The hyperon transverse momentum distributions and dynamical difference between proton-proton and antiproton-proton collisions

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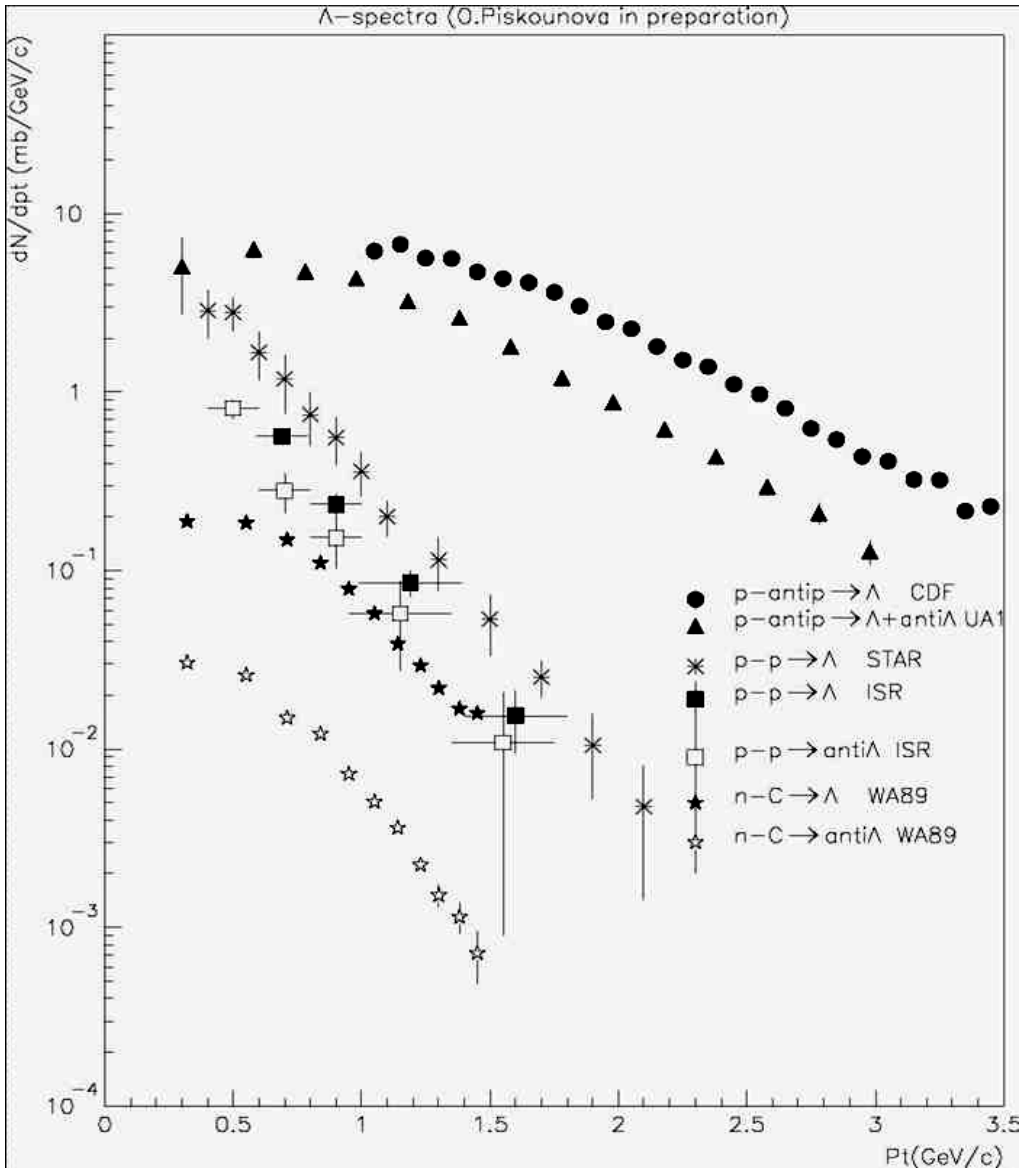
Summary

- The analysis of data on hyperon transverse momentum distributions, dN/dp_t, that were gathered from various experiments (WA89, ISR, STAR, UA1 and CDF) allows us to conclude about the important difference in the dynamics of multiparticle production in proton-proton and antiproton-proton collisions.
- **Asymmetric reactions are providing us with a new "stereoscopic" view on the hadroproduction mechanism.**
- The spectra of hyperons that are produced with proton beam have the sharp exponential slope at low p_t, while the spectra with antiproton beam have not.
- **Baryon spectra are sensitive to quark-diquark structure of interacting particle and to the energy splitting between these components.**
- Unfortunately, this difference was not studied enough at ISR, where both projectiles were available. The important fact is that the latest experiments of highest energies were carried out with antiproton beams.
- It was mistake to suggest that pp and ppbar reactions at high energy are giving the similar transverse momentum distributions. The spectra of hyperons that are produced with proton beam have the sharp exponential slope at low Pt, while the spectra with antiproton beam have not. The highest energy experiments (UA1 and Tevatron) shows the growing average transverse momenta, that is not a result of growing energy - it is the result of different form of transverse momentum spectra in different reactions.
- This statment makes us convinced in necessarity of exact measurements for p_t spectra of multiparticle production in antiproton-proton interactions of various enegies in order to estimate the contribution from diquark-antidiquark string fragmentation.

Hyperon distributions at the different beams



Spectra in proton-proton reactions (fixed target exps, ISR and STAR)

$\sim e^{-6\ Pt}$, that should work for LHC too.

Spectra in antiproton-proton reactions (UA1 and CDF) have the different slope and no exponential peak below Pt = 1 GeV !

Pomeron Pt distributions in proton-proton collisions (QGS model)

published in A.I. Veselov, O.I. Piskunova, K.A. Ter-Martirosian, Phys.Lett.B158:175,1985.

