Overview of the MELOS-1, Mars exploration program in Japan

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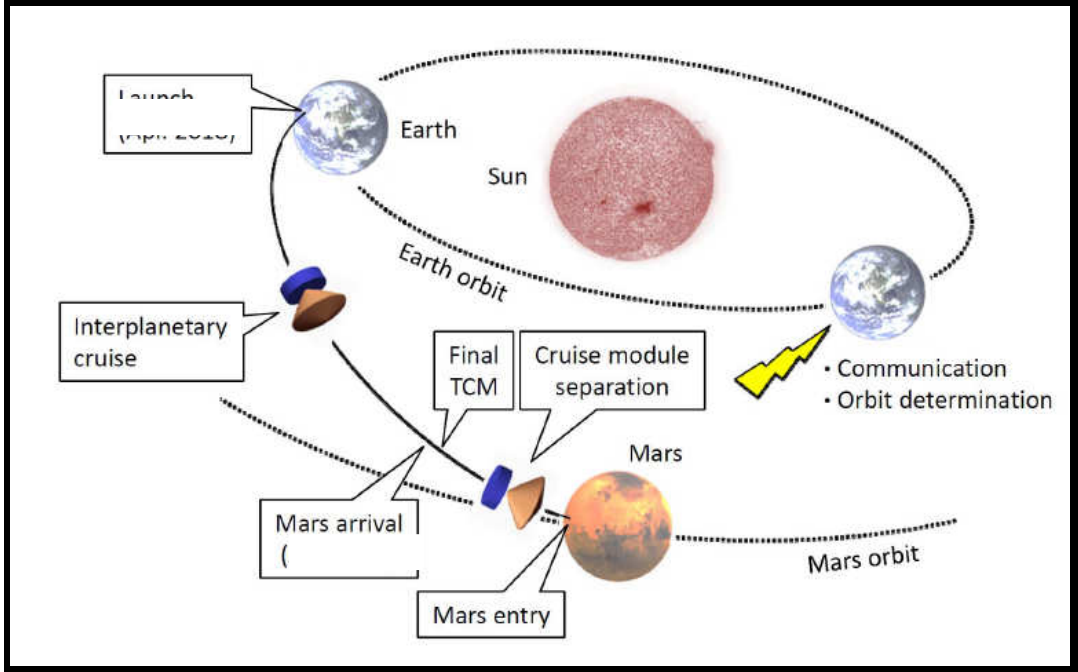
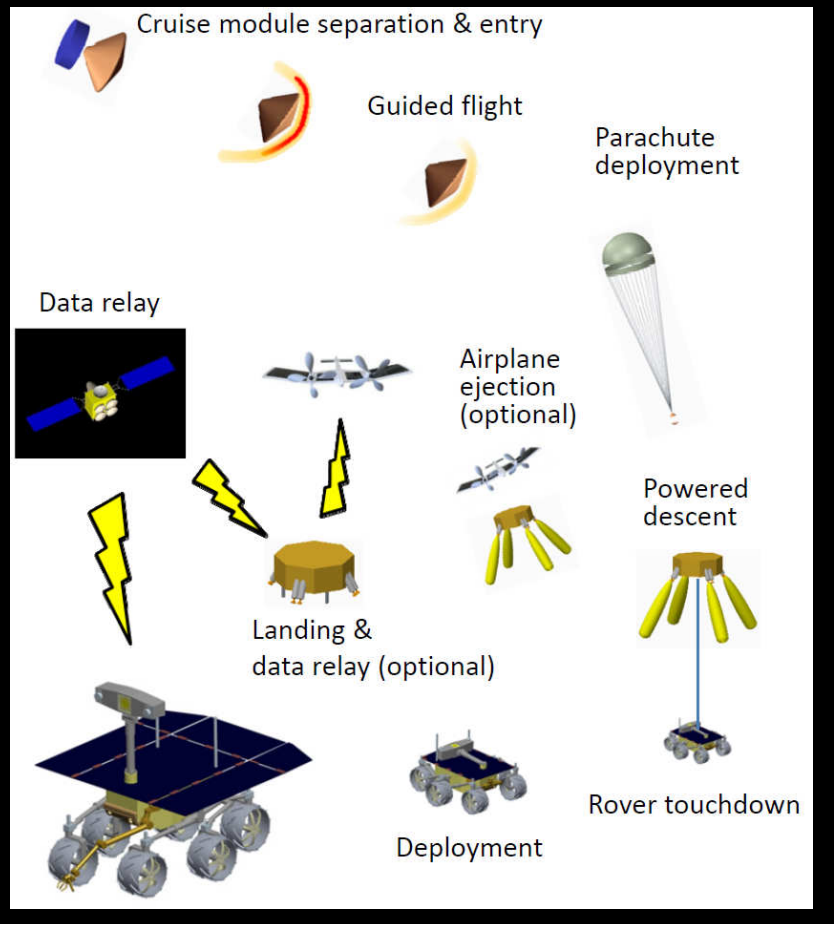
MELOS-1 base-line scenario (previously considered)



