

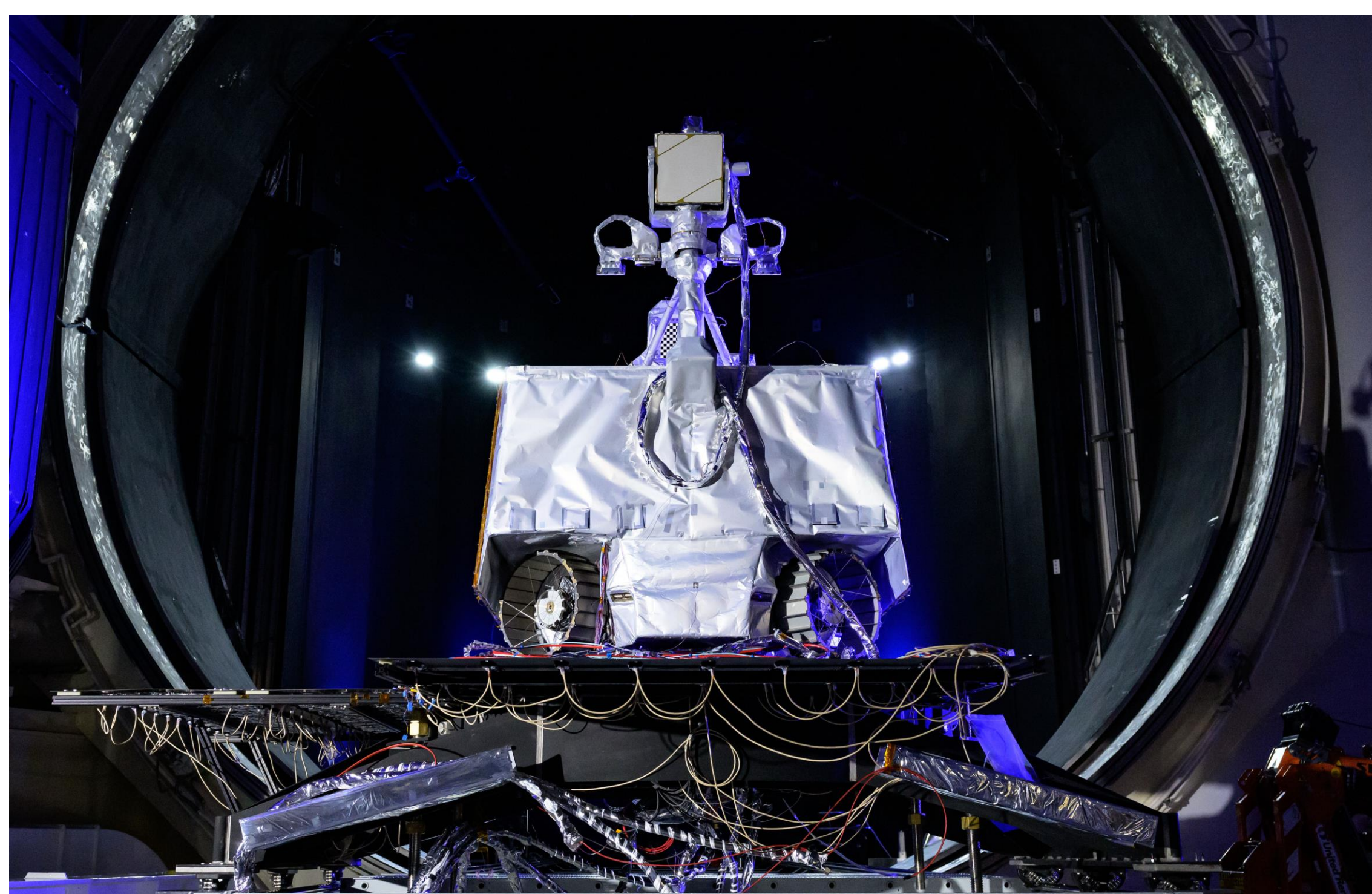
Volatiles Investigating Polar Exploration Rover (VIPER) System Integrated Thermal Vacuum Test Planning and Preparation

