Optical satellite downlinks at DLR - OSIRIS

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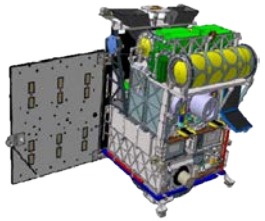
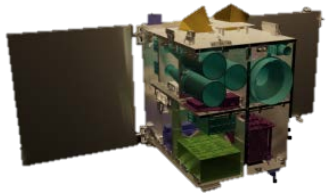
OSIRIS development roadmap

OSIRISv2:
Closed-Loop Body Pointing
Data rate: up to 1 Gbit/s



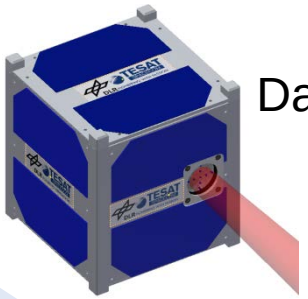
2017 2016



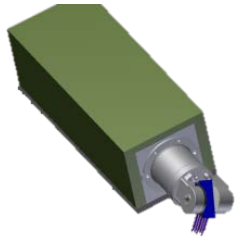
OSIRISv1:
Open-Loop Body Pointing
Data rate: up to 200 Mbit/s

2018

OSIRIS4CubeSat:
Active Beam Steering combined with body pointing
Data rate: up to 100 Mbit/s



2018



OSIRISv3:
Active Beam Steering with Coarse Pointing Assembly
Data rate: up to 10 Gbit/s

