

Search for the chiral magnetic effect with identified particles in 39 GeV Au+Au

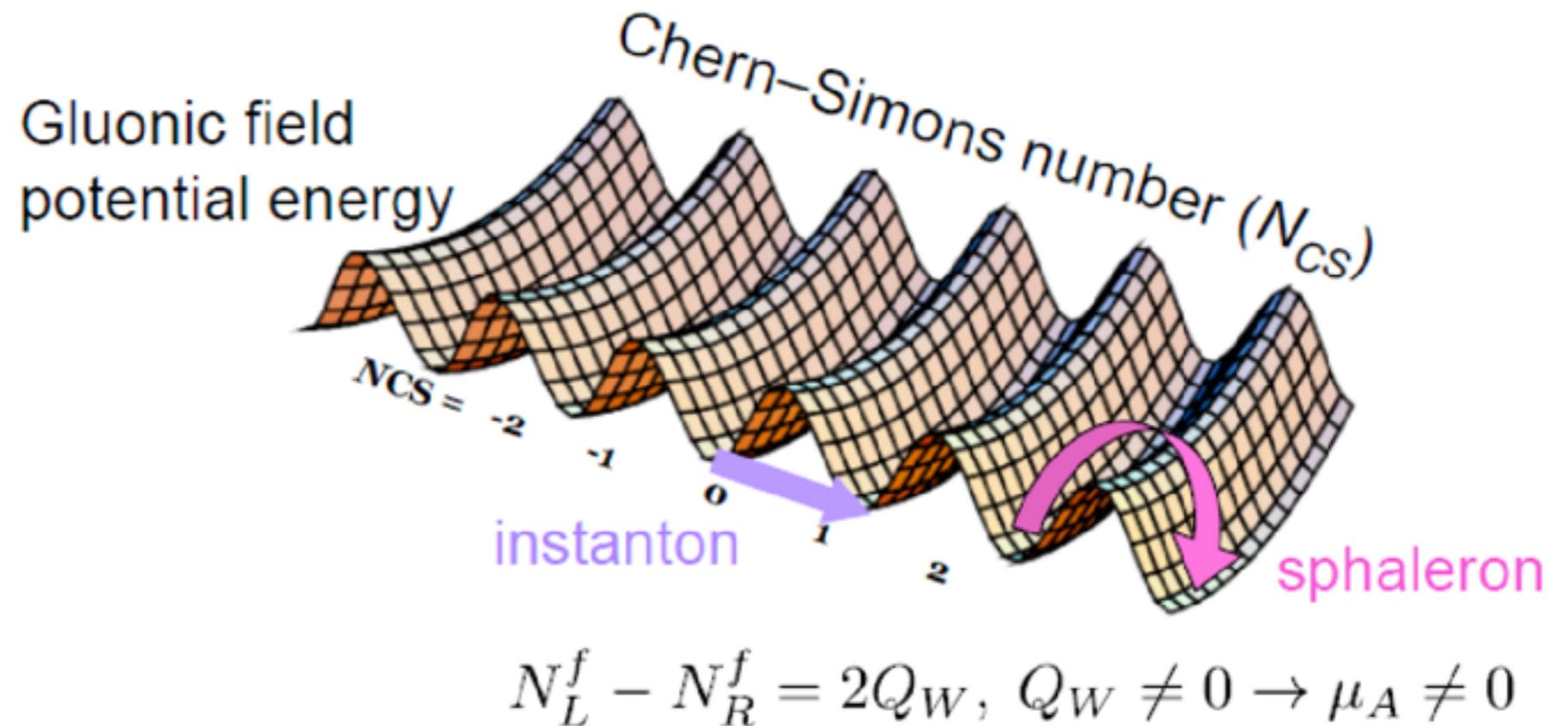
Yiwen Huang
University of California, Los Angeles



