Elliptic Flow Measurements with the PHENIX Detector System

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PHENIX Collaboration

PHENIX

Outline

Elliptic Flow ?

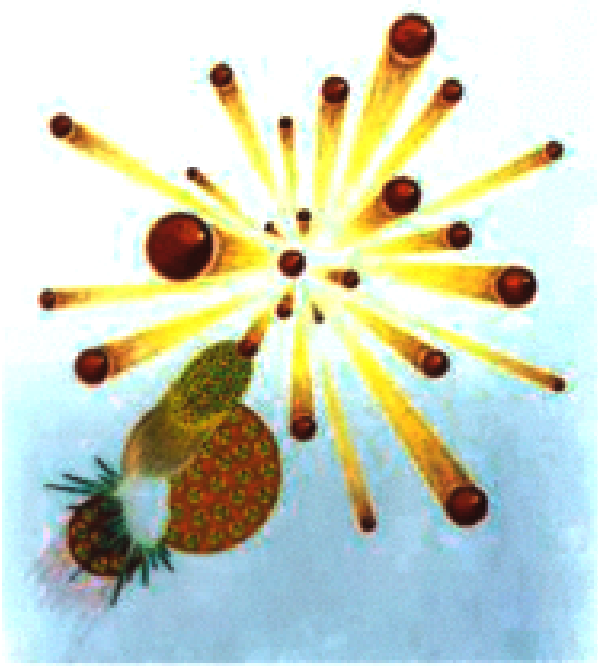
Motivation

Analysis

(Correlation Technique)

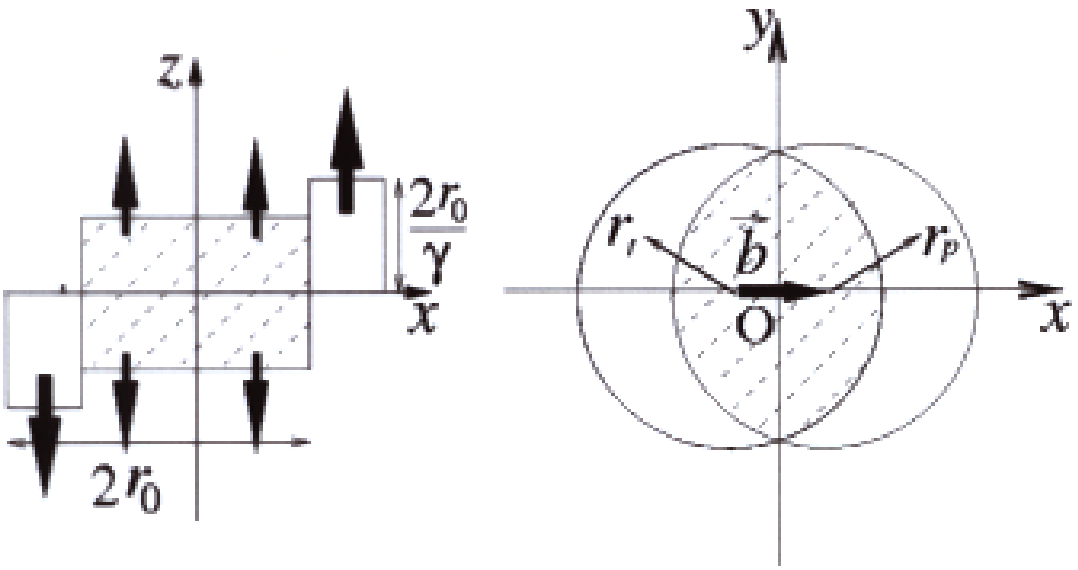
Results

Summary/Outlook



Elliptic Flow ?

Azimuthal Asymmetry in the Flow of Particle Momentum or Energy



Reaction Plane Transverse Plane

Notion

$$t_{expan} \sim \frac{R}{c_S}$$

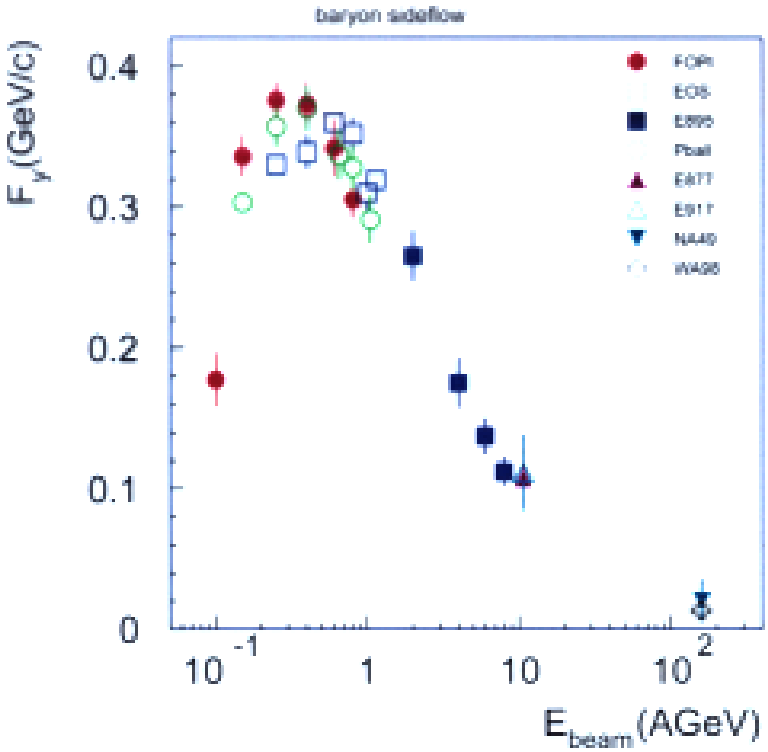
$$t_{pass} \sim \frac{2R}{\gamma_0 v_0}$$

Low Energy:
Squeeze-out

High Energy
In-plane Emission

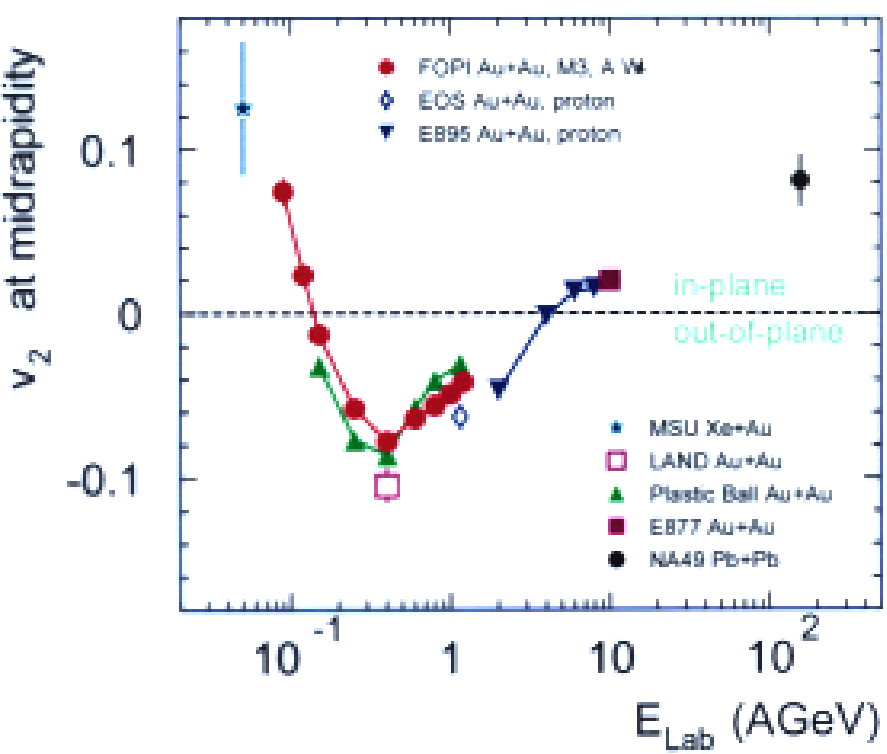
$$\frac{dN}{d\phi} \sim [1 + 2v_1 \cos(\phi) + 2v_2 \cos(2\phi)]$$

