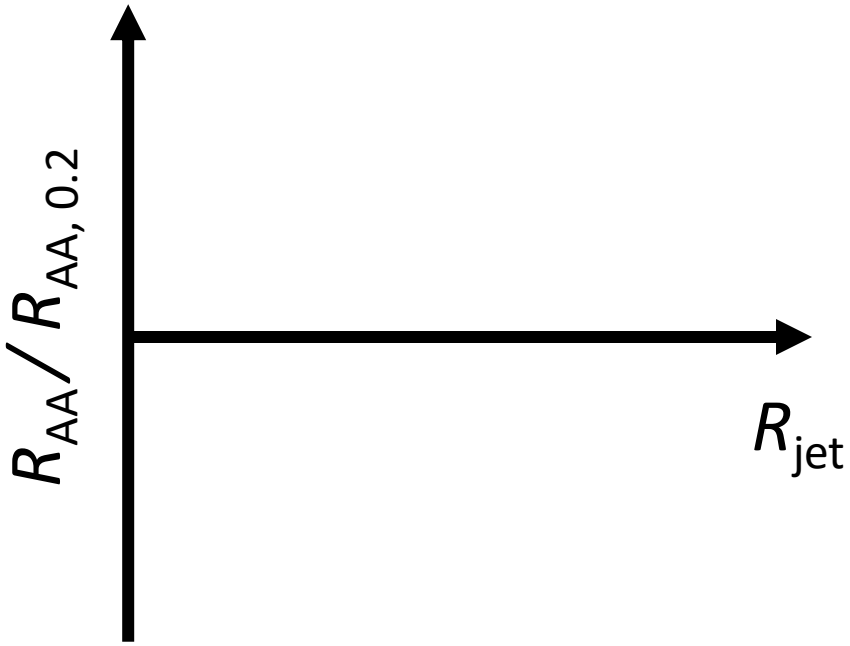
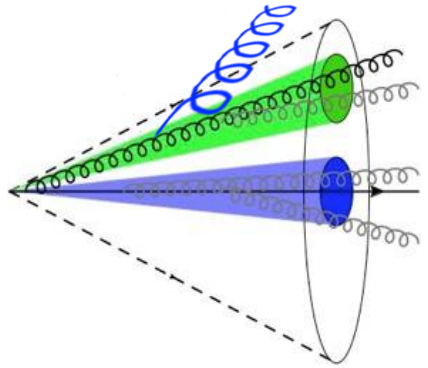
Measurement of the *R*-dependence of jet quenching in pp and Pb–Pb collisions with ALICE

11th Hard Probes conference, March 28th 2023

Christos Pliatskas on behalf of the ALICE collaboration

Are large jets more quenched?





Sketch: QM19, Yi Chen

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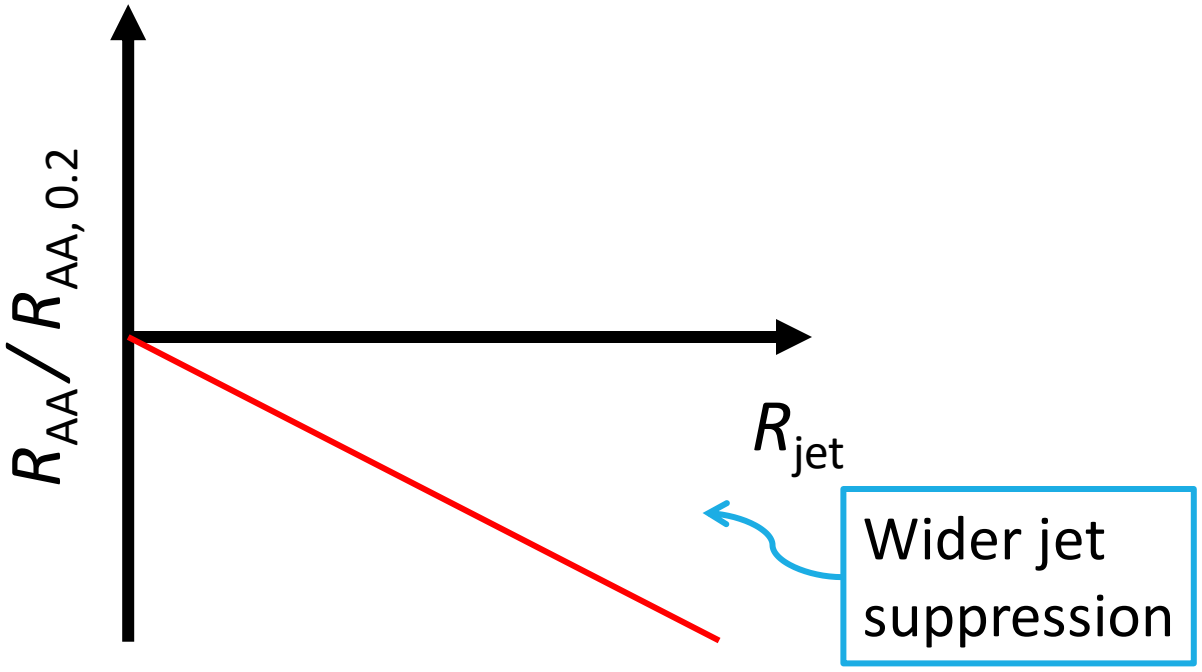

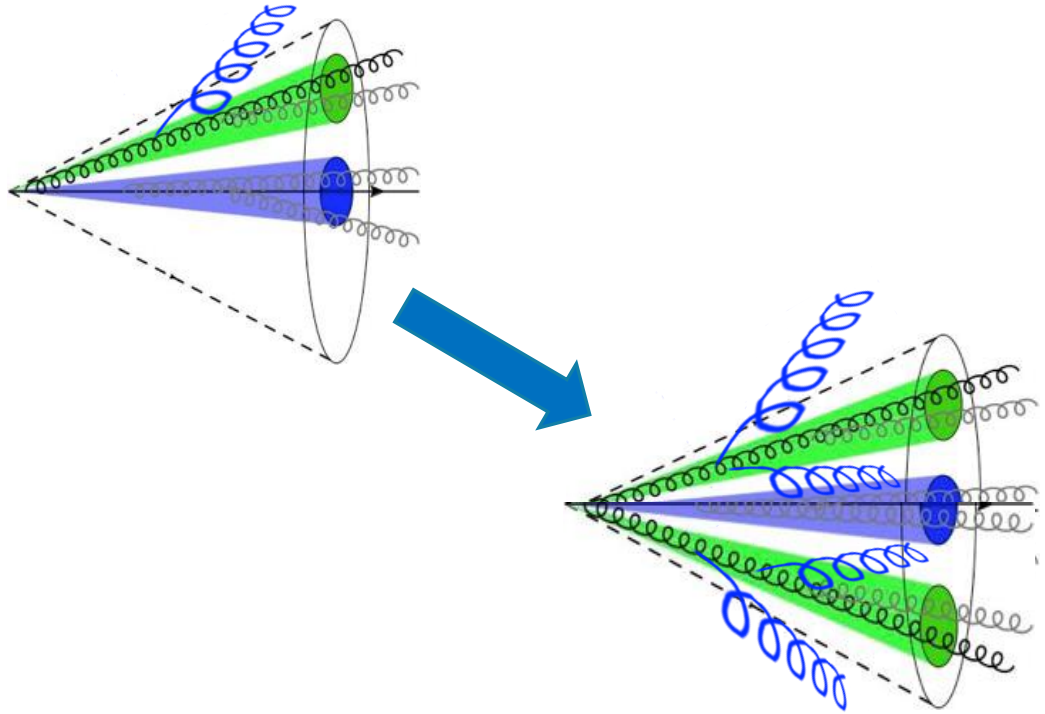

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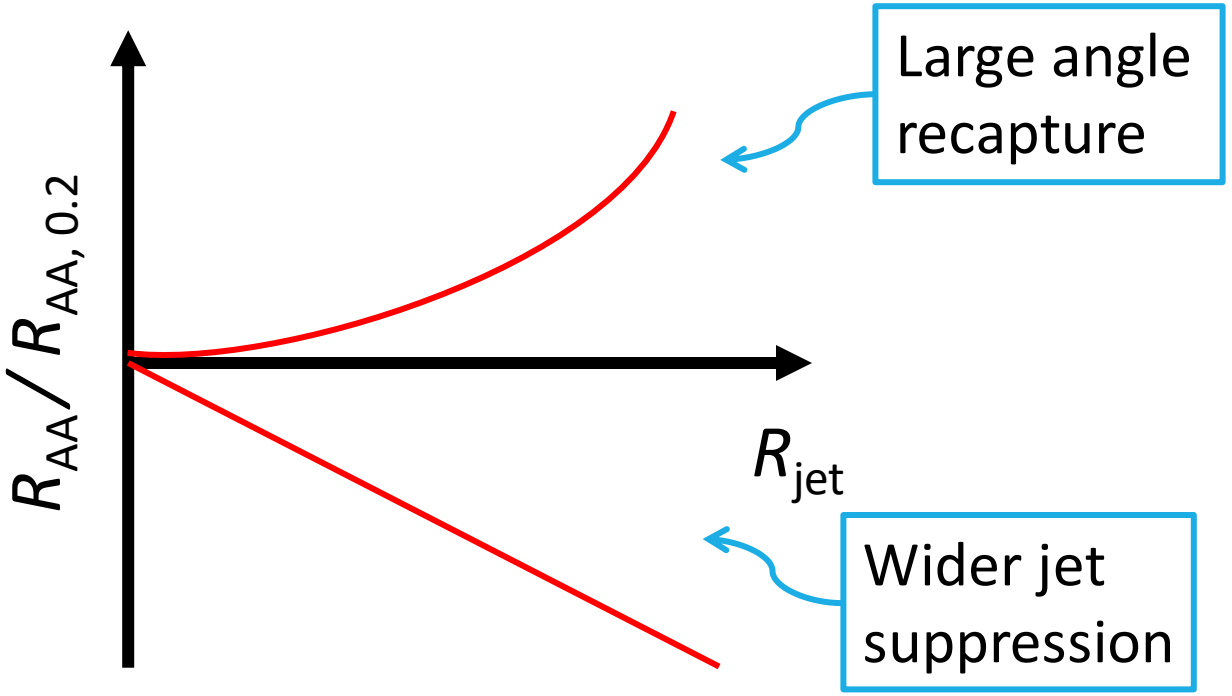

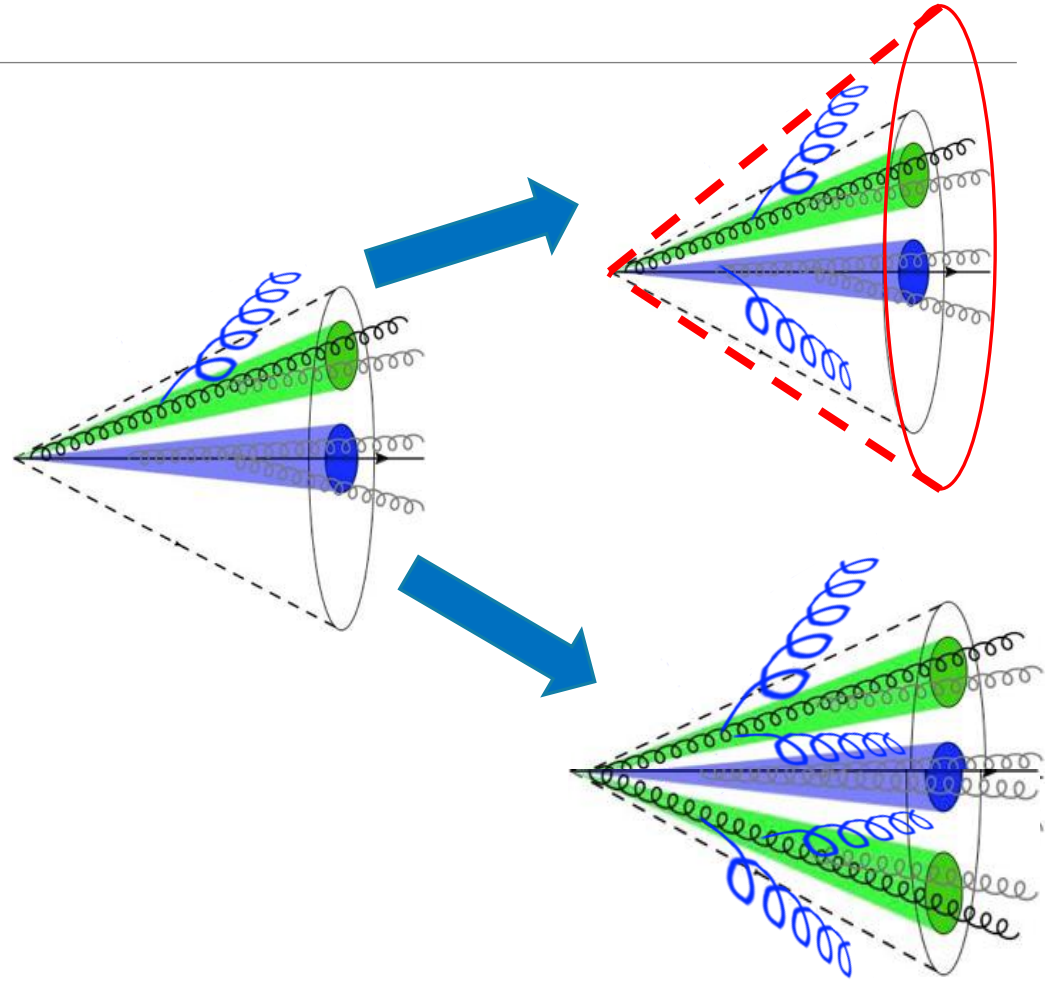

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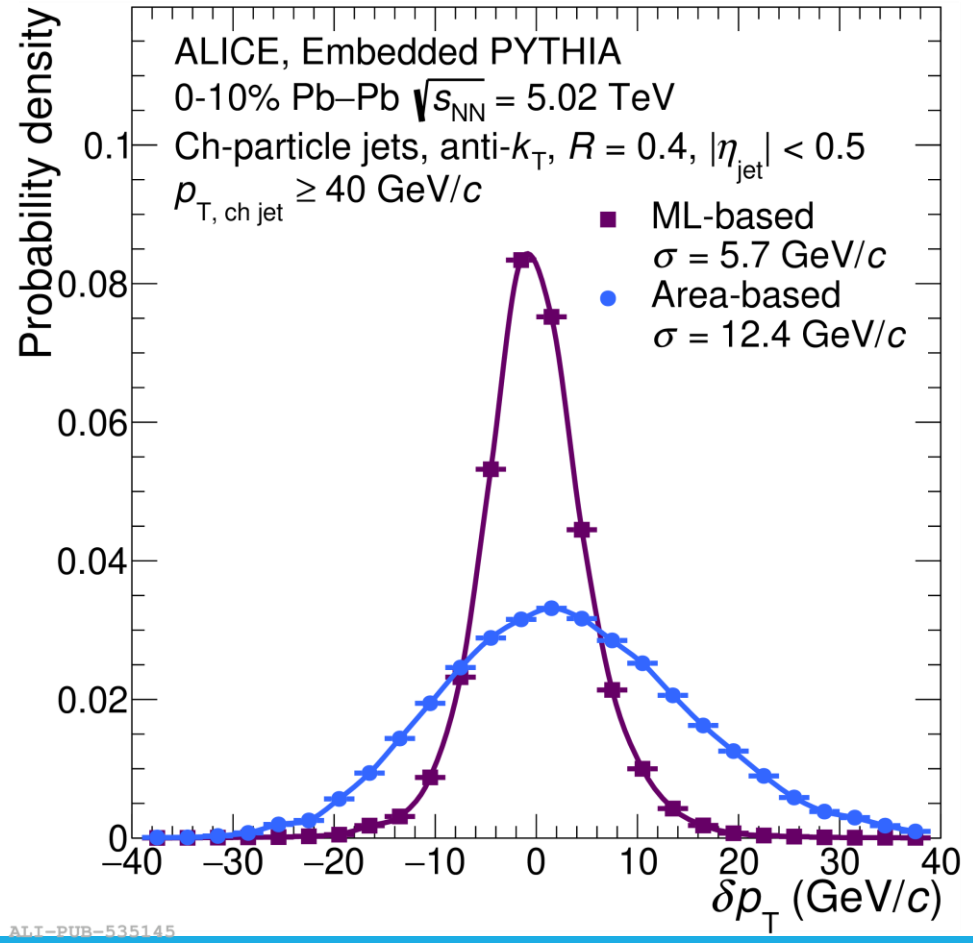
ML-based correction for p_T-smearing due to background

- ALICE area-based approach: jet p_T correction.
- ML approach: map measured to corrected jets through a neural network.



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

ML-based correction for p_T-smearing due to background

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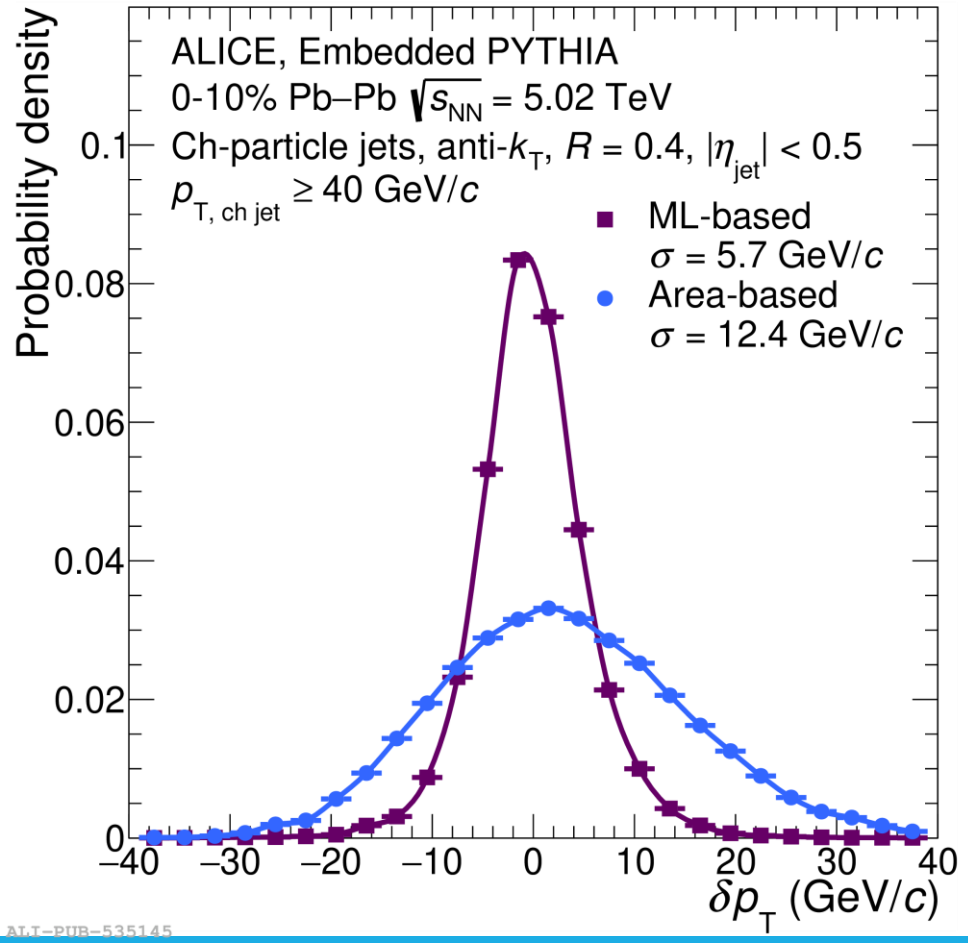
- More precise jet energy resolution with the ML-based method at large R.



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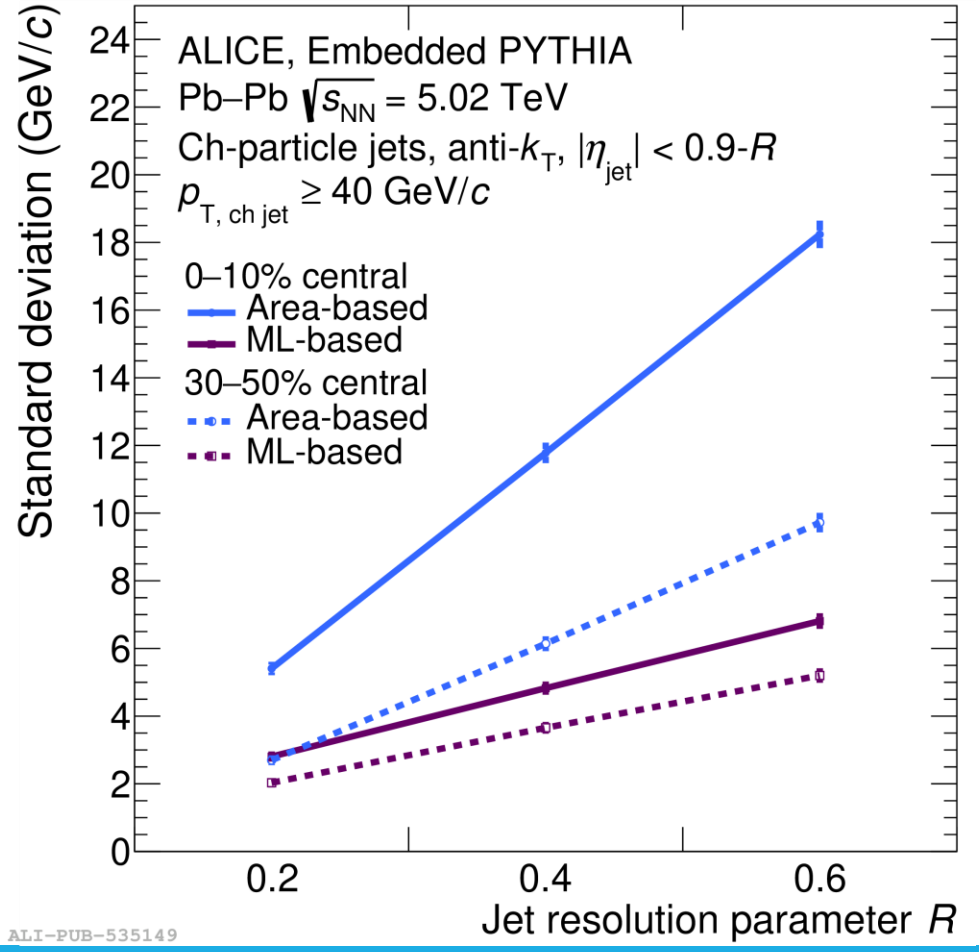
ML-based correction for p_T-smearing due to background

- ALICE area-based approach: jet p_T correction.
- ML approach: map measured to corrected jets through a neural network.
- More precise jet energy resolution with the ML-based method at large R.
- However, this method introduces fragmentation function bias.



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R-dependence of jet nuclear modification factor

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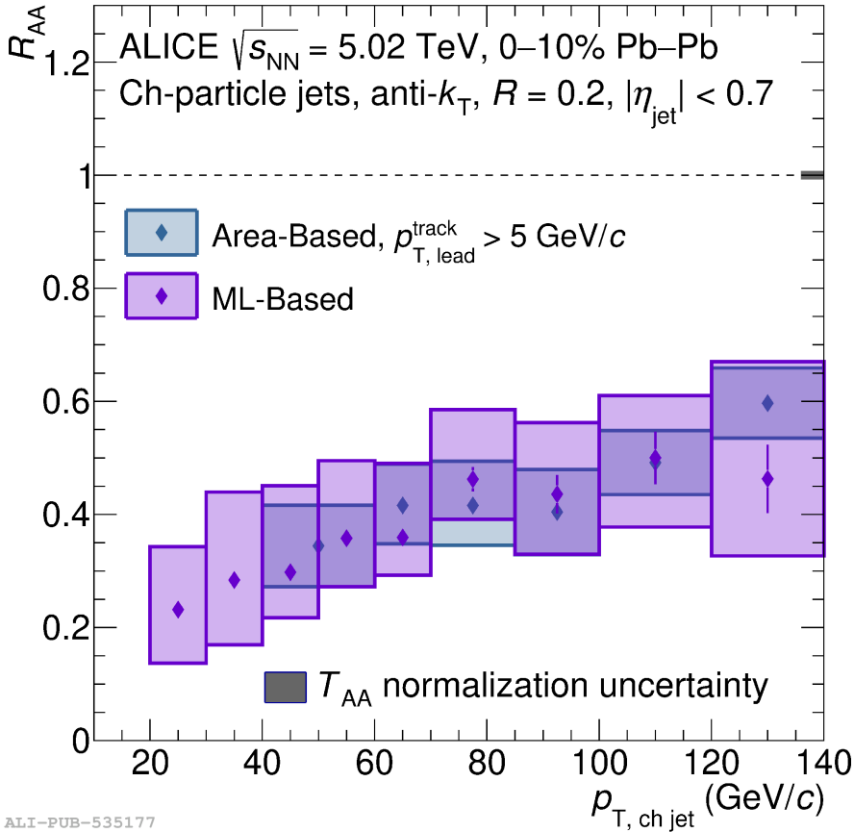

R=0.2

R-dependence of jet nuclear modification factor

R increases

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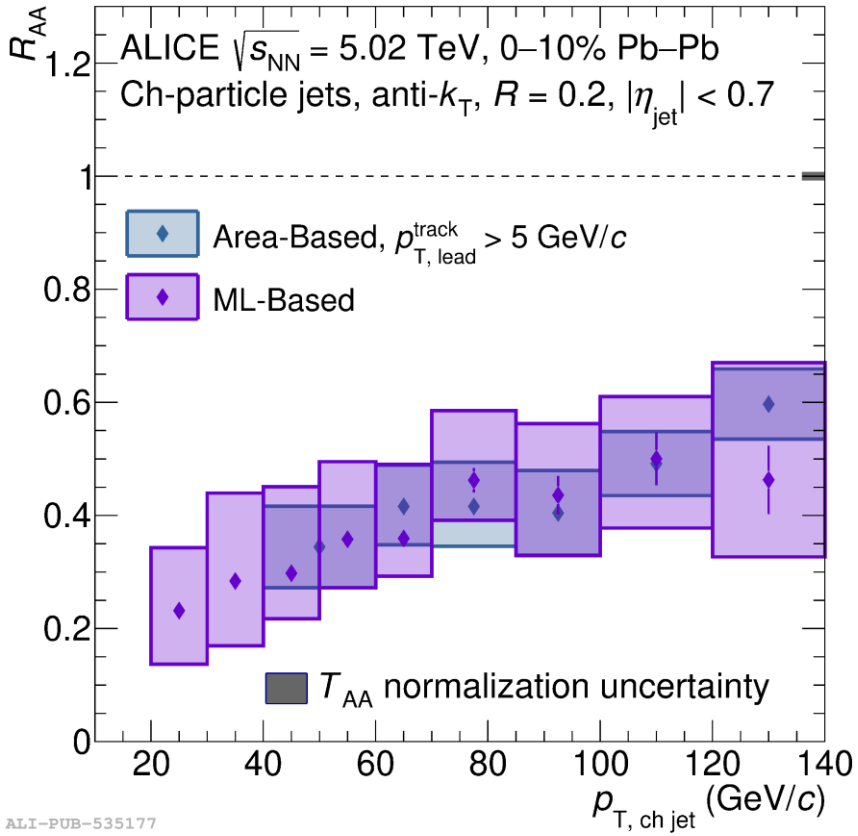

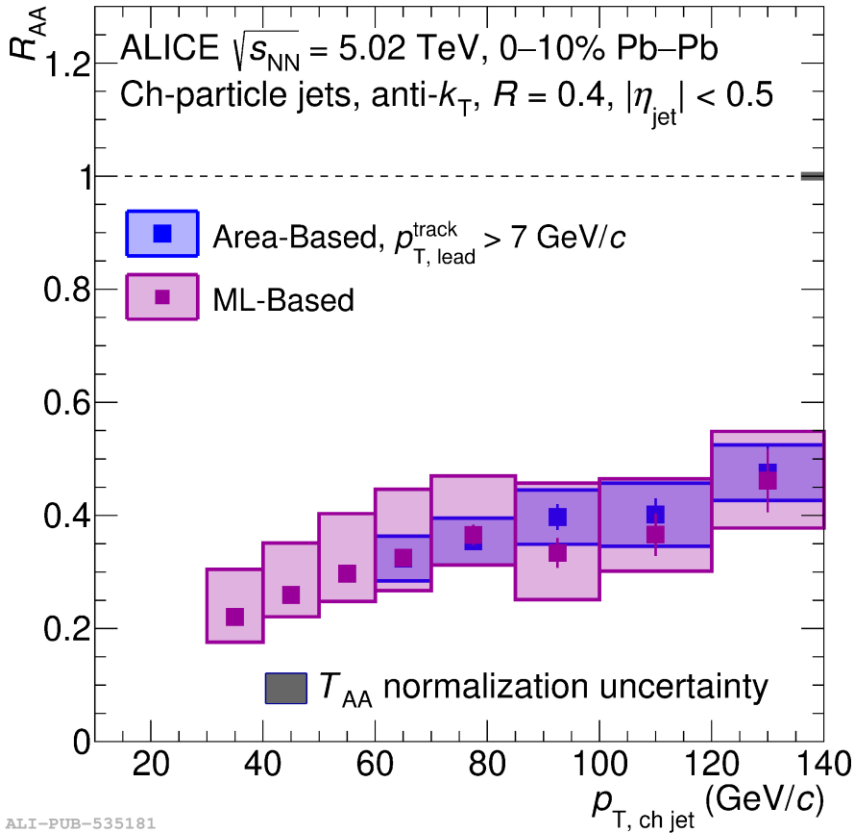

R=0.2

R=0.4

R-dependence of jet nuclear modification factor

R increases

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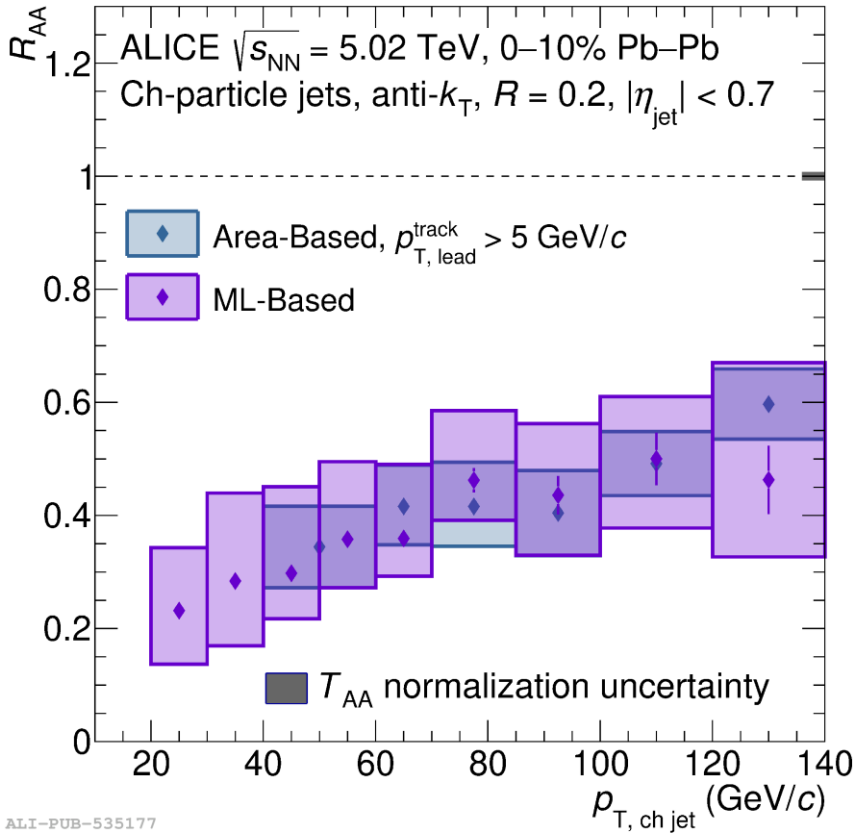
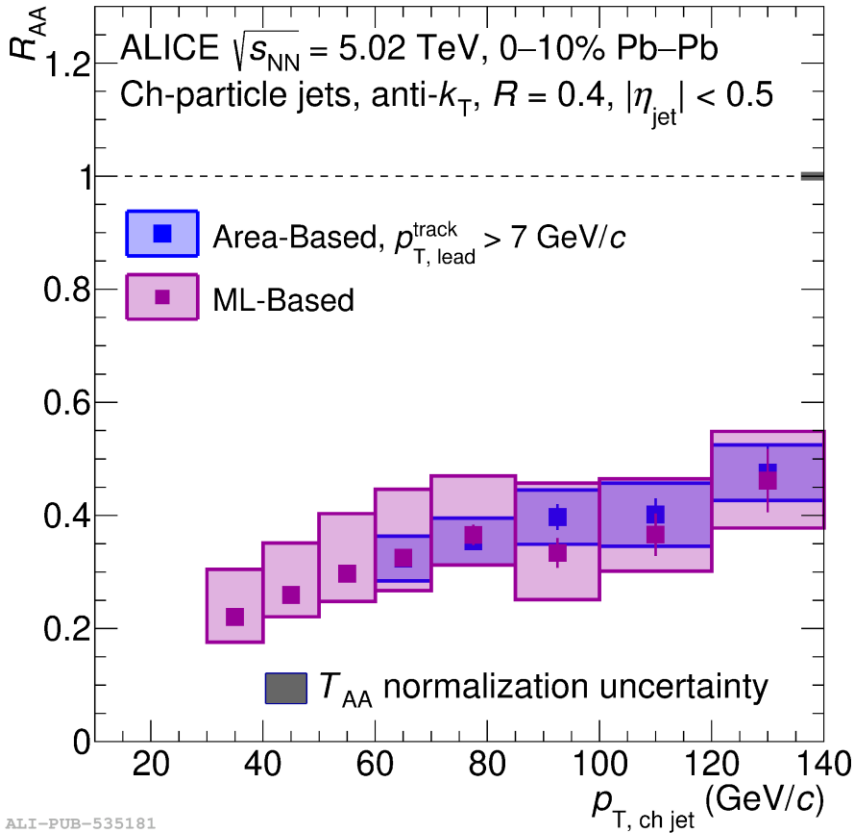
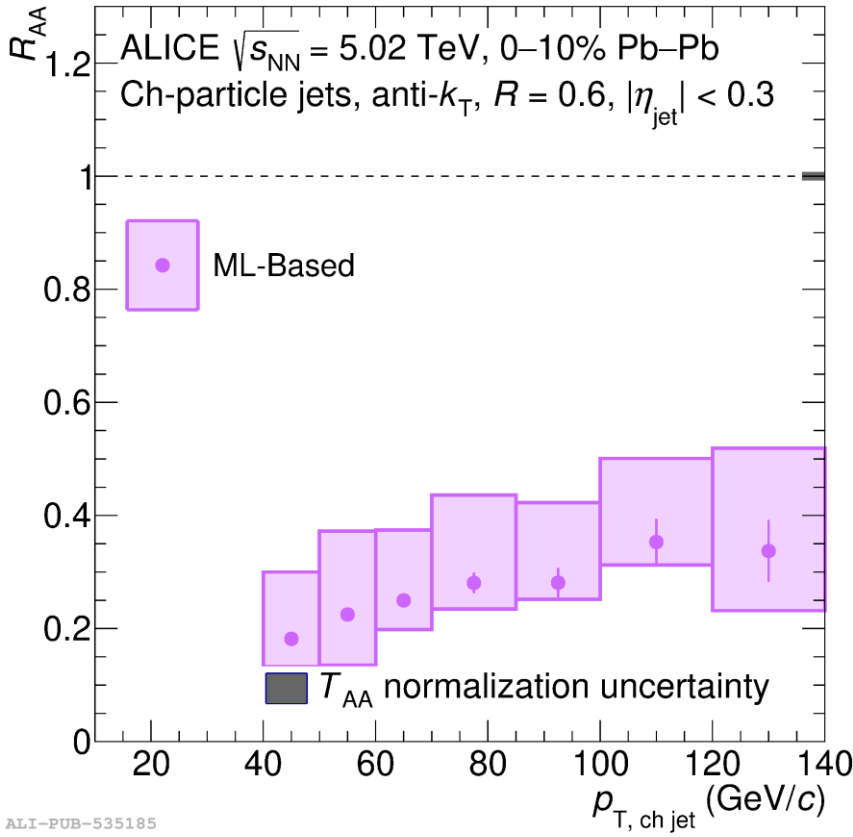




