Computational Design Studies for an Ion Extraction System for the Oak Ridge National Laboratory "Volume-Type" ECR Ion Source

H. Zaim[*] and G.D. Alton
Physics Division, Oak Ridge National Laboratory[†]
P. O. Box 2008, Oak Ridge, TN 37831-6368

A three-electrode system for optimally extracting high intensity, multi-charged, ion beams from an all-permanent-magnet, "volume" type, ECR ion source has been computationally designed. The results of these studies clearly show the importance of the adjustability of the extraction gap in order to ensure high quality, minimum divergence ion beams. Details of the electrode system design, as well as angular divergence and RMS emittance versus extraction parameter data (e.g., perveance and extraction gap), are provided for ion beams of varying intensity, charge state, and mass, under the influence of a magnetic field. Under optimum extraction conditions (i.e., minimum divergence, thus highest quality and transportability), the plasma meniscus reaches an optimum curvature and the current density has an optimum value; these values are found to closely agree with those derived from elementary analytical theory for extraction of space-charge dominated beams. Results of studies of the influence of mirror-magnetic fields on beam angular divergence during extraction provide a clear explanation of why the emittances of admixtures of highly-charged ion beams are large compared to those for individual charge-state beams.

[*] Ph.D. graduate student, University of Versailles, Versailles, France.
[†] Managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.