STATUS OF THE VE-RFQ INJECTOR FOR THE ISL CYCLOTRON*

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Abstract

The new VE-RFQ-injector for the cyclotron at HMI in Berlin is now being commissioned. The ECR-source together with the RFQ's supply heavy ion beams with 90 - 360 keV/u for q/A > 0.15 matched to the isochronous cyclotron. Properties of the new injector, results of rf-tests, and first beam measurements will be presented.

1 INTRODUCTION

The scientific program at the ISL, the former VICKSI-facility has changed from nuclear physics to solid state physics [1,2]. The VICKSI-facility consisted of two external injection beamlines, a Van-de-Graff and a Tandem injector with a separated sector cyclotron as postaccelerator. To meet the demands of the solid state physics users the Tandem injector is replaced by a combination of an ECR-source mounted on a 200 kV platform and a two stage VE-RFQ with a frequency range of 85 to 120 MHz [3]. See figure 1.

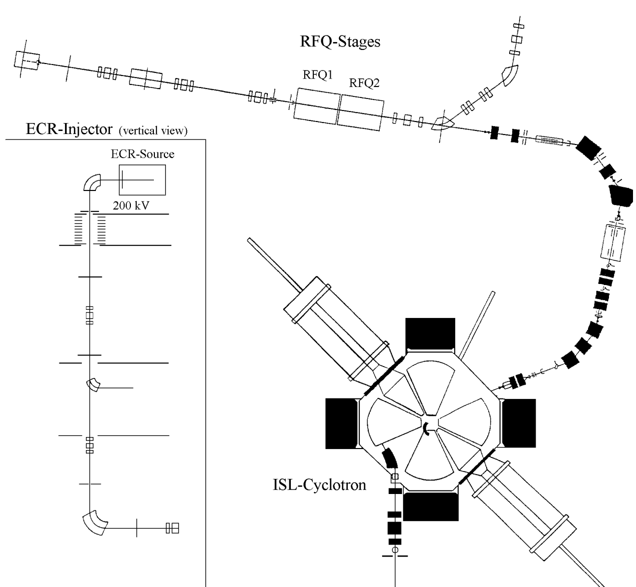

Figure 1: Scheme of the beamline

The ECR-RFQ-combination will accelerate the ions to energies between 0.09 and 0.36 MeV/n to cover the range of final energies out of the cyclotron between 1.5 and 6 MeV/n.

Therefore the 4-Rod-VE-RFQ is split into two RFQ stages, with the possibility of operating the second stage either as an accelerator or as an radial focussing transport channel [4,5].

2 MEASUREMENTS

2.1 Flatness

The voltage along the electrodes (flatness) is an important input factor for the particle simulations, especially for high duty factor operations (cw). The flatness of RFQ1 and RFQ2 was measured and is compared to the prediction in figure 2.

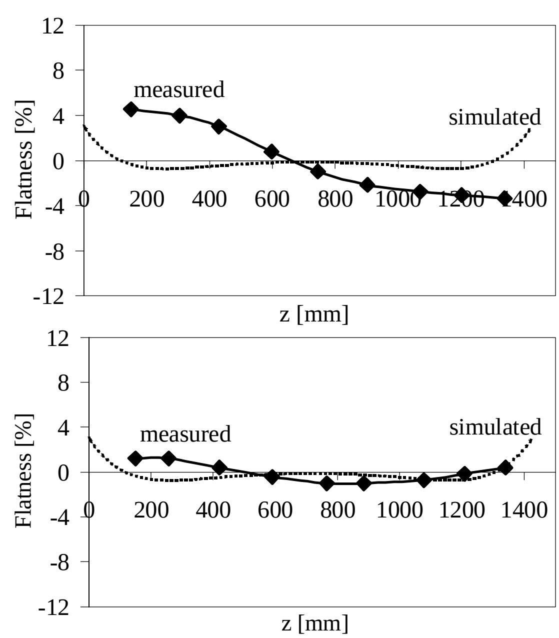

Figure 2: Measured and simulated flatness of RFQ1 (upper) and RFQ2 (lower).

The measurements agree well with the good flatness simulated, especially considering that the calculations were made for unmodulated electrodes. The measured

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differences between the two RFQ´s result from the varying electrode parameters (aperture, modulation), which change the capacity per length. But the variation is very low and should have no influence on the beam.

