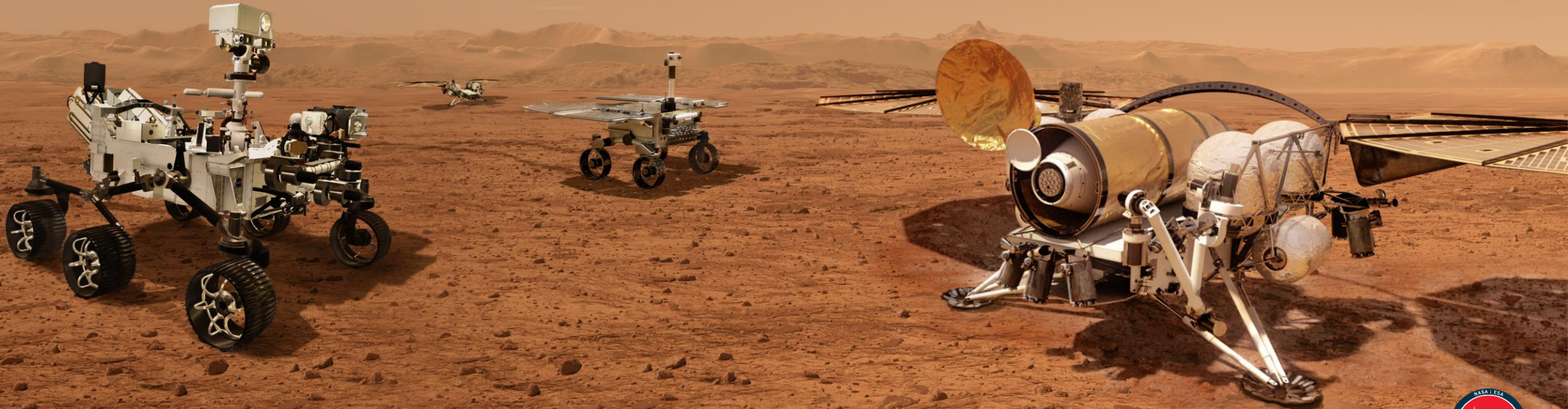


Mars Sample Return Overview

Joe Gasbarre

MSR Deputy Program Director - Technical

March 31, 2022



What is the Mars Sample Return Program?

The Mars Sample Return Program (MSR) is an ambitious, international science mission to collect and return rock and sediment samples from the Martian surface.

It has been a priority of the past two National Academy Decadal Surveys

It will be the first “round-trip” to another planet, paving the way for future human exploration

MSR is a complex mission.

Requires a set of capabilities that were not demonstrated 20, or even 10, years ago.

It is only possible today as a result of the \$10+B investment made through the formulation, technology and operational projects of the past decades, coupled with a strong international partnership with ESA.



