Neutralizing

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Charged

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Surfaces

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on Mars

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Abstract

We have studied the interaction of five different insulator materials that have been rubbed over martian soil simulant using the Mars Environmental Compatibility Assessment (MECA) electrometer, which is an instrument intended to be part of a future Mars lander mission. The electrometer was designed primarily to study (1) the electrostatic interaction between the martian soil and the insulator materials, which are attached to the electrometer. The MECA/Electrometer is also capable of measuring (2) the presence of charged particles in the martian atmosphere, (3) the local electric field strength, and (4) the local temperature. We will present results that indicate that a martian soil simulant can triboelectrically charge up an insulator surface. Data taken at 6 mbar and at room temperature will be presented. We will also discuss methods of neutralizing these insulator surfaces, and will present data for some of these methods.

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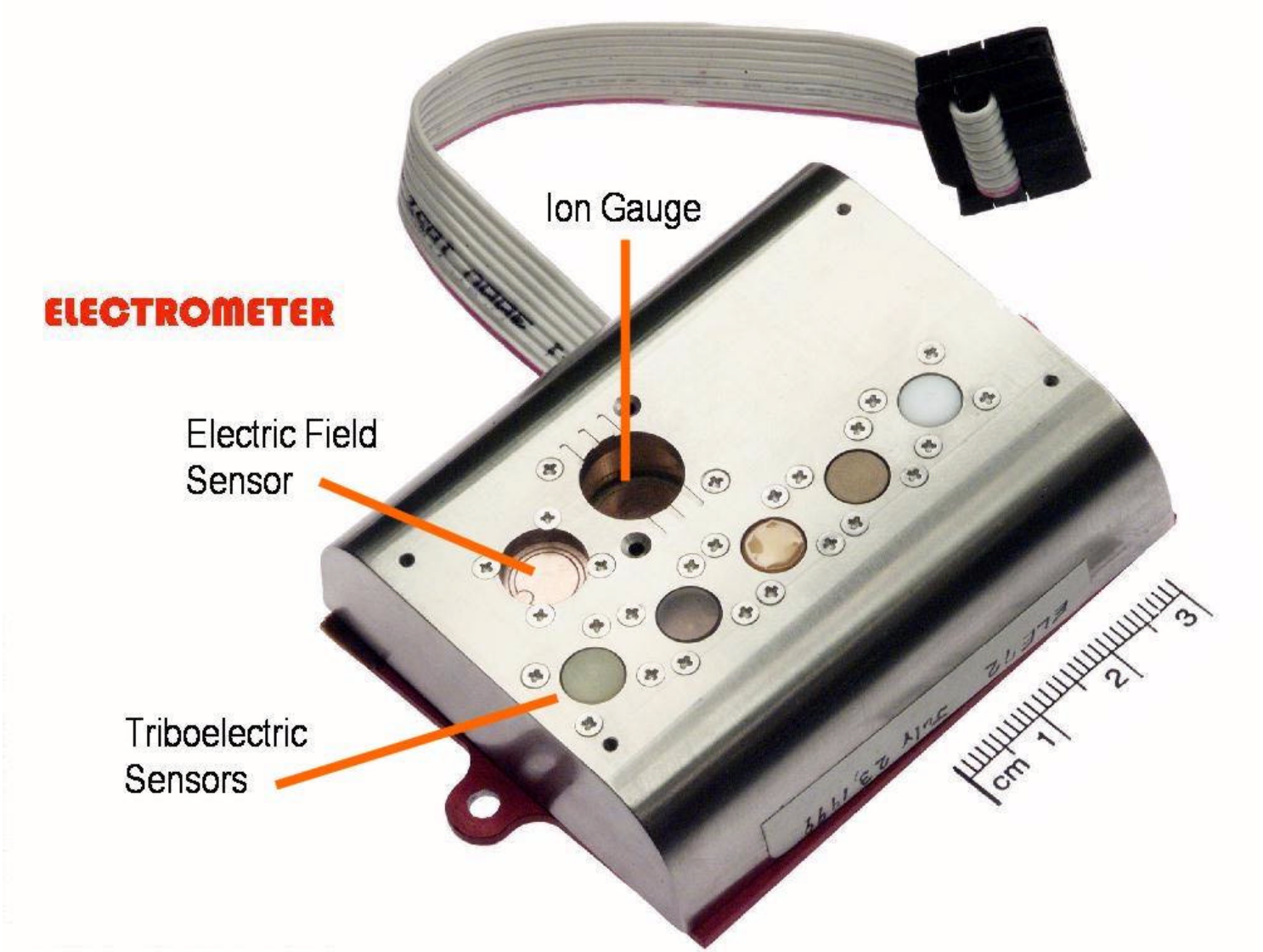
Introduction

