Resolution Effects in the Hybrid Strong/Weak Coupling Model

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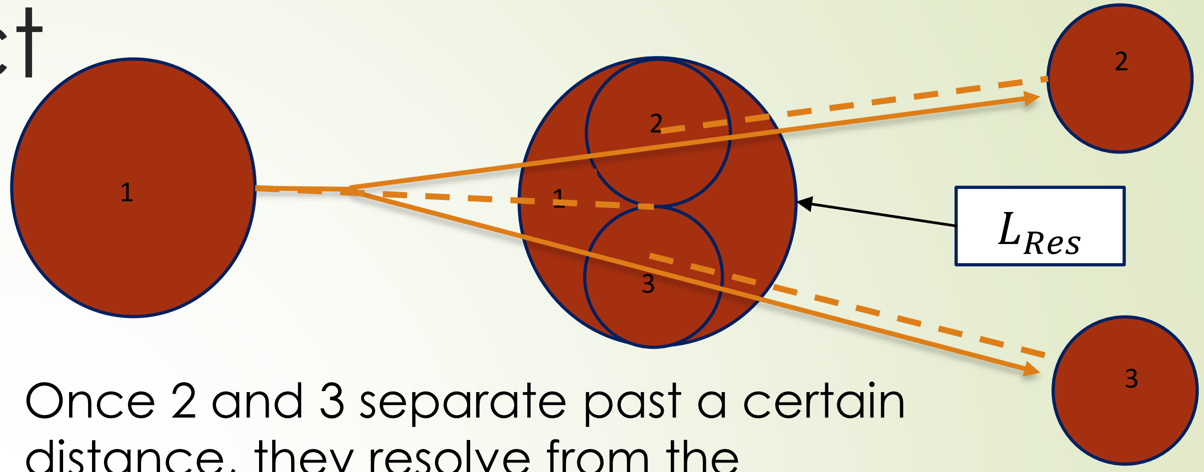
All About the Hybrid Model One More Time

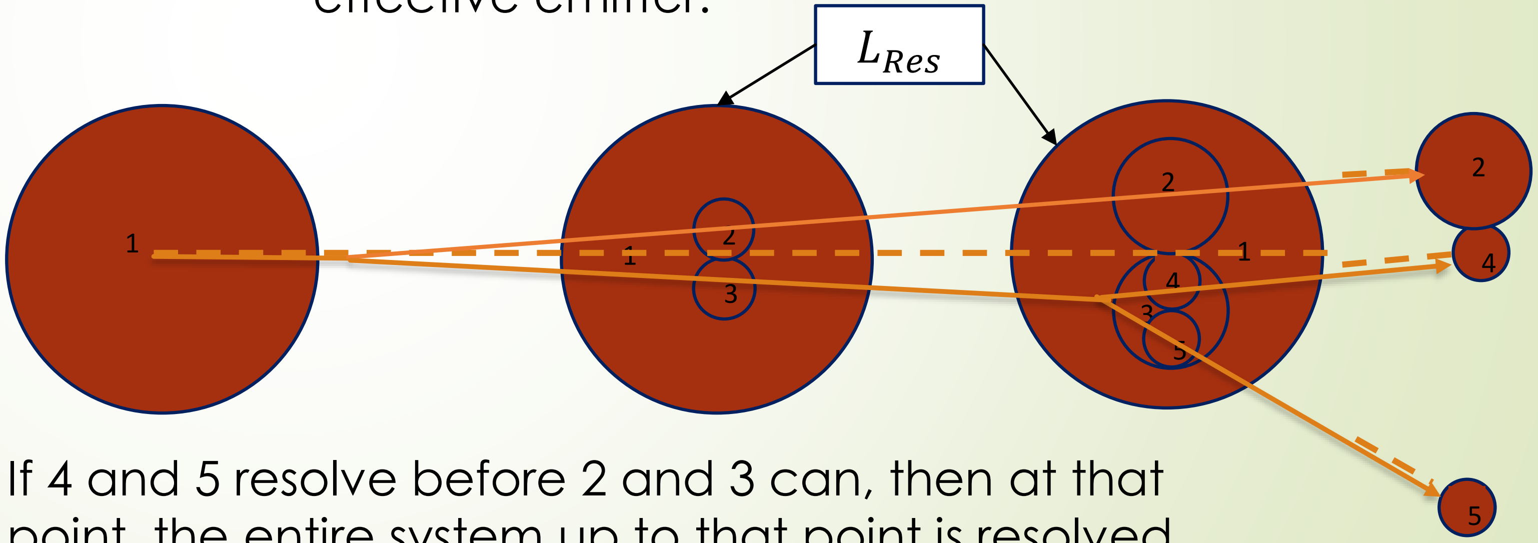
- Just kidding

Resolution Effect

- The Quark Gluon Plasma cannot resolve sister partons from their mother until they are separated by a certain distance, L_{Res}.
- If any of the daughters or granddaughters etc. of a particle resolve before that particle, that particle must resolve at that time.



Once 2 and 3 separate past a certain distance, they resolve from the effective emitter.



If 4 and 5 resolve before 2 and 3 can, then at that point, the entire system up to that point is resolved.

