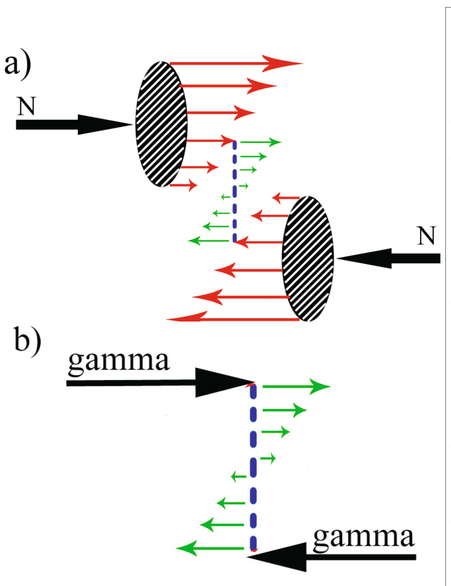
Two component model for hadroproduction in high-energy collisions

A.A. Bylinkin*, N.S. Chernyavskaya, A.A. Rostovtsev

* alexandr.bylinkin@cern.ch

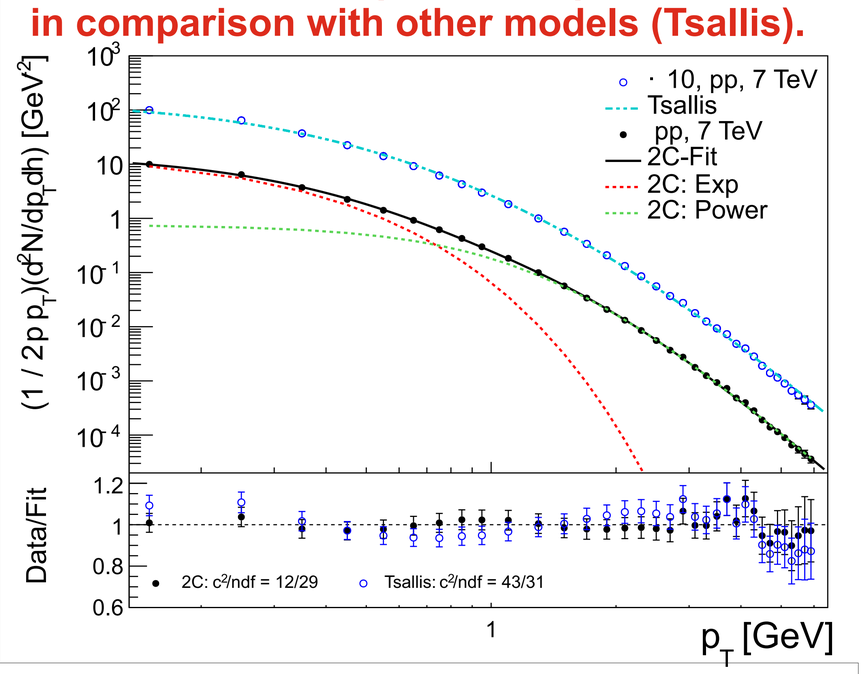


Introduction

The baryon-baryon high energy interactions one could decompose into at least two distinct sources of produced hadrons. The first one is associated with the baryon valence quarks and a quark-gluon cloud coupled to the valence quarks. Those partons preexist long time before the interaction and could be considered as being a thermalized statistical ensemble. When a coherence of these partonic systems is destroyed via strong interaction between the two colliding baryons, these partons hadronize into particles released from the collision. The hadrons from this source are distributed presumably according to the Boltzmann-like exponential statistical distribution in transverse plane w.r.t. the interaction axis. The second source of hadrons is directly related to the mini-jet fragmentation of the virtual partons (pomeron in pQCD) exchanged between two colliding partonic systems. The radiated partons from this pomeron have presumably a typical for the pQCD power-law spectrum. Therefore, we suggest to approximate the charged particle spectra by a sum of an exponential and a power-law distributions:

$$\frac{d^2\sigma}{\pi dy(dp_t^2)} = A_1 exp(-E_{Tkin}/T_e) + \frac{A_2}{(1+\frac{P_T^2}{T^2 N})^N}$$

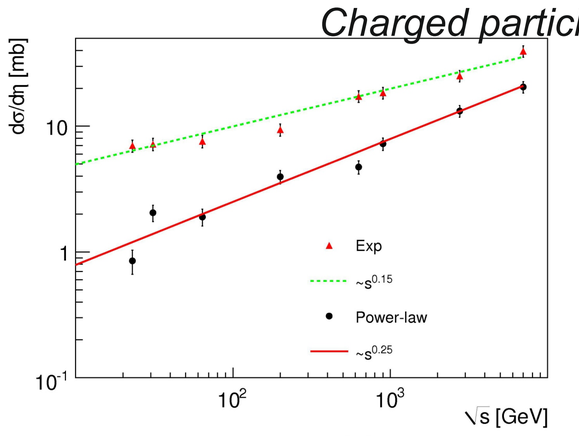
Much better description of experimental data in comparison with other models (Tsallis).

