

A hybrid strong/weak coupling approach to jet quenching



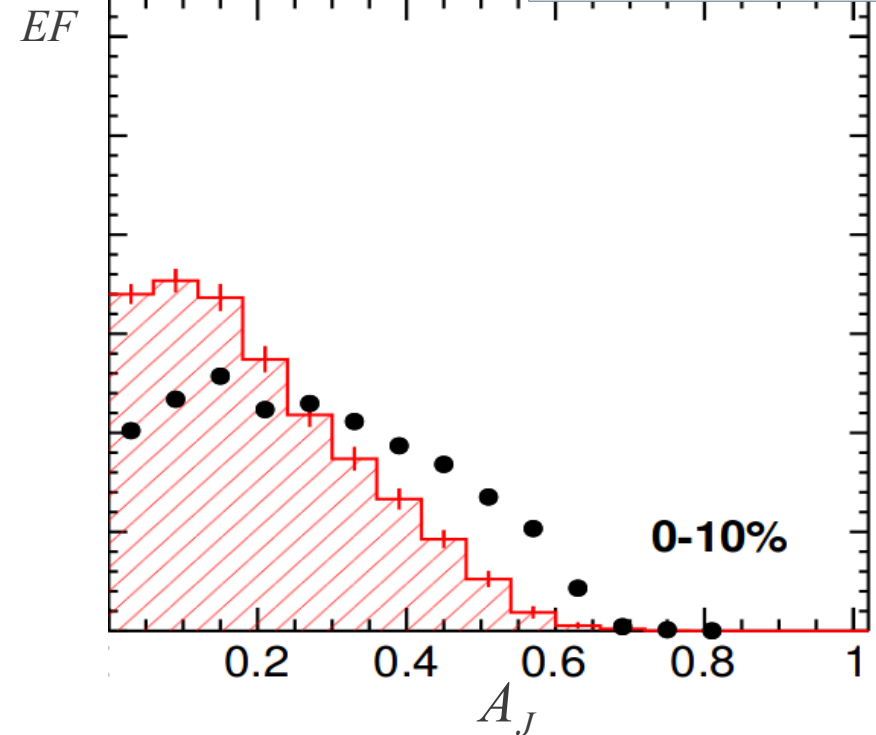
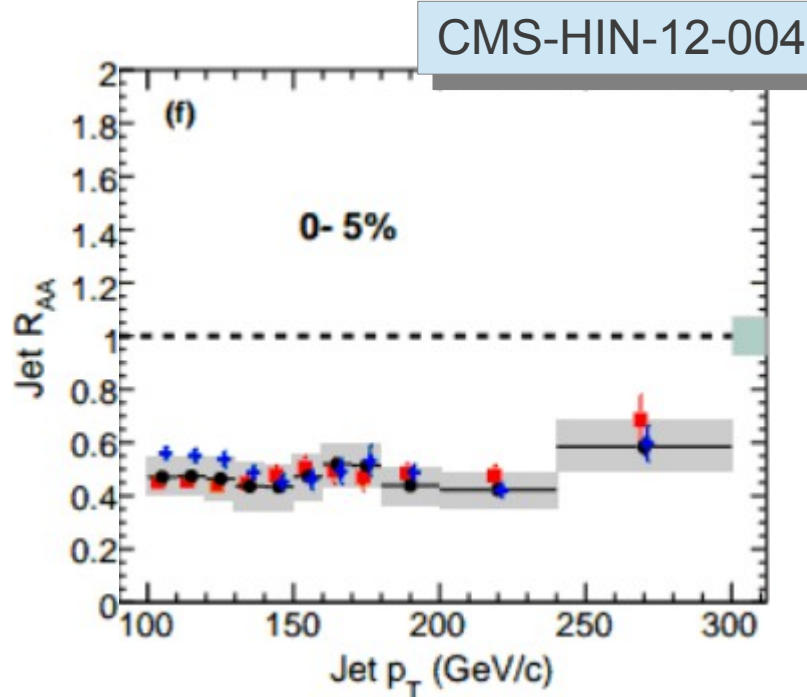
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together with Doga Gulhan, Guilherme Milhano,
Jorge Casalderrey and Krishna Rajagopal

Motivation

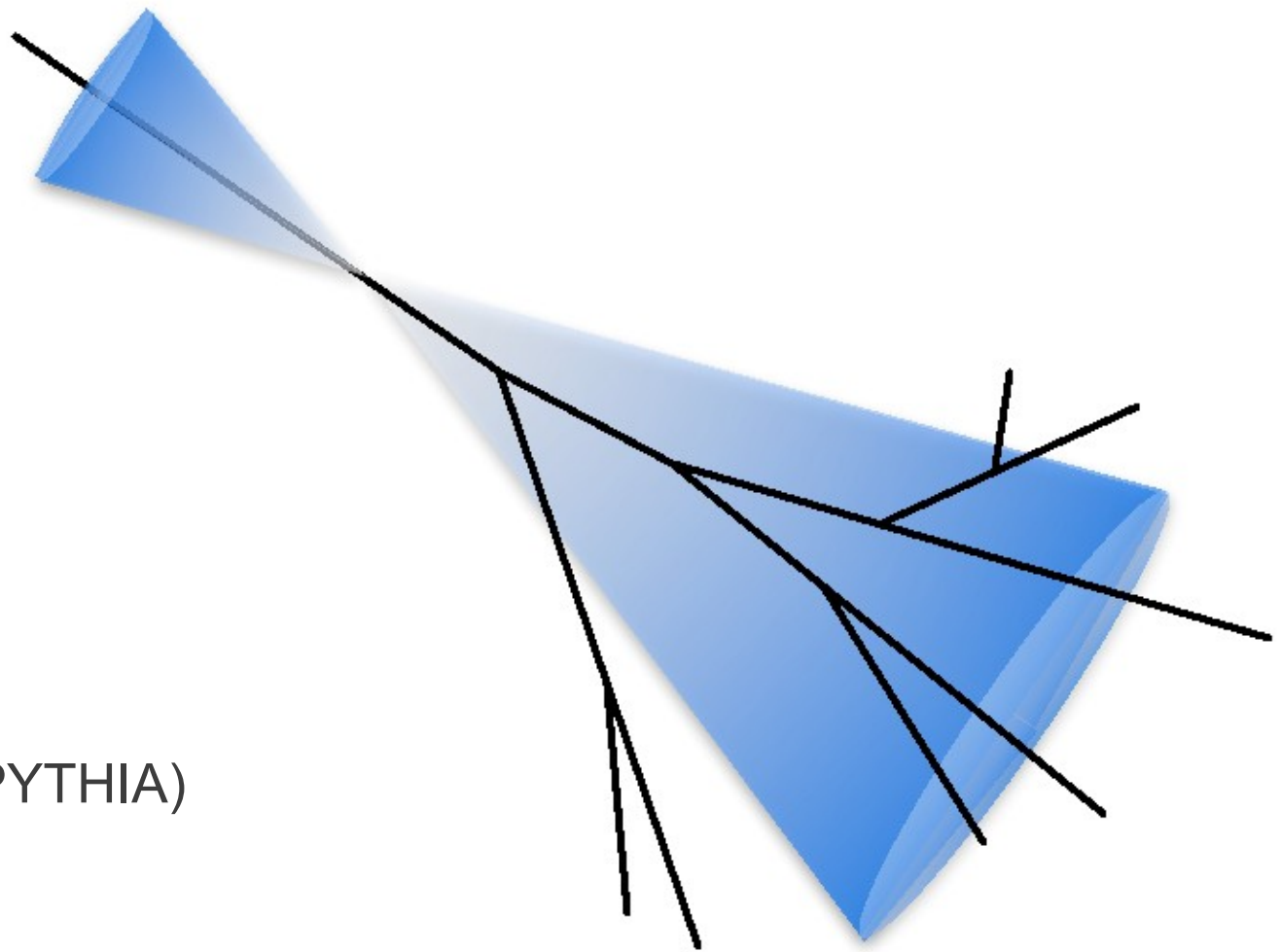
arXiv:1202.5022



- Jets get modified: Energy Loss
- Many models include:
 - Radiative Energy Loss (perturbative) plus
 - Collisional Energy Loss (soft momentum energy transfer of order $\mu_D \sim T < 1$ GeV)
- We explore strongly coupled models

Quin et al, 1012.5280
Young et al 1103. 5769
Y. He et al 1105.2566
Renk 1112.2503
Zapp et al 1212.1599

Hybrid Model



- Jet shower perturbative (PYTHIA)
- Additional loss in rungs \rightarrow strongly coupled, non-perturbative
- Assign lifetime to every rung $\tau_f = \frac{2E}{Q^2}$. Final partons fly until critical temperature is reached.
- We always stay at parton level !

