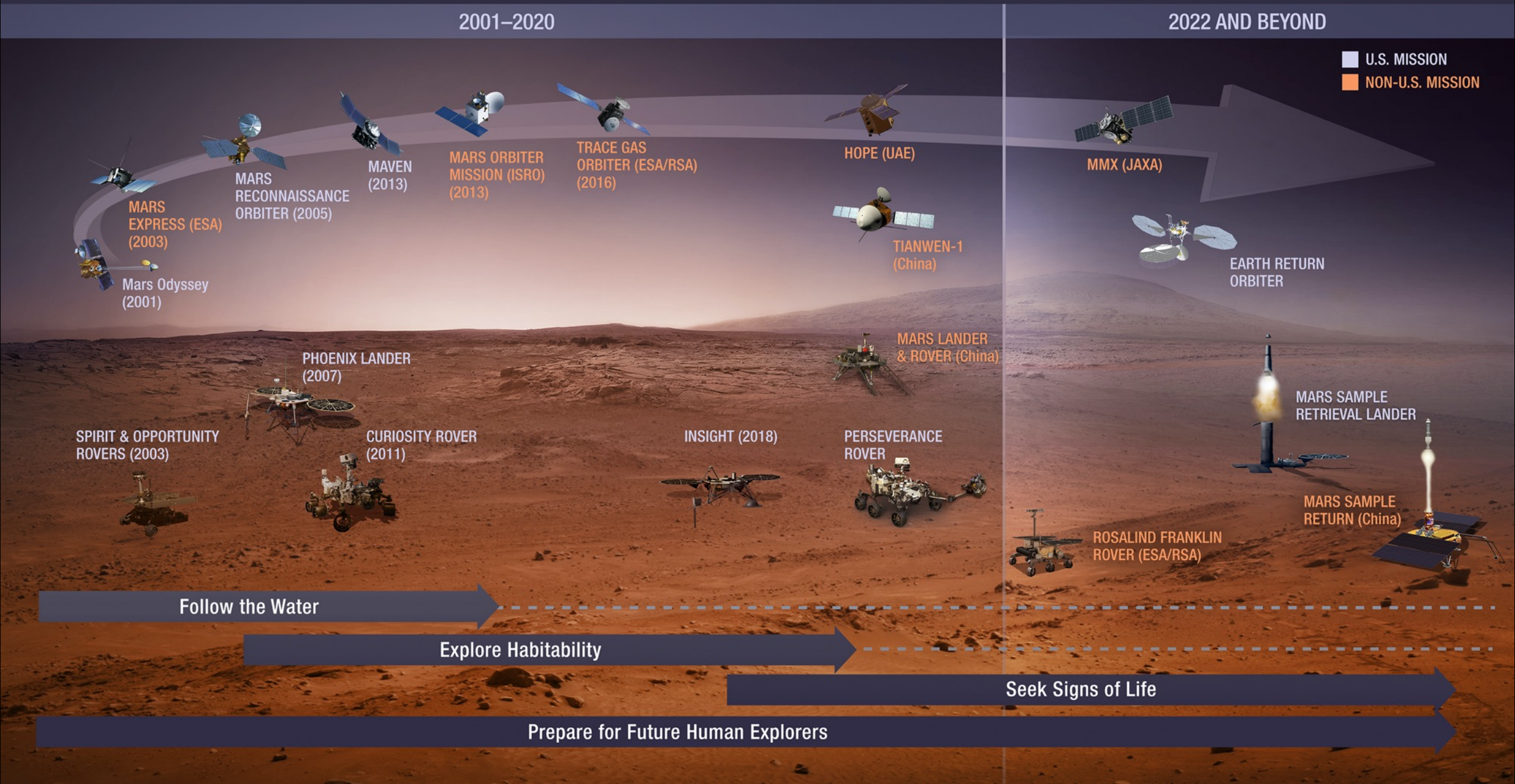
Mars Missions



CURRENT TECHNOLOGY INVESTMENTS

PROPULSION
Nuclear Systems
Providing A Robust and Efficient
System to Mars and Back to Earth

