

FUTURE HEAVY ION PROGRAM

LESSONS FROM PHOBOS

Wit Busza

MIT

EXPERIENCE TEACHES US THAT

A QUANTUM JUMP IN THE AVAILABILITY OF NEW TOOLS

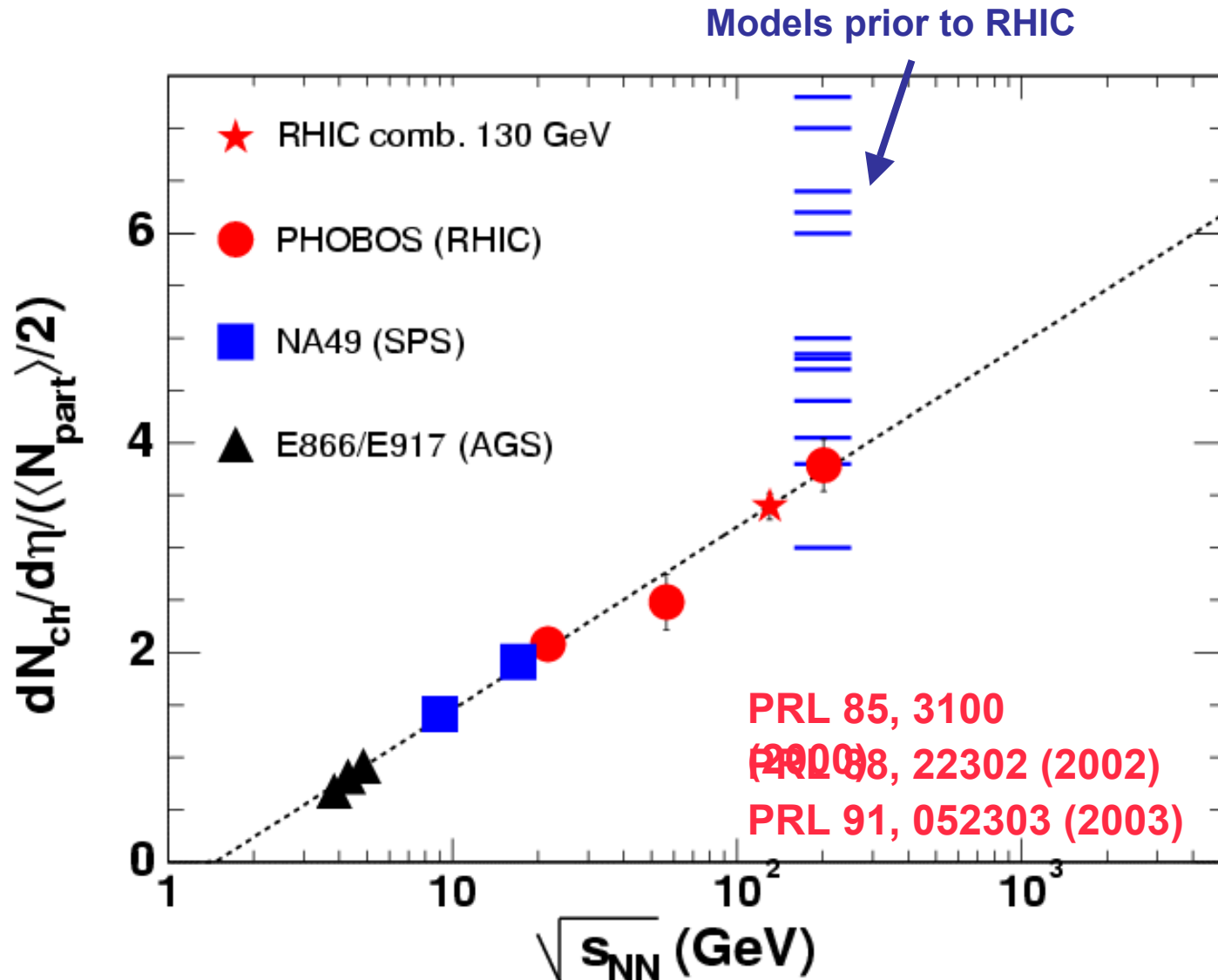
- ENERGY
- LUMINOSITY
- DETECTORS

LEADS TO A QUANTUM JUMP IN OUR UNDERSTANDING

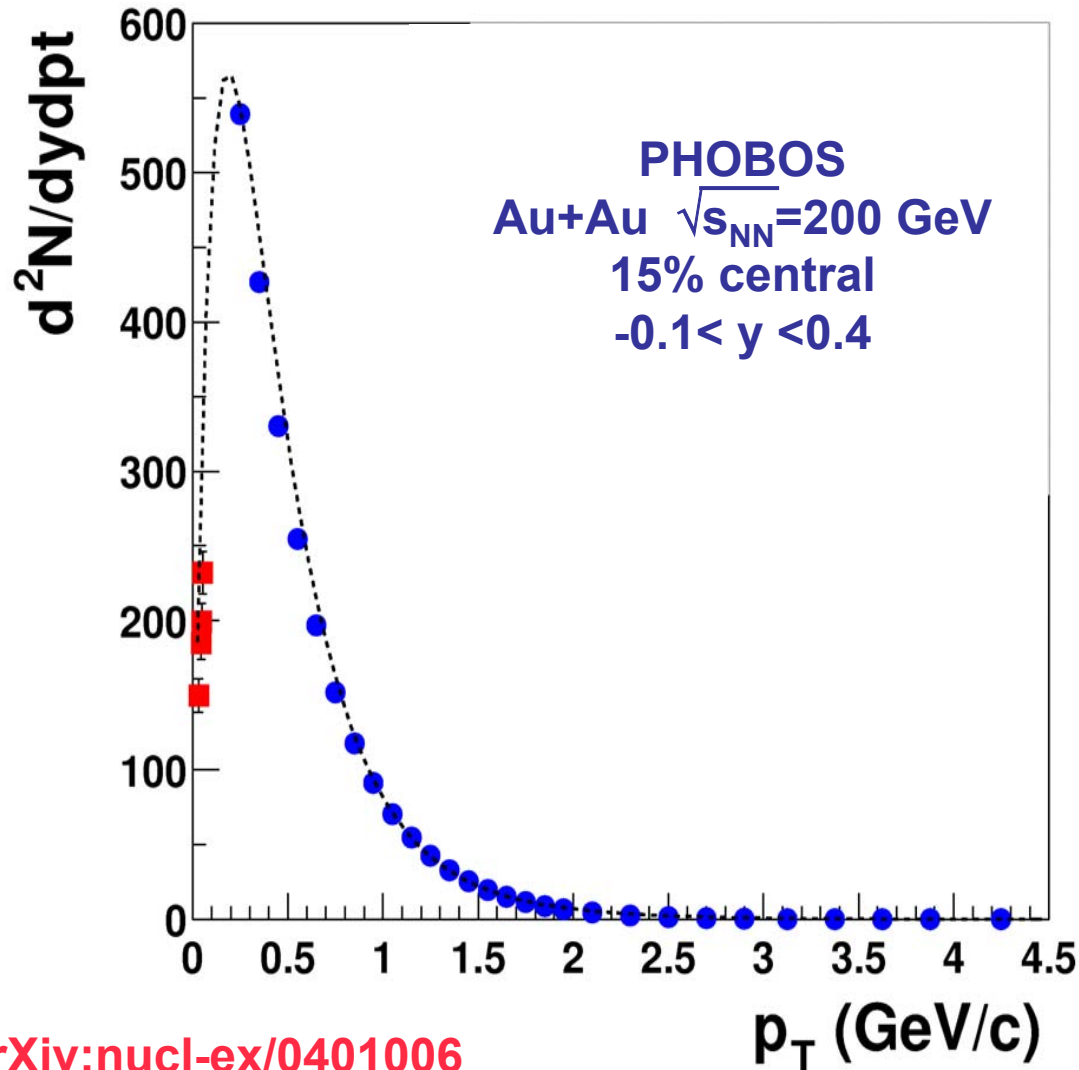
RHIC WAS NO EXCEPTION, NOR WILL RHIC II OR LHC BE ONE!