Excitation function

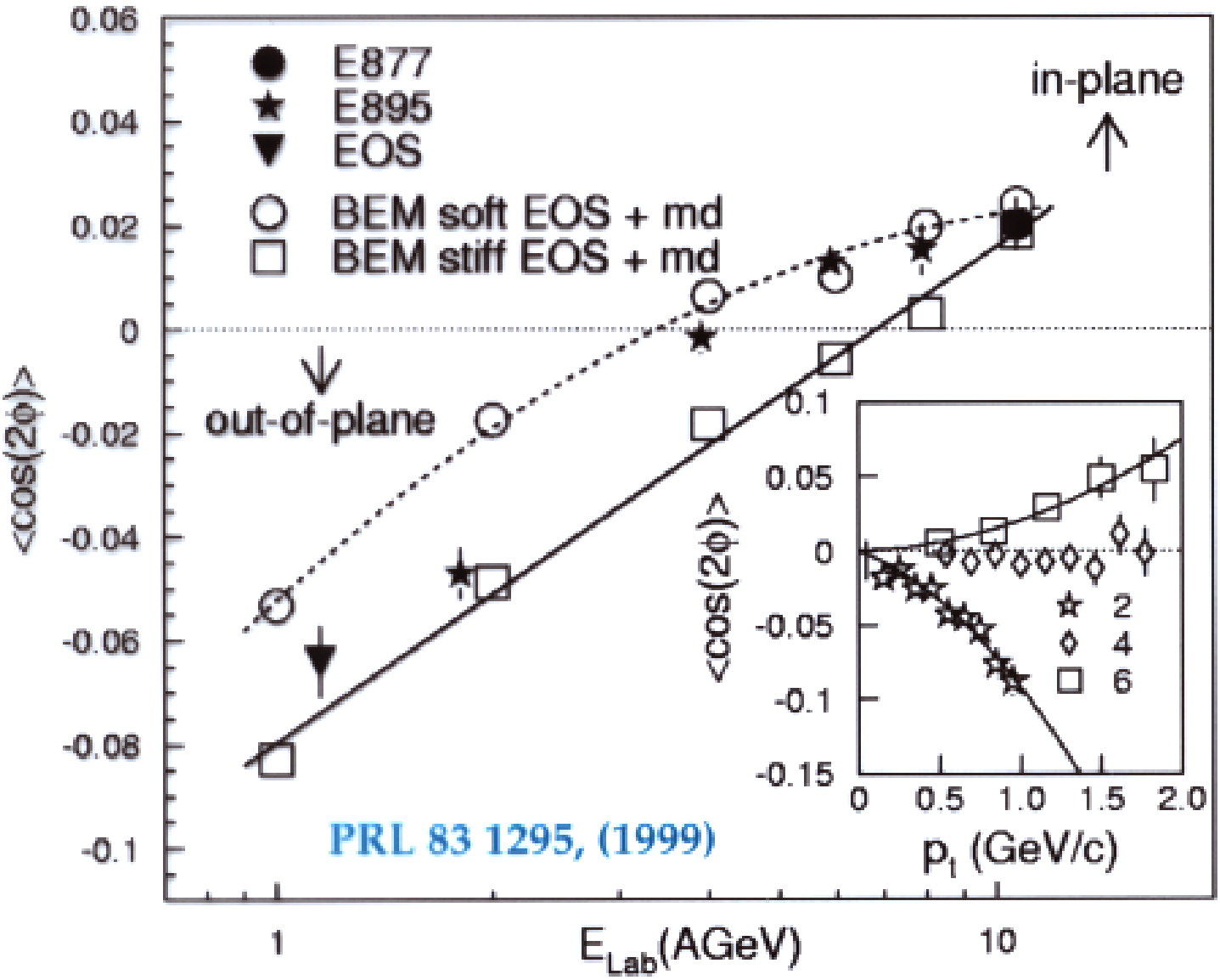


Elliptic Flow Data

Excitation function for semicentral collisions



Elliptic Flow



The Transition from Negative to Positive Elliptic Flow Occurs ~ 4 AGeV

PHENIX

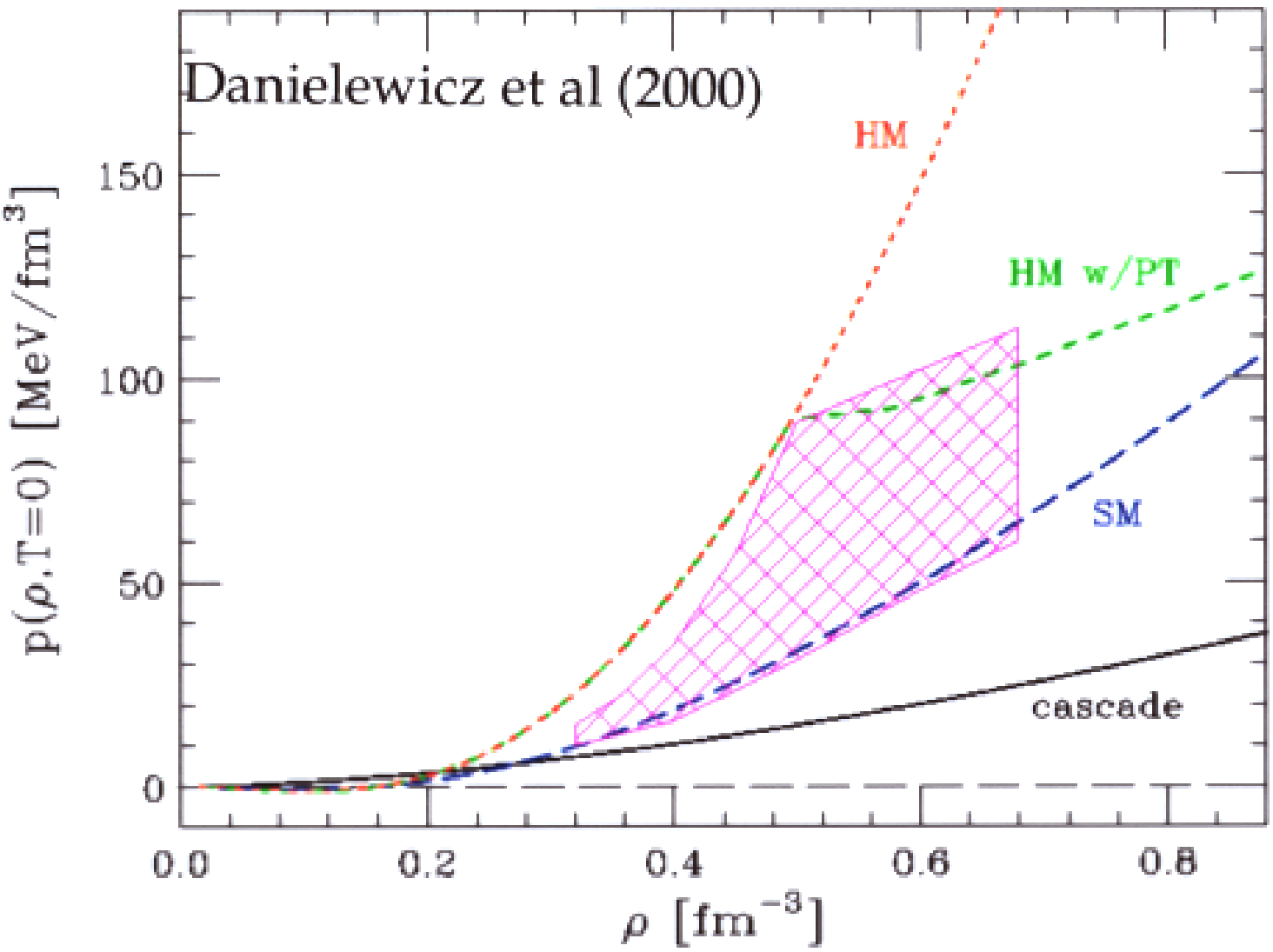
Motivation

Why Study Elliptic Flow ?

