



EXPLORESpace TECH
TECHNOLOGY DRIVES EXPLORATION

Prototype Demonstration of Solar-Carbothermal System to Extract Oxygen from Regolith

“Value of Resources: Recipe for In-Situ Resource Utilization on Space Frontiers”

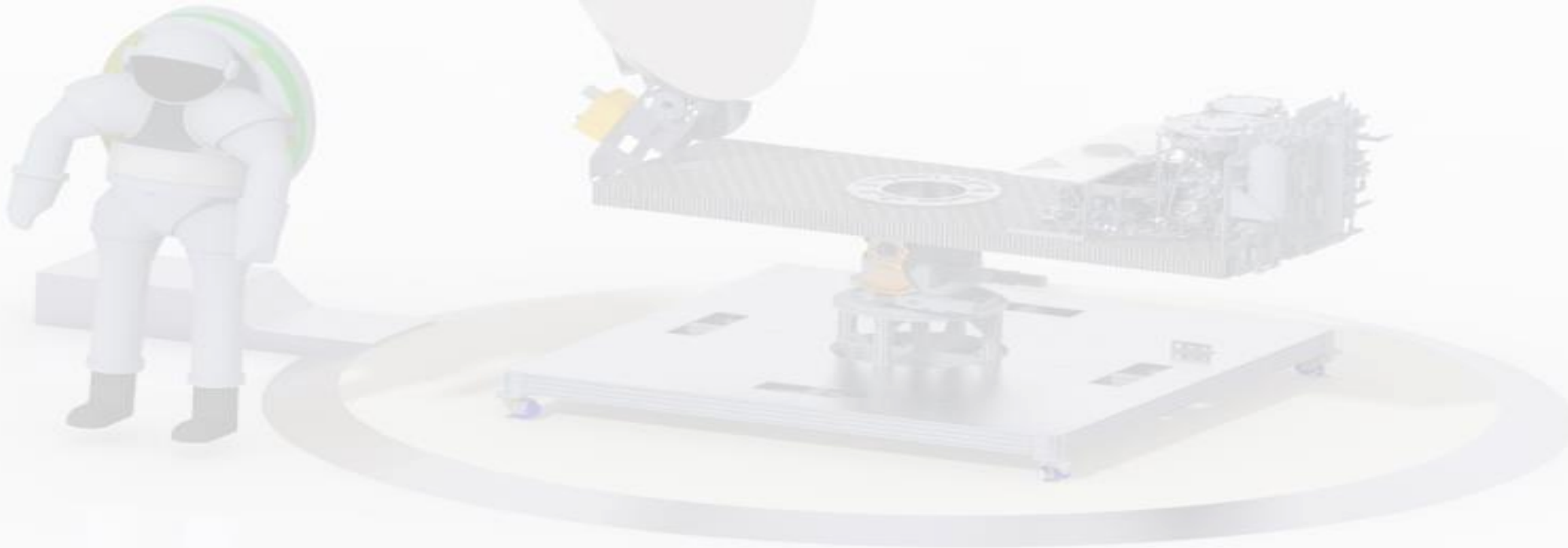
May, 2026

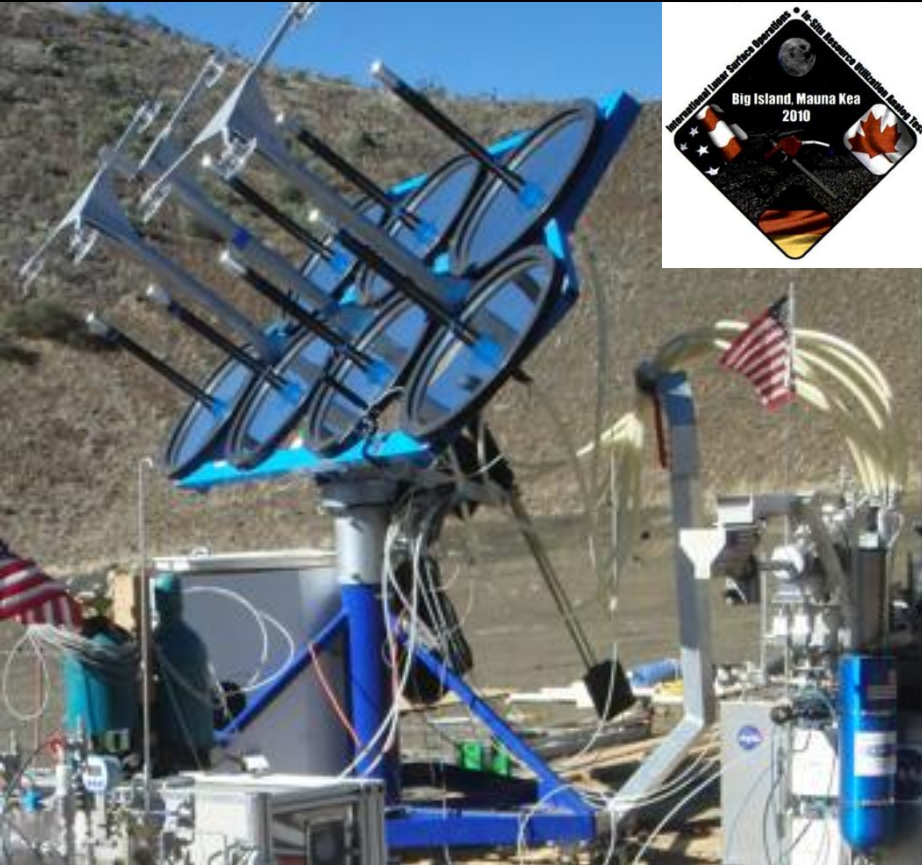
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CaRD Project Goal



