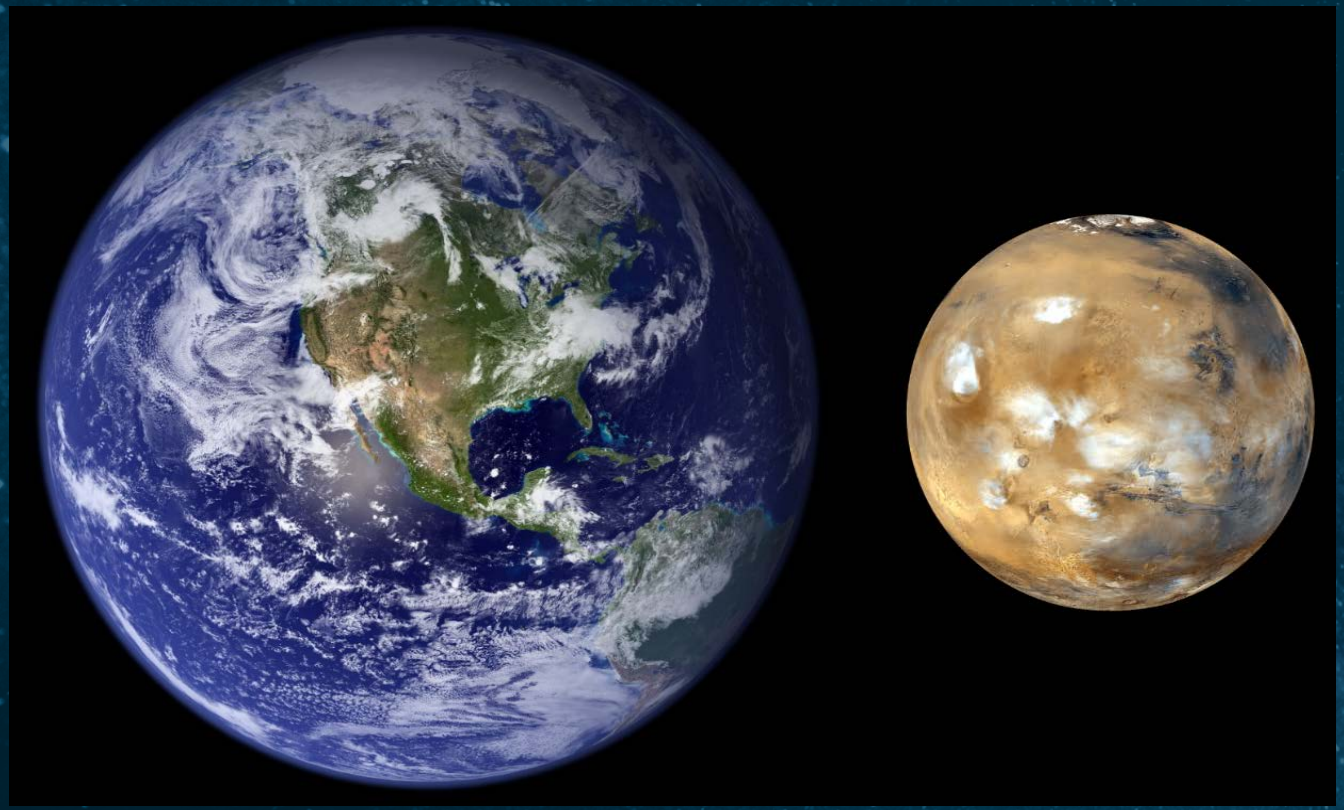
Mars Sample Return – The Earth Return Orbiter Securing Mars

SpaceTech Masters Symposium

Edrich Yau, 23/07/2021, ESA/ESTEC,

Why Mars and what has Security got to do with it?



Half the radius of Earth, so Gravity is much less

Further from the sun so colder (-10 deg C at the warmest day)

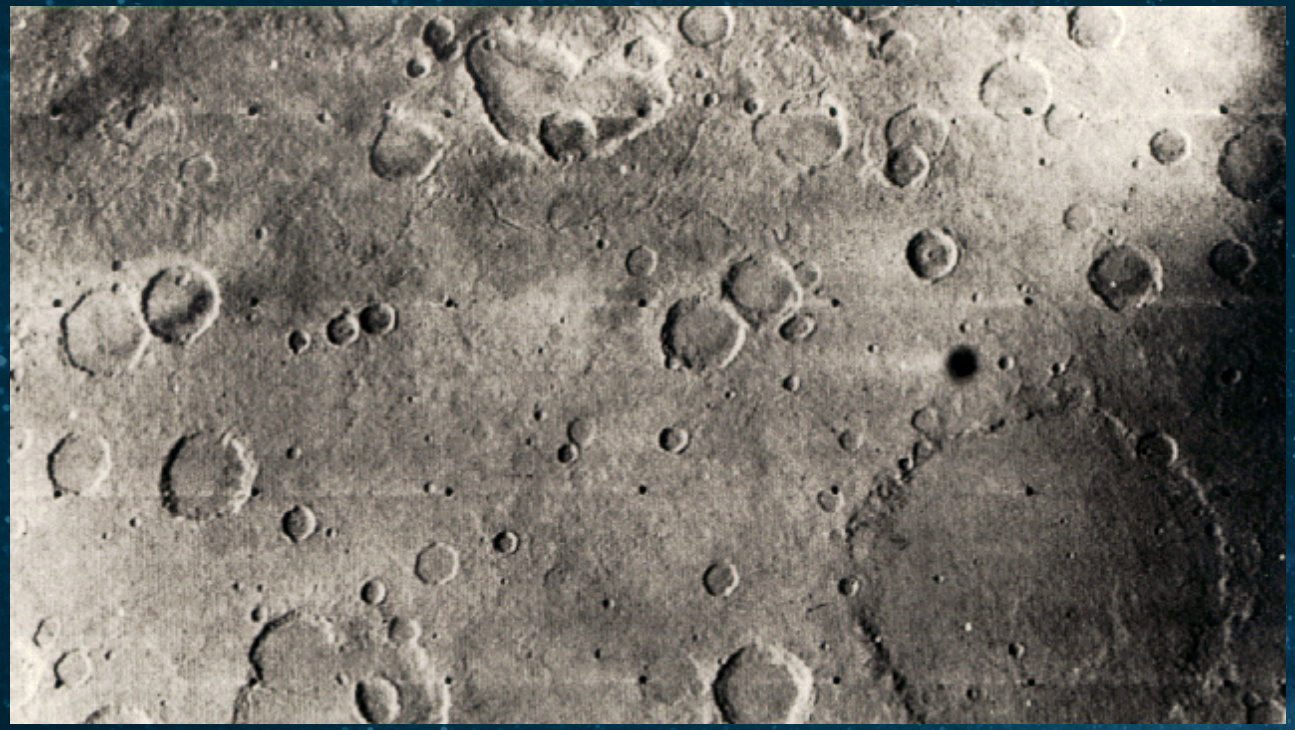
No magnetic core so no protection from radiation from the Sun

2.7AU from Earth at the max separation distance

Are we seriously worried about an Alien attack?

