

Optical Systems

Creator
Developer
Manufacturer

Challenges and Applications of Compact
Optics for Space Exploration

22/09/2023 – Paris, EPIC meeting

LAMBDA-X | HIGH-TECH
INNOVATION

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Outline

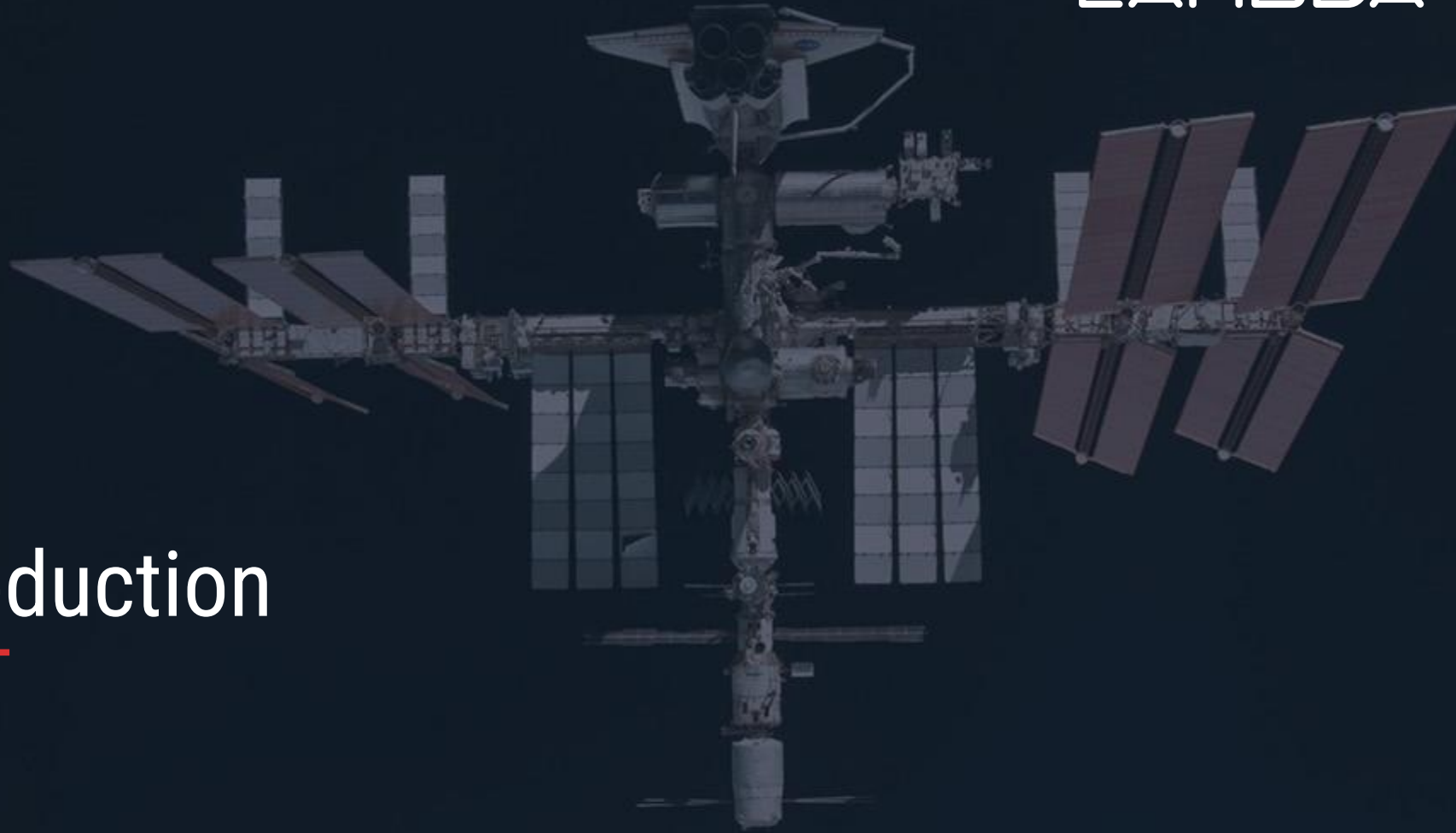
- Introduction – Lambda-X activities
- The space environment
 - Peculiarities of the space environment
 - Constraints on the hardware (design, integration & qualifications)
- Hands-on examples – Lambda-X optics in space missions
- Conclusions

