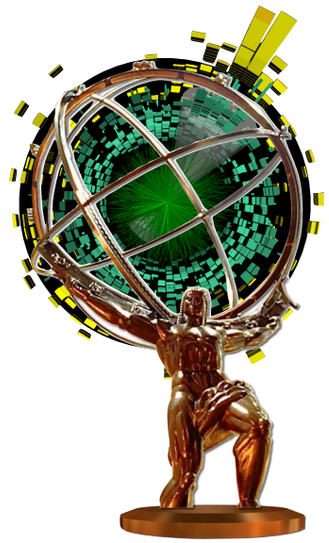


QUARK MATTER ANNECY 2011

COLUMBIA UNIVERSITY

Measurement of charged particle pseudorapidity density in Pb+Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV with the ATLAS detector

Yujiao Chen, for the ATLAS Collaboration

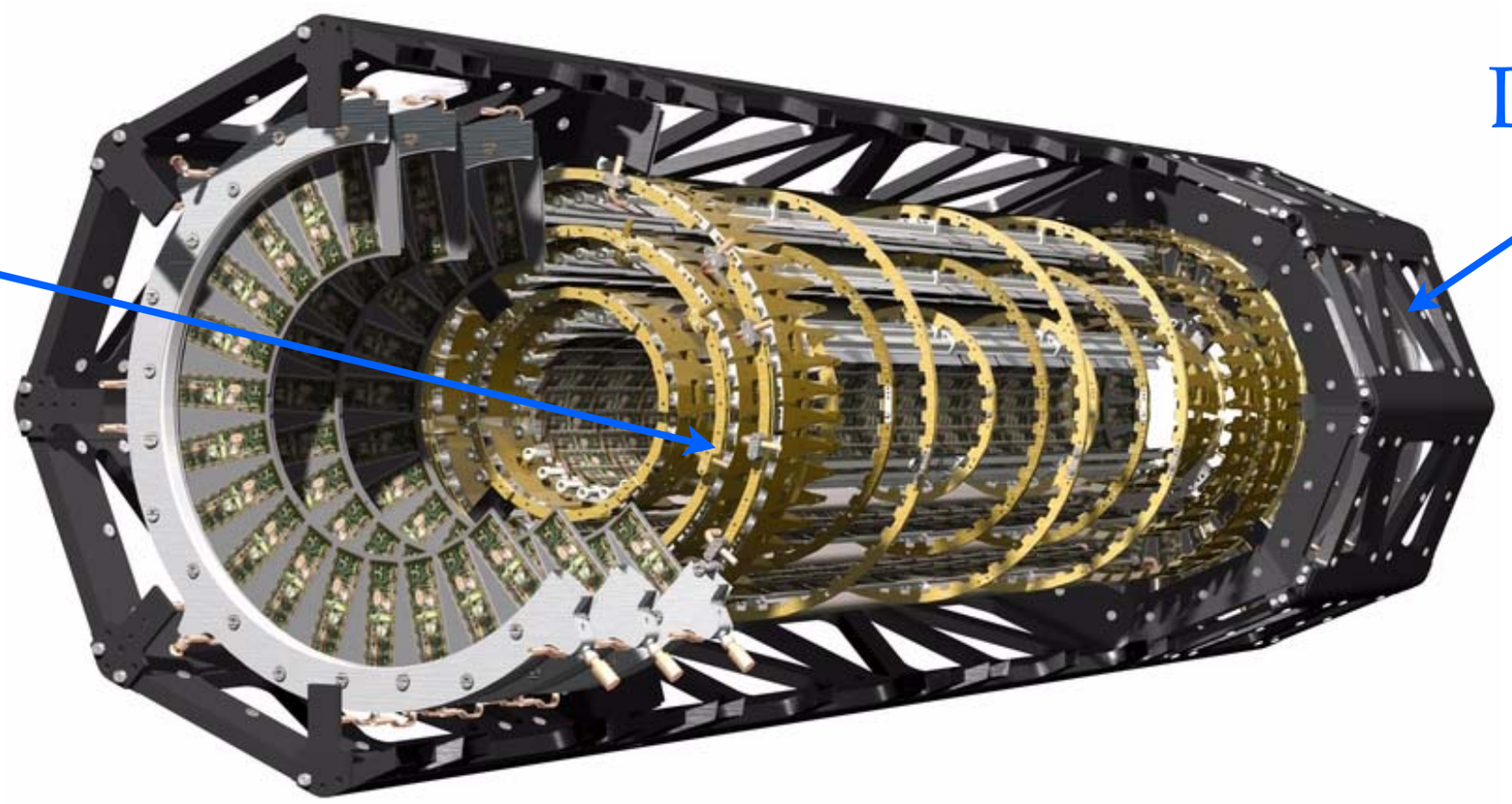
Physics department, Columbia university

Introduction

- Connection with energy/entropy production in early stages of heavy ion collisions.
- Past measurements exhibit interesting geometrical scaling properties.
  - ➡ Multiplicity at mid-rapidity scales faster than $\langle N_{part} \rangle$, but in a way that is energy independent.
  - ➡ Total multiplicity scales with $\langle N_{part} \rangle$.
- Hard to predict:
  - ➡ Low momentum regime
  - ➡ Non-perturbative QCD
  - ➡ Multiple body interactions
  - ➡ Different approaches: CGC, empirical scaling rules, Landau hydrodynamics etc

ATLAS pixel detector

- High precision tracking device, very close to beam pipe.
- Three barrel layers (50.5, 88.5, 122.5 mm in radius), six disk layers, three on each side.
- Active area≈1.8 m^2 with ≈ 80×10^6 pixels arranged into 1744 modules.
- Placed in a 2 T solenoid field when turned on. B-field was off for this analysis.
- Pixel barrel used in this analysis, $|\eta|<2.0$



Methods description

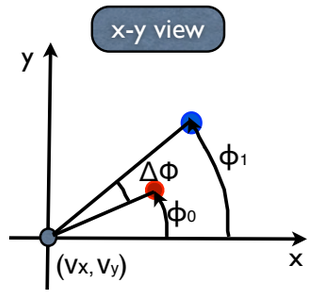
✦ Pixel tracking: ATLAS standard tracking algorithm, pixel detector only

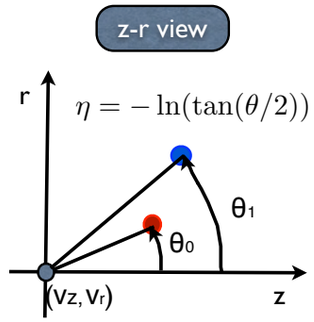
✦ Two-point tracklet method:

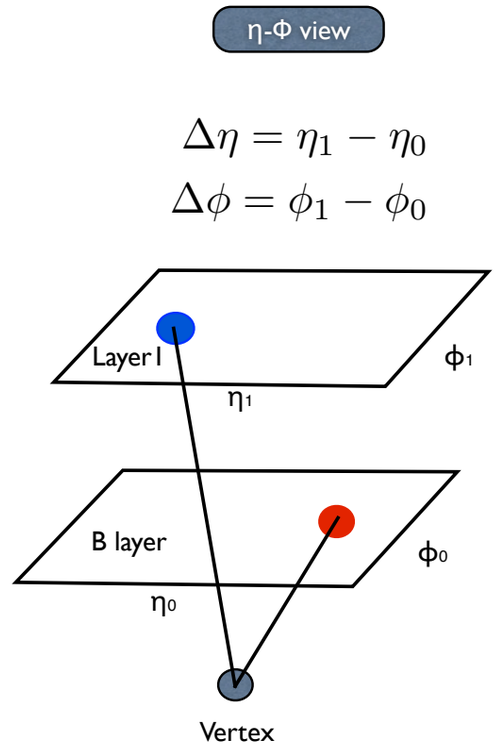
❖ Select high quality clusters.

