Jet spectra evolution as a function of center of mass energy in pp collisions with ALICE

Universität Münster

Graduiertenkolleg 2149 Research Training Group

FSP ALICE

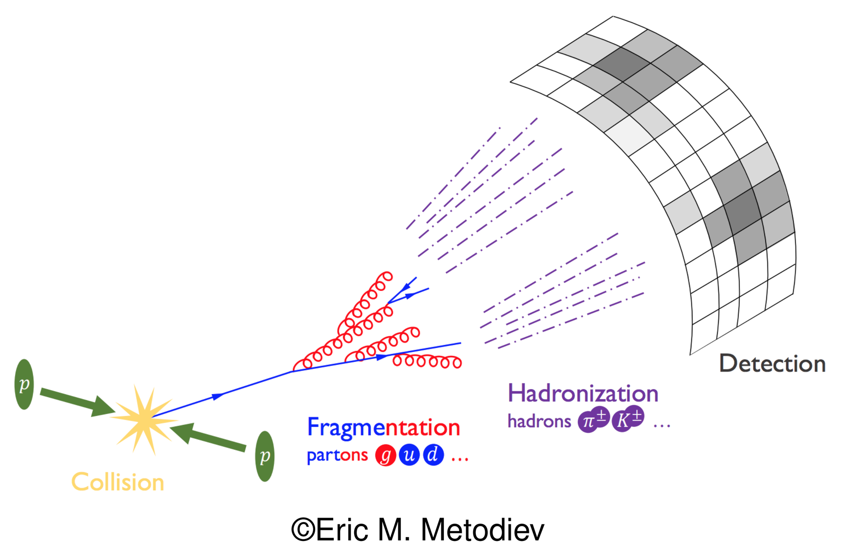
ALICE

Archita Rani Dash on behalf of the ALICE Collaboration

Institute of Nuclear Physics, University of Münster, Germany

archita.rani.dash@cern.ch

Jet Production in Hadronic Collisions

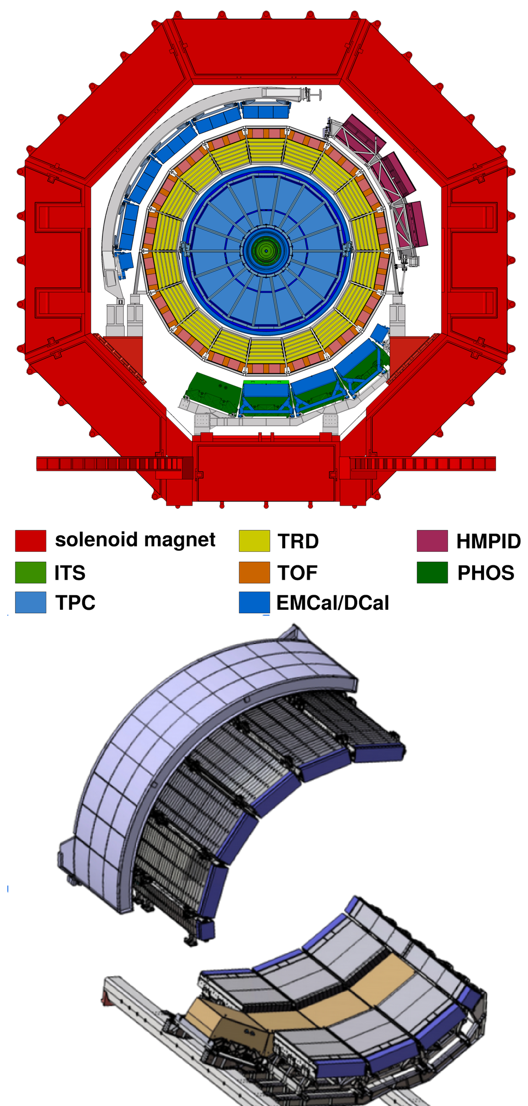


©Eric M. Metodiev

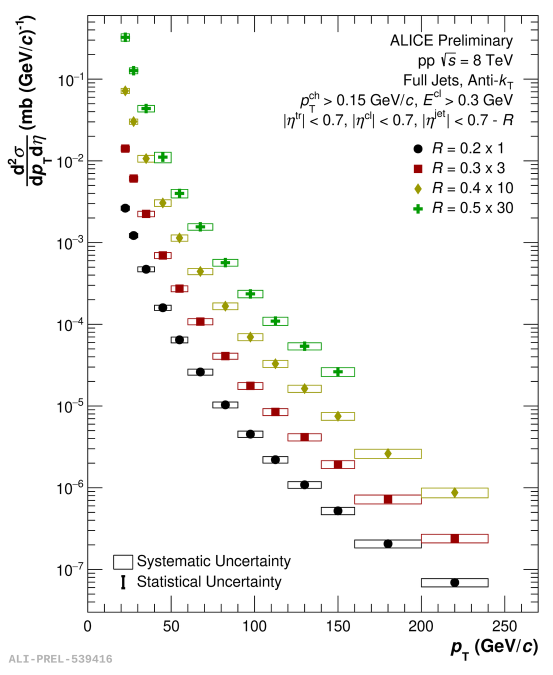
- jets are collimated sprays of particles originating from hard scattered partons [1,2]
- theoretically calculable in pQCD
- inclusive jet production in pp collisions
  - → reference for more complex systems [1,2]
  - □ p-Pb collisions (study of cold nuclear matter)
  - □ Pb–Pb collisions (study of QGP medium)
  - → provide constraints on [2,3]
  - □ PDFs
