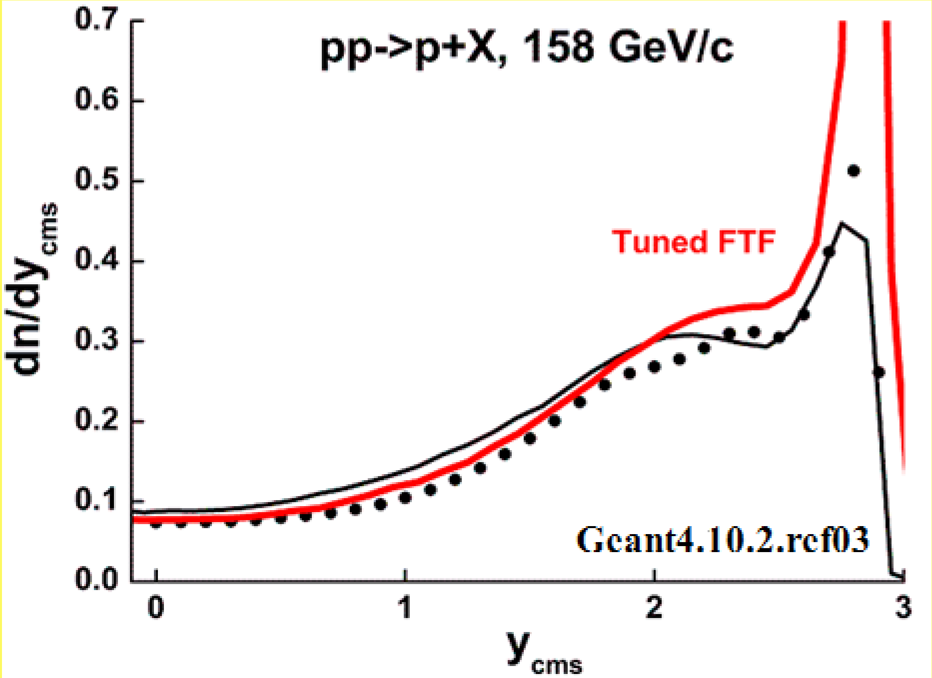
Only string fragmentation functions for baryon production can be changed!

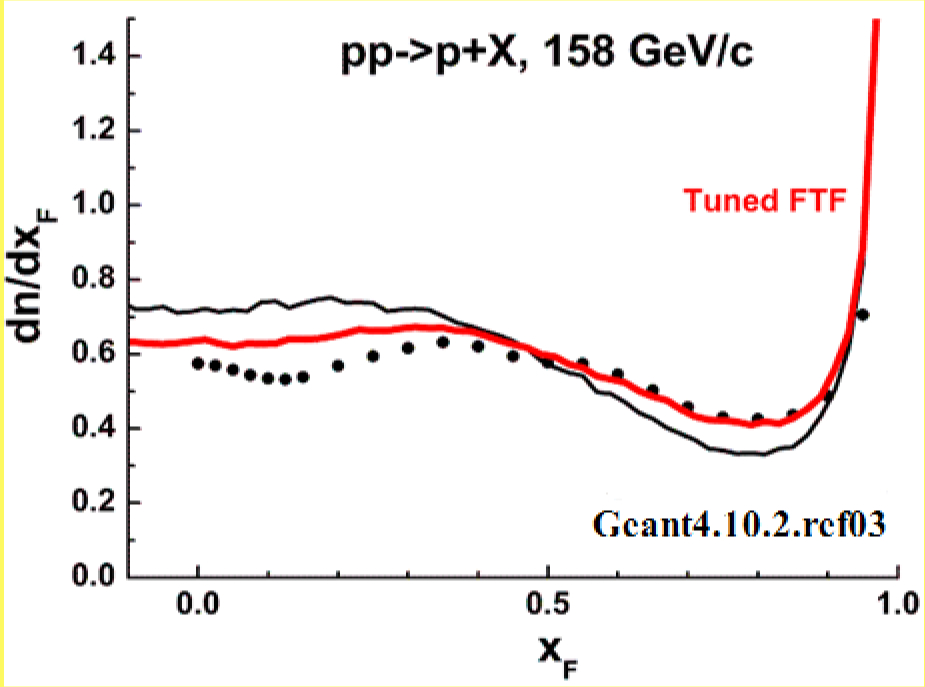
I have tested various fragmentation functions. The best one is:

F(z)~xmin + (xmax-xmin) x^n

n = 2.5 for B(1/2), and n=0.75 for B(3/2).

Result for proton spectra



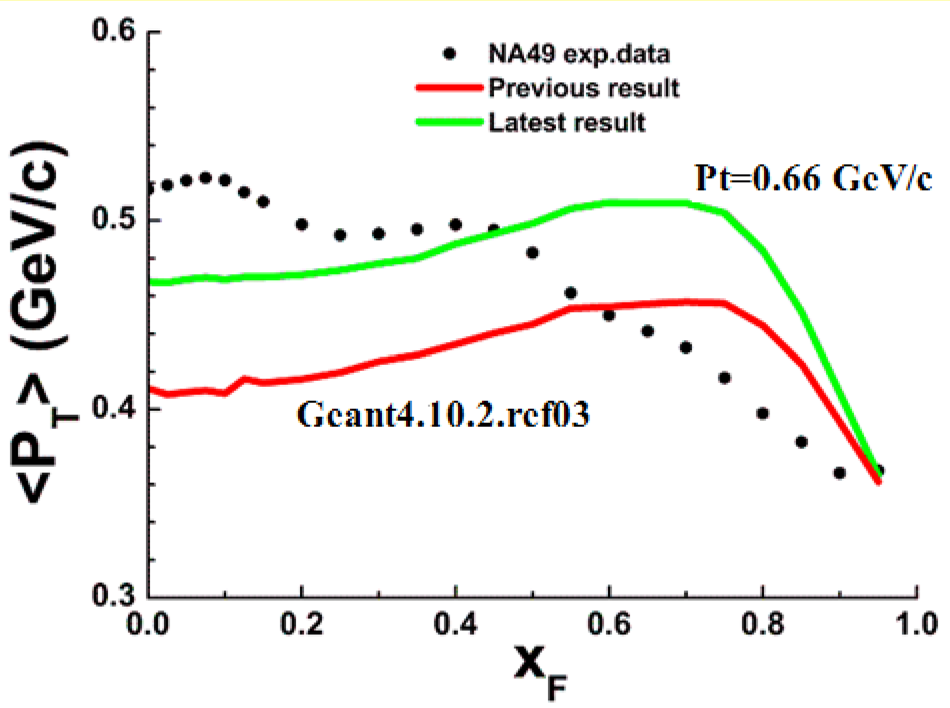


The description is not a perfect one, but it is reasonable.

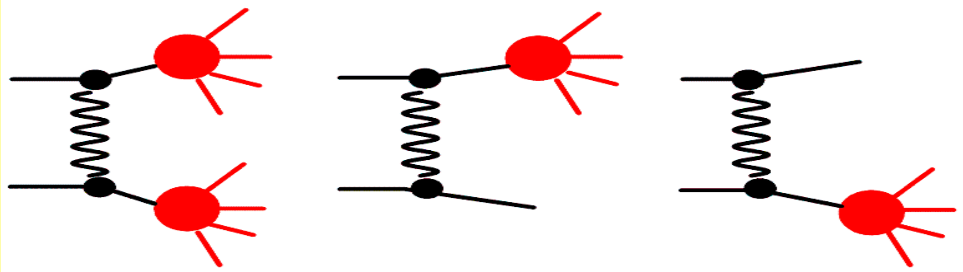
A question is – Why there are various descriptions of xF and rapidity spectra?

Probably, Pt distributions are not quite well!?

Tuning of proton Pt distributions



Exp. Data by NA49 Collaboration on p+p->p+X at 158 GeV/c



String fragmentation
<Pt>=0.5 at string fragmentation
<Pt>=0.66 for baryons
<Pt>=0.435 for mesons

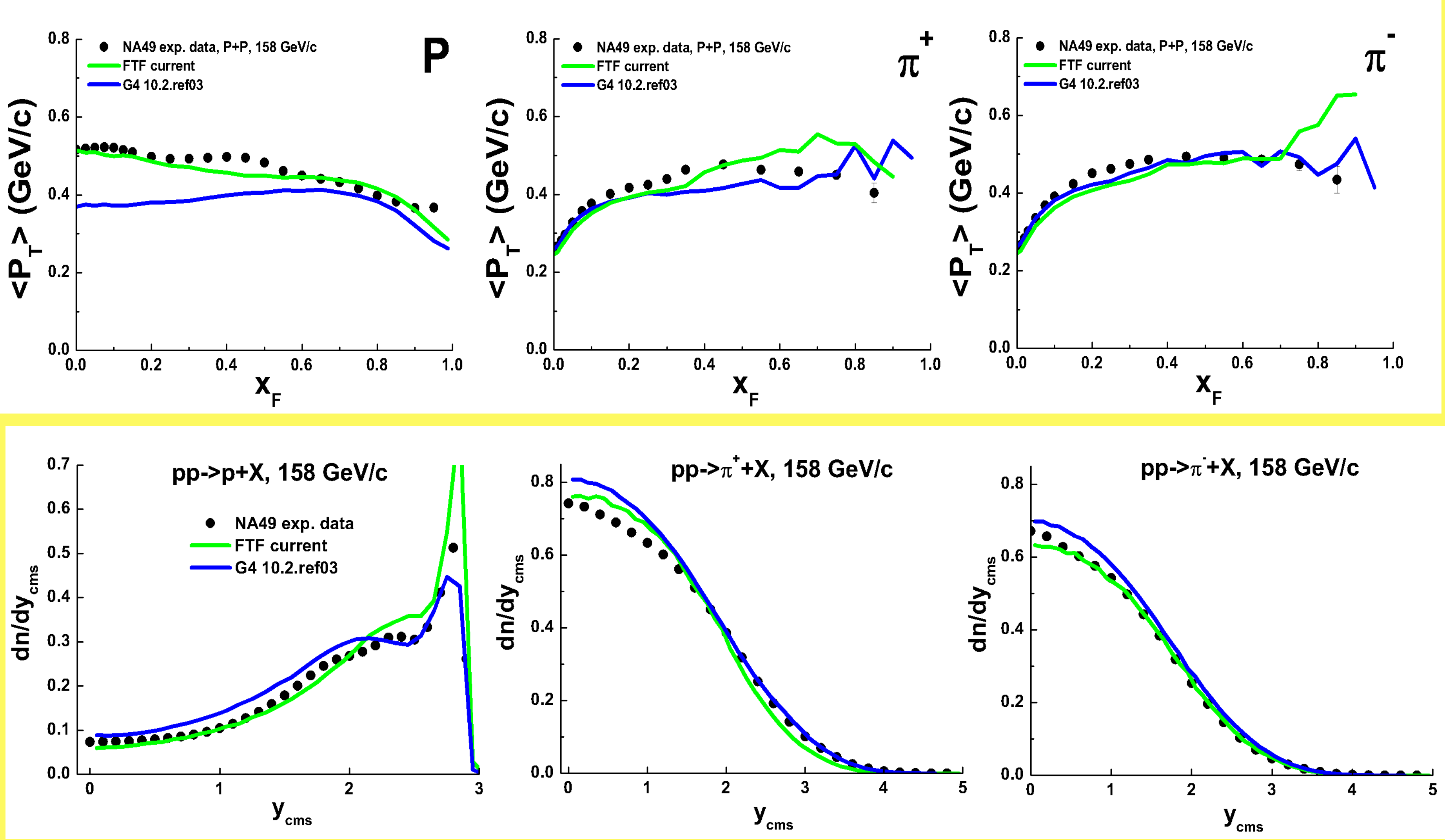
Before <Pt^2>=0.3 <Pt^2>=0.3 (GeV/c)^
Now <Pt^2>=0.3 <Pt^2>=0.15 (GeV/c)^2

