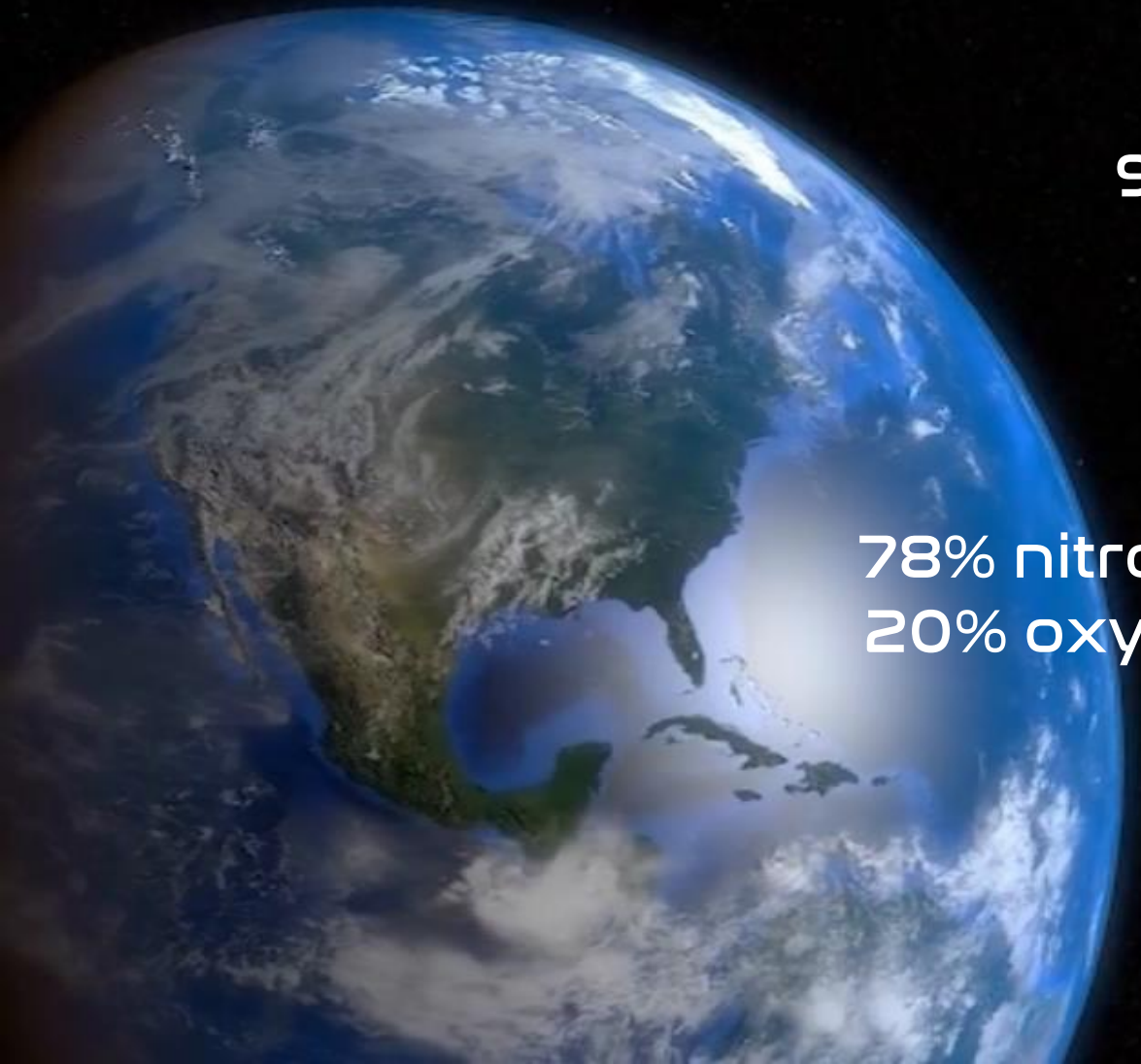
Martian Rover for Human Exploration

Earth and Mars Comparison



Gravity:

