PHOBOS Npart Determination

Patrick Decowski / MIT
for PHOBOS

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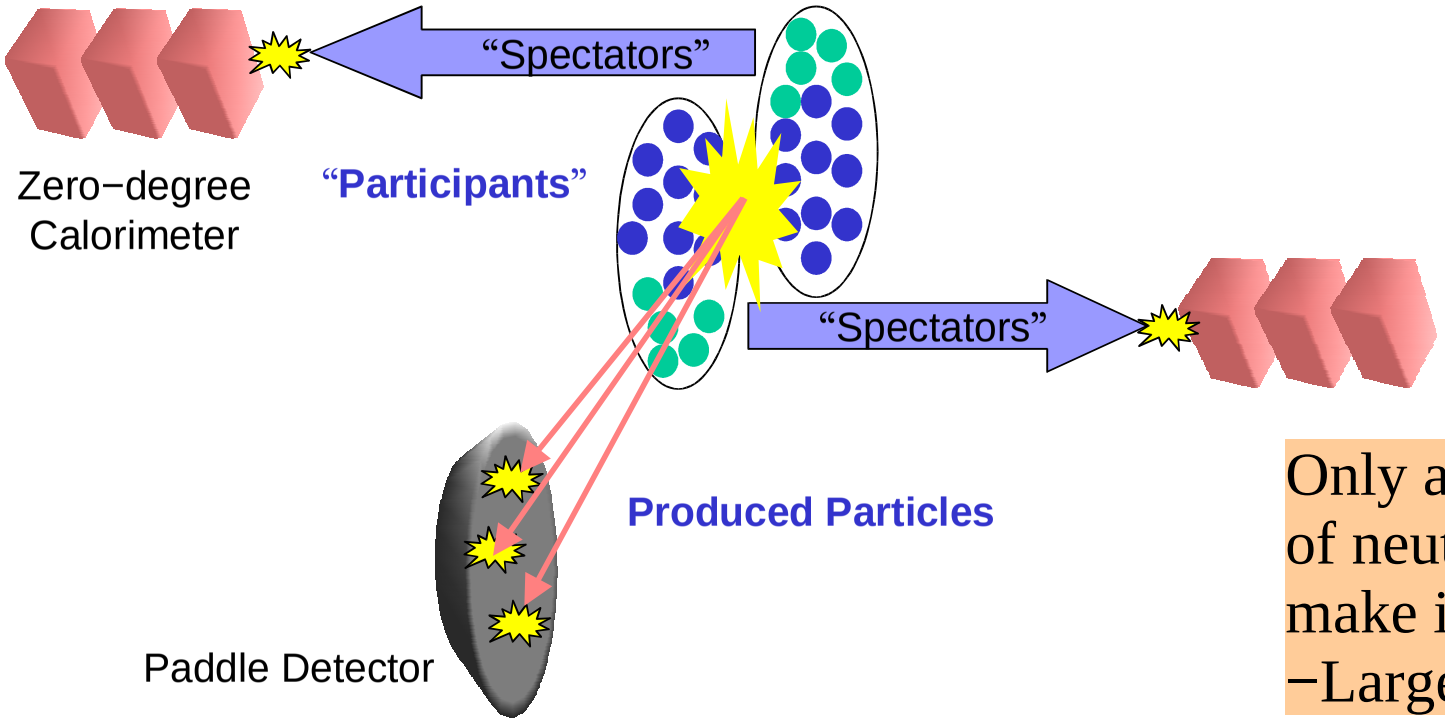
Participants & Spectators

- Measuring N_{spec} gives the number of participants
  - $N_{part} = (A - N_{spec})$
- Life due to ZDCs not so simple at RHIC

