Can we measure η/s from the shape of $v_2(p_T)$?

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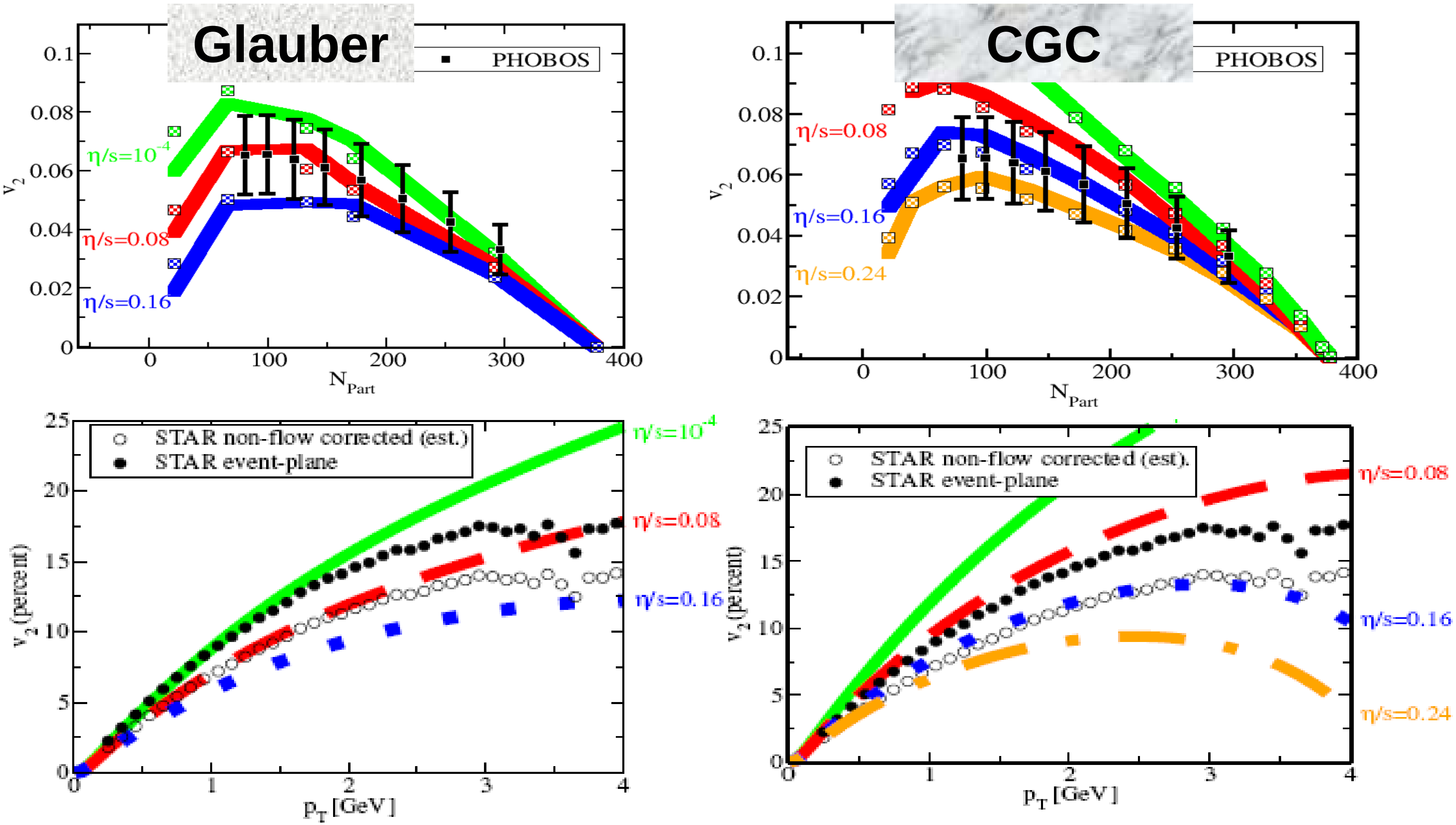
Outline

