

Optical Systems

Creator
Developer
Manufacturer

Technical challenges for compact optics
in space missions

19/10/2022

LAMBDA-X | MASTERS IN INNOVATION

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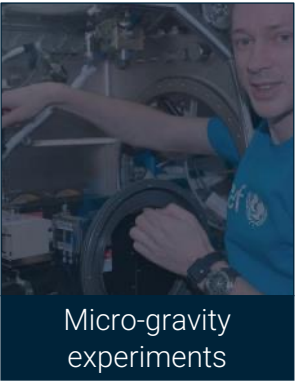
- Introduction - LX activities
- The space environment
 - Peculiarities of the space environment
 - Constraints on the hardware (design, integration & qualifications)
- Hands-on examples – LX optics in space missions
- Conclusions

Since
1996

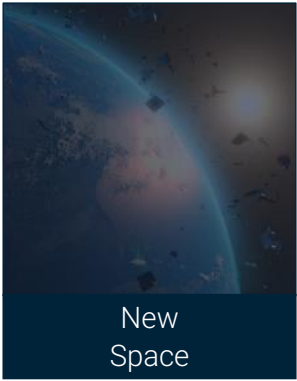
30+
instruments
deployed in
Space

More than
40
experts

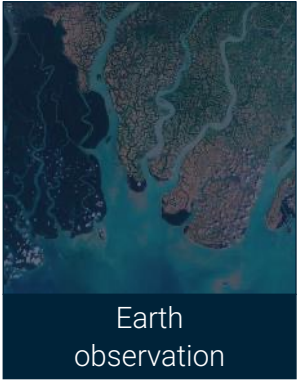
Introduction



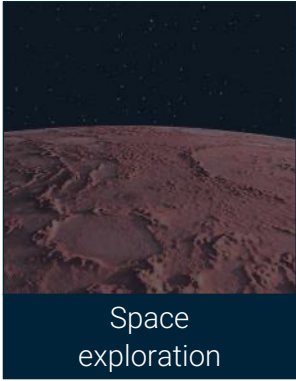
Micro-gravity experiments



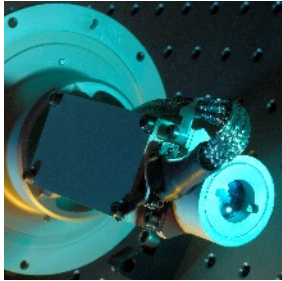
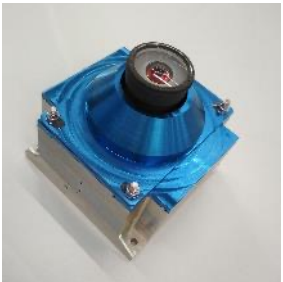
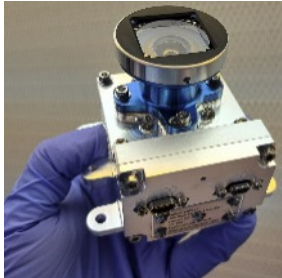
New Space



Earth observation



Space exploration



Characteristics of the space environment

Space environment can be very harsh...

