STATUS OF THE REX-ISOLDE LINAC*

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Abstract

The Radioactive beam Experiment (REX-ISOLDE) [1] a pilot experiment testing a new concept of post acceleration of radioactive ions at ISOLDE/CERN is under progress. Radioactive singly charged ions delivered by the on-line mass separator ISOLDE are accumulated in a Penning trap, then charge bred to A/q < 4.5 in an electron beam ion source (EBIS) and finally accelerated in a LINAC from 5 keV/u to a final energy between 0.8 and 2.2 MeV/u. The resonant structures of the LINAC consist of a Radio Frequency Quadrupole (RFQ) accelerator, a 3-gap split ring buncher, an interdigital H-type structure and three 7-gap spiral resonators, which allow to vary the final energy. New beam line calculations of the mass separator and the matching section between the RFQ and the IH-structure have been done. A test beam line including a duoplasmatron ion source, an electrostatic quadrupole lens system and a prototype of a diagnostic box is assembled. The vacuum tank of the IH-structure is in production as well as the buncher. The RFQ is assembled and ready for first vacuum tests. The first 7-gap resonator is almost completed and first tests are sheduled. The present paper describes the status of the separator and the REX-ISOLDE LINAC.

1 INTRODUCTION

REX-ISOLDE is a first generation Radioactive Ion Beam (RIB) project to explore the structure of neutron rich Na, K, Ca and Mg isotopes and the possibilities of an effective post acceleration of exotic ions due to charge breeding with dedicated state of the art machines. The frame parameters of the LINAC are an operation frequency of 101.28 MHz which is the half frequency of the CERN proton LINAC II, the timing of the extraction and a repetition rate of up to 50 Hz require a maximum duty cycle of 10%. To be flexible in the kind of experiment and for different ion species the exit energy has to be variable between 0.8 and 2.2 MeV/u. [2]. The radioactive ions are injected into the LINAC with an A/q-ratio between 3 and 4.5. The used structures is a 4-rod RFQ similar to the first RFQ of the Heidelberg high current injector [3] using mini-vanes as electrodes.

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In addition an IH-structure is used as a booster structure which is a small version of the tank1 of the lead LINAC-IH-structure at CERN [4]. For matching the phase spread of the ion beam out of the RFQ to the longitudinal phase acceptance of the IH-structure a 3-gap split ring resonator is used. The energy variation is done by three 7-gap spiral resonators similar to the structures used at the Heidelberg high current injector [5]. The complete experiment is shown in Fig.1 including the beam optics and the target region.

2 HARDWARE STATUS

All resonance structures of the LINAC are now in production or already delivered. Hence an overview of the hardware status can be given. The installation of the LINAC at ISOLDE takes place in the next shut down period. The Penning trap is fully assembled and first tests of the injection system have been done [6]. The beam line trap-EBIS has been calculated and is now under construction. The cryostat of the EBIS was damaged after a He-quench test and is now in repair. The vacuum system of the EBIS as well as the collector and the gun are completed and shipped to CERN.

2.1 The q/A separator

The ion beam leaving the EBIS contains impurities from residual gas inside the EBIS. Therefore a q/A-separator is required with a resolving power of about 150. In order to be independent in the resolving power from the energy spread of the ions due to the potential depression of the electron beam of the EBIS an achromatic system was chosen, where the resolving power is dependent on the EBIS emittance [7]. The amount of radioactive isotopes from ISOLDE can be down to 100 times lower than the number of residual gas ions. Thus the overlap of the mass peaks at the mass separation slit must not be higher than 0.01%. Therefore the EBIS emittance has to be lower than 10 π mm mrad (2σ) to get a resolving power of 150. The hardware of the separator is in production, the vacuum system is delivered. The electrostatic quadrupole quadruplet (EQQ1) is completed and built into the test beam line.

The deflector tank is in production as well as the deflector. The construction of the electrostatic lenses is

completed. The deflecting magnet with a maximum field of 0.2 T is ordered.