- Introduction and Motivation
- Viscous Hydro Calculations
- Parameterize the Hydro Curve
- Results and Discussions
- Summary

Caveats

- Viscous hydro is not perfect yet
- An experimentalist attempt to compare data to theory
- Many assumptions in this analysis

Motivation

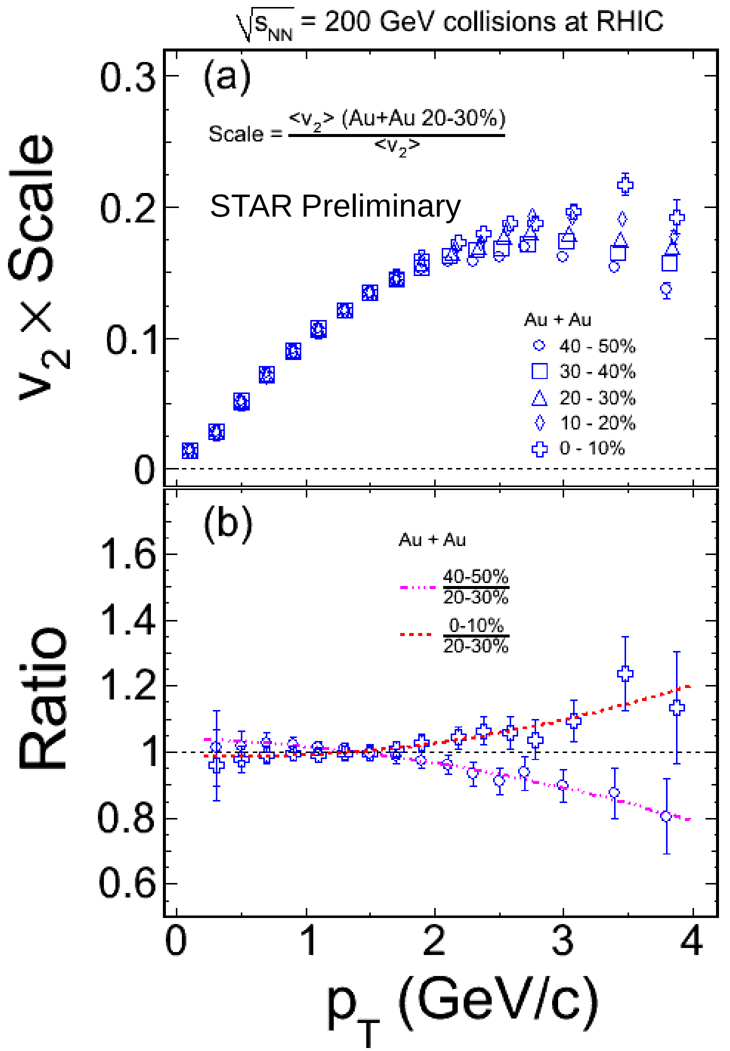


- Glauber vs.CGC ~ a factor of 2 difference on the extracted value of η/s

  η/s < 5(1/4π)

[1]P. Romatschke and U. Romatschke, Phys.Rev.Lett.99:172301, 2007 (arXiv:0706.1522)
[2]M. Luzum and P. Romatschke, Phys. Rev. C 78, 034915, 2008 (arXiv:0804.4015)

