# Plasma Window as Charge Stripper Complement

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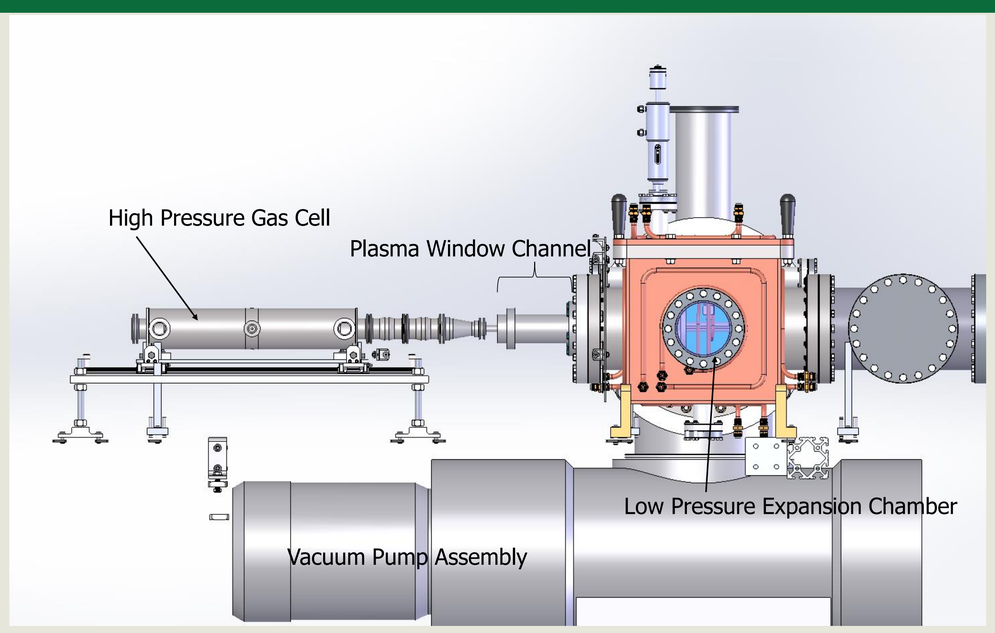
## Introduction




A challenge facing facilities, as the demand for higher intensity beams rises, is a stripping media that's highly resistant to degradation, such as a recirculating He gas stripper [1]. A method of keeping the He gas localized in a segment along the beamline by means of a Plasma Window (PW) positioned on both sides of the gas stripper has been proposed and the initial design set forth by Ady Hershcovitch [2] and Peter Thieberger. Hershcovitch and collaborators conducted initial tests using He on an apparatus similar to that in this work, achieving gas flow conductance reduction factor of about 10 at BNL [1].

The Plasma Window is a wall stabilized DC arc discharge [3] that greatly inhibits the flow of gas between high (~300 torr) and low (~1 torr) pressure regions that the window connects, so provides an interface between high and low pressure without the need for solid material. Currently, the scaling laws for the PW's operation are not wholly understood.

