Development of FTF and QGS models
V. Uzhinsky, september 2017

Main task of FTF solved in 2017: implementation of “rotating” strings

QGSM implementation is very old. It is needed to improve it. 2016 -- a correction of string fragmentation functions. 2017 -- process cross sections.

Content:

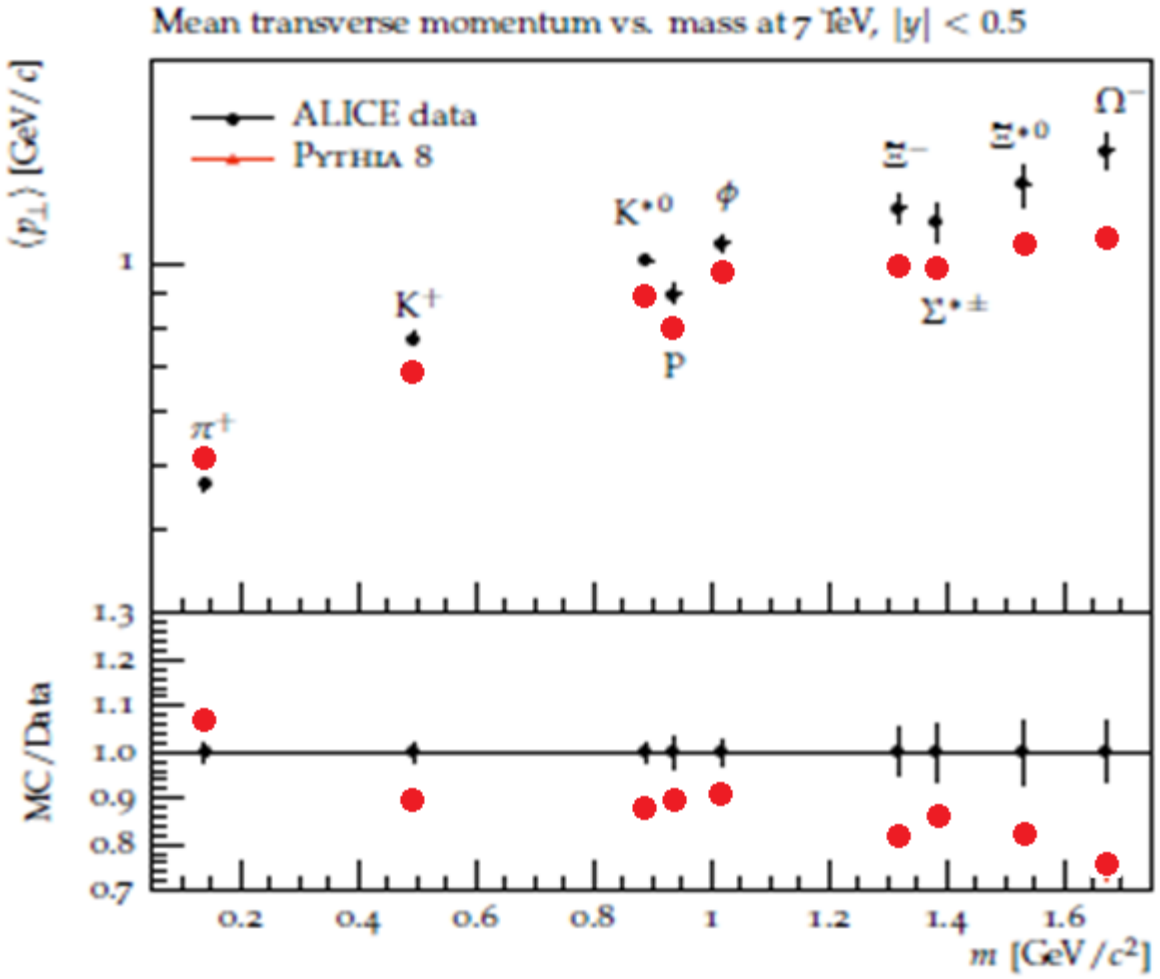
1. **Problems of Pythia, problems of FTF**
2. **Rotating strings implementation and its results**
3. **Pomeron and non-vacuum reggeon cross sections**
4. **Cutting of non-vacuum region exchanges**
5. **Conclusion**

Latest results for Pi- C interactions at 158 and 350 GeV/c Measured by NA61/SHINE Collaboration.

1. Problems of Pythia

N. Fischer and T. Sjostrand, JHEP 1701 (2017) 140
Thermodynamical String Fragmentation

Problems of Pythia: It does not reproduce particle yield and <Pt> dependence on particle types (ALICE data).



Two main ideas of the paper:
1 Variation of the string tension due to string fusion.
***2* Thermodynamical String Fragmentation;**
exp(-Mt had/T)

Mt=sqrt(m^2+Pt^2)

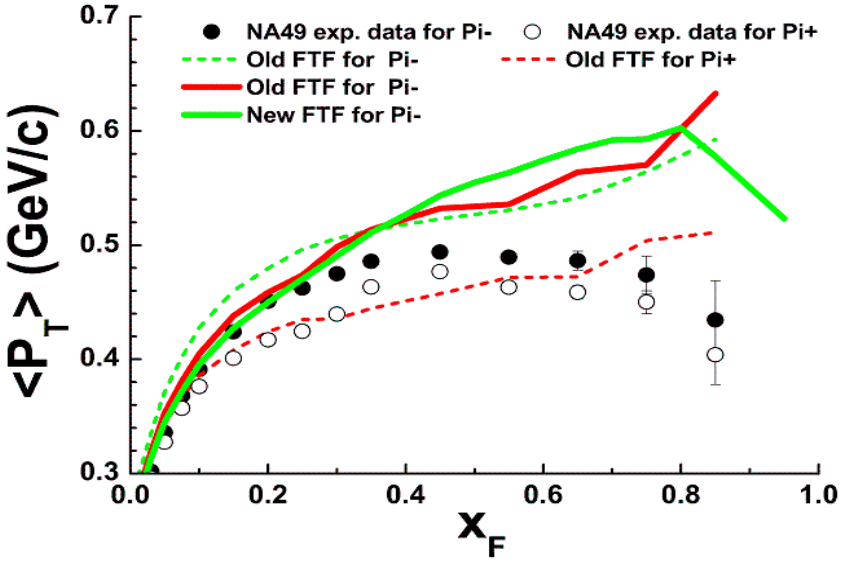
A. Bialas, Phys.Lett. B466 (1999) 301: Fluctuations of the string tension and transverse mass distribution

