

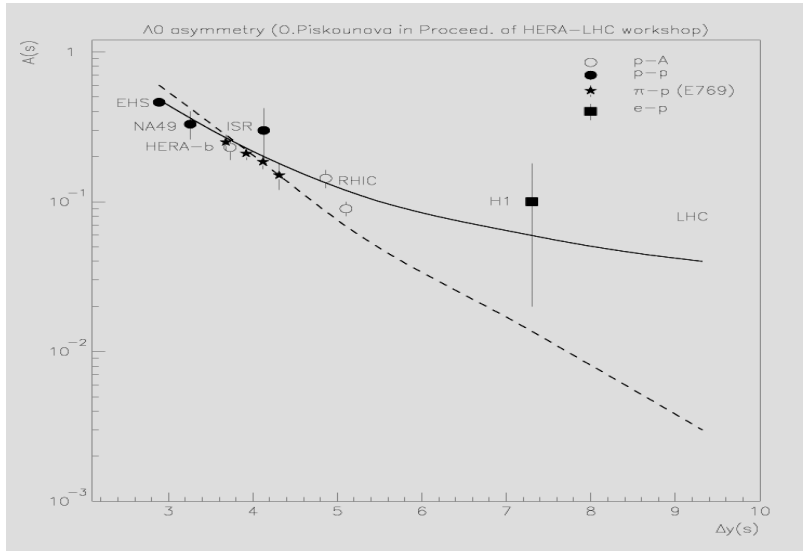
Baryon spectra at LHC experiments and CR spectra of VHE.

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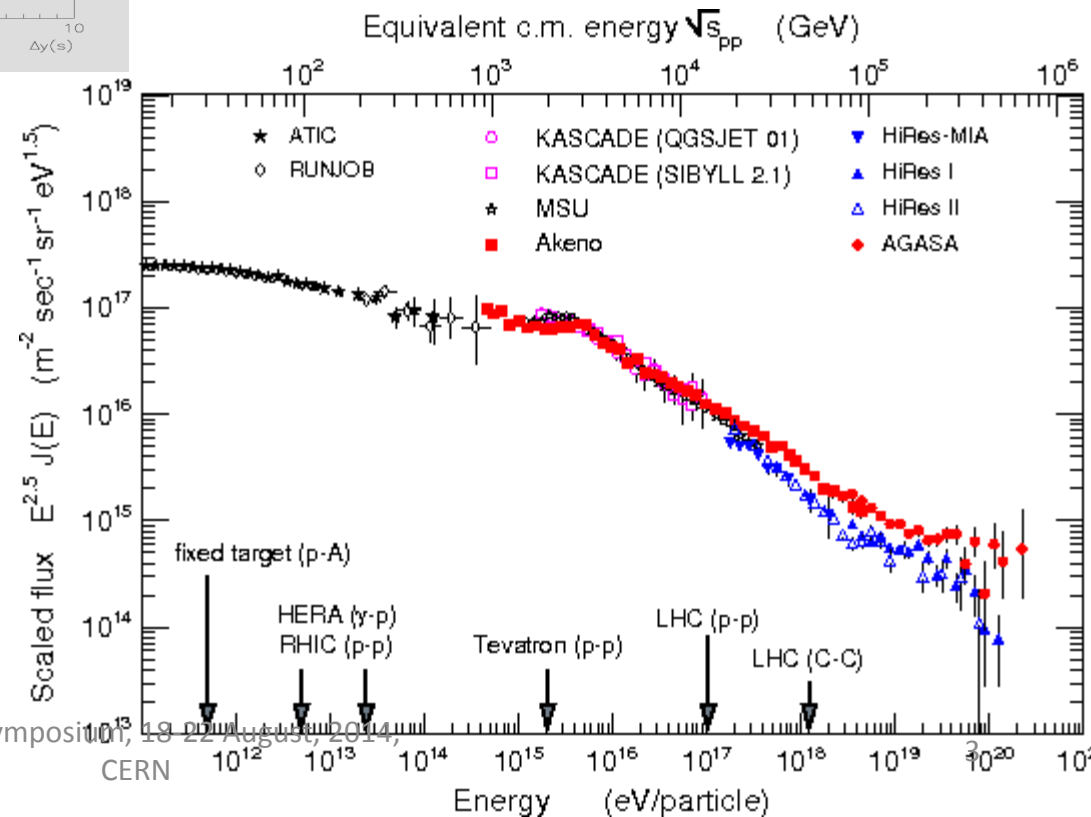
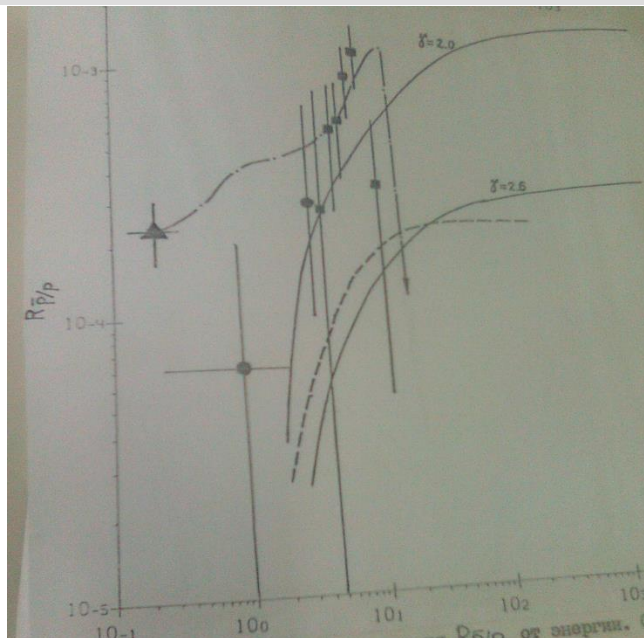
Outline

