

exail



OPTICAL, SPACE & QUANTUM COMMUNICATIONS

INCREASING DATA TRANSMISSION RATE AND
SECURING DATA

EXAIL PRESENTATION

Stronger together

1500

EMPLOYEES

250+

MILLIONS EUROS
OF TURNOVER

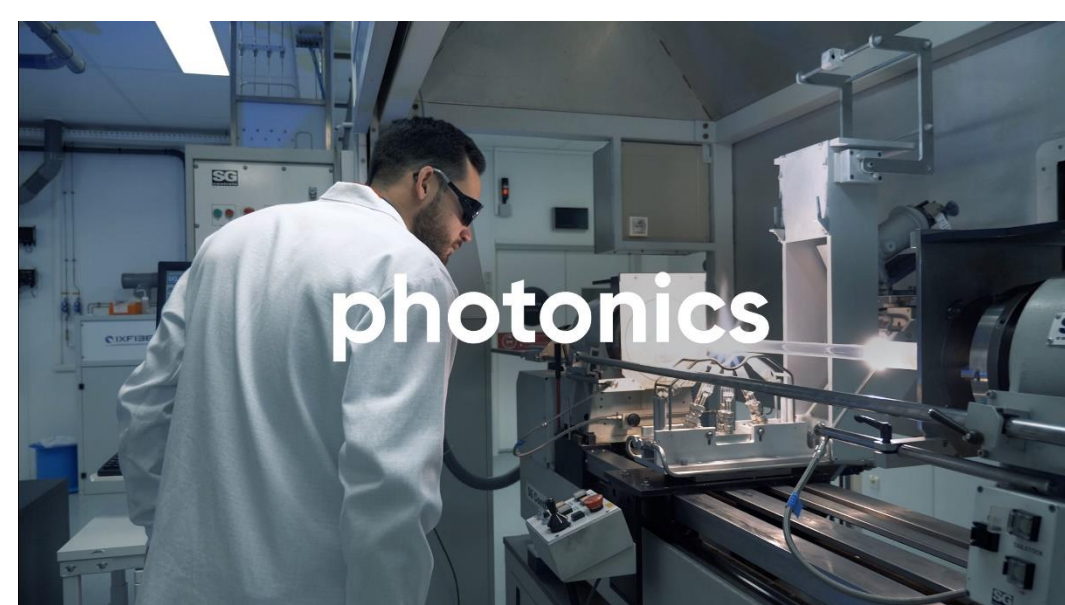
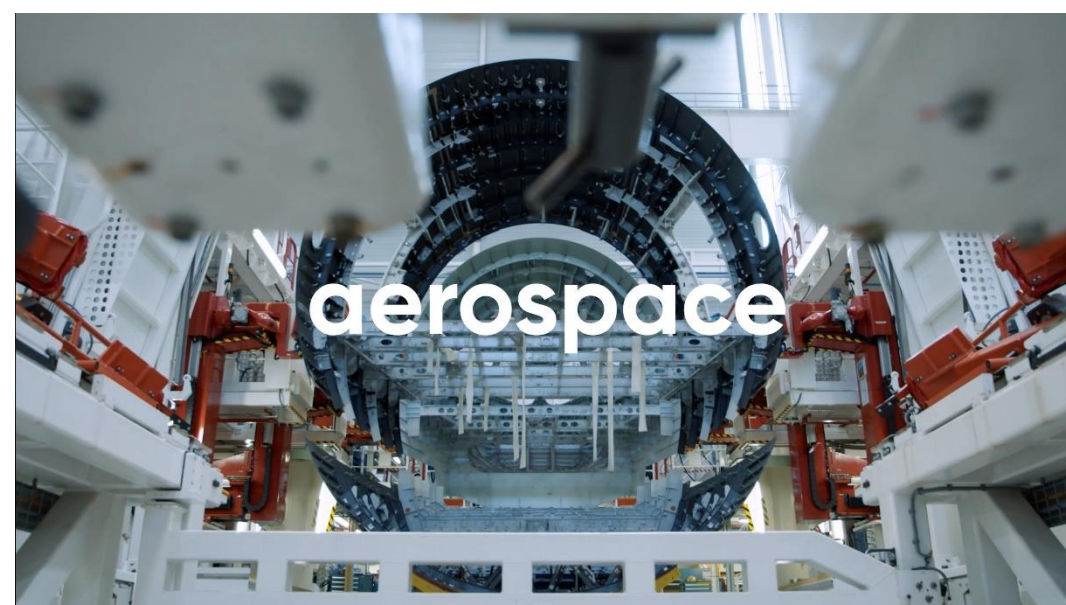
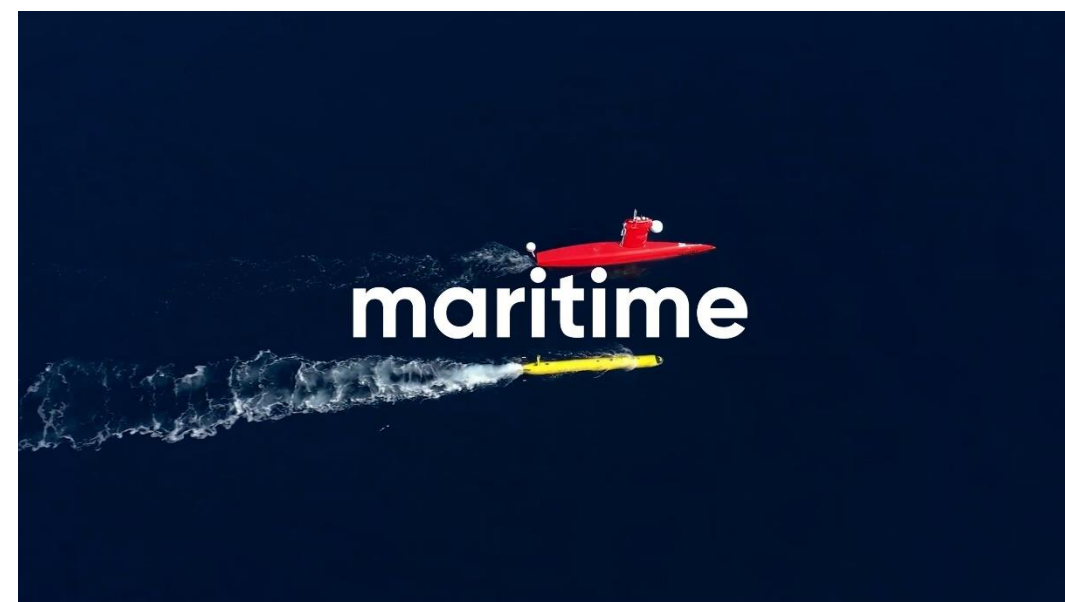
20+

