TESAT

SCALABLE OPTICAL TERMINAL FOR NANOSATS – SCOT 20

FEATURING INTERSATELLITE AND DIRECT-TO-EARTH LINKS

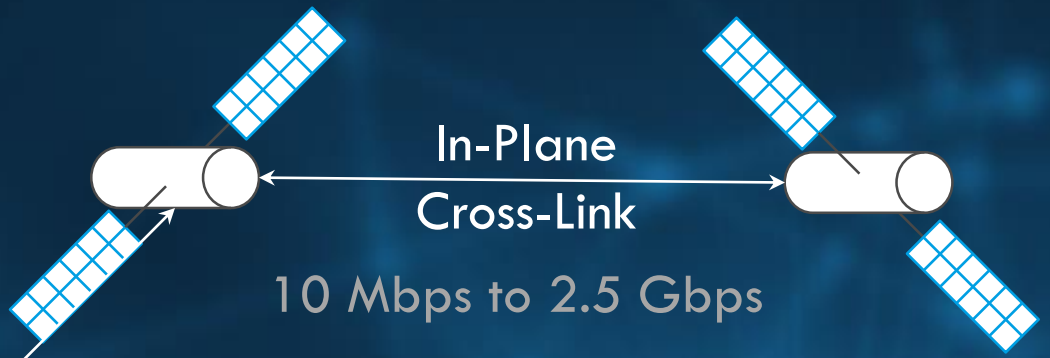
2023-12-14

DOC-CLASS: O-K2

Introduction & Applications of Optical Coms Solutions

TESAT

LEO Orbit



direct-to-earth

Optical Global Ground Network

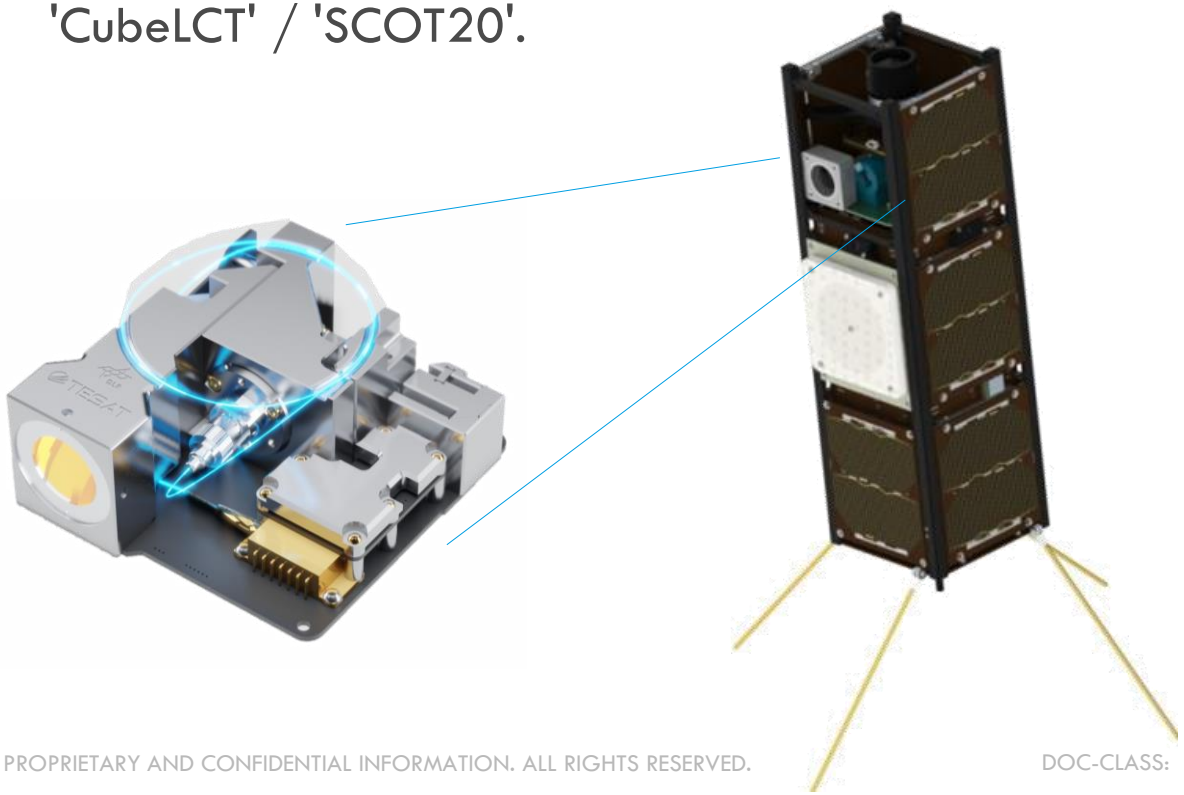
Services

System-Engineering | Commissioning | Link Planning | Maintenance

In-Orbit Heritage: PIXL-1 Press Release

[Demonstration of data transmission from a microsatellite by laser (dlr.de)]

- During the PIXL-1 mission, DLR was able to demonstrate complete end-to-end transmission, from image acquisition and data transfer by laser to processing on the ground, marking a significant first.
- The technology has been transferred to industry and is now being marketed by TESAT with the name 'CubeLCT' / 'SCOT20'.