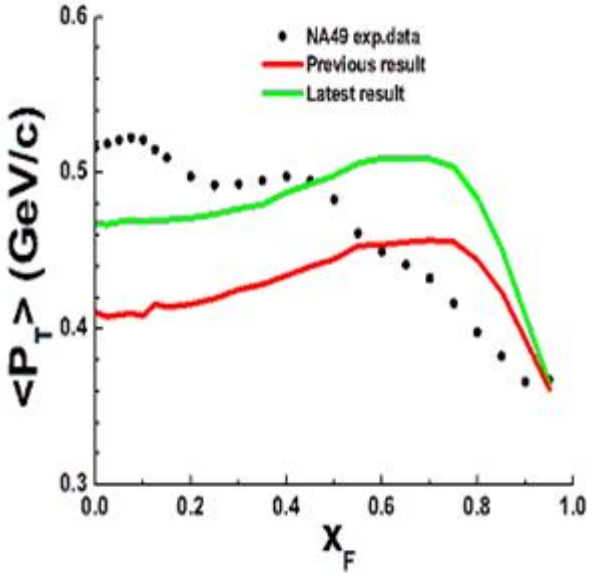
R. A. Janik and R. Peschanski, Phys. Lett. B576 (2001) 90 The Lund model at nonzero impact parameter

Schwinger formula: $\exp\left(-\pi m_{\perp q}^2/\kappa\right) = \exp\left(-\pi m_q^2/\kappa\right) \exp\left(-\pi p_{\perp q}^2/\kappa\right)$

1. Problems of FTF

<Pt> - Xf correlations are approximately reproduced for Pi mesons, but not for protons! (see red and green lines)





<Pt>=0.5 GeV for mesons and baryons at string fragmentation
Better results were obtained at
<Pt>=0.66 for baryons
<Pt>=0.435 for mesons

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

Final <Pt> of particles at a string fragmentation:
for mesons – 435 MeV/c for baryons (1/2) - 435 MeV/c
for baryons (3/2) - 900 MeV/c

A regular solution was needed!

2. Rotating strings implementation and its results

Simple ideas – Introduction of Mt distributions, and rotate fragmenting strings

following to
Vladimir Lugovoi, Rotating String, arxiv: 9811486 [hep-ph]
and H. J. Schulze and J. Aichelin, Phys. Rev. D43 (1999)
Main idea: Fragmenting strings are rotating.

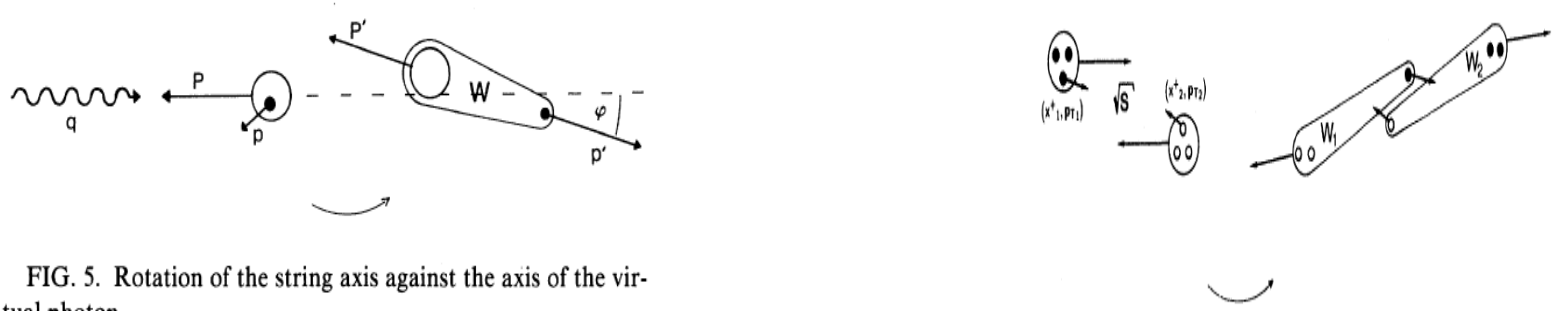
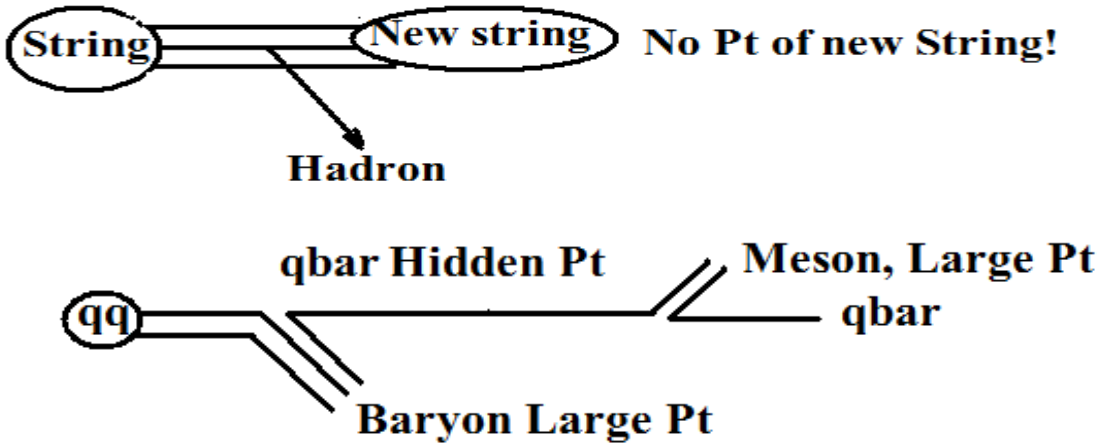


FIG. 5. Rotation of the string axis against the axis of the virtual photon.

