Sorting out energy loss for medium-modified jets

Jasmine Brewer

With Guilherme Milhano and Jesse Thaler

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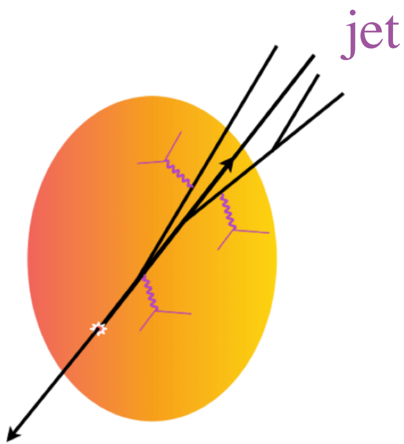
Jets: a multi-scale probe of the QGP



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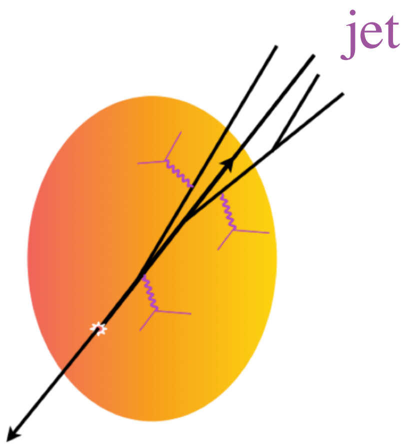

- How is a jet modified by the quark-gluon plasma?

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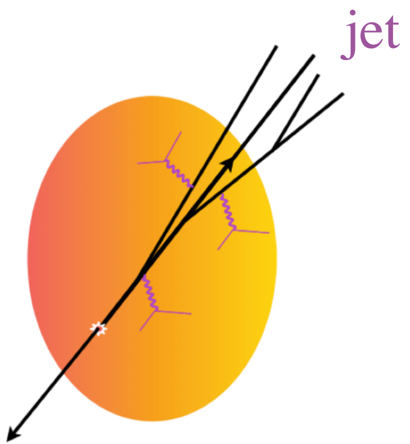

- How is a jet modified by the quark-gluon plasma?
- What can we learn about the medium on different length scales?

Key question: compare A-A jets to which p-p jets?

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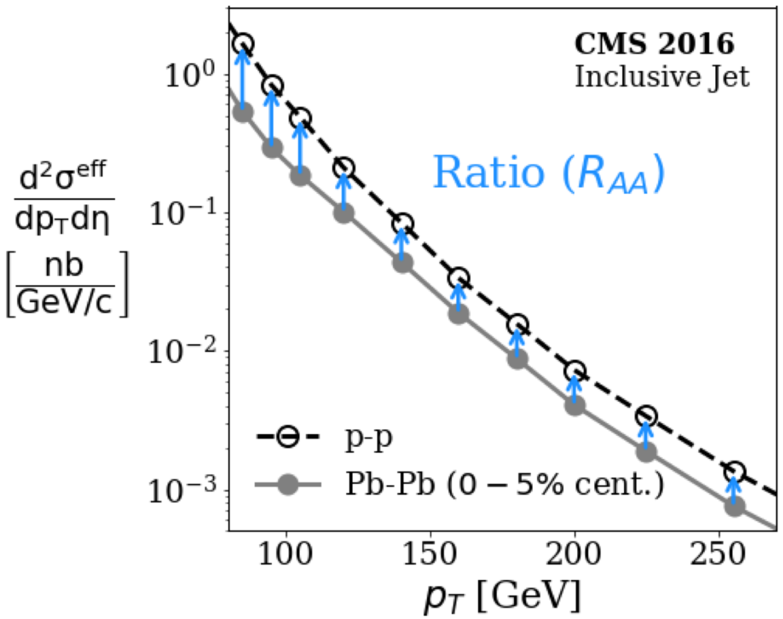
- Standard answer: match final (reconstructed) p_T



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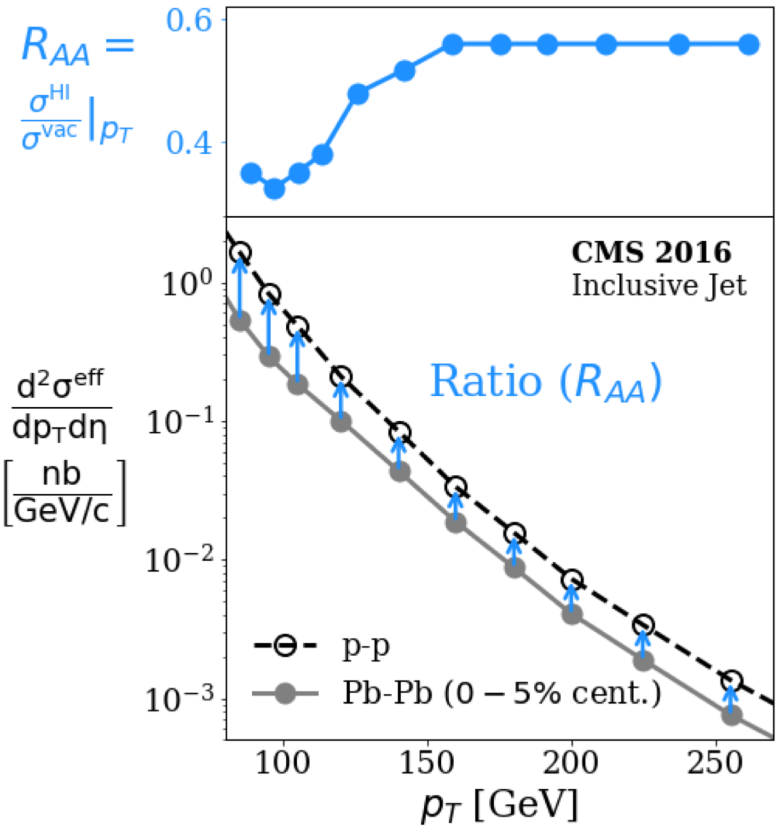

“Jet modification” observables: part modification and part bias

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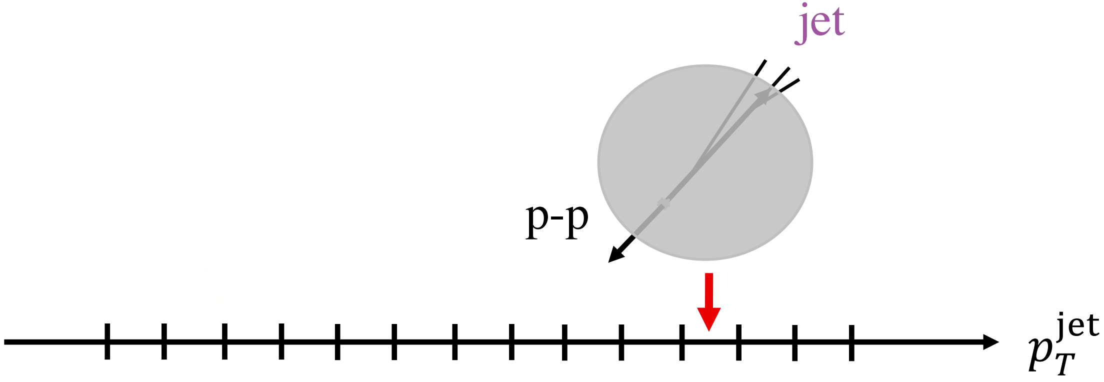

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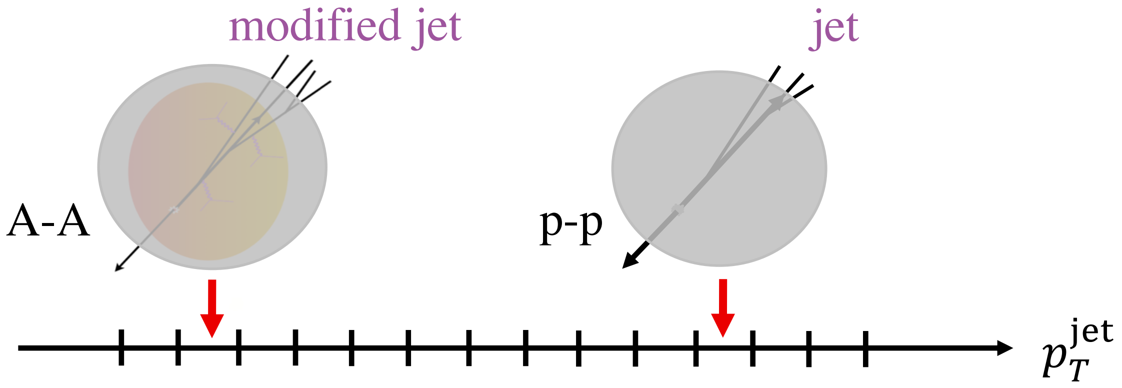

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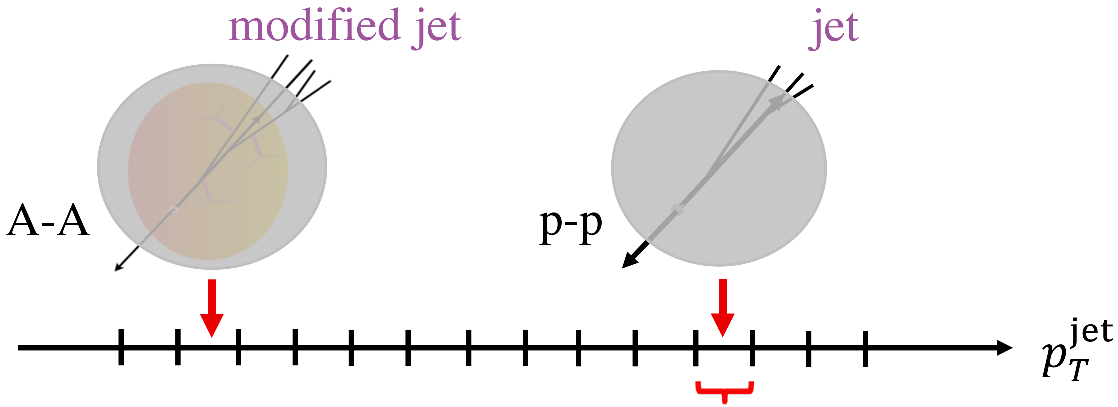