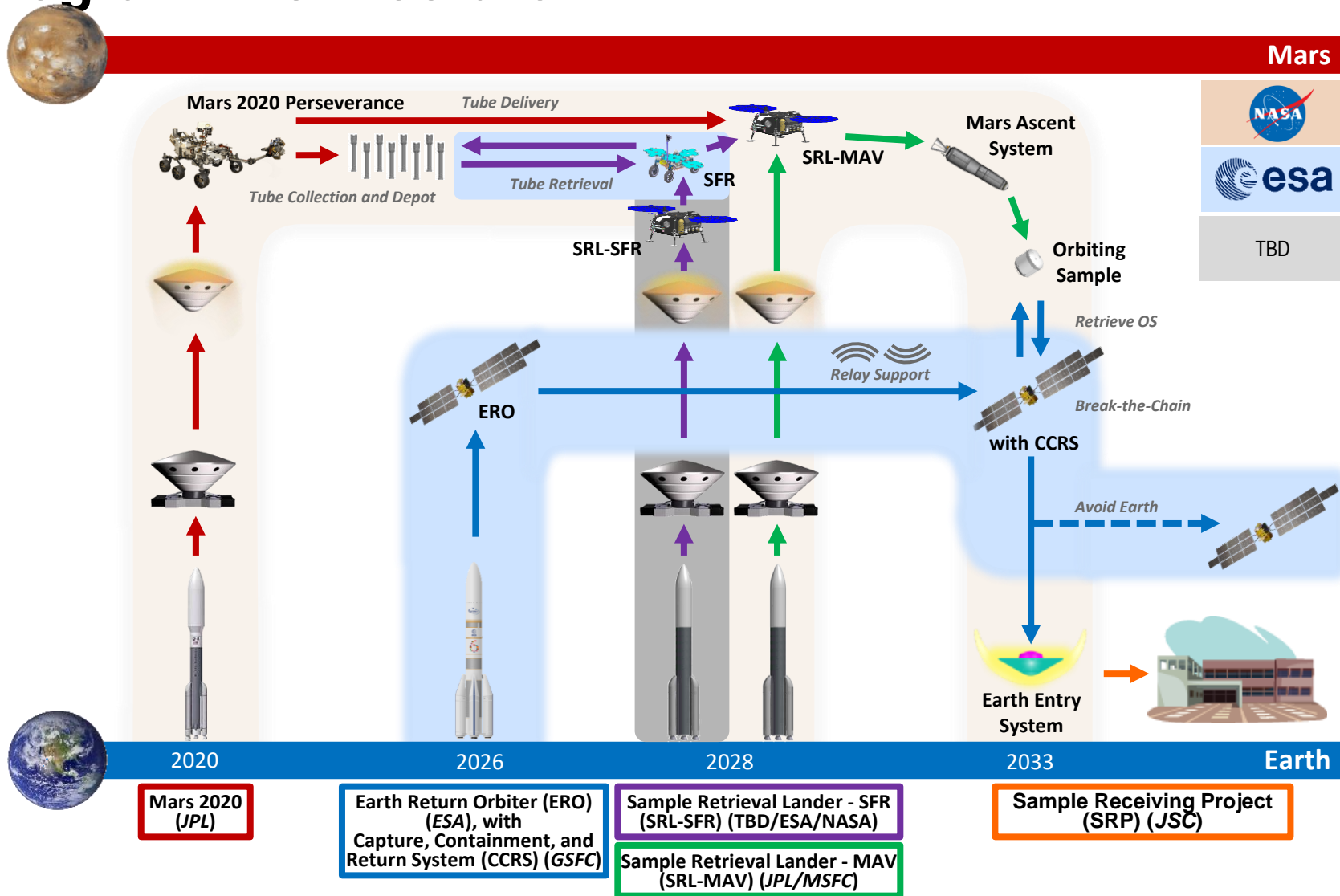
GOAL — First Sample Return From Another Planet

A priority since 1980 and of two National Academy Decadal Surveys
A first-step “round-trip” in advance of humans to Mars

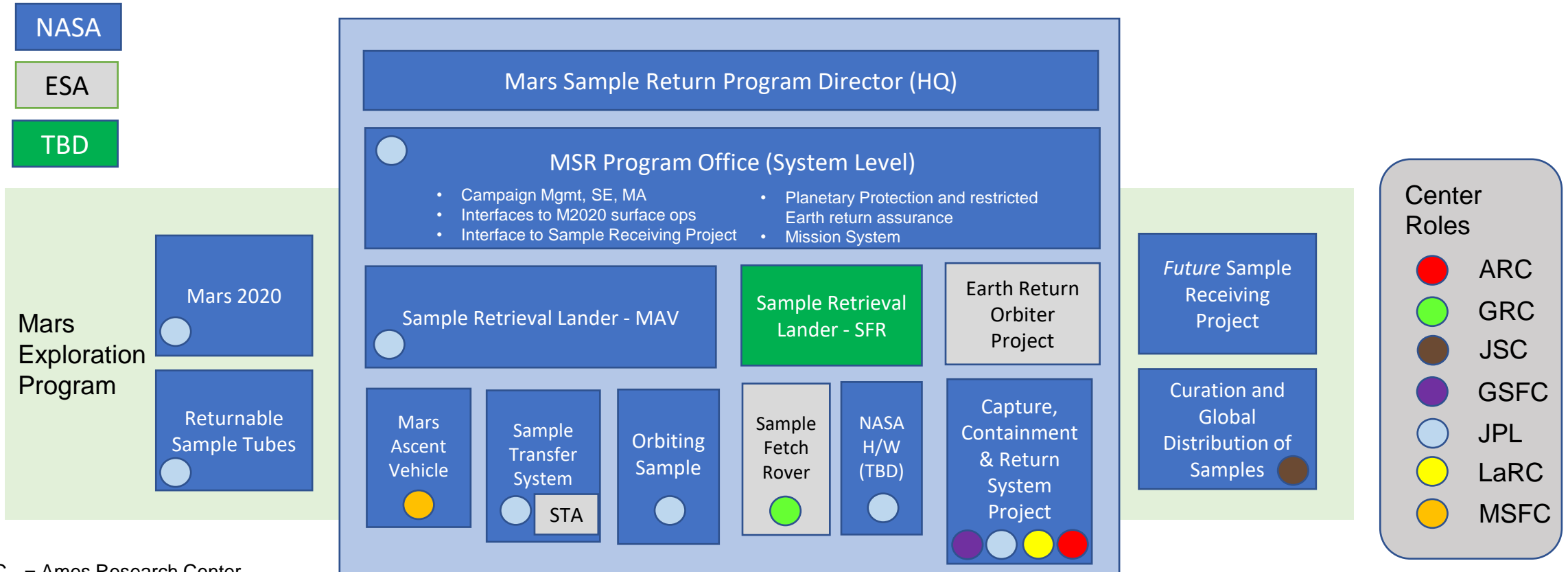
The oldest known life on Earth existed ~3.5 billion years ago,
a time when Mars was habitable. Today,
<<1% of the Earth’s surface is 3 billion years or older
>50% of the Mars’ surface is 3 billion years or older