LUND String Fragmentation Model in Geant4!



2. Rotating strings implementation and its results

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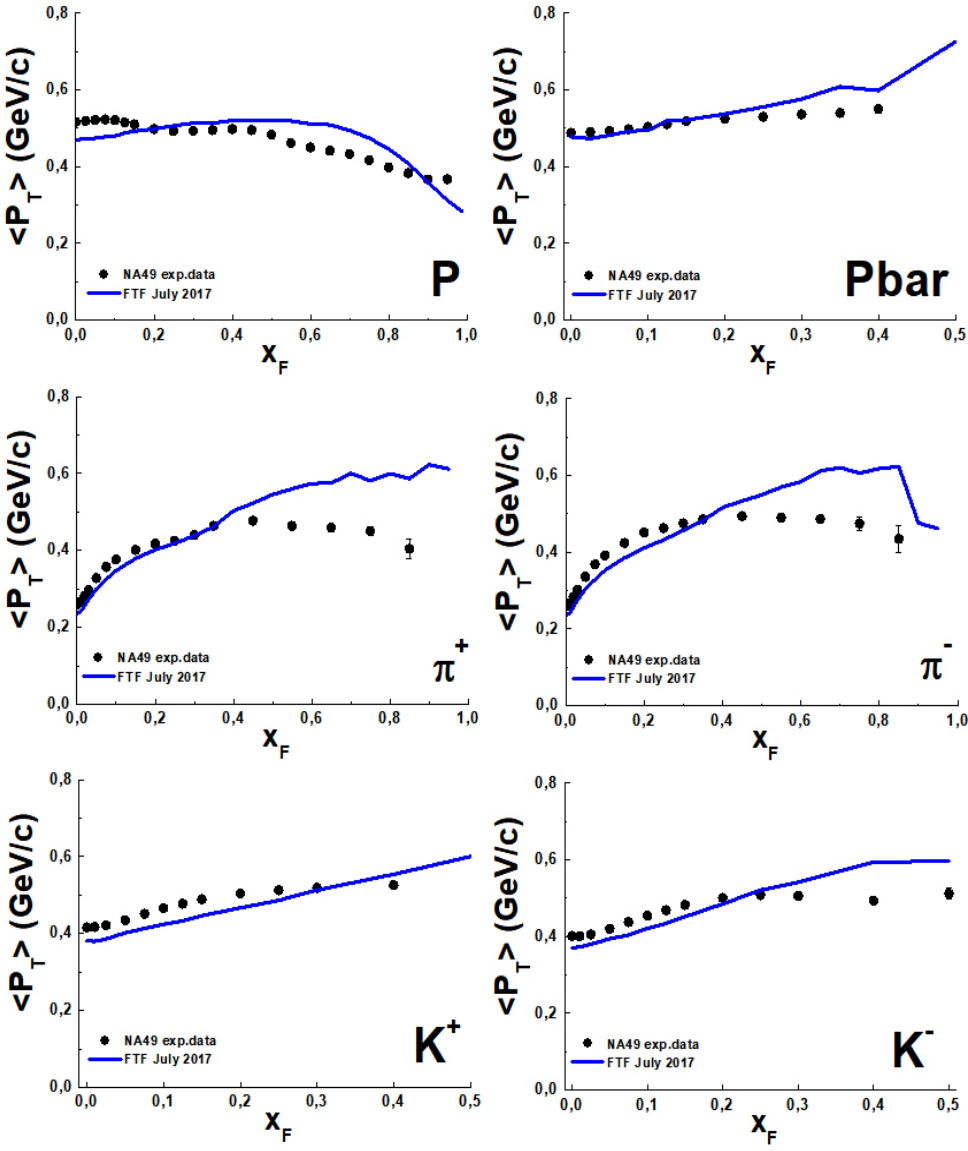
Main idea: Fragmenting strings are rotating.

At the end of Feb. 2017 implementation of the rotating string was finished. Bugs fixing and parameter tuning continued 5 months. Due to these, results of string fragmentations changed, and description of hadron-nucleon and hadron-nucleus interactions was improved.