Plasma Modelling

- Woods-Saxon density profile
- Entropy and Temperature related by ideal gas E.O.S
- Entropy density is assumed to be proportional to number of participants
- Bjorken hydro for time dependence (neglecting transverse expansion)
- No quenching before 0.5 fm (transverse frame)
- Initial temperature at zero impact parameter is 0.4 GeV. Stop quenching when T reaches 0.175 GeV

Three Models

- Light $\rightarrow \frac{dE}{dt} \sim \frac{1}{\sqrt{(t-t_s)}} \rightarrow \frac{dE(t)}{dt} = -\left(\frac{C_R}{C_F}\right)^{\frac{1}{3}} \alpha_L \frac{E_i^{5/3} T^{4/3}}{E(t)}$

- Heavy $\rightarrow \frac{dE(t)}{dt} = -\frac{C_R}{C_F} \alpha_H E(t) T \quad \gamma < \left(\frac{M}{T \sqrt{(\lambda)}}\right)^2$

(out of the validity range)

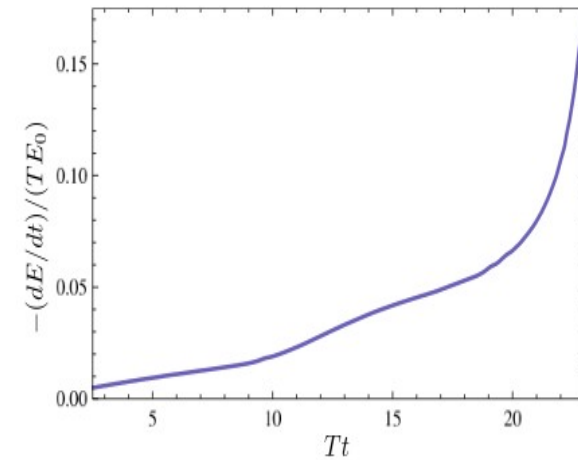
as control also:

- Collisional $\rightarrow \frac{dE(t)}{dt} = -\frac{C_R}{C_F} \alpha_C T^2$

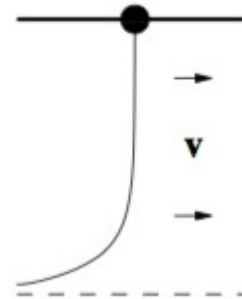
Wicks et al. nucl-th/0512076



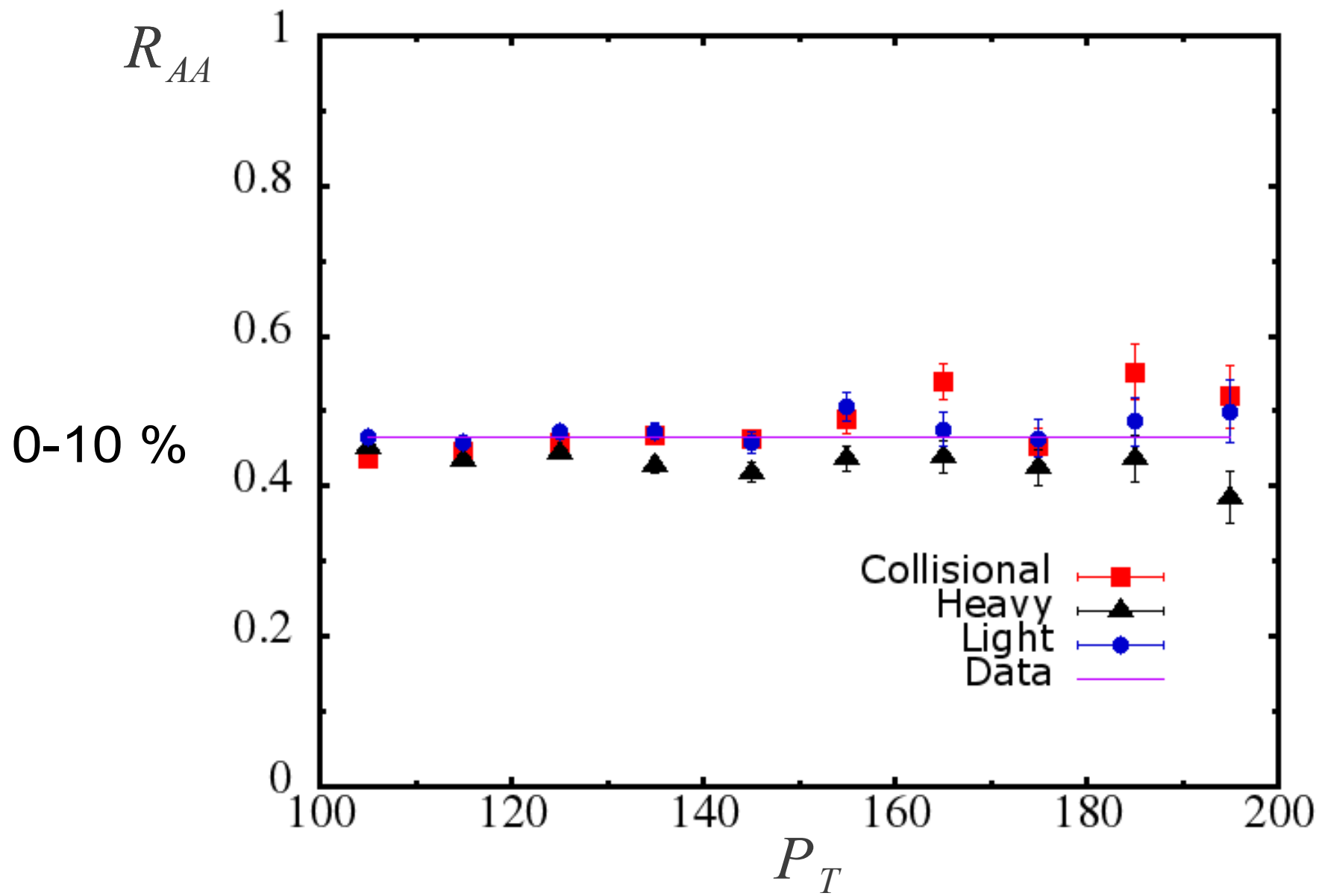
Chesler et al 0810.1895



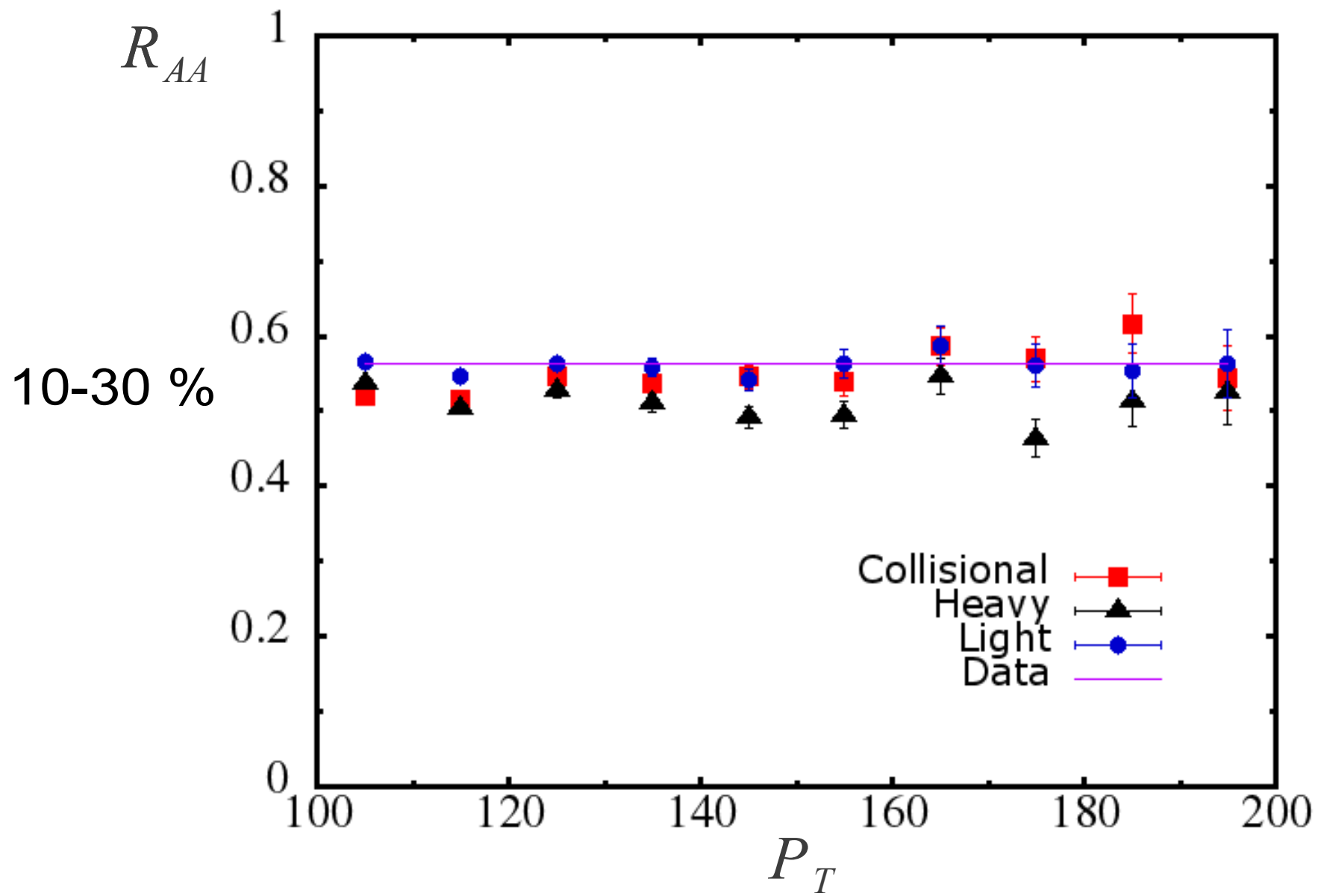
Herzog et al 0605158



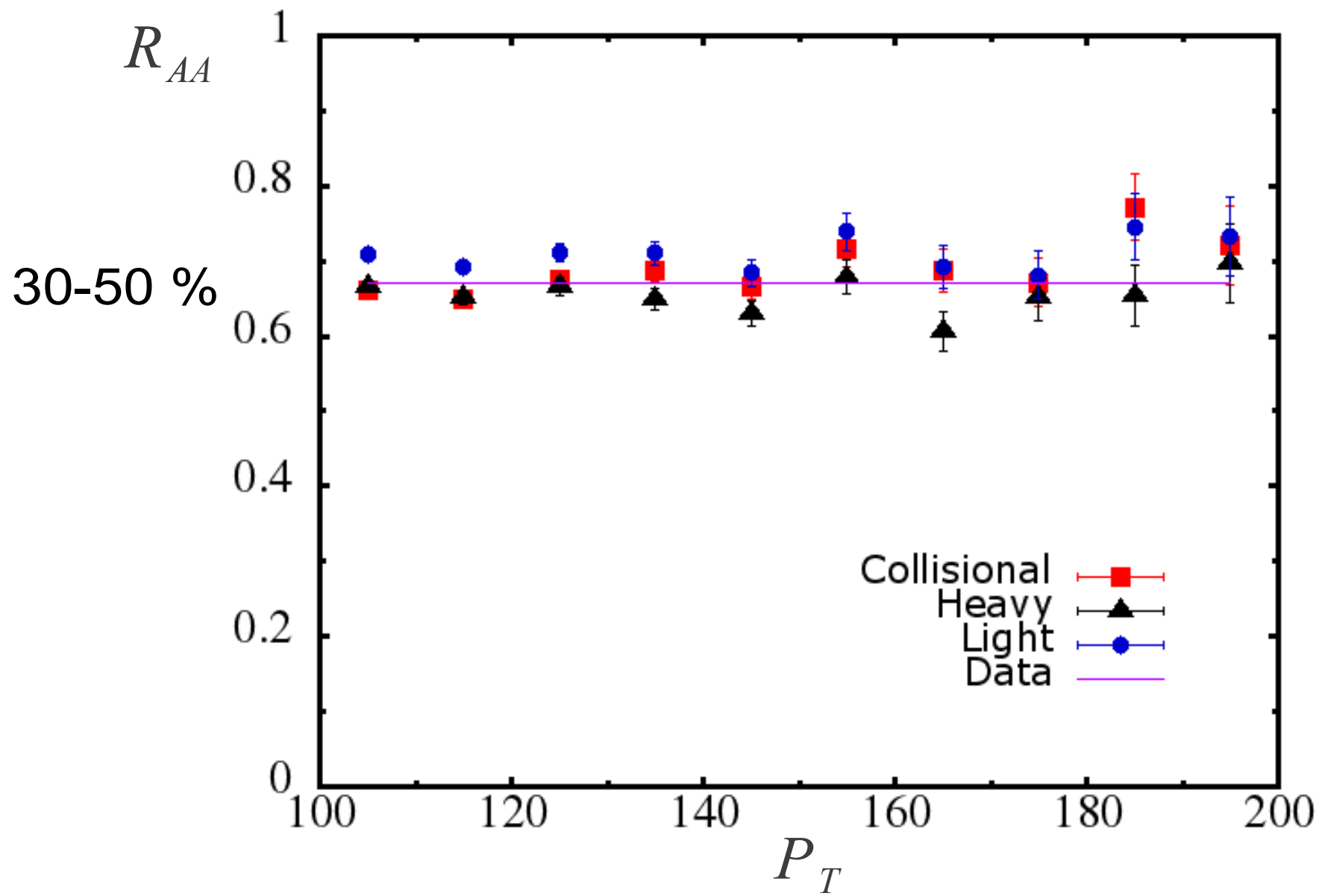
$\alpha_i \equiv$ fitting parameter