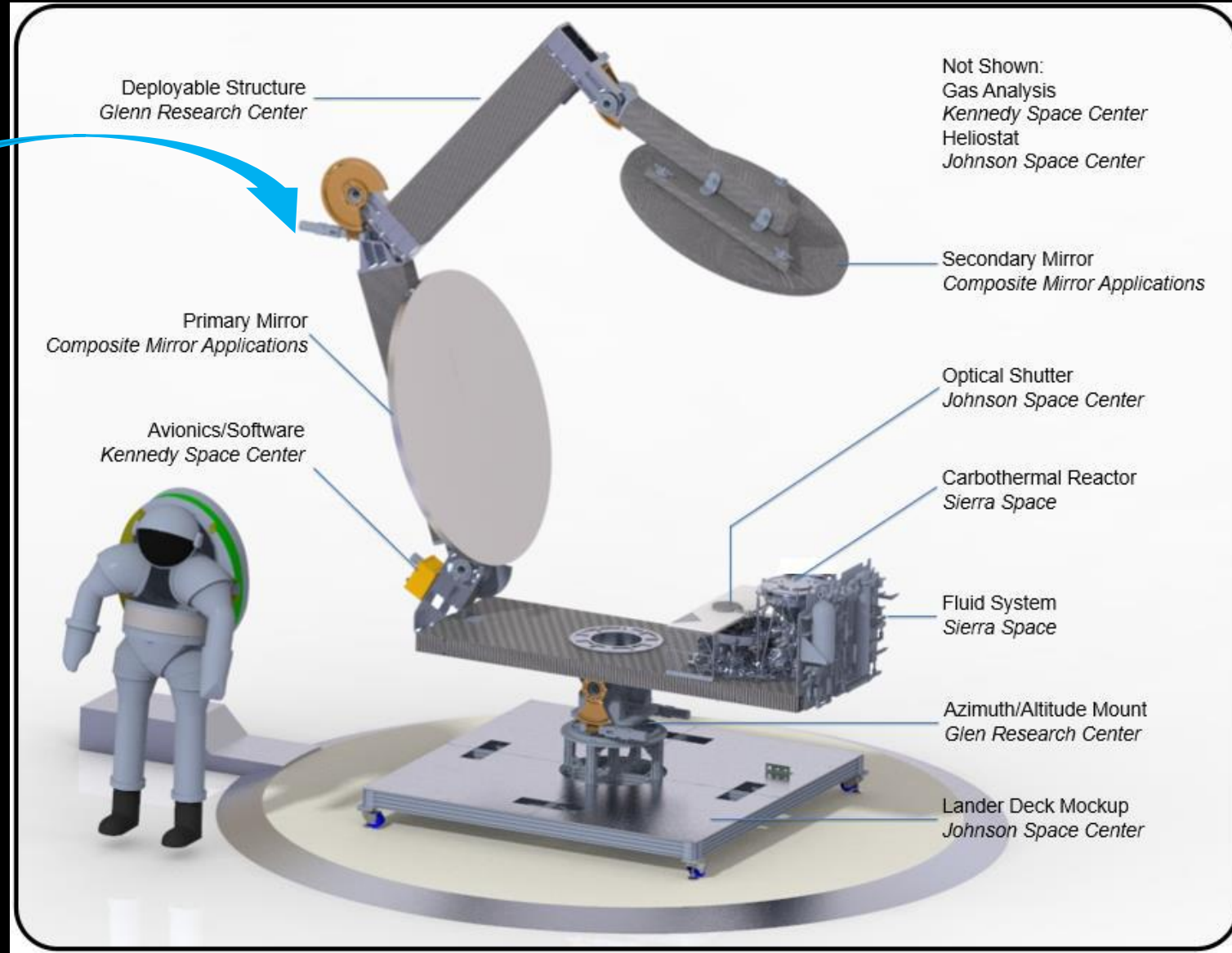
- The Carbothermal Reduction Demonstration (CaRD) project was an effort to develop a prototype system to demonstrate the extraction of oxygen from simulated lunar regolith using concentrated solar energy and a carbothermal reaction
- The prototype consisted of a deployable solar concentrator capable of tracking the sun, optical splash plate and shutter, carbothermal reactor, fluid system, gas analysis, and a control system consisting of avionics and software



