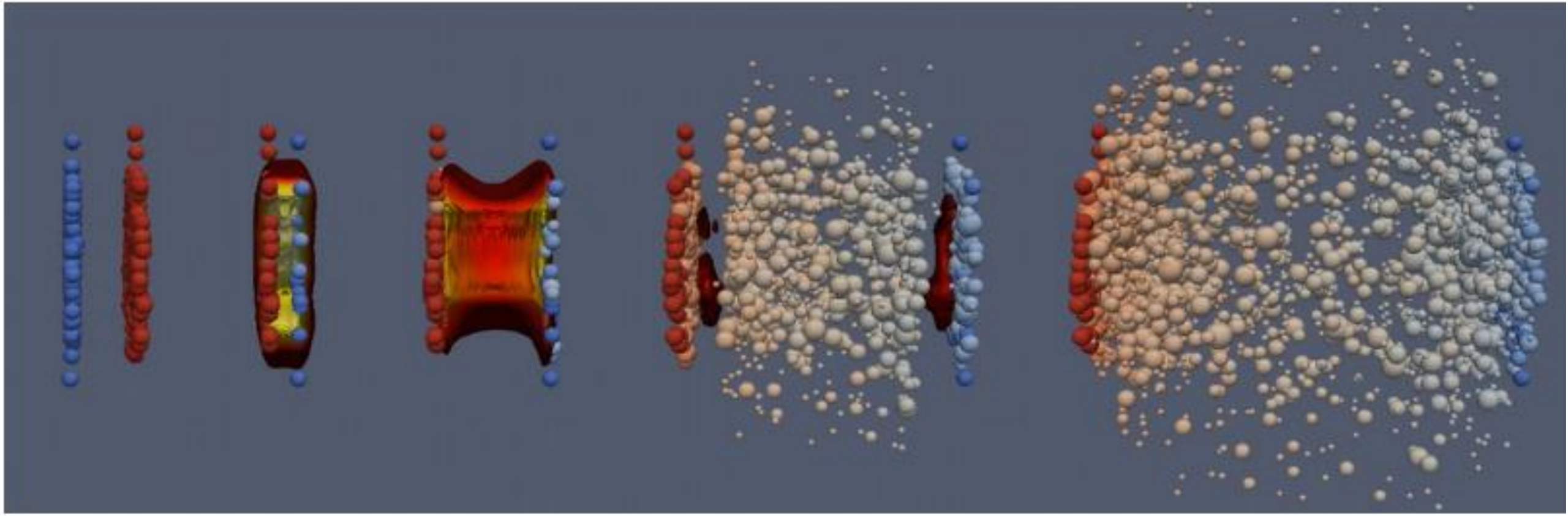
Measurement of jet quenching cone-size dependence in pp and Pb–Pb collisions with ALICE

PRESENTATION BY CHRISTOS PLIATSKAS STYLIANIDIS, NNV MEETING

NOVEMBER 3RD 2023,LUNTEREN

Utrecht University

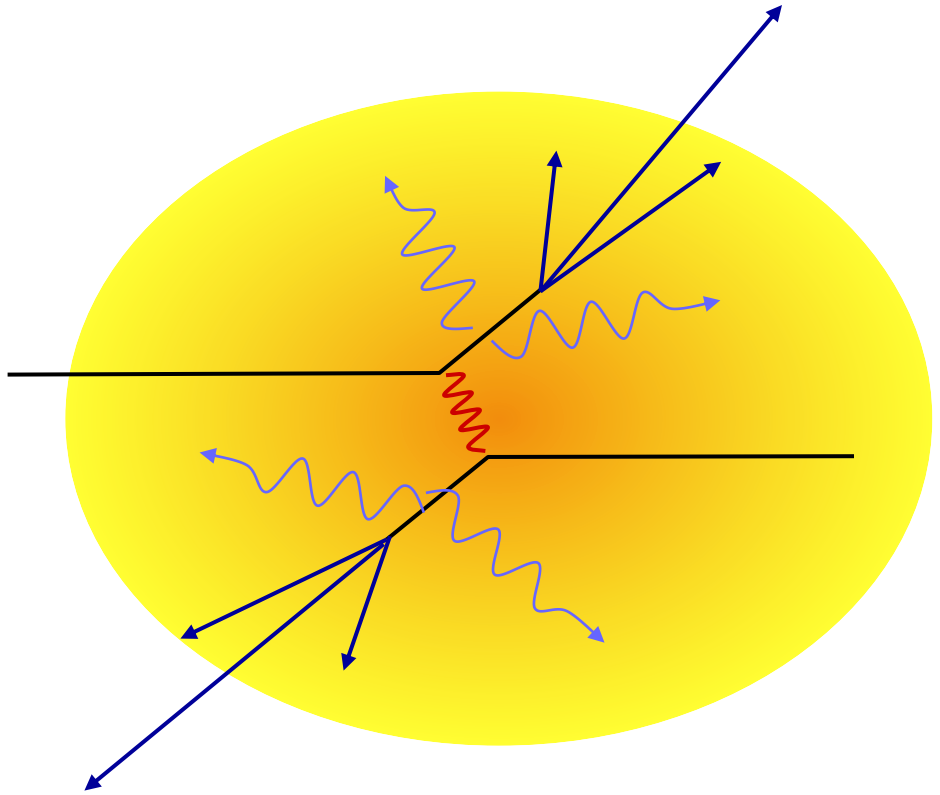
Heavy Ion collisions and Quark Gluon Plasma (QGP)



arXiv:2208.05290 [nucl-ex]

Jets as witnesses of QGP evolution

- Heavy ion collisions produce:
  - Hot and dense medium of deconfined matter
  - High energy partons as a result of hard scattering



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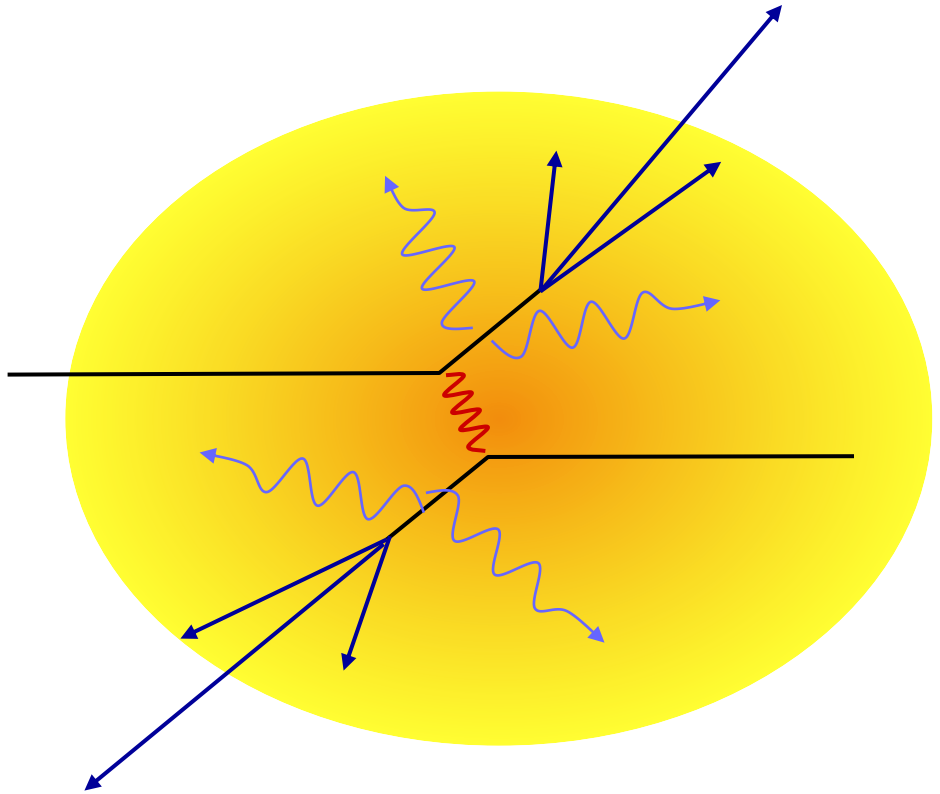

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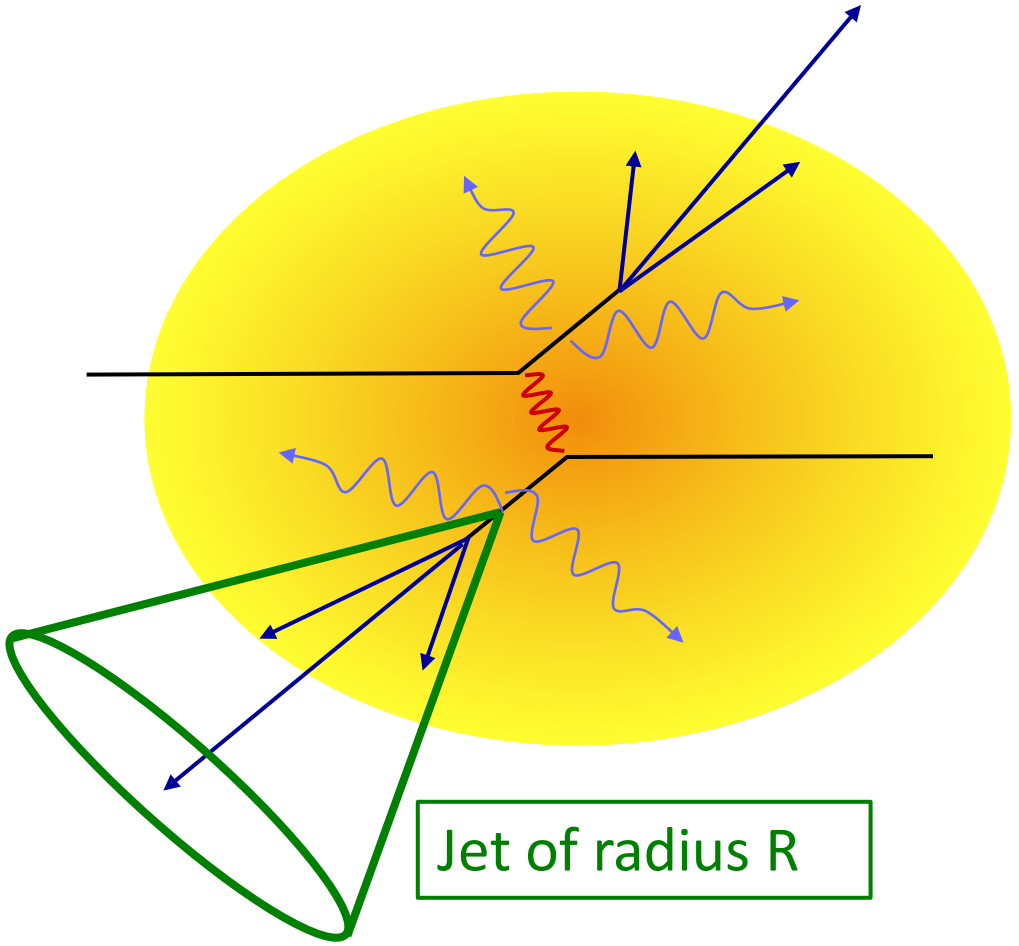
- Cluster parton shower products → jets



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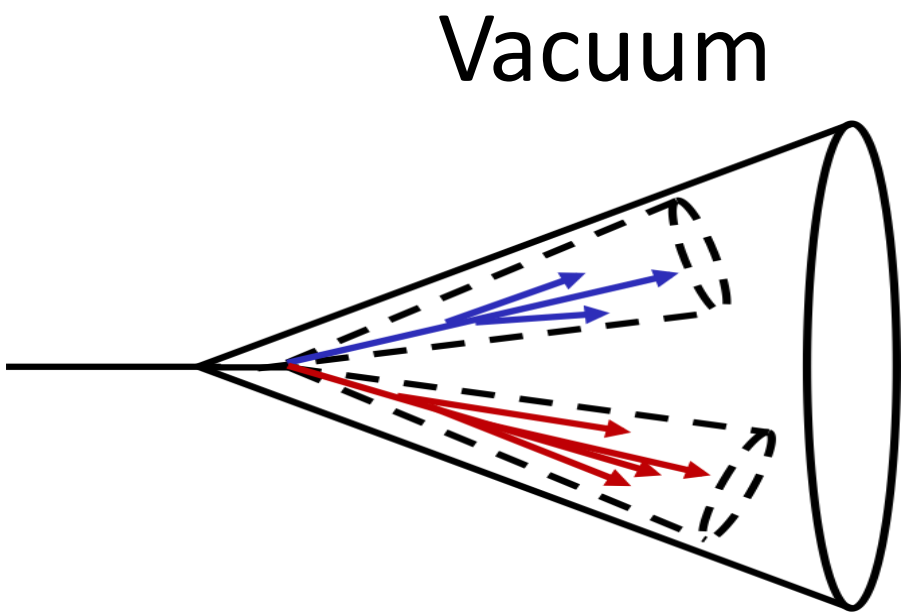

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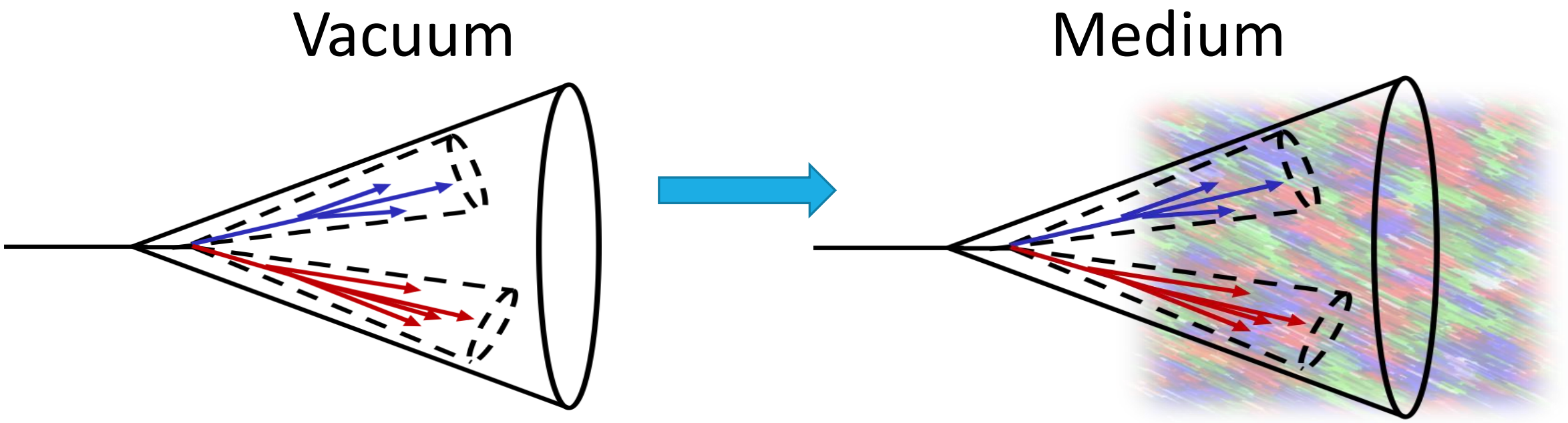
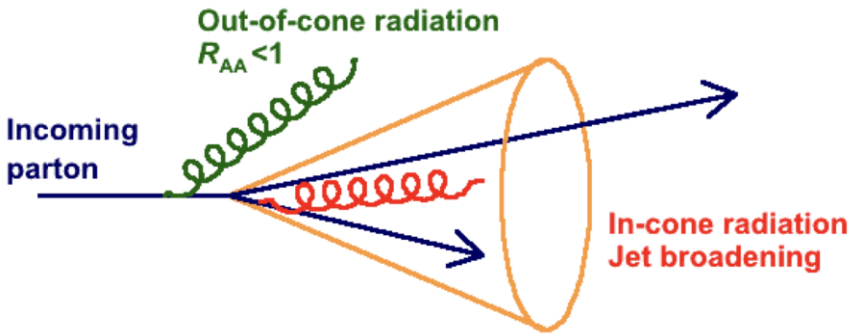


“Jet quenching” can have many aspects…

Medium-induced energy loss



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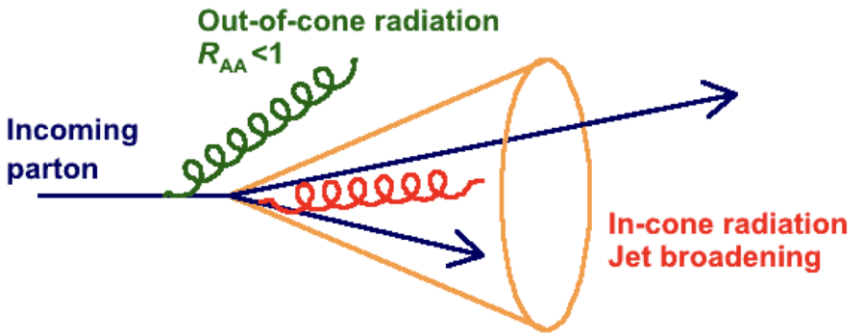

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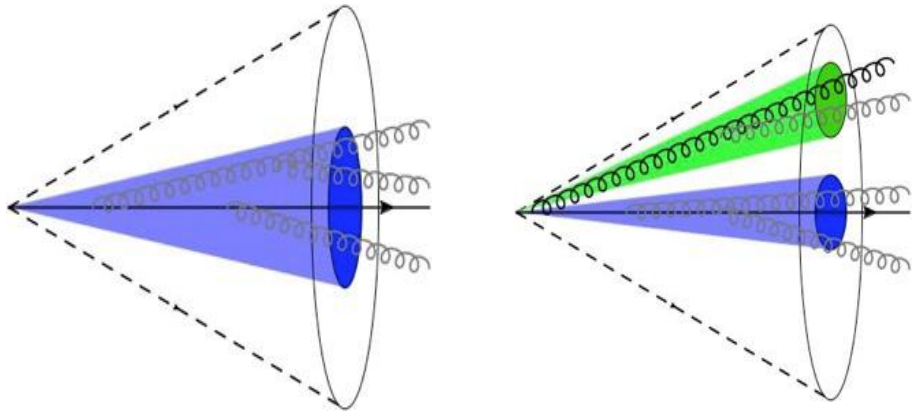

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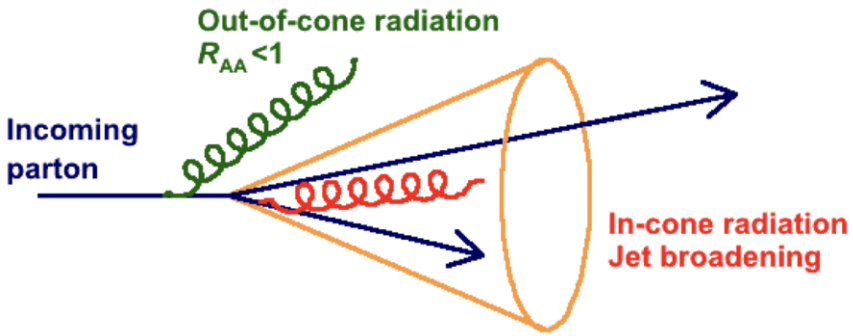

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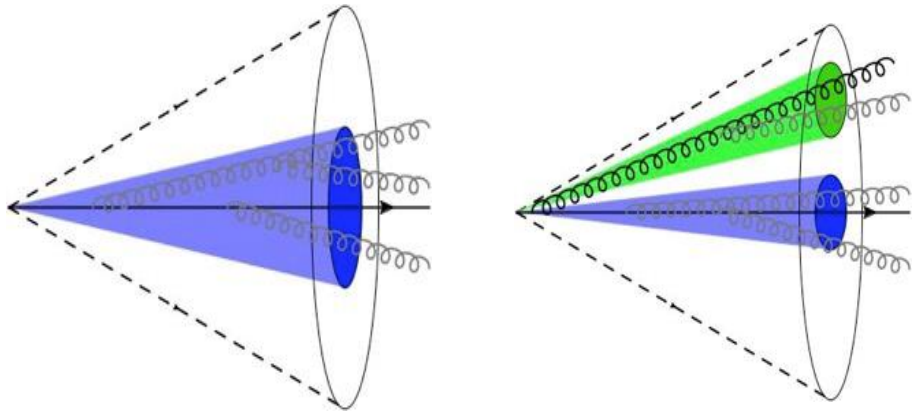
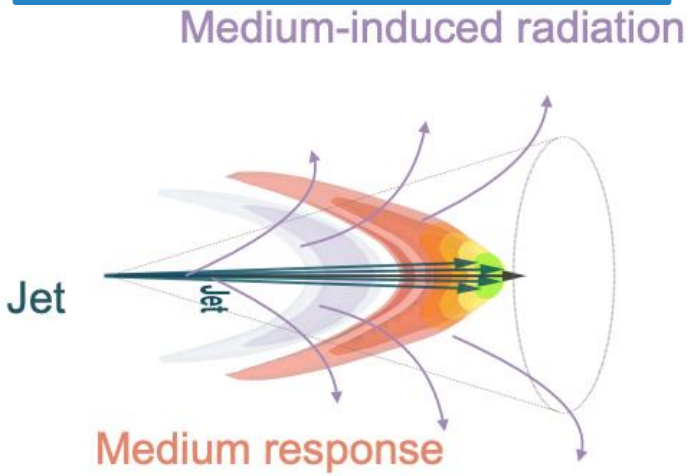


Medium recoil



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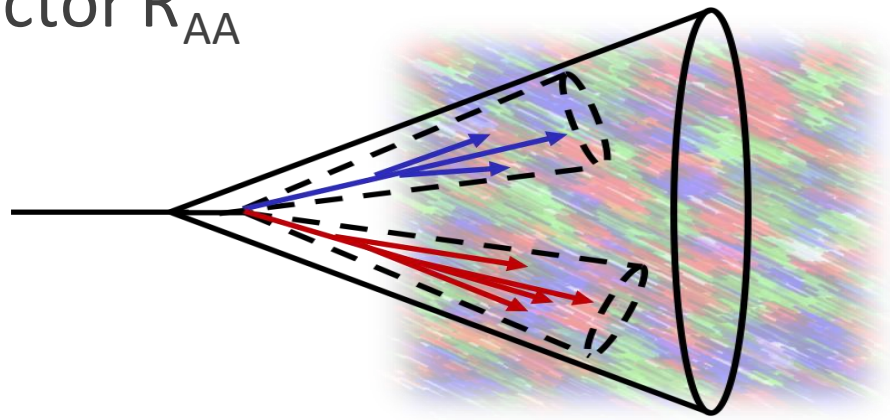

