

25 April 2018

SSL ROSA Qualification Status

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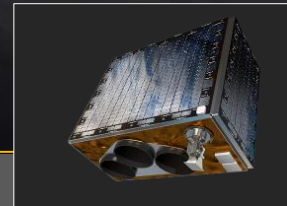
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SSL ROSA

Why, What and How



Space Power Workshop
25 April 2018



WHY:

■ SSL ROSA Objectives

- Qualify ROSA for anticipated missions
 - Various sizes and bus applications
- Commercialize ROSA technology for broad use
 - Path-find processes and tooling to improve ROSA
- Develop ROSA for SSL product lines
 - Optimize interfaces for 1300 Bus and other platforms

SSL ROSA Mass Benefits



SSL ROSA Program Insertion

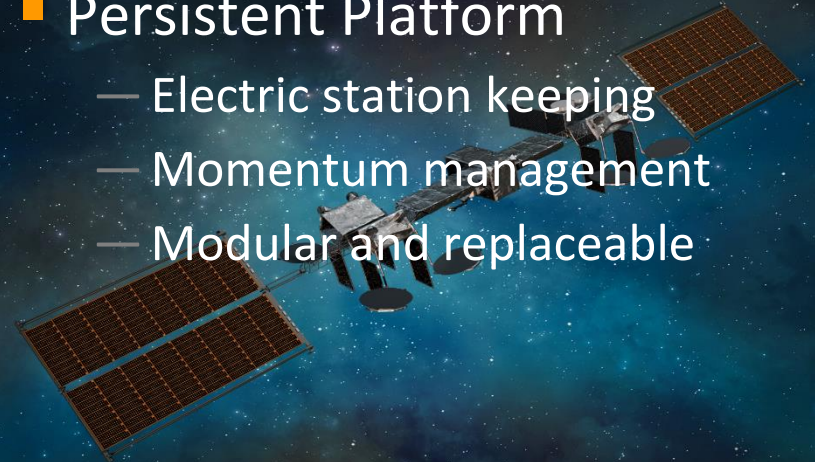
■ On-orbit Satellite Servicing

- Small stowed volume
- Enables Electric Orbit Raising
- Increased agility - retractable