9.807m/s² 3.711m/s²

Average temperature

15°C -63°C

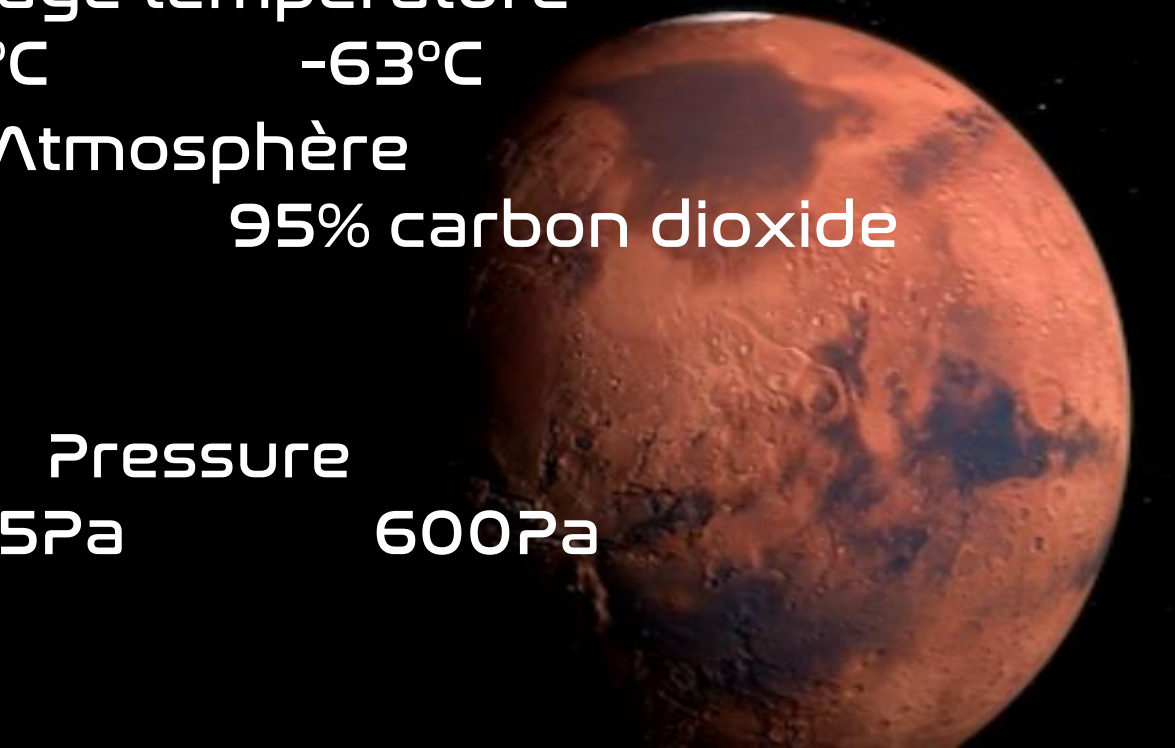
Atmosphère

78% nitrogen 95% carbon dioxide

20% oxygen

Pressure

101 325Pa 600Pa



Earth and Mars Comparison

Terrain:
Regolith
steep terrain
no water supply

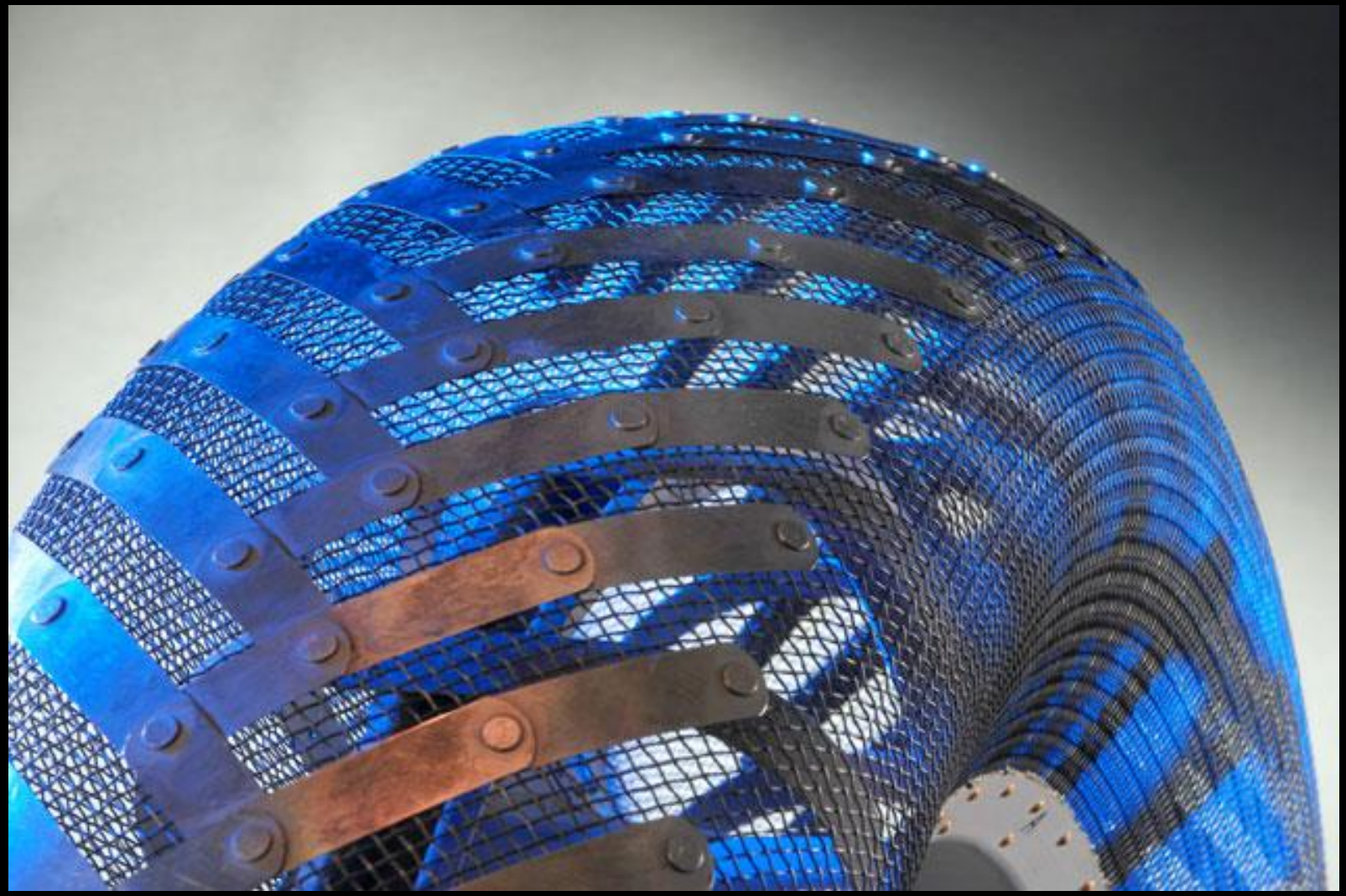
Solar Radiations

No help on Mars
Limited energy
100% autonomous

Specifications

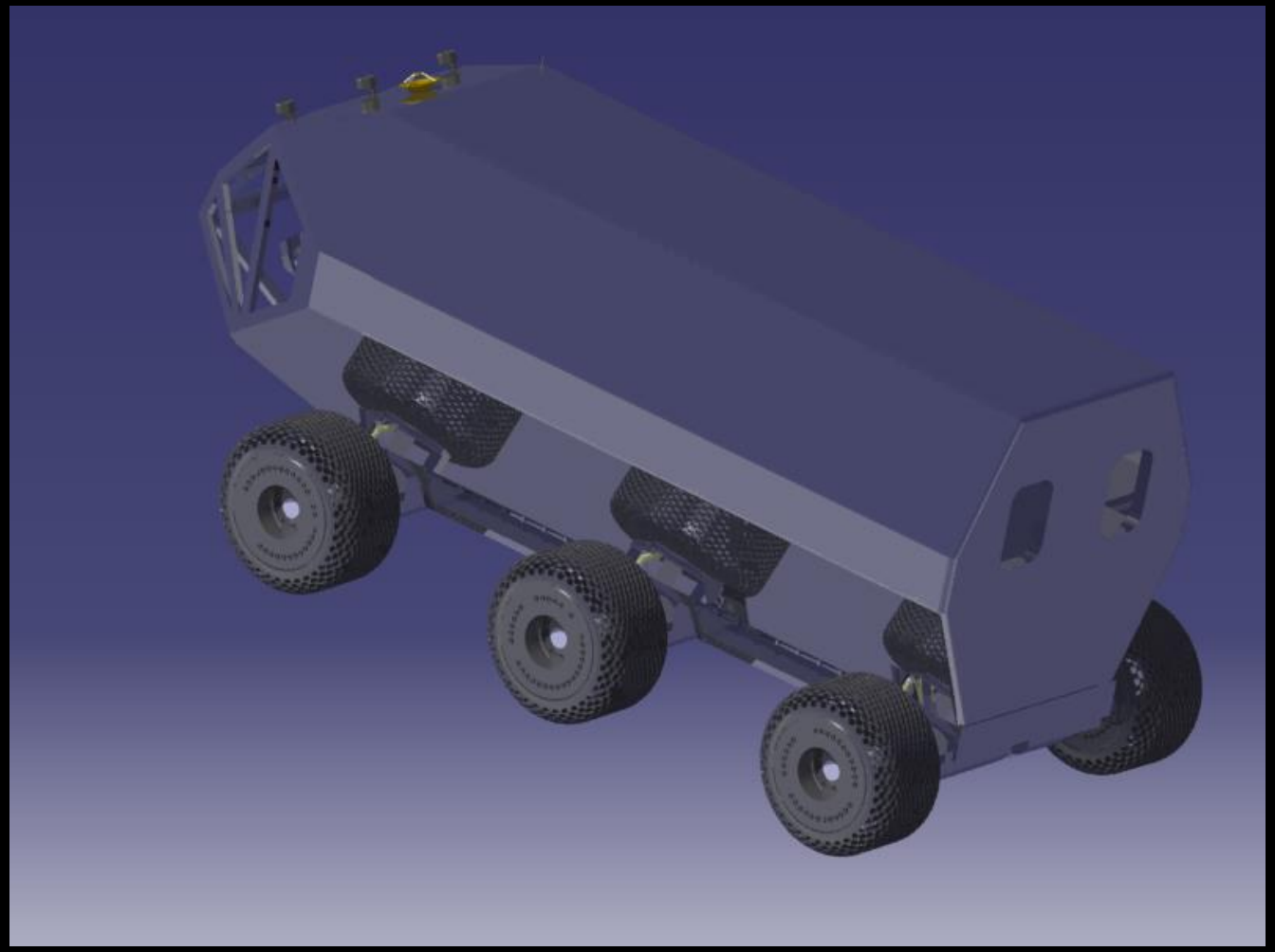
- Range of action = 200km
- Mass < 8T
- Autonomy > 15days
- All-land Rover and able to cross rocks over 50cm
- 2 Passengers and up to 6 in emergency mode
- Pressurized at 0.5 bars
- Overlapped conception & robust

Wheel’s technology



All credits to NASA

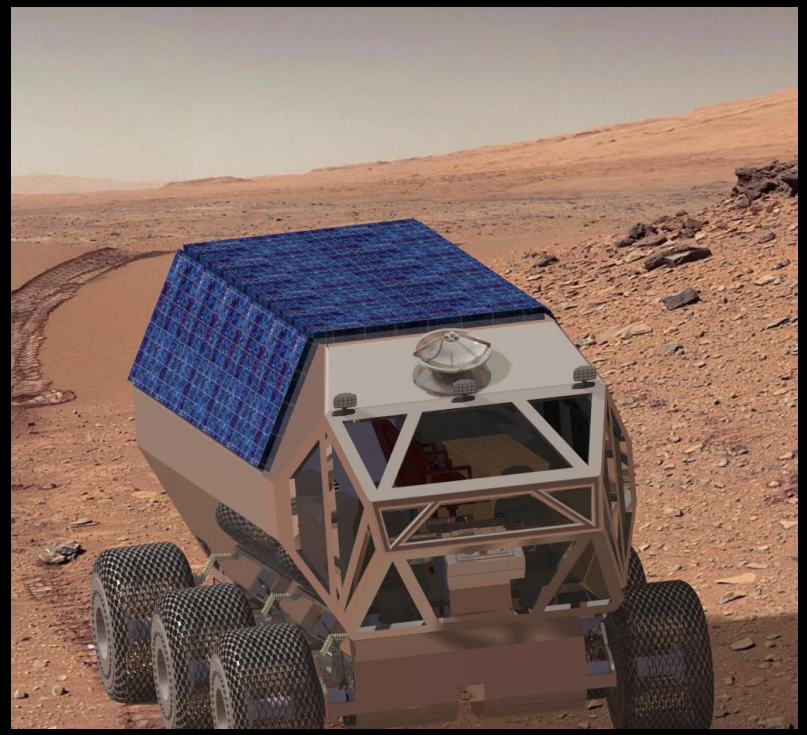
Martian Rover :

