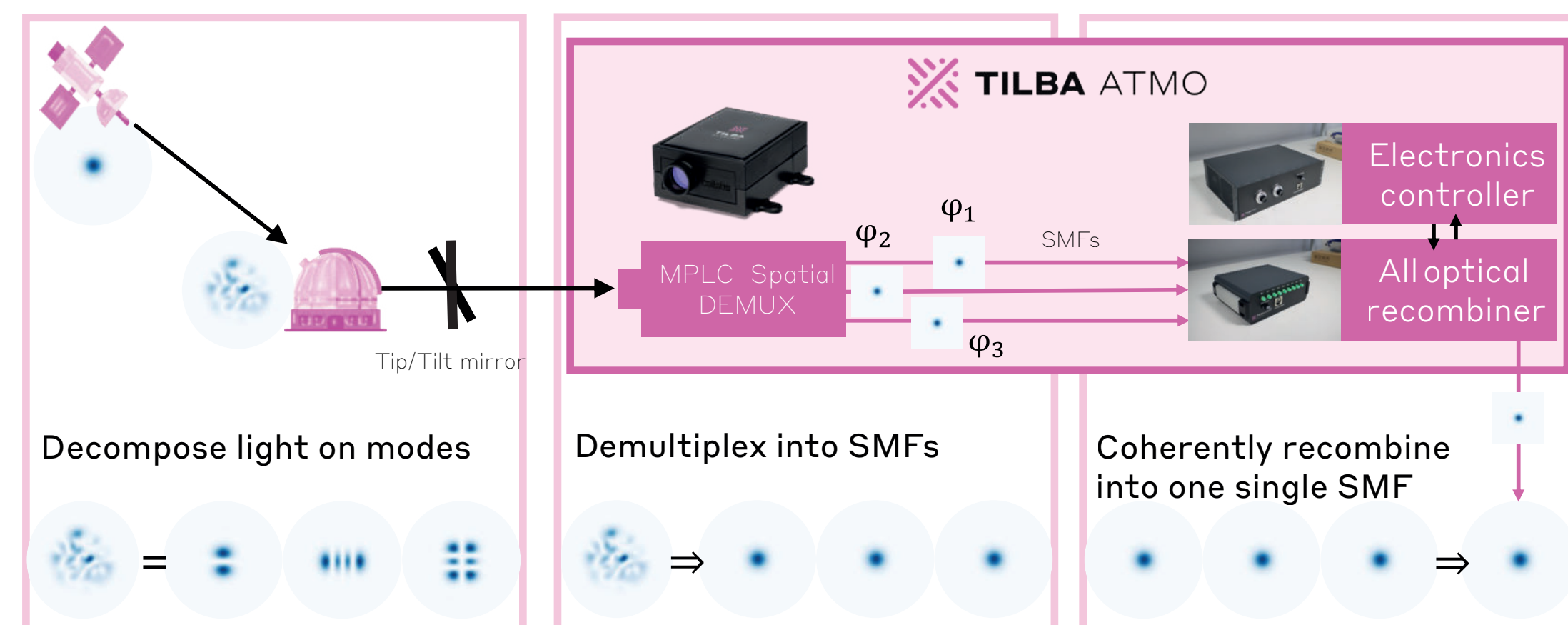


Optical Ground Station for 10 Gbps or More LEO-to-Ground Link

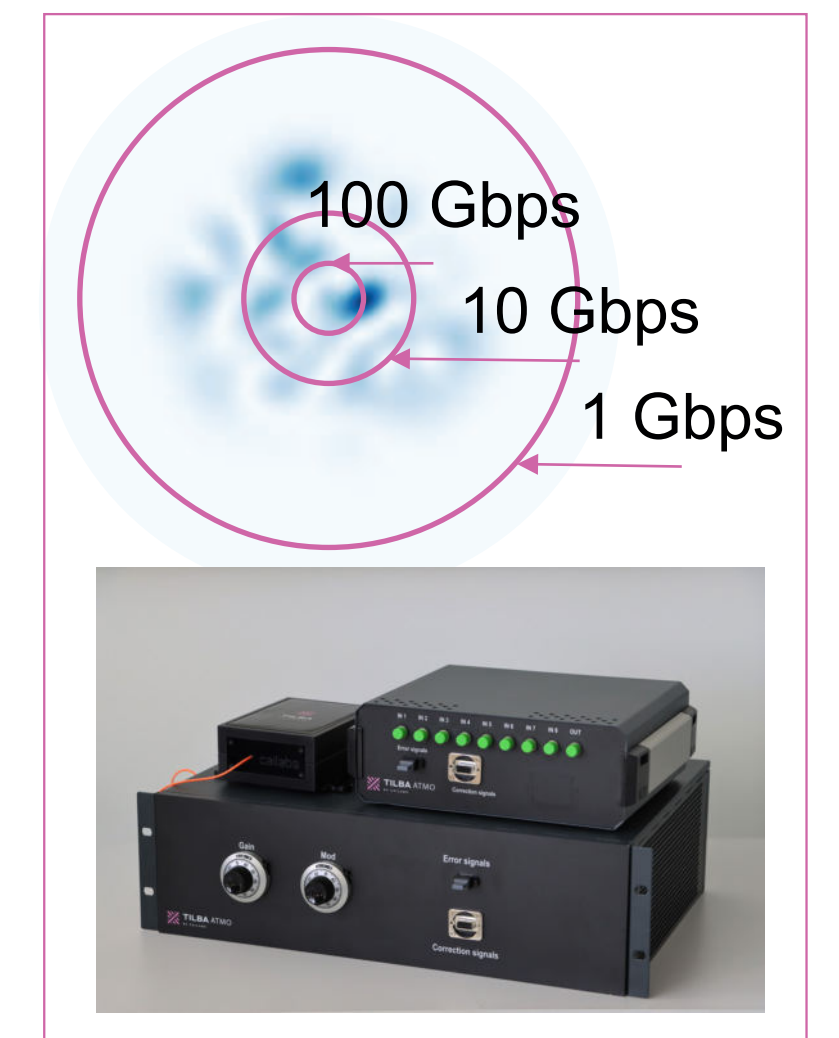
Utilizing TILBA-ATMO for Turbulence Mitigation

M. Meunier, D. Schanne, G. Vallet, A. Beuland, H. Lehec, P. Jian, G. Labroille, O. Pinel
Cailabs, Rennes, FRANCE

TILBA-ATMO: Cailabs' core technology for turbulence mitigation



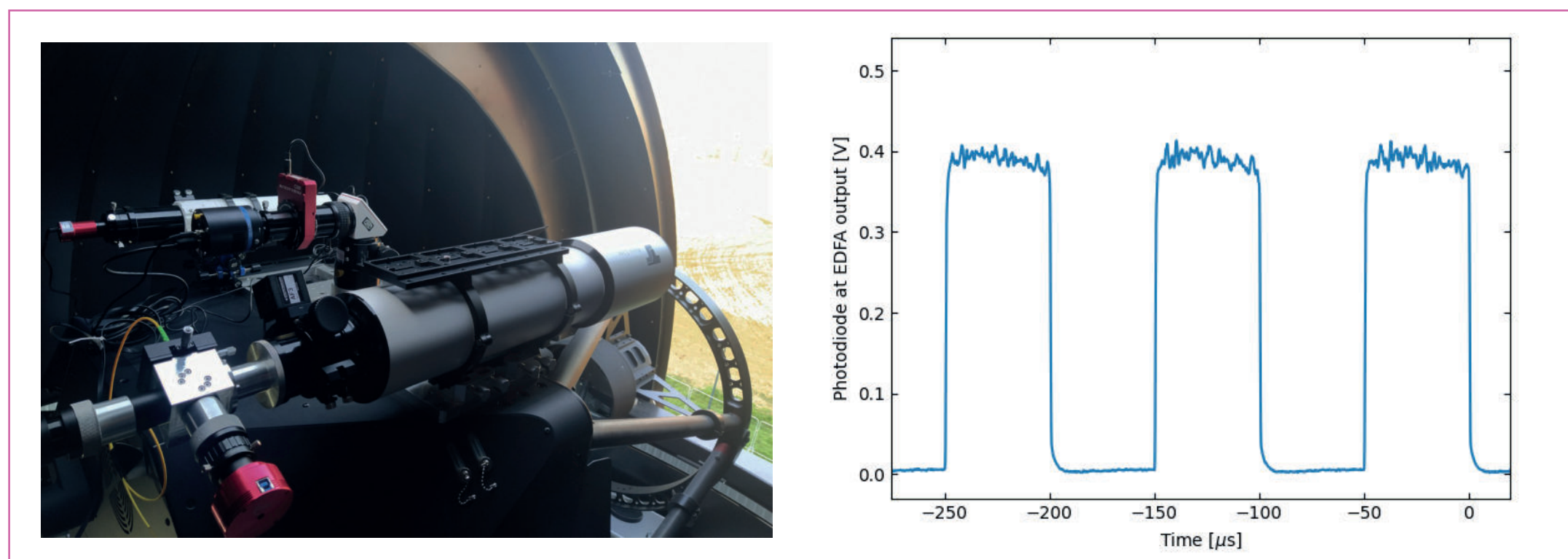
- **Turbulence mitigation is mandatory** for high throughput (> 1 Gbps) laser communication under the stratosphere: smaller detector for higher signal-to-noise ratio
- TILBA-ATMO corrects and couples a disturbed beam into a standard single-mode fiber (SMF): enables the use of standard telecom equipment (e.g. EDFA), agnostic to modulation format (direct detection or coherent) [1] [2]
- TILBA-ATMO is based on Cailabs' proprietary technology MPLC (Multi-Plane Light Conversion), developed since 2013 and already mature for terrestrial telecommunications



