Unsolved Problem in RHIC Physics

Unsolved (or NewlyFound) Problems at RHIC

Mach Cone / Color Cerenkov

Many low pT particles are observed along the Quenched Jet
(Angle from Jet = 120 deg.)

J/ ψ Production Mechanism

With the expected absorption ratio at SPS,
J/ψ yield @ RHIC is underestimated.

Baryon(Hyperon)-Hadron azimuthal angle correlation

Around the high pT baryon angle, many hadrons are observed
as in the case of jet production → Baryons are also formed in jets.

High p_T v_2 problem

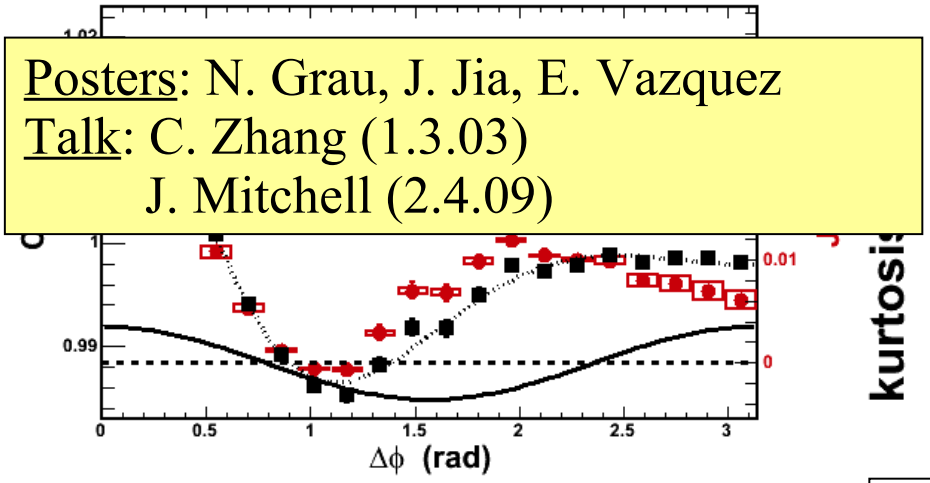
With the energy loss explaining p_T spectrum,
elliptic flow is calculated to be too small at high p_T.

And Many....

Jet Functions

nucl-ex/0611019
(submitted to Phys. Rev. Lett.)

Posters: N. Grau, J. Jia, E. Vazquez
Talk: C. Zhang (1.3.03)
J. Mitchell (2.4.09)

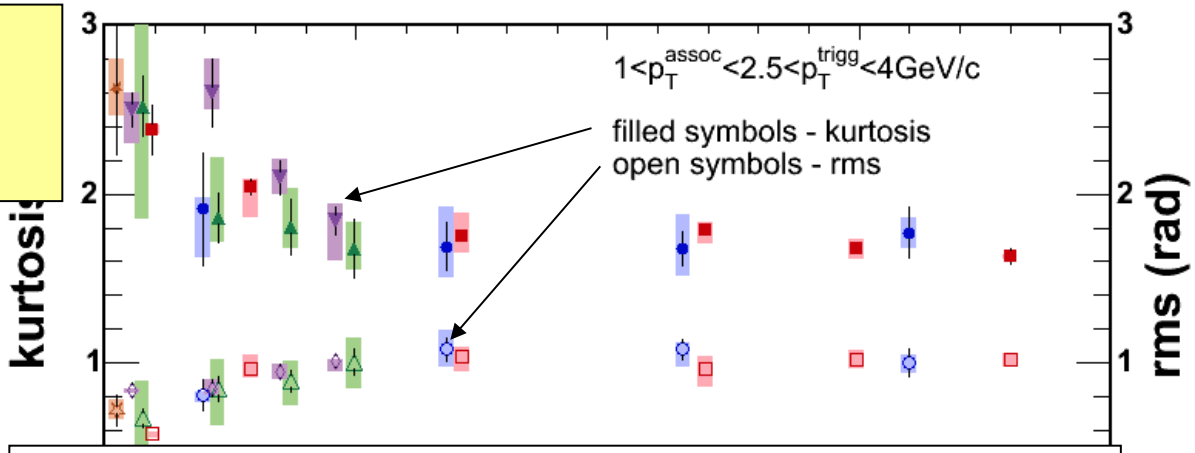


$$\mu_n = \left\langle (\Delta\varphi - \pi)^n \right\rangle$$

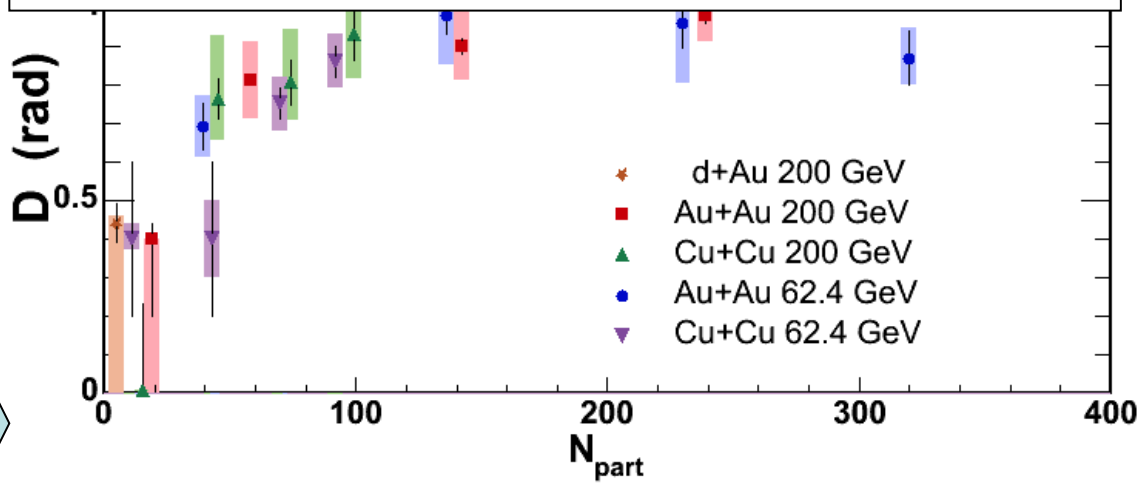
$$rms = \sqrt{\mu_2}$$

$$kurtosis = \mu_4 / \mu_2^2$$

$$J(\Delta\varphi) = G(\Delta\varphi) + G(\Delta\varphi - \pi + D) + G(\Delta\varphi - \pi - D)$$



