Yale

ALICE-PUBLIC-2021-002

Primary Lund jet plane density in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE

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(on behalf of the ALICE Collaboration)
Quark Matter 2022 (Remote Poster), April 5th 2022

Wright Laboratory

ALICE

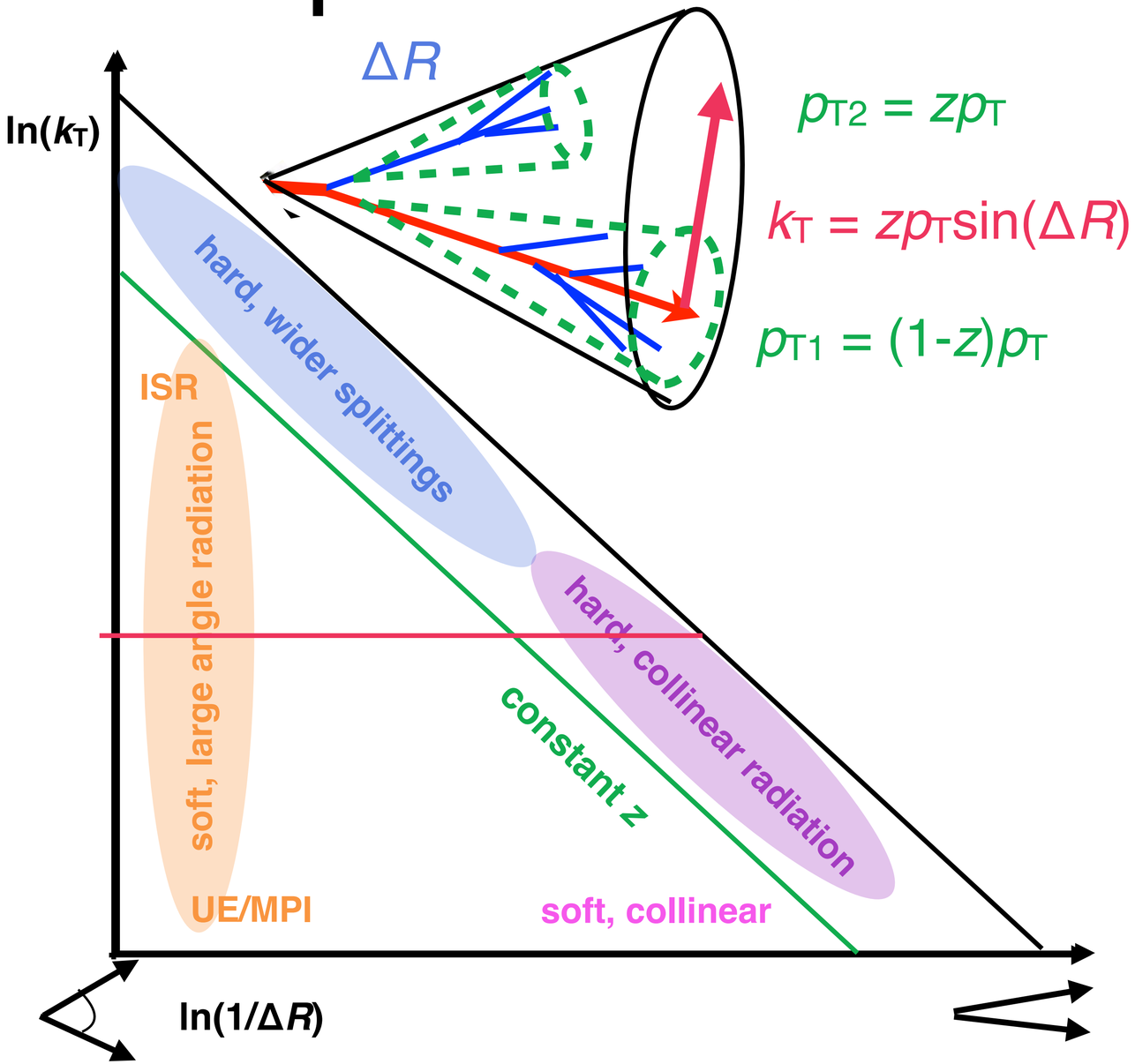
Exploring the phase space of QCD

- Lund diagram can be used to isolate regions of QCD phase space

*Andersson et al ZPC43 (1989)
Dreyer et al JHEP 12 (2018)