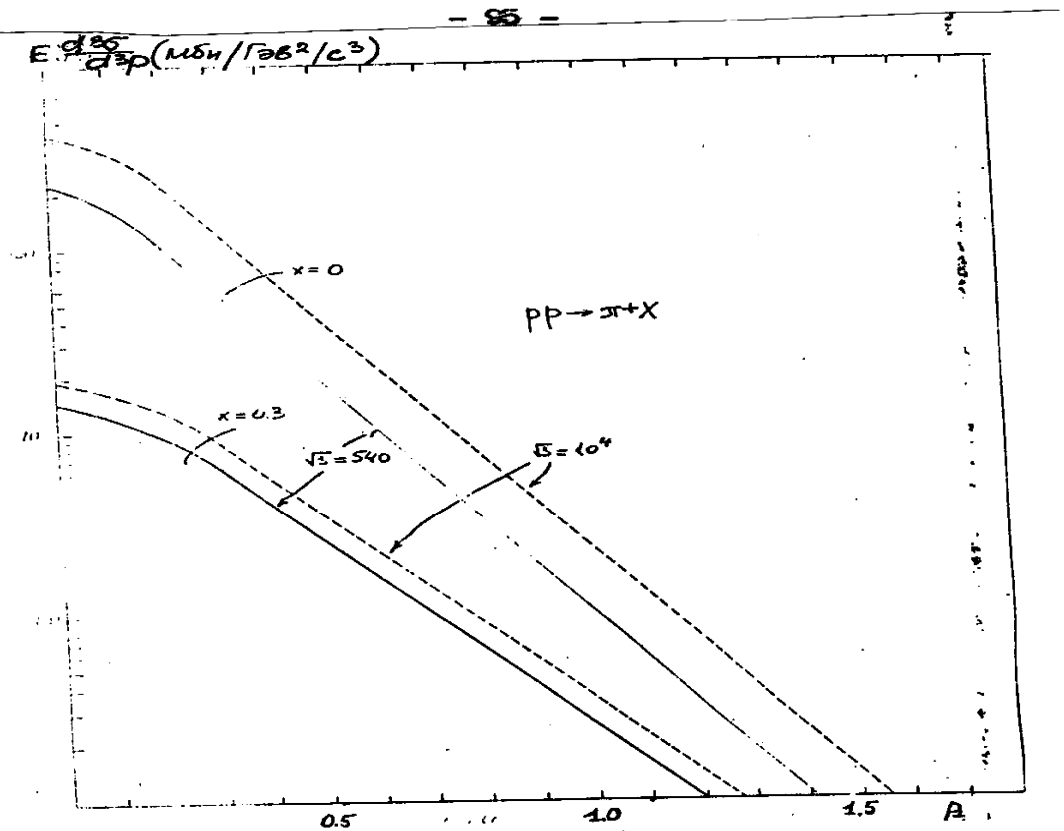
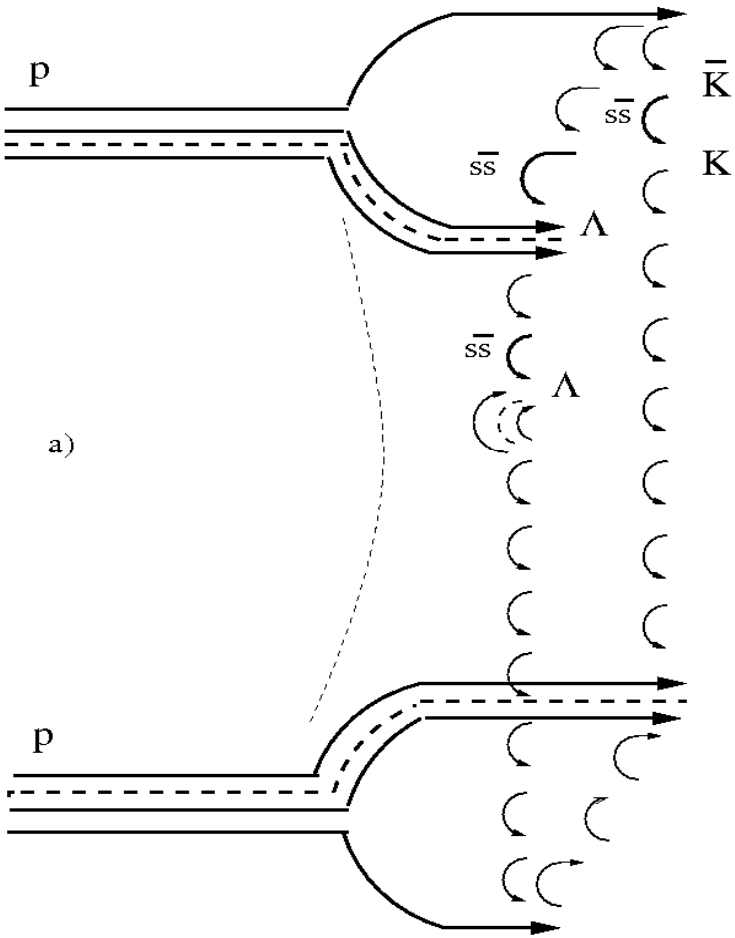
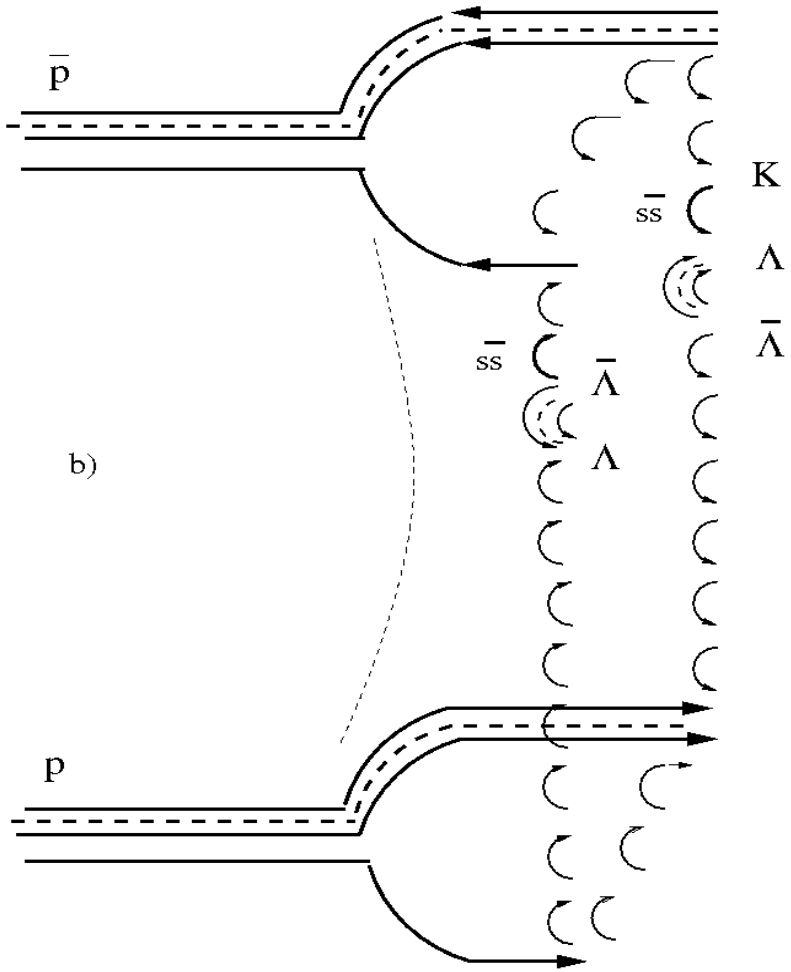


Рисунок 38. Изменение распределений π^+ мезонов поперечному импульсу при переходе от энергии $\sqrt{s}$ = 540 Гэв (сплошная кривая) к $\sqrt{s}$ = 10^4Гэв (штриховая) при $x=0$. и $x=0.3$.