■ Persistent Platform

- Electric station keeping
- Momentum management
- Modular and replaceable



■ High Power Interplanetary and Cis-lunar

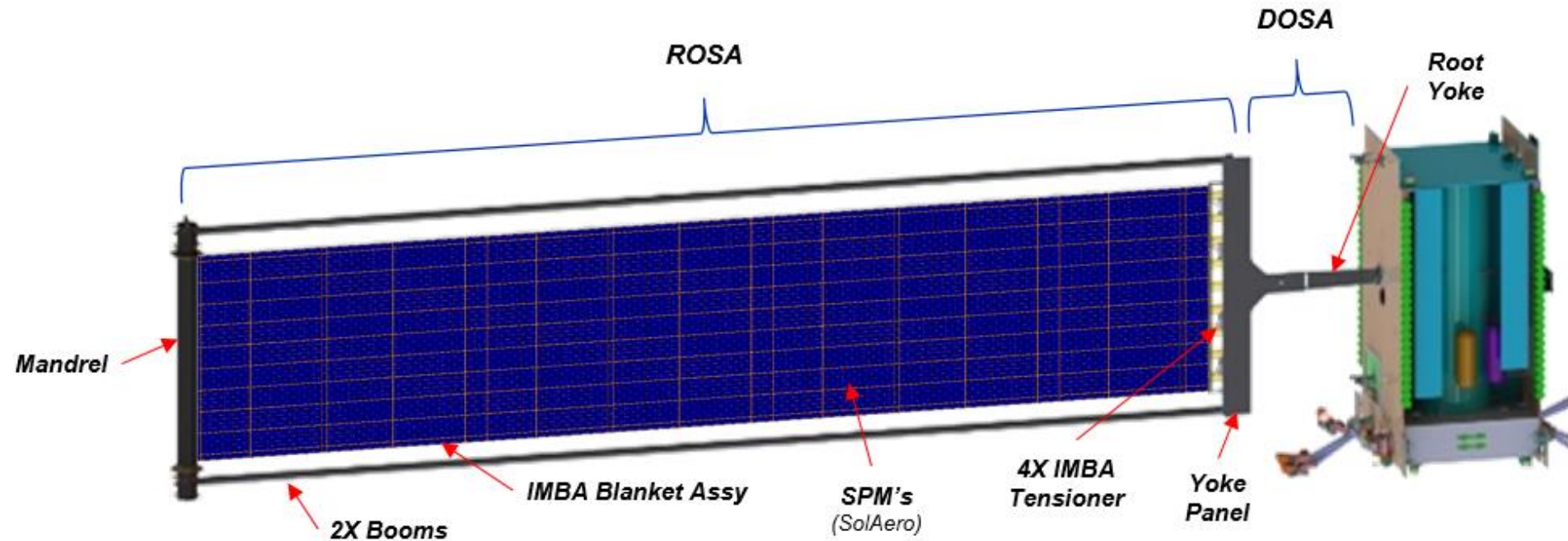
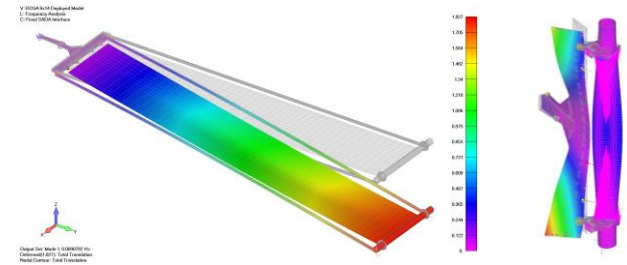
- Ideal for Solar Electric Propulsion
- Low mass, high specific power
- Enables LILT operations



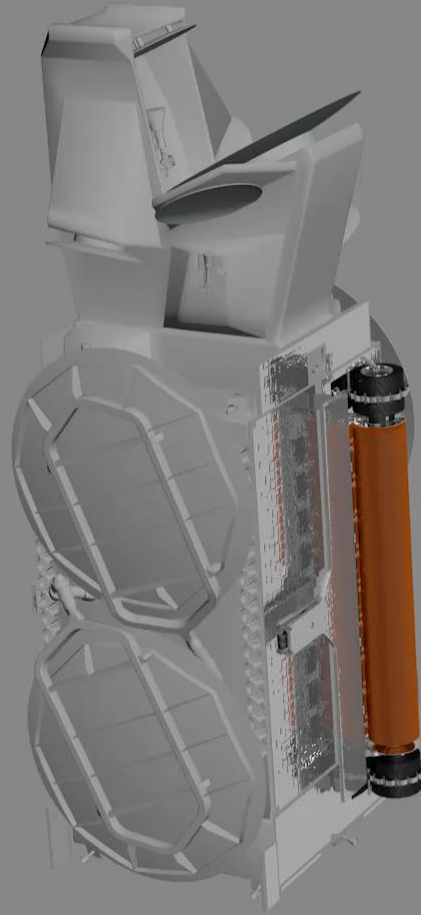
WHAT:

■ SSL ROSA Qualification Wing

- Components sized to scale from 6-14 kW BOL
 - Up to 18 kW for all-electric propulsion
- Baseline configuration is 14 kw BOL at 100V
- Deployment torque margin > 3:1
- Deployed frequency of > 0.06 Hz, stowed frequency > 25Hz (X and Y axis)