Outline

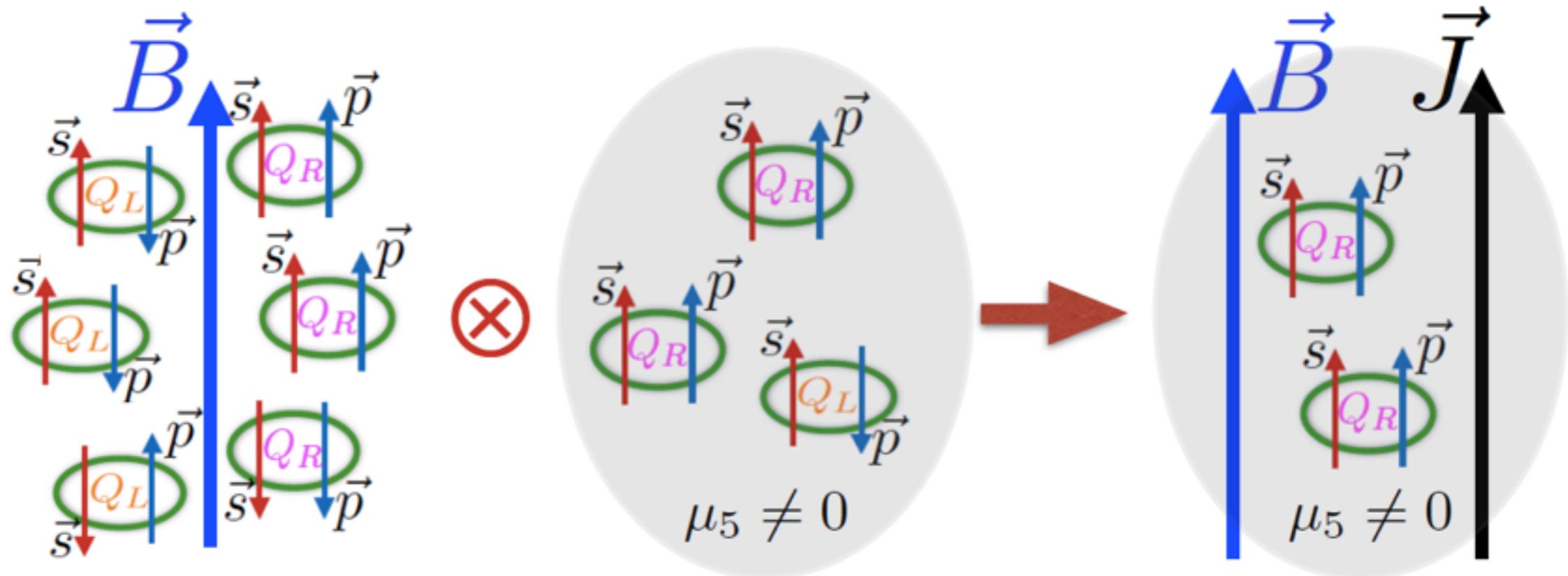
- Physics Motivation
- Methods
- PID results
- Summary

QCD Vacuum Transition



- QCD vacuum transition:
- nonzero topological charge
- chirality imbalance (local parity violation)

Chiral Magnetic Effect



Kharzeev, D.E. et al. Prog.Part.Nucl.Phys. 88 (2016) 1-28 arXiv:1511.04050 [hep-ph]

- Configuration with non-zero topological charge converts left(right)-handed fermions to right(left)-handed fermions, generating electromagnetic current along B direction and leading to electric charge separation.

