First results on particle correlations from ALICE

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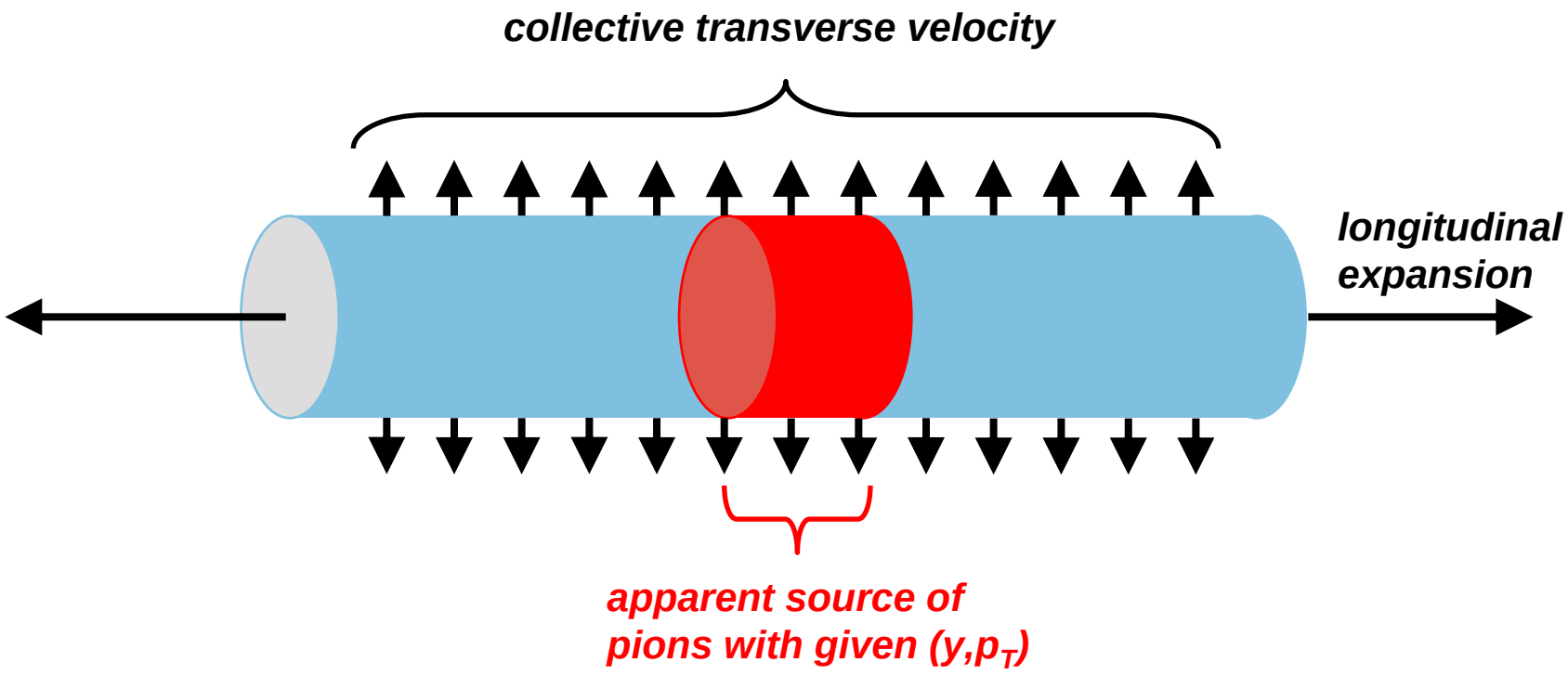
for the ALICE Collaboration

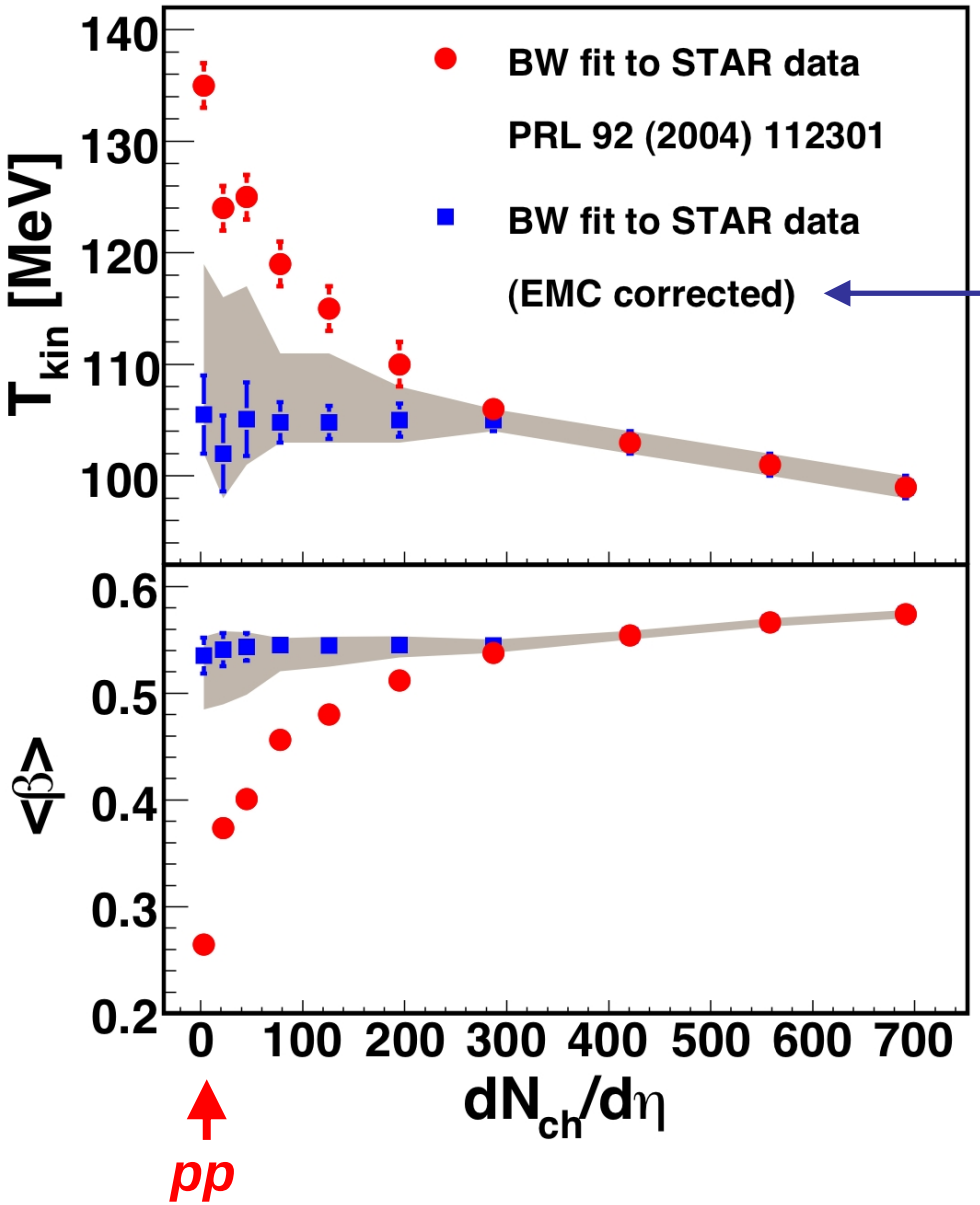
- *why two-pion correlations*
- *two-pion correlations in pp at 900 GeV*
- *first look at the 7 TeV data*
- *try harder: high-p_T correlations*
- *summary*

Collectivity in nuclear collisions



- transverse expansion → p_T spectra look thermal but boosted
  → transverse source size depends on p_T
- longitudinal expansion → longitudinal source size depends on p_T