***The first billion years and life’s beginning in the Solar System:
The record is on Mars***

MSR Program Architecture



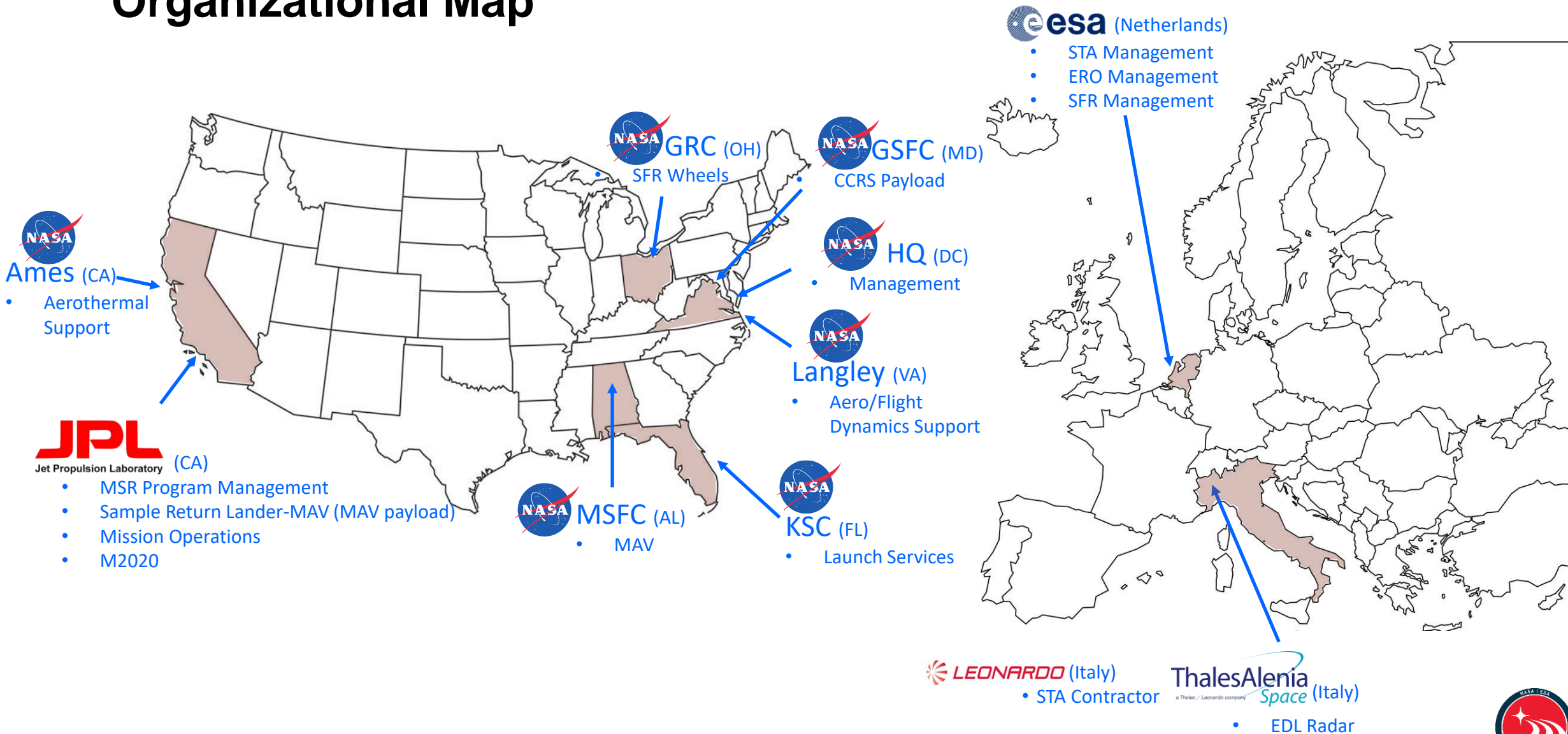
MSR Program Structure (Agency & Center Contributions)