Observable: γ correlator

$$\frac{dN_{\pm}}{d\phi} \propto 1 + 2a_{\pm} \sin(\phi^{\pm} - \Psi_{RP})$$

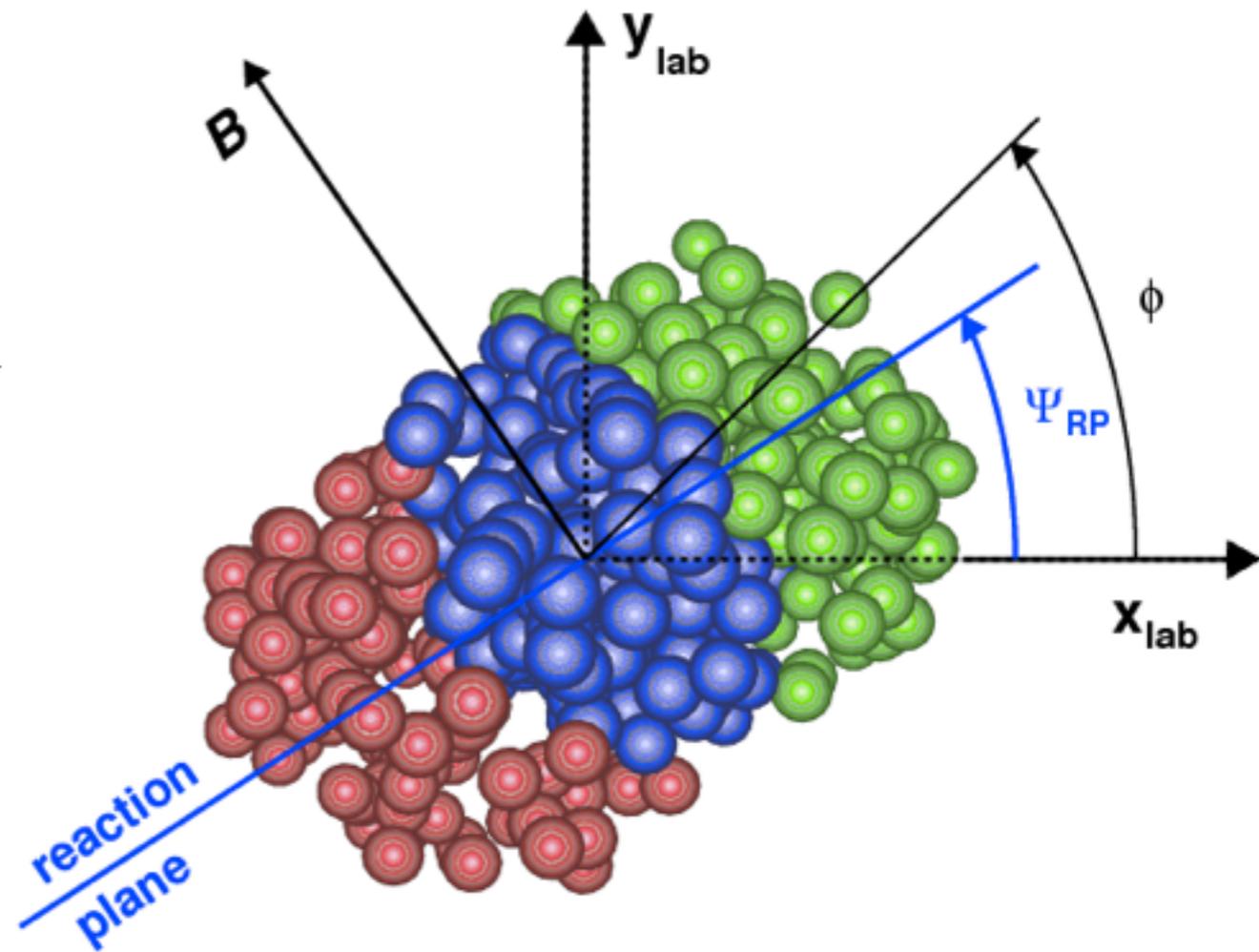


$$\begin{aligned} \gamma &= \langle \cos(\phi_{\alpha} + \phi_{\beta} - 2\psi_{RP}) \rangle \\ &= [\langle v_{1,\alpha} v_{1,\beta} \rangle + B_{in}] - [\langle a_{\alpha} a_{\beta} \rangle + B_{out}] \end{aligned}$$

- Directed flow: expected to be same for “same sign” and “opposite sign”
- Background effects: largely cancel out, but flow-related background may still exist.
- P-even quantity: still sensitive to separation effect, i.e., different for “same sign” and “oppo sign”

Event Plane Reconstruction

- Shifting method is used to make corrections to the event plane.