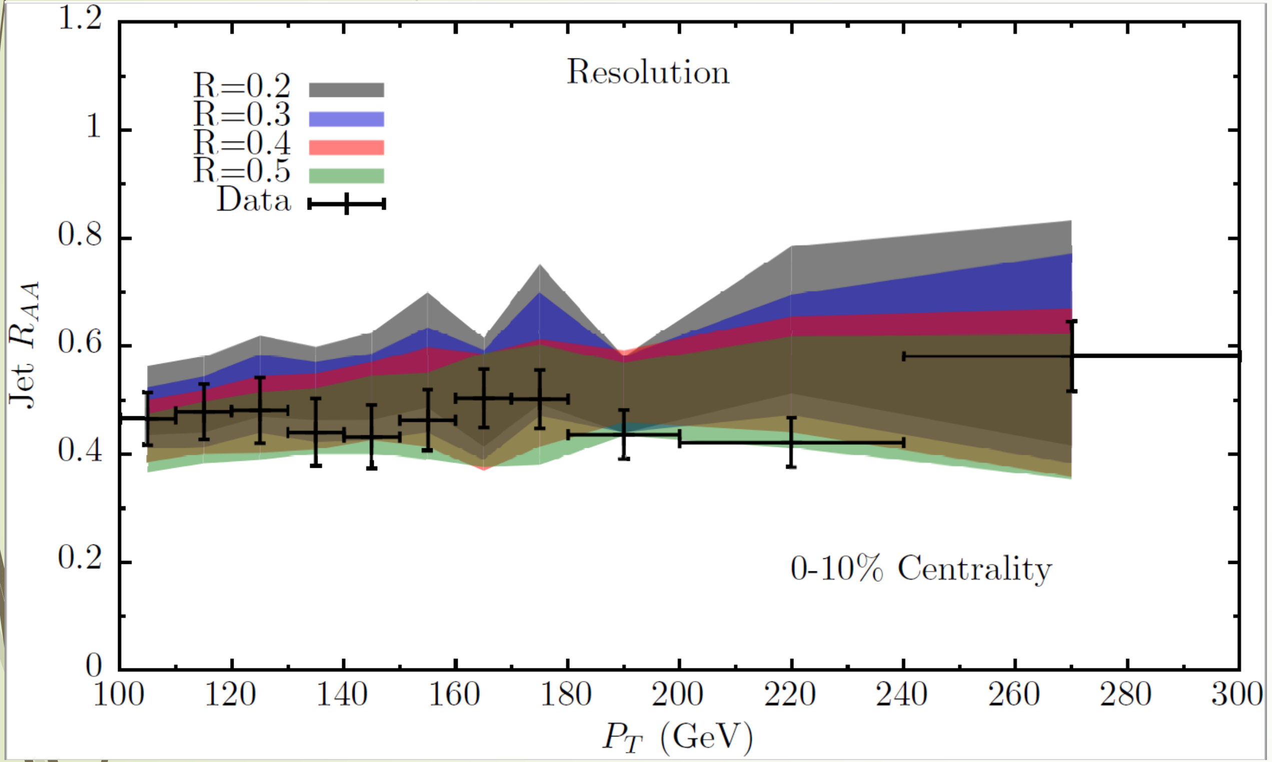
Resolution Distance, L_{Res}

- We expect L_{Res} in a certain region to be comparable to the Debye length or the screening length for charges at that part of the plasma.

$$L_{Res} \approx \lambda_D$$

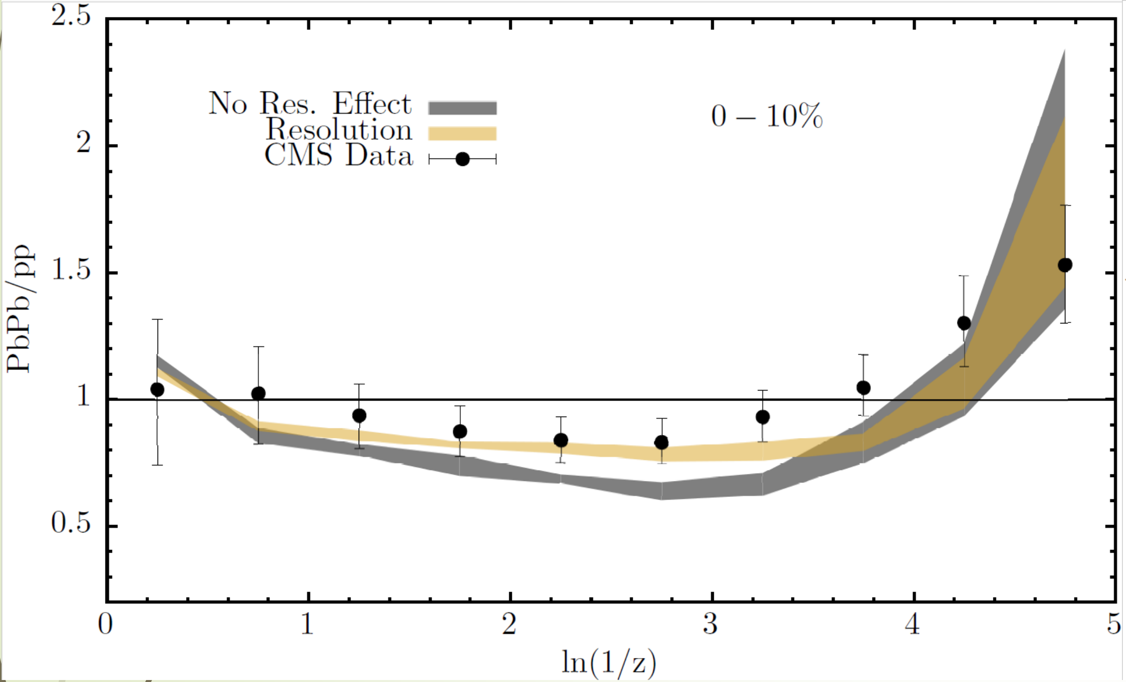
- We can use estimates of λ_D in the strong and weak coupling limits.
- In the weak coupling regime, $\lambda_D \approx \frac{2.6}{g\pi T}$, and $\alpha_{QCD} \approx \frac{1}{3} \Rightarrow g \approx 2$
- With strong coupling, AdS/CFT calculations in [Bak, Karch, Yaffe 2007] yield that $\lambda_D \approx \frac{.3}{\pi T}$, but correcting for extra degrees of freedom, λ_D in QCD at strong coupling must be larger than this.
- We chose $\lambda_D \approx \frac{1}{\pi T}$ as a start, with $\lambda_D \approx \frac{1}{2\pi T}$ and $\lambda_D \approx \frac{2}{\pi T}$ as further exploratory values.

