DRESDEN EBIS-SC – A NEW GENERATION OF POWERFUL ION SOURCES FOR THE MEDICAL PARTICLE THERAPY

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Abstract

A new generation of EBIS sources, the Dresden EBIS-SC, is being designed for applications in medical particle therapy. The Dresden EBIS-SC is a superconducting compact ion source which is based on the most modern principles of refrigeration technology as well as electron-beam technology. Besides DC currents of protons, C^{6+}, O^{8+} and other ions the Dresden EBIS-SC provides ion pulses for single-turn and multi-turn injection into a synchrotron with pulse widths varying from 1 μs up to 100 μs. The Dresden EBIS-SC will produce up to (2...3) $\times 10^{10}$ protons and (2…4)$\times 10^{9}$ C^{6+} ions.

INTRODUCTION

Three generations of high-innovative room-temperature EBIS/EBIT ion sources of highly charged ions have been developed by the collaboration of the Technische Universität Dresden and the DREEBIT GmbH Dresden since 1999 [1]. These sources differ in the extractable currents of highly charged ions and can be applied in research, in industrial technologies as well as in medicine.

In the past it was demonstrated at different scientific centres that EBIS devices are reliable for the use as ion sources for injectors to synchrotrons. Based on such experiences the combination of an EBIS as source of C^{6+} ions and protons for the use in medical synchrotrons was already proposed 15 years ago [2,3] and is recently again under discussion [4]. However, a practical realisation of this idea has not been achieved, but the enormous progress in ion-source technologies should now allow the introduction of EBIS devices into the medical particle therapy now.

Actually a new class of high-current ion sources for particle therapy, the so-called Dresden EBIS-SC, is under construction. This source will feature beam parameters satisfying the requirements for medical synchrotrons [5,6] leading to a compact and a low-cost solution for medical applications in particle therapy.

THE DRESDEN EBIS-SC

The operation principle of an EBIS can be found for example in [7,8]. EBIT and EBIS were characterized by their capability to produce ions with the highest ion charge states now available. Furthermore, beside the property to produce highly charged ions for some applications intense currents of highly charged ions are of interest. This is the motivation for the development of a fourth ion source generation using the most advanced techniques for forming high magnetic fields and for the transport of intense and high dense electron beams. This ion source, the Dresden EBIS-SC, will produce ion currents of highly charged ions like C^{6+}, H_2^+ and protons high enough to use this source for particle therapy purposes.

Figure 1: 3D presentation of the Dresden EBIS-SC.

A 3D presentation of the Dresden EBIS-SC is shown in Fig. 1. This ion source is actually under construction and will be available in 2008. The device will be very compact with an overall length of about 50 cm and a diameter based on DN200CF. No liquid gases are required. Simply water as coolant for the anode and the electron collector should be available with regular water pipe pressure.

Table 1: Design parameters of the Dresden EBIS-SC

Parameter	**Value**
Total length	circa 50 cm
Magnetic field	up to 6 T
Electron energy	up to 30 keV
Electron current	up to 1 A
Electron current density	up to 1000 A/cm^2
Trap length	20 cm; 8 drift tube segments
Trap capacity	up to 5×10^{10} elementary charges

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