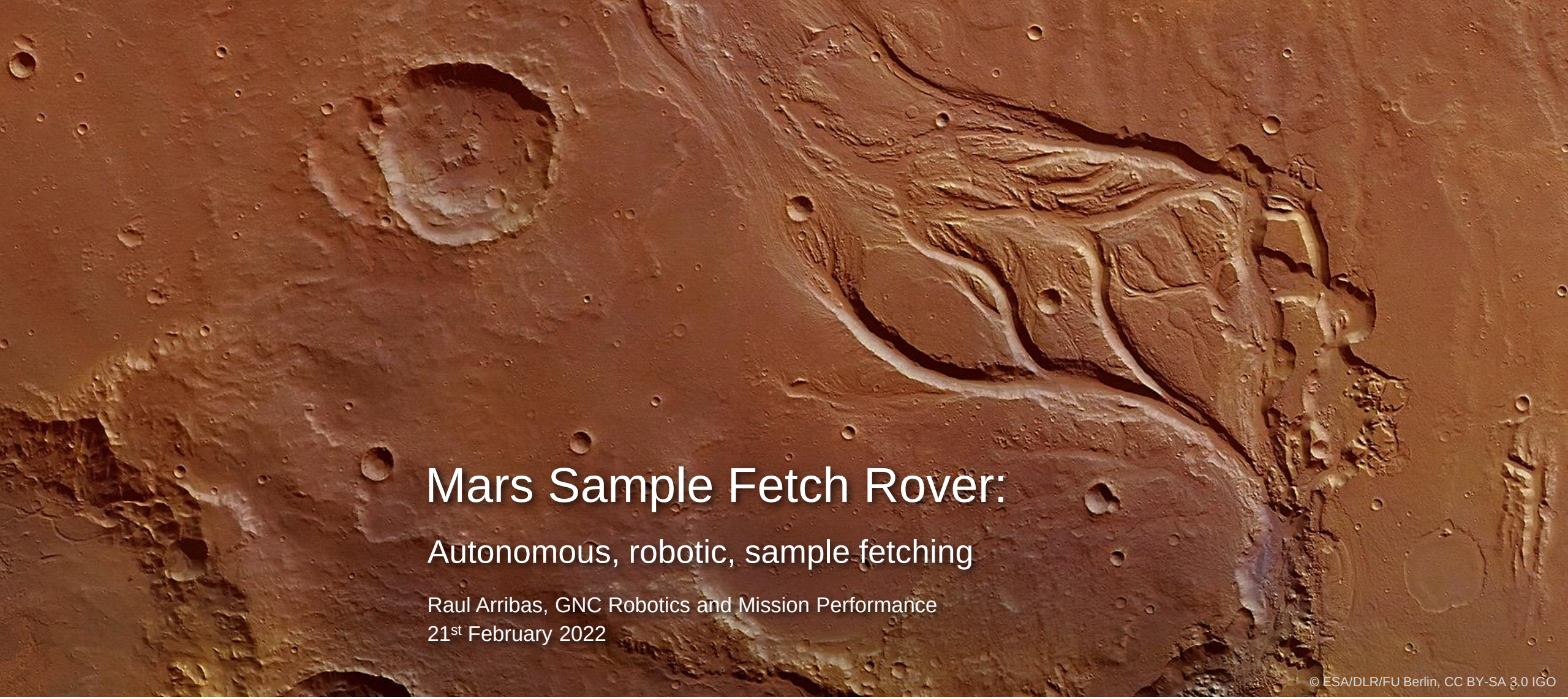

Mars Sample Fetch Rover:

Autonomous, robotic, sample fetching

Raul Arribas, GNC Robotics and Mission Performance

21st February 2022

DEFENCE AND SPACE

AIRBUS

1. **Overview of Mission**
2. High Autonomy
3. Fast Development

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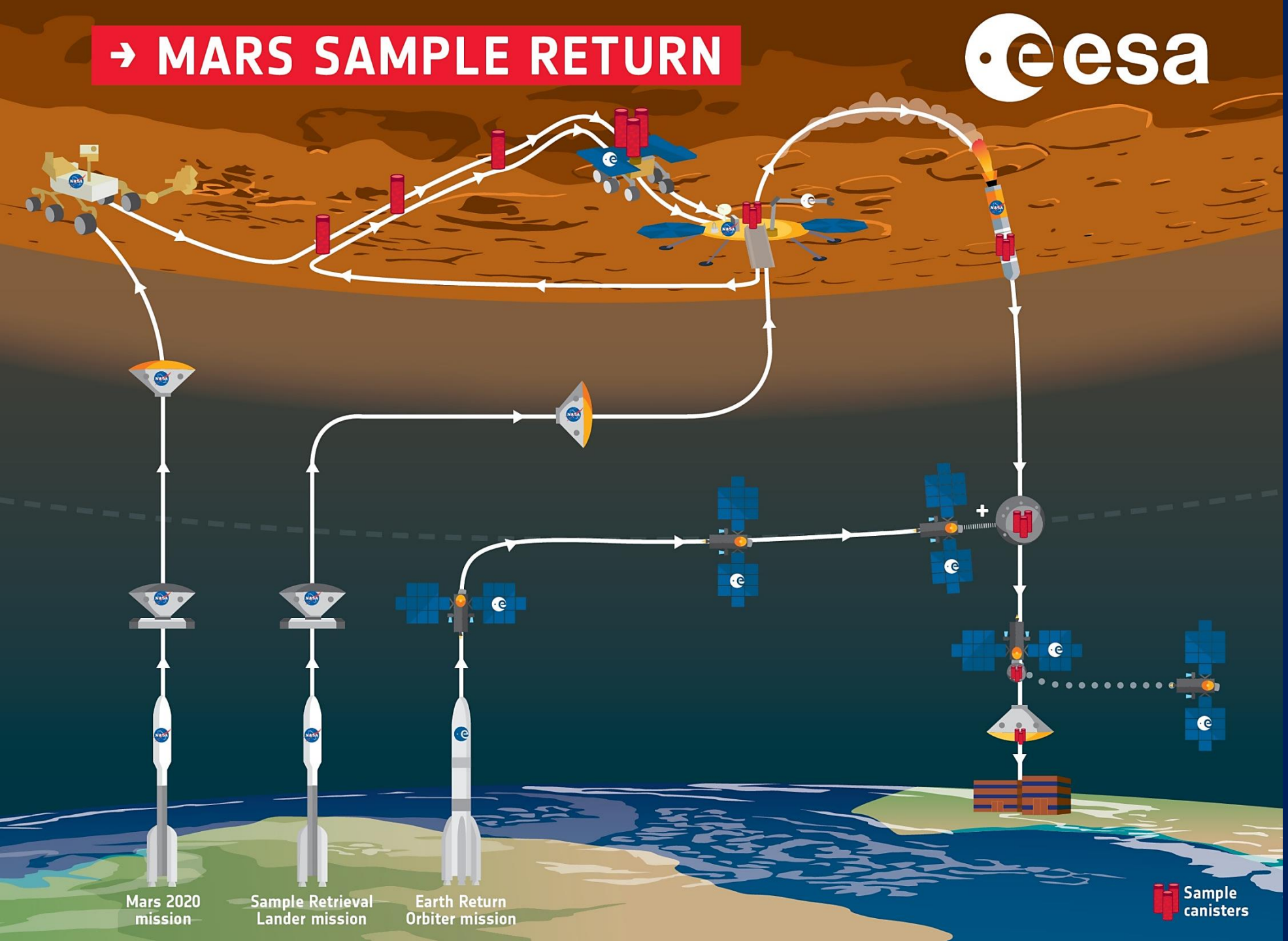


