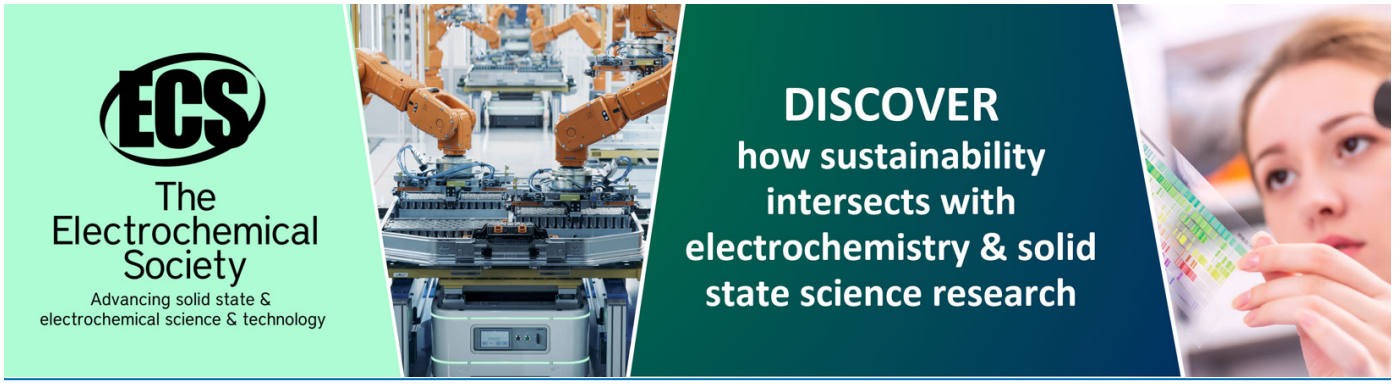
On the beam emittance/brilliance of highly charged ions extracted from the Frankfurt 14GHz Electron-Cyclotron-Resonance-Ion-Source in standard and enhanced (MD) mode



On the beam emittance/brilliance of highly charged ions extracted from the Frankfurt 14GHz Electron-Cyclotron-Resonance-Ion-Source in standard and enhanced (MD) mode

J. C. Müller[*1], R. Dörner[*], F. King[*], L. Schaechter[+], K. E. Stiebing[*2]

[*] Institute for Nuclear Physics, Goethe Universitaet, Max von Laue Str. 1, D-60438 Frankfurt am Main, Germany
[+] National Institute for Physics and Nuclear Engineering, 77425 Bucharest, Romania

Synopsis Electron Cyclotron Resonance Ion Sources (ECRIS) provide only moderate emittances as compared to other types of ion sources. Besides considerable effort to improve the total output of ECRIS´s by dedicated modifications (gas mixing, wall coating etc.), it is important to also determine the influence of such improvements on the beam quality. In this contribution dedicated experiments on the influence of the MD method [1] on the emittance/brilliance of extracted ion beams from the Frankfurt 14GHz ECRIS are presented.

Electron-Cyclotron-Resonance-Ion-Sources (ECRIS) are widely used as injectors of highly charged ions into linear accelerator structures. Substantial experimental and theoretical effort has been made to improve this type of ion source with regard to their high charge state performance. One of these methods is the use of a special layer with a well-defined metal-dielectric transition at the inner wall of the plasma chamber (MD-method) [1], which has been tested in detail in a series of experiments at the 14 GHz ECRIS of the IKF in Frankfurt (see Figure 1).

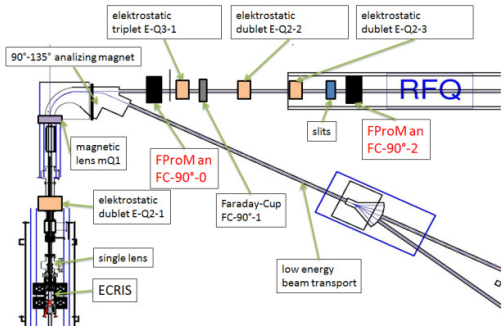


Figure 1. Infrastructure of the Frankfurt 14GHz ECRIS and RFQ installation, FProM: Frankfurt profile and emittance monitor.

This method strongly increases the output of highly charged ions and allows reducing the x-ray load for a given intensity [2]. Dedicated measurements have shown that the effect is due to an increase of density and temperature of the plasma electrons as compared to the standard stainless steel walls [3].

To effectively inject the ion beam into subsequent accelerator structures and/or into a transport channel to the experiments a sufficiently small emittance is needed. In order to provide information on the influence of the MD-method on these beam parameters dedicated experiments have been performed in the frame of a master thesis [4].

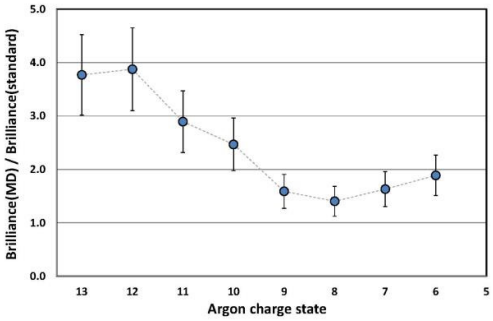


Figure 2. relative brilliance of argon ions extracted from the ECRIS in MD configuration as a function of the charge state, normalized to the brillaince for the standard source.

In Fig. 2 the relative brilliance of extracted argon ions as a function of the charge state from the ECRIS in MD configuration is presented and demonstrates the strong improvement of the brilliance particularly for high charge states. These results will be discussed in detail.

References

[1] L. Schaechter *et al* 1999 *Rev.Sci.Instr.***70** 1367
[2] L. Schaechter *et al* 2000 *Rev.Sci.Instr.***71** 918
[3] L. Schaechter *et al* 2002 *Rev.Sci.Instr.***73** 4172
[4] J. C. Müller 2015 "*Emittanzmessungen an der Frankfurter Elektron Zyklotron Resonanz Ionenquelle*" Master Thesis IKF

[1] E-mail: janmueller@atom.uni-frankfurt.de
[2] E-mail: stiebing@em.uni-frankfurt.de