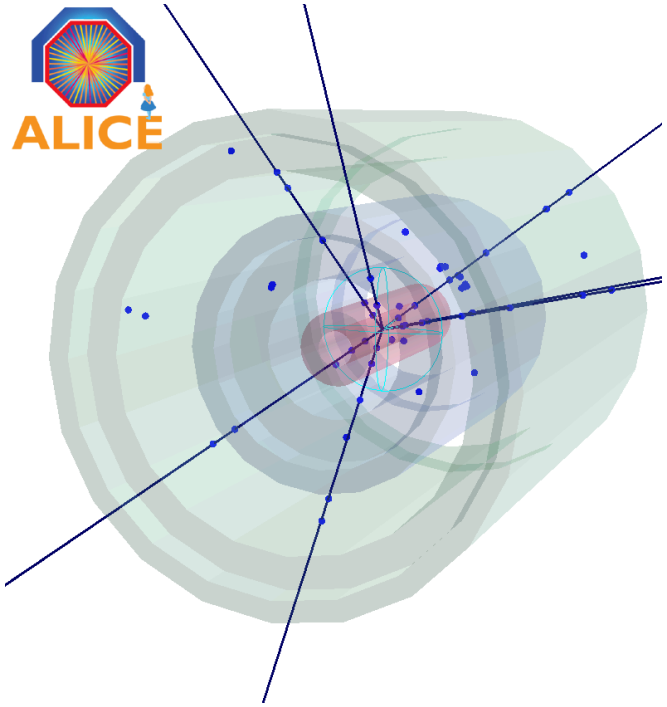


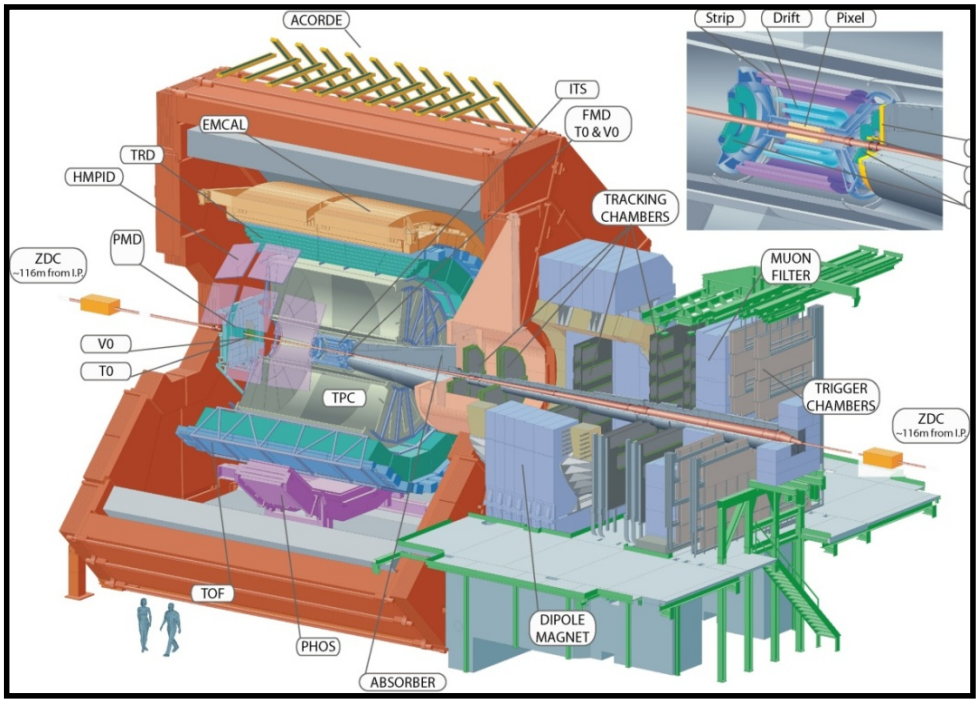
General properties of *pp* collisions with ALICE

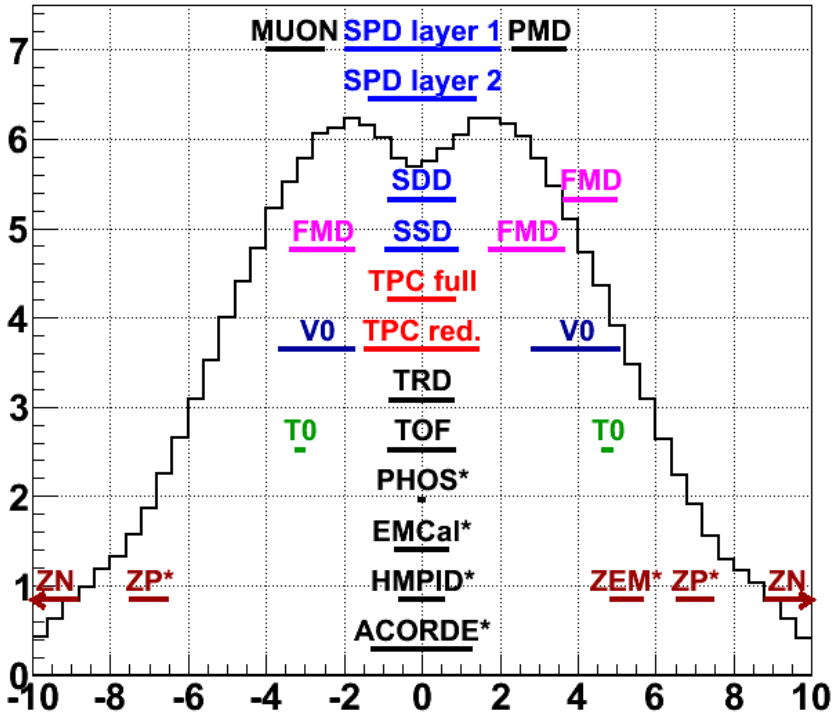
Martin Poghosyan
For the ALICE Collaboration

Winter Workshop on Recent QCD Advances at the LHC
Les Houches, France
Feb. 13 -18, 2011

Detector configuration

ITS, TPC, TOF, HMPID, MUON, V0, T0, FMD, PMD, ZDC, TRD, EMCAL, PHOS

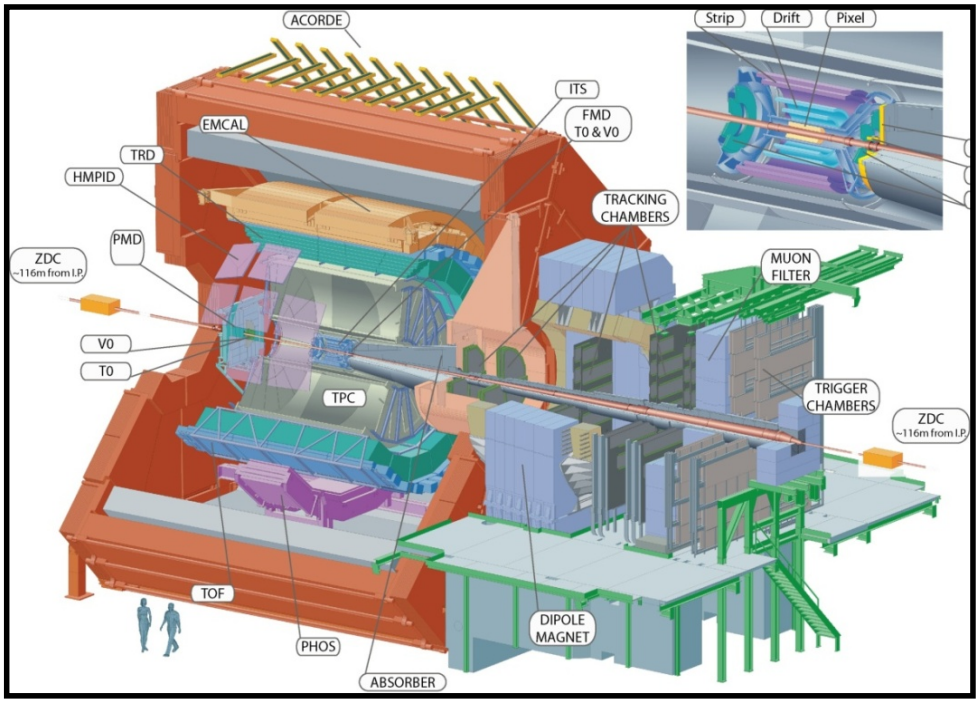




A Large Ion Collider Experiment
- High granularity (up to dN/dy~8000)
- Minimized material
- Good PID
- Good acceptance for p_t down to 100 MeV/c

Detector configuration

ITS, TPC, TOF, HMPID, MUON, V0, T0, FMD, PMD, ZDC, TRD, EMCAL, PHOS

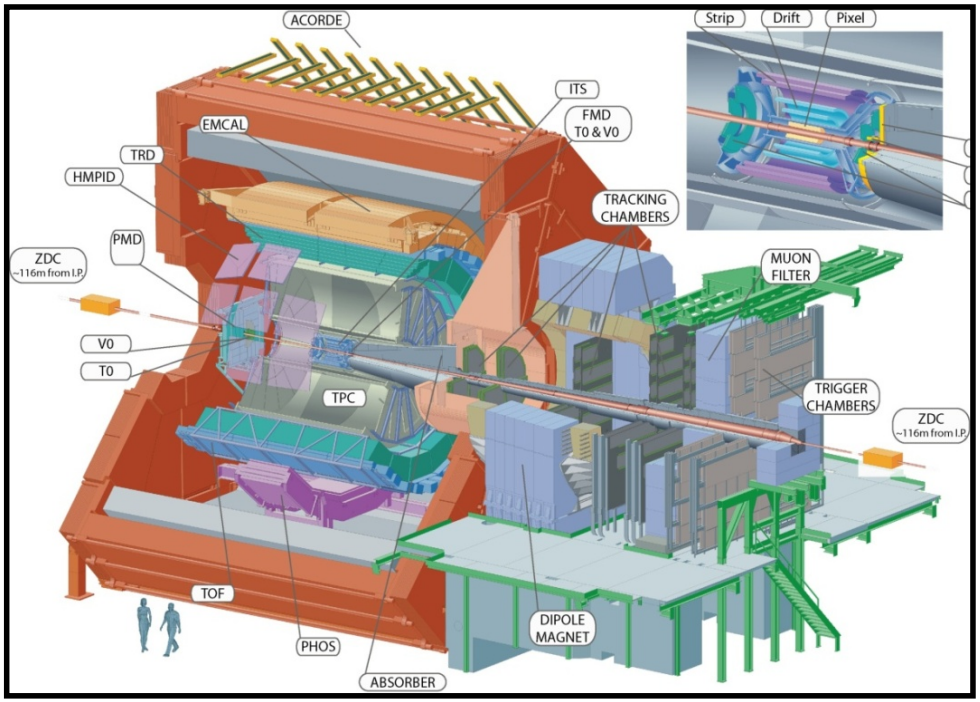


Beam	Energy	# of Events
pp	900 GeV	~ 8 M MB
pp	2.36 TeV	~ 40 k MB
pp	7 TeV	~ 800 M MB ~ 50 M muons ~ 20 M high N_{ch}
PbPb	2.76 TeV/N	few 10^7 MB