Launch	Apr. 2018	Aug. 2020	Oct. 2022
Mars arrival	Jan. 2019	Mar. 2021	Dec. 2023
Time of flight (day)	277	221	426
Season of southern hemisphere	Summer	Autumn	Winter
Earth departure V_∞ (km/s)	3.461	3.981	3.815
Mars arrival V_∞ (km/s)	3.784	2.553	3.994
Distance from Earth at arrival (au)	1.49	1.55	2.50
Time to sunset at arrival (min)	421	121	394
Easiness of launch from TNSC	Good	Poor	Poor+
Accessibility to target	Good	Good	Good
Communication at arrival	Good	Good	Poor

Lauch vehicle assumed to be H-IIA202
Entire system consists of a cruise stage and Entry-Descent-Landing (EDL) module, weighing 800kg
EDL has a small rover carried by sky crane



Due to the constraints of budget and some other reasons,
we have to modify the mission scope;
several mission scopes are currently discussed

- A very simple engineering demonstrator for aerocapture/orbiter insertion to Mars orbit (wet 350kg)
- Mars airplane for magnetic anomalies (wet 400kg)
- Small lander for meteorological instrument or seismometer (wet 450kg)
- Small rover for life detection (wet 500-800kg)

MELOS1 Rover (bigger than Sojourner, smaller than MER)

Mass: 60kg with 6-7kg payload

Limited mobility

Mobility: 0.04m/s, ~25m/sol; surmounting 0.2m steps

Power: 350Wh/sol at 40S; Mission period: 90 days

Environmental study package for dust and atmosphere

Measurement of temperature, pressure, and direction and speed of wind, eletromagnetic and acoustic wave measurements, methane detector, particle size-distribution measurement, Camera with filters, LIDAR,

Biosignature-detection package (fluorescence microscopy)

Sample processing device, fluorescent dyes, microscope

Other instruments

Ground Penetrating Radar, LIBS, Seismometer, iVLBI, Accelerometer (MEMS)

Environmental study package for dust and atmosphere

Surface soil is controlled by wind rather than local geology; Atmospheric dust is a major contributor to heating of the lower atmosphere

Atomospheric science team is specifically interested in particle entrainemt mechanism to atmosphere

- **Saltation-induced dust entrainment**
  (Ibrahim et al., 2008; Merrison, 2012)
- **Dust devil** (e.g., Martin, 1995)
  - Devil tracks everywhere (Fisher et al., 2005)
  - Dominant in the southern hemisphere (Whelley and Greeley, 2008)
- **Dust fountaining associated with CO_2 and H_2O**
  (Christensen et al., 2006)

Instrument package include those for wind velocity (3D), pressure, shapes of particles, and electromagnetic observation

Biosignature-detection package (fluorescence microscopy)

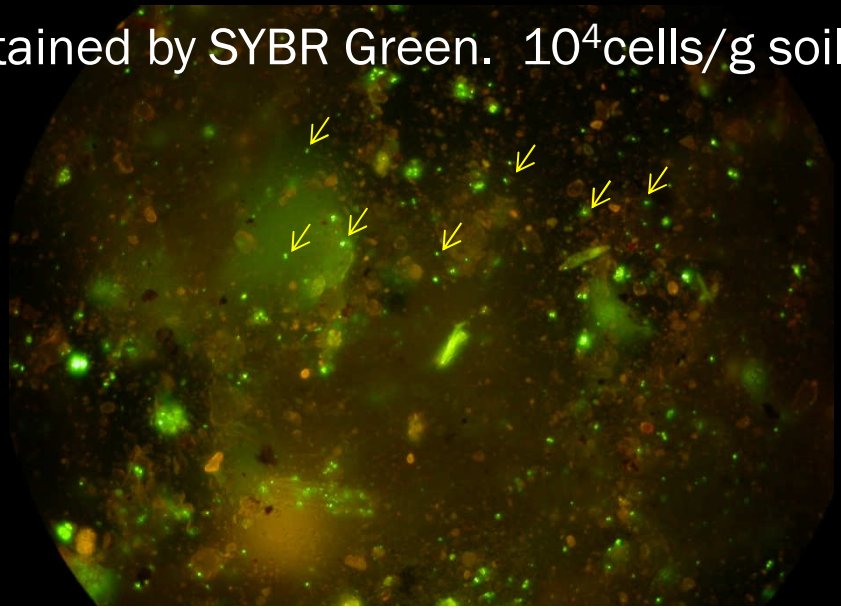
Life once created may be difficult to be completely extinguished