ARC = Ames Research Center
 GSFC = Goddard Space Flight Center
 GRC = Glenn Research Center
 JPL = Jet Propulsion Lab (Cal Tech)
 JSC = Johnson Space Flight Center
 LaRC = Langley Research Center
 ESA = European Space Agency



Organizational Map

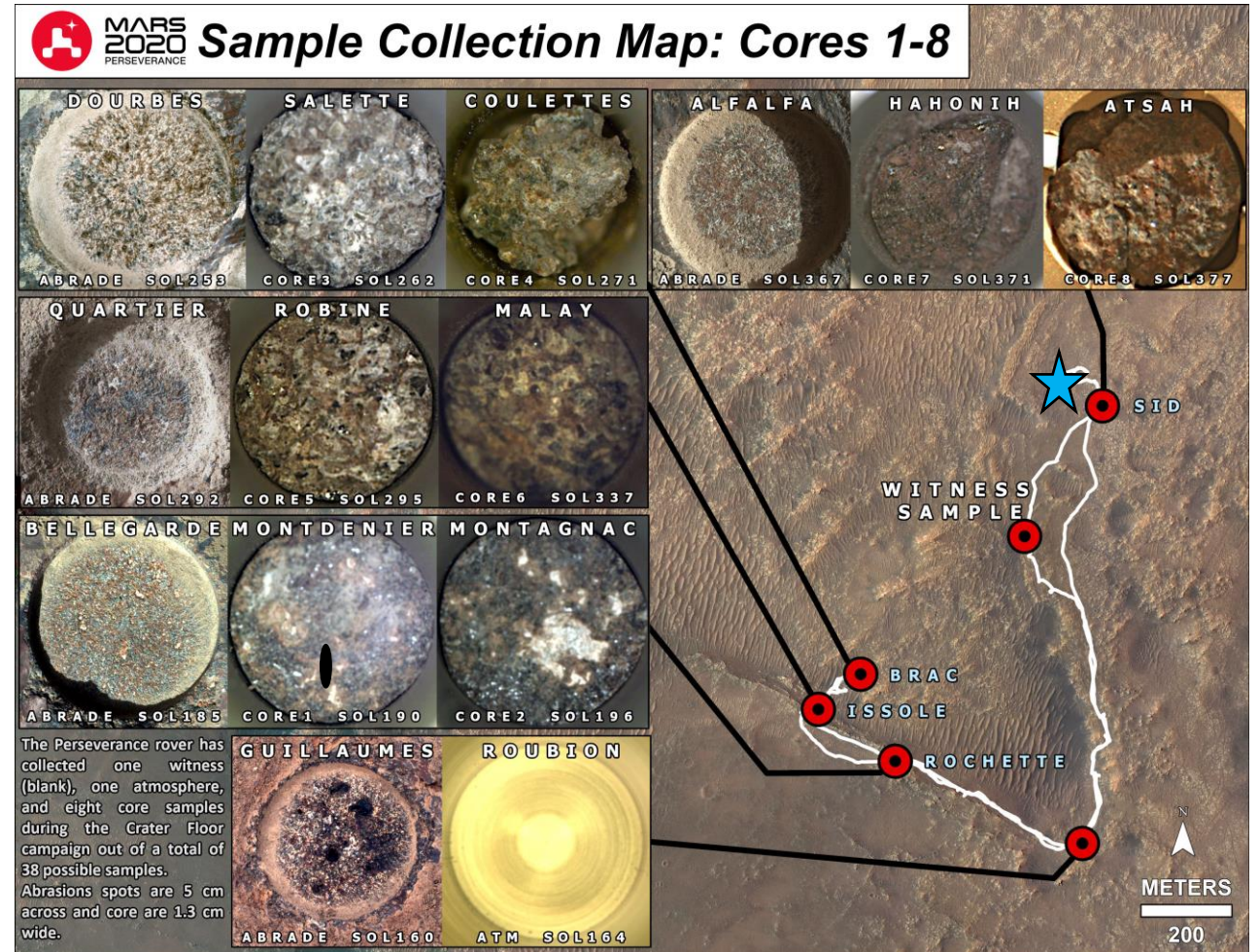


Samples Collected by Perseverance

Perseverance completed its crater floor science campaign in mid March after collecting the 8th rock core sample near the Octavia E. Butler Landing site. The rover is now conducting a rapid traverse campaign to drive counter-clockwise around the Séítah dune area towards the Delta front.