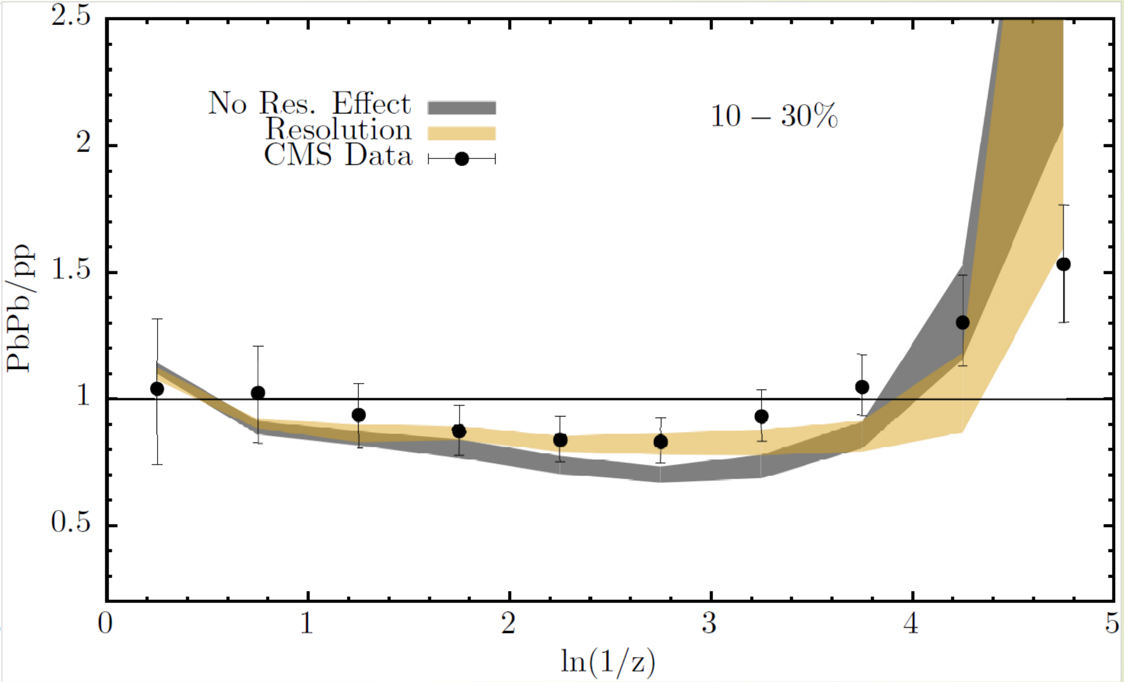
RAA vs. R with Resolution Effect at $L_{Res} = \frac{1}{\pi T}$



- We fit the one parameter, κ, in the model to the first bin in the RAA data for R=0.3 jets.
- RAA is not significantly altered by this effect, and remains a good way to choose kappa.
- Spread in κ is 0.346 to 0.453, an increase of about10% over no resolution.

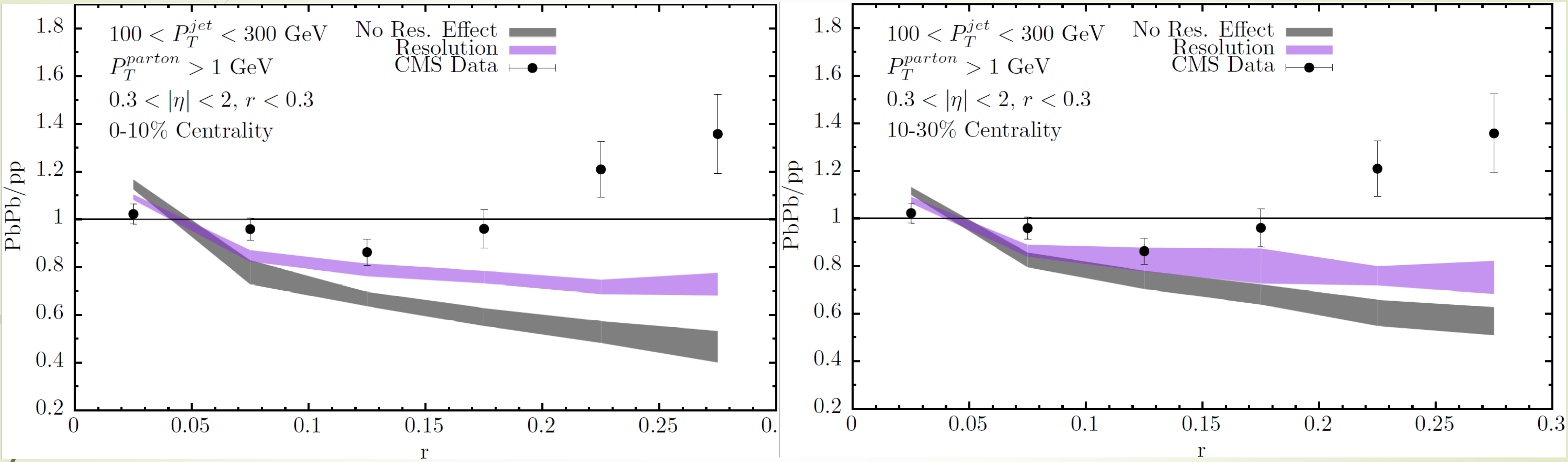
Partonic Fragmentation Functions with $L_{Res} = \frac{1}{\pi T}$





