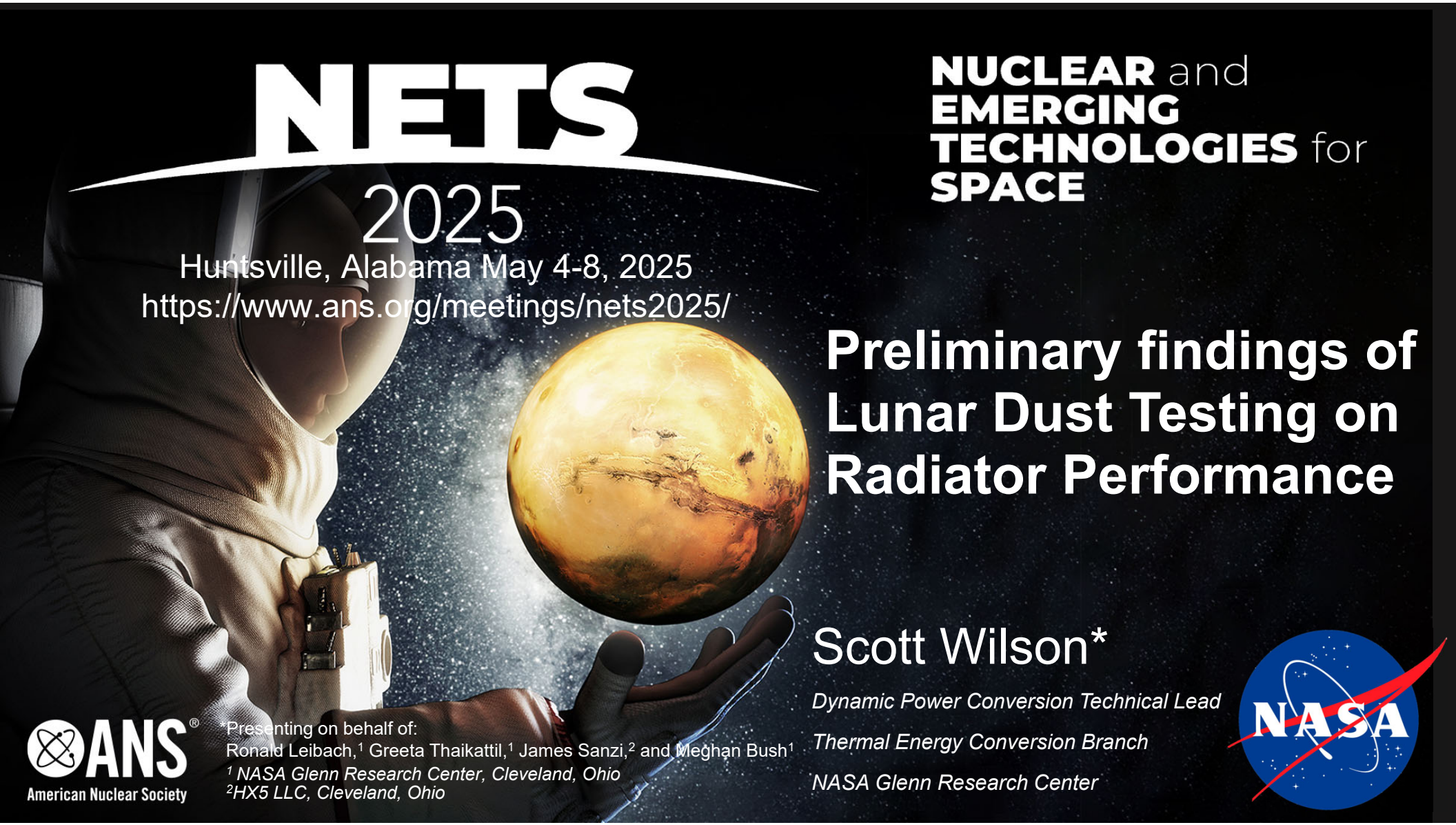


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NUCLEAR and EMERGING TECHNOLOGIES for SPACE