Mission Architecture

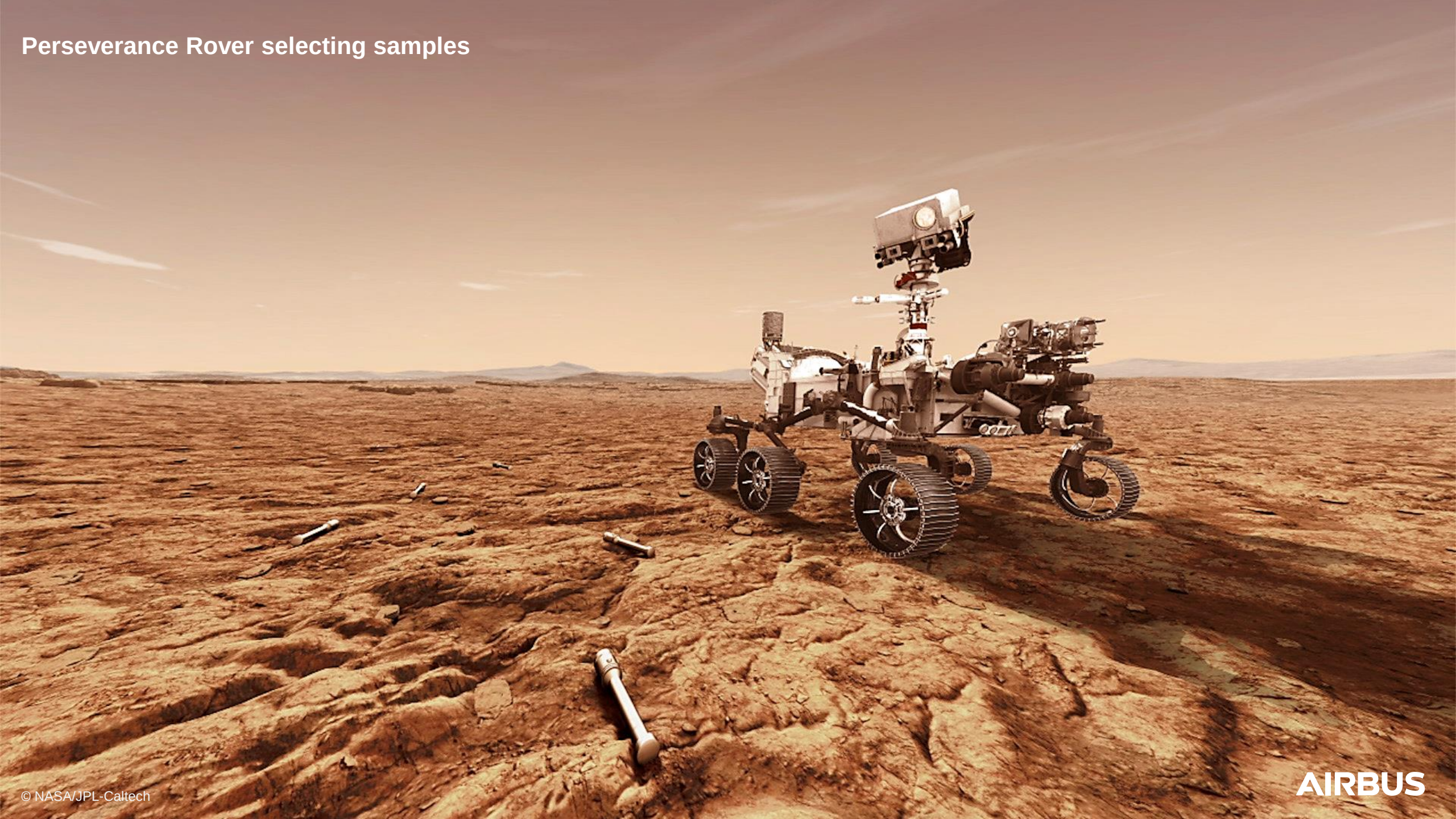
International Mars Sample Return

3 launches

2020 – 2031

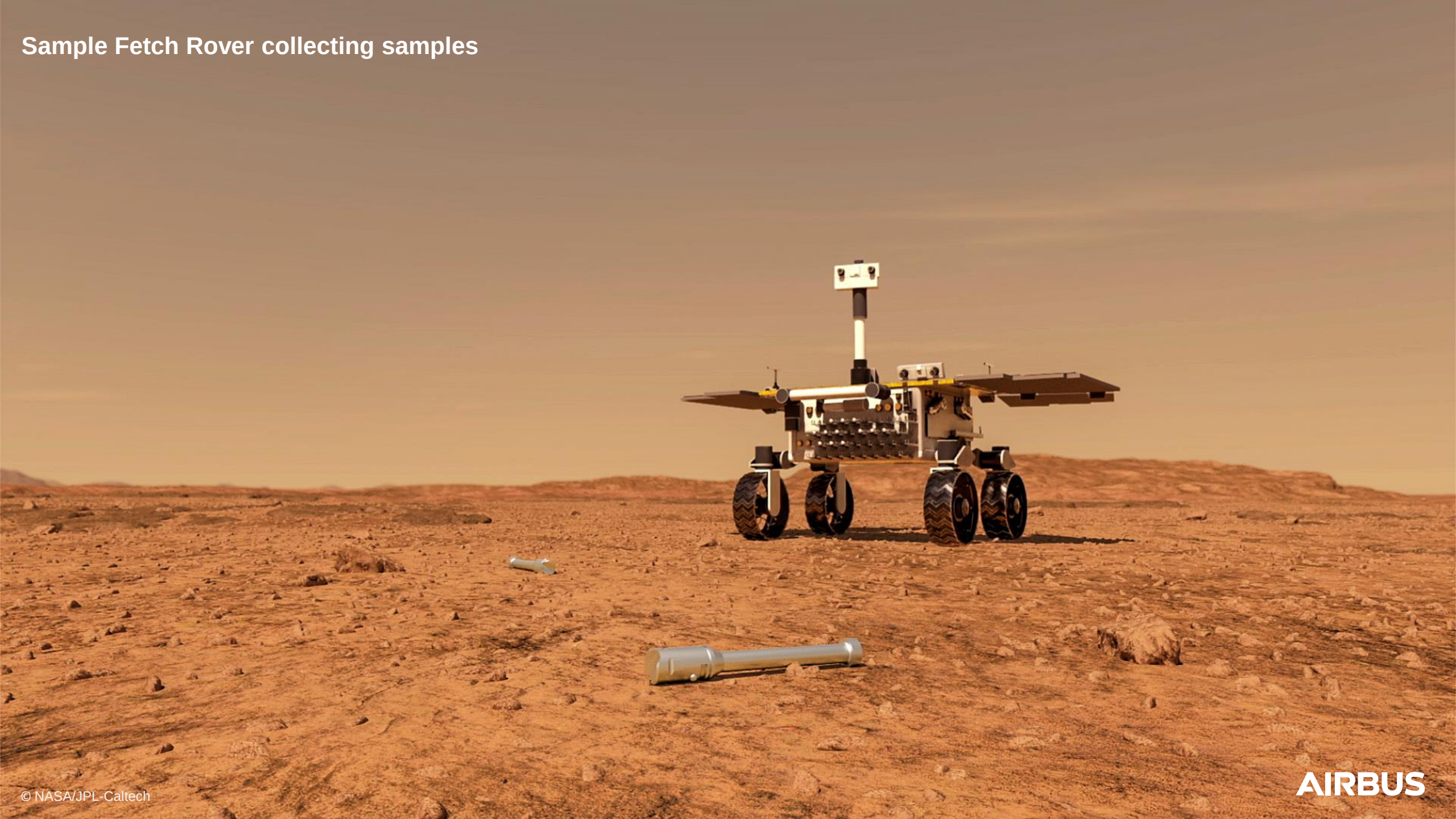
AIRBUS

Perseverance Rover selecting samples