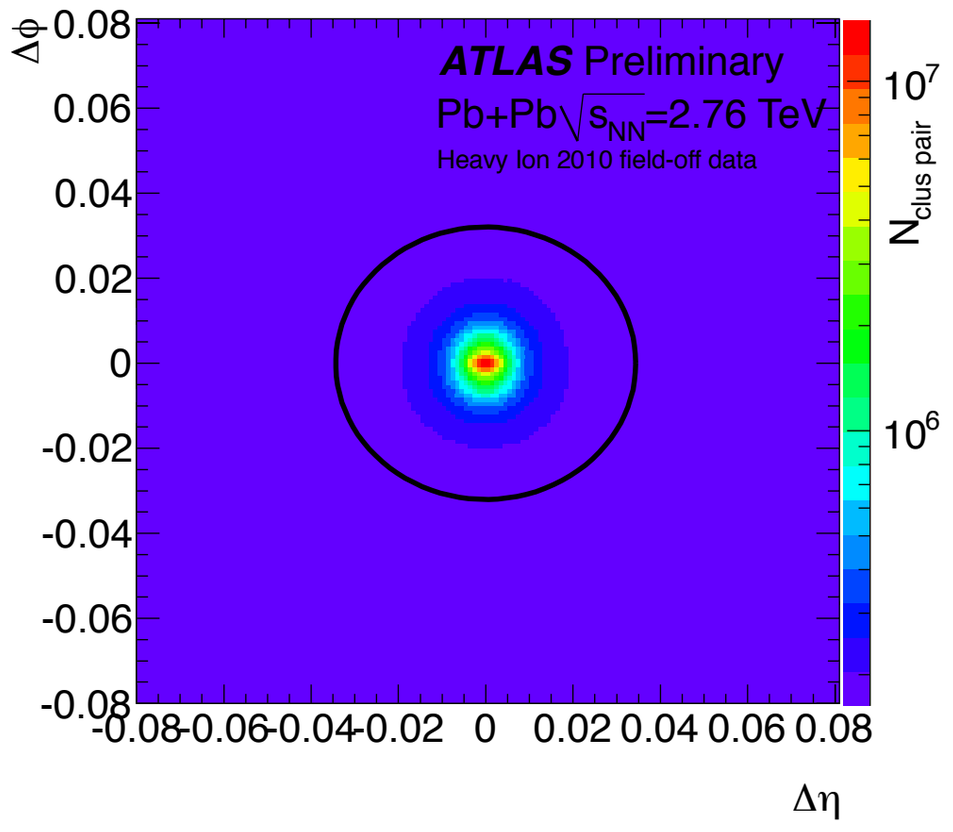
❖ Select cluster pairs aligned with primary vertex:

$$\sqrt{\left(\frac{\Delta\eta}{\sigma_{\Delta\eta}}\right)^2+\left(\frac{\Delta\phi}{\sigma_{\Delta\phi}}\right)^2} < 3*\sqrt{2}$$









Two-point tracklet method

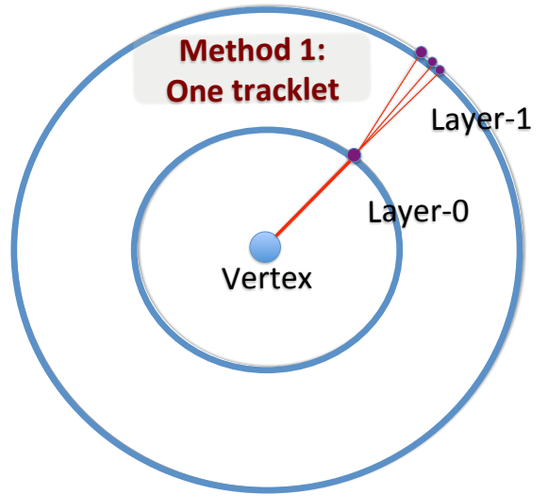
✦Two methods used to count tracklets.

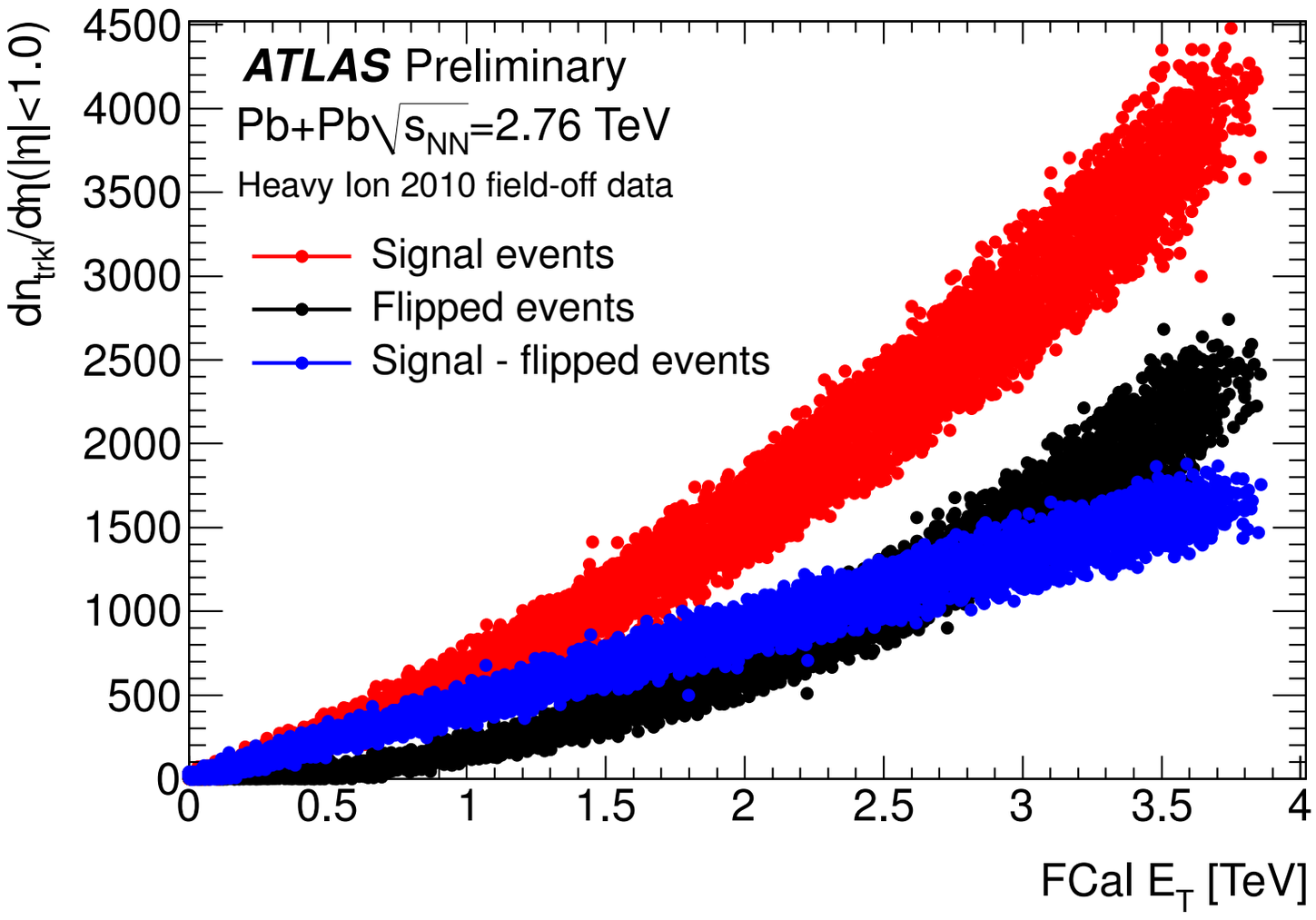
➡Method 1: multiple associations to layer-0 treated as one tracklet.

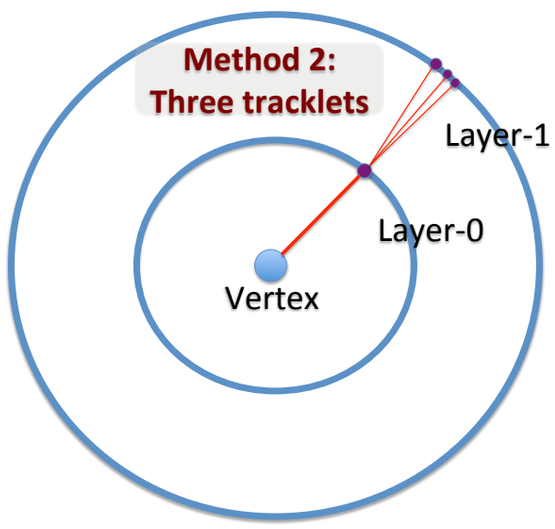
➡Method 2: multiple associations to layer-0 treated as multiple tracklet candidates.