National Aeronautics and
Space Administration



Jodi Turk¹, Elijah Stewart¹, Tim Page²

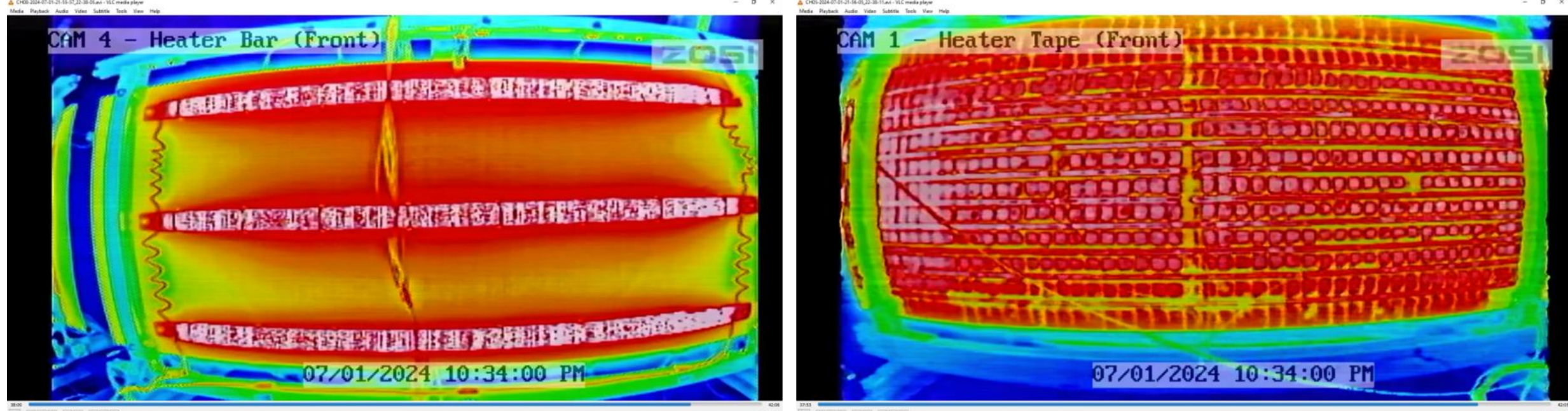
NASA Marshall Space Flight Center ¹EV34 ²EV34/ESSCA



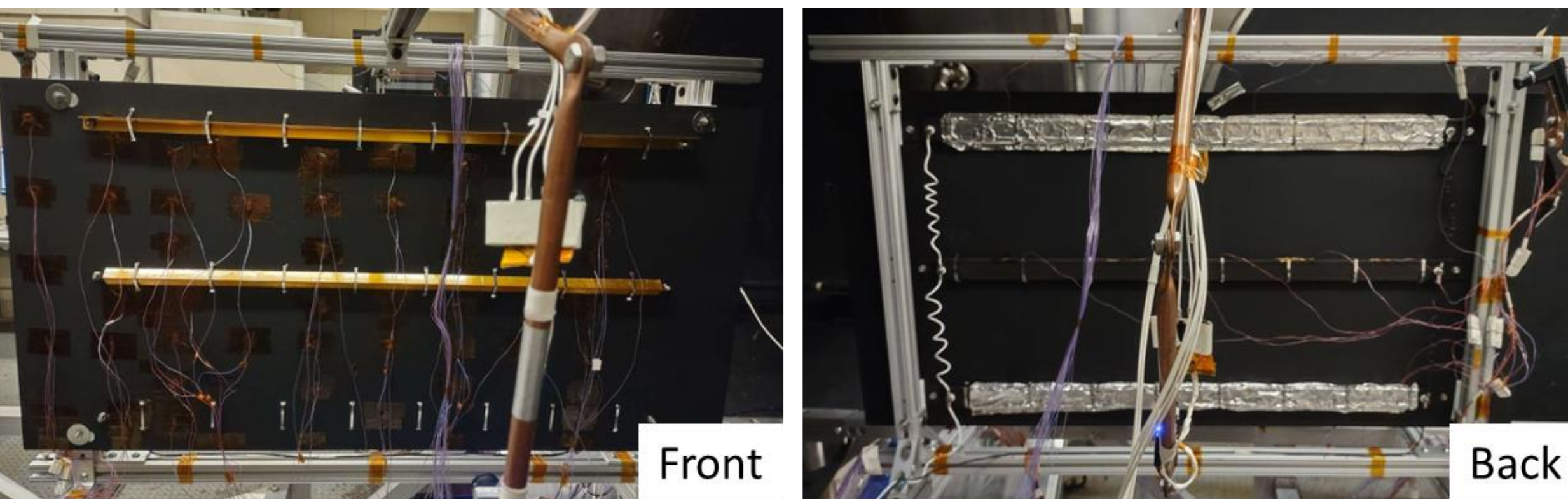
Volatiles Investigating Polar Exploration Rover (VIPER) is a rover designed to go to the lunar south pole to drill for ice and other volatiles. During the mission, the rover will experience a wide range of temperatures. To verify VIPER can meet the mission requirements a system integrated thermal vacuum (TVAC) test was planned in Chamber A at Johnson Space Center. To impose the environment on VIPER during TVAC the thermal radiant heat enclosure (TRHE) was used.