Transverse expansion



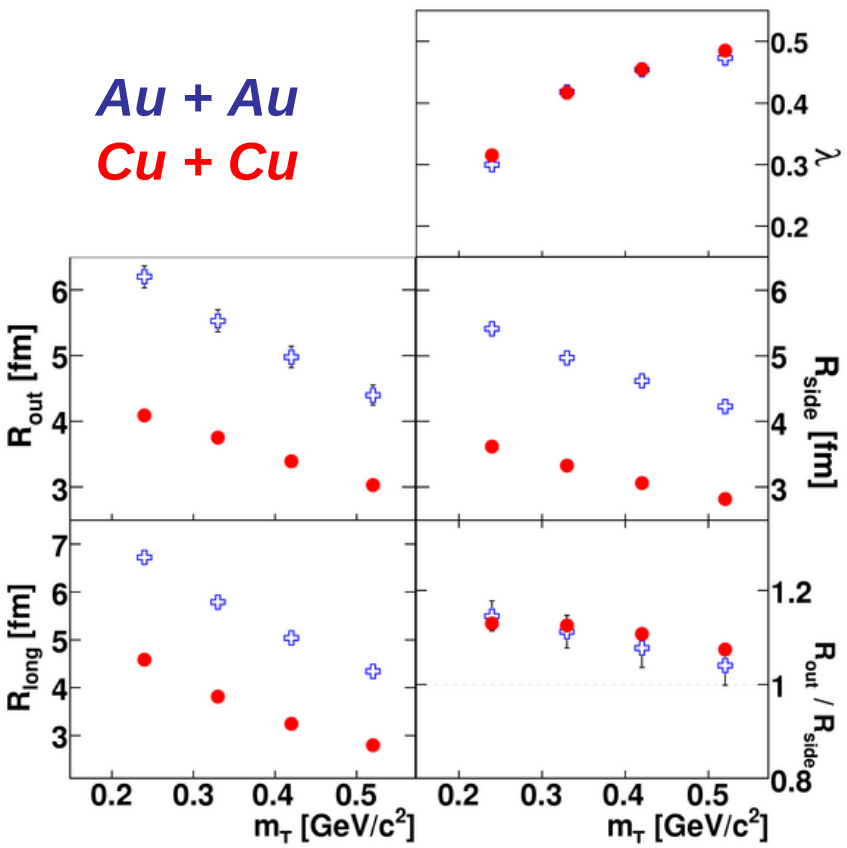
temperature and transverse flow when energy conservation treated properly

Phys.Rev.C79:034908,2009

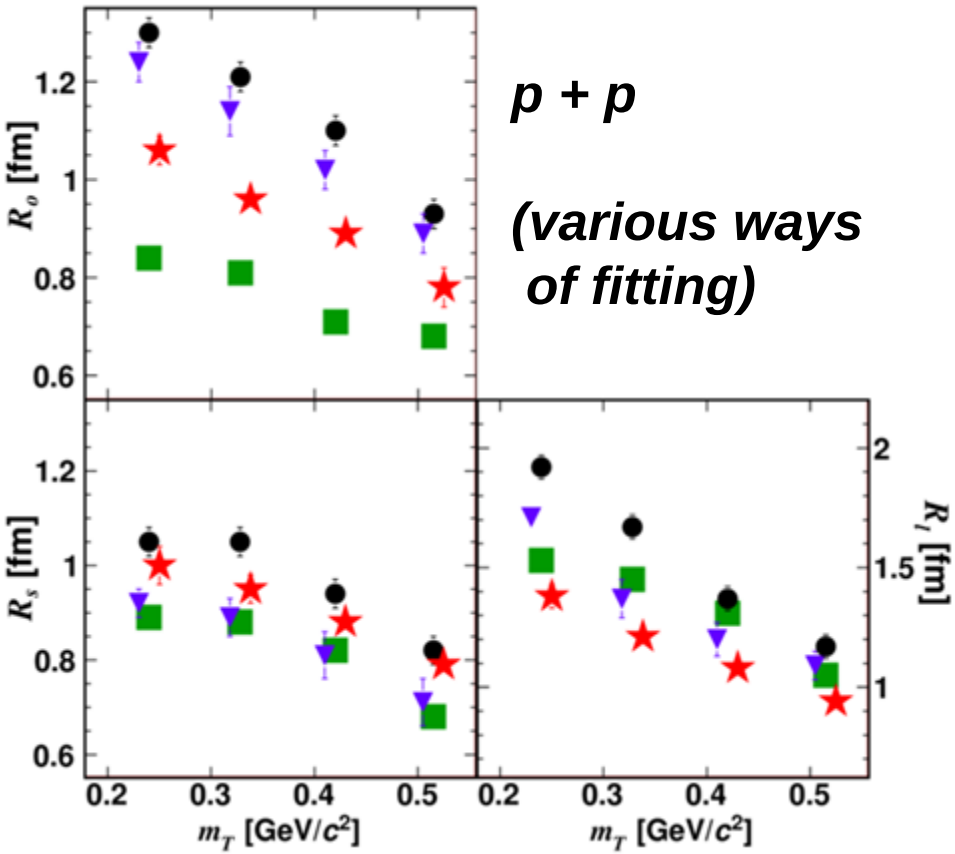
"transverse expansion is there already in pp collisions"

Pion source size from STAR

STAR, Phys. Rev. C 80 (2009) 24905



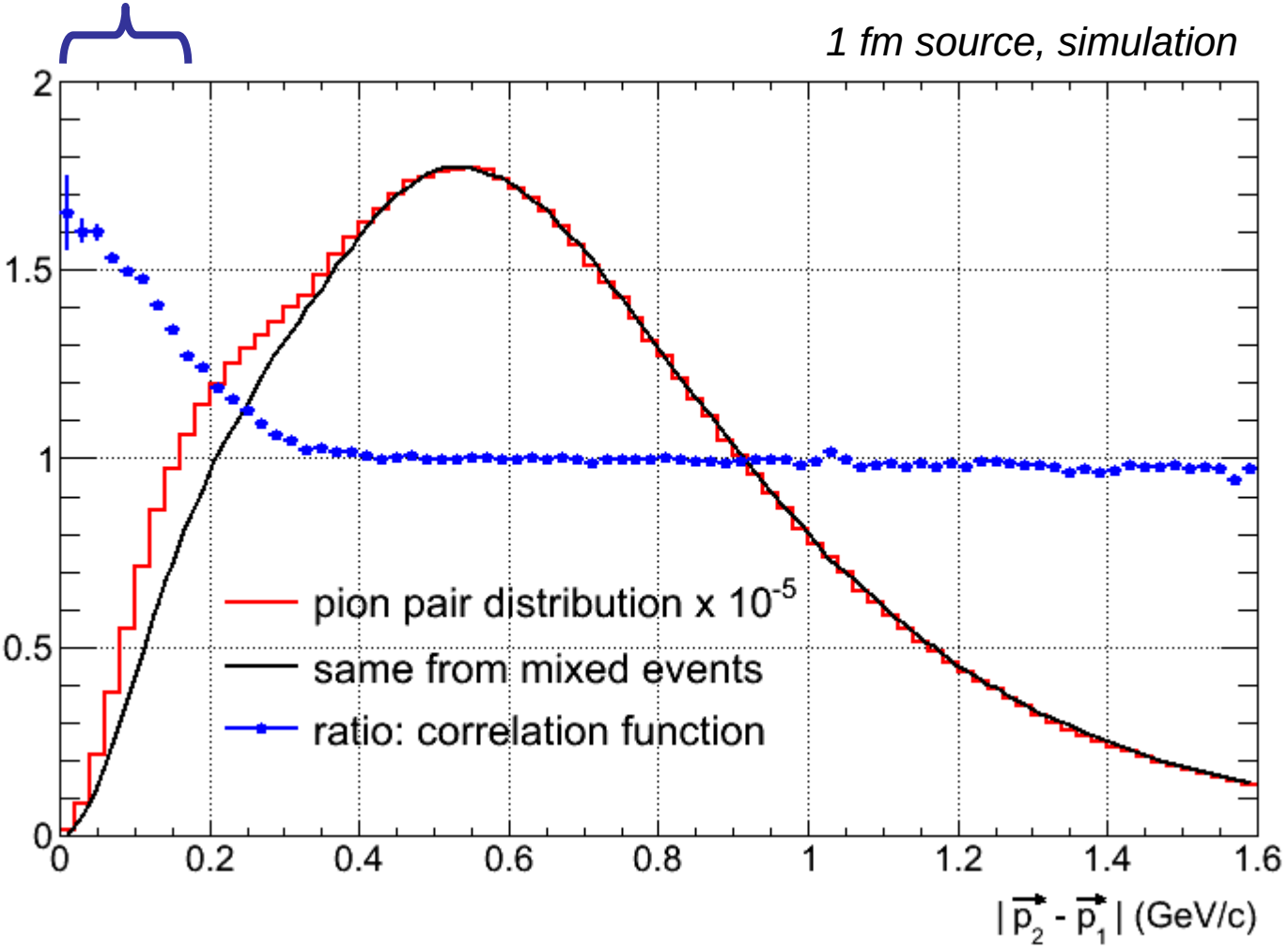
STAR, arXiv:1004.0925 [nucl-ex]



p_T dependence of pion source size similar in nuclear and pp collisions

identical-pion correlation analysis technique (HBT)