  - □ strong coupling constant α_s

(Full)Jet Reconstruction in ALICE

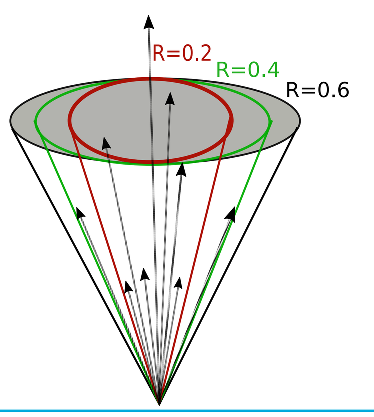
- **charged-particle jet reconstruction** [3,4]
  - – "charged-particle tracks" : ITS + TPC
  - – full φ acceptance'
  - – jets required to be fully contained within the TPC
  - – $|\eta| < 0.9$
  - – $p_{\mathrm{T},track} > 150$ MeV/c
- **full jet reconstruction** [4]
  - – "charged-particle tracks" : ITS + TPC
  - – "neutral constituents" : EMCal clusters
  - – Run:$\Delta\varphi$ 1 & 2/3: 100° /107°
  - – $|\eta| < 0.7$
  - – $E_{cluster} > 300$ MeV
  - – jets required to be fully contained within the EMCal
  - – $80° + R_{\mathrm{jet}} < \varphi_{\mathrm{jet}} < 187° - R_{\mathrm{jet}}$
  - – $|\eta_{\mathrm{jet}}| < 0.7 - R_{\mathrm{jet}}$
- jets reconstructed with the **FastJet package** using the **anti-k_T algorithm** with the **E-scheme** [5]