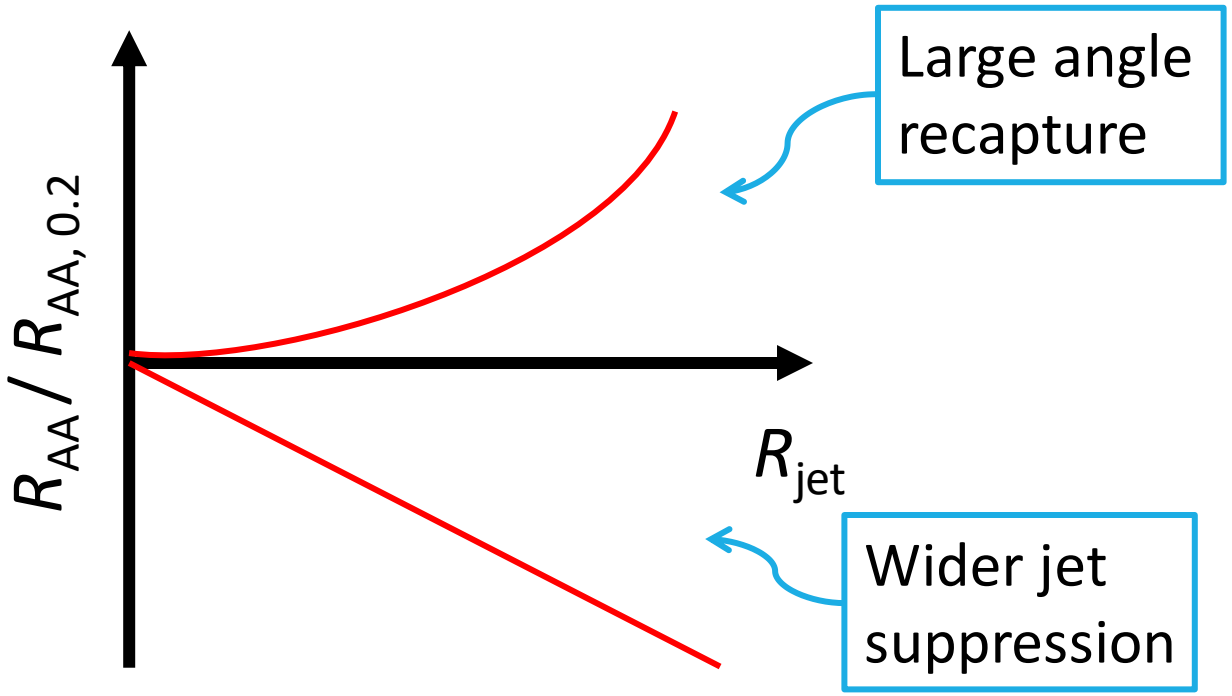


R=0.2

R=0.4

R=0.6

R-dependence of jet nuclear modification factor



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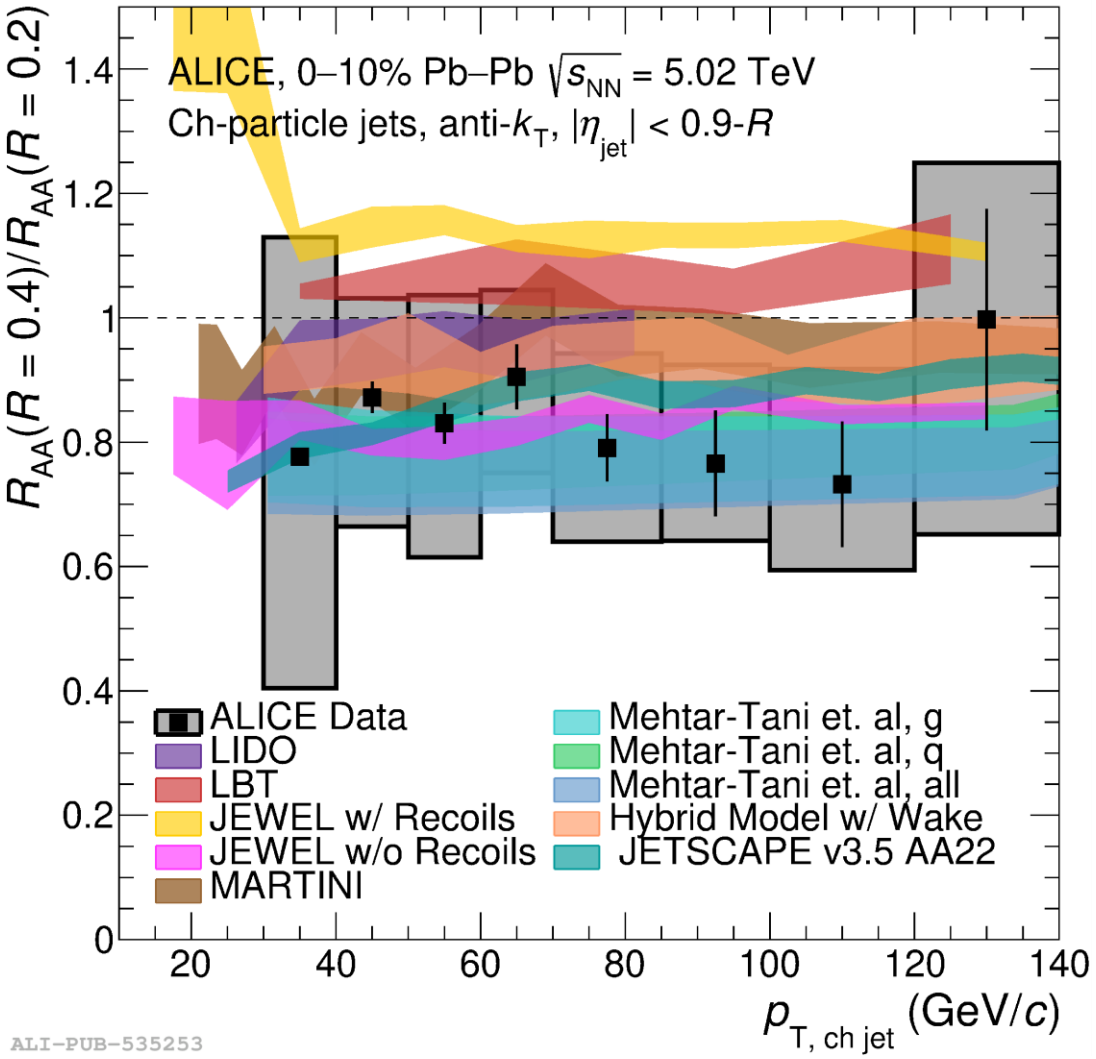

R=0.4/*R*=0.2

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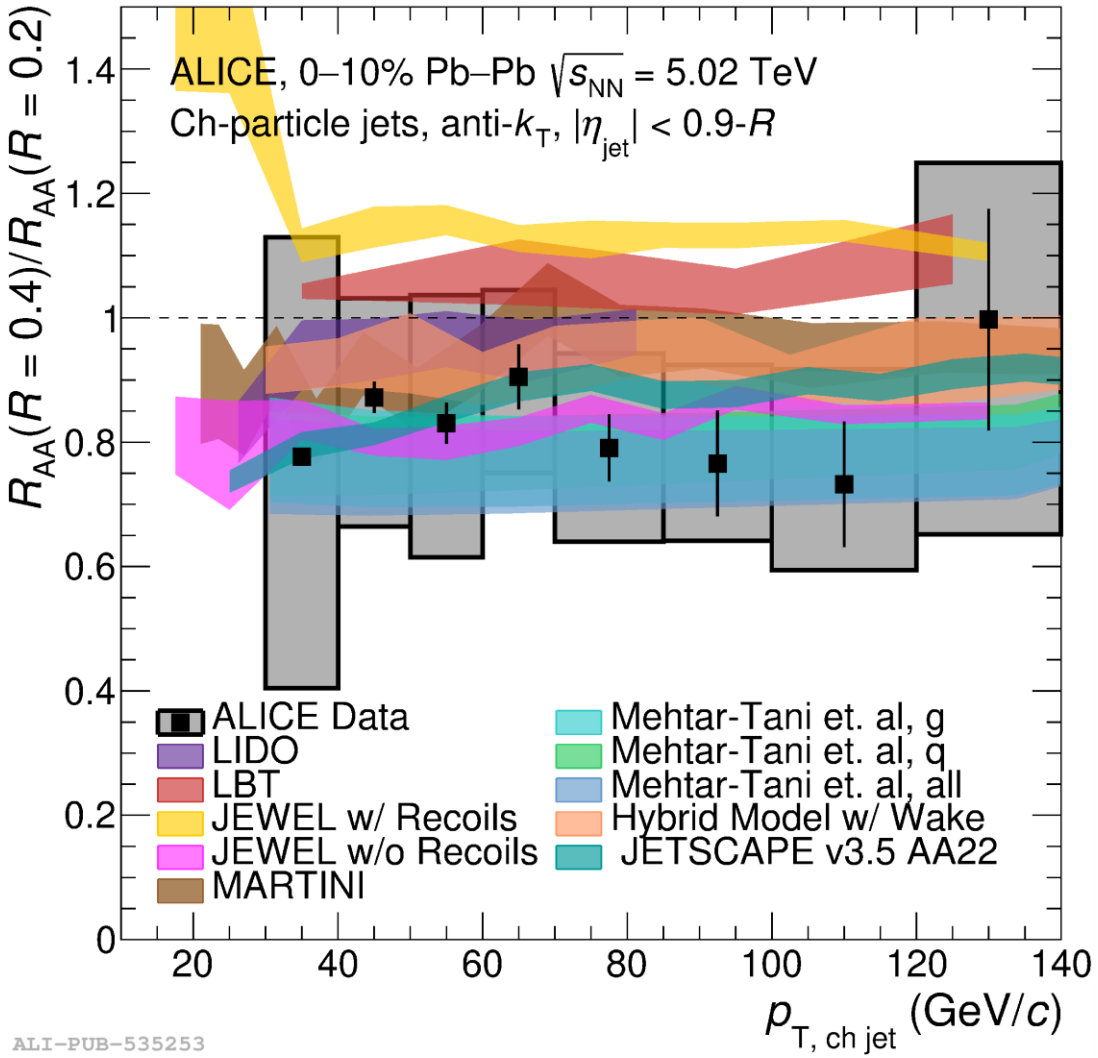

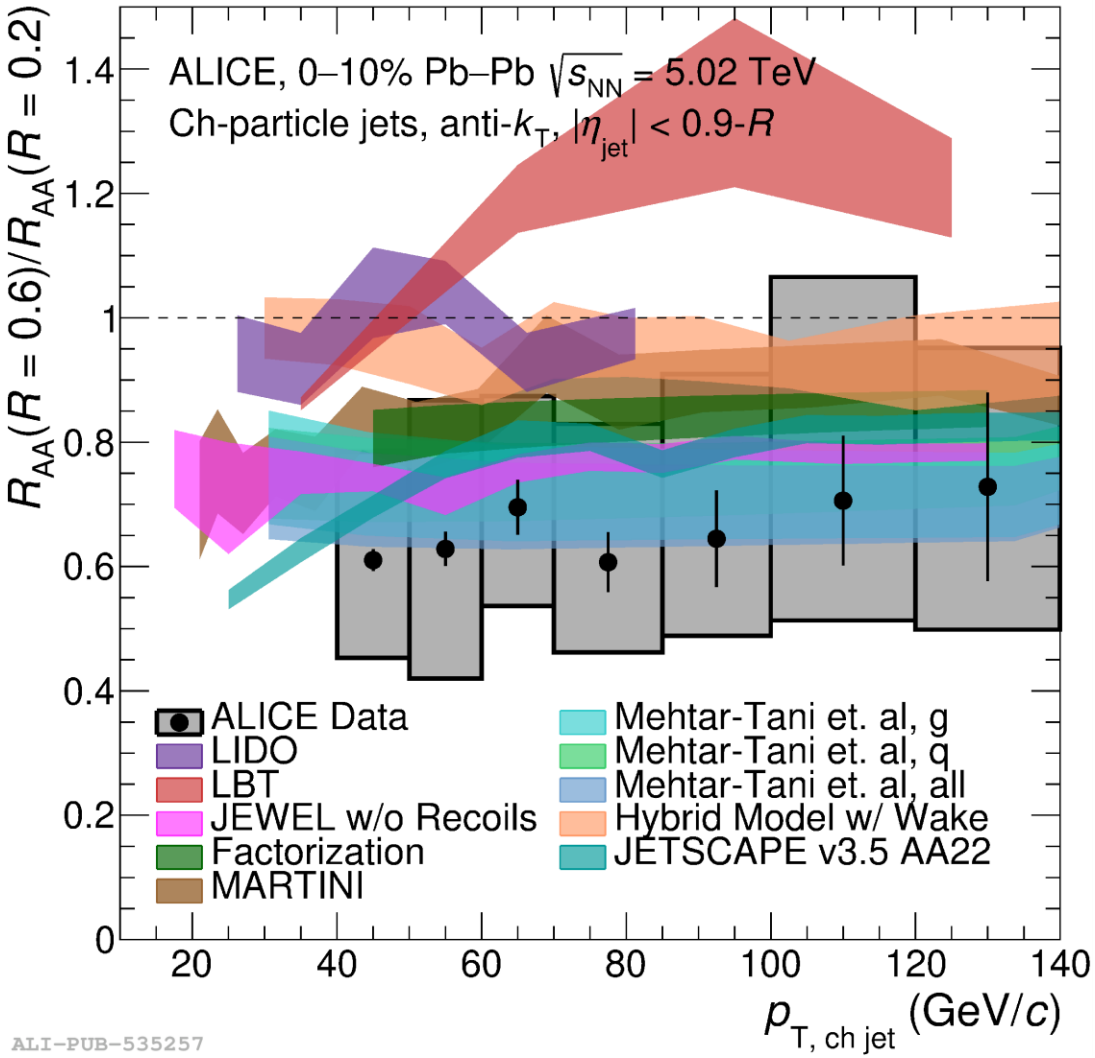

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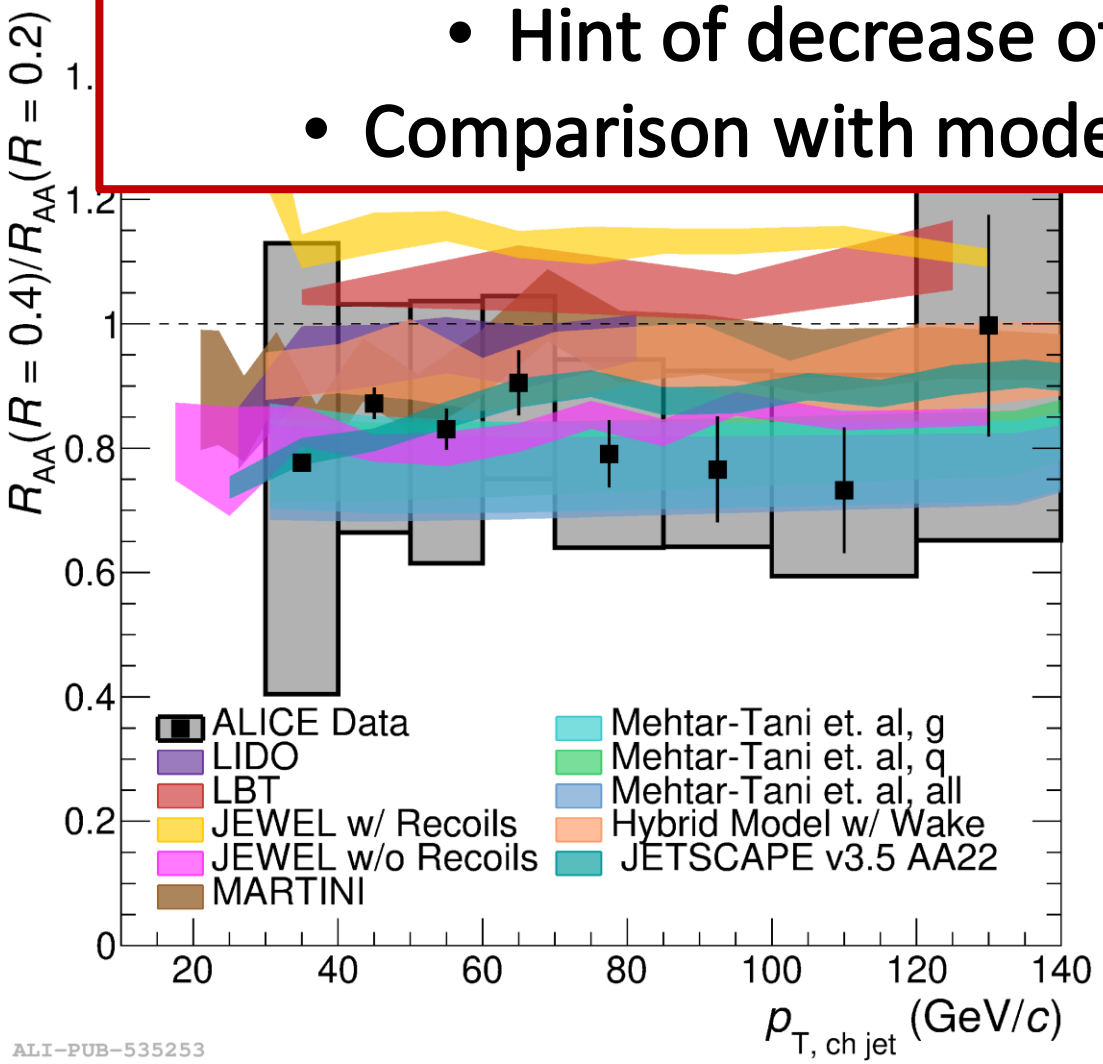
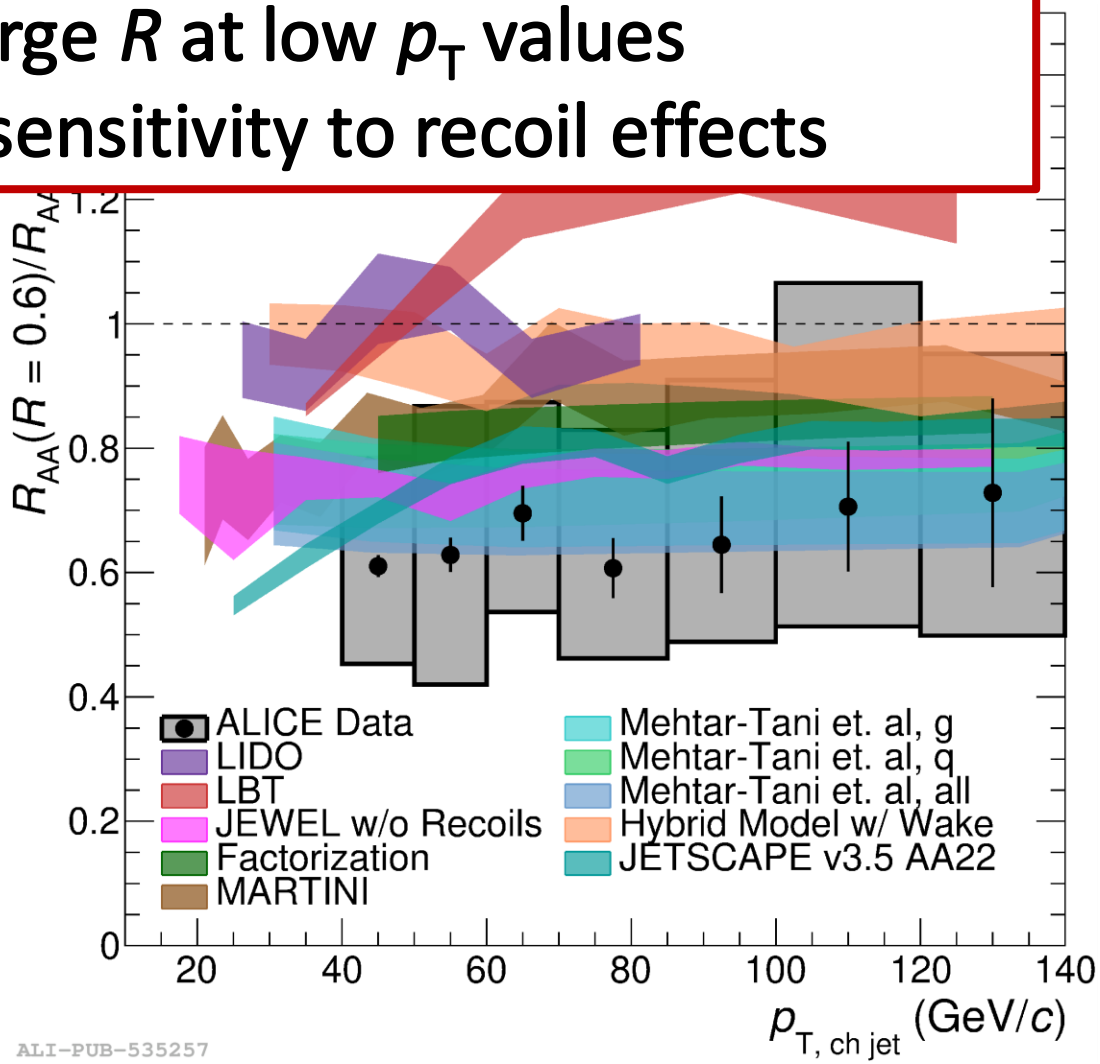
R=0.6/*R*=0.2

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





R=0.4/*R*=0.2

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R-dependence of jet yields

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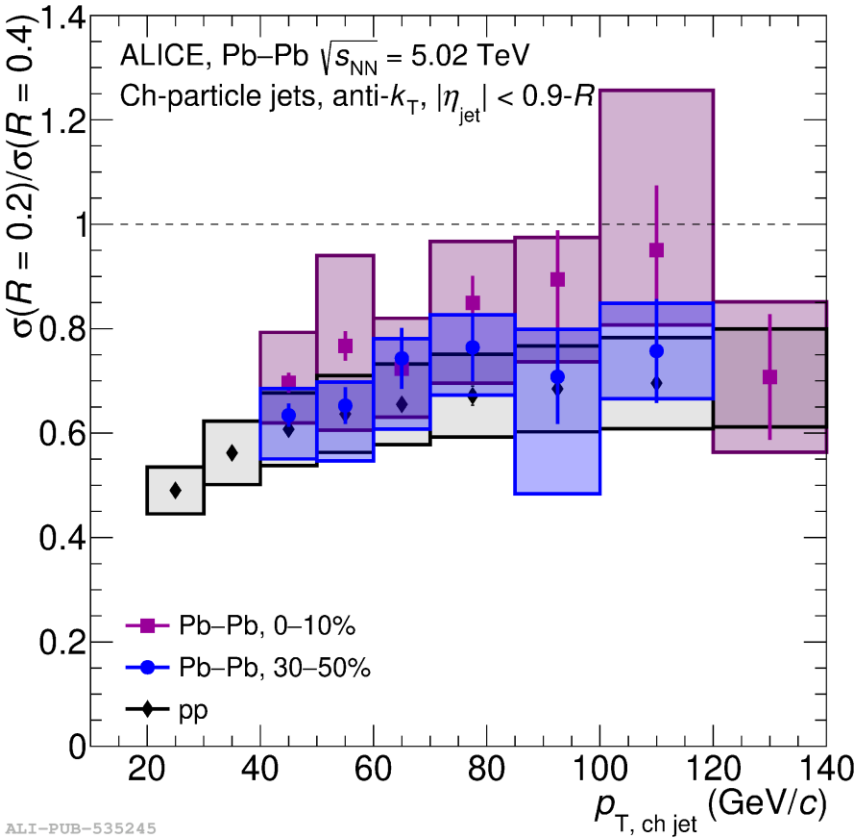

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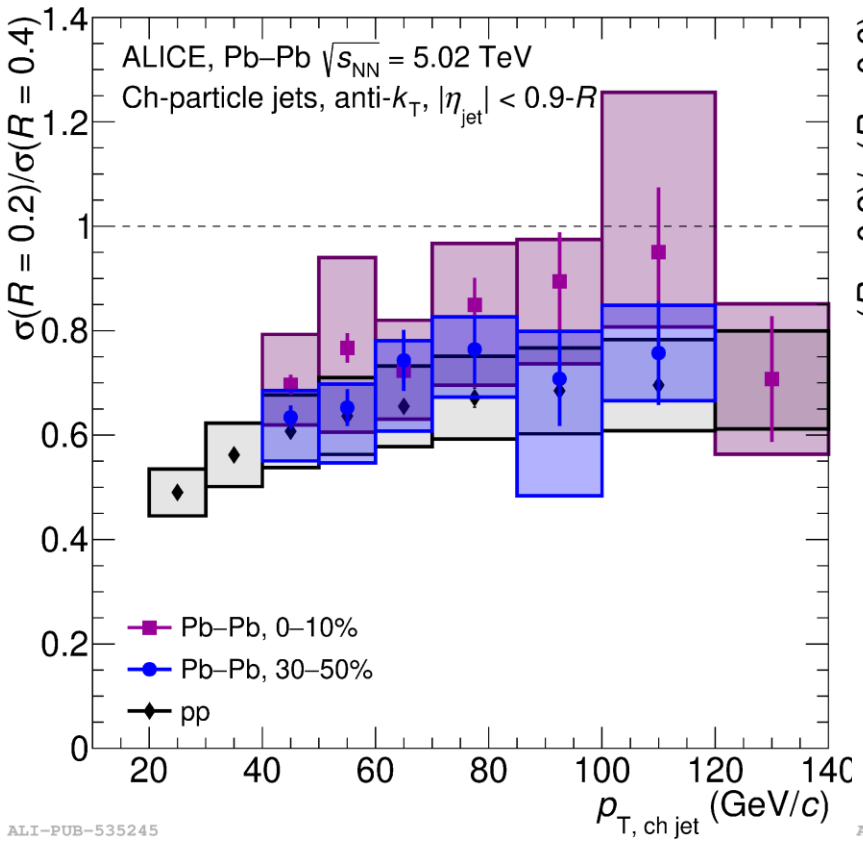

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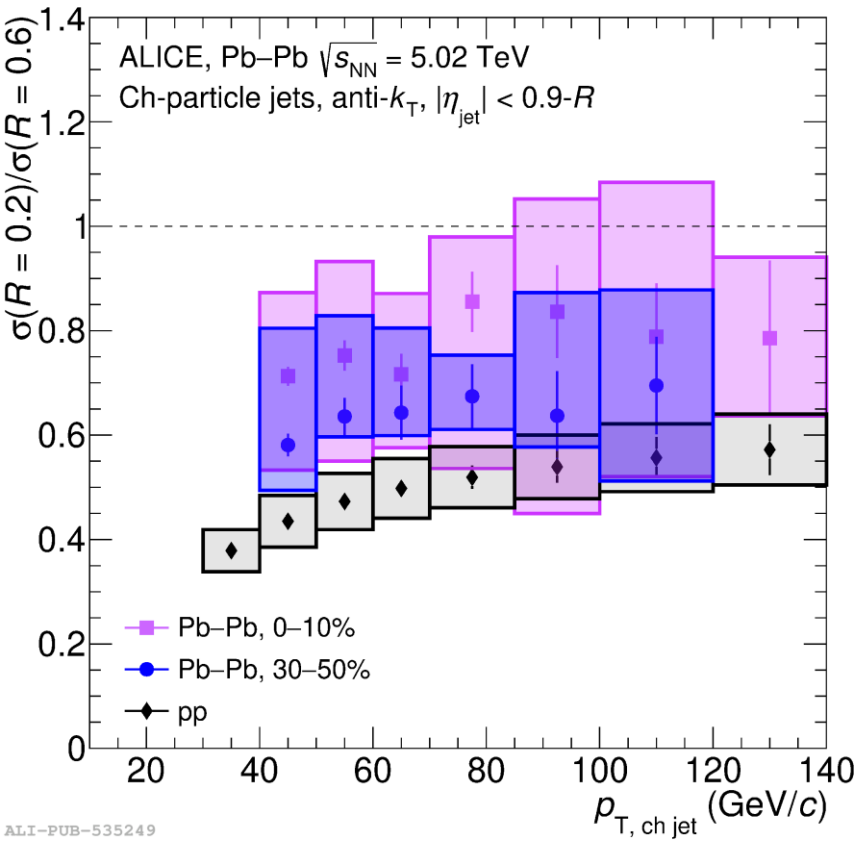

