DEVELOPMENT AND PERFORMANCE OF A PROTON AND DEUTERON ECR ION SOURCE*

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Abstract

A 5mA proton and deuteron rf source is under production at ACCEL. This source will provide the front end of our superconducting proton/deuteron linear accelerator. The design of the source is based on the proven AECL design of a 100 mA proton source [1]. The paper will describe the design of the source and the layout of the test bench currently set up at ACCEL to characterize the source. Results of the beam dynamic simulations performed to optimise the source geometry based on KOBRA 3D will be presented as well.

INTRODUCTION

In 2003 ACCEL was contracted by SOREC on the production of a turn key proton and deuteron accelerator. For this purpose ACCEL started to design an electron cyclotron resonance ion source which is based on the AECL model.

Table1: Desired specification

Parameter	Value
Maximum beam current H+, H2+, D+	5mA
Minimum beam current H+, H2+, D+	0.03mA
Beam current ripple at max current (%)	6
Beam current ripple at min current (%)	3
Normalized 90% (2 sigma) emittance X/Y	< 0.2 π.mm.mrad
Mormalized (1 sigma) emittance X/Y	< 0.05 π.mm.mrad

Several modification of the original design had to be done to reach the desired specification (see Tab.1):

- To decrease the emitted beam current to 5mA the extraction geometry had to be changed.
- To meet the requirements of the RFQ the ion source uses a smaller acceleration voltage than the original one.
- To avoid damage of the vacuum window at the rf infeed by electron impacts the window had been displaced behind the first bend of the rf-wave guide.

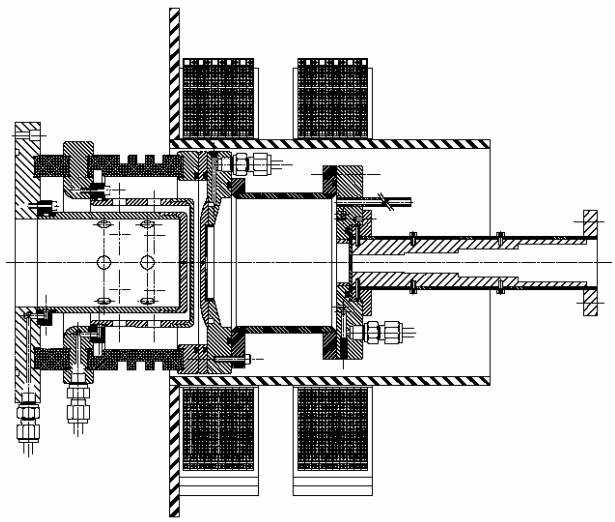

Figure1: The source design used at ACCEL.

SIMULATION RESULTS

To reach the desired beam specification we needed to simulate the beam extraction of the source in forehand. We used the 3D software Kobra3 for simulation. It was necessary to find a geometry that delivers an emittance < 0.2 π.mm.mrad for both protons and deuterons. The desired maximal current of 5mA determined the beam hole diameter.

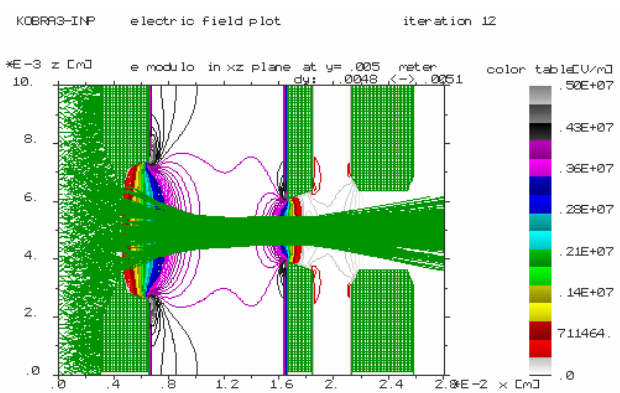

Figure 2: Simulated extraction of deuteron beam.

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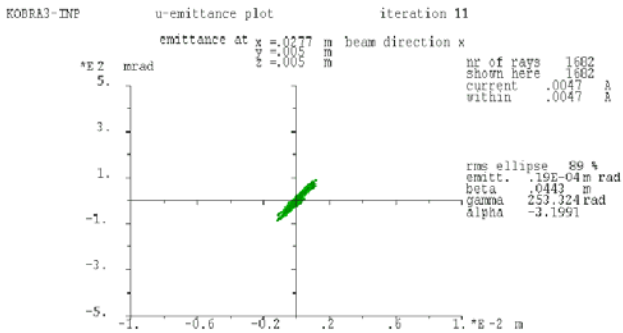

Figure 3: Emittance of simulated deuteron beam.

STATUS

Currently the ECR Ion Source is installed and combined with the low energy beam transfer line in its test bench.