Preliminary findings of Lunar Dust Testing on Radiator Performance

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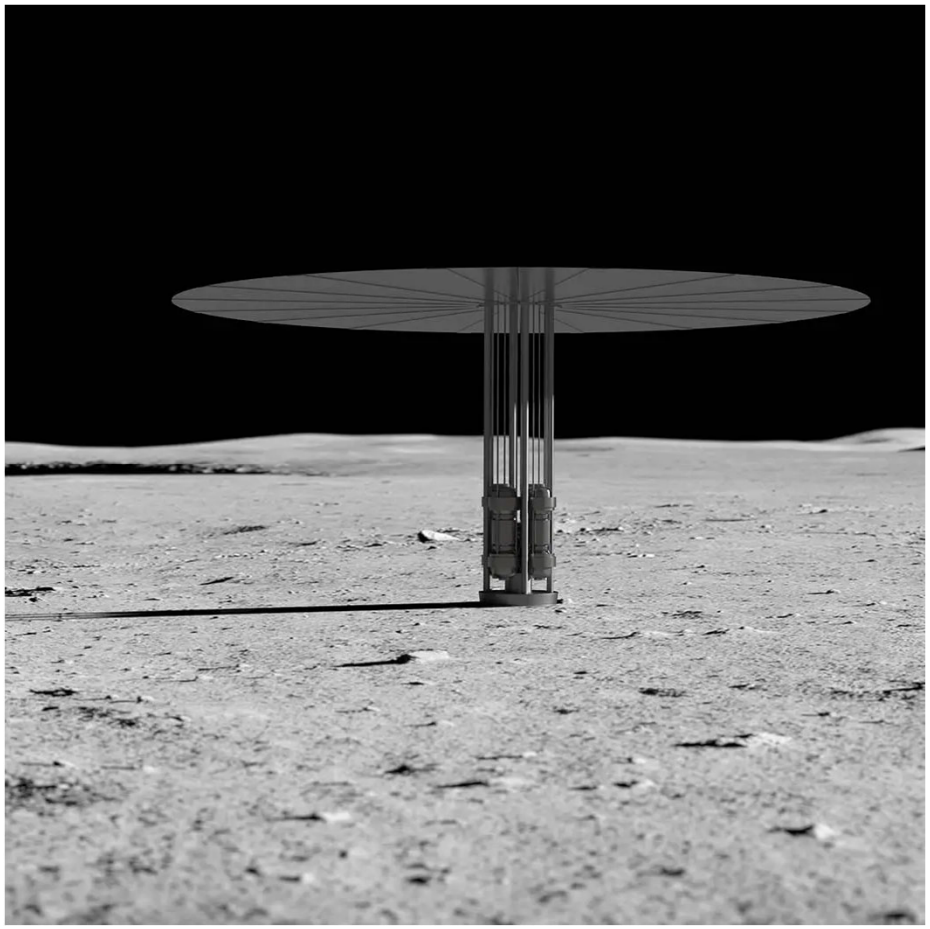
[2] *HX5 LLC, Cleveland, Ohio*

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Background

- FSP's 40 kWe system may require ~200 m^2 of thermal control surface
- Dust as a mission detriment has been studied since the Apollo missions
- The effects of dust on radiator heat rejection performance have not been fully characterized
- **It is advantageous to pin-point methodologies for recreating lunar environments to create a suitable testing platform**