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 P_t 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

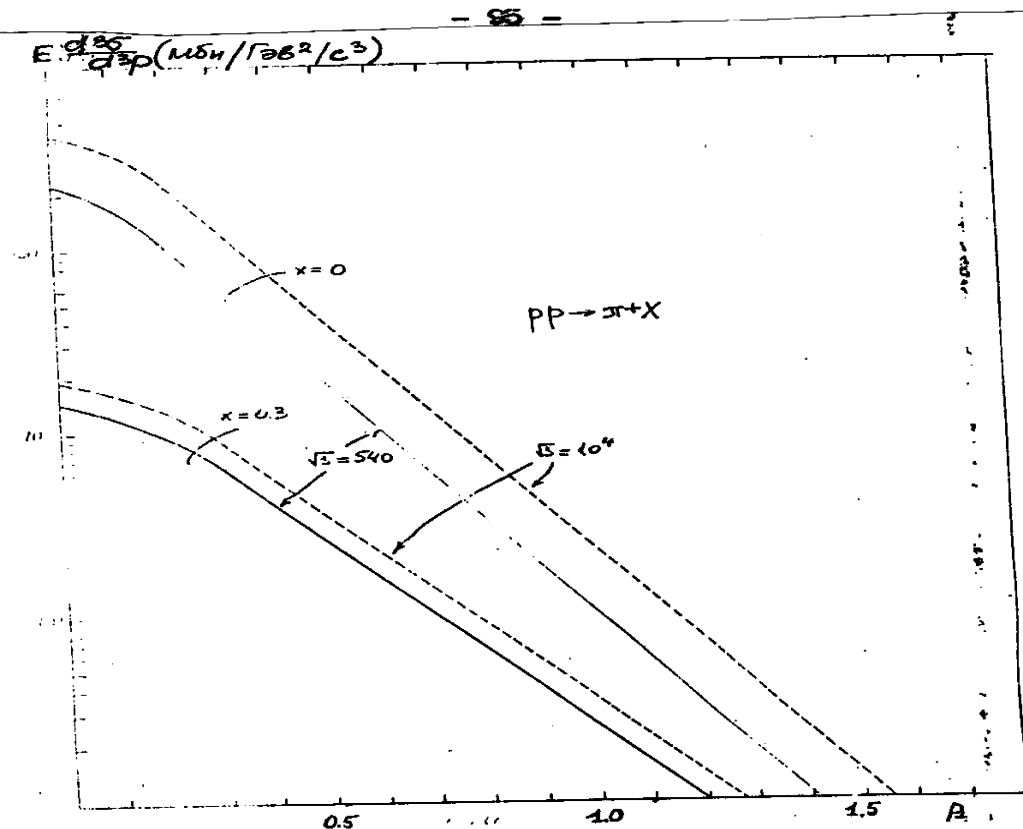


We can study the features of baryon spectra beginning from global CR proton distribution up to delicate measurement results on asymmetry caused by the baryon charge transfer at the collider experiments