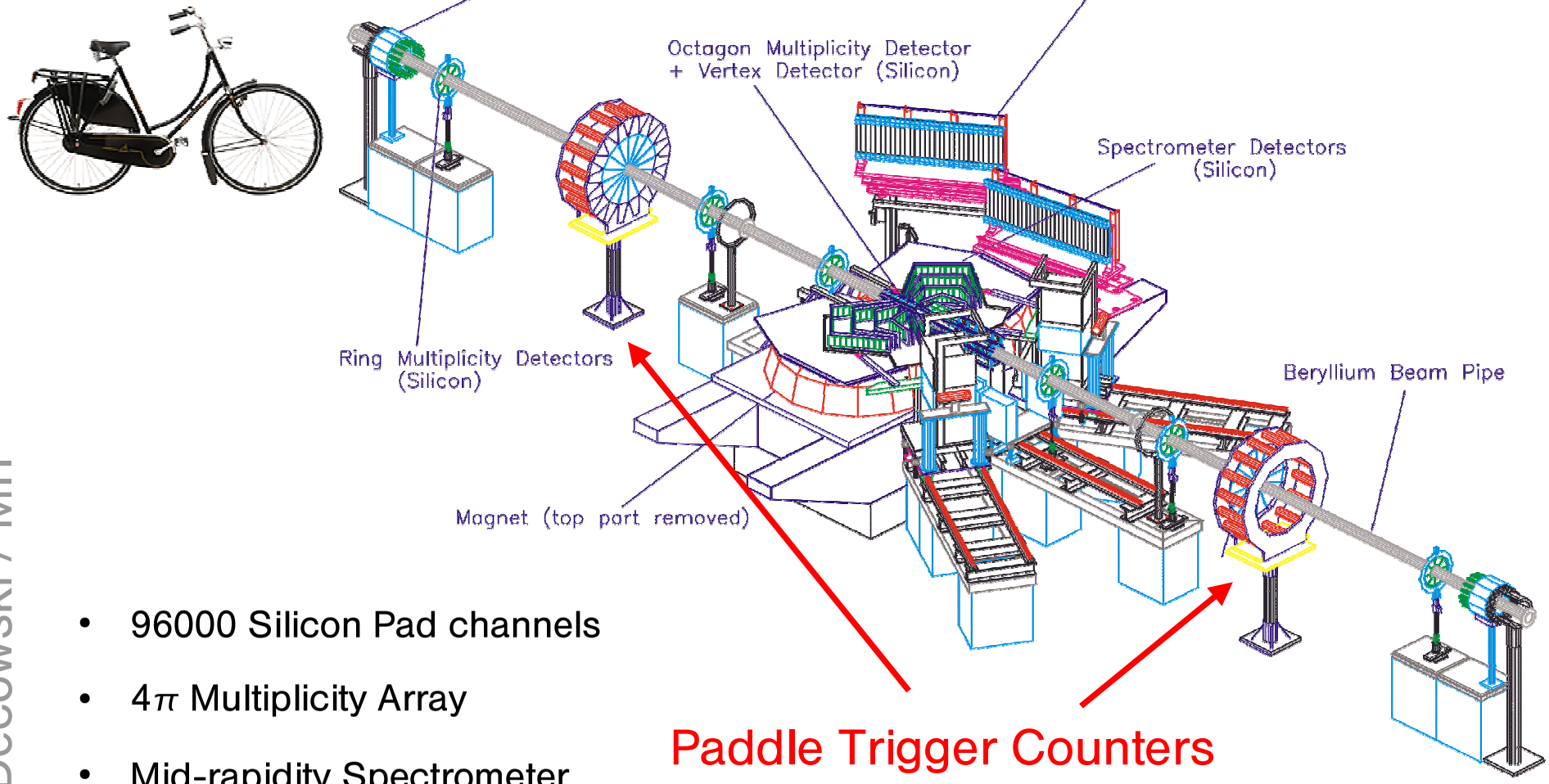


Only a small amount of neutral spectators make it to the ZDC:
−Large fluctuations

Experimentalist view of N_{part}

- PHOBOS measures some % Cross Section, not N_{part}
- Measured % Cross Section has to be corrected for trigger inefficiencies
- Convert % Cross Section to N_{part} using MC
  - Need to incorporate fluctuations in the measurement
    - ”Smearing” of detector response
    - Fluctuations in number of particles (due to varying interaction vertex etc)

PHOBOS Detector



- 96000 Silicon Pad channels
- 4π Multiplicity Array
- Mid-rapidity Spectrometer
- Scintillator Paddles + ZDC for Triggering
- TOF wall for high-momentum PID

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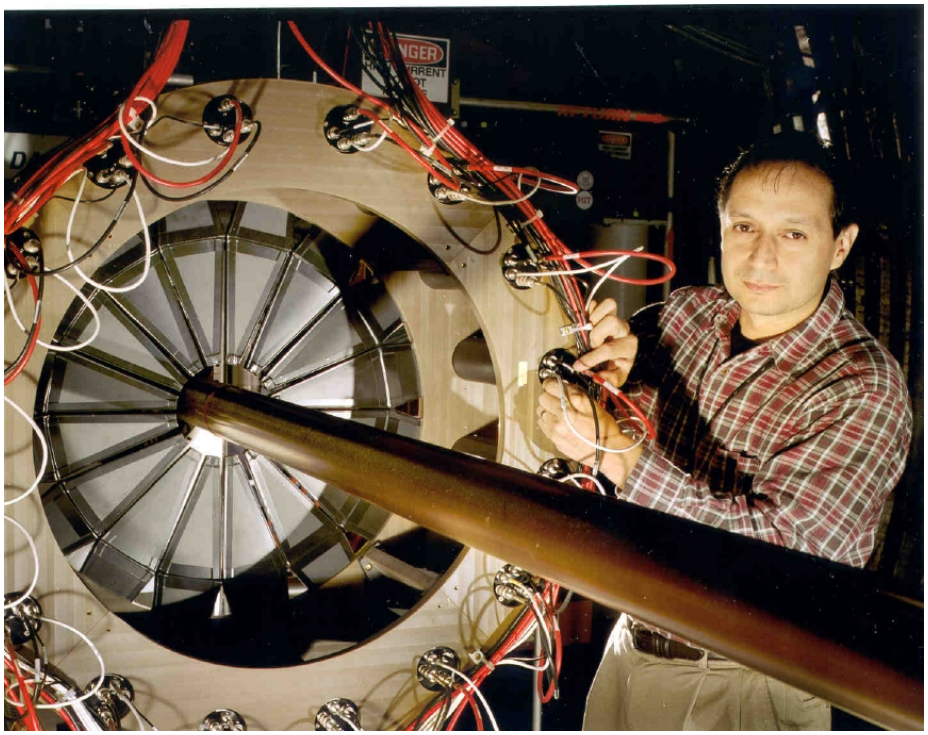
Paddle Counters



- 2 barrels of 16 scintillators (BC404) each
  - 3.21m from the nominal vertex
  - Cover $3 < |\eta| < 4.5$
  - ADC and TDC information available