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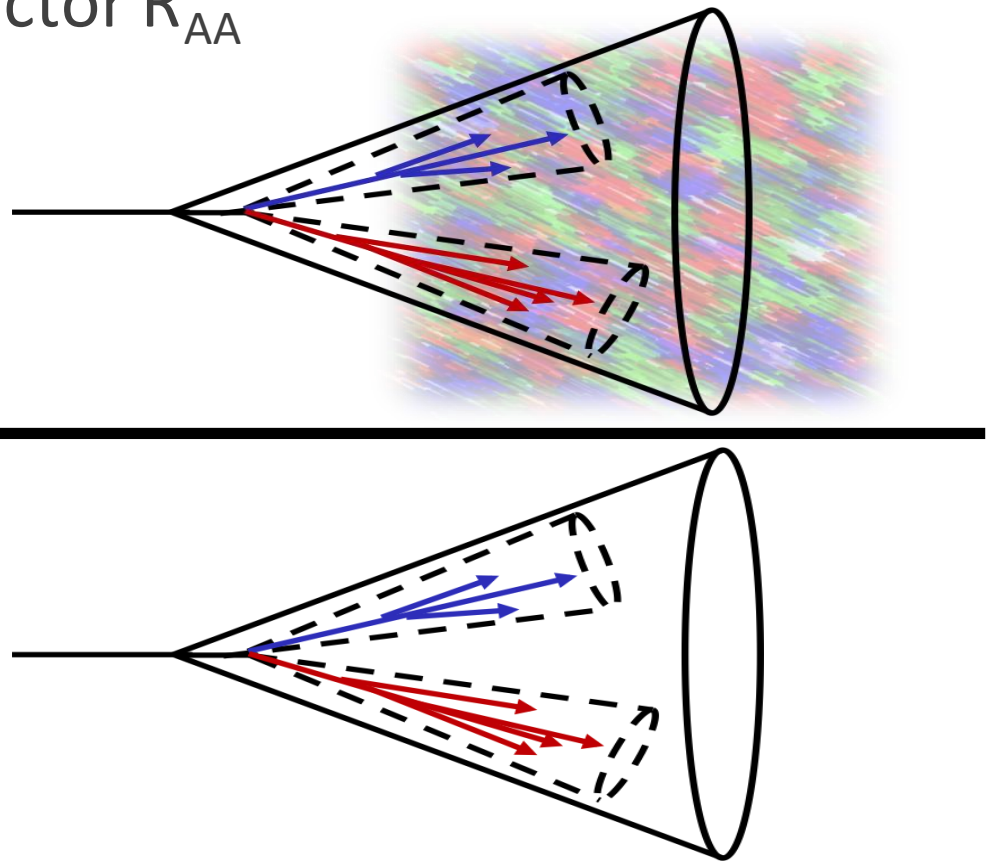

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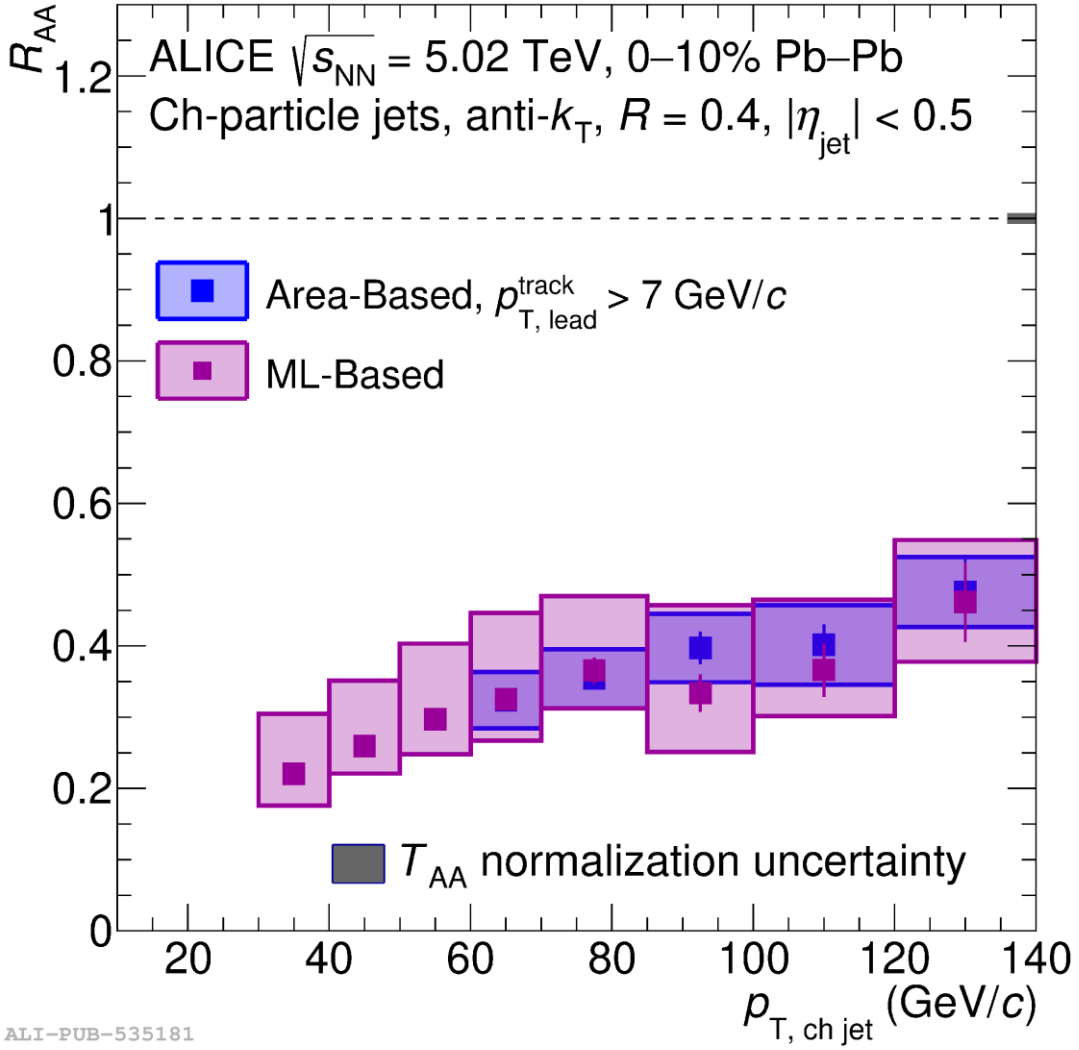

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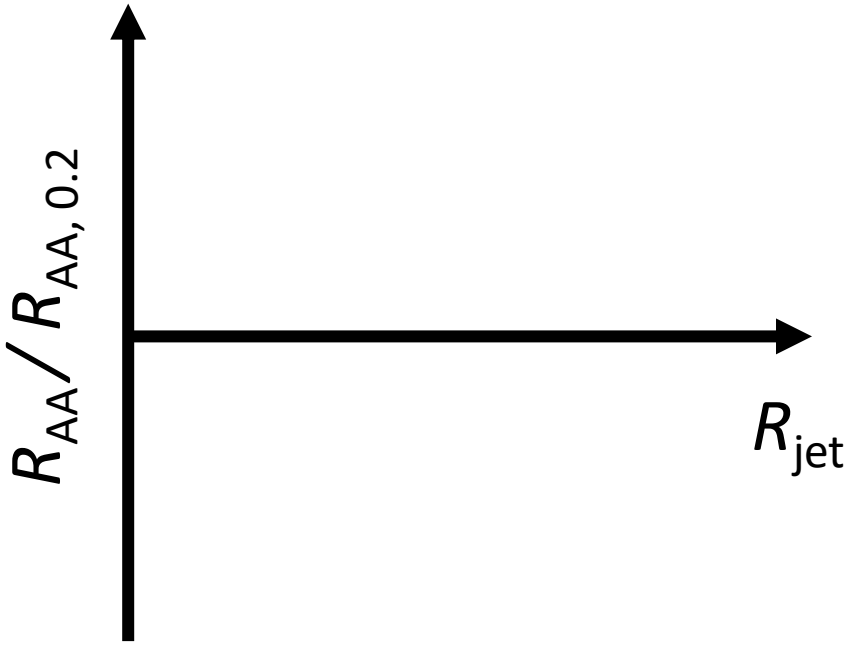
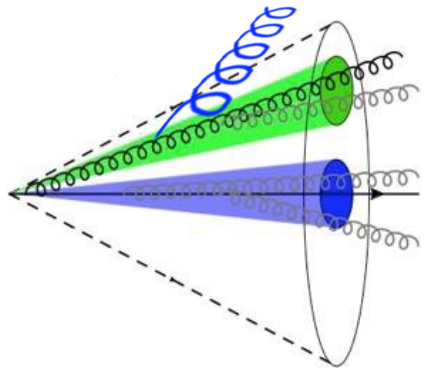
Are large jets more quenched?





Sketch: QM19, Yi Chen

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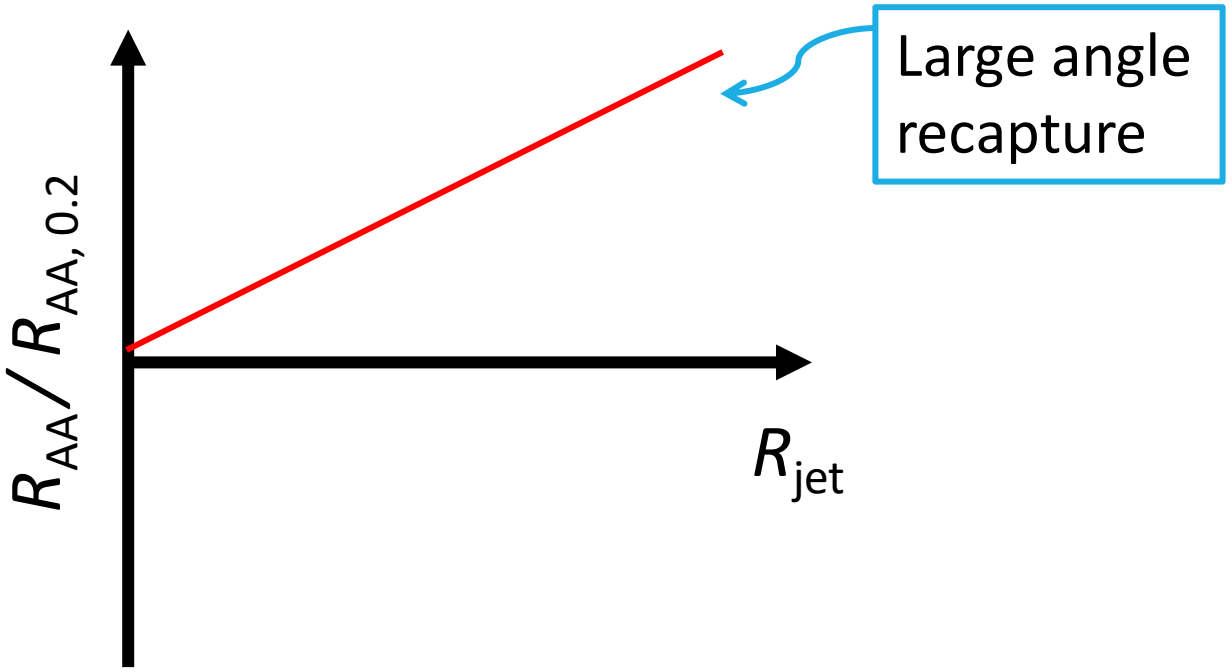

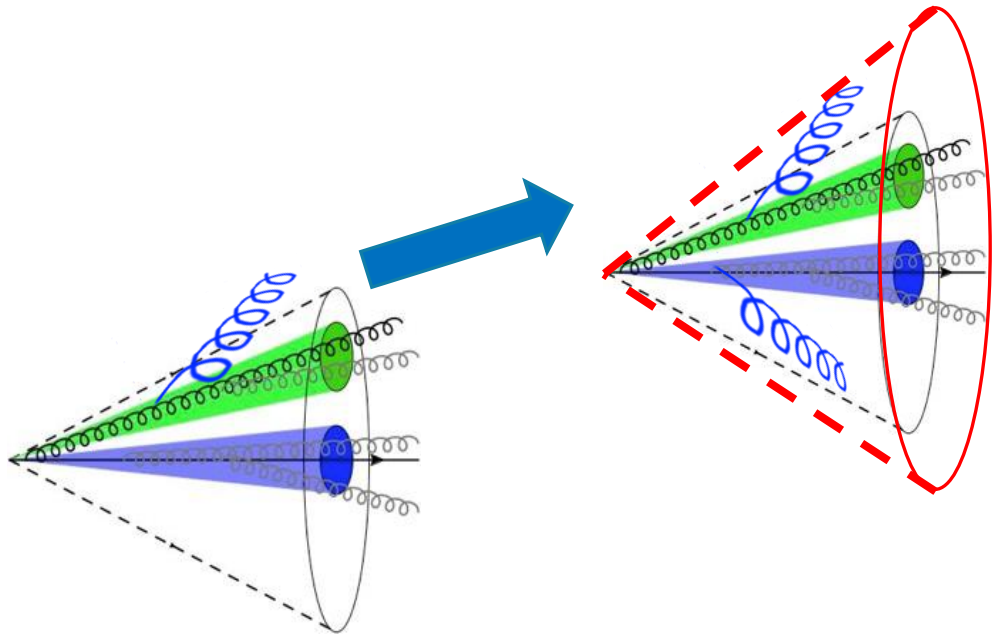

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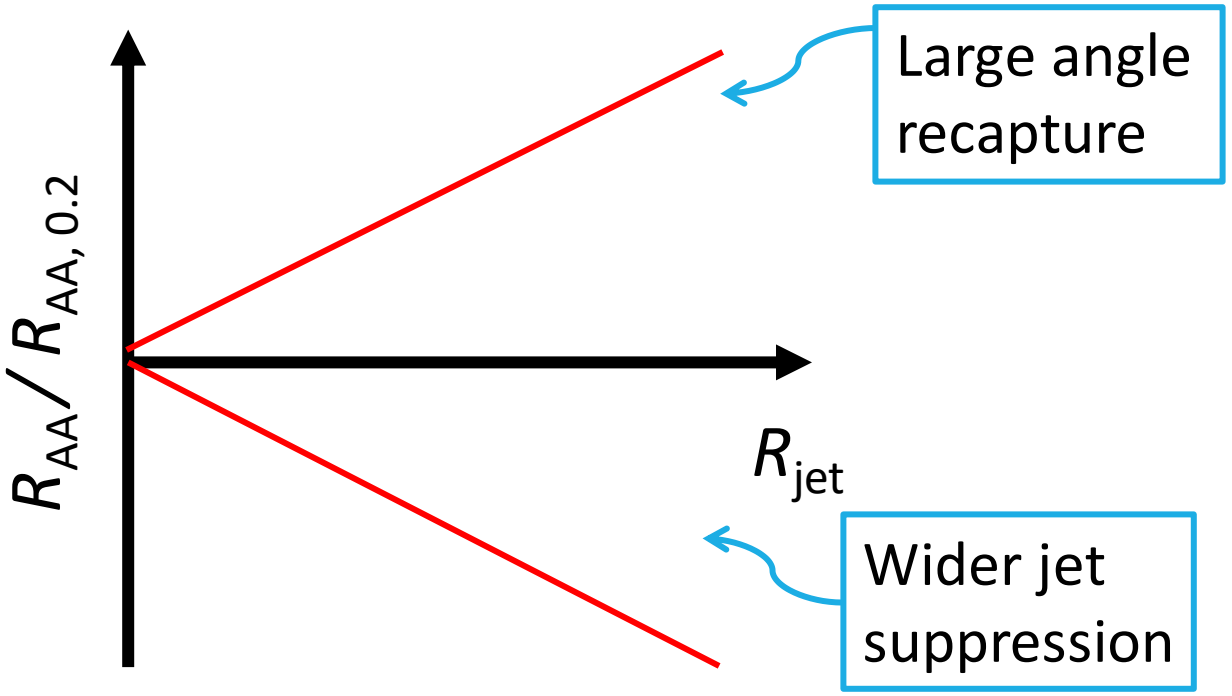

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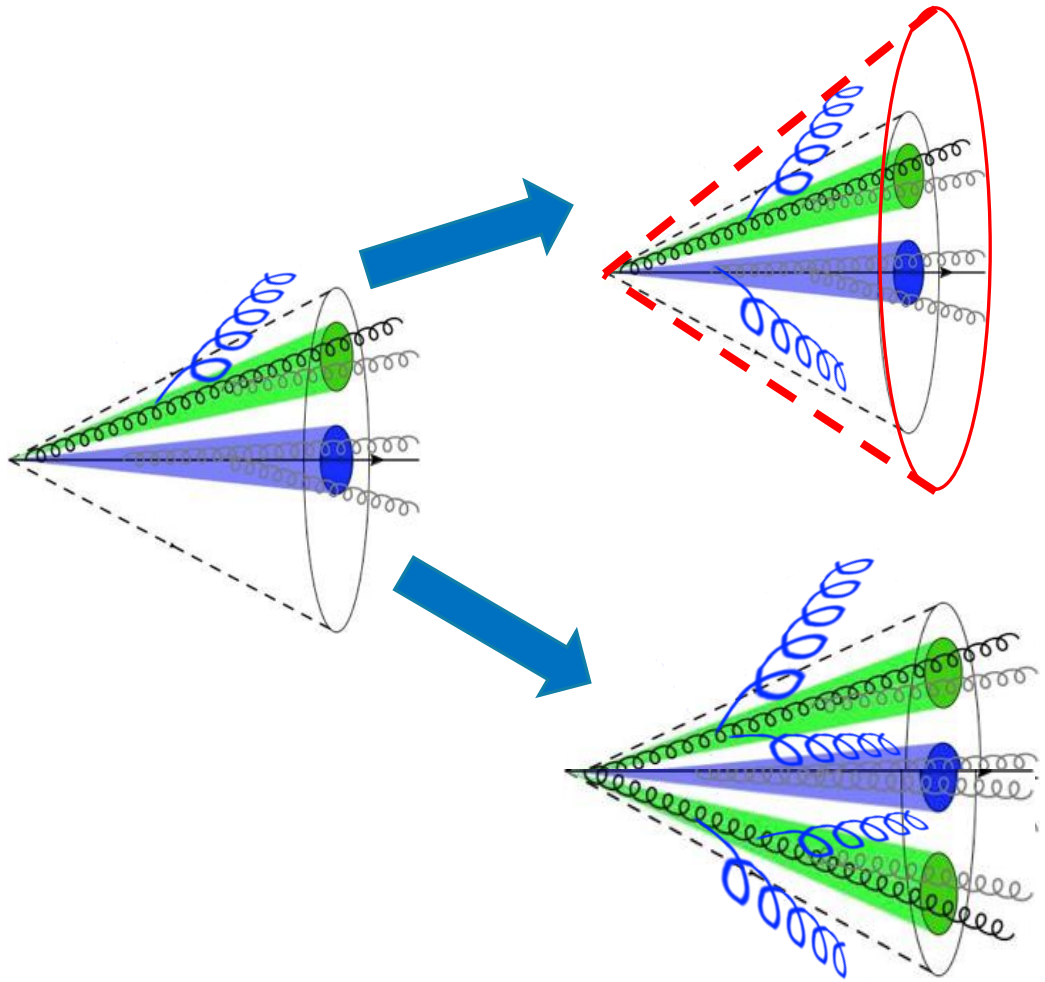

R-dependence of jet nuclear modification factor

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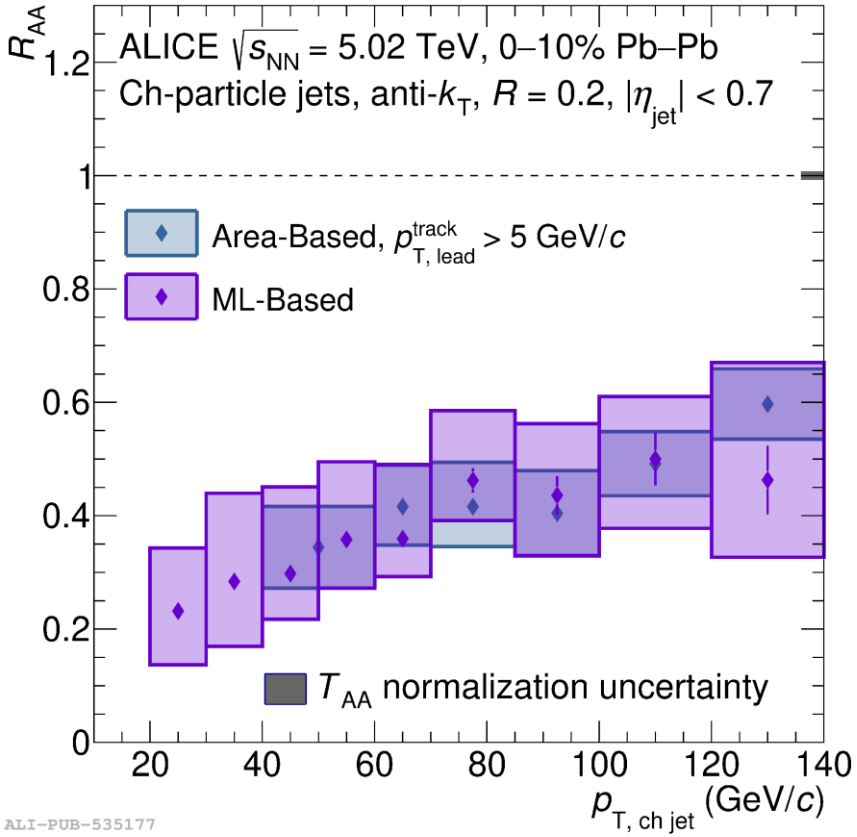

