PHENIX high p_T results

- Introduction : what are we after ?
- Nuclear modification factor and collision geometry
- (some) Run2 p+p and Au+Au results
- Run3 d+Au Preliminary results

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SUBATECH

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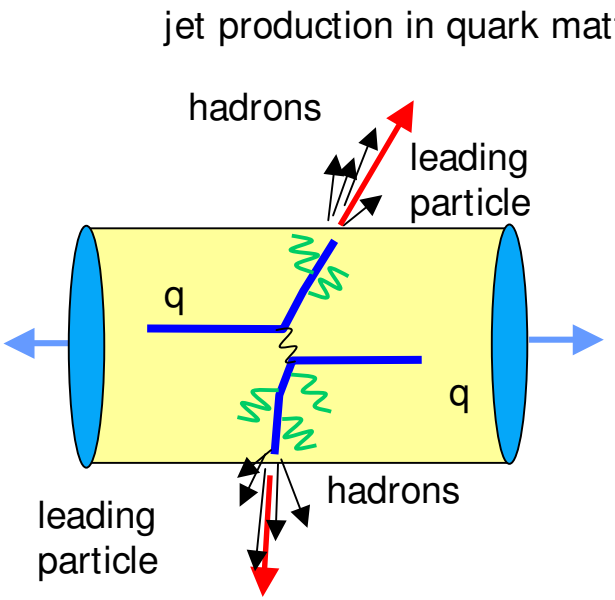
What we're after : partonic matter

- In colored "quark matter" partons are expected to lose significant energy via gluon bremsstrahlung, leading to :
  - attenuation or absorption of jets "jet quenching"
  - suppression of high p_T hadrons
  - modification of angular correlation(*)
  - changes of particle composition (**)



(**) See also T. Chujo talk, Fri. May 23, RHI//session

(*) See also J. Rak talk, Fri. May 23, RHI//session

Nuclear modification factor I

$$R_{AB} = \frac{\left(1/N_{AB}^{evt}\right) d^2N_{AB}/dydp_T}{\langle T_{AB} \rangle \, d^2\sigma_{pp}/dydp_T}$$

$$\langle T_{AB} \rangle = \langle N_{coll} \rangle / \sigma_{NN}$$

$T_{AB} = \int d^2\mathbf{r} T_A(\mathbf{r}) T_B(\mathbf{b}-\mathbf{r})$ Nuclear overlap function

$T_A(b) = \int dz \rho_A(b,z)$ Nuclear thickness function

} from Glauber model

R_{AB}=1 if no nuclear medium effect

R_{AB}>1 : enhancement, e.g. Cronin effect

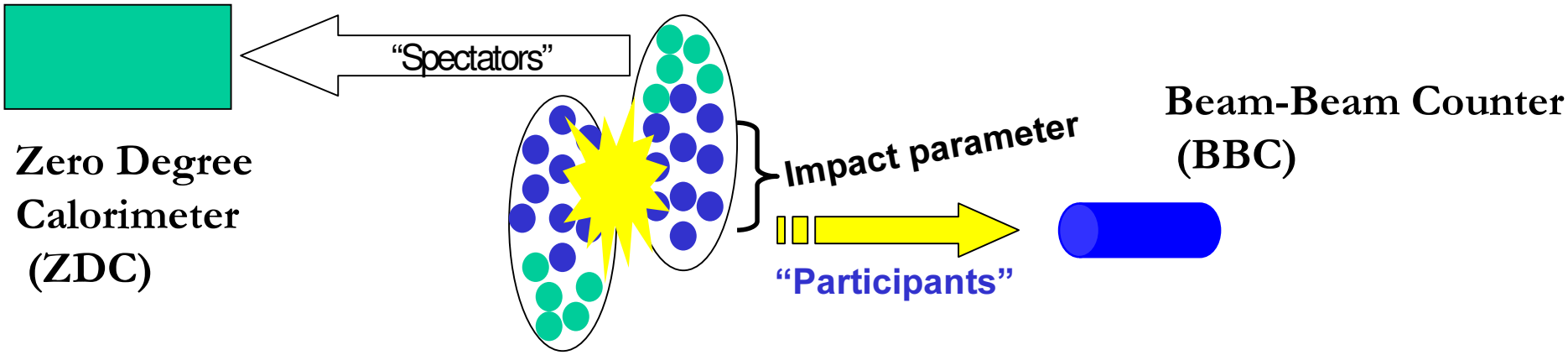
R_{AB}<1 : suppression

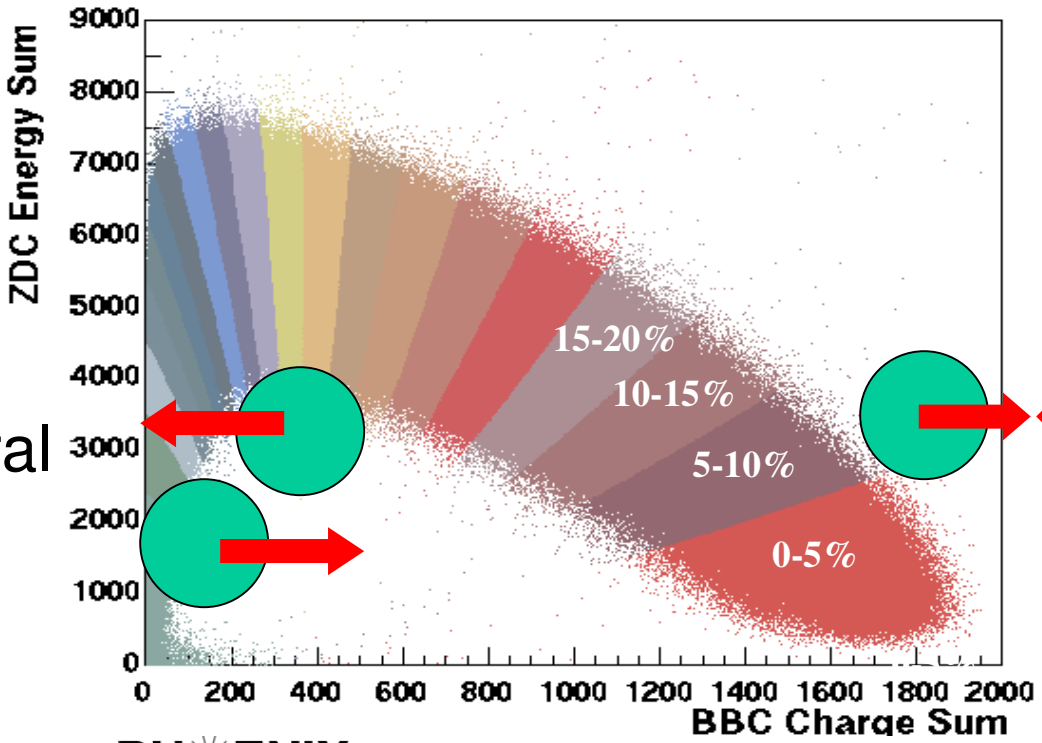
Nuclear modification factor II

Other definition, ratio of two centralities results

$$R_{cp} = \frac{\left\langle T_{AB}^{central} \right\rangle \left(1/N_{central}^{evt}\right) \, d^2N_{AB}^{central}/dydp_T}{\left\langle T_{AB}^{periph} \right\rangle \left(1/N_{periph}^{evt}\right) \, d^2N_{AB}^{periph}/dydp_T}$$