To optimize the performance of the TRHE a set of tests were conducted on aluminum panels in Chamber E at JSC. The first test configurations included a heater bar panel where all heater bars were attached with zip ties and the bottom bar had a thermal interface material (TIM) between the heater bar and the aluminum panel (top) and a second panel with Clayborn heater tape (bottom).

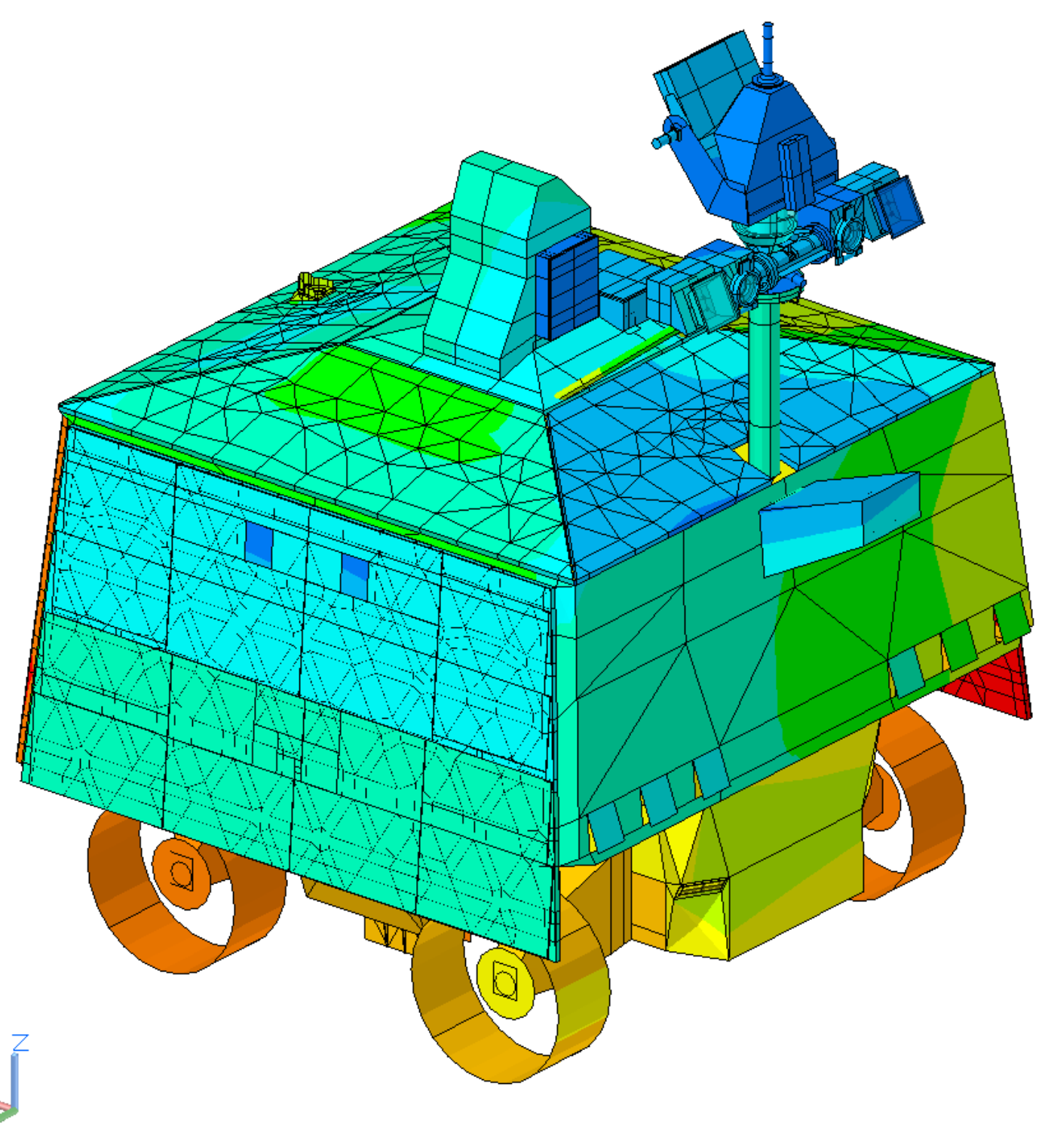
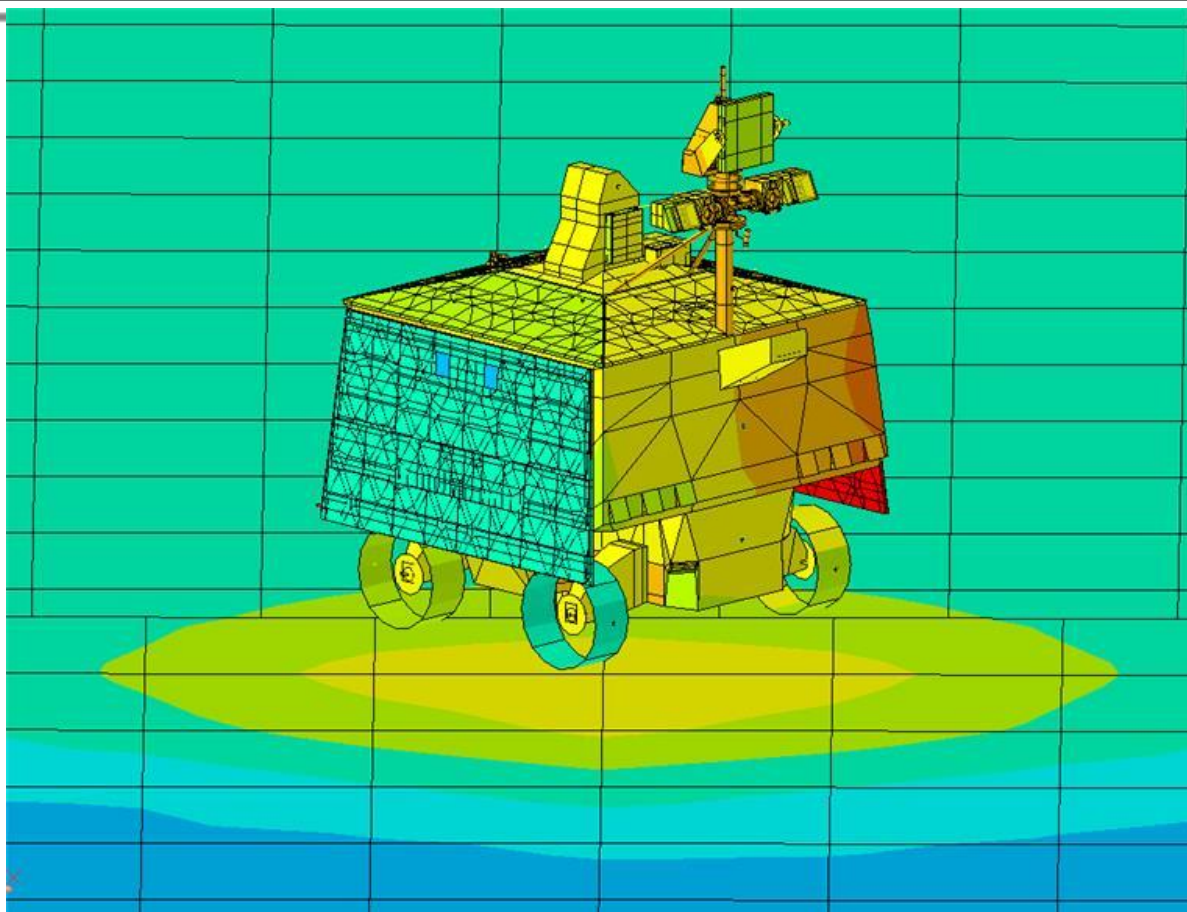
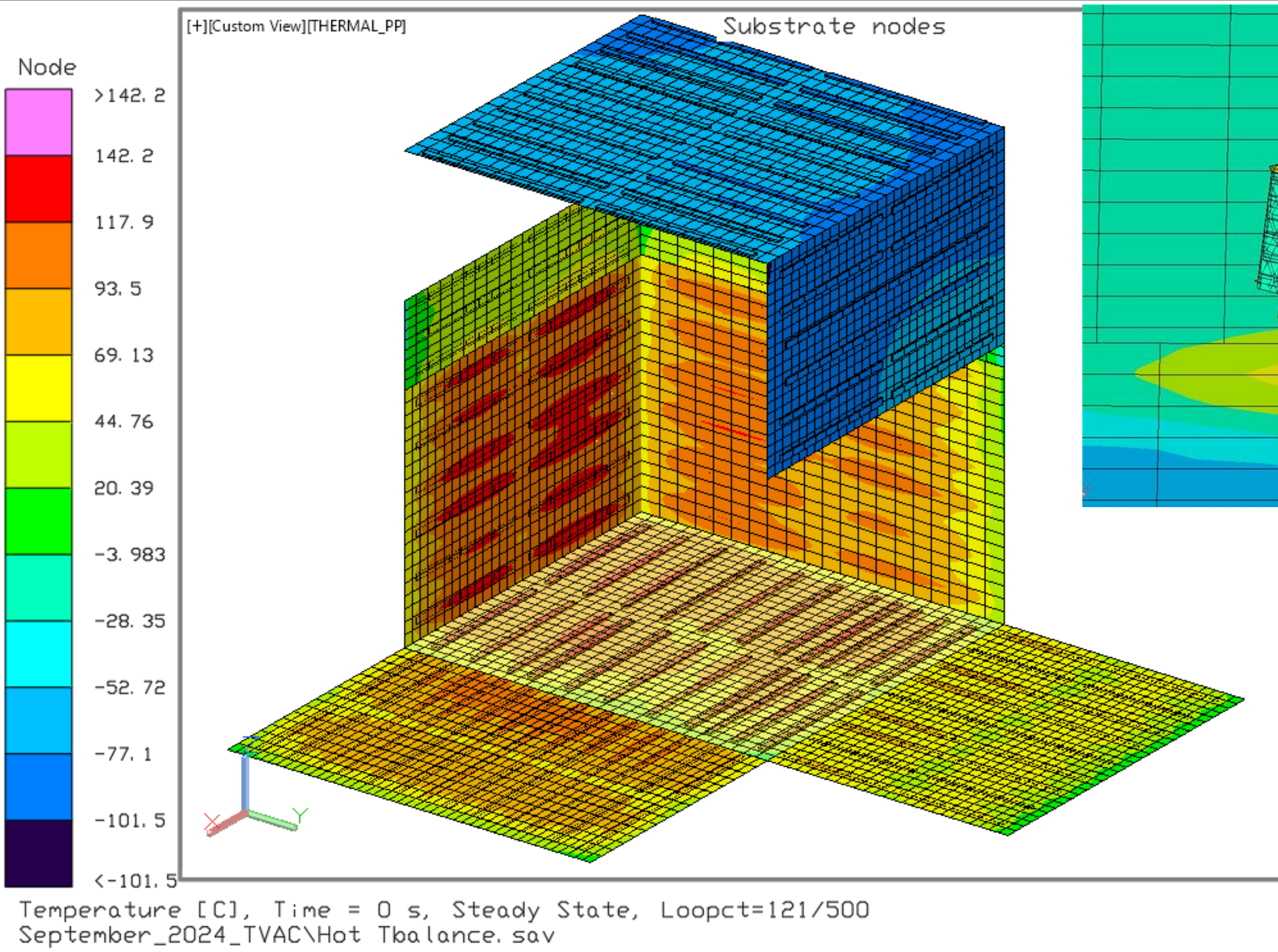