It is totally ridiculous!

What is there on Mars?



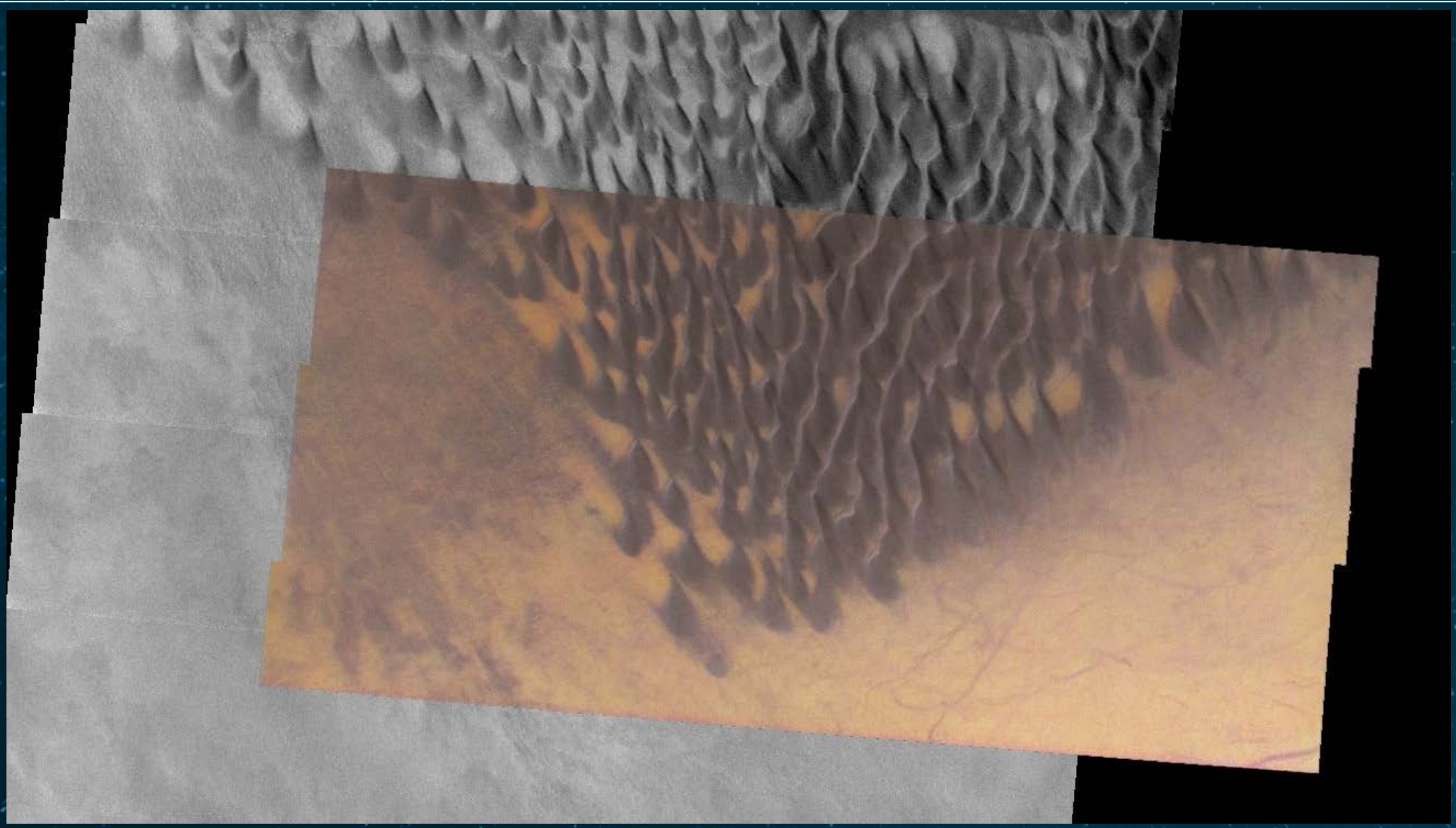
Mariner 4 images looked disappointing

But Hubble showed an atmosphere,

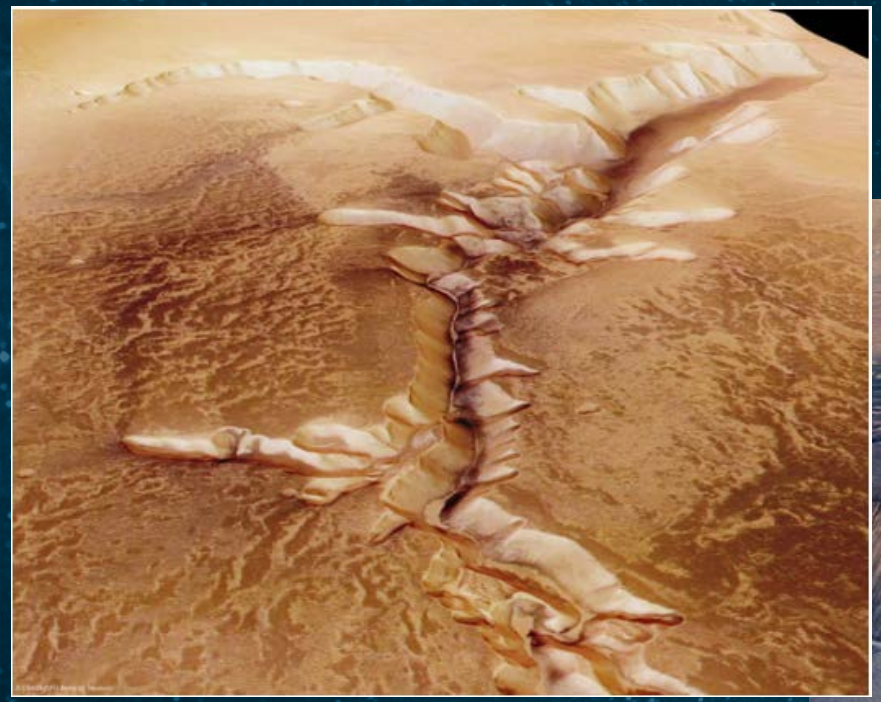
- Clouds

- Seasons

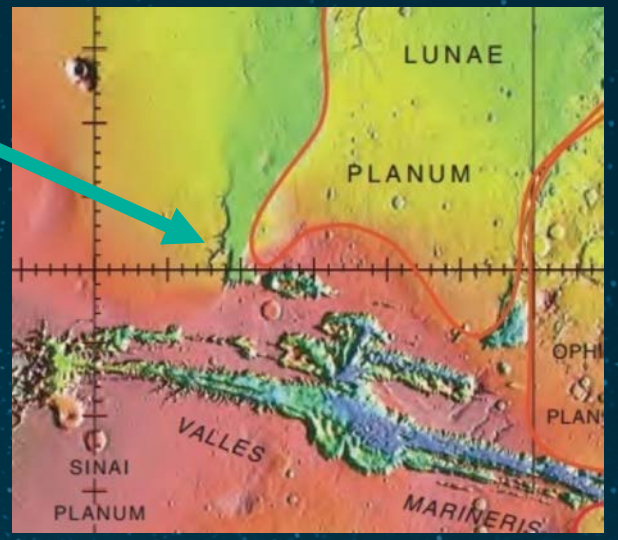
Dynamic landscape

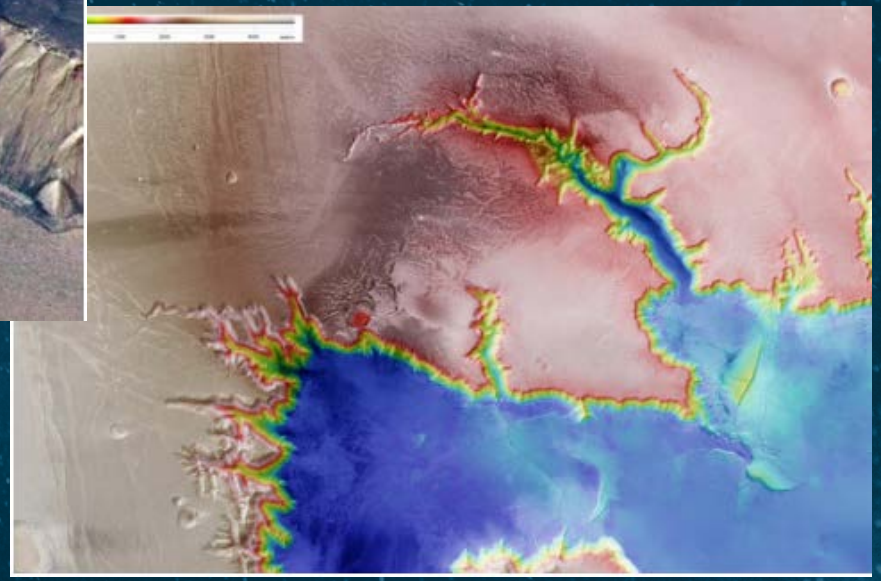


Mars Express Satellite imagery



