BROOKHAVEN
NATIONAL LABORATORY

Azimuthal anisotropy v_2 in central U+U collisions at STAR

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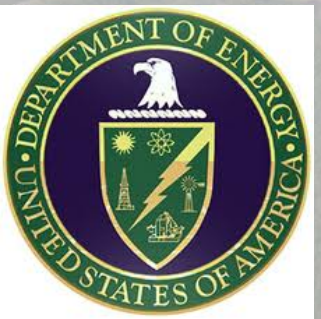
for the STAR Collaboration



Office of Science
U.S. Department of Energy

Motivation

The prolate shape of uranium nuclei provides the possibility to study

- Local parity violation
- Path length dependence of jet quenching
- Particle production in heavy ion collisions

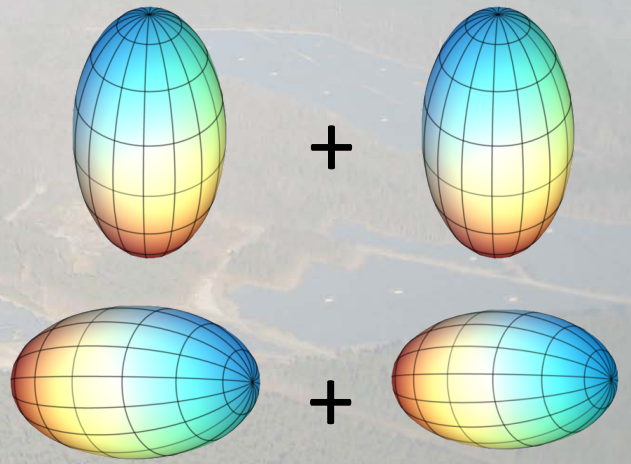
However

- Can we see a difference between Au+Au and U+U?
- Can we separate body-body and tip-tip collisions in U+U?

Au+Au Collisions

Oblate(in average)

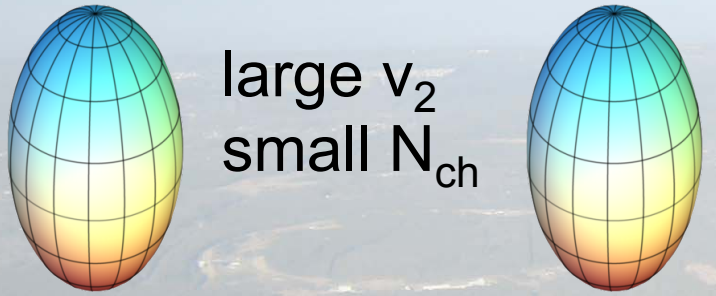
U+U Collisions



Prolate(in average)

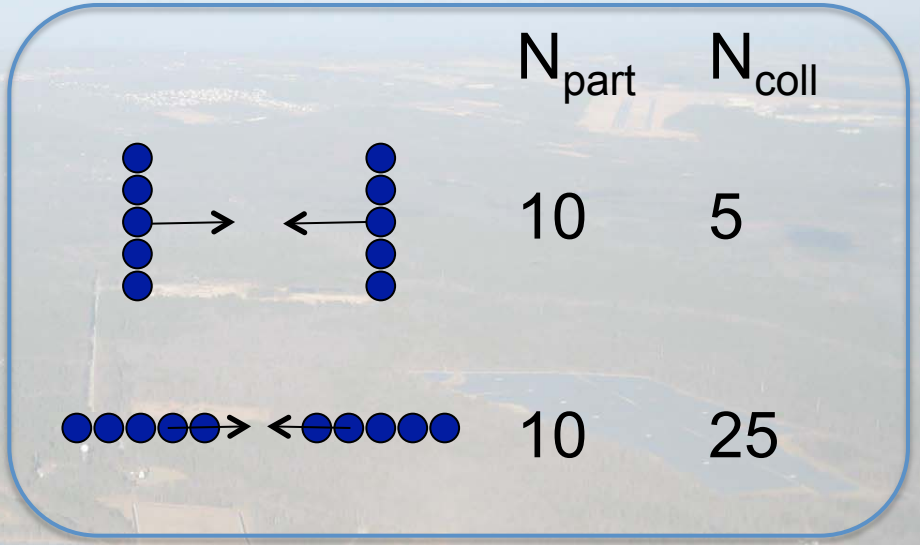
Can we separate body-body and tip-tip?

