

Matter Effects at SPS energies

What we can learn about stopping from the
system size dependence of
net baryon rapidity distributions.

H. Ströbele, Univ. Frankfurt
for the NA49 collaboration

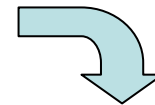
Outline

- **Motivation and perspectives**
- **The data:**
 - **Centrality selected net proton (d, ^3He) distributions from min bias Pb+Pb collisions at 40 and 158 GeV/nucleon (new NA49 data).**
 - **Net proton distributions from $p+p \Rightarrow p + X$ at 158 GeV/c as reference (new NA49 data).**
 - **Some AGS and RHIC data for comparison**
- **Resume**

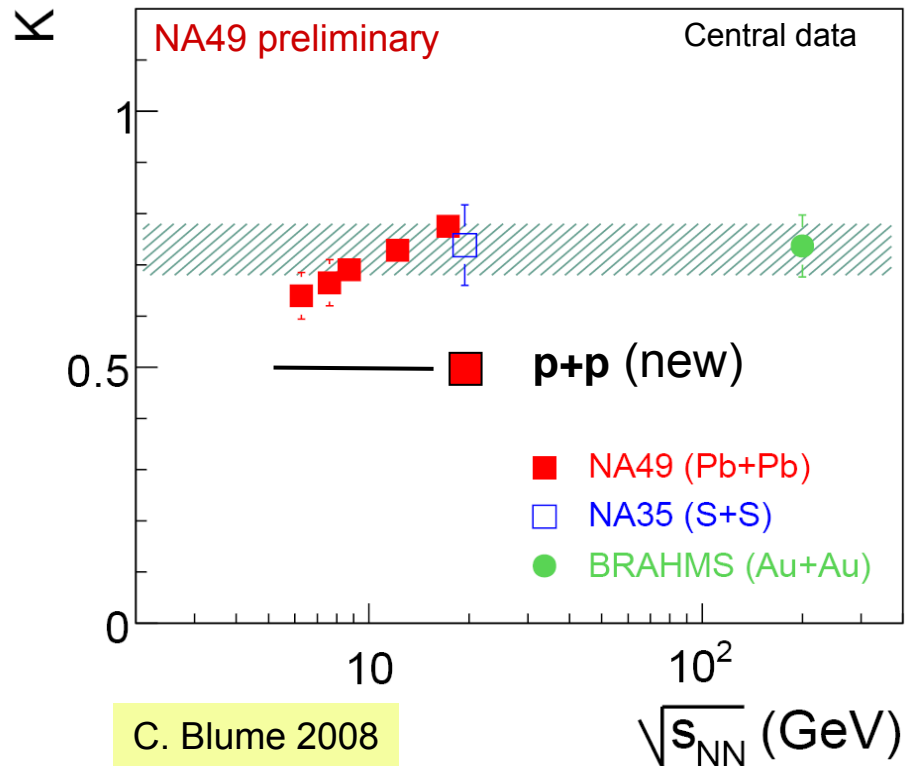
Motivation (I)

Stopping in A+A versus p+p

- Mean rapidity shift of incident nucleons
- inelasticity (K) a measure of energy loss
- **shape change of dn/dy of net nucleons**

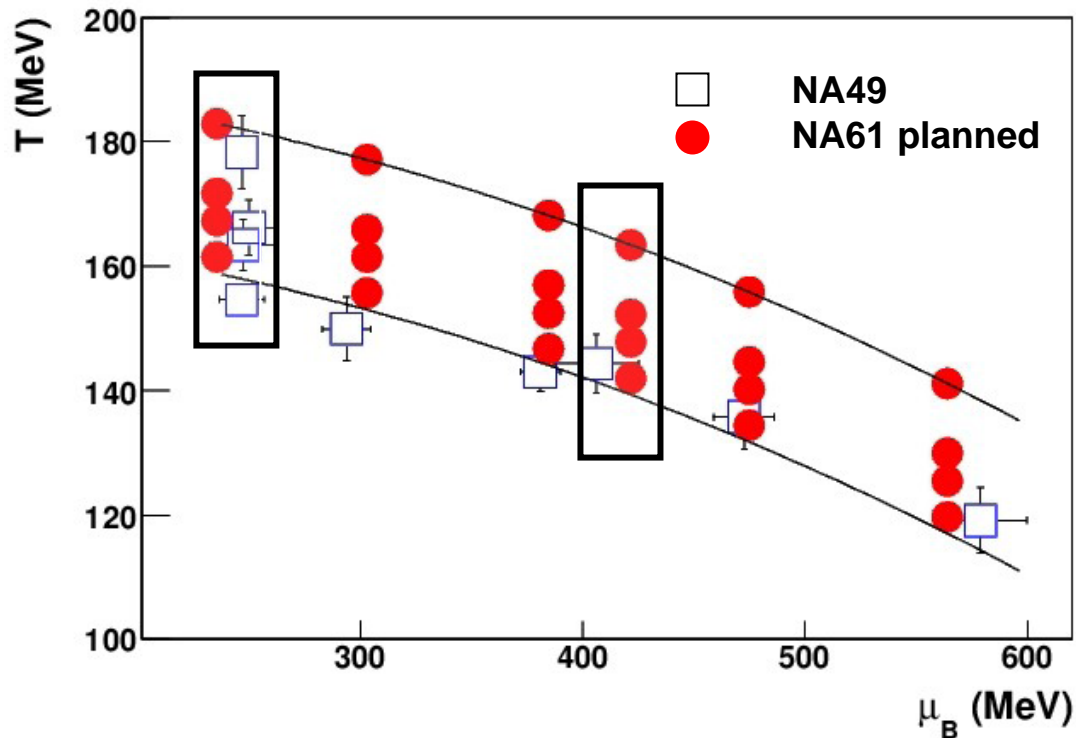


$$K = E_{\text{inel}} / (\sqrt{s}/2 - m_p)$$



Motivation (II)

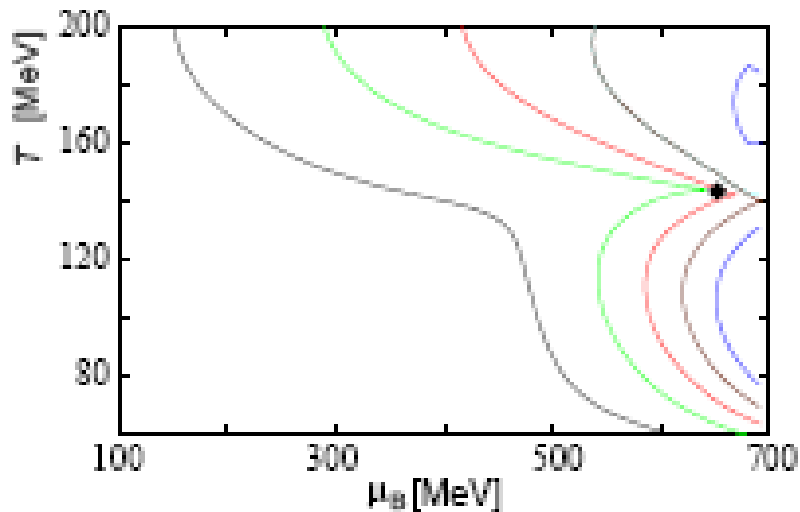
Freeze-out points in the T - μ_B plane at different energies and for different system sizes (NA61 strategy, but here for centrality selected Pb+Pb collisions and only two energies).



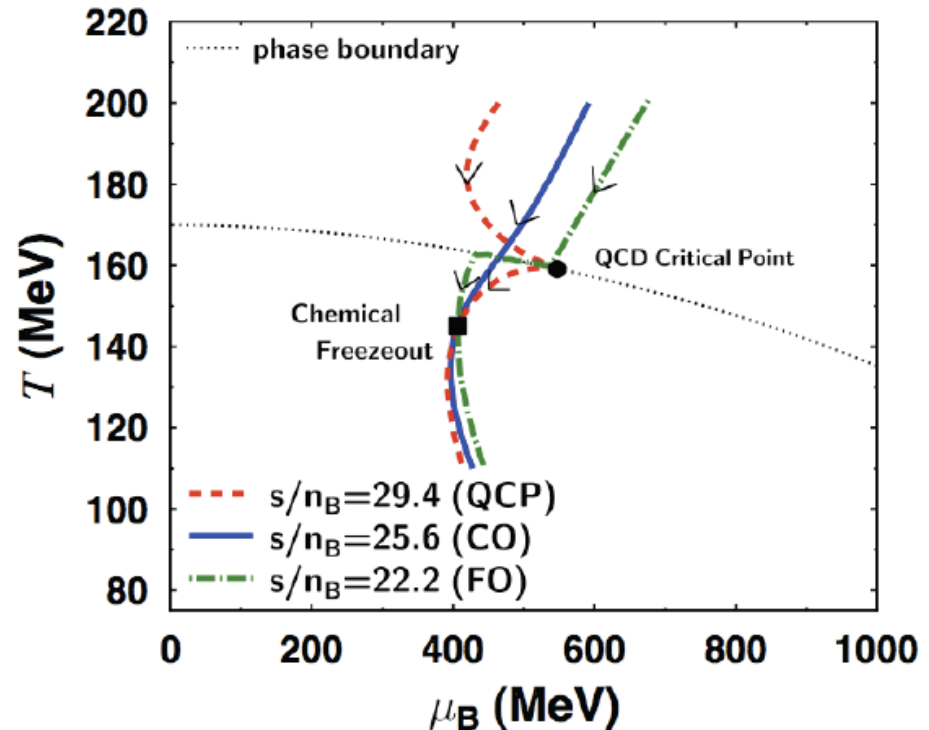
No centrality dependence of μ_B predicted by SHM, Becattini, Manninen, Gazdzicki.
hep-ph/0511092

Perspective

Hydrodynamics predicts focusing of the system trajectories close to the critical point, which may be observed by studying T and μ_B as function of system size (or centrality).