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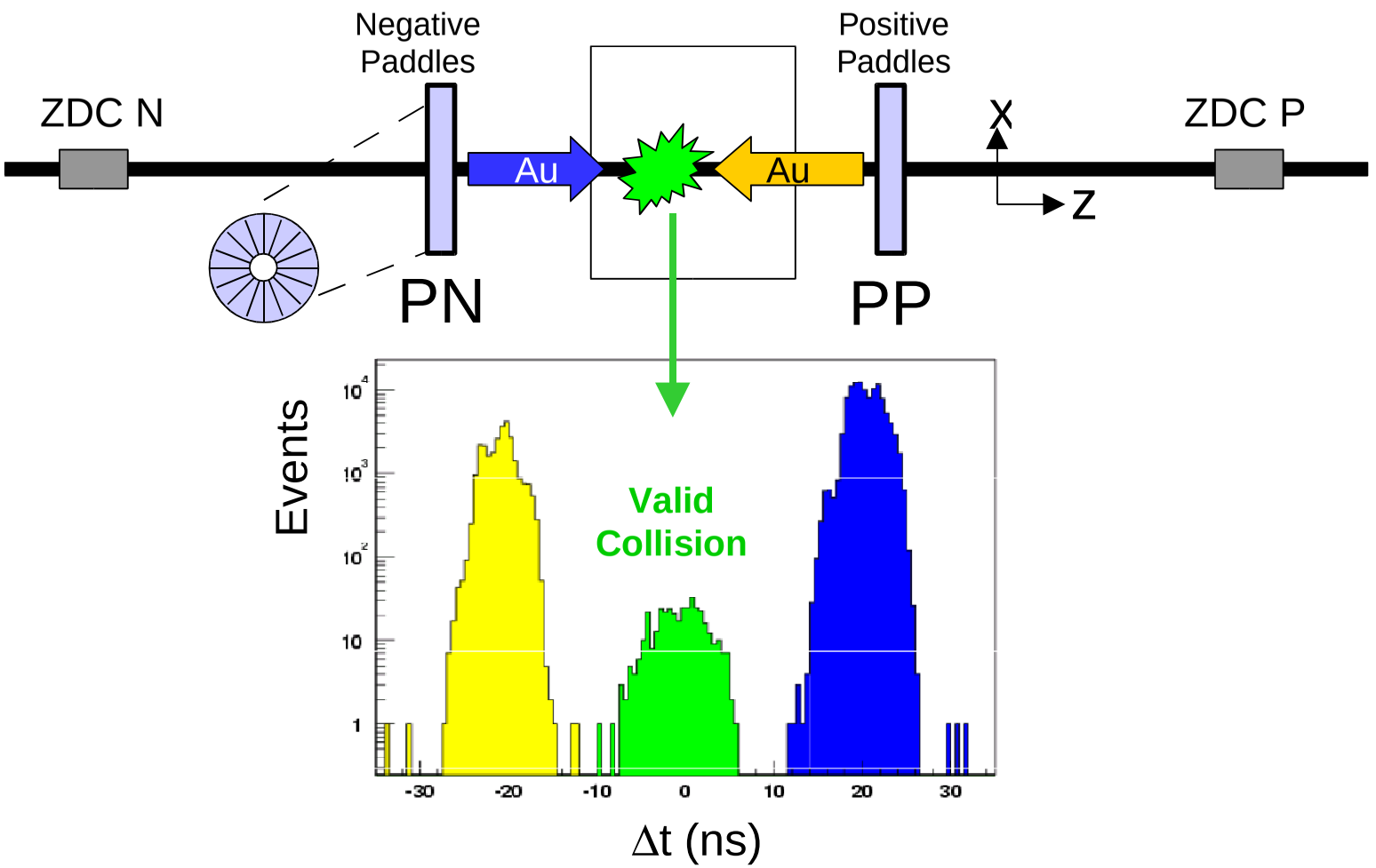
Triggering on Collisions



- Coincidence between Paddle counters at $\Delta t = 0$ defines a valid collision
- Paddle + ZDC timing reject beam−gas background

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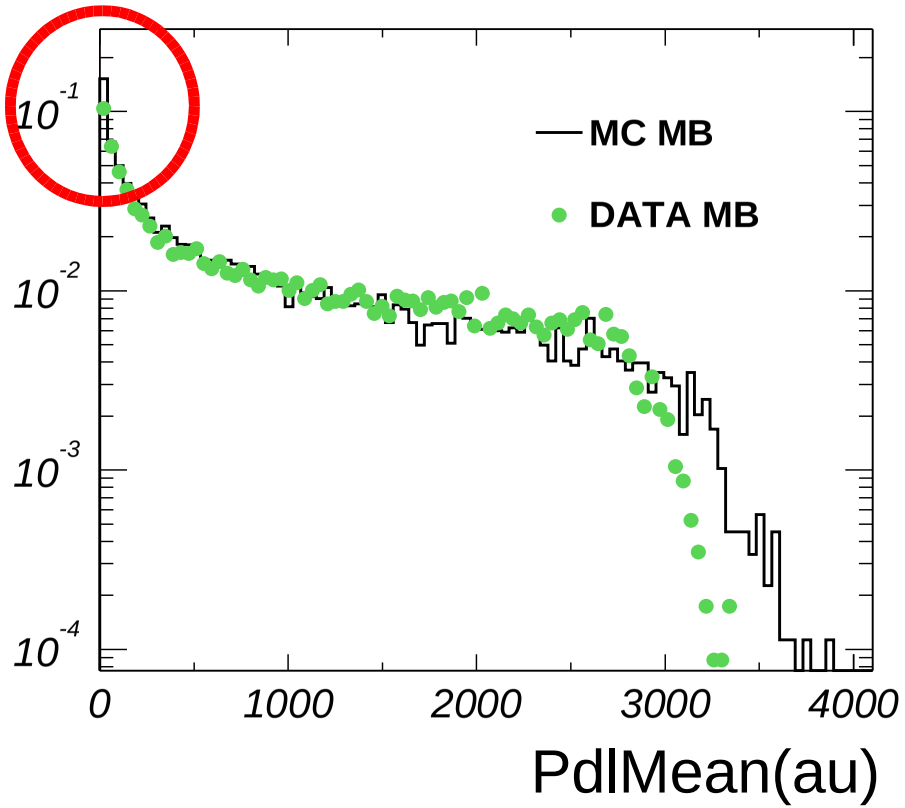
Estimating Trigger Inefficiency

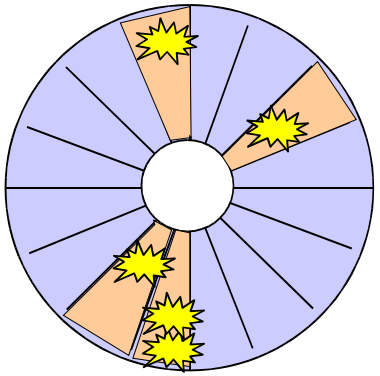
- Smearing of MC Paddle response
  - Pedestal noise & timing jitter
- Hard to distinguish what happens at small PdlMean
- Better: count the number of slats that were hit in the paddle counters