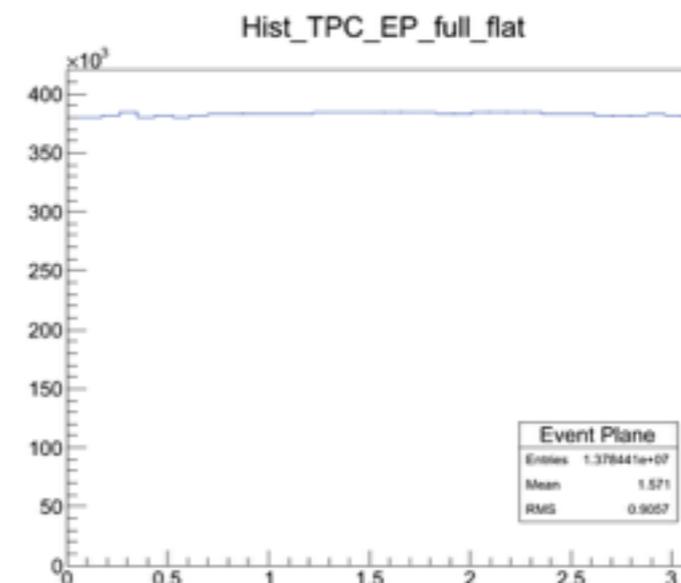
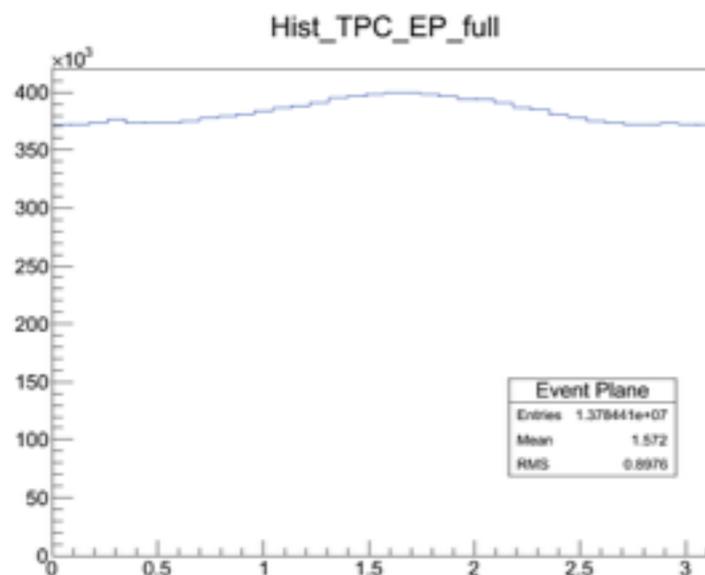


$$\frac{dN}{d\psi} = \frac{a_0}{2} + \sum_n (a_n \cos n\psi + b_n \sin n\psi)$$

$$\frac{dN}{d\psi} = \frac{dN}{d\psi'} \cdot \frac{d\psi'}{d\psi} = \frac{a_0}{2} \cdot \left(1 + \sum_n (-n \cdot A_n \sin n\psi + n \cdot B_n \cos n\psi)\right)$$

$$A_n = -\frac{2}{n} \cdot \frac{b_n}{a_0} = -\frac{2}{n} \langle \sin n\psi \rangle$$

$$B_n = -\frac{2}{n} \cdot \frac{a_n}{a_0} = \frac{2}{n} \langle \cos n\psi \rangle$$



Cuts & Identification of Pions and Protons

- Event

Vertex (cm)	(-30,30)
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- Particles

