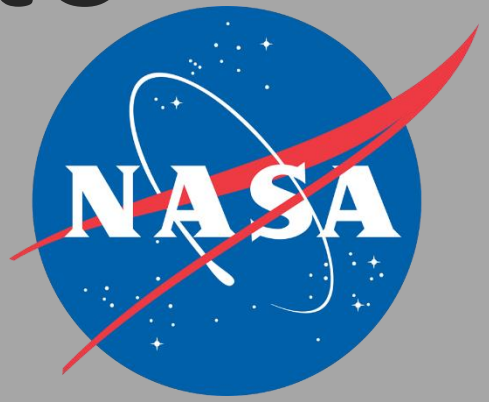
Application of a Fast Modulation Technique to Retarding Potential Analyzers



AMELIA GAGNON – UNIVERSITY OF NORTH DAKOTA

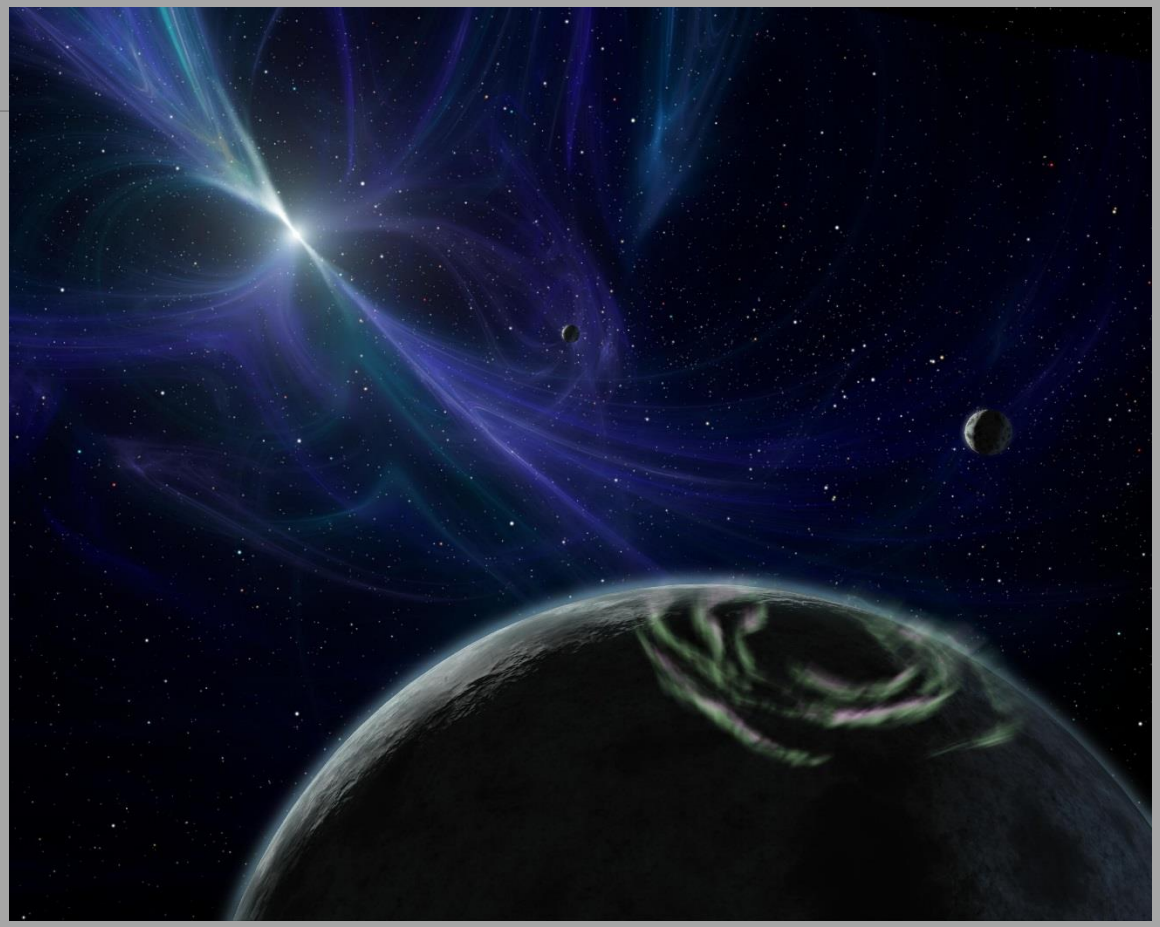
MENTOR: PAUL CRAVEN

SPACE ENVIRONMENTAL EFFECTS, EM50, MSFC

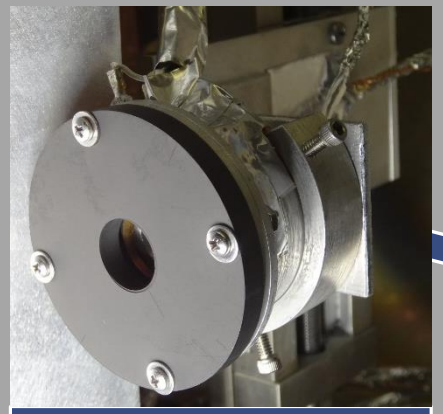
The Project:

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

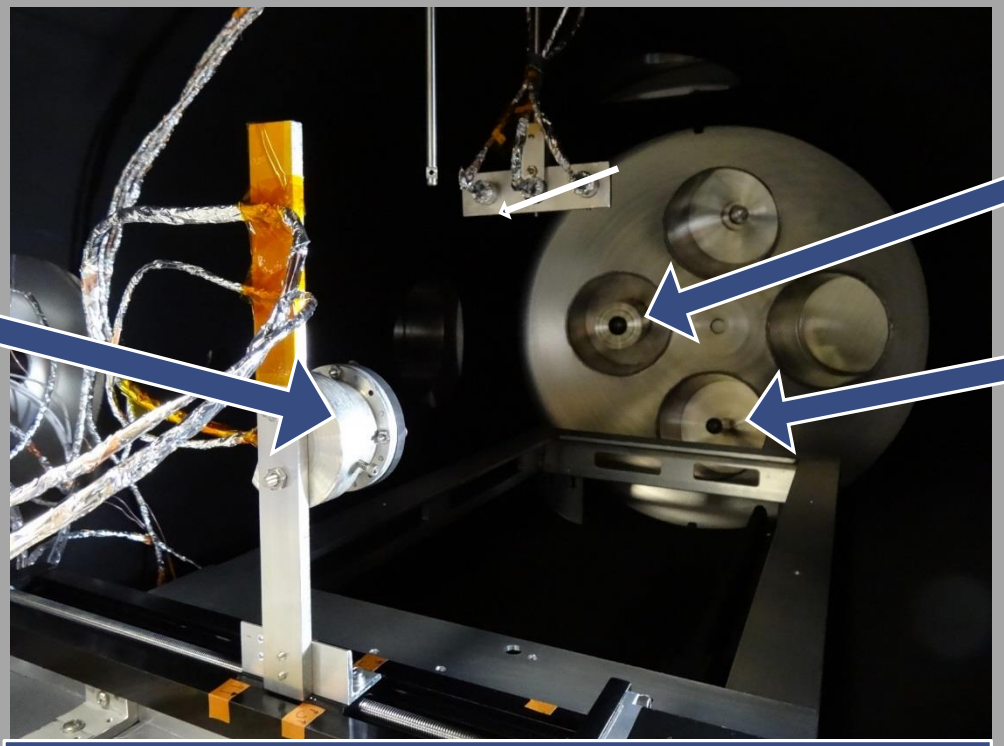
What is a Plasma?



Equipment



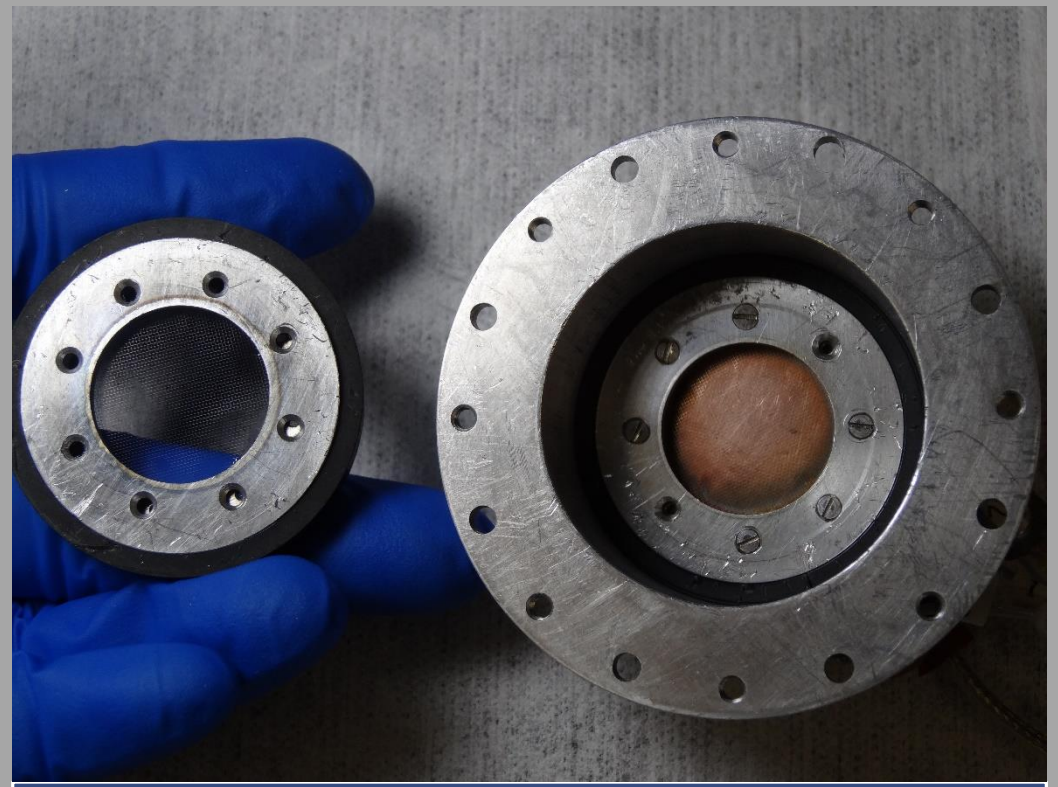
Retarding Potential Analyzer (RPA)



RPA Test Setup in Vacuum Chamber

What is an RPA?