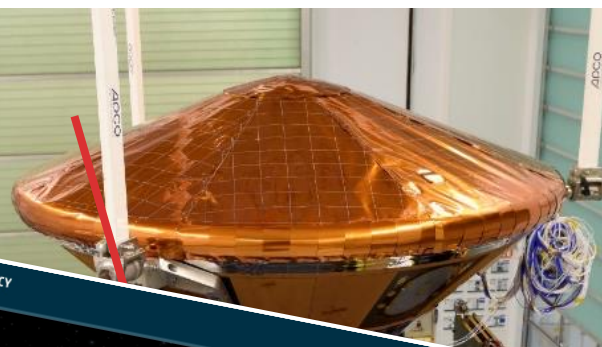
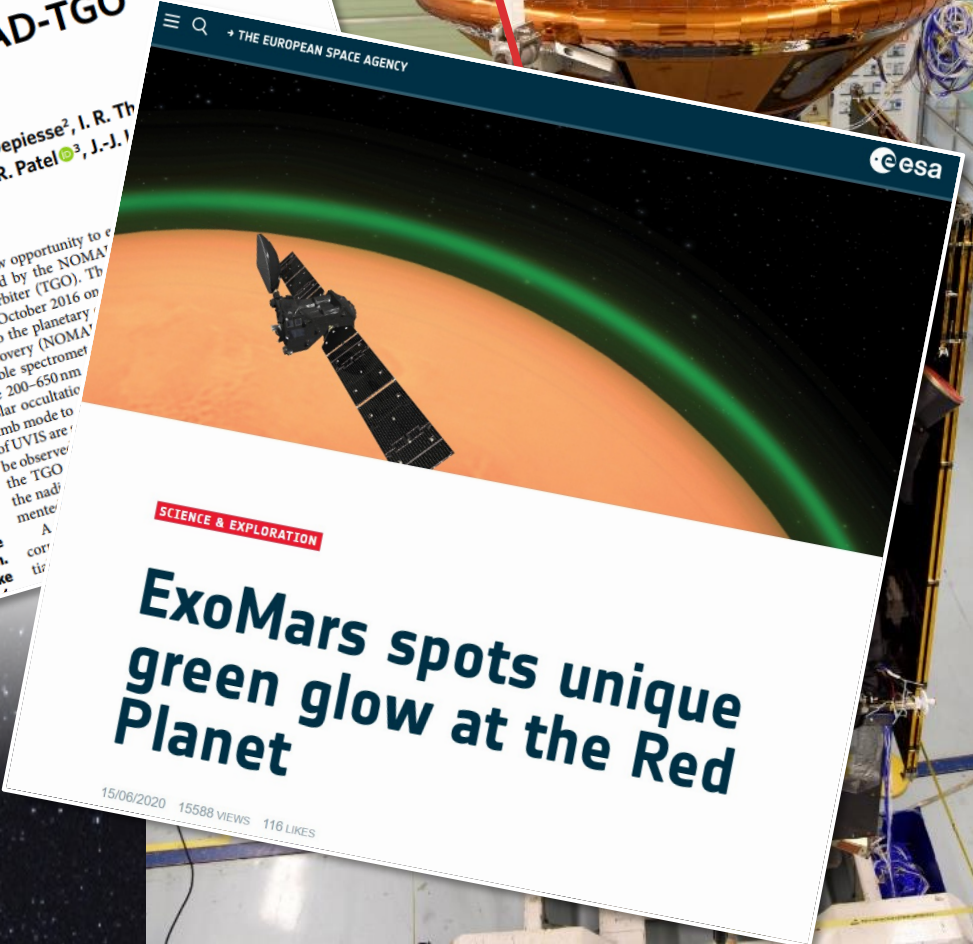
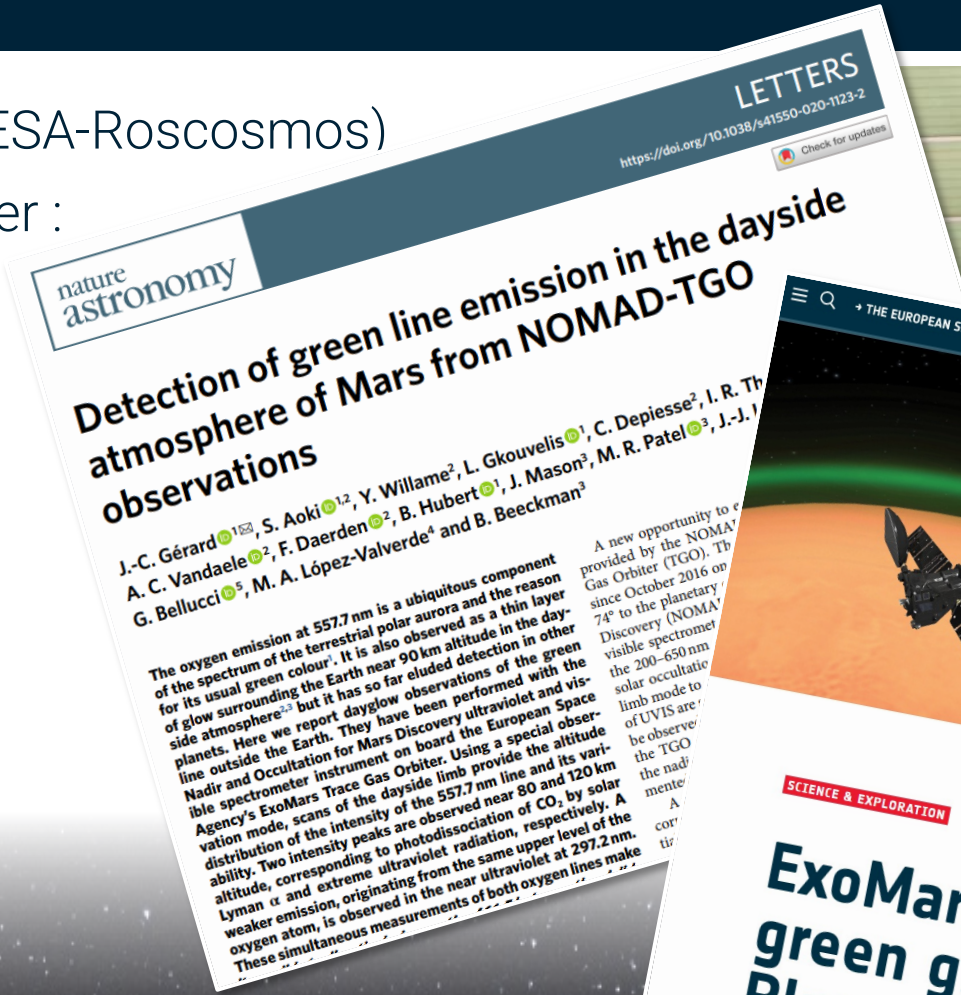
- It starts at ~130km
 - Light and small structures
 - Vibration resistant (launch)
- Temperature (large gradients) (no convection)
 - Athermal designs & shielding
 - Thermal cycling tests
- Vacuum
 - Outgass & contamination
 - Clear Room integration
- Radiation (radiation & particles)
 - Damage of materials (electronics, glasses, ..)
 - Qualifications



