Introduction

Besides regularly delivering C$^{2+}$ ions for the heavy ion therapy the HLI is mainly serving the high duty cycle experiments investigating superheavy elements (SHE), which request beams of rare isotopes in most cases. The most suitable ion source for this purpose is an ECR ion source (ECRIS) with its high efficiency and low material consumption. At GSI there is the demand to increase the intensity of the ECRIS as it is also requested at other European accelerator laboratories. Within EURONS of FP6 the joint research activity ISIBHI (Ion Source for Intense Beams of Heavy Ions) started at the beginning of 2005. A prototype of a new generation of ECRIS will be built that can be adapted to the different requirements in cw and pulsed mode. Higher ion beam intensities from an ECRIS require an increase of the plasma density. According to semiempirical scaling laws and to experiments at present ECRIS [2, 3, 4] the electron density is directly related to the square of the microwave frequency. Considering the electron cyclotron resonance condition and following scaling laws for the magnetic flux in ECRIS [3] the increased microwave frequency requires an increase of the magnetic field above 2.2 T implying the use of superconducting magnets.

Superconducting Magnets and Cryostat

The minimum B configuration of MS-ECRIS will consist of a mirror field generated by 3 coaxial solenoidal coils and of a radial field generated by hexapolar coils which are coaxial with the mirror coils. The solenoid coils are surrounding the hexapole. The cryostat design includes high temperature superconducting (HTS) current leads and cryocoolers for operation in stand-alone mode. Four separate power supplies (3 for the solenoids and one for the hexapole) will be used to get optimal conditions for adjusting the magnetic plasma confinement. The magnetic system and the cryostat are under construction at ACCEL Instruments [5]. The double wall plasma chamber is water-cooled and should be able to dissipate a maximum RF power of 10 kW. It is placed in the central warm bore of the magnet cryostat. A 2 mm lead shield between the plasma chamber and the insulator will reduce the X-ray emission thereby reducing the heat load of the cryostat. High voltage insulation will be provided by a 4 mm thick polyetheretherketone (PEEK) cylinder between the chamber and the cryostat. The length of the plasma chamber will be about 650 mm.

Microwave Injection

The RF power to be injected into the plasma chamber of MS-ECRIS is estimated to be about 6 to 10 kW following the experiences of previous experiments [2]. The microwave injection line will reproduce the reliable layout used for the SERSE ECRIS including filters and bending unit [2]. A new design for the 60 kV dc break is under study, allowing the full power transmission for long time operation. The microwave will be provided by a 28 GHz transmitter based on a gyrotron tube of 10 kW maximum power. The cryostat provides magnetic shielding of the stray field produced by the superconducting magnet system using high permeability iron for the external walls. So the residual magnetic field will be lower than 2 mT at 4 m distance from the cryostat at the position of the transmitter in order to ensure the safety of the gyrotron tube.

Experimental Setup

The ECR injector test setup (EIS) at GSI [6] will be used to investigate the MS-ECRIS source. The presently installed CAPRICE ECRIS including support stand and extraction box will be replaced by the MS-ECRIS with its ancillary equipment while the beam transport line will be upgraded to handle the increased power dissipation caused by the high extraction currents of MS-ECRIS. The transport through the beamline has been studied with different computer codes to investigate the influence of space charge and its compensation. The maximum beam magnetic rigidity allowed by the beamline is 0.088 T m, which is suitable for full characterization of any beam at a voltage of 40 kV or lower.

According to the time schedule of ISIBHI the experimental program will start after spring 2007 until the end of 2008.

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