



EF05 Highlights: SEC Perspective

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EF05 - Precision QCD

Conveners: Michael Begel, Stefan Hoeche, Michael Schmitt

- ▶ **General scope:** Strong Coupling, Precision observables, Jet Substructure, Perturbative QCD calculations and MC simulations, Non-perturbative QCD dynamics
 - ▶ Many overlaps with EF01, 03, 04, 06, 07, plus Theory and Computational Frontiers
- ▶ **Website:** <https://snowmass21.org/energy/qcd>
- ▶ **Indico category:** <https://indico.fnal.gov/category/1139/>

Restart after the pause

- ▶ EF05 conveners are currently collecting status updates for individual LOIs
- ▶ Groups are restarting and group leaders are preparing outlines to define content
- ▶ The subgroup report is meant to be finalized by May 2022, which means we need
 - ▶ a semi-final version of each contribution by March 2022
- ▶ The conveners would like to invite you to give updates on your ongoing projects
 - ▶ Contact the EF05 group by Email, Slack, ...
- ▶ If you have new ideas and studies to propose, please let the conveners know
 - ▶ So they can plan to include your contribution in the final document
 - ▶ Make other topical groups / other frontiers aware of it
 - ▶ Help connect you to people working in similar directions
- ▶ **If you are new to Snowmass, join the EF05 mailing list**
 - ▶ **(SNOWMASS-EF-05-PRECISION_QCD)**
 - ▶ **We would especially like to invite young scientists!**

EF05 + jet substructure

Jet substructure is a key technique for the reconstruction of boosted objects. Grooming algorithms significantly reduce the sensitivity to pileup, due to the reduced jet area. The original jet mass can be recovered, with reasonably low degradation of mass resolution. Figure 20-31 shows the jet mass distribution in $Z' \rightarrow t\bar{t}$ events before and after the application of trimming, for increasing values of $\langle\mu\rangle$. Trimming is implemented