Compare features of p-p and A-A jets

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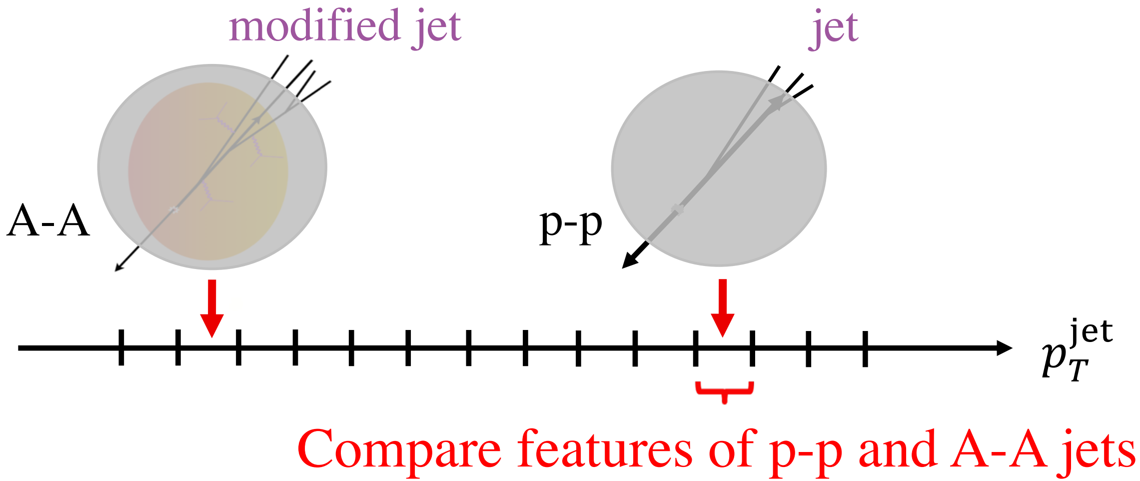

- Significant biases from migration of jets to lower energy

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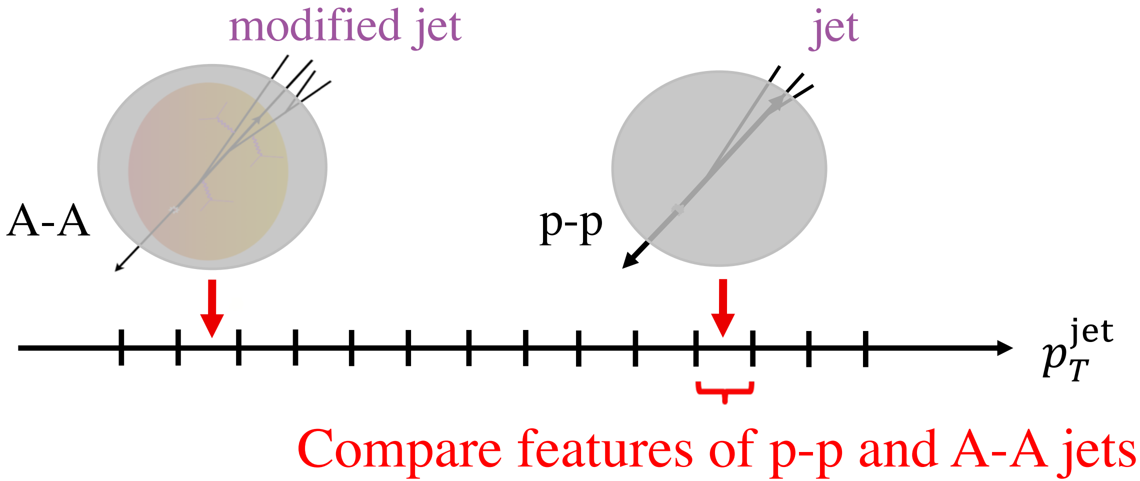

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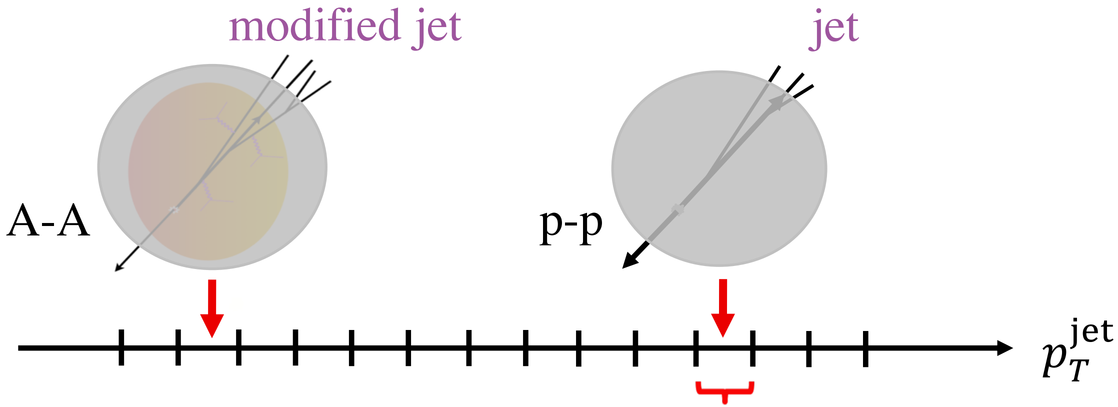

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- Significant biases from migration of jets to lower energy
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Often requires significant theory input to interpret measurements

Key question: compare A-A jets to which p-p jets?

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- Another answer: match in (effective) cumulative jet cross-section

$$\sigma^{\text{eff}} = \sigma^{\text{pp}}, \sigma^{\text{HI}}/\langle T_{AA}\rangle$$

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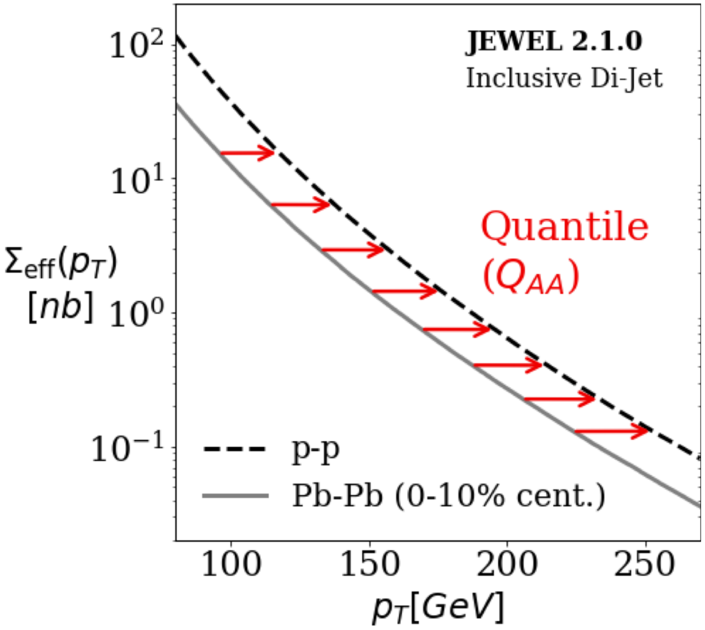
- "Quantile" matching



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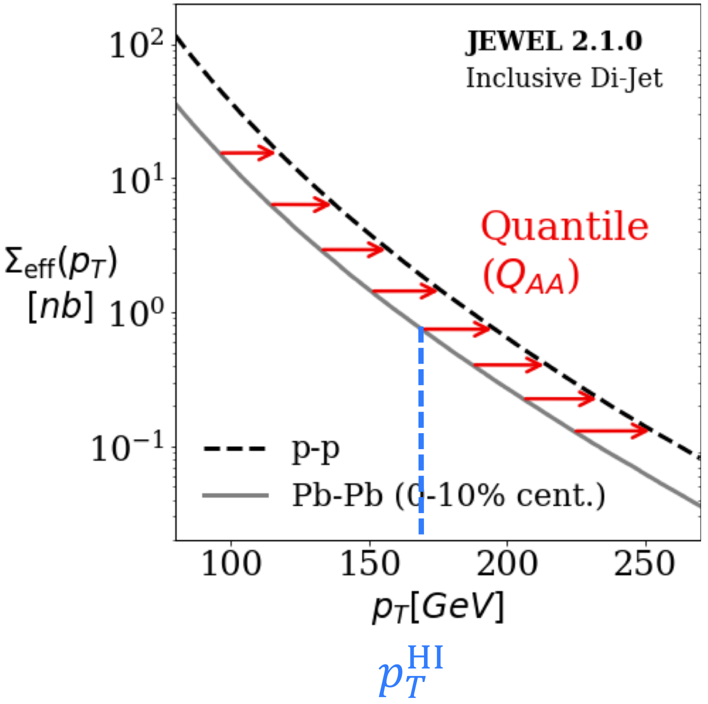

