



Contribution ID: 930

Type: Poster

Exploring dense nuclear matter at J-PARC heavy ion project

Many phenomena are expected, such as the transition to the deconfined phase and color superconductivity (CSC), in ultra-high density matter. Heavy ion collision with $\sqrt{s_{NN}} = \sim 5$ GeV is expected to be most advantageous to generate and study such ultra-high densities ($\rho > 3\rho_0$).

J-PARC Heavy Ion Project (J-PARC-HI) is an experimental project aimed at studying the ultra-high density matter by using a heavy ion beam with the most suitable energy (1-12 AGeV). While the current J-PARC is a 30 GeV proton accelerator, the J-PARC HI will use the current acceleration scheme as much as possible with only adding the injector. The design of the injector and the acceleration scheme at the latter stage of the injector are being studied in detail by the J-PARC facility.

We have the staging plan of the project divided into two stages. The main difference between each stage is whether the booster ring is a reuse of the KEK-Proton Synchrotron or newly constructed. Even in the early stage, we expect to achieve an intensity of 10^8 Hz. In the final stage, the world's highest intensity heavy ion beam of 10^{11} Hz is expected.

The primary goal of the first stage is considered to observe non-confined phases in high-density regions by temperature measurement via di-electron radiation. To achieve this, we have already proposed an upgrade plan for the J-PARC E16 experiment. As an additional step, we believe it is important to discover an anomalous increase in low-mass electron pairs, which is expected to be a sign of the onset of CSC. To observe this effect, we are considering a detector system with emphasis on wide acceptance and measurement of soft processes. By emphasizing measurement of soft processes with wide acceptance, it becomes possible to access important themes such as fluctuations and multi-particle correlations for not only di-electron, and it will also be complementary to CBM. This talk will present simulation results on key physics opportunities in the detectors considered.

Category

Experiment

Collaboration (if applicable)

J-PARC-HI

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