NASA AEROSPACE BATTERY WORKSHOP

- 21st January 2026 -

Scalable battery pack designed for Lunar Terrain Vehicles

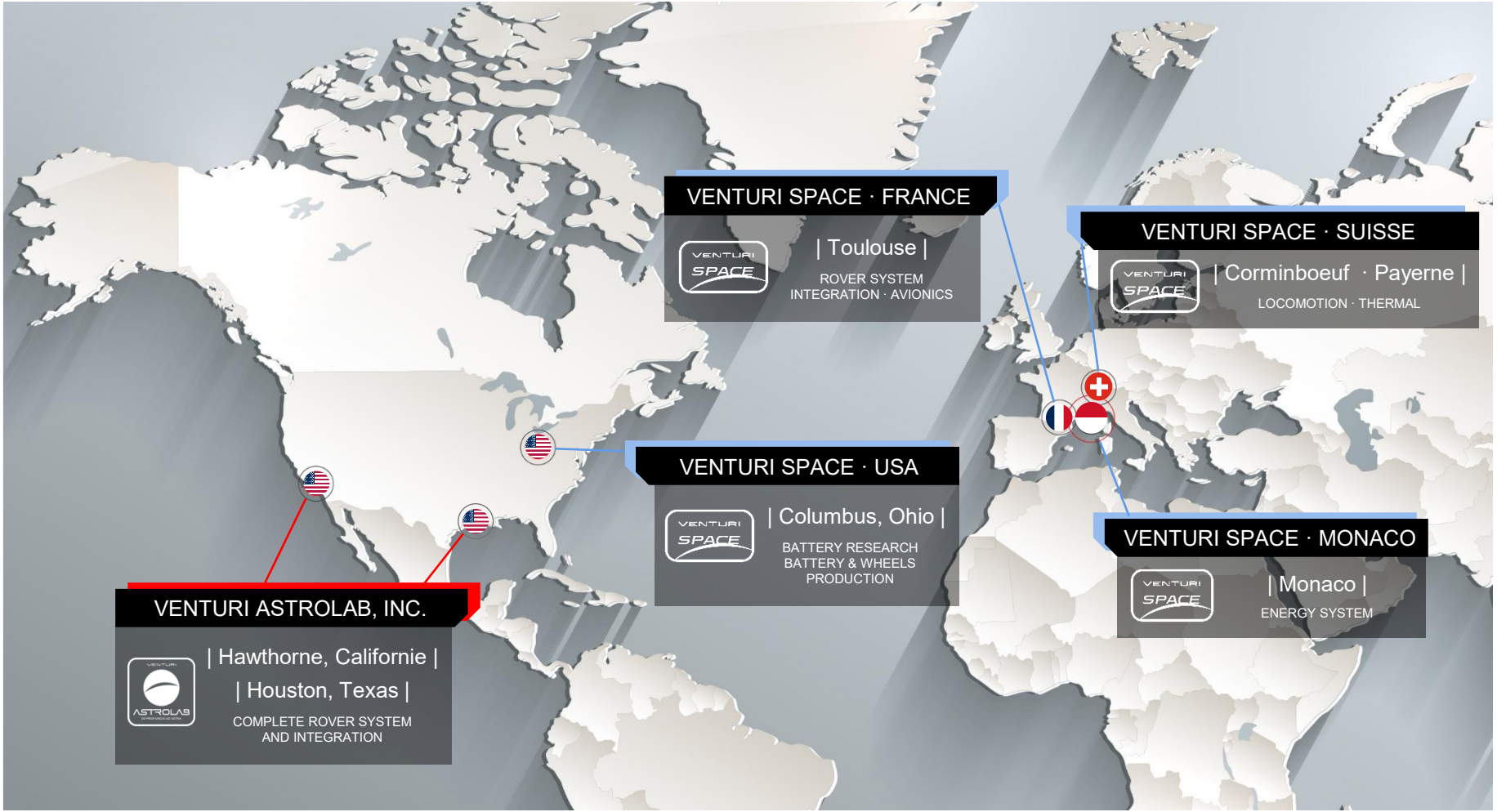
Franck Baldet
Venturi Space Monaco
CTO

Michael Johanni
Venturi Space USA
President

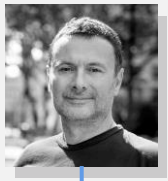
HISTORY BACKGROUND

Gildo Pastor
President Venturi Group Owner

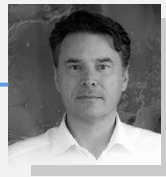
- Monaco, Home of Venturi since 2000 when the firm became a Pioneering Expert in Electric Mobility.
- Venturi's projects are driven by a visionary President, Gildo Pastor, and the extraordinary collaborative work of the passionate men and women who make up the Venturi team.
- In 2021, after two decades of innovation in terrestrial electric vehicles, Venturi's President Gildo Pastor repositioned the firm in the space sector to focus on planetary mobility.


VENTURI SPACE · FRANCE
| Toulouse |
ROVER SYSTEM
INTEGRATION · AVIONICS
VENTURI SPACE · SUISSE
| Corminboeuf · Payerne |
LOCOMOTION · THERMAL
VENTURI SPACE · USA
| Columbus, Ohio |
BATTERY RESEARCH
BATTERY & WHEELS
PRODUCTION
VENTURI SPACE · MONACO
| Monaco |
ENERGY SYSTEM
VENTURI ASTROLAB, INC.
| Hawthorne, Californie |
| Houston, Texas |
COMPLETE ROVER SYSTEM
AND INTEGRATION

VENTURI SPACE ORGANISATION



Gildo Pastor
President & CEO of Venturi Space



Dr. Antonio Delfino
Director of Space Affairs Venturi Space Group

MONACO

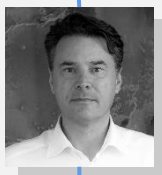
Franck Baldet
COO & CTO

FRANCE

Xavier Chevrin
CEO

Stéphane Mary
CTO

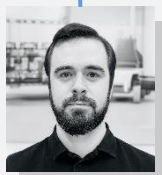
SWITZERLAND



Dr. Antonio Delfino
Cofounder & CEO

David Olsommer
CTO

USA



Michael Johanni
President

SOUTH POLE ENVIRONMENT

- 1/6 earth gravity
- Temperature -170°C to +110°C
- Permanent shadow -240°C
- Extended nights lasting more than 250Hr

NASA LTVS REQUIREMENTS

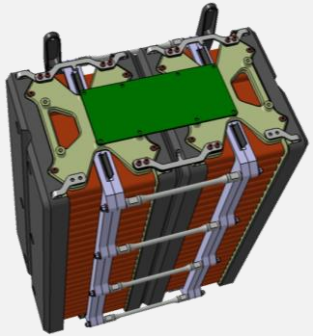
- Unpressurize space vehicle manned and remote operation
- 20km of continuous traverse
- Up to 20kph
- Operate continuously 8h00 EVA
- Around 1300km/year
- 10 years on the moon with one or multiple rovers
- Survive Lunar shadow nights

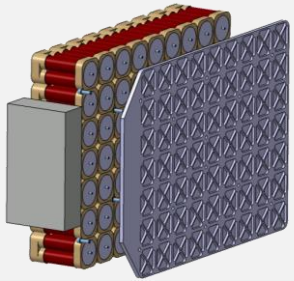
CELLS BENCHMARK IN 2022-2023

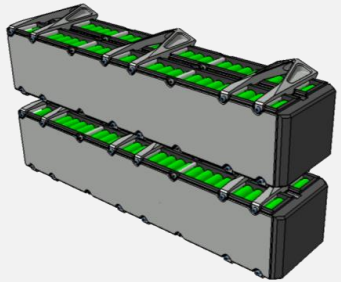
	2022			2030
	SPACE GRADE PRISMATIC	SPACE GRADE CYLINDRICAL	COTS 21700	COTS 21700
SIZE	Th 18.6 x W 60.5 x H 68.7 mm	ø 33 x H 103 mm	ø 21 x H 70 mm	ø 21 x H 70 mm
CAPACITY [Ah]	5.6	12	4.5	-
SPECIFIC ENERGY [Wh/kg]	151	219	269	350 *
VOLUMETRIC ENERGY DENSITY [Wh/L]	265	523	668	869 *
SPACE HERITAGE	51 LEO	Was in Quali phase	None or poor	-
TEMPERATURE RANGE [°C]	Discharge -40°C/+85°C Charge -30°C/+85°C	Operating +10°C / +40°C Special test @-20°C	Discharge -40°C/+60°C Charge -0°C/+60°C	-