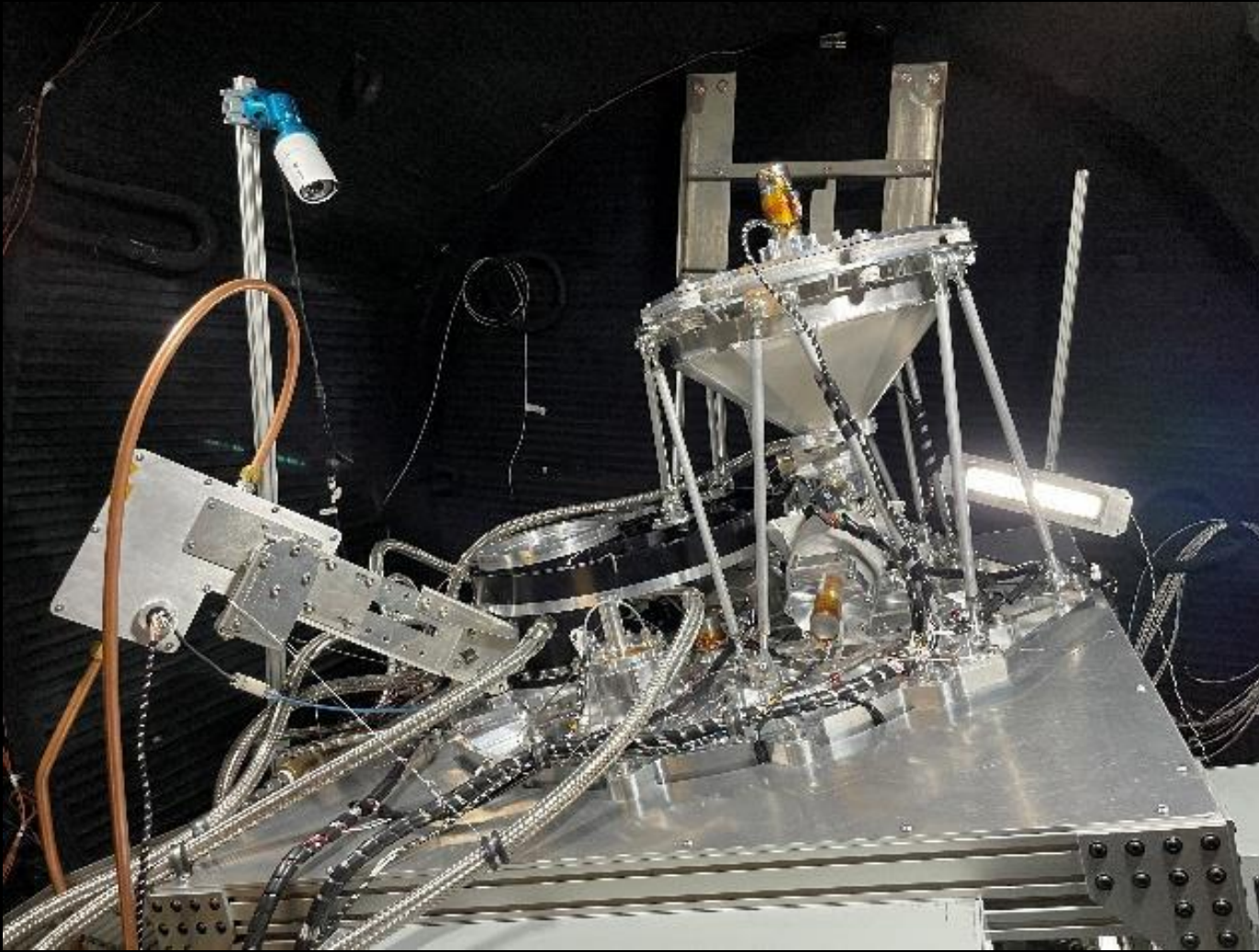


First Solar-carbothermal process demonstrated in 2010 in Mauna Kea as part of ISRU Dust to Thrust Field Demo

