Baryon spectra at LHC experiments and CR spectra of VHE.

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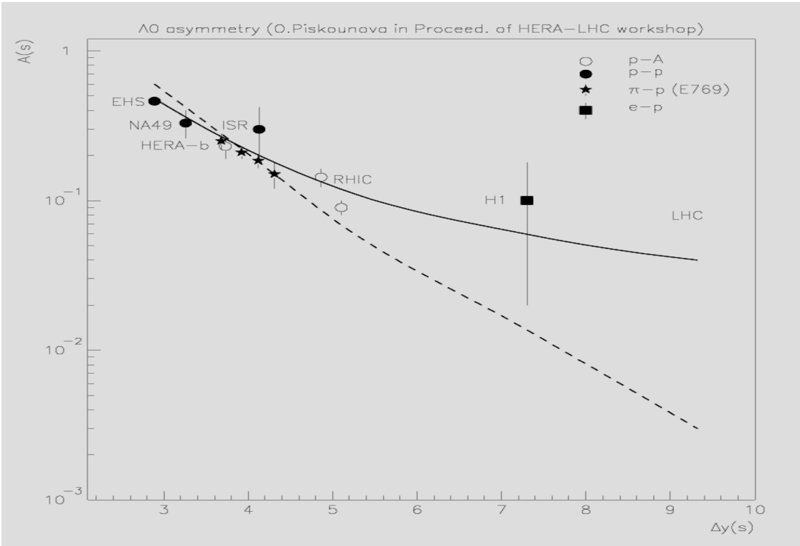
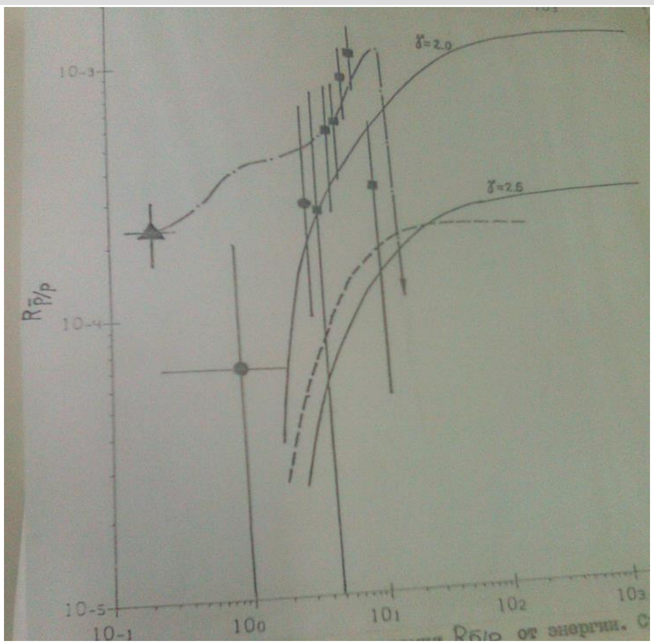
Outline

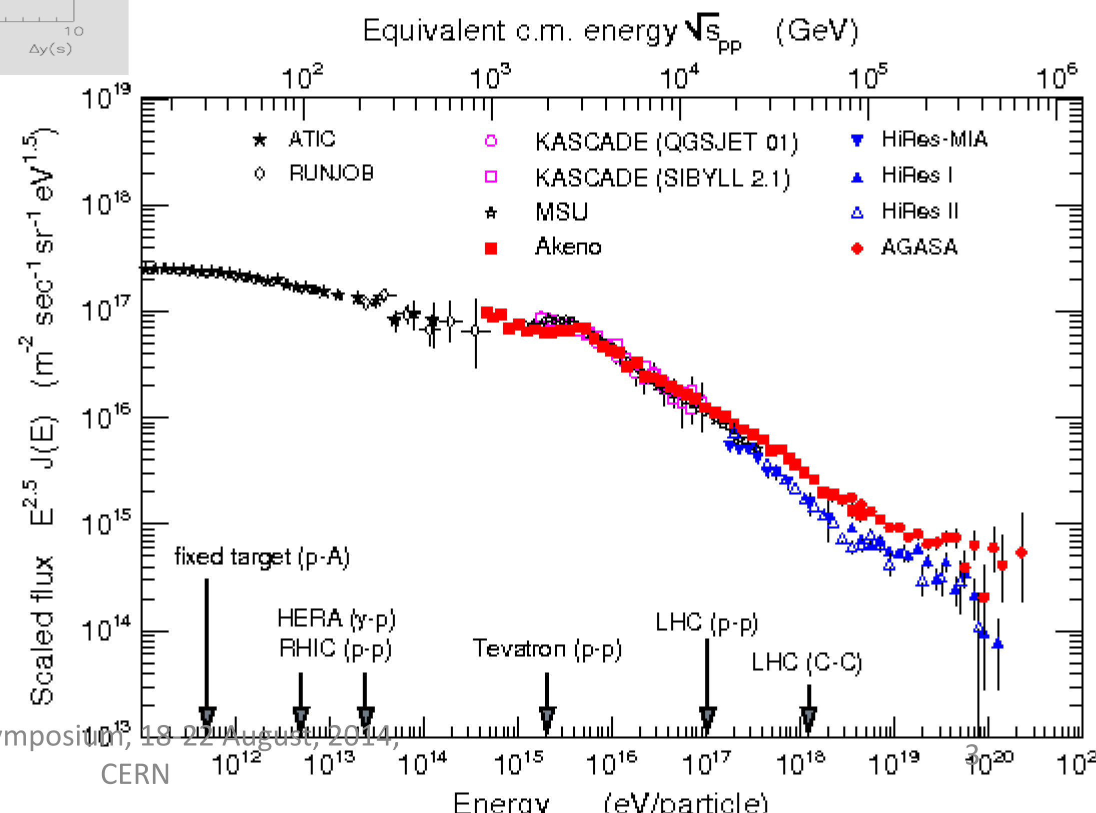
1. The spectra of baryons at LHC can explain the features of CR spectra
2. CR protons of VHE have been produced after DM annihilation into quark jets
3. The growing antiparticle/particle ratios can not be the result of acceleration of matter that is mostly positive around us
4. The growing ratios are the result of local leading asymmetry in baryon spectra that are produced in the kinematical region of proton target fragmentation
5. The study of baryon transverse momentum distributions at LHC ($\sqrt{s}$=0.9 – 7. TeV) shows no important changes that may be responsible for the “knee” in CR spectra
6. Average Pt of baryons are slowly growing with energy
7. The transverse momentum spectra of baryons (protons, hyperons, charmed and beauty baryons) are changing at LHC energies

Specific features of baryon spectra



We can study the features of baryon spectra beginning from global CR proton distribution up to delicate measurement results on asymmetry caused by the baryon charge transfer at the collider experiments





Multipomeron 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.