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

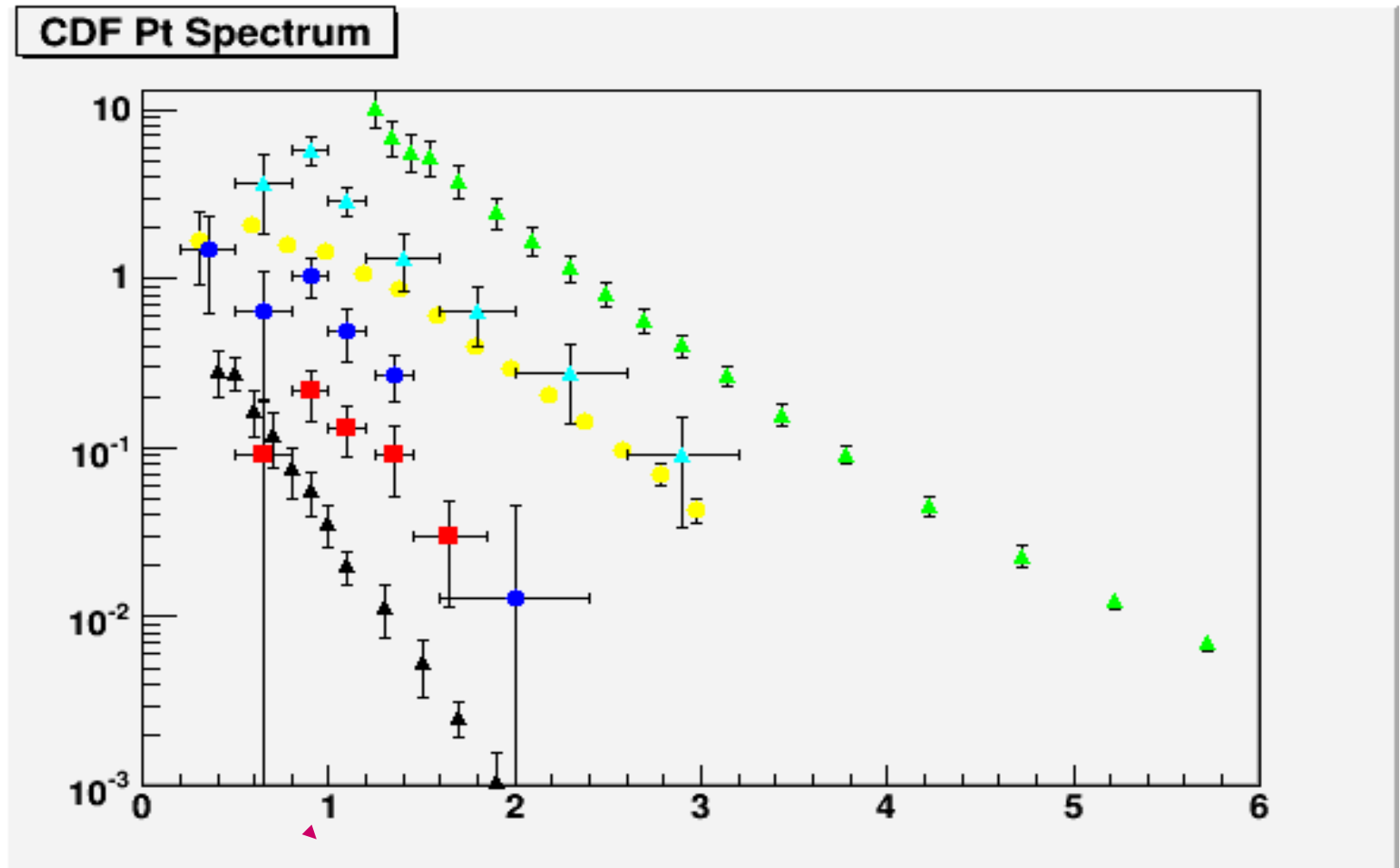
published in A.I. Veselov, O.I. Piskunova, K.A. Ter-Martirosian,
Phys Lett B158:175 1985.



The QGS approach:
 Pt spectra were described with one exponent $\sim e^{-B(mt-m_0)}$, $B \sim 6.0$ GeV $^{-1}$, $mt = \sqrt{m_0^{**2} + \langle Pt \rangle^{**2}}$, up to $P_t = 1.5$ 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.

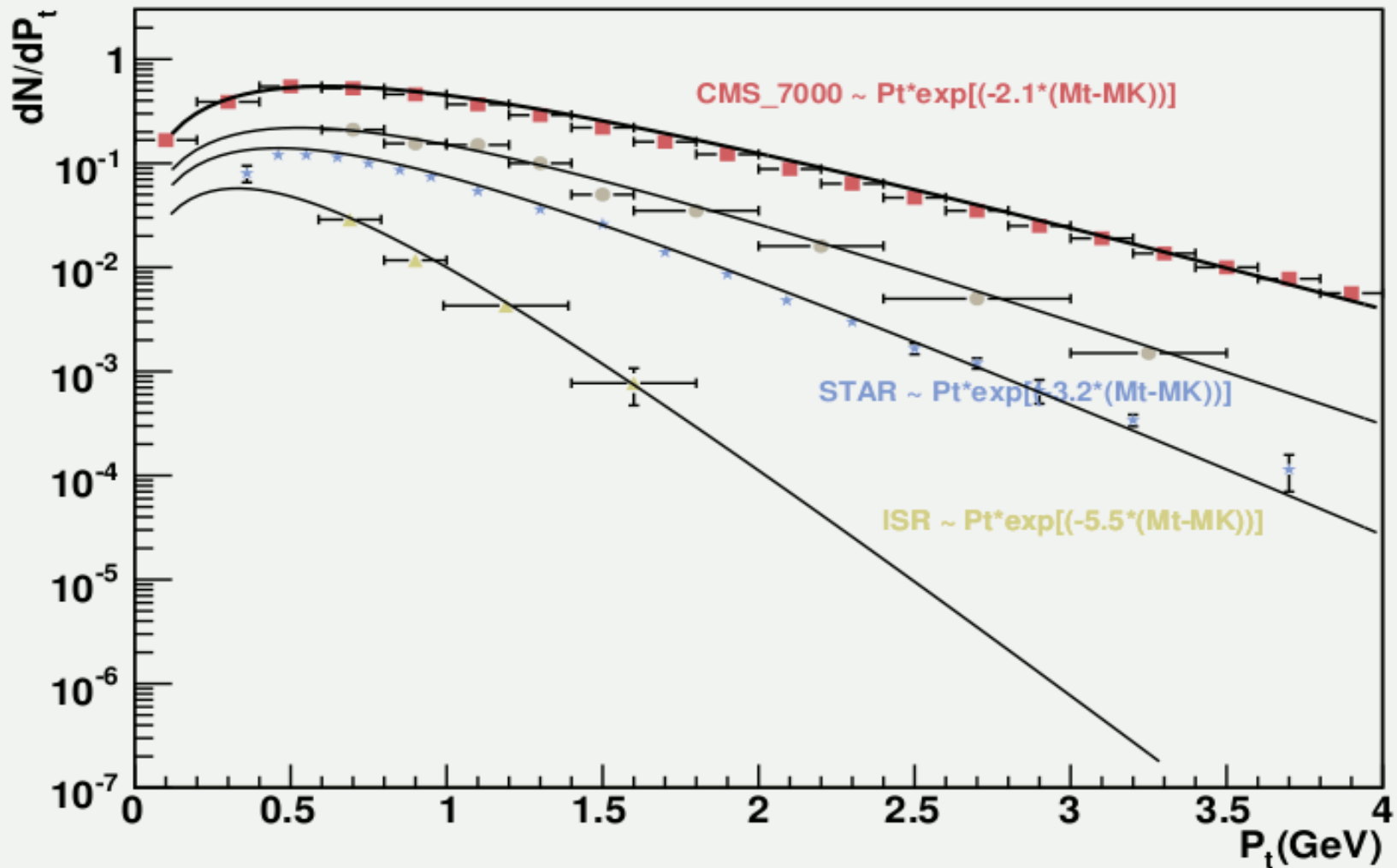
Рисунок 38. Изменение распределений π^+ мезонов поперечному импульсу при переходе от энергии $\sqrt{s} = 540$ Гэв (сплошная кривая) к $\sqrt{s} = 10^4$ Гэв (пунктирная) при $x=0$, и $x=0.3$.