Compare the Shape of $v_2(p_T)$

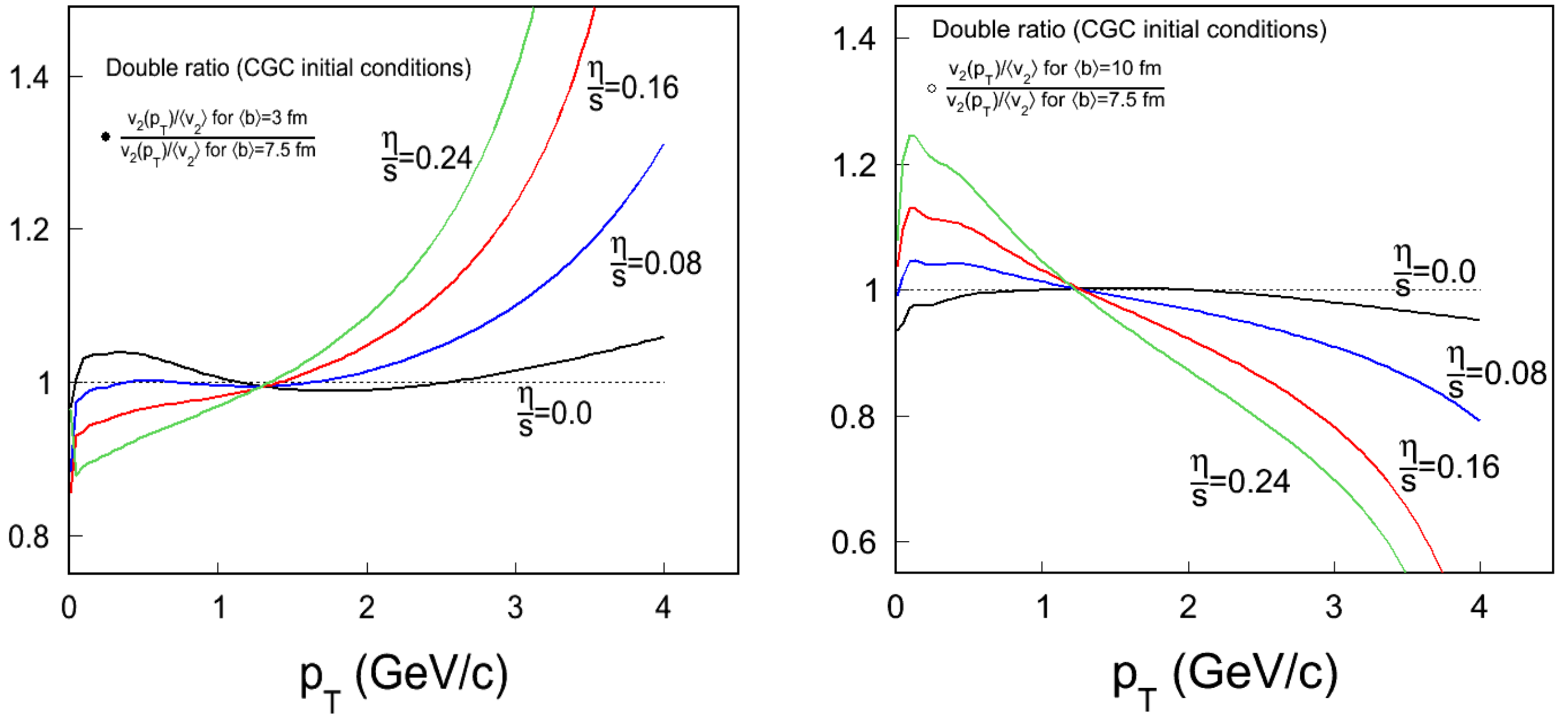


- (a) Normalize $v_2(p_T)$ in each centrality bin to 20-30% by $\langle v_2 \rangle$
  - $\langle v_2 \rangle$: average v_2 $0.15 < p_T < 2$ GeV/c
- (b) The ratio of data points in panel (a)
  - 40-50%/20-30%
  - 0-10%/20-30%

Data: v_2\{FTPC\} charged hadrons

Viscous Hydro Calculations

200 GeV Au+Au Collisions



- The same procedure, but for a set of η/s values in the viscous hydro calculations.
- <b> = 3 fm: 0-10%; <b> = 7.5 fm: 20-30%; <b> = 10 fm: 40-50%.