ENTRY, DESCENT, LANDING
Enable Landing Large Payloads

DEEP SPACE OPTICAL COMMUNICATION
Enable Fast And More Efficient
Communication Critical to Long
Duration Mission Success

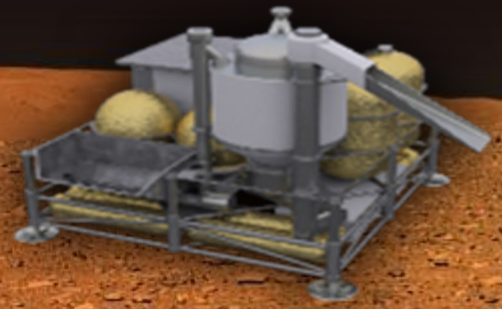
PRECISION LANDING
Enable Landing With
Improved Accuracy While
Avoiding Local Landing
Hazards

CRYOFLUID MANAGEMENT
Enabling Long-Term
Space Storage of
Cryogenic Propellants

INTELLIGENT ROBOTICS
Enabling New Discoveries on
the Surface and Augmenting
Operations for Missions

SURFACE POWER
Nuclear Fission
Enabling Support
Operations and
Infrastructure on Mars

IN SITU RESOURCE UTILIZATION
Providing Greater
Propellant and Water/Air
Consumables From
Local Resources



WHAT DO WE KNOW ABOUT MARS?

Radiation

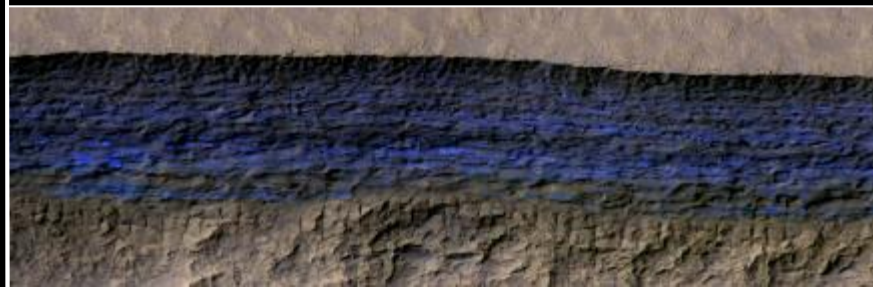
From the Radiation Assessment Detector (RAD) on Curiosity, the radiation dose of a nominal Mars mission (about two years including transit) would exceed NASA's career limit for astronauts, if left unshielded.