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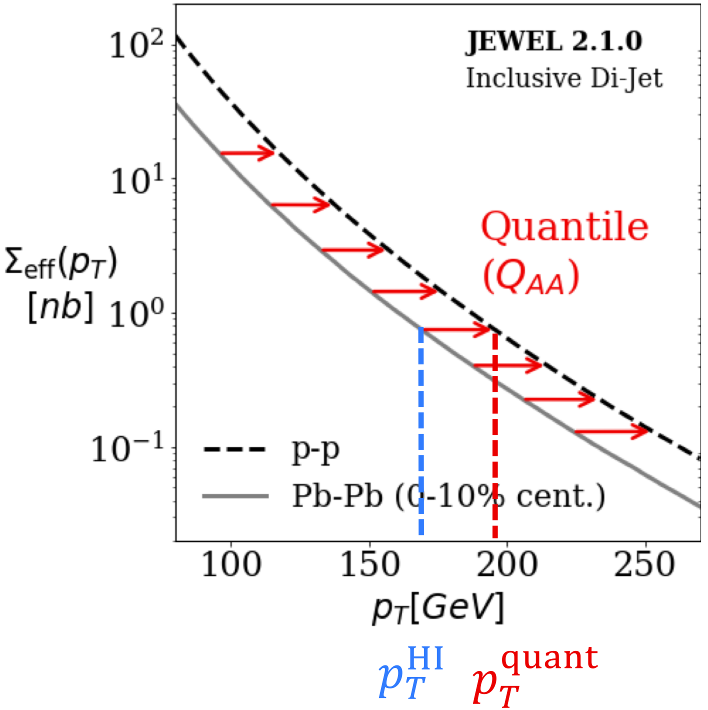

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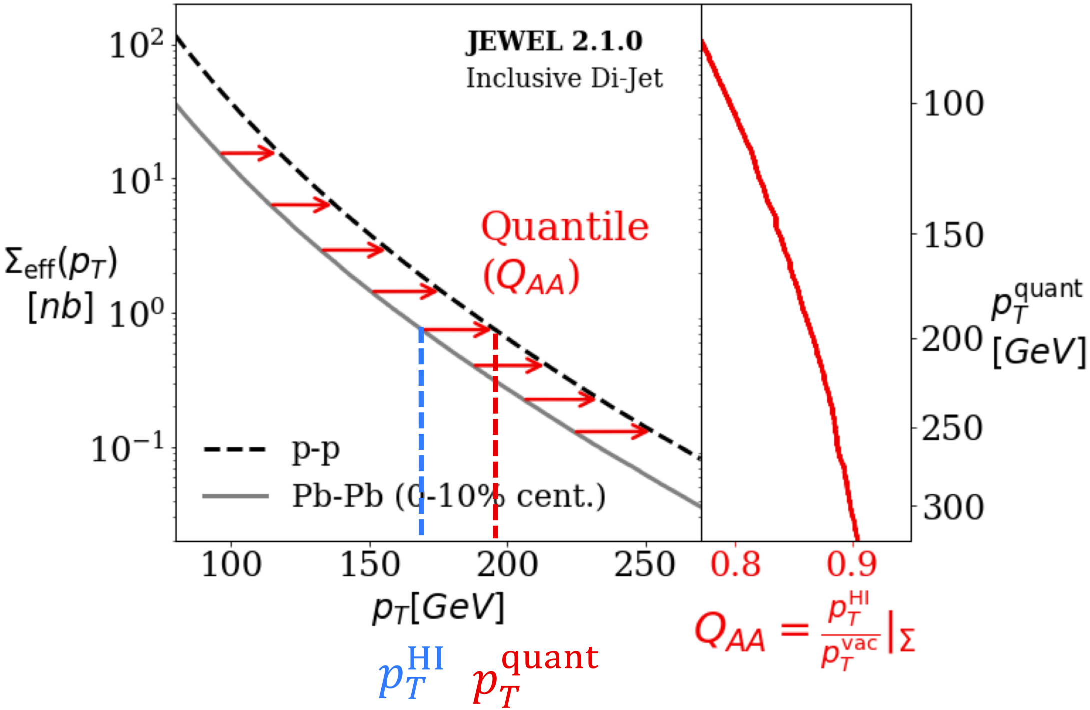
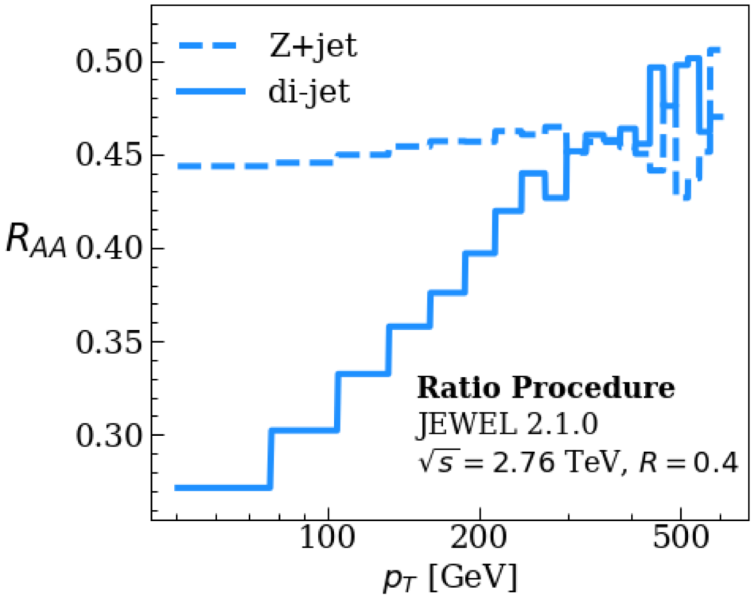
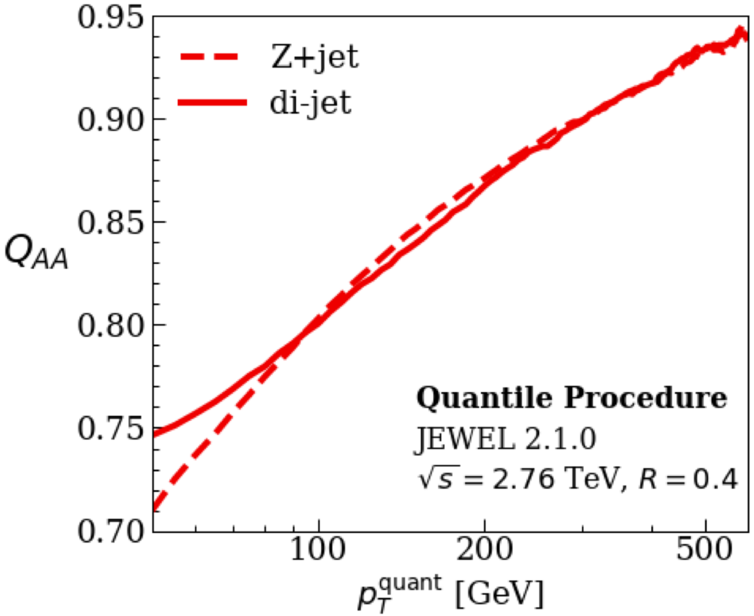


Interpretation of R_{AA} and Q_{AA} is significantly different…



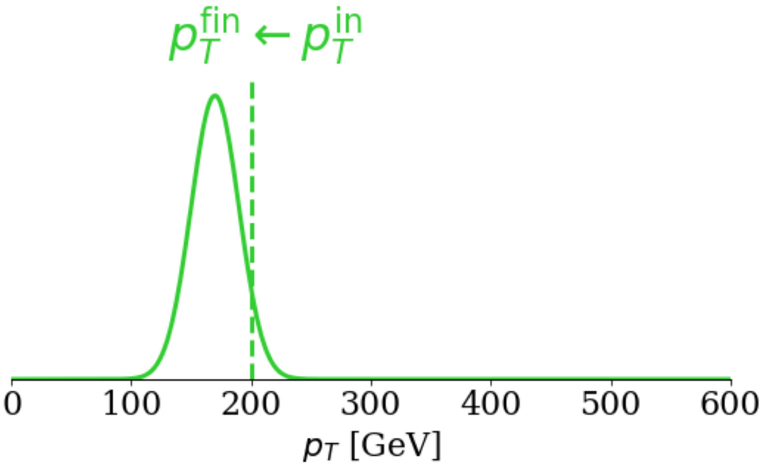


Average jet loss per p_T

Average p_T loss per jet

That was Q_{AA} -- what about p_T^{quant}?