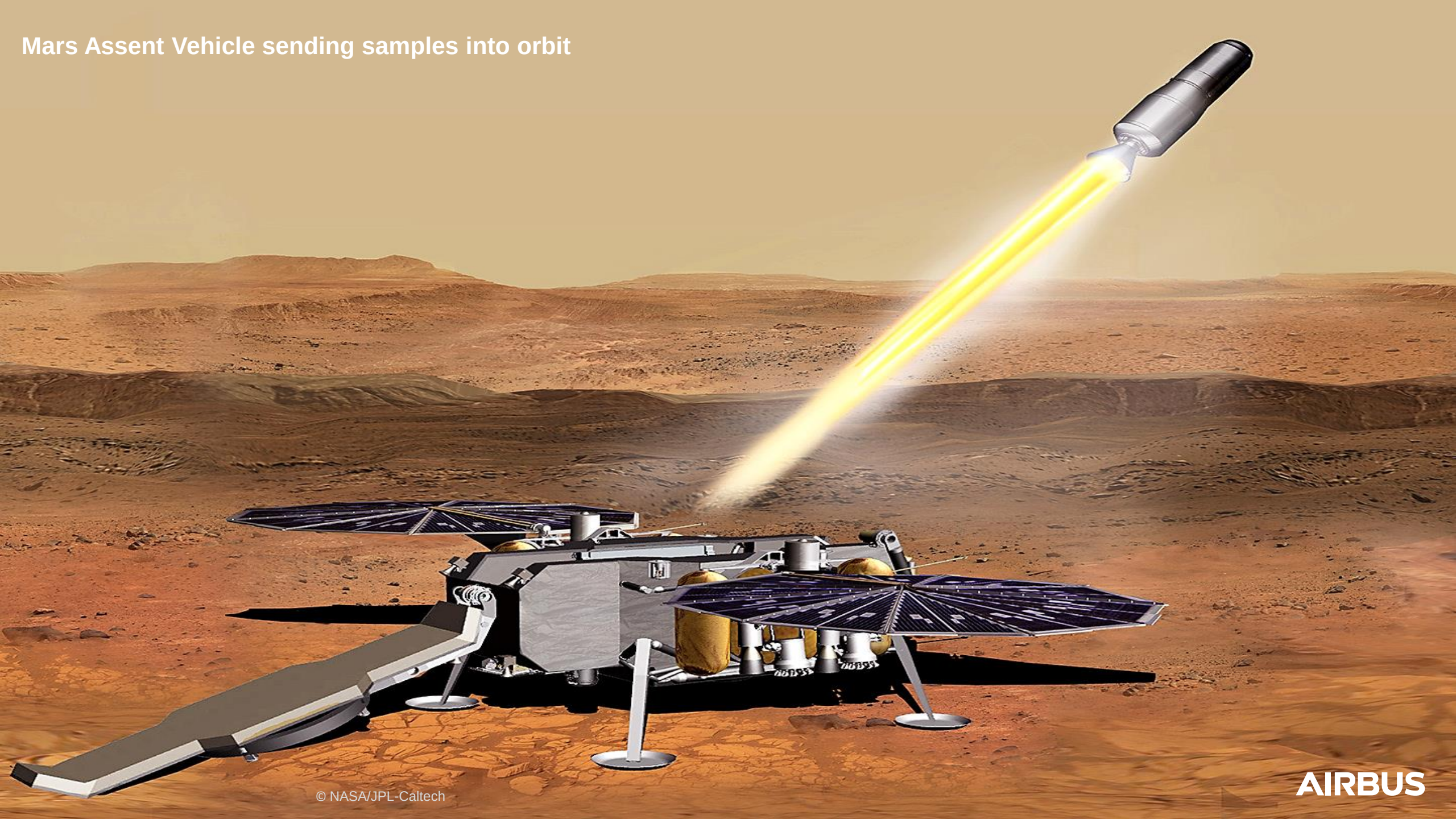
AIRBUS

Sample Fetch Rover collecting samples



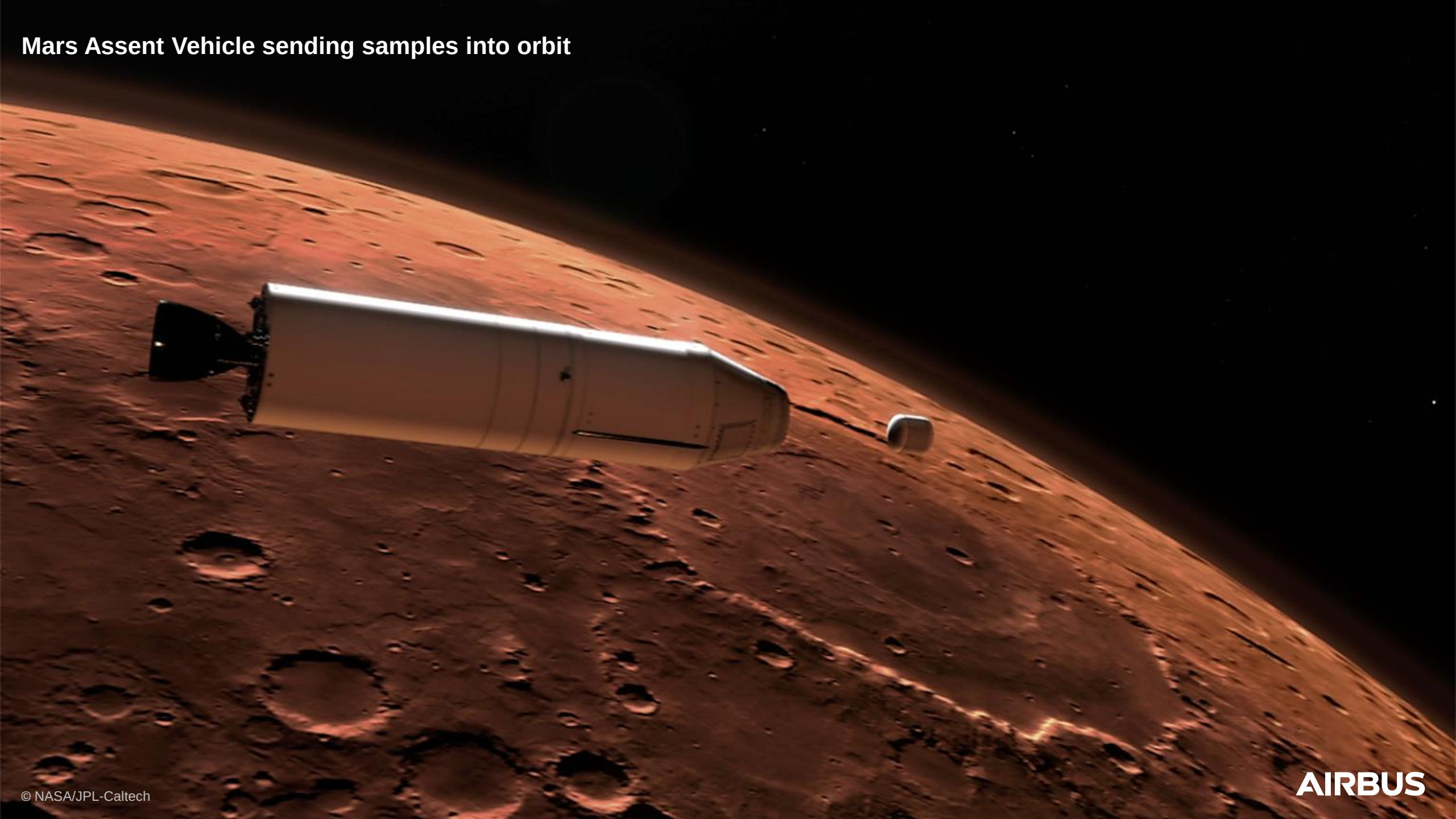
AIRBUS

Mars Assent Vehicle sending samples into orbit



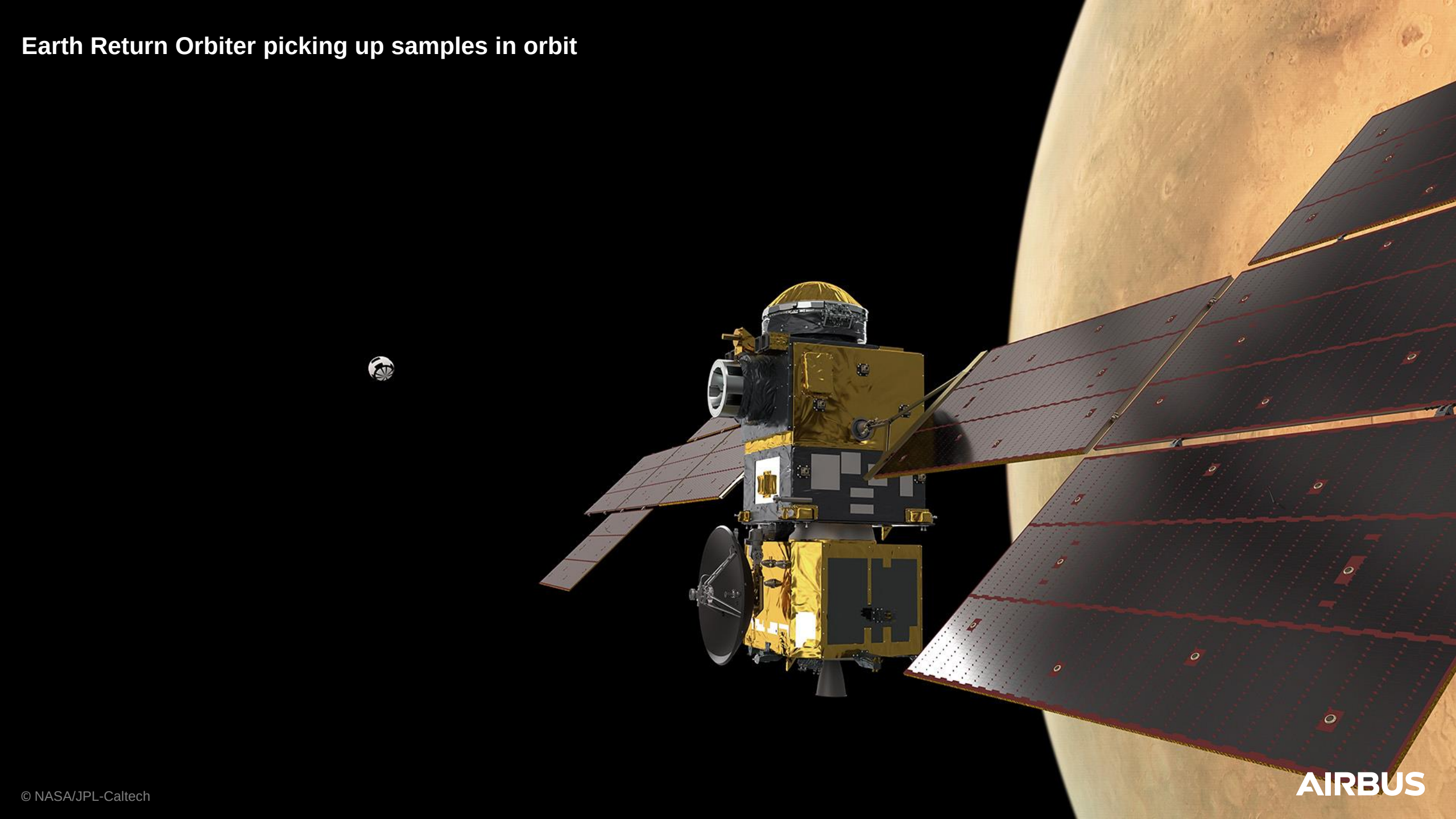