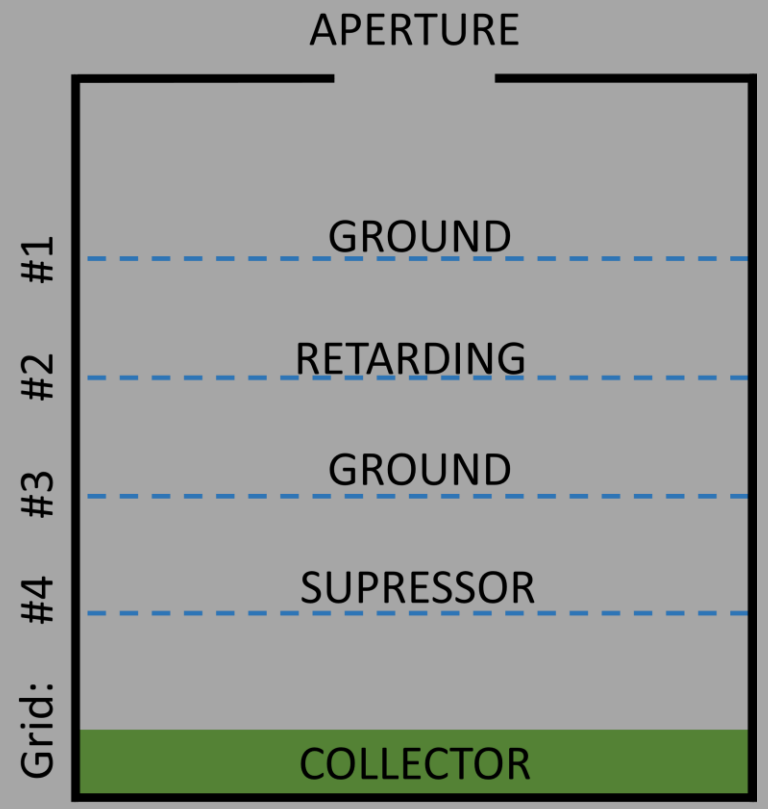
Equipment: Retarding Potential Analyzer (RPA)



RPA Grids

Copper Collector

Equipment: Retarding Potential Analyzer (RPA)



RPA Cross Section

Electroformed Nickel Mesh Grid – 90% Transparency

The Project:

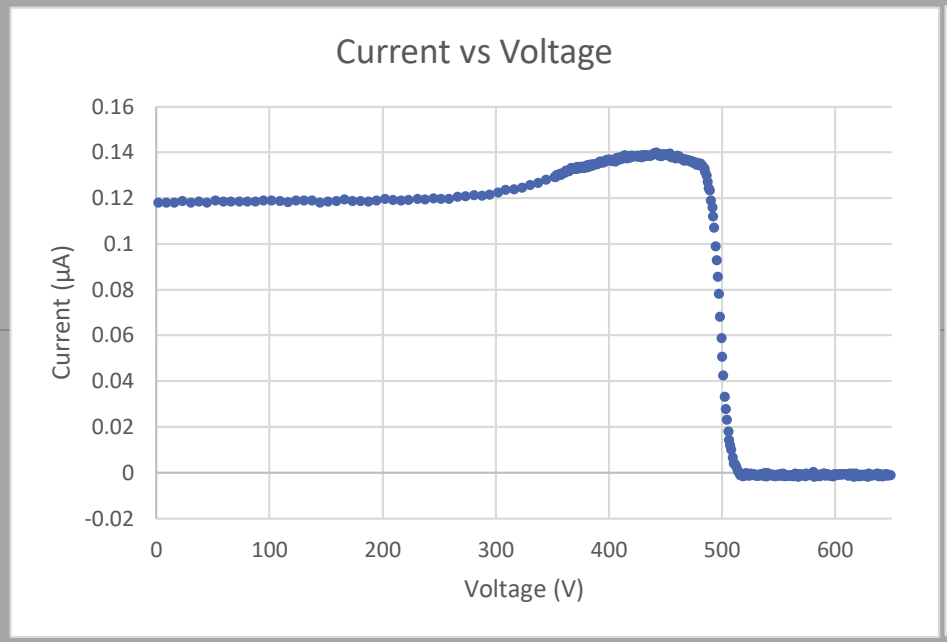
Can the Smithsonian Astrophysical Observatory method work for other RPAs?