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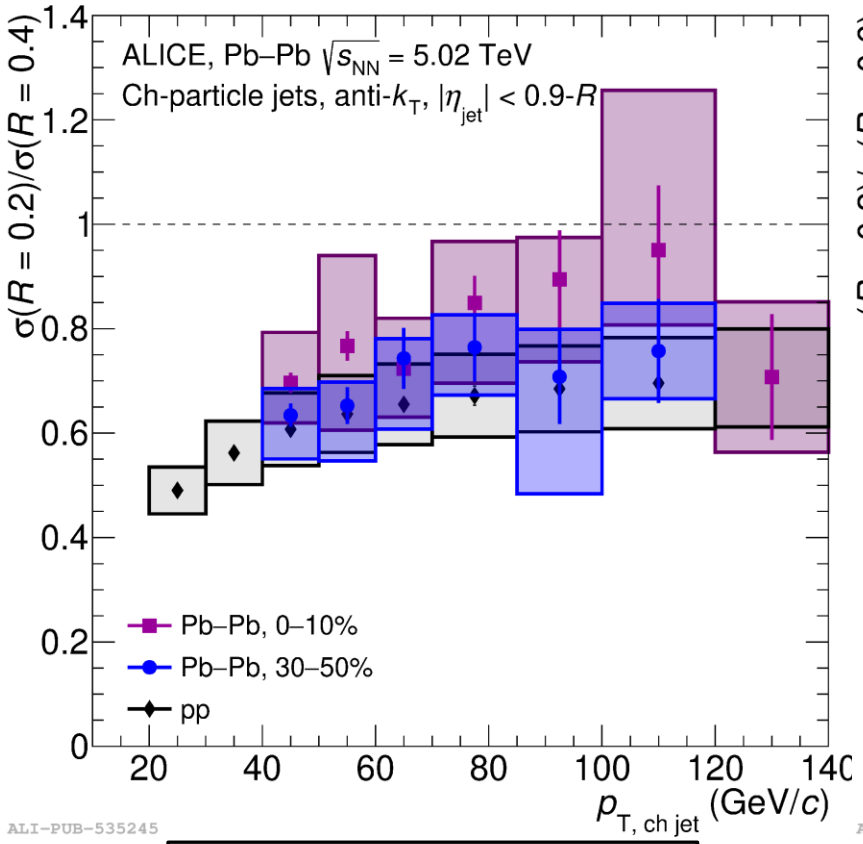
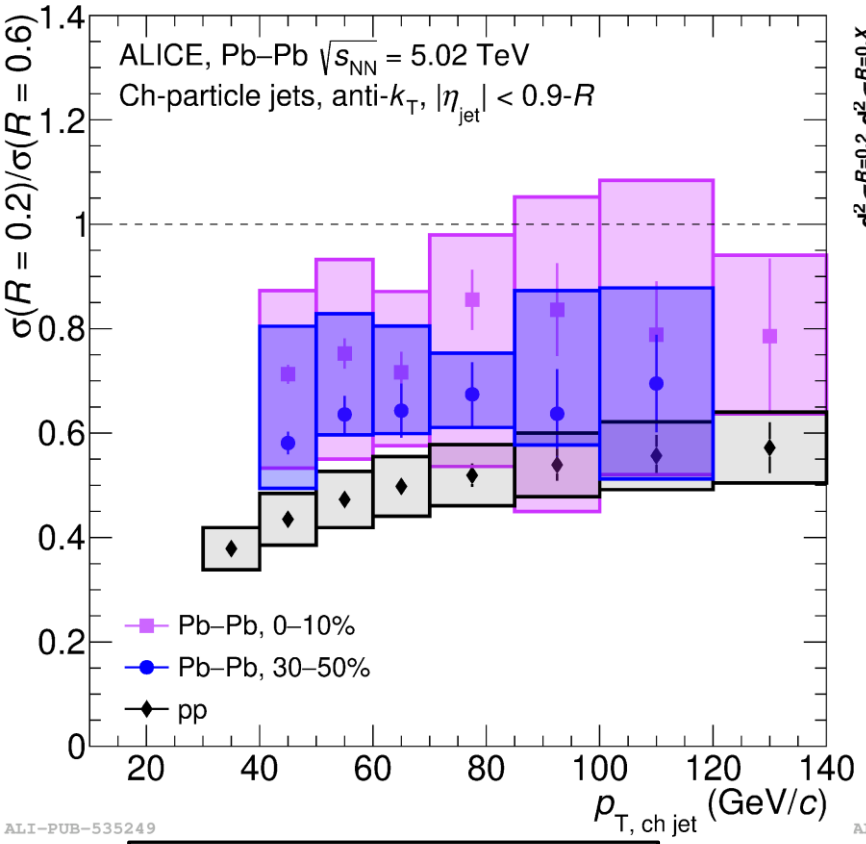
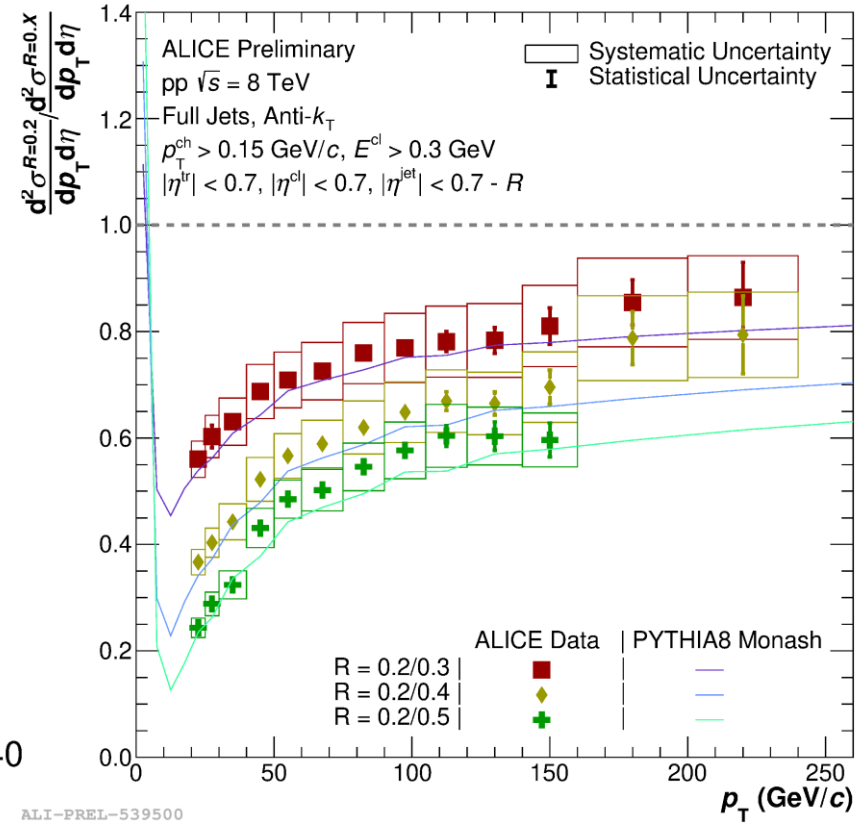






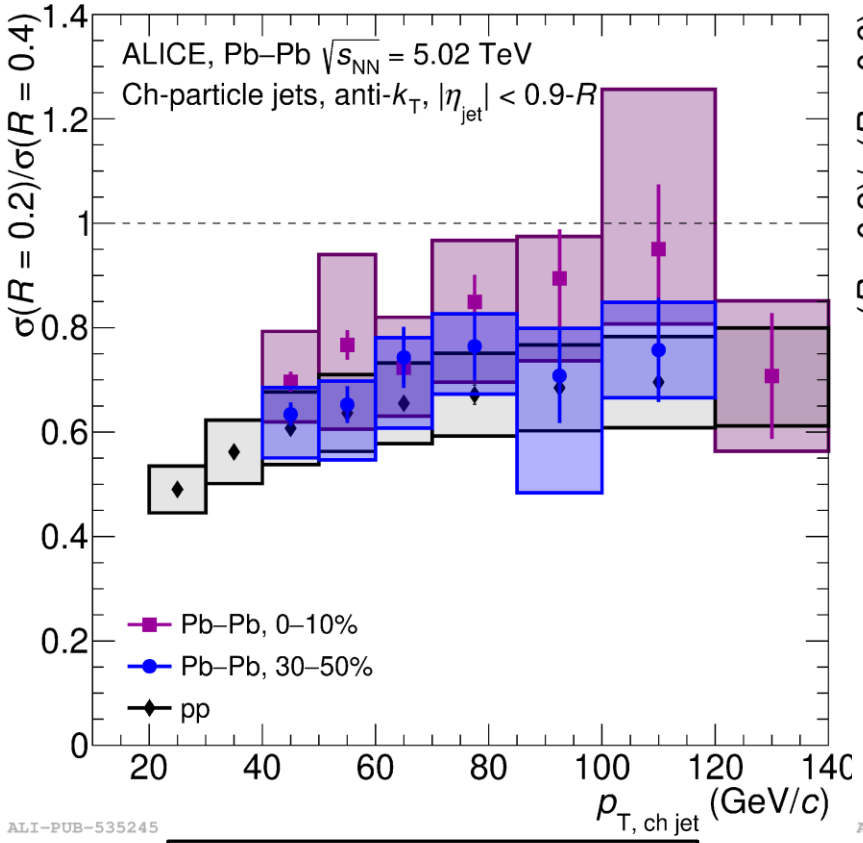
R=0.2/*R*=0.4

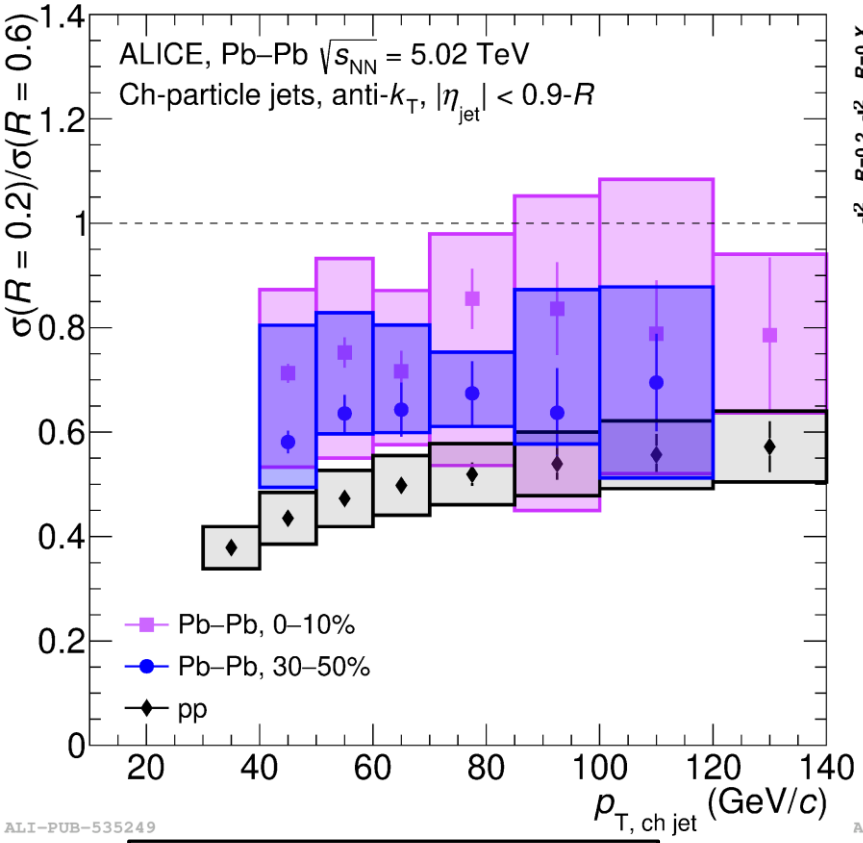
R=0.2/*R*=0.6

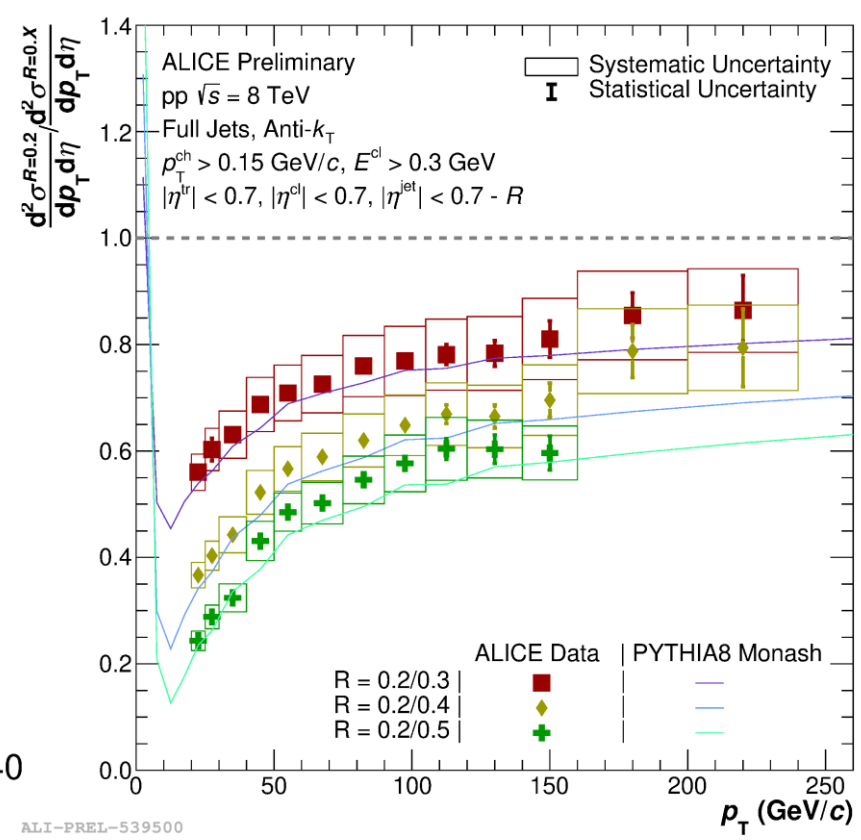
Full jets @ pp

R-dependence of jet yields

Smaller ratios in pp compared to Pb–Pb -> Intra-jet narrowing







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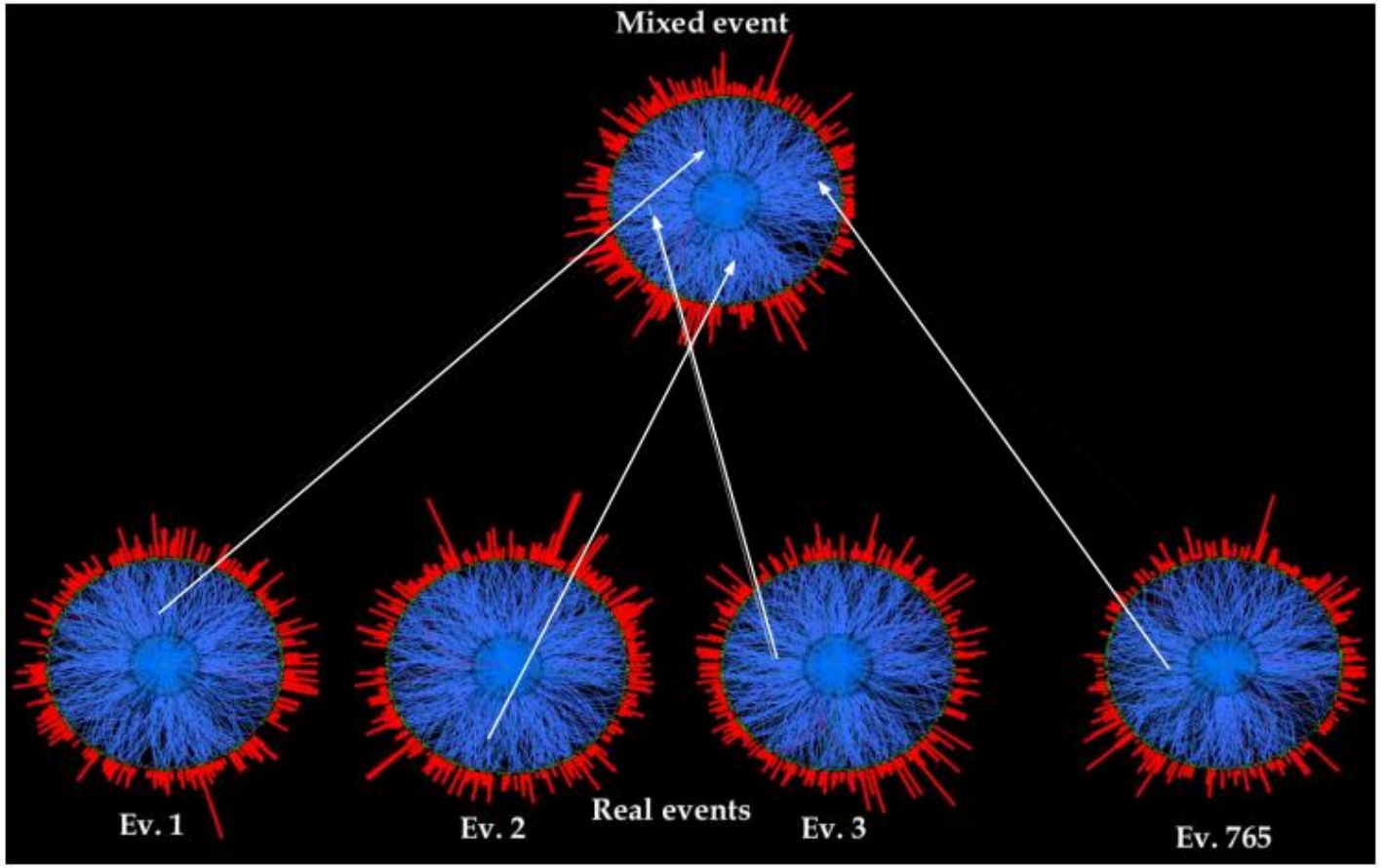
R=0.2/*R*=0.6

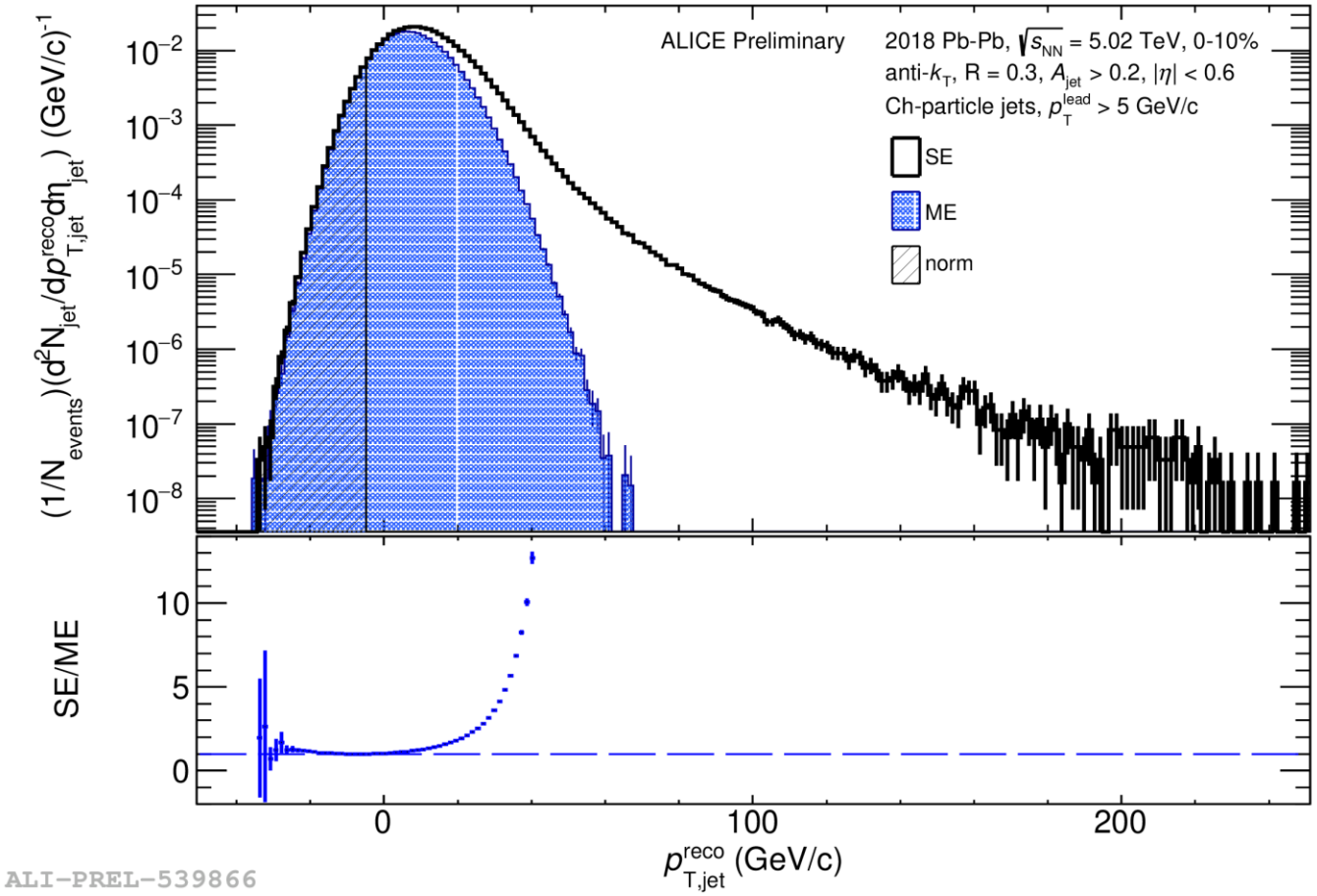
Full jets @ pp

Towards low jet p_T measurement with Mixed Event (ME) method

- Create 9600 event categories based on multiplicity, Ψ_2 ,z-vertex, p_T^{sum}, Ψ_3
- Create full mixed event with random track selection from each event
- No correlations between the particles!
- Leading track selection $p_T^{lead} \geq 5$ GeV/c → Specific jet population

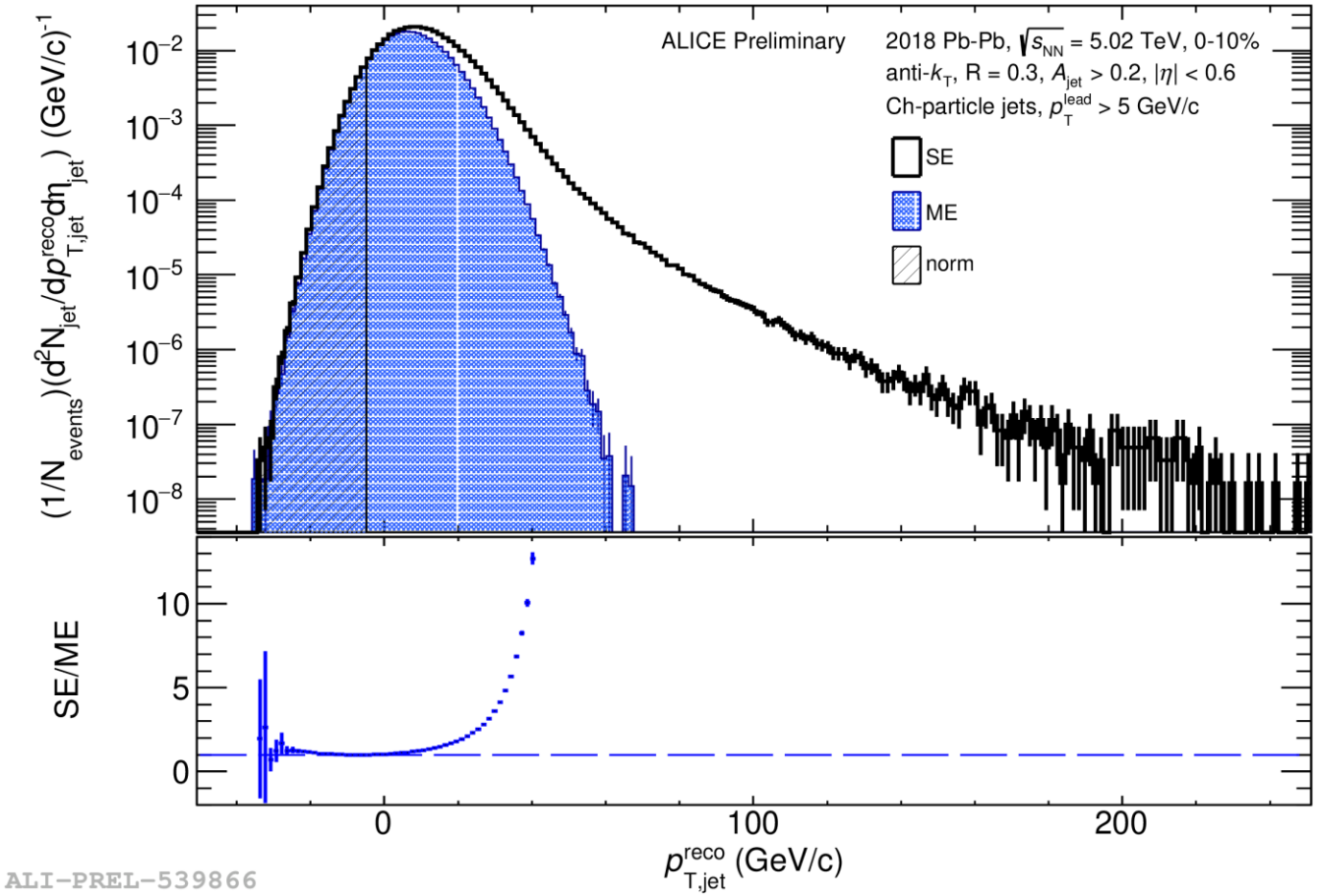


ME-based correction for fake jet yield

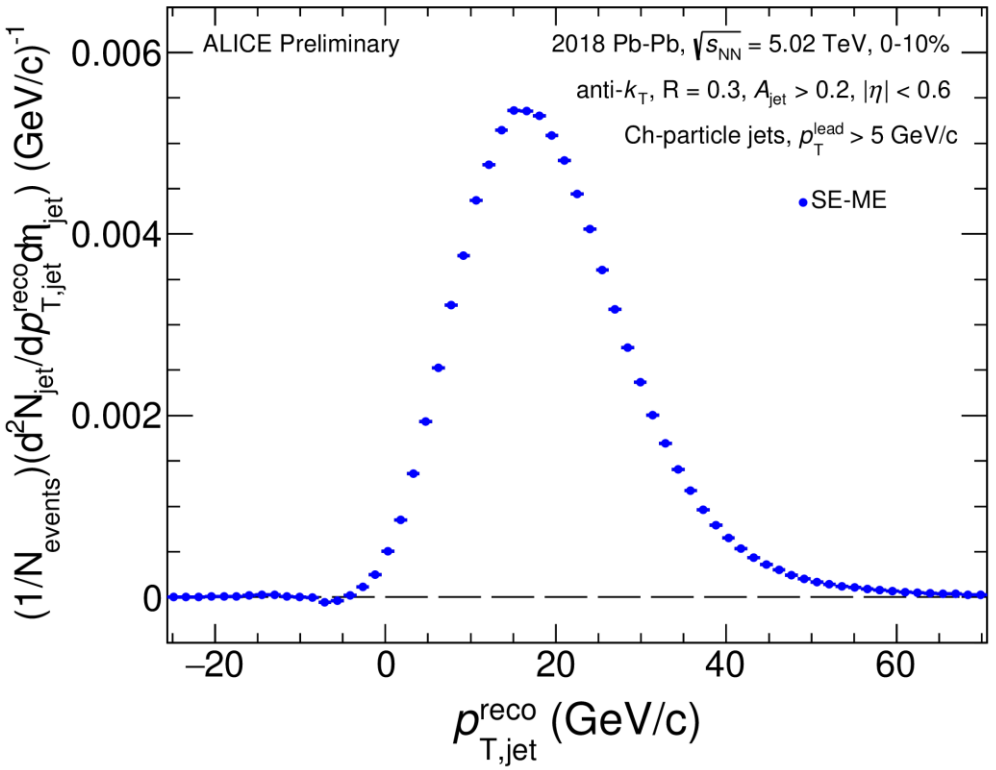


- Area-based jet p_T correction for both SE and ME jets.
- Match ME to SE in region with only uncorrelated yield.
- Fake jet yield removal by subtraction of ME from SE.

