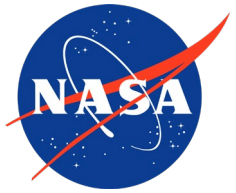


Electrostatic Regolith Interaction Experiment (ERIE) Electrometer Instrument Development

James R. Phillips III[1], Adrienne R. Dove[2], Kathryn G. Robertson[1], Krystal L. Acosta[1], Jerry J. Wang[1], Jeffrey E. Dyas[1], Sara Wijas[2], Richard Wakefield[2], Lucas Dillon[2]

[1]NASA Kennedy Space Center (KSC) Electrostatics and Surface Physics Laboratory (ESPL)

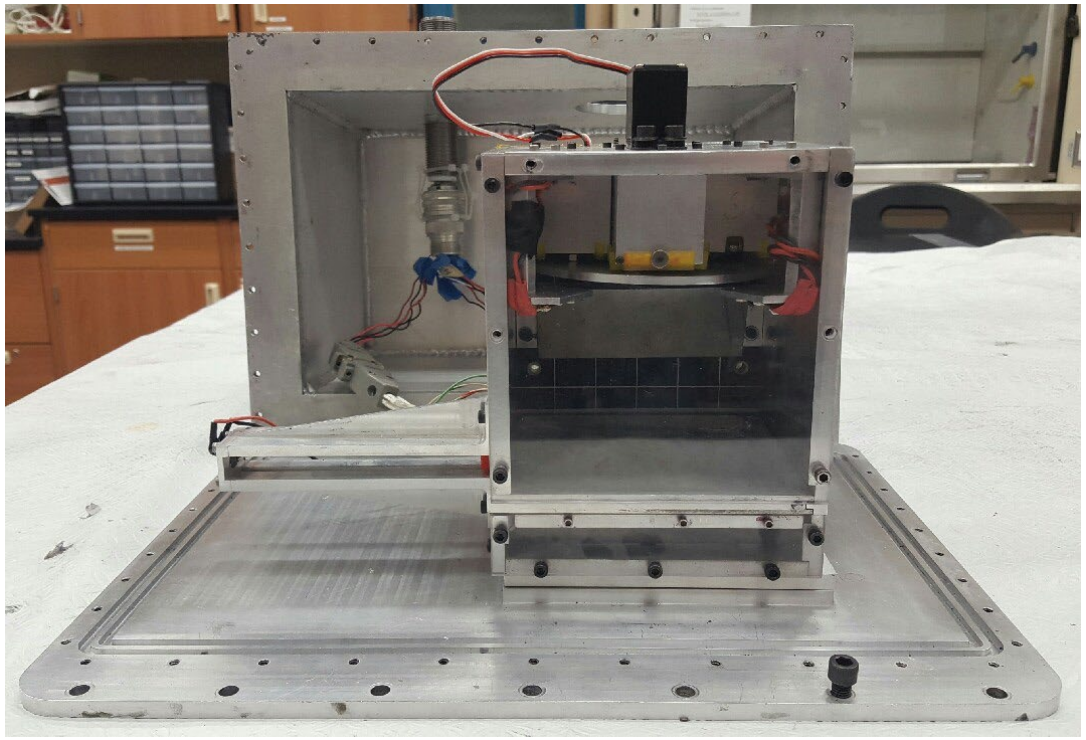
[2]University of Central Florida (UCF) Center for Microgravity Research (CMR)