Pervasive Notion:

- **Important Probe for:**
  - **the EOS.**
  - **Phase transition**
  - **Reaction Dynamics**

Motivation



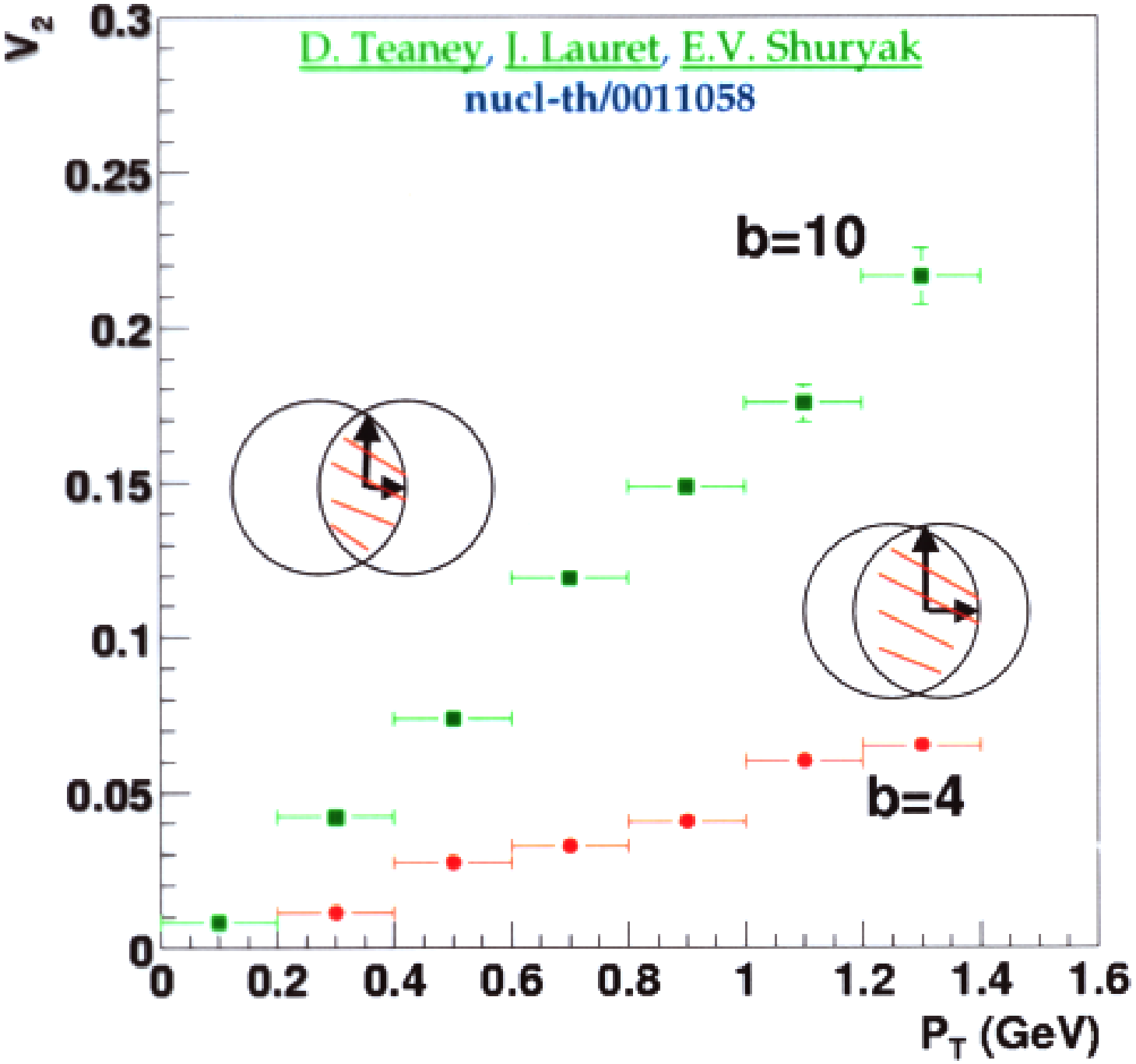
The EOS can be Constrained by Flow Measurements

Motivation

At RHIC Elliptic Flow is Expected to be Sensitive to the Hard QGP Phase

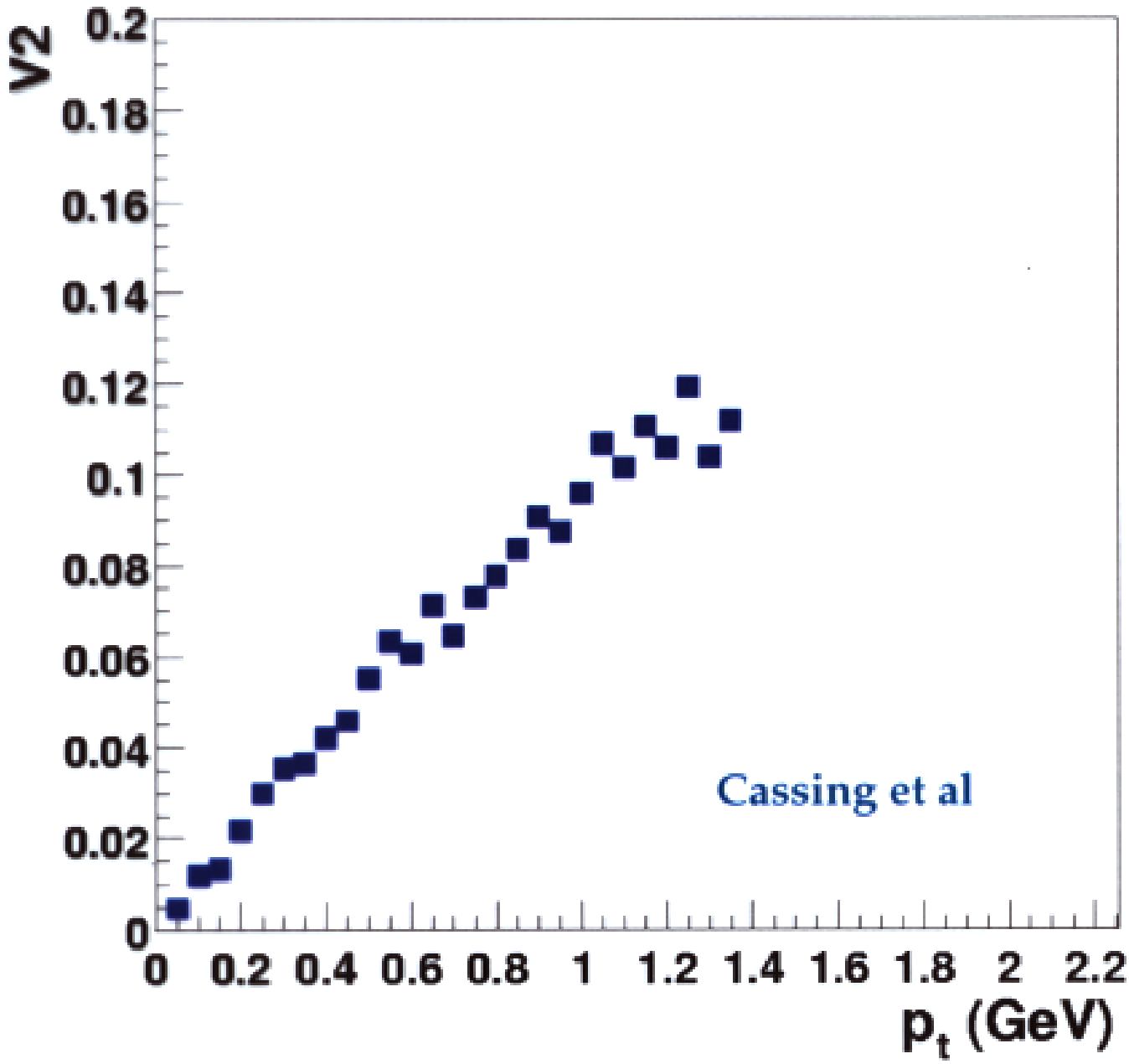
Predicted Signals are Fairly Well Defined and Reasonably Understood