Since
1996

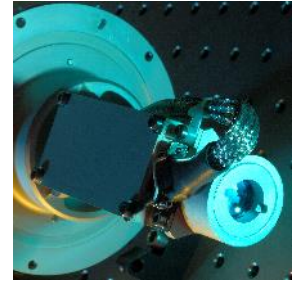
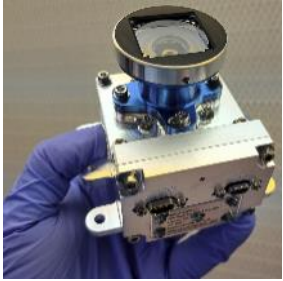
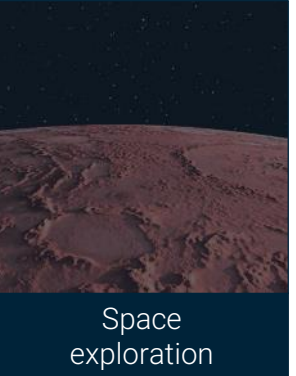
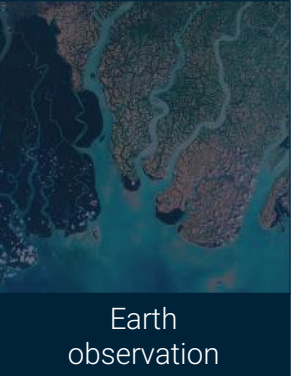
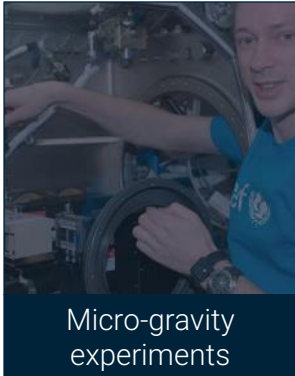
30+
instruments
deployed in
Space

More than
40
experts

Introduction



Space at Lambda-X



The background of the slide is a photograph of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including its central truss, multiple solar panel arrays, and various modules, is clearly visible against the dark background of space. The Earth's horizon is visible at the bottom of the frame, showing a thin layer of atmosphere and the blue and white colors of the planet.

The constraints on the hardware
The space environment

Characteristics of the space environment

Space environment can be very harsh...

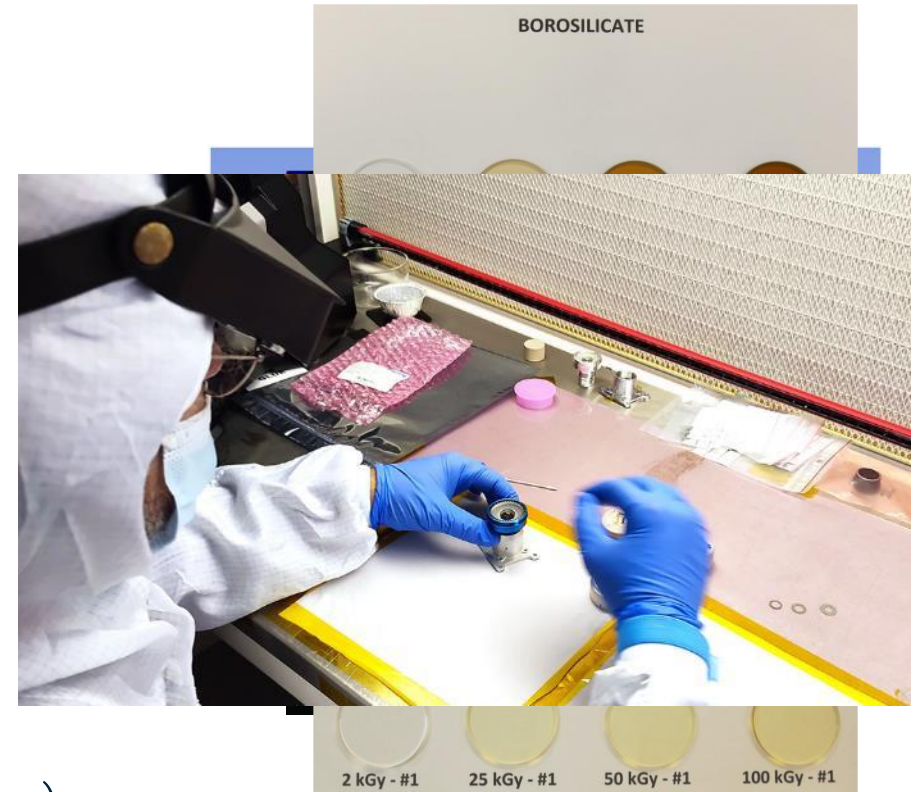
- It starts at ~130km
 - Light and small structures
 - Vibration resistant (launch & landing)