Commercialization Phase

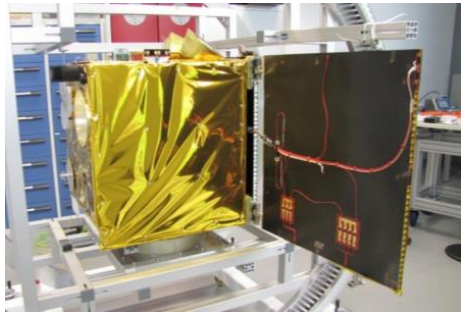
DLR

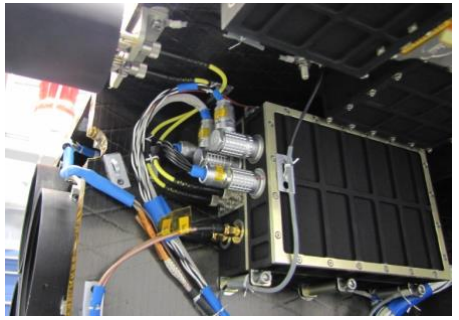
TESAT SPACECOM

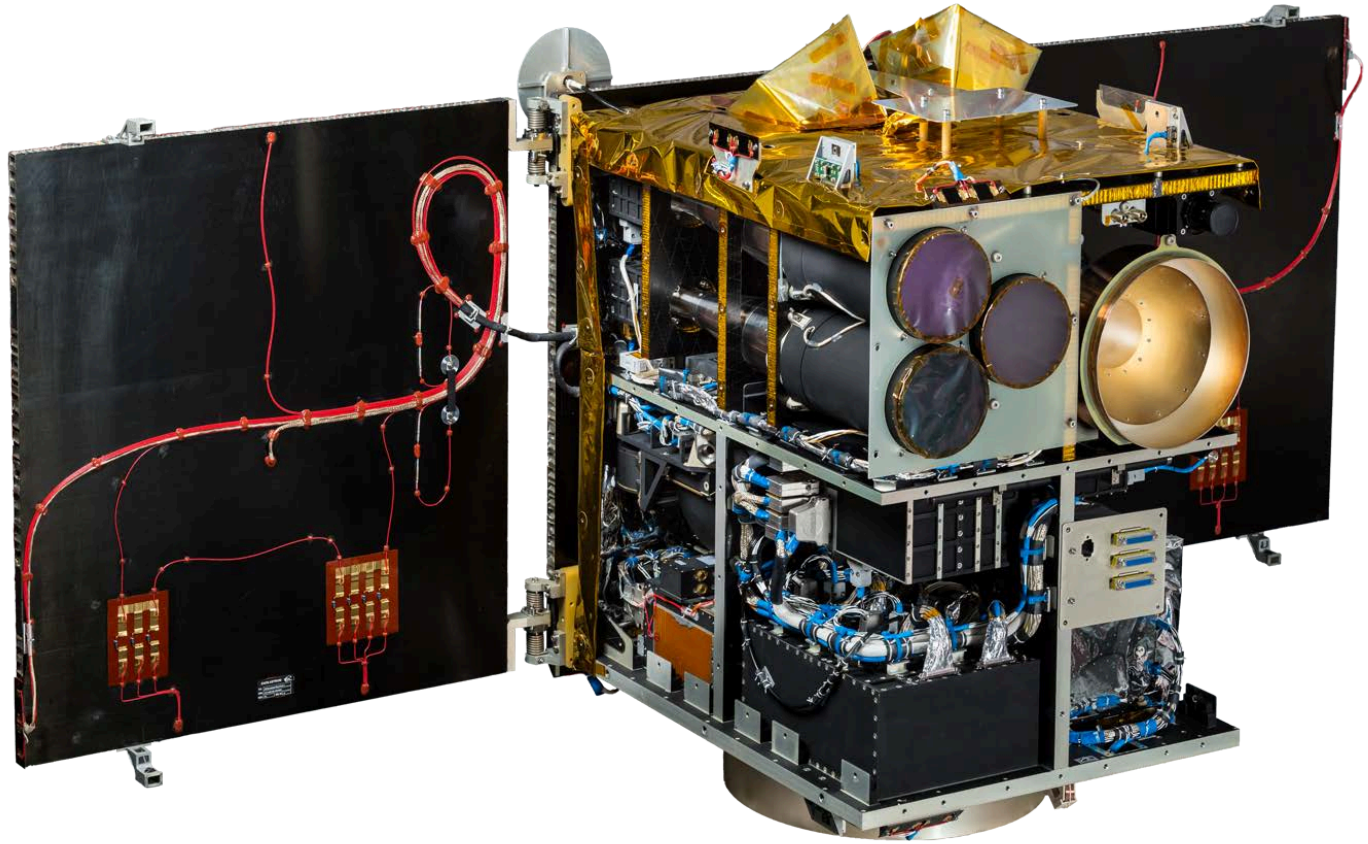
DLR

OSIRISv1 on Flying Laptop

- Launch: 14th of July, 2017
- Open loop body pointing
- 100 Mbps, 1550 nm, 1.2 kg