% OF TURNOVER
INVESTED IN R&D

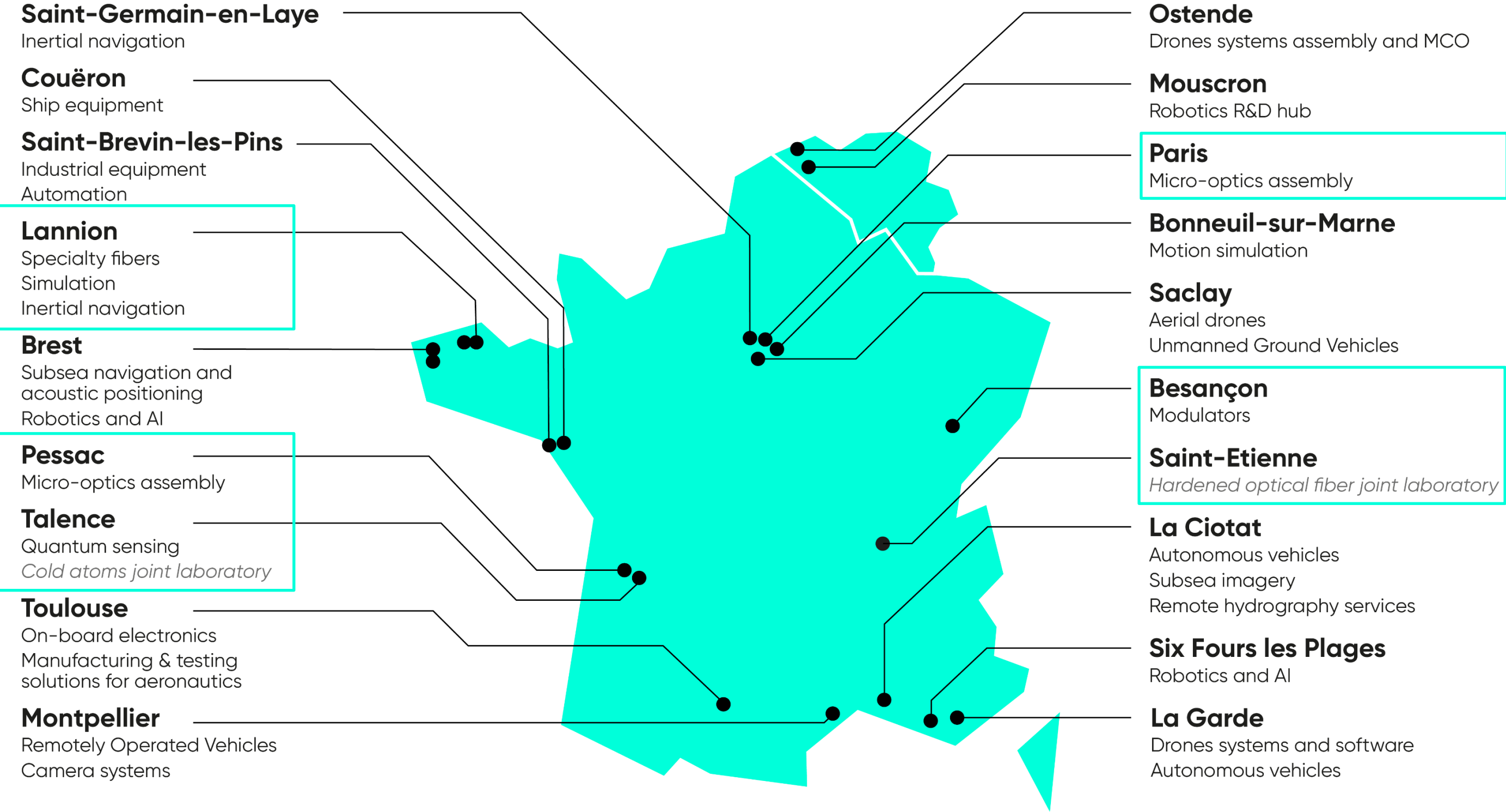
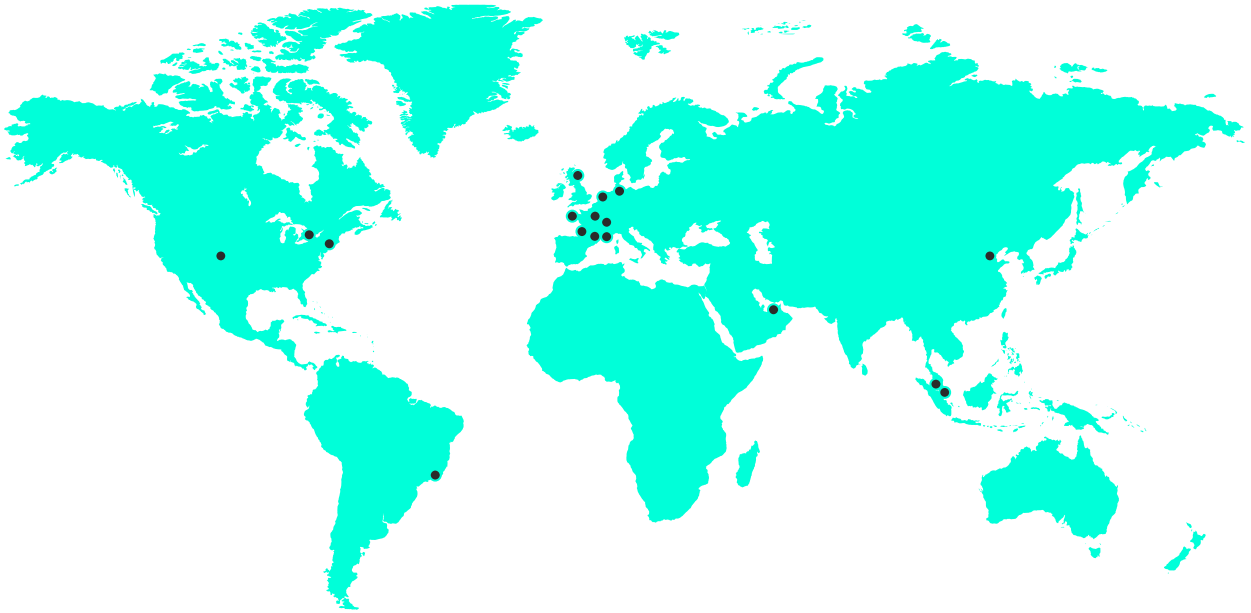
80%

OF TURNOVER
IN EXPORT

Cutting-edge technologies



A unique technological know-how



21 INDUSTRIAL SITES



2 JOINT RESEARCH LABORATORIES

The Exail Photonics activities



Specialty Fibers – Lannion
Fibers and FBG
60 employees
2 500 sqm

IXFIBER



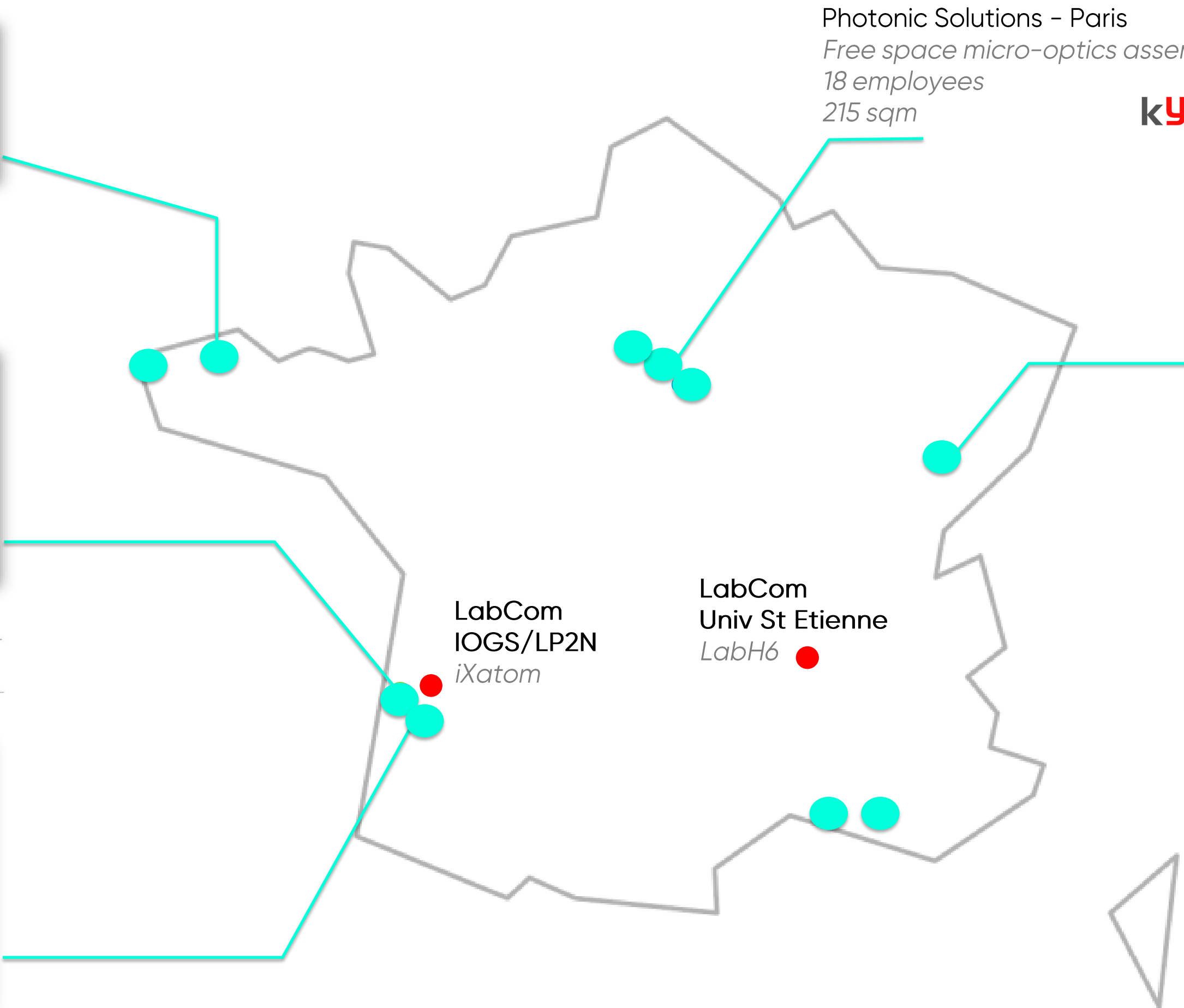
Quantum Sensors – Talence
Instruments and Lasers
35 employees
560 sqm

