

Validation of FTF and QGS models for charmed particles production

A. Galoyan 20.11.2019

We consider the following papers with exp. data on charmed particles production:

1. Feynman-x and Transverse Momentum Dependence of D Meson Production in 250 GeV p, K, and π Interactions with Nuclei . (Fermilab E769 Collaboration) G. A. Alves, et.al, **Phys.Rev. Lett, V77, N 12, 1996, 239**
2. Measurements of charmed meson production in interactions between 350 GeV/c π - particles and nuclei. Beatrice Collaboration (Adamovich.et al.,) **Nucl. Phys. B495 (1997) 3-37**
3. Inclusive properties of D mesons produced in 360 GeV π -P interactions. NA27 LEBC-EHS Collaboration . **Phys. Lett. Volume 161B, 1985, P.400**
4. Charm D-meson production IN 360 GeV/c pp interactions; Comparison with pi π -p at the same energy. LEBC EHS Collaboration (M. AGUILAR-BENITEZ e. al,) **Phys. Lett. V.123B, N 1,2 1983, P.103**
5. Charm hadron properties in 400 GeV/c p p interactions. LEBC-EHS Collaboration (M. Aguilar-Benitez et al.,) **Z. Phys. C - Particles and Fields 40, 321 -346 (1988)**
6. Total forward and differential cross sections of neutral D mesons produced in 500 GeV/c π -nucleon interactions. E 791 Collaboration (E.M. Aitala at.el,) **Phys Lett B 462 (1999) P. 225**
7. D-Meson Production in 800-GeV/c pp Interactions . LEBC-MPS Collaboration (R. Ammar et. al.,) **PHYS. REV. LETT. 61, N19, 1988, P.2185**
8. Measurement of D^0 , D^+ , D^{s+} and D^{*+} production in fixed target 920 GeV proton-nucleus collisions. The HERA-B Collaboration (I. Abt et al.,) **Eur. Phys. J. C 52, 531-542 (2007)**
9. Hadronic production of Λ_c from 600 GeV/c π^- , Σ^- and p beams. SELEX Collaboration (F.G. Garcia et/al.,) **Physics Letters B 528 (2002) 49**

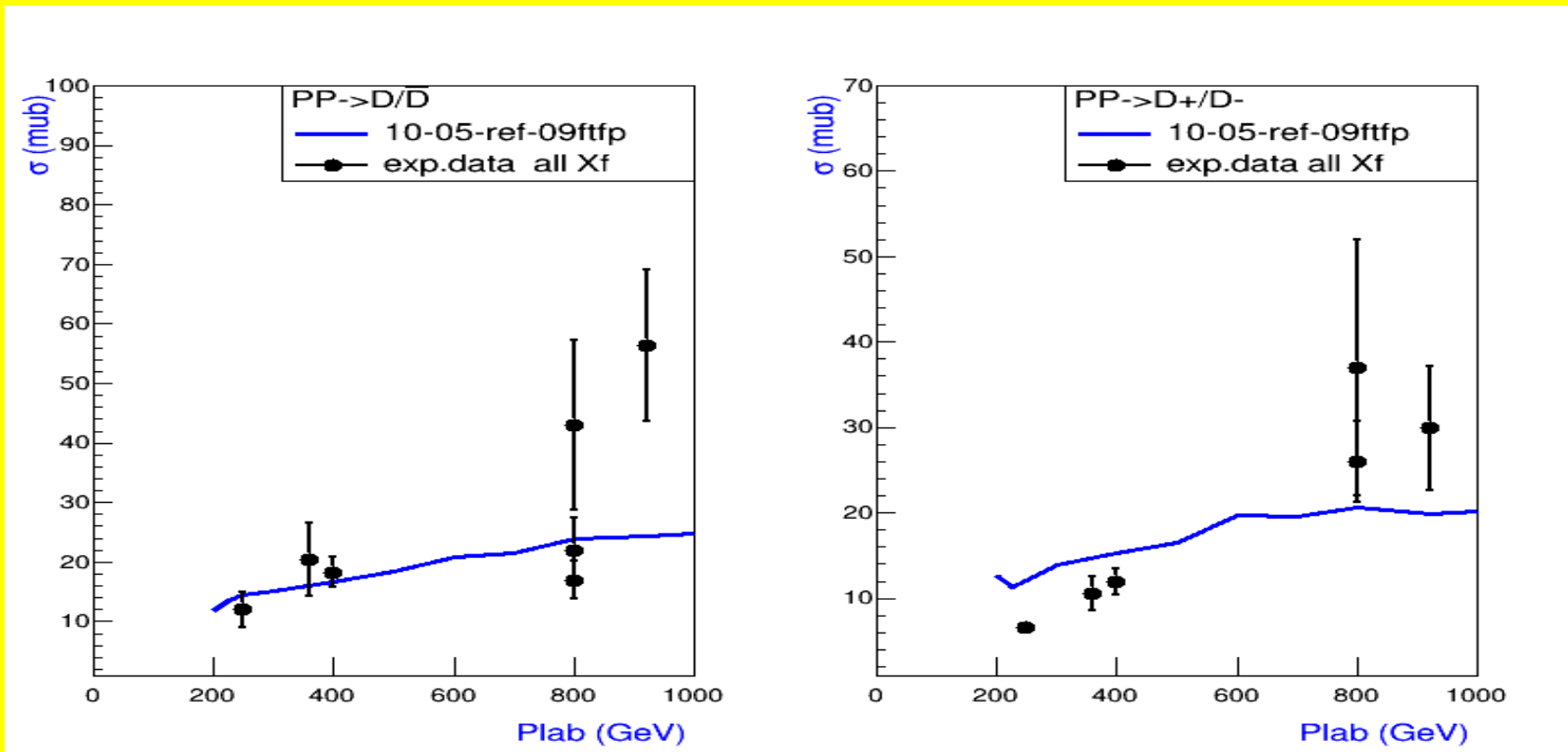
Tuning of charm quark production

Heavy flavour hadro-production from fixed-target to collider energies

C. Lourenco (CERN), H.K. Wohri (Lisbon, IST & CERN). **Phys.Rept. 433 (2006) P.127**

There is a review of the hadro-production data presently available on open charm and beauty absolute production cross-sections, collected by experiments at CERN, DESY and Fermilab. The published charm production cross-section values are updated, in particular for the “time evolution” of the branching ratios.

There are summarised the data used in the present study, obtained with proton and pion beams, at energies ranging from $E_{lab} = 200$ to 920 GeV.