A Large Ion Collider Experiment
- High granularity (up to dN/dy~8000)
- Minimized material
- Good PlD
- Good acceptance for p_t down to 100 MeV/c

Detector configuration

ITS, TPC, TOF, HMPID, MUON, V0, T0, FMD, PMD, ZDC, TRD, EMCAL, PHOS



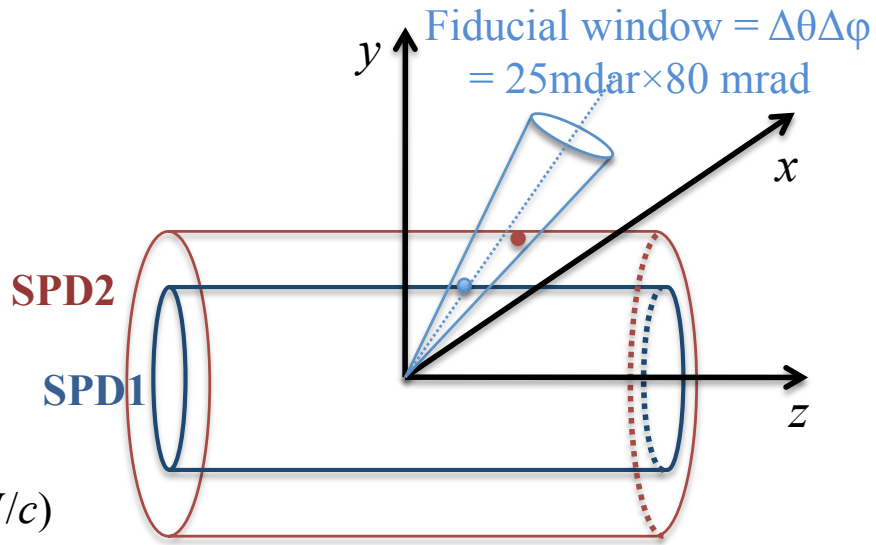
Pb-Pb collisions ➔ Alberica Toia
Jets and High pt hadrons ➔ Oliver Busch
Heavy flavors ➔ Francesco Prino.
Quarkonia ➔ Woo Jin Park

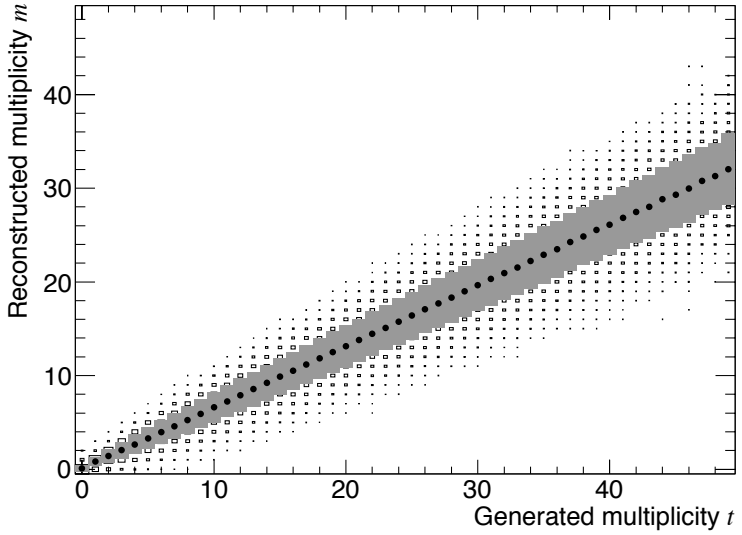
A Large Ion Collider Experiment
- High granularity (up to dN/dy~8000)
- Minimized material
- Good PID
- Good acceptance for p_t down to 100 MeV/c

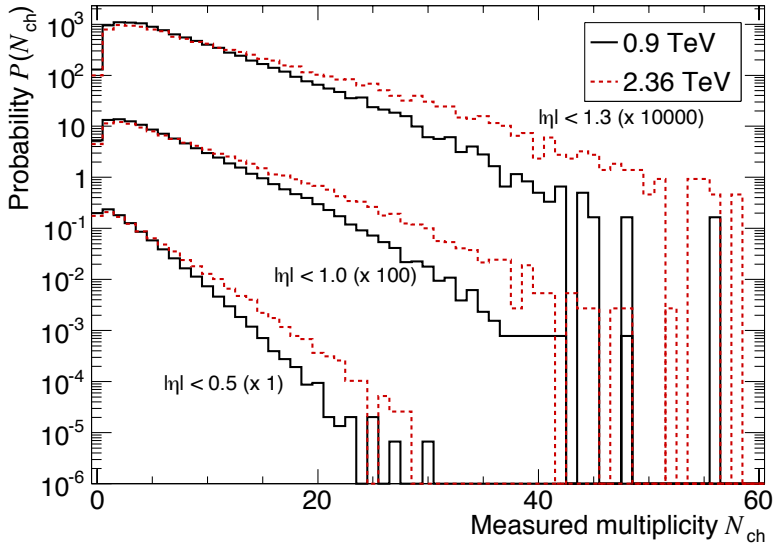
Charged particle multiplicity measurement with Silicon Pixel Detector

K. Aamodt et al., EPJ **C68** (2010) 89

- Two innermost layers of the ITS
- Radii of 3.9/7.6 cm ($|\eta| < 2.0/1.4$)
- ~8 M channels
- Trigger & Tracking
- ~80% active (because of cooling problems)
- Fast aligned/calibrated and used to estimate the
  - position of the interaction point
  - number of primary tracks ($|\eta| < 1.4$; $p_T > 50$ MeV/c)