## Summary

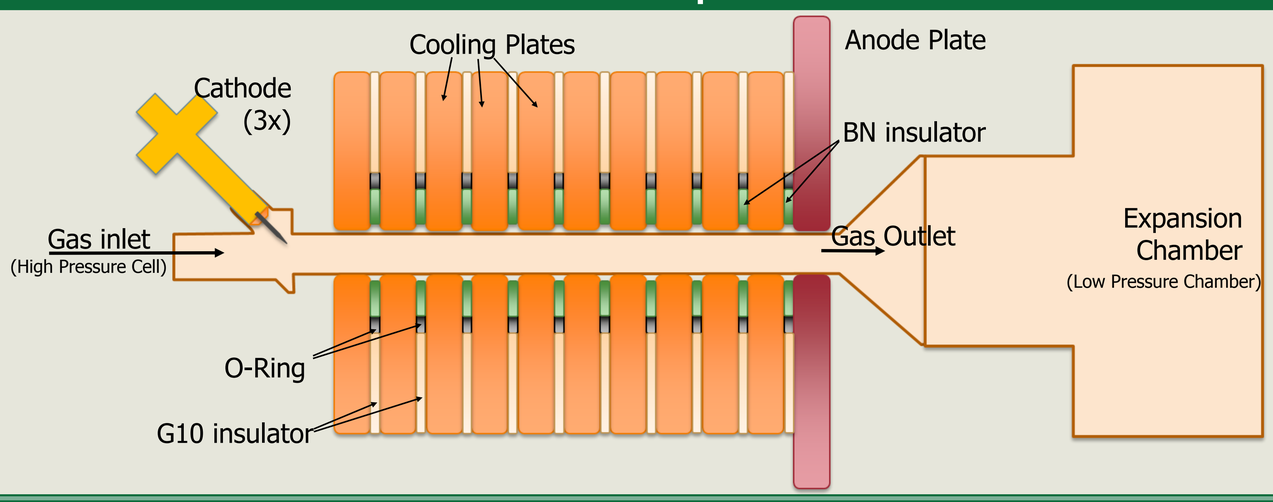
Preliminary data from Ar experiments shows Plasma Window can sustain a large pressure differential, up to three orders of magnitude, while maintaining a flowrate much lower than that achievable without arc.

## Future Work

To help determine axial scalings of plasma properties, we will employ a UV-Vis spectrometer to determine an integral value of electron density and temperature. We are also assembling an apparatus to measure via DMM the potential drop across each plate along the PW channel.

Additionally, experiment will be repeated with He gas.

## Experiment: Plasma Window

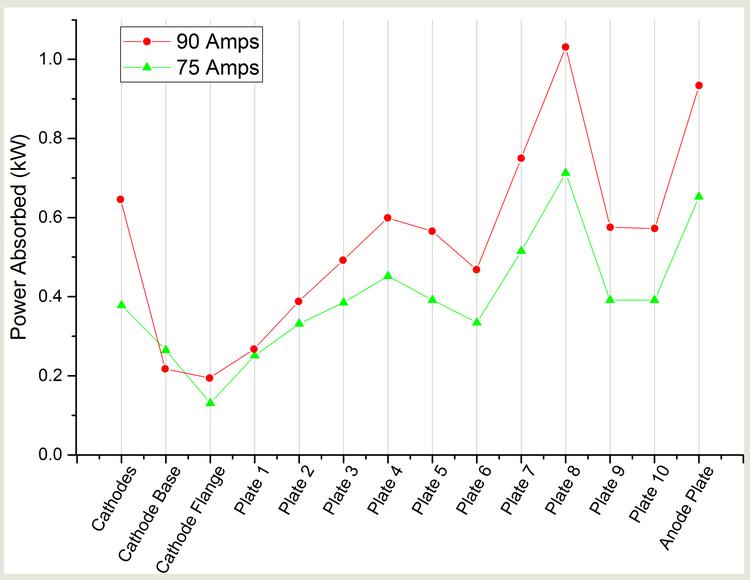



The window is comprised of ten 1cm thick floating voltage metal plates separated by O-rings, boron-nitride spacers, and G10 insulating spacers all 1 mm thick. A final grounded anode plate of 10.6 cm diameter is added at the end and in contact with the expansion chamber. The ten metal cooling plates have outer diameter of 6.1 cm, and every plate has an inner hole of diameter 6 mm. Each plate, cathode, cathode-holding structure, and anode are cooled by a continuous flow of water.