ME-based correction for fake jet yield



ALI-PREL-539866



ALI-PREL-540739

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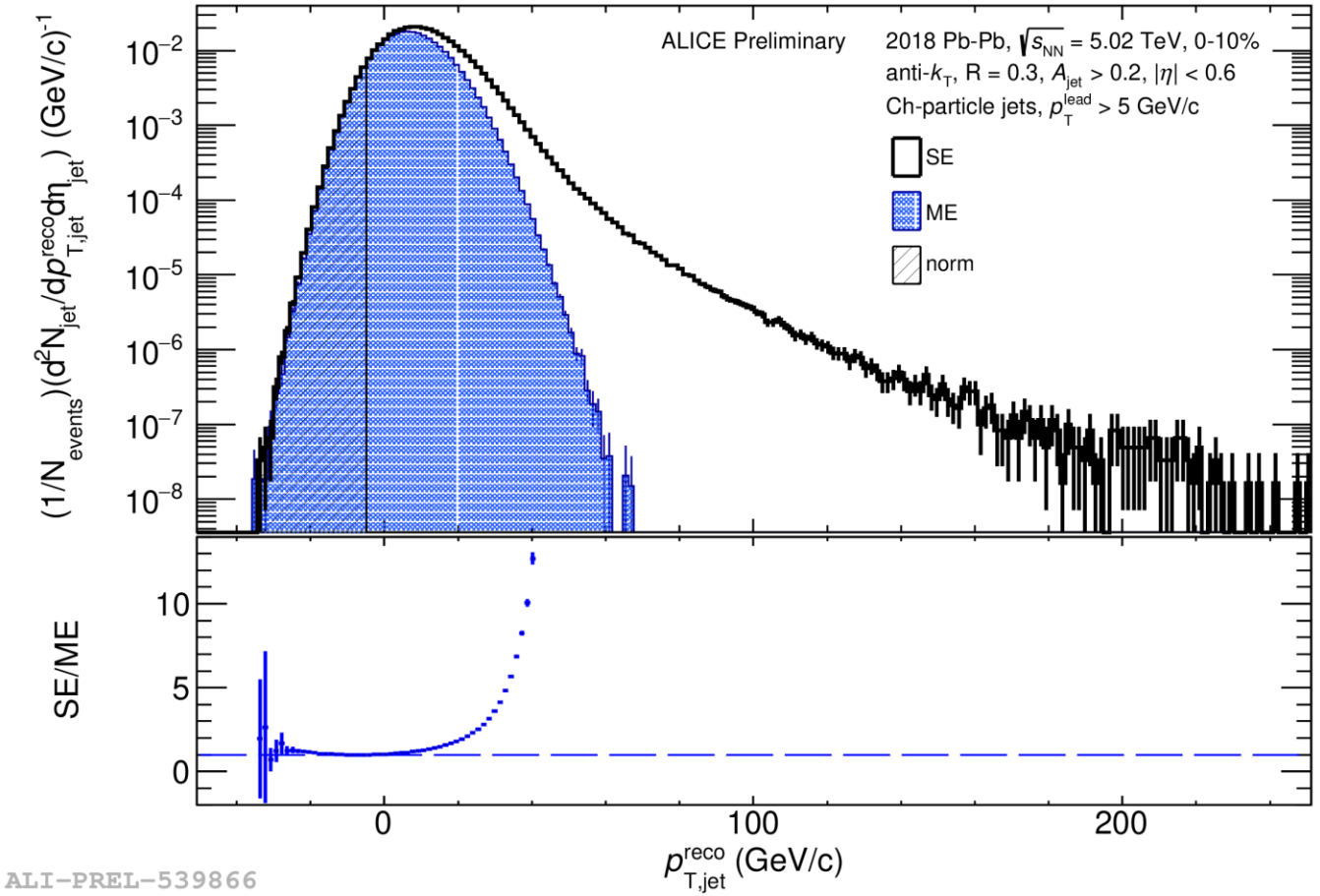

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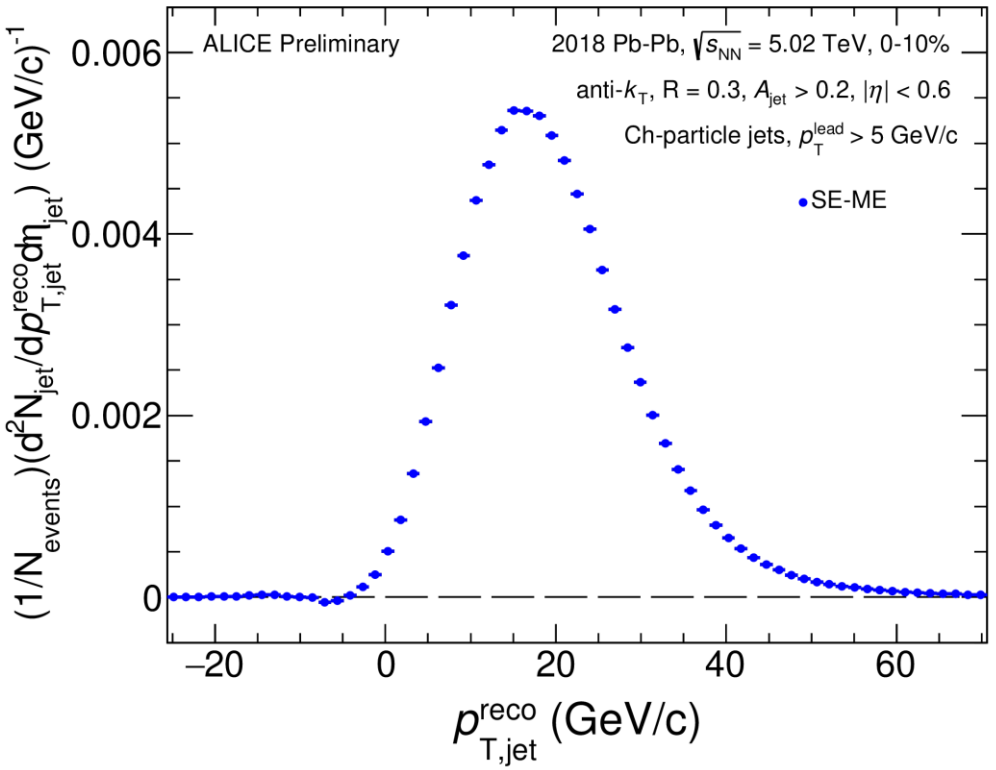
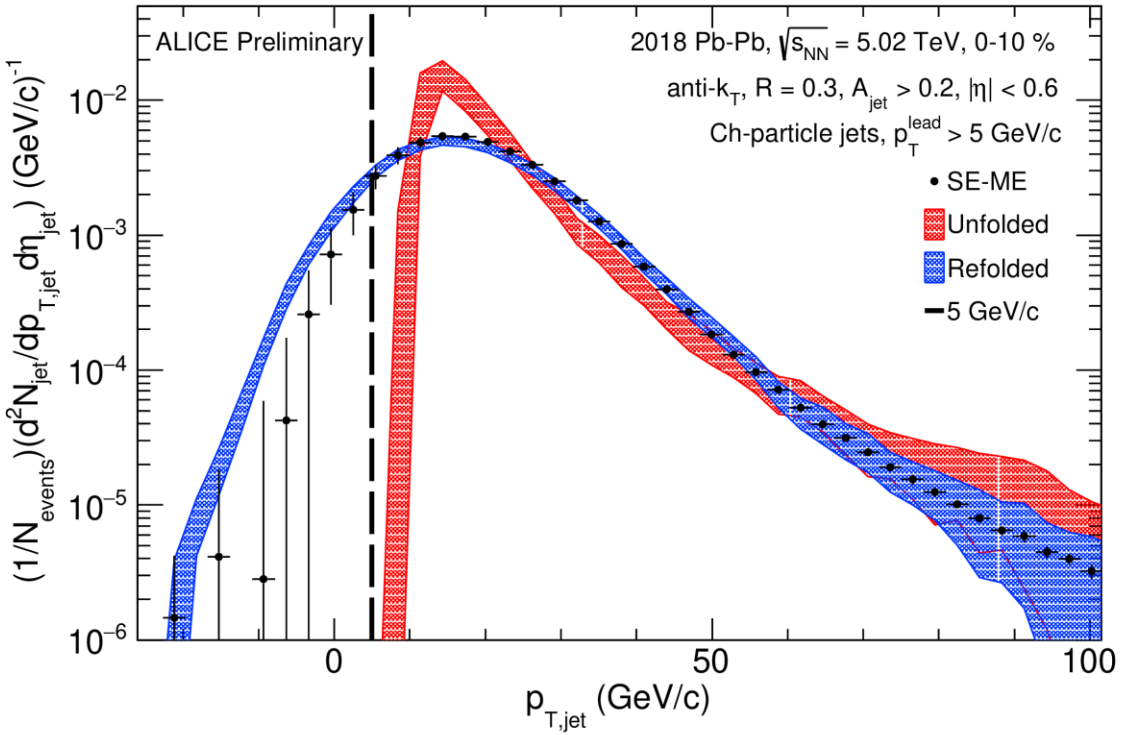


ALI-PREL-540739

Residual distribution is zero in the normalization range

Quasi-inclusive jet p_T distribution with ME method

- Unfolded measurement probes the jet p_T yields down to 5 GeV/*c*.
- This method fully removes the uncorrelated background.
- The effect of the leading track bias has to be explored.



ALI-PREL-539644

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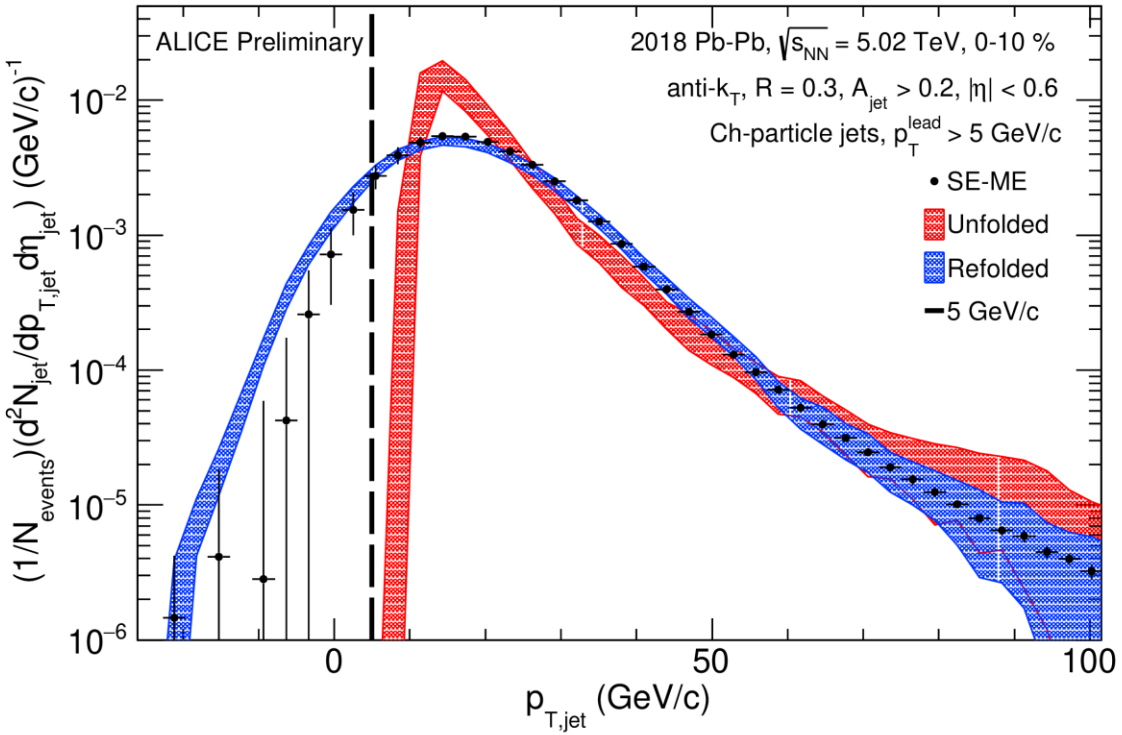
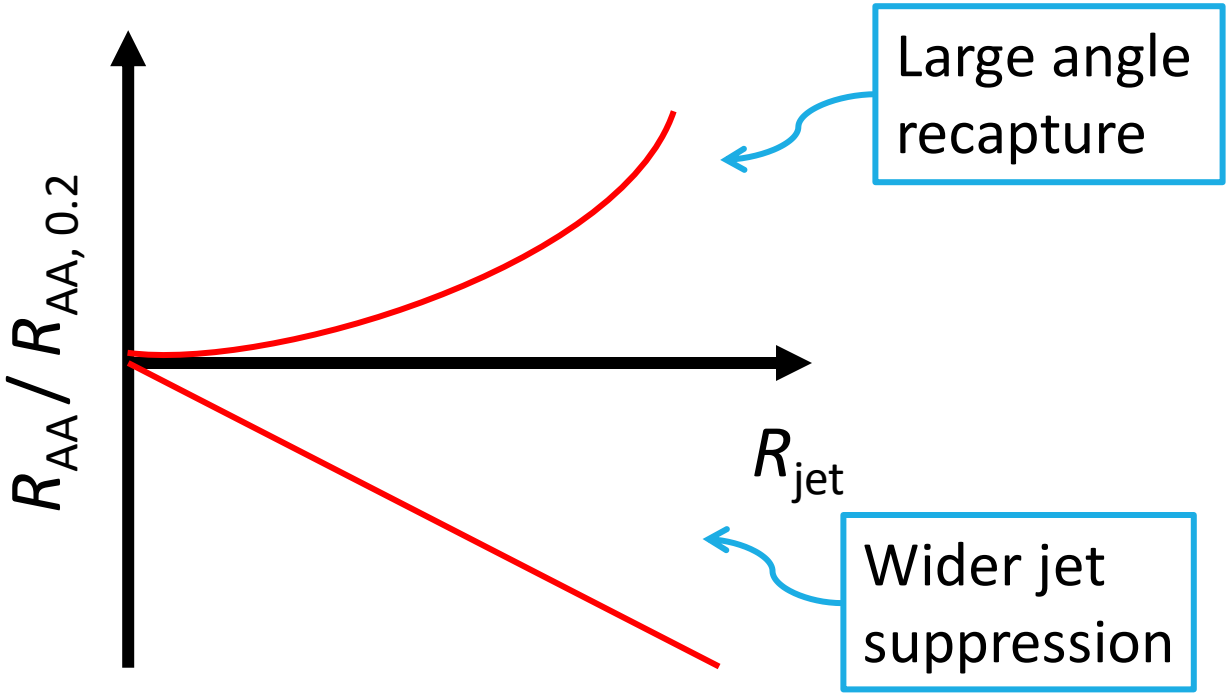


ALI-PREL-539644

Recover the lost energy by measuring down to very low jet p_T

An alternative approach to the question



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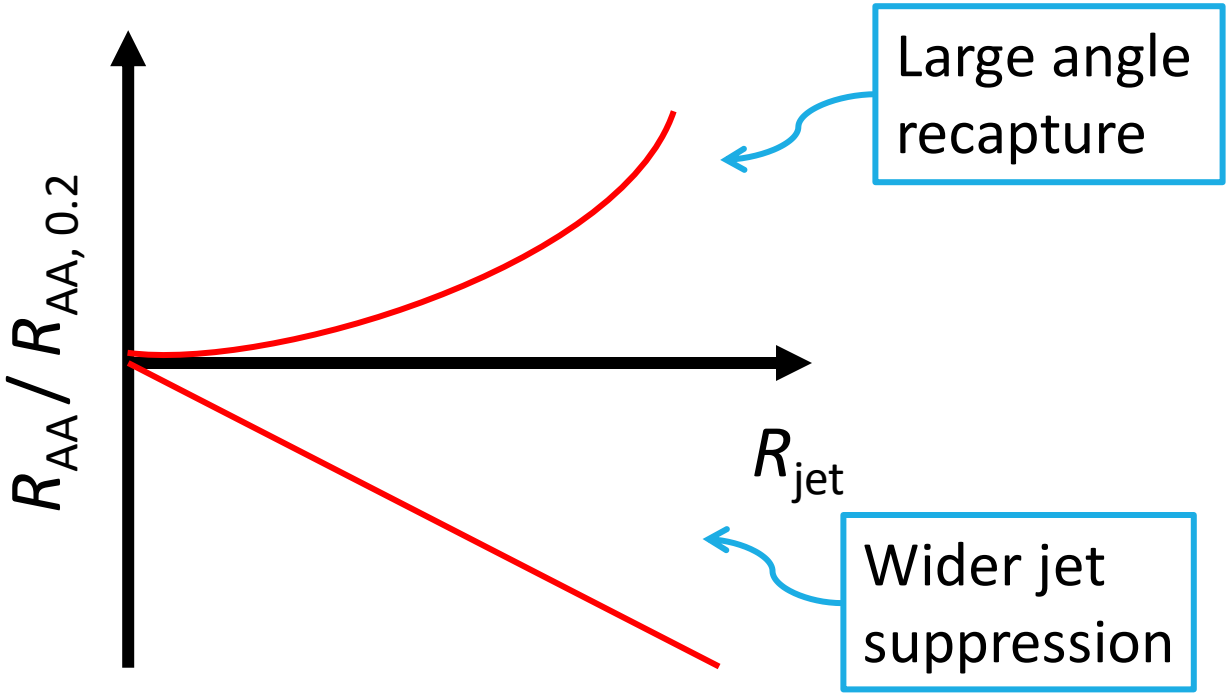
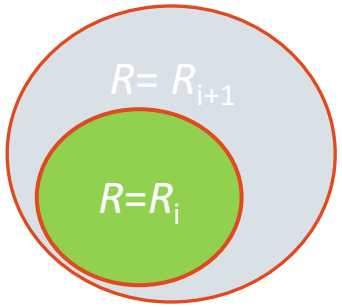


Energy flow definition:

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



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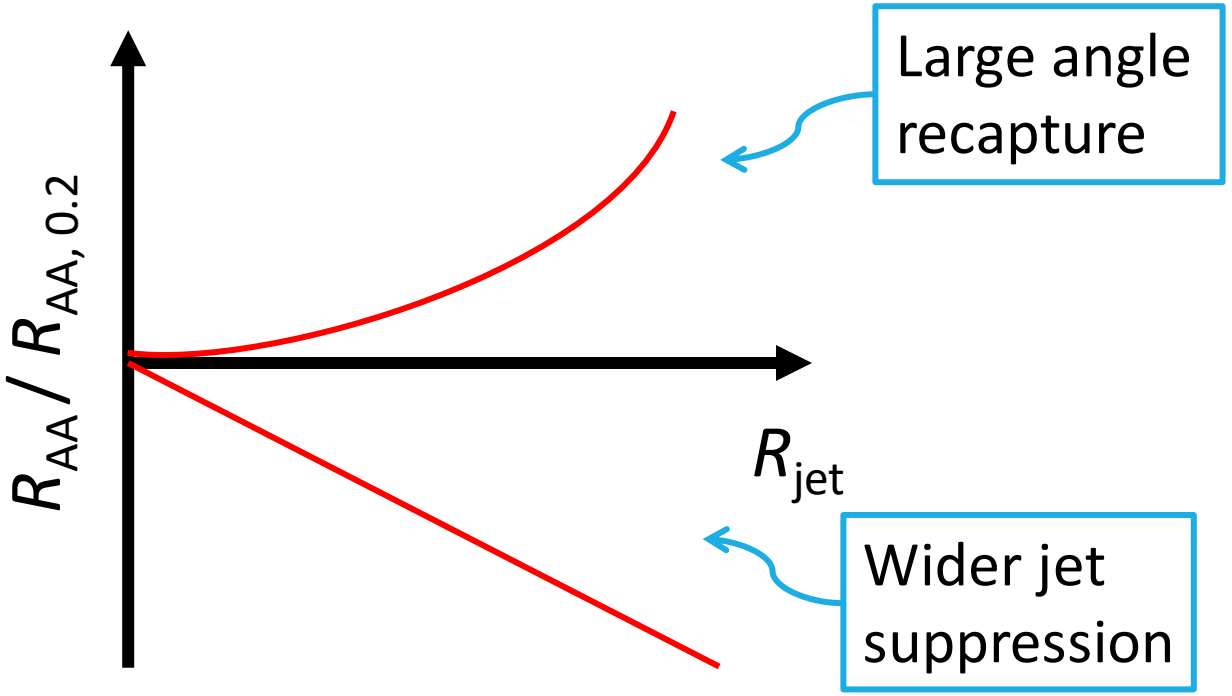

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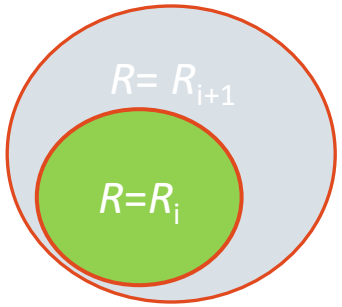

Using a measurement in pp as baseline, study the effect of the energy loss mechanisms in Pb–Pb

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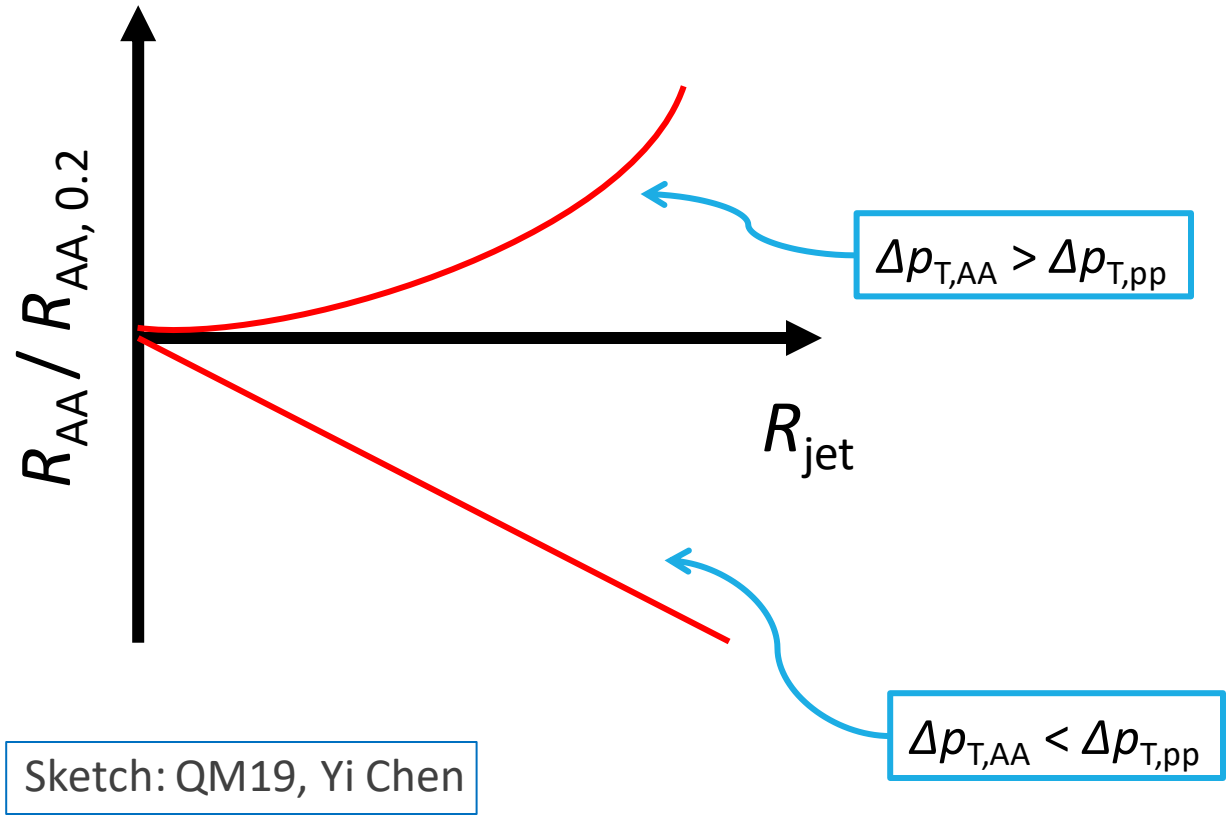

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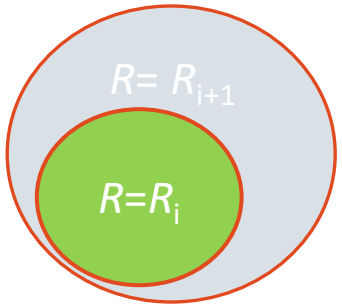

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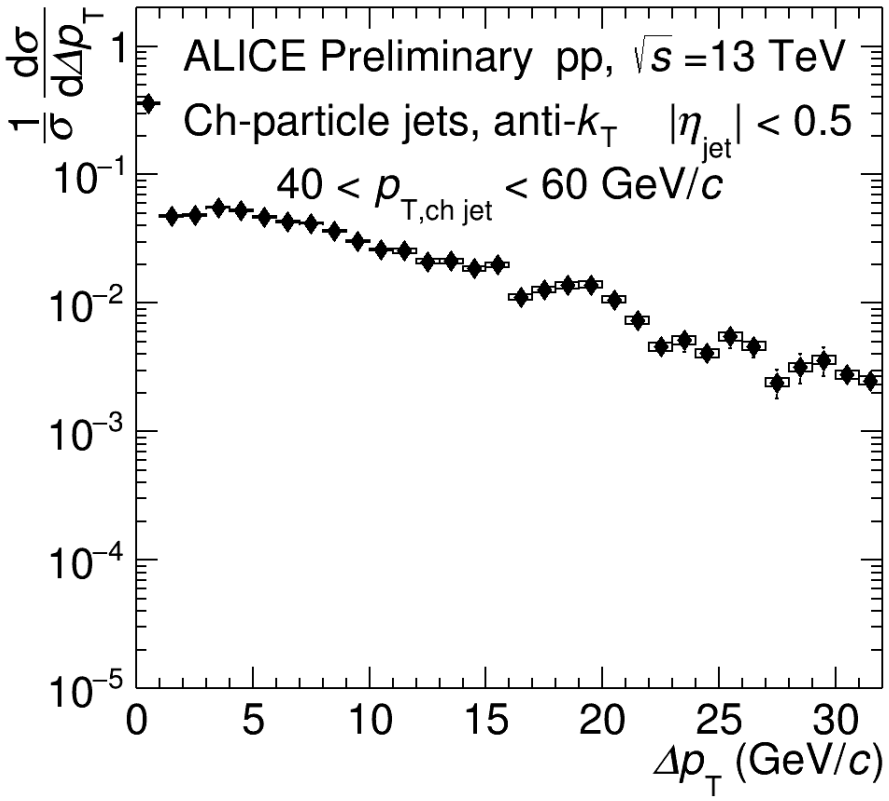
Jet energy flow measurement in pp collisions



- Distinct peak at Δp_T =0.
- Larger R → Steeper distributions
- Smooth transition from narrow to wide jet cone radii.

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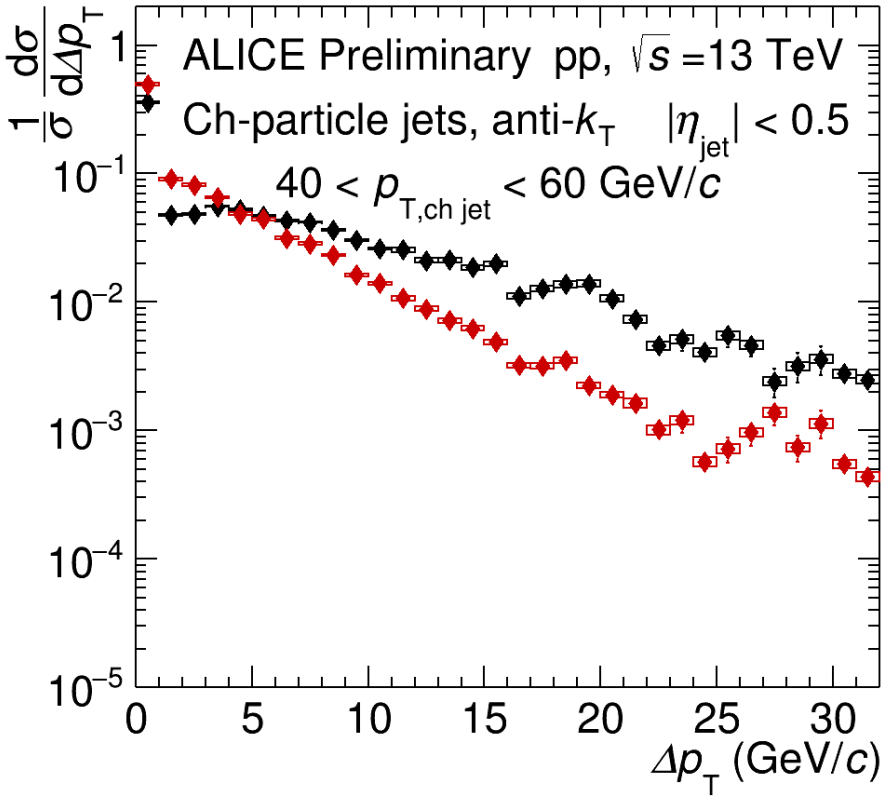

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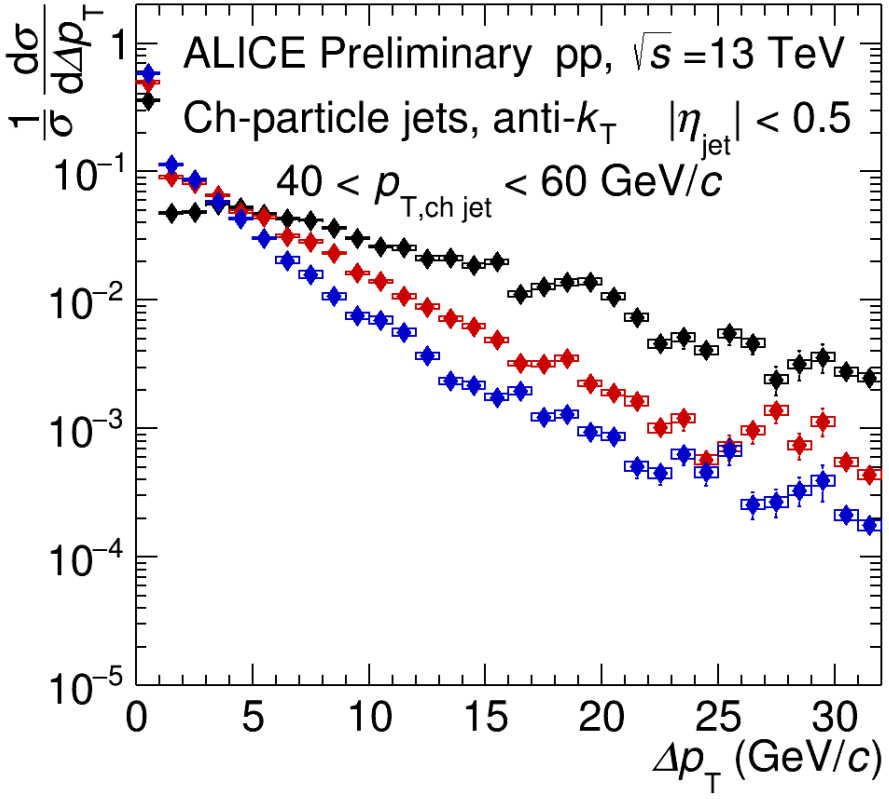

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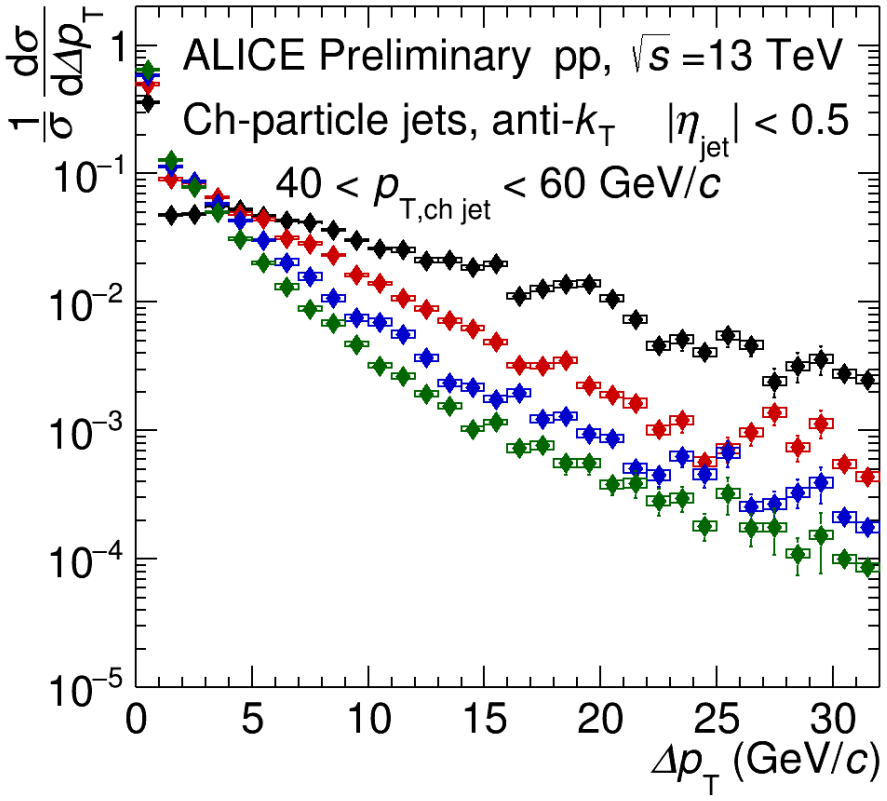

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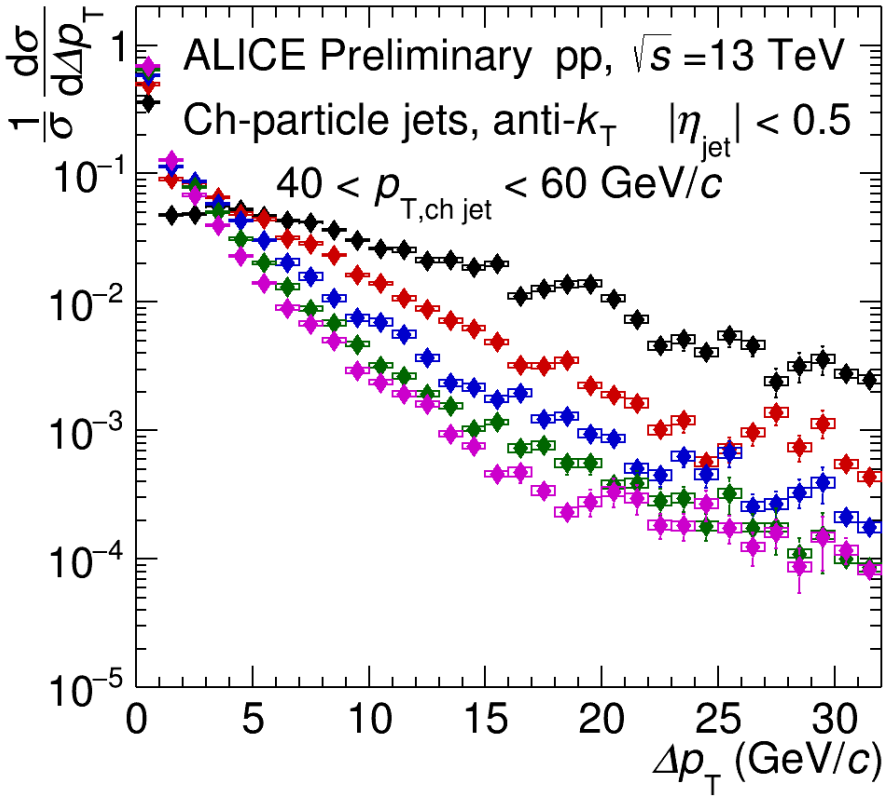
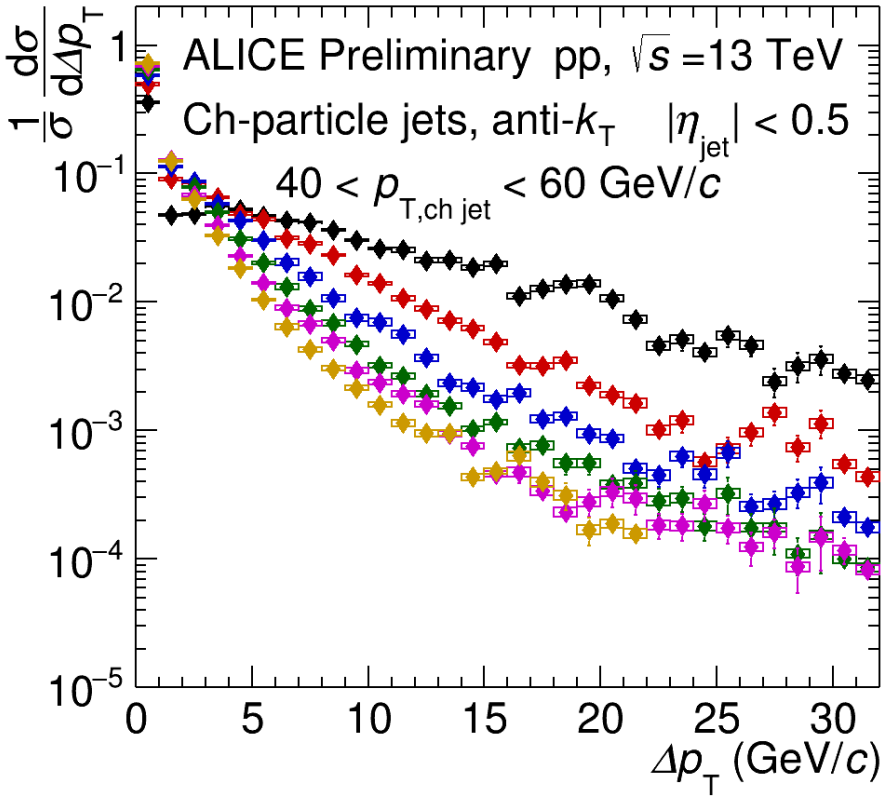


- Distinct peak at Δp_T =0.
- Larger R → Steeper distributions
- Smooth transition from narrow to wide jet cone radii.