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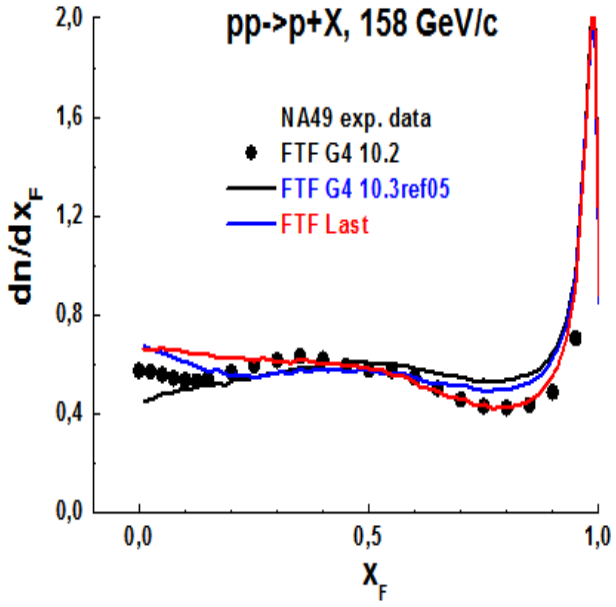
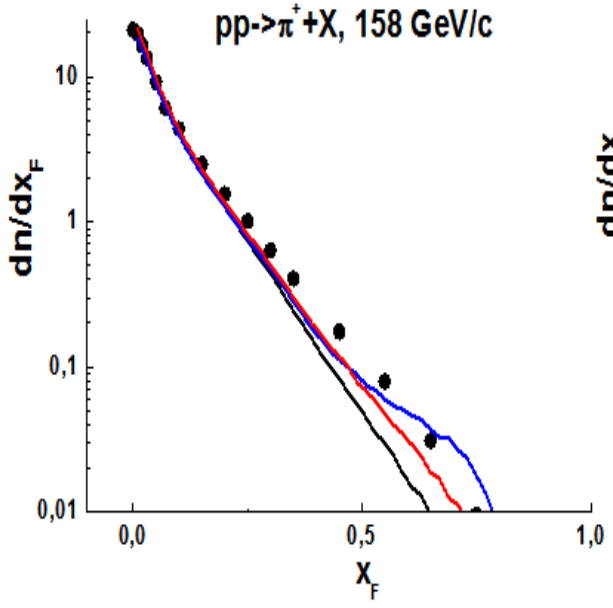
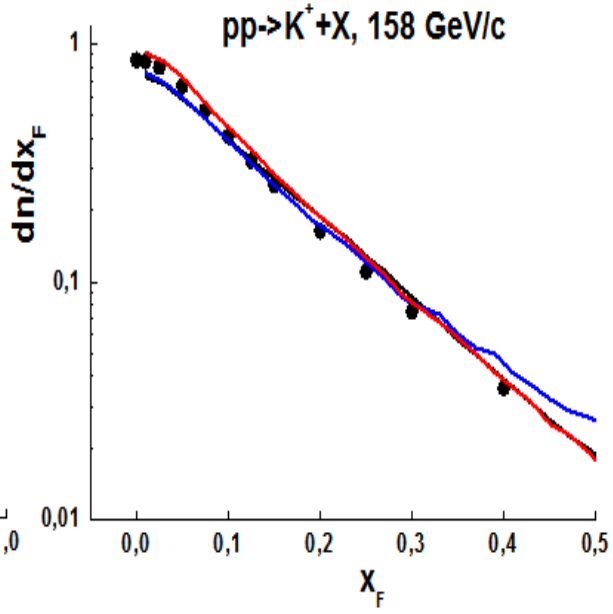
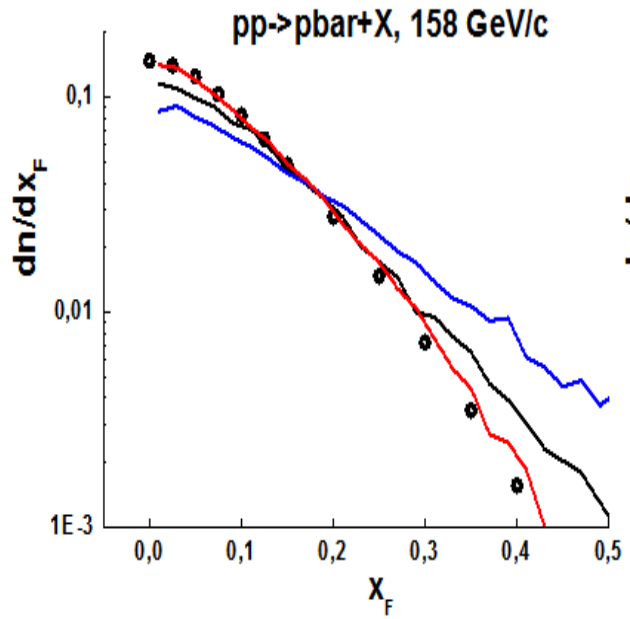
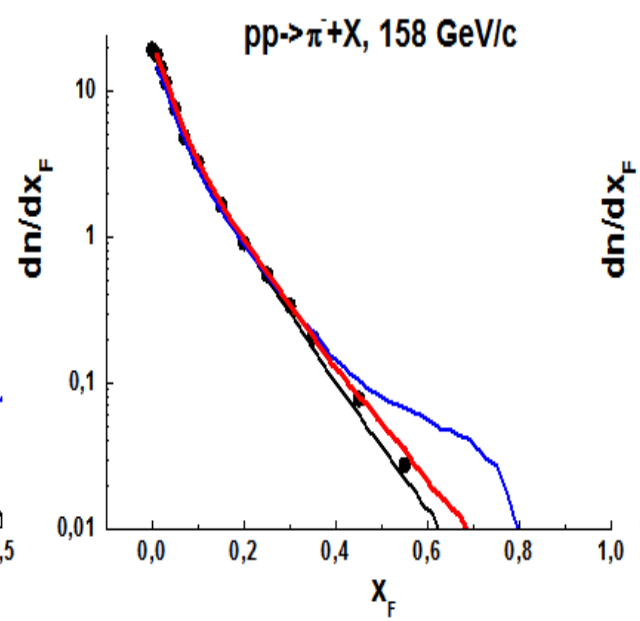
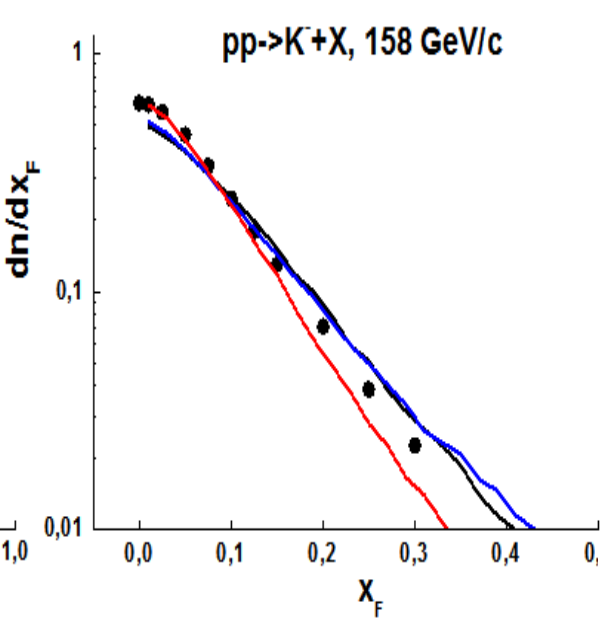