We often assume multiplicity depends partially on the number of participants and partially on the number of collisions



large v_2
small N_{ch}

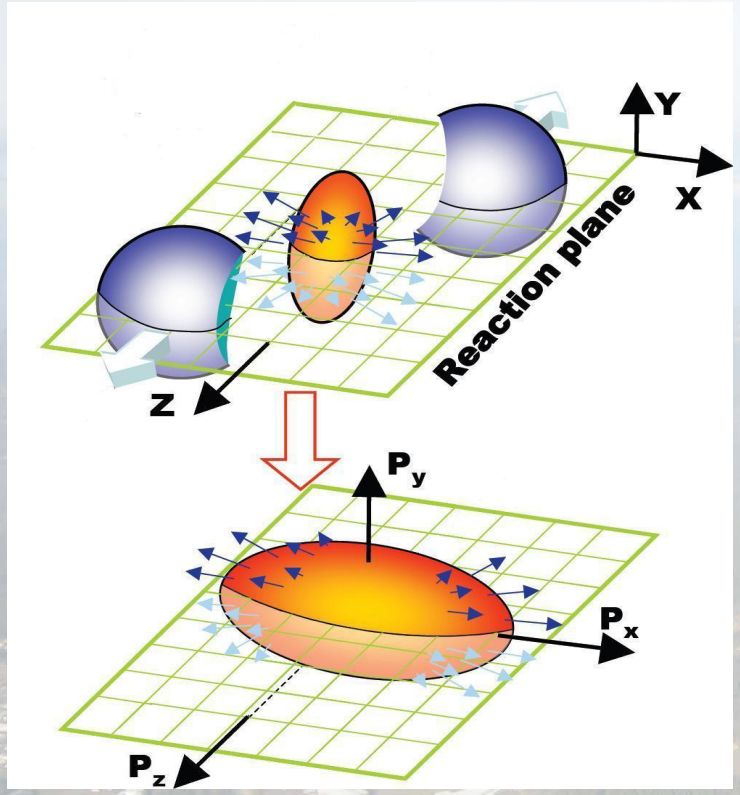
Small v_2
large N_{ch}



Use Zero Degree Calorimeter (ZDC) to select on spectators

Central U+U collisions are an ideal testing ground for particle production: Is large v_2 associated with lower N_{ch}?

Observable



$$\frac{dN}{d\varphi} \propto (1 + 2\sum_{n=1}^{+\infty} v_n \cos[n(\varphi - \psi_n)])$$