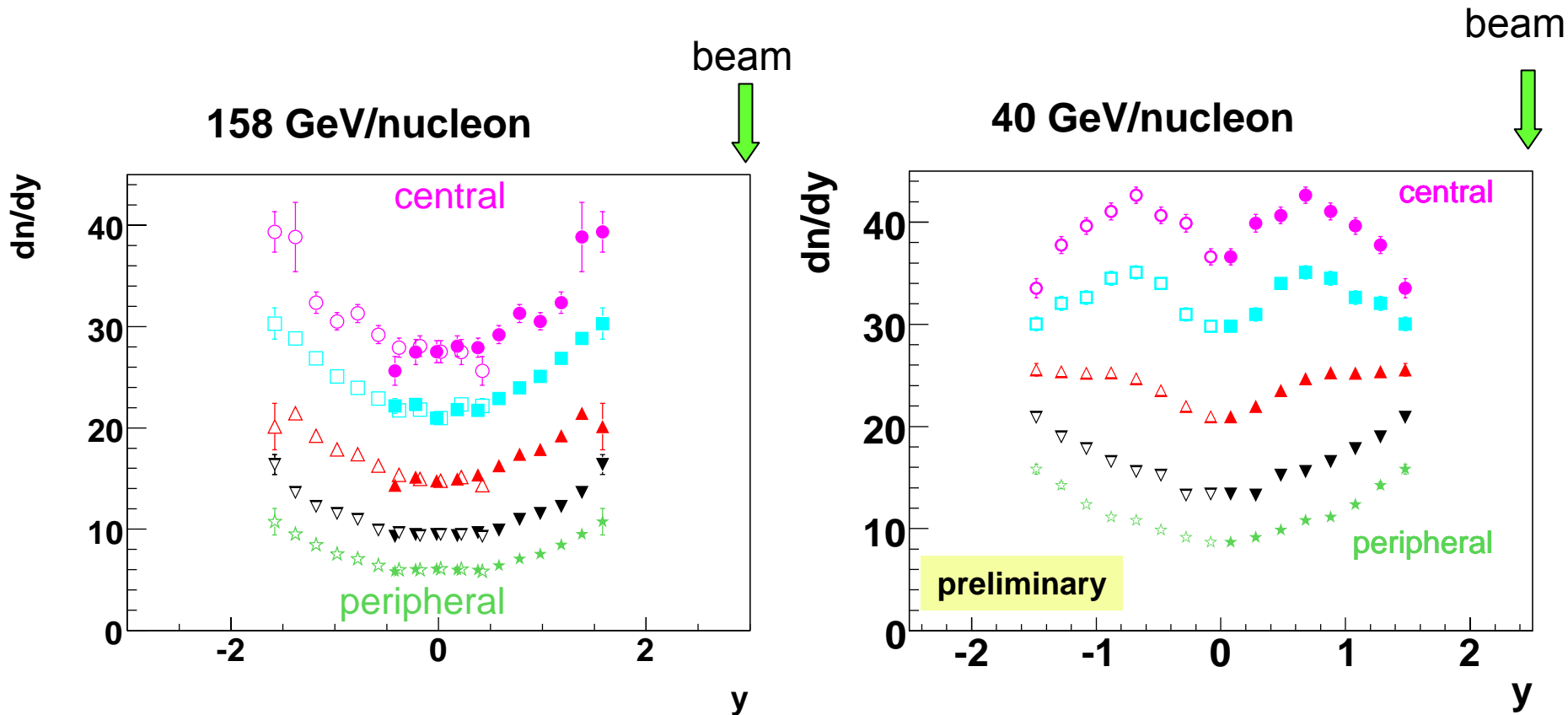


Nonaka, Asakawa, nucl-th/0410078



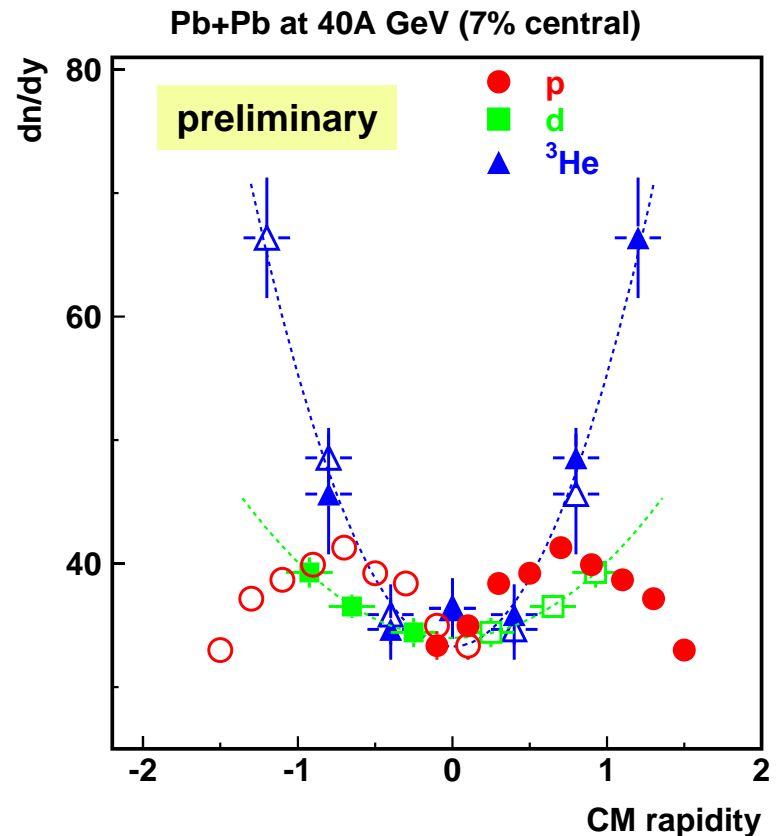
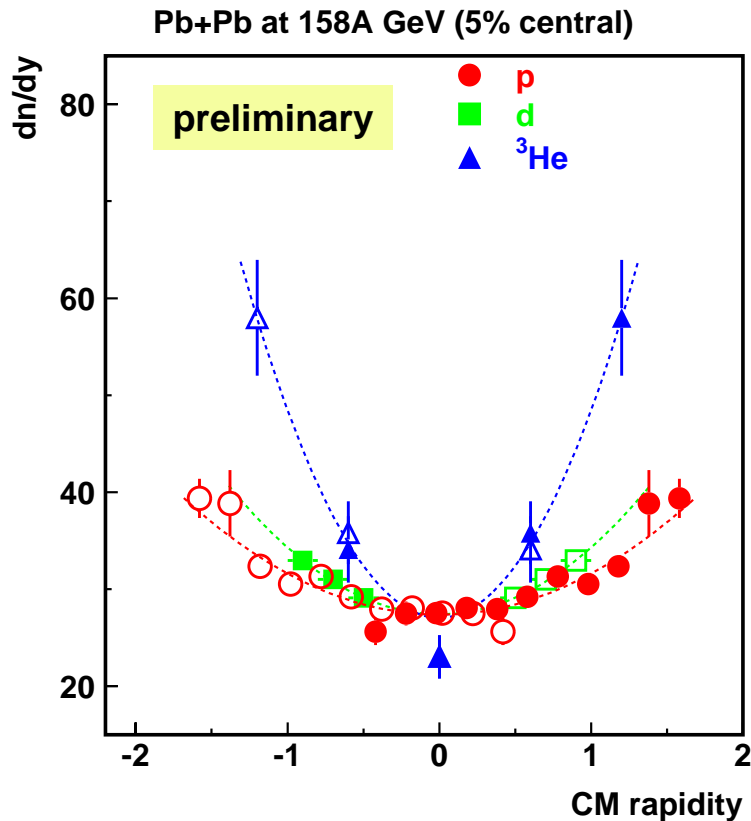
The (new NA49) data

dn/dy of **net protons** in Pb+Pb at different centralities



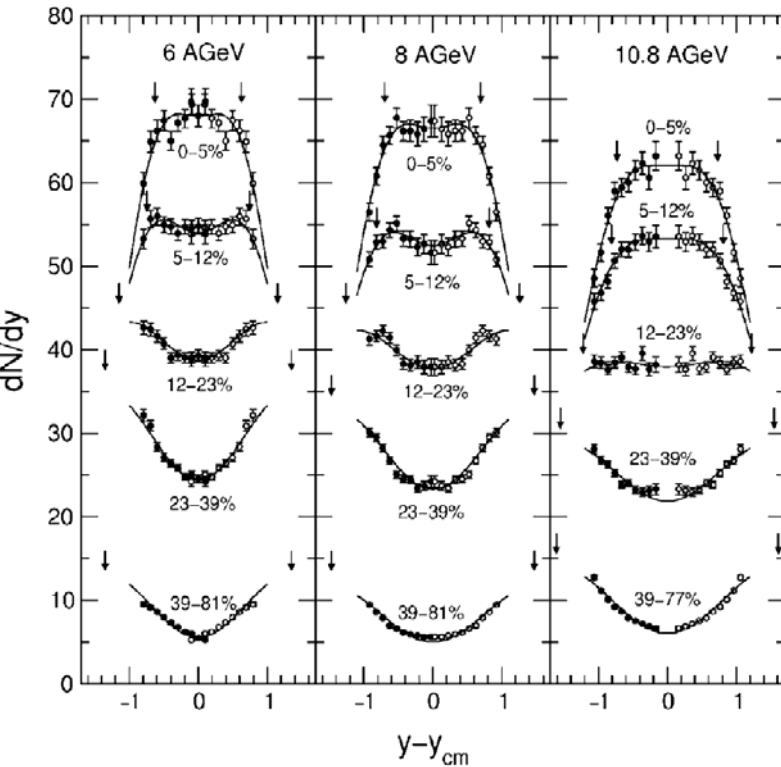
The (new NA49) data

dn/dy of **net protons, d, and ^3He** in central Pb+Pb
at 158 and 40 GeV/nucleon

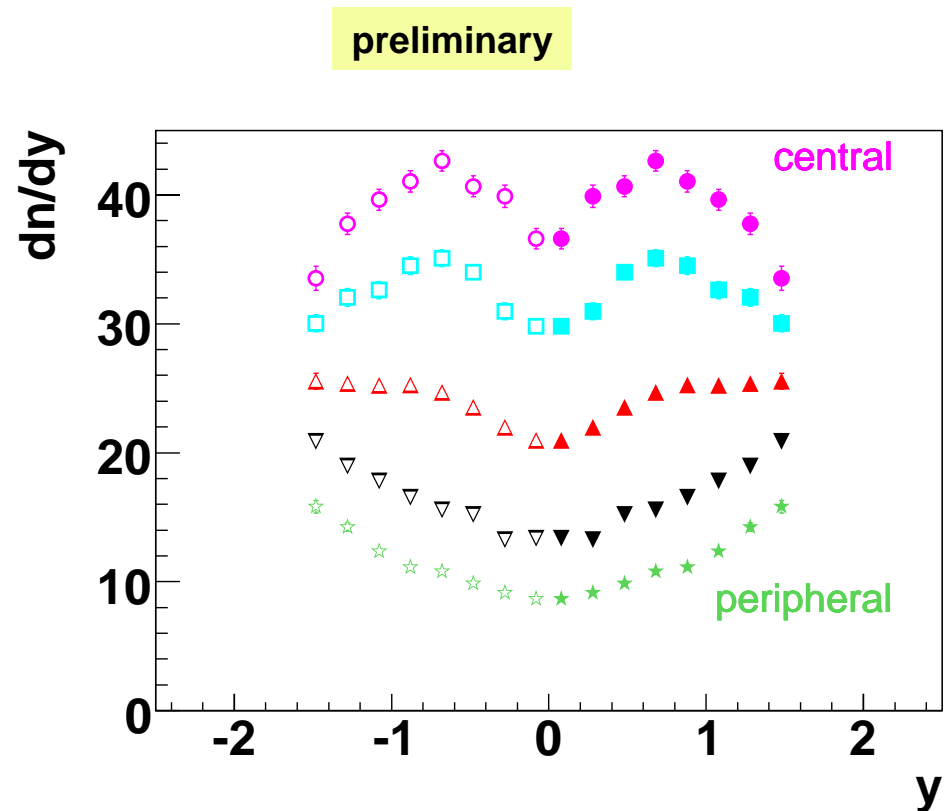


Comparison to AGS

AGS data (Au+Au)



NA49 data (40 GeV/nucleon Pb+Pb)

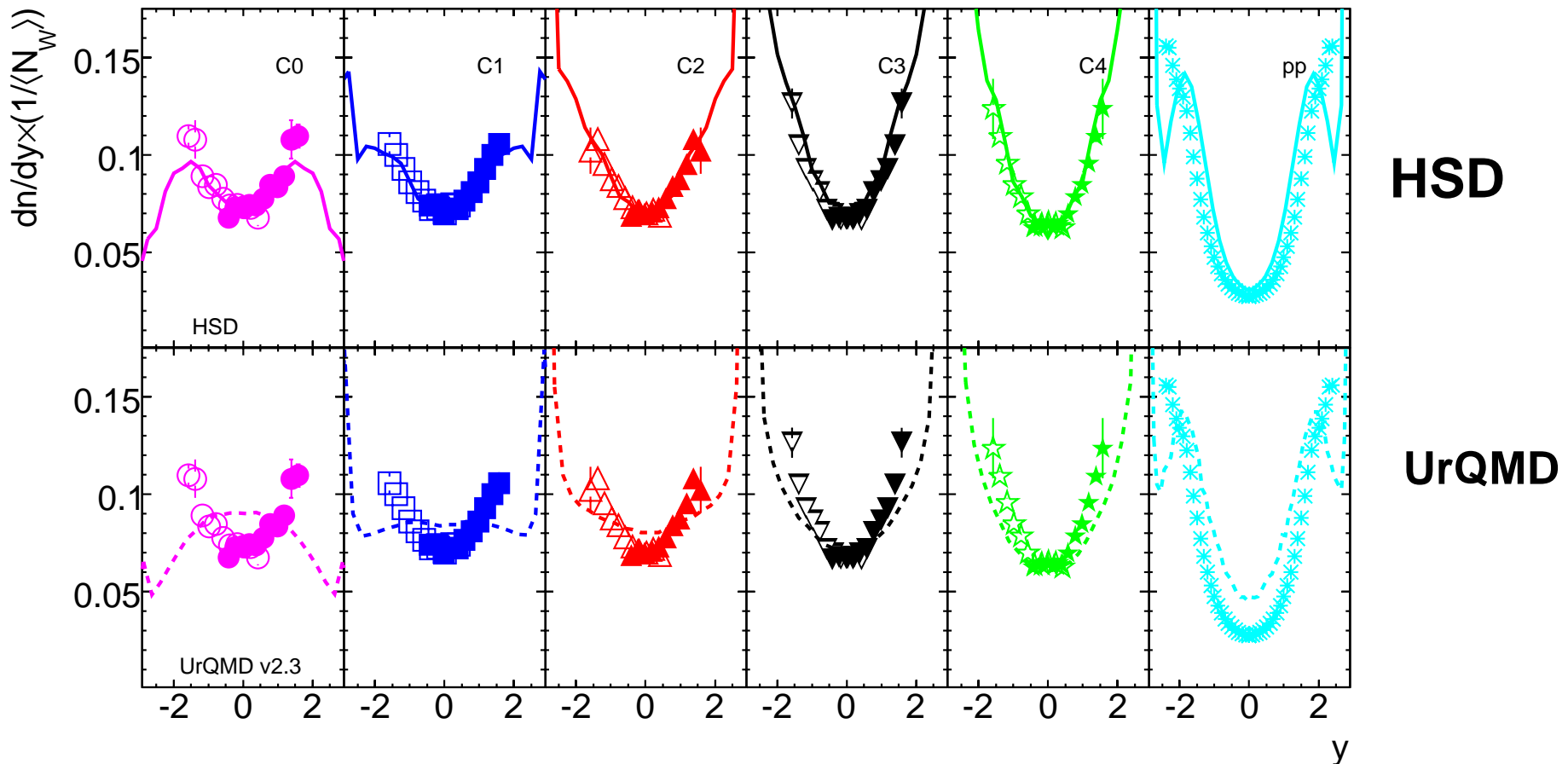


(Back et al., PRL86(2001)1970)

CPOD @BNL June 2009
H. Ströbele, Uni. Frankfurt

No midrapidity plateau at 40 GeV/nucleon?

