



Town meeting: heavy ion and QGP physics at CERN

Final discussion

As for the previous Strategy Updates in 2012 and 2018, this one-day Town Meeting will aim at formulating a **consensus view** of the entire scientific community with research focus on ultra-relativistic heavy ion collisions. Following the charge of this Strategy Update, the meeting will focus on the scientific opportunities with ion beams at the HL-LHC and at CERN fixed-target experiments.

On the following slides, we compile draft (not final) statements that should feature prominently in the consensus report submitted to EPPSU

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The top priority for future quark matter research in Europe is the full exploitation of the physics opportunities arising with nuclear beams over the full lifetime of HL-LHC.

ALICE 3 is a completely new dedicated high-energy nuclear physics experiment, based on innovative detector concepts, with particle identification and unprecedented pointing resolution over large acceptance in rapidity and transverse momentum. It offers unique opportunities to advance quark matter research in HL-LHC Run 5, in particular via measurements of electromagnetic radiation, heavy flavour, and particle correlations.

The **LHCb Upgrade2**, motivated mainly by the LHCb flavor physics programme, will offer unique opportunities for quark matter research in run 5 at the HL-LHC, in particular with measurements of heavy-flavour and the initial stages in collider mode and in fixed-target mode.

The **Phase-2 CMS and ATLAS** feature particle identification, high-rate capability, and broad pseudorapidity coverage. They will significantly advance quark matter research by precisely characterizing high-momentum transfer and photonuclear processes that require high statistics. Operating at peak luminosity in Run 4 and beyond, they will provide access to the 3D structure, microscopic dynamics, and substructure of quark matter.

At lower center of mass energies where high baryon density is reached, advances in detector technologies provide opportunities for a new generation of precision measurements that address central questions about the QCD phase diagram:

The **NA60+ detector** at the CERN SPS will explore for the first time the whole SPS energy range ($6 < \sqrt{s_{NN}} < 17$ GeV), addressing open questions in the electromagnetic (thermal dilepton production around T_c , signals of chiral symmetry restoration) and charm sector (onset of charmonium suppression, charm hadronization in a high- μ_B QGP) with unprecedented event rates. The **CBM detector** at FAIR will allow the exploration of high baryon density towards lower center of mass energies, including the study of electromagnetic processes.

NA61/SHINE will continue to investigate the onset of QGP-related signatures with lighter ions.

The design choices for FCC-hh and its injectors should allow for the possibility to inject heavy ions, so that questions only accessible at higher center of mass energies or only with future detector technologies can finally be studied as part of the FCC physics programme.

The proposed **addition of a second heavy ion source** and upgrades of the heavy ion complex would significantly improve the full exploitation of the scientific opportunities arising for the collider and fixed target heavy ion programmes.

Dedicated support for theoretical research are needed to fully exploit the opportunities arising from the upcoming precision era of nuclear research at collider and fixed target energies.