2025 CaRD Integrated Prototype

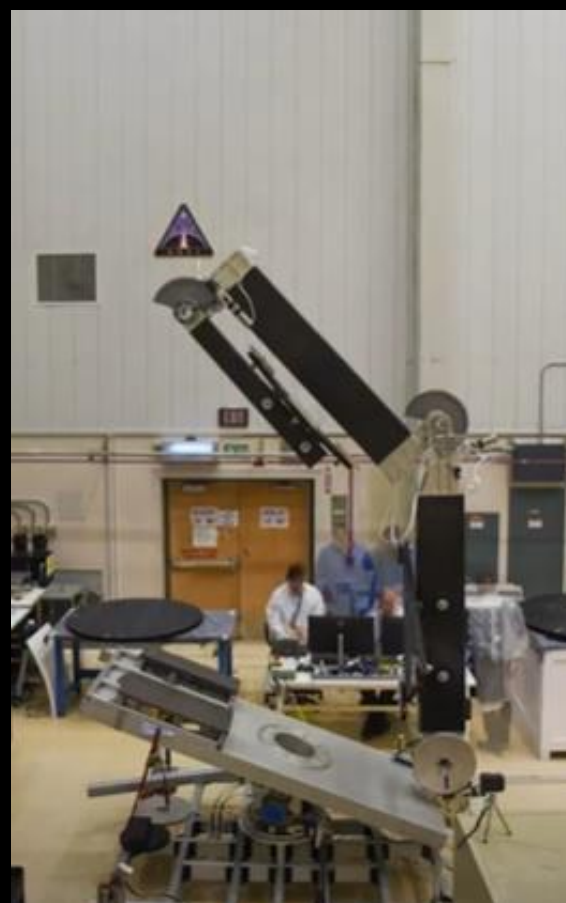
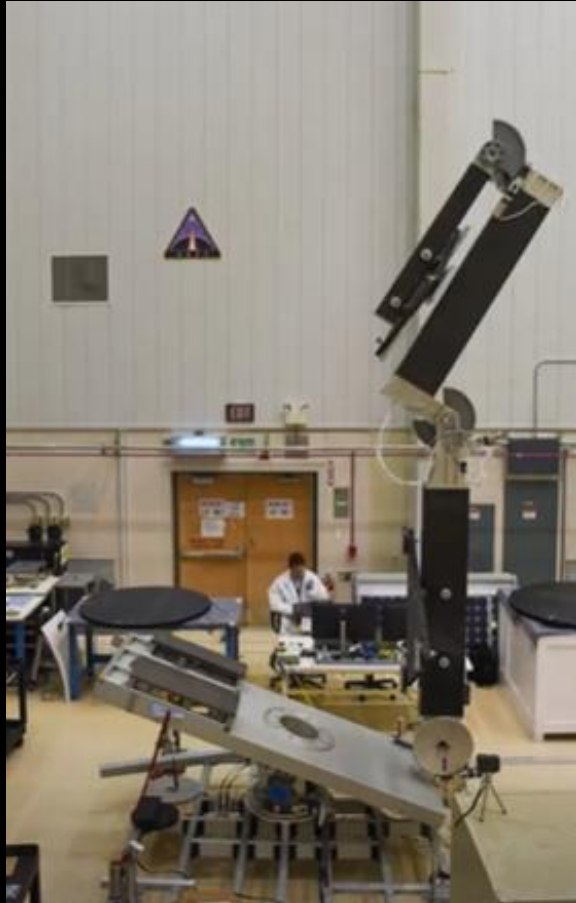