IR Camera Images of the Temperature Gradients for Heater Bar (left) and Heater Tape (right) panels.

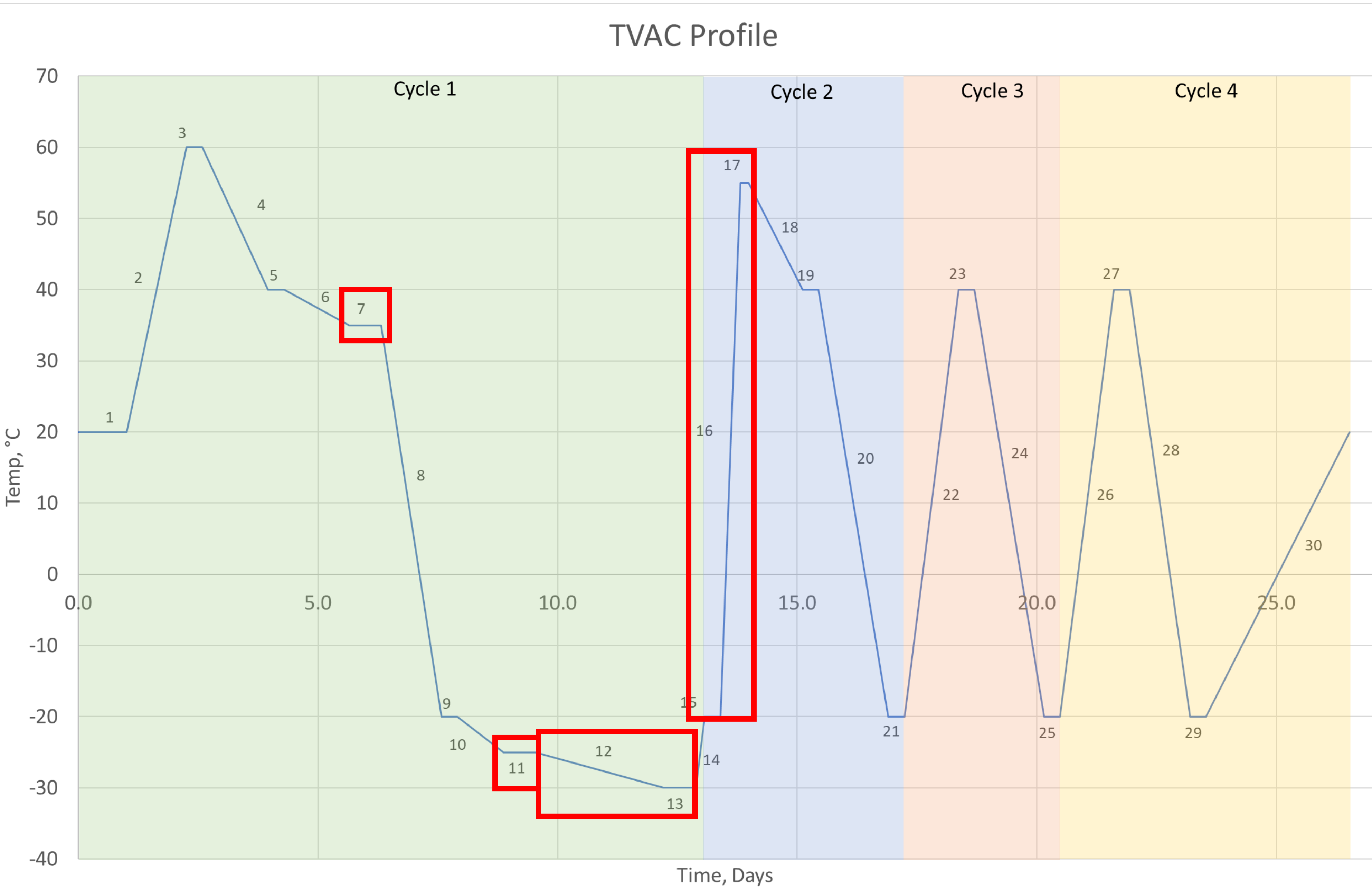


Based on the results of the first configuration a second test was performed with reworked heater bar attachment. The top heater bar had a bar stiffener and Ultra High Vacuum (UHV) foil backing added. The middle bar had a bar stiffener added. The bottom bar had UHV foil backing added. To balance the mass added with the performance the design with only the UHV foil backing was selected.

An integrated thermal model (ITM) was used to define the hottest and coldest environments that would be targeted for the TVAC test. The ITM served as a base for the model and the TVAC test hardware was built around it. One piece of test hardware was the TRHE. The TRHE went through several design iterations before the final design was selected for the TVAC test. The hot environment was the primary focus for the original geometry of the TRHE. The cold environment also impacted the design of the TRHE by keeping it open, having a high emissivity, and a low thermal mass since radiation to the chamber shroud was the only way to cool the enclosure. The TRHE was modeled in Thermal Desktop with the heater bars to account for the gradients created across the panels.



Segment	Segment Time (hr)	Absolute Time (Days)	Description
1		0.0	Start