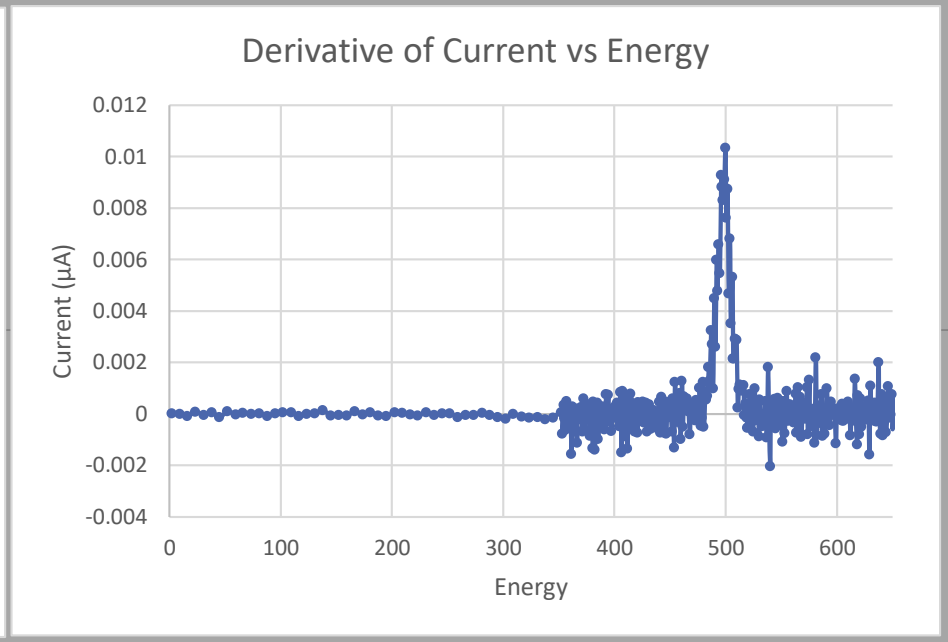
Traditional Method

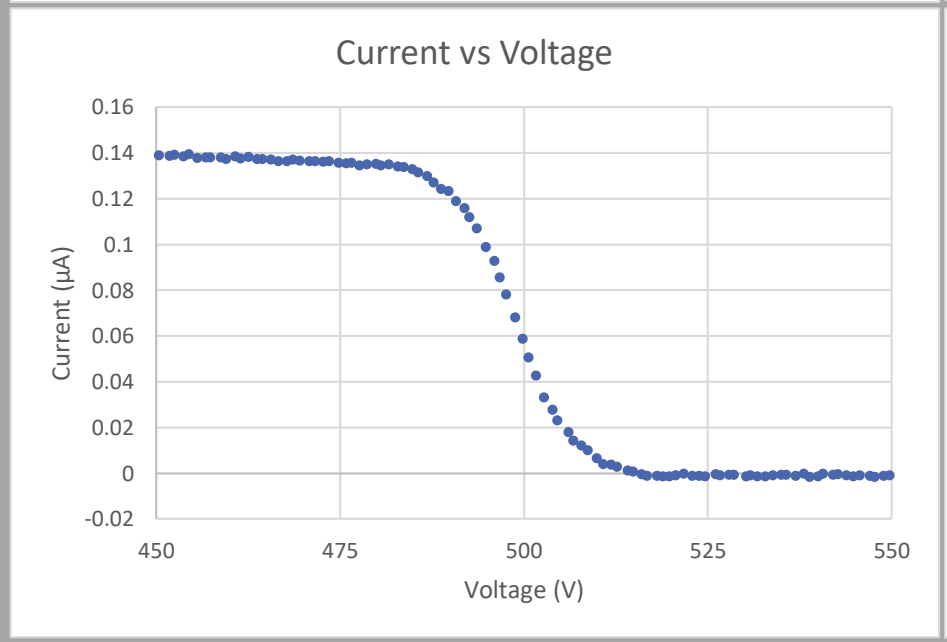
Apply DC voltage to retarding grid.
Wait specified time.
Measure collector current.

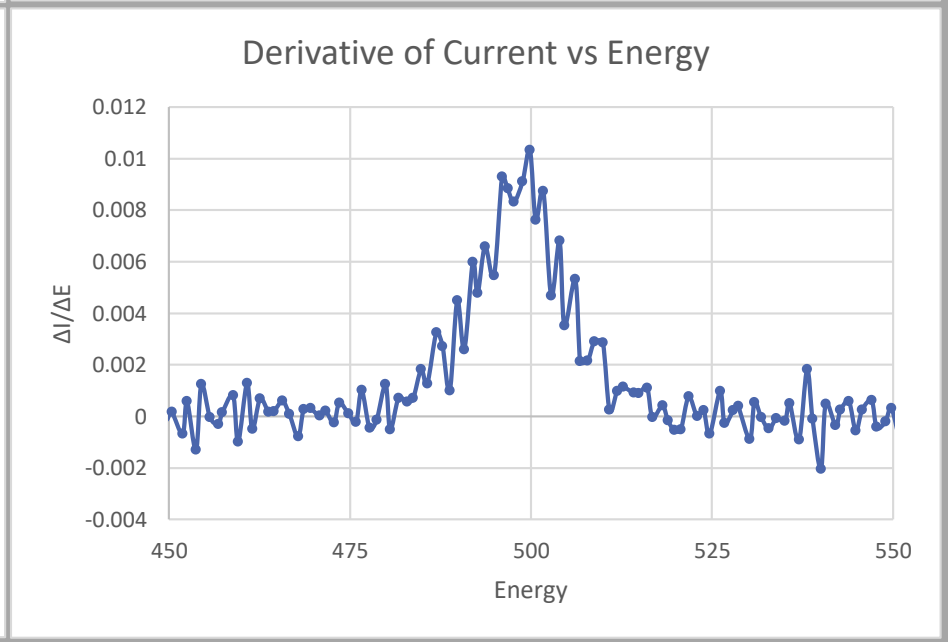
Repeat first step over specified voltage range.