SSL ROSA Deployment Animation



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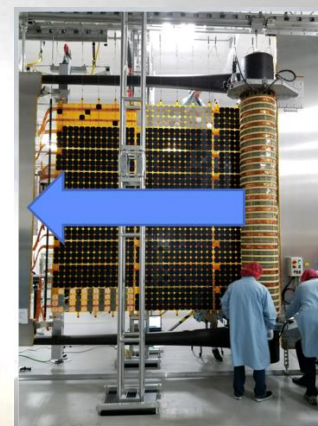
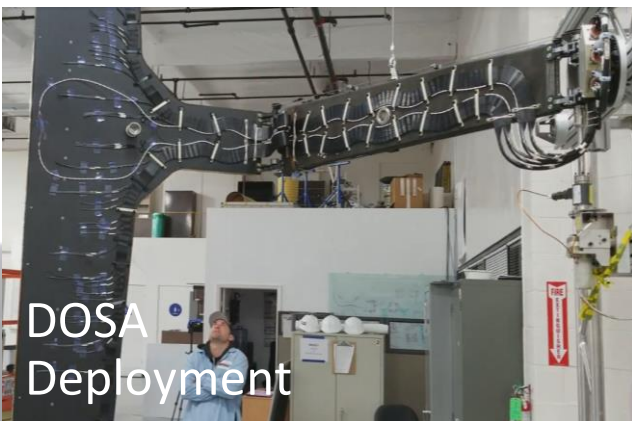
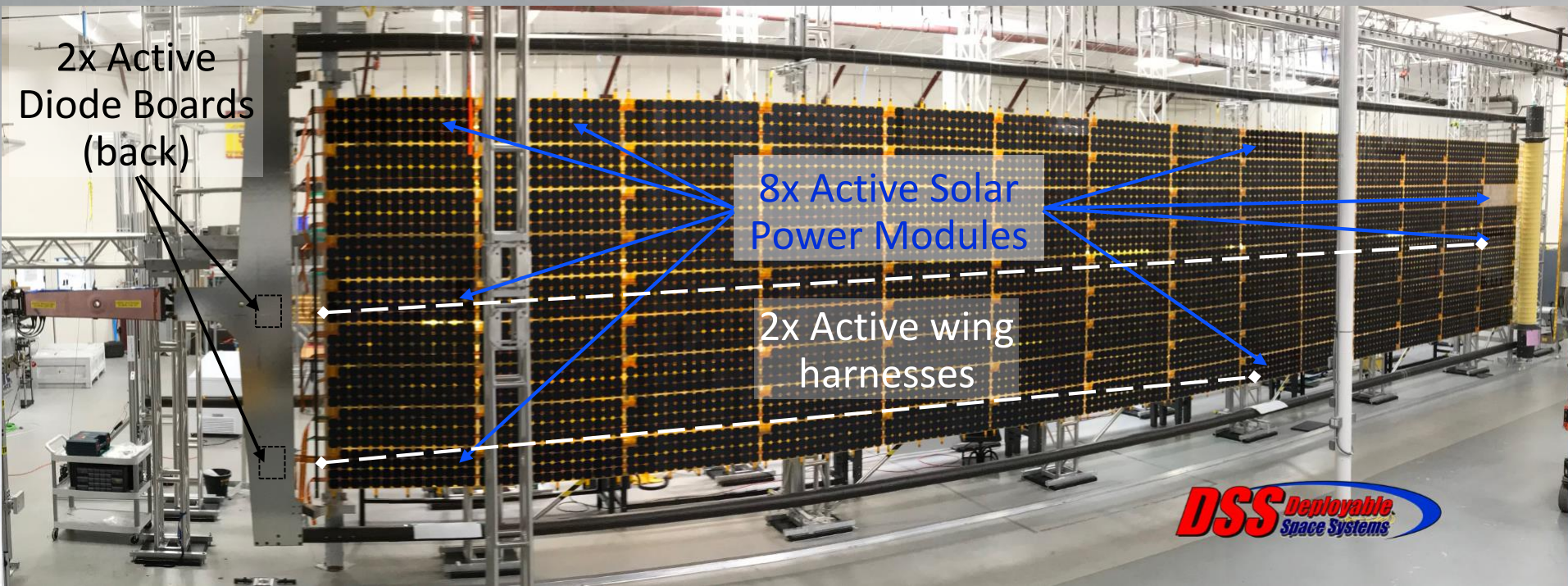
HOW:

- **SSL is executing a rigorous and robust qualification program for ROSA**
 - Full Qualification Model Wing
 - Multiple ambient deployments and stows
 - Vibration (Random and Sine)
 - Cold deployment
 - GEO Life Cycle Testing in Vacuum to -198°C and -230°C
 - 1X GEO Risk Mitigation
 - 1.5X GEO Qual Coupons
 - Materials Testing
 - UV, Radiation, Material Properties, Ion Erosion (SPT Plume)
 - Combined Environments Testing
 - Proton, Electron, Thermal Cycling, ESD
 - Threat Resiliency

SSL ROSA QM Wing Deployment



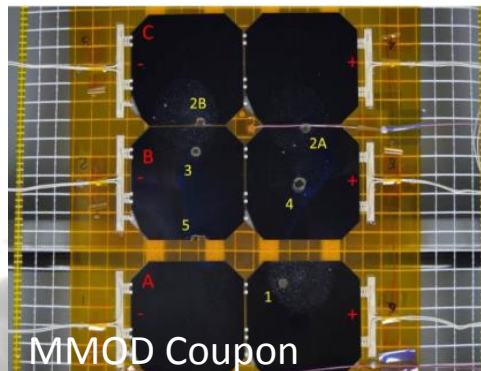
SSL ROSA Qualification Model Wing



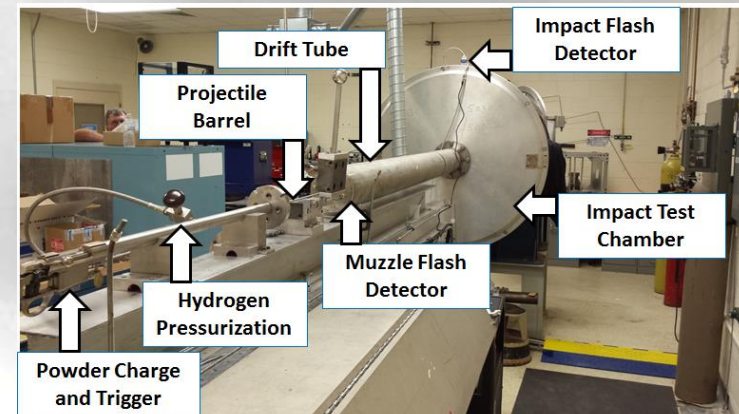
SSL ROSA Phase A Risk Reduction Coupon Tests

Phase A – 3 test coupons

- JPL/Caltech
 - Evaluated for possible thermal runaway due to electrical current collection from EP thruster
 - Plasma ESD test
- NASA MSFC
 - Micrometeoroid impact/ESD test
 - Generated plasma at impact sites
 - No sustained arcs
 - No propagation during post-test thermal cycling



ESD/ parasitic current collection test at JPL/Caltech



Micrometeoroid impact test at NASA MSFC

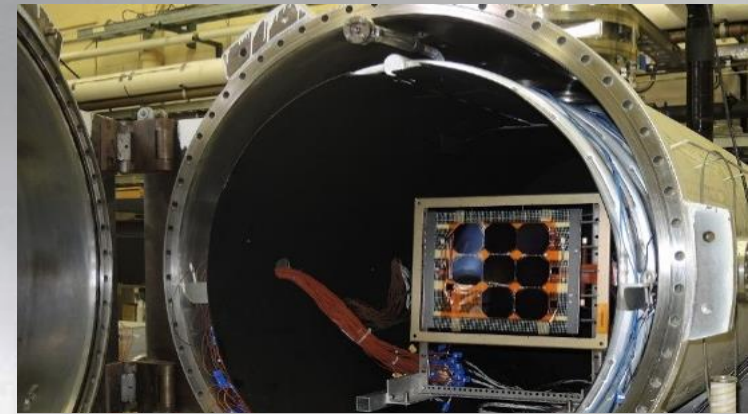
SSL ROSA Phase B Risk Reduction Coupon Tests