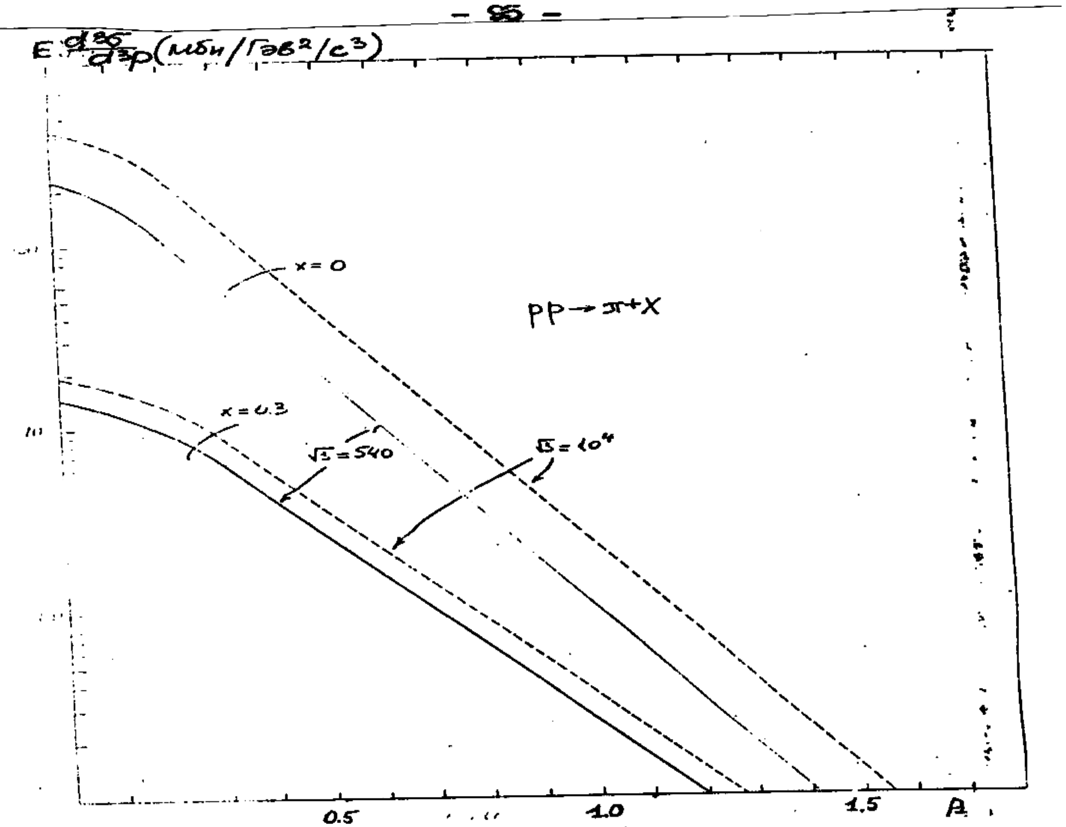
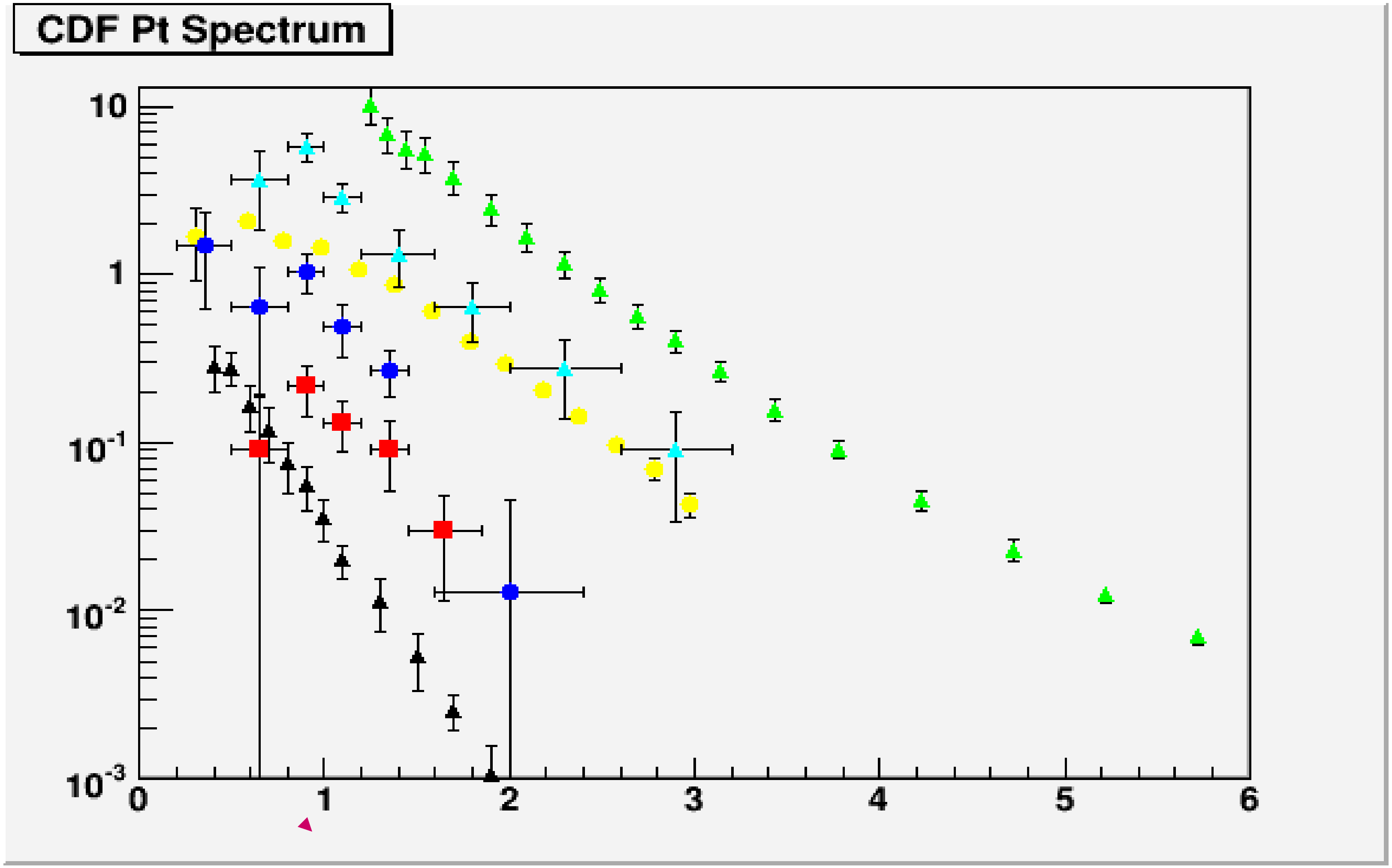


