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INITIAL STAGES
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COLLISIONS

Machine Learning and Multi-Parton Interactions in pp collisions from RHIC to LHC energies

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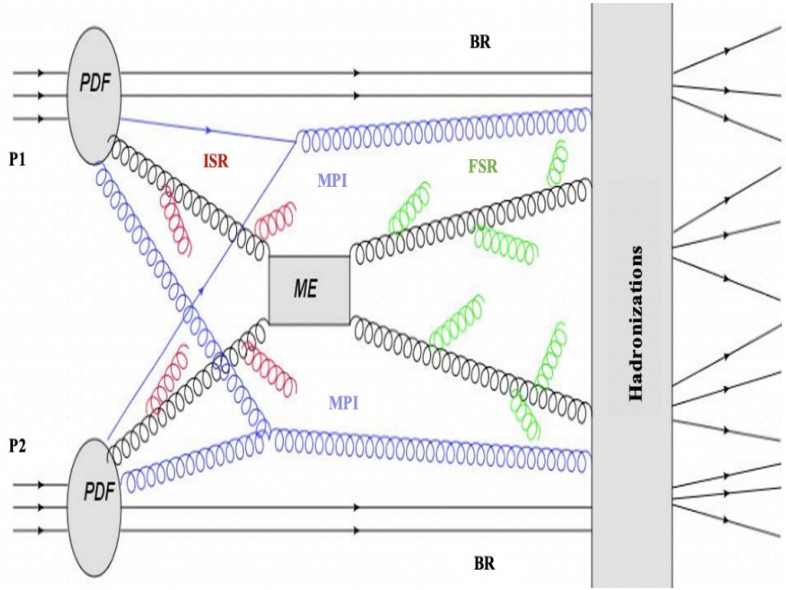
Based on Phys. Rev. D, 102, 076014 (2020)

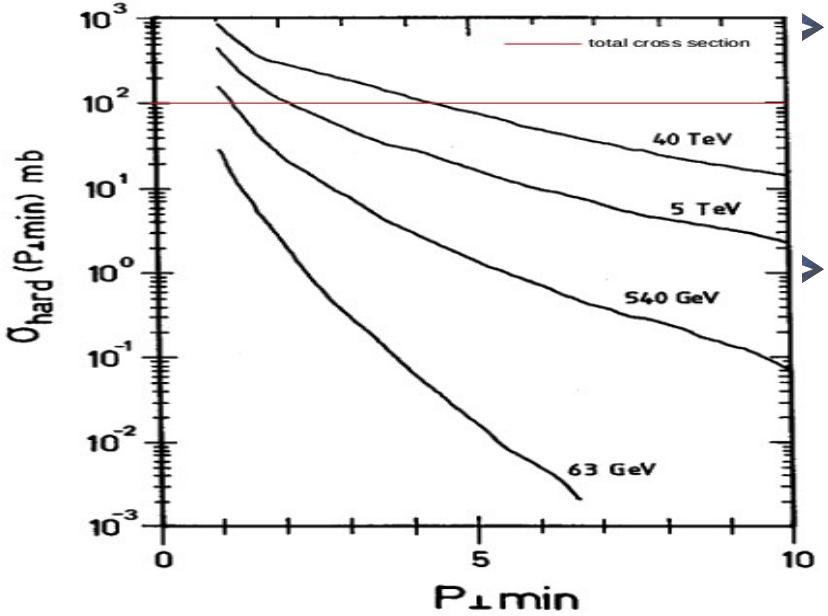
Introduction



T. Sjöstrand, M. Zijl., Phys.Rev. D 36 (1987) 2019.

Antonio Ortiz et al., Phys. Rev. Lett. 111, (2013) 4, 042001.

