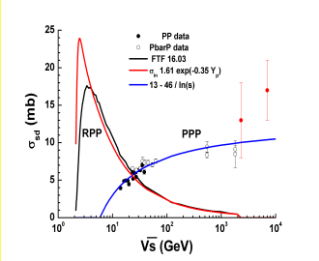
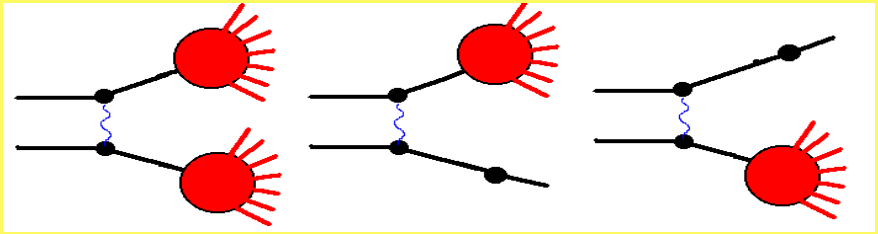
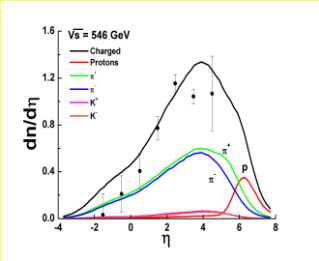
Recent Developments in Fritiof (FTF) Model

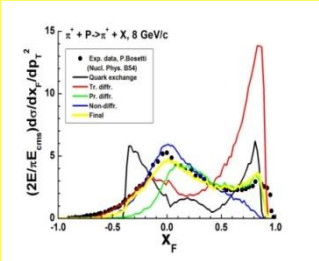
V. Uzhinsky, 11.09.12

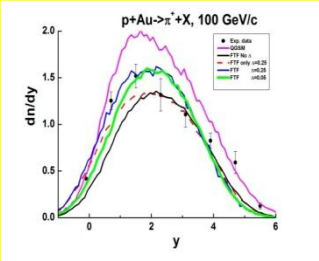
Main topic: Diffraction dissociation implemented in Geant4





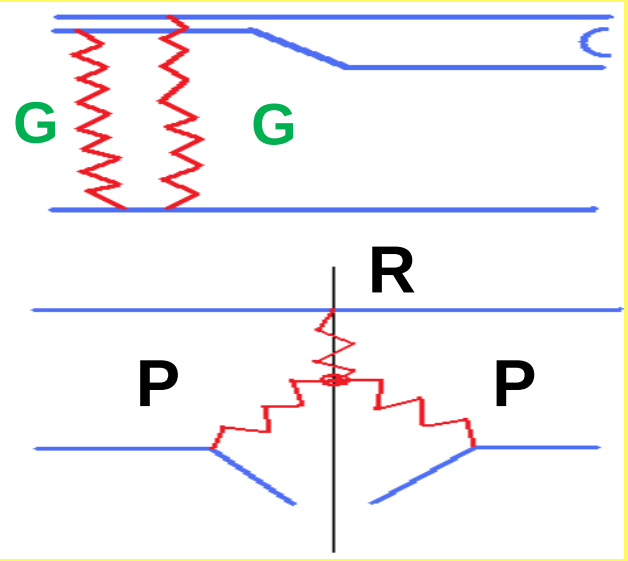


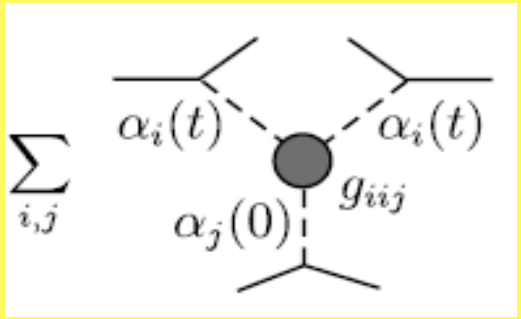


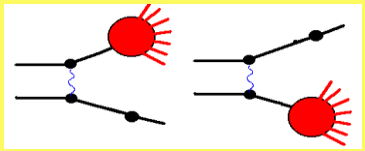


1. Determination of diffraction dissociation cross sections in pp-interactions
2. Properties of diffractive produced system
3. Cross sections of the diffraction in pion and kaon interactions with nucleons
4. Sampling of mass in non-diffractive events, dW = (0.5/P + 0.5) dP
5. Change of s-sbar pair creation probability and change of qq-qqbar creation probability
6. Description of P P, Pi P, K P, pA, pi A and K A data
7. Conclusion

What is the diffraction?

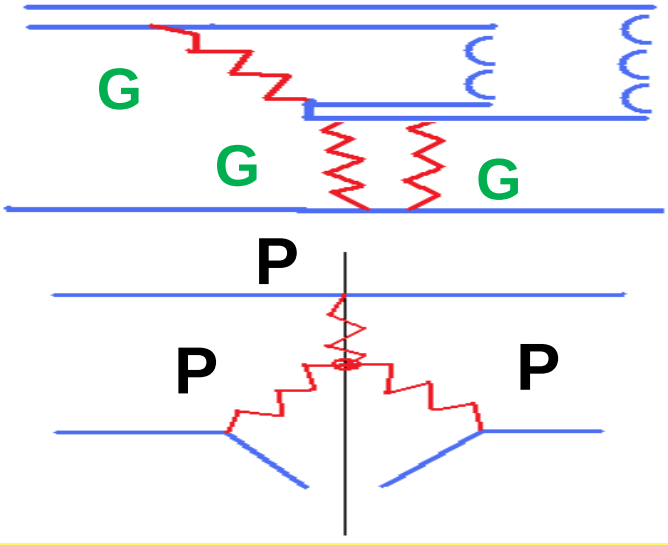


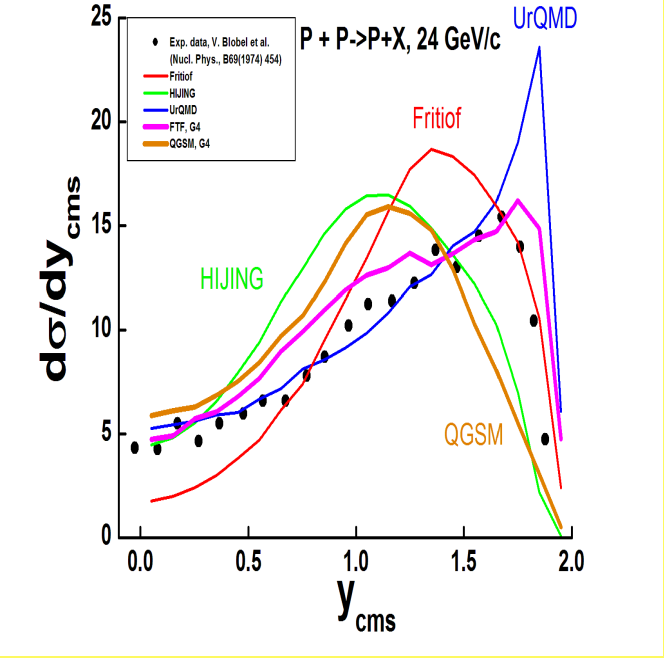


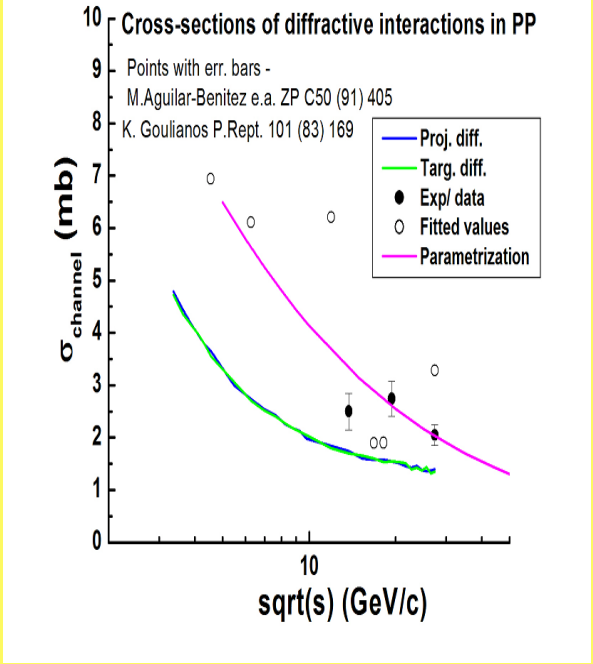


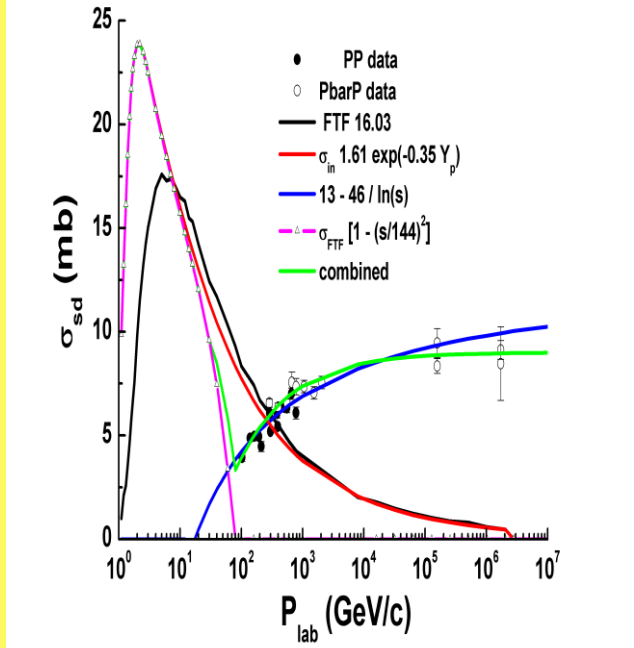
$1/M^3$

$1/M^2$

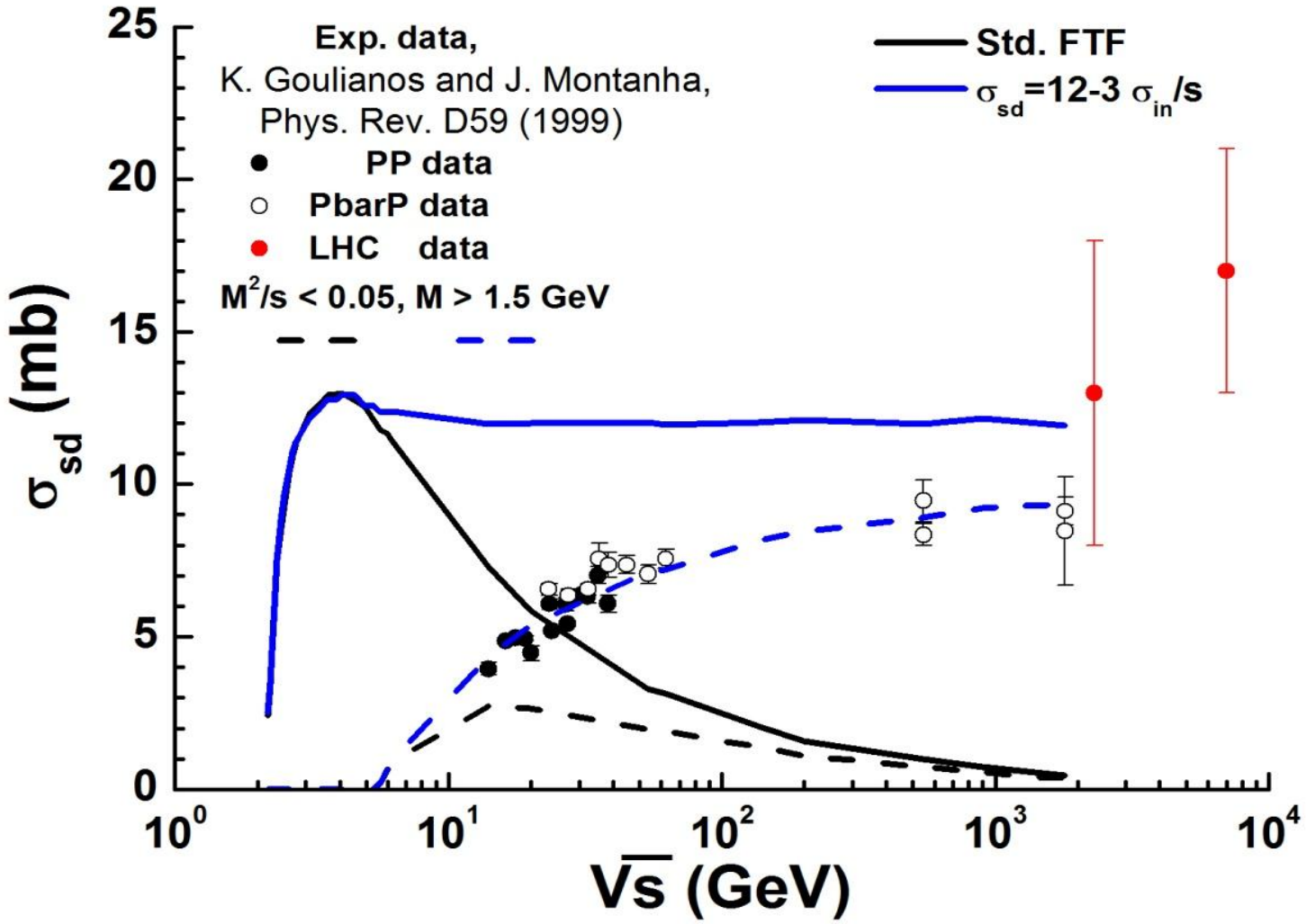




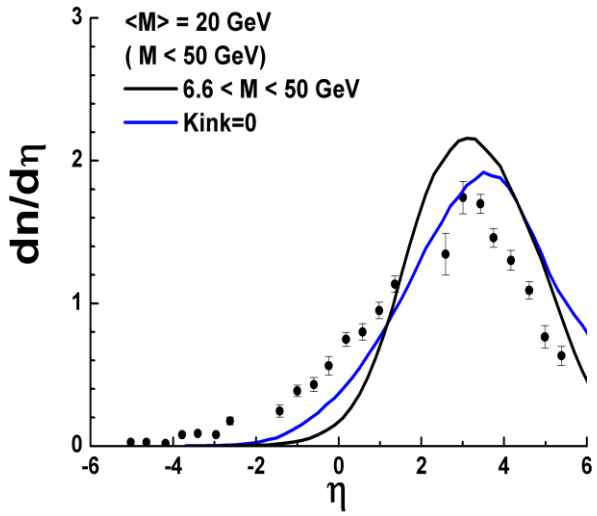


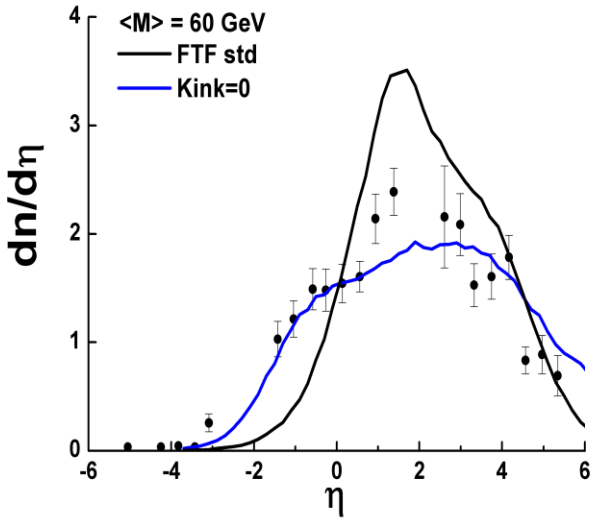


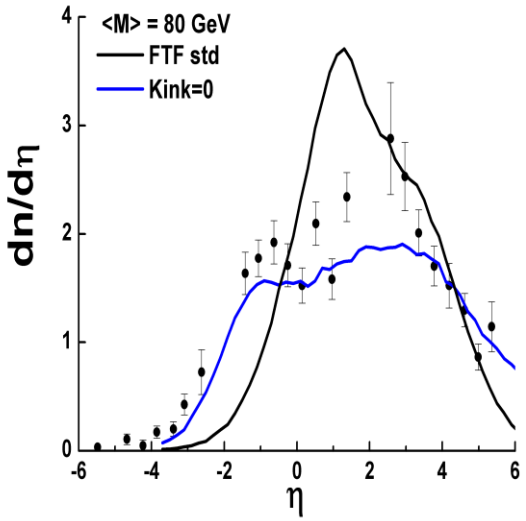
Estimation of the pp cross sections

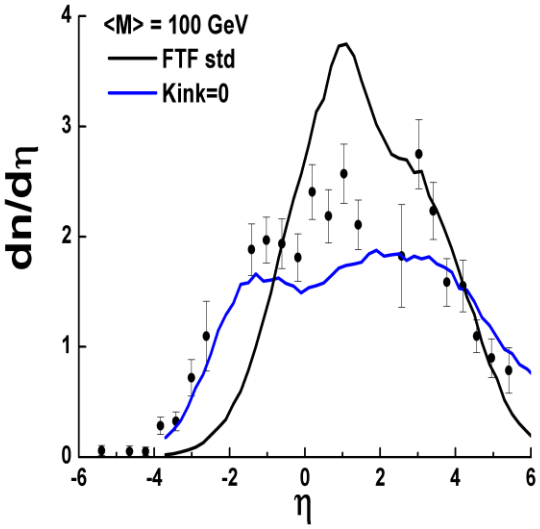


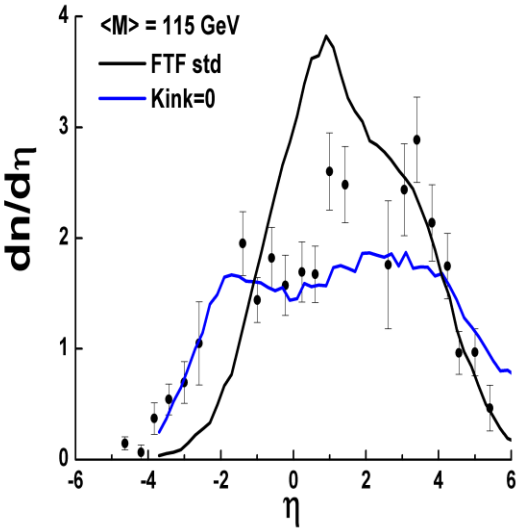
Properties of the diffraction

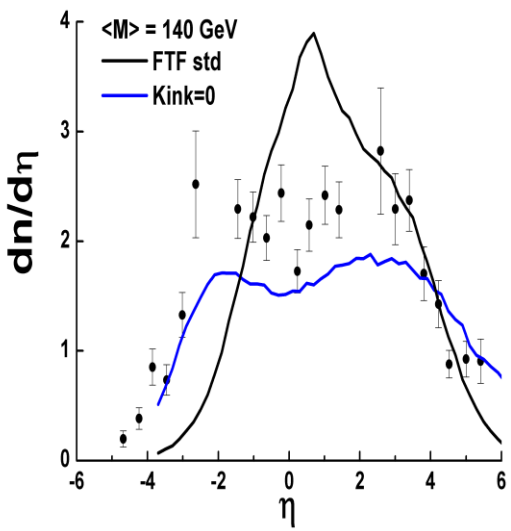






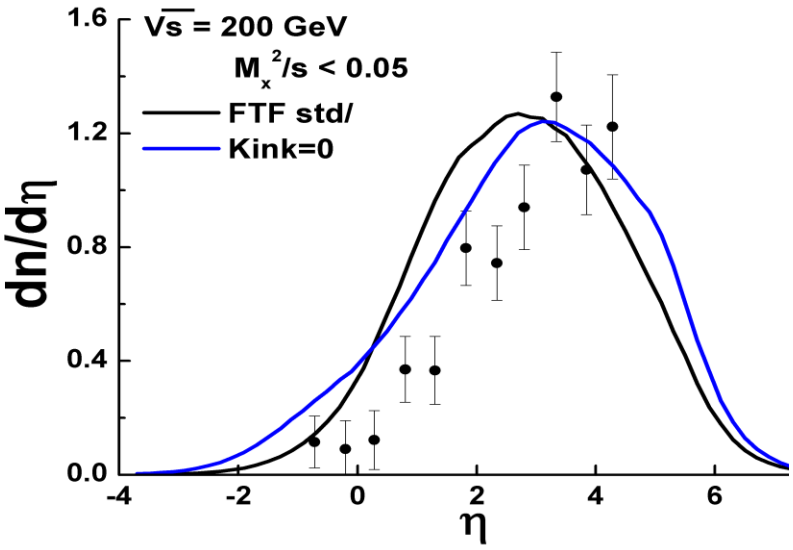


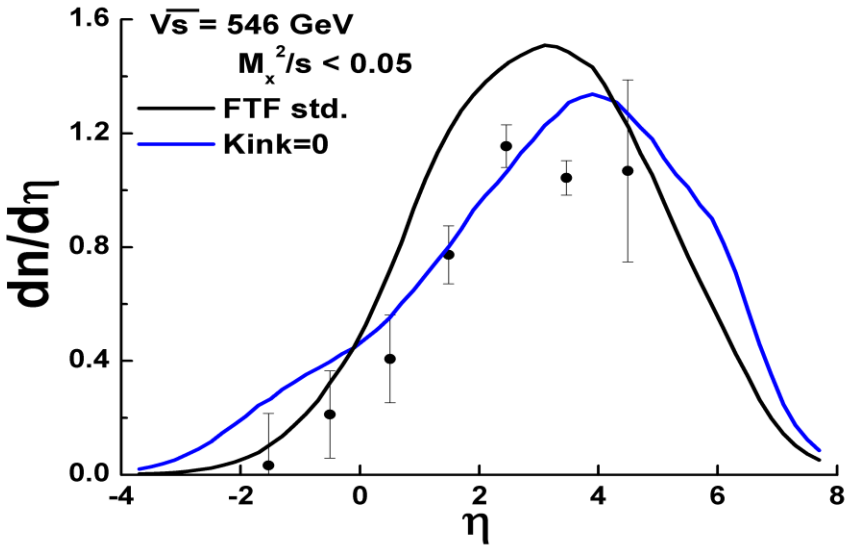


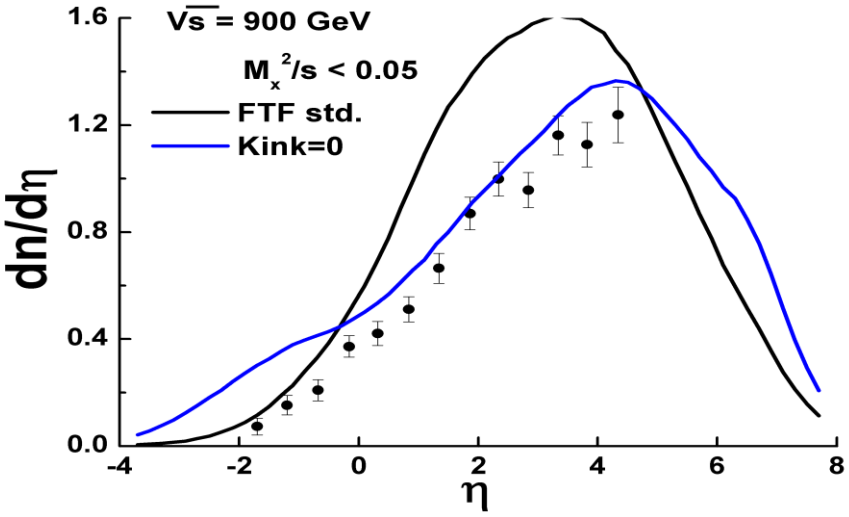


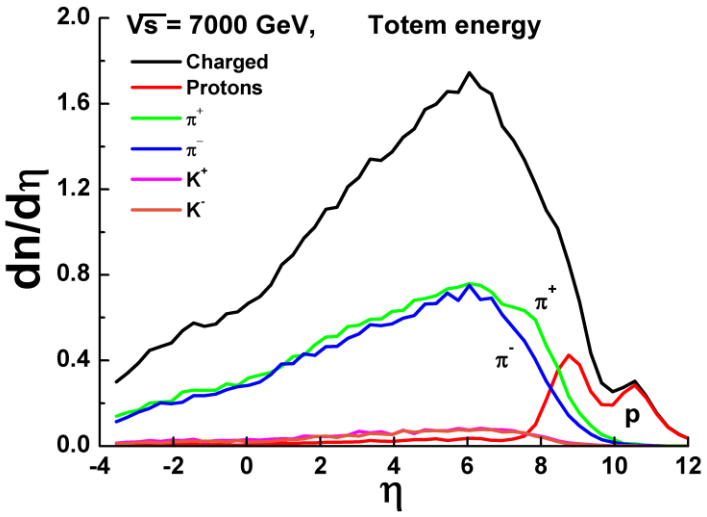
Kinky strings are not needed, sqrt(s)=546 GeV

Kinky strings are not needed !