Complicated structure of the dependence is a puzzle!

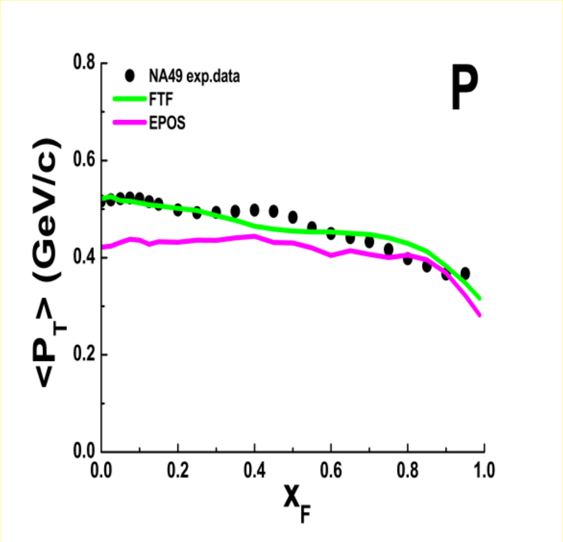
Δ isobar are dominating at xF < 0.8. Pt of Δ must be increased!

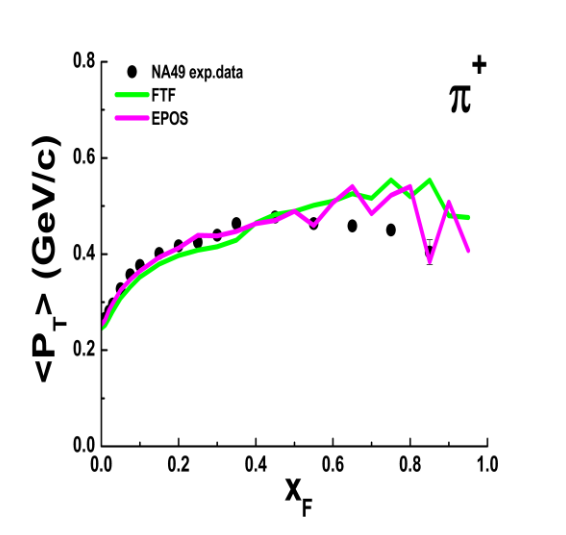
Current FTF and G4 10.2.ref03

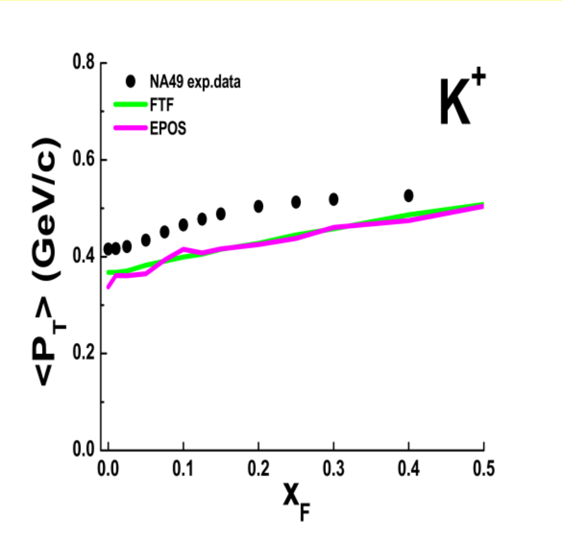
<Pt> at string fragmentation: 435 MeV/c for mesons
435 MeV/c for nucleons
1000 MeV/c for Δ isobar!



NA49 exp. Data, <Pt> - Xf, 158 GeV/c, FTF and EPOS







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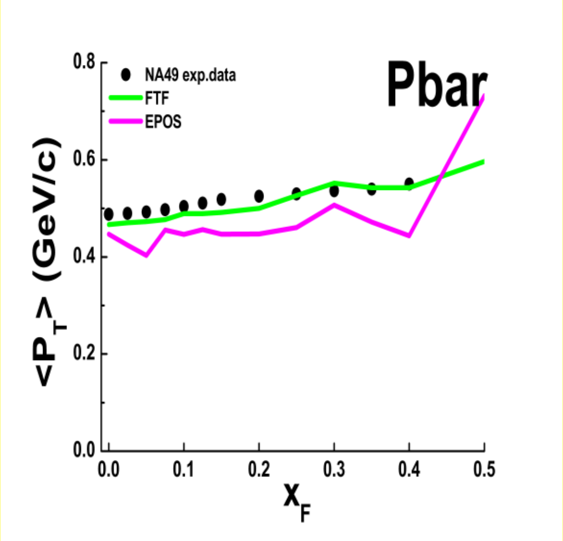

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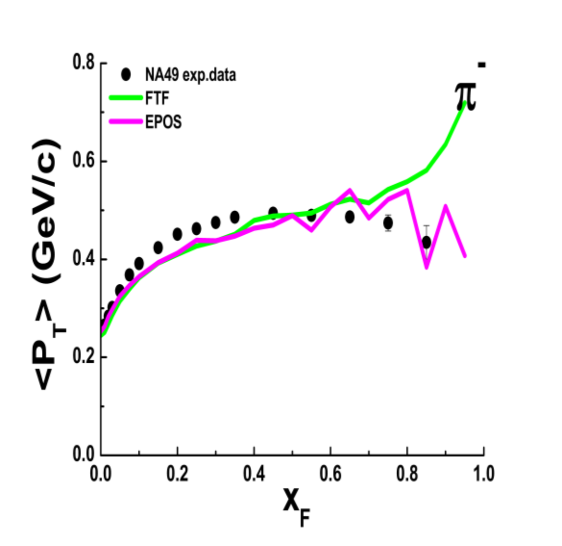
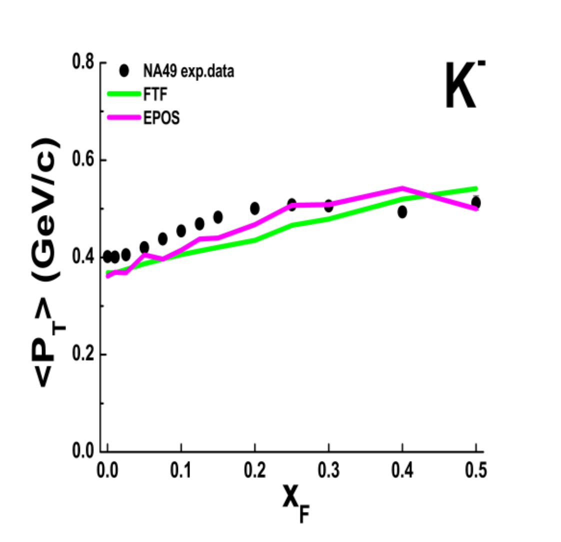
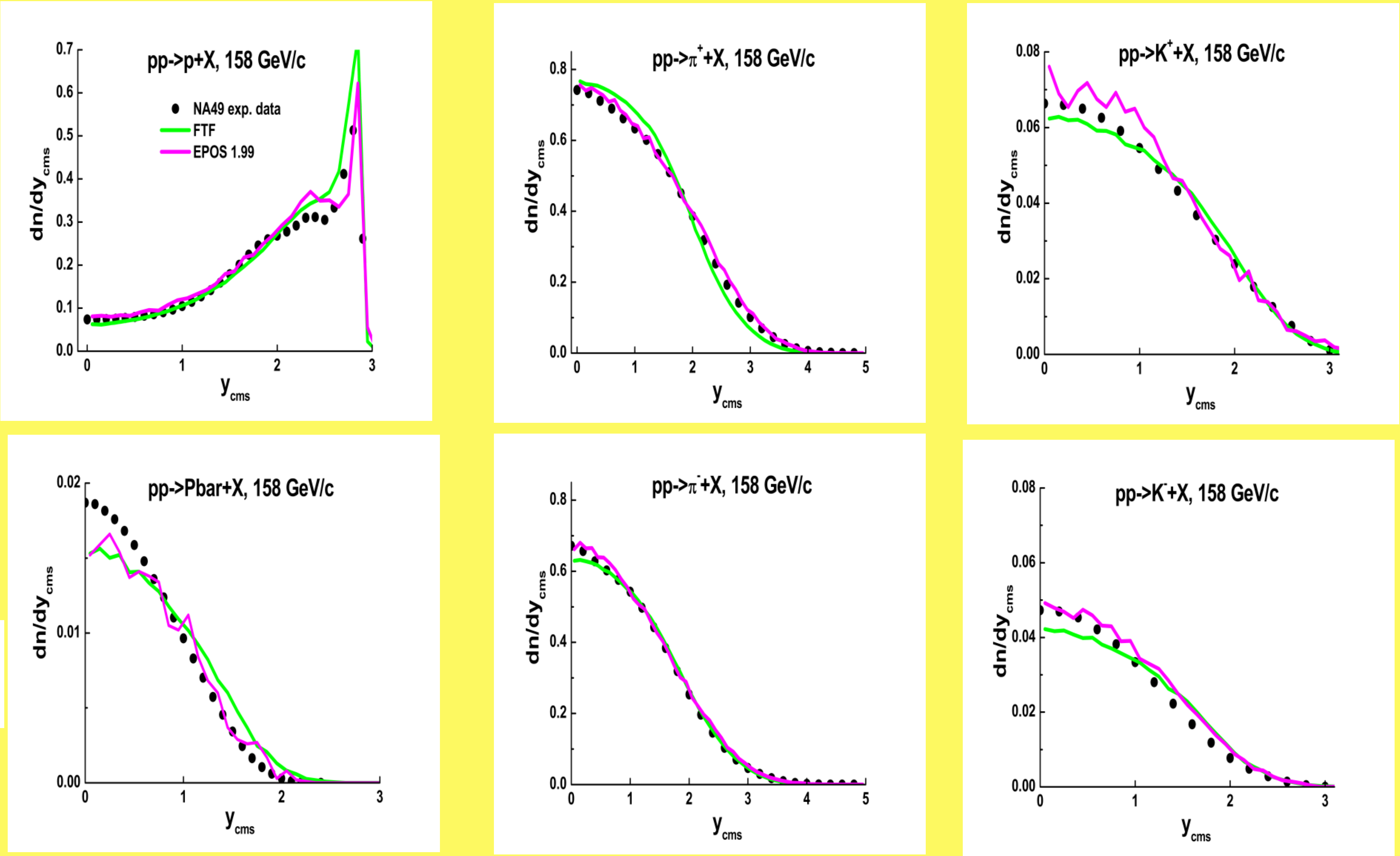




