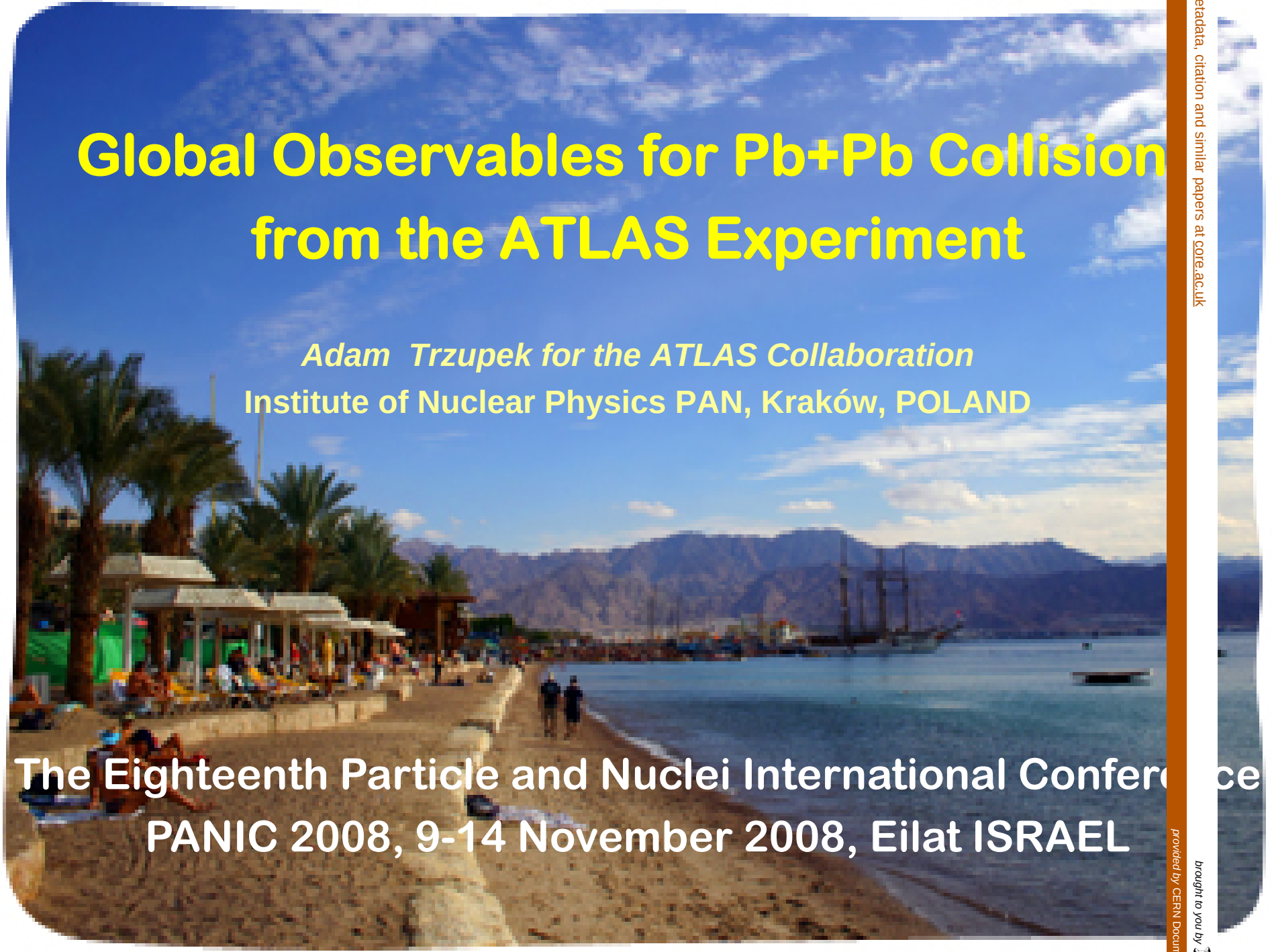
Global Observables for Pb+Pb Collision from the ATLAS Experiment

Adam Trzupek for the ATLAS Collaboration
Institute of Nuclear Physics PAN, Kraków, POLAND



The Eighteenth Particle and Nuclei International Conference
PANIC 2008, 9-14 November 2008, Eilat ISRAEL

Global Observables for Pb+Pb at LHC Energies

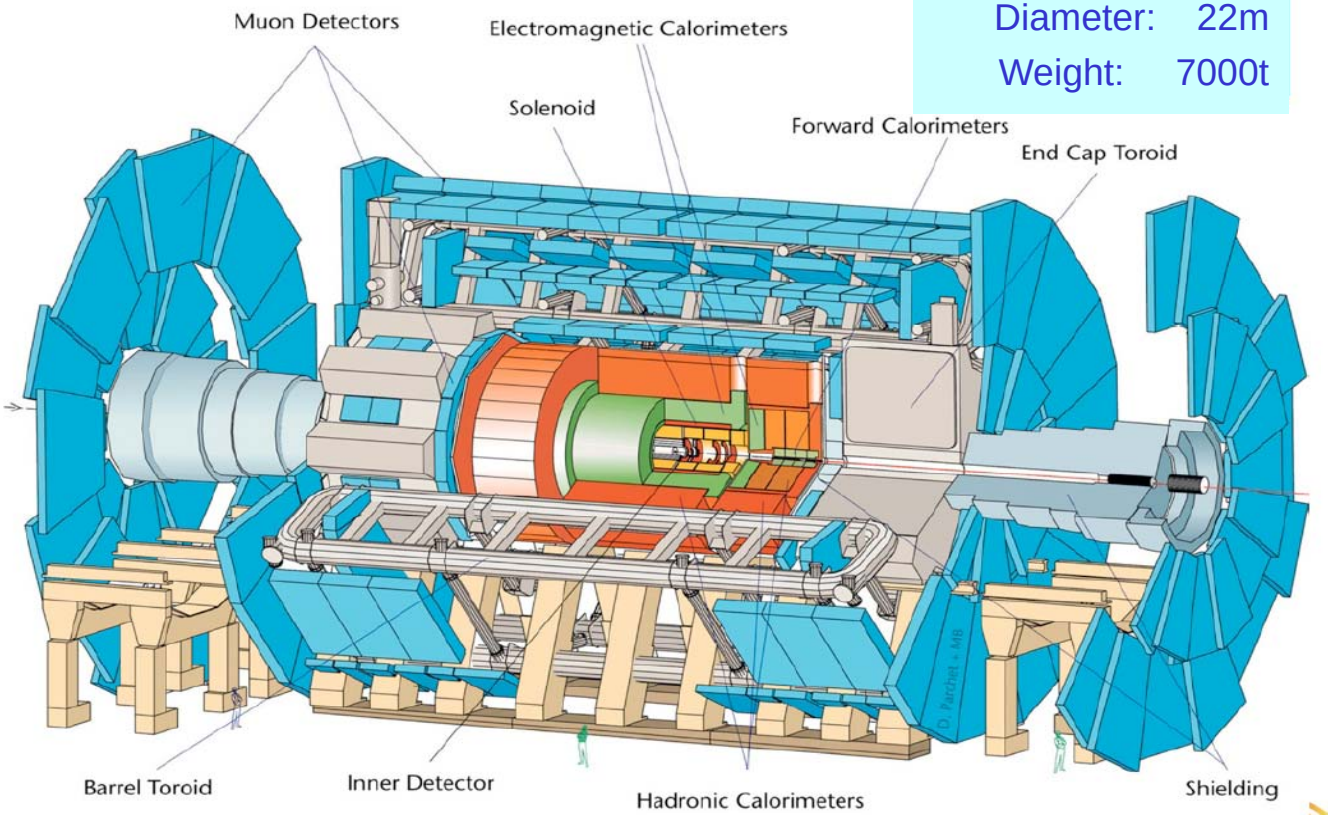
$\sqrt{s_{NN}}$:	RHIC (Au+Au)	→	LHC (Pb+Pb)
	200 GeV		*5500 GeV*