The hyperon data of UA5

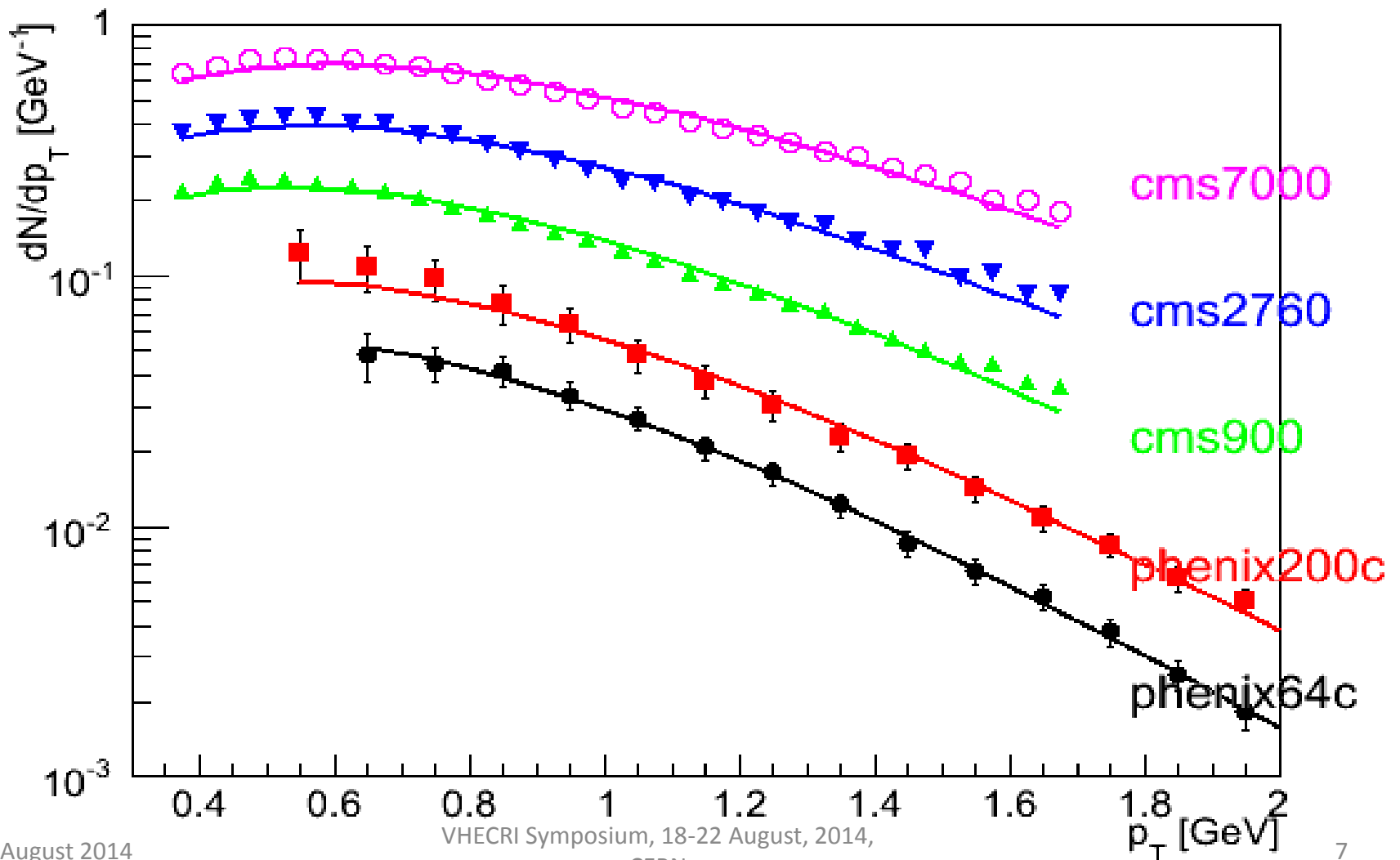


Data are from STAR(black); UA5 energies: sqrt(s) = 200 GeV(red), 546GeV(blue), 900GeV(aqua); UA1 630GeV(yellow) and CDF(green).