RHIC SURPRISES

Particle Density near Mid-Rapidity

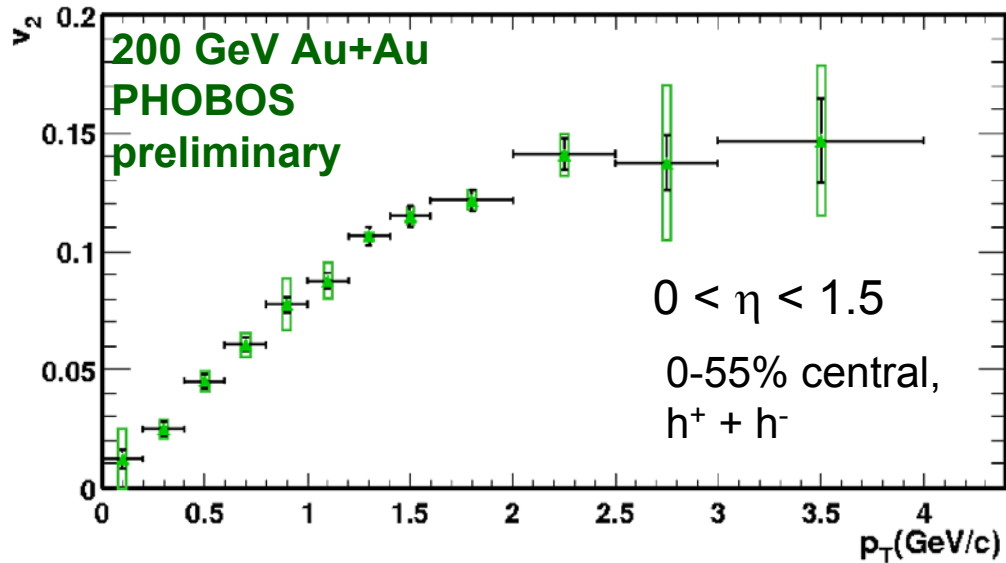
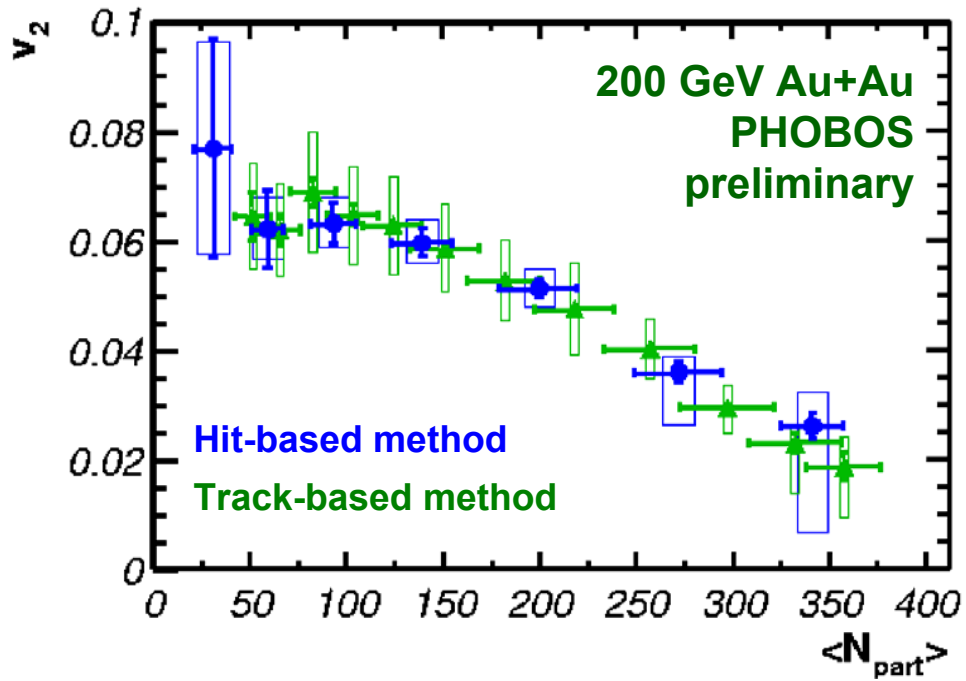


Small number of particles produced with very low p_T :