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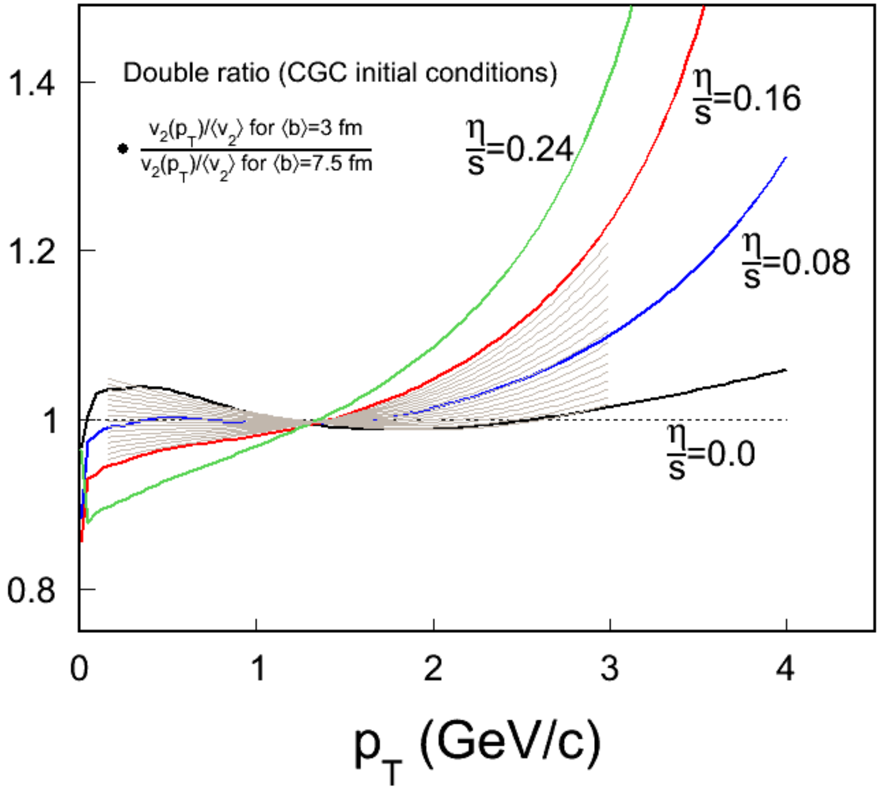
Parameterize the Hydro Curve