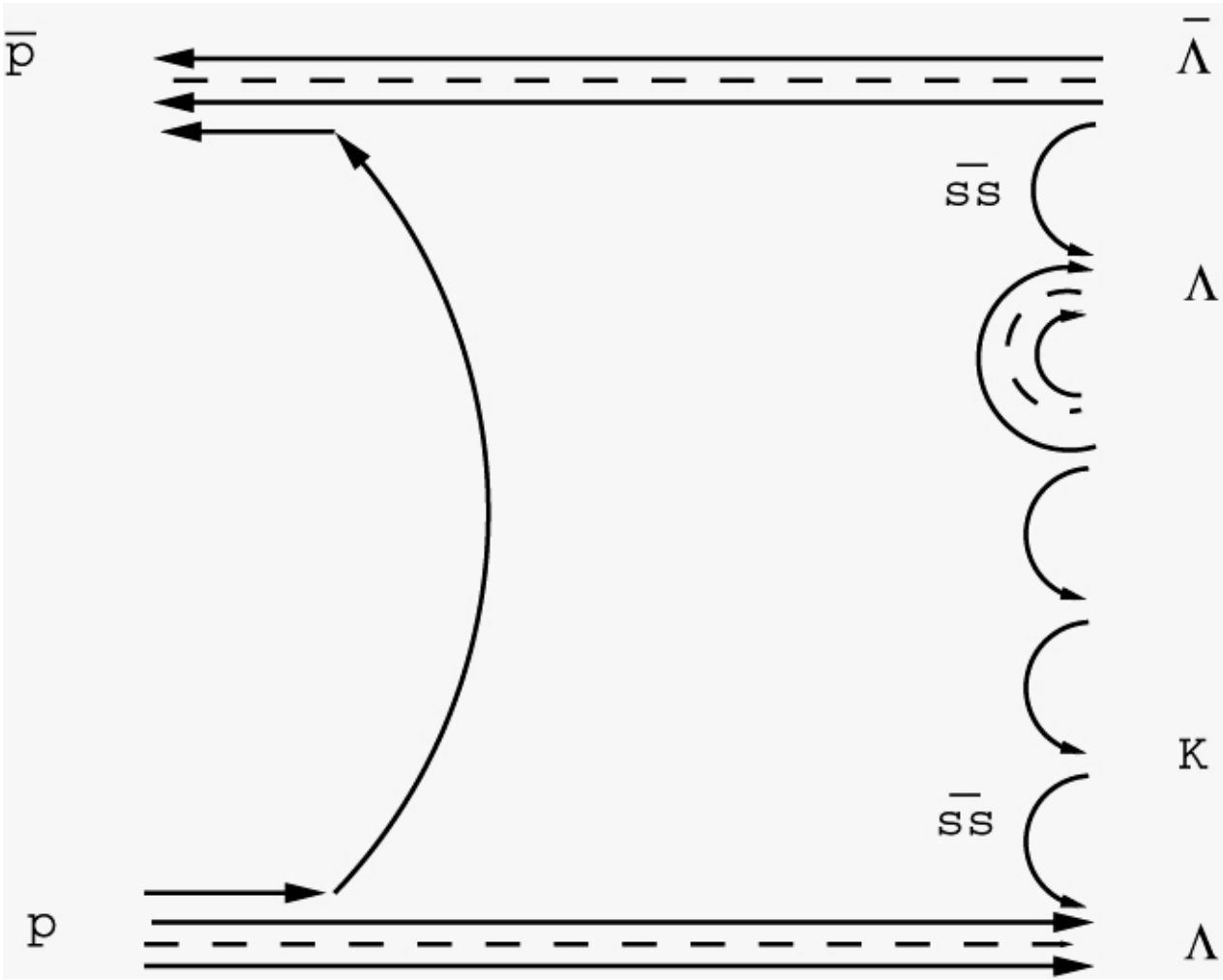
The QGSM approach:
Pt spectra were described with one exponent ~ e-B(m-m0), B~6.0 GeV-1, m= sqrt(m02+<p>**2), up to p+= 1.5 GeV/c.**
Spectra are growing due to the total cross section. The exponential form is remained.
Spectra of pions, kaons, protons and antiprotons were described in this way.