AIRBUS

Mars Assent Vehicle sending samples into orbit



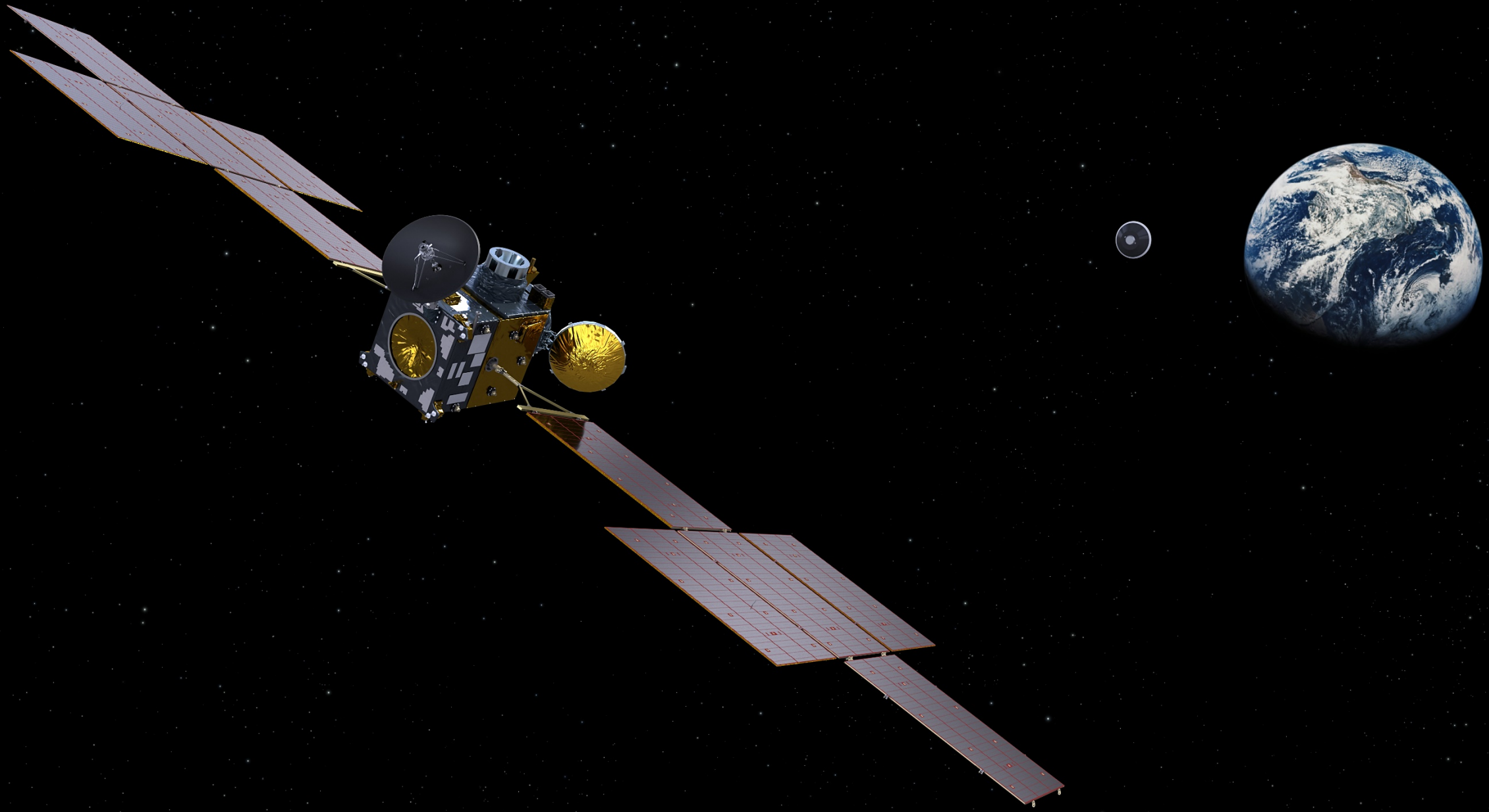
AIRBUS

Earth Return Orbiter picking up samples in orbit



AIRBUS

Earth Return Orbiter sending samples to Earth



AIRBUS

Key challenges: timeline

Timeline constrained by orbital mechanics

Need to transfer from Mars to Earth and back. Due to the alignment of the planets this presents a tight time constraint.