Results of FTF and EPOS are very closed to each other! Only problem with Pt of protons and antiprotons in EPOS. K+/K- common problem.

NA49 exp. Data, dn/dy, 158 GeV/c, FTF and EPOS



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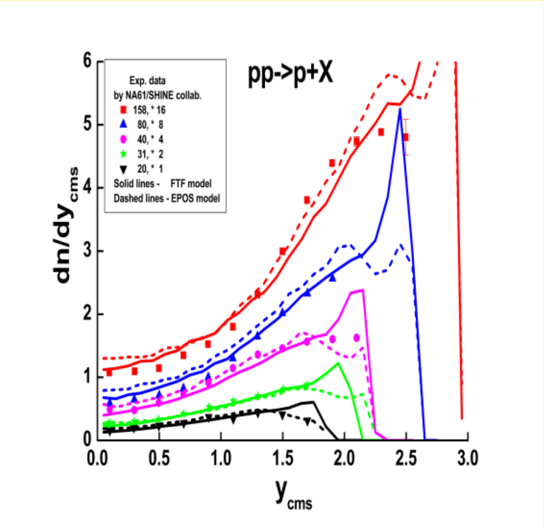
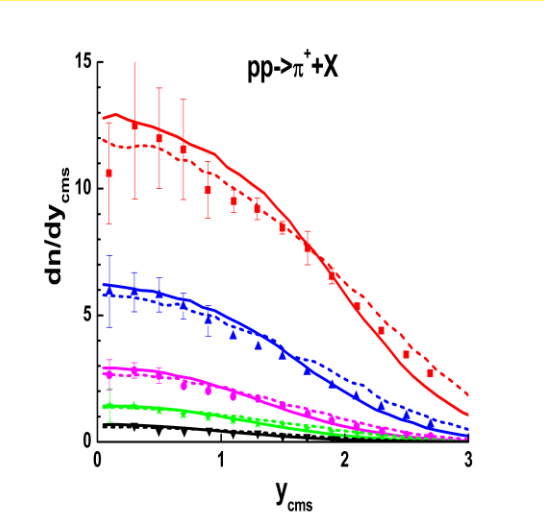
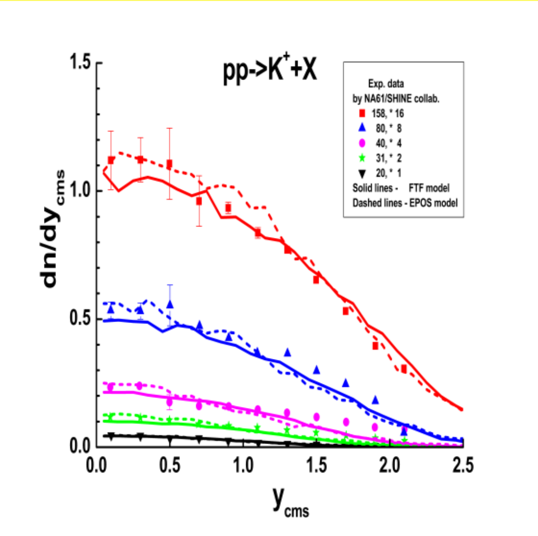
Results of FTF and EPOS are practically coincided! A correct description of diffractive protons at xF~1 is a problem.

NA61/Shine exp. Data, dn/dy, Pi-, 20, 31, 40, 80, 158 GeV/c

Marek Gazdzeski, D.T. Larsen, 2015







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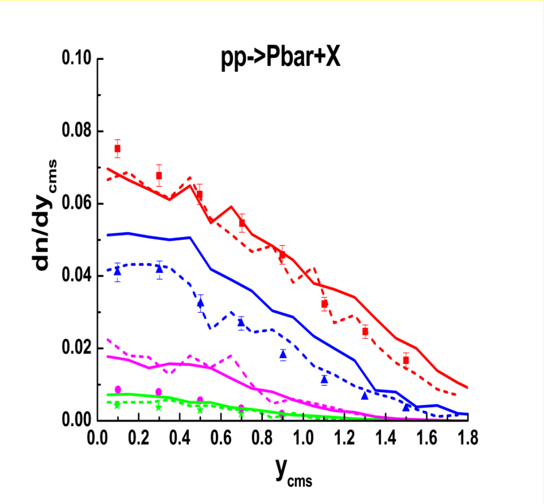