AA Collision centrality determination





PHENIX in 2003: Design Configuration

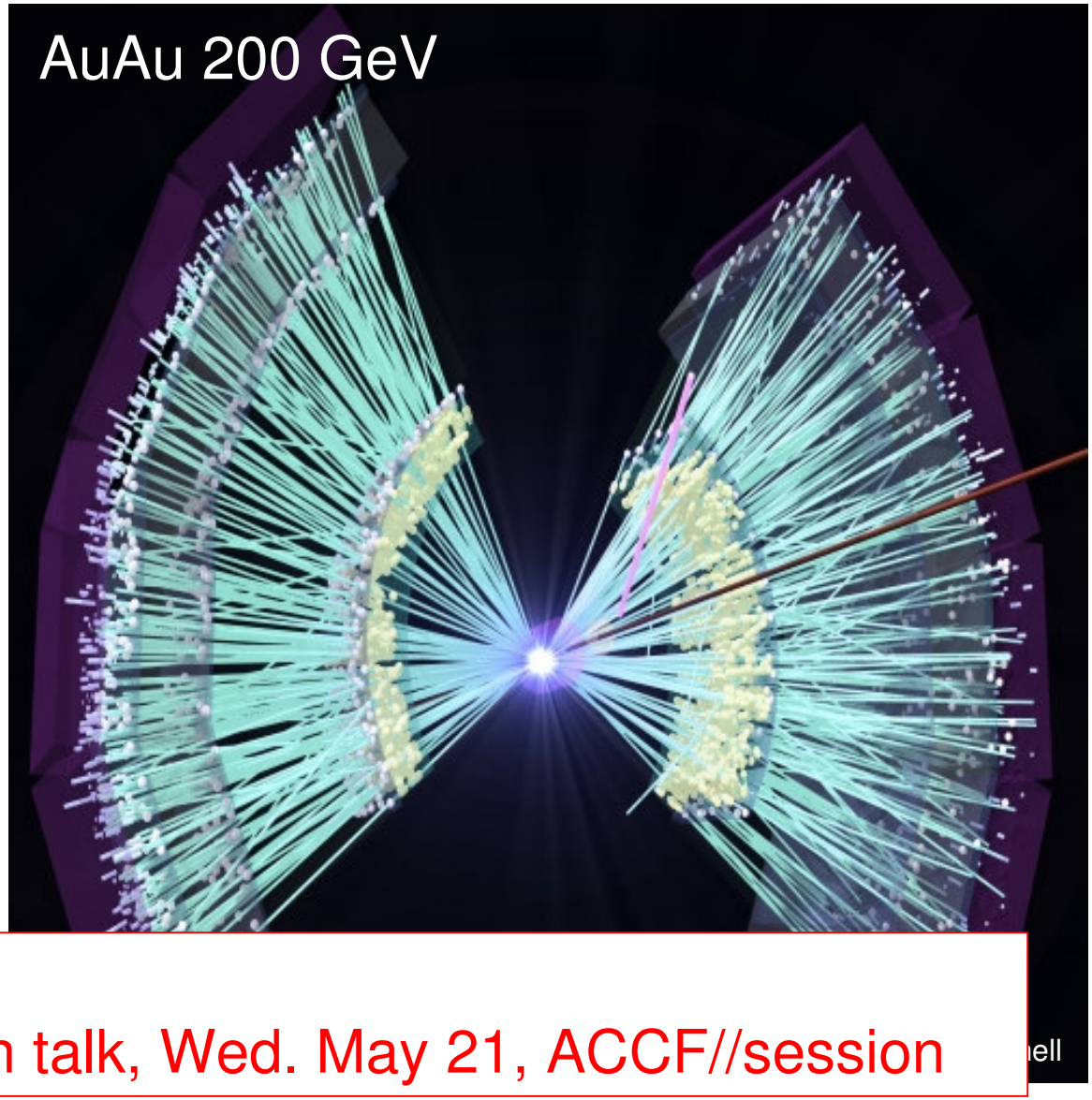
Central Arm Tracking
- Drift Chamber
- Pad Chambers
- Time Expansion Chamber

Muon Arm Tracking
- Muon Trackers

Calorimetry
- PbGl and PbSc
- Forward Hadron Calorimeters

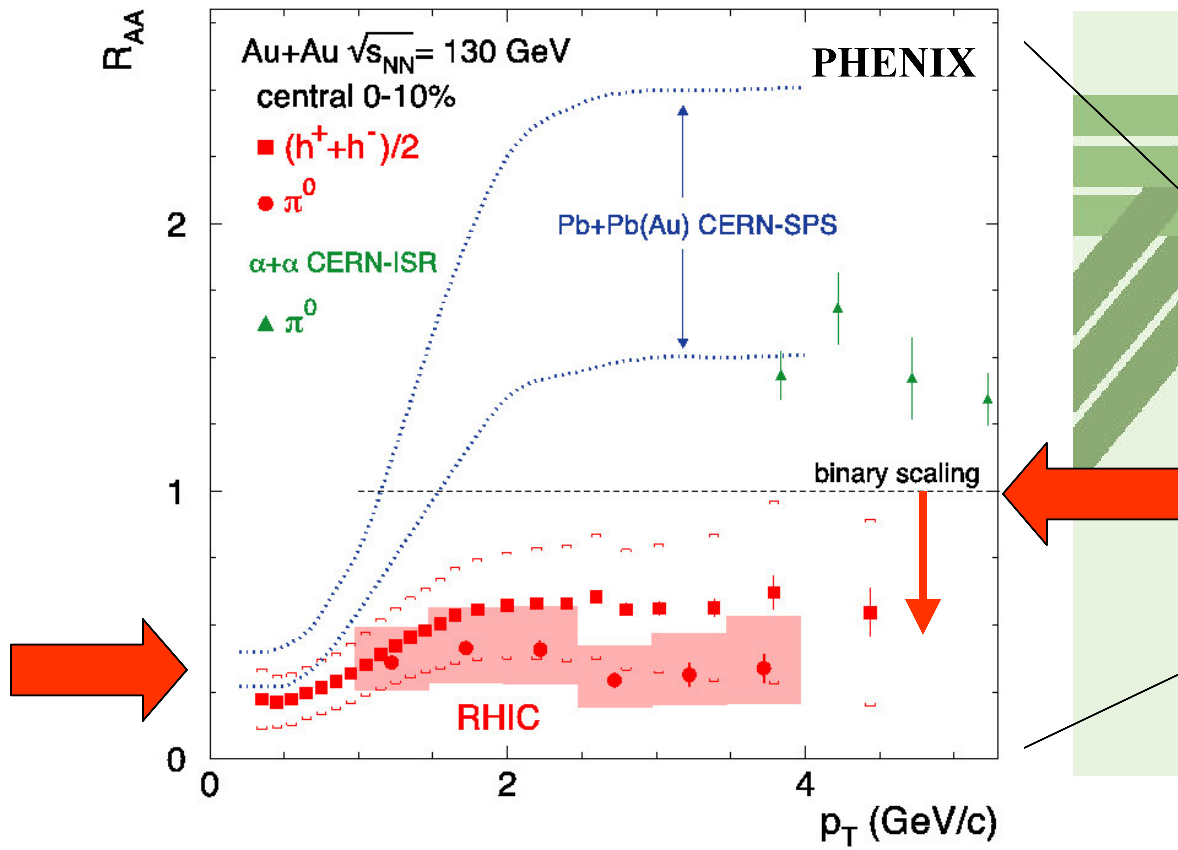
Particle Id
- Muon Identifiers
- RICH
- TOF
- TEC