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

NOMAD instrument - UVIS

- ExoMars Trace Gas Orbiter (ESA-Roscosmos)
- Compact UV-VIS spectrometer :
 - 200-650 nm
 - ~1.5 nm resolution
 - nadir or limb observations
- Launched in 2016
- Arrived at final orbit in 2018



UVIS

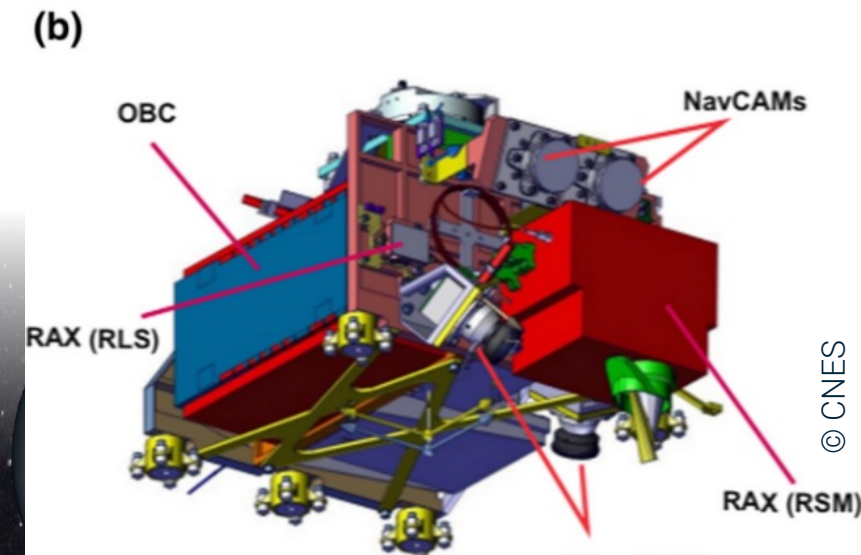
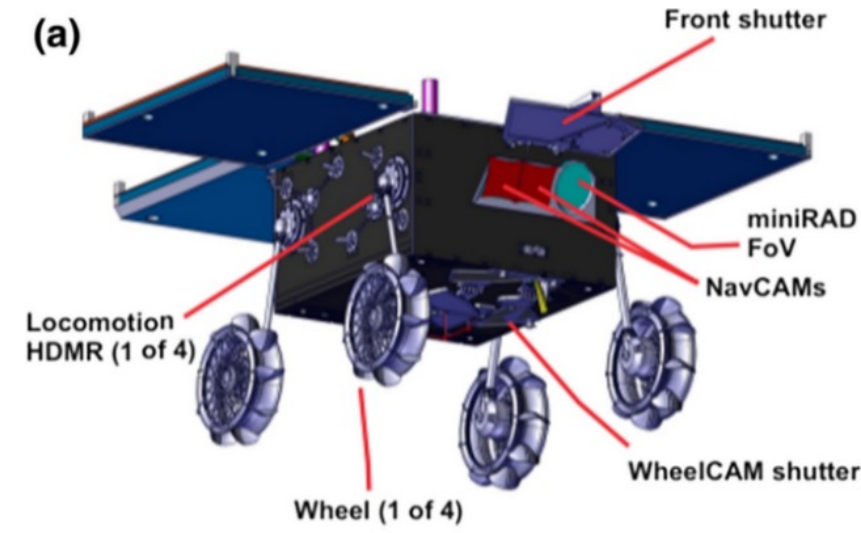