Cailabs' Optical Ground Station with TILBA-ATMO

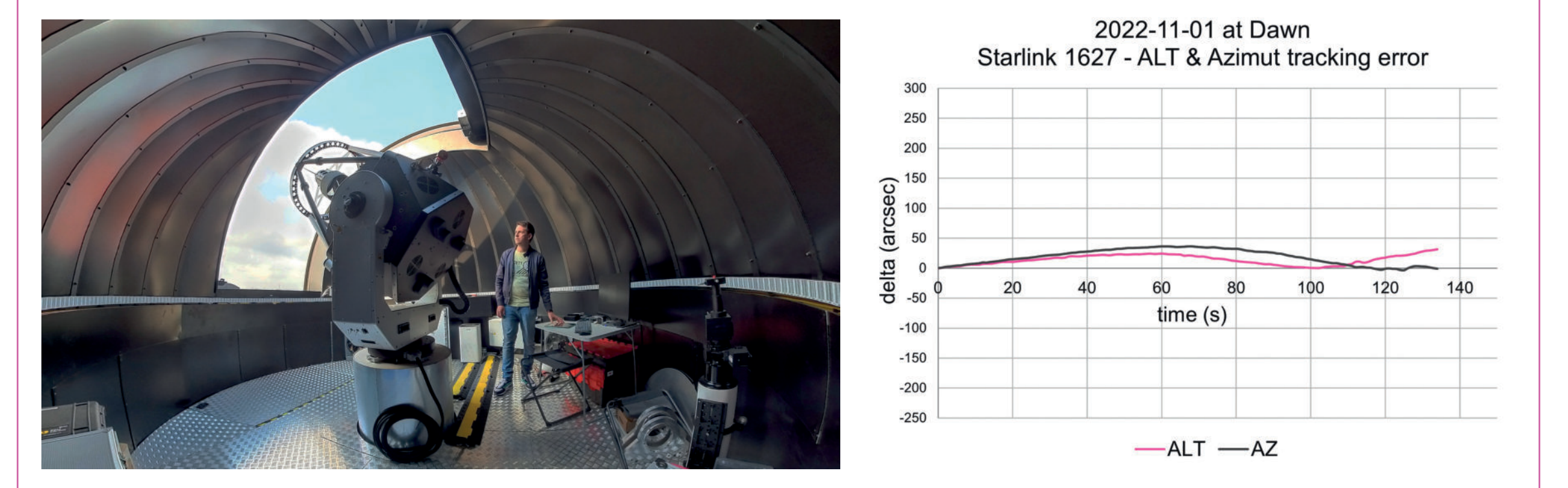
Satellite Illumination System

- Current beacon: 1590 nm, 5W, 10 kHz (CCSDS compliant) [5]



