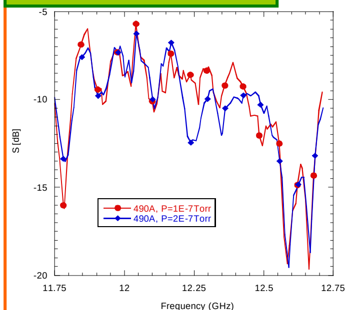
Performance of the LBNL AECR-U with a TWTA

Janilee Y. Benitez, M. Kireef-Covo, D. Leitner, and C. M. Lyneis
Lawrence Berkeley National Laboratory, One Cyclotron Road, Berkeley, California 94720

Abstract

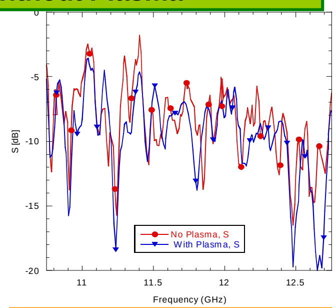
The Advanced Electron Cyclotron-Upgrade ion source (AECR-U) at the Lawrence Berkeley National Laboratory has successfully utilized double frequency microwave heating (14.3 GHz and 10.36 GHz) for several years. Recently a traveling wave tube amplifier (TWTA), that works in the frequency range of 10.75GHz-12.75GHz, was added as a secondary heating frequency, replacing the previous 10.36 GHz Klystron. The TWTA opens the possibility to explore a wide range of secondary frequencies and a study has been conducted to understand and optimize its coupling into the AECR-U. In particular, the reflected power dependence on heating frequency has been mapped out with and without the presence of plasma. A comparison is made to determine how the presence of plasma, confinement fields, and other source parameters affect the reflected power and if and how the amount of reflected power can be correlated to the source ion beam performance.

Reflected Power & Pressure



The graph shows how the reflected power changes with pressure.

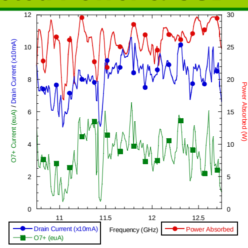
Reflected Power with & without Plasma



The presence of plasma changes the amount of reflected power at some frequencies.

Reflected Power & CSD

a.



b.

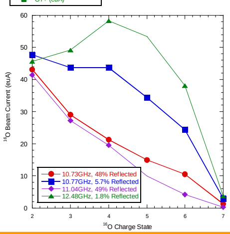


Figure a shows the trend of $^{16}O^{7+}$ current with power absorbed. Figure b shows that at certain instances the charge state distribution can be correlated to reflected power.

Reflected Power & Forward Power

a.

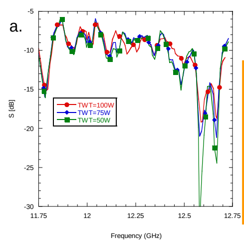


Figure a shows that the % of reflected power changes at certain frequencies as power is increased.

b.

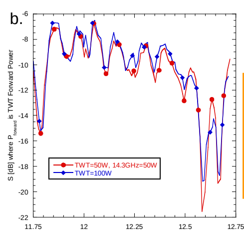


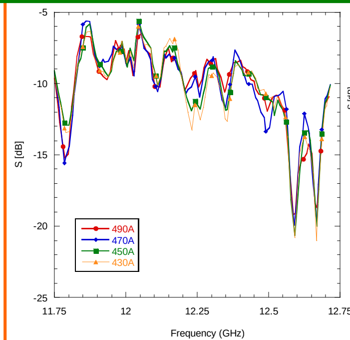
Figure b shows that the reflected power does not change with a double frequency heated plasma.

TWT System & Data Acquisition

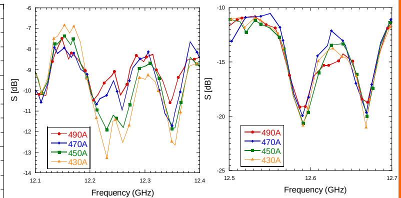
The data is recorded using a Labview program. The Labview program is used to sweep the TWT frequency. It samples the frequency, drain current, faraday cup current, and reflected power 100 times and records the average.

The reflected power is presented in terms of the S-factor. It is given by $S = 10\log(\frac{P_{reflected}}{P_{forward}})$

Reflected Power & Axial Field



a.

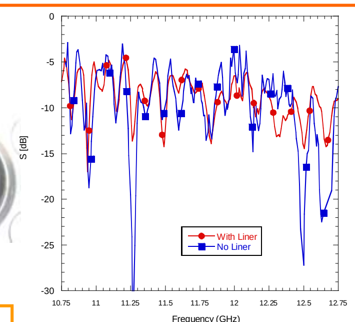


b. c.

Measurements were done to see the effect of the magnetic field on the reflected power. At certain frequencies there appears to be a trend. Figures b and c are zoomed in portions of a.

Reflected Power with a Tantalum Liner Installed

a. b.
Figures: a. AECR-U plasma chamber with six radial slots. b. AECR-U plasma chamber with Ta liner installed.



The figure shows how the reflected power changes with and without the presence of the liner. With no liner, as in normal operation, there are frequencies where power is effectively coupled out of the chamber.

Acknowledgements

This research was conducted at LBNL and was supported by the Director, Office of Energy Research, Office of High Energy and Nuclear Physics, Nuclear Physics Division of the U.S. Department of Energy under Contract DE AC03-76SF00098.