Result is single Current vs Voltage curve.


Current vs Voltage
Current (μA)
Voltage (V)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
0
100
200
300
400
500
600


Derivative of Current vs Energy
Current (μA)
Energy
0.012
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
0
100
200
300
400
500
600


Current vs Voltage
Current (μA)
Voltage (V)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.02
450
475
500
525
550

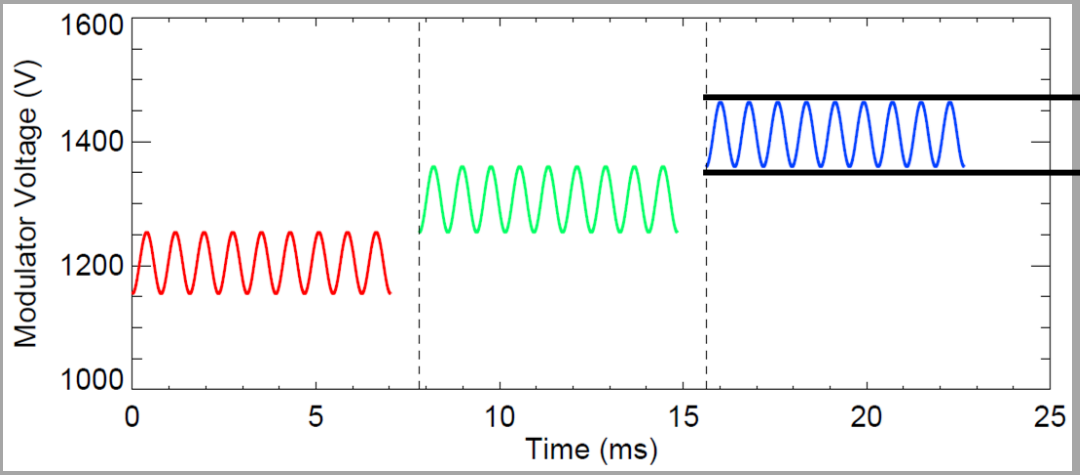

Derivative of Current vs Energy
ΔI/ΔE
Energy
0.012
0.01
0.008
0.006
0.004
0.002
0
-0.002
-0.004
450
475
500
525
550

Smithsonian Astrophysical Observatory (SAO) Method

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

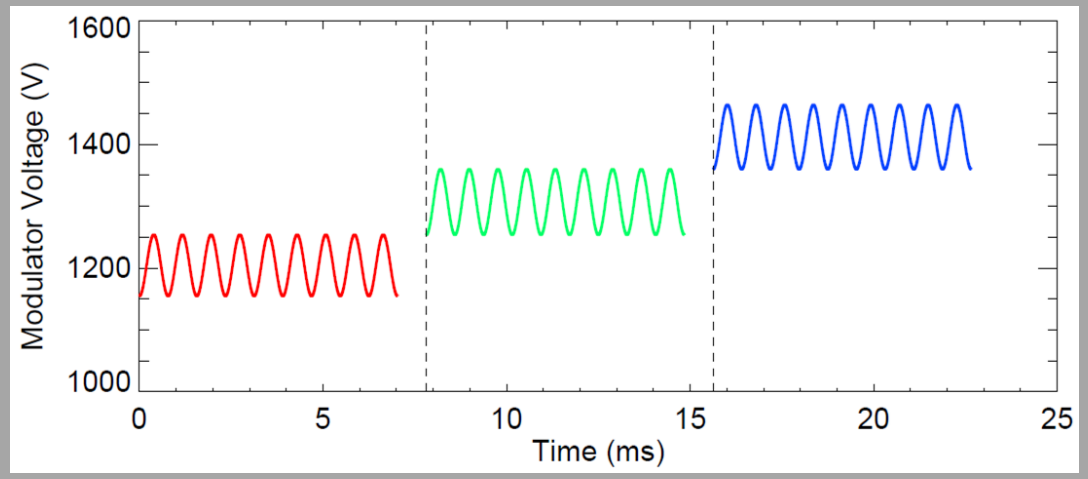
Repeat first step over fixed range of energy windows.

Result is distribution of Current vs Energy.