TRL 6 Demonstration of CaRD



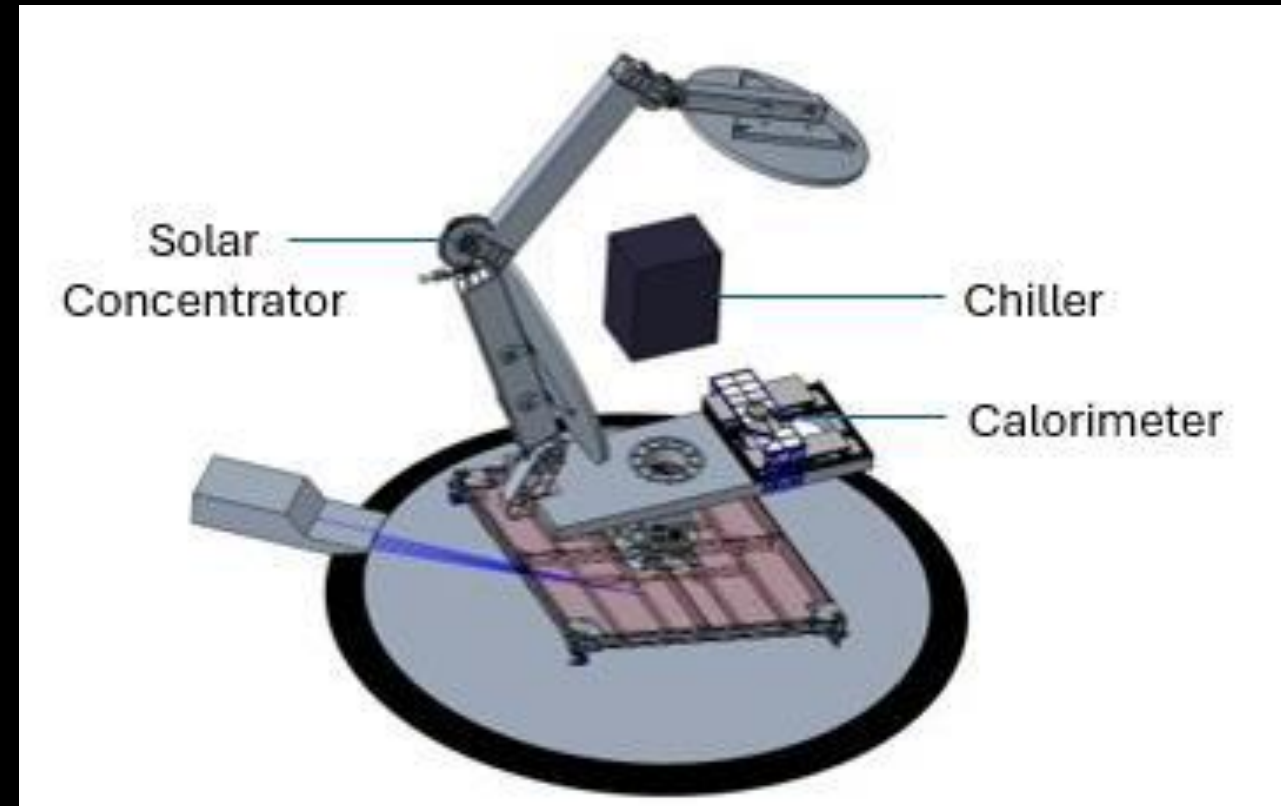
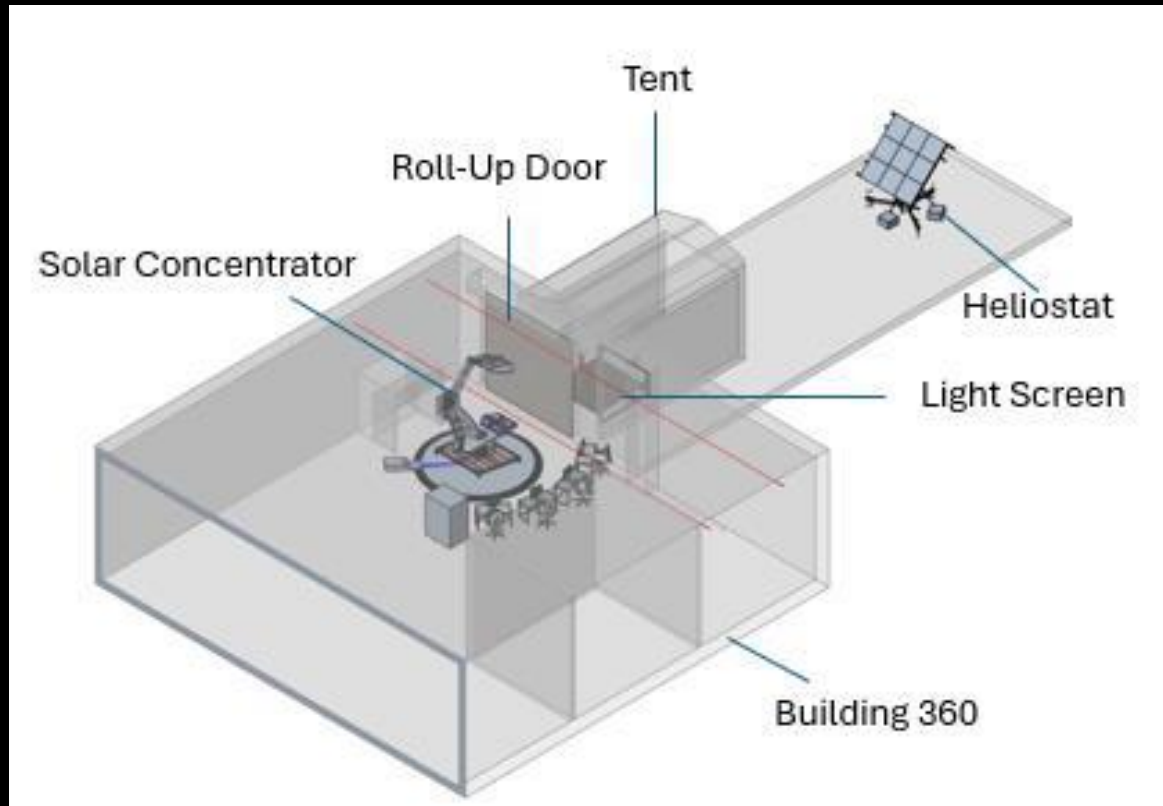
Carbothermal Oxygen Production Reactor (left), Carbothermal Oxygen Production reactor (COPR) Test in 15 ft Dirty TVAC chamber at JSC's Energy Systems Test Area (right)