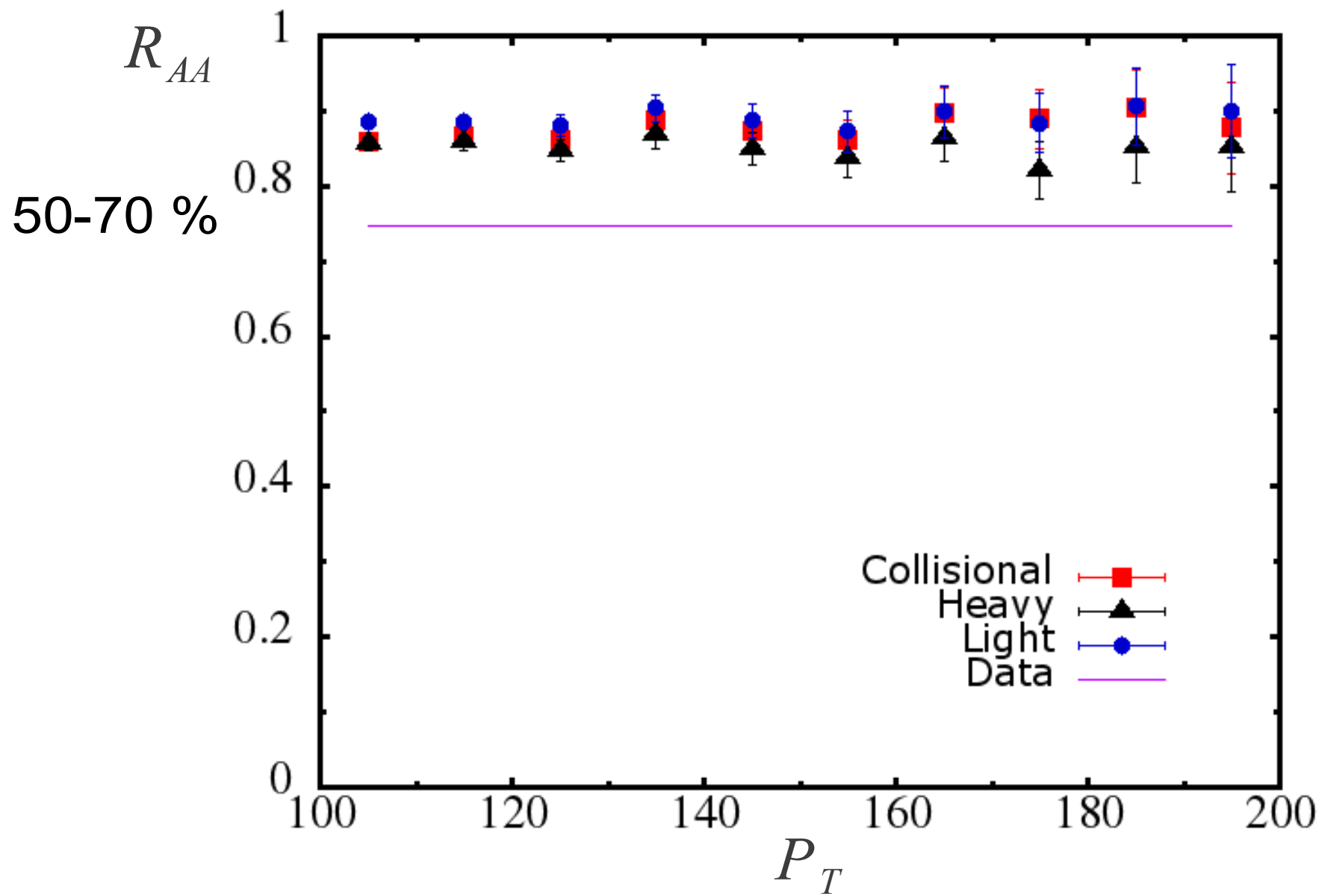


Fit R_{AA} to match data at central collisions



We let it evolve with centrality



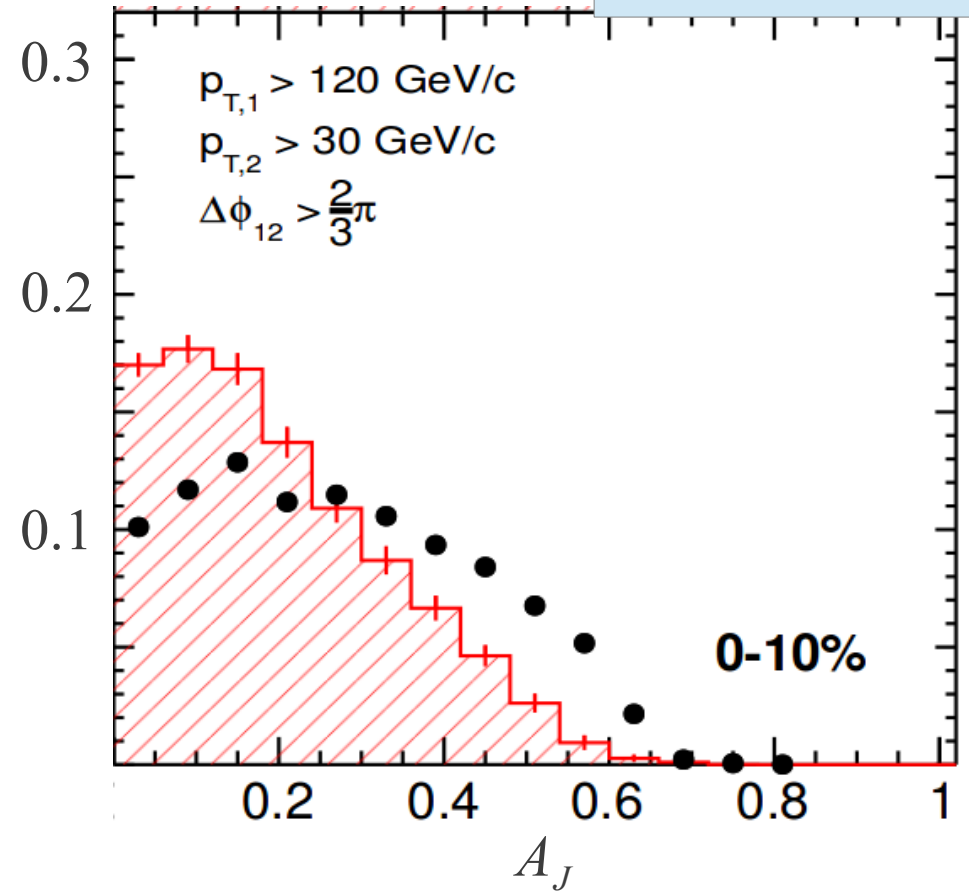
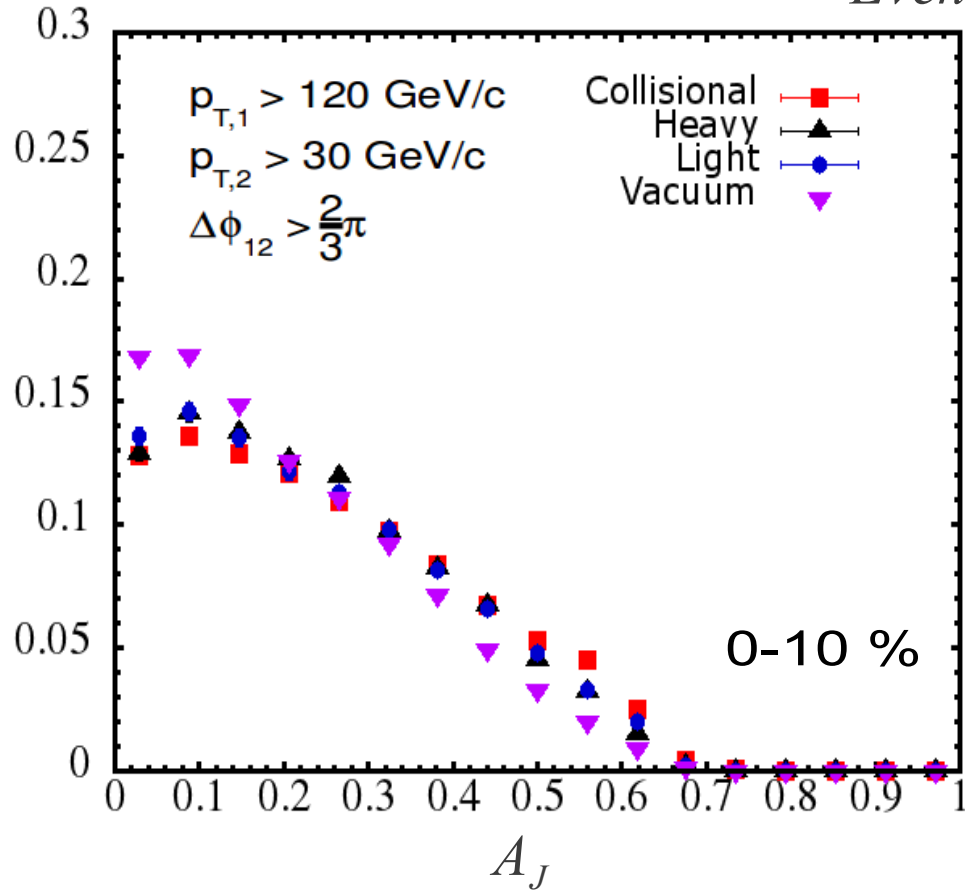


The model describes R_{AA} dependence on centrality at central and mid-peripheral bins, but deviates at most peripheral.