QGSM diagrams for pp and ppbar

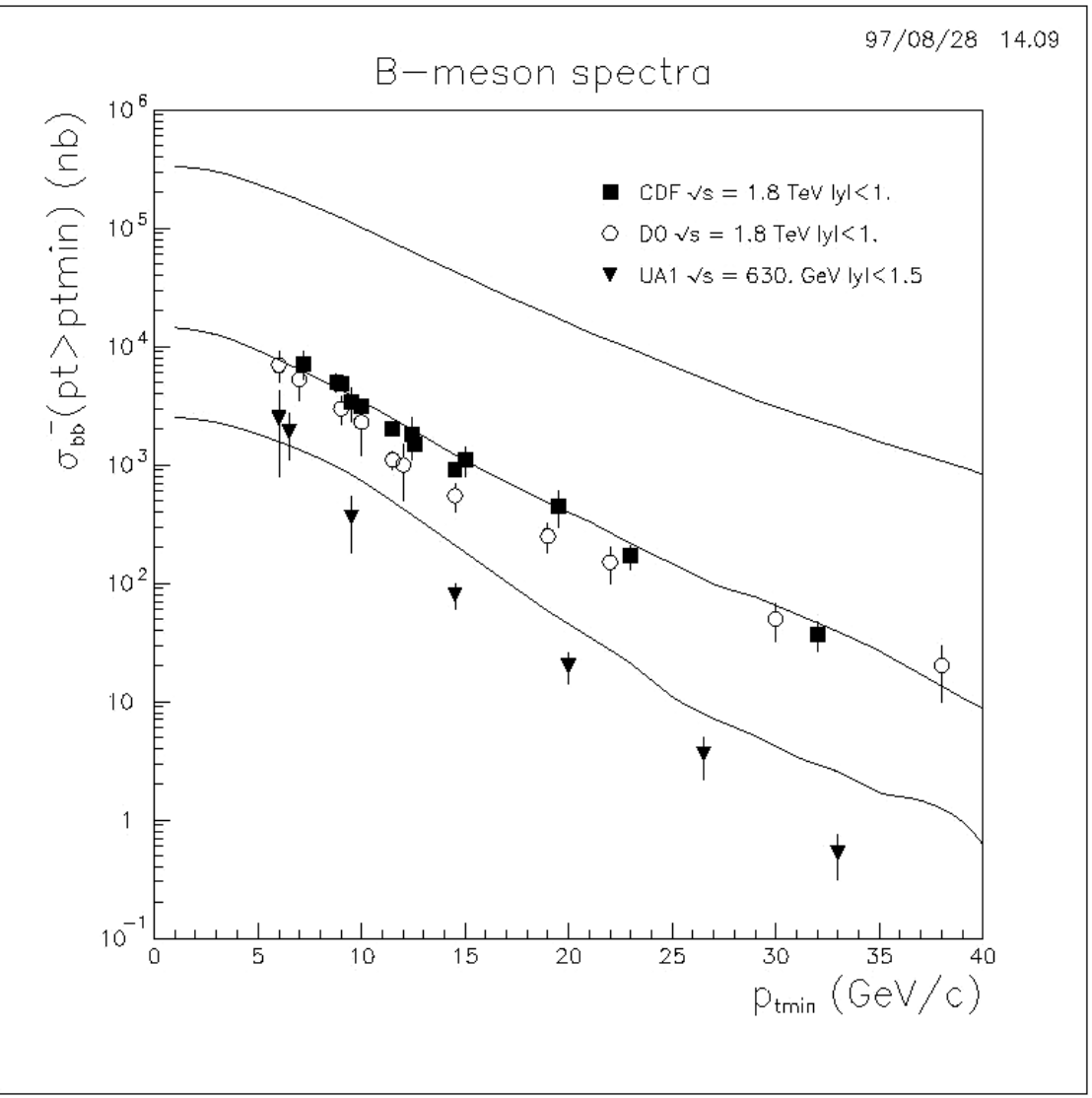




Λ production diagram at low energies

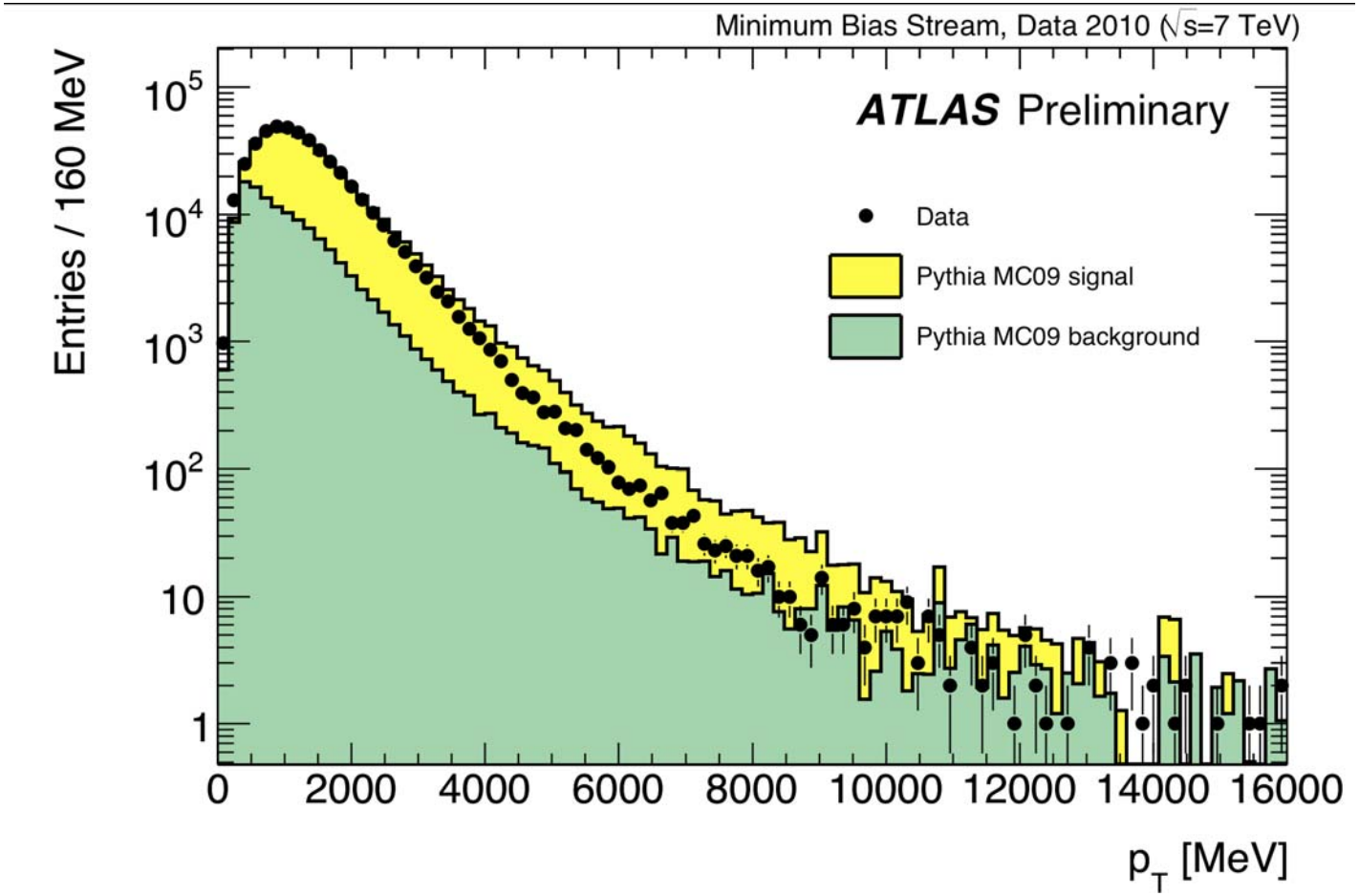


Previous evidence of different slope of spectra



This slope gave rather low production X section of B-meson in Tevatron experiments (published in Phys.Atom.Nucl.64:392,2001. e-Print: hep-ph/0001252)