Рисунок 38. Изменение распределений π^+ мезонов поперечному импульсу при переходе от энергии $\sqrt{s}$ = 540 Гэв (сплошная кривая) к $\sqrt{s}$ = 10^4 Гэв (штриховая) при x = 0. и x = 0.3.

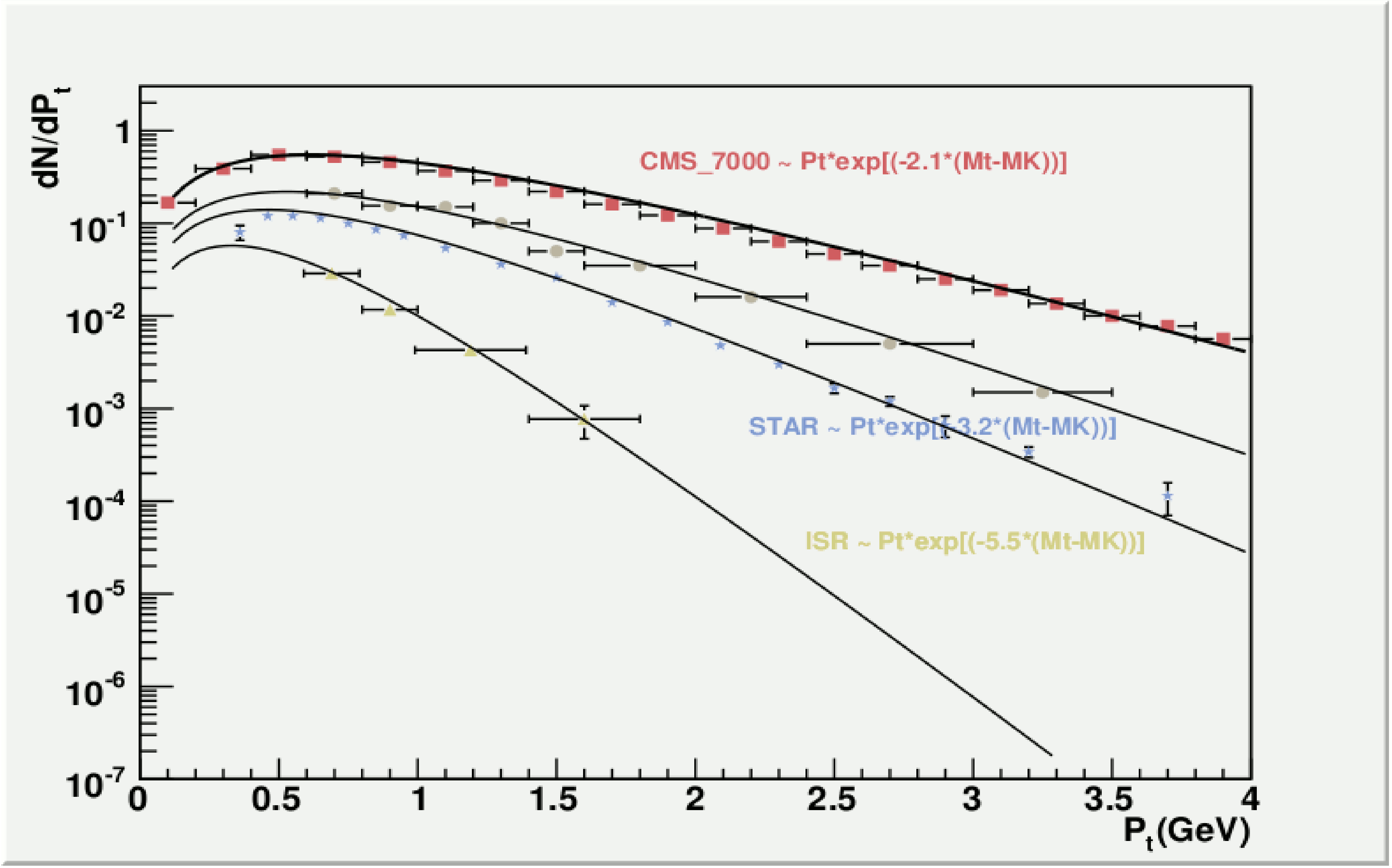
The QGSM approach:
Pt spectra were described with one exponent ~ e-B(mt-m0), B~6.0 GeV-1, mt= sqrt(m02+<Pt>**2), up to Pt= 1.5 GeV/c.**
Spectra are growing due to the total cross section. The slope is not changing with energy.
Spectra of pions, kaons, protons and antiprotons have been described in this way.