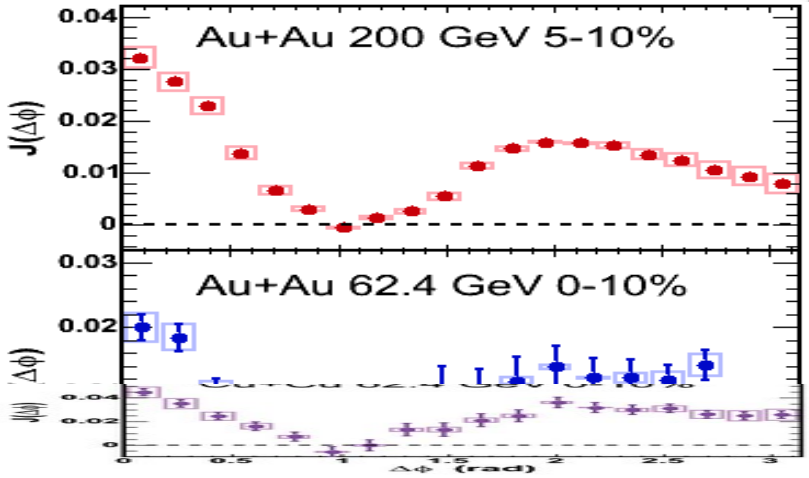
rms, kurtosis and D also independent of p_T of associated hadrons - poses challenge to color Cerenkov models

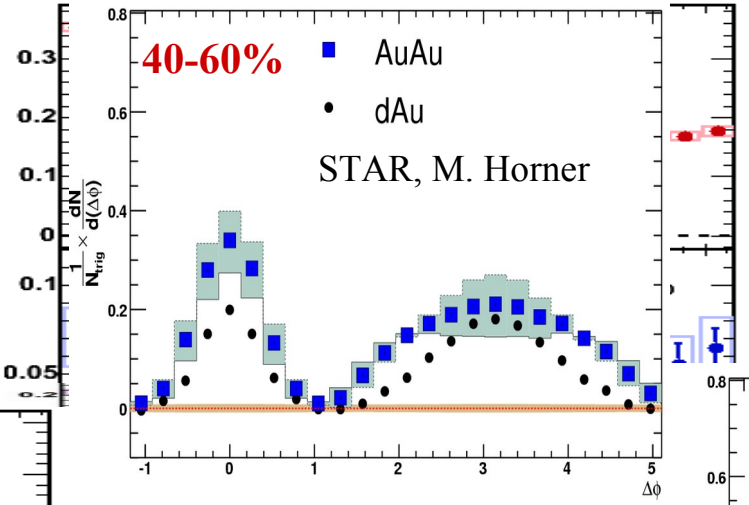


John Lajoie (PHENIX) @ QM2006

Di-hadrons: away-side shape

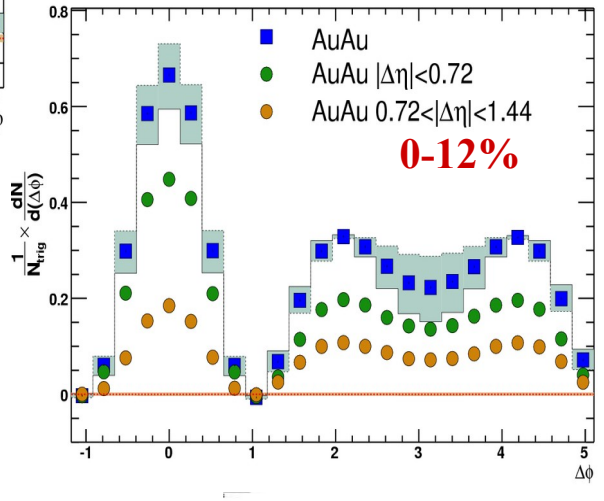
PHENIX: C. Zhang, N. Grau, J. Jia, E. Vazquez





$2.5 < p_{T,trig} < 4.0$ GeV/c
$1.0 < p_{T,assoc} < 2.5$ GeV/c

High statistics
Run IV data



Clear evolution peripheral → central:
Widening, flattening and 'dip at π'

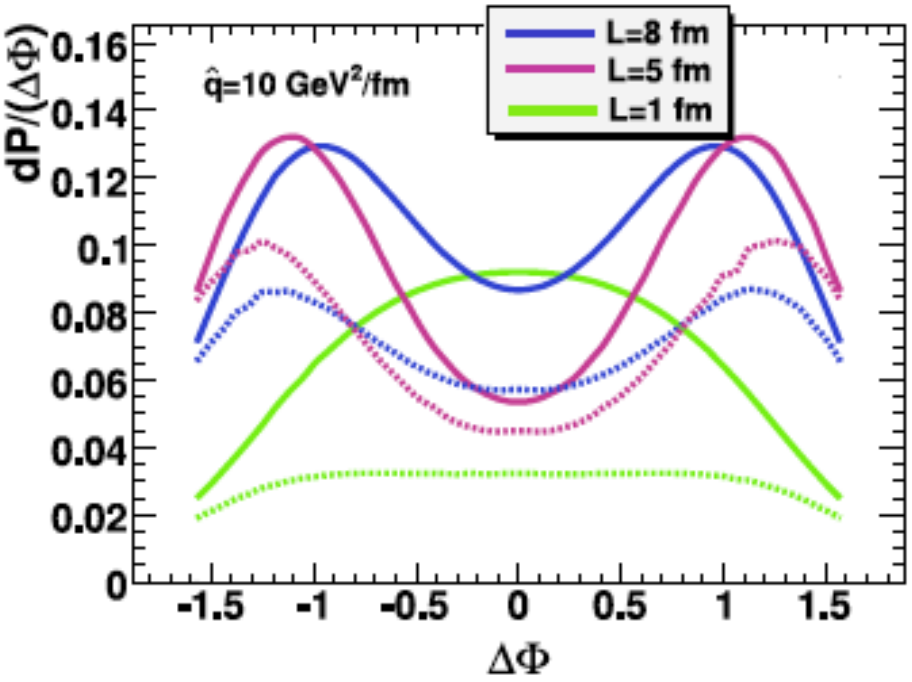
Jet Correlations: *Larry McLerran @ QM2006*

