Azimuthally-sensitive two-pion interferometry in U+U collisions at STAR

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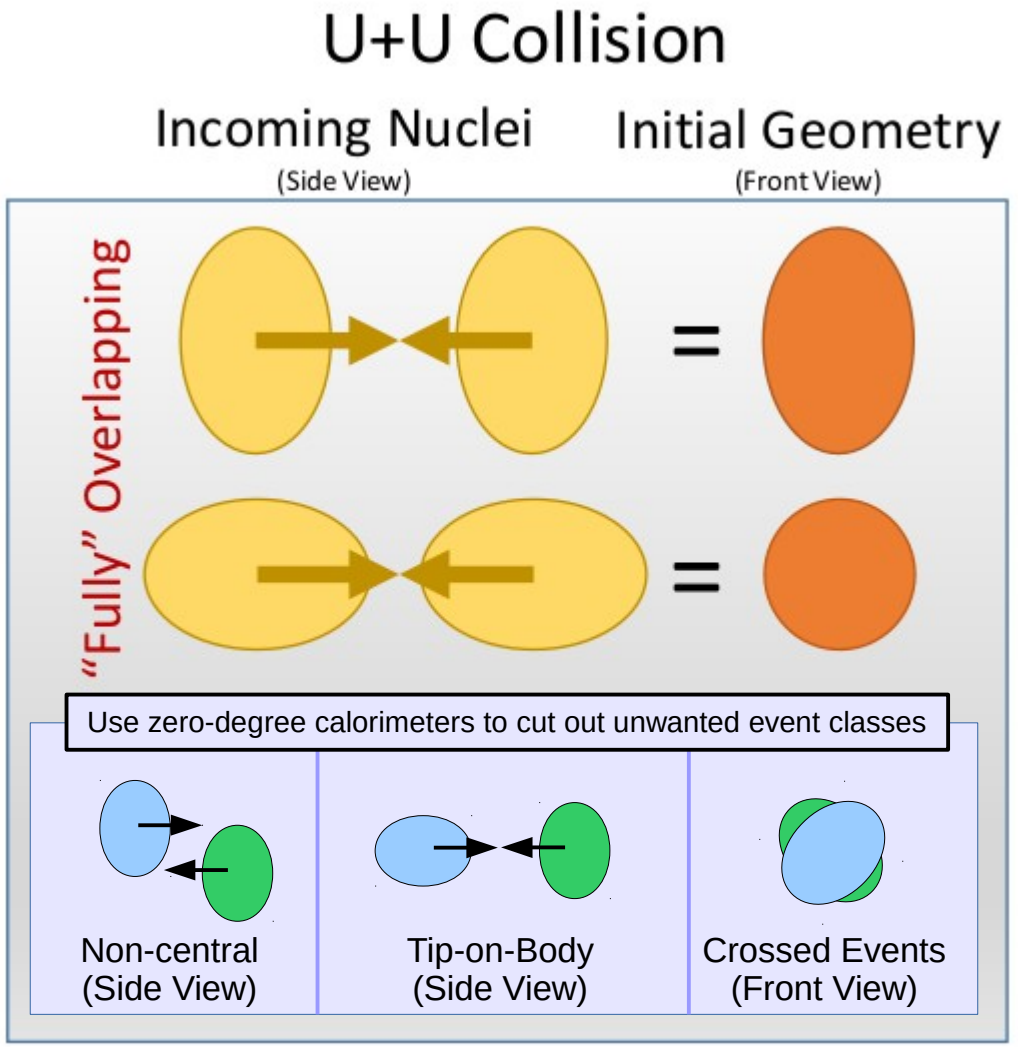
APS Ohio-Region Section – 3/28/15

Outline

- Shape selection in U+U
- 2^{nd} order femtoscopy
- Data Set
- Results
- Conclusions

Shape selection in U+U?