– Departure window for Earth – Mars transfer

– Departure window for Mars – Earth transfer

Additionally, need to avoid Dust Storm season, to ensure fast turn-around

Applies to flight operations:

– Limited time for surface and orbital operations at Mars

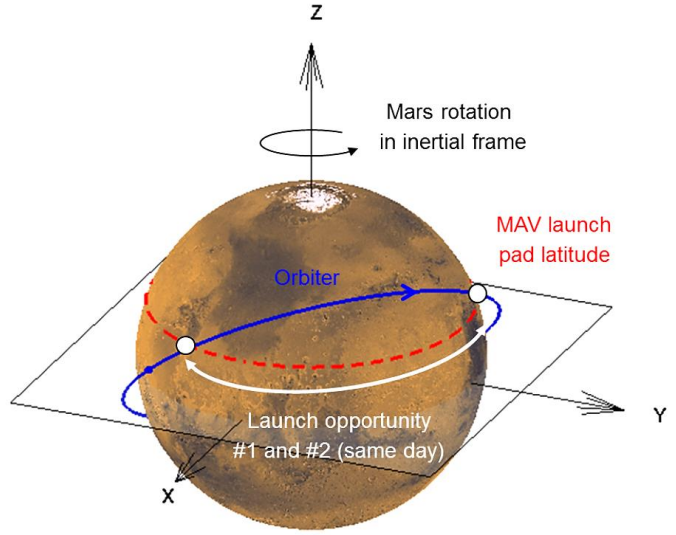
– Up to 30min for ground in the loop Tele-Commands