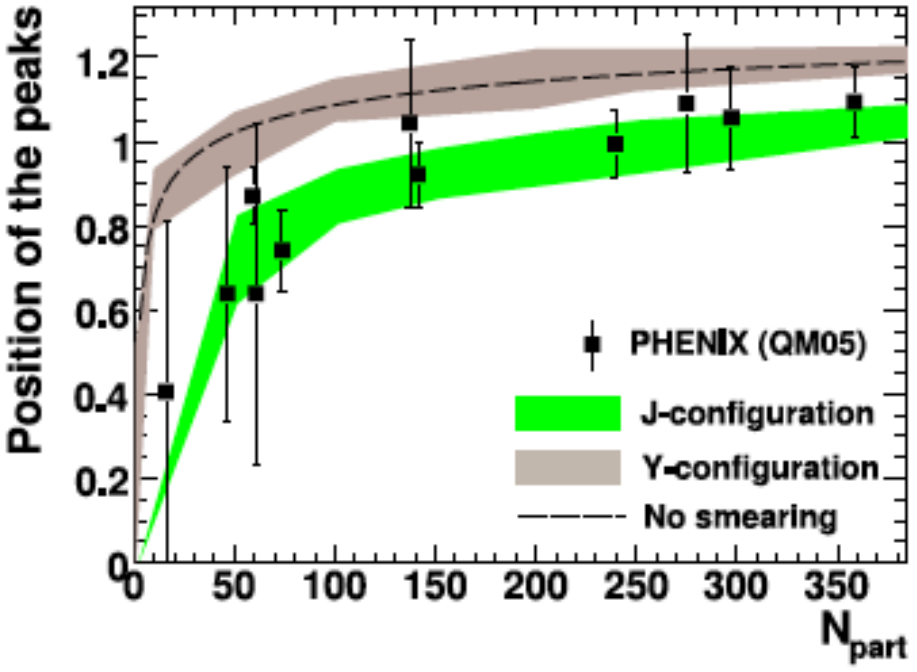
Mach cones one of earliest proposals for heavy ion collisions:
Greiner, Stocker and Frankfurt group

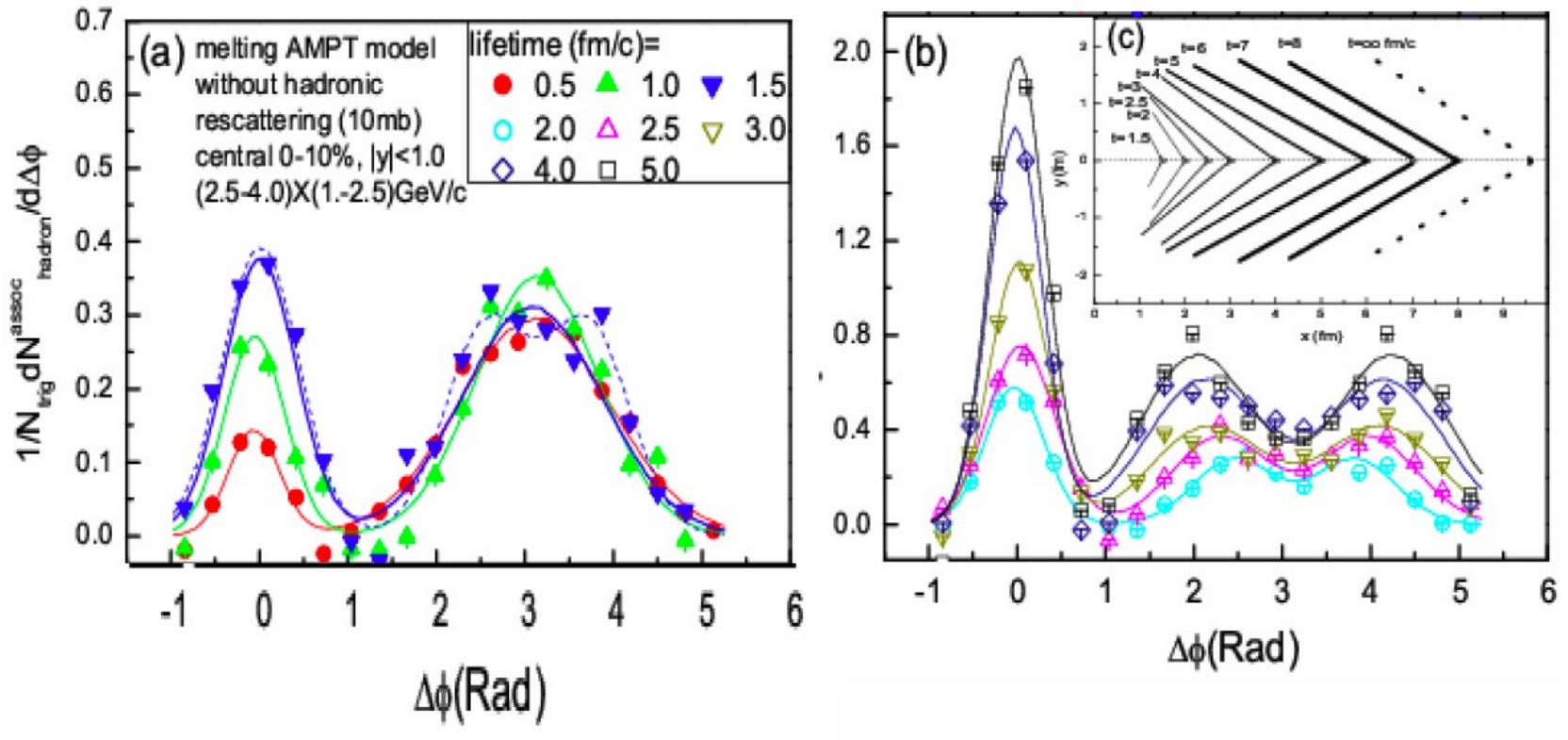
Cherenkov radiation and Mach cones possible,
but devil in the details

Possible explanation as Sudakov form factor for
jet emission by Salgado et. al?