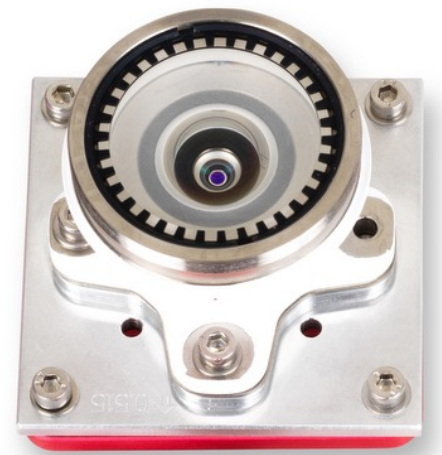
JUICE – optics for monitoring camera

- JUperiter ICy moons Explorer (ESA)
- 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's!)
- Currently assembled & tested at ESA
- Launch: 2023 – ETA: 2031



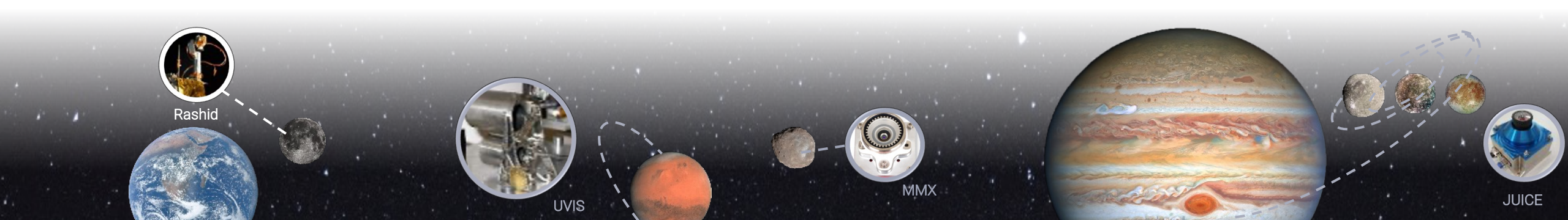
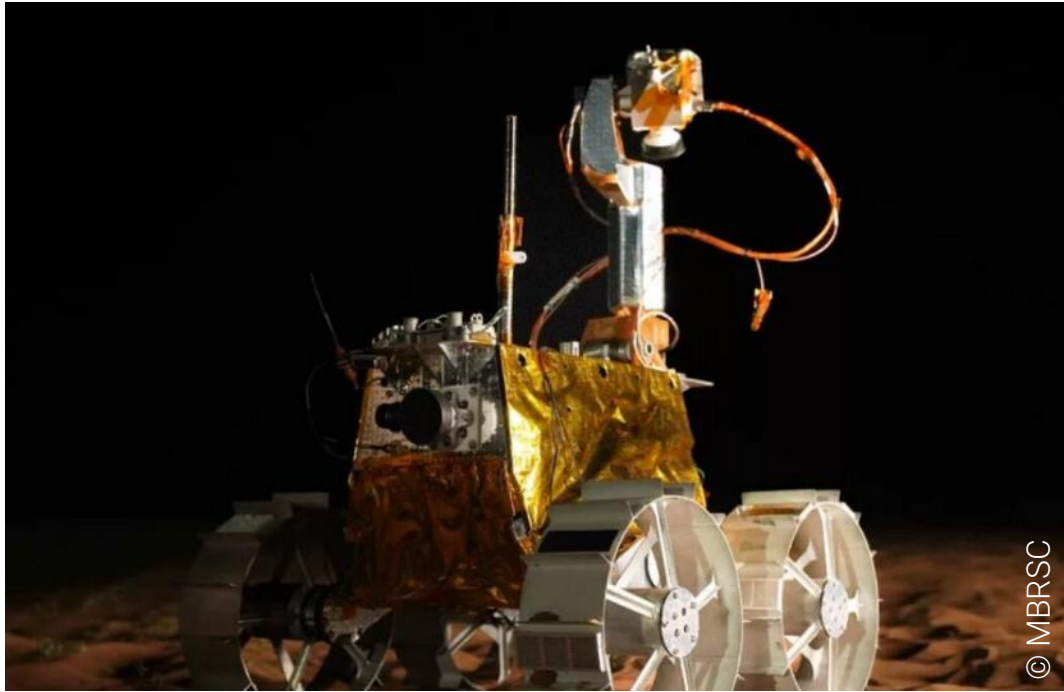
MMX – optics for navigation camera