	24	1.0	Chamber pumpdown to vacuum
2	30	2.3	Hot ramp #1
3	8	2.6	Hot Surv/Bakeout
4	33	4.0	Cold ramp #1 and shroud cool down
5	8	4.3	Hot Ops #1
6	32.7	5.7	Cold ramp #2
7	16	6.3	T-Bal Hot Ops
8	30	7.6	Cold ramp #3/RF Comm Functional
9	8	7.9	Cold Ops #1
10	23.3	8.9	Cold ramp #4
11	16	9.5	T-Bal Cold Ops
12	64.2	12.2	Hibernation Cold Ramp
13	16	12.9	Hibernation T-Balance
14	4.5	13.1	Hot ramp #2
15	8	13.4	Cold Dwell/Battery Charging
16	10	13.8	Transit Bakeout Transient
17	4	14.0	Transit Bakeout Dwell
18	27	15.1	Hot Ramp #3
19	8	15.4	Hot Ops #2
20	35	16.9	Cold Ramp #5
21	8	17.2	Cold Ops #2
22	27	18.4	Hot ramp #4
23	8	18.7	Hot Ops #3
24	35	20.2	Cold ramp #6
25	8	20.5	Cold Ops #3
26	27	21.6	Hot ramp #5
27	8	21.9	Hot Ops #4
28	30	23.2	Cold ramp #7
29	8	23.5	Cold Ops #4
30	72	26.5	Warmup/Repress/Presoak



The objectives for the TVAC test were defined based on ARC-STD-8070 Space Flight System Design and Environmental Test Standard and included exposing the rover to expected hot and cold environments to collect data needed to correlate the ITM. To meet the guidelines in 8070 and allow for specific mission operations to be tested the VIPER System Integrated TVAC Profile was developed. The profile had the VIPER rover being tested over 26.5 days. It included four hot and four cold operational segments as well as hot thermal balance, cold thermal balance, hibernation, and science instrument bakeout.