Asymmetry

Event Fraction

arXiv:1202.5022



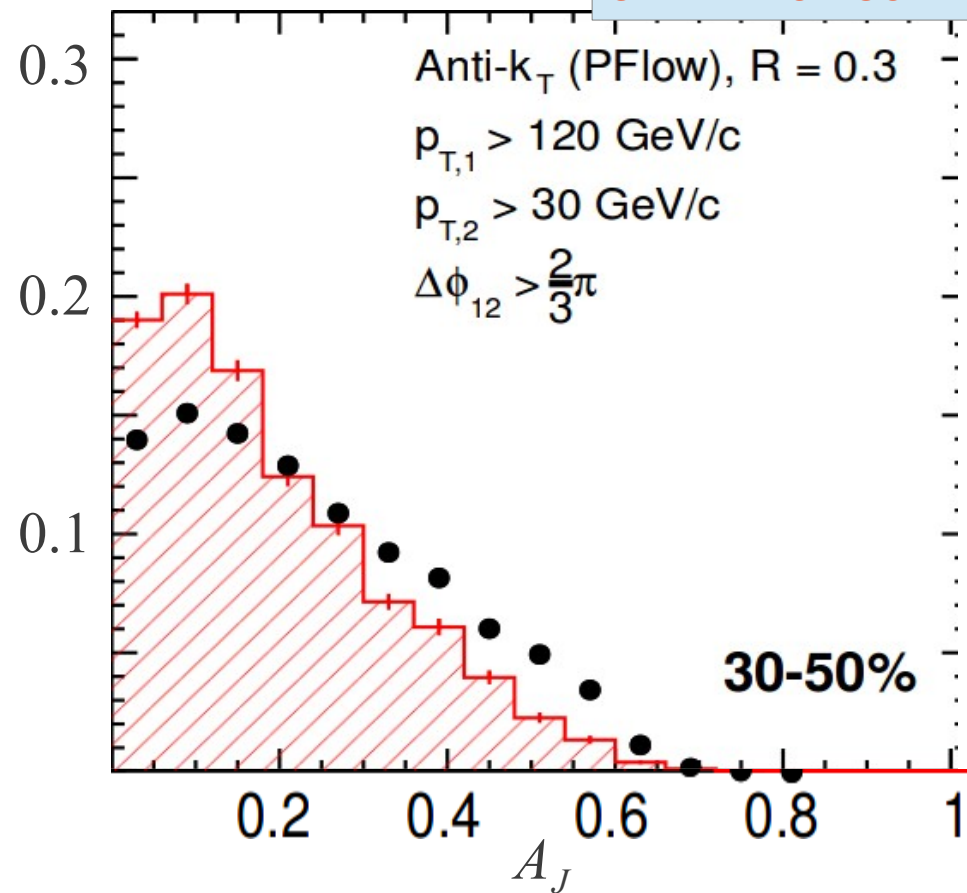
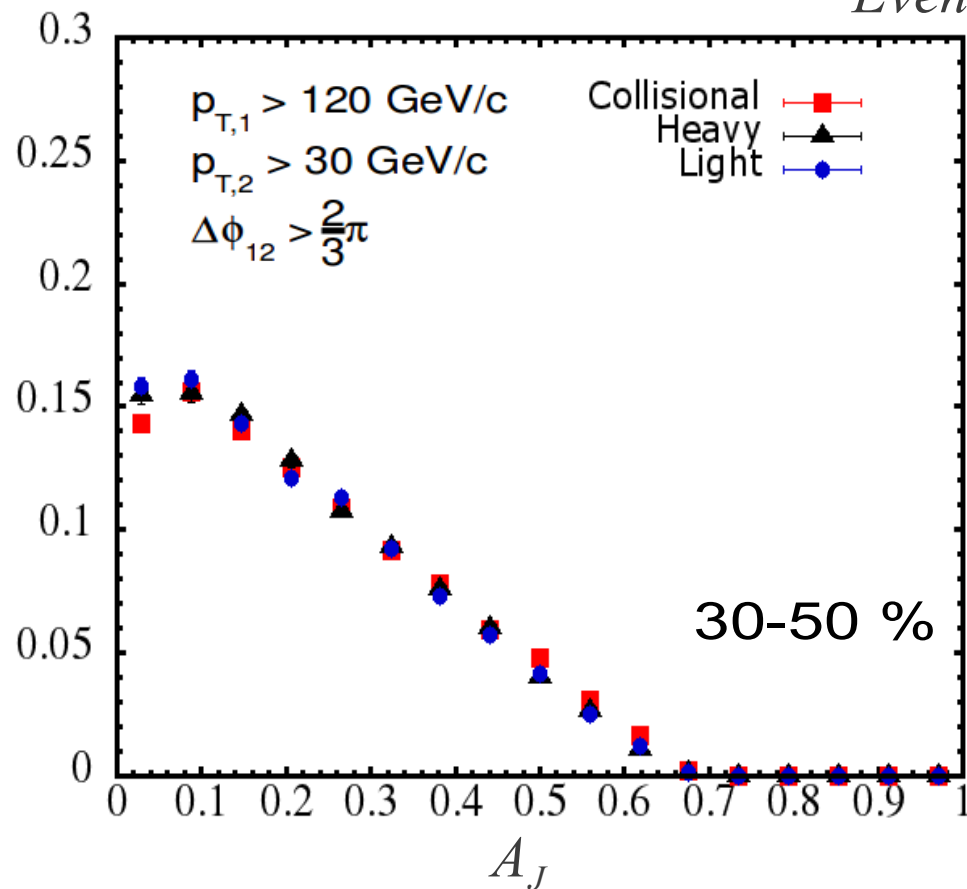
$$A_J \equiv \frac{P_{T1} - P_{T2}}{P_{T1} + P_{T2}}$$