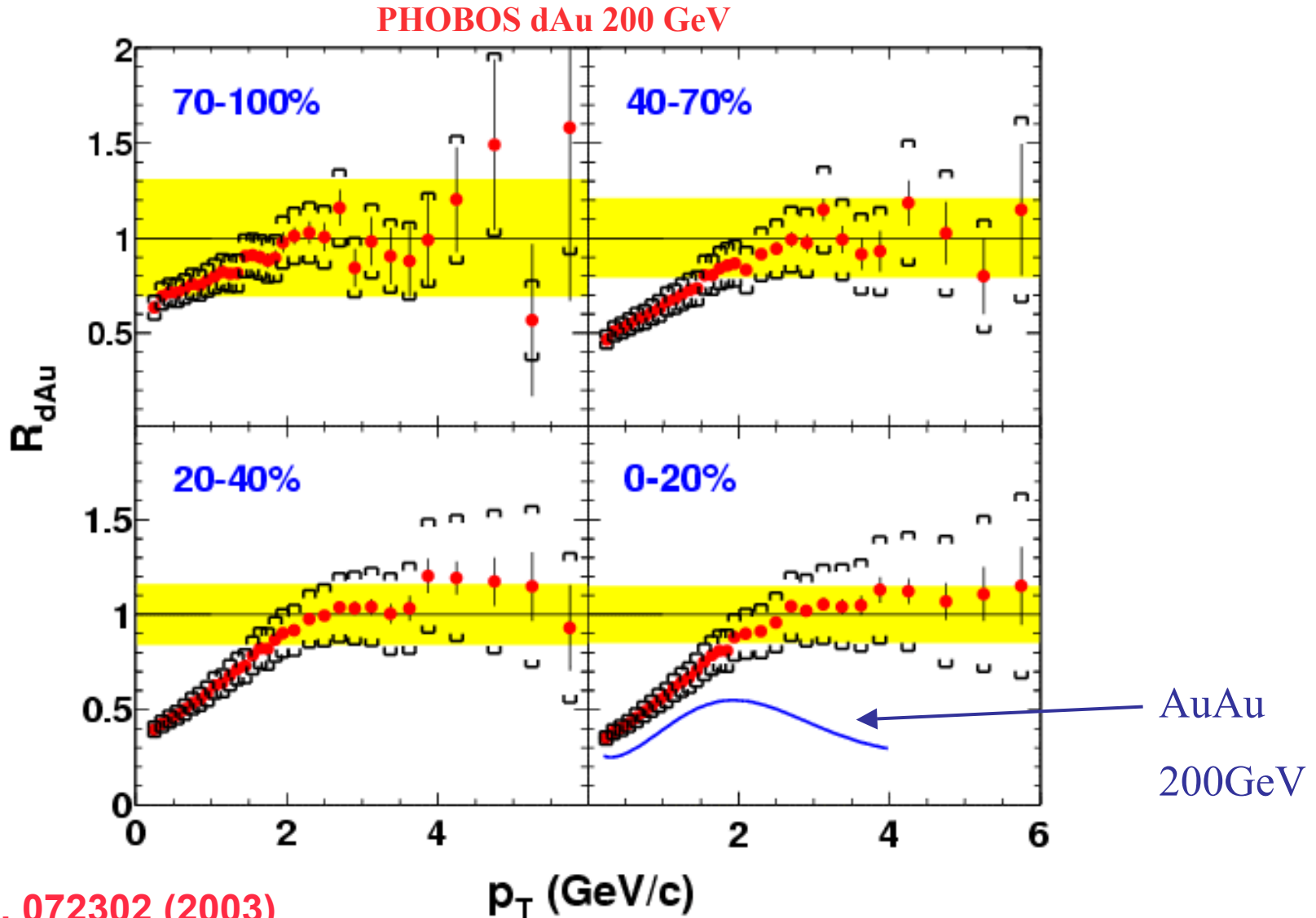


In a large volume weakly interacting system you could expect the development of particles with long wavelength

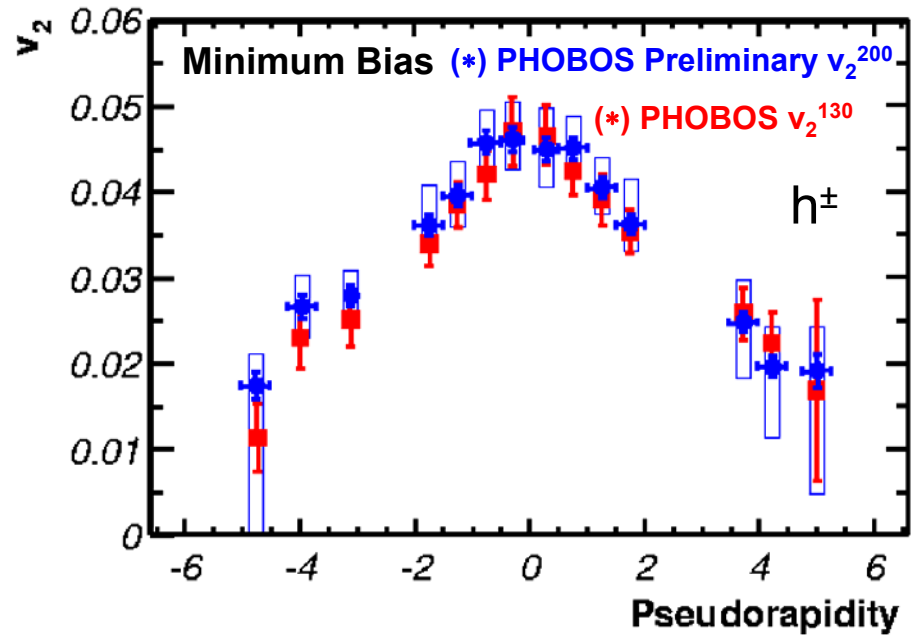
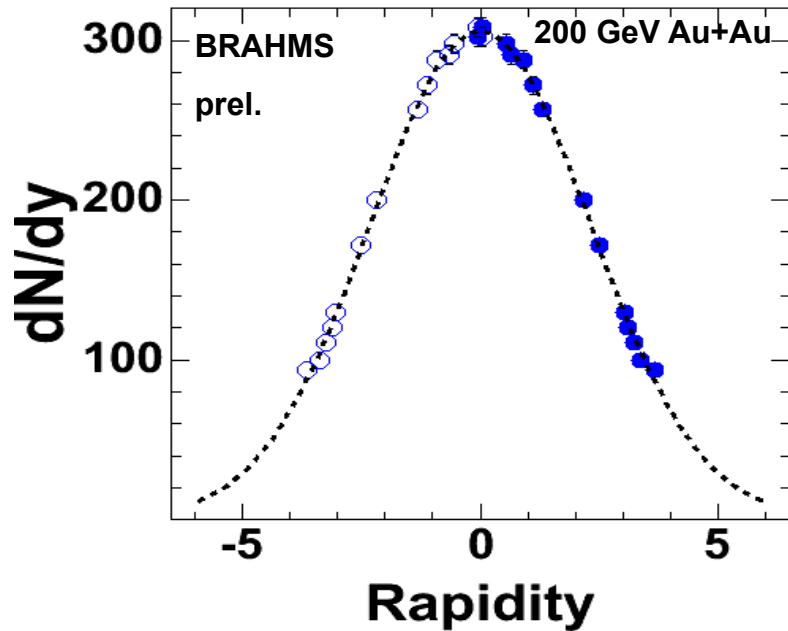
Medium is strongly interacting:



Evidence for strongly interacting medium from the suppression of high- p_T particles:



