

# Switch to Space 2022

Egmont Palace, Brussels  
October 19th, 2022

Topic 3: Space Technologies for Moon & Mars



## How Radio Wave Technology, Boiled Eggs and the Inner Structure of Mars are Related

Mattias Genbrugge, Project Manager at Antwerp Space

# Agenda

Teaser: How **Radio Wave Technology**,  
**Boiled Eggs** and the Inner Structure of **Mars**  
are Related



**EXOMARS 2022**

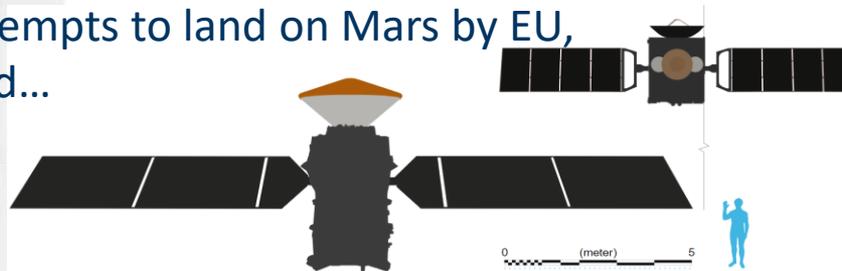
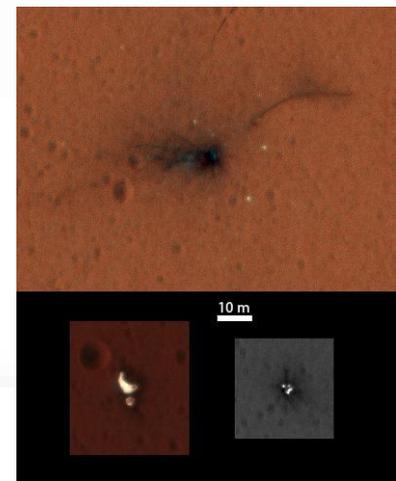
**LARA**



**RF Space Technology**

# EXOMARS 2016

- ▶ Collaboration between ESA (European Space Agency) and Roscosmos (Russian Space Agency)
- ▶ [https://www.esa.int/Science\\_Exploration/Human\\_and\\_Robotic\\_Exploration/Exploration/ExoMars](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/ExoMars)
- ▶ **Mission 1: EXOMARS 2016 = Trace Gas Orbiter and a Lander**
  - **TGO:** satellite orbiting Mars to detect methane and other trace gasses, that could be evidence of potential (past?) biological activity
  - **Lander:** to test technology for **future soft landings** on the surface of Mars. To measure atmospheric electricity on Mars and local meteorological conditions.
- ▶ Since 1960, half of the attempts to land on Mars by EU, Russia and USA have failed...



# EXOMARS 2022

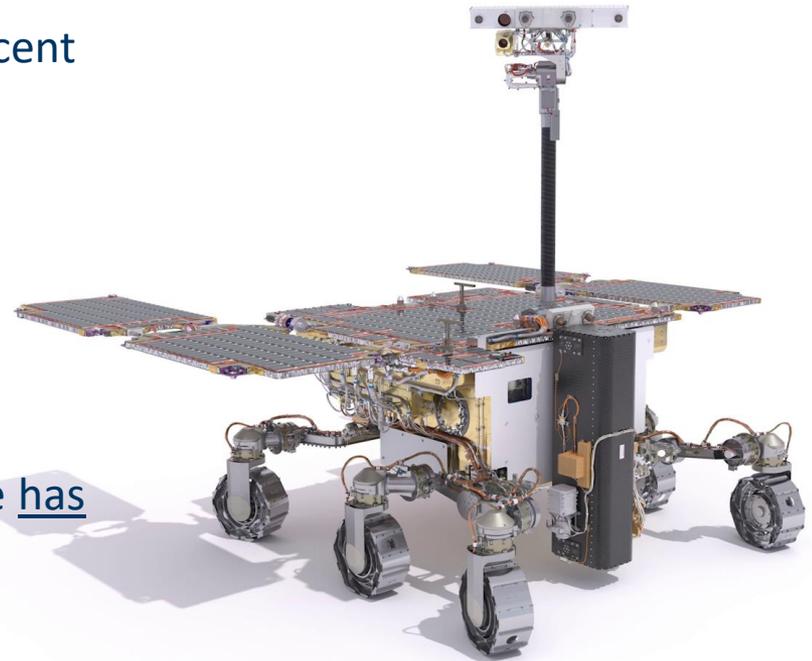
▶ Mission 2: EXOMARS 2022 = Carrier Module, Descent Module (Lander) and a Rover

- Launcher: Russian
- Carrier Module: European
- Descent Module: Russian
- Rover: European

▶ Objective: to address the question of whether life has ever existed on Mars!

▶ But... ESA Statement 17/03/2022:

*...acknowledged the present impossibility of carrying out the ongoing cooperation with Roscosmos on the ExoMars rover mission with a launch in 2022, and mandated the ESA Director General to take appropriate steps **to suspend the cooperation activities** accordingly.*



Next opportunity: 2028??

