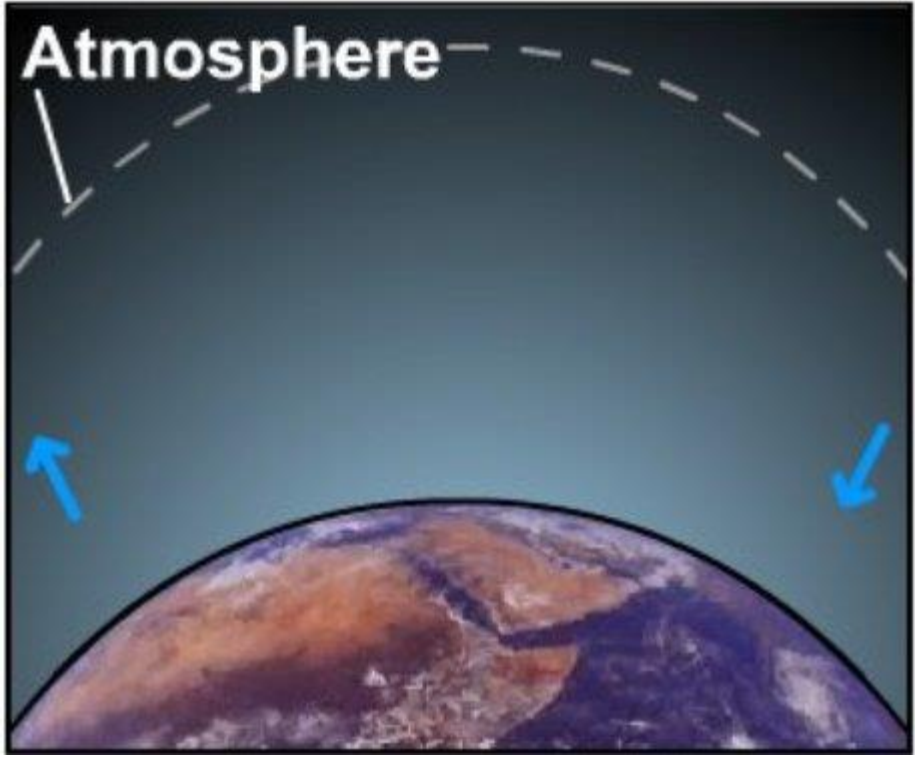
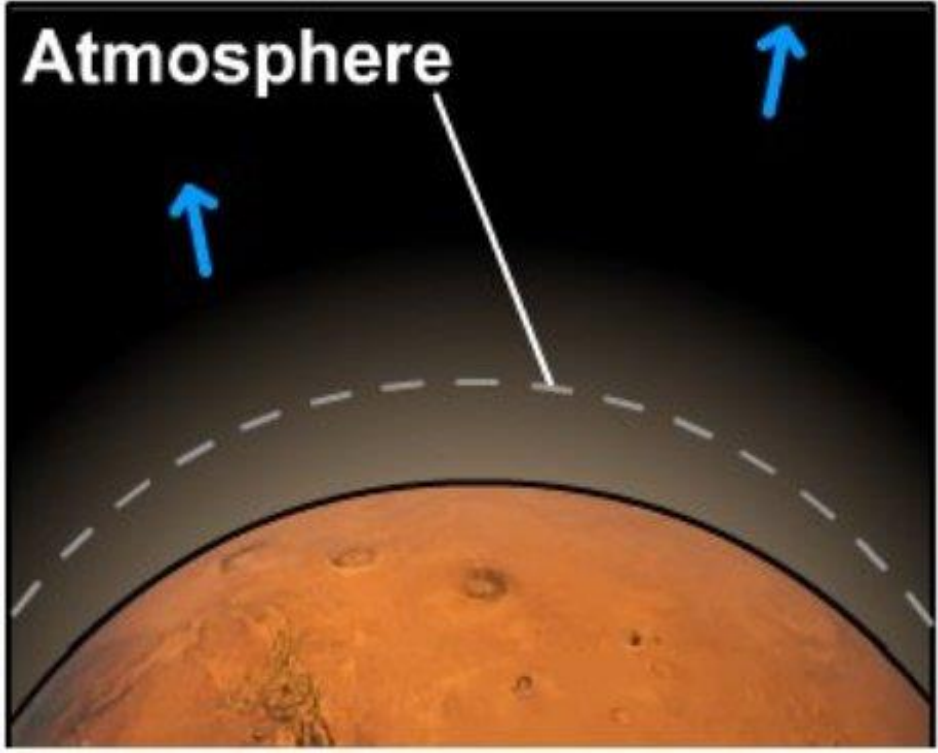
# Mission to Mars

Bergen Astronomiske Forening
25. november 2019

Øyvind Grøn

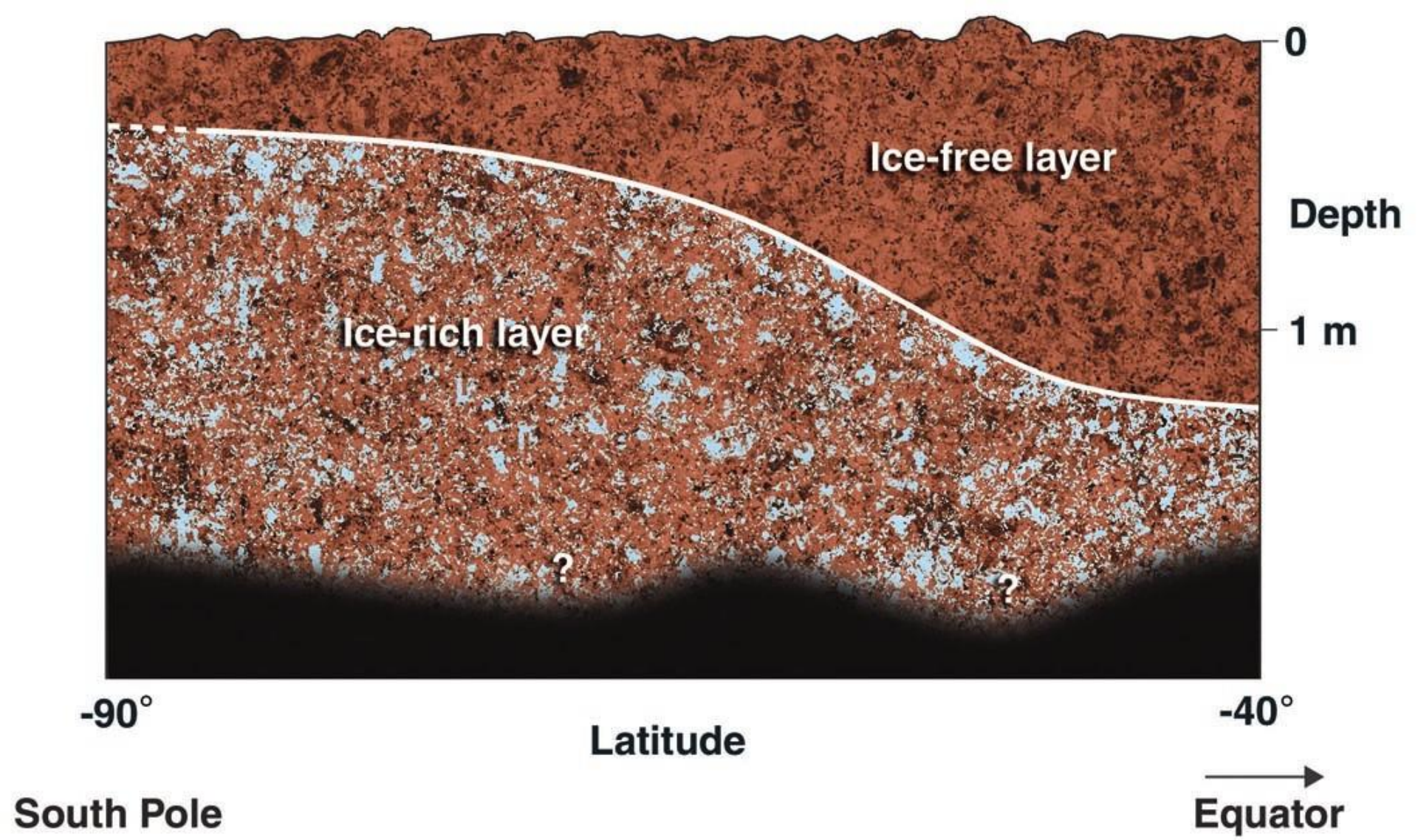
Mars har omtrent halvparten så stor radius som Jorda, men bare litt over 1/10 av Jordas masse.



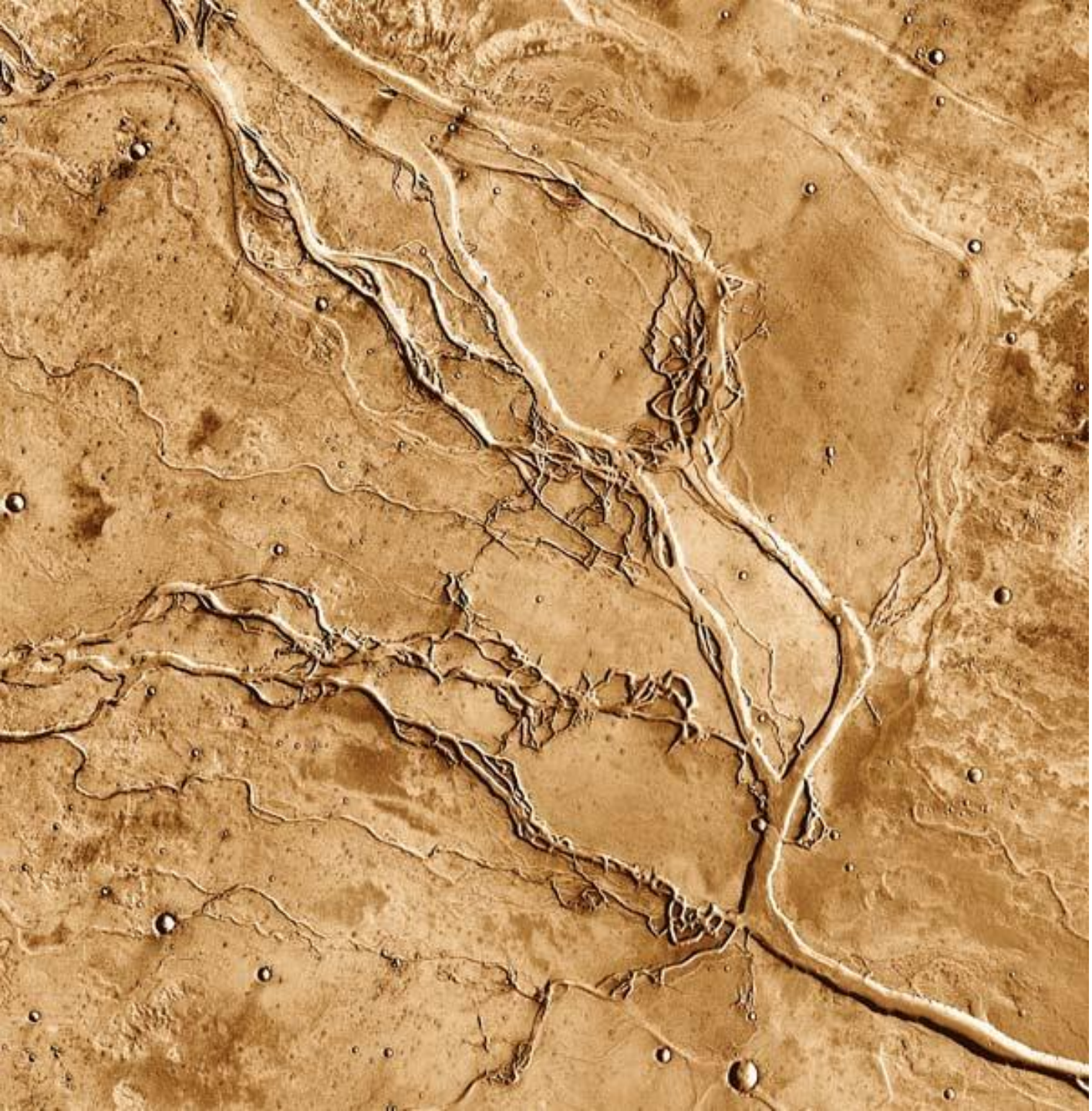




**Til venstre:** Jorda har stor nok masse, og dermed sterkt nok gravitasjonsfelt til å holde på atmosfæren sin.

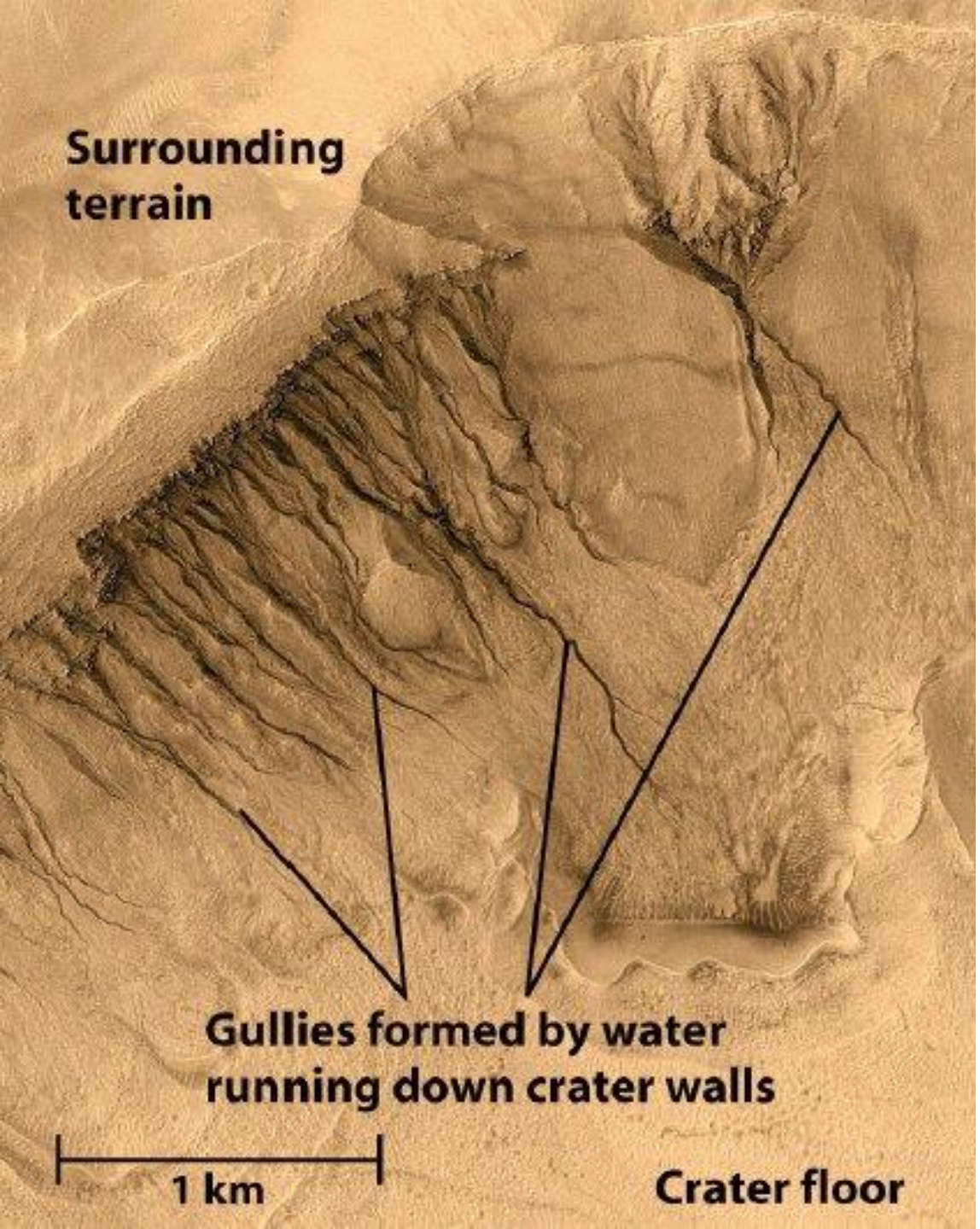
**Til høyre:** Mars har bare 1/10 av massen til Jorda og halvparten så stor radius. Dermed er tyngdeakselerasjonen på Mars bare 4/10 av den på jorda. Derfor lekker atmosfæren til Mars lettere ut i rommet.



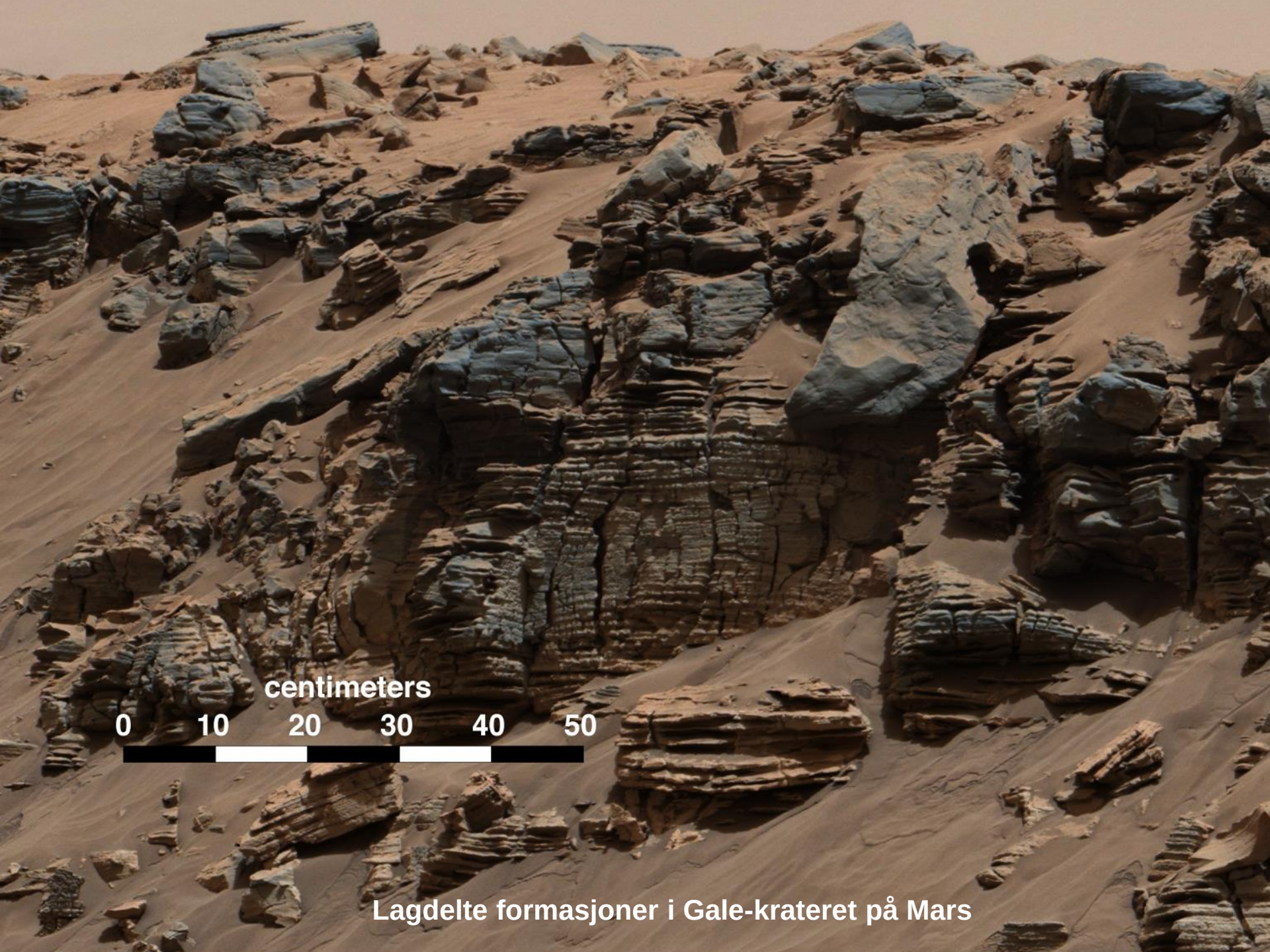

Den øverste delen av jordsmonnet på Mars er tørt, men radarobservasjoner tyder på at det er store mengder is lenger nede. Der er et tykt lag hvor mellom 20% og 50% av massen består av is.



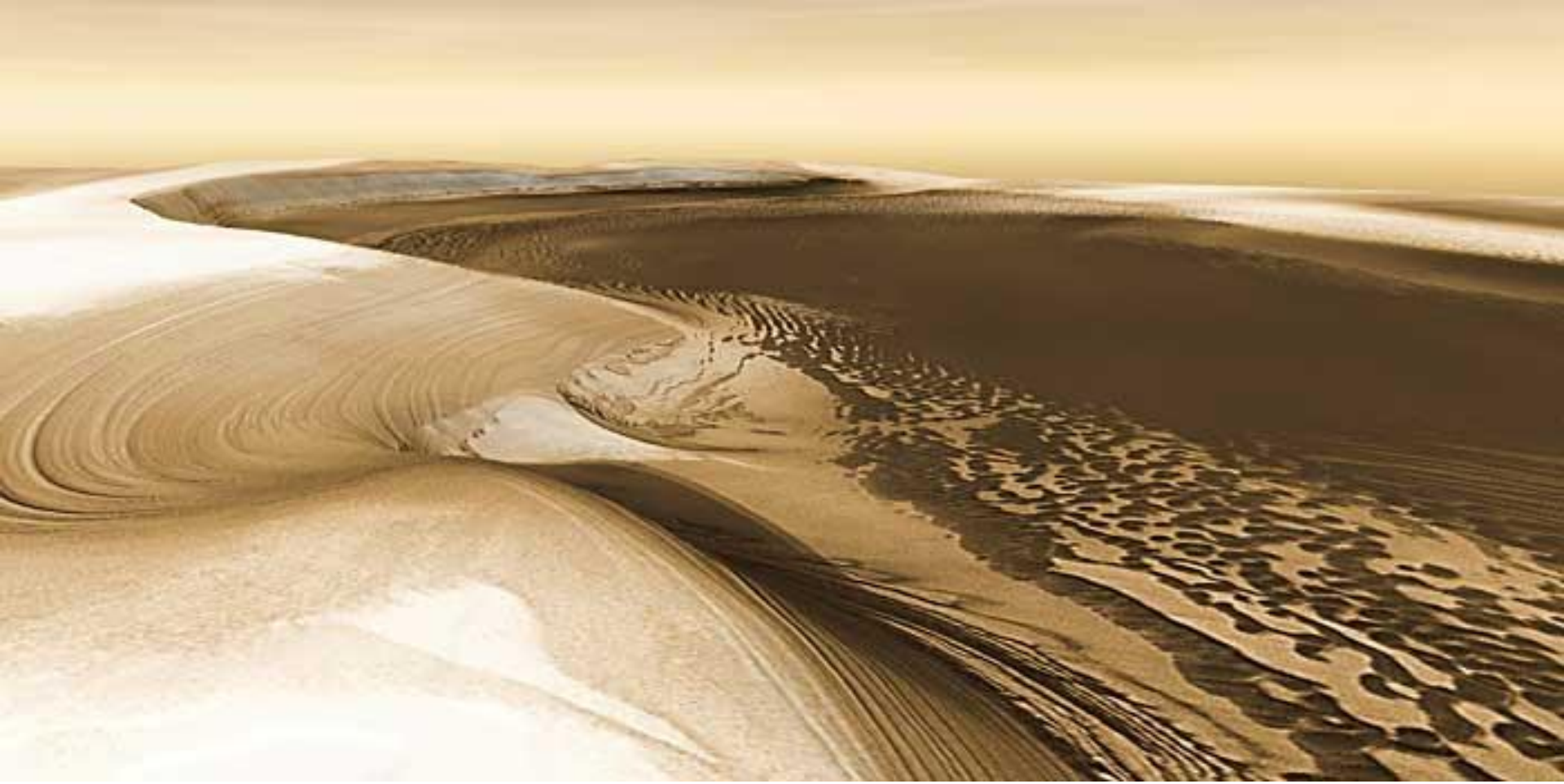
Vannet som gravde ut disse kanalene, kom sannsynligvis fra reservoarer av is under en vulkan. Varme fra vulkanen fikk isen til å smelte. Landskapet har en utstrekning på 200 km.