- **Measurements of $dN_{ch}/d\eta$, $dE_T/d\eta$, elliptic flow:**
  - **Dynamics of hot and dense medium (perfect fluid)**
  - **Properties of the initial state (energy/gluon density, …)**
  - **Test of model predictions (Color Glass Condensate, hydrodynamics, …)**

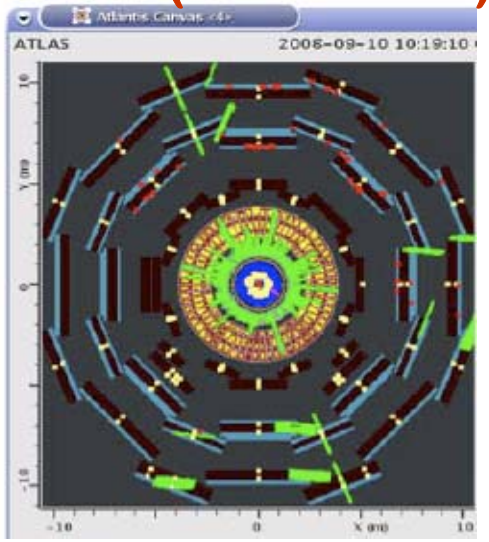
- **Focus on Day-1 of Pb+Pb physics at LHC**
  - **Minimum bias pp collisions (2009) – base line for Pb+Pb**

The ATLAS Central Detector

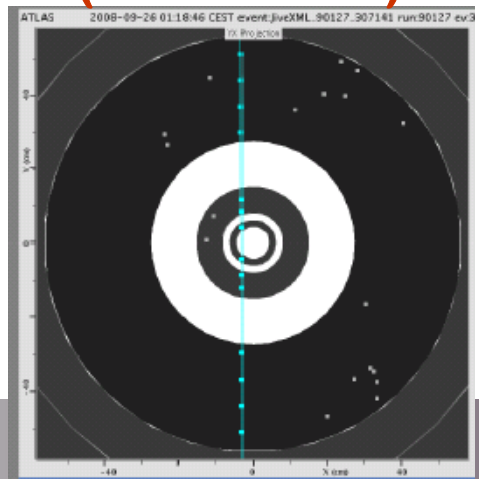
Detector parameters:
Width: 44m
Diameter: 22m
Weight: 7000t



First beam event in ATLAS (2008-09-10)



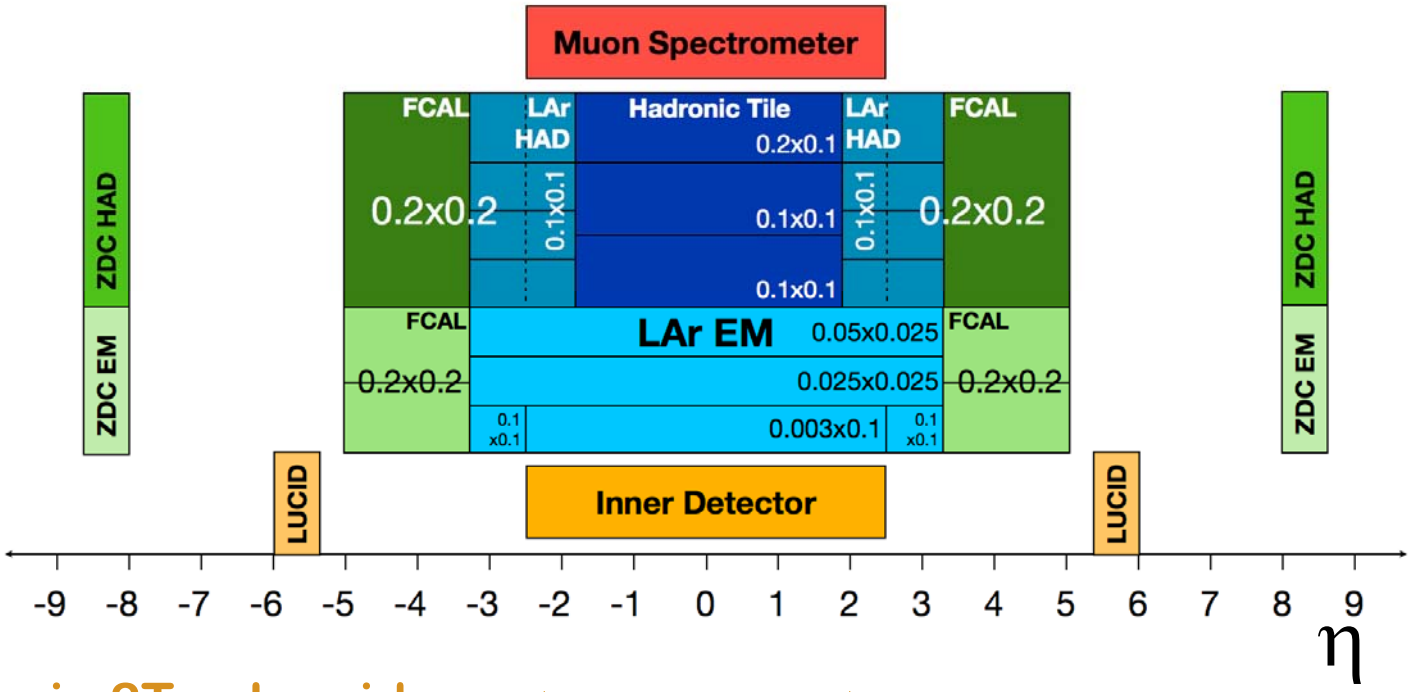
Cosmic track in ID (SCT + Pixel):