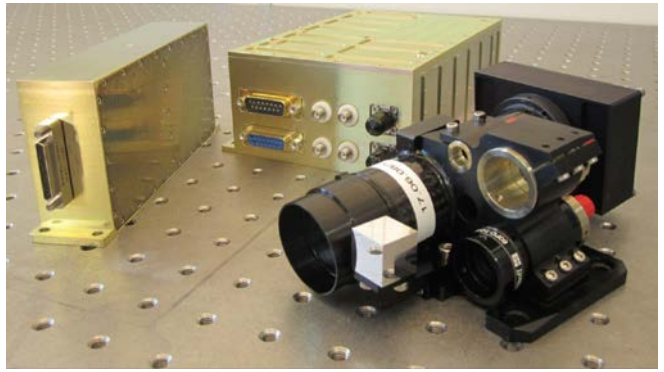


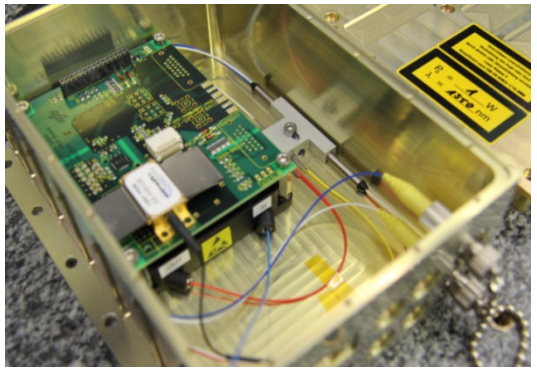


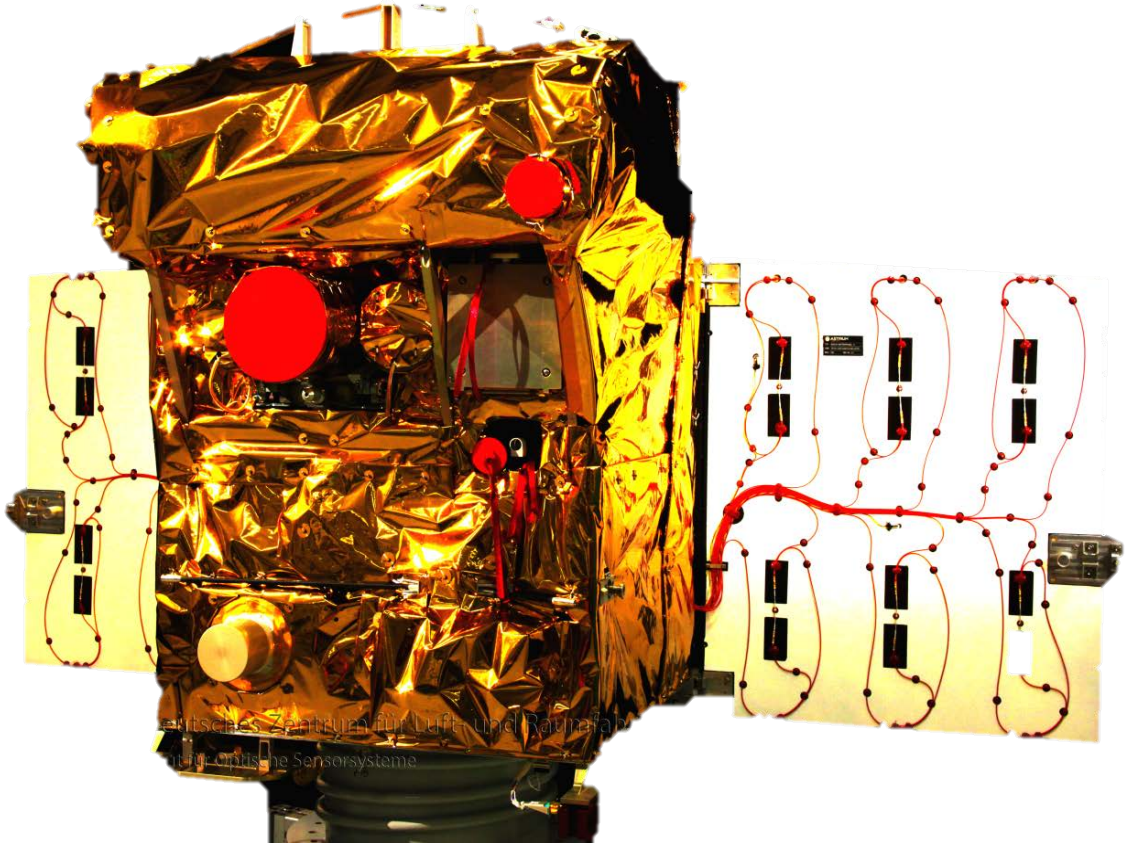
Flying Laptop, University of Stuttgart

OSIRISv2 on BIROS

- Launched 22nd of June, 2016
- Closed loop body pointing (with aid of beacon laser)
- 1 Gbps, 1550 nm, 1.64 kg