Motivation

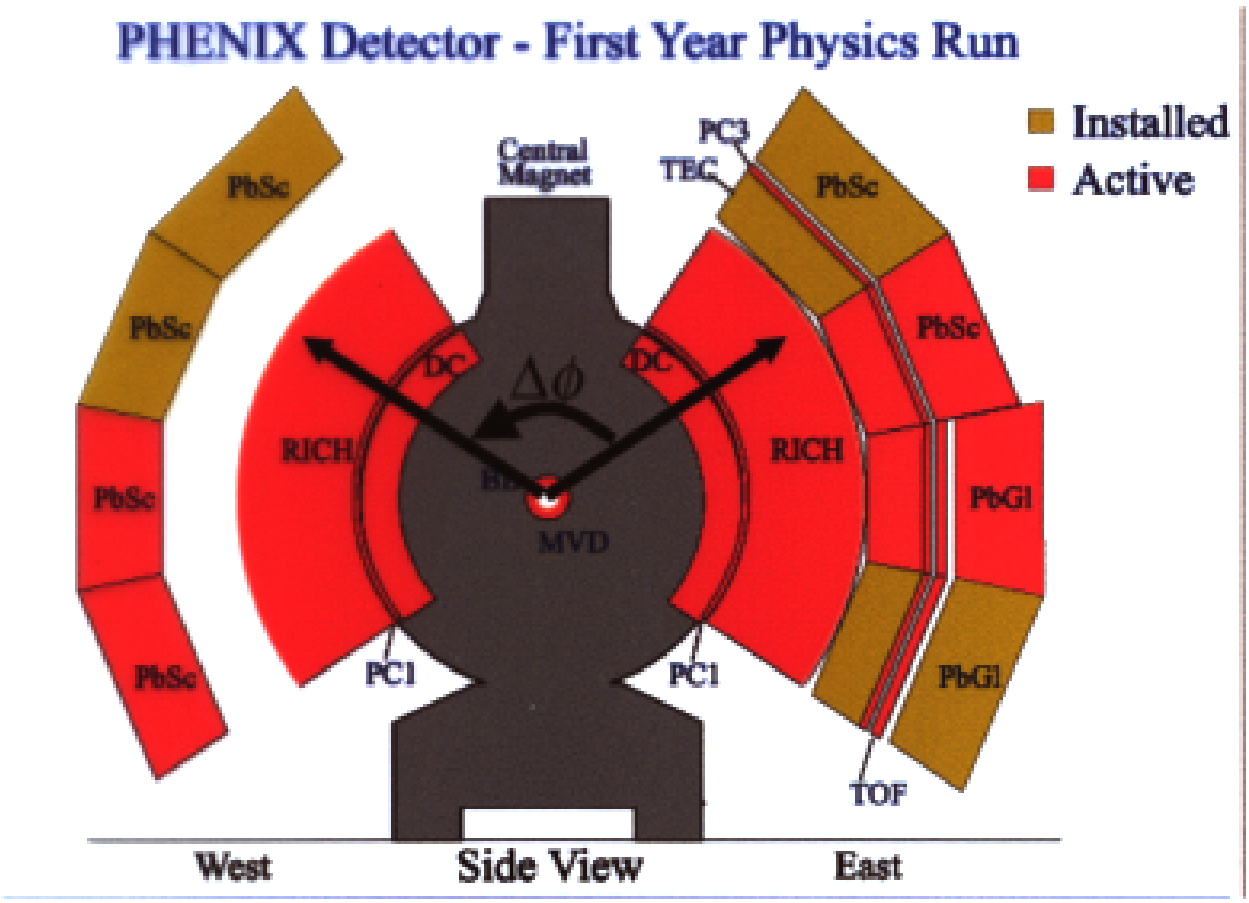


Models Predict Strong Sensitivity to Pt and Impact-parameter

Motivation


v2
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2
p_t (GeV)
Cassing et al

Analysis



Study $\Delta\phi$ Correlation between particles:

$$\frac{dN_{pairs}}{d\Delta\phi} \propto \left(1 + \sum_{n=1}^{\infty} 2v_n^2 \cos(n\Delta\phi)\right)$$

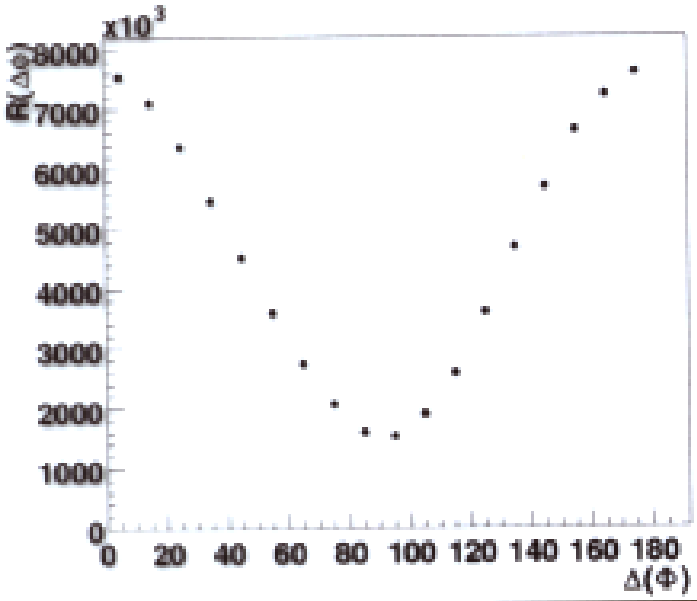
- **Event by event reaction plane determination & Dispersion Corrections Circumvented**
- **Uncertainties associated with Acceptance, efficiency … Reduced**

Small Signal !!

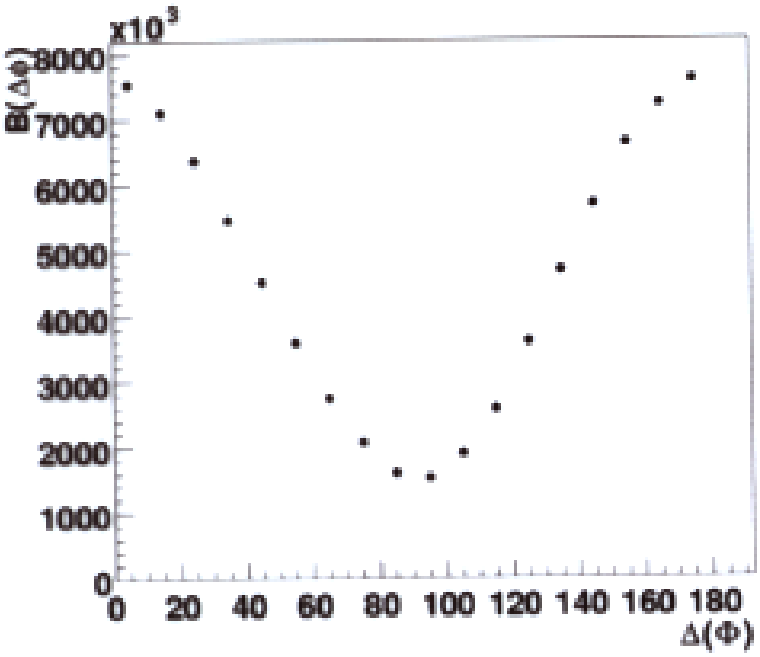
Analysis Procedure

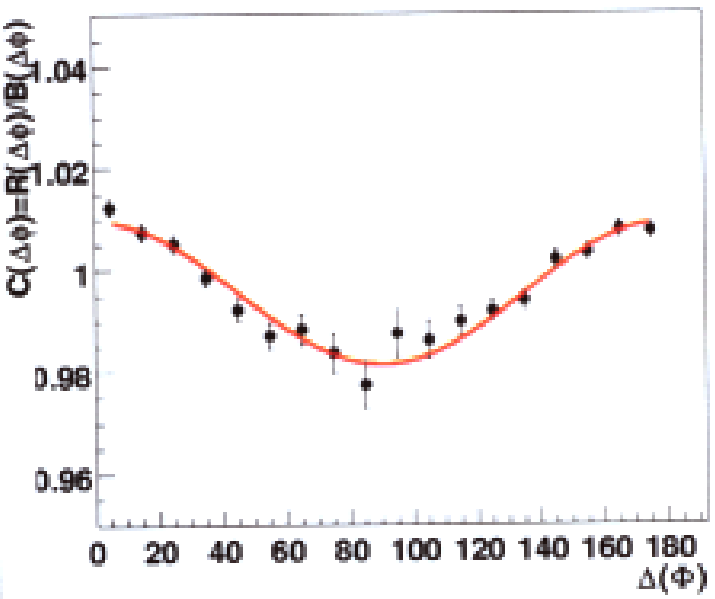
Wang et al.,
PRC 44, 1091 (1991)
Lacey et al.
PRL 70, 1224 (1993)

