Jet Propulsion Laboratory
California Institute of Technology

Affordable Surface and Subsurface Exploration of Mars using SHEILD

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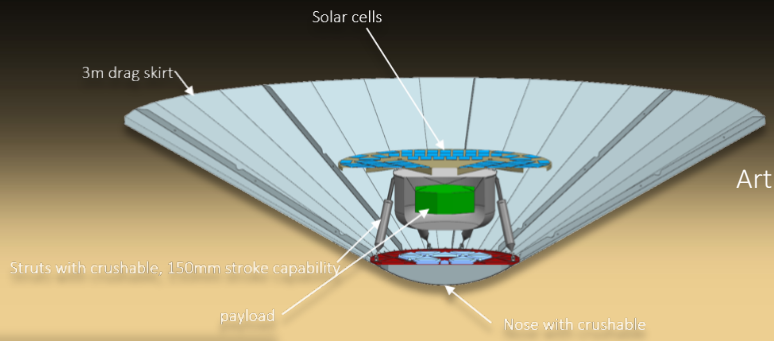
SHIELD Mars Exploration Lander Concept



Artist Concept

Parameter	Full Scale
Projected Diameter	1.8m
Nose Radius	0.45m
Crush Stroke	0.25m
Mass	50 kg

SMALL HIGH IMPACT ENERGY LANDING DEVICE

SHIELD would enable the transportation of small scientific payloads affordably to the surface.

- Landed Mass: 50kg
- Science Payload Mass: 6kg
- Impact load range 1000 g – 2000 g.
- Static science platform, investigating options for surface and aerial mobility.
- Target mission duration: 90 sols to 1 Martian year (latitude dependent)
- Science goals of high priority for Decadal science, MEPAG, and HEO SKG's.

Low Cost Approach

- Hosted, secondary, or dedicated P/L configurations.
- Does not have a parachute or propulsive deceleration. Uses low ballistic coefficient to slow down.

Compelling Surface Science Measurements

Fundamental & New Single Measurements

Targeted Science
- Focused
- instrument suite.

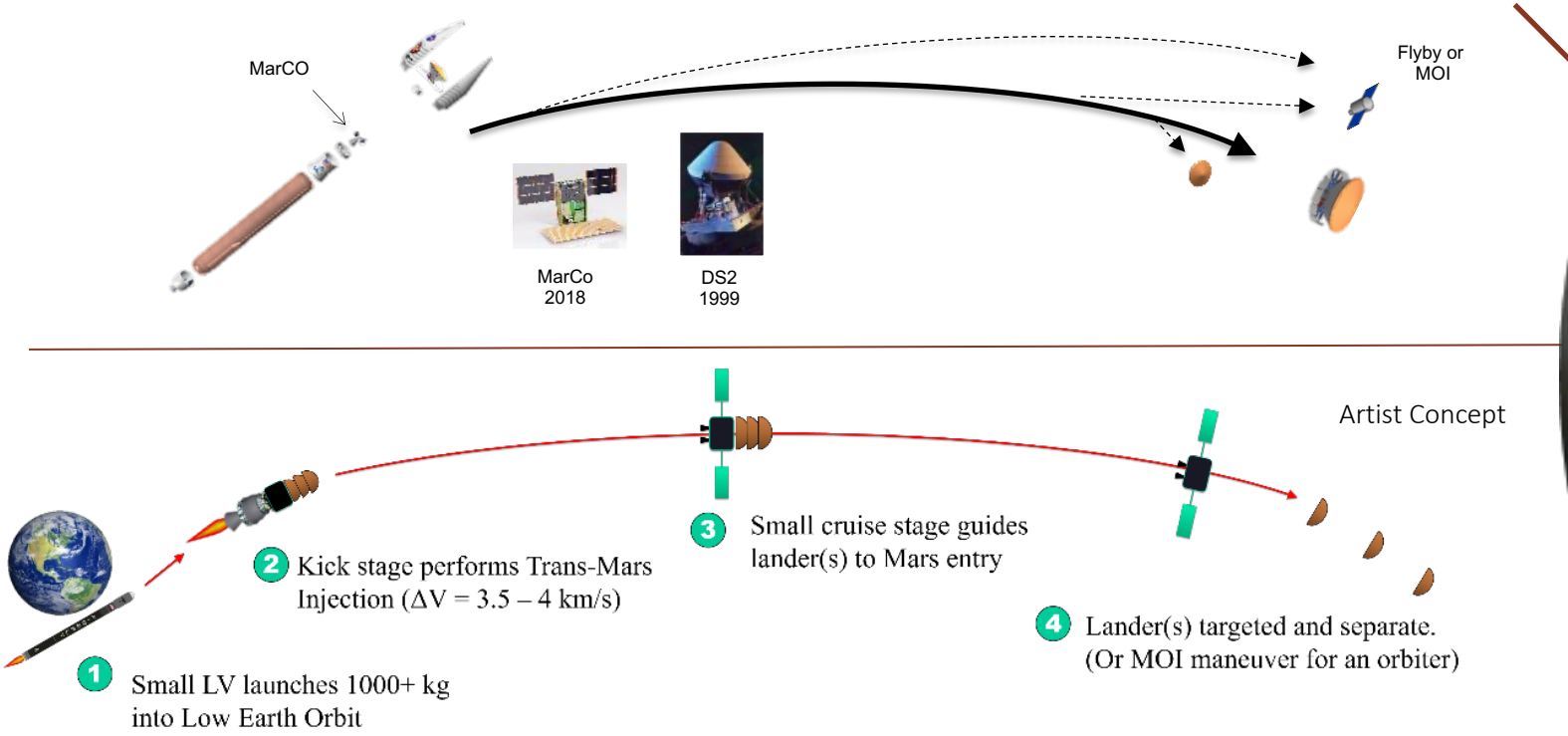
3D/4D is the Science
- Global Coverage
- Networks
- Causality
- Processes
- Scouts

