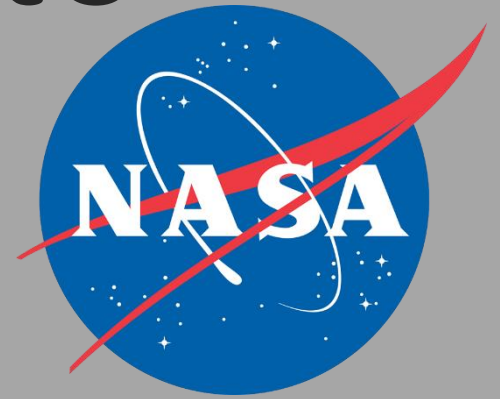


Application of a Fast Modulation Technique to Retarding Potential Analyzers



AMELIA GAGNON – UNIVERSITY OF NORTH DAKOTA

MENTOR: PAUL CRAVEN

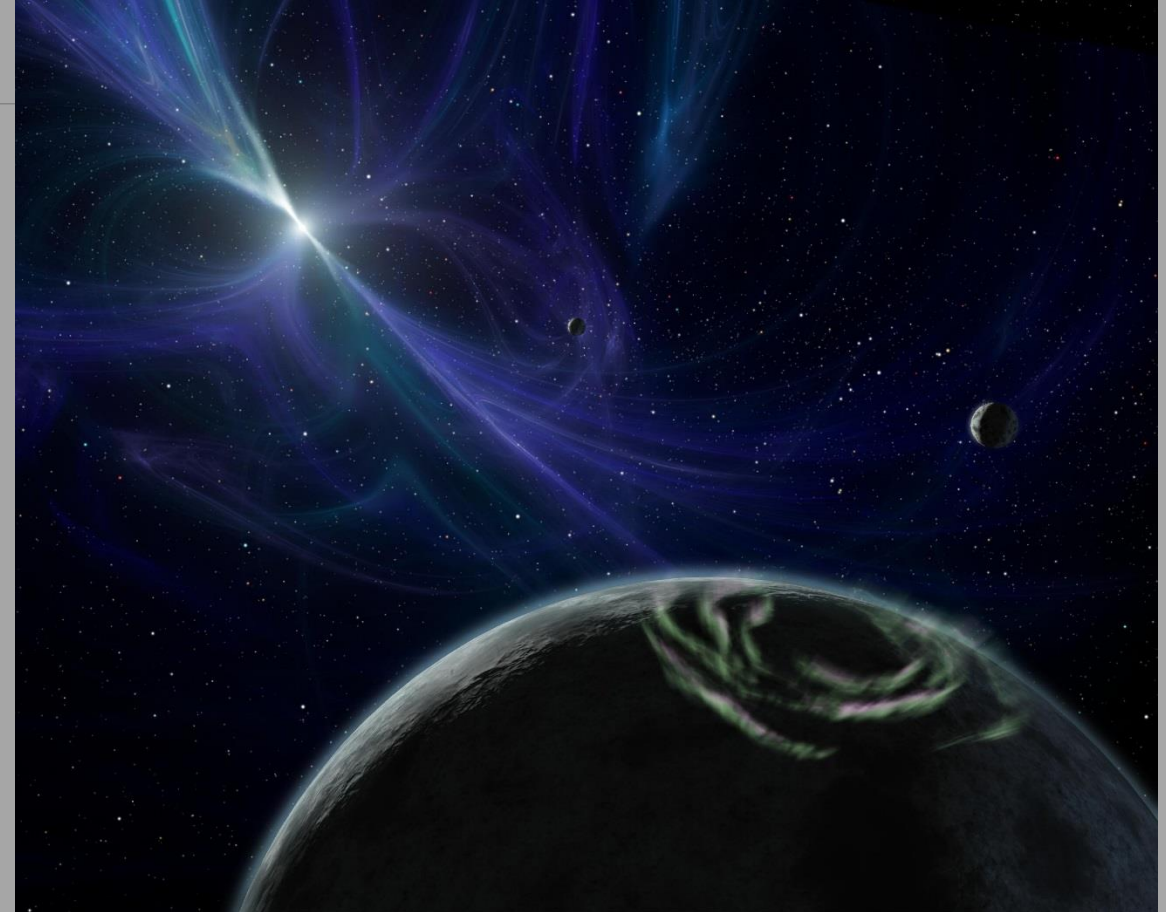
SPACE ENVIRONMENTAL EFFECTS, EM50, MSFC



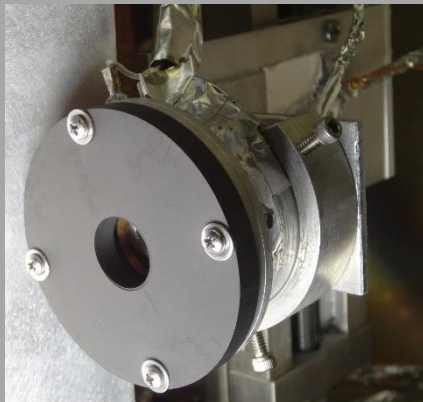
The Project:

Can the Smithsonian Astrophysical Observatory method for plasma measurement work for other RPAs?