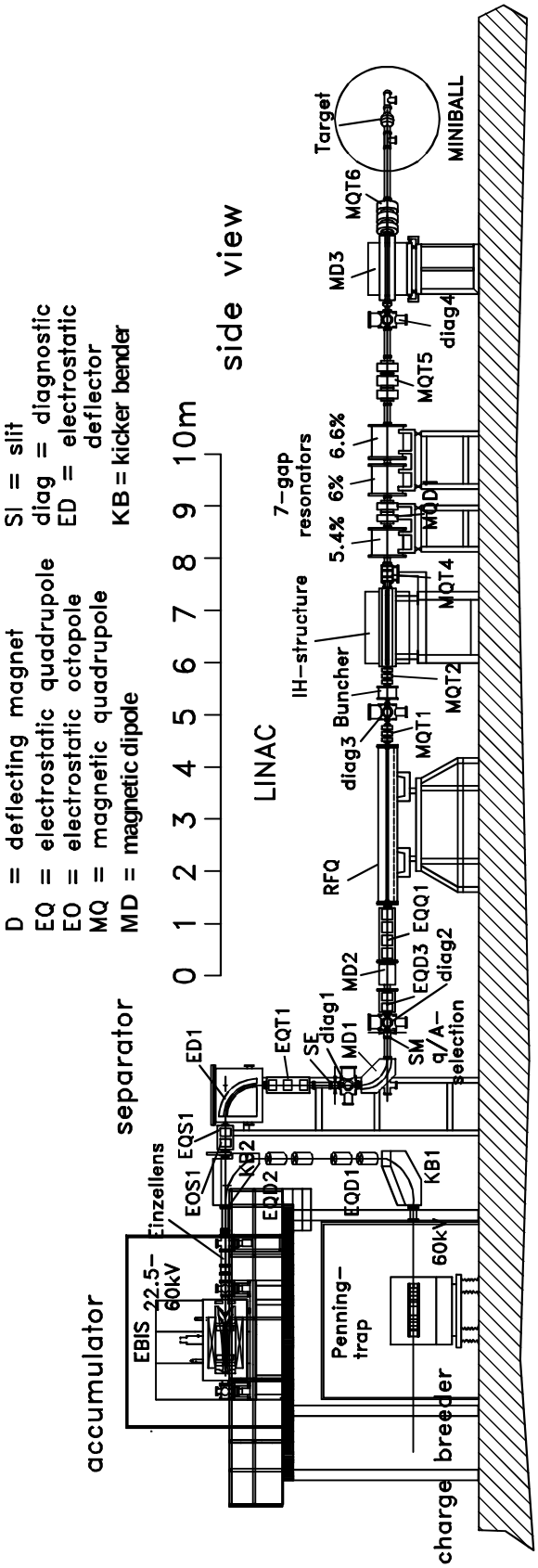

Figure 1: Layout of REX-ISOLDE.

This magnet has the possibility to shape the exit pole face for higher order corrections by iron fingers mounted at the mirror plates.

2.2 The four-rod RFQ

The REX-ISOLDE-RFQ has been assembled and a first frequency tuning has been done. In these measurements the flatness of the rod voltage, the quality factor and the shunt impedance have been determined. The resonator is ready for the first vacuum test. For the power test the water cooled ground plates have to be mounted and the final alignment has to be done. More details about the RFQ are presented in [8] on this conference.

2.3 The buncher

The vacuum tank for the Split Ring Buncher has been manufactured and leak checked. Next step is copper plating at GSI. An 1:1 model of the resonator has been built and tuned to the proper frequency. The final drift tube assembly has been manufactured. Fig.2 shows a view of the present tank with the split rings.

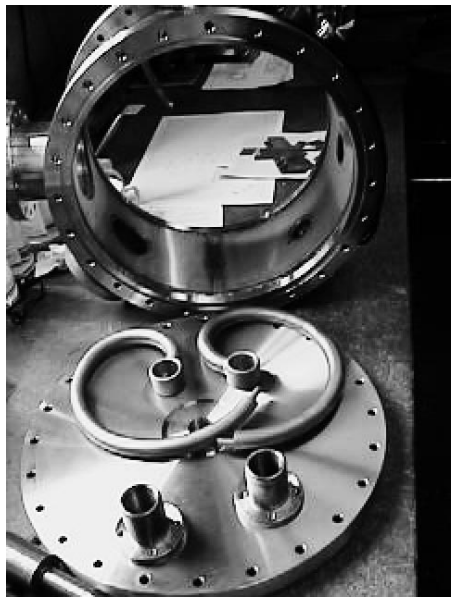

Figure 2: Vacuum tank of the buncher and the split ring structure.