Inner tracking, EM and hadronic calorimeters, muon spectrometers

Acceptance of ATLAS

(2π Azimuthal Acceptance)



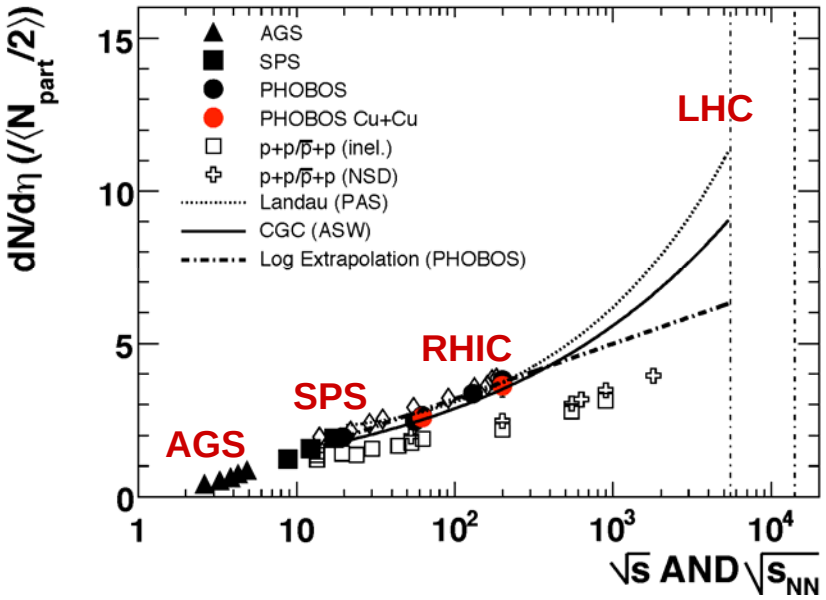
Tracking in 2T solenoid

E_T measurement

High potential to study global variables in Pb+Pb collisions

Charged Particle Multiplicity

$dN_{ch}/d\eta$ in Pb+Pb at LHC energy

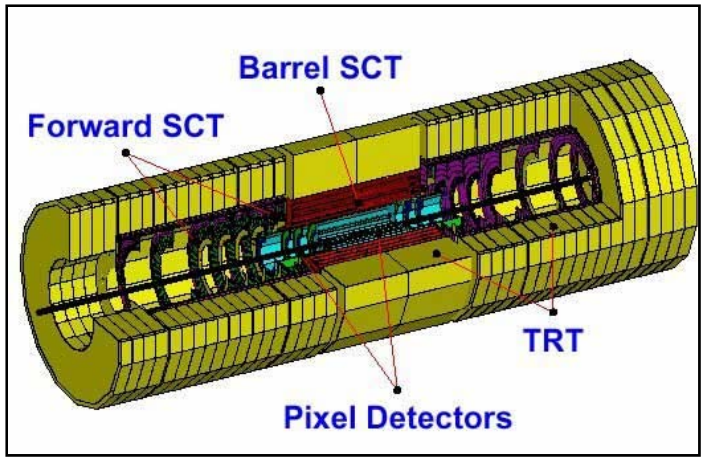


N_{part} - number of participating/wounded nucleons in AA collision

Day-one measurement:

