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CMS MTD upgrade and prospects for identified jet substructure measurements for QGP studies

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The CMS detector at the LHC is a versatile experimental device for explorations of various aspects of the standard model, searches for exotic hadrons and beyond the standard model physics, such as extra dimensions and dark-matter particle candidates. The experimental apparatus has also been used to perform dedicated studies of the primordial form of deconfined partonic matter, the quark-gluon plasma (QGP), produced at the LHC in collisions of heavy nuclei. The CMS capability for precise reconstruction of jets, the collimated streams of particles produced in the initial stages of the collisions by hadronization of hard scattered partons, led to many insights into the QGP properties by comparing the in-vacuum reference measurements from proton-proton collisions with heavily modified samples of jets observed after strong interactions with the QGP. Bulk particle measurements indicate the presence of novel hadronization mechanisms in the QGP; however, experimental measurements of (sub)jet properties with identified hadrons that would provide a more direct connection to initial-state partons are still limited. The CMS upgrade with the minimum ionizing particles (MIP) Timing Detector (MTD) will provide time information with high precision and allow the identification of charged pions, kaons, and (anti)protons over an extended kinematic range. This upgrade, combined with the excellent jet reconstruction capabilities, will open new avenues for QGP studies, including flavor/color-charge dependences in jet quenching and deciphering the interplay between these novel hadronization mechanisms with modified "traditional" fragmentation processes. As we stand on the cusp of these new opportunities, a critical component of the MTD—the ETROC chip—has completed several stages of pre-production tests, delivering the expected time resolutions. As the new upgrade is poised to progress toward production, assembly, and installation, the future of jet studies for the CMS heavy ion program has never been more exciting!

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