Joint DESY and University of Hamburg Accelerator Physics Seminar

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(16:00 in Room 459/30b)

Design of the eRHIC Electron Ion Collider

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Abstract

The nuclear physics community strongly supports the construction of an electron ion collider (EIC). The physics program was unanimously endorsed by the recently published Study of the National Academy of Science on the physics case of electron ions collisions which is summarized by three fundamental questions: How does the mass of the nucleon arise? How does the spin of the nucleon arise? What are the emergent properties of dense systems of gluons? To address these questions, the eRHIC electron ion collider, one of the two proposals being worked out to apply for funding of a construction project by the Department of Energy, is laid-out to have luminosities of up to $L = 10^{34}$ cm^{-2}s^{-1}. Both beams, hadron and electrons are spin polarized (up to 80%) with flexible spin pattern, a large range of center of mass energies of 20 GeV — 140 GeV is accessible, and the interaction regions enable very large detector acceptance. eRHIC is based on the very successful relativistic heavy ion collider RHIC which requires only small modifications and already performs on the required level for eRHIC. In the same tunnel, an electron storage ring of 5 GeV — 18 GeV is installed to enable electron collisions with the 275 GeV hadron beam. On-energy, fully polarized electrons with both polarities are accelerated by a spin transparent rapid cycling synchrotron in the RHIC tunnel. It has a special lattice with a high quasi-periodicity of 96 which avoids all spin-depolarizing resonances up to 18 GeV. The electron beam in the storage ring requires beam currents of up to 2.5 A. The beam-beam tune shift values of 0.012 for hadrons have been established in RHIC operation and the beam-beam tune shift for electrons of 0.1 have been achieved at KEKB. HERA also achieved an electron beam-beam tune shift of 0.1. To achieve highest luminosity values, small Hadron emittances must be realized. For balancing the corresponding strong intra-beam scattering with an initial emittance growth time of 2 hours, strong hadron cooling is required. A scheme based on micro-bunching coherent electron cooling has been worked out which promises cooling times of less than 1 h for the 275 GeV proton beams. The eRHIC development is captured in a comprehensive pre-conceptual design report. The presentation will summarize the design and will expand on beam dynamic and technological challenges.

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