Comparison to transport models (normalized, 158 GeV/nucleon data)



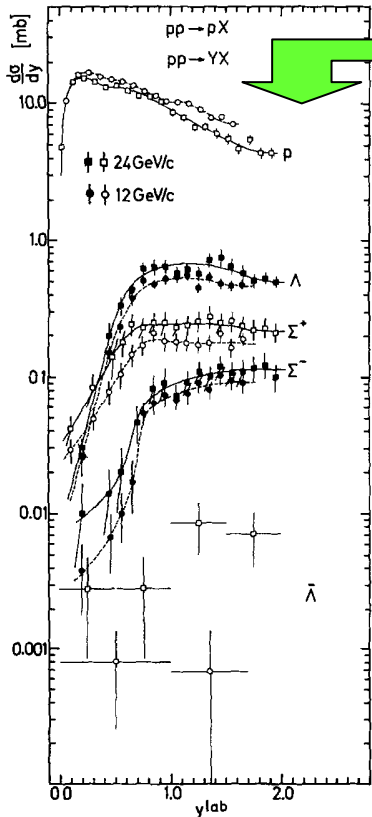
p+p collision data

12, 24 GeV/c,

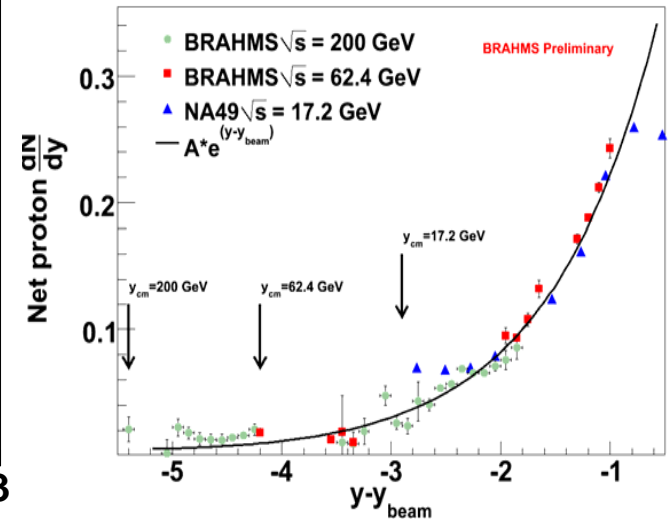
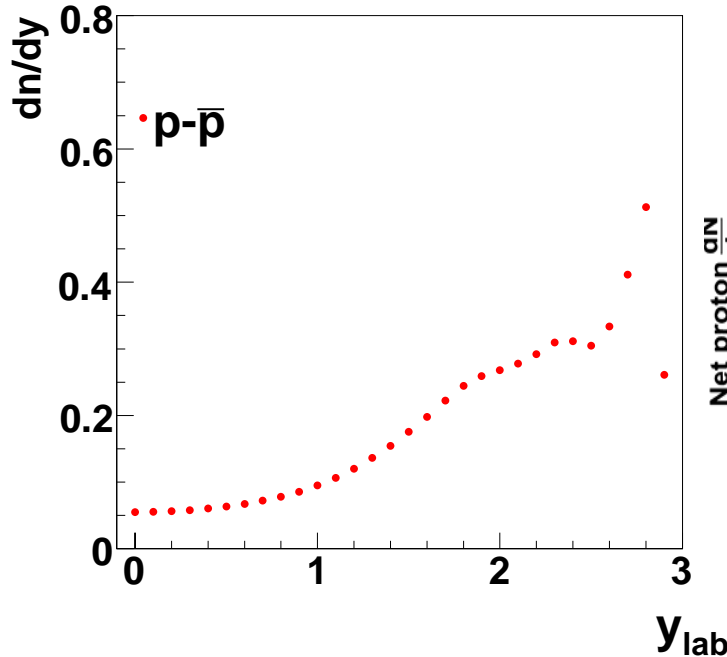
158 GeV/c (new!),

and

RHIC data



midrapidity

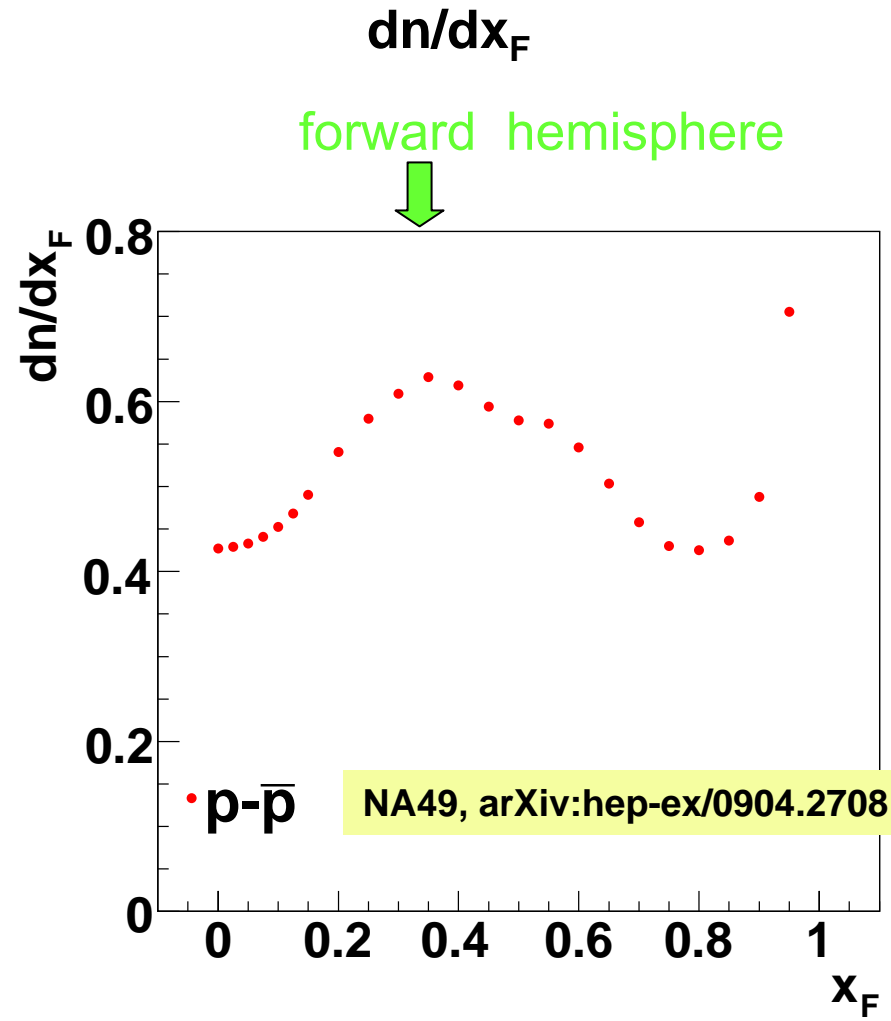
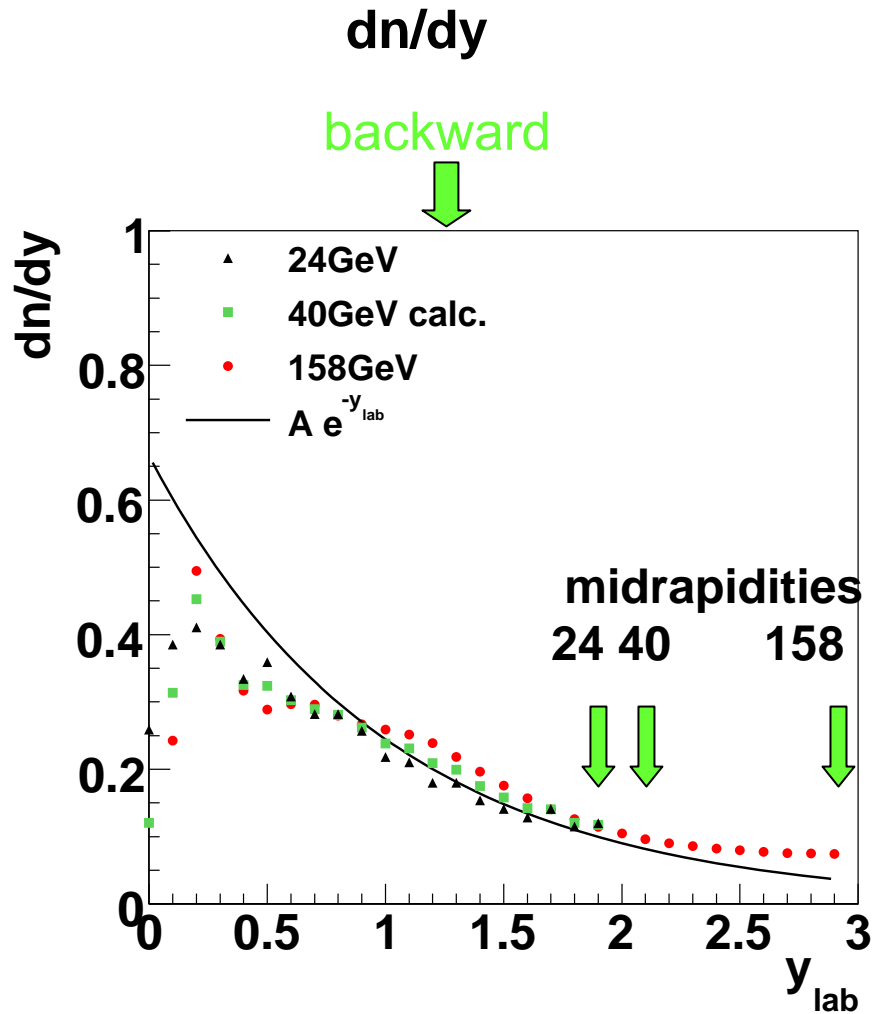


Blobel et al., NPB69,454

NA49, arXiv:hep-ex/0904.2708

Dalsgaard, QM09

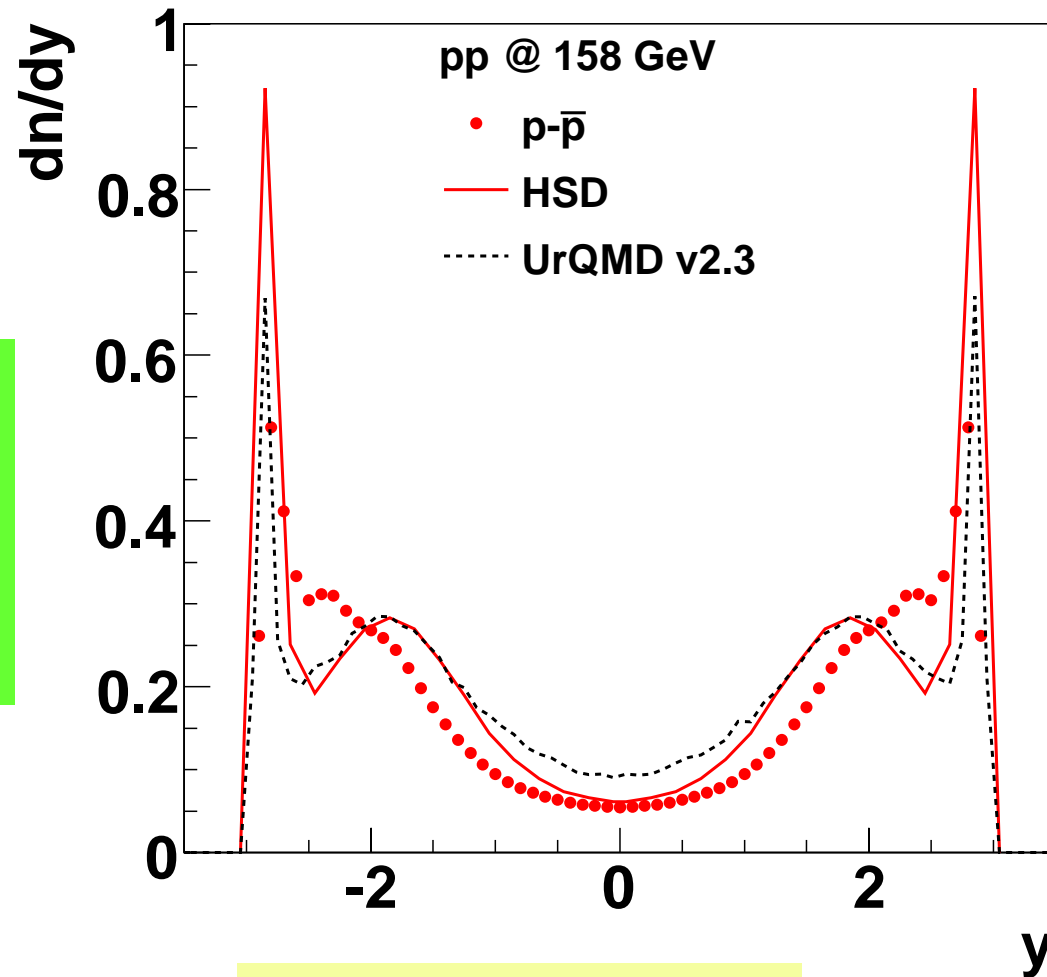
p+p collision data



Comparison to transport models

(158 GeV/c p+p data)

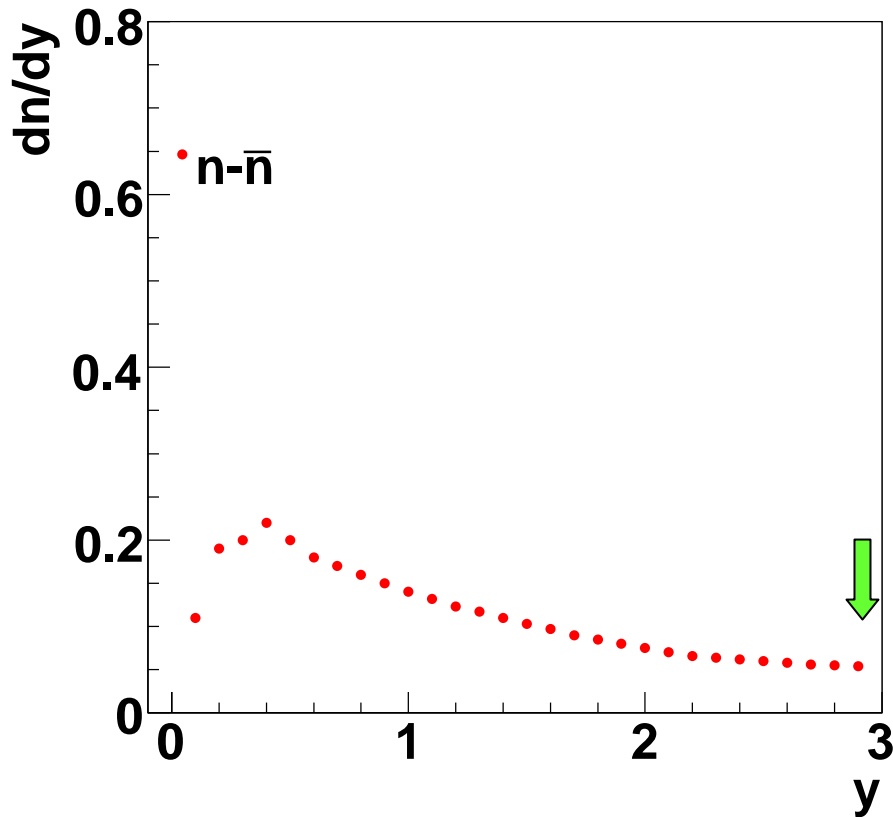
Significant differences in the region, where the energy loss per unit of rapidity is highest. Homework for the model experts.