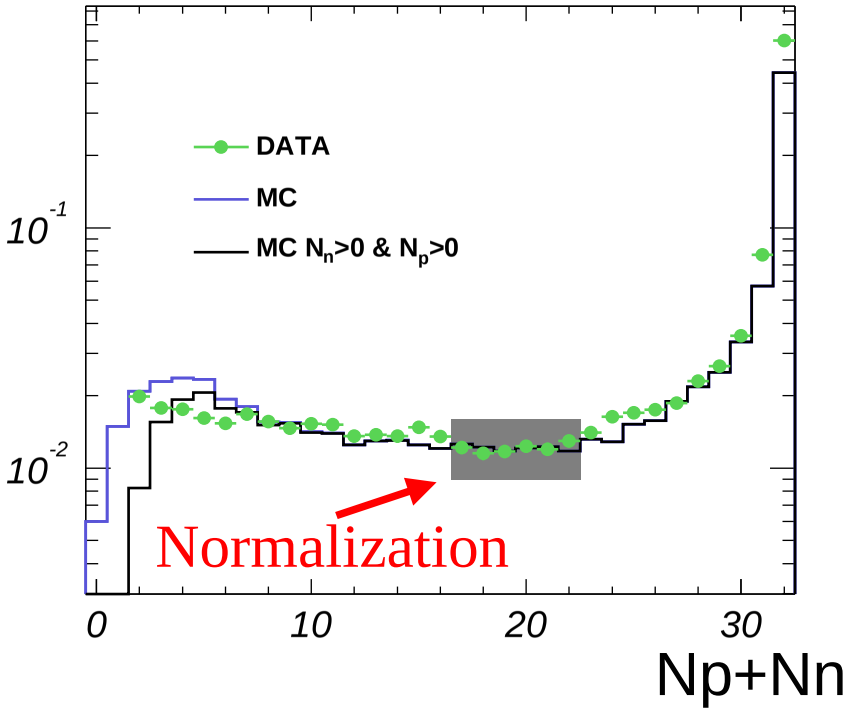


PdlMean: Average of Truncated mean of ADC signal of both paddle barrels

Estimation of Missing Cross Section

- Np+Nn: Total number of 'fired' paddle slats
  - MC: Did one or more particles traverse a slat?
  - DATA: Was there signal above noise threshold?
- In DATA, coincidence in both paddle counters requires Np>0 & Nn>0
- We use HIJING to simulate the minimum-bias distribution