Echus Chasma





Echus Chasma

100km long and 10km wide.

May have channelled water

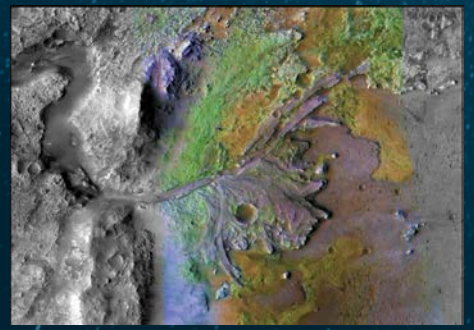
https://www.esa.int/Science_Exploration/Space_Science/Mars_Express/Echus_Chasma

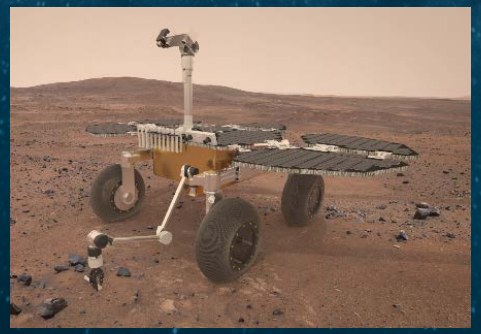
Mars Sample Return Campaign

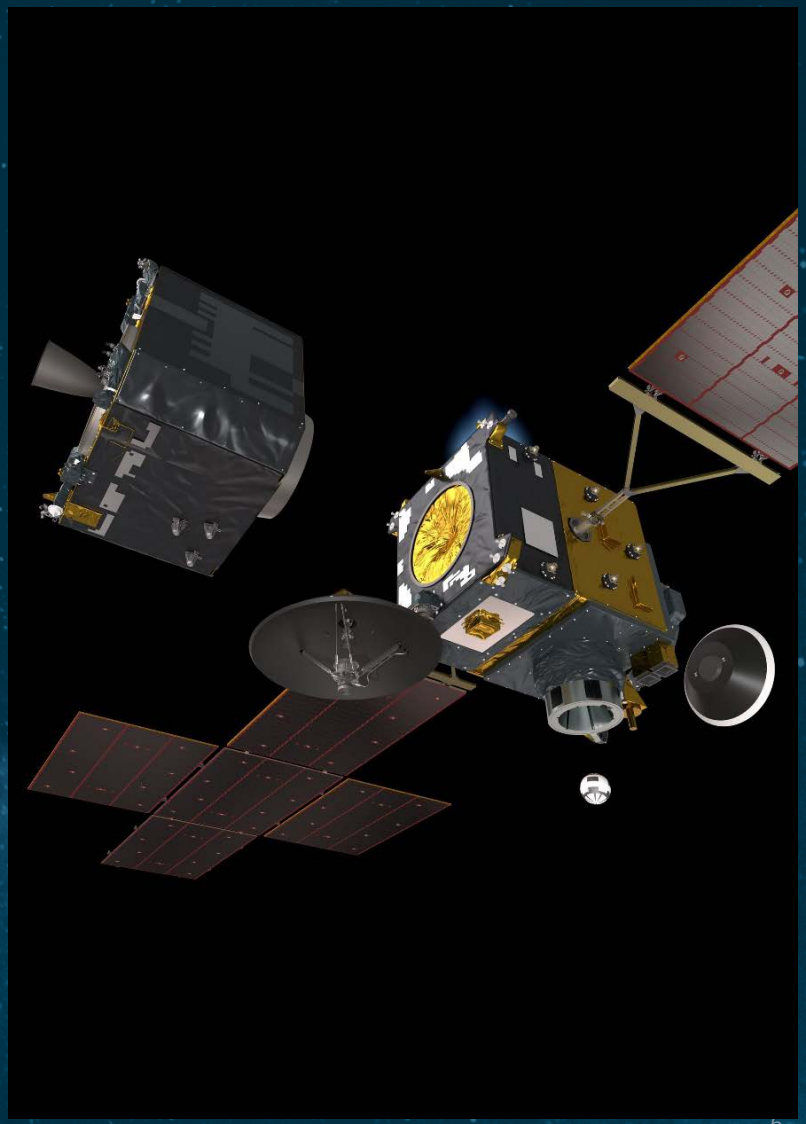
The Trilogy has already begun!