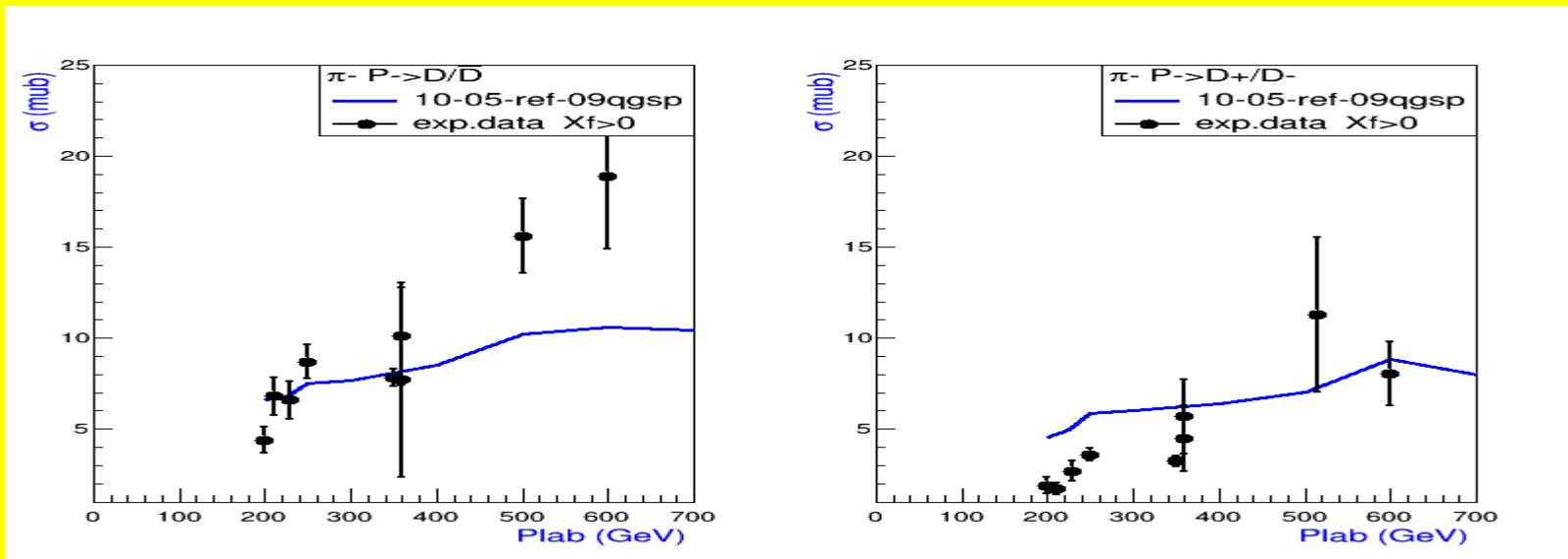
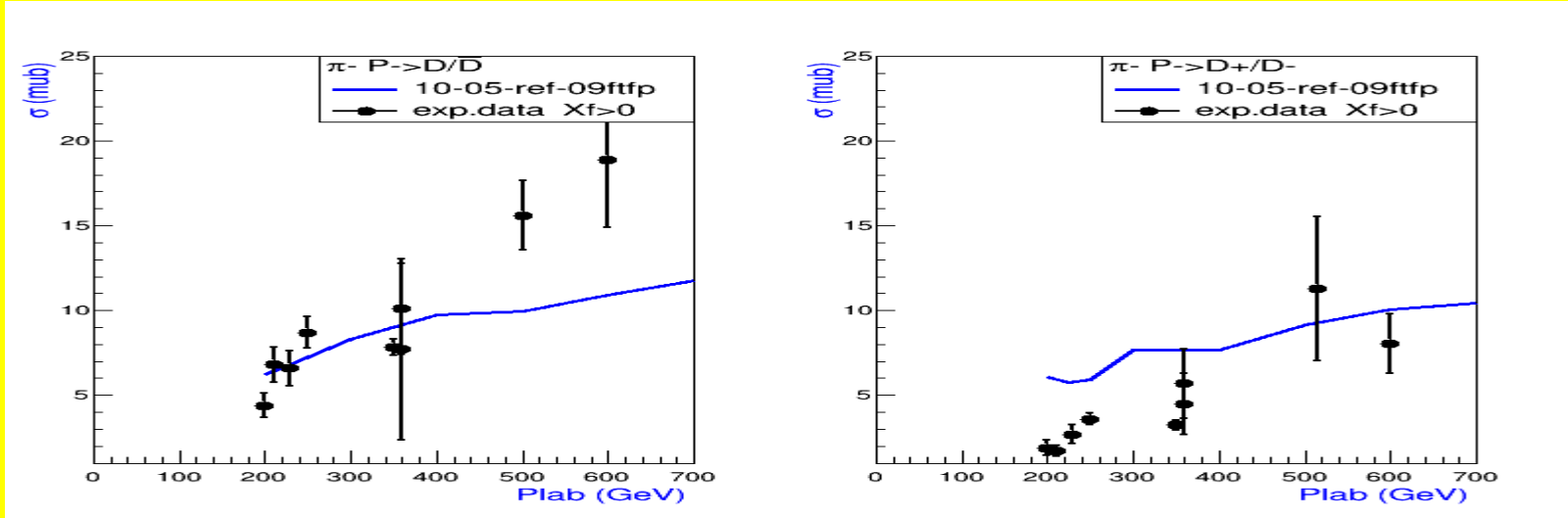


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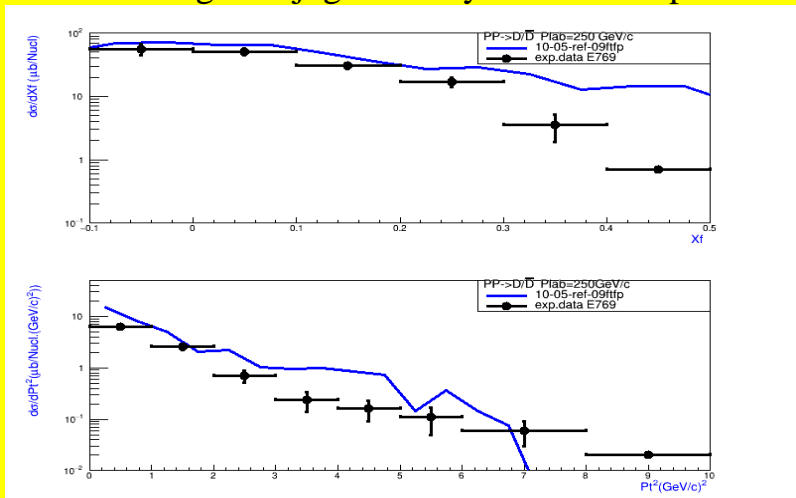
Differential distributions of charmed mesons

Feynman-x and Transverse Momentum Dependence of D Meson Production in 250 GeV p, K, and π Interactions with Nuclei . (Fermilab E769 Collaboration) G. A. Alves, et.al, Phys.Rev. Lett, V77, N 12, 1996, 239

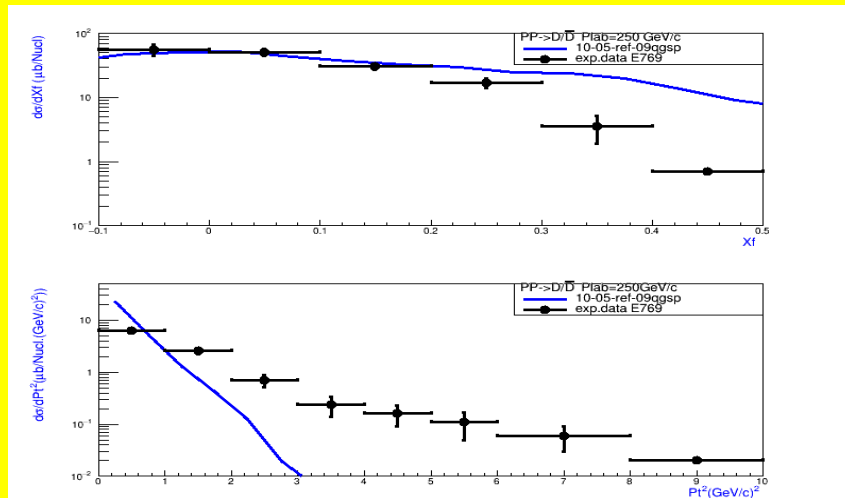
The E769 data set was collected using collisions of negatively and positively charged 250 GeV mixed secondary beams on a multifoil target of Be, Cu, Al, and W. D meson signals are obtained by combining the decays: $D^+ \rightarrow K^- \pi^+ \pi^+$, $D^0 \rightarrow K^- \pi^+ \pi^+$. Charge conjugate decays are also implied.

$$\sigma_A = \sigma_n A^\alpha$$

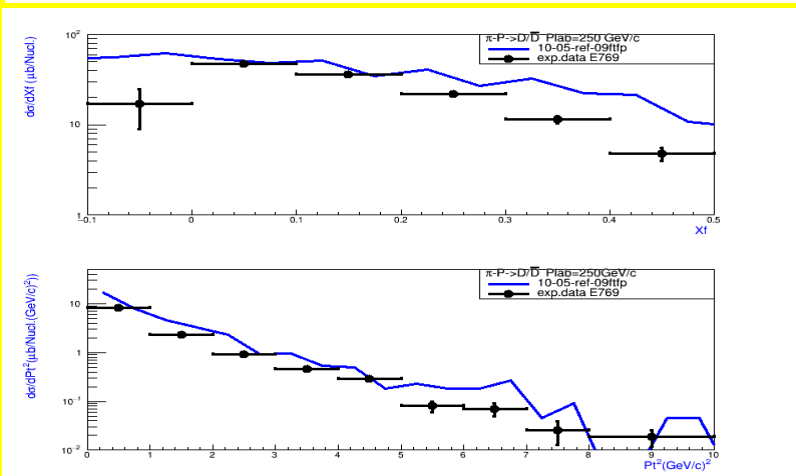
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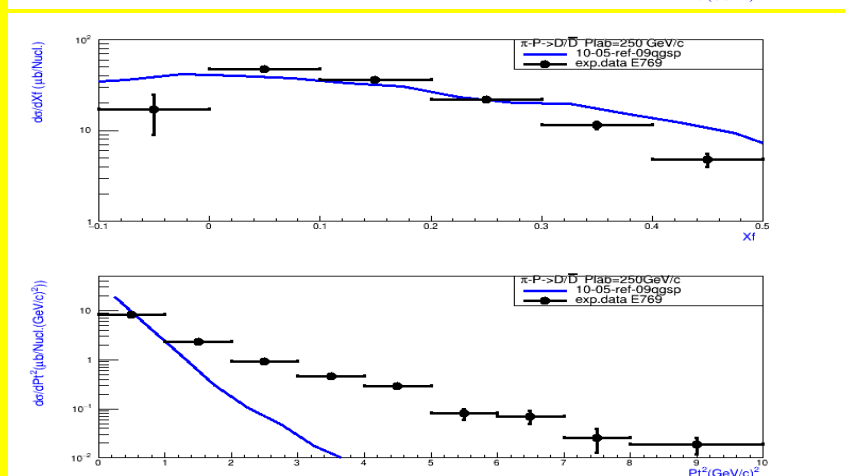
QGS