# EXOMARS 2022: Descent Module and Rover



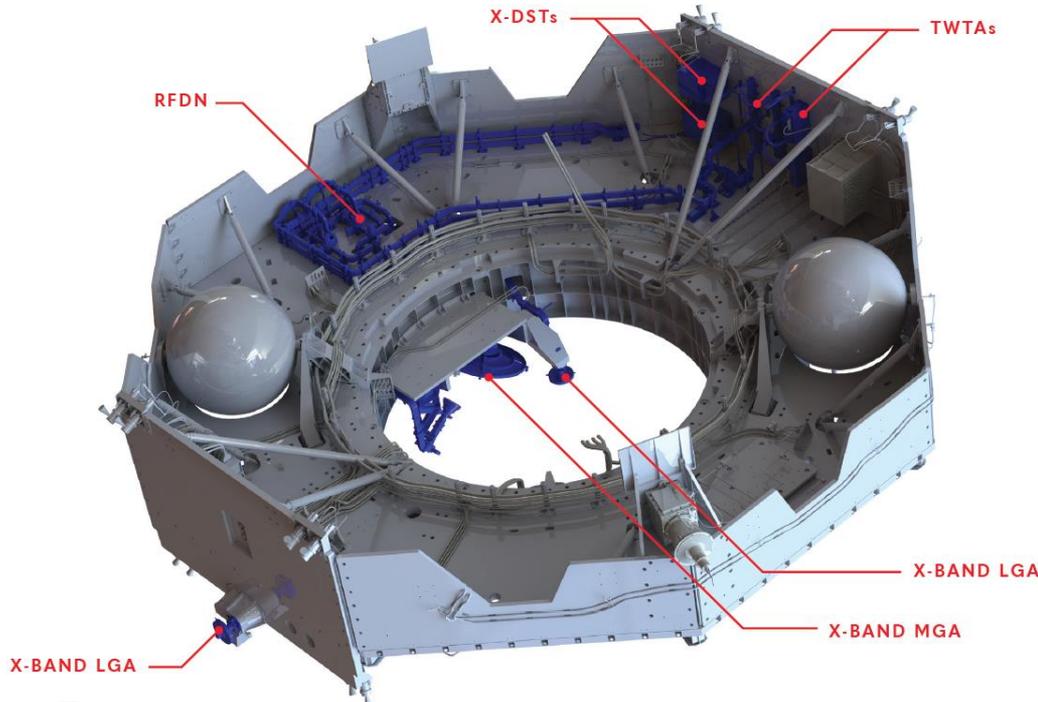
# Space Communication Technology



**antwerpspace**  
An OHB Company

- The Carrier Module with its Communication System from **Antwerp Space**

- Deep Space Transponder (DST)
- Travelling Wave Tube Amplifier (TWTA)
- RF Distribution Network (RFDN)
- Low and Medium Gain Antennas (LGA/MGA)



## COMMUNICATION SUBSYSTEM



|                       |                  |
|-----------------------|------------------|
| RF POWER (TWTA)       | 95 watt          |
| MAX DISTANCE TO EARTH | 15 light-minutes |
| MASS (CM+ DM)         | 2600 kg          |
| MASS SUBSYSTEM        | 31 kg            |
| TRAVEL TIME           | 9 months         |



# Space Technologies for Mars: LaRa

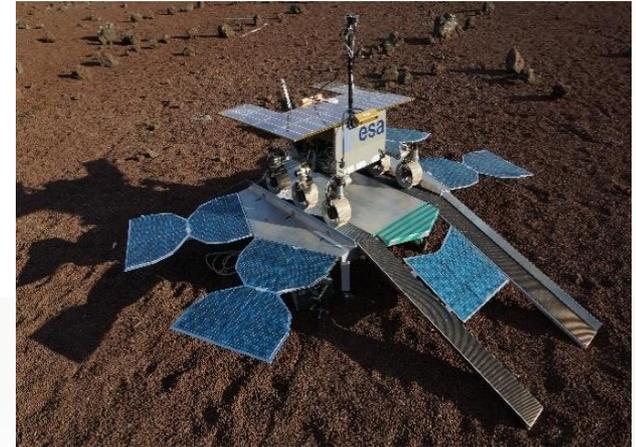


## LaRa: Lander Radio-Science Instrument

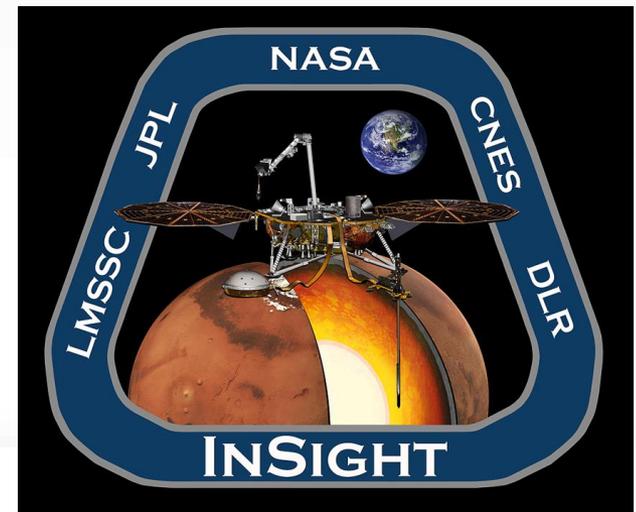
- The LaRa Instrument was built by **Antwerp Space** in collaboration with the **UCL** for the Antenna Design.



- Scientific Team from **Royal Observatory of Belgium (ROB)** which has world-renown expertise in this scientific field.  
<https://lara.oma.be/>