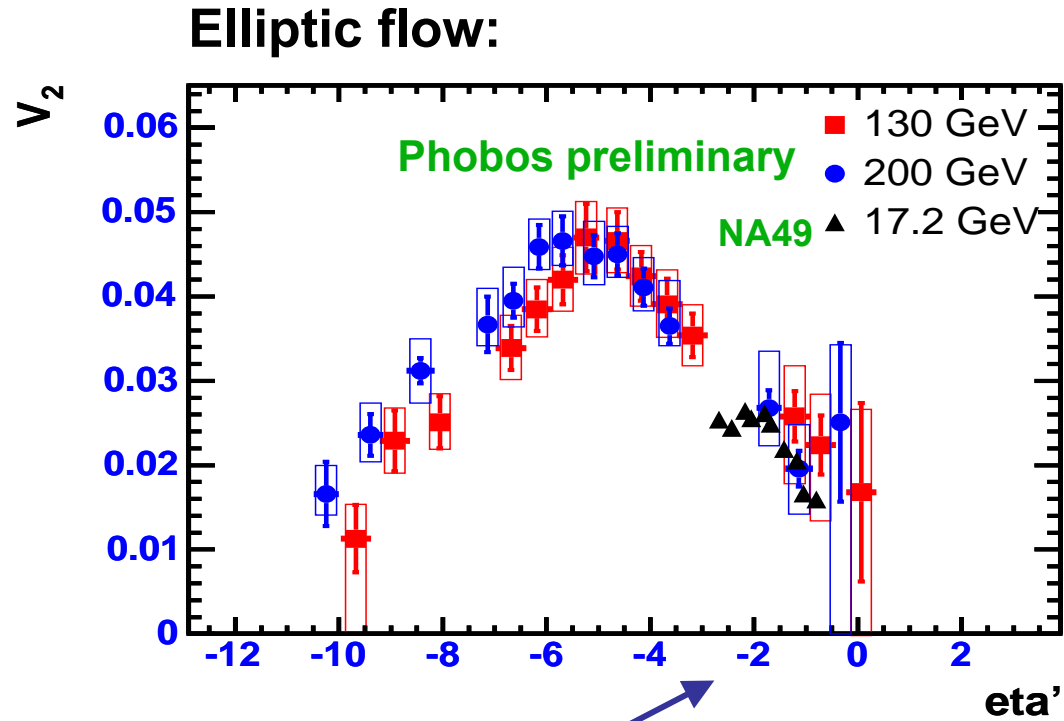
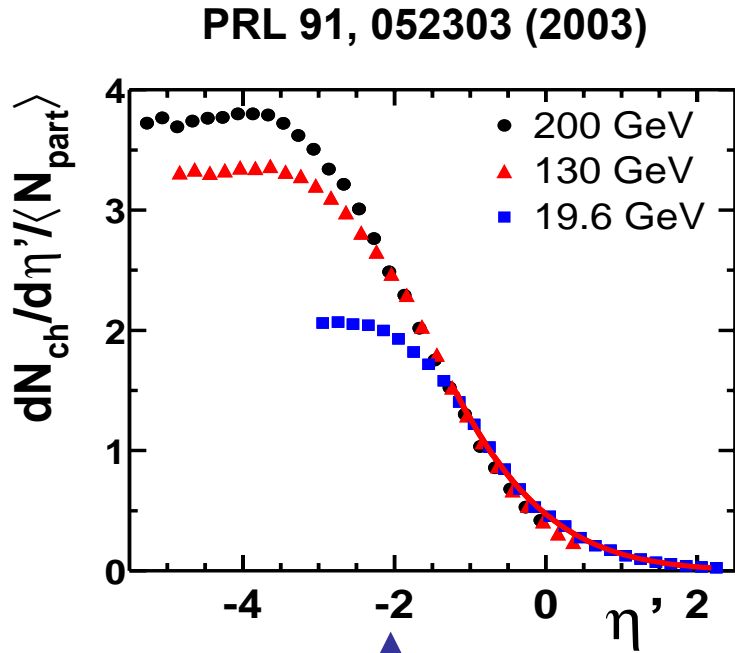
No boost invariant central plateau seen in dN/dy



(* Nucl. Phys. A715 (2003) 611-614

(* PRL 89, 222301 (2002)

Bulk properties dominated by fragmentation regions:



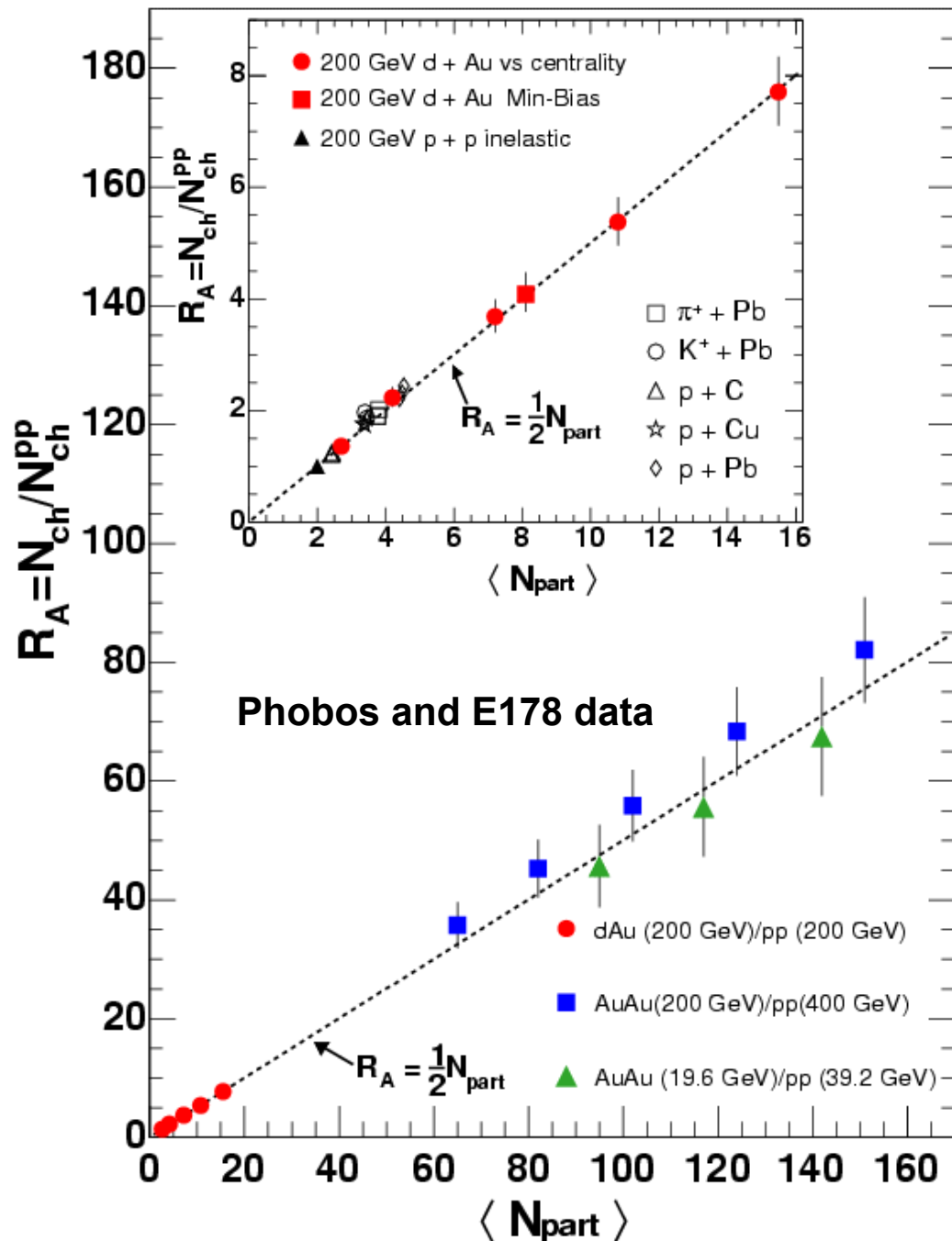
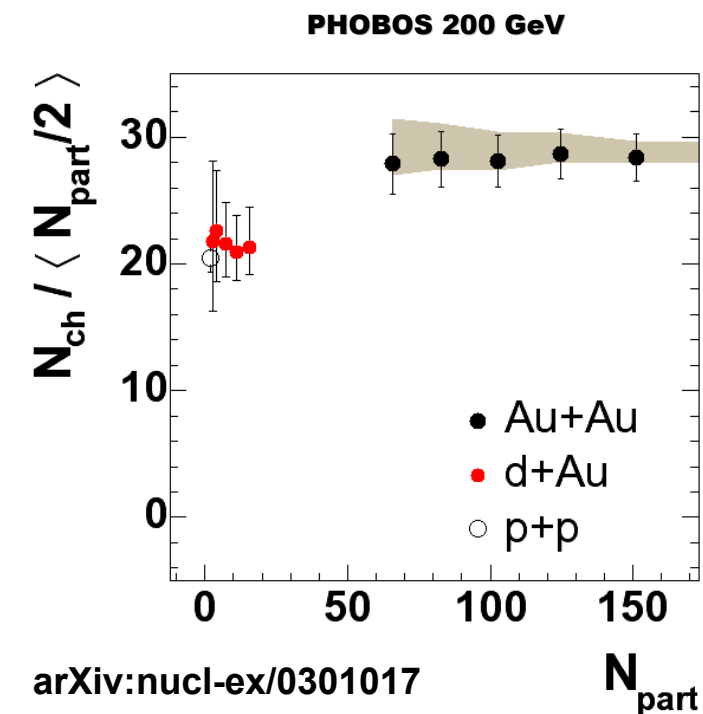
To see the limiting behavior, imagine that RHIC collided beams with **asymmetric energy**, with $\eta' = -2$ corresponding to $y = 0$.

