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# Triboelectric Charging of an Insulator's Surface Using Martian Soil Simulant

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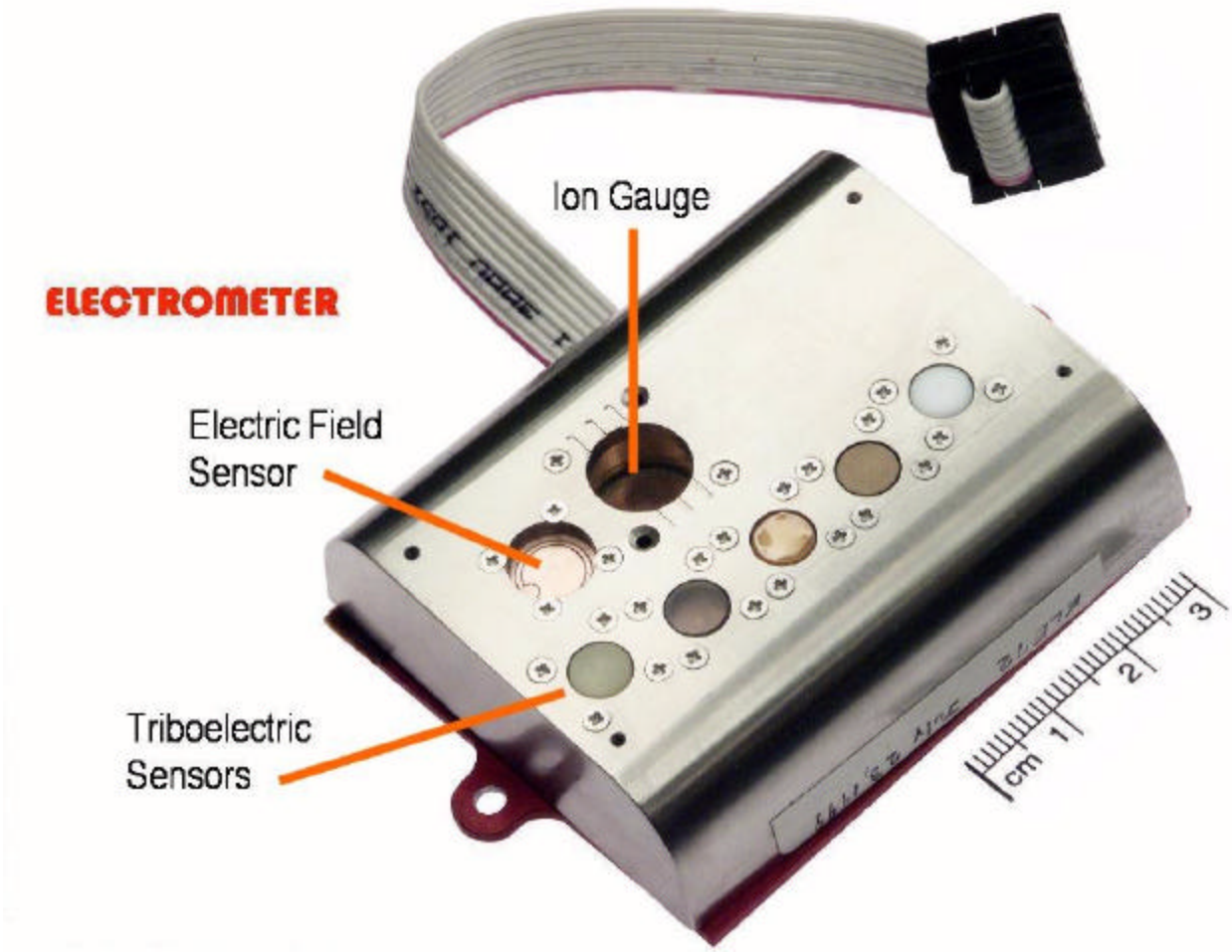
# Introduction

- Dry surface conditions and fine clays of the martian soil are conducive to electrostatic charge buildup which may compromise performance and safety of equipment:
  - Solar cell performance will degrade as dust collects on the solar panels.
  - Dust that collects on viewing ports will reduce light throughput.
  - Thermal radiators will become clogged by dust.
  - Movement of mechanical parts will be impeded.
  - Dust will adhere to space suits.
- Using the MECA (Mars Environmental Compatibility Assessment) Electrometer, an instrument jointly designed by scientists at JPL and KSC, we have investigated the simultaneous electrostatic charging of five types of insulating materials under identical conditions using frictional contact with Martian soil.