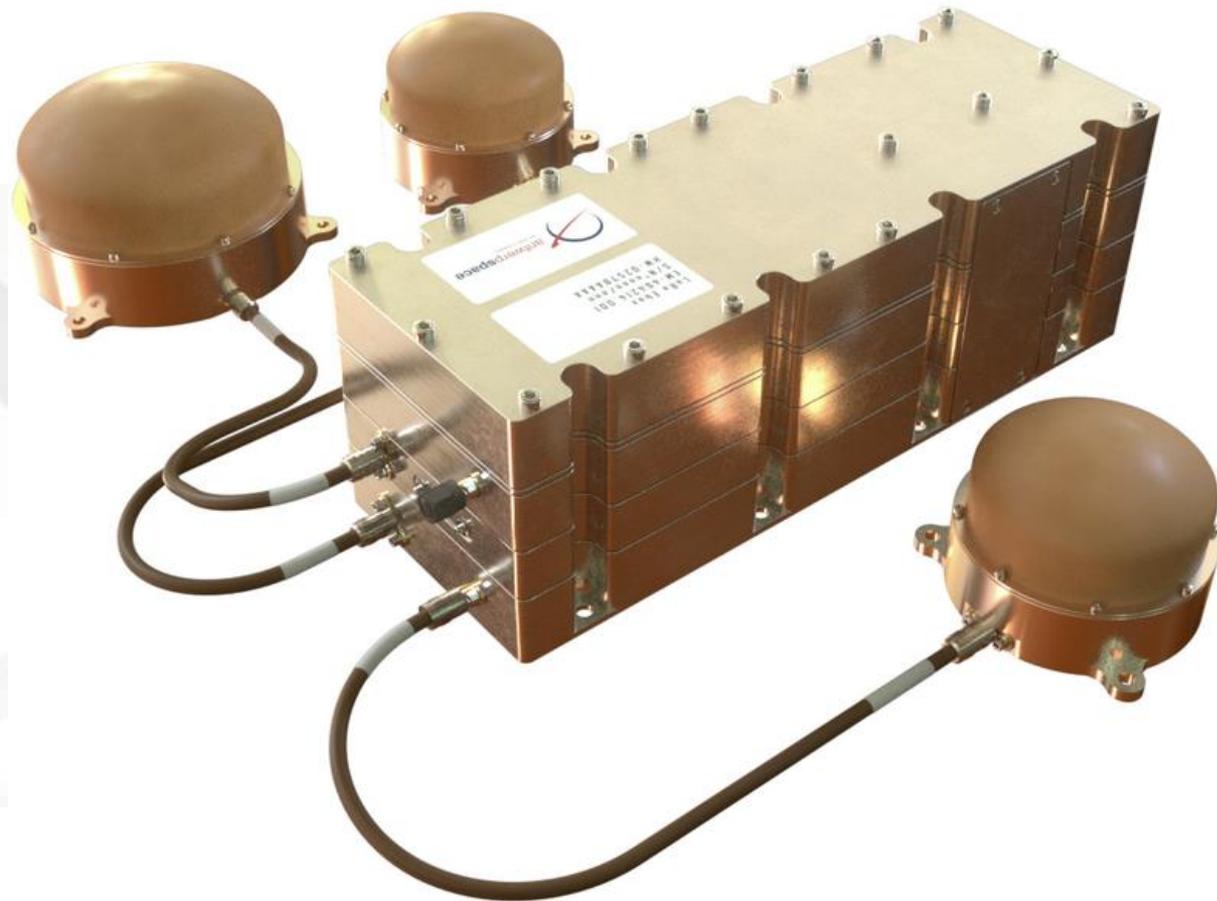


- This would have been (or will be in 2028?) the very first Belgian instrument to land on Mars !
- LaRa is mounted on the Descent Module (Lander)



# Space Technologies for Mars: LaRa

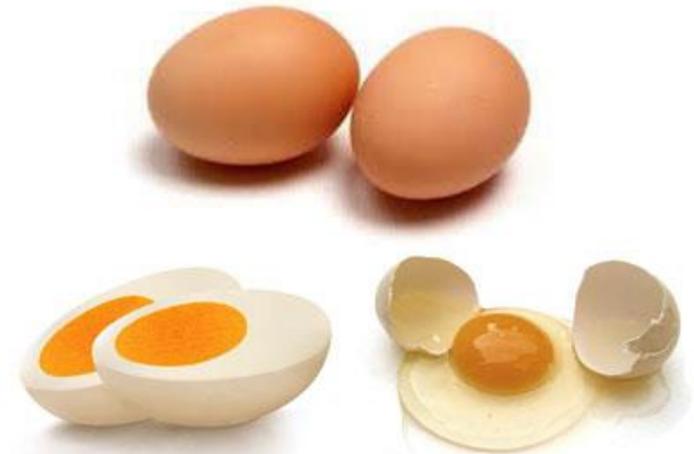
- The LaRa Instrument consists of the transponder electronic box, the receiving/transmitting antennas, and the interconnecting harness.



# Space Technologies for Mars: LaRa

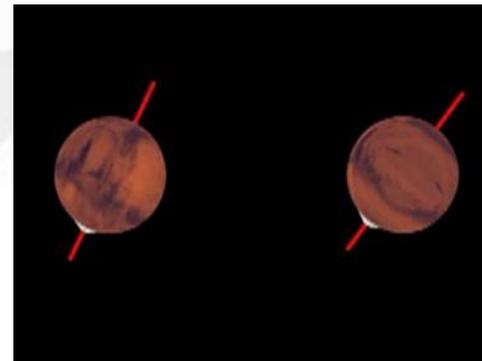
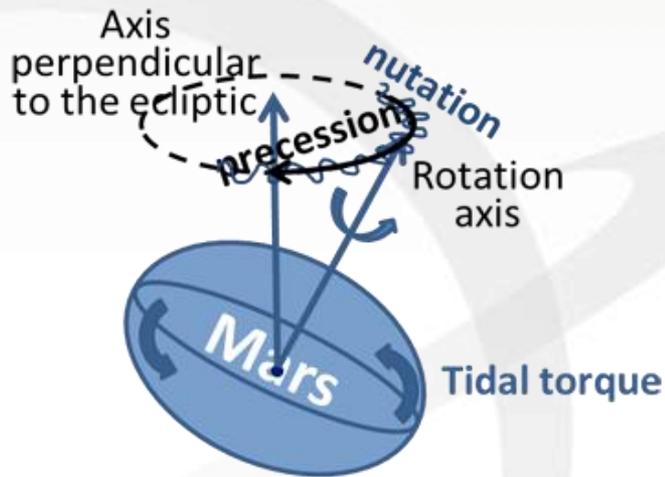
## The Principle of the LaRa Instrument

- LaRa is a radioscience geodesic experiment to precisely **measure the rotation and orientation of Mars**.
- The rotation of a boiled egg noticeably differs from that of a raw egg: when it is still raw, it will 'wobble' more.
- This observation shows that information on the inside of an egg can be obtained from its rotation. The same idea applies to the rotation and orientation of **Mars**.