High value science at low cost, would be complementary to any MSR efforts.

Notional Mission Scenarios: Delivering SHIELD from Earth to Mars

Hosted Payload on Mars Orbiter or Mars Bound Mission

- Launch Configuration: Hosted Payload or Dual Manifest



Launch on Large or Small Launch Vehicle

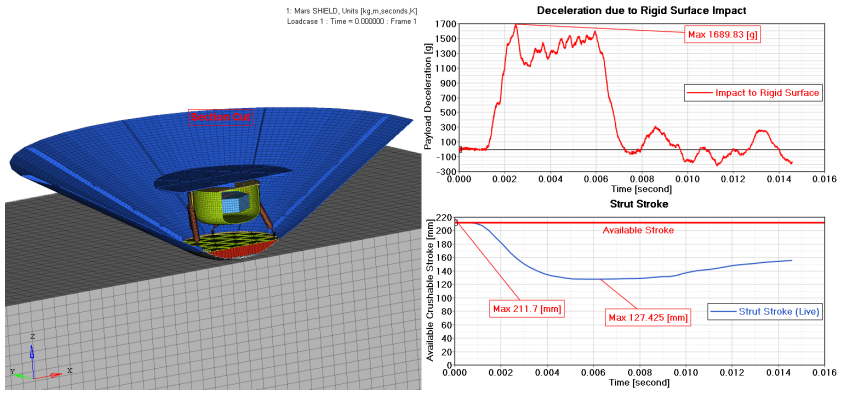
- Launch Configuration: Multiple SHIELD landers and cruise stage s/c.

SHIELD Lander EDL Concept of Operations

Entry Mass: 40 kg

Aeroshell Geometry (Pioneer): D=1.8m, '45 deg spherecone'

