EFFECT OF MAGNETIC FILTER IN A VOLUME PRODUCTION MULTICUSP ION SOURCE*

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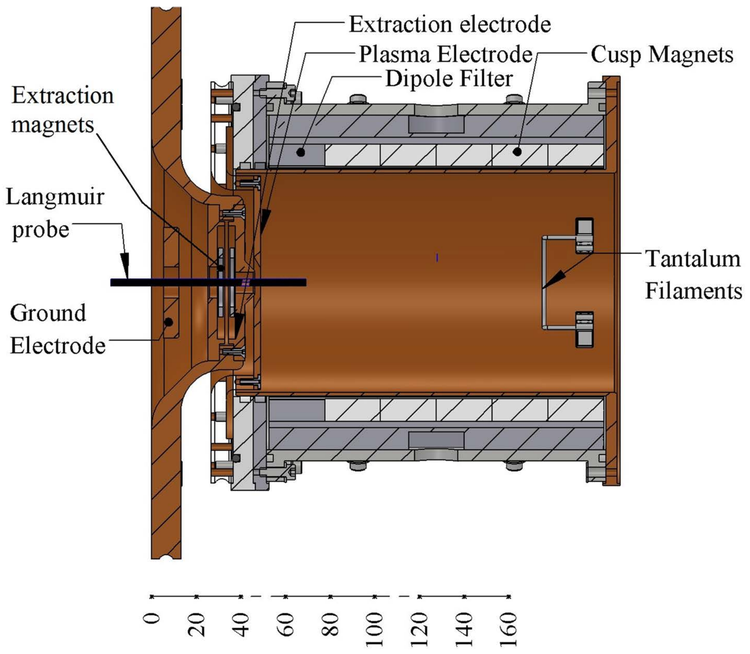
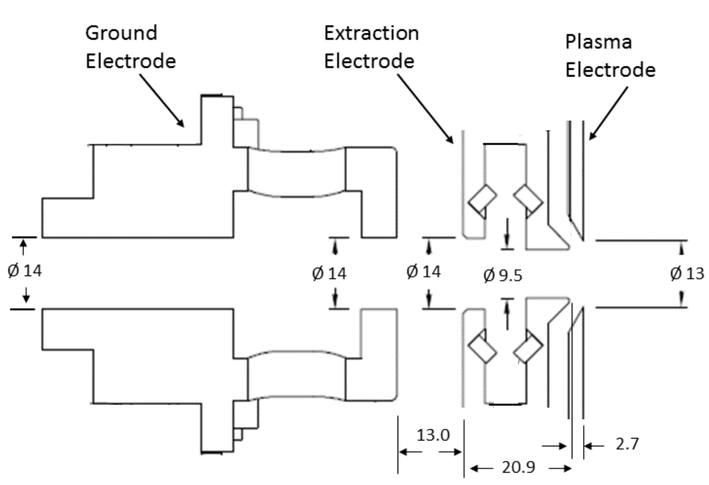
Abstract

D-Pace's TRIUMF licensed volume production multicusp ion source[1] utilizes dipole magnetic fields inside the plasma chamber to filter out energetic electrons that lead to the destruction of negative ions inside the source. The ion source uses the same magnetic field for the extraction of negative hydrogen and deuterium ions. In this paper, we investigate if different magnetic field strengths are required for H_2 and D_2 plasmas for maximum negative ion extraction. The effect of varying the strength of the magnetic filter fields in the extraction of negative ions of hydrogen and deuterium is studied. The response of plasma parameters like electron temperature and electron density to different magnetic fields are determined using a Langmuir probe.