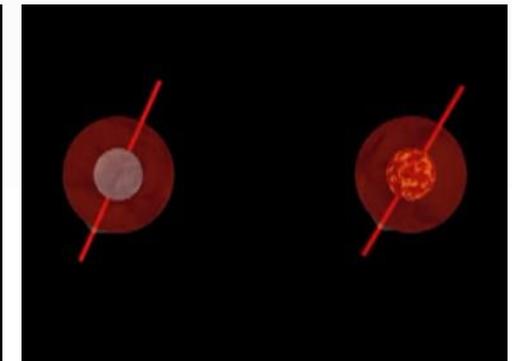


# Space Technologies for Mars: LaRa

- Changes in the orientation of a planet can be divided into two components:
  - Precession** describes the long-term trend of the orientation changes in space. It carries the pole of the polar axis at a uniform rate in an anticlockwise sense along a circle on the surface of the celestial sphere, centred on the normal to the Mars orbital plane (ecliptic)
  - Nutation** is the name given to the superimposed shorter-term periodic variations



Nutation of Mars with a solid core (left) and a liquid core (right)

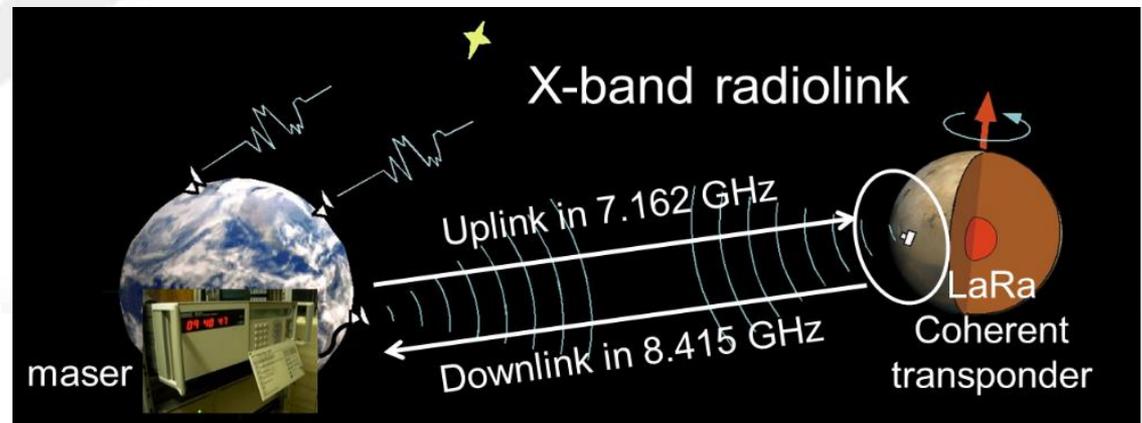


Interior of Mars with a solid core (left) and a liquid core (right)

# Space Technologies for Mars: LaRa

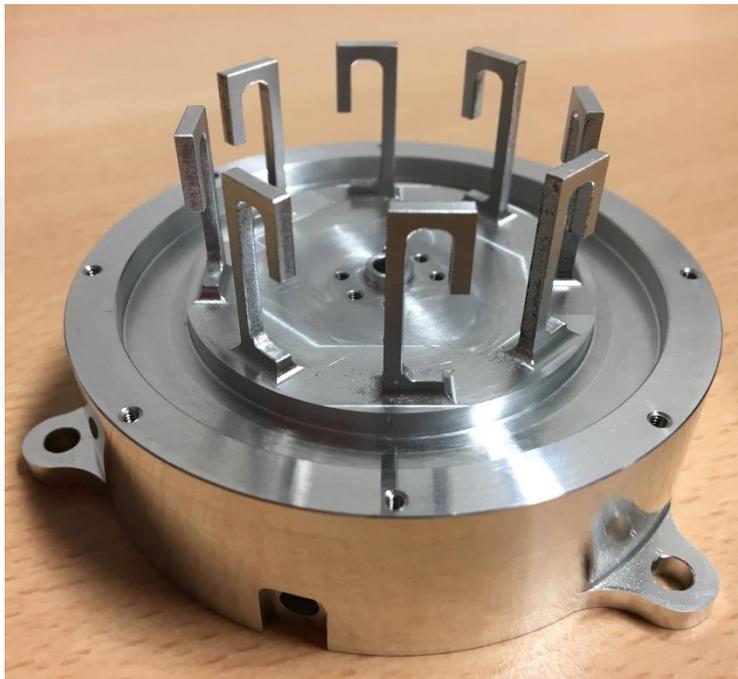
- ▶ The observation of the rotation and orientation of Mars can be performed by using **radioscience**, i.e. by tracking precisely the relative changes in the position of a lander on the surface of Mars with respect to terrestrial ground stations on Earth.
- ▶ The **relative radial velocity** of the Earth and the Martian Lander is inferred from **Doppler effects** measured at the Earth ground stations.
- ▶ LaRa transmits a signal from Mars over 220 million kilometers of distance from a tiny antenna with only **5W** transmission power.