- ✓ Perseverance & Ingenuity (30 July 2020) now at Jezero Crater
- ❖ Sample Return Lander & Sample Fetch Rover (2026)
- ❖ Earth Return Orbiter (2026)

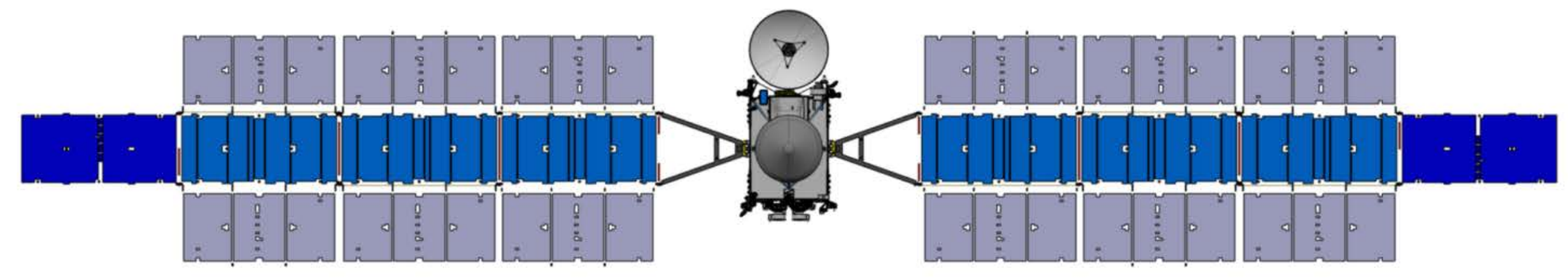
Returning Martian Samples to Earth





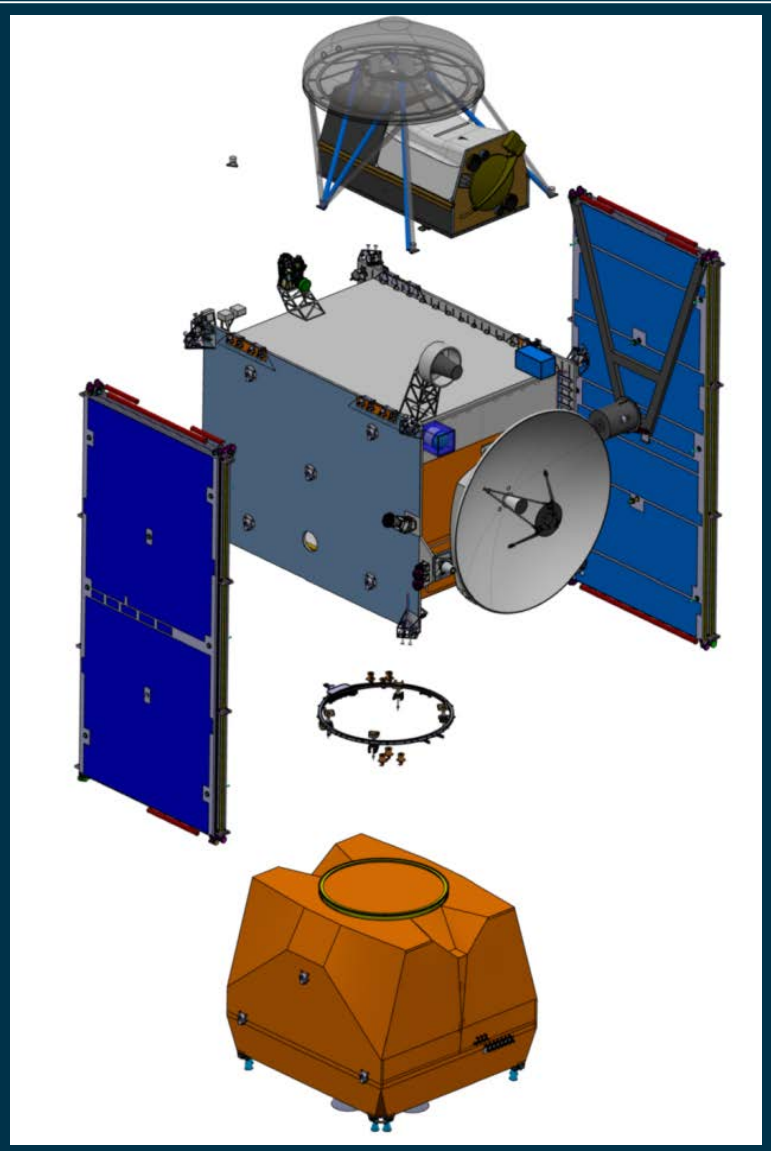


Overview of the spacecraft



- ✓ Approx 6.5 Tonnes (wet mass)
- ✓ Solar Array = 39m x 6.6m
- ✓ 41 kW (at Earth BoL)
- ✓ 4 Electrical Propulsion thrusters
- ✓ 2 separate Chemical Propulsion systems
- ✓ 100W TWTA with 2.3m Main Dish (HGA)
- ✓ Supports 250kbps at 2.2AU
- ✓ Triple redundant TTC system
- ✓ 4 OnBoard Computers & security modules
- ✓ UHF comms for Mars Relay

