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Understanding biases in experimental multiplicity estimations for pp collisions at the LHC

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Measurements from the LHC and RHIC of proton-proton (pp) and proton-lead (pPb) collisions have revealed that the onset of phenomena normally associated with heavy-ion collisions also appear in smaller collision systems, particularly in collisions that produce large particle densities. However, unlike their larger heavy-ion counterparts, multiplicity production in pp collisions is dominated by large, spatial fluctuations. The origin of these fluctuations is model-dependent, currently understood to be driven by large parton showers or collisions with several multiple-parton interactions.

Consequently, measurements of high multiplicity pp collisions will necessarily be biased toward different phenomenological processes, considering which phase-space the multiplicity estimate is performed.This is particularly the case for experiments at RHIC and the LHC, where various subdetectors have limited azimuthal and pseudorapidity coverage, complicating direct comparisons of multiplicity-differential studies between different experiments.

This contribution examines how the different experiments at RHIC and the LHC measure multiplicity production in pp collisions, and discusses whether it is feasible to directly compare different estimations of "high-multiplicity" events selected with nonidentical phase-space constraints. Model simulations from state-of-the-art Monte Carlo generators are presented to highlight that these effects arise not from detector geometries or inefficiencies, but rather from the phase-space selection itself in relationship to the underlying physics processes. Furthermore, several observables commonly utilized to estimate the size of the underlying event, such as transverse spherocity, transverse charged particle density, and flattenicity will be discussed in this context.

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