- Temperature (large gradients & no convection)
 - Athermal designs & shielding
 - Thermal cycling tests

- Vacuum
 - Outgass & contamination
 - Clear Room integration

- Radiation (electromagnetic & particles)
 - Damage of materials (electronics, glasses, ..)
 - Radiation qualifications

Synergistic effects



A. Floriduz, & J.D. Devine, 2018, 18th European Conference on Radiation and Its Effects on Components and Systems (RADECS) IEEE.

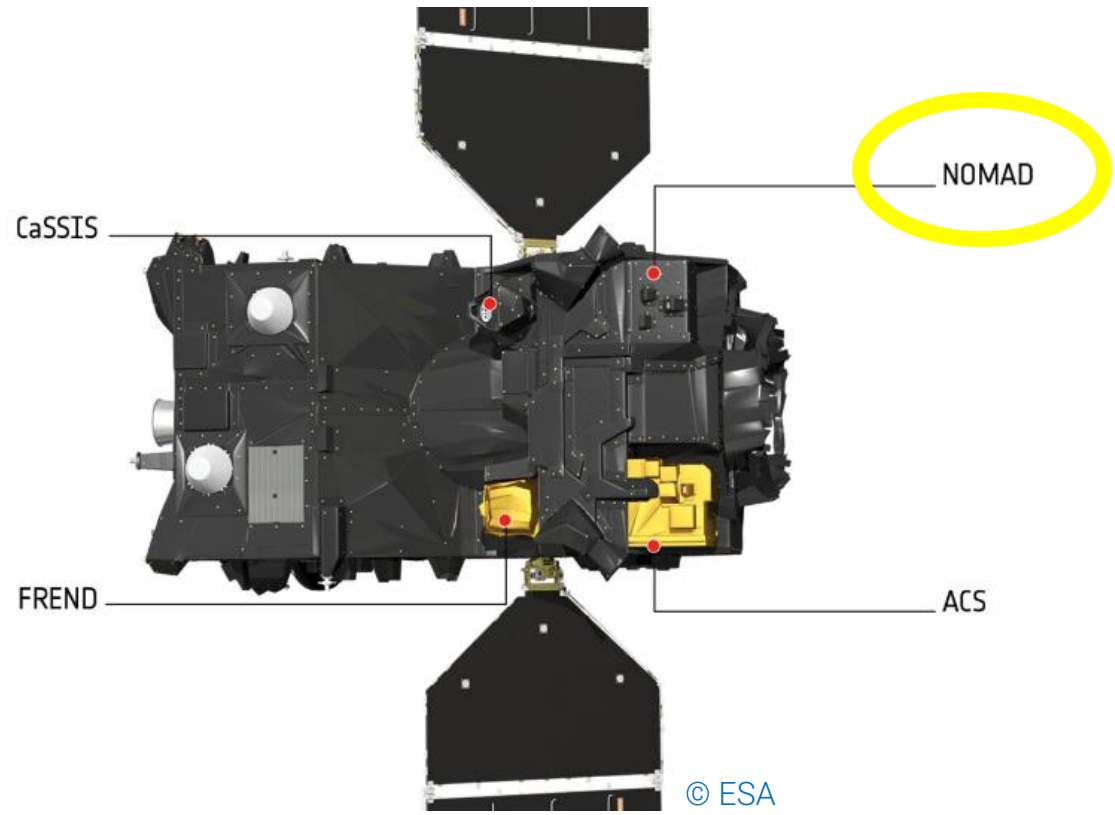
Some hands-on examples – past, present and future

Lambda-X optics in space missions

NOMAD instrument - UVIS

ExoMars 2016 - Trace Gas Orbiter

- ESA-Roscosmos mission
- Martian orbit
- Four instruments (spectrometers, camera and neutron detector) to study the Martian atmosphere and surface
- Timeline:
 - Launched in 2016
 - Arrived at final orbit in 2018
 - Still ongoing



NOMAD instrument - UVIS

- NOMAD (Nadir and Occultation for Mars Discovery):
 - two IR spectrometers
 - Lambda-X: High-sensitivity UV-VIS spectrometer for orbital identification of atmospheric components
- Specifications:
 - 200-650 nm
 - ~1.5 nm resolution
 - Compact (700g for 12.5 x 16.5 x 9.5 cm³)
 - Athermal design
 - Nadir & solar occultation observations



