

A detailed image of a satellite in orbit above Earth. The satellite has a central body with various instruments and two large, rectangular solar panel arrays extended outwards. The Earth's surface is visible below, showing a mix of land and water, with city lights glowing at night. The sun is a bright, circular light source in the upper left, casting a glow on the satellite and the Earth's horizon. The background is the deep black of space, filled with distant stars.

**exail**

**SOLUTIONS FOR SPACE  
APPLICATIONS**

# exail at a glance

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**80**

YEARS OF  
EXPERIENCE

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**250+**

MILLION EUROS  
OF TURNOVER

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**80%**

OF TURNOVER  
ACHIEVED ABROAD

---

**1500+**

EMPLOYEES

---

**10**

REFERENCES OF  
SPACE GRADE FIBERS  
(GUARANTEED RIA)

---

**1000+**

KM OF SPACE QUALIFIED  
FIBERS FLYING

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**200+**

MODULATORS  
IN SPACE

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**30+**

SATELLITES EQUIPPED  
WITH ASTRIX  
GYROSCOPES

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**6+**

MILLIONS HOURS IN  
ORBIT FOR ASTRIX  
GYROSCOPES

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## **Competencies & capabilities in Space**

Exail is a leading high-tech industrial group specializing in cutting-edge robotics, maritime, navigation, aerospace and photonics technologies. With a strong entrepreneurial culture, Exail delivers unrivaled performance, reliability and safety to its civil and defense clients operating in severe environments. From the deep sea to outer space, Exail expands their capabilities with a full range of robust in-house manufactured components, products and systems.

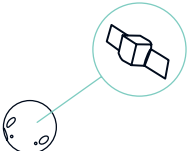
With a dedicated team for space products for more than 20 years, Exail has end to end control of its value chain, from the R&D carried out in its engineering offices through manufacturing in the company's own production shops and quality control.

Production sites have large clean rooms for the manufacturing of space components and systems. Numerous skillful experts are available together with all the required means to develop, test and qualify products for space. Exail supplies numerous space actors following ECSS standards.

# SPACE PORTFOLIO

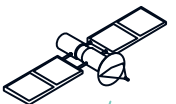
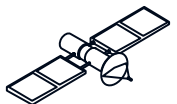
## Navigation & guidance

Inertial Measurement Unit (IMU)  
for safe landing on other planets  
and scientific missions



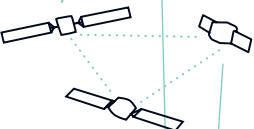
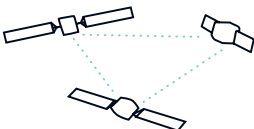
## Attitude & Orbit Control Systems (AOCS)

Fiber-Optic Gyroscopes (FOG)  
for telecom satellites



## Attitude & Orbit Control Systems

FOG for Earth observation,  
strategic telecom satellites  
and constellations



## Navigation & guidance

Inertial Navigation  
Systems for launchers



- ..... up to 125 Gb/s, 10 or 25 Gb/s NRZ or DPSK per optical channel
- up to 125 Gb/s, 10 or 25 Gb/s NRZ or DPSK per optical channel
- - - - per optical channel, Analog up to 10 GHz, NRZ or DPSK  
up to 10 Gb/s, or PPM

Altitude

GEOSTATIONARY  
ORBIT (GEO)

36 000 km

2 000 km

LOW EARTH  
ORBIT (LEO)

400 km

## Laser communications between GEO, LEO satellites and Earth

Multiplexers / Demultiplexers  
90°Hybrids  
LiNbO<sub>3</sub> Modulators  
Rad Hard Fibers and FBGs  
Low Noise Optical Amplifiers  
Optical Channel Emitters  
Optical Channel Receivers  
High-speed Transceivers

## Laser communications between ground base stations, aircrafts and satellites

Atomic clocks  
ModBox Optical Reference  
Transmitters and Receivers  
Low Noise Optical Amplifiers  
Multiplexers / Demultiplexers  
90°Hybrids



# FROM FIBERS & COMPONENTS TO INTEGRATED SYSTEMS

## Space grade solutions

Exail masters the manufacturing of TRL9\* "flight proven" optical components and systems. The company' space-grade products and systems are robust by design and based on proven technology deployed in the harshest orbit (GEO). They also fit many requirement of the New Space market for LEO/MEO satellites and constellations.

\*Highest level of Technology Readiness Level (from 1 to 9)

Thanks to Exail's expertise in the telecommunication domain, its experience in assembling complex systems and its space background, the company can now provide integrated systems for the space market, such as:

- Low Noise Optical Amplifier (LNOA): Pump diode laser, active fiber
- Optical Channel Emitter (OCE): seed laser, LiNbO<sub>3</sub> modulateur, matching RF amplifier, Mux
- Optical Channel Receiver (OCR): Demux, photoreceiver, 90° hybrids

Exail also delivers atomic clocks and ModBox reference transmitters and receivers for ground base stations.