Total 10 tubes sealed:
1 Witness blank
1 Atmospheric sample
8 Rock Core samples

- ★ Octavia E. Butler Landing Site
- Sampling Sites



Courtesy of Fred Calef and M2020 team

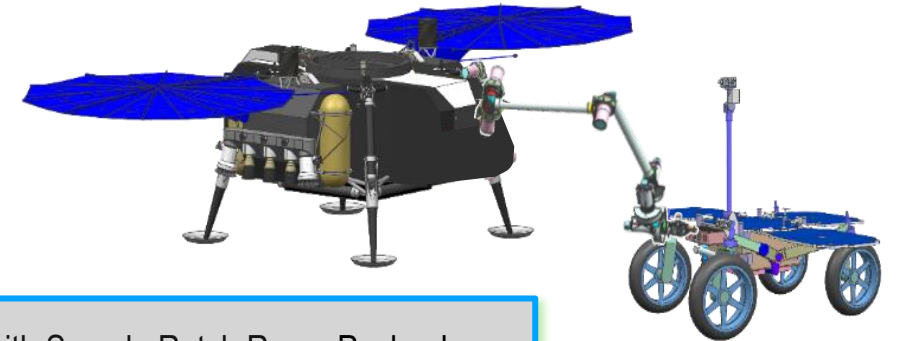
Program Elements

Dual Landers

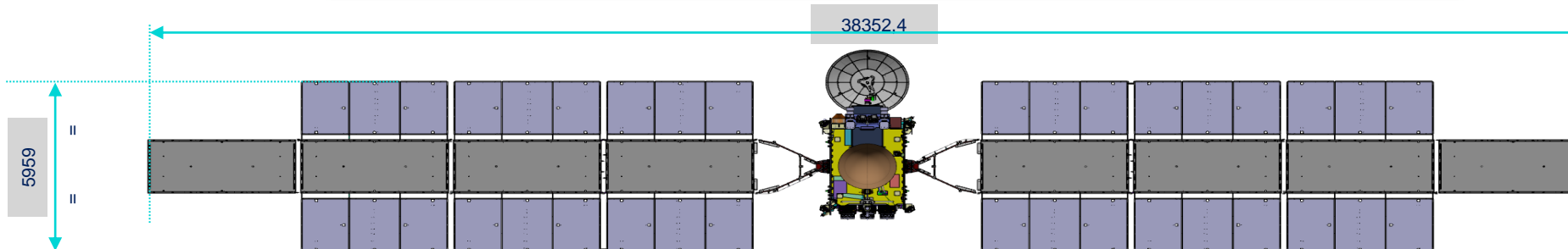
SRL-MAV with Mars Launch System Payload



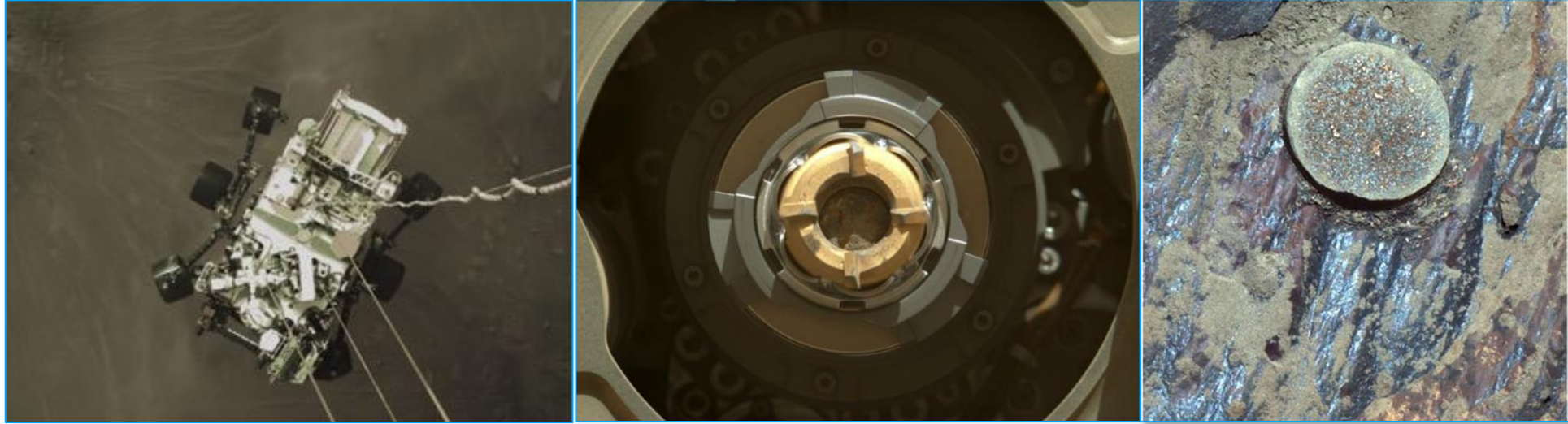
SRL-SFR with Sample Return Rover Payload