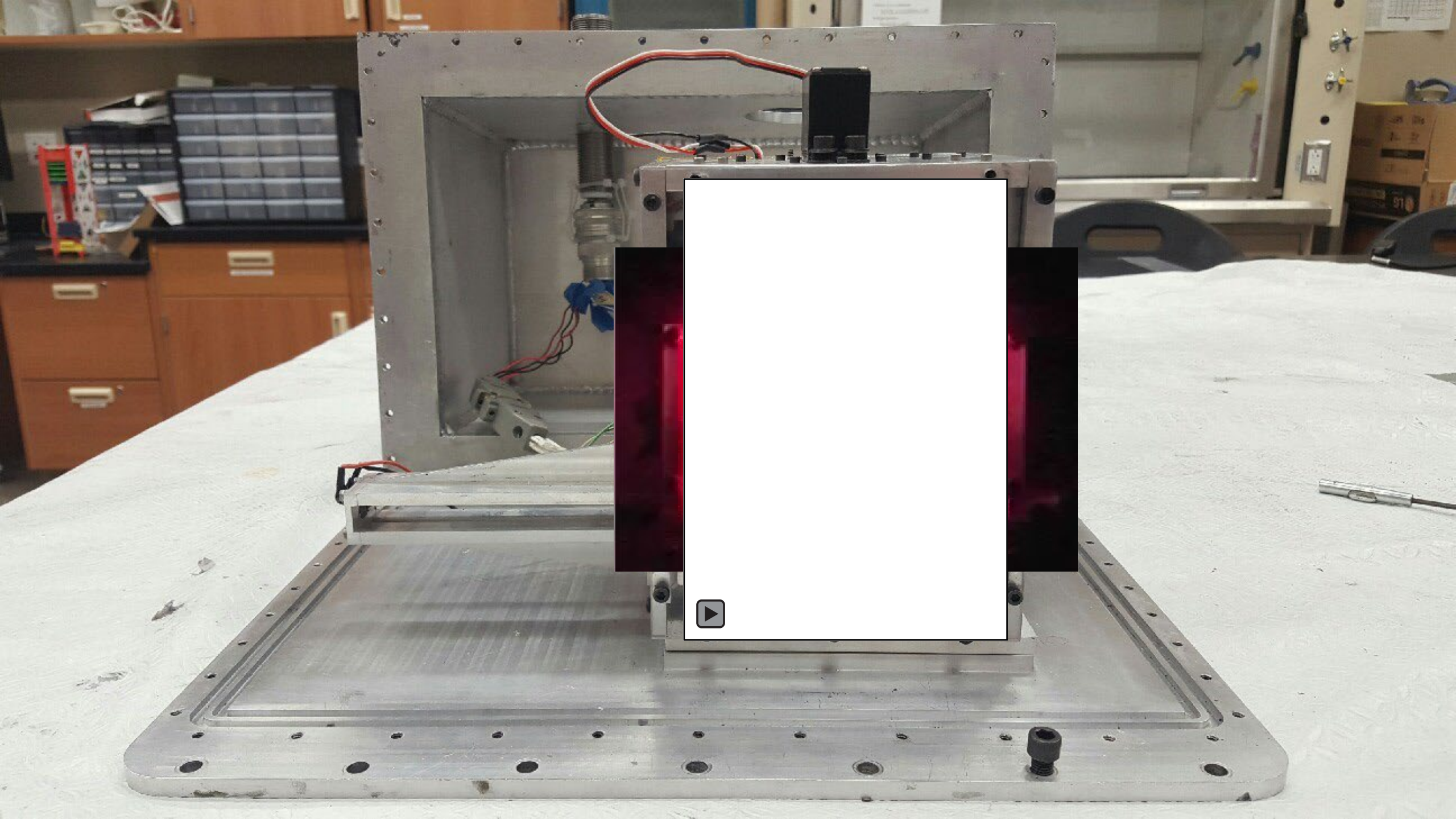
Background

- Advance the understanding of natural and induced charged grain behavior on the Moon, asteroids, and other low gravity bodies comprised of charged dust particles
- Electrostatic Regolith Interaction Experiment (ERIE) is a joint venture between UCF CMR and NASA KSC ESPL seeking to examine charged dust grain behavior on microgravity suborbital flight
  - UCF: COLLisions Into Dust Experiment (COLLIDE)
  - KSC: Wheel Electrostatic Spectrometer (WES)

COLLisions Into Dust Experiment (COLLIDE)

- Microgravity experiment to study cratering events in granular beds flown on Space Shuttle, parabolic aircraft, and suborbital flights
- Retains granular material under vacuum in tray behind metal door, which then opens and releases particles into larger open volume when microgravity is achieved
- Electrostatic repulsion between grains in bed was observed prior to collision with impactor