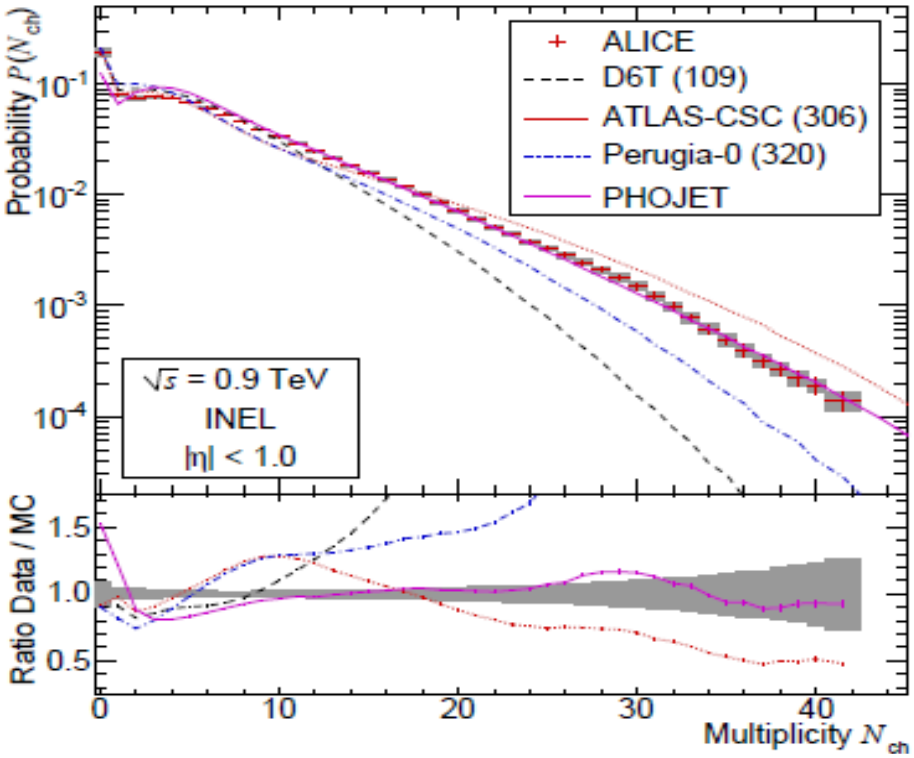


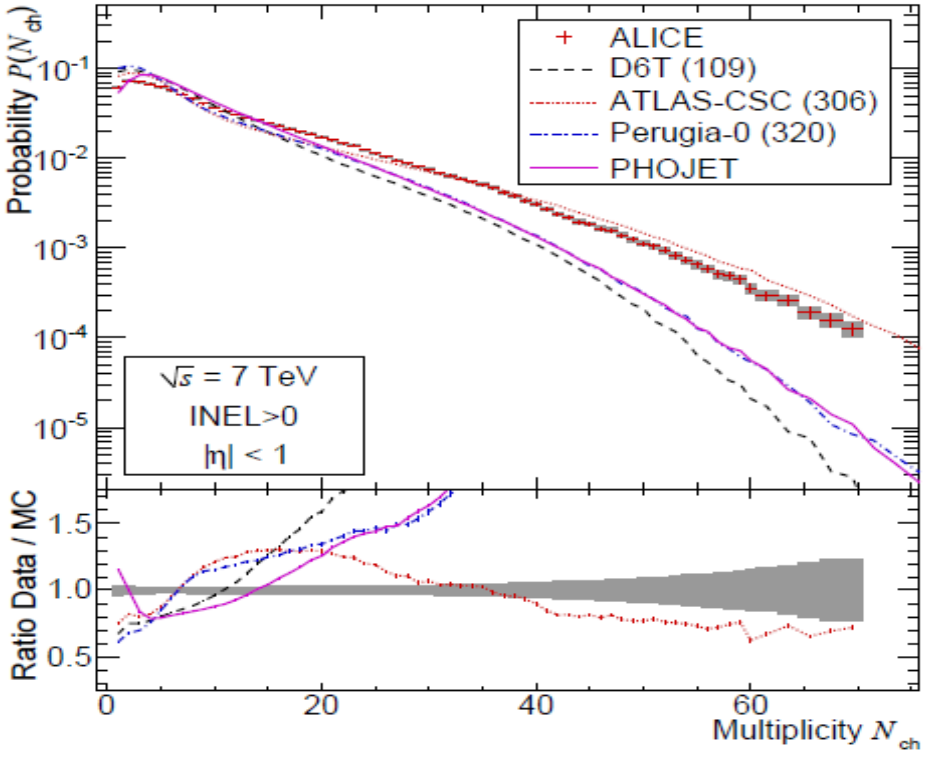


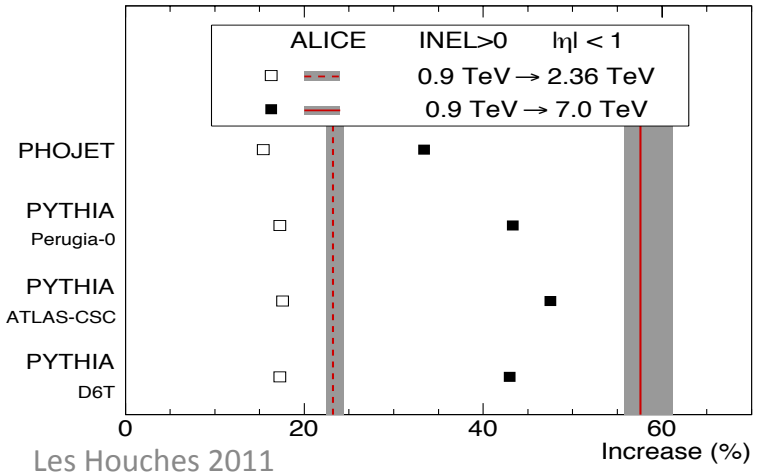


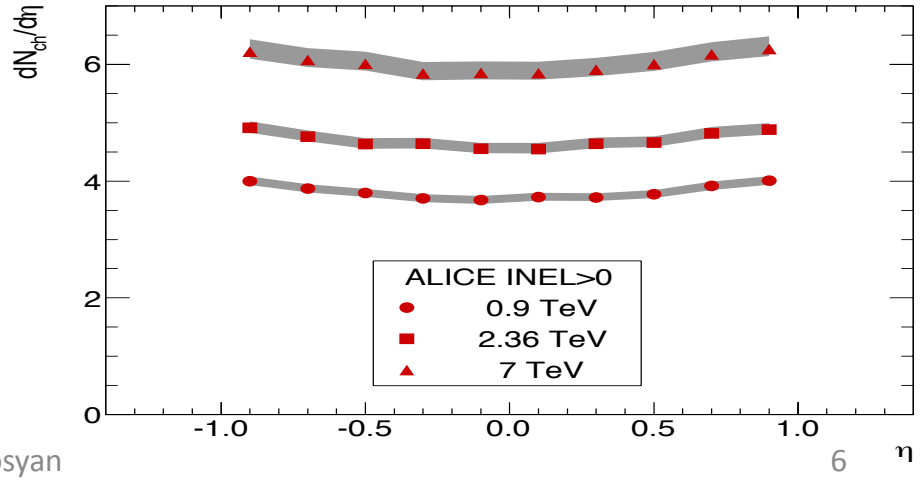
Multiplicity distribution

K. Aamodt et al., EPJ **C68** (2010) 345









How to go from Inel>0 to Inel, NSD ?

- The Inel>0 sample is an accurate measurement but
  - no data at lower energies for comparison
  - useless for analytical models
- One has to correct for diffractive processes for going from Inel>0 to Inel or NSD.
  Mainly normalization problem: densities of particles in diff. processes are rather small at mid-rapidity, but their cross-sections are not negligible.
- What is the definition of diffraction?
  Theory: coherence, quantum numbers, …. Pomeron exchange
  Experiment: rapidity gap

Understanding of diffraction dissociation of hadrons is important for understanding (non-diffractive) *hh*, *h*A and AA collisions.
Diffractive intermediate states have a small influence on *h*A and AA total cross-section (at current energies they are close to a black limit) but they have a strong impact on *hh* interaction cross-section and on inclusive spectra in *hh*, *h*A and AA collisions.

If no diffractive intermediate states:

$$pp: \quad \frac{dN}{dy} \propto \frac{1}{\sigma} s^{\Delta}$$

$$PbPb: \quad \frac{dN}{dy} \propto A^{4/3} s^{\Delta}$$

$\Delta \approx 0.12$ from fit to data on pp and ppbar total and elastic cross-section

Inel. and NSD for ALICE at 0.9 and 2.36 TeV

K. Aamodt et al., EPJ **C68** (2010) 89

- Data samples are selected as follows:

  SPD *or* V0A *or* V0C for Inel at 900 GeV (at least one charged particle in 8 units of pseudorapidity)

  V0A *and* V0C for NSD at 900 GeV

  At 2.36 TeV V0 was not in.

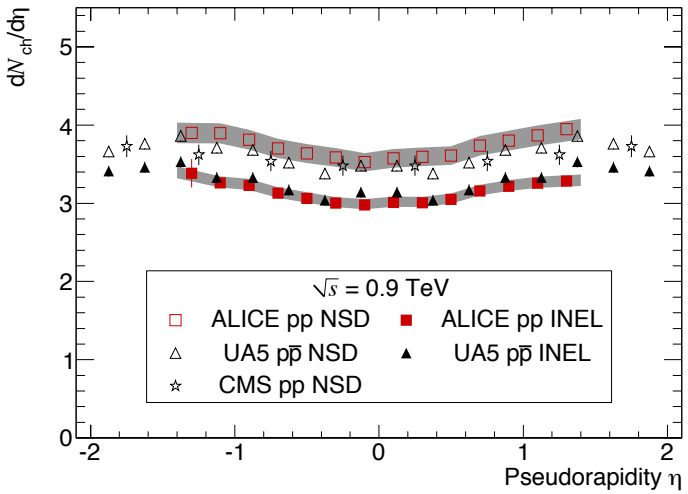
- MC (efficiency/process-type/…):

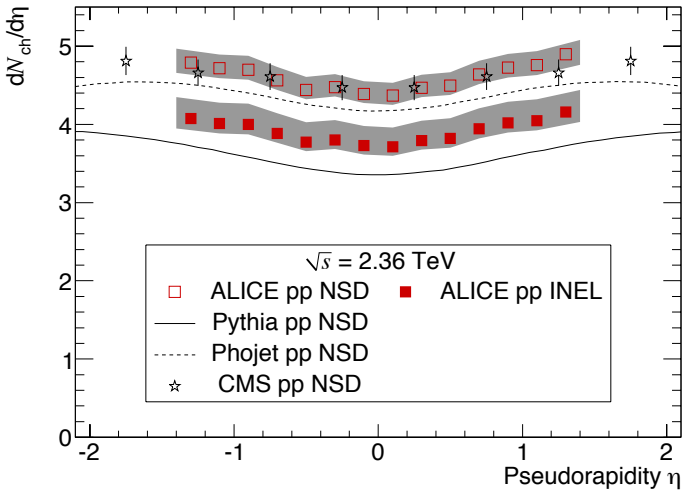
  PYTHIA and PHOJET

  SD and NSD are mixed using SD and Inel cross-sections from UA5 and E710

  at 900 GeV 0.153 ± 0.023 (UA5)

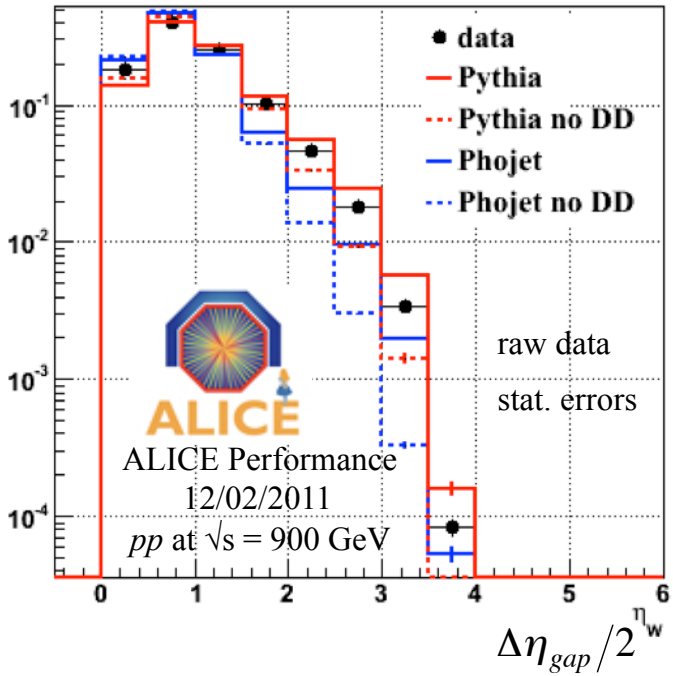
  at 1.8 TeV 0.159 ± 0.024 (E710) – practically no extrapolation needed for 2.36 TeV

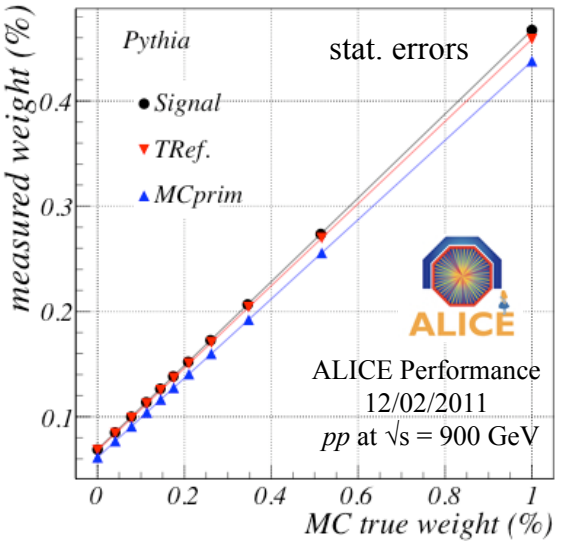


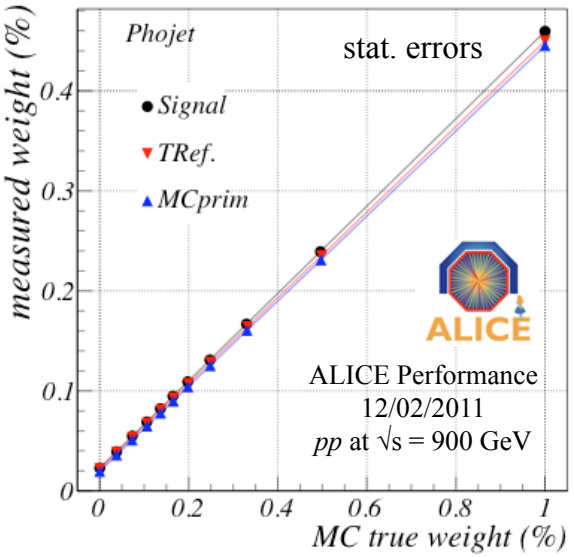


Measuring SD and DD with ALICE

Strategy: Identify diffractive process based on the kinematics of the produced particles in 9 units of pseudorapidity.