N_{part} scaling for:

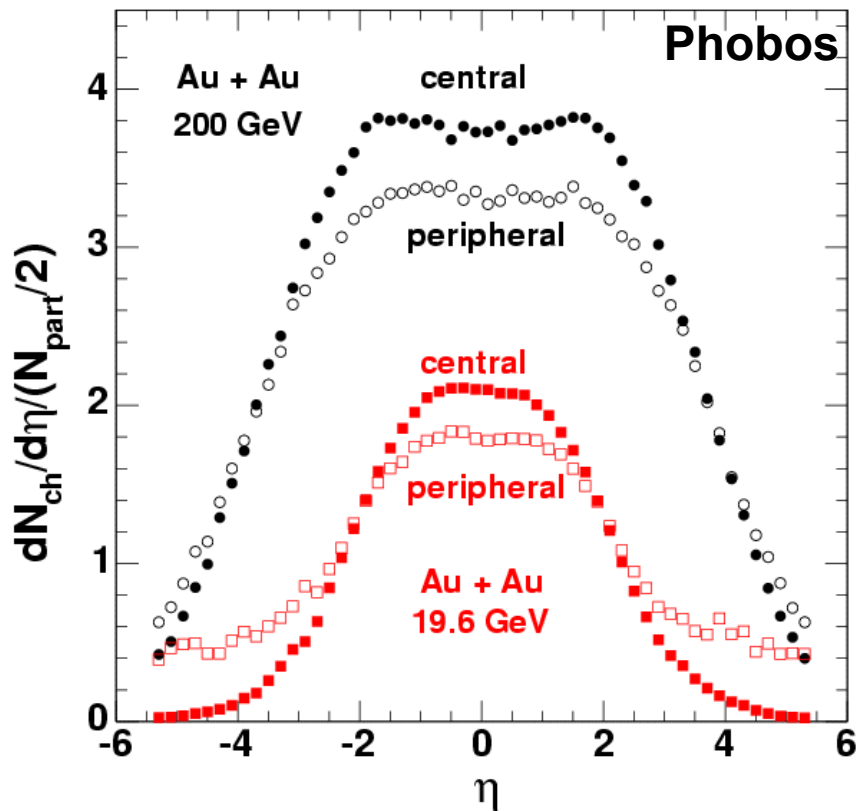
$\pi A, KA, pA, dA, AA$

10 GeV to 200 GeV

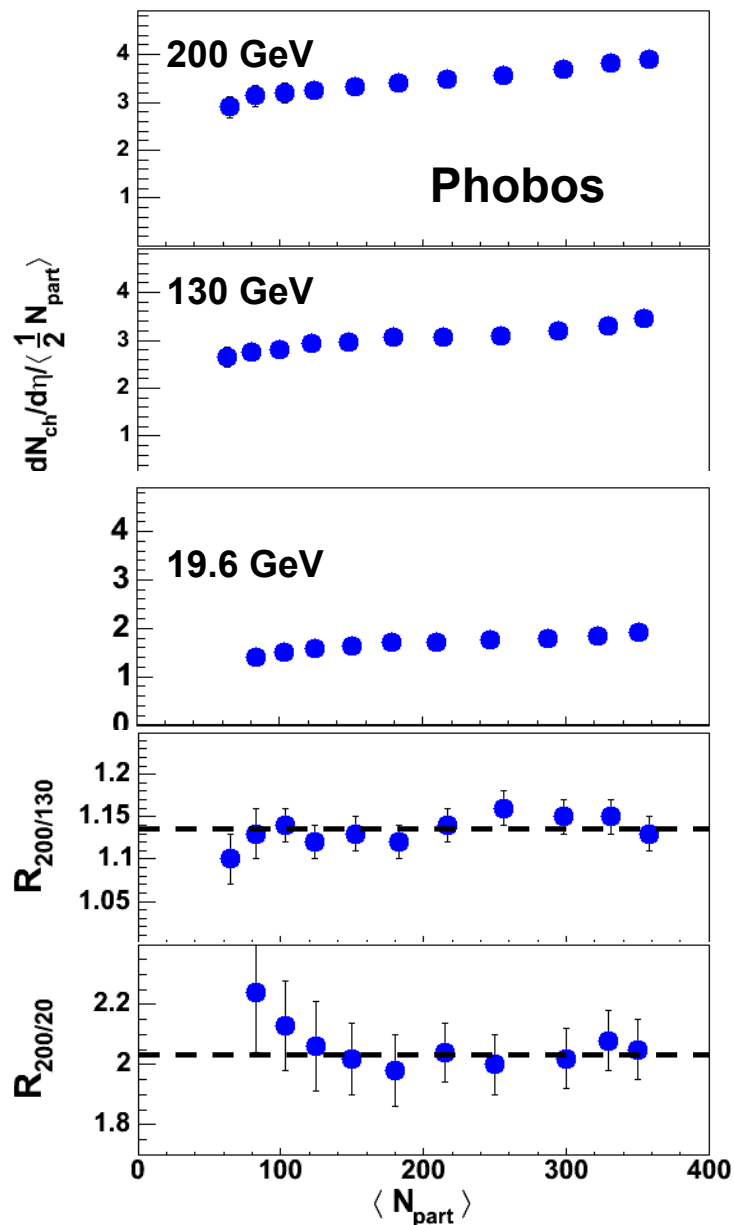
N_{part} from 2 to 344

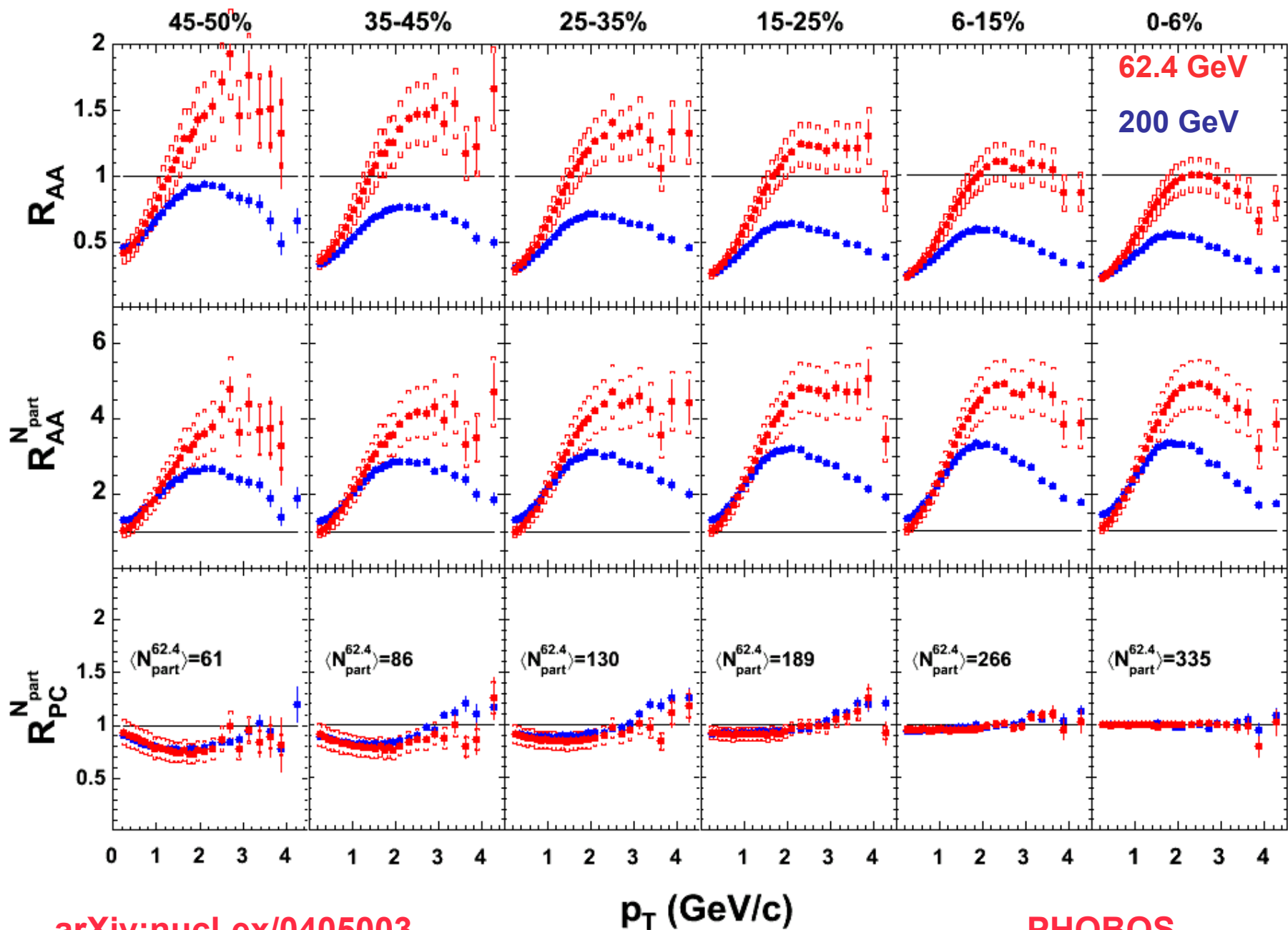


N_{part} scaling for symmetric collisions:



Centrality Dependence at $|\eta| < 1$





- To date, in Heavy Ion Collisions, *there is no evidence* for the weakly interacting **QGP**, as naively imagined by a large segment of the community before RHIC turn-on,...

...however,

