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European Strategy for Particle Physics 2026: the NA60+/DiCE experiment at the SPS

The exploration of the phase diagram of Quantum ChromoDynamics (QCD) is carried out by studying ultrarelativistic heavy-ion collisions. The energy range covered by the CERN SPS ($\sqrt{s_{NN}} \sim 6 - 17$ GeV) is ideal for the investigation of the region of the phase diagram corresponding to finite baryochemical potential (μ_B), and has been little explored up to now. We propose in this document a new experiment, NA60+/DiCE (Dilepton and Charm Experiment), that will address several observables which are fundamental for the understanding of the phase transition from hadronic matter towards a Quark-Gluon Plasma (QGP) at finite μ_B . In particular, we propose to study, in Pb-Pb collisions, as a function of the collision energy, the production of thermal dimuons from the created system, from which one can obtain a caloric curve of the QCD phase diagram that may be sensitive to the order of the phase transition. In addition, the measurement of a $\rho - \omega$ mixing contribution will provide conclusive insights into the restoration of the chiral symmetry of QCD.

Studies of open charm and charmonium production will also be carried out, addressing the measurement of transport properties of the QGP and the investigation of the onset of the deconfinement transition. Reference measurements with proton-nucleus collisions are an essential part of this program.

The experimental set-up couples a vertex telescope based on state-of-the-art monolithic active pixel sensors (MAPS) to a muon spectrometer with tracking detectors (MWPC). Two existing CERN dipole magnets, MEP48 and MNP33, the first being stored and the second currently in use by NA62, will be used for the vertex and muon spectrometers, respectively. The continuing availability of Pb-ion beams in the CERN SPS is a crucial requirement for the experimental program.

After the submission of a LoI, the experiment proposal is currently in preparation and is due by mid 2025. The start of the data taking is foreseen by 2029/2030, and should last about 7 years.

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