❖Flipped event: $(z - Vz) \rightarrow -(z - Vz)$, $\Phi \rightarrow \pi - \Phi$

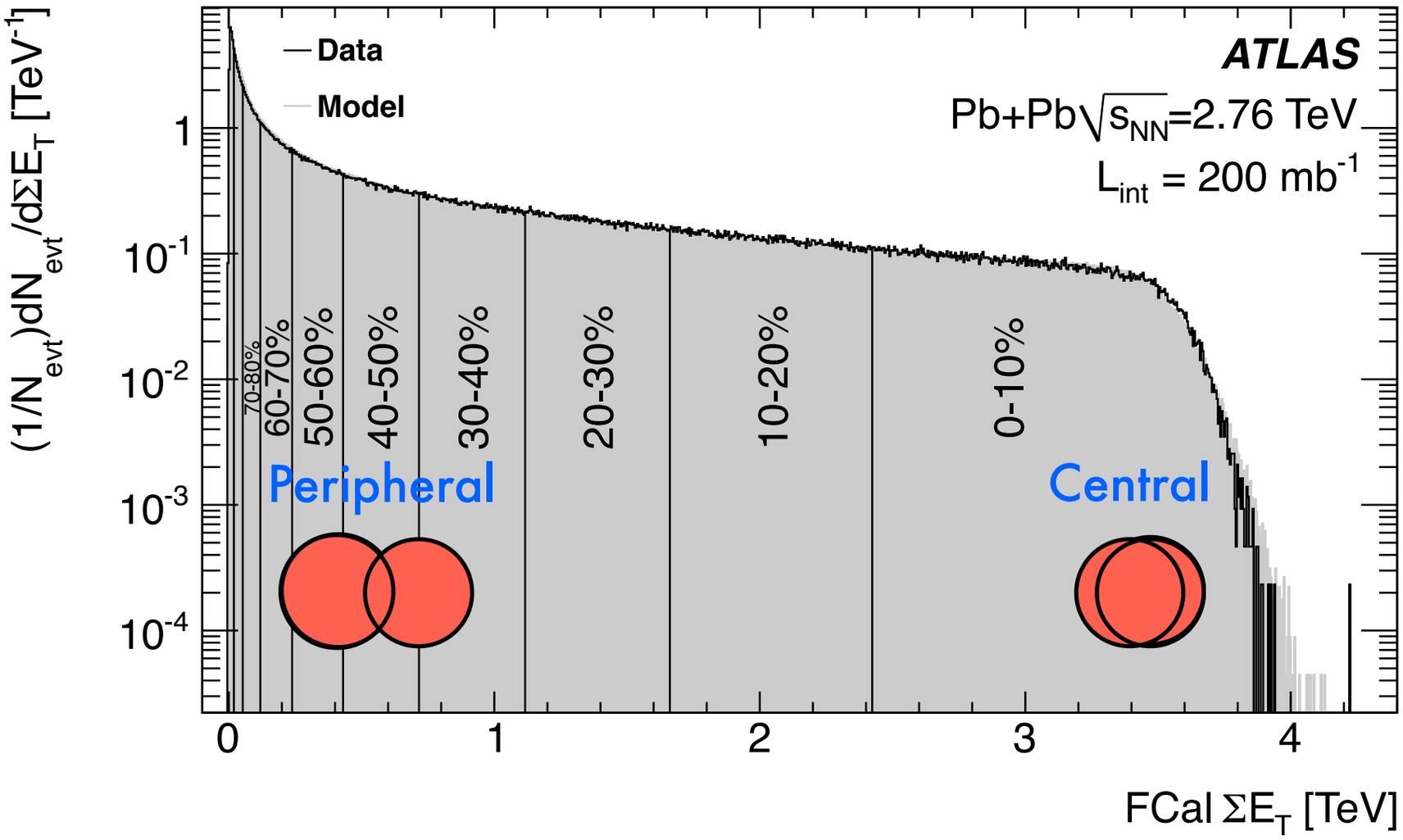
❖Subtract combinatorics using flipped events







Centrality definition



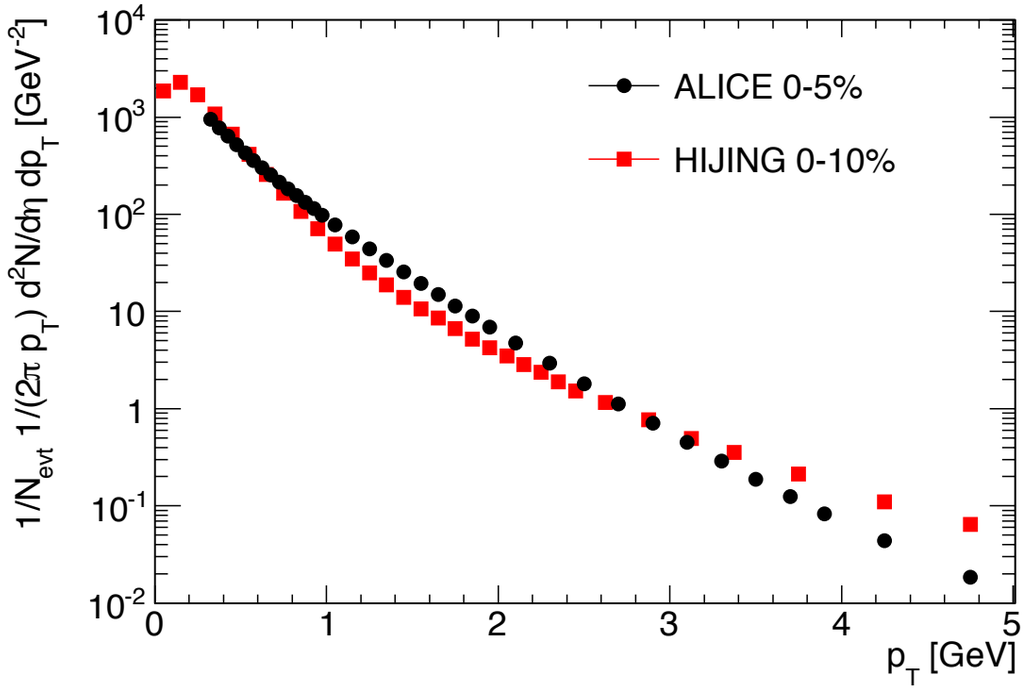
- Use Forward calorimeter transverse energy
  $3.2<|\eta|<4.9$

  ➡ Sampling fraction: $f = 100 \pm 2\%$

MC samples p_T re-weighting

✦HIJING p_T spectrum differs significantly from data.

✦HIJING spectrum much higher at low p_T.



✦Re-weighting Procedure:

➡A re-weighting function is applied to HIJING sample to account for p_T difference between data and MC, used only for corrections, not for p_T measurement.

➡Re-weighting function is obtained from pixels tracks from B-on data.

➡The re-weighted HIJING spectrum agrees relatively well with data.

