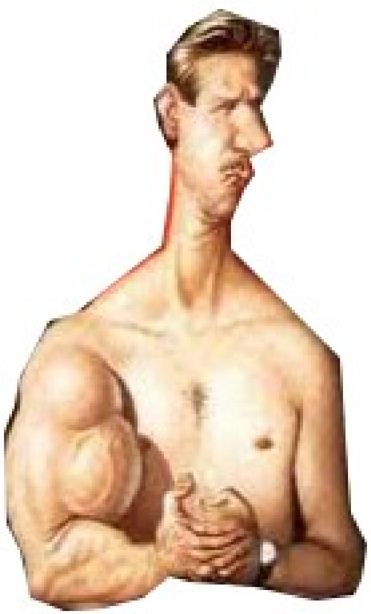
A hybrid strong/weak coupling approach to jet quenching



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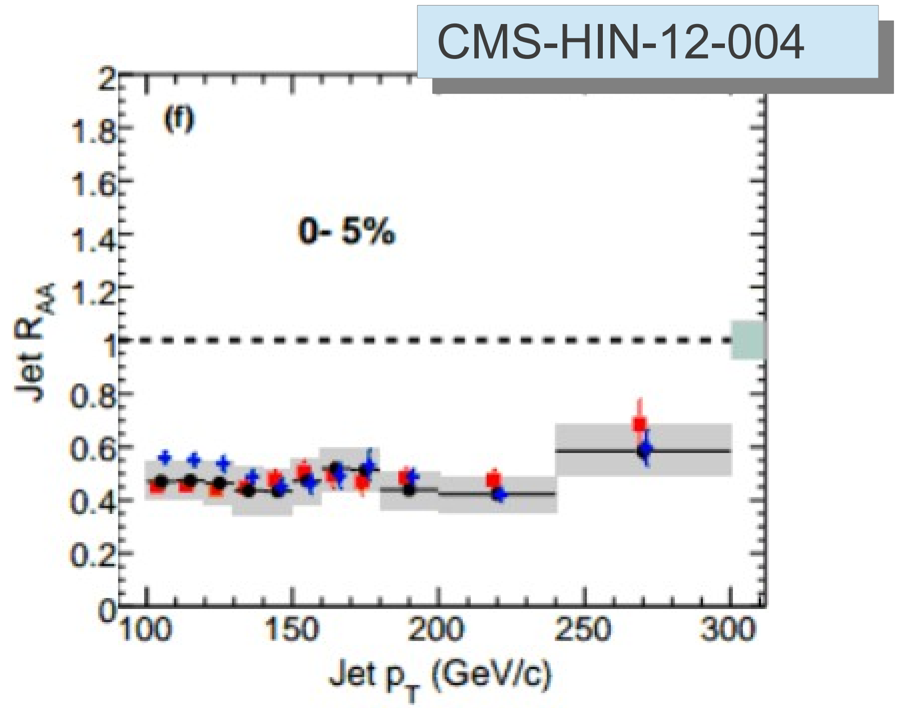
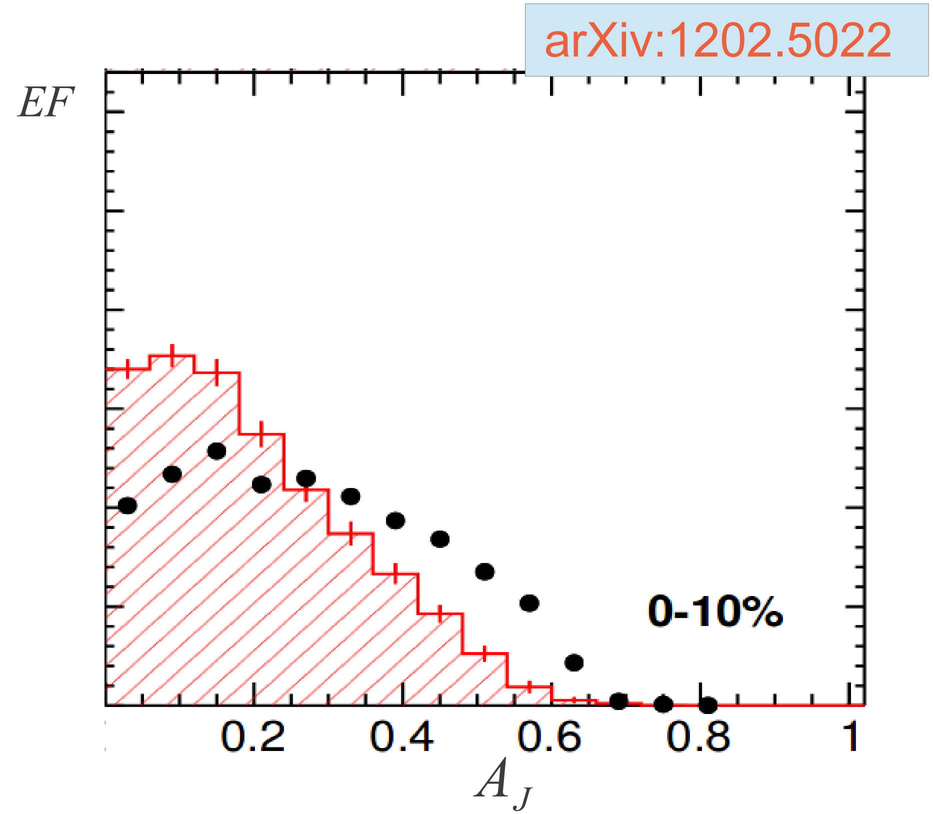
Motivation





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

Quin et al, 1012.5280

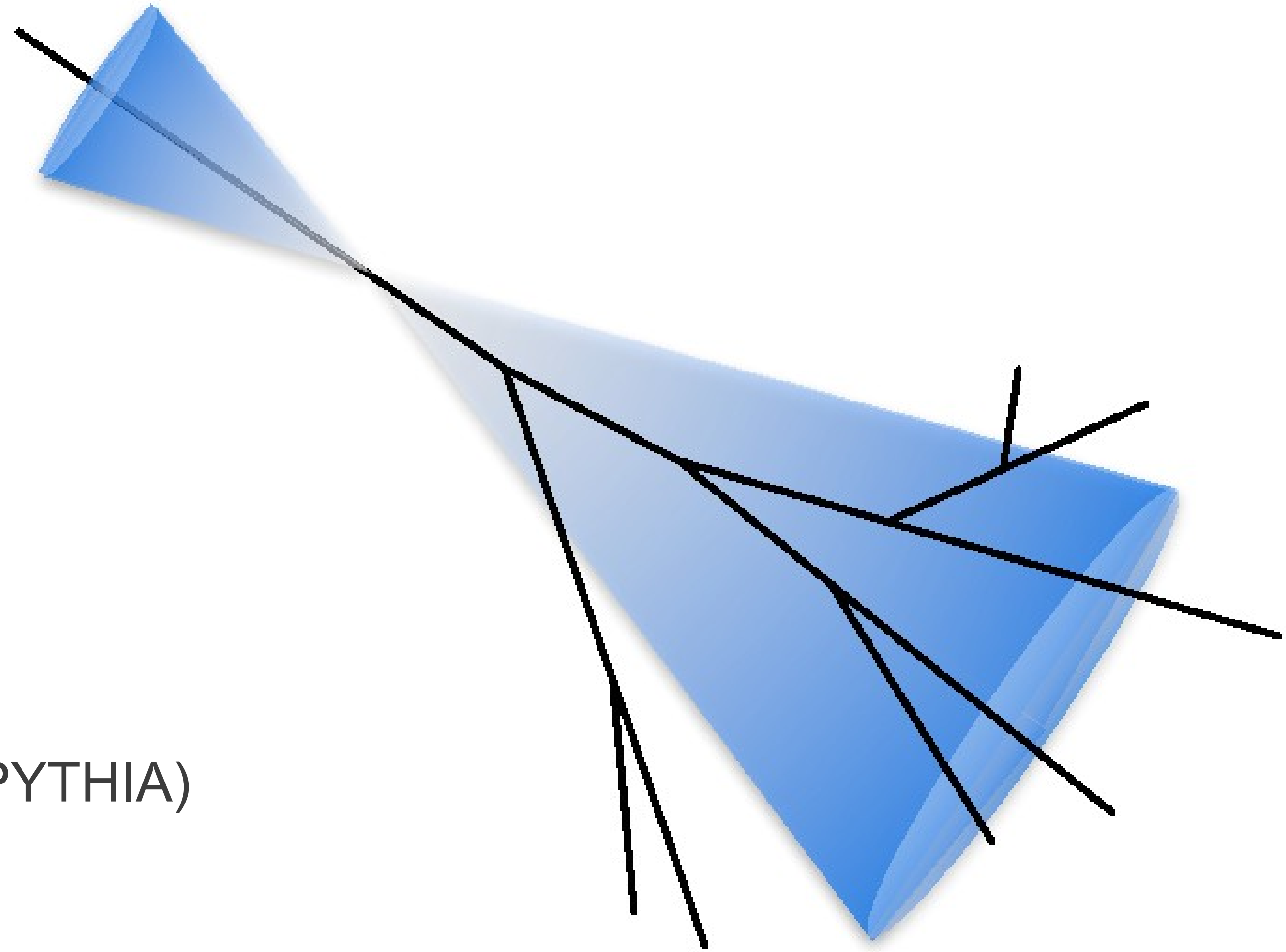
Young et al 1103. 5769

Y. He et al 1105.2566

Renk 1112.2503

Zapp et al 1212.1599

Hybrid Model



- Jet shower perturbative (PYTHIA)
- Additional loss in rungs → 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