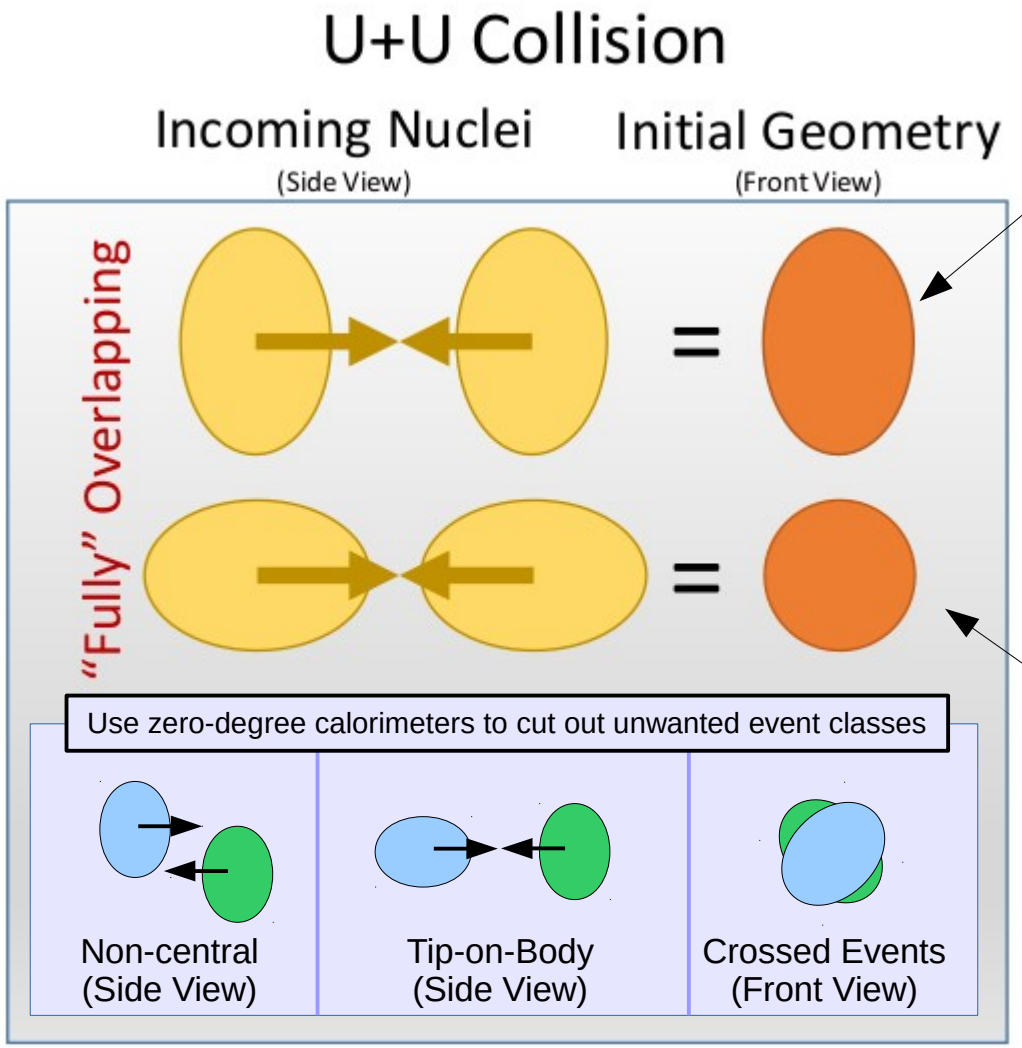


# of spectator neutrons (per side)

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

H. Wang, QM2014

Shape selection in U+U?