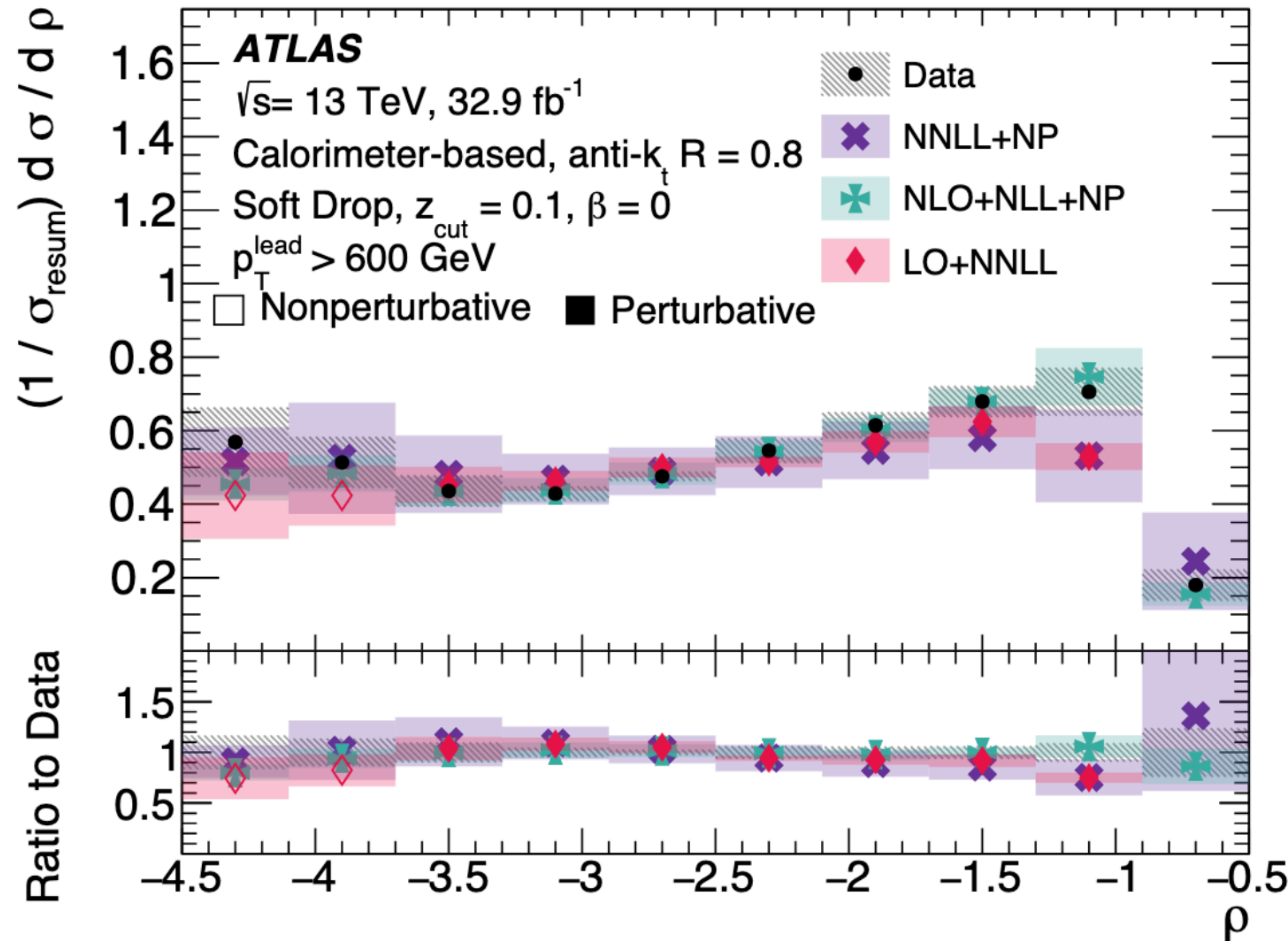
- ▶ For the 2013 Snowmass report, jet substructure was mainly considered a tool for boosted object (W/Z/H/t) tagging
 - ▶ Lots of development in our understanding of jet substructure since this time!
 - ▶ Many applications for improving our understanding of fundamental QCD topics
- ▶ Jet substructure provides a powerful way of looking at jet formation across multiple scales → trying to answer several questions about how it can be used
 - ▶ *What new effects can be measured using substructure that cannot be measured in other ways?*
 - ▶ *How can substructure measurements complement other approaches for QCD measurements?*
 - ▶ *What are the experimental and theoretical limitations of existing techniques, and how can we move beyond these?*
 - ▶ ...