2.2 Rf-Measurements

First plans have foreseen a moveable coupling loop to ensure a steady high matching. Experiments with the coupling loop led to a frequency independent geometry and position close to the end of a support stem, resulting in a reflection better than –25 dB over the total frequency range. See figure 3.

Figure 3: Picture of the final coupling loop position

Both RFQ’s have been tested at frequencies between 85 and 120 MHz with a power-consumption of at least 18 kW. These tests confirmed once more the ability of the RFQ’s to work under the cw conditions.

After transport to and installation at HMI the former mechanical- and rf-status was successfully confirmed. A gamma-spectroscopy at 120 MHz (figure 4) showed that with a power-consumption of 5 kW both RFQ’s reach an electrode voltage of 20.8 kV which corresponds to a shuntimpedance Rp = 86 kΩ.

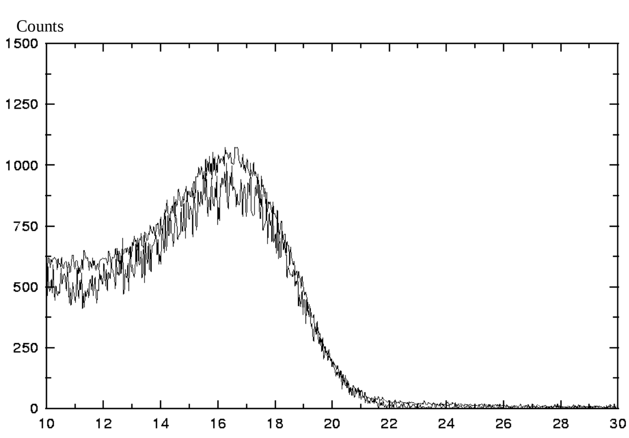

Figure 4: γ-spectroscopy of both RFQ’s at 120 MHz and 5 kW

2.3 Beam-Measurements

At 05-05-1998 the first accelerated beam through the ISL-RFQ was measured. At a frequency of 120 MHz an $^{16}O^{4+}$ beam was accelerated to 5.617 MeV. This result was reached with rf-parameters close to the theoretical values. Without the buncher-chopper combination in front of the RFQ a transmission of 40 % occurred, close to the simulated values. The transmission increased to 70 % with operational bunchers and without the chopper.

The spectroscopy in figure 5 shows the detected ion-beam behind the RFQ. The difference between the measured value of 4.81 MeV and the beam energy of 5.617 MeV is due to the special property of the detector and the method of calibration. An „ionisation-defect“ in the semiconducting detector leads to lower energies. The two peaks at 2.213 and 3.116 MeV result from other interactions between the target-foil and beam.

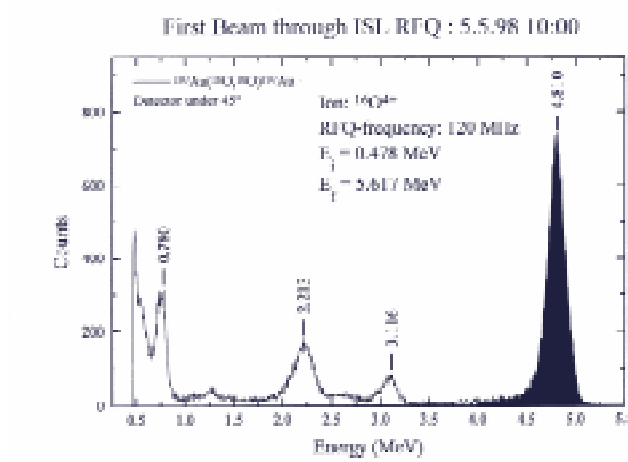

Figure 5: Spectroscopy of first beam through ISL-RFQ

3 STATUS AND SCHEDULE

The VE-RFQ at HMI has operated successfully with very high cw-fields and with proper output energy. More experiments at different frequencies will complete the first series of beam tests. Another series of experiments will concentrate on testing the second RFQ-stage operating in transport-mode.

At the same time the work is going on to complete the beamline behind the RFQ and on installing the necessary beam-optical device to adapt the beam to the cyclotron.

First experiments of injecting a beam into the cyclotron are scheduled for the middle of August.

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