200 GeV Au+Au Collisions



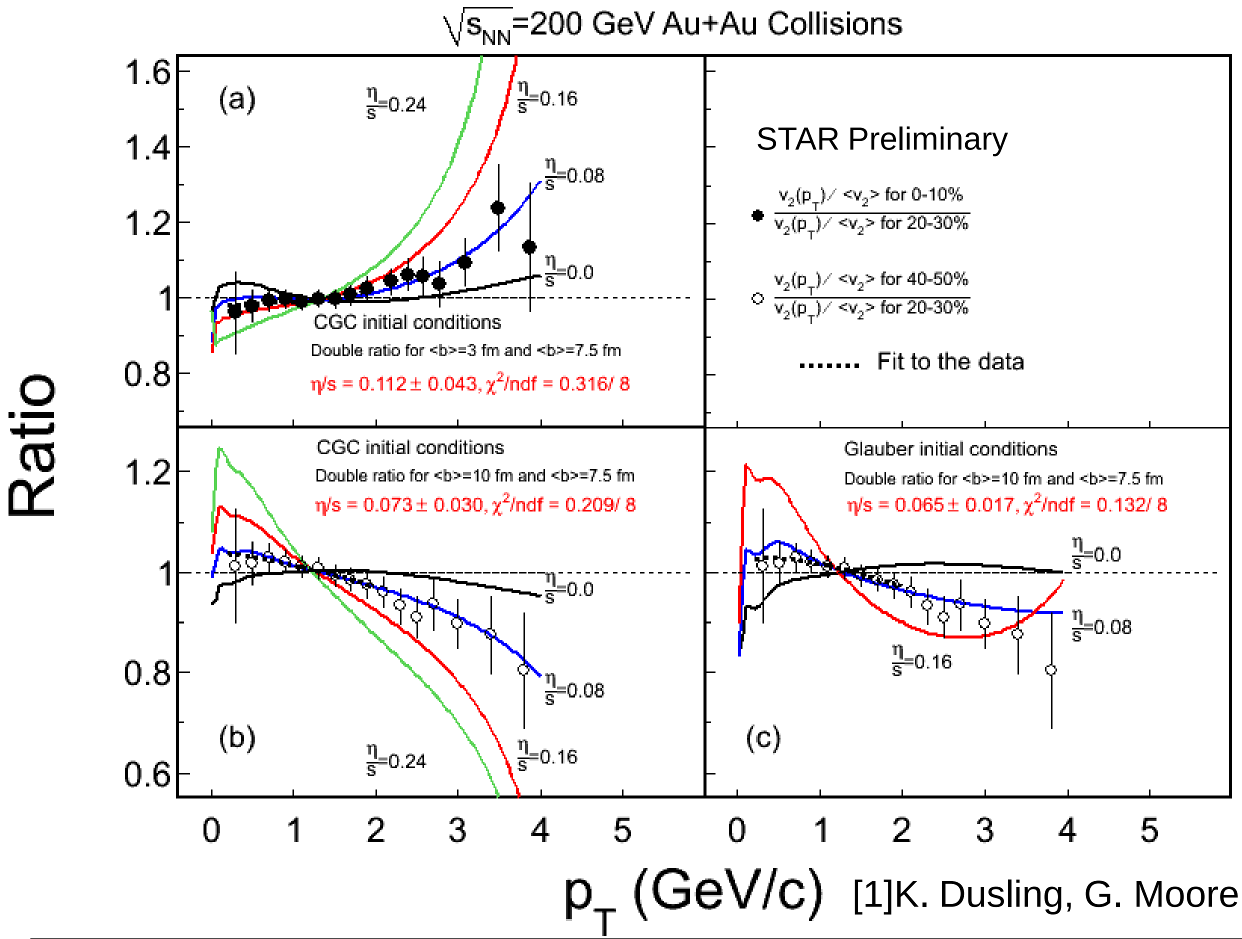
1) Fit each hydro curve with a 3rd order polynomial.

2) Fit the parameters of the 3rd polynomial as a function of η/s.

3) With 1) and 2) we can parameterize the curves as a function of η/s.

- The parameterized function for η/s from 0.0 to 0.16 in steps of 0.01 are shown.
- The function falls precisely on all the hydro curves and changes very smoothly between them.