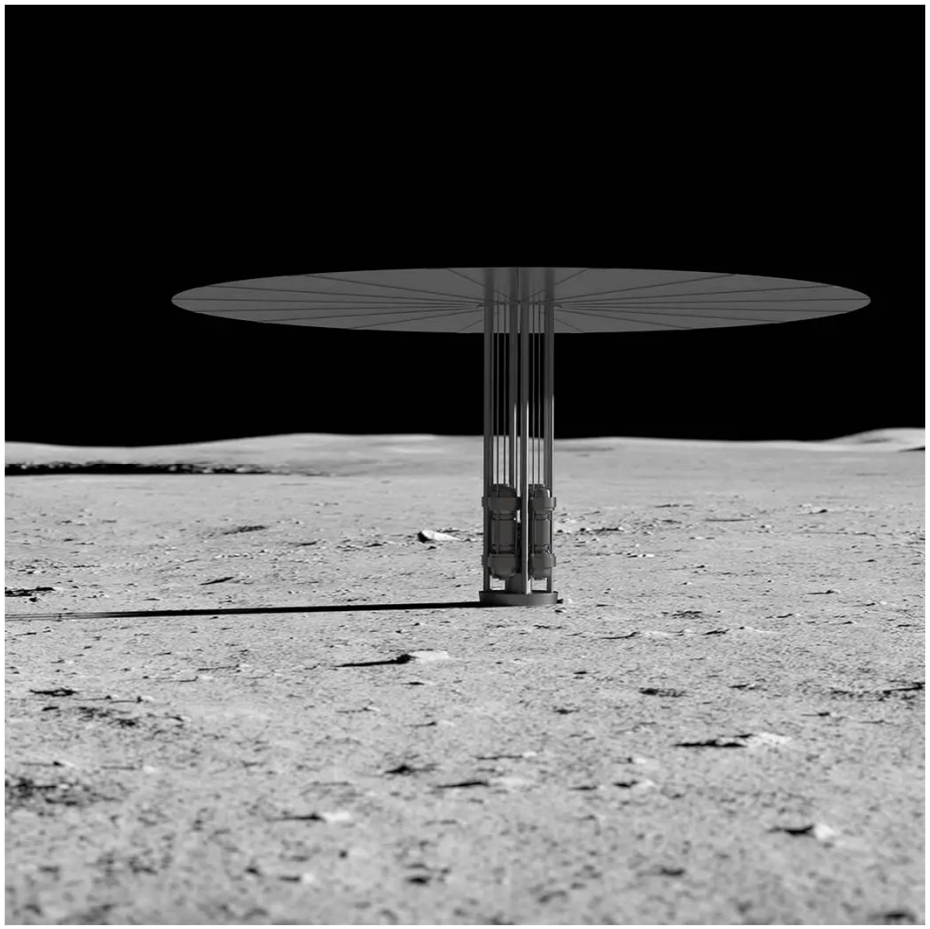


Purpose

The Risk of Radiator Dust Demonstration (R2D2) effort serves to create an in-house platform for regolith testing to assess the risk of regolith on heat rejecting radiators.

The goal of Phase I is to create a generalized test platform for depositing dust on an operating radiator.

The results of this study will serve to hone more focused Phase II efforts.