- Resolution effect pushes the curve down on the left and up in the middle
- The hard early particles in the shower live a little longer and are quenched for longer periods of time, and the later softer particles are hidden initially and quenched for reduced periods of time.
- The increase in the middle of the plot is due to more particles surviving with that energy fraction. Drop on left for same reason: more surviving particles in the middle means hard particles on the left have smaller fraction of total energy.

Partonic Jet Shapes with $L_{Res} = \frac{1}{\pi T}$

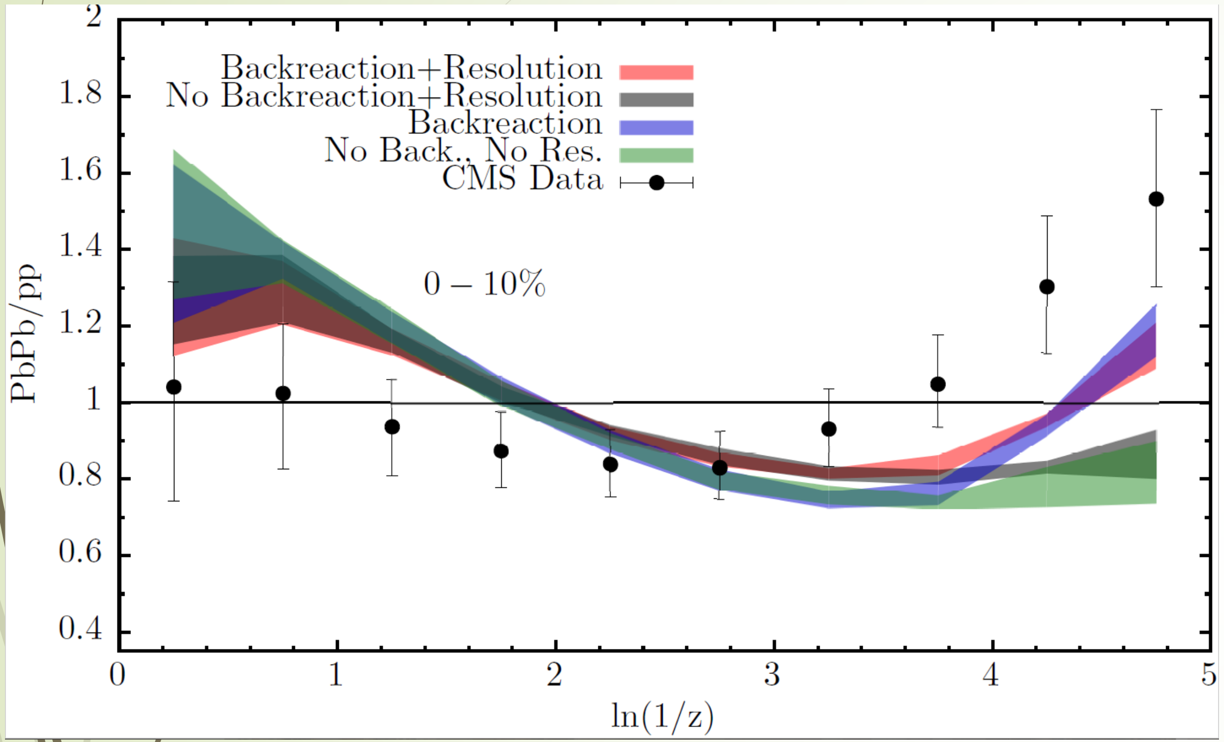


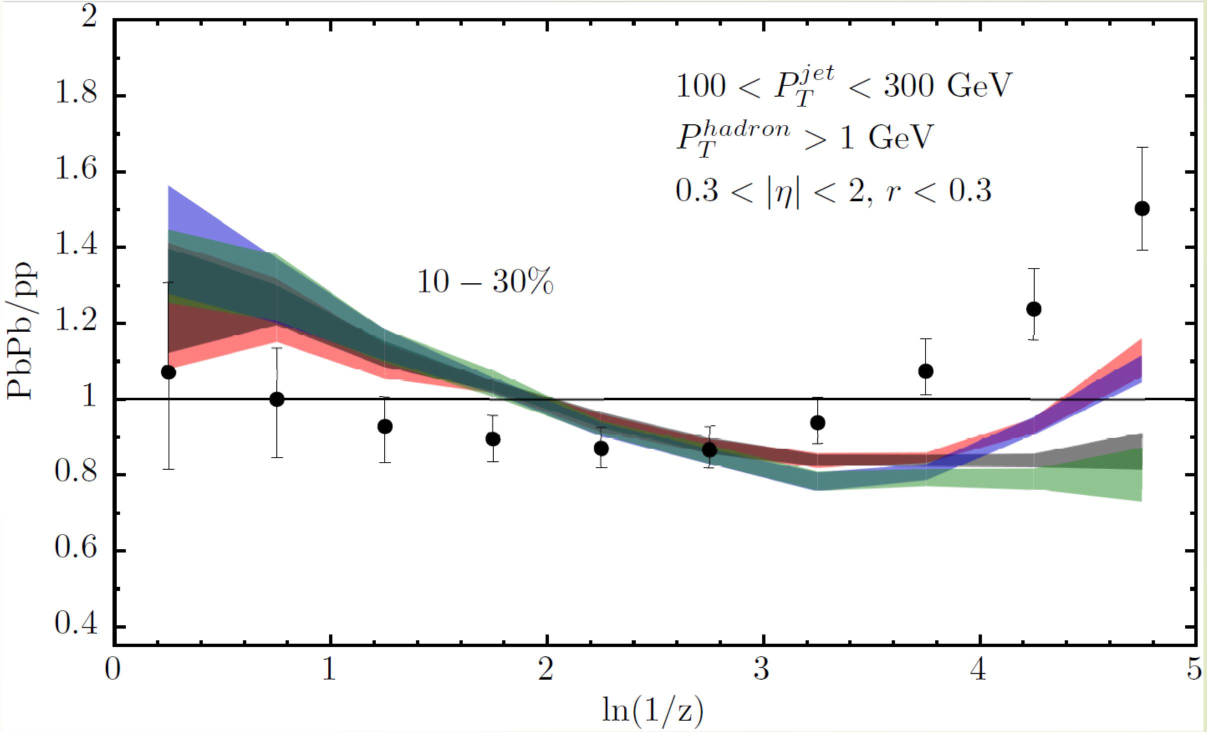
- Resolution effect pushes the curve down on the left and up on the right