Entry Phase



Artist Concept

Cruise Stage Separation

Entry Interface
Alt=126 km
V = 6 km/s,
EFPA: -11.5 deg

Peak Heating
Capsule
RFPA: -7.1 deg
Altitude: **55.6** km
Velocity: 4.98 km/s

Peak Deceleration
8.96 gs
Altitude: 46.3 km
Velocity: 3.61 km/s

Transonic Phase I
Mach 1.1
Altitude: 22.6 km
Velocity: 236 m/s
Q= 62.7 Pa

Transonic Phase II
Mach 0.85
Altitude:15.7 km
Velocity: 188.3 m/s
Q=72.8 Pa

Pre Landing
Altitude:5 km
RFPA: -87.5deg
Velocity: 135 m/s

Touchdown
Altitude (MOLA): -3.0 km
Velocity: 99 m/s

E-10 min *E-0 s* *E+76s* *E+94s* *E+212.5 s* *E+253 s* *E+321 s* *E+391 s*

Subsurface Investigations using the SHIELD concept

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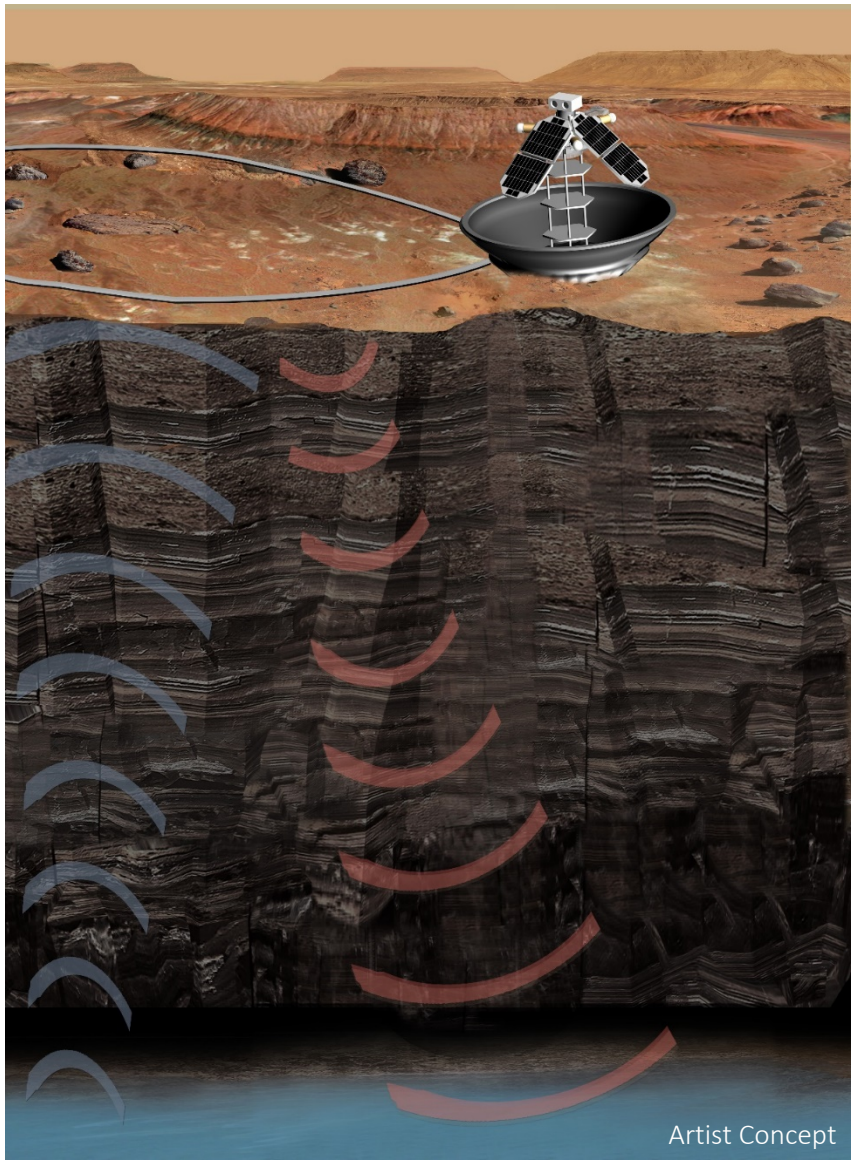
Science Objective: Subsurface liquid water detection using transient electromagnetic sounder.
Primary Instrument: TH2OR TEM Liquid Sounder; 100 m transmit loop, receive loop, detector electronics.
Secondary Instrument Options: Meteorological sensors, trace gas sensors, dust sensors, and/or imager(s). Ruggedized for impact and environment
Mission Duration: Primary -1 month, Extended -1 Mars year
Configuration: <3 SHIELD landers with cruise stage
Mission Design: Ballistic trajectory, landing at equator +/- 30° latitude