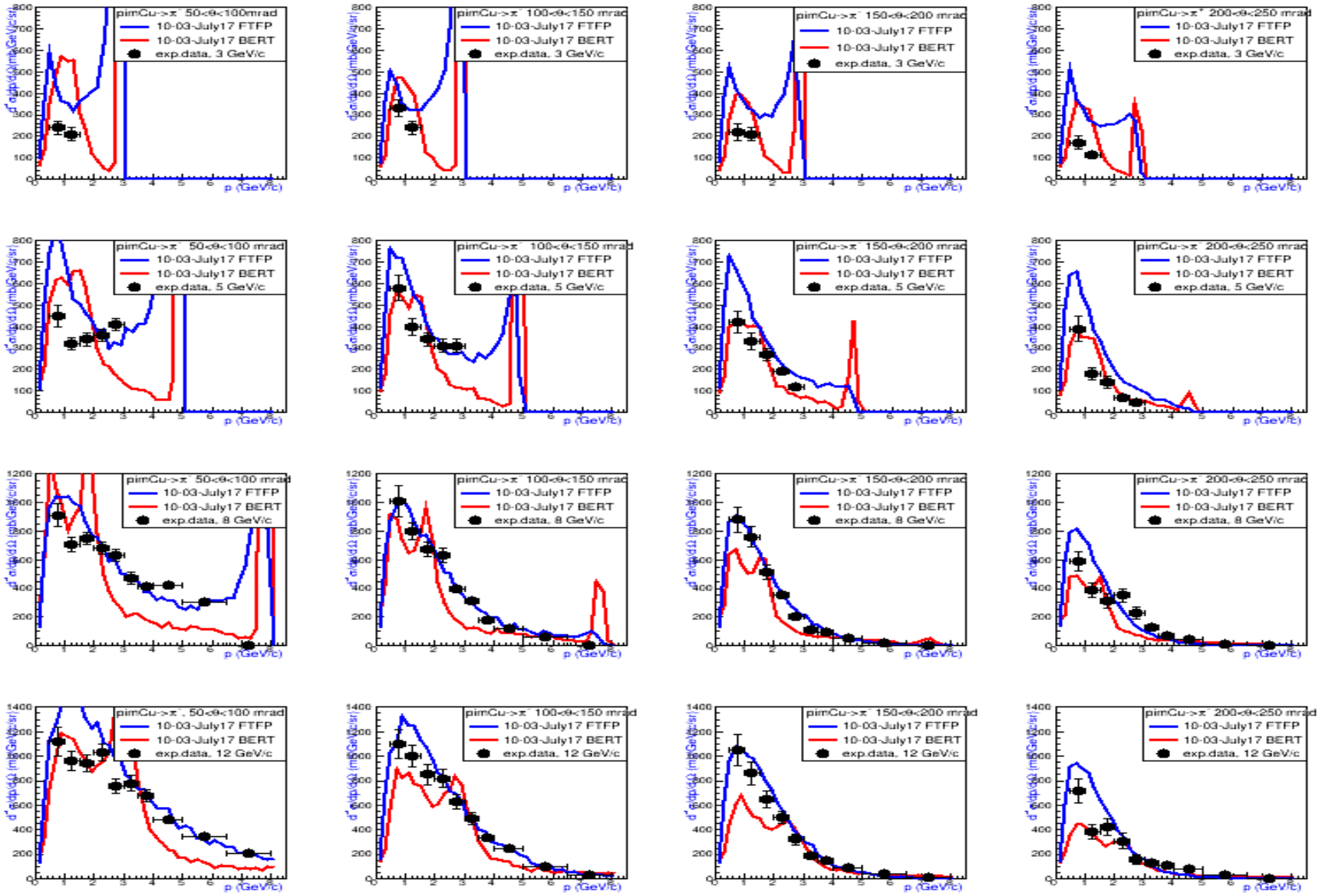








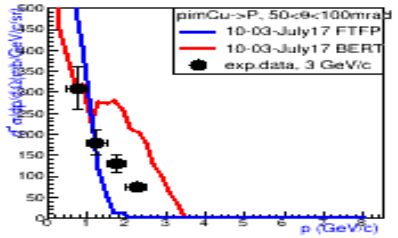
Bertini and FTF for HARP experiment , Pi-+Cu->Pi-

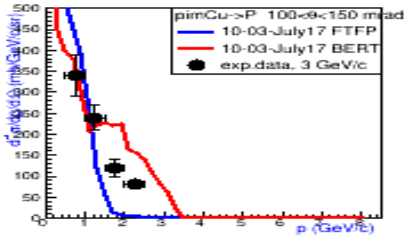


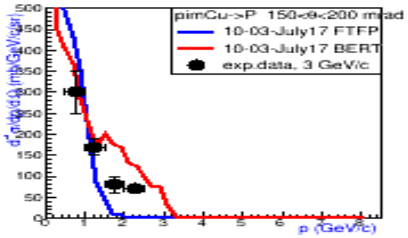
Overestimation of meson production in FTF at low energies.

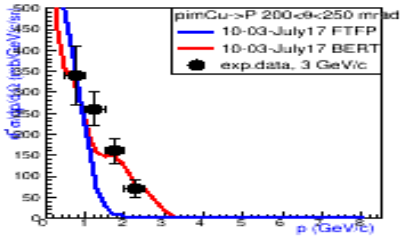
Very strange structures in Bertini!