** From Fraunhofer Institute for Systems and Innovation Research ISI*
Lithium-Ion Battery Roadmap – Industrialization Perspectives Toward 2030 report published in December 2023

BATTERY PRELIMINARY DESIGN STUDY







2030
PROJECTION

SPACE GRADE PRISMATIC	SPACE GRADE CYLINDRICAL	COTS 21700	COTS 21700
Battery weight | 259.10 kg * Nb Cells | 1152 Energy | 23.55 kWh Secific Energy | 90.89 Wh/kg	Battery weight | 136.59 kg * Nb Cells | 504 Energy | 23.22 kWh Secific Energy | 169.99 Wh/kg	Battery weight | 151.09 kg * Nb Cells | 1344 Energy | 23.22 kWh Secific Energy | 153.68 Wh/kg	Battery weight | 160.7 kg * Nb Cells | 1344 Energy | 31.44 kWh Secific Energy | 195.64 Wh/kg

** No Insulation layers, no brackets, no enclosure, no ejecta protection*

→ DECIDED TO SELECT 21700 CELLS

STANDARDS & WORK INSTRUCTION

DESIGN

JSC20793 RevD Crewed Space Vehicle Battery Safety Requirements

TESTING

SMC-S-017 Lithium-Ion Battery For Spacecraft Applications
SMC-TR-06-11 Test Requirements for Launch, Upper-Stage, and Space Vehicles

USE OF COTS CELLS FOR CREWED SPACECRAFT BATTERIES

EP-WI-035 Receiving Inspection
EP-WI-036 Initial Assessment
EP-WI-033 Lot Acceptance Test
EP-WI-037 Screening Cells

LEVERAGING MODULAR BATTERY DESIGN

- Scalable design

- Energy density
- Homogeneous temperature betwen cells (max delta 3°C)

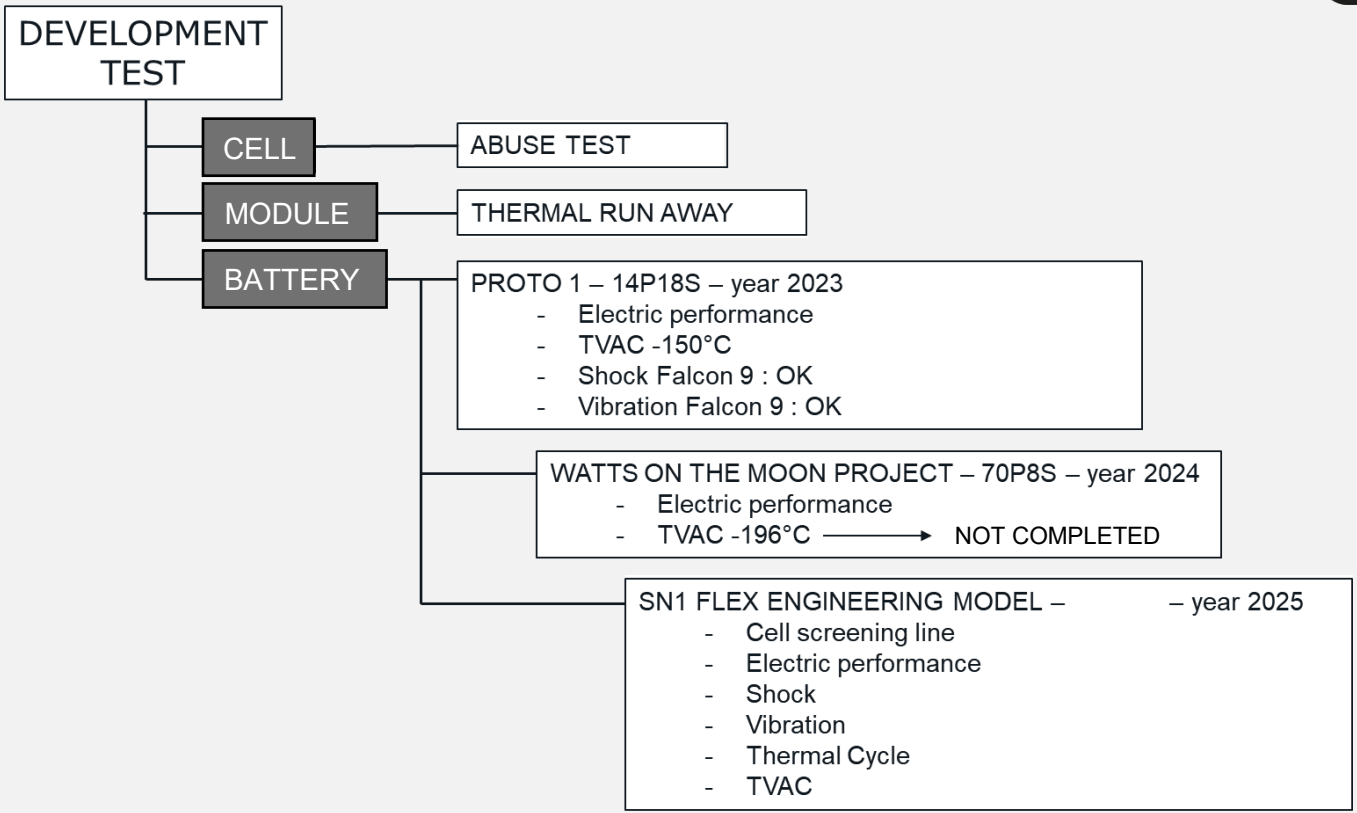
- Avoid thermal run away (TR) propagation (adequate cell spacing and heat rejection from the TR cell)
- Protect the adjacent cells from possible top vent, bottom or side wall and/or spin groove ruptures

- Ejecta control
- Protect all of the cabling and wiring to ensure it does not become an external short path
- Individually fuse parallel cells or strings of series cells and prevent bypass by conductive ejecta
- Prevent flames and sparks from exiting the battery enclosure