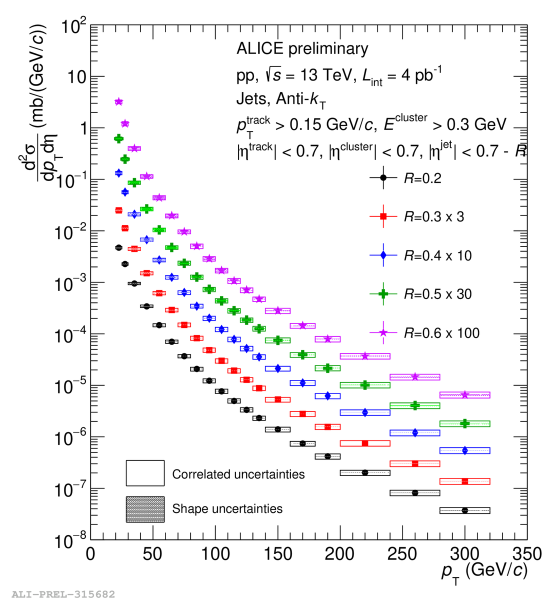


Full Jet Cross-Sections in pp Collisions



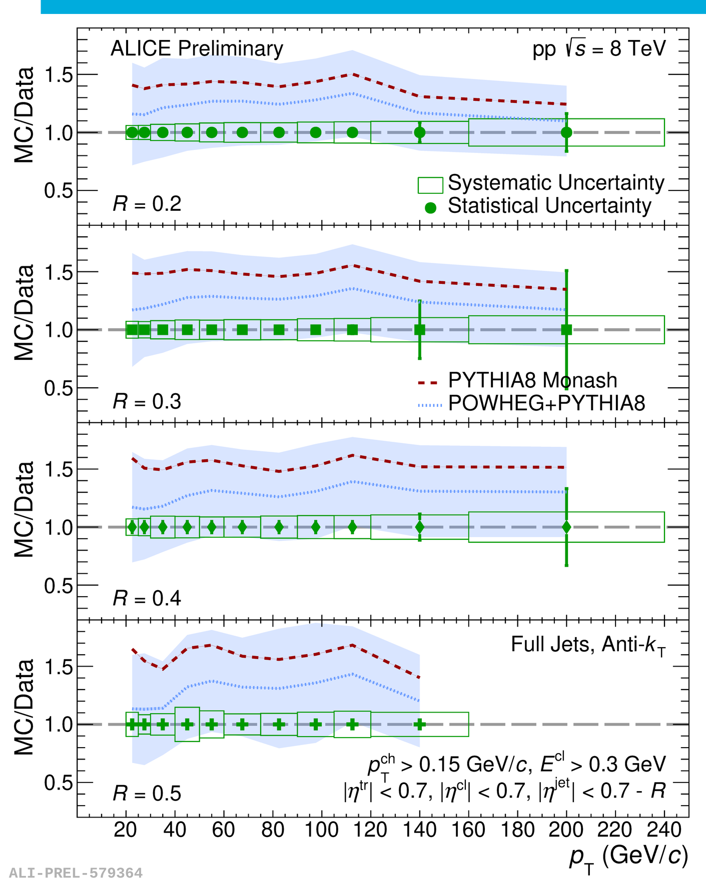
- **Invariant cross sections for full jet production**
- use of EMCal triggers makes it possible to reach high jet p_T values
- change in spectral shape with change in jet resolution R