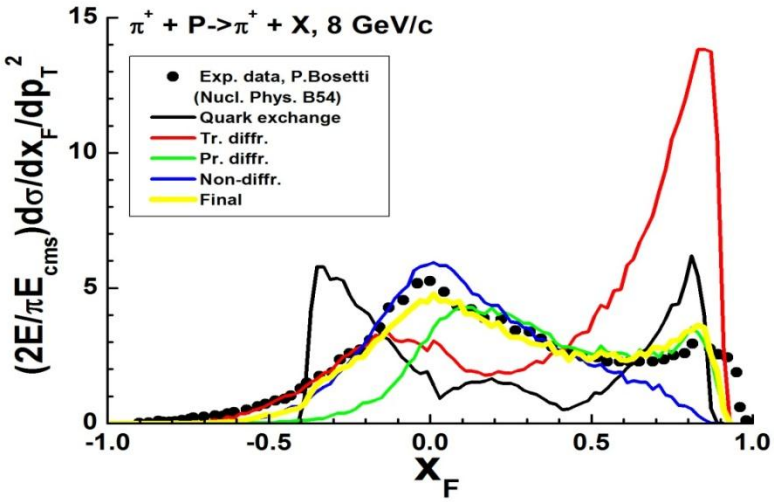


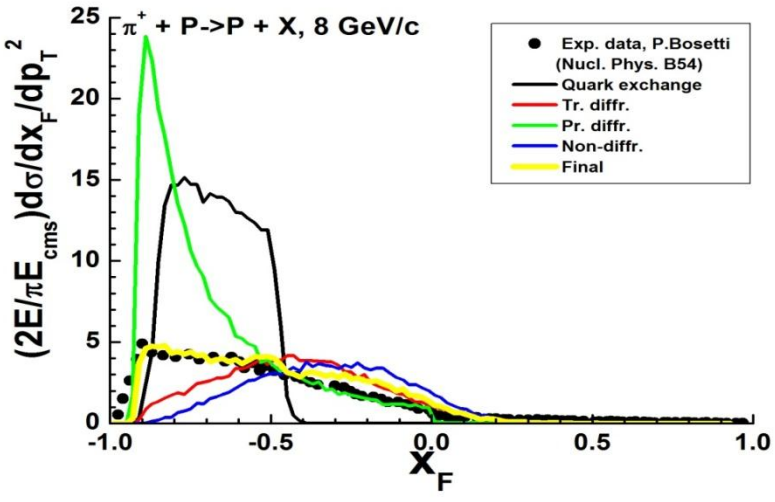


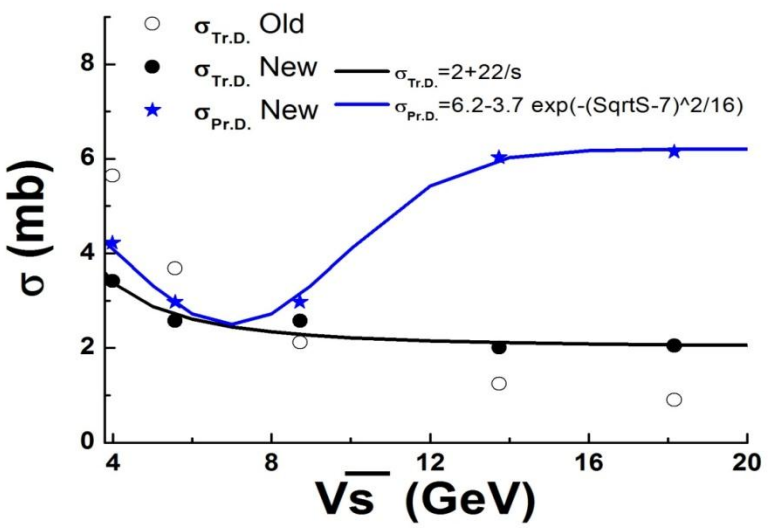


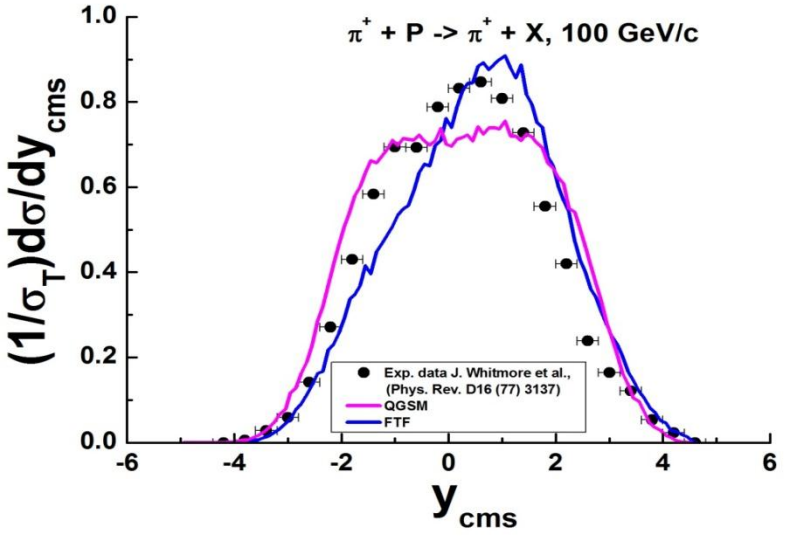
It took a lot of efforts to account this in hA-interaction.

Estimation of the πp cross sections

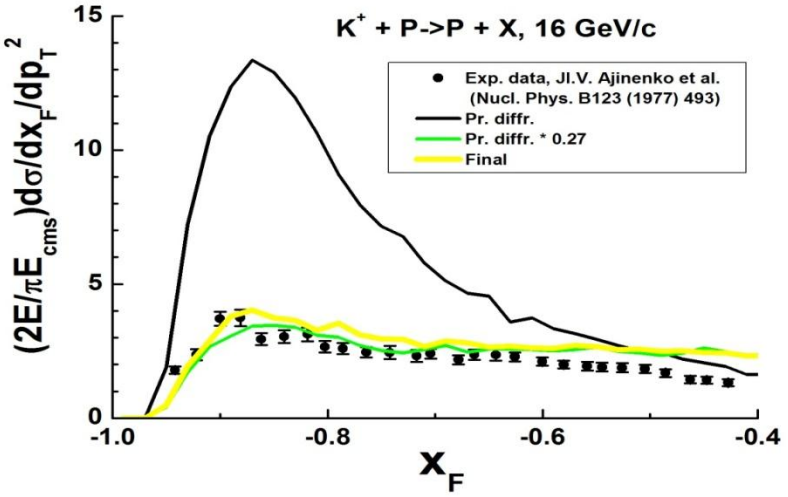


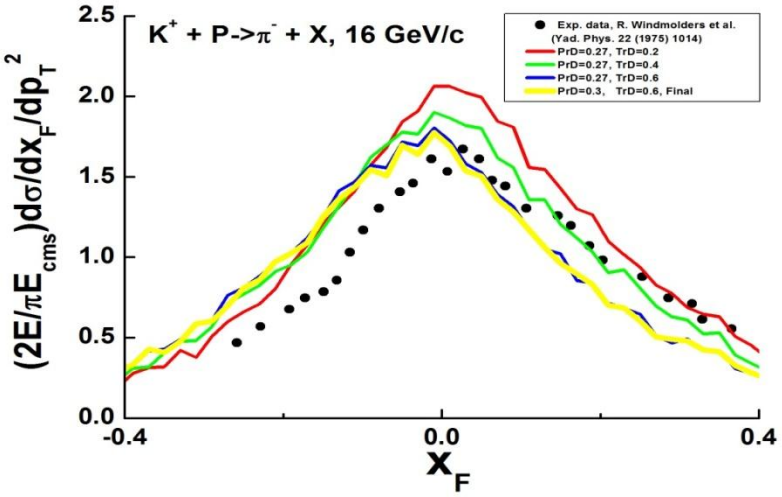


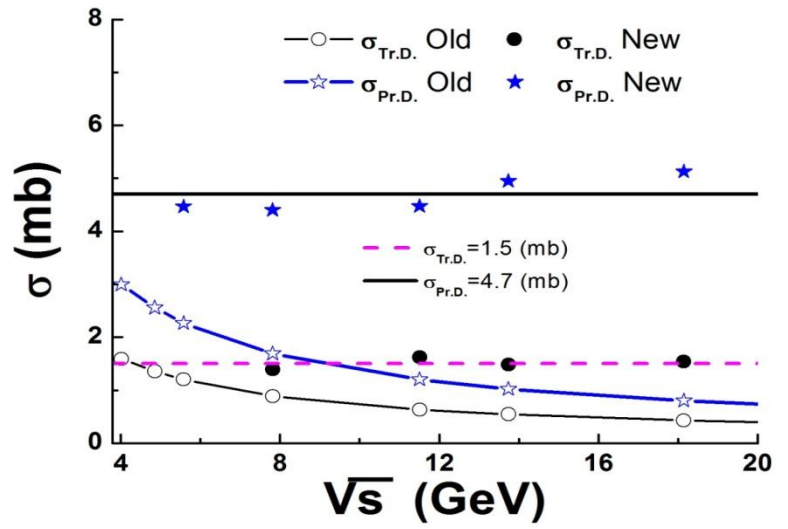


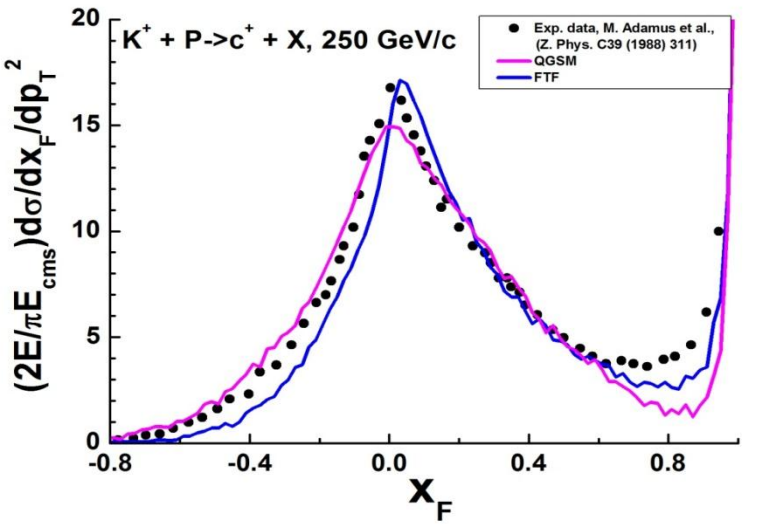


Estimation of the K p cross sections

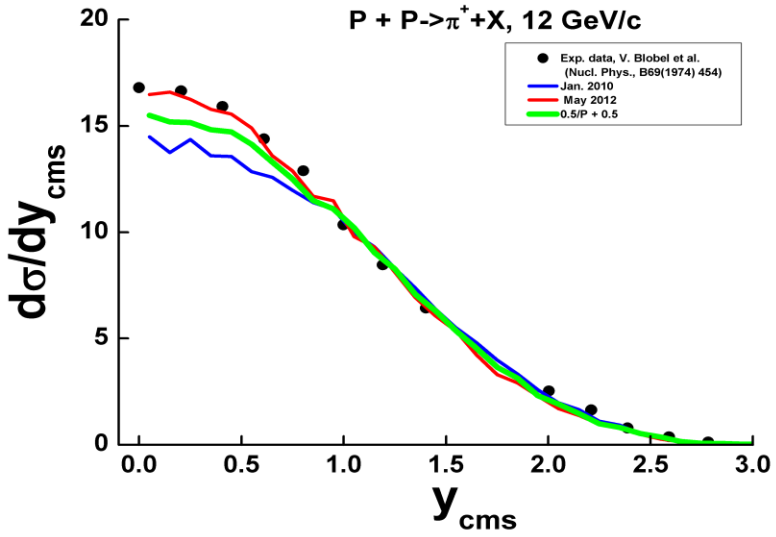


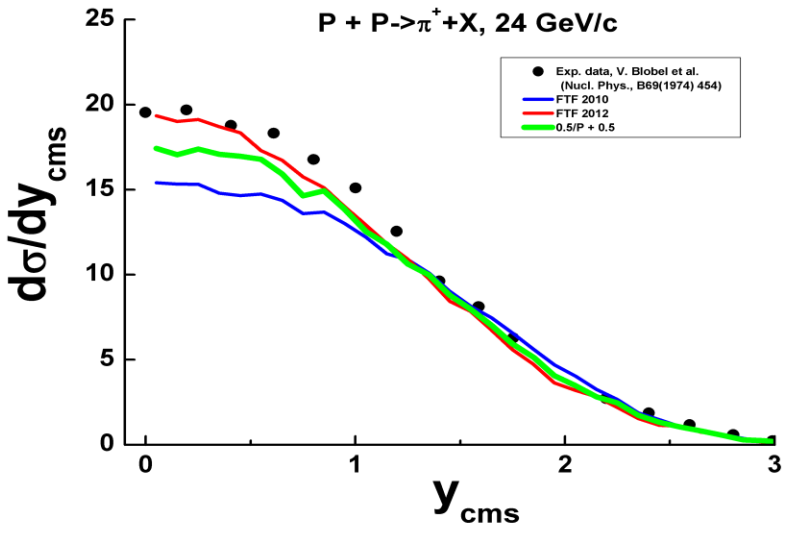


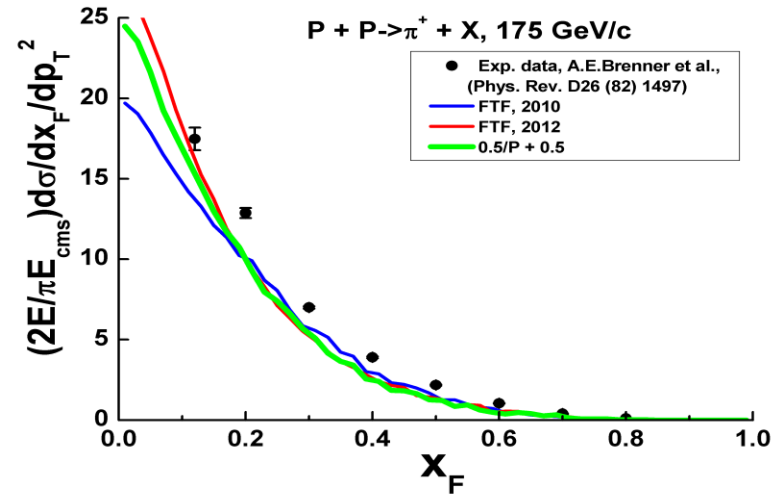


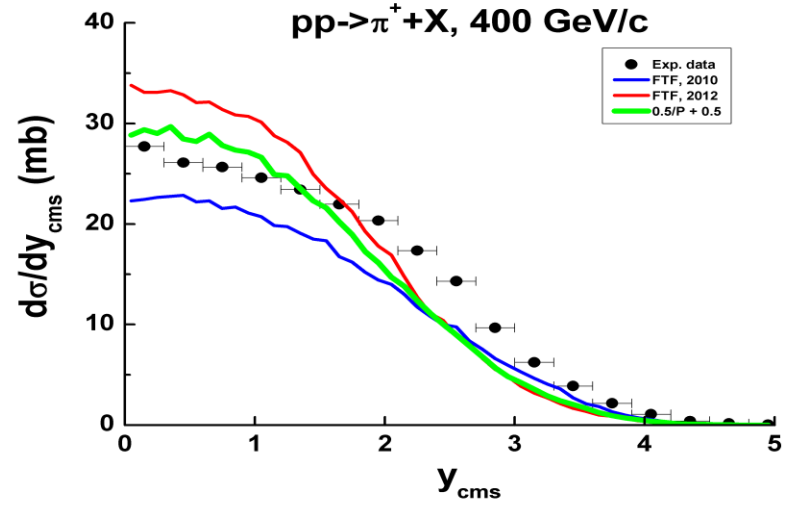


Inclusive spectra in PP



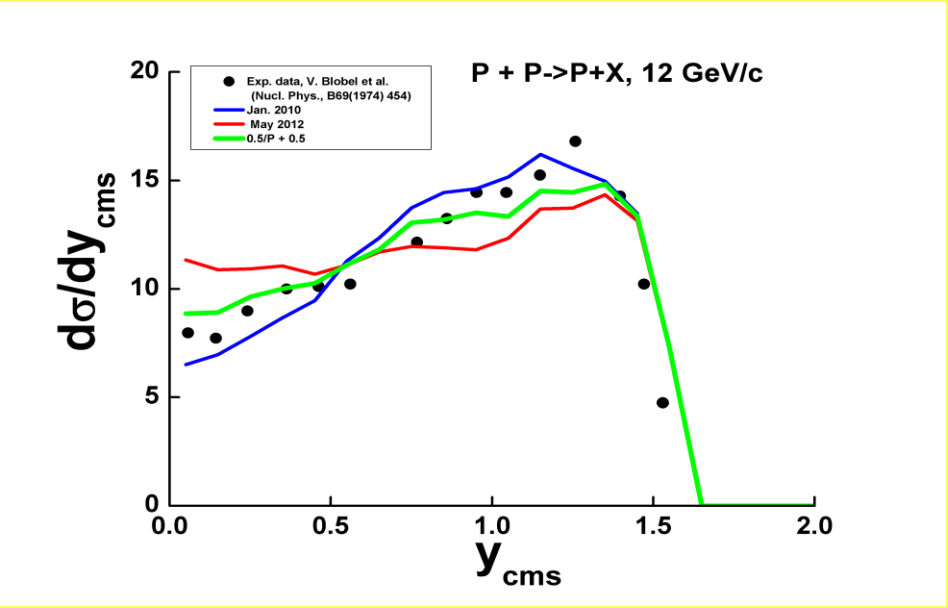


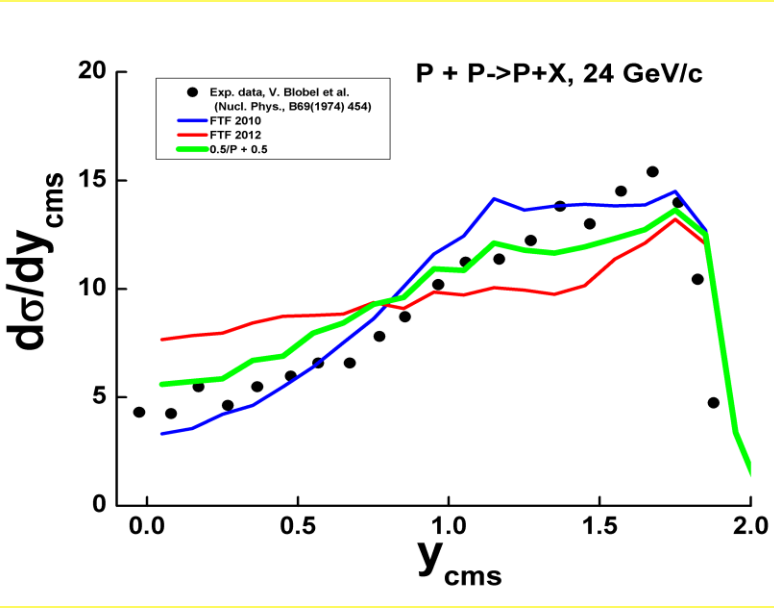


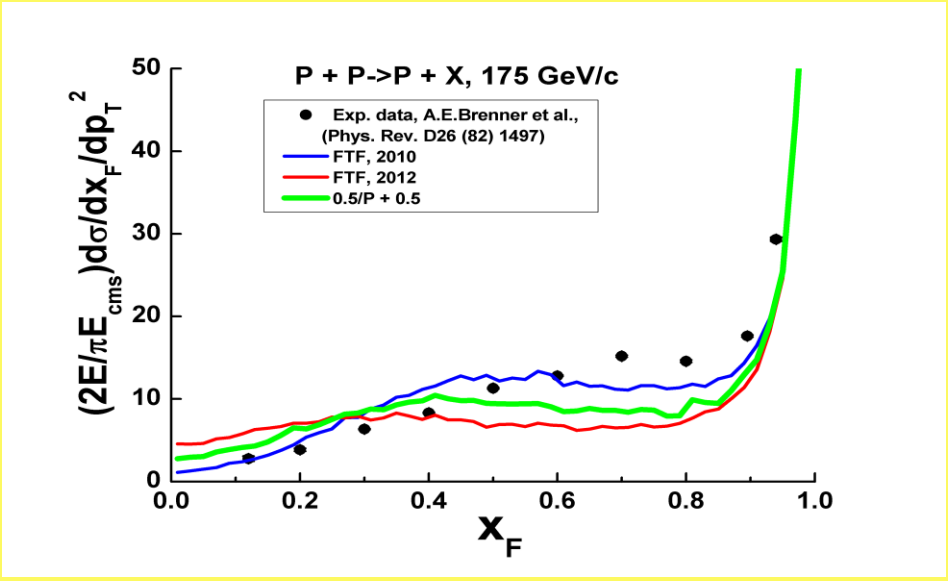


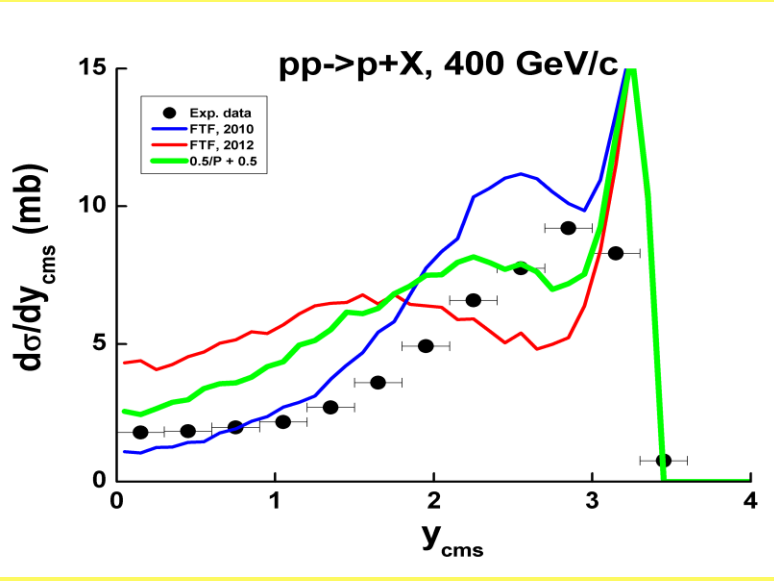
Sampling of mass in non-diffractive events, dW = (0.5/P + 0.5) dP