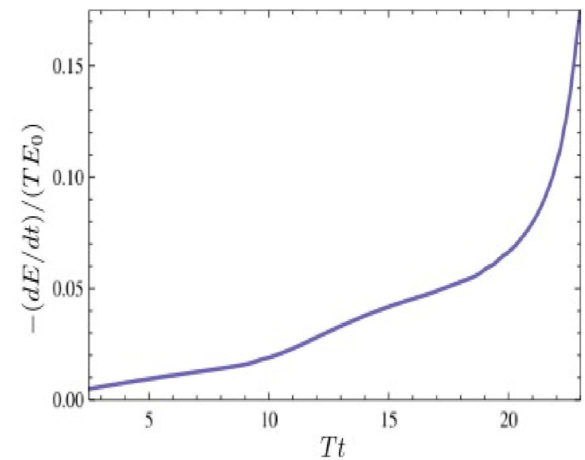
- Woods-Saxon density profile
- Entropy and Temperature related by ideal gas E.O.S
- Entropy density is assumed to be proportional to number of participants
- Bjorken hydro for time dependence (neglecting transverse expansion)
- Systematics included through two "extremal" scenarios involving initial temperature and starting quench time

  ($T_0 = 0.4\,GeV\,;\, t_0 = 0.5\mathrm{fm}$ or $T_0 = 0.45\,GeV\,;\, t_0 = 0\mathrm{fm}$)
- Stop quenching when T reaches 175 MeV

Three Models

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

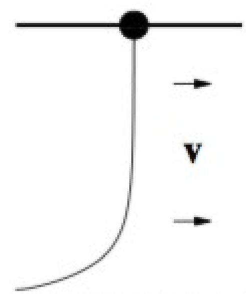
Chesler et al 0810.1895



- Heavy $\rightarrow \frac{dE(t)}{dt} = -\frac{C_R}{C_F}\alpha_H E(t) T$

(out of the validity range) $\gamma < (\frac{M}{T\sqrt{\lambda}})^2$

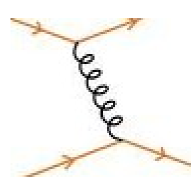
Herzog et al 0605158



as control also:

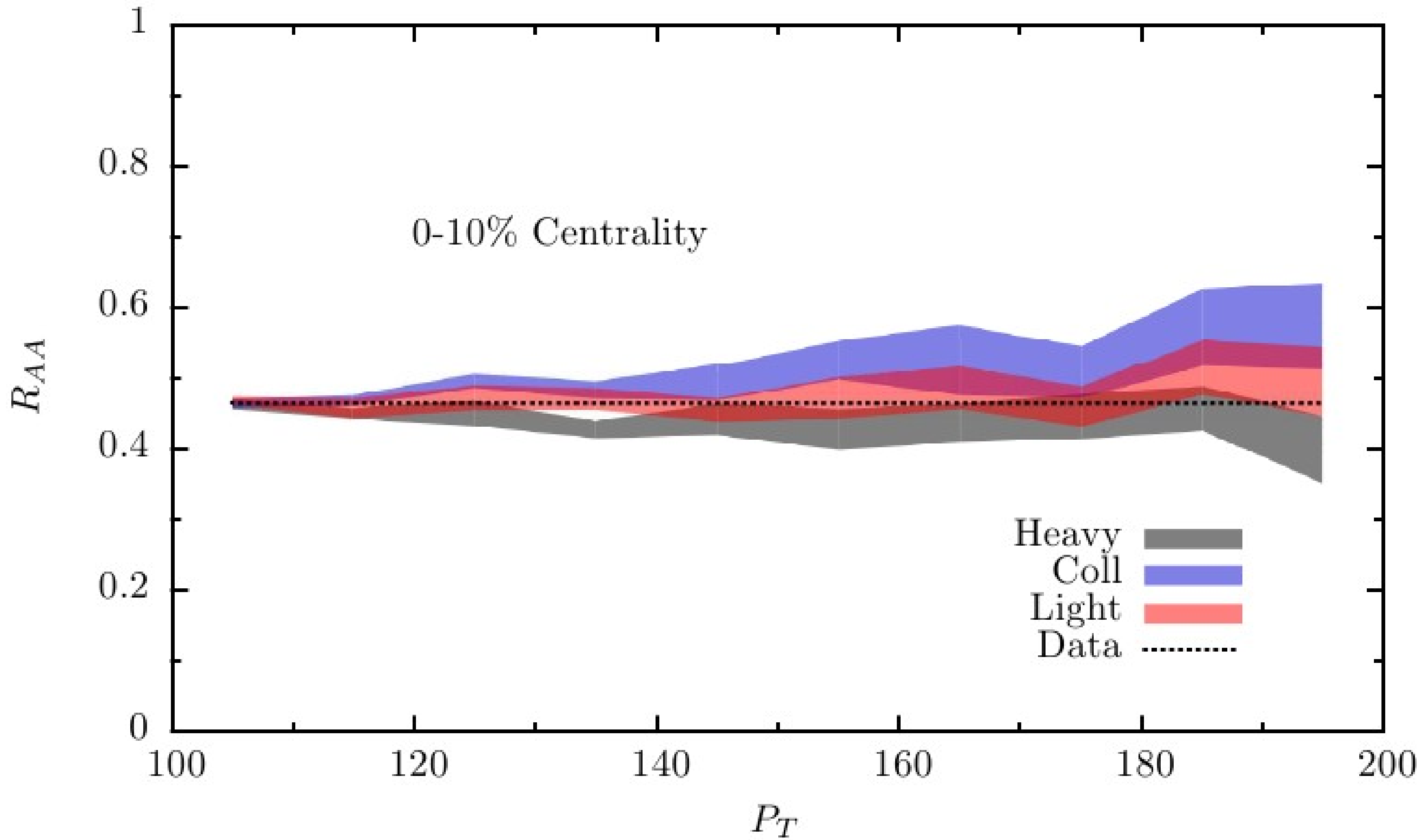
- Collisional $\rightarrow \frac{dE(t)}{dt} = -\frac{C_R}{C_F}\alpha_C T^2$