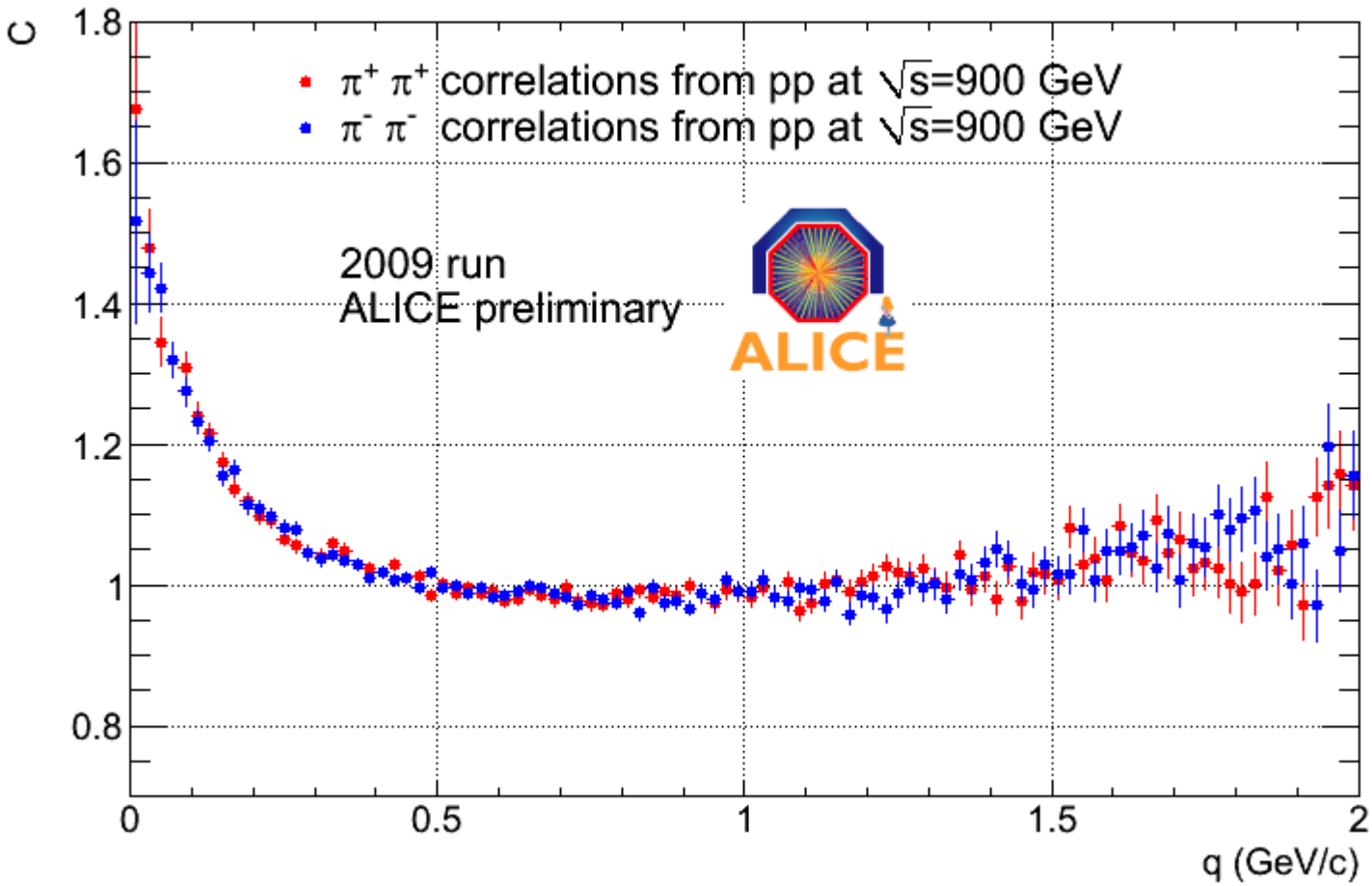
peak width ~ 1 / source size



pion source size accessible experimentally


pp at sqrt(s) = 900 GeV
250 k minimum bias events
10 days starting on Dec 6, 2009