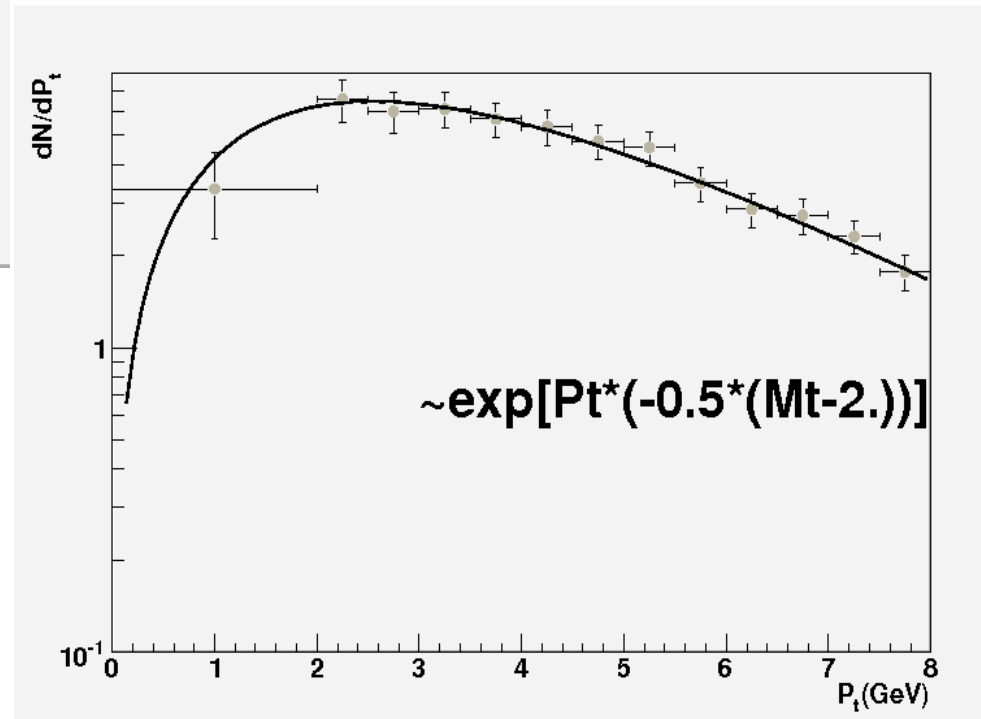
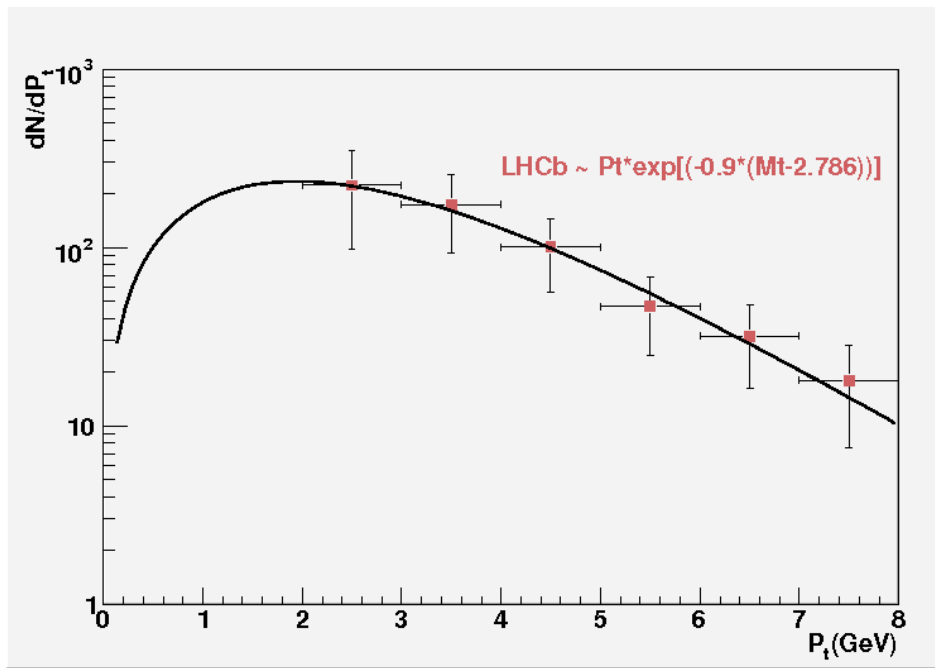
The changes in the slope of hyperon P_t - spectrum