How to Extract η/s



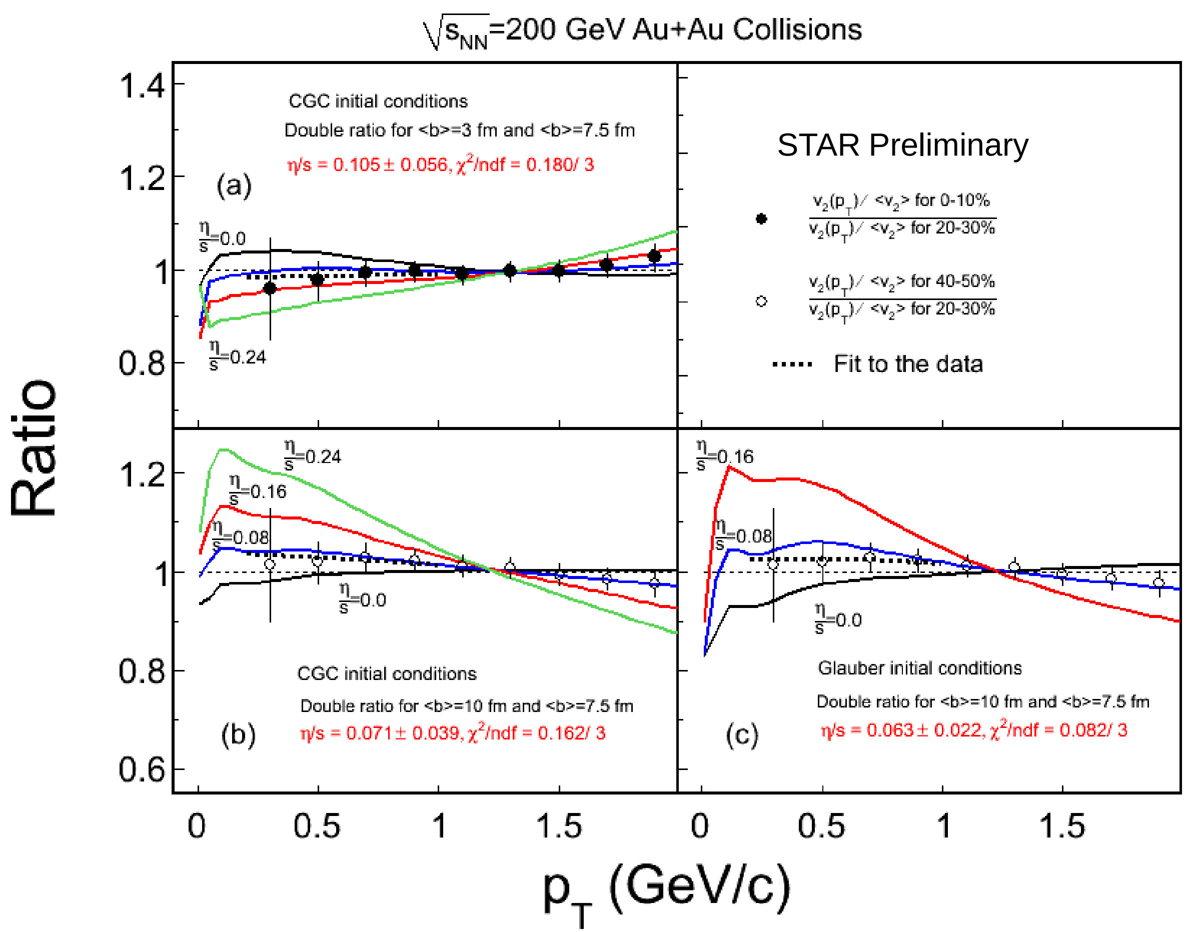
[1]K. Dusling, G. Moore and D. Teaney, arXiv:0909.0754

- Data: v_2\{FTPC\}
- Fit range: $0.15 < p_T < 2$ GeV/c
- Non-flow should cause us to underestimate η/s in peripheral but overestimate η/s in central.
- Less dependence on the eccentricity model.

- In the viscous hydro model, it assumes viscous corrections δf go as p^2[1]
- Dominated by higher p_T (more sensitive to q-hat) but η is defined by low p_T [1]

q-hat: the typical transverse momentum squared transferred to the particle per unit length