Sorting out energy loss: quantile matching



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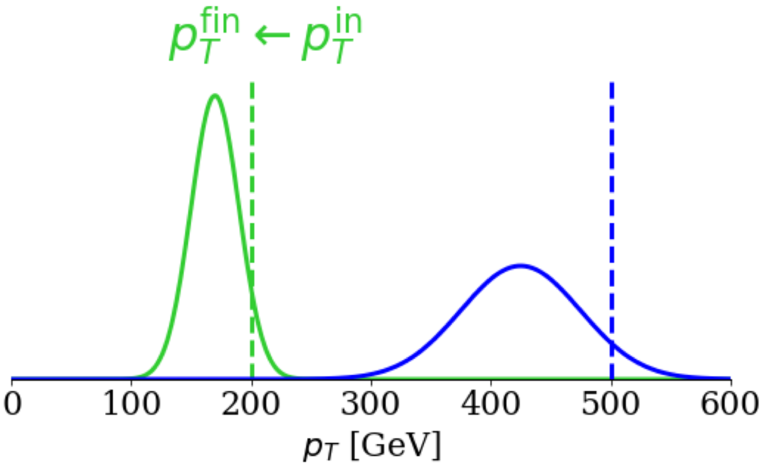

Quenched and initial p_T have same ordering

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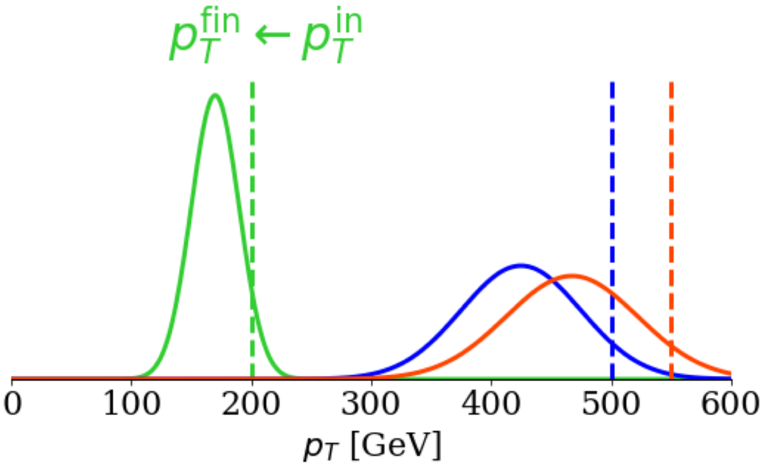
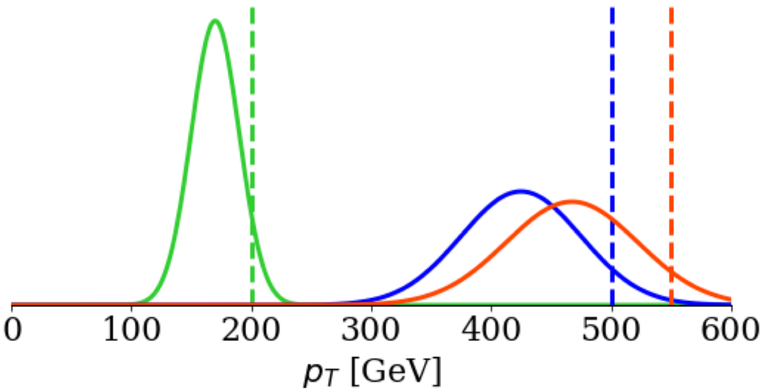


Quenched and initial p_T ^may have same ordering

Sorting out energy loss: quantile matching

Energy loss is...

on average monotonic in p_T



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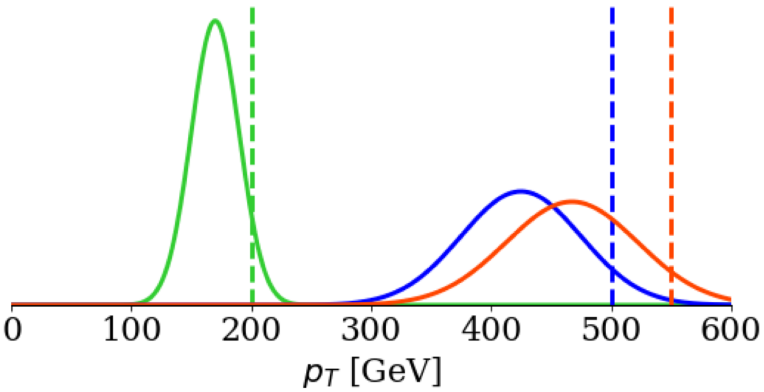

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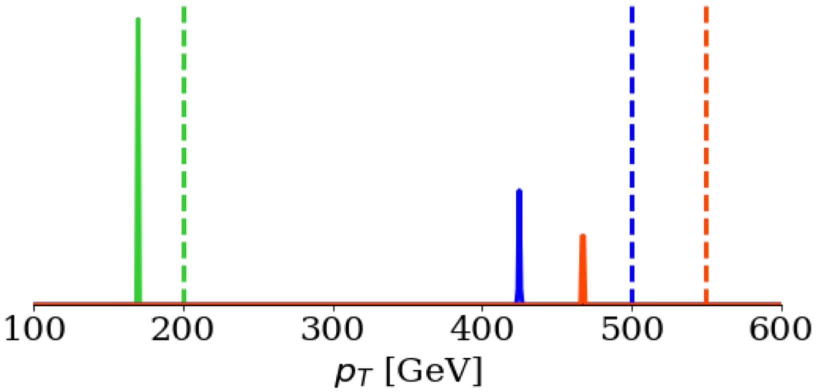

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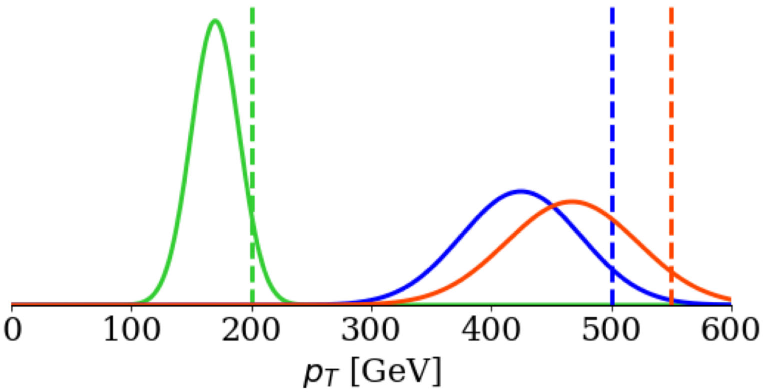

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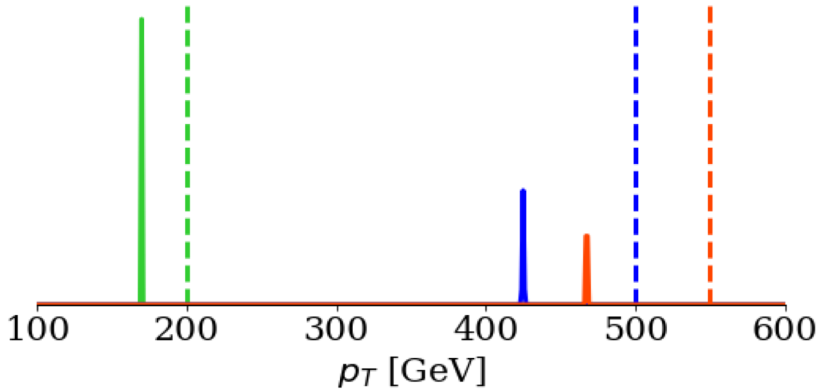

In this limit, quantile matching gives equivalent jets in p-p and A-A

Sorting out energy loss: quantile matching

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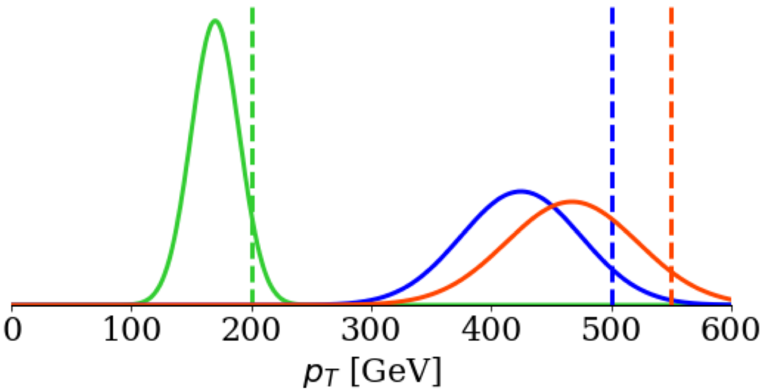

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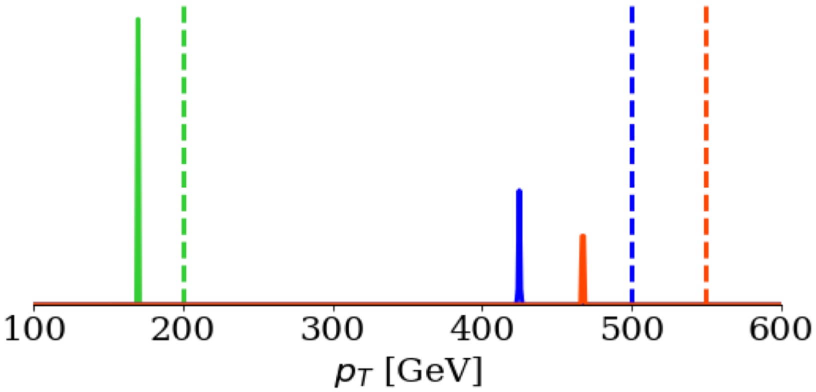
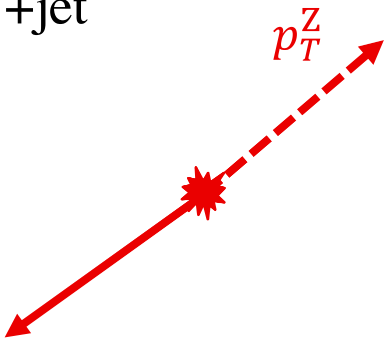


How does quantile matching work in the more realistic case?

How to quantify that?

How to quantify that?