The jet mass

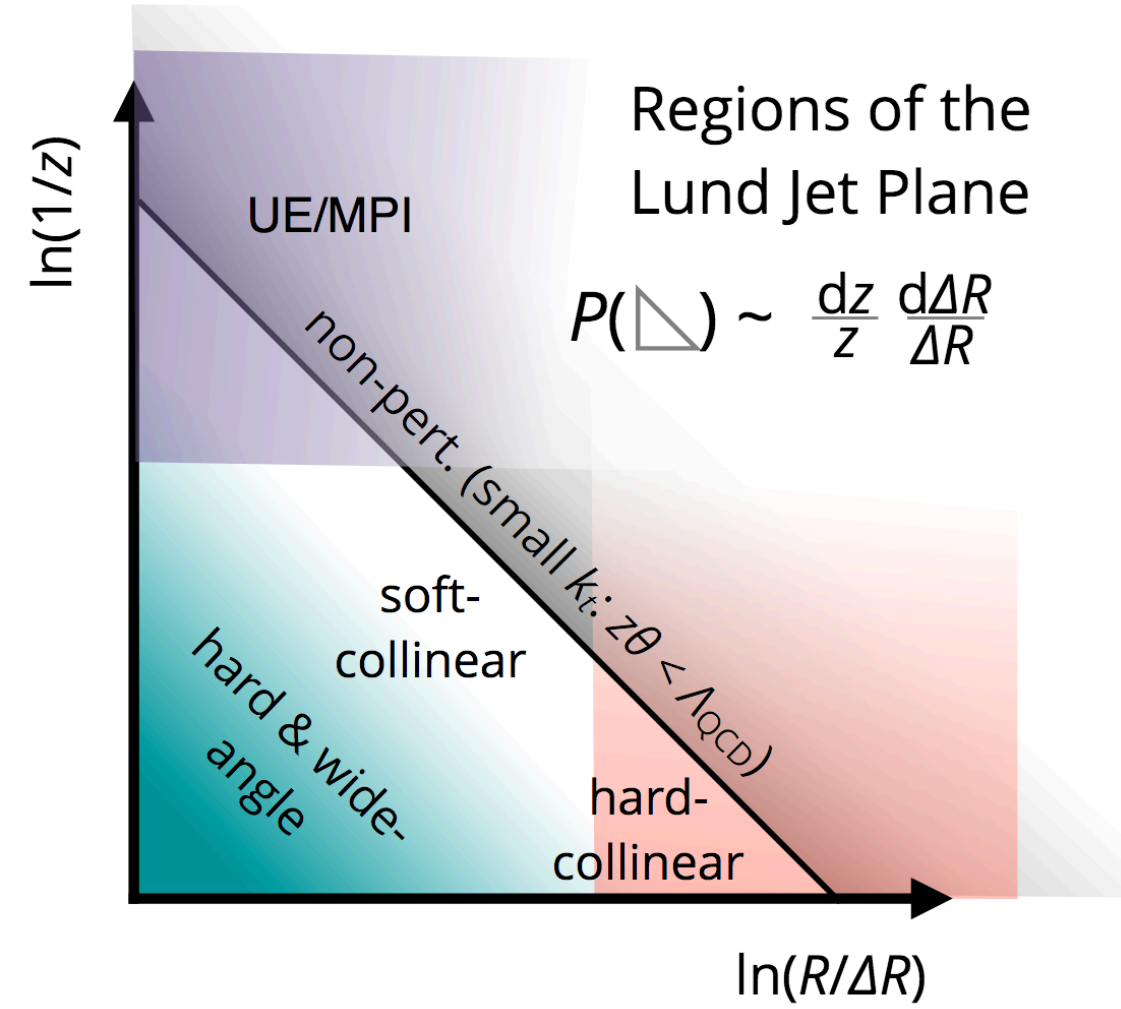
- ▶ Now have accurate theoretical predictions for a variety of jet substructure observables
- ▶ Showing measurement of $\rho = \log_{10}(m^2 / p_T^2)$, compared to three different theoretical predictions
- ▶ Very good agreement between data and predictions, with small experimental uncertainties
- ▶ Opens the door to measurements of other observables, different QCD effects
- ▶ Many more measurements of substructure observables by several experiments in recent years

