Electrometry for Characterizing the Local Electrical Environment in Dynamic Regions While Avoiding Associated Hazards

$T.L.Jackson^{1,2}, W.M.Farrell^{1,2}$

$^{1}NASA/Goddard\ Space\ Flight\ Center$ $^{2}NASA's\ Lunar\ Science\ Institute$

Introduction

Astronauts and roving objects exploring dynamic regions (i.e. NEOs, Mars, lunar polar craters) can experience electrical charge buildup through contact electrification. Under certain conditions, charge accumulation can become substantial, lasting for an extended period of time. This charge accumulation presents hazards such as destruction of equipment, dust adhesion and electrostatic discharge. Knowing ones charged state will enable avoidance of such hazards and xPED provides a way to monitor this state.

Scenario

As shown in Figure 1, the human system (astronaut) is represented by a capacitor, which holds the charge that xPED can monitor. When the switch is closed, the astronaut is roving and collecting charge. By knowing the electrical characteristics of an environment, we are better suited to understand and avoid the associated risks, increasing human system survivability during missions to NEOs, the Moon and Mars.

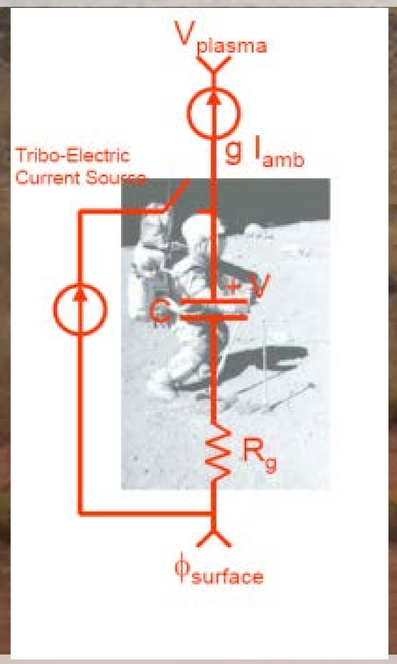

Figure 1: Astronaut equivalent circuit for tribocharging (Farrell et al. 2008)

The Instrument

The Exploration Portable Electrostatic Detector (xPED) is a stand-alone, miniature electrometer that houses on board digital storage for collecting data on the local electrical environment for analysis at a later time. The electrometer is shown in Figure 2, along with the xPED system ready for use in a mock EVA. Currently, the digital storage capability is being added to the electrometer device. xPED is, essentially, a charge hazard detector and a new science enabling tool, observing and collecting data for any environment it is placed in.

Figure 2: Electrometer, and early xPED system

Concept in Use

xPED has been used to successfully sense high electric fields from terrestrial mixing dust columns (Jackson and Farrell 2006), local tribo-charging while roving through dusty terrain during a mock EVA, and changes in the local electrostatics of the environment during a thunderstorm (Jackson and Farrell 2012). Figure 3 shows the data collected by an early version of xPED. The electric field sensed during a dust devil interception in California was ~58kV/m, indicating that large tribo-electric fields are expected in mixing dust columns.

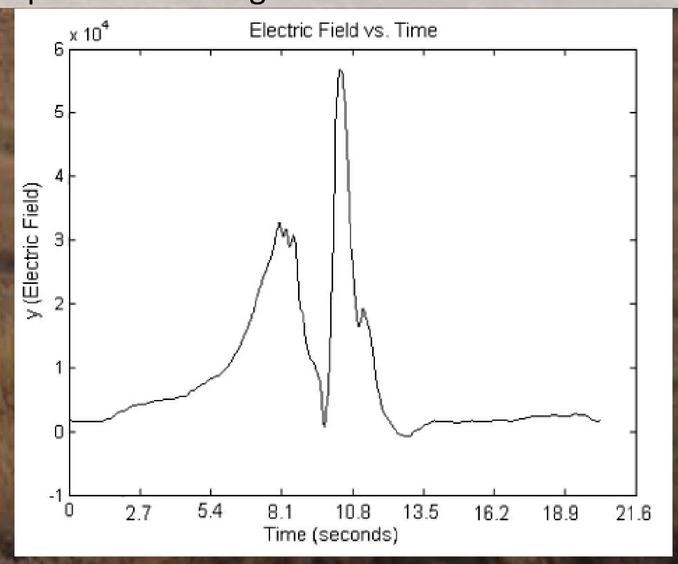

Figure 3: Electric field in a tribo-charged dust devil (Jackson and Farrell 2006).