- Martian Moons eXploration (MMX) (JAXA -Japan Aerospace Exploration Agency)
- Navigation cameras (stereo)
 - FOV: 118°; DoF: 10 cm to inf
 - VIS
 - 5 x 4 x 4 cm³
- Qualifications:
 - Temperature under vacuum: -45°C to 70°C
 - Vibrations – 34G's random
- Currently assembled & tested at CNES
- Launch: 2024 – ETA: 2025



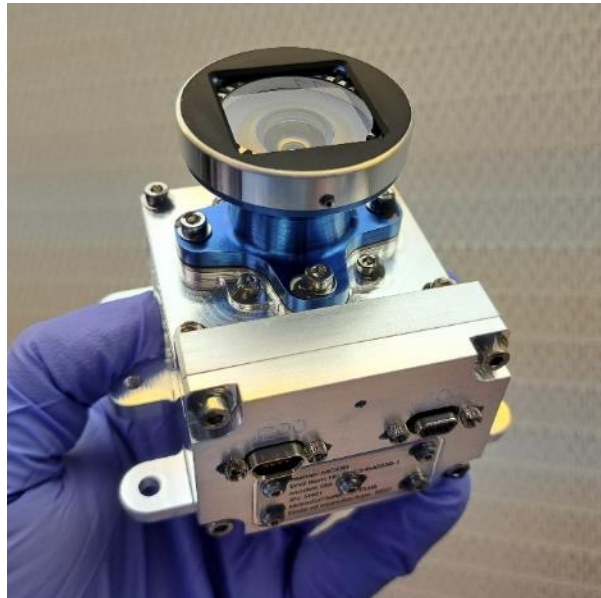
Lunar Rovers

- Navigation / monitoring cameras for 3 rovers
 - Rashid - mohammed bin rashid space centre (MBRSC) - 2022



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 - Nova-C - Intuitive machines – 2024



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 - PROSPECT - ESA – 2023 TBC

A 3D CAD model of a lunar lander is shown with three yellow lines pointing to specific instruments. The instruments are: ProSEED (a drill), ProSPA SIS (a sample inlet system), and ProSPA lab (a laboratory module).