Correction procedure

✦Pixel tracking:

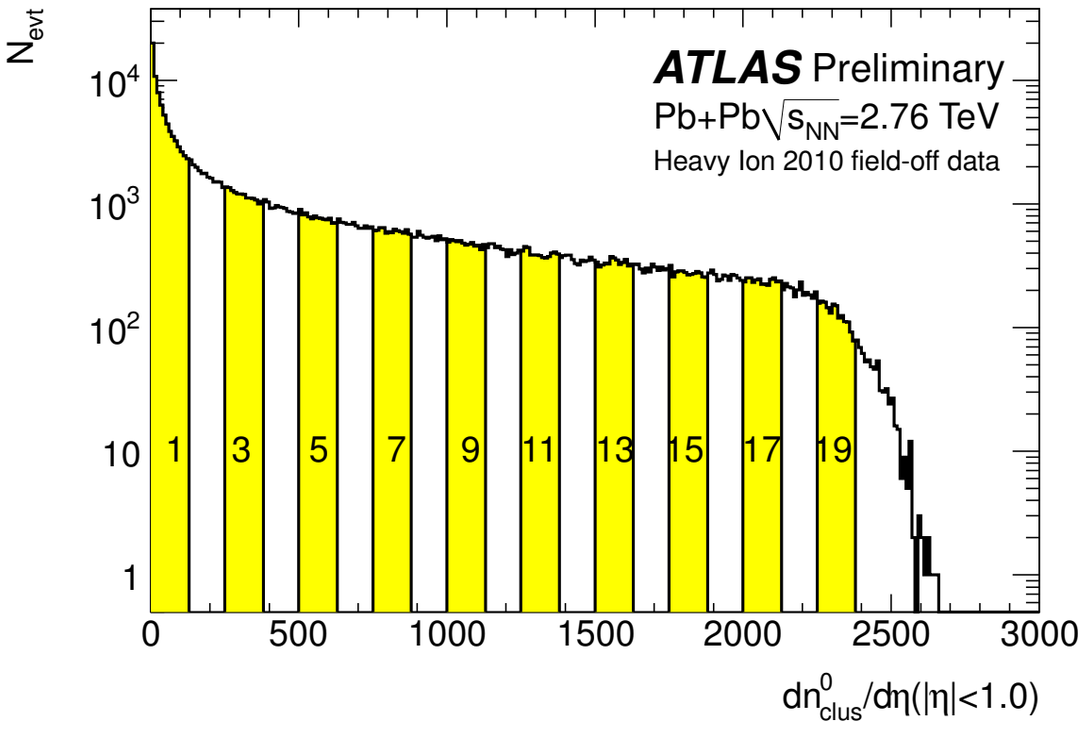
Efficiency: $\epsilon_{pt}(\eta) = \frac{N_{pr}^{match}(\eta)}{N_{pr}(\eta)}$, Background: $b_{pt}(\eta) = \frac{N_{pt}^{backg}(\eta)}{N_{pt}(\eta)}$

Correction factor: $$C_{pt}(\eta) = \frac{1 - b_{pt}^{backg}(\eta)}{\epsilon_{pt}(\eta)}$$

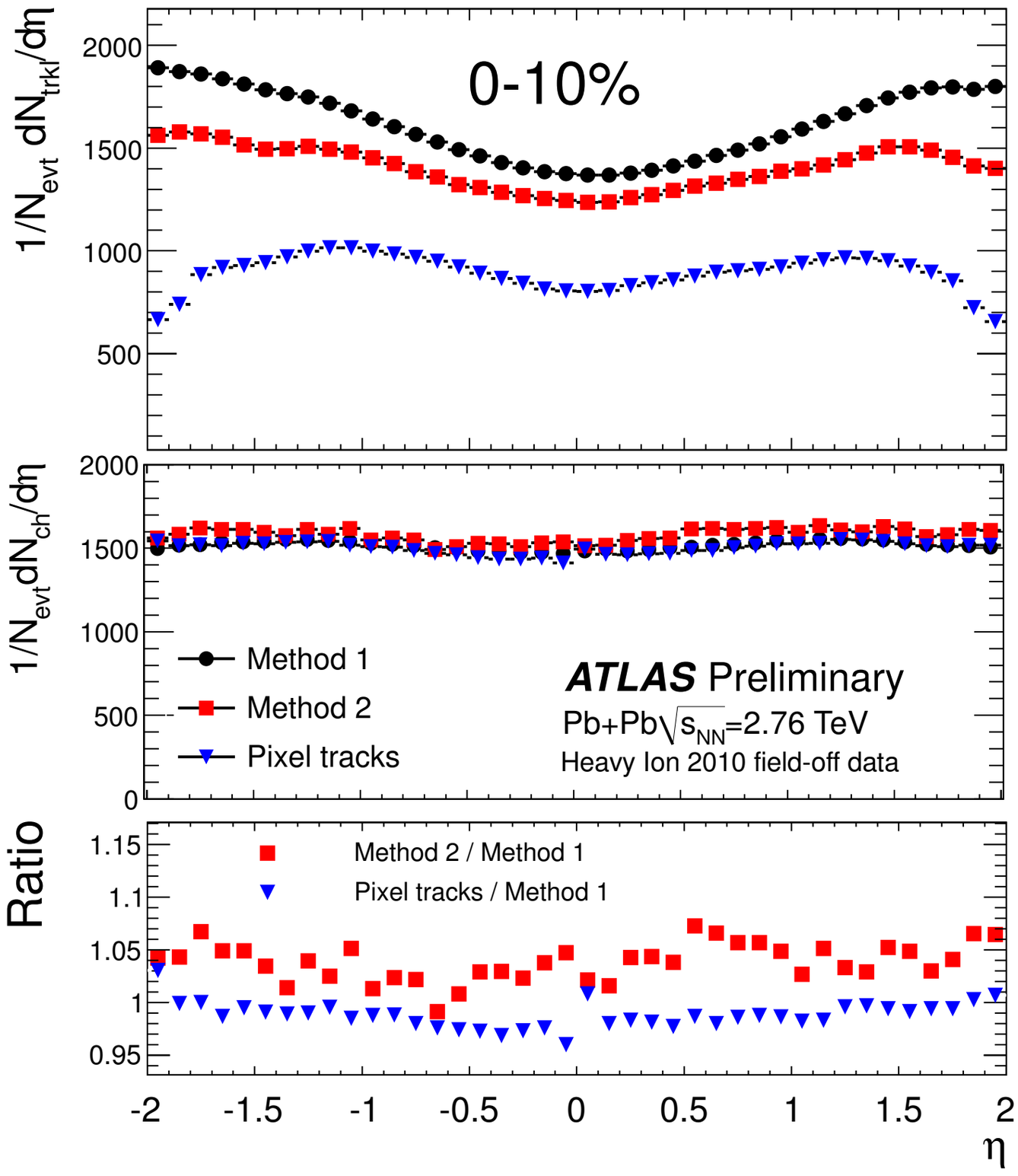
✦Tracklet methods:

Correction factor: $C_{2pt}(\eta) = \frac{N_{pr}(\eta)}{N_{2pt}(\eta)}$

✦Correction factors are calculated in different occupancy intervals ($dn^0_{clus}/d\eta(|\eta|<1.0)$).