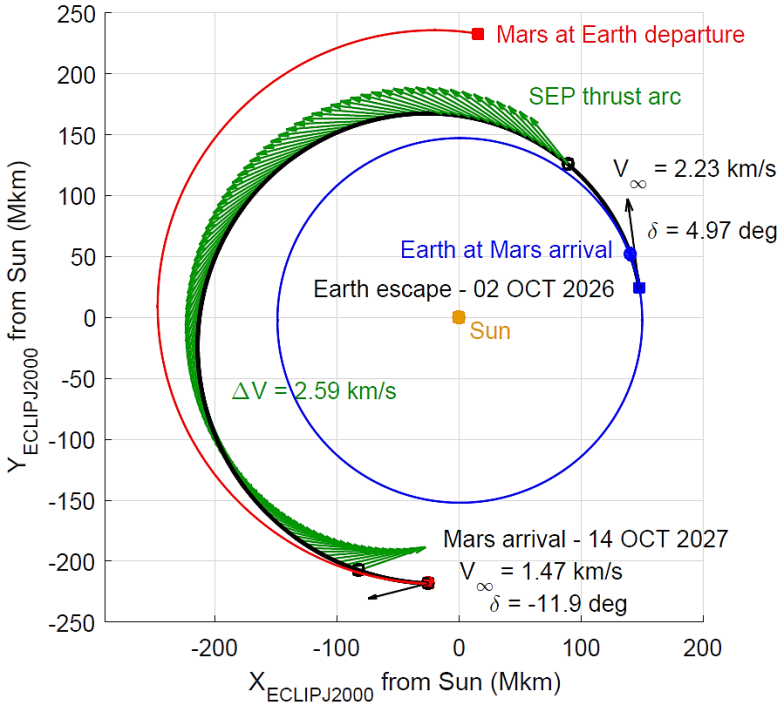
→Requires: **High autonomy**

Applies to mission development

– Launch opportunity at 2028, need bespoke Rover Designed, Verified, Tested

→Requires: **Fast development**



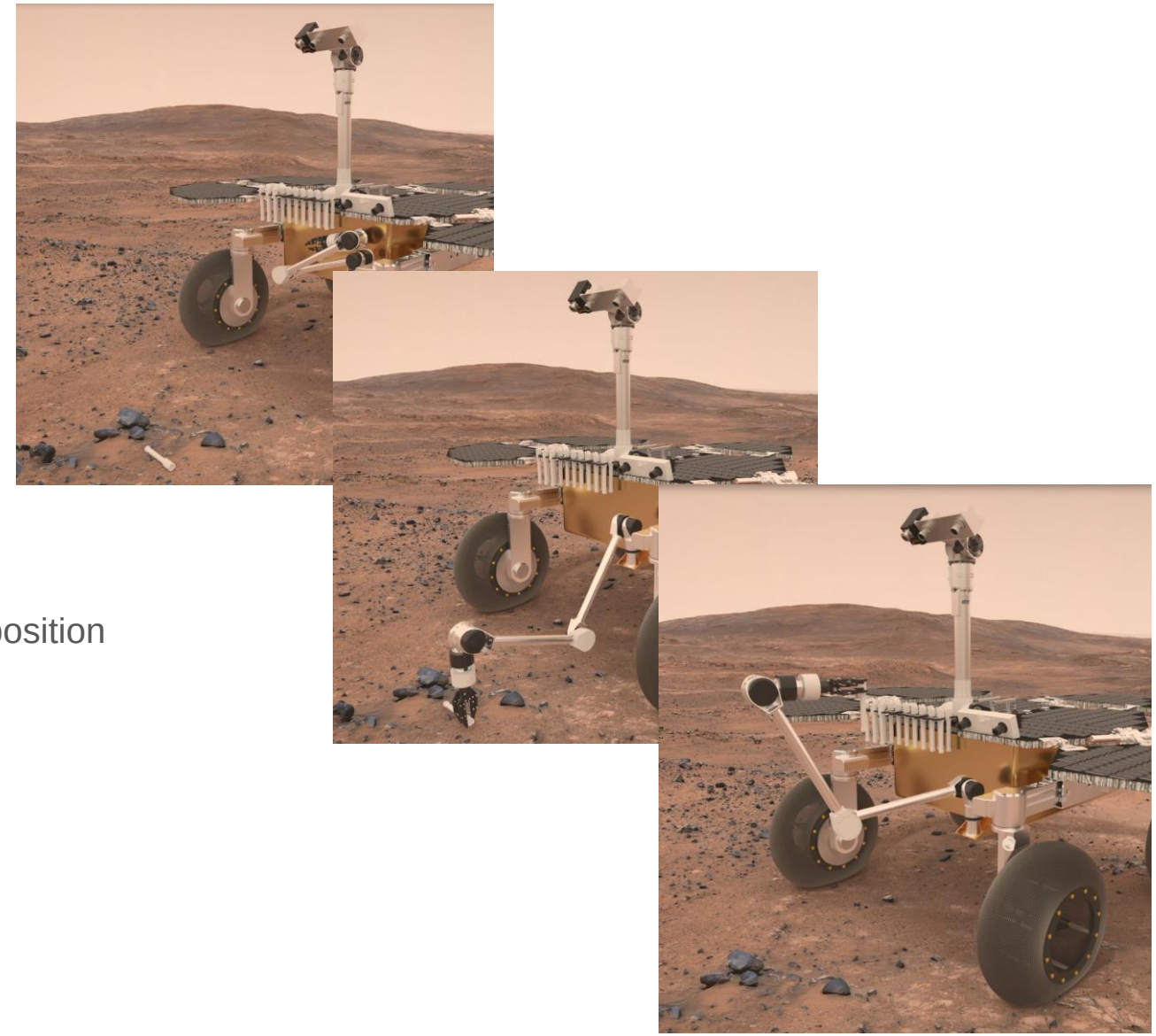


1. Overview of Mission
2. **High Autonomy**
3. Fast Development

Raul Arribas, GNC Analyst

21st February 2022

High Autonomy



Detect

- Using NavCam on mast
- Visual Based Detection System (Machine Learning Algo.)
- Identify sample + position relative to rover
- Point cloud of terrain to avoid obstacles

Grasp

- Arm and Gripper System calculating trajectories based off position and terrain
- Visually check the grasping in gripper

Stow

- Manipulate the delicate sample for storage

High Autonomy

Vision and arm system fully integrated with autonomous logic with

- Robotics ToolBox
- Statistics and Machine Learning Toolbox

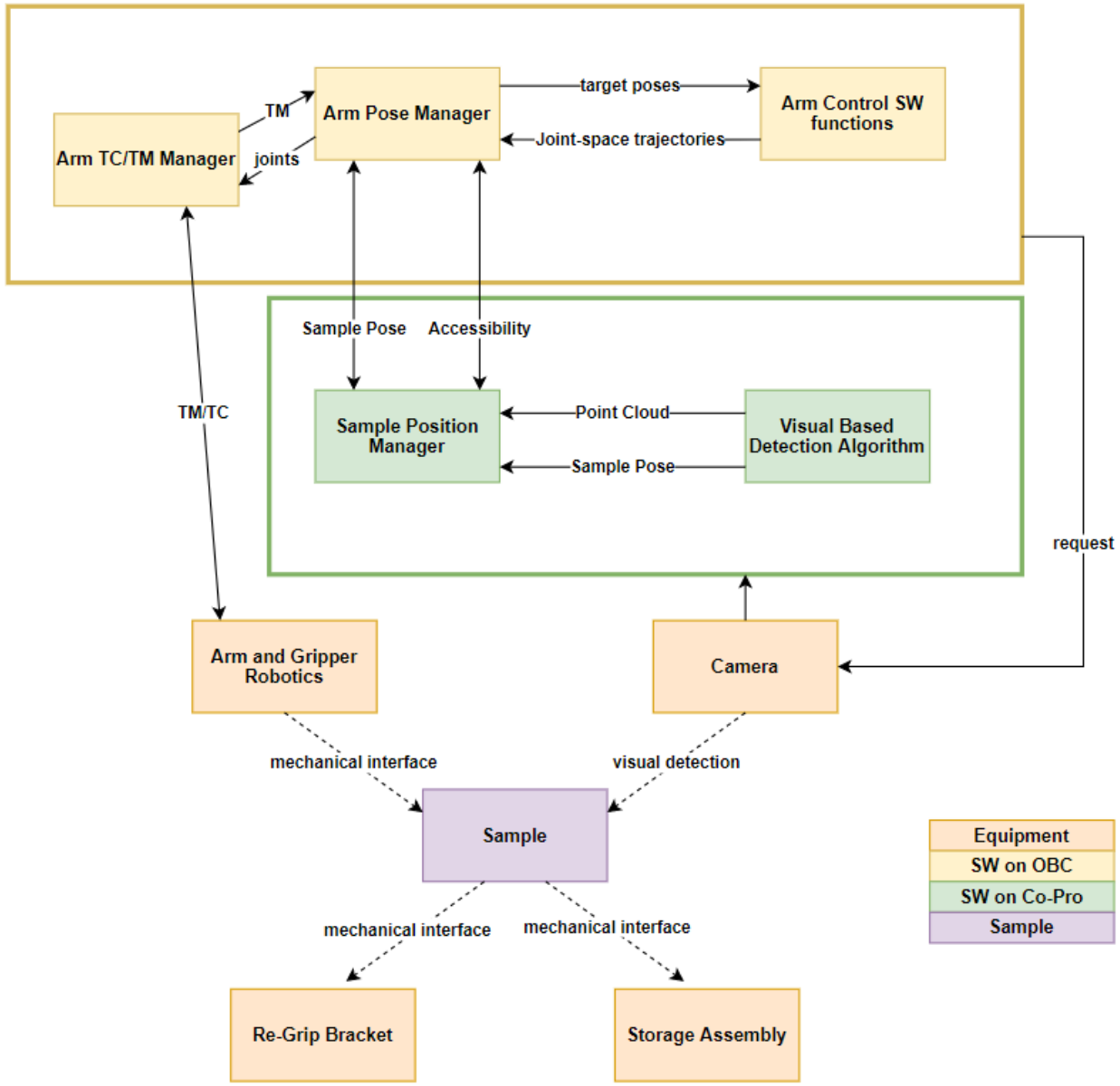
- State-machine with visibility of all the equipment
- Asynchronous processer for computation intensive tasks
- Arm/Gripper and Camera interact with Sample

