STATUS OF THE REX-ISOLDE PROJECT*

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Abstract

The Radioactive beam Experiment REX-ISOLDE, a pilot experiment testing a new concept of post acceleration of radioactive ions at ISOLDE/CERN is in progress. Singly charged radioactive ions delivered by the online mass separator ISOLDE are accumulated in a Penning trap (REX trap), charge bred in an electron beam ion source (EBIS), separated from the residual gas in a mass separator and then accelerated in a Linac with output energies between 0.8 and 2.2 MeV/u.

The REX trap is in operation, a first test beam was already injected. The design phase of the EBIS is finished and the construction has been started. The superconducting magnet is delivered.

The Linac consists of a radio frequency quadrupole (RFQ) accelerator, an interdigital IH-structure and 3 seven gap resonators to vary the final energy. The RFQ is assembled and vacuum tested, a beam test for the RFQ is in preparation. The vacuum tank of the IH-structure is machined, the assembly of the resonator has started. The first 2 seven gap resonators of the high energy section are finished and ready for power tests, the last one is ready for assembly.

1 INTRODUCTION

The Radioactive beam Experiment (REX-ISOLDE) at ISOLDE/CERN [1, 2, 3] is under progress, first hardware components are completed and some tests of the components were performed. In the experiment the radioactive ions of charge 1+ from the on-line mass separator ISOLDE will be cooled and bunched in a Penning trap (REX trap), charge bred in an electron beam ion source (EBIS), separated from the residual gas ions and finally accelerated in a short LINAC to a target energy between 0.8 and 2.2 MeV/u. The LINAC consists of a radio frequency quadrupole (RFQ) accelerator, which accelerates the ions up to 0.3 MeV/u, an interdigital H-type (IH) structure with a final energy between 1.1 and 1.2 MeV/u and three seven gap resonators, which allow the variation of the final energy. All components of the experiment are either in production or undergo first test measurements. The lay-out of REX-ISOLDE is shown in fig. 1.

* Work supported in part by the German Federal Ministery for Education, Science, Research and Technology (BMBF) under contract No. 06HD802I and No. 06LM868I(2).

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2 REX TRAP

The Penning trap is fed from the ISOLDE main beam line where the beam axis is 1.27 m above the floor. The Penning trap is fully assembled on a 60 kV high voltage platform including the differential pumping stages which ensure good vacuum conditions in the beam line. High tension tests with the equipment and first tests of ion injection into the trap have been carried out in order to investigate the injection optic [4]. The electrode structure consisting of gold plated copper rings isolated by ceramic spacers is assembled and installed in the solenoid bore. The central field strength is 3 T and the gas pressure inside the trap 10^{-3} mbar for rest gas cooling. A plasma ion source has been installed to test the ion capture with a stable 60 keV $^{40}Ar^{+}$ beam. These capture tests were done in the beginning of 1999 and the first ions were trapped. A new shielding due to charging of the insulators are installed and will be tested in the near future. The singly charged ions will be extracted from the trap with a typical bunch length of 10 μs every 20 ms and accelerated to 60 keV.

3 EBIS

In the EBIS the ions are bombarded by a 0.5 A, 5 keV electron beam with a current density of about 200 A/cm^2 [5]. In the EBIS the ions will be charge bred in about 15 ms to a charge to mass ratio between 0.22 and 0.34, which is well suited for the mass separator and the LINAC. After several

0-7803-5573-3/99/$10.00@1999 IEEE.

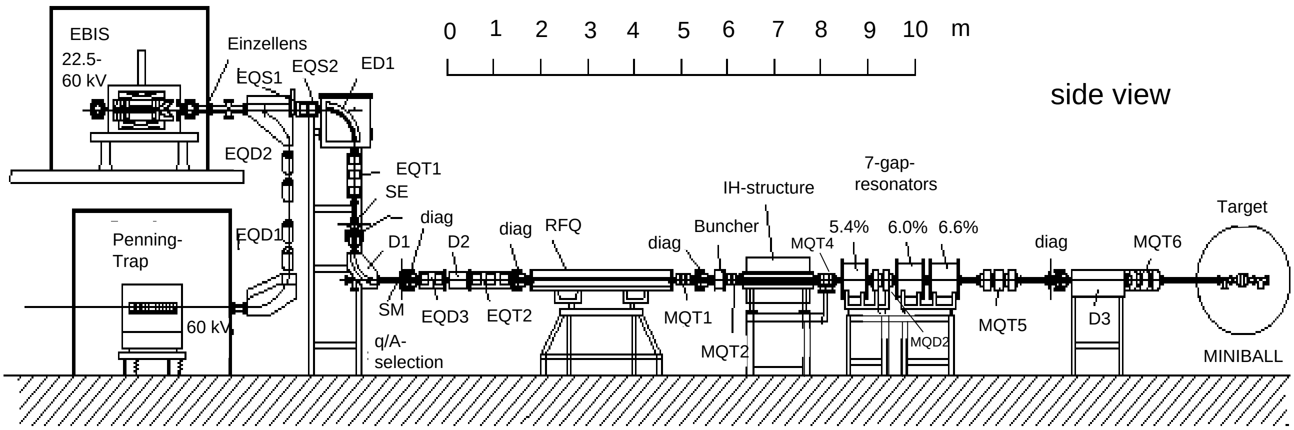

Figure 1: Lay-out of the REX-ISOLDE experiment

repairs of the REX-EBIS solenoid by the manufacturer due to damages occurring during quench tests, the EBIS magnet is now back at CERN and ready for operation. The vacuum system is completed and being assembled at Stockholm. The electron gun, the collector and the electrode system are completed and will be shipped to CERN. As shown in fig. 1 the EBIS rests on a platform above the trap. This platform has been completed and the high voltage platform for the EBIS has been mounted on top of that support.

