

Extended longitudinal scaling – LHC predictions

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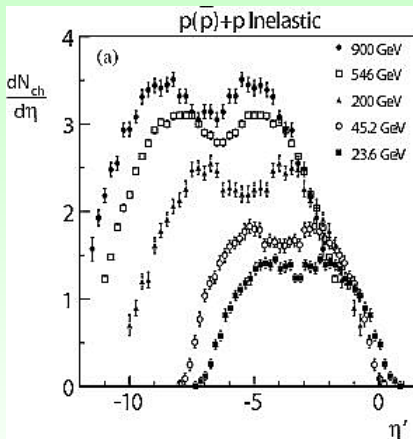
Institute of Theoretical Physics
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CERN THEORY INSTITUTE
The first heavy ion collisions at the LHC
16 August - 10 September 2010



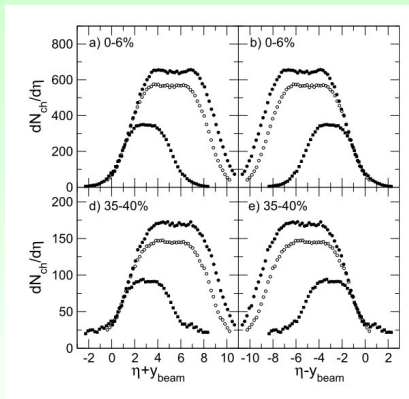
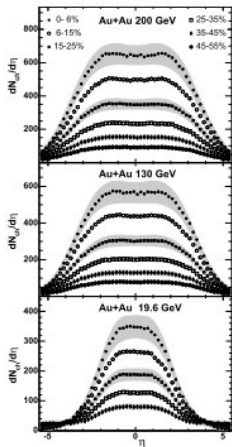
Longitudinal scaling

$\frac{dN}{dy}$ independent of energy in the rest frame of one of the colliding particles.

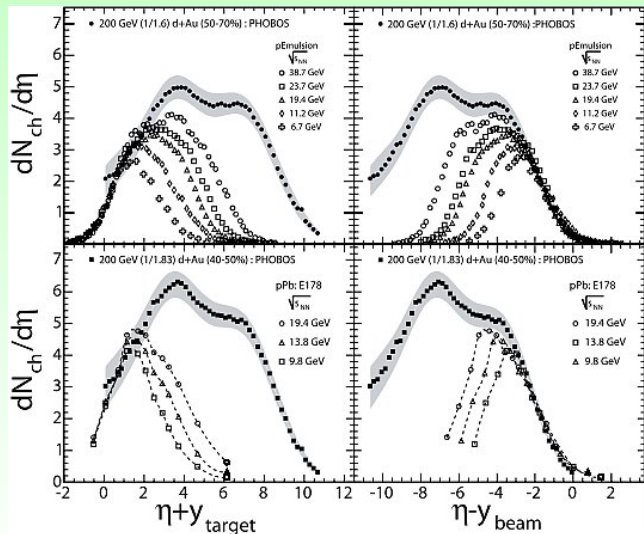


Longitudinal scaling A-A

Extended longitudinal scaling in rapidity distributions?



Longitudinal scaling p-A



Longitudinal scaling

What about LHC energies?

YES

- W. Busza Acta Phys. Polon. B **35**, 2873 (2004); J. Phys. G **35**, 044040 (2008)
- A. Bialas, A. Bzdak, R. Peschanski Phys. Lett. B **665**, 35, (2008)
- ...

NO

- P. Brogueira, J. Dias de Deus and C. Pajares, Phys. Rev. C **75**, 054908 (2007)
- J. Cleymans, J. Strumpfer and L.T. Phys. Rev. C **78**, 017901 (2008))
- ...



Central plateau

It was widely expected that the rapidity distribution of particles produced in relativistic heavy-ion collisions would show a plateau around central rapidities

It was not observed at SPS energies

It was not observed at RHIC energies

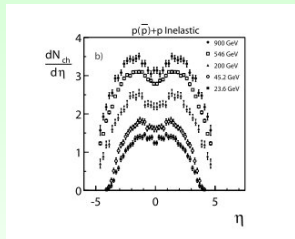


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pseudorapidity

$$\tanh \eta = \frac{P_L}{P} = \cos \theta$$

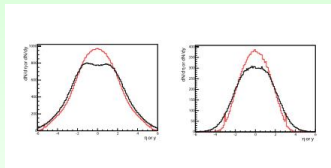
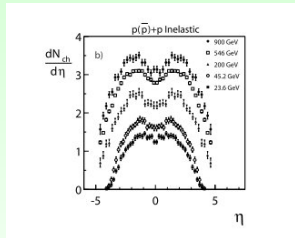