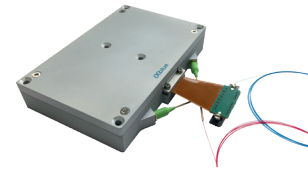
**Mux, Demux,  
90° hybrids,  
micro-optics  
assemblies**



**Harsh  
environment  
fibers**



**LiNbO<sub>3</sub> modulators**



**Integrated systems (LNOA, OCE, OCR)**



**Atomic clock**



**Optical Reference Transmitter (PPM,  
NRZ, DPSK modulation schemes)**



# SOLUTIONS FOR OPTICAL SPACE COMMUNICATIONS

## Fully integrated transceiver for high-speed space communications

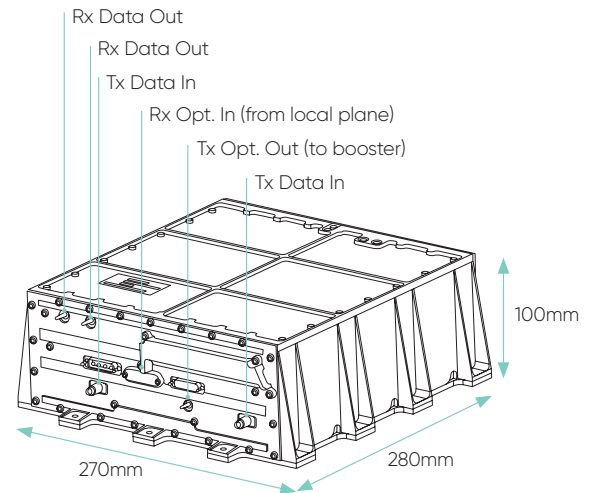
To respond to the challenge of communication in space, which demands increasing data volumes transmission, ESA initiated the FOLC\* project, supported by the French Space Agency (CNES), and with Airbus Defence and Space and Exail as partners.

Through the FOLC project frame, Exail has developed a ready for flight model transmitter and receiver for a data transmission rate of 20 Gbit/s per optical channel.

Exail's fully integrated optical transceiver for space communication, houses a transmitter based on 1 to 6 emission channels and a receiver based on 1 to 8 reception channels. Parameters such as the total weight of the device and its maximal power can be customized according to customers needs.

The transceiver can be used for constellations counting between two to thousands of satellites.

\* (Feeder for Optical Link Constellation)



# NAVIGATION, ATTITUDE & ORBIT CONTROL SYSTEMS

## Space proven gyroscopes and inertial navigation systems

Developed in partnership with Airbus Defence & Space since 2000, Astrix are high-performance space grade 3-axis Fiber-Optic Gyroscopes (FOGs) designed to withstand the challenges of harsh and radiative space environments.

The Astrix Series is a fail-safe inertial solution for numerous space applications such as military and scientific satellites, global navigation, telecommunications and Earth observation satellites. Astrix gyroscopes can be used in all orbits (LEO, MEO and GEO) and also at Lagrange points and for interplanetary missions. It has been selected by very demanding customers all around the world, including European Space Agency (ESA) for Aeolus, Sentinel 2, Solo, MTG and Pléiades programs.

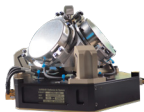
Recently, Exail has developed Astrix NS, a dedicated gyroscope to address the challenges of the New Space market. Astrix NS brings high-inertial performance and reliability in a compact design and at a competitive price.

Exail also offers a qualified safety Inertial Navigation System (INS) for launcher, on board all Ariane 5 since 2020 and Ariane 6 from 2022.

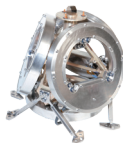
Finally, Exail is developing the first European cost-effective Inertial Measurement Unit (IMU) for space applications, in the frame of the European funded programme EURISA, with 3 major actors of the space ecosystem – Airbus Defence and Space, ETH Zurich, German Aerospace Center (DLR).



**Astrix NS**



**Astrix 90**



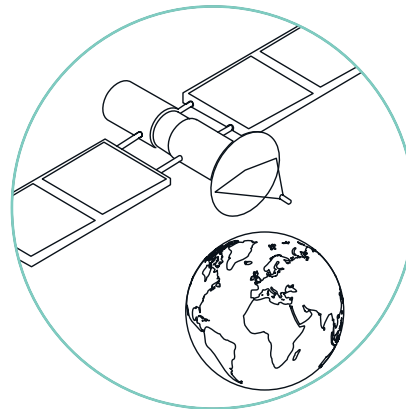
**Astrix 200**

## FOG technology

Leveraging 30 years of advanced expertise in Fiber-Optic Gyroscopes, Exail has complete mastery over all the components that are integrated into its systems, from the optical fibers, to integrated optical circuits and accelerometers.

## Robust and reliable

FOGs are solid-state systems that do not involve any movement of mechanical parts. Operating as a single component and relying only on light motion, they are highly resistant to external disruptions such as shocks, extreme temperatures, magnetism and vibrations, and operate in extreme environments. Therefore they are highly reliable for long space missions.



**6 million**  
hours in orbit  
without incident

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