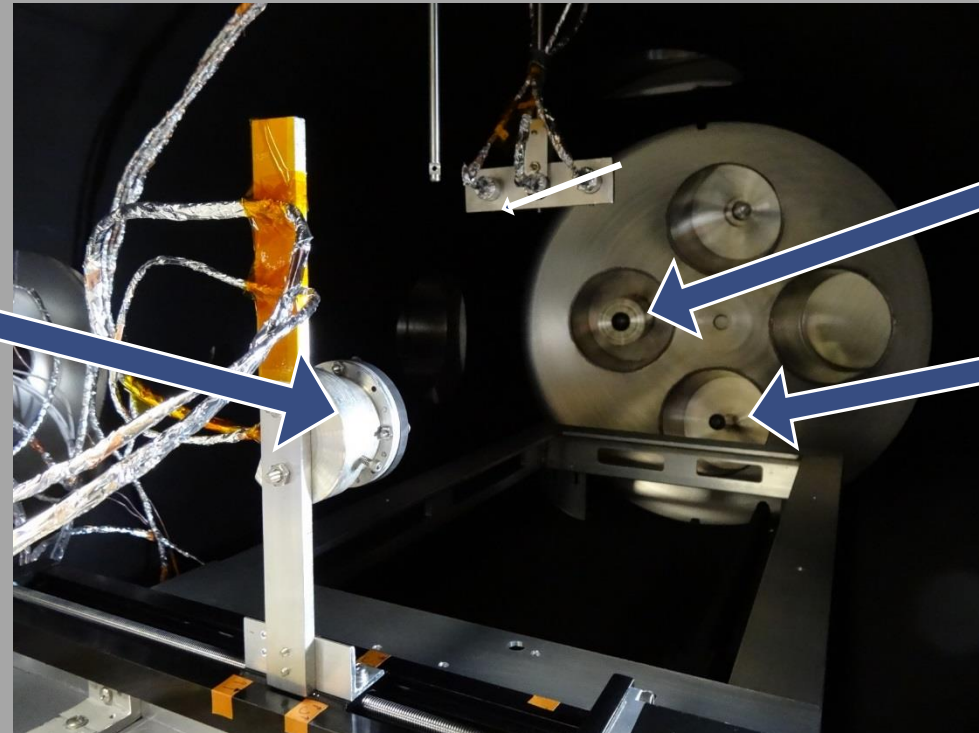
What is a Plasma?



Equipment



Retarding
Potential
Analyzer (RPA)



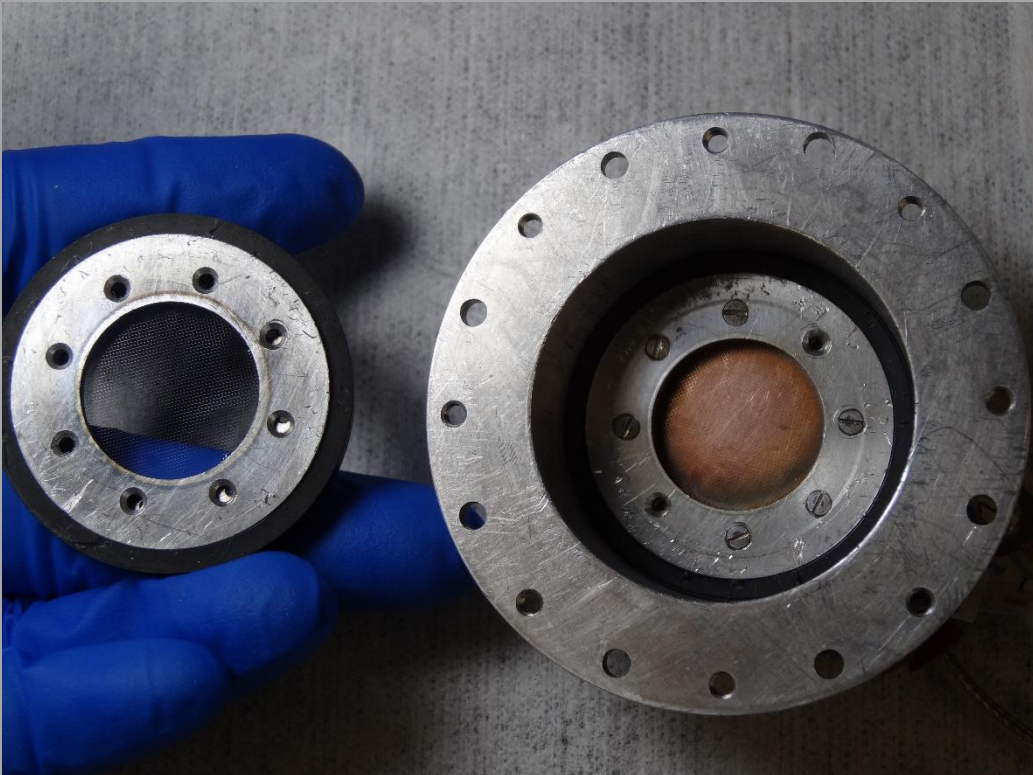
Electron Source

Ion Source

RPA Test Setup in Vacuum Chamber

What is an RPA?

