AKBP 5: Hadron Accelerators – New Devices and Techniques

Time: Tuesday 14:00–15:30 Location: AKBP-H13

AKBP 5.1 Tue 14:00 AKBP-H13

Optimization of proton spin coherence time with three families of sextupoles at prototype EDM ring — •Aleksei Melnikov for the JEDI-Collaboration — Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

The JEDI collaboration aims to perform a direct measurement of the electric dipole moment (EDM) of protons. For this purpose the prototype storage ring (PTR) is designed. It will allow for feasibility studies of many experimental techniques that are needed to perform an ultimate precision storage ring EDM measurement.

A prototype EDM ring is an intermediate step before building the final storage ring to demonstrate sufficient beam lifetime and SCT (Spin Coherence Time) in a pure electrostatic ring as well as in storage ring with combined electric and magnetic bending elements.

The current lattice of such a ring has fourfold symmetry and operates in a frozen spin mode with weak vertical focusing. Two existing sextupole families are used to increase the spin coherence time. In the current design the maximum value of proton SCT is about 100 s. The proposed way to increase SCT is to insert the third family of sextupoles to adjust chromaticities and second order momentum compaction factor to any desired value. All three families should be located at points with different ratios of optical functions and dispersion. A racetrack option of the prototype ring with strong focusing is proposed to fulfill this requirement. The adjustment of the third sextupole family helped to increase proton SCT up to 1000 s.

AKBP 5.2 Tue 14:15 AKBP-H13

Simulations of Beam Dynamics and Beam Lifetime for the Prototype EDM Storage Ring — •Saad Siddique[1,2,3], Jörg Pretz[1,2], and Andreas Lehrach[1,2] for the JEDI-Collaboration — [1]Institute of Nuclear Physics Forschungszentrum Jülich Germany — [2]Institute 3B Physikzentrum RWTH University Aachen Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH Darmstadt Germany

The matter-antimatter asymmetry may be explained through CP-violation by observing a permanent electric dipole moment (EDM) of subatomic particles. An advanced approach to measure the EDM of charged particles is to apply a unique method of "Frozen spin" on a polarized beam in an accelerator. To increase the experimental precision step by step and to study systematic effects, the EDM experiment can be performed within three stages: the magnetic ring COSY, a prototype EDM ring and finally all electric EDM ring. The intermediate ring will be a mock-up of the final ring, which will be used to study a variety of systematic effects and to implement the basic principle of the final ring. The simulations of beam dynamics of prototype EDM ring with different lattices are performed to optimize the beam lifetime and to minimize the systematic effects. The preliminary design of prototype EDM ring helped to estimate the beam losses by using analytical formulas. Further investigations on enhancing EDM measurement precision and reducing systematic effects are in process.

AKBP 5.3 Tue 14:30 AKBP-H13

Spin tune response to vertical orbit correction at COSY — •Artem Saleev for the JEDI-Collaboration — University of Ferrara, Ferrara, Italy

Searches of electric dipole moments (EDM) of charged particles in pure magnetic rings, such as COSY, or electrostatic and hybrid magnetic-electric storage rings, planned in the future, require new methods to disentangle the EDM signal from the large background produced by magnetic dipole moments. In these experiments, the sources of systematic background are in-plane magnetic fields. It is important to distinguish the origins of the in-plane magnetic fields, which could be produced intentionally by vertical orbit correction to keep the beam on a closed path, or unintentionally due to the alignment errors of the magnets. We propose to use the method of spin tune mapping to determine the relative importance of the two origins. Such method was successfully tested at COSY when local vertical orbit correction was applied.

AKBP 5.4 Tue 14:45 AKBP-H13

Modeling of the optical setting for the measurement of the electric dipole moment of protons at cooler synchrotron COSY — •Mariia Manerova[1,2,3], Andreas Lehrach[1,2], and Maximilian Vitz[1,2] for the JEDI-Collaboration — [1]Institute for Nuclear Physics IV, FZ Jülich, Germany — [2]III. Physikalishes Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Electric Dipole Moments (EDMs) of elementary particles are considered to be an excellent probe of physics beyond the Standard Model (SM). They violate parity and time reversal, while through the CPT-theorem also breaking the CP-symmetry. This mechanism may explain the matter-antimatter asymmetry in the universe.