Earth Return Orbiter & CCRS Payload



When is the MSR Mission?



February 2021: NASA's Perseverance Rover landed on Mars in February 2021. It is collecting samples to be returned to Earth.

2027: ESA's Earth Return Orbiter will launch to Mars. Its payload is the NASA Goddard Capture, Containment, and Return System (CCRS). It will receive the Martian samples and return them to Earth.



When is the MSR Mission (continued)?

Dual Landers Touch Down

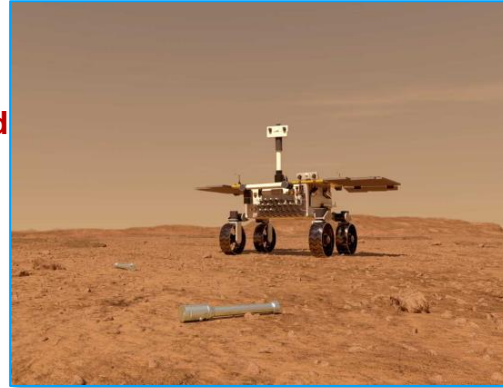
SRL-MAV: MAV Payload



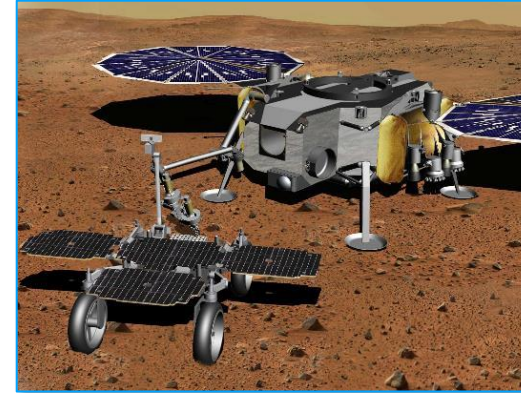
SRL-SFR: SFR Payload



The Sample Fetch Rover Exits SRL-SFR & Retrieves Sample Tubes



Fetch Rover's Tubes Are Transferred To SRL-MAV



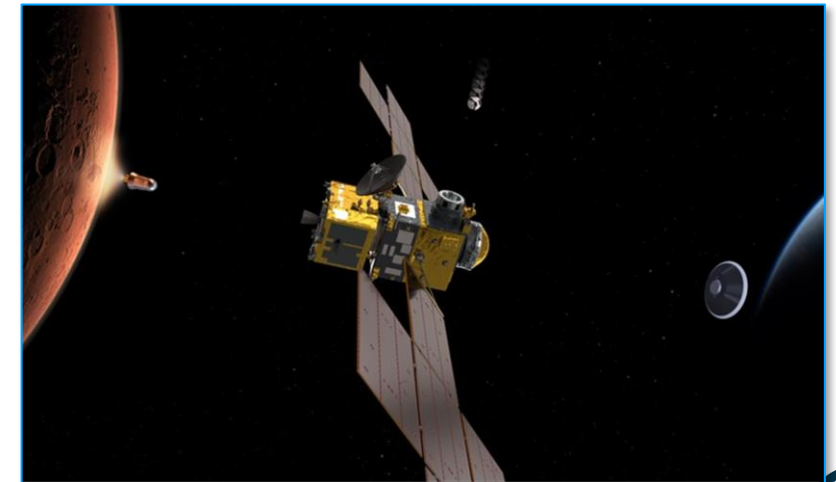
MAV Launches With Samples



2028: SRL-MAV (provided by NASA) and SRL-SFR (Provided by TBD) will launch to Mars.

2030: Samples will be retrieved and launched off the Martian surface, then captured by the Earth Return Orbiter with its Capture-Containment-Return Payload. The ERO begins its journey back to Earth.