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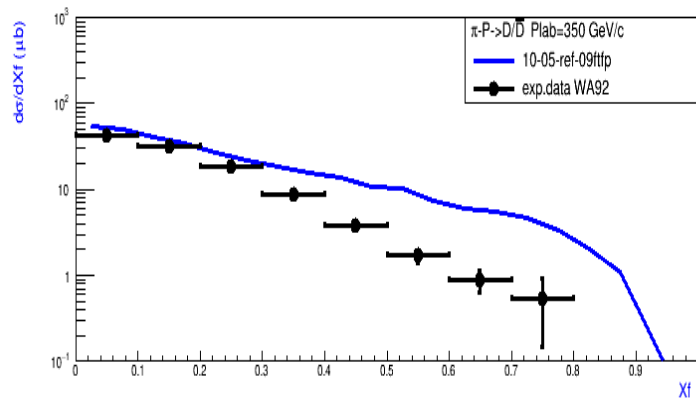
Differential distributions of charmed mesons

Measurements of charmed meson production in interactions between 350 GeV/c π^- particles and nuclei

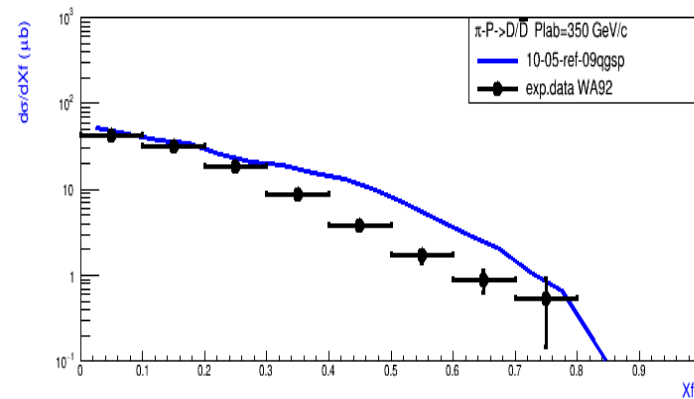
Beatrice Collaboration (Adamovich et al.), **Nucl. Phys. B495 (1997) 3-37**

Charmed-meson production by 350 GeV/c π^- -meson incident on copper C and tungsten W targets has been studied in the WA92 experiment, performed at the CERN Omega spectrometer. Reconstruction of decays from the set $D^0 \rightarrow K^- \pi^+$, $D^0 \rightarrow K^- \pi^+ \pi^+ \pi^+$, $D^+ \rightarrow K^- \pi^+ \pi^+$, $D_s^+ \rightarrow \phi \pi^+$ and charge conjugates has yielded a sample of about 7000 charmed mesons, produced with $X_f > 0$.

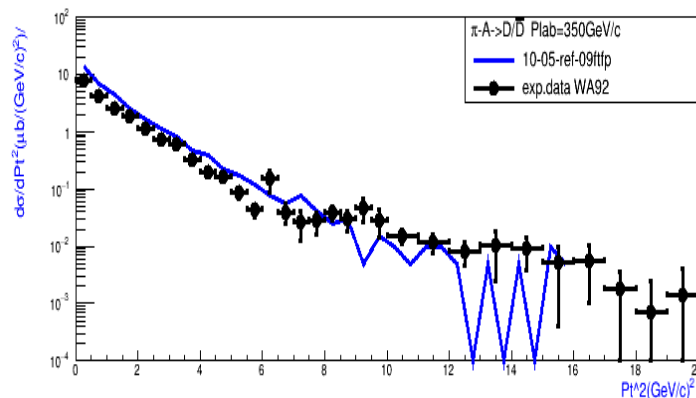
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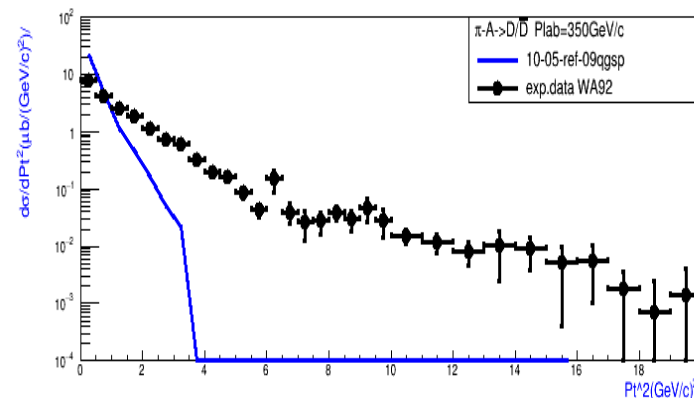
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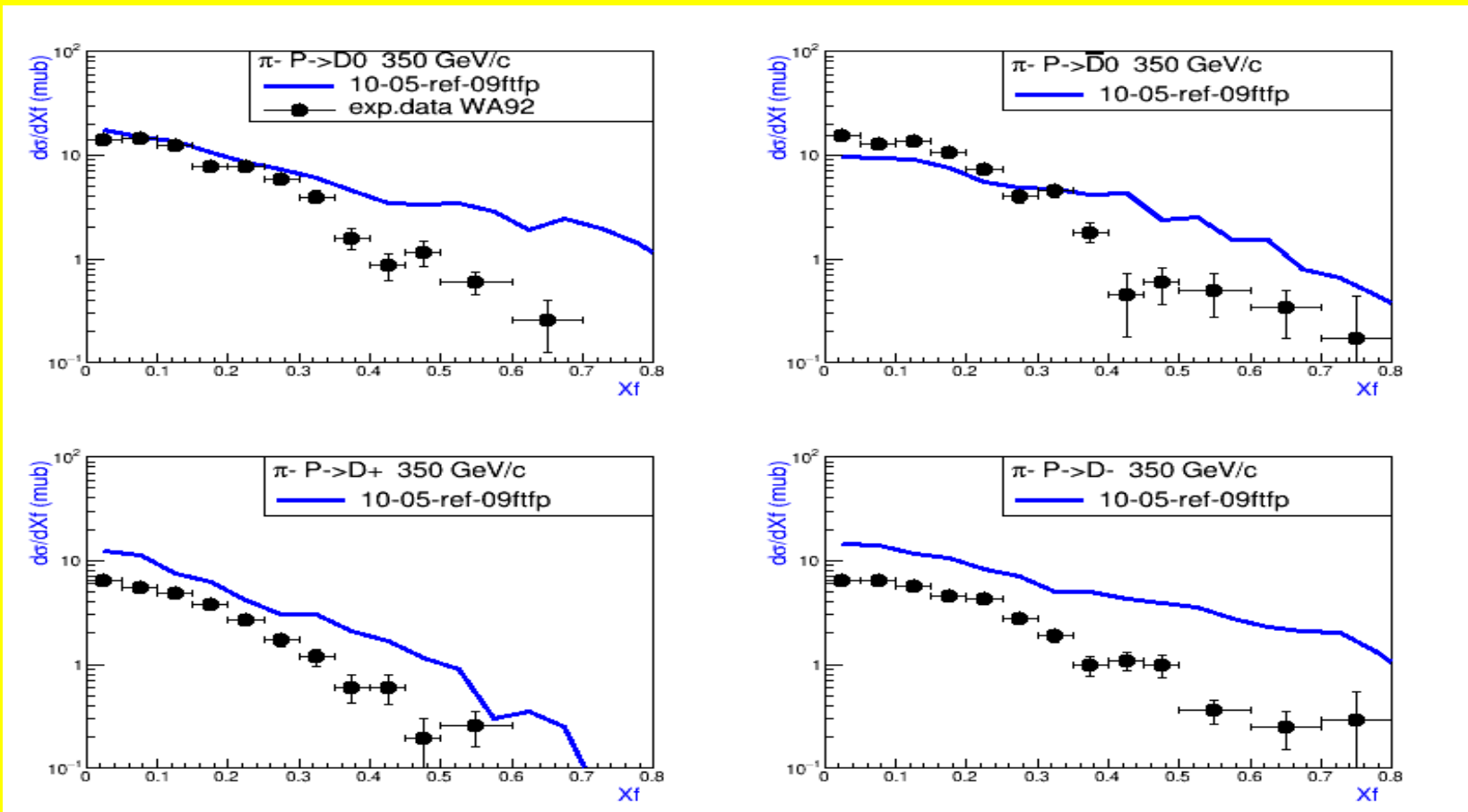
QGS