- constrain model predictions

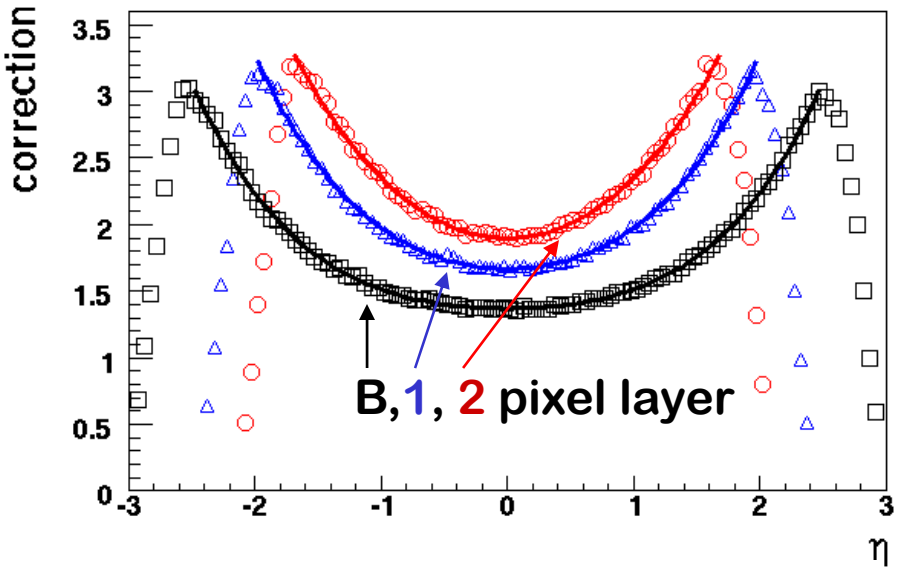
ATLAS Inner Detector

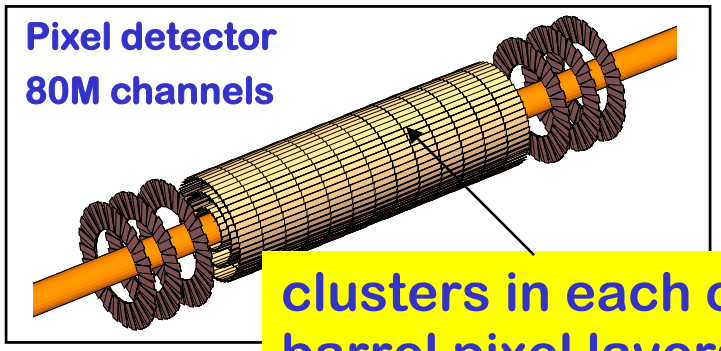


$dN_{ch}/d\eta$ - measurements of position of hits in ID

Detector hit occupancies:
(Pb+Pb, 5.5 TeV, b < 1 fm):
Pixels < 2%
SCT < 20%

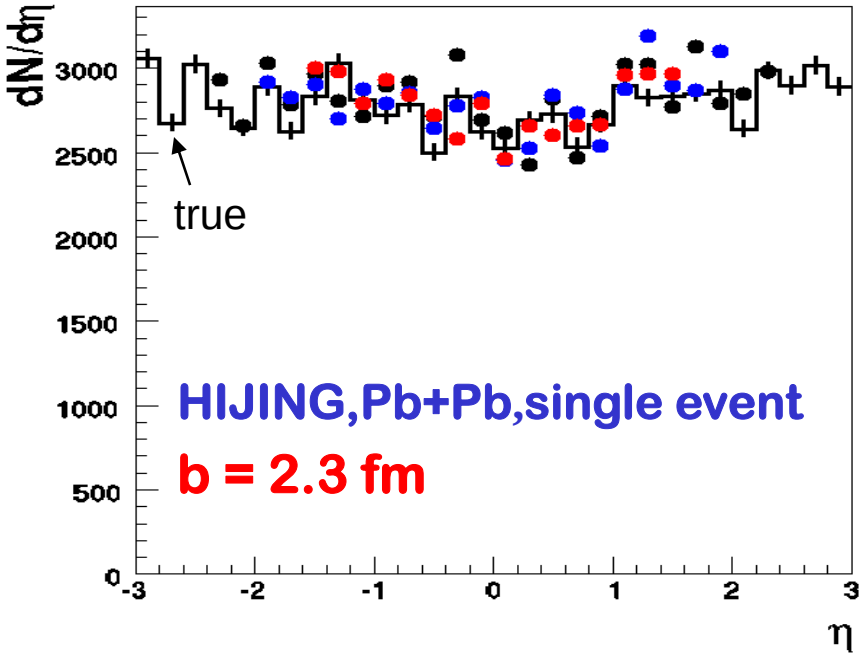
Multiplicity from Si Hit Counting

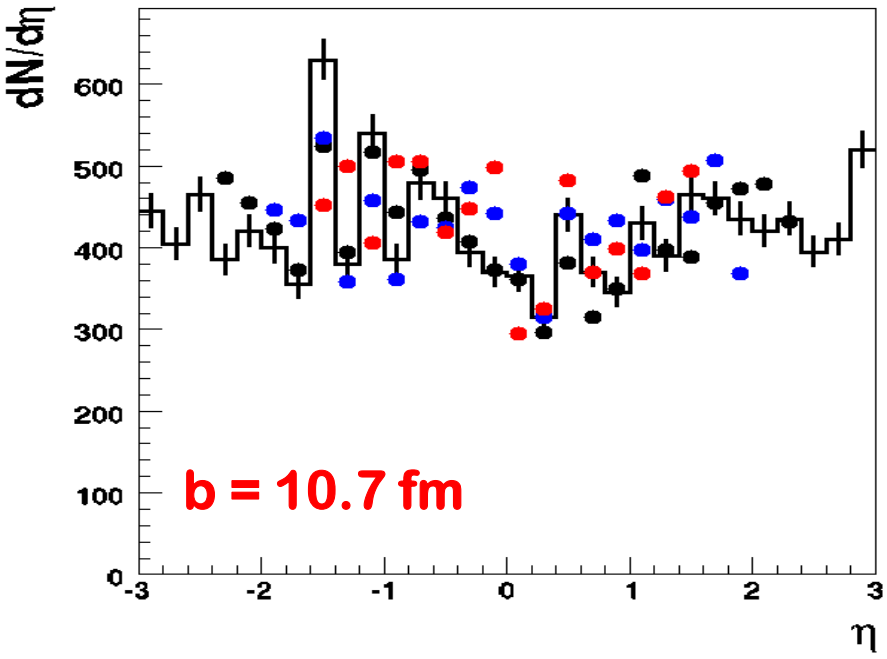




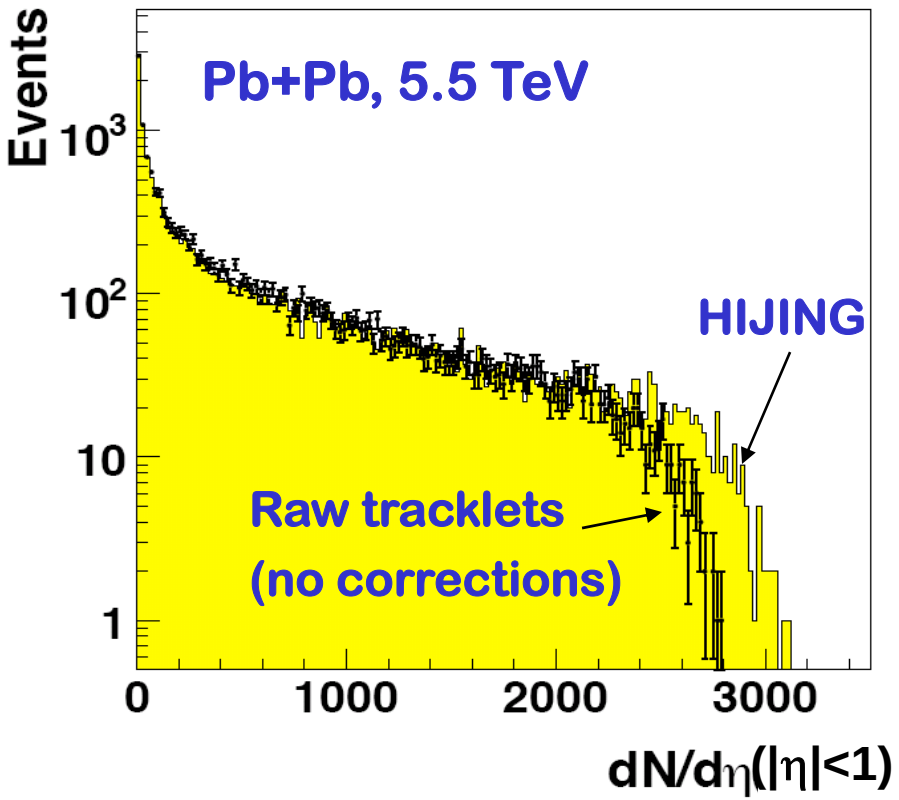
clusters in each of 3 barrel pixel layers

