

# Charged hadron distributions in a two component model

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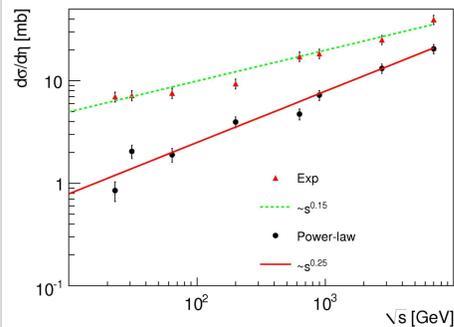


## Introduction

At high energies,  $\sqrt{s}$ , the multiparticle production is usually considered in terms of the pomeron exchange. Besides the single pomeron exchange there are more complicated contributions described by the multi-pomeron diagrams in the framework of the Reggeon Field Theory.

Due to large absorptive (multi-pomeron) effects it is not easy to study the properties of the *individual* pomeron experimentally. Thus, the behavior of the power-like part of single particle inclusive cross sections provides a most direct information about the 'bare' pomeron properties.

## Energy dependences

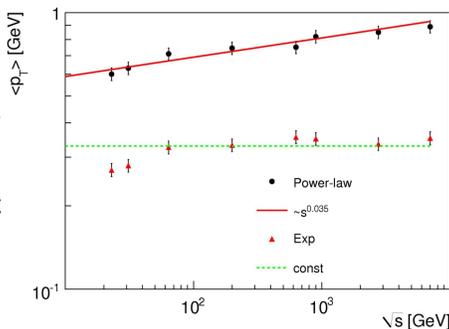


**Charged particle densities  $d\sigma/d\eta$  grow with energy  $\sim s^\Delta$ :**

- For the power-like part of the spectra we observe  $\Delta \sim 0.25$  - close to the value expected for the pQCD (BFKL) pomeron after the resummation of the NLL corrections.
- The value of  $\Delta$  coming from the 'exponential' component is lower ( $\sim 0.15$ ) since it is strongly affected by absorptive corrections.

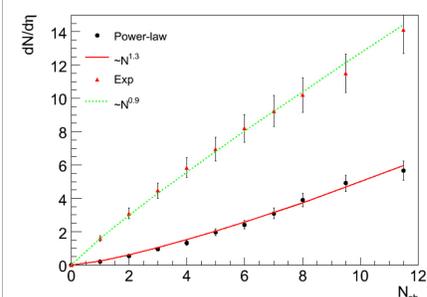
## Mean transverse momenta $\langle p_T \rangle$

- is almost constant for the 'exponential' part,
- Increase for the power-like term can be related with the growth of the typical transverse momenta of mini-jets which hadronization is responsible for this part of the spectra.



ISR, PHENIX, UA1, ALICE data

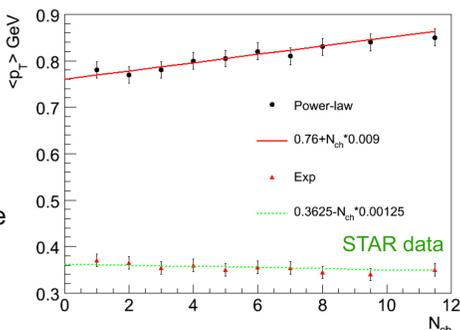
## Multiplicity dependences



**Charged particle densities  $d\sigma/d\eta$ :** According to the AGK rules the charge multiplicity in hadronic interactions is proportional to the number of pomerons involved.  $\rightarrow$  the contribution from the power-like component (mini-jets) grows faster than that from the 'exponential' one

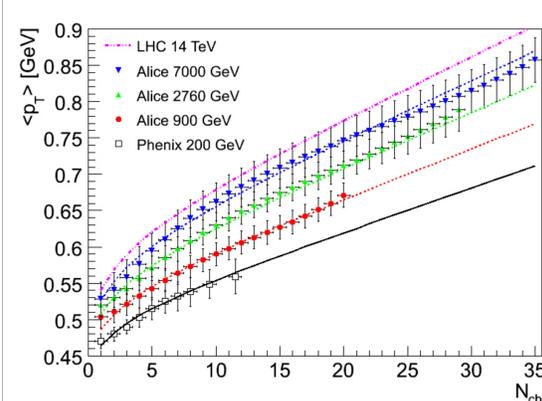
## Mean transverse momenta $\langle p_T \rangle$

Within the Regge theory the higher multiplicity events are described by the diagrams with a larger number,  $n$ , of 'cut' pomerons ( $N_{ch} \sim n$ ). Accounting for mini-jet contribution the  $\langle p_T \rangle$  should increase with  $N_{ch}$  since another way to enlarge multiplicity is to produce mini-jets with larger  $E_T$ .



STAR data

## Predictions for LHC-energies



The observed dependences can be used to make predictions on the mean transverse momenta,  $\langle p_T \rangle$ , as a function of multiplicity  $N_{ch}$  at higher energies and tested on the available data from LHC. *Rather good agreement between the prediction and the experimental data measured by the ALICE collaboration at different energies is observed.*