Wicks et al. nucl-th/0512076



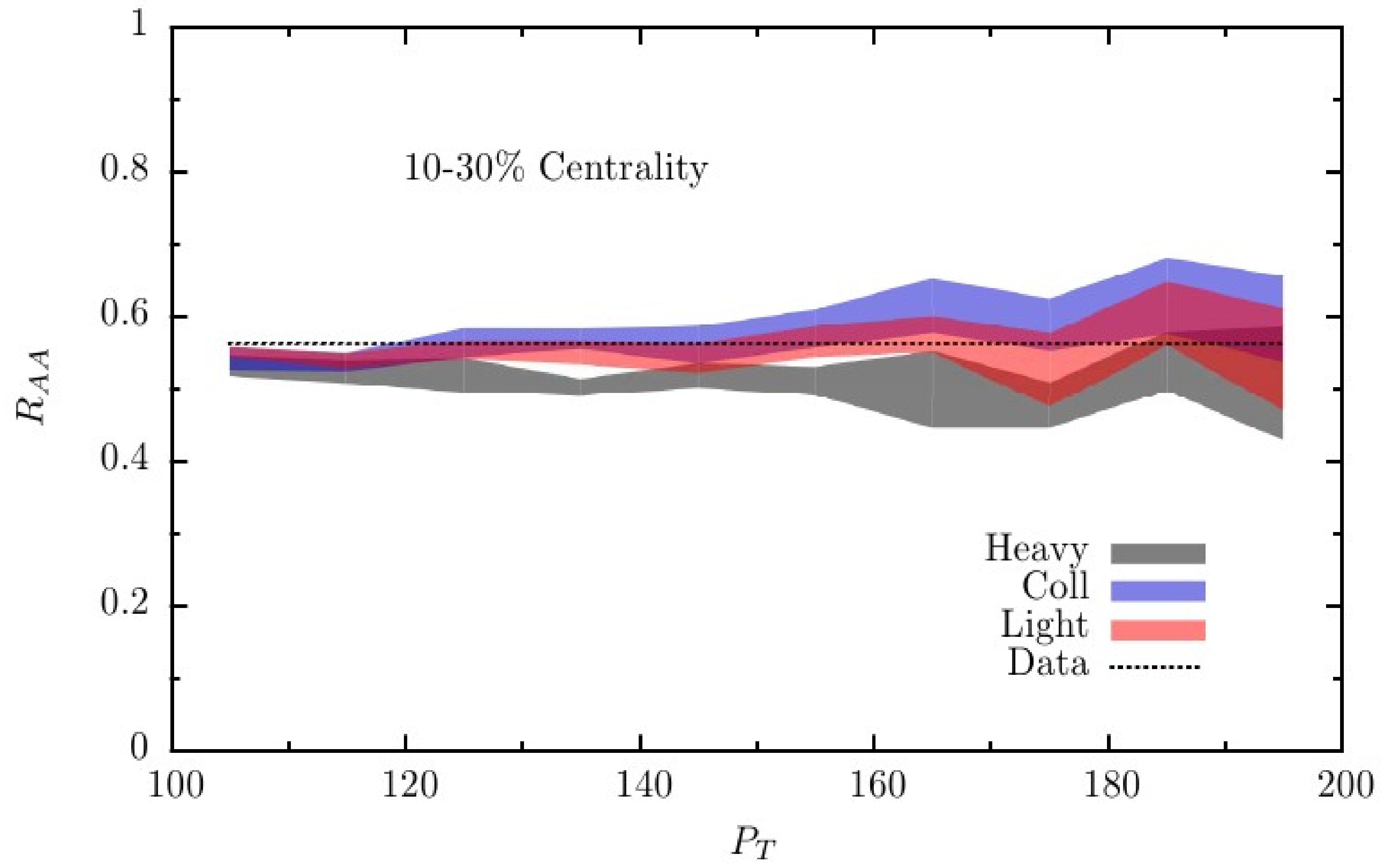
α_i ≡ *fitting parameter*

Nuclear modification factor



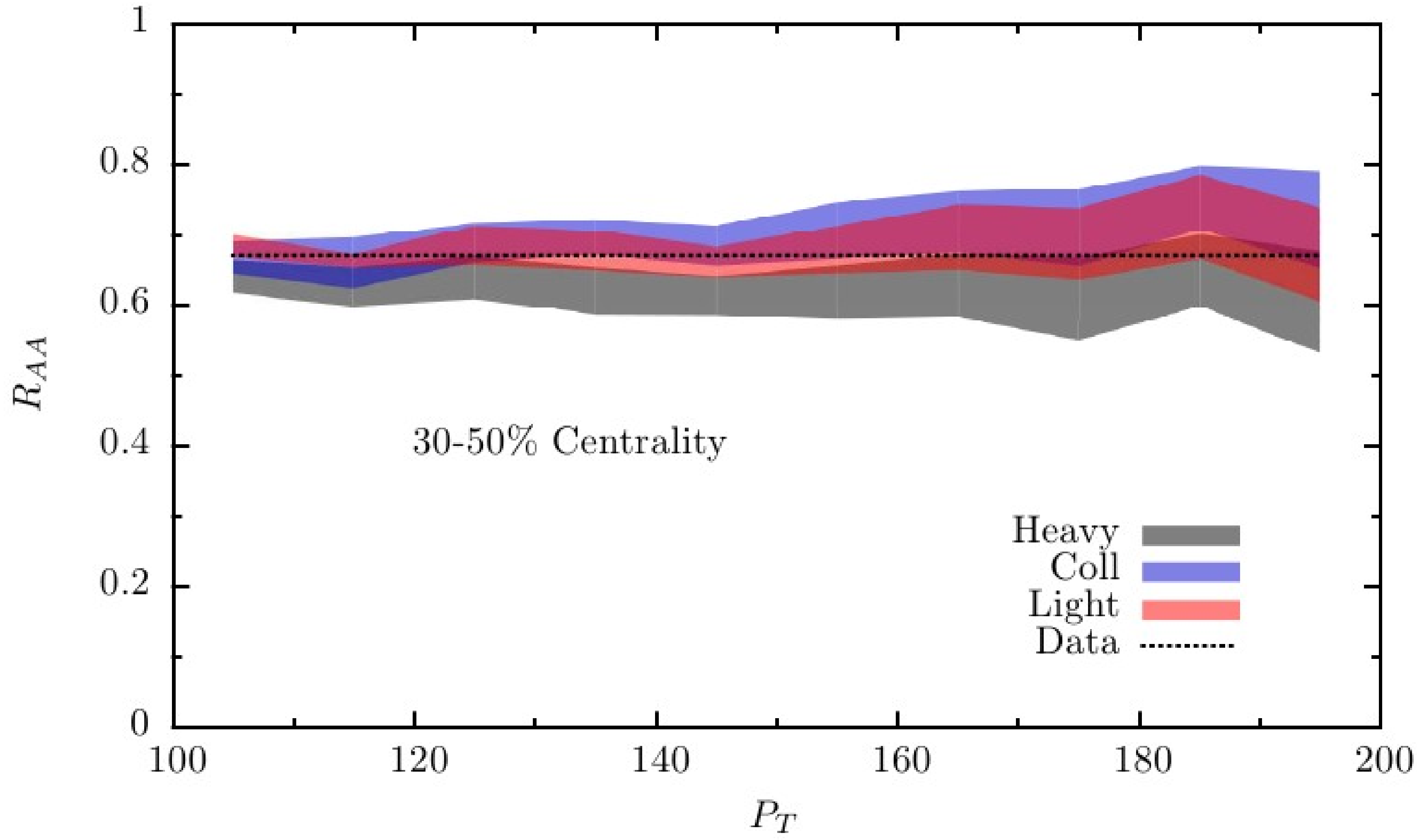
Fit R_{AA} to match data at central collisions