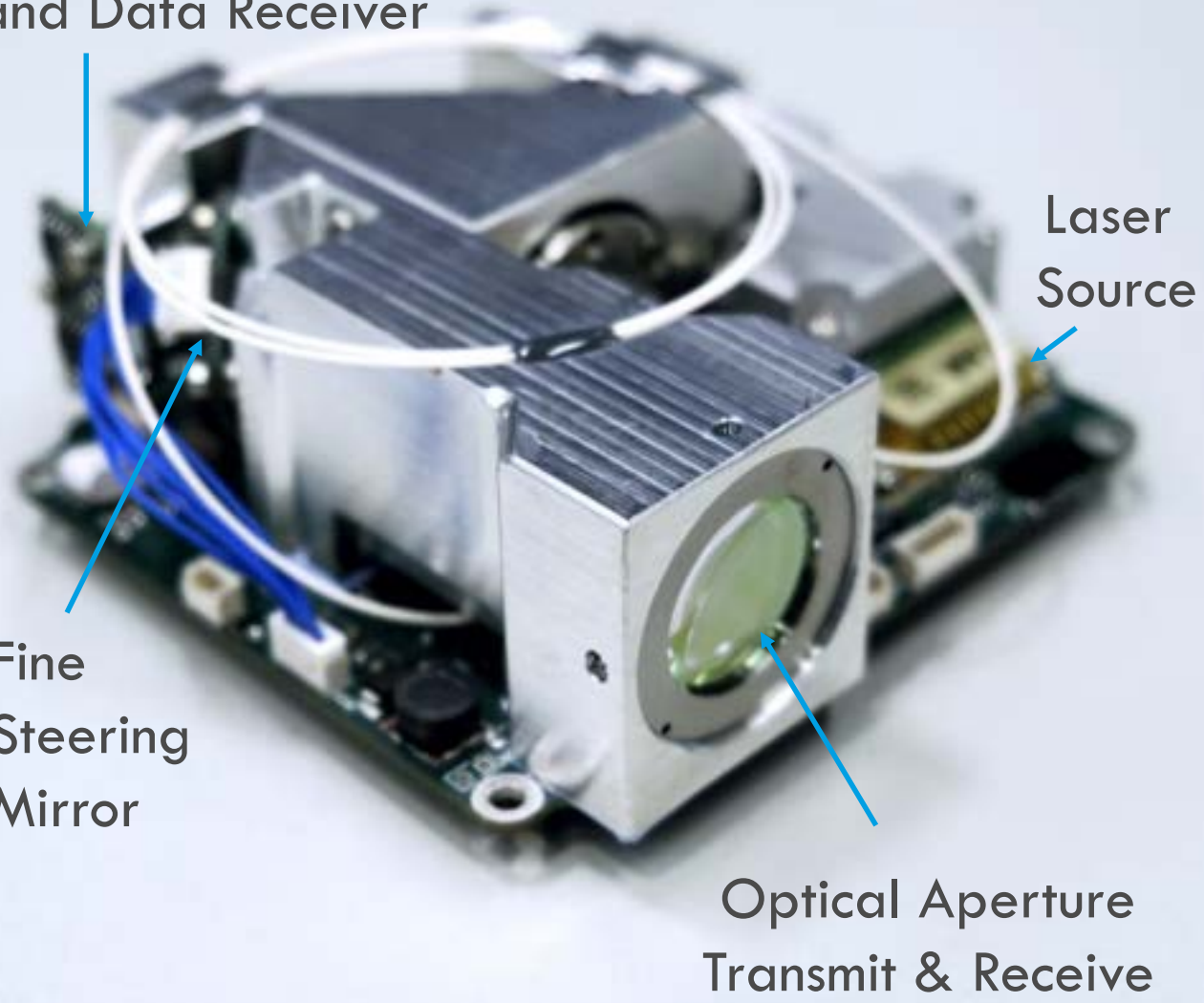


Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

October 30, 2023 | **OSIRIS4CubeSat**

Demonstration of data transmission from a microsatellite by laser

CubeSat Laser Terminal Design „CubeLCT“

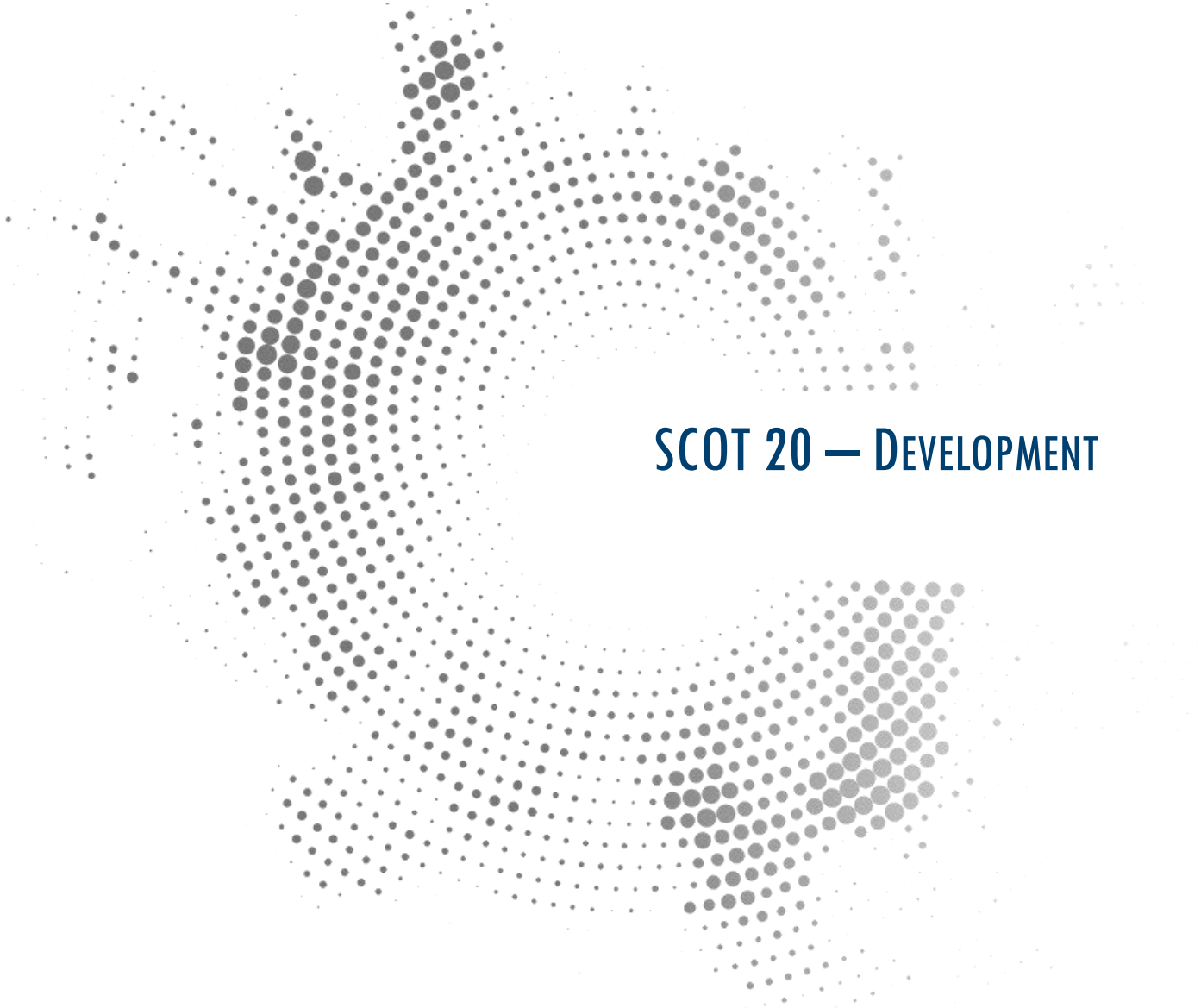


- Downlink Channel Rate 100 Mbps (75 Mbps user)
- Uplink several kbps

- Link Distance 1800km
- internal fine steering capability +/- 1°
- Use of S/C OBC and S/C body pointing
- Data interface LVDS

- 9x9,5x3,5 cm^3
- 0,4 kg
- 10 W (peak)

- First models delivered to customer for demonstration missions
- First mission flight in January 2021
- **Terminal not available anymore, replaced by new generation product “SCOT 20”**