$$v_n = < \cos n(\varphi - \psi_n) >$$

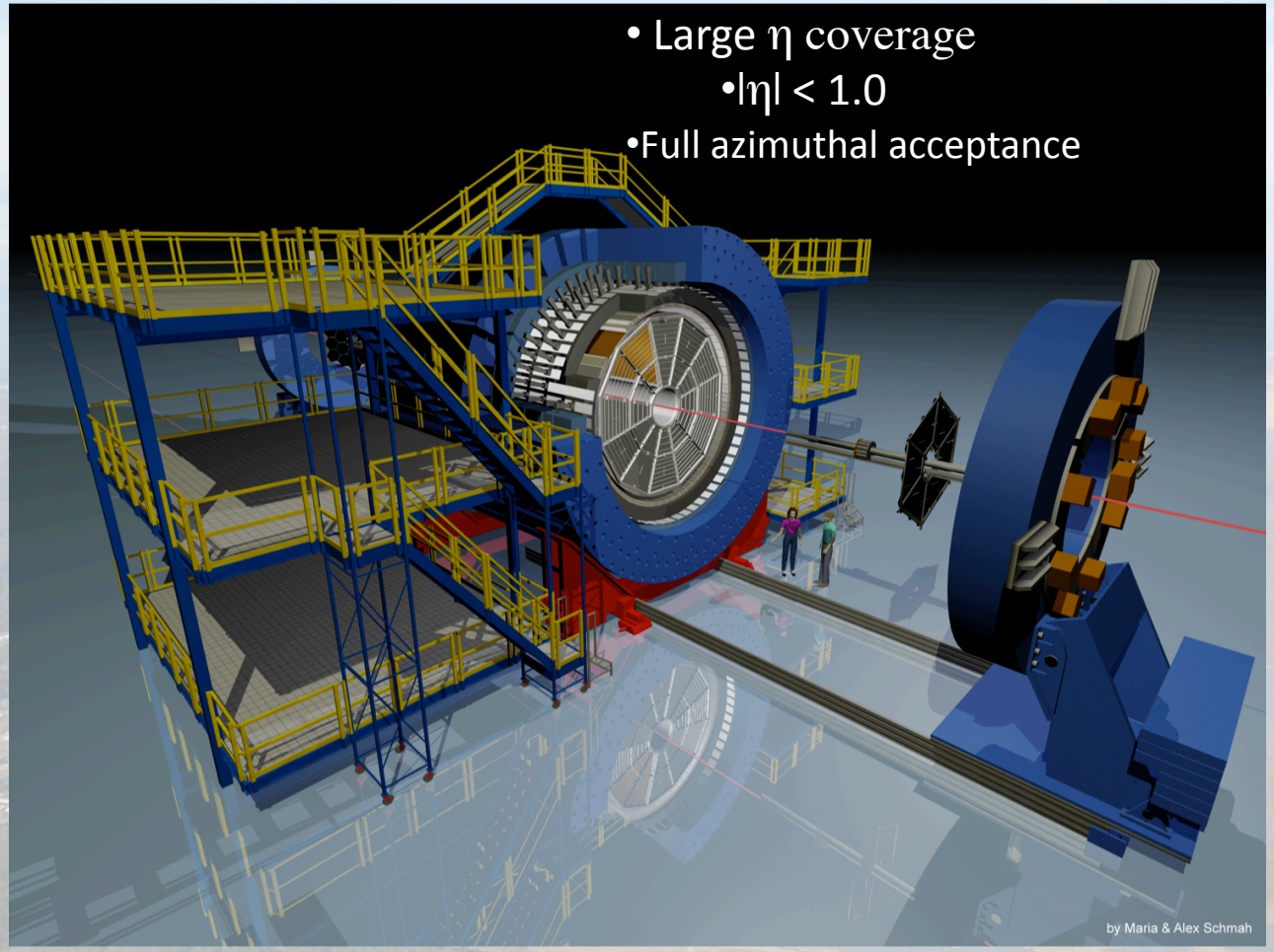
- Cumulant $v_2\{2\}$ with acceptance corrections

$$c_2\{2\} = <\cos 2(\phi_1 - \phi_2)> - <\cos 2(\phi_1)><\cos 2(\phi_2)> - <\sin 2(\phi_1)><\sin 2(\phi_2)>$$