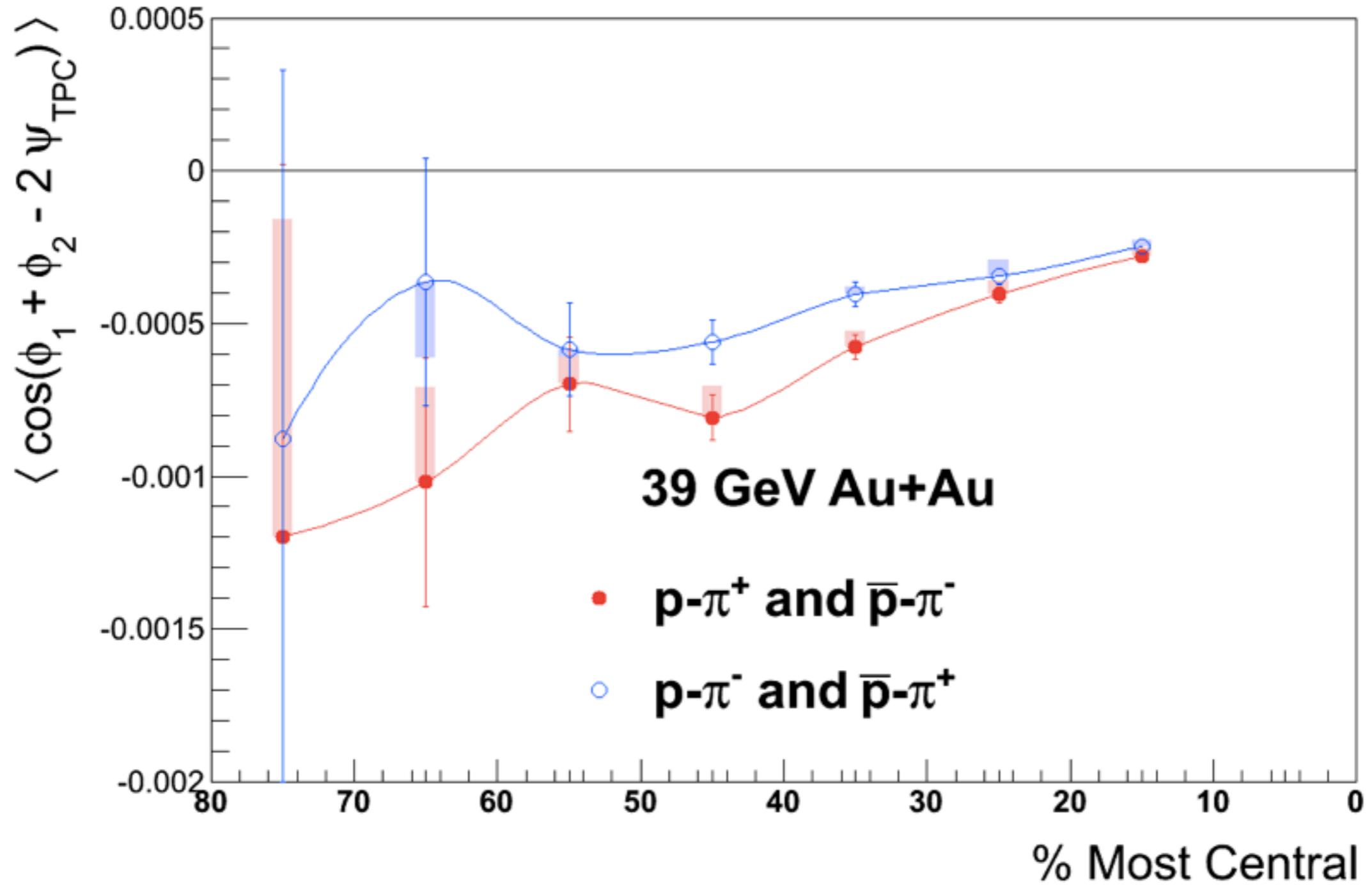
Eta	-1,1	
Dca (cm)	Proton	< 1
	Pion	< 2
Tof	Flag	> 0
	β	> 0
	Ylocal	(-1.8,1.8)