The hyperon data of UA5

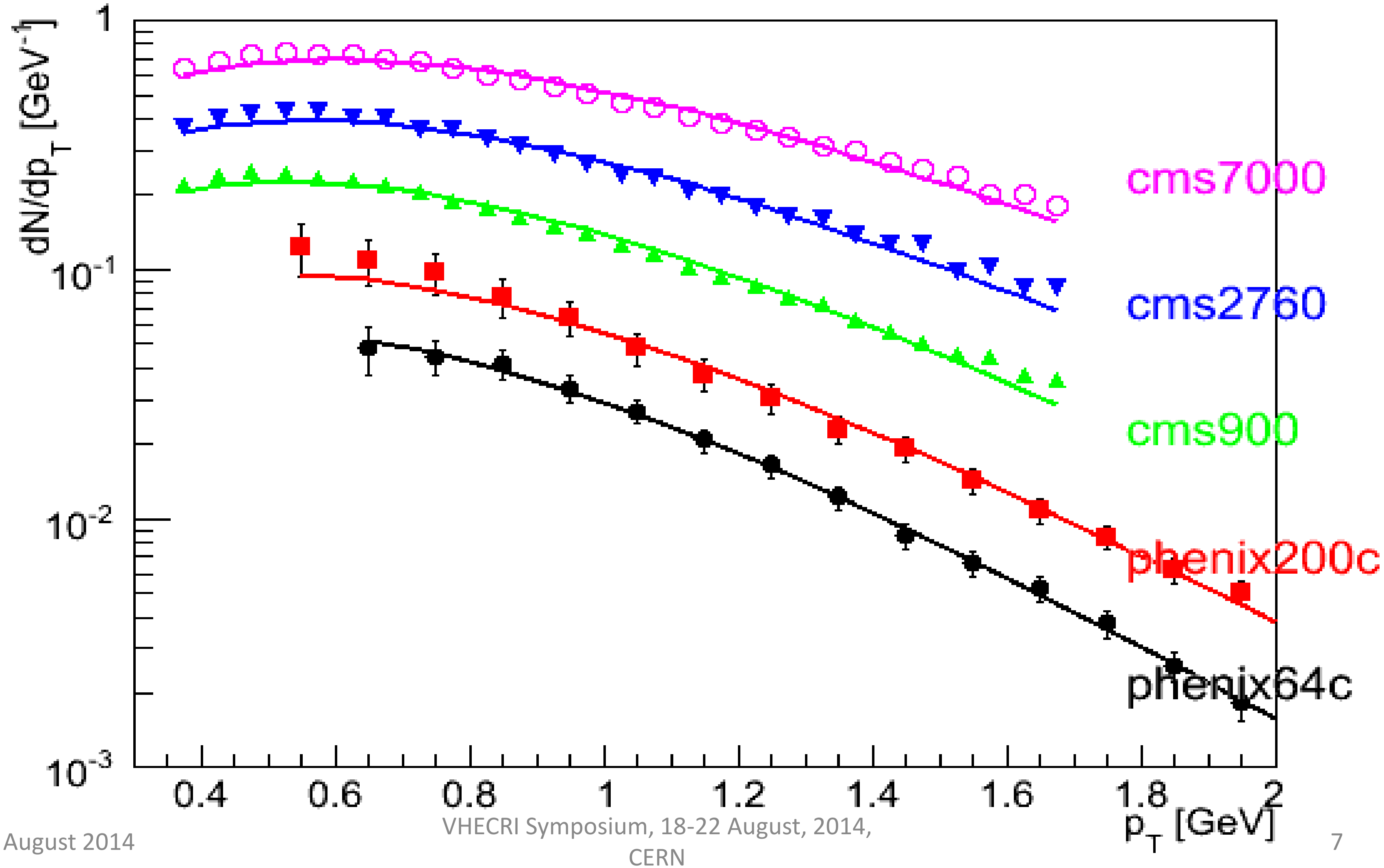


Data are from STAR(black); UA5 energies: sqrt(s) = 200 GeV(red), 546GeV(blue), 900GeV(aqua); UA1 630GeV(yellow) and CDF(green).

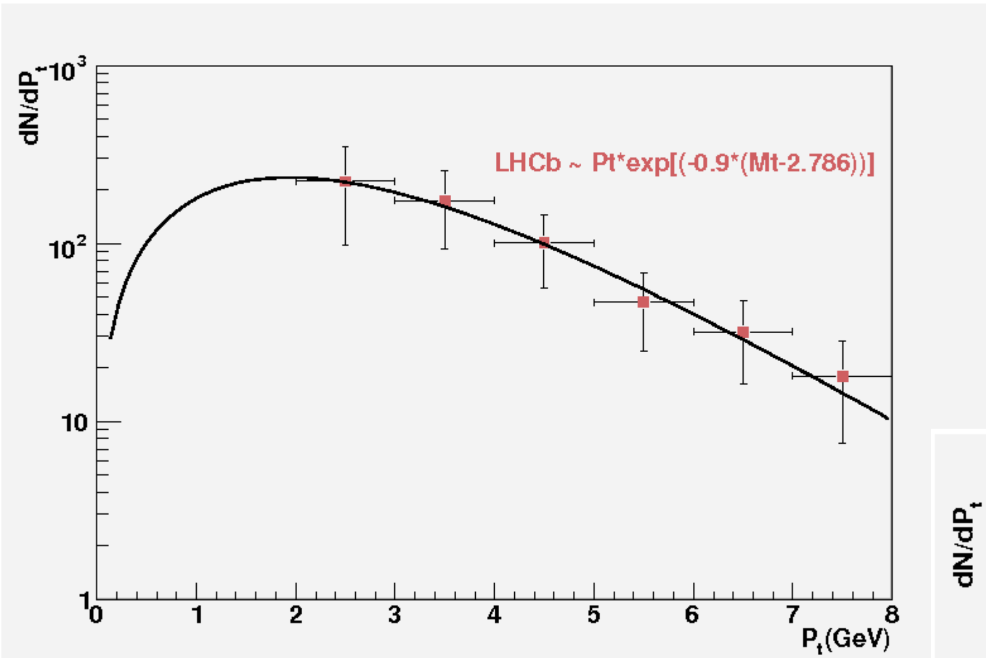
The changes in the slope of hyperon Pt- spectrum