Phase B – 7 test coupons

- NASA Glenn (1 coupon)
 - Thermal balance test
- Arnold Engineering Development Center (AEDC) (6 coupons)
 - Thermal Vacuum cycling
 - 1320 cycles from 106°C to -198°C
 - 30 cycles with temperature increments down to -230°C



Risk Mitigation Coupons



*Thermal balance evaluation at
NASA GRC*

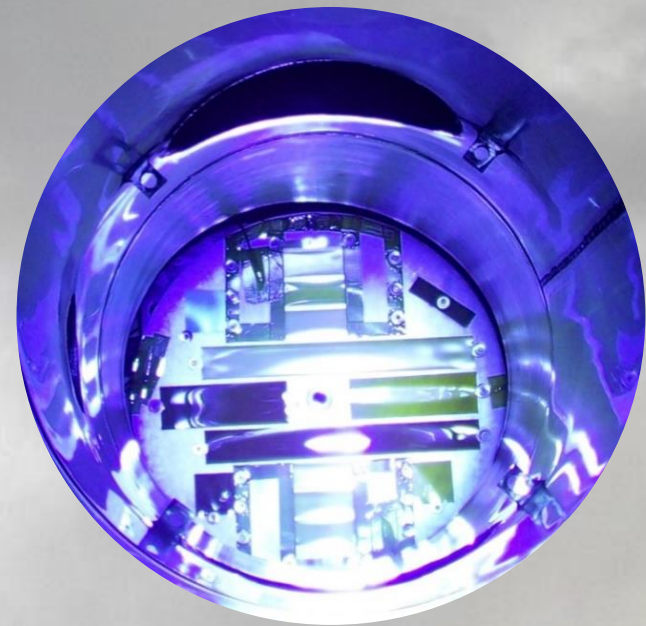


*Thermal Vacuum Cycling Chamber
7A at AEDC*

SSL ROSA Material Characterization Tests

ROSA Material Samples at MSFC

- Solar Array material tests at BOL to EOL
 - Combined space environment exposures of materials
 - UV, electrons, protons
- Characterize material properties
 - Material strength
 - Material modulus
 - CTE
 - Thermal properties

