Enhancement of the AC RPA

Mordecai Ben Israel, Alabama A&M University
Mentor: Paul Craven, PhD (MSFC EM41)

Abstract

The overall goal of this research project is to improve the response and sensitivity of the AC Retarding Potential Analyzer (RPA). The AC RPA can accurately measure the flux, energy, and energy distribution of charged particles in a space environment. The enhancement of the sensor derives from changes that increase sensitivity of flux measurements through reduction of the baseline noise. The enhanced AC RPA sensor allows diagnosis of required charge particle beams necessary for tests of materials, instruments and subsystems, for future exploration missions.

AC RPA Fundamentals

- See Figure 1
- Charge particle beam enters the fixed aperture of the instrument
- AC signal on modulator voltage allows energy discrimination (through retarding electric fields)
- Particles whose energy are greater than the retarding electric fields will reach the collector plates and recorded as current
- To eliminate secondary electron emission from the collector plates, a negative biased suppressor grid is located immediately upstream of the collectors
- Use of AC signals on the modulator grid requires grounded grids to be placed between the modulator and the collector in order to minimize capacitively induced current

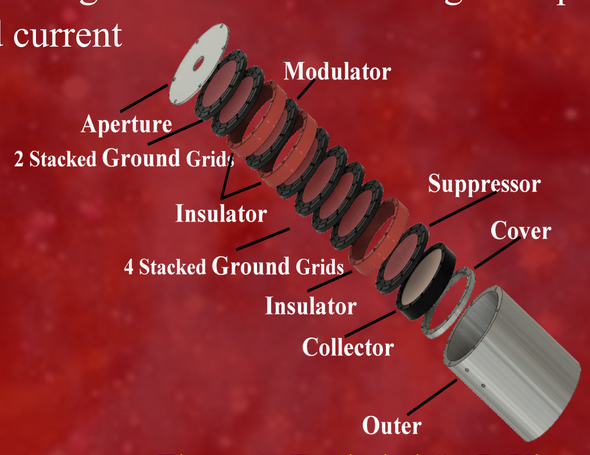

Figure 1: Exploded CAD View of the AC RPA

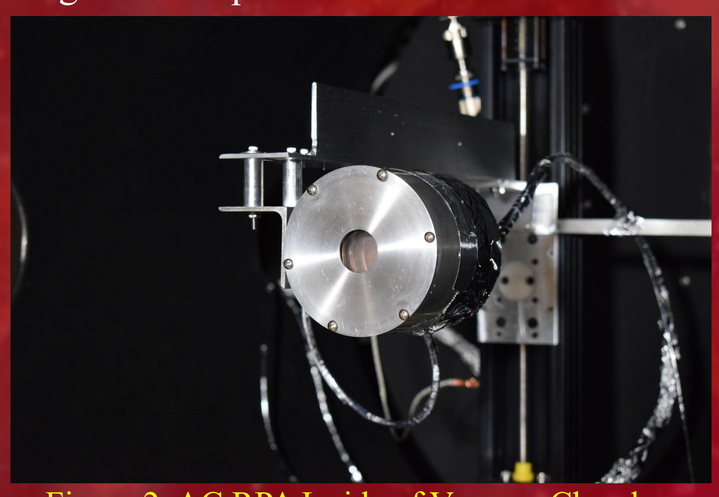

Figure 2: AC RPA Inside of Vacuum Chamber

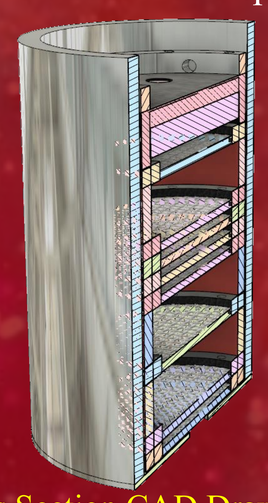

Figure 3: Cross Section CAD Drawing of the AC RPA

Results

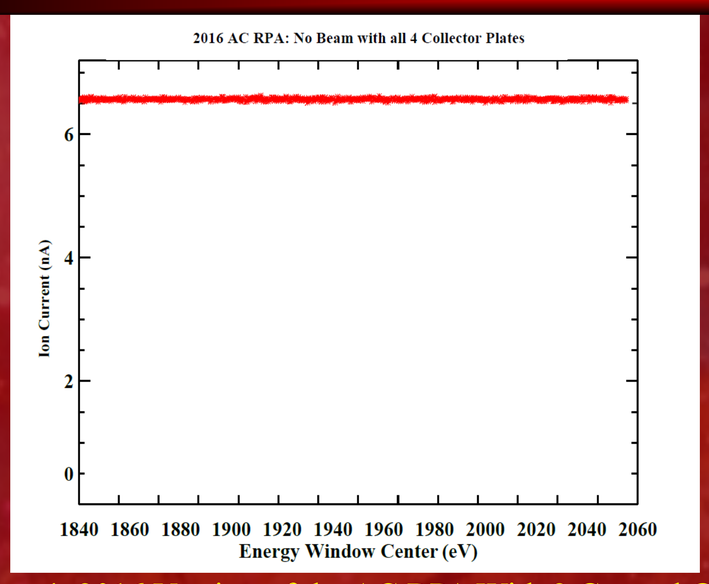

Figure 4: 2016 Version of the AC RPA With 2 Ground Grids
4 Collector Plates Connected
Induced Current ≈ 6.5 nA

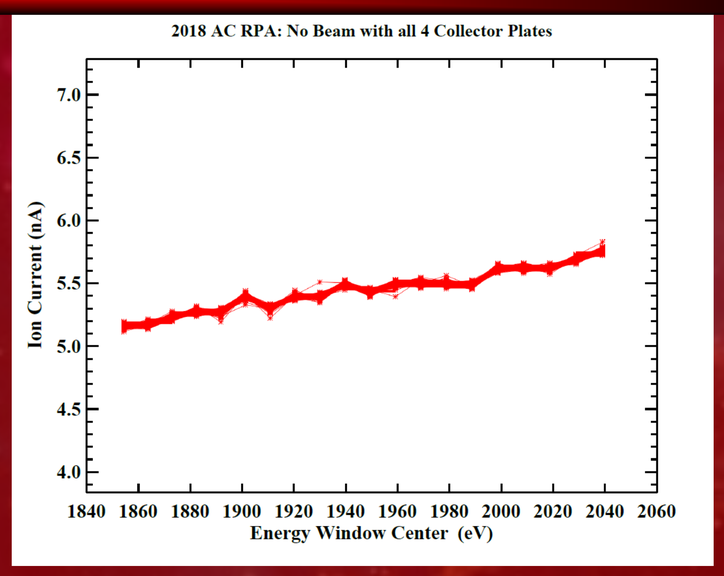

Figure 5: 2018 Version of the AC RPA With 4 Ground Grids
4 Collector Plates Connected
Induced current ≈ 5.5 nA (20% decrease)

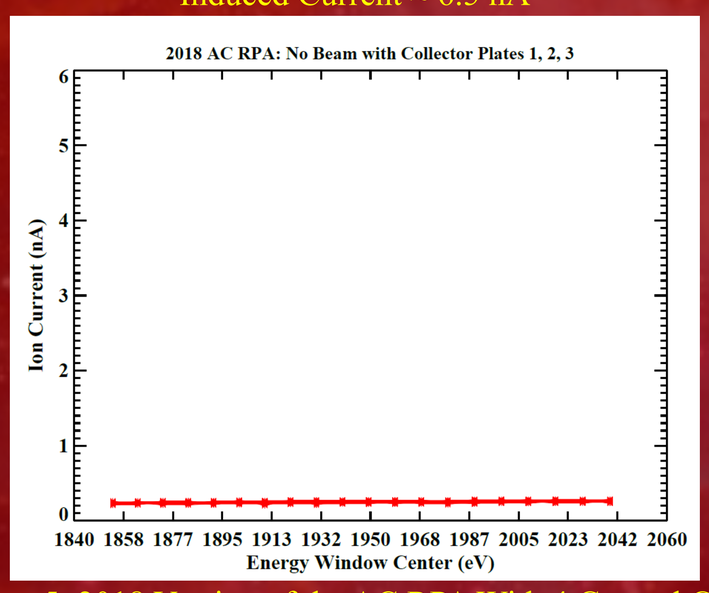

Figure 5: 2018 Version of the AC RPA With 4 Ground Grids
3 Collector Plates Connected
Induced Current ≈ 0.25 nA (Factor of 20 decrease!)