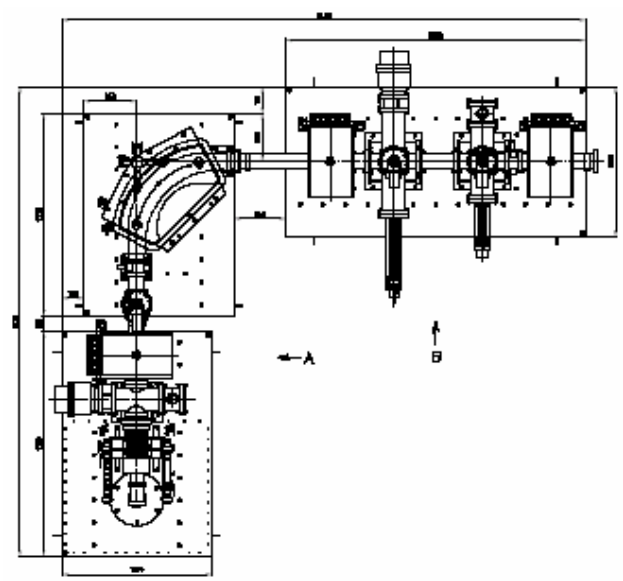

Figure 4: Top view of the ECR Ion Source with LEBT.

The LEBT includes the beam diagnostic consisting of slits and wire scanners and faraday cups. All diagnostic elements except of the wire scanner are water cooled to be able to absorb the full energy of the beam.

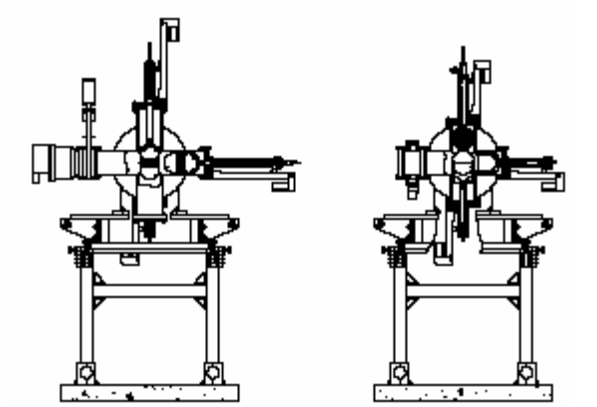

Figure 3: Beam diagnostic at LEBT.

First test showed that the Plasma is easy to ignite, even with low rf power (110W), after the magnet field of the solenoids surrounding the plasma chamber had been optimised. At the first run a proton beam of 0.1mA had been extracted by a 20kV acceleration, this value will be increased by optimising the fields of the involved solenoids.

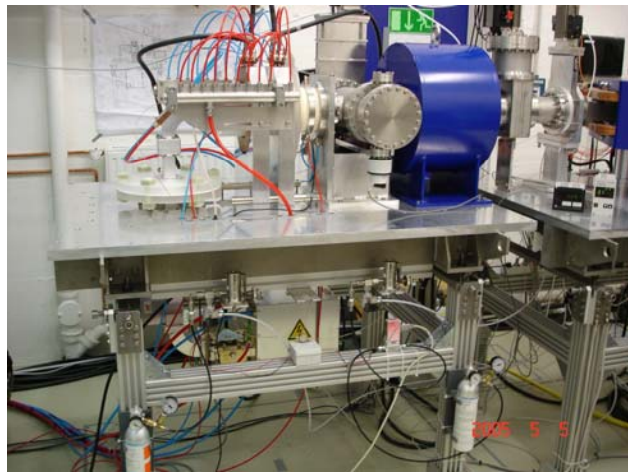

Figure 5: Side view of the ECR ion source.

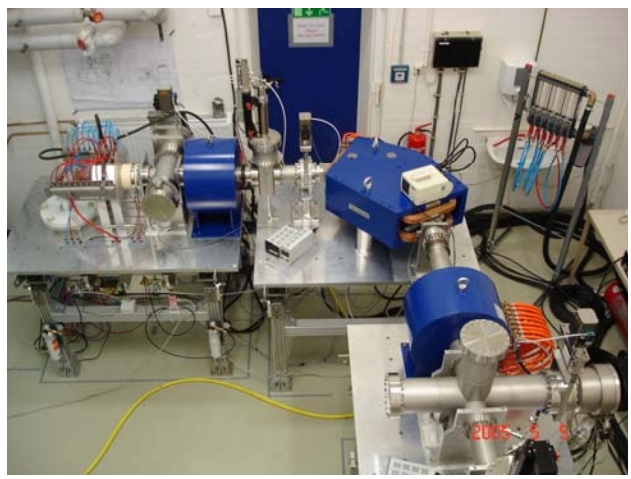

Figure 6: Top view of ECR ion source with LEBT.

Currently ACCEL is analysing the extracted beam and comparing it with previous simulations to optimise the beam shape.

NEXT STEPS

During the next week the extracted proton beam will be brought to its design value. After that the settings will optimised for transversal emittance and all parameters checked for their stability. To simulate deuteron operation H_2^+ will be used, due to legal limitations given for the use of the in house test bench.

REFERENCES

[1] Taylor T and Mouris J F 1993 Nucl. Instrum. Methods A 336 1