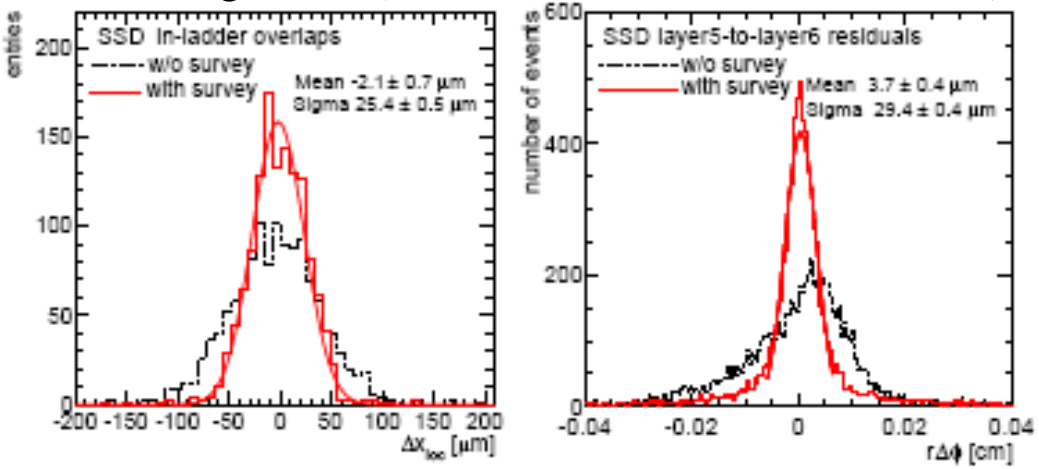




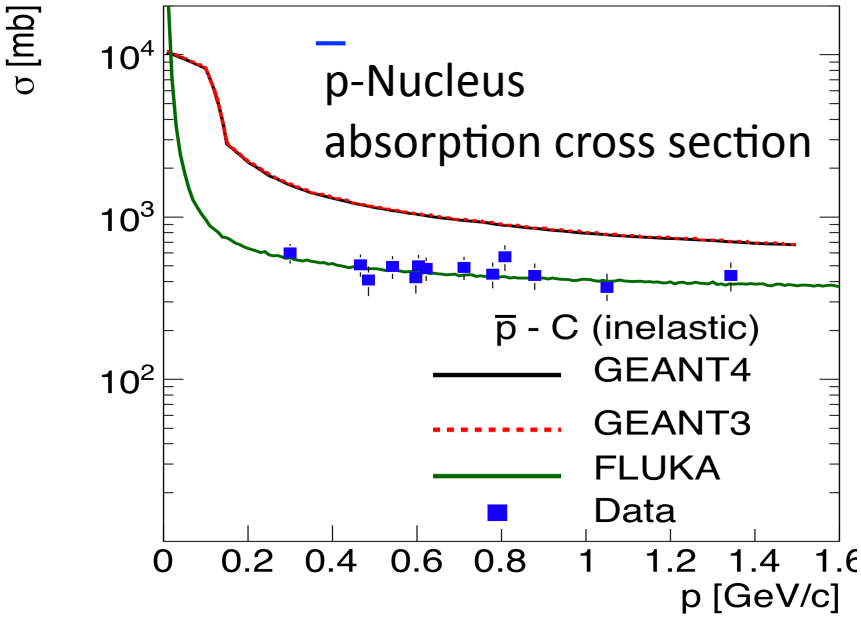
Preliminary result on σ_{SD}/σ_{NSD} at $\sqrt{s}$ = 900 GeV is in good agreement with UA5 data.

Full tracking requires much more

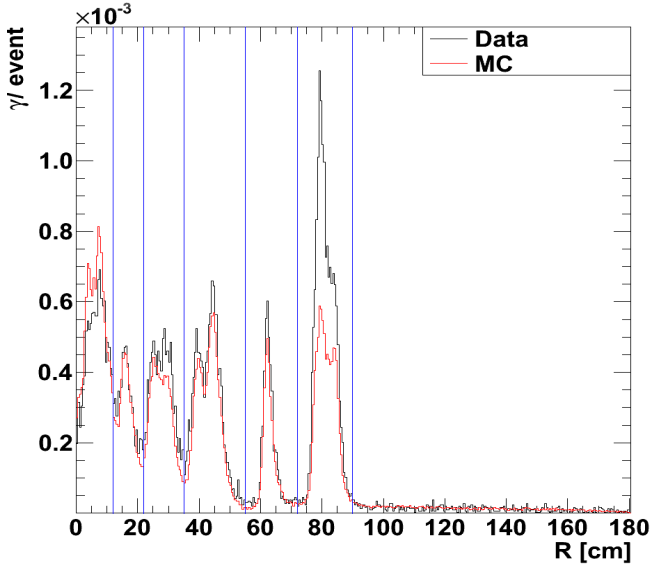
Alignment (K. Aamodt et al., J. Instrum. 5, P03003)

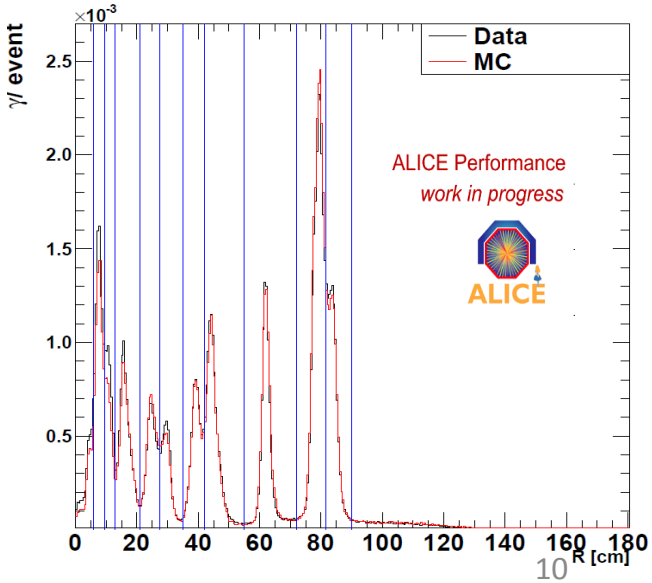


Proper transport through detector
(P. Christakoglou, ALICE-INT-2010-006)



