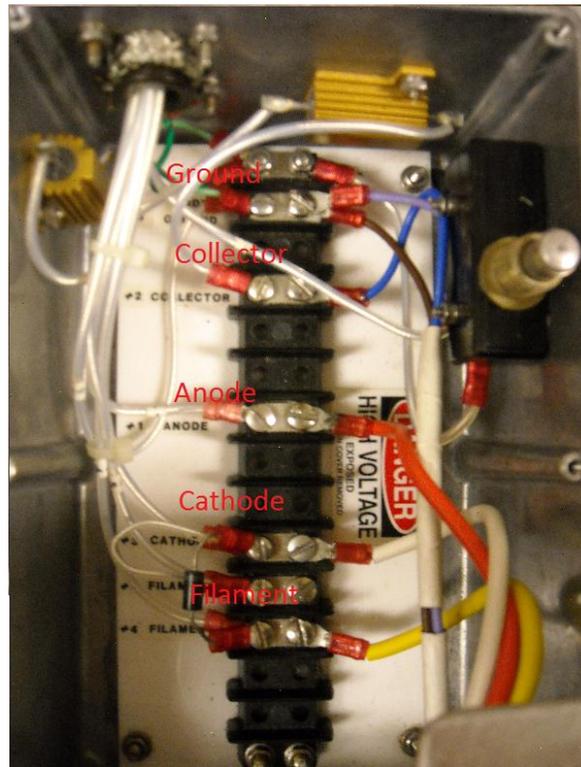


## Characterization of Microwave Generating Vacuum Tubes

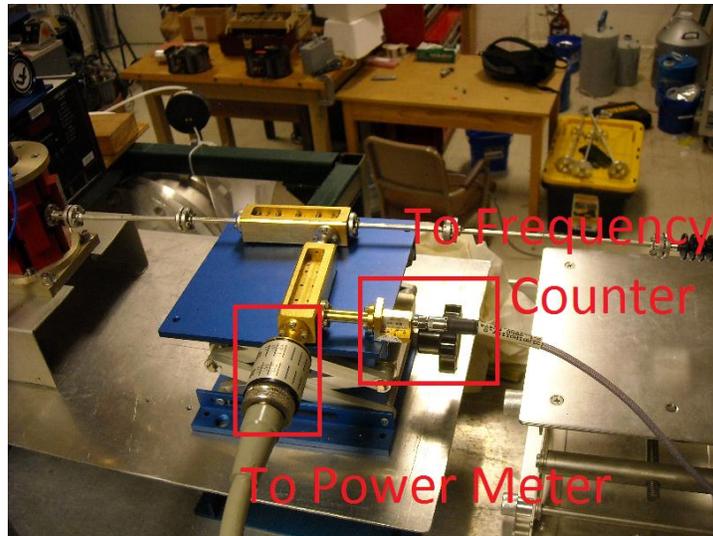
This is a performance report on several Extended Interaction Oscillators (EIOs) and Carcinotrons in the Polarized Target Lab. In total, there were 5 EIOs oscillating around 140 GHz, 2 EIOs oscillating around 180 GHz, and 3 Carcinotrons oscillating around 70 GHz. Before testing, the tubes had to be setup in working order. Each operating range requires its own setup, which will be explained in their corresponding sections.

The EIOs operating at 140 GHz were tested first. The EIO is connected to the power supply following a color code

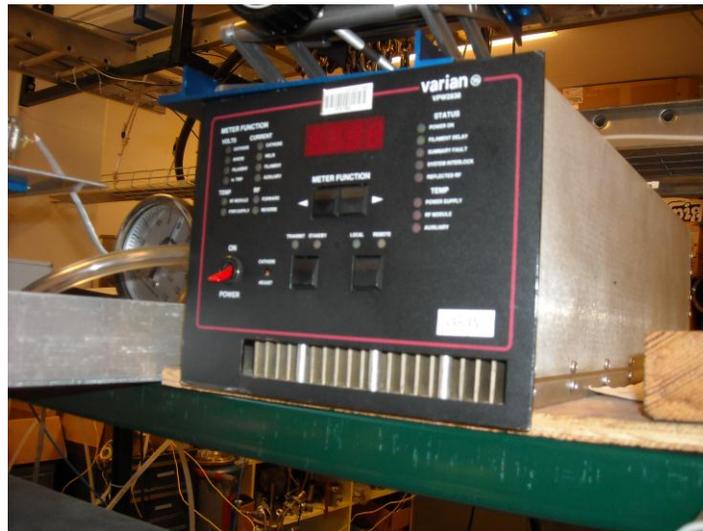


Color	Purple + Brown	Blue	Red	White	Yellow
Connection	Ground	Collector	Anode	Cathode	Filament