Deflected jets al a Vitev?





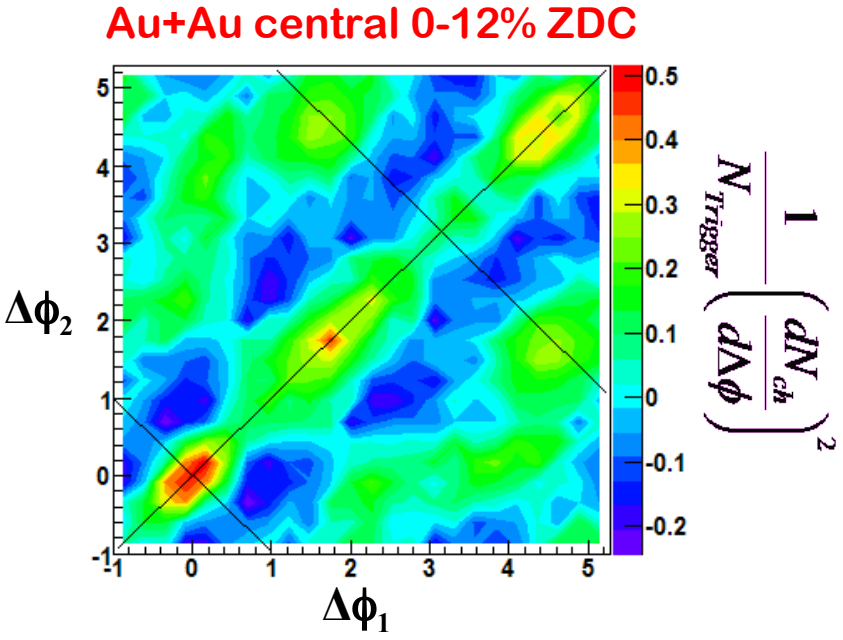


Mach Cone: $v_s^2 \sim 10^{-2}$

Radiation and scattering: No cone

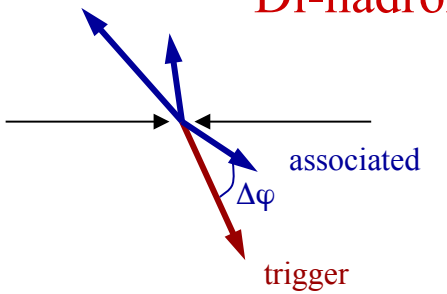
Cerenkov: Wide angles

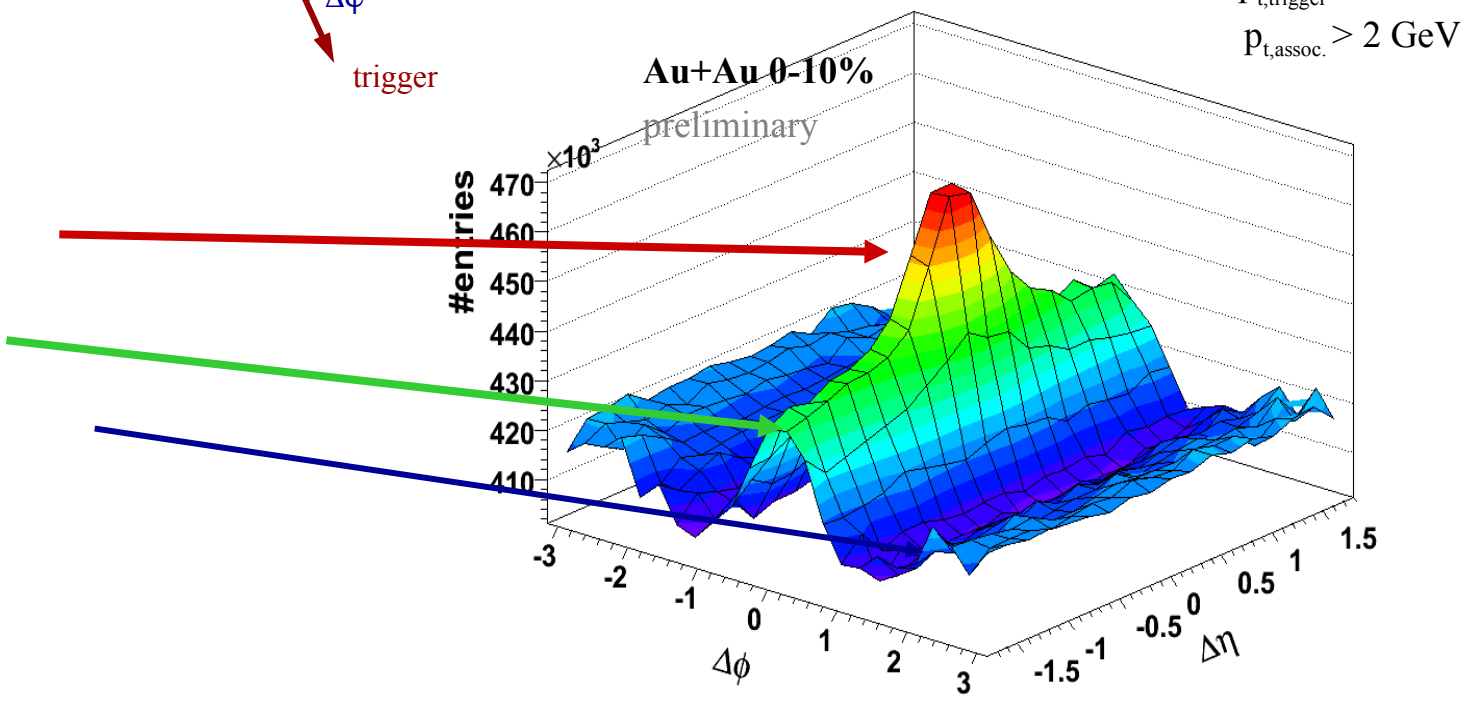
Larry McLerran @ QM2006



Fragmentation and energy loss I: near-side

Di-hadron correlations





M. Calderon, J. Putschke

Components

- **Near-side jet peak**
- **Near-side ridge**
- **Away-side (and v_2)**

Two distinct questions:

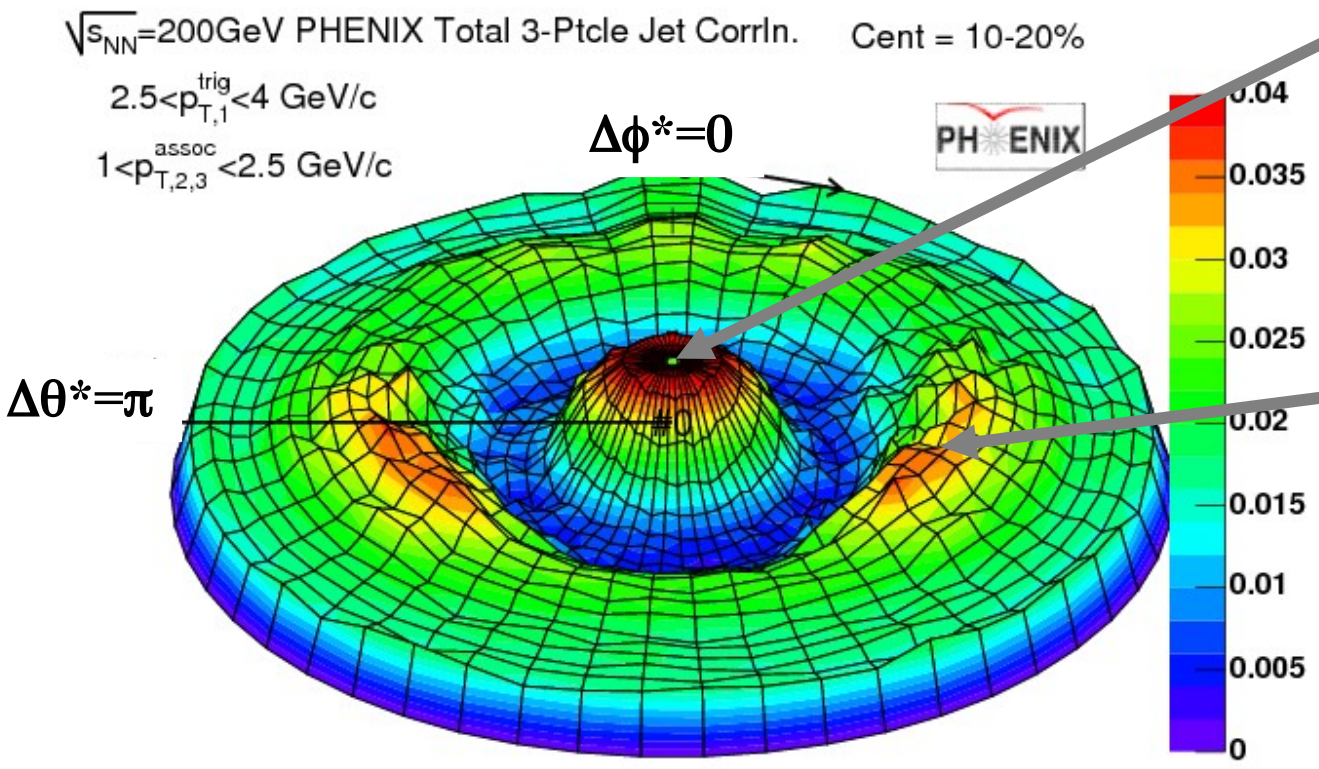
What is it ?
- 'something' coupling to long flow ?
- Can this quantify E-loss ?

How to deal with it?
- Need to subtract for near-side studies?

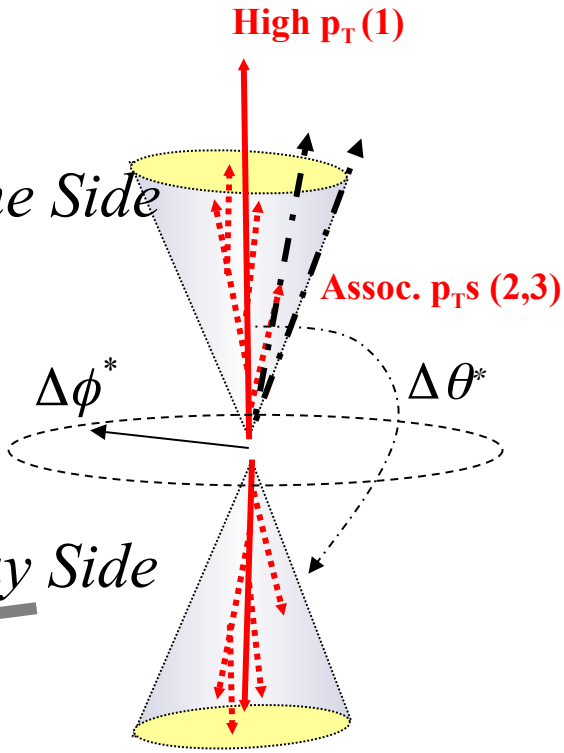
Lesson: The near-side jet does interact with the medium

3-Particle Correlations

(3 particles from di-jet) + (2 from dijet + 1 other)