Global Detectors
- BBC
- ZDC/SMD
- NTC
- MVD



Details:
E. O'Brien talk, Wed. May 21, ACCF//session

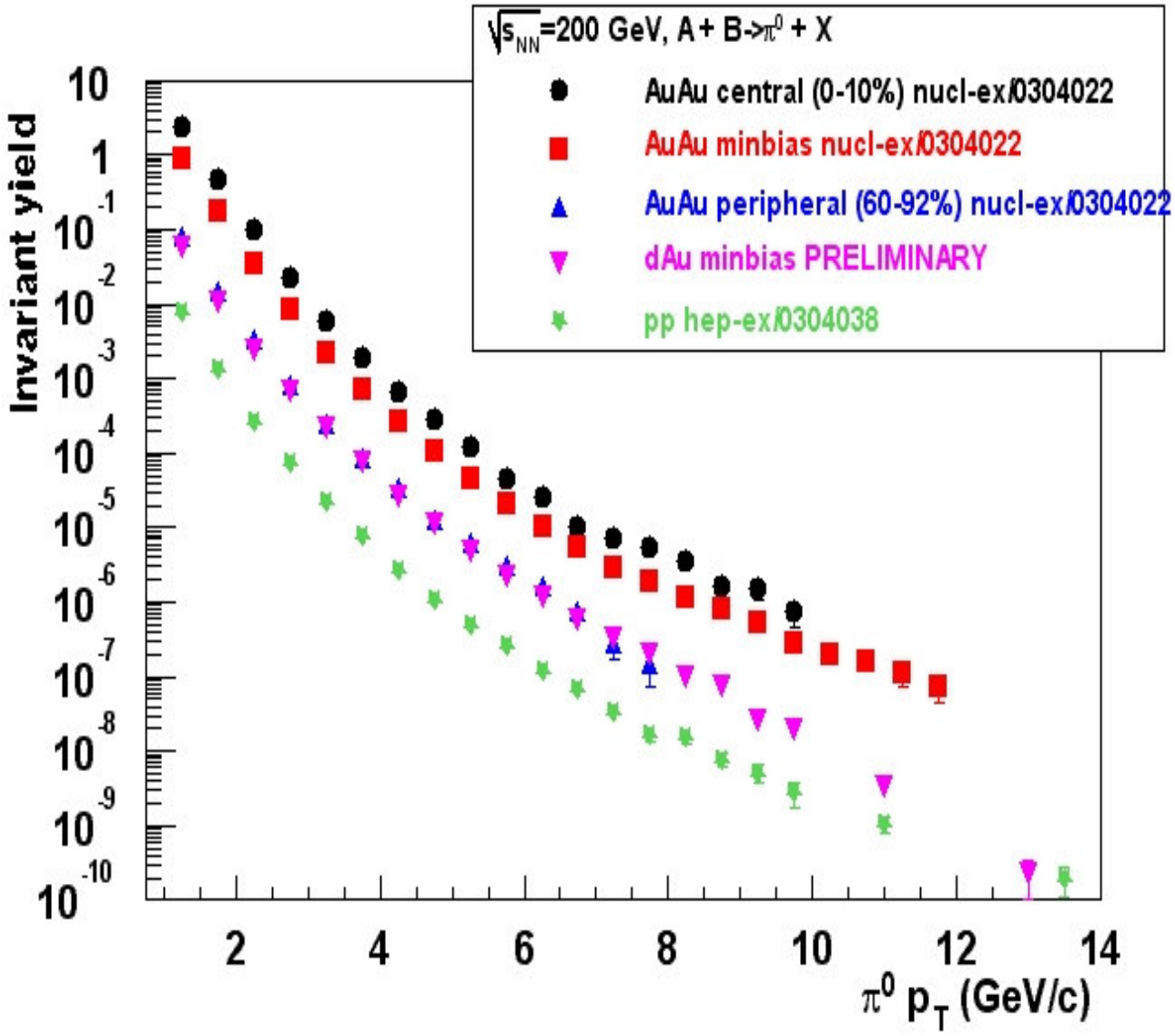
Once upon a time @ 130 GeV …



First observation of *large* suppression of high p_T hadron yields

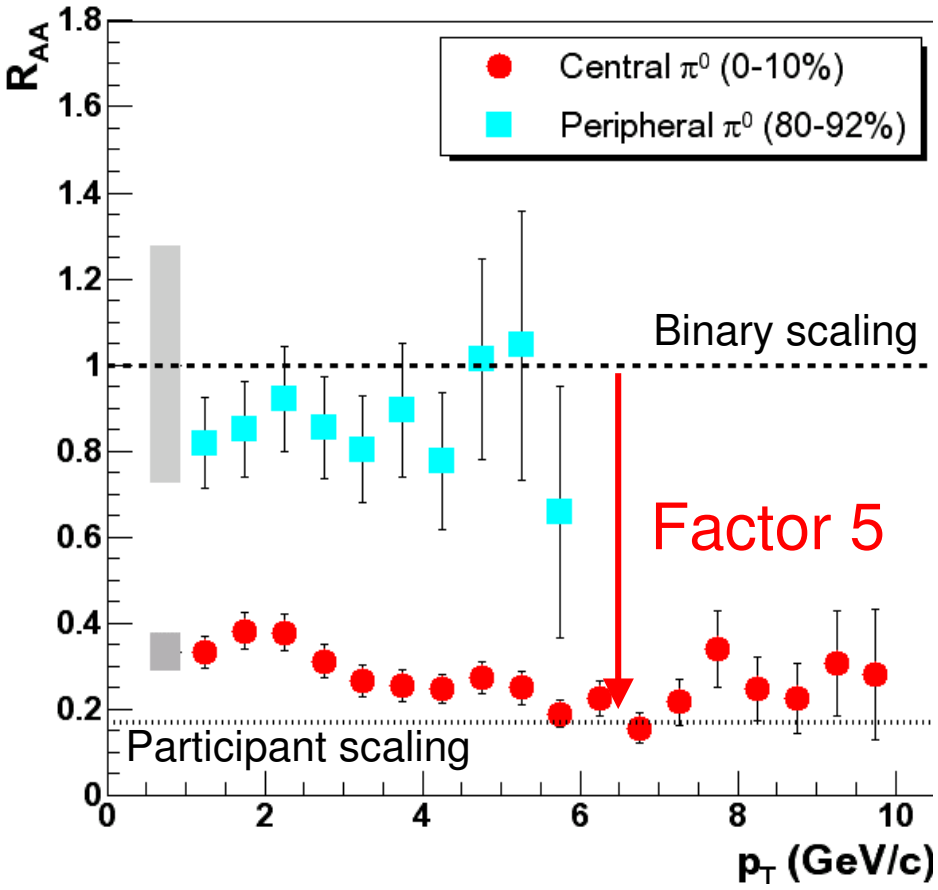
Run2 and Run3 : 200 GeV

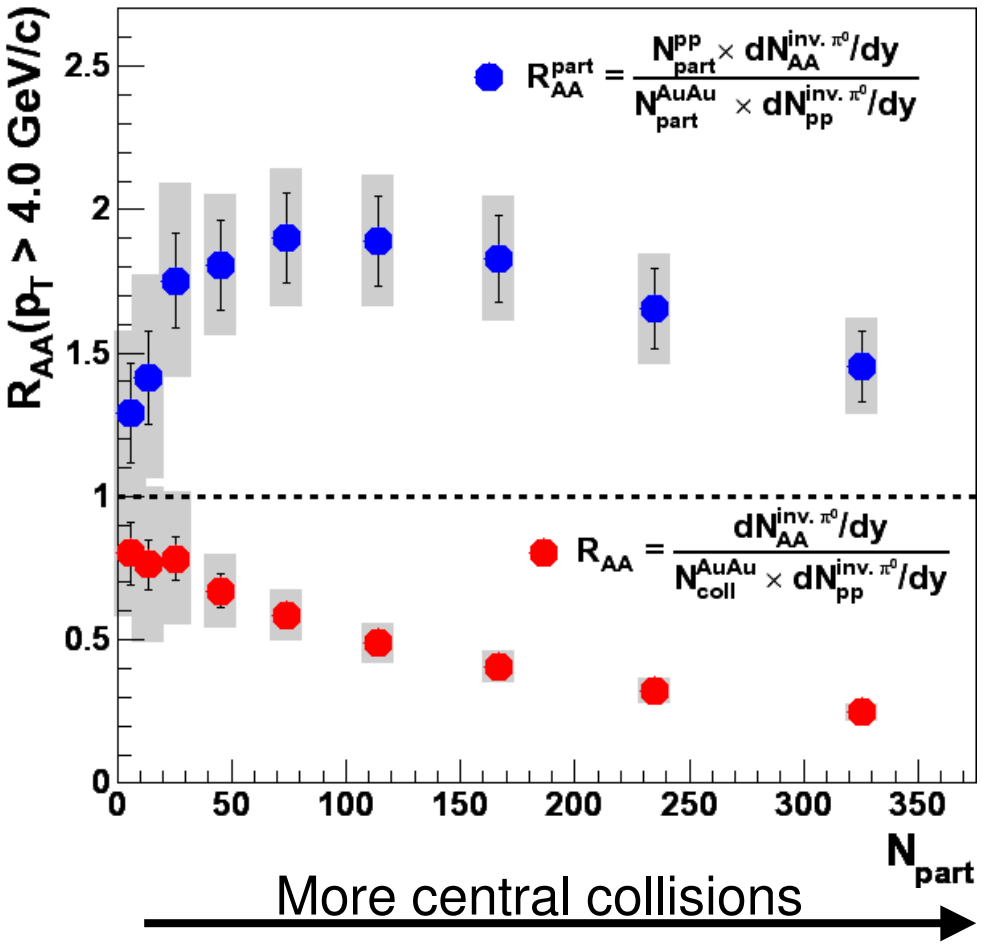
- More statistics in AuAu
- p+p reference measured also
- d+Au results becoming available