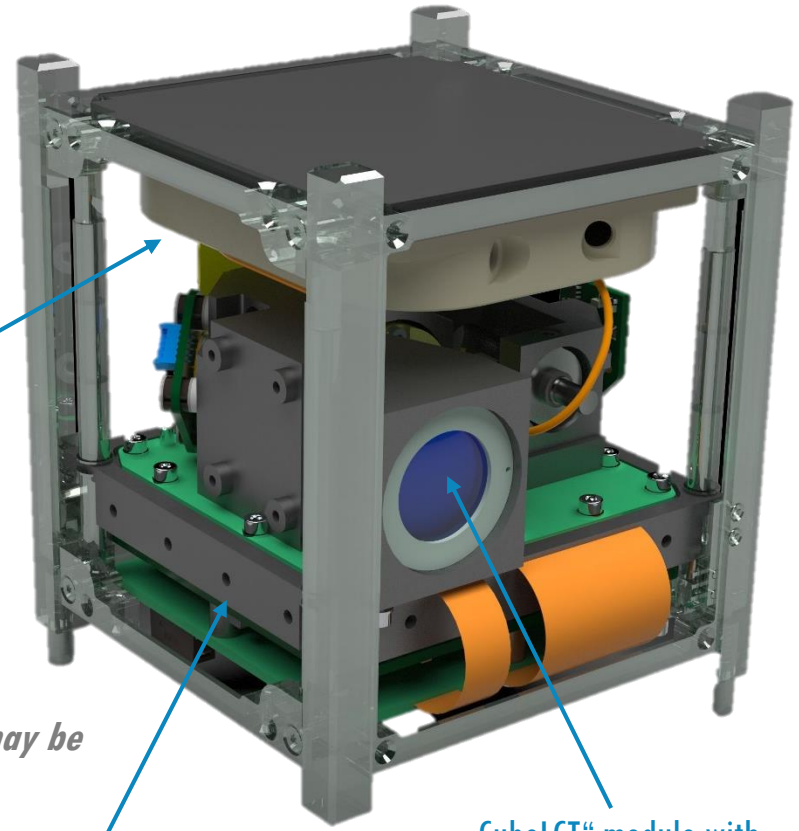
SCOT 20 – DEVELOPMENT

SCOT 20 – Scalable Optical Terminal for NanoSats with 20 mm Aperture

ISL & DTE capability

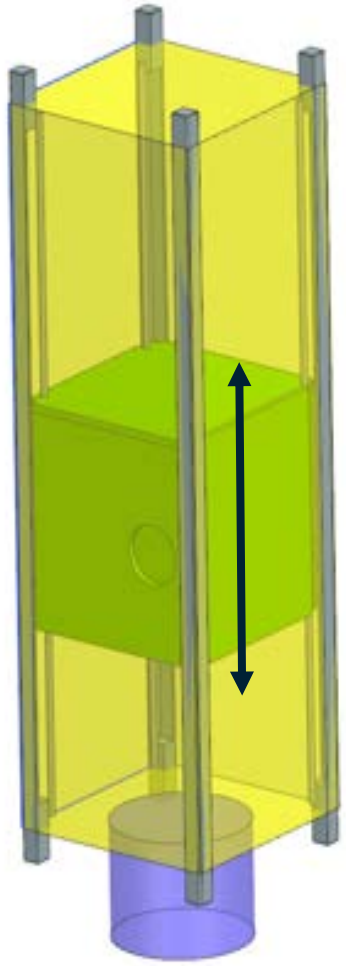
- **New NanoSat Laser Terminal Product "SCOT 20"**
  - Full bidirectional design enabling intersatellite links with up to 100 Mbps (or 2.5 Gbps unidirectional (Tx) SDA v3.0 standard)
  - For Direct-to-Earth links baseline: 100 Mbps
    Can be extended to 2.5 Gbps (based on unidirectional mode above)
- **Based on existing Laser Terminal Design "CubeLCT"**
  - **Re-Use of existing optical module**
  - Extension with Data Receiver, Optical Amplifier and dedicated Onboard Computer
- **Introduction of dedicated LCT Onboard Computer**
  - for handling of advanced commanding for DTE & ISL
  - for data handling incl. FEC
- Thermal Interface (baseplate at the bottom of picture) suited also for SmallSat platforms
- 10 x 10 x 10 cm^3
- Weight ~1,6 kg, DC Power < 35 W (peak)