Equipment: Retarding Potential Analyzer (RPA)

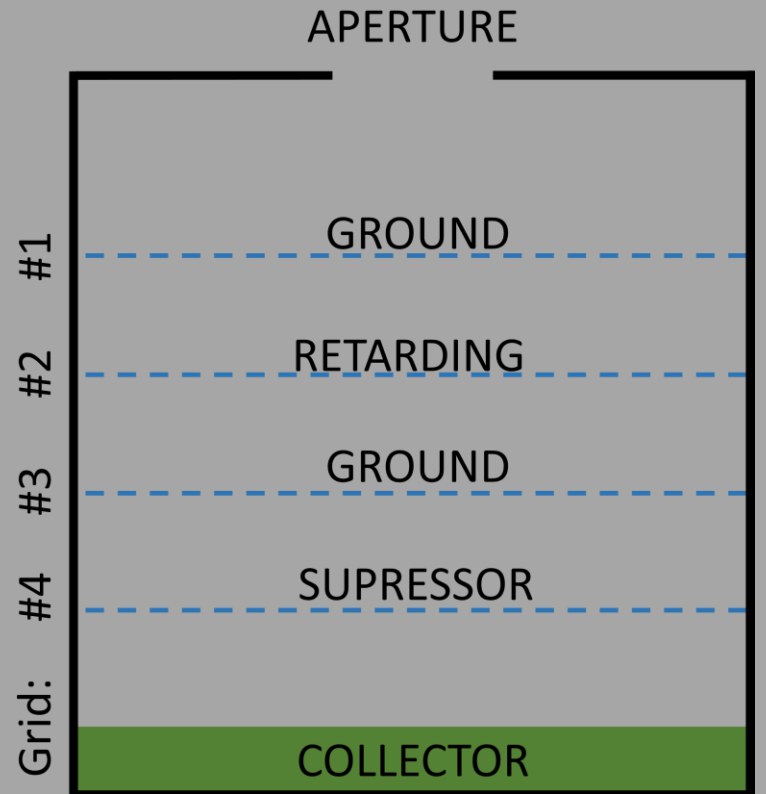


RPA Grids

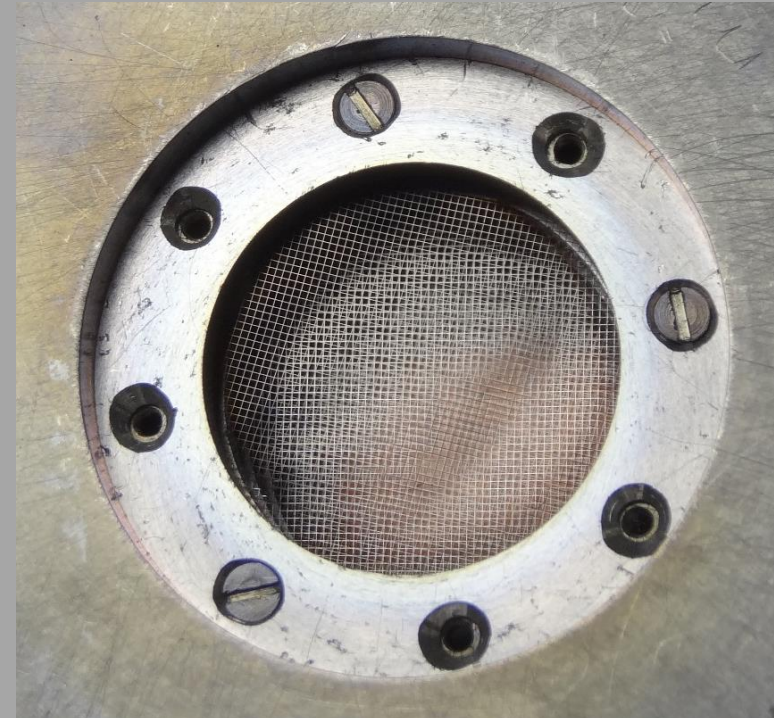


Copper Collector

Equipment: Retarding Potential Analyzer (RPA)



RPA Cross Section



Electroformed Nickel Mesh Grid
– 90% Transparency

The Project:

Can the Smithsonian Astrophysical Observatory method work for other RPAs?