ProSEED
Excavates samples from lunar sub-surface for delivery to multiple instruments.
Drill box with 1.2 metre single string drill
Push-tube to collect ProSPA sample
Rotary-translation stage to deliver sample to ProSPA oven or another instrument

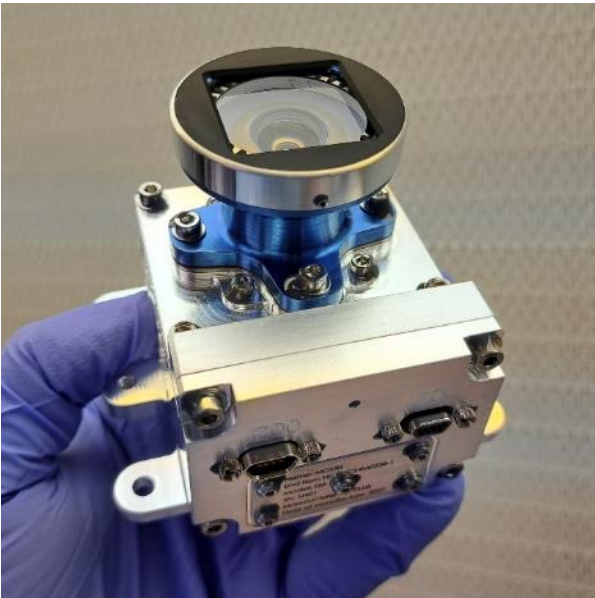
ProSPA SIS
A Solids Inlet System for receiving, imaging, sealing and heating drilled samples.
Sample inlet
25 ovens on rotary carousel
SamCam 3-D multispectral imager
Tapping station to seal and heat sample ovens

ProSPA lab
A miniature (37 x 27 x 13 cm, 8 kg) laboratory for chemical and isotopic analysis.
Ion trap mass spectrometer for evolved gas analysis
Thermo-chemical reactors for sample processing and extraction of oxygen for ISRU demonstration
Magnetic sector mass spectrometer for precise isotope ratios