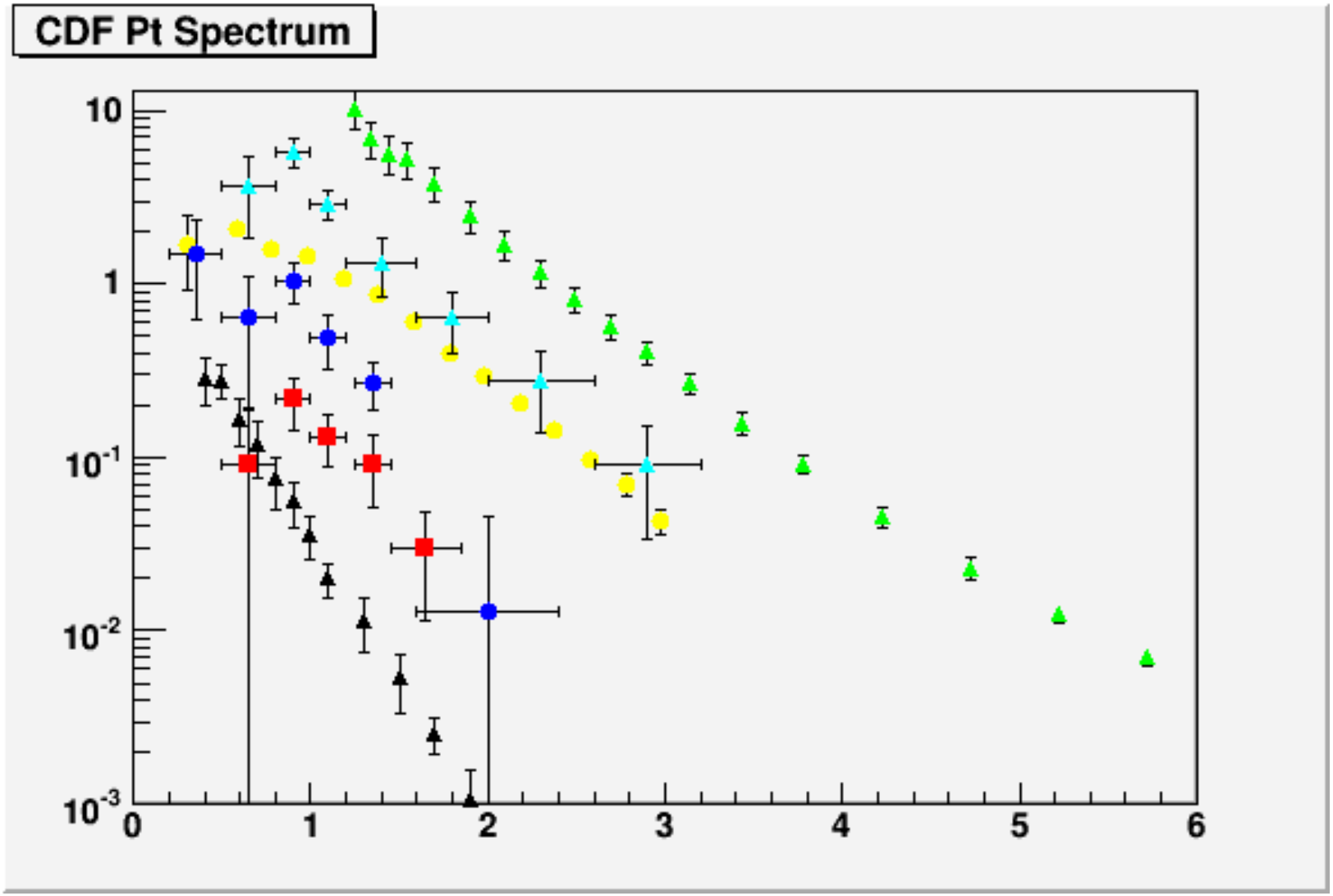
Spectrum of Λ in ATLAS



$\Lambda^0 \rightarrow p\pi^-$ (+ c.c.)

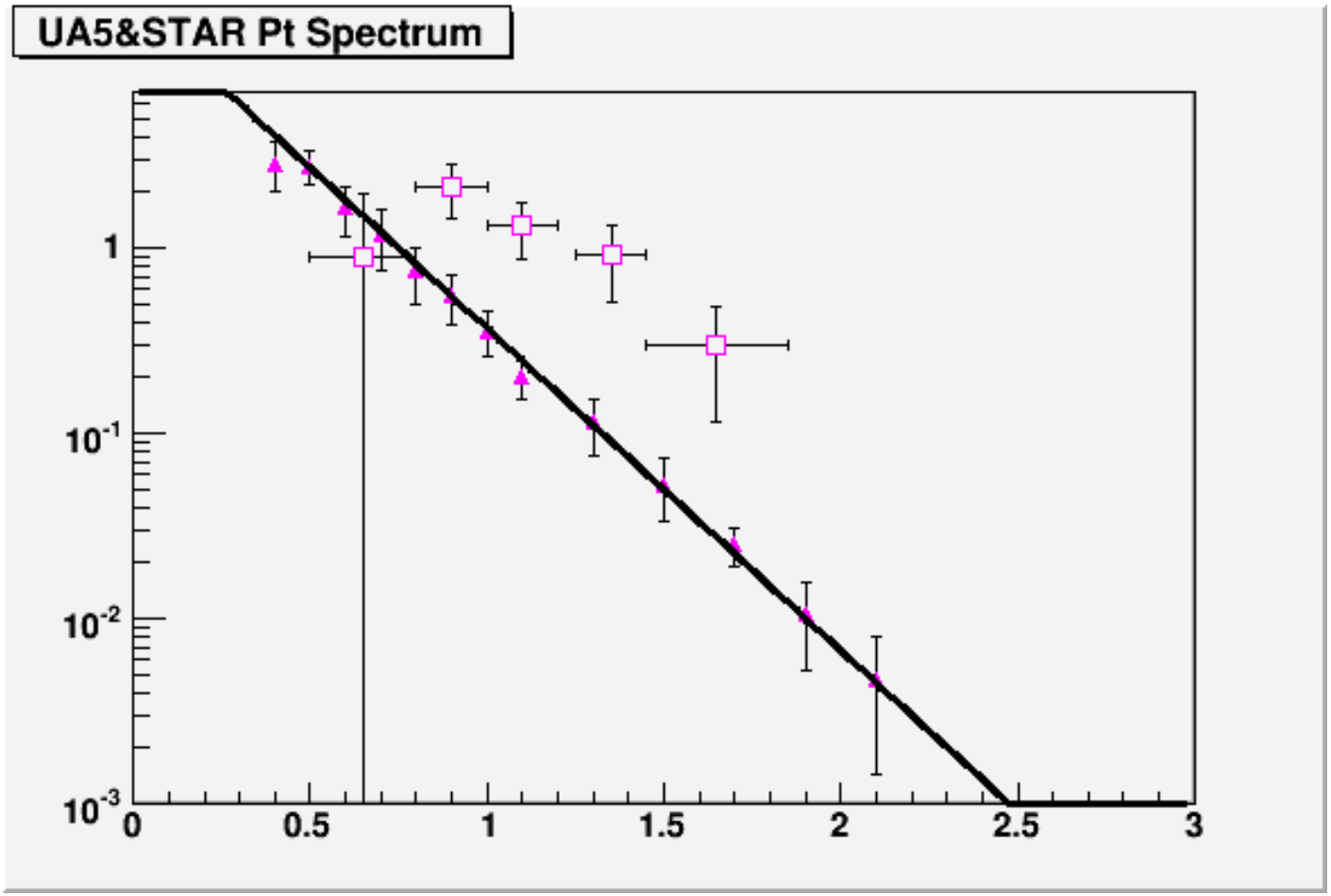
MC is harder in p_t

The data of UA5



Data are from STAR(black); UA5 energies: sqrt(s) = 200 GeV(red), 546GeV(blue), 900GeV(aqua); UA1 630GeV(yellow) and CDF(green).