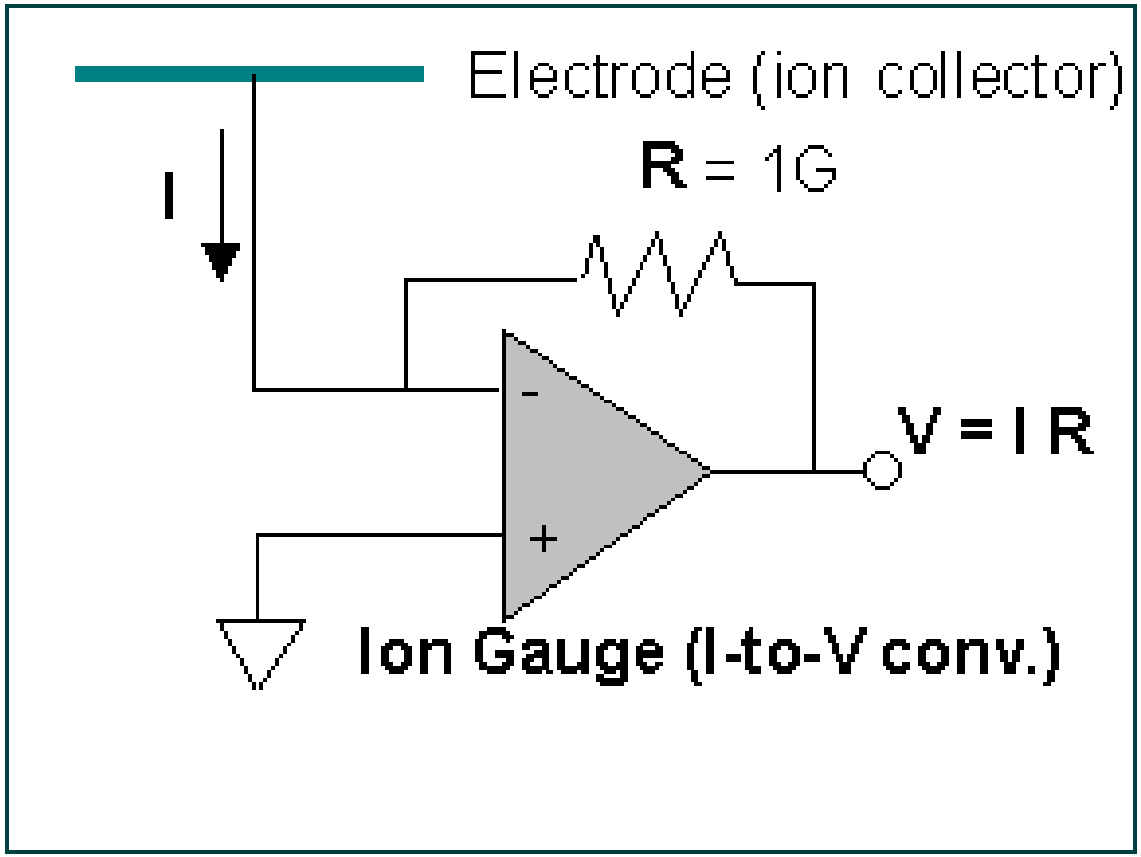
- **How does an object become electrically charged on the surface of Mars?**
  - A surface that rubs against the Martian soil will become triboelectrically charged by the soil.
  - A surface that is exposed to a dust storm in the Martian atmosphere, or to ionizing radiation, may also become charged.

- **What happens when the “dust settles” on charged surfaces?**
  - 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.

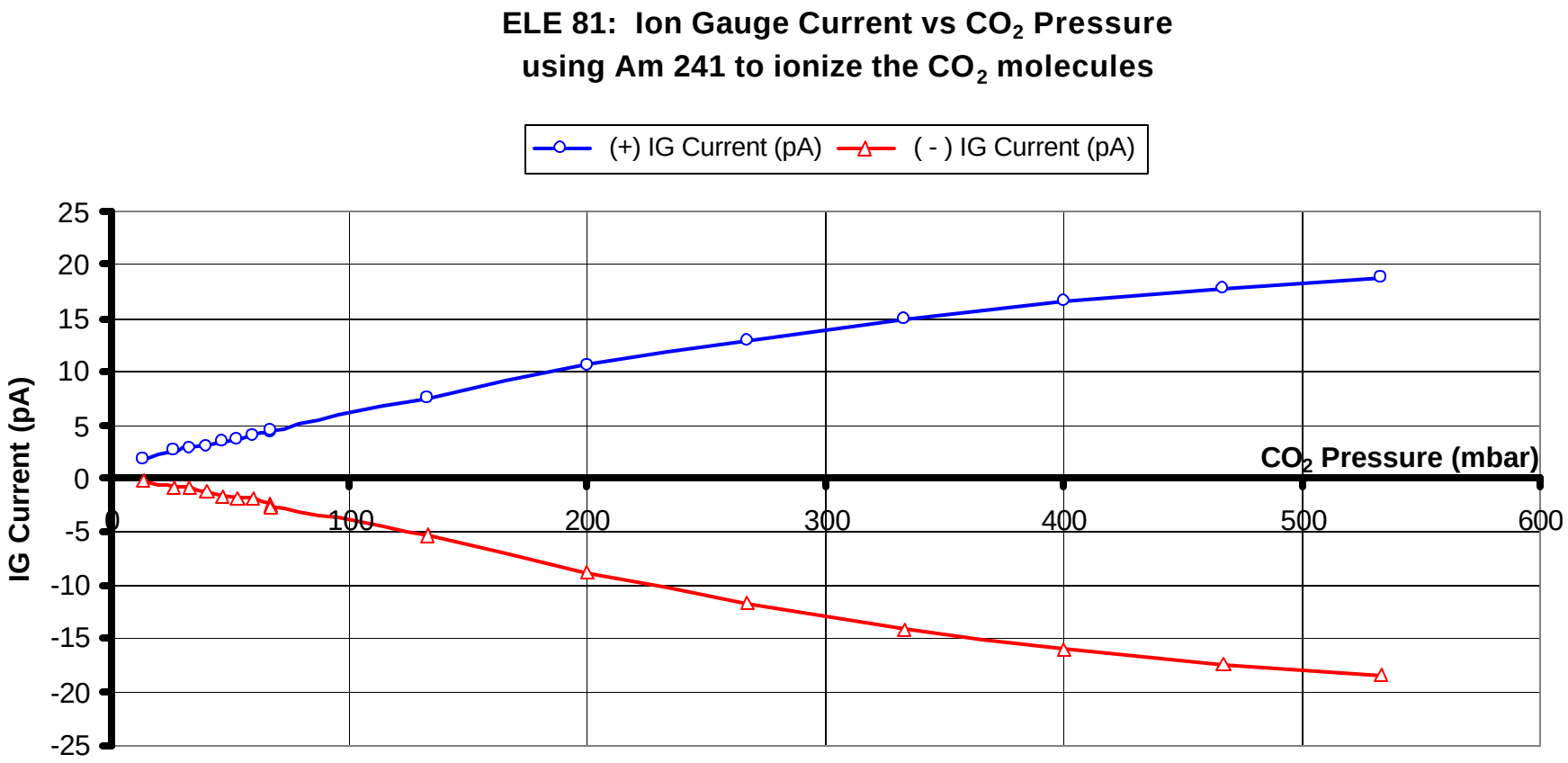
- **How do we neutralize an electrically charged object on Mars?**
  - Minimize charging in the first place by avoiding the usage of materials that are easily charged by triboelectric contact with the Martian soil and dust.
  - Neutralize a charged object by providing a region of positive and negative ions near the surface of the charged object. Ions having an opposite charge will be attracted to the charged surface thus neutralizing the object.