The Electrometer used in this study to measure the amount of tribolectric charge generated on the surfaces of five types of insulators - Fiberglass/Epoxy, Lexan, Teflon, Rulon J, Lucite

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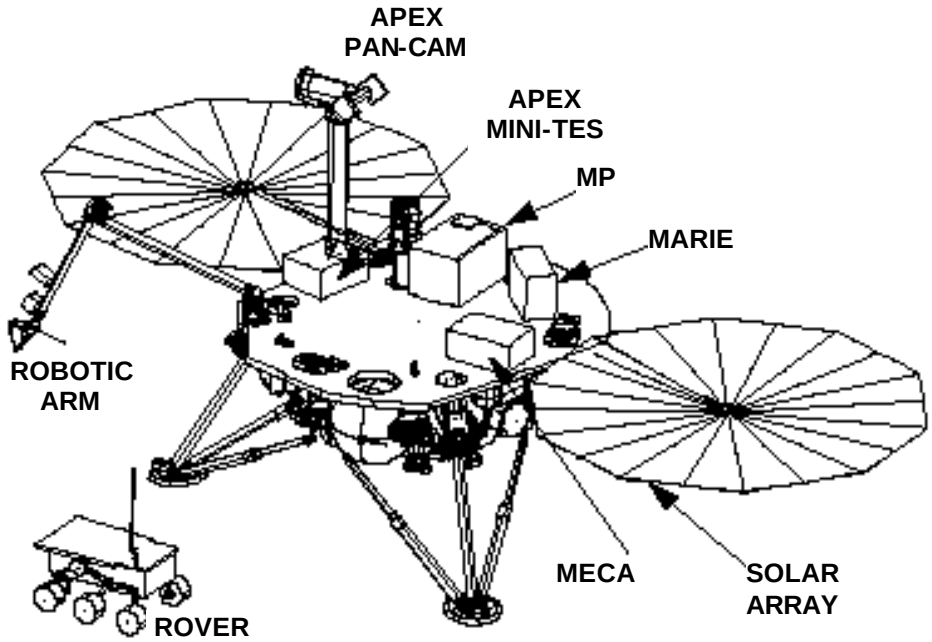


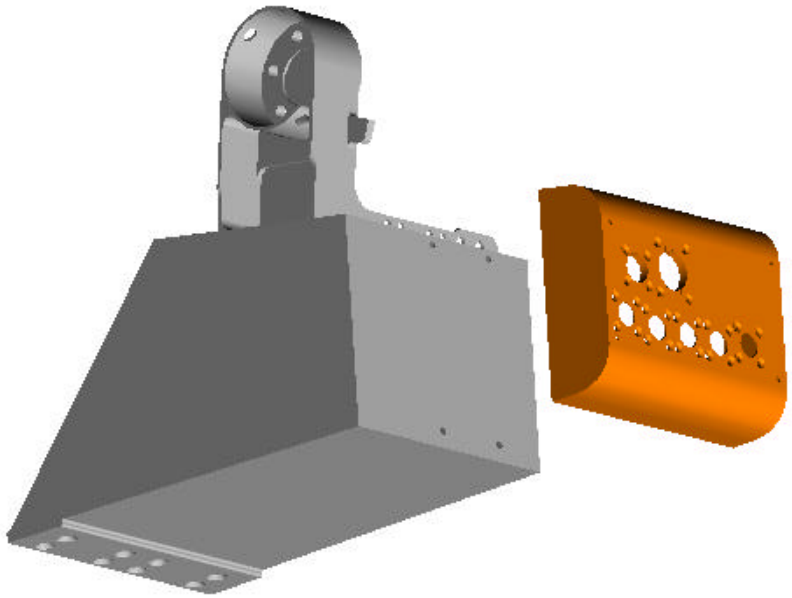

Proposed location of the electrometer in the Mars Surveyor 2001 Mission, now redesigned. A similar configuration will be proposed for a future mission.