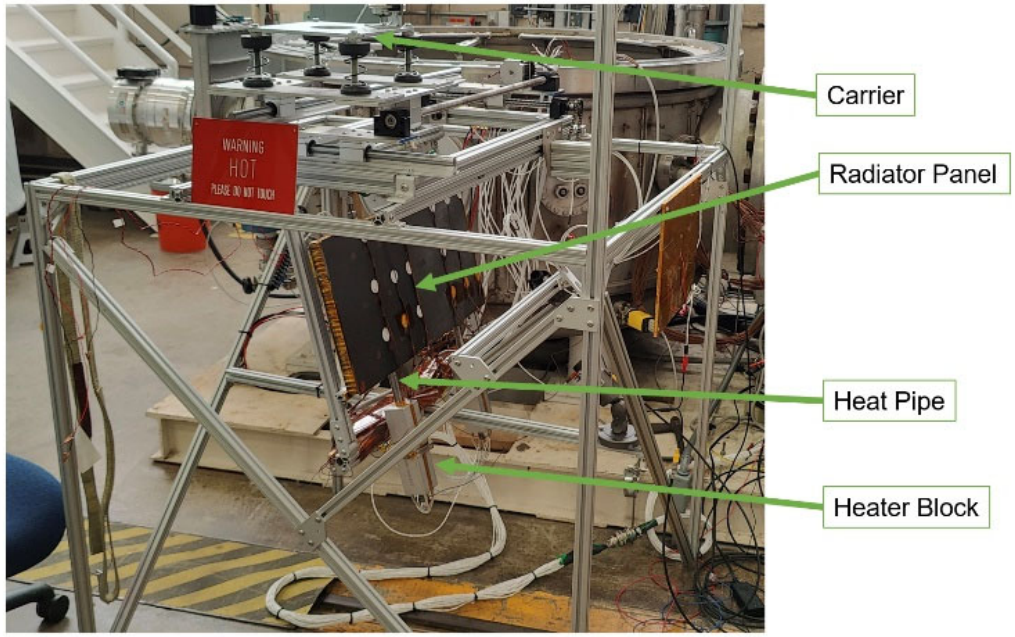


Methodology

Radiators are installed in aluminum frame beneath a dust deposition system.

Assembly placed in a vacuum chamber, radiators are brought to operational temperatures.

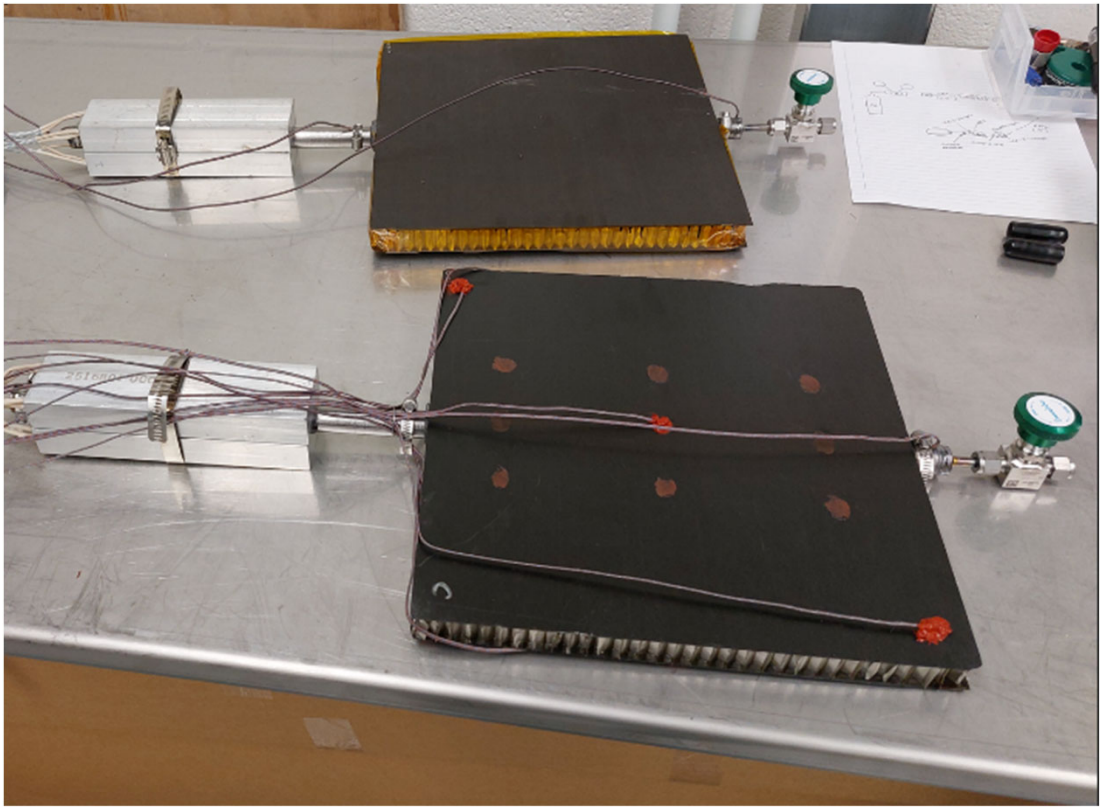
The deposition system releases dust atop of the radiator surface. Thermal response is studied via IR imaging and a thermocouple array.