- The hard early particles in the shower, which are in the center of the jets, are quenched for longer periods of time, while the later softer particles, found at all angles in the jet, are hidden initially and quenched for reduced periods of time
- The increase at the right of the plot is due to more particles surviving at larger angles. Drop on left for same reason: more surviving particles on the right of the plot means hard particles on the left have smaller fraction of total energy.

Missing PT

- We are also looking at the consequences of including resolution effects on the “Missing p_T” observables with delta and a_j cuts
- Mild quantitative modifications at $L_{Res} = \frac{1}{\pi T}$.

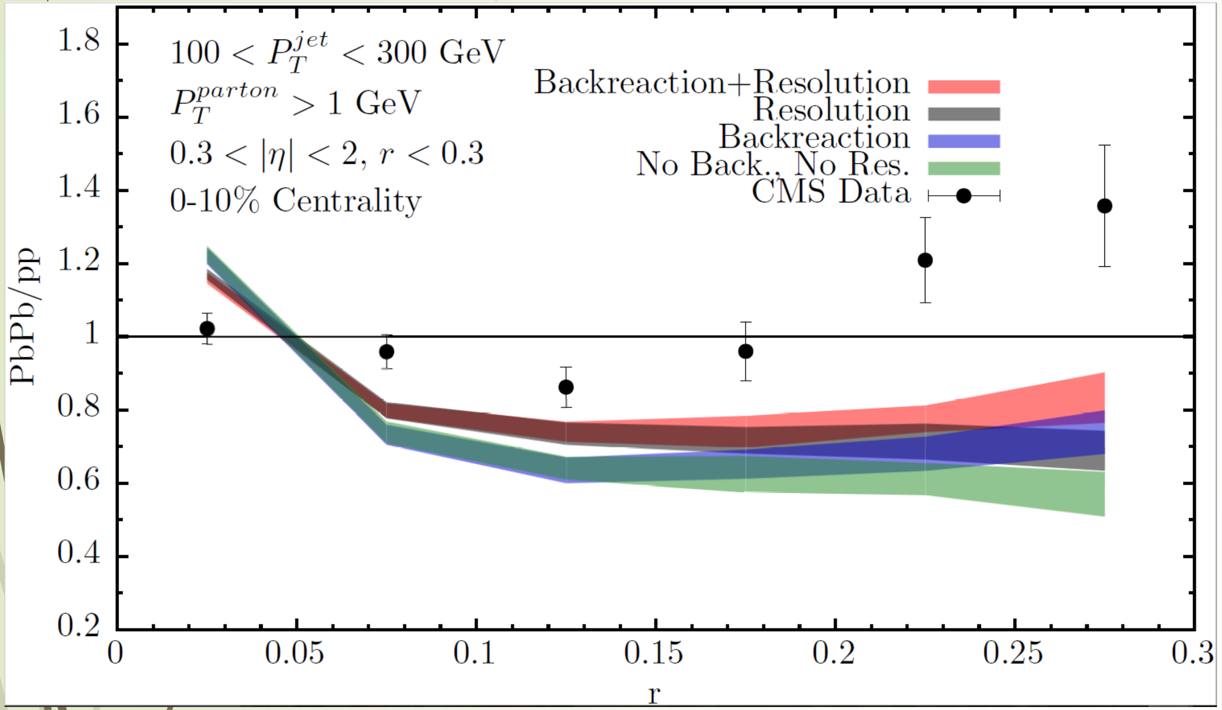
Hadronic Fragmentation Functions at $L_{Res} = \frac{1}{\pi T}$