- Identified Particles

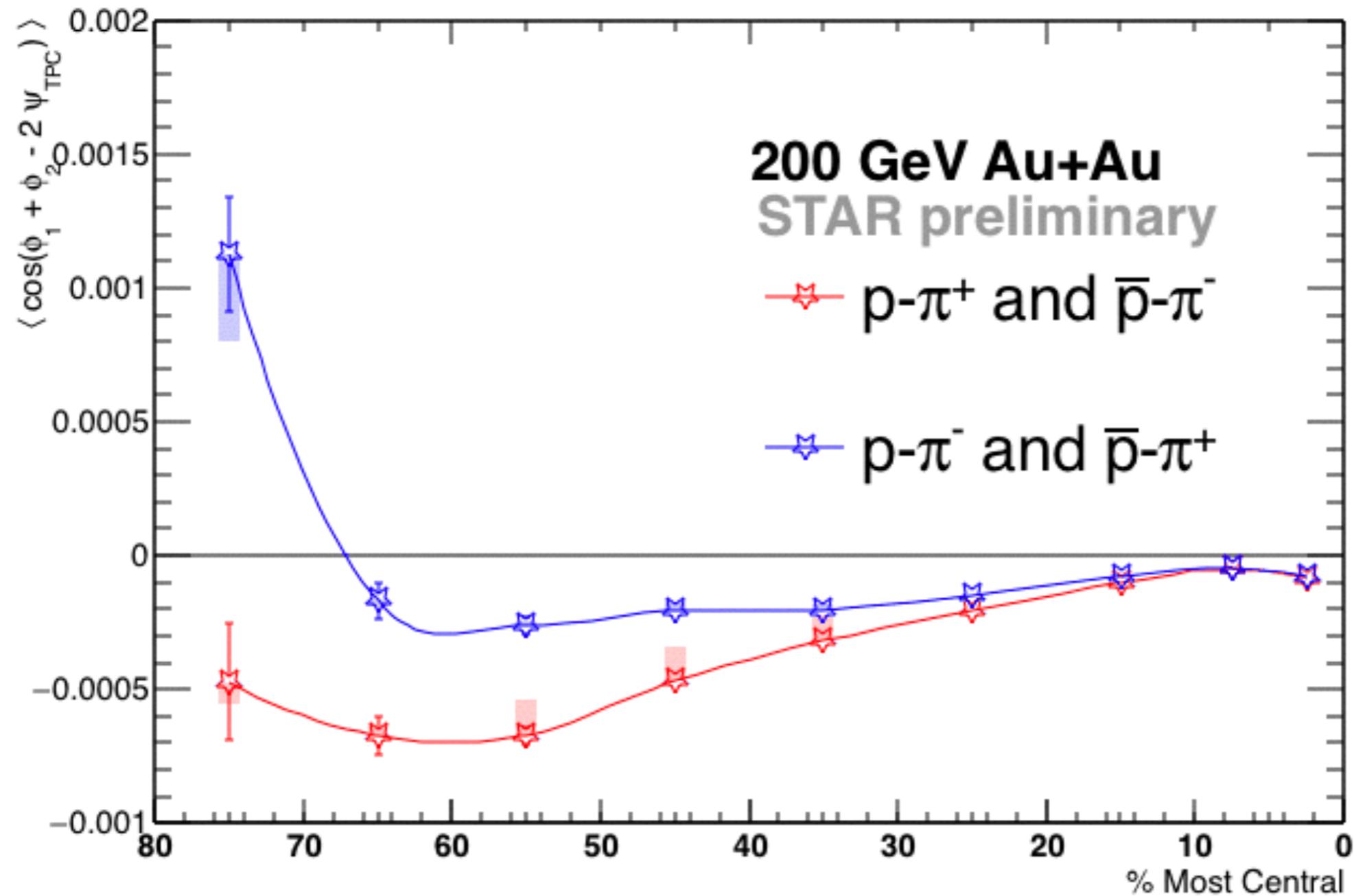
Mass ² (GeV ² /c ⁴)	Proton	(0.8, 1)
	Pion	(-0.01, 0.1)
pT (GeV/c)	Proton	(0.4, 2)
	Pion	(0.15, 0.1.6)
nSigma of Proton		(-2, 2)
nSigma of Pion		(-2, 2)

- The cuts are from Gang and Liwen.