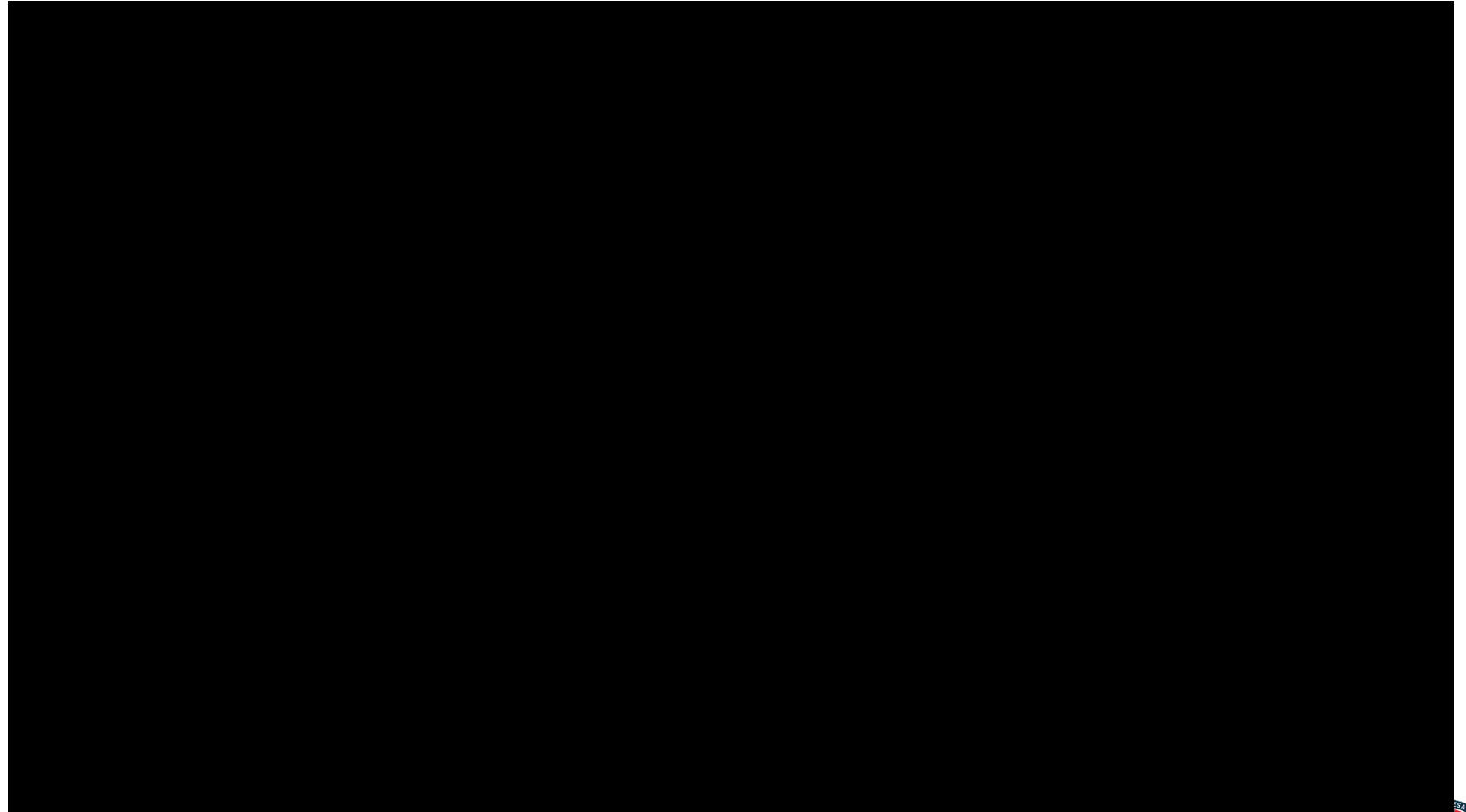
2033: The samples touch down at the Utah Test and Training Range. Samples are collected for scientific handling.



Testing MSR Technology

VECTOR = Vertically Ejected Controlled Tip-Off Release

- VECTOR is a pre-ignition separation mechanism for the MAS
- VECTOR provides a MAS separation state with a vertical velocity and pitch rate
- MAS ignition occurs a set time after separation within an established window that allows for successful flyaway