Differential distributions of charmed mesons

Measurements of charmed meson production in interactions between 350 GeV/c π^- particles and nuclei. Beatrice Collaboration (Adamovich et al.) Nucl. Phys. B495 (1997) 3-37
Differential cross sections with respect to X_f have been determined for the various types of charmed meson.

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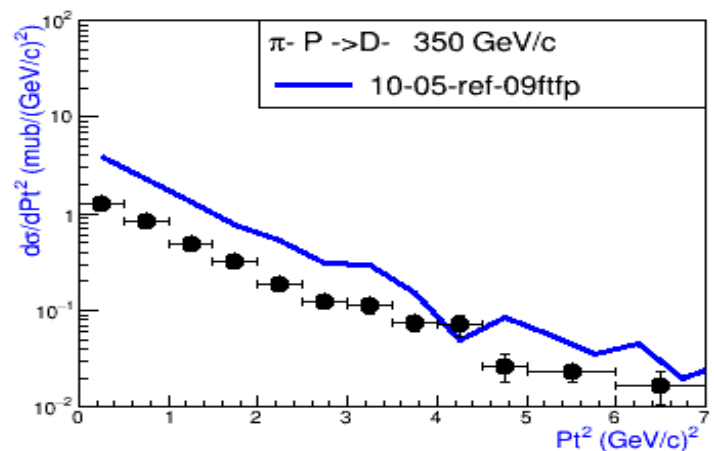
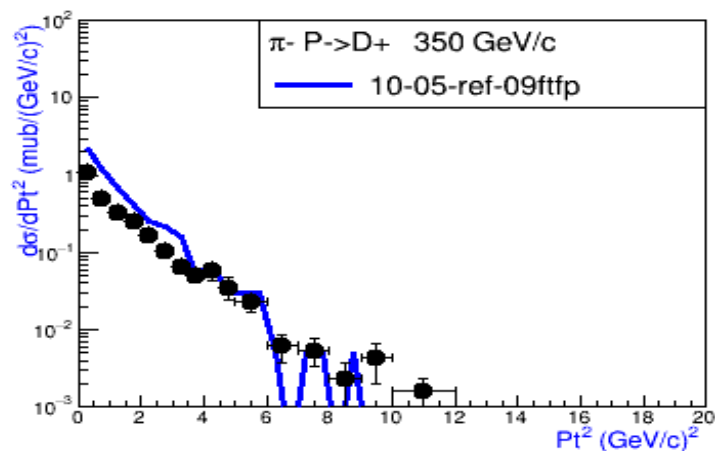
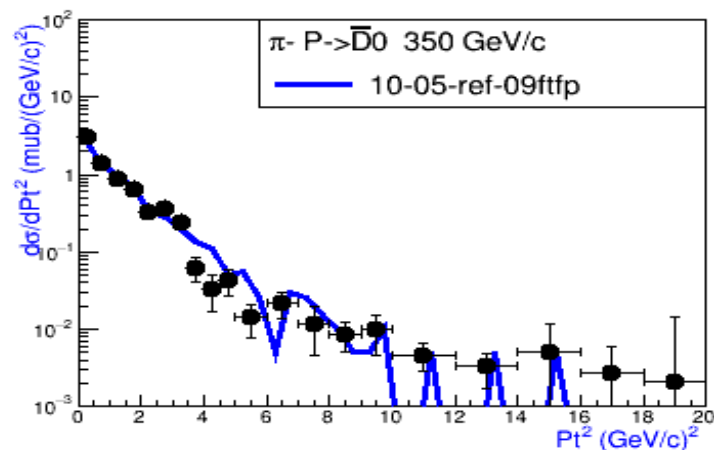
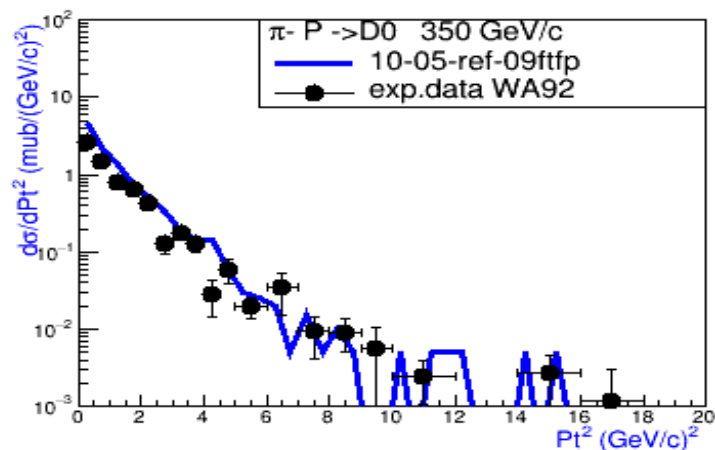
Particle-antiparticle asymmetries have been analysed. The asymmetries as functions of X_f have been determined for D^- with respect to D^+ and for D^0 with respect to \bar{D}^0 . At $X_f=0$, asymmetry is close 0, is around to 0.4 for $X_f=0.5$ and approaches 1.

Differential distributions of charmed mesons

Measurements of charmed-meson production in interactions between 350 GeV/c π^- particles and nuclei.

Beatrice Collaboration (Adamovich.et al.) Nucl. Phys. B495 (1997) 3-37

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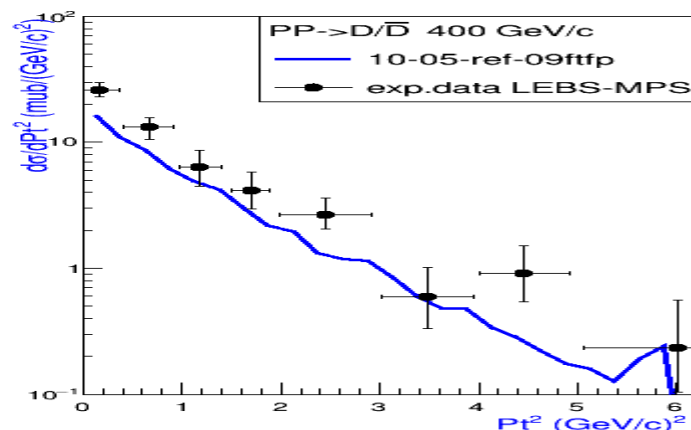
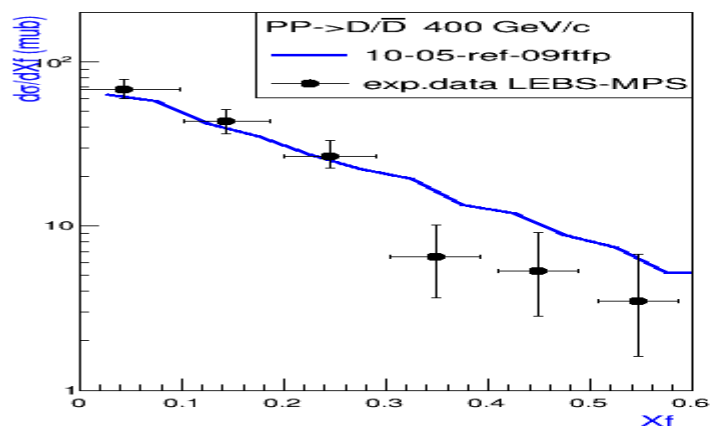
The Pt^2 spectra obtained for different types of charmed meson all have a similar shape.