$$correction = \frac{< dN_{clus}/d\eta >}{< dN_{ch}/d\eta >}$$



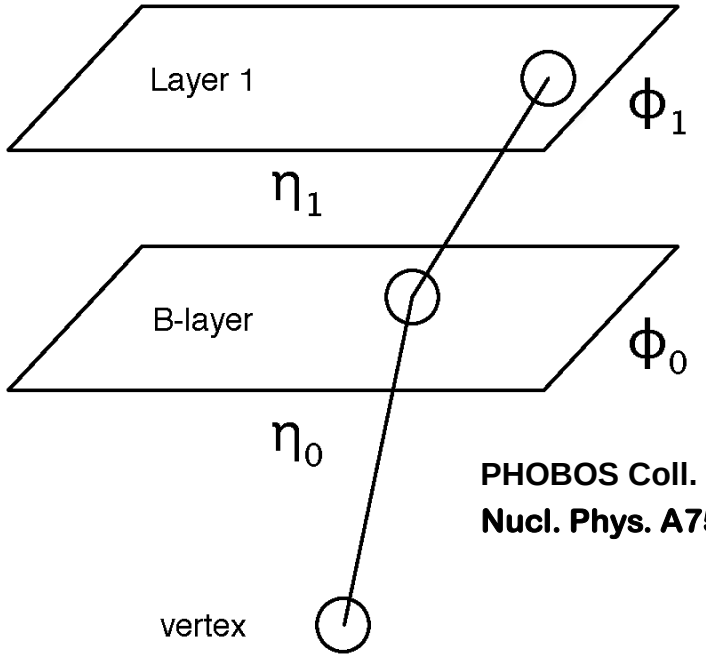


Charged Multiplicity from Tracklets



„Tracklets" counting

- B-layer and Layer1 of barrel pixel



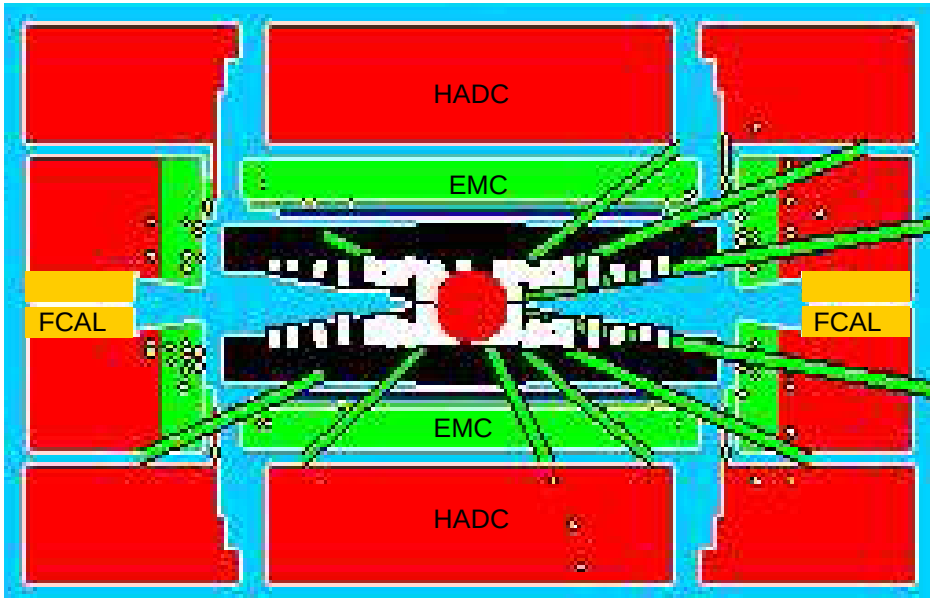
PHOBOS Coll.
Nucl. Phys. A757, 28

Tracklet method provides good estimate of event-by-event multiplicity

Collision Centrality

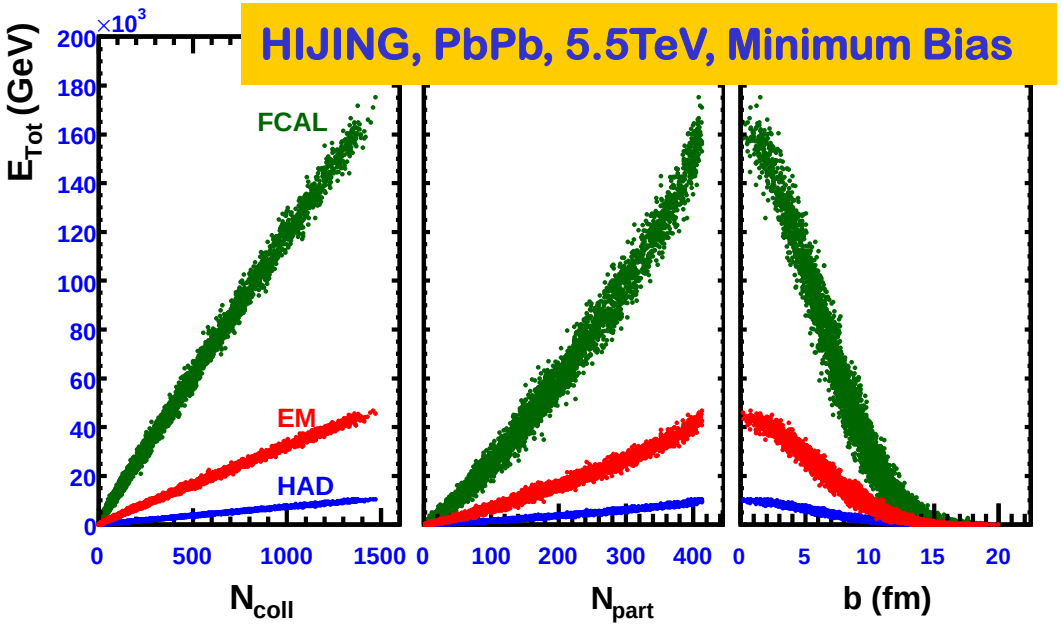
ATLAS calorimeters:

- **electromagnetic (green)**
- **hadronic(red)**
- **forward (orange)**



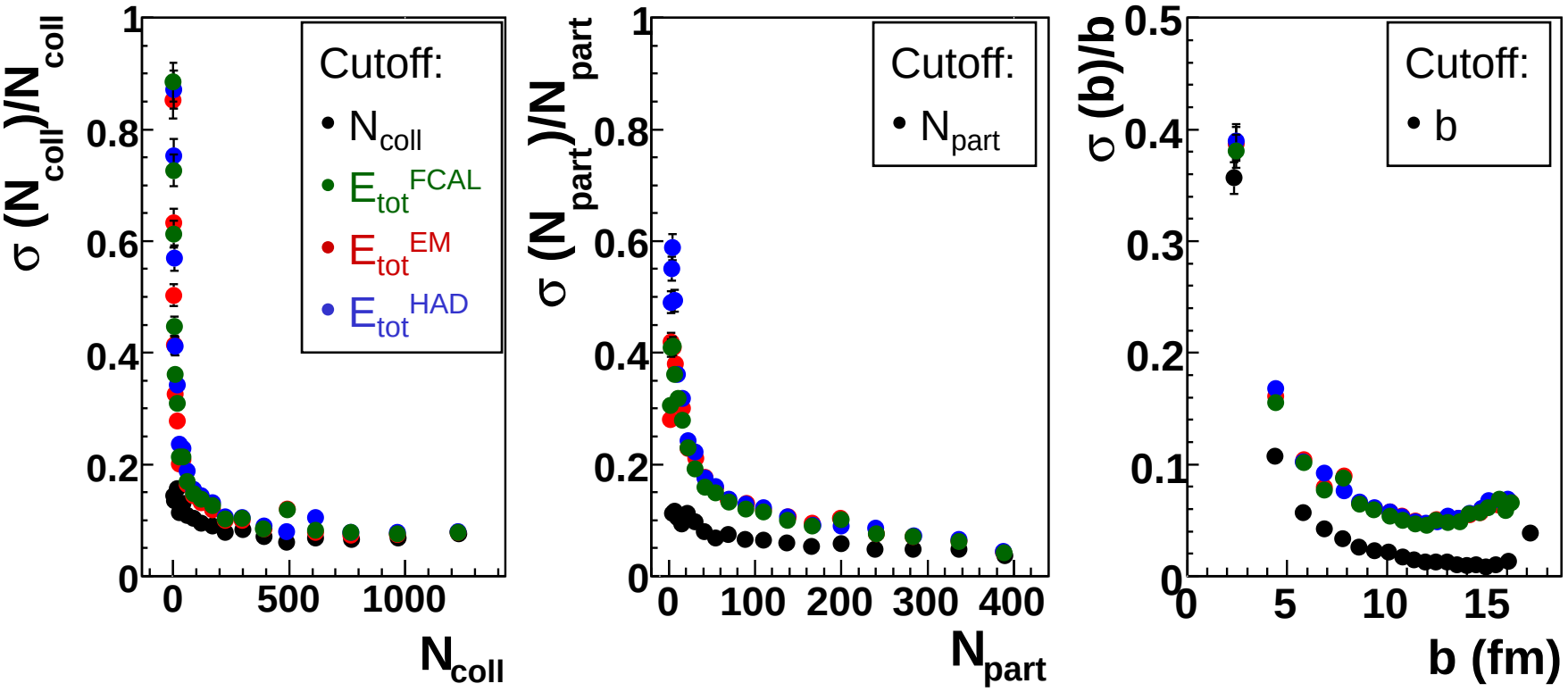
$$E_{Tot} = \sum_{cells} E_{Tot}$$

E_{tot} is monotonically correlated with collision parameters (N_{coll} , N_{part}, b)



Collision Centrality

HIJING, Pb+Pb, 5.5 TeV, Minimum Bias, 20 x 5% centrality bins



Precise centrality estimation in the ATLAS detector

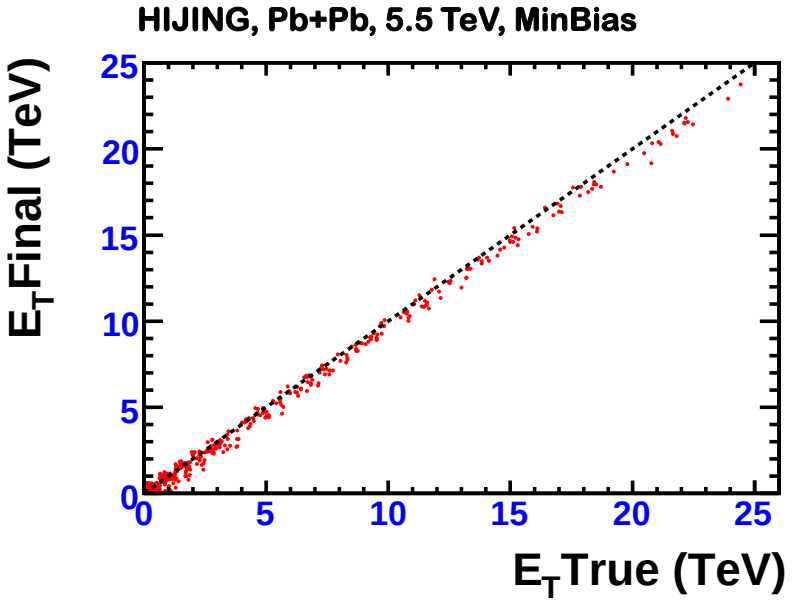
E_T Measurement in Pb+Pb Collisions

Methods to reconstruct E_T:

- **Cluster-based**

$$E_T\text{Final} = \Sigma\, E'_T(\text{cell}) + \Sigma\, E_T\text{Muon} + E_T\text{Cryo}$$