Tracks:
BBC Vertex < 20
Mult > 5



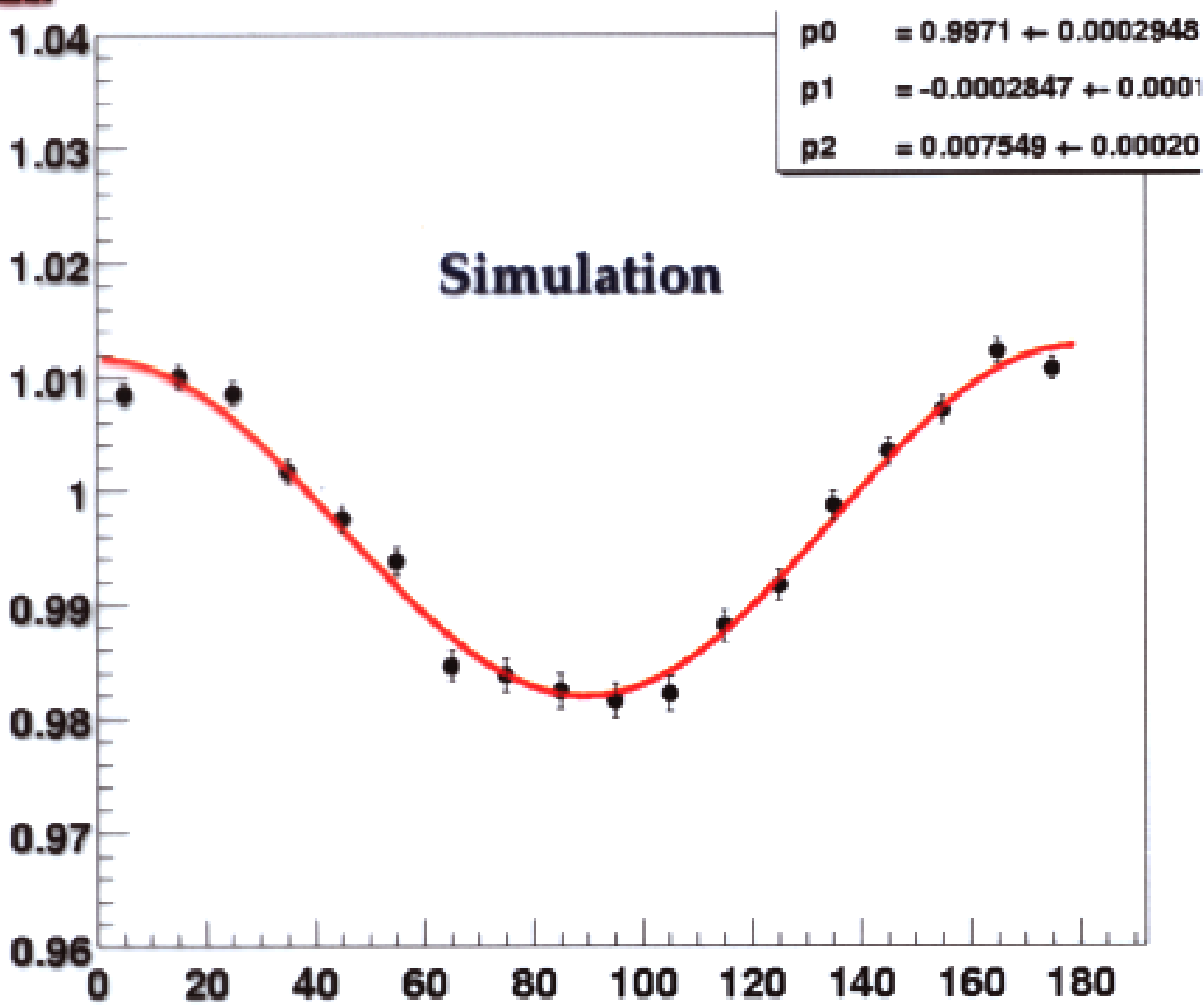
$$C(\Delta\phi) = \frac{N_{cor}(\Delta\phi)}{N_{uncor}(\Delta\phi)}$$





Small Signal Does not Imply Small Signal to Noise

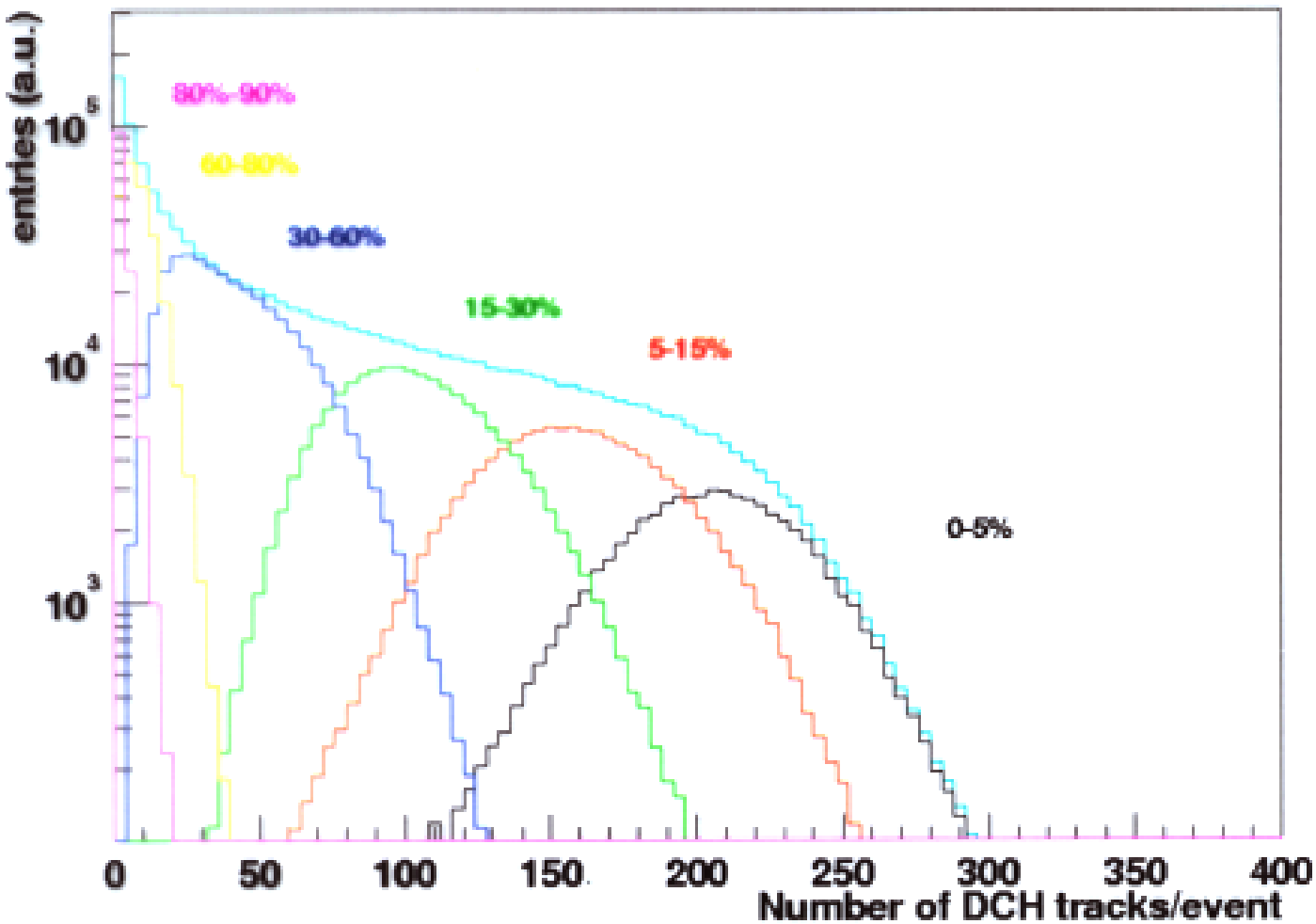
Analysis



Input Flow Processed Through the full Detector Response Chain is very well Reproduced