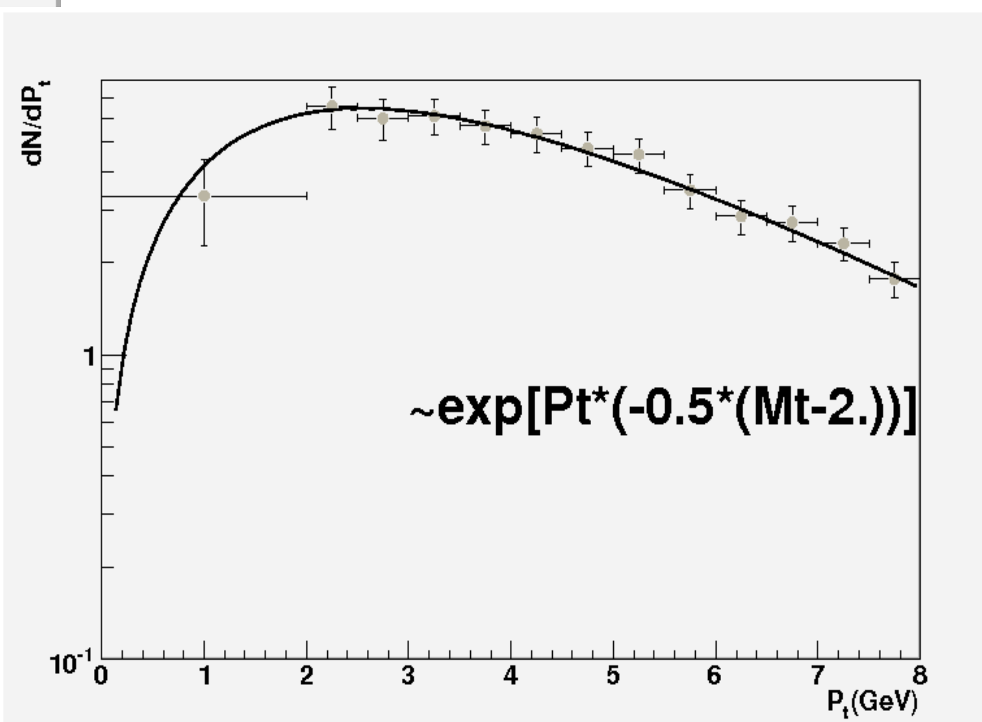
Proton spectra



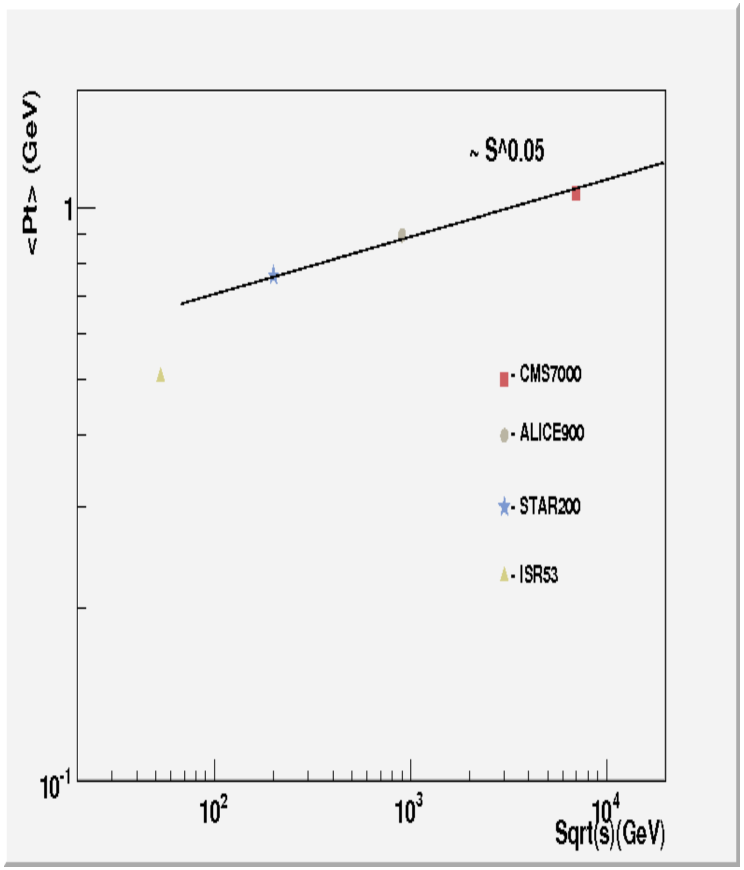
HEAVY FLAVOR BARYON DATA (LHCB)