Jet energy flow measurement in pp collisions



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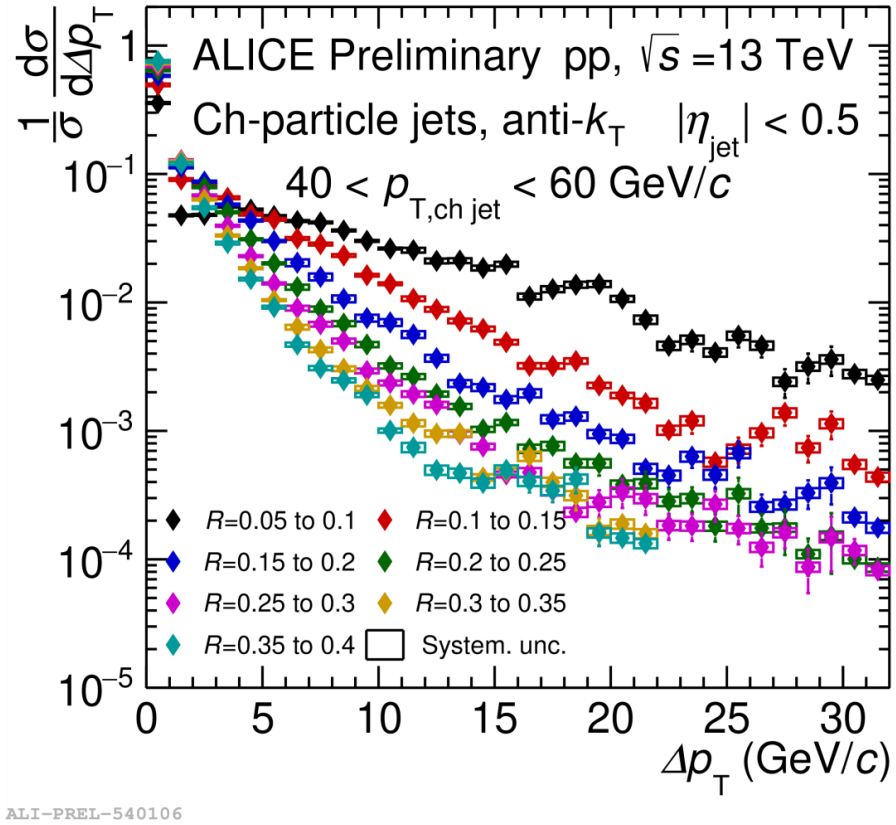

R increases

- Distinct peak at Δp_T =0.
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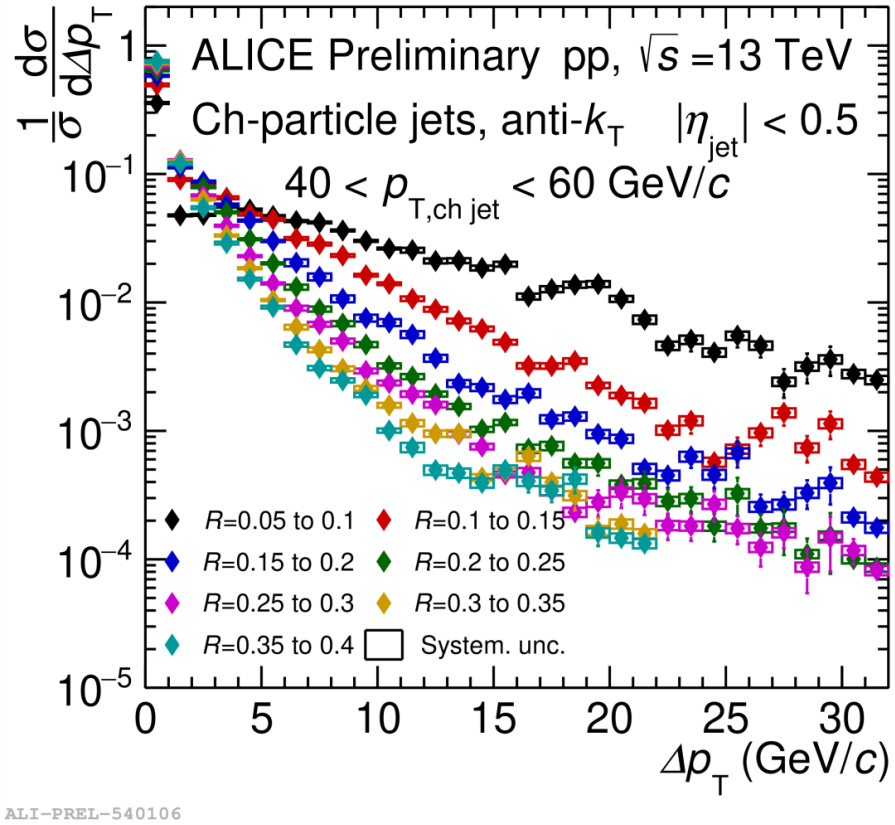
- Smooth transition from narrow to wide jet cone radii.

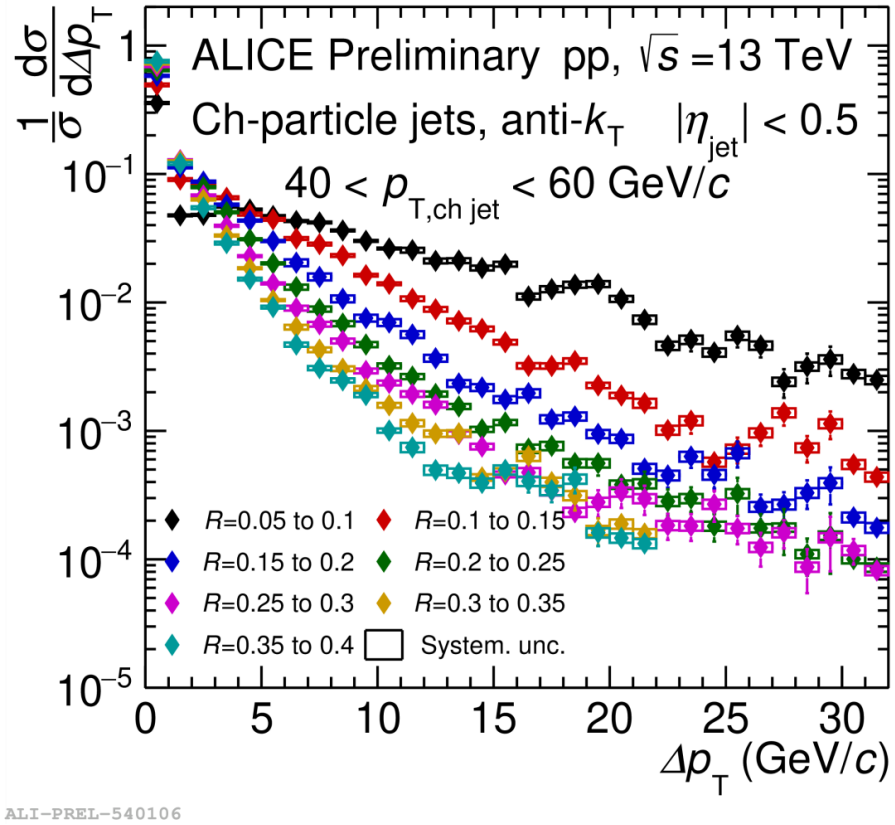
Jet energy flow measurement in pp collisions



R increases

Distribution mean

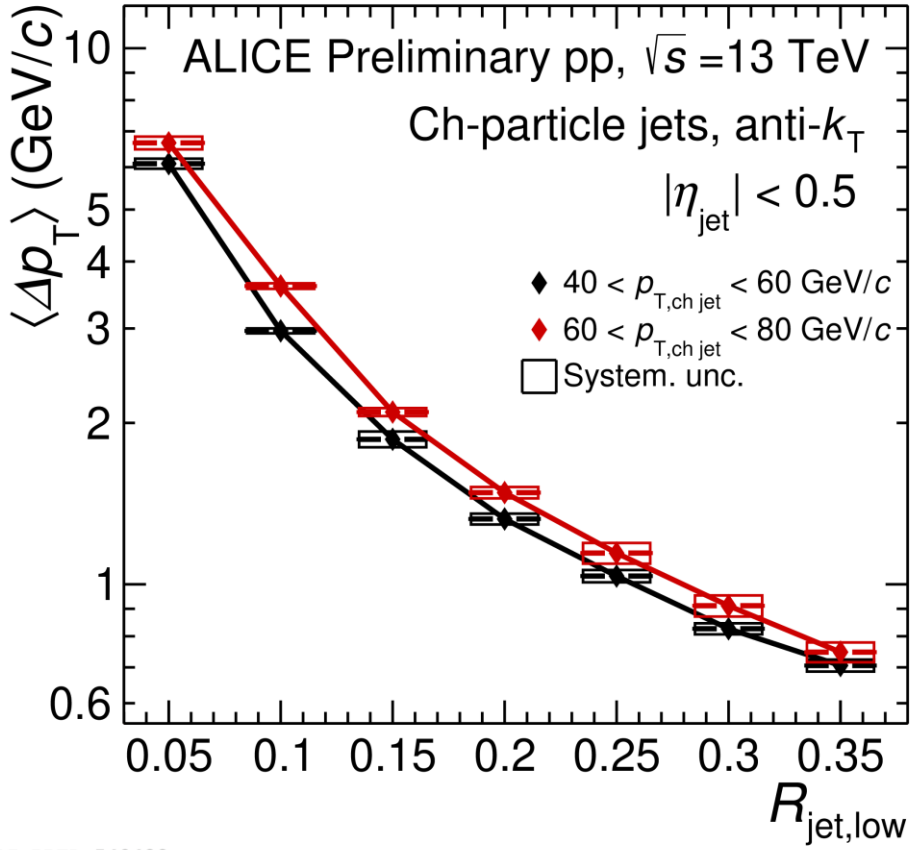
Jet energy flow measurement in pp collisions



ALI-PREL-540106

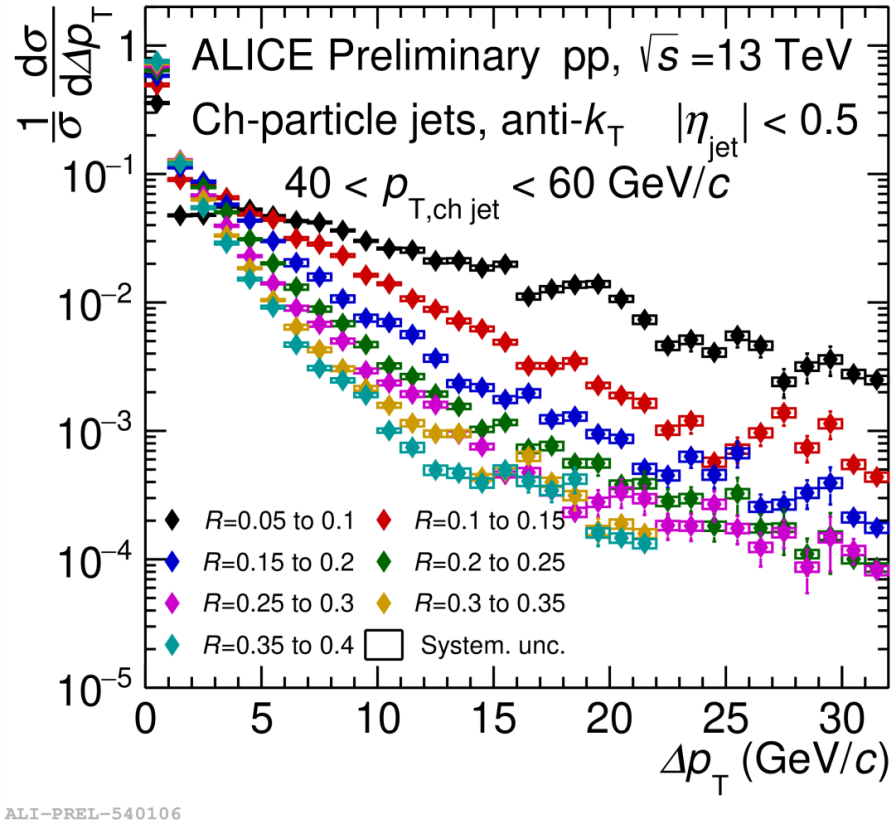
R increases

Distribution mean



ALI-PREL-540489

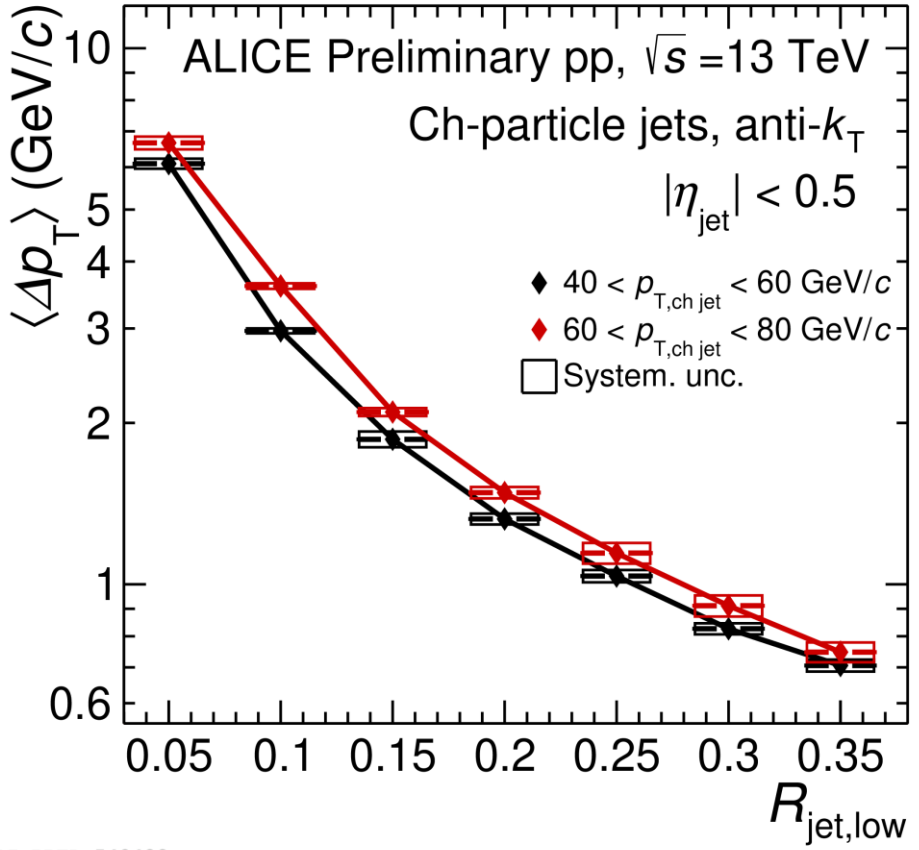
Jet energy flow measurement in pp collisions



ALI-PREL-540106

R increases

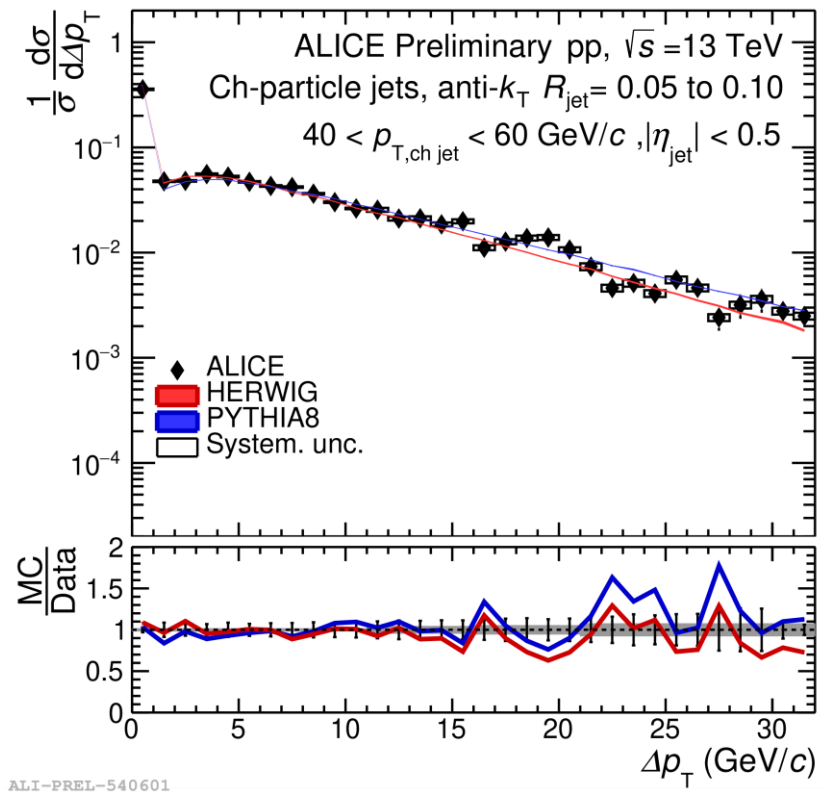
Distribution mean

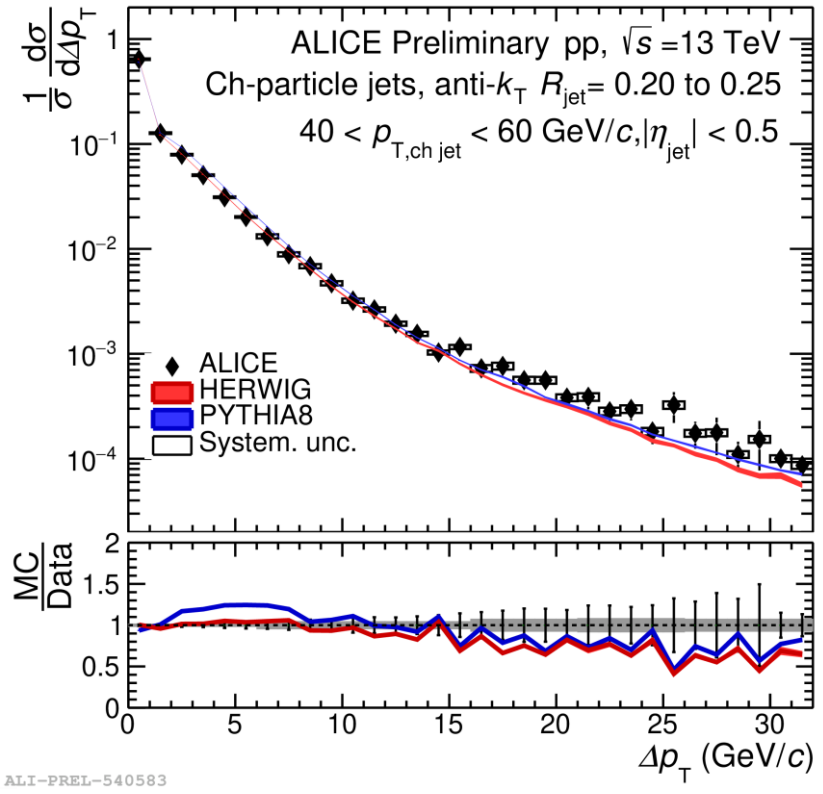


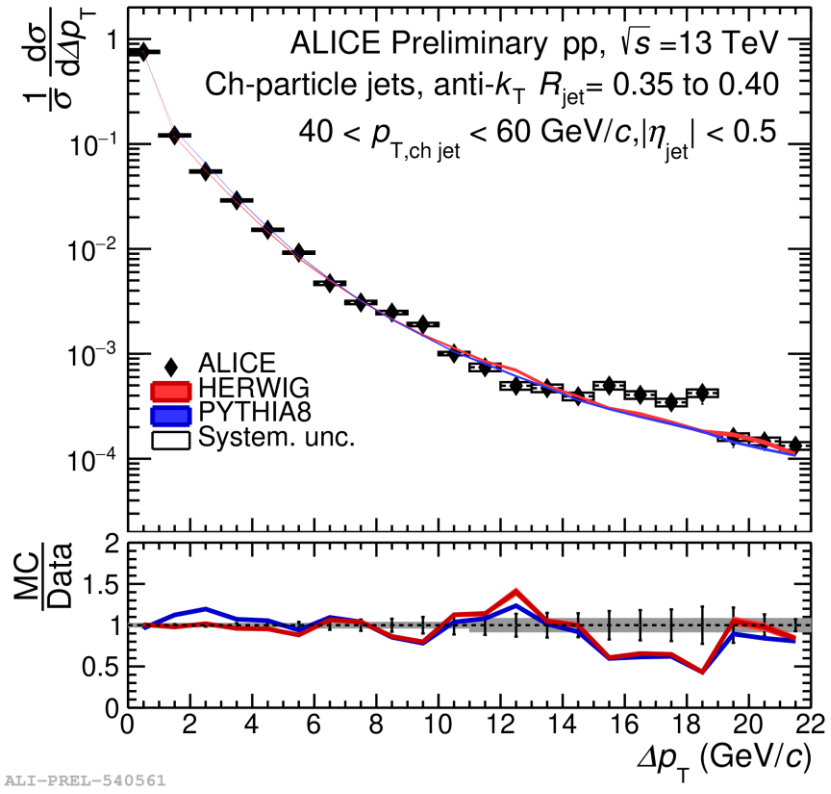
ALI-PREL-540489

Mean energy flow rapidly decreases as function of *R*

Jet energy flow measurement: Model comparison

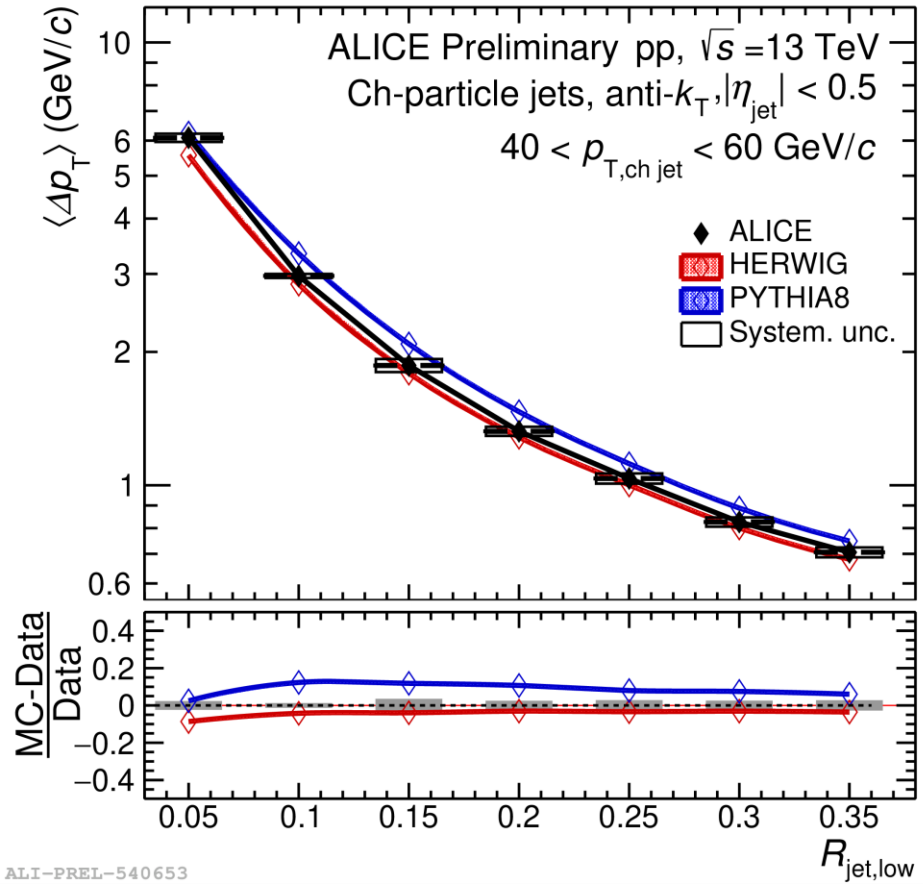






R=0.05 to R=0.1	R=0.2 to R=0.25	R=0.35 to R=0.4

Jet energy flow measurement: Model comparison



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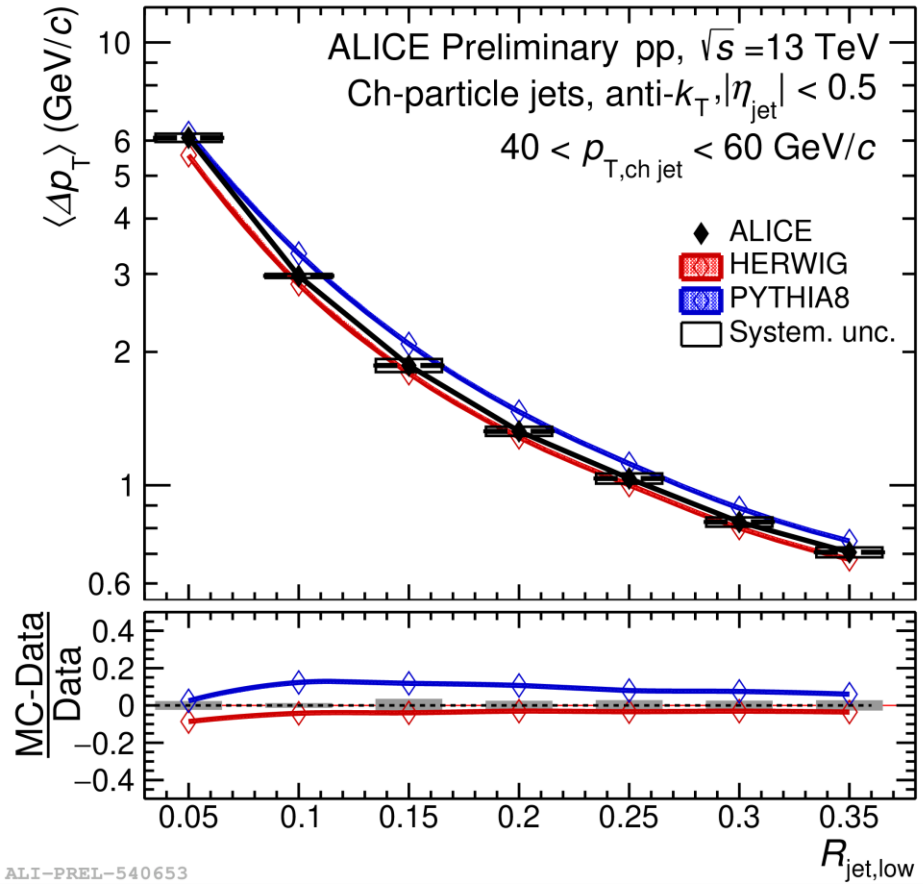