- We have *discovered* a strongly interacting medium with extremely high energy density whose description in terms of simple *hadronic* degrees of freedom makes no sense;
- Furthermore, we have *discovered* that much of the data can be expressed in terms of simple scaling rules which suggest the existence of strong global constraints.

NEEDS OF FUTURE HEAVY ION PROGRAM

1. FAR MORE DETAILED STUDY OF PHENOMENA SEEN TO DATA

* MUCH HIGHER STATISTICS

- ABILITY TO LOOK SEPERATELY AT PRODUCTION OF ALL TYPES OF PARTICLES

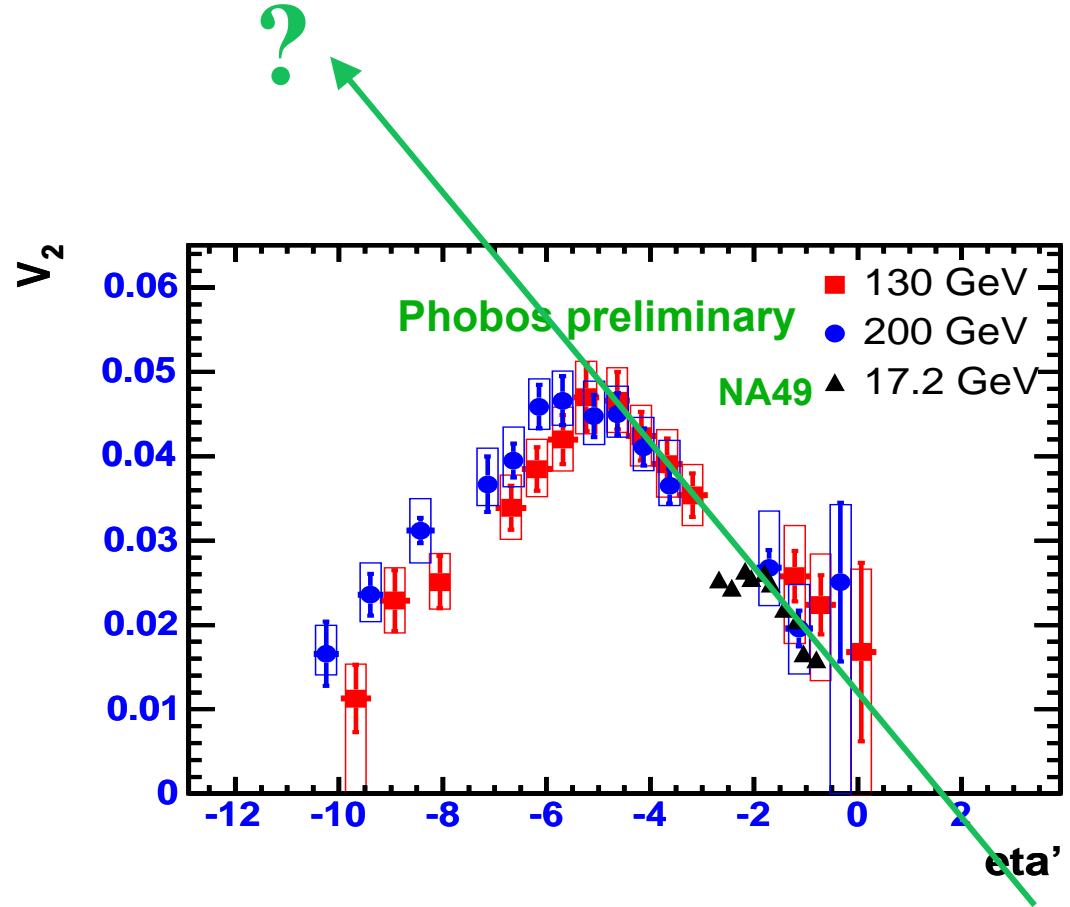
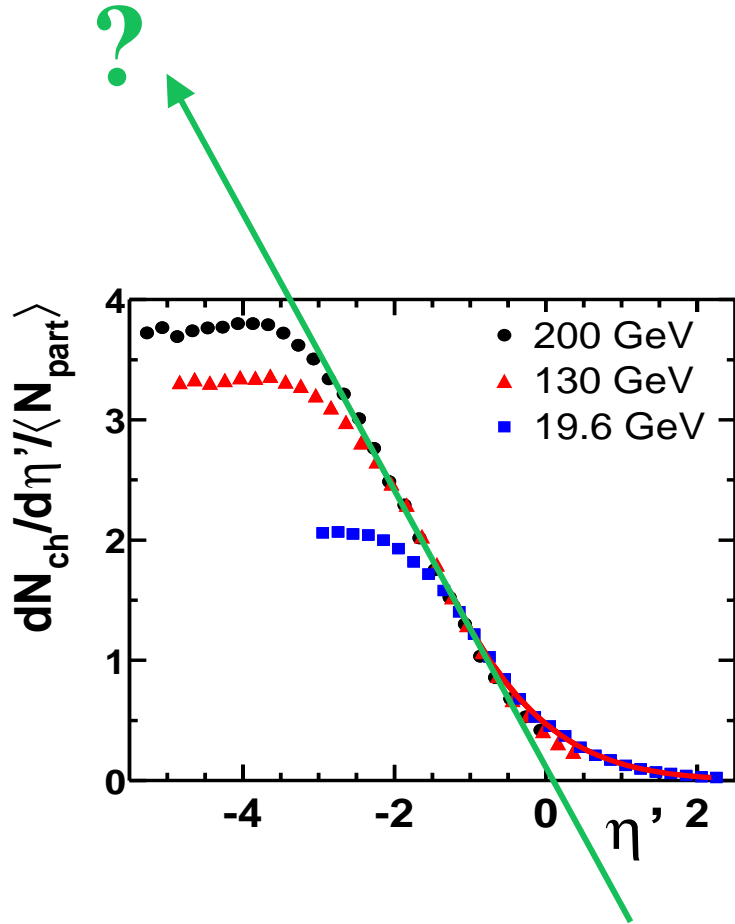
* GREATER VARIETY OF INITIAL CONDITIONS