Inclusive spectra in PP

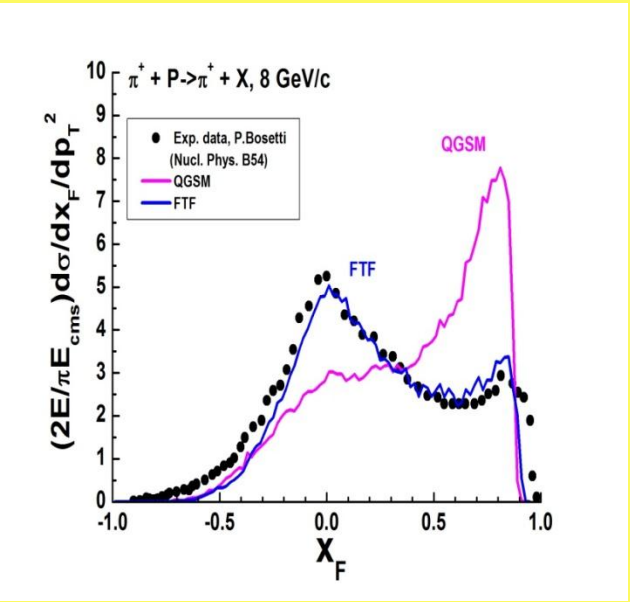


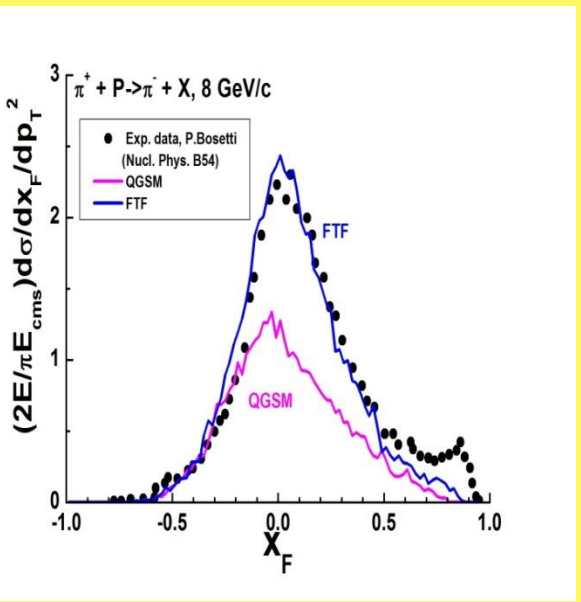


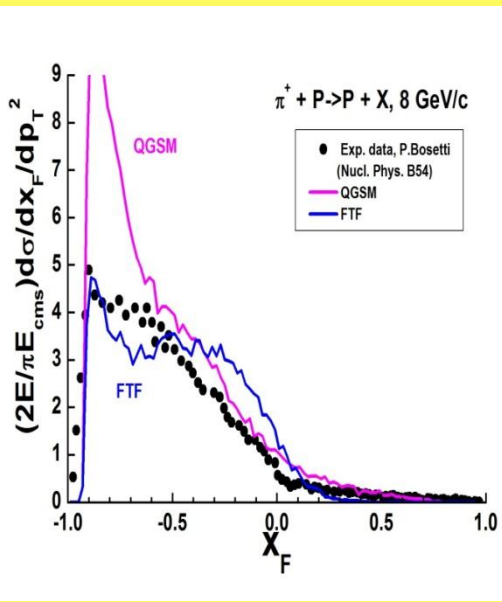


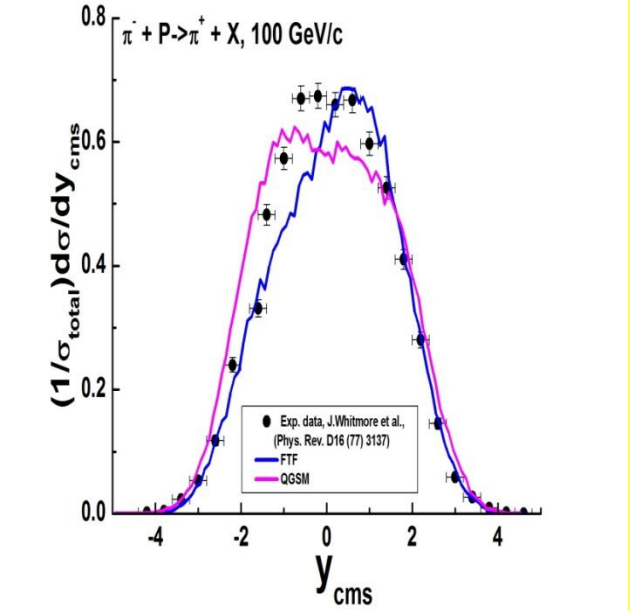


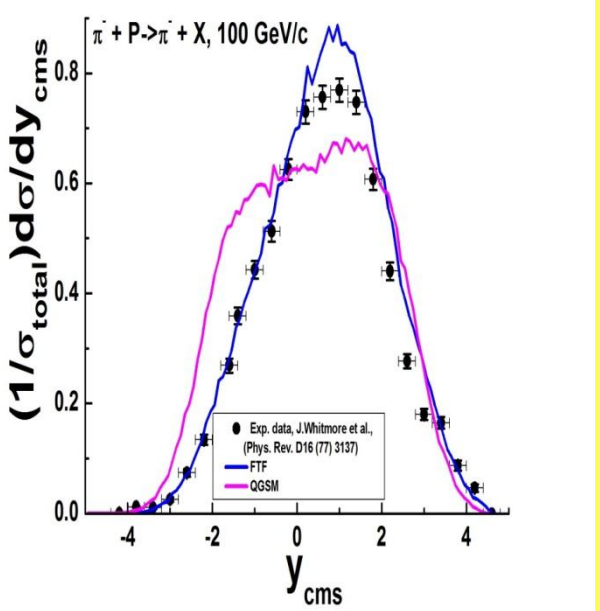
Inclusive spectra in Pi P

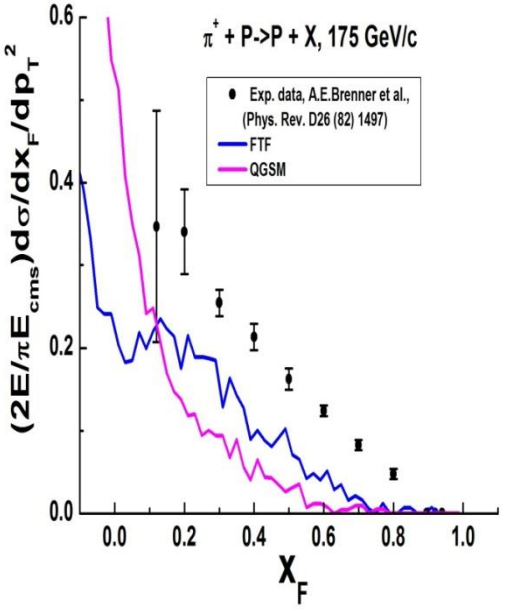




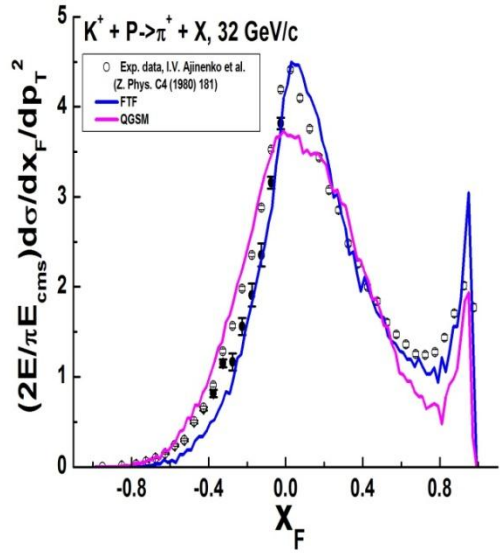


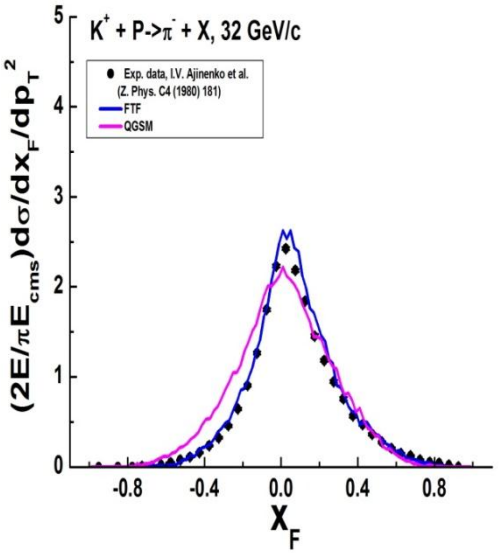


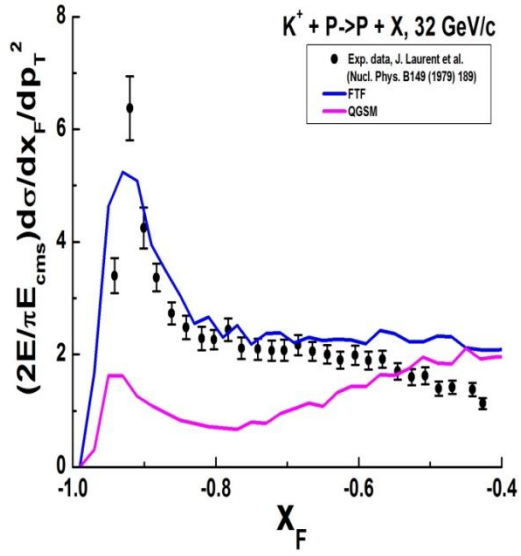


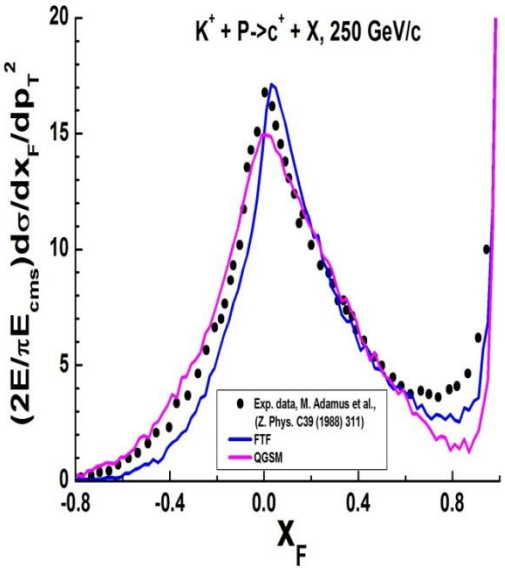


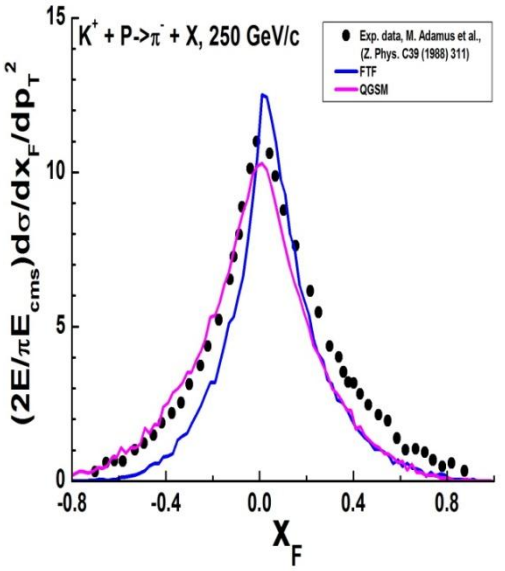
Inclusive spectra in K P

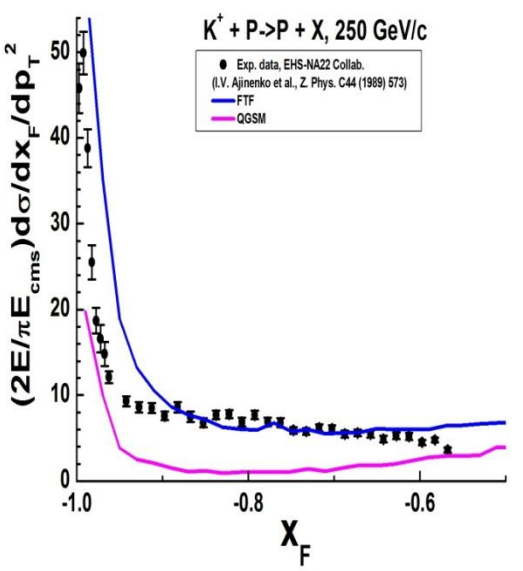




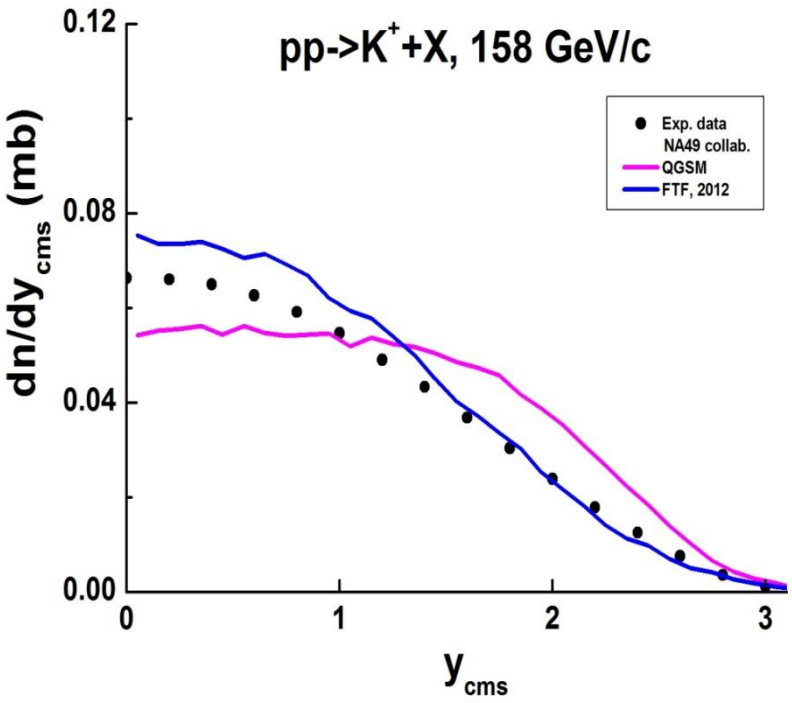


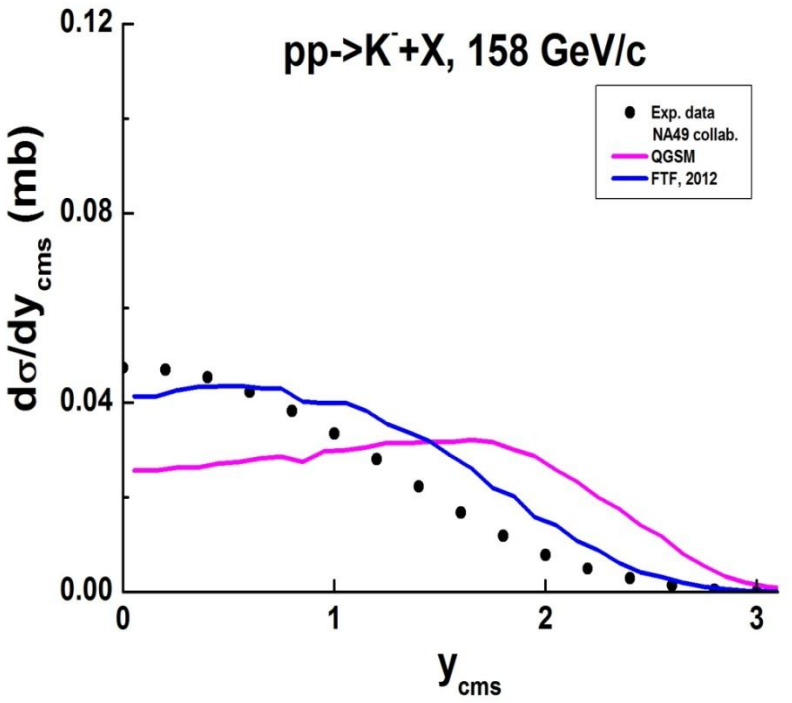


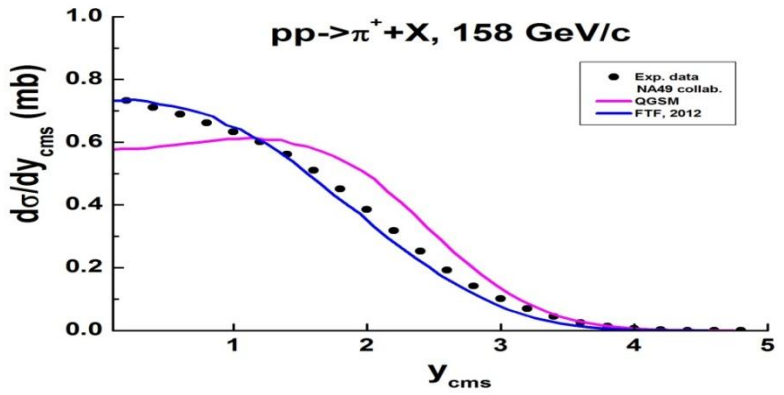


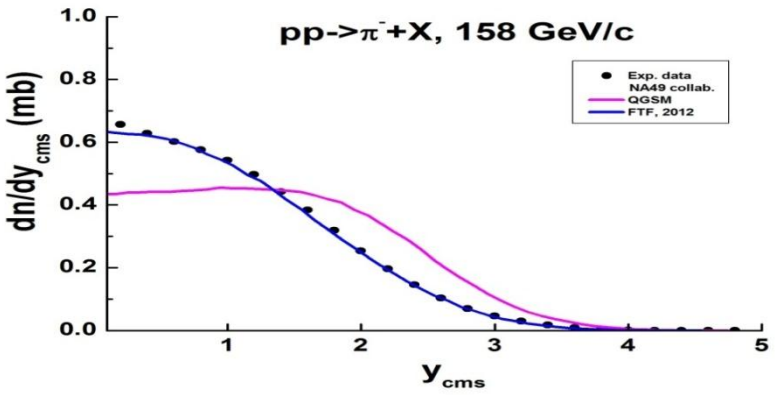


Change of s-sbar pair creation probability (it was large!)