Jet p_T increases

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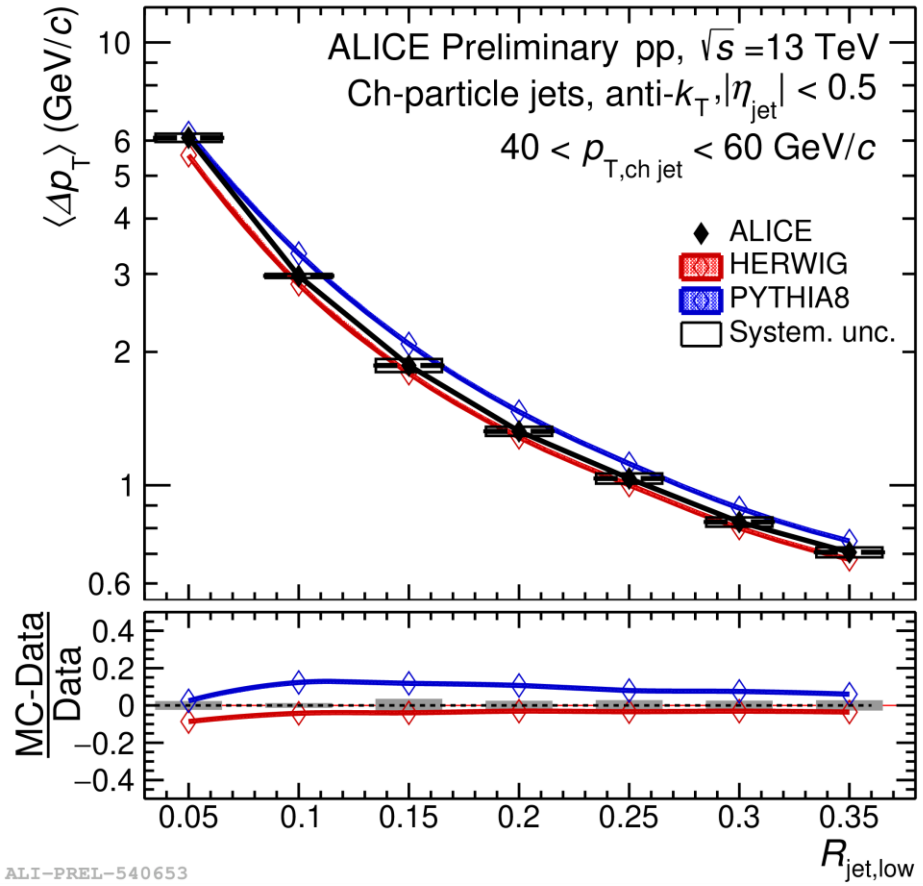
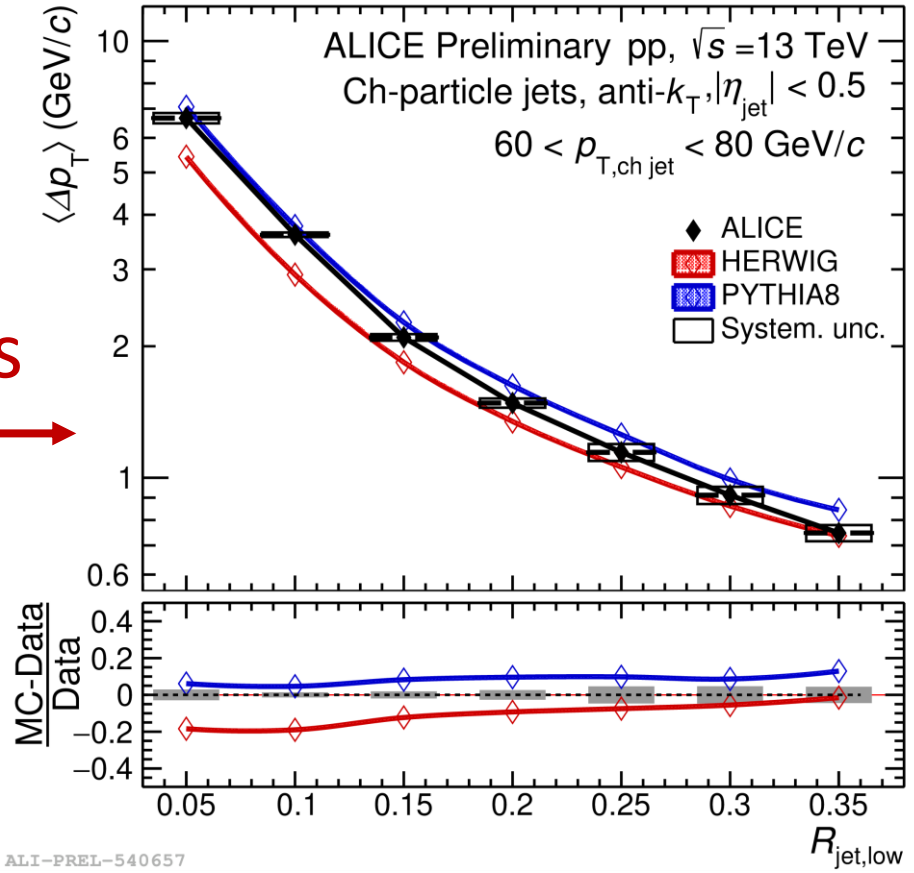
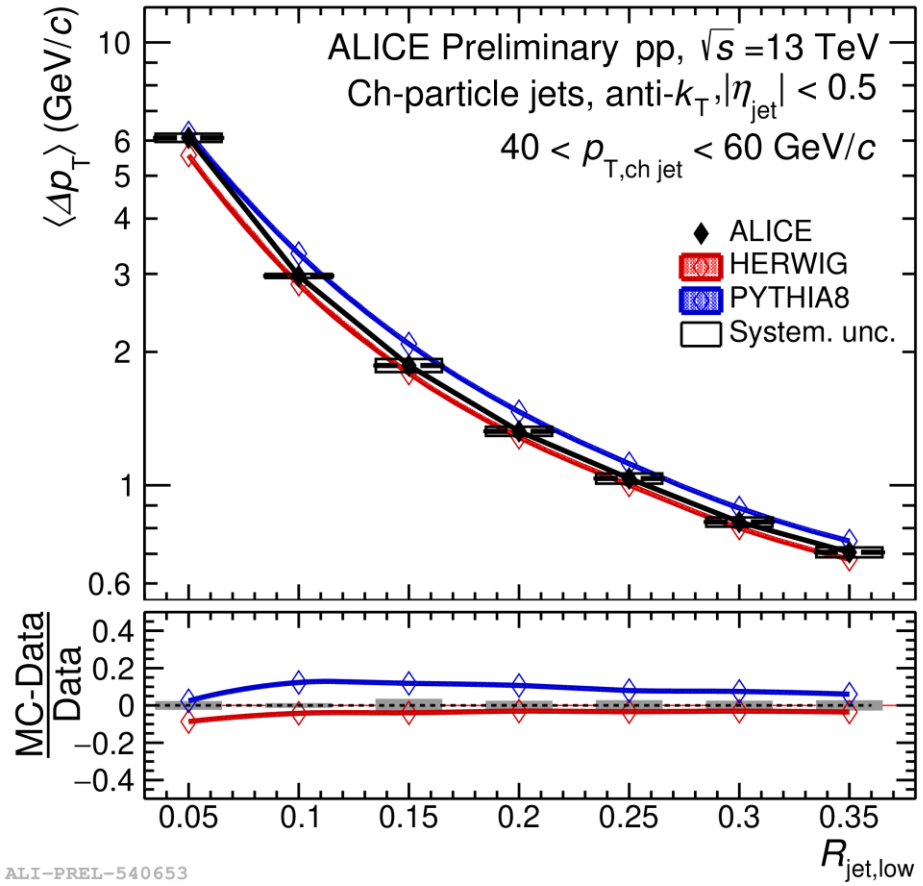


Jet p_T increases



Jet energy flow measurement: Model comparison

Good description of the measurement by both models



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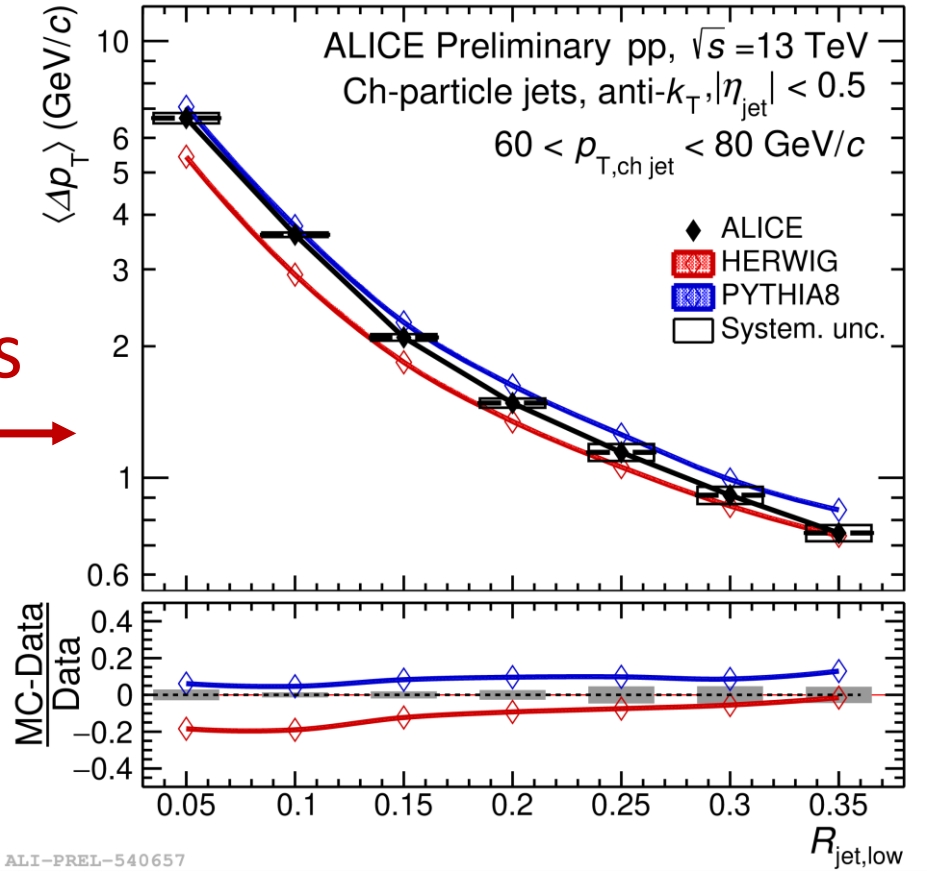
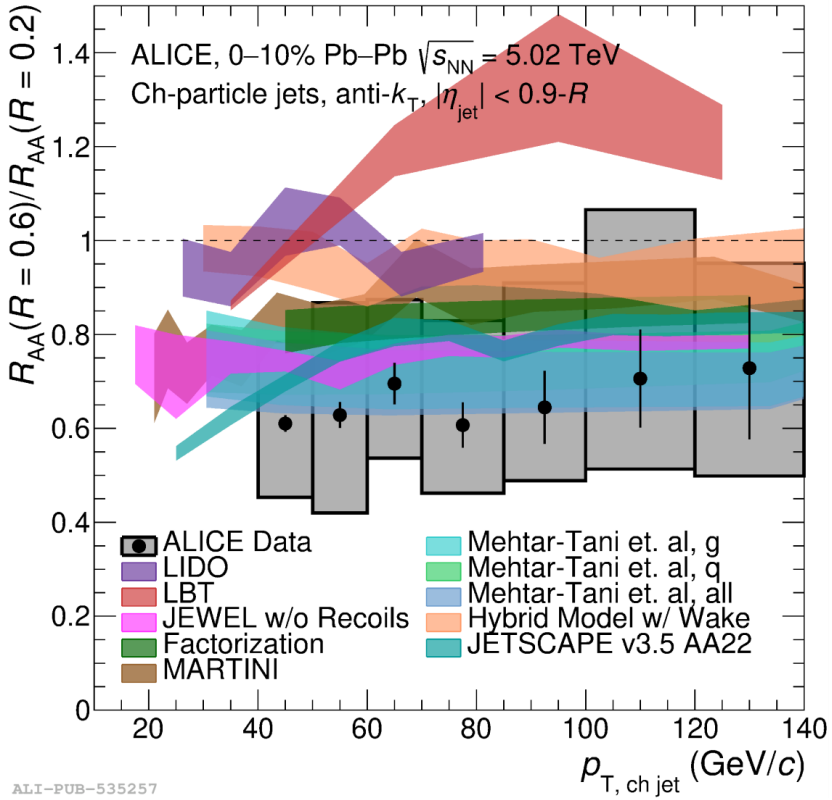


Summary & Outlook

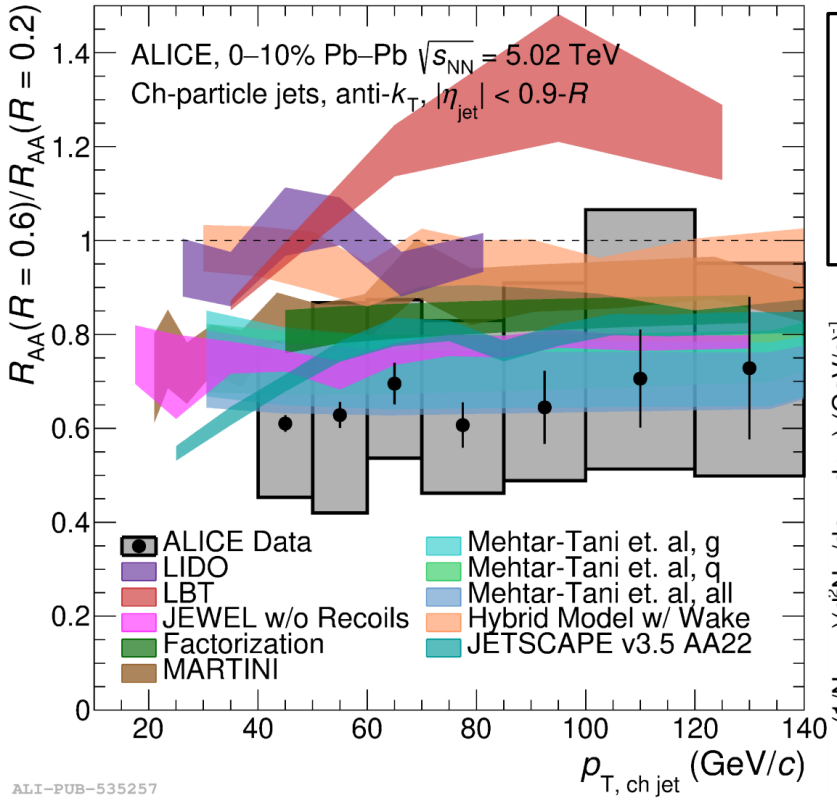
Summary & Outlook



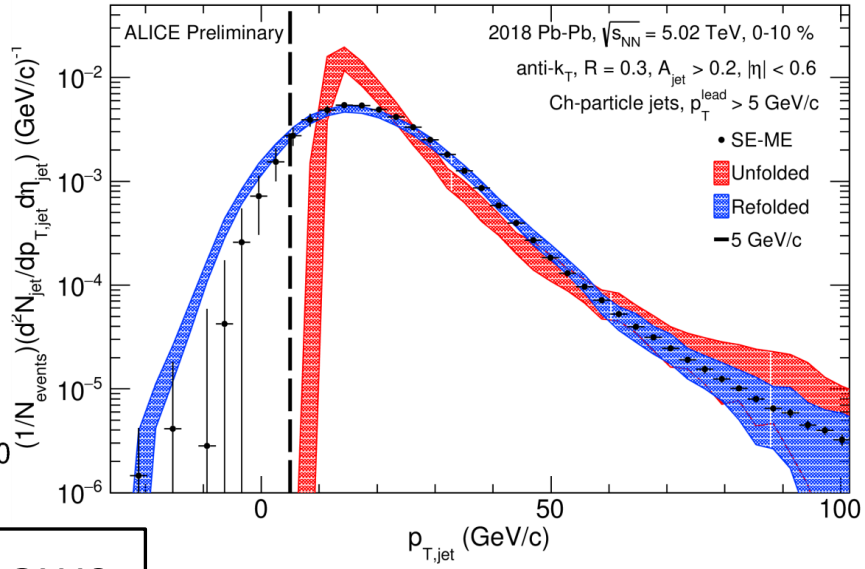
ML-based R_{AA} measurement shows hint of R-dependence at low jet p_T.

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

Summary & Outlook



Mixed event method allows jet yield measurement in unprecedented p_T regime



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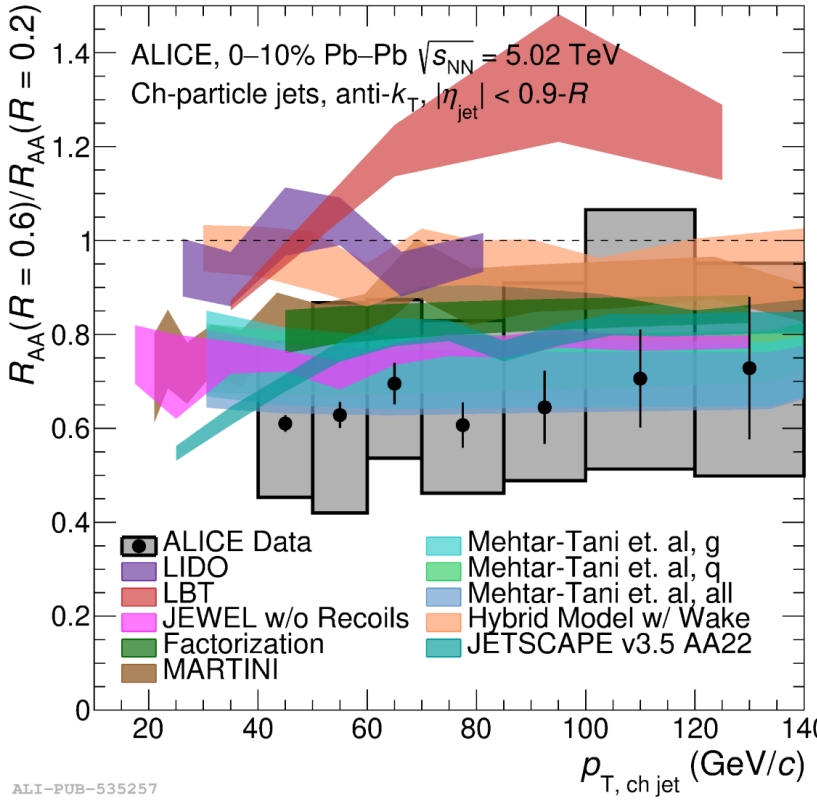

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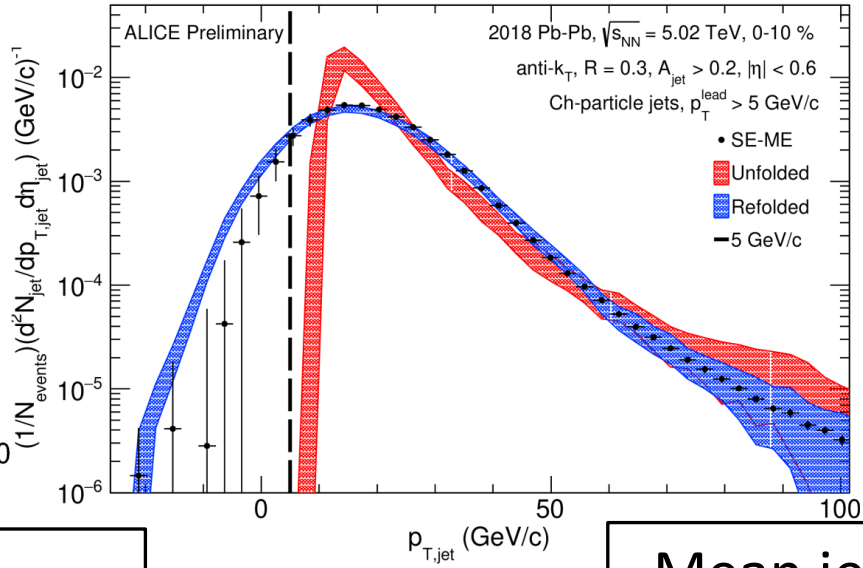

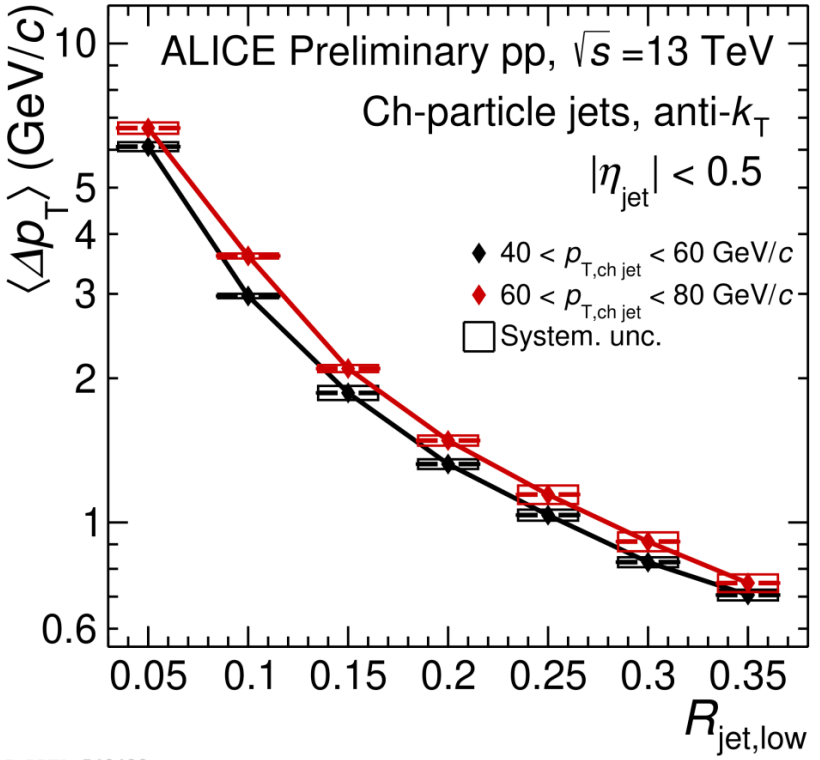

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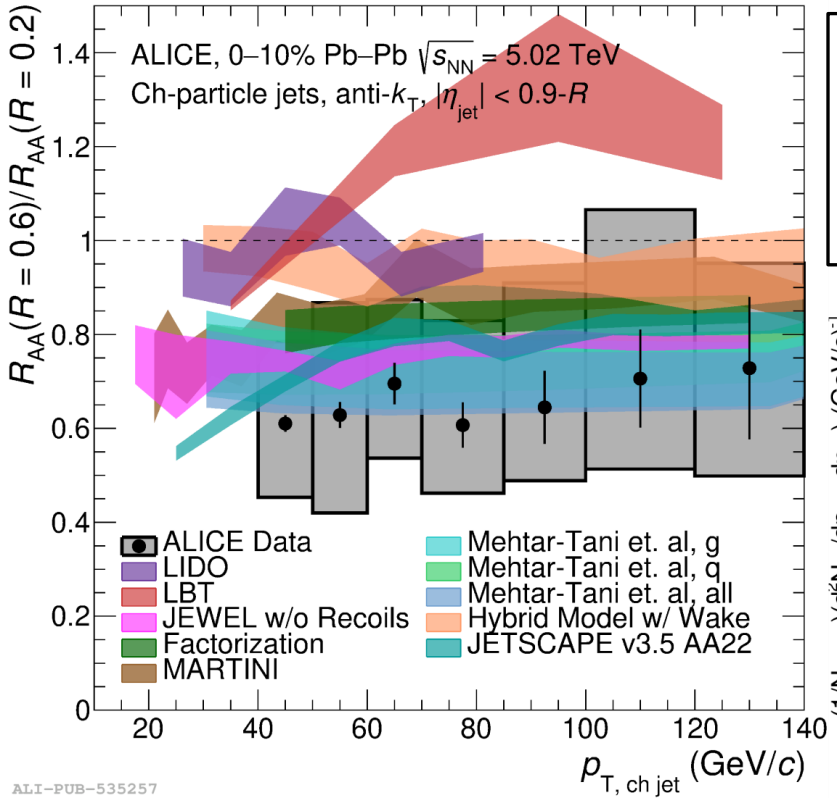
ALICE jet contributions

- Talks:
  - Raymond Ehlers on hardest $k_{T,g}$ splittings in Pb-Pb (Tues, 11:10)
  - Yongzhen Hou on yield enhancement and acoplanarity at low p_T in Pb-Pb (Tues, 12:10)
  - Florian Jonas on initial-state photons in p-Pb (Tues, 14:00)
  - Ezra Lesser on jet mass and angularities in Pb-Pb (Tues, 17:10)
  - Rey Cruz-Torres on jet axes and energy-energy correlations in pp and Pb--Pb (Tues, 17:50)
  - Preeti Dhankher on D^0-tagged jet angularities in pp (Wed, 11:10)
  - Antonio Palasciano on in-jet fragmentation and correlations of charmed mesons and baryons in pp (Wed, 14:40)
  - Caitie Beattie on charged-particle jet with event-shape engineering in Pb-Pb (Thurs, 10:20)
- Posters:
  - Jaehyeok Ryu on charged jet j_T in pp (Tues, 18:15)
  - Rey Cruz-Torres (for Debjani Banerjee) on multiplicity dependence of charged-particle jet properties in pp (Tues, 18:15)

Summary & Outlook



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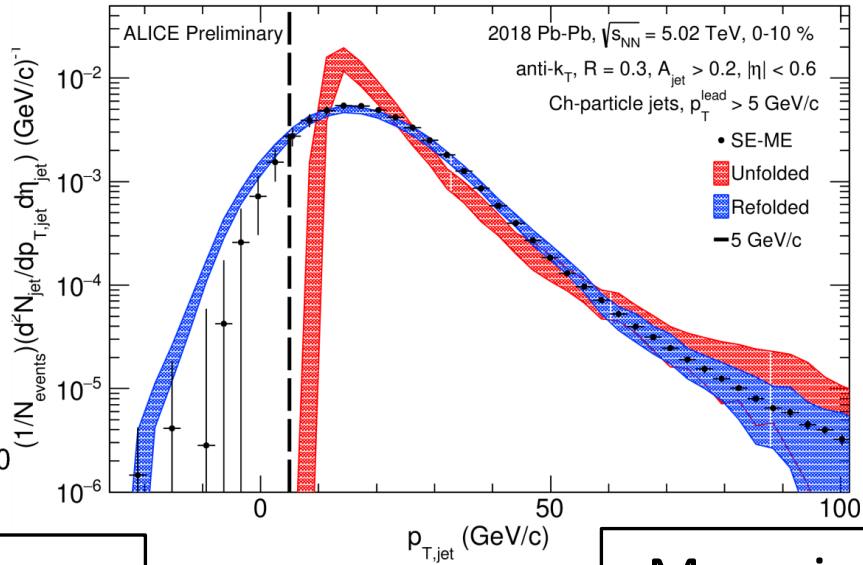

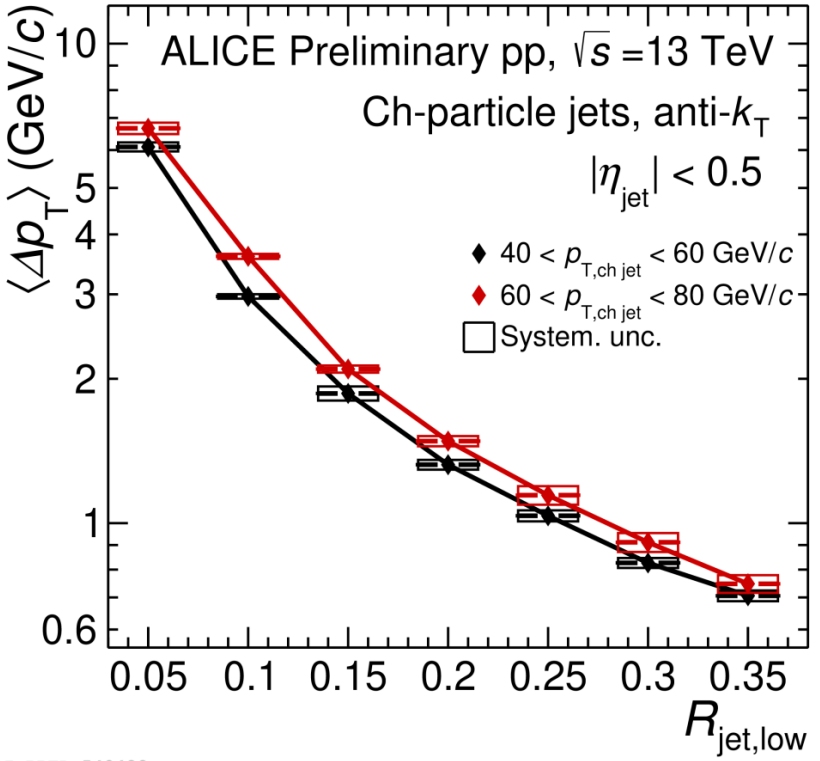

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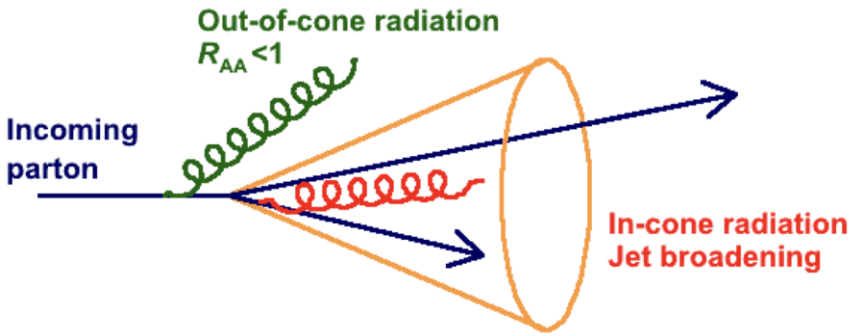
Backup slides

“Jet quenching” can have many aspects…

Medium-induced energy loss



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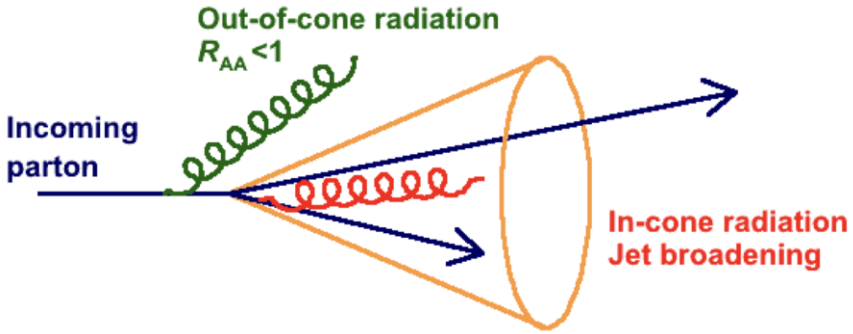
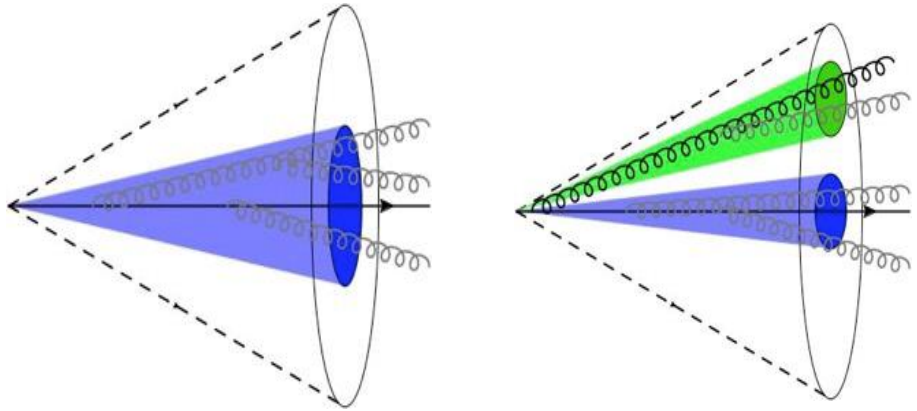


Coherence effects



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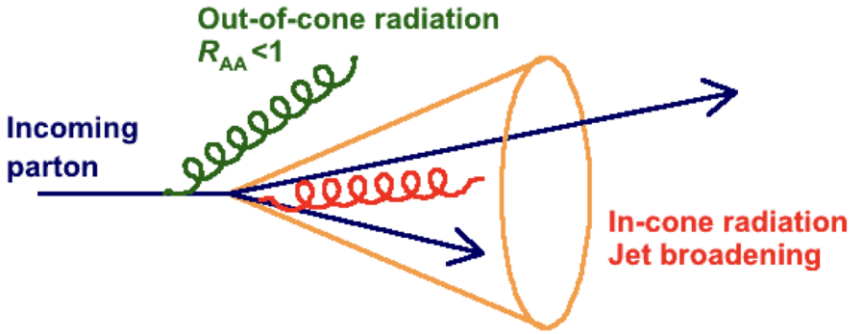