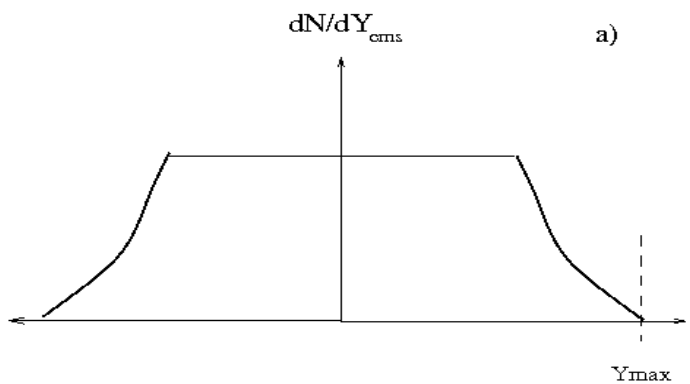
Comparison of pp vs ppbar at sqrt(s) = 200GeV

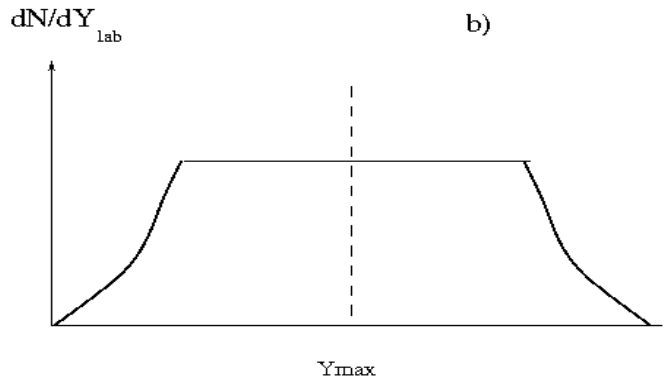


There is an extra contribution in the p-pbar spectrum at Pt > 1 GeV/c

The construction of Pt spectra in asymmetric reactions

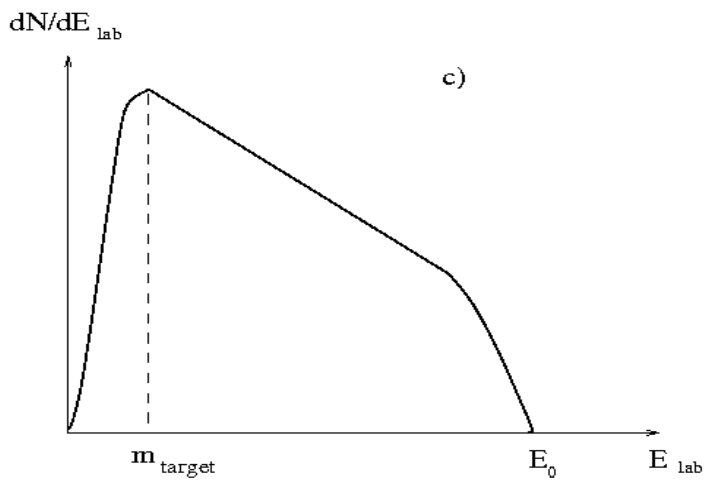
The procedure of spectrum calculation should be the same as in X_F and in rapidity, but Pt spectra are measured in laboratory system .



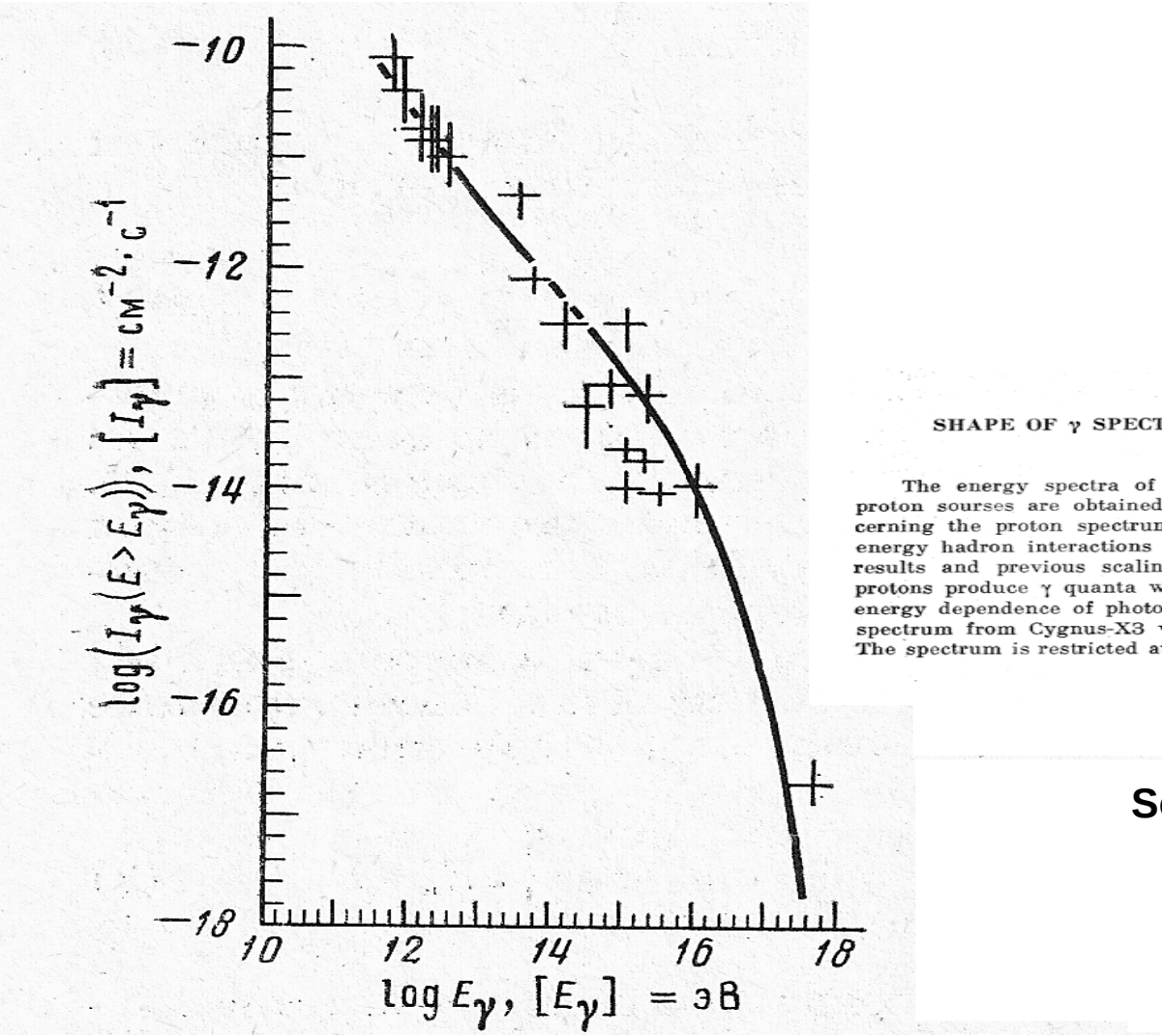


dN/dY = xdN/dx = EdN/dE

dN/dE = 1/E* dN/dYlab



An example of similar recalculation for pp -> π^0 ->γ



PISKUNOVA O. I.