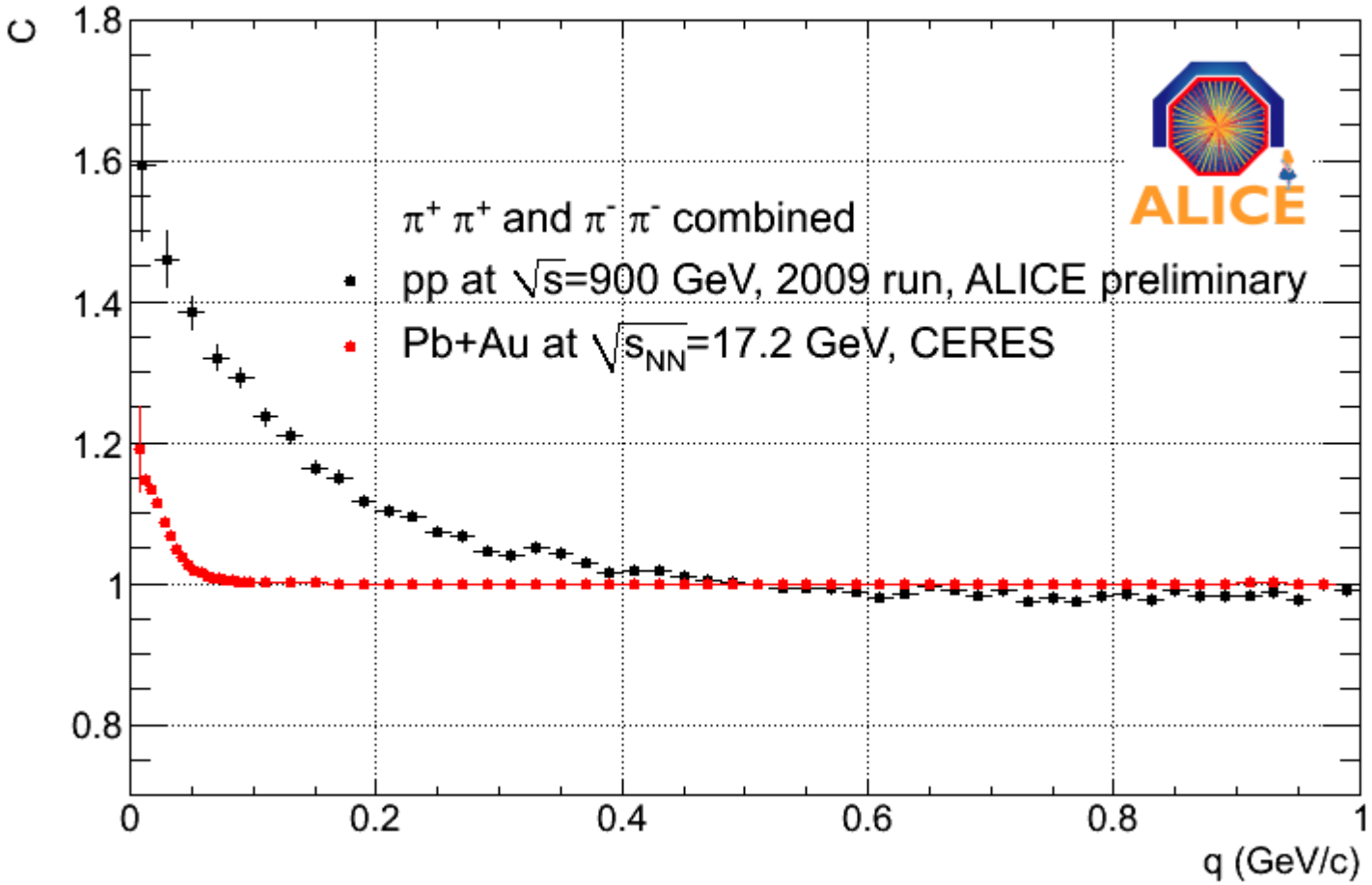
identical pion correlation functions



error bars: statistical

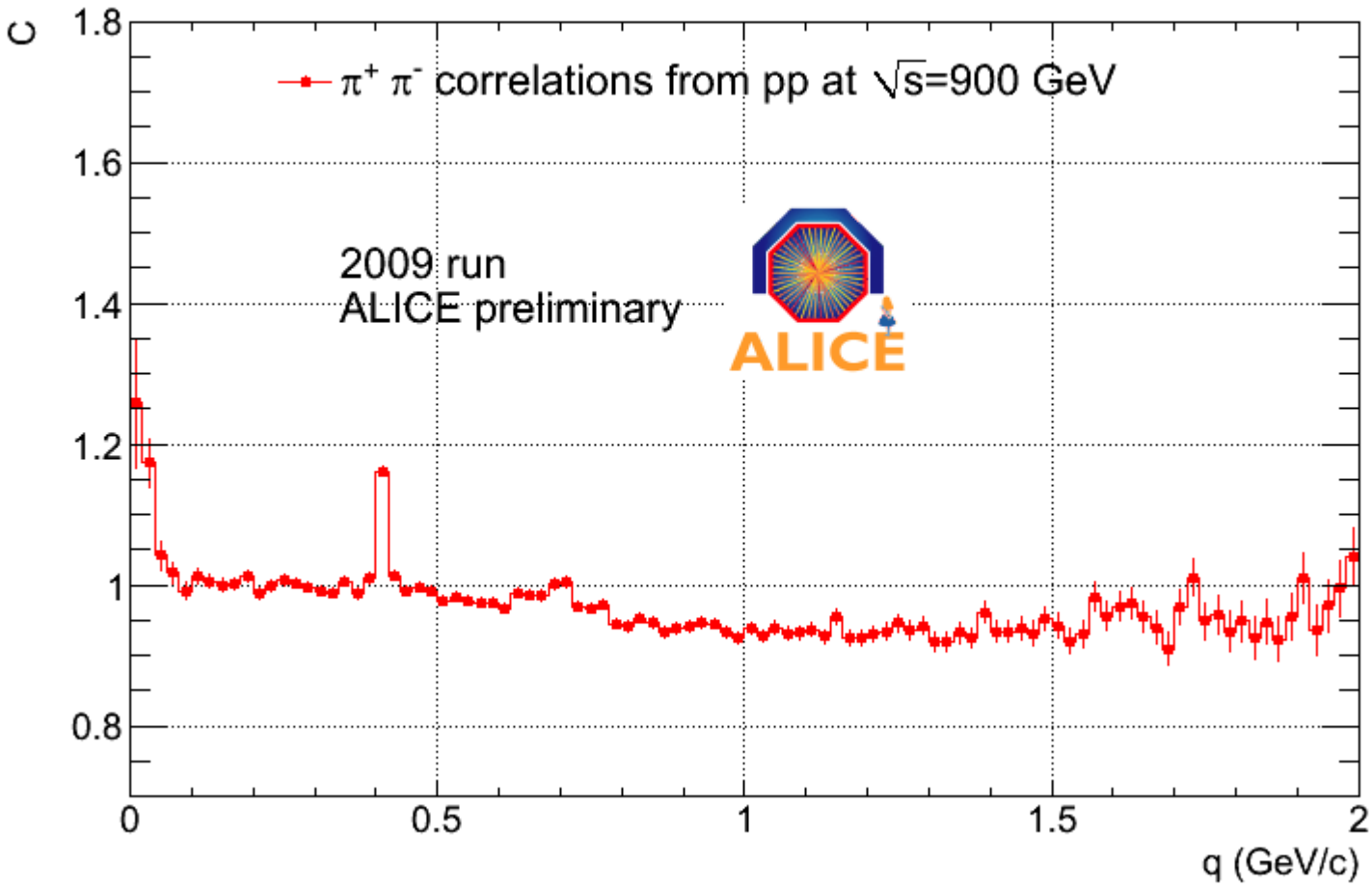
Bose-Einstein peak clearly visible

Two-pion correlation functions in A+A and pp collisions



baseline shape is the challenge in pp collision data

Unlike-sign pion correlation function

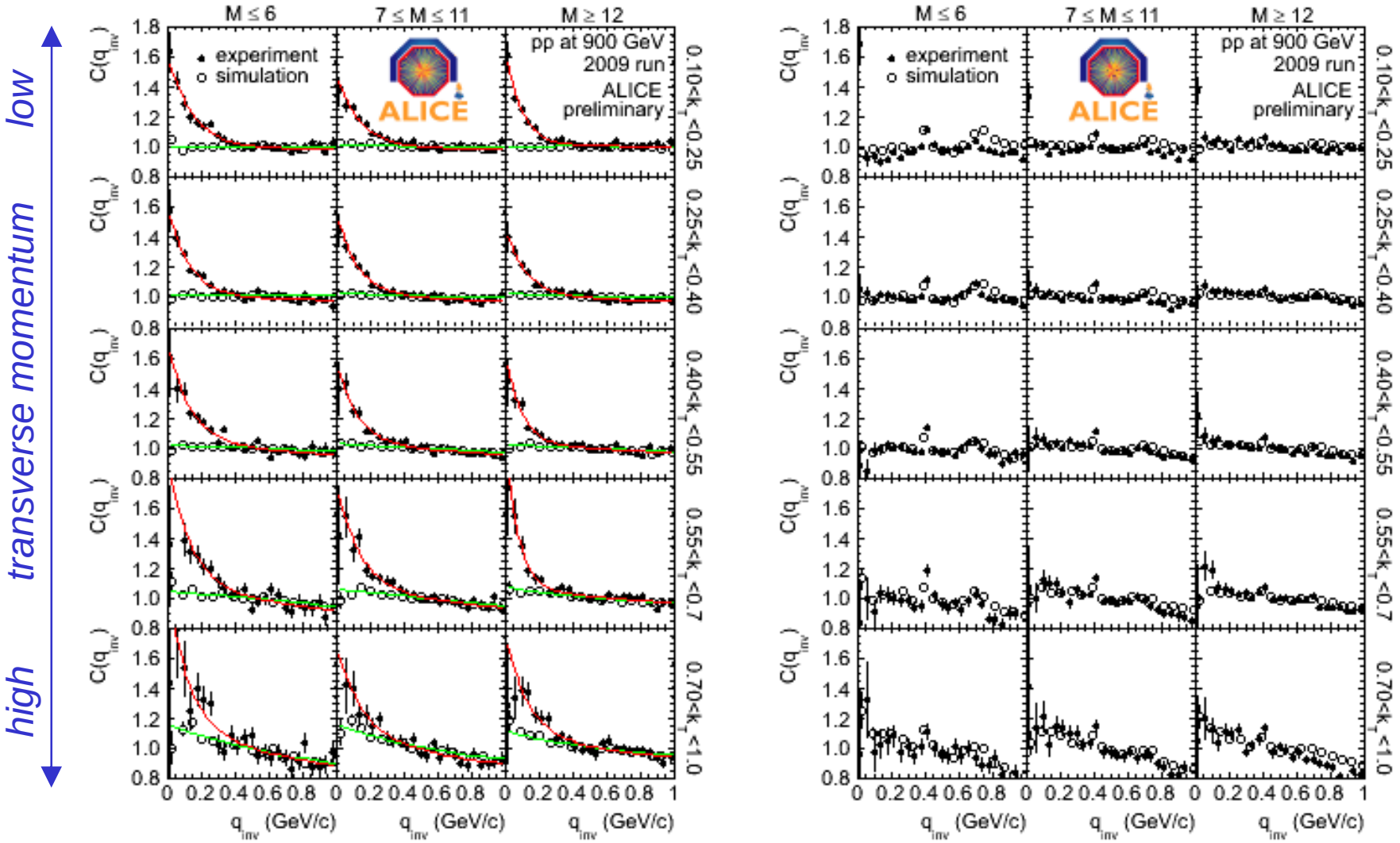


Coulomb and K^0_S peaks visible

Multiplicity and transverse momentum dependence

identical pions