MUQUANS
PRECISION QUANTUM SENSORS



Photonic Solutions – Pessac
Free space micro-optics assembly
15 employees
200 sqm

kYLia



Photonics and Quantum COTS solutions, from components to instruments

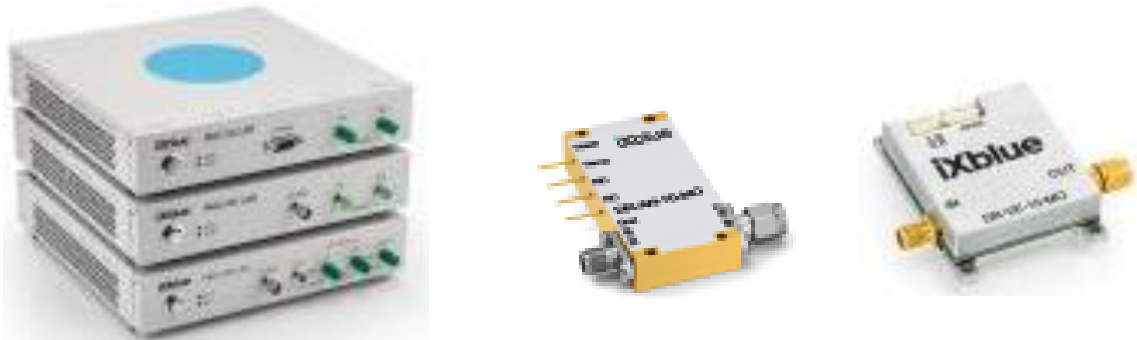
➤ Scalable technologies to address a full range of applications

Components

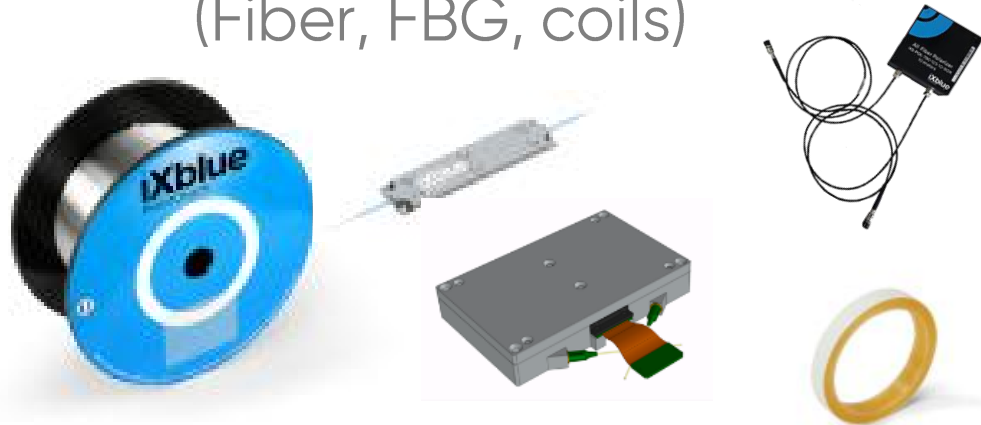
LiNbO₃ Phase, Amplitude, IQ Modulators (COTS, Space model)



Modulators Matching components (RF Amplifier, Low Noise Electronic)



Fibers and fiber solutions (Fiber, FBG, coils)