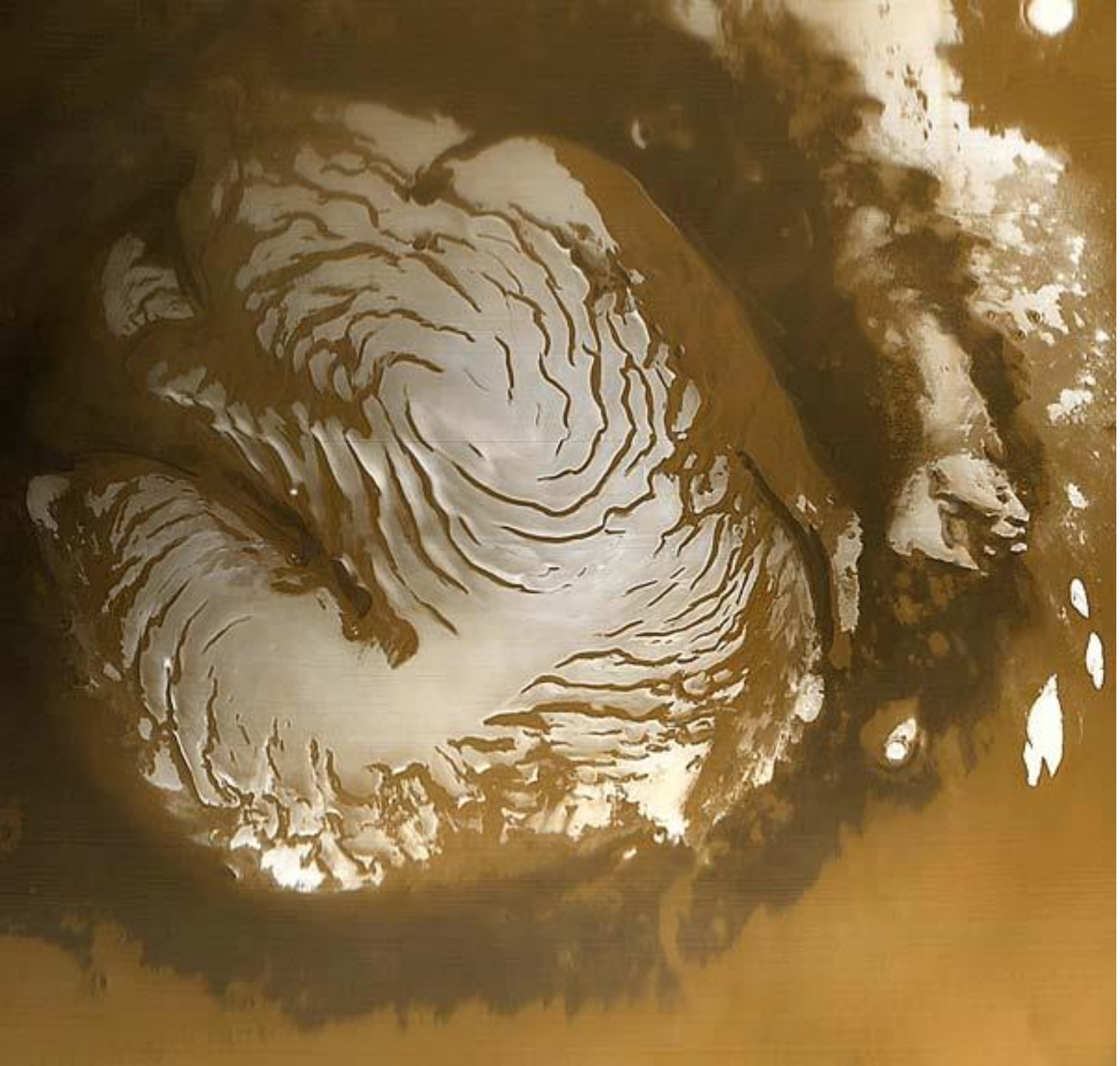

Gullies – uttørkede elveleier – er dannet ved at vann er kommet ut av bratte skråninger som omgir bunnen av et krater.




Lagdelte formasjoner i Gale-krateret på Mars

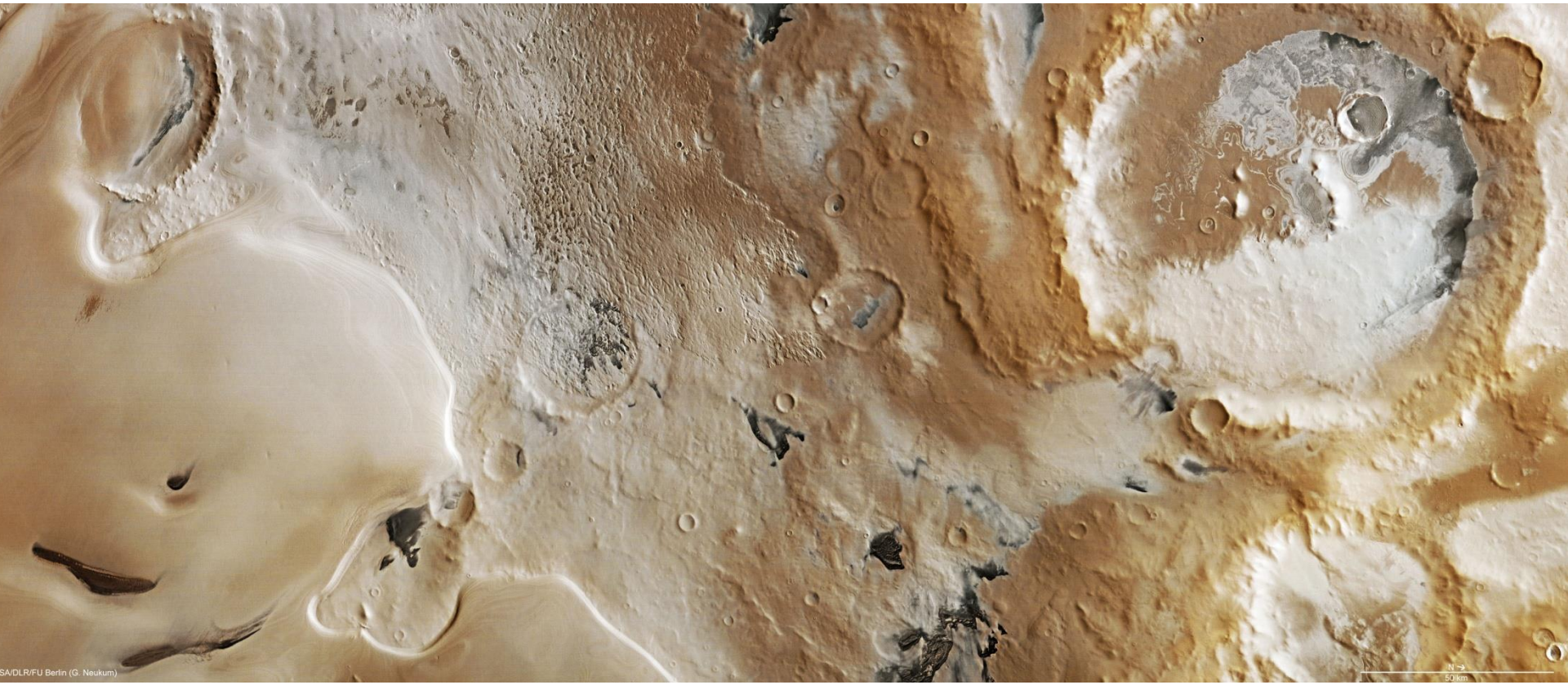


Delikat lagdeling i utkanten av det den nordlige polare iskappen på Mars. Mørke sanddyner har begravd den lavere delen av terrenget. Det avbildete landskapet har en utstrekning på 100 km.

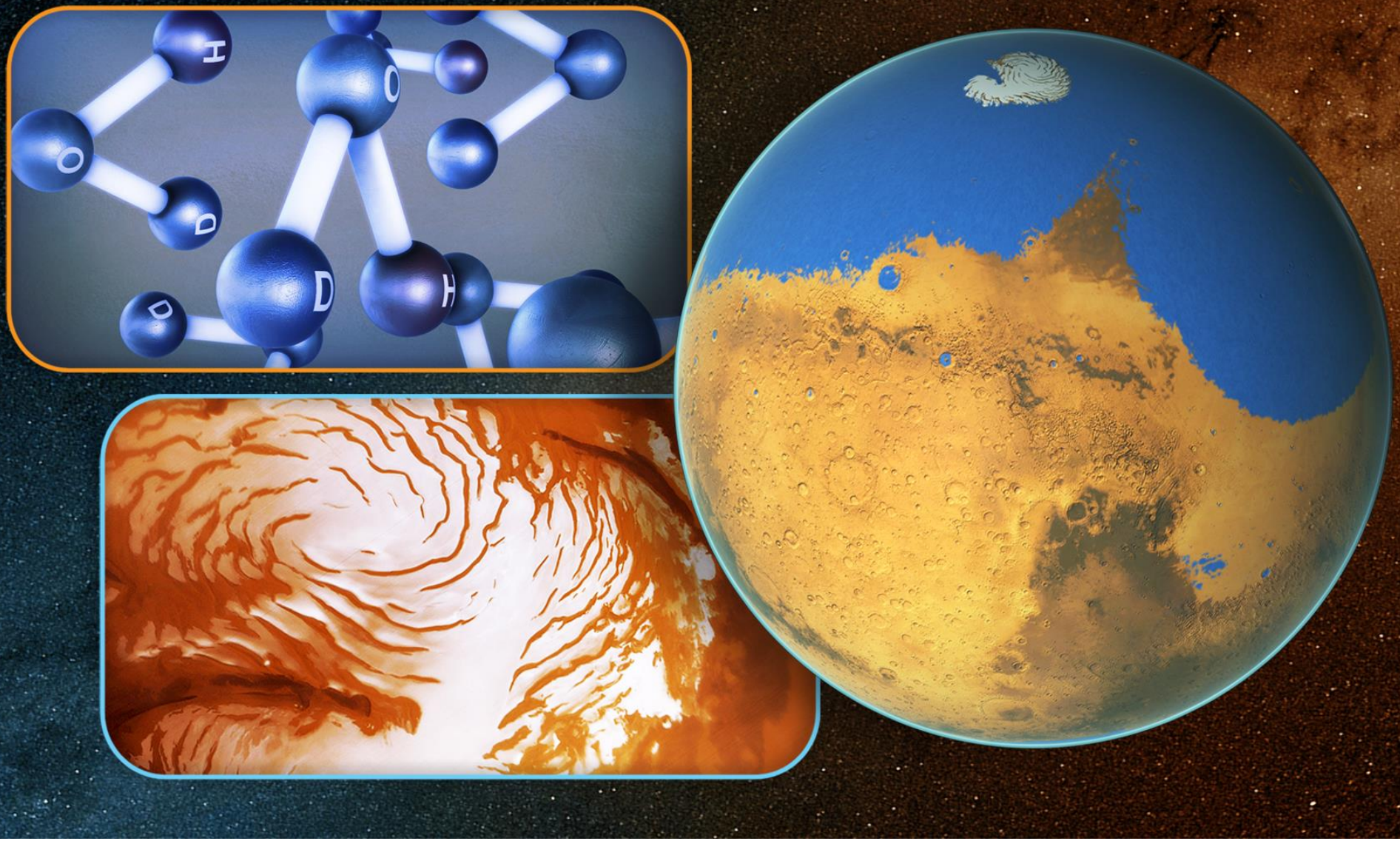


Iskappen ved Nordpolen til Mars er omgitt av store ørkenaktige områder dekket av sand.

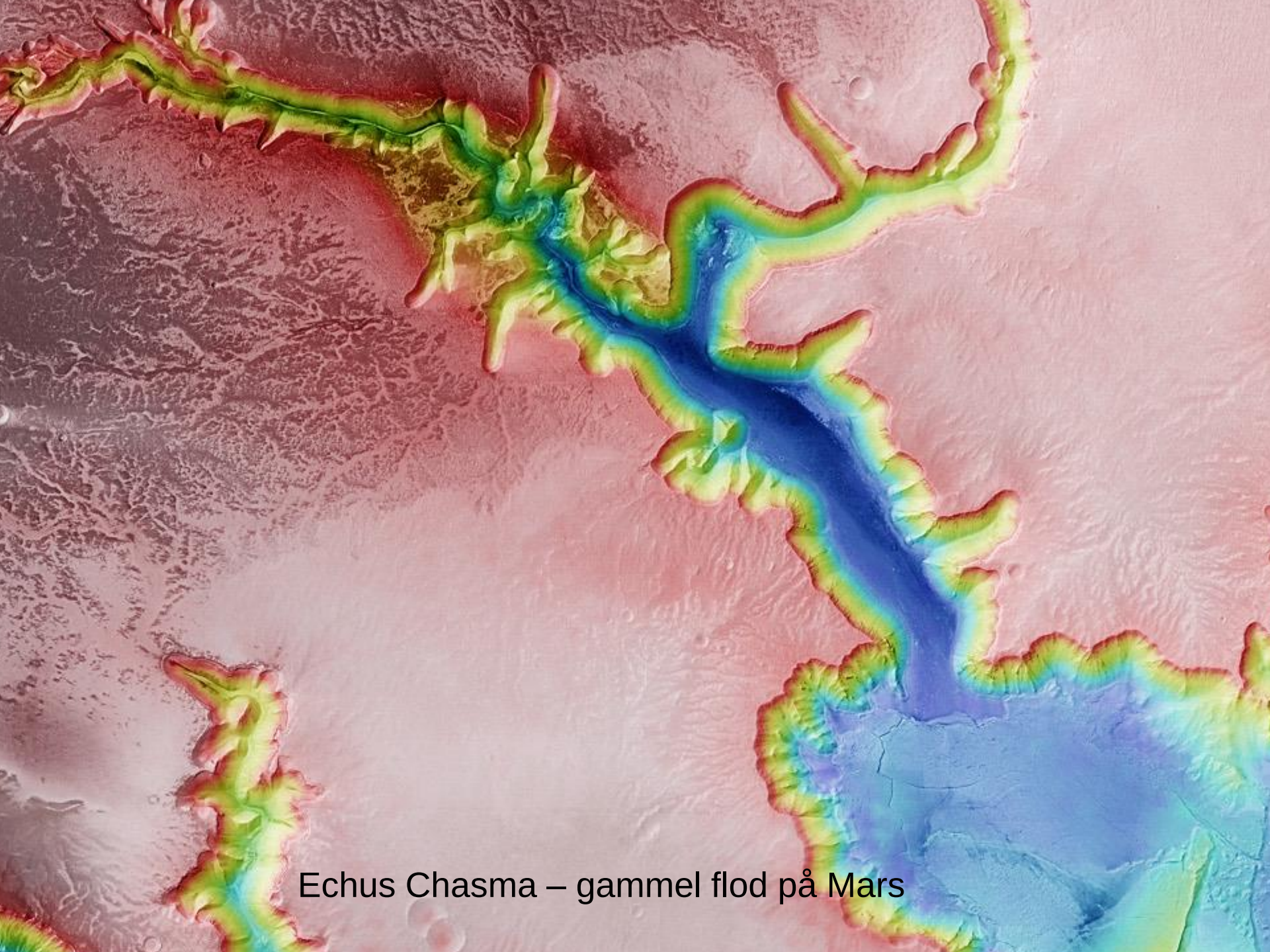
Utkanten av iskappen ved Nordpolen til Mars fotografert med Mars Reconnaissance Orbiter.




En del av sydpolområdet på Mars dekket av is

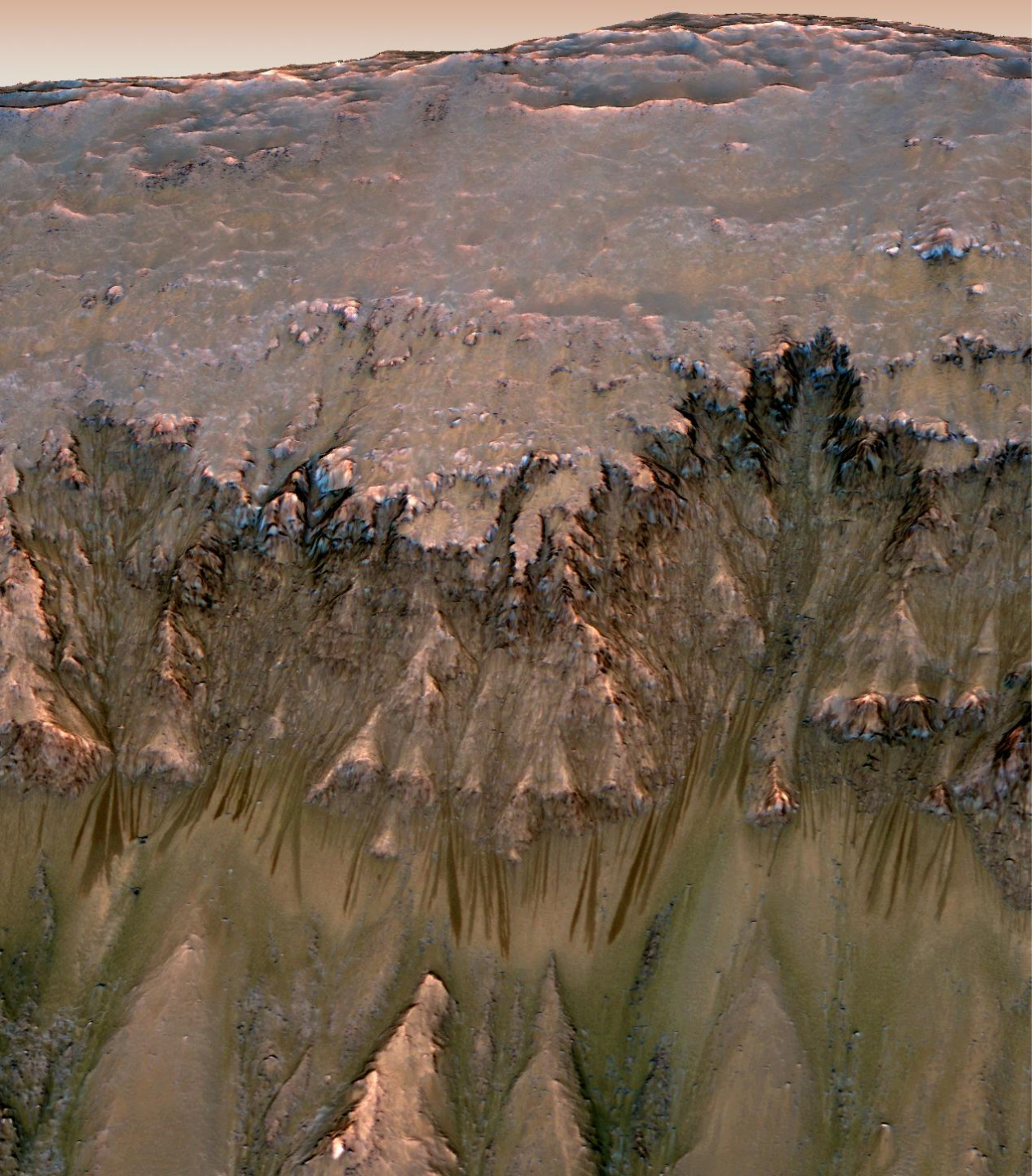



Iskappene på Mars er en blanding av vanlig vann, tungtvann og tørris

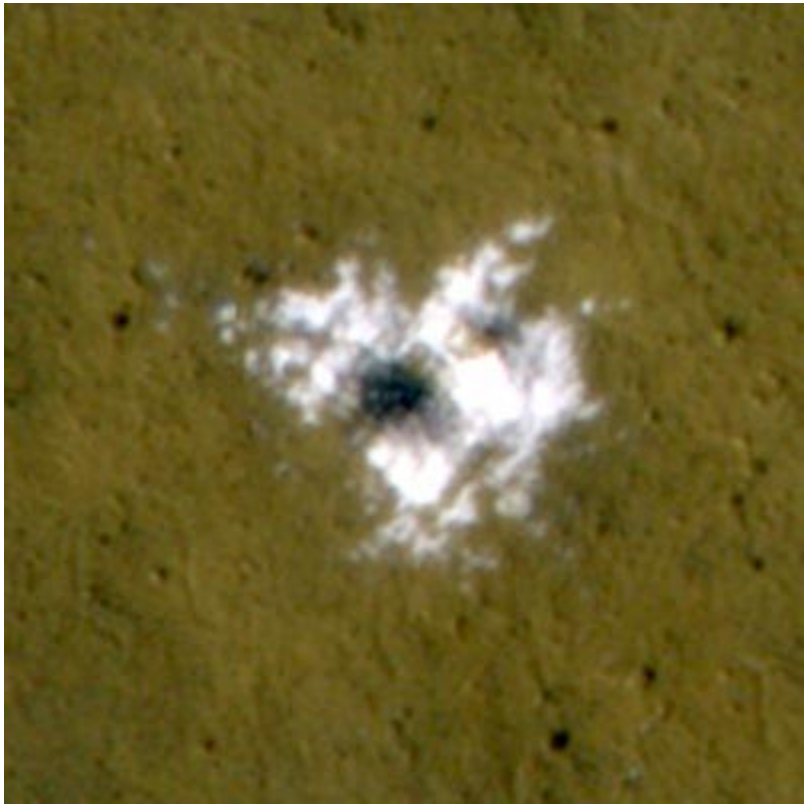


Echus Chasma – gammel flod på Mars

En simulering av hvordan det kan ha vært på Mars for 3 milliarder år siden

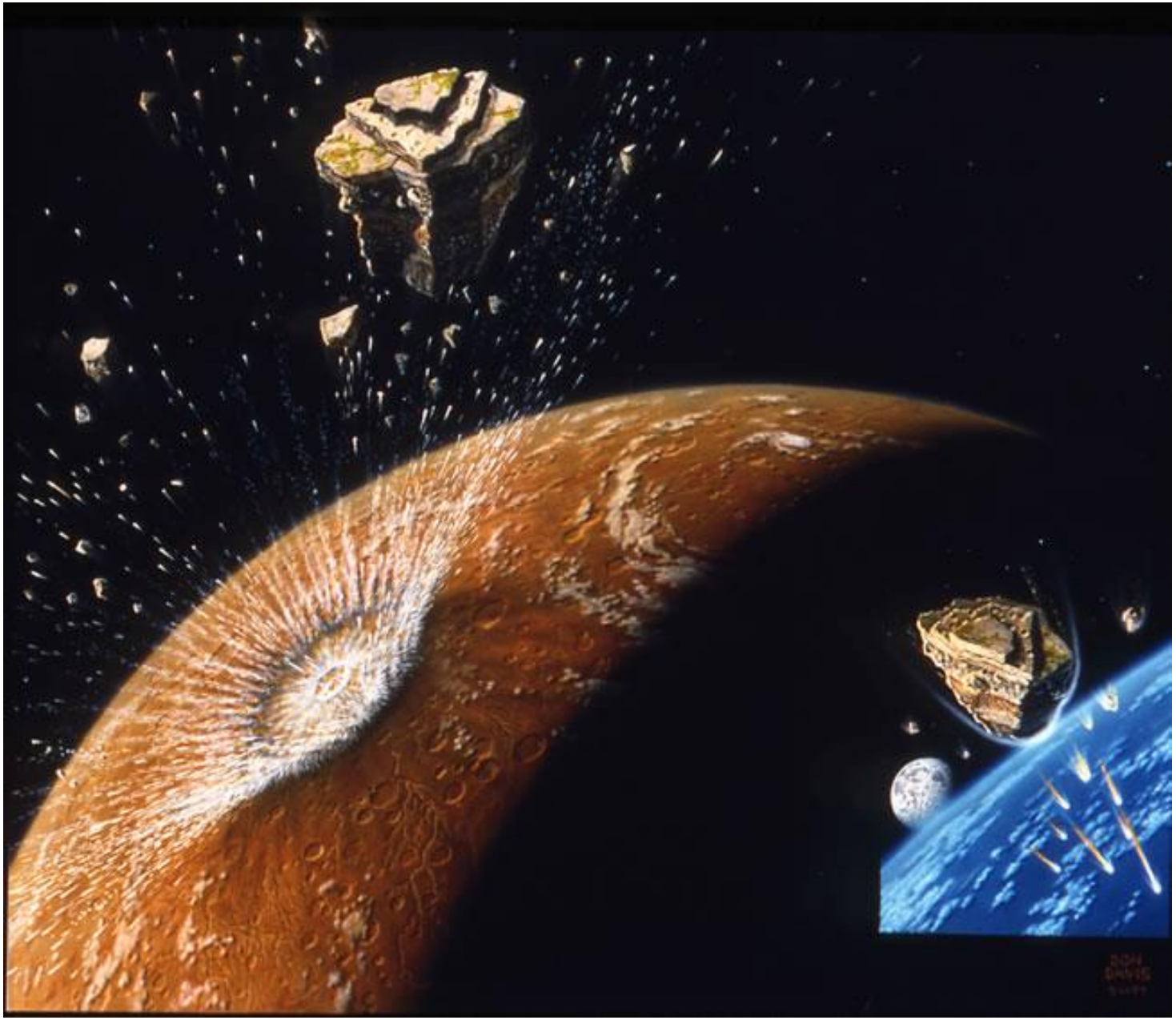


*Den 4. august 2011 ble det annonsert at en serie fotografier tatt ved hjelp av Mars Reconnaissance Orbiter (MRO) har avslørt tegn til at det finnes vann på Mars i vår tid. De mørke feltene er bare noen meter brede og noen hundre meter lange, dukker opp om våren, blir større om sommeren og forsvinner om vinteren.*