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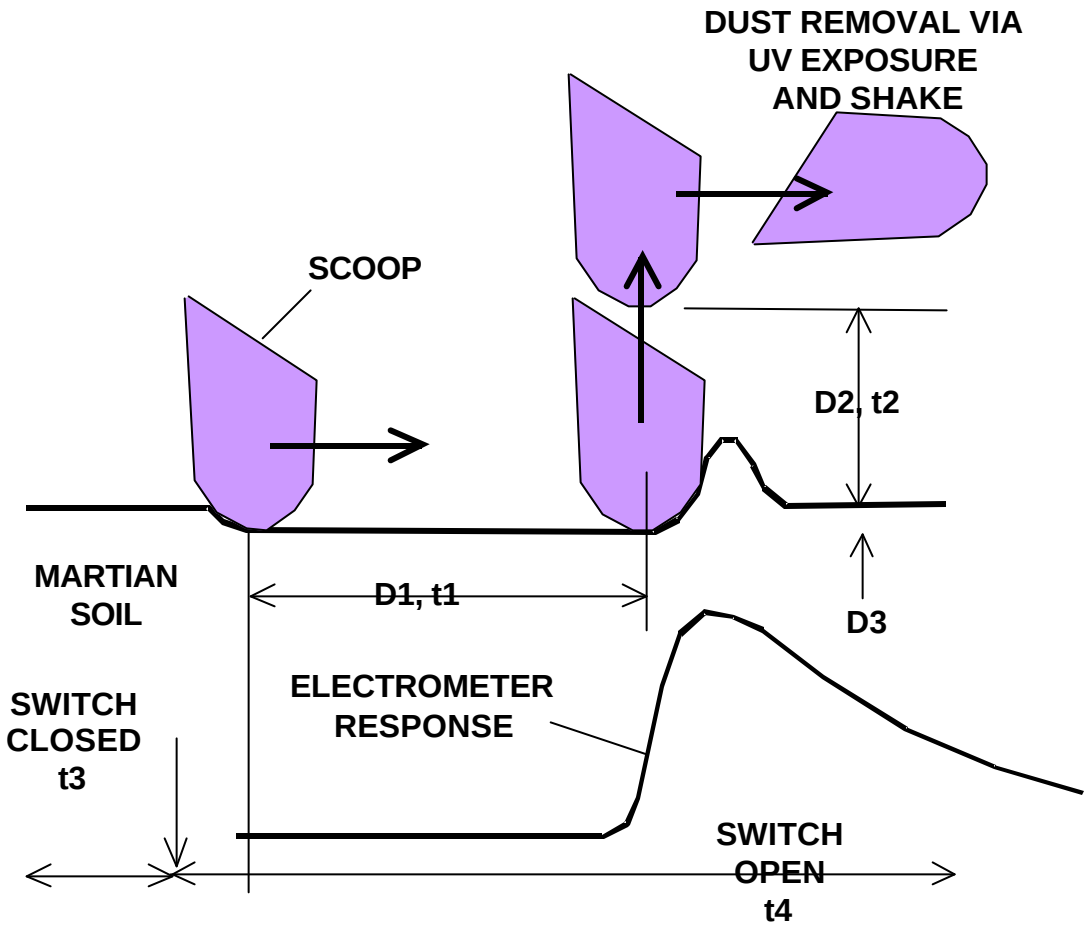