The JEDI (Jülich Electric Dipole moment Investigations) collaboration uses storage rings to measure the EDMs of protons and deuterons with high precision. In a preliminary experiment, measurements of the EDM for deuterons were performed at COSY (COoler SYnchrotron) in Jülich. One important prerequisite for these experiments was the modelling of the optical settings and the beam orbit in COSY to analyze the EDM measurement results.

Further steps include measurements of the proton EDM at COSY. The planned experiments on the proton spin coherence time at COSY will therefore be accompanied by simulation calculations with Bmad. The talk focuses on the model calculation of the beam orbit and optical functions of COSY and compares those to the measurement to achieve a significantly better model description of COSY.

AKBP 5.5 Tue 15:00 AKBP-H13

Laser cooling of bunched relativistic ion beams at the FAIR SIS100 — •Danyal Winters[1], Michael Bussmann[2,3], Daniel Kiefer[4], Volker Hannen[5], Thomas Kühl[1,6], Sebastian Klammes[1,4], Benedikt Langfeld[4], Ulrich Schramm[2,7], Mathias Siebold[2], Peter Spiller[1], Thomas Stöhlker[1,6,8], Ken Ueberholz[5], and Thomas Walther[4,9] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]CASUS Görlitz — [4]TU-Darmstadt — [5]Uni Münster — [6]HI-Jena — [7]TU-Dresden — [8]Uni-Jena — [9]HFHF Frankfurt am Main

The heavy-ion synchrotron SIS100 is the core machine of the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. It is capable of accelerating a large range of ions, produced by the injector (the upgraded GSI facility), up to highly relativistic velocities and extracting them for unique experiments, e.g. APPA/SPARC. In order to cool such intense beams of heavy highly charged ions, laser cooling of bunched ion beams was preferred. Therefore, the laser cooling pilot facility at the SIS100, being also the only in-ring experiment, is currently being realized. We will present this project and give an update of its current status. We will also give an overview of the laser and detector systems that will be used.

AKBP 5.6 Tue 15:15 AKBP-H13

Dispersive coupling in low-energy electron cooling at CRYRING@ESR — •Claude Krantz[1], Zoran Andelkovic[1], Christina Dimopoulou[1], Frank Herfurth[1], Regina Hess[1], Michael Lestinsky[1], Esther B. Menz[1], Konstantin Mohr[1,2], Wilfried Nörtershäuser[2], Andreas Reiter[1], Jon Rossbach[1], Rodolfo Sánchez[1], and Gleb Vorobjev[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt — [2]Institut für Kernphysik, TU Darmstadt, 64298 Darmstadt

The heavy-ion storage ring CRYRING has been recommissioned at GSI/FAIR. Downstream of the ESR, the ring can serve as a platform for precision experiments on highly-charged ions produced by the full GSI accelerator chain. In a complementary standalone mode, CRYRING can operate with weakly or singly charged ions provided by a local low-energy injector. Especially singly-charged ions are often limited to storage velocities of the order of $10^{-2}\,c$, not to exceed the maximum rigidity allowed by the bending magnets. Electron cooling of so slow beams is challenged by dispersive coupling effects which lead to entanglement of the horizontal and longitudinal cooling rates. If dispersion in the cooler section is significant, over-optimisation of cooling for one degree of freedom can lead to cancellation or even reversal of the cooling force in the other dimension. At CRYRING@ESR, the effect was found during preparation of a singly-charged beam of Mg^+ for an atomic-physics experiment, where unwanted heating of longitudinal ion motion by the electron cooler was observed. Dedicated machine studies on dispersive electron cooling at CRYRING are planned.