Turn-key devices and systems

μoptics and passive optics integration



Transmitters, transceivers, laser pilot, coherent regeneration station



Lasers (Narrow-linewidth, high-power) Optical Low Noise & Power amplifiers



Instruments

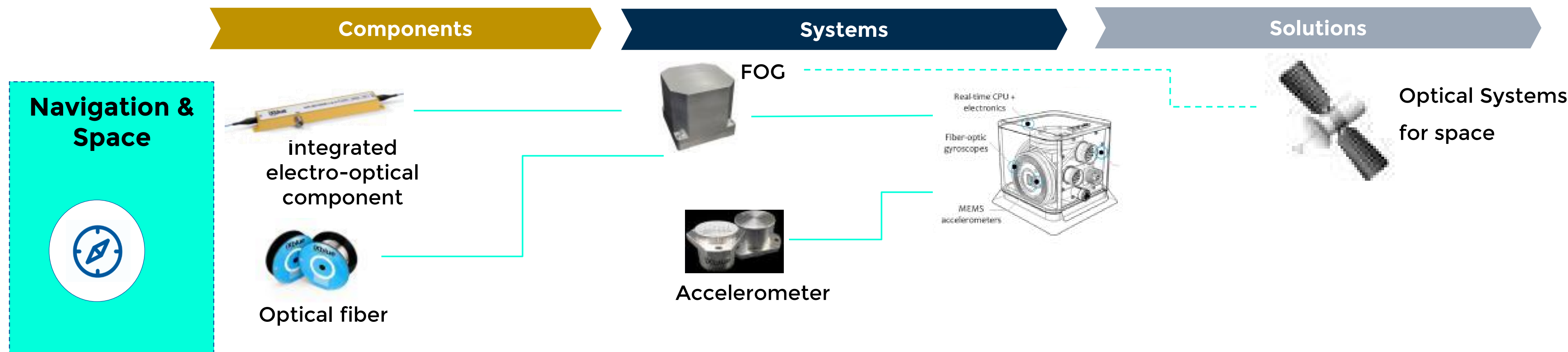
Absolute Quantum Gravimeter



Cold atom frequency metrology



Navigation solutions – Fiber optic gyroscope



• **Astrix – Space grade FOG**

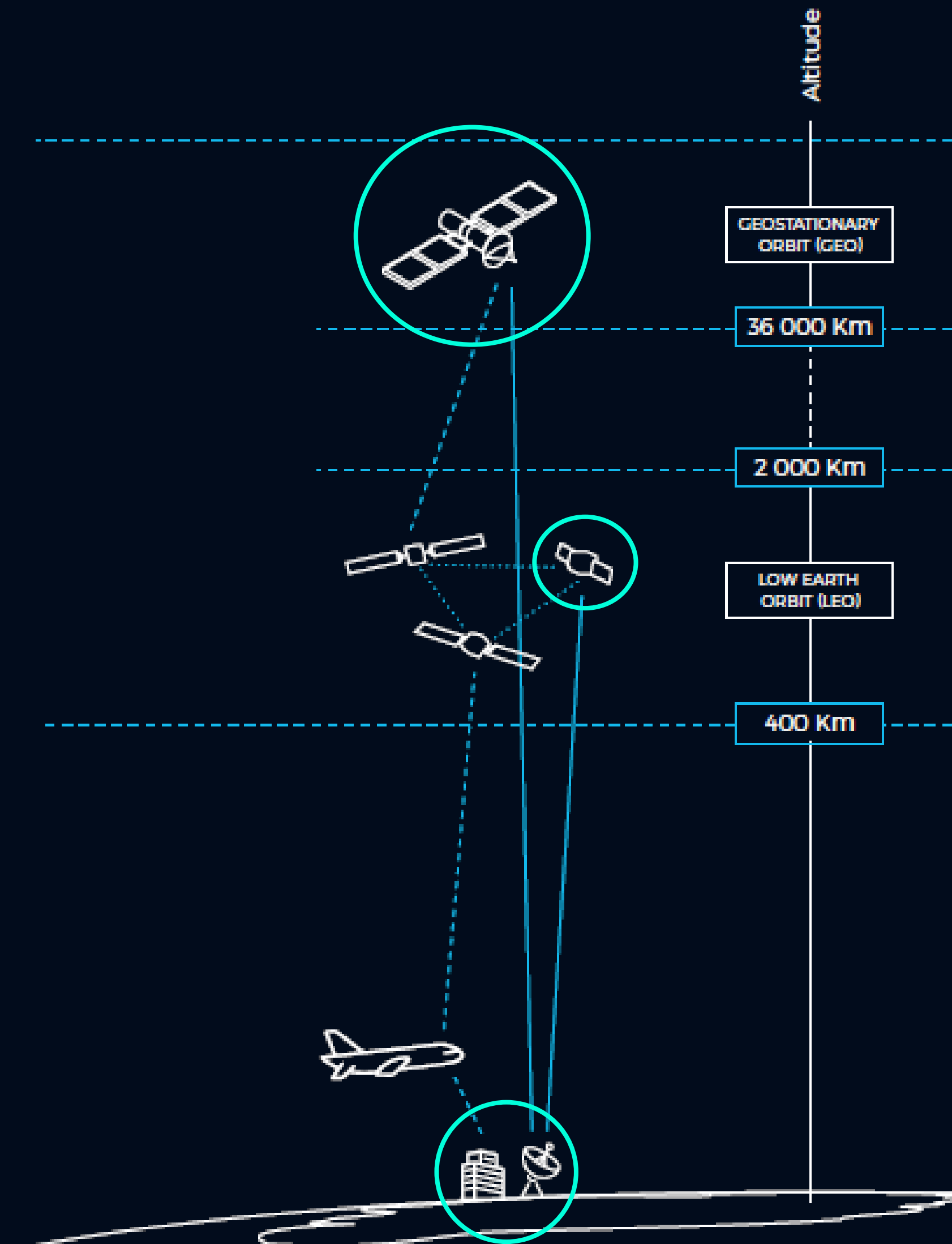
- +20-years partnership between iXblue and Airbus Defence & Space
- +30 satellites are equipped with iXblue Astrix
- +6 million hours in orbit without incident



RISE OF SPACE OPTICAL COMMUNICATION

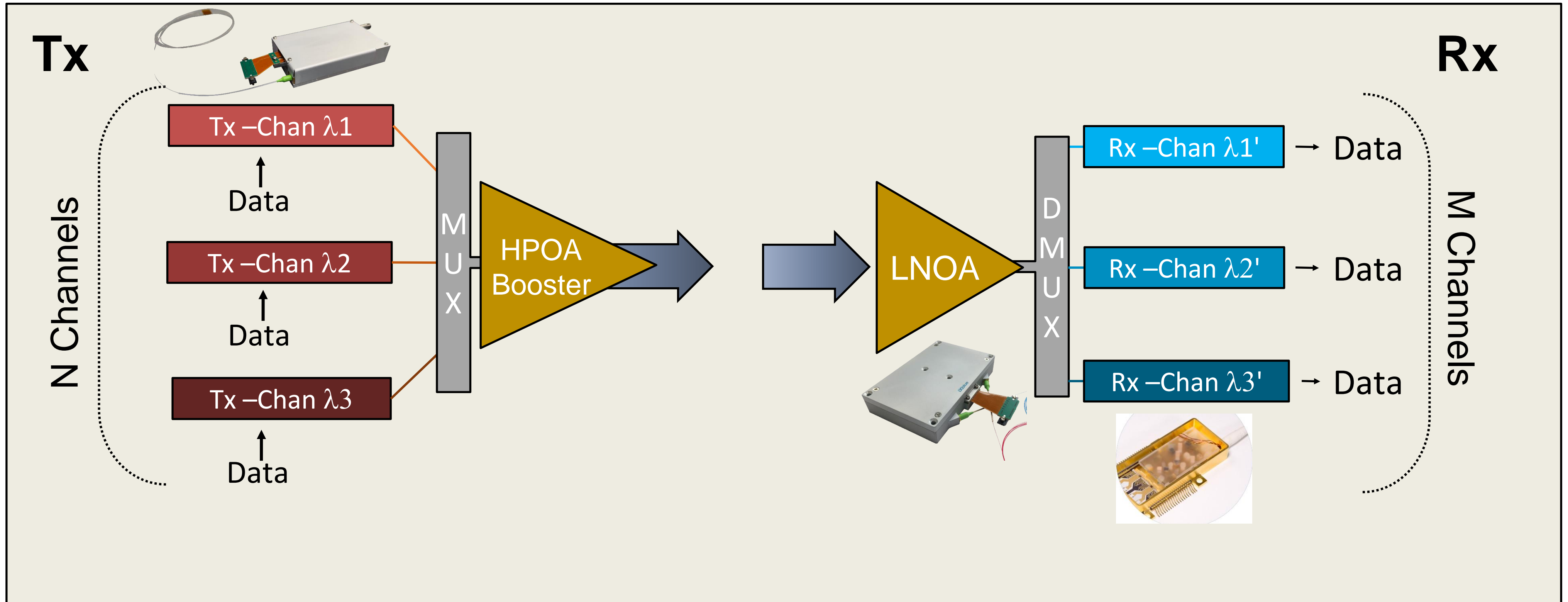
Optical link between ground and space

- Replacement of conventional electrical approach by photonic components & systems
 - More compact, lighter and cost-effective satellites
 - Increase of data rate to hundreds of Gb/s and higher than Tb/s
 - No frequency authorization requirement
 - Secure transmission with reduced beam diameter
- LEO-LEO inter & intra satellite constellation communication:
 - 2-3 years on-flight target. Up to 7 years in space
 - Few attenuation → no amplification needed. COTS transceiver
- Optical link on GEO Feeder satellite implies :
 - equipment design that can handle up to 15-year lifetime under harsh environment (radiations, vacuum, thermal cycling...)
 - Signal power and contrast sufficient enough to compensate atmospheric attenuation



