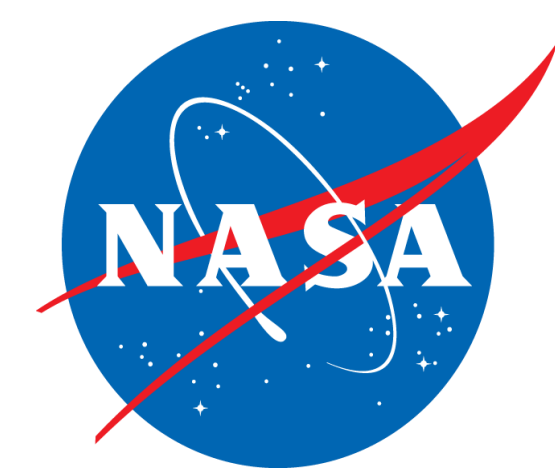


Space Environment Testing of Photovoltaic Array Systems at NASA’s Marshall Space Flight Center



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MSFC Test & Evaluation Capabilities

Testing

- ✓ Ultra-Violet (UV) Exposure
- ✓ High energy Charged Particle Radiation
 - Electron and Proton
- ✓ Thermal Cycling
- ✓ Plasma and Beam Environments

Evaluation

- ✓ Electrostatic Discharge (ESD) Screening
- ✓ PV Power Output including Large Area Pulsed Solar Simulator (LAPSS)
- ✓ Optical Inspection and Measurement

High Energy Charged Particle Radiation

Device	Energy Range (MeV)	Flux Range (nA/cm ²)	Maximum Beam Diameter (cm)
Electron Accelerator	0.2 – 2.5	0.03 – 10	40
Proton Accelerator	0.04 – 0.7	1 – 10	40



The High Energy Charged Particle Radiation facility.

Thermal Cycling

- MSFC’s Environmental Test Facility has multiple thermal cycle chambers
- The “V3” system is a vacuum based thermal cycle chamber dedicated to testing PV array coupons
- Customized thermal profiles in the range of +130 C to -180 C.



Solar array wire coupons being heated in the V3 thermal cycle chamber.

Plasma & Beam Environments

- ✓ LEO Plasma: 0.1 eV Electrons, 5 eV Drifting Ions
- ✓ Thruster Plasma: 250 eV – 1 keV Xenon Ions
- ✓ Hollow Cathode Plasma: 0.5 eV Electrons, 10⁶ Density
- ✓ Broad Beam Ions: 150 eV to 8 keV
- ✓ Narrow Beam Protons: 500 eV to 10 keV
- ✓ Broad Beam Electrons: 90 eV to 100 keV
- ✓ Neutral Atomic Oxygen: 5 eV, 5 x10¹⁵ atoms/cm²/sec



HISET facility at MSFC.

Electrostatic Discharge (ESD) Screening

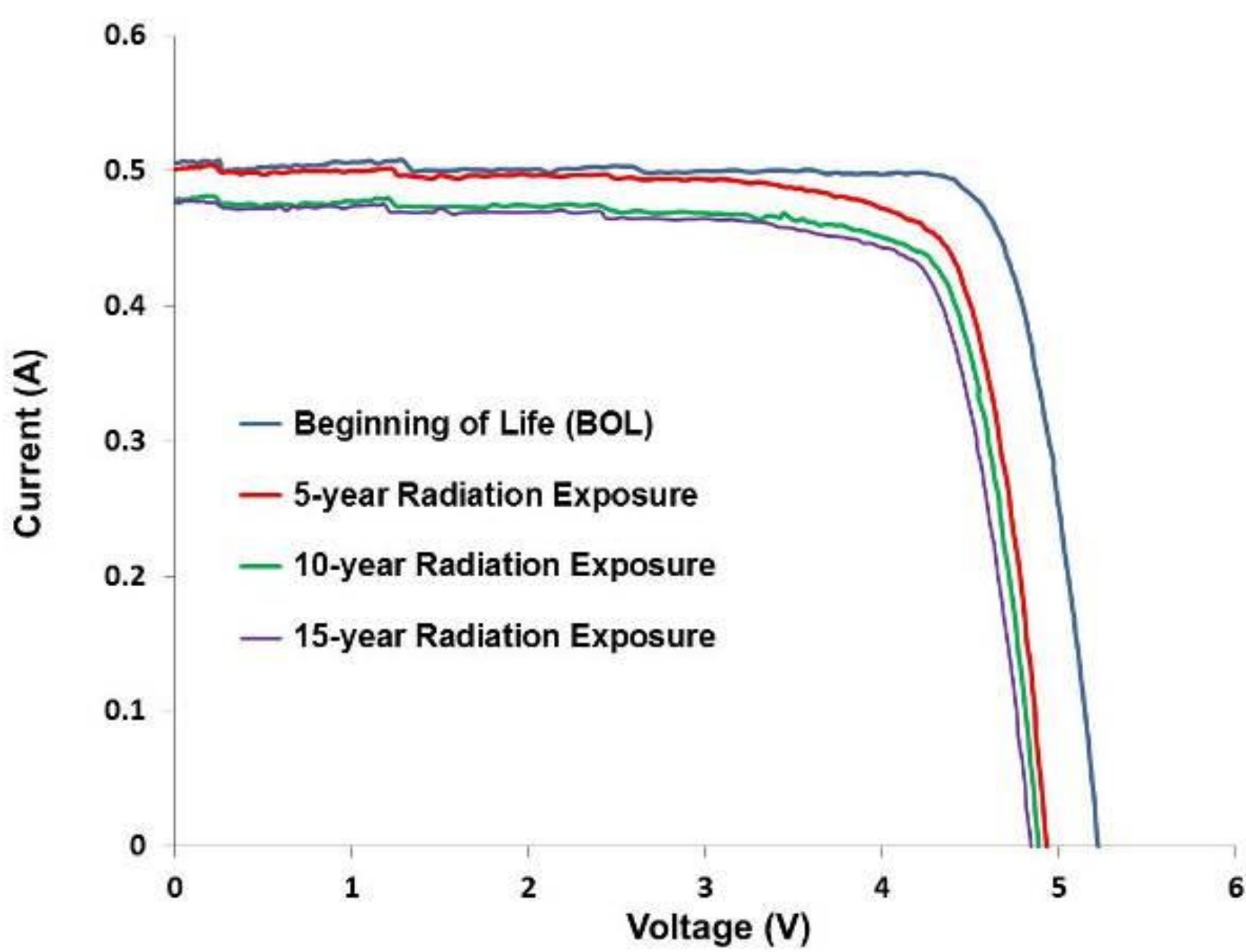
ESD testing compliant with ISO-11221: Arc inception voltage and secondary arc testing