PHENIX Preliminary



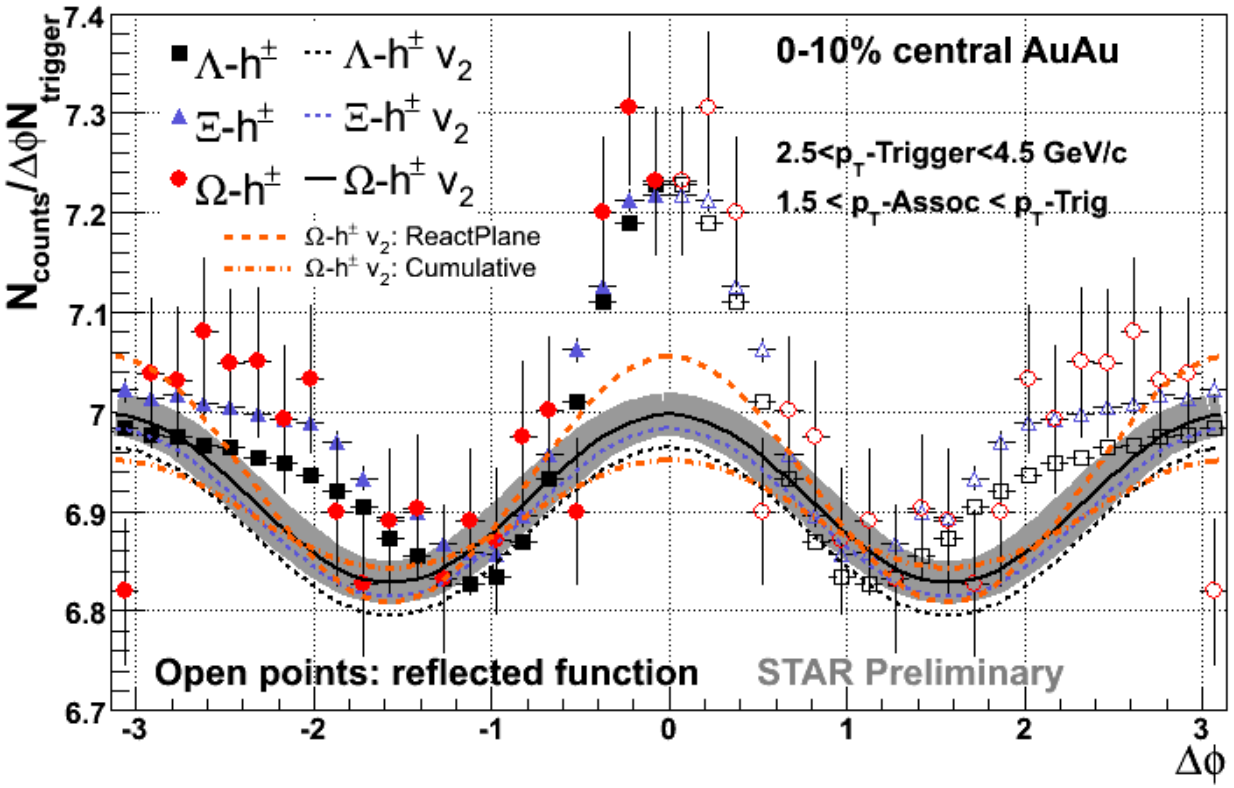
$$\Delta\phi^* = \phi^*_{12} - \phi^*_{13}$$

$$\Delta\theta^* = \theta^*_{12}$$

John Lajoie (PHENIX) @ QM2006

Λ,Ξ,Ω-h correlation

J. Bielcikova



Near-side yield similar for Λ, Ξ, Ω triggered correlations

Initial expectation: Ω dominantly from TTT recombination, no associated yield

R. C. Hwa et al., nucl-th/0602024

Revisited (at QM06): possible large contribution from reheated medium

Experimental tests pending

Marco van Leeuwen @ QM2006

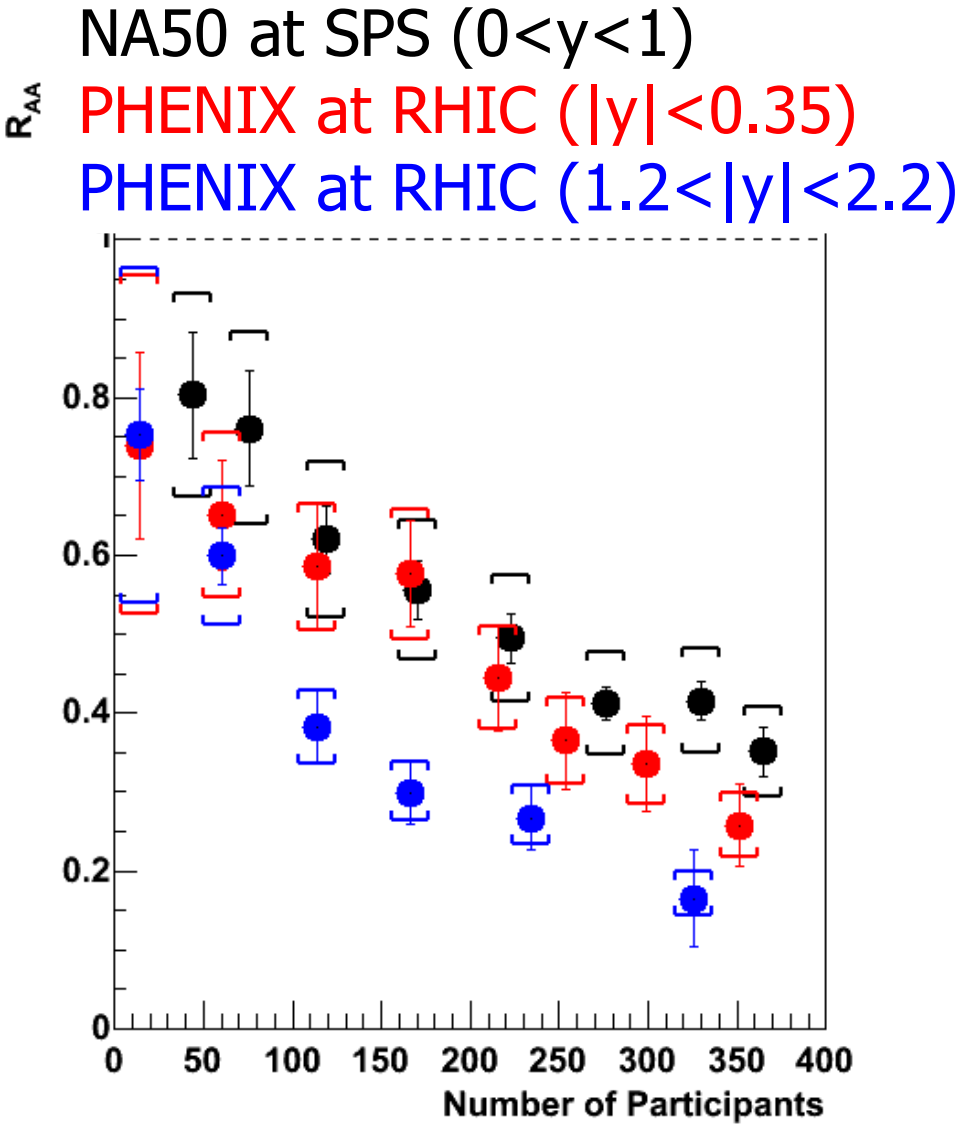
J/Ψ Suppression at SPS and RHIC

Suppression patterns are remarkably similar at SPS and RHIC!

