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## Probing the QGP: Recent Advances in Heavy-Flavour Physics with ALICE at the LHC

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The ALICE experiment at the Large Hadron Collider (LHC) is a leading tool for studying Quark-Gluon Plasma (QGP), a state of matter that existed shortly after the Big Bang. While heavy-ion collisions, particularly lead-lead (Pb-Pb), remain the primary method for probing QGP, ALICE also investigates proton-proton (pp) and proton-lead (p-Pb) collisions to explore reference data, small system effects, and collective phenomena in different collision environments.

Heavy quarks, namely charm and beauty quarks, play a crucial role in these studies. Due to their large masses, they are produced predominantly in the initial stages of the collision via hard-parton scatterings, making them valuable probes of the early system dynamics. In particular, their interactions with the hot and dense QGP provide insights into the medium's properties, such as its temperature, density, and transport coefficients. Measuring heavy-flavor production in proton-proton (pp) collisions serves as an essential baseline for perturbative QCD (pQCD) predictions, while comparisons with proton-lead (p-Pb) and lead-lead (Pb-Pb) collisions allow researchers to disentangle cold nuclear matter effects from hot QGP effects.

This contribution presents an overview of recent ALICE results on open heavy-flavor production in pp, p-Pb, and Pb-Pb collision systems, with a focus on how these measurements advance our understanding of QGP formation, heavy-quark energy loss mechanisms, and the interaction of heavy quarks with the QCD medium.

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