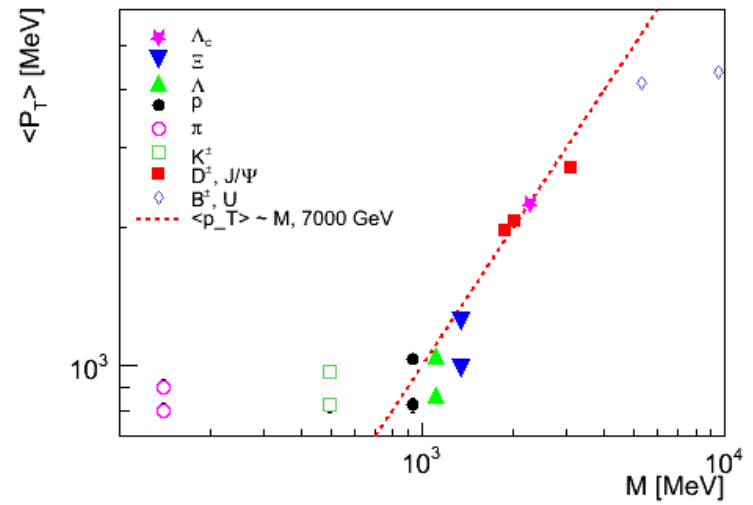
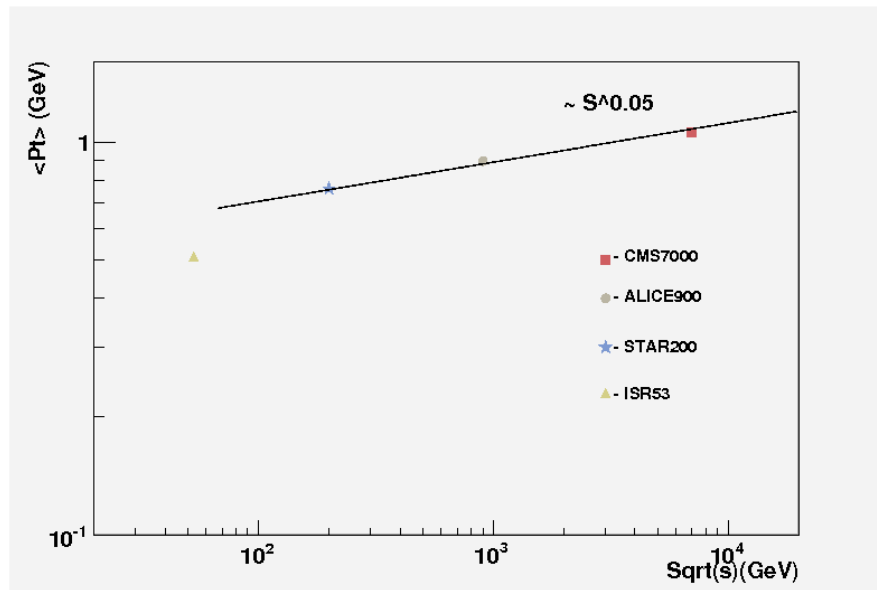
Proton spectra



Heavy flavor baryon data (LHCb)



Average Pt at LHC



Baryon/antibaryon production asymmetry

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

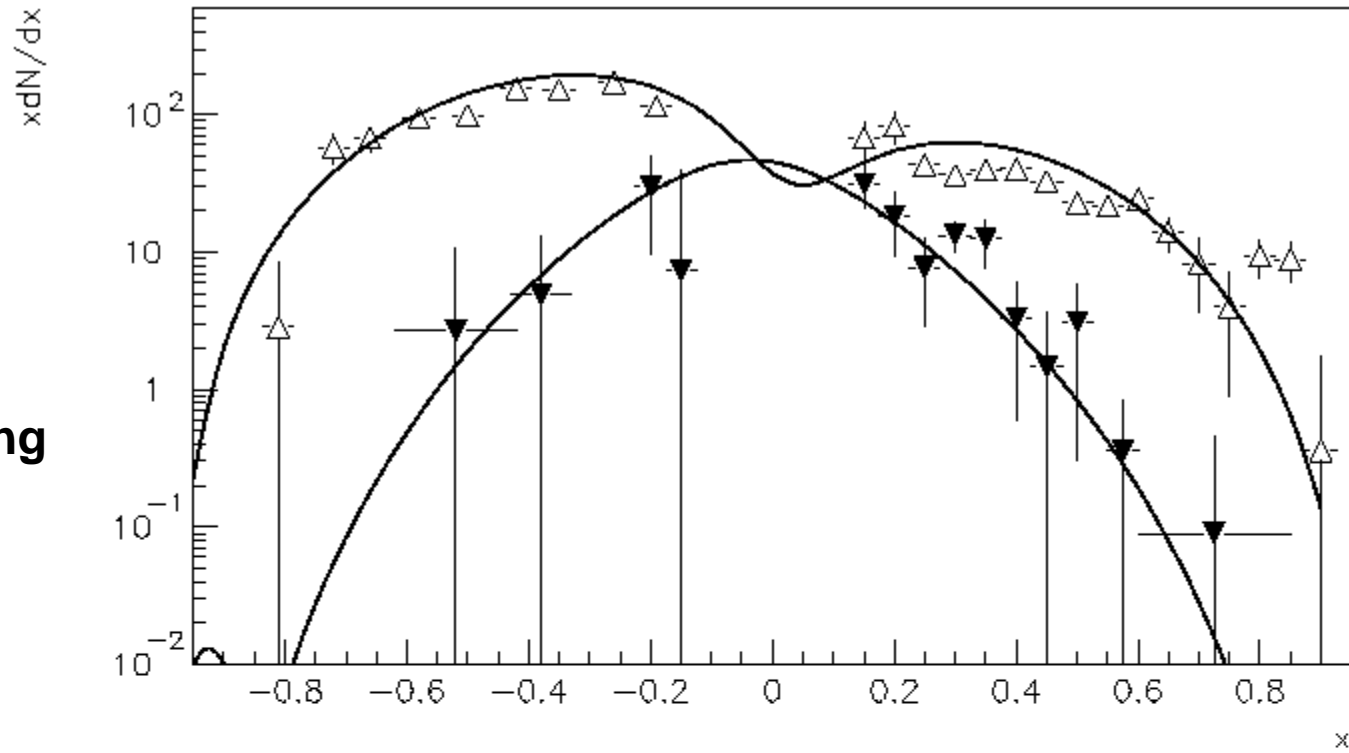
- due to quark (diquark) transfer from the target -> leading asymmetry
- due to string junction transfer from the baryon target (few % at LHC).