$$v_2\{2\} = \sqrt{c_2\{2\}}$$

- Study multiplicity dependence of $v_2\{2\}$

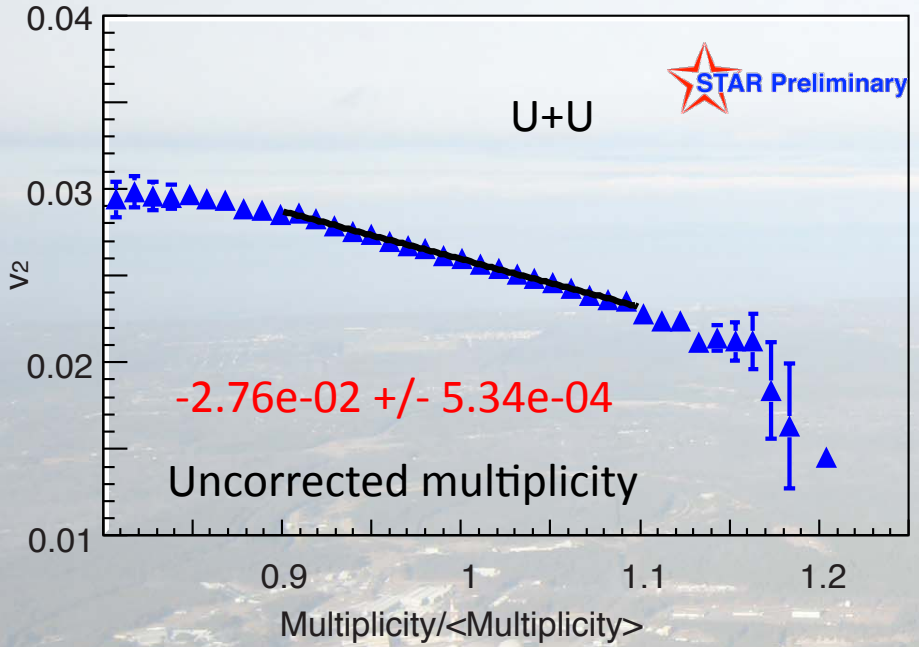
Data Set

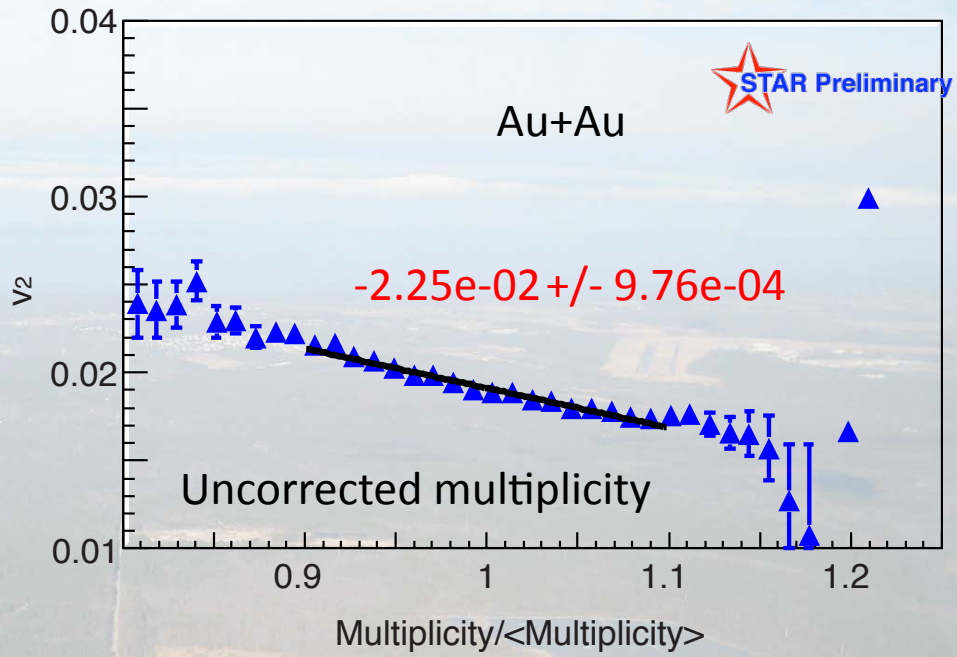


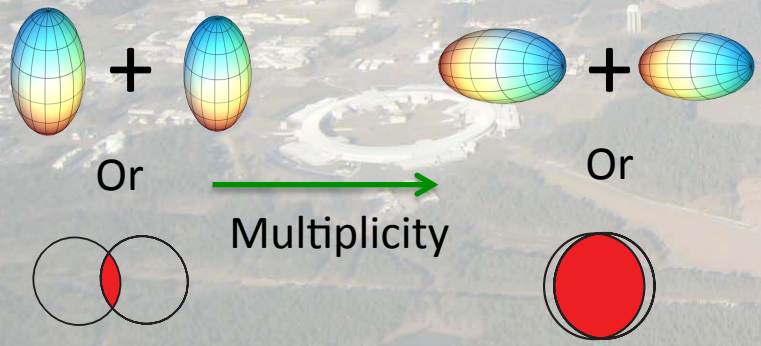
	$\sqrt{s_{NN}}$ (GeV)	Year	# of events*
Au+Au	200	2011	3M
U+U	193	2012	6M

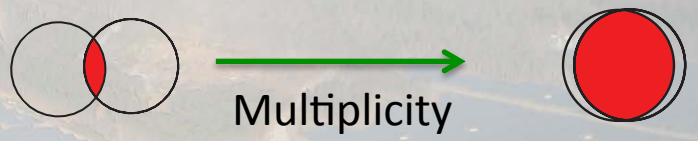
* Events for 1% most central ZDC used in analysis