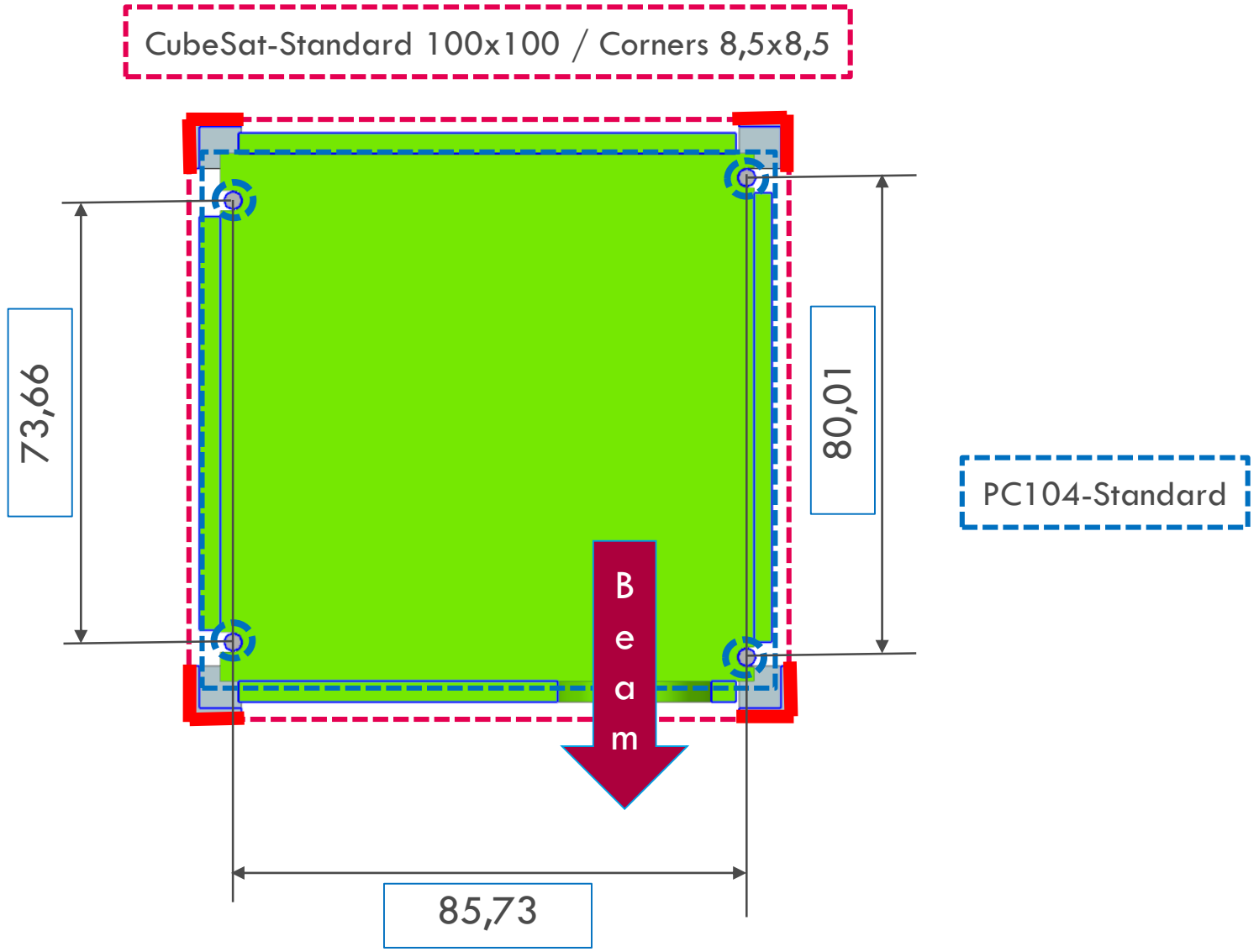
Design Variant for CubeSats



SCOT 20 FOR CUBESATS

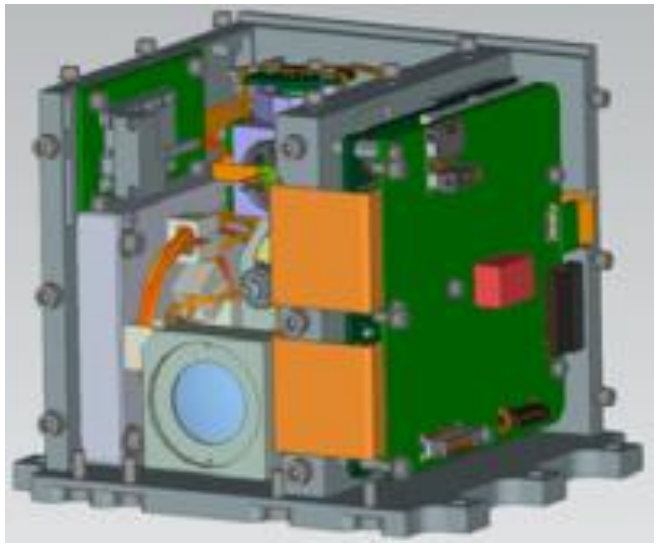
Foreseen Accomodation on PC104 standard rods





SCOT 20 FOR SMALLSATS

- 10 x 10 x **11.35** cm^3
- Weight ~1,7 kg
- DC Power < 35 W (peak)
- Thermal design allows continuous operation



SCOT20 Variant for SmallSats in LEO

Current design status, may be subject to change

SCOT20 with Housing

Design Details

- **COTS Approach**
  - Data Handling Unit → TRL 9
  - Optical Power Amplifier
    → technology flight proven
  - Electronics → SCOT80 Heritage at TESAT