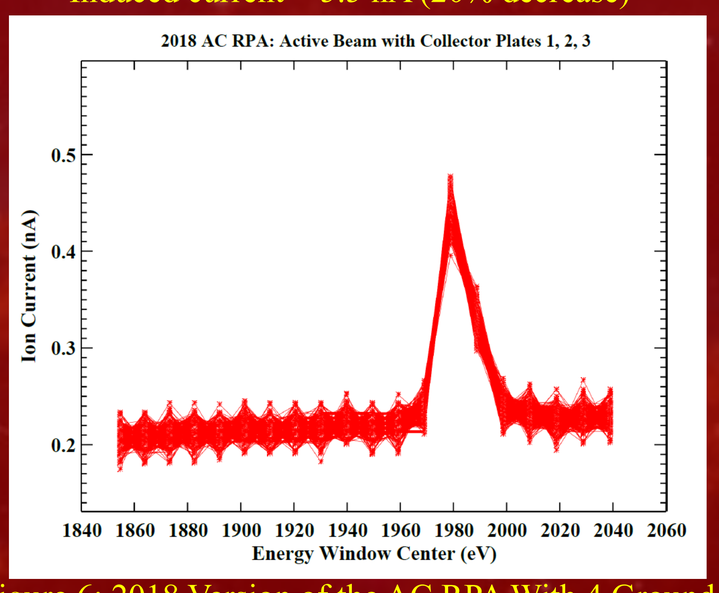

Figure 6: 2018 Version of the AC RPA With 4 Ground Grids
3 Collector Plates Connected
Induced Current ≈ 0.25 nA
Measuring an Argon Ion Beam

Conclusion and Acknowledgments

Additional ground grids proved to be only slightly effective in their ability to reduce capacitive coupled current in the collector. The biggest contributor to the induced current is due to one collector segment that is in close proximity to the modulator grid wire. When collector segment 4 is grounded and not used for collection of charged particles, there is a decrease in the induced current by a factor of 20! In the next design iteration, a shielded modulator wire will be employed to further decrease the induce current levels and still allow use of all collector segments.

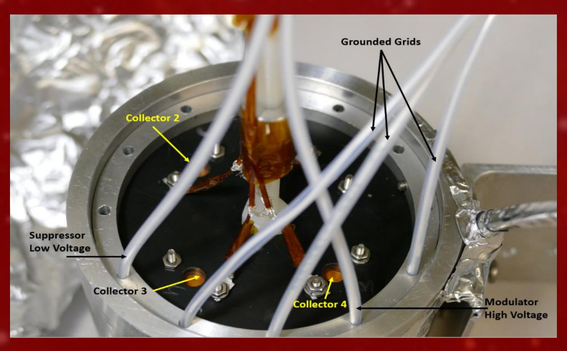

Figure 7: 2018 AC RPA Wires Relative to the Collector

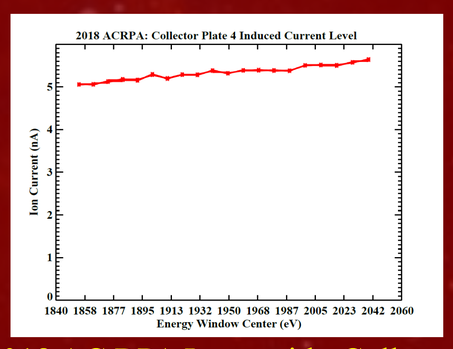

Figure 8: 2018 AC RPA Issue with Collector Segment 4

Acknowledgments

Special thanks to the Following:

- *NASA*
- *USRA*
- *Todd Schneider*
- *Ken Wright*
- *Erin Hayward*
- *Jesse McTernan*
- *Anthony Case*