Available online at www.sciencedirect.com
SCIENCE DIRECT®
Vacuum 78 (2005) 385–388
VACUUM
SURFACE ENGINEERING, SURFACE INSTRUMENTATION & VACUUM TECHNOLOGY
www.elsevier.com/locate/vacuum

Preliminary results on the DECRIS 14-2m ECR heavy-ion injector source

Andrej Zeleňák[a,*], Maroš Gregor[b], Miloslav Štefečka[a], Vladimír Gašparík[a], Peter Kováč[a]

[a]*Cyclotron Centre of the Slovak Republic, Karloveská 63, 842 55 Bratislava, Slovakia*
[b]*Slovak Institute of Metrology, Karloveská 63, 842 55 Bratislava, Slovakia*

Abstract

The DECRIS 14-2m multiply charged heavy-ion injector source, designed, manufactured and tested at the Joint Institute of Nuclear Research, Dubna (JINR), has recently been installed and commissioned at the Cyclotron Centre of the Slovak Republic, Bratislava (CC SR). The source is of the electron cyclotron resonance (ECR) design and together with ion optics and beam transport lines is fitted to a UHV target chamber for first stage tests. A description of the source is given here together with some preliminary results on ion yield and efficiency of beam transport.

Keywords: ECR; Ion source; Injector; ECRIS

1. Introduction

The Electron Cyclotron Resonance (ECR) Laboratory has been opened in February 2004, in the Cyclotron Centre of the Slovak Republic (Bratislava, Slovak Republic). The activities of the laboratory will be focused on the current problems of the materials research as surface science and engineering, physics of highly charged ions and their interaction with surfaces. The laboratory is based on the ion source DECRIS 14-2m and experimental channels. It is a multiply charged heavy-ion source based on the ECR principle (see e.g. [1]). It was designed and manufactured in the Joint Institute of Nuclear Research (JINR), Dubna, Russia. Dubna electron cyclotron resonance ion source (DECRIS 14-2m) was already tested at the test bench in Dubna from March to July 2001 [2]. The ion source DECRIS 14-2m and its ion-optic line was reassembled, tested and put into operation in Bratislava by the specialists from JINR from October to December 2003. The transport beam line in the first low-energy channel transports the ion beams to an ultra high vacuum

*Corresponding author. Tel.: +421 2 602 94 744; fax: +421 2 602 94 748.
E-mail address: zelenak@ccsr.gov.sk (A. Zeleňák).

0042-207X/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.vacuum.2005.01.054

(UHV) target chamber. A postacceleration by 150 kV and a vacuum chamber are planned for the second channel.

2. Description of the ECR ion source

The ECR ion source named DECRIS 14-2m [3] is complete heavy-ion injector, which can deliver multiply charged ion beams from gaseous and solid materials with a beam energy up to $Q \times 25\,\mathrm{kV}$ (where Q is the charge state of ions). A design of the magnetic and mechanical structure of the DECRIS 14-2m is based on the version DECRIS-2 [4]. The improvements of DECRIS 14-2m are related to the magnetic structure of the hexapole and solenoid coils, and a microwave system of the ion source. The ion source is operated at a microwave frequency of 14 GHz and maximal power of 2 kW. The scheme of the magnetic structure and axial magnetic field of the ECR ion source in DECRIS 14-2m is shown in Fig. 1. The gaseous and solid substance inlet system used for the production of the multiply charged ion beams is situated at the injection side of the ion source. The solid substance inlet system is based on a miniature oven (minioven) for the evaporation of the solid substances, the minioven positioning mechanism and the heater power supply. The solid substance is placed into the minioven and then inserted through the bias electrode into the plasma chamber. As the solid material is heated, its vapour diffuses into the plasma and the atoms of the material are progressively ionized. The minioven heater can be used up to 900 °C. The heater temperature is determined indirectly from the heater current and voltage.

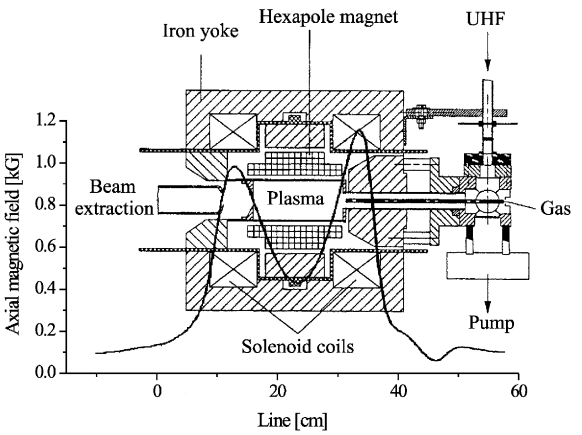

Fig. 1. The scheme of the magnetic structure of the ECR ion source DECRIS 14-2m and its axial magnetic field.

The transport beam line of the ion source is approximately 5.6 m long. It consists of the focusing and analysing magnets, the vacuum system, the ion beam diagnostic systems, the safety and control systems and the utilities (the water cooling system, the compressed air system, etc.). The main feature of the transport beam line and analysing line is their ability to bend the ion beam towards the low-energy experimental channel with the UHV target chamber. The scheme of the transport line with the ECR ion source is shown in Fig. 2. The vacuum system consists of cryogenic,

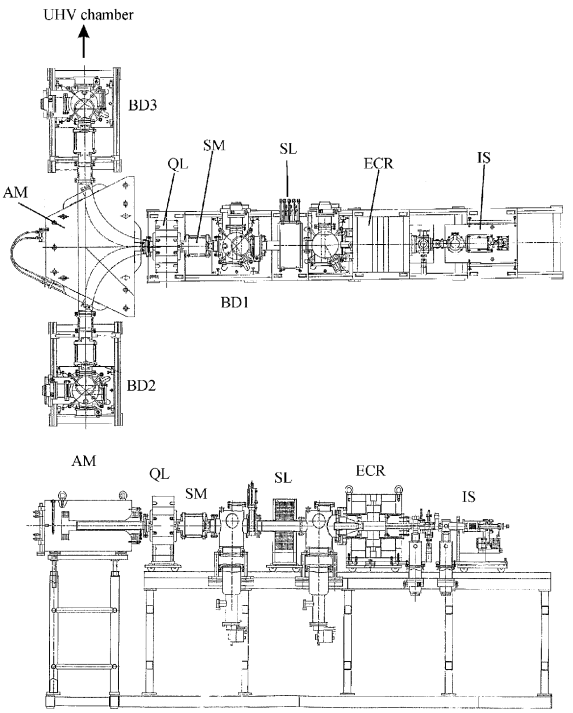

Fig. 2. The scheme of the transport line with the ECR ion source: ECR—electron cyclotron resonance ion source, IS—inlet system (gases and minioven for solid substances), SL—solenoid, SM—steering magnet, QL—quadrupole, AM—analysing magnet, BD—block of diagnostics.