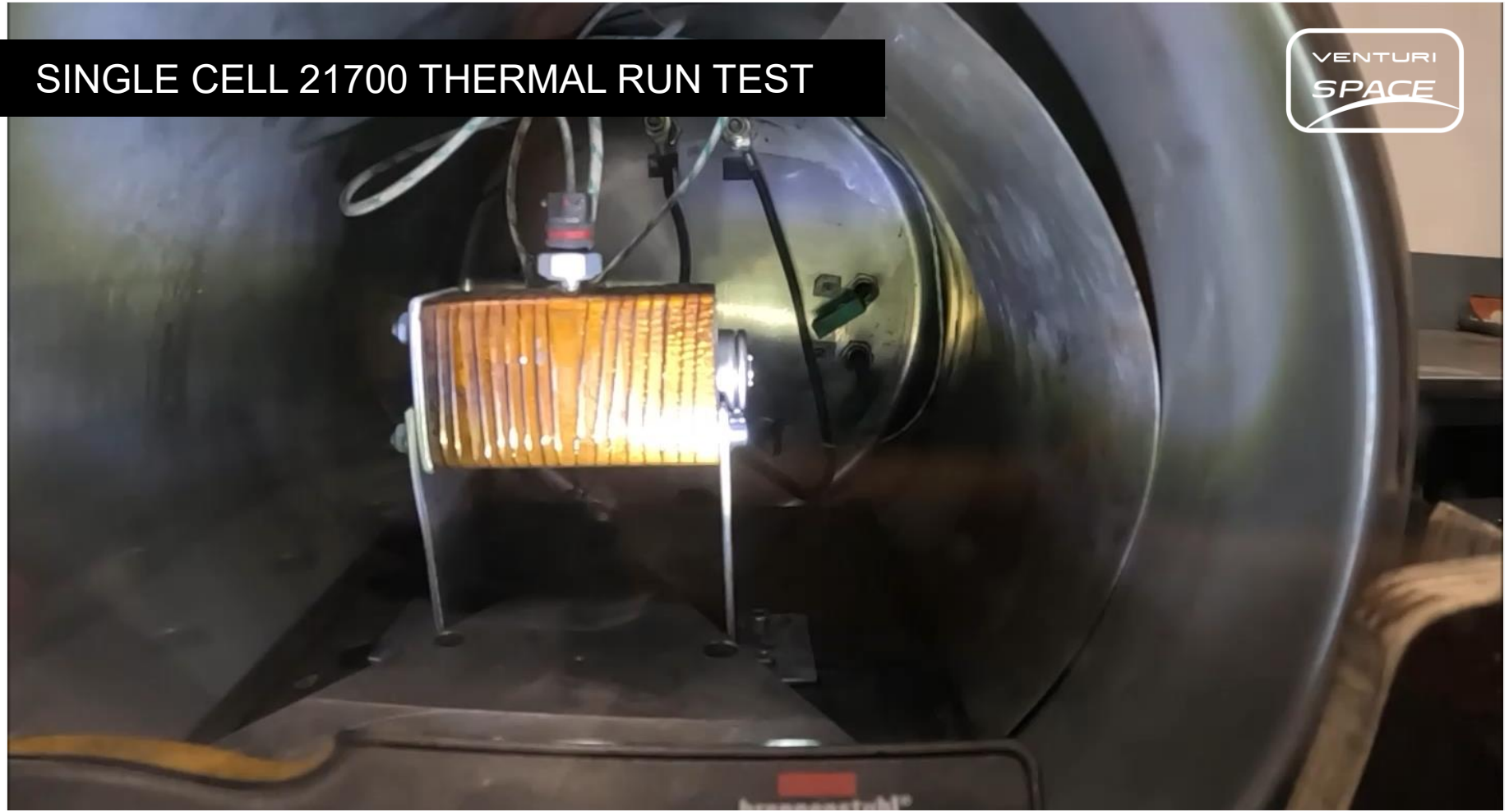
- Keep battery working after a TR

- 2 faults tolerant against catastrophic failures

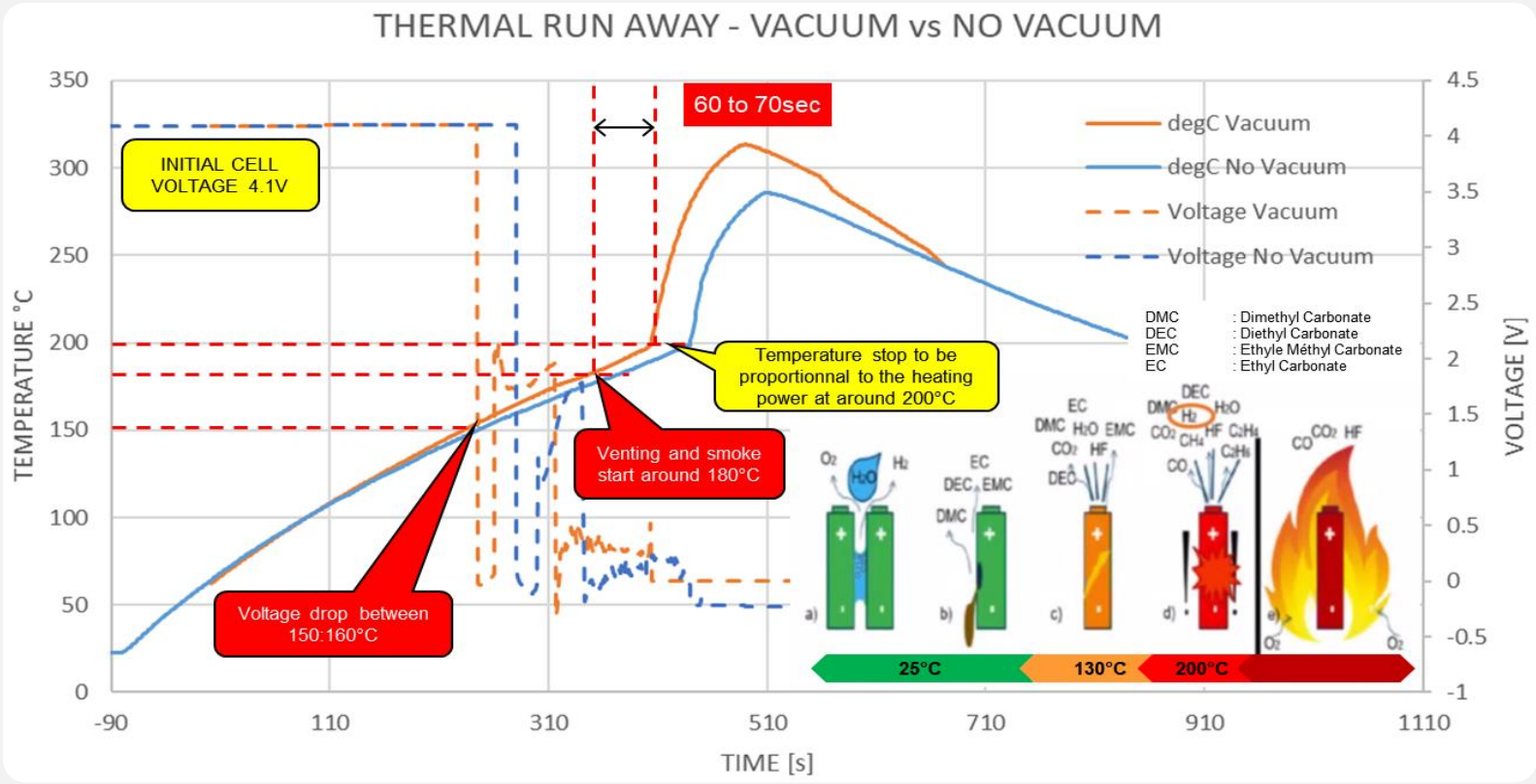
DEVELOPMENT TEST



SINGLE CELL 21700 THERMAL RUN TEST

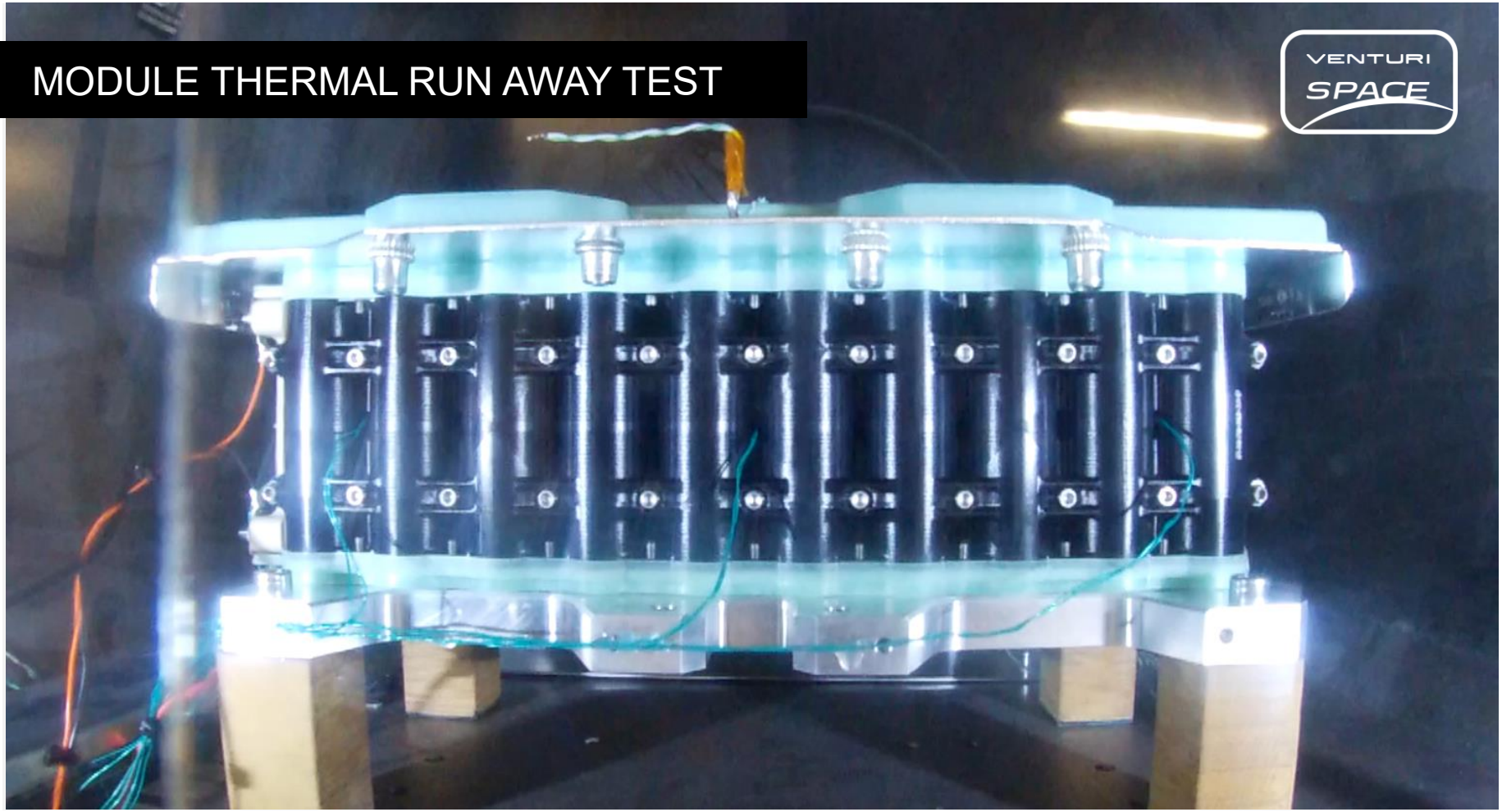


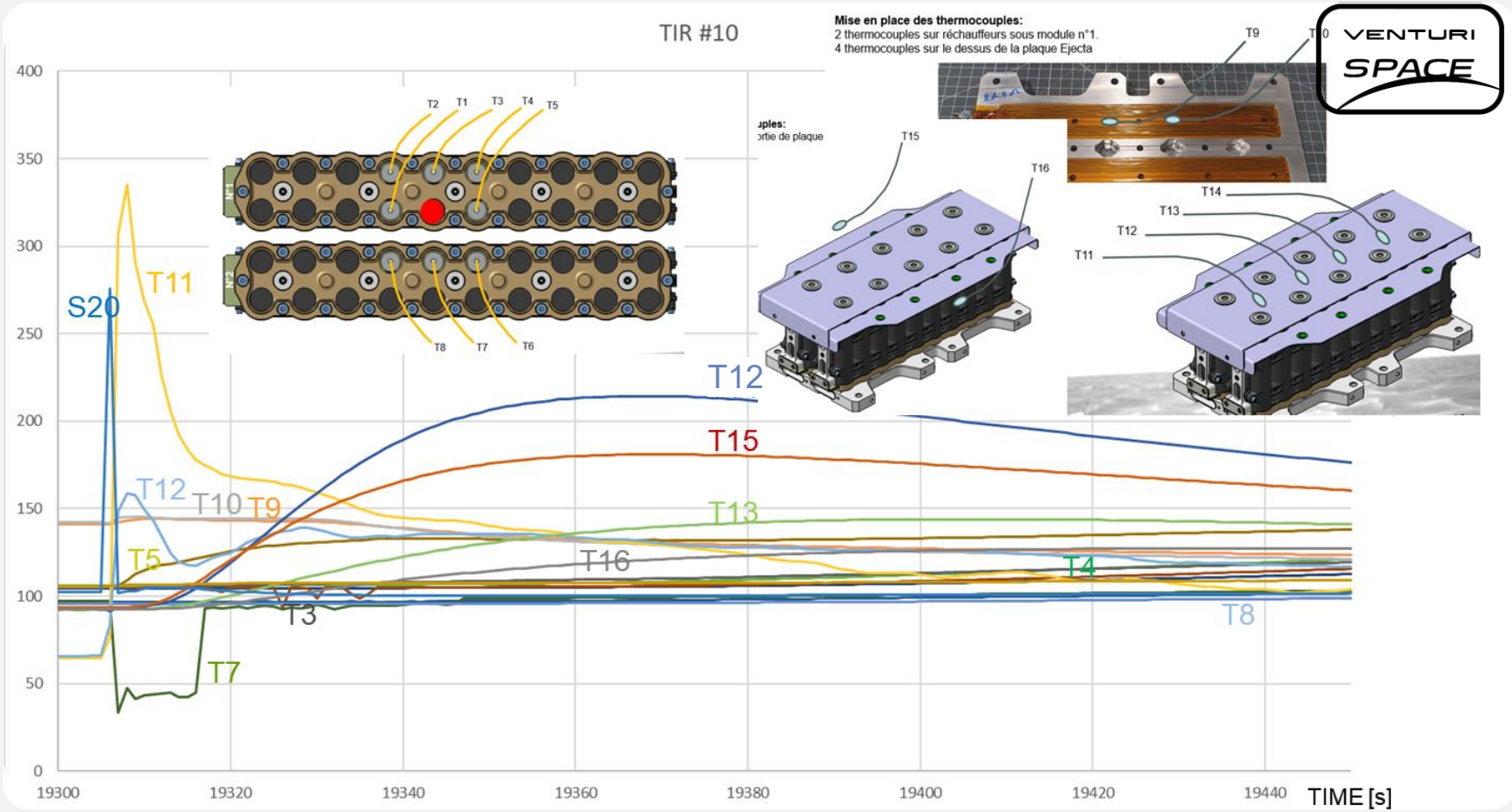
SINGLE CELL 21700 THERMAL RUN



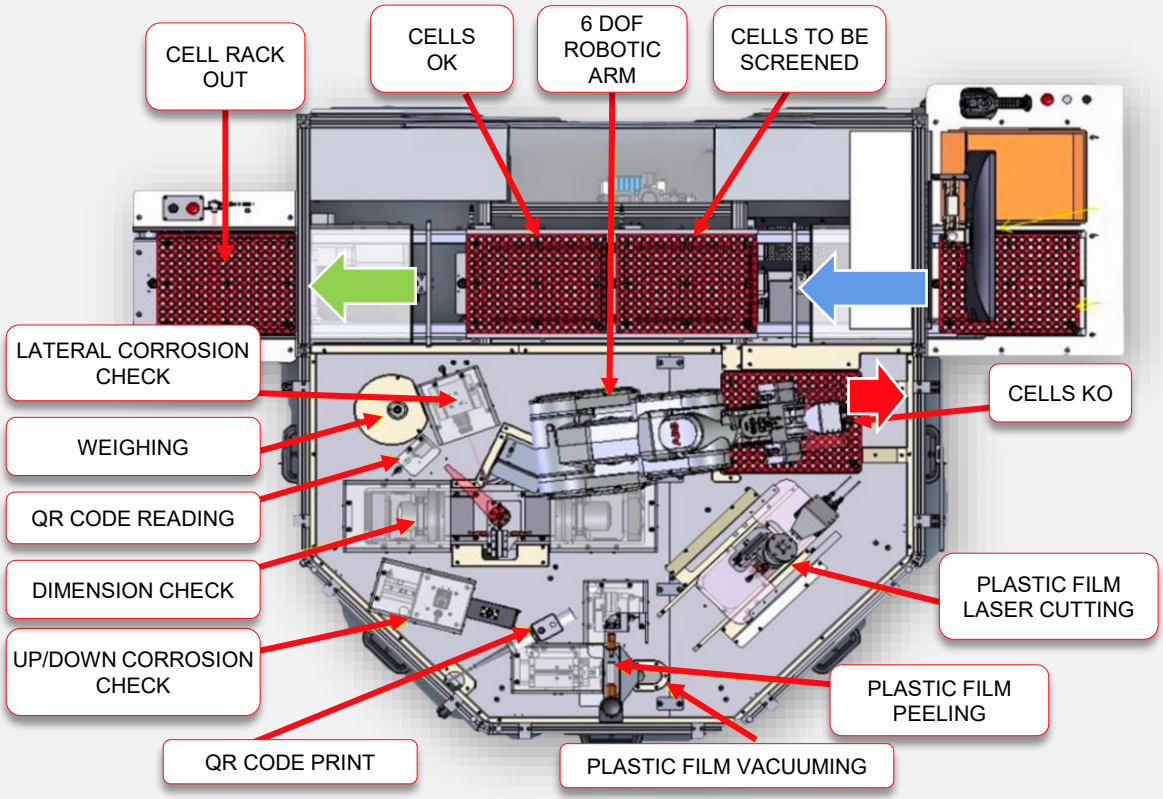
MODULE DESCRIPTION

MODULE THERMAL RUN AWAY TEST



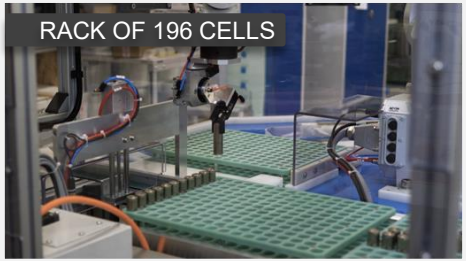

TIR #10
Mise en place des thermocouples:
2 thermocouples sur réchauffeurs sous module n°1.
4 thermocouples sur le dessus de la plaque Ejecta
VENTURI SPACE
TEMPERATURE [°C]
TIME [s]
S20
T11
T12
T10
T9
T5
T3
T7
T15
T13
T16
T4
T8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16