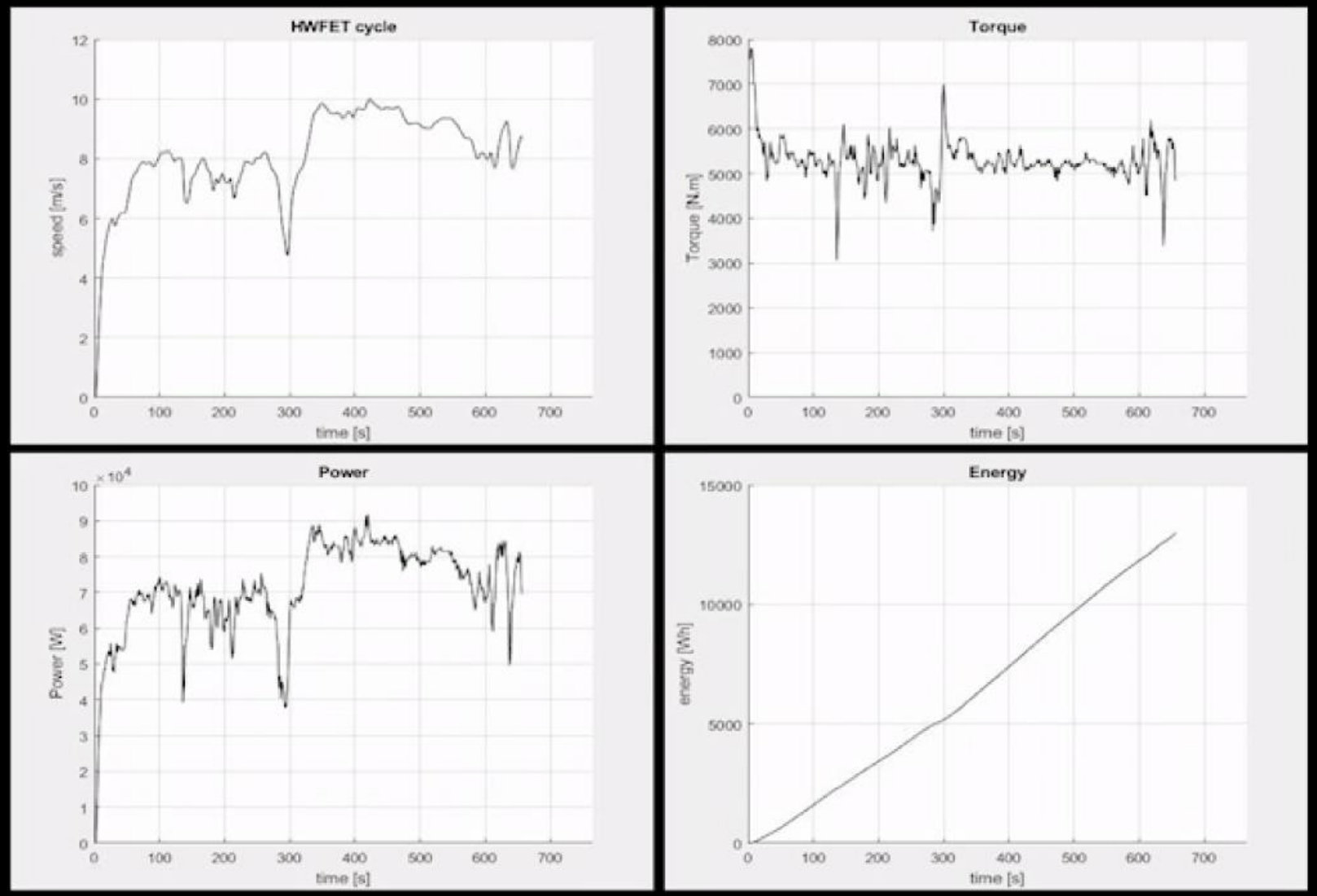


Simplified schematic of the wheel-motor couple

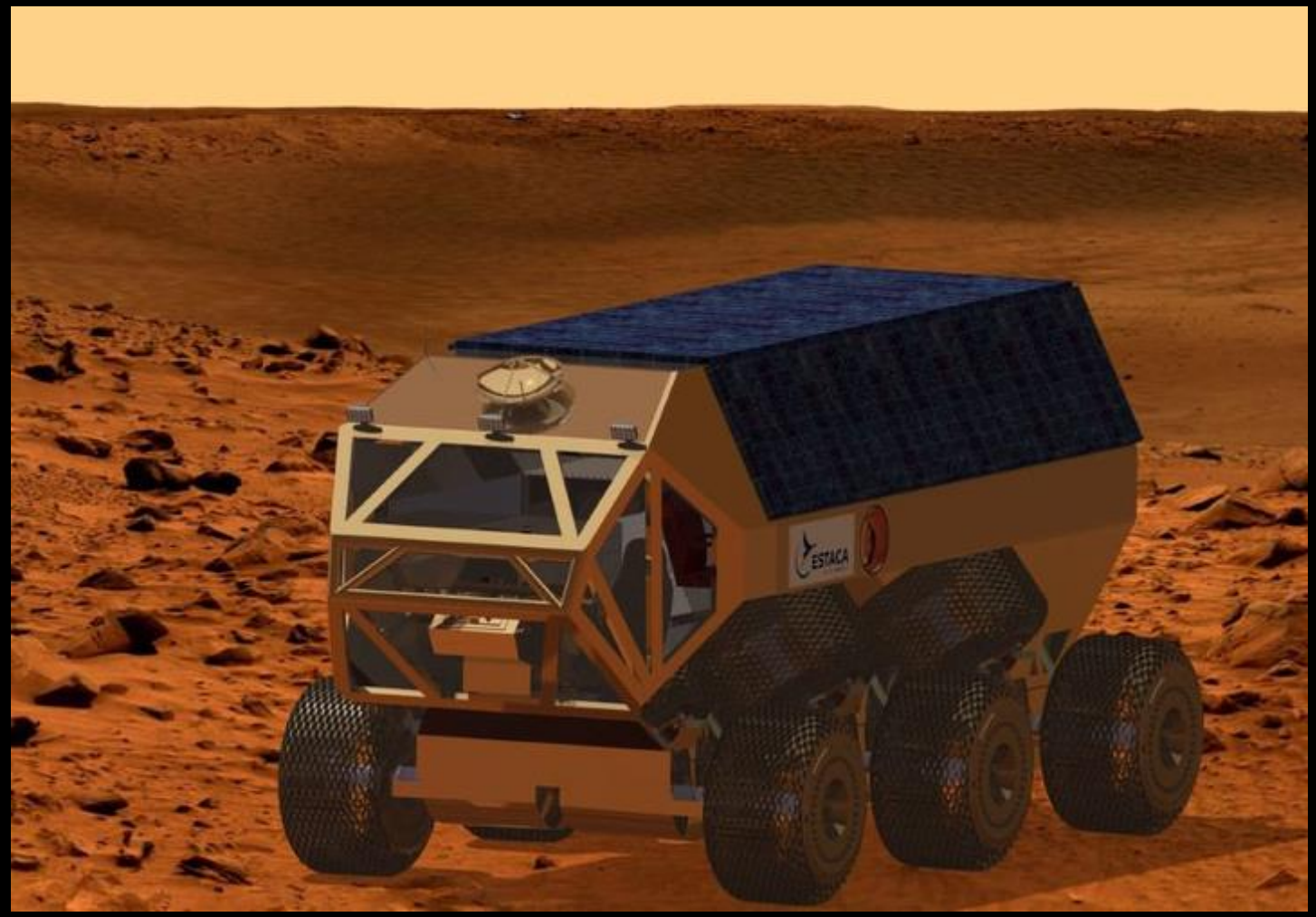
- Electric propulsion
- 1m20 diameter
- 6 wheels
- 36km/h max. speed

Computation





Selected configuration:



- Torque: 13470N.m
- Engine power: 180kW
- Energy: 970kWh
- Fail Ops/Fail Ops
- 28°: maximum slope