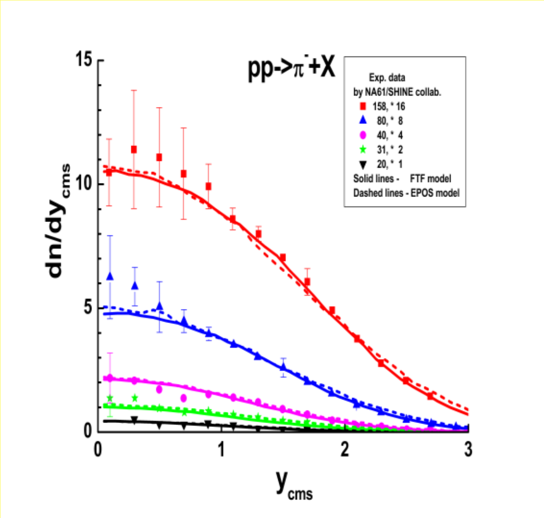

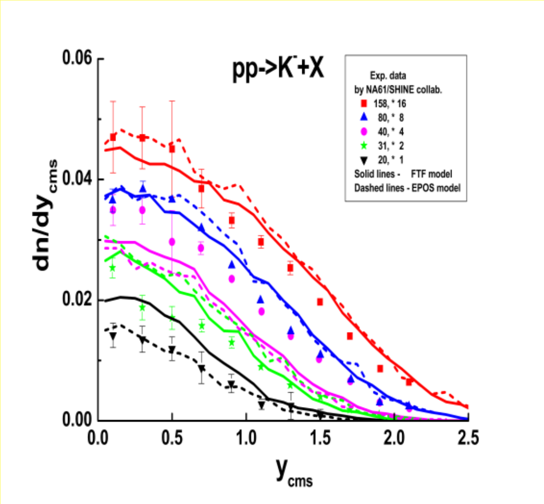

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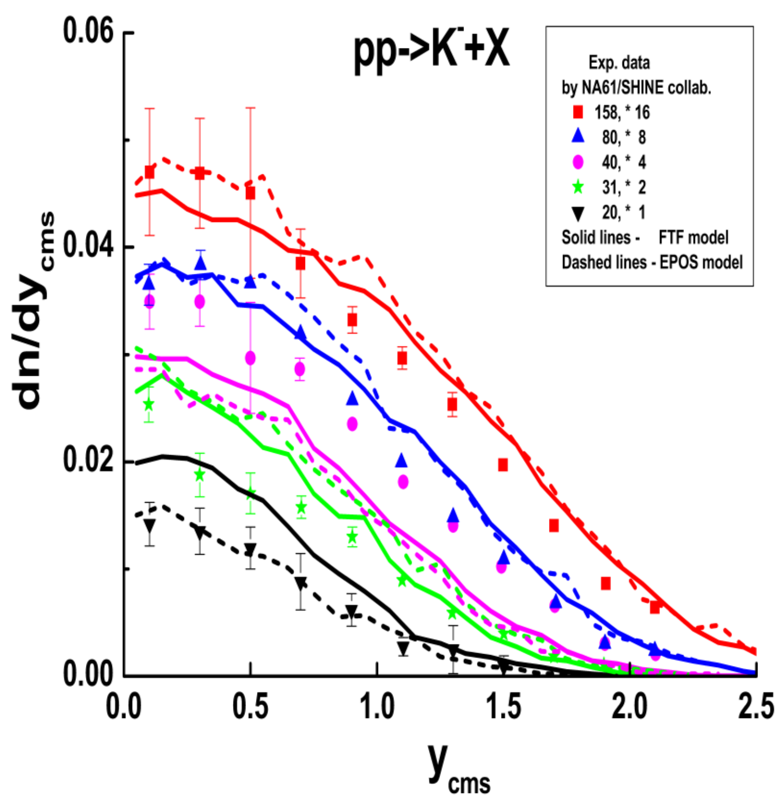
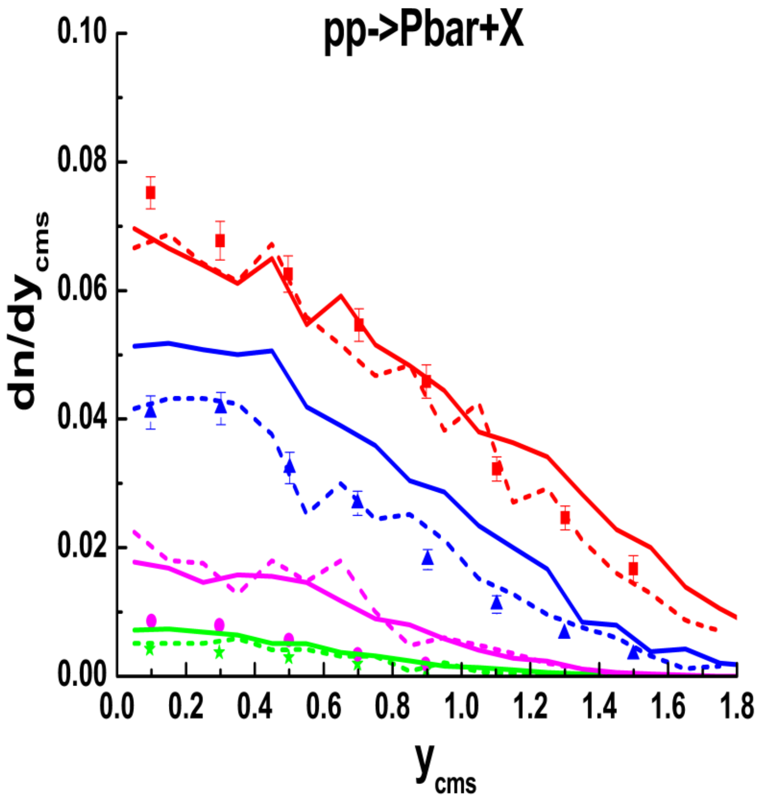
FTF and EPOS give good results for most of the particles!
There are problems with energy dependence of K- and Pbar.

Problems: K- mesons and anti-protons.





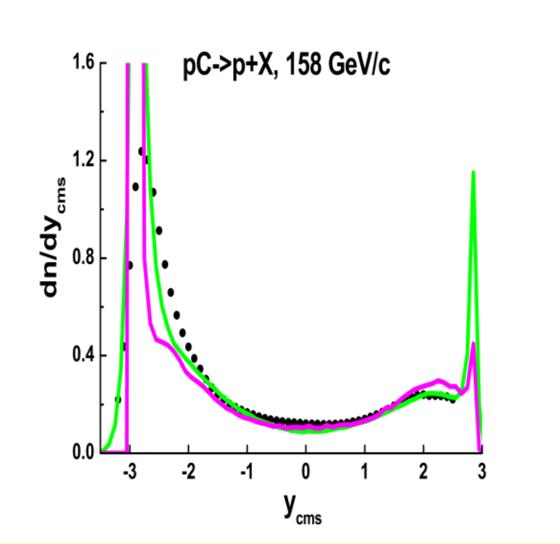
New parameters for LUND string fragmentation functions into K-mesons and anti-protons were introduced in the G4LundStringFragmentation:

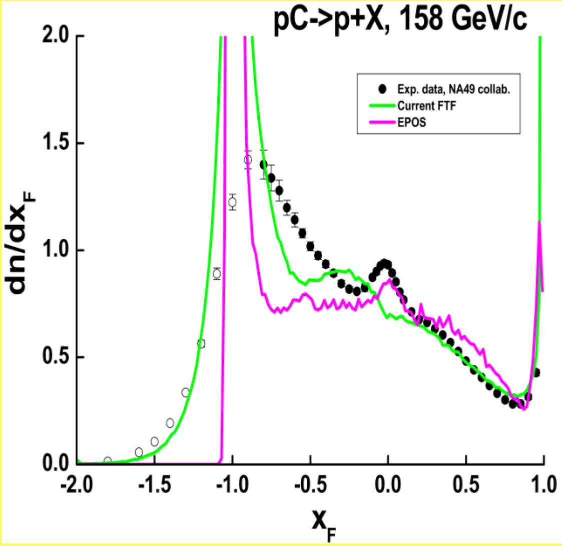
$F_{(LUND)}(z) \sim (1-z)/z \exp(-a\, Mt^2/z)$

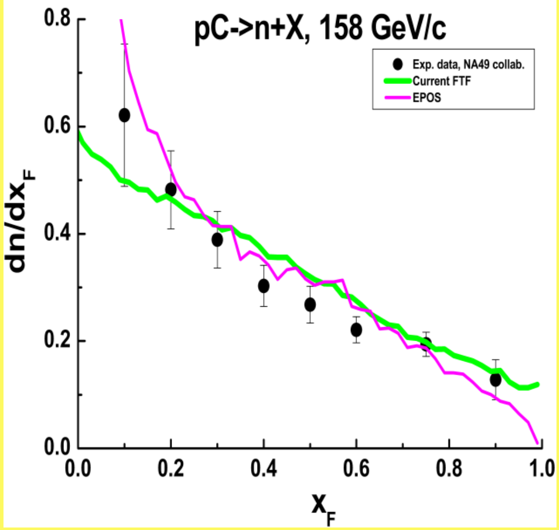
a=0.233 for K-mesons and a=0.0862 (std a=0.7)

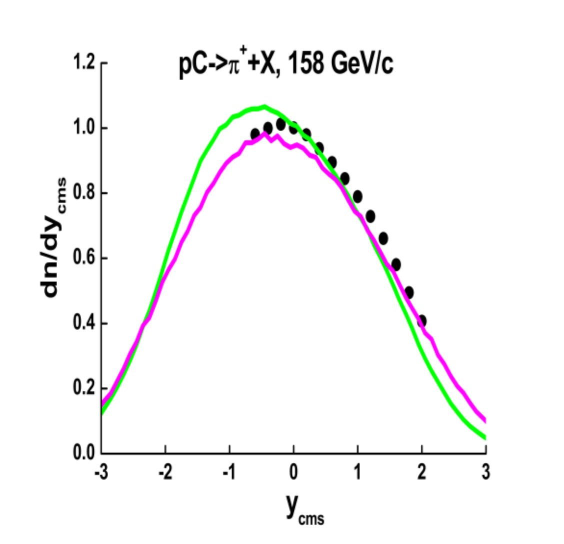
The sharp transition in anti-proton production at Plab ~ 30 – 40 GeV/c is unsolved!

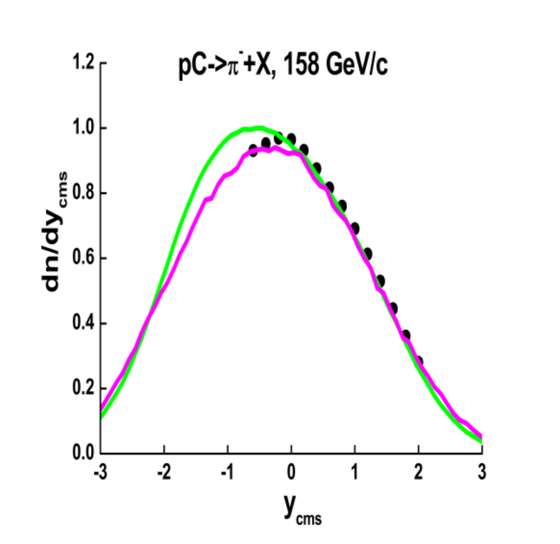
NA49 exp. Data, dn/dx and dndy, p+C,158 GeV/c