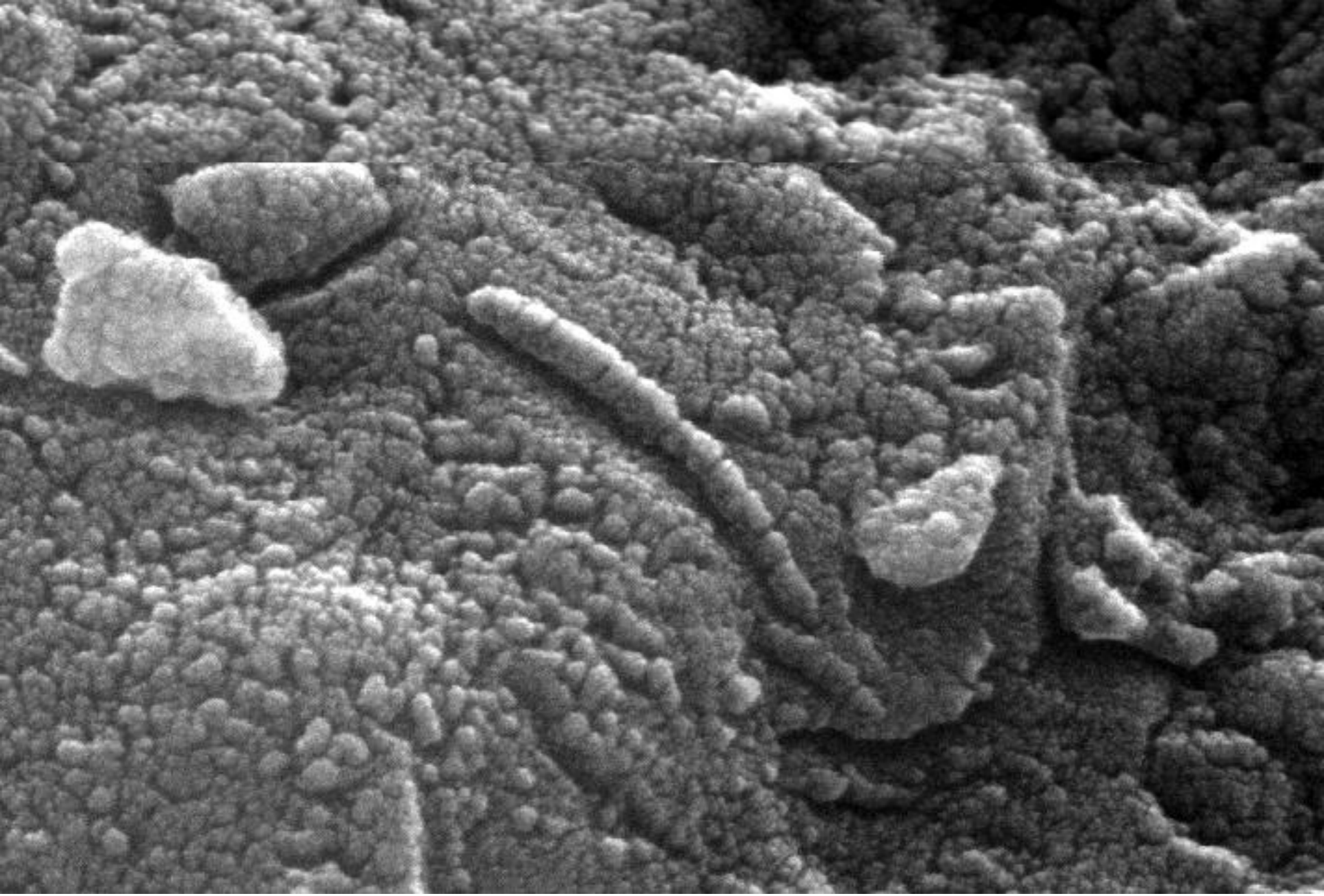


Dette er et fotografi av et nytt nedslagskrater på Mars tatt med et kamera på Mars Reconnaissance Orbiter 18. september 2008. Krateret har en utstrekning på 8 meter. Ved hjelp av spektroskopiske analyser med Compact Reconnaissance Imaging Spectrometer har forskerne funnet ut at det hvite området består av vannis.


Meteoritten ALH 84001 er en stein fra Mars. Terningen er 1 cm3.



Figuren illustrerer hvordan et stort meteorittnedslag kan ha slått løs steiner så hardt at de har frigjort seg fra tyngdefeltet til Mars og blitt til meteorer.



Bilde av overflaten til meteoritten ALH 84001 tatt med elektronmikroskop

## What is Space Radiation?

Space radiation is different from the kinds of radiation we experience here on Earth. Space radiation is comprised of atoms in which electrons have been stripped away as the atom accelerated in interstellar space to speeds approaching the speed of light.

Space radiation is made up of three kinds of radiation: particles trapped in the Earth's magnetic field; particles shot into space during solar flares; and galactic cosmic rays, which are high-energy protons and heavy ions from outside our solar system.

All of these kinds of space radiation represent ionizing radiation.

**Real Martians: How to Protect Astronauts from Space Radiation on Mars**

Radiation, at its most basic, is simply waves or sub-atomic particles that transports energy to another entity – whether it is an astronaut or spacecraft component. The main concern in space is particle radiation.

Energetic particles can be dangerous to humans because they pass right through the skin, depositing energy and damaging cells or DNA along the way.

This damage can mean an increased risk for cancer later in life or, at its worst, acute radiation sickness during the mission if the dose of energetic particles is large enough.

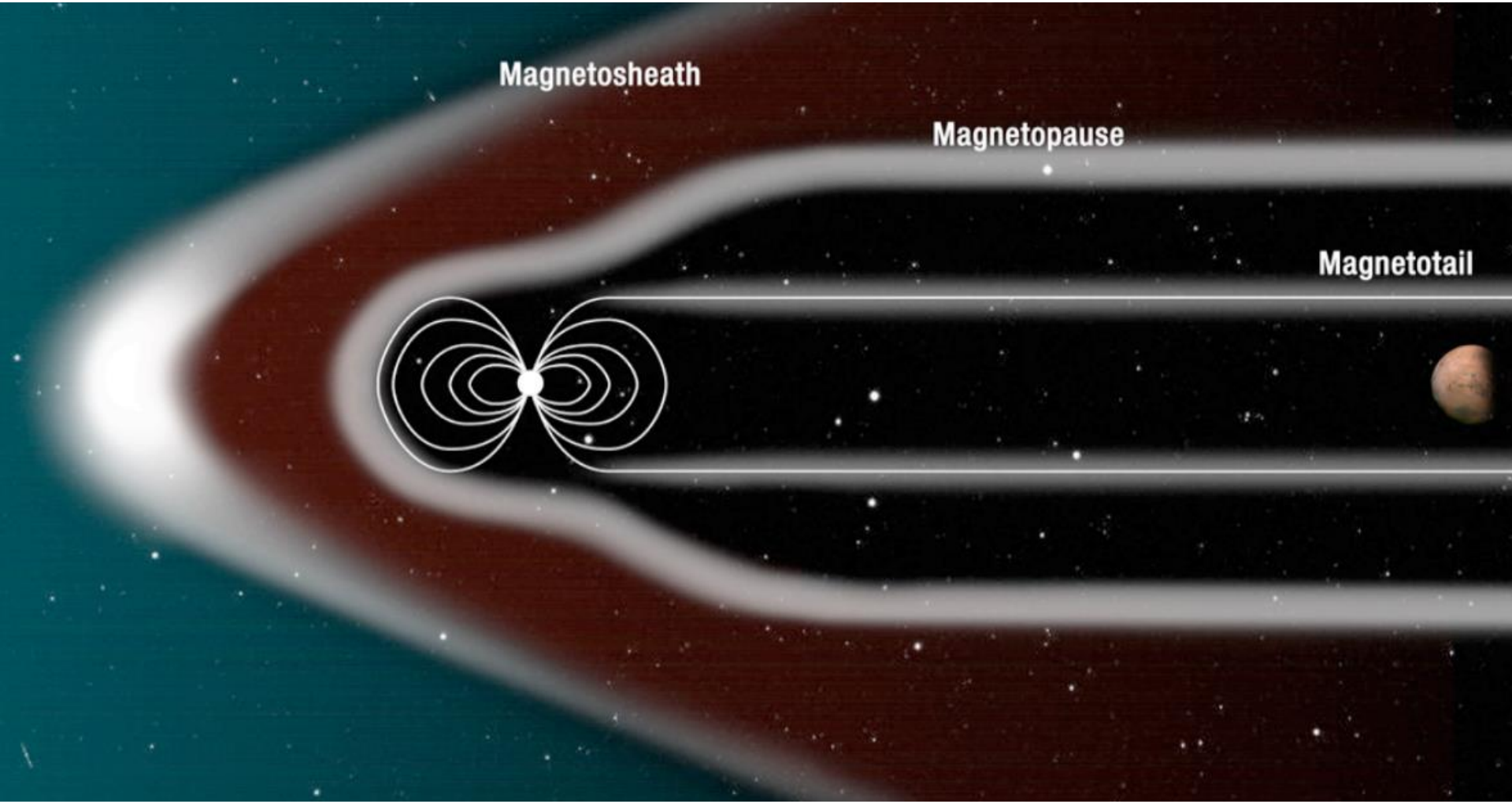
A human mission to Mars means sending astronauts into interplanetary space for a minimum of a year, even with a very short stay on the Red Planet. Nearly all of that time, they will be outside the magnetosphere, exposed to the harsh radiation environment of space.

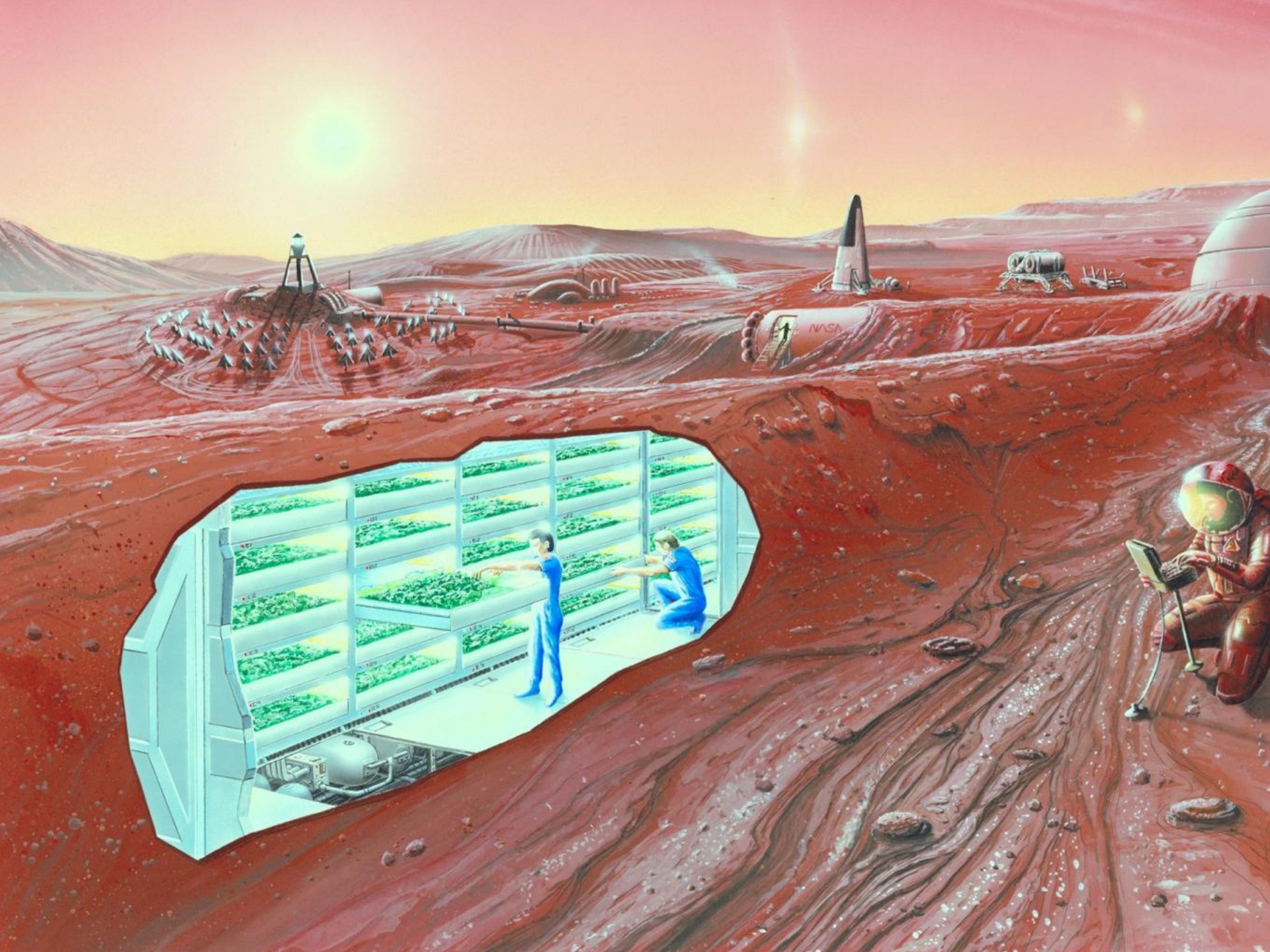
Mars has no global magnetic field to deflect energetic particles, and its atmosphere is much thinner than Earth’s, so they'll get only minimal protection even on the surface of Mars.

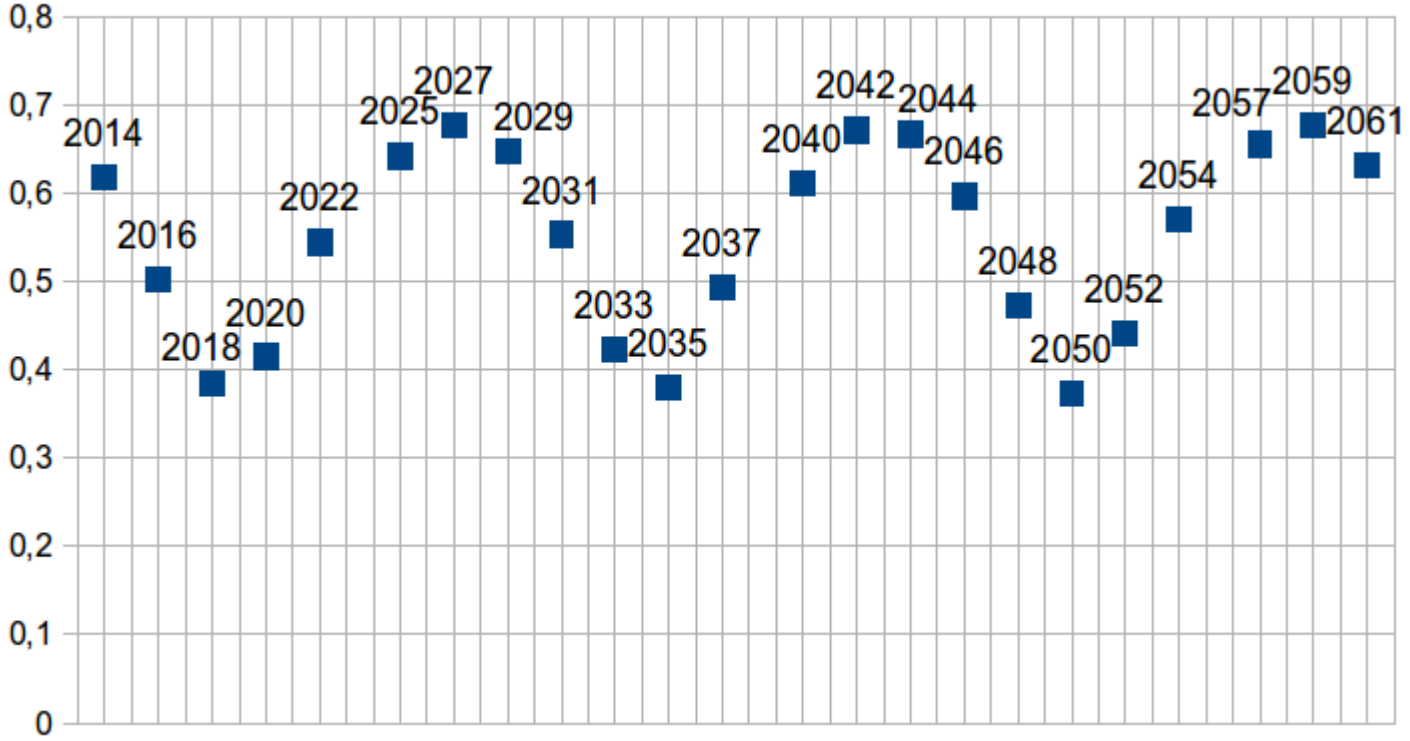
We’re still working on finding a material that is a good shield and can act as the primary structure of the spacecraft,” said Sheila Thibeault, a materials researcher at NASA’s Langley Research Center.

One material in development at NASA has the potential to do both jobs: Hydrogenated boron nitride nanotubes—known as hydrogenated BNNTs—are tiny, nanotubes made of carbon, boron, and nitrogen, with hydrogen interspersed throughout the empty spaces left in between the tubes. Boron is also an excellent absorber secondary neutrons, making hydrogenated BNNTs an ideal shielding material.

**A concept for an artificial magnetic shield that would prevent a terraformed Martian atmosphere from being blown into space by solar storms of high-energy particles.**




NASA




Minimumsavstanden mellom jorda og Mars
med jordas avstand fra sola som avstandsenhet.
Avstanden varierer med en periode på omtrent 15 år.
Vi hadde et minimum i 2018,
og det neste kommer mellom 2033 og 2035.


# Human Exploration of Mars

# Design Reference Architecture 5.0

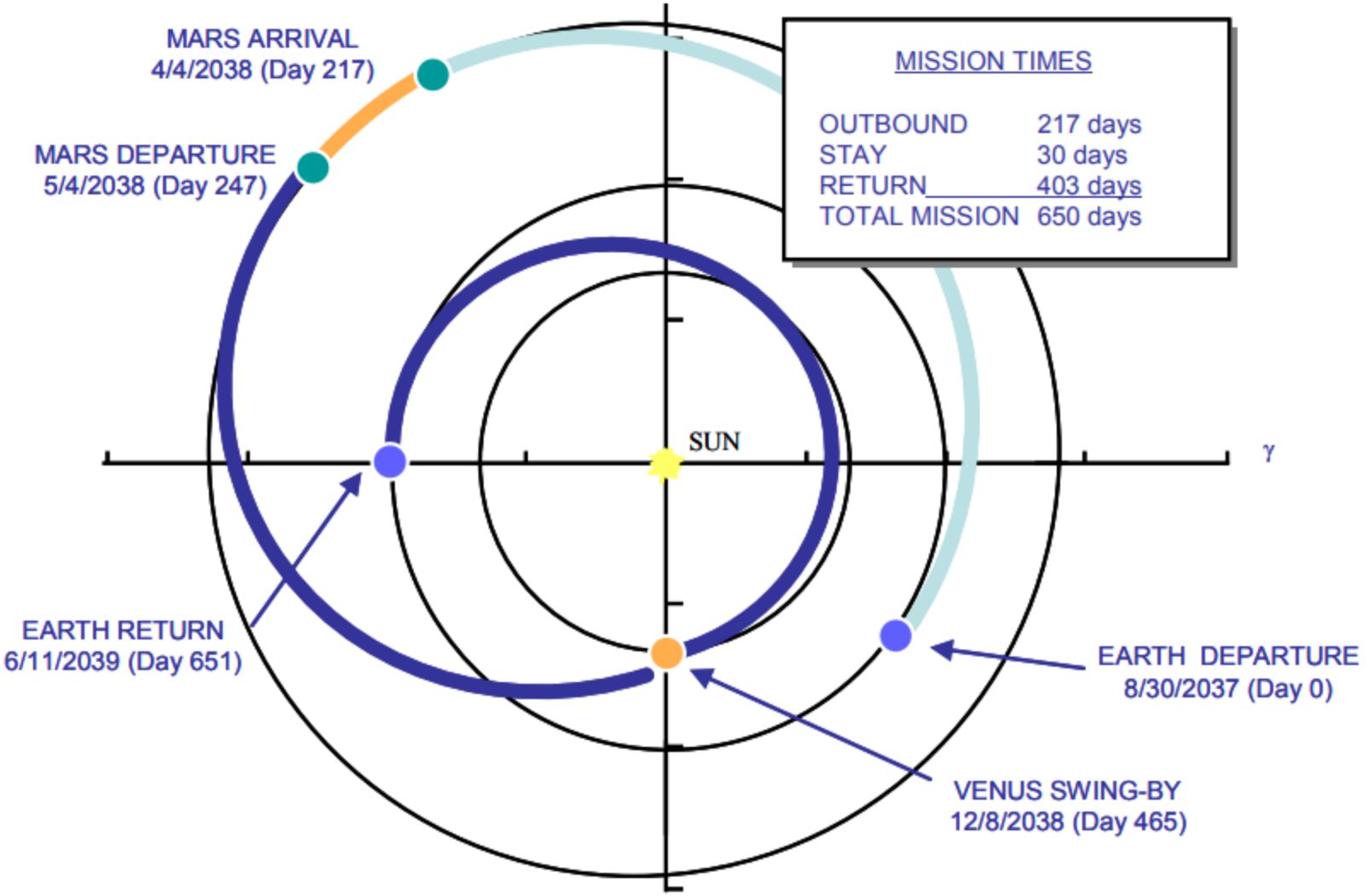



**Figure 3-4.** Typical Opposition Class short-stay mission.

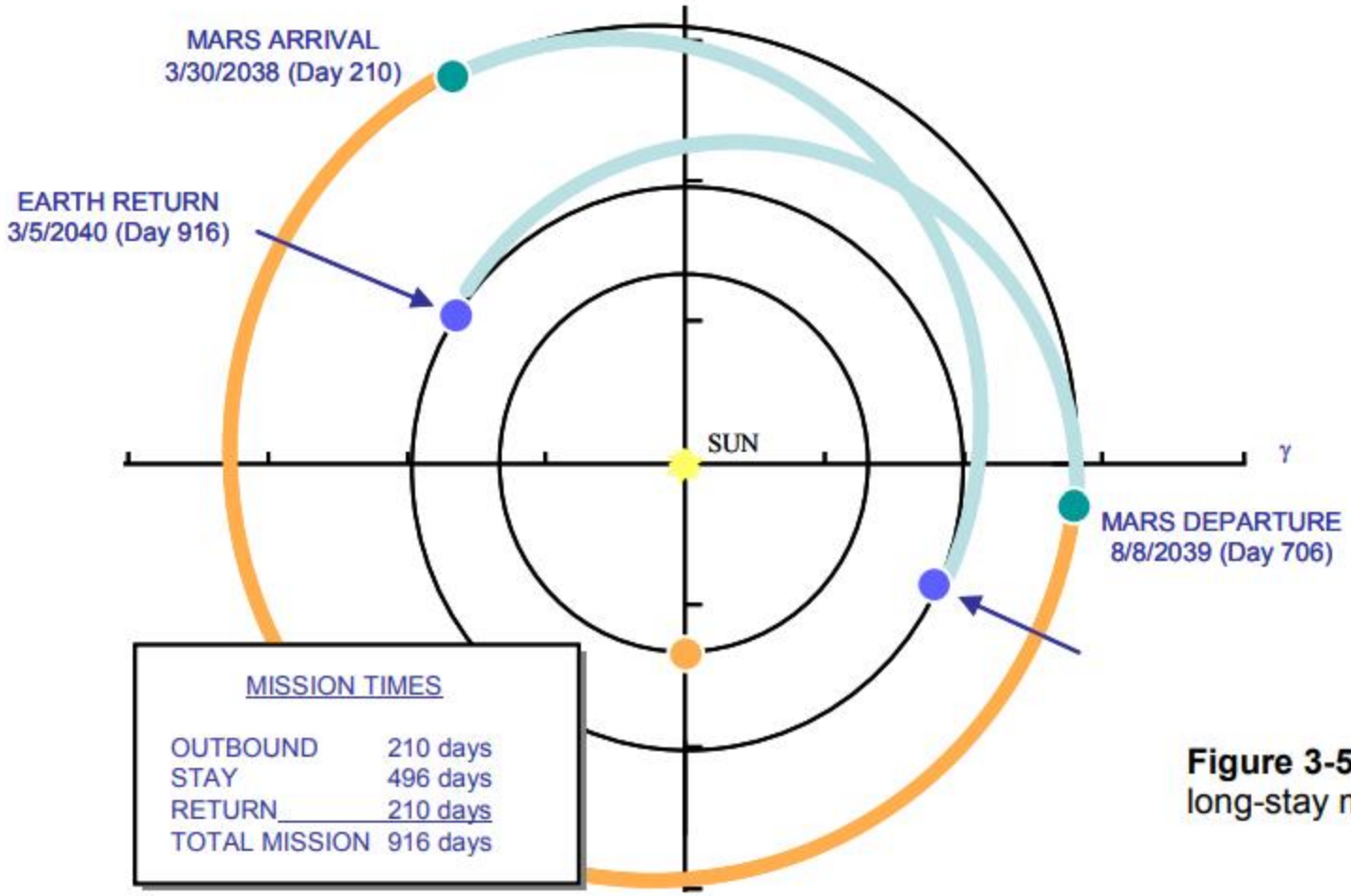



**Figure 3-5.** Typical Conjunction Class long-stay mission.

## *Crew Exploration Vehicle/Earth Return Vehicle*

**Figure 4-8.** Orion crew exploration vehicle.


Painting of a landing on Mars (1986)