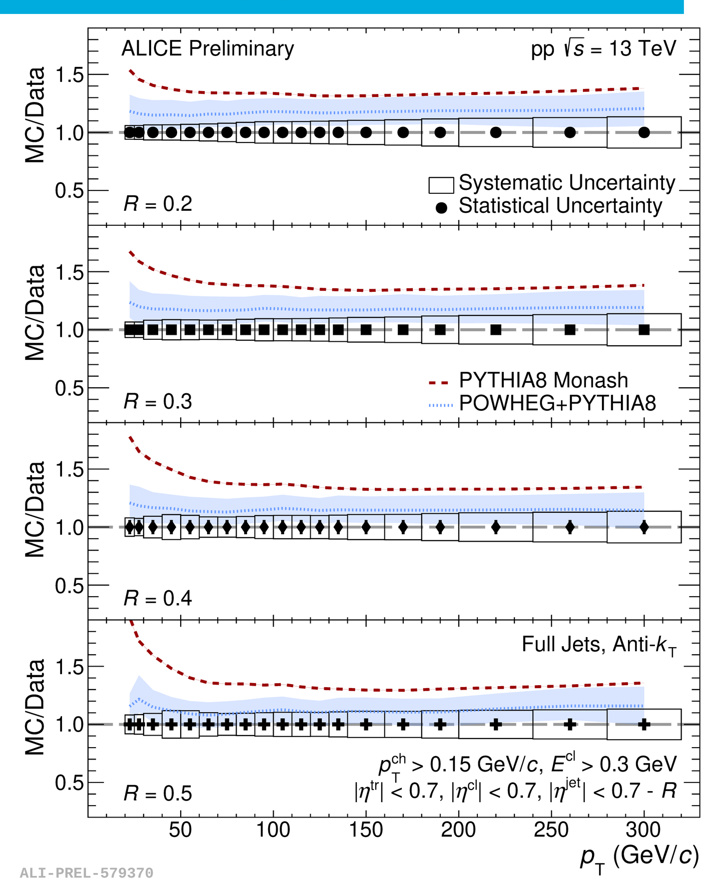




- $R = \sqrt{\eta^2 + \phi^2}$, where R is the jet resolution parameter in the $(\eta - \phi)$ plane

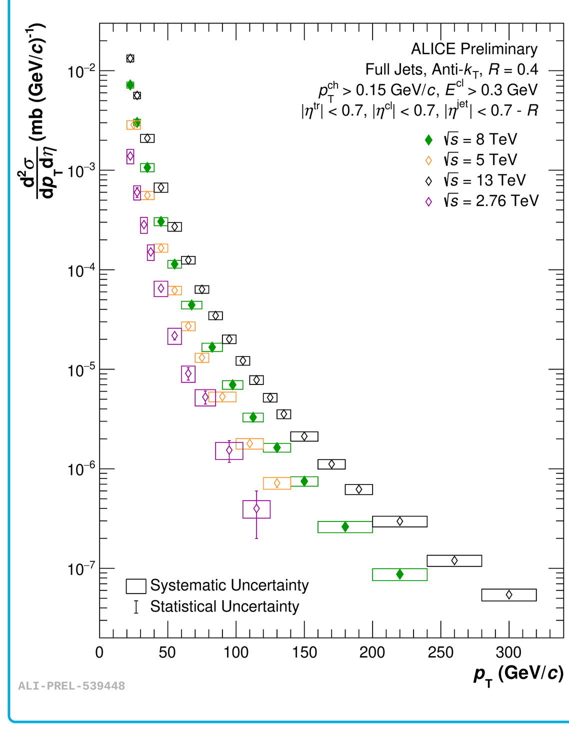
Comparisons with MC Generators in pp Collisions



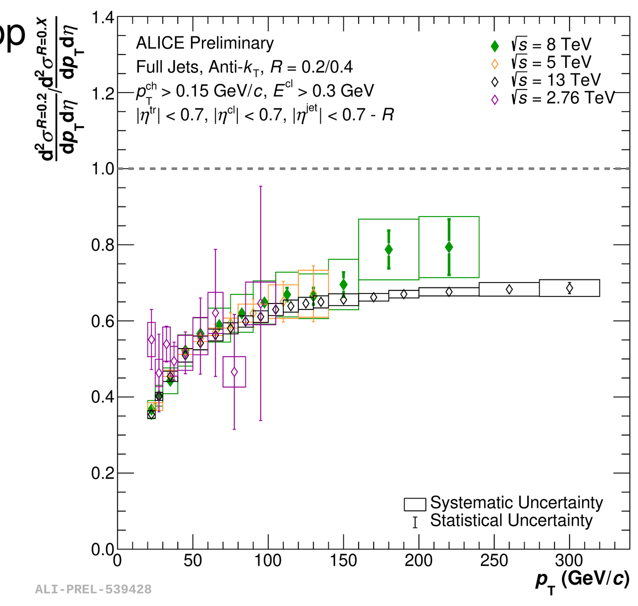


- **inclusive full jet cross section at $\sqrt{s} = 8$ TeV (left) and 13 TeV (right)**
  - □ helps to probe the radial profile of energy within a jet cone
  - □ important observable to study jet fragmentation and hadronisation
  - □ provides data inputs for the global PDF fits
  - □ **PYTHIA** alone **over-predicts data** by ≈ 50% but describes cross-section ratios well [6]
  - □ predictions including **POWHEG** agrees with data within uncertainties [7]
  - □ **NLO correction** provides a better description