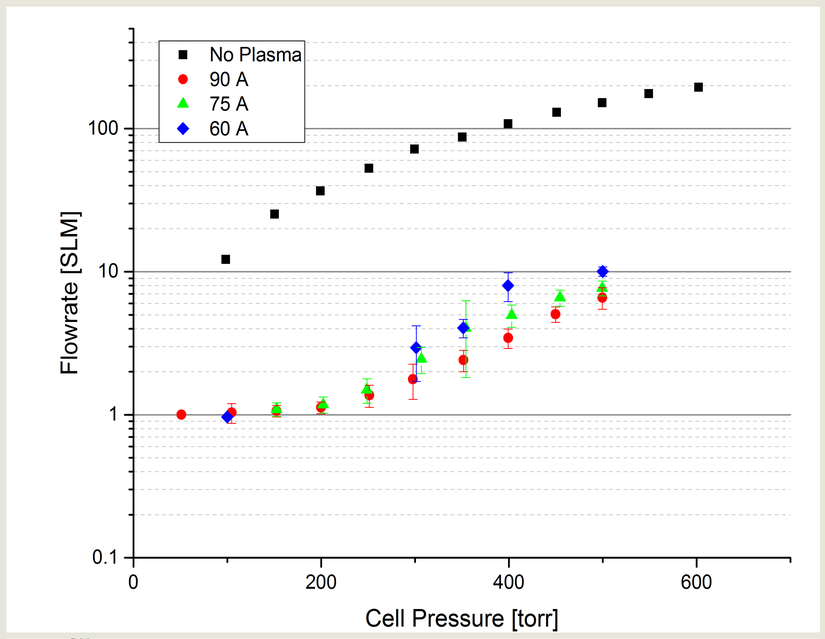
## Results: PRELIMINARY Ar DATA with MSU Test Stand

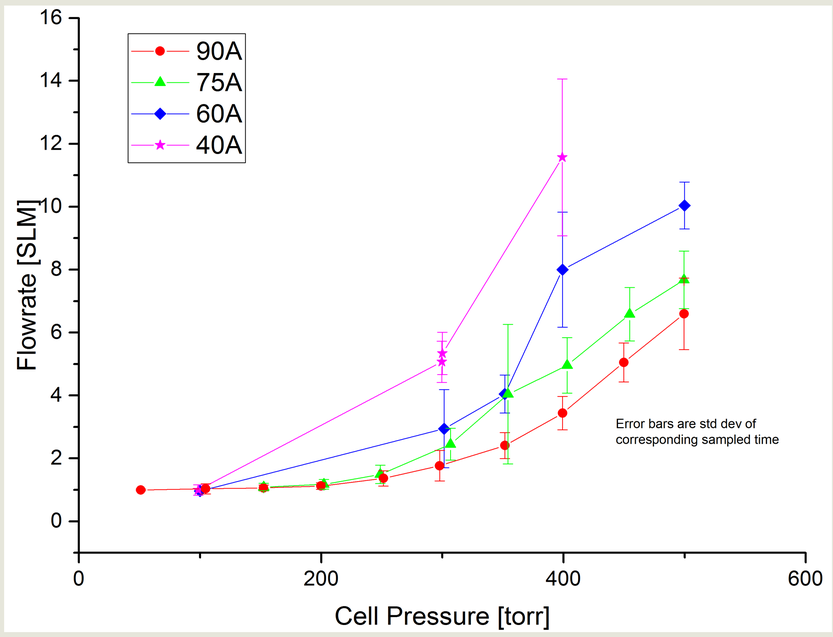
A MKS 250E Gas Inlet Pressure/Flow Control Module adjusts gas flow such that pressure on inlet side is fixed at a chosen value. The PW has been used to reduce flowrate by a factor of up to 40 at 90 A total supplied current and inlet pressure (cell pressure in this work) of 300 torr, from the case of un-ionized flow. An apparent difference in scaling of flowrate with respect to cell pressure is observed, suggesting the involvement of plasma properties in determining flowrate for a given pressure.