Life support

Life support systems

Robustness

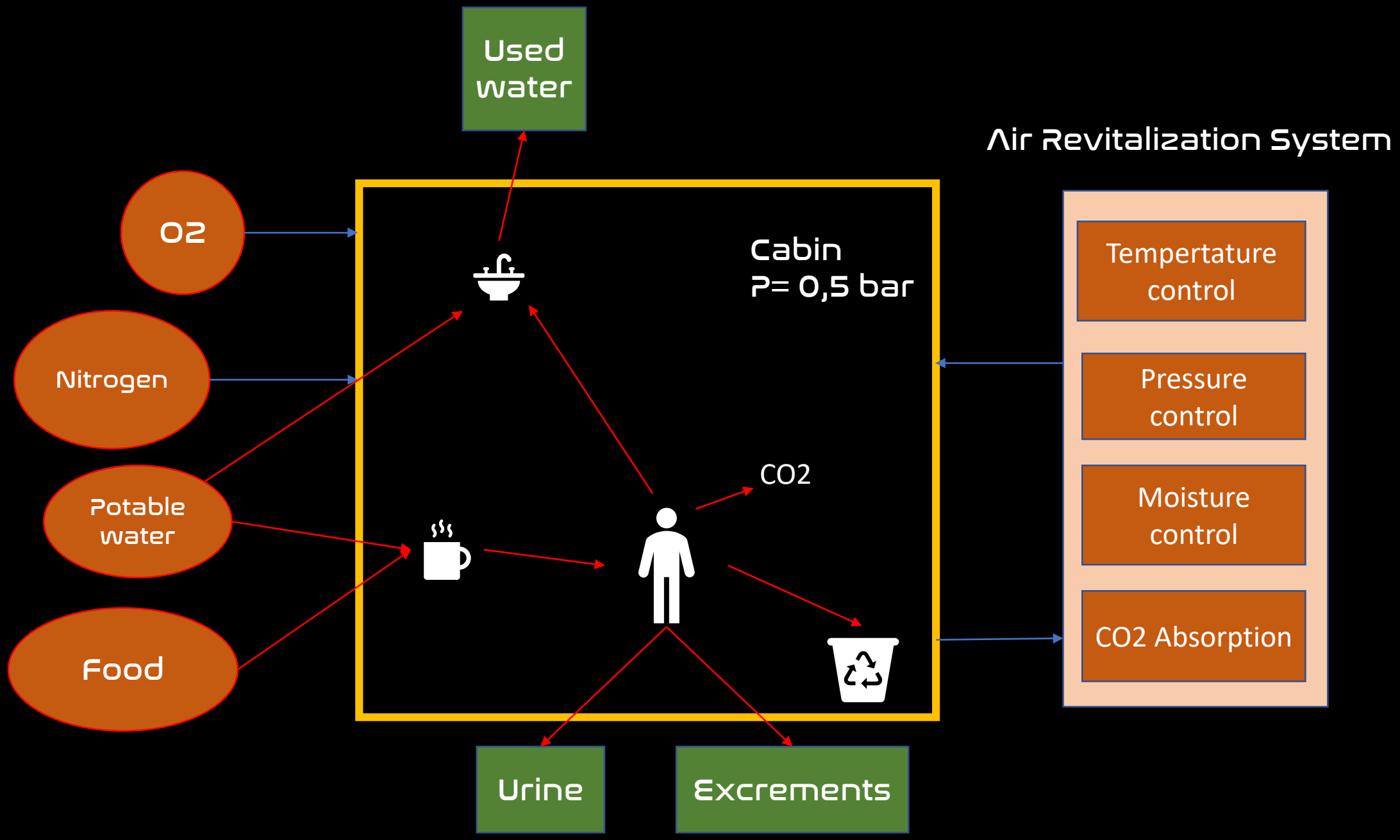
Efficiency

Low power consumption

Adapted for a small space

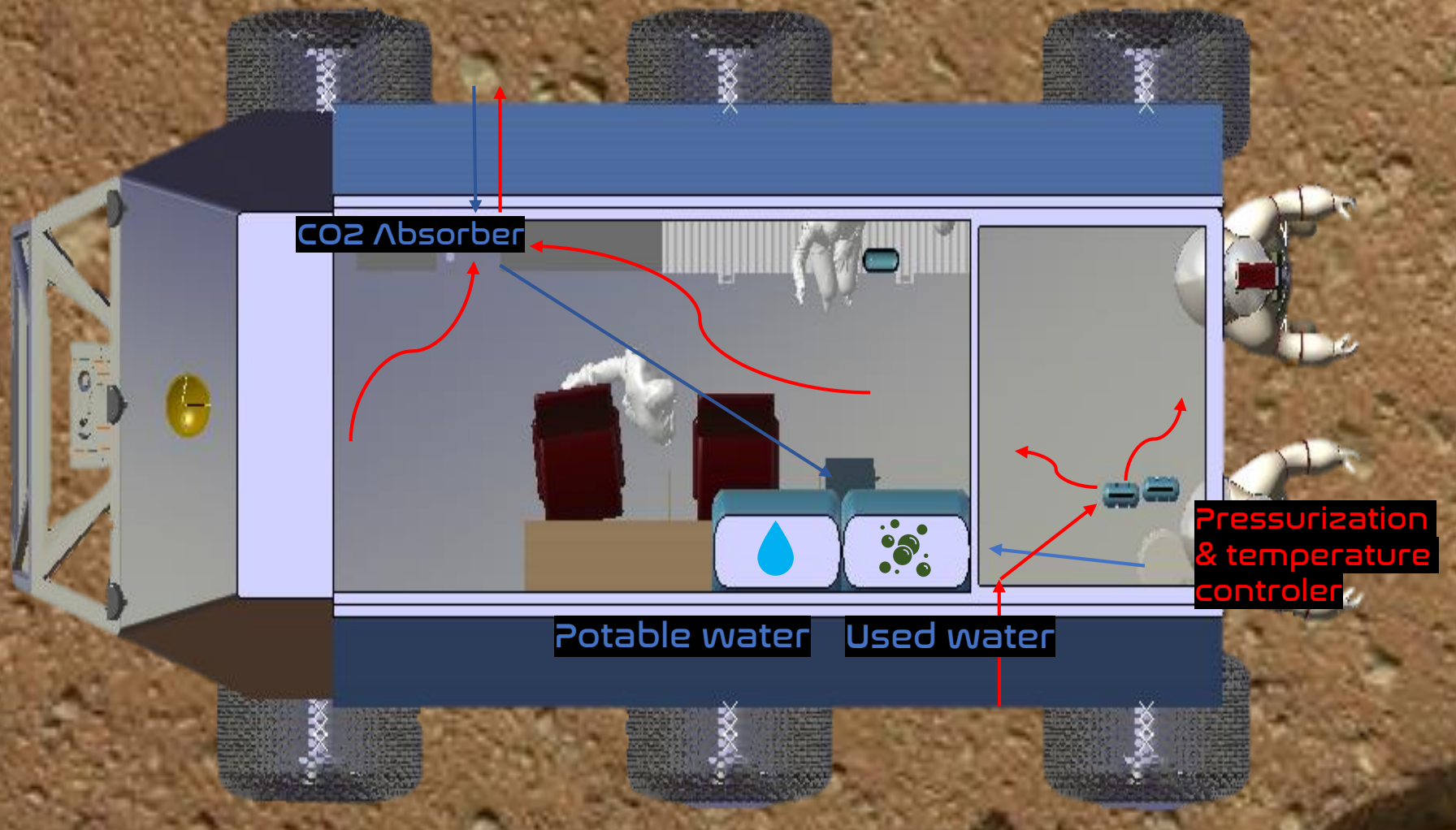
Reparable in emergency

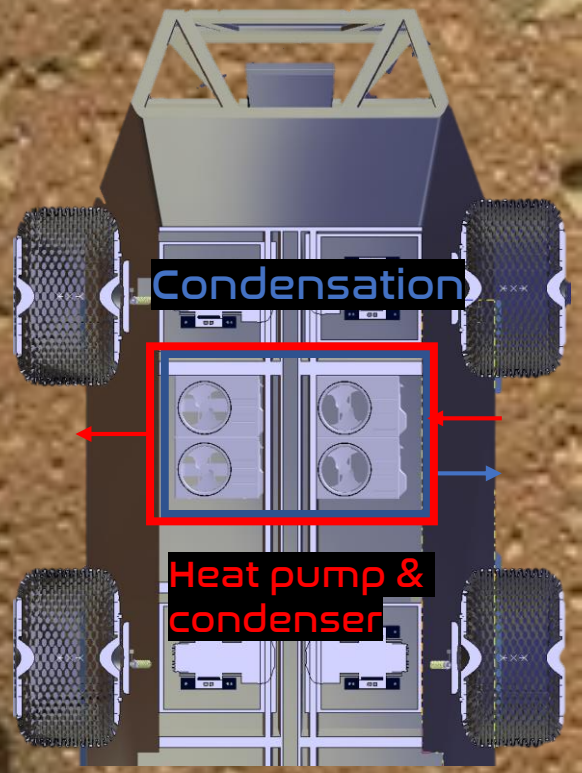
Easily maintainable

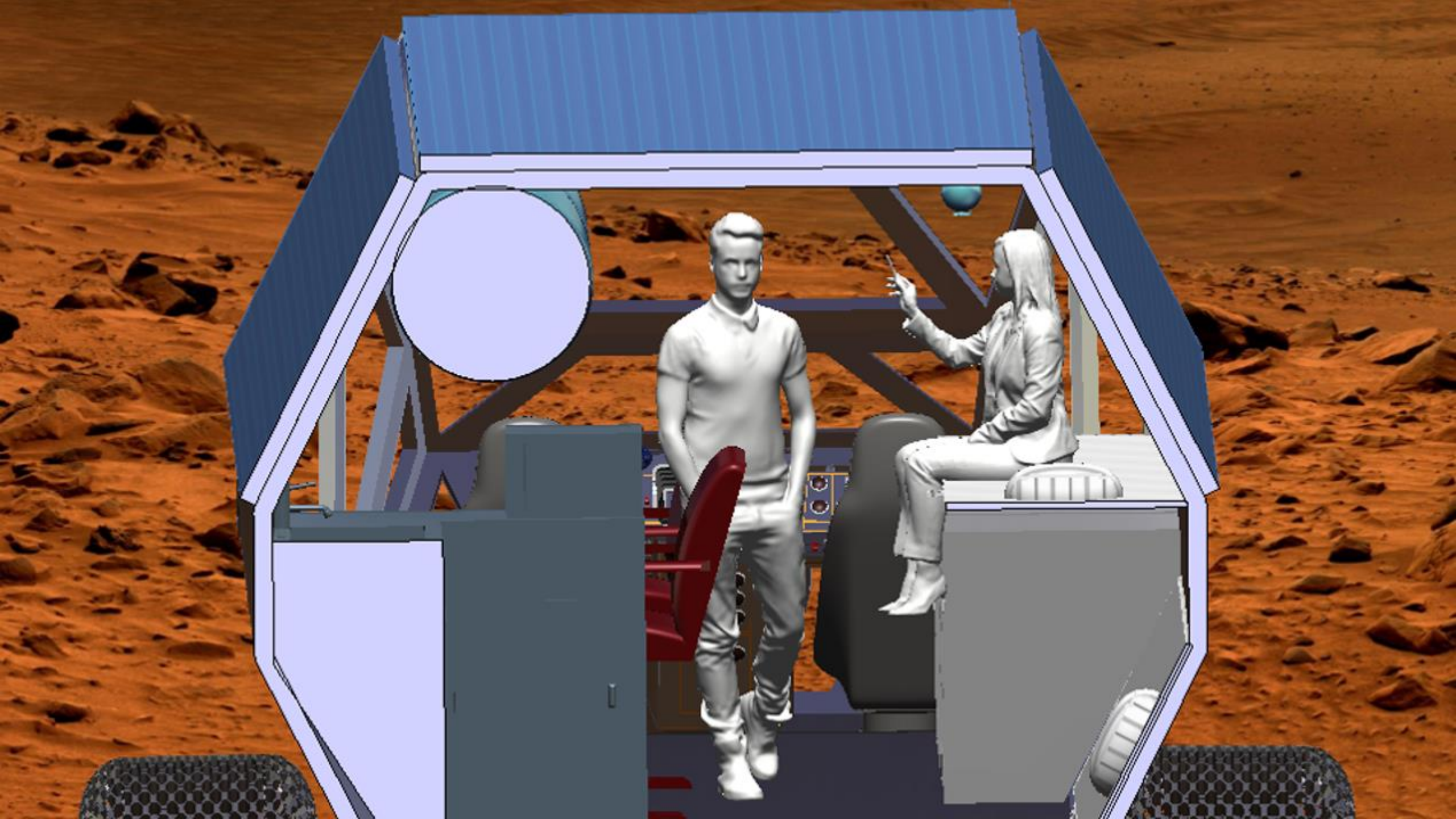

Used water
Air Revitalization System
O2
Nitrogen
Potable water
Food
Cabin
P= 0,5 bar
CO2
Tempertature control
Pressure control
Moisture control
CO2 Absorption
Urine
Excrements

Air Revitalization

Water systems





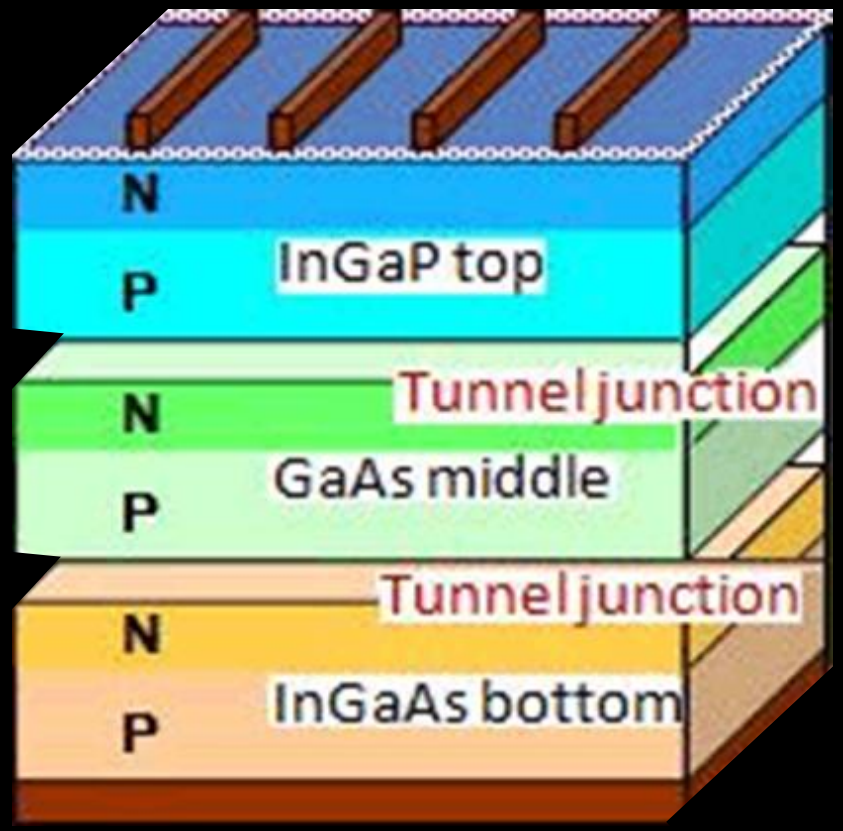


Energy Produced

Energy Needed Aboard

Area	What	maximum consomption (kWh)
Vital System	CO_2 & H_2O absorption, heat pump…	405
Wheels' Engines	6 wheels with an engine for each one	970
Scientific Equipment	on board computer, command system	125
Total		1500
Total with a 20% margin		1500 x 1.2 = 1800

Solar Energy : Multi Junction Pannels



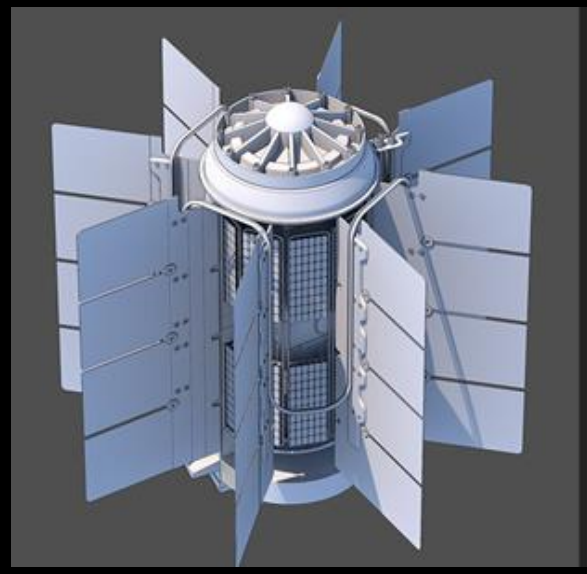
- 3 layers of semicapacitor
- Efficiency : 65%

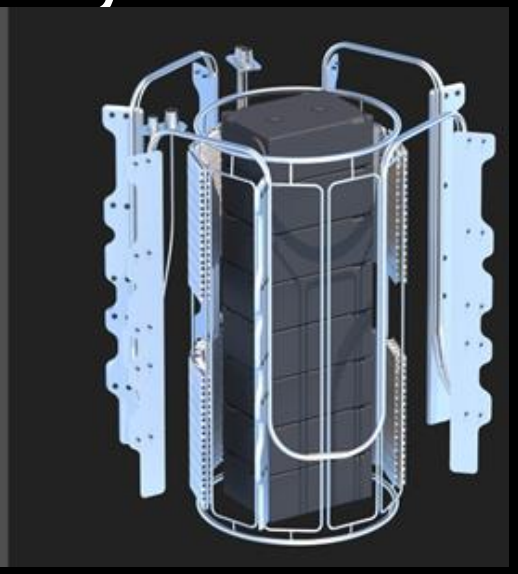
Solar Energy : Multi Junction Pannels

- Solar irradiation on Mars : 296 Wh/m^2
- Solar pannels surface : 15.4 m^2
- Efficiency : 65%