unlike-sign pions

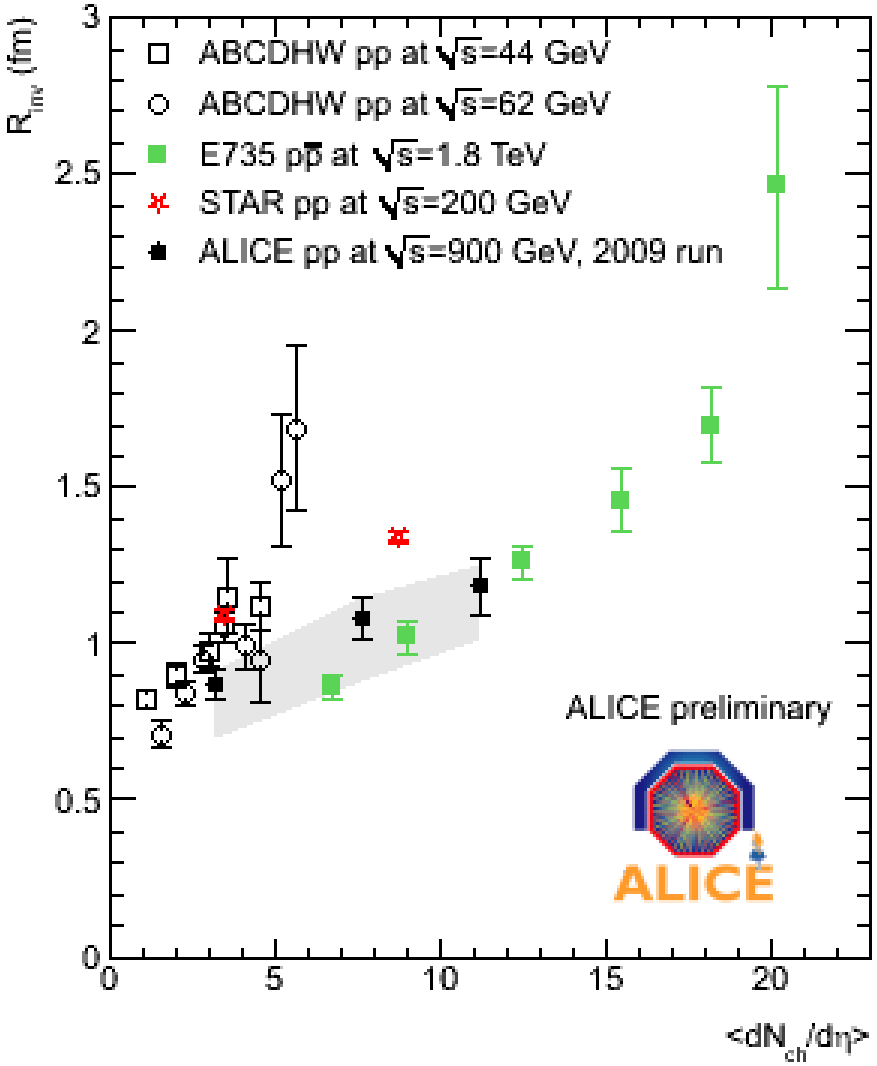


low — *transverse momentum* — *high*

low — *multiplicity* — *high*

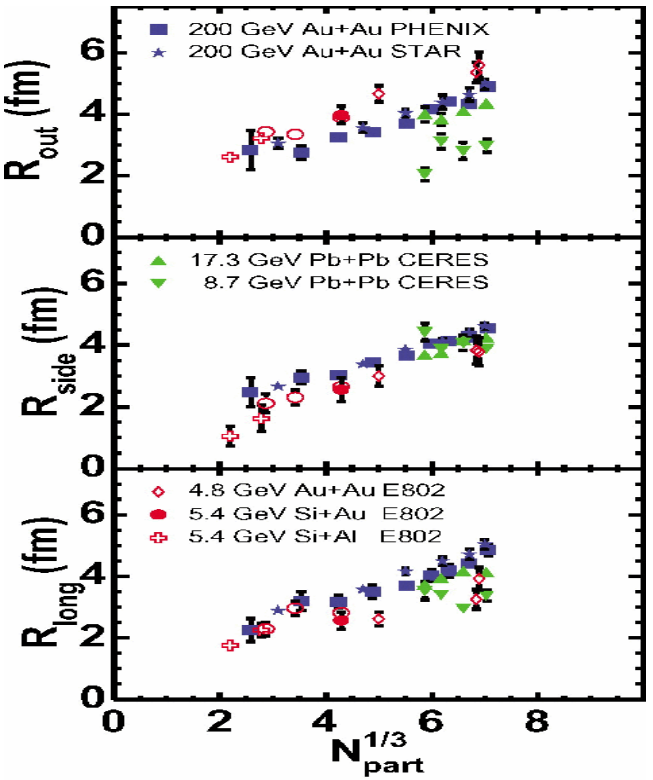
baseline has to be treated properly

Multiplicity dependence



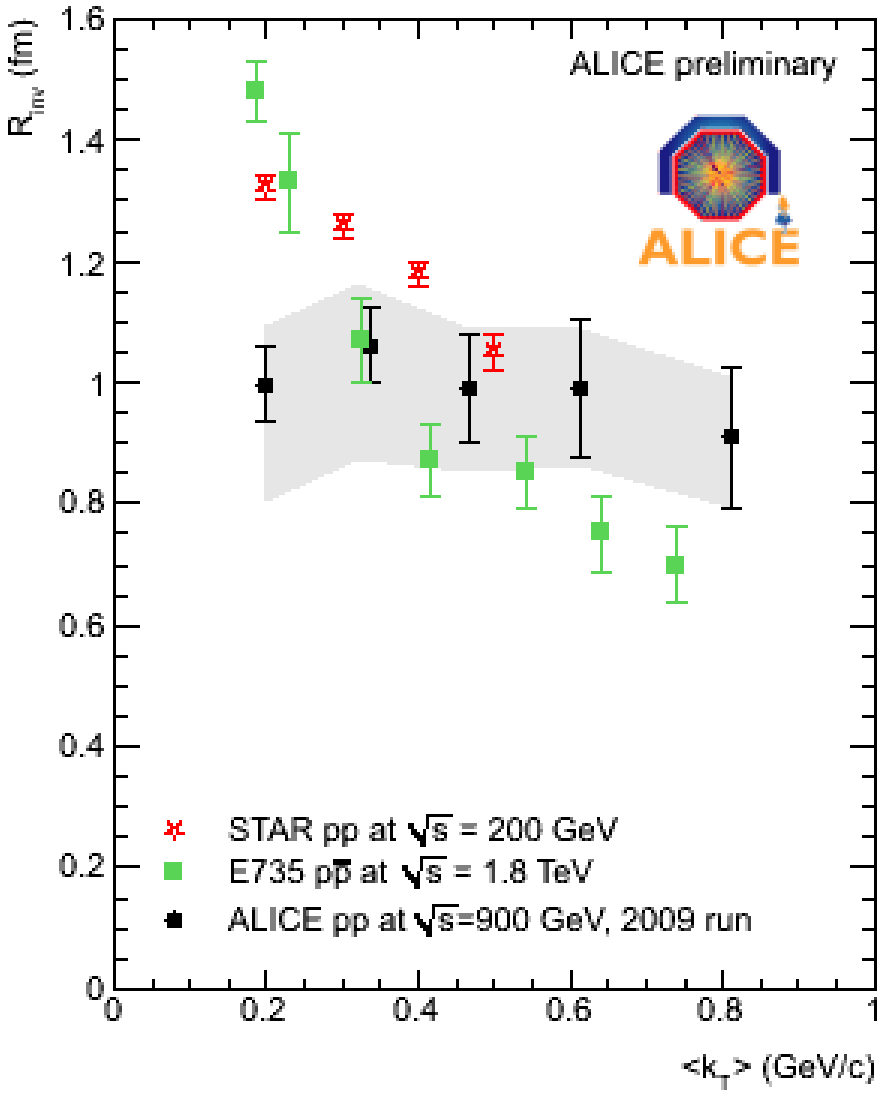
for comp.: nuclear collisions

M. Lisa, Ann. Rev. Nucl. Part. Sci. 55, 357



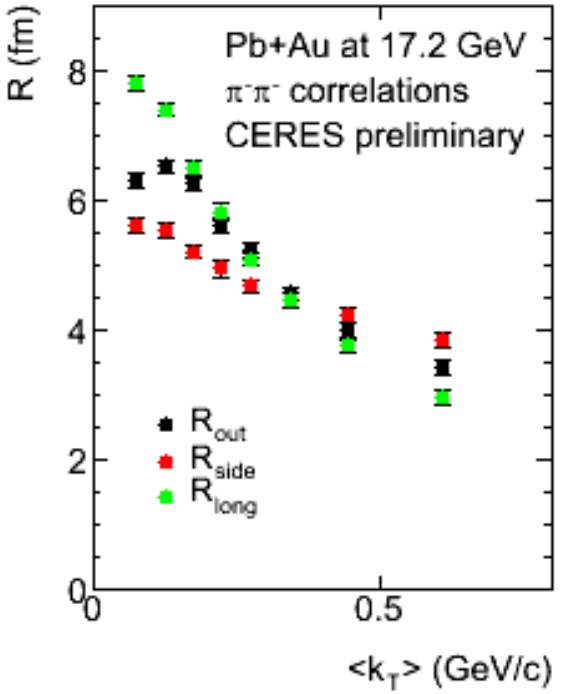
visible dependence in pp → HBT radii depend on multiplicity rather than on collision geometry

