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Improvements to a 13.56 MHz RF Powered H^- Ion Source

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D-Pace's new 13.56 MHz RF powered H^- ion source, a hybrid design between the TRIUMF licensed filament powered ion source [1] and the University of Jyväskylä licensed RF ion source [2], has been shown to be less efficient than the filament powered ion source, even though both sources use the same body and extraction system [3]. The difference is thought to be due to RF power losses to the outside of the ion source, to the lack of plasma confinement on the back plate of the ion source, and to the absence of a sputtered tantalum coating on the plasma chamber walls. We believe that the lack of confinement on the back plate also causes the RF window to get hot, with a maximum temperature measured at 450 ℃ at 3.5 kW of RF power. We are investigating the use of a solenoid and permanent magnets behind the antenna and the back plate of the ion source to create a magnetic field that further confines the plasma by preventing the electrons from striking the RF window. Electron tracking simulations show that both methods can reduce the electron density on the RF window in similar proportions as with the filament ion source. Furthermore, we present the effect of sputtering a tantalum coating on the plasma chamber of the ion source on the production of H^- ions in the RF powered source. Our results show an increase in H^- beam current at higher RF powers with a fresh coat, and a subsequent decrease in beam current over time.

References

[1] Kuo, T., et. al. "On the development of a 15 mA direct current H^- multicusp source." Review of scientific instruments 67.3 (1996): 1314-1316.

[2] Kalvas, T., et. al. "A CW radiofrequency ion source for production of negative hydrogen ion beams for cyclotrons." AIP Conference Proceedings. Vol. 1655. No. 1. AIP Publishing, 2015.

[3] Melanson, Stephane, et. al. "H^-, D^-, $C_2{}^-$: A Comparison of RF and Filament Powered Volume-Cusp Ion Sources." 8th Int. Particle Accelerator Conf. (IPAC'17), Copenhagen, Denmark, 14-19 May, 2017. JACOW, Geneva, Switzerland, 2017.

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