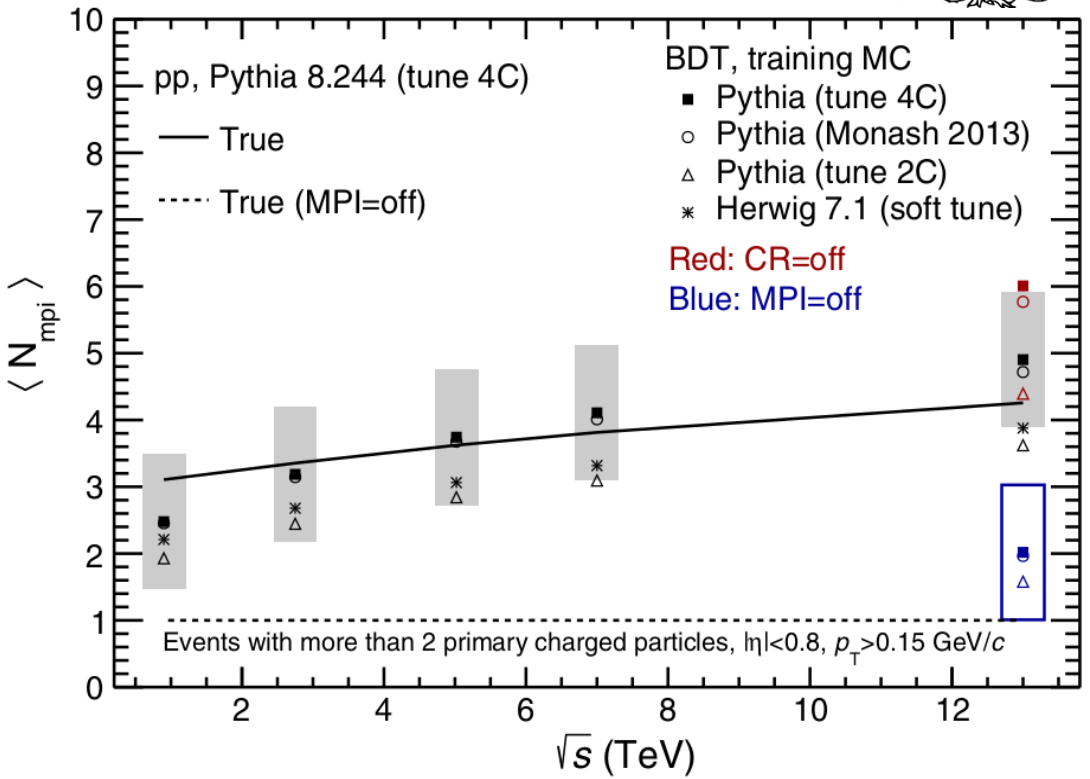
- Given the composite nature of hadrons, several parton-parton interactions (MPI) can occur within the same proton-proton collision



- At the LHC energies the hard cross section exceeds the total proton-proton cross section
- Multi-parton interactions help to describe charge-multiplicity distributions and flow-like patterns observed in pp collisions
- In this work, for the first time we extract the MPI activity from pp data