R=0.2

R-dependence of jet nuclear modification factor

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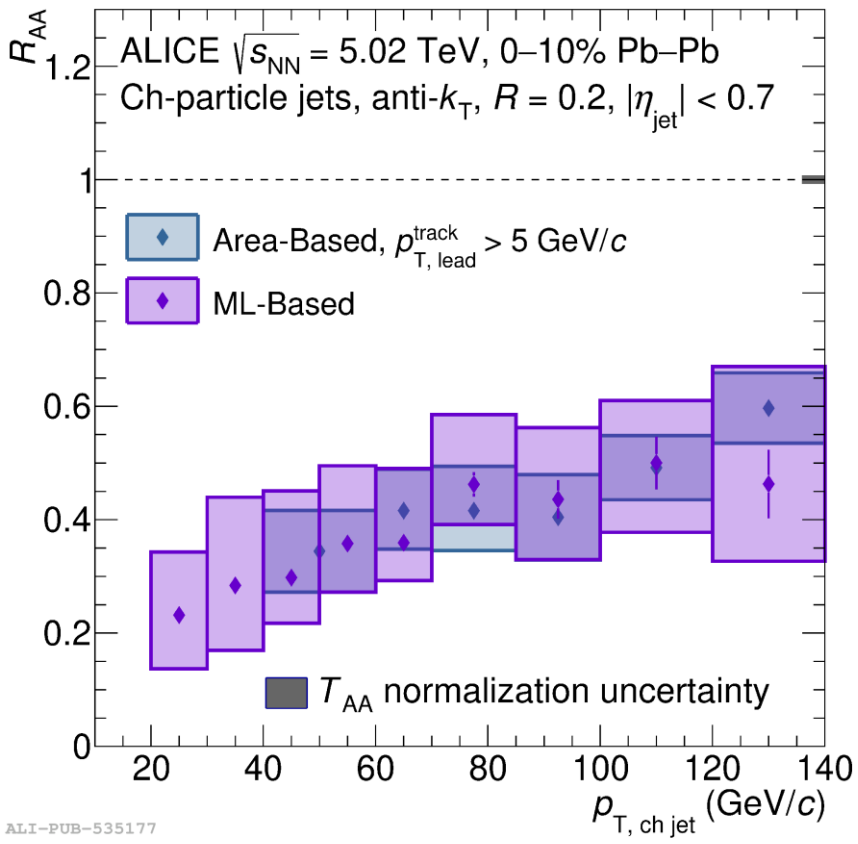
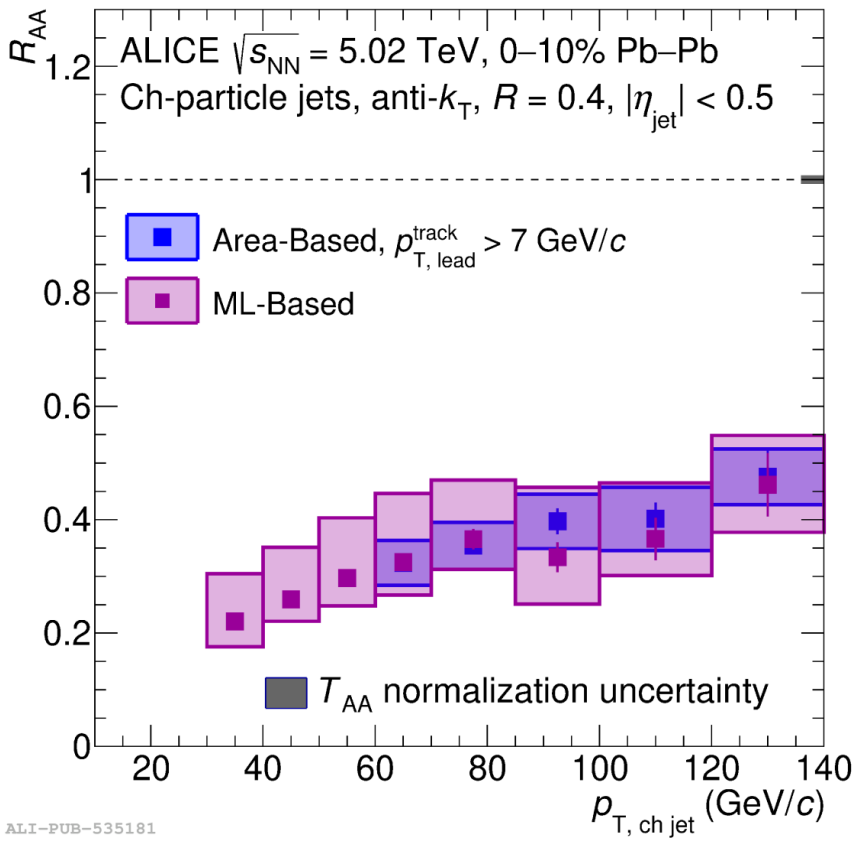
R increases →





R=0.2

R=0.4

R-dependence of jet nuclear modification factor

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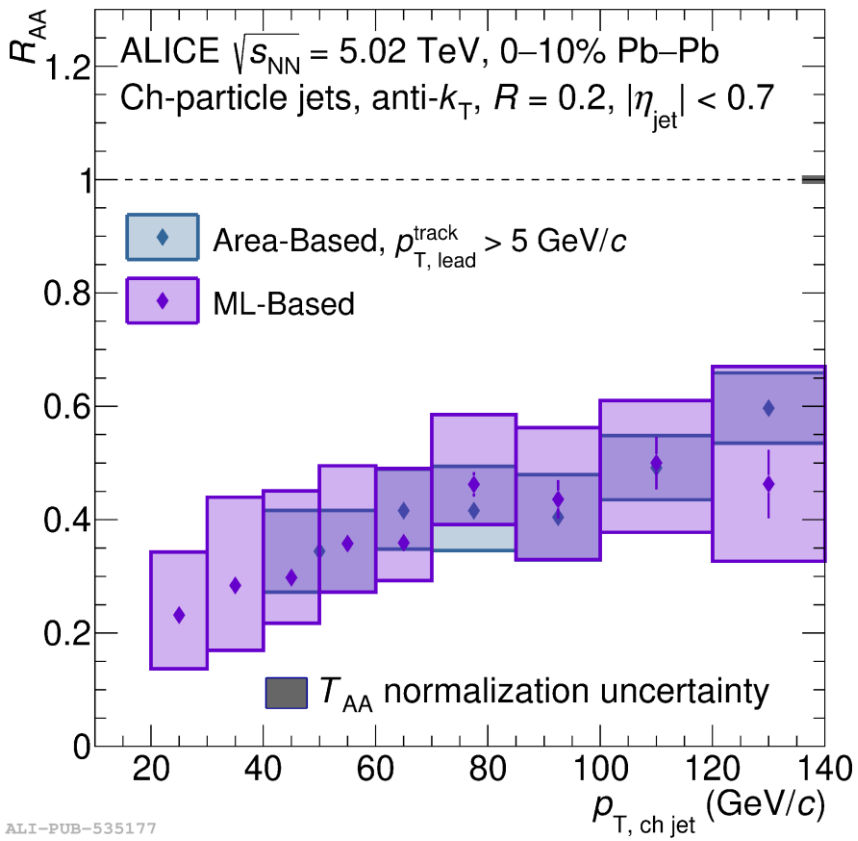

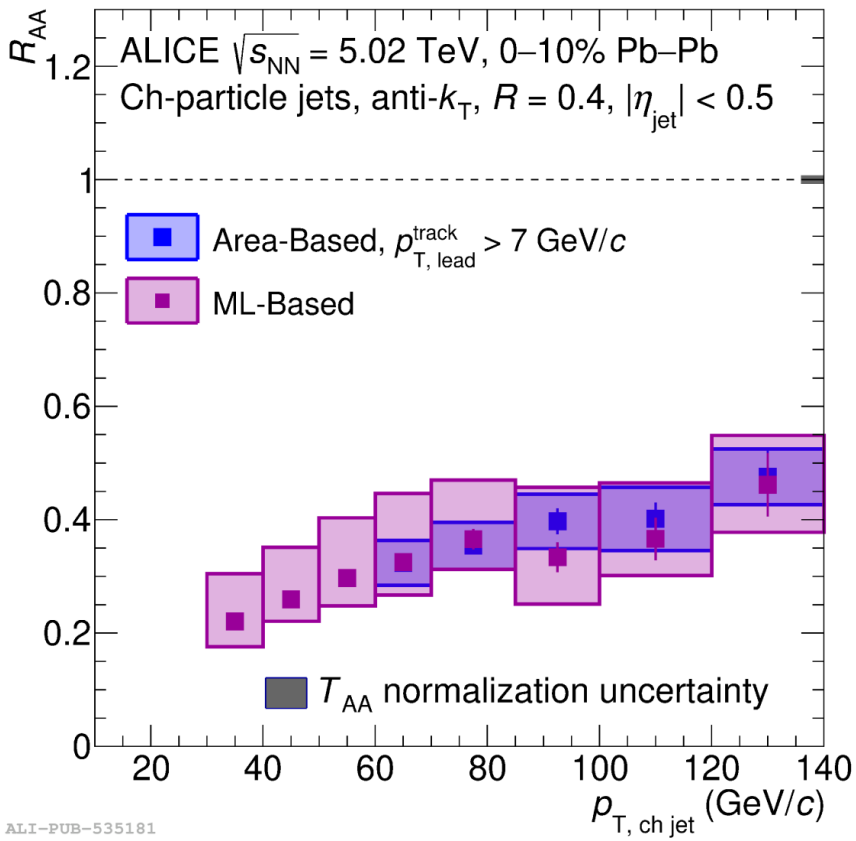

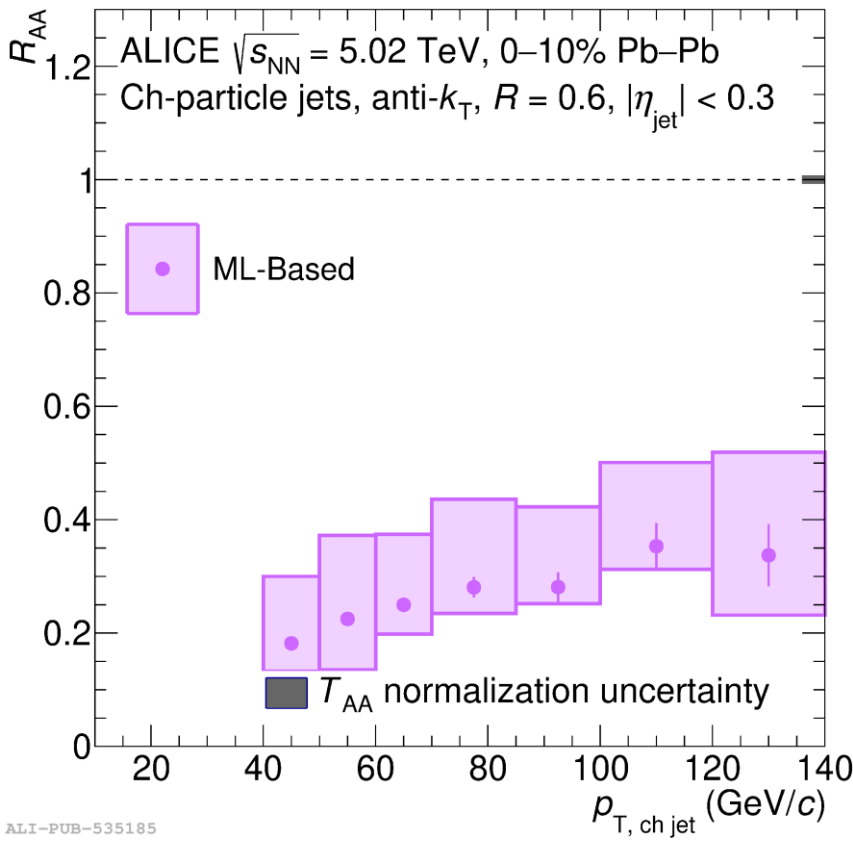

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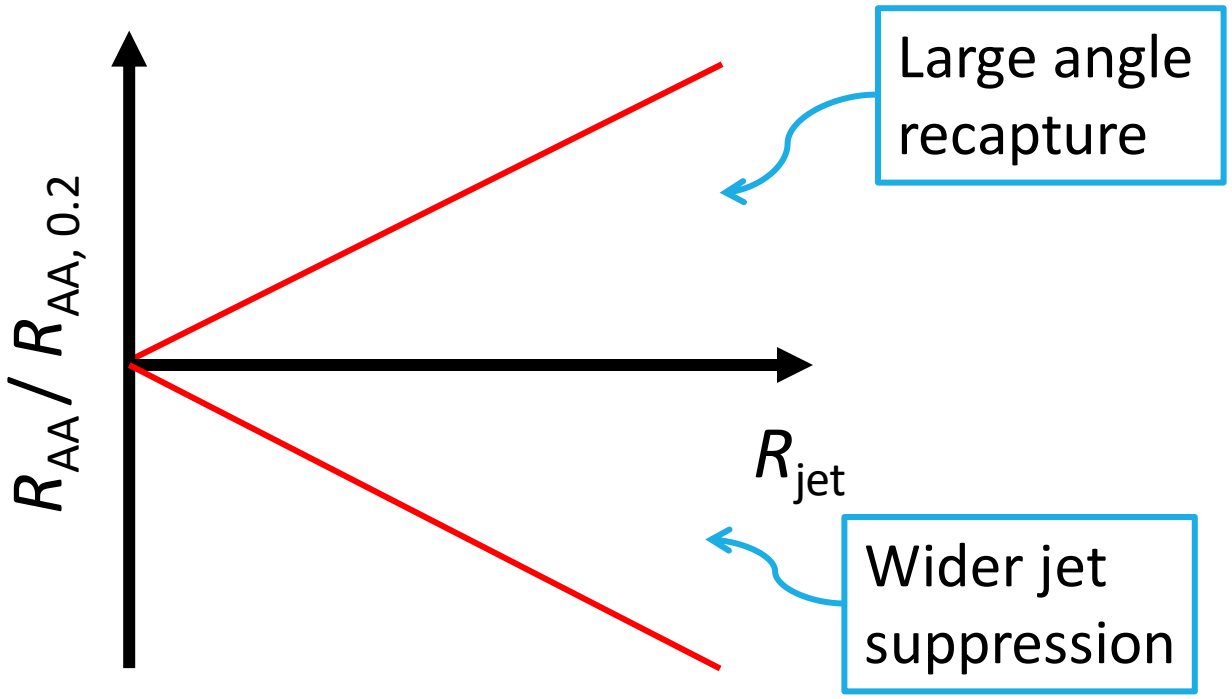

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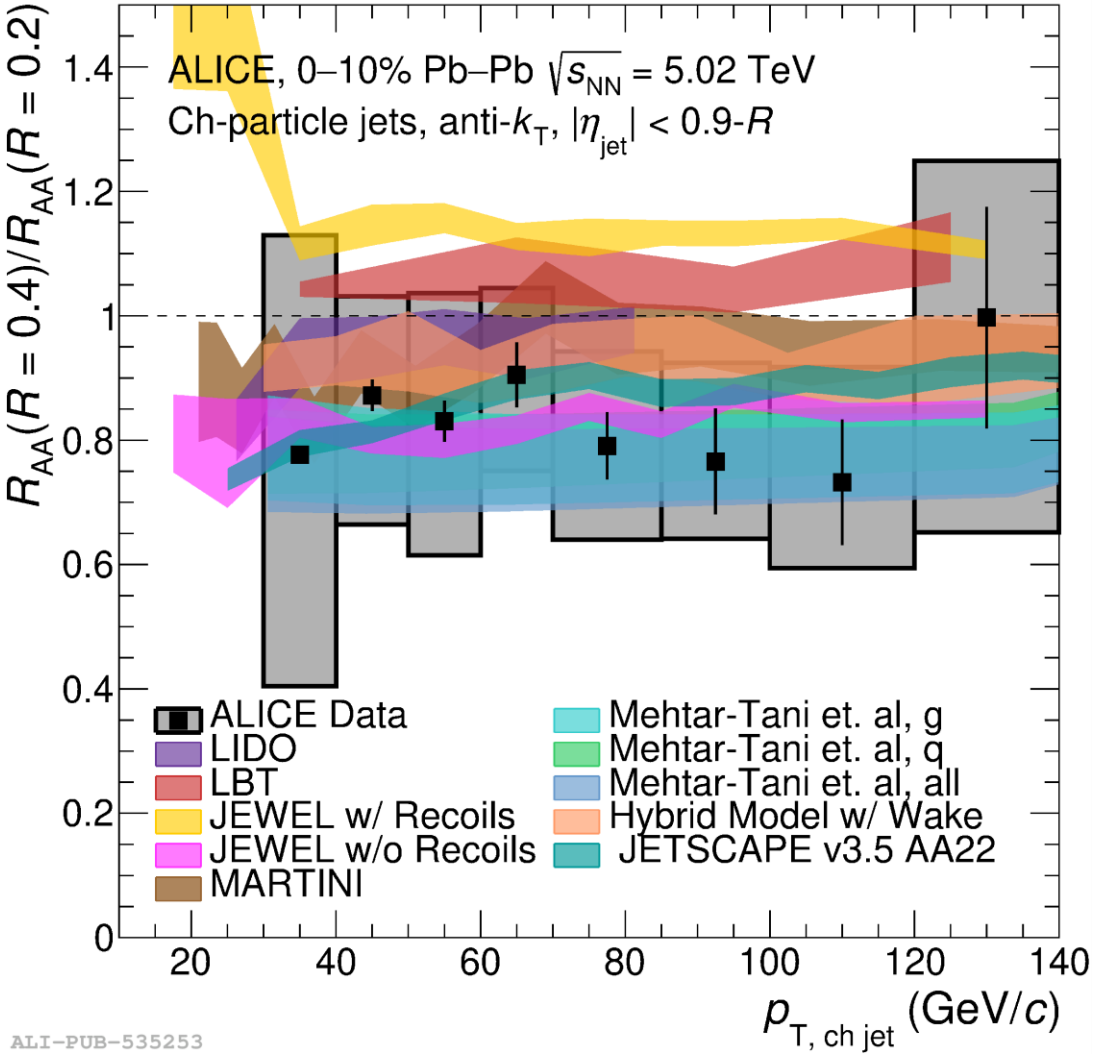

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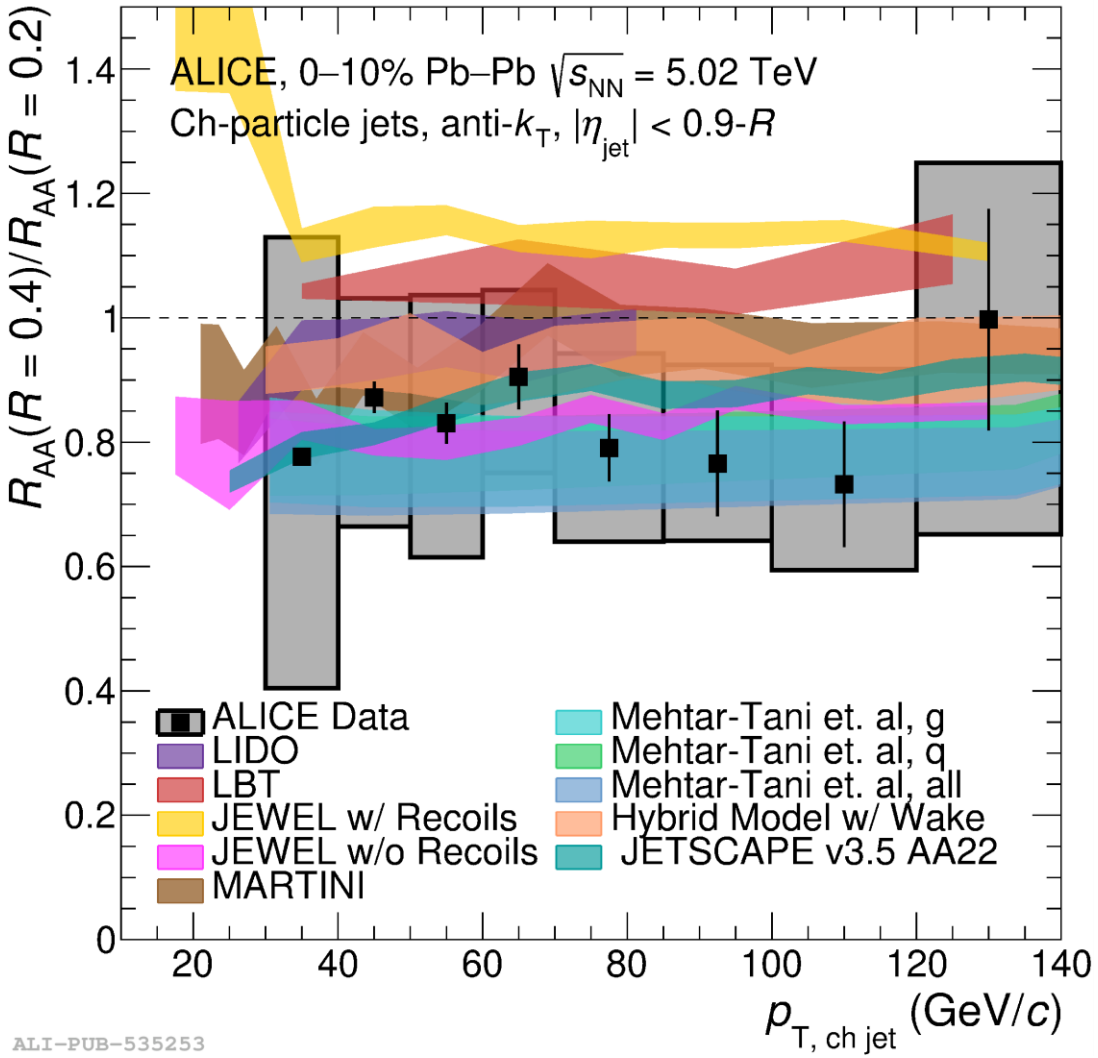