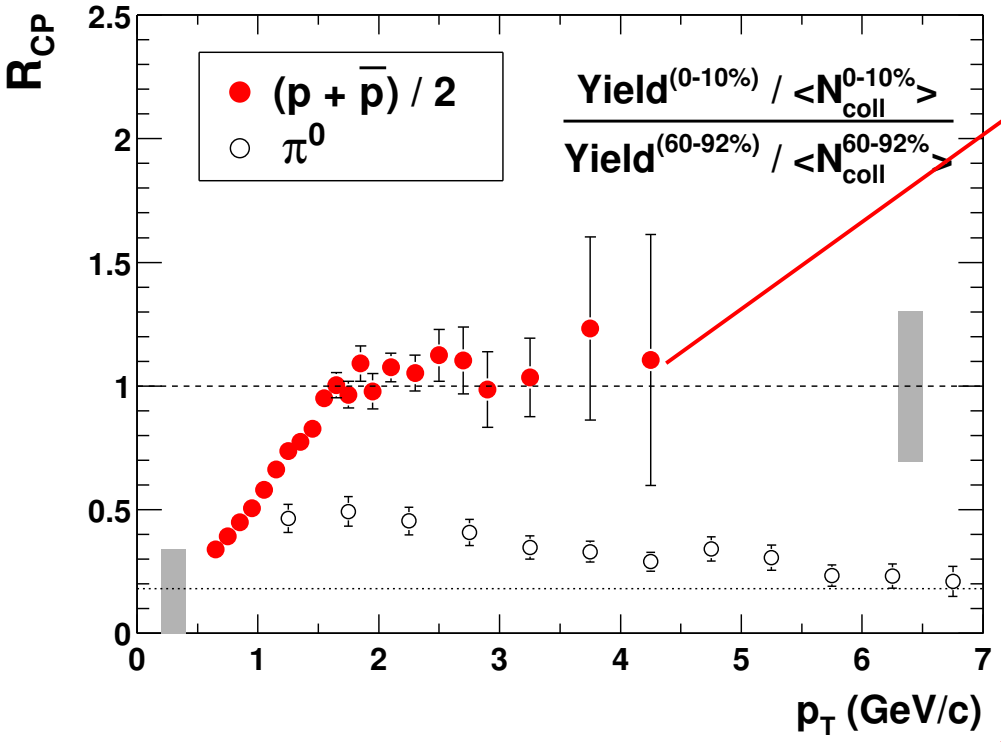
R_{AA} in Au+Au : suppression

nucl-ex/0304022, submitted to PRL

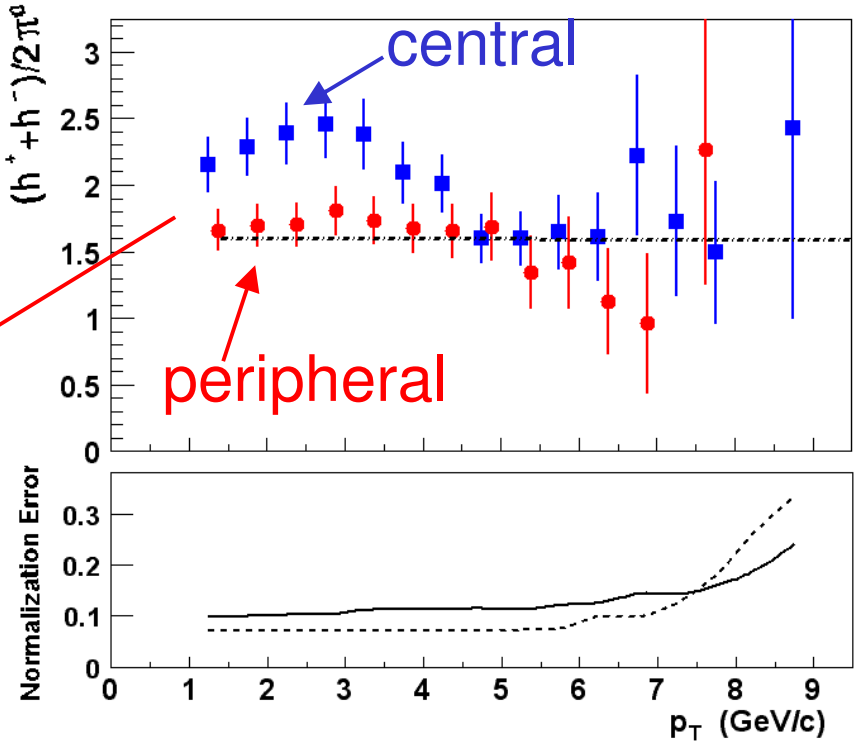




Suppression is also particle dependent



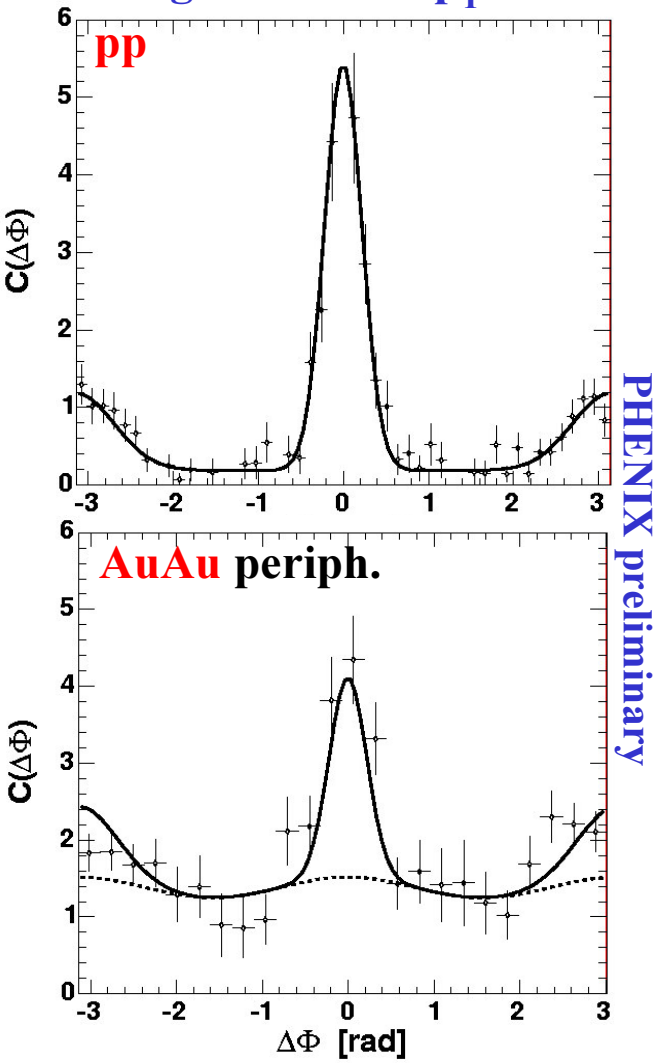
- No apparent suppression in proton yields for 2 <p_T<4 GeV/c
- Different production mechanism for protons?



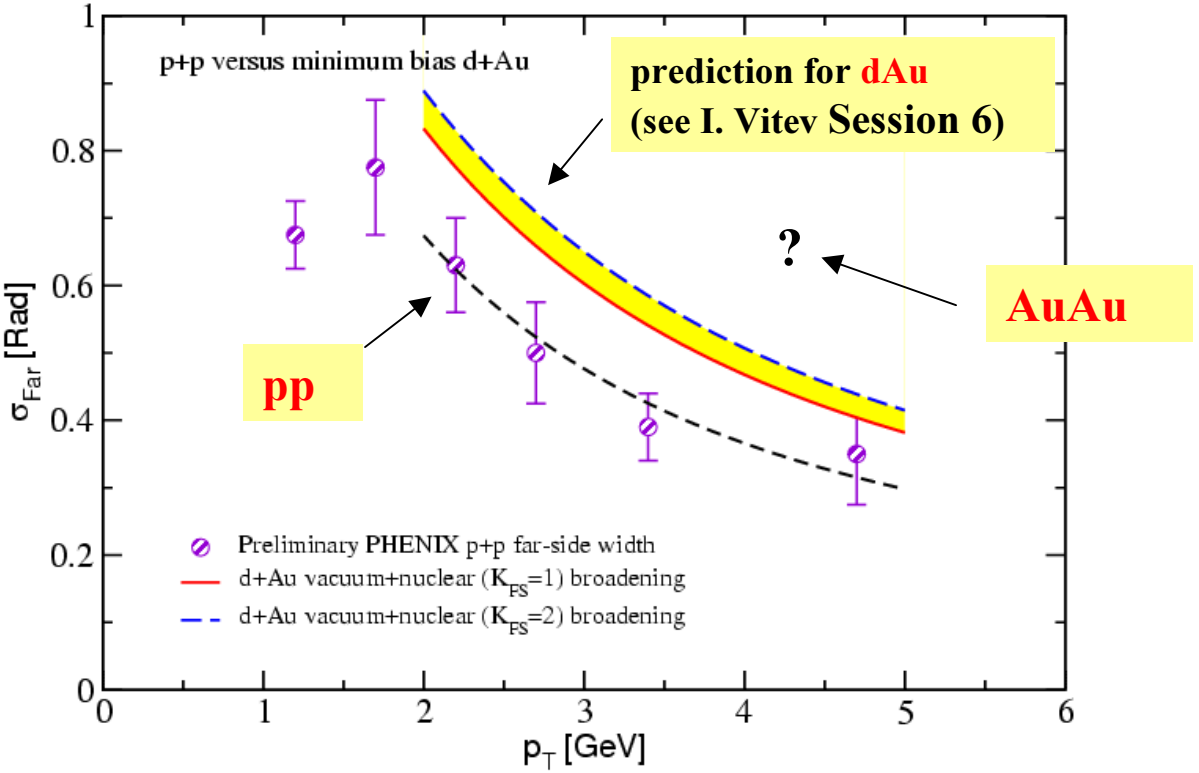
- $(h^+ + h^-)/2\pi^0$ ~ 50% greater in central than peripheral at mid p_T
- similar again for p_T>5 GeV/c

Another view : angular correlations

Charged hadrons $p_T \approx 3$GeV/c



Quenching of high-p_T partons in AuAu coll -> modification of azimuthal correlation between jet fragments - $\langle j_T \rangle$, $\langle k_T \rangle$ - broadening.