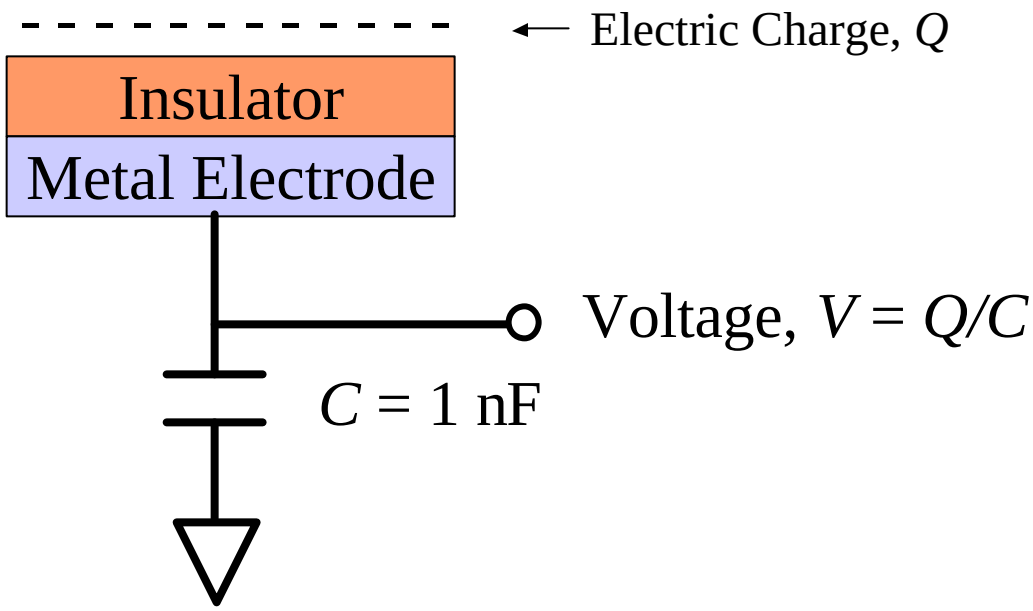
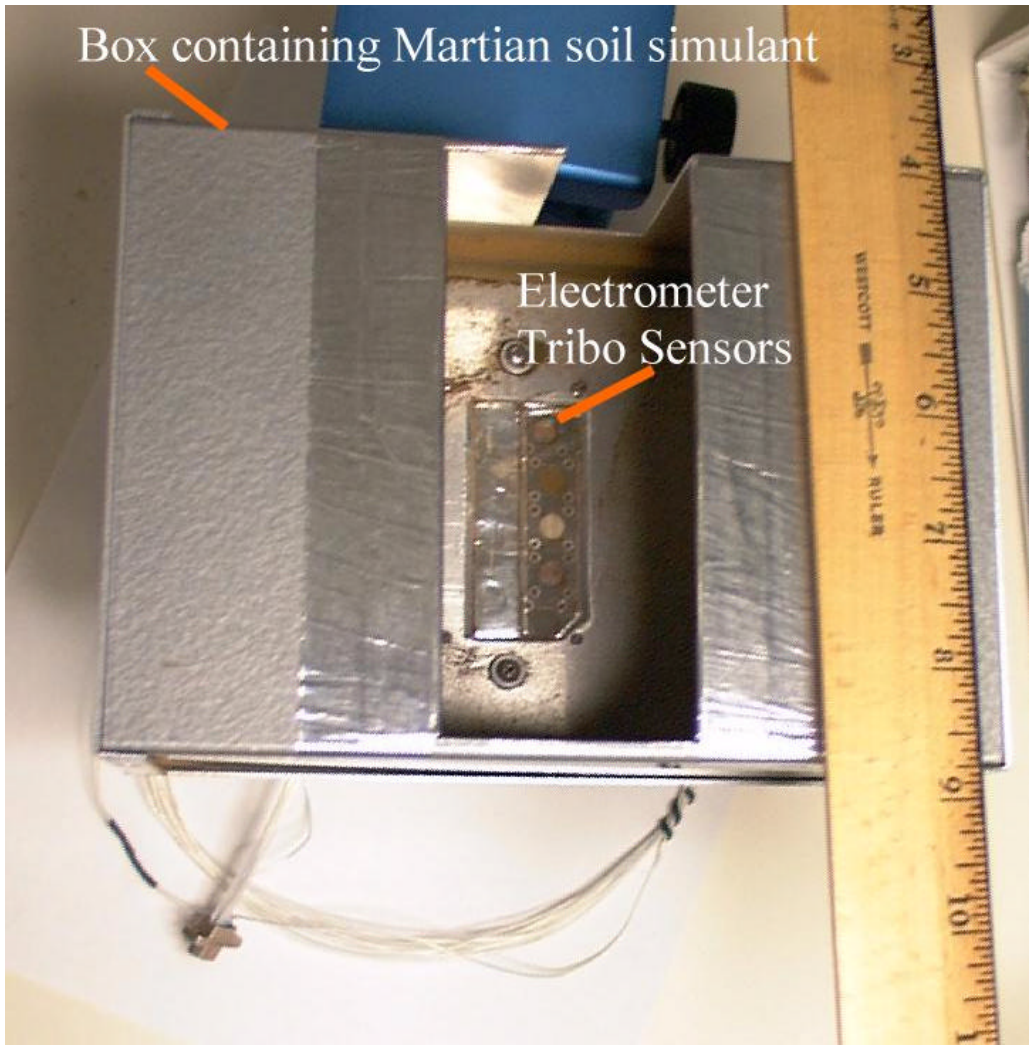