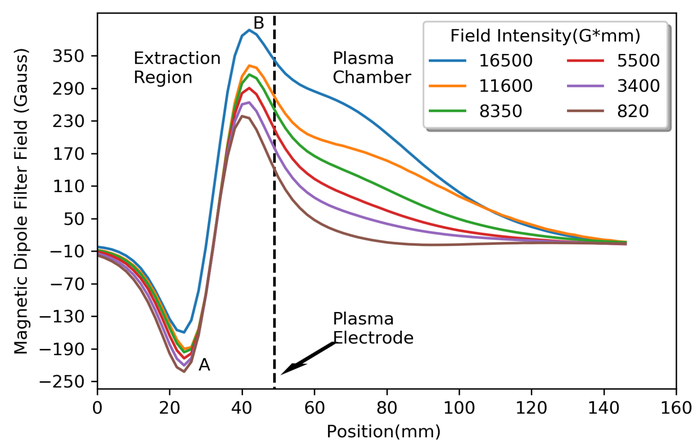
Schematics of the ion source & Extraction system



Ion Source



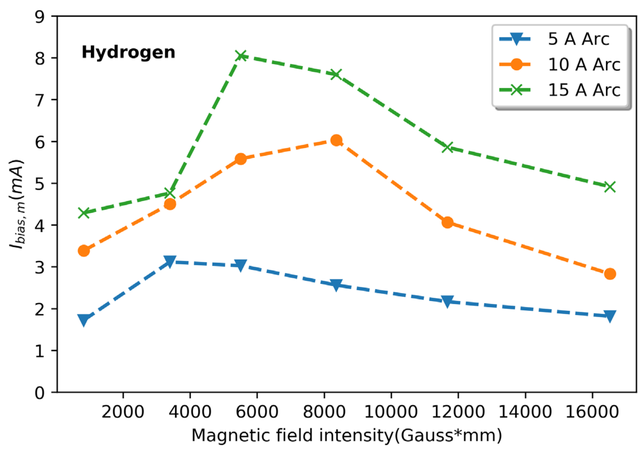
Extraction system

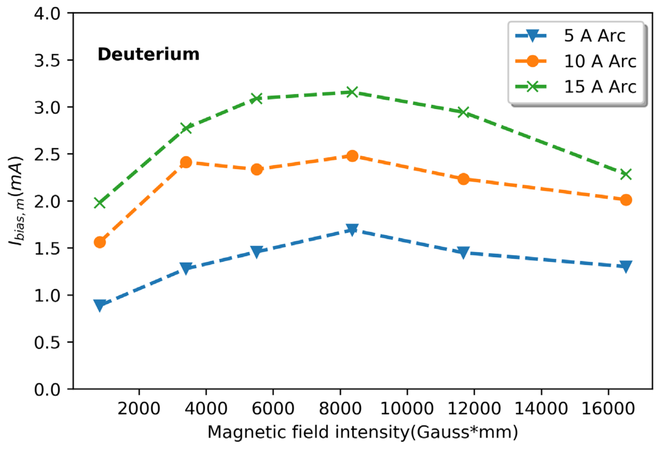


Magnetic field distribution inside the source for different filter fields

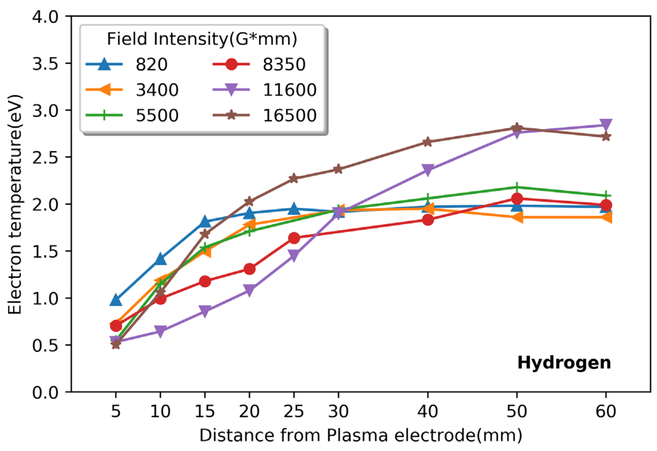
Results

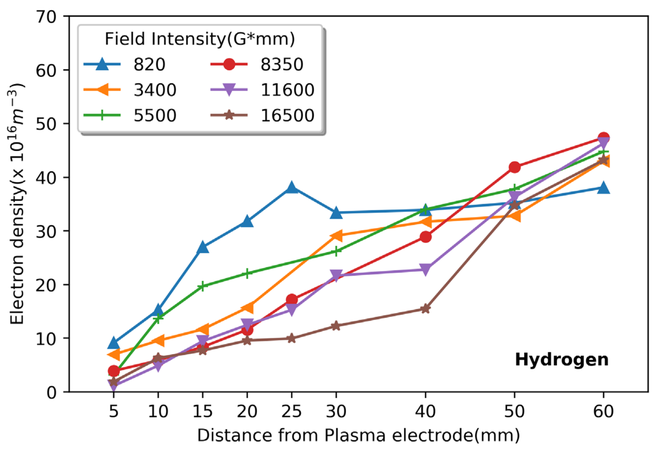
- **Maximum extracted currents[2] for H_2 & D_2 for different arc currents, at arc voltage of 120 V and bias voltage of 5 kV. Gas flows are optimised for maximum beam currents.**

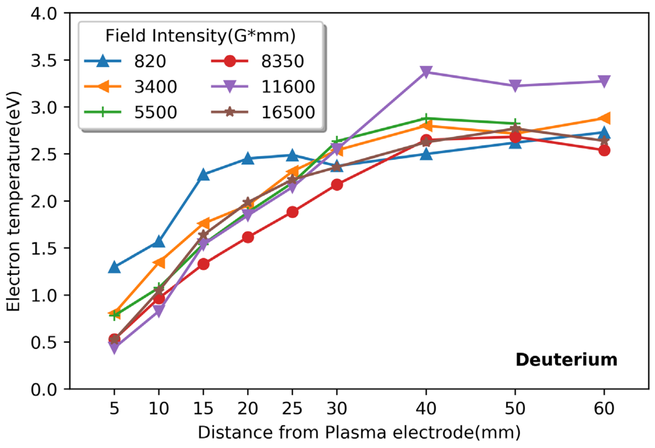


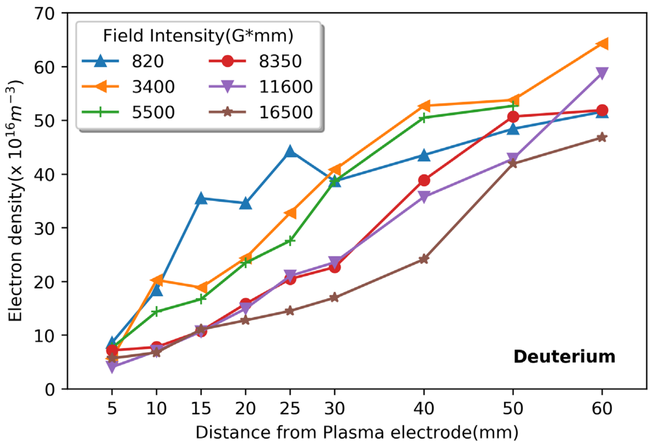


- **Variation in electron temperature and electron density for H_2 & D_2 are studied at arc current of 5 A , arc voltage of 120 V and gas flow of 7.5 sccm, using Langmuir probe[3]. Plasma electrode and source are at ground potential. Results are shown below.**









Conclusions

- Dipole magnetic filter field plays an important role in the formation of negative ions in H_2 and D_2 plasmas.
- The dipole magnetic filter field should be optimized for extracting maximum beam currents, as too low(<3500 G*mm) or too high fields(>10000 G*mm) result in low beam currents.
- Maximum ion currents are obtained for H_2 and D_2 when electron temperatures are in the range 0.5 eV at 5 mm from plasma electrode.
- Results indicate that D_2 plasma requires a higher magnetic field(7000-8000 G*mm) than H_2 (4000-6000 G*mm) for optimum negative ion current extraction.

References

[1]T. Kuo *et al.*, "On the development of a 15 mA direct current H− multicusp source," *Review of scientific instruments*, vol. 67, no. 3, pp. 1314-1316, 1996.
[2]S. Lawrie, D. Faircloth, A. Letchford, M. Whitehead, and T. Wood, "Detailed beam and plasma measurements on the vessel for extraction and source plasma analyses (VESPA) Penning H− ion source," *Review of Scientific Instruments*, vol. 87, no. 2, p. 02B122, 2016.1.
[3]Merlino R L. Understanding Langmuir probe current-voltage characteristics. American Journal of Physics. 2007;75(12):1078-85.

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