See J. Rak Friday May 23, Session 6

Origin of the suppression ?

Initial State Effect(s)

- Gluon saturation (Color Glass Condensate)
  - Property of the nuclear wavefunction
    - Should be present both in AA and in p(d)A

$$R_{dAu} \simeq \sqrt{R_{AuAu}} \approx 0.5$$

- Cronin effect $R_{dAu} \geq 1$
- Shadowing: decreases R_{dAu}

Final State Effects

- Hadronic absorption
- Parton recombination
- Energy loss of partons in dense matter
  - Related to density of the medium (dNg/dy)
  - Not in dAu

$$R_{AuAu} < 1$$

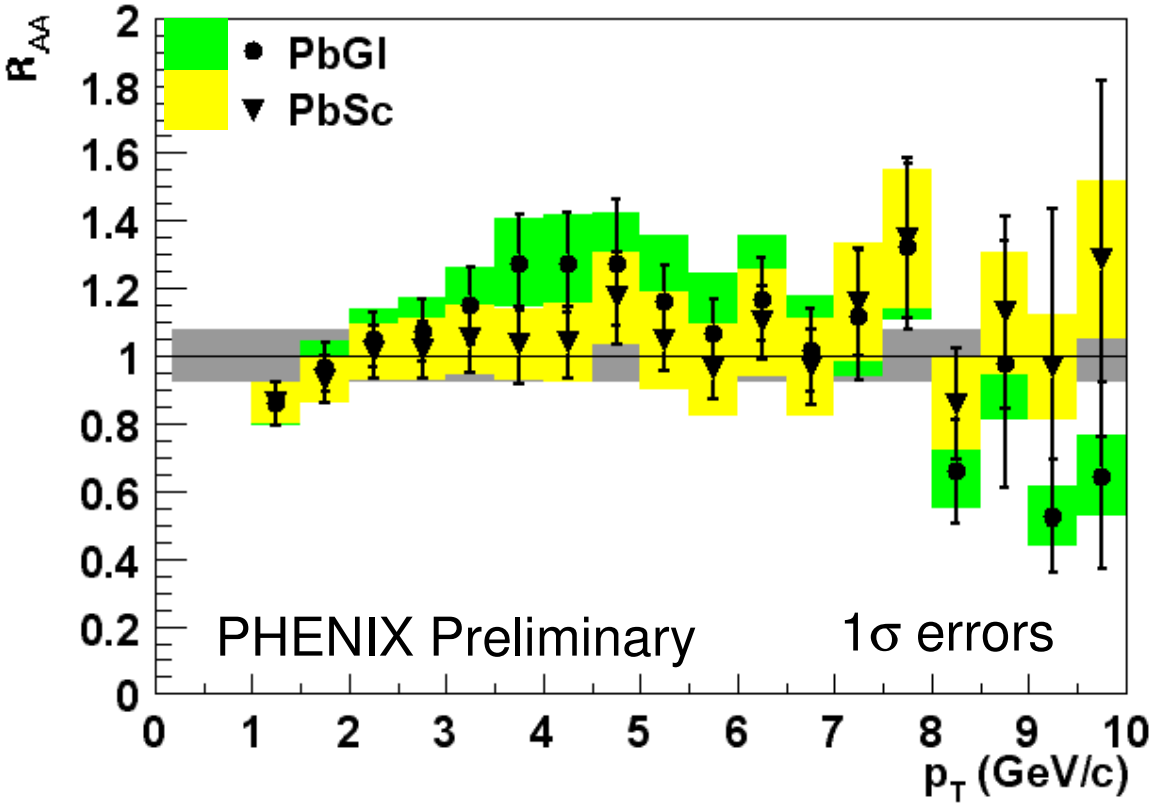
d+Au data
can disentangle those !

d+Au 200 GeV : π^0

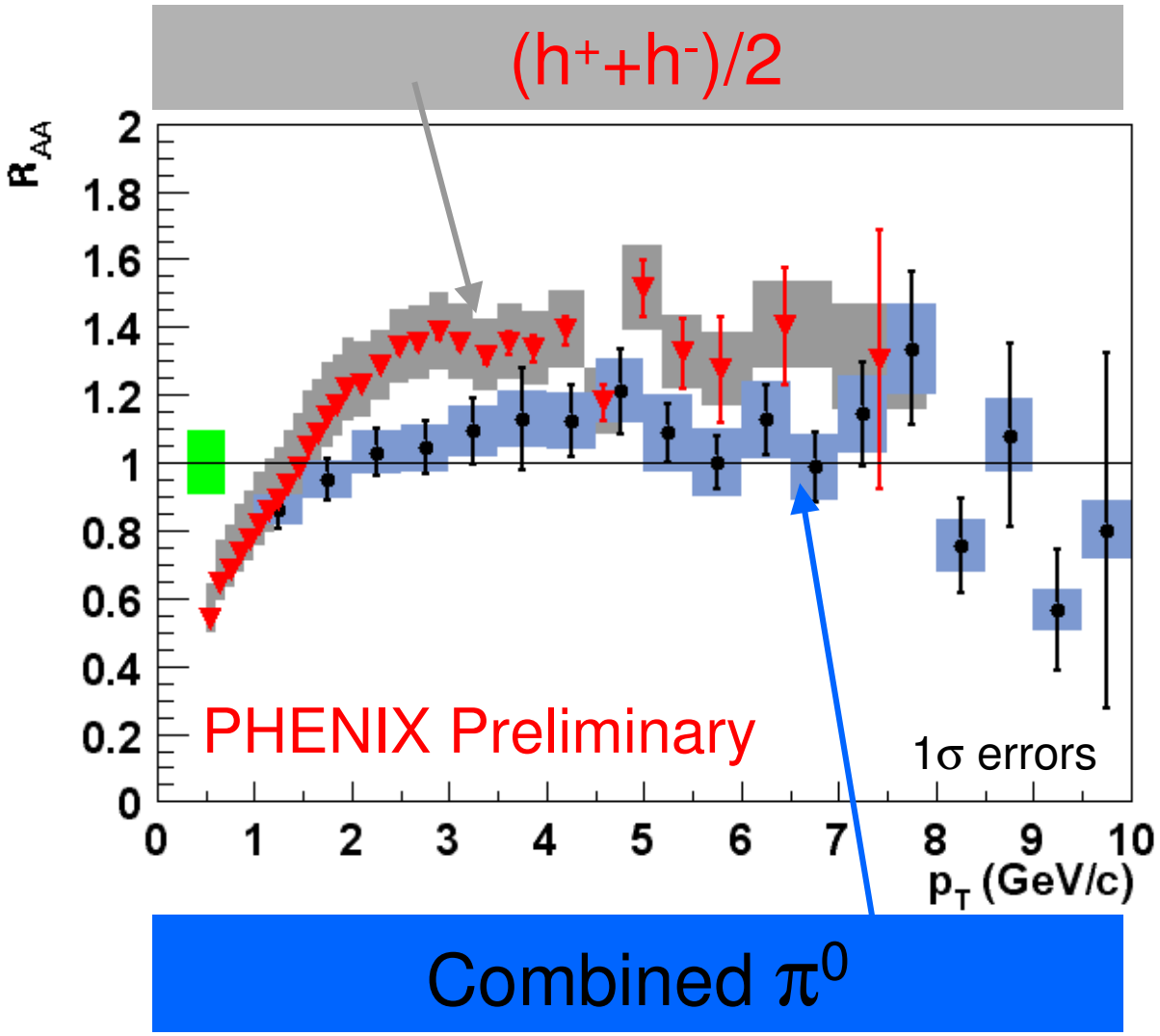
Neutral pions are measured with 2 independent Calorimeters – PbSc and PbGl