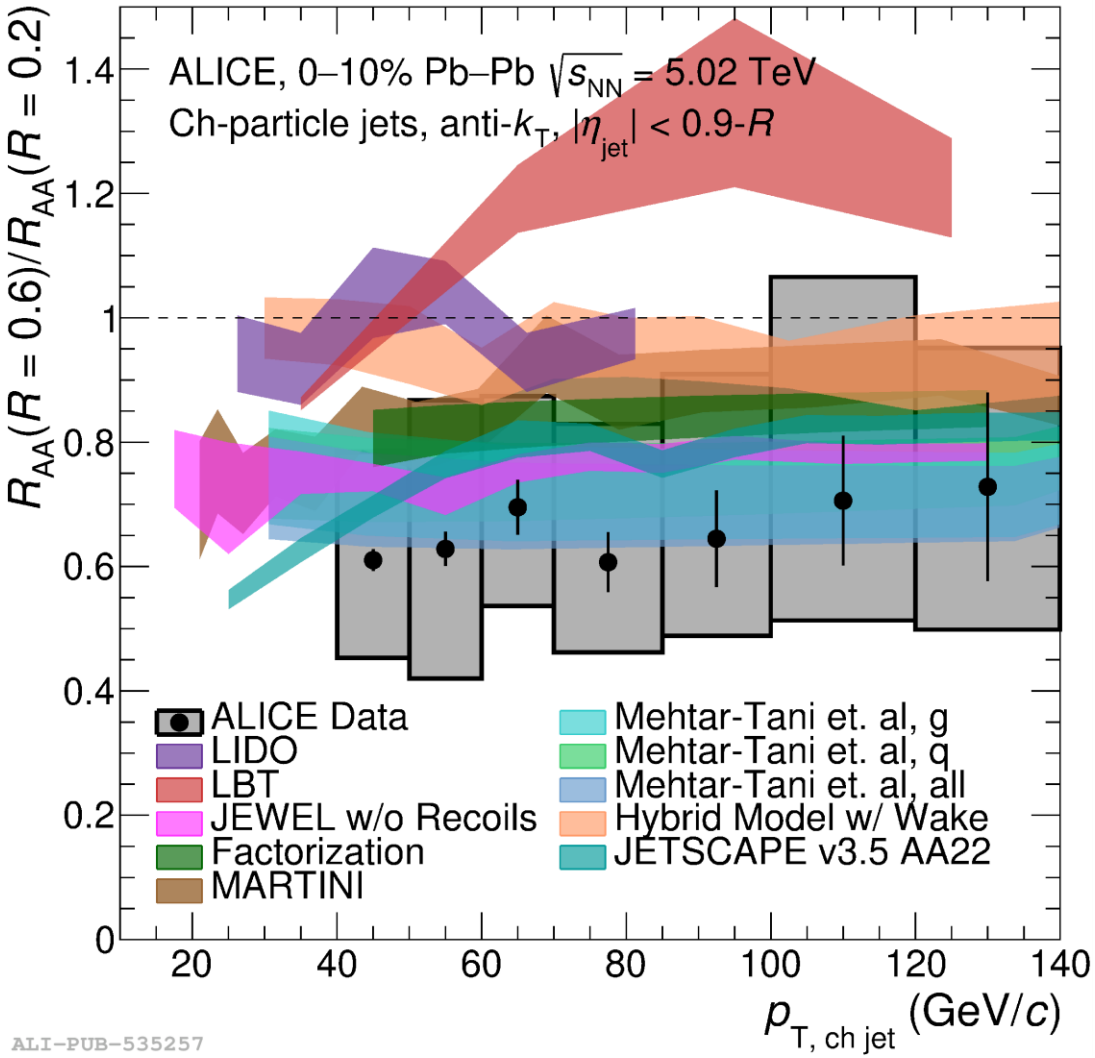

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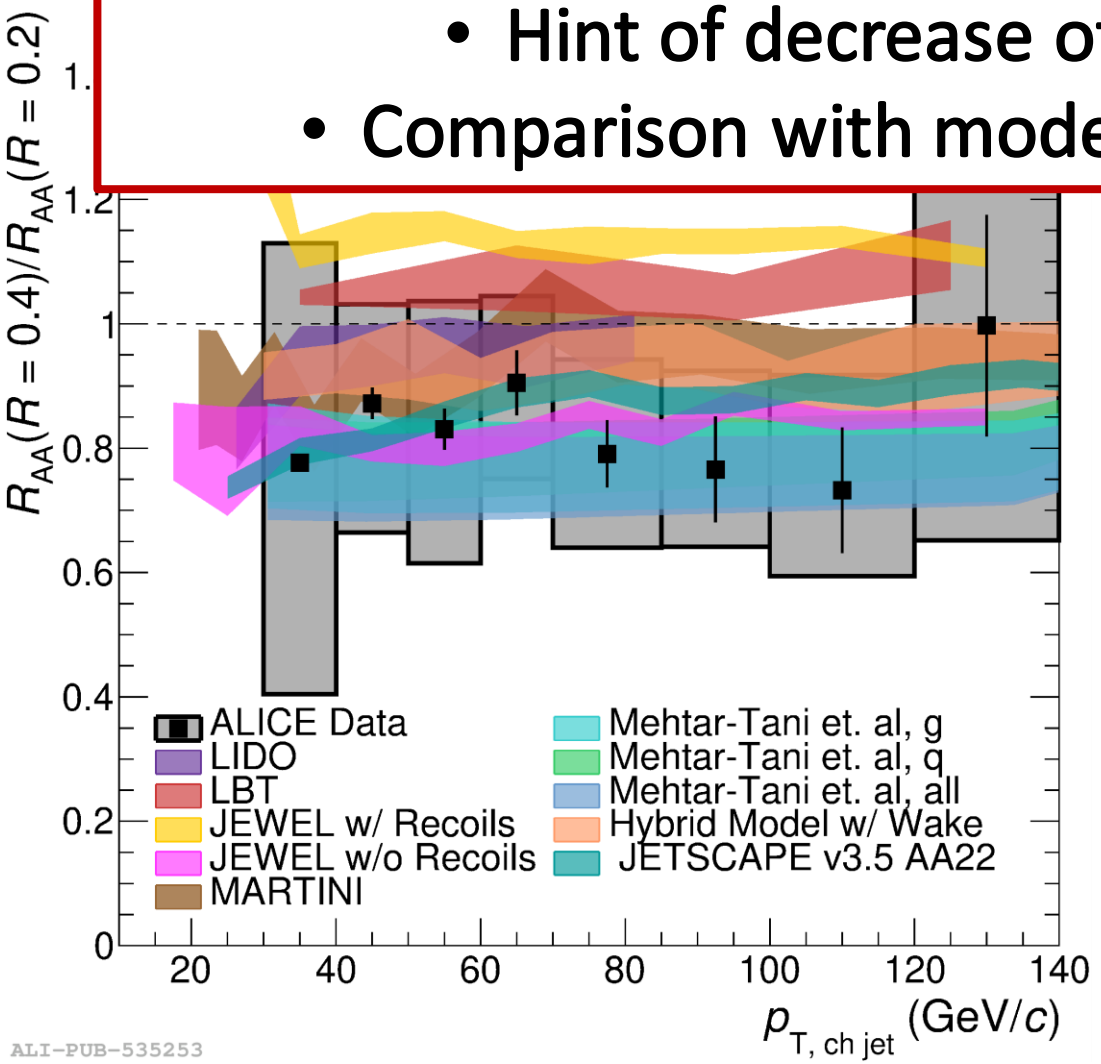
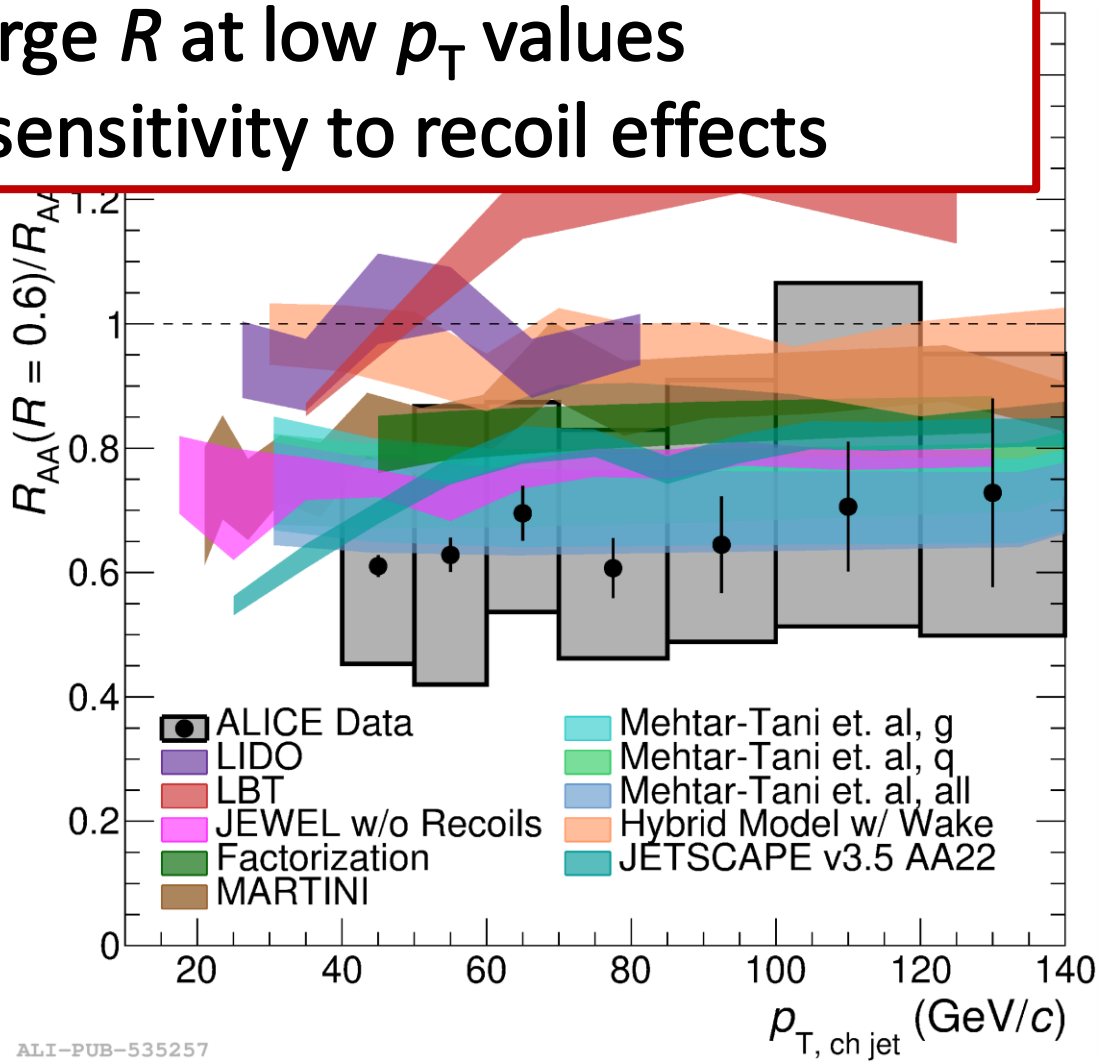
R-dependence of jet nuclear modification factor

- Hint of decrease of R_{AA} for large R at low p_T values
- Comparison with models shows sensitivity to recoil effects





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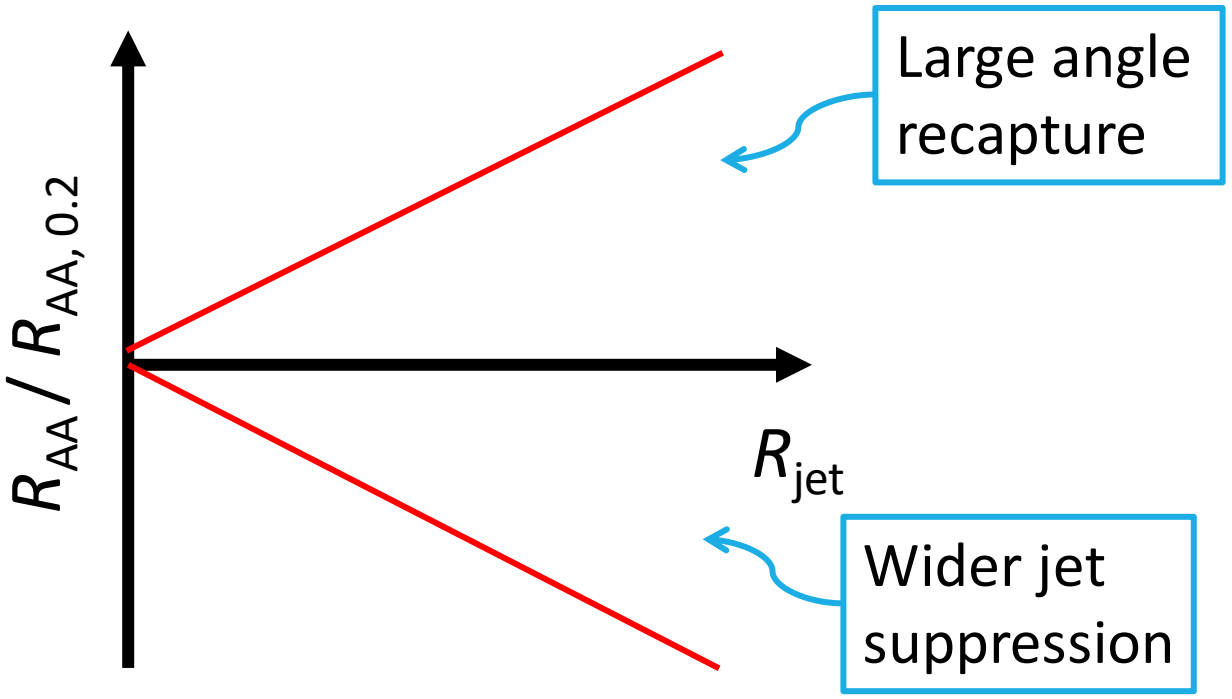
An alternative approach to the question



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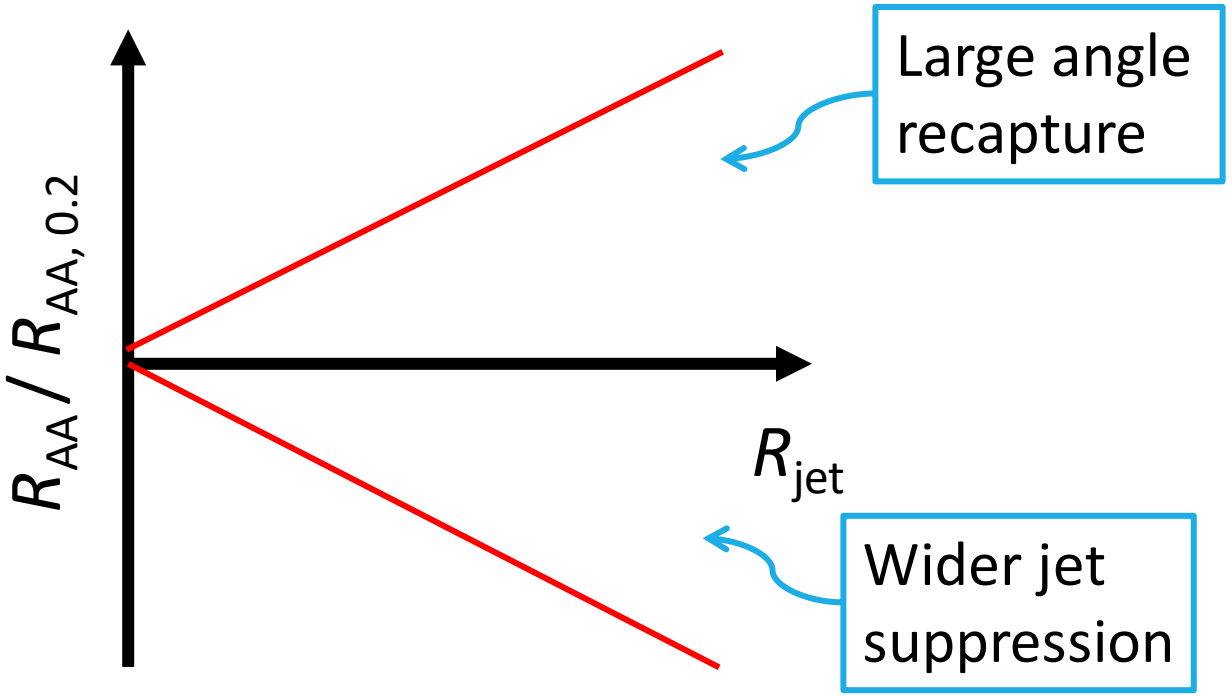
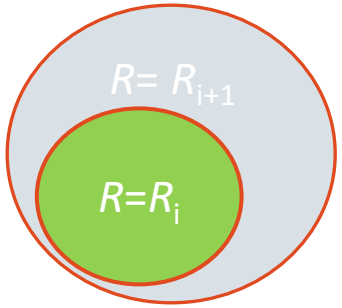


Energy flow definition:

$\Delta p_T = p_T(R_{i+1}) - p_T(R_i)$



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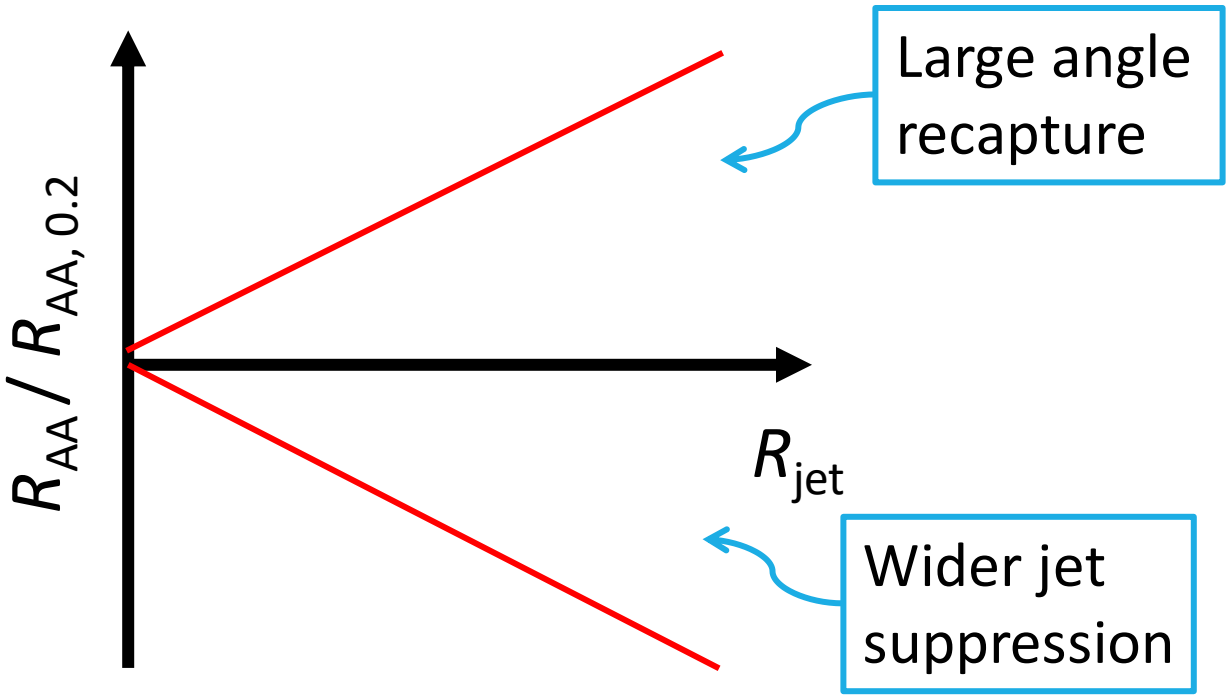

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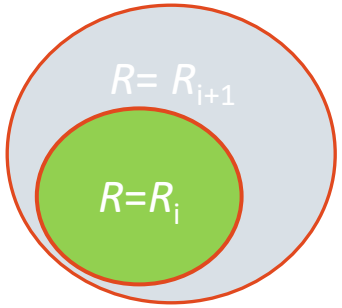

Using a measurement in pp as baseline, study the effect of the energy loss mechanisms in Pb–Pb

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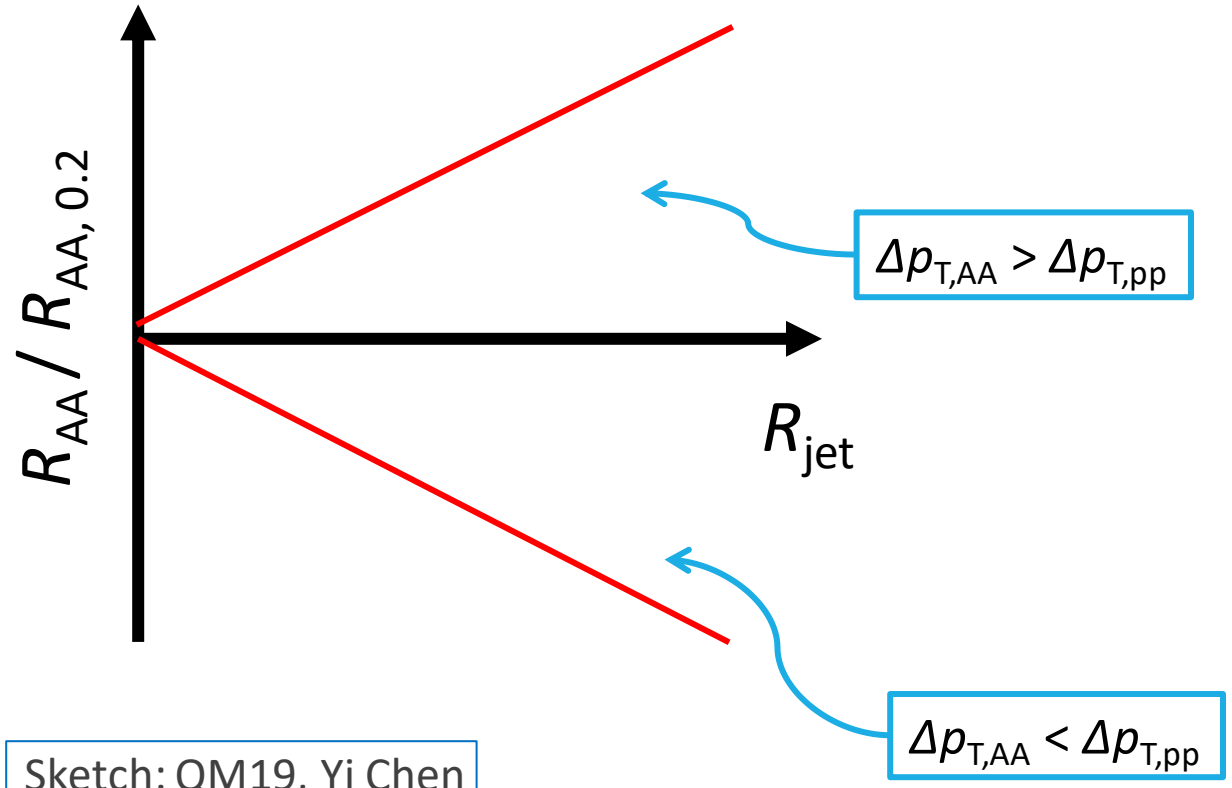