Comparison of three methods



Raw

Corrected

Ratio

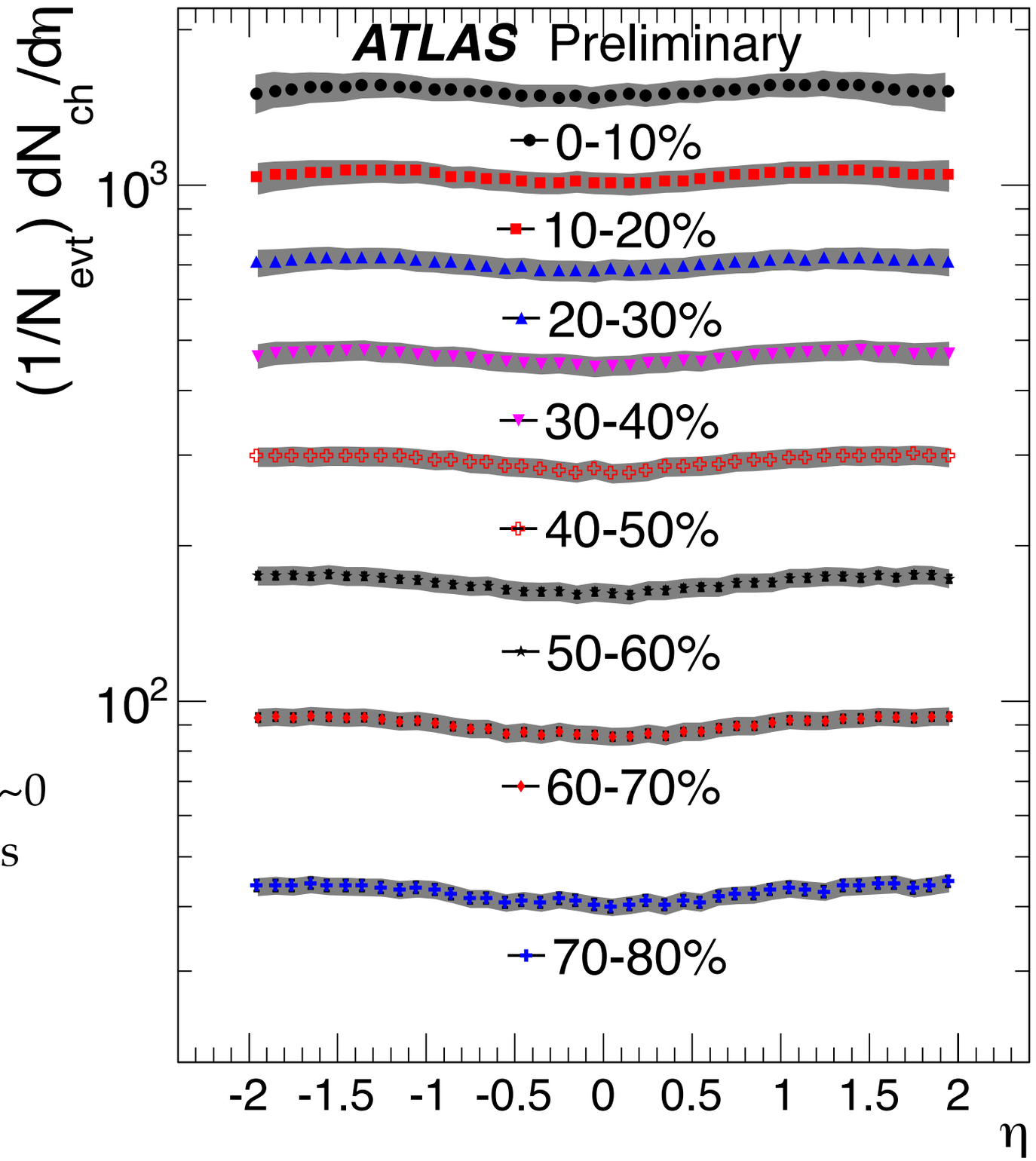
$dN_{ch}/d\eta$ distribution

Systematic uncertainties

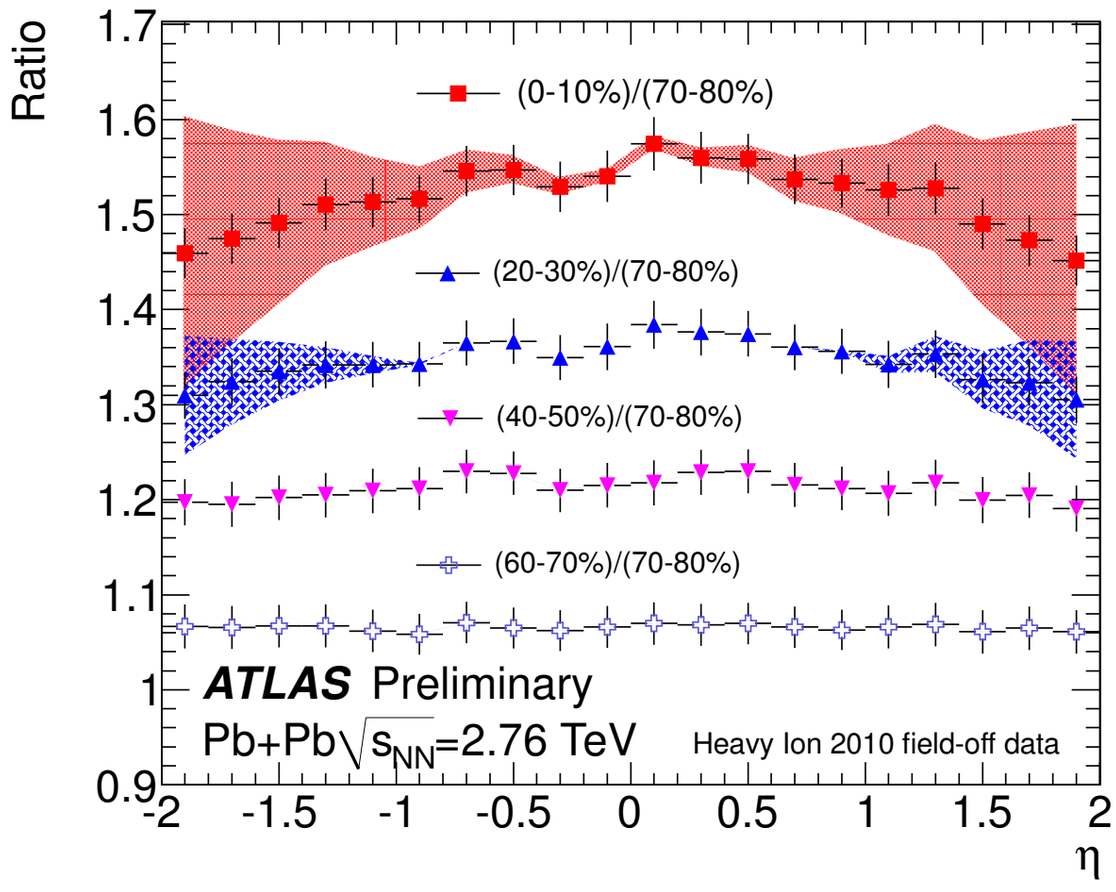
Source	Uncertainty (0-10%)	(70-80%)
MC detector description	0.4%	0.4%
Extra material	2%	2%
$\Delta\mathcal{R}$ cut	1%	1%
p_{T} re-weighting	0.5%	0.5%
Hadron flavor composition	1%	1%
Enhanced K_s, Λ.	1%	1%
HYDJET	0.5-7.5% vs. η	0%
Analysis Method	3.5%	1%
Combined ($\eta = 0$)	4%	3%
Combined ($\eta = 2$)	8.5%	3%

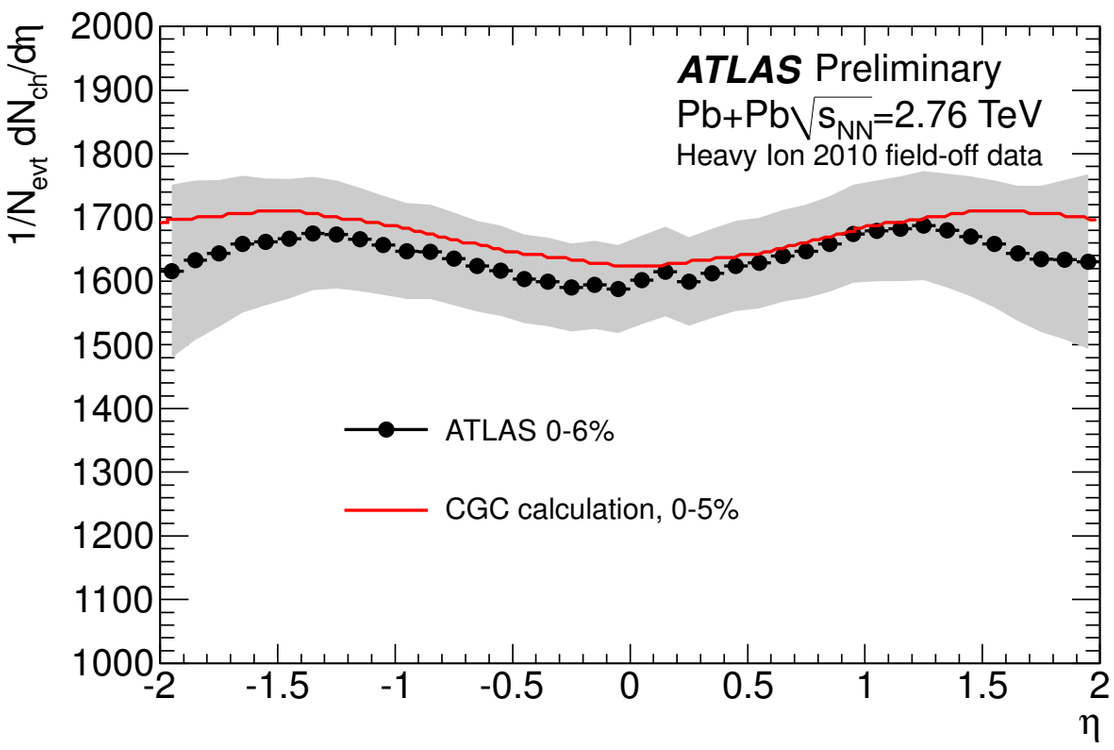
5% increase of yield from η~0
to η~1 in peripheral events

