Beam experiments with the Grenoble Test
Electron Cyclotron Resonance Ion Source at iThemba LABS
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Abstract
At (iThemba Laboratory for Accelerator Based Sciences (iThemba LABS) a new electron cyclotron resonance source (ECRS) was installed and commissioned. This source is a copy of the Grenoble Test Source (GTS) for the production of highly charged ions. The source is similar to the GTS-LHC at CERN. A collaboration between the Accelerators and Beam Physics Group of CERN and the Accelerator and Engineering Department of iThemba LABS resulted in the manufacturing of the GTS2 at iThemba LABS, in which the results of CW and afterglow operation for Helium and Oxygen as supporting gases are presented.

Introduction
iThemba LABS provides accelerator and ancillary facilities for research and training in physical, biomedical and materials science. At the heart of the iThemba LABS accelerators complex is the variable-energy, separated-sector cyclotron. A high-intensity 14MeV proton beam, pre-accelerated in the first solid-pole injector cyclotron is used for therapy and proton therapy. The diagnostic beam line of the GTS2 at iThemba LABS, in which the results of CW and afterglow operation for Helium and Oxygen as supporting gases are presented.

Beam Line Set-Up
The set up of the beam lines in the ECRIS vault with the new diagnostic beam line for the GTS2 allows for simultaneous operation, i.e. the required beam for cyclotron acceleration will be delivered from one source, while the second source can be used for beam development. The diagnostic beam line of the GTS2 has on interface which focuses the beams on the double-focusing distance in front of the RF magnet. Behind the magnet a horizontal slit is situated on the double-focusing distance to ensure sufficient mass resolution. The diagnostic line is completed with a chamber containing a slit-harp emittance device for both transverse planes and a Faraday cup.

GTS2 ECRIS
The coils, the permanent magnet assembly, the plasma chamber and all mechanical parts of the GTS2 were manufactured by different companies in Europe, which were also involved in manufacturing the GTS-LHC. For the vacuum system of the source three 700l/s turbo pumps (one at injection and two at extraction), one 70l/s turbo pump for the oven system and two dry 1.6T. A 600A bipolar power ion source for the injection, centre and extraction electrode. The plasma source for the injection- and extraction area can deliver 350mA at 45kV, leading to a maximum field of 1T. A 660kW bipolar power supply is connected to the centre coil. The permanent magnet array in the Hallhain configuration produce 1.27T at the plasma wall surface. The 2-3kW microwave wave guides operating at 14.5 and 18GHz are connected to the source via WR62 wave guides. The active plasma chamber volume which is manufactured from Aluminium is 1430cm³ at an active length of 30cm and a diameter of 7.8cm. The triode extraction system consists of a plasma electrode which is positioned at the end of the permanent magnet array in the plasma chamber, an intermediate electrode at a distance of 30mm to the plasma electrode, and a ground electrode at 5mm distance to the intermediate electrode. The apertures diameters of the electrodes are 12, 17, and 17mm, respectively. The source can be operated with two resistive loads which were not installed during the experiments. The bias disc (BD) has a surface of approximately 12cm² and is positioned at 18mm distance from the injection chamber exit flange which roughly corresponds to a position at the beginning of the permanent magnet array in the plasma chamber.

References