2.4 The IH-Structure

The booster part of the LINAC is a short IH-structure with a maximum resonator voltage of 5.04 MV. Identical to the twin brother structure tank1 of the CERN lead LINAC the REX-ISOLDE-IH-structure consists of a center frame which carries the drift tubes and two half shells which are double walled for water cooling reasons. In fig.3 one can see the two walls of both half shells and the center frame with the support of the drift tubes. The photo was taken before the frequency tuning via the half shell length has been done. The big holes in the half shells are for the pumping flange, the incoupling loop and the inner-tank triplet lens. The triplet lens mounted in the IH-

vacuum tank is now completed and will be delivered from DANFYSIK within the next three weeks. After the final production of the tank all parts will be copper plated until the end of the year. The drift tubes will now be brazed to the supports and both will than be copper plated.

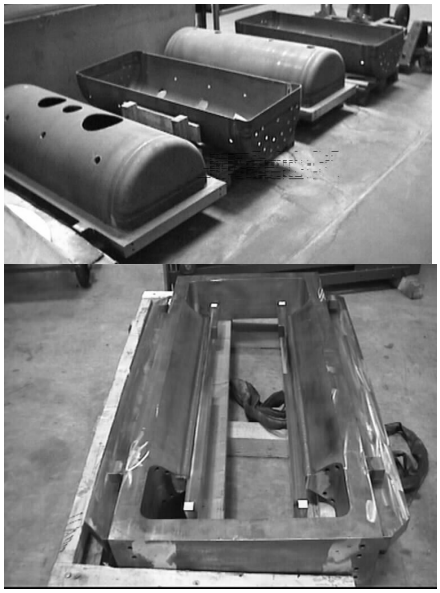

Figure 3: Half shells and center frame of the IH-structure before the final assembly at the company NTG.

2.5 The 7-gap resonators

The high energy section of the REX-ISOLDE LINAC consists of three 7-gap resonators each with a single resonance structure. It consists of a copper half shell to which three copper arms are attached on each side. Each arm consists of two hollow profiles, surrounding the drift tubes and carrying the cooling water. Copper segments on both sides allow to tune the resonator to the required frequency. The optimization of all model resonators is finished. The resonators will achieve the design voltage of 1.75 MV at 90 kW incoupled rf-power.

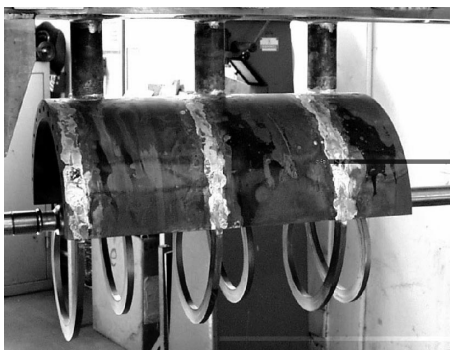

Figure 4: Resonance structure of the 5.4% power resonator directly after brazing of the arms into the half shell.

All components of the power resonators (tank, half shells, arms and drift tubes) are in production (fig.4) or already finished. The first half shell (5.4% resonator) is brazed and will be assembled into the tank after cleaning and polishing of the surface. After the tuning to the right frequency the resonator will be ready for vacuum, power and beam tests. The production of the resonators are well within the time schedule, expecting the first accelerated beam in 1999.

3 TEST BEAM LINE

In order to test the RFQ as the first acceleration stage, an injection system as well as an ion source are required. Therefore a duoplasmatron ion source has been borrowed from the university of Frankfurt. For the present geometry the calculated current of 1^+ He-ions is about 38 μA assuming 20 kV extraction voltage. This current will be reduced by collimators and slits down to 1 μA in order to reduce the emittance to the EBIS emittance. For beam diagnostic the prototype of a diagnostic box for REX-ISOLDE developed at KU Leuven will be used. In order to get the right beam slope in both transverse directions for the injection into the RFQ the electrostatic quadrupole quadruplet of the mass separator will be used. In the first stage the beam leaving the RFQ will be examined. Later the matching section will be included and the buncher will be tested with the He-beam as well.

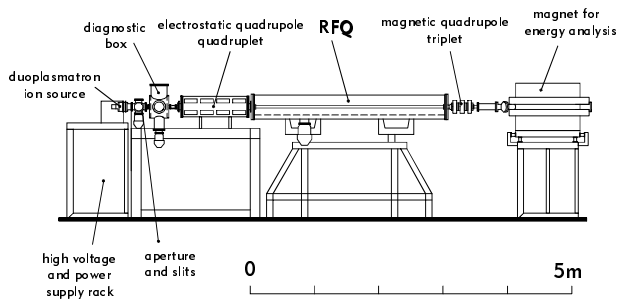

Figure 5: Lay-out of REX-ISOLDE test beam line for beam analysis of the RFQ beam

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