Traditional Method

Apply DC voltage to
retarding grid.
Wait specified time.
Measure collector
current.

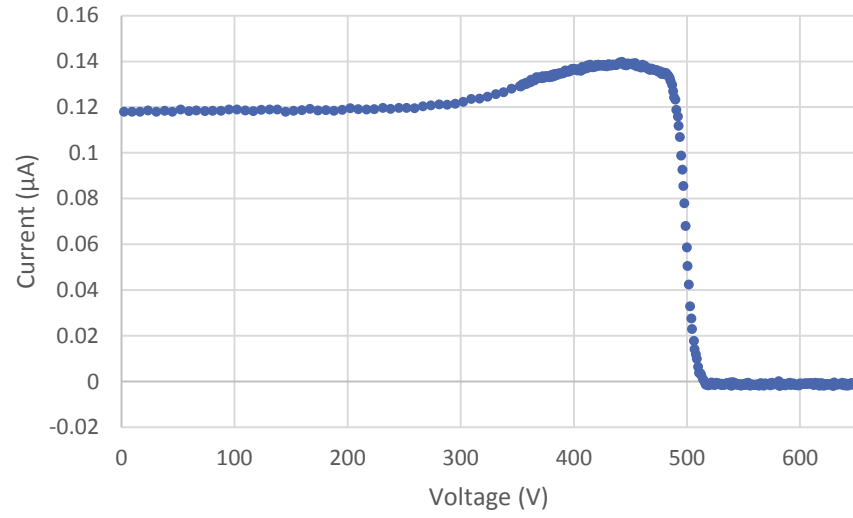


Repeat first
step over
specified
voltage
range.

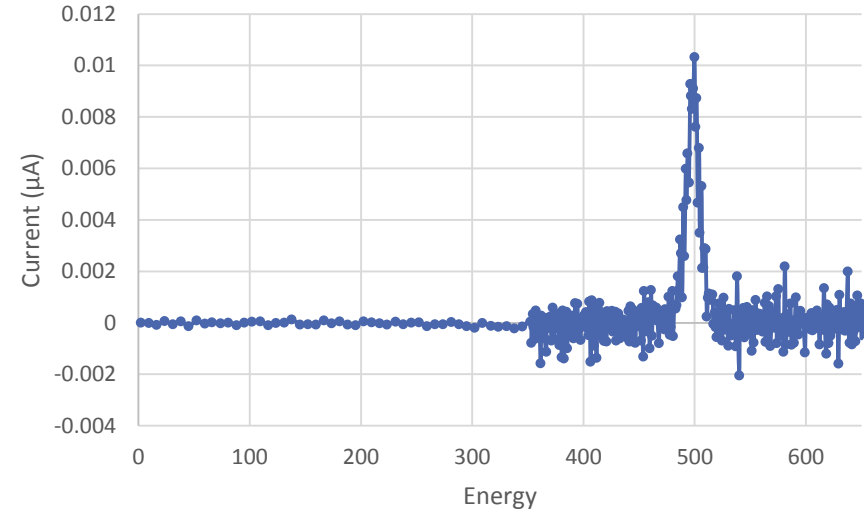


Result is
single
Current vs
Voltage
curve.