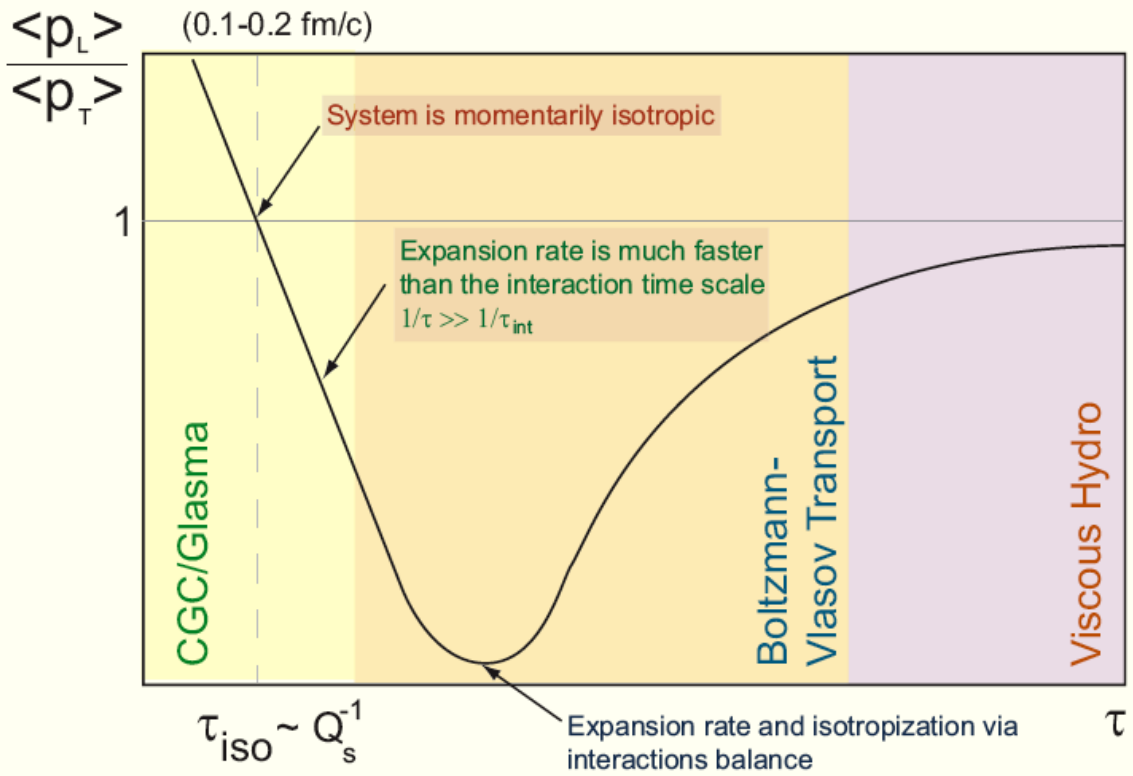
Cold matter suppression larger at SPS, hot matter suppression larger at RHIC, balance?

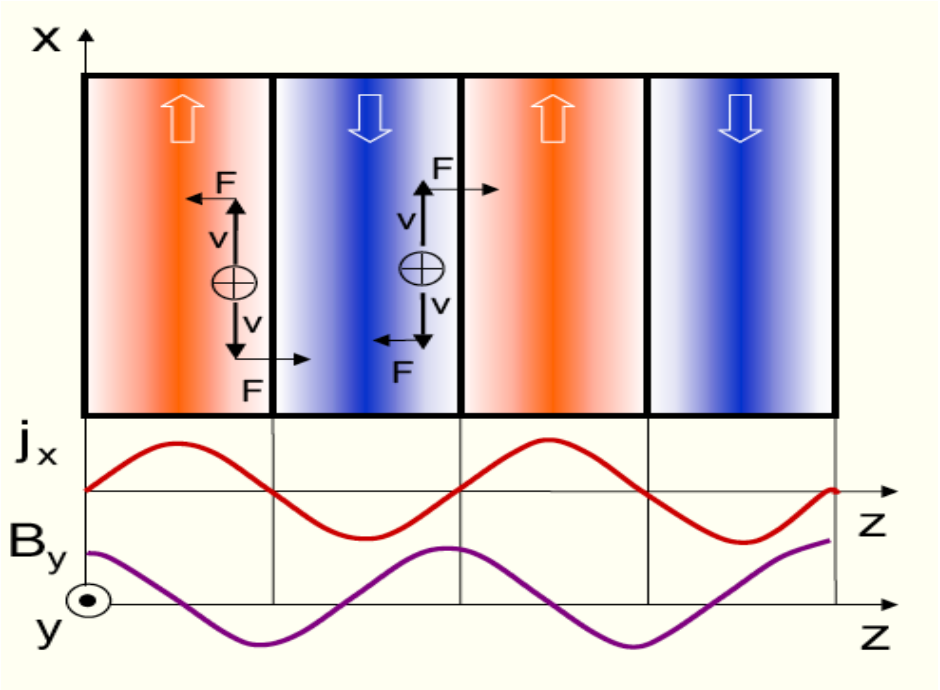
Recombination cancels additional suppression at RHIC?

How did we get so "lucky"?