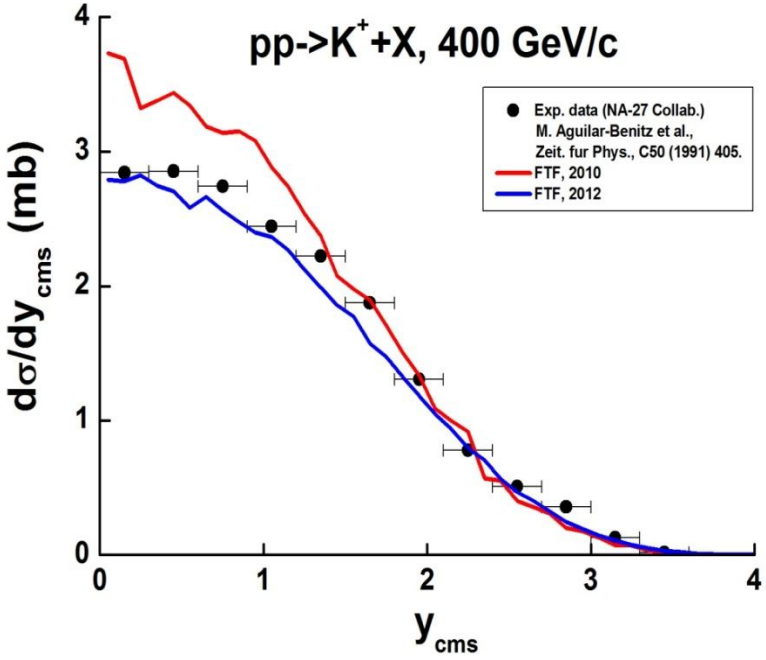


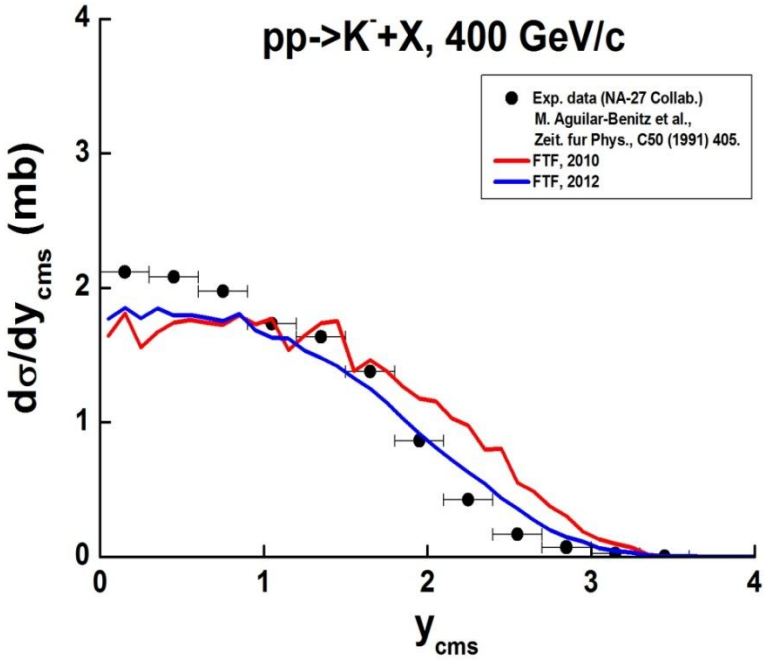


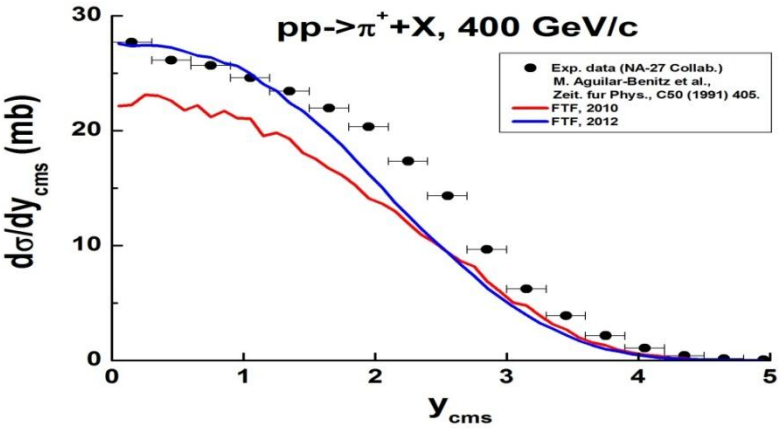


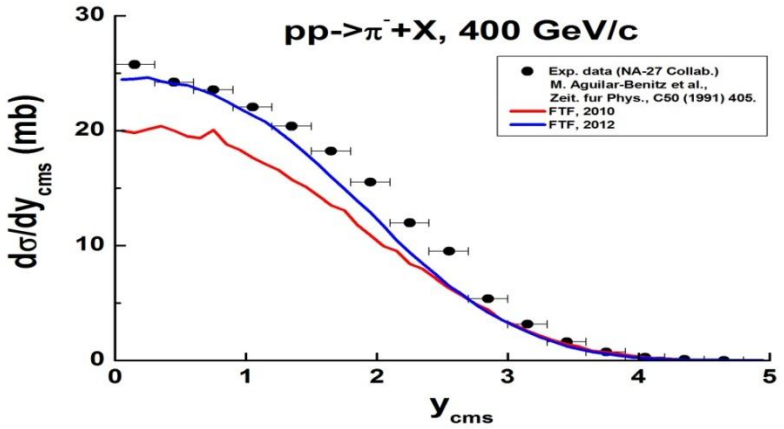
Exp. Data of NA-49 Collaboration

Change of s-sbar pair creation probability

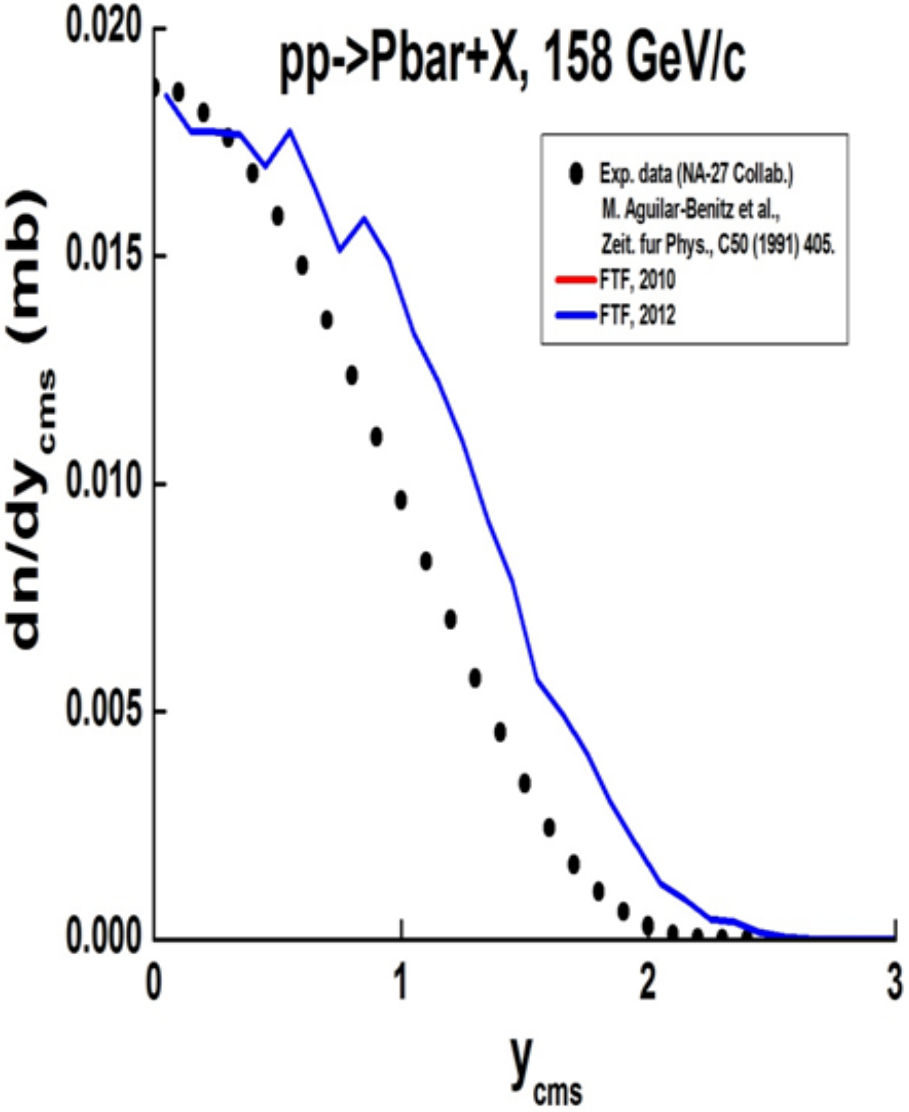


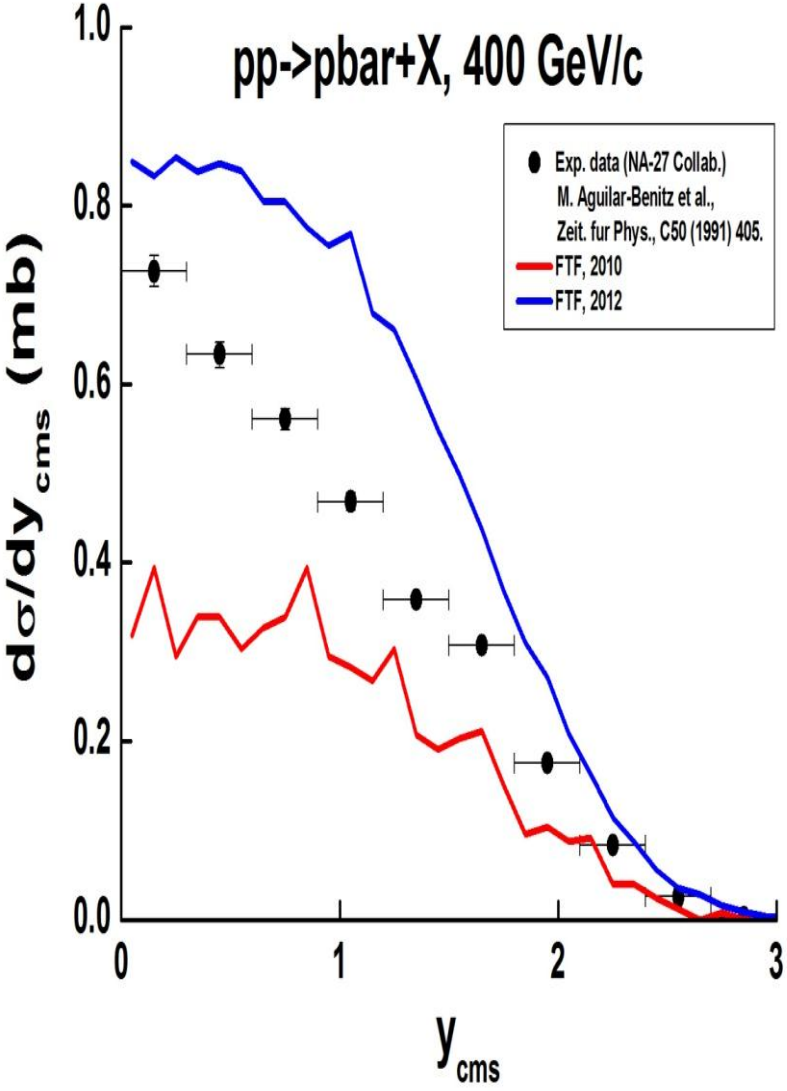






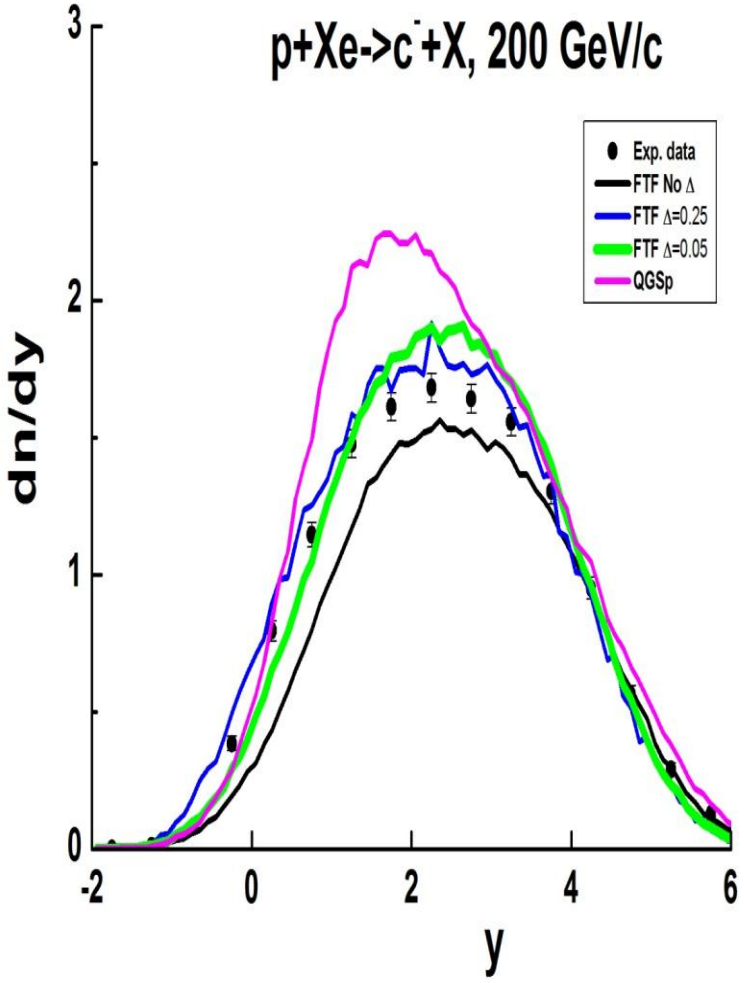
Change of qq-qqbar creation probability

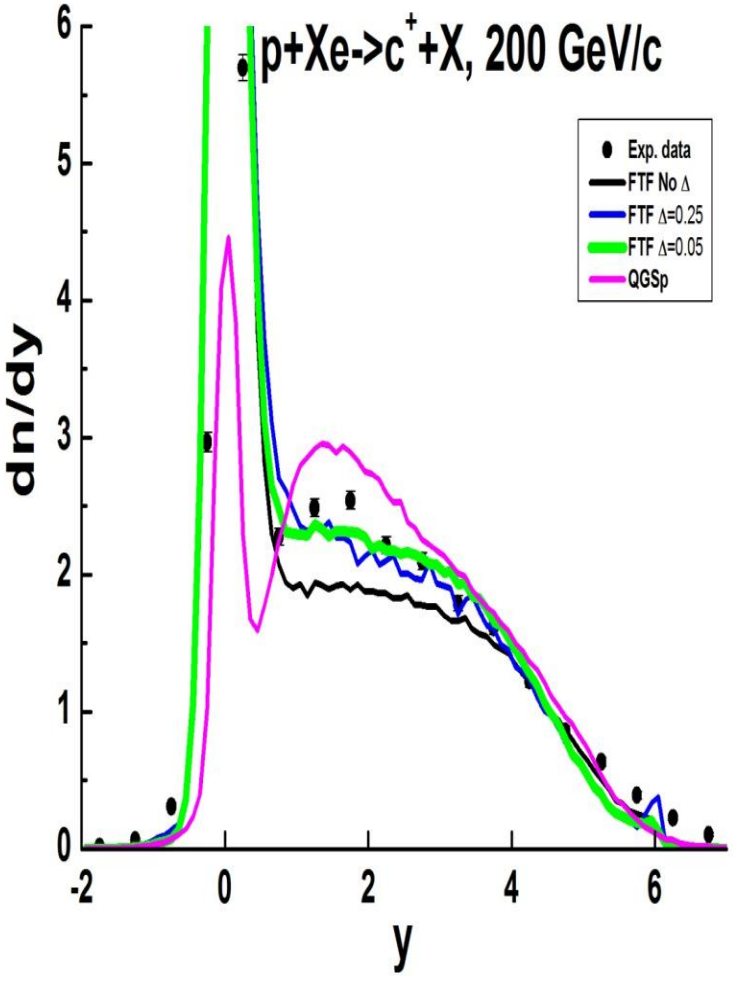




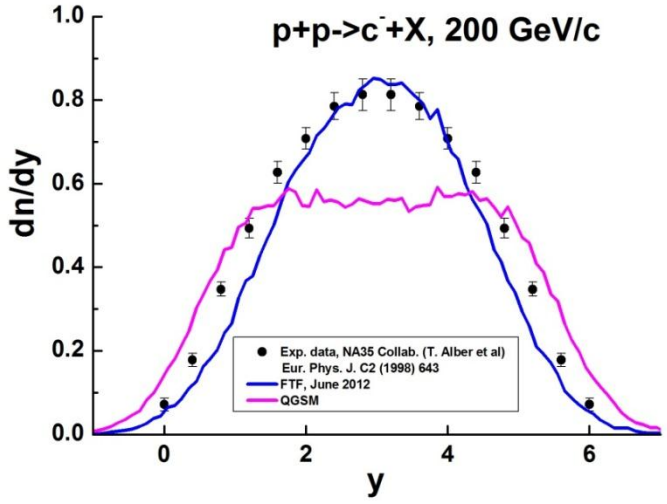
Description of pA-, π A- and K A- data

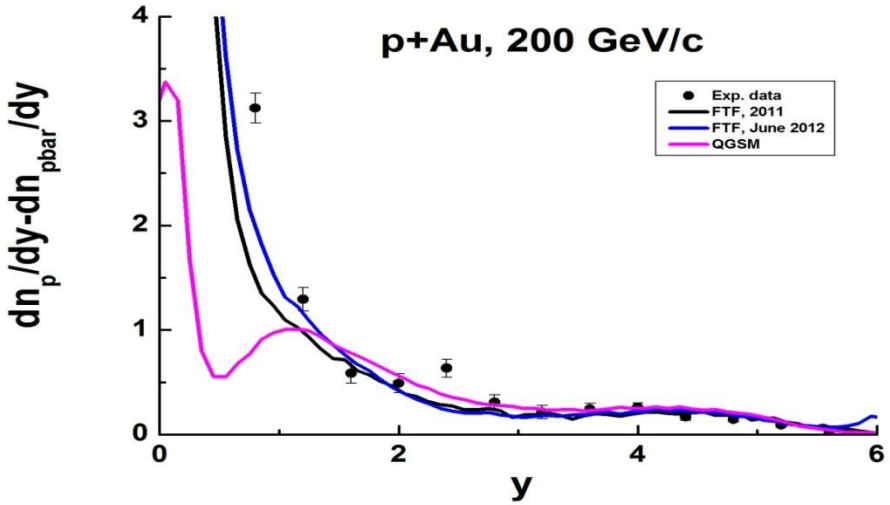
C. de Marzo et al. Phys. Rev. D26 (1982) 1019

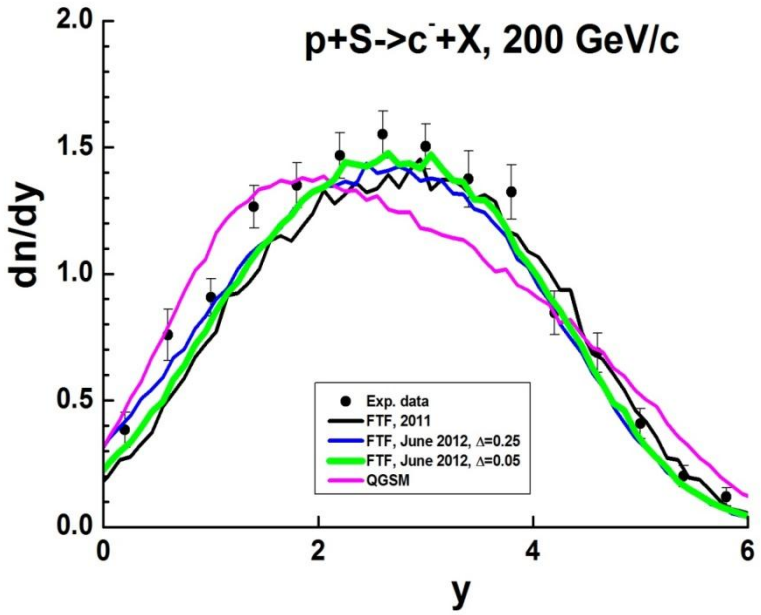


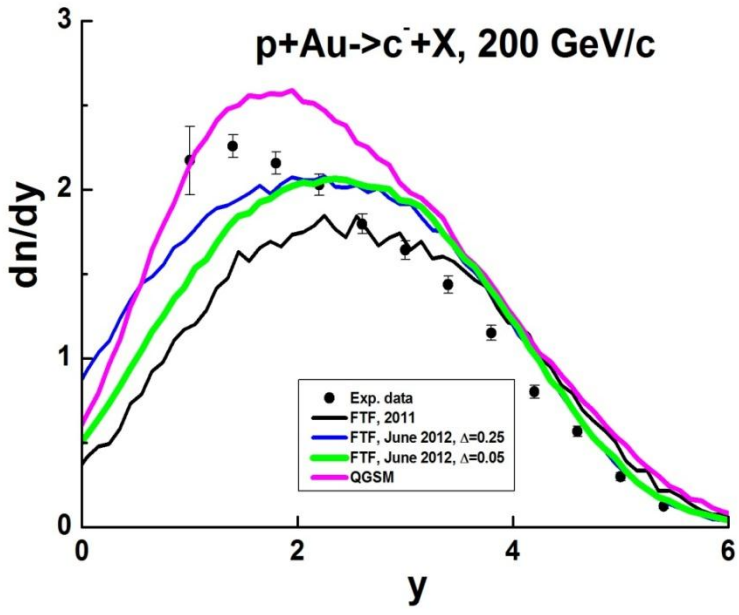


NA35 Collab. (T. Alber et al.) Eur. Phys. J. C2 (1998) 643

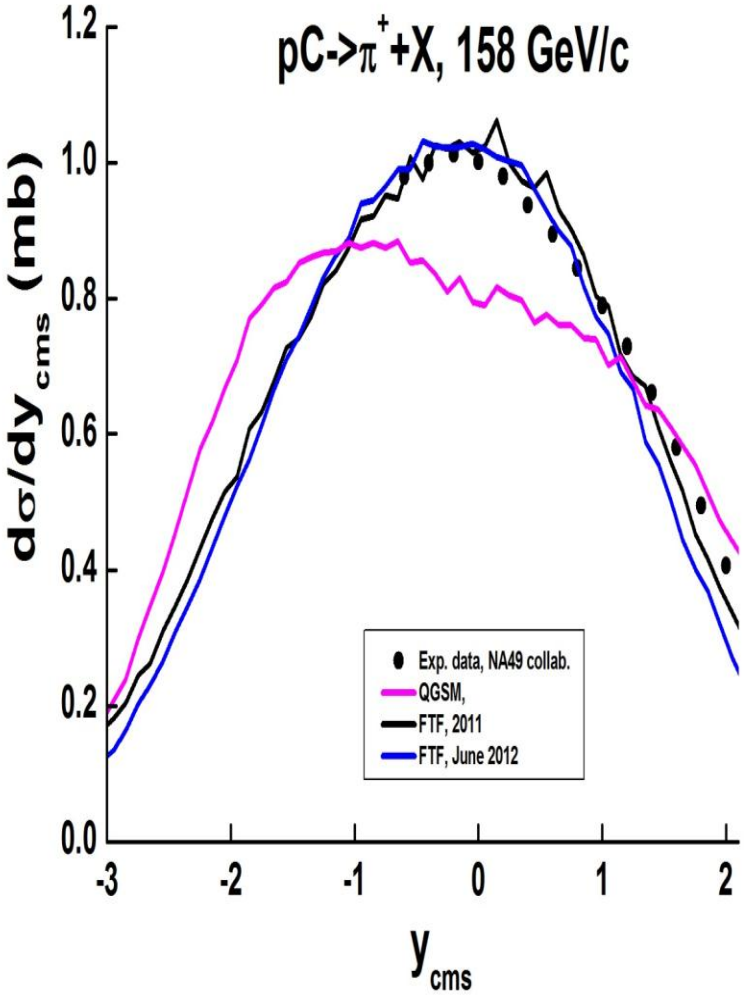


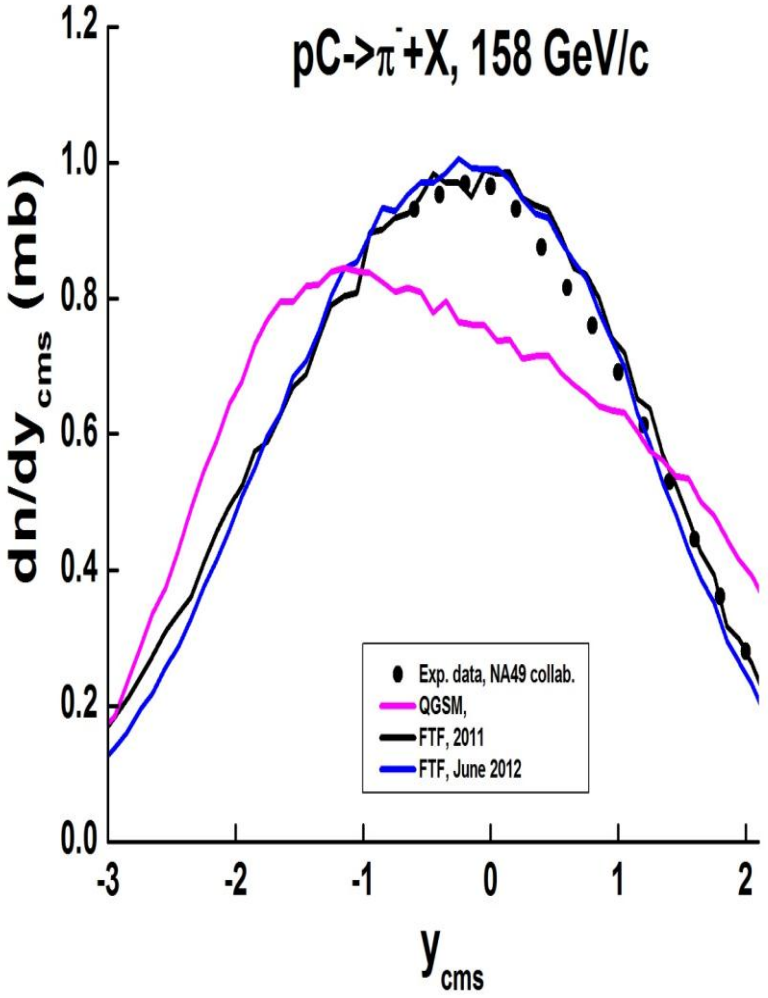






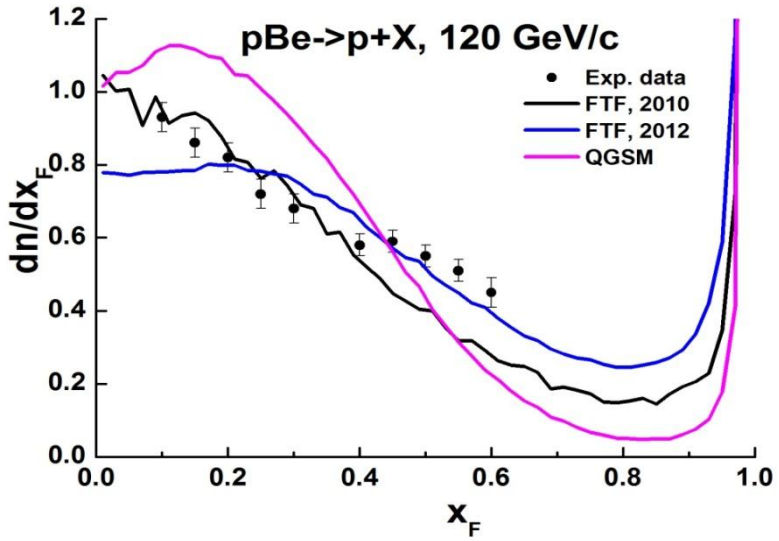
NA49 Collaboration (C. Alt et al.), Eur. Phys. J., C49 (2007) 897.