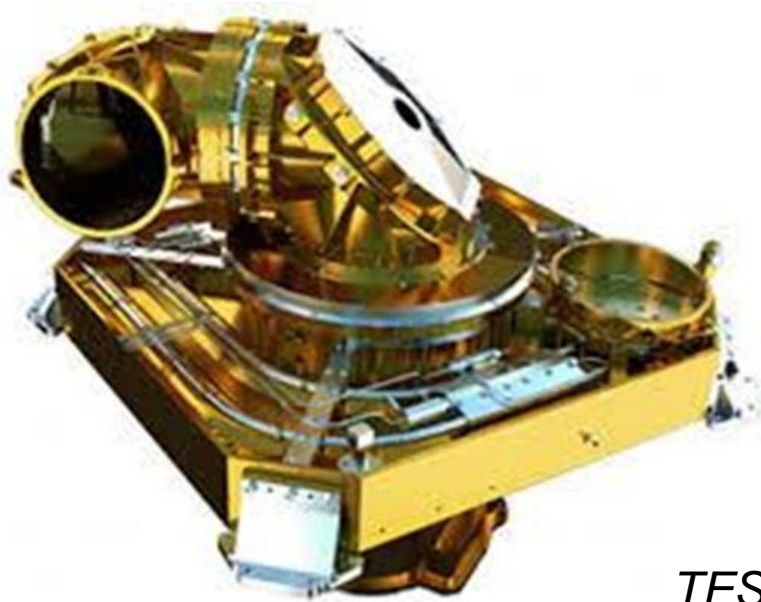
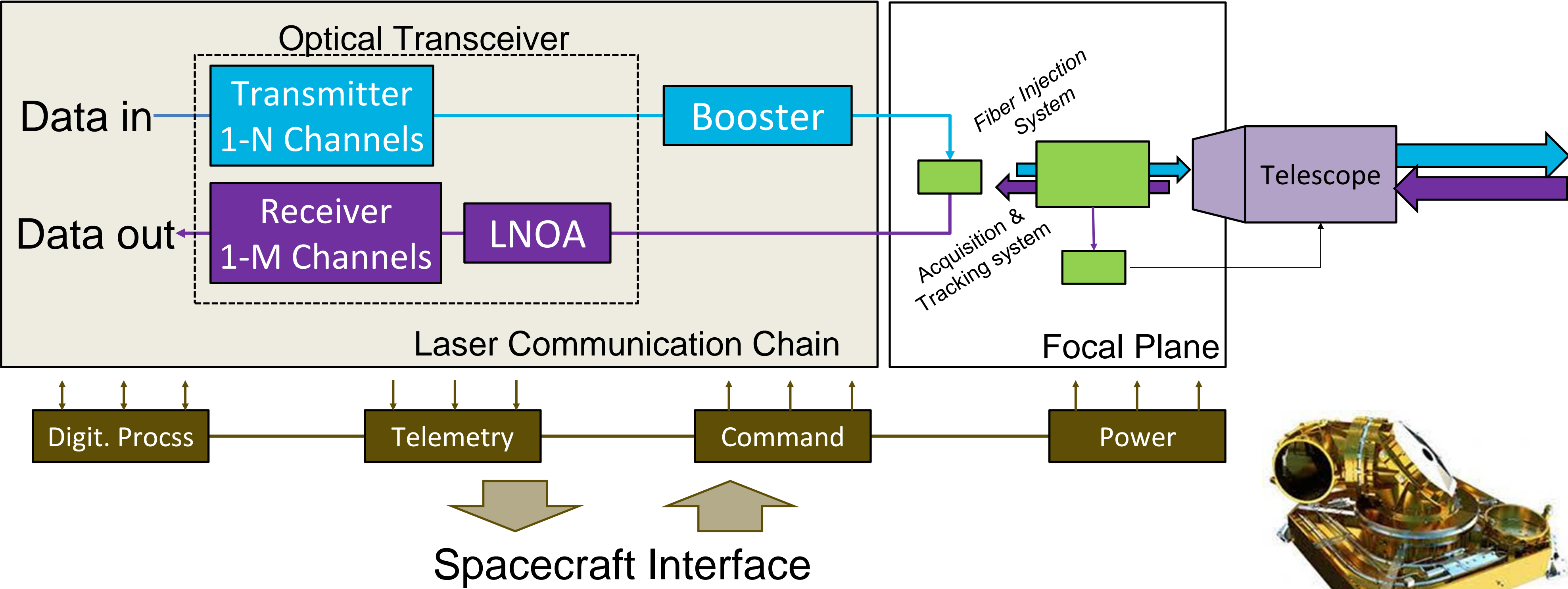
Space laser communication

➤ Architecture WDM Architecture (wavelength multiplexing)



Space laser communication

➤ Typical LCT architecture (Laser Communication Telescope)



TESAT

exail

Space grade solutions, telecom, and scientific

TRL9 Fibers, LiNbO₃ Modulators and free space optical assemblies



- Space Grade PM Gyro Fibers & RadHard Space Grade Doped Fibers
 - +10 references in stock with guaranteed Radiation Induced Attenuation (RIA)
 - +1000 km space qualified fibers delivered
 - Guaranteed Radiation Induced Gain Variation (RIGV) on Er, Yb and Er/Yb fibers



- On-board Amplitude and Phase LiNbO₃ modulators
 - 850 nm & 1064 nm & 1550 nm TRL9 modulators
 - more than 30 projects delivered, and 10 on-going projects involved
 - +300 Flight Models modulators delivered

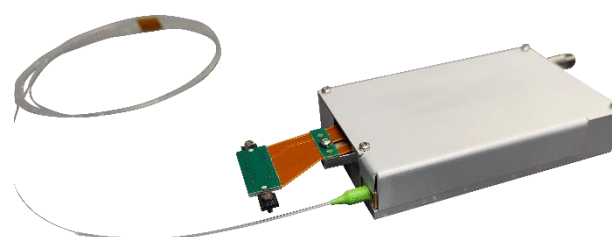


- On-board free space optical assemblies
 - TRL9 hybrid coherent mixers
 - TRL6 Multiplexers & Demultiplexers
 - TRL9 custom free space optical assemblies

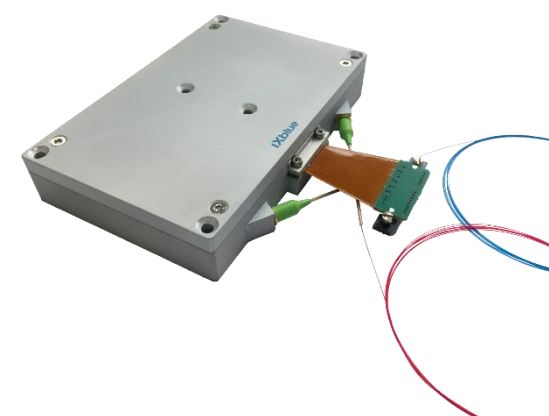


Space grade solutions, telecom, and scientific

Development of optical transceiver for GEO-Ground & LEO-ground telecommunications