- **ISL bidirectional data rate depends on link distance**
  - max. 100 Mbps at 1500 km

- **Use of S/C body pointing**
  - internal fine steering capability +/- 1°
  - **required attitude knowledge error of sat platform: 0.1°**

- **Flight Models available Q3/2024**

SCOT 20 CONCEPT WITH CPA

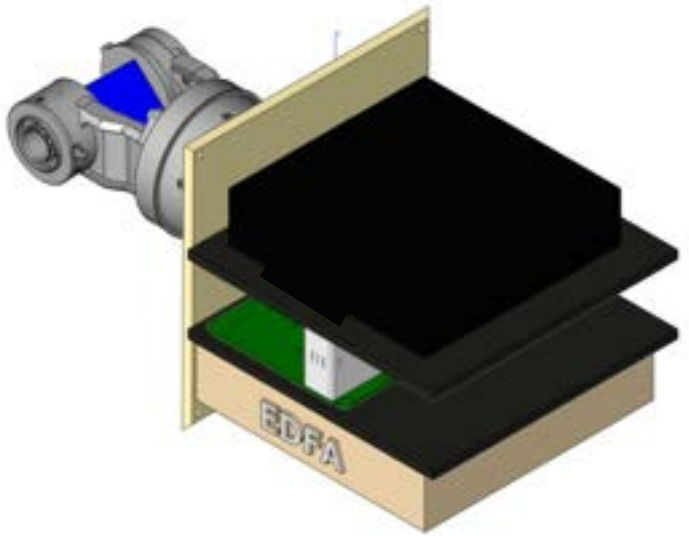
Further Extension

Coarse Pointing Assembly (CPA) Concept

- Removes need for S/C Body pointing for a single Laser Terminal
- Allows independent beam steering capability if 2 or more Laser Terminals per spacecraft shall be used simultaneously