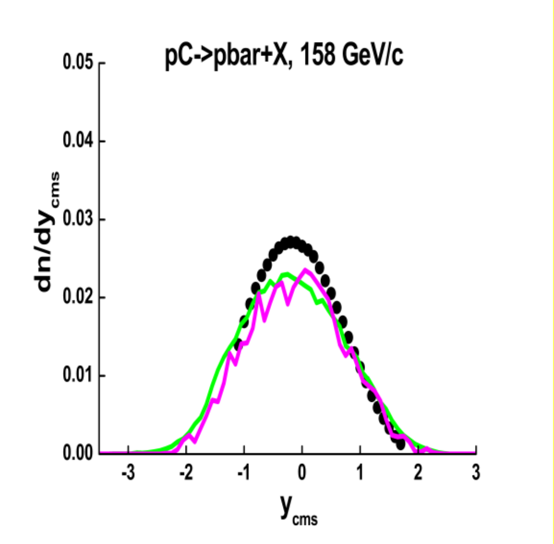












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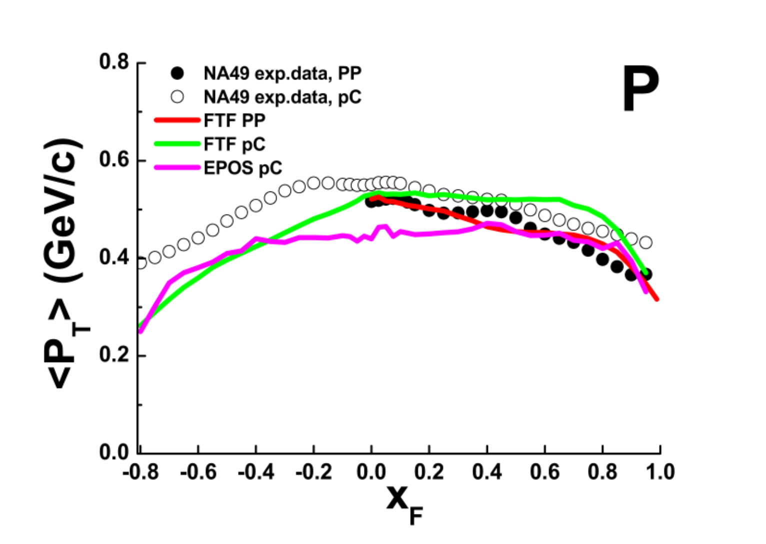
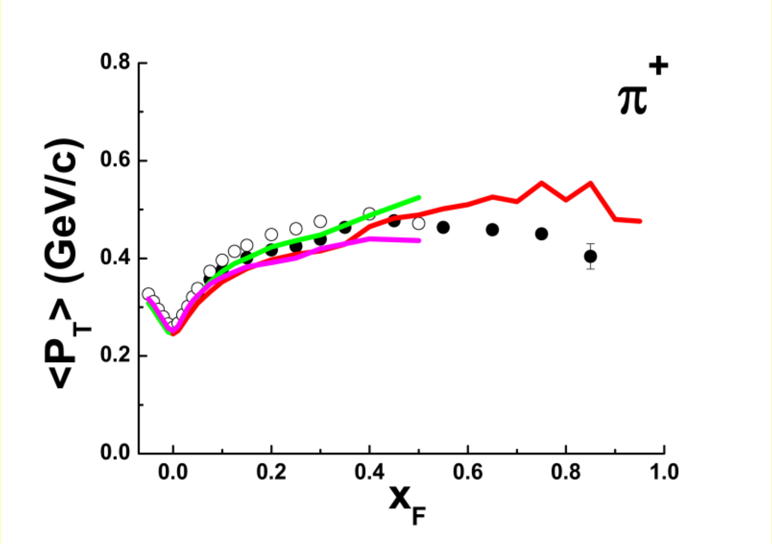
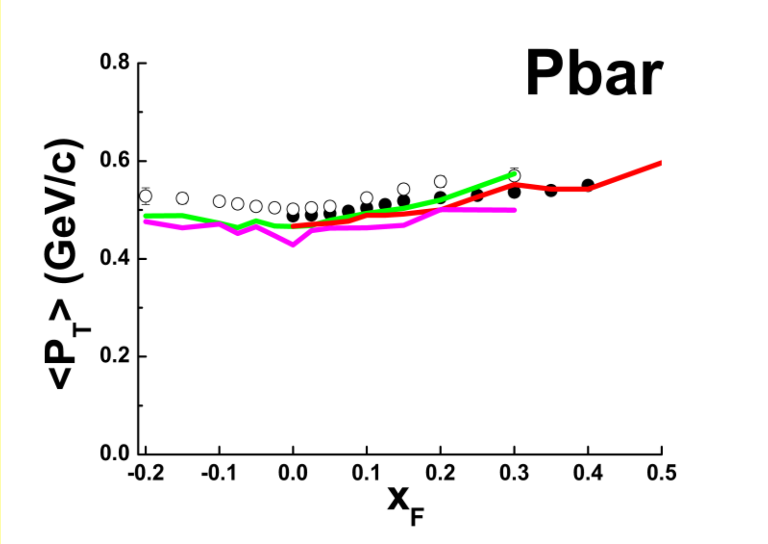
Results of FTF and EPOS are very closed to each other!

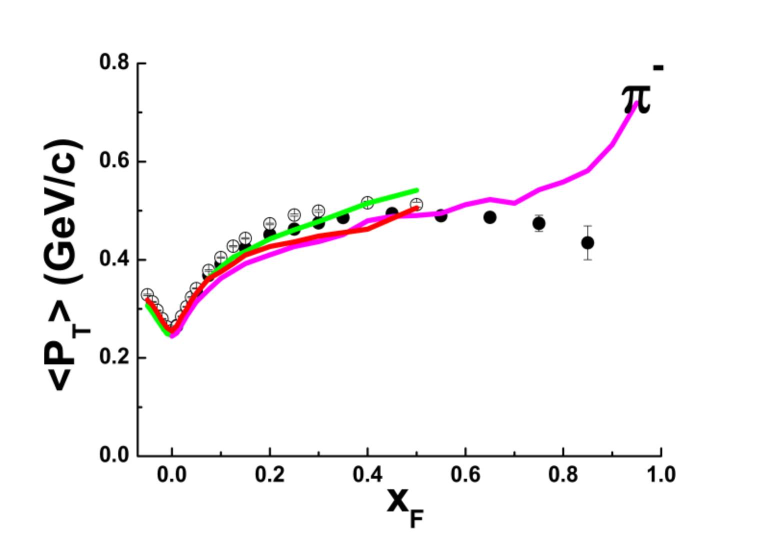
Only problem with protons in the target fr. region.