ERO Staging

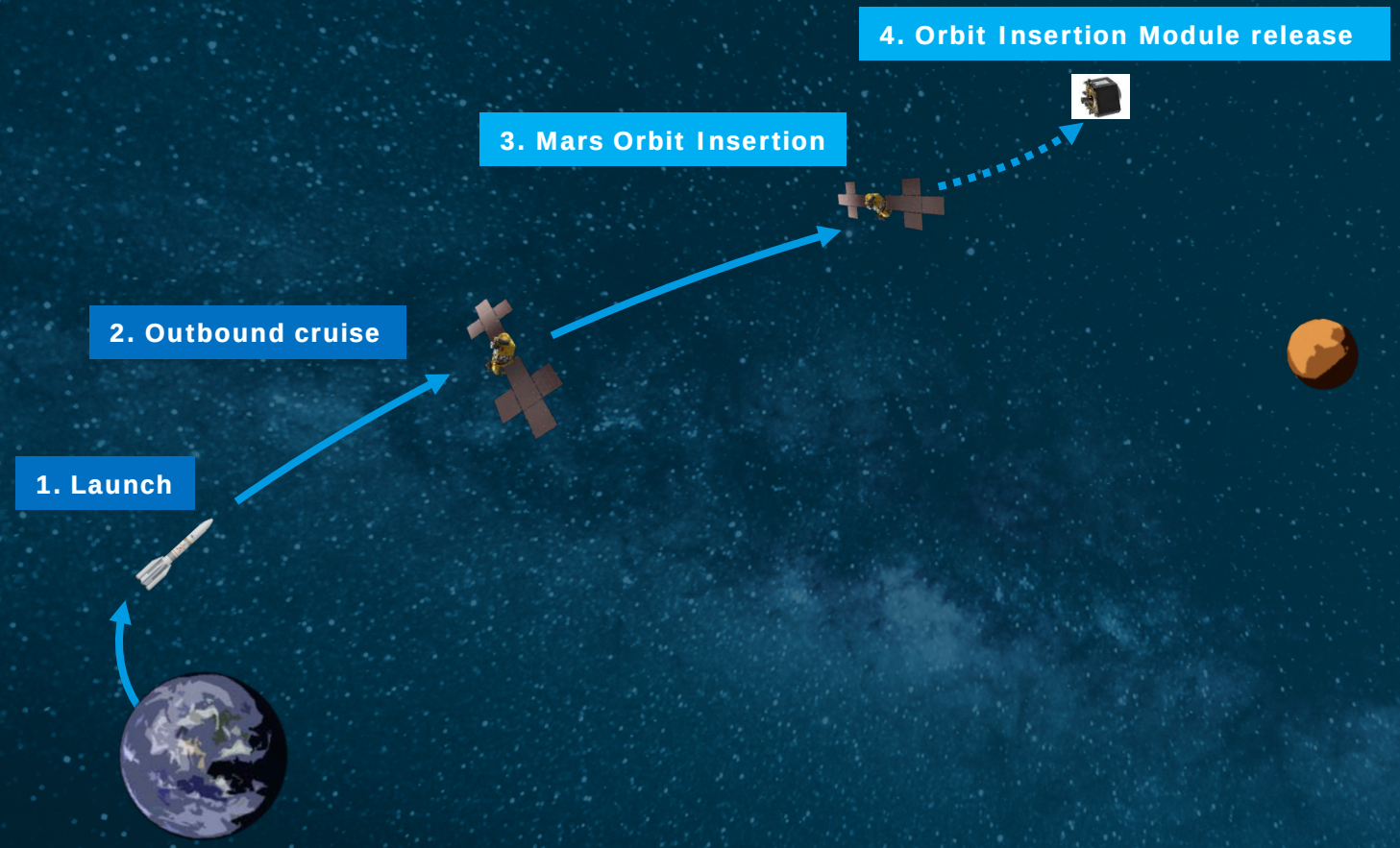


CCRS and Rendezvous Sensor Suite
CCRS Total (w/o RSS)≈ 500 kg
EES ≈ 100 kg
CCM > 200 kg (Jettisoned at Mars)
OS ≈ 8 kg

Main Module (“Return Stage”)
Dry Mass = 2200 kg
Electric Propulsion:
- 3 x active + 1 spare
- Thrust Range = 0.13 – 0.75 N
- Isp = 4000s
- Xenon Mass = 1100 kg
- Delta-V = 10 km/s

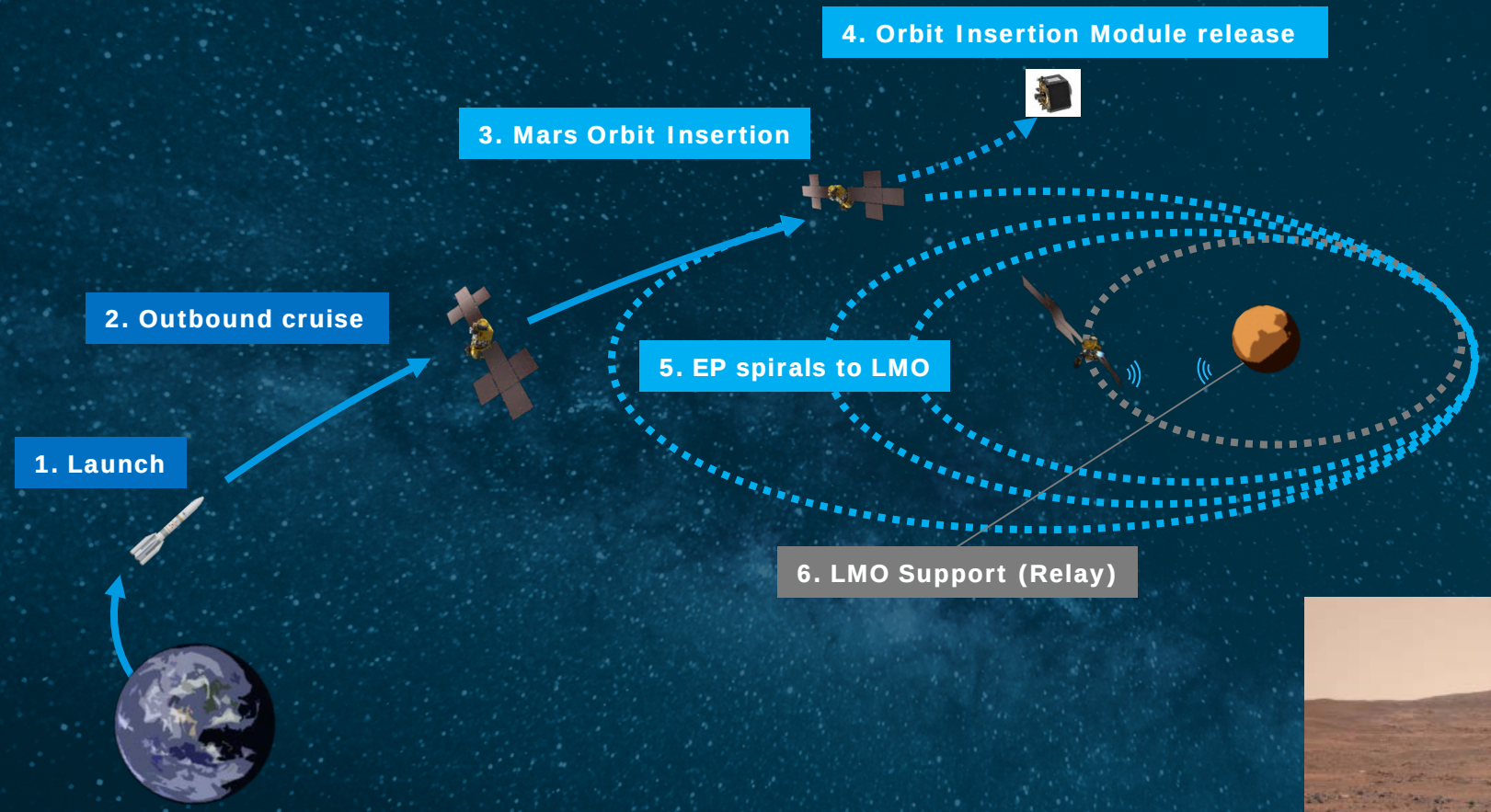
Orbit Insertion Module (“Drop Stage”)
Jettisoned at Mars
- Dry Mass = 600 kg
- Prop Mass = 1900 kg

