Contribution ID: **480** Type: **Contributed Talk**

Heavy-ion physics studies for the Future Circular Collider

Wednesday 21 May 2014 13:10 (20 minutes)

A five-year international design study called Future Circular Collider (FCC) has been launched by CERN with a kick-off meeting in February 2014. The main goal is a hadron collider with a centre-of-mass energy of the order of 100 TeV for pp collisions in a new 80-100 km tunnel in the Geneva area. The target start of operation would be 2035-40.

Operating such machine with heavy ions is an option that is being considered in the accelerator design studies. It would provide, for example, Pb-Pb and p-Pb collisions at $\sqrt{s_{\rm NN}} = 39$ and 63 TeV, respectively, with monthly integrated luminosities of the order of 5-10/nb.

We will present first ideas on the physics opportunities with heavy ions at the FCC.

The Quark-Gluon Plasma (QGP) state produced in Pb-Pb collisions at 39~TeV is expected to have initial temperature and energy density substantially larger than at LHC energy, a stronger flow field and freeze-out volume twice as large. The larger temperature could entail novel features, like changes in the quarkonium spectrum and abundant in-medium production of charm quarks. The latter could determine an increase in the number of degrees of freedom (from 3 to 4 quark flavours).
The larger energy and luminosities will make new, rarer, hard probes available (like top quarks and $Z + Jets$), which could give access to the time-evolution of the medium properties, e.g. of its opacity.

In the sector of small-x and saturation physics, the increase in centre-of-mass energy of a factor seven with respect to the LHC will extend the kinematic coverage in x and Q^2, providing, with pA and γA (ultra-peripheral collisions), access to the saturation region down to $x < 10^{-6}$ with perturbative probes like heavy quarks and quarkonia.

High-density or collective effects in high-multiplicity pp and pA events could become more dramatic, with the increase of energy and high-multiplicity reach.

Opportunities for electroweak physics studies in UPC gamma-gamma collisions, as well as the impact of heavy-ion data at the FCC for ultra-high energy cosmic-ray physics, will also be summarized.

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Session Classification: Future experimental facilities, upgrades, and instrumentation

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