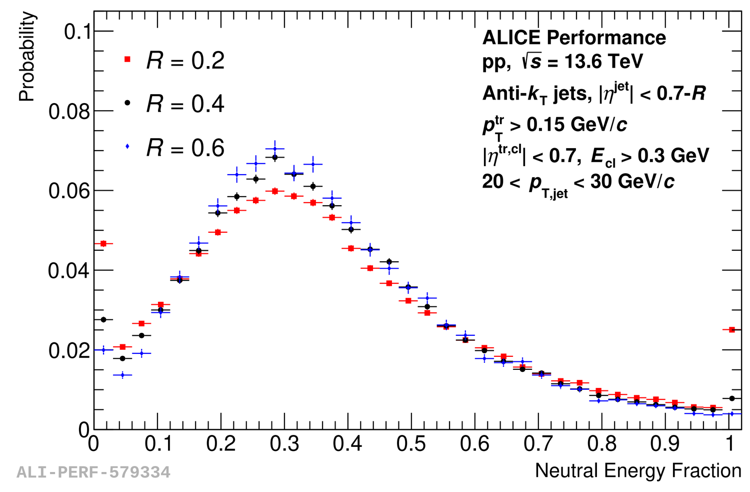
Collision Energy Dependence in pp Collisions



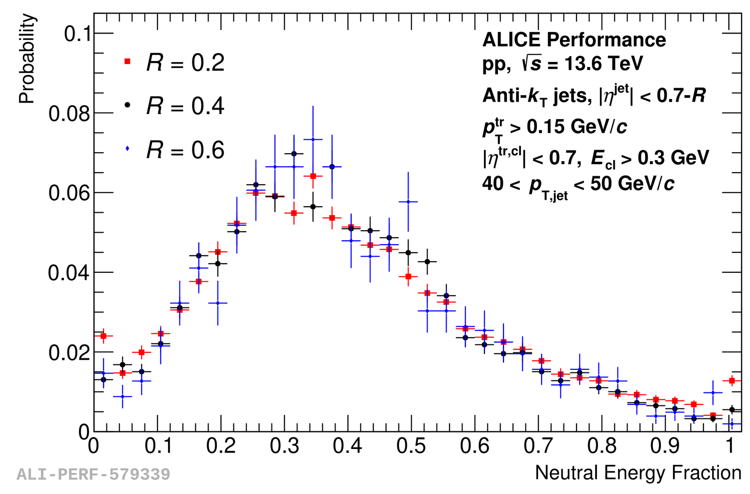
- inclusive jet measurements in pp
  - □ **sensitive to all the stages of jet formation**
  - □ constrain MC models
- **harder spectra with increased collision energy**
- **follow a power law dependence:** $(\sqrt{s})^n$
- baseline for larger collision systems
- **fragmentation to first order independent of collision energy**



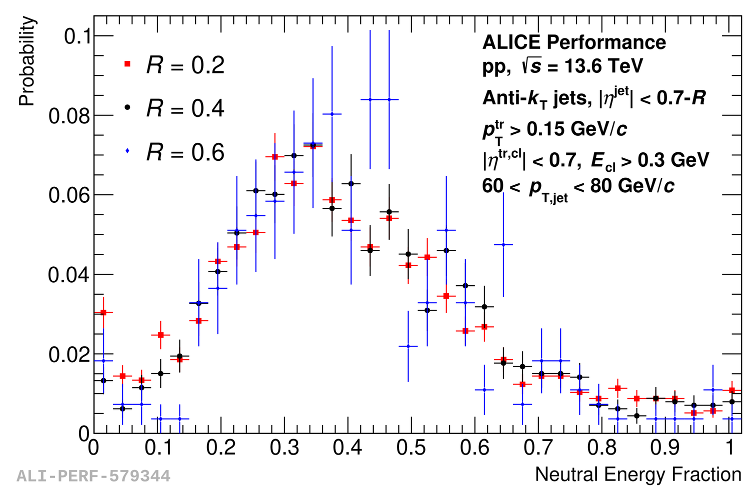
First Full Jet Performance Studies in Run 3 in pp Collisions at $\sqrt{s} = 13.6$ TeV