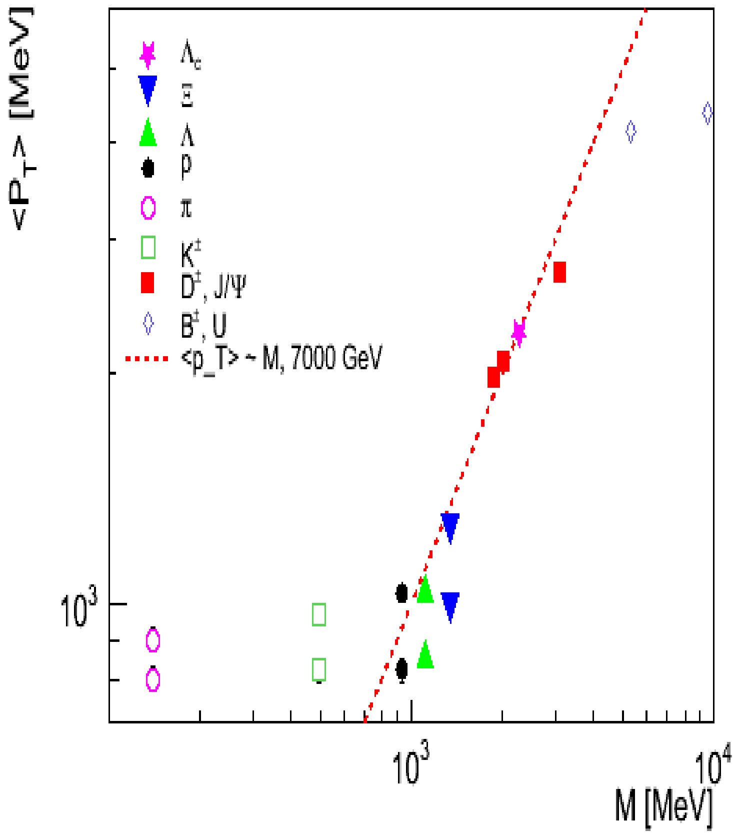


LHCb:pp->Bmesons



Average Pt at LHC





Baryon/antibaryon production asymmetry

If targets are baryons (proton, nuclei) it should bring “local” charge asymmetries into baryon production spectra:

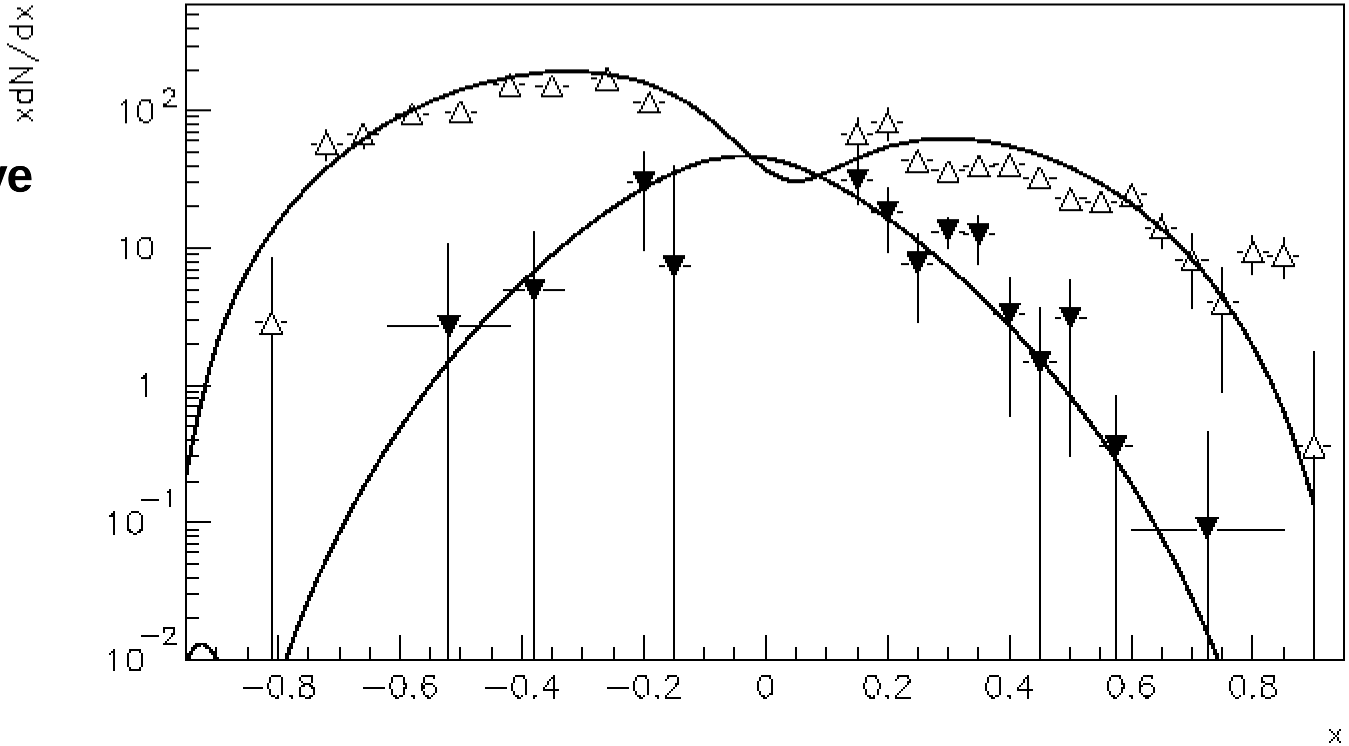
- due to quark (diquark) transfer from the target -> leading asymmetry
- due to string junction transfer from the baryon target (few %% at LHC).

The secondary particles from the baryon decays have to show the charge asymmetry growing with energy.

In the case of CR interactions these spectra are seen in laboratory system and having very specific form at the ends.

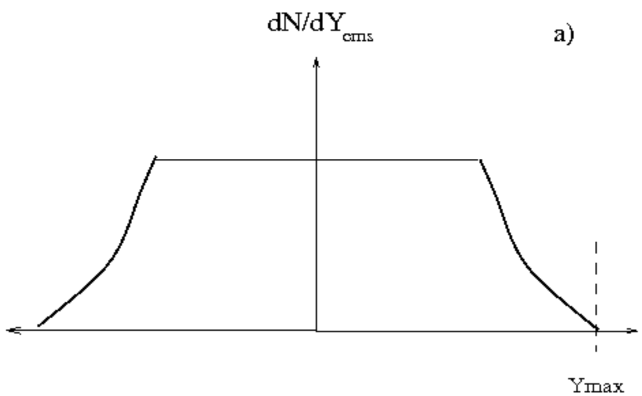
Specifics of baryon spectra, leading fragmentation

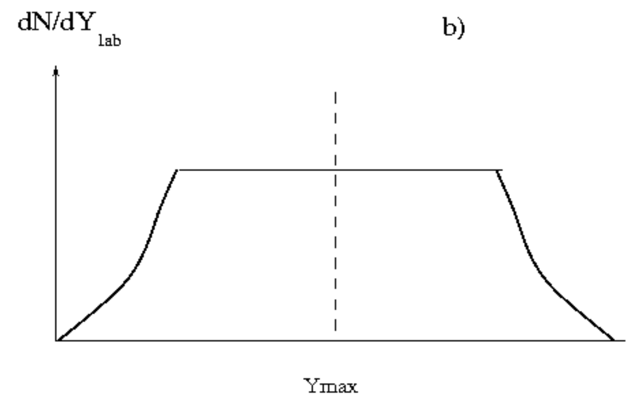
Spectra of baryons have specific leading behaviors in fragmentation regions