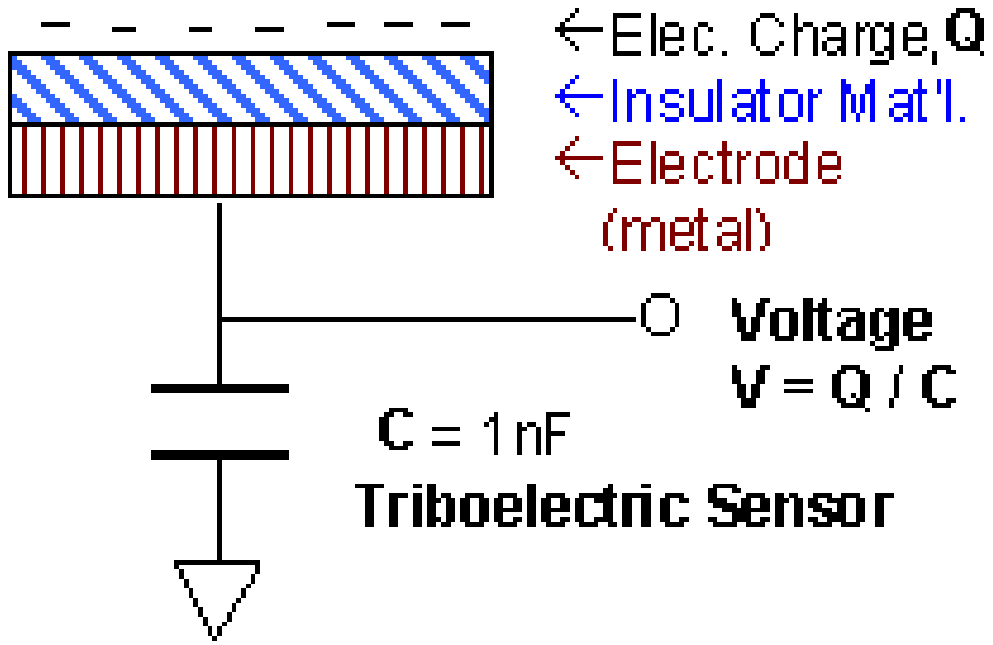
The Electrometer used in this study to measure the amount of tribolectric charge generated on the surfaces of five types of insulators - Fiberglass/Epoxy, Lexan, Teflon, Rulon J, Lucite



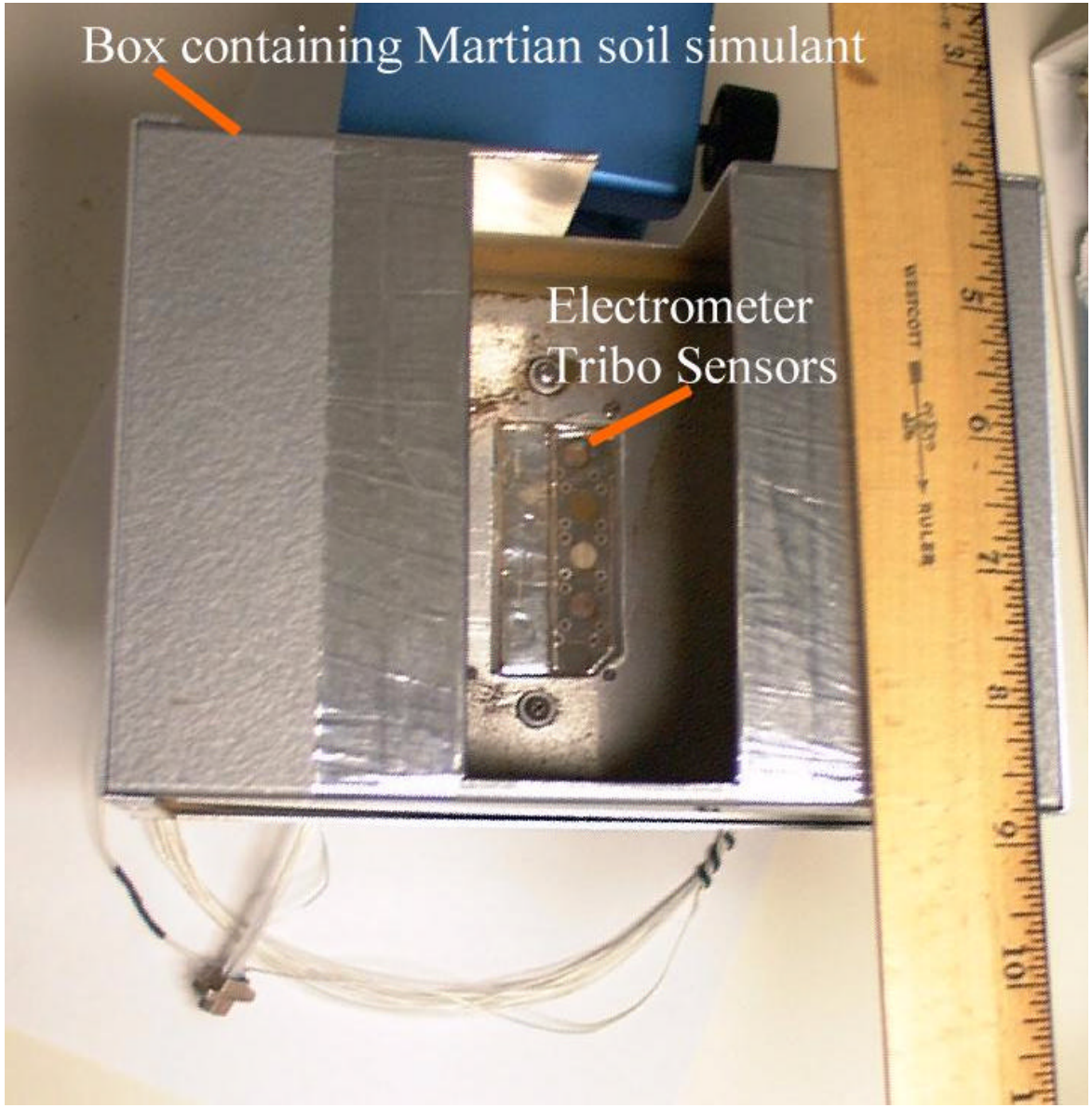
The electrometer also contains an ion gauge whose output voltage is proportional to the number density of nearby charged particles. A simplified view of the ion gauge circuit is shown above.