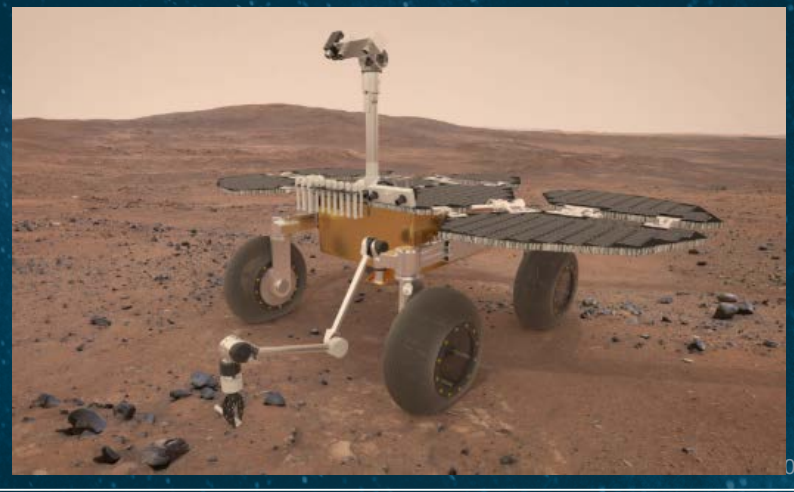
Earth Return Orbiter Mission Phase Overview



Outbound trip to Mars

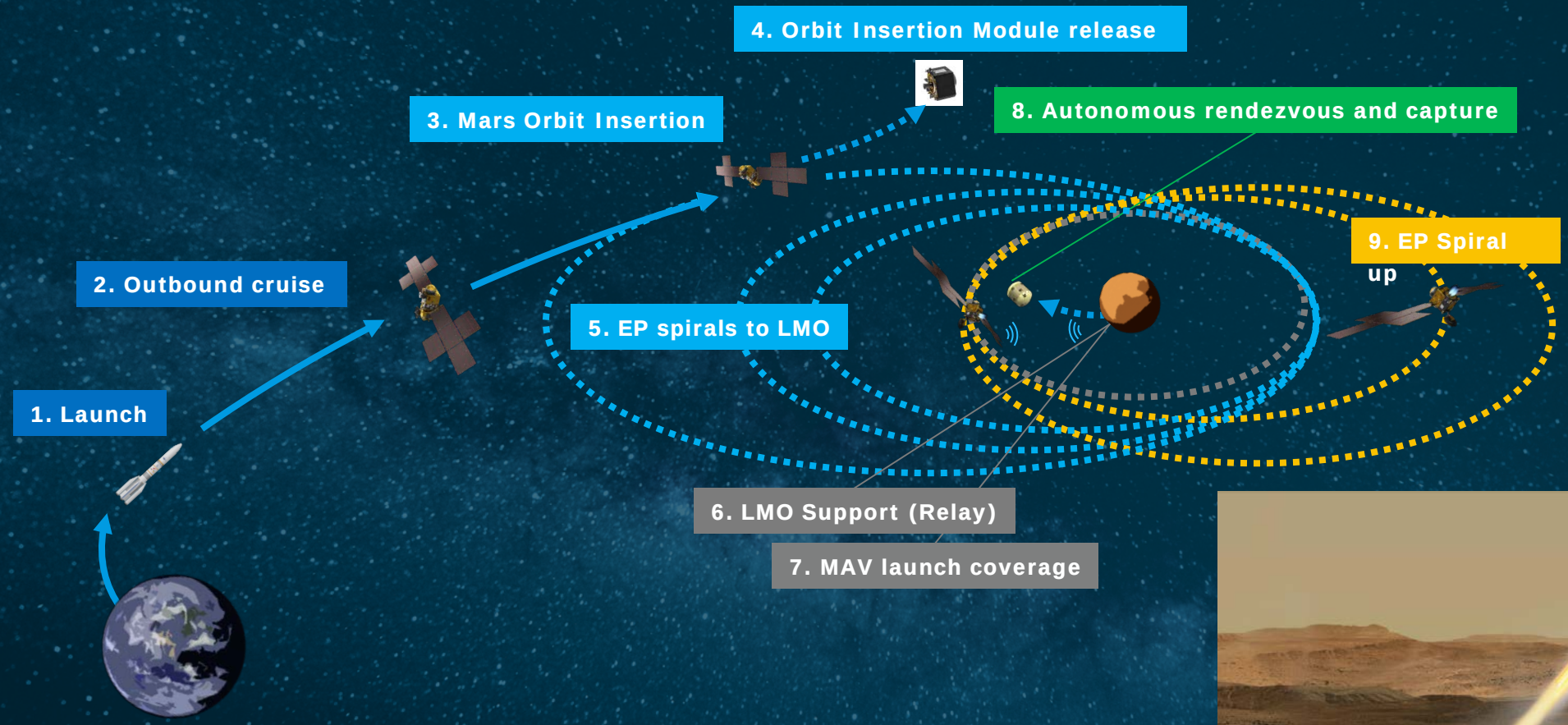
Earth Return Orbiter Mission Phase Overview