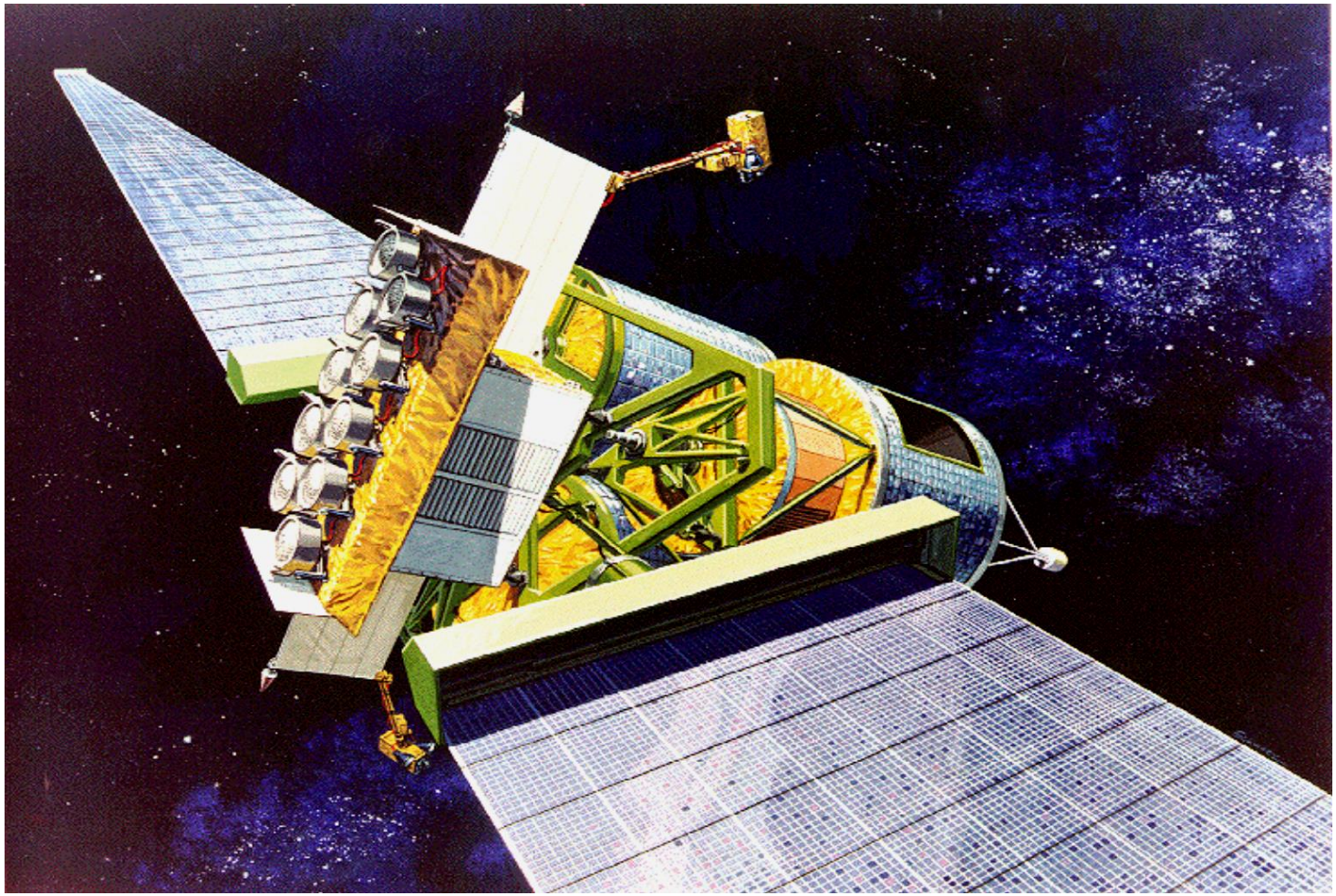

A **nuclear thermal rocket, NTR,** is a thermal rocket where the heat from a nuclear reaction replaces the chemical energy in a chemical rocket.

In an NTR, a working fluid, usually liquid hydrogen, is heated to a high temperature in a nuclear reactor and then expands through a rocket nozzle to create thrust.

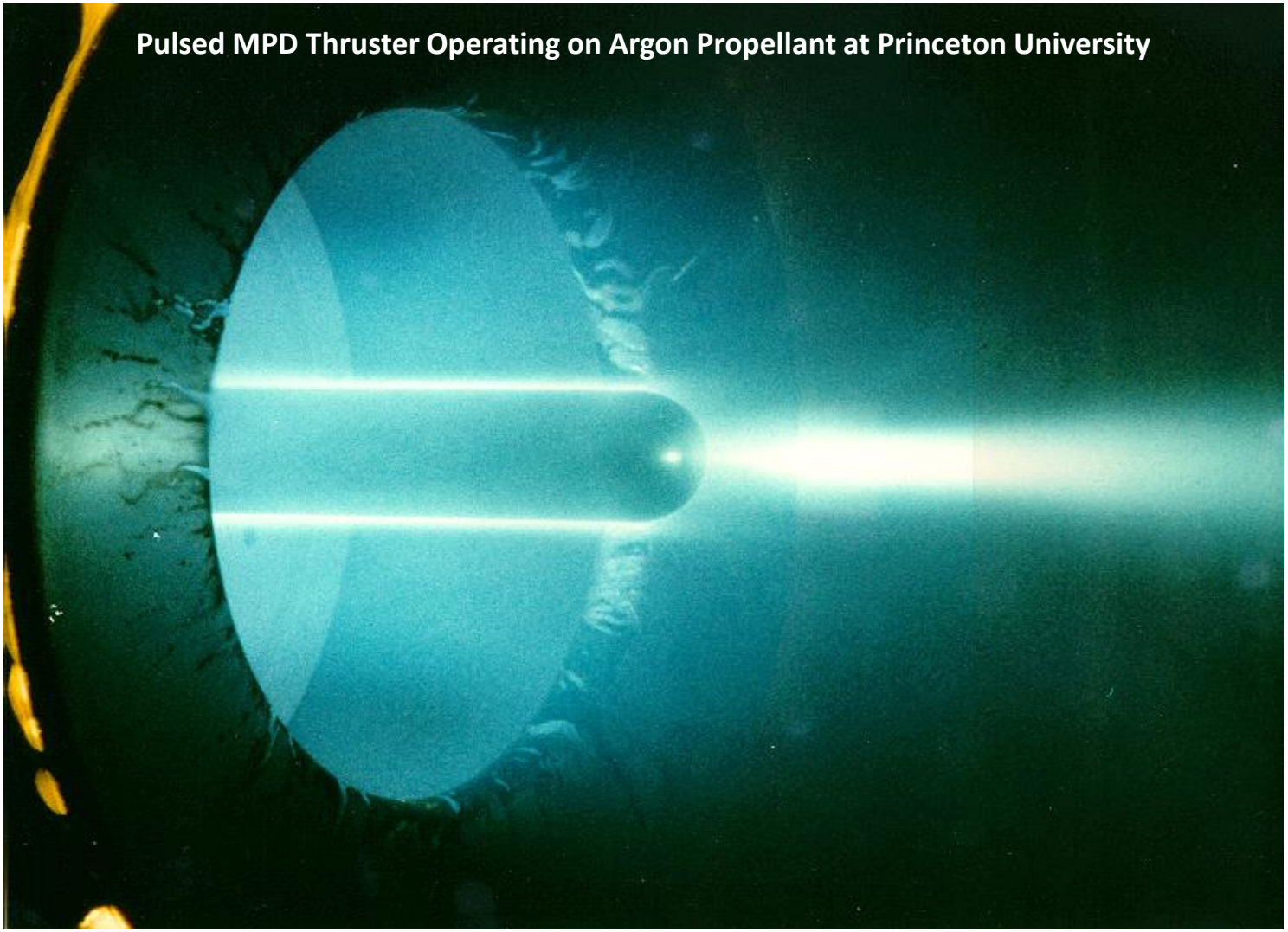
The external nuclear heat source theoretically allows a higher effective exhaust velocity and is expected to double or triple payload capacity compared to chemical propellants that store energy internally.


MTV-P02
Copernicus-B

# Solar Electric Propulsion Module

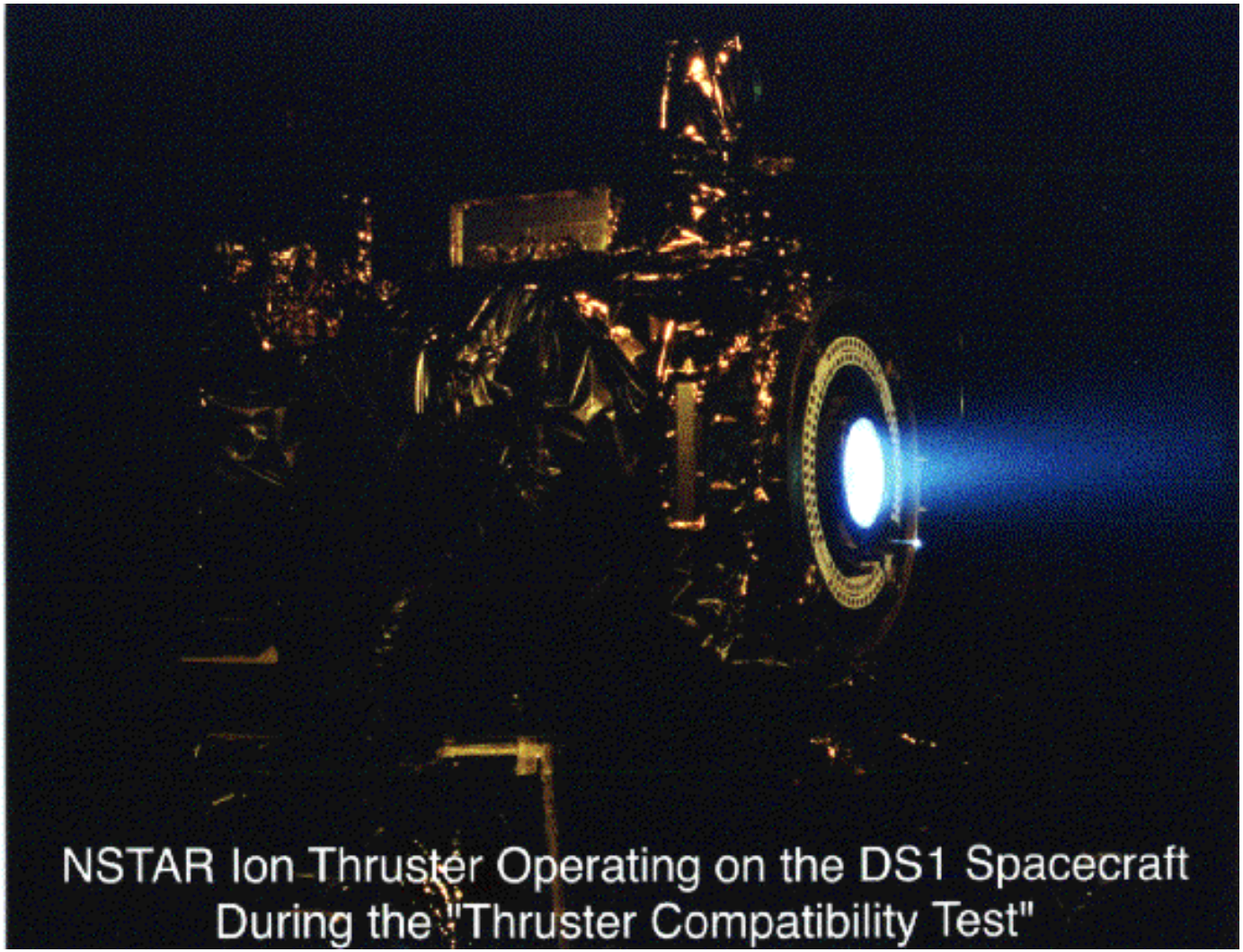


# Magneto Plasma Dynamic (MPD) Thruster



# Deep Space 1

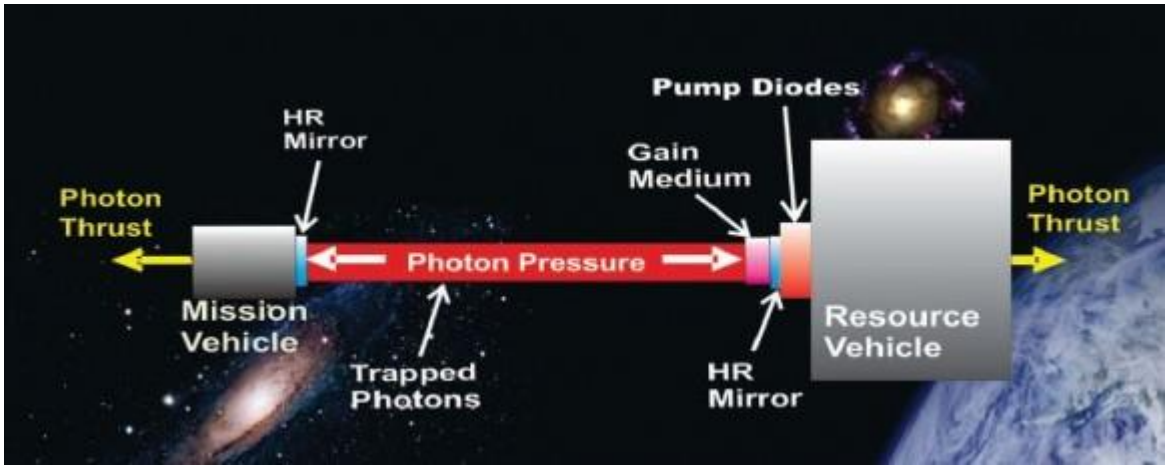
# Deep Space 1 Thruster / Spacecraft Compatibility Testing



February 24, 2016

**NASA thinks there's a way to get to Mars in three days**

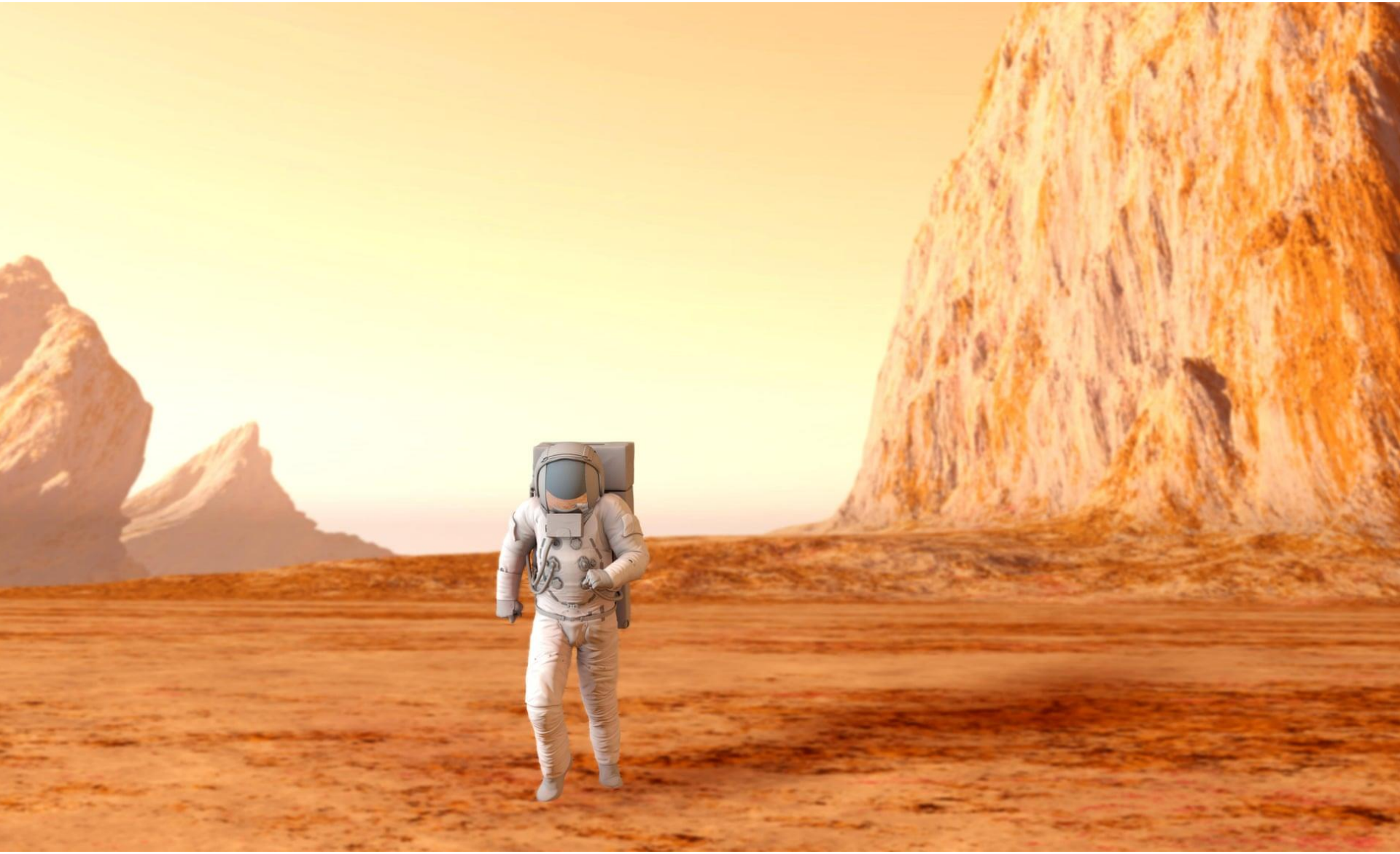
by Evan Gough, Universe Today




Physics Professor at the University of California, Santa Barbara, may have come up with something: photonic propulsion, which he thinks could reduce the travel time from Earth to Mars to just 3 days, for a 100 kg craft.

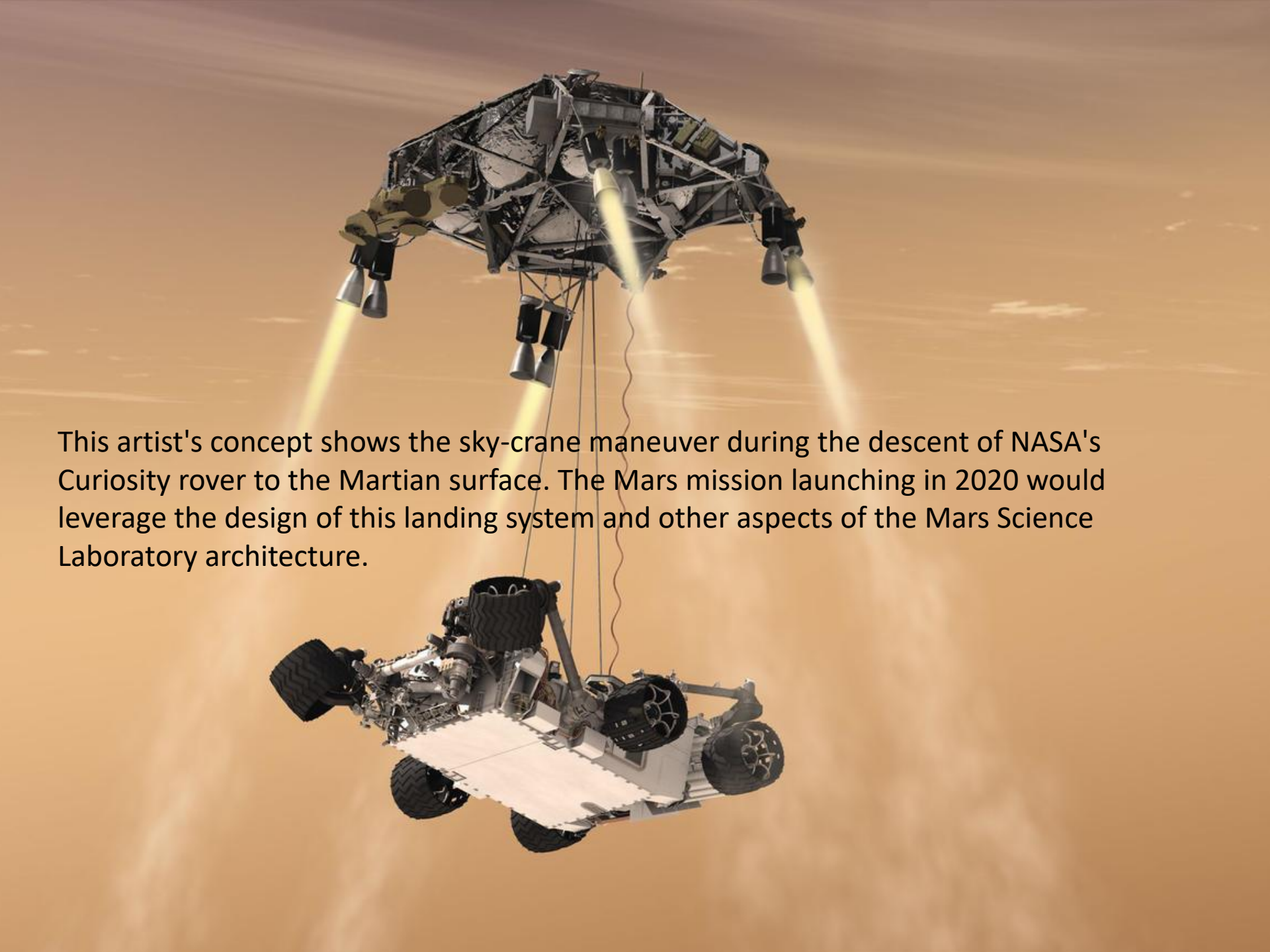
an interplanetary stage and lander stage come together over Mars

# Will we be ready to put a human footprint on Mars in 15 years?



11. januar 2018: In 15 years' time, will this be a photograph rather than an artist's impression?