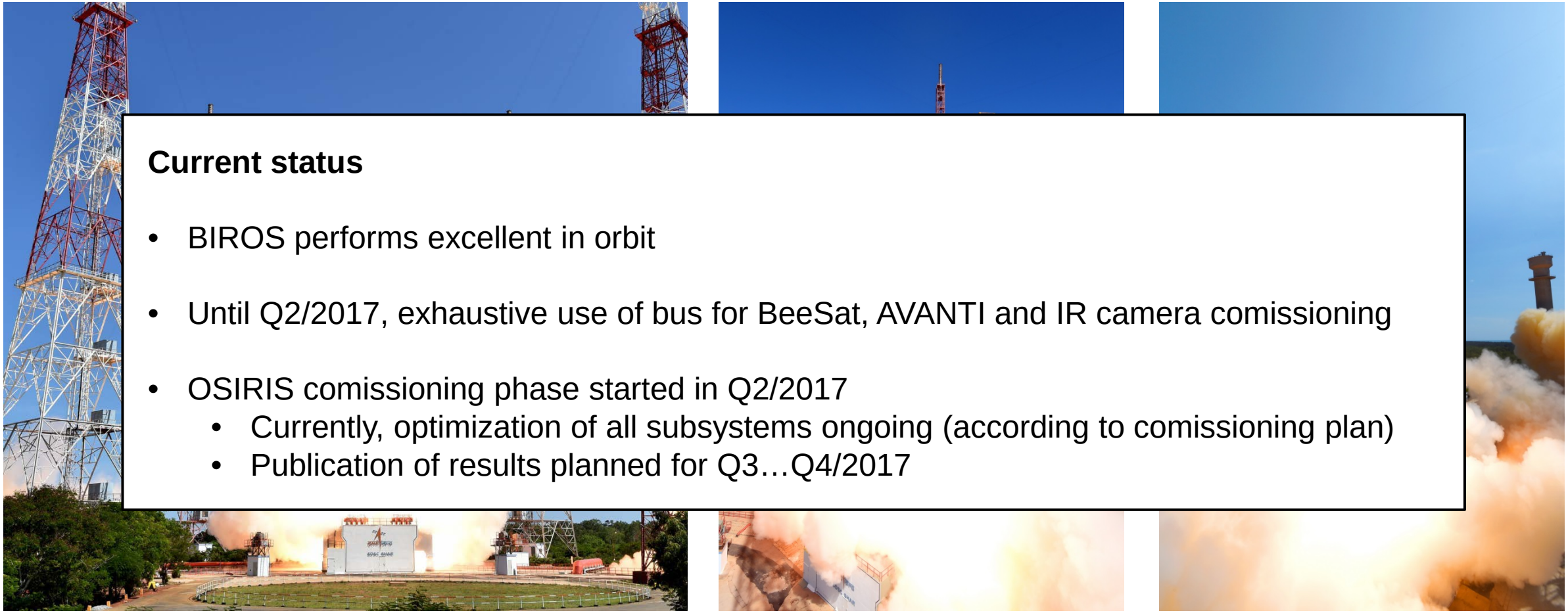






BIROS, DLR Berlin

BIROS launch, 22/06/2016, 3:56 UTC

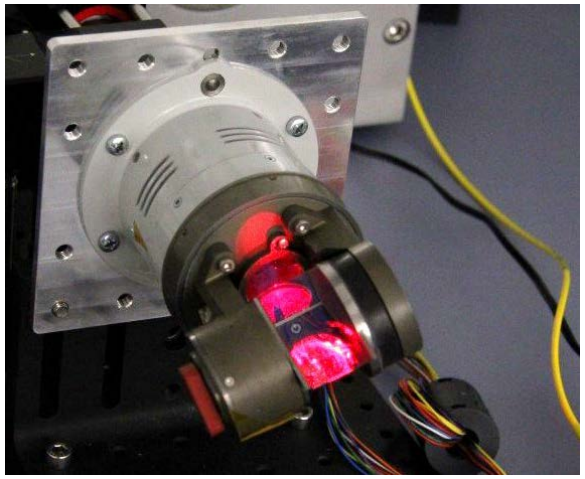


Current status

- BIROS performs excellent in orbit
- Until Q2/2017, exhaustive use of bus for BeeSat, AVANTI and IR camera comissioning
- OSIRIS comissioning phase started in Q2/2017
  - Currently, optimization of all subsystems ongoing (according to comissioning plan)
  - Publication of results planned for Q3…Q4/2017

3rd OSIRIS generation (currently in development)

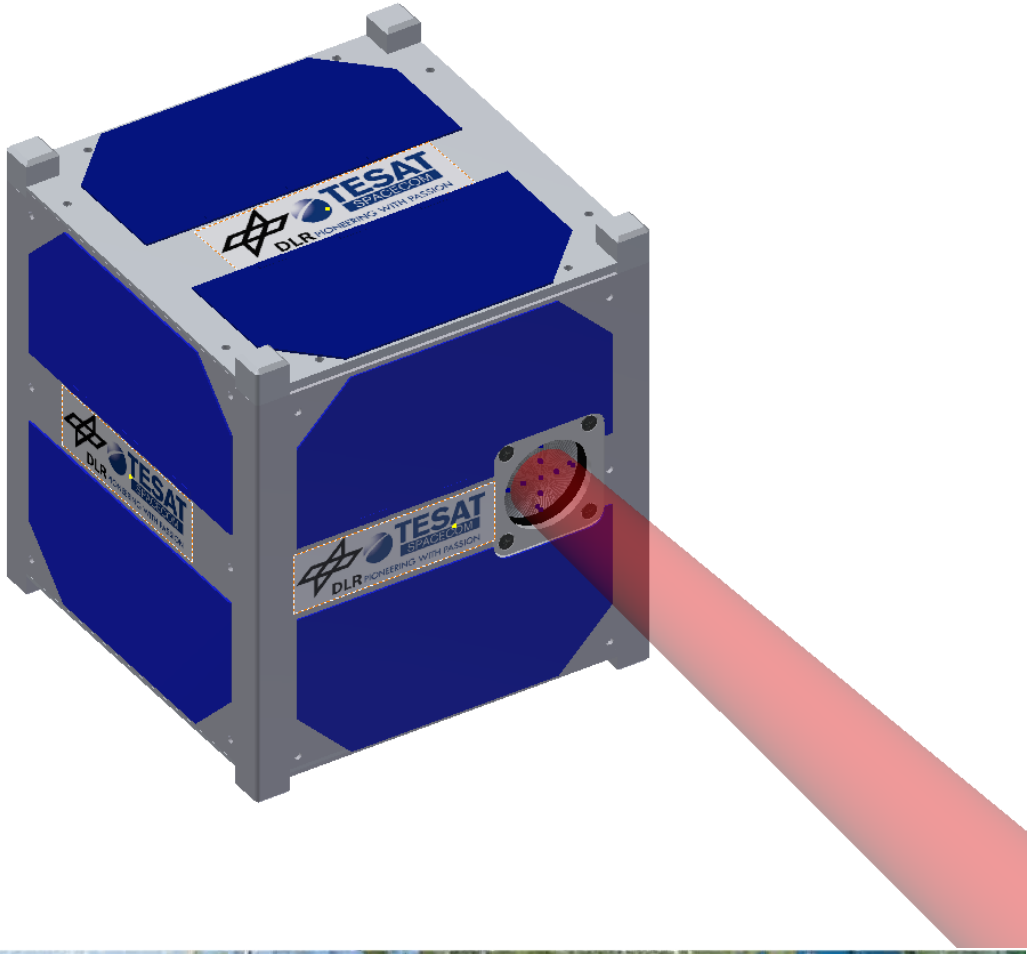
- Dedicated Coarse Pointing Assembly (CPA) for satellite-independent operation
- Addition of On-Board Storage and computer system
- System Performance: **10 Gbps, < 5 kg, ~50 W**
  (Future: Extension to N*10 Gbps)
- Design lifetime: 5 years
- Launch: End of 2018 / beginning 2019
- **Reference implementation for upcoming CCSDS-standard**