(coherent transponder: a transponder in which a fixed relation between frequency and phase of input and output signals is maintained)

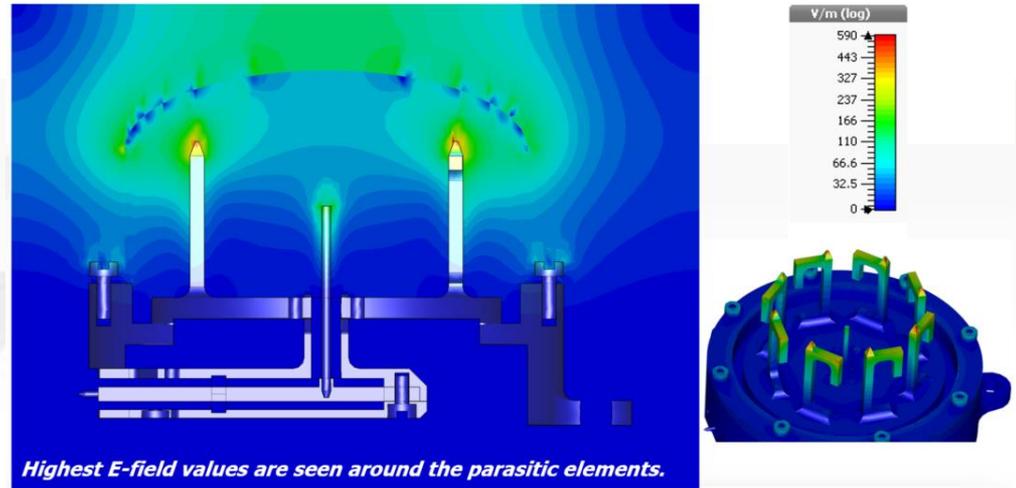


# Space Technologies for Mars: Multi-disciplinary Engineering

## LaRa Receive antenna prototype (designed by UCL)

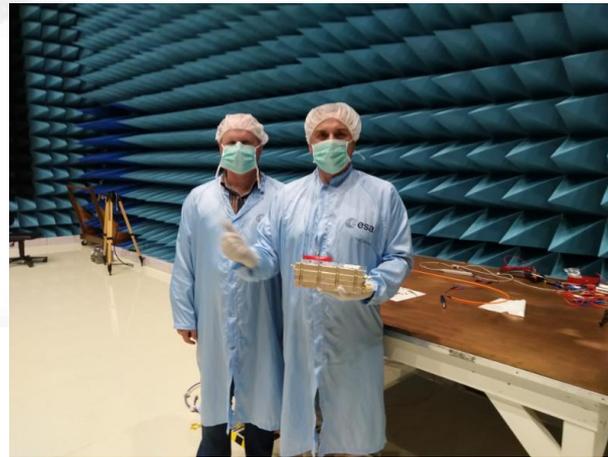


LaRa Receive antenna - ESD simulations



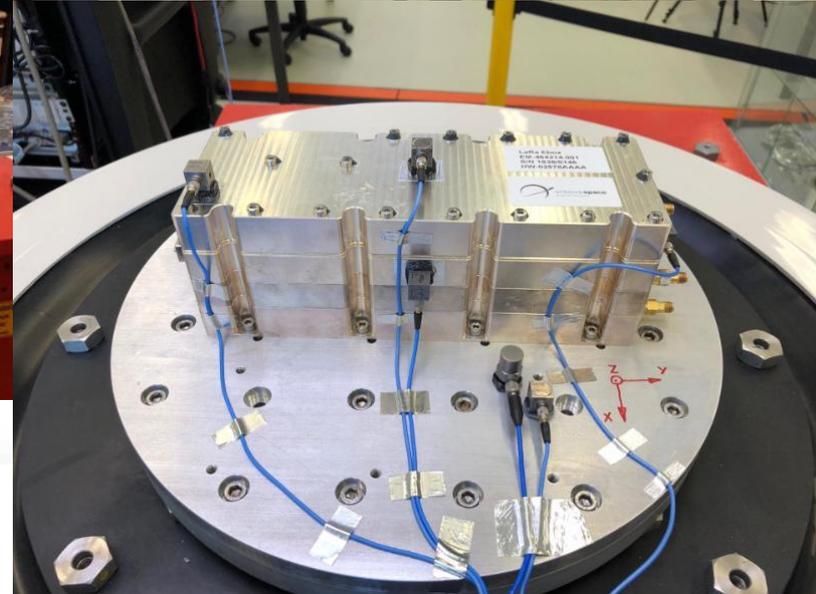
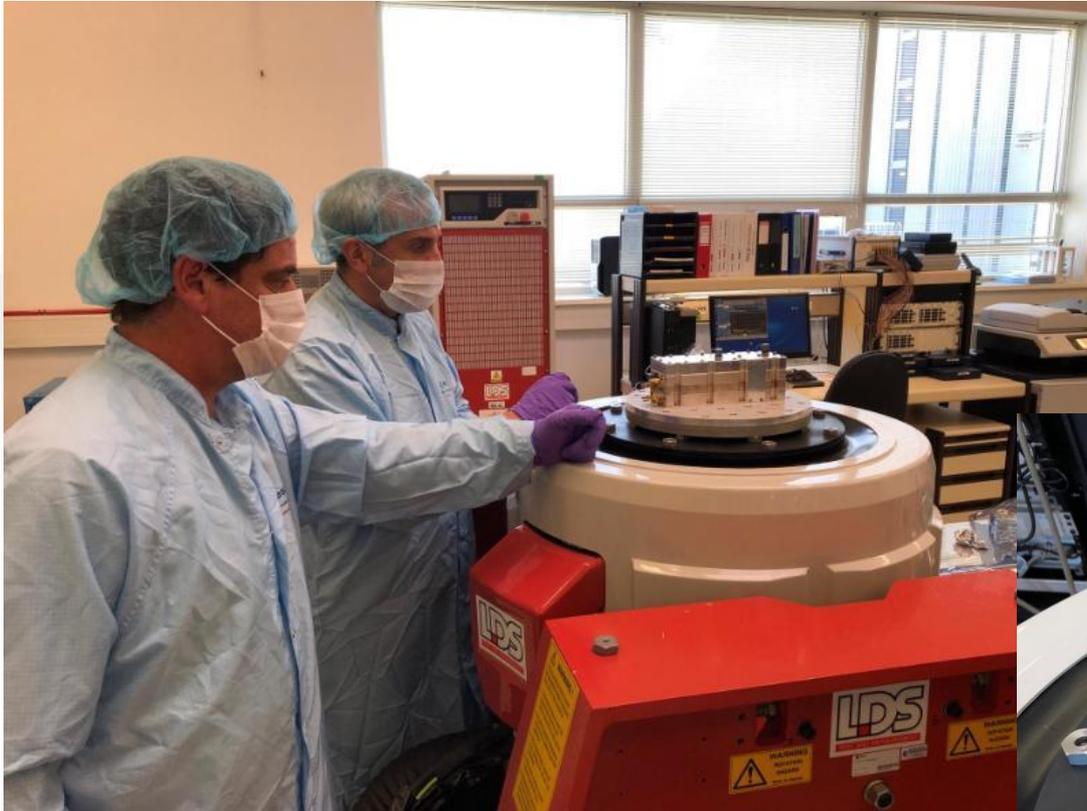
# Space Technologies for Mars:

## LaRa electronics – EMC testing



# Space Technologies for Mars

## LaRa electronics – Vibration testing



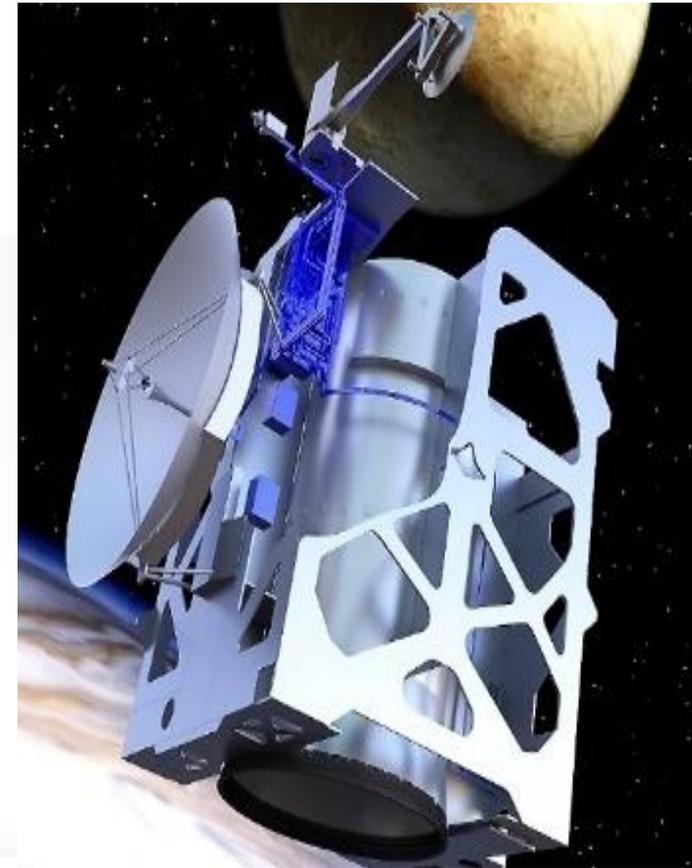
# Agenda

A few words about other **RF**  
**Technologies** developed by **Antwerp**  
**Space...**

# Missions to other planets

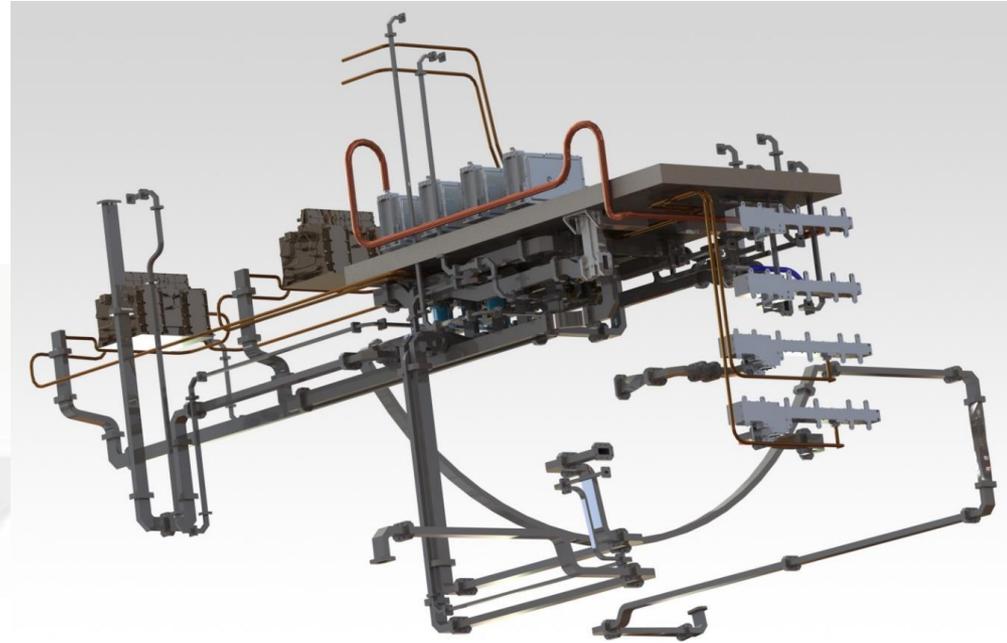
## JUICE Communication Subsystem

- JUICE - JUperiter ICy moons Explorer  
Planned for launch in **April 2023**, travelling 588 million kilometers with an arrival at Jupiter in 2029. It will spend at least three years making detailed observations of the giant gaseous planet Jupiter and three of its largest moons, Ganymede, Callisto and Europa.
- Finding out more about Ganymede is a main objective of JUICE since the ocean might be habitable.
- One of Ganymede's most remarkable features is its intrinsic magnetic field. No other moon in the Solar System is known to have one.
- Ganymede conceals an ocean under its icy shell, one that may contain more water than all surface water on Earth combined.