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

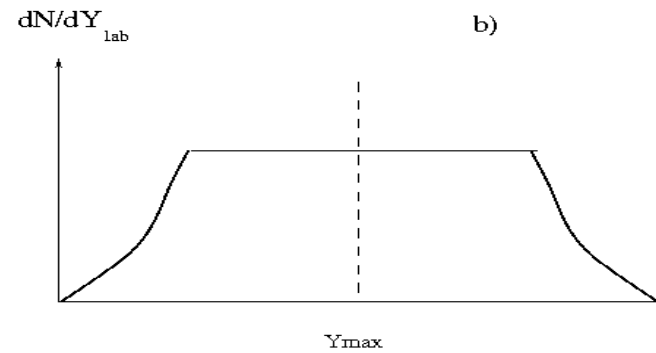
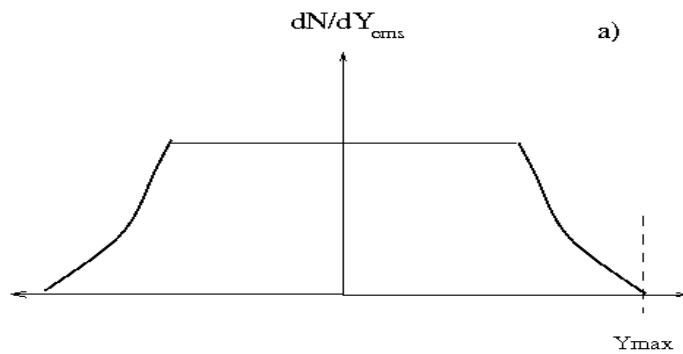
Specifics of baryon spectra, leading fragmentation

**Spectra of baryons
have specific leading
behavior**



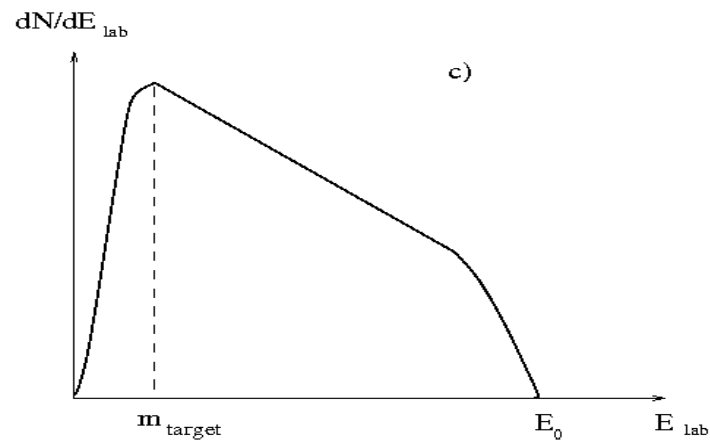
$$\Sigma p \rightarrow \Lambda^0 (\Lambda^{-0})$$