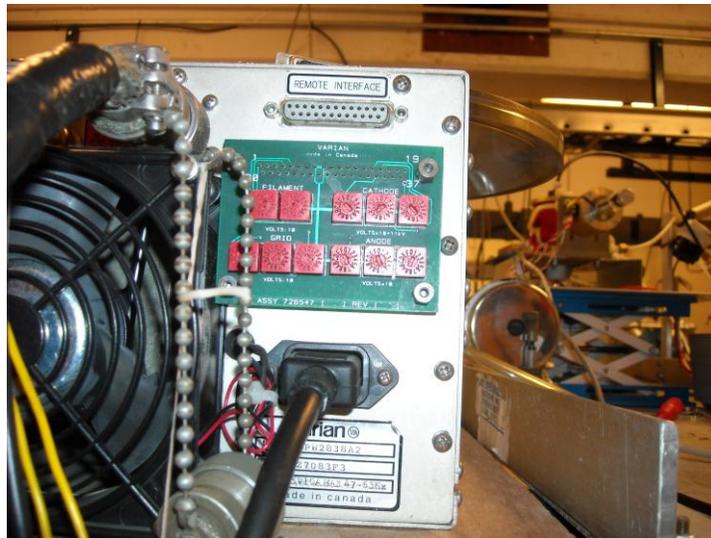
The target setup is shown in the image below.



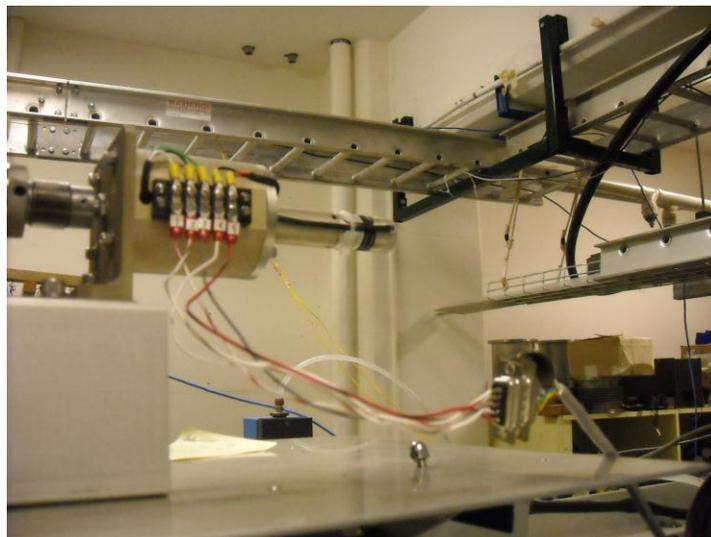
The testing parameters were set according to the same conditions recorded in previous tests. These parameters are recorded in each respective spreadsheet. For each EIO, the Frequency was measured as a function of Cathode Voltage as well as Bellows Position (when applicable). The result is that frequency increases linearly as a function of Cathode Voltage for a constant bellows position.



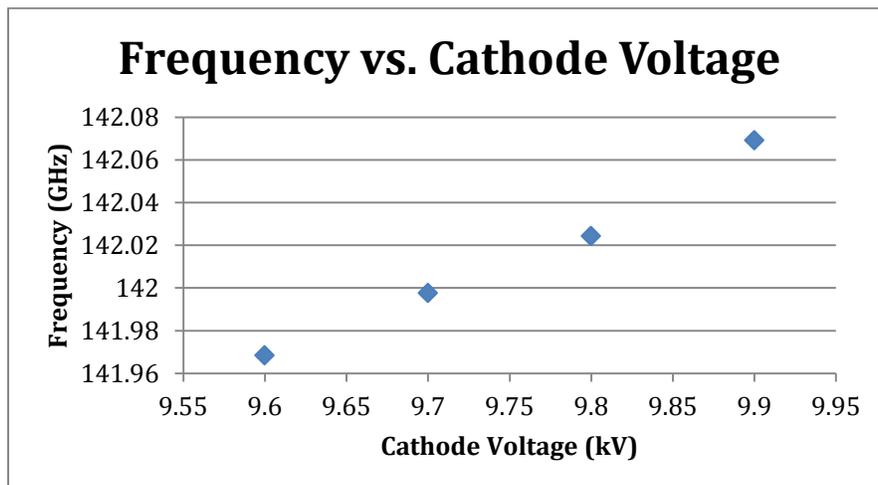
Power Supply for 140 and 180 GHz EIO's



Adjust testing parameters from back panel



Bellows Position



Result for EIO #EO638J2 for constant Bellow Position 5.448

The relationship between frequency and bellows position varies between EIOs.