Dijet imbalance not quite strong enough

Asymmetry

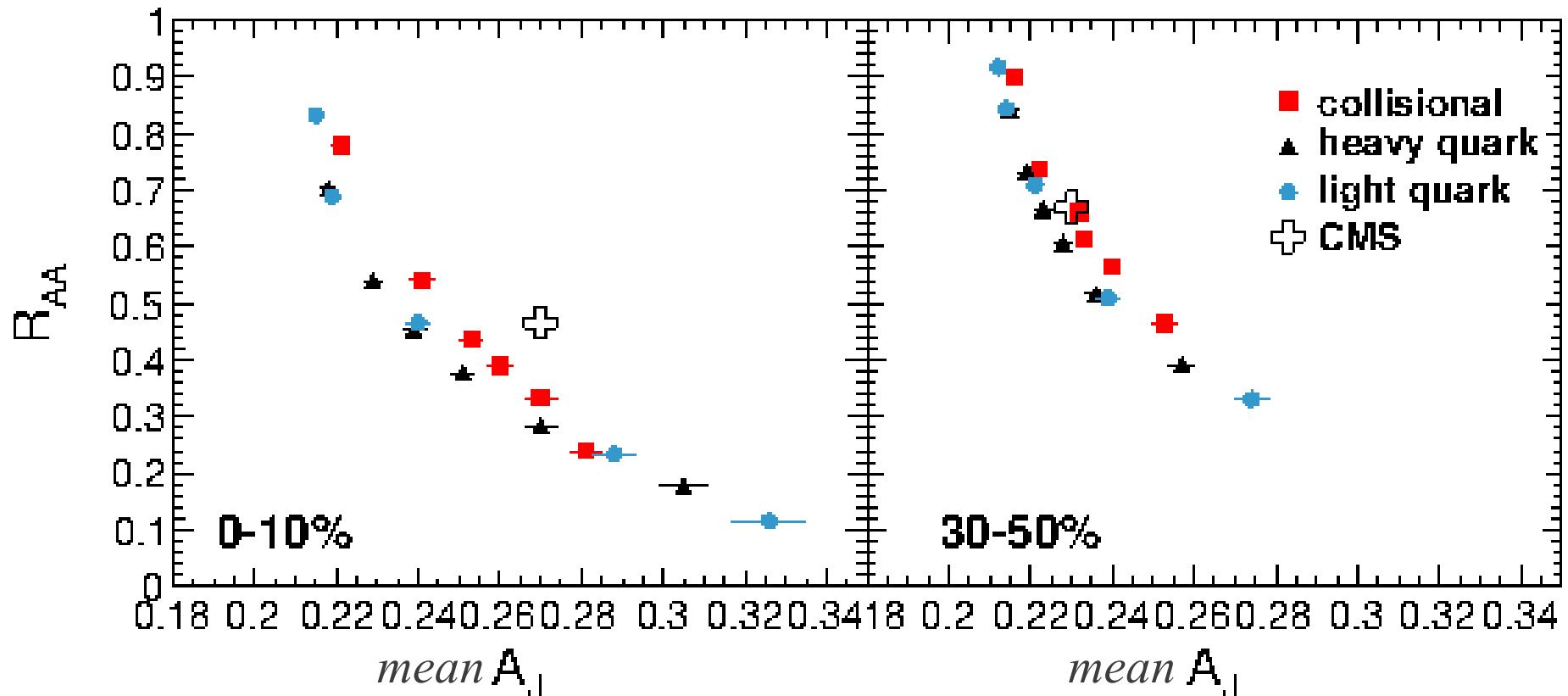
Event Fraction

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$$A_J \equiv \frac{P_{T1} - P_{T2}}{P_{T1} + P_{T2}}$$

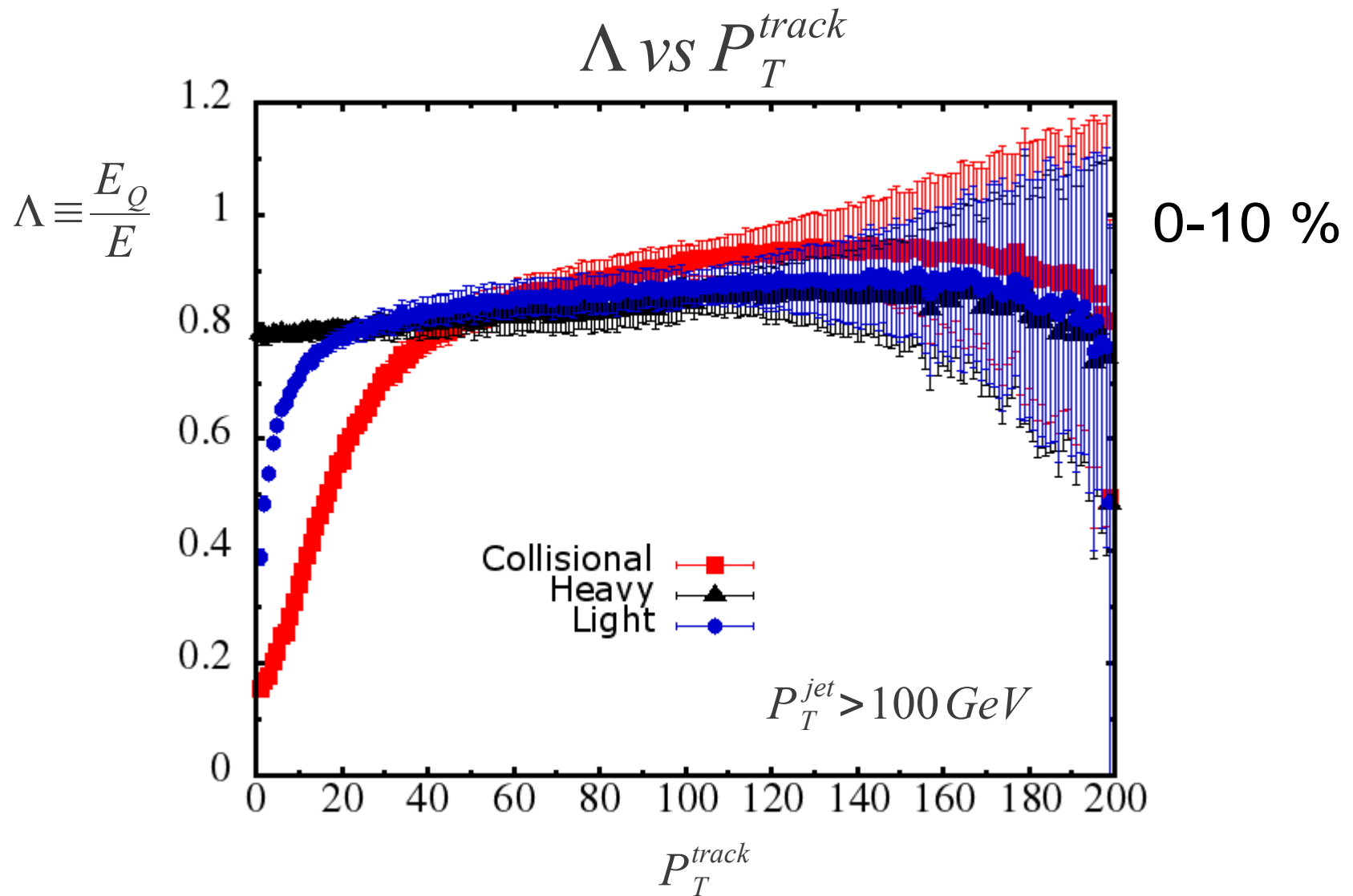
Scanning Parameter Space : R_{AA} vs mean A_J



The models don't show significant differences

Mild disagreement in most central bin may point to an additional source of energy loss... (Radiative?)