- ABILITY TO MAKE MUCH MORE QUANTITATIVE COMPARISON OF MODELS WITH DATA

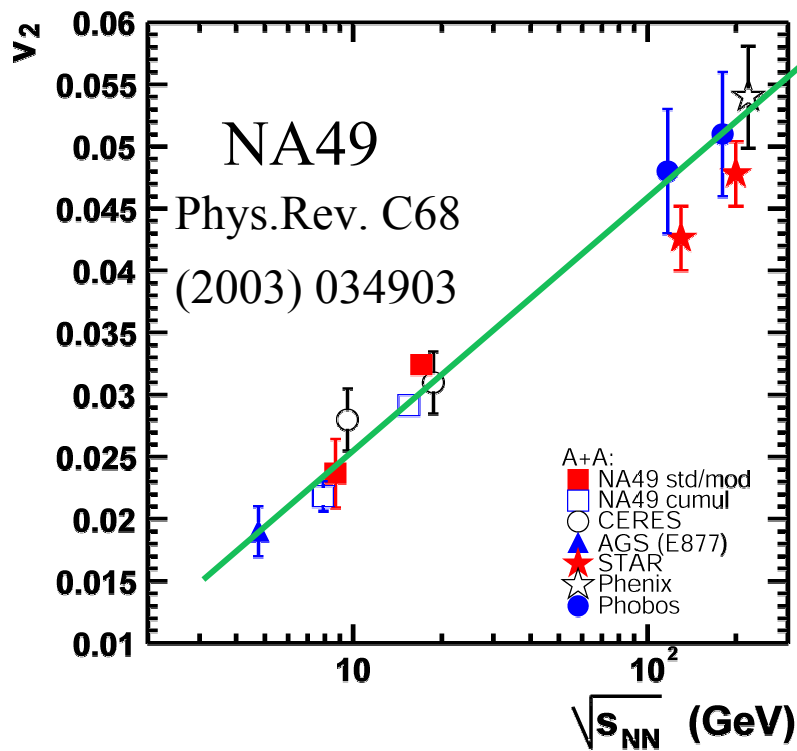
2. CHECK PREDICTIONS AT HIGHER ENERGIES

* ARE WE ON THE RIGHT TRACK?

Will linear “limiting fragmentation” curve hold at LHC?