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ZDC	U+U	Au+Au
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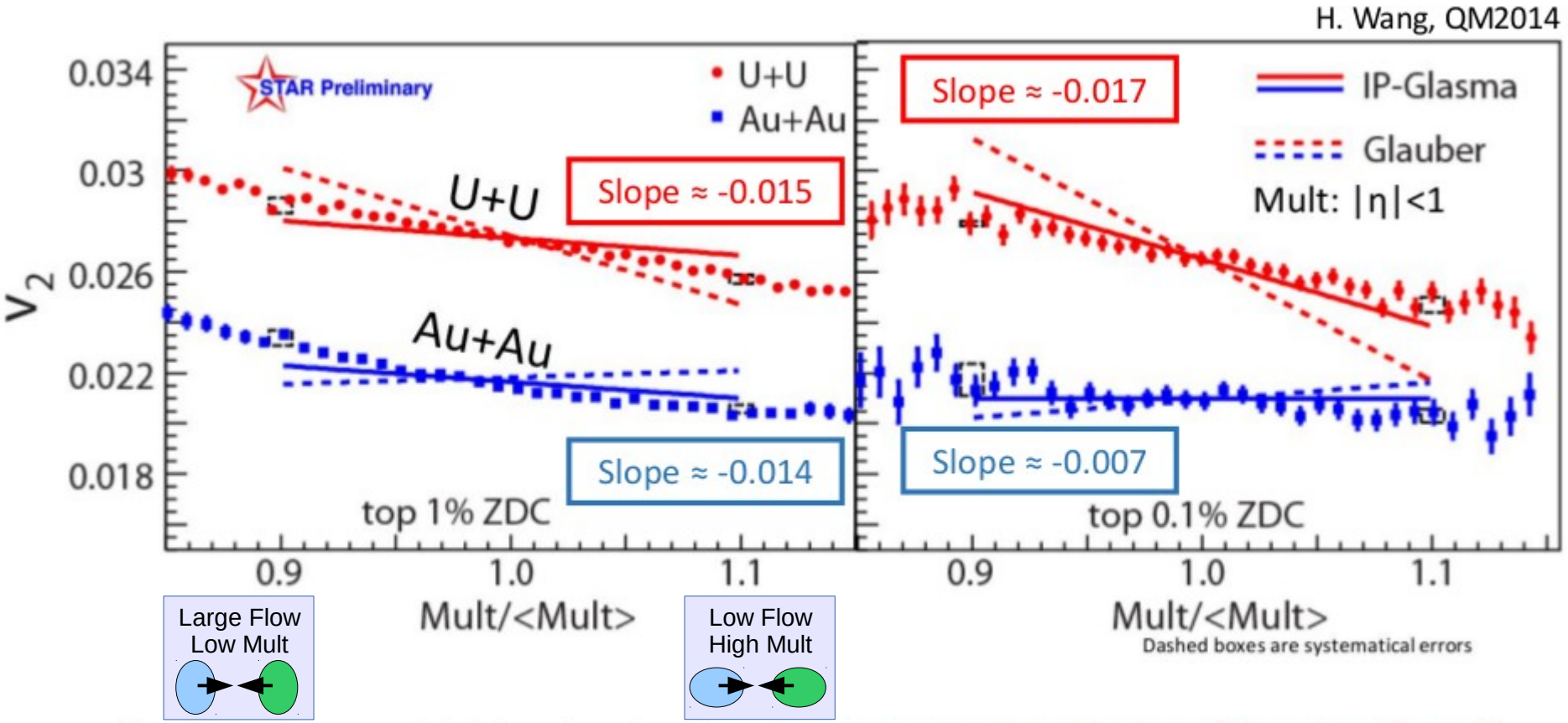
Large Flow
Low Multiplicity