China's new facility for making simulated Mars landings, which the country is using to prep for a Red Planet mission scheduled to launch in 2020.

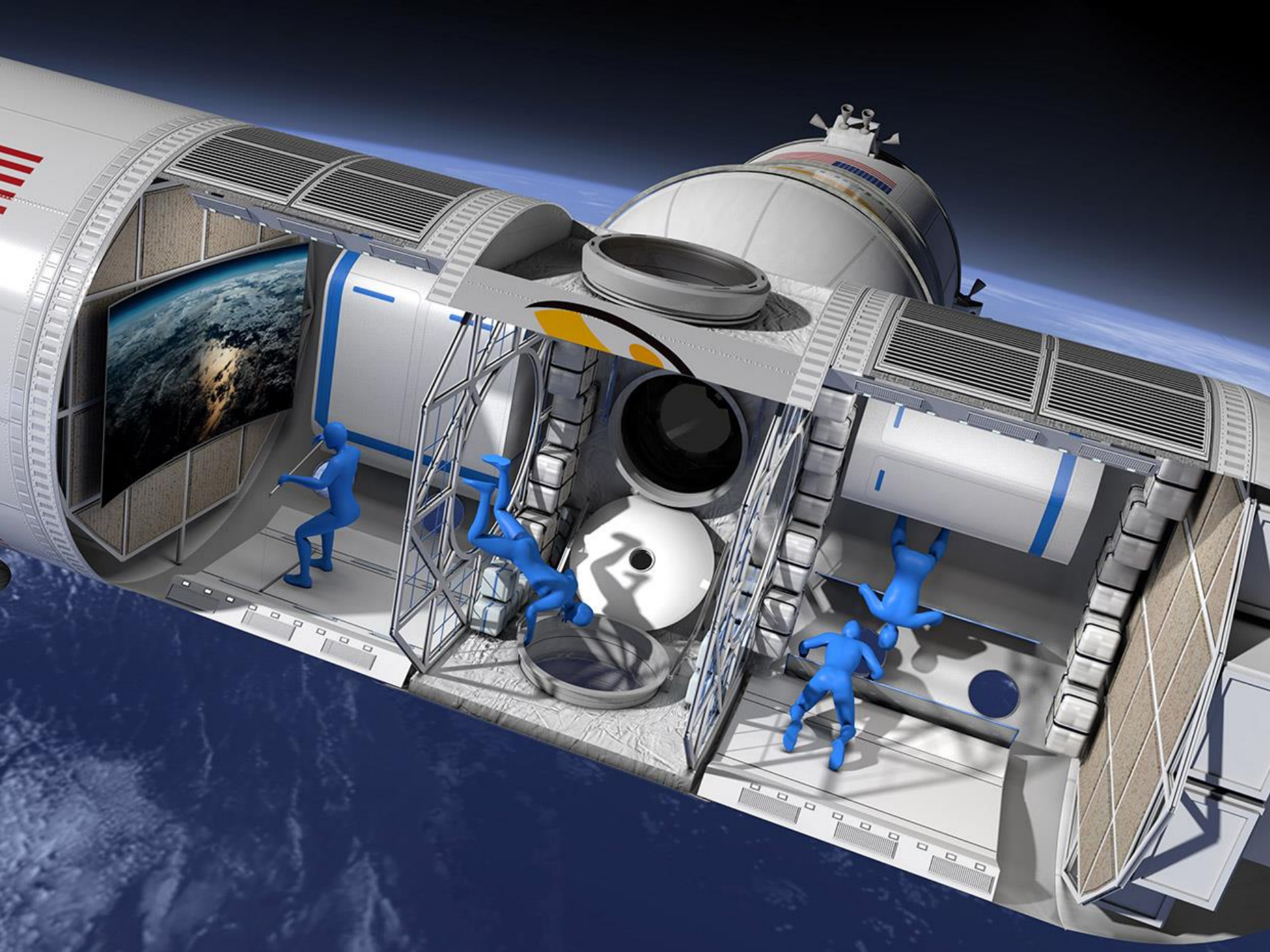


This artist's concept shows the sky-crane maneuver during the descent of NASA's Curiosity rover to the Martian surface. The Mars mission launching in 2020 would leverage the design of this landing system and other aspects of the Mars Science Laboratory architecture.

Kanskje en stopp på et romhotell på reisen til Mars vil være godt

Orion Span
Orion Span

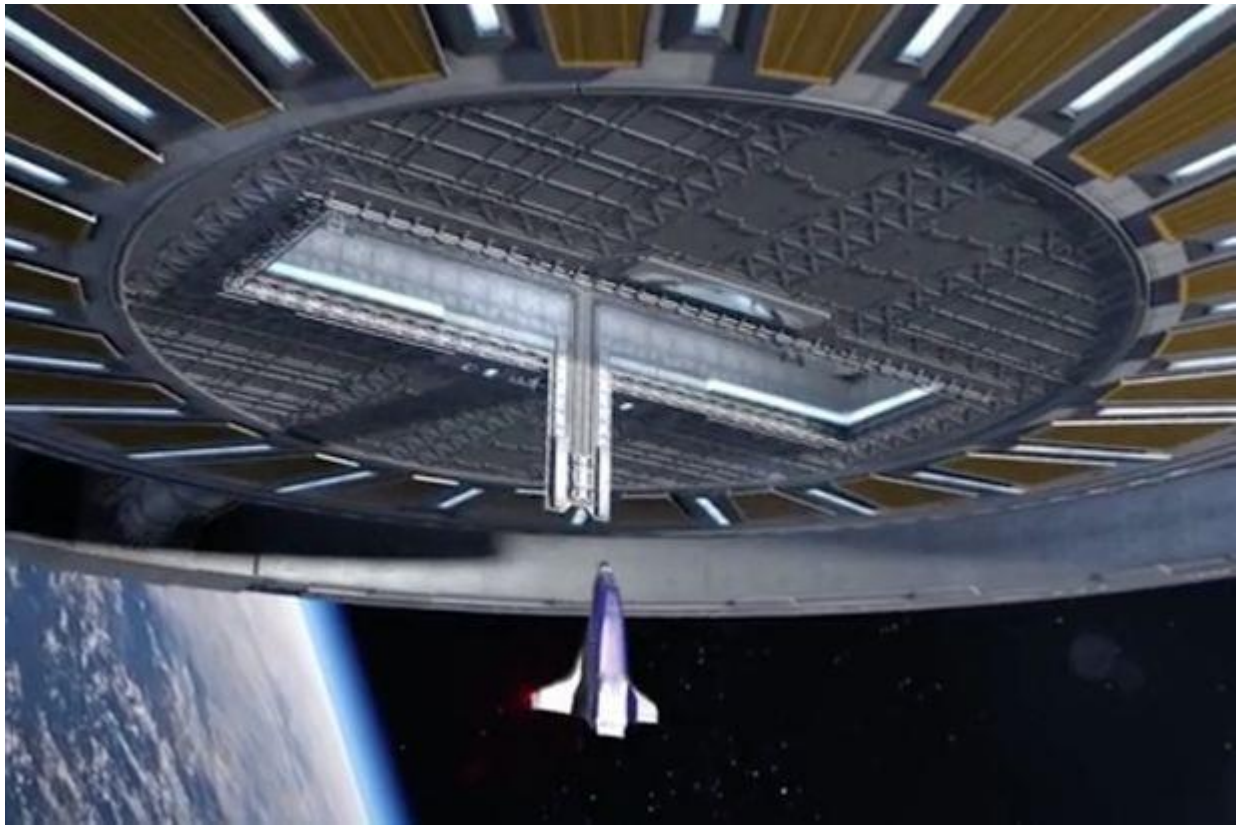

Orion



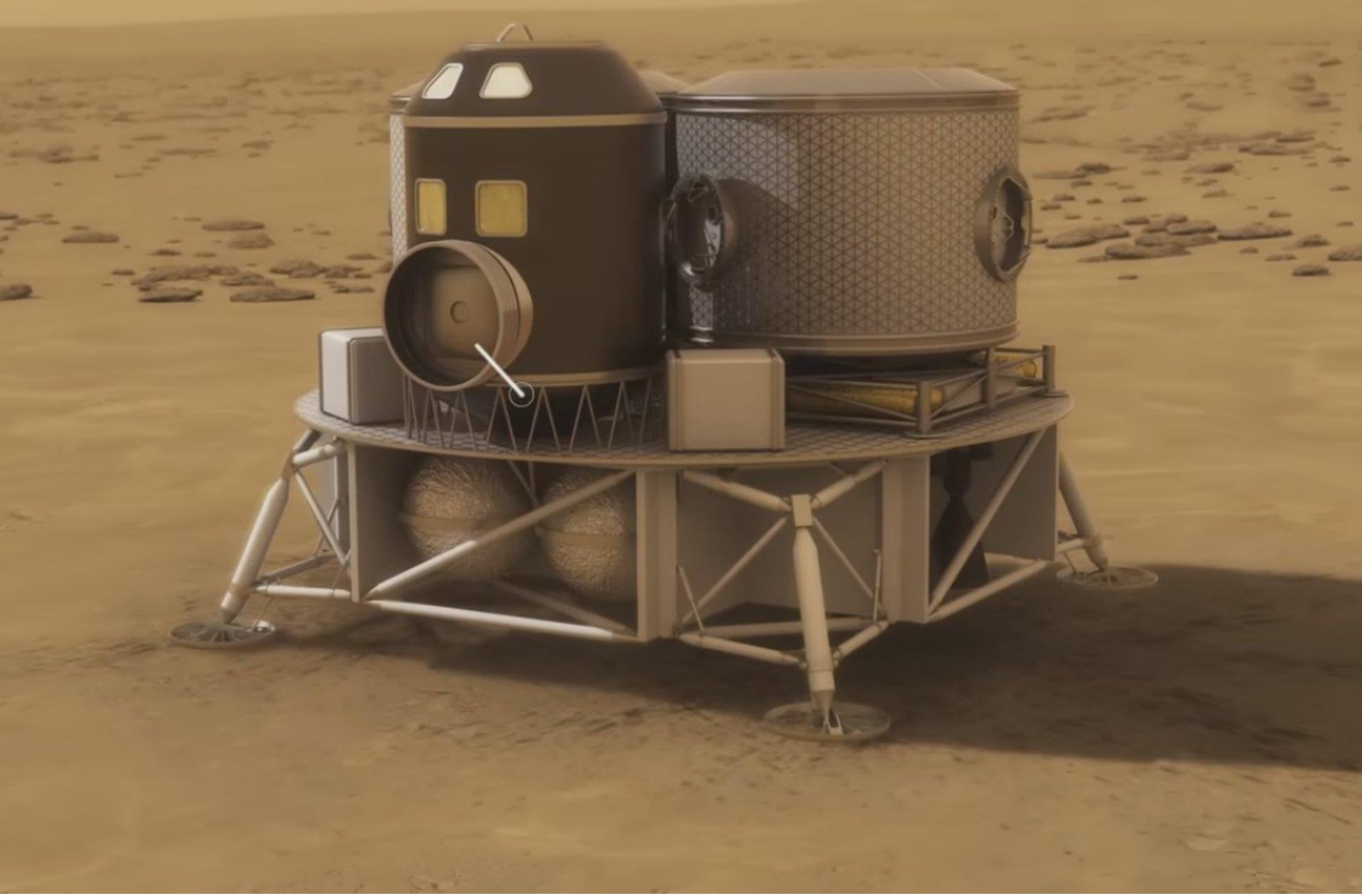
Von Braun Station
The space hotel could be open as early as 2025
THE GATEWAY FOUNDATION

The space hotel will have gravity so guests can walk around

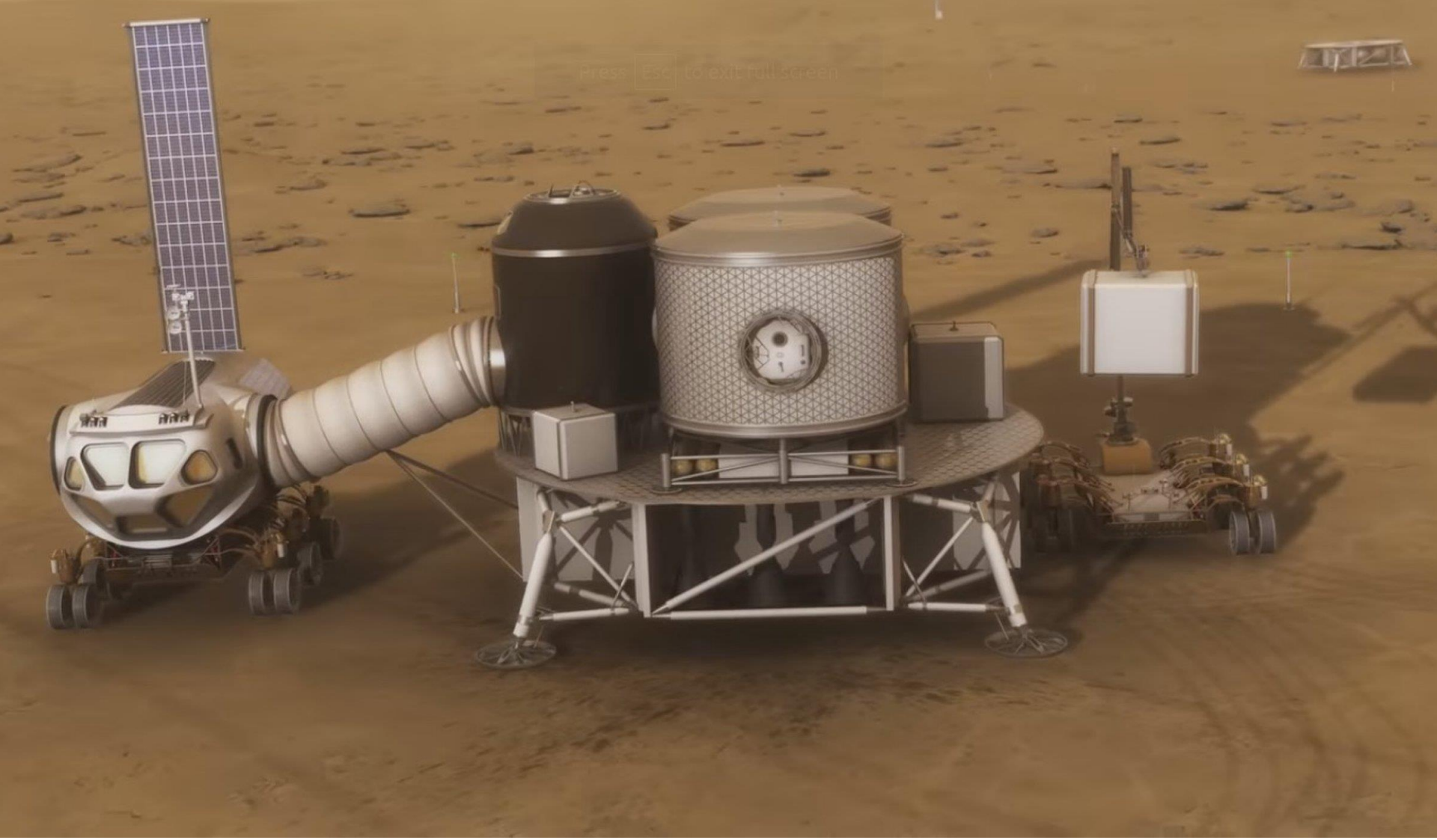
Guests will arrive by space shuttle



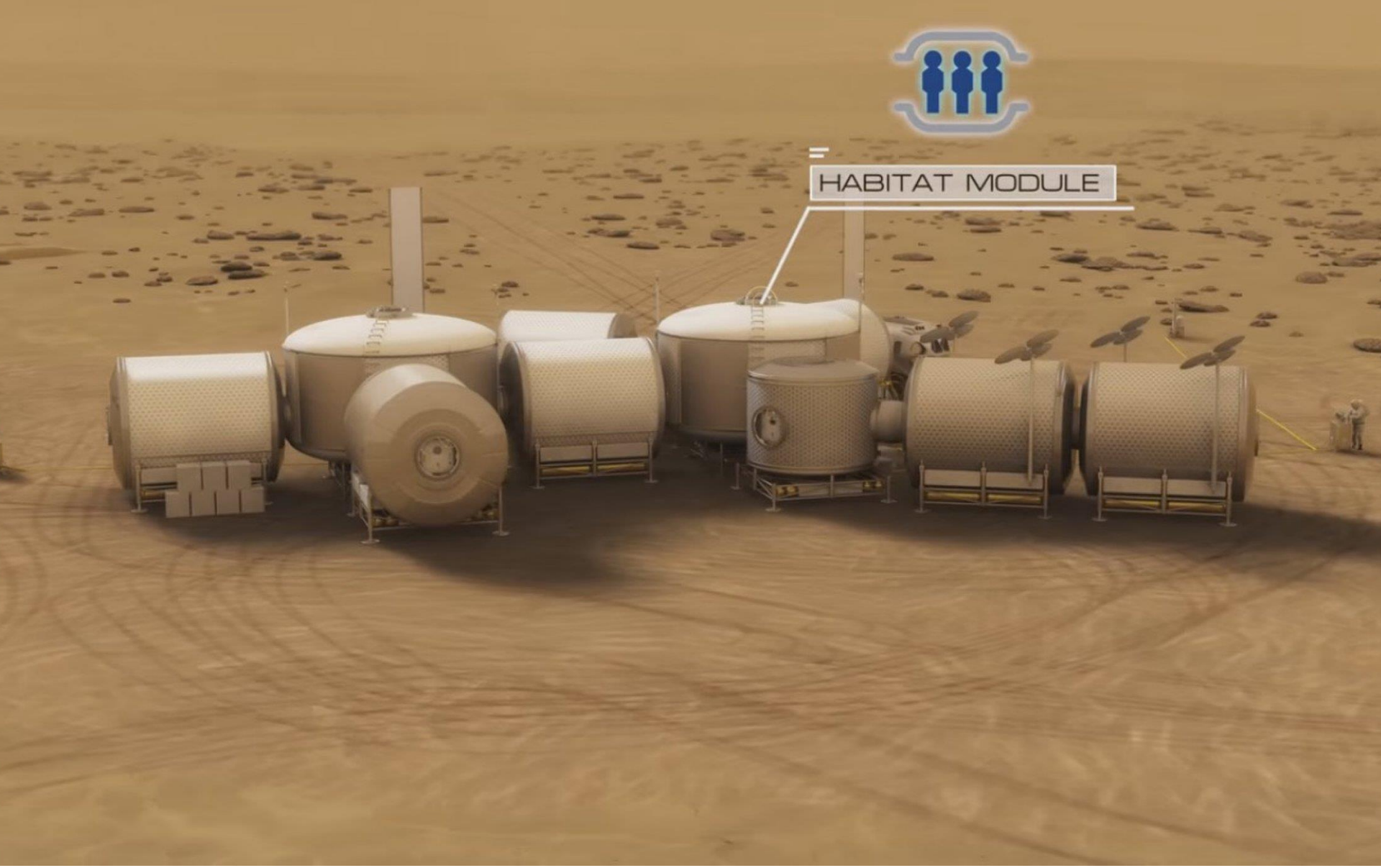
This is a spacecraft intended to bring humans to Mars. It is modeled after the Orion spacecraft that saw its first uncrewed test in 2014



This is the Mars crewed lander.



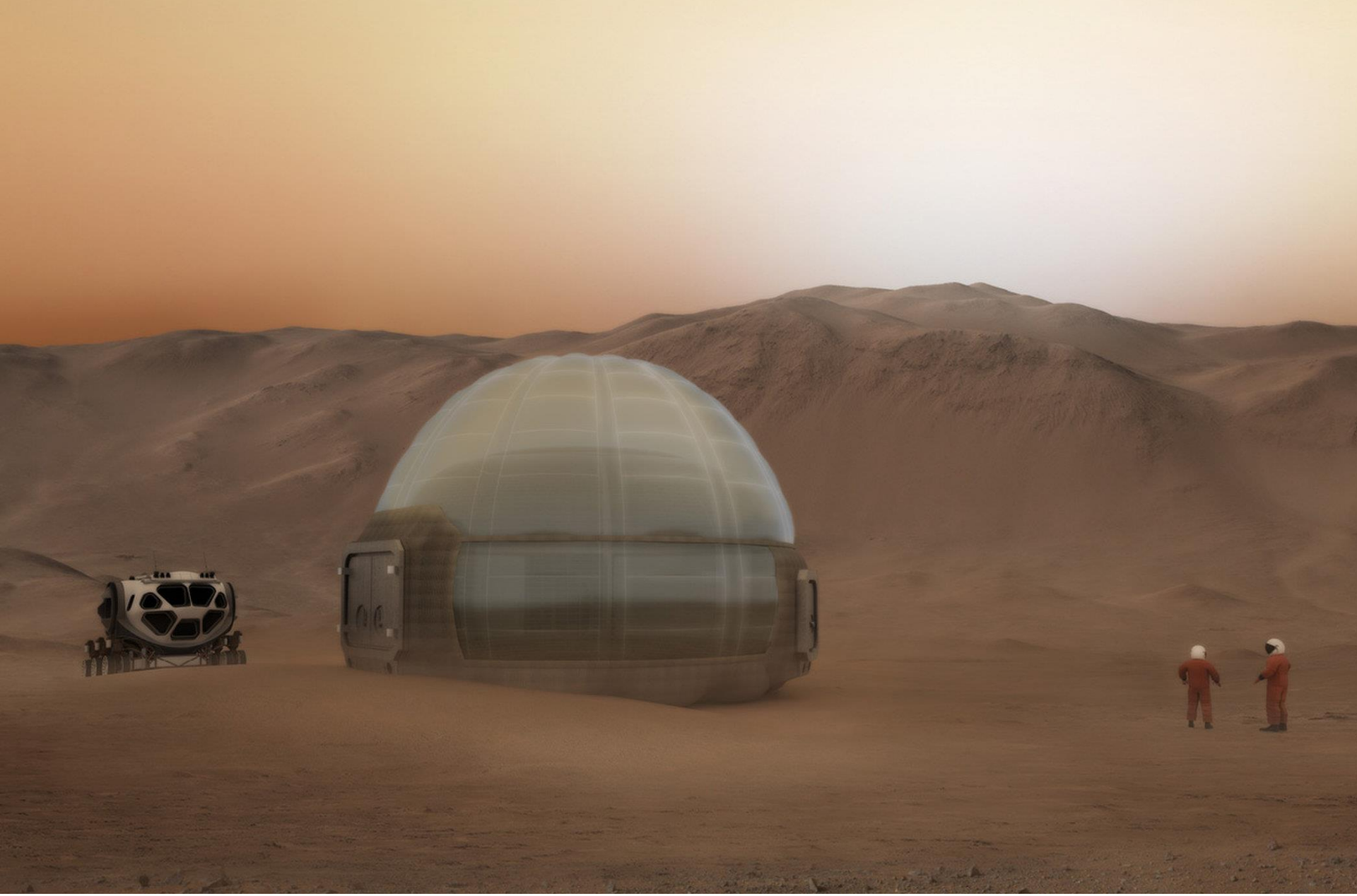
The crew will work in pressurized rovers
(seen at left, during a cargo transfer)



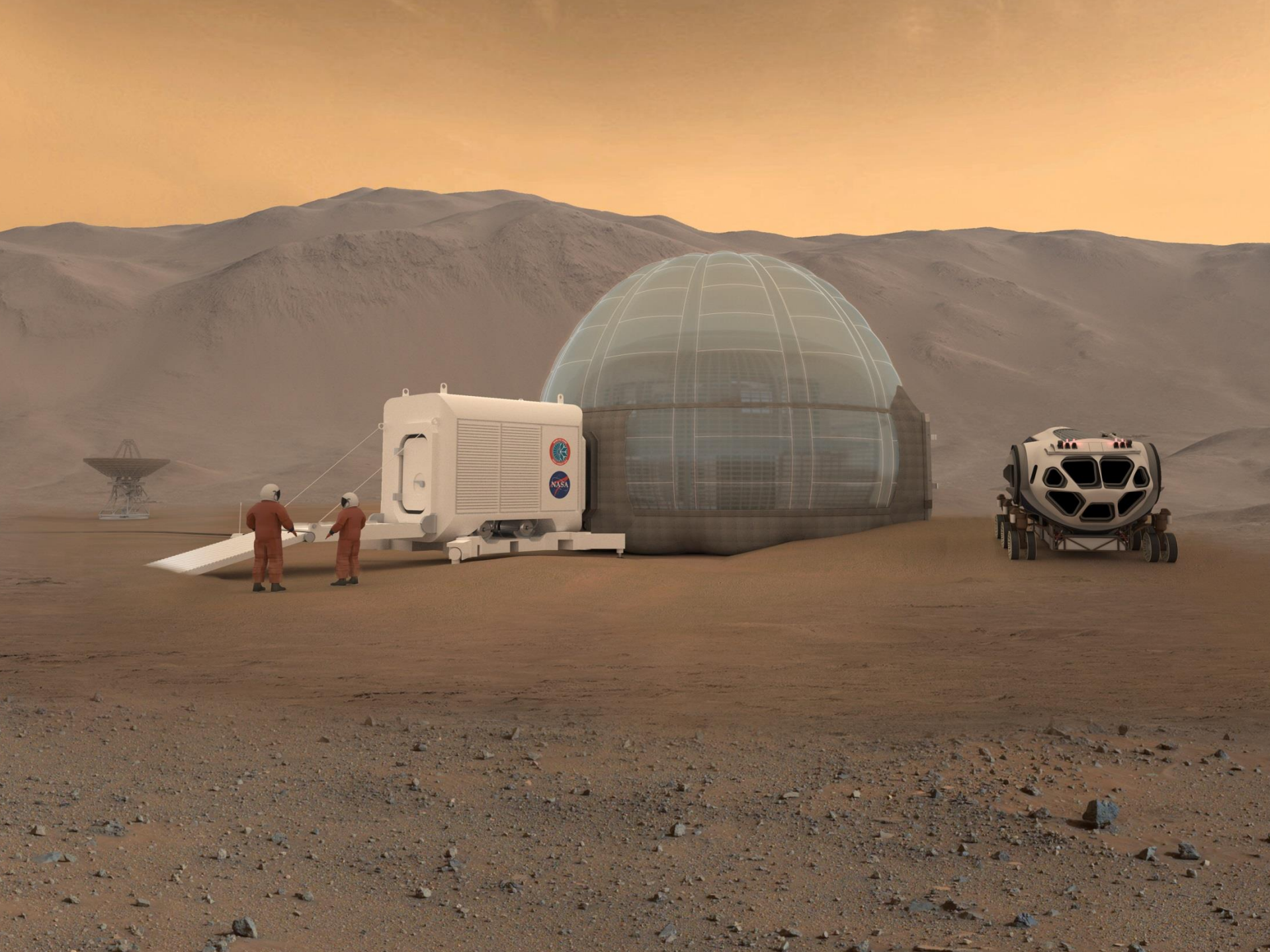

This is one concept for a Martian human base – NASA 2016. It includes logistics modules, an astrobiology lab, a science module and a habitat module. Rovers would attach directly to the modules so that astronauts could transfer directly to the vehicles without going outside.


