

# Uncovering Energy Loss in Small Systems via the $\tau$ -Algorithm

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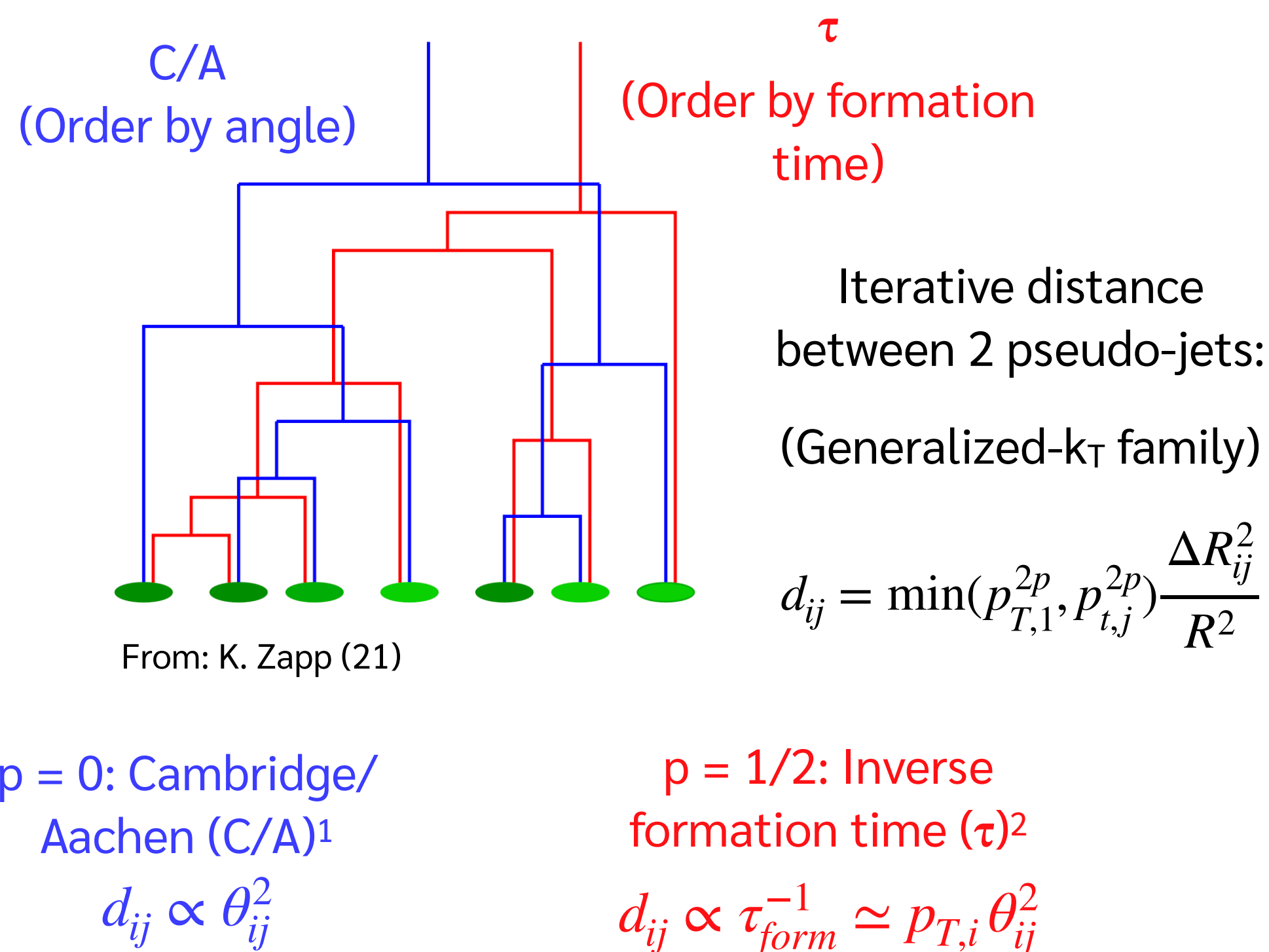
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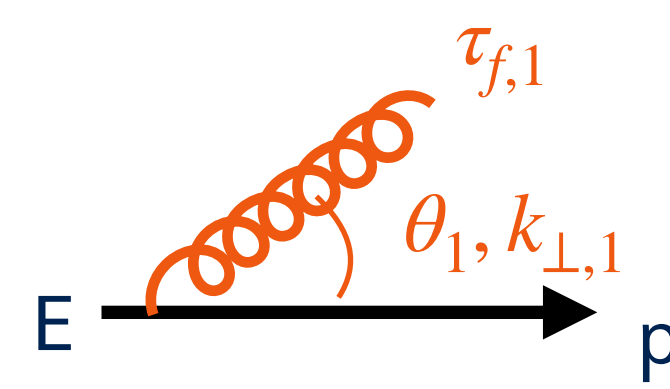
## The $\tau$ -Algorithm

