Installation and commissioning of the D-Pace ion source on the K150 cyclotron

B.T. Roeder, G. Tabacaru, H.I. Park, S. Molitor, S. Schmidt, S. Melanson[1] and A. George[1]
[1]*D-Pace Inc., 305-625 Front St., Nelson, BC, Canada*

This year, the pre-existing H^- ion source, the prototype LIISA source from JYFL [1] for the K150 cyclotron has been replaced by a similar, but more versatile ion source from D-Pace Inc. The Positive/Negative Filament Ion Source [2], licensed from TRIUMF lab in Canada, is a direct current, volume cusp source. This ion source is capable of producing both positive and negative ^1H and ^2H ions, as well as $^3He^+$ and $^4He^+$ ions. The previous H^- ion source was not able to produce positive ion beams without significant mechanical modifications to the extraction electrodes. By contrast, the D-Pace ion source can be switched from positive to negative ion extraction and vise-versa by changing the polarity of a few high voltage power supplies and adding voltage to the electron suppression electrode. Thus, the D-Pace ion source can easily provide positive and negative ions at high intensity since the modifications needed to change the polarity of the ions are external to the ion source.

The pre-existing H^- ion source was dismounted in January 2024. A new support structure was constructed to hold the additional weight of the new ion source. The Positive/Negative Filament Ion Source consists of 1) a plasma chamber containing a tantalum filament for heating the plasma and associated extraction electrodes, 2) a diagnostic box containing additional electrodes, an X-Y steering magnet, flanges for mounting turbo pumps and other diagnostic tools such as a faraday cup and an emittance scanner. A picture of the new ion source and its support structure is shown in Fig 1.

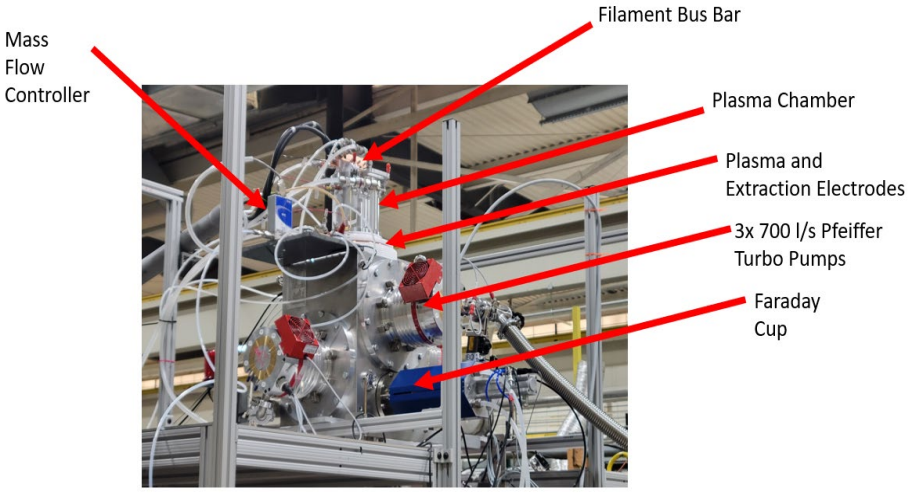

FIG. 1. The Positive/Negative Filament Ion Source as installed above the K150 cyclotron.

Installation of the new ion source was relatively straight-forward and only required small modifications to the support structure for alignment. A MKS mass flow controller was added to the gas inlet line to control the gas flow into the ion source more precisely than in the previous ion source. Control of the gas flow has been shown previously to affect the ion source intensity and emittance. The associated power supplies and electronic connections to the ion source were also modified, as suggested

by the D-Pace Inc. staff. These modifications allowed operation of the ion source in both positive and negative ion mode, and also fixed a polarity issue with the bias of the arc voltage and the plasma electrode that had existed in the pre-existing H^- source.

As of March 2024, the new ion source has been installed and commissioning will continue in the coming year. H^- beam with intensities up to 20 μA have been accelerated and extracted (as H^+) from the K150 cyclotron. $^4He^+$ beam with intensity up to 9 μA has also been accelerated and extracted from the cyclotron.

The high intensity light-ion beams from the new ion source will benefit the basic research and applied science programs by providing reliable, stable hydrogen and helium beams for future projects.

[1] H.L. Clark *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2009-2010), p. V-6, http://cyclotron.tamu.edu/progress-reports/2009-2010/.
[2] S. Melanson *et al.*, J. Phys. Conf. Ser. **2743**, 012038 (2024).