$\Sigma p \to \Lambda^0$ ($\bar{\Lambda}^0$)

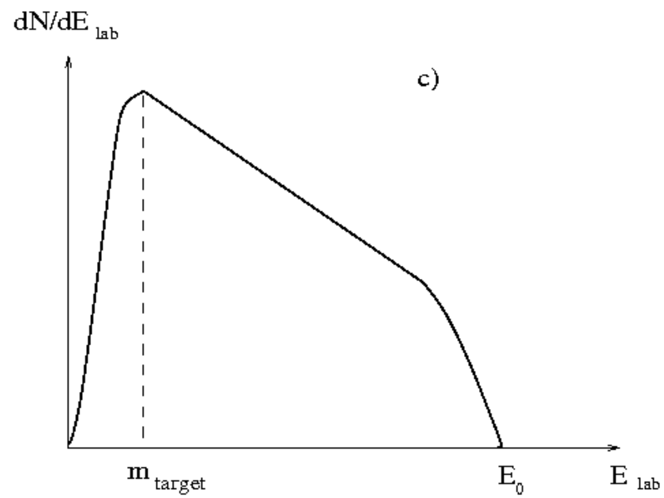
The spectra in lab. system



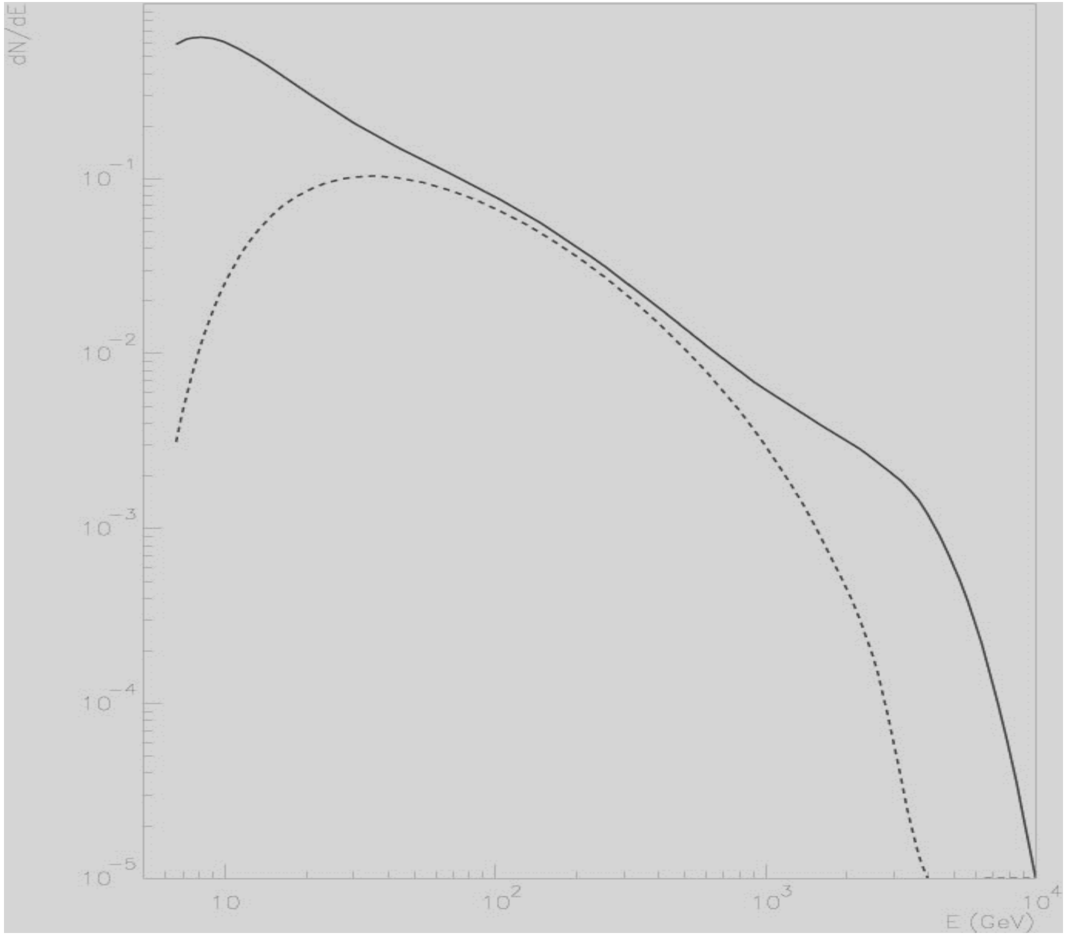


$$dN/dY = x dN/dx = E dN/dE$$

$$dN/dE = 1/E^{*}\ dN/dYlab$$



Baryon/antibaryon spectra in lab. system



The difference in baryon/antibaryon production spectra in lab.system is the reason of charge asymmetries in the spectra of particles in cosmic rays.
This picture shows the spectra of Λc calculated in laboratory system in 2000's before LHC era.
At LHC energies the central part of distribution has to grow and spectra become rather "whimsical".

