Status of the REX-ISOLDE Project ◇

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REX-ISOLDE [1,2] is an experiment with energetic radioactive beams at the already existing RIB-facility ISOLDE at CERN. It makes fully use of the vast experience and availability of many low energetic radioactive 1^+ ion beams from the on-line mass separator ISOLDE. Fig.1 shows the general layout of the experiment and the concept of post acceleration. REX-ISOLDE is the first RIB experiment using a device with buffer gas cooling for accumulation and bunching of ions and a high performance EBIS for charge multiplication of the ions to simplify the accelerator as much as possible. This concept of charge breeding of the radioactive ions [3] in comparison to stripping will be explored in future in more detail in an EU-network for charge breeding. Though REX-ISOLDE focuses on specific experiments with final beam energies up to 2.2 MeV/u, options for extensions to higher and lower beam energies are on hand, which open up a broad field of future experiments in nuclear spectroscopy, nuclear astrophysics and solid state physics.

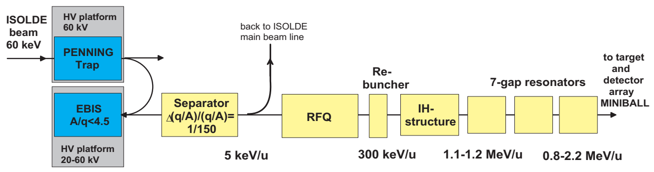

Fig. 1: Schematic of the concept to produce energetic radioactive beams with REX-ISOLDE.

The scheme of REX-ISOLDE is pursued in several steps fulfilling separated functions. The 1^+ beam is first bunched in a Penning trap and its phase space is reduced by cooling. In the electron beam ion source (EBIS) the 1^+ ions are then converted to highly charged ions by bombarding them with an intense electron beam. In the next step a separator selects the wanted charge-to-mass ratio. This bunched low-energetic beam of highly charged ions is first accelerated in a 4-rod RFQ-LINAC to 0.3 MeV/u. In the following IH-structure and the three 7-gap resonators the ions are further accelerated to a tunable final energy between 0.8 MeV/u and 2.2 MeV/u. After a momentum analysis in a dipole magnet the ions are transported to a target, which is surrounded by a highly efficient detector system. An additional beam line will be used for experiments which do not require the MINIBALL γ-detection array. In addition to the high energy experiments ions from the trap or from the mass separator can be guided back to the ISOLDE main beam line for low energy experiments of e.g. solid state physics.

Bunching of the radioactive beam is required in the proposed acceleration scheme, because charge-state breeding in the EBIS requires a typical time of about 20 ms and the LINAC operates with a duty factor of 10%. For the low-intensity radioactive beams it is furthermore advantageous to compress the ions in short pulses in order to increase the signal to background ratio in the measurements. The basic technique applied to accumulate and bunch the beam is to continuously inject the radioactive ions into a large Penning trap, where they are stopped by collisions with the atoms of a buffer gas, accumulated, purified and finally extracted as pulses. REXTRAP [4] is a 1 m long cylindrical trap structure filled with buffer gas in a 3 T magnetic field (fig.2). It is mounted on a high voltage platform close to 60 kV in order to retard the ions from 60 keV to some eV suitable for injection into the trap. First experiments with the trap have been done in order to determine the extraction emittance, the purification of the beam and the influence of space charge effects inside the trap. In first experiments emittances of 2 π mm mrad at 2.5 keV extraction energy have been measured and overall bunching efficiencies of 20% have been reached with a rather low buffer gas pressure. With higher pressure about 100% effieciency can be achieved. 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.

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 bender and two quadrupole triplet lenses. Along the transfer beam line there are several differential pumping stages in order to decouple the buffer gas filled Penning trap from the ultra high vacuum of the EBIS. The transfer line is being built up and will be installed in beginning of 2000. In the EBIS the ions are bombarded by an 0.5 A, 5 keV electron beam with a current density of about 200 A/cm^2. In the EBIS the ions will be charge bred to a charge to mass ratio between 0.2 and 0.34, which is well suited for the mass separator and the LINAC. The EBIS is fully assembled, as can be seen in fig.2. The electron gun, the collector and the electrode system have been tested with

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