First Humans On Mars (Artist Concept; 12 June 2019)

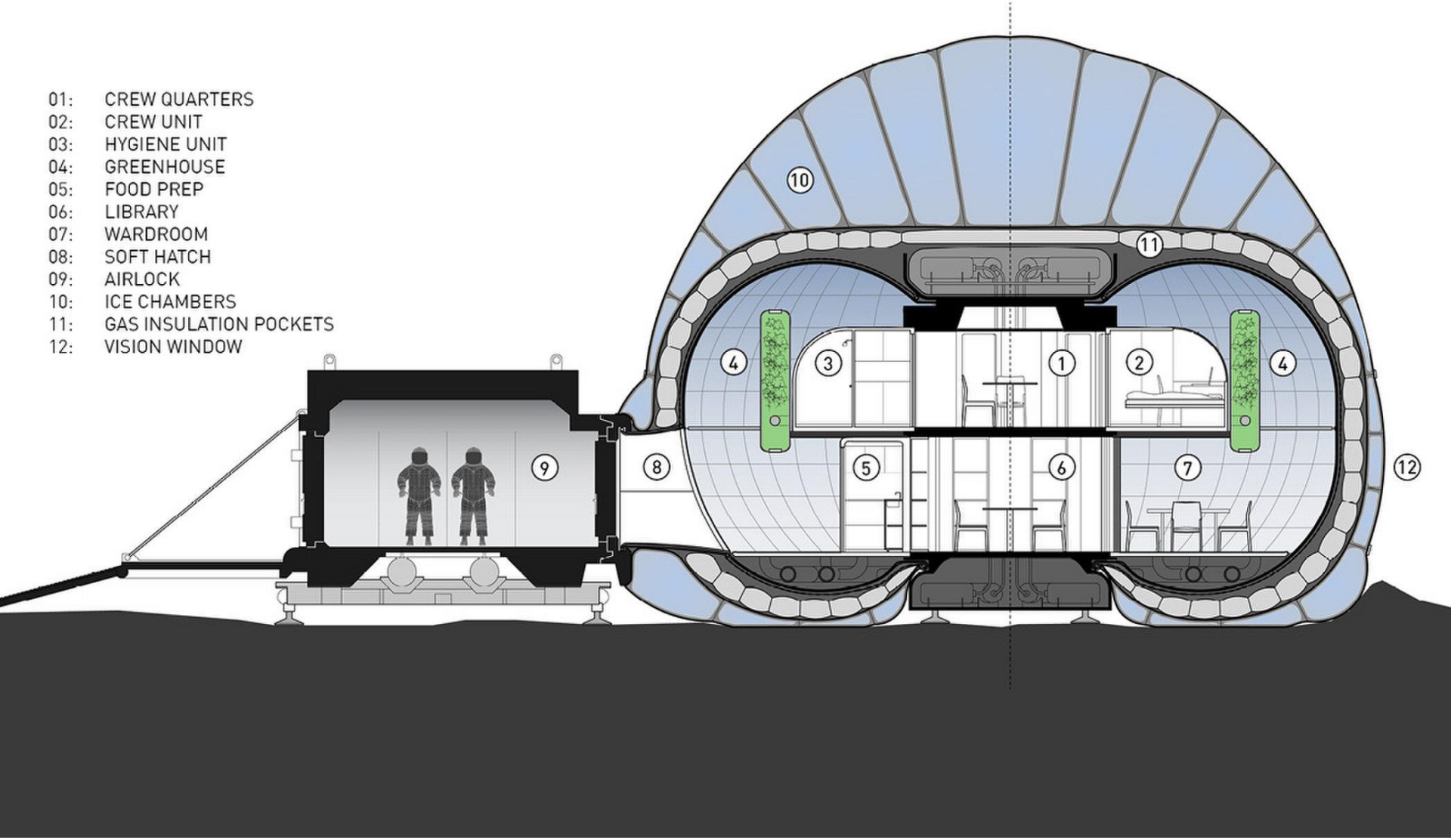
Mars Ice Home is a feasibility study conducted at NASA Langley Research Center in 2016. Responding to the problem of galactic cosmic radiation being the most significant issue for human health on long duration Mars surface missions.



Future colonists stand outside the Mars Ice Home, which was designed as part of a feasibility study at NASA Langley Research Center in 2016 in collaboratioon with SEArch+ and CloudsAO.

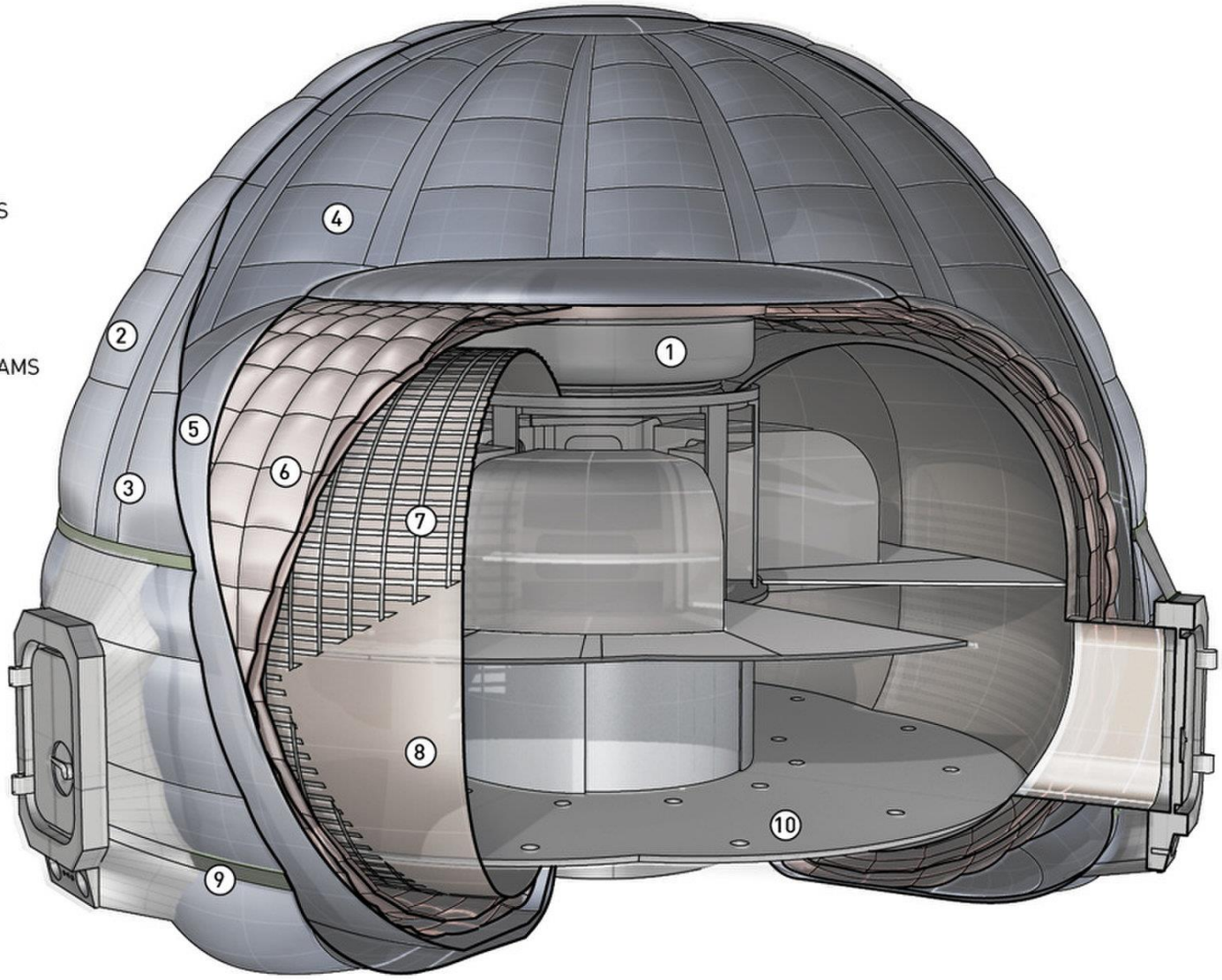

NASA

A view inside the Mars base. While mission control is a radio call away, astronauts will need to wait an average of 20 minutes for a response. This will require them to do much of the work themselves, requiring lots of training for matters such as maintenance.
The pictured facility is capable of doing several things. One option is rapid prototyping, which means manufacturing things on-site using computer-aided design (such as 3D printing).




In order for future crewed missions to survive life on the Red Planet, there are a number of safety features that must be in place in the structures that they stay in. The Mars Ice Home ensures the safety and comfort of these brave astronauts by including a hygiene unit, an airlock, and plenty of room in the crew quarters.

01: WATER BLADDER
02: OUTER LAYER: BETA CLOTH
03: STRUCTURAL VERTICAL SEAMS
04: ICE CHAMBER LAYER
05: MYLAR INTERLAYER
06: CO2 INSULATION POCKETS
07: RESTRAINT LAYER
08: BLADDER AND SCUFF LAYERS
09: STRUCTURAL HORIZONTAL SEAMS
10: HVAC CONCEALED IN FLOOR

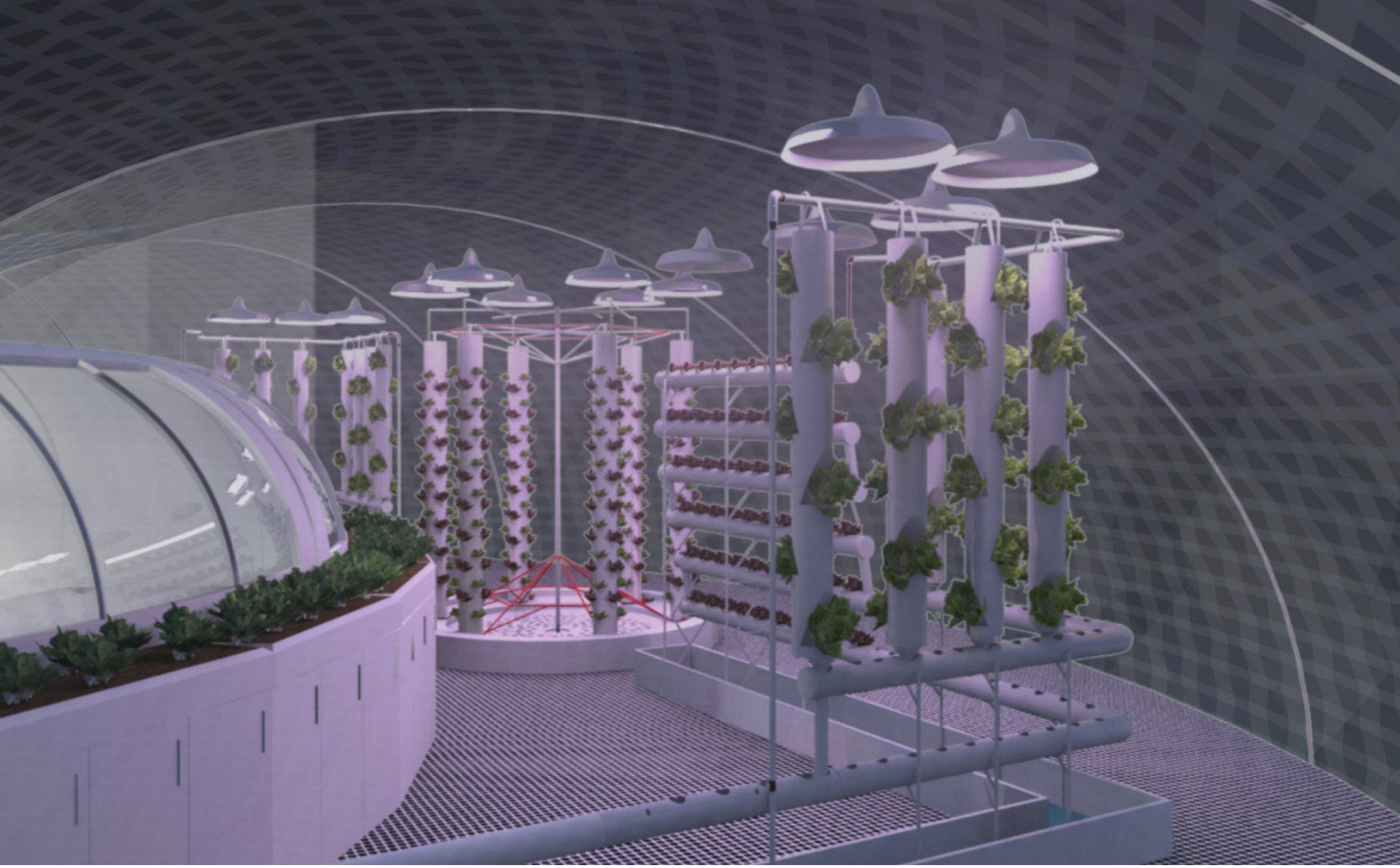



The many layers of the Mars Ice Home ensure that future residents on the Red Planet will be safe from the dangers that the planet presents. The structure maintains a safe atmospheric pressure and will protect astronauts from harmful radiation and the dust storms that happen frequently on the planet.

Depiction of plants growing in a Mars base.
NASA plans to grow plants for space food.

There are comfortable quarters for the crew who would inhabit the Mars Ice Home. Equipped with a bed and a desk, each "room" is fairly spacious (at least as far as astronaut sleeping arrangements are concerned). The rooms are simply designed, but brightly lit and made for comfort and utility.

At night, astronauts have access to nighttime lighting in their quarters. Rooms may also have hydroponic plant systems within them, which are not ony functional, they also add a bright and cheery pop of color and reminder of home to the room.

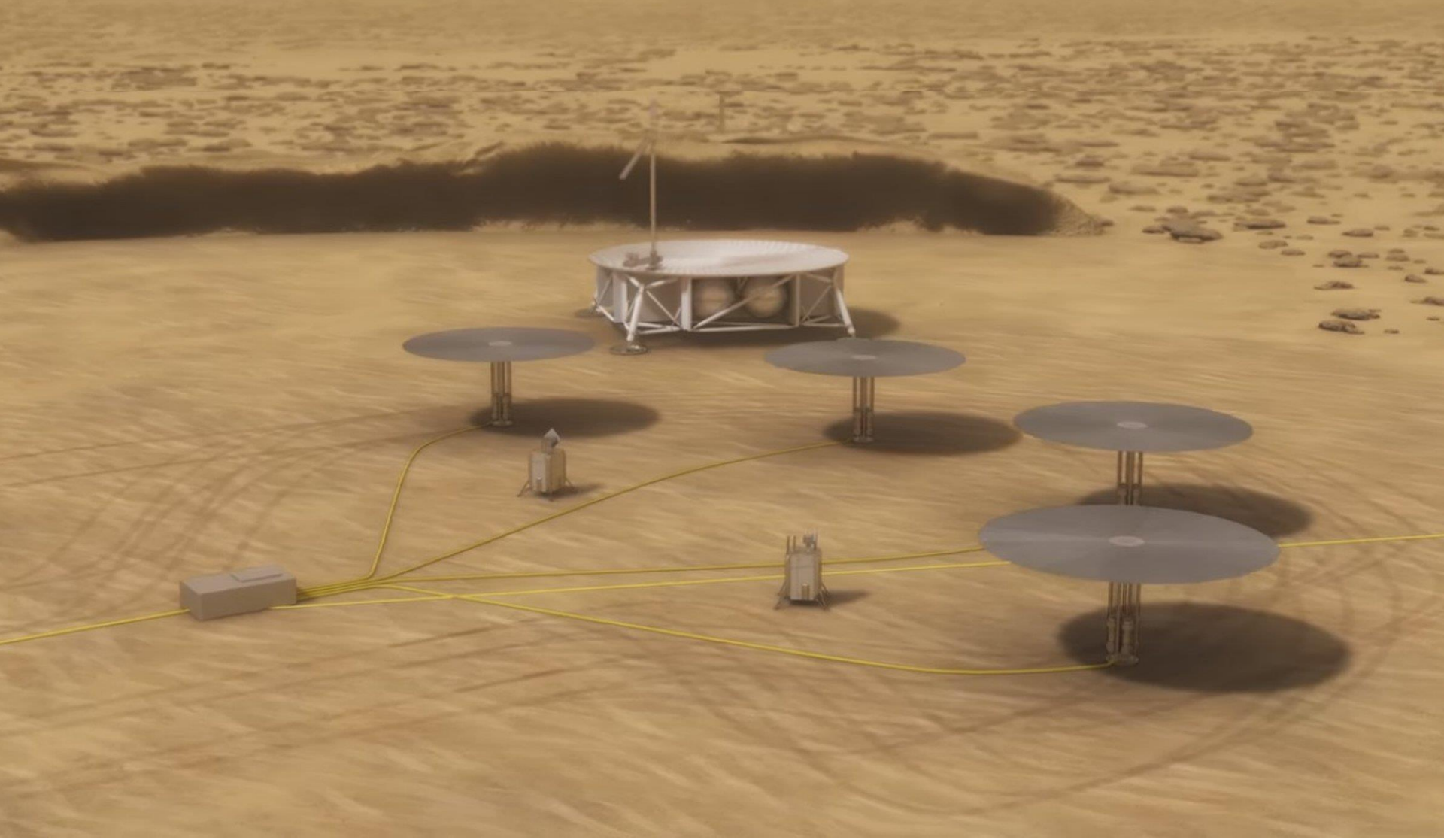


There is a greenhouse within the Mars Ice Home. Likely using hydroponic growing techniques, future colonists will be able to not only experiment with growing food and plant-life on Mars, they will also be able to sustain for longer periods of time on the planet through modern agriculture within the structure.