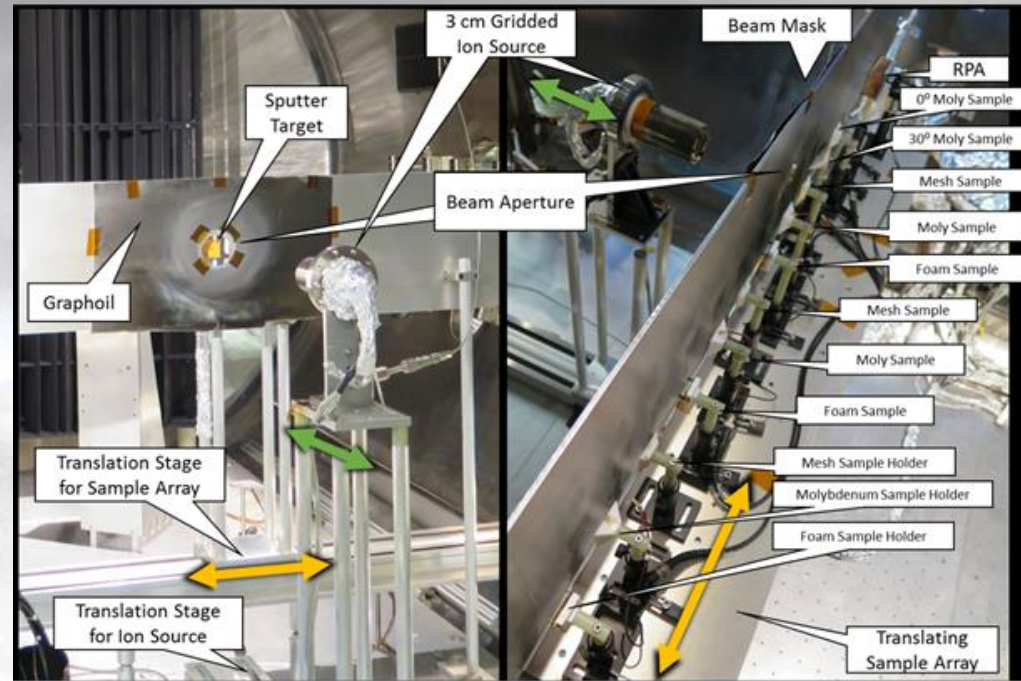


Material Samples Under UV Exposure at NASA MSFC

SSL ROSA Material Erosion Tests

■ Aerospace Corporation

- Erosion due to electric thrusters
- New materials as used on SSL ROSA

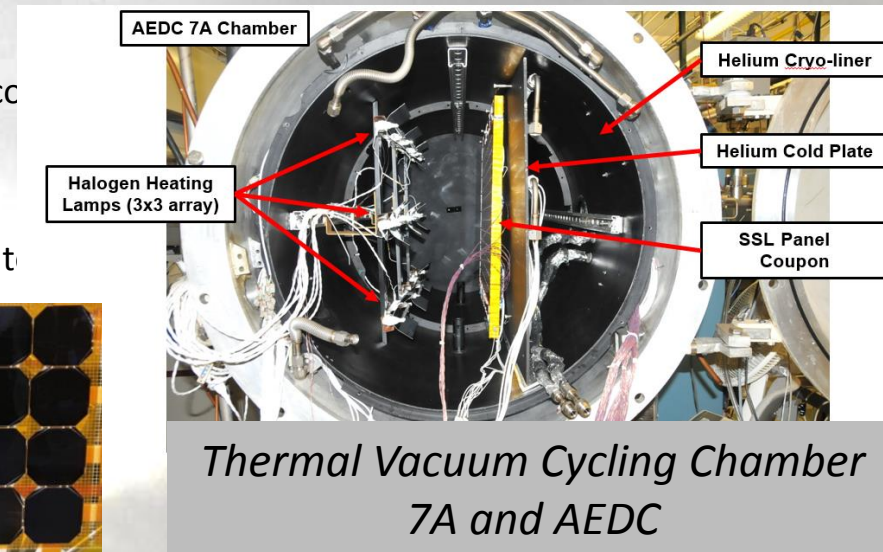
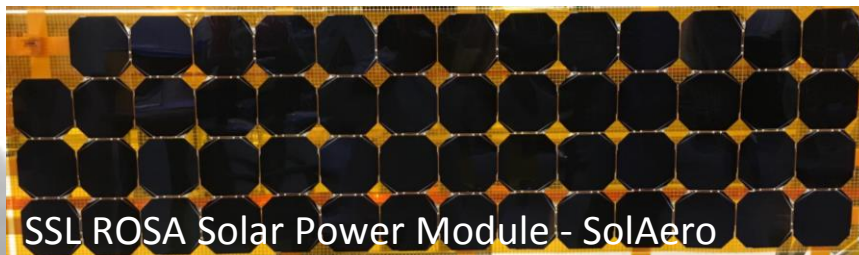
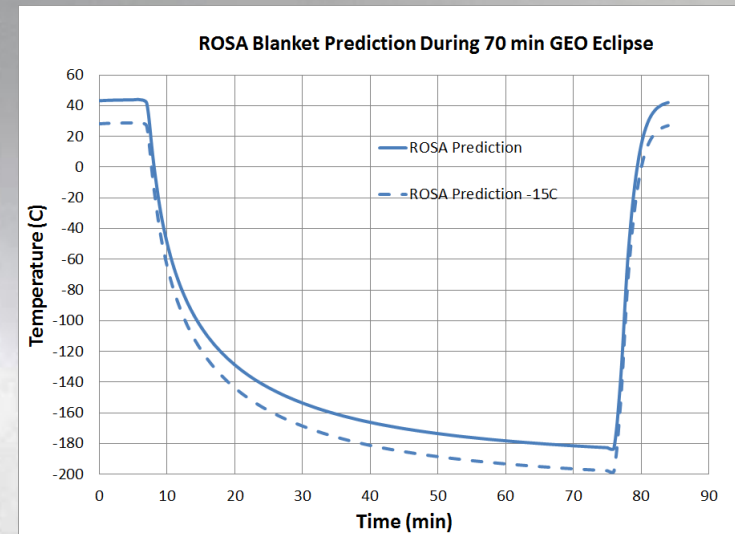