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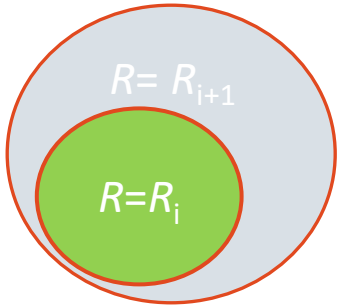

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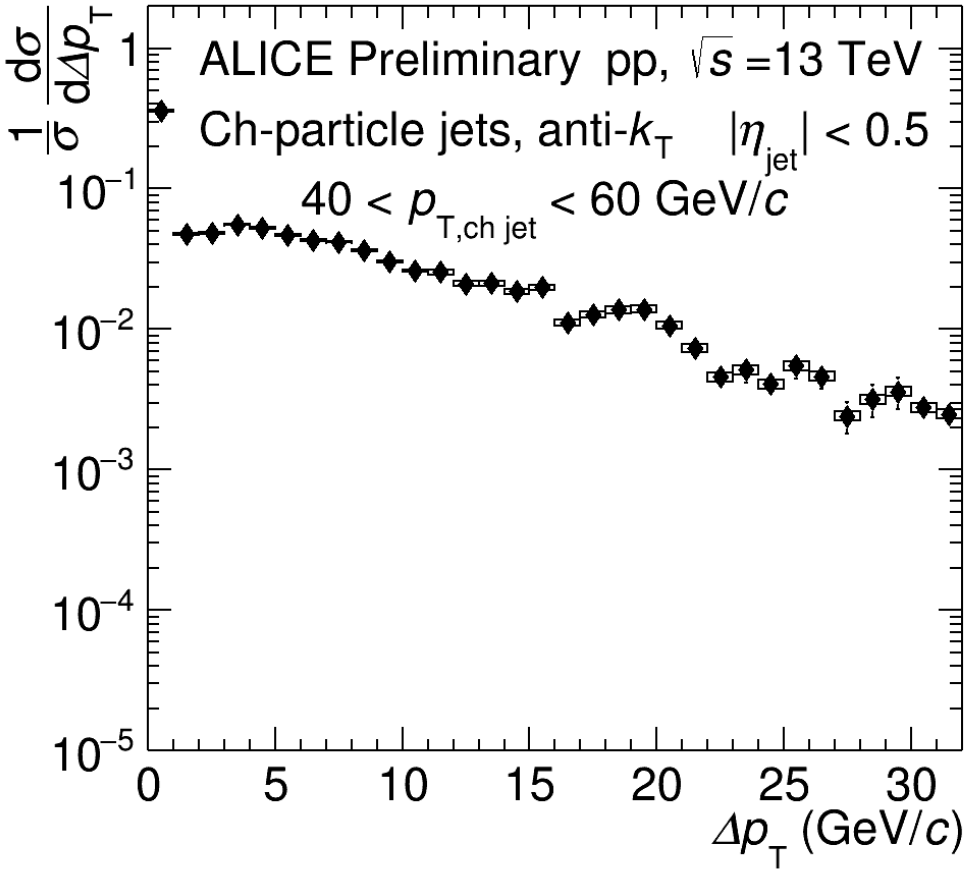
Jet energy flow measurement in pp collisions



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- Larger R → Steeper distributions
- Smooth transition from narrow to wide jet cone radii.

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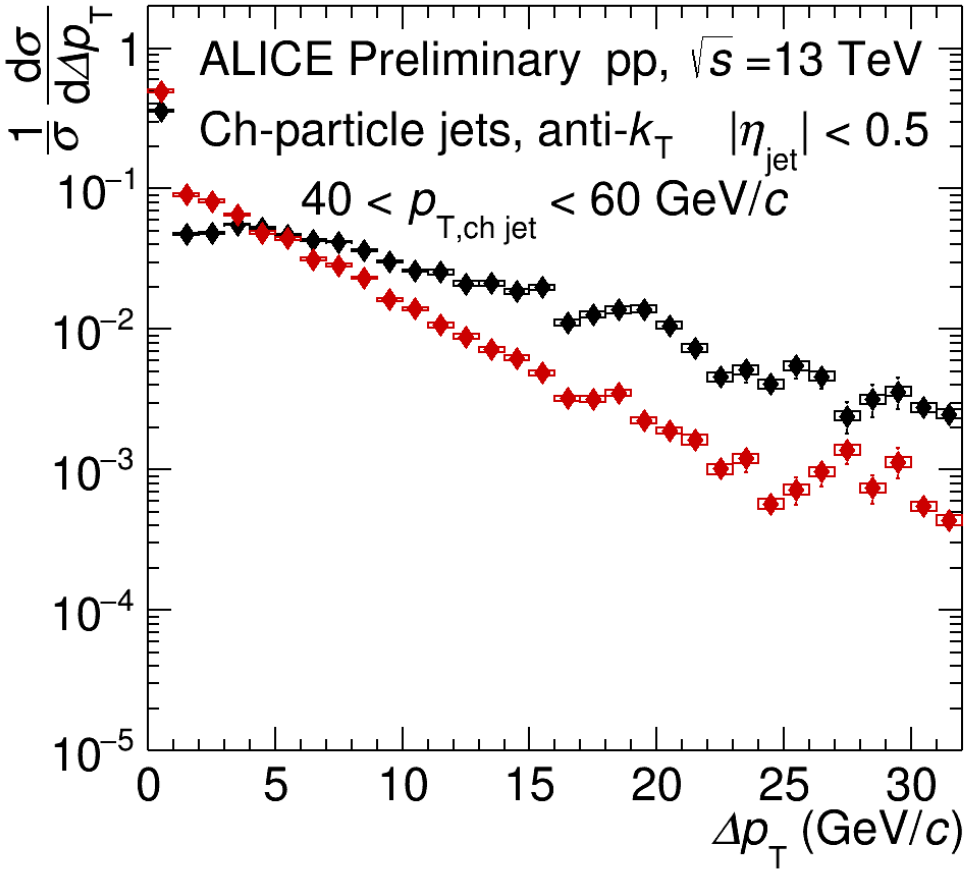

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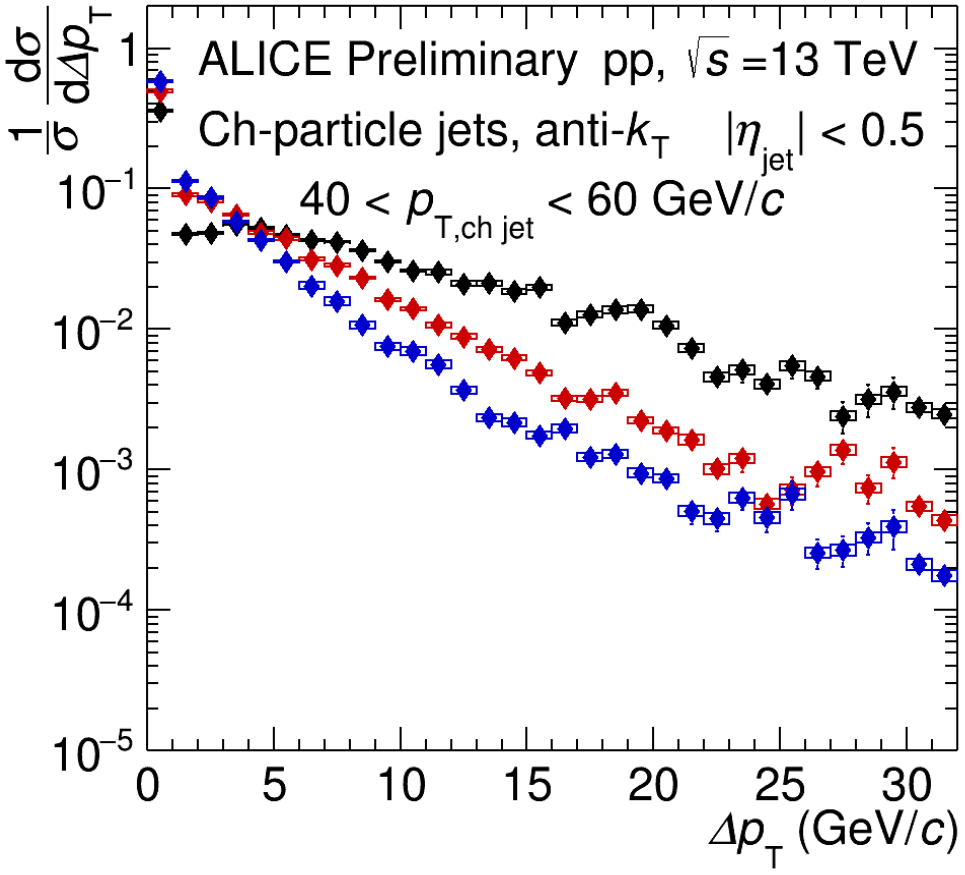

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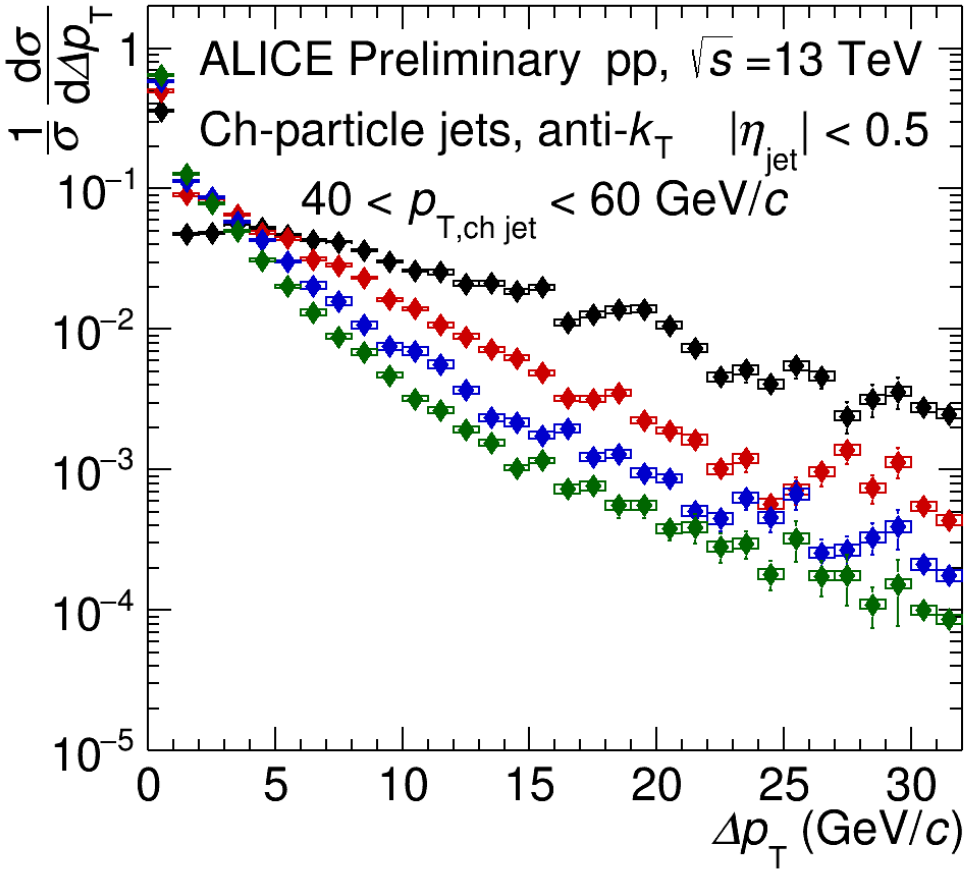

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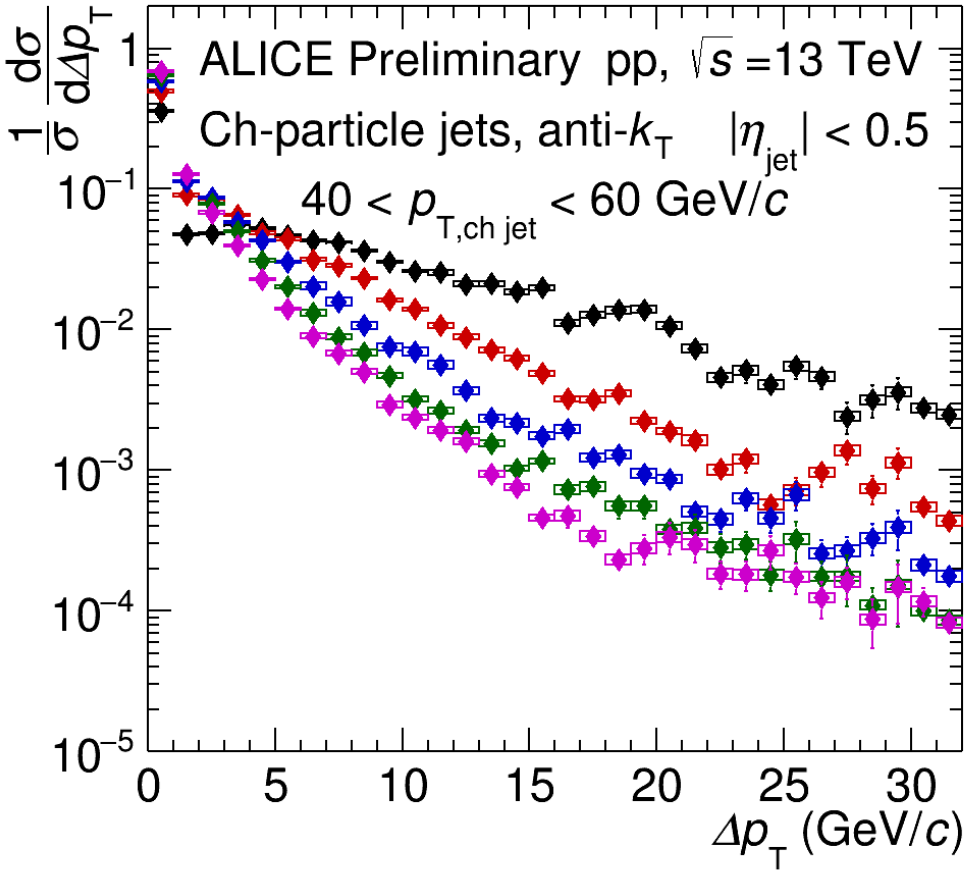

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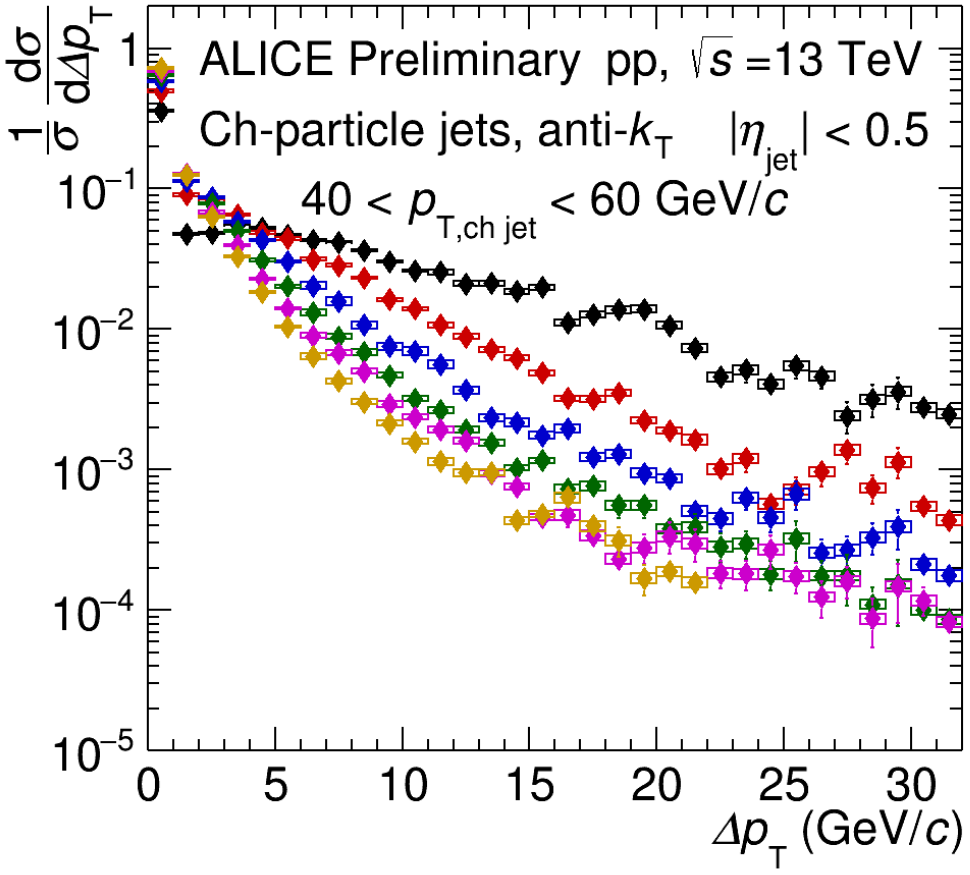

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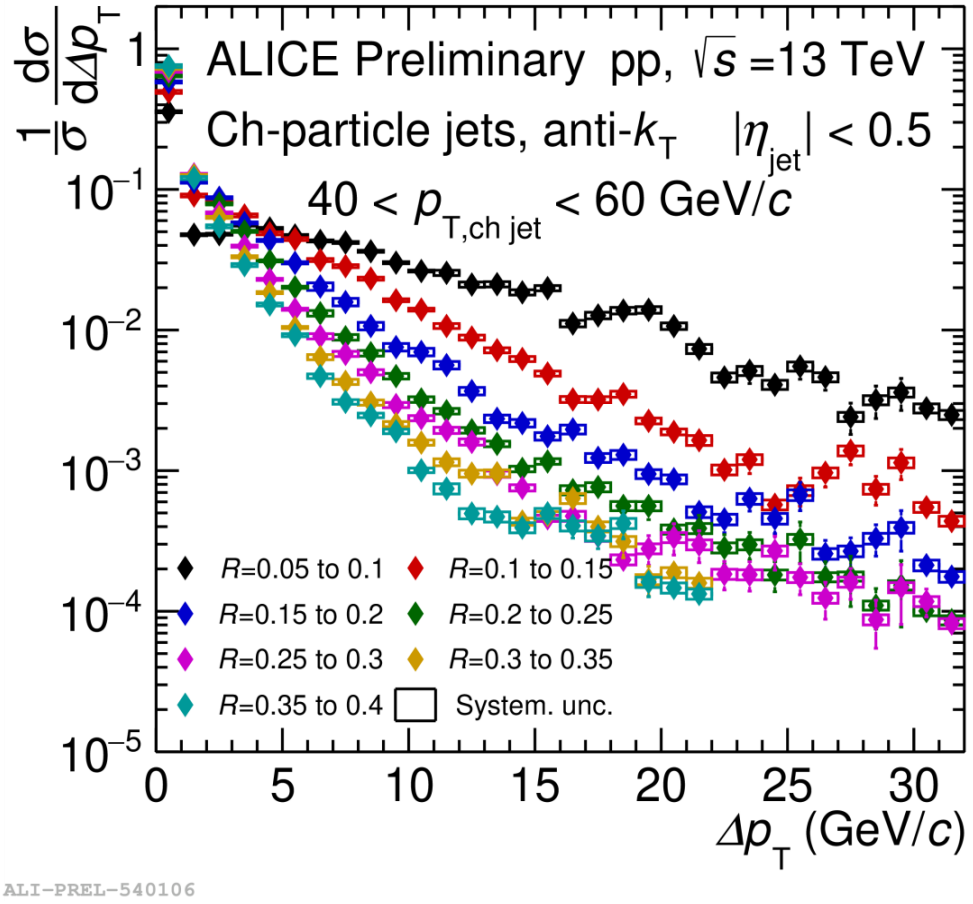