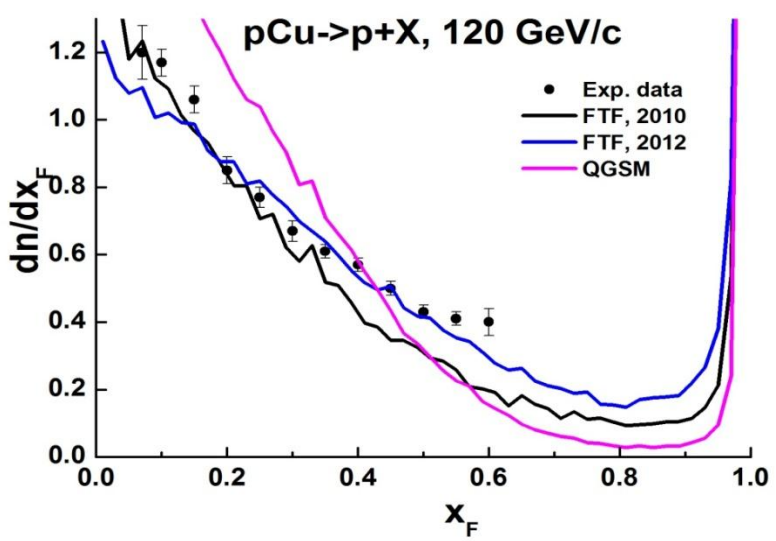


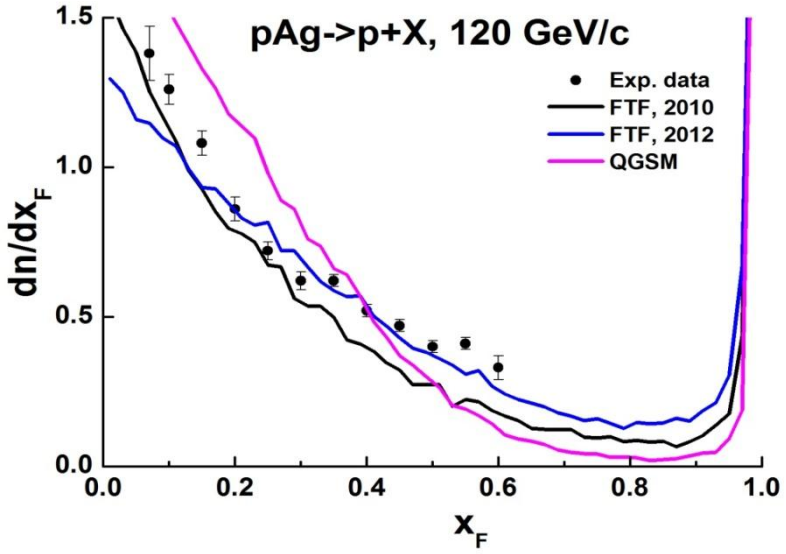


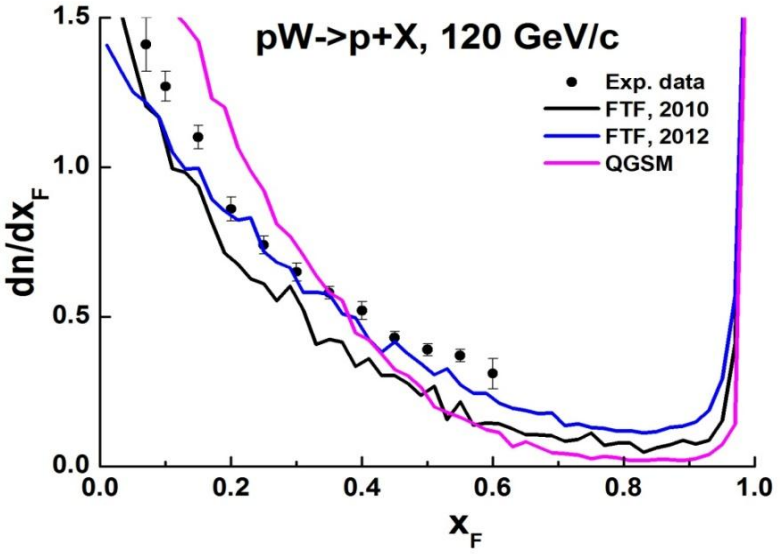
Exp. Data of NA-49 Collaboration

Description of CERN-SPS data on pA->pX, 120 GeV/c



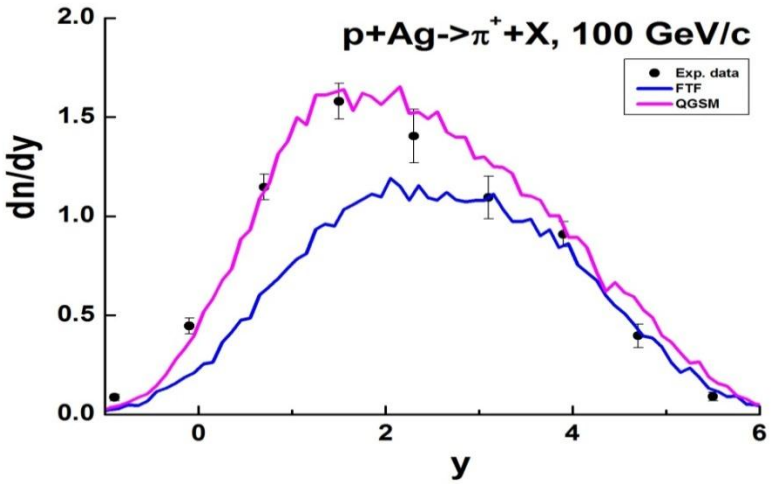


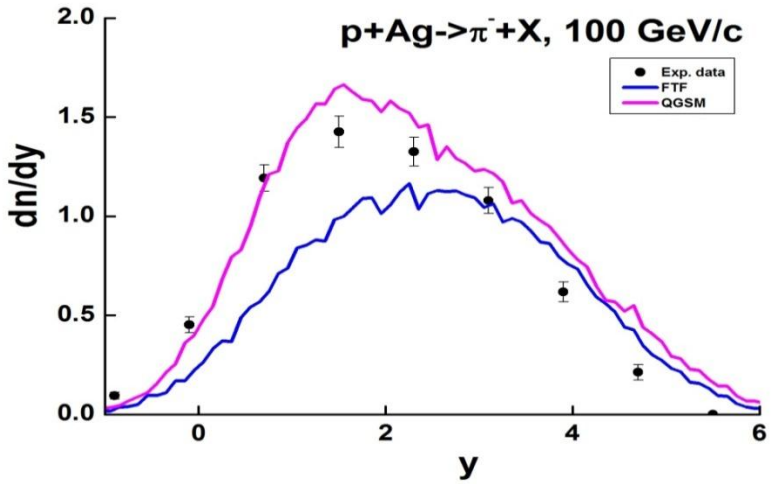


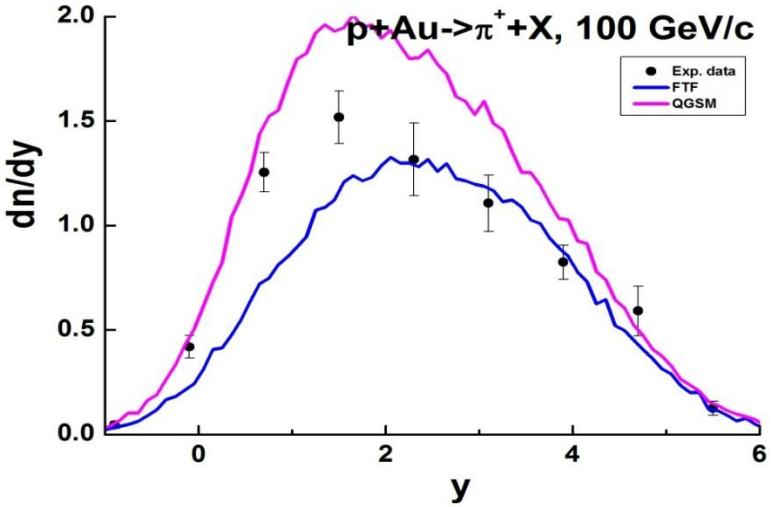


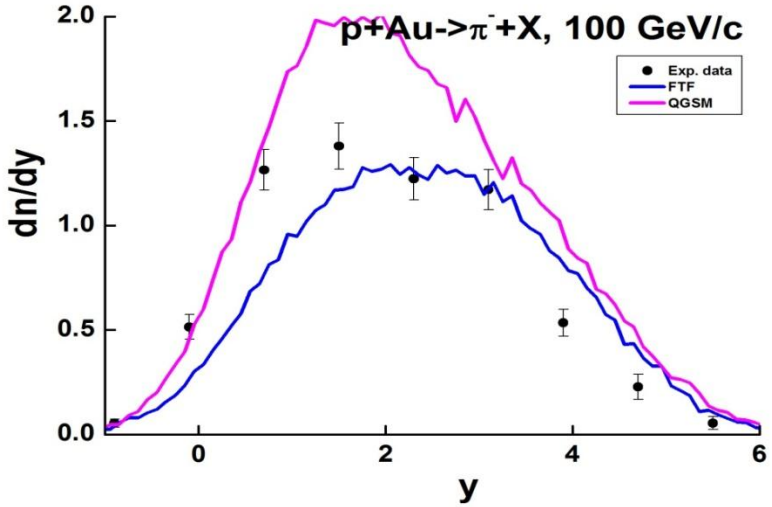
Description of data on pA interactions at 100 GeV/c

J.J. Whitmore et al., Z. Phys. C 62, 199-227 (1994)





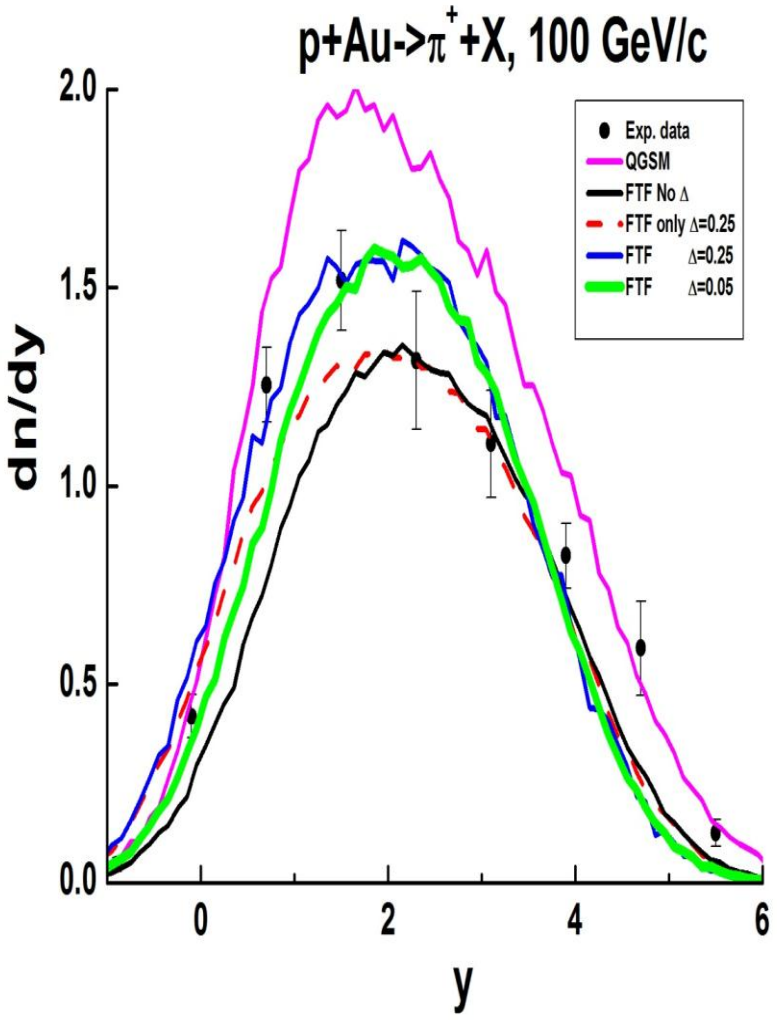


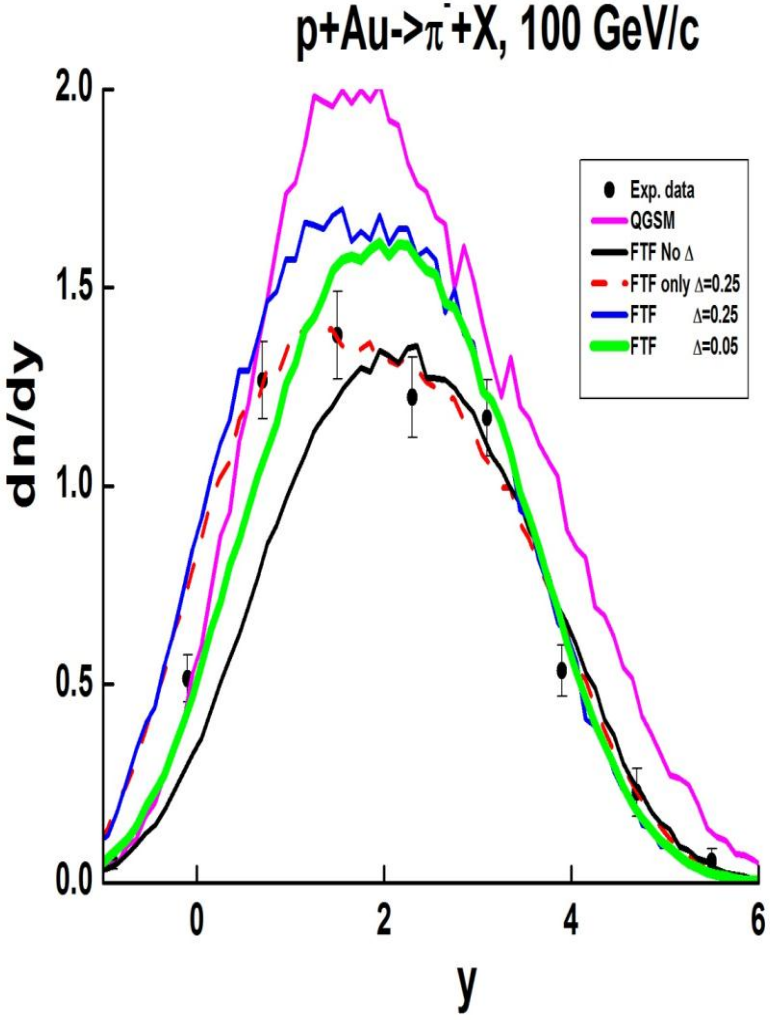


Insufficient meson production in the target fragmentation region!

Description of data on pA interactions at 100 GeV/c

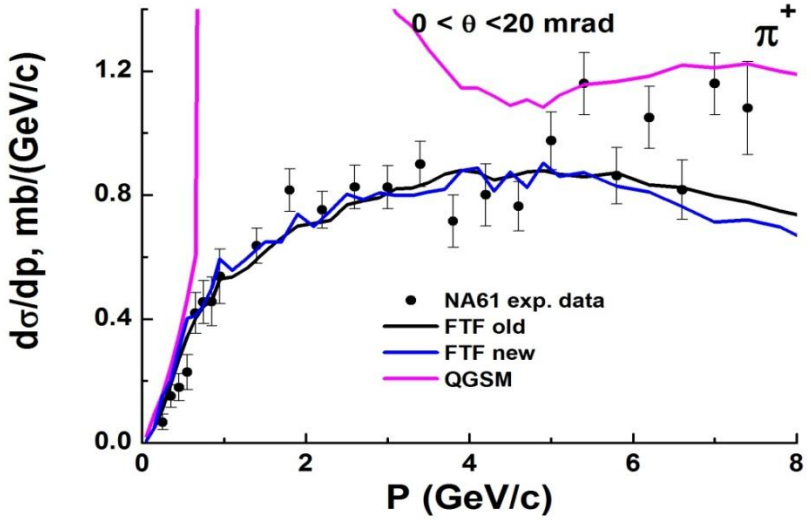
J.J. Whitmore et al., Z. Phys. C 62, 199-227 (1994)

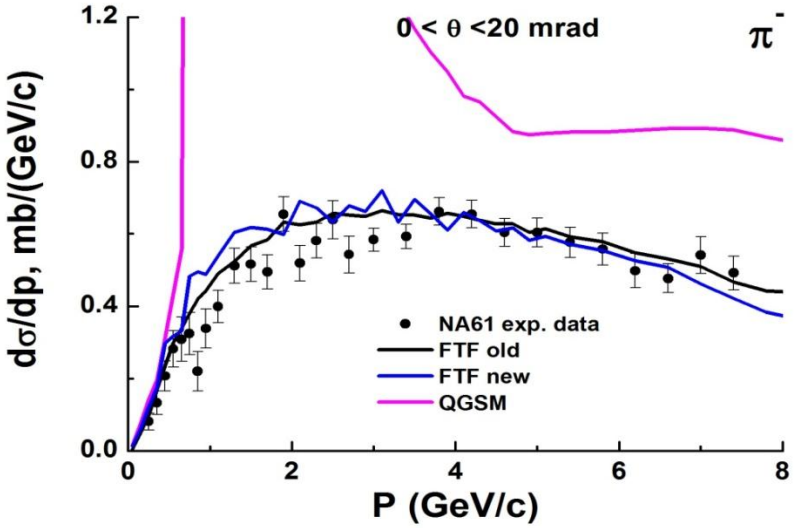


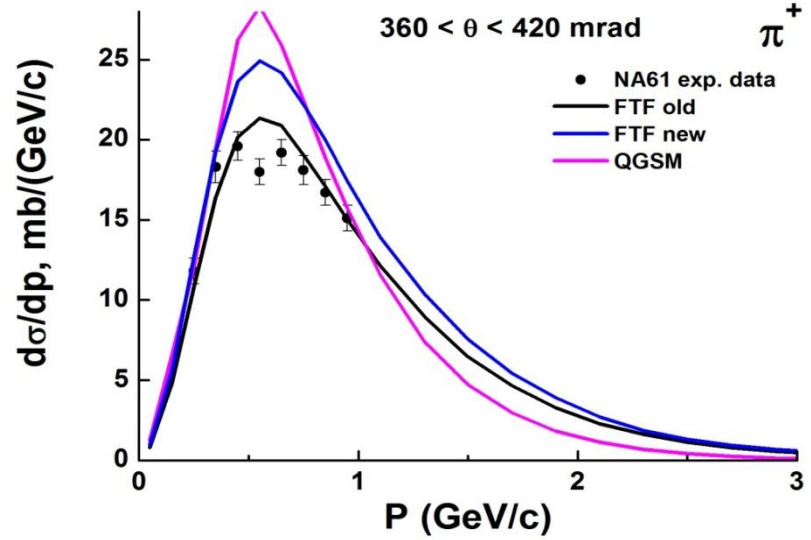


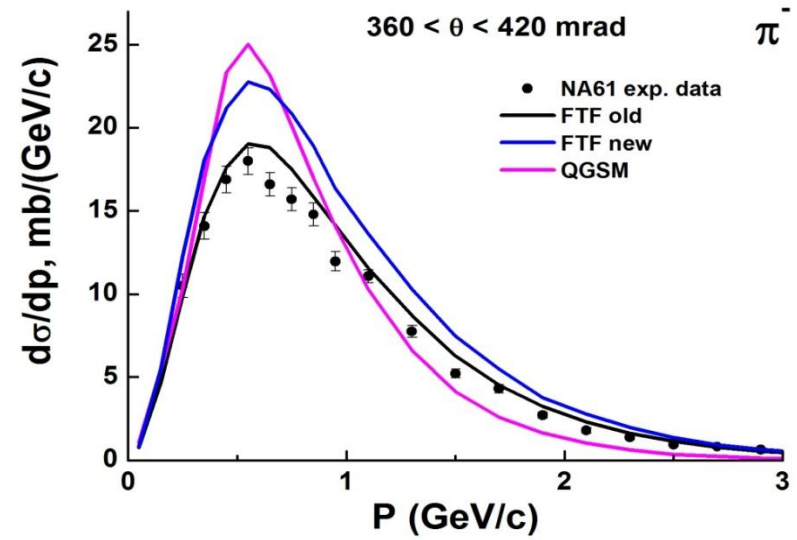
Activation of the Δ-isobar in the reggeon cascading