1% ZDC



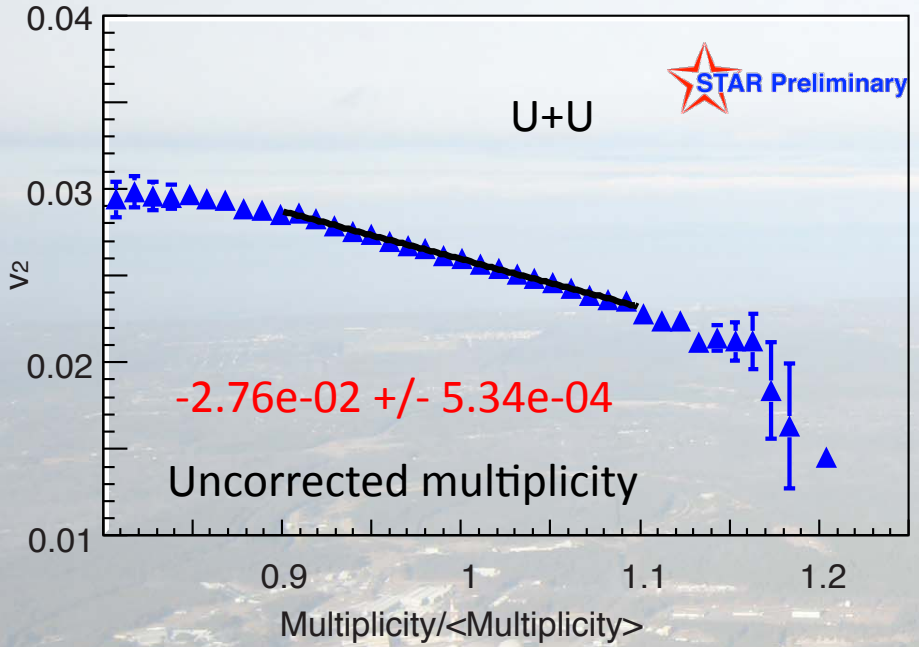


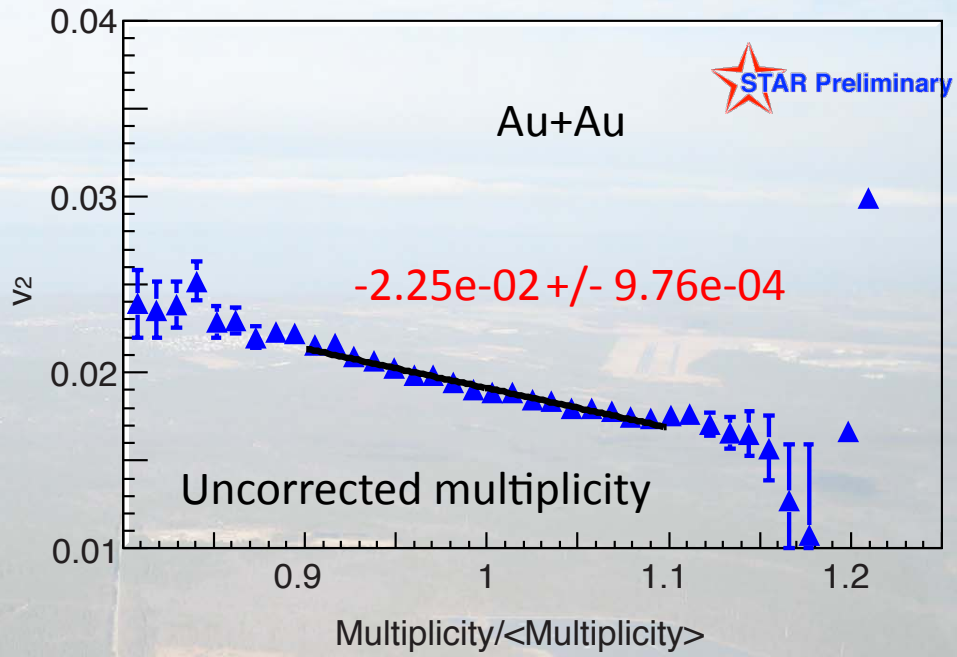


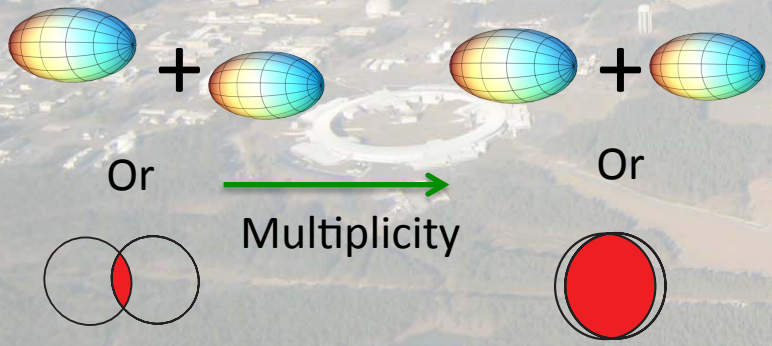


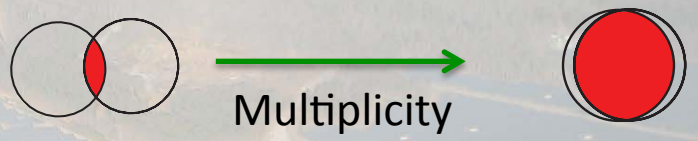
- Use normalized multiplicity to cancel multiplicity independent efficiency
- Apply a linear fit to extract multiplicity dependence of v_2, the slope parameter