Nuclear modification factor

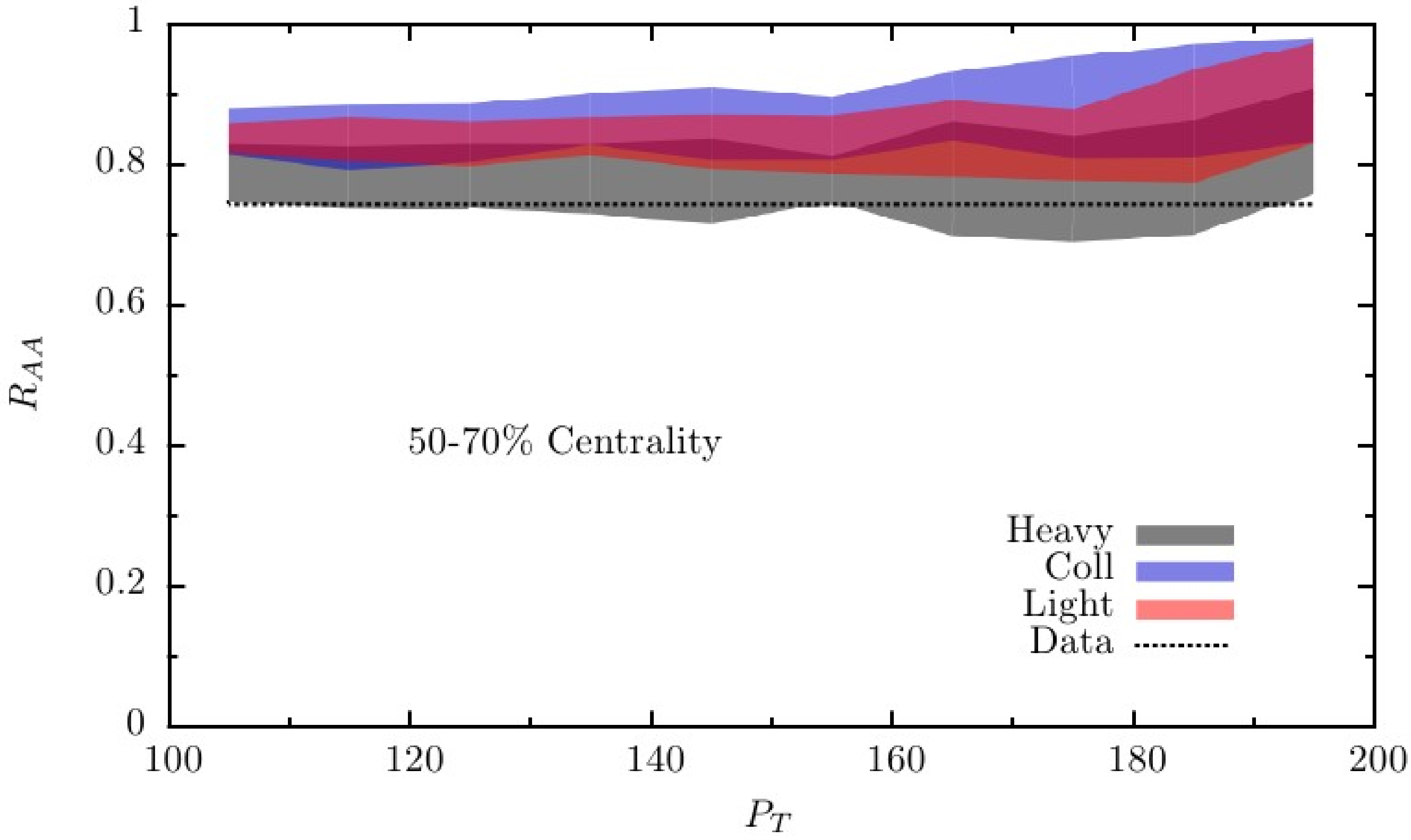


We let it evolve with centrality

Nuclear modification factor

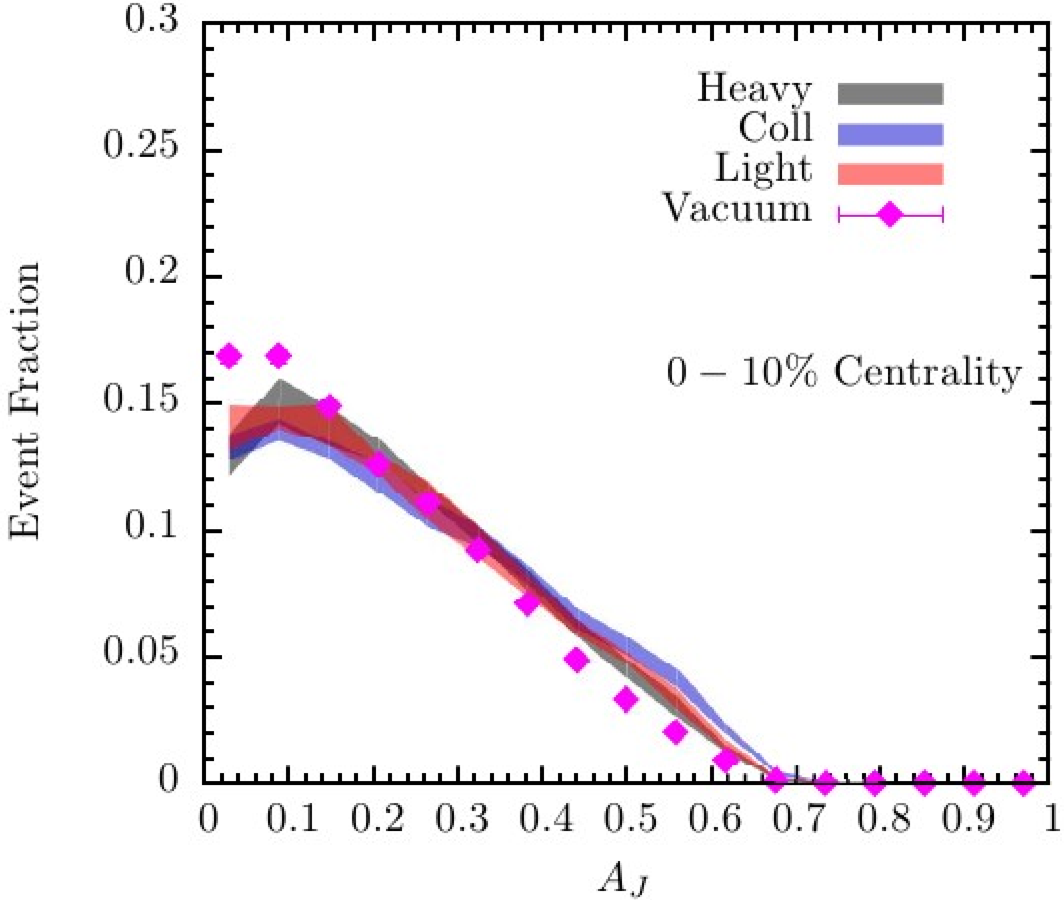


Nuclear modification factor

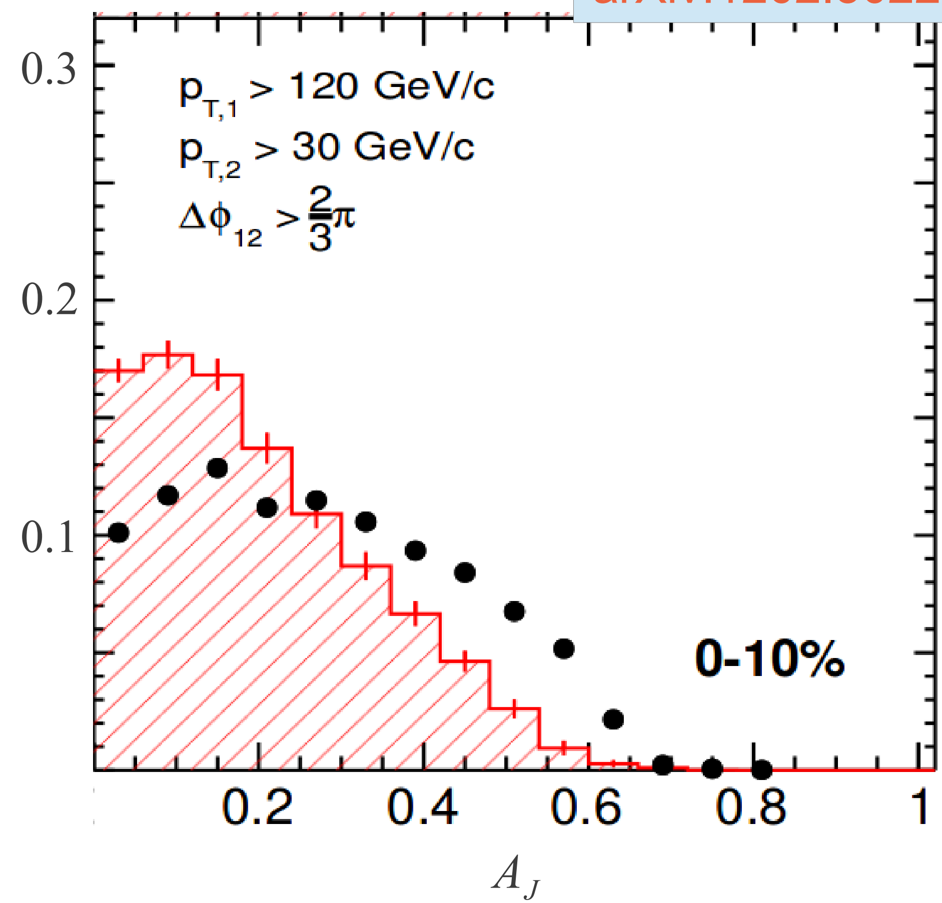


The model describes R_{AA} dependence on centrality at central and mid-peripheral bins, but deviates at most peripheral.