Mars greenhouses
feature in many
colonization designs

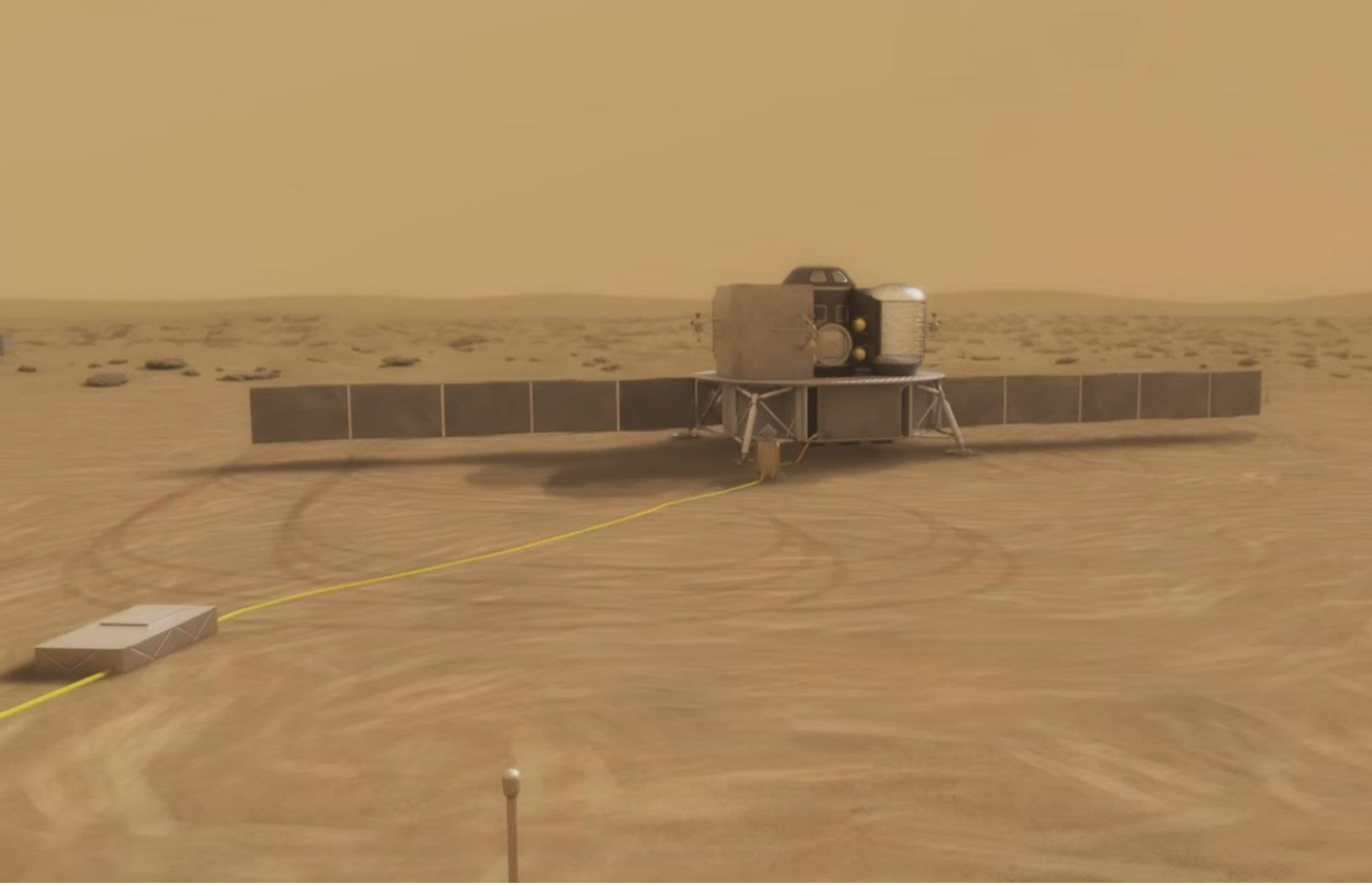
person in a spacesuit on Mars

Artist's concept of crew members setting up
weather monitoring equipment on the surface of Mars

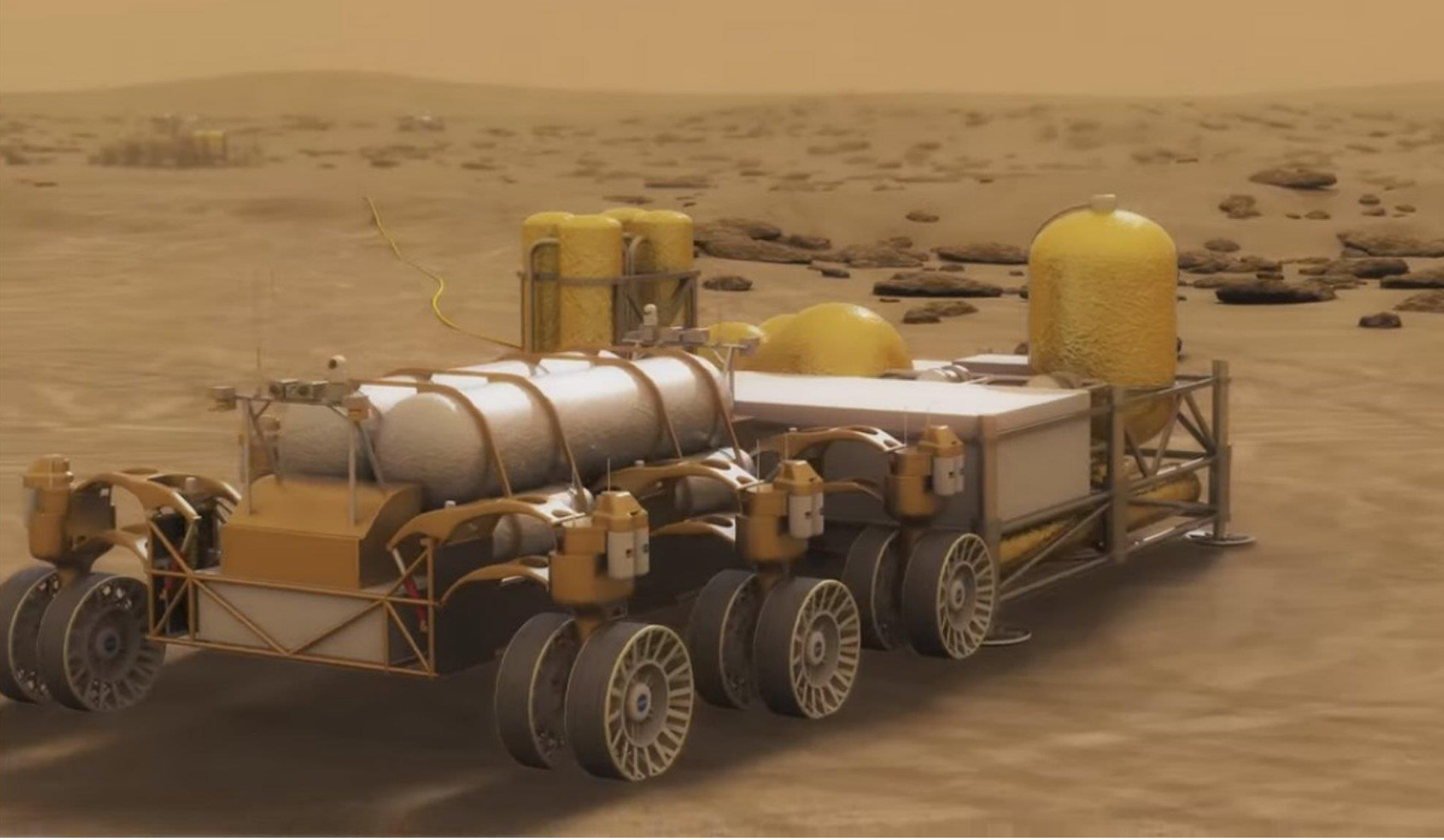


**Solar Power Station on Mars**

Mars happens to be a very harsh environment, with strong sandstorms and deep-freezing cold nights. Designing a reliable power system to withstand all of this will be the utmost engineering challenge. This is why one will use multiple power systems; if one fails, others could pick up the slack until repairs take place.

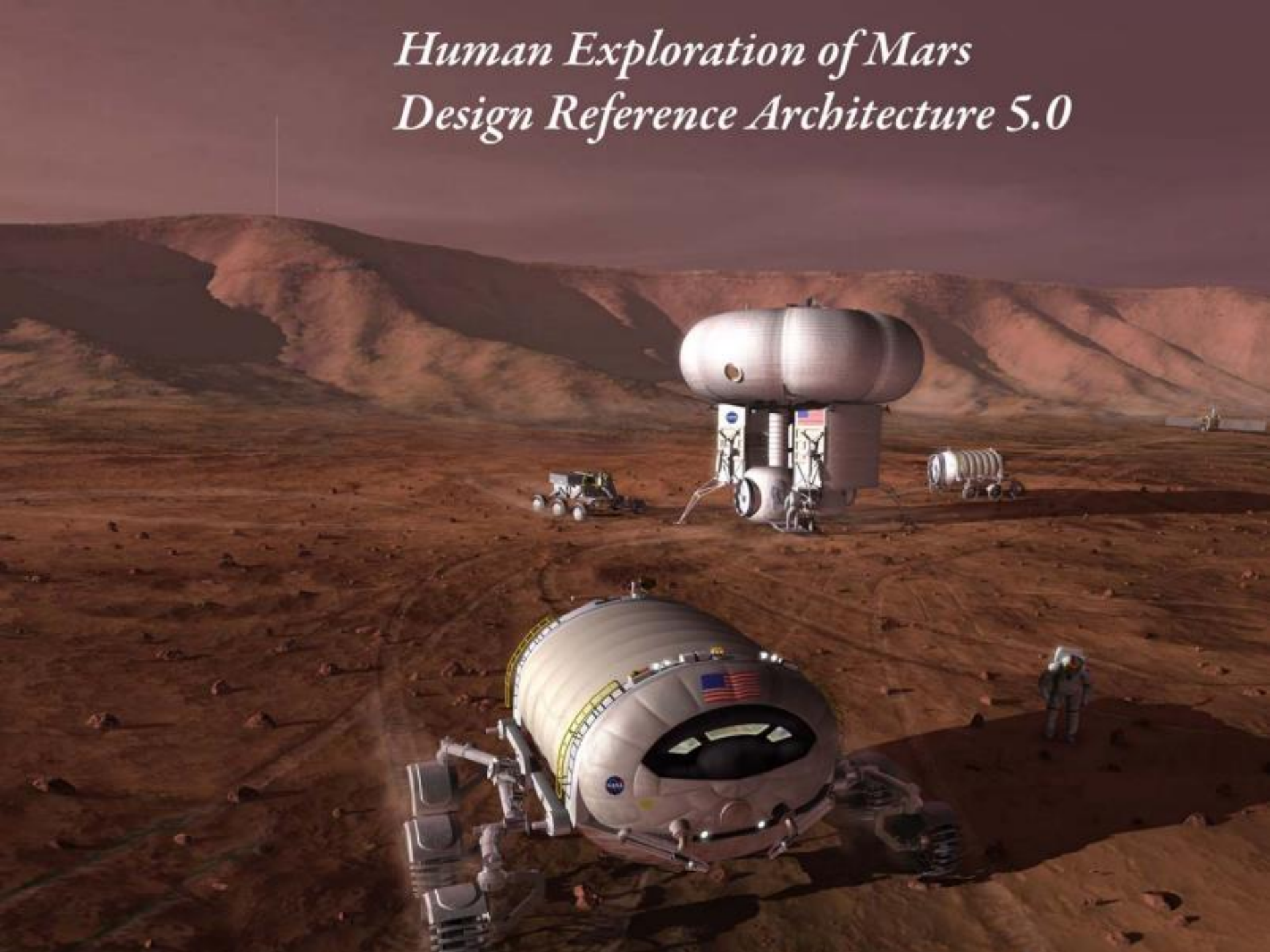


This spacecraft, called the Mars Ascent Vehicle Lander, is supposed to be the astronauts' trip home to Earth. The descent and ascent craft are different in this artist's conceptualization. This is to save weight.



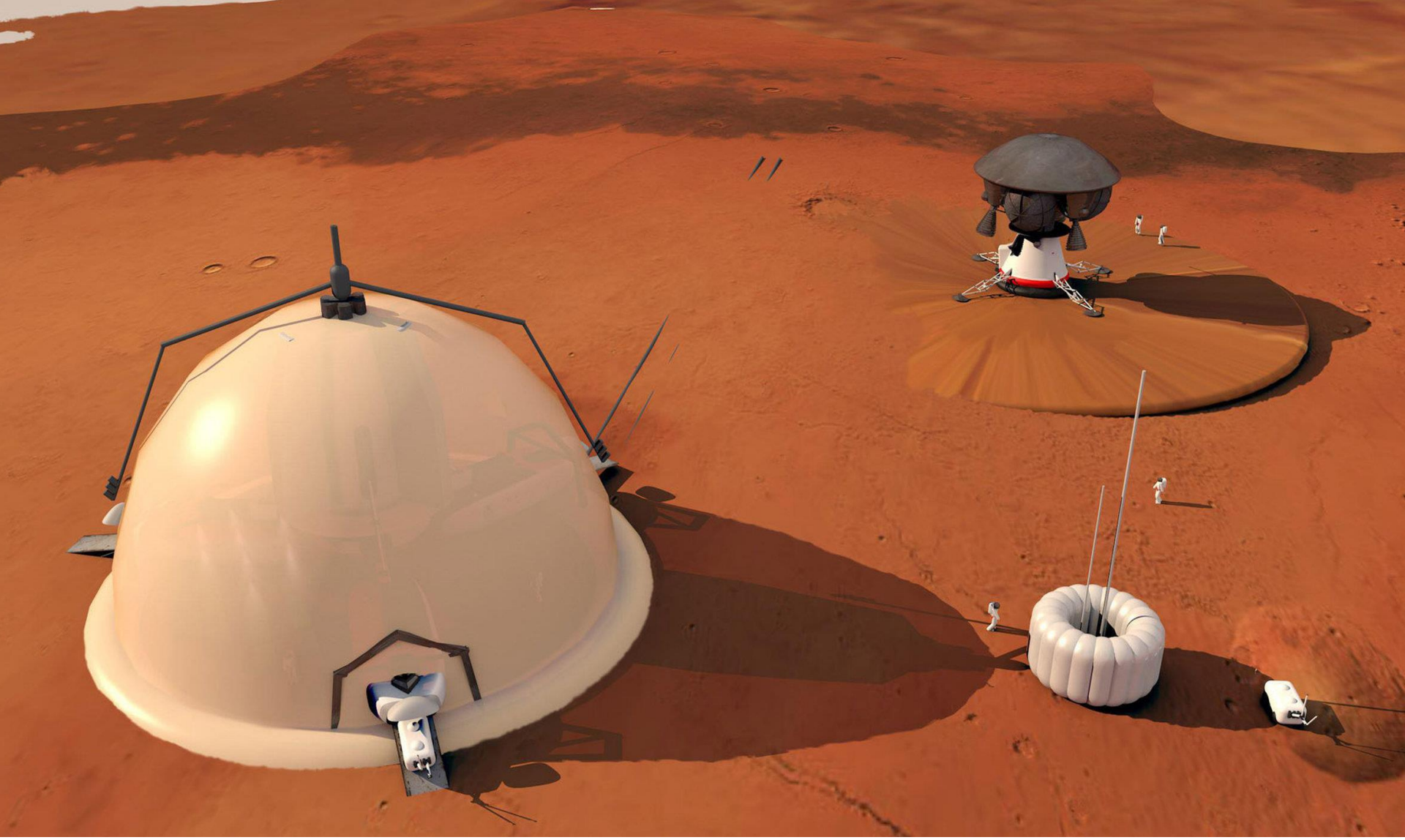
Shown here is a propellant production and transportation station, located not far from a facility that mines regolith (Martian dust).

# *Human Exploration of Mars Design Reference Architecture 5.0*



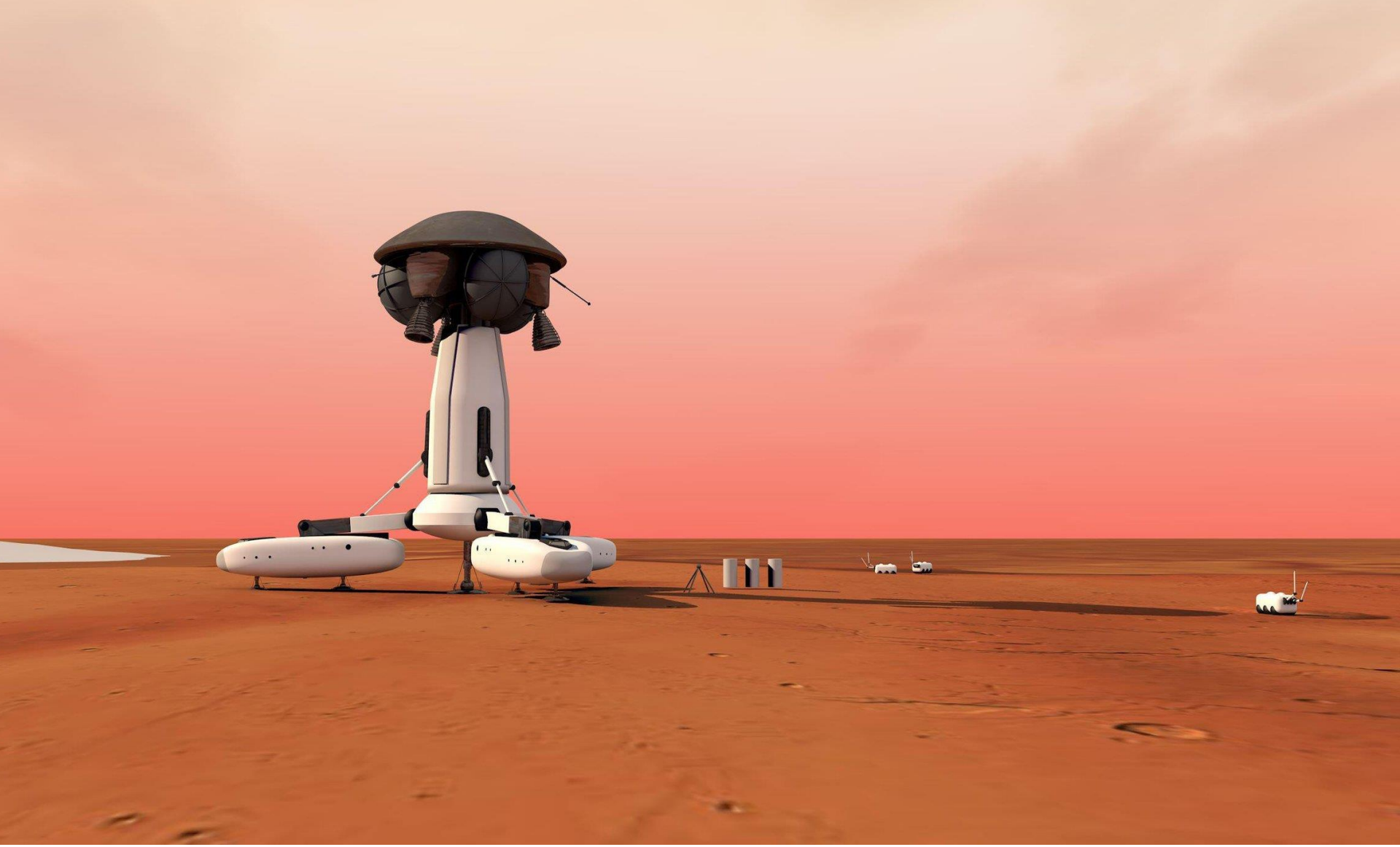
**Mobile Home** – An artist's concept depicting long-range exploration by using pressurized rovers on the surface of Mars.


6
HUDSON



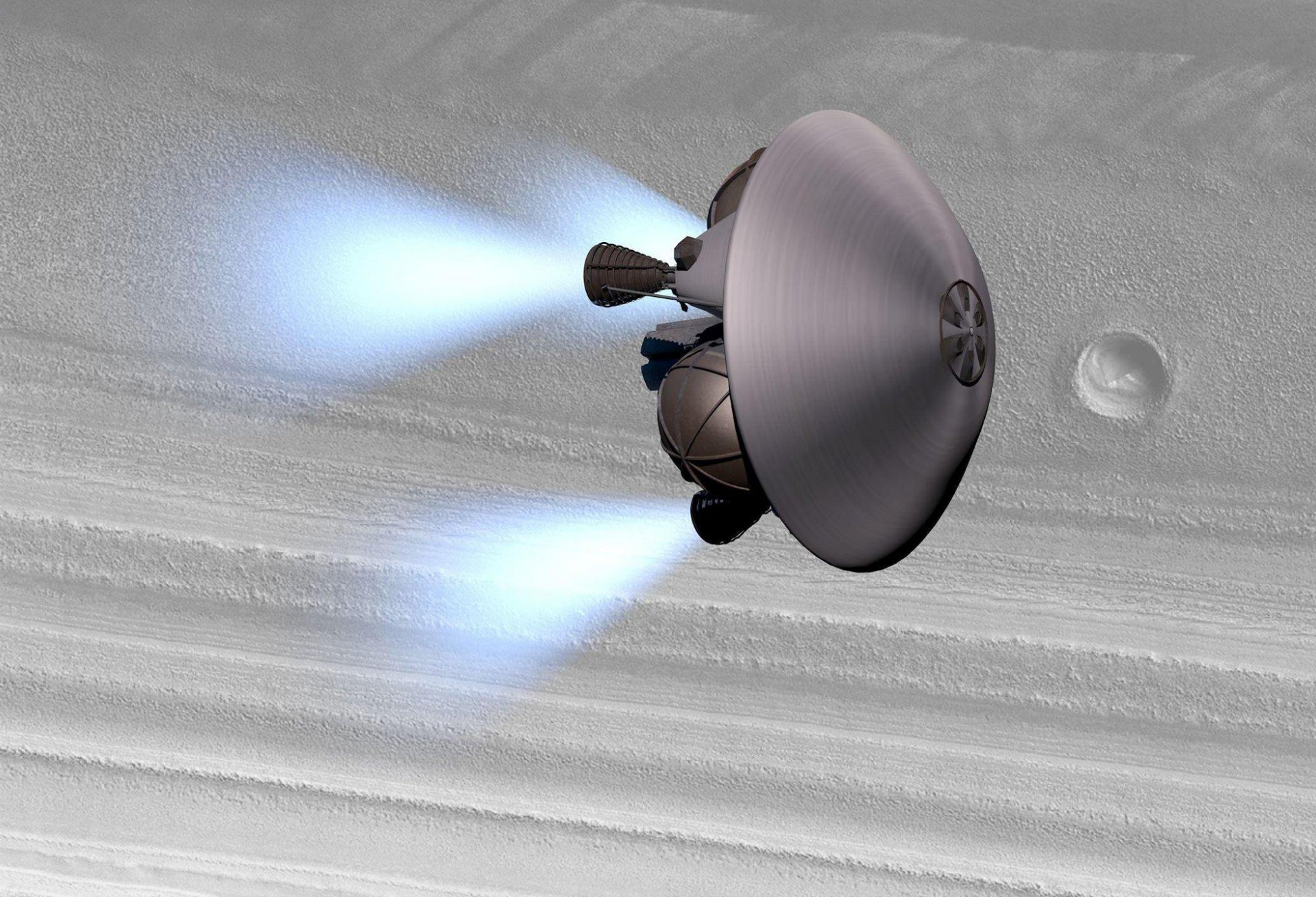
This artist's illustration depicts a novel Mars colony base concept by researchers at Switzerland's Federal Polytechnic School in Lausanne, which would use an igloo-like habitat near the Martian north pole as a home for astronauts.

Crane landing with crew module, artist view.



Crane landing, artist view.

Crane take off, artist view.

