The MAFFTRAP Penning Trap System

J. Szerypo, D. Habs, S. Heinz, J. Neumayr, and P.G. Thirolf

The MAFF facility (Munich Accelerator for Fission Fragments) planned at the research reactor FRM-II in Munich is dedicated to produce, cool and accelerate high-intensity neutron-rich radioactive beams.

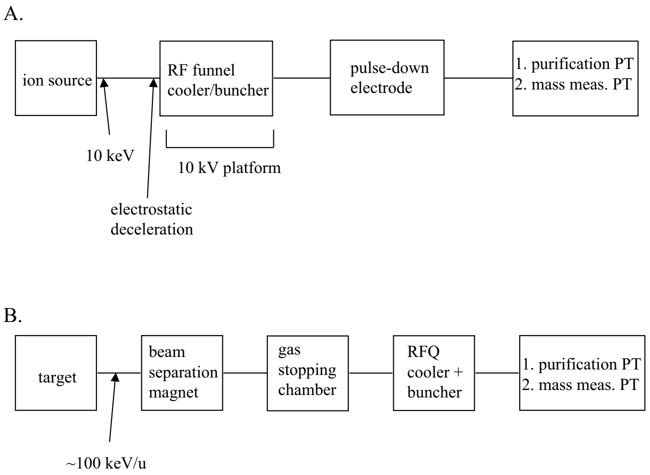

Fig. 1: MAFFTRAP testing assembly diagram.

The experimental activities at MAFF will focus around nuclear spectroscopy studies and nuclear mass measurements. One of the experimental devices serving this purpose will be the ion trap system MAFFTRAP [1]. Its main tasks are:
1) to decelerate, cool, bunch and purify the radioactive beam,
2) to perform high-precision (of the order of 10^{-7} [2]) nuclear mass measurements.

Before operating at MAFF, MAFFTRAP will be tested at the MLL (Maier-Leibnitz Laboratory) Tandem. The test stand is sketched in Fig. 1. Part A) shows a diagram for off-line testing. The assembly consists of:
1) an off-line ion source emittinga 10 keV stable ion beam,
2) an RF funnel cooler/buncher [3], on the 10 kV HV-platform in order to decelerate the ion beam to about 100 eV for an efficient cooling,
3) a pulse-down electrode, that is switched instantaneously from about 10 kV to nearly ground potential when the ion bunch from the RF funnel is inside. This procedure allows to decrease the total ion energy from 10 kV to a few tens of eV, which is required for an ion bunch injection into the Penning trap.
4) a double Penning trap system in one superconducting magnet, consisting of the cooling/isobaric purification Penning trap and the precise mass measurement Penning trap.

Part B) of the Fig. 1 shows a scheme for radioactive ion beam testing. It is composed of:
1) a target chamber, where the beam from the MLL Tandem produces, after fusion reaction, radioactive recoil nuclei. They are further separated from the primary beam by the
2) 90 degree beam separation magnet (B about 1 T),
3) a gas stopping chamber for the radioactive ions' deceleration [4] (to eV range),
4) a system of the RFQ cooler and buncher devices,
5) a double Penning trap system as in point A).

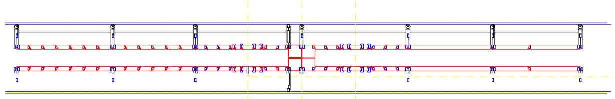

Fig. 2: MAFFTRAP electrode structure.

The Penning trap electrode structure is shown in Fig. 2. The two traps are separated by the 5 cm long, 2 mm diameter diaphragm, dividing the structure into different pressure zones: higher pressure (He buffer gas, about 10^{-4} mbar) in the purification trap, and lower pressure (about 10^{-6} mbar) in the mass measurement trap. The whole structure is placed on small wheels, allowing smooth inserting into the vacuum tube. The electrodes and holders of the structure were already machined in the LMU workshop and their examples are shown in Fig. 3.

Fig. 3: MAFFTRAP electrodes and holders.

In the year 2003 the B=7 T superconducting magnet for the Penning trap system was ordered. It will arrive to LMU in spring of 2004.

In a collaboration with K. Blaum of the University of Mainz, the off-line test stand will also be used for building and testing another Penning trap system. It will use the FTICR technique for ion detection [5] (in contrast to the MCP-TOF technique used by the MAFFTRAP set-up) and will allow for a non-destructive mass measurement of single ion species. This technique is also foreseen to be applied for MAFFTRAP in a future.

References

[1] J. Szerypo *et al.*, Nucl. Instr. Meth. **B204** (2003) 512
[2] G. Bollen *et al.*, Nucl. Instr. Meth. **A368** (1996) 675
[3] S. Heinz *et al.*, this report p. 94
[4] J. Neumayr *et al.*, this report p. 92
[5] C. Weber, Ph.D. thesis, GSI, 2004