Asymmetry



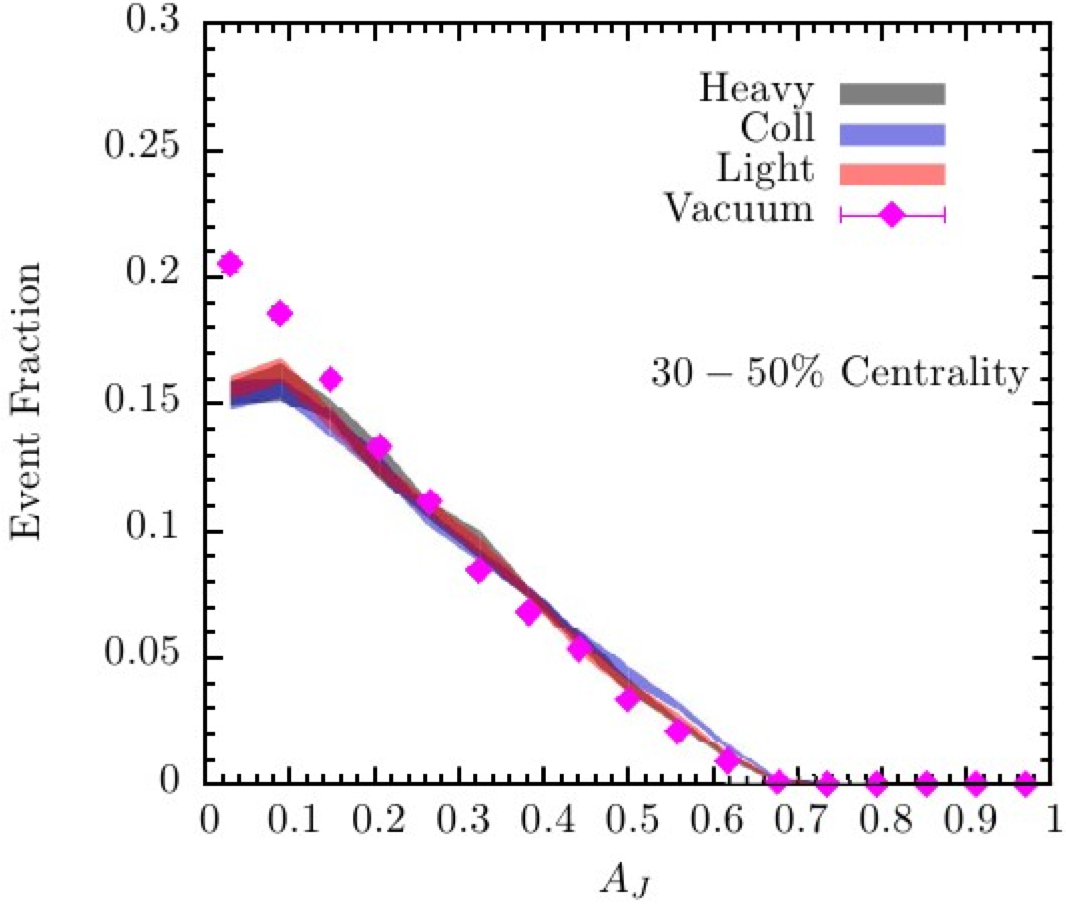
arXiv:1202.5022



$$A_J = \frac{P_{T,1} - P_{T,2}}{P_{T,1} + P_{T,2}}$$

Dijet imbalance not quite strong enough

Asymmetry



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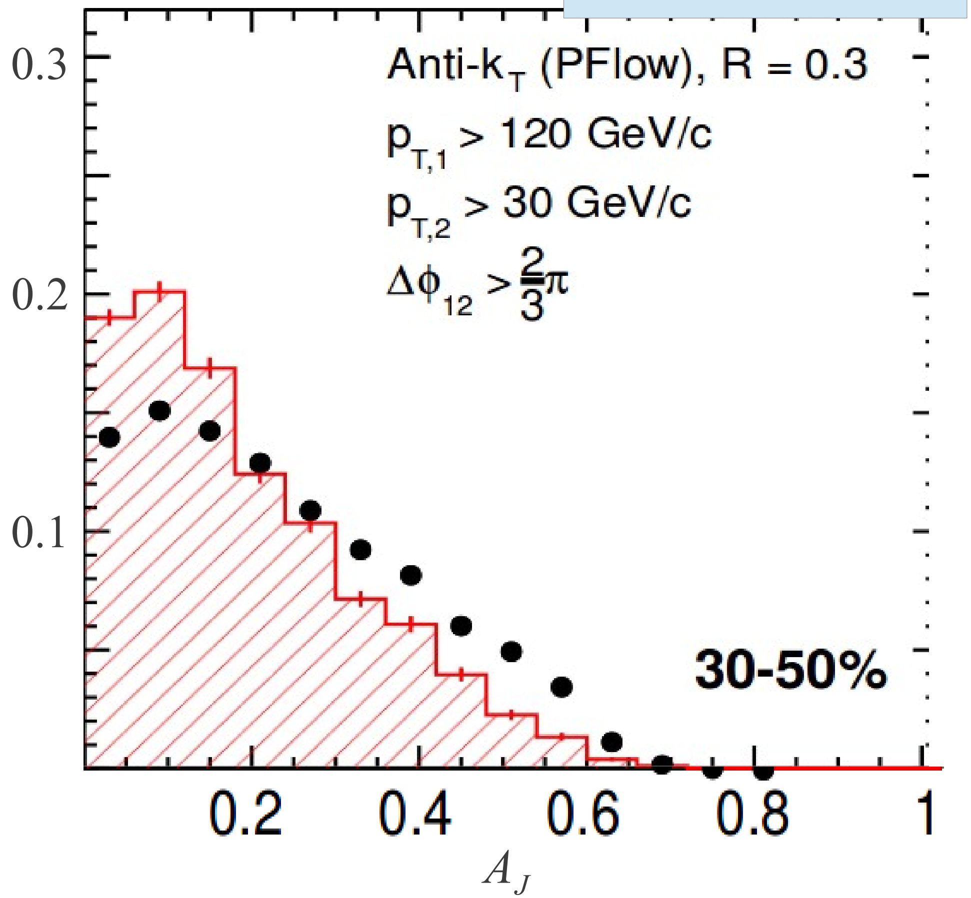
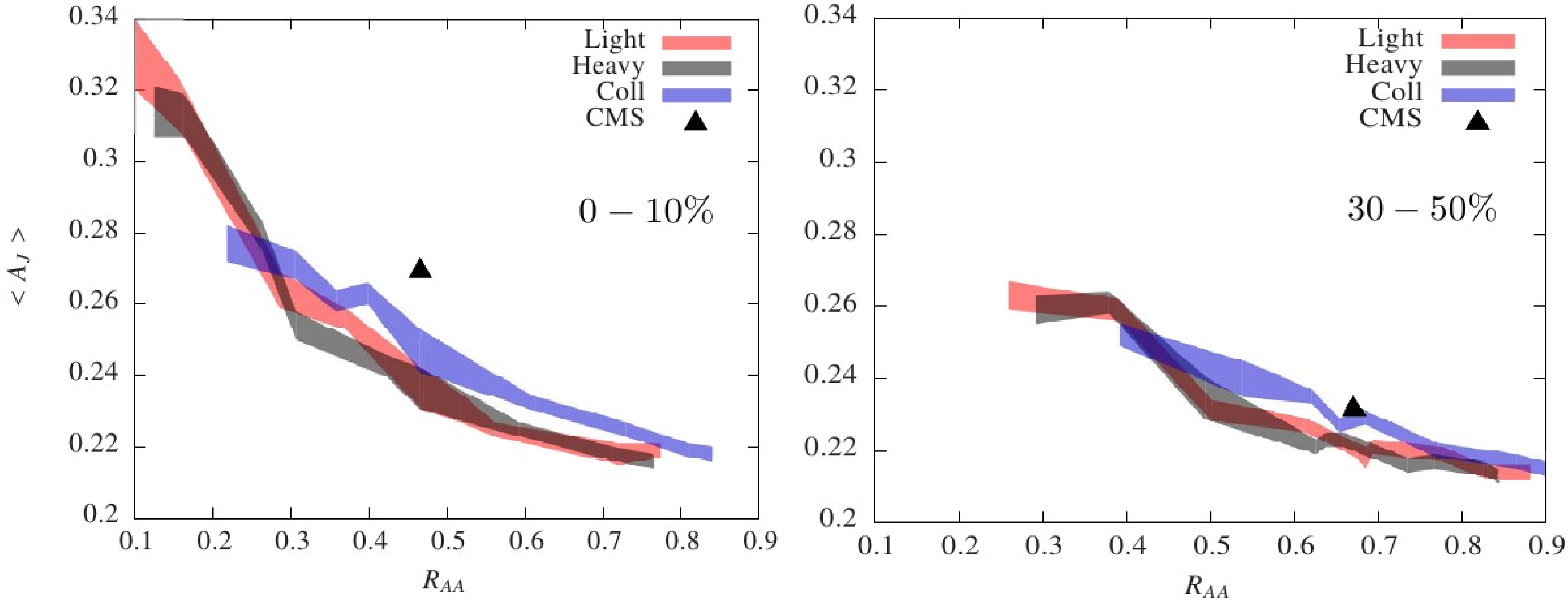


Scanning Parameter Space



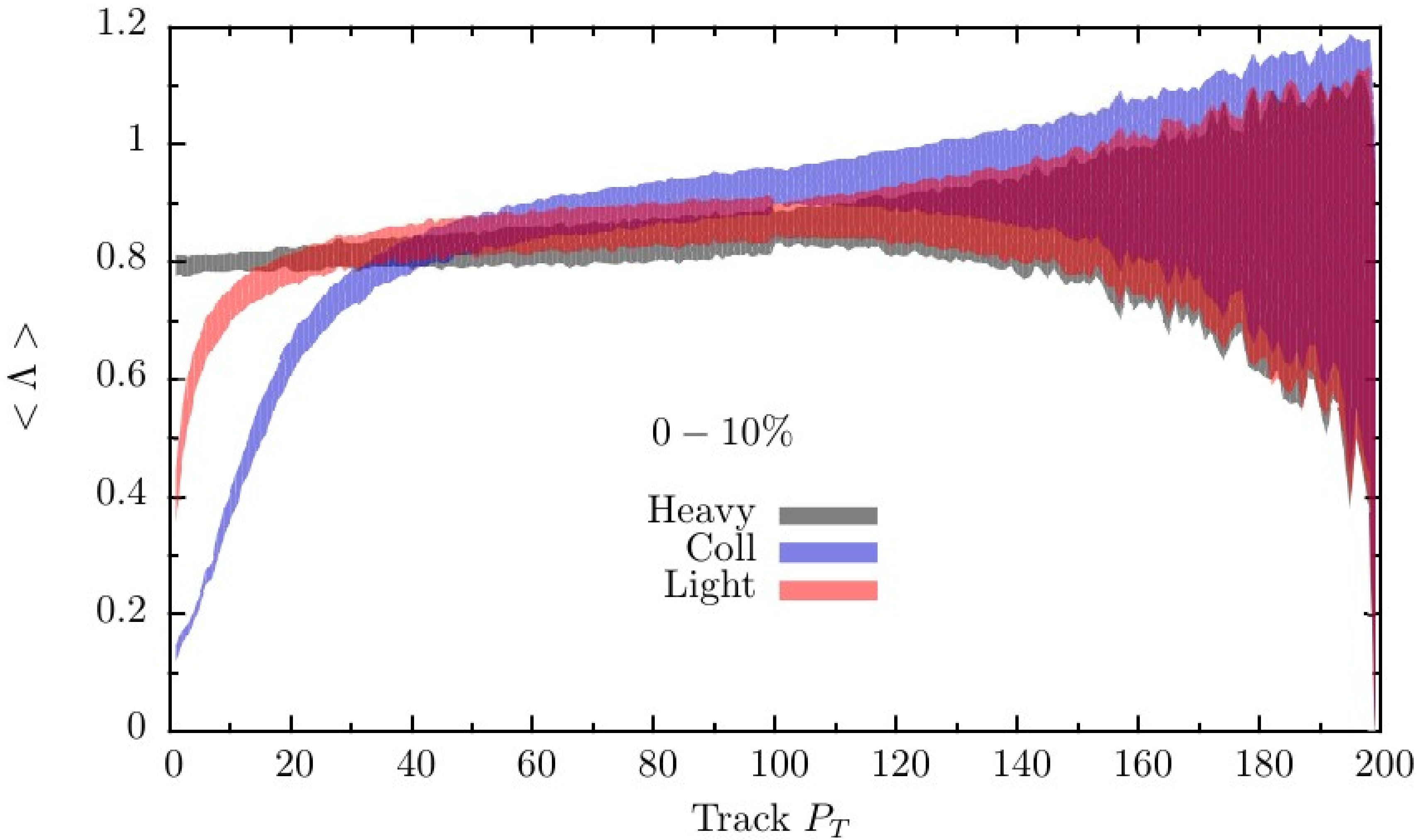
The models don't show significant differences

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

How can we distinguish between models?