510 kWh generated for the mission

RTG (Radioisotope Thermoelectric Generator)

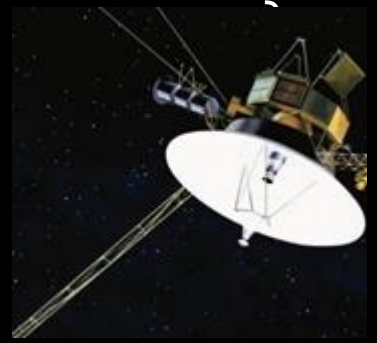




- High Reliability
- Efficiency Too Low

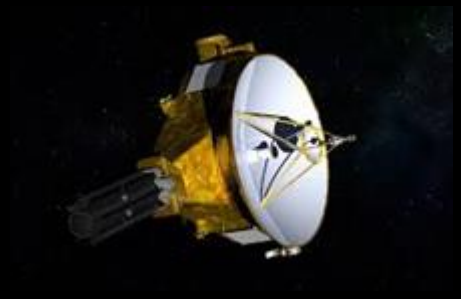
RTG has been used for the supply of energy of many probs :

Voyager 1 & 2 (extra solar

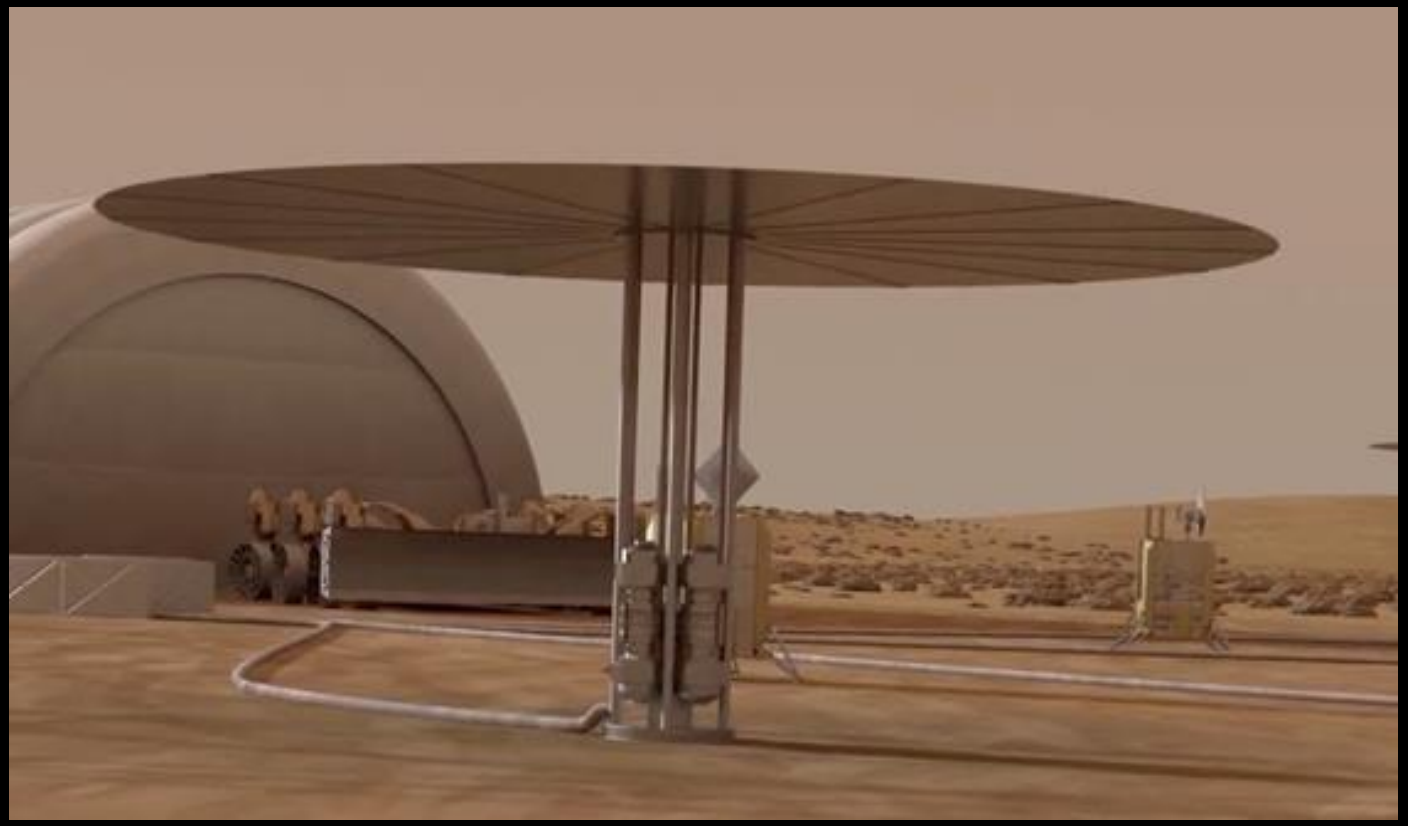


Cassini (Saturn)

New Horizon (Pluton)



Kilopower



Pros

- Enough Energy Produced

Drawbacks

- Very Large
- Very Heavy (1500kg)
- Health Risk (gamma ray : death radiations

Stock Energy

Lithium-Ion Batteries

4 batteries

Masse of each batterie : 310 kg

Volume of each batterie : 0.34 m^3

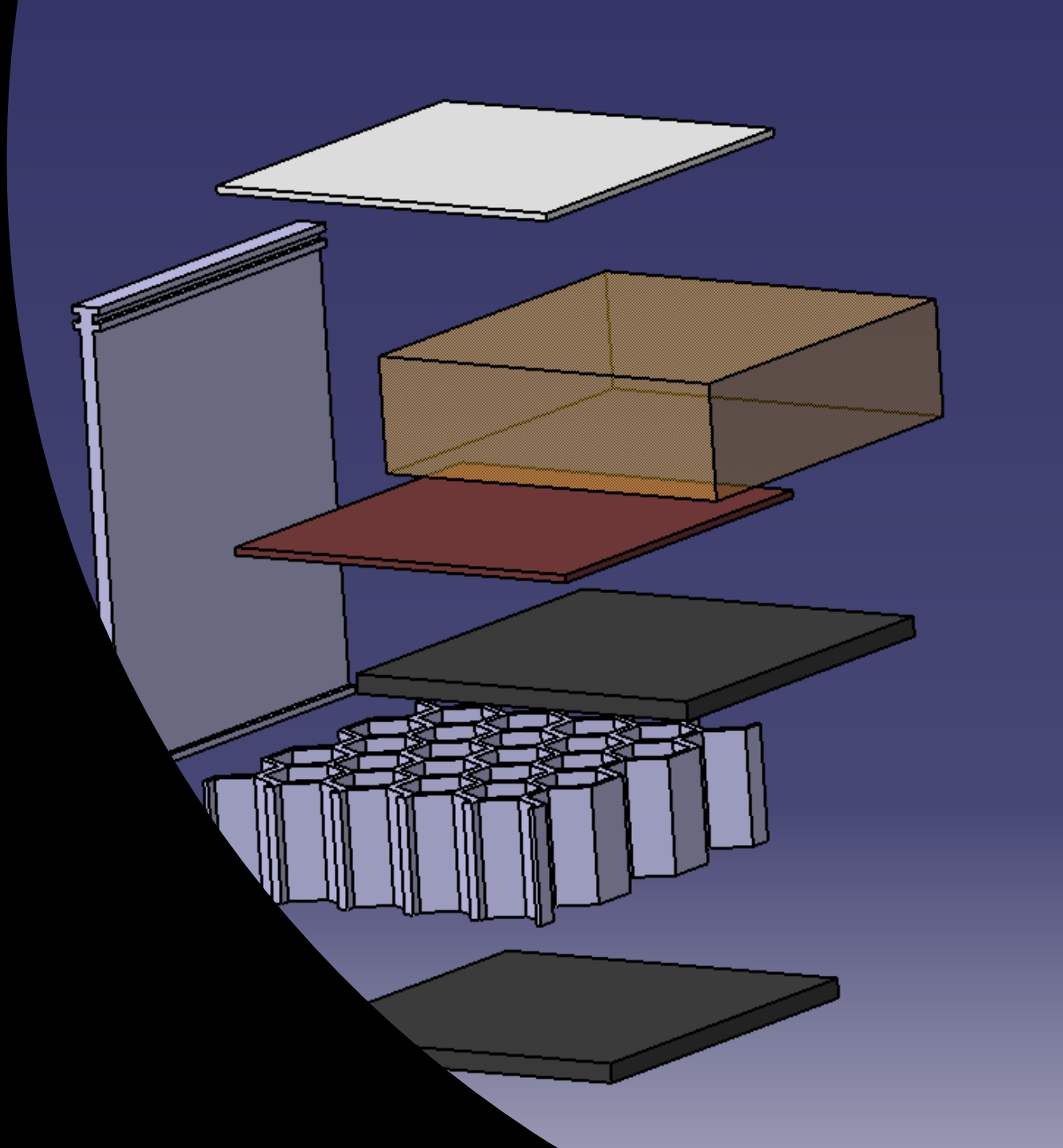
Batteries integrated to the rover's frame

New technology actually being developped :
Stuctural batteries

Structure

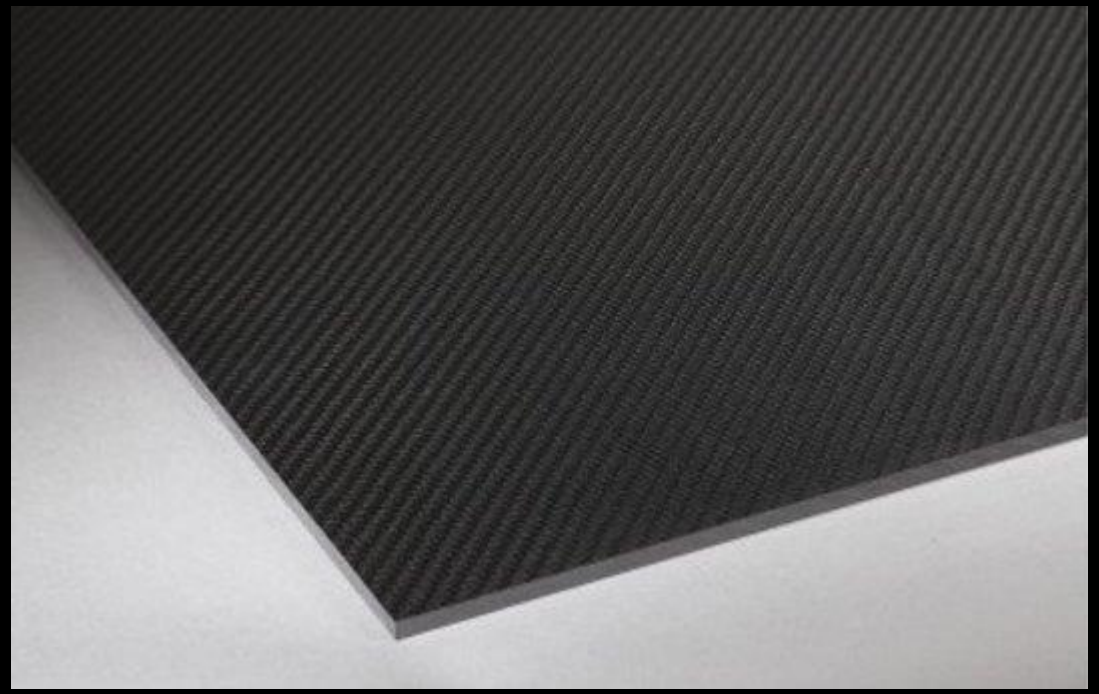
- Thermal Resistance
- Mechanical Resistance
- Radiation Protection

- Support Cycling
- Fireproof
- Lightweight



What will compose this structural sandwich?