Proper material budget description

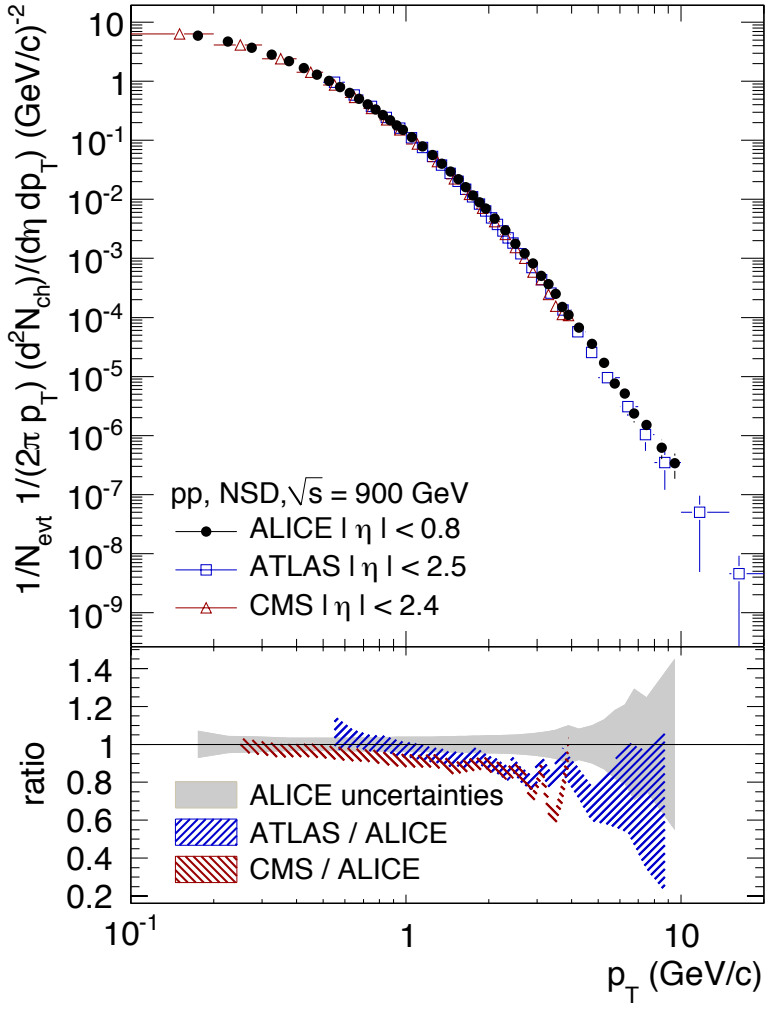


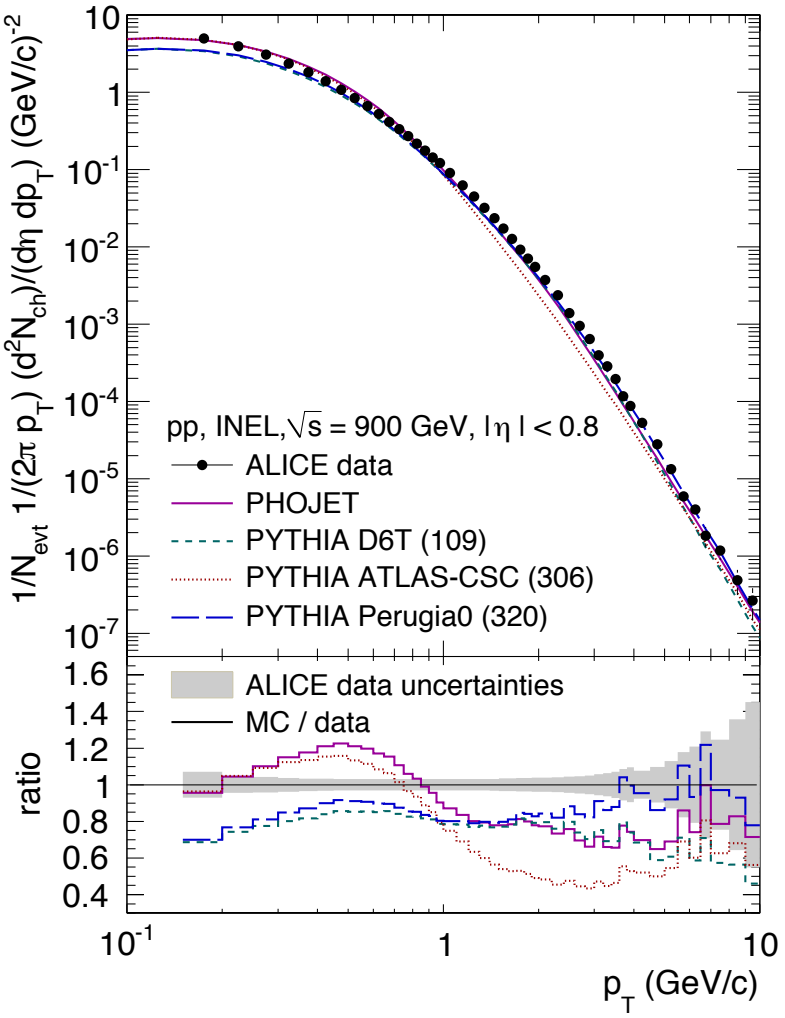


Transverse momentum distribution at 900 GeV

K. Aamodt et al., Phys. Lett. **B693** (2010) 53

ITS+TPC tracking

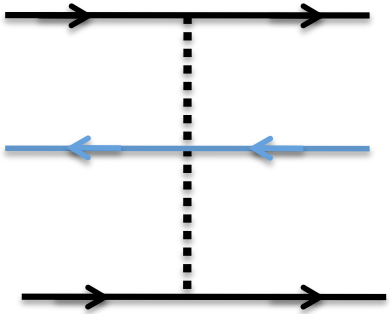




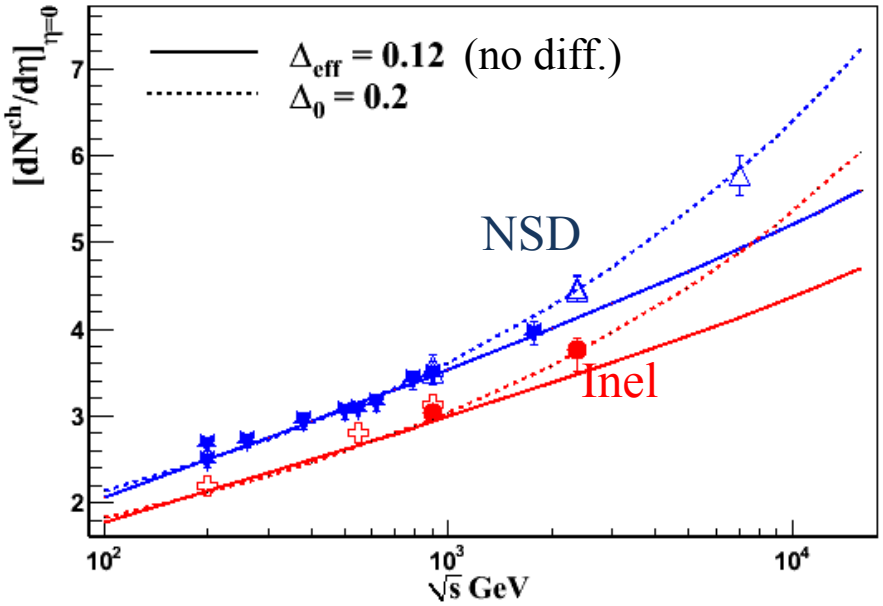
Spectrum seems to get harder towards mid-rapidity

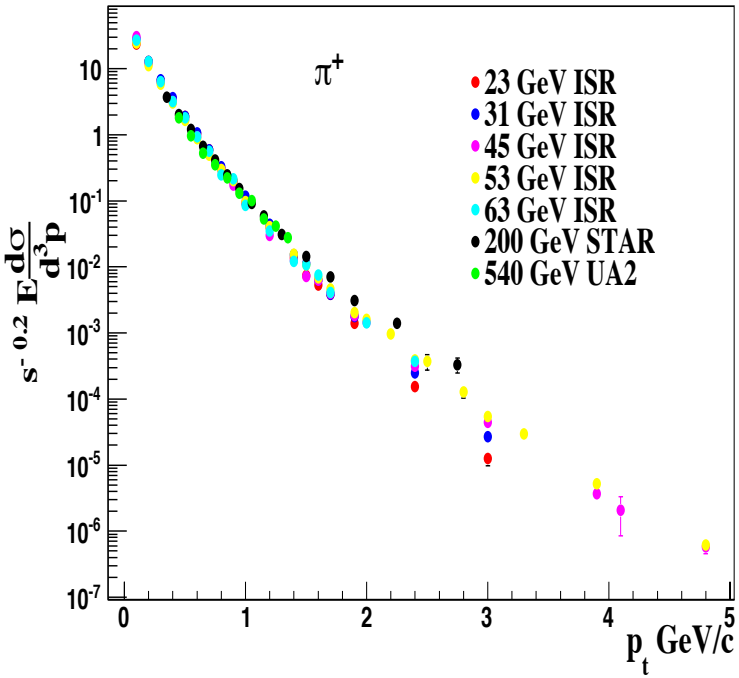
Inclusive spectra as a function of √s

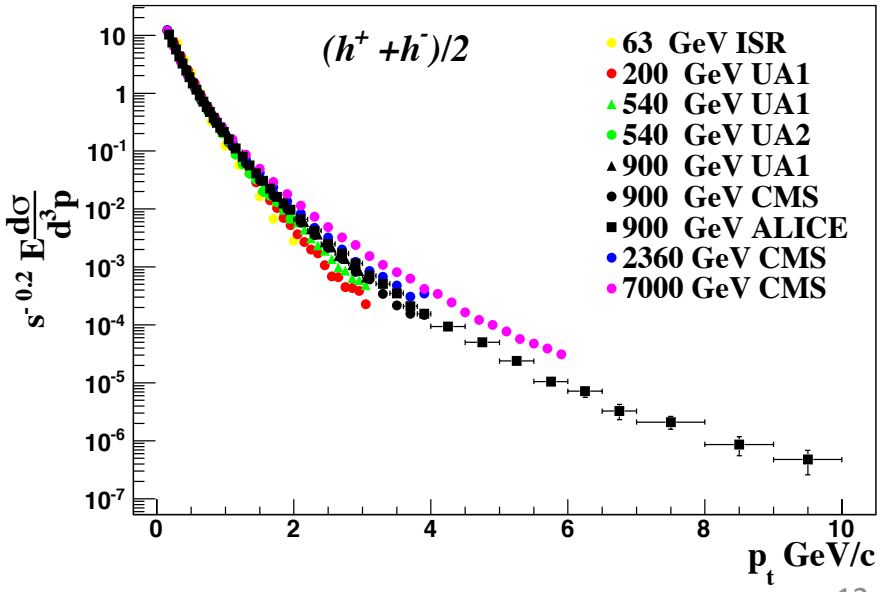
ALCIE data taken from K. Aamodt et al., EPJ **C68** (2010) 89 and Phys. Lett. **B693** (2010) 53.



$$E\frac{d\sigma}{d^3p} = s^{\Delta} f(p_t)$$







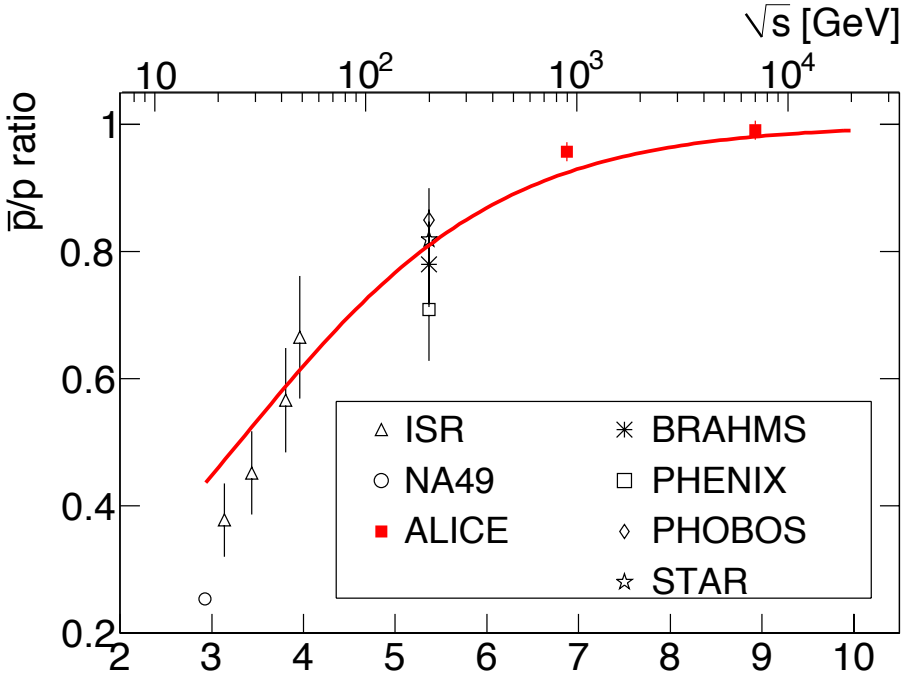
Antiproton/proton ratio at mid-rapidity

K. Aamodt et al., Phys Rev Lett. **105** (2010)

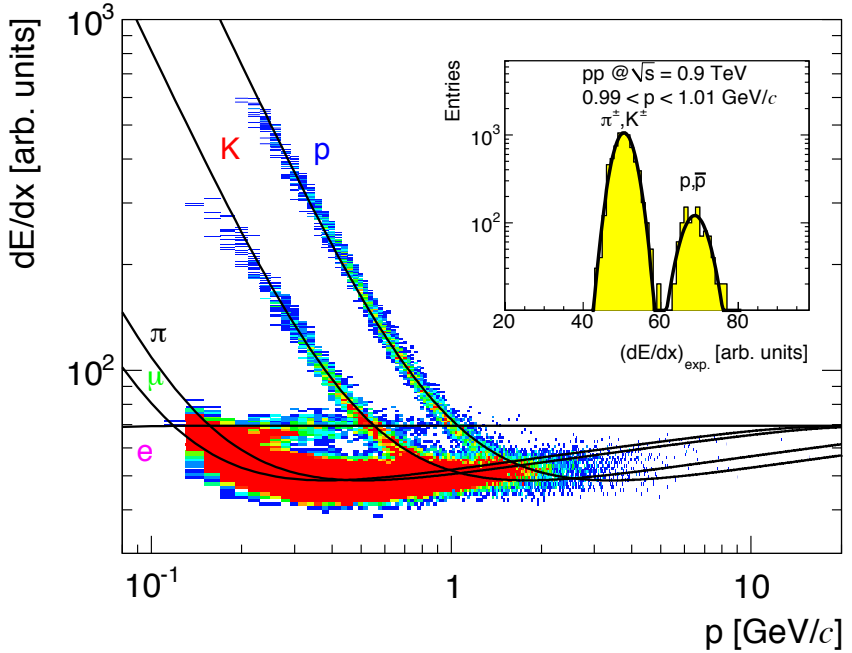
$$|y| < 0.5 \quad 0.45\ GeV < p_t < 1.05\ GeV$$