Description of NA61 data on p+C at 31 GeV/c

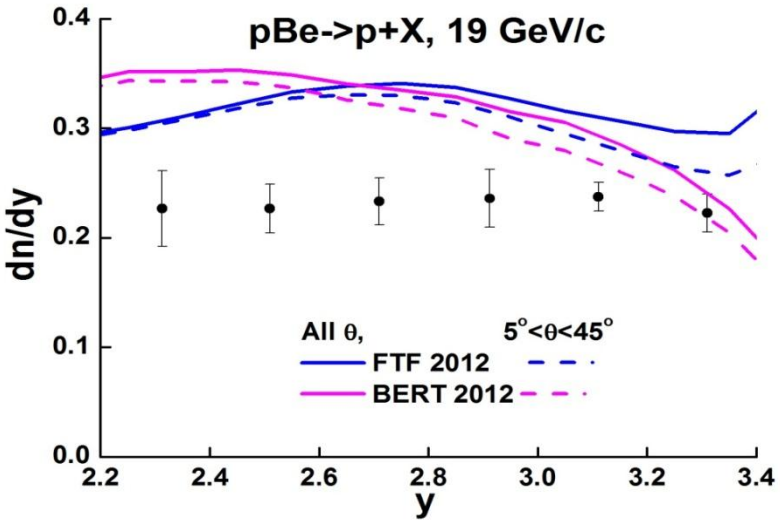


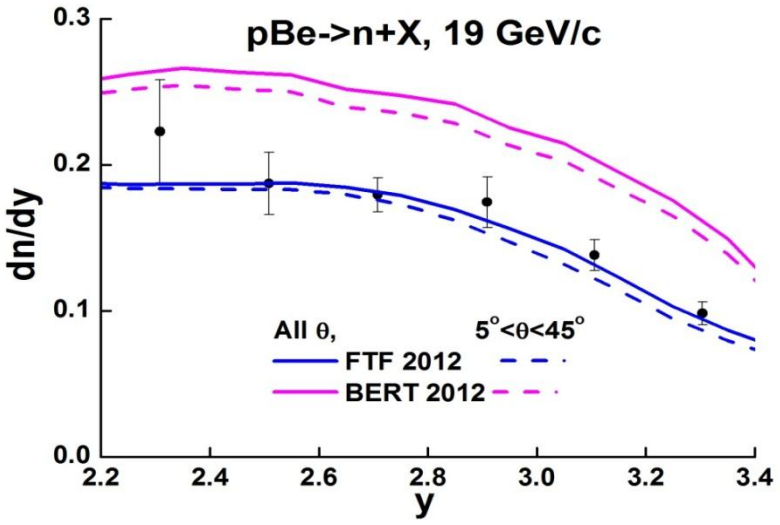


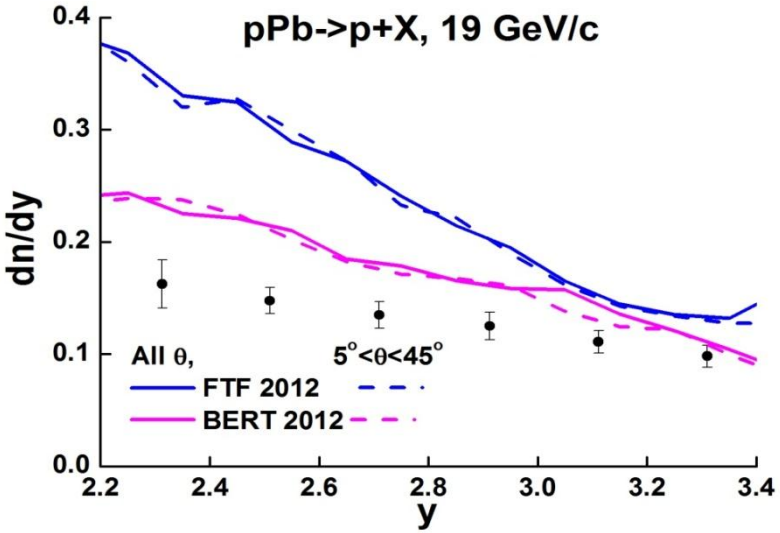


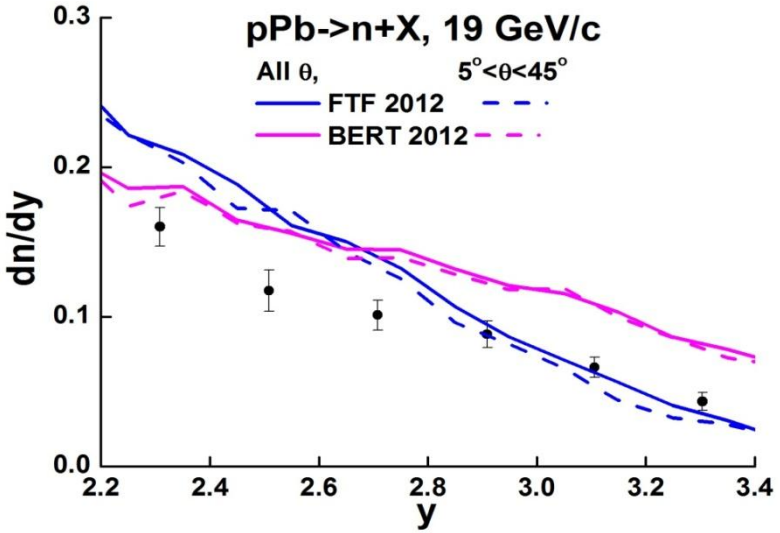


Description of BNL data on pA->pX, 12 and 19 GeV/c

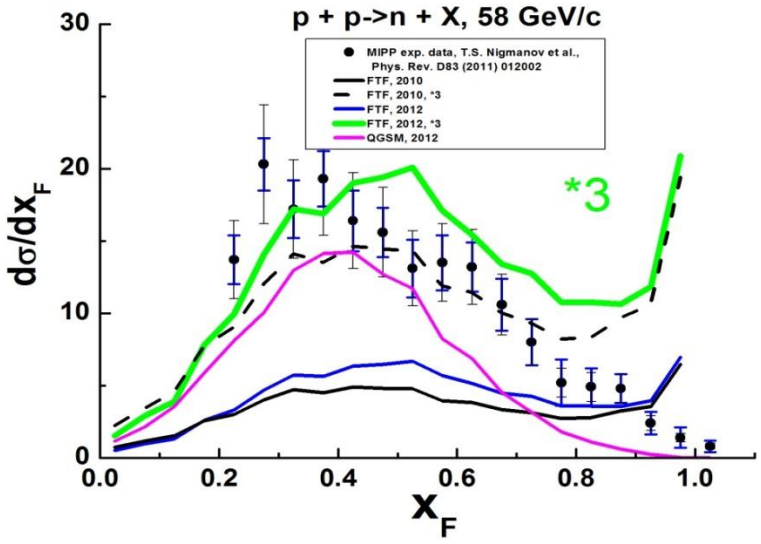


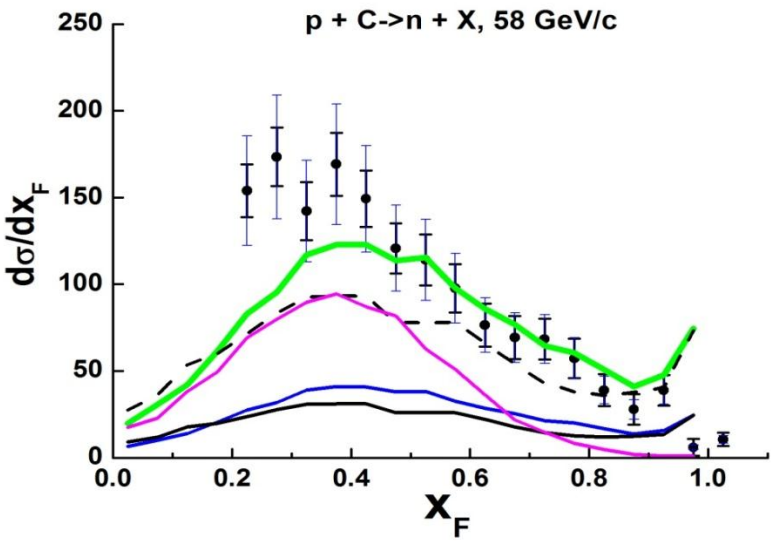


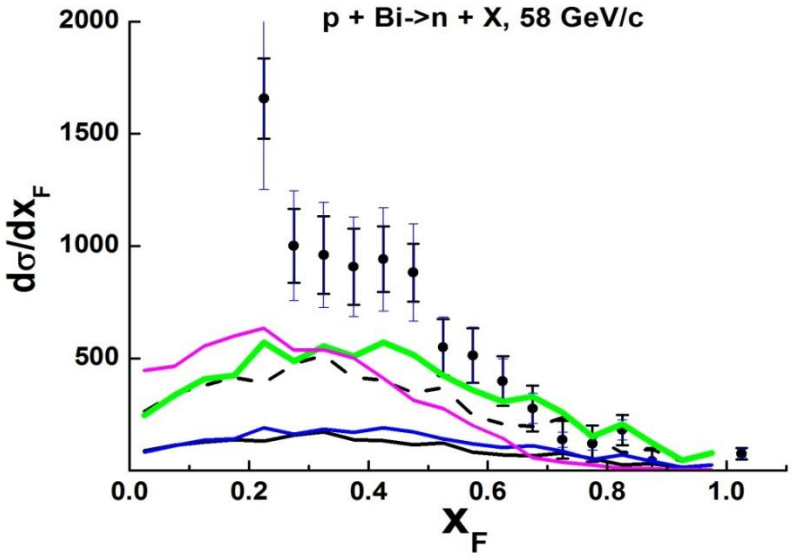


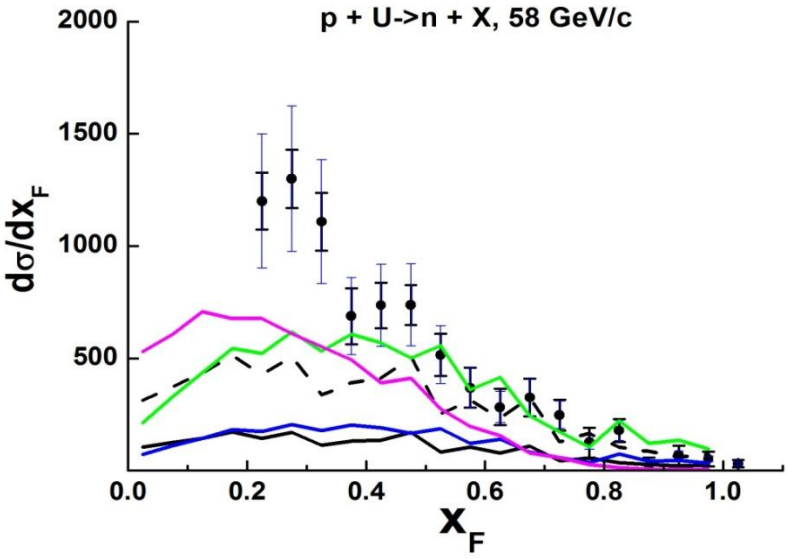


Description of MIPP data, 58 GeV/c

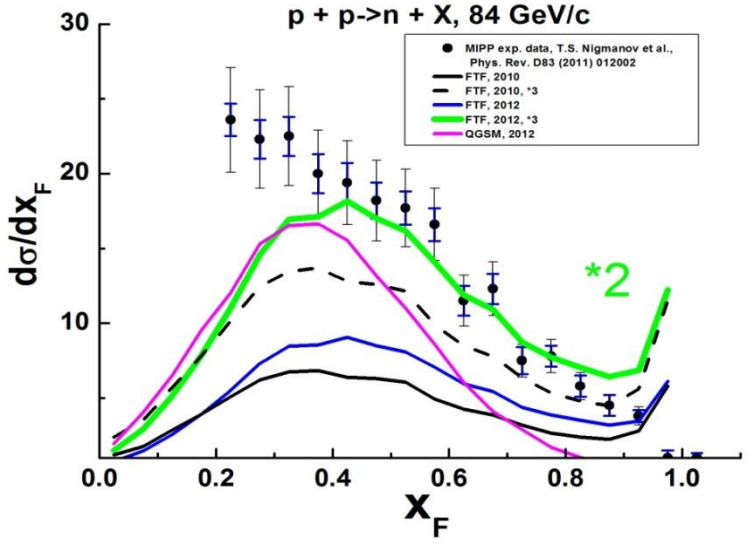


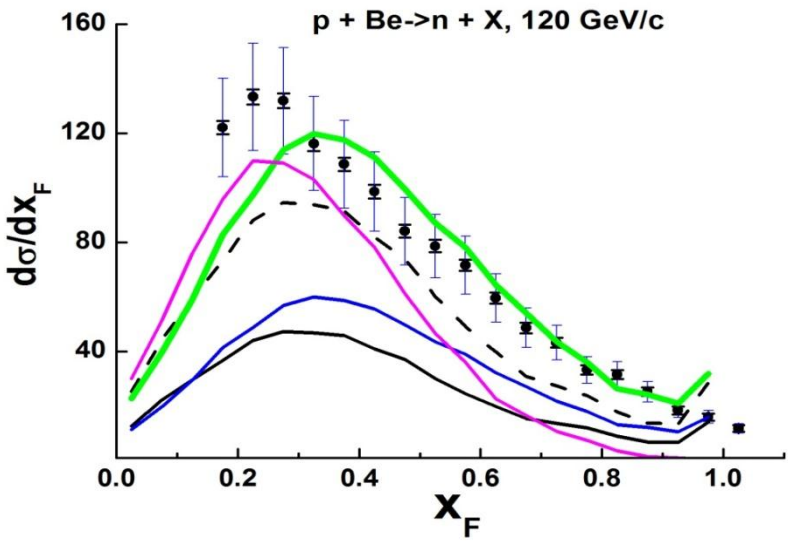


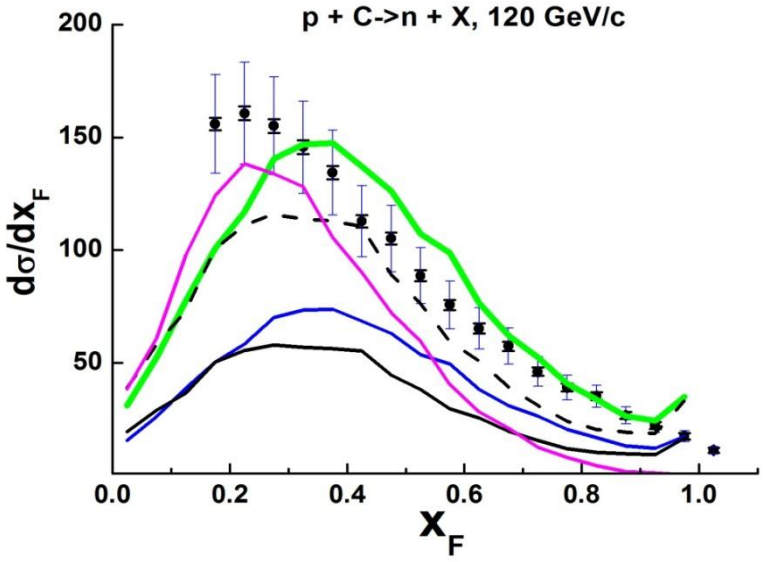


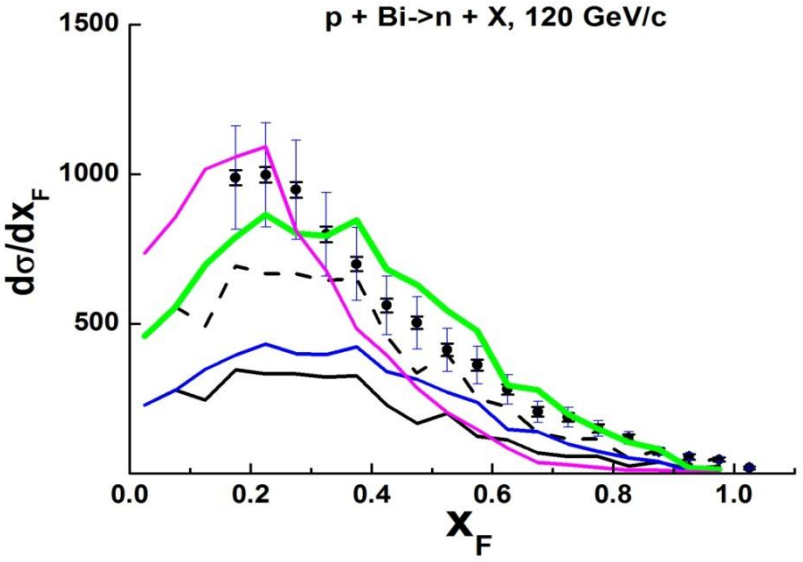


Description of MIPP data, 84 and 120 GeV/c

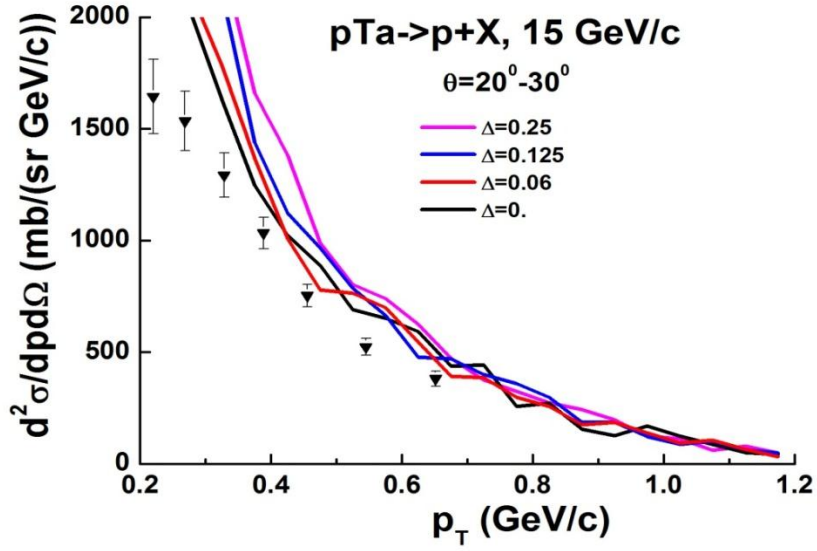


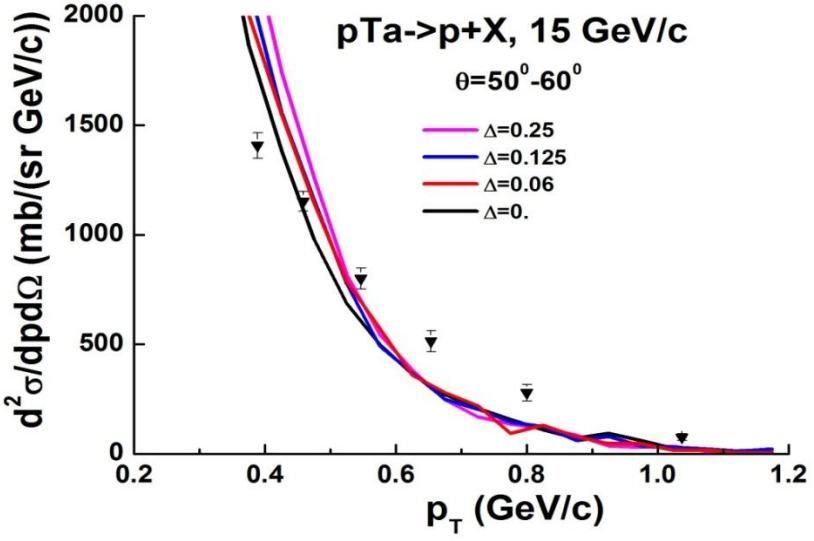


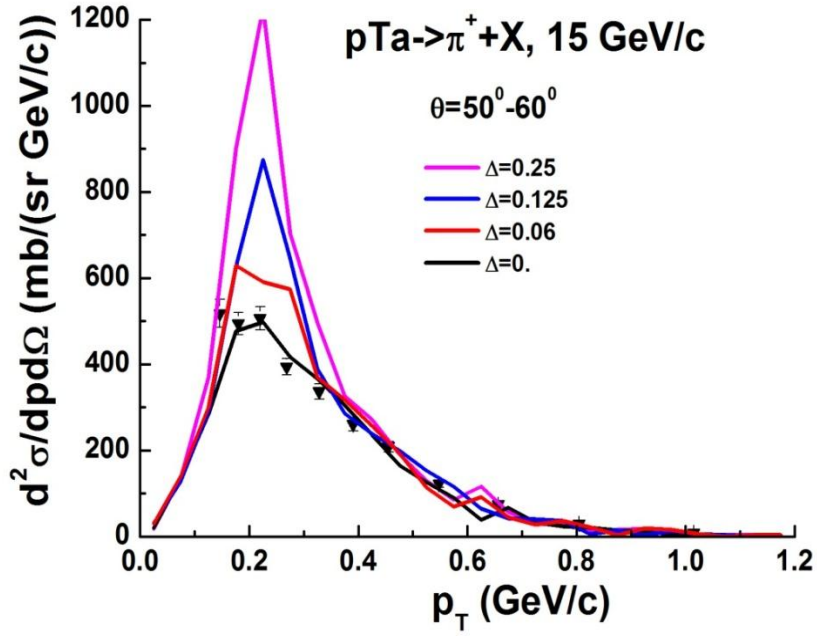


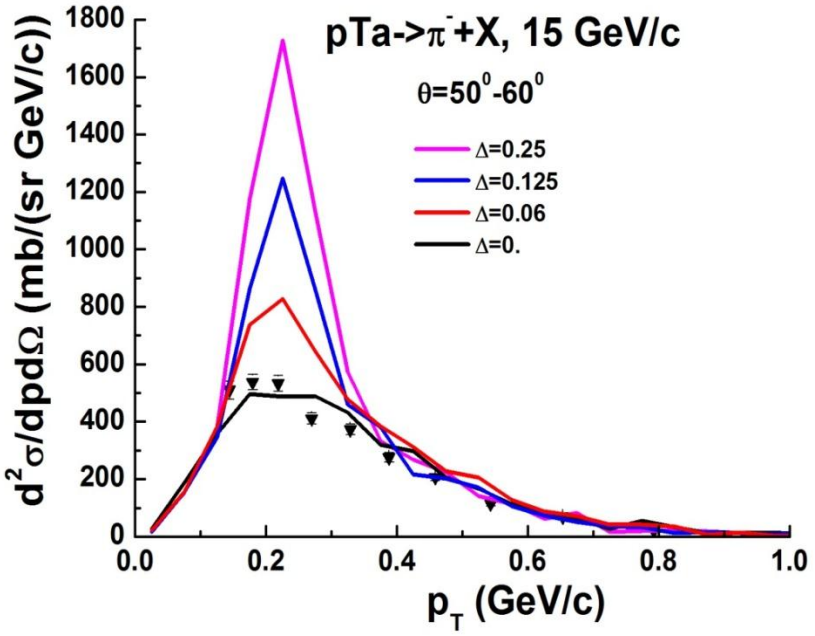


Description of HARP-CDP data on pTa interactions

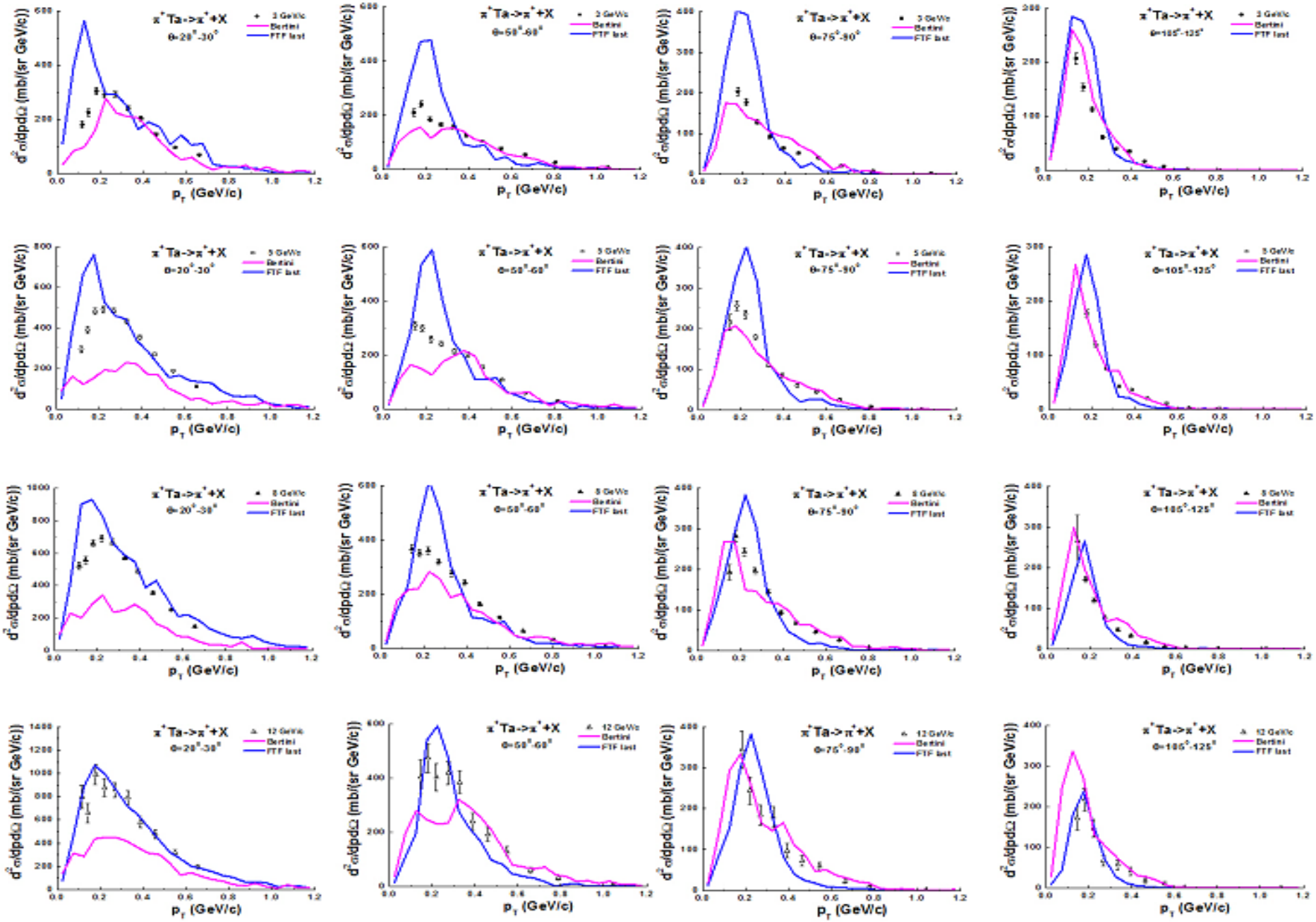




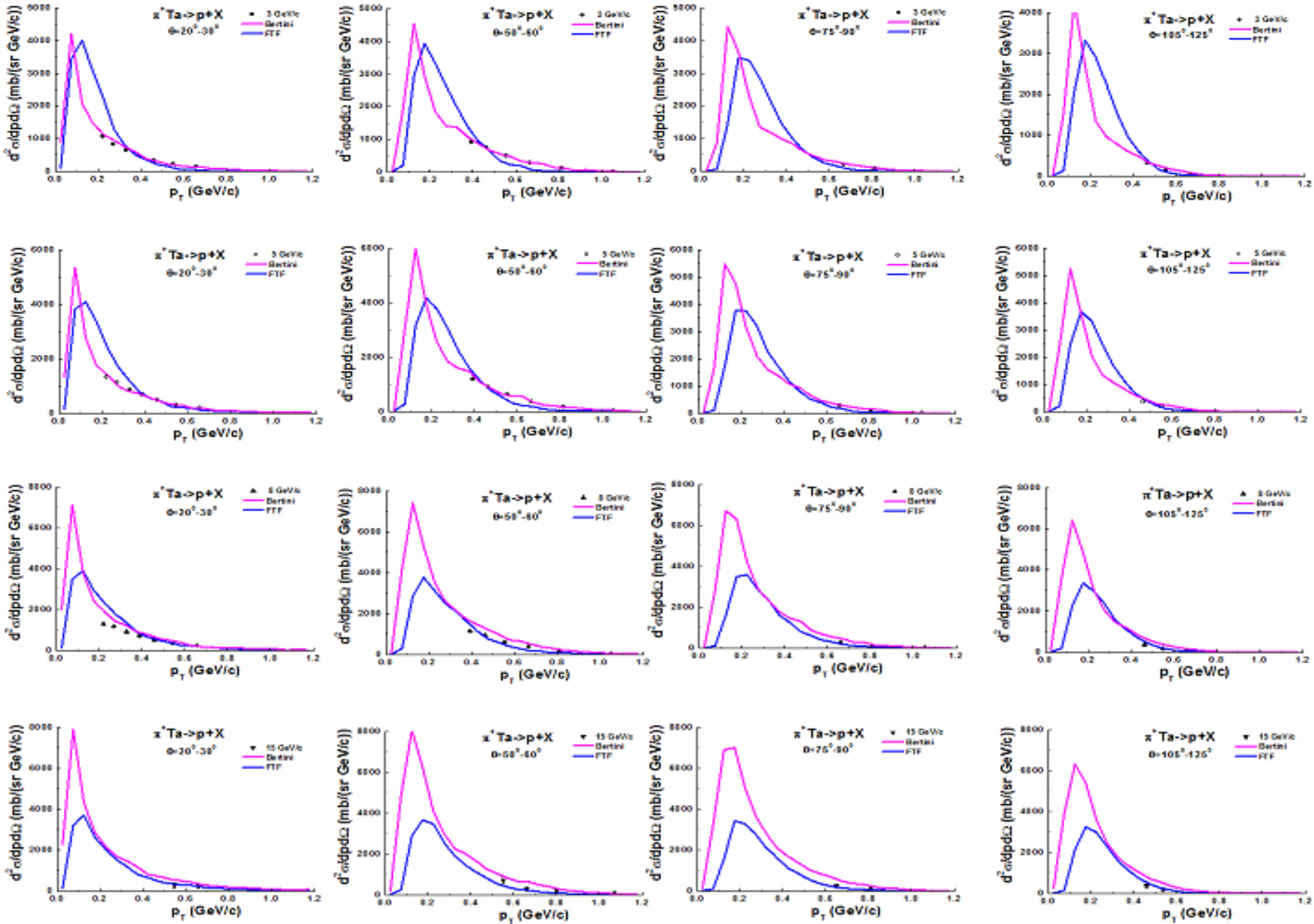




Description of HARP-CDP data on Pi+ Ta ->Pi+ X



Description of HARP-CDP data on Pi+ Ta ->P X, ?????



Conclusion

Baryon diffraction is essential improved in FTF!

1. Diffraction dissociation cross sections in PP-, Pi P- and K P interactions have been estimated.
2. Diffractive strings are not kinky strings!
3. Results of FTF at low energies are saved.
4. New string mass distribution in NSD is proposed.
5. s-sbar pair creation probability and qq-qqbar creation probability are tuned.
6. The model works quite well for pp-interactions.