<u>If we want to go > kms</u>

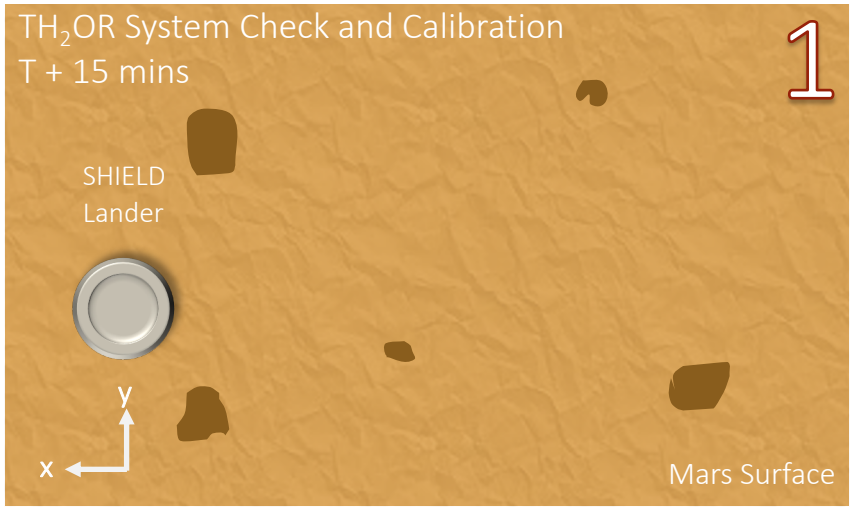
- ~100 m loop diameters , < 10 W, and integration times of hours.
- If mission constraints do not allow a large loop, a ~10 m diameter TEM system can theoretically sense Martian aquifers down to ~2-3 km if the integration time and power can be extended.

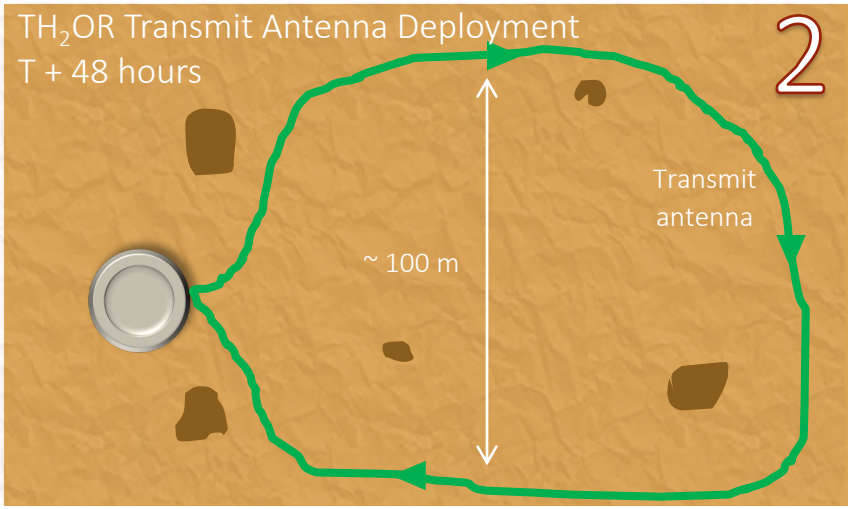
<u>If < 1km suffices</u>

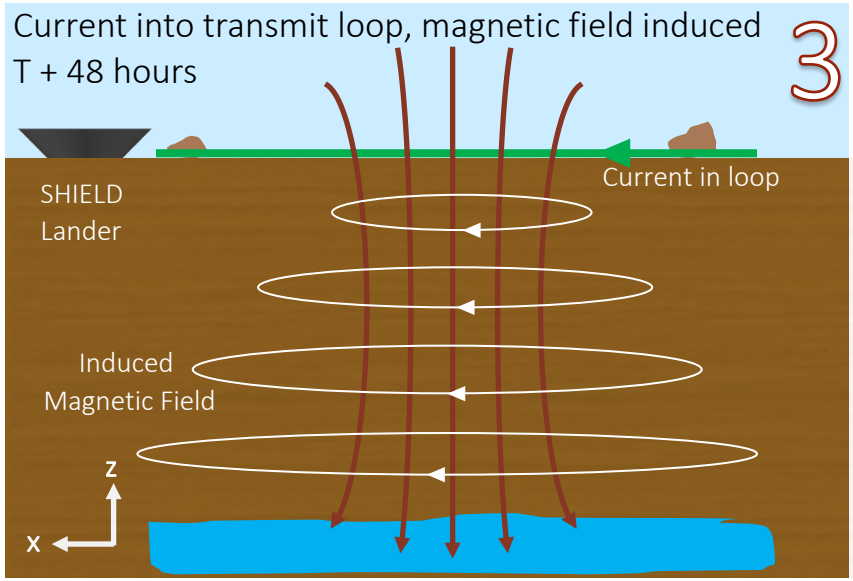
- ~2-m loop TEM systems with their modest mass, power, and AWG are suited to study subsurface liquid water below ~1 km on Mars.