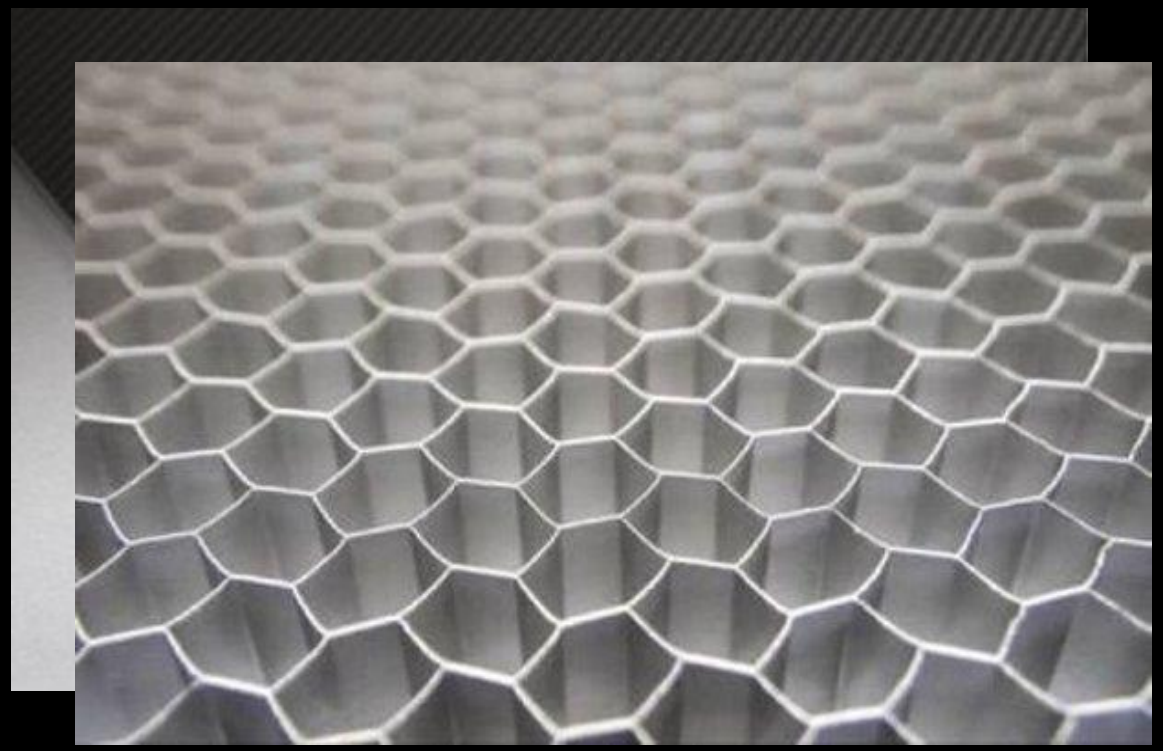
Carbone Epoxy T-650/35/Epoxy



- Shocks Absorber
- Lowest Thermical Expansion Coefficient among C-Epoxy
- Lowest Density

What will compose this structural sandwich?

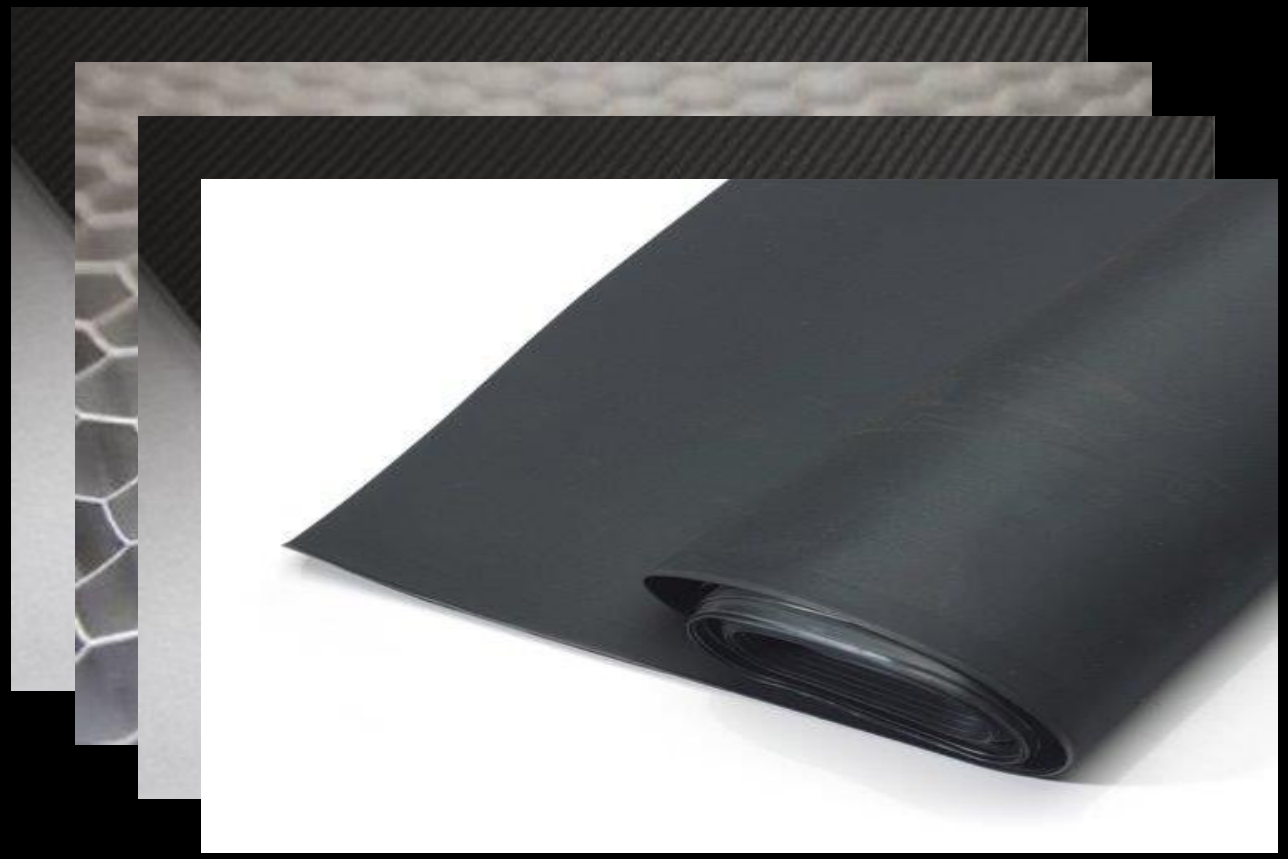
Honeycomb Structure



- Great Mechanical Properties
- Thermal Resistance
- Lightweight (Aluminum)
- (Radiative Protection)

What will compose this structural sandwich?

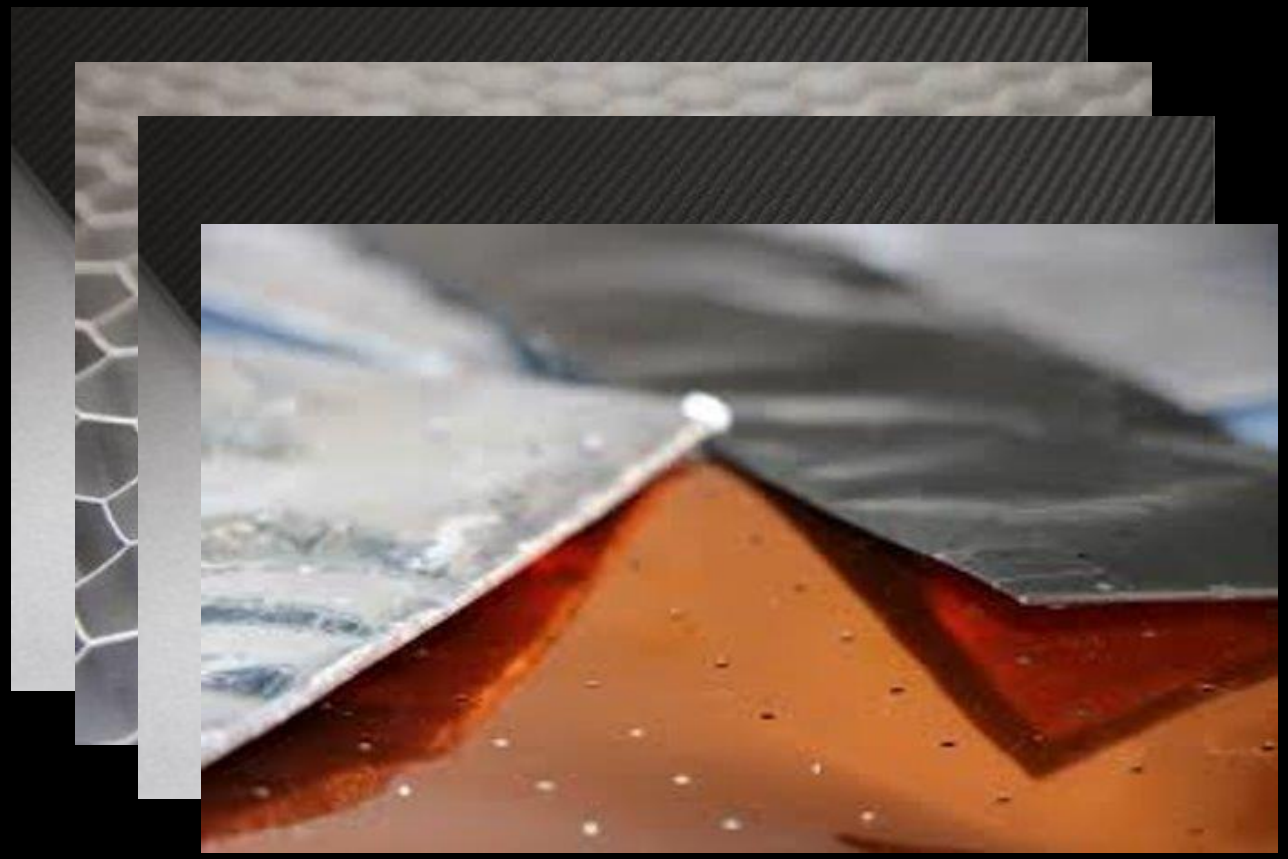
MLI & Polymeric EPDM



- Martian Environment Leakproof
- Used in the Automotive Industry
- Link between the MLI and the Carbone Epoxy

What will compose this structural sandwich?