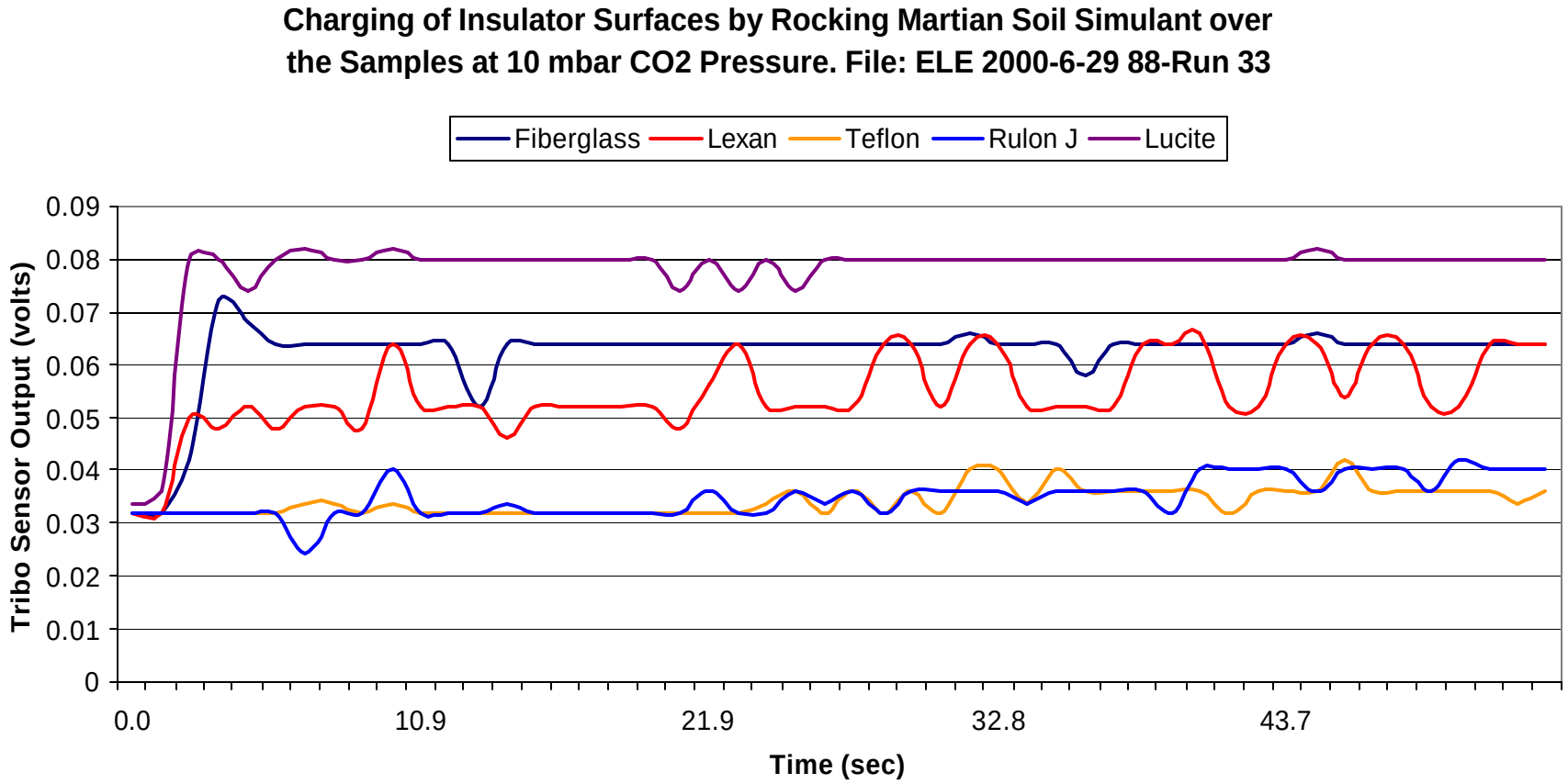
The ion gauge is able to detect the positive and negative ions generated by a nearby weak alpha-particle source Am 241 in a CO_2 atmosphere over a pressure range that extends down to Martian atmospheric pressure.