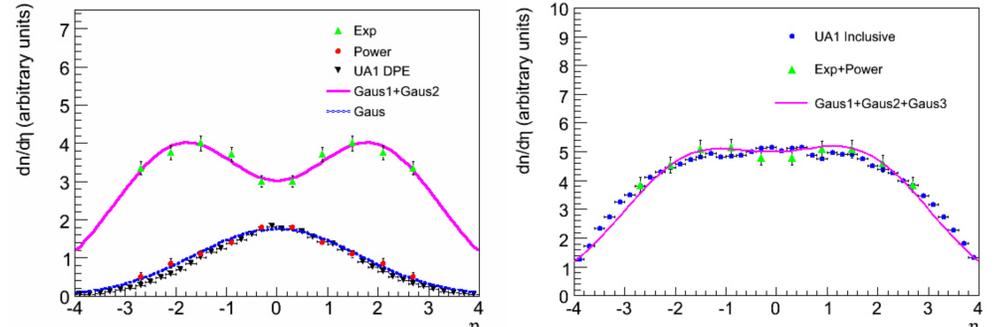
## Pseudorapidity distributions

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

Thus, charged particle densities  $d\sigma/d\eta$  for 5  $\eta$ -intervals calculated separately for the 'exponential' and 'power-law' terms from the fits to UA1 data are parameterized with Gaussian distributions, respectively:

$$(d\sigma/d\eta)^{pl} = A_{pl} * \exp[-0.5((\eta - \eta_{pl})/\sigma_{pl})^2] \quad \text{and} \\ (d\sigma/d\eta)^{exp} = A_{exp1} * \exp[-0.5((\eta - \eta_{exp1})/\sigma_{exp1})^2] + A_{exp2} * \exp[-0.5((\eta - \eta_{exp2})/\sigma_{exp2})^2],$$

with  $\eta_{pl} = 0$ ,  $A_{exp1} = A_{exp2}$ ,  $\eta_{exp1} = -\eta_{exp2}$  and  $\sigma_{exp1} = \sigma_{exp2}$ .

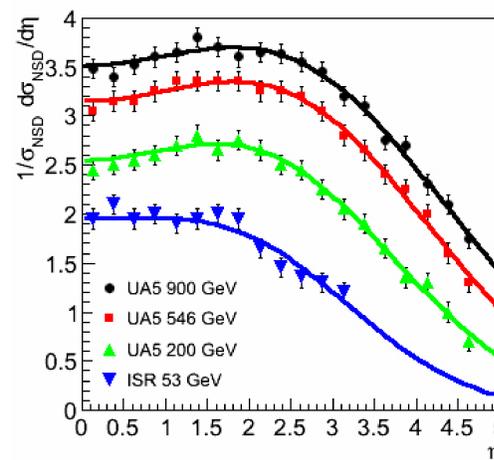


The difference between the shapes of pseudorapidity distributions for double pomeron exchange (DPE) and minimum-bias (MB) events and the existence of a relatively wide plateau in the latter can be qualitatively explained in terms of the two component model.

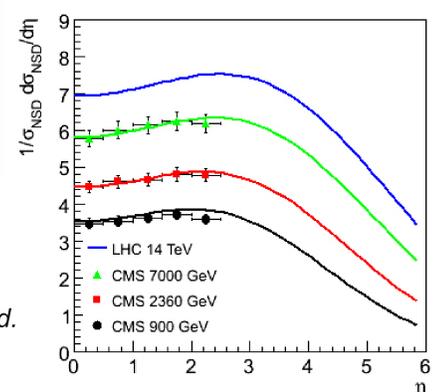
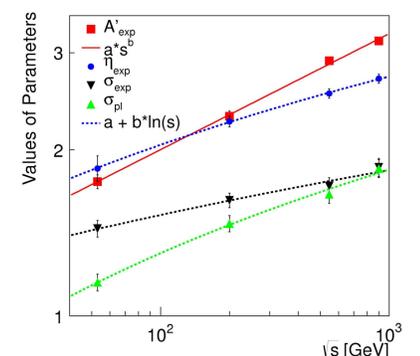
## Scaling of distributions

This study can be done, using the data on pseudorapidity distributions measured under the same experimental conditions by the UA5 Detector.

### Gaussian fits



The observed dependences can be used to make predictions on charged particles pseudorapidity distributions at LHC-energies. *Good agreement between the predictions and the available experimental data is observed.*

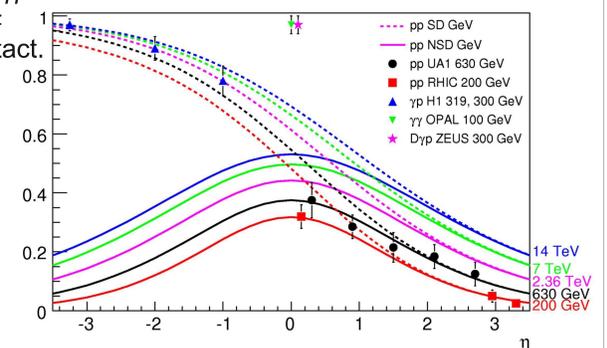


## Relative Contribution $R = \text{Power-law} / (\text{Exp} + \text{Power-Law})$

It was shown that contrary to  $pp$ -collisions, spectra produced in  $\gamma p$  or  $\gamma\gamma$ -interactions have no room for the exponential term. From the proposed model, one can expect that  $R$  as a function of pseudorapidity  $\eta$  for  $\gamma p$ -interactions should have the behavior similar to single-diffractive (SD)  $pp$ -collisions, in which one of the protons remains intact.

This hypothesis is supported by the observation that charged particle spectra measured in diffractive photoproduction ( $D\gamma p$ ) by the ZEUS experiment can be also described by the power-law term only.

*Predictions calculated from the observed dependences are shown together with the results obtained from the fits of various experimental data.*



## Conclusions

1. Transverse momentum spectra of charged particles have been considered in terms of the two component model.
2. The observed dependences have been shown to qualitatively agree with the Regge theory with the perturbative QCD pomeron.
3. The shapes of the pseudorapidity distributions also agree with that one can expect from the two component model.
4. Predictions on charged particle production at LHC have been made and tested on available experimental data.

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arxiv:1404.7302