ESD arc site formation PV array coupon.

LAPSS PV Power Output

1 sun illumination over 1.1 m² (12.2 ft²) with 3% variation and spectrum distribution control



Current versus Voltage (I-V) curves generated using the LAPSS system at MSFC.

Optical Inspection & Measurement

- ✓ Optical Microscopy
- ✓ Hemispherical Emissivity
- ✓ Solar Absorptance

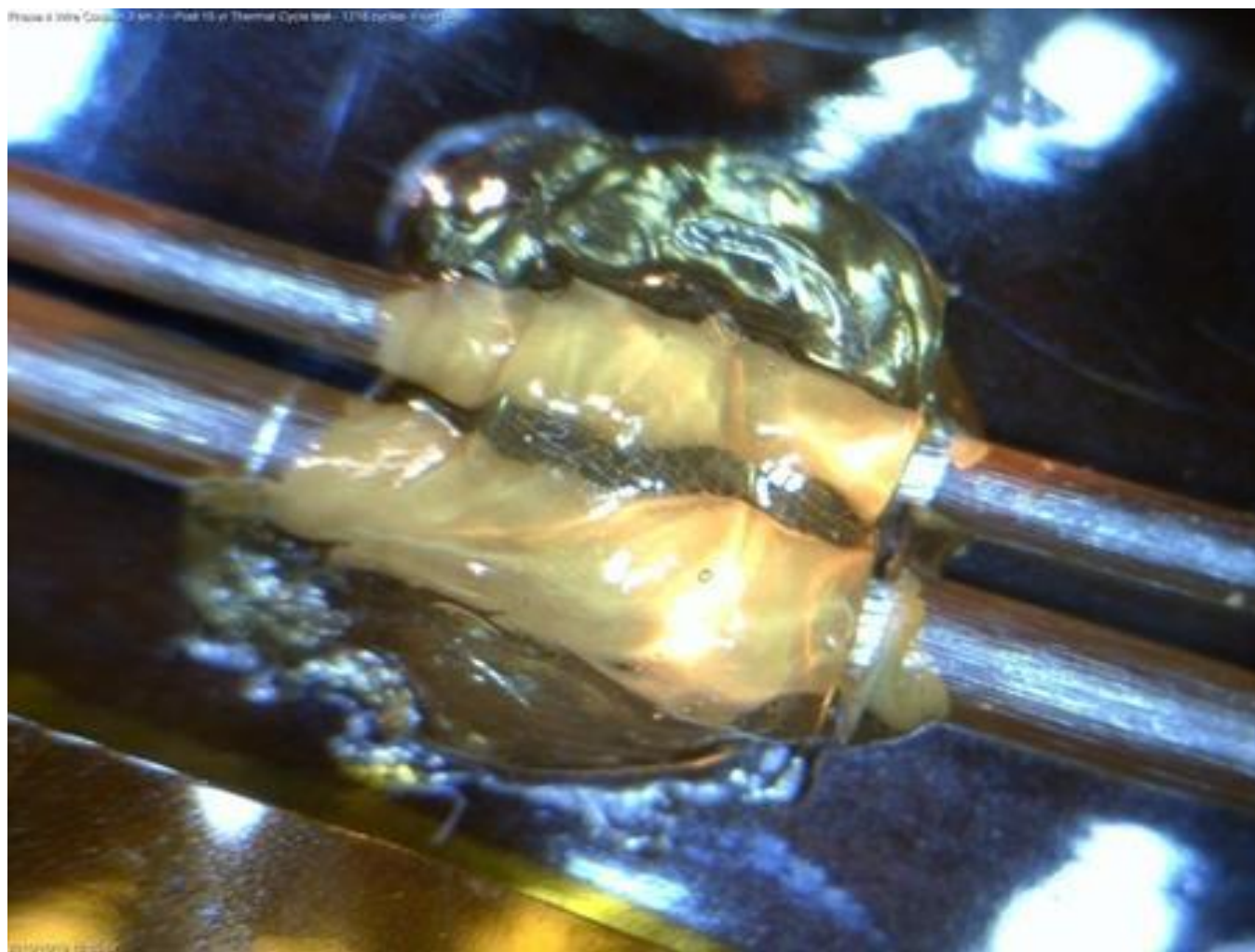
Test Results



Solar array wire coupon at Beginning of Life (BOL).



Solar array wire coupon after 15 year equivalent of on-orbit UV exposure.



Insulated wires on a solar array test coupon after being subjected to 15 year equivalent GEO environment exposure.

Summary

Mission success depends on testing your systems under realistic space environment conditions. The team at NASA’s Marshall Space Flight Center is ready to help you succeed.

Contacts

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Solar cell samples undergoing combined (VUV & NUV) radiation exposure tests at MSFC.