Pointing, Acquisition & Tracking

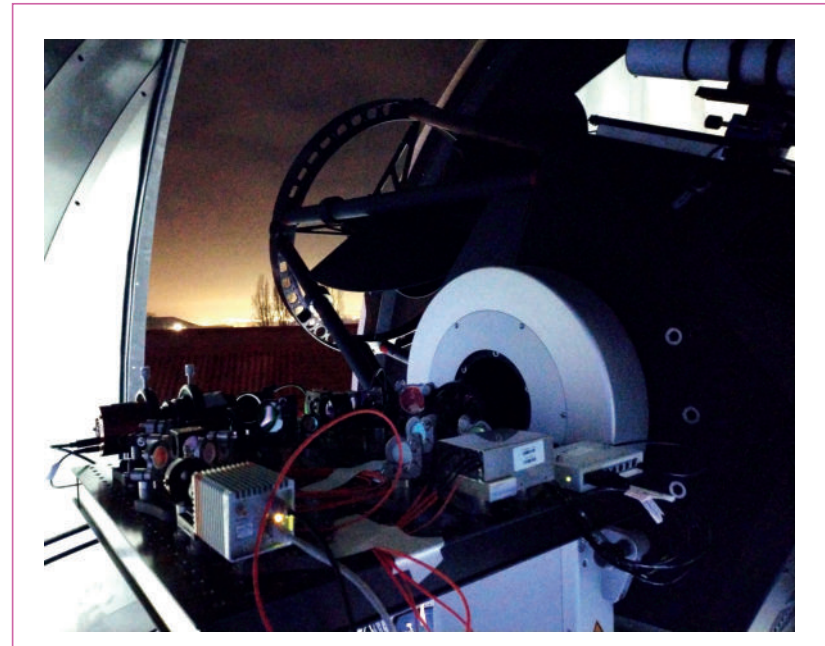
- 800 mm telescope
- Forkmount with Nasmyth focus
- Pointing accuracy: 10 arcsec RMS
- LEO tracking accuracy: 2.5 arcsec RMS (10 sec) [3]



Example of open-loop tracking of a LEO satellite

Optical Injection System

- Carbon breadboard on Nasmyth port
- Includes visible camera, tip-tilt and coupling in multimode fiber