MLI & Polymeric EPDM



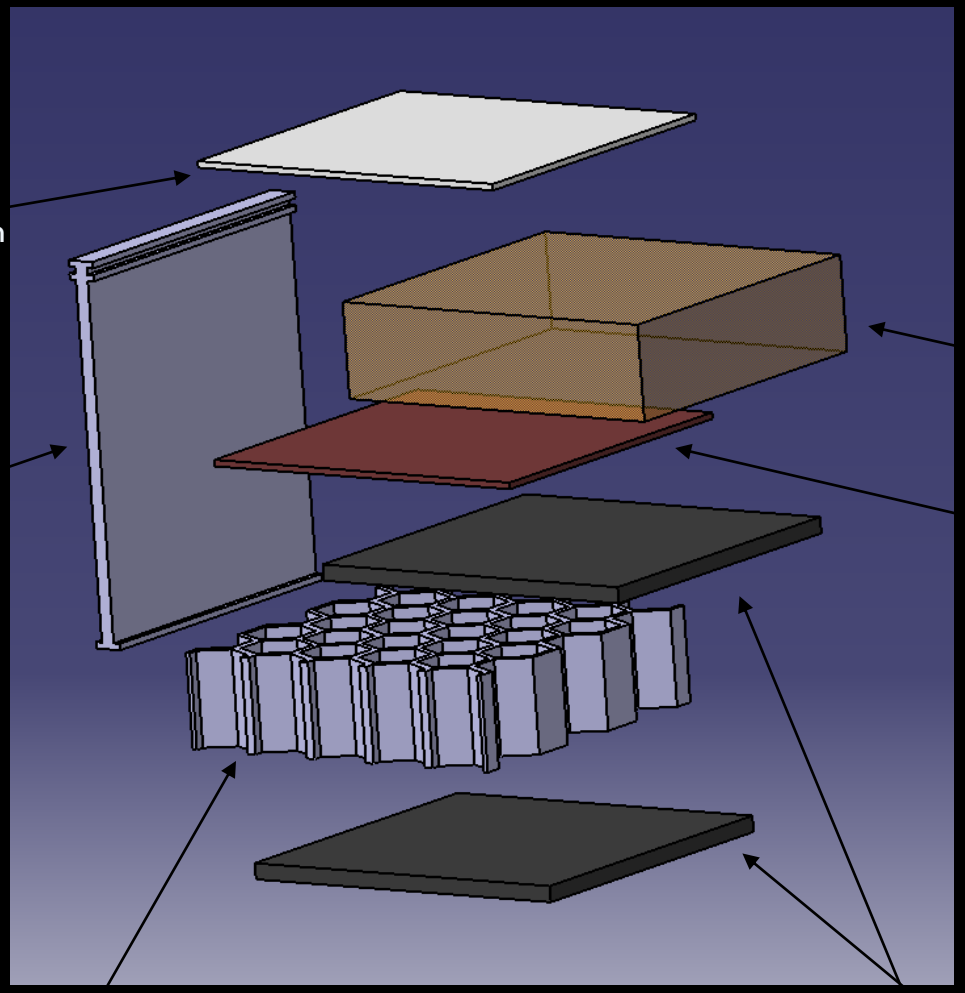
- Radiative Protection
- Lightweight (thin sheets)

What will compose this structural sandwich?

Radiative Events : Boric Polyethylene Shield

- Great Protection to radiative events
- Shield to Gamma Ray (bore)
- Used in the nuclear and medical fields

What will compose this structural sandwich?



Material	Thickness (cm)	Mass (kg)
C-Epoxy	0.25	616
Honeycomb	1.5	40
EPDM	0.25	205
MLI	1.5	~5
Aluminum	0.1	166
Pasti-Shield	5	601
Total	8.6	~1630

