First Successful Operation of the SHIPTRAP Facility ◇

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First on-line tests at the ion trap facility SHIPTRAP at GSI were successfully performed. The facility was set up to deliver very clean and cooled beams of singly-charged recoil ions produced at the SHIP velocity filter. SHIPTRAP consists of a gas cell for stopping and thermalizing high-energy recoil ions from SHIP, a radiofrequency quadrupole ion guide for extraction of the ions from the gas cell (extraction RFQ), a linear RF trap for accumulation and bunching of the ions (RFQ buncher), and a tandem Penning trap system for isobaric purification and high precision measurements. The scientific programme of the SHIPTRAP facility comprises mass spectrometry, nuclear spectroscopy, laser spectroscopy and chemistry of transuranium elements.

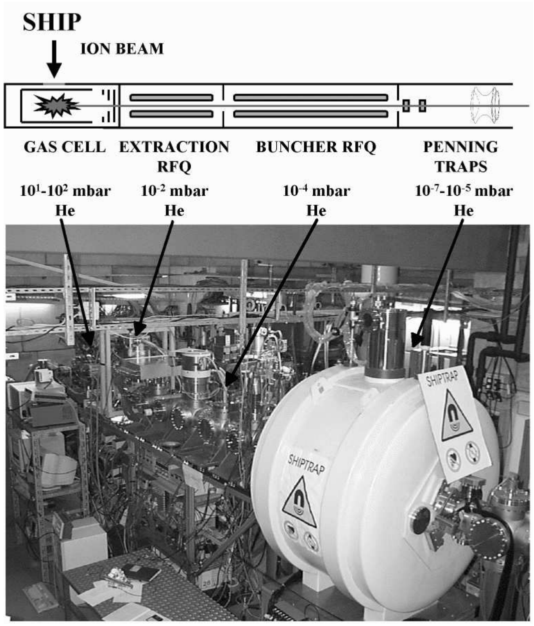

Fig. 1: Schematic view (top part) and picture of the SHIPTRAP facility at GSI.

In the SHIPTRAP setup the beam of exotic nuclei produced and preseparated at SHIP enter the helium-filled stopping cell through a thin metallic window. This gas cell had been tested at the tandem accelerator in Garching and was coupled to SHIPTRAP for the first time. Due to the gas flow and applied electric fields, the ions (predominantly singly charged) are guided through the exit nozzle. This frontend part of SHIPTRAP is subject to a separate report [1] and therefore will not be discussed here in more details. The extracted beam is guided by an RFQ and injected into the buncher RFQ which is used as an ion accumulator and buncher.

The ion bunching system is a 1m long RFQ immersed in a low-pressure buffer gas. The four rods have a diameter of 9 mm at a distance of 7.86 mm between two opposite rods. The rods are divided into 34 segments. Given a proper choice of the applied voltages, a potential slope with a harmonic potential well at the end of the quadrupole structure can be createt. When the ions lose energy in collisions with the buffer gas, they accumulate in this trap and can be extracted as a short bunch of cool ions.

A double Penning trap system was installed in a 7 Tesla superconducting magnet with two homogeneous field centres 20 cm apart from each other. Both Penning traps have cylindrical electrodes with an inner diameter of 32 mm. In the first trap the ion bunches from the RFQ buncher are captured and isobarically purified by mass-selective RF excitation of the ion motion. The second trap is optimized for high-accuracy mass measurements. The traps are separated by a diaphragm for differential pumping.

In a first on-line test, primary beam ^{40}Ca ions with 5.9 MeV/u from the UNILAC filtered by SHIP (pulse duration: 6 ms, repetition rate: 50 Hz) were stopped in the gas cell at 50 mbar He pressure. The extracted $^{40}Ca^+$ ions from the cell were guided and accumulated into the RFQ buncher with a repetition rate of 10 Hz. The $^{40}Ca^+$ ions were finally extracted as a short ion bunch (FWHM: 580 ns) and identified by time of flight with a microchannel plate (MCP) detector. Fig. 2 shows the resulting TOF spectrum, where the dominant peak represents the stopped and extracted Ca-ions.

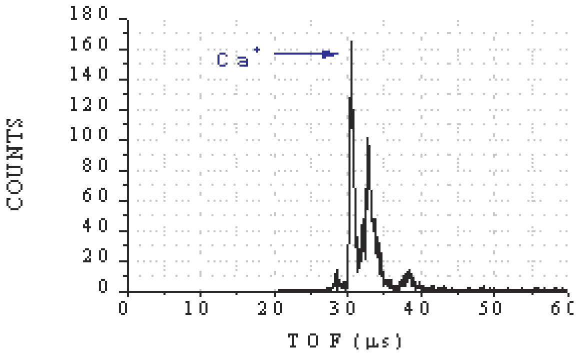

Fig. 2: First on-line tests of the SHIPTRAP facility: $^{40}Ca^+$ ions, delivered by SHIP, were stopped in a gas cell, accumulated and trapped in a RFQ buncher, and identified by time-of-flight detection.

Thus the complete SHIPTRAP setup for the first time proved successful operation. Further optimization of the efficiency and performance of the trap system is in progress.

References

[1] J. Neumayr et al., this report, p.83

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