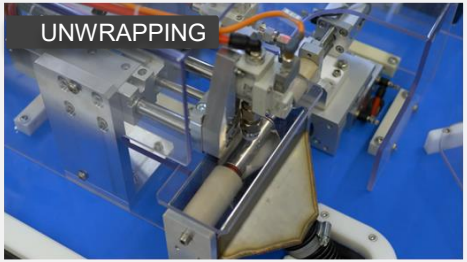
CELL SCREENING LINE PROCESS

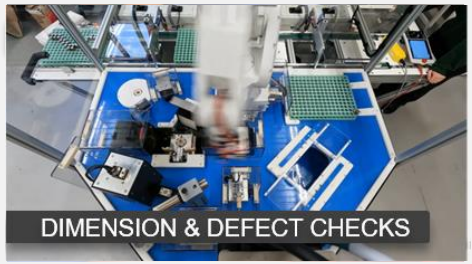


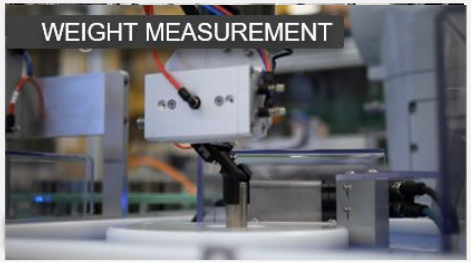
CELL SCREENING LINE PROCESS

CELL SCREENING LINE PROCESS









BATTERY ASSEMBLY LINE PROCESS

CELL SCREENING → STORAGE → CELL SCREENING → STORAGE

MODULE COMPONENTS PREPARATION → STORAGE → MODULE ASSEMBLY → BUS BAR WELDING → QUALITY CONTROL → STORAGE

PACK COMPONENTS PREPARATION → STORAGE → PACK ASSEMBLY → BUS BAR WELDING → ELECTRONIC INTEGRATION → QUALITY CONTROL → THERMAL INSULATION ASSEMBLY → ACCEPTANCE TEST → STORAGE → DANGEROUS GOOD PACKAGING PREPARATION

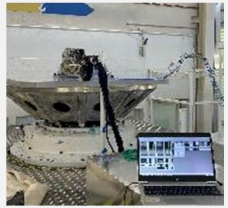
ISO 8 Clean Room
AS9100 certification planned Feb 2026





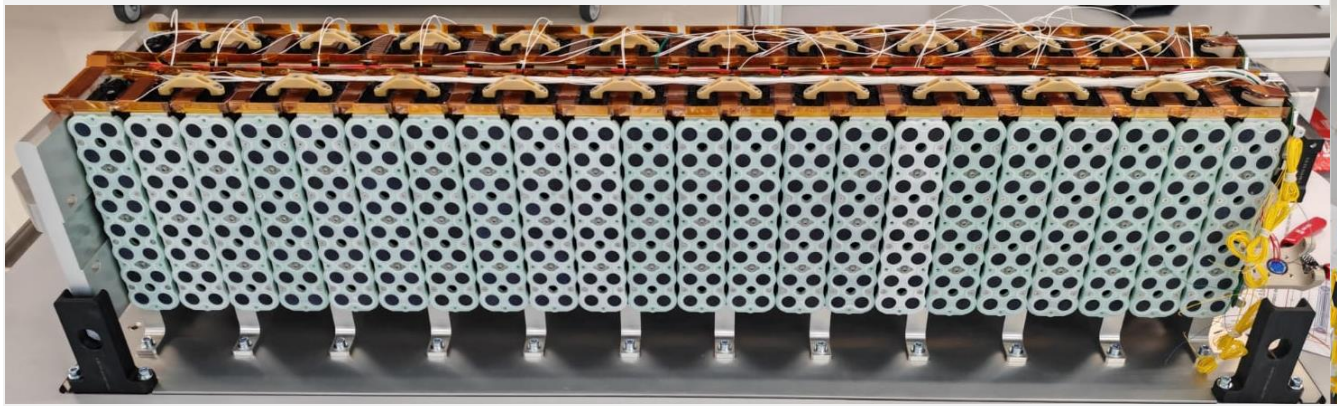




FIRST BATTERY ENGINEERING MODEL - 2025

- ✓ Charge/discharge test
- ✓ Shock tests (Falcon Heavy)
- ✓ Vibration test (JSC 20793)
- ✓ TVAC (-170°C)



MOON

FLIP

WIDTH 1.54 m
LENGTH 2.32 m
HEIGHT 2.00 m
WEIGHT 450 kg
WHEELS 930mm

FLEX

WIDTH 3.17 m
LENGTH 4.20 m
HEIGHT 3.63 m
WEIGHT 1400 kg
WHEELS 930mm

MONA LUNA

WIDTH 1.64 m
LENGTH 2.50 m
HEIGHT 2.77 m
WEIGHT 750 kg
WHEELS 930 mm

MARS

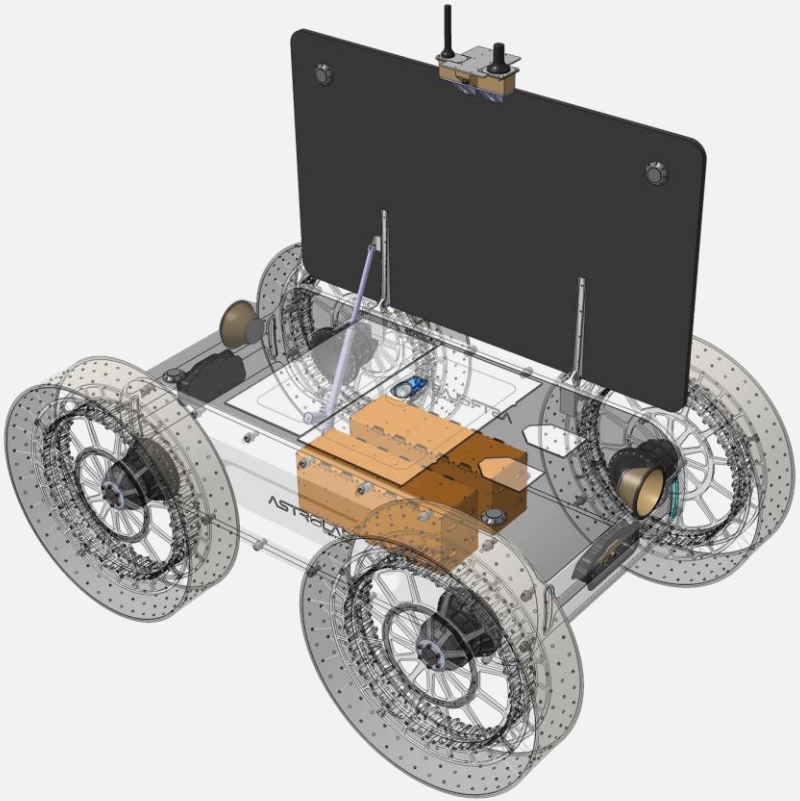
FLEX

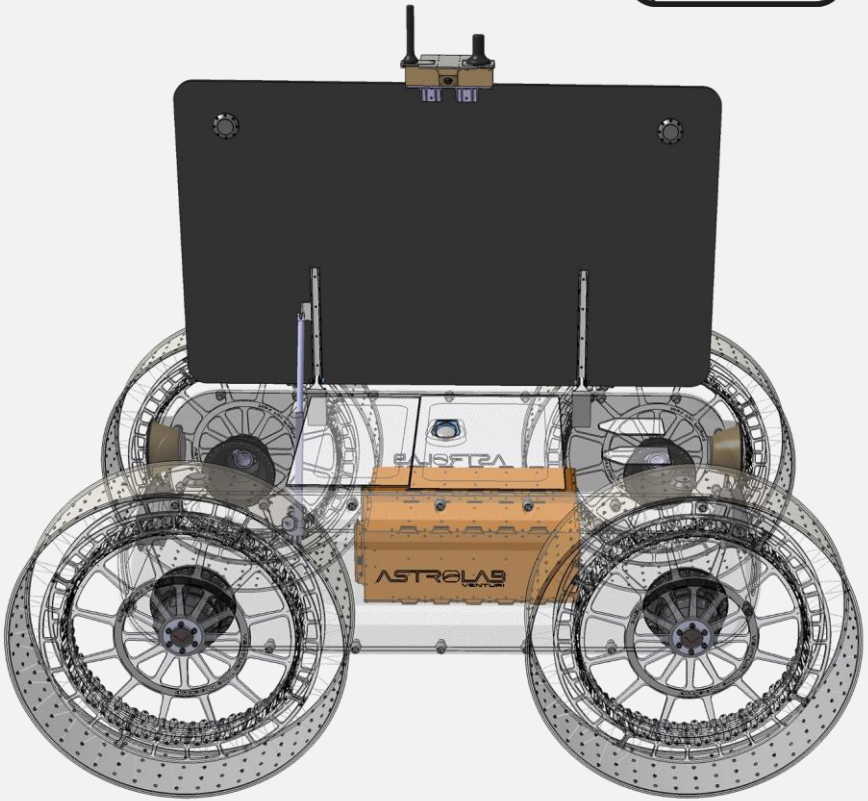
WIDTH 3.72 m
LENGTH 3.58 m
HEIGHT 2.84 m
WEIGHT 2000 kg
WHEELS 630 mm