JUICE – optics for monitoring camera

Jupiter ICy moons Explorer:

- ESA mission
- Jupiter and Jovian moons orbit
- 10 instruments to study Jupiter and its three large water-rich moons – Callisto, Europa and in particular Ganymede
- Timeline:
 - Launched in April 2023
 - ETA: 2031

10 science instruments
+ 1 experiment
+ 1 radiation monitor

Juice will:

- Explore Jupiter's icy moons – in particular huge, magnetised, water-rich Ganymede
- Investigate Jupiter's complex environment in depth
- Study the Jupiter system as an archetype for gas giants across the Universe

Juice will be the first spacecraft to:

- Perform a lunar-Earth gravity assist
- Change orbit from another planet to one of its moons (Jupiter to Ganymede)
- Orbit a moon other than our own

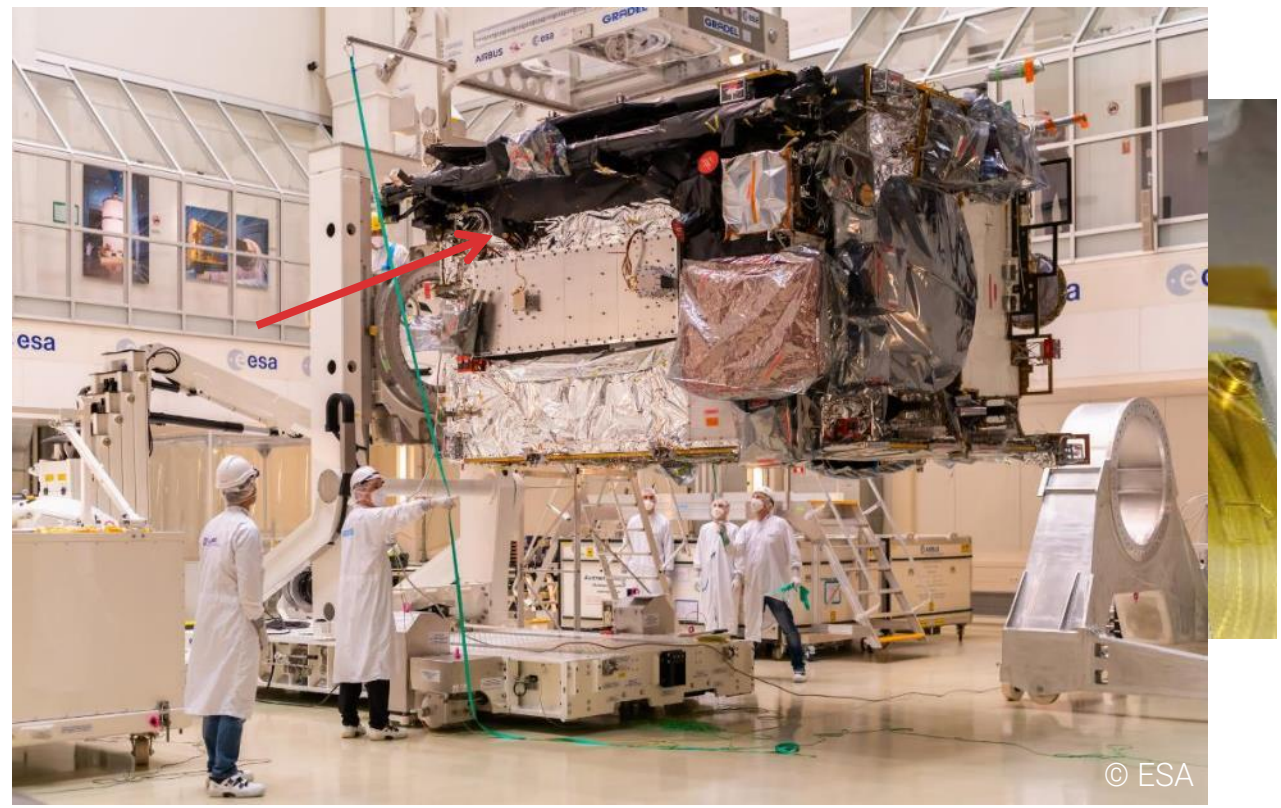
Juice will address two key themes of ESA's Cosmic Vision 2015–2025:

- What are the conditions for planet formation and the emergence of life?
- How does the Solar System work?