# Proposed Scoop Operation




# Triboelectric Sensor

The output voltage of the tribolectric sensor circuit is proportional to the amount of electric charge that is generated on an insulator's surface after rubbing the surface against Martian soil simulant, or other abrasive. The gain of the circuit is 0.25 nC/V.




Box used to “rock” Martian soil simulant over tribo sensors in a vacuum chamber at low $CO_2$ pressure.

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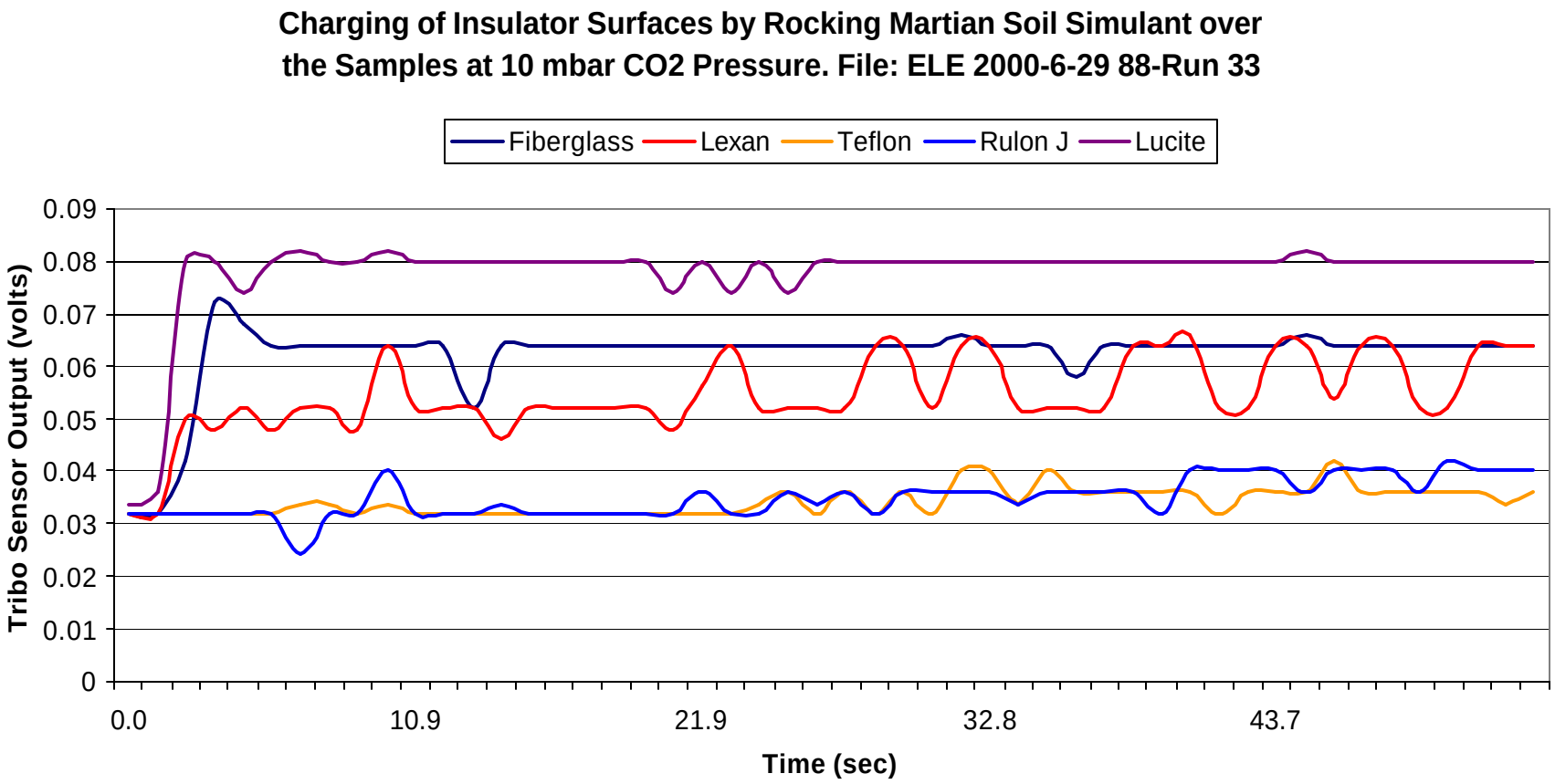


Data obtained in $CO_2$ at 10 mbar using the rocking device. The first few data points are taken prior to rocking the Martian soil simulant over the sensors. Time interval between data sampling is 1.1 sec.