1% ZDC









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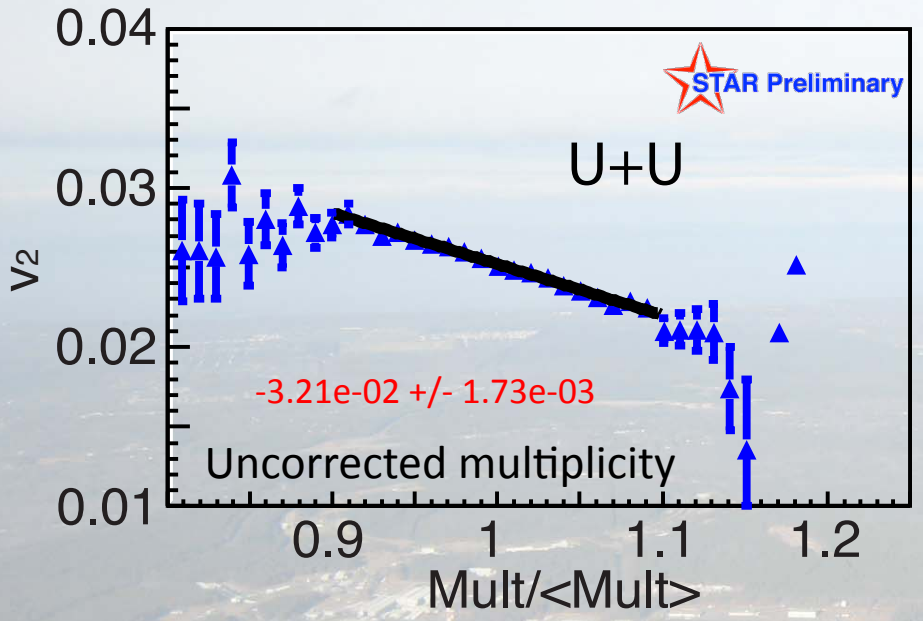
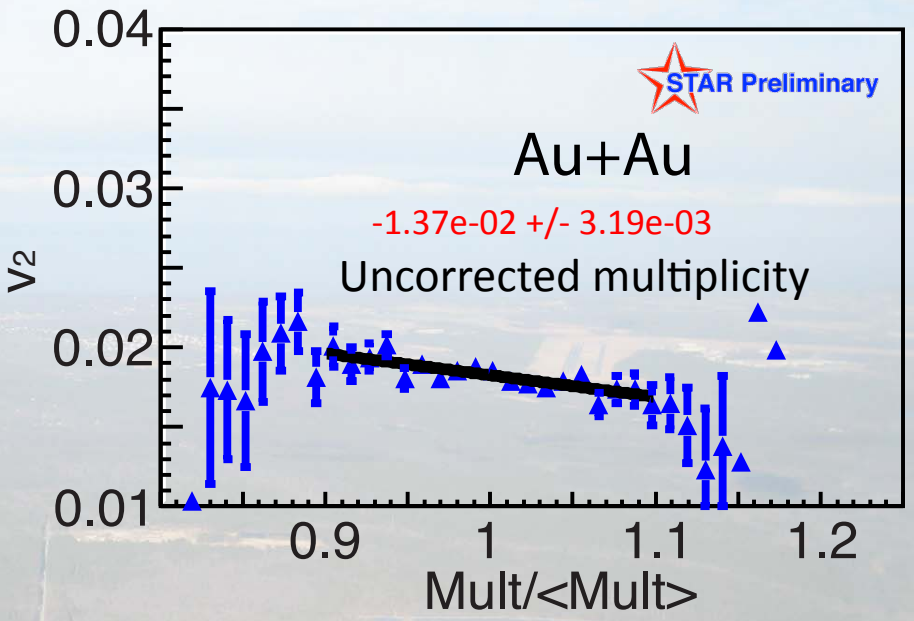
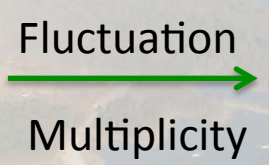
0.1% ZDC

