Development of the SPECTRAP experimental setup for laser spectroscopy of cold & trapped HCI*

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The new SPECtroscopy TRAP (SPECTRAP) experiment under development within the framework of the HITRAP project will measure ground state hyper-fine splittings in cold, trapped, highly-charged ions (HCI) extracted from the HITRAP facility [1] by means of laser spectroscopy. It is a dedicated cryogenic (Penning) trap, laser and detection system, built in close collaboration with Imperial College London, TU Darmstadt, and the Universities of Münster and Mainz. The cryogenic surrounding allows for efficient cooling of ions during storage, thus opening the possibility for precision experiments with ions nearly at rest. Its optical accessibility (axial and radial) furthermore allows laser cooling, laser excitation and optical detection, making it an ideal tool for laser spectroscopy of HCI [2]. The trap will be operated with a Helmholtz-type superconducting magnet, which was consigned to GSI by Lawrence Berkeley National Laboratory (LBNL), with courtesy of Prof. Dieter Schneider (LBNL) and Prof. Dave Church (Texas A&M University) who are also supporting the project. The system had previously been called RETRAP, and comprised, besides the magnet, a hyperbolic ion trap, ion manipulation and detection components as well as the corresponding electronic and cryogenic components [3].

In March 2007 the RETRAP experimental setup was dismantled at Berkeley (see Fig.1), packed and prepared for shipment to GSI, where it arrived in May 2007. By now a new platform for purposes of the SPECTRAP setup has been constructed next to the re-injection channel, and we have started mounting the newly-arrived equipment on it. At the moment, the magnet as well as the electronic and cryogenic system are being checked and prepared for implementation into the SPECTRAP experiments.

A new open-endcap cylindrical Penning trap [4] has been developed and constructed at Imperial College in London, gold-plated at GSI and assembled. Starting already in 2006, off-line tests of the trap electrode structure were performed at Mainz University [5, 6]. It was operated in radio-frequency mode and loaded from an external argon ion sputter gun. Ar^+ ions were successfully stored for extended periods of time, and the obtained results have shown that the trap operated close to the expected parameters. In the next step, the trap will be mounted into the SPECTRAP magnet, and the work on the mechanical and electronic tasks for the purpose has started.

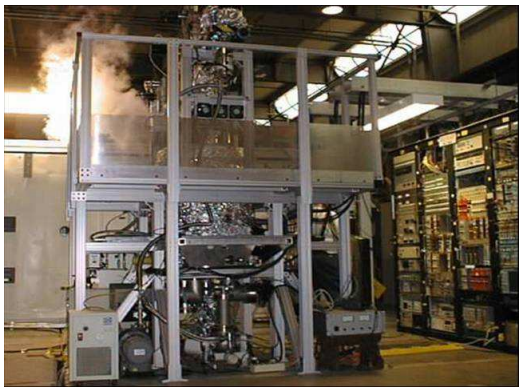

Figure 1: The RETRAP setup before shipment to GSI

In addition, the first laser system for the planned laser spectroscopy experiments was constructed and tested at Mainz University [6]. It consists of an external cavity diode laser, a reference Fabry-Perot interferometer for frequency locking and the corresponding electronics. Using a red laser diode (670 nm) the system was successfully tested by exciting Li atoms and observing the fluorescence. Future laser systems may include diodes with different wavelengths, ranging from 397 nm (UV) to 1550 nm (IR).

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