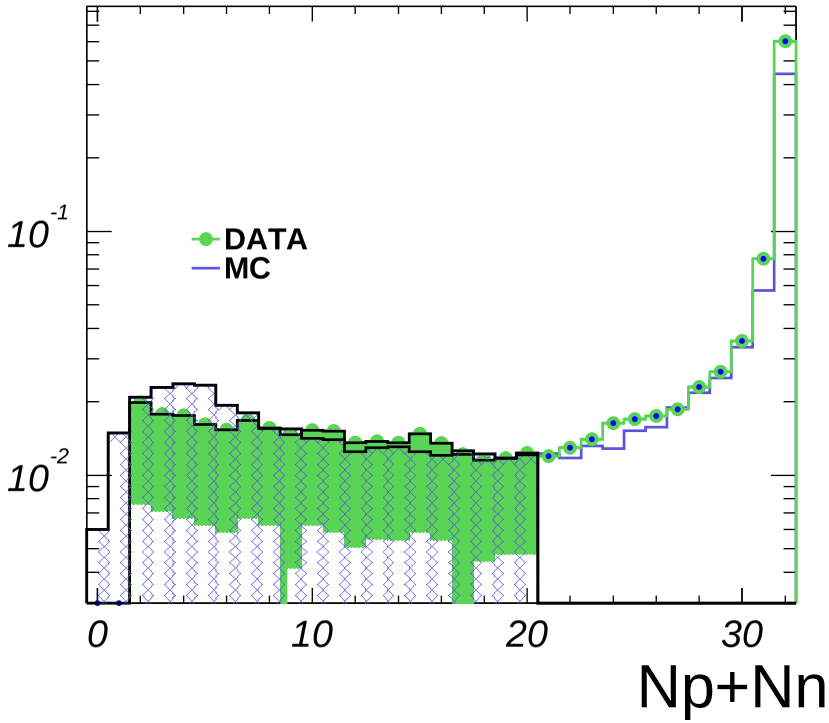




Plateau region from
Np+Nn = ~10 to ~22

Missing Cross Section

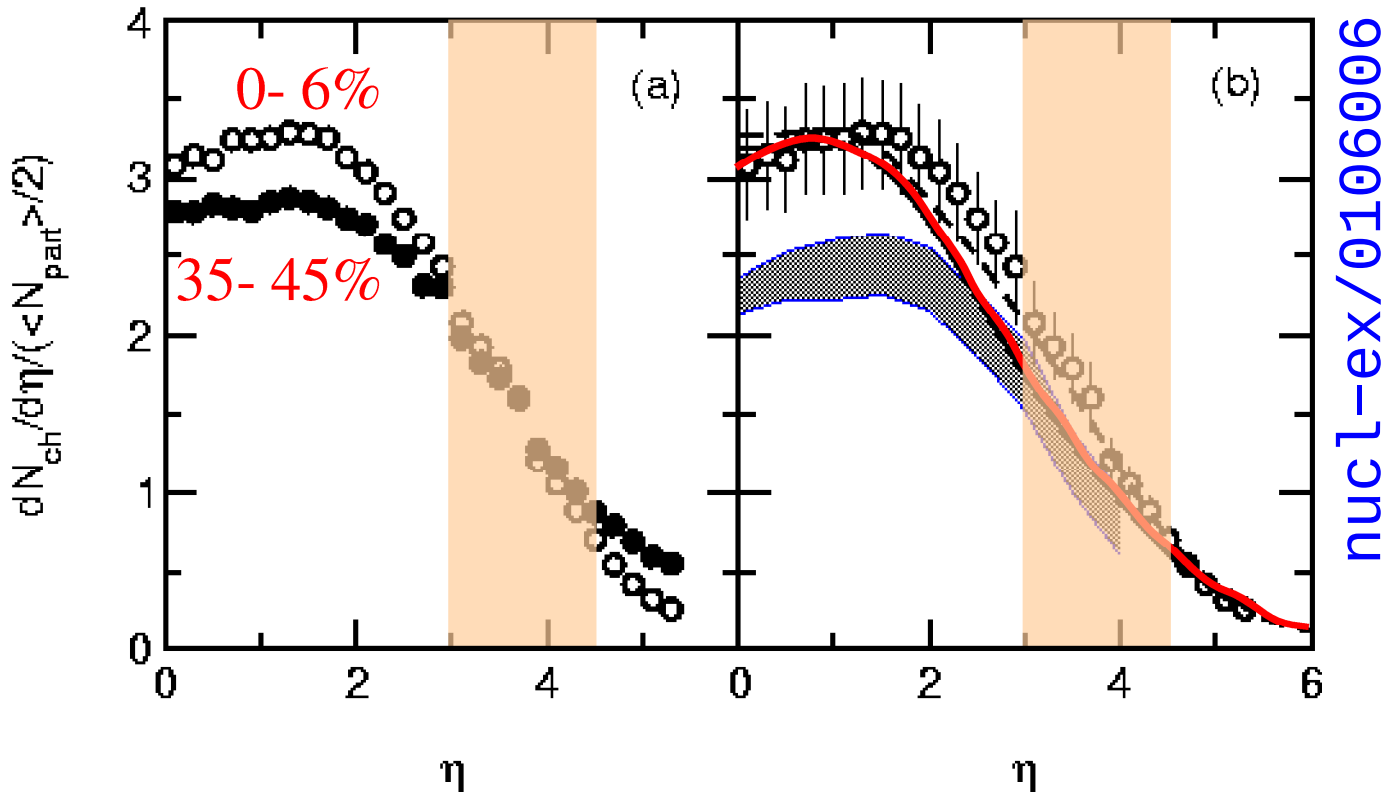
- Integrate normalized Np+Nn distribution up to some bin in the plateau region
- Missing number of events: $\Delta I = I_{MC} - I_{DATA}$
- Missing cross section: $\Delta\sigma = \dfrac{\Delta I}{I_{DATA}^{full} + \Delta I}$



Phobos measures 97± 3% of the inelastic cross section

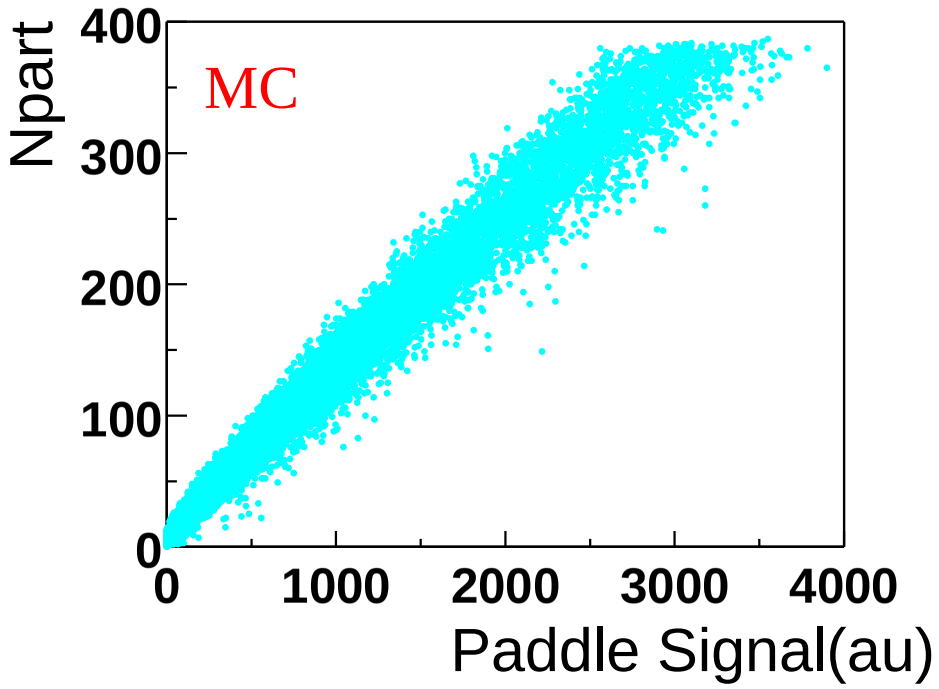
What happens at Np+Nn > 30?

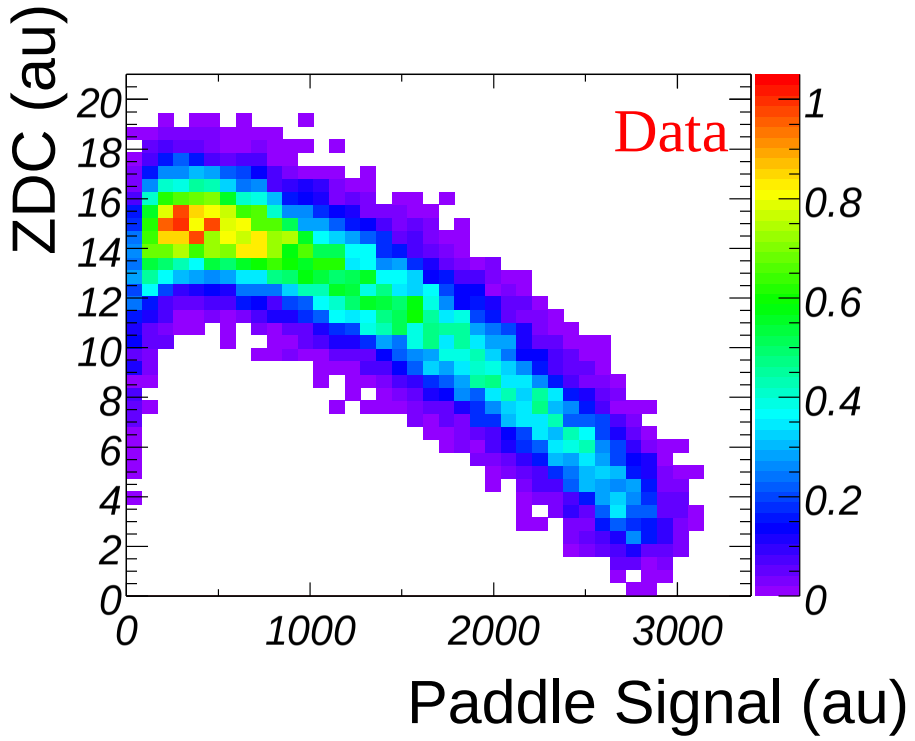
- Charged particle production per participant pair is higher in DATA than in HIJING