- $\log(k_T) > 0$ separates perturbative from non-perturbative regime

- Isolate different QCD effects like Initial State Radiation (ISR), Underlying Event (UE), Multiple Parton Interactions (MPI), hadronization, perturbative vs. non-perturbative emissions, etc. and tune MC models

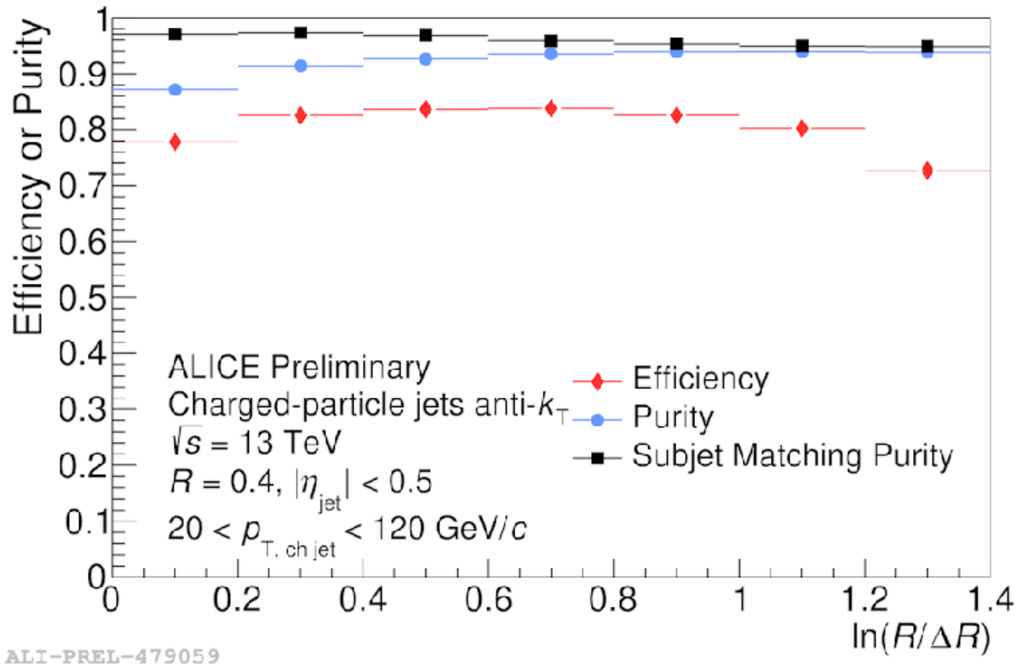


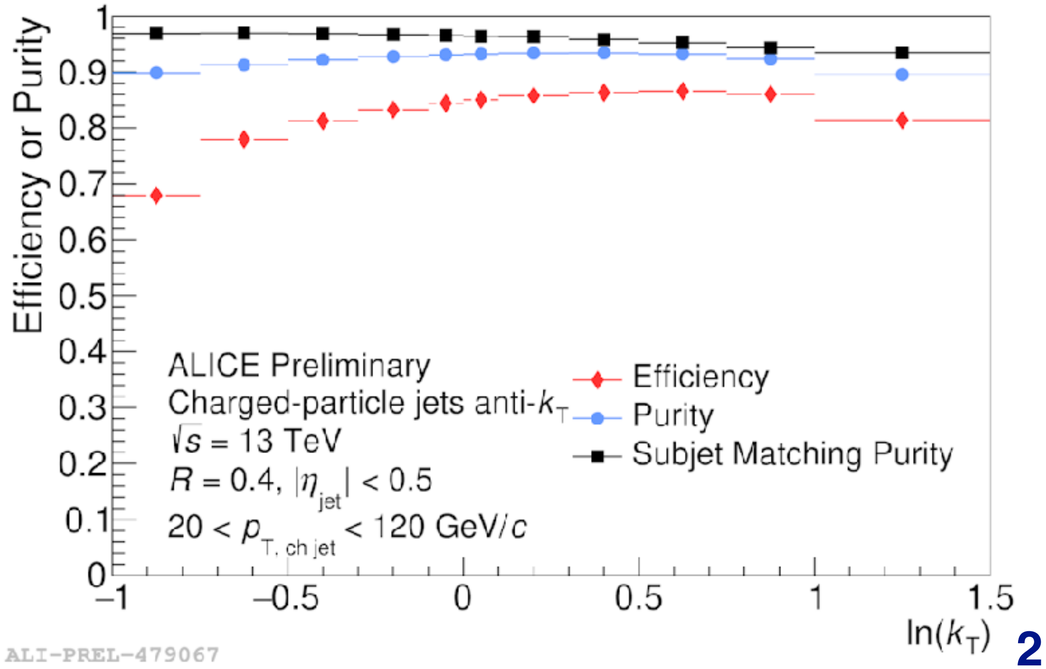
arXiv:1808.03689

Analysis procedure

- Primary Lund plane density at intermediate p_T (~20-120 GeV/c) with ALICE $\sqrt{s}$ = 13 TeV pp data
- Recluster anti-k_T R = 0.4 jets with C/A and follow splittings from leading prong
- Fully correct with 3D unfolding in p_T, ln(k_T), ln(R/ΔR)
  - Calculate the efficiency and purity: $e = \frac{N_{\text{true}}^{\text{match}}}{N_{\text{true}}}$ $p = \frac{N_{\text{reco}}^{\text{match}}}{N_{\text{reco}}}$
  - Correct the raw data for the purity $N_{\text{raw,corr}} = p * N_{\text{raw}}$
  - Unfold using response and correct unfolded result for the efficiency $N_{\text{tot}} = (1/e) * N_{\text{unf}}$
  - Normalize with 1D unfolded spectra
  - Subjet matching purity: did the true splittings end up in the correct reconstructed splittings?

Subjet matching purity is very high!