Labels in infographic: Ganymede, Europa, Callisto, esa

JUICE – optics for monitoring camera

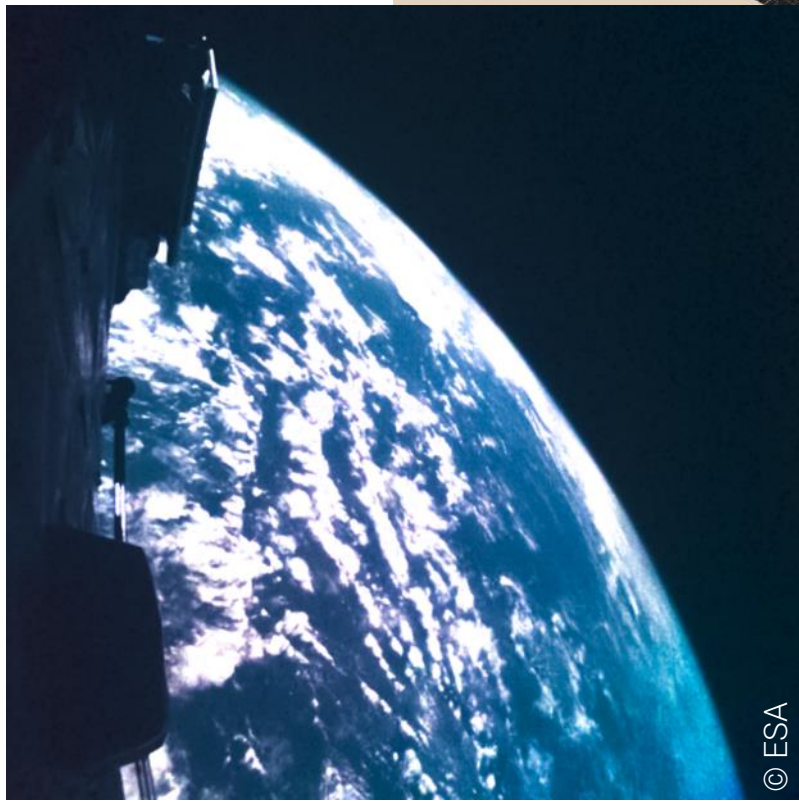
- Optics for 2 monitoring camera
- Specifications:
 - FOV: 90°-105°; DoF: 1.2m to inf
 - VIS
 - 4.5 x 5 x 5 cm³
- Qualifications:
 - Temperature: -40°C to 70°C
 - Radiation (40Mrad!)



JUICE – optics for monitoring camera

JUICE MONITORING CAMERAS

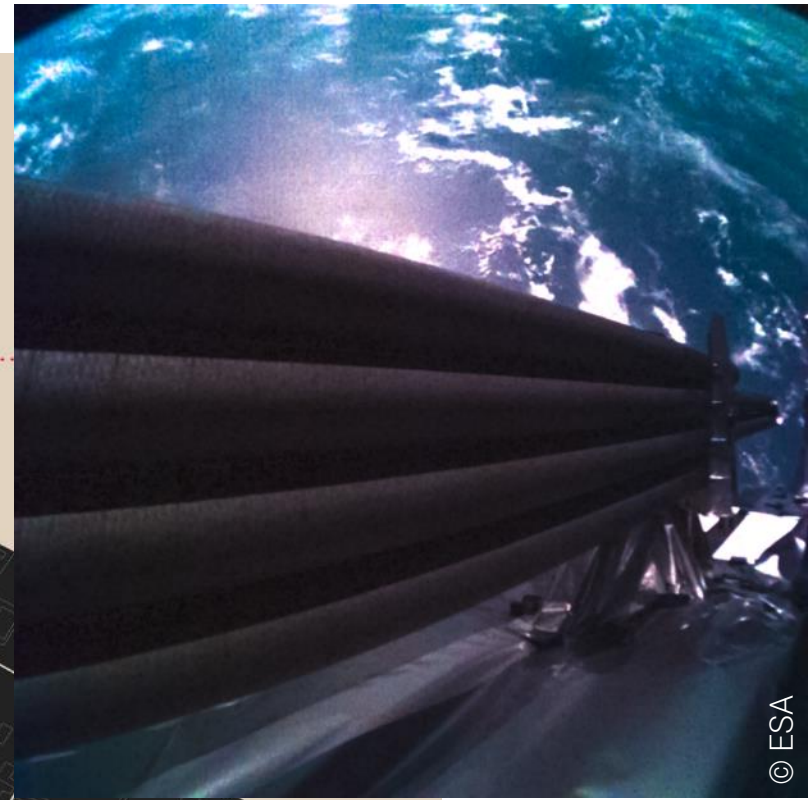
ESA's Jupiter Icy Moons Explorer (Juice) has two cameras that provide snapshots with different fields of view of the Jupiter system.