# COMS Fact Sheet

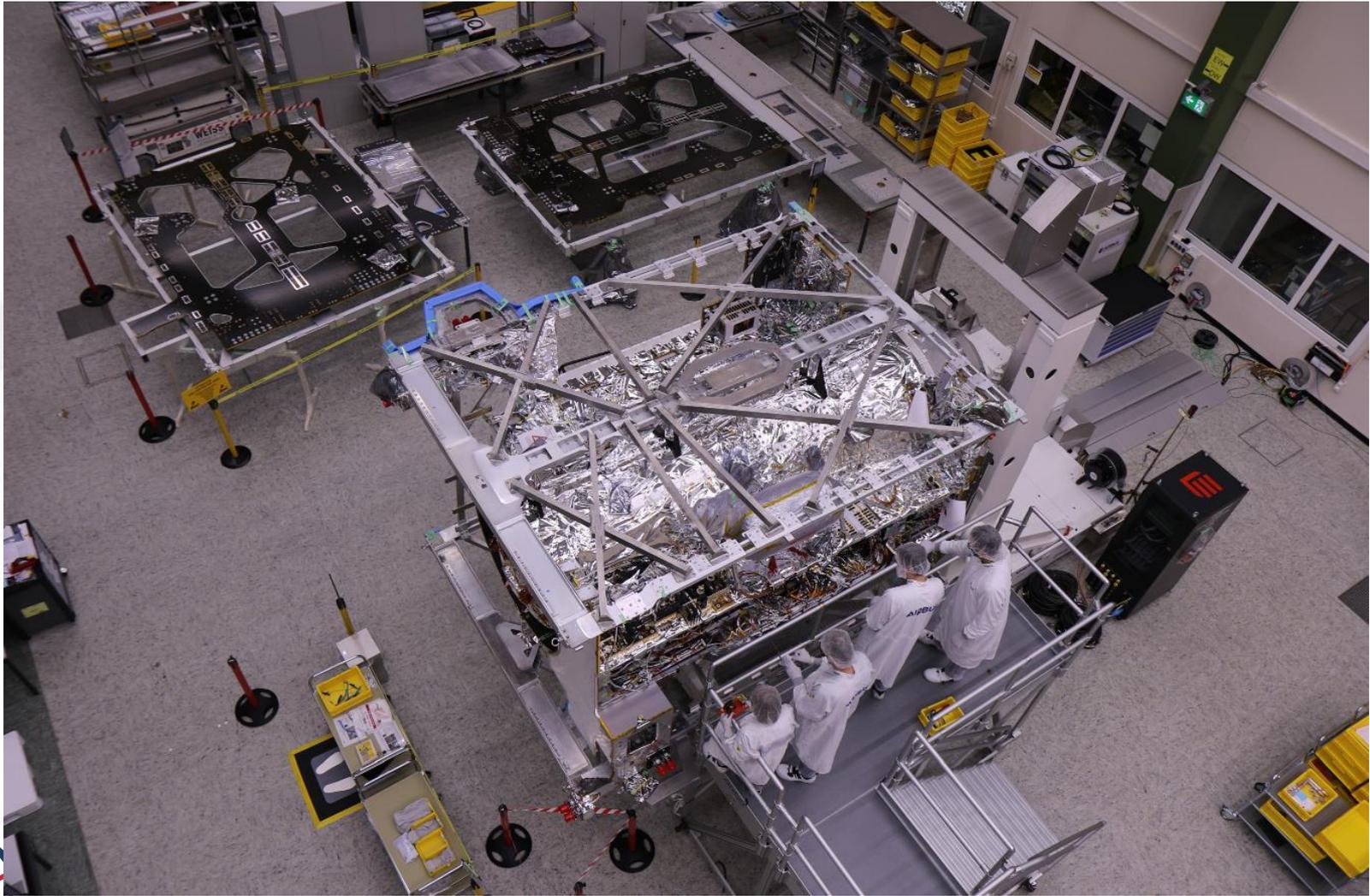
- ▶ Mass ~ 35 kg
- ▶ Equipment
  - 34 units / components
  - 19 m coaxial cable
  - 30 m waveguide
  - 10 m HV cable
- ▶ Power Consumption < 215 W
- ▶ Heat Dissipation < 167 W
- ▶ Reliability
  - X-band transmit chain > 99.44 %
  - X-band receive chain > 98.96 %
  - Ka-band transmit chain > 99.54 %



Integration: it is easy in the lab...



But difficult on the Spacecraft!



...or IN the Spacecraft.