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rapidity

$$\tanh y = \frac{P_L}{E} = \beta$$



Rapidity in the thermal model

An extension to the thermal model (F. Becattini and J. Cleymans: J. Phys. G **34**, S959 (2007))

A Gaussian distribution of fireballs

$$\rho(y_{FB}) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left(-\frac{y_{FB}^2}{2\sigma^2}\right).$$

The rapidity distribution of particle i

$$\frac{dN^i}{dy} = \int_{-\infty}^{+\infty} \rho(y_{FB}) \frac{dN_1^i(y - y_{FB})}{dy} dy_{FB}.$$

The temperature and the baryonic chemical potential are related via the freeze-out curve deduced from particle yields at varying beam energies.

$$T = 0.166 - 0.139\mu_B^2 - 0.053\mu_B^4$$

J. Cleymans, H. Oeschler, K. Redlich and S. Wheaton

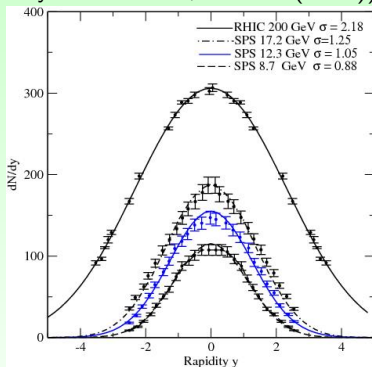
Phys. Rev. C **73**, 034905 (2006)

and rapidities: $\mu_B = 0.237 + 0.011y_{FB}^2$



Rapidity in the thermal model

(J. Cleymans, J. Strumpfer and L.T.
Phys. Rev. C **78**, 017901 (2008))

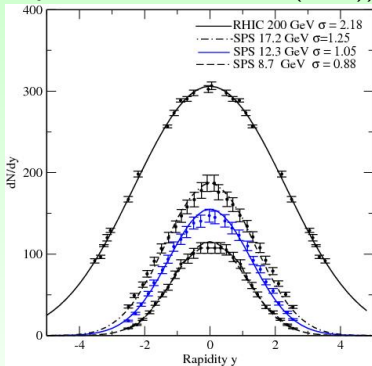


The pion rapidity spectra used to
fit the Gaussian fireball
distribution

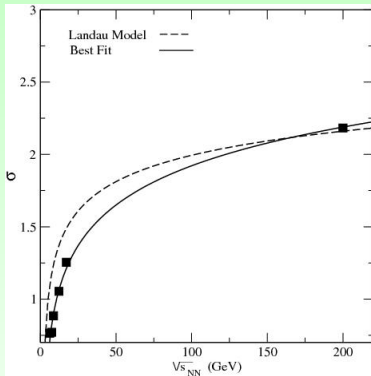


Rapidity in the thermal model

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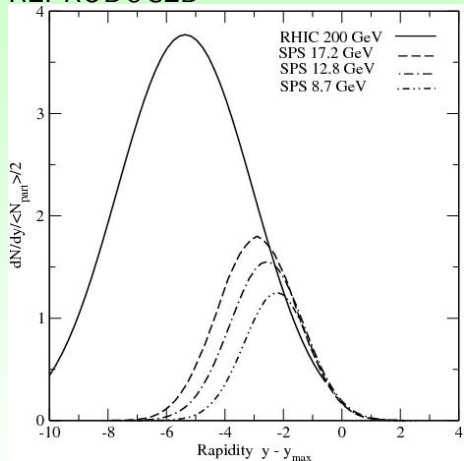
Energy dependence of the distribution width

The Landau model

$$\sigma^2 \approx \ln \sqrt{s_{NN}} / 2m_P$$

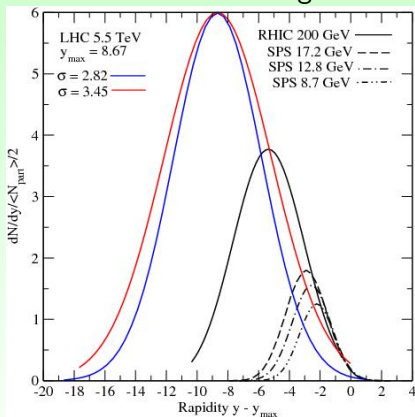
Longitudinal scaling – till RHIC

REPRODUCED



Longitudinal scaling– beyond RHIC

VIOLATED: extended longitudinal scaling is not expected at LHC energies



the fitted curve

$$\sigma_{LHC} = 3.45$$

the Landau model

$$\sigma = 2.82$$