OSIRIS4CubeSat

- Highly compact system design (~0,3U)
- Data rates up to **100 Mbit/s** at 8 W power consumption
- Active beam steering + body pointing
- Basis for scientific and demonstration missions

- System demonstration mission: **2018**



Cooperation between DLR and Tesat Spacecom

- Cooperation agreement with Tesat Spacecom signed on 9th of June, 2016
  - Prof. Ehrenfreund, CEO DLR
  - A. Hammer, CEO Tesat

- Goals of cooperation
  - Evaluation of OSIRIS-technology for potential future Tesat-products
  - Collaborative developments in various fields
  - Industrialization of OSIRIS

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

TESAT SPACECOM

Signing ceremony at Institute‘s Anniversary (9th of June, 2016)

International cooperation

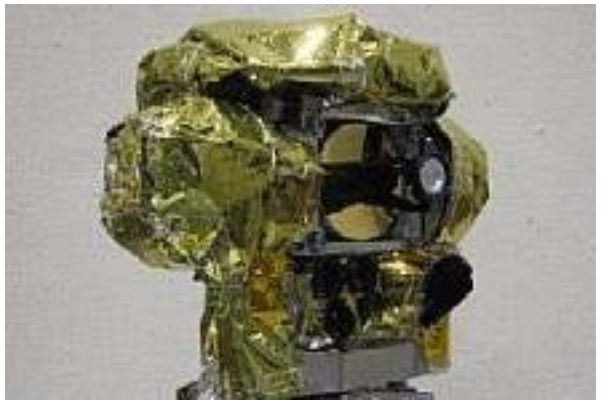
- DLR cooperates extensively with the international scientific community

- Downlinks from KIRARI / JAXA to DLR, 2006 & 2009
- Downlinks from SOTA / NICT to DLR, 2016

- Downlinks from OPALS to DLR, NASA-JPL, 2015/2016

- International OSIRIS campaign planned

- Standardisation at CCSDS
  - DLR-KN heads the „low complexity LEO“ group (relevant for optical downlinks)
  - Partners: NASA, ESA, CNES, NICT, DLR

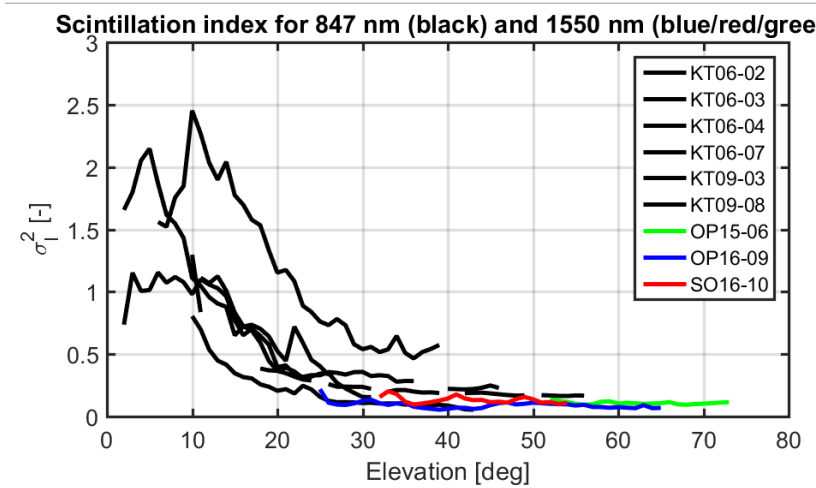


SOTA, NICT / Japan

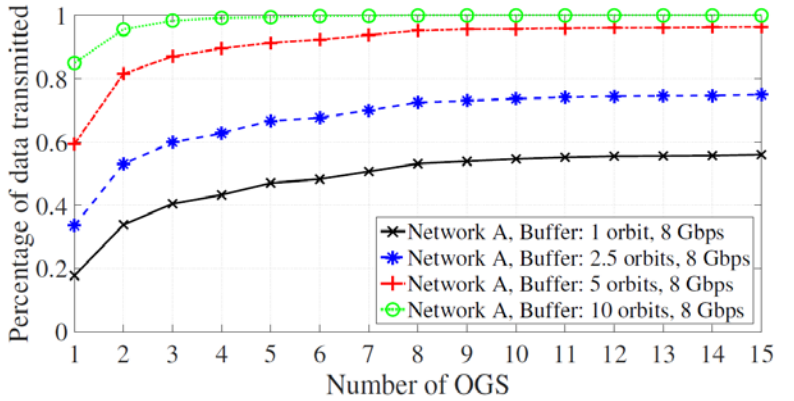
OPALS, NASA-JPL

Examples of scientific work at DLR (w.r.t. satellite downlinks)