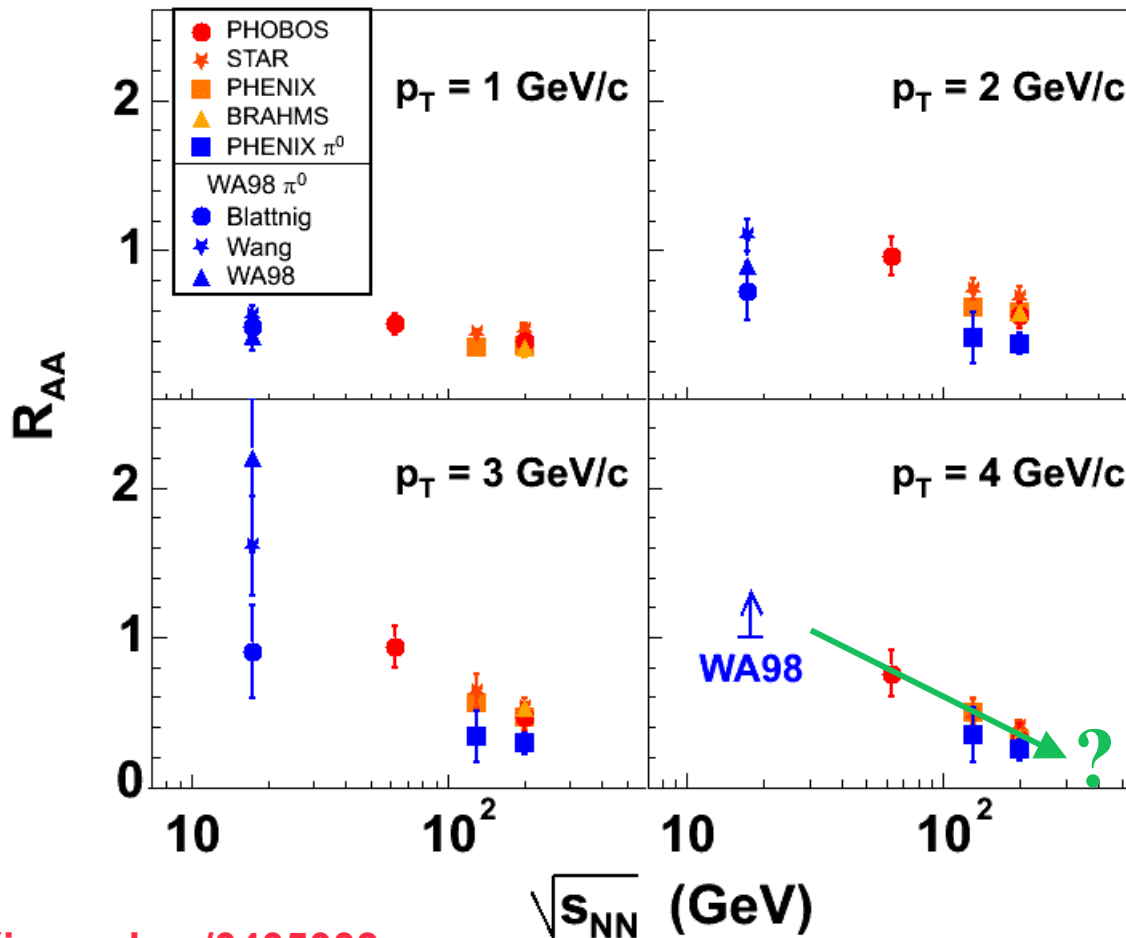


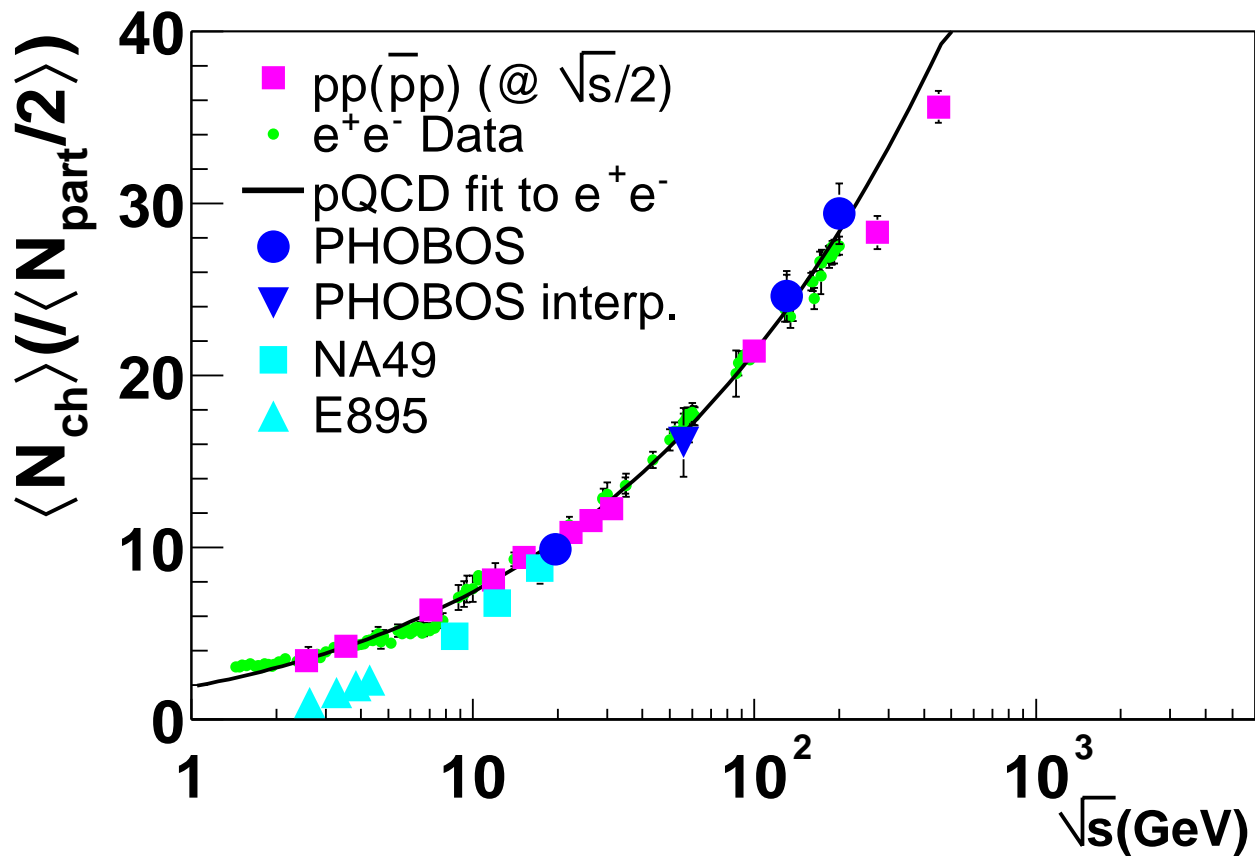
Will flow exceed hydrodynamic limit?



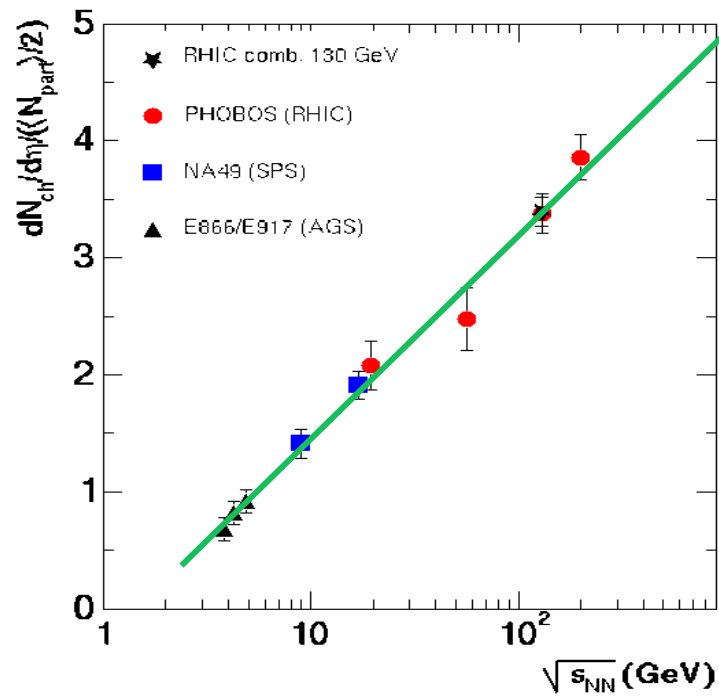
R_{AA} Cannot be negative!

R_{AA} as a function of $\sqrt{s_{NN}}$





arXiv:nucl-ex/0301017



LESSONS FROM PHOBOS

- **NATURE IS FULL OF SURPRISES**
- **NEED QUALITATIVELY IMPROVED TOOLS TO MAKE MAJOR BREAKTHROUGHS:
QUALITATIVELY BETTER DETECTORS,
SIGNIFICANTLY MORE EVENTS, MUCH HIGHER ENERGY**
- **CURRENT RHIC DATA SUGGESTS THERE ARE SURPRISES AROUND THE CORNER**