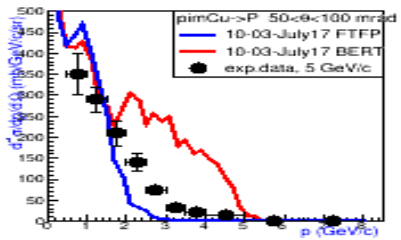
Bertini and FTF for HARP experiment , Pi-+Cu->P

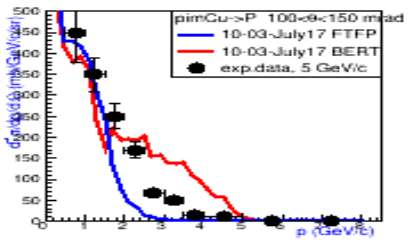


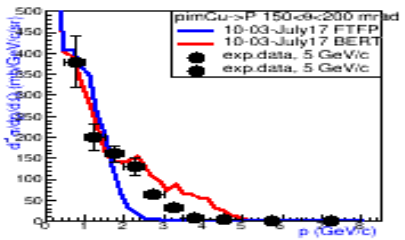


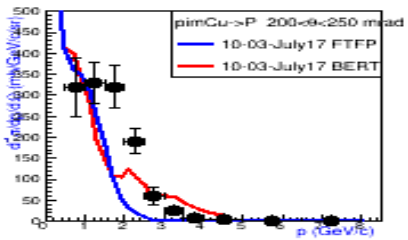


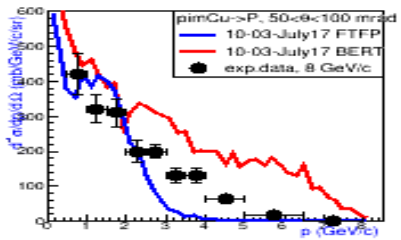


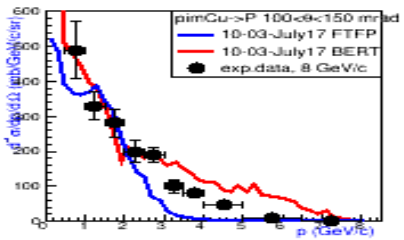


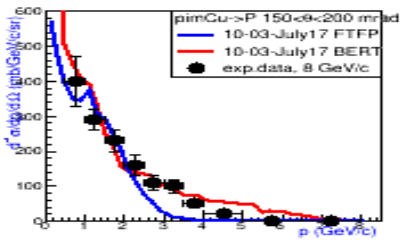


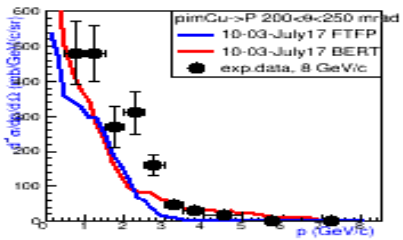


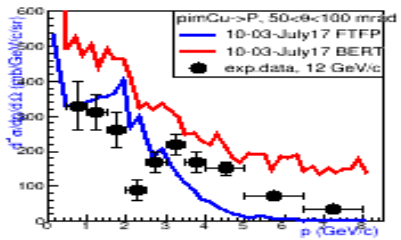