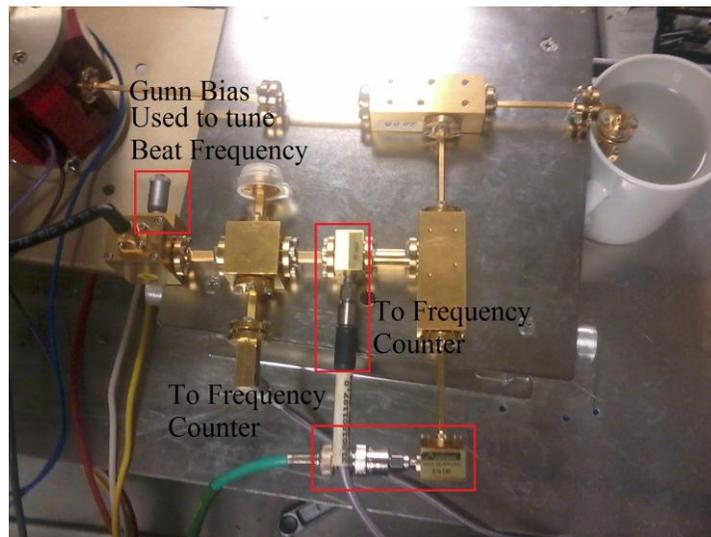
The result of each individual EIO is in the table below.

EIO #	Result
EO638J2	Operates fine. Oscillates around 140 GHz
EO735M4	Oscillates around 141 GHz. Contains pockets at certain bellows position where the tube loses power
EO738G5	Operates around 140 GHz. Minor leak issue
EO199C0	Major leak problem – unable to test. Previous tests show oscillating range around 137 GHz
EO104J8	Doesn't work. No Previous test data available

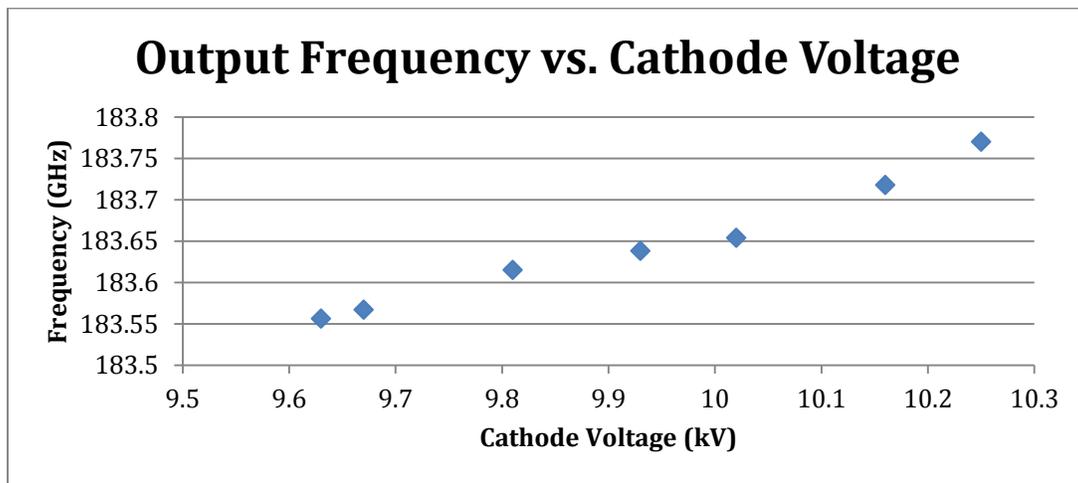


EO199C0 Leak Issue

The EIOs operating at 180 GHz were tested next. The color code for the connections to the power supply remains the same. The target setup is shown in the image below.



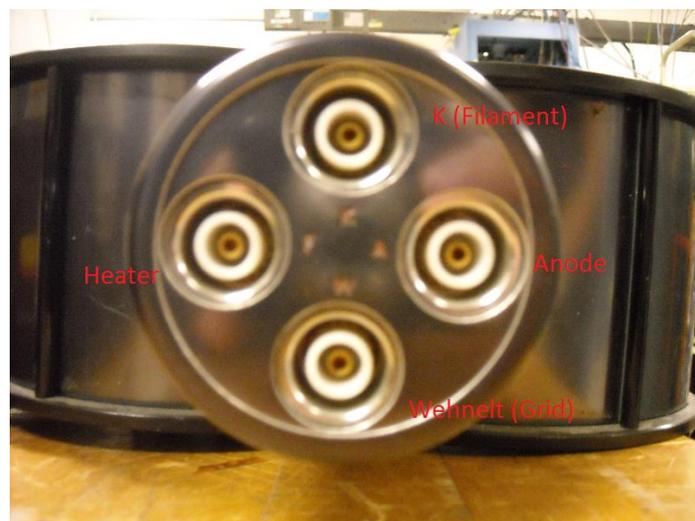
The two frequency counters are used to determine the output frequency of the EIO. One counter measures the RF Frequency which is ~90 GHz. The other counter measures the beat frequency, which must be tuned to the order of ~1 GHz using the Gunn Bias. This occurs at about 2.40. The output frequency is then  $(2 \times [\text{RF Frequency}]) + [\text{Beat Frequency}]$ , which is around 180 GHz. There is no Bellows position for the 180 GHz EIOs. Once again, the output frequency was measured as a function of the cathode voltage. The data shows a linear relationship.