(30-80% centrality class)



$dN_{ch}/d\eta$ distribution

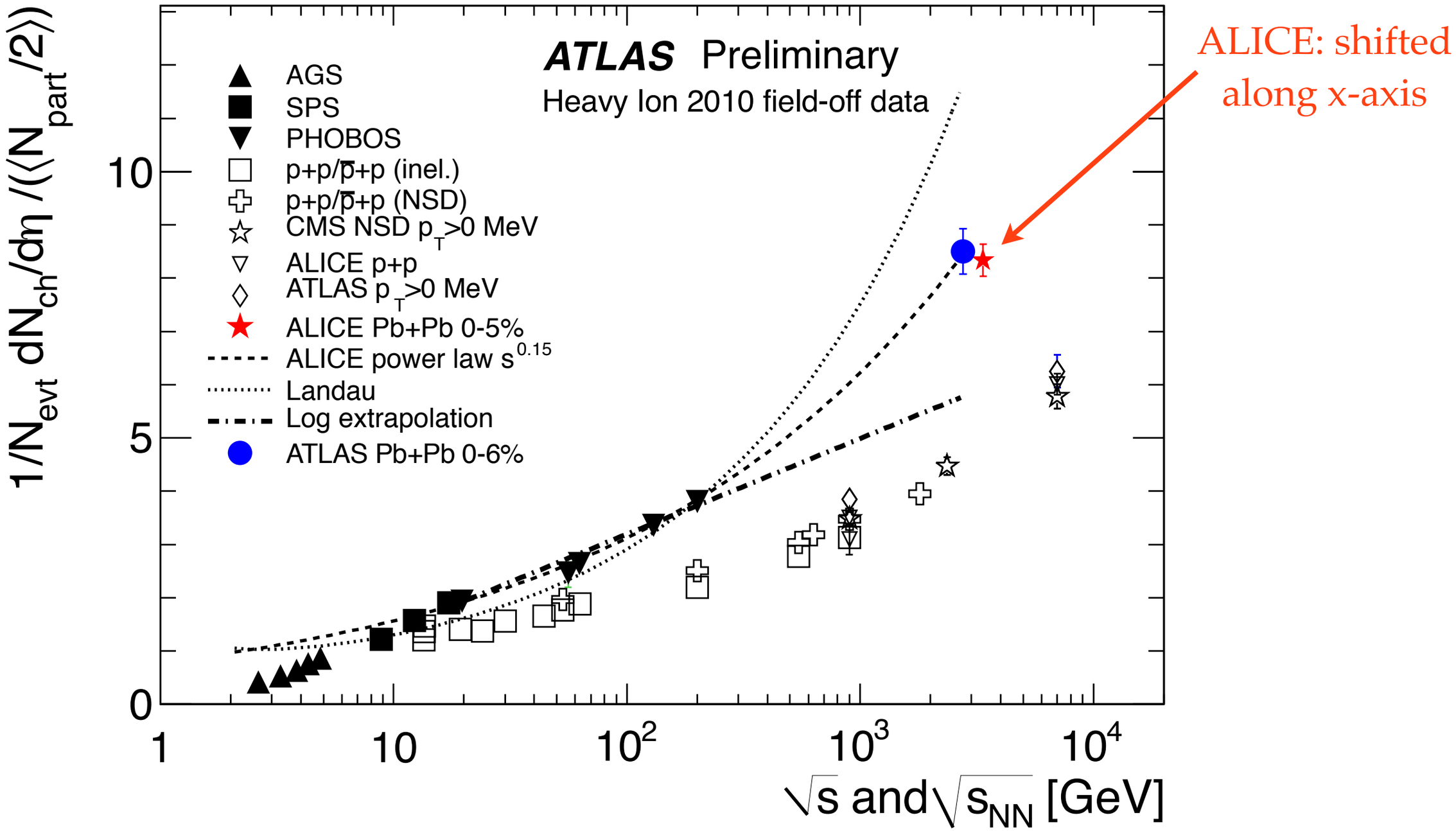




Ratio of central to peripheral

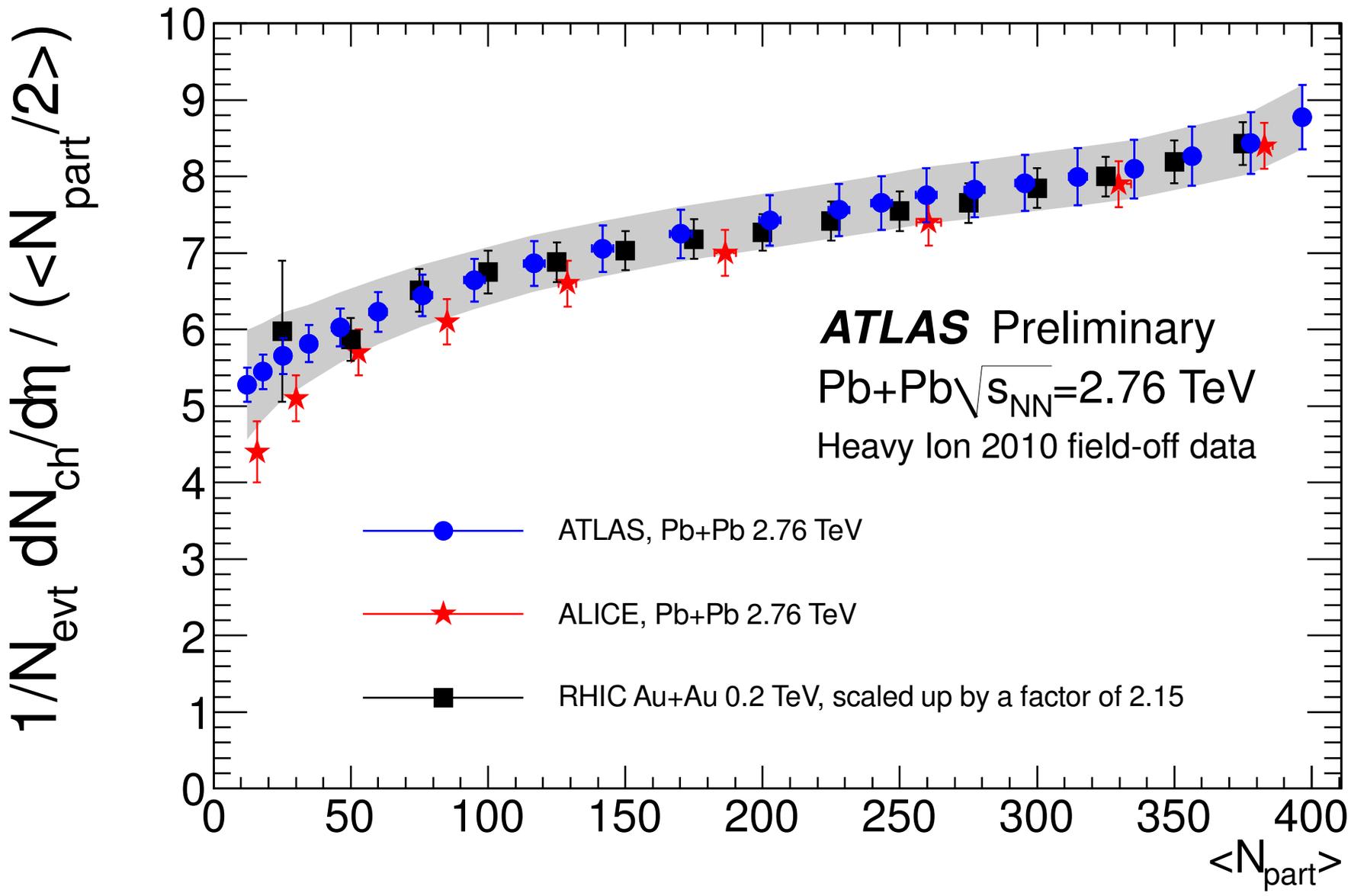
Eugene Levin,
Amir H. Rezaeian,
arXiv:1102.2385 [hep-ph]