© ESA



© ESA



© ESA

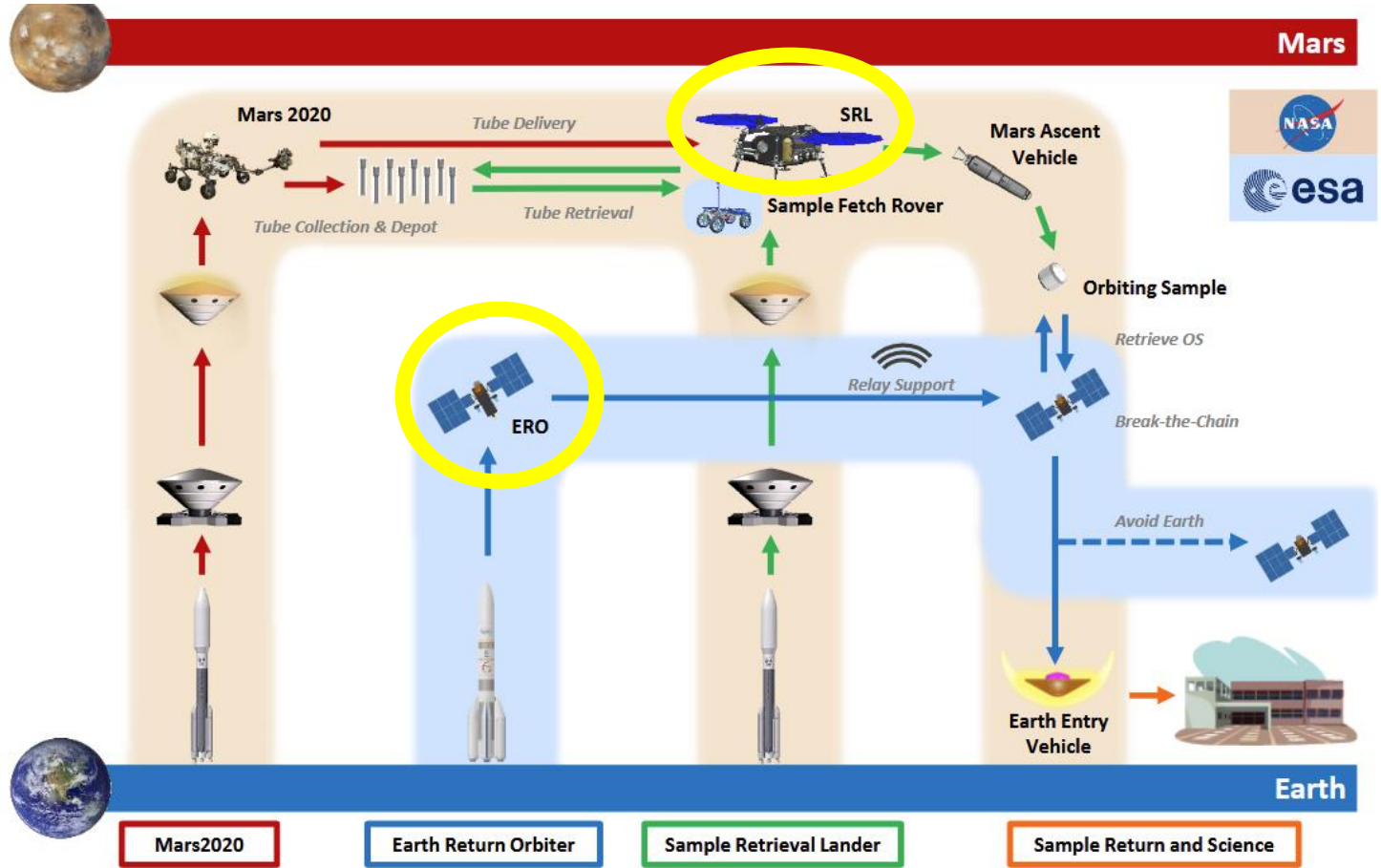
*Published images may appear in a different orientation to the sketches shown here.
Fields of views are representative after all probes have been deployed.*