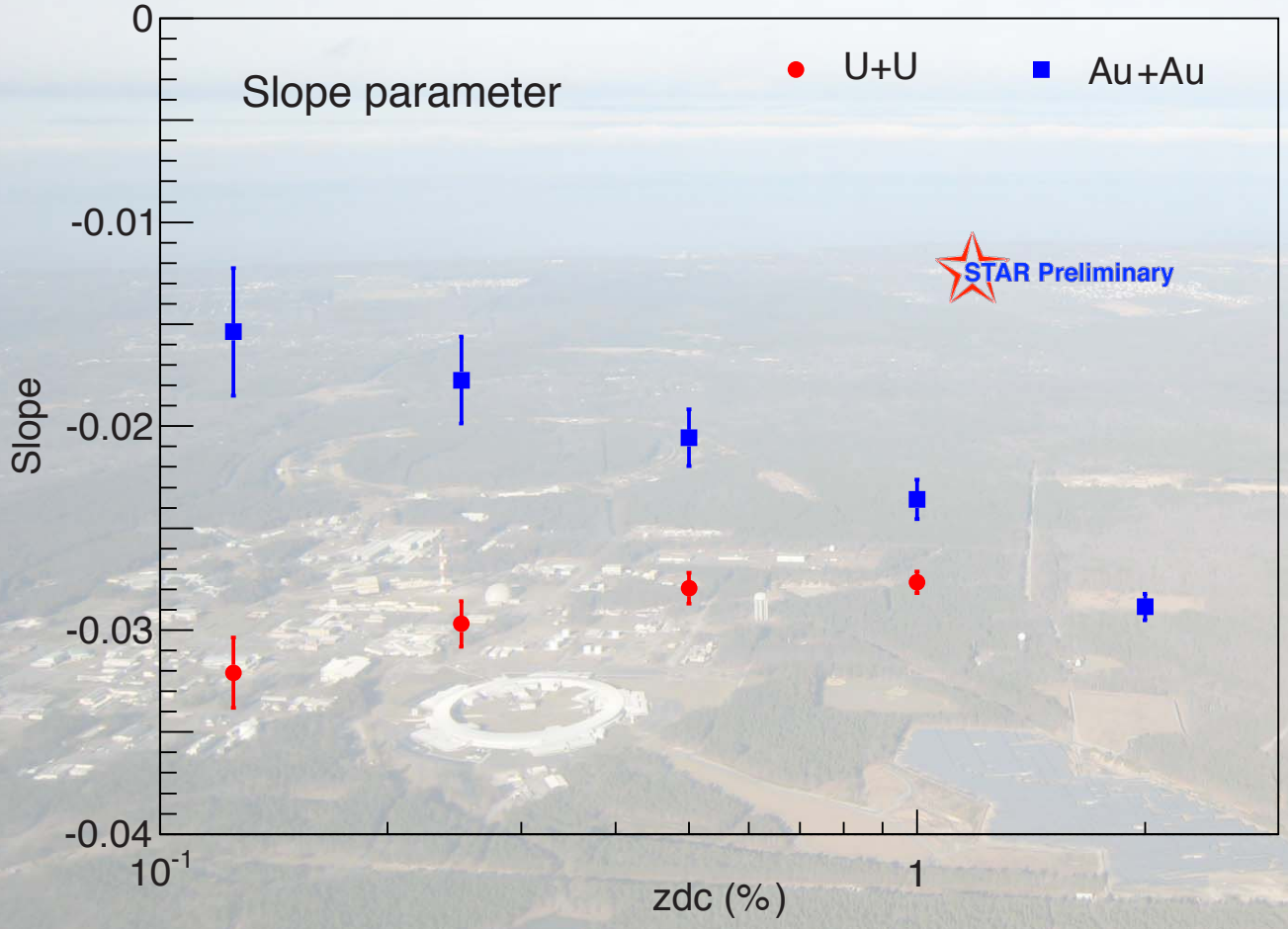






- Use normalized multiplicity to cancel multiplicity independent efficiency
- Apply a linear fit to extract multiplicity dependence of $v_{2,}$ the slope parameter