### A jet re-clustering algorithm QGP studies



### QCD Parton Formation time

Understood as the time it takes for a quark/gluon to radiate

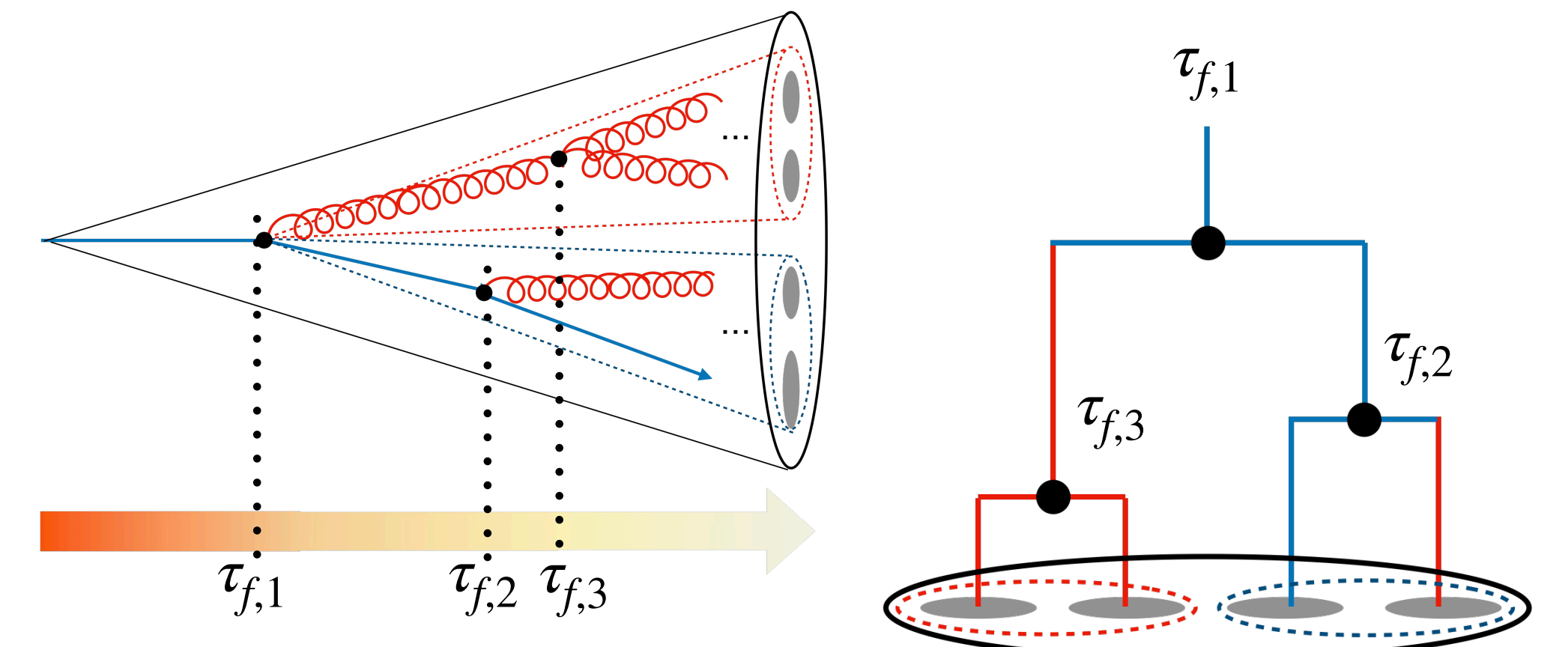


(Estimated from Heisenberg uncertainty principle)