Determining Npart Experimentally I

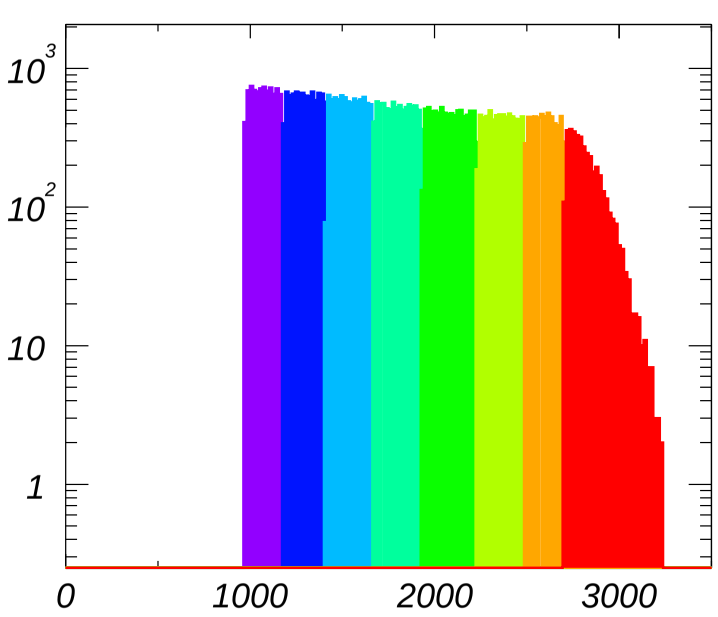
- Look for a variable that monotonically increases with N_{part}
  - Paddle detectors in $3 < |\eta| < 4.5$ satisfy criterion
- Correlation between ZDC and Paddle confirm assumption

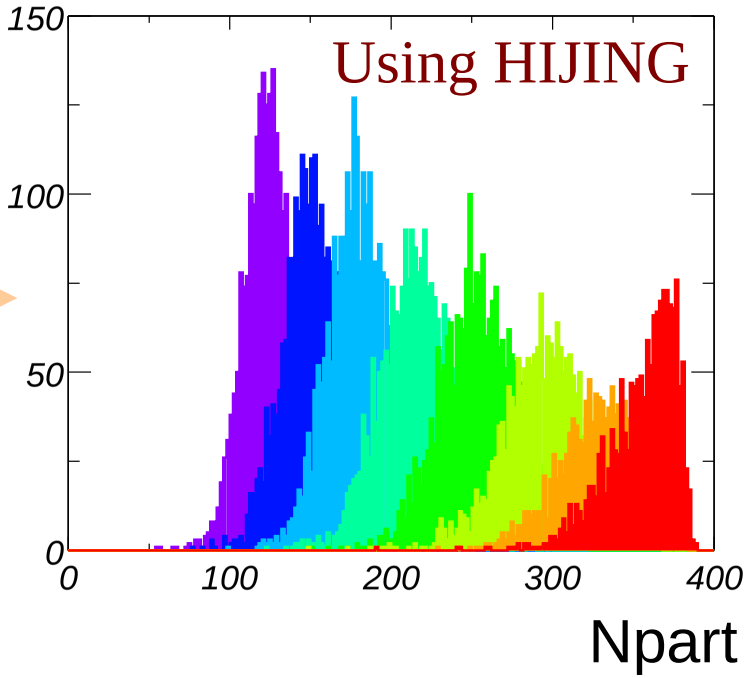




Determining Npart Experimentally II

- Match MC Paddle Signal distribution to DATA
  - Include any ”smearing” of detector response
- Make cuts in cross section in the paddle signal distribution and assign to centrality bins
- See what <Npart> the MC gives - HIJING provides the Glauber calculation