- Additional Mass: ~1 kg
- Additional power consumption: ~5 W (peak)

- **Available Q3/2025**



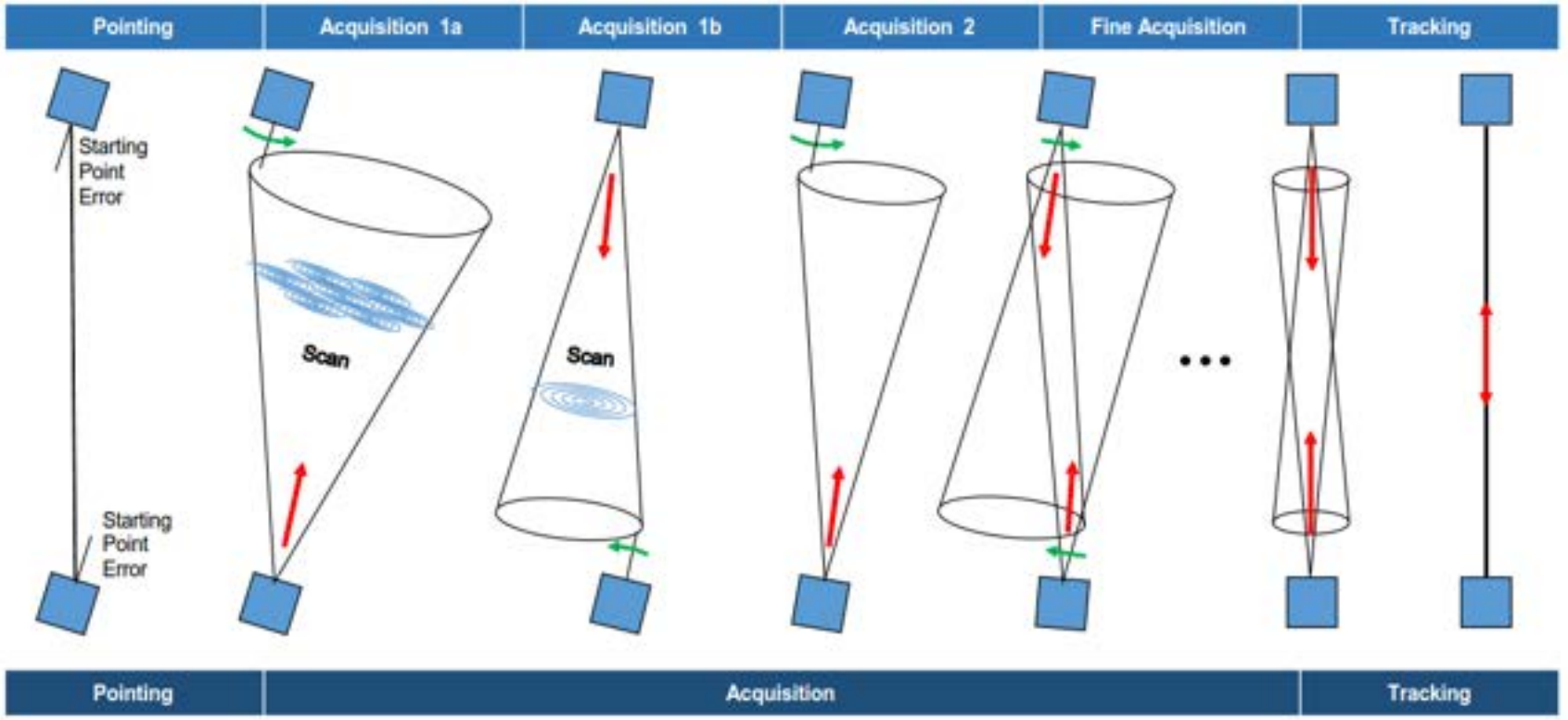
Conceptual image from DLR IKN. TESAT realization will differ significantly.