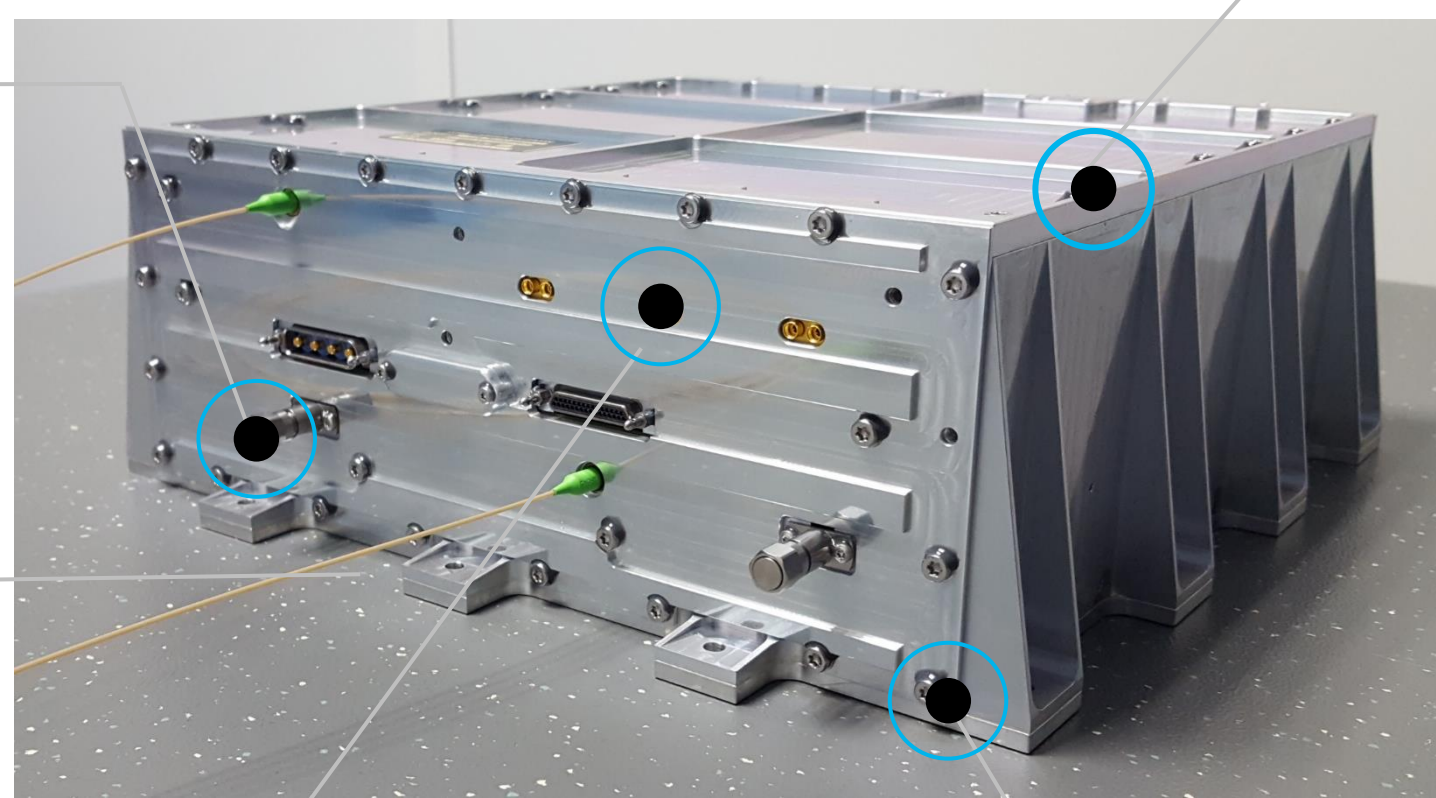


OCE /
Optical Channel Emitter



LNOA /
Low noise amplifier

OCR / Optical Channel Receiver



Receiver stage
3 multiplexed channels
10 Gb/s OOK modulation
analog modulations
> -40dBm input power allowed

Transmitter stage
2 multiplexed channels
10 Gb/s DPSK modulation
> 7dBm output power/channel

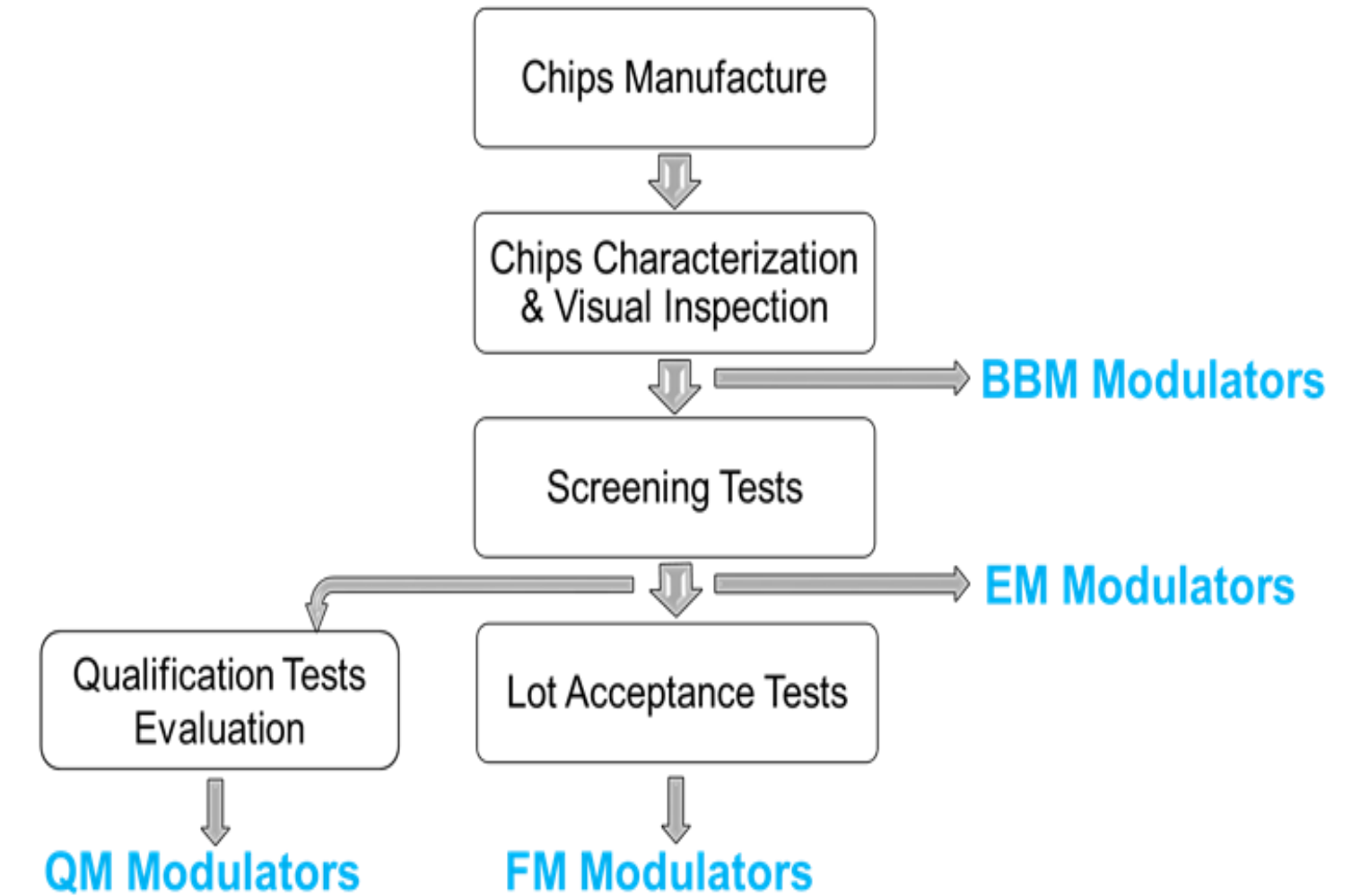
Exail strategy

➤ Components, modules and complete systems:

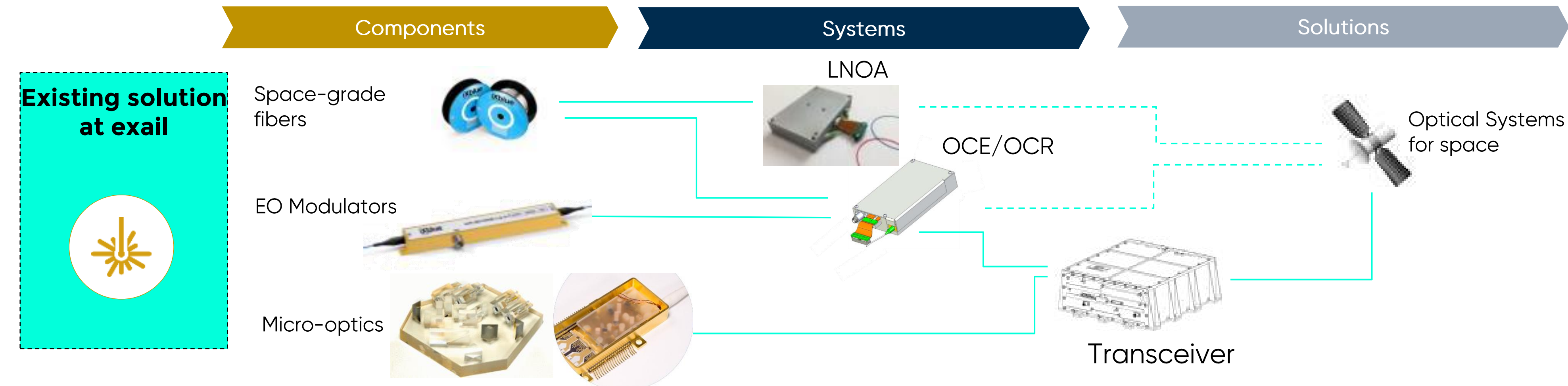
- Unit delivery or small/medium volumes quantities
- Several grades : BBM, EM and FM
- On-request qualification depending on customer need