Differential distributions of charmed mesons

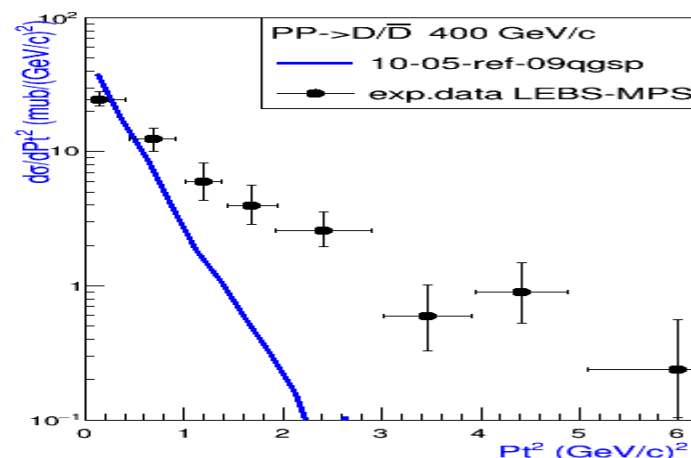
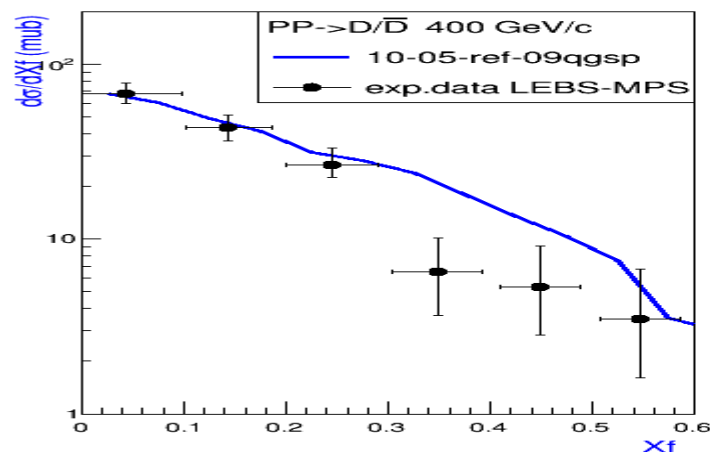
Charm hadron properties in 400 GeV/c p p interactions. LEBC-EHS Collaboration (M. Aguilar-Benitez et al.,) Z. Phys. C - Particles and Fields 40, 321 -346 (1988)

A study of the properties of charm particles produced in 400 GeV/c pp interactions was performed using the high resolution hydrogen bubble chamber LEBC in association with the European Hybrid Spectrometer at the CERN SPS. The complete analysis of total 2220000 triggered chamber pictures results in a sample consists of 217 D/Db decays.

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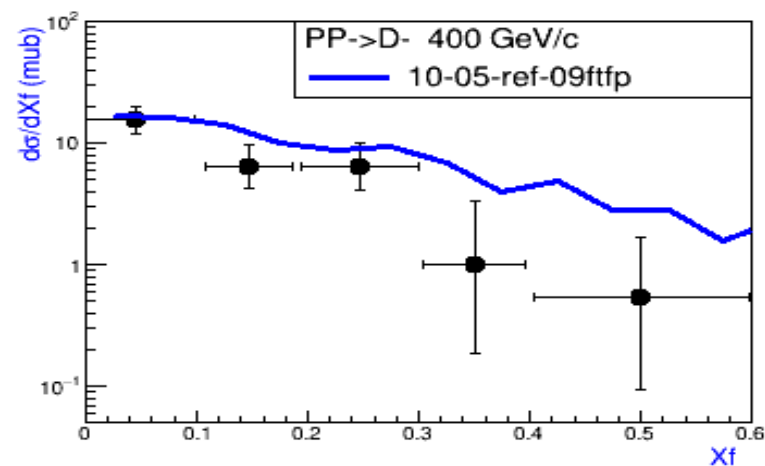
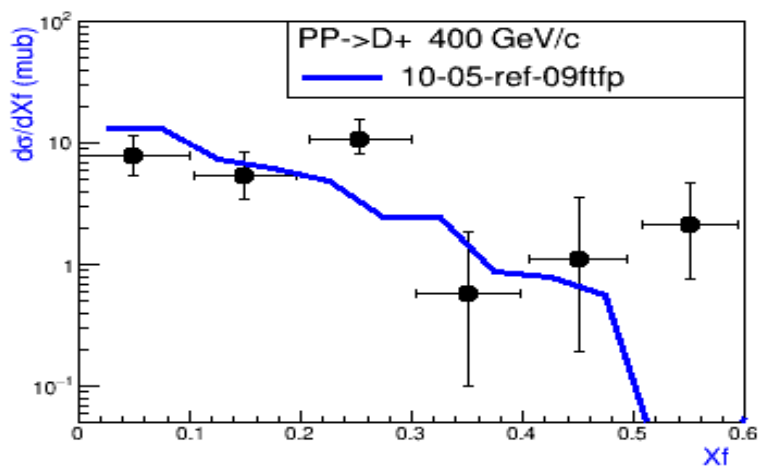
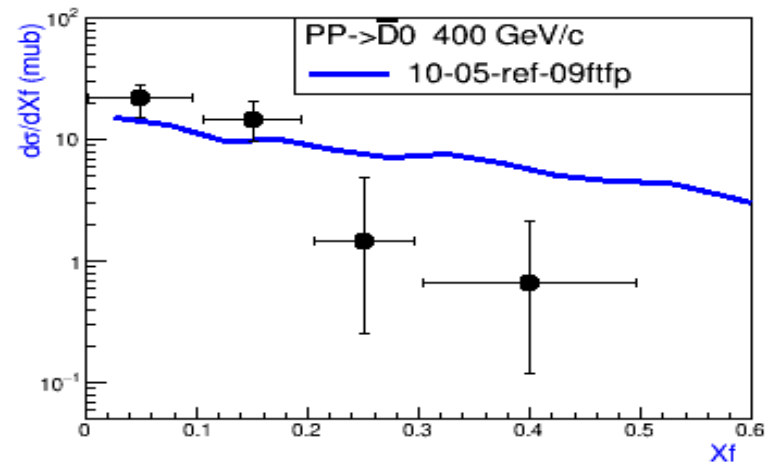
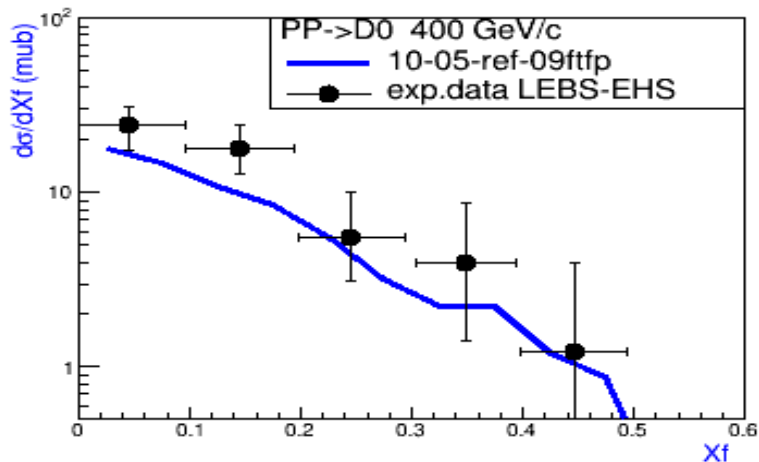
QGS



Differential distributions of charmed mesons

Charm hadron properties in 400 GeV/c p p interactions. LEBC-EHS Collaboration (M. Aguilar-Benitez et al.,) *Z. Phys. C - Particles and Fields* 40, 321 -346 (1988)