ATL-COM-PHYS-2008-07

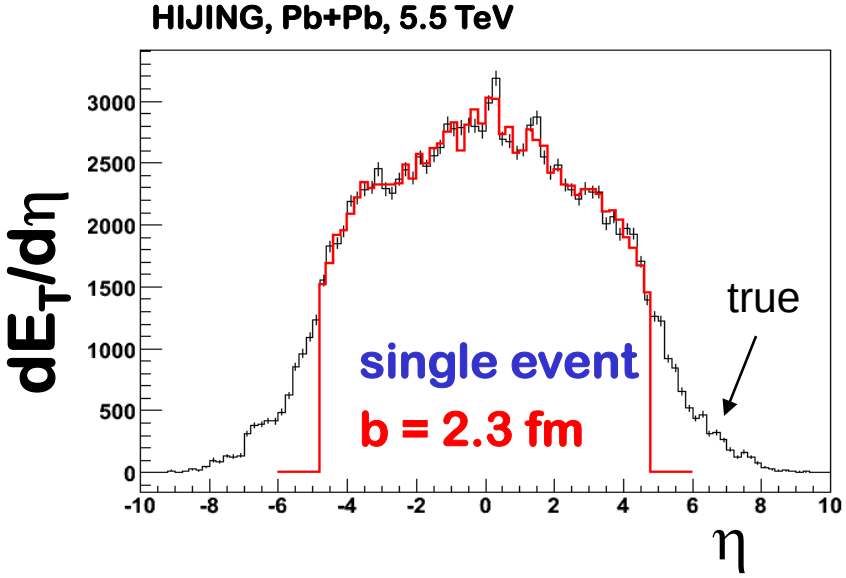


- **Cell-based**

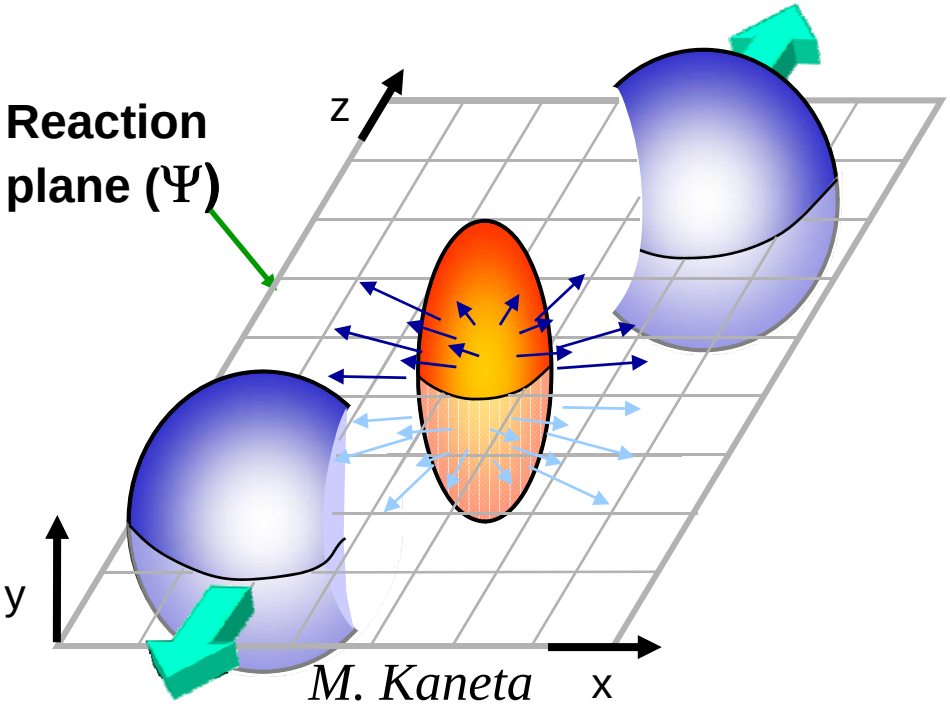
$$dE_T^{cell}/d\eta = \frac{1}{\Delta\eta}\sum_i E_{T,i}^{cell}(\eta,\varphi)$$

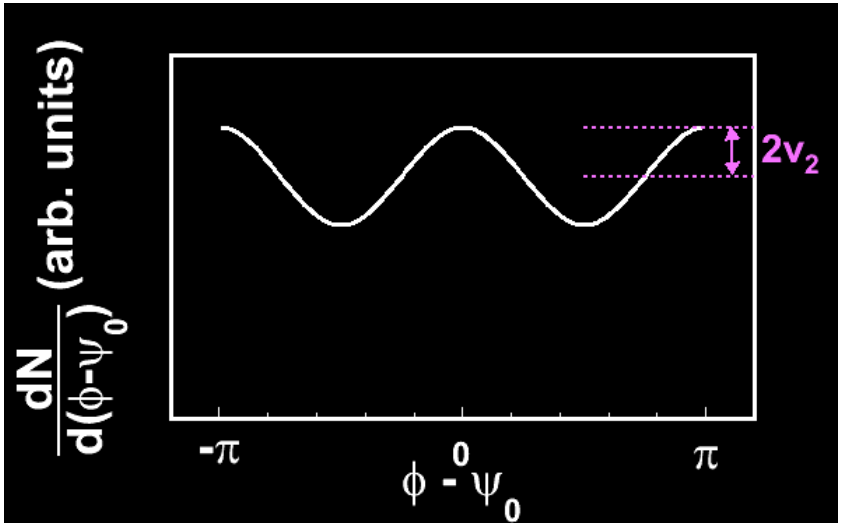
$$correction = \frac{< dE_T^{MCtrue}/d\eta >}{< dE_T^{cell}/d\eta >}$$

Good agreement at bin level



Azimutal Anisotropy of Produced Particles



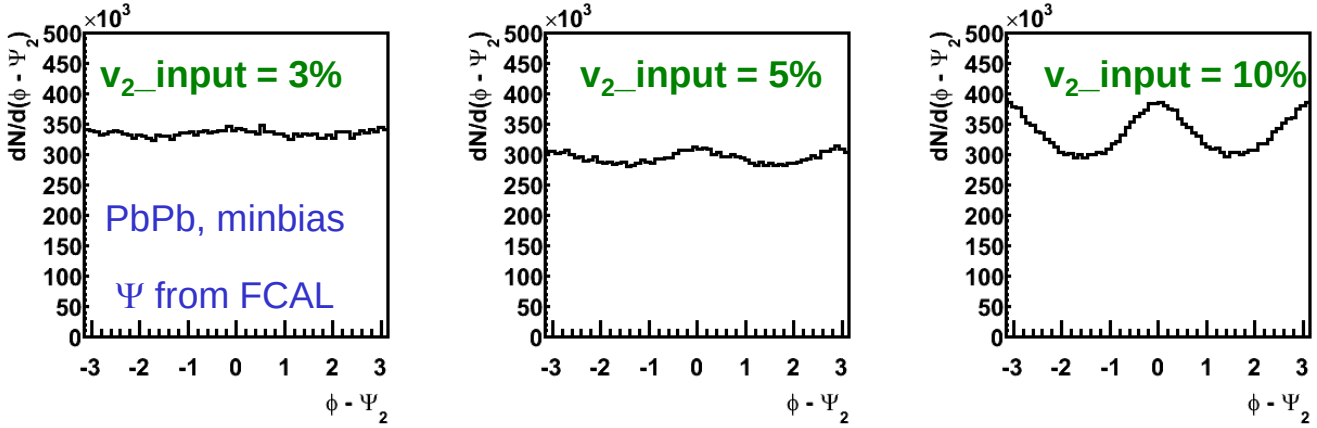


- **Pressure gradients lead to azimuthal anisotropy**
- **Elliptic flow is the second harmonic in the Fourier expansion of azimuthal particle distribution**