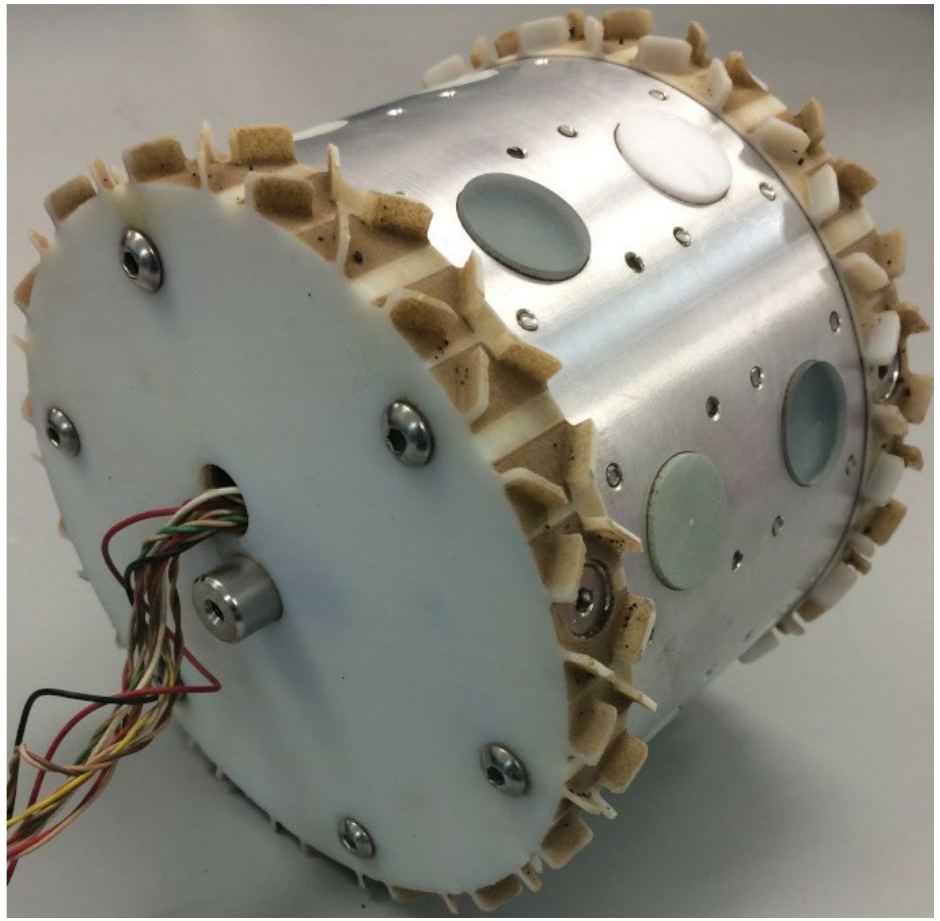


Mars Environmental Compatibility Assessment (MECA) Electrometer

- Suite of triboelectric, ion current, and electric field sensors developed by JPL/KSC planned to fly to Mars in 2001
- Five different insulator materials spanning triboelectric series contact the surface:
  - Lucite™
  - Garolite™
  - Lexan™
  - Teflon™
  - Rulon-J™