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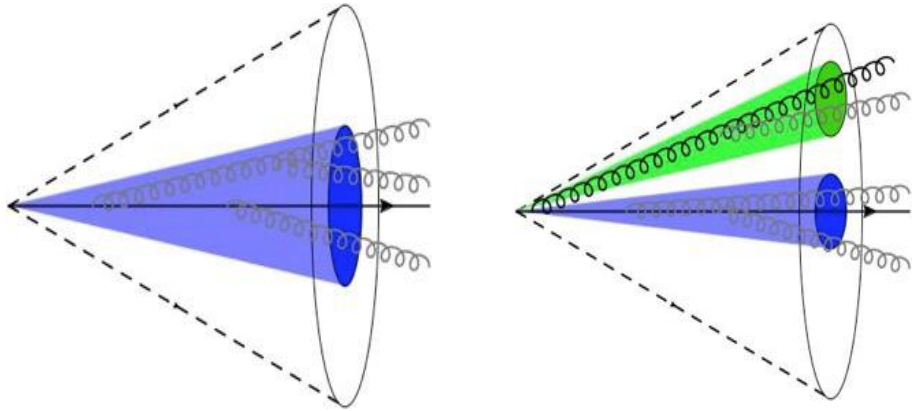
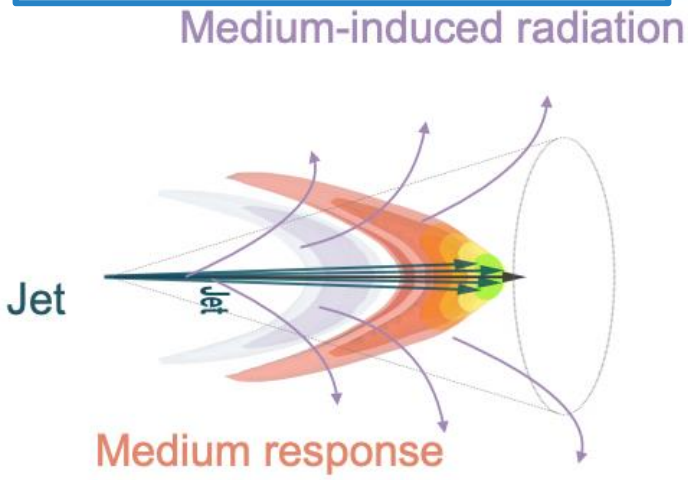
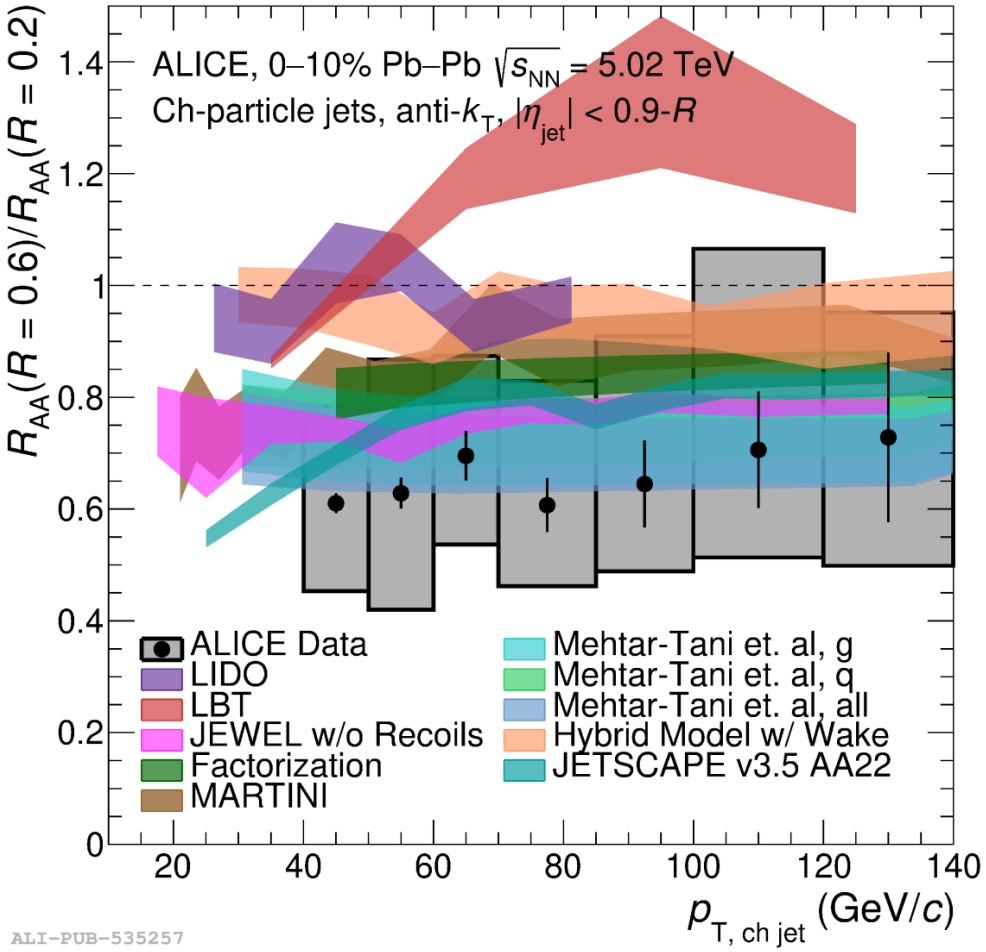
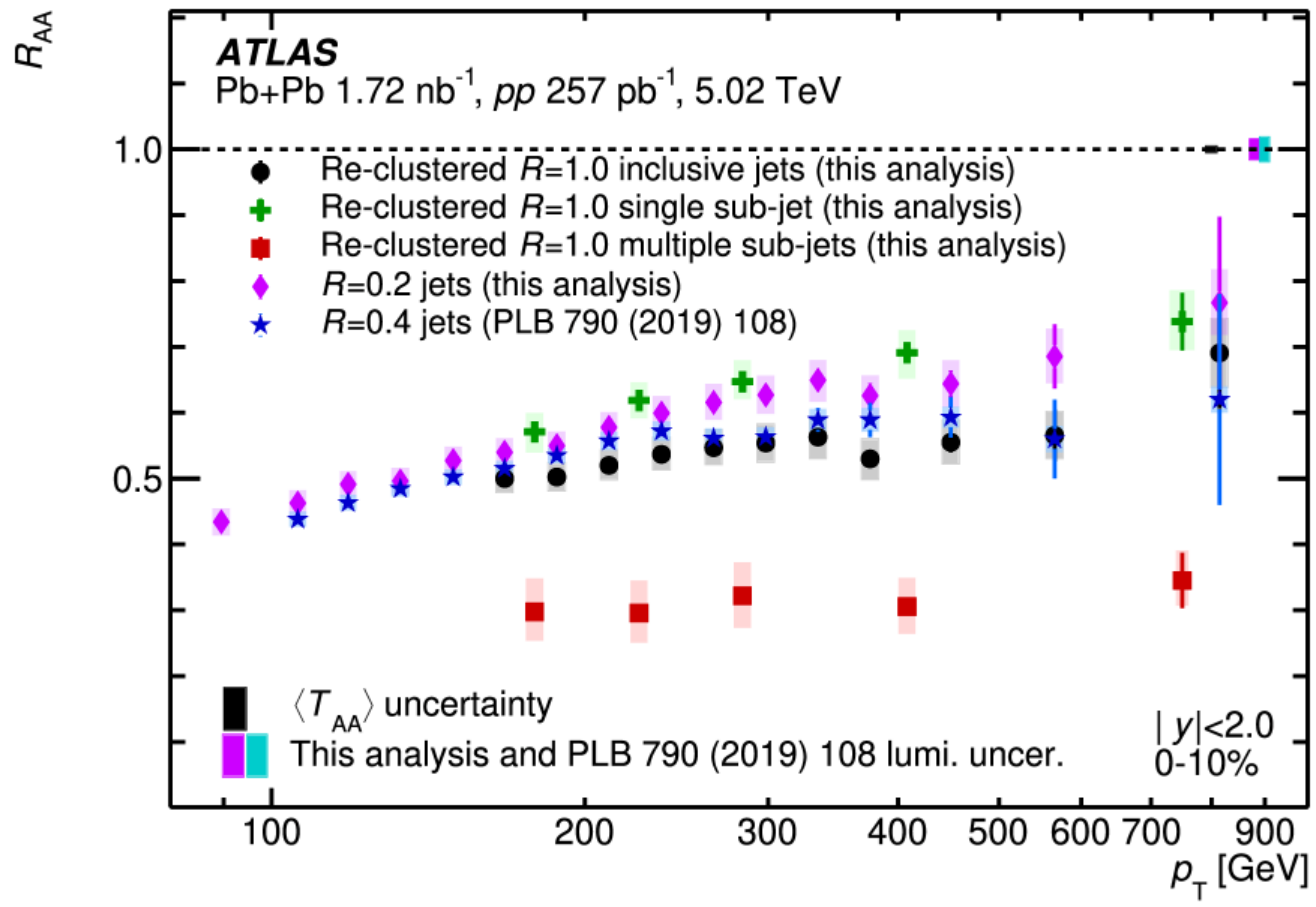


Medium recoil



R-dependence of jet nuclear modification factor -ATLAS

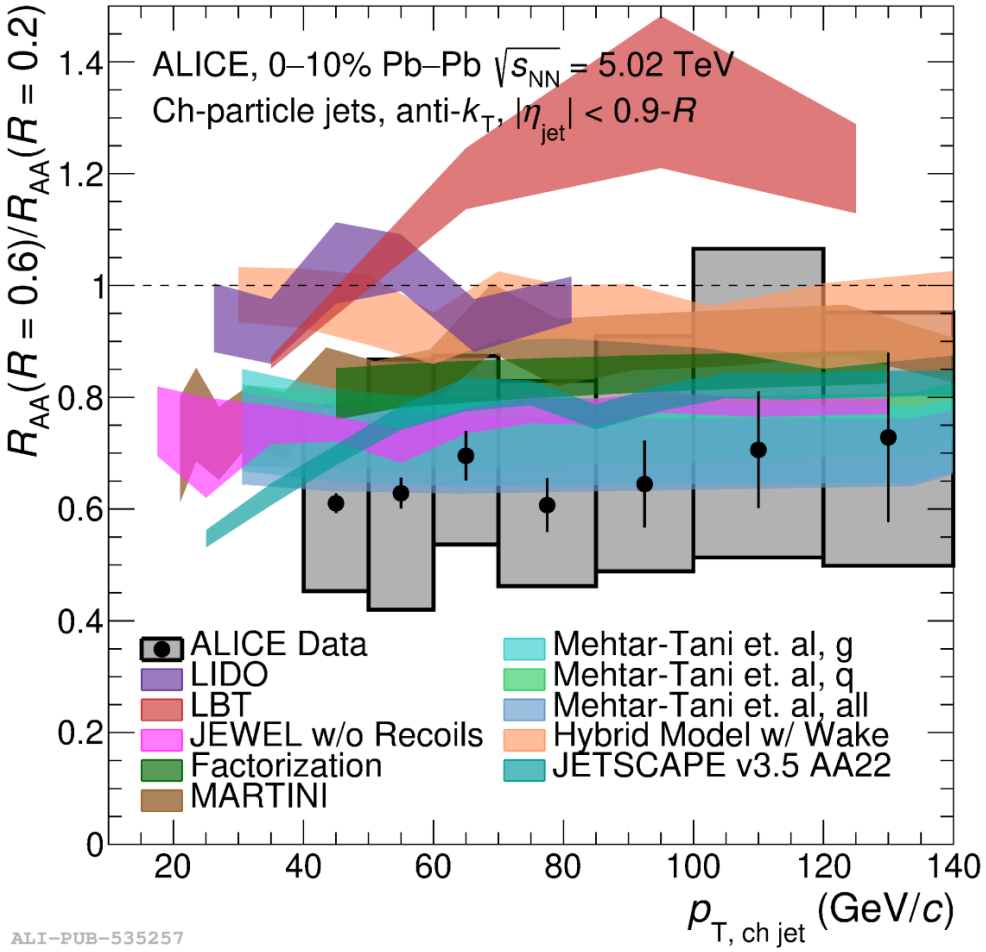


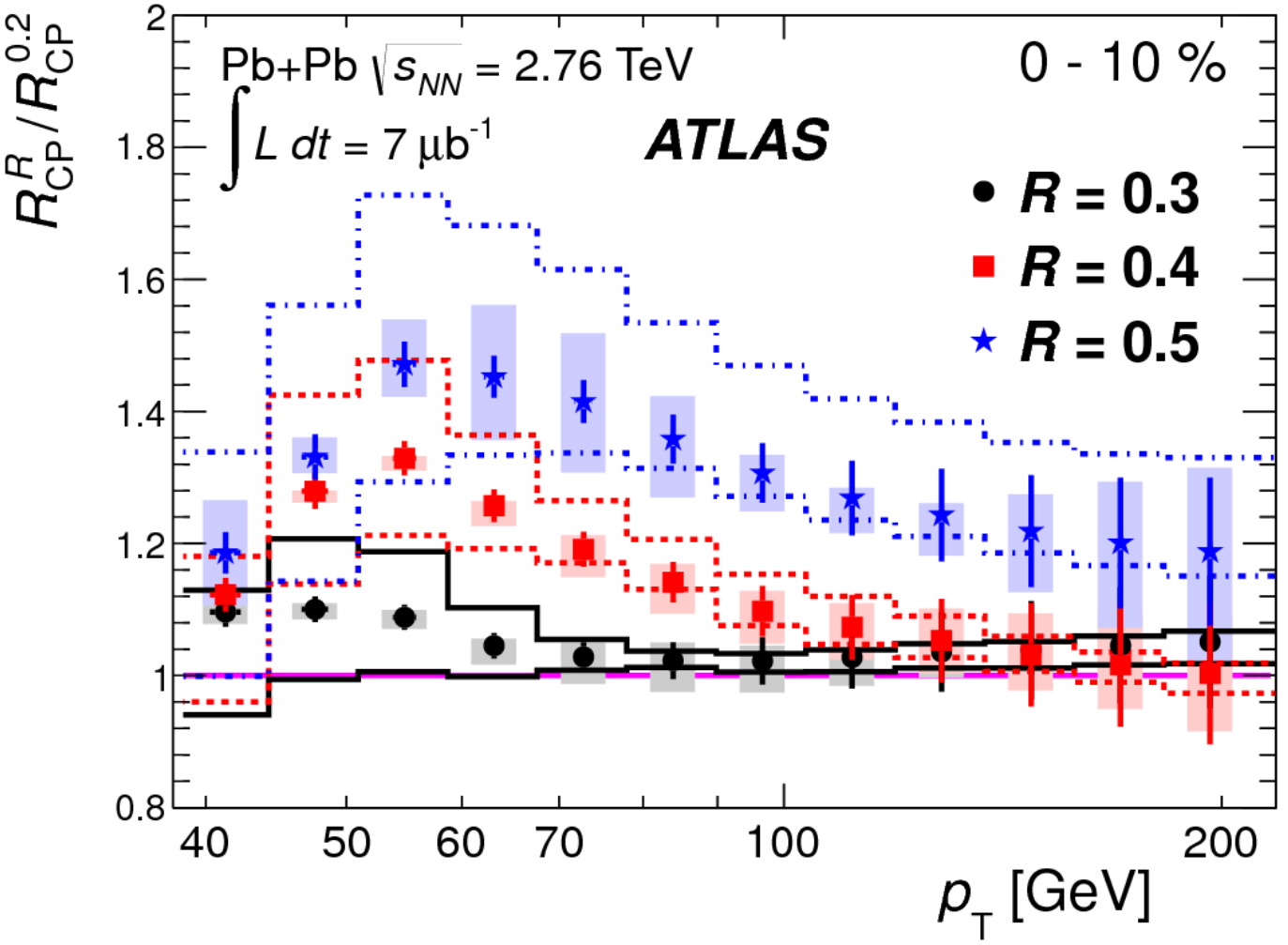


ALICE: https://arxiv.org/abs/2303.00592

ATLAS: https://doi.org/10.48550/arXiv.2301.05606

R-dependence of jet nuclear modification factor -ATLAS

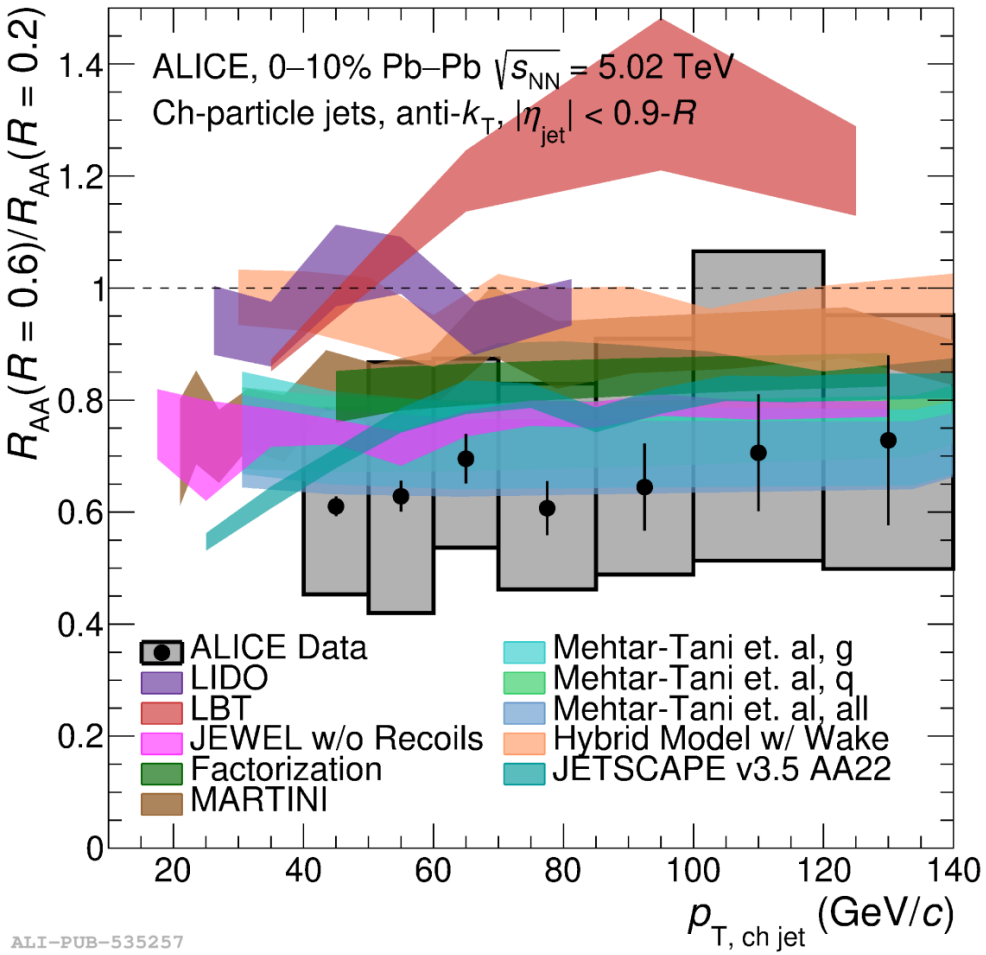


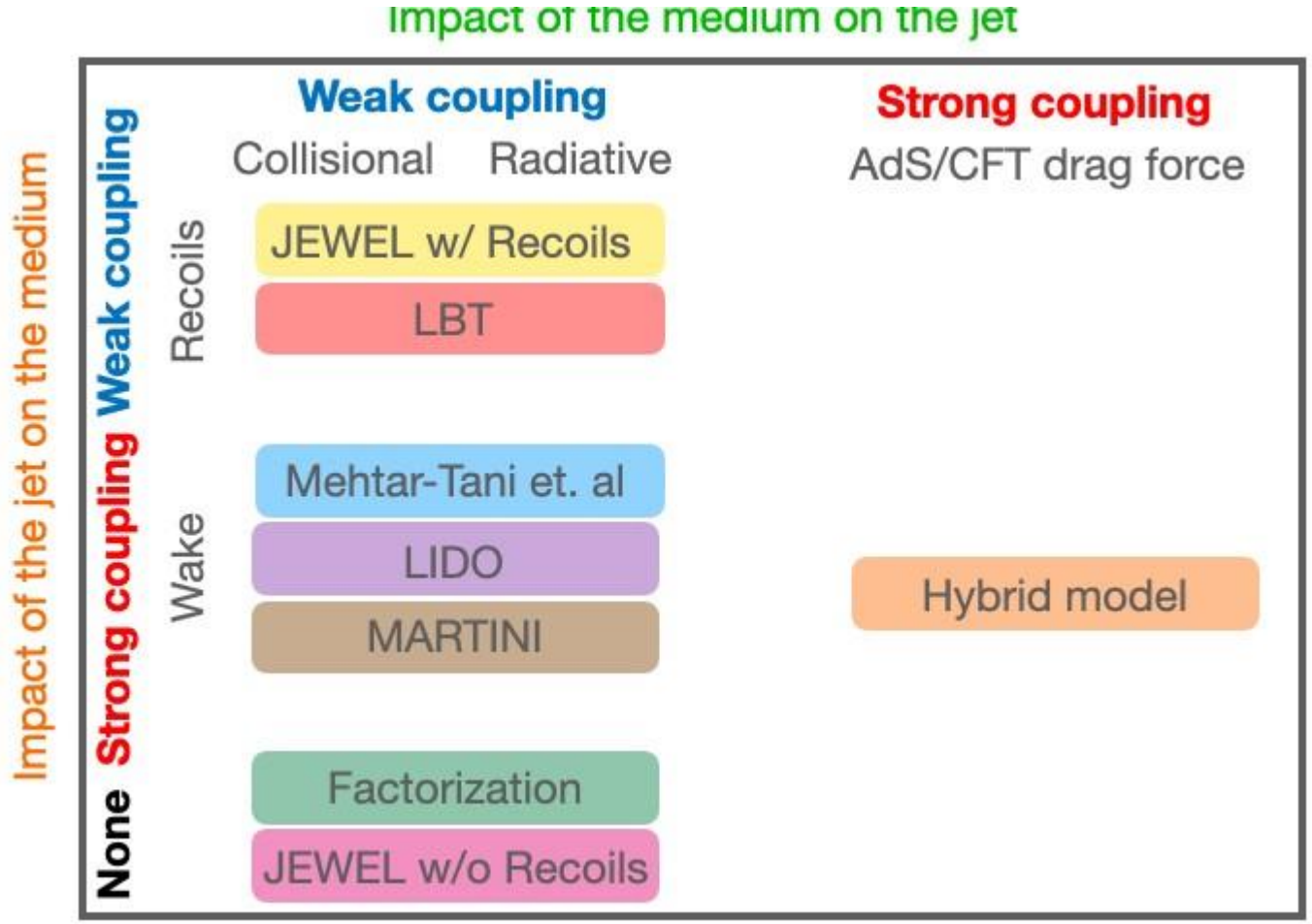


ALICE: https://arxiv.org/abs/2303.00592

ATLAS: https://doi.org/10.1016/j.physletb.2013.01.024

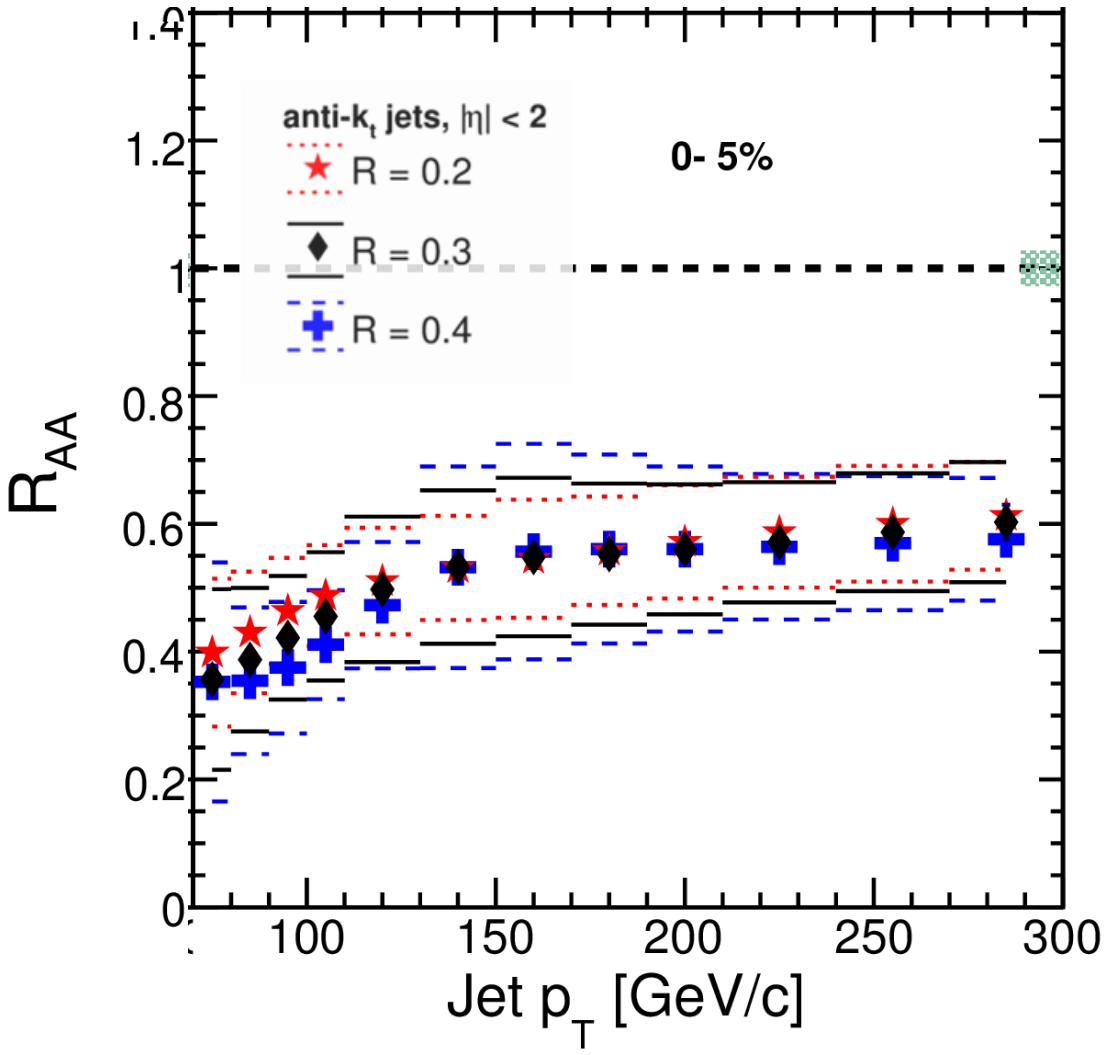
R dependence of jet nuclear modification factor – Models



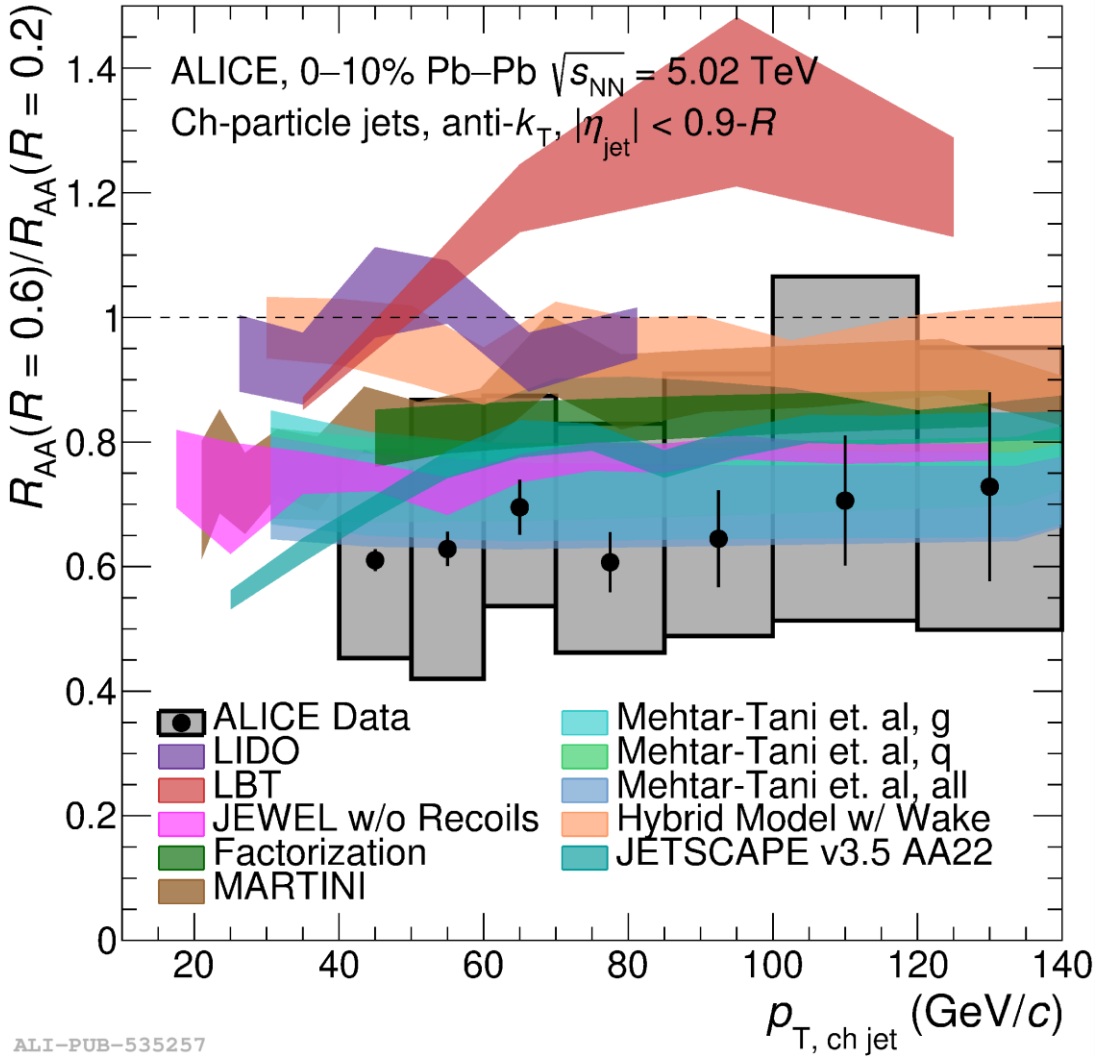


ALICE: https://arxiv.org/abs/2303.00592

R-dependence of jet nuclear modification factor- CMS

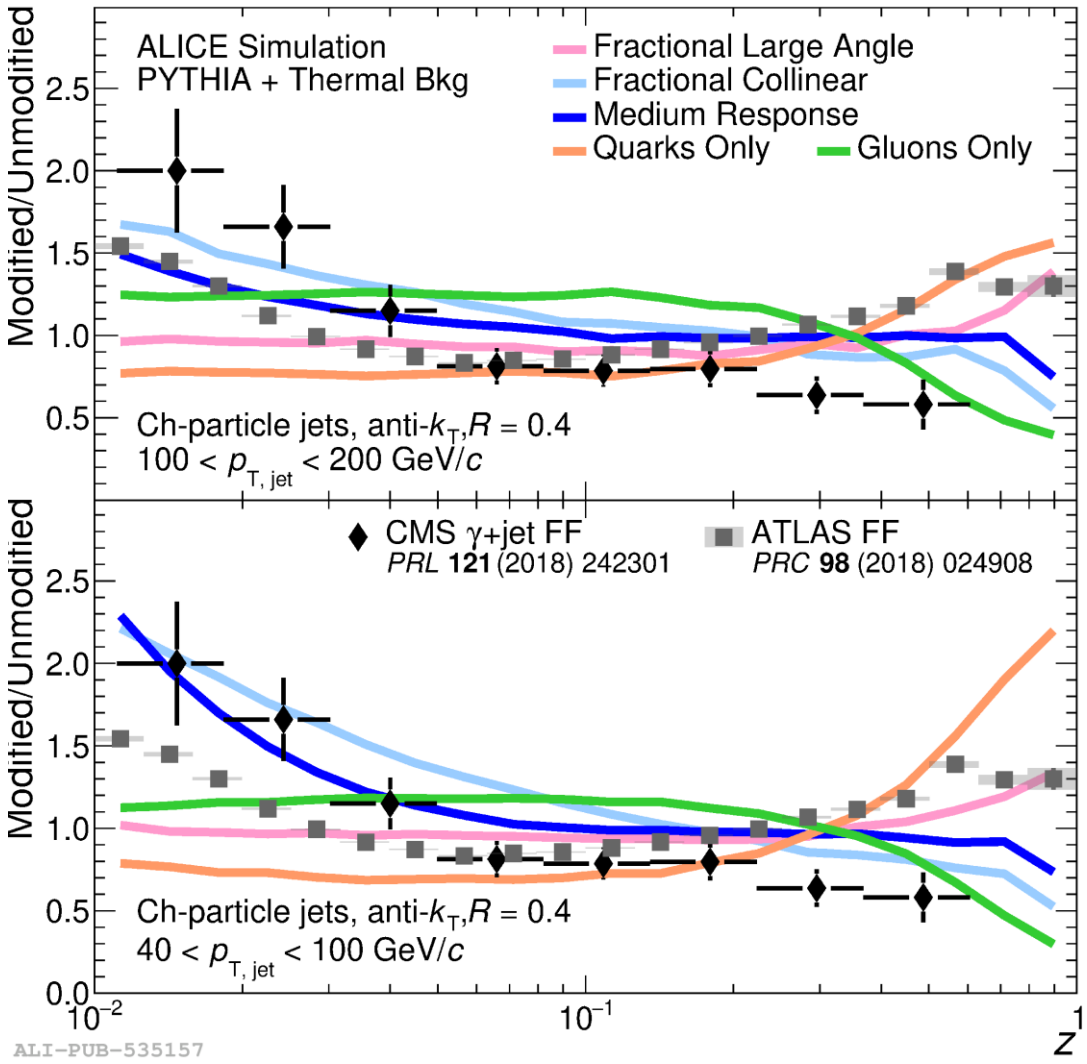


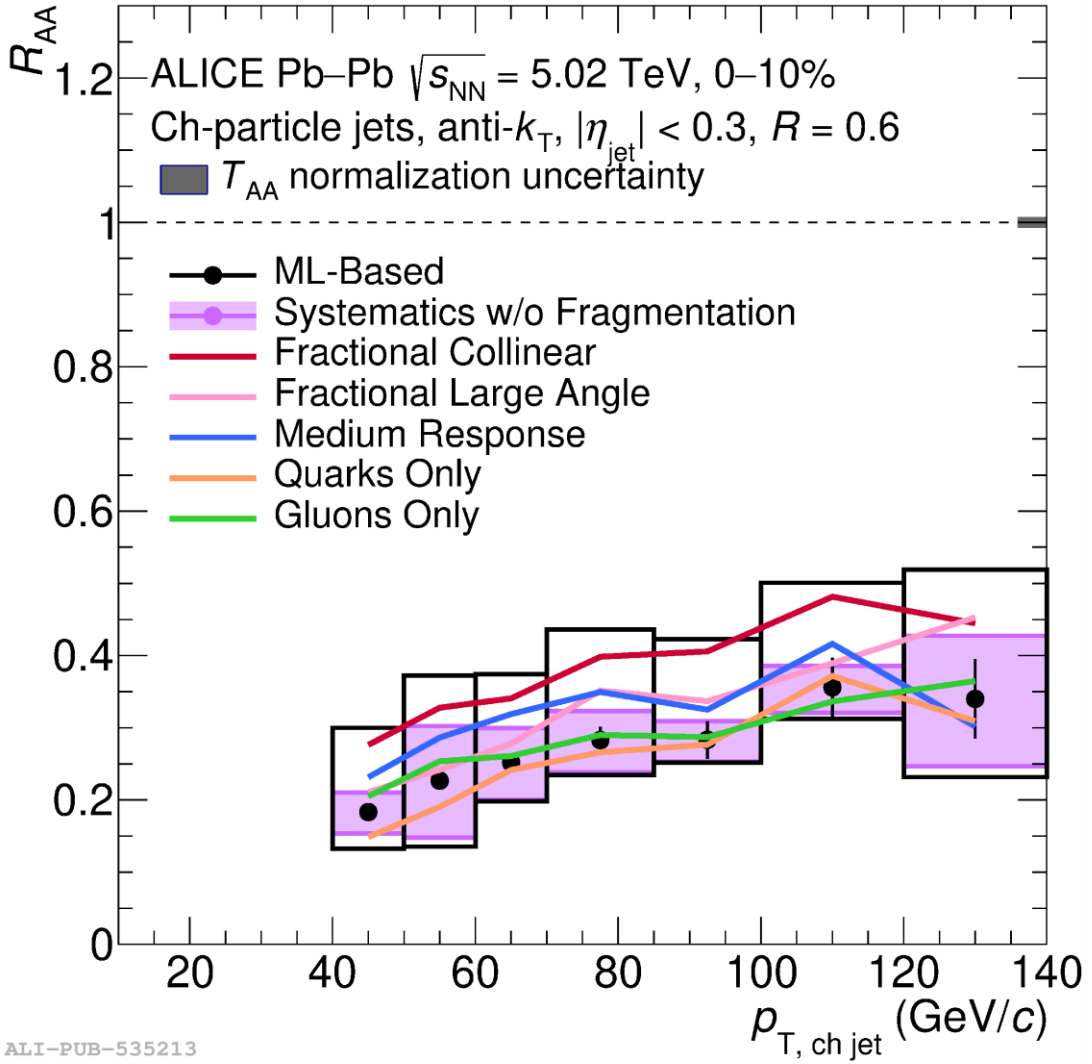
CMS: https://doi.org/10.1103/PhysRevC.96.015202