$\Lambda = P_{T,Q}/P_T$

Λ vs P_T^{track}

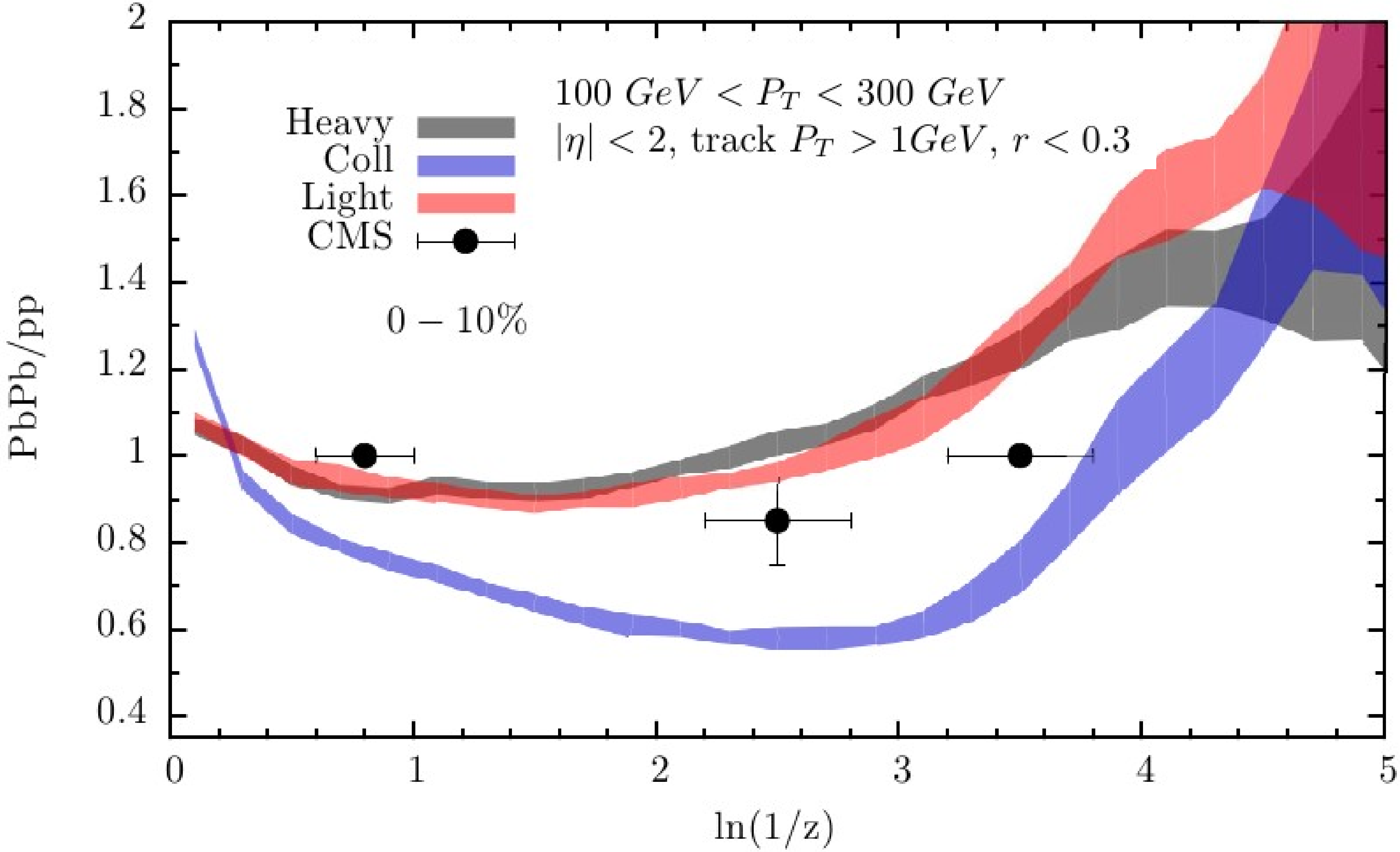


The mean quenching factor that a track belonging to a jet gets is different for different models.

Directly related to Fragmentation Functions

Fragmentation Functions

PARTONIC LEVEL!

