HITRAP – a facility for experiments on heavy highly charged ions and on antiprotons

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HITRAP - a facility for experiments on heavy highly charged ions and on antiprotons

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HITRAP is a facility for very slow highly-charged heavy ions at GSI. HITRAP uses the GSI relativistic ion beams, the Experimental Storage Ring ESR for electron cooling and deceleration to 4 MeV/u, and consists of a combination of an interdigital H-mode (IH) structure with a radiofrequency quadrupole structure for further deceleration to 6 keV/u, and a Penning trap for accumulation and cooling to low temperatures. Finally, ion beams with low emittance will be delivered to a large variety of atomic and nuclear physics experiments. Presently, HITRAP is in the commissioning phase. The deceleration of heavy-ion beam from the ESR storage ring to an energy of 500 keV/u with the IH structure has been demonstrated and studied in detail. The commissioning of the RFQ structure and the cooler trap is ongoing.

With the novel technique of deceleration, trapping and cooling of highly charged ions, atomic physics studies on slow highly charged ions up to uranium U^{92+} interacting with photons, atoms, molecules, clusters, and surfaces will become possible [1,2]. The enormous amount of electronic potential energy (≈ 1 MeV in the case of uranium U^{92+}) per ion, deposited on a surface, will provide insight into surface phenomena in a so far inaccessible regime [3].

In addition to collision studies, high-accuracy atomic physics experiments on trapped or slow highly charged ions will be a significant part of the atomic physics program of HITRAP. Sensitive tests of quantum electrodynamics (QED) for bound electrons in the strongest electromagnetic fields available in the laboratory for extended periods of time will be performed by measuring the g-factor of the bound electron, the binding energies of a single or of few electrons including the Lamb shift or the hyperfine structure of a stable isotope of an element in different high charge states with utmost accuracy [1,2,4].

At the future FAIR Project, HITRAP will be an integral part of the collaborations SPARC (Stored Particles Atomic Physics Research Collaboration) and FLAIR (Facility for Low-energy Antiproton and Ion Research) [4]. The HITRAP facility at FLAIR/SPARC can be equally well used for highly charged ions and antiprotons to bring them down to sub-thermal energies as all components have been carefully designed to be operable in an A/q range of < 3. From the cooler trap, the particles will be extracted and delivered to heavy-ion and antiproton physics experiments. Extraction is possible both in DC mode and bunched mode.

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