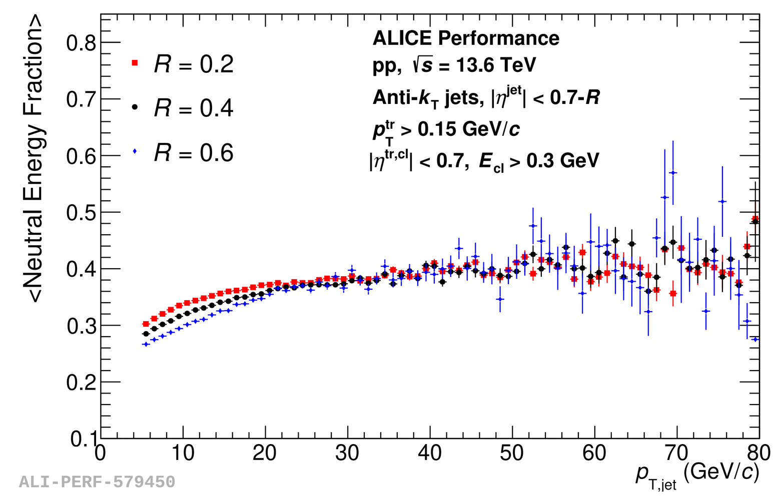


- **Probability distribution of Neutral Energy Fraction in different jet p_T intervals**
  - □ Neutral Energy Fraction (NEF) = $\frac{\text{Neutral Energy in a Jet}}{\text{Total Jet Energy}}$
  - □ characterizes the fraction of jet energy deposited in the EMCAL for Minimum Bias (MB) events
  - □ modest (quantitative) dependence on jet resolution parameter
  - □ clear evidence of a strong dependence on jet p_T in the lower p_T regions (20-40 GeV/c)



- **Mean Neutral Energy Fraction as a function of jet p_T for different jet resolution parameters**
  - □ shows strong jet p_T dependence in the lower jet p_T regions for MB triggers
  - □ NEF increases from approximately 0.3 to ~ 0.4 with increase in jet p_T





Summary and Outlook

- **Inclusive full jet cross-section (R dependent ratio) measurements in pp collisions**
  - □ reference for more complex systems, such as p–Pb and Pb-Pb collisions
  - □ help to understand jet formation
  - □ provide constraints for different theoretical models
  - □ LO (PYTHIA): good agreement with cross section ratios
  - □ NLO (POWHEG): provides better description of full jet cross sections within uncertainties
- **Performance of full jets in Run 3 in pp collisions**
  - □ Neutral Energy Fraction distributions (without hadronic correction) in good shape with Run 3 pp data

Outlook:

- important validation of jet physics with a completely new detector design in Run 3
- increased statistics due to new continuous readout system + EMCAL hardware triggers (2023 data)
- full jet measurements comparison with NLO predictions in Run 3 pp collisions at 13.6 TeV
- reference measurement for probes fully exploiting the gain in statistics, e.g. gamma-jet correlations

References

1. Rosi Reed, J. Phys.: Conf. Ser. 446, 012006 (2013)
2. ALICE Collaboration, Phys. Rev. C 101, 034911 (2020)
3. ALICE Collaboration, JINST 5, P03003 (2010)
4. ALICE Collaboration, JINST 18, P08007 (2023)
5. M. Cacciari et al., Eur. Phys. J. C 72, 1896 (2012)
6. T. Sjöstrand, CPC 246, 106910 (2020)
7. S. Frixione et al., JHEP 11, 070 (2007)

Acknowledgements

The author acknowledges financial support from BMBF in the ErUM Framework and DFG GRK2149.