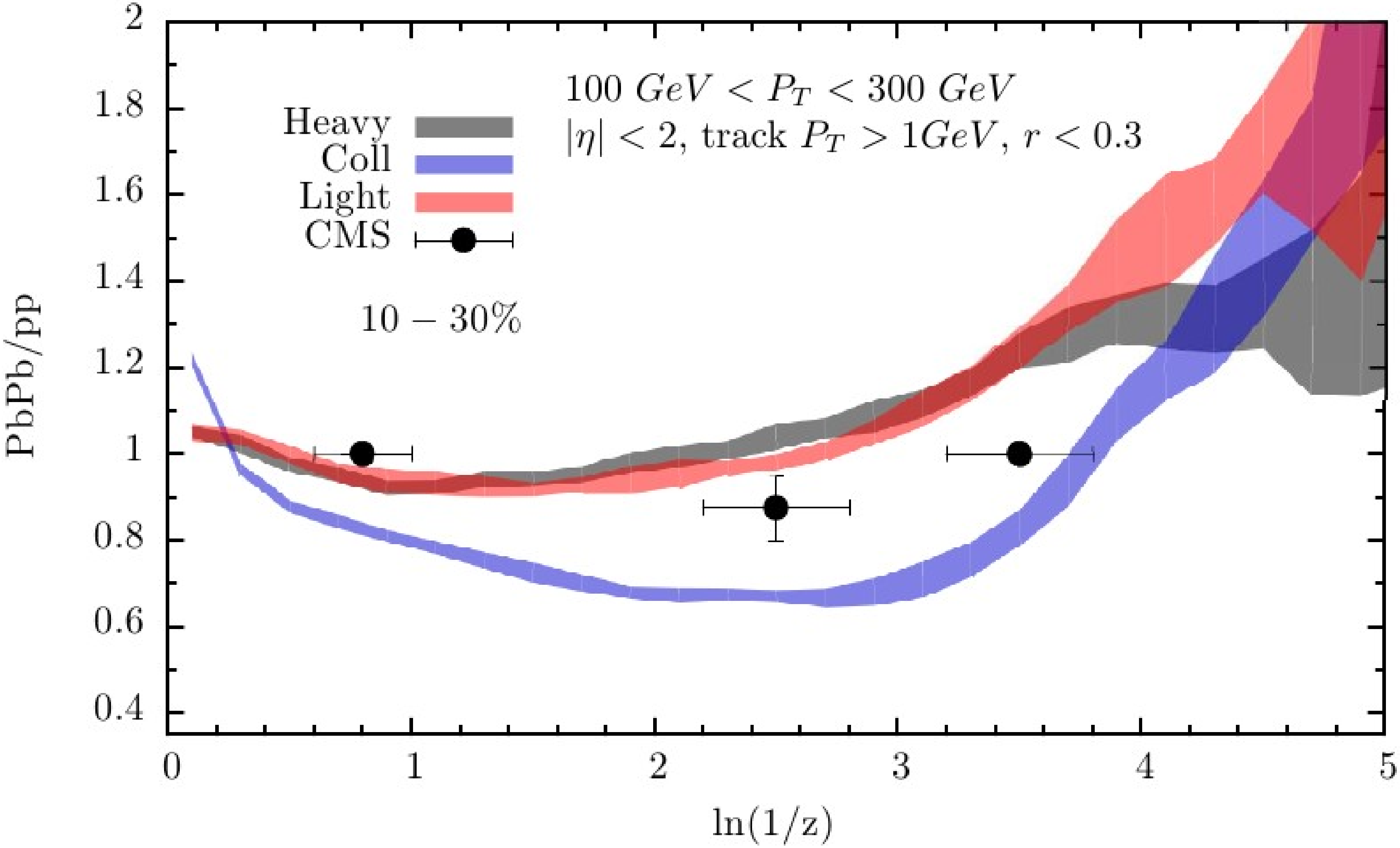


Collisional→ too strong, soft particles suppression

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

Fragmentation Functions

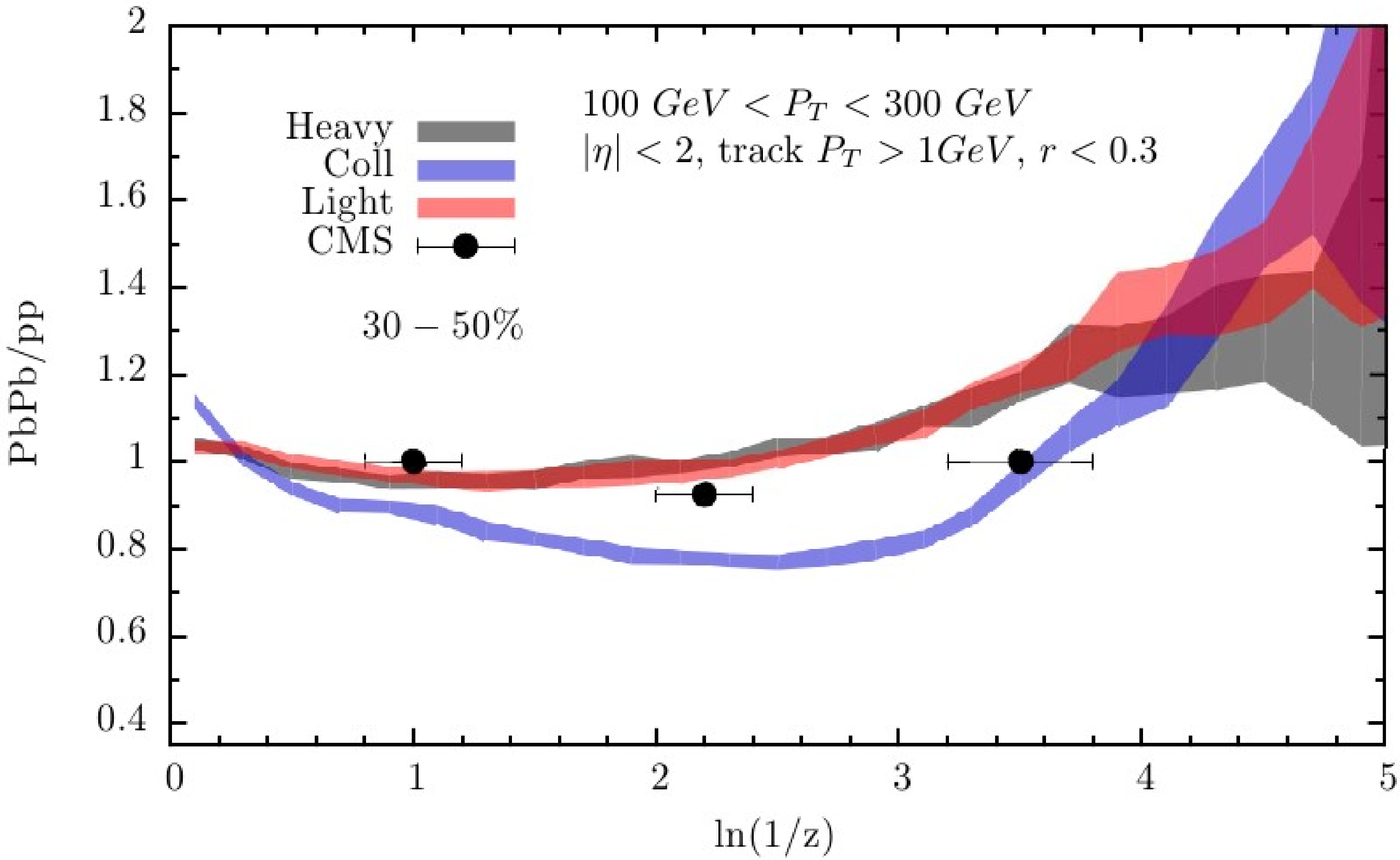
PARTONIC LEVEL!



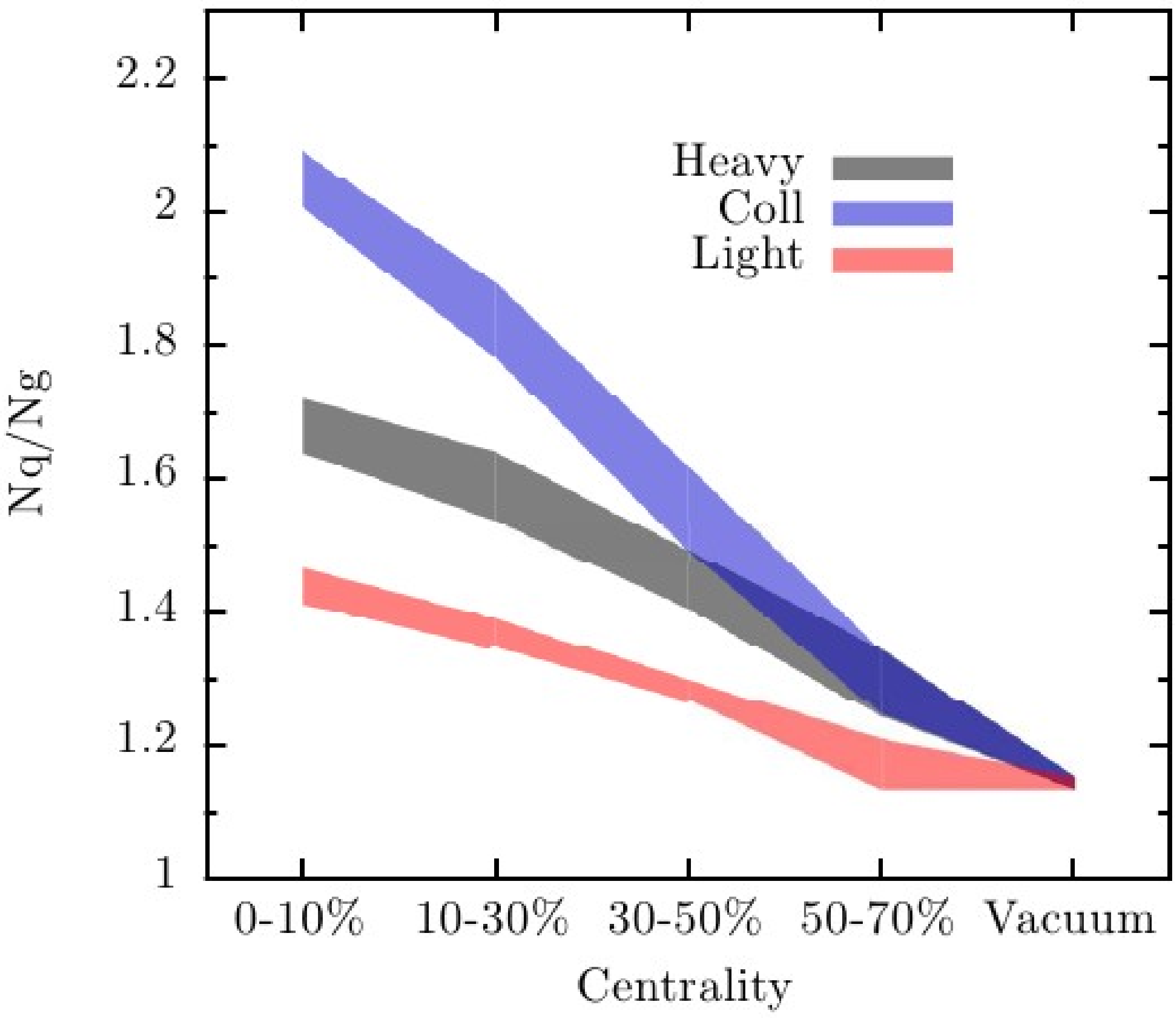
One would expect that for the hadronic version the curve should shift to the right

Fragmentation Functions

PARTONIC LEVEL!



Colour charge dependence



Quark Initiated Jets (Nq) over
Gluon Initiated Jets (Ng)

Non-trivial C_R dependence yields change of species

An additional discriminant between models

To be studied:

b to inclusive jet yield as apotential observable

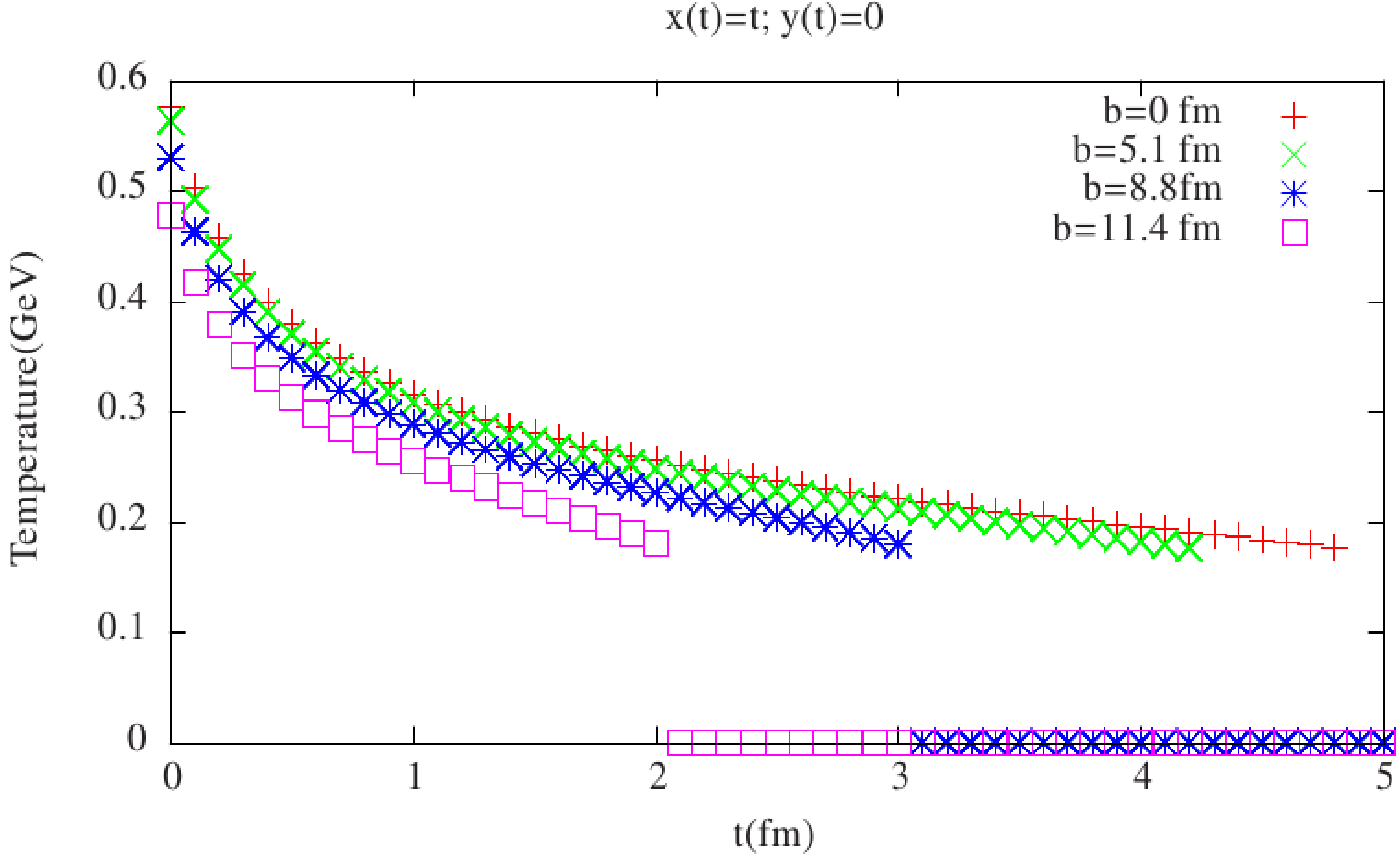
Conclusions

- 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!!!!