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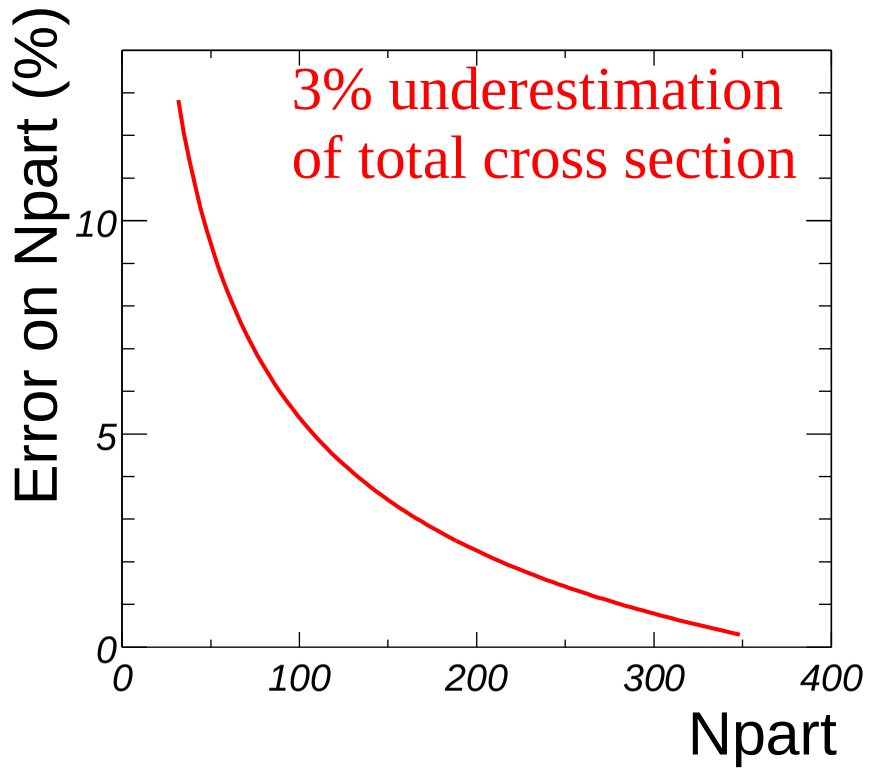
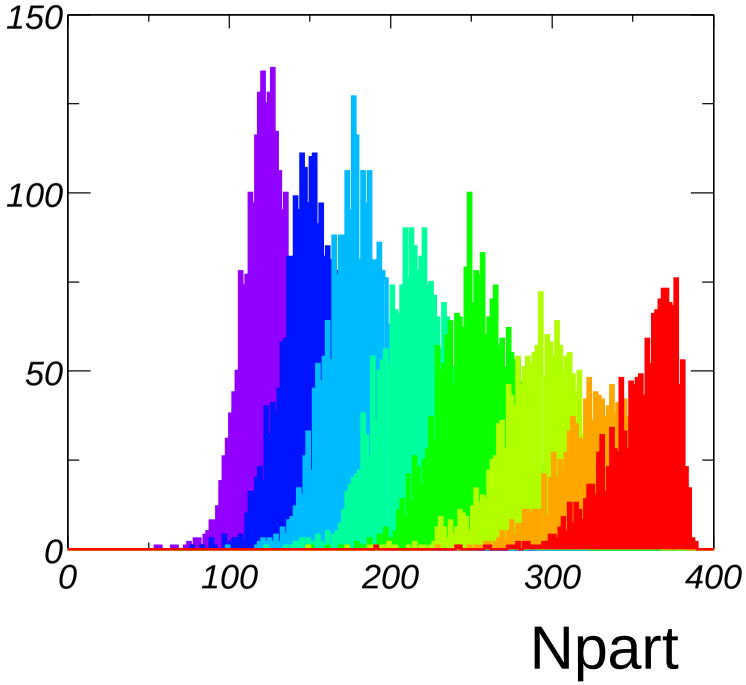
3% Underestimation of Tot CS

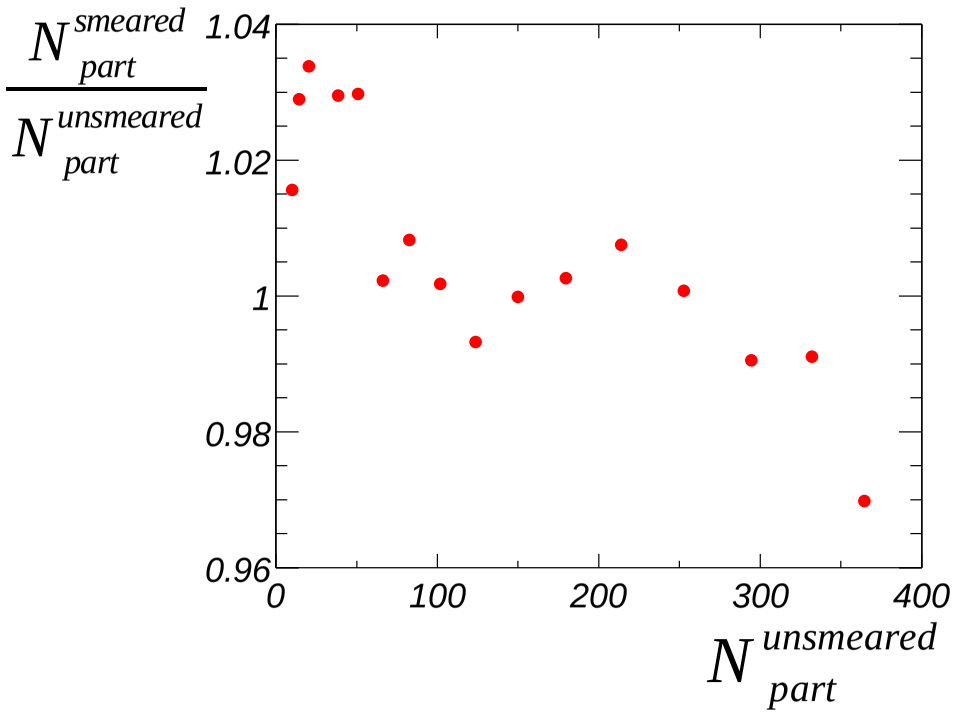
- Paddle detectors see 97±3% of inelastic cross section
  - Error on cross section gives > 5% error on N_{part} for $N_{part} < 100$