Transverse momentum dependence

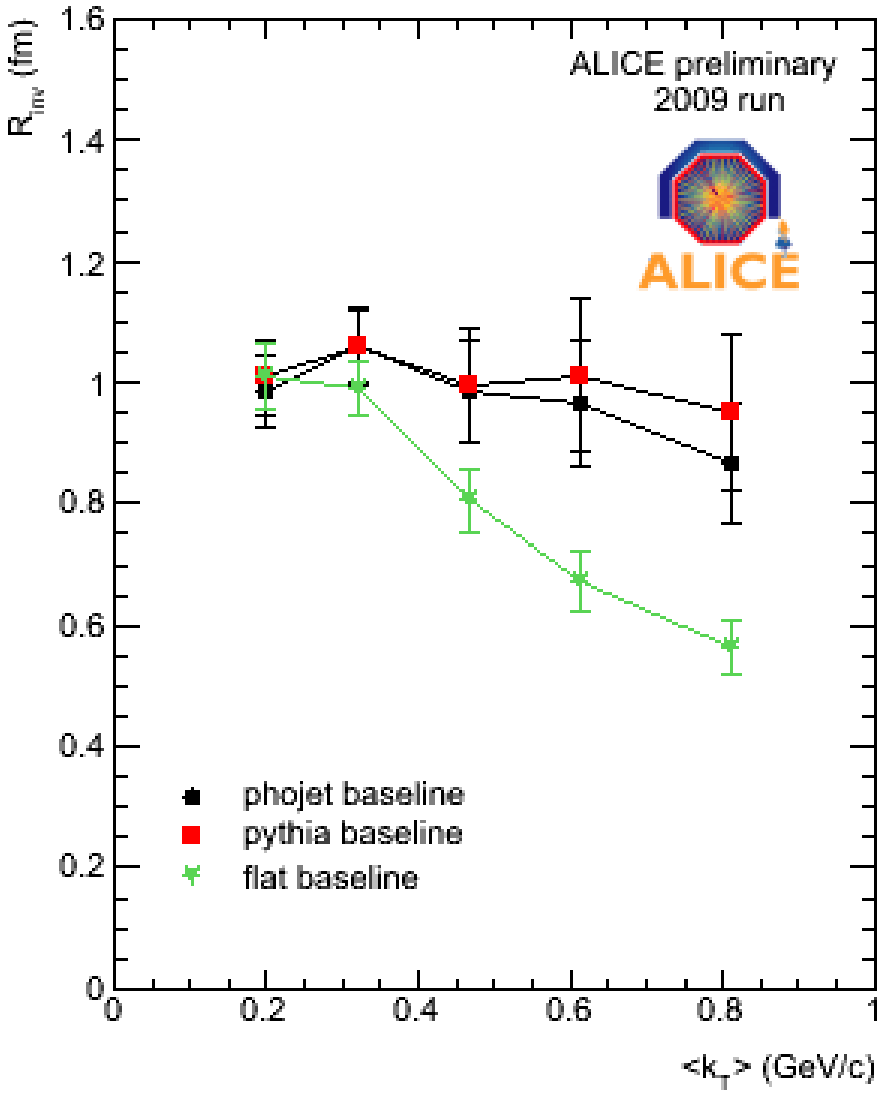


no significant dependence on transverse momentum

for comparison: in nuclear collisions



Dependence on the baseline assumption



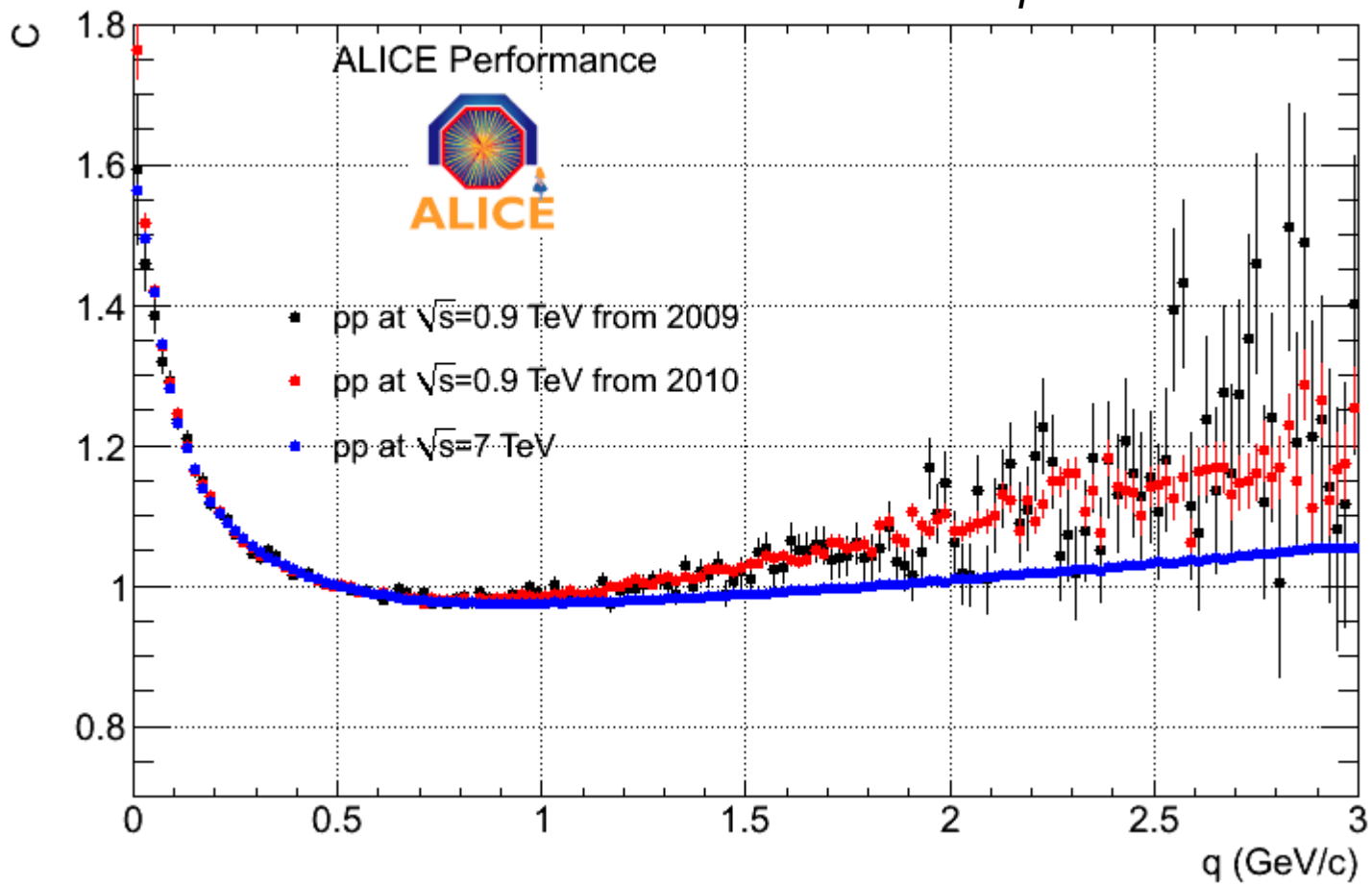
but: transverse momentum dependence is sensitive to the baseline shape assumption