7. A good description of exp. data on p A and Pi A interactions has been reached.

The Bertini model is well for pTa interactions at Plab <= 5 GeV/c now!
The FTFp model is well above Plab >= 5 GeV/c.

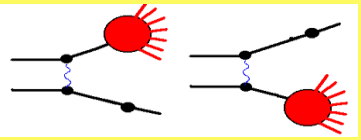
Wishes

Estimation of evaporated nucleon multiplicity and spectra is still problematic due to lack of exp. data. It would be well to use calorimetric data!

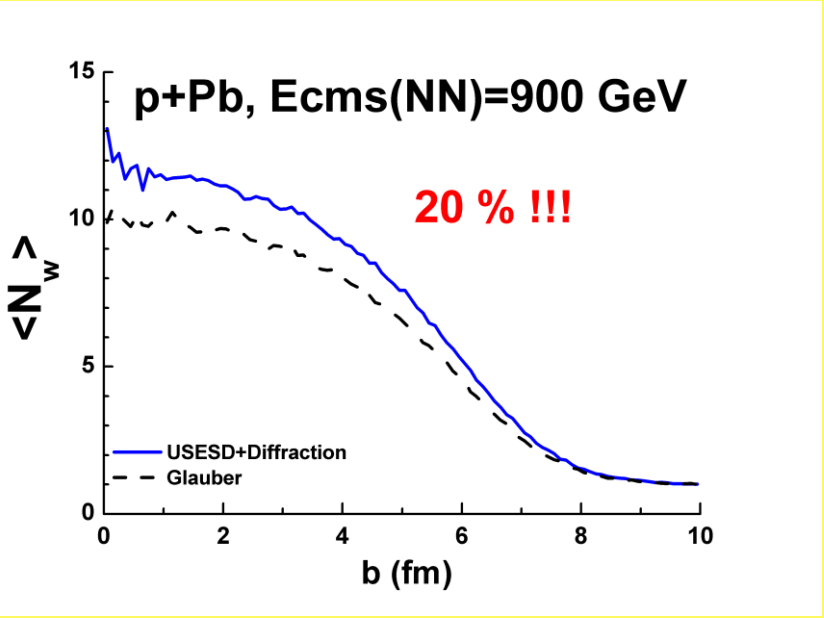
The diffraction in hadron-nucleus interactions has to be studied more carefully.

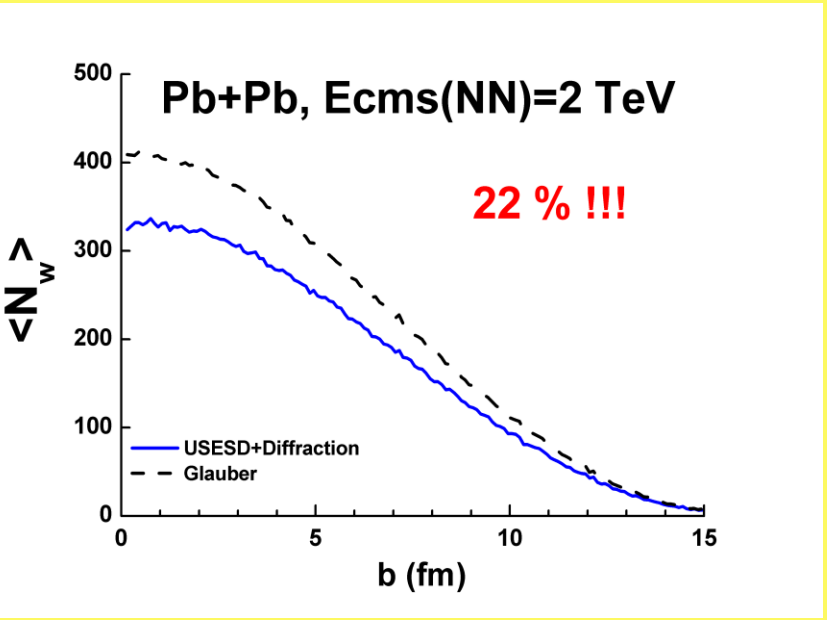
It would be well to improve the Bertini and QGS models.

Diffraction in FTF can be checked in P+Pb interactions at LHC (4.4 TeV). The experiment was planed on November 2012.



Understanding of the diffraction dissociation is very important for RHIC and LHC!



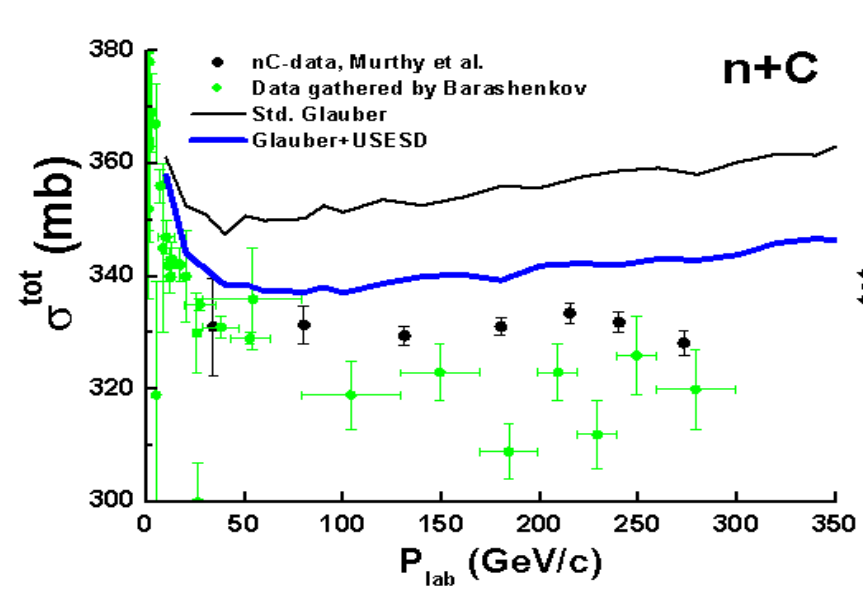


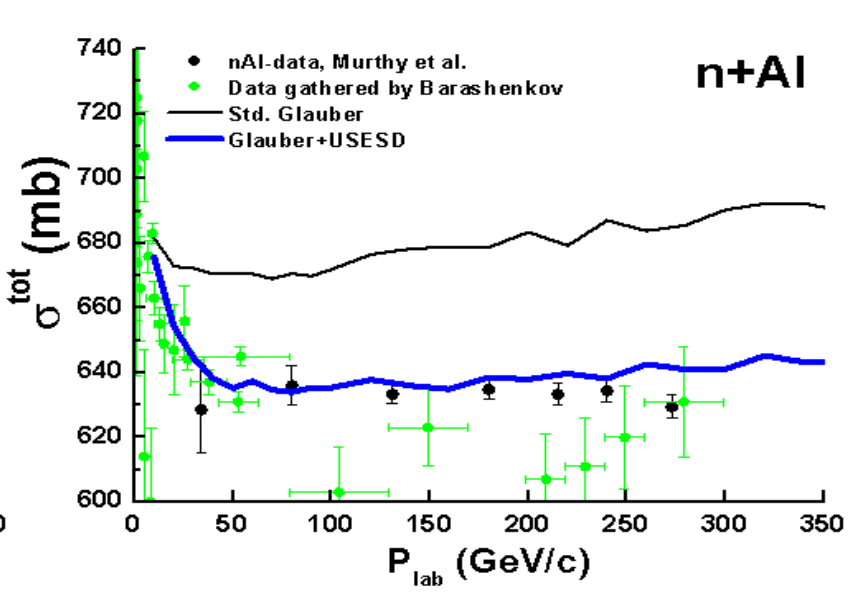
V.V.Uzhinsky, JINR-P2-81-789 preprint, Dec 1981.
Estimation Of Inelastic Shadowing Effects In Elastic Nucleus-nucleus Scattering. (In Russian)

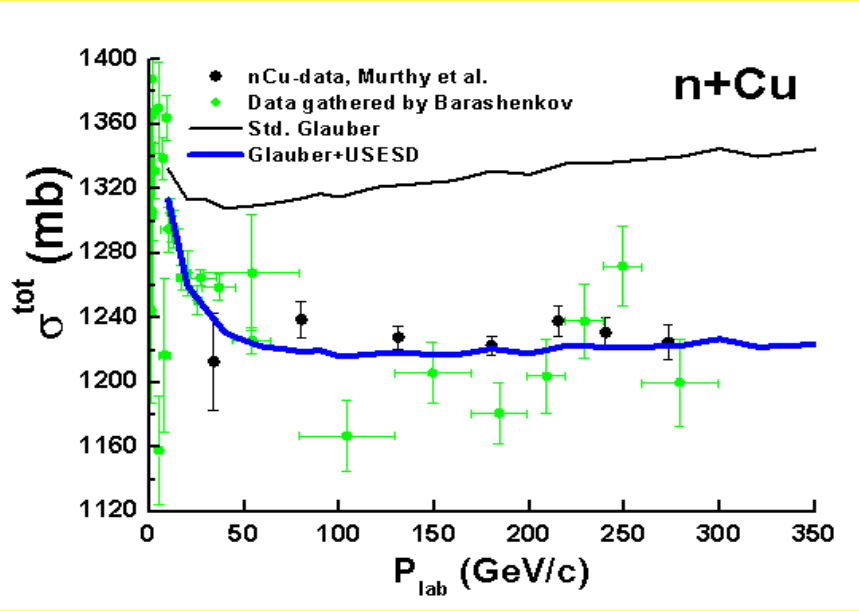
$$\sigma_{hA}^{tot} = 4\pi \int b\, db \left[1 - e^{-\sigma_{hN} T_A(b)}\right], \; Glauber\; formulae$$

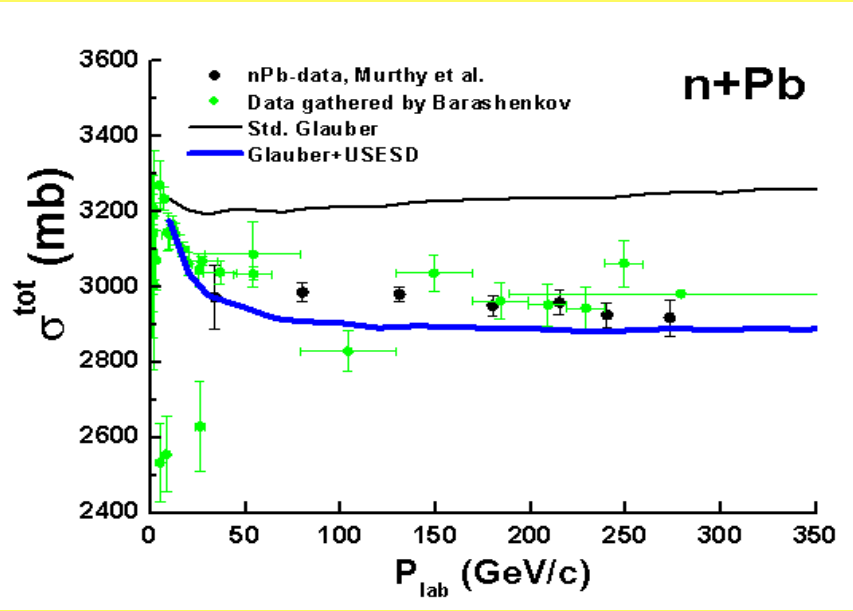
$$\sigma_{hA}^{tot} = \frac{4\pi}{C_p} \int b\, db \left[1 - e^{-C_p \sigma_{hN} T_A(b)}\right]$$

pA and nA interactions









Data of the Pierre Auger Observatory

arXiv:1208.1520, 9 Aug. 2012, High Energy Physics - Experiment (hep-ex)
Measurement of the proton-air cross-section at sqrt{s}=57 TeV with the Pierre Auger Observatory

