Study of jets in p+p and p+Pb collisions at the LHC using POWHEG-Box

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1. Motivation

Recent experimental results on jet production at LHC show that next-to-leading order (NLO) calculations are required to achieve a good description of data. In this contribution, the study of NLO simulations of jet production in proton-proton collisions a with centre of mass energy of 7 TeV and proton-lead collisions at 5.02 TeV is presented. These simulations were carried out using POWHEG-Box, implementation of positive weight hardest emission NLO generator, with parton showering provided by PYTHIA8. In p+Pb collisions the nuclear modification of parton distribution functions (PDF) was implemented by EPS09 nuclear modification factors of parton distribution.

We present the calculations and systematic studies of jet production cross sections and comparison of proton-lead yields with proton-proton baseline, $\mathbf{R_{p+Pb}}$. These observables provide information about cold nuclear matter effects on jet production.

2. Analysis setup

– NLO calculations were carried out using the **POWHEG-Box** framework [1].
– Parton showers and hadronization processes were implemented via **PYTHIA8** [2] with tune 4C [3].
– Jet reconstruction was done using the anti-k_T algorithm included in the **FastJet** package [4]. Several values of the resolution parameter R were used.
– **CTEQ6.6** parametrizations [5] of parton distribution functions of protons were used. The Pb nuclear modification factors were taken from **EPS09** [6]. In addition, the nuclear PDFs taken from **HKN07** [7] were used as a cross check.
– Parameters of POWHEG-Box and PYTHIA8 simulation setup were validated by track-only jet results from p+p at $\sqrt{s} = 7$ TeV obtained by the ALICE experiment [8].
– The simulation parameters were modified to account for modified PDFs for p+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV.

3. Contributions to systematic uncertainties

Several sources of systematic uncertainties were studied:
– vartiations in **factorization** (μ_F) and **renormalization** (μ_R) **scales** are double and halve in accordance with

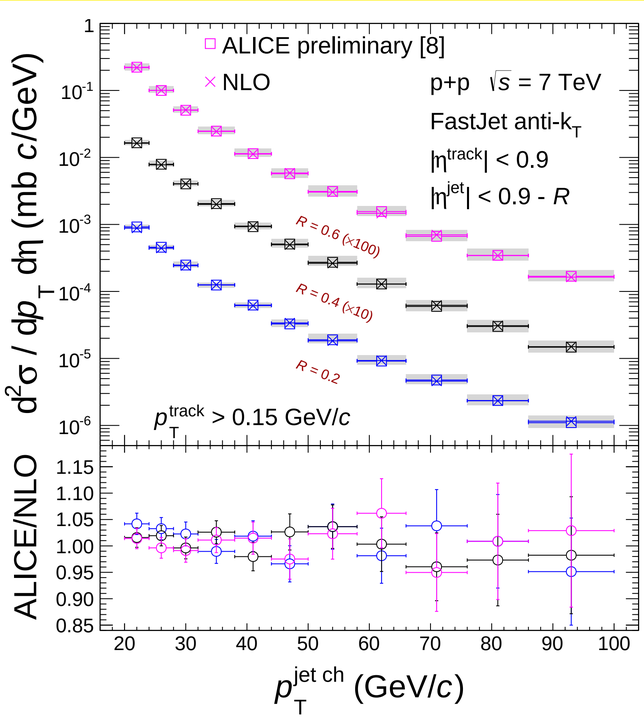
$$0.5 \leq \frac{\mu_R}{\mu_F} \leq 2.0. \quad (1)$$

The maximal deviation from the case with no modification of scales is taken as an uncertainty.
– **CTEQ6.6** and **EPS09** contain 22 and 15 parameters, respectively. Their variation from the central set contributes an independent uncertainty to studied observables [5].
– The discussed systematic uncertainties are summarized in the table.