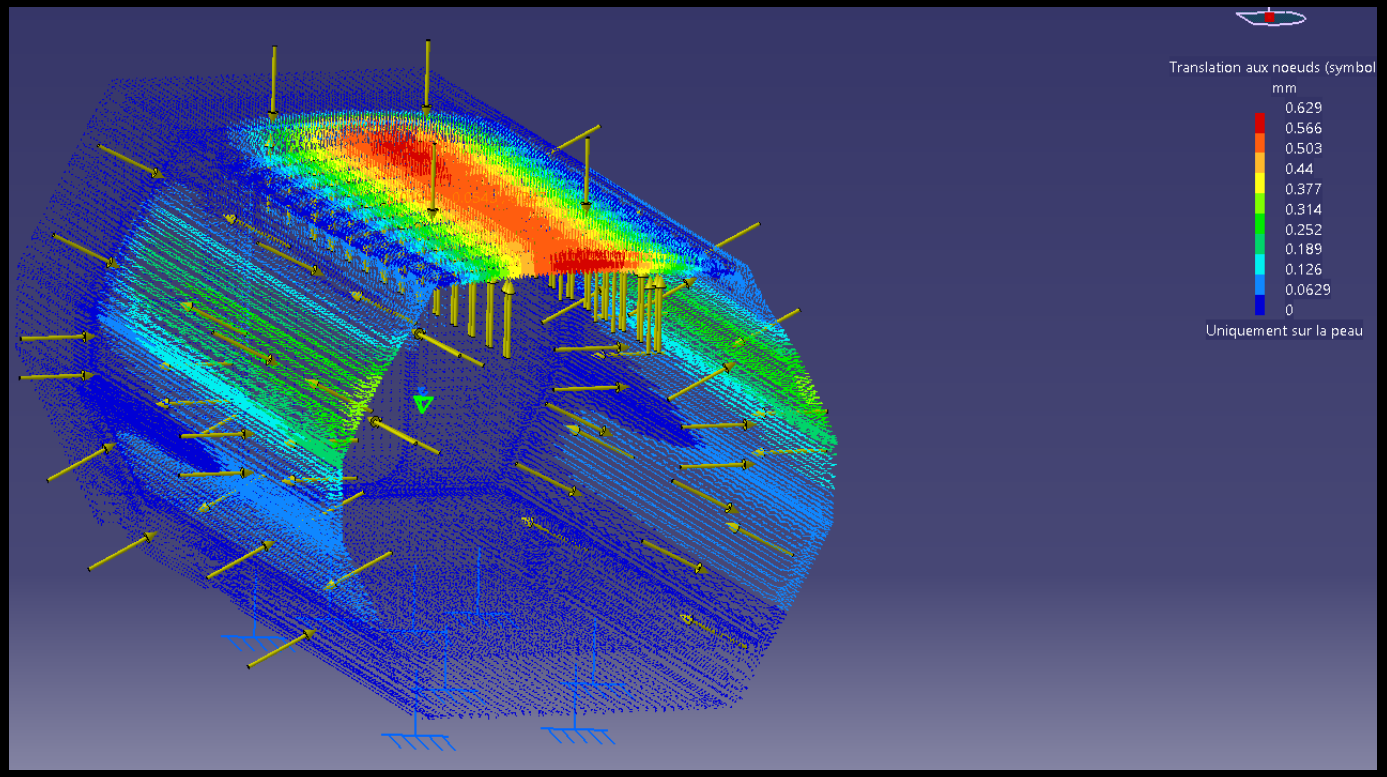
Part Design

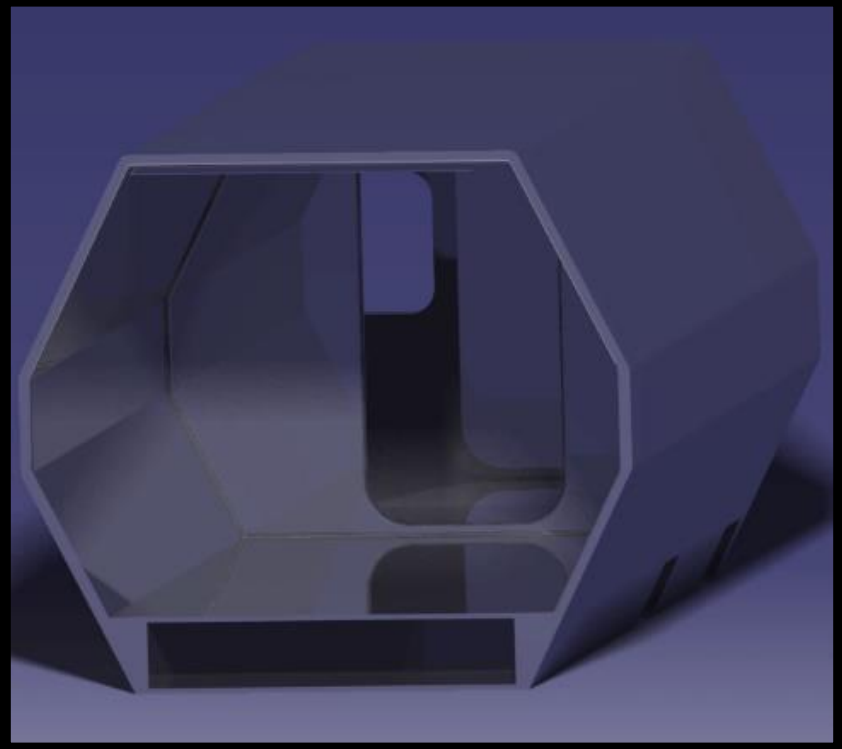
The inspiration

- The Paris-Dakar race's Trucks
- Already existing rover
- The movies

The structure

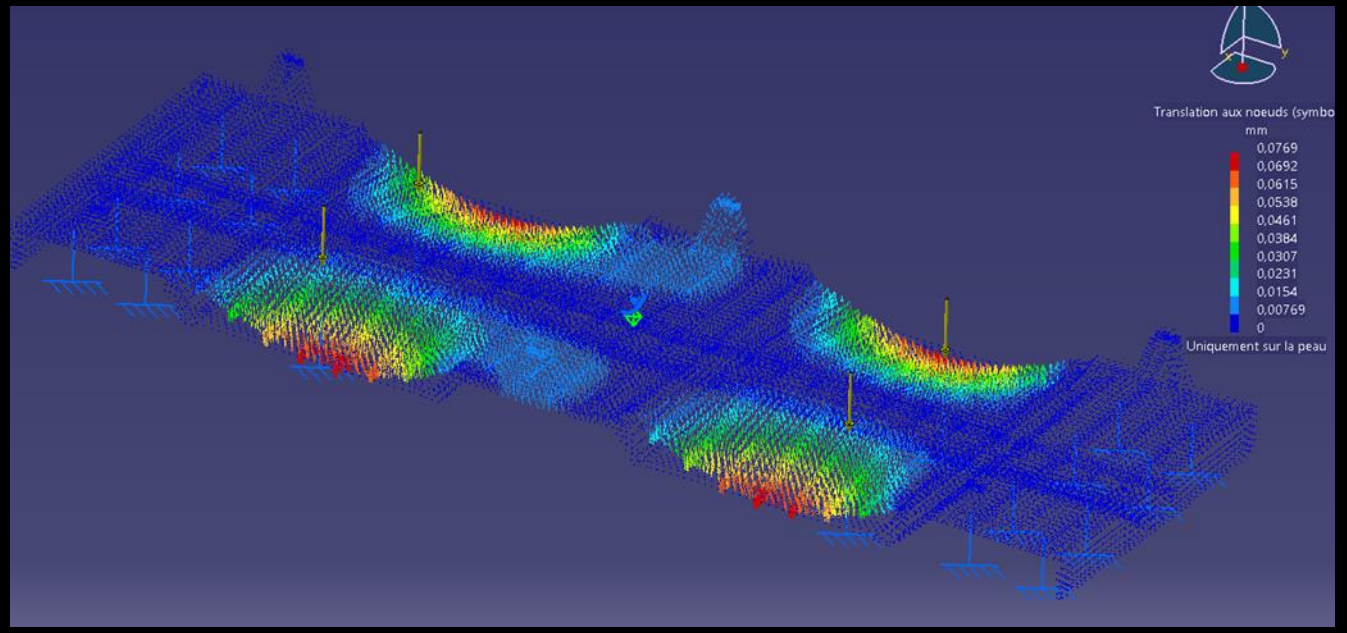
- Compromise between a ergonomic structure and the mechanical resistance

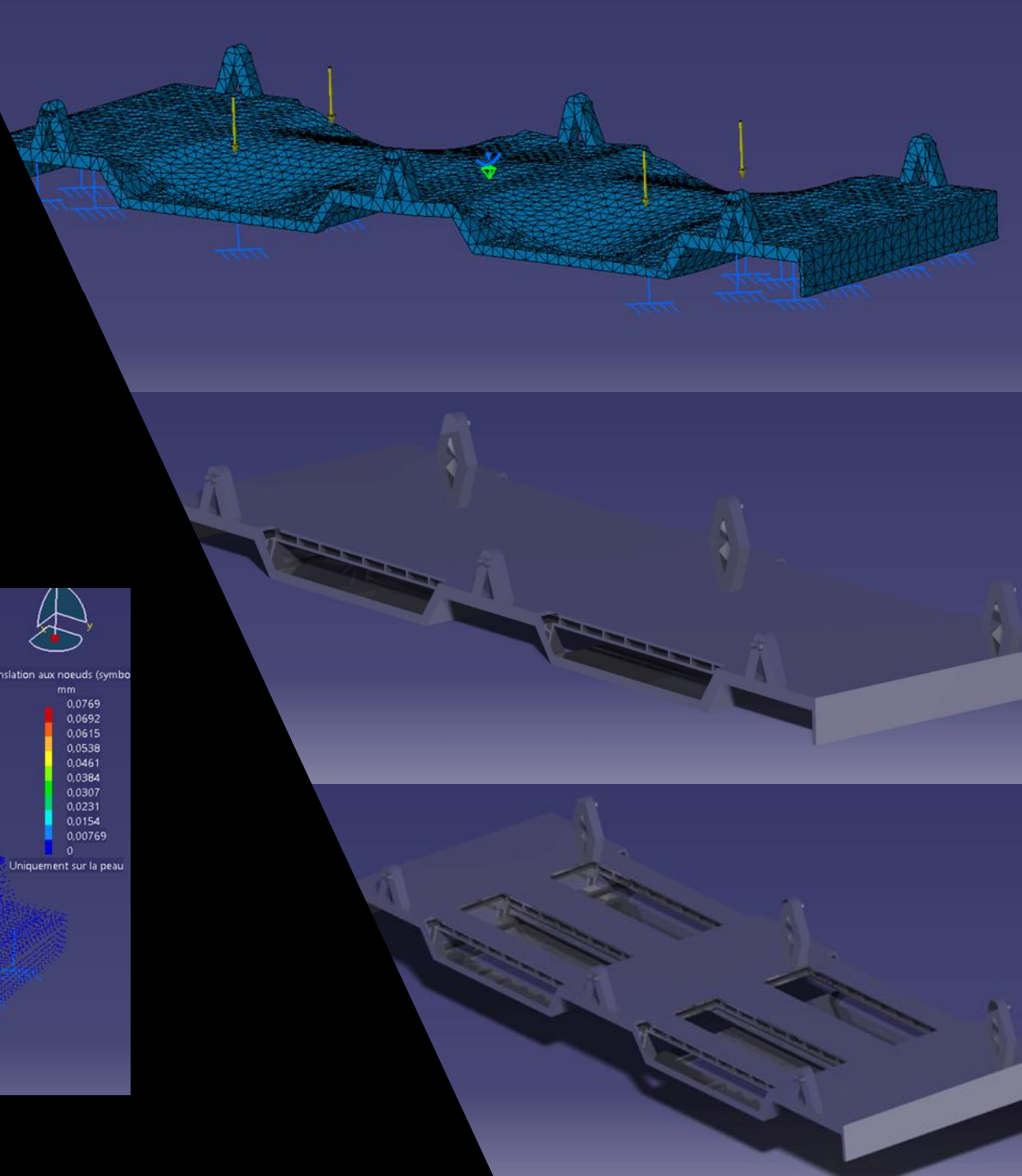




The frame

- Iteration to optimize the mass





Special Thanks:

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- Richard Heidmann, Planète Mars Founder
- Mars Society
- ESTACA, our Engineering school
- ESO (ESTACA Space Odyssey)
- Marc Milon for the design of the logo

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Thank you for your attention

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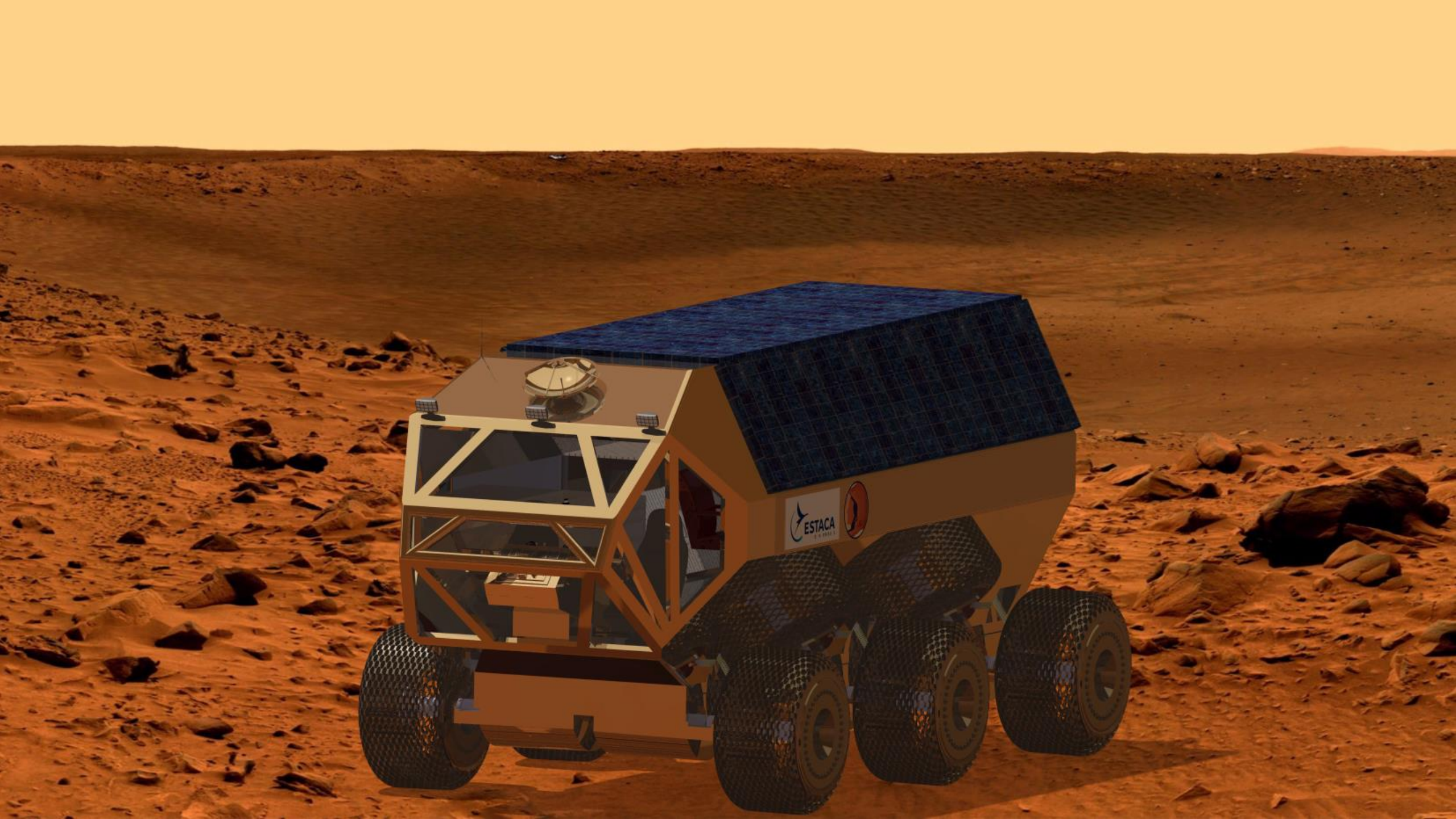
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