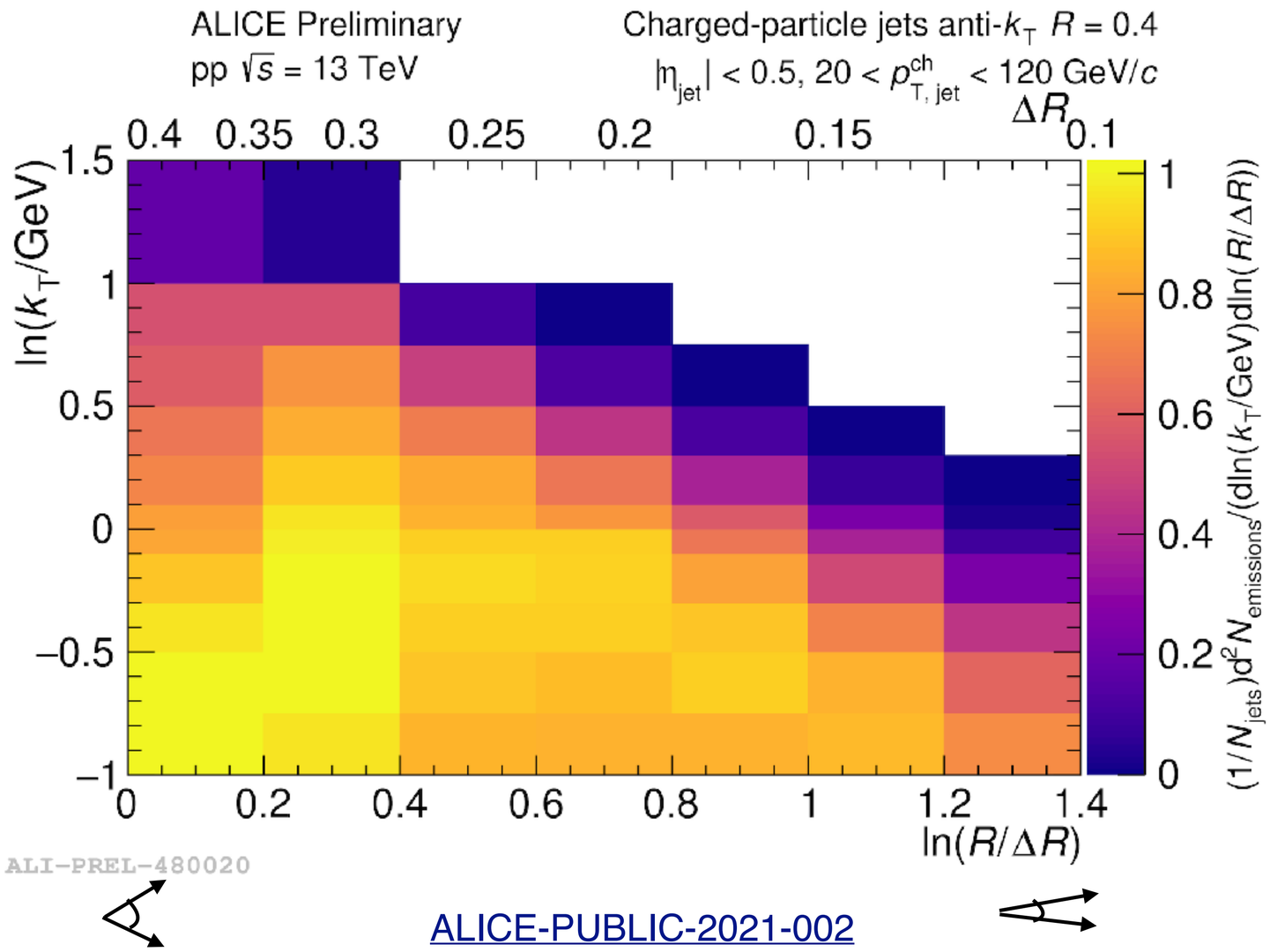
Unfolded Lund plane density

Fully corrected Lund plane in pp collisions for charged-particle jets between 20–120 GeV/*c*

k_T reach out to 5 GeV/*c*

Make projections to isolate regions of phase space and make detailed comparisons to generators

	Parton Shower	Hadronization
PYTHIA8 Monash *CPC* 178 (2008) 852-867	k_T ordered	Lund string
Herwig 7 *EPJC* 76 (2016) 4, 196	Angular ordered	Cluster
Sherpa (AHADIC) *JHEP* 02 (2009) 007	Dipole shower	Cluster
Sherpa (Lund)	Dipole shower	Lund string



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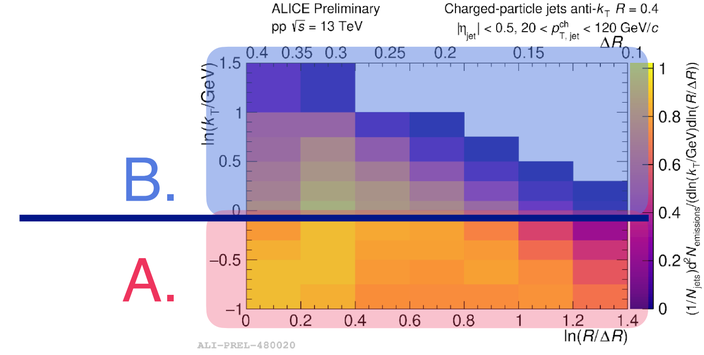
Regions of the Lund plane