Hardware

Radiators

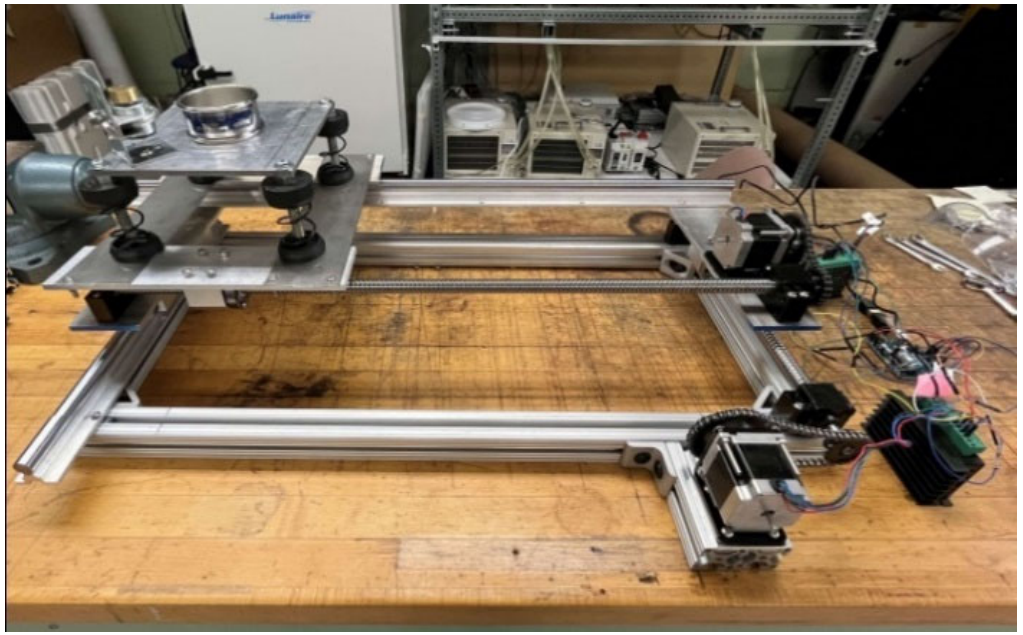
- Developed in 2006 by ACT
- Water-titanium heat pipe
- GFRC facesheets bonded w/ POCO foam



Hardware

Deposition System

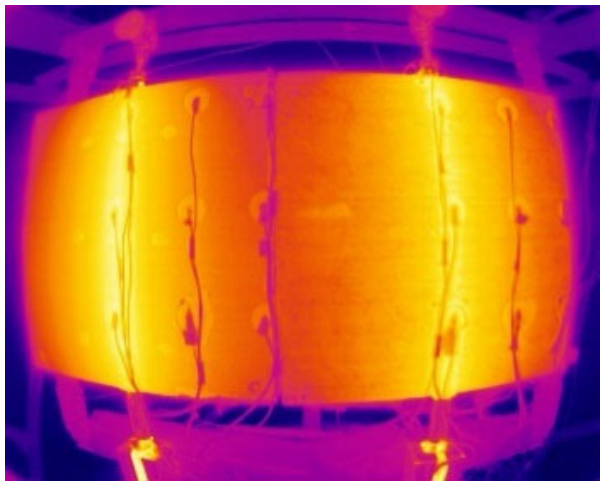
- 2 axis motorized gantry
- 75 micron sieve
- Eccentrically-weighted vibration motor



Instrumentation

- 22 TCs per panel
  - 9 per facesheet
  - 4 per heat pipe
- IR camera
  - Allows for higher resolution thermal profiles
  - Calibrated by TC data
- Voltage Bias Power Supply
  - One lead connected to facesheet, other connected to assembly framing

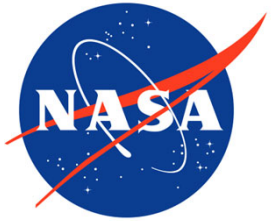




Test Plan

1. Pump down vacuum
2. Heat radiators to nominal operation temperature (200C at condenser)
3. Run deposition system
4. Pause, allow for thermal response
5. Change voltage bias
6. Repeat, 0-100V.