s_{NN} dependence



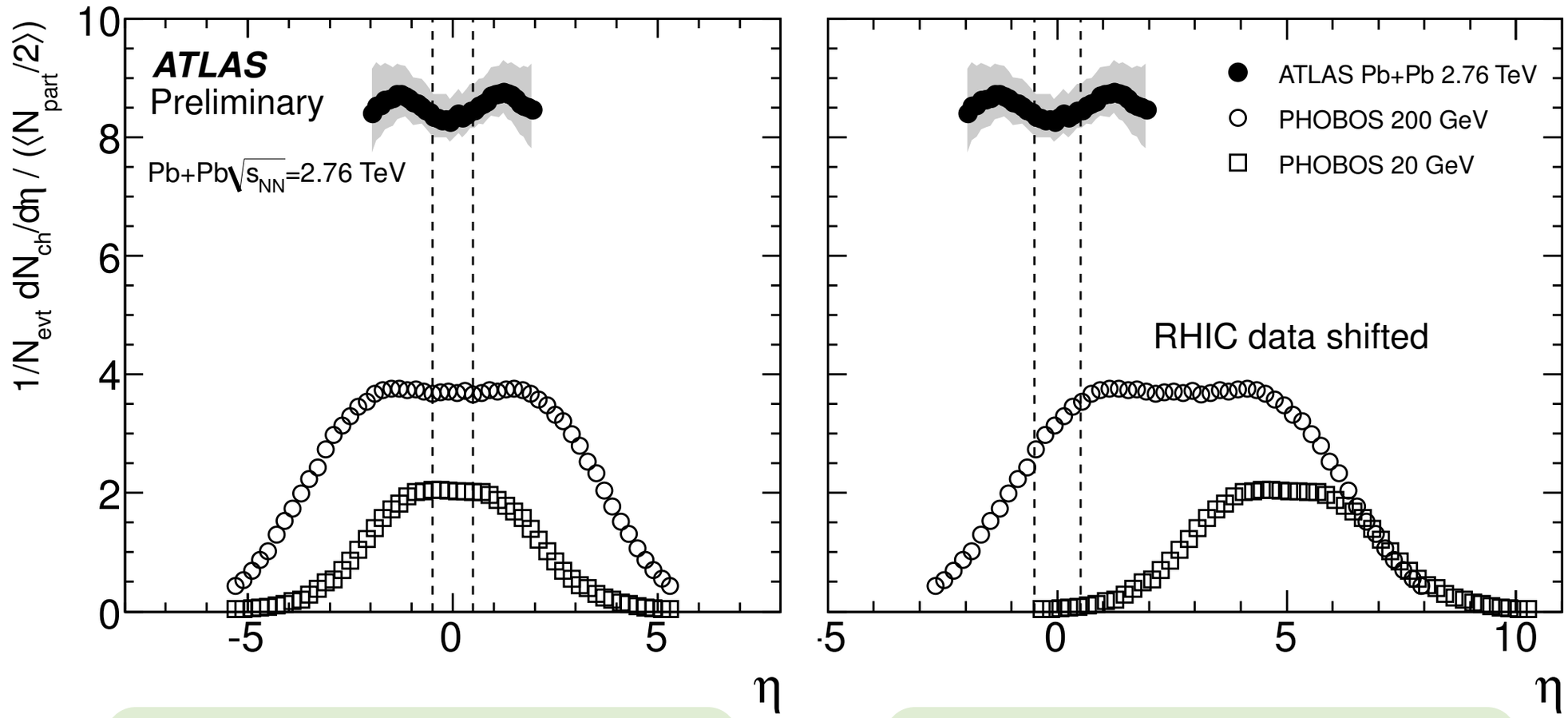
ALICE: shifted along x-axis

N_{part} dependence



RHIC result scaled up by a factor of 2.15 to match central ATLAS result.

$dN_{ch}/d\eta/\langle N_{part}/2\rangle$ shape comparison



Comparison with PHOBOS results, which extended over $|\eta|<5.4$

Shift one of the RHIC projectiles into rest frame of one of the LHC projectiles

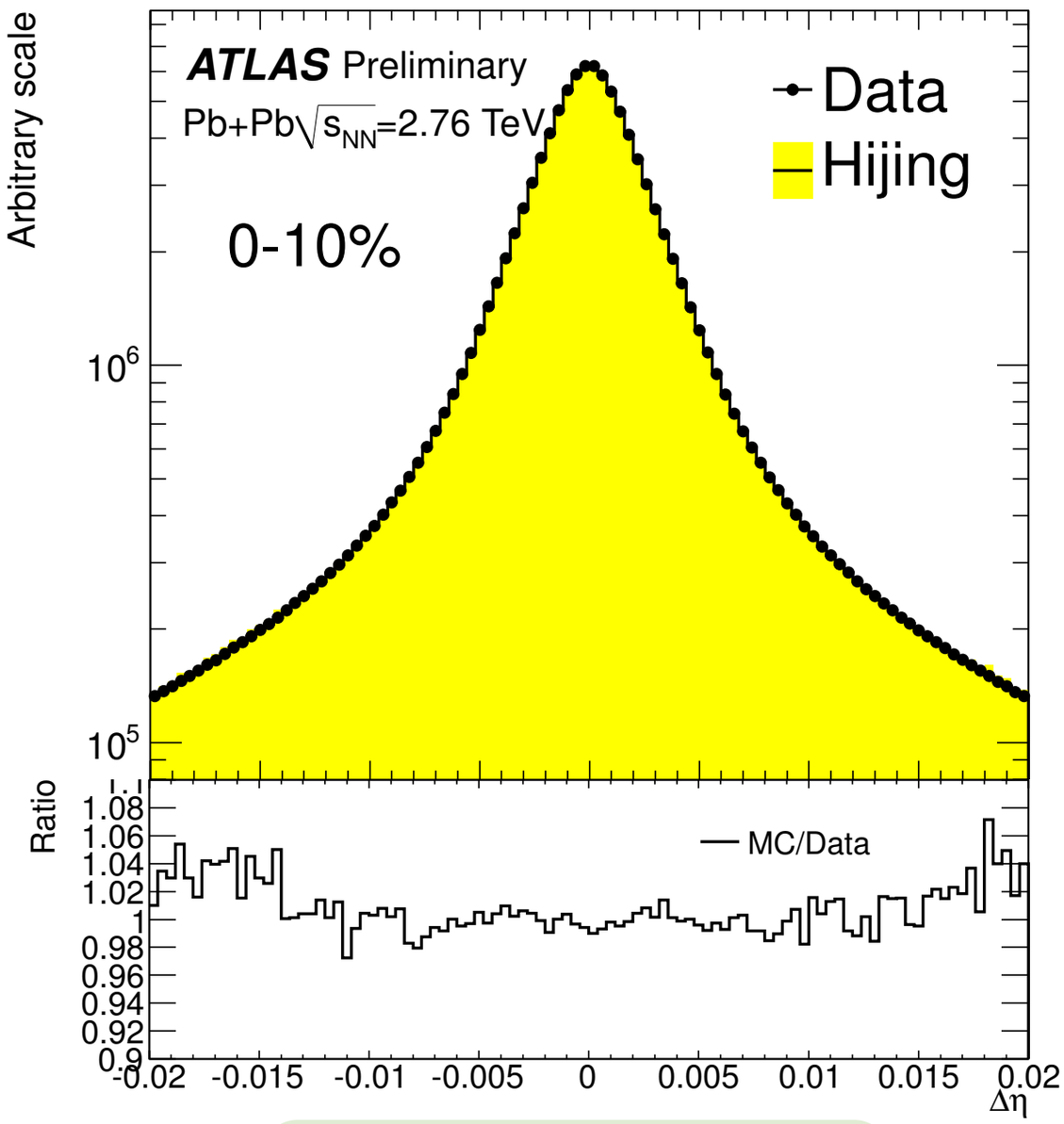
Extended measurement to high pseudorapidity region($|\eta|<2.0$), but not yet able to address details of limiting fragmentation, which requires further forward region measurement.