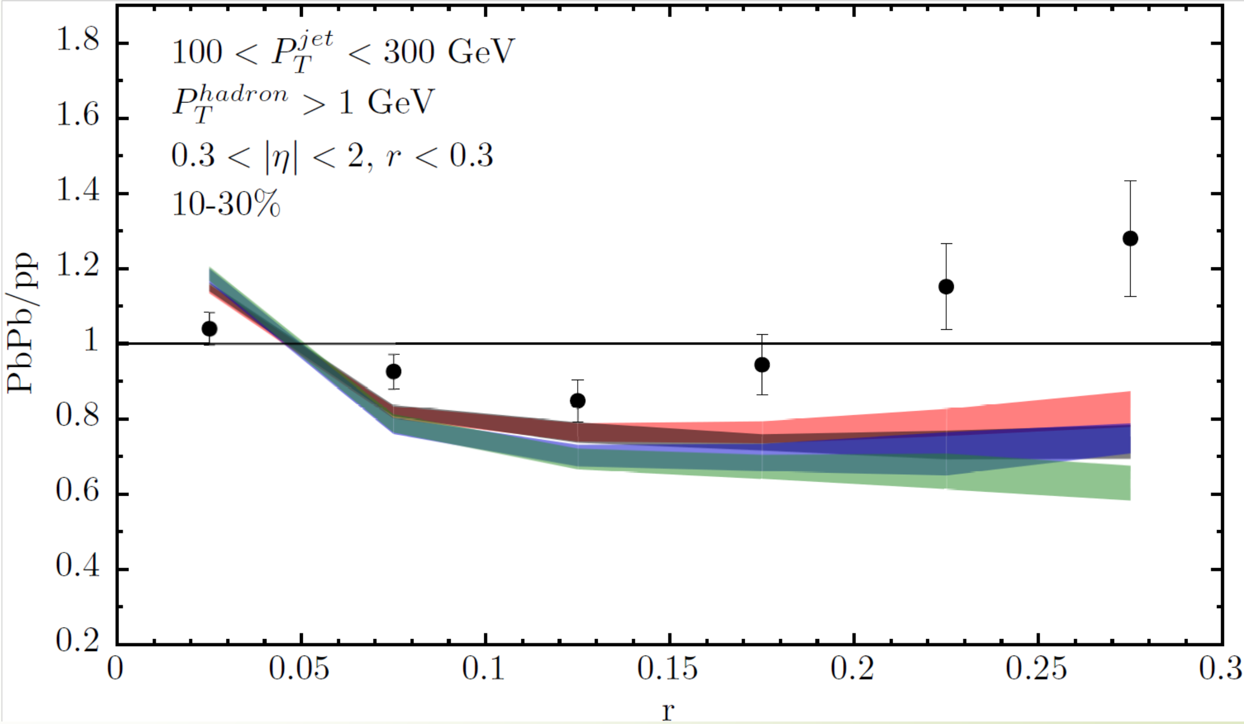




- Resolution effects for hadronized Jet Fragmentation Functions shows the same behavior as for partonic Jet Fragmentation Functions
- The middle part of the curve lifts as the later softer particles are hidden in the effective emitters and quenched for reduced periods of time
- The left part of the curve dips as the hard particles are relatively unchanged, but they make up less of the energy fraction of the jet

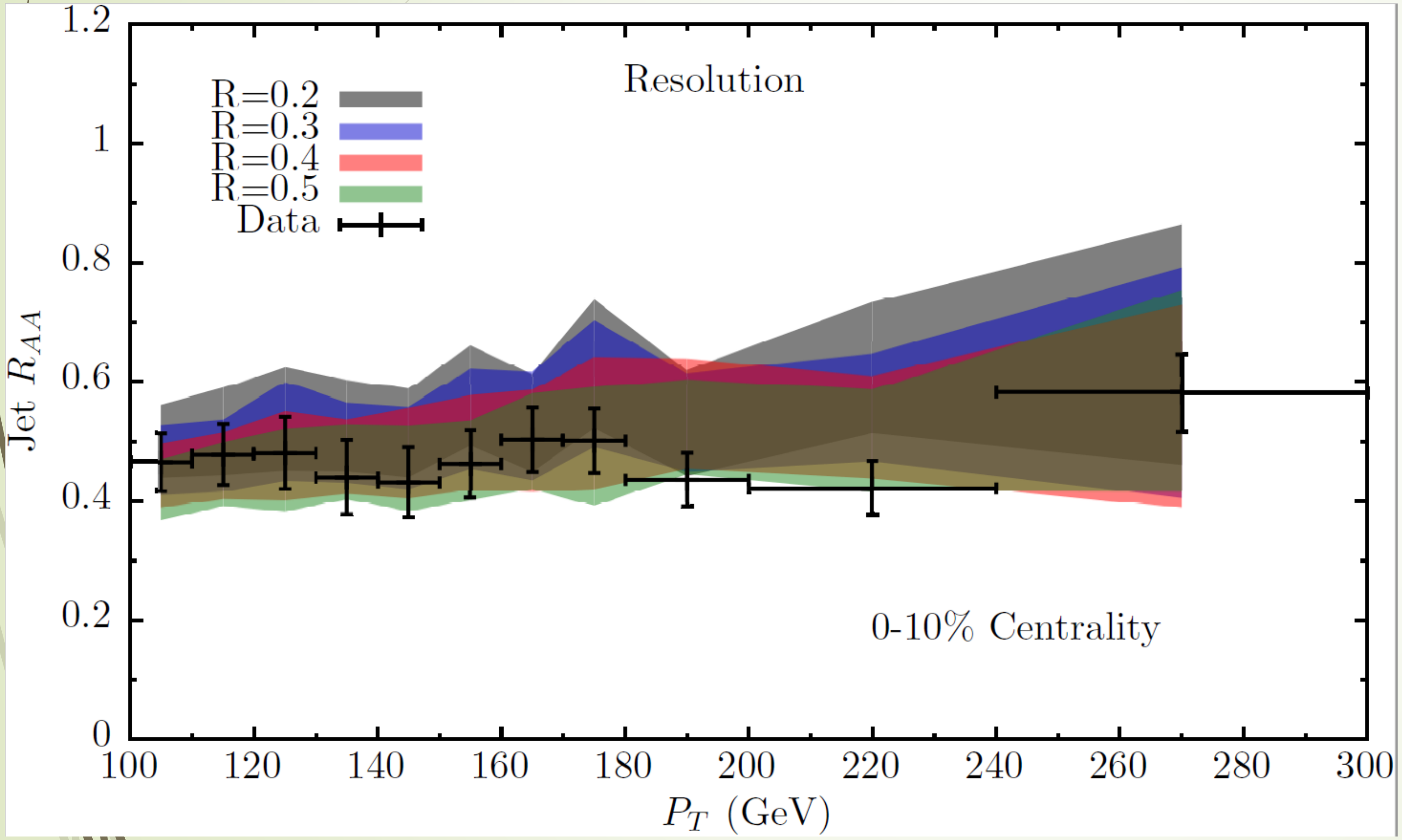
Hadronic Shapes at $L_{Res} = \frac{1}{\pi T}$