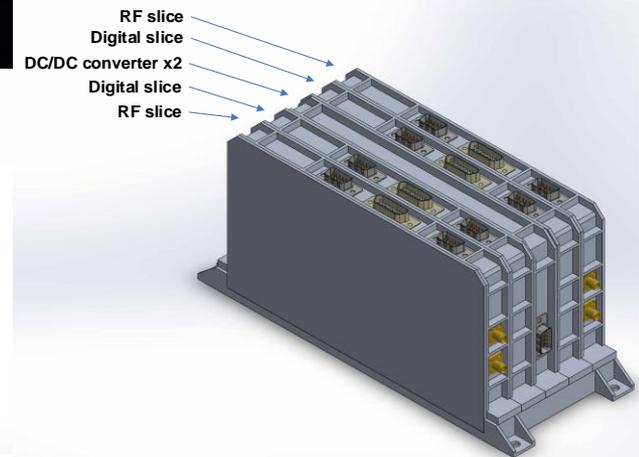
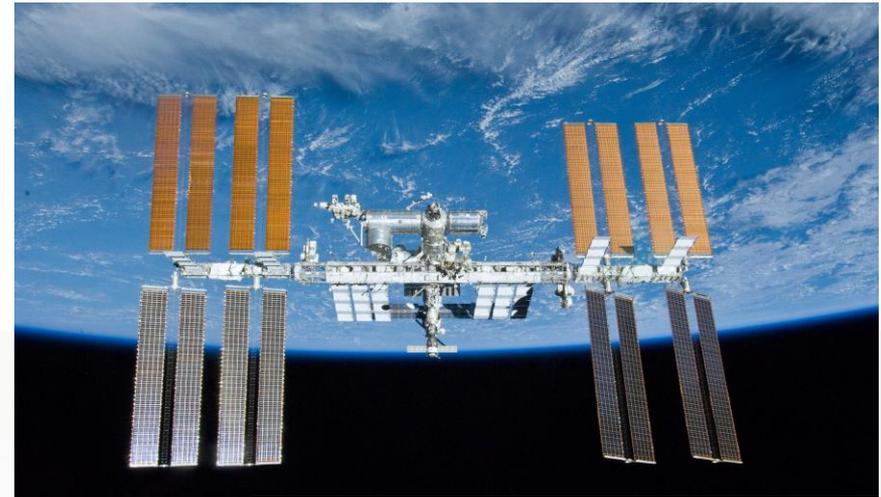
But the view is always amazing...



# Missions around earth...

## ARGO Software defined radio

- Antwerp Space equipping the International Space Station with broadband internet
- A first milestone in applying this new modem technology in the future on a global scale
- Currently operating on the ISS
- A State-of-the-Art technical solution that creates a giant leap forward compared to existing modem technology





**Join us!**

**Questions?**

# Who's working with us?



# Meet our people



What motivates me in my job is leading a highly qualified team, designing high quality, innovative solutions as well as interacting with customers and subcontractors from all around the world, all driven by the same objective of a successful mission.

**Delphine Van Vynckt**  
Project Manager

# Meet our people



It is amazing how many engineering disciplines are involved when you do space flight projects. This makes our projects both challenging and interesting to work on. I enjoy the international environment we are working in, while at the same time we are a relatively small company where everyone is always eager to help one another.

**Jo Van Langendonck**  
Head of System Engineering

# Working with us



Holidays



Onboarding



(Career) Development



Fascinating workplace



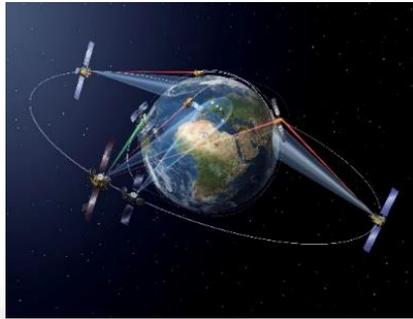
Flexible working



Fun @ work

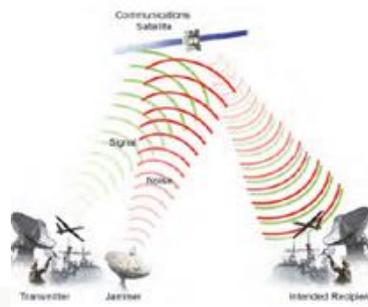


# State-of-the-art technology developments...



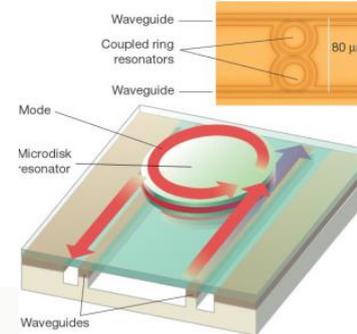
## Inter-satellite communication

Highly innovative & flexible software defined radio platforms



## Radio-frequency interference mitigation

Monitoring and preventing increasing RFI issues with satellites



## Photonics for Telecom payload

μwave photonics applied to Frequency conversion & switching



## Inter Planetary TT&C transponder

Integrated X/X TT&C PDHT equipment in support to ESA science missions

# Vacancies

**We are looking for the best and brightest talents to join us !  
Young enthusiasts with a passion for space !**

## **Job opportunities**

- ▶ Radar System Engineer
- ▶ Navigation System Engineer
- ▶ Communication System Engineer
- ▶ Business Development Manager
- ▶ Project Manager Flight Projects
- ▶ RF & Microwave Designer
- ▶ FPGA Design Engineer
- ▶ Digital Design Engineer
- ▶ Bid Manager

## **Thesis subjects related to**

- ▶ Photonics design
- ▶ Radar system study
- ▶ Communication system study
- ▶ Algorithm Design
- ▶ FPGA/VHDL
- ▶ Digital Design
- ▶ Embedded Design
- ▶ Hardware electronics
- ▶ Software

# Antwerp Space within the OHB group

## ANTWERP SPACE

**20**

**EUR MILLION**  
Antwerp Space revenue

**70**

**EMPLOYEES**  
At Antwerp Space level

## OHB SE

### SPACE SYSTEMS

- 100% **OHB System AG**, Bremen & Oberpfaffenhofen, Germany
- 100% **OHB Italia S.p.A.**, Milan, Italy
- 100% **LuxSpace Sàrl**, Betzdorf, Luxembourg
- 100% **Antwerp Space N.V.**, Antwerp, Belgium
- 100% **OHB Sweden AB**, Stockholm, Sweden

**917**

**EUR MILLION**  
Consolidated total revenue

### AEROSPACE + INDUSTRIAL PRODUCTS

- 70% **MT Aerospace AG**, Augsburg, Germany
- 70% **MT Mechatronics GmbH**, Mainz, Germany
- 70% **MT Aerospace Guyane S.A.S.**, Kourou, French Guiana
- 100% **OHB Teledata GmbH**, Bremen, Germany
- 74.9% **OHB Digital Services GmbH**, Bremen, Germany

**2420**

**EMPLOYEES**  
At group level