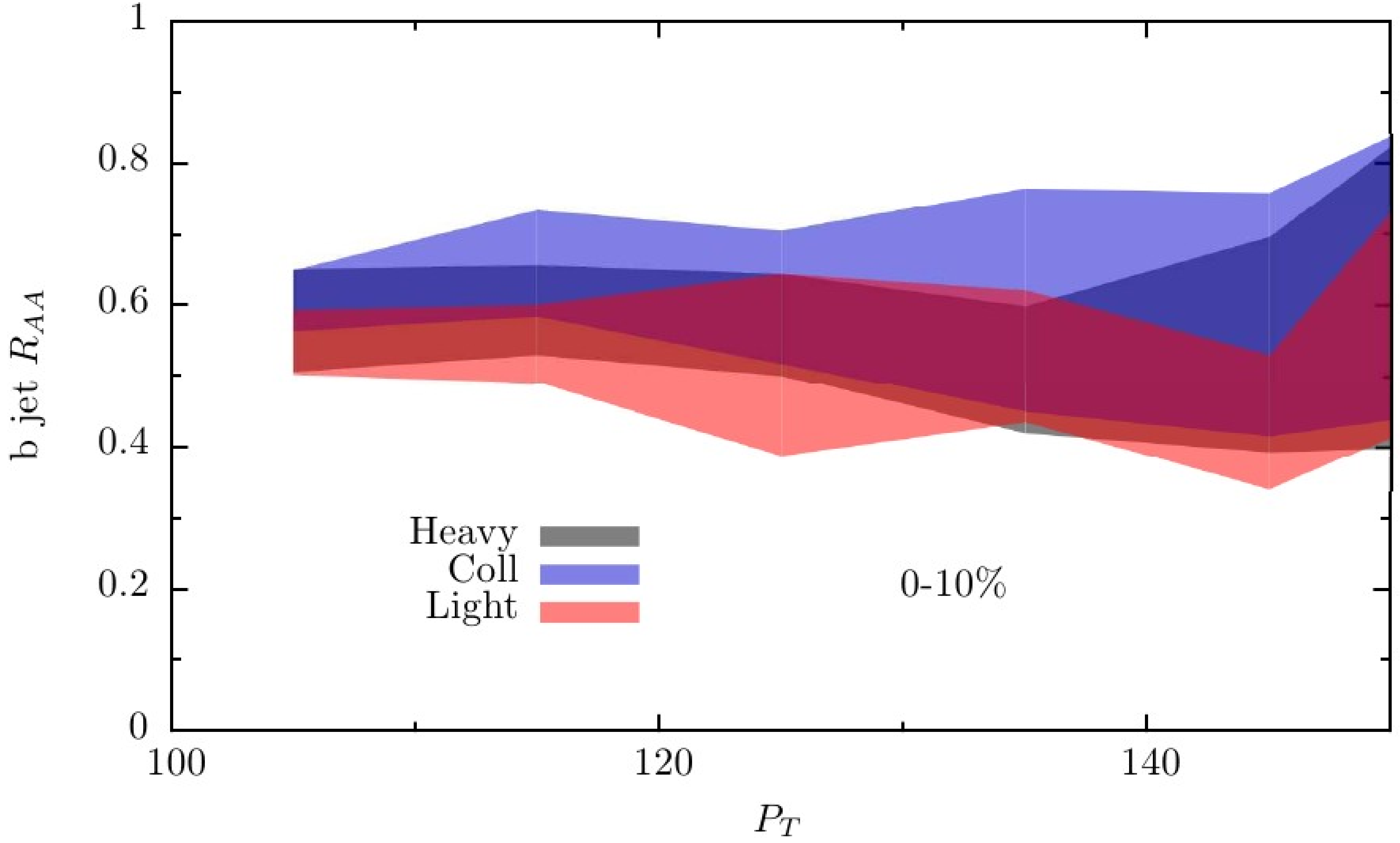
Backup

Temp profile



B Tagging

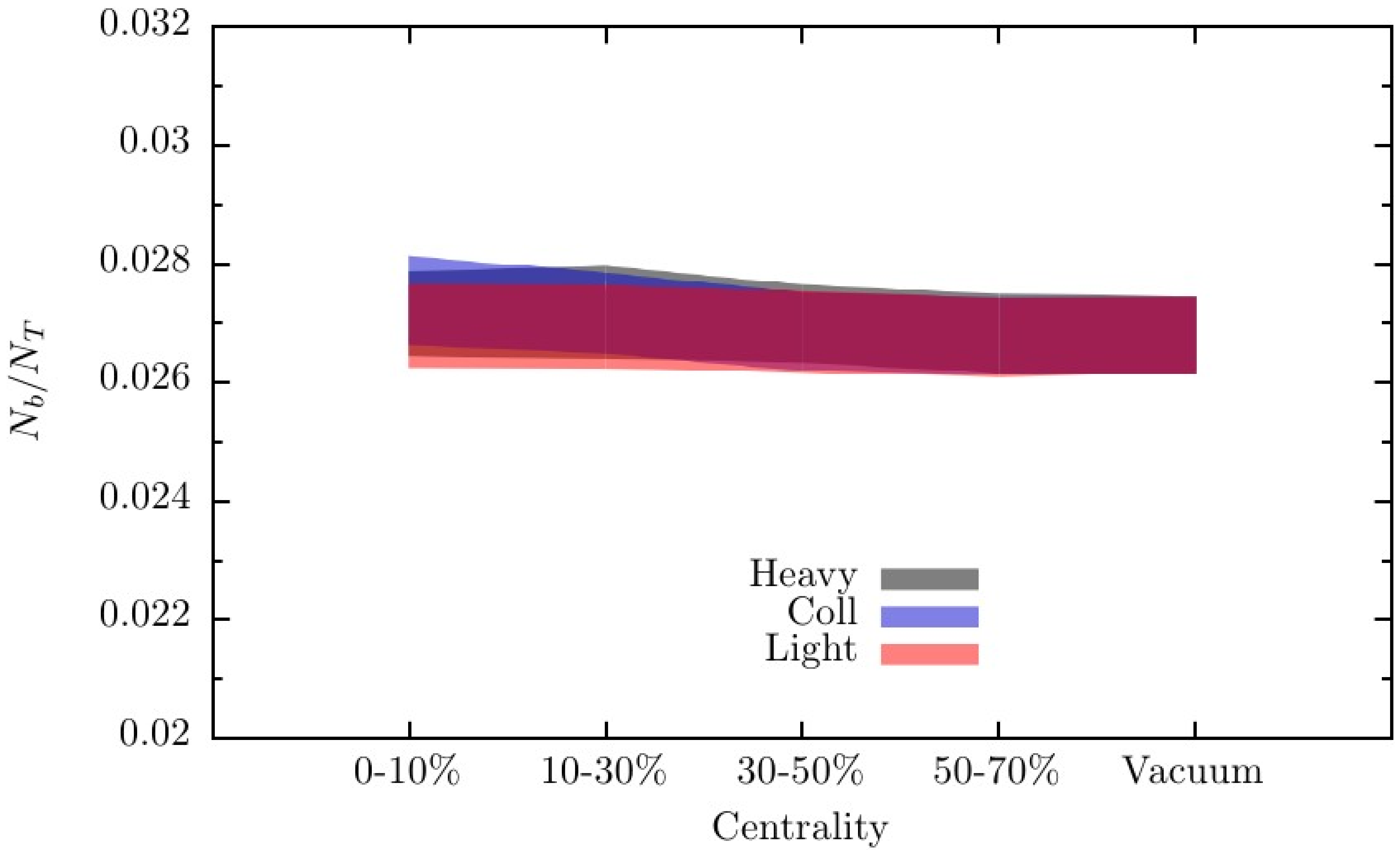
PRELIMINARY !!!



b-jets consistent with inclusive

B Jets/Inclusive vs Cent.

PRELIMINARY !!!



Number of B jets over total number of jets

doesn't depend on centrality