$$0.9\ TeV: \quad \bar{p}/p = 0.957 \pm 0.006 \pm 0.014$$

$$7\ TeV: \quad \bar{p}/p = 0.990 \pm 0.006 \pm 0.014$$



$$\Delta y = \tfrac{1}{2}\ln s$$



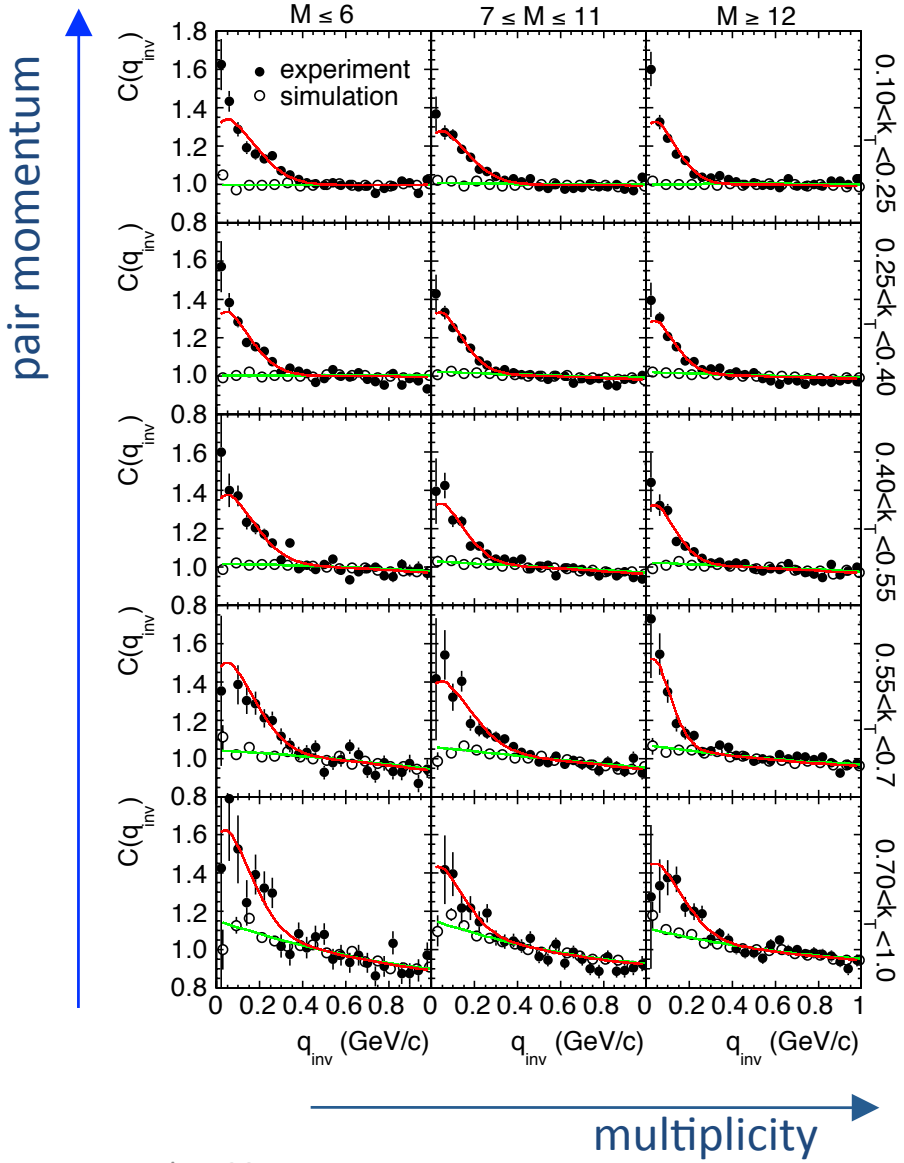
$$\frac{\bar{p}}{p} = \frac{1}{1 + C\exp\{(\alpha_{SJ} - \alpha_P)y\}}$$

$$\alpha_P = 1.2,\ \alpha_\omega = 0.5;\ \ C \approx 11$$

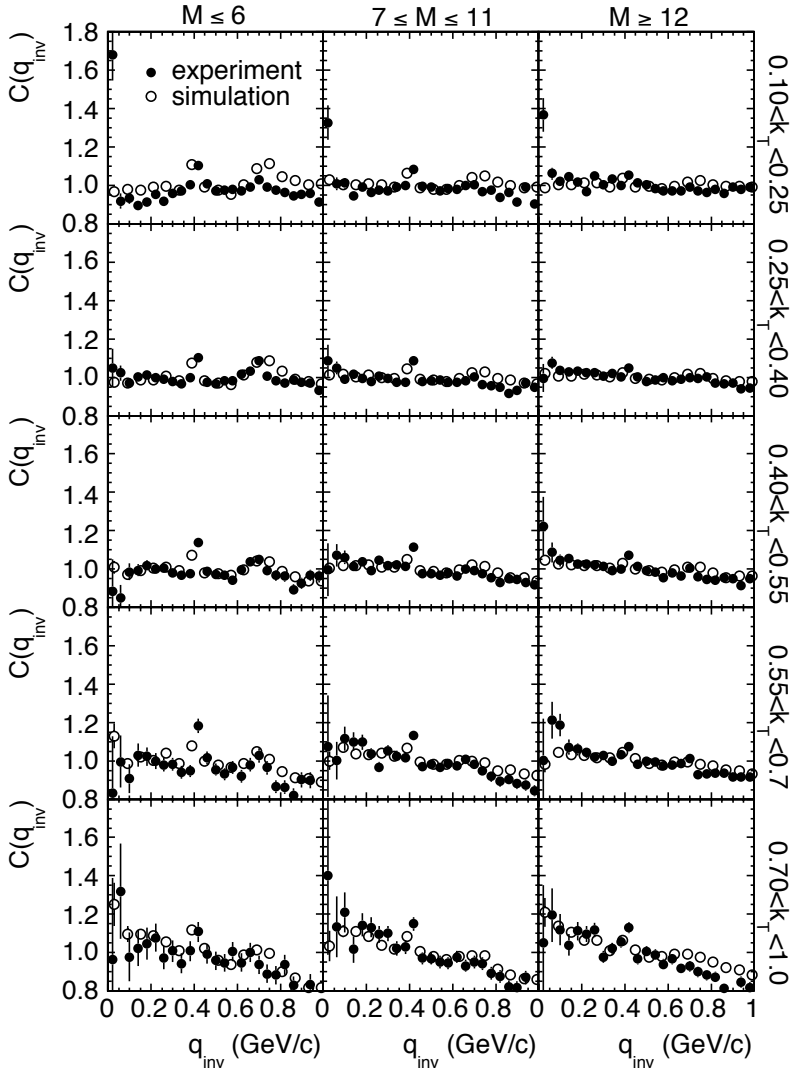
Bose–Einstein correlations (HBT)