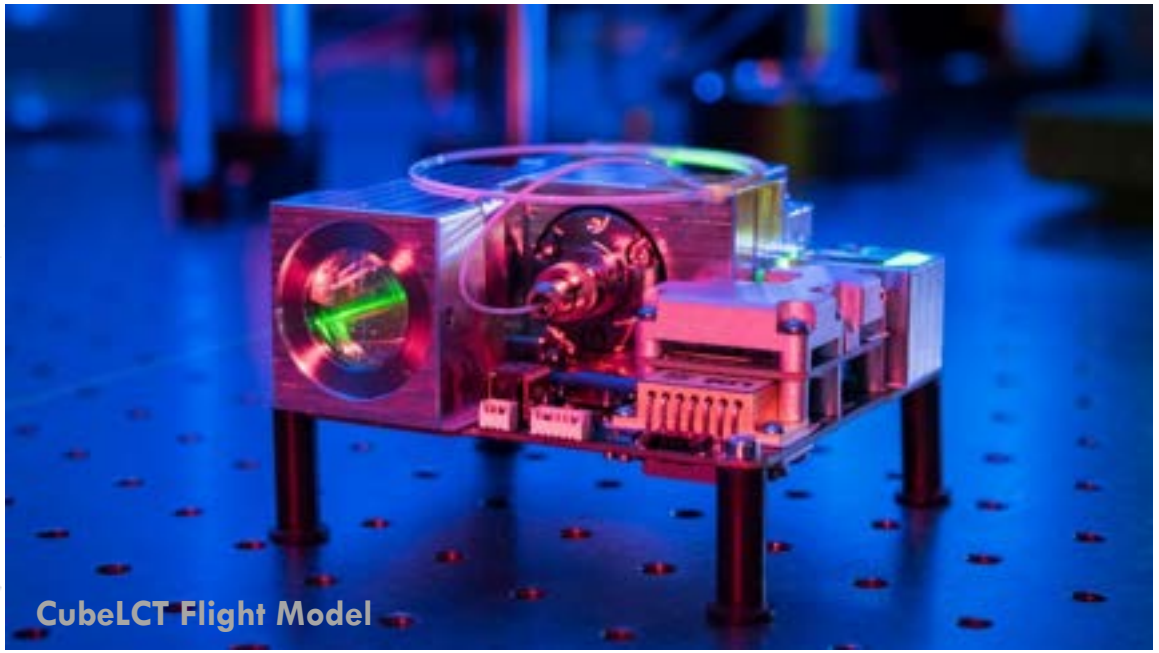
SCOT20 – Main Characteristics

Parameter	Value	Comment
Lifetime	5 years for Smal LEO, 3 years for CubeSat	
Weight excluding coarse pointer	< 1.6 kg (including harness)	Depends on accomodation
Dimensions excluding coarse pointer	1U (10 x 10 x 11.35 cm^3)	With baseplate, without 1U CubeSat Standard Volume can be achieved
Power consumption	< 35 W	
Main Bus Voltage	12 V & 5 V, not isolated from Ground	Automatic start when powered
Coding	LDPC 5G	
Pointing accuracy (tracking)	± 1 deg	
Pointing accuracy requirements (acquisition ISL)	< ± 0.1 deg	Impact on acquisition time
S/W Updates	All codes and software shall be updatable in orbit via TM/TC I/F	
Optical Coms Standard	**Compatibility to SDA Optical Communications Terminal (OCT) Standard Version 3.1 which includes:** • Pointing, Acquisition & Tracking (PAT) Strategy • Wavelength • Physical Layer + Sync/Coding Layer • data rate up to 2.5 Gbps in Tx direction (SCOT20 is access terminal to SDA constellation)	

SCOT20 – PAT Strategy

- **P**ointing, **A**cquisition & **T**racking strategy according to SDA Optical Communications Terminal (OCT) Standard Version 3.1
- The figure shows the PAT Geometric Acquisition Scheme. The Red arrows denote an active TX beam, the cone around the arrow depicts the size of the uncertainty cone (outer scan radius). Green arrows denote pointing adjustment and reduction of uncertainty cone




CubeLCT Flight Model

Stay tuned, More to Come

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