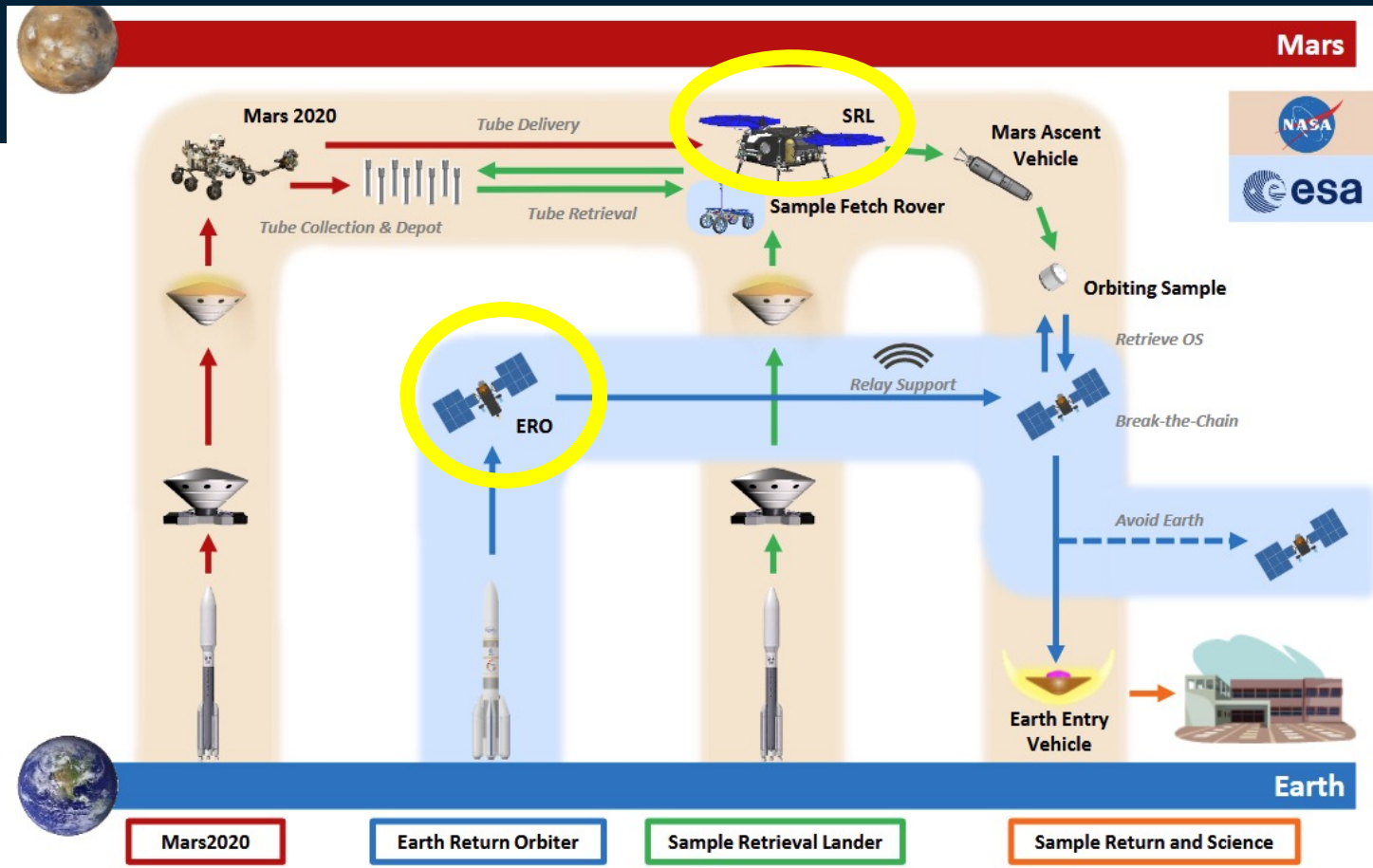
Lunar Rovers

- Navigation / monitoring cameras for 3 rovers
 - Rashid - mohammed bin rashid space centre (MBRSC) – 2022
 - Nova-C - Intuitive machines – 2024
 - PROSPECT - ESA – 2023 TBC
- Specifications
 - Various FoV and DoF depending on the application
 - VIS and VIS-NIR (PROSPECT)
- Qualifications
 - Temperature: -110°C to 70°C
 - Radiations (PROSPECT): 300kRad's



MSR – ERO & STA

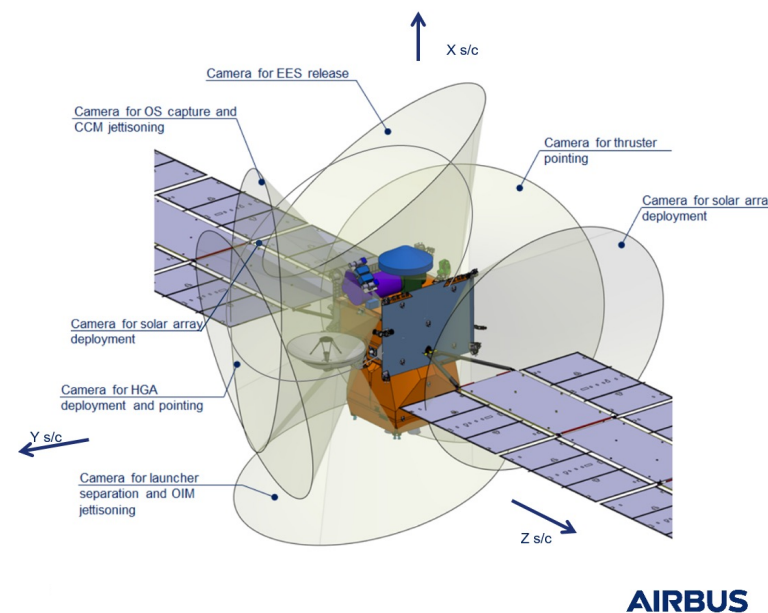
Mars Sample Return (ESA-NASA):
collect and return samples to Earth
by 2031



MSR – ERO & STA

Mars Sample Return (ESA-NASA):

- Earth Return Orbiter:
 - 7 monitoring optics
 - FOV: 110°; DoF: 1 m to inf
 - Temperature: -60°C to 70°C
 - Radiations: 1.6 Mrad's
 - Currently Phase C



Mars Sample Return (ESA-NASA):

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Summary

LX is an active partner in the field of space discovery.

Space is big and fun, and there is still a lot to do!

<https://hightech.lambda-x.com/jobs/>



Thank you for your attention !

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