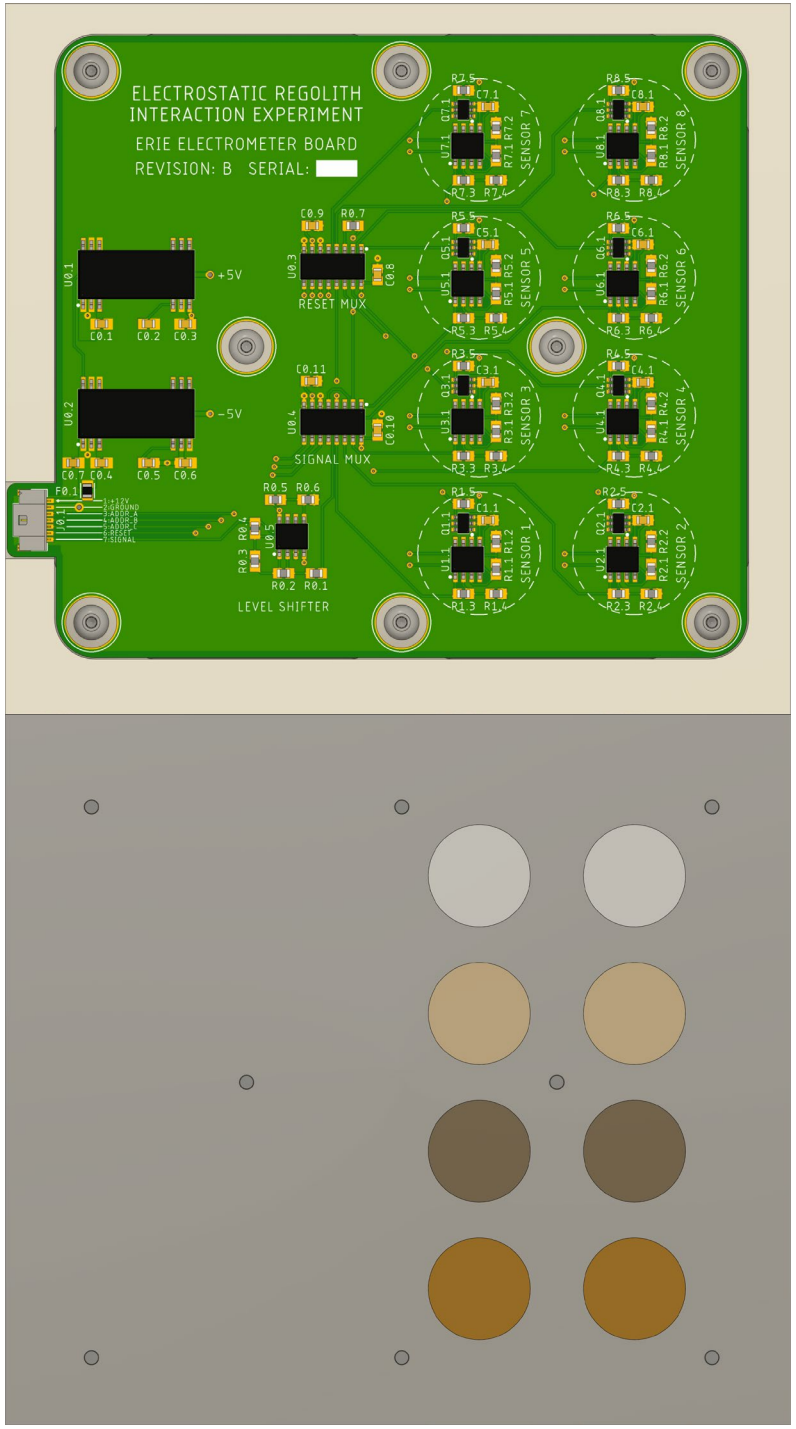
Wheel Electrostatic Spectrometer (WES)

- Updated triboelectric sensors from MECA electrometer installed along circumference of rover wheel proposed to characterize triboelectric properties of Martian regolith through contact with surface as wheel rotates