$$\tau_{form} \sim \frac{E}{M_{virt}} \frac{1}{M_{virt}}$$

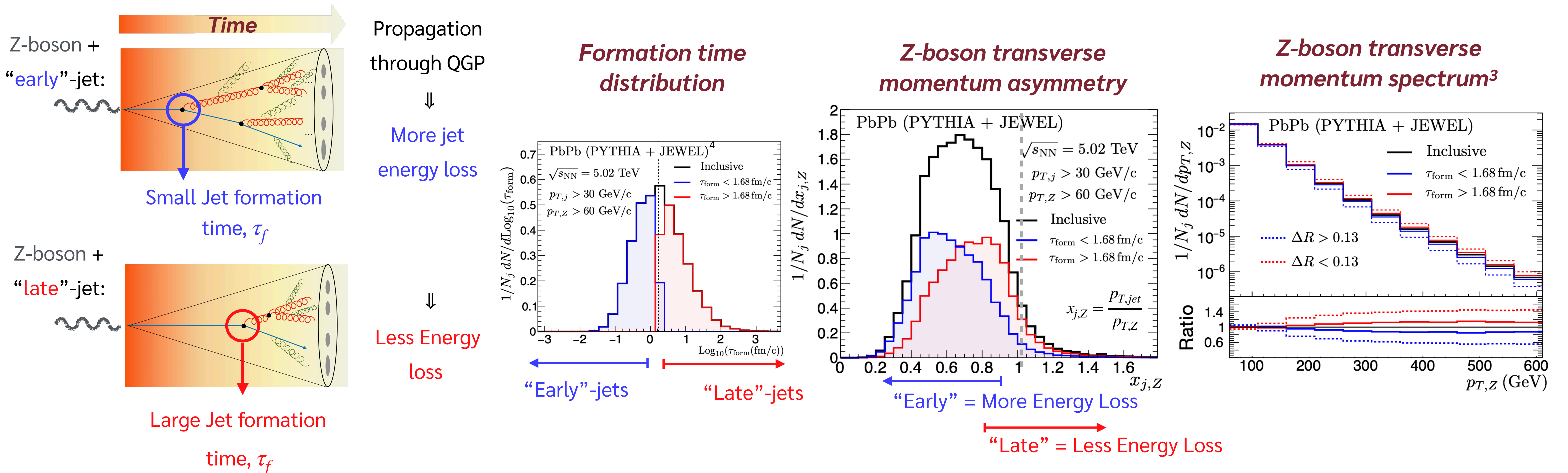
### The “earliest” jet clustering step

First unclustering step is the one with the shortest formation time