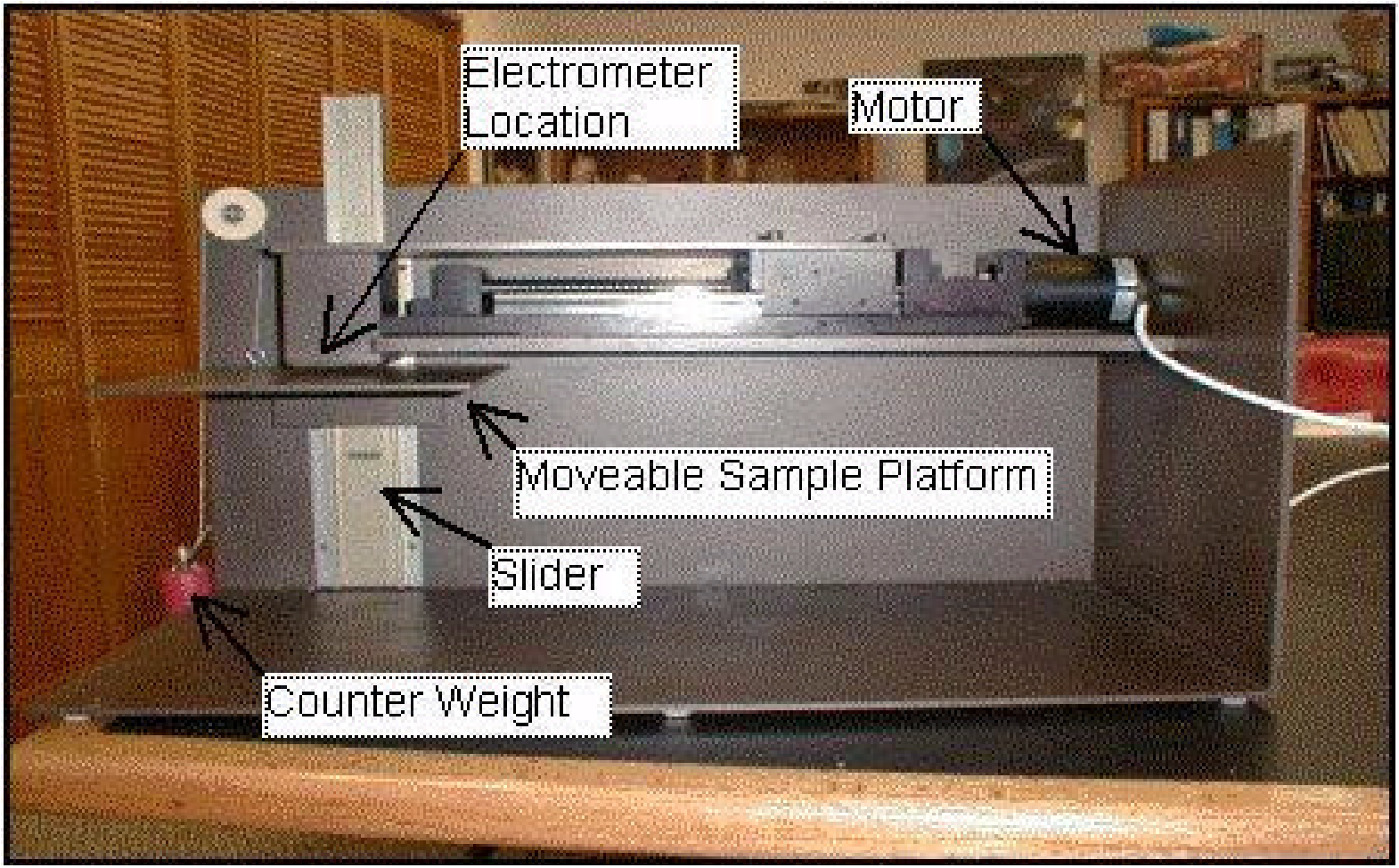
The output voltage of the tribolectric sensor circuit is proportional to the amount of electric charge that is generated on an insulator's surface after rubbing the surface against Martian soil simulant, or other abrasive.



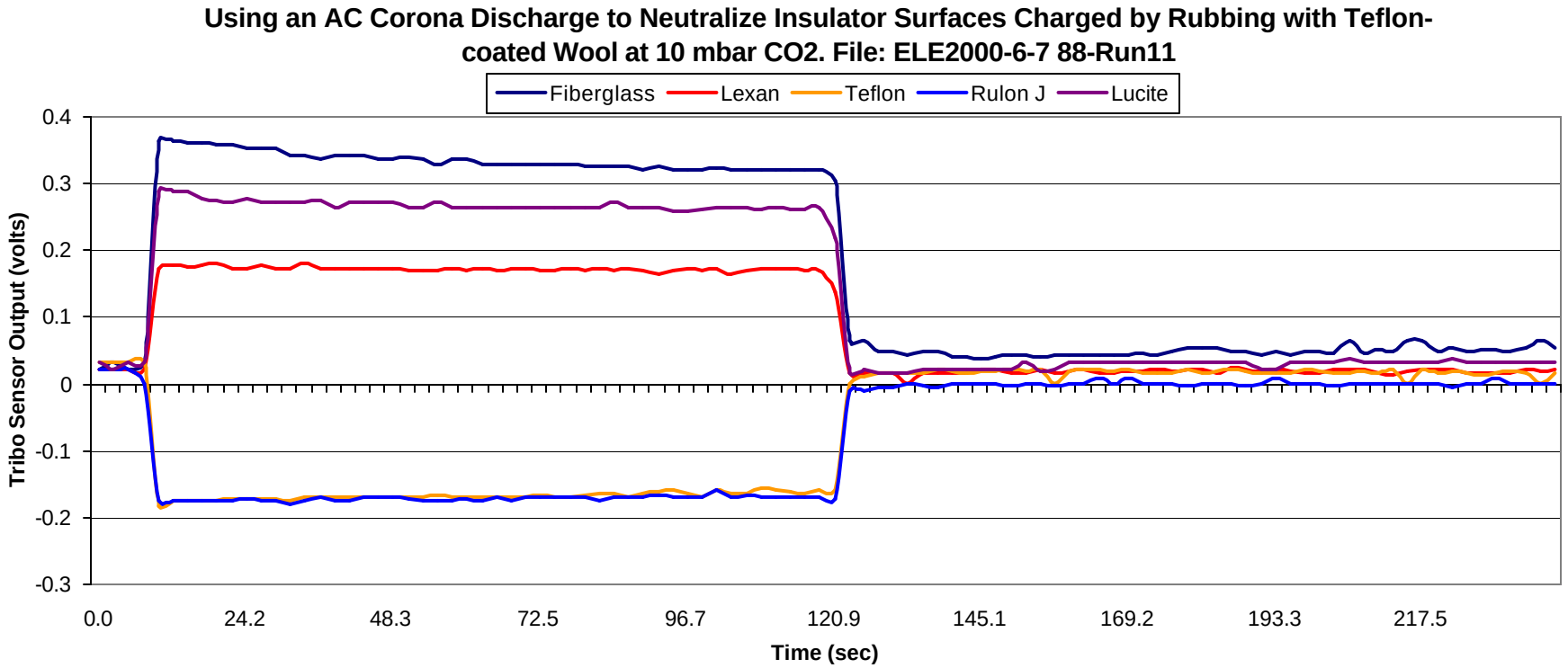
Box used to “rock” Martian soil simulant over tribo sensors in a vacuum chamber at low CO_2 pressure.