Momentum Space Anisotropy Time Dependence





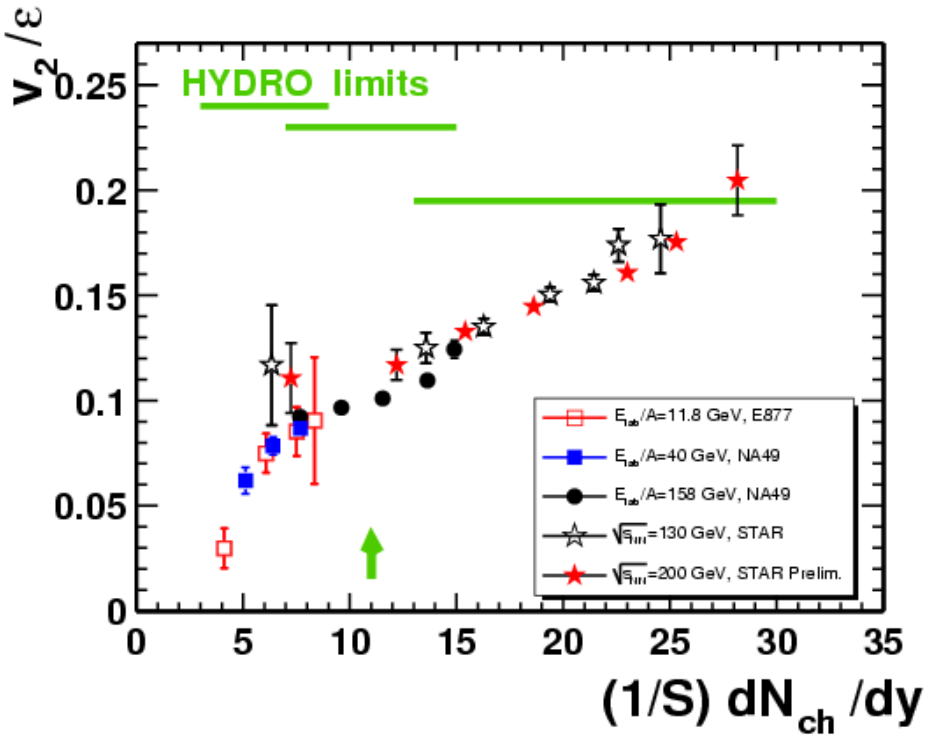
Instabilities driven by momentum anisotropy

Larry McLerran @ QM2006

How Perfect is the sQGP?

CGC Initial Conditions allow for higher hydro limit.

LHC?



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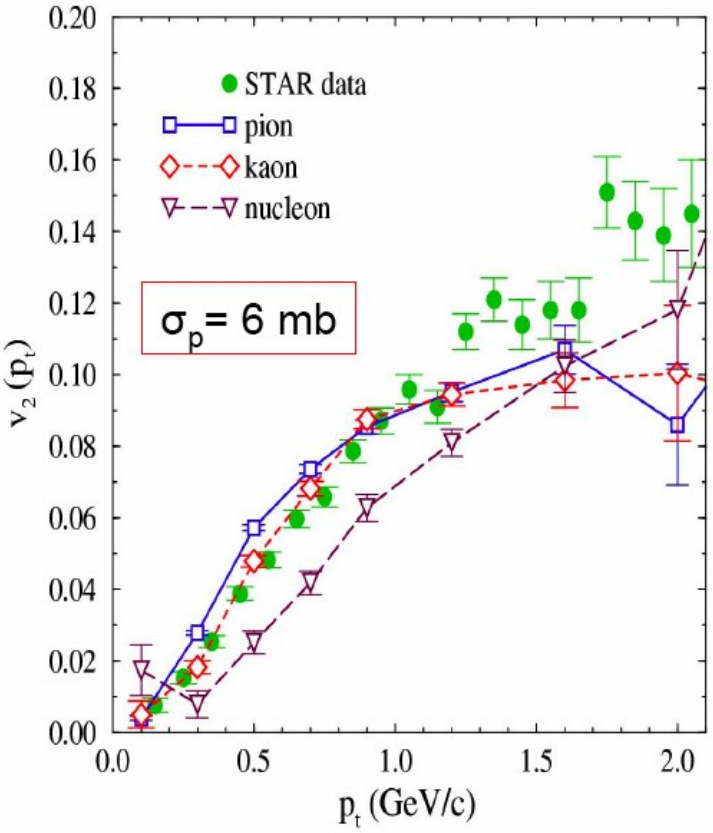


CGC Initial Conditions?

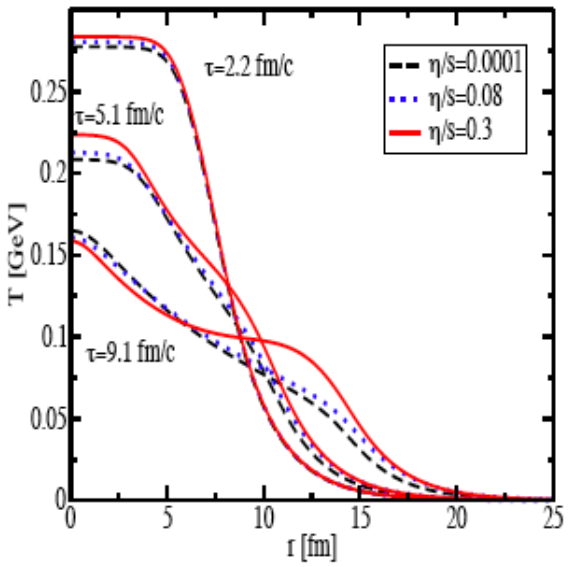
Large parton cross sections not required for flow.

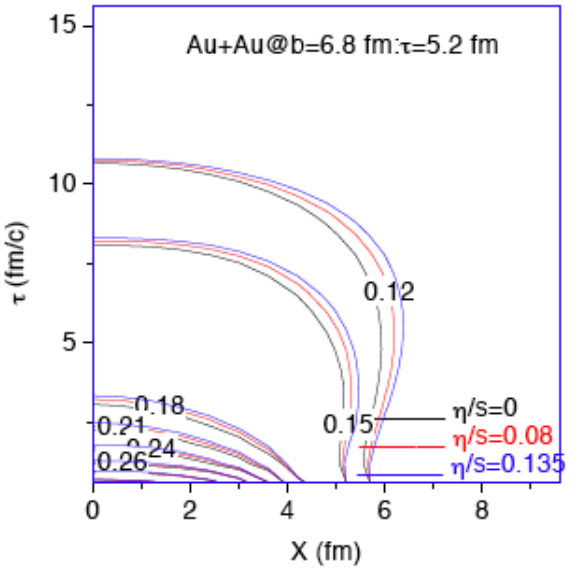
Thermalization through mutligluon interactions?

Plasma Instabilities?

Viscosity effects are unknown, computation is theoretical challenge.

- Temp. vs. Rad. for different τ
- Temp. contours in the τ, R plane





Viscous Hydrodynamics:

Becoming practical

Larry McLerran @ QM2006