Result for EIO #EO951F3

Both EIOs worked very well without any issues.

The final tests were the 70 GHz Carcinotrons, which use a separate power supply. They are connected to the power supply using four cables in a compass configuration where the Filament (labeled K) is North, the Anode is East, the Grid (labeled Wehnelt) is South, and the Heater is West.



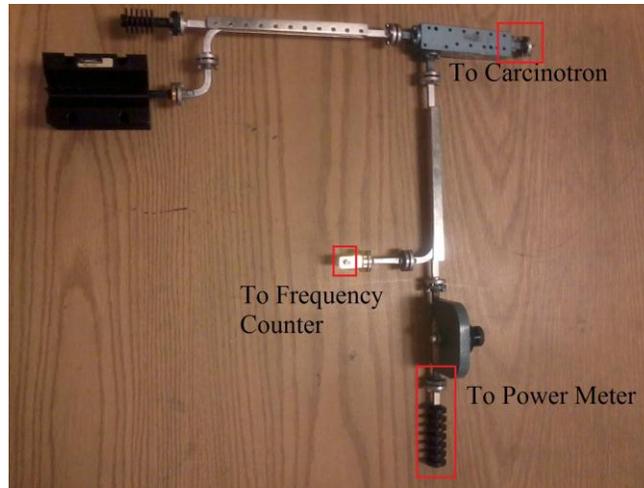


A specific set of instructions must be followed in order to turn on the power supply.

1. Turn on the Heater and set the current to the appropriate value
2. After 5 minutes, turn on the Grid and set the voltage to the appropriate value
3. Turn on the Line and set it to the minimum testing value (typically around 3 kV)
4. Turn on the Anode and set to the appropriate value

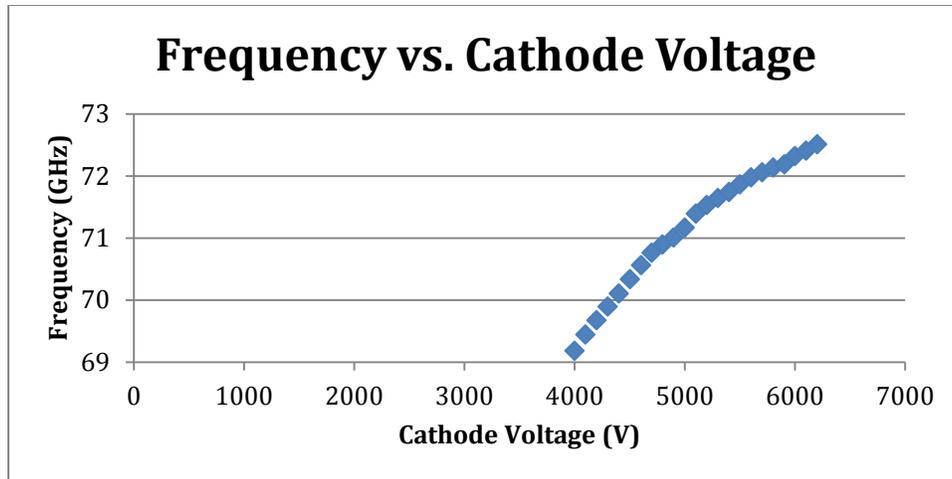


The Carcinotron should be set up with the following attachment.



Normally, a power meter is attached, but we were unable to find the right transition piece between the different band sizes.

The test shows that frequency increases nearly linearly as a function of cathode voltage for lower values, with the rate of change slowly decreasing.



Test result for Carcinotron #351-01

The result of each carcinotron is in the table below

Carcinotron #	Result
239-5	Settings not optimal. Frequency counter often loses reading
351-01	Major leak issue fixed after replacing all of the tubing
234-1	Works as expected

For more testing data, consult the spreadsheets included with this file.