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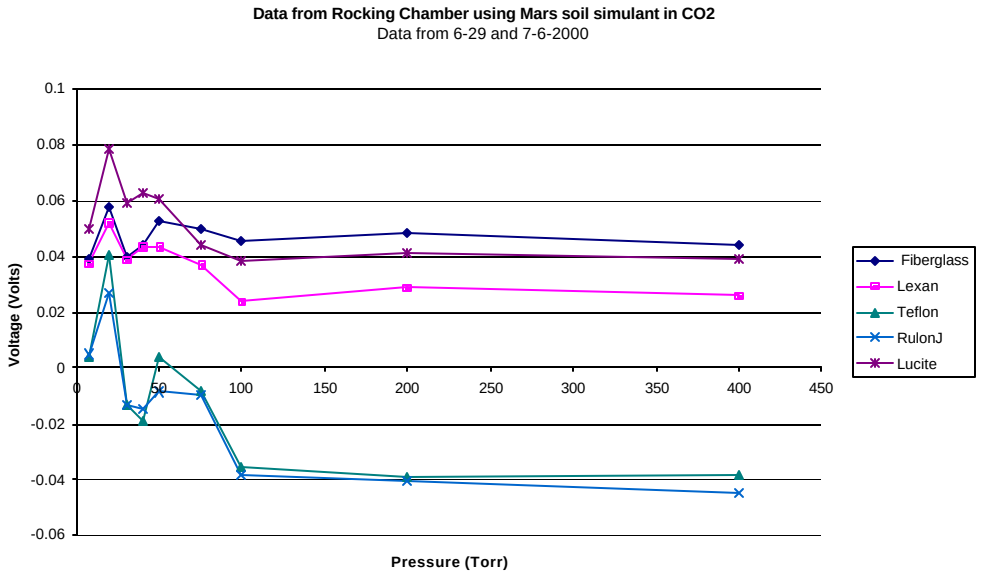
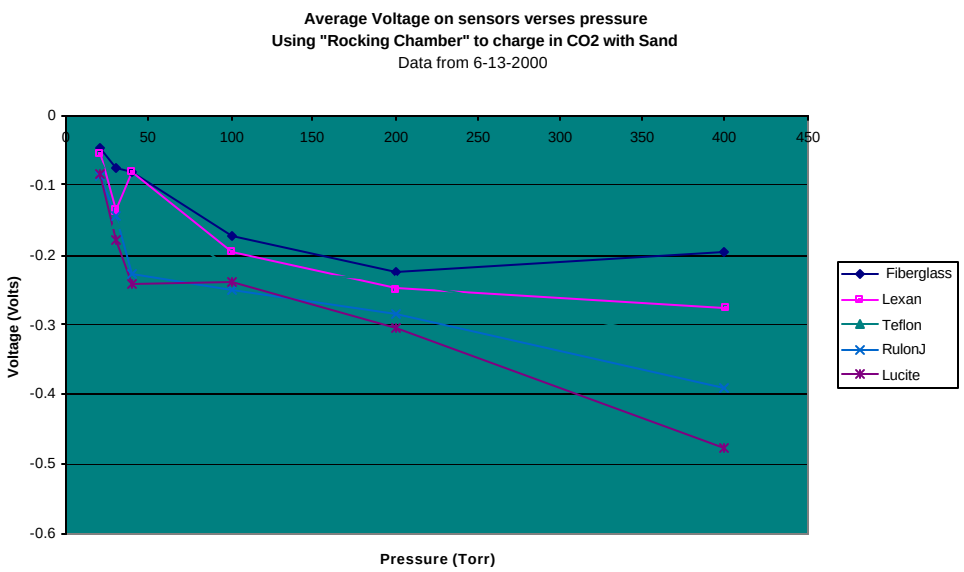
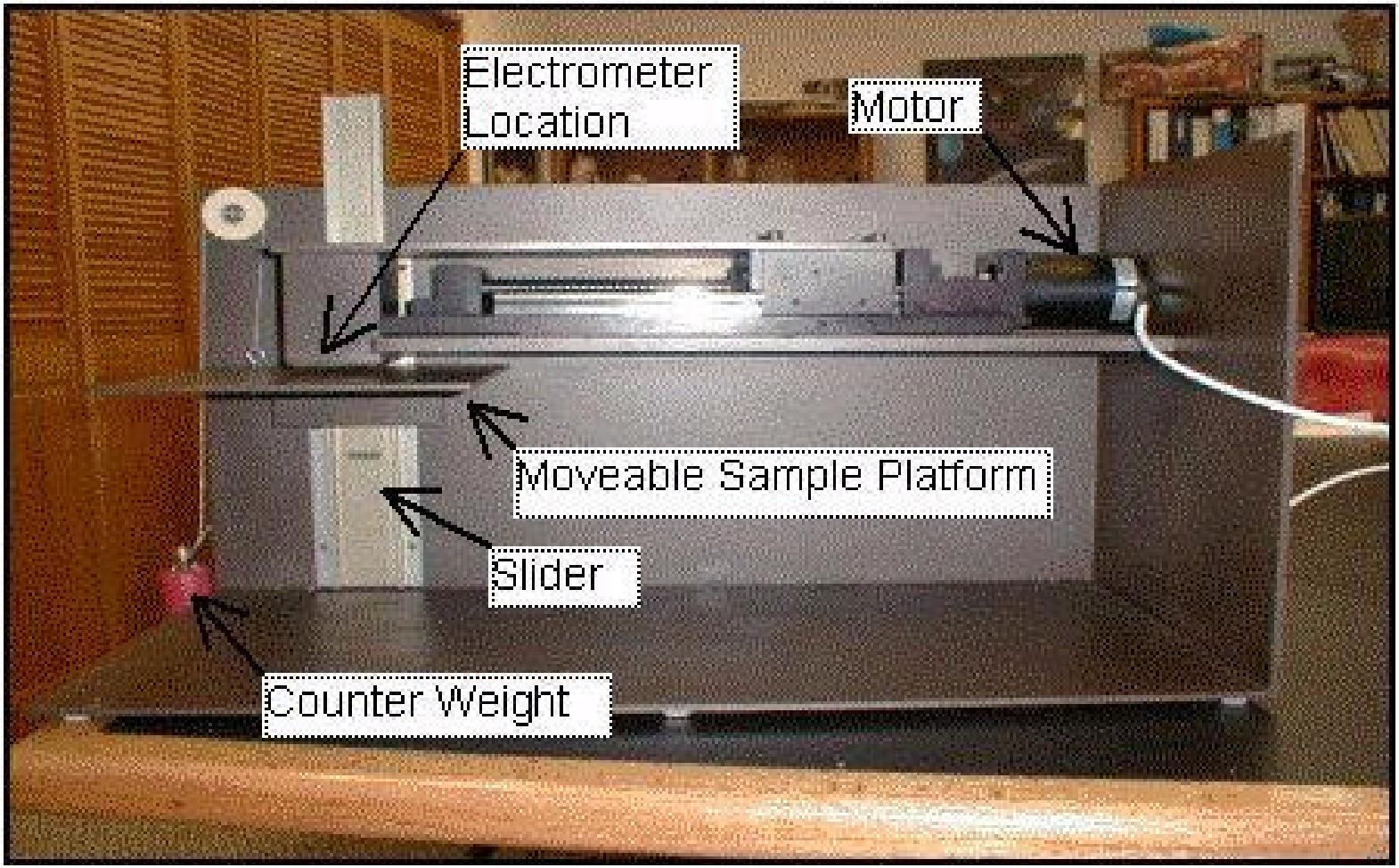