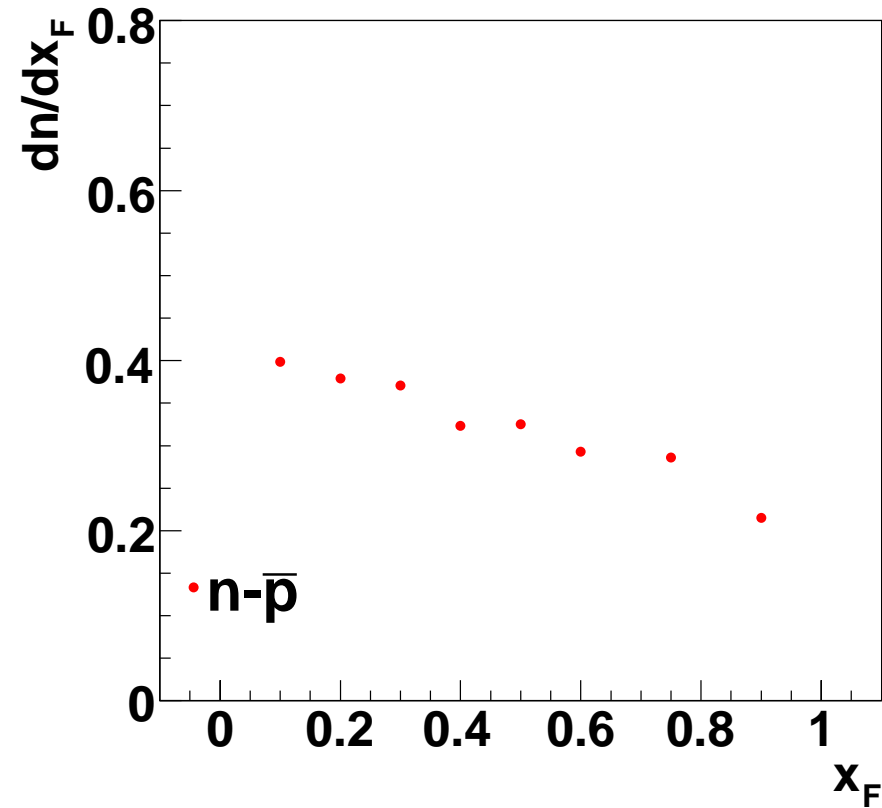
p+p collision data

neutrons (-antiprotons)

dn/dy (computed)



dn/dx_F

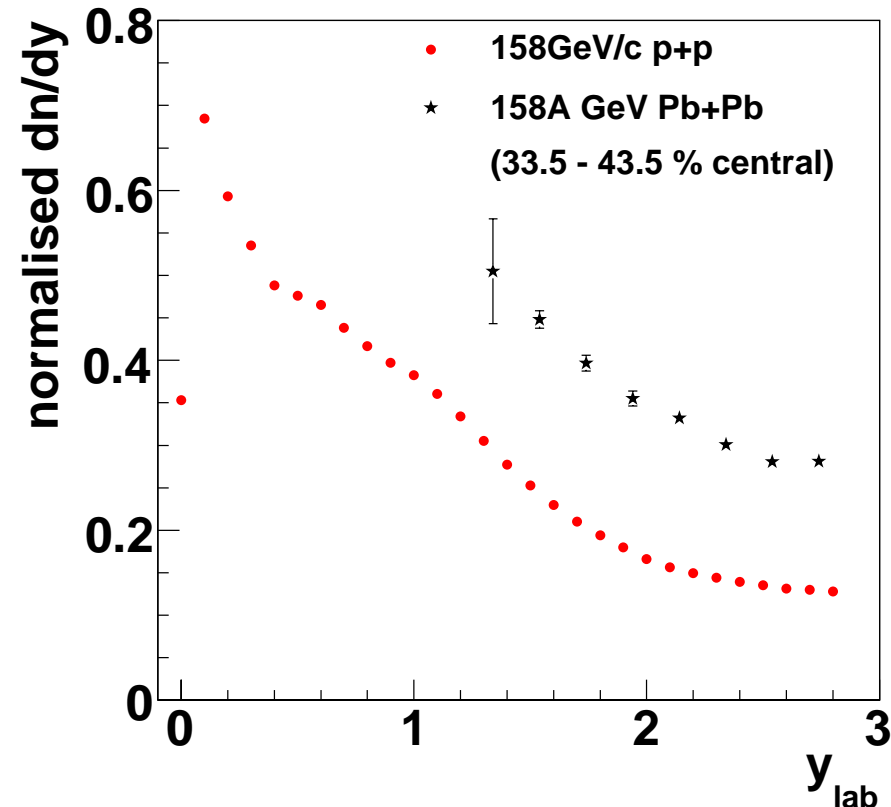
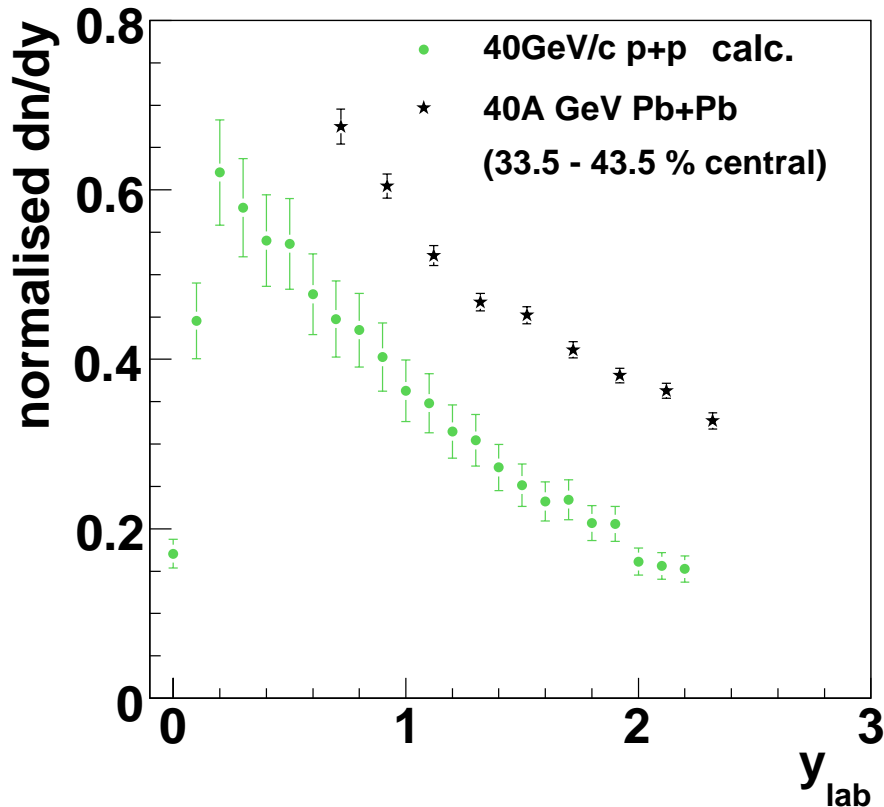


The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon

158 GeV/nucleon

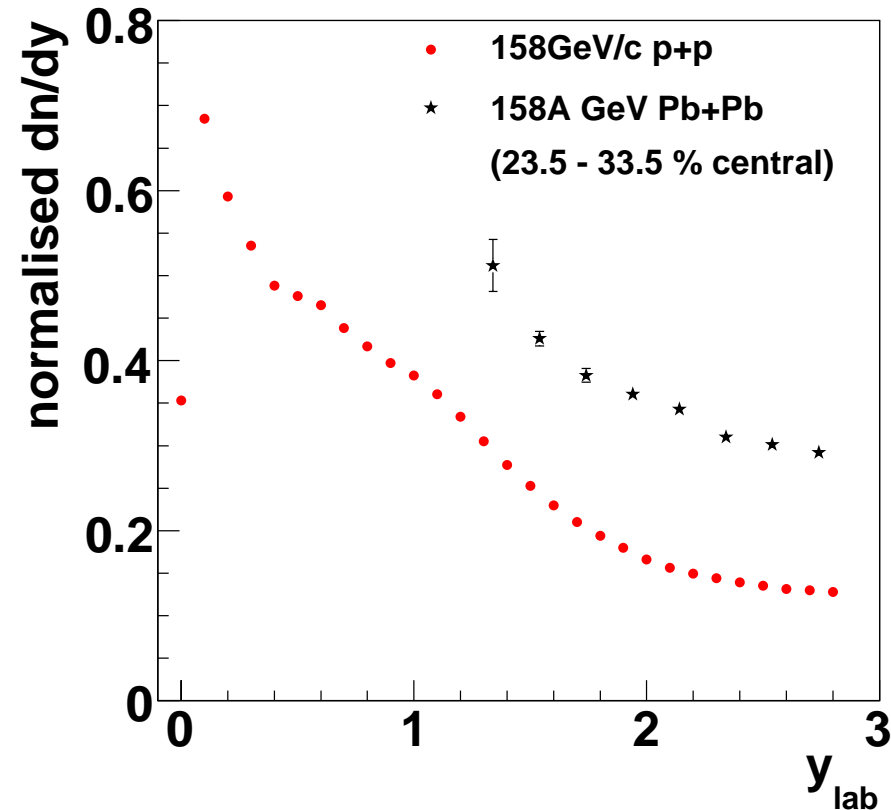
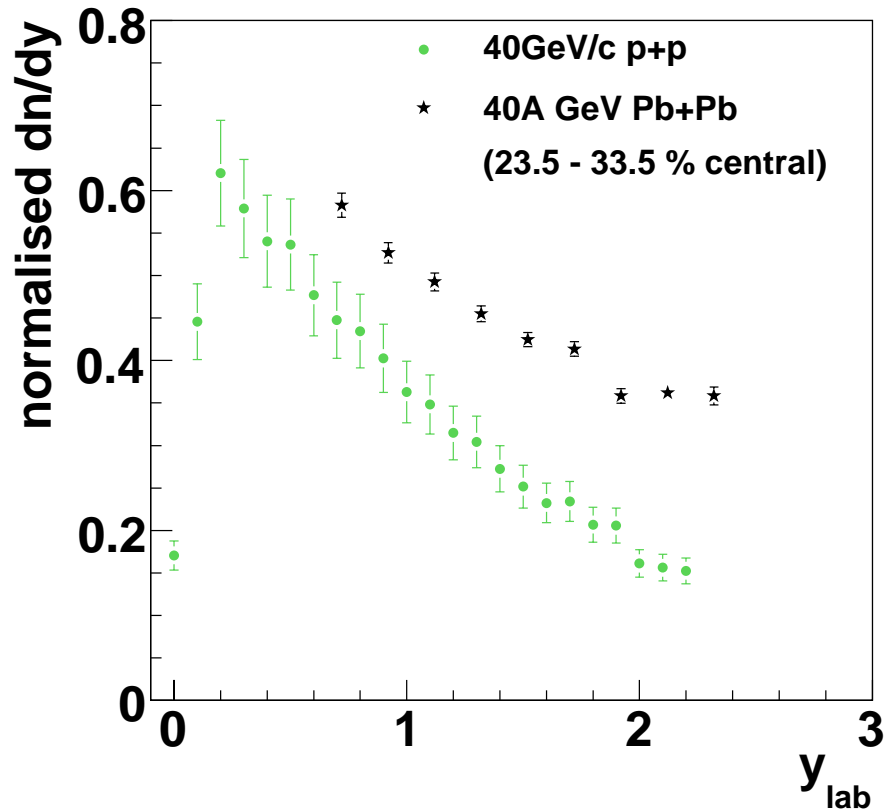