Analysis

Raw multiplicity Distribution



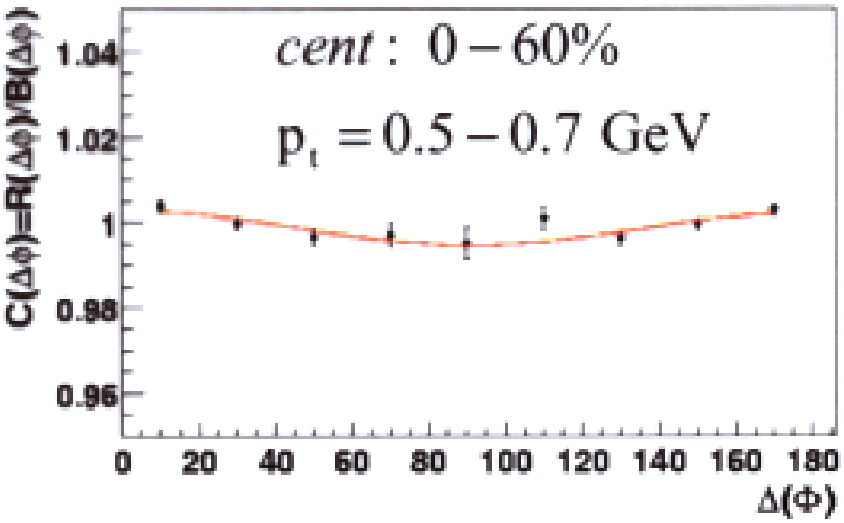
The Correlation Function is Studied As a Function of Centrality

