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Fixed Superthin Solid Target and Colliding beams in a single experiment –a novel approach to study the matter under new extreme conditions (live)

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A novel approach to the experimental and theoretical study of the properties of QCD matter under the new extreme conditions is discussed. Our simulations demonstrate a possibility to reach the initial temperature over 300 MeV and baryonic charge density exceeding the ordinary nuclear density by a factor of three. Such conditions could be realized in the high luminosity (HL) experiments at LHC by means of utilizing scattering of the two colliding beams at the nuclei of a solid target which is fixed at their intersection point.
A new distinctive feature of the proposed experiments is based on the implementation of the superthin solid target operated in the core of colliding beams. This approach is grounded on the successful data-taking process in the LHCb experiment running the colliding and fixed gaseous target modes simultaneously. The thickness of a solid target is assumed to be of the order of the upgraded gaseous target SMOG2 with a storage cell [1].
Assuming the instantaneous luminosity of colliding proton beams at HL LHC of 1036cm−2s−1 and the fixed micropowder jet target of Ni [2] with a thickness of 1016atoms ·cm−2 one can expect the triple nuclear collision rate of 100 s−1. Similar conditions might be realized by inserting into a beam core a superthin graphene target (10-100 atomic layers). We shall present entirely new mechanical construction for handling such target remotely. The third option of the superthin solid target to be discussed is based on 1 μm thick microstrip sensors [3] operated in a beams'halo. Among the advantageous features of superthin and super-light solid micro targets are the orders of magnitude better spatial localization of primary vertices, a large variety of target nuclei, a possibility to run an experiment with a few targets simultaneously, etc.
To simulate the triple nuclear collisions, we employed the UrQMD 3.4 model [4, 5] for the beam center-of-mass collision energies $\sqrt{s}$ = 2.76 TeV. As a result of our modeling, we found that in the most central and simultaneous triple nuclear collisions the initial baryonic charge density is about 3 times higher than the one achieved in the ordinary binary nuclear collisions at this energy. In contrast to the binary nuclear collisions, the high value of baryonic charge density leads to a strong enhancement of proton and Λ-hyperon production at the midrapidity and to a sizable suppression of their antiparticles. A principally new kind of scattering reactions, like a nucleus-fireball interaction, can be studied in such experiments. We argue that at lower energies of collisions the triple nuclear collision method can be of principal importance for locating the (tri)critical endpoint of the QCD phase diagram.
References:

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