LAUNCH OPENING WINDOW

MID 2026	FLEX-C STARSHIP MOON LANDING DEMO FLEX-LTVS (CREWED MISSION) ARTEMIS 5	ARGONAUT MOON LANDING DEMO 2030	TBD

FLEX INNOVATION PLATFORM





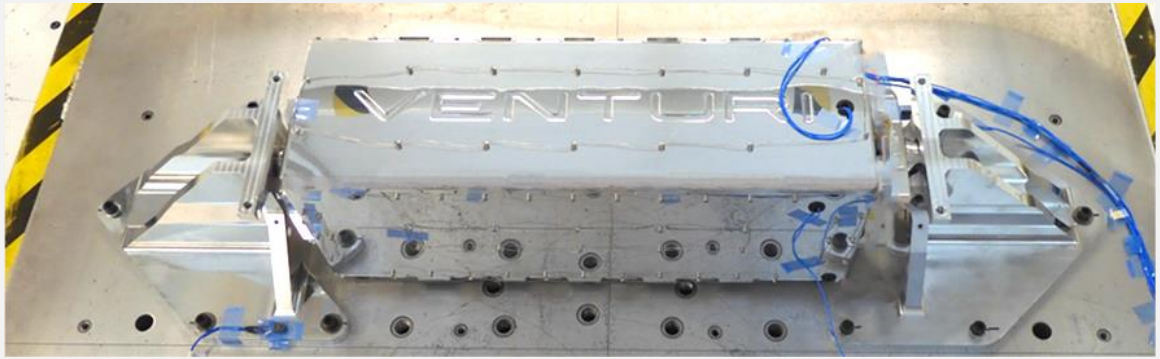
FLIP - FLIGHT BATTERIES

Venturi Space Teams developped, produced and qualified the battery packs

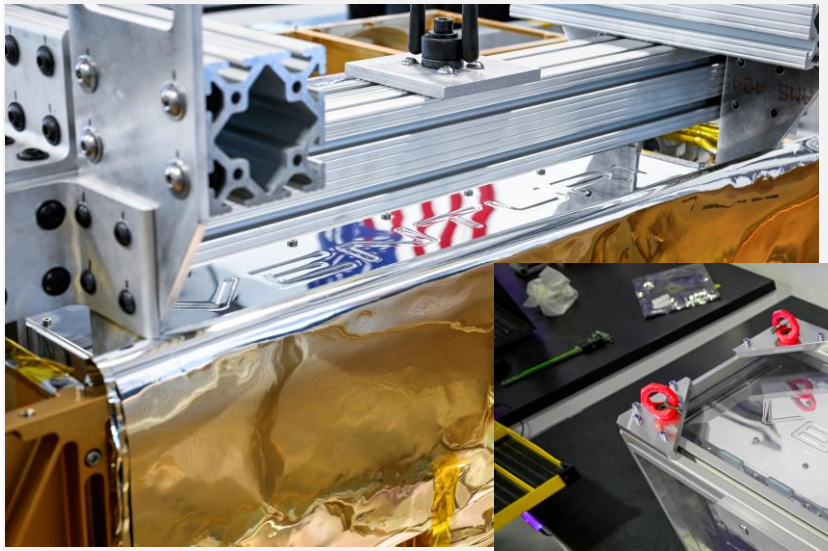
Cells format	: 21700
Energy	: 6.2 kWh
Weight Energy Density	: 126 Wh/kg
Volumetric Energy Density	: 149 Wh/L
Produced	: qty 6 Flights june 2025

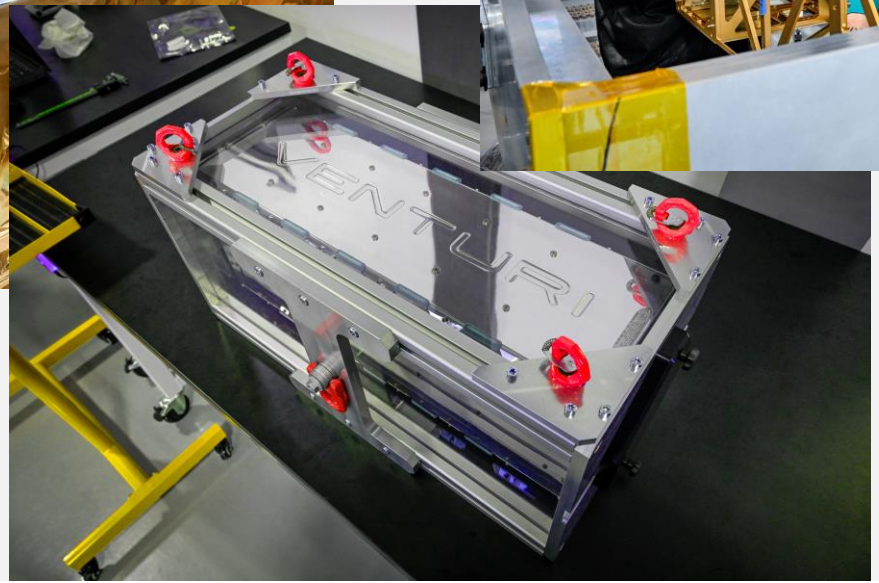
Cells Monitor Unit and Battery Distribution Unit integrated within the battery packs

- Module voltage & temperature monitoring
- Pack voltage and current monitoring
- Module balancing
- Power bus switch