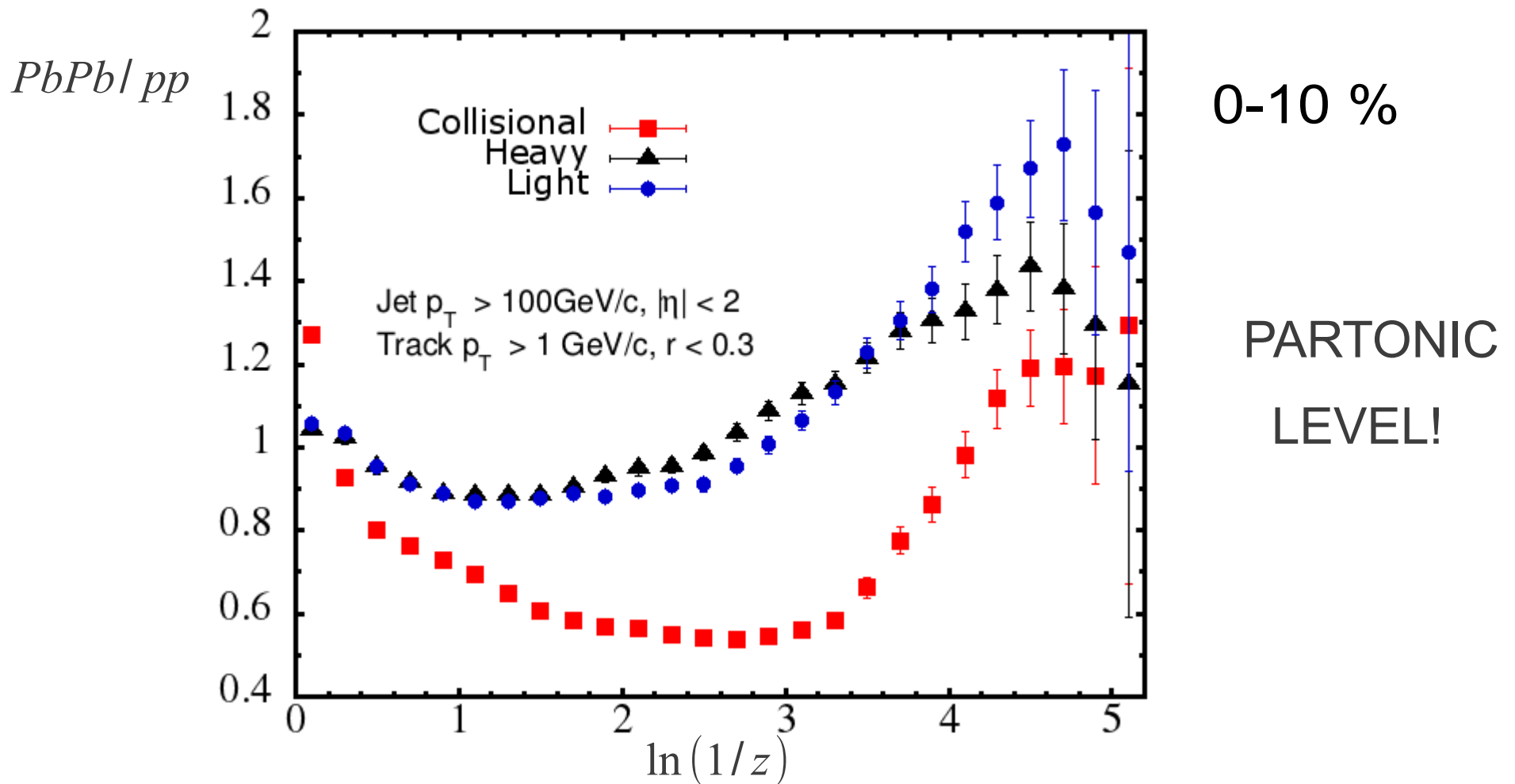
How can we distinguish between models?



The mean quenching factor that a track belonging to a jet gets is different for different models.