Small Flow
High Multiplicity

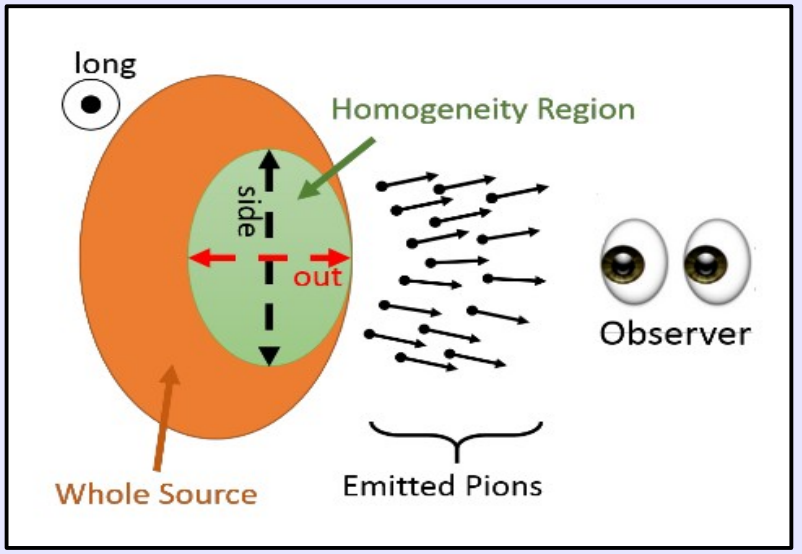
H. Wang, QM2014

Shape selection in U+U?



- At 1%, Au and U look similar: *impact parameter fluctuations?*
- At 0.1%, Au and U separate: *shape selection?*

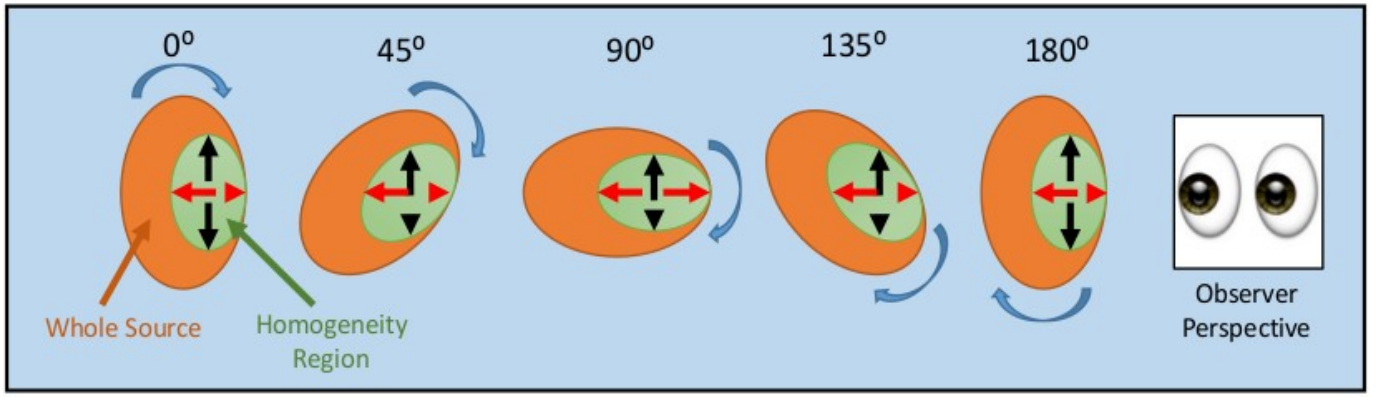
Azimuthal Femtoscopy



- Femtoscopy probes 3D shape of ***homogeneity regions***
- Determine 3 length scales: R^2_{out}, R^2_{side}, R^2_{long}, and the transverse correlation $R^2_{out\text{-}side}$