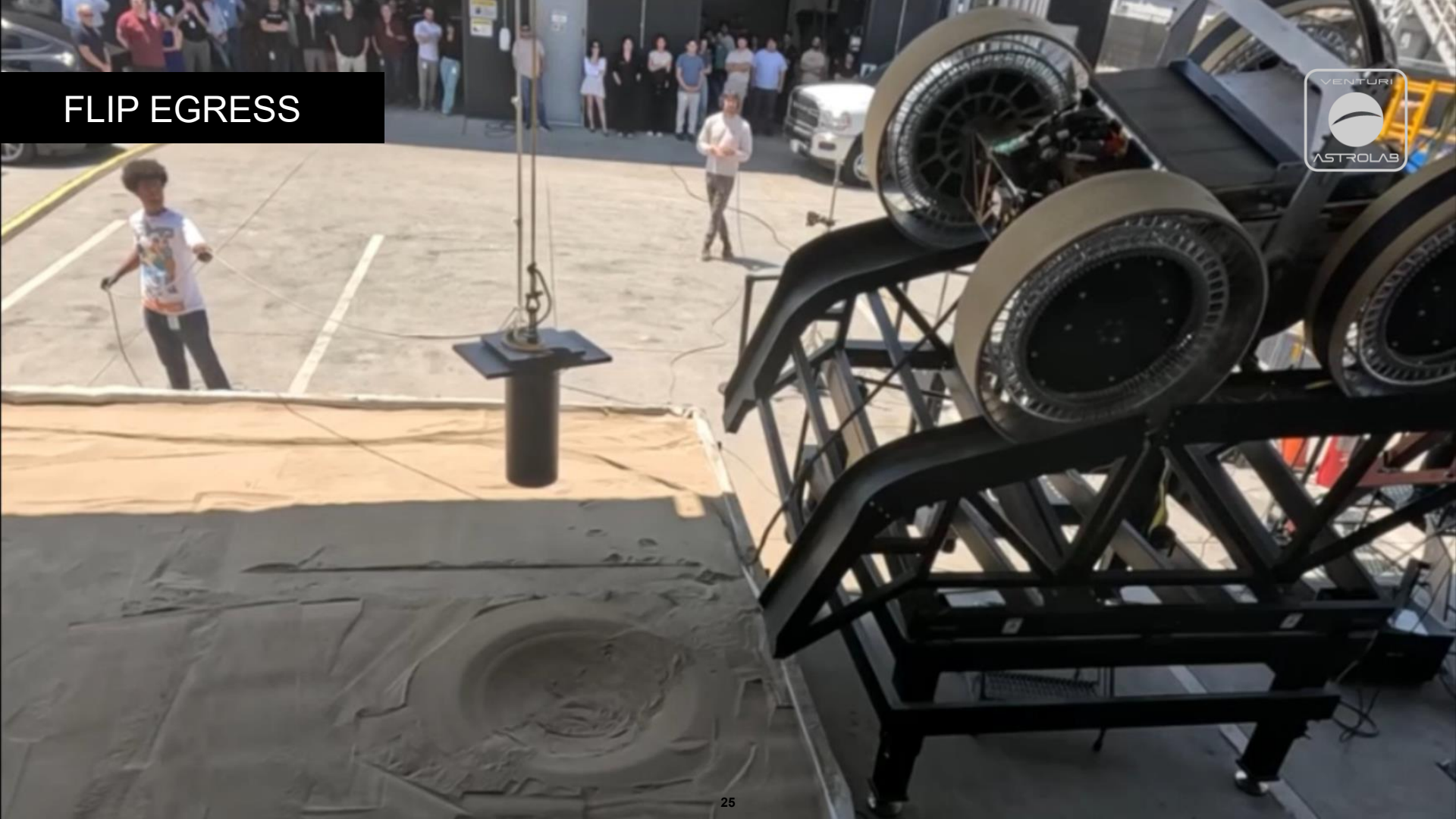


FLIP - FLIGHT BATTERIES

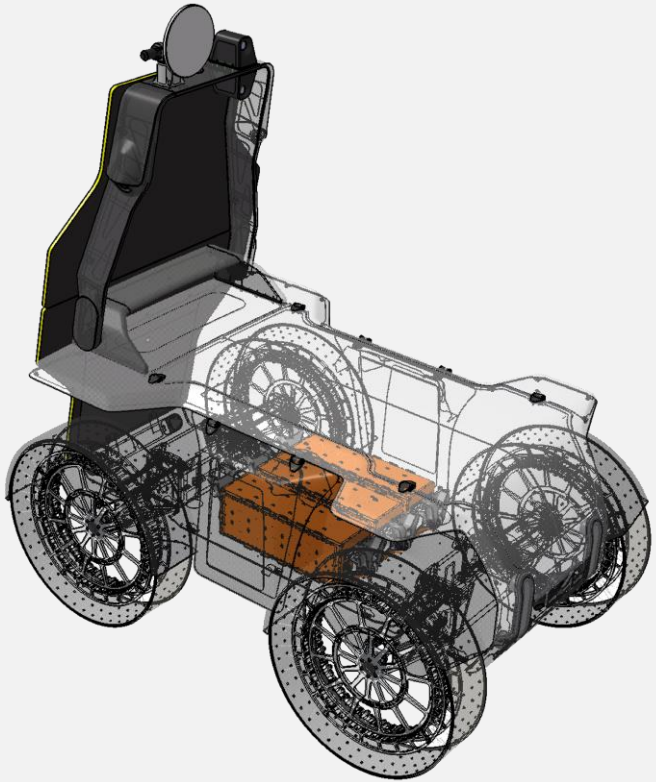


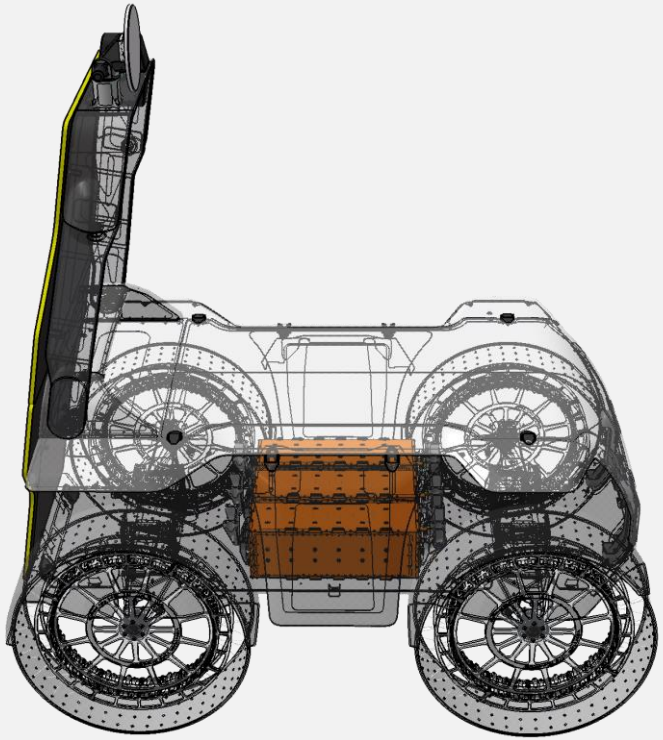


FLIP EGRESS



MONA LUNA · BREAD BOARD





MONA LUNA - 32P13S BATTERIES

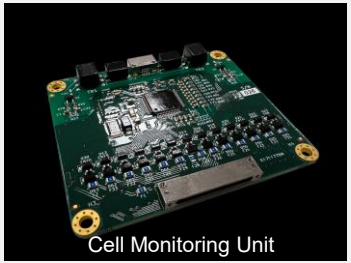
Venturi Space Teams developped, produced and qualified the batteries, the electronic boards and the software

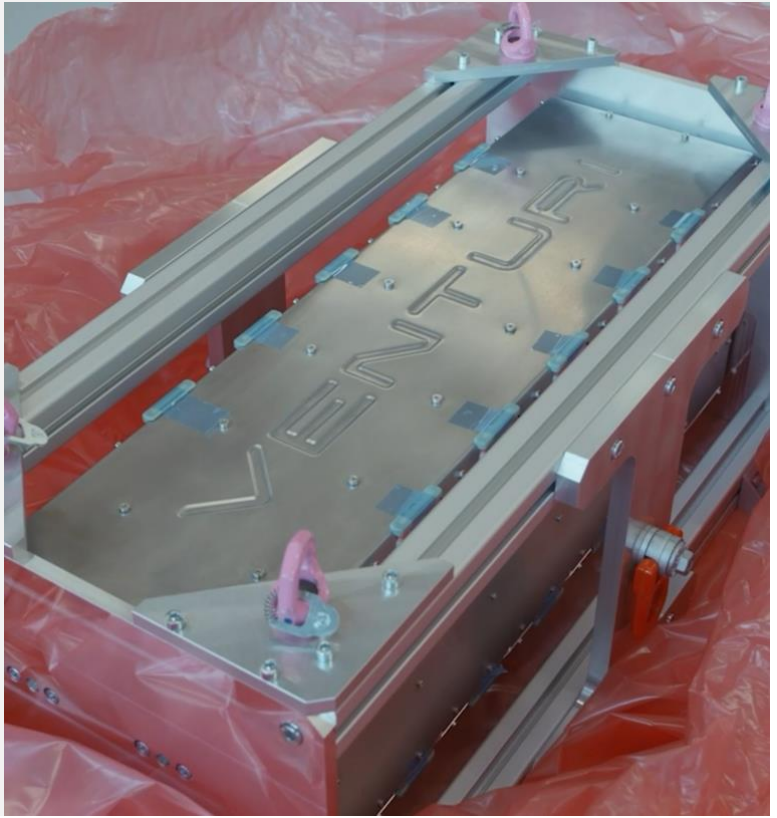
Cells format	: 21700	Energy	: 6.7 kWh
Voltage range	: 35.1V to 54.6V	Specific energy	: 126 Wh/kg
Weight	: 53 kg	Produced	: qty 3 Oct 2025

- Battery Management and health Supervision
- Power bus switch control (Pos, Neg, pre-Charge)
- Cells / Battery voltage, current and temperature monitoring
- Battery electrical insulation monitoring
- Re-armable Overcurrent protection