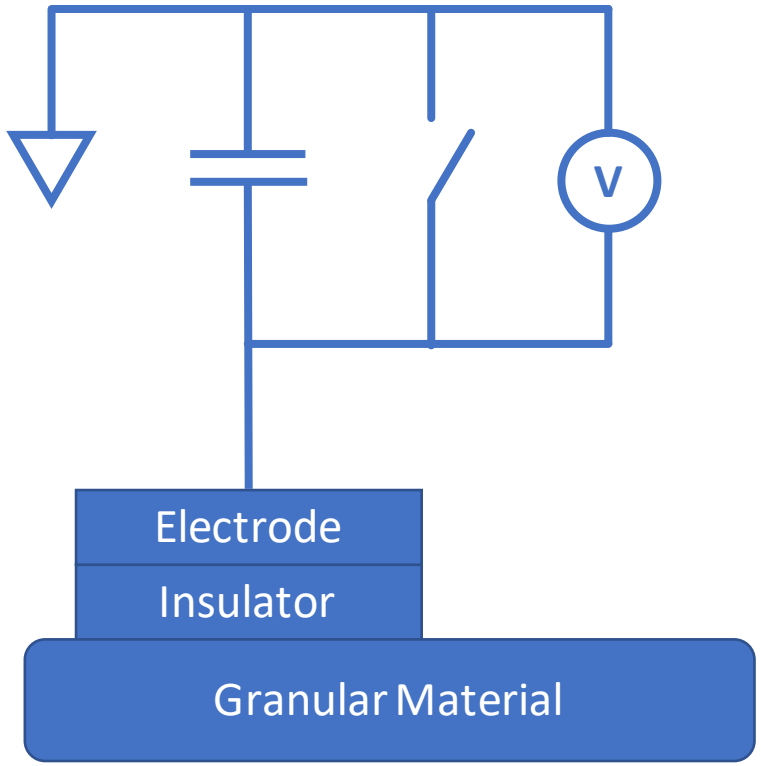


ERIE Electrometer

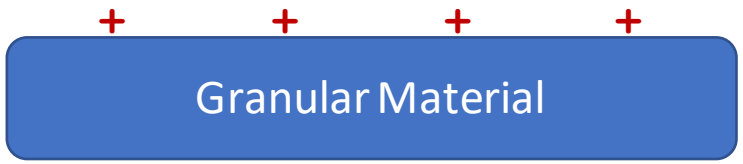
- Improved triboelectric sensors from WES installed inside COLLIDE dust retaining door
- Measures charge transferred between granular material and insulators protruding through door
- Insulator disks span triboelectric series so each will accumulate charge consistent with relative position to grains within series as door slides open
  - Sensors 1/2 (−−) Teflon™ Polytetrafluoroethylene (PTFE)
  - Sensors 3/4 (+) Garolite™ Fiberglass/Epoxy Composite
  - Sensors 5/6 (++) Lucite™ Polymethylmethacrylate (PMMA)
  - Sensors 7/8 (−) Lexan™ Polycarbonate