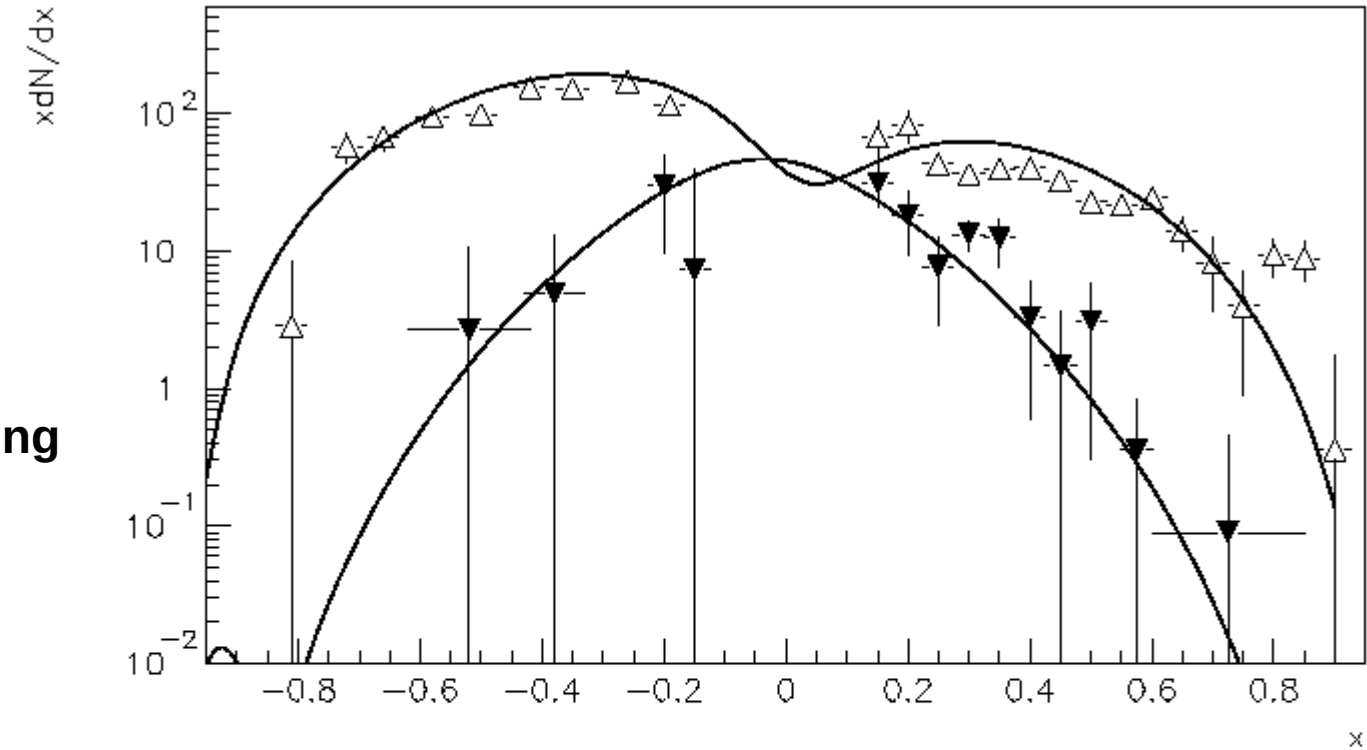
SHAPE OF γ SPECTRA FROM COSMIC SOURCES OF HIGH-ENERGY PROTONS

The energy spectra of photons, produced in π^0-decays near high-energy cosmic proton sourses are obtained. Calculations were made under various assumptions concerning the proton spectrum. The predictions of quark-gluon-strings model for high-energy hadron interactions were used. There is a numerical difference between these results and previous scaling model calculations. It is shown, that monoenergetical protons produce γ quanta with power energy spectrum E_γ^{-1}. This can be seen in the energy dependence of photon emission from recently observed Herculis-AM. The γ-ray spectrum from Cygnus-X3 was calculated with power index of proton spectrum −2,1. The spectrum is restricted at $E_p^{max} = 10^9$ Gev.

Sov.J. of Nucl Phys., 1989

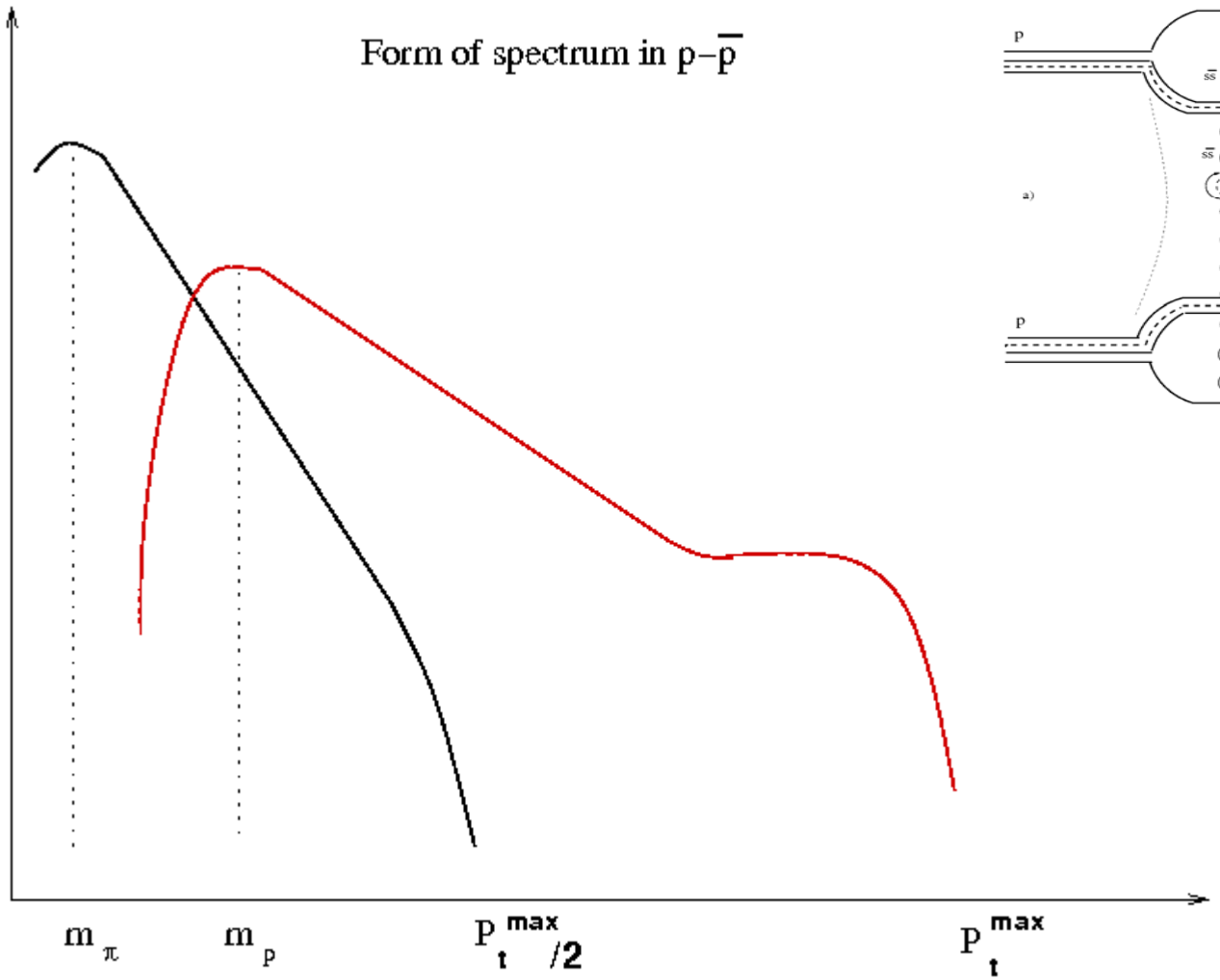
Specifics of baryon spectra, leading fragmentation