The spectra in lab. system

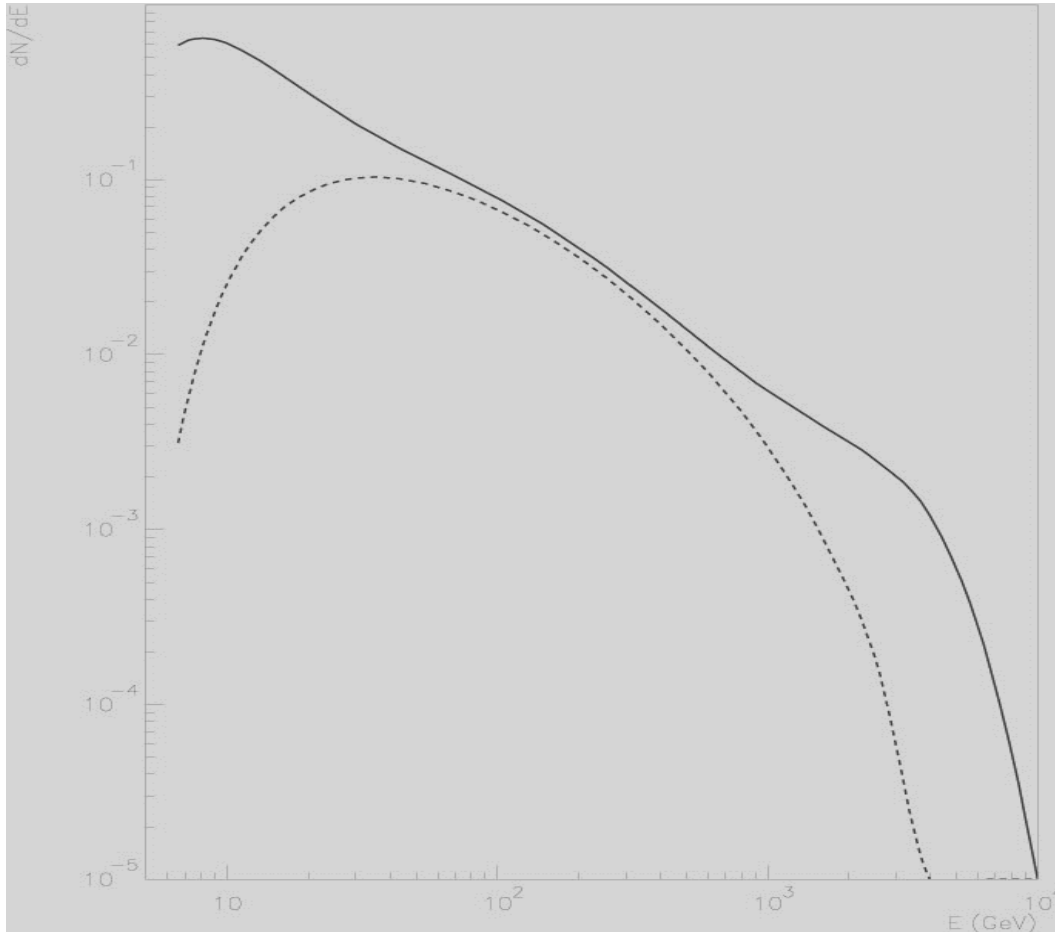


$$dN/dY = x dN/dx = EdN/dE$$

$$dN/dE = 1/E * dN/dY_{\text{lab}}$$



Baryon/antibaryon spectra in lab. system

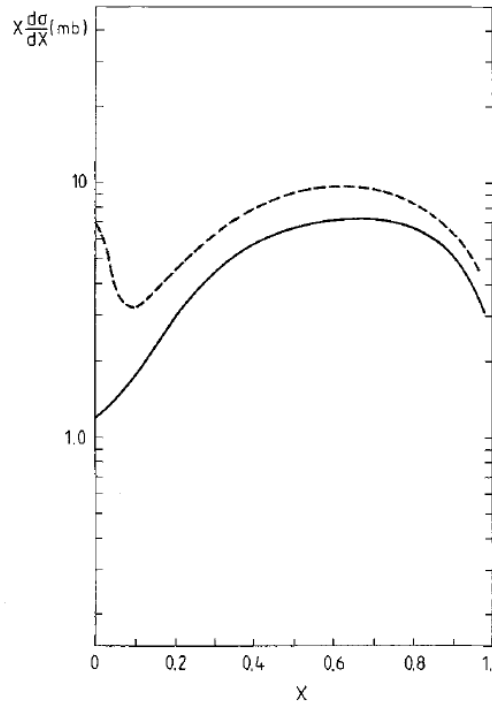
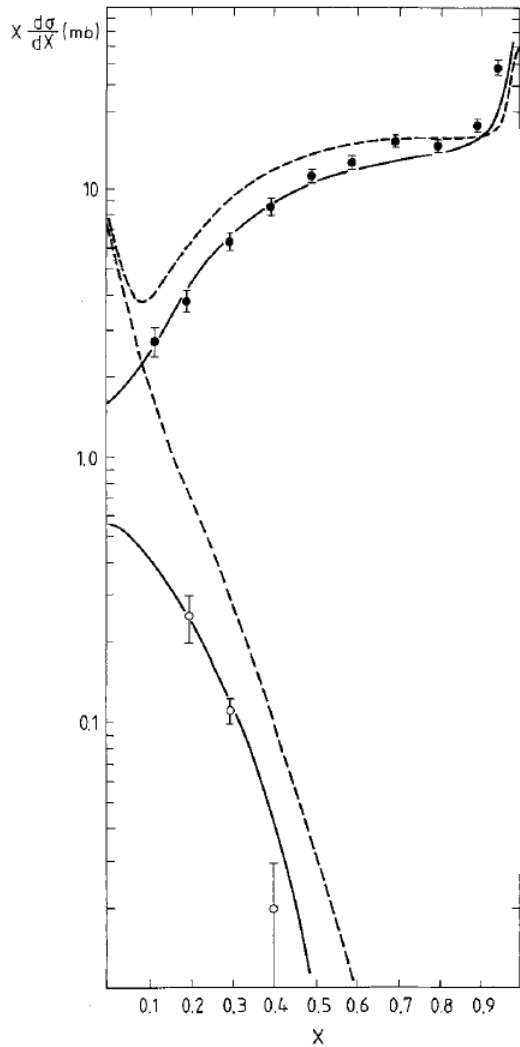


The difference in baryon/antibaryon production spectra in lab.system is the reason of charge asymmetries in the spectra of particles in cosmic rays.

This picture shows the spectra of Λ_c 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 in high energy interactions



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 or 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

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

O.I. Piskunova (Lebedev Inst.). 1990. 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
3. More interesting issue is antiparticle/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)?