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Stopping heavy, highly charged ions - The HITRAP decelerator and cooling trap

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The HITRAP facility, located at the GSI Helmholtzzentrum für Schwerionenforschung GmbH in Darmstadt, Germany, is designed to decelerate, cool and transport heavy, highly charged ions (HCI) created by the GSI accelerator complex to various attached experiments. The system consists of a two-stage deceleration structure, an interdigital H-type linac (IH) and a radio-frequency quadrupole (RFQ), followed by a cryogenic Penning-Malmberg trap for subsequent ion stopping cooling. The deceleration stages reduce the ion energy from initially 4 MeV/u to 500 keV/u and to 6 keV/u respectively, before forwarding a slow, but hot ion bunch towards the cooling trap.
The trap is operated in a so-called nested configuration, in which the electrons, created by an external photoelectron source, are stored simultaneously with ions and serve as cold thermal bath. Via Coulomb interactions the ions transfer their energy to the electrons, which continuously dissipate energy via synchrotron radiation, due to their circular motion in the strong magnetic field of the trap.
After cooling, a low-energy transfer beamline allows the transport and delivery of those ions towards users at different experiments. A Dresden EBIT, attached to the beamline, is used for commissioning of the cooling trap as well as a source of light HCI for some experiments.
So far, deceleration of heavy HCI has been set up down to 6 keV/u, though the process is somewhat hampered by a low delivery rate of one ion bunch per 40 seconds. The subsequent electron cooling process is under development with promising results. A routine operation of the transport beamline is set up and light ions are transported from the EBIT towards the cooling trap. There they are regularly stored and mixed with electrons. An interaction between them has been verified, however a clear cooling effect could not be observed so far. The current status of this development as well as future aspects will be presented.

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