NA49 exp. Data, <Pt> - Xf, p+C, 158 GeV/c



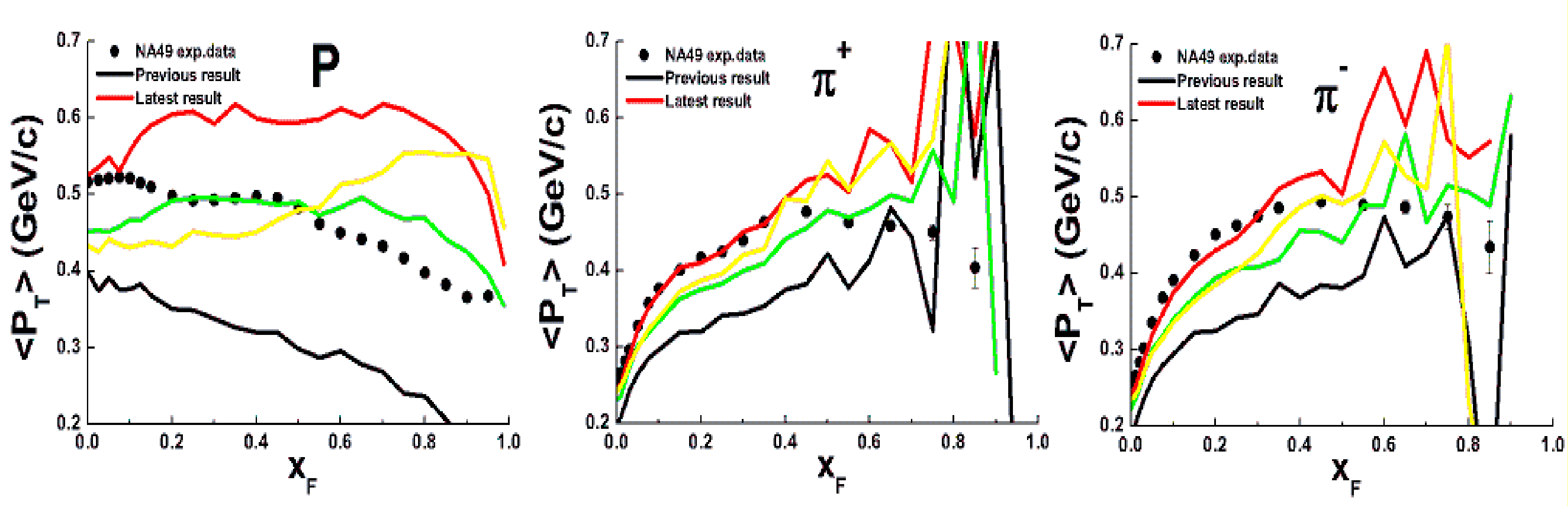


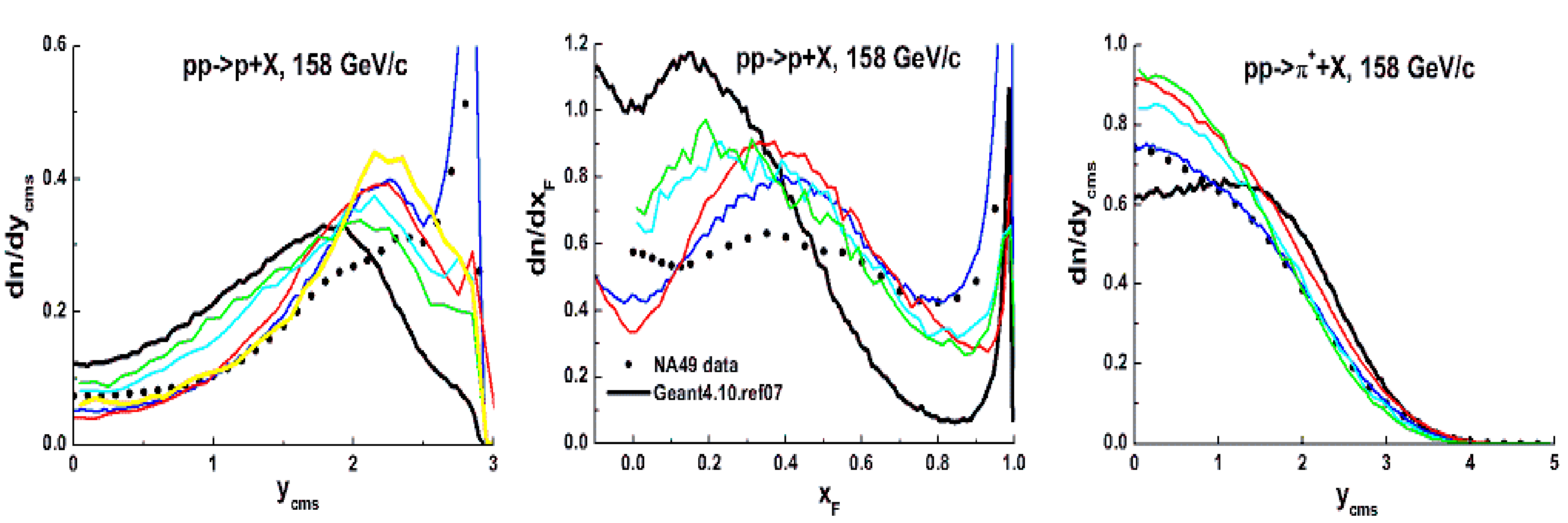




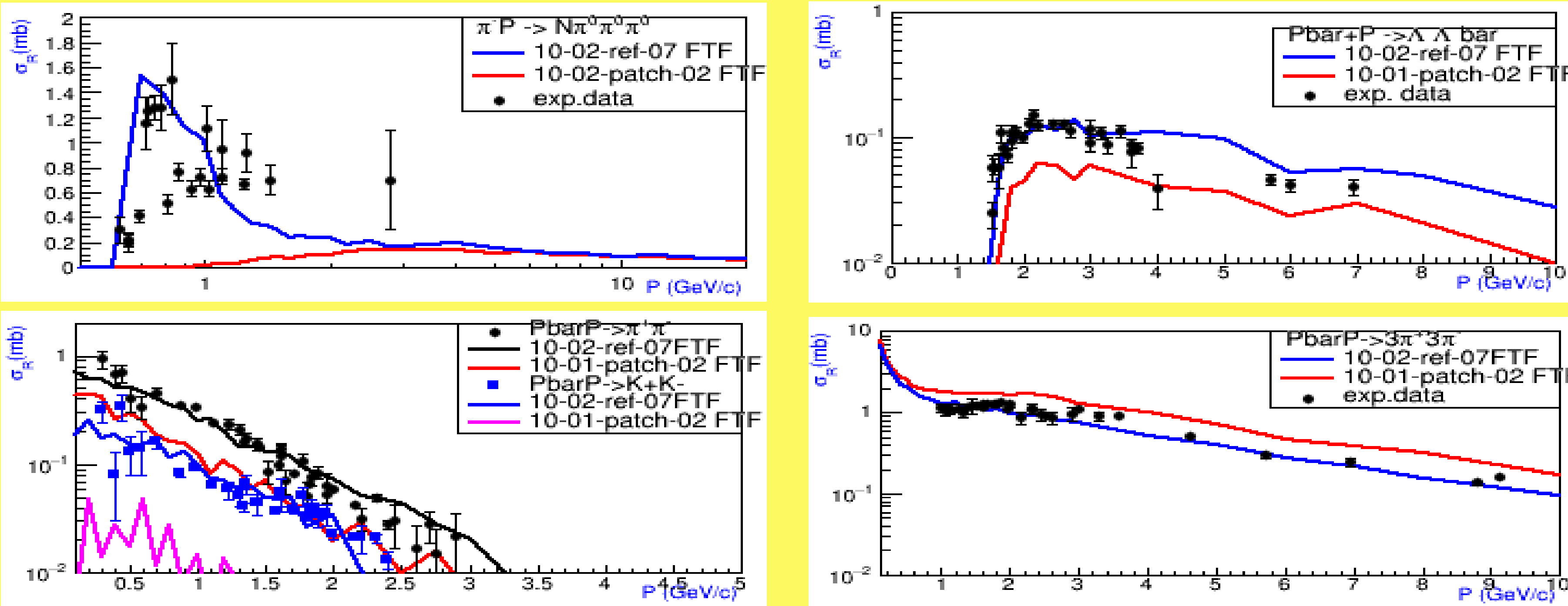
Results of FTF and EPOS are very closed to each other! Only problem with Pt of protons.

The analogous work is now doing for QGSM

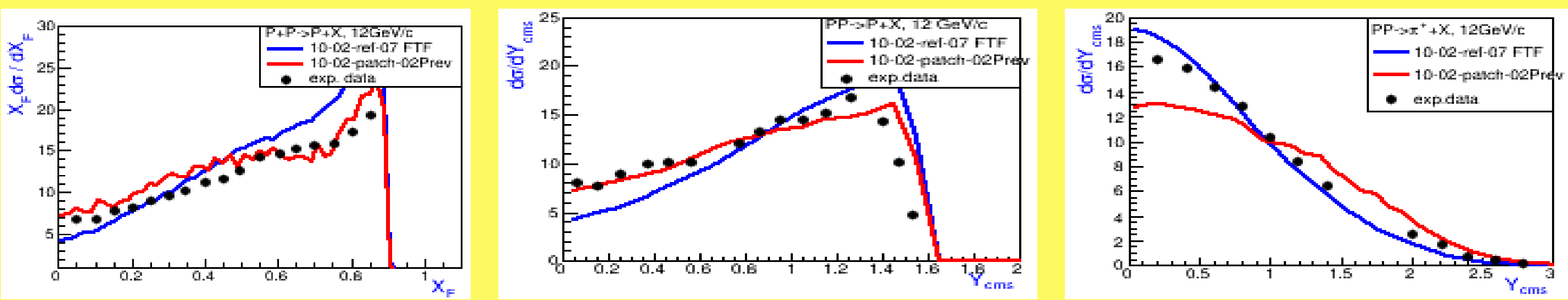




Validation of FTF

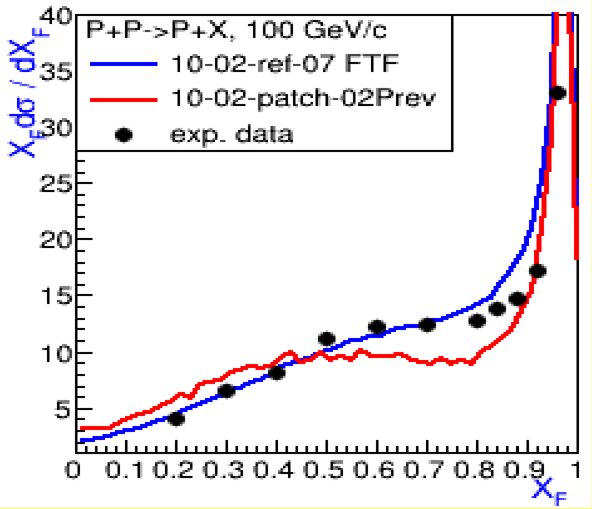


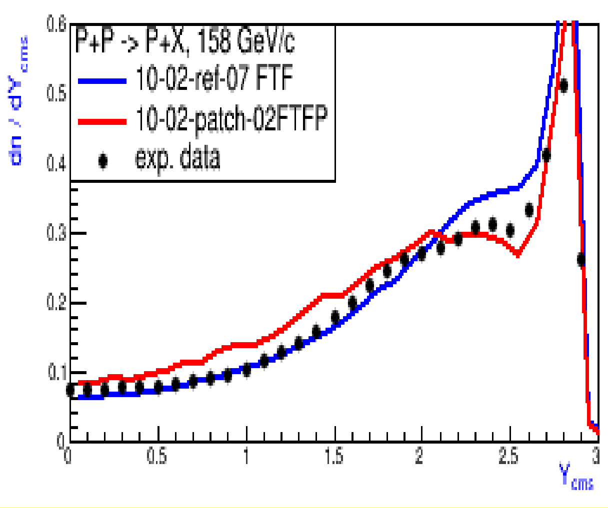
Description of channel cross sections in Pbar+P interactions is improved.

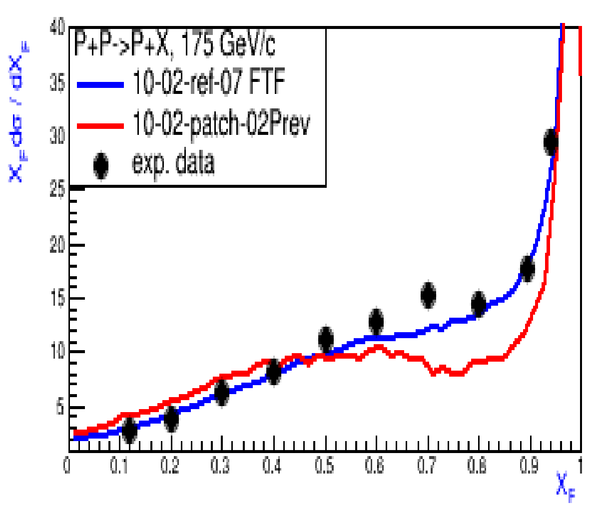


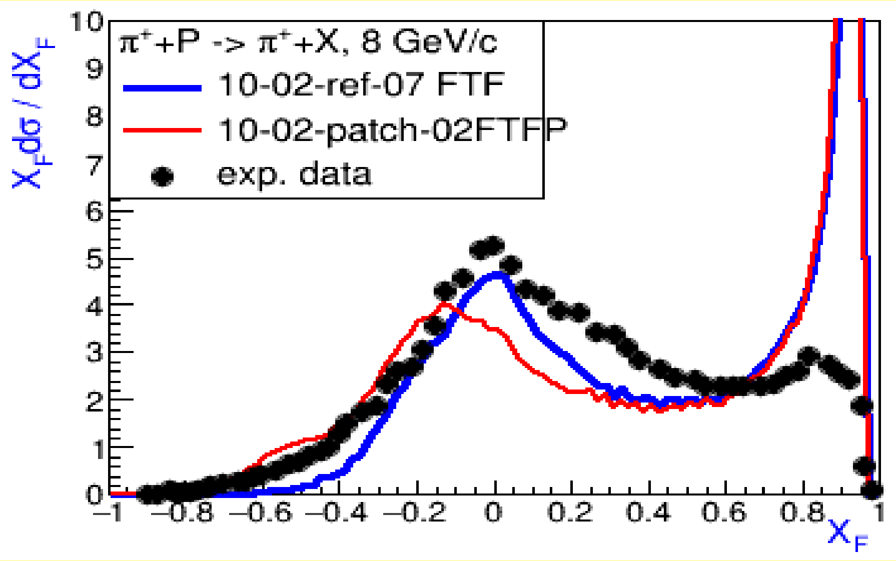
Proton and pion spectra in PP interactions are changed.