- 2 results agree within errors

- Not suppressed relative to binary scaling

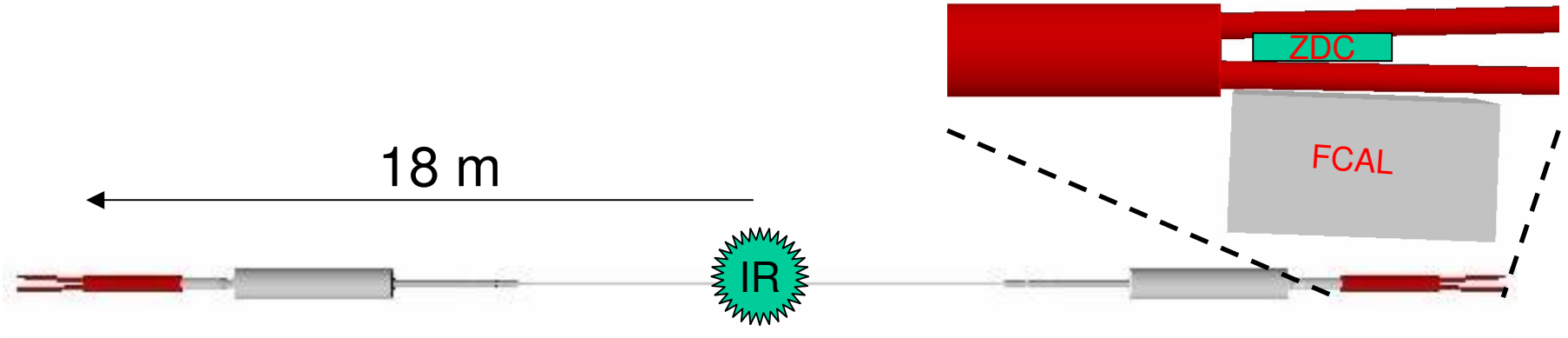


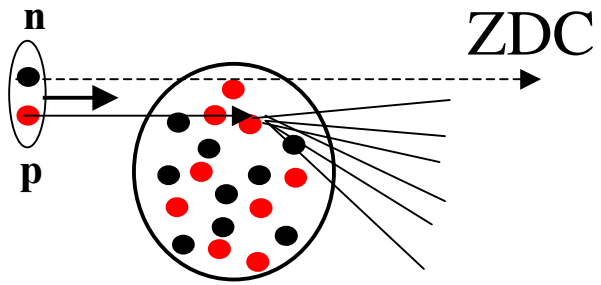
d+Au 200 GeV : π^0 and $(h^+ + h^-)/2$



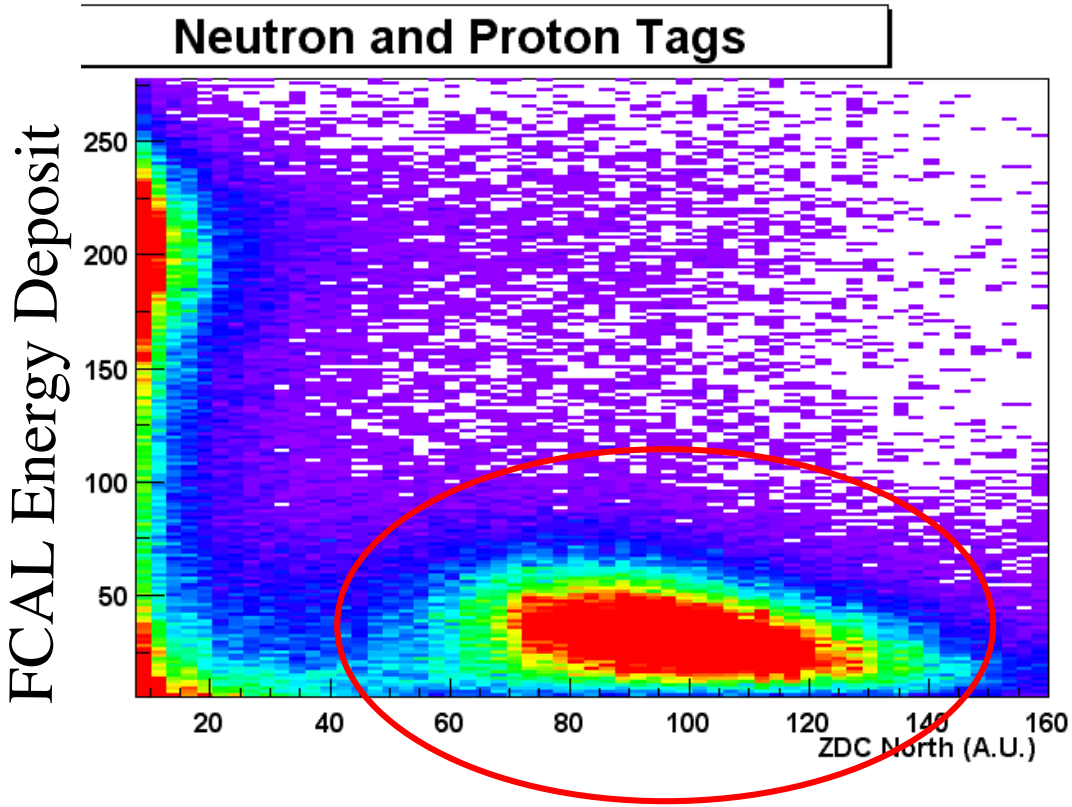
- No suppression
- Cronin type enhancement
- Data suggests that enhancement is more pronounced for charged hadrons than for neutral pions

First grasp at centrality selection in dAu



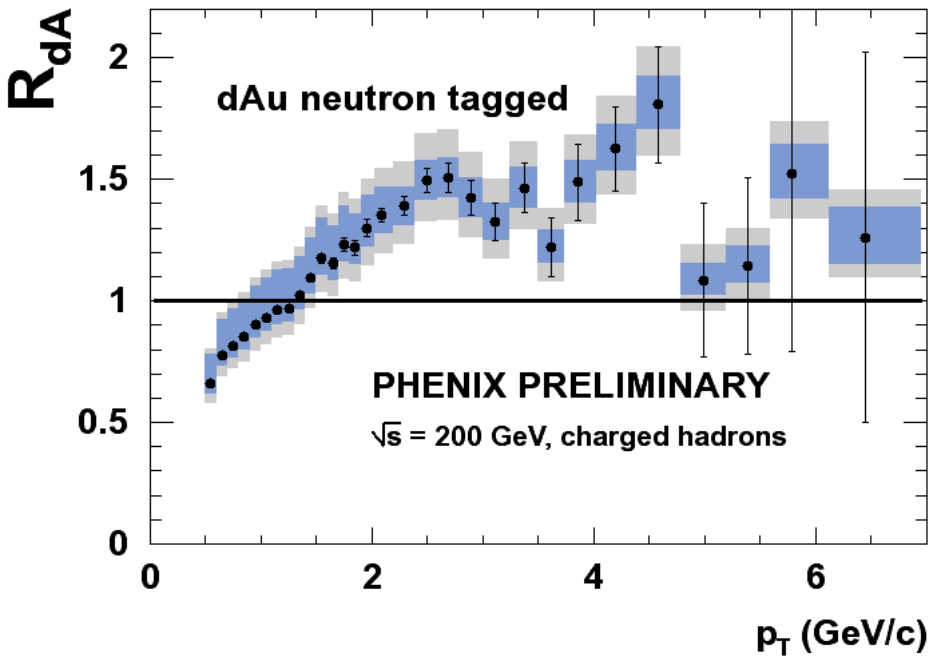


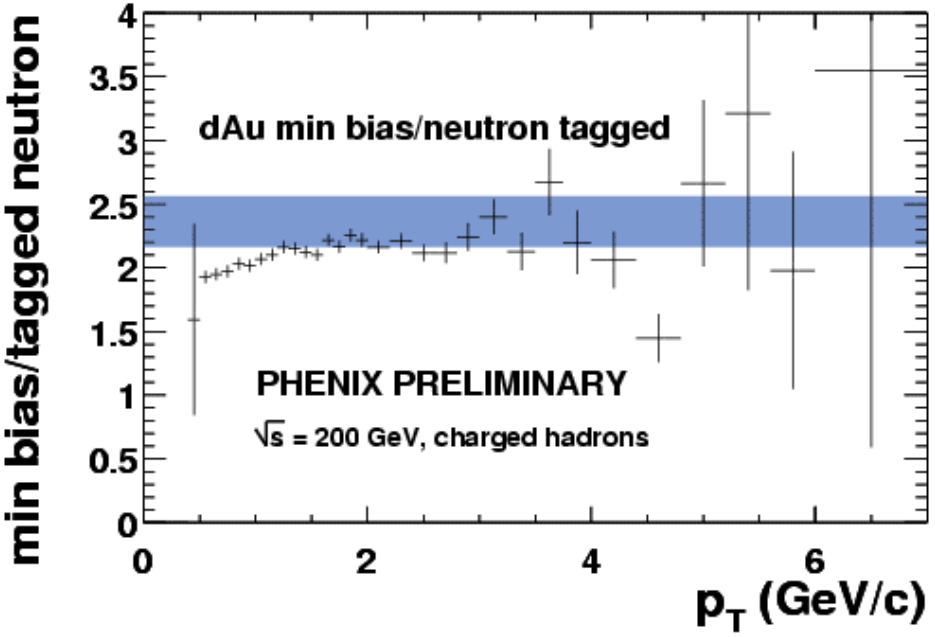
Neutron tagged events are enhanced in very-peripheral collisions