R increases

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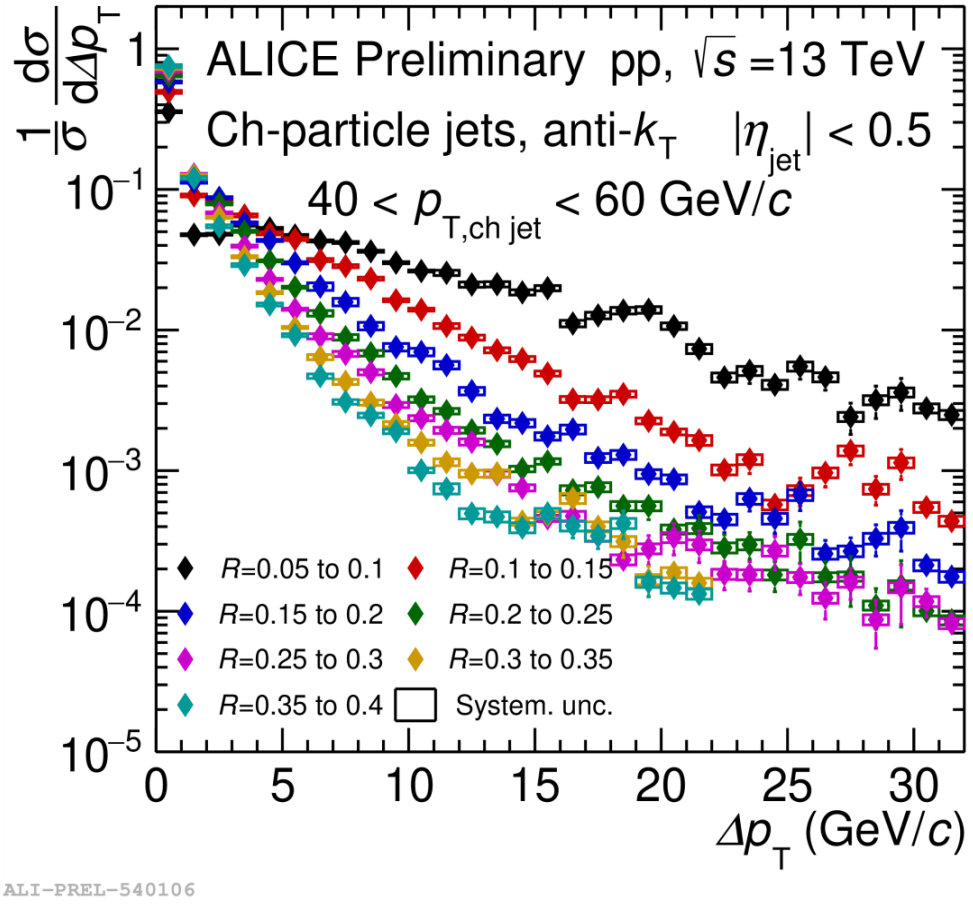

R increases

Distribution mean

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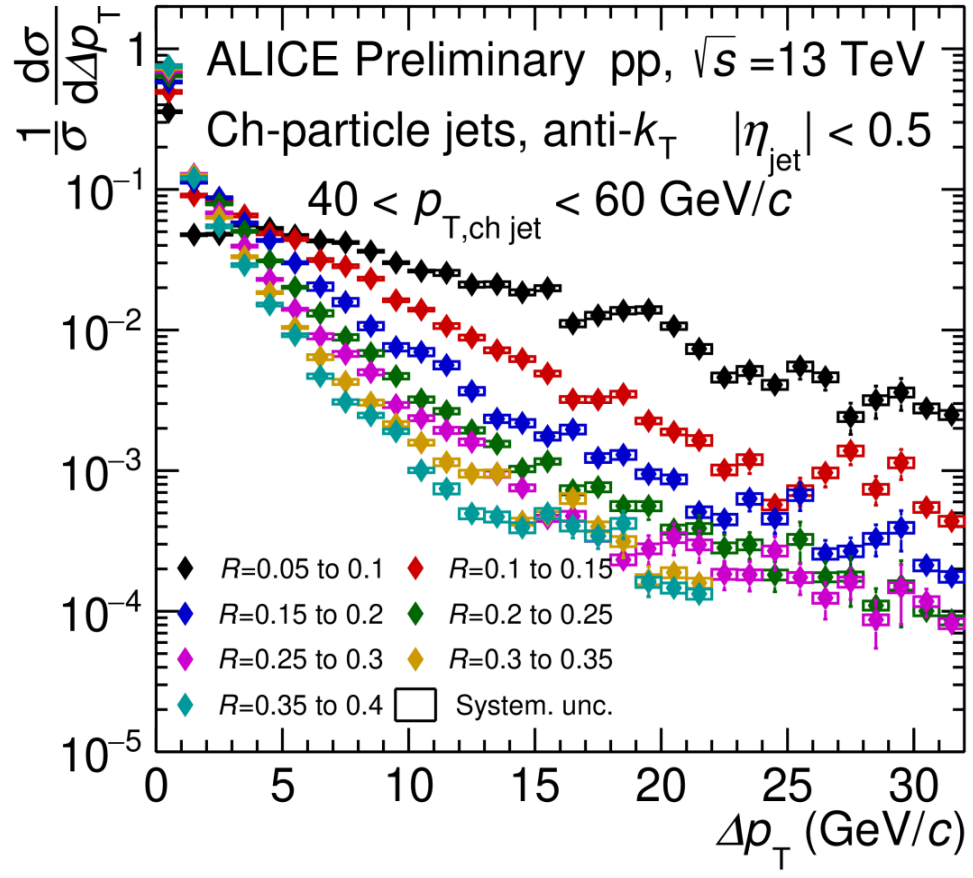

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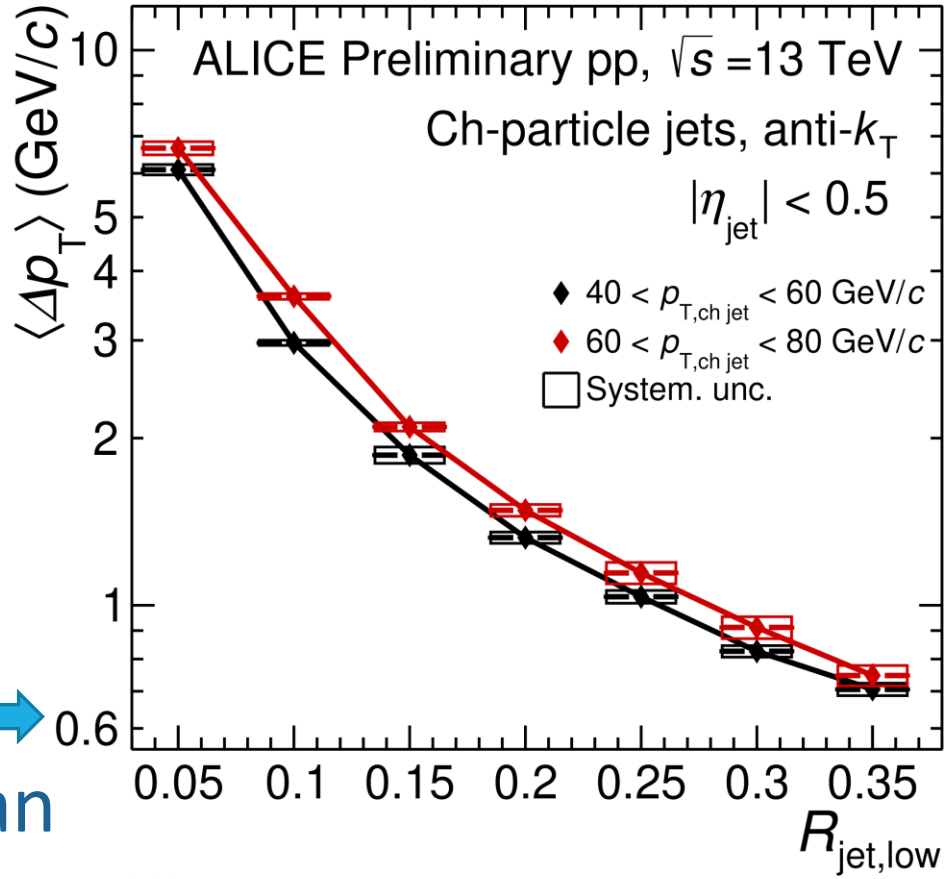

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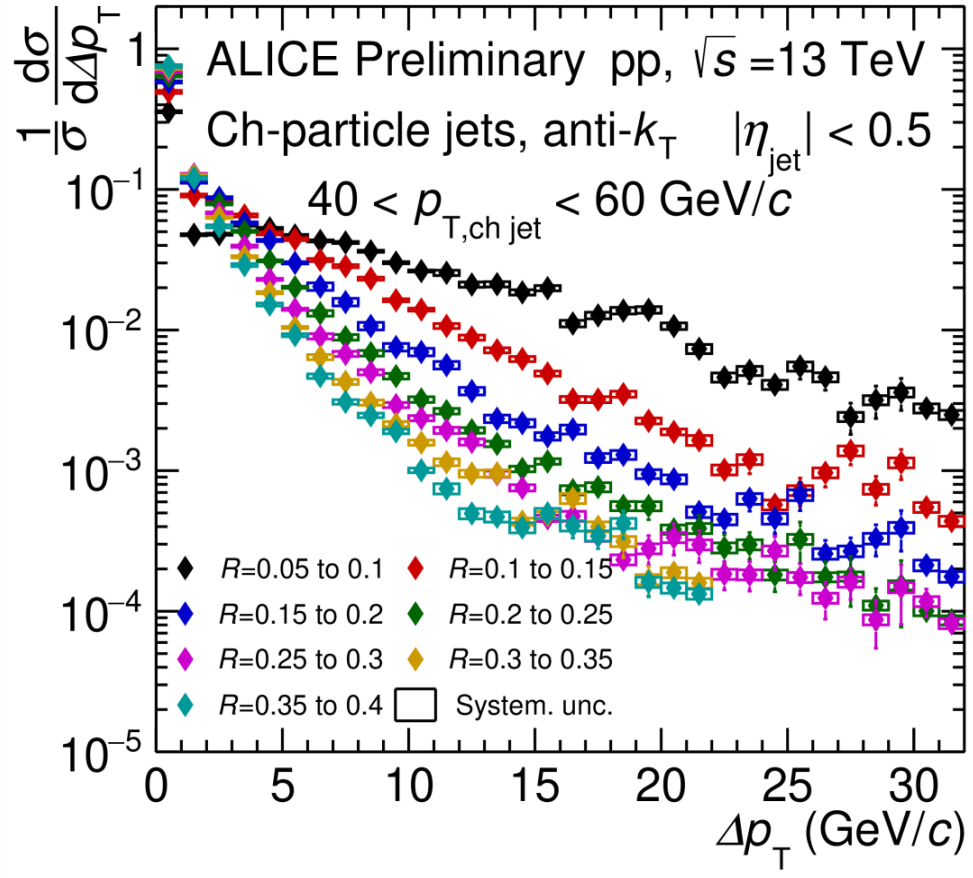
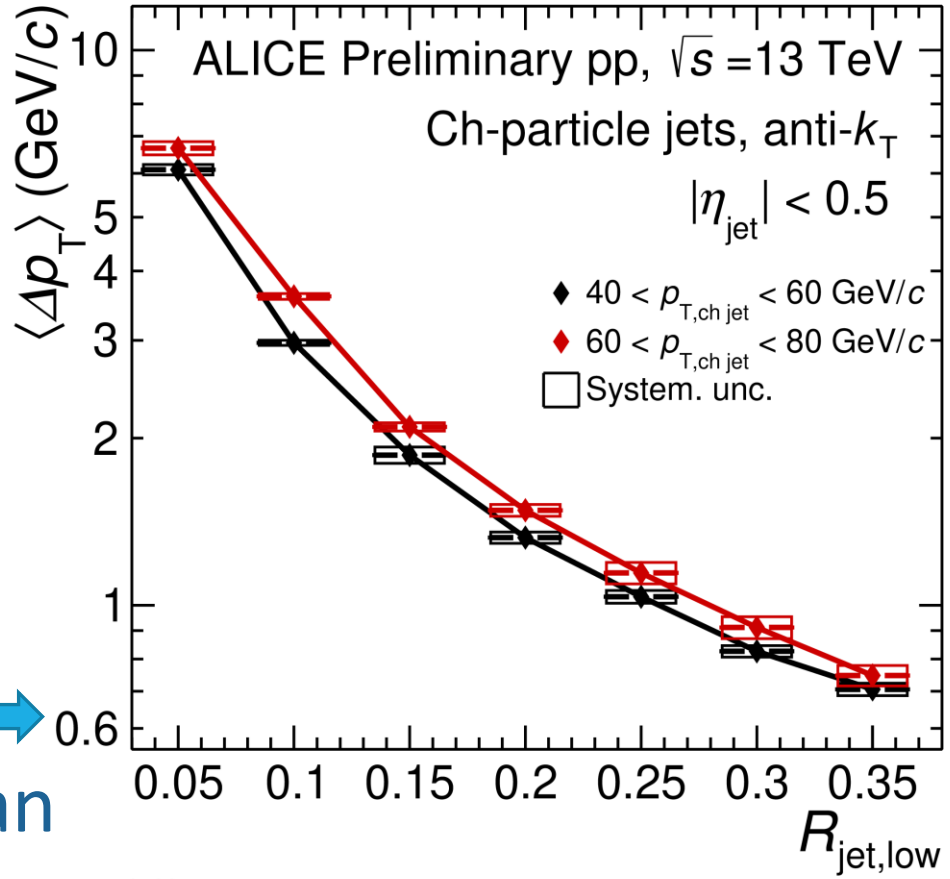
Jet energy flow measurement in pp collisions



