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CMS Phase-2 Upgrades for Heavy Ion Physics in the High-Luminosity LHC Era

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The intriguing phenomena emerging in high-density quantum chromodynamics (QCD) matter are being extensively studied in the LHC's heavy ion program, and will be explored in greater depth during the high-luminosity LHC (HL-LHC) era. To meet the challenges of HL-LHC, the CMS experiment is undergoing significant Phase-2 upgrades, including the MIP Timing Detector (MTD), which provides 30 ps timing resolution for minimum ionizing particles (MIPs). With its large pseudorapidity coverage up to $|\eta| < 3$, the MTD enables particle identification (PID) via time-of-flight (TOF) measurements, offering new opportunities for probing QCD matter. Coupled with an upgraded wide-acceptance tracker ($|\eta| < 4$) and high-granularity calorimetry ($|\eta| < 5$), these upgrades will allow for more detailed investigations of the quark-gluon plasma (QGP), such as the (3+1)-dimensional evolution of heavy flavor quark dynamics and particle composition inside jets over a wide angular range. Additionally, the improved detector capabilities will significantly expand opportunities in ultraperipheral collisions (UPCs), enabling precise measurements of photon-induced processes, which are crucial for studying the gluonic structure of nuclei. This talk will discuss new physics opportunities enabled by the Phase-2 upgrades covering a wide range of topics. The latest status of the MTD project, including its R&D advancements and prototyping efforts, will also be presented.

Category

Experiment

Collaboration (if applicable)

CMS

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