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Deciphering QCD Parton formation time in Heavy-Ion Collisions

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The extended coloured medium, the Quark-Gluon Plasma (QGP), created in heavy-ion collisions offers a unique opportunity to examine the time structure of QCD radiation. Leveraging on new jet clustering tools [1], it is possible to generate a time-ordered sequence within jets that correlates with the QCD parton formation time. The concept of QCD parton formation time, though underexplored, is emerging as a crucial parameter for understanding in-medium energy loss [2]. Early-developing jets, with formation times shorter than the medium's length, exhibit substantial suppression, while late-developing jets remain largely unaffected compared to proton-proton collisions. This differential behaviour underscores the potential of parton formation time as an indicator of jet-medium interactions. In this talk, we will discuss the next critical steps: developing a comprehensive physical model of QCD parton formation time, establishing a solid theoretical foundation for both vacuum and in-medium radiation. By using jet quenching Monte Carlo event generators, we will further illustrate how to enhance the precision characterization of the QGP.

[1] e-Print: 2012.02199

[2] e-Print: 2401.14229

Presenter: APOLINARIO, Liliana (LIP (PT))

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