K. Aamodt et al., Phys. Rev. **D82** (2010) 052001

identical pions

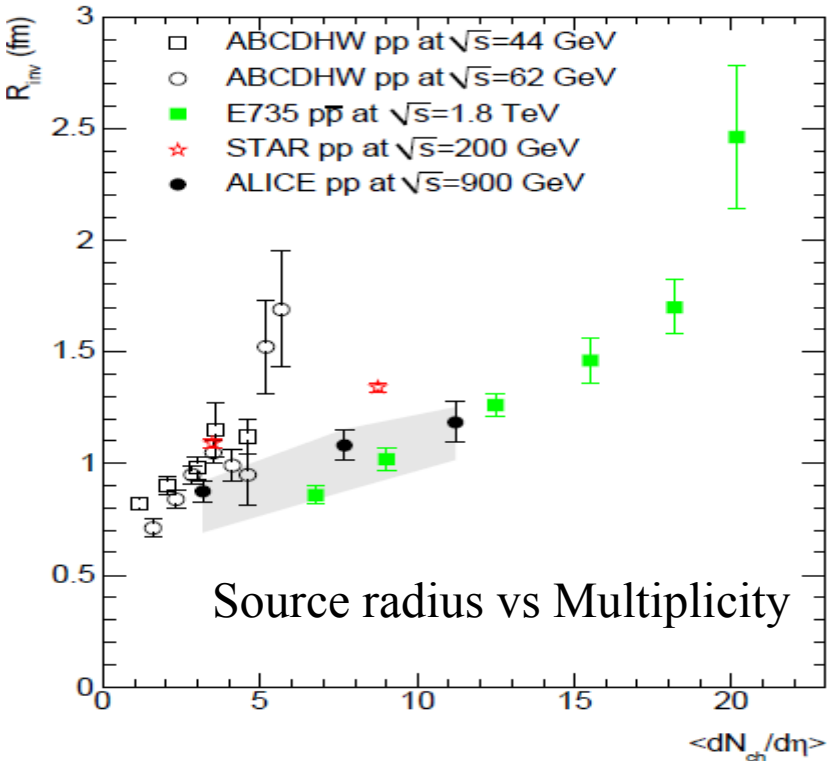


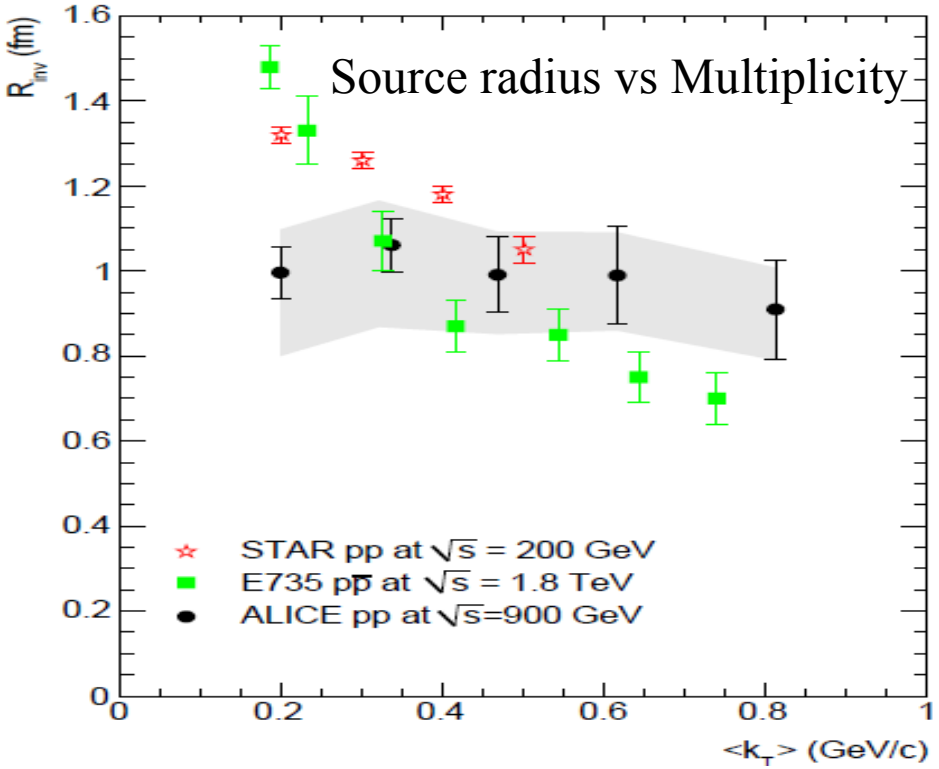
unlike-sign pions



Source radius at √s = 900 GeV

K. Aamodt et al., Phys. Rev. **D82** (2010) 052001

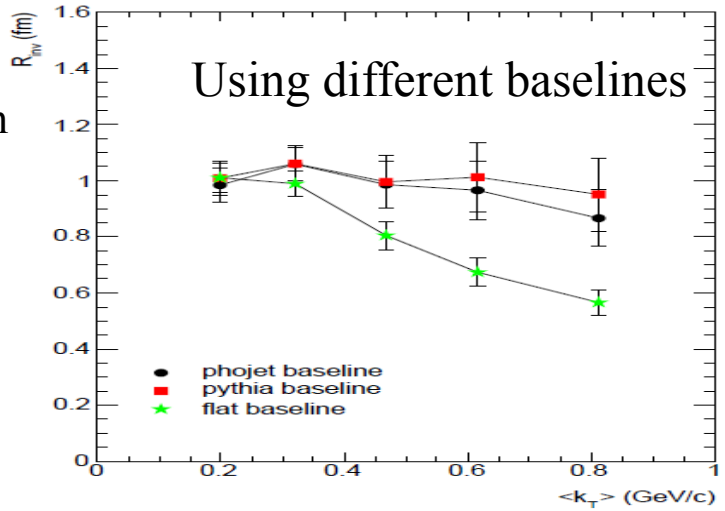




- Radius increases with N_{ch}, comparable to ISR, RHIC, Tevatron
- rather constant vs $\langle k_T \rangle$

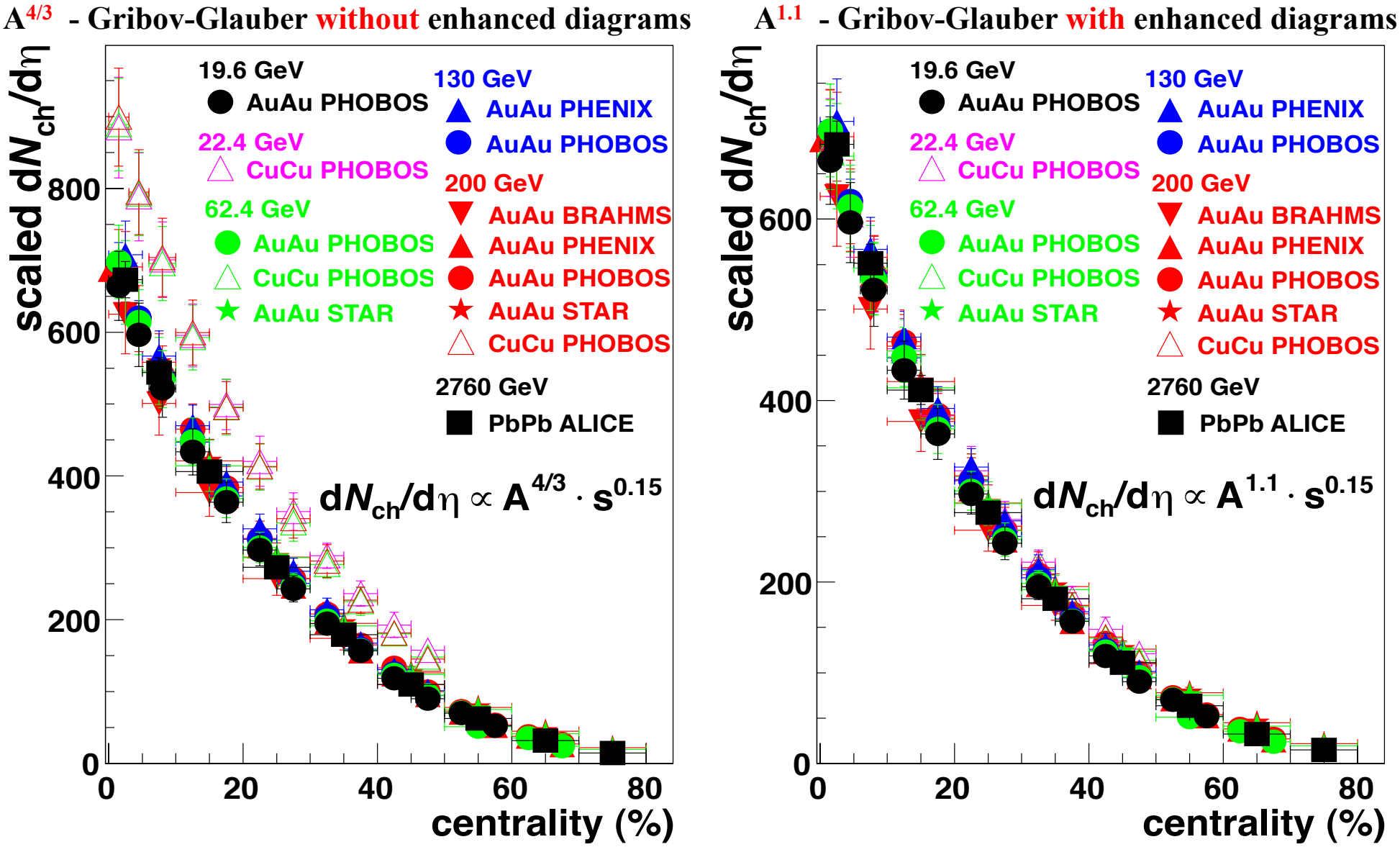
  flat baseline results to k_T dependent radius

  dependence usually interpreted as sign of 'flow' in heavy ions



dN/dη depends on $A^{4/3}$ or $A^{1.1}$?

A. Capella, A. Kaidalov, J. Tran Thanh Van, arXiv:hep-ph/9903244 (note, published before the RHIC era!)



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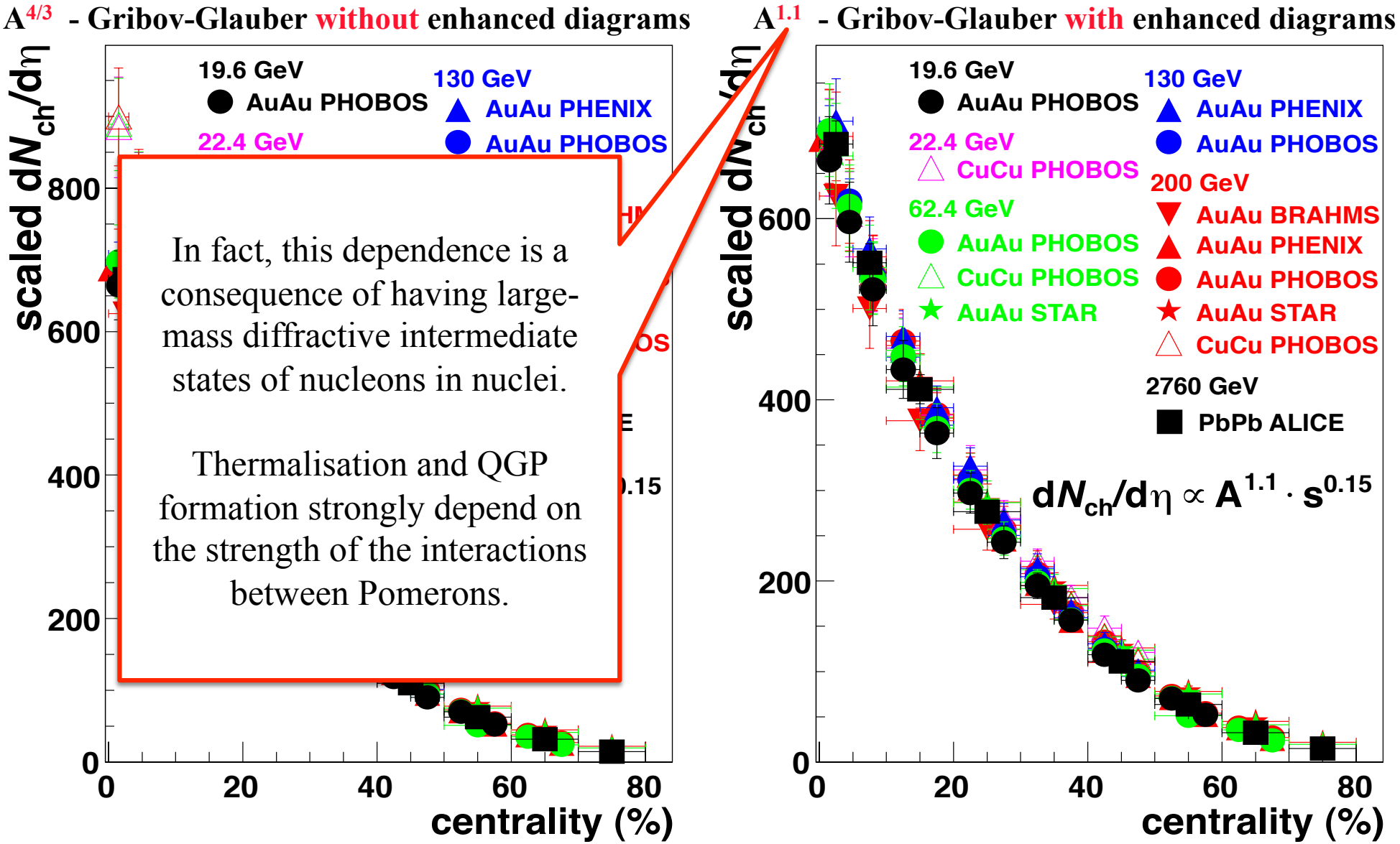