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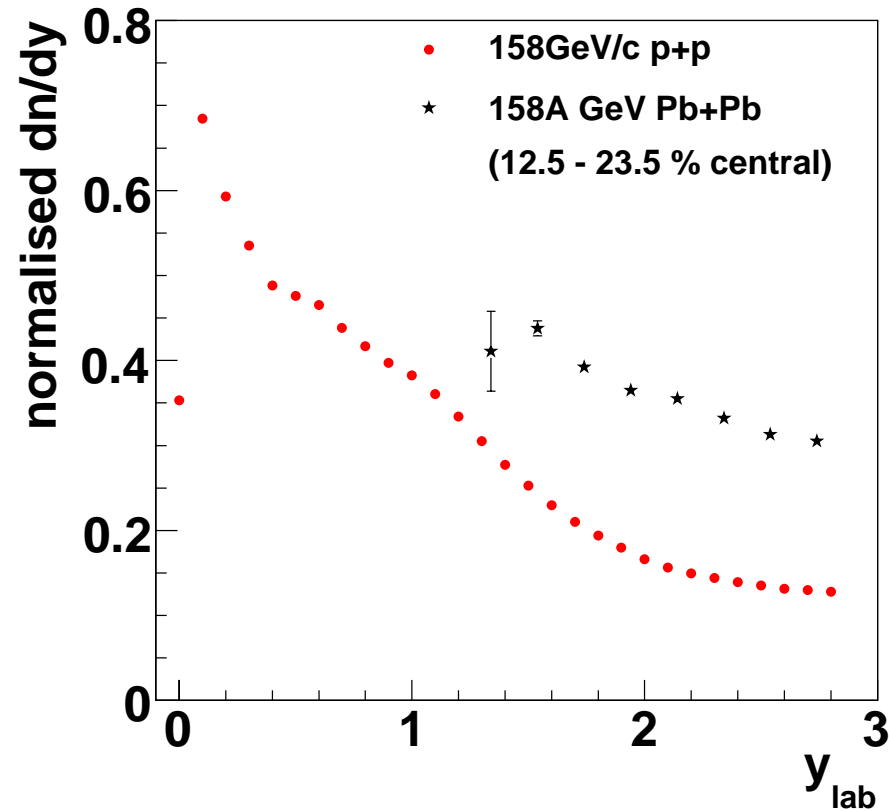
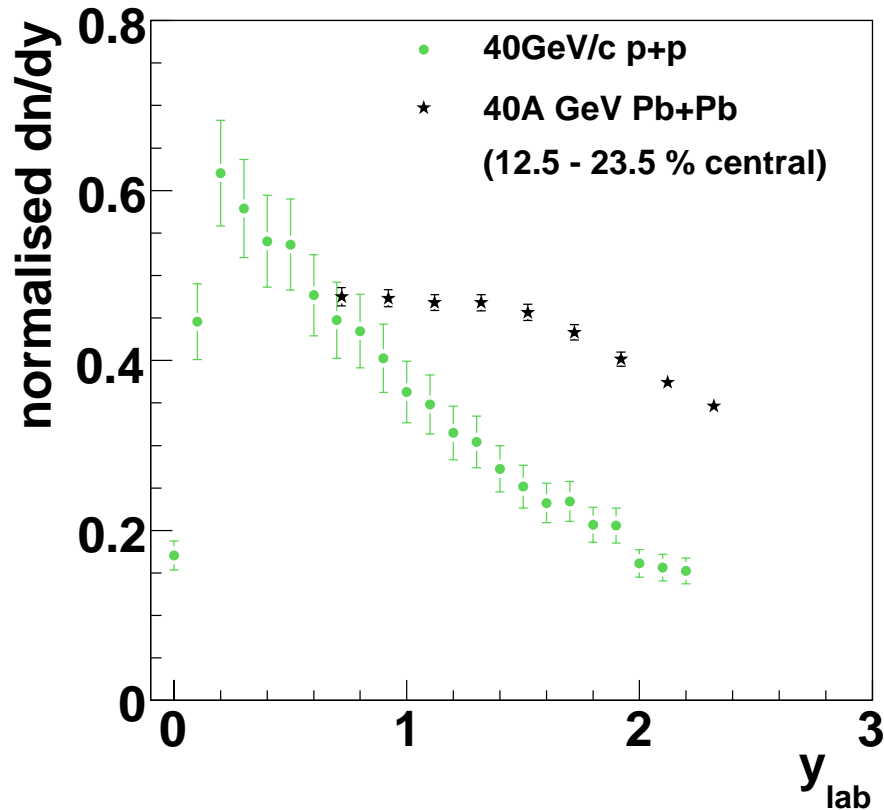


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158 GeV/nucleon

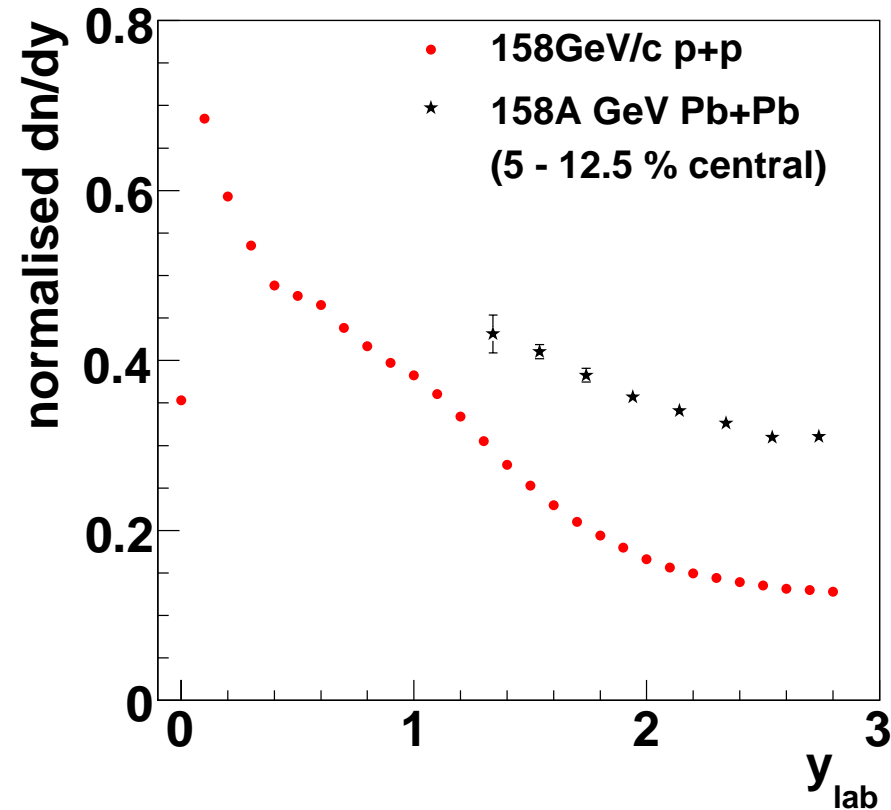
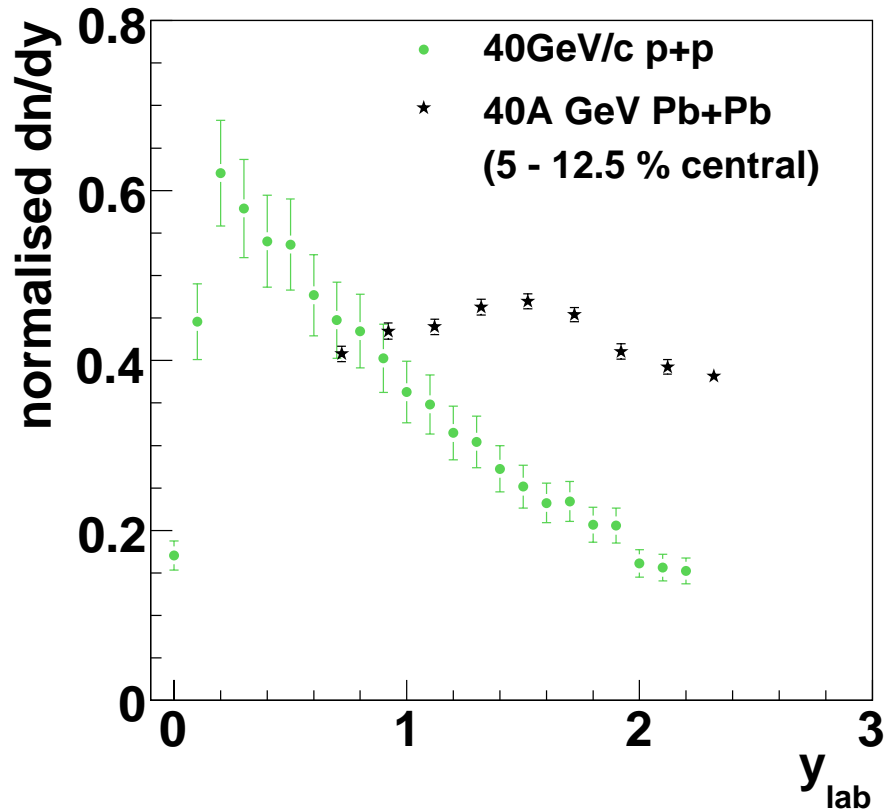


The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon

158 GeV/nucleon

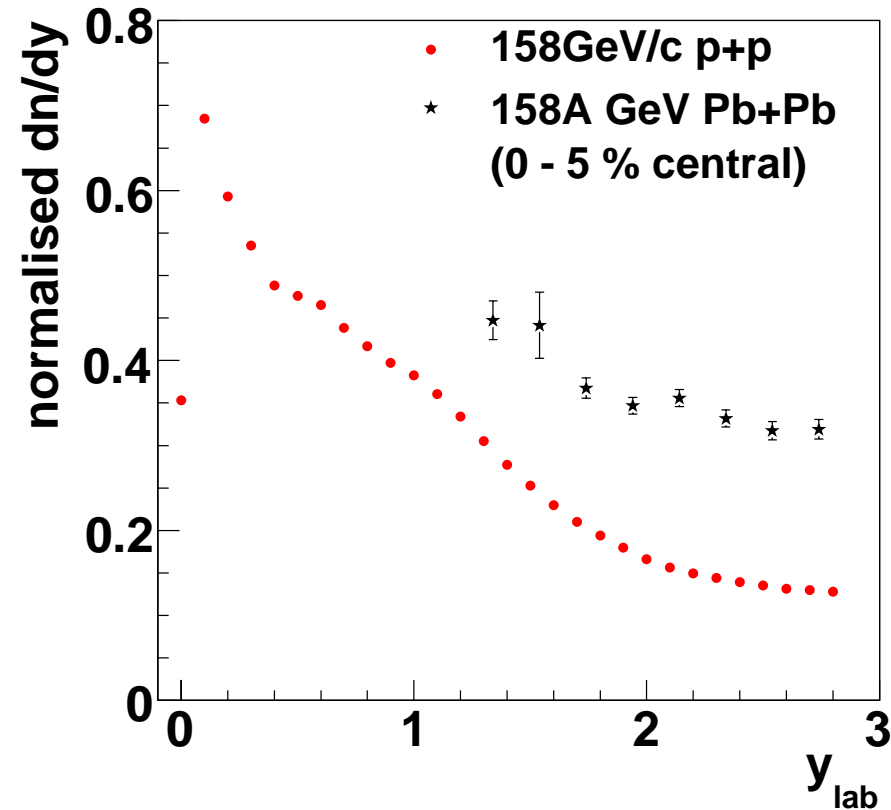
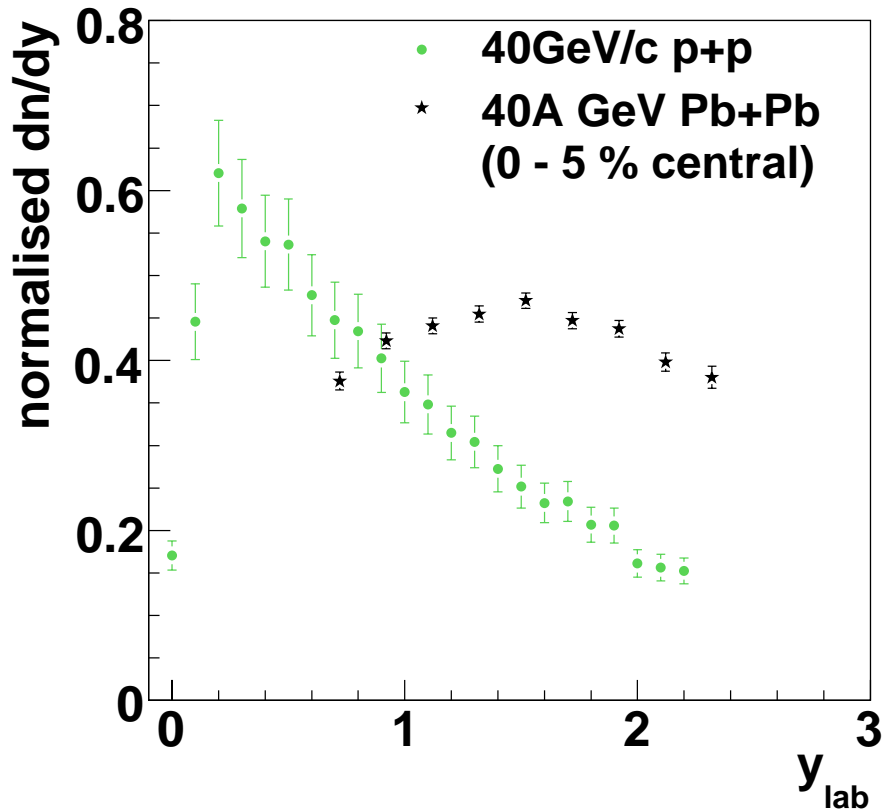


The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon

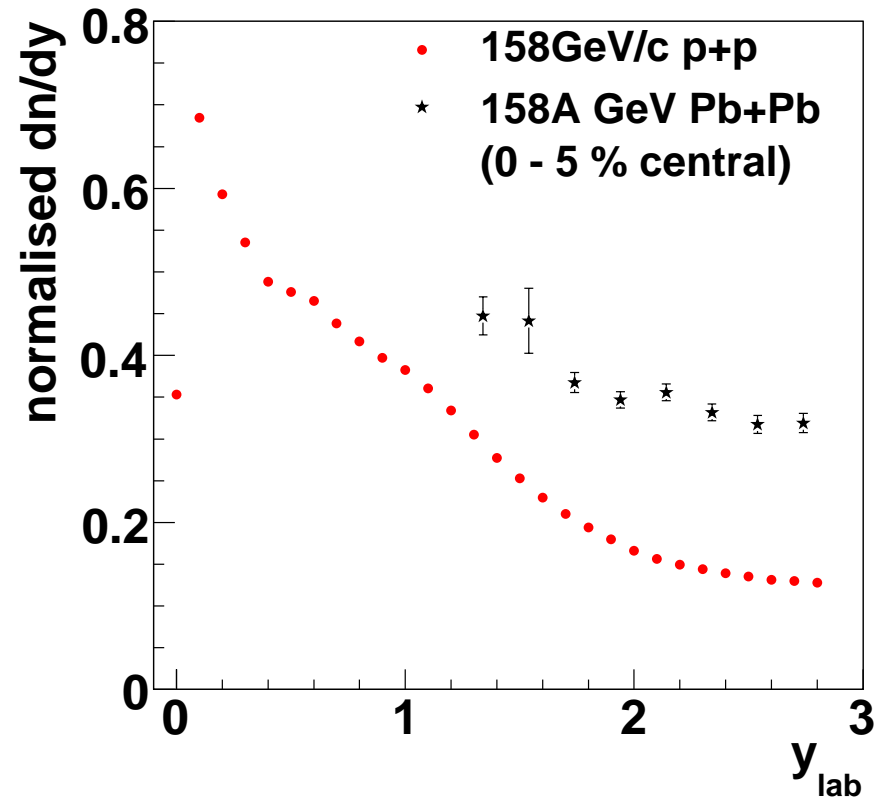
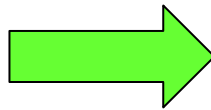
158 GeV/nucleon



The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

Little or no change in shape with centrality **in the acceptance** .
Only the integral varies, as does number of wounded nucleons.