Charge generated with Mars Simulant in Rubbing Chamber as a function of pressure.




Charge generated with Ottawa Sand in Rubbing Chamber as a function of pressure.




Machine used to rub the electrometer over Martian soil simulant and other materials.

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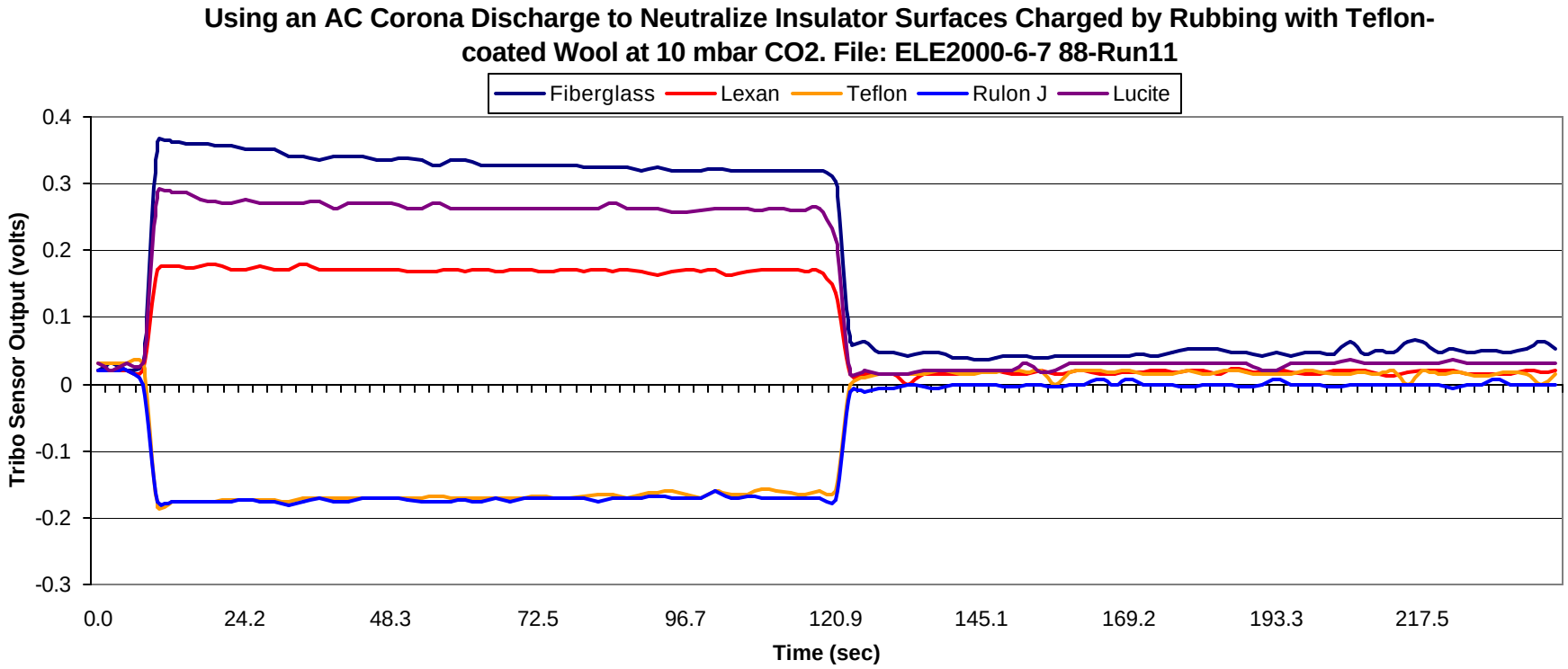


Charging and discharging of insulators at 10 mbar in a $CO_2$ atmosphere. The time interval between data sampling is 2.4 sec. Normal discharging is observed between 10 and 121 seconds. At 121 seconds, an applied corona discharge air ionizer quickly neutralizes the charged samples.