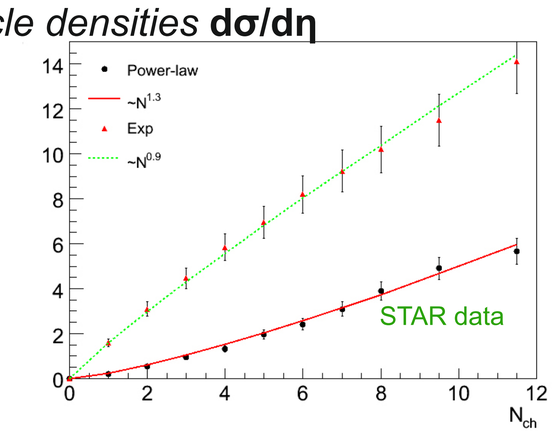


Not just a good choice of a parameterization, but a way to understand the underlying hadroproduction dynamics:

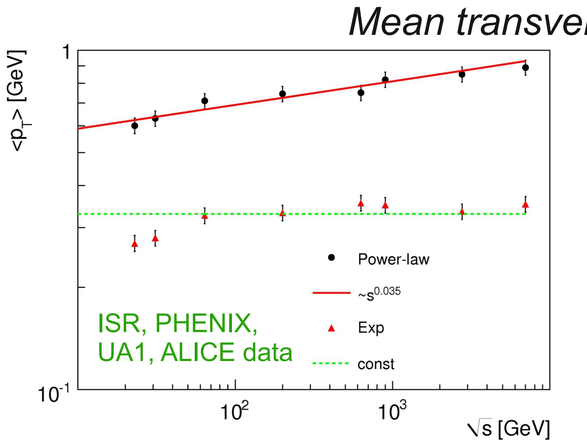
Exponential and power-law terms behave differently as a function of the collision energy, charged particle multiplicity, pseudorapidity region or the type of interaction or produced particle.