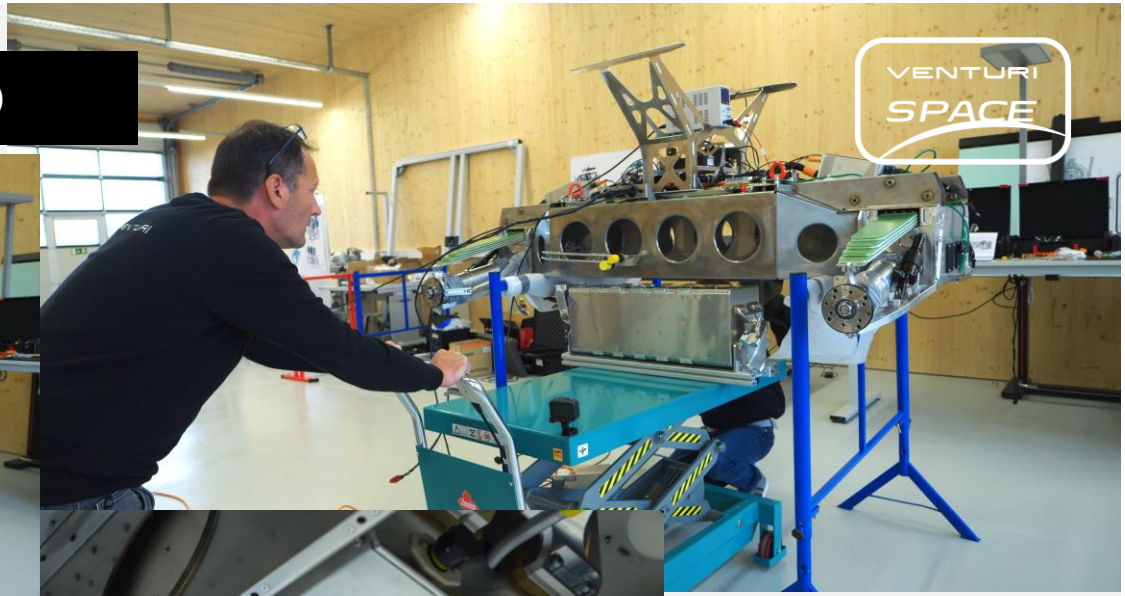

Battery Management Unit


Battery Disconnect Unit


Cell Monitoring Unit



MONA LUNA · BREAD BOARD

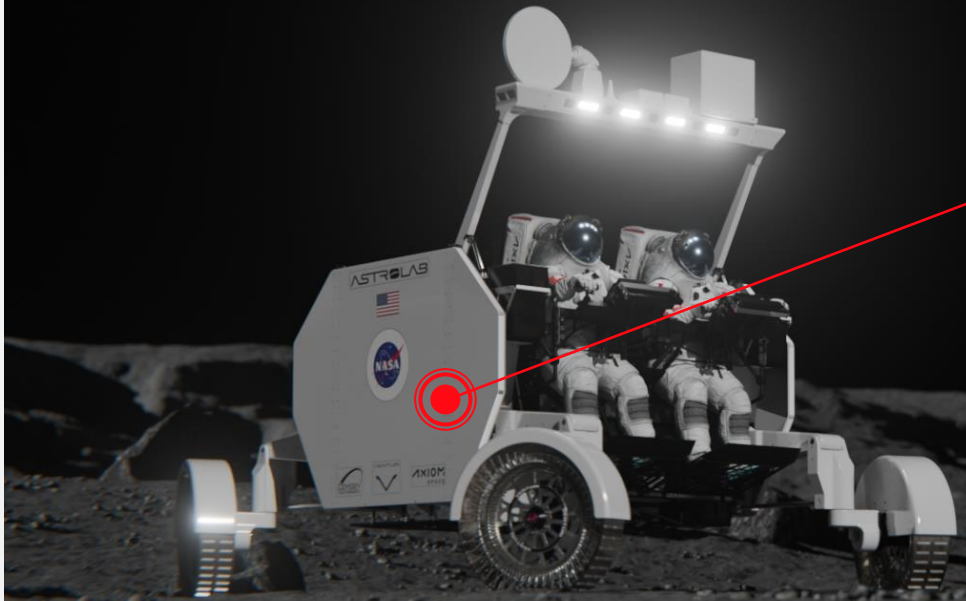


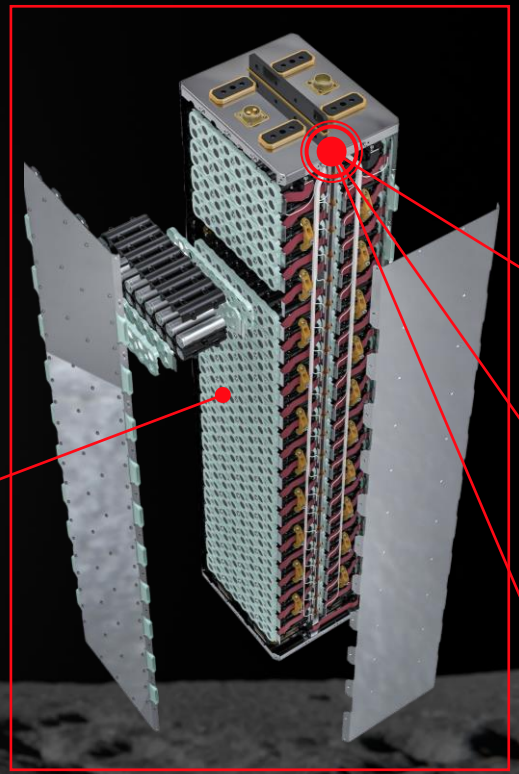
MONA LUNA · TESTS AT ESA LUNA ANALOG FACILITY

FLEX-C · FLEX-LTVS · FLEX-MARS

Venturi Space development, production and qualification in USA & Europe

- Battery packs + BMU, BDU & CMU
- Wheels





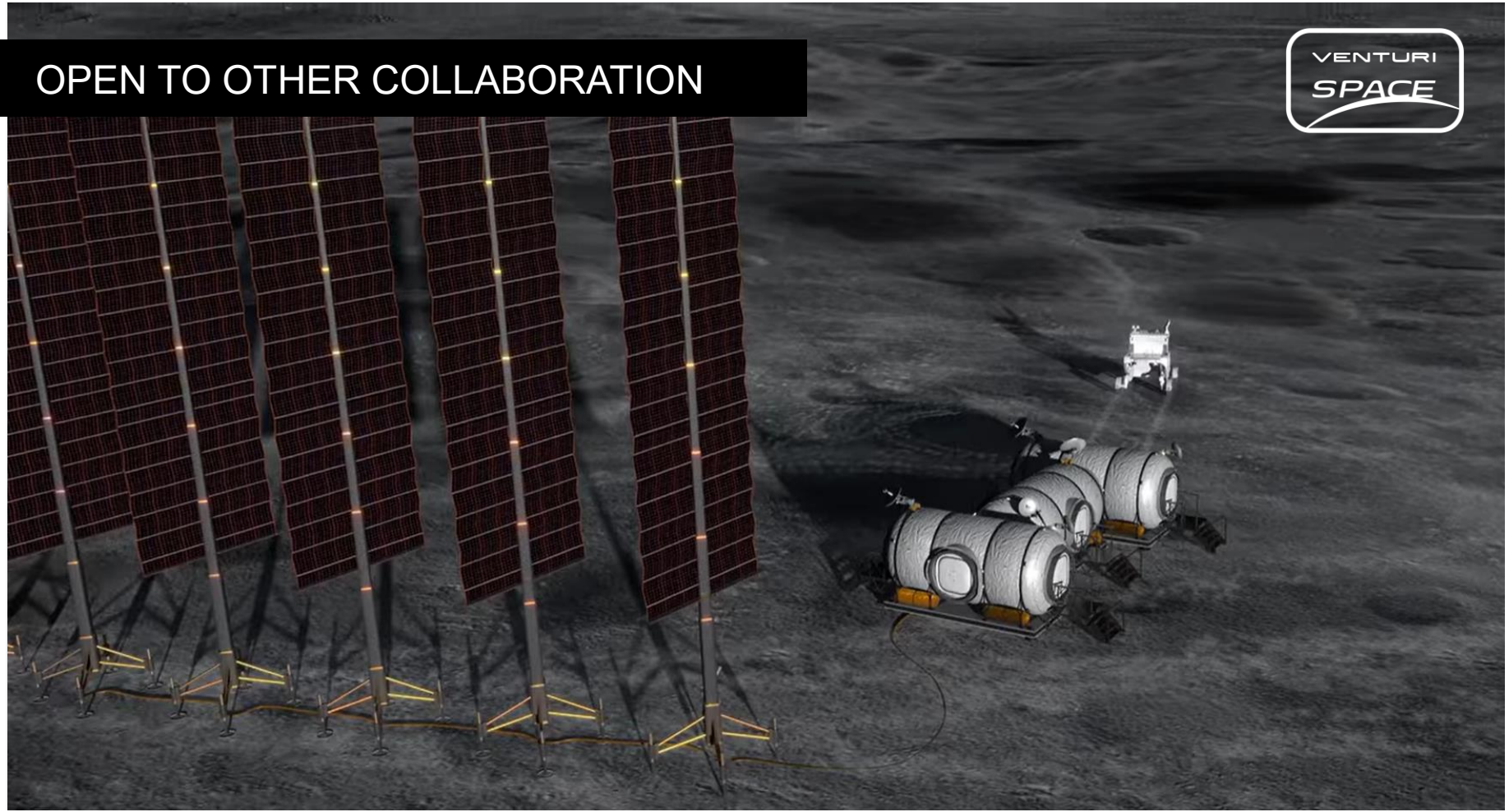
Battery Management Unit

On Development

Battery Distribution Unit

Cell Monitoring Unit

OPEN TO OTHER COLLABORATION



VENTURI *SPACE*