Status of the REX-ISOLDE Project ◊

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REX-ISOLDE [1] an experiment with energetic radioactive beams at the already existing RIB-facility ISOLDE at CERN is now in the commissioning period. First experiments with the different components have already been done. The starting point of REX-ISOLDE was a new concept to convert a low energetic radioactive beam from ISOLDE in an efficient way to a high energy beam. The concept of post acceleration is the use of the techniques of buffer gas cooling, charge breeding in an high charge state ion source and post acceleration in optimized LINAC structures. The concept of charge breeding of the radioactive ions [2,3] in comparison to stripping is now under investigation in the EU-RTD-network "charge breeding". The basic technique applied to accumulate and bunch the beam is to continuously inject the radioactive ions into a large Penning trap. A variety of injection and cooling experiments have been done to explore the capability of REXTRAP. With beams from ISOLDE a maximum efficiency of 27% could be measured, whereas 45% efficiency could be reached with Cs beams from the test ion source. The main losses occur in the injection part of the trap, where the required electrode voltage level of the einzel lens can not be reached in order to focus the beam through the small injection diaphragm. Penning discharges restrict the voltage to 1 kV whereas for ligh ions 2-3 kV are required. This explains the strong mass dependence of the overall cooling efficiency. Influences of the space charge for particle intensities of about 10^6 particles per pulse have been seen in the increased energy spread of the extracted ions and in a deterioration of the cooling efficiency [4]. Investigations of the injection system are on the way to overcome the injection losses. The singly charged ions will be extracted from the trap and accelerated to 60 keV. Between trap and EBIS there is a transfer line which consists of two electrostatic 90^o benders and two quadrupole triplet lenses. The transmission is 100% for 60 keV beams, whereas the transmission is reduced to 30% in case of a 30 keV beam, which has been used for the first REX-ISOLDE test run in November 2000. The acceptance of the beam transfer line is about 30 π mm mrad.

According to the design of the REXEBIS the ions are bombarded by an 0.5 A, 5 keV electron beam with a current density of about 200 A/cm^2. The measured perveance of the electron gun (1.5 μA/V$^{3/2}$) is a little bit higher than expected. Losses at the collector barrier restrict the electron beam current to 350 mA at the moment. The emitted electron current from the cathode changed over the beam time. It is obvious that the LaB_6 crystal of the cathode moves in the graphite clamps and that the cathode needs to much heating power. In the next shut down period a new cathode will be installed, in order to reach higher beam currents up to 500 mA. Fig.1 shows two rest gas spectra for different confinement times. From those spectra a current density of 180 A/cm^2 could be derived. In addition 68% of the total trap capacity could be extracted and a compensation time of 50 ms has been reached. Within the expected breeding time of 20 ms no neutralization of the electron charges due to rest gas ions will occur. In the next shut down the axis of the EBIS toward the mass separator will be readjusted. An additional diagnostic in front of the EBIS and the improvement of the vacuum conditions in the EBIS with a new drift tube structure are foreseen as well.

The S-shaped beam line between the EBIS and the LINAC is a mass separator which separates the few highly-charged radioactive ions out of the ions from the residual gas. In the last year all optical elements have been delivered to CERN and installed in the beam line. The vacuum system and the SIMATIC control have been installed as well. The cabling is completed and first commissioning measurements have been done. Therefore the separator was used for the analysis of the residual gas beam from the EBIS in order to determine the different elements. The calculated beam dynamic in the separator could be probed by diagnostic devices. The beam spot at the positions of the diagnostic boxes has been measured and compared with the calculation. The measured beam sizes are in good agreement with the calculated values. The A/q-resolution derived from the measured rest gas spectra is 100.

All structures have been tested in Munich and in Heidelberg and the rf-parameter have been determined. In addition beam tests with the RFQ, the re-buncher and the 7-gap resonators have been performed. Beam emittance and energy analysis have been carried out with the RFQ and the re-buncher matching section.

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