ALI-PREL-540106

R increases

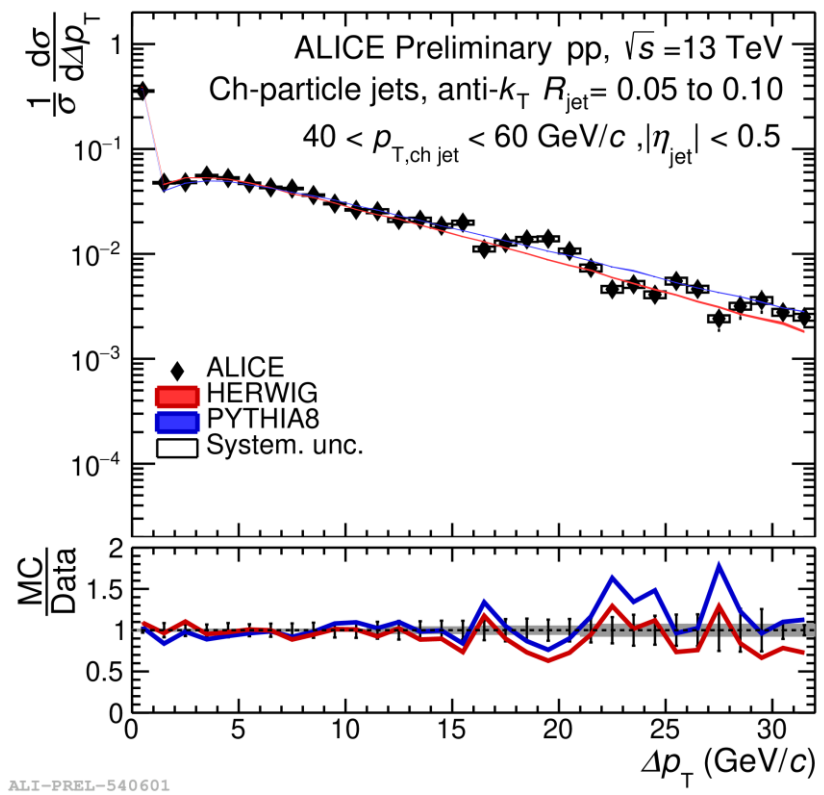
Distribution mean

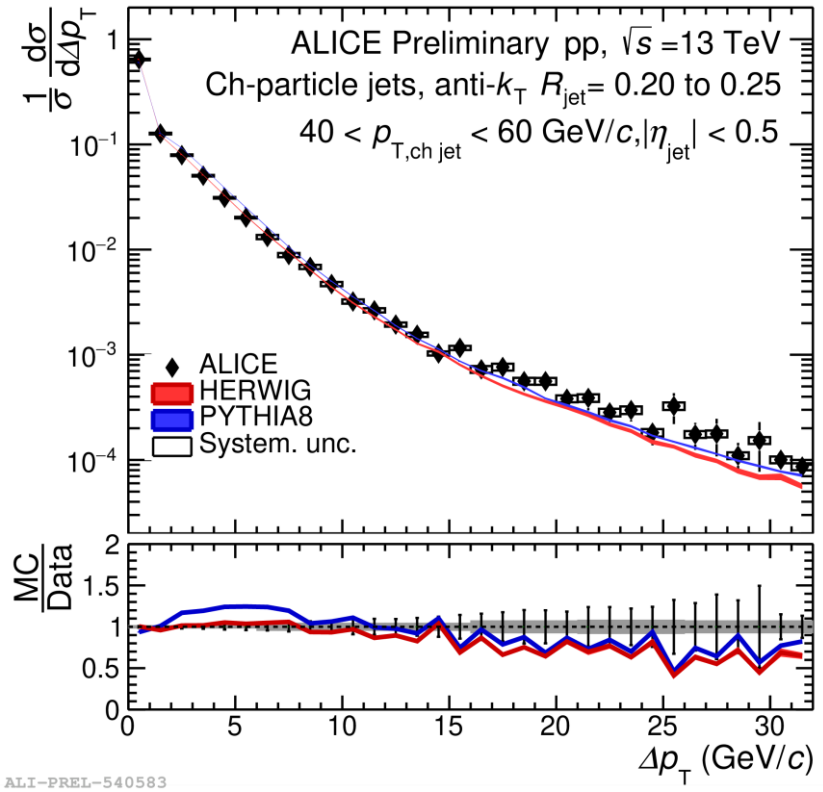


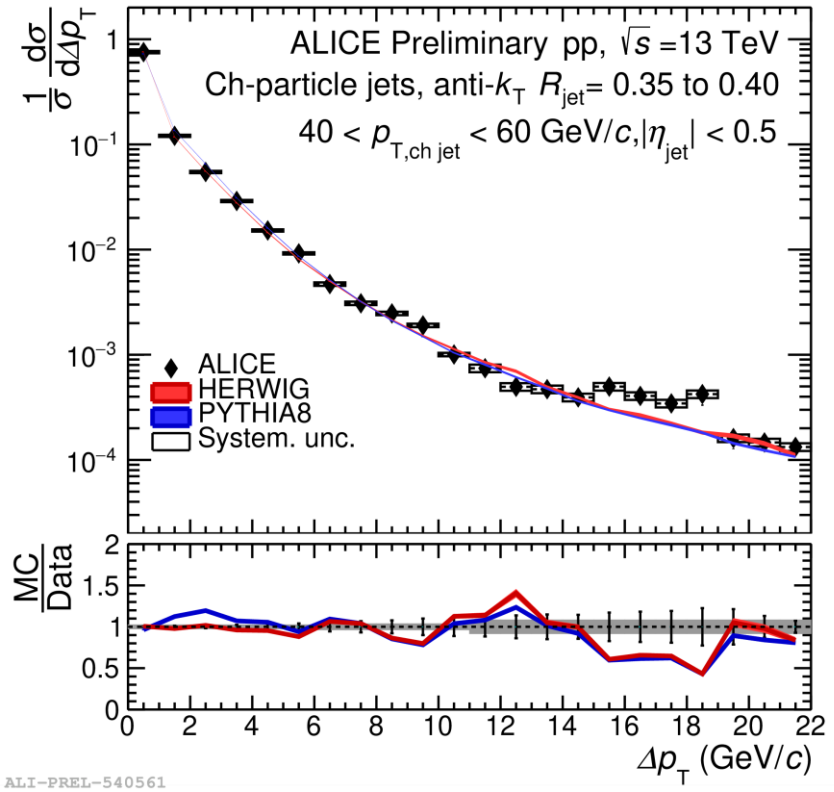
ALI-PREL-540489

Mean energy flow rapidly decreases as function of R

Jet energy flow measurement: Model comparison





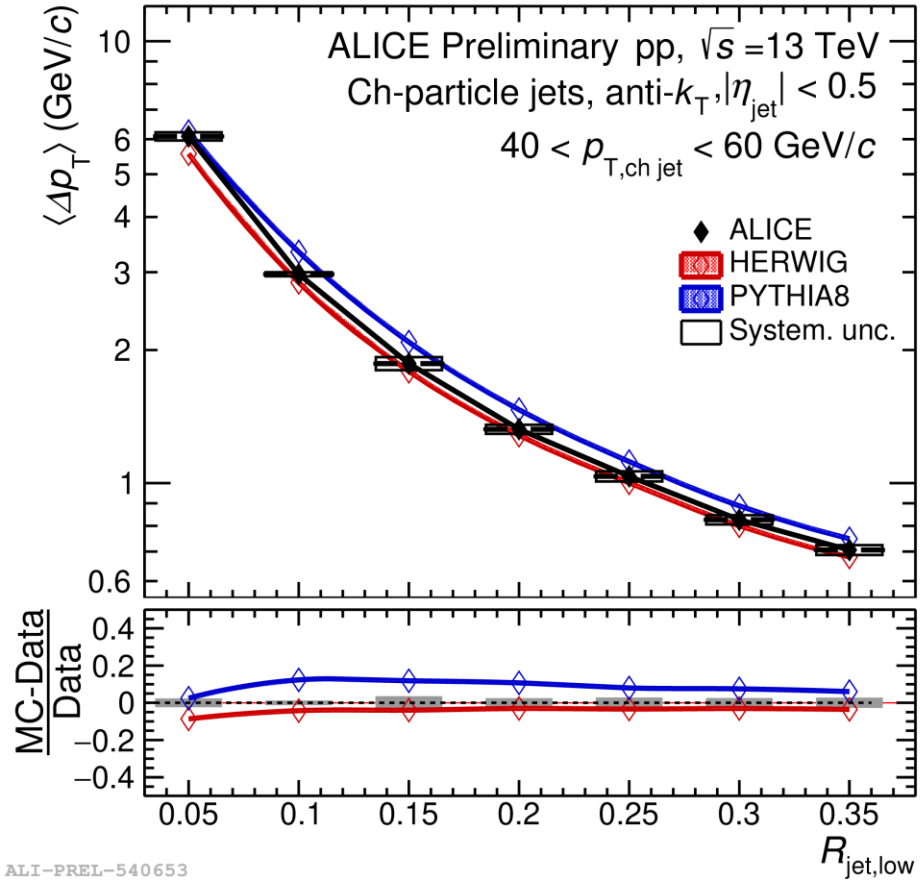


R=0.05 to R=0.1

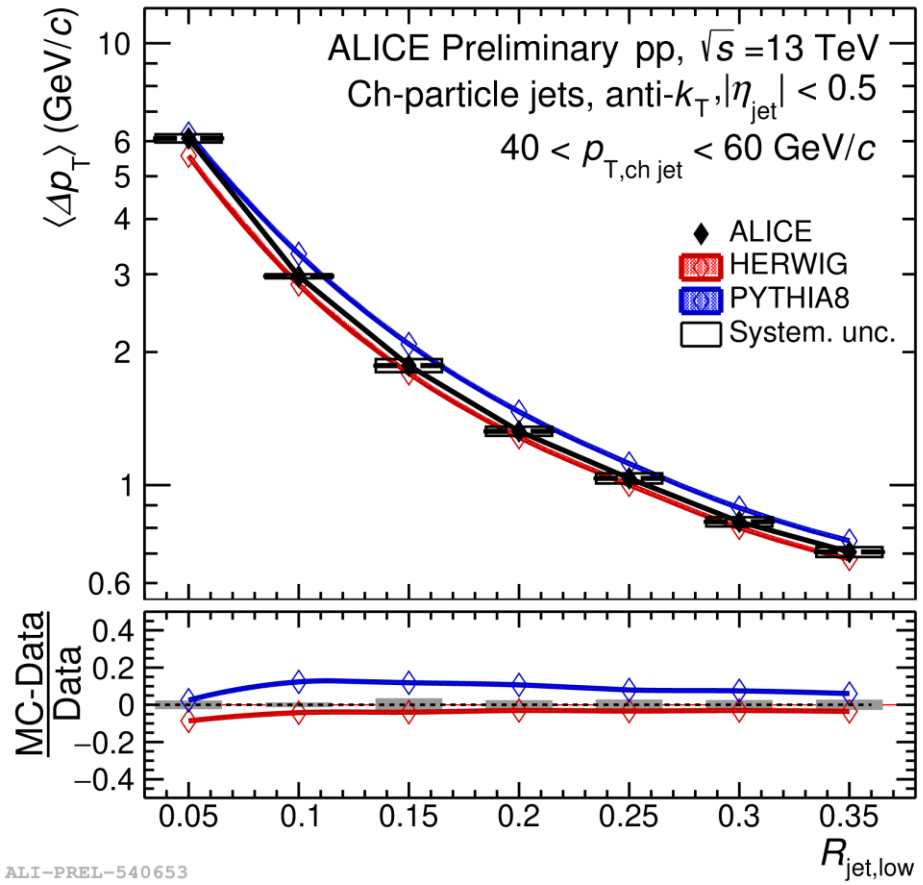
R=0.2 to R=0.25

R=0.35 to R=0.4

Jet energy flow measurement: Model comparison

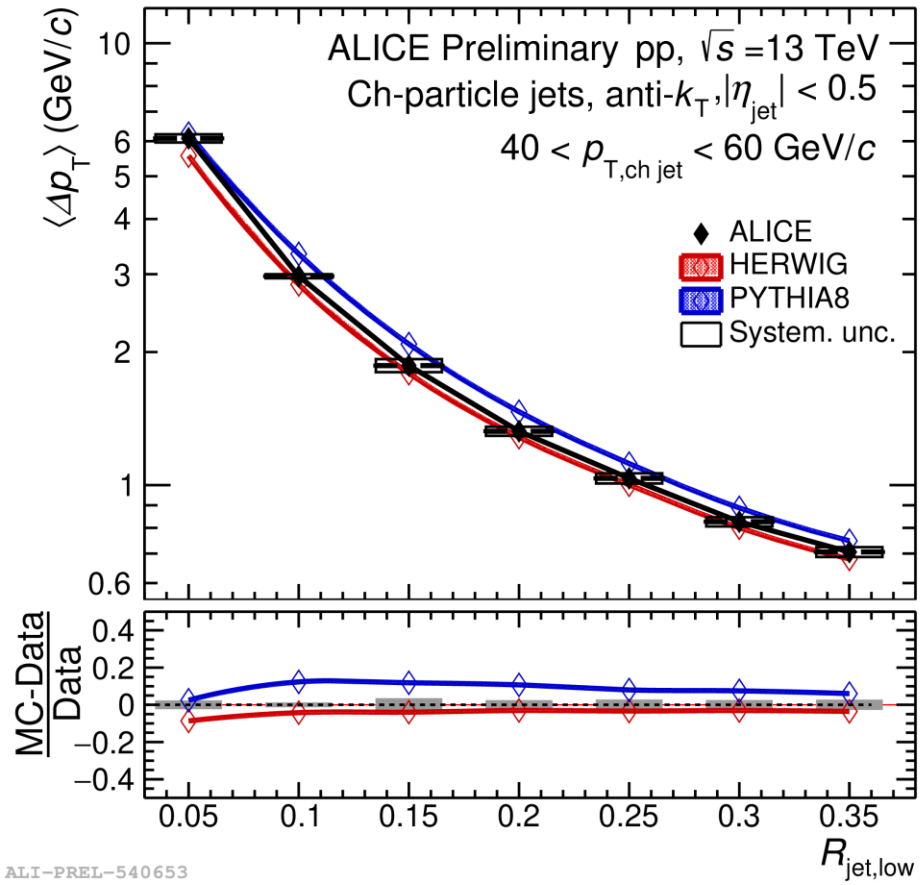


Jet energy flow measurement: Model comparison

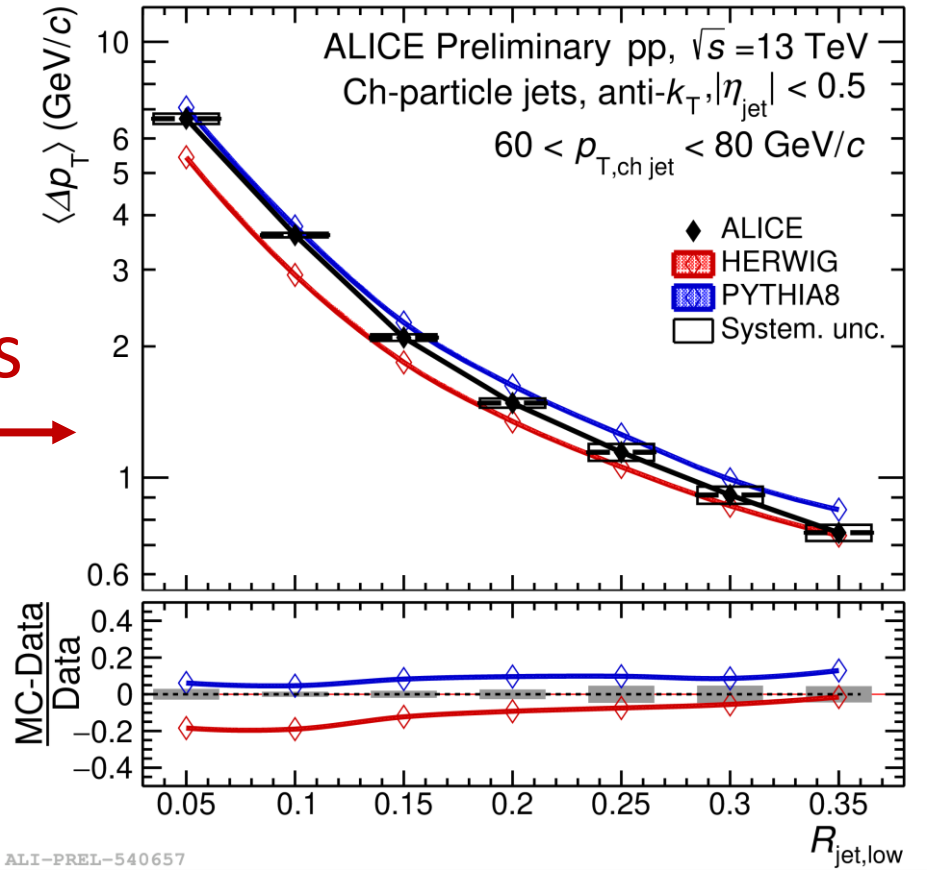


Jet p_T increases

Jet energy flow measurement: Model comparison

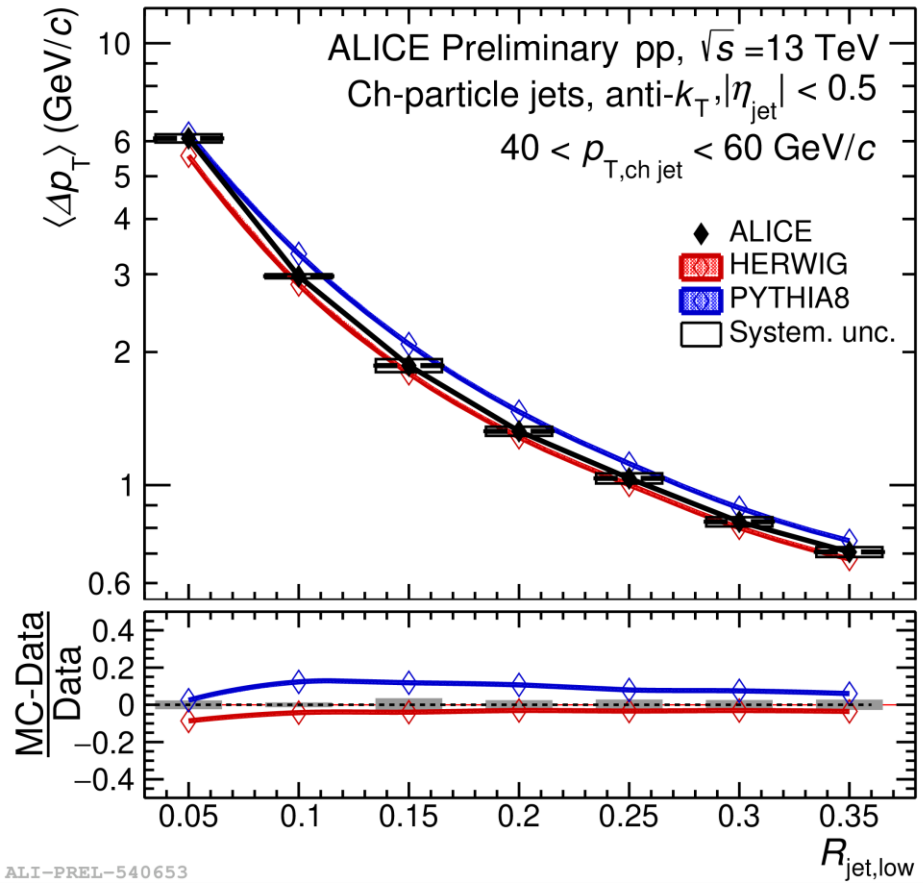


Jet p_T increases

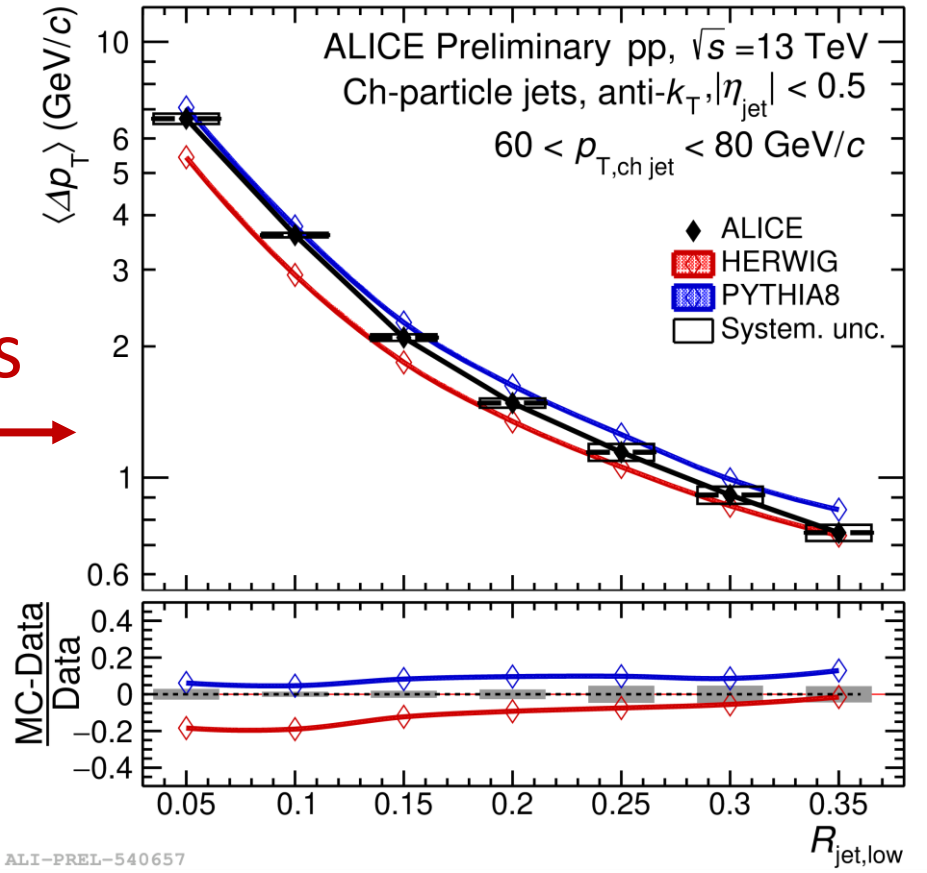


Jet energy flow measurement: Model comparison

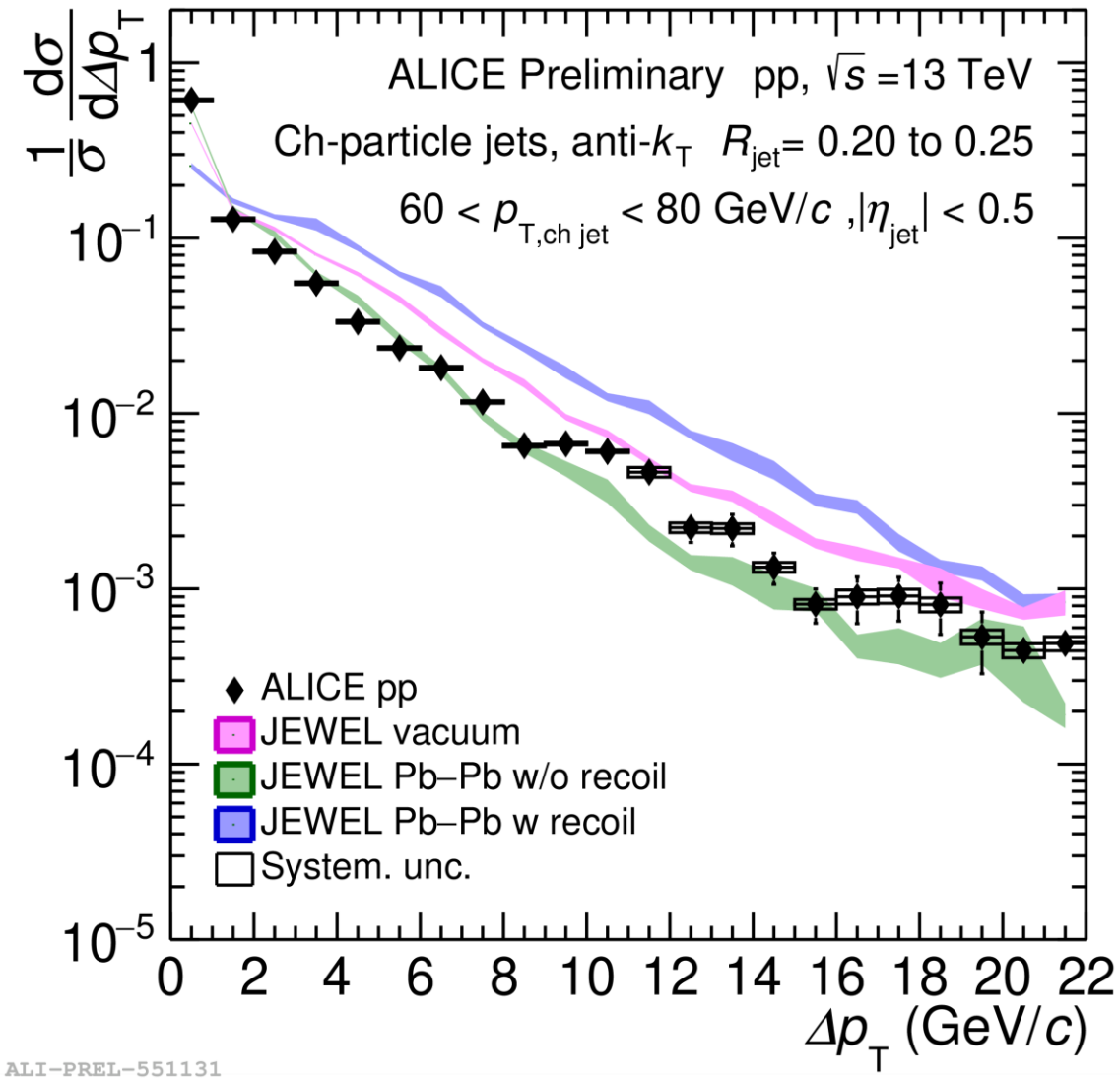
Good description of the measurement by both HERWIG and PYTHIA



Jet p_T increases

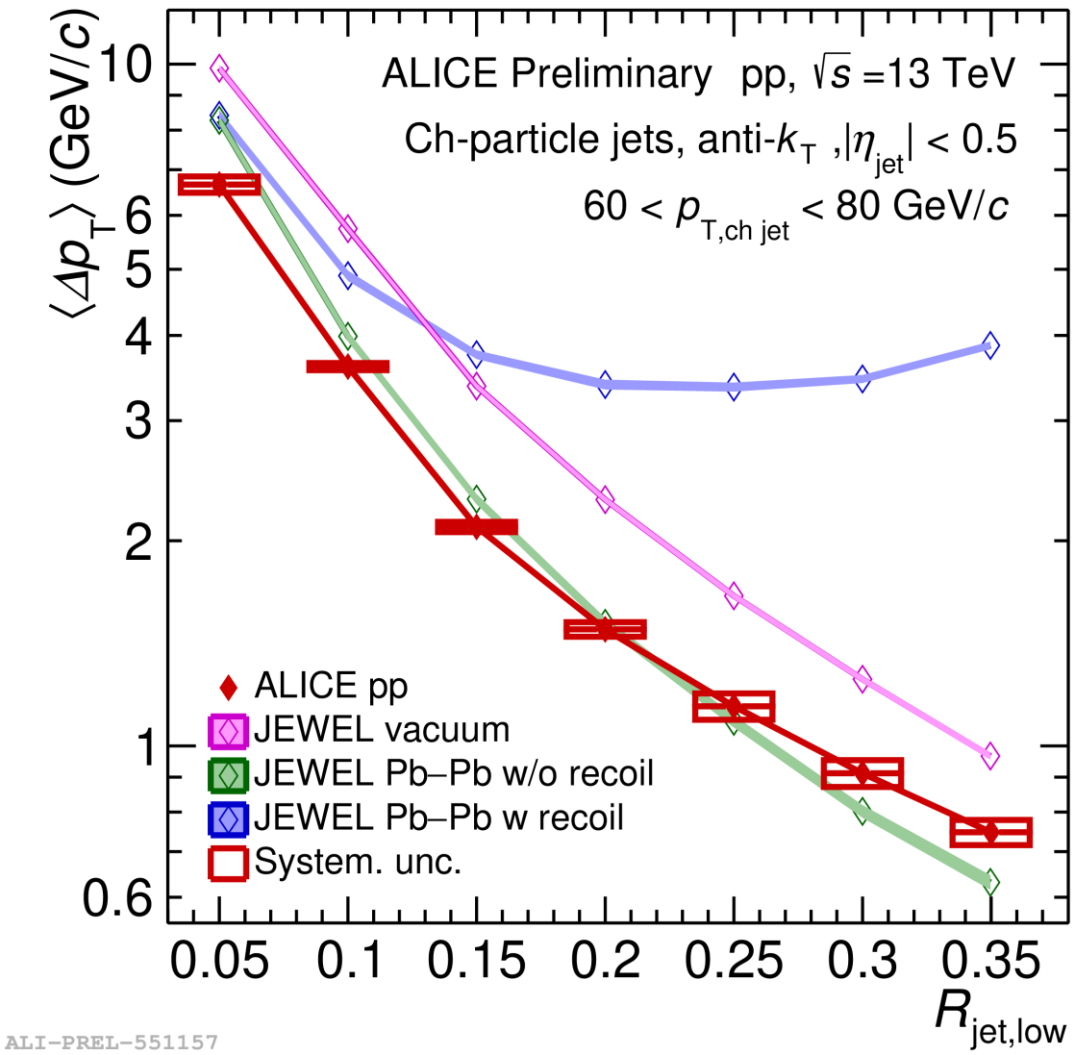


Model predictions for HI measurement



- Observable is sensitive to recoil effects.
- JEWEL Δp_T prediction in vacuum >> ALICE pp measurement.
- Disagreement in vacuum predictions impedes interpretation for JEWEL AA simulations.