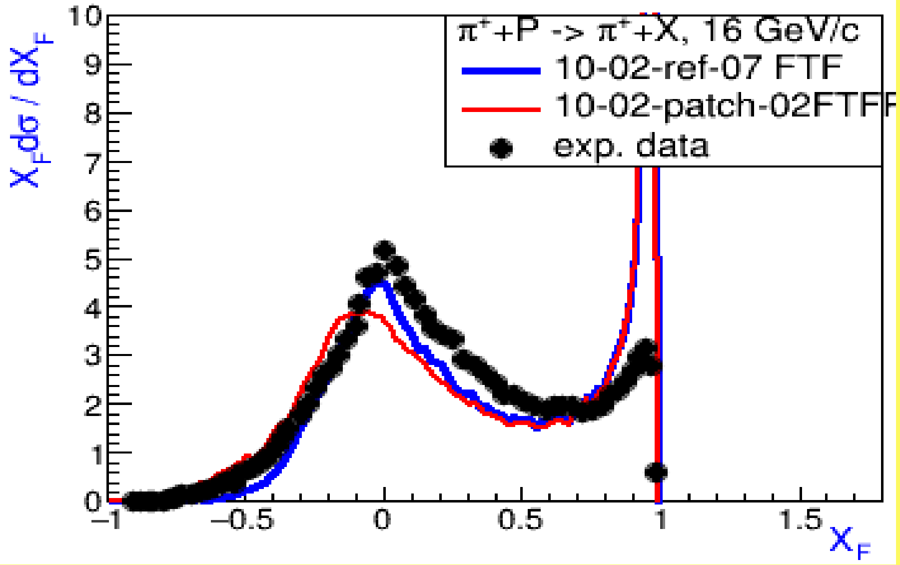
Validation of FTF, proton spectra in PP and Pi P interactions





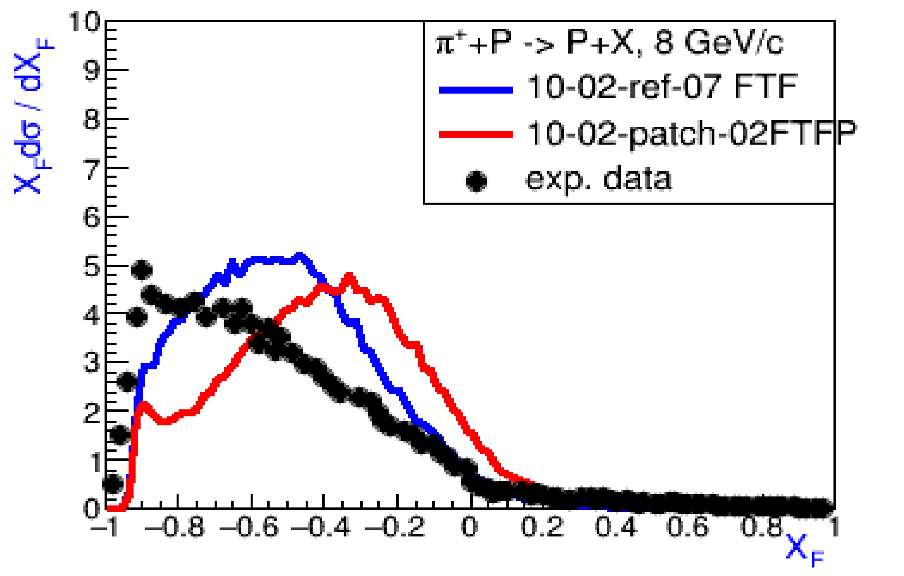


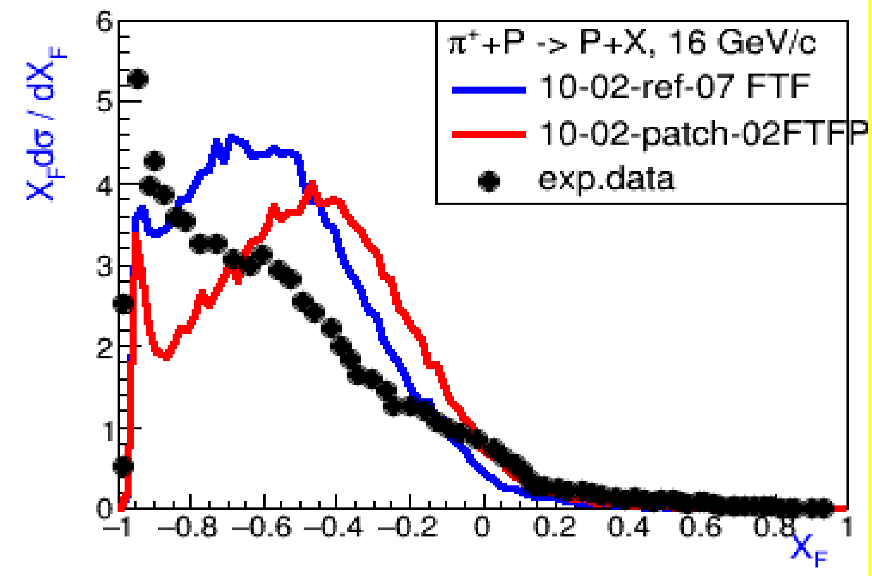


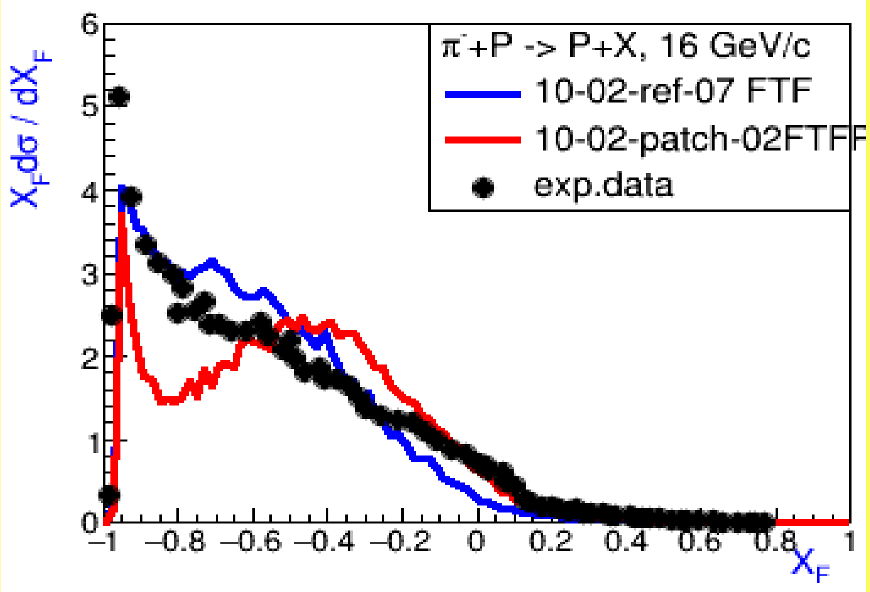


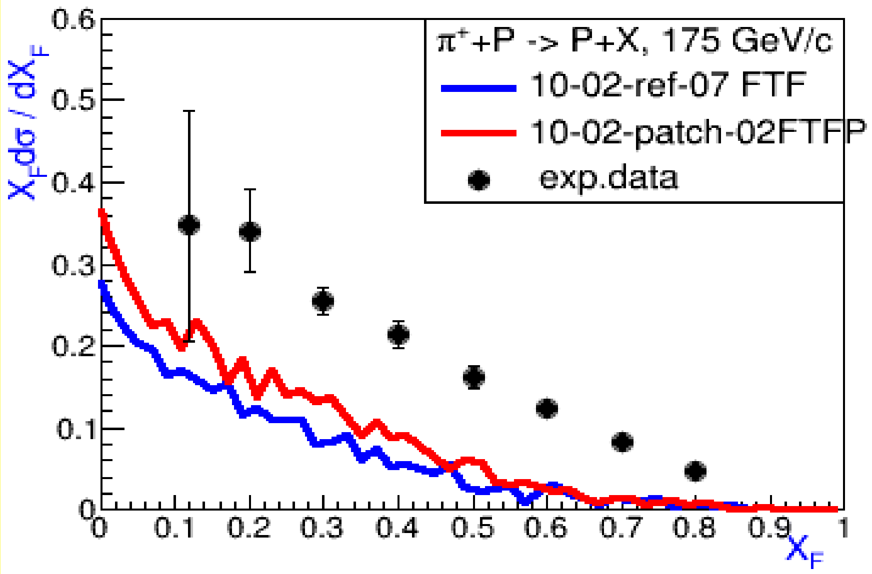
It is very important that proton spectra in Pi P interactions are also improved.

Validation of FTF, proton spectra in Pi P interactions



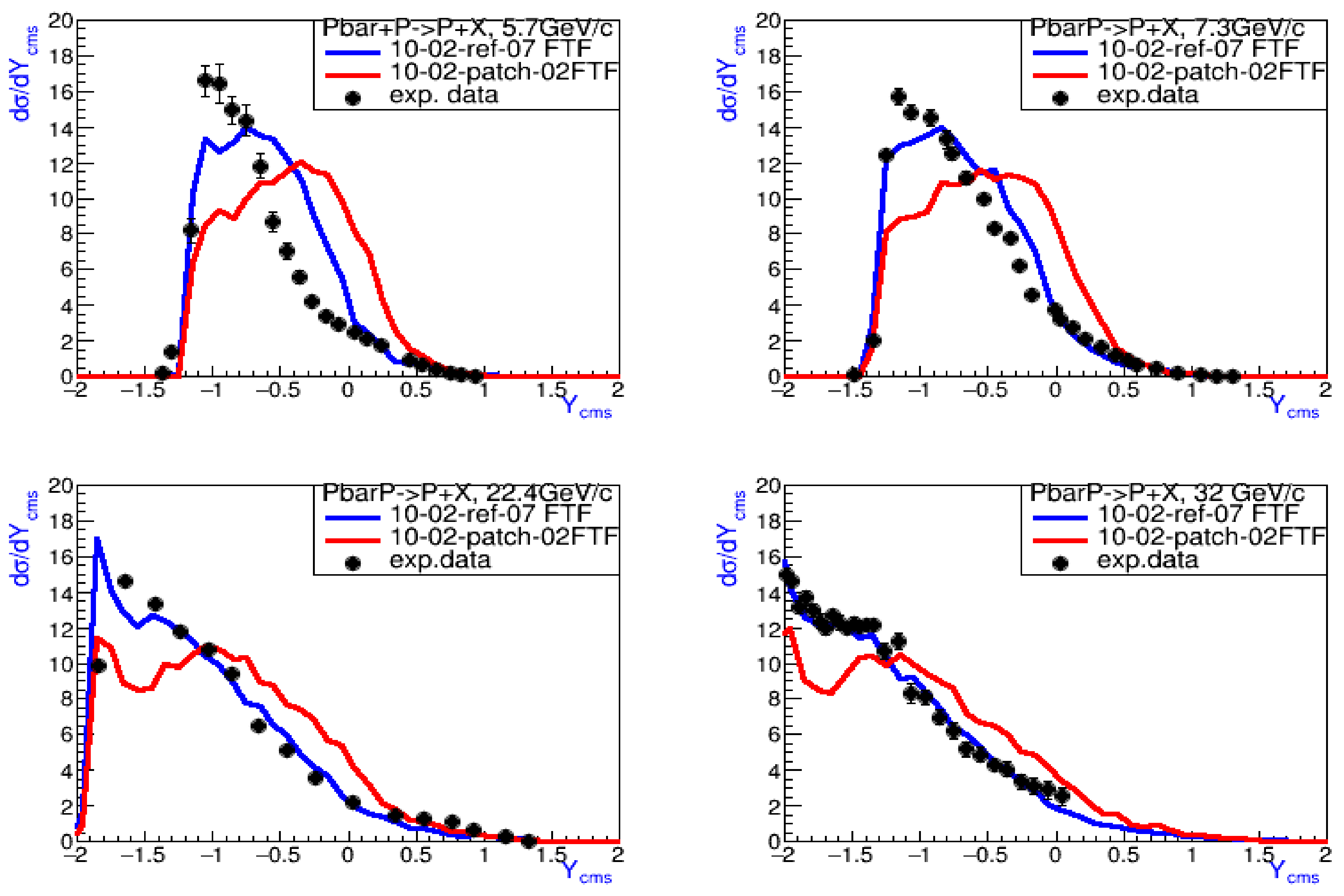






It is very important that proton spectra in Pi P interactions are also improved.