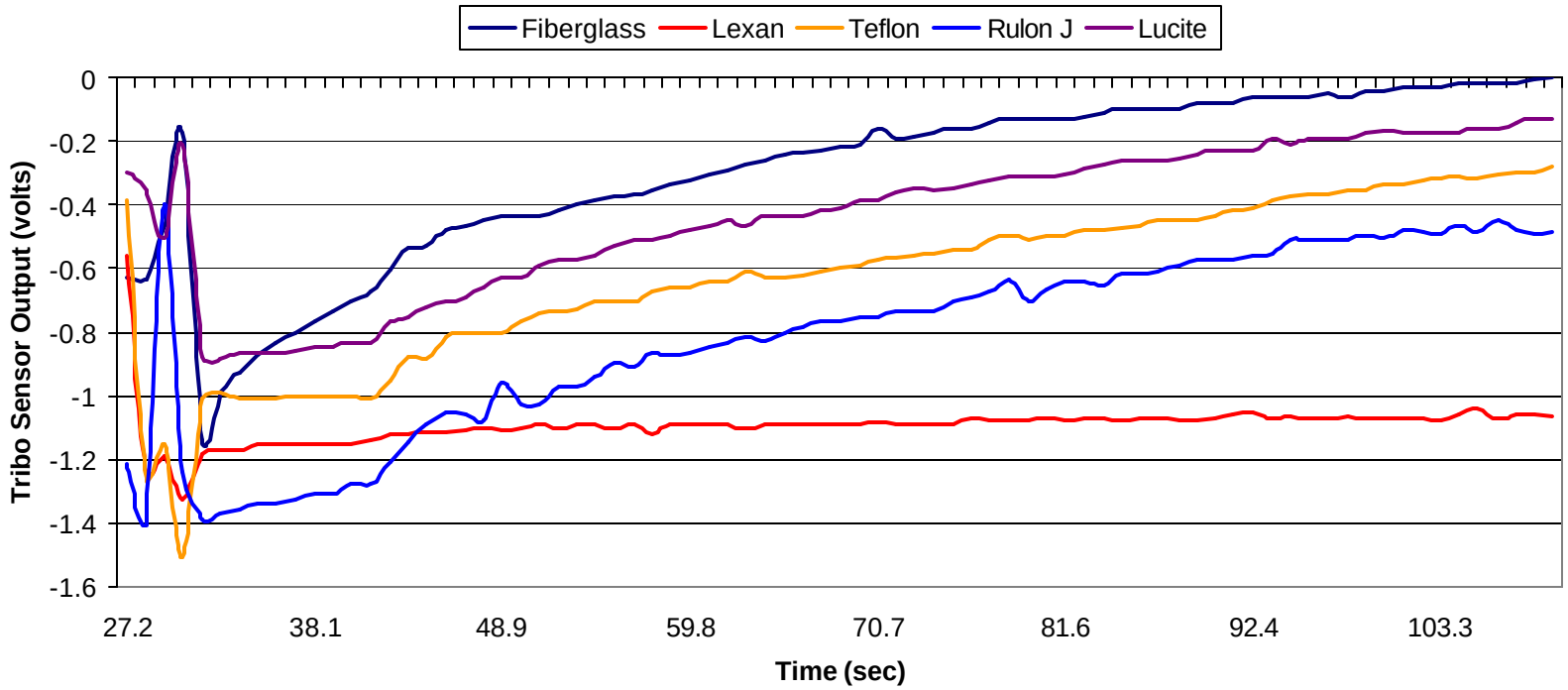
Data obtained in CO_2 at 10 mbar using the rocking device. The amount of charge generated on the five insulators is proportional to the output voltage. The first few data points are taken prior to rocking the Martian soil simulant over the sensors. Time interval between data sampling is 1.1 sec.