Slope vs. ZDC

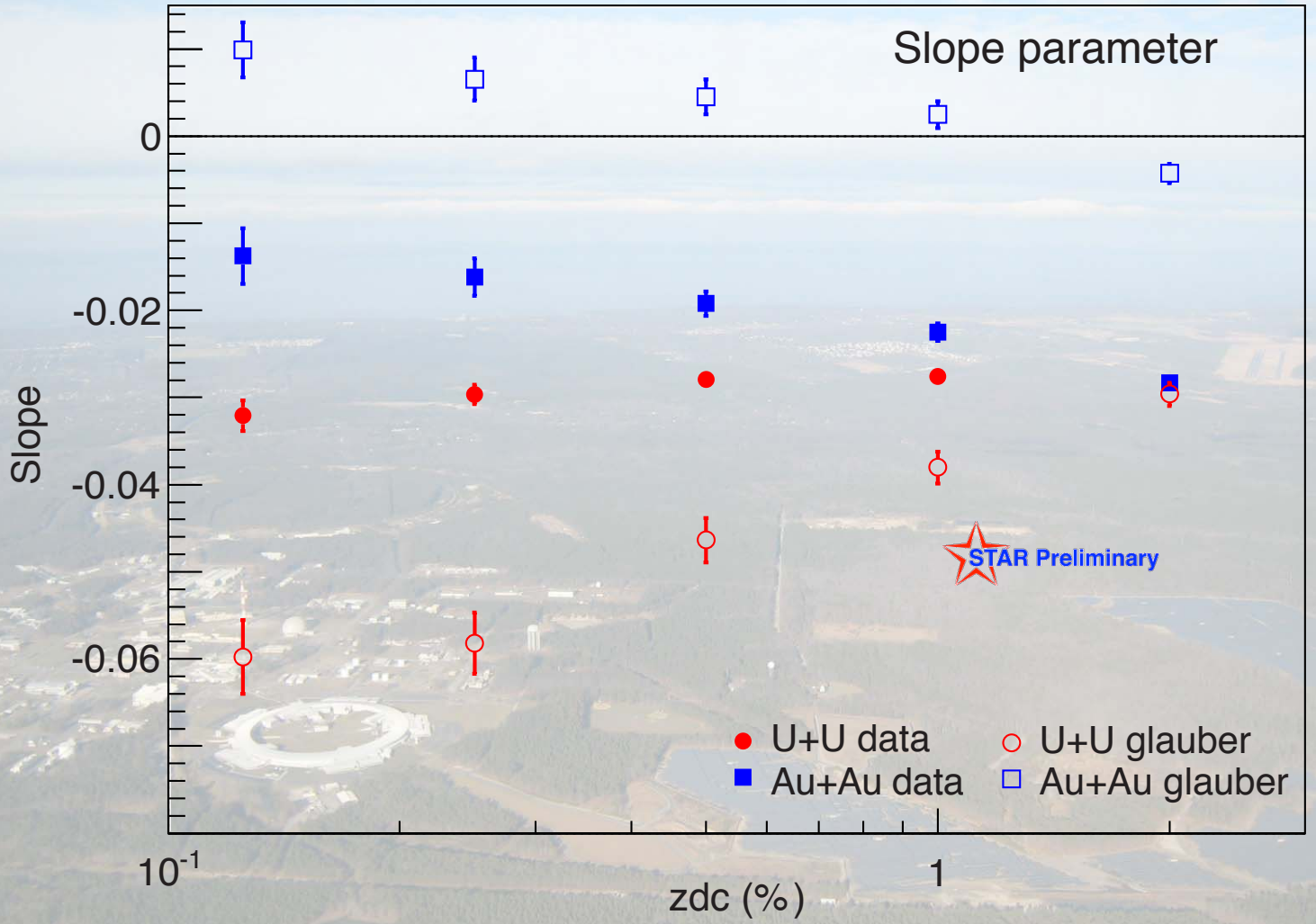


ZDC Centrality	U+U	Au+Au
0.125%	6	4
0.25%	7	5
0.5%	9	6
1.0%	12	8
2.0%	17	12

Number of spectator neutrons in each direction from glauber model

We see a clear difference between U+U and Au+Au

Slope vs. ZDC



- Compare with eccentricity calculated from glauber simulations
- Simulation results are scaled down to match the experimental v_2
  - Scale factor is 0.2 for U+U, 0.25 for AuAu

Summary

- We observed a difference between U+U and Au+Au at central collisions

- We observed a correlation between v_2 and multiplicity in central U+U collisions
  - Possible ways to separate body-body and tip-tip
  - Weaker than glauber model predictions