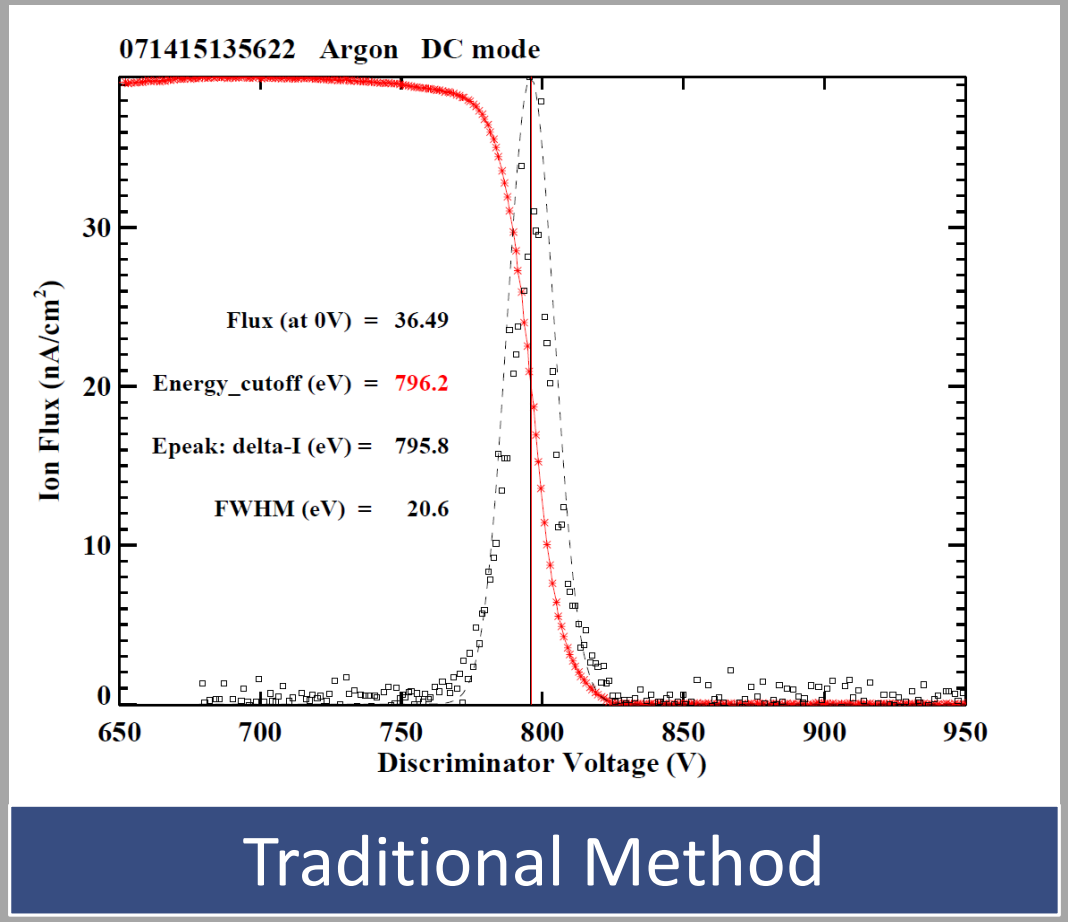
Single Energy Window

Smithsonian Astrophysical Observatory (SAO) Method

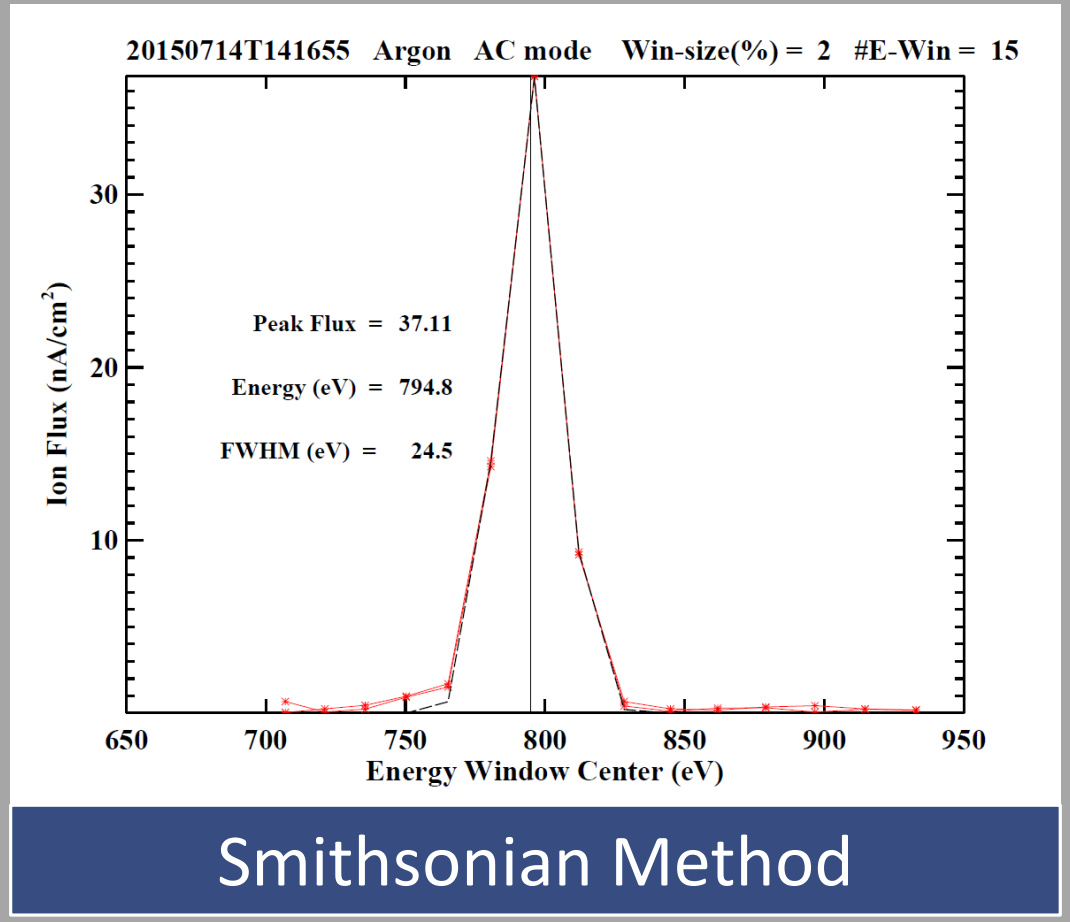


Energy Window Number	Energy Window Lower Value (V)	Energy Window Upper Value (V)	Energy Window Width (V)
0	100	105	5
1	105	110.25	5.25
2	110.25	115.7625	5.5125
3	115.7625	121.5506	5.7881
4	121.5506	127.6282	6.0776
5	127.6282	134.0096	6.3814
6	134.0096	140.71	6.7004
…	…	…	…
46	898.5008	943.4258	44.9250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