Model predictions for HI measurement



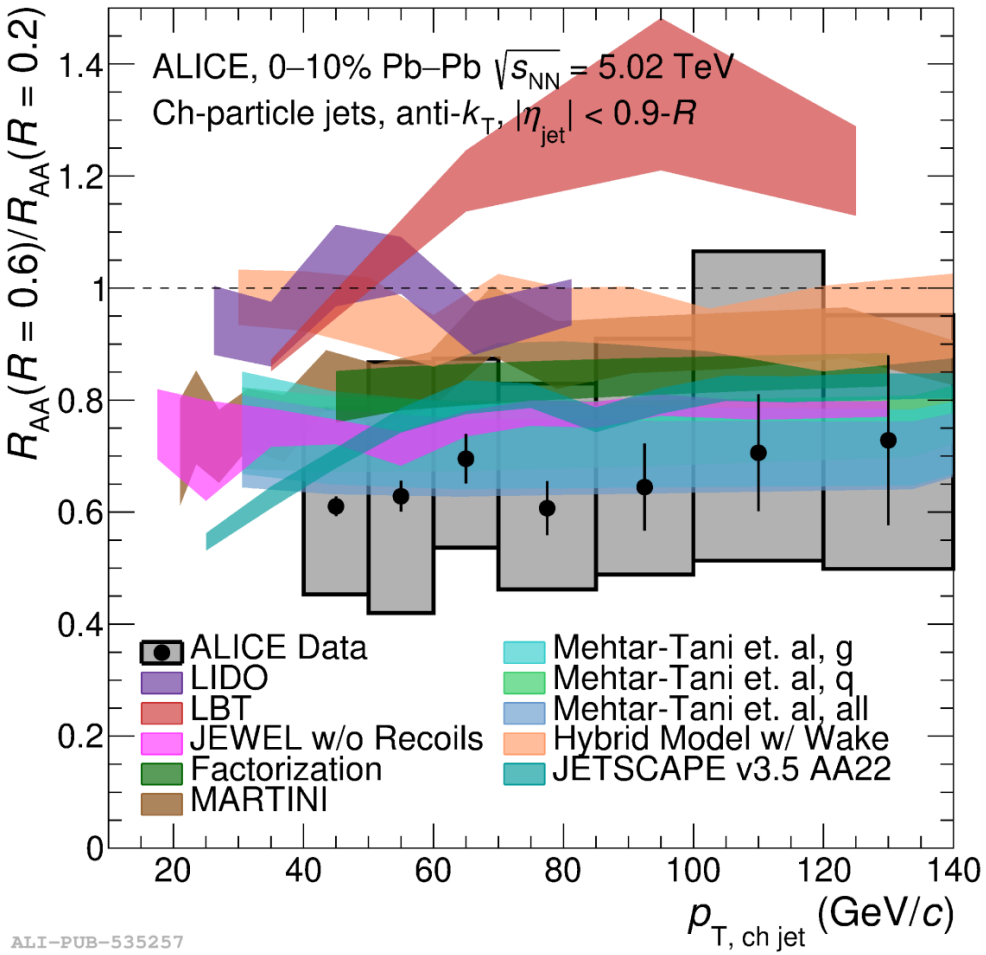
- JEWEL predictions for jet quenching:
  - Recoil effects → Recovery of energy at large R.
  - No recoil effects → Narrower jet energy profile

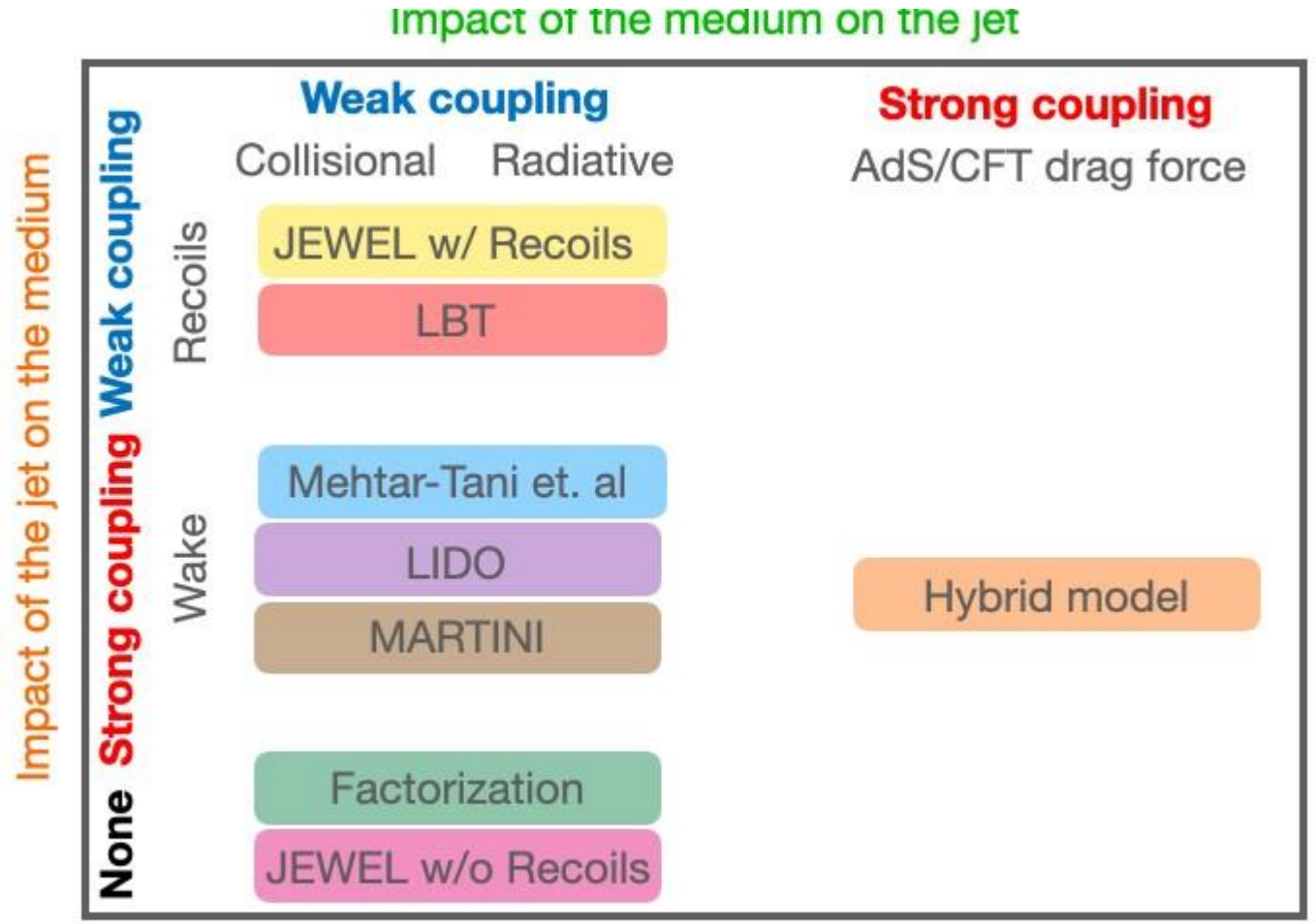
Summary & Outlook

- Jets serve as excellent probes for the study of the QGP medium dynamics.
- R_{AA} measurements clearly demonstrate jet quenching in HI collisions.
- Cone-size dependence of jet quenching is sensitive to competing effects.
  - Measurements of R_{AA} show hints of decrease at large jets in low momenta.
- Novel jet energy flow observable and its measurement in pp collisions presented.
  - Mean jet energy flow monotonically decreases as a function of R
  - Model predictions showcase the sensitivity of the observable to recoil effects in the medium.
- Jet energy flow measurement in ALICE Pb-Pb data is on the way.

Backup

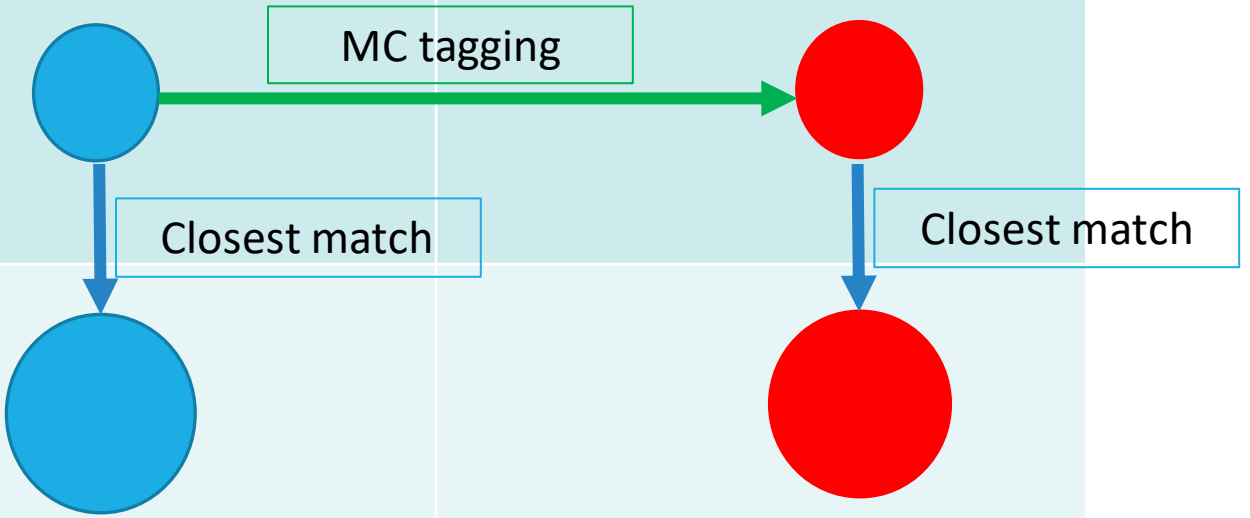
R dependence of jet nuclear modification factor – Models



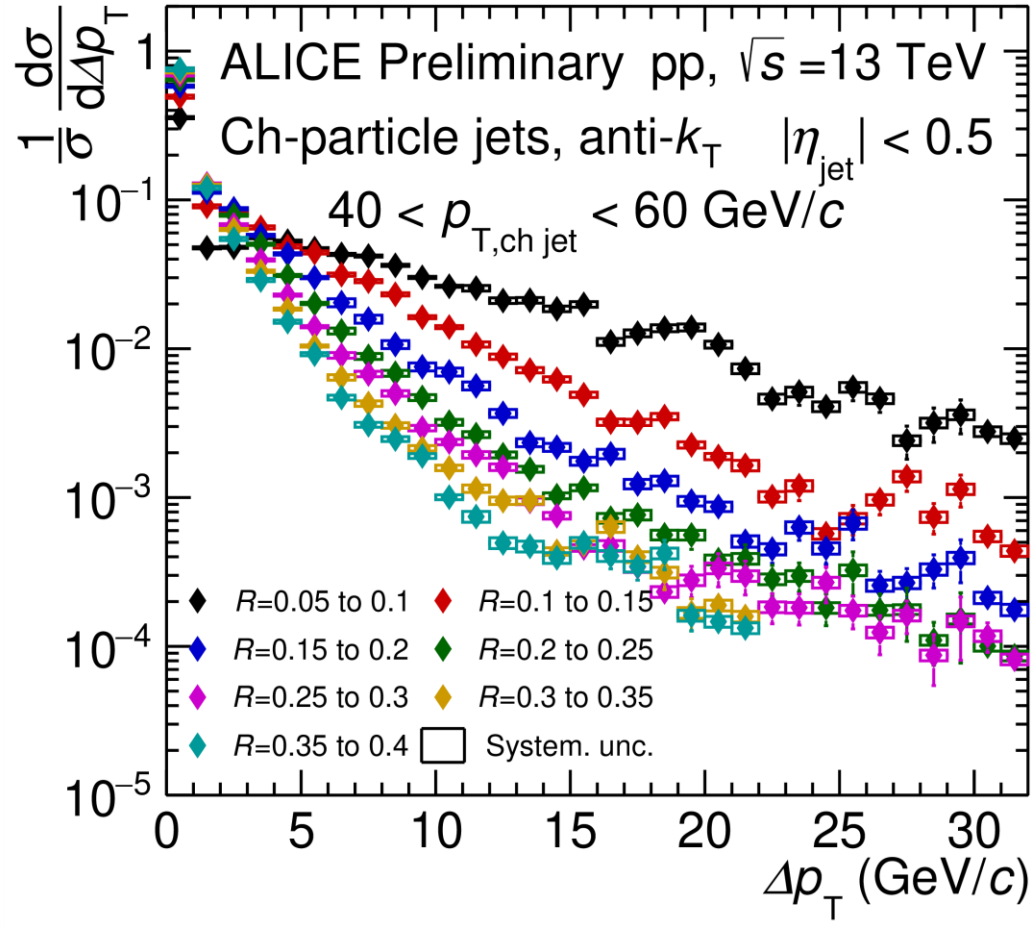


ALICE: https://arxiv.org/abs/2303.00592

Matching/Tagging procedure

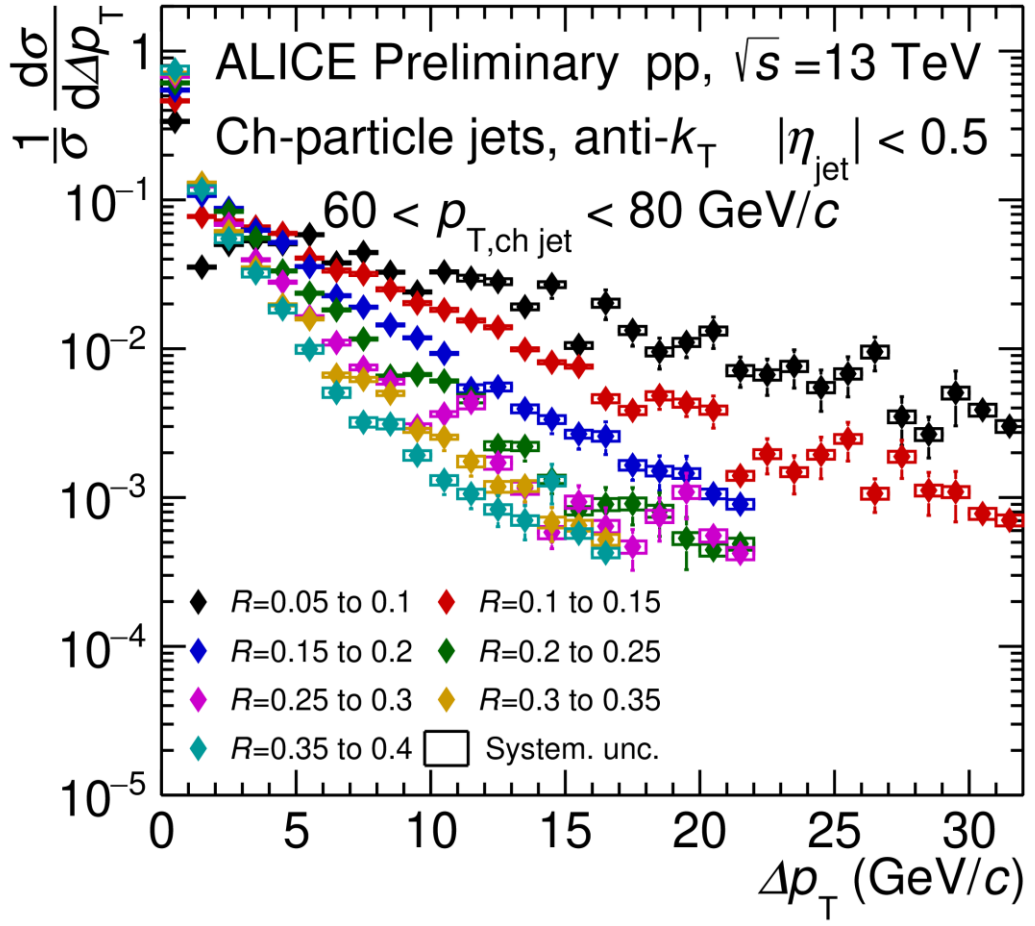
R_{jet}	PYTHIA Truth /Generator/ Particle level	PYTHIA Hybrid/Detector/ Reconstructed level
R=0.2		
R=0.25		

Jet energy flow distributions: jet p_T dependence



ALI-PREL-540106

$40 < p_T < 60$ GeV/c

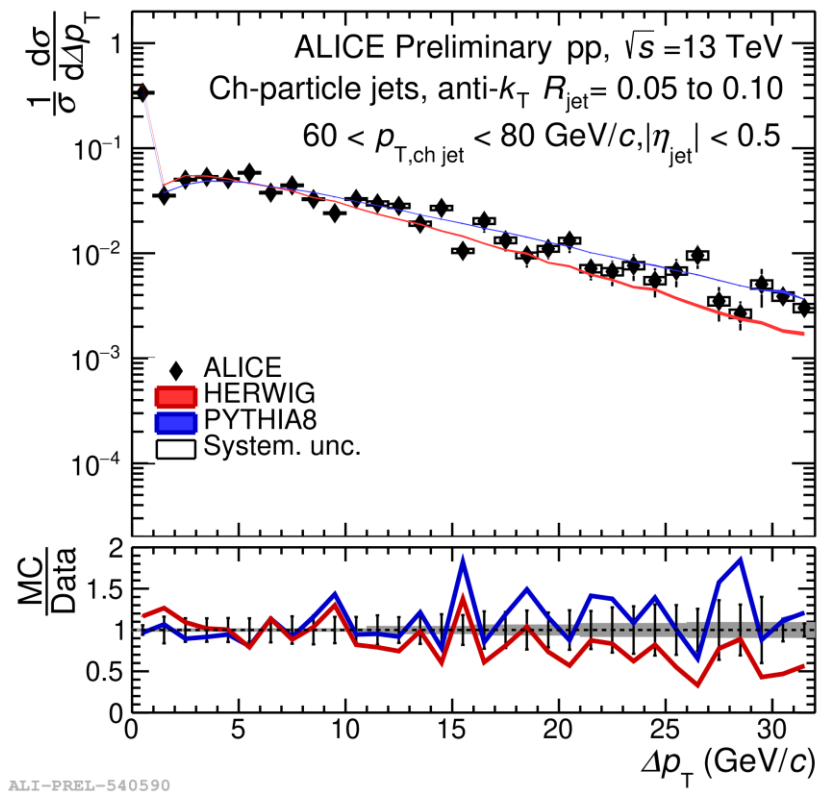


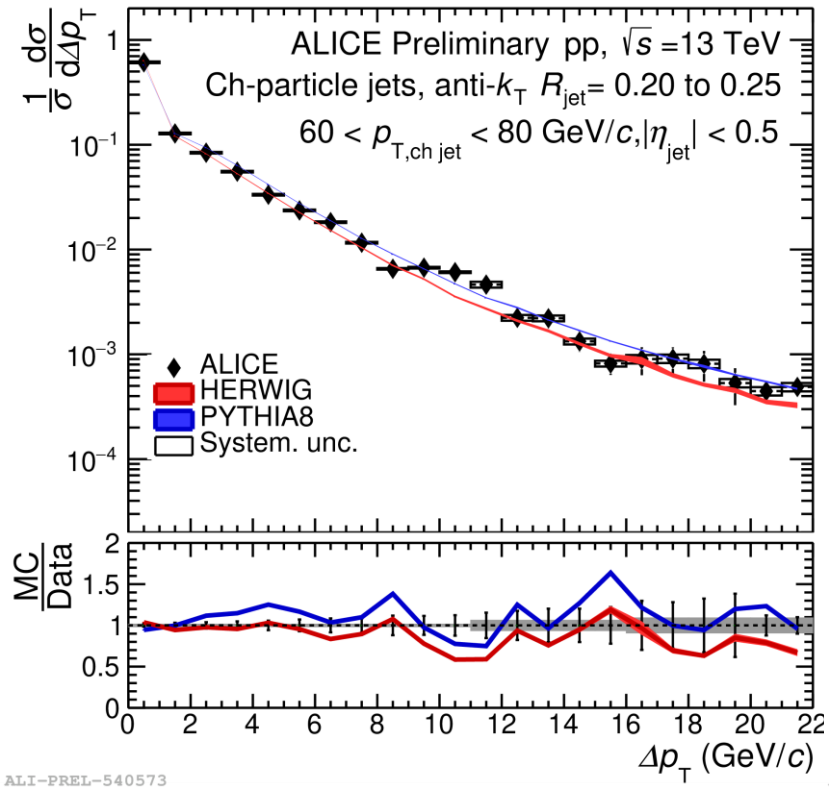
ALI-PREL-540102

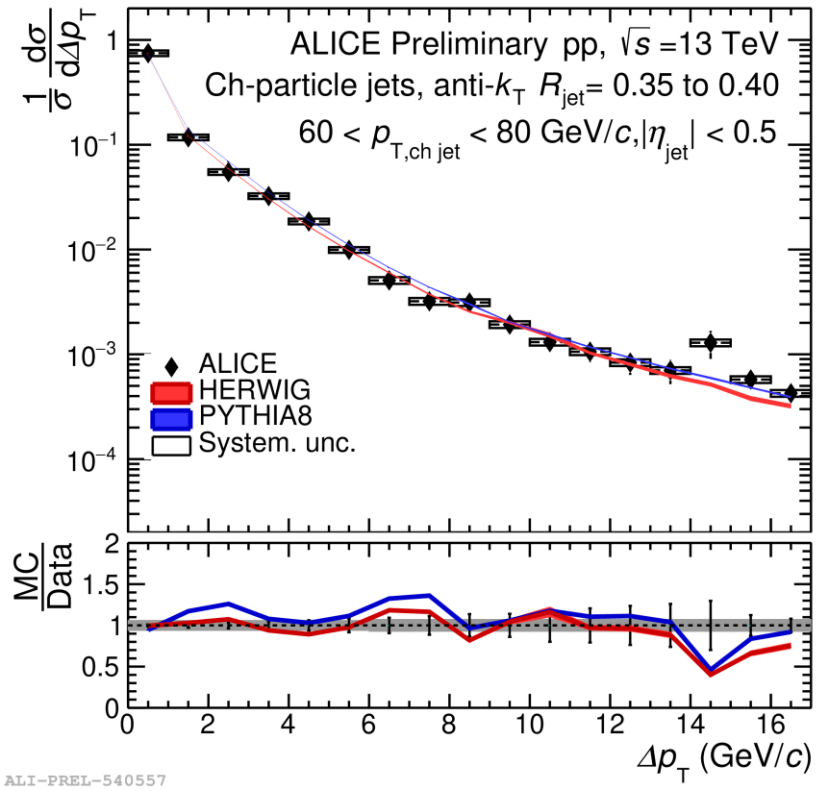
$60 < p_T < 80$ GeV/c

Jet energy flow measurement: Model comparison

Good description of the measurement by both HERWIG and PYTHIA







R=0.05 to R=0.1

R=0.2 to R=0.25

R=0.35 to R=0.4