MSR – monitoring and navigation optics

Mars Sample Return (MSR)

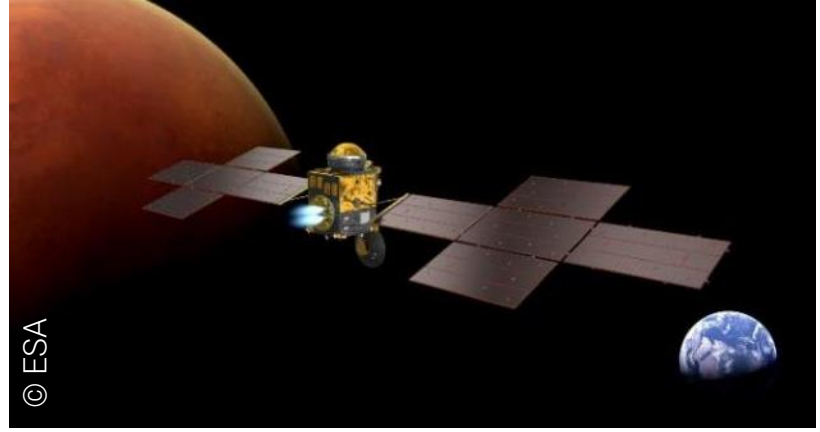
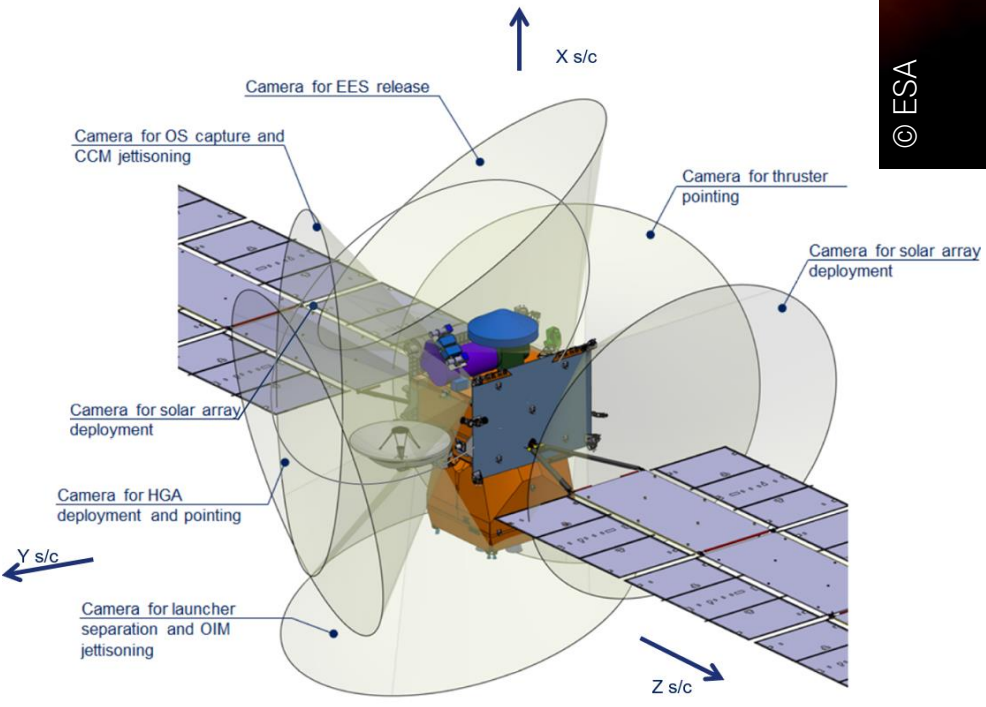
- ESA-NASA mission
- Martian orbit and landing
- Orbiter and rovers to collect and return samples collected by the Mars Perseverance rover to Earth
- Timeline:
 - Planned launches in 2027 (orbiter) and 2028 (lander)
 - Expected to return to Earth in 2033



MSR-ERO – monitoring cameras

ERO (Earth Return Orbiter)

- 7 monitoring optics
- Specifications:
 - FOV: 80°; DoF: 1 m to inf
 - VIS
- Qualifications
 - Temperature: -60°C to 70°C
 - Radiations: 1.6 Mrad
- Currently Phase C