Factor	Limit for terrestrial life	Mars
Gravity	~ 0 to unknown higher *g*	0.376 *g*
Temperature	Active from -20°C to 122°C	-87°C to -5°C or 20 °C?
Pressure	Survivable lowest: 0.6 kPa Survivable highest: 1.6 Gpa	Atmosphere 0.6 kPa (*ca.* 6/1000 of Earth)
Vacuum	Survivable	0.4 kPa
Salinity (NaCl%)	0 to >30% (saturation)	Evaporites
Water activity (Desiccation)	~ 0.6 (bio-activity) ~ 0 (survival)	~ 0
Ionizing radiation	1440 Gy	150 mGy $year^{-1}$
pH	-0.06 to 12.5	7.7±0.5
Redox potential	Limits undefined	Highly oxidizing
UV radiation	~ 5000 J m^{-2}	~ 20 J m^{-2} s^{-1}

Atacama desert, Chile

Microbes in Atacama desert

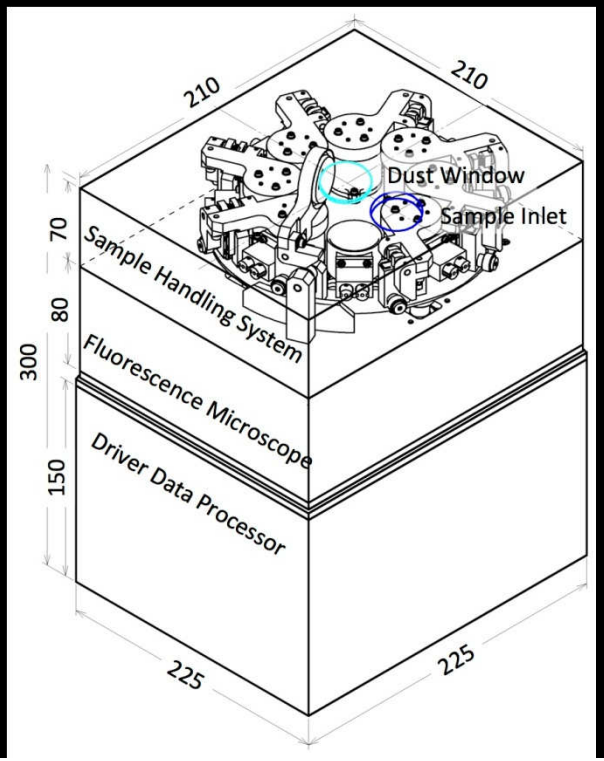
stained by SYBR Green. 10^4cells/g soil

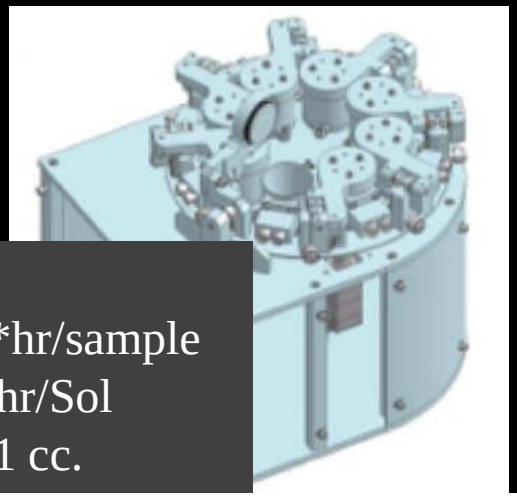


Biosignature-detection package (fluorescence microscopy)

Life Detection Microscope

- LDM is designed to search for possible “cells” in the regolith at several centimeters below the surface of Mars.
- LDM is equipped with specially designed pigment system to distinguish biotic organic compounds from abiotic
- Equipped with 1 μm/pixel resolution, which is more than ten times higher than any microscopic imager flown in space, LDM will be able to get high-resolution visible images of regolith and dust particles.





Mass:10.2 kg
Power: 255 Watt*hr/sample
500 Watt*hr/Sol
Sample volume: 1 cc.

Summary

- Primary scientific objectives of MELOS-1 are detections of biosignatures and environmental measurements
- Engineering team is actively working on the tentative plan; constrains are getting clearer
- Our resources are limited, though interested in Mars mission!

JAXA's missions to solar system bodies

NOZOMI mars mission (1998) – not arrived at Mars
Hayabusa asteroid mission (2003)
Kaguya lunar mission (2007)
Akatsuki Venus mission (2011)
Hayabusa2 asteroid mission (2014)
BepiColombo Mercury mission (2015)

Mars mission (2020+?)
Lunar rover mission? Asteroid mission?