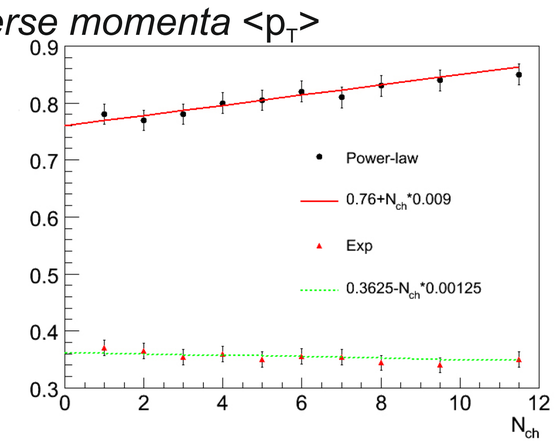
Charged particle densities **dσ/dη**

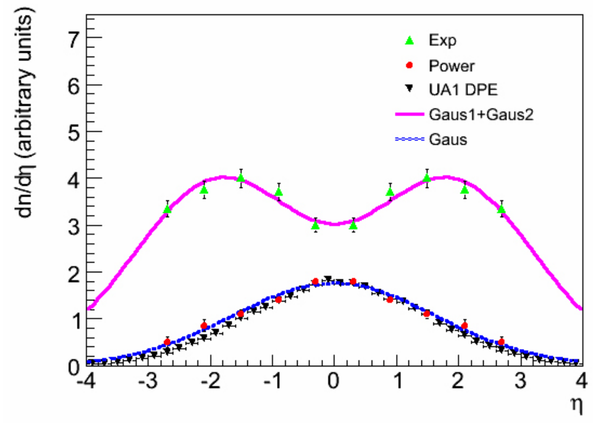




Mean transverse momenta $\langle p_T \rangle$



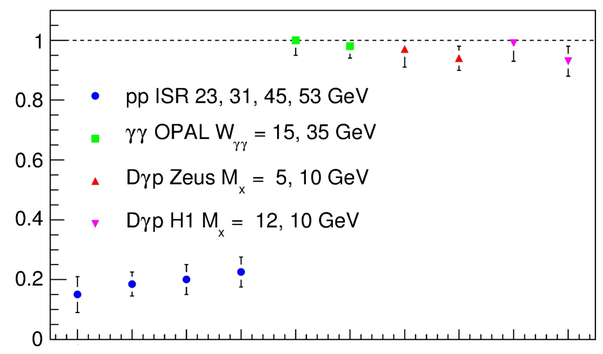




Hadrons produced via the mini-jet fragmentation should be concentrated in the central rapidity region (η~0), while those coming from the proton fragmentation are expected to dominate at high values of η due to non-zero momenta of the initial partons along the beam-axis.

Relative Contribution

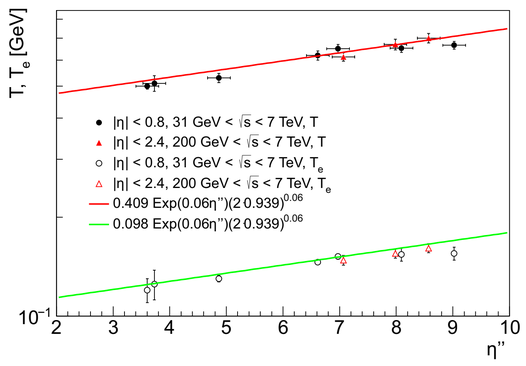
R = Power-law / (Exp + Power-Law)

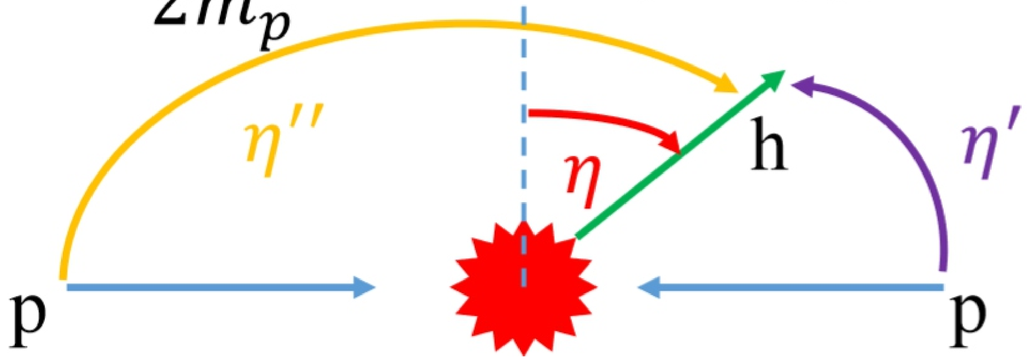


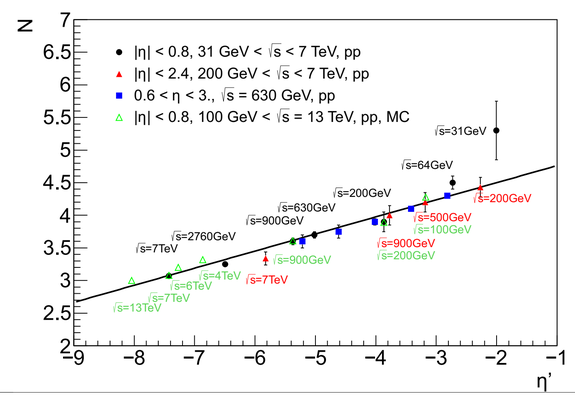
Exponential term contribution dominates in pp-collisions, while it is almost absent in gamma-gamma interactions, diffractive processes, or heavy-flavour production.

Rapidity separation - a universal factor characterizing all parameter variations

$$\eta'' = |\eta| + \log(\frac{\sqrt{s}}{2m_p}) \qquad \eta' = |\eta| - \log(\frac{\sqrt{s}}{2m_p})$$