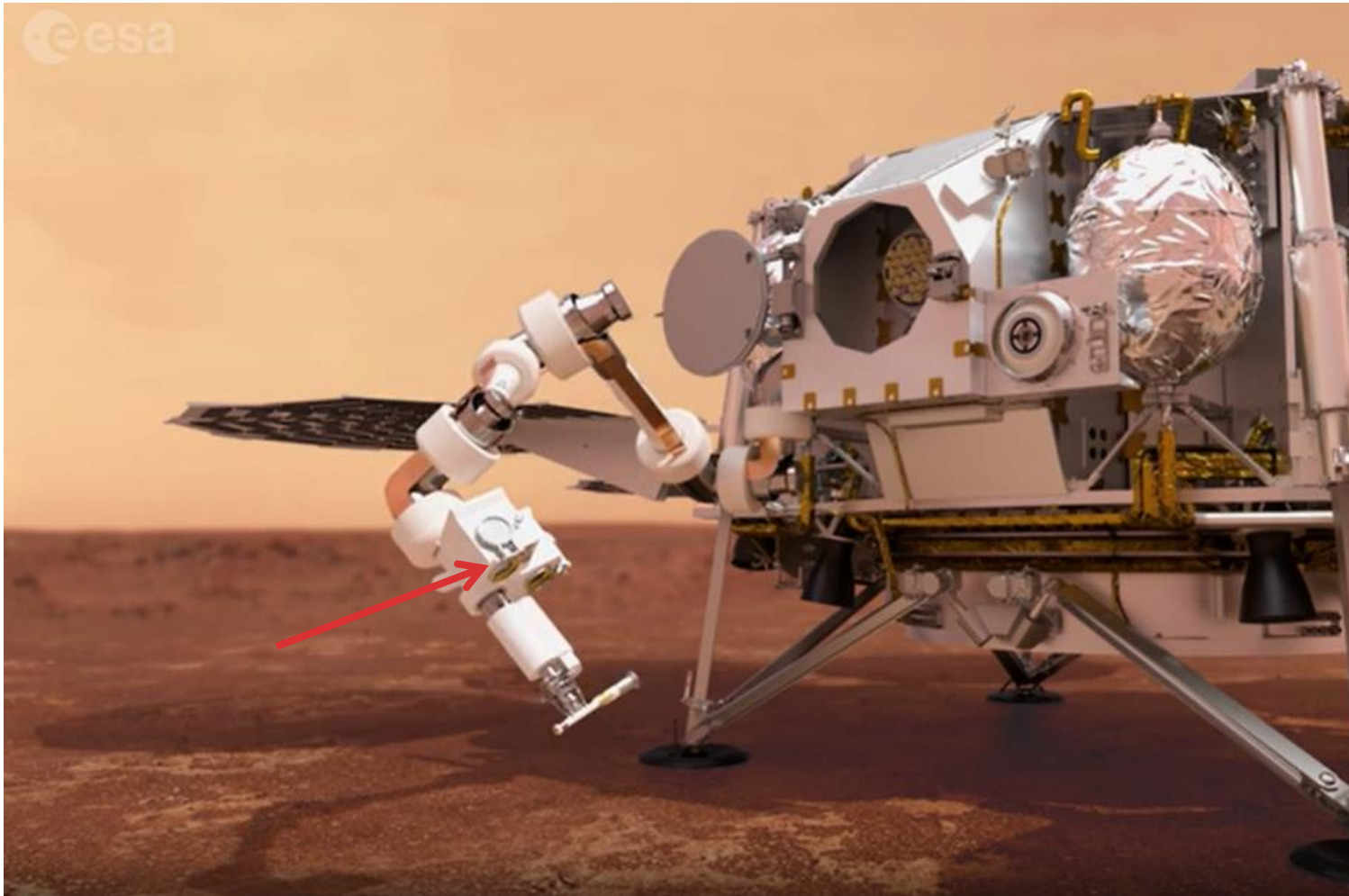


AIRBUS

MSR-STA – navigation cameras

STA (Sample Transfer Arm) on the lander

- Two navigation cameras
- Specifications:
 - FOV: 58°; DoF: 0.3-1 m
 - VIS
- Qualifications
 - Temperature: -130°C to 70°C
 - Radiations: 1.6 Mrad
 - Sterilisable instrument
- Currently Phase B



Conclusions



Conclusions

- Instruments in space are subjected to a particularly exigent environment
- Lambda-X is an active partner in the field of optics for space discovery (and other space fields too!)



Thank you for your attention !

LAMBDA-X
MASTERS IN INNOVATION

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