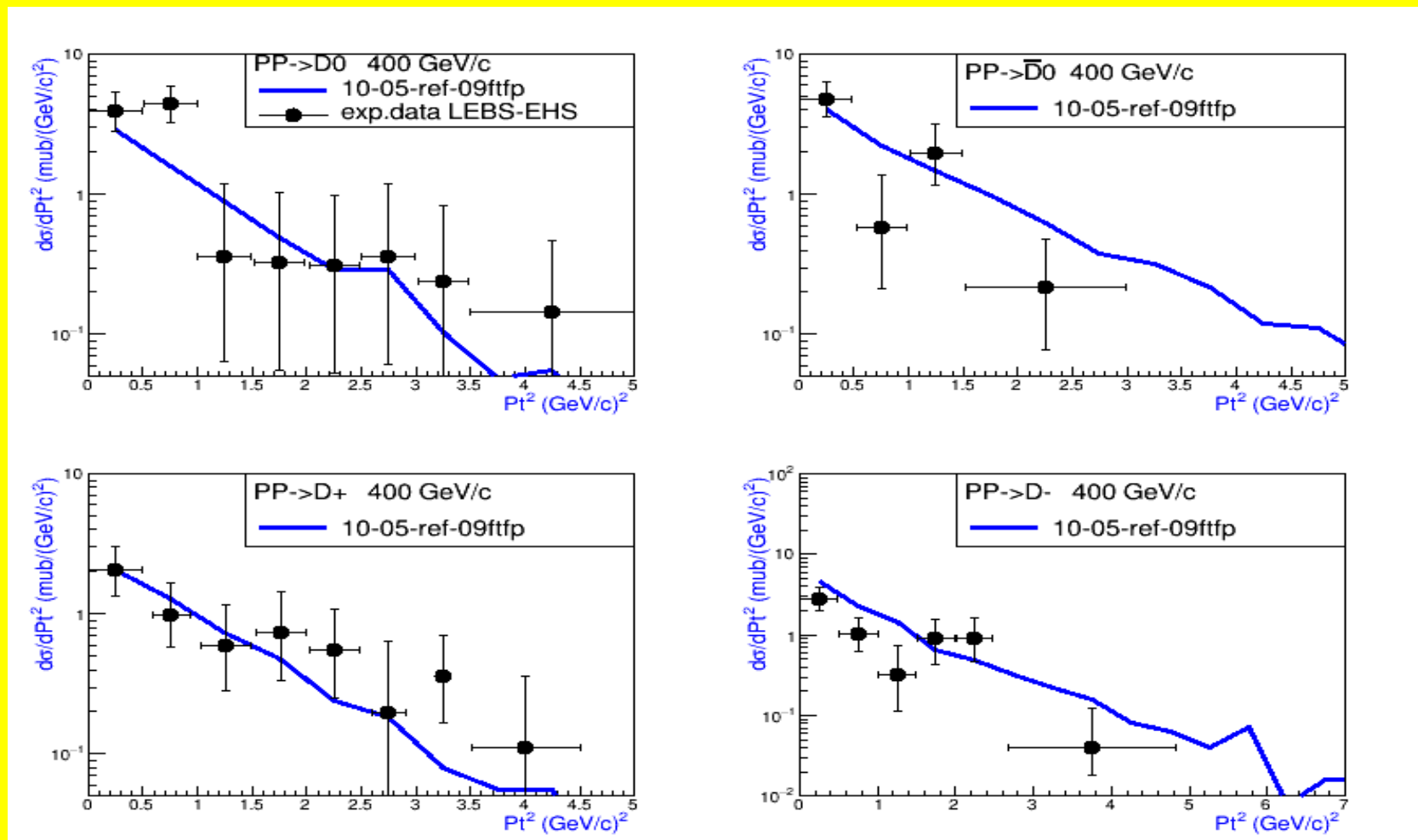
FTF



Differential distributions of charmed mesons

Charm hadron properties in 400 GeV/c p p interactions. LEBC-EHS Collaboration (M. Aguilar-Benitez et al.,) *Z. Phys. C - Particles and Fields* 40, 321 -346 (1988)

FTF



The authors used QCD parton-fusion model for describing these data.

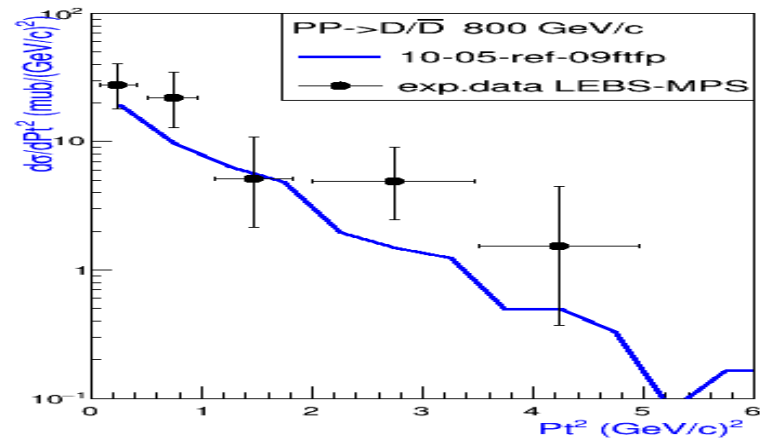
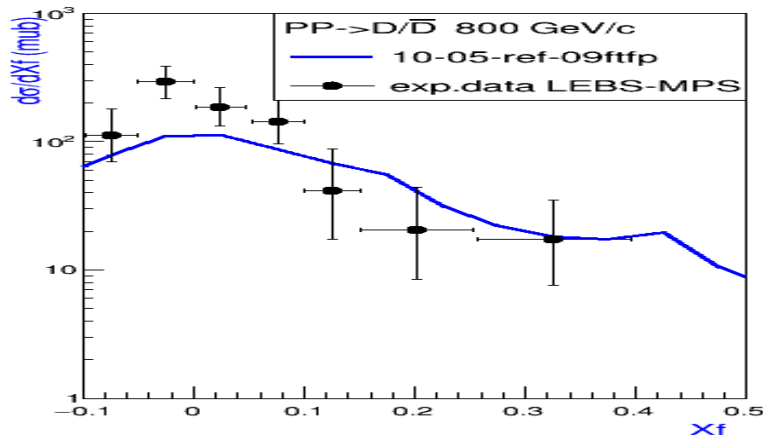
Cross sections for different types of D-mesons have been presented at all Xf

Differential distributions of charmed mesons

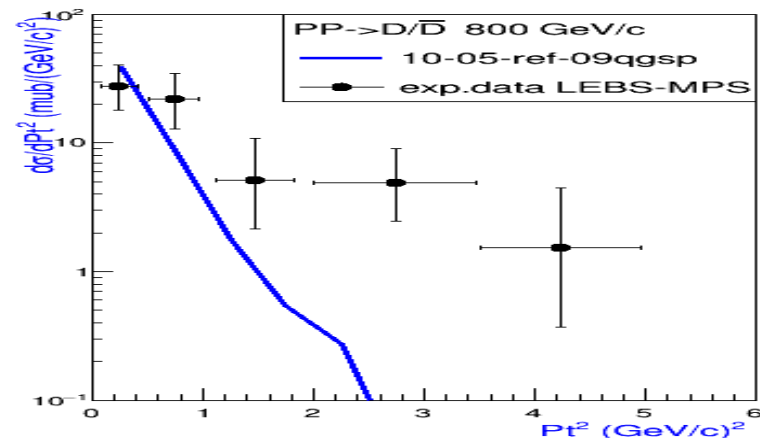
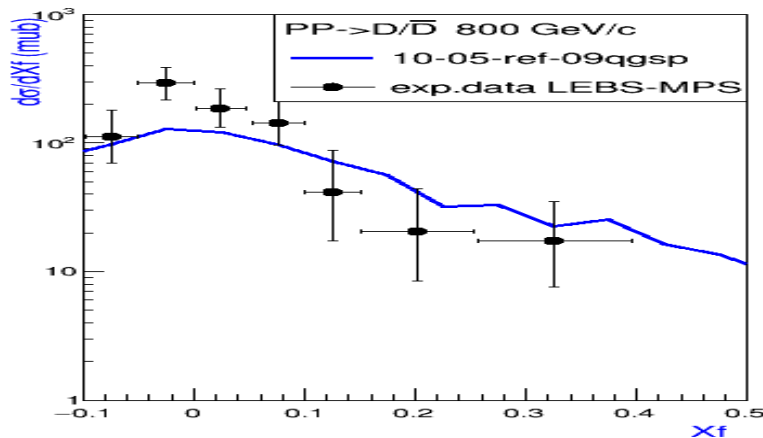
D-Meson Production in 800-GeV/c pp Interactions .