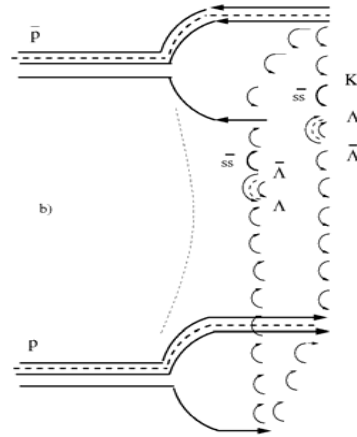
Spectra of baryon have specific leading behavior



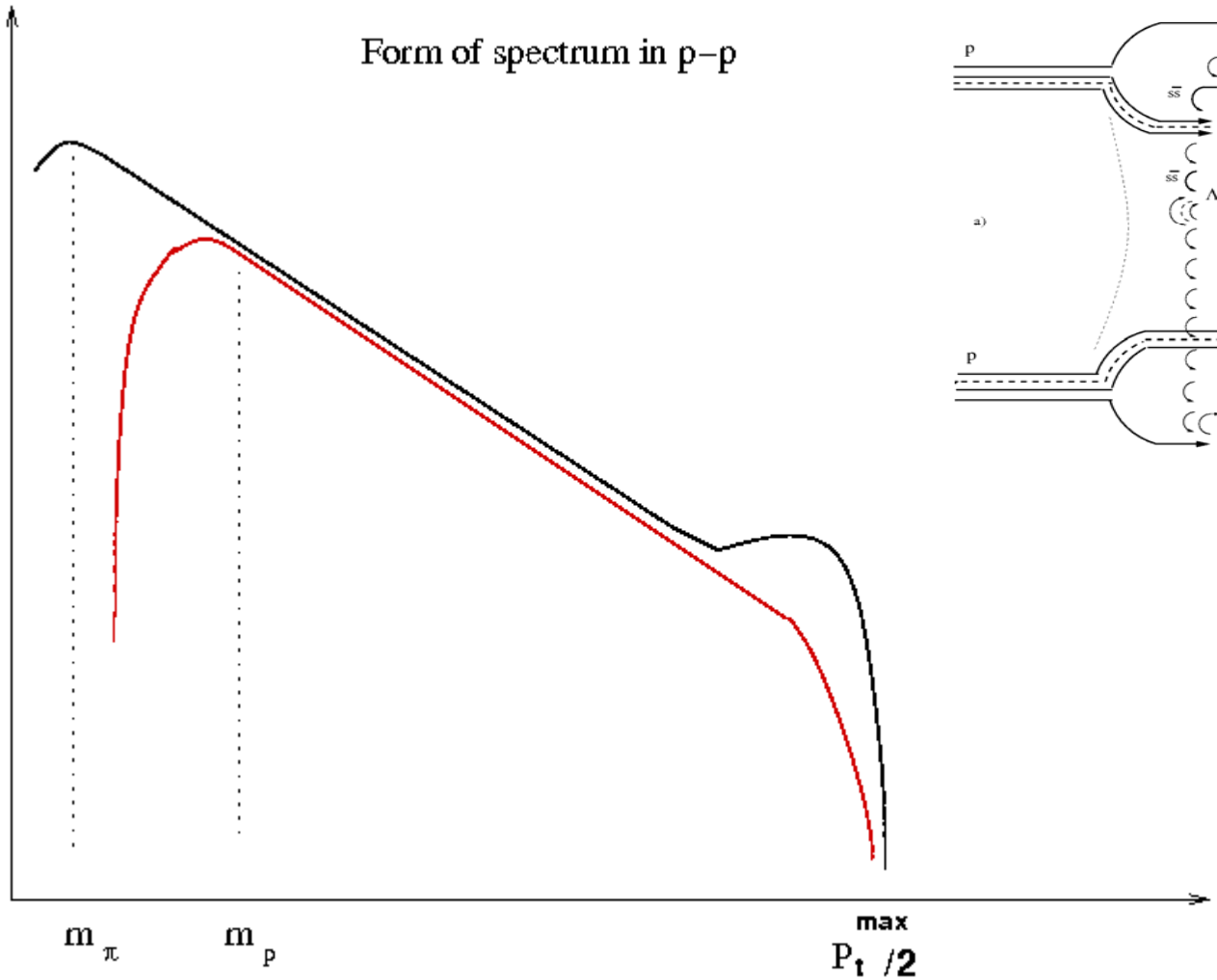
$\Sigma p \rightarrow \Lambda^0 (\Lambda^{-0})$

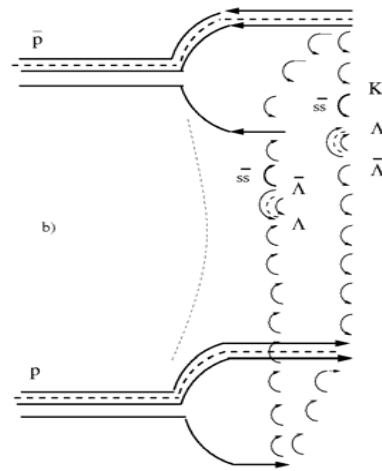
Asymmetric ppbar reaction





Predictions for baryon Pt spectra in pp at LHC





No dip, no peak at proton mass. The change of the slope at higher Pt due to the leading behavior of baryon spectra.

Conclusions

The self-consistent procedure for the calculation of baryon Pt spectra is suggested in the framework of QGSM.

It makes calculations similar to the X_F spectra descriptions.

It is explaining the difference between spectra in pp and ppbar reactions.

The cross sections are kept equal for both collisions.

Some specifics for baryon spectra at LHC can be predicted.