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Test 1

0-100V sweeps performed w/ no issues.

Due to uncertainty of deposition, the shaker motor was amplified. This led to the sieve overturning.

Lessons learned

- Dust is being deposited despite camera visuals
- The shaker motor can operate above nominal voltage, but there is a limit



Test 2

All sweeps were performed without issue.

Lessons Learned

- Dust adheres as low as 0V
- There is no indication that additional dust adheres past the first sweep

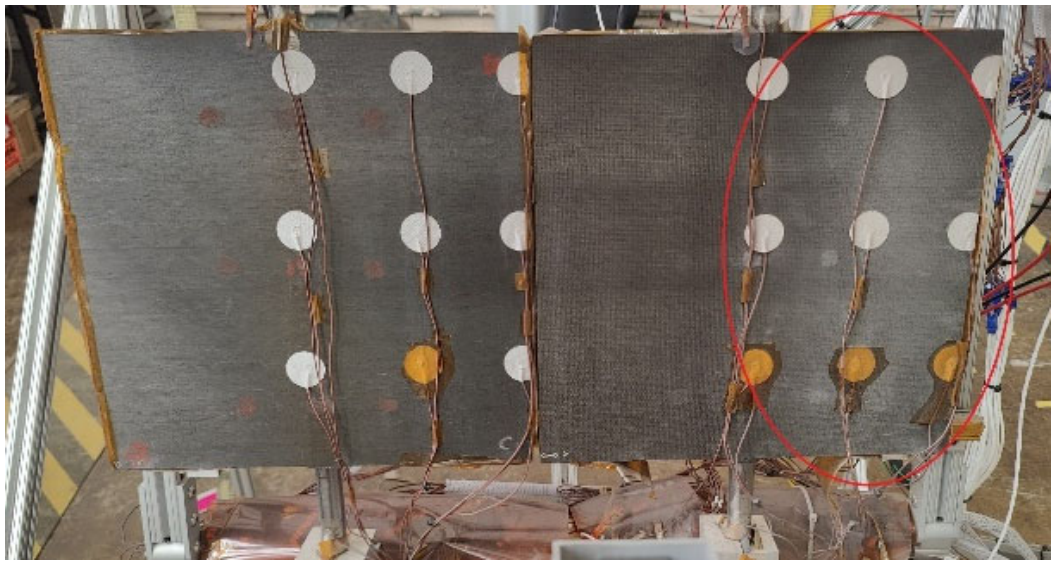


Test 3

75 micron sieve swapped for 250 micron sieve to alleviate concerns that not enough dust was being deposited