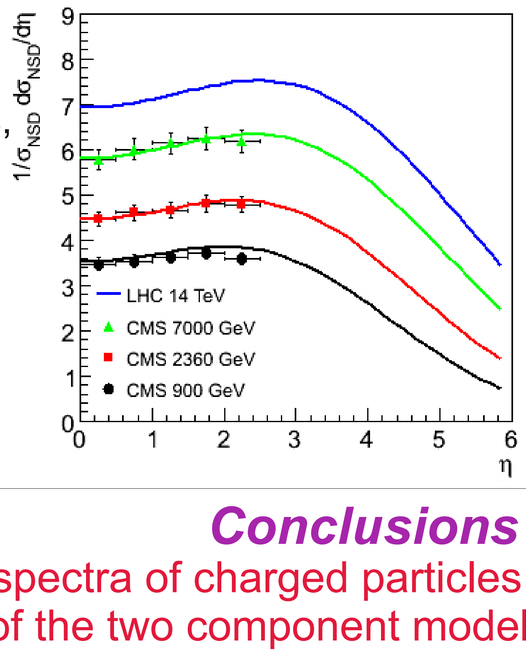


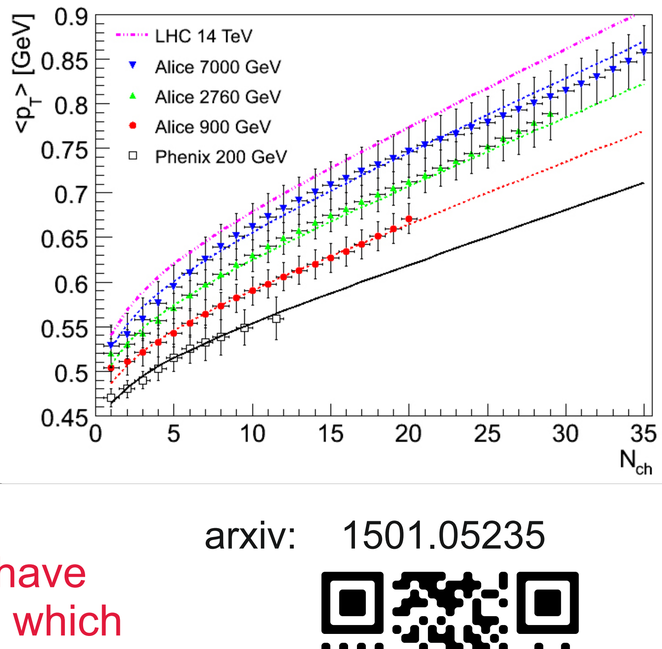


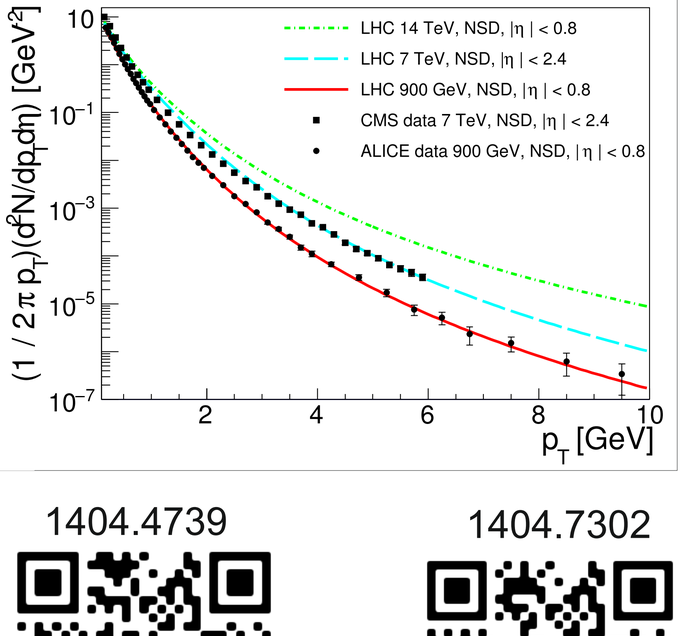


Predictions for LHC-energies

The observed dependences can be used to make predictions on the pseudorapidity distributions, mean transverse momenta $\langle p_T \rangle$ as a function of multiplicity N_{ch} and the transverse momentum spectra at higher energies which are successfully tested on the available experimental data from LHC.







Conclusions

1. Transverse momentum spectra of charged particles have been considered in terms of the two component model, which is shown to provide the best description of the experimental data.
2. Parameter variations on the collision energy, pseudorapidity and multiplicity have been studied and a universal factor was found.
3. Predictions on charged hadron production at LHC have been made and successfully tested on the available experimental data.

arxiv: 1501.05235 — EPJC 75 (2015) 4, 166;

1404.4739 — PRD 90 (2014) 1, 017501;

1404.7302 — NPB 888 (2014) 65-74