Commissioning of the First Trap of the MLLTRAP System ◇

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The MLLTRAP, presently under commissioning and testing at the Maier-Leibnitz-Laboratory (Garching), is a novel double Penning trap facility designed to perform high-precision nuclear mass measurements. For the detailed description of the setup see the annual report 2006 [1].

During 2007 the control and measurement system (CS & MM6) developed at SHIPTRAP (GSI) [2] was implemented and adapted to the local environment. The hardware of the control system consists of a PC computer equipped with CAN-bus, GPIB and a NI timing card. A running control system allowed us to prove the working principle of the first trap (purification trap).

The first step was the trapping test, where ions from the Cs-ion source were captured, cooled in a Helium buffer gas and released from the purification trap, see Fig. 1, which shows the counts detected in the MCP as a function of the time of flight (TOF) which is directly related to the mass of the ions. A trapping time of 0.5 seconds was used here. The pressure in the gas feeding line was $p_{\mathrm{line}} = 2 \cdot 10^{-3}$ mbar, which corresponds 10-100 times lower pressure in the trap.

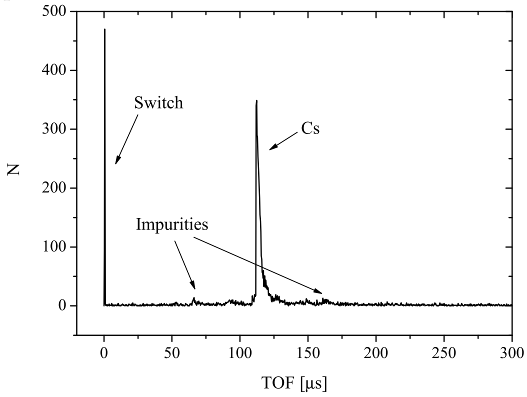

Fig. 1: Counts as a function of TOF from the purification trap to the MCP detector. The trapping time was 0.5 s and the gas pressure in the feeding line was $p_{\mathrm{line}} = 2 \cdot 10^{-3}$ mbar.

Also both magnetron and cyclotron excitations were successfully tested in the purification trap as shown in the figures 2 and 3. They show the magnetron excitation (Fig. 2) and cyclotron excitation (Fig. 3) for ^{133}Cs, respectively. The magnetron excitation is applied to the ring electrode of the trap in dipole mode. This mass-independent excitation moves the ions to larger orbits and subsequently during ejection through a 2 mm diameter exit hole the count rate detected at the MCP behind the trap reduces to a minimum at the value of the resonance frequency.

The cyclotron excitation, $f_c = 1/2\pi \times qB/m$, is mass dependent and is applied in quadrupole mode. F_c recenters all ions into the trap center that correspond to this particular cyclotron frequency. Since the magnetic field is very homogeneous ($\Delta B/B < 0.3$ ppm), one can use the cyclotron excitation applied after a magnetron excitation for isobaric mass purification. The mass resolution that could be achieved in the cyclotron excitation scan displayed in Fig. 3 for ^{133}Cs is R=32 000, which corresponds to R=150 000 at mass range 58 as achieved with the comparable trap system at JYFLTRAP [3].

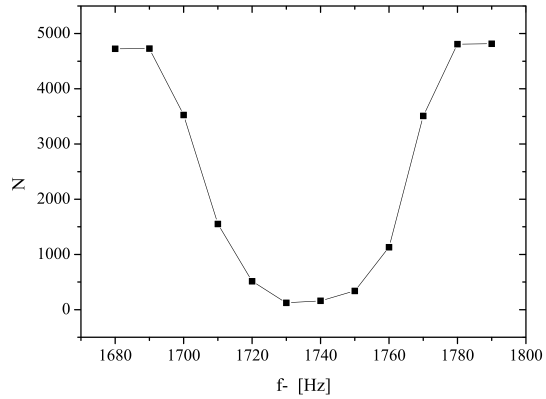

Fig. 2: The picture shows counts as function of the magnetron excitation frequency. This mass-independent excitation moves all ions in the trap away from the trap center. The buffer gas pressure in the gas feeding line was $p_{\mathrm{line}} = 2 \cdot 10^{-3}$ mbar and the cooling time before excitation was 250 ms. Excitation time was 20 ms at 150 mV amplitude.

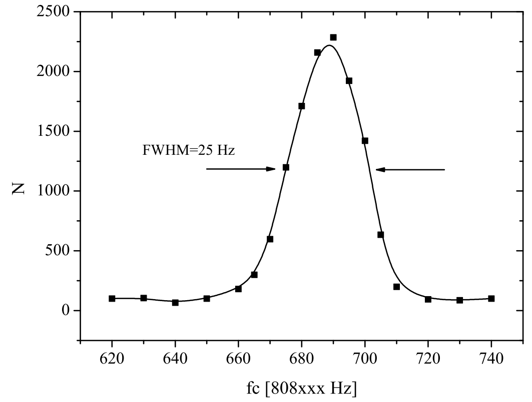

Fig. 3: The picture shows counts as a function of the cyclotron excitation frequency for ^{133}Cs. This mass-dependent excitation moves only those ions back to the trap center that exhibit this particular cyclotron frequeny $f_c = 1/2\pi \times qB/m$. Operational parameters were $p_{\mathrm{line}} = 2 \cdot 10^{-3}$ mbar, $T_{\mathrm{cool}} = 250$ ms, $T(\omega_-) = 20$ ms, $A(\omega_-) = 170$ mV and $T(\omega_c) = 150$ ms, $A(\omega_c) = 151$ mV. This scan corresponds to a mass resolving power of R=32 000.

During the year 2008 a pumping barrier will be implemented between the purification trap and the measurement trap, allowing for a larger pressure difference between the two traps. After this the commissioning of the second trap will follow.

References

[1] J.B. Neumayr *et al.*, Annual report 2006, p. 81

[2] M. Block *et al.*, Eur. Phys. J **A25 Supp.** (2005) 49

[3] V. S. Kolhinen *et al.*, Nucl. Instr. and Meth. **A528** (2004) 776

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