- Channel measurements during various missions
- Development of Adaptics Optics
- Theoretical studies, e.g. on satellite downlink availability
  - ESA project ONUBLA (General Studies Programme)
  - Many interesting findings, e.g. on buffer sizes, network topologies, …
- Development of optimized and CCSDS-conform coding schemes



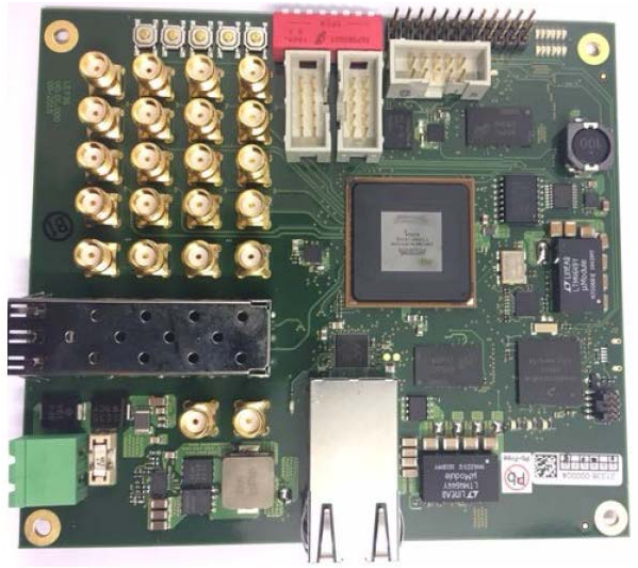
Scintillation in optical satellite downlinks



Influence of buffer size on optical satellite downlinks

FEC optimized for optical transmission channels

- DLR has heritage in development of (FPGA-based) coding systems
- „Laser Ethernet Transceiver“ (LET) for data rates from 100 Mbps to 1 Gbps, optimized for aeronautical optical links
- Completely new development of On-Board-Computer ongoing
  - Optimized for satellite downlink channel
  - Coding according to CCSDS
  - Space-qualified, radiation tolerant COTS
  - > 10 Gbps
  - Tbyte-class mass memory



DLR laser ethernet transceiver optimized for aeronautical applications (1 Gbps user rate)