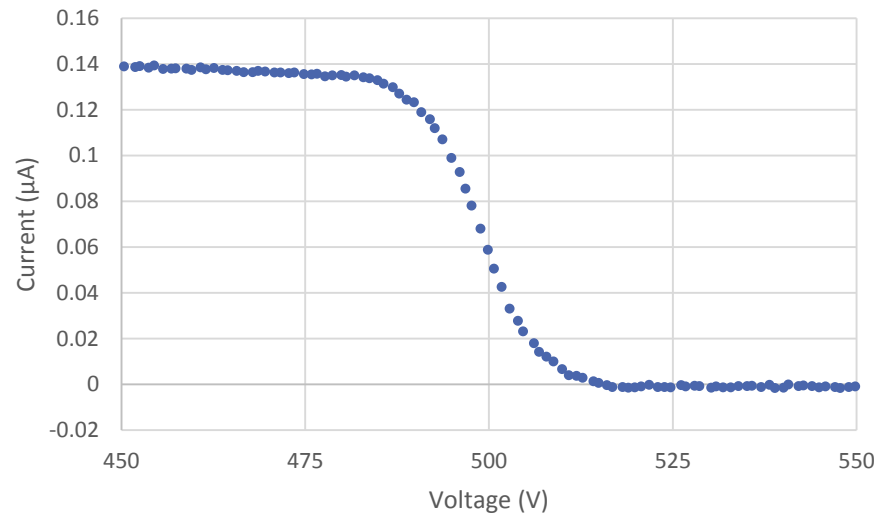
Current vs Voltage



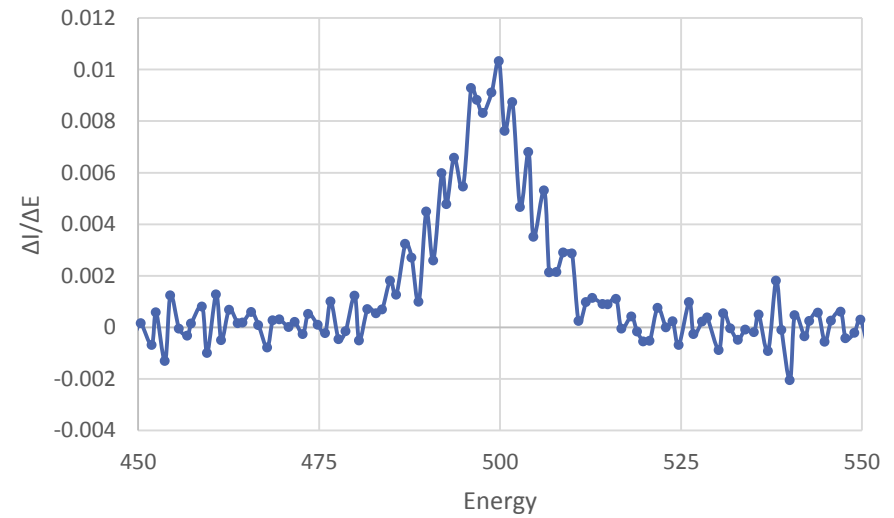
Derivative of Current vs Energy



Current vs Voltage



Derivative of Current vs Energy



Smithsonian Astrophysical Observatory (SAO) Method

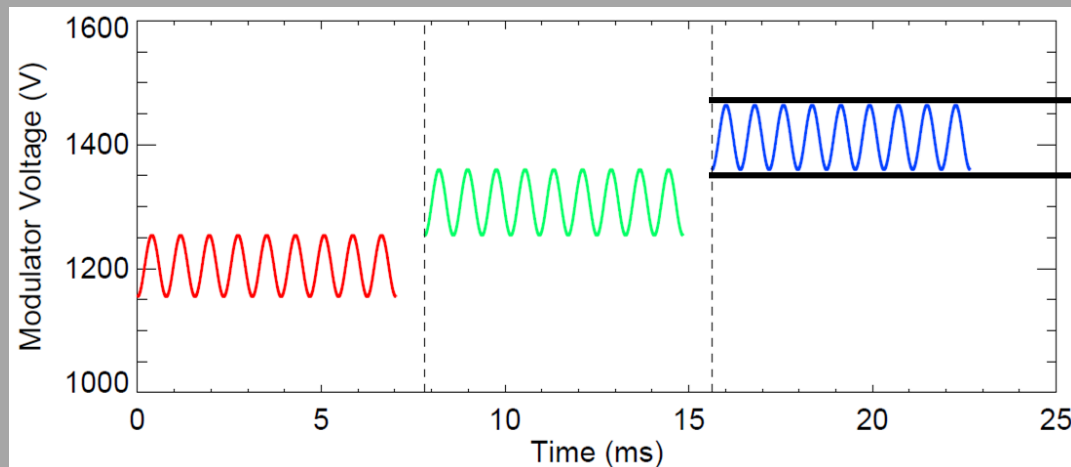
Apply AC modulated voltage to retarding grid.
Measure phase-locked collector current response.



Repeat first step over fixed range of energy windows.

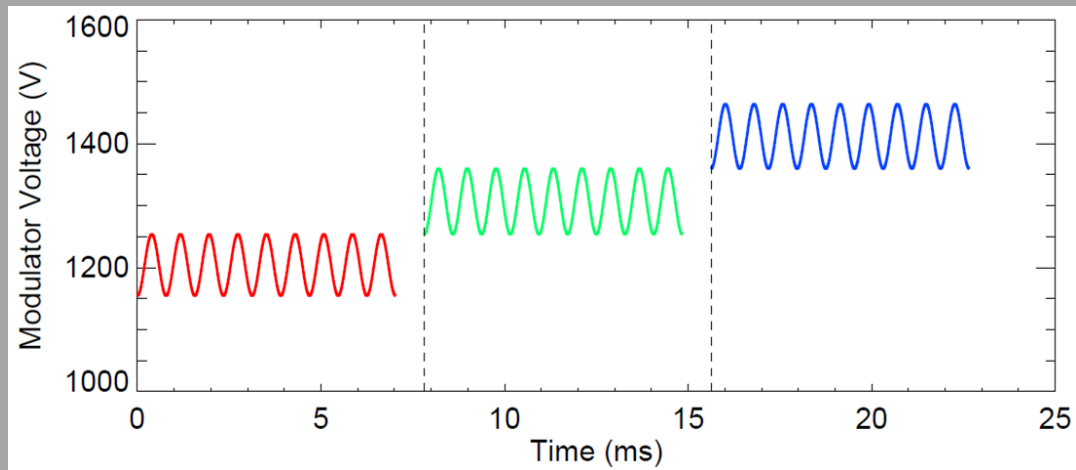


Result is distribution of Current vs Energy.