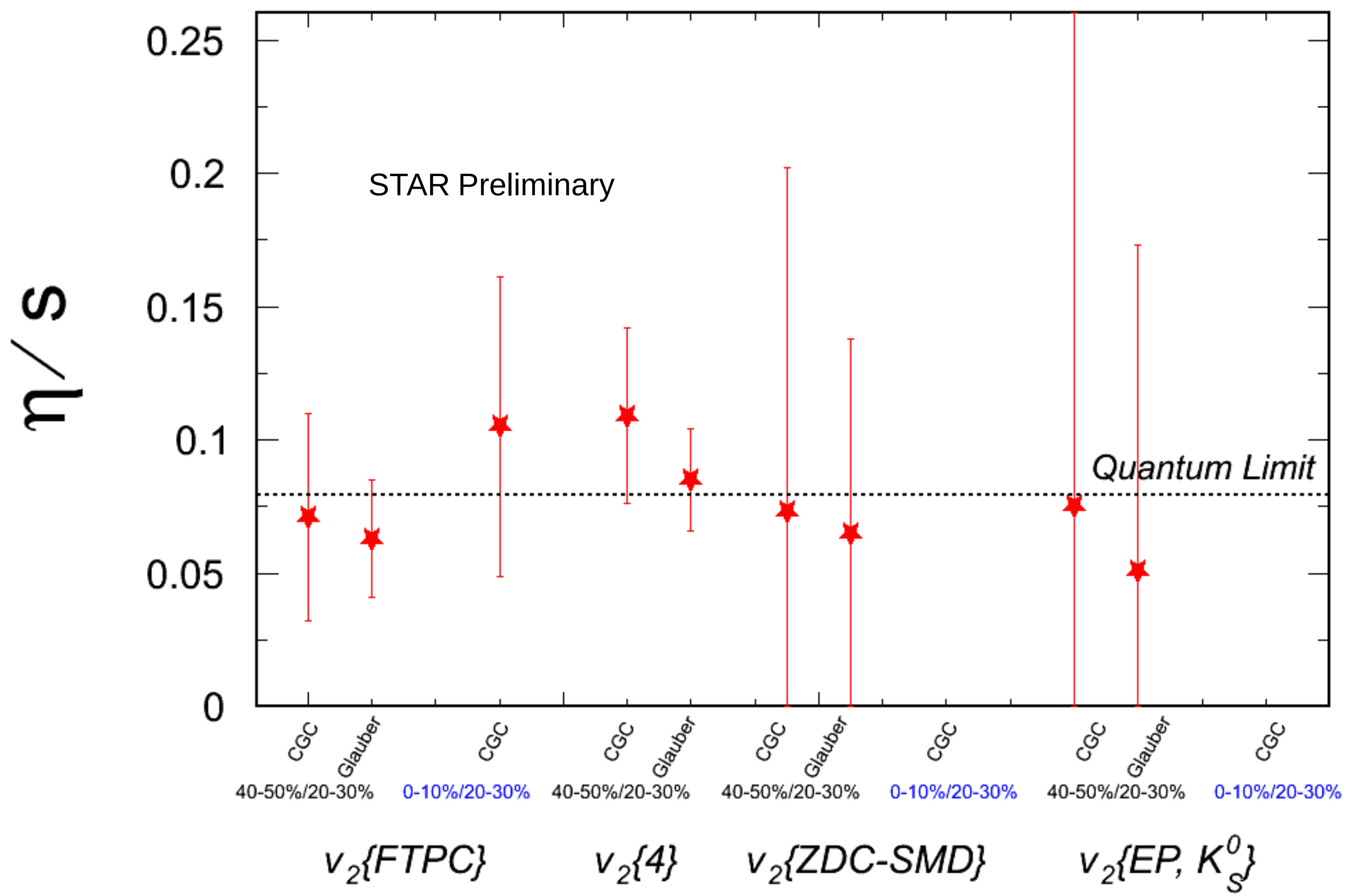
What p_T Range?



[1]K. Dusling, G. Moore and D. Teaney, arXiv:0909.0754

- Data: v_2\{FTPC\}
- Fit range: $0.15 < p_T < 1$ GeV/c
- The shape change at p_T>1 GeV/c is dominated by q-hat
- We can still exclude the large value of η/s
- Try hydro with δf~p^α for α=1, 1.5, 2 to see if shape is sensitive
- Can we extract q-hat?

Results of Comparison to Hydro



- **η/s: (0.5~2)/(4π)**
  - Less dependence on the eccentricity models
  - Fit range: $0.15 < p_T < 1$ GeV/c

Summary

- **The advantages of extracting η/s using the shape of $v_2(p_T)$:**
  - **Centrality dependence and magnitude of the initial eccentricity is poorly understood**
  - **Analysis to first order cancels out dependence on eccentricity**
  - **Shape of $v_2(p_T)$ vs. system-size sensitive to the transport properties, η/s and q-hat**

- **η/s estimate from different v_2 methods →**

help us to understand how the non-flow and v_2 fluctuation affect the estimation