Z+jet



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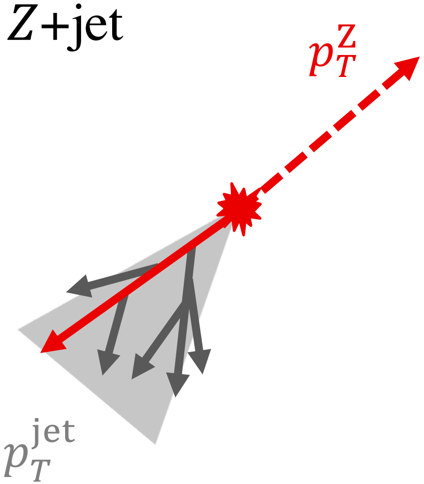

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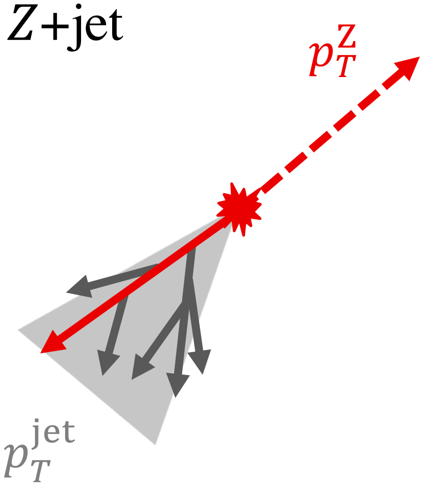
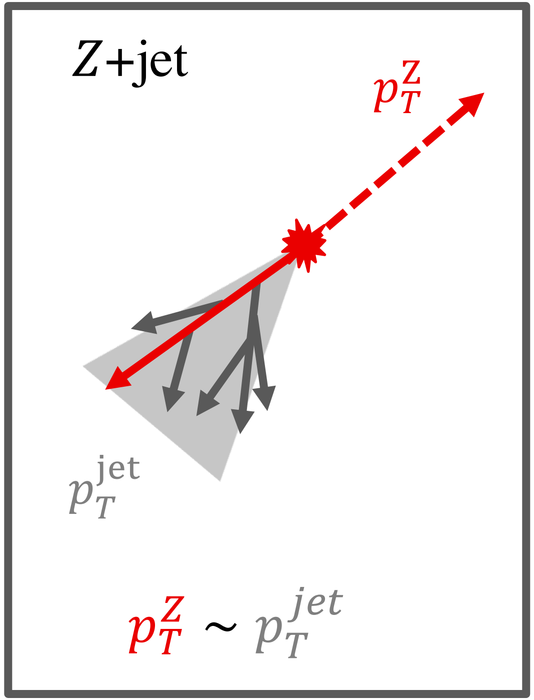


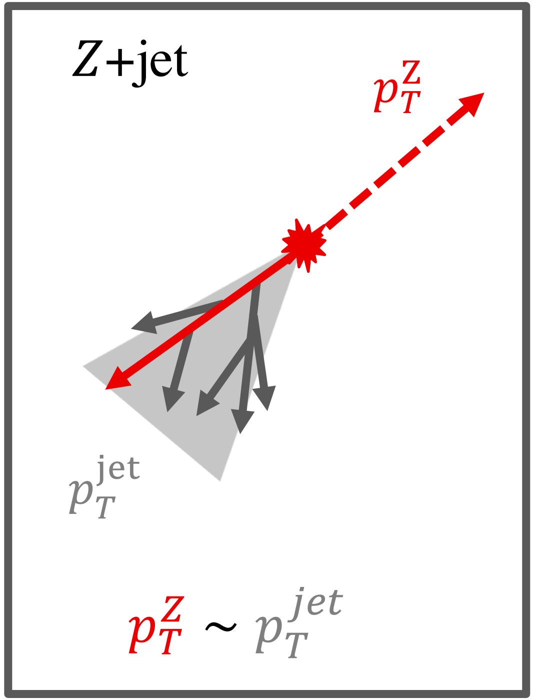
$p_T^Z \sim p_T^{jet}$

How to quantify that?



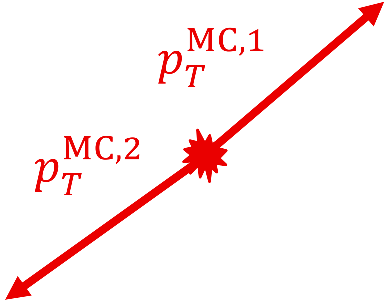
Probe of p_T^{jet} in data

How to quantify that?



Probe of p_T^{jet} in data

Di-jets



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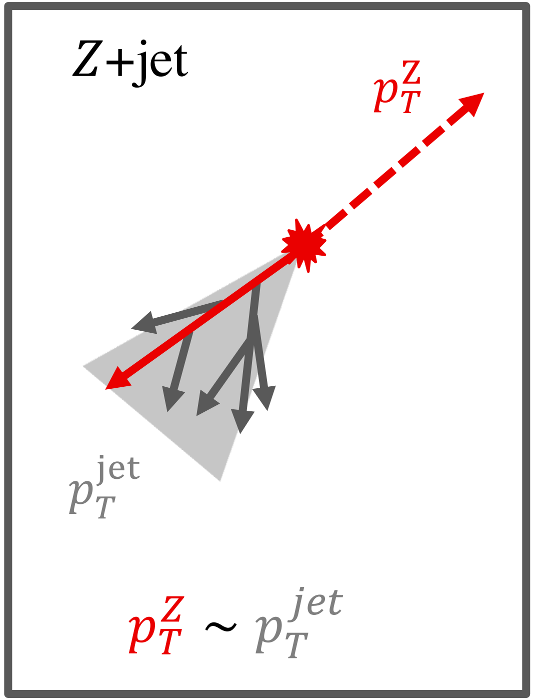

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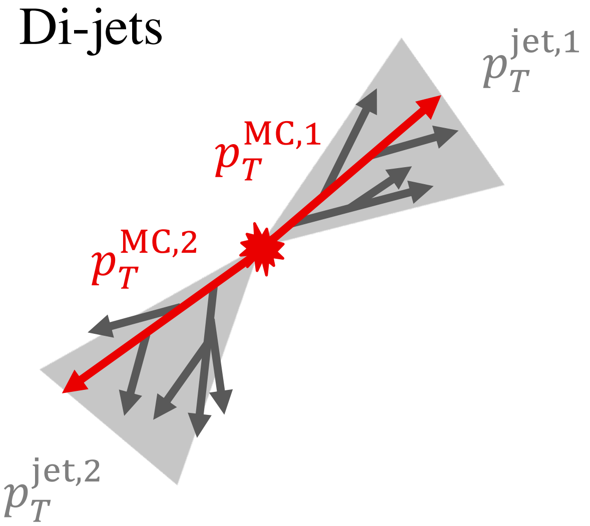

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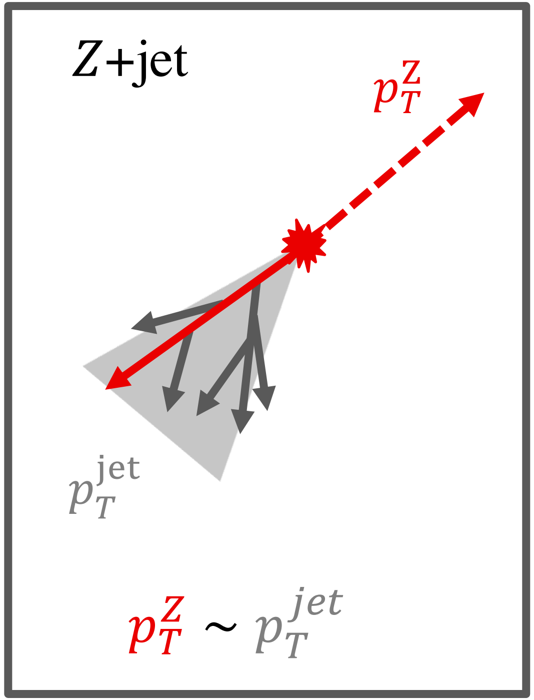

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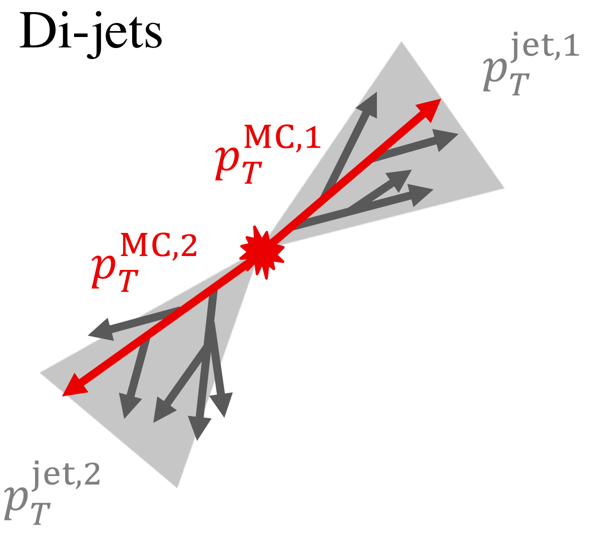

Unphysical $p_T^{MC} \sim p_T^{jet}$

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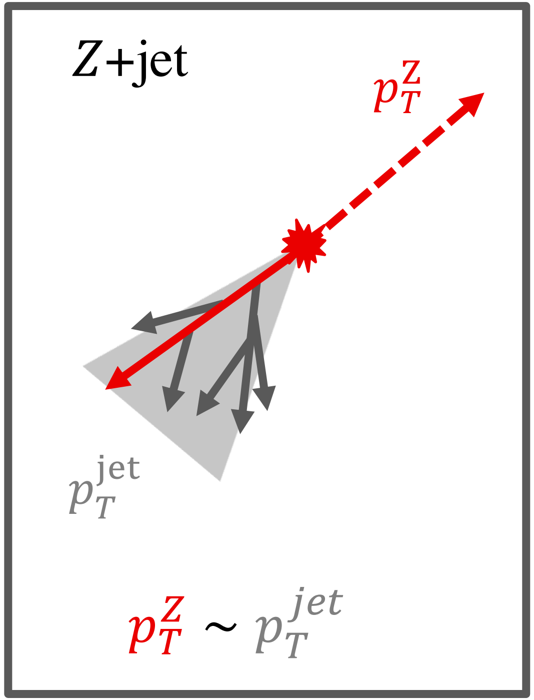