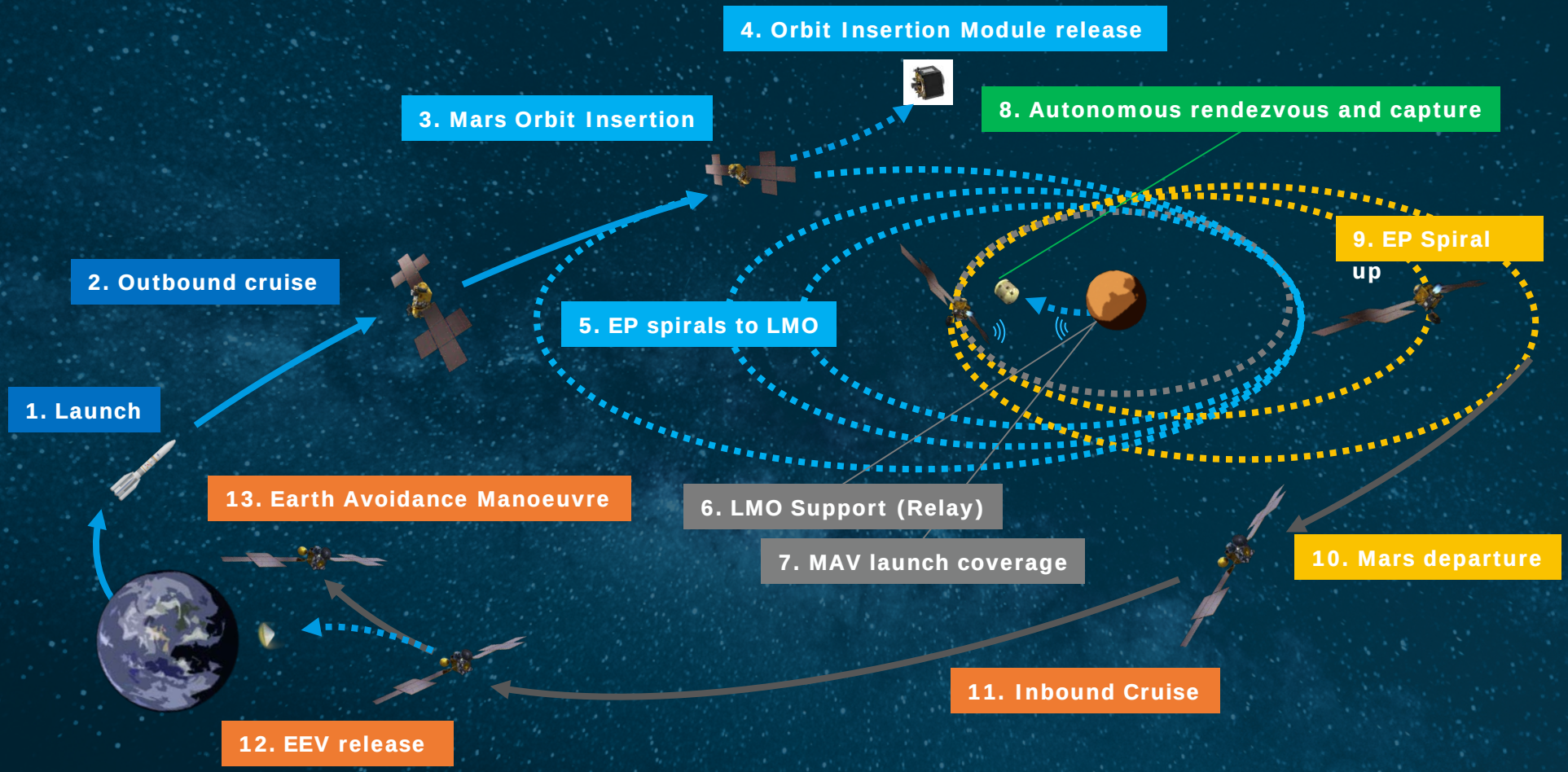
Communications support activities

Earth Return Orbiter Mission Phase Overview



MAV launch and Rendezvous

Earth Return Orbiter Mission Phase Overview



In-bound return trip to Earth + Earth Avoidance Manoeuvre

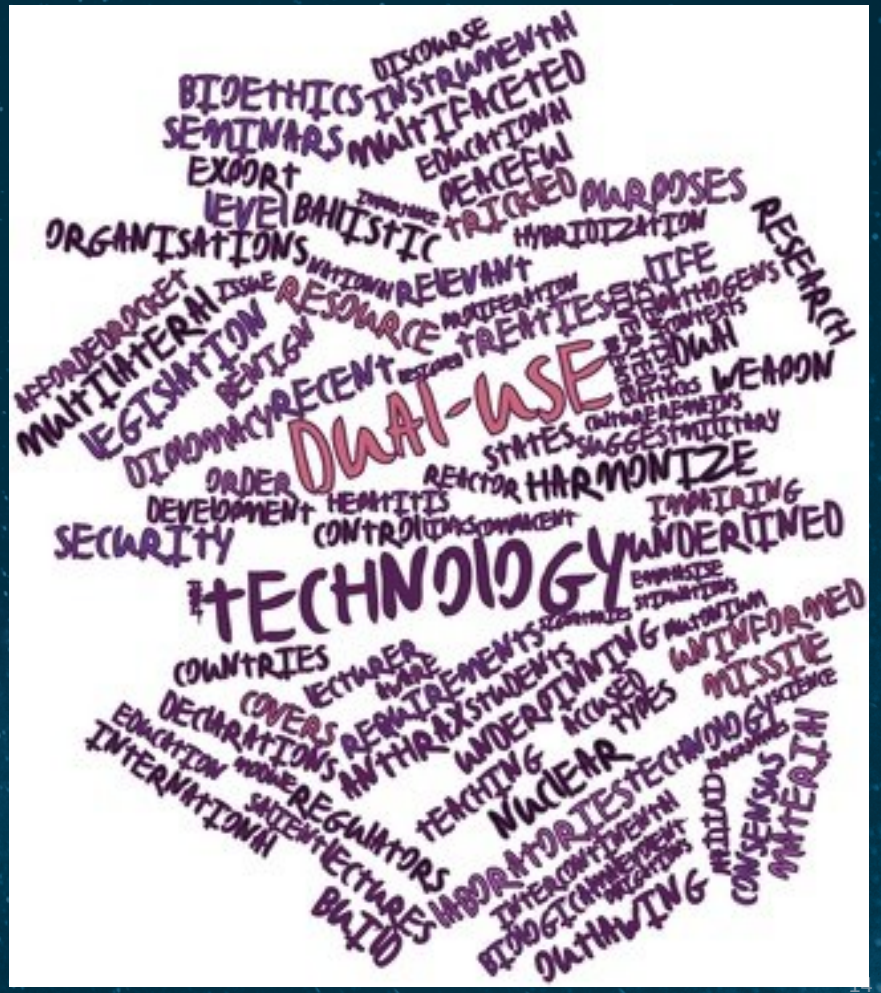
But still,…Why Security ???