Centrality Dependence of R_{dA}

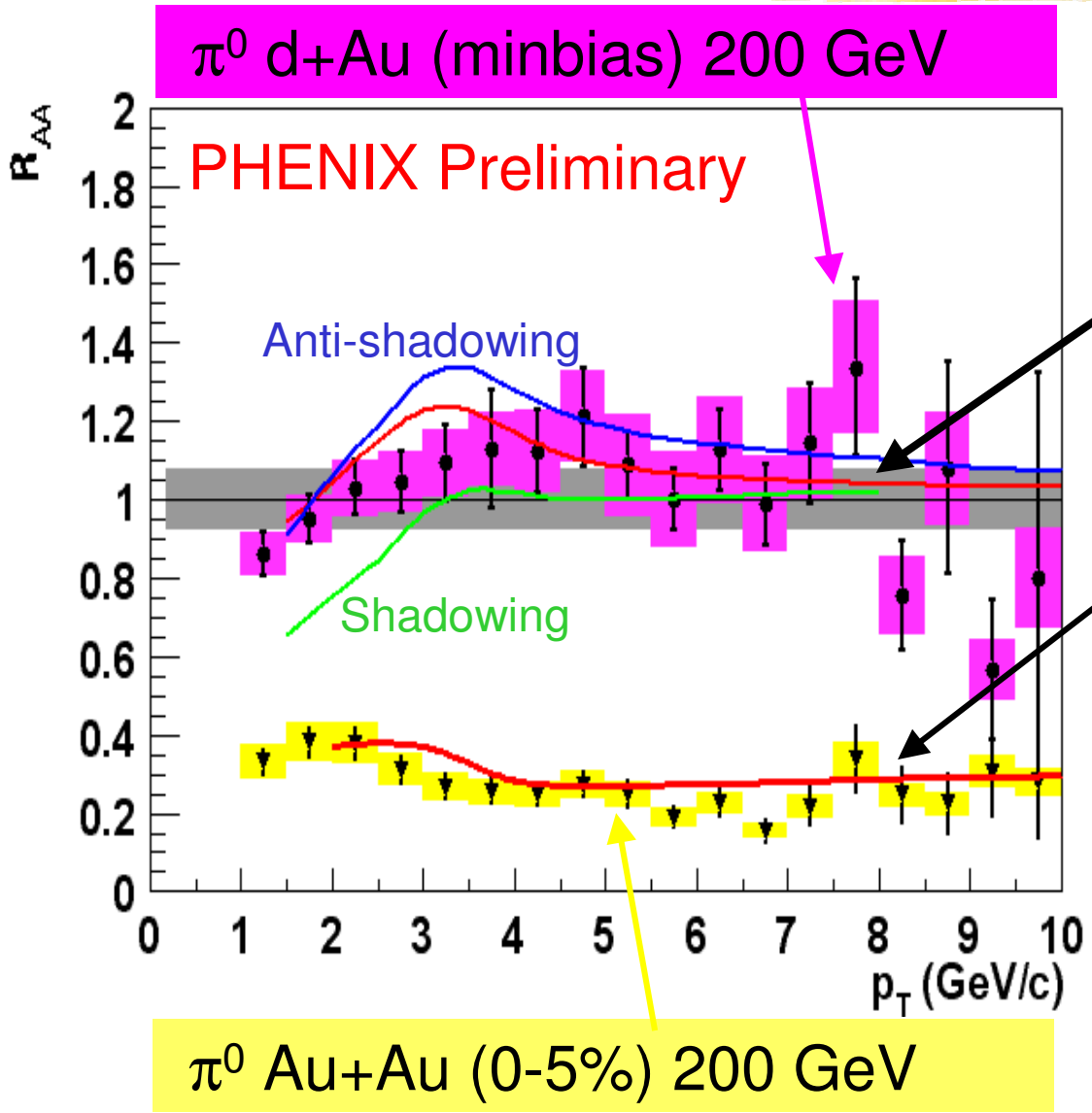
Comparison of very-peripheral events (<Ncoll>=3.6+/-0.4)
to minimum bias events (<Ncoll>=8.5+/-0.7)





Data indicates no centrality dependence

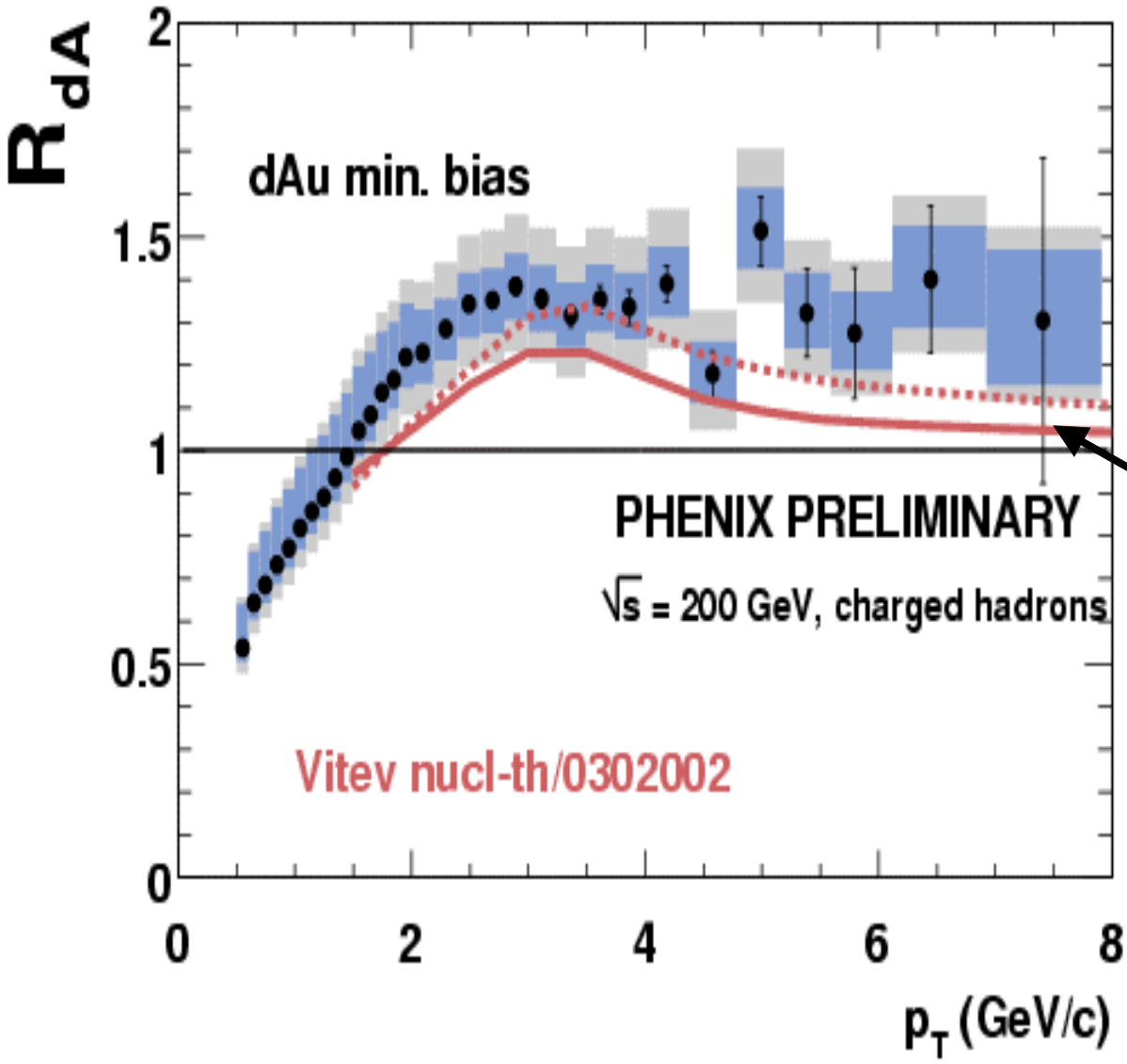
Data(1) vs Theory : π^0



d+Au: I. Vitev, nucl-th/0302002 and private communication.

Au+Au: I. Vitev and M. Gyulassy, hep-ph/0208108, to appear in Nucl. Phys. A; M. Gyulassy, P. Levai and I. Vitev, Nucl. Phys. B 594, p. 371 (2001).