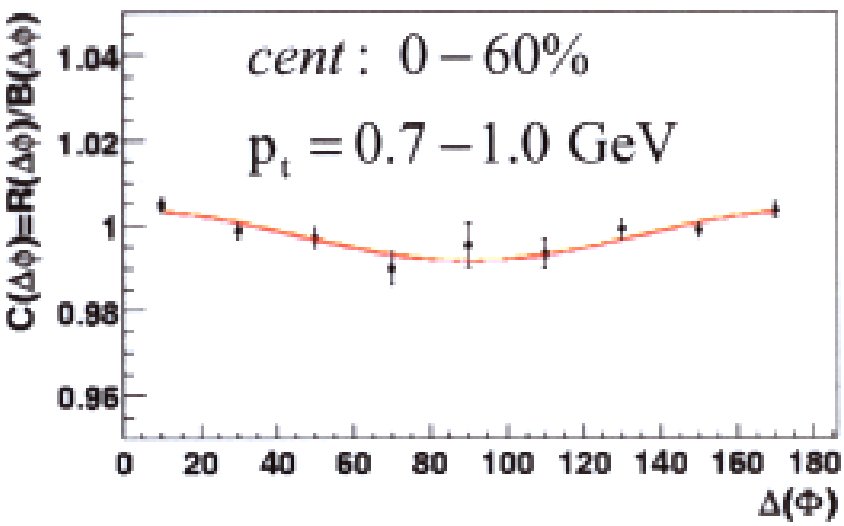
Results

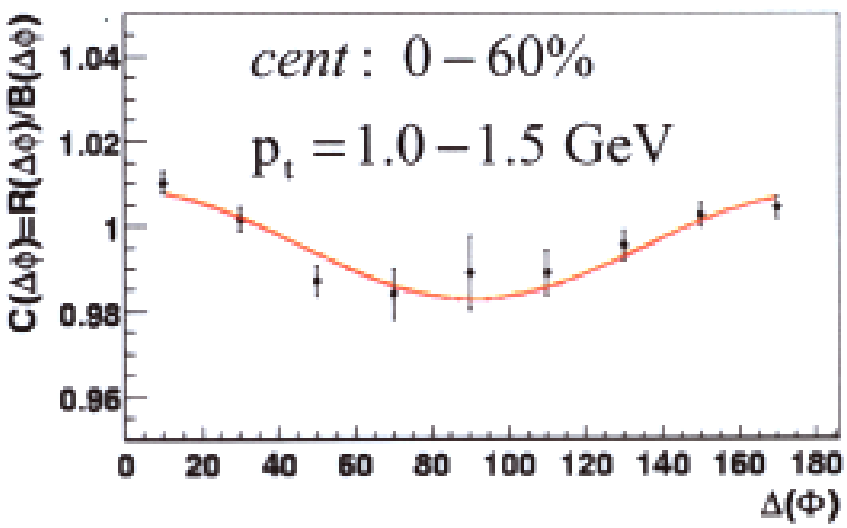
P_t Dependence

PHENIX Preliminary

Systematic Errors Under Study







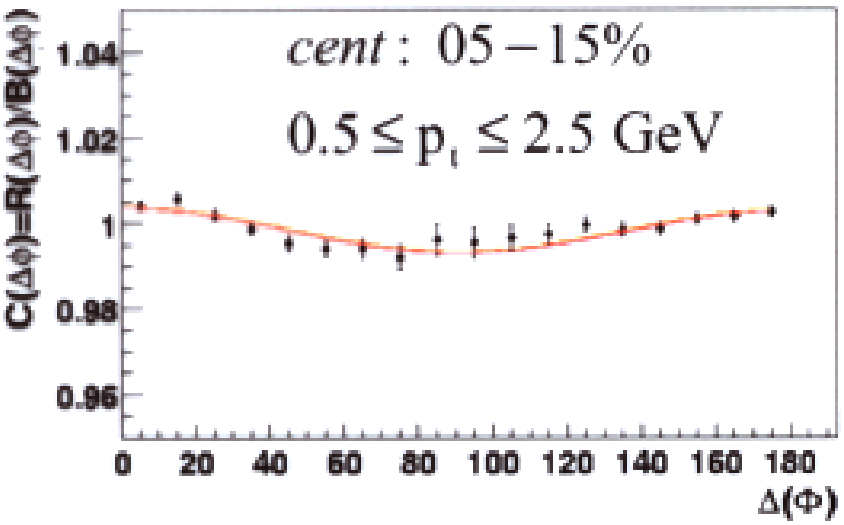
PHENIX

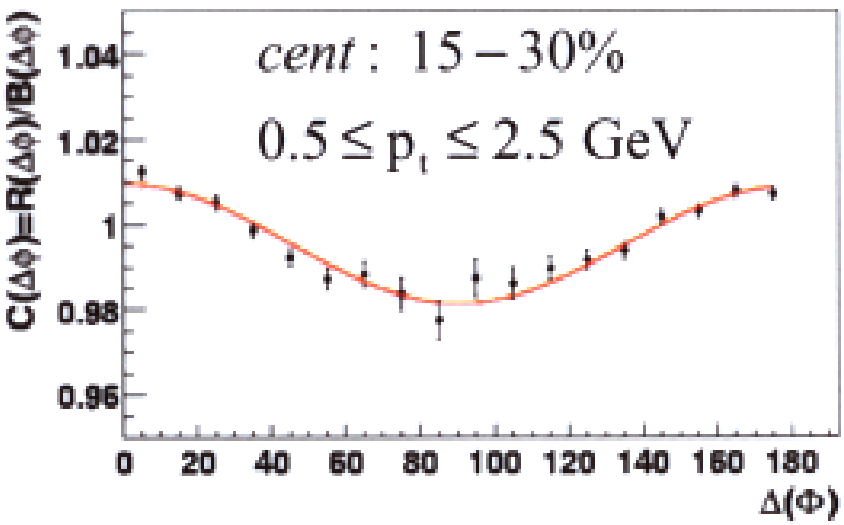
Results

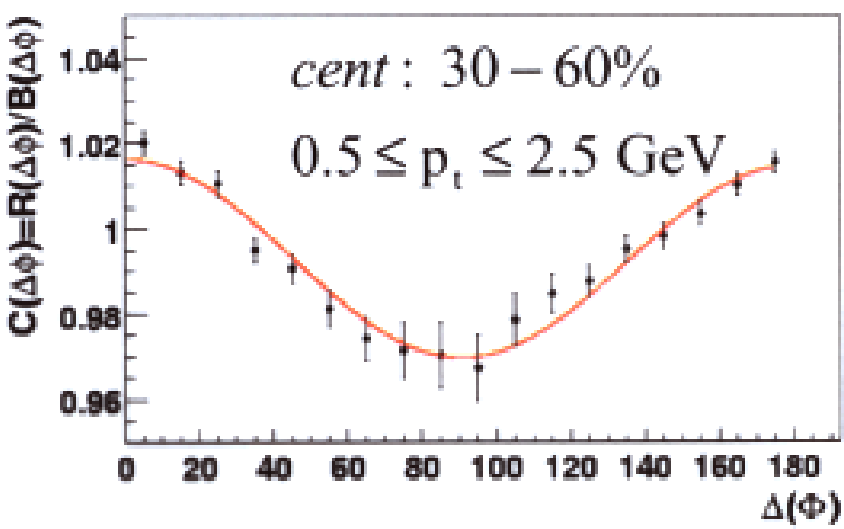
Centrality Dependence

PHENIX Preliminary

Systematic Errors Under Study

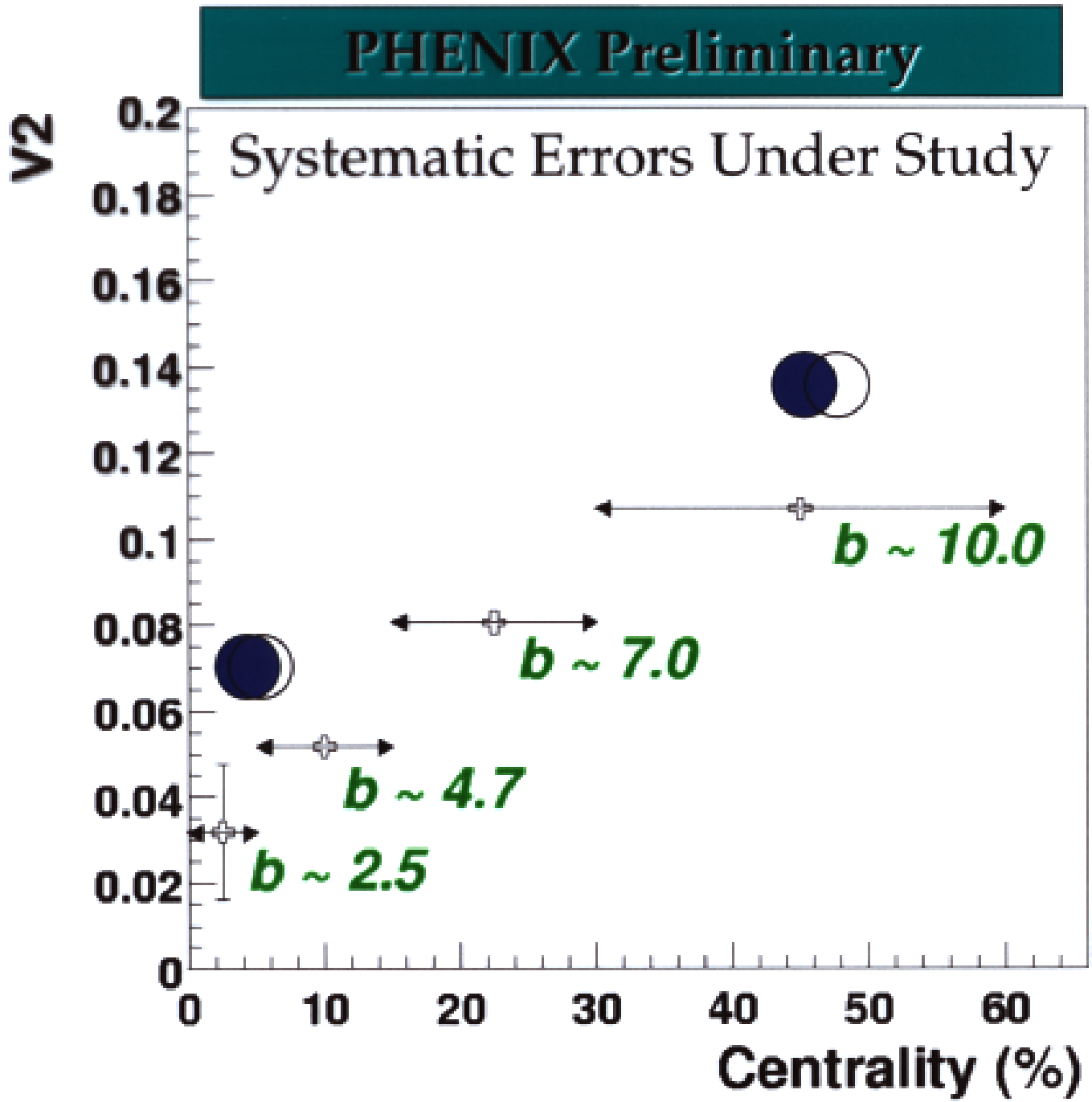




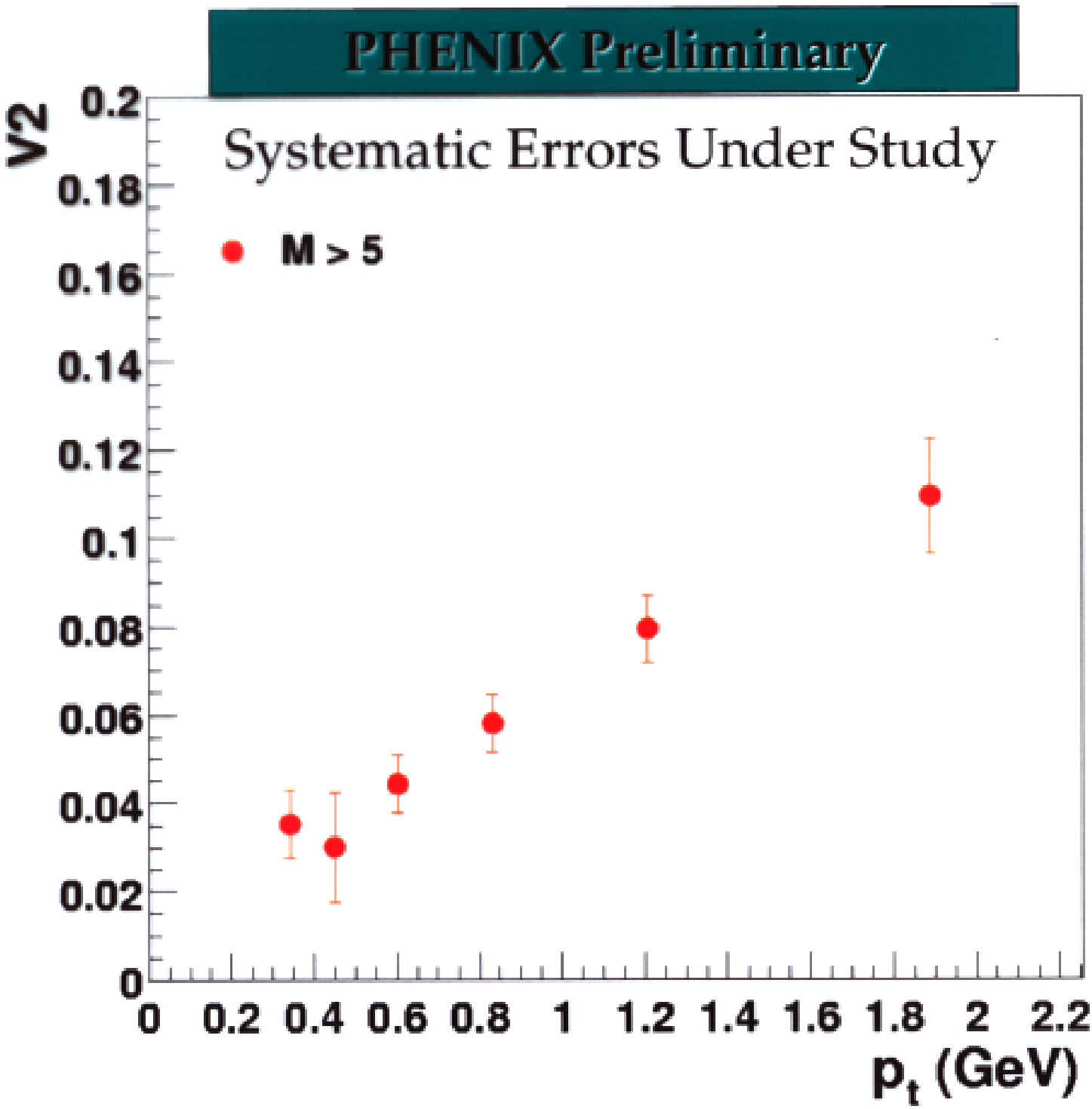


PHENIX

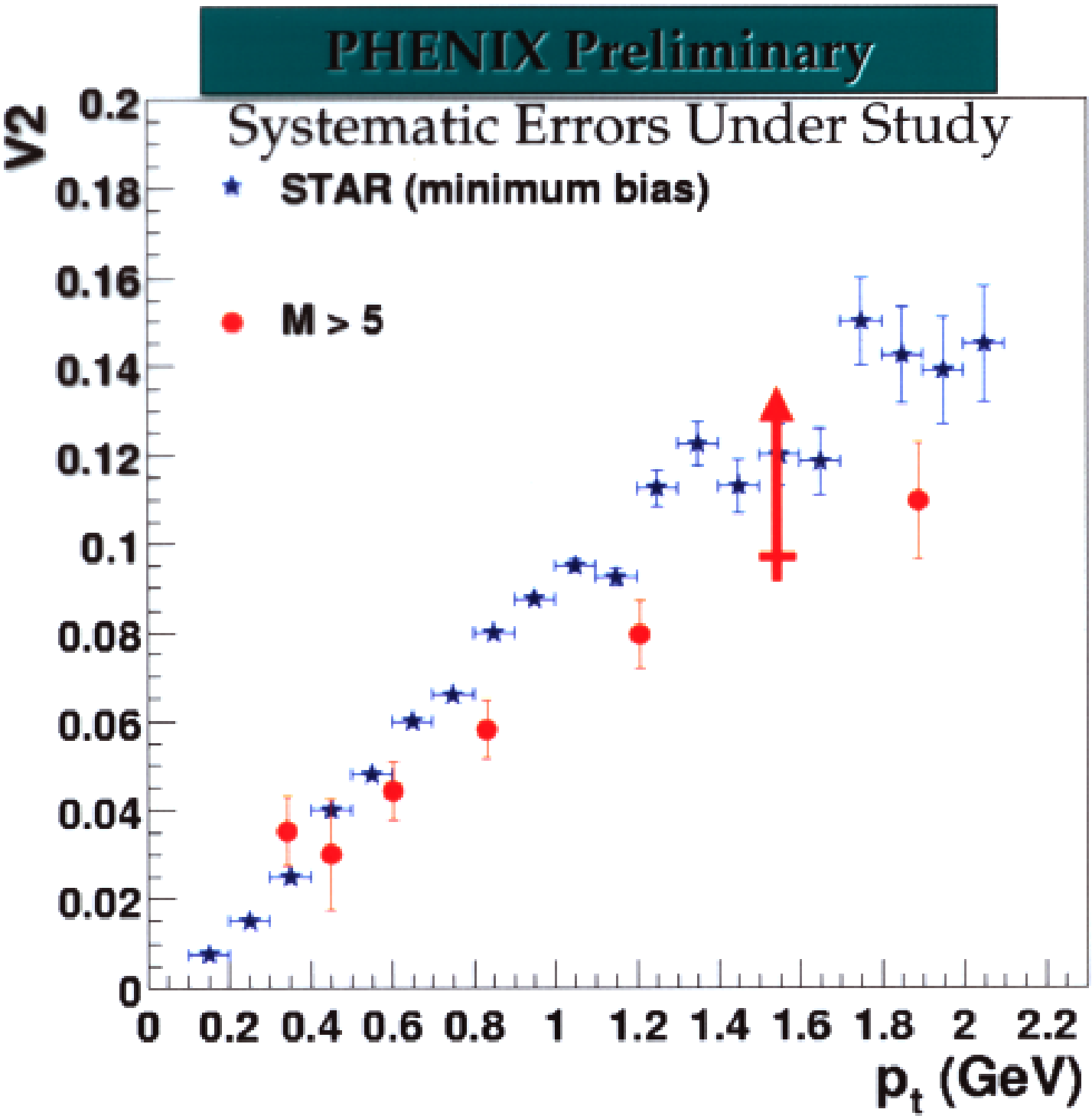
Results


PHENIX Preliminary
Systematic Errors Under Study
v2
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
Centrality (%)
b ~ 10.0
b ~ 7.0
b ~ 4.7
b ~ 2.5

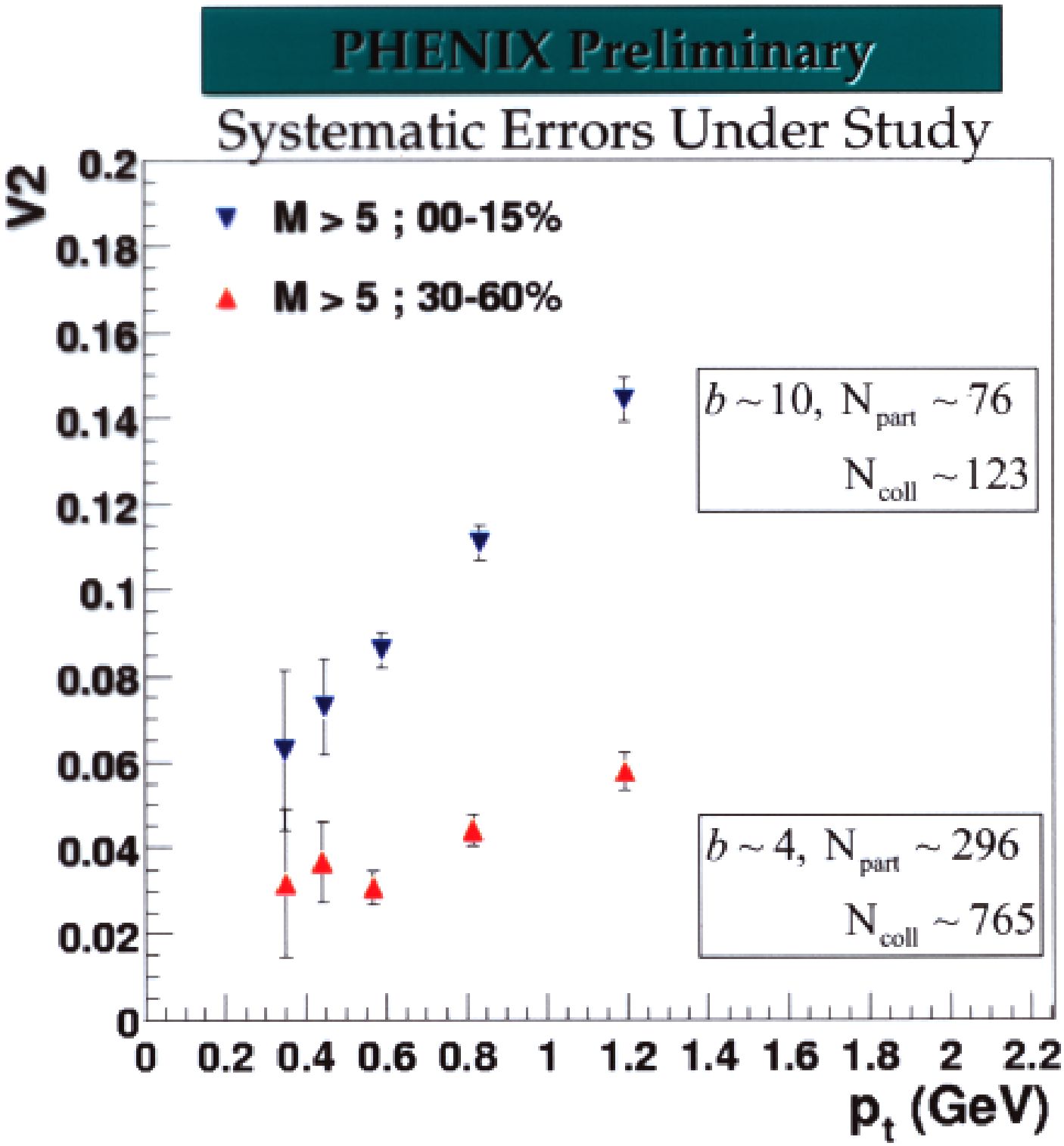
Results


PHENIX Preliminary
Systematic Errors Under Study
M > 5
v2
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2
p_t (GeV)

Results


PHENIX Preliminary
Systematic Errors Under Study
STAR (minimum bias)
M > 5
v2
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2
p_t (GeV)

Results


PHENIX Preliminary
Systematic Errors Under Study
V2
M > 5 ; 00-15%
M > 5 ; 30-60%
b ~ 10, N_part ~ 76
N_coll ~ 123
b ~ 4, N_part ~ 296
N_coll ~ 765
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2
p_t (GeV)

Summary

Elliptic Flow Observed at RHIC With the PHENIX Detector

- **Observed Elliptic Flow is Larger than that observed at the:**
  - **AGS**
  - **SPS**
- **The observed Elliptic Flow Shows a Strong Dependence on**
  - Centrality
  - P_t
- **Qualitative Data trends Follow Model Prediction**
  - **Detailed Model Comparisons to follow → Implications**

Further Analysis in progress !!