Proton spectra in QGSM for high energy interactions

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A.B. Kaidalov and O.I. Piskunova: Inclusive Spectra of Baryons

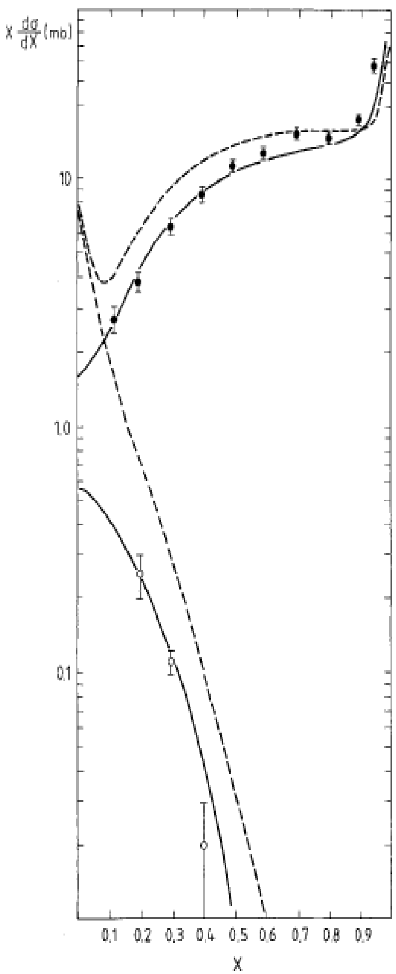

Fig. 6. Inclusive spectra of p and $\bar{p}$ at different energies. ϕ – p_L = 175 GeV/c [6]. Full curves are calculated in QGSM for $\sqrt{s}$ = 20 GeV, the dashed curves are predictions for $\sqrt{s}$ = 540 GeV

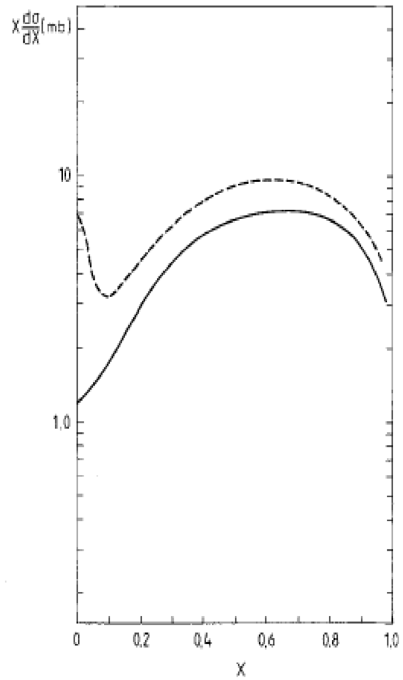

Fig. 7. Predictions of QGSM for inclusive spectra of neutrons at $\sqrt{s}$ = 20 GeV (full curve) and $\sqrt{s}$ = 540 GeV (dashed curve)

The description of the Λ and $\bar{\Lambda}$-spectra at various energies is shown in Fig. 8. A maximum in the Λ-spectrum is displaced to the smaller value of x in comparison to spectrum of neutrons (because the fragmentation functions of diquarks into Λ-hyperon have an extra power $(1-Z)^{\alpha_R(0)-\alpha_\varphi(0)}$ – see (6), (7)) in agreement with experimental observations. Note also that there are no diagrams of "undeveloped cyl-

The proton spectra for high energy collisions should have "deeps"

at the edges of rapidity range . Unfortunately, it can not be seen in LHC experiments. In CR spectra it gives some "knees" and "shoulders", if we suggest that these spectra are results of VHE interaction.

"Inclusive Spectra Of Baryons In The Quark - Gluon Strings Model"

A.B. Kaidalov, O.I. Piskunova

Z.Phys. C30 (1986) 145

The ends of spectra, as proton as neutron ones, have to follow the regge asymptotics:

~(1-x)^6

Gamma rays spectra from VHE source

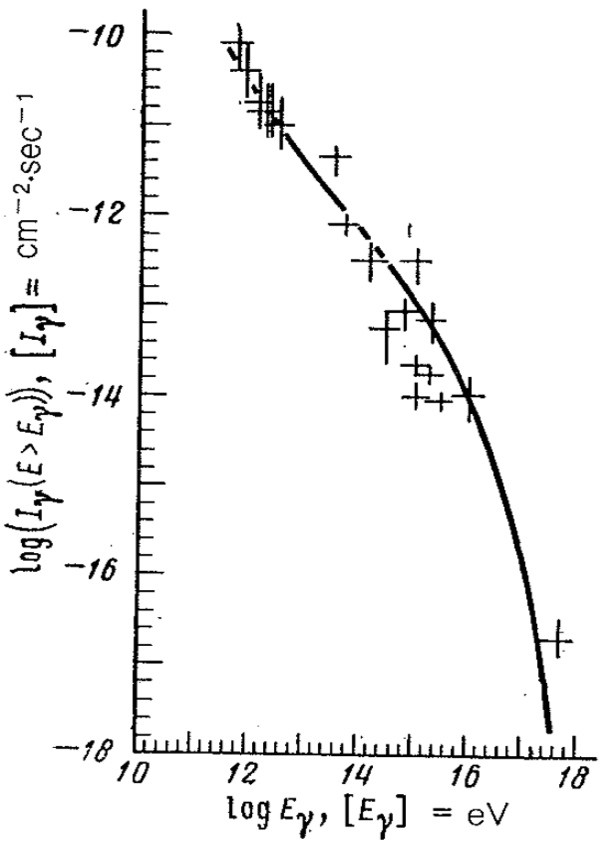

FIG. 2. The integrated distribution of the source Cygnus-X3.

847 Sov. J. Nucl. Phys. **51** (5), May

The shape of gamma spectrum was described for the reactions:

pp ->π0 -> 2γ in the laboratory system.

The shape of spectrum at the end reproduces the pion spectra in pp collisions.

"Shape of gamma spectra from cosmic sources of high-energy protons."

O.I. Piskunova (Lebedev Inst.)
Sov.J.Nucl.Phys. 51 (1990) 846-848

Conclusions

1.The study of baryon transverse momentum spectra from LHC experiments shows that results were not predicted, but they are understandable.

2. Hadron interactions of VHE in detectors can not cause the “knee” in CR spectra. The form of proton spectrum may be modulated at the interactions in the sources of CR.

3. More interesting issue is antipaticle/particle spectra asymmetries as an effect of target “positiveness” in VHE CR interactions with matter

4.Growing charge asymmetries of secondary particle spectra in CR may be generated by the baryon production in the CR interactions with positive matter targets.

5. There is always existing a few percent asymmetry at LHC energies because of string junction transfer from the target protons.

6. How the initial particles of VHE are created, (DM annihilation into high energy particle jets)?