120 M events used for this talk


900 GeV pp
7 M minbias events
1-3 May 2010
2.1 M events used for this talk

7 TeV and new 900 GeV data

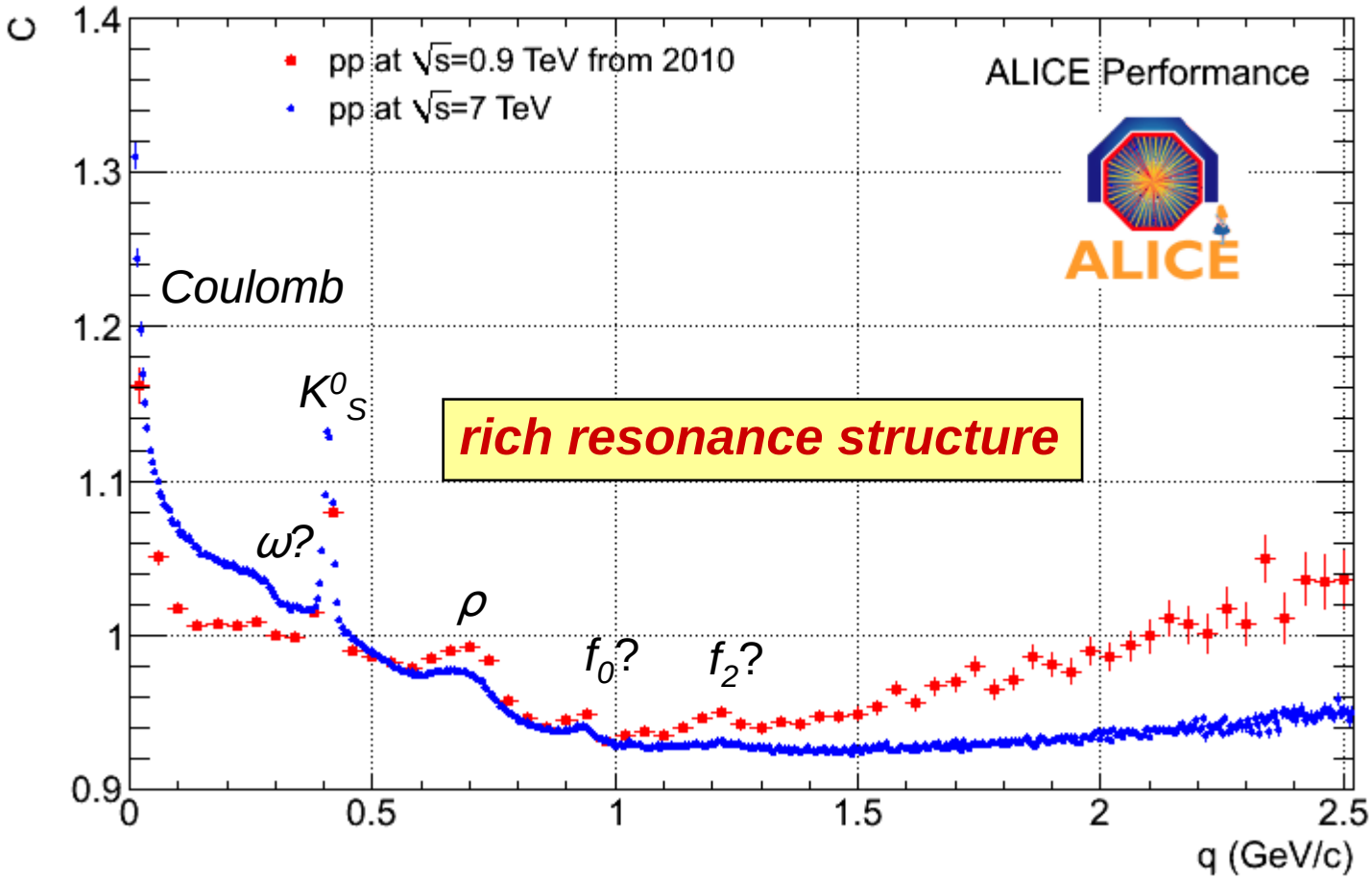
identical pion correlations



120 M events at 7 TeV
2.1 M events at 0.9 TeV

high-q baseline flatter at 7 TeV

$\pi^+\pi^-$ correlations at 7 TeV



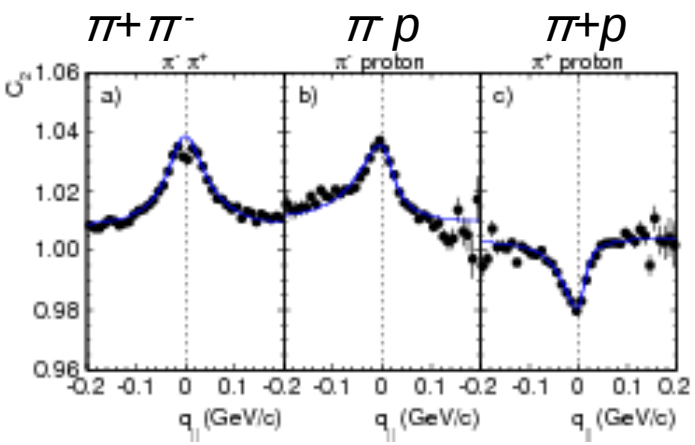
low-q baseline steeper at 7 TeV → origin: jets?

high-q baseline flatter at 7 TeV → origin: momentum cons.?

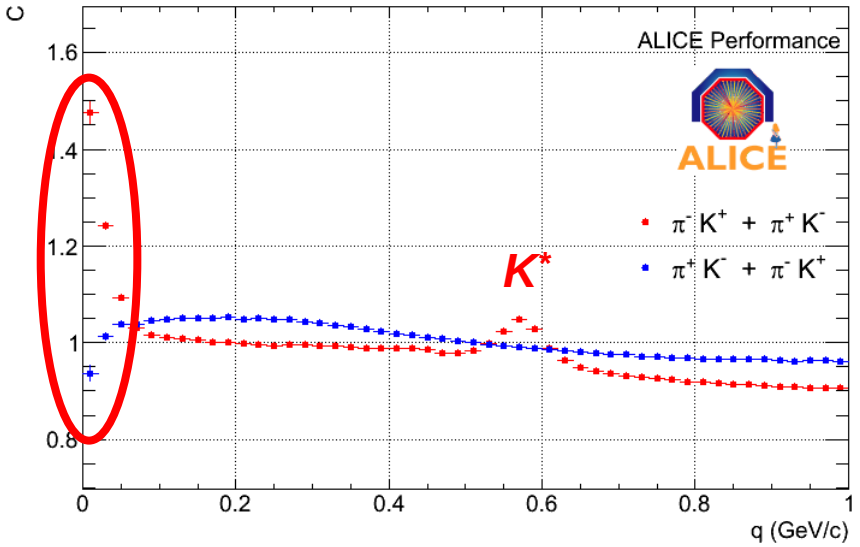
Non-identical particle correlations from pp at 7 TeV

$C(q_{out})$ asymmetry -- another handle on transverse flow

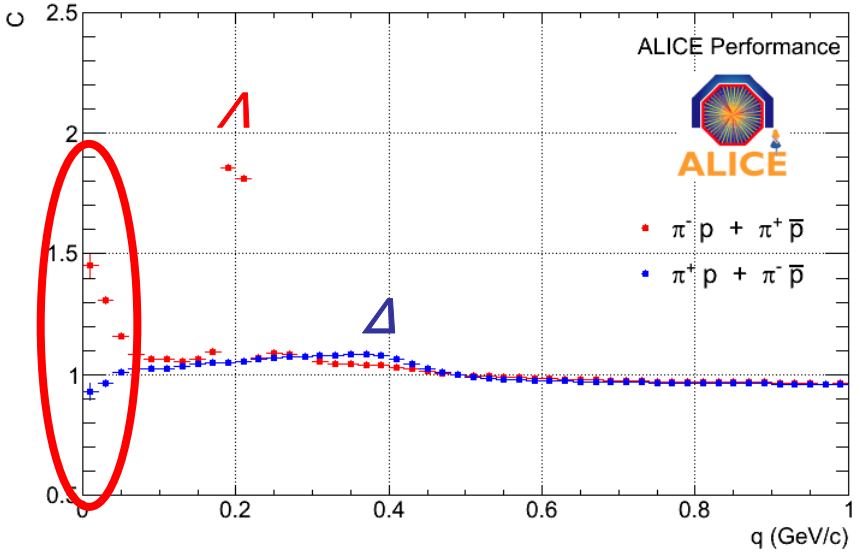
example:
Pb+Au at 17.2 GeV
CF's from CERES



pion - kaon

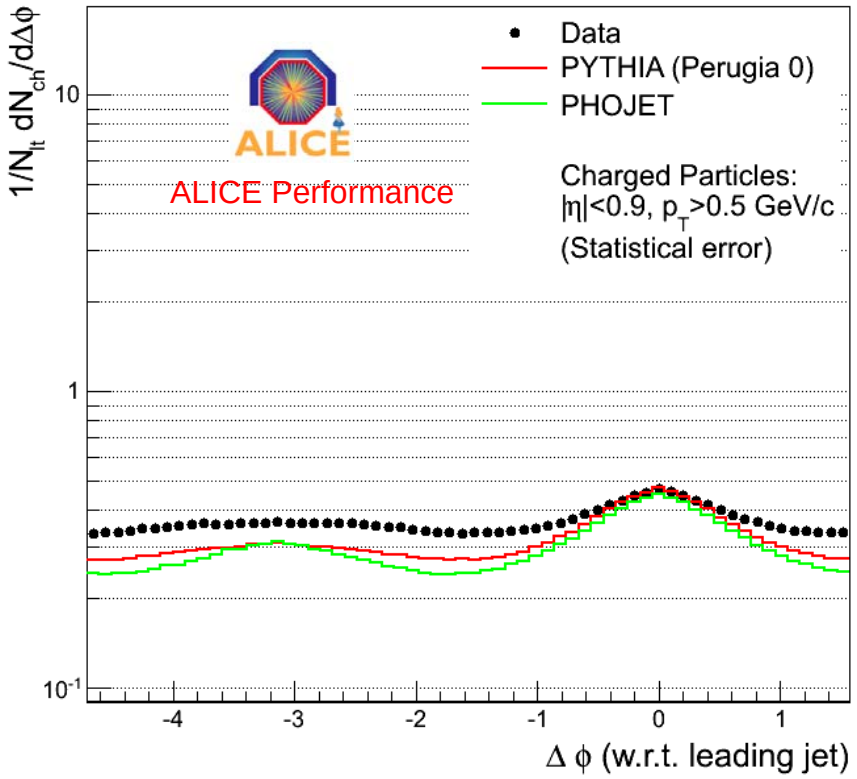


pion - proton

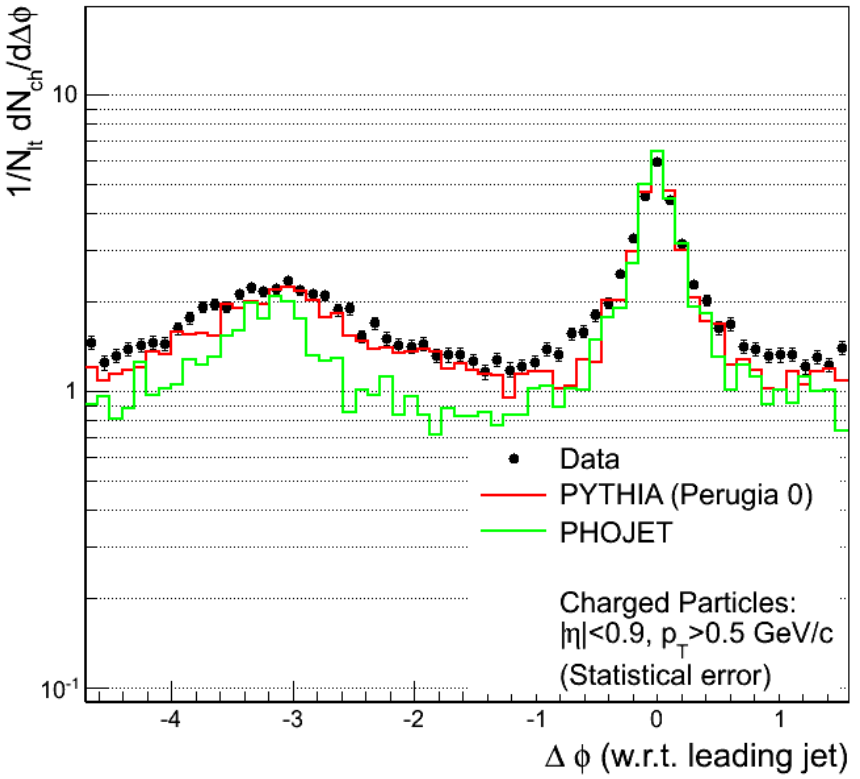


High-p_T correlations

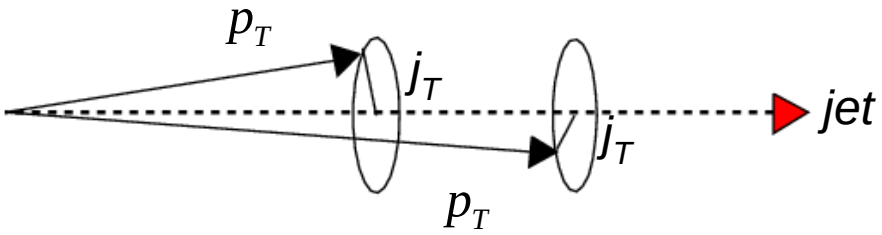
0.5 GeV/c < $p_{T,lt}$ < 2.5 GeV/c



10 GeV/c < $p_{T,lt}$ < 15 GeV/c



sizable jet-like correlations
near-side peak width depends on $p_{T,lt}$
transverse dynamics of jets is soft