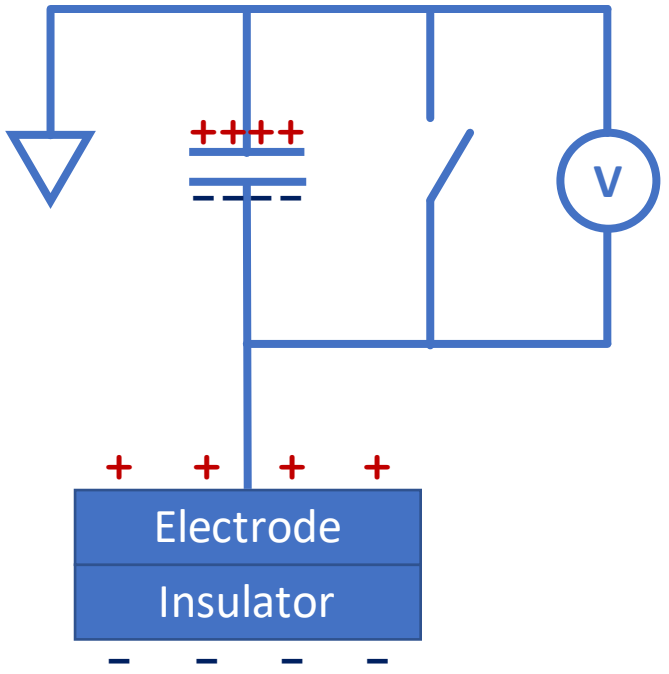


Triboelectric Sensor Detail



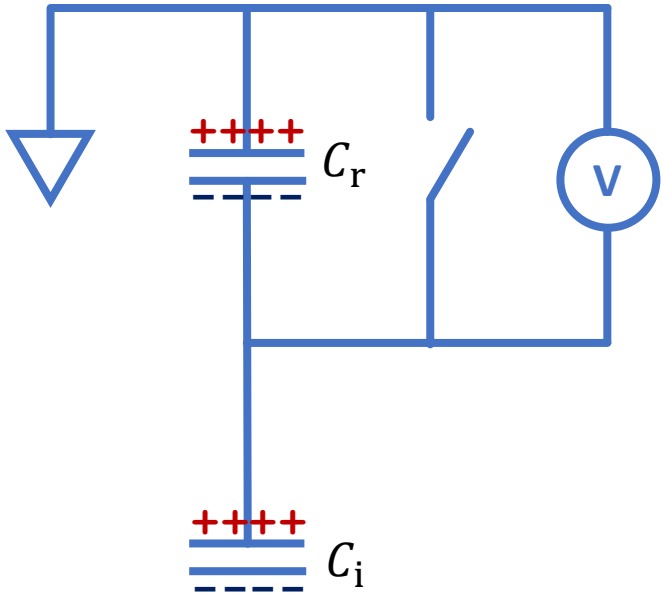
Triboelectric Sensor Detail



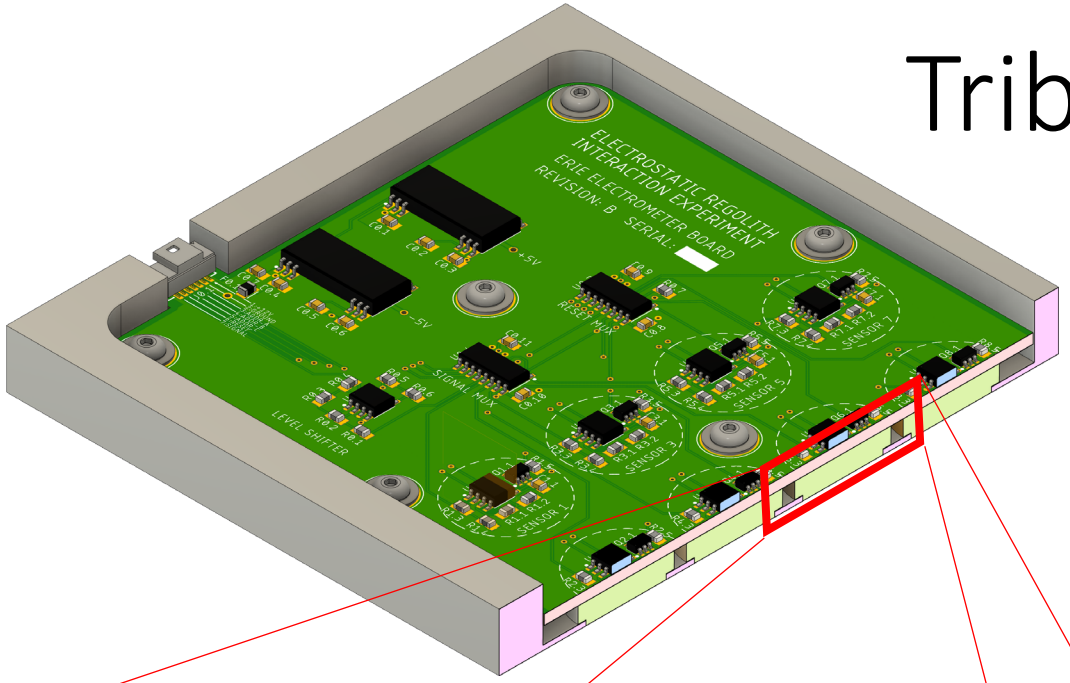


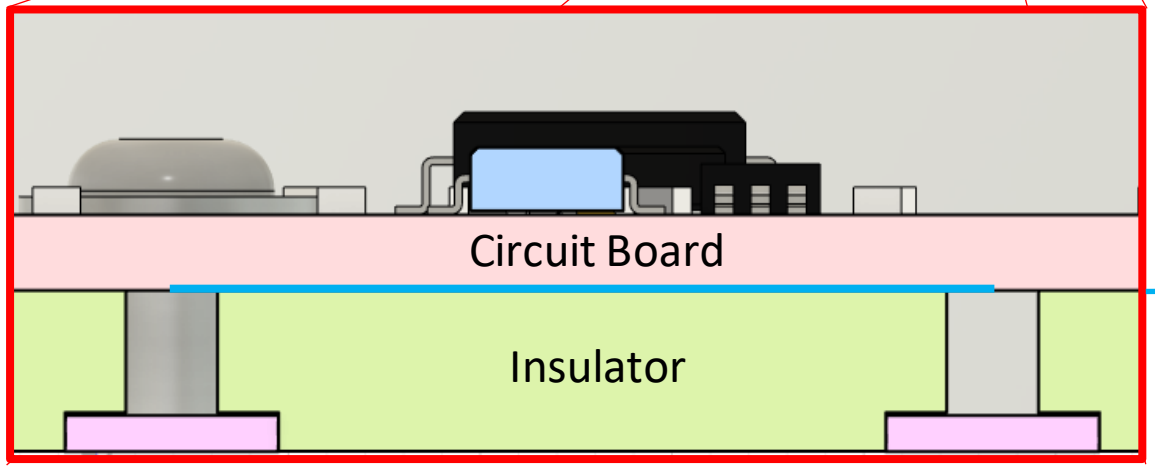
Triboelectric Sensor Detail

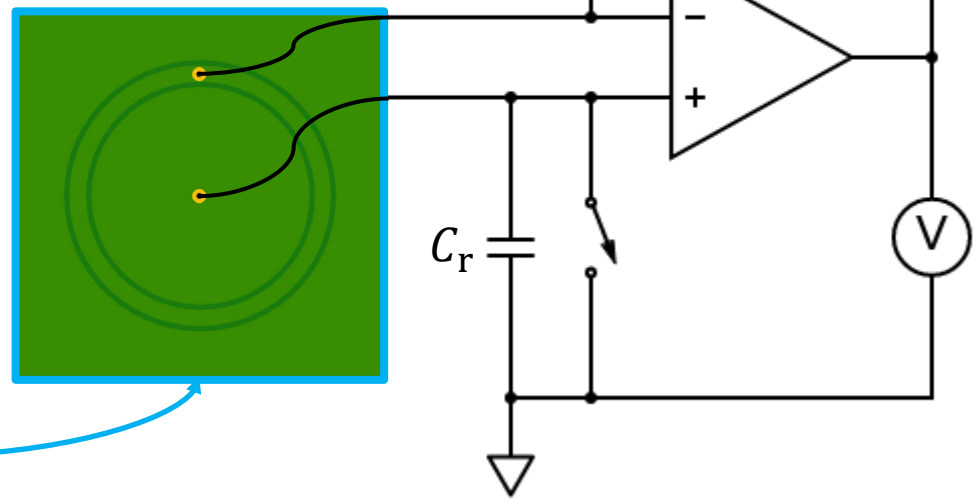
- Charge, Q, deposited on an insulator surface induces an equal charge, Q, on a series reservoir capacitor, C_r
- $Q = C_\mathrm{r}V_\mathrm{r} = C_\mathrm{i}V_\mathrm{i} \;\rightarrow\; V_\mathrm{r} = V_\mathrm{i}\dfrac{C_\mathrm{i}}{C_\mathrm{r}} = \dfrac{Q}{C_\mathrm{r}}$
- Circular insulator of radius, r, and thickness, t, has capacitance given by $C_\mathrm{i} = \varepsilon_\mathrm{r}\varepsilon_0\dfrac{\pi r^2}{t}$