ATLAS: softdrop observables

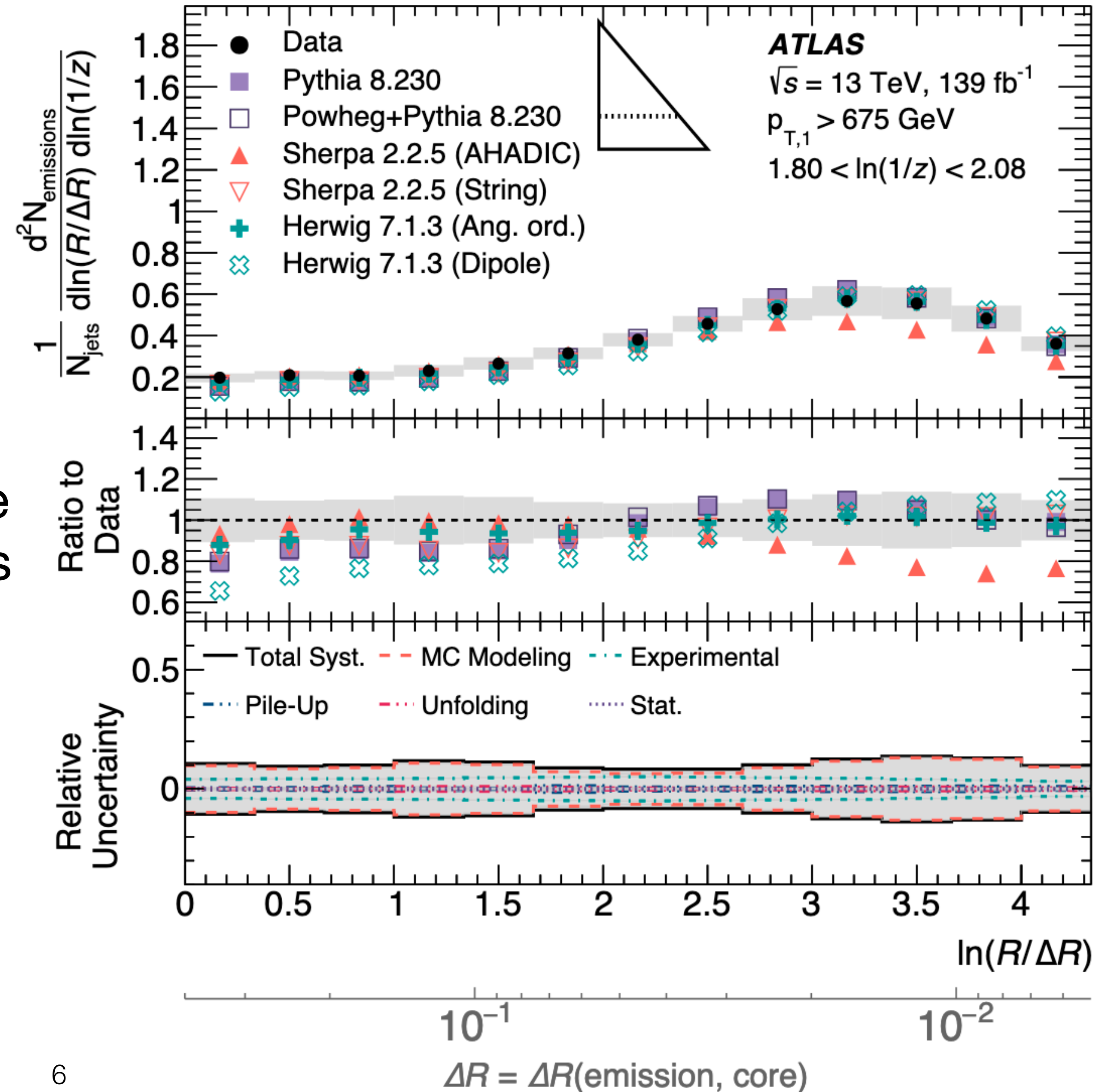
CMS jet mass measurement



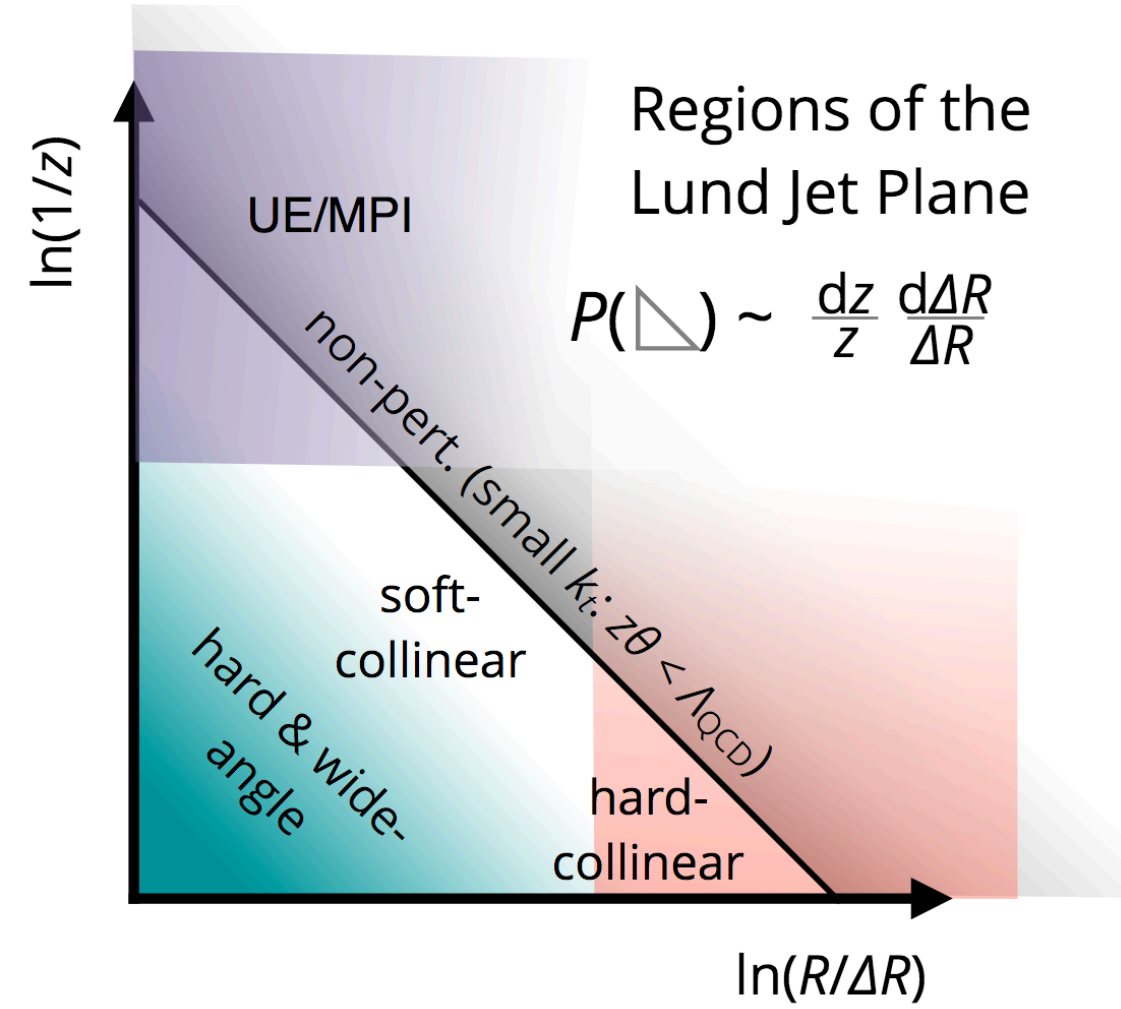
The Lund jet plane



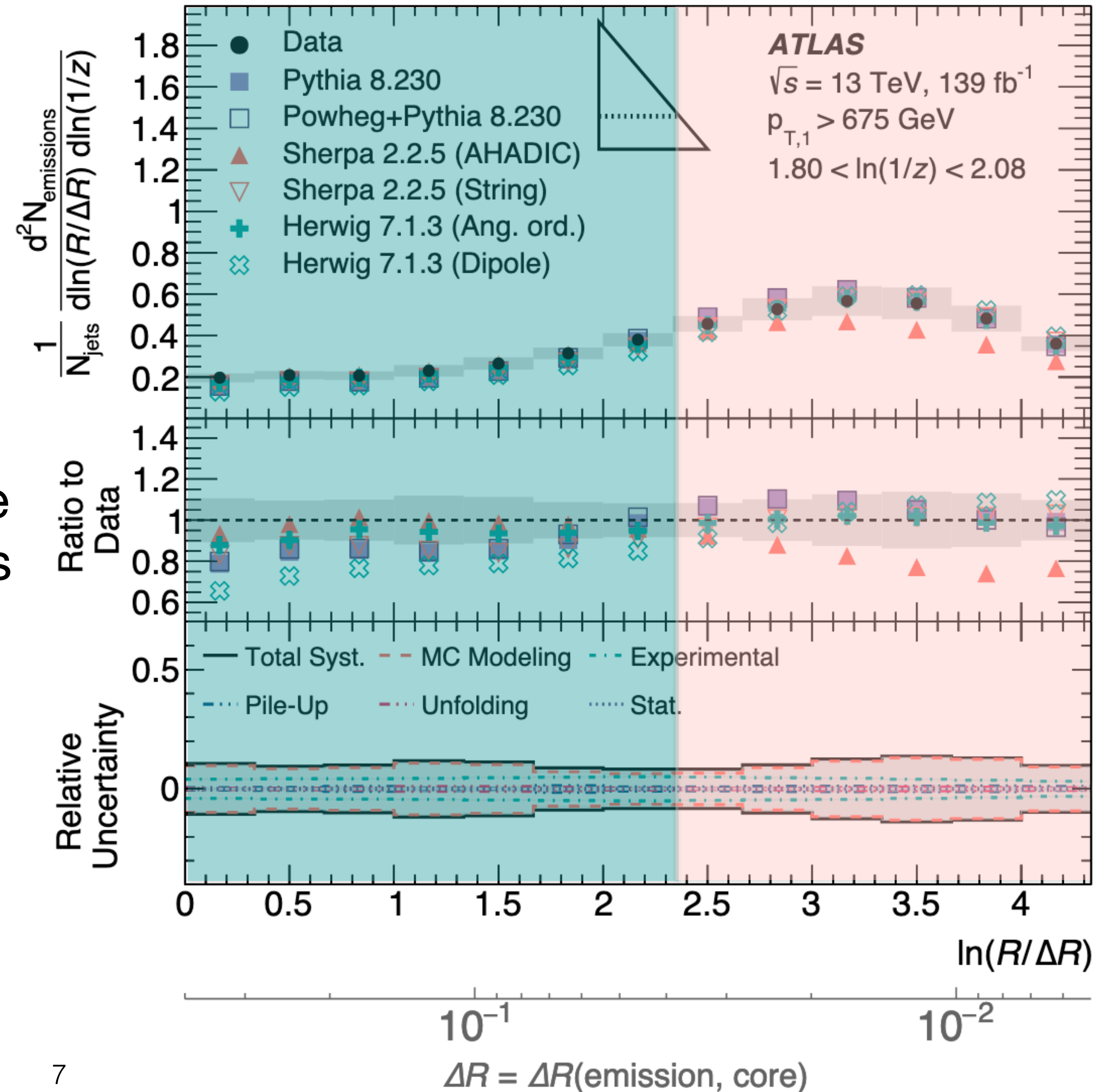
- ▶ The Lund jet plane is an observable where different effects dominate different regions of the plane
- ▶ Measurement of the 2D plane demonstrates the factorization through comparisons to different MC generators
- ▶ New possibilities for understanding parton showers & hadronization, and how to improve their modeling



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Summary

- ▶ A deep understanding of QCD is critical to the goals of the energy frontier
 - ▶ Many exciting topics being studied by EF05, with close connections to many other Snowmass groups
- ▶ QCD is a rapidly-changing field, with many new ideas to explore
 - ▶ Lots of new jet substructure techniques, relevant to understanding QCD at current and future colliders
 - ▶ In addition to jet substructure, many advances in higher-order predictions, MC generators, and much more!
 - ▶ Snowmass provides a unique opportunity to explore these new ideas, and discuss their impact on new experiments & their design
- ▶ Get in touch with the EF05 conveners if you are interested in getting involved!

Thanks!