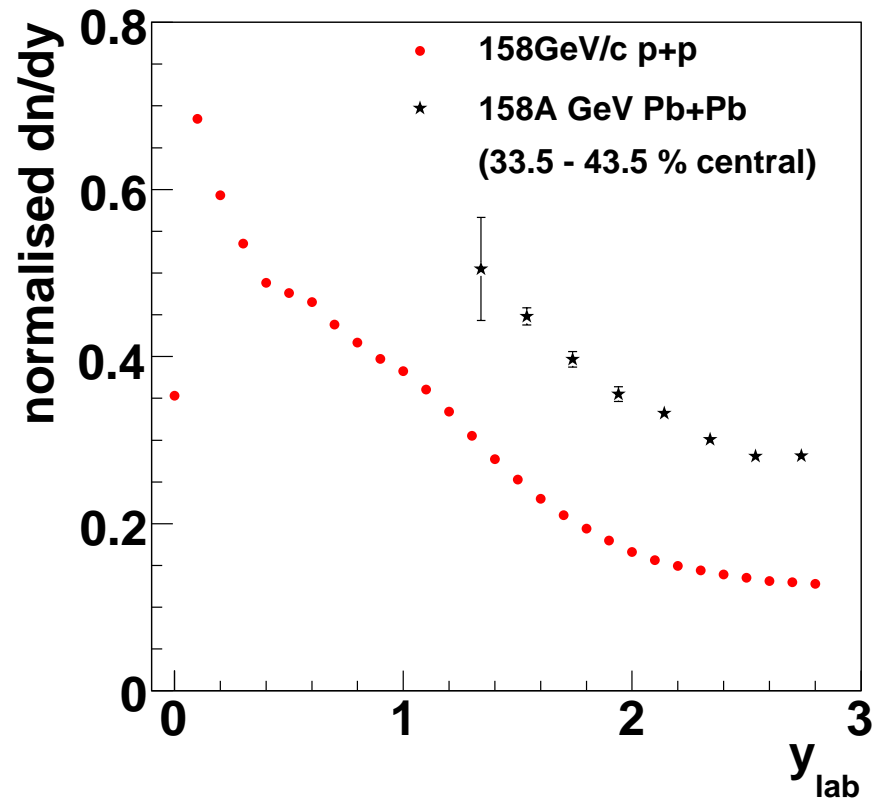
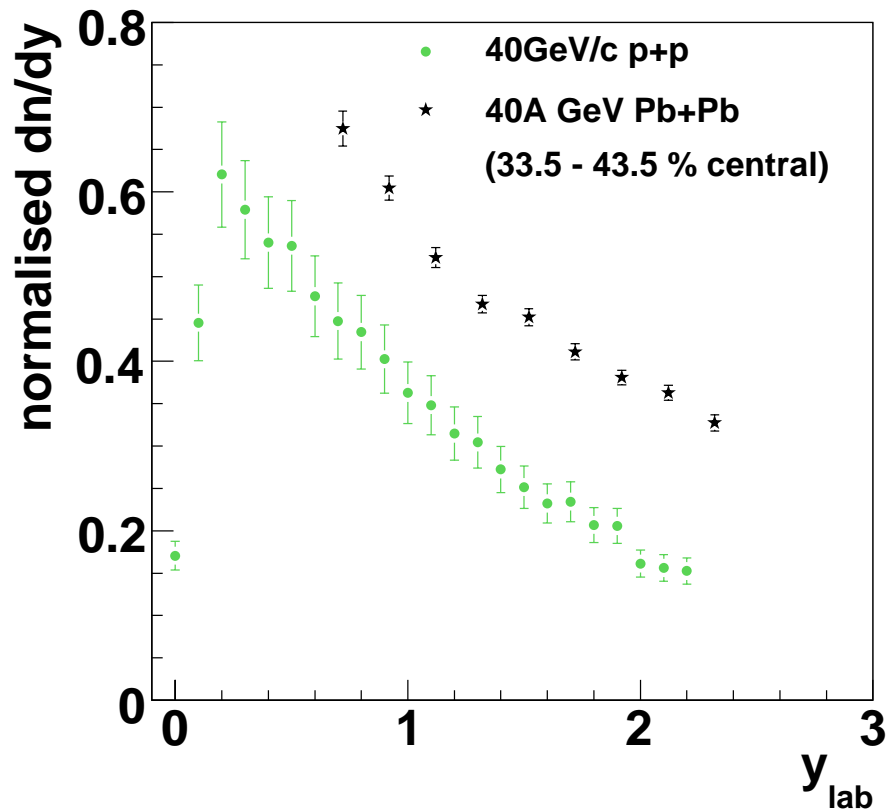


The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon

158 GeV/nucleon

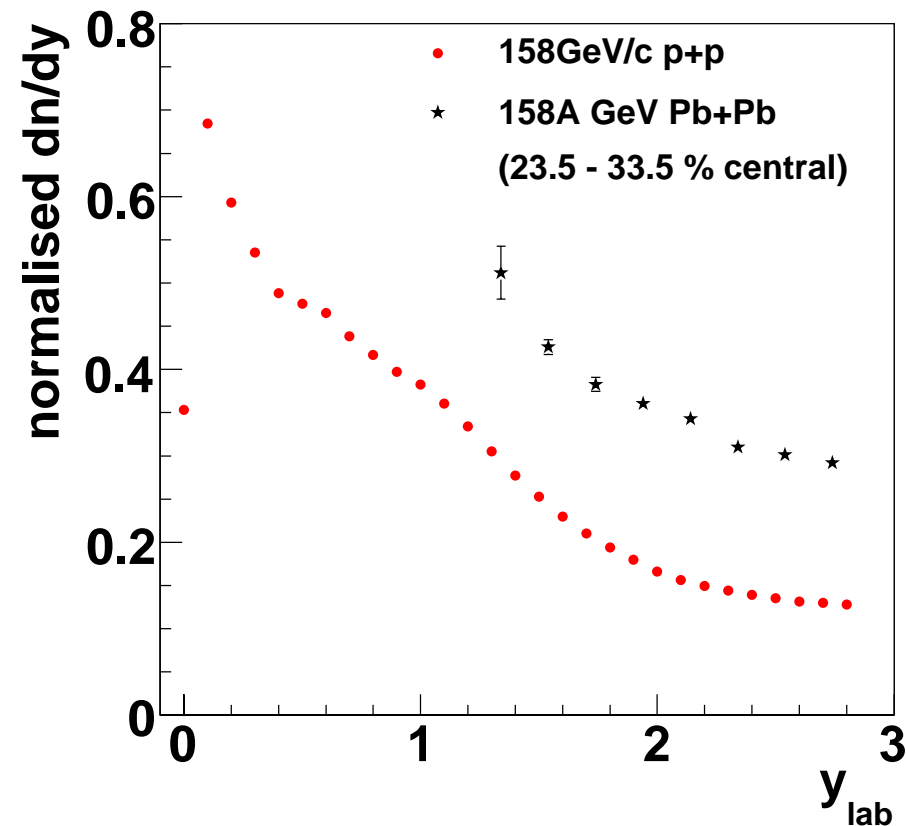
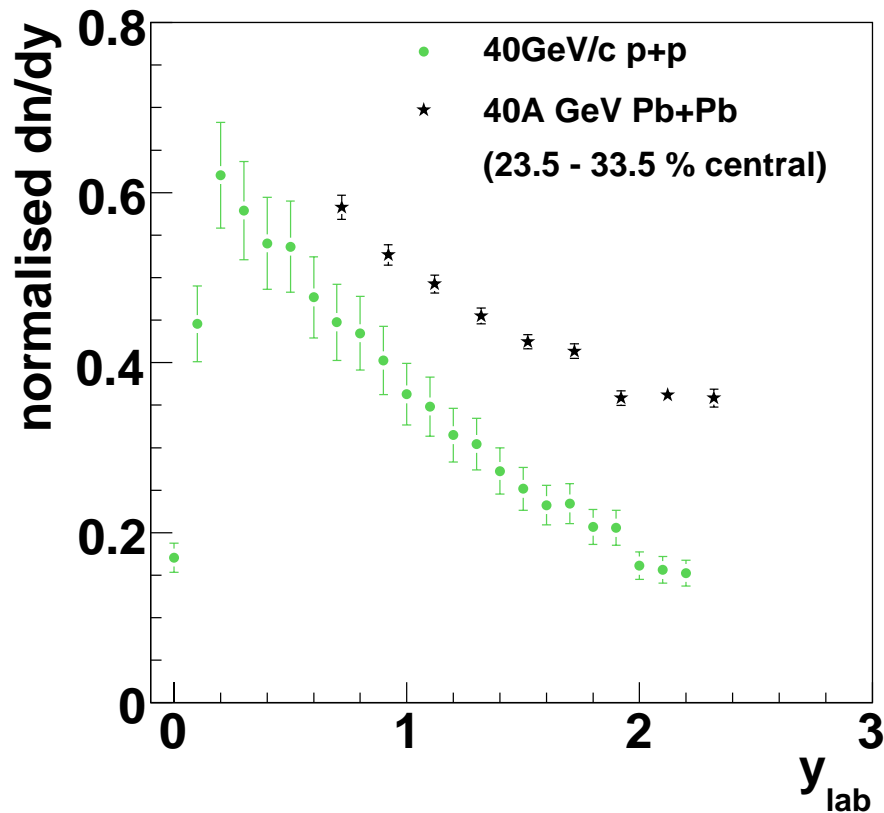


The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon

158 GeV/nucleon

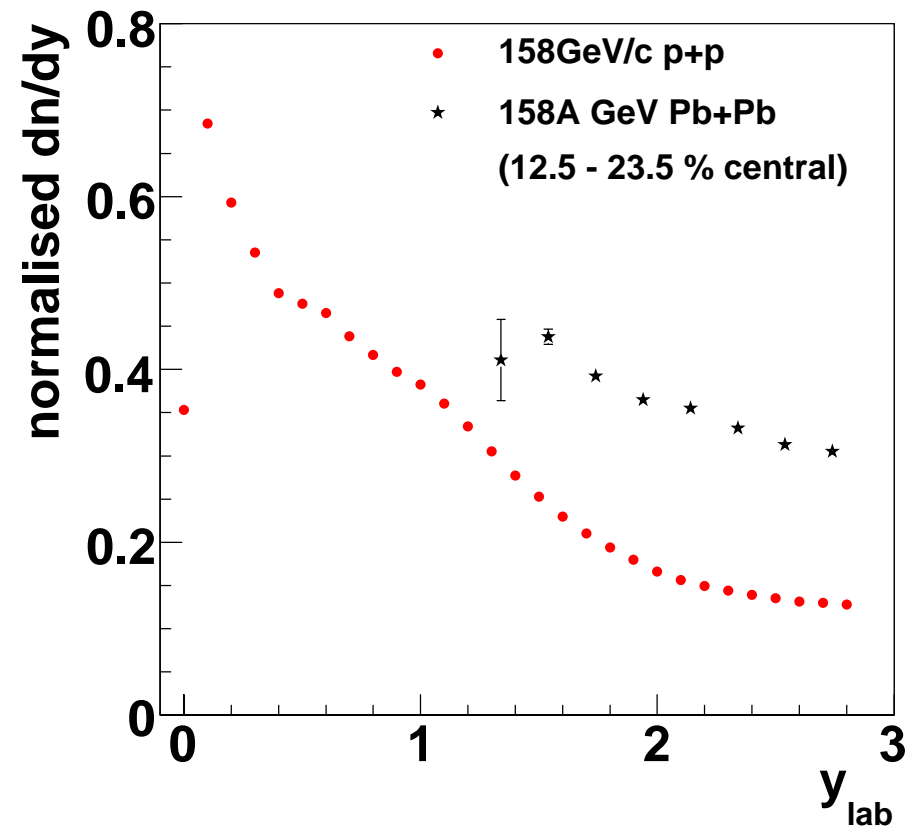
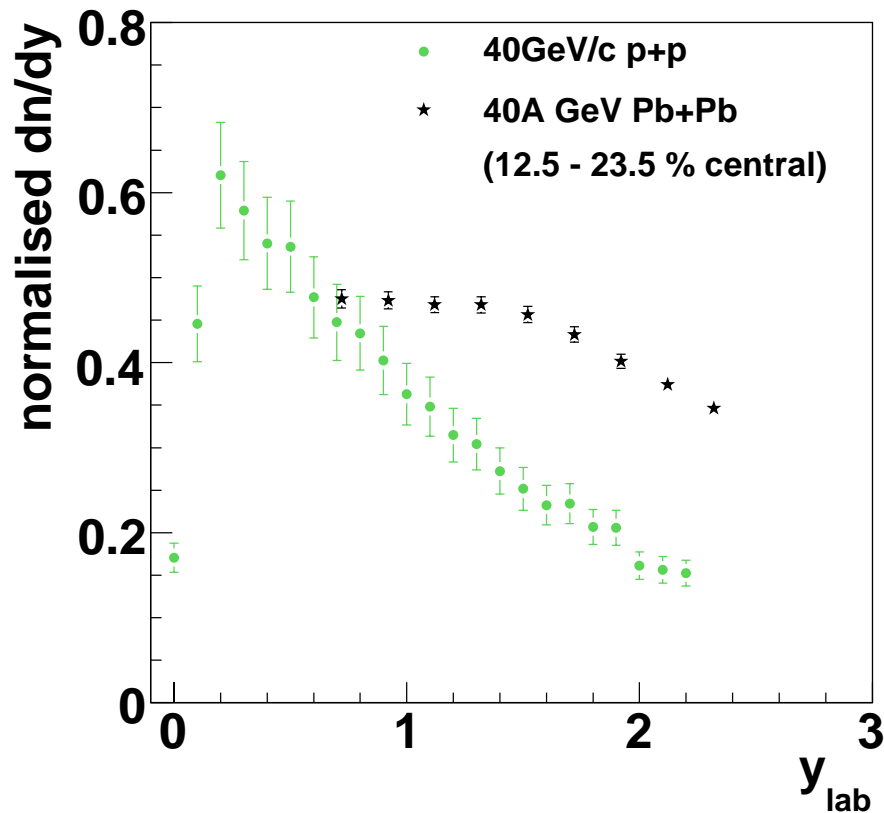