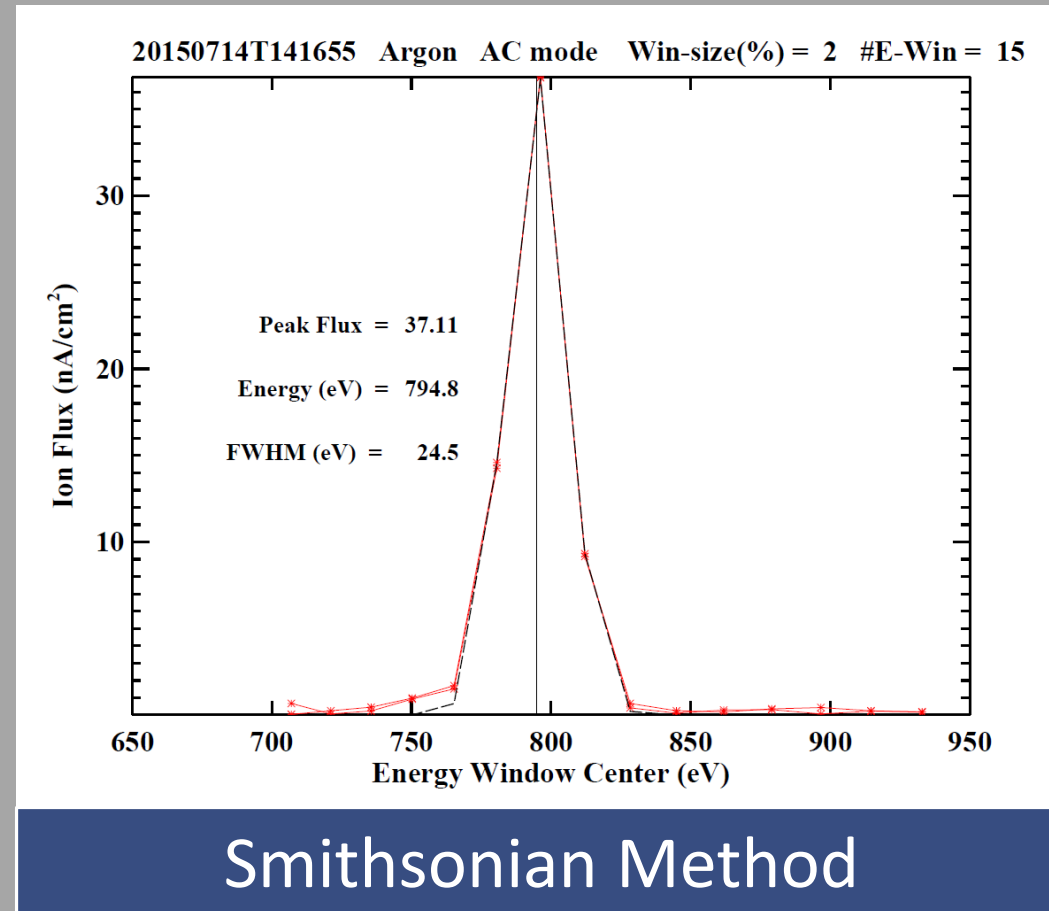
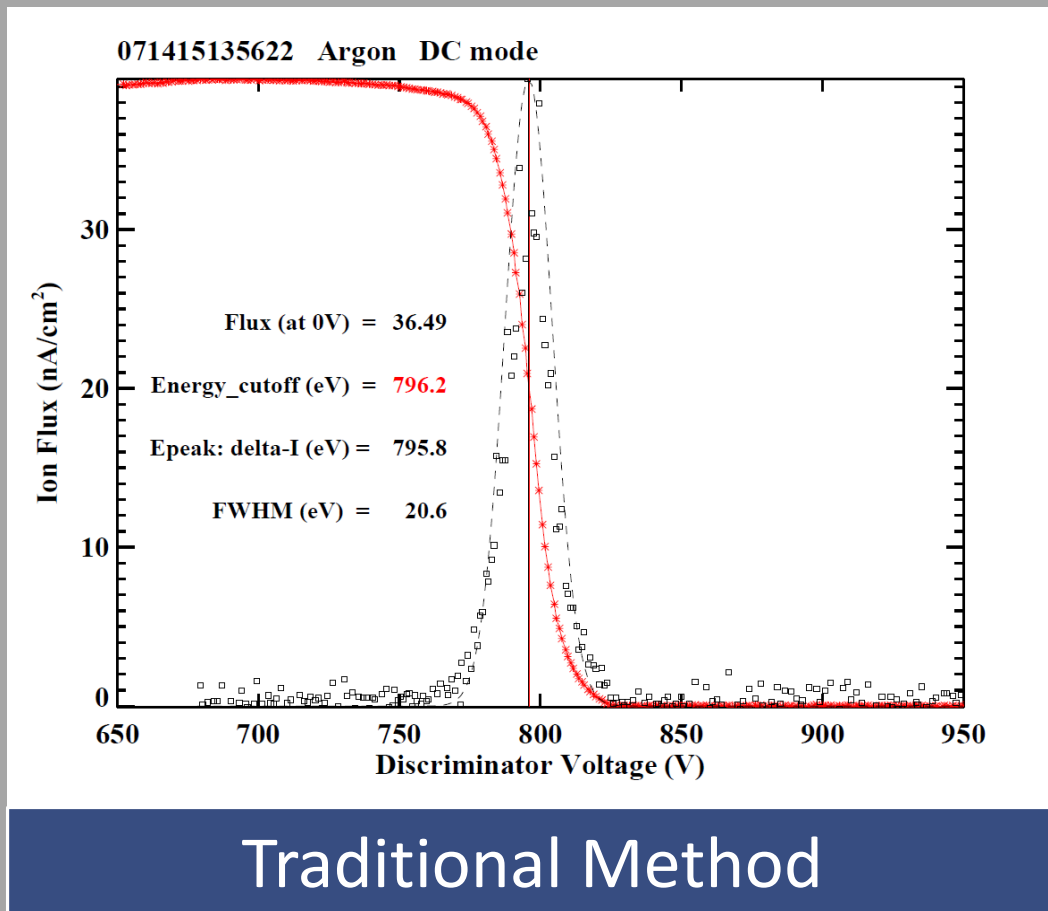
Single Energy Window