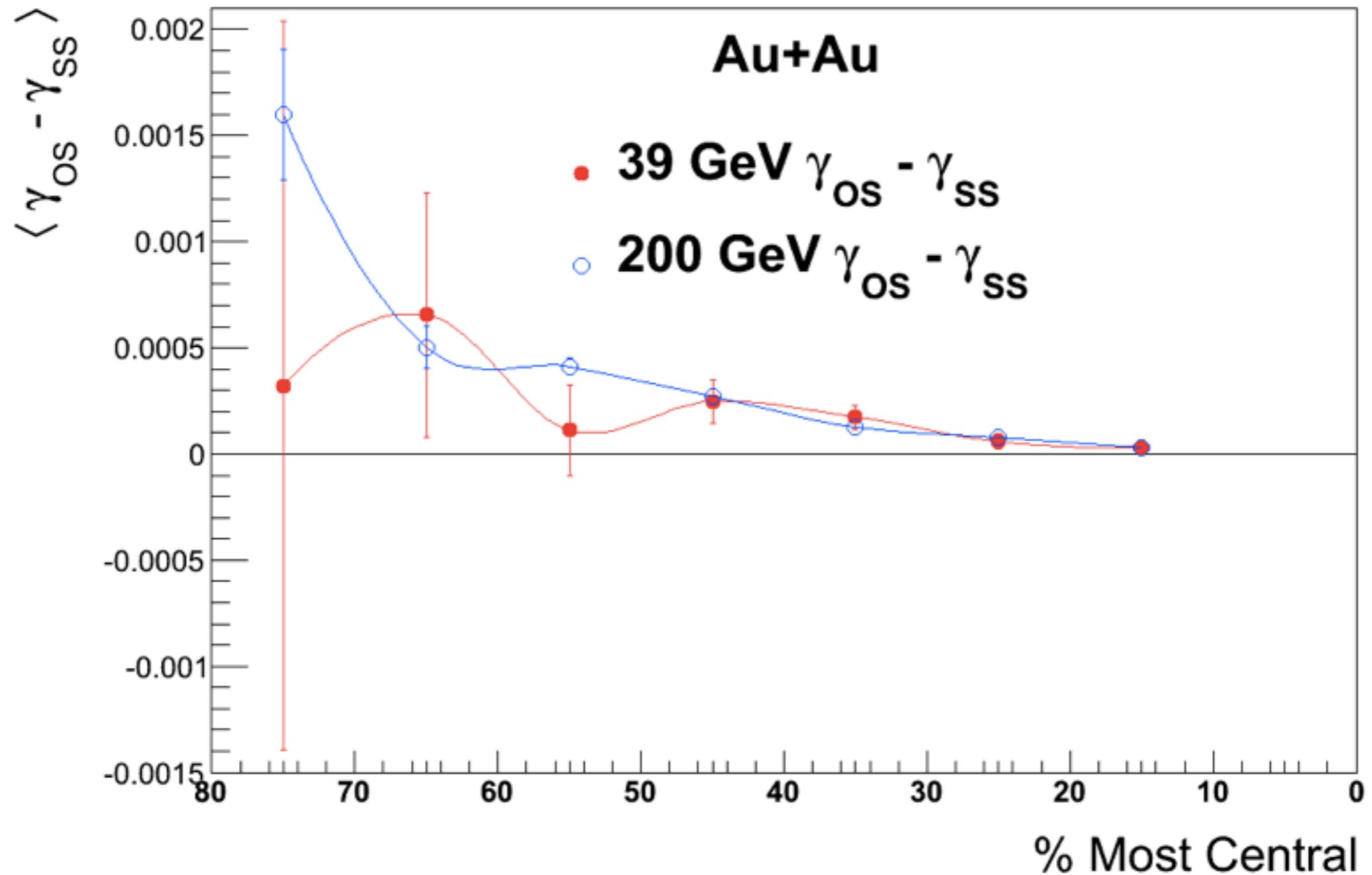
PID Results (39 GeV)



PID Results (200 GeV Au+Au) from Liwen Wen



Difference in γ Correlator



Summary & Outlook

- The γ correlator vs. centrality results of 39 GeV resembles those of 200 GeV; Difference in γ correlator matches;
- Outlook:
 - Finish all statistics;
 - Look at correlation for other identified particles, pion-pion, proton-proton, kaon-kaon, etc.
 - Background study;
 - Invariant mass of lambda;
- Submit a poster abstract for the Conference Experience for Undergraduates (CEU) opportunity at 2016 DNP Fall Meeting.