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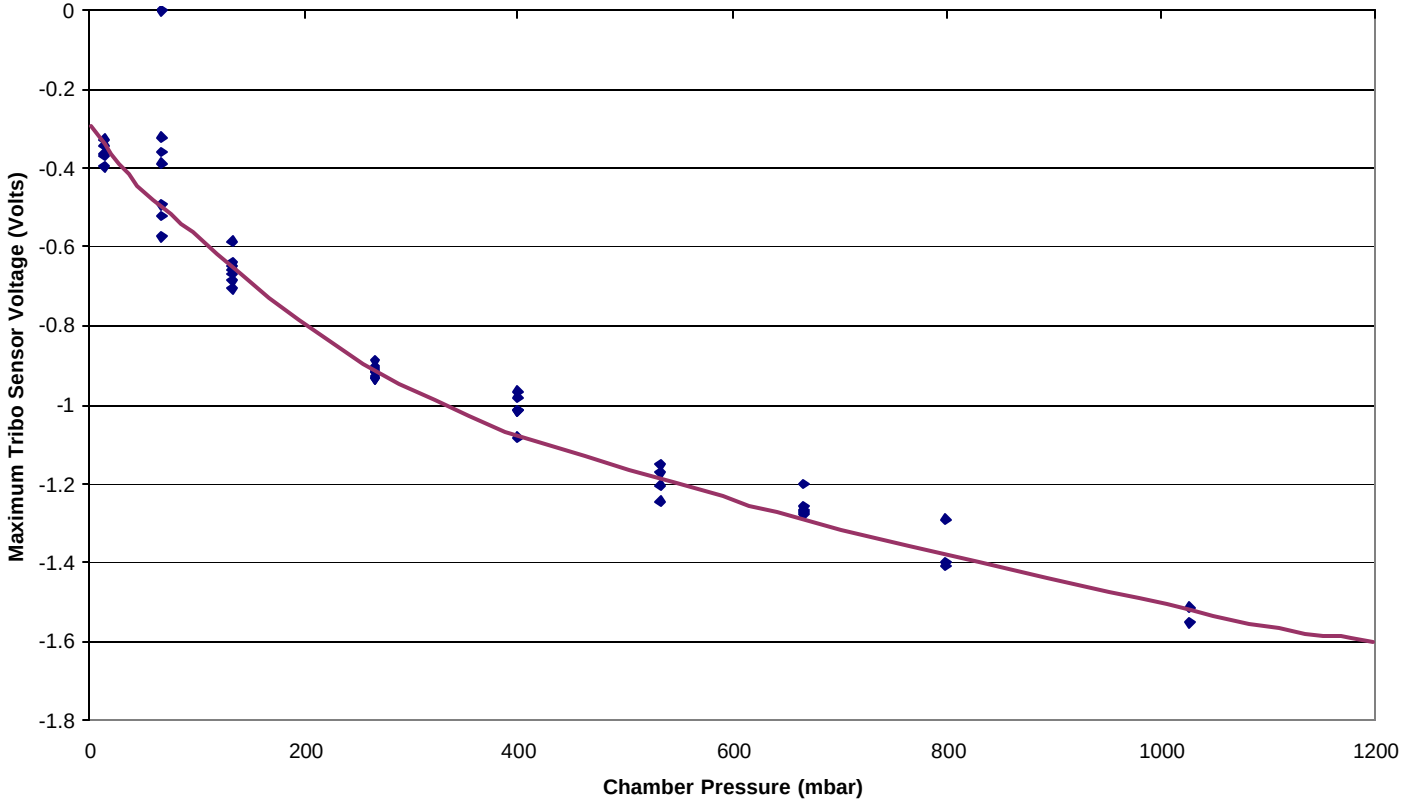
**Max. Tribo Sensor Voltage (Teflon) vs Chamber Pressure (Dry Air)**
(at room temperature, 7 - 10% relative humidity)




The data was taken in a dry air environment (relative humidity range: 7 - 10%) over a pressure range from 10 mbar to atmospheric pressure. The data show that the maximum charge developed on insulators decreases with pressure.

# Conclusions

- We have described the general operation of the MECA Electrometer and obtained preliminary data showing that 5 different insulators (fiberglass/epoxy, polycarbonate, teflon, Rulon J, and polymethylmethacrylate) acquire an electrostatic charge when rubbed with Martian soil simulant particles in a $CO_2$ atmosphere and at 10 mbar.
- We have also shown that charged materials can be neutralized at Martian atmospheric pressures (10 mbar) using a commercial off-the-shelf air ionizer.
- Additional experiments with different martian simulants are currently being designed for the new Electrostatics Mars Environmental Chamber, coming on line in the next few weeks.