N_{part} Corrections due to Smearing

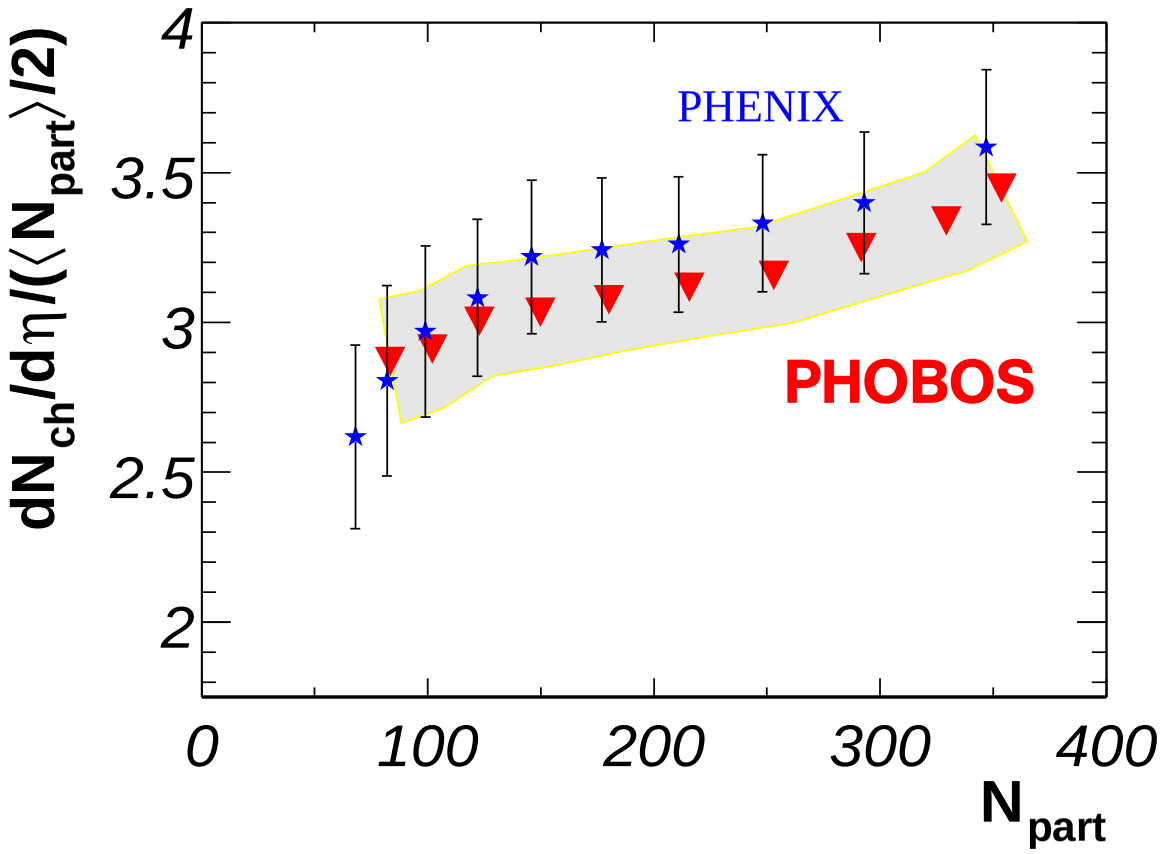
- Effective correction to N_{part} due to fluctuations and paddle smearing
- Half of the correction is added to the systematic error of N_{part} determination





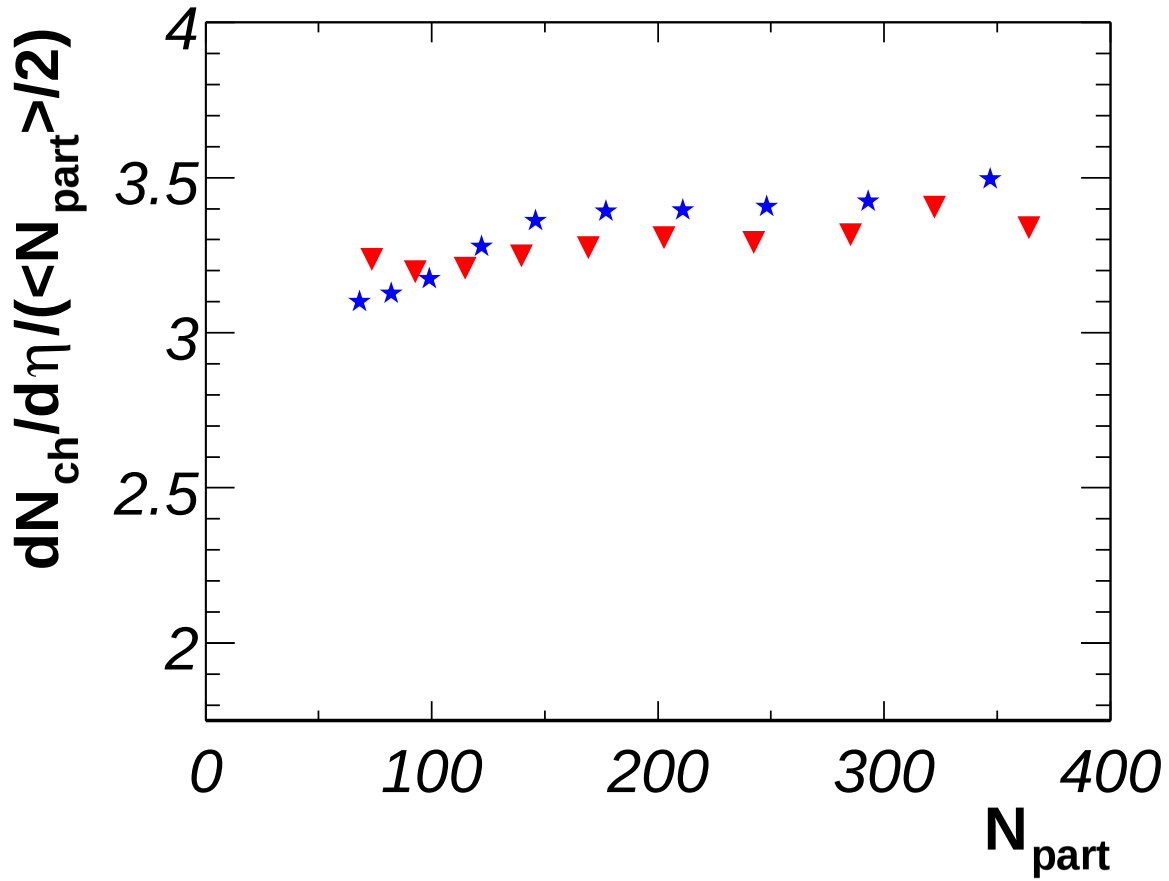
QM2001: dN/deta vs Centrality

- PHOBOS uses HIJING for the Glauber calculation
- PHENIX uses a Hard Sphere MC, giving very similar N_{part} results to HIJING (Peter Steinberg's talk)



Being Provocative

- Replotting the dN/deta result using Optical Glauber N_{part} values



Summary

- PHOBOS is sensitive to 97±3% of the minimum-bias cross section using the paddle detectors
- PHOBOS uses the paddle counters in $3 < |\eta| < 4.5$ to measure centrality
  - ZDC is still under study
- Systematic error on N_{part} is > 5% at $N_{part} = 100$ and approx. 1.5% for most central events
  - Error on inelastic cross section
  - Smearing of paddles