## Calibrated energy loss

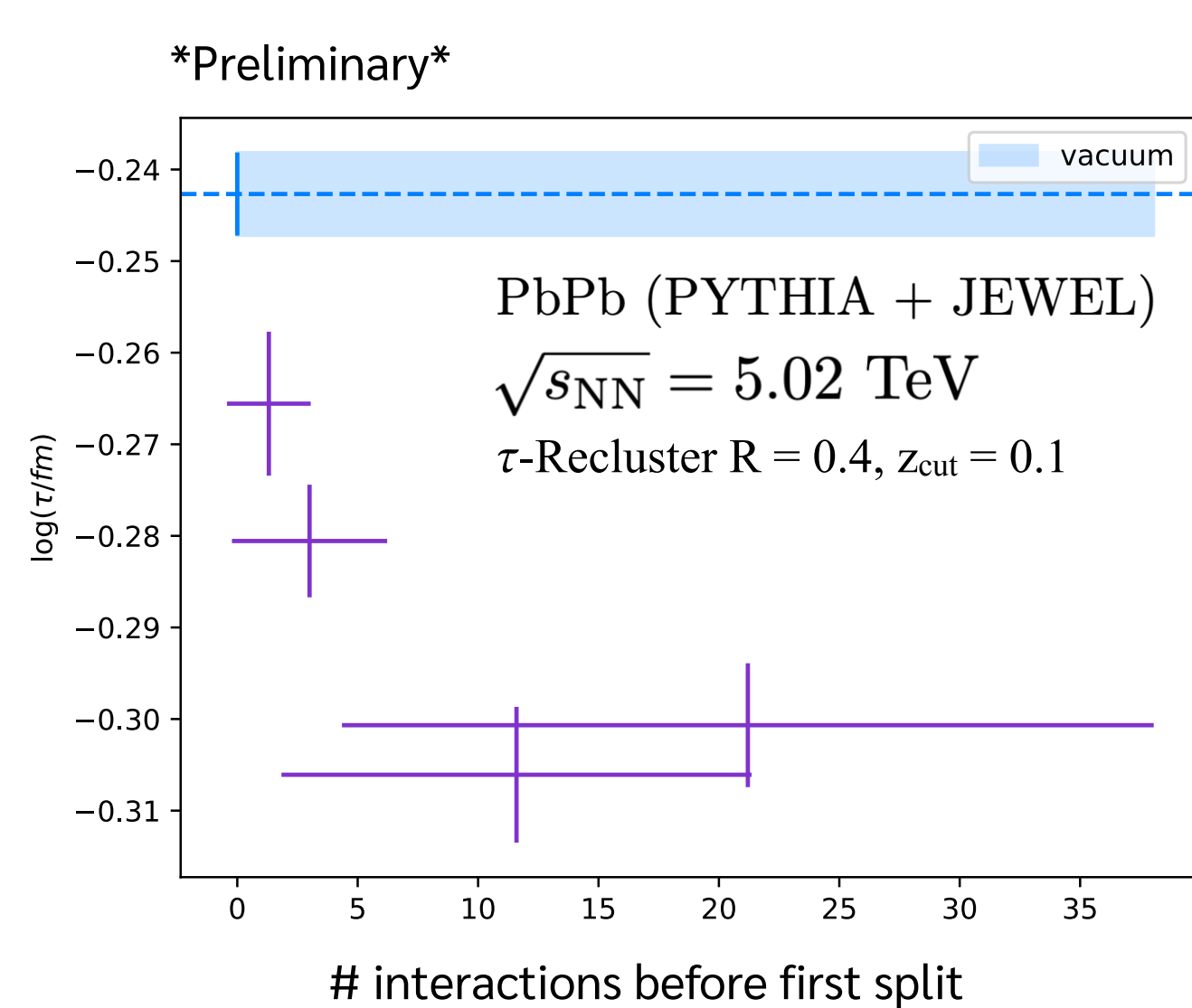
In heavy-ion collisions, formation time allows to **select jets strongly modified by the QGP and assess energy loss** with smaller dependence on initial jet transverse momentum