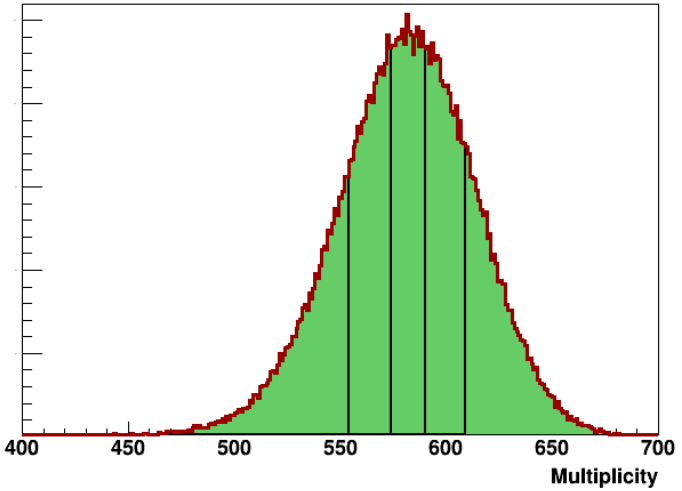
- Length scales ***oscillate*** as source is viewed from different angles
- Magnitude of oscillation provides ***eccentricity***

$$\varepsilon_f \equiv \frac{R_y^2 - R_x^2}{R_y^2 + R_x^2} \approx 2\frac{R_{s,2}^2}{R_{s,0}^2}$$



Data Set and Cuts

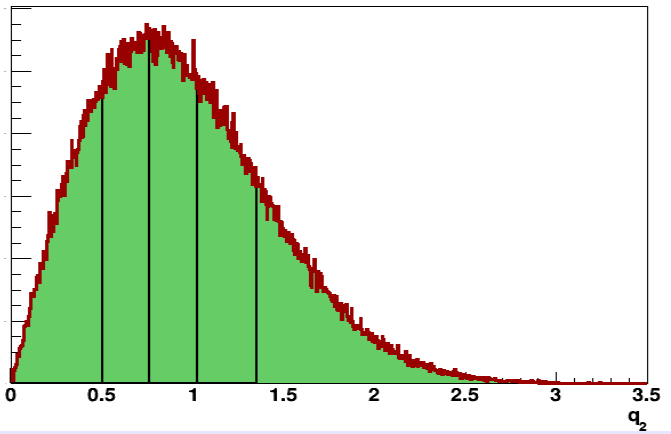
- 7M 1% ZDC triggered events (“fully overlapping”) after basic event cuts
- Use STAR Time Projection Chamber for PID (No ToF)
- Perform analysis in four ZDC bins:
  0.0-0.25%, 0.25-0.50%,
  0.50-0.75%, 0.75-1.0%
- Five bins in multiplicity



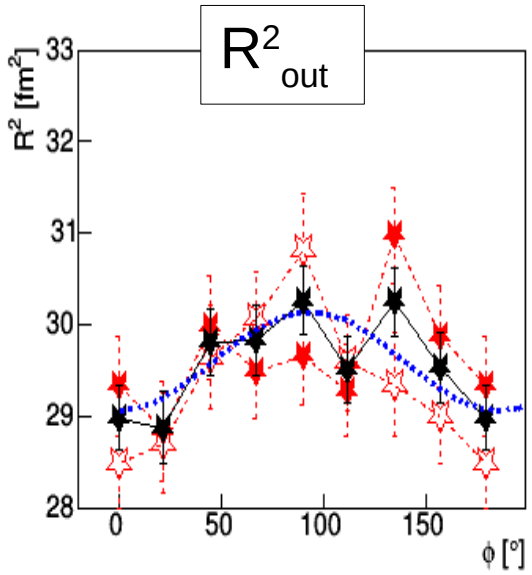
- Five bins in ***reduced flow parameter, q_2***
- Similar to v_2 flow vector, but normalized by multiplicity

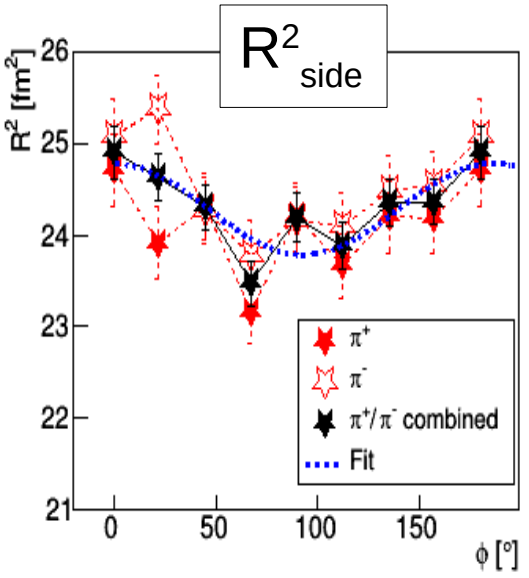
$$q_{2,x} = \frac{1}{\sqrt{M}} \sum_{i=1}^{M} \cos 2\phi_i$$