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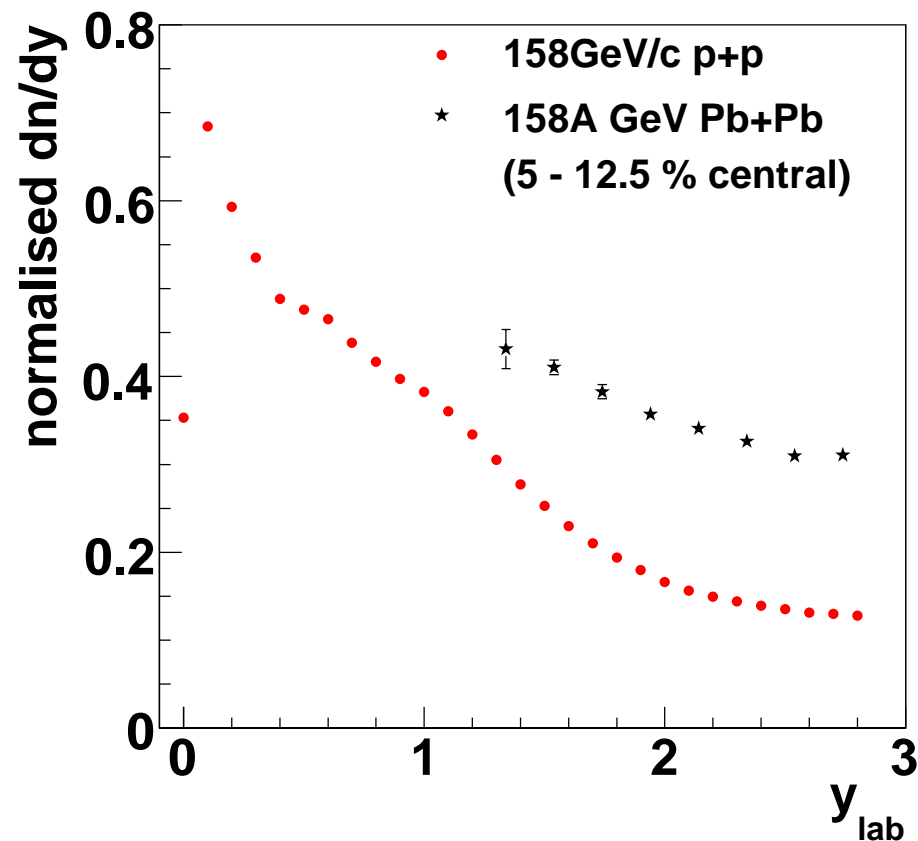
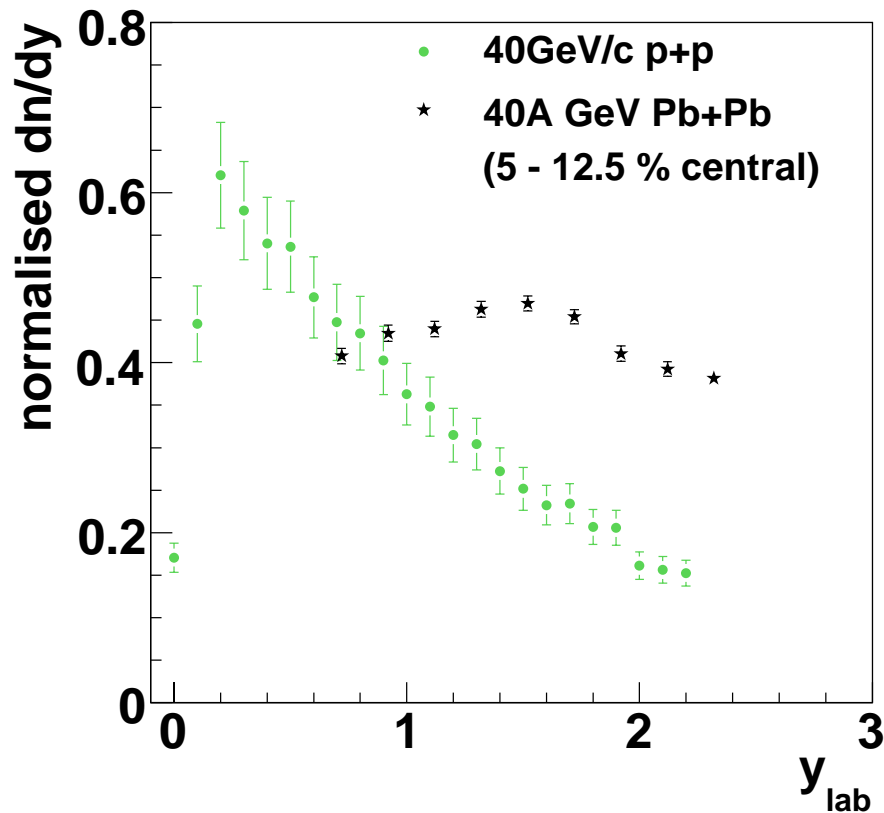


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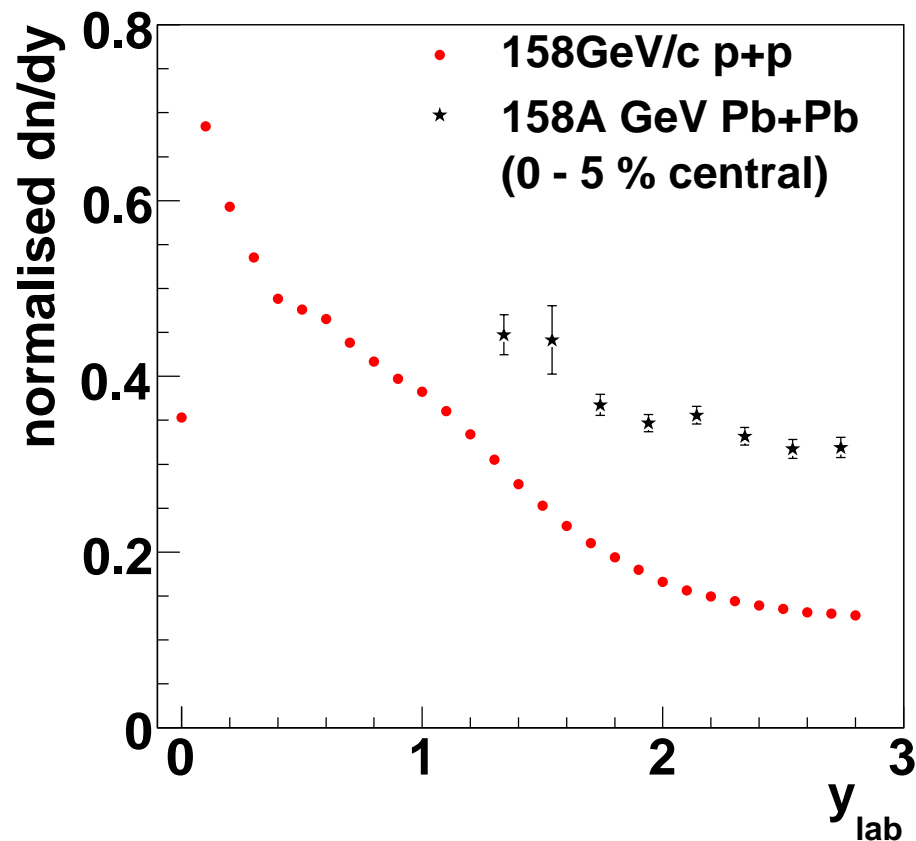
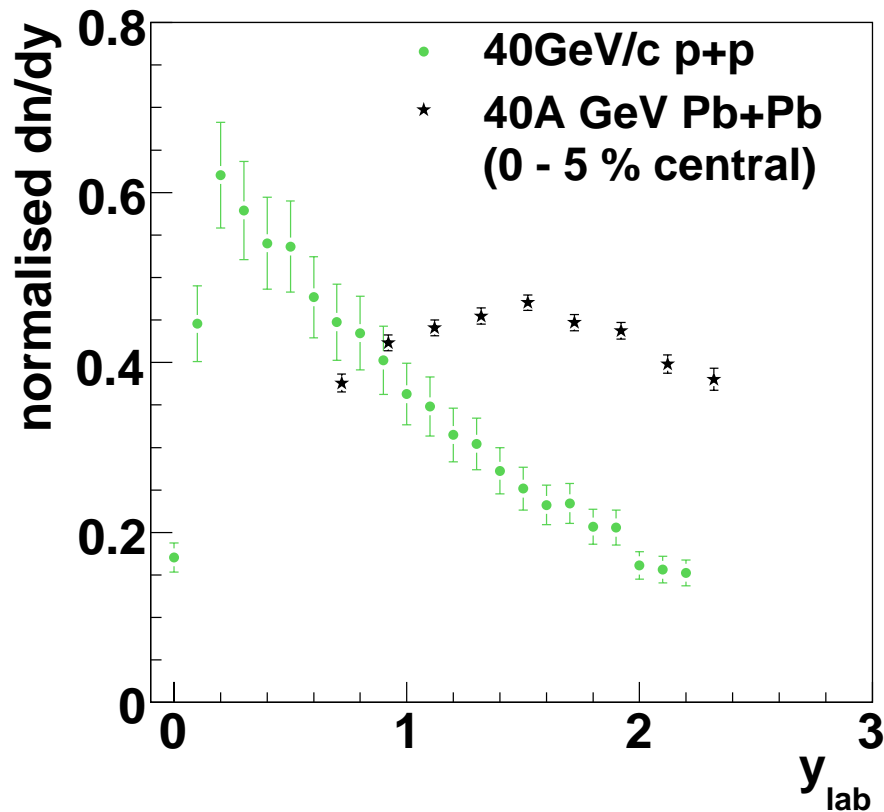


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40 GeV/nucleon

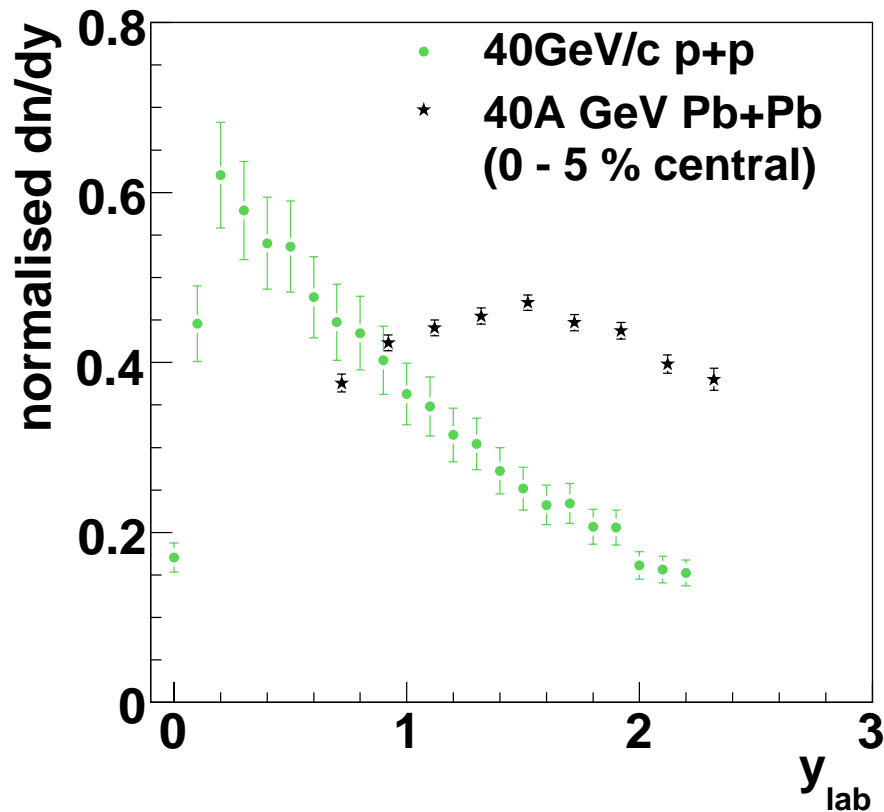
158 GeV/nucleon



The (new NA49) Pb+Pb data

normalized to N_w and comparison to NN

40 GeV/nucleon



Little or no change in shape with centrality **above $y_{lab} \sim 1.6$** corresponding to $x_F > 0.4$.
Constant "peak" position?