Project onto angular axis to separate pert. vs. NP splittings

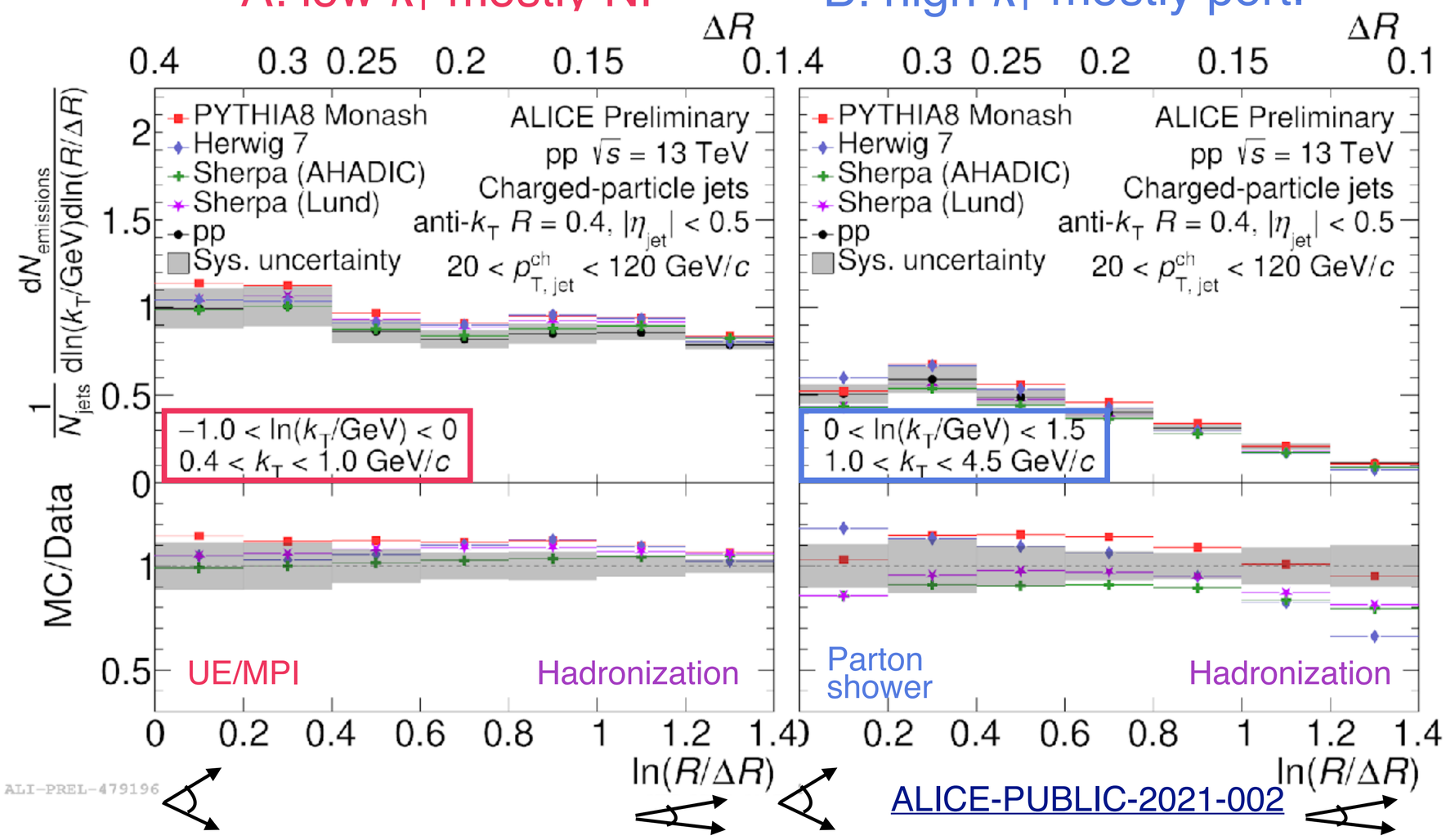


Agreement with MC
~10% in most cases

Herwig suppressed relative to data for hard collinear splitting

A: low k_T mostly NP

B: high k_T mostly pert.