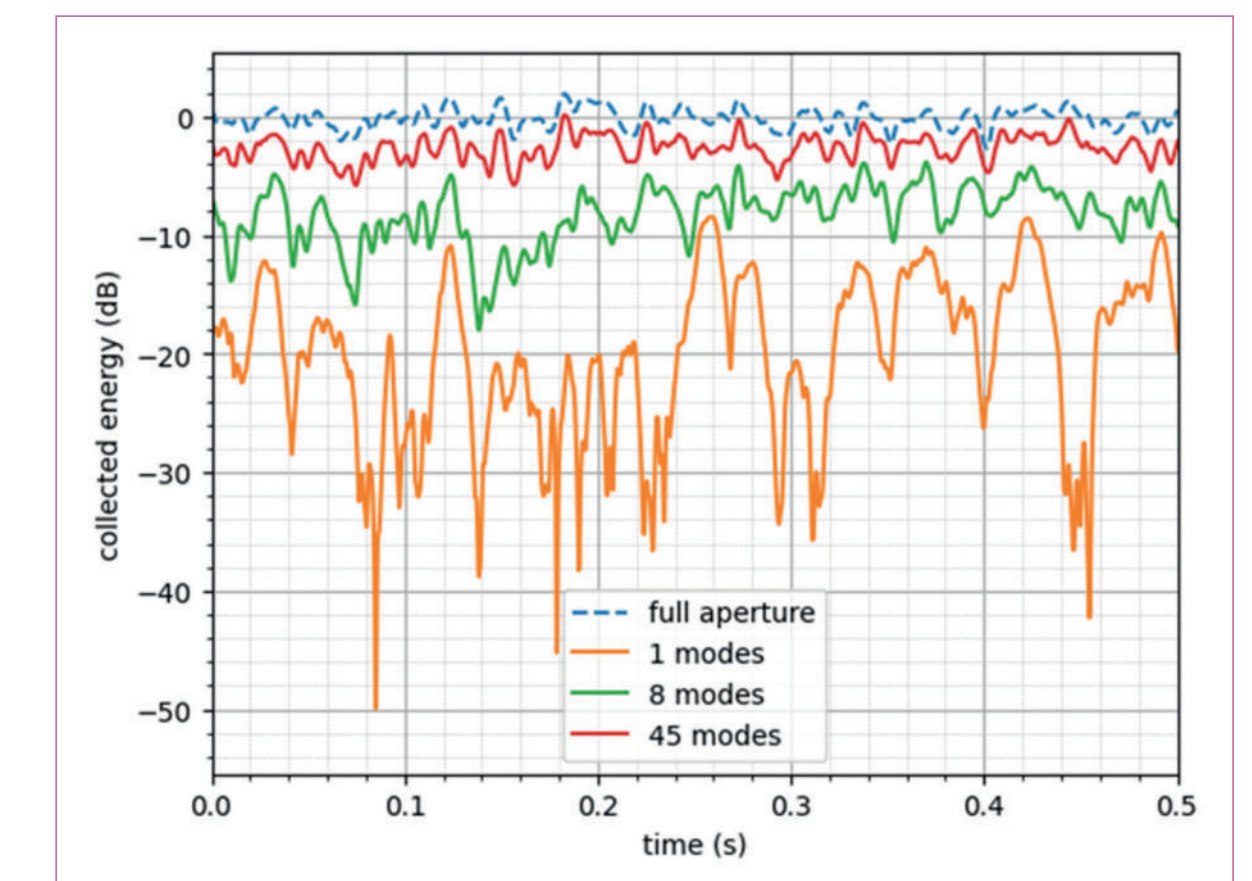


Infrastructure

- Dome at 16 meters elevation
- Over 3 uncoupled pillars

Communication chain

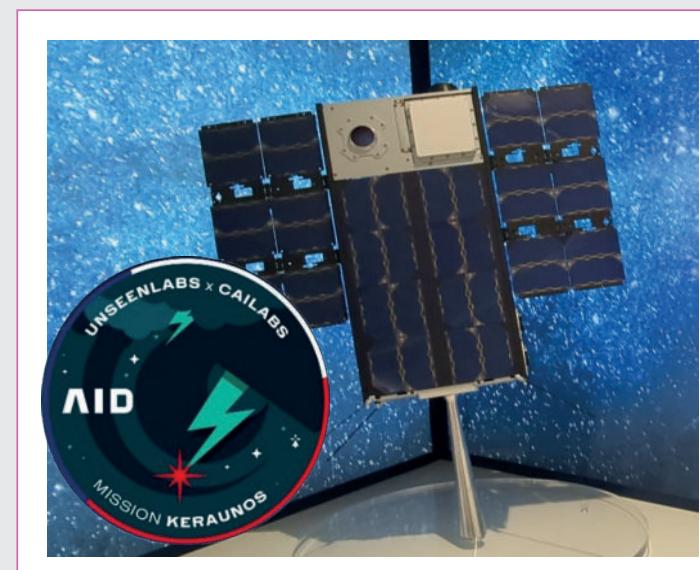
- CCSDS compliant, up to 10 Gbps OOK
- Turbulence mitigation with 45 modes TILBA-ATMO [4]



Perspectives on Cailabs' OGS

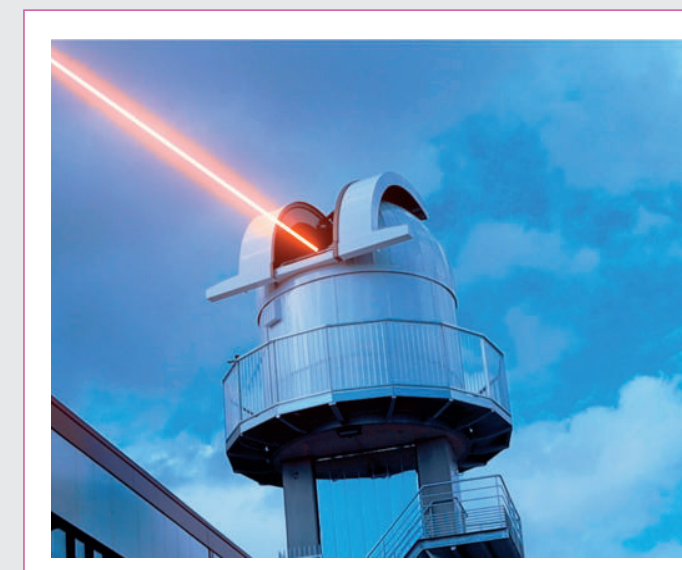
Q4 2023

Start of operation for project Keraunos Demonstration of LEO-to-ground links



Q4 2023 – Q1 2024

Upgrade to SDA Tranche 0 and 1 compatibility
Demonstration of bidirectional links



2024

Deliveries of 1st industrial OGS designed for commercial operation



References

- [1] R. Mata-Calvo et al., Alternative passive fiber coupling system based on Multi-Plane Light Conversion for satellite-to-ground communications, SPIE LASE 2020
- [2] A. Billaud et al., 10 Gbps free-space optical communication link using Multi-Plane Light Conversion turbulence mitigation, ICSSO 2022
- [3] M. Meunier et al., Optical ground station for LEO-to-ground link utilizing a Multi-Plane Light Conversion device for turbulence mitigation, SPIE LASE 2023
- [4] A. Billaud et al., 100 Gbps and 45-mode Multi-Plane Light Conversion based turbulence mitigation for FSOC, SPIE LASE 2023
- [5] A. Biswas et al., Optical-to-Orion ground terminal at Table Mountain Facility, SPIE LASE 2023