SSL ROSA Material Erosion Tests at the Aerospace Corporation

SSL ROSA Qualification Coupon Tests – Ongoing

TV Cycling (2x, 55-cell coupons)

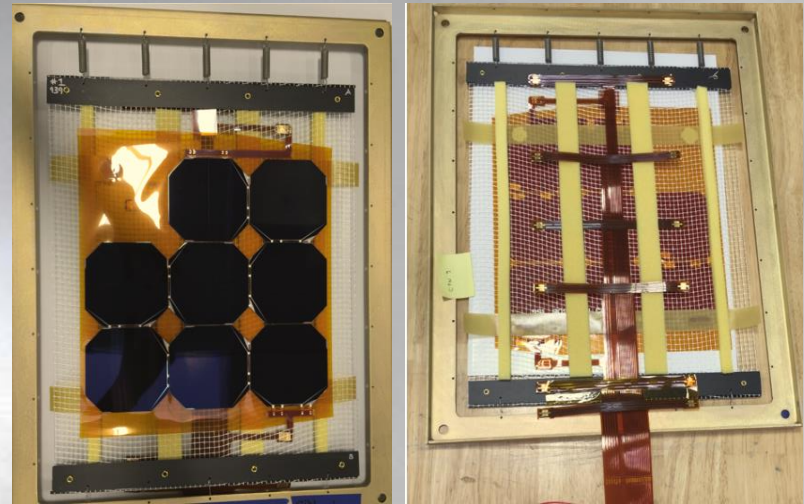
- Electric Orbit Raising (EOR) eclipses
 - 780 cycles: +106°C down to -217°C
- GEO eclipses
 - 1980 GEO Cycles, 1.5X life: +106° to -198°C
- AEDC 7A Chamber
 - Upgraded as a result of lessons learned during recent rigid panel TV testing
 - Expanded heater lamp bank with closed loop control
 - Enhanced data acquisition and test control
 - Redundant, automated over-temp shutoff
 - Higher-voltage string biasing / continuity monitoring



SSL ROSA Qualification Coupon Tests – Ongoing

SSL Combined Environmental Tests (6x, 8-cell coupons)

- NASA MSFC
 - ESD
 - UV Radiation
 - Electron/proton particle radiation
 - Thermal cycling
 - Electric thruster plumes



Combined Environments test coupon to be tested at NASA MSFC (1 of 7)