Directly related to Fragmentation Functions

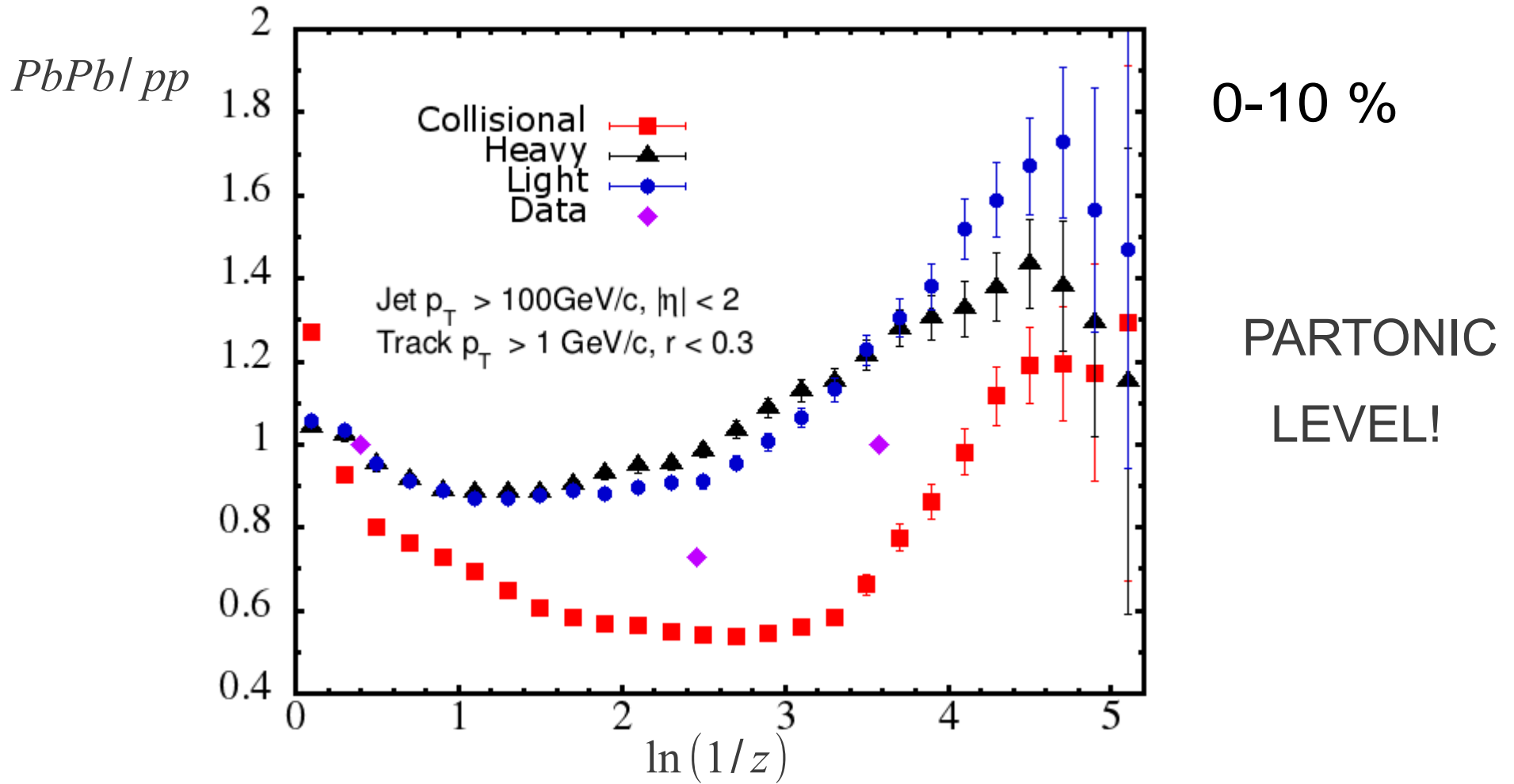
Fragmentation Functions



Collisional → too strong, soft particles suppression

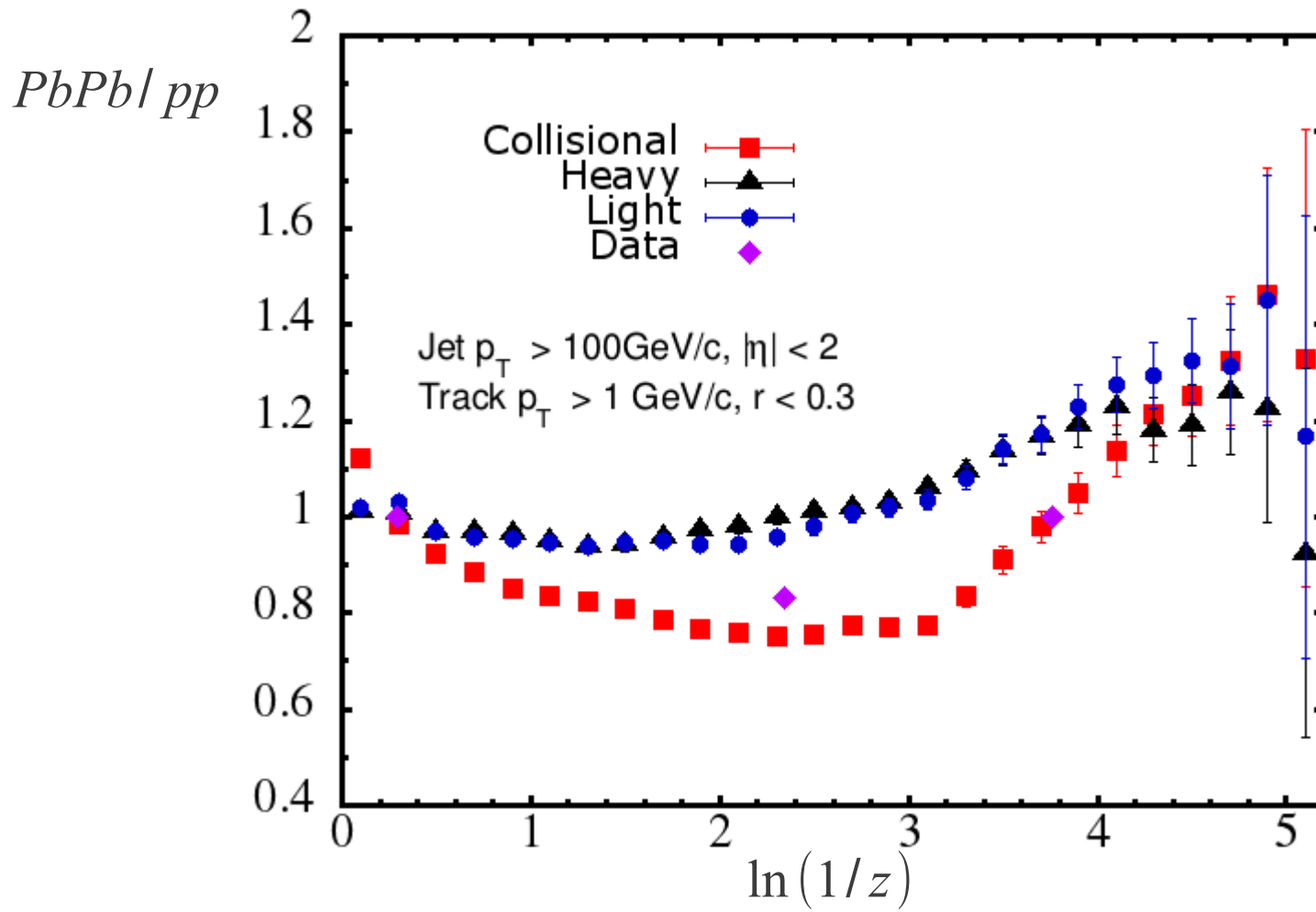
Heavy and Light → mild behaviour: more “consistent” with data

Fragmentation Functions



One would expect that for the hadronic version the curve should shift to the right

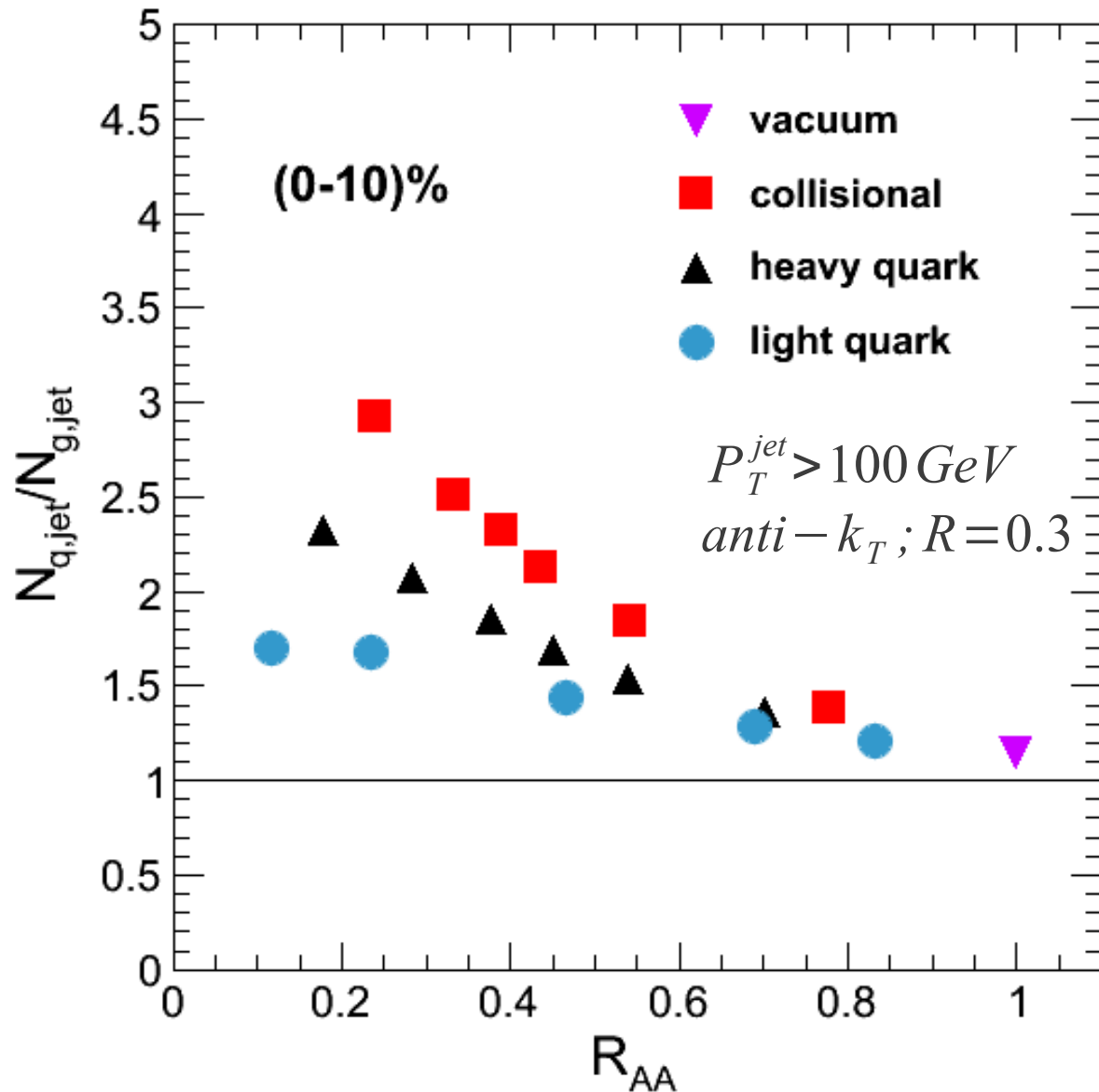
Fragmentation Functions



30-50 %

PARTONIC
LEVEL!

Colour charge dependence



Non-trivial C_R dependence
yields change of species

An additional discriminant
between models

To be studied:

b to inclusive jet yield as a
potential observable

Conclusions

- Hybrid model describes qualitatively (and in some cases quantitatively) many of the features of jet quenching
- Simultaneous description of R_{AA} and dijet asymmetry points towards additional source(s) of energy loss
- The momentum dependence of quenching favours strongly coupled models for the non-radiative component of energy loss
- The non-trivial C_R dependence could be used to further discriminate the origin of such a component

Thank you!!!!

Backup

Alpha Values

- Heavy: 0.025
- Light: 0.2
- Coll.: 9