Validation of FTF, proton spectra in Pbar P interactions



The proton spectra in Pbar P interactions are improved.

Validation of FTF, p + A interactions

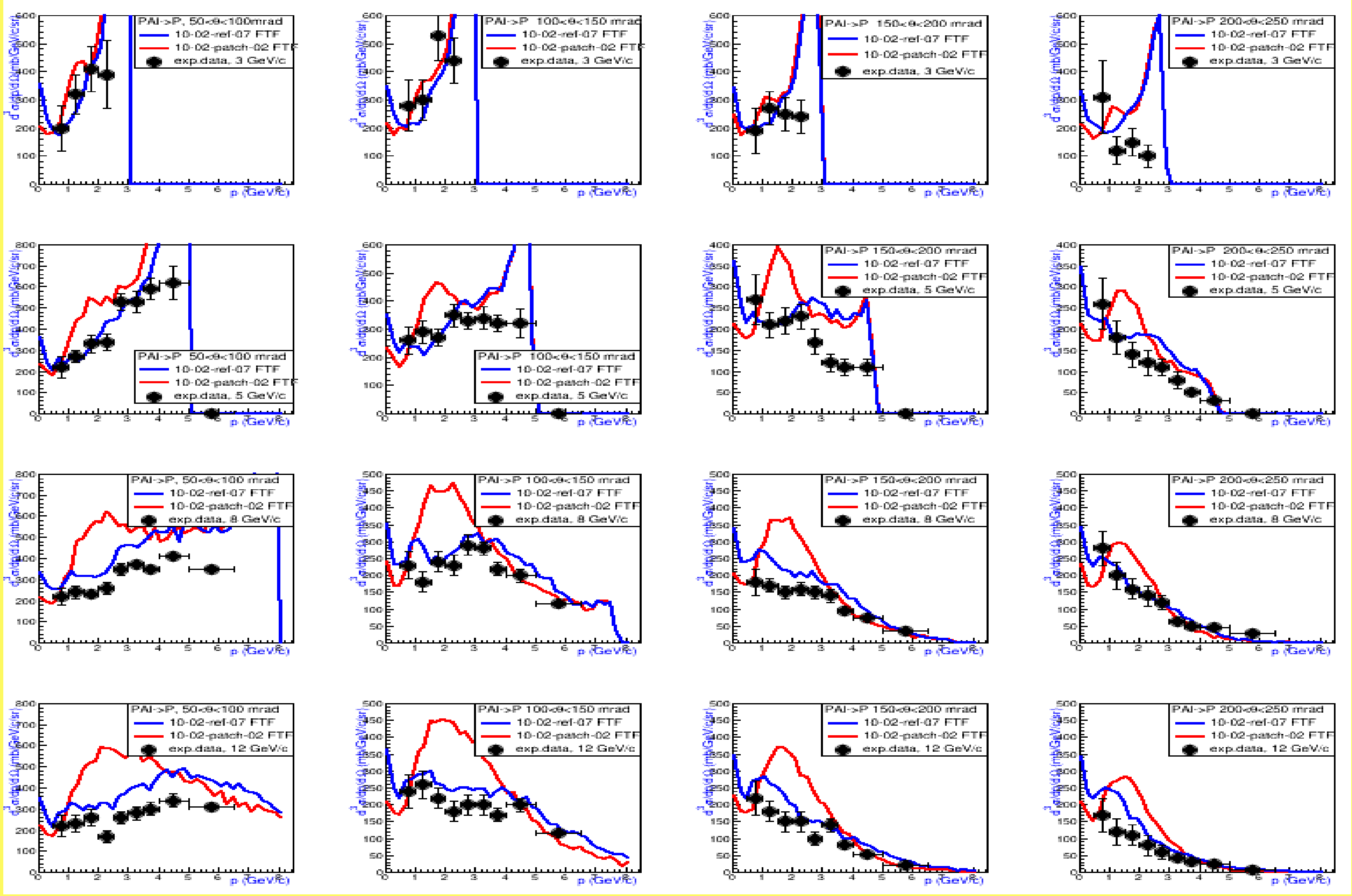
Proton spectra in p+ Al. HARP exp. data

3 GeV/c

5 GeV/c

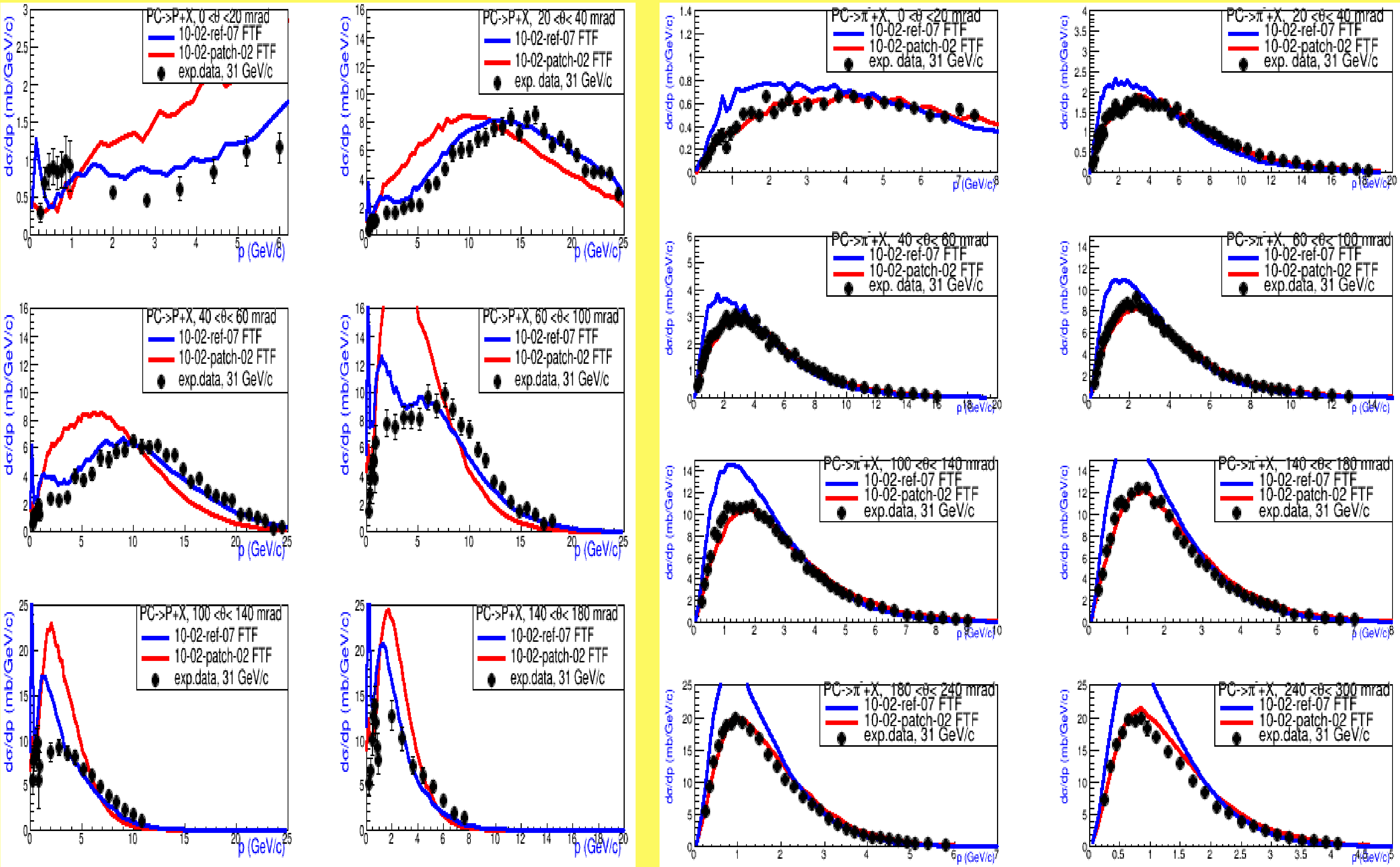
8 GeV/c

12 GeV/c



The proton spectra in P A interactions are improved at Plab >= 5 GeV/c.
Pi- improved also. Pi+ spectra are a little bit worse.

Validation of FTF, proton and Pi- meson spectra in p+C interactions at 31 GeV/c



Proton spectra are OK. **Pi meson ones have to be improved!**

Summary

The main message of us is, Δ isobars must be special treated in ALL string fragmentation model!

1. **Fragmentation functions for baryons were chosen:**
   F(z)~xmin + (xmax-xmin) x^(n-1), n = 2.5 for B(1/2), and n=0.75 for B(3/2).

2. **<Pt> of particles at a string fragmentation are tuned:**
   for mesons and baryons (1/2) – 435 MeV/c
   for baryons (3/2) - 1000 MeV/c !!!

3. **Improvement of FTF validation is proposed – accounting of Eta and Eta prime decays.**
4. **Smearing of Delta mass is implemented in quark exchange processes.**
5. **Antibaryon annihilation was improved.**

FTF model is on the level of other models for pp interactions. What will it be for nucleus-nucleus ones?

The main problem of models, except EPOS, was a description of baryon spectra. It is now solved in part in FTF.

Description of general features of particles inclusive spectra in PP interactions at 20 – 158 GeV/c is reached!
<Pt> - Xf correlations are reproduced!