Weather

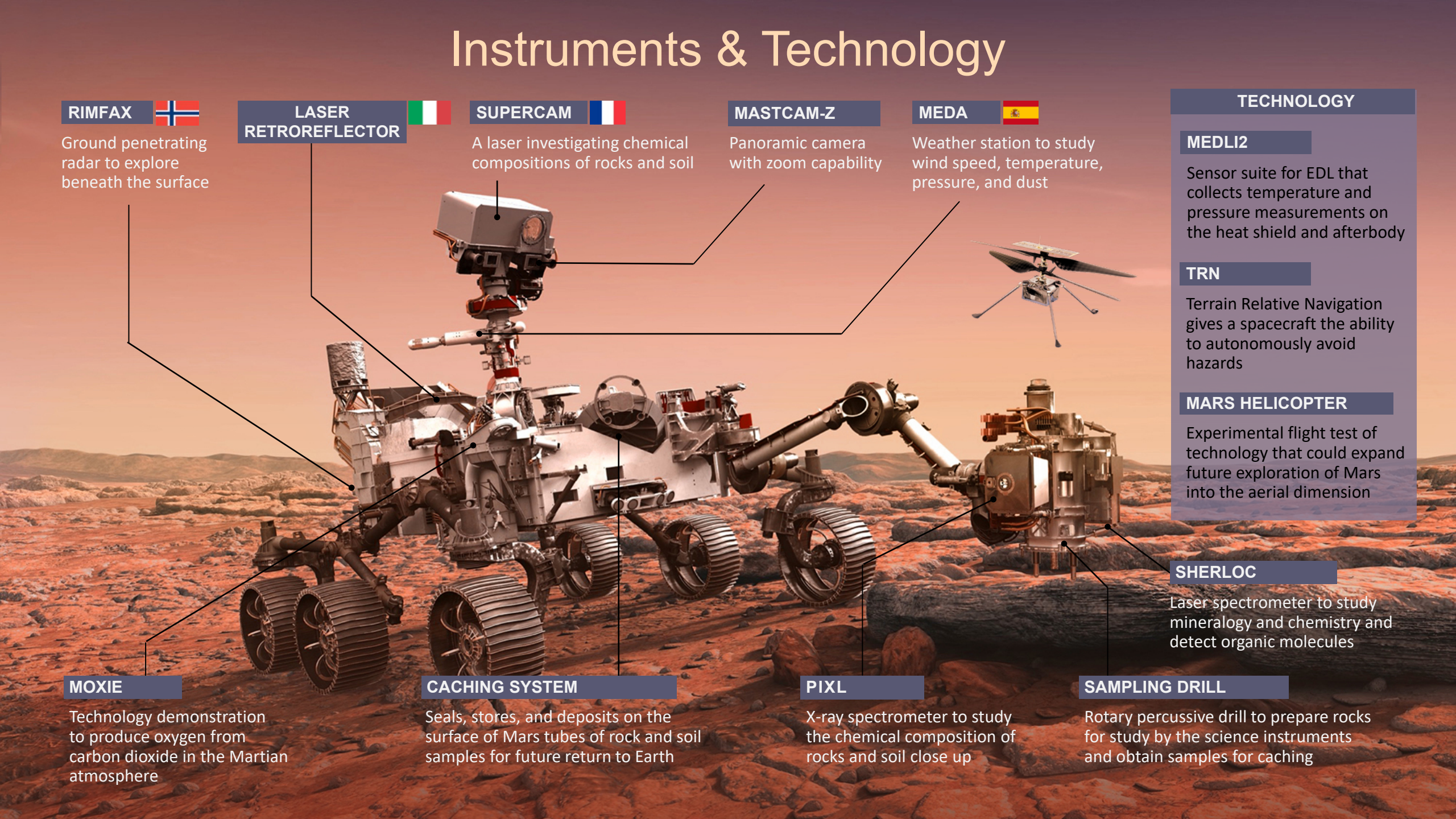
Dust storms occur about every three Martian years and can be so thick that light coming through the atmosphere is severely reduced. This could be mission ending, as we saw with the exploration rover, Opportunity, in the 2018 global dust storm.

Resources

Mars has subsurface ice that may be accessible in mid-latitudes on Mars. An important potential resource for human exploration.



Instruments & Technology



RIMFAX

Ground penetrating radar to explore beneath the surface

LASER RETROREFLECTOR

SUPERCAM

A laser investigating chemical compositions of rocks and soil

MASTCAM-Z

Panoramic camera with zoom capability

MEDA

Weather station to study wind speed, temperature, pressure, and dust

TECHNOLOGY

MEDLI2

Sensor suite for EDL that collects temperature and pressure measurements on the heat shield and afterbody

TRN

Terrain Relative Navigation gives a spacecraft the ability to autonomously avoid hazards

MARS HELICOPTER

Experimental flight test of technology that could expand future exploration of Mars into the aerial dimension

SHERLOC

Laser spectrometer to study mineralogy and chemistry and detect organic molecules

MOXIE

Technology demonstration to produce oxygen from carbon dioxide in the Martian atmosphere

CACHING SYSTEM

Seals, stores, and deposits on the surface of Mars tubes of rock and soil samples for future return to Earth

PIXL

X-ray spectrometer to study the chemical composition of rocks and soil close up

SAMPLING DRILL

Rotary percussive drill to prepare rocks for study by the science instruments and obtain samples for caching

WHERE WE NEED INVESTMENT TODAY

Understanding the Martian Environment

Use robotic missions to prove technologies and to learn about the weather, radiation, and resources on Mars.

Developing Technology

Prioritize investments to address the toughest challenges of sending humans to Mars

Simulating Mars Missions with ARTEMIS

Wherever possible, use the Lunar environment to validate Mars exploration systems and operations in the 2020s