Contribution ID: **89**

Type: **not specified**

Improving the vacuum baseline for in-medium jet physics studies

In ultra-relativistic heavy-ion collisions, it is possible to reach extreme conditions of temperature and density that allow to recreate the primordial state of the Universe where the fundamental degrees of freedom of Quantum Chromodynamics (quarks and gluons), are deconfined: the Quark-Gluon Plasma (QGP). The study of this hot and dense medium is at the forefront of the physics research at the most energetic heavy-ion colliders: RHIC (BNL) and the LHC (CERN). Jets - collimated bunches of particles that result from the branching of highly energetic partons —are produced concurrently with the QGP in the collision and thus modified with respect to their vacuum counterparts (e.g., jets produced in proton-proton collisions). Such modifications, resulting from the interaction between a jet and the QGP, are collectively referred to as "jet quenching"and provide detailed insights into the properties of the QGP.

Current theory-to-data comparisons in heavy-ions jet physics primarily rely on the adaptation of widely used Monte Carlo proton-proton event generators, so as to incorporate QGP-induced effects. The accuracy of these tools is thus a critical ingredient in the inference of QGP properties. By now, there have been several experimental observations of a poor description of proton-proton results by jet quenching Monte Carlo generators. One of the missing ingredients in these codes are next-to-leading corrections in the matrix element generation.

This work aims to delve into the differences arising from using a LO or NLO vacuum baseline for jet quenching studies. This will be done combining simulation tools, such as PYTHIA and MADGRAPH and also analytical computations of medium-induced modifications.

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