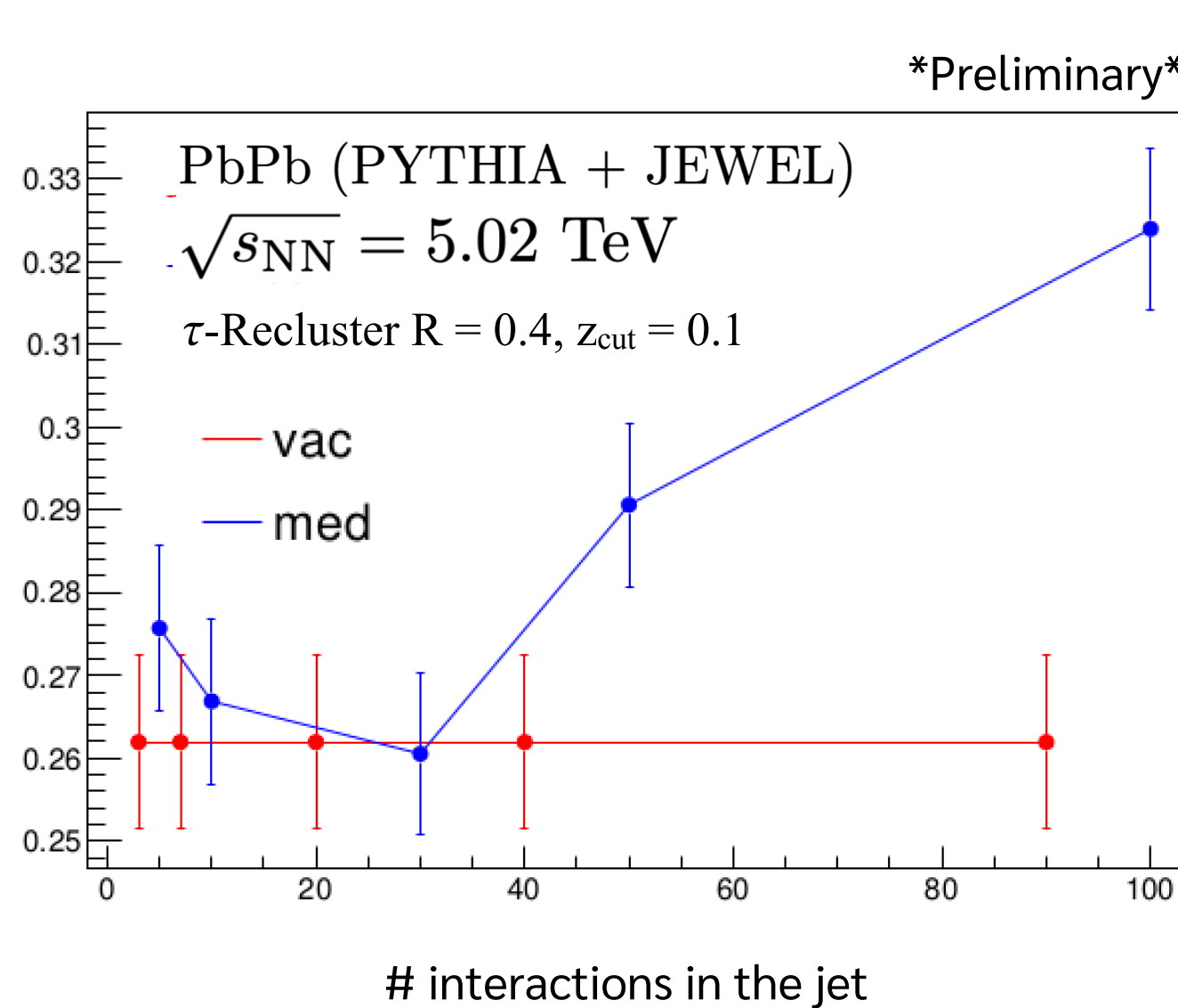
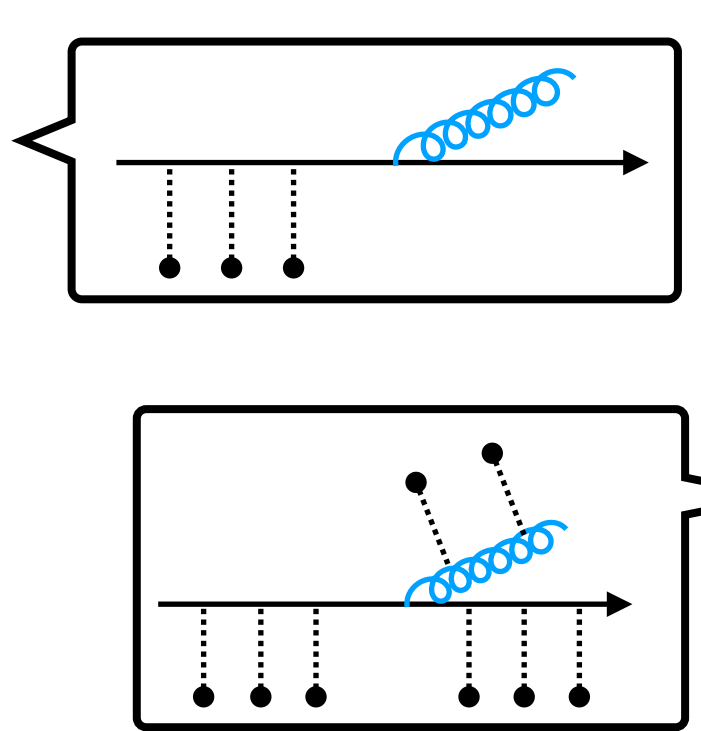
## Going for small systems...

The interplay between the **in-medium effects** will determine how the **formation time distribution** will be **modified**. Going for a simpler setup:

### Constant medium density and fixed number of interactions

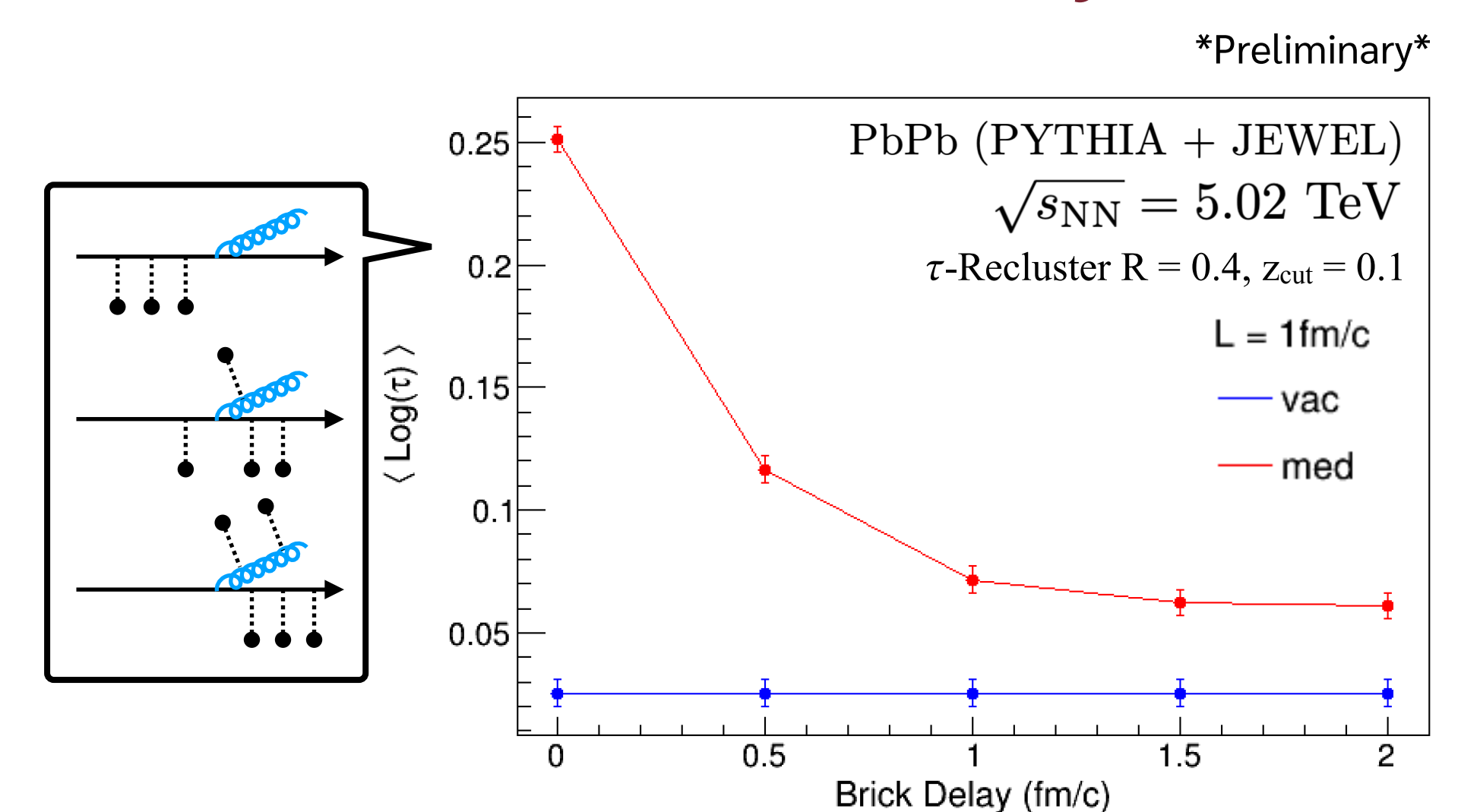


In-medium interactions break angular ordering



Energy loss will dominate with increasing number of interactions

### Small brick with different delay times



Delaying brick results into a  $\tau_f$  close to vacuum reference  
(Energy loss still contributes to shift  $\tau_f$ )

## Outlook

- $\tau$ -Algorithm first unclustering step shows a promising avenue for more differential jet measurements
- Future work aims to assess  $\tau_f$  resolution and its modification to more realistic conditions (evolving medium, production points, scattering potential, ...)

## References

1. Dokshitzer, Leder, Moretti, Webber, JHEP 08 (1997) 001
2. L. Apolinário, A. Cordeiro, K. Zapp, Eur.Phys.J.C 81 (2021) 6, 561
3. L. Apolinário, P. Guerrero-Rodriguez, K. Zapp, Eur.Phys.J.C 84 (2024) 7, 672
4. K. Zapp, Eur.Phys.J.C 74 (2014) 2, 2762