Results



Traditional Method

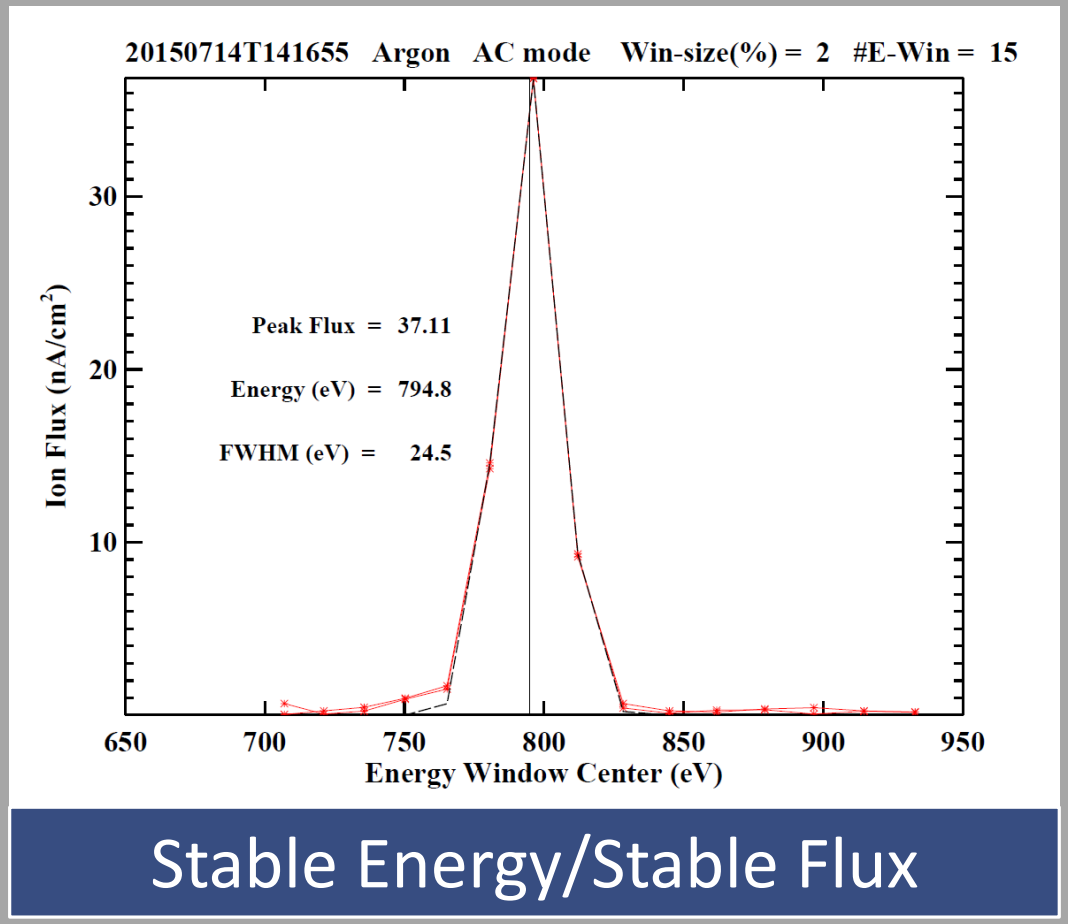


Smithsonian Method

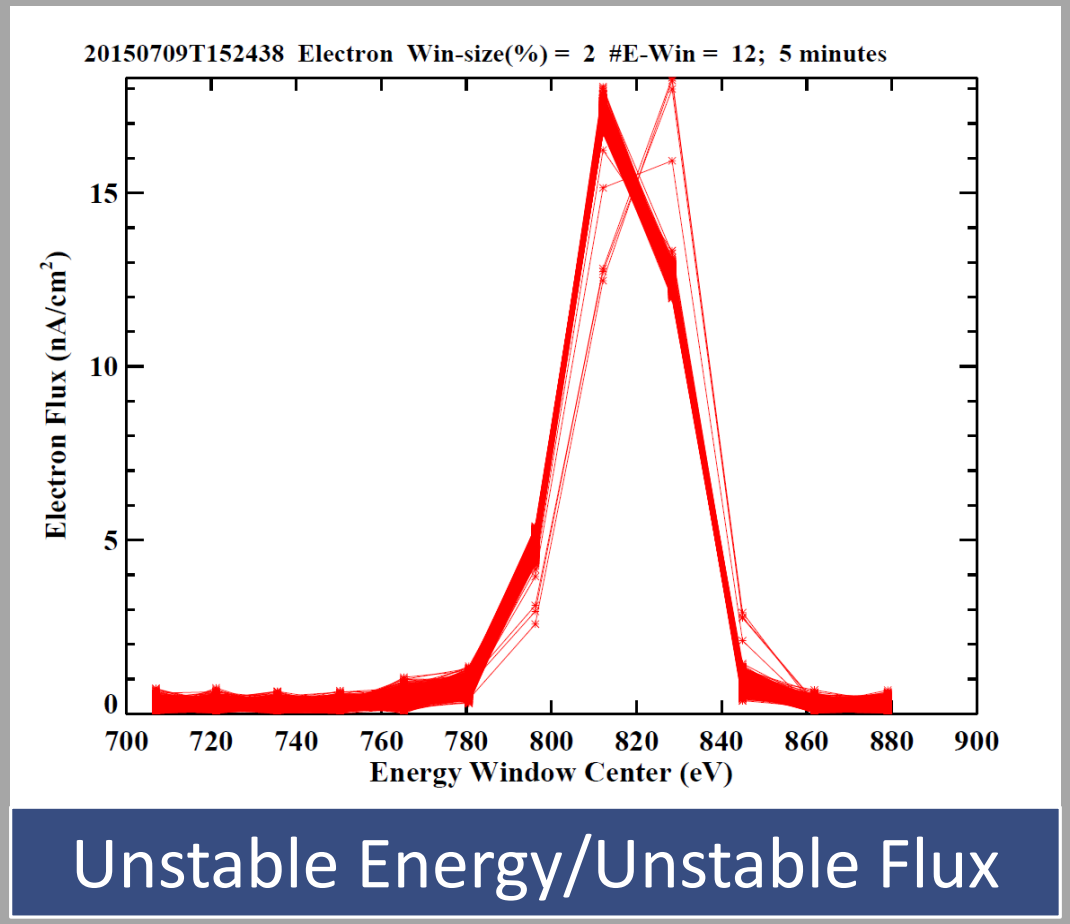
Comparison of Methods

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

Results