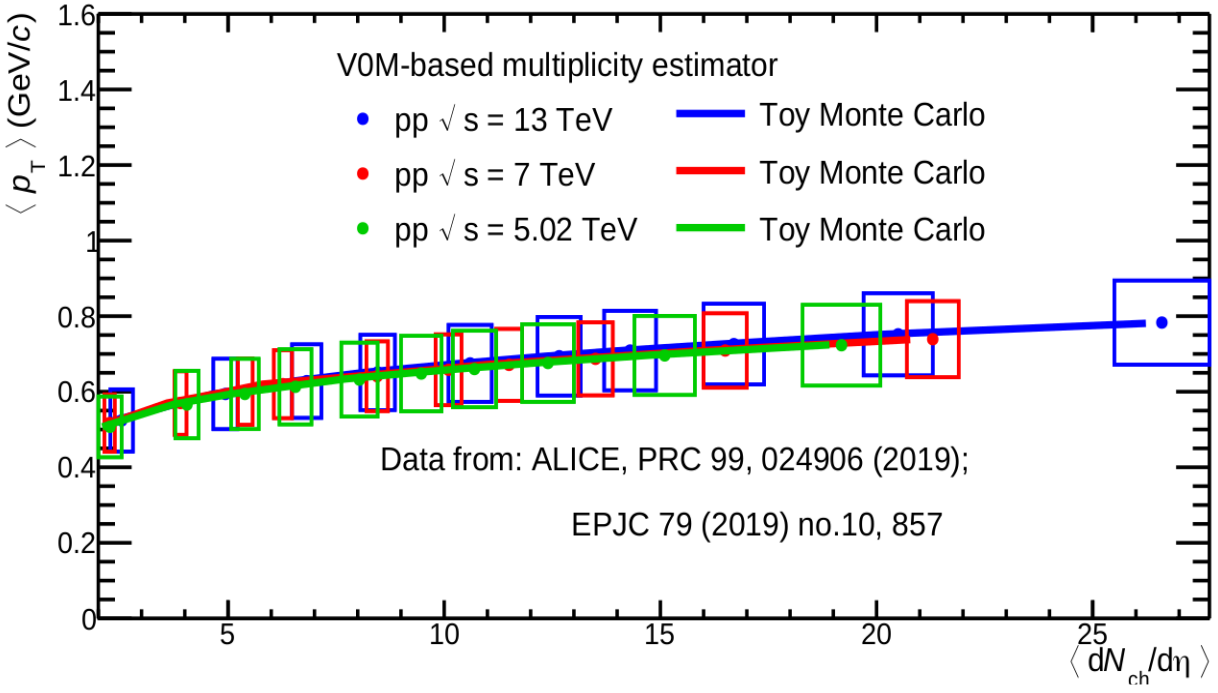
Training and testing using MC

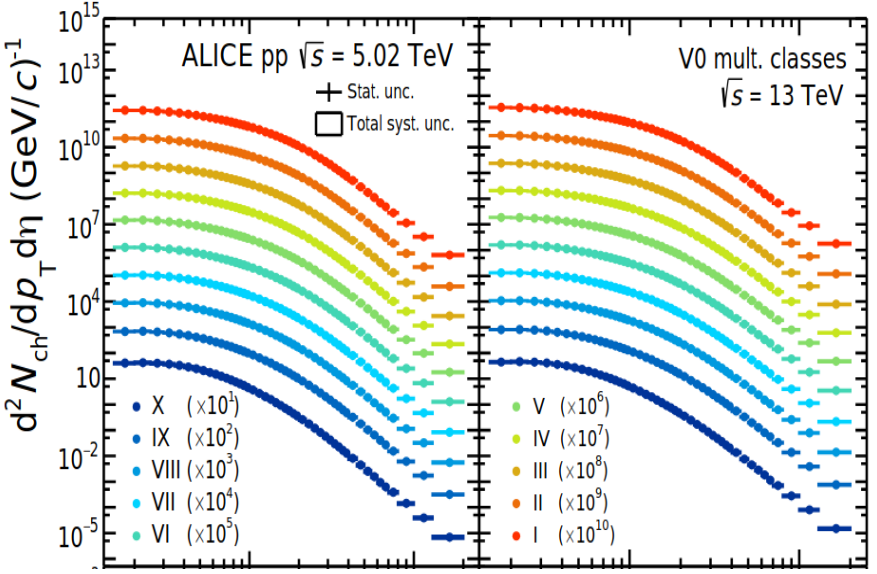
- We have used multivariate regression technique based on boosted decision trees (BDT)
- The extraction of N_{mpi} is a regression problem in which one gives input variables and obtain a target variable that in this case is the N_{mpi}
- Training for the MPI-activity estimation is performed on simulated samples of pp collisions at 13 TeV using PYTHIA 8.244 event generator (tune 4C)
- Within uncertainties, the method reproduces the energy dependence of N_{mpi}
- When MPI are off on the simulations, the method gives a value that is consistent with unity within uncertainties
- Within uncertainties, N_{mpi} given by the regression is independent of color reconnection



Antonio Ortiz et al., Phys. Rev. D, 102, 076014 (2020).

Analysis of data





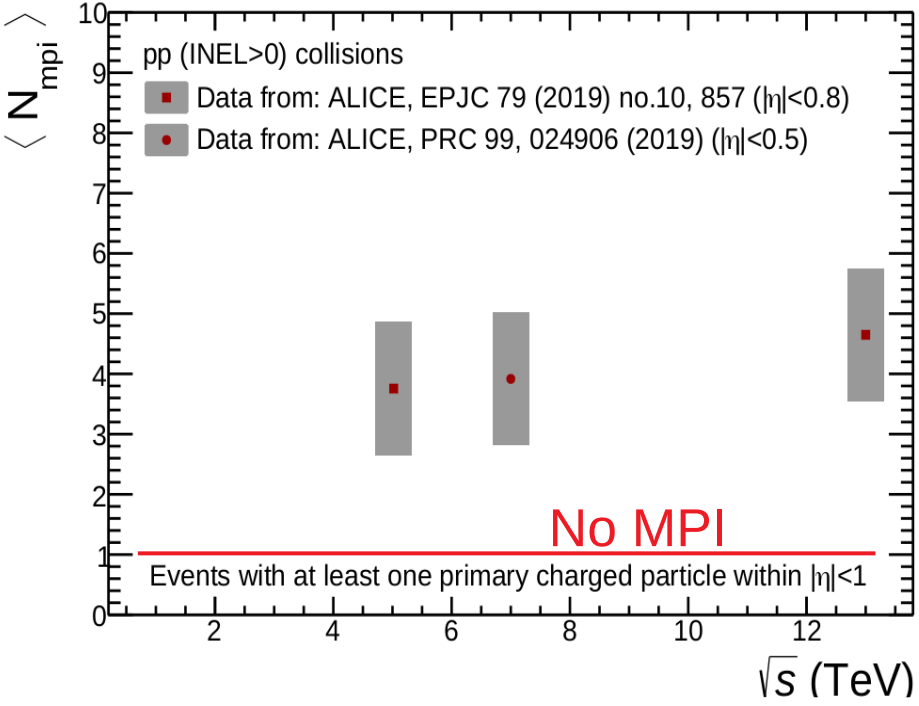
ALICE Collaboration, Eur. Phys. J.C 79 (2019) 10, 857.