LEBC-MPS Collaboration (R. Ammar et. al.,) **Phys. Rev. Lett. 61, N19, 1988, P.2185**

Here, measurements of the D meson X_f and P_t behaviour are determined from both liquid hydrogen bubble chamber (LEBS) and mutiparticle spectrometer Fermilab MPS. The apparatus was exposed to 800-GeV/c protons.



FTF



QGS

The authors used QCD parton-fusion model for describing these data. In the paper inclusive D meson production cross sections were given at 800 GeV/c for all X_f .

Differential distributions of charmed mesons

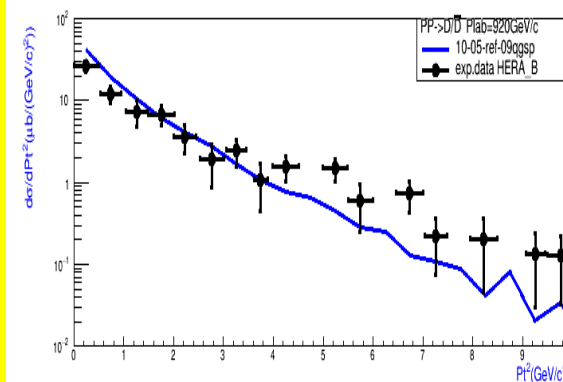
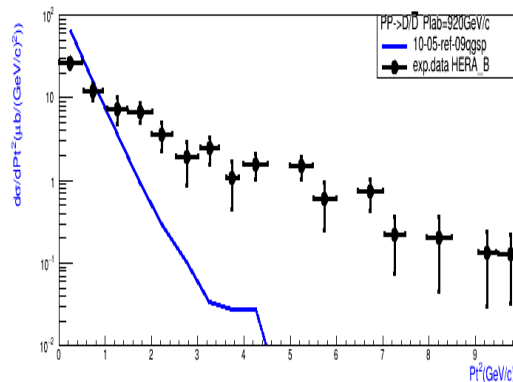
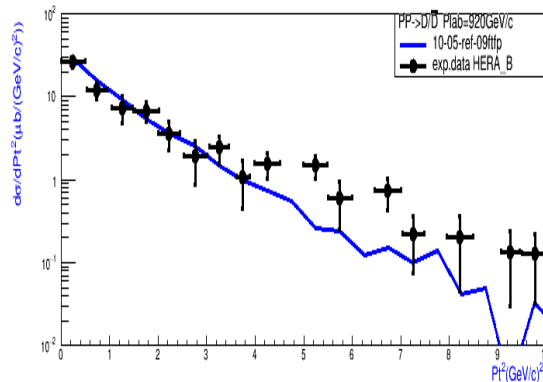
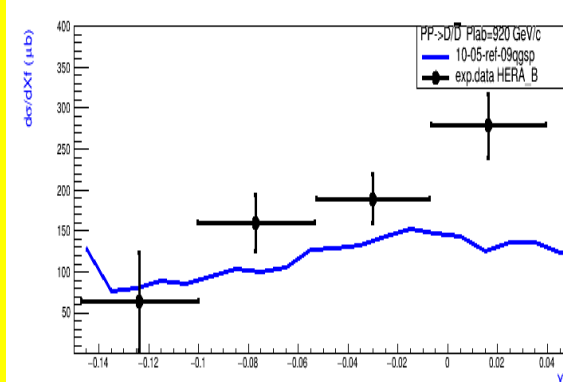
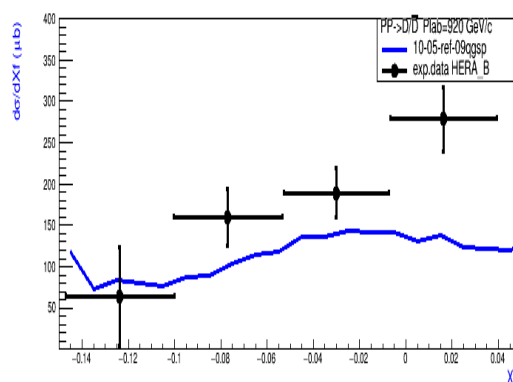
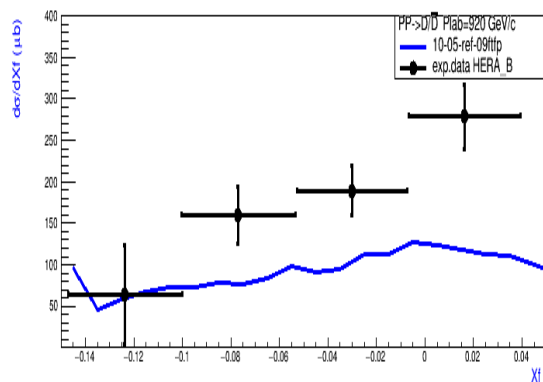
Measurement of D^0 , D^+ , D_s^+ and D^{*+} production in fixed target 920 GeV proton–nucleus collisions. The HERA-B Collaboration (I. Abt et al.,) Eur. Phys. J. C 52, 531(2007)

Collisions of the 920 GeV HERA accelerator proton beam in C, Ti and W fixed targets have been measured with the HERA-B fixed targeted spectrometer. Here D represents a D^0 , D^+ , D_s^+ or D^{*+} detected through the decay channels: $D^0 \rightarrow K^- \pi^+$, $D^+ \rightarrow K^- \pi^+ \pi^+$, $D_s^+ \rightarrow \phi \pi^+ \rightarrow K^- K^+ \pi^+$, and $D^{*+} \rightarrow D^0 \pi^+ \rightarrow K^- \pi^+ \pi^+$ and charge conj. channels.

FTF

QGS

QGS +Mt distr.



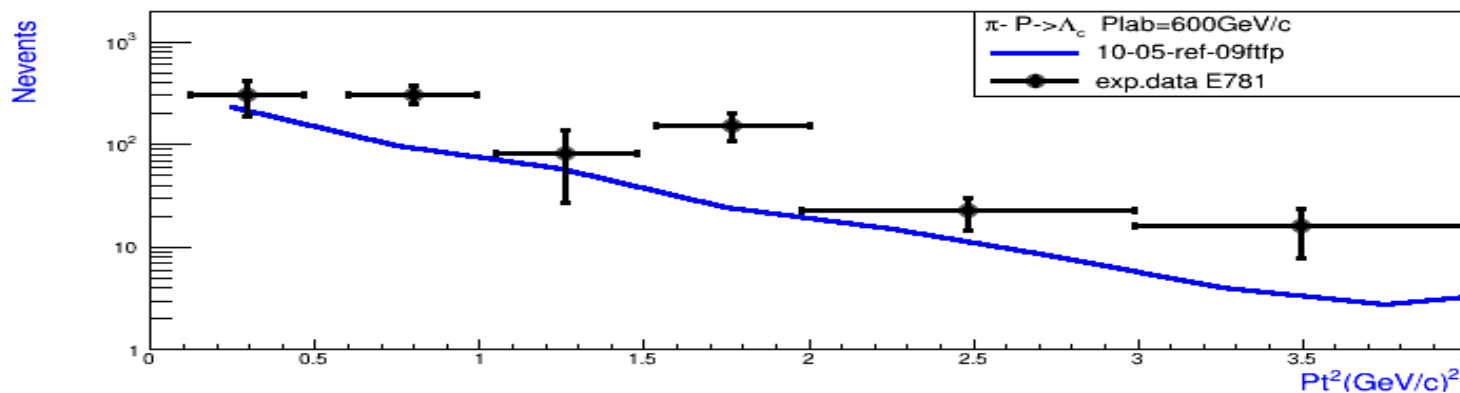
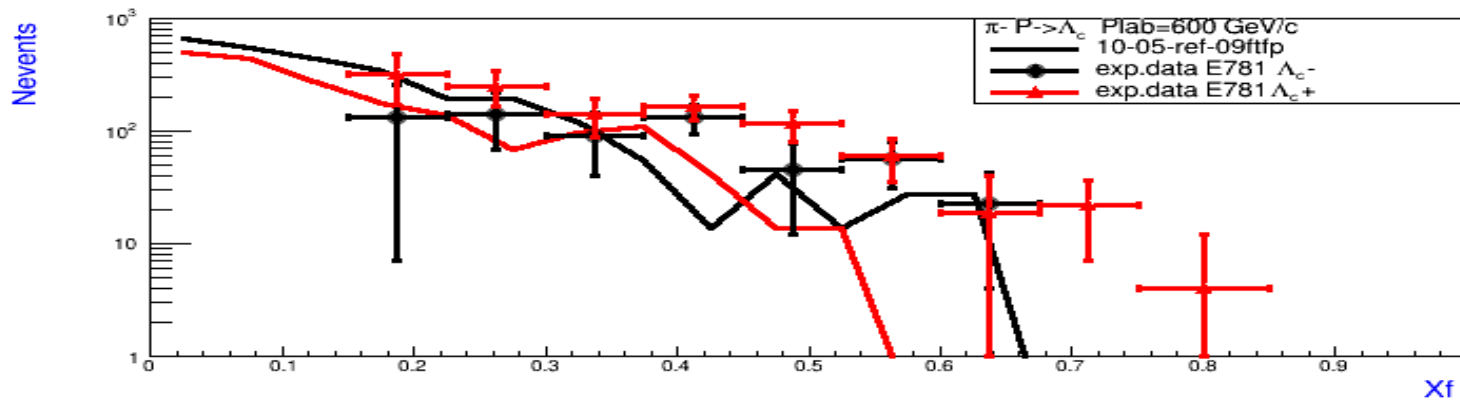
Differential distributions of charmed baryons