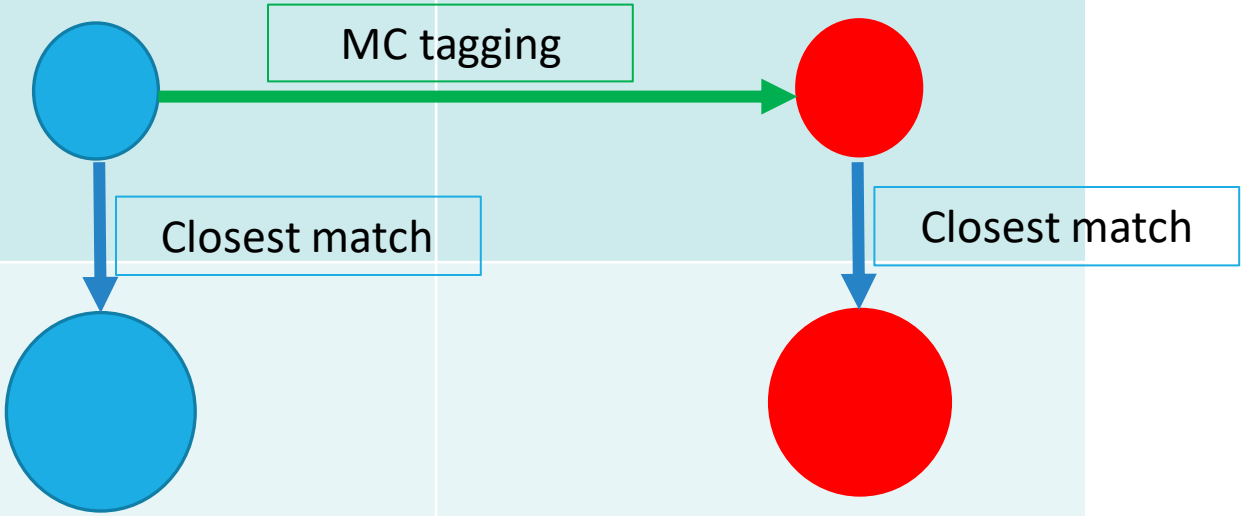
ALICE: https://arxiv.org/abs/2303.00592

ML-based method: Fragmentation function bias

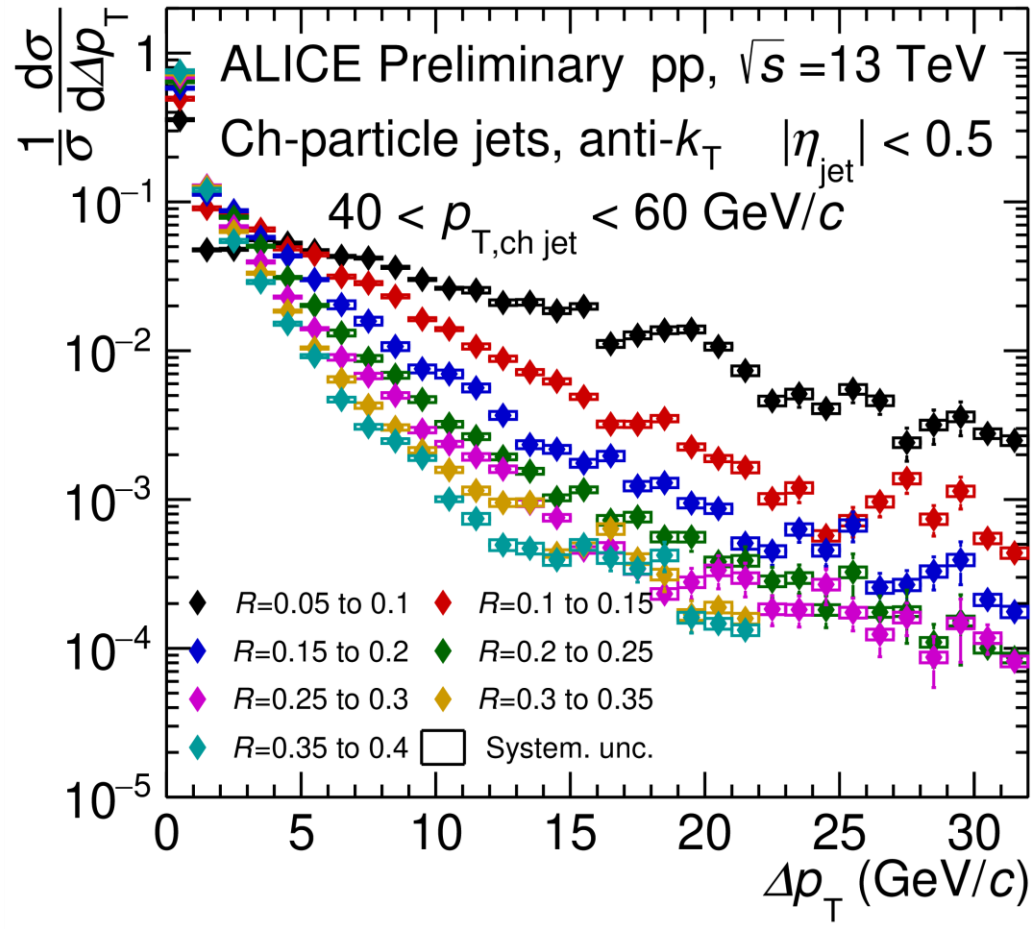




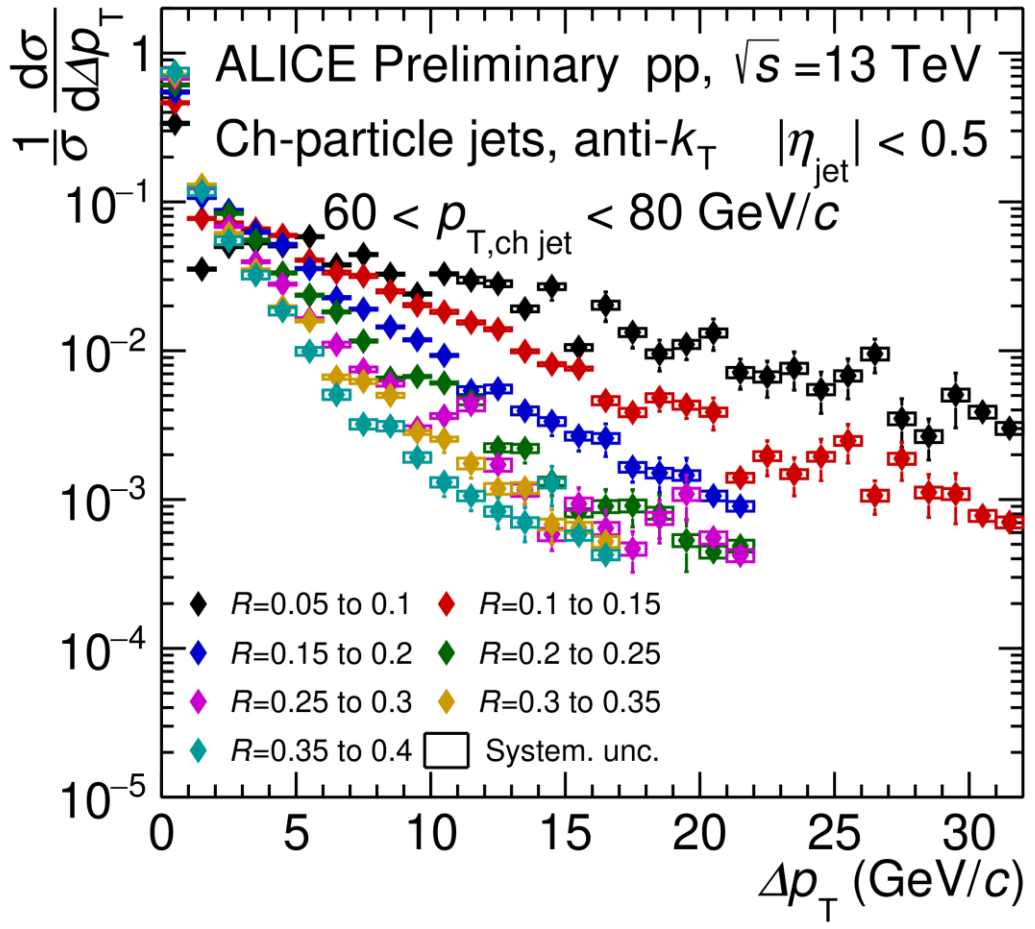
Matching/Tagging procedure

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

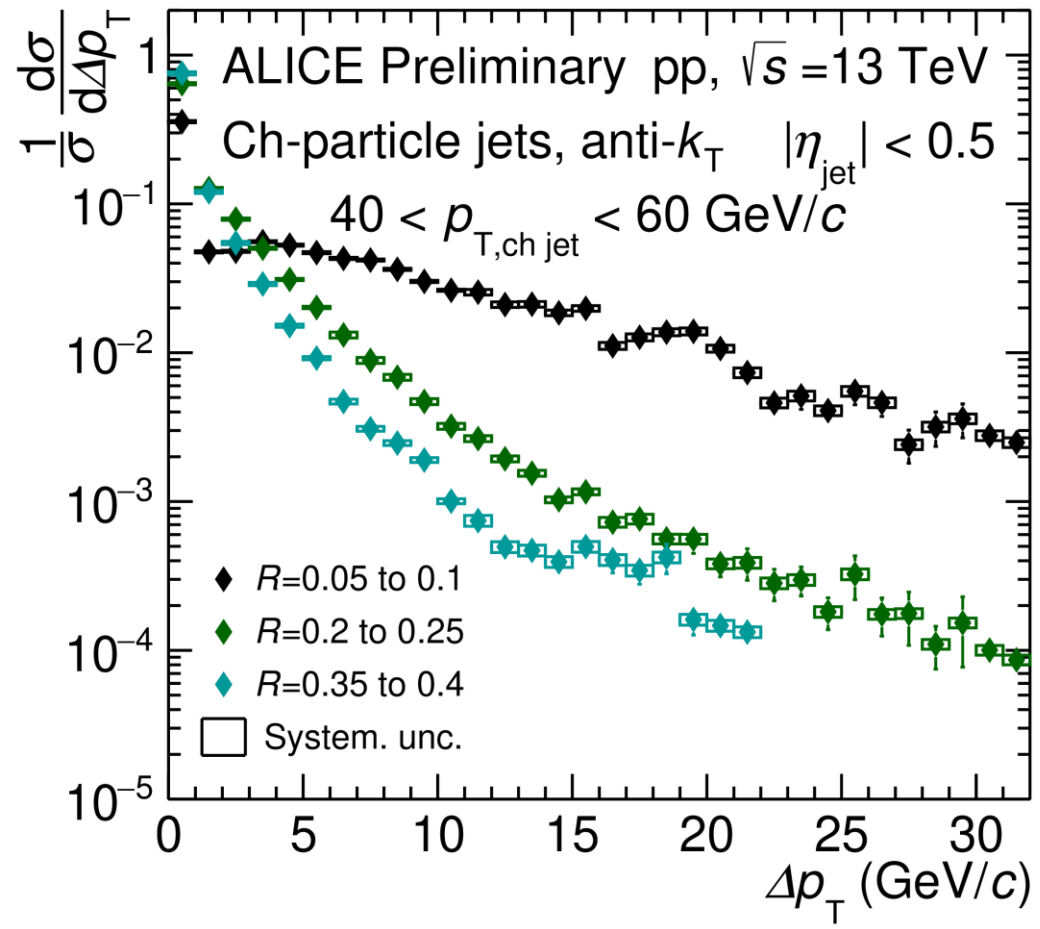


$40 < p_T < 60$ GeV/c



$60 < p_T < 80$ GeV/c

Jet energy flow distributions: jet p_T dependence



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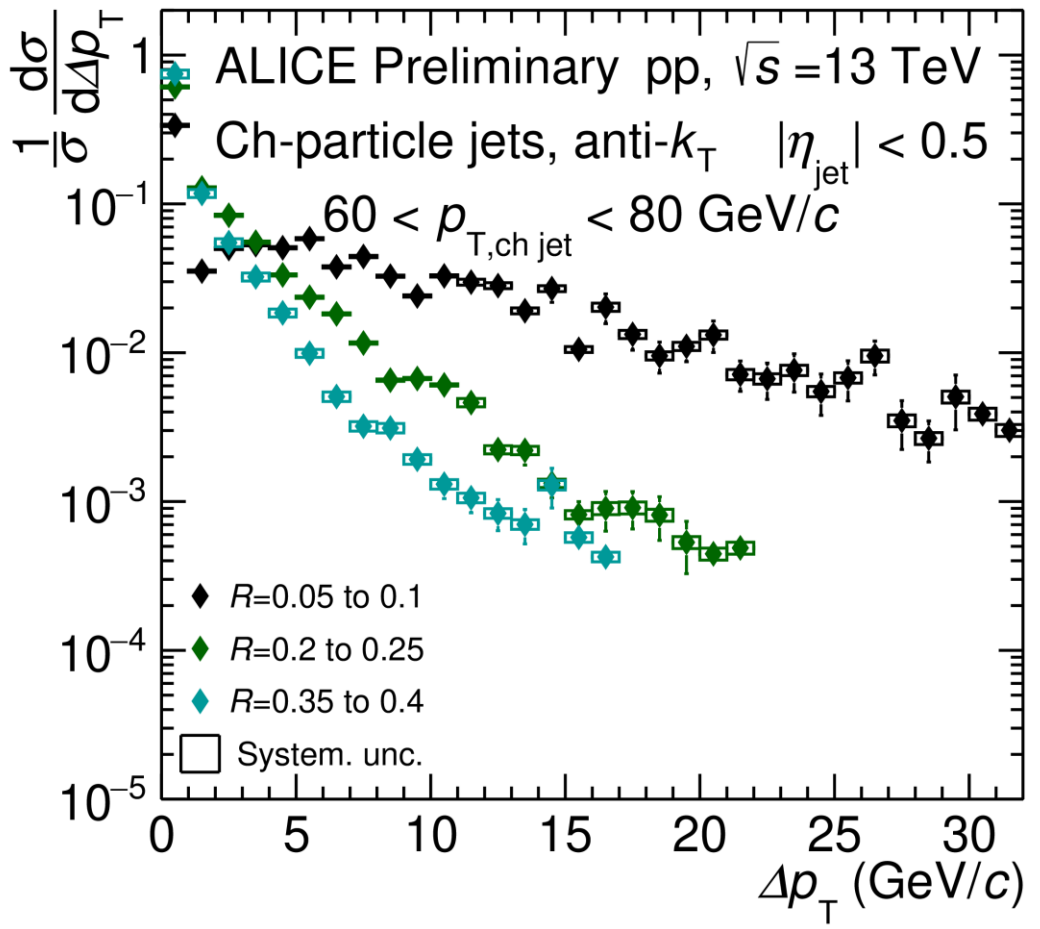

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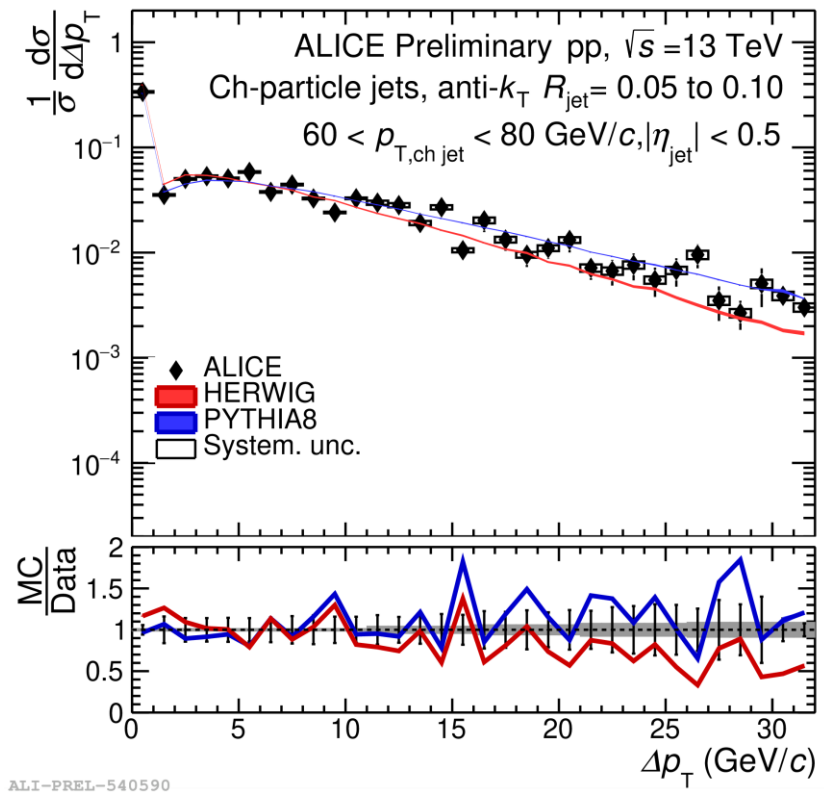
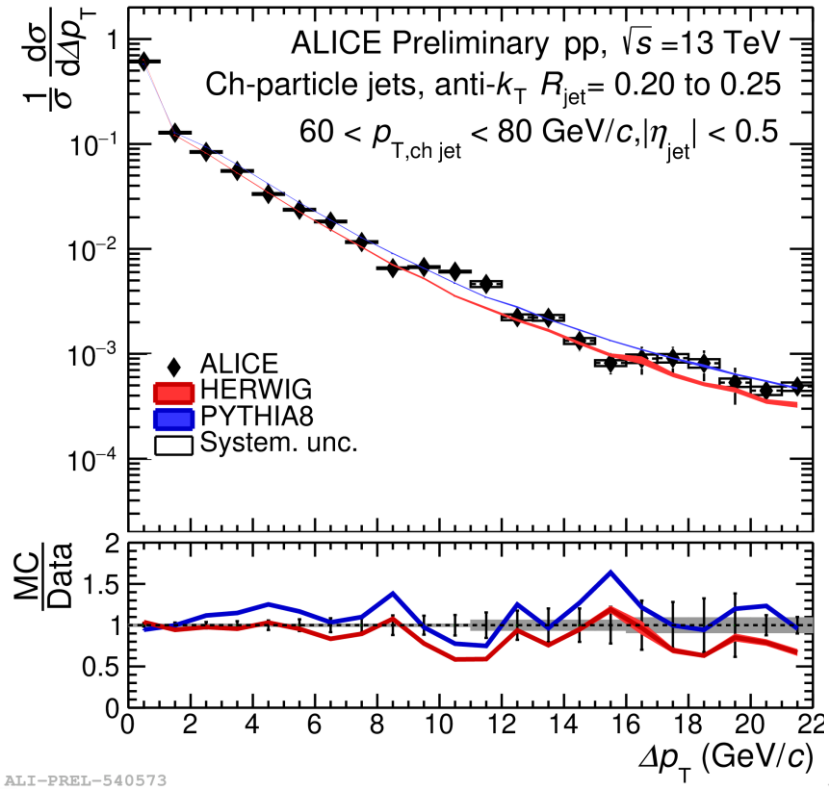
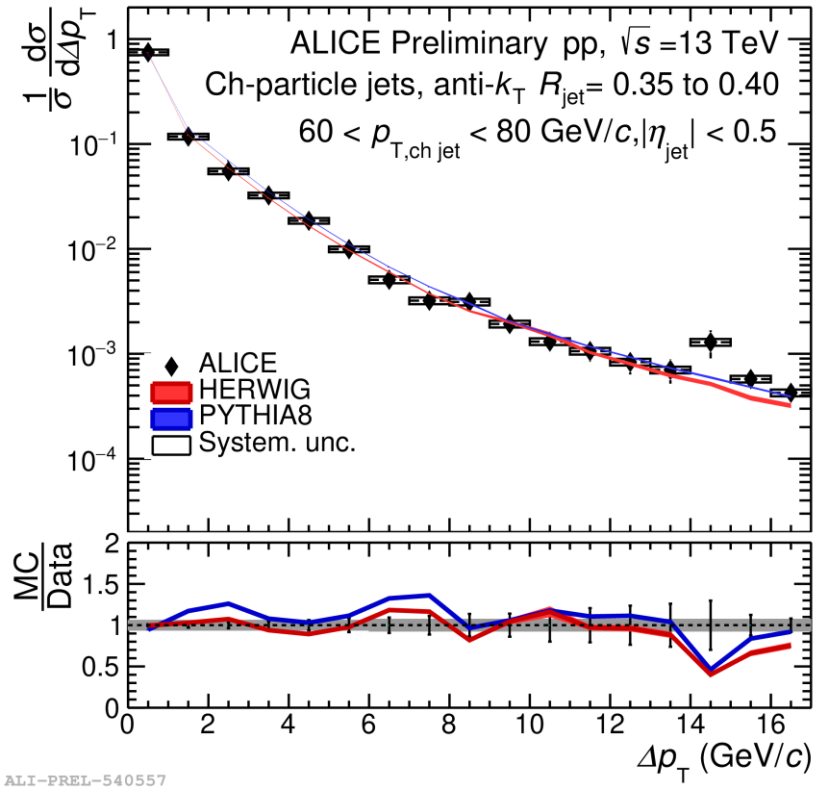




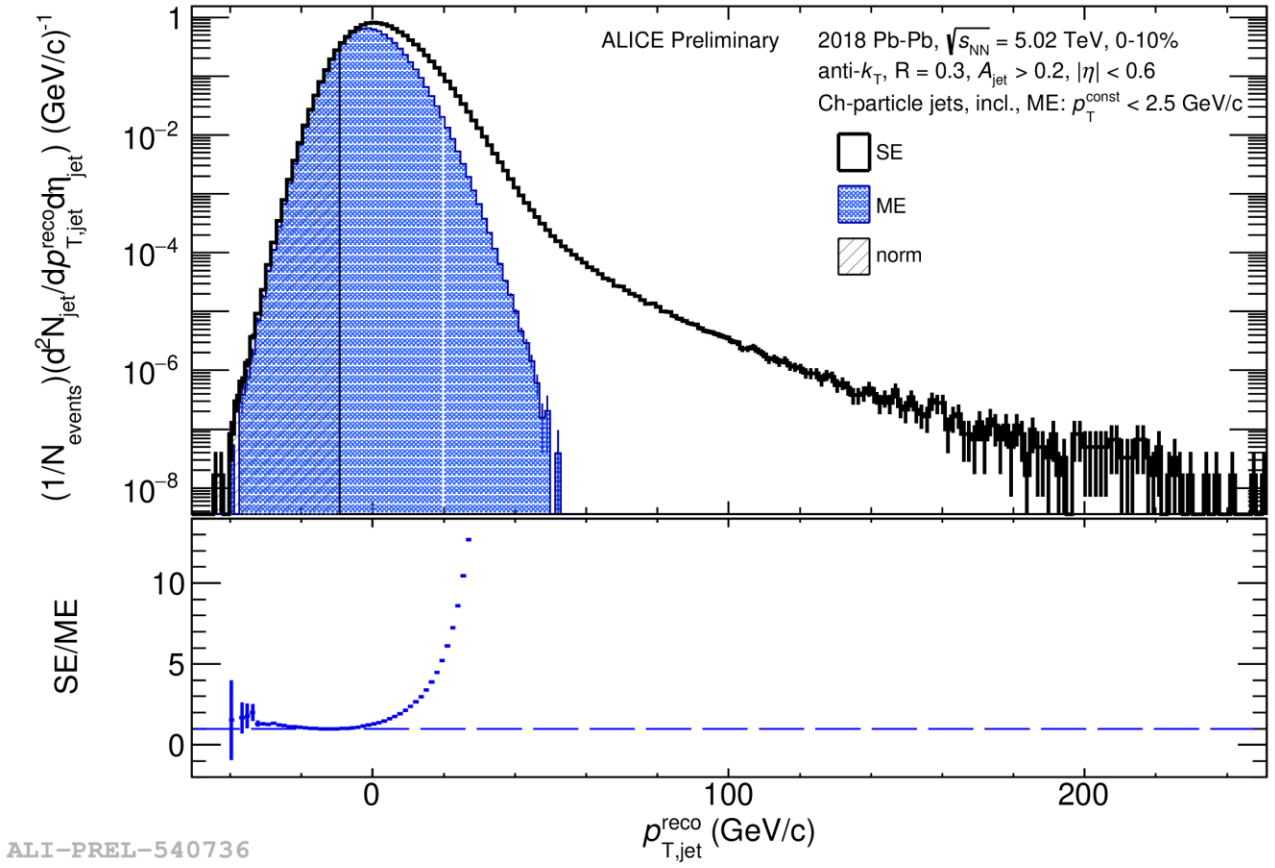


R=0.05 to R=0.1

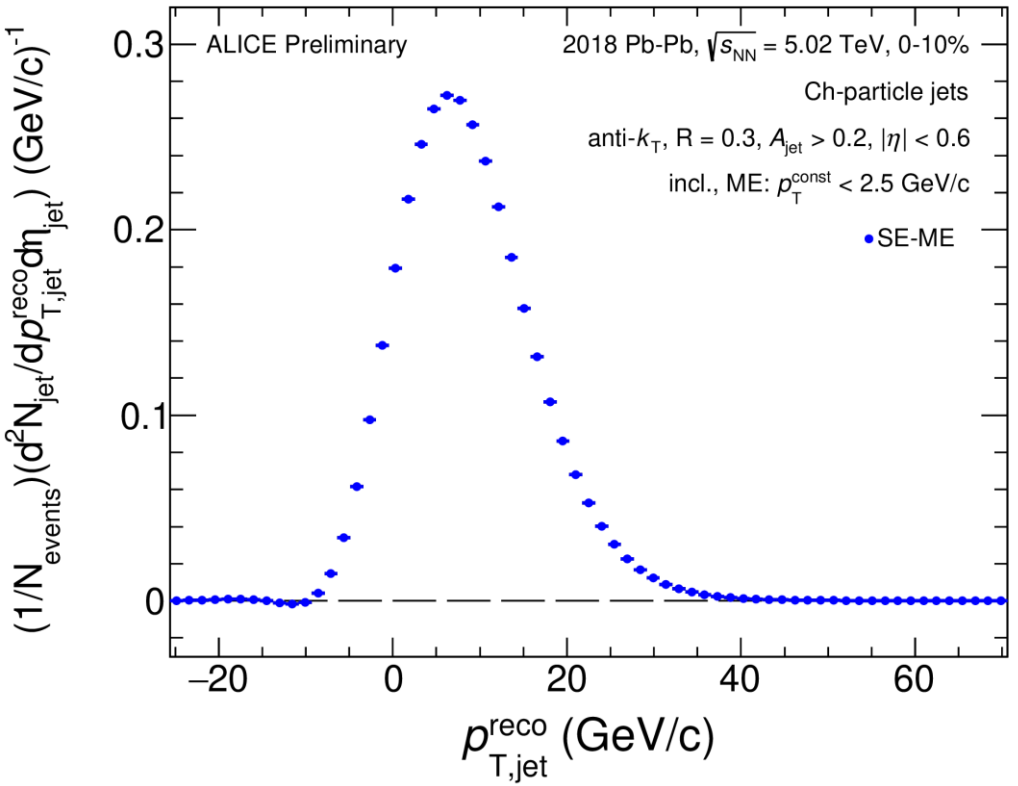
R=0.2 to R=0.25

R=0.35 to R=0.4

Mixed event background subtraction- Inclusive jet yield



ALI-PREL-540736



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