Solar Concentrator Deployment Sequence



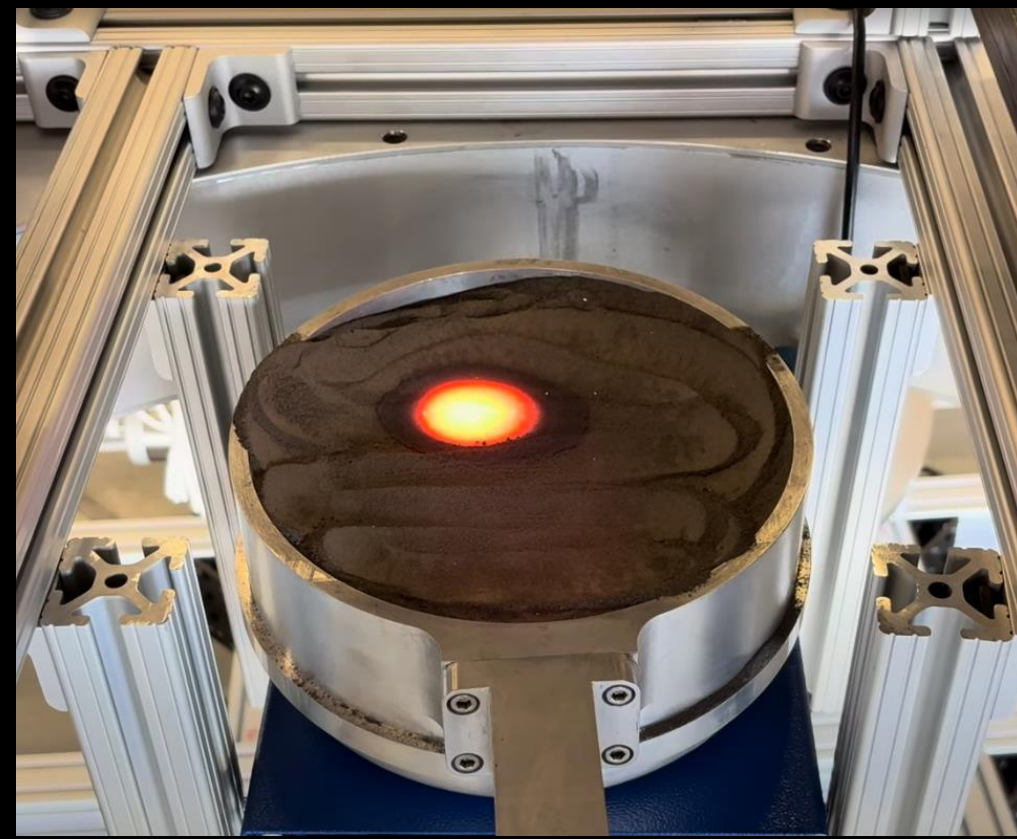
Stowed Configuration (Left), Deployed Configuration (Right) and Intermediate Steps (Middle)

Solar-Carbothermal Test System Configuration



Overall Test Configuration (left) Prototype Configuration for Calorimeter Test (Right)