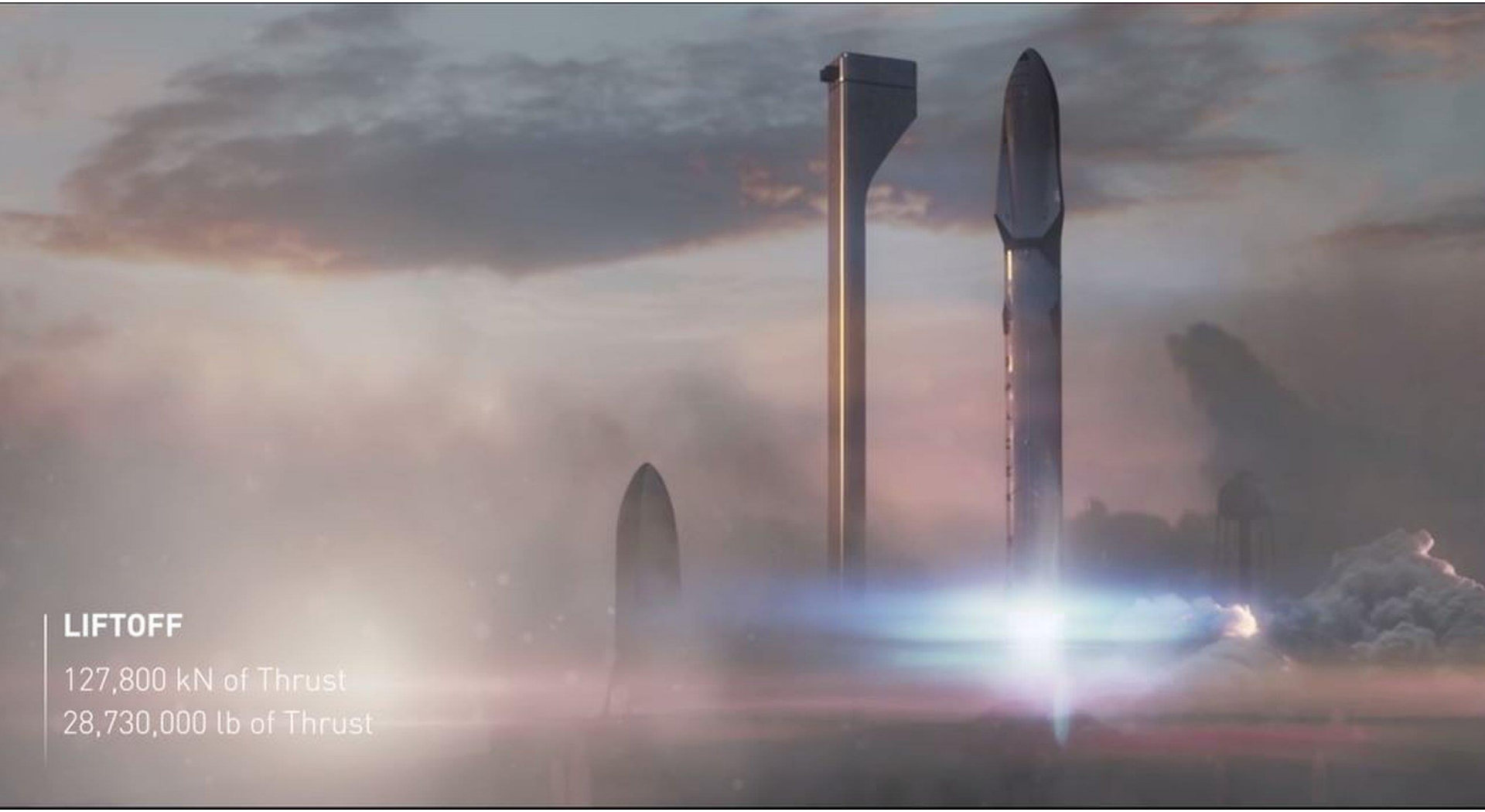


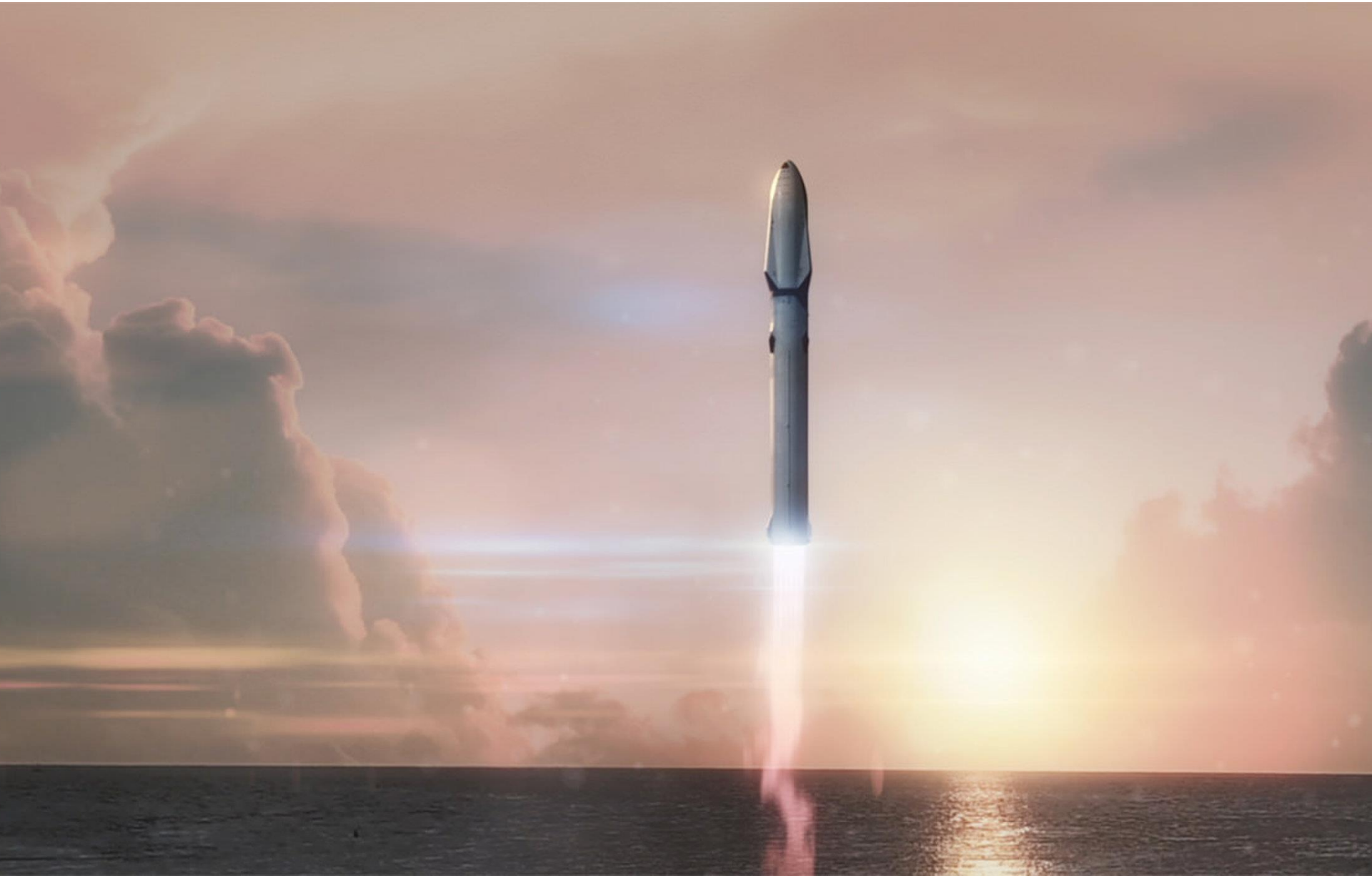
Crane on orbit, artist view.

# SpaceX Interplanetary Transport System Preparing for Launch

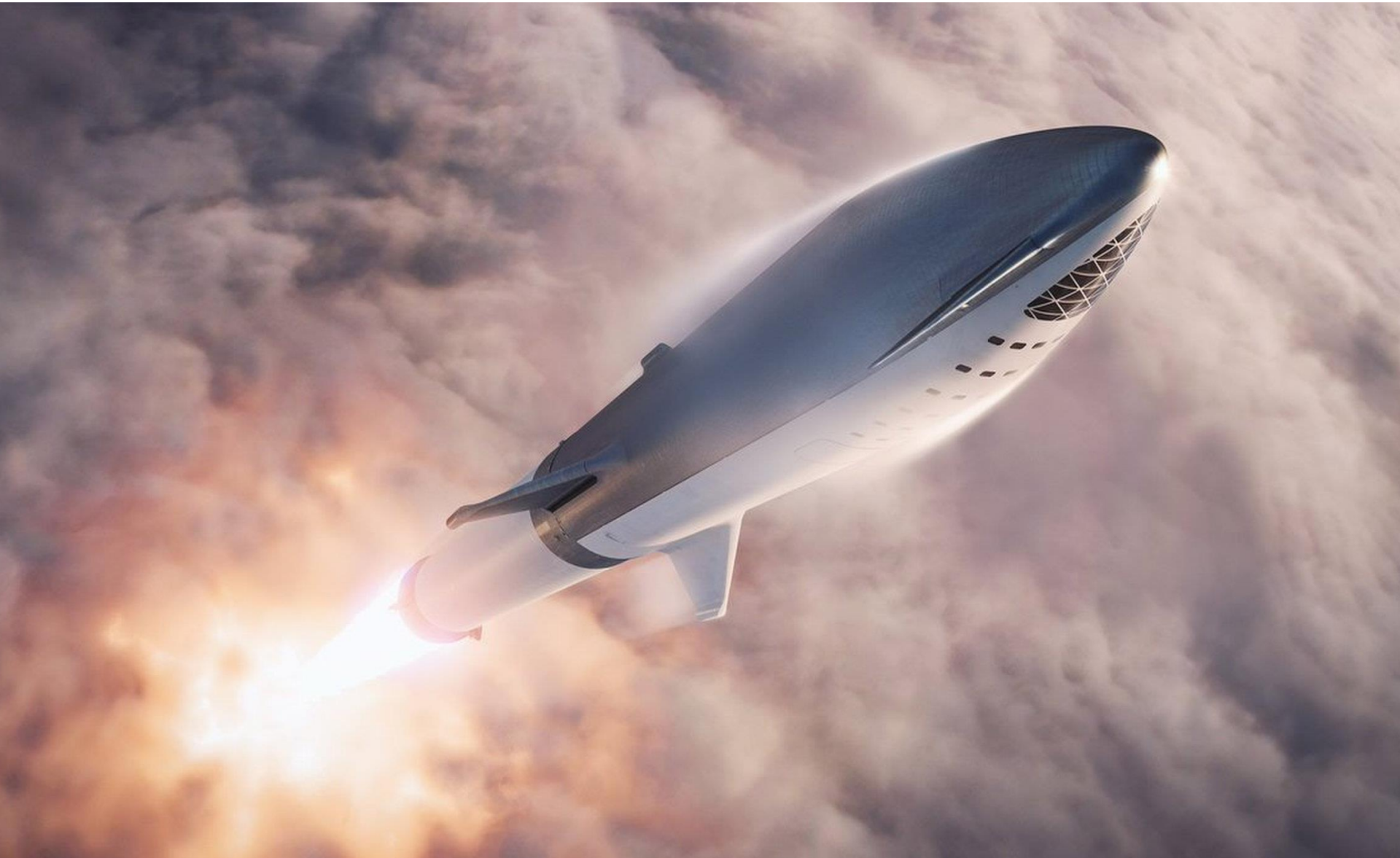
SpaceX, The Interplanetary Transport System will launch from Cape Canaveral, Florida. The entire system stands 122 meters tall.

Elon Musk has unveiled plans for a new spacecraft that he says would allow his company SpaceX to colonise Mars, build a base on the moon, and allow commercial travel to anywhere on Earth in under an hour. Musk says the company hopes to have the first launch by 2022, and then have four flying to Mars by 2024.

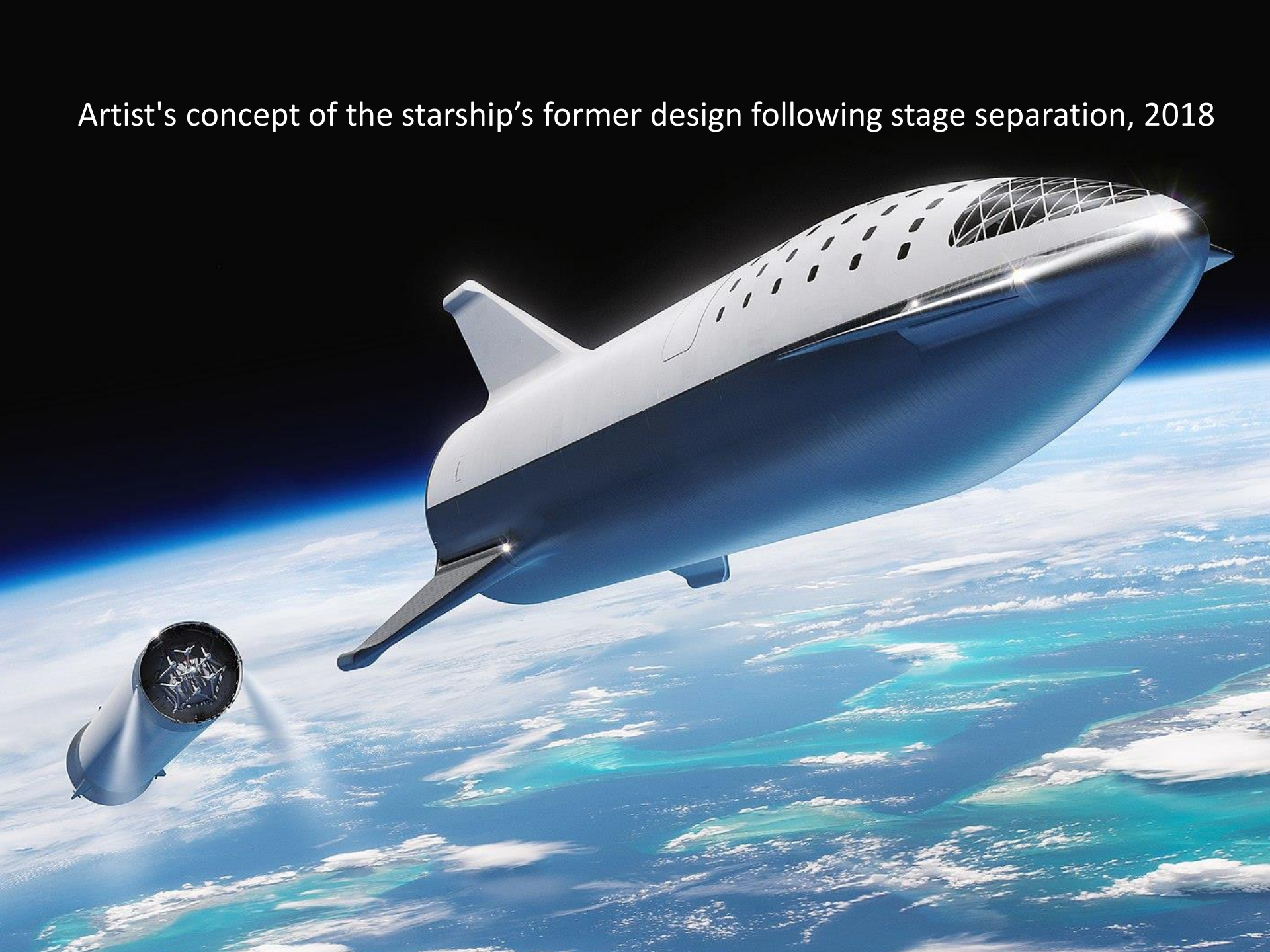

LIFTOFF
127,800 kN of Thrust
28,730,000 lb of Thrust



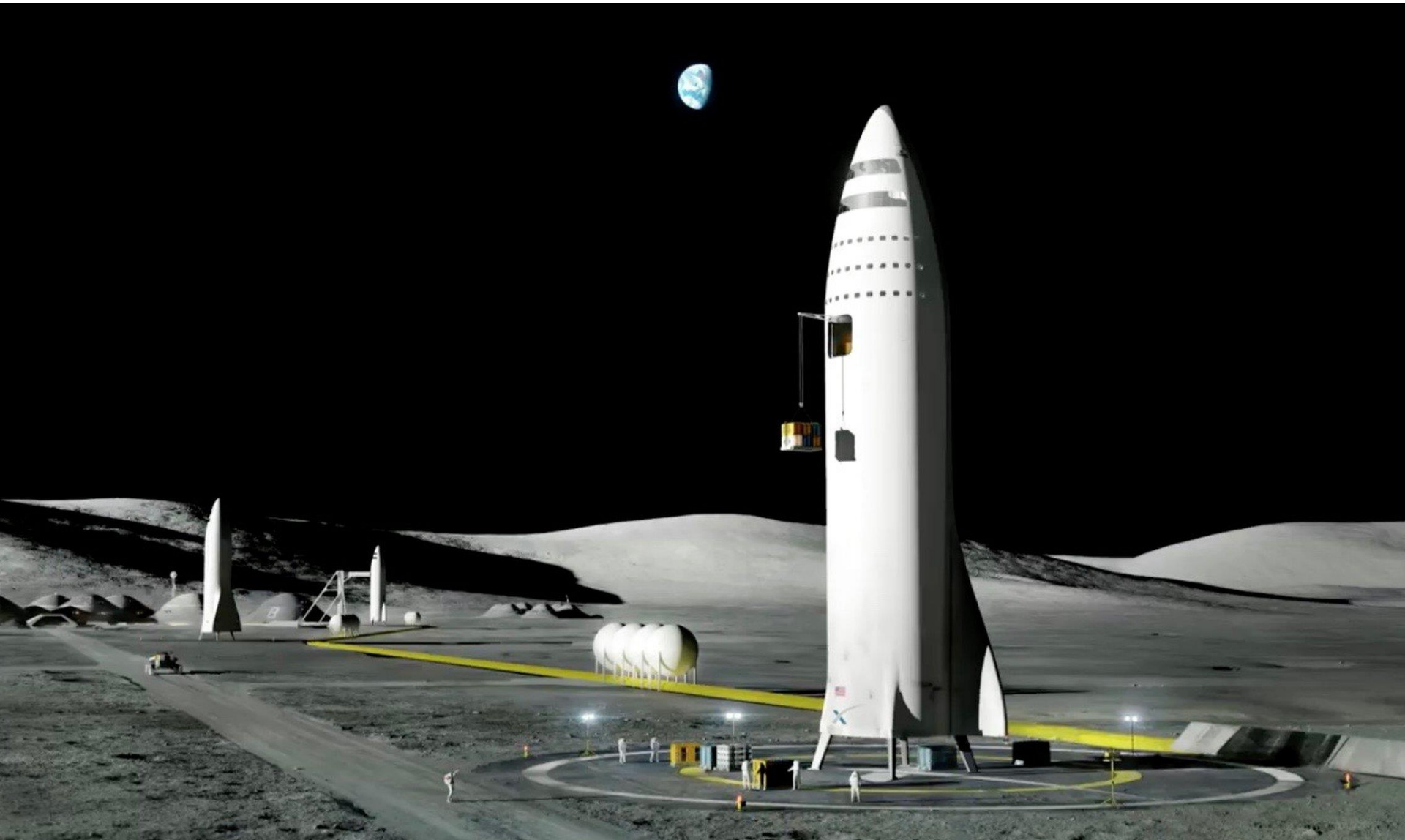
SpaceX CEO Elon Musk unveiled this new rendering of the company's Big Falcon Rocket spacecraft ahead of the announcement Sept. 17, 2018



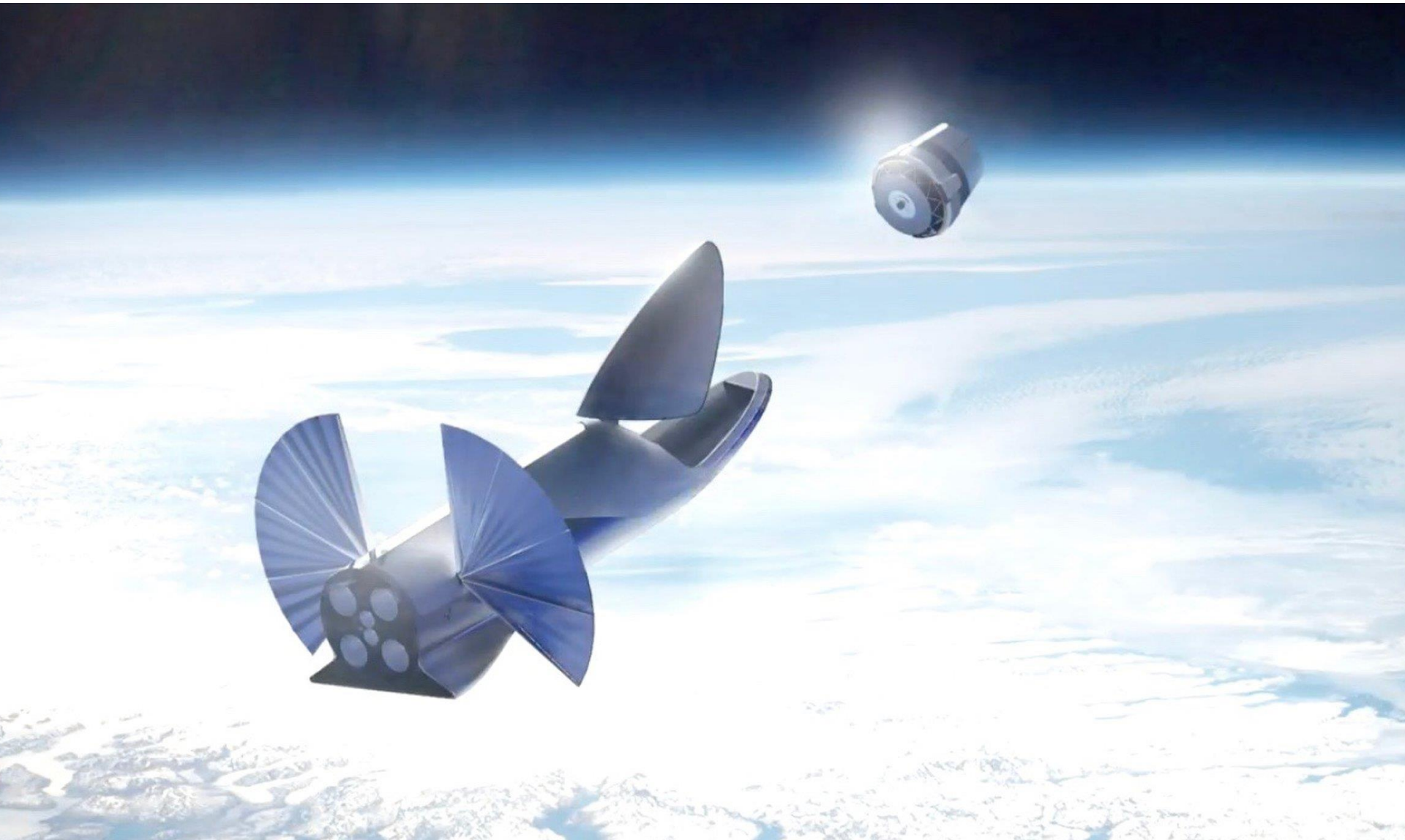
Artist's concept of the starship’s former design following stage separation, 2018



The BFR architecture isn’t Mars-specific; the system could help establish a base on the moon, Musk said.

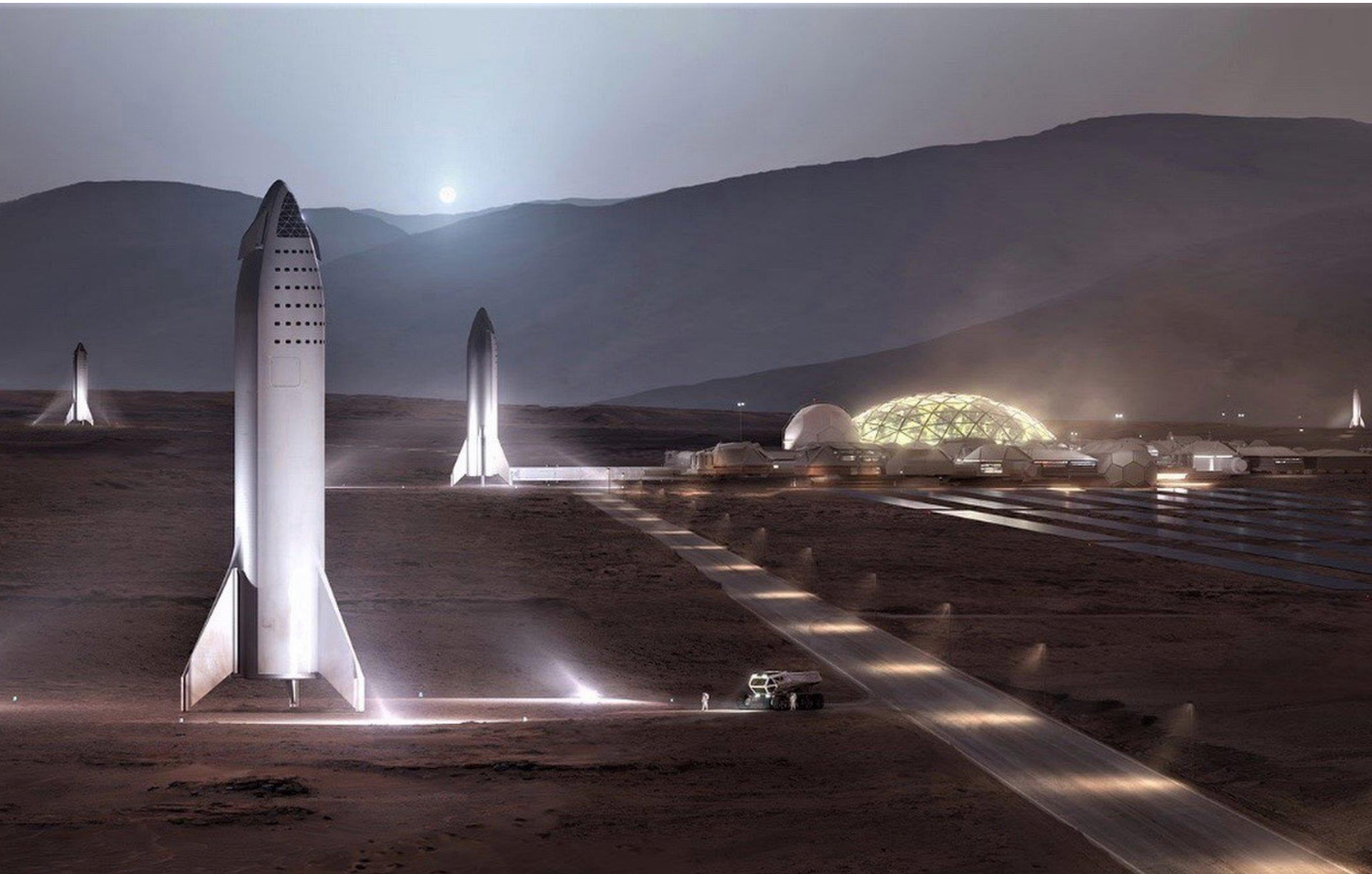


The BFR system will be able to launch very large satellites, Musk said.



SpaceX founder Elon Musk presented the rocked M1 in late September 2019.
It is part of the company's deep-space transportation system.
The architecture consists of a 50 meter tall spaceship called Starship,
and a huge rocket known as Super Heavy.

# A Base on Mars? It Could Happen by 2028, Elon Musk Says



This mockup of SpaceX's planned Mars colony, named "Mars Base Alpha," shows multiple rockets parked at a safe distance from a cluster of pressurized buildings that serve different purposes in the Mars colony. Elon Musk plans to start building the Mars colony