



## **OPTICAL NETWORK PRODUCTS FOR SPACE — OPPORTUNITIES FOR PICs**

Hanno Scheife, 2024-06-04

EPIC Technology Meeting on Photonic Integration and Packaging at Fraunhofer IZM

**Core Business**      Satellite Payloads,  
Equipment & Subsystems

**Employees**        1,100

**Turnover**          ca. 300 million Euro

**Total area**        63,000 m<sup>2</sup>