Conclusions

- ALICE is in a good shape

  Performance of track and vertex reconstruction and particle identification close to design value for both *pp* and PbPb

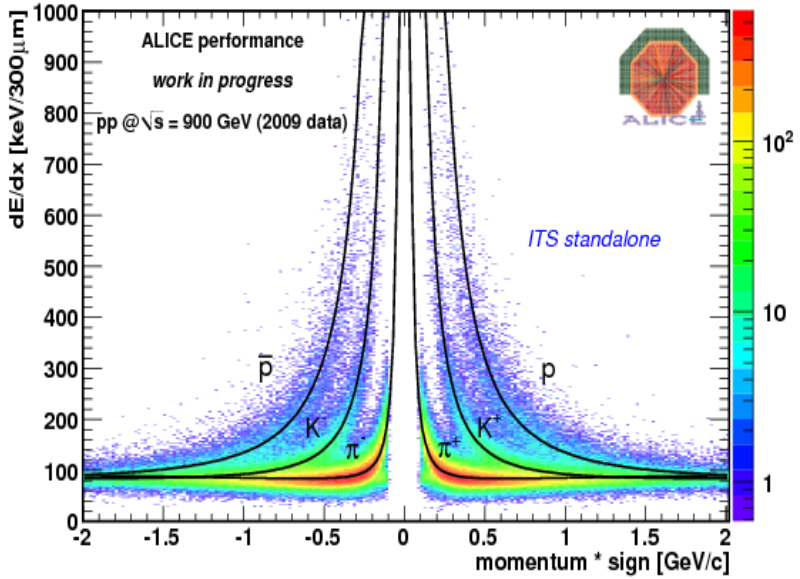
- Physics analysis well underway. Already some important results during one year of data taking:

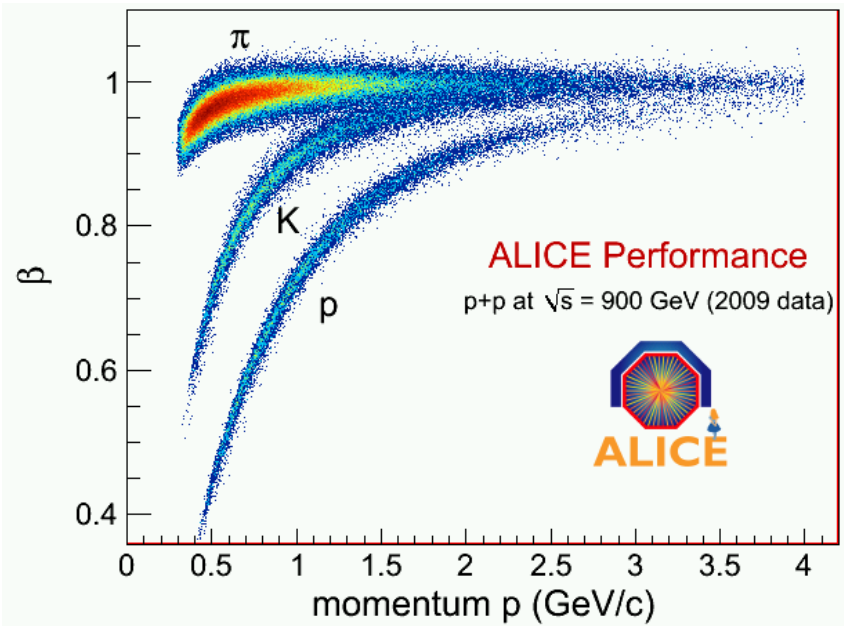
Published results	
pp	
N_{ch} multiplicity & distributions	
900 GeV:	EPJ **C65** (2010) 111
900 GeV, **2.36** TeV:	EPJ **C68** (2010) 89
7 TeV:	EPJ **C68** (2010) 345
Momentum distributions (**900** GeV)	Phys. Lett. **B693** (2010) 53
Bose Einstein correlations (**900** GeV)	Phys. Rev. **D82** (2010) 052001
pbar/p ratio (**900** GeV & **7** TeV)	Phys Rev Lett **105** (2010)
Pb-Pb	
Multiplicity in central collisions	Phys. Rev. Lett. **105** (2010) 252301
v2	Phys. Rev. Lett. **105** (2010) 252302
RAA	Phys. Lett. **B696** (2011) 30
Multiplicity vs centrality	arXiv:1012.1657
Bose Einstein correlations	Phys. Lett. **B696** (2011) 328

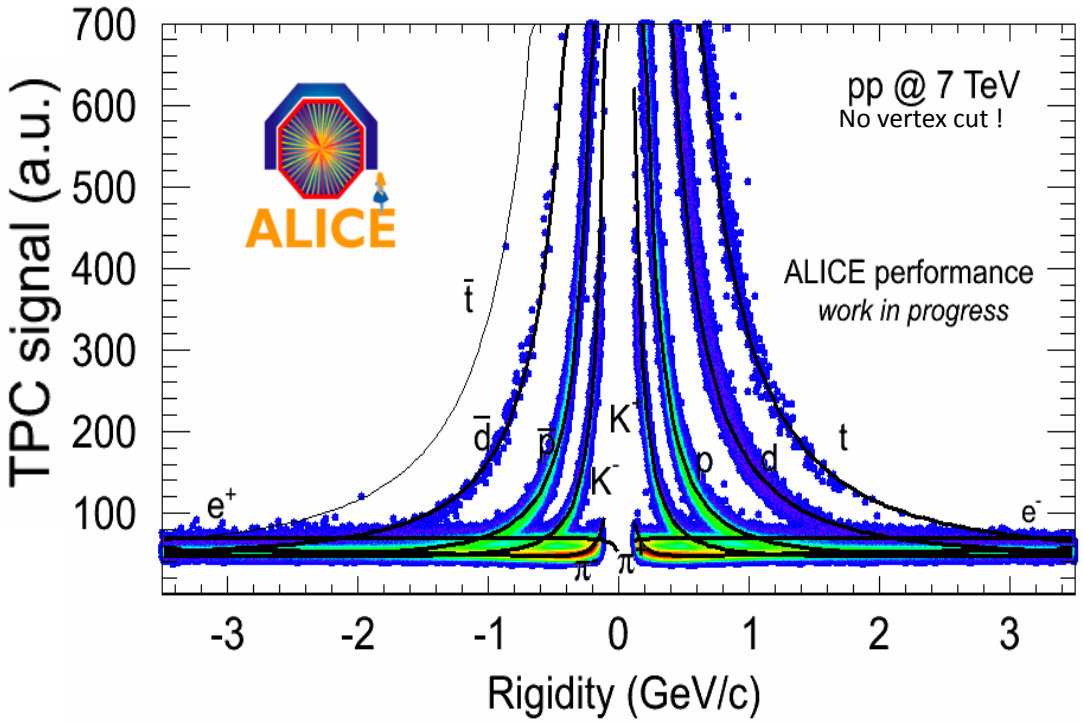
Many ongoing analysis…

Backup slides

Particle Identification

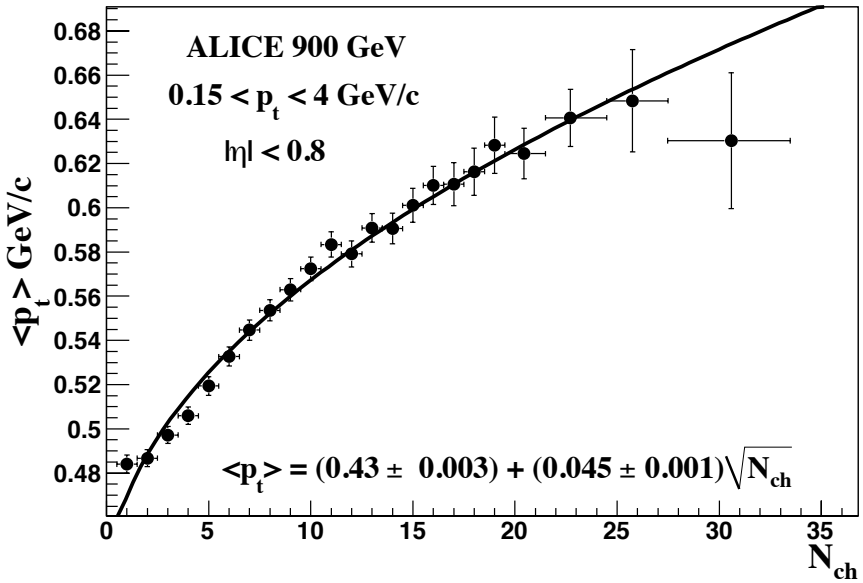


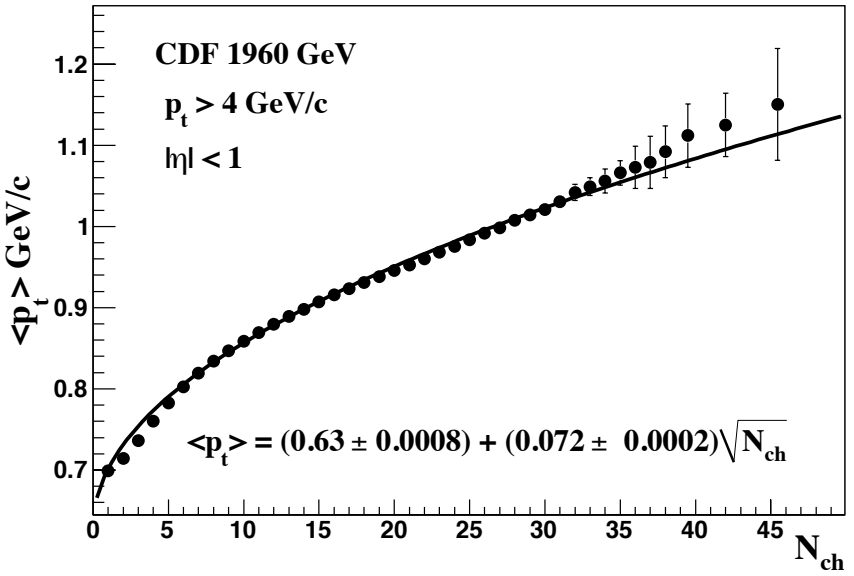




$\langle p_t \rangle$ as a function of N_{ch}

ALCIE data taken from K. Aamodt et al., Phys. Lett. **B693** (2010) 53





Number of cut Pomerons $\sim s^{\Delta}$

$p_t^2 \sim$ Number of cut Pomerons

Number of charged particles ~ Number of cut Pomerons

$$\Rightarrow p_t \sim \sqrt{N_{ch}}$$