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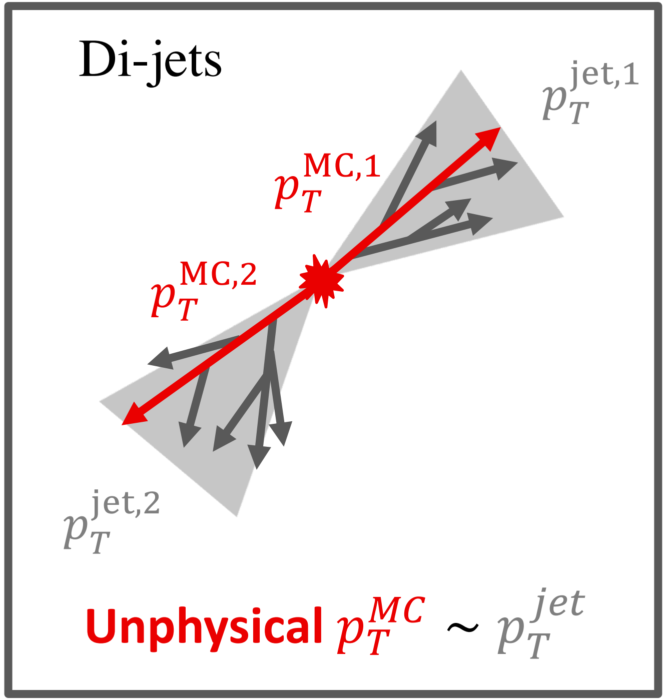
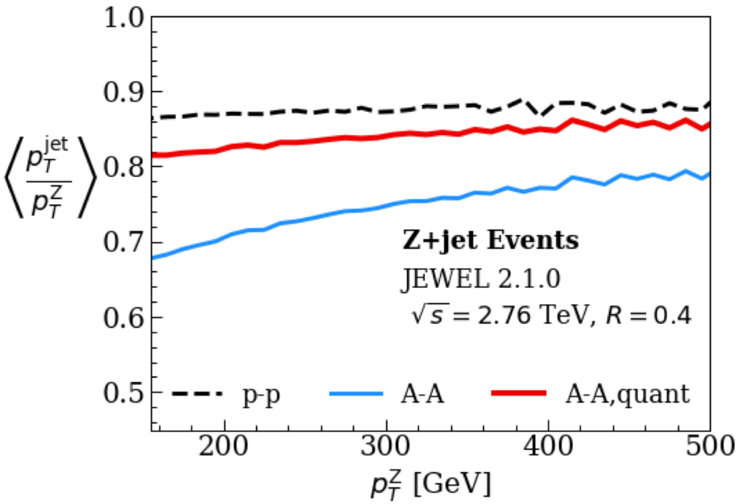


Probe of p_T^{jet} in Monte Carlo

Quantile matching approximates initial p_T of A-A jets

Z+jet



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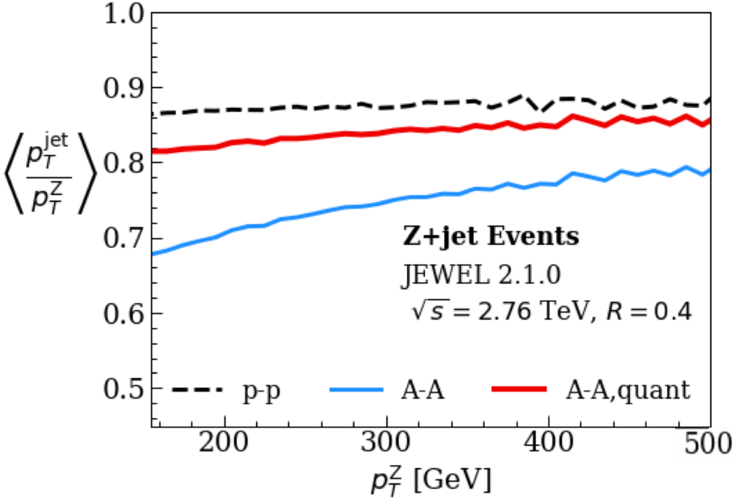

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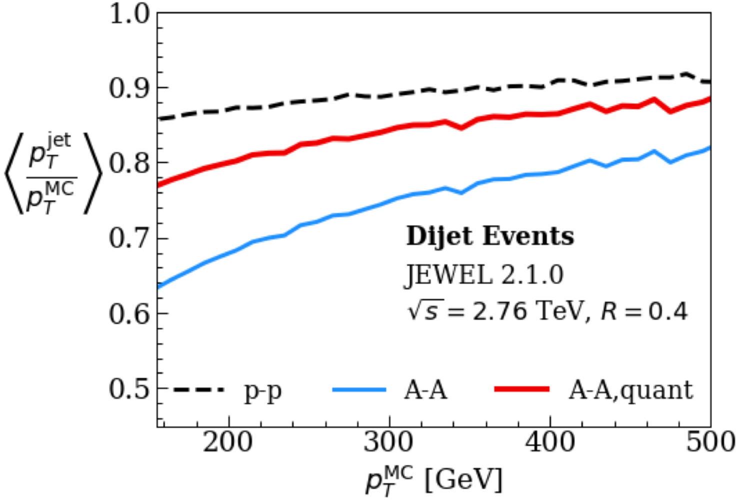

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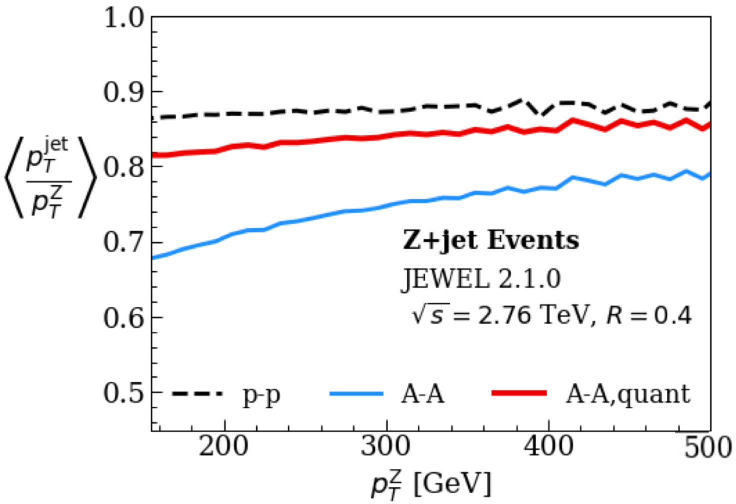

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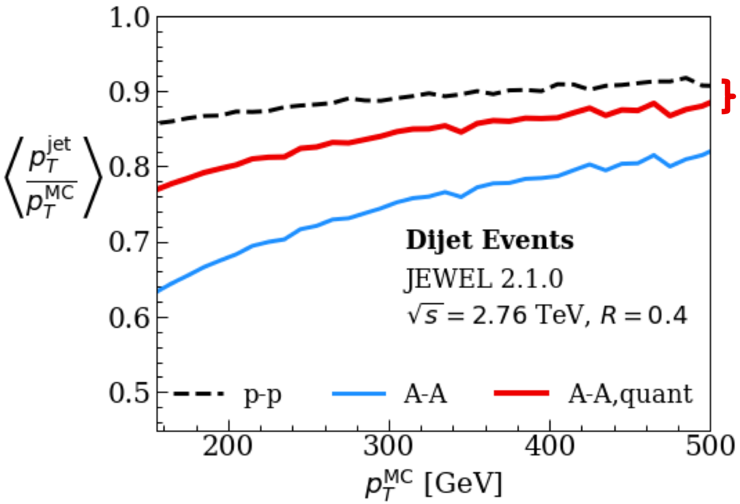
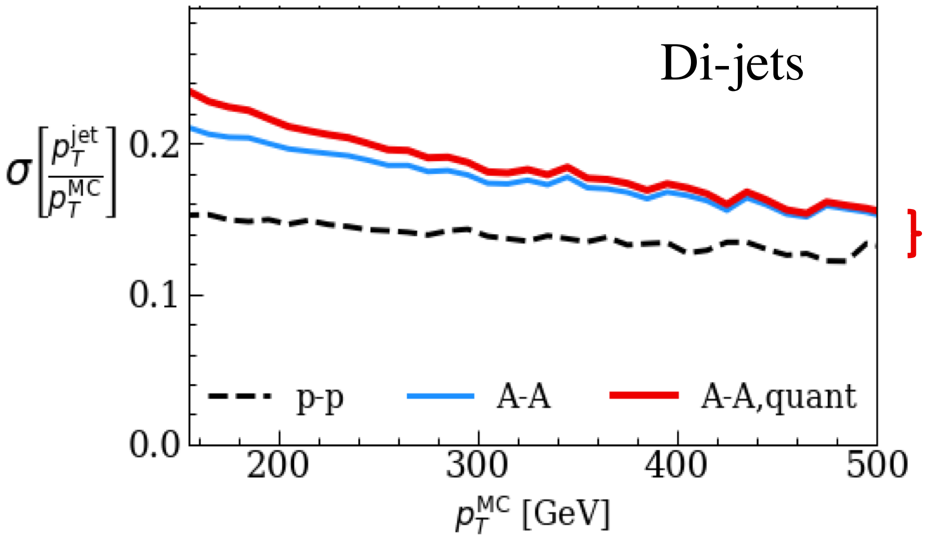