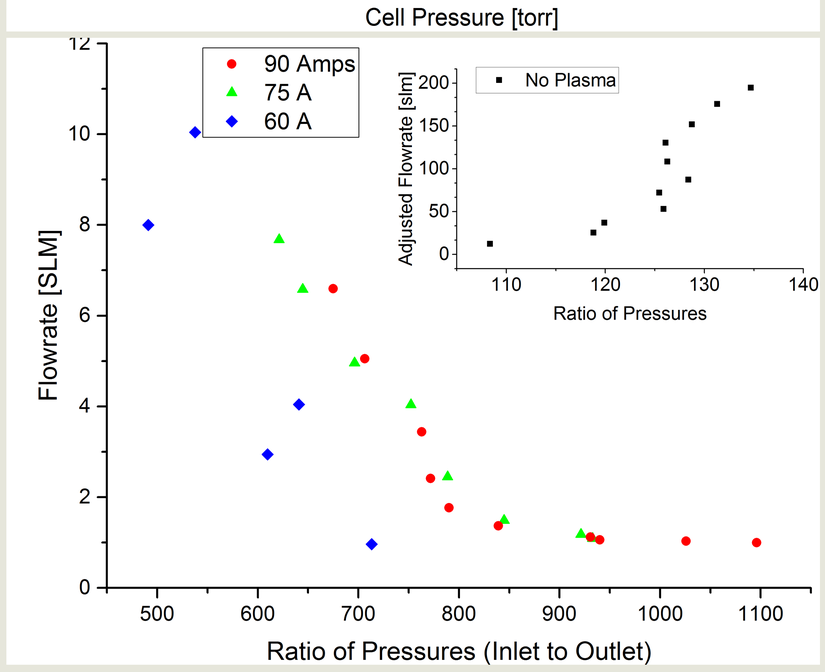
For all measurements, values plotted are averages of a certain number of collected points over a certain collection time, usually about 40 and 60 seconds respectively.

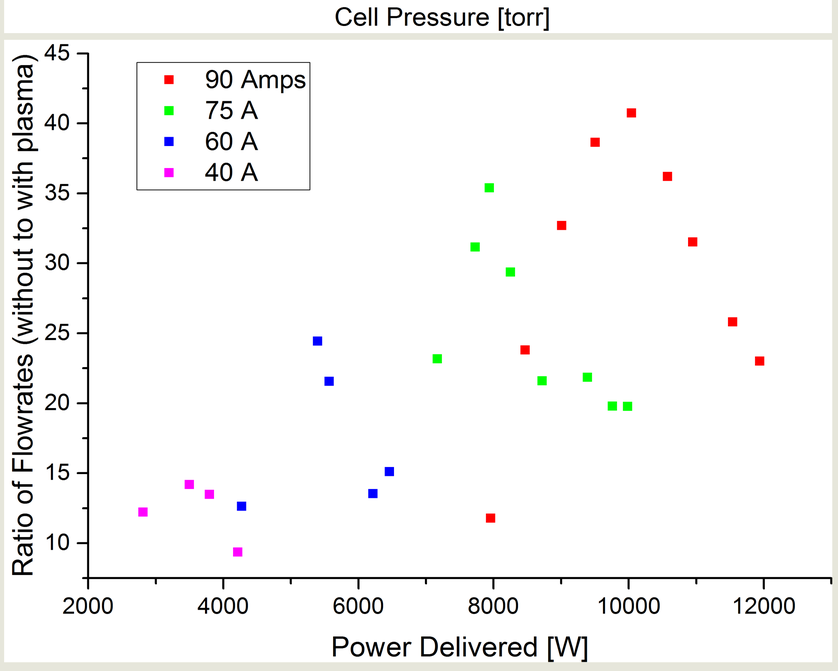



Each water cooled plate has a known coolant flowrate into it, and its inlet and outlet temperatures are measured.




[1] J. Nolen and F. Marti, "Charge Strippers of Heavy Ions for High Intensity Accelerators," *Rev. of Accel. Sci. and Technol.*, vol. 6, pp. 221-236, 2013.
[2] A. Hershcovitch, "A plasma window for transmission of particle beams and radiation from vacuum to atmosphere for various applications," *Phys. of Plasmas*, vol. 5, no. 5, p. 2130, 1998.
[3] H . Maecker, *Z. Naturforsch.*, 11 a, pp. 457-459, 1956.B.

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