Visual Detection

- Request Camera image
- Detect Sample with Machine learning
- Use Sample Pose and Point Cloud for accessibility to plan arm mc

Arm motions

- Target poses sent to Arm Control SW
- Joint space trajectories sent to Arm TC/TM manager
- TM received of moving arm



1. Overview of Mission
2. High Autonomy
3. **Fast Development**

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21st February 2022

Autocoding / Code Generation

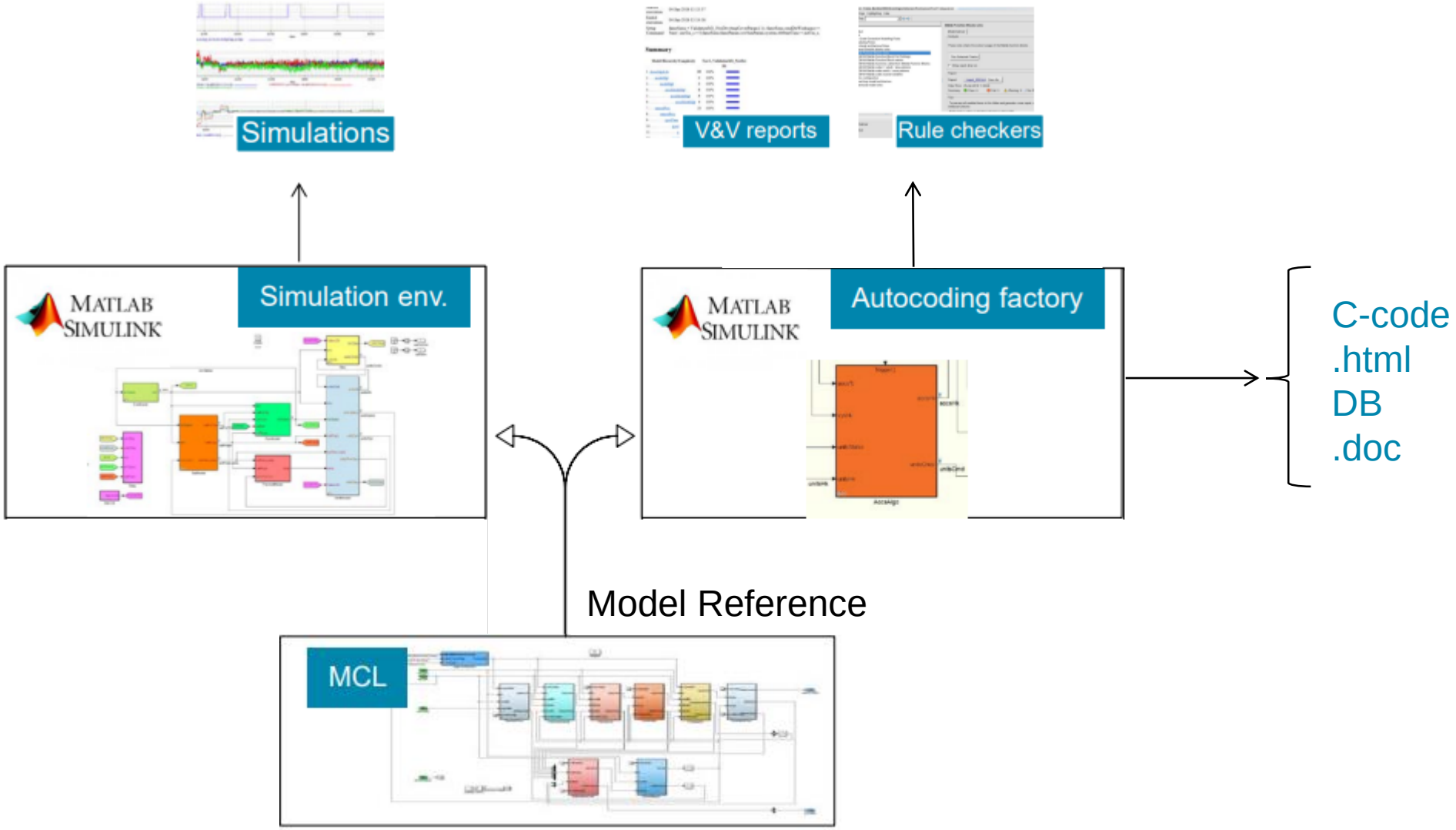
Objective: to optimize our process by exploiting full capability of MATLAB/Simulink environment, and keeping the ECSS compliancy

Solution: C-code generated vis embedded coder from MATLAB/Simulink, with automatically generated documentation

- Airbus developing autocode systems for a long time
- OneWeb: first autocoded control system in flight
  - Software modules integrated autocode / generated code
  - All 3 modes have been run
  - Nominal spacecraft behaviour achieved + delivered on time

- Ensures ECSS standards:
  - ECSS E-60: AOCS
  - ECSS E-40: SW
  - ECSS Q-80: SW PA
  - Automatic Code Generation for AOCS/GNC SW Handbook

Further Details:
Jerome Bourdon
jerome.bourdon@airbus.com



- MCL: fundamental algorithm controlling flight dynamics
- Embedded both in:
  - Simulation environment
  - Autocoding factory

Autocoding at a glace

C-code generated from MATLAB/Simulink

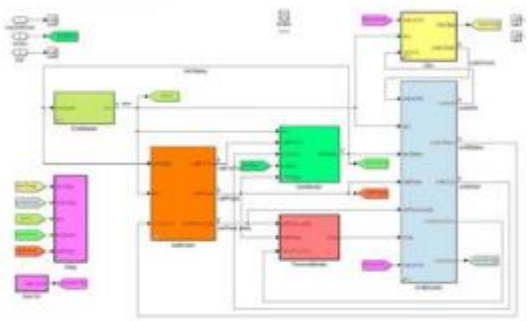
Simulations

Functional Validation

Software

Fault Detection

Flight/ Maintenance



Conclusion

Summary of presentation:

Overview of Mission
- Returning samples from Mars
- Very short time on Mars
- Strict launch window

High Autonomy
- Detection, Grasp and Stow
- Machine Learning

Fast Development
- High-level algorithms developed in MATLAB/Simulink
- Flight software C-code (generated)
- Documentation (generated)

Look forward to sharing as development progresses