- C_i is determined by permittivity of insulator
- C_r is low leakage capacitor installed on board
- V_r is measured via electrometer amplifier and is directly proportional to accumulated charge, Q



Triboelectric Sensor Detail

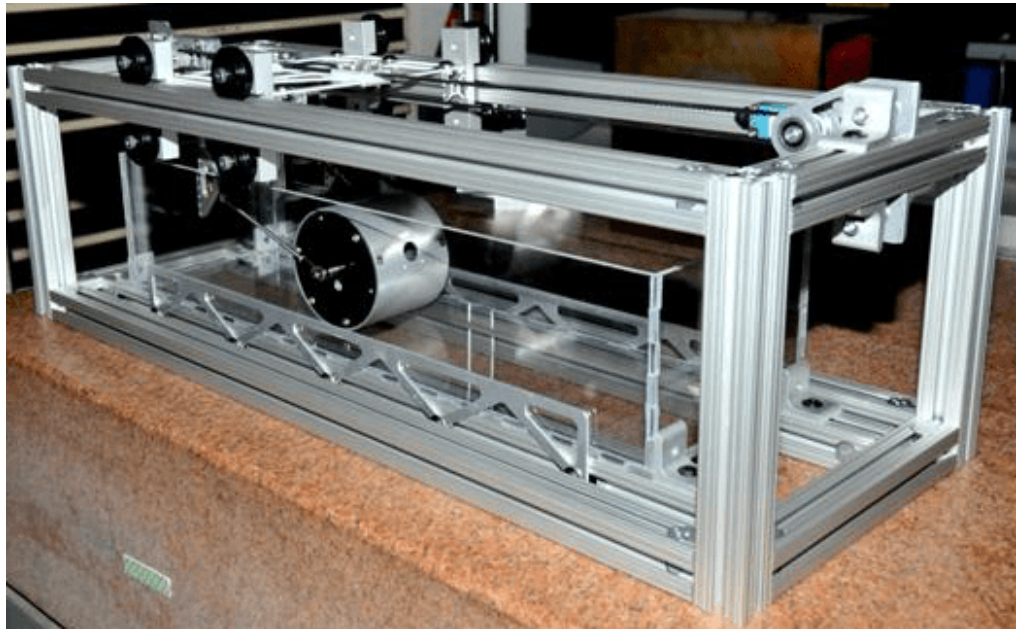






Calibration / Testing

- Applied known voltages to sensor pads without insulators installed
- Charged capacitors to known voltage and transferred entirety of charge into sensor pads
- Rubbed insulator materials against sensors with insulator disks installed
- Installed door on translation stage previously used to test WES under vacuum with regolith simulants



Suborbital Flight

- Flight results at next conference!