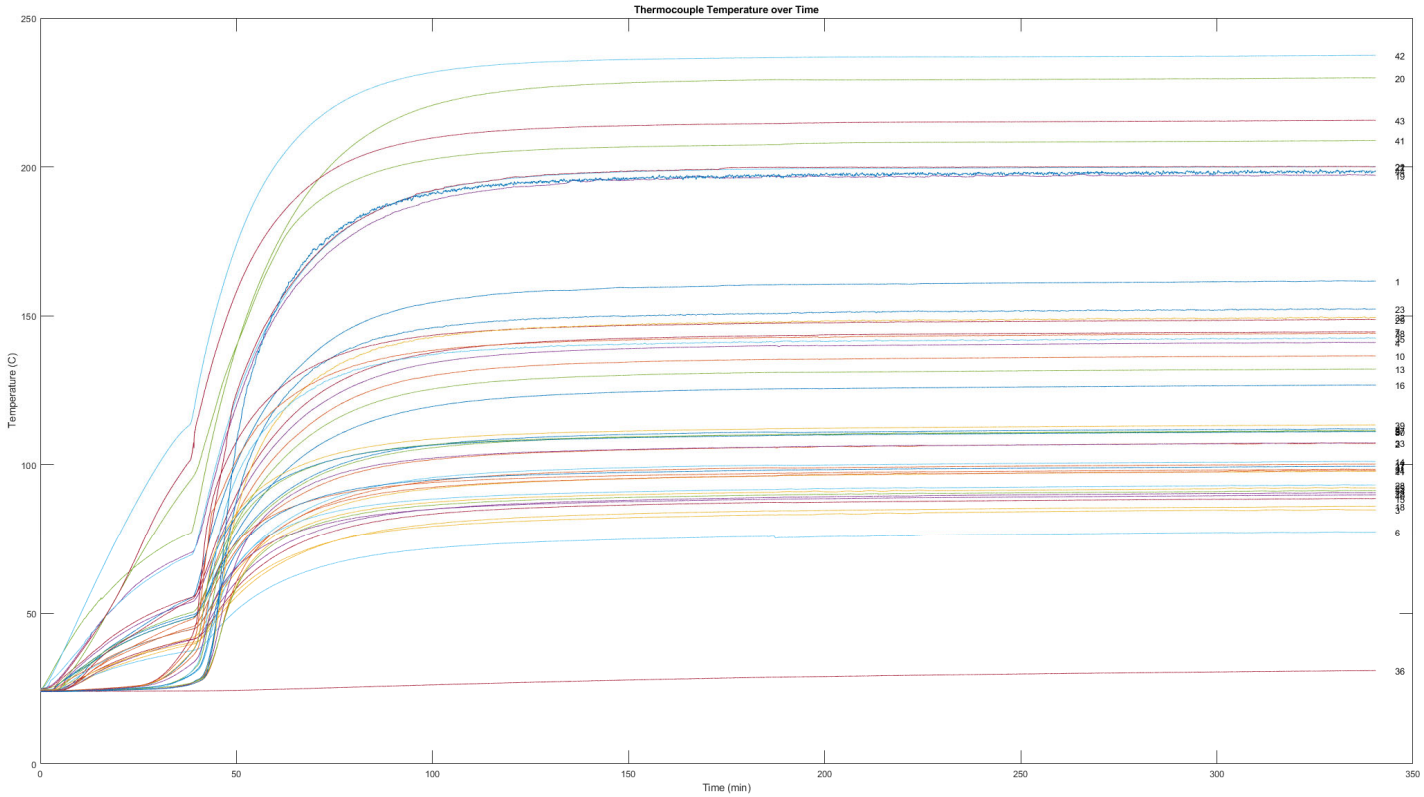
Lessons Learned

- Dust volume must scale with sieve size
- No indication that dust adhesion increases w/ deposition volume



Results

Figure shows total thermocouple dataset over time.