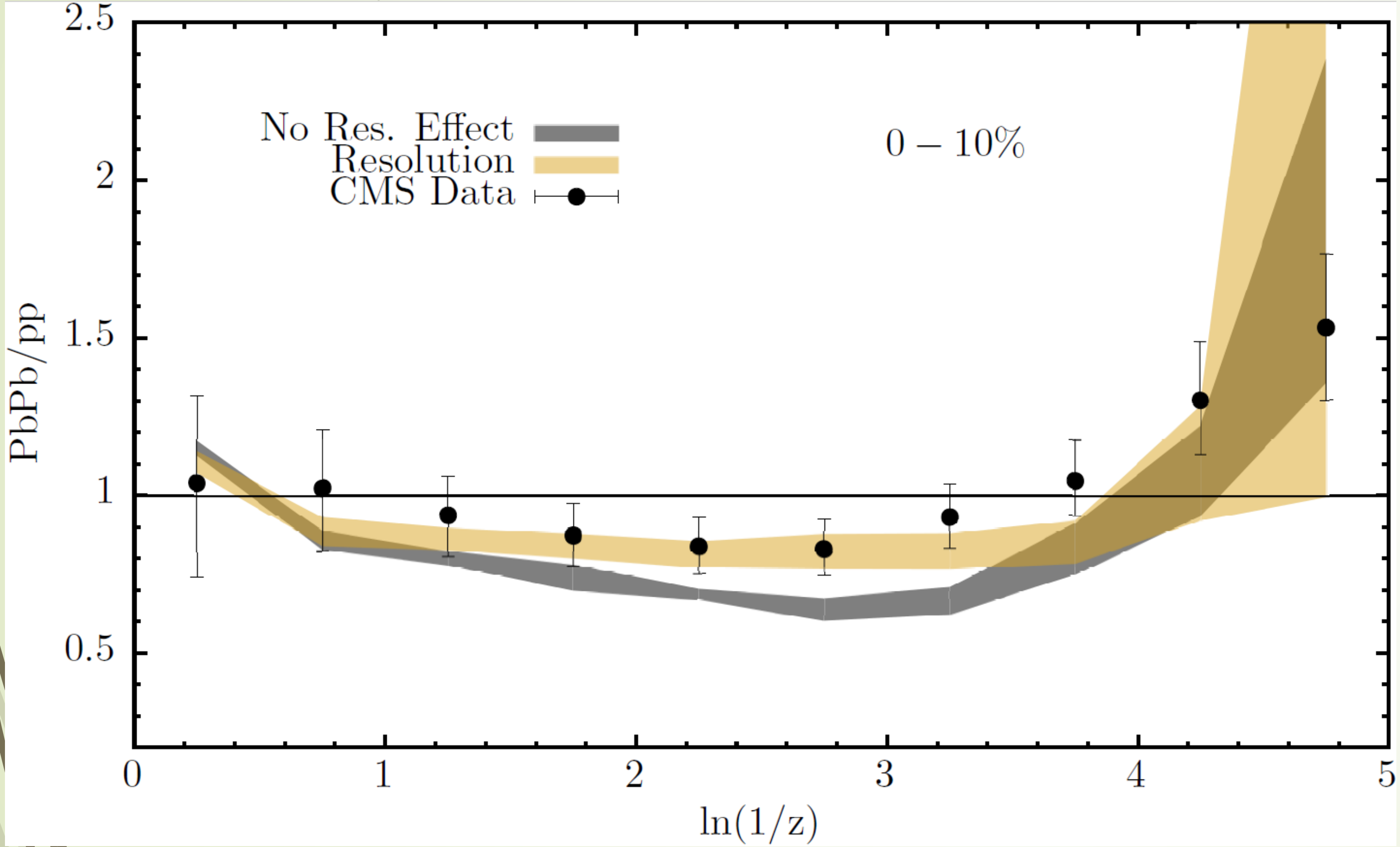
- Resolution effects for hadronized Jet Shapes shows the same behavior as for partonic Jet Shapes
- The middle of the curve lifts as the later softer particles at large angles are hidden and quenched for reduced periods of time
- The left part of the curve dips as the hard particles are relatively unchanged, but they make up less of the energy fraction of the jet