} mean more similar

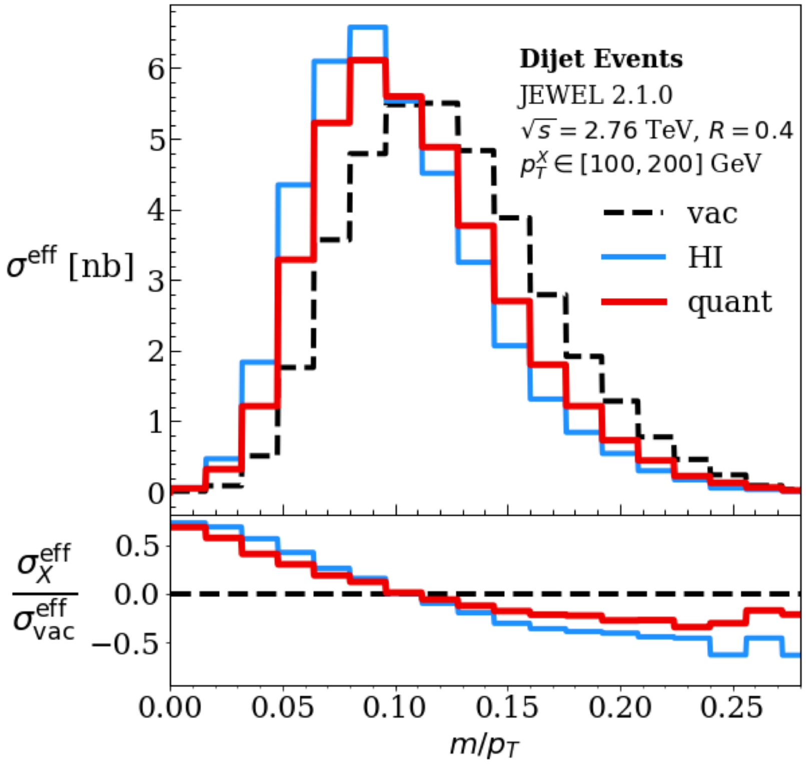
Compared to reconstructed p_T in A-A…

Quantile procedure does not undo energy loss fluctuations



larger standard deviation

Application to modification observables



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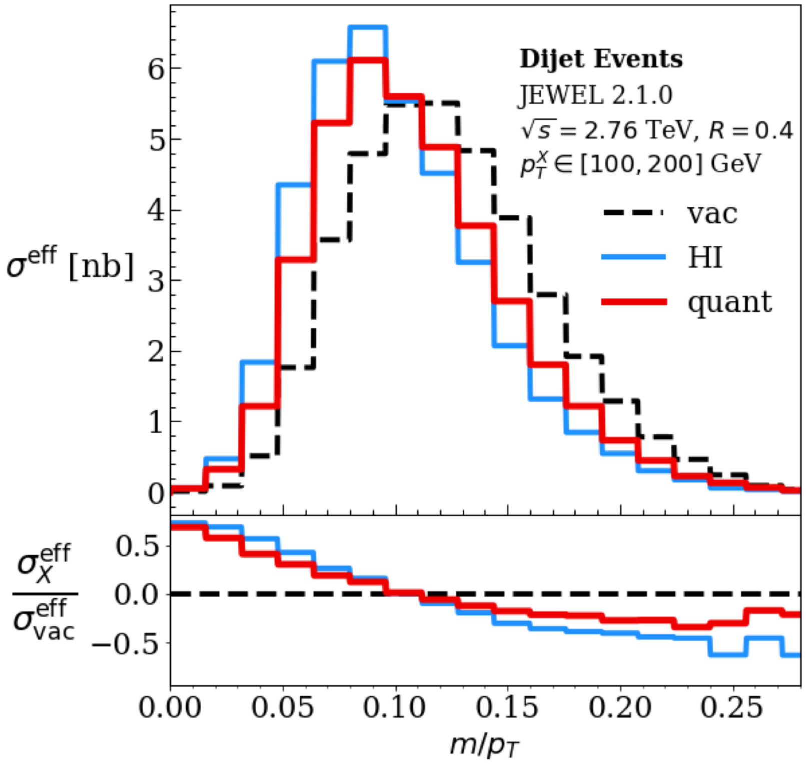

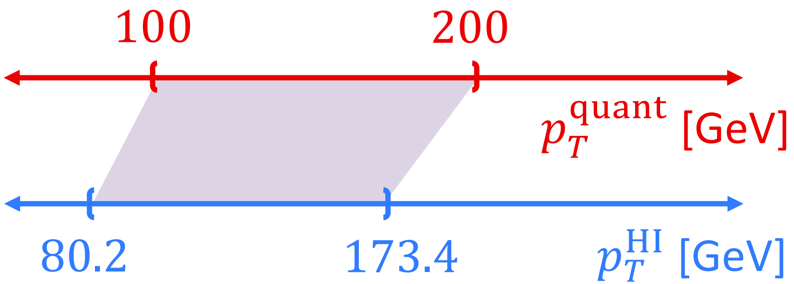

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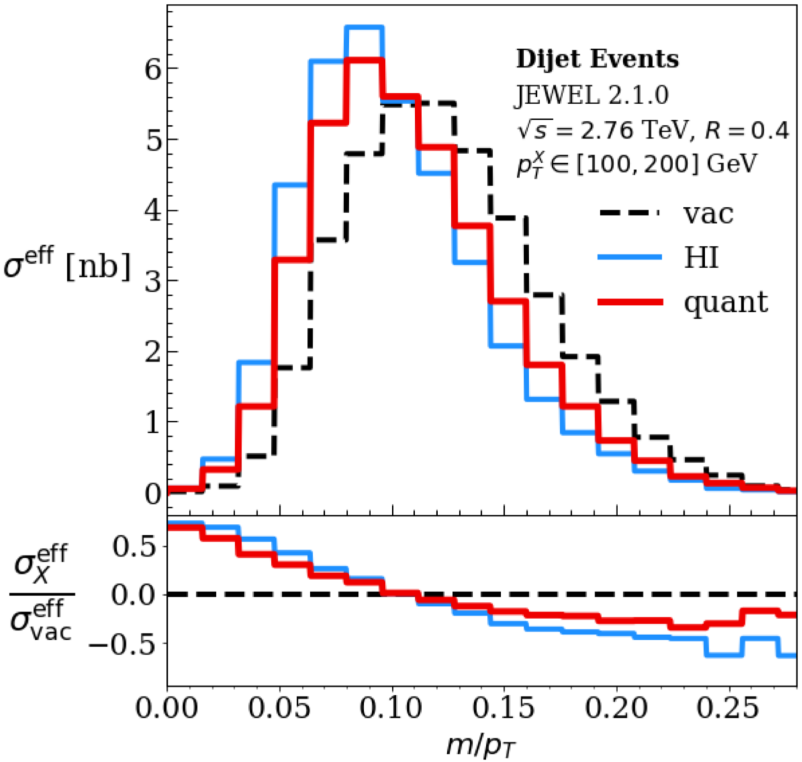

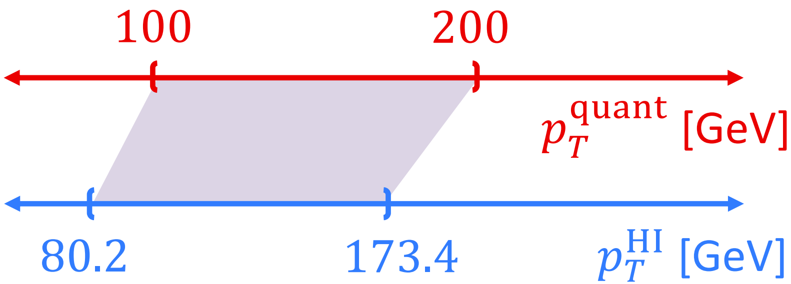

- Sensitivity to matching indicates significant jet p_T migration effects

Summary

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- Demonstrated two new observables: Q_{AA} and p_T^{quant}

Summary

Q_{AA}:

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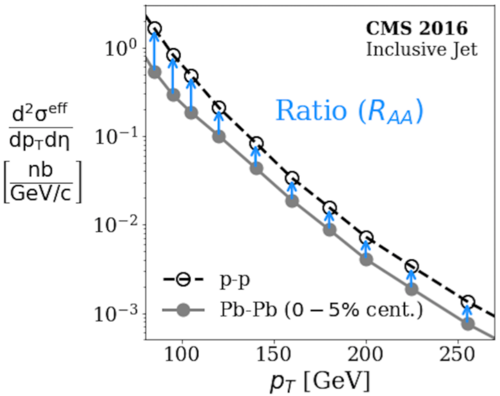
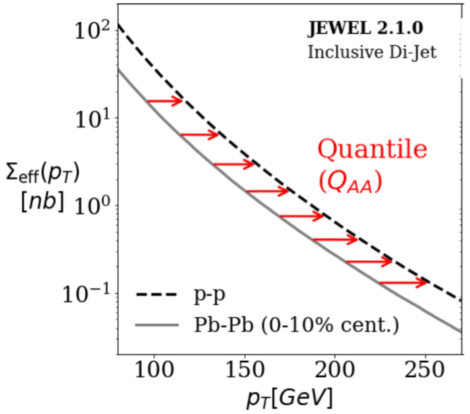
Q_{AA}:

Contains different information about the spectra than R_{AA}





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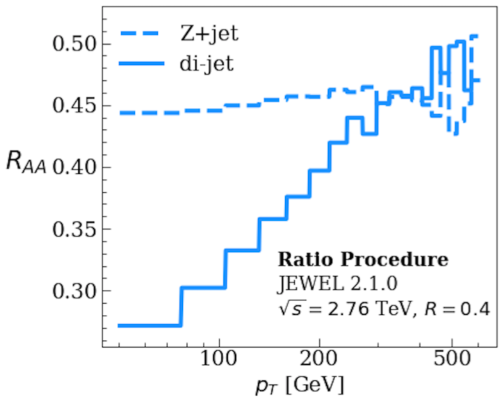
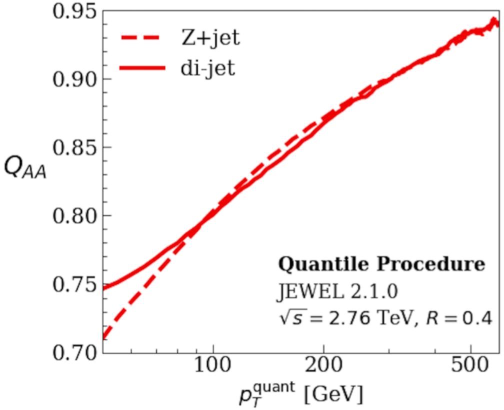
Contains different information about the spectra than R_{AA}

- In particular, less sensitive to low-p_T part of spectrum





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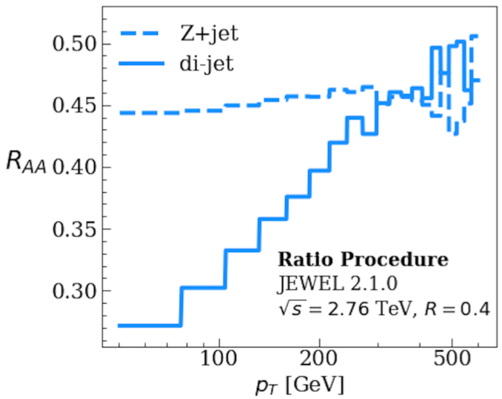

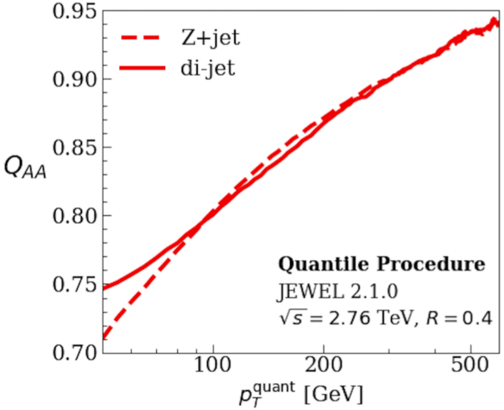

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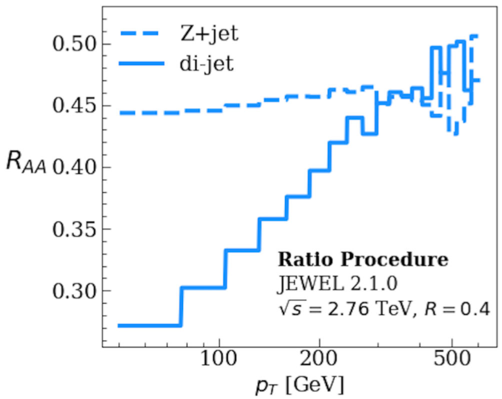
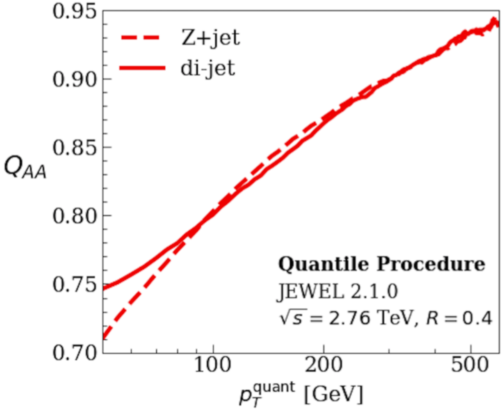
- Interpretation as average energy loss





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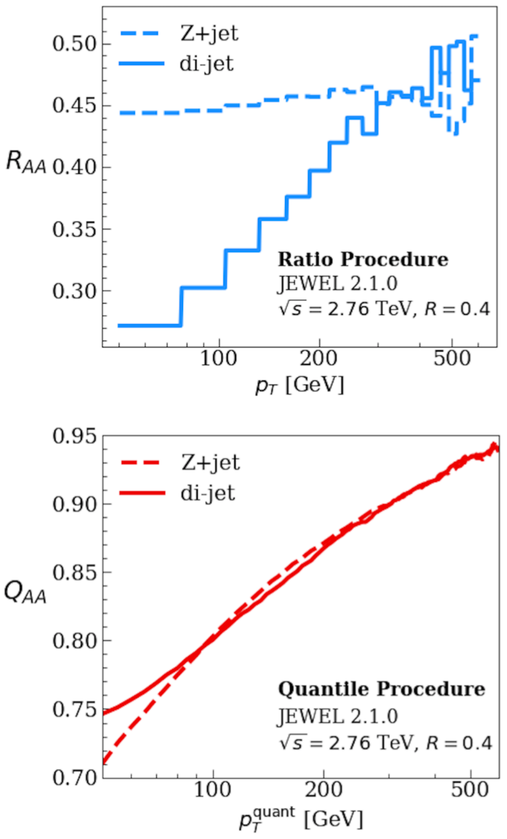
Theoretical clarity

- Interpretation as average energy loss
- does not require convolving theory results with p-p spectrum



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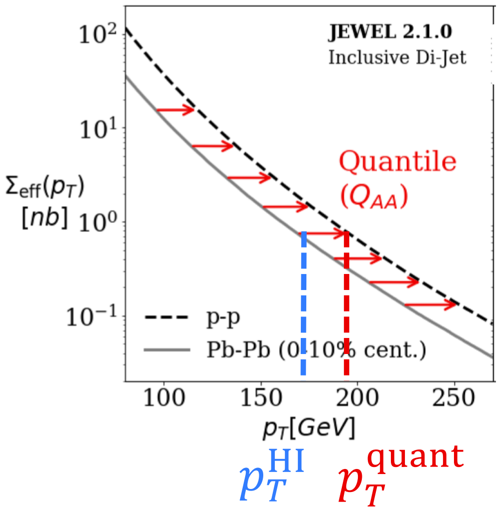
Horizontal shift of spectrum gives a proxy for the initial p_T of a heavy-ion jet

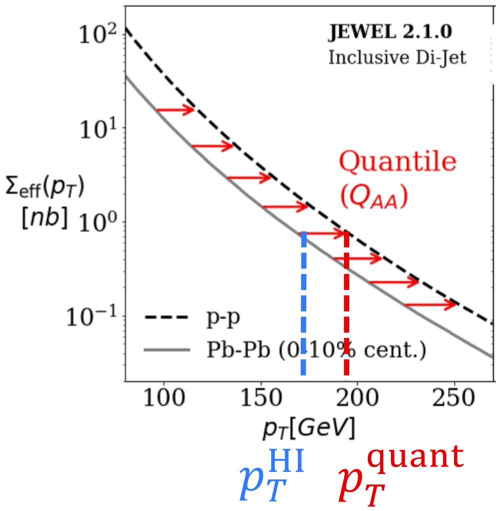


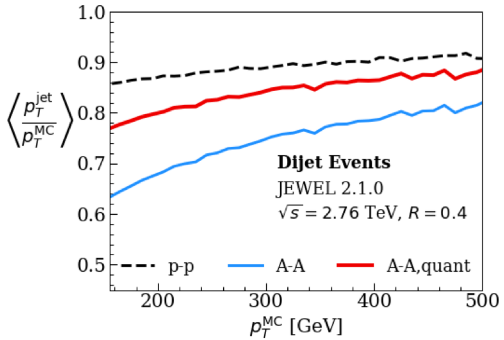
Summary

p_T^{quant}:

Horizontal shift of spectrum gives a proxy for the initial p_T of a heavy-ion jet

- p_T^{quant} is similar on average to the initial p_T of a jet before quenching





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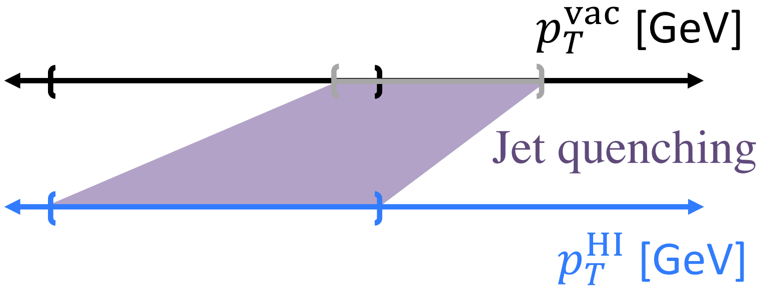

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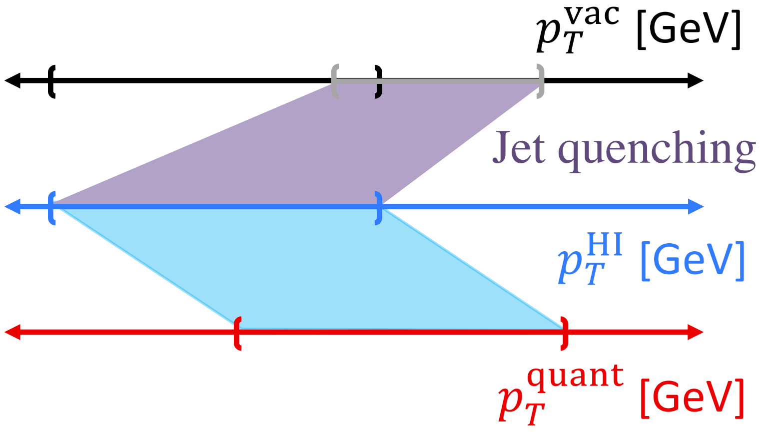

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- Can further constrain models