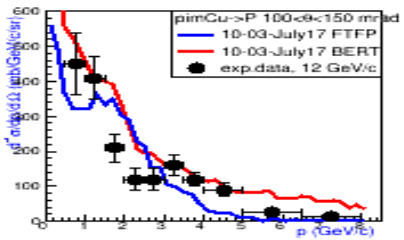


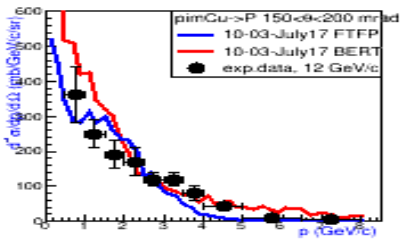


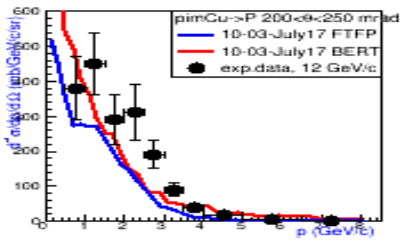












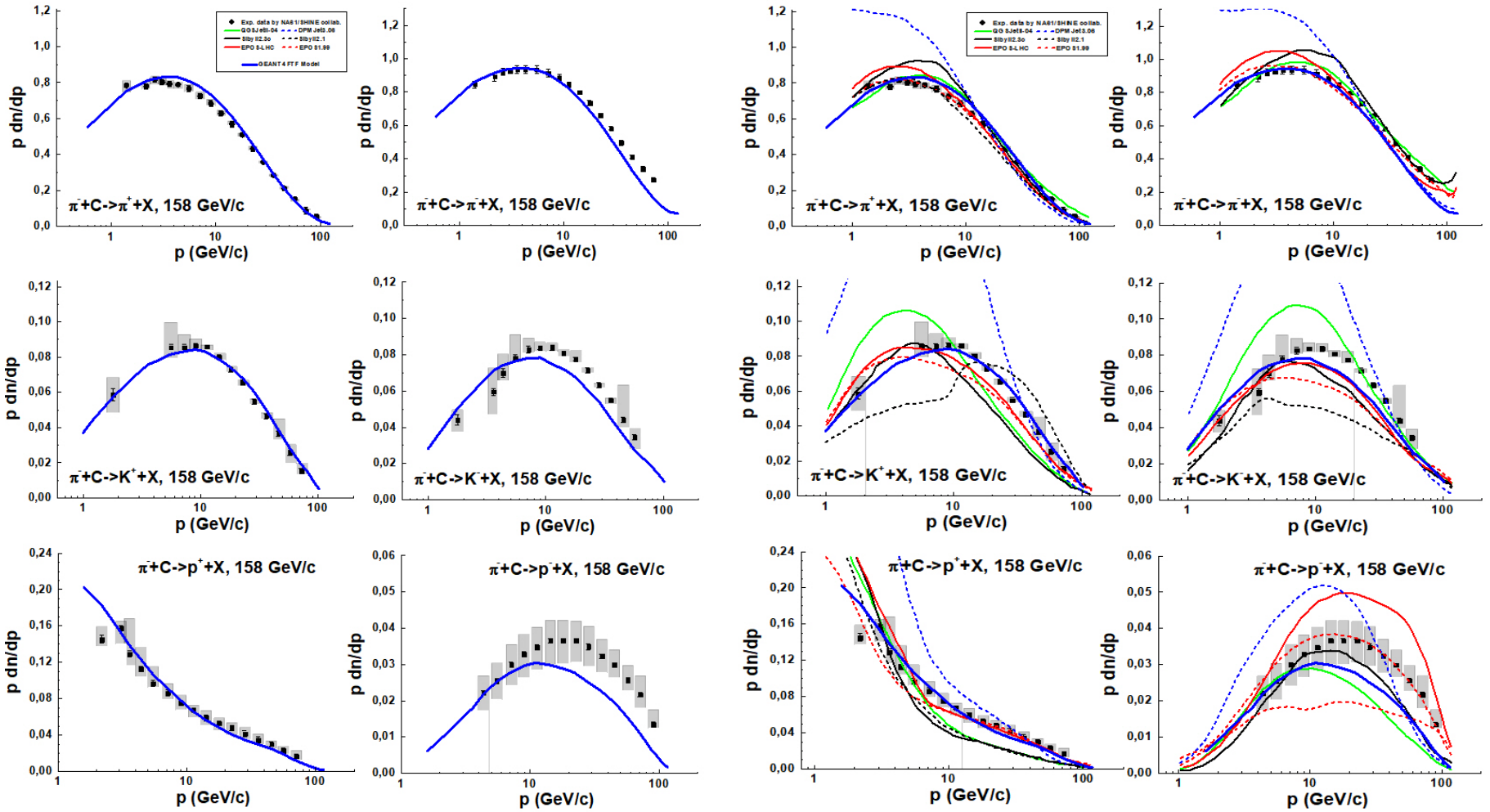
Form of the distributions in bertini at P >= 5 GeV/c is not right.

Underestimation of proton production in FTF at 3 GeV/c.

More results see on http://vuzhinsk.web.cern.ch/vuzhinsk

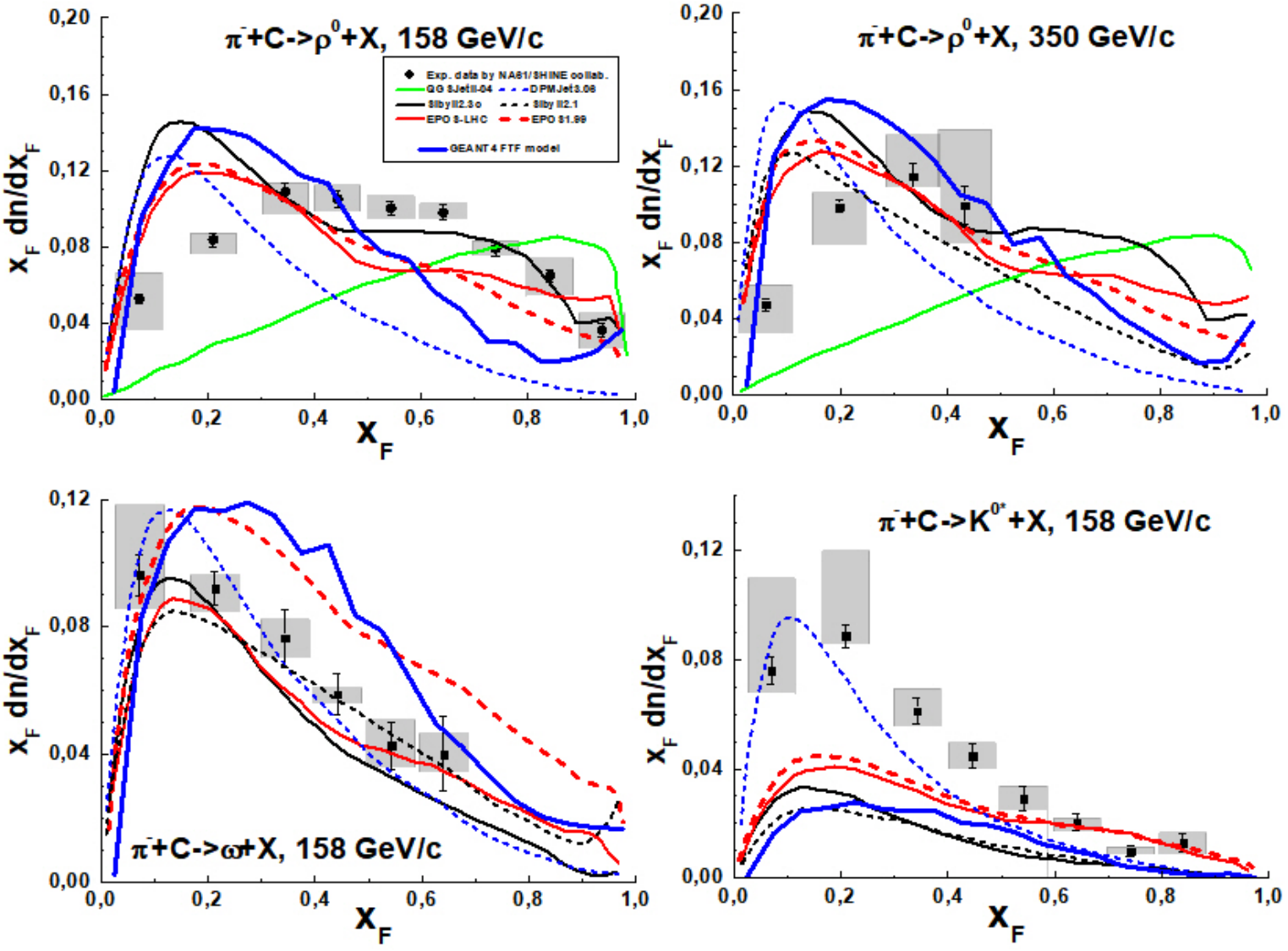
3. Latest results for Pi- C interactions at 158 and 350 GeV/c