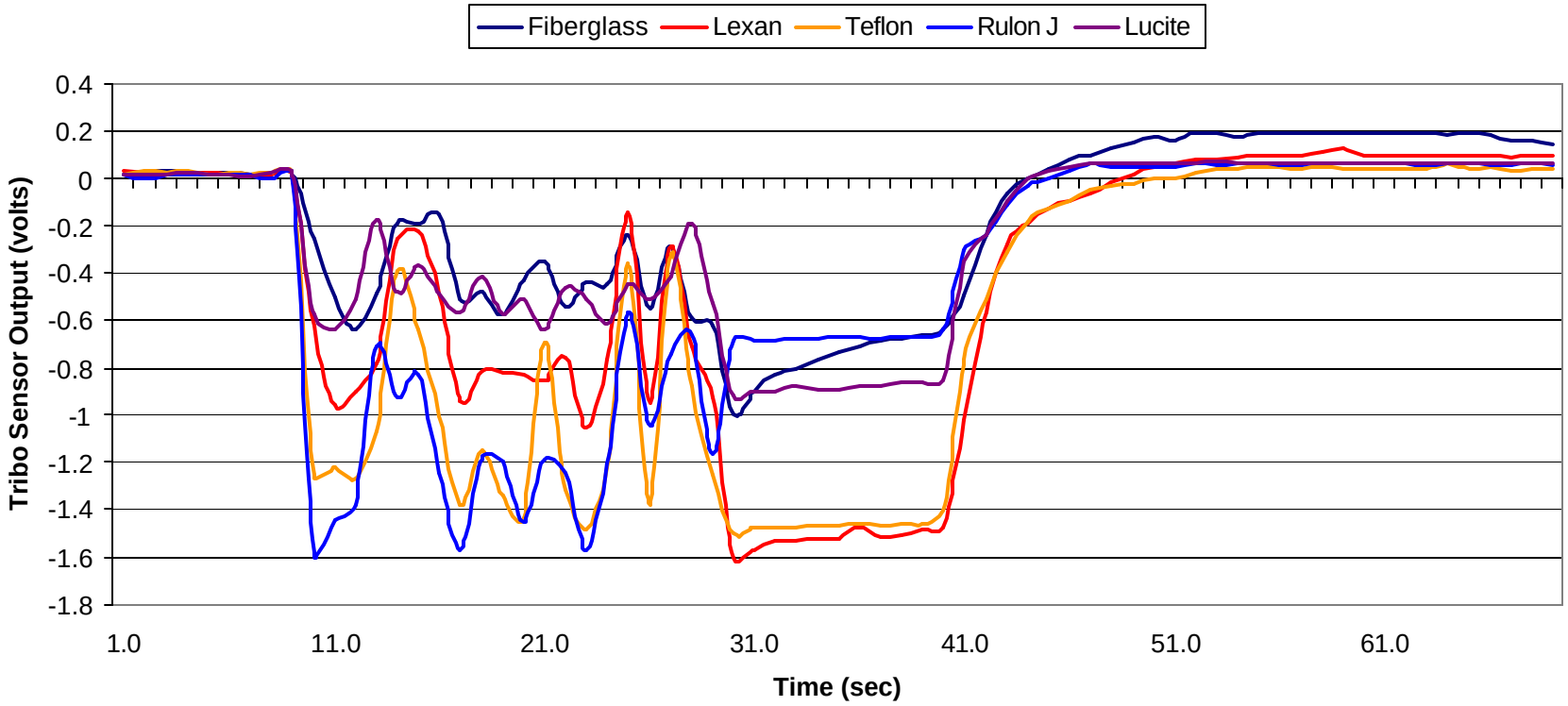
Machine used to rub the electrometer over Martian soil simulant and other materials.



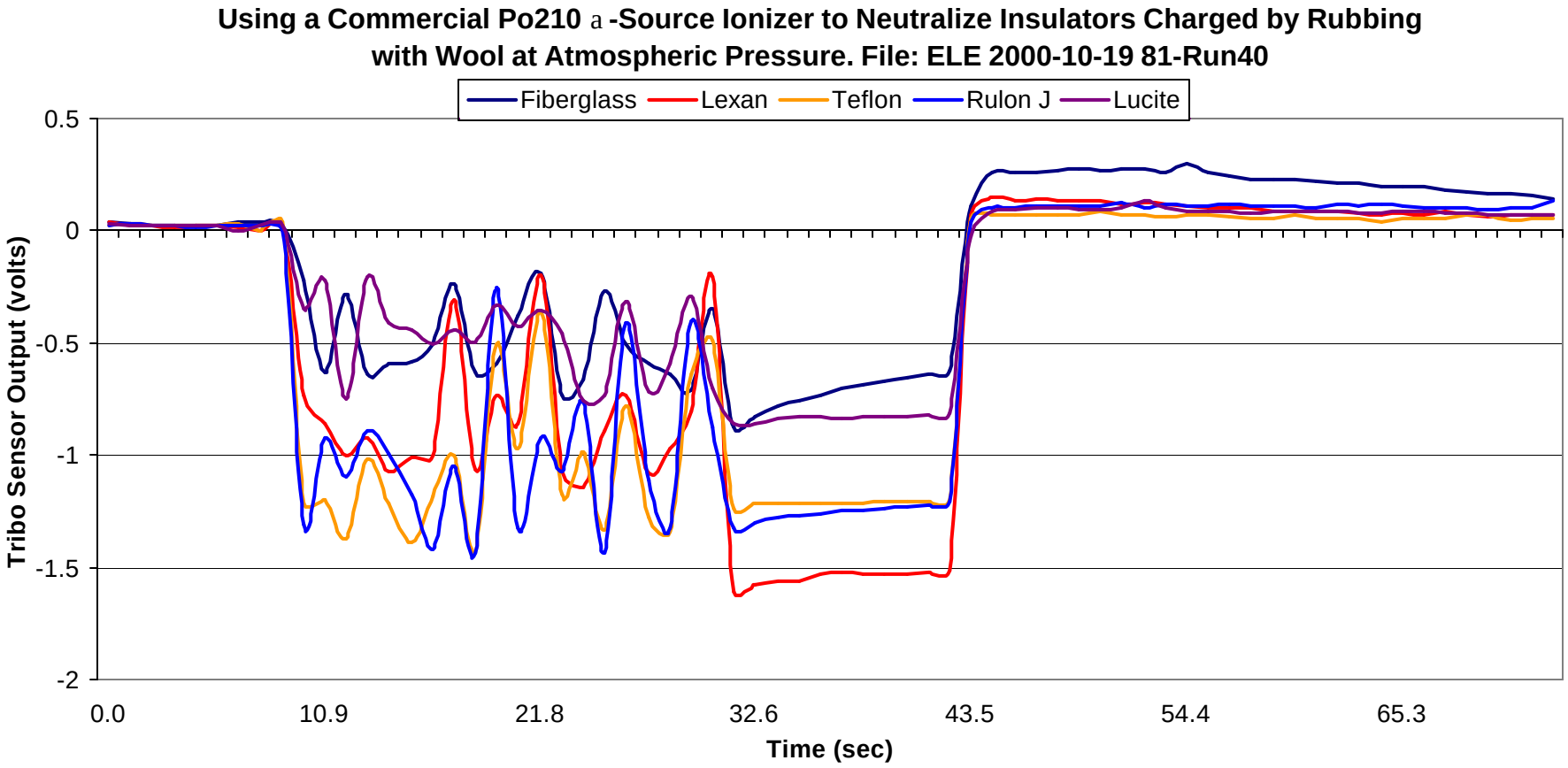
Data obtained in air atmosphere at 10 mbar by rubbing with Teflon-coated wool. The amount of charge generated on the five insulators is proportional to the output voltage. The first few data points are taken prior to rubbing the insulator samples over wool. The time interval between data sampling is 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.