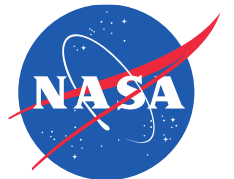




EES Manufacturing Demonstration Unit #1 Drop Test

Utah Test and Training Range March 1, 2022

NASA / USAF Team Photo

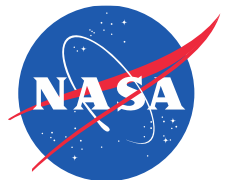


MDU1 Drop Test Video

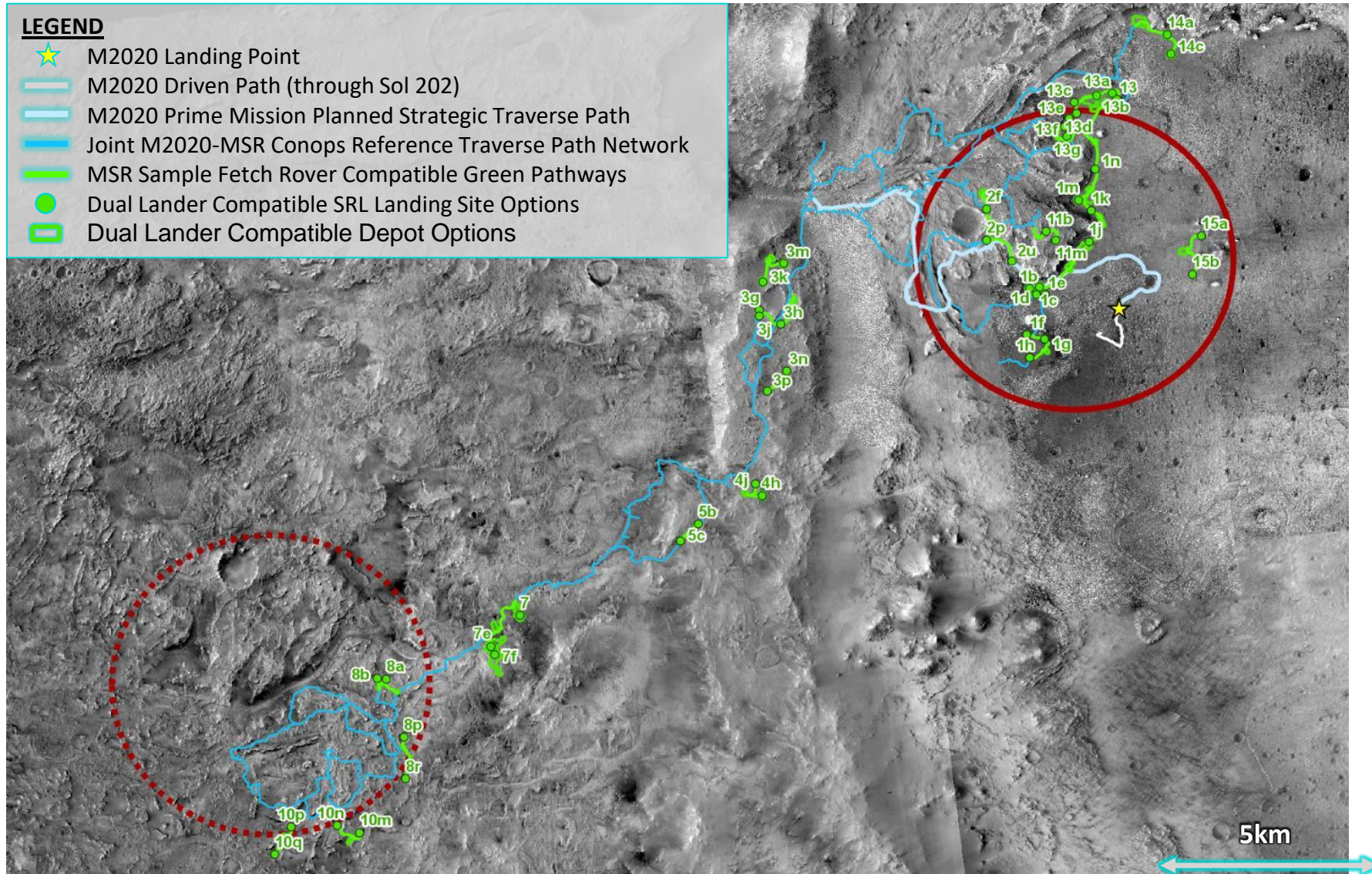
Drop Altitude: ~1000 ft

Terminal Velocity at impact: ~33 m/s

Utah Test and Training Range – March 1, 2022



Notional MSR Dual-Lander Green Pathways



Summary

- This is the most significant planetary science undertaking in a generation
- Now is the time!
 - Perseverance on surface of Mars collecting samples
 - Orbital Relay assets in place around Mars
- MSR is made possible by strong and significant partnerships with European colleagues at ESA and their industrial consortiums