Optical Ground Stations

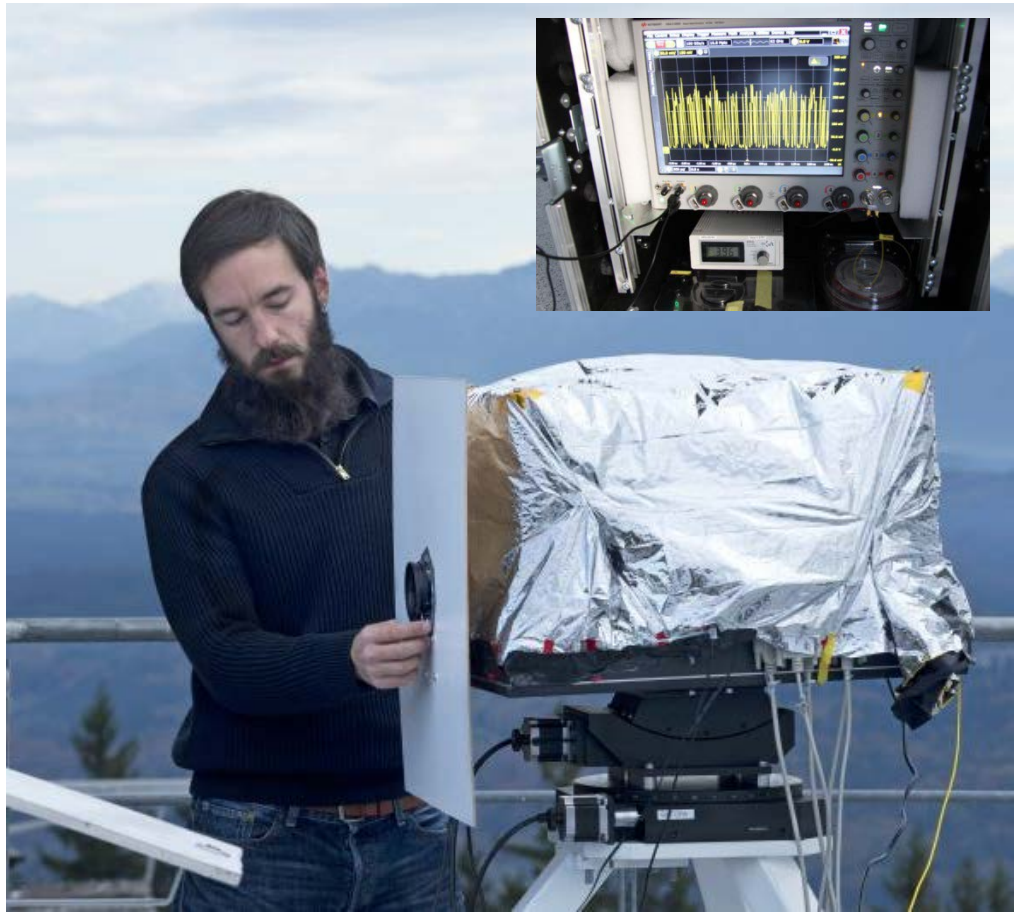
Optical Ground Station Oberpfaffenhofen

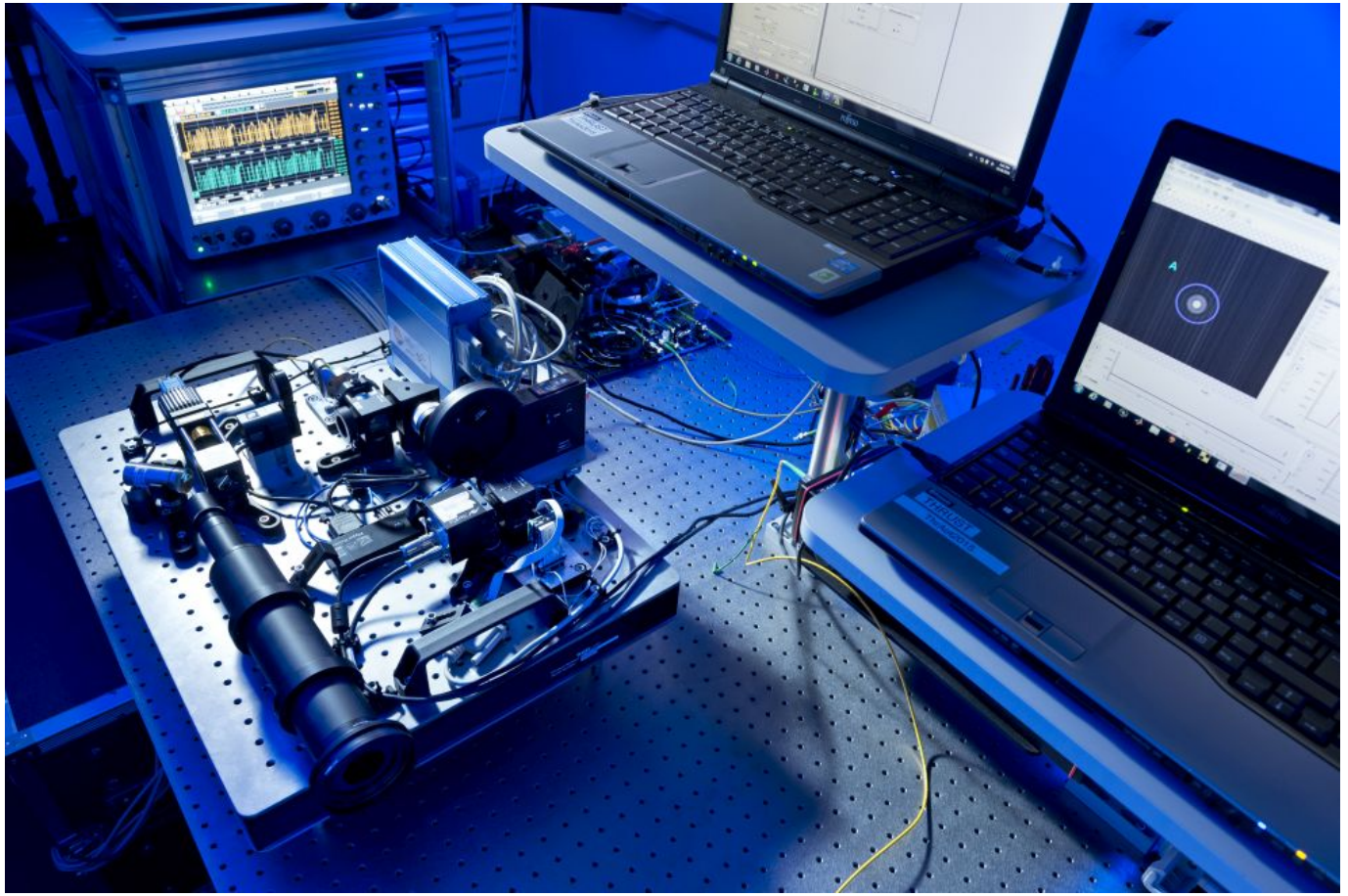
- Optimized for scientific measurements
- 80 cm telescope with coudé room by 2018
- Adaptive Optics by 2019