Recently, NA61/SHINE Collaboration presented results on particle production in Pi- C Interactions at 158 and 350 GeV/c - arxiv: 1705.08206 (May 2017) [nucl-exp] and Raul R. Prado for the NA61/SHINE Collab., arXiv: 1707.07902 (July 2017) [hep-exp].



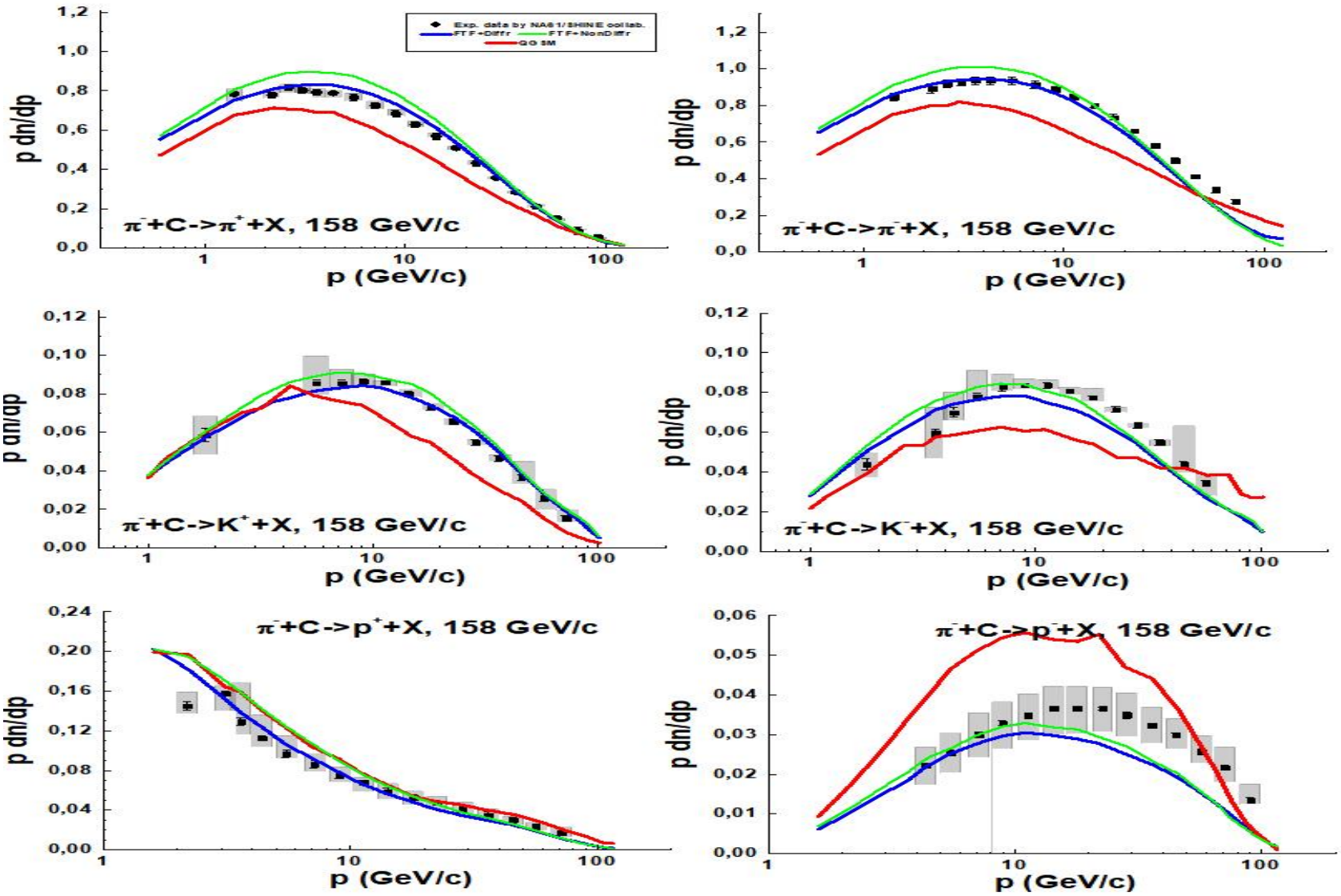
The analogous results we have at 350 GeV/c.

3. Latest results for Pi- C interactions at 158 and 350 GeV/c
Results for mesonic resonance production



Predictions of FTF are very close to predictions of EPOS 1.99!

3. Latest results for Pi- C interactions at 158 and 350 GeV/c FTF and QGSM



Conclusion

1. Implementation of exponential Mt distribution and rotating strings in FTF model allowed to improve the model results especially for pion-nucleus interactions.

2. The HARP Collaboration data on Pi A interactions at 3 – 15 GeV/c are described quite well. FTF and Bertini model give close results.

3. New data of NA61/SHINE Collaboration on Pi- Carbon interactions at 158 and 350 GeV/c are reproduced quite well.

4. Work with QGS model is going on.

5. There are some problems in Bertini model. Recoil momenta of nuclear residuals are too large. It would be well check the Bertini model at low energies, and improve it, if possible.