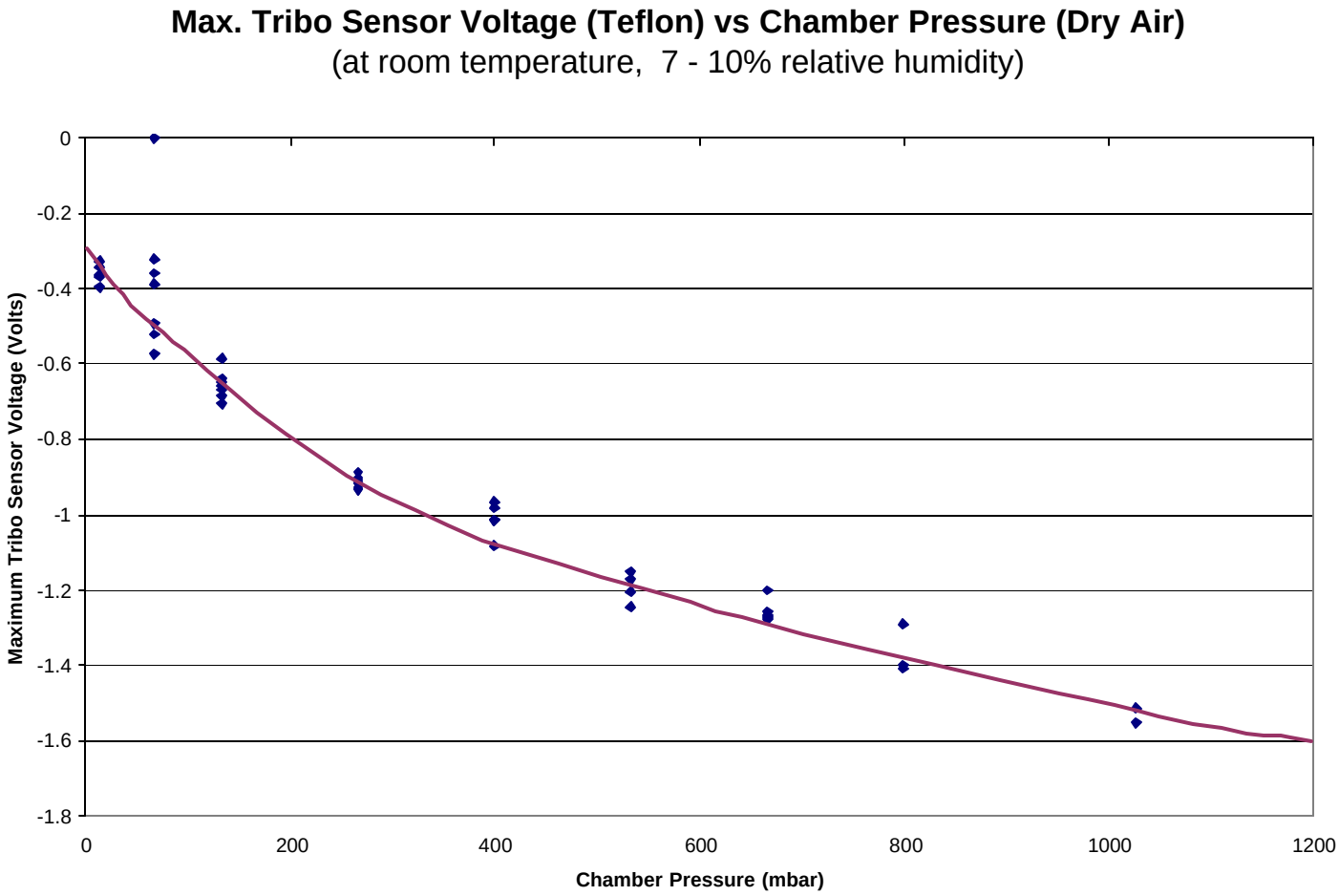
Data obtained in air at atmospheric pressure by rubbing with plain wool. The first few data points are taken while rubbing the insulator samples with wool. The time interval between data sampling is 1.1 sec. Normal discharging is observed between 30 and 40 seconds. At 40 seconds, an α-source (Am 241) is positioned within 3 mm of the charged samples as a means of neutralizing the materials.



Data obtained in air at atmospheric pressure by rubbing with plain wool. Rubbing begins at 10 sec and ends at 30 sec. Normal discharging is observed between 30 and 40 sec. At 40 sec, a commercial Po 210 α-source air ionizer is turned on in front of the samples, and the charged materials are quickly neutralized.



Data obtained in air at atmospheric pressure by rubbing with plain wool. Rubbing begins at 10 sec and ends at 30 sec. Normal discharging is observed between 30 and 40 sec. At 40 sec, a commercial ac corona discharge air ionizer is turned on in front of the samples which quickly neutralizes the charged materials.



Triboelectric sensor voltage for Teflon versus chamber pressure in a dry air atmosphere. The amount of charge generated by rubbing Teflon with plain wool is proportional to the voltage. The data was taken in a dry air environment (relative humidity range: 7 - 10%) over a pressure range from 10 mbar to atmospheric pressure.

Conclusions

- We have demonstrated that charged materials can be neutralized at Martian atmospheric pressures (10 mbar CO_2) using commercial off-the-shelf air ionizers that employ:
  - a weakly radioactive alpha-particle source such as Am 241 or Po 210 with a circulating fan, or
  - an AC corona discharge with a circulating fan.