Data (2) vs theory : charged hadrons



Calculation is for π only

Summary

- Using p+p, d+Au and Au+Au RHIC results, coherent picture of high p_T production starts to emerge
- Definitely central Au+Au collisions exhibit very specific characteristics, not seen elsewhere (pp or dA)
- First d+Au results indicate that suppression in Au+Au is more likely a *final* state effect, rather than an *initial* state effect.

PHENIX

12 Countries; 57 Institutions; 460 Participants

Brazil University of São Paulo, São Paulo
China Academia Sinica, Taipei, Taiwan
China Institute of Atomic Energy, Beijing
Peking University, Beijing
France LPC, University de Clermont-Ferrand, Clermont-Ferrand
Dapnia, CEA Saclay, Gif-sur-Yvette
IPN-Orsay, Universite Paris Sud, CNRS-IN2P3, Orsay
LLR, Ecole Polytechnique, CNRS-IN2P3, Palaiseau
SUBATECH, Ecole des Mines de Nantes, CNRS-IN2P3, Univ. Nantes
Germany University of Münster, Münster
Hungary Central Research Institute for Physics (KFKI), Budapest
Debrecen University, Debrecen
Eötvös Loránd University (ELTE), Budapest
India Banaras Hindu University, Banaras
Bhabha Atomic Research Centre, Bombay
Israel Weizmann Institute, Rehovot
Japan Center for Nuclear Study, University of Tokyo, Tokyo
Hiroshima University, Higashi-Hiroshima
KEK, Institute for High Energy Physics, Tsukuba
Kyoto University, Kyoto
Nagasaki Institute of Applied Science, Nagasaki
RIKEN, Institute for Physical and Chemical Research, Wako
RIKEN-BNL Research Center, Upton, NY
University of Tokyo, Bunkyo-ku, Tokyo
Tokyo Institute of Technology, Tokyo
University of Tsukuba, Tsukuba
Waseda University, Tokyo
S. Korea Cyclotron Application Laboratory, KAERI, Seoul
Kangnung National University, Kangnung
Korea University, Seoul
Myong Ji University, Yongin City
System Electronics Laboratory, Seoul Nat. University, Seoul
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Georgia State University, Atlanta, GA
University of Illinois Urbana Champaign, IL
Iowa State University and Ames Laboratory, Ames, IA
Los Alamos National Laboratory, Los Alamos, NM
Lawrence Livermore National Laboratory, Livermore, CA
University of New Mexico, Albuquerque, NM
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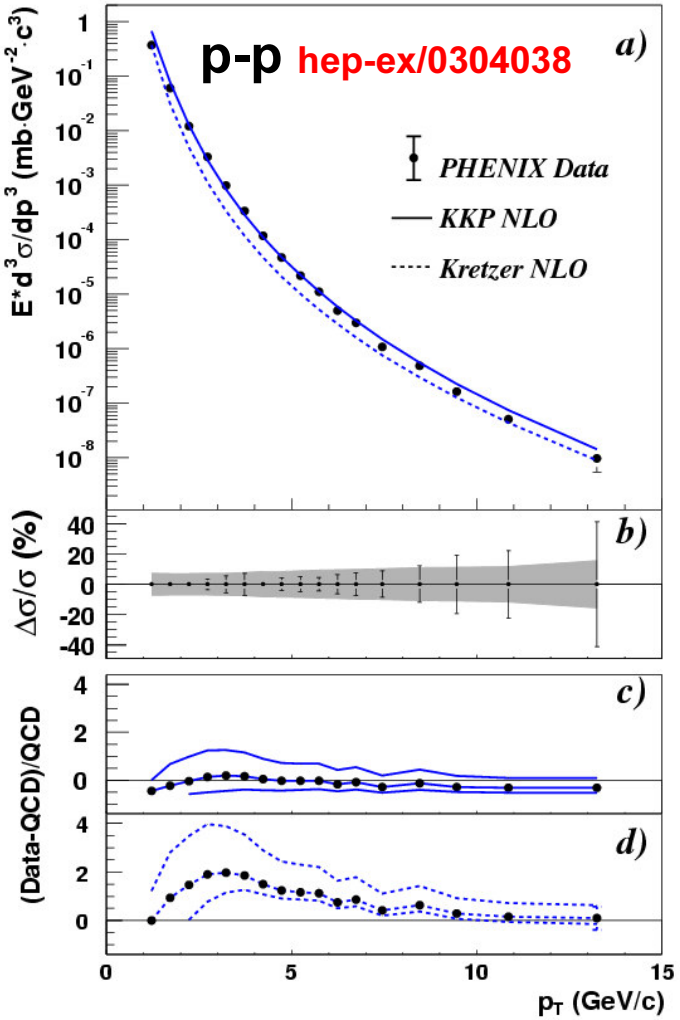
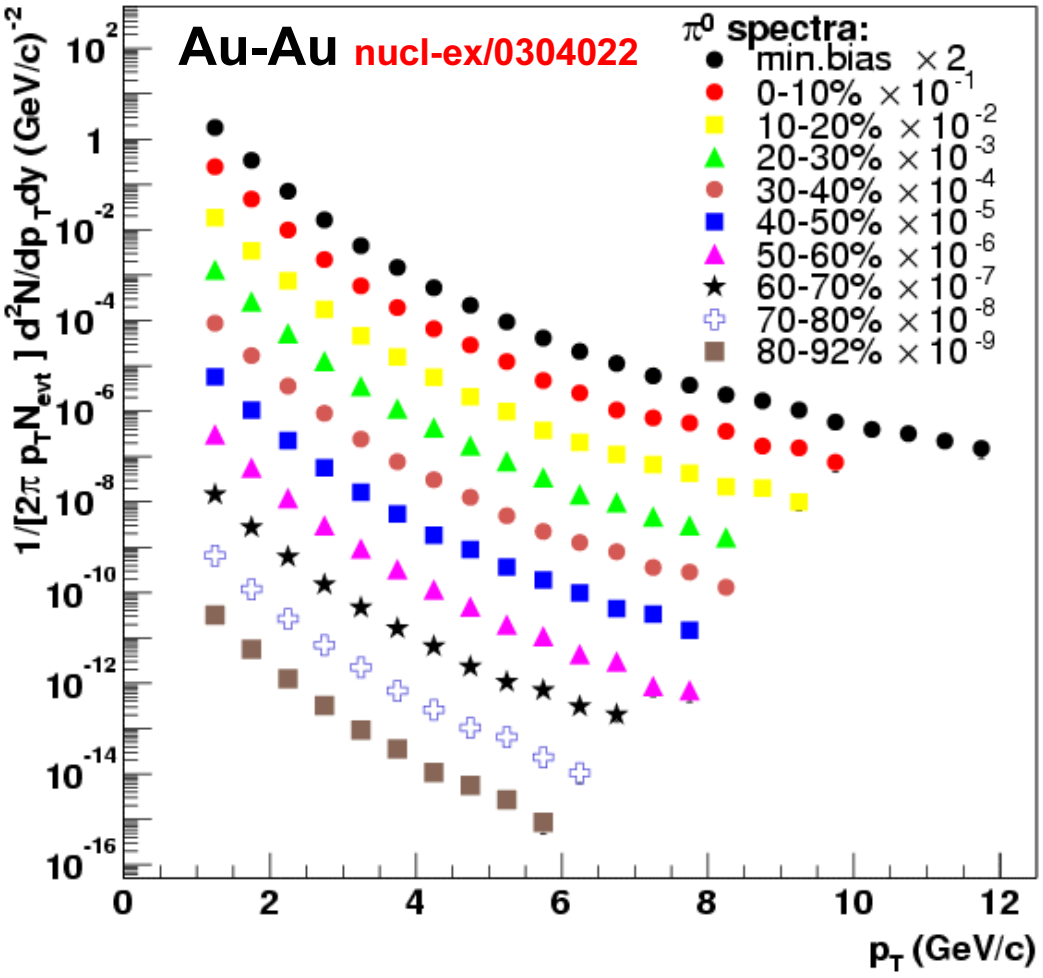
Oak Ridge National Laboratory, Oak Ridge, TN
University of Tennessee, Knoxville, TN
Vanderbilt University, Nashville, TN

BACKUP SLIDES

Run2 p+p and Au+Au : π^0





Submitted to PRL

PHENIX Runs

Run	Year	Species	$s^{1/2}$ [GeV]	$\int Ldt$	N_{tot}
01	2000	Au-Au	130	1 μb^{-1}	10M
02	2001/2002	Au-Au	200	24 μb^{-1}	170M
		p-p	200	0.15 pb^{-1}	3.7G
03	2002/2003	d-Au	200	2.74 nb^{-1}	5.5G
		p-p	200	ongoing	

Particle composition at high pt

p/π ~1 at high p_T for central collisions

In peripheral collisions p/π ~ 0.4