Committee on Space Research (COSPAR) Planetary Protection Policy

- “To protect the space environment from “harmful contamination” which would endanger the integrity of the scientific exploration of outer space including the search for life.”
- “Most importantly, it also helps to preserve the terrestrial biosphere from possible contamination by extraterrestrial material”
- Predates the Outer Space Treaty (OST 1967)

Security Assurance Needs Overview

- Unclassified mission
- Return of Bio-Contained Sample
- CAT-V Backward Planetary Protection Mission
- Export Controlled Items (Dual use technology)
- Landing in Utah Test and Training Range
- Mission Success
- Agency Reputation



Satellite Hacking

- US DOD event Satellite DEFCON Ethical Hackers
- 2011 - US-German ROSAT (NASA Computers Hacked By Intruders - Via Satellite - (satellitetoday.com))
- 2007-8 – Landsat-7 & EOS AM-1 (Hackers Interfered With 2 US Government Satellites | Space)
- 2021 Ransomware attacks
- Identity or technology theft
- Private data and information

Applied Security Process

- We don’t have an ECSS for this (yet) ! But … Consultive Committee for Space Data Systems CCSDS 350.1-G-2 (Security Threats against Space Missions) helps

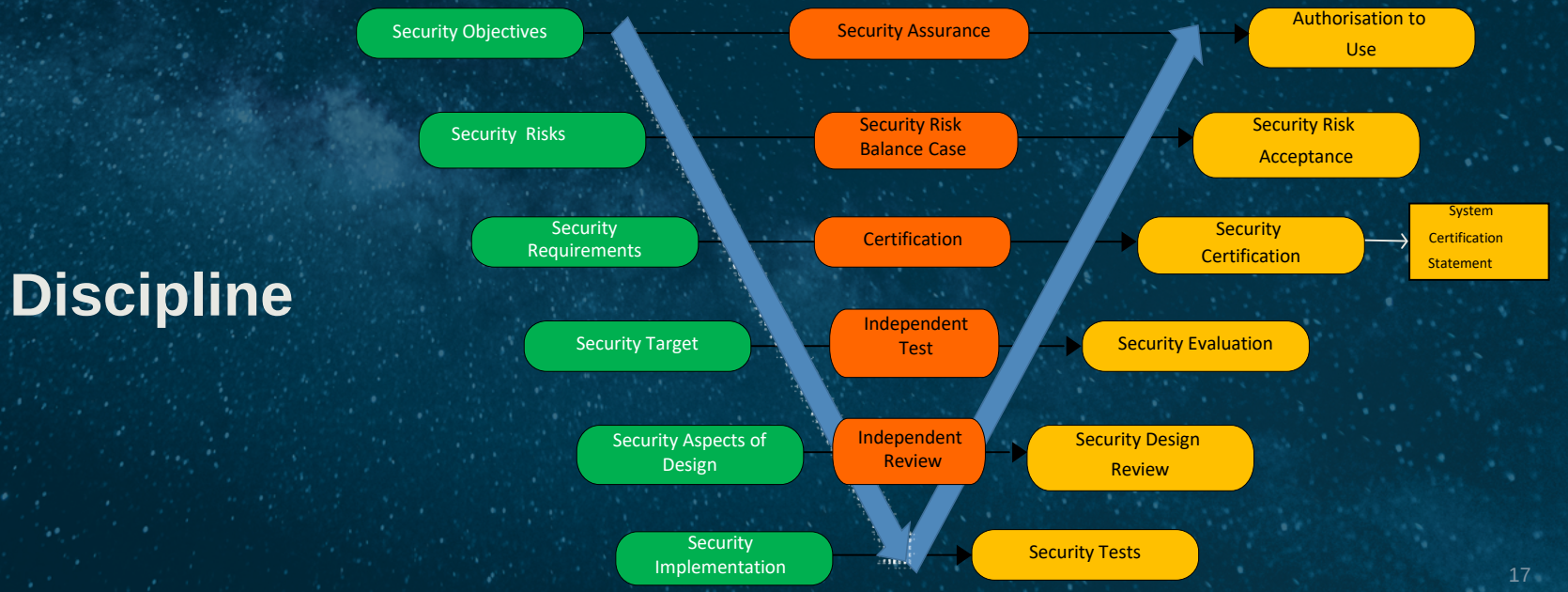
1. Initiated an over-arching Security Working Group (now includes ADS Prime)
2. Established key stakeholder concerns (e.g. NASA/JPL, ESOC) => Risk Appetite/Profile
3. Considered which adversaries are in/out of scope
4. Elaborated a High level Threat & Vulnerability Assessment
5. Completed Space Segment detailed Security Risk Analysis
6. Piggybacking Security through existing ESA standards and processes (dependability, Testing philosophy, industrial ISMS)

Take Away Messages

- Security can help but can hinder : understand why you want it!
- Understand your stake holders needs and recognise your assets
- Who are you protecting it from?
- Focus your security level at the appropriate threshold
- Think (just a little bit) about the security from the beginning

- **Security is a**

  Systems Engineering Discipline




Thank You
Questions?
AIRBUS