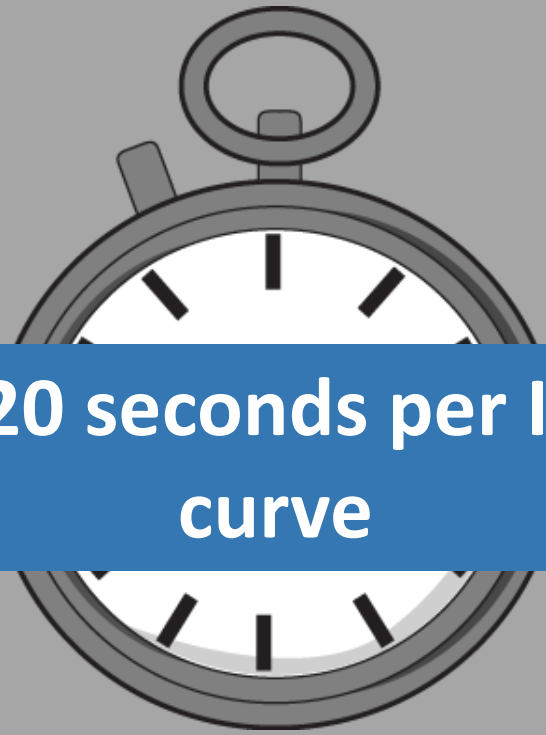


Stable Energy/Stable Flux



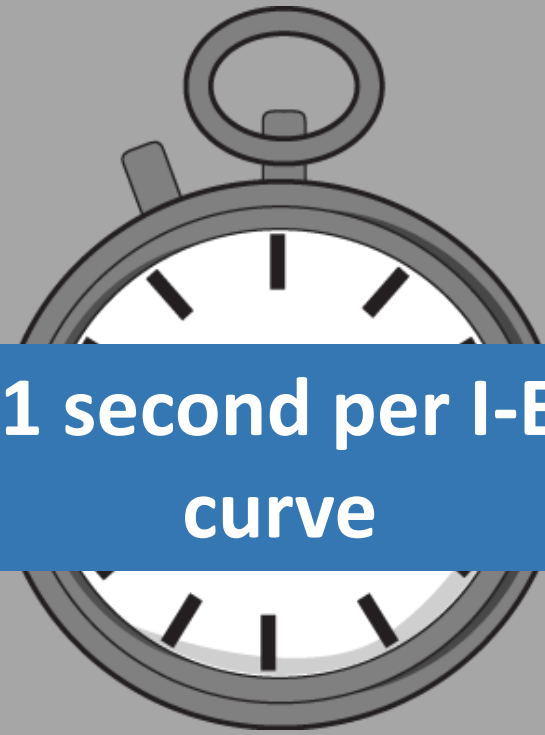
Unstable Energy/Unstable Flux

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.
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