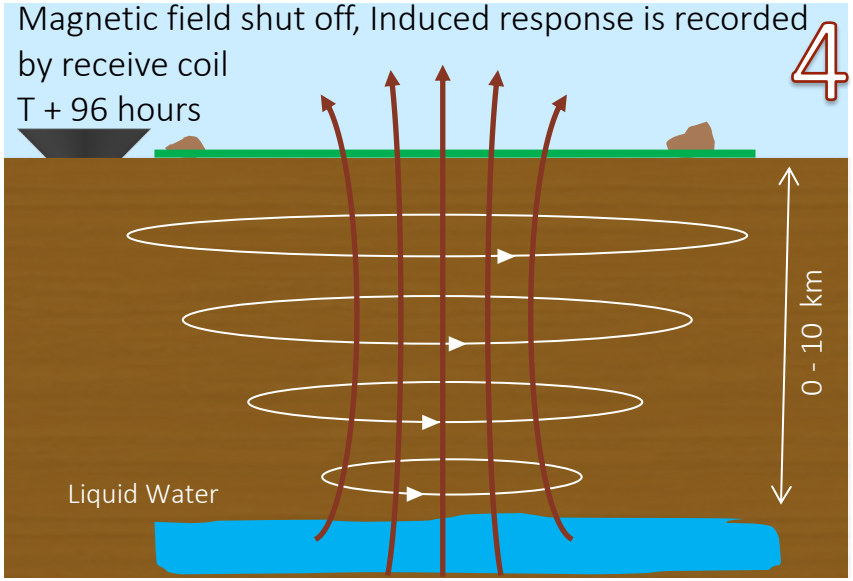


Science Concept of Operations









Notional Flight System for Subsurface Water Detection Mission Concept

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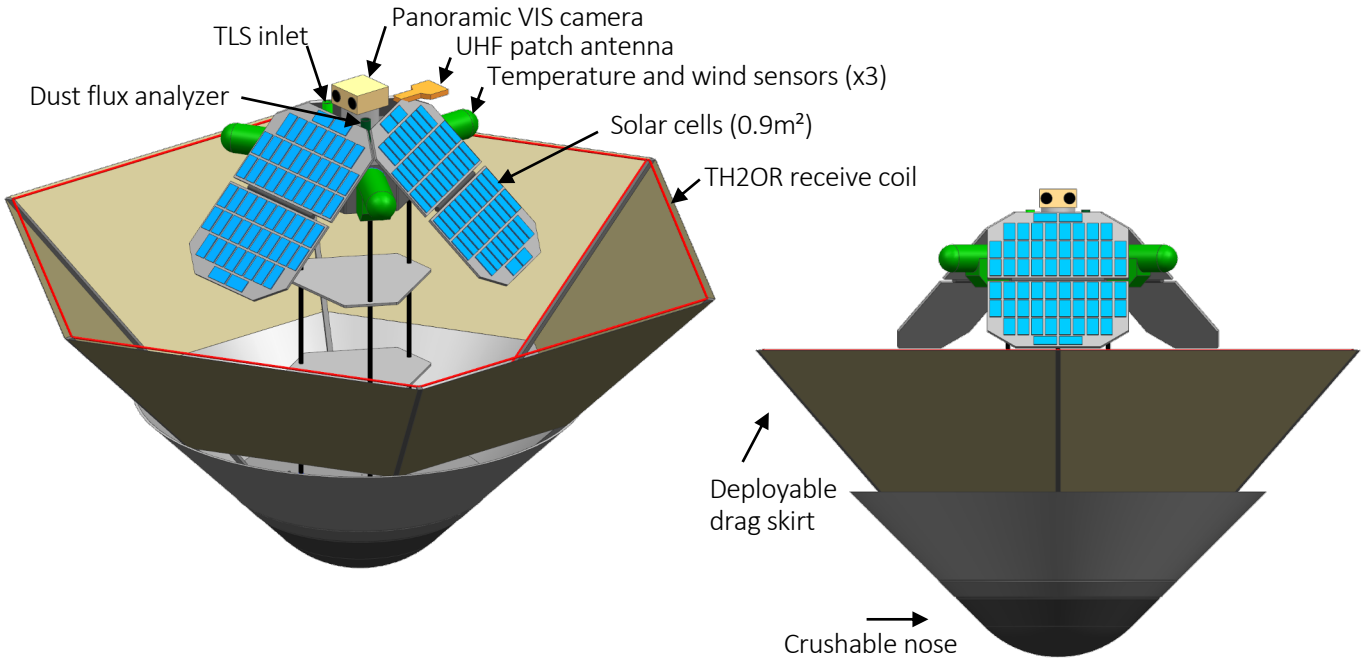
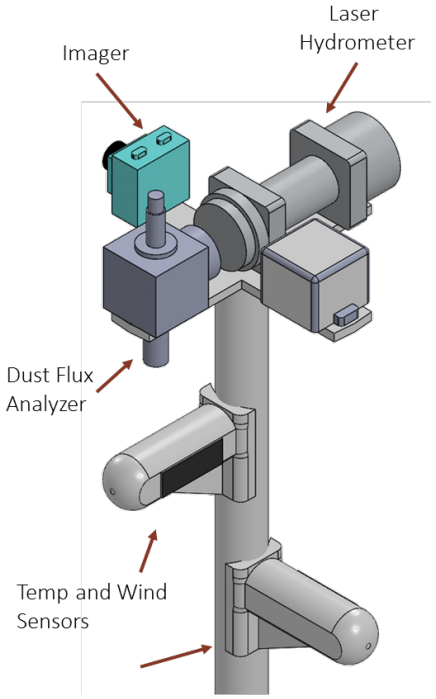
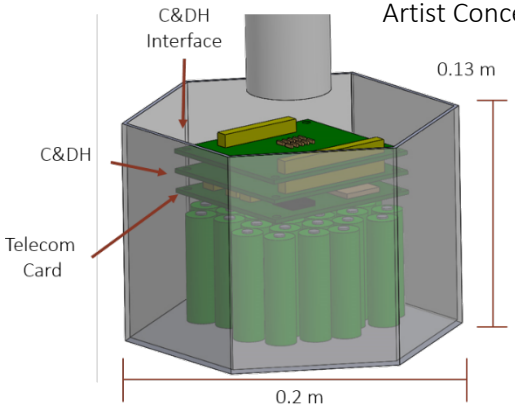




Artist Concept

- **Payload Mass Maximum Expected Value (MEV):** 6 kg
- **Power**: 0.9m solar array, 200Wh energy storage capacity
- **Telecom:** UHF Relay with <8kbps data rate(s), 19 Mb daily volume
- **Payload Impact Acceleration:** 1000 – 2000 g



Warm Electronics Box rated for -120° C, operational temperature of 20° to -20° C

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SHIELD Mars Exploration Lander Concept

Scientifically Compelling

SHIELD can accomplish decadal class surface and sub-surface science exploration while being complementary to Flagship missions in type of science investigation.

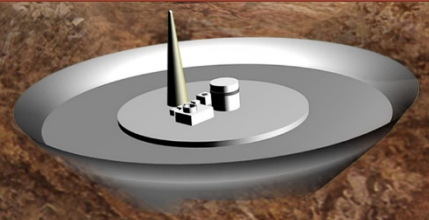
Low Cost

The SHIELD lander concept cost target is $50 M per lander with a total mission cost target of <$200 M which includes cruise and launch vehicle.

Technically Feasible

SHIELD is capable of delivering 6 kg of science payload per lander. Each lander has a landing ellipse of 100 x 20 km.

SHIELD would enable the transportation of small scientific payloads affordably to the surface of Mars.



Artist Concept

Backup