Transportable Optical Ground Station

- Optimized for data reception
- 60 cm telescope
- Worldwide use with short lead-time

Selected further topic: Optical GEO feeder links
➔ World record: 1.72 Terabit-per-second over 10.4 km

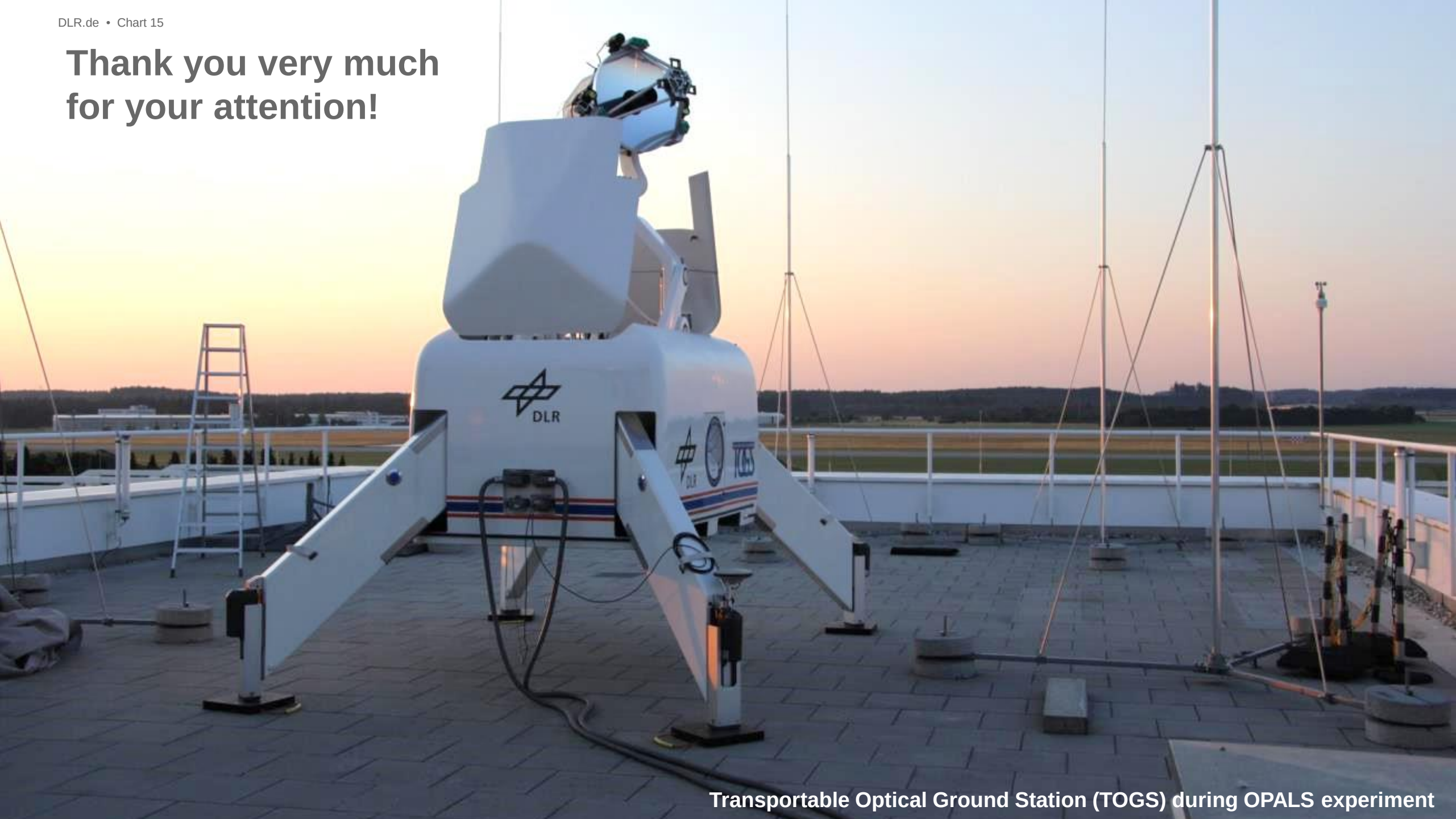




Input to ESA scylight roadmap

- Funding for optical communications and associated topics through ESA scylight is well appreciated and an important contributor towards the operational use of optical data links in space applications
- From DLR Space Research and Technology point-of-view, topics with high importance are…
  - Cost-efficient, yet powerful optical downlink systems
  - Optical GEO feeder links
  - Inter-satellite-links for mega-constellations
  - Quantum key distribution
  - Adaptive Optics suitable for strong turbulence conditions

Thank you very much for your attention!



Transportable Optical Ground Station (TOGS) during OPALS experiment

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