➤ Markets:

- For all orbits
- Terrestrial version for ground stations
- For all kind of space mission (optical communications, observation, navigation)



Strategy & Exail need concerning space optical communications

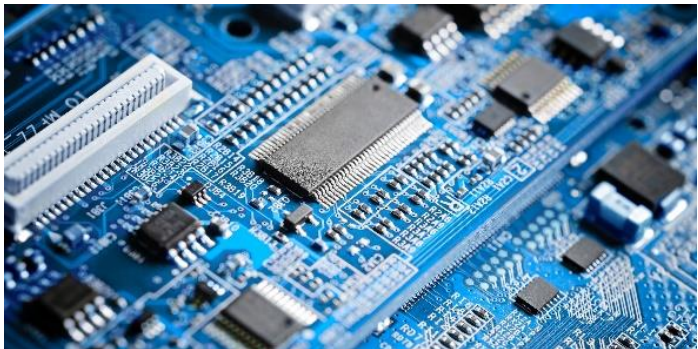


Current objectives for space grade systems

Increase data rates, output power / Reduce weight, size & consumption

Our Need

- Space compatible LF electronics
- Space-grade laser



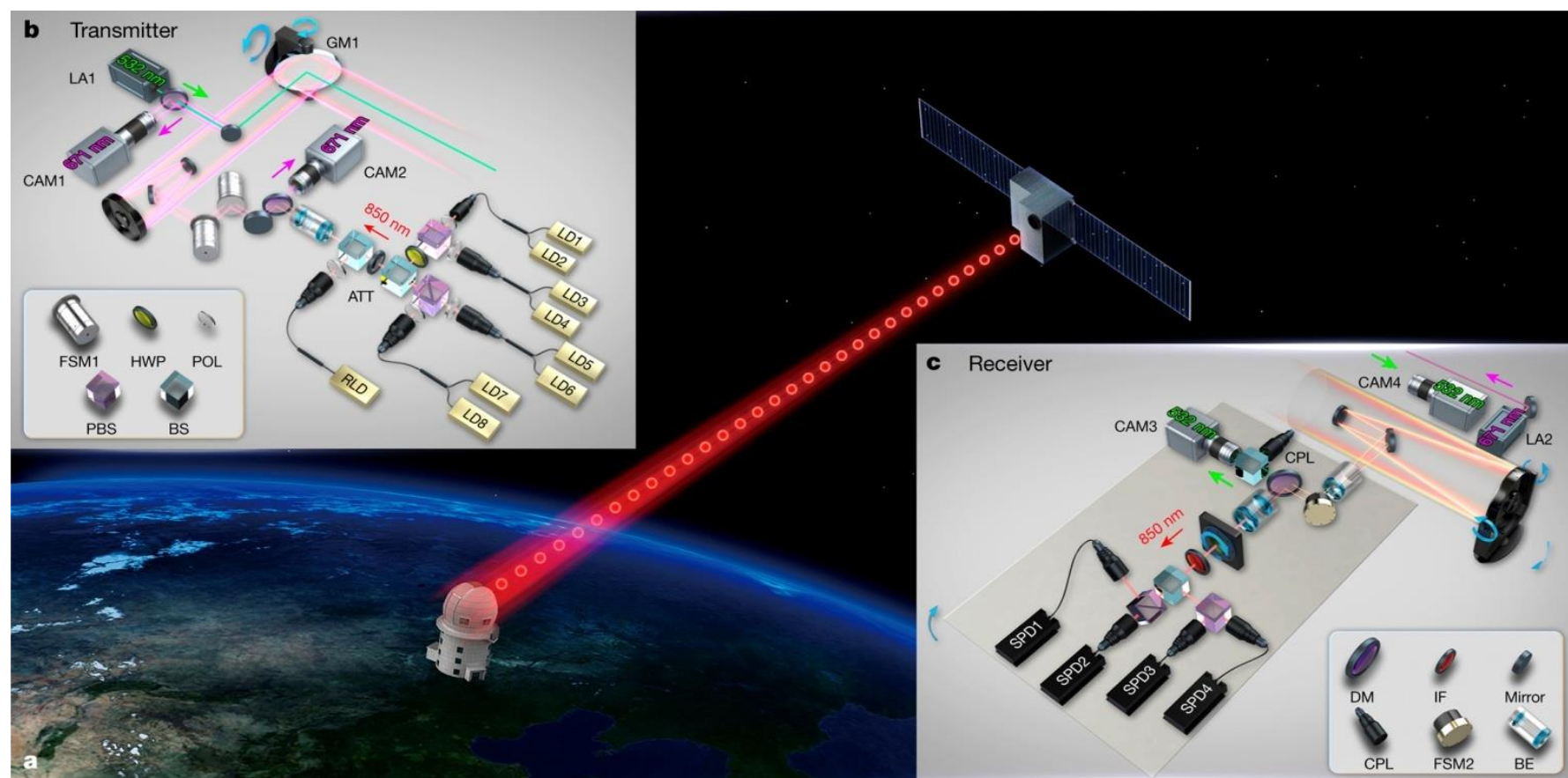
- Space-grade RF amplifier
- Space-grade high speed photodetector