Conclusions

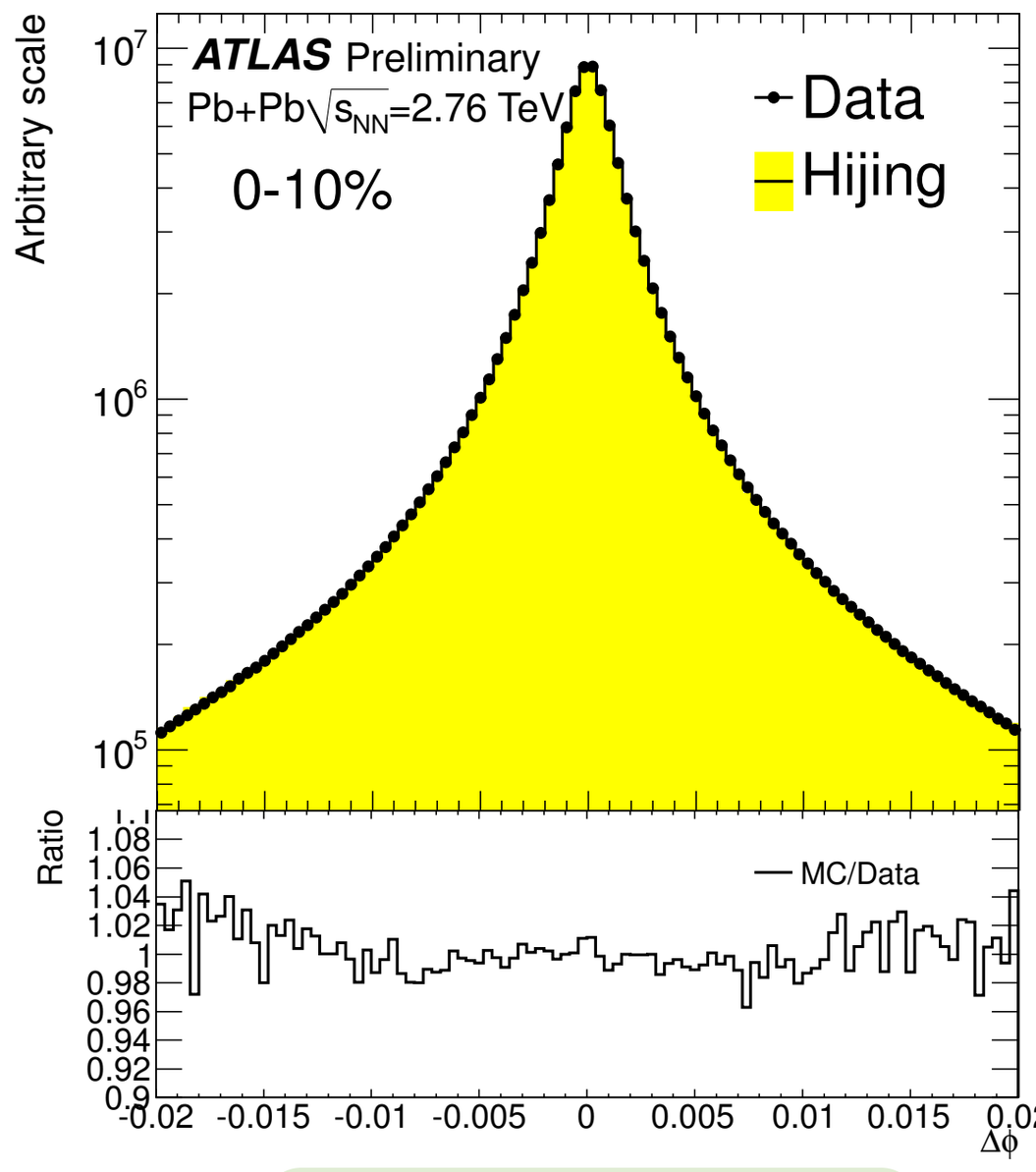
- $dN_{ch}/d\eta$ over $|\eta|<2.0$ measured in different centrality bins.
  - 5% increase from $\eta\sim0$ to $\eta\sim1$ in peripheral events (30-80% centrality class).
  - No significant shape change in different centrality class.
- Energy and N_{part} dependence of $dN_{ch}/d\eta/\langle N_{part}/2\rangle$ at mid-rapidity are compared with other experiments.
  - Confirms RHIC N_{part} dependence trend.
  - Result is consistent with other experiments.
- $dN_{ch}/d\eta$ shape also compared with PHOBOS results.

Backup

Data-MC comparison



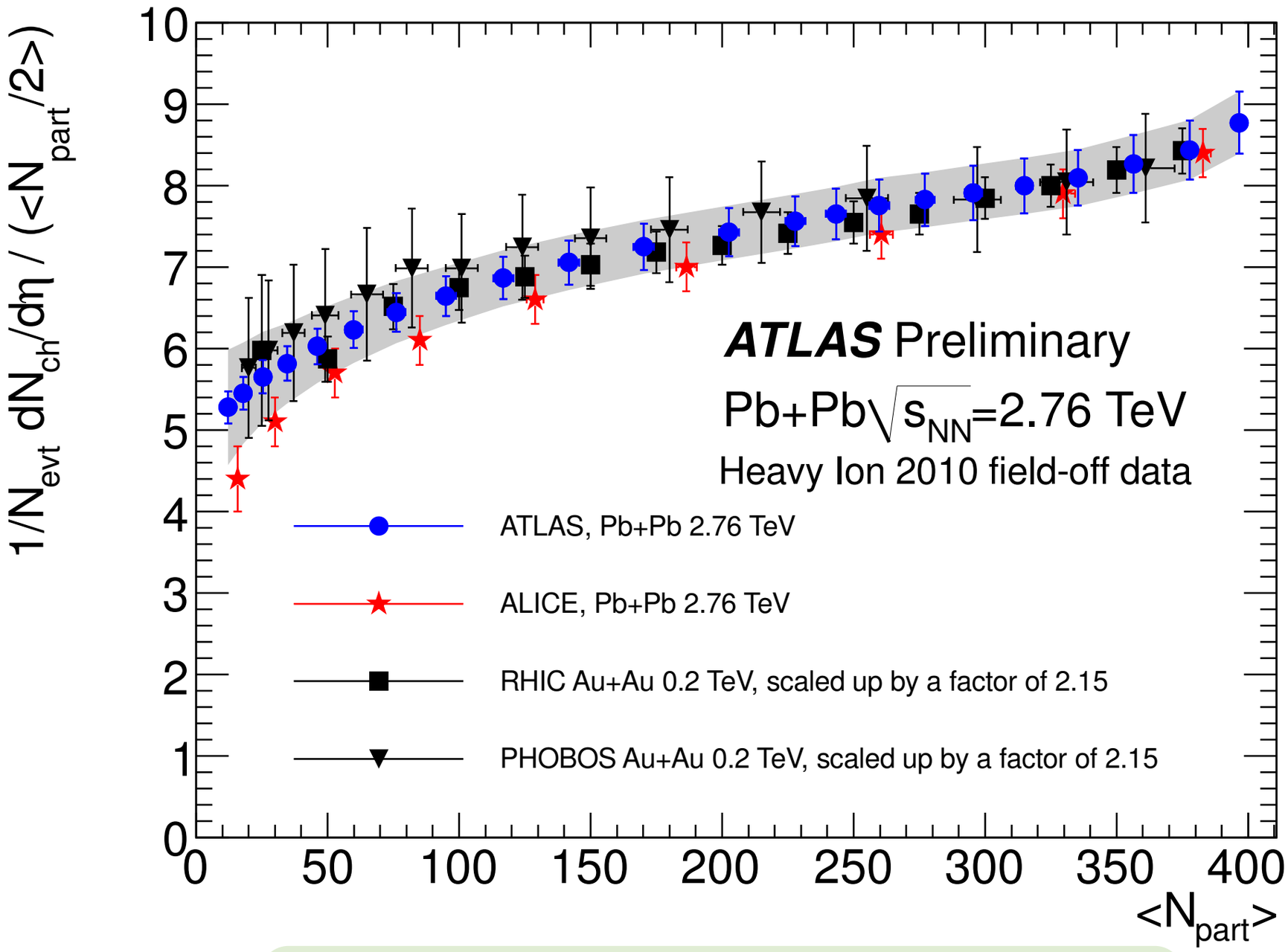
Δη distribution



ΔΦ distribution

MC sample with re-weighting procedure

N_{part} dependence



RHIC/PHOBOS result scaled up by a factor of 2.15 to match central ATLAS result.