RAA at $L_{Res} = \frac{2}{\pi T}$



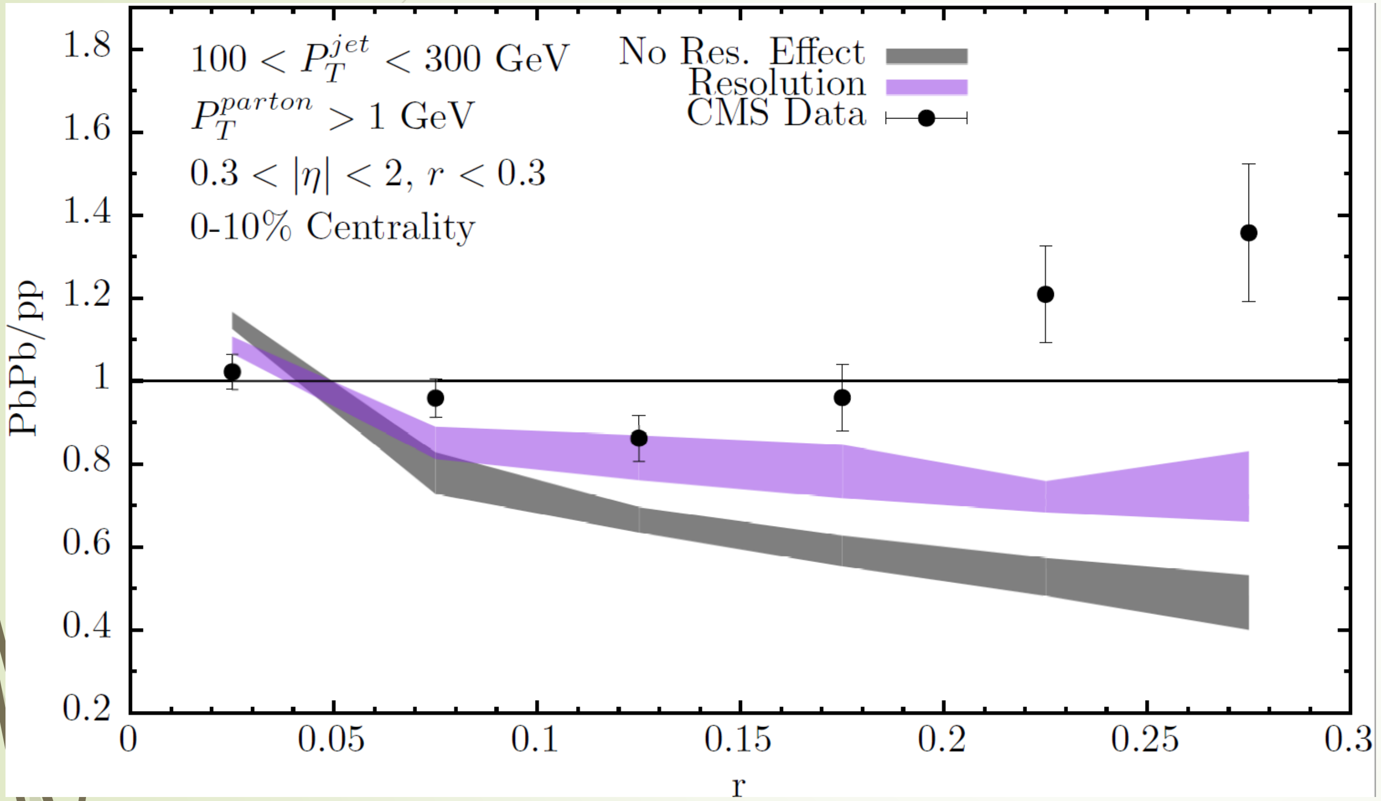
- We again fit κ in the model to the first bin in the partonic RAAvsR for $L_{Res} = \frac{2}{\pi T}$
- RAA is not changed much from the previous fit, as it is resistant to changes in κ and remains a good way to choose κ.
- Spread in κ is now 0.346 to 0.462

Fragmentation Functions at $L_{Res} = \frac{2}{\pi T}$



- Preliminary, lower statistics
- Far left of the plot is farther down with $L_{Res} = \frac{2}{\pi T}$, and far right is raised with respect to the same plot at $L_{Res} = \frac{1}{\pi T}$.
- The change in effect between $L_{Res} = \frac{1}{\pi T}$ and $L_{Res} = \frac{2}{\pi T}$ is relatively small.

Partonic Shapes at $L_{Res} = \frac{2}{\pi T}$



- Preliminary, lower statistics
- Far left of the plot is farther down with $L_{Res} = \frac{2}{\pi T}$, and far right is raised with respect to the same plot at $L_{Res} = \frac{1}{\pi T}$.
- The change in effect between $L_{Res} = \frac{1}{\pi T}$ and $L_{Res} = \frac{2}{\pi T}$ is relatively small.

Conclusions

- The analysis is ongoing.
- The resolution effect hides the later softer fragments in their earlier harder parents for some time, changing the Jet shapes and Fragmentation Functions in the direction of data from CMS and leaving RAA relatively unaltered.
- Compared to the effect of $\frac{1}{\pi \mathrm{T}}$ resolution scale vs no resolution, $\frac{2}{\pi \mathrm{T}}$ resolution scale is a further small improvement, but not as large a change.
- We are exploring different values of the resolution scale and plan to investigate more effects like the Soft Drop splitting function.