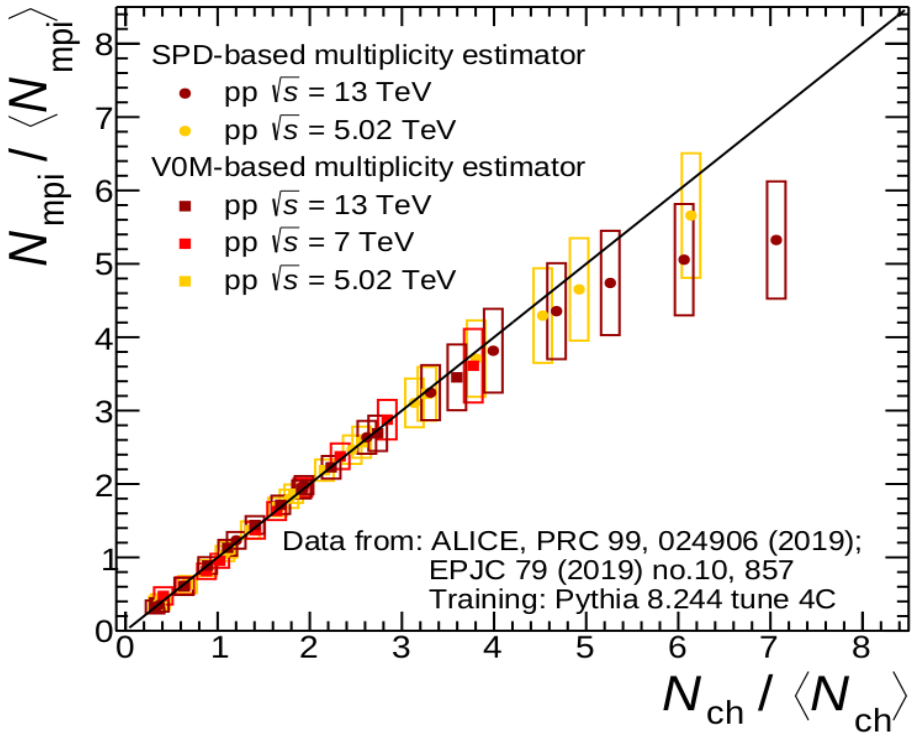
ALICE Collaboration, Phys. Rev. C 99 (2019) 2, 024906.

- In this analysis, we have used the published ALICE data on p_T spectra as a function of event multiplicity. The data are available for pp collisions at 5.02, 7 and 13 TeV

Results

- Data are consistent with the presence of MPI





- For $N_{ch} < 3$ $\langle N_{ch} \rangle$ the self normalized N_{mpi} increases linearly with the event multiplicity
- For higher multiplicities, we observe a deviation of the self normalized N_{mpi} with respect to the linear trend. This result is fully compatible with the so-called “mini-jet analysis” *ALICE Collaboration, JHEP09, 049 (2013).*

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Summary

- MPI can help to describe charge-multiplicity distributions as well as the flow like patterns in pp collisions
- We have applied machine learning to extract MPI from data, the method was successfully tested with MC
- The minimum-bias data supports the presence of MPI in pp collisions
- For higher multiplicities, the self normalized N_{mpi} has a deviation with respect to the linear trend. This result is compatible with the so-called “mini-jet analysis”

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