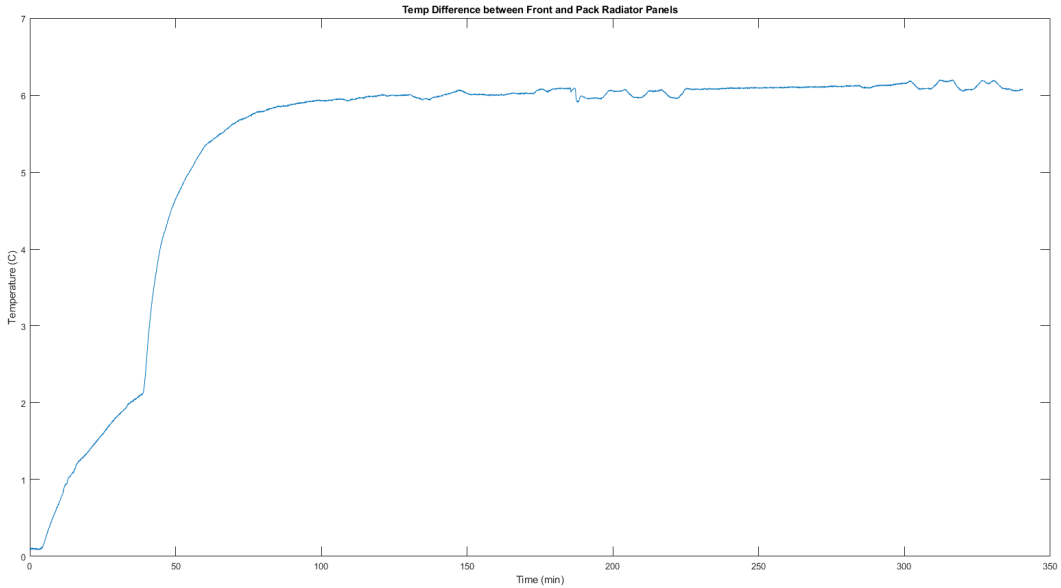


Results

To study thermal response, look at T_{front}-T_{back}

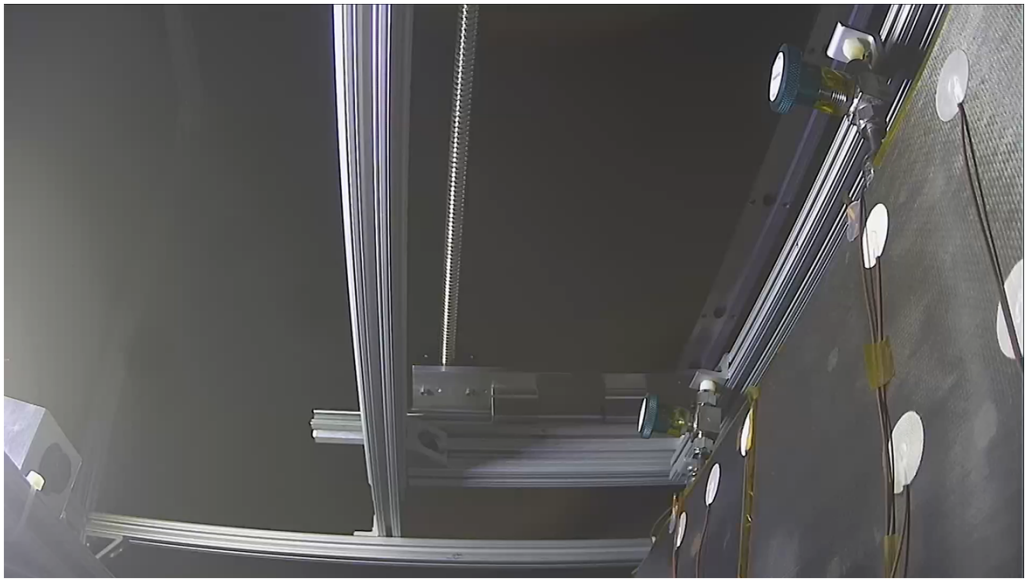
- Pre-deposition T_{front}-T_{back} = 6.07C
- Pre-deposition T_{front}-T_{back} = 6.09C

We can conclude that more focused studies must be performed to observe an accurate thermal response.



Discussion

Test video shows that the panel saturated almost instantly



This implies that the test was not capable of applying the magnitude of charge required for increased saturation.

Conclusion

- **Manual saturation thermal response study**
- **Ionic charge induction to force saturation study**

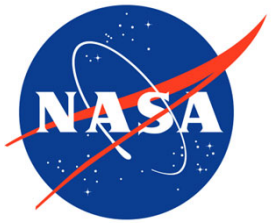
Future Tests

Phase I successfully revealed what areas of focus to explore in order to fully characterize the thermal response of lunar dust on radiators.

These tests may include

- Manual dust saturation
- Ionic charging
- Coated panel testing
- Solar absorptance studies





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Thank You

Co-authors

- Greeta Thaikattil
- Jim Sanzi
- Meghan Bush

Questions/Comments?

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