Summary

- ***HBT radii in pp collisions at 900 GeV depend on multiplicity but not (much) on transverse momentum***
  three-dimensional analysis will give more information

- ***correlation baseline of crucial importance***
  distorted by high-pt correlations

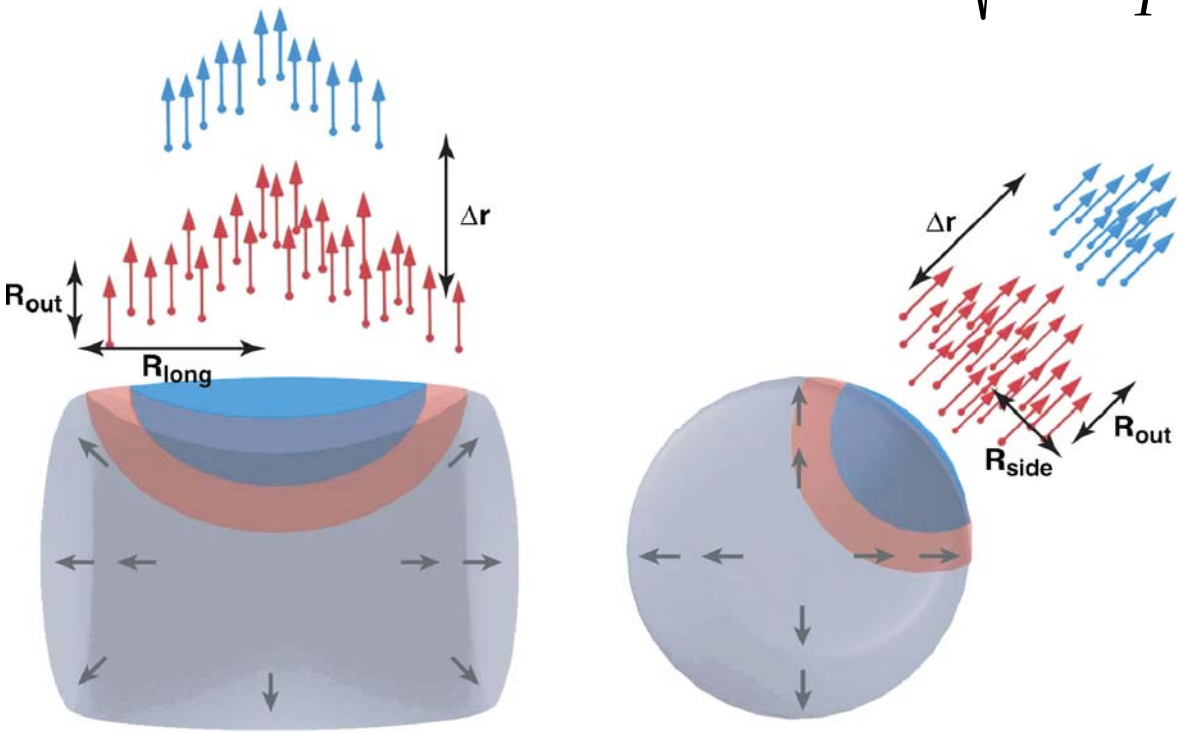
- ***transverse dynamics of jets is soft***
  another potential application of the HBT technique

backup

transverse momentum dependence of R_{side}

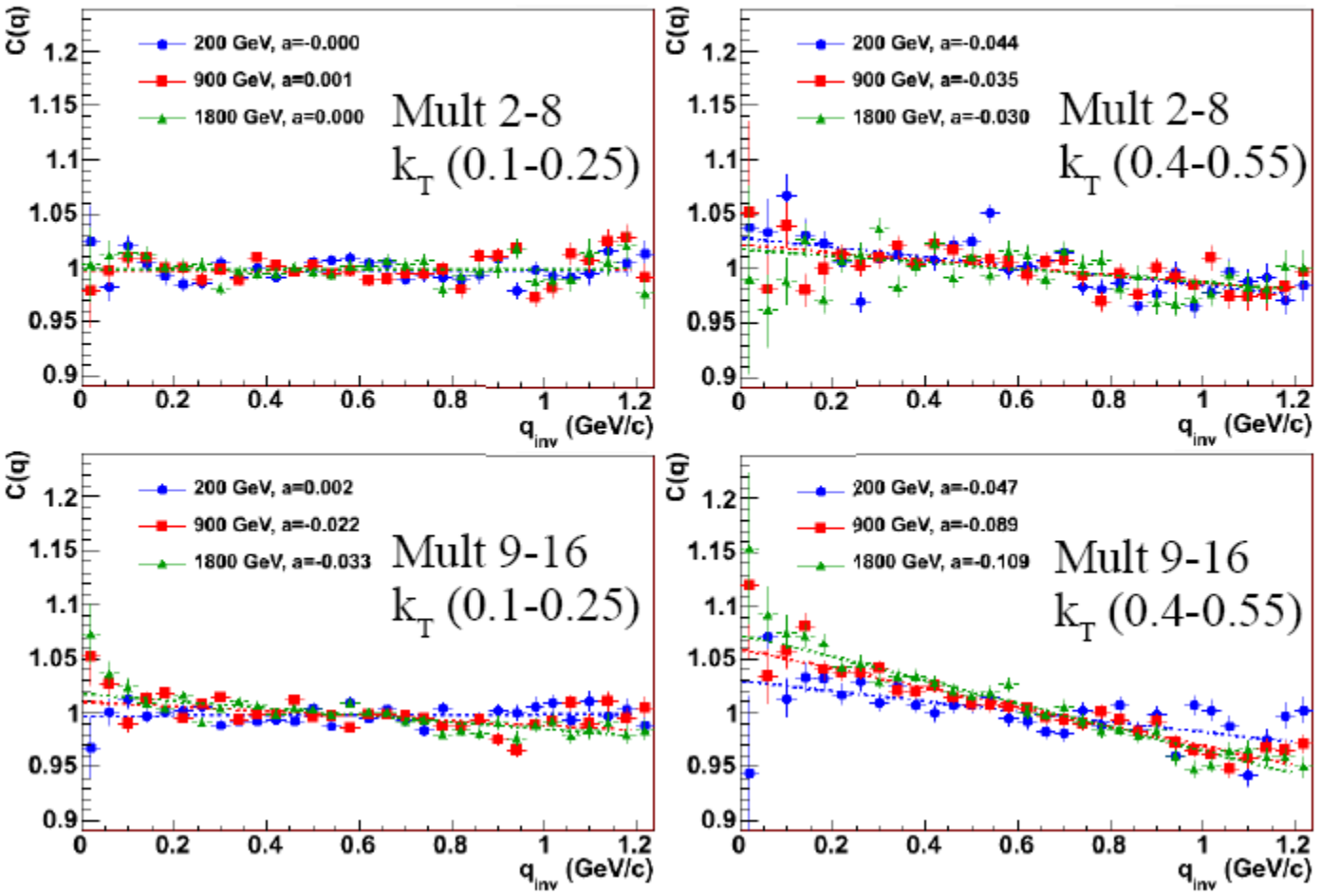
$$R_{long} = \tau_f \sqrt{\frac{T}{m_t} \frac{K_2(m_t/T)}{K_1(m_t/T)}}$$

$$R_{side}(p_\perp) = \frac{R_G}{\sqrt{1 + \frac{m_\perp \eta_f^{\,2}}{T}}}$$



Lisa MA, et al. 2005.
Annu. Rev. Nucl. Part. Sci. 55:357–402

- "underlying event" correlations grow with energy, pair k_T and multiplicity: probably small at 200GeV, strong at 1.8 TeV



study by Adam Kisiel

baseline slope significant at 0.9 TeV and above