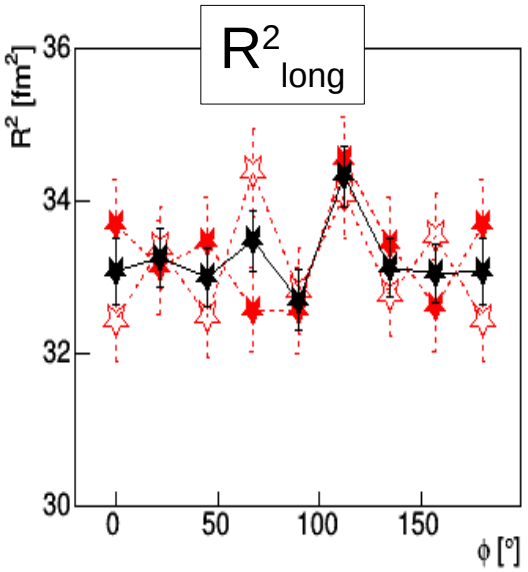
$$q_{2,y} = \frac{1}{\sqrt{M}} \sum_{i=1}^{M} \sin 2\phi_i$$

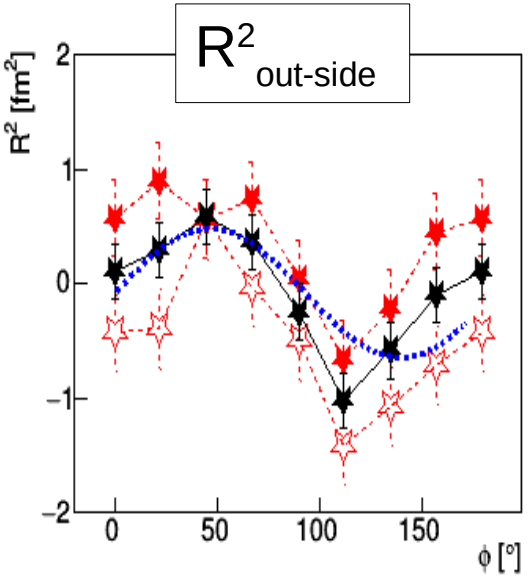


Results





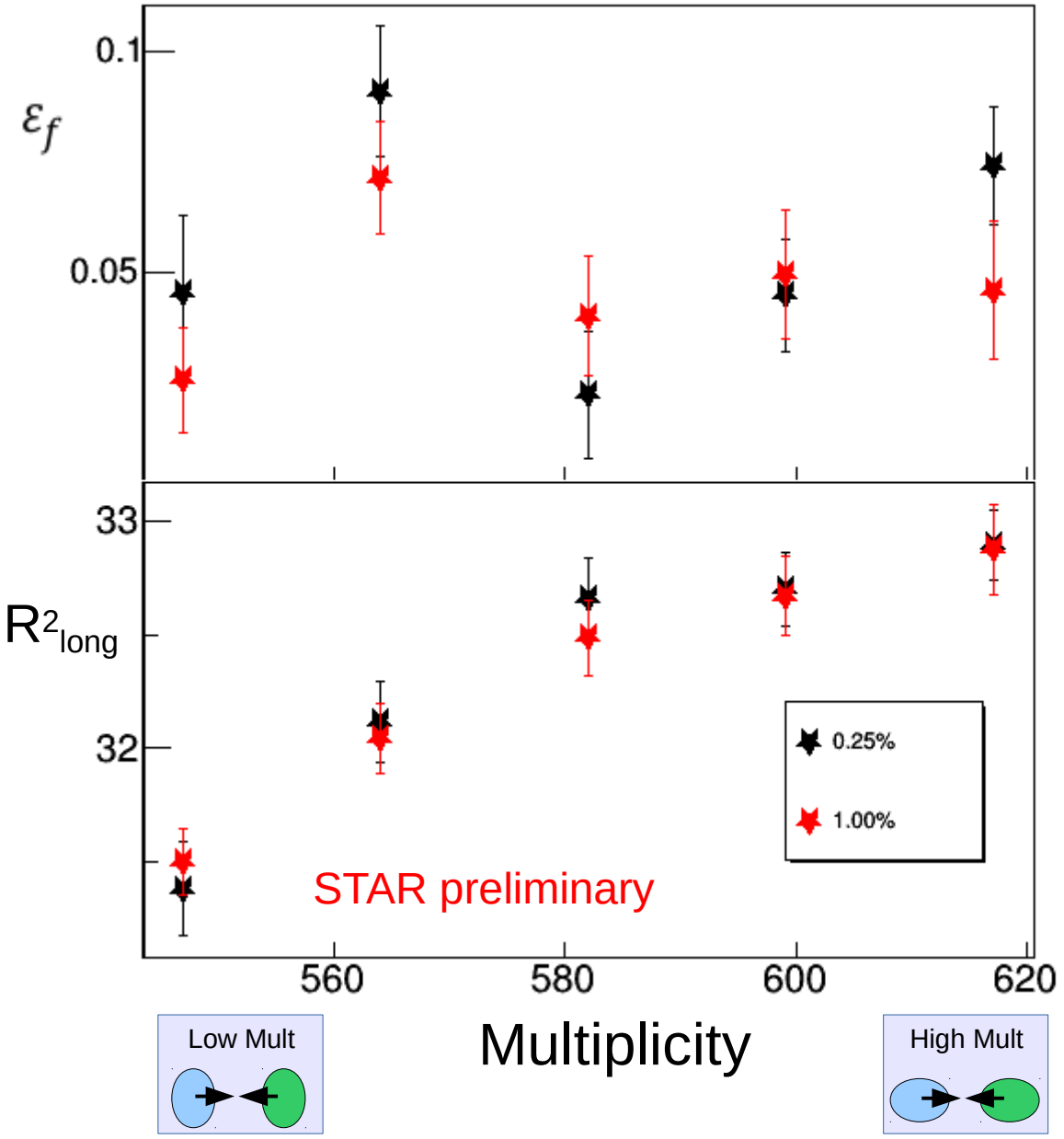




Clear 2nd order oscillation in ***transverse radii***
Get ***freeze out eccentricity*** from R^2_{side}

$$\varepsilon_f \equiv \frac{R_y^2 - R_x^2}{R_y^2 + R_x^2} \approx 2\frac{R_{s,2}^2}{R_{s,0}^2}$$