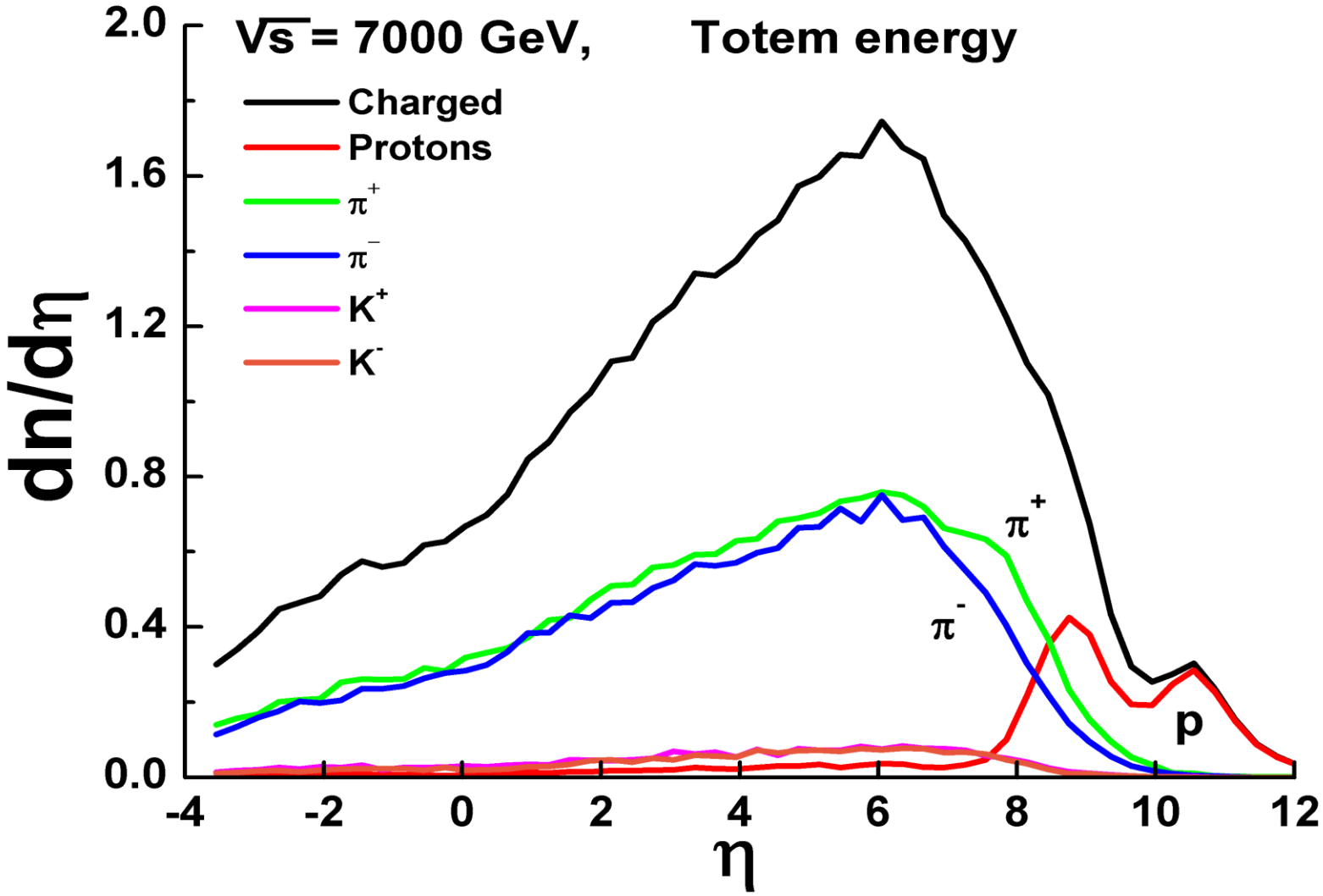
Comments: 9 pages, 4 figures, Accepted at PRL
Production X **505 +/- 22 (stat) +/- 32 {sys}**

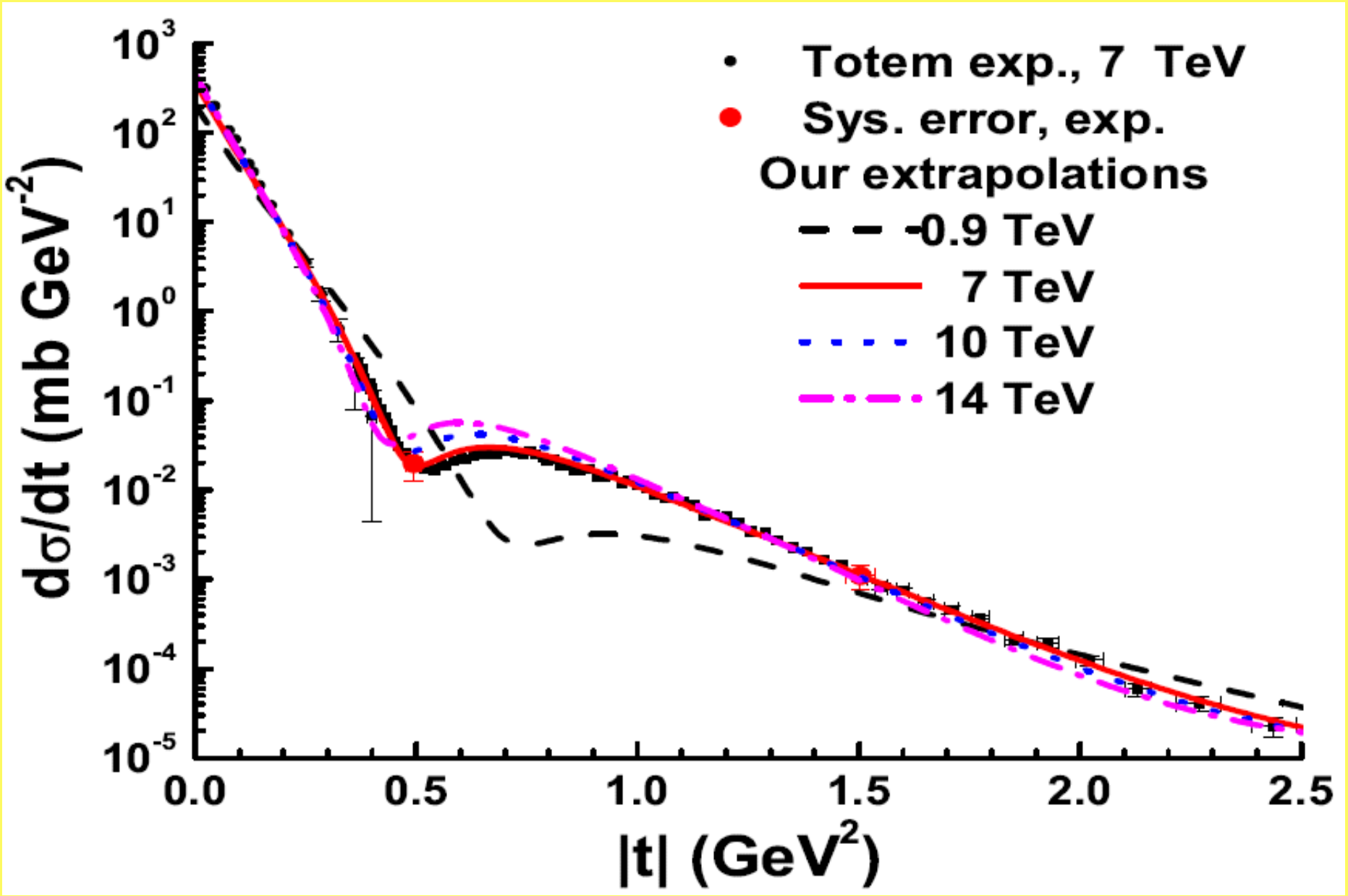
	Total	Elast.	AB->AX (q.el.)	Prod.
USESD	775	232	32.6	511
Glaub.	868	307	38.5	523

Prediction for the LHC, p+Pb

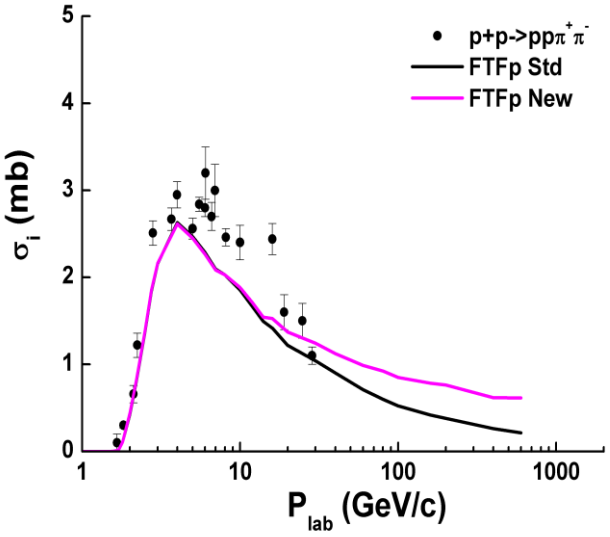
SqrtS (GeV)	XtotpA	XelpA	XabaxpA	Xprod	XprGlaub.	% T. Gl.
900	3286	1154	54	2078	(2144) 3 %	3851 15 %
2000	3408	1207	58	2143	(2212) 3 %	4009 15 %
5000	3530	1257	58	2215	(2286) 3 %	4163 15 %
7000	3563	1271	60	2232	(2303) 3 %	4206 15 %
9000	3593	1283	62	2248	(2320) 3 %	4244 15 %
14000	3644	1304	62	2279	(2353) 3 %	4307 15 %

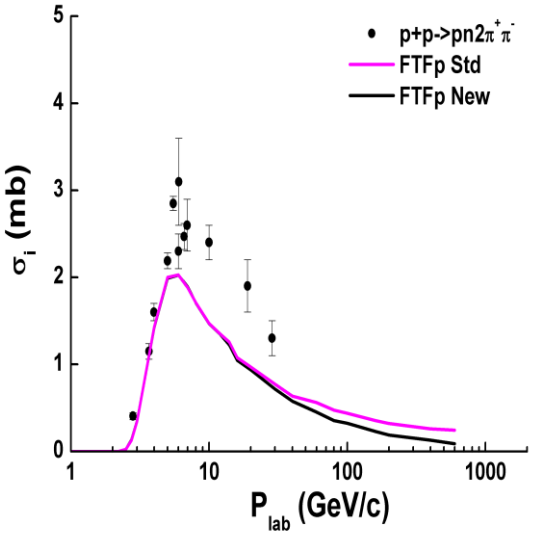
Diffraction for LHCf and Totem experiment

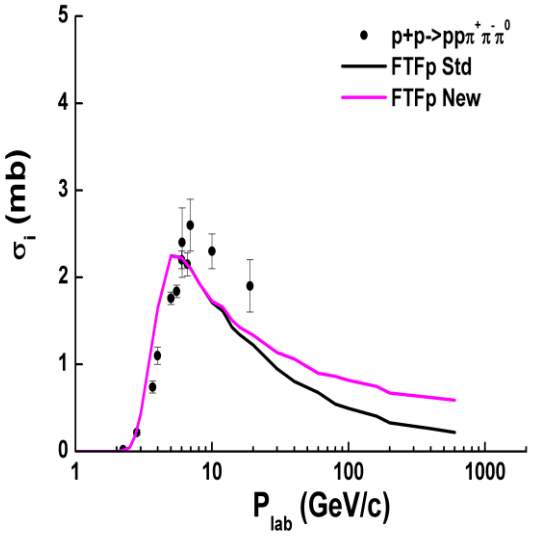


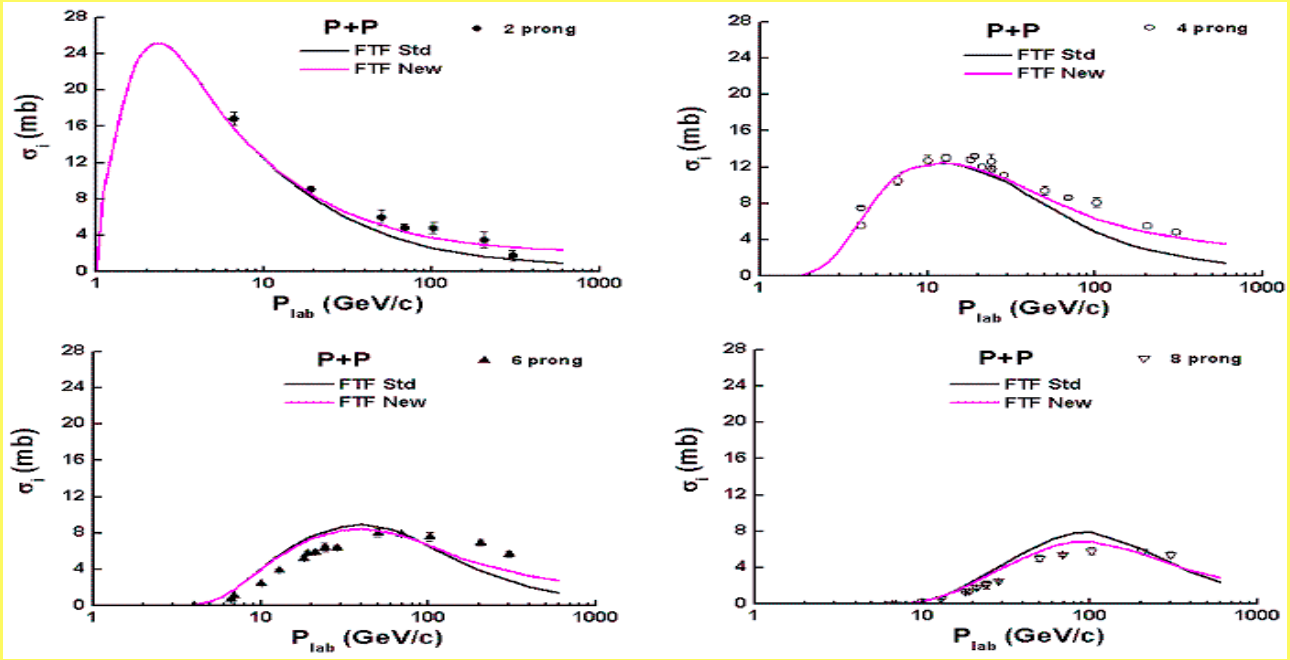

Totem exp., 7 TeV
Sys. error, exp.
Our extrapolations
0.9 TeV
7 TeV
10 TeV
14 TeV
dσ/dt (mb GeV-2)
|t| (GeV2)
10^3
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0.0
0.5
1.0
1.5
2.0
2.5

PP interaction channel cross sections









Theoretical estimations of the cross section

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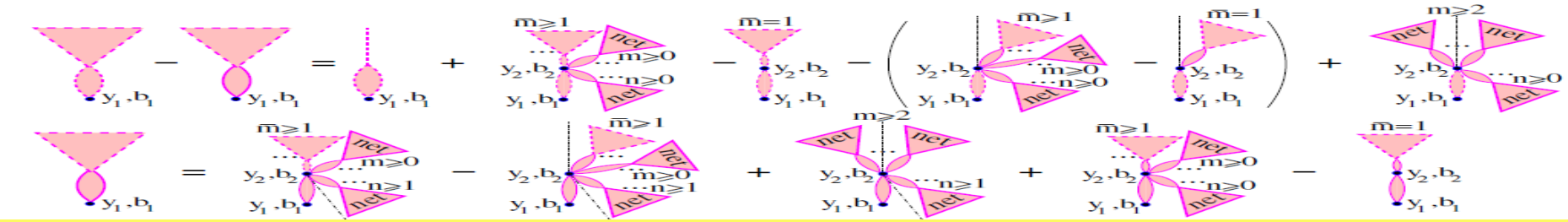


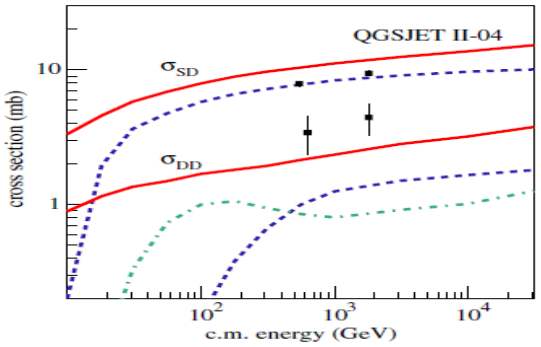
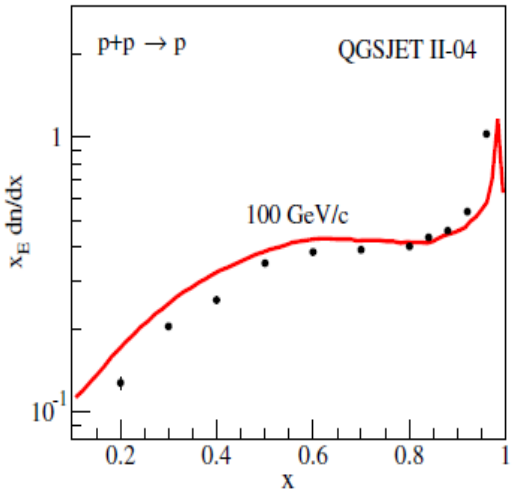
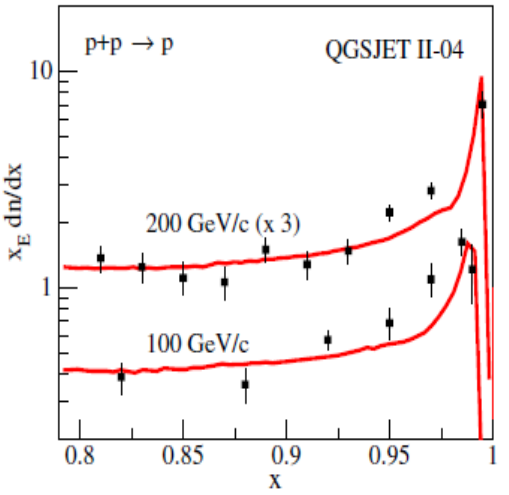


FIG. 12 (color online). Calculated single $\sigma_{pp}^{SD}(M_X^2/s < 0.15)$ and double $\sigma_{pp}^{DD}(y_{gap}^{(0)} \geq 3)$ diffraction proton-proton cross sections (solid lines), compared to CDF data (points) [26,27]; high mass diffraction contributions to σ_{pp}^{SD}, σ_{pp}^{DD} (dashed lines); contribution to σ_{pp}^{DD} from a high mass diffraction of one proton and a low mass excitation of the other one (dotted-dashed line).





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Influence of diffraction on other processes?

Predictions of the Quark–Gluon String Model for pp at LHC
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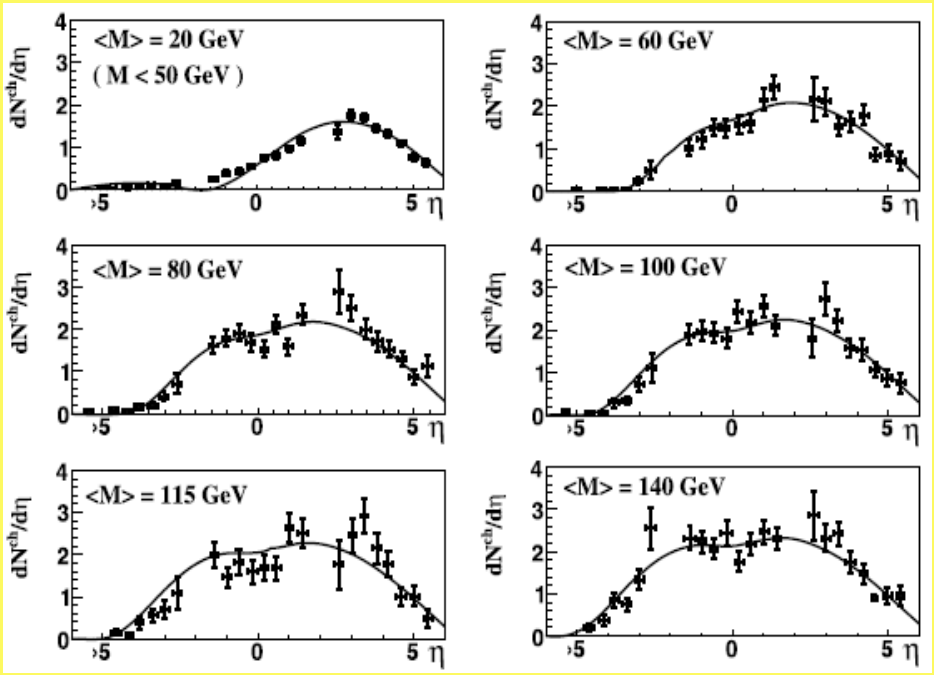
$$\sigma_n(\xi) = 4\pi \frac{\lambda}{nC}\left[1 - \exp\{-z\}\sum_{l=0}^{n-1}\frac{z^l}{l!}\right]. \quad (1)$$

Here $z = C\gamma/\lambda \exp\{\Delta\xi\}$, $\lambda = R^2 + \alpha'_P\xi$, and $\xi = \ln(s/s_0)$. The values of parameters γ, λ, R^2 and α'_P which characterize the residue and the trajectory of the pomeron are found from fit to data on pp and $p\bar{p}$ total interaction and elastic scattering cross-section in [22, 23]: $\gamma = 2.14$ GeV^{-2}, $R^2 = 3.3$ GeV^{-2}, $\Delta = 0.12$, $\alpha'_P = 0.22$ GeV^{-2}, $C = 1.5$.



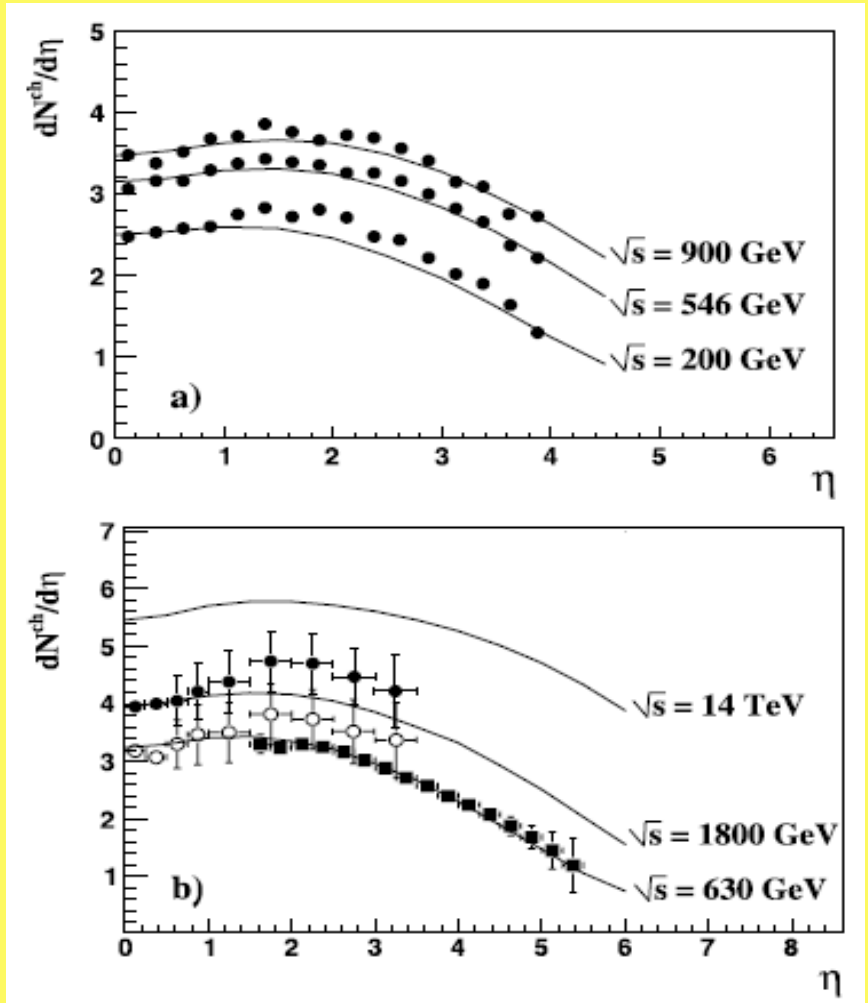


Fig. 5 Comparison of model's prediction with data on charged particles pseudorapidity distribution in NSD events and prediction for LHC: (a) description of UA5 data [32, 33], (b) description of CDF and P238 data (*circles* and *squares*, respectively) [34, 35]