Demonstration of Solar-Carbothermal System



Heliostat and Tracking (Left), Illuminated Solar Concentrator (Middle) and Molten JSC-1A Simulant at Focal Point (Right)

Compilation of CaRD Prototype Data



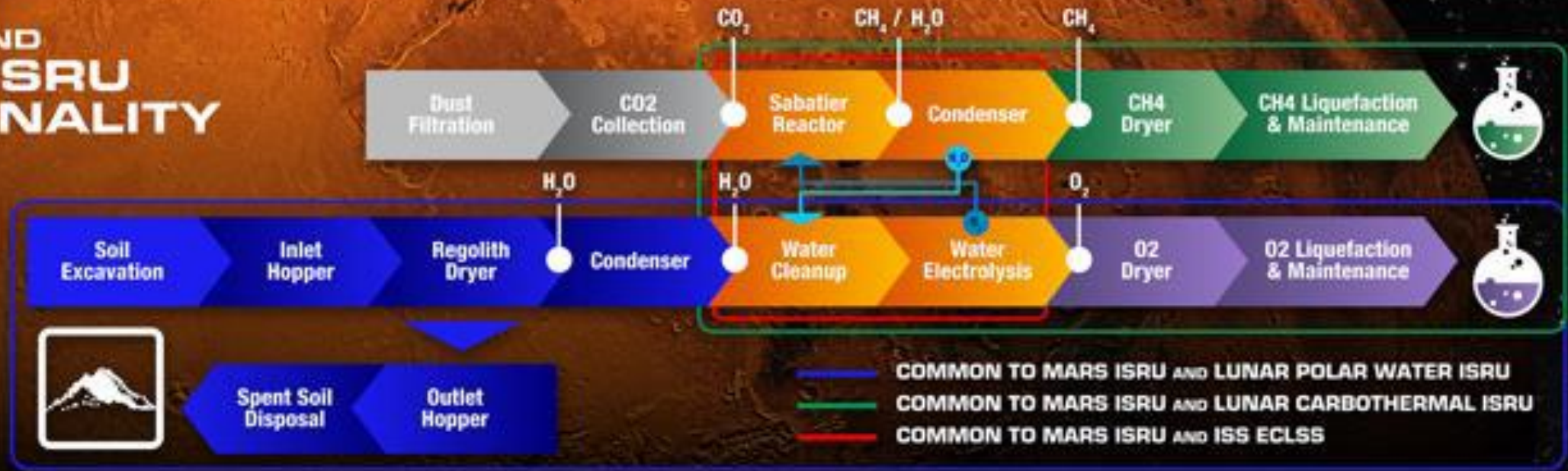
System	Test Date	Location	Simulant	~Input Solar Flux (W/m ²)	Aperture Area (m ²)	Delivered Power (W)	gO/kWh Input Energy
First-generation	2/4/2010	Mauna Kea, HI	Tephra	989	2.3898	780	0.35
CaRD ETU Brassboard	2/15/2023	Houston, TX	Greenspar 250	laser		1380	N/A
CaRD Prototype	8/26/2025	Houston, TX	Greenspar 250	550	1.889	595	0.29
CaRD Prototype	8/27/2025	Houston, TX	Greenspar 250	675	1.889	730	0.39
CaRD Prototype	8/28/2025	Houston, TX	NUW-LHT-5M	550	1.889	595	0.51
CaRD Prototype	8/28/2025	Houston, TX	NUW-LHT-5M	550	1.889	595	0.28
CaRD Prototype	Prediction	Moon	Regolith	1370	1.889	1561	Unknown
CaRD Prototype	Prediction	Moon	Regolith	1370	1.670	1380	9.53

Compilation of CaRD Prototype Data, with Comparisons to Similar Tests and Predictions

CaRD process and Commonality with Mars ISRU and ECLSS



MARS AND LUNAR ISRU COMMONALITY



IN-SITU RESOURCE UTILIZATION



Thank You. Questions?