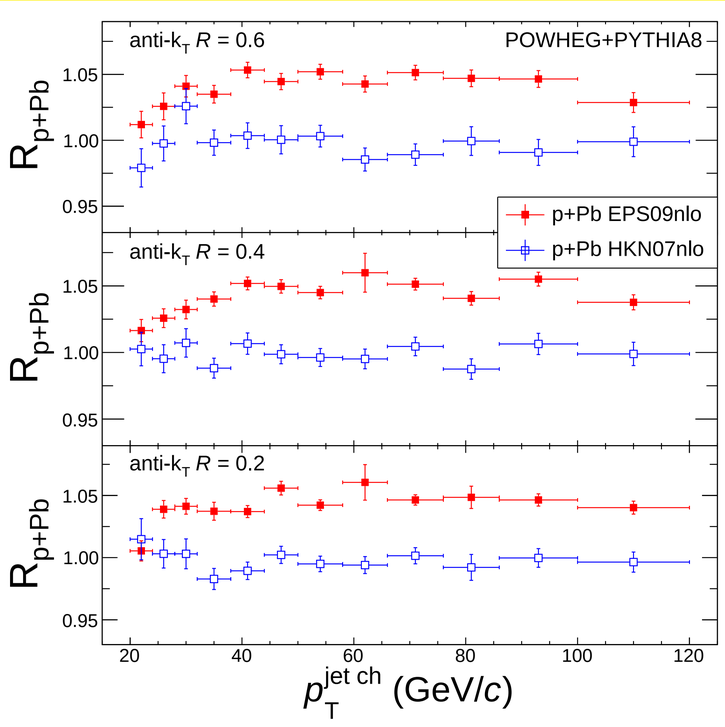
source	CTEQ6.6	EPS09	scale variation
jet spectra	6%	10%	12%
jet spectra ratios	5%	6%	4%

– different **PYTHIA8 tunes** provide additional variations to the results. These are not included in presented results.

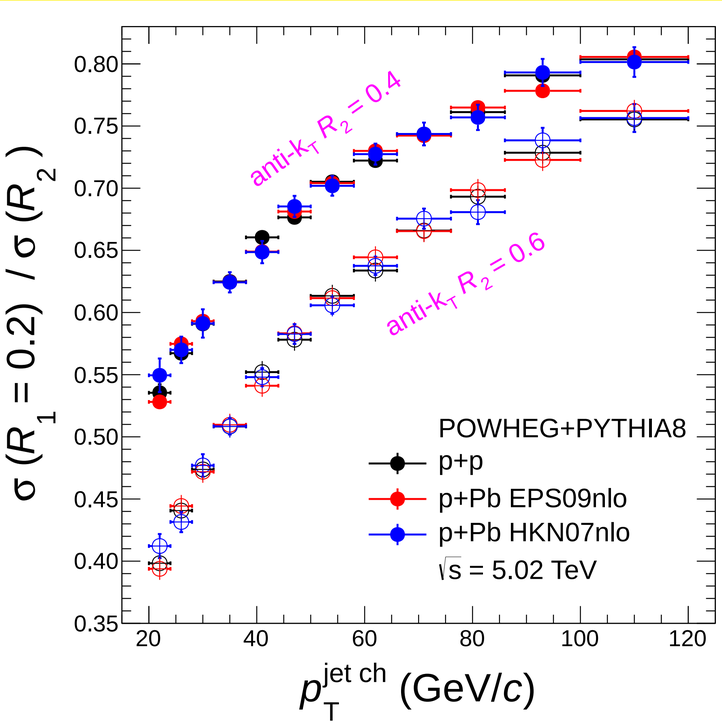
4. Results



NLO jet spectra in p+p collisions at 7 TeV compared to the ALICE preliminary results [8].



Comparison of NLO predictions for p+p and p+Pb at 5.02 TeV in form of their ratio.



Comparison of change in jet collimation using ratio of jet cross-section with different R in p+Pb.

5. Conclusion

The POWHEG-box simulation provides a very good description of charged jet production (within 10%) measured in p+p collisions at $\sqrt{s} = 7$ TeV by the ALICE collaboration.

The jet nuclear modification factor in p+Pb collisions at 5.02 TeV, $\mathbf{R_{p+Pb}}$, with a p+p reference calculated by POWHEG at the same collision energy indicates minimal or no modification at all for jets reconstructed using charged particles in the momentum range $p_T < 120$ GeV/c.

To characterise shape of jets via its collimation, ratios of spectra reconstructed with different resolution parameters are studied. A change in the initial parton composition toward increased gluon abundance could lead, due to different structure of gluon and quark jets, to modification of these ratios. However, the observed ratios are not sensitive to this change and within statistical uncertainty are consistent with the p+p baseline.

6. References

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