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ALICE 3: a next-generation heavy-ion experiment at the LHC

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ALICE is the heavy-ion experiment at the CERN LHC designed to study the properties of strongly interacting matter under extreme energy densities and temperatures. Despite the vast number of measurements that have led to crucial advances in our understanding of the QCD phase diagram and the Quark-Gluon Plasma (QGP), several fundamental questions will remain unanswered even after the completion of the current decade's LHC program.

To address these open questions and fully exploit the LHC's potential as a heavy-ion collider beyond Long Shutdown 4, the ALICE Collaboration has proposed a next-generation, fully silicon-based detector featuring an unprecedentedly low material budget, exceptional tracking, vertexing, and particle identification capabilities over a wide momentum range down to a few tens of MeV/c. Cutting-edge technologies are being developed to achieve a track-point resolution better than 10 microns for particles with transverse momentum above 200 MeV/c. Additionally, the compact design of the experiment imposes stringent requirements on the TOF system, including a global time resolution of approximately 20 ps which is beyond the state-of-the-art of current silicon-based sensor technologies. The ambitious R&D effort required to meet these stringent technological demands is not only crucial for ALICE 3 but will also pave the way for future applications and experiments in High-Energy Physics and beyond.

The ALICE 3 experiment will enable novel measurements of low pT heavy-flavor particles to explore the approach to thermal equilibrium, as well as high-precision dielectron emission studies to investigate the time evolution of the QGP temperature and the mechanism of chiral symmetry restoration. Furthermore, ALICE 3 will explore multi-charm baryon production, charm-charm correlations, and contribute to hadronic physics through femtoscopic studies and searches for supernuclei. It will also provide valuable insights into fundamental physics by testing the Low theorem for ultra-soft photon emission.

This contribution presents a comprehensive overview of the future ALICE 3 experiment, outlining its physics motivations and focusing on the status of R&D for the selected detector technologies.

Abstract Category

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