Characteristics of stopping (in A+A)

- It is important to include neutrons when studying stopping in A+A and p+p collisions.
- Is coalescence at the origin of light fragments? (40A GeV)
- Hyperbolic scaling for $|x_F| < 0.4$, thus a y-range around midrapidity which increases with beam energy.
- Tentative interpretation:
 - Nucleons in this range have undergone a violent interaction (in N+N and in A+A collisions).
 - **Only one violent interaction of each nucleon in A+A collisions!**
 - Secondary collisions change the shape of dn/dx distributions only in the range $|x_F| > 0.4$

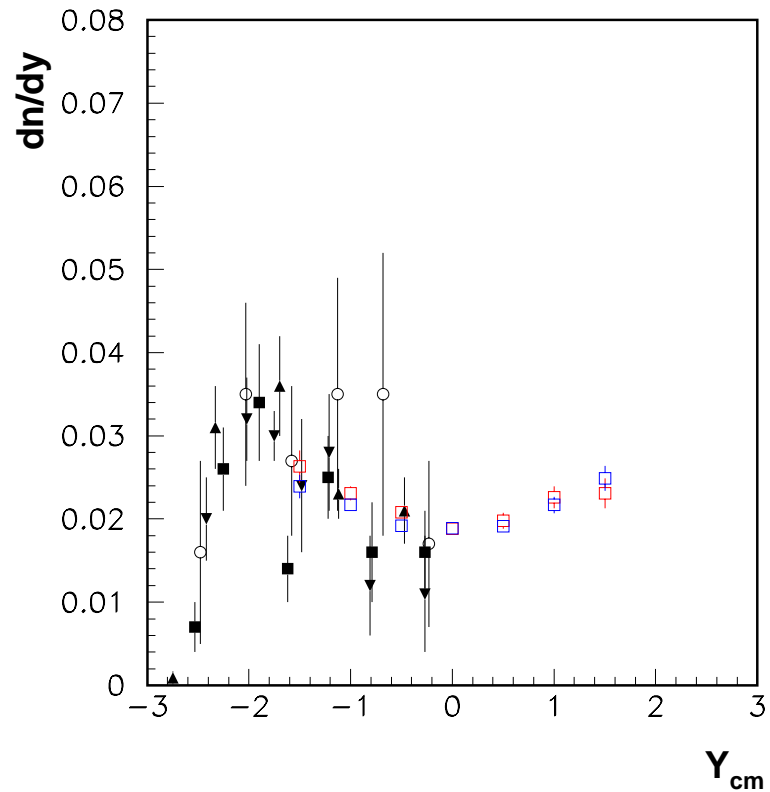
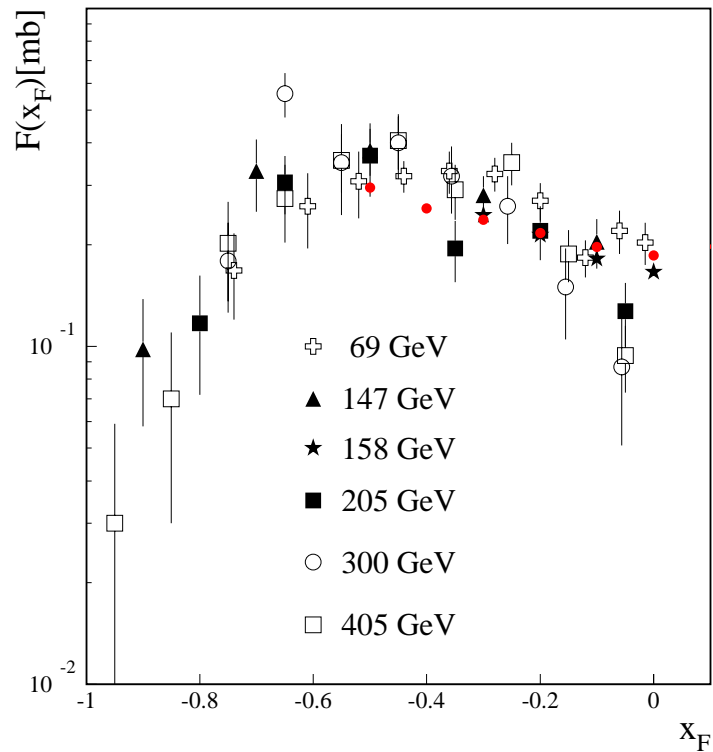
Thank You

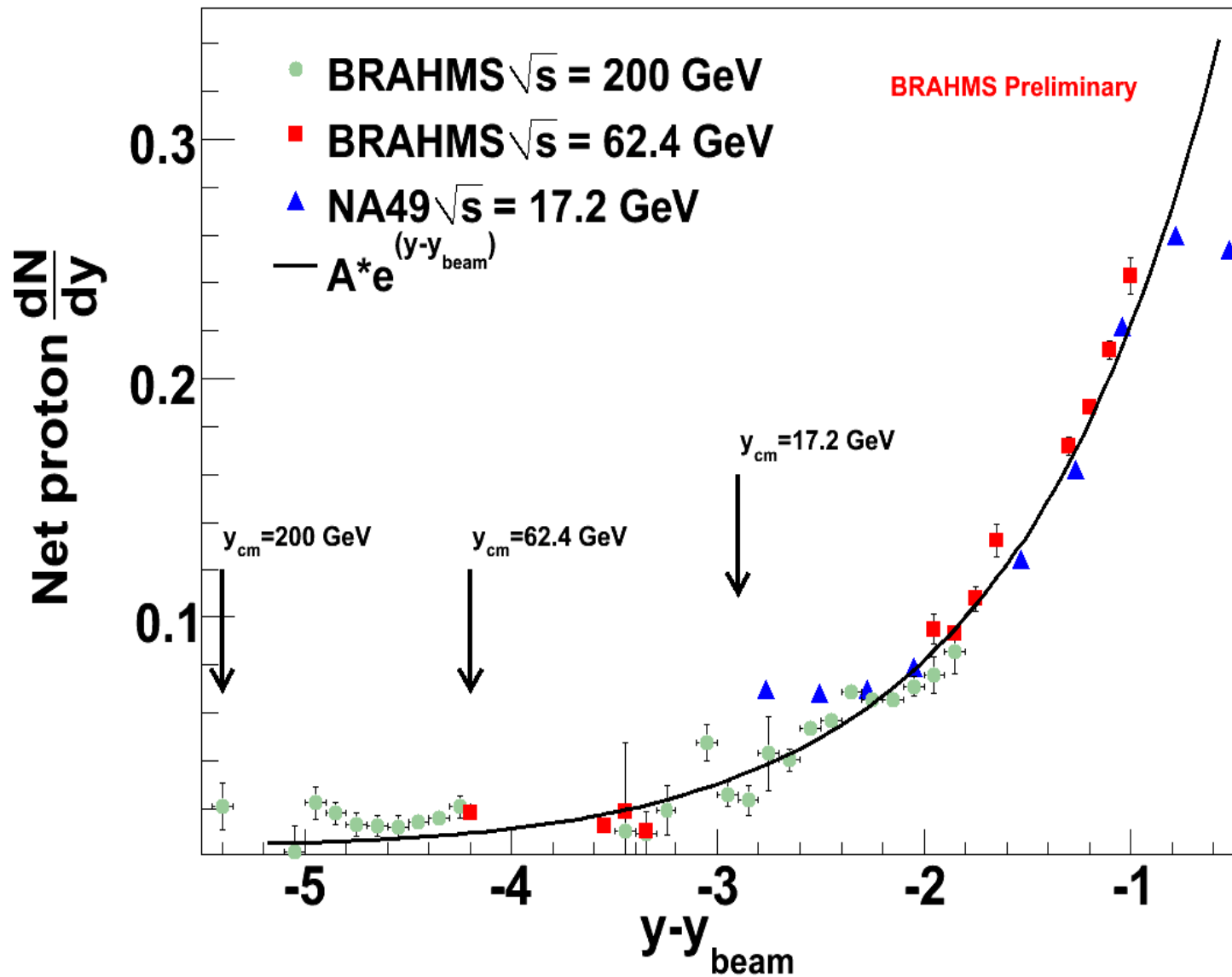
Backup slides

- There are three regions relevant for stopping:
 - diffractive regime for $x_F > x_{F\text{dif}}(E_{\text{beam}})$
 - standard energy loss $x_{F\text{standard}} < x_F < x_{F\text{dif}}$
 - central scaling $|x_F| < 0.4$ (60% energy loss caused by violent interactions).

p+p collision data

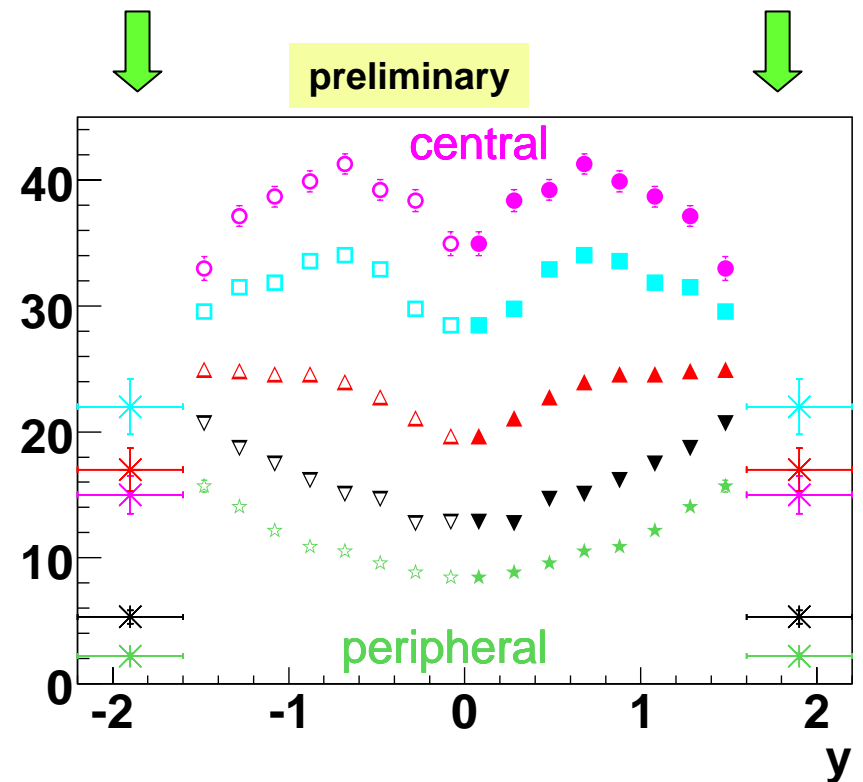
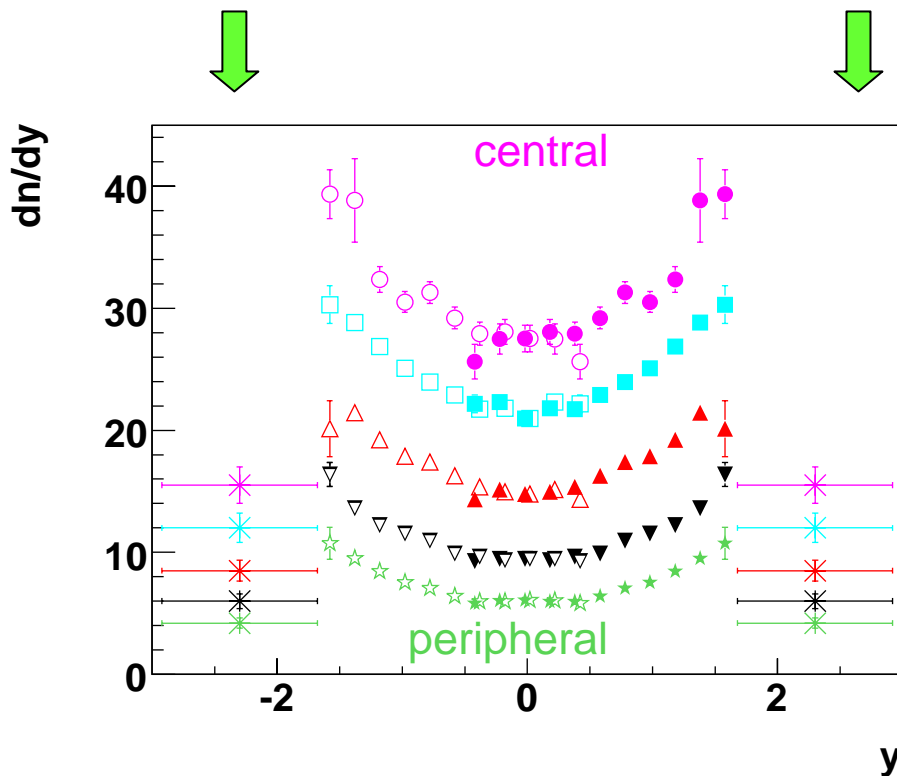
on hyperons (Lambdas)





The (new NA49) data

Extrapolation into unmeasured region by means of **charge** and **baryon number** conservation



The (new NA49) data