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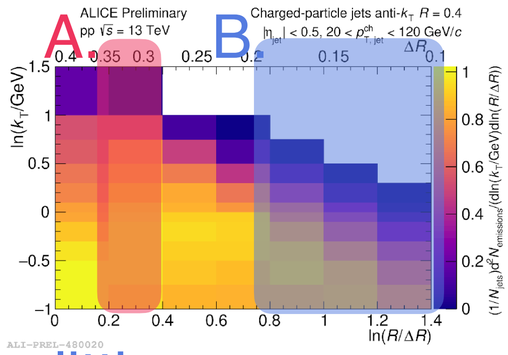
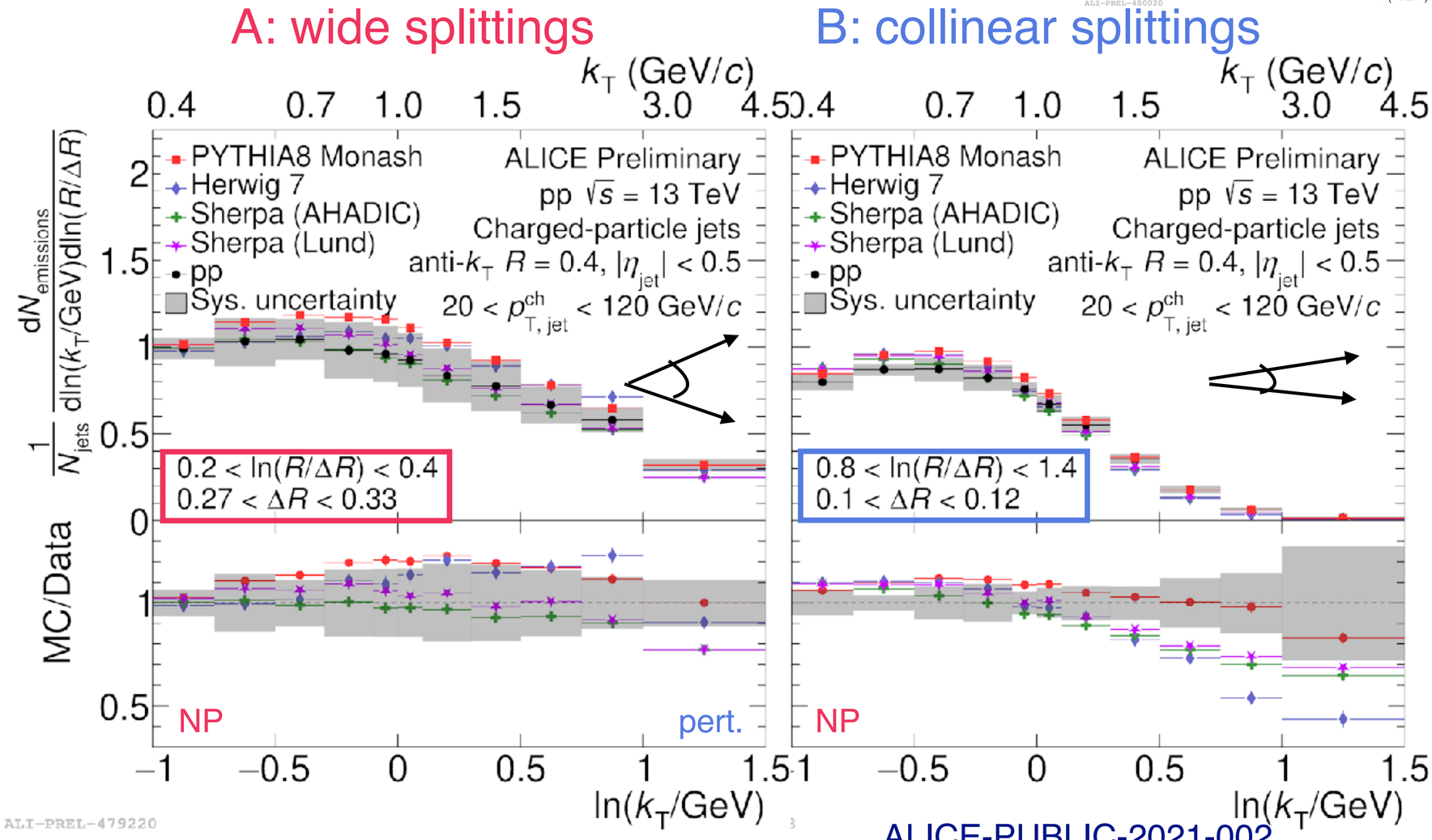
Regions of the Lund plane

Project onto momentum axis to separate wide vs. narrow splittings



Agreement with MC
~10% in most cases

Significant suppression of MC compared to data for hard collinear splitting



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