Smithsonian Astrophysical Observatory (SAO) Method



Energy Window Number	Energy Window Lower Value (V)	Energy Window Upper Value (V)	Energy Window Width (V)
0	100	105	5
1	105	110.25	5.25
2	110.25	115.7625	5.5125
3	115.7625	121.5506	5.7881
4	121.5506	127.6282	6.0776
5	127.6282	134.0096	6.3814
6	134.0096	140.71	6.7004
...
46	898.5008	943.4258	44.9250
47	943.4258	990.6	47.1742

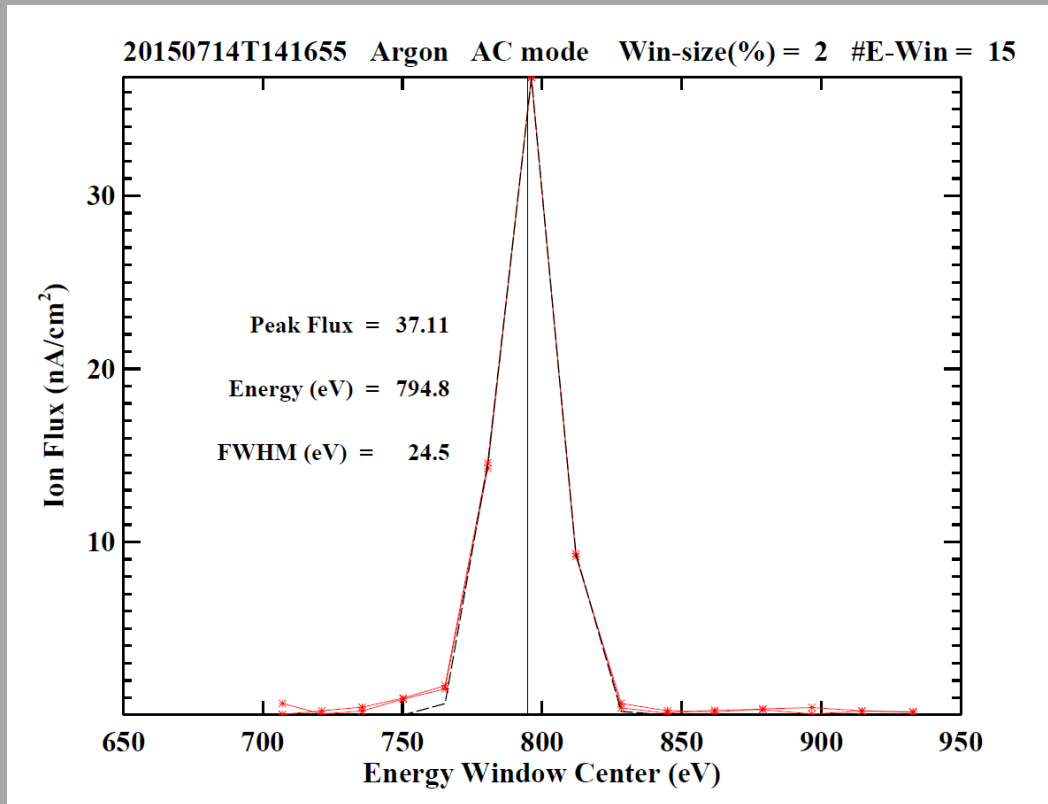
Results



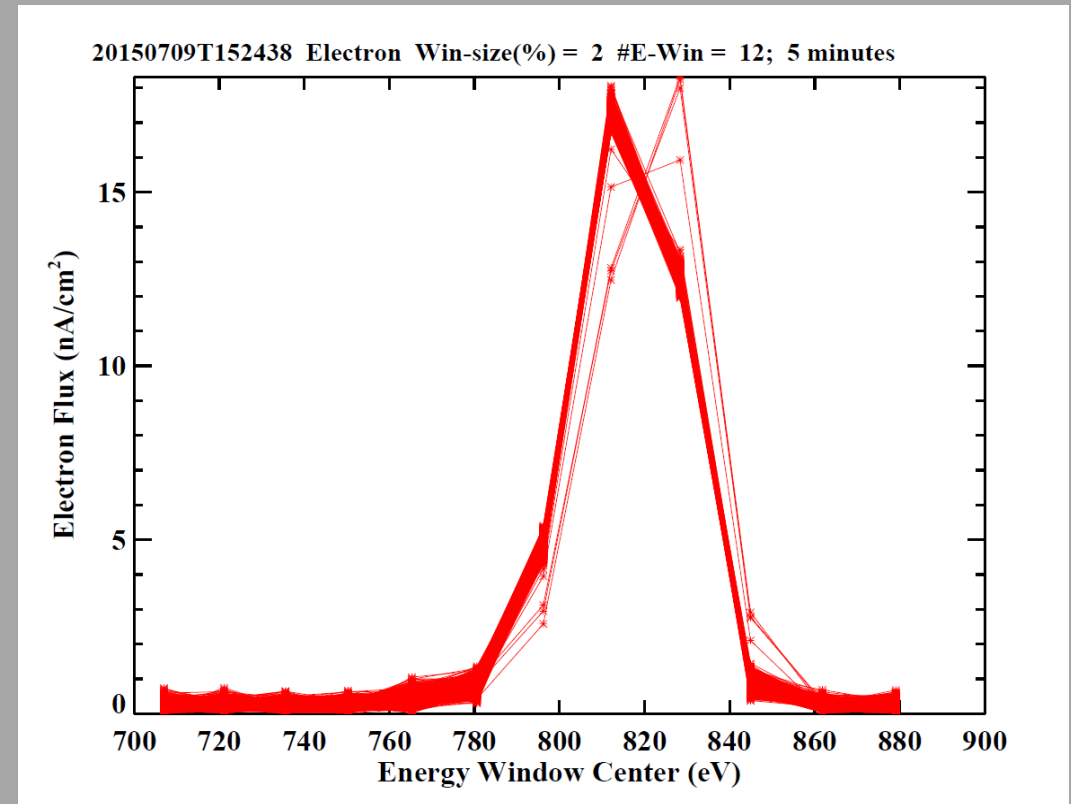
Comparison of Methods

Traditional Method		SAO Method
✓	Beam Energy	✓
✓	Energy Spread	✓
✓	Flux	✓
✗	Energy Stability	✓
✗	Flux Stability	✓
✗	High Speed	✓

Results



Stable Energy/Stable Flux



Unstable Energy/Unstable Flux

Comparison of Methods



**120 seconds per I-E
curve**

Traditional Method



**1 second per I-E
curve**

Smithsonian Method

Why is this important?

Faster testing

Real-time data feedback

Additional information with this method

Conclusion

This method worked

Group is going to do further testing with higher voltages

End goal: use this measurement method within the group

Questions?



References

- Case et al., Design of a Sun-pointing Faraday Cup for Solar Probe Plus, *Thirteenth International Solar Wind Conference*, Poster 5-2, Kona-Kailua, Big Island, Hawaii, 18-22 June, 2012.
- clker.com/cliparts/2/k/n/l/C/Q/transparent-green-checkmark-md.png
- content.mycutegraphics.com/graphics/sports/stop-watch.png
- K. W. Olgivie, et al., SWE, A comprehensive plasma instrument for the Wind spacecraft, *Space Sci. Rev.*, vol. 71, p. 55, 1995.
- nasa.gov/images/content/397961main_HoH1.jpg
- science.nasa.gov/media/medialibrary/2007/04/27/27apr_nox_resources/Blitzschlag.jpg
- upload.wikimedia.org/wikipedia/commons/thumb/b/ba/Red_x.svg/2000px-Red_x.svg.png