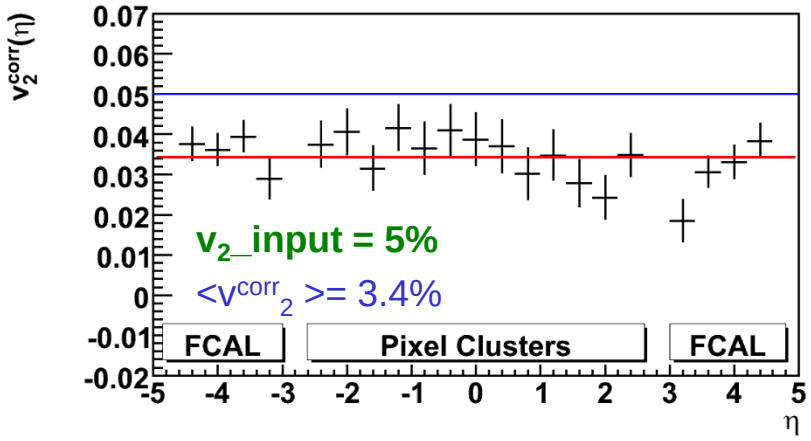
$$dN/d(\phi-\Psi_0) = N_0\,(1 + 2v_1\cos(\phi-\Psi_0) + \mathbf{2v_2}\cos(2(\phi-\Psi_0)) + \ldots)$$

Elliptic Flow Reconstruction in ATLAS

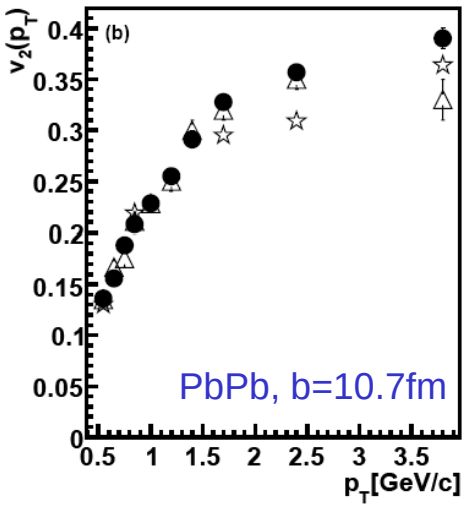
HIJING simulations with input flow v_2=0.03/0.05/0.1



v_2 (Ψ) - pixel clusters and cells



v_2 (Ψ) - tracks



modified HIJING
v_2 from 2P corr.
v_2 from RP method

v_2_input = extrapolation from AA data at lower energies

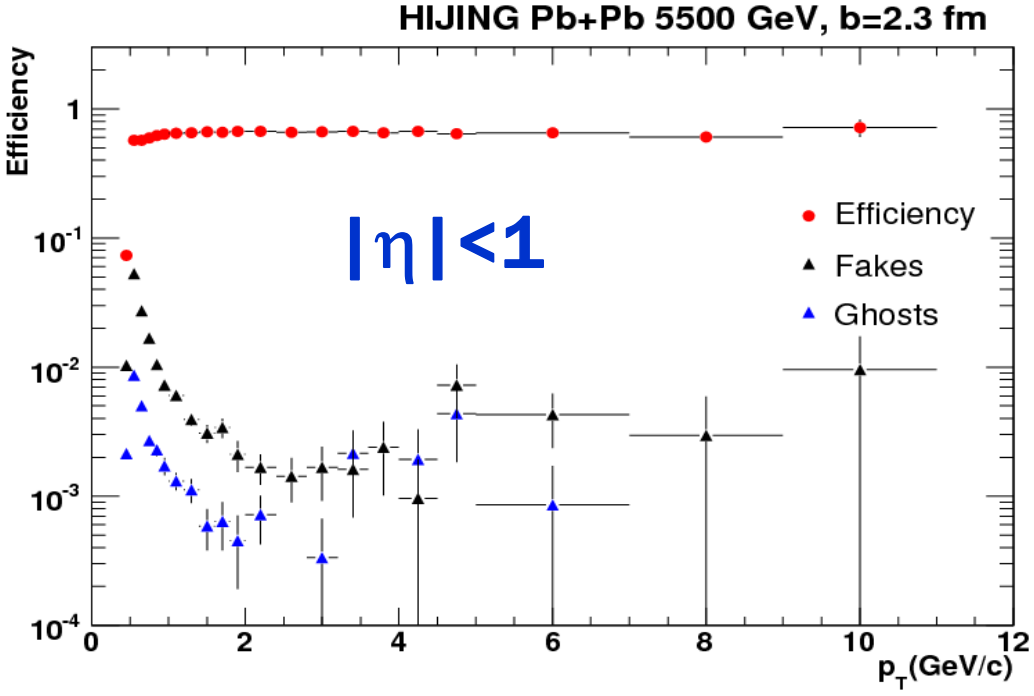
Summary

- **High potential of the ATLAS experiment to study global variables for Pb+Pb collisions**
  - **Large acceptance and fine granularity of tracking and calorimeter systems**
- **Different methods are tested for measurements:**
  - **Particles multiplicity**
  - **Transverse energy distribution**
  - **Elliptic flow**
  - **Collision centrality**

Global Variables are Day-1 Physics of LHC Pb+Pb Collisions

Thank you!

ATLAS Tracking in Pb+Pb collisions



- **Track reconstruction in Si detectors:**
  - 3 layers of pixel
  - 8 layers of strips (SCT)
- **Excellent track reconstruction at $|\eta| < 1$ in most central Pb+Pb collisions**

Challenges for Pb+Pb environment:

- Suppress high fake track rates for $|\eta| > 2$
- Enhance efficiency at low-p_T (< 0.5 GeV/c)