4 MASS SEPARATOR

The S-shaped beam line between the EBIS and the LINAC consists of a mass separator [6] to separate the few highly-charged radioactive ions from ions originating from the residual gas. The deflecting magnet has been ordered and the construction of the electrostatic elements has been completed. The electrostatic lenses are now in production. The massive ridge which carries the electrostatic deflector and the vertical beam line of the separator (fig. 1) will be mounted to the same concrete tower which carries the trap-EBIS transfer beam line.

5 LINAC

The RFQ is the first structure of the LINAC [7]. It is now fully assembled, which means the water cooled ground plates, the stems and the mini-vane like quadrupole electrodes are mounted in the tank and the capacitive plungers are installed, cabled and tested. The vacuum system has been installed and first vacuum tests have been performed. Low level frequency tuning and flatness measurements have been done. Alignment of the electrodes, final adjustment of the voltage flatness and the installation of the incoupling loop are presently being performed.

The IH-structure of REX-ISOLDE [8] is a short version of the IH-tank1 of the CERN LINAC III [9] and consists of a center frame which carries the drift tubes and two half shells carrying cooling jackets. The first acceleration section is followed by an inner tank quadrupole triplet lens, which has been delivered and will be installed after some test measurements and the delivery of the IH-vacuum tank. The drift tubes and the stems are completed and are now beeing copper plated together with the IH-vacuum tank. The piston tuners are in production. The change of the final energy of the IH-structure via the piston tuners has been examined once more by a detailed MAFIA model of the power resonator. The calculations are in very good agreement with measurements taken from the vacuum tank of the power resonator and show the required tuning by changing the half shell height [10].

The production of the three seven gap spiral resonators forming the back part of the LINAC [11] is almost finished. The design velocities of the resonators were fixed to 5.4%, 6.0% and 6.6% of the velocity of light and the field optimization at the operation frequency of the power amplifiers (f=101.28 MHz) of the three down scaled models resulted in an achievable resonator voltage of 1.75 MV at 90 kW incoupled rf power.The 5.4% und 6.0% power resonators are finished and ready for high power rf and beam tests. Fig. 2 presents a view inside the resonator. The resonance structure is connected to the tank via three stems, in which the copper hollow profiles for the cooling of the arms and the drift tubes are brazed together. Fine tuning is done with a tuning plate. With segments connected on the half shell the so called rough tuning to 101.28 MHz is done. The resonator is seen here on a test bench where the low level rf measurements were done.

The 6.6% resonator is assembled, the tuning to the amplifier frequency of 101.28 MHz is presently done.

So far low level RF measurements have been performed with the 5.4% and 6.0% resonator yielding parameters shown in table 1. In particular, these measurements show that a resonator voltage of 1.9 MV can be expected with a rf power of 90 kW, which is safely above the design voltage of 1.75 MV. As the first out of three rf power amplifiers

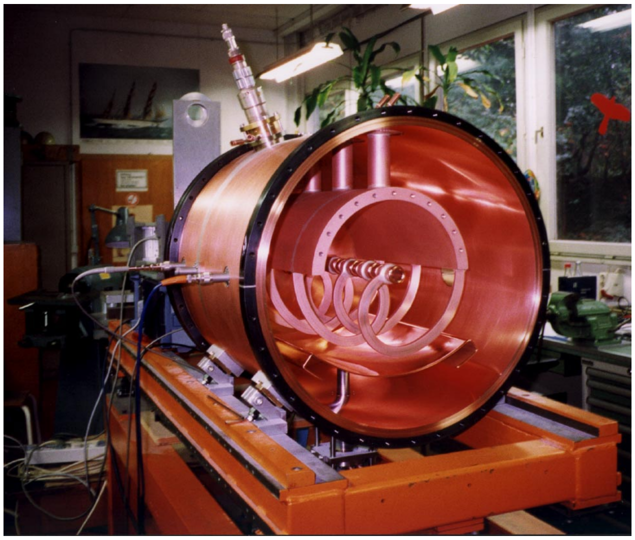

Figure 2: *The 5.4% power type resonator*

providing 100 kW with a duty factor of 10% has been delivered in December 1998, high power and beam tests have now been started. The second rf amplifier is in production and will be delivered directly to Munich. The residual three rf power amplifiers will be completed until end of 1999 and delivered directly to CERN.

The set up of the fully tested 7-gap-resonators at CERN is planned to take place in autumn 1999.

parameter	5.4% resonator	6.0% resonator
f [MHz]	101.28	101.28
Q–value	5620 ± 50	5420 ± 50
Z [MΩ/m]	71 ± 6	68 ± 5
U_0 [MV]	1.9 ± 0.1	1.9 ± 0.1

Table 1: *Measured parameters of the 5.4% and 6.0% power type resonators, f = frequency, Z = shunt impedance, U_0 is the expected resonator voltage reached with an rf power of 90 kW.*

6 TARGET

The MINIBALL γ-detector array [12] consists of a new generation of Ge-detectors with large full-energy peak efficiency to make an optimum use of the expensive radioactive beams. With its compact arrangement it is mainly suited for detecting events with small γ-ray multiplicities. In the final system the array will consist of 14 clusters with 3 individually encapsulated 6-fold segmented Ge-detectors. A prototype has been tested and have shown resolutions around 2.1 keV at 1.33 MeV γ-energy. 6 Clusters are expected to be operational when REX-ISOLDE starts operation. The electronics for MINIBALL will be purchased from the company XIA; in contrast to former Ge-detector electronics, all analog circuits are replaced by digital electronics using flash ADC's and DSP's. The target chamber is completed and has been vacuum tested. Prototypes of the particle detectors (double sided silicon strip detector DSSSD) have been produced and tested with an alpha-source.

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