Hadronic production of Λ_c from 600 GeV/c π^- , Σ^- and p beams.

SELEX Collaboration (F.G. Garcia et al.) Physics Letters B 528 (2002) 49

X_f and P_{t2} distributions for Λ_{c+} and Λ_{c-} were measured at Fermilab E781 (SELEX)

The exp.data were measured in the SELEX spectrometer using incident beams of π^- and Σ^- at 600 GeV/c and proton beam at 540 GeV/c. The SELEX spectrometer is a three-stage magnetic spectrometer designed to cover charm production in the forward hemisphere.

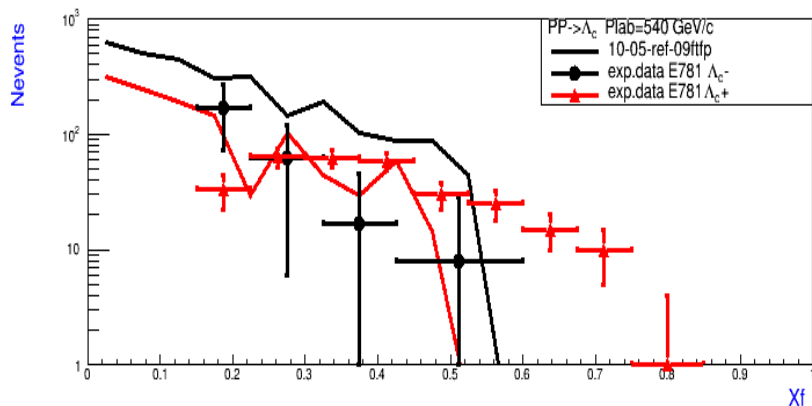


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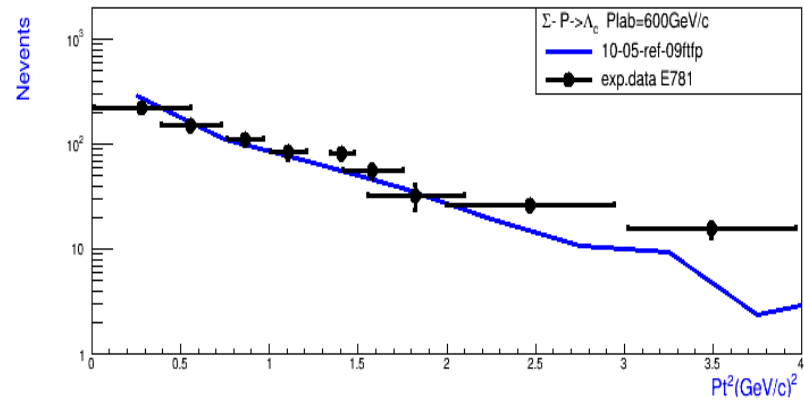
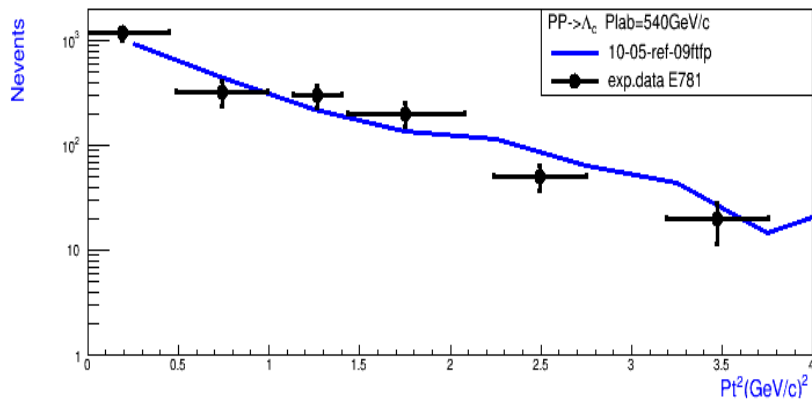
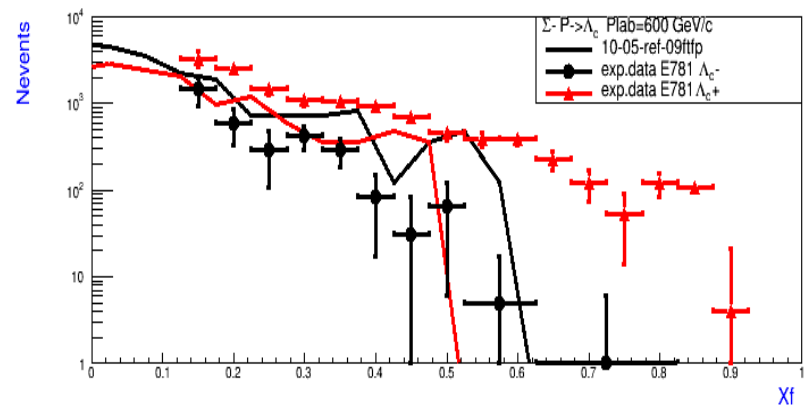
Differential distributions of charmed baryons

Hadronic production of Λ_c from 600 GeV/c π^- , Σ^- and p beams.
SELEX Collaboration (F.G. Garcia et/al.,) Physics Letters B 528 (2002) 49

FTF PP 540 GeV/c



FTF Σ^- P 600 GeV/c



Exp. data show that Xf dependence of Λ_c^+ production is similar for all three beams. Both baryon beams show a strong enhancement of the production of Λ_c^+ over Λ_c^- , while the two are produced comparably from a pion beam.

Conclusion

For the first time, **charm production** is implemented in G4 hadronic generators – **FTF** and **QGS** models by V.Uzhinsky and A.Ribon.

For validation of the models for charm production, it was done:

1. **Experimental data on charmed particles production are digitized and collected. Corresponding calculation codes and Root scripts are created.**
2. **Charmed quark pair production Probability is estimated approximately.**
3. **Differential cross sections of D-meson production in PP and πP interactions at energies from 200 GeV/c to 920 GeV/c are calculated in FTF and QGS models.**
4. **Comparison with exp. data show quite good description of D-meson Pt^2 distributions in FTF model. QGS model with Gaussian distribution for Pt^2 does not give reasonable results for Pt^2 distributions. First attempt of implementation of “mT” distribution in QGSM leads to promising results.**
Results of comparison for Xf distributions of D-mesons are satisfactorily at low energies. At high energies, it is needed to take into account QCD processes for description of Xf spectra.
5. **Xf and Pt^2 distributions are calculated for Λ_c^+ and Λ_c^- produced in PP, π^-P , and Σ^-P interactions at initial momenta 600 GeV/c and compared with exp. data. Calculated Pt^2 distributions are comparable with exp. data. To reproduce Xf spectra of Λ_c^\pm , it is needed fine tuning of FTF parameters.**