TOWARD QUANTUM OPTICS

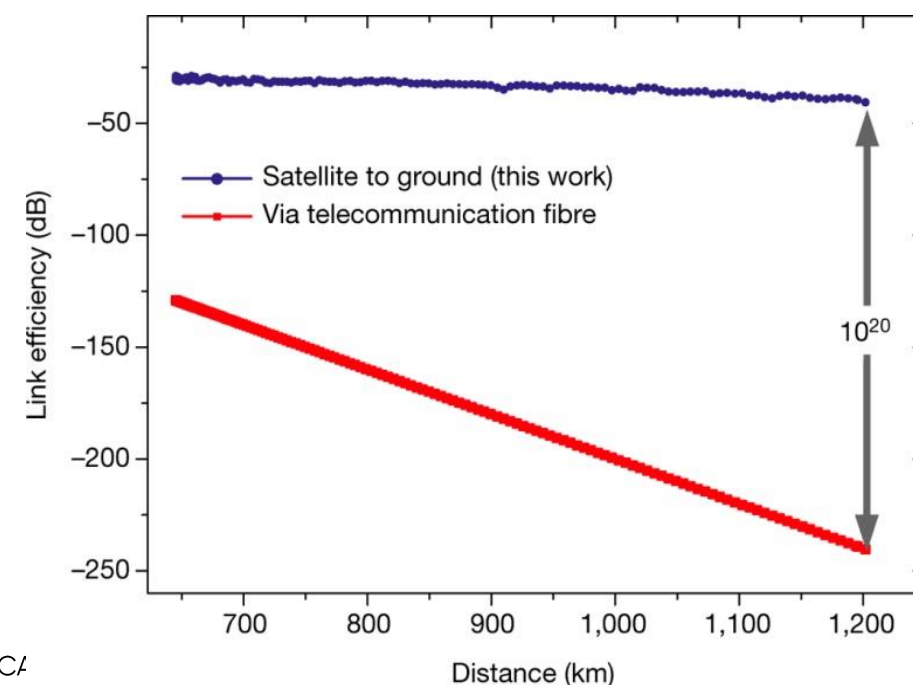
FOR DATA SECURING

Space quantum cryptography

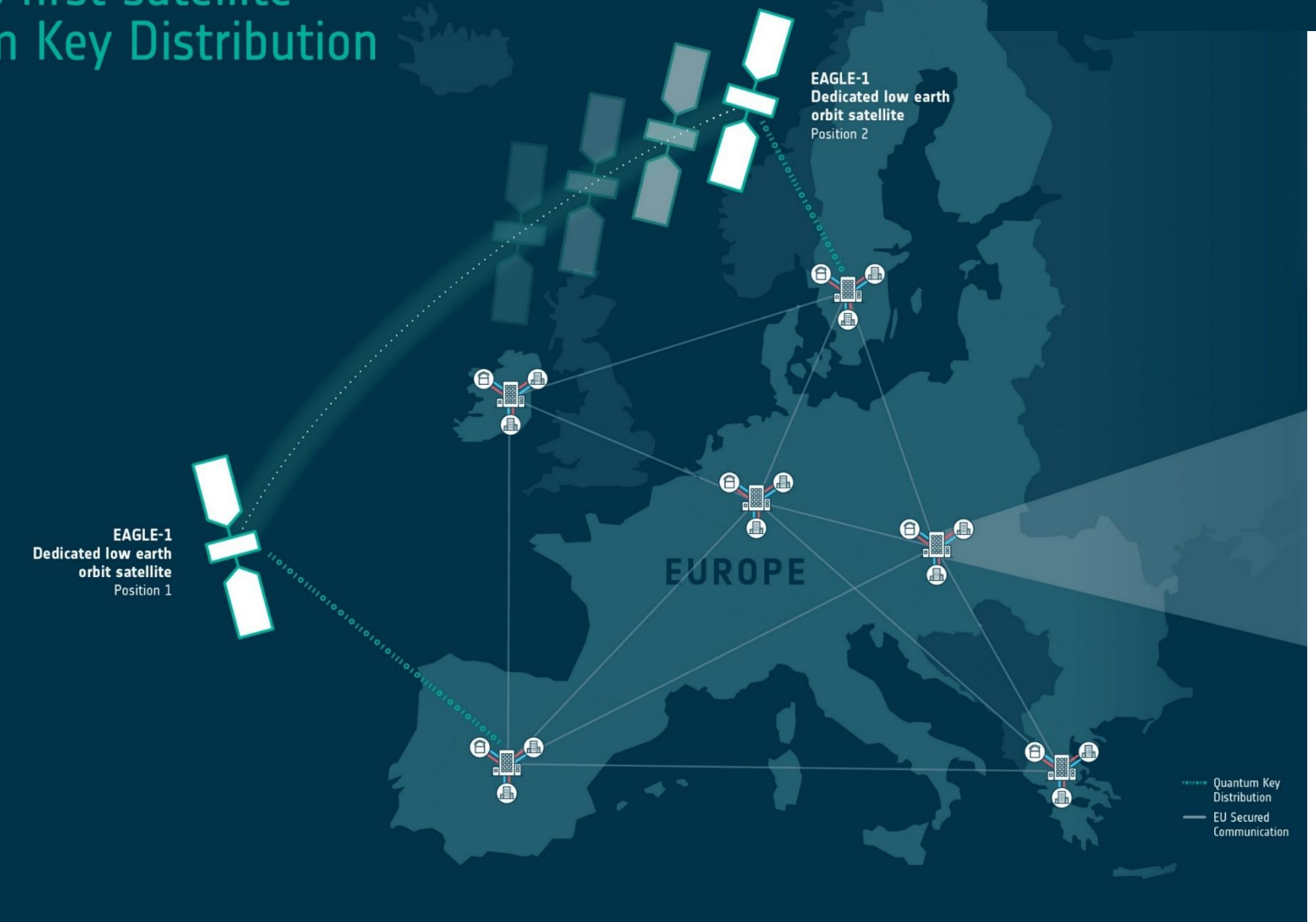
- Quantum key distribution between two ground stations by the mean of a satellite.
- First demonstration by Micius chinese satellite in 2016
- Ongoing european response with projects Eagle-1 & QKDSat



 Liao, SK., Cai, WQ., Liu, WY. *et al.* Satellite-to-ground quantum key distribution. *Nature* 549, 43–47 (2017) **nature**

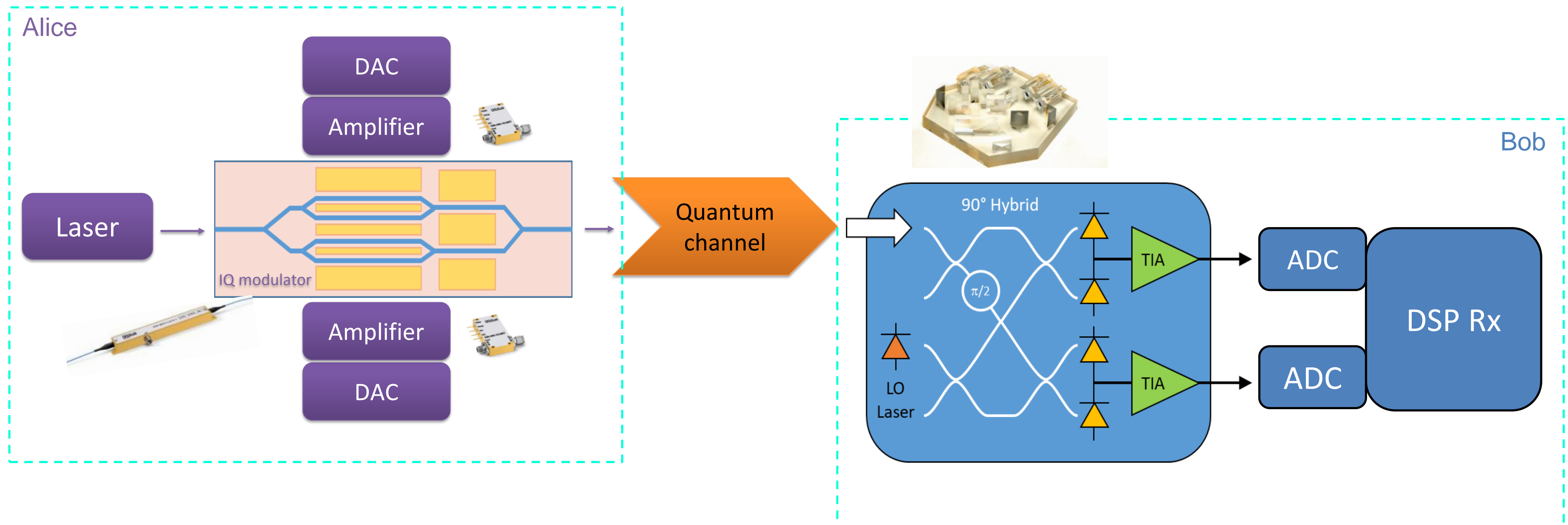


EAGLE-1: Europe's first satellite Quantum Key Distribution system



➤ CVQKD systems development with Thales & CNRS (for terrestrial market)

- Information encoded in amplitude and phase (phase & intensity modulators or IQ modulator)
- use standard telecom components and DSP techniques
- high-rates at metro scale
- cost-effective



CONCLUSION

CONCLUSION

➤ Emergence of space optical telecommunication

- Several optical links in orbit with a few Gb/s data rates. Ongoing projects to increase data rates to several hundred of Gb/s.
- Space components & systems require adapted qualification
- First European QKD satellite in preparation

➤ Exail to propose space compatibles components & optical transceivers

- Looking for optoelectrical components to improve performances & data rates
- Looking for space qualified electronics

THANK YOU