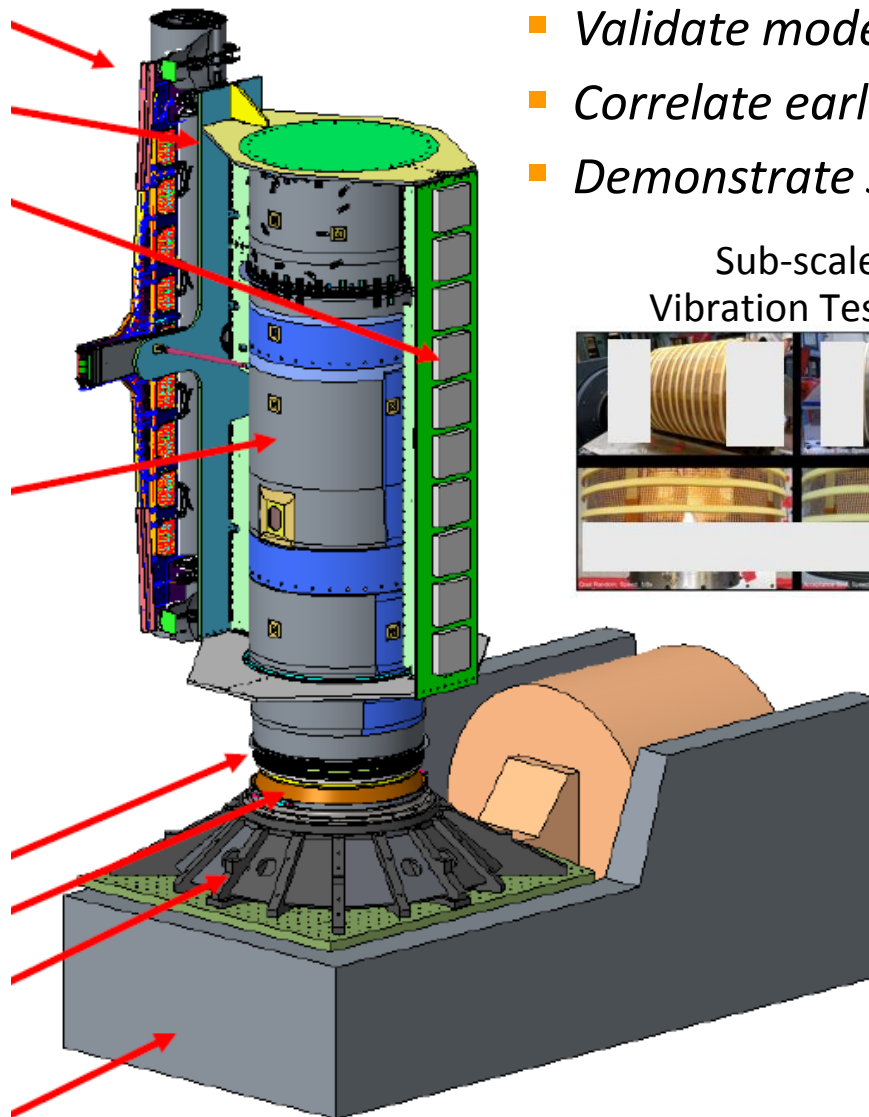
SSL ROSA QM Wing Vibration Testing – May/June



QM ROSA
Adapter Plates
Mass Simulators

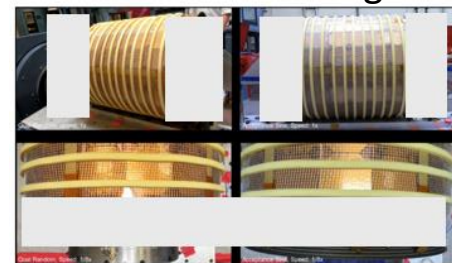
Vibration Test
Model (VTM)

V-Band Clamp
Vibe Flexure
Vibe Adapter
Vibe Table



- Validate models
- Correlate earlier tests
- Demonstrate survival

Sub-scale
Vibration Testing



Summary

- SSL, DSS and SolAero are executing a **rigorous and robust** qualification program for the SSL ROSA
- ROSA is baselined on **multiple SSL programs** including on-orbit servicing, persistent platforms, and cis-lunar missions
- SSL continues our partnership with DSS to prepare ROSA for **upcoming flights in 2020 and 2021**

ACKNOWLEDGEMENTS

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JPL/Caltech

NASA Marshall Space Flight Center

The Aerospace Corporation

SSL, SolAero and DSS ROSA team members

THANK YOU