Results – Multiplicity dependence



- No clear signal in eccentricity vs. multiplicity

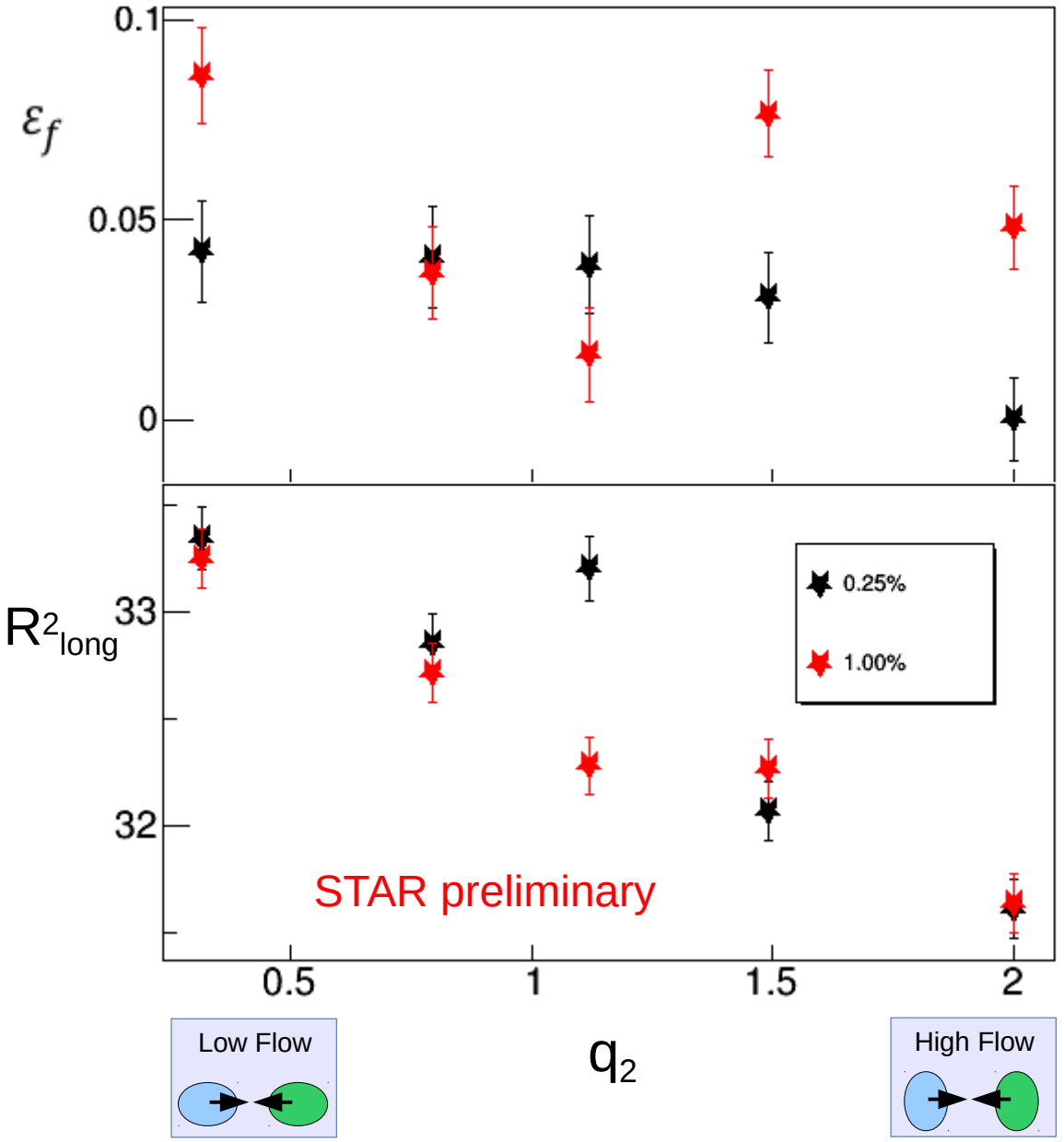
- R^2_{long} goes the right way, but could be trivial dependence

More initial energy density gives

higher mult ***and*** larger R^2_{long}

without shape selection

Results – q_2 dependence



- No clear signal in eccentricity vs. q_2, though scatter decreases with tighter cuts on ZDC
- R^2_{long} follows trend one might expect

Body-Body events should have more flow ***and*** smaller R^2_{long}

Conclusions

- Definite 2nd order signal for femtoscopic radii
- Multiplicity:
  - No systematic trends in freeze out eccentricity
  - R^2_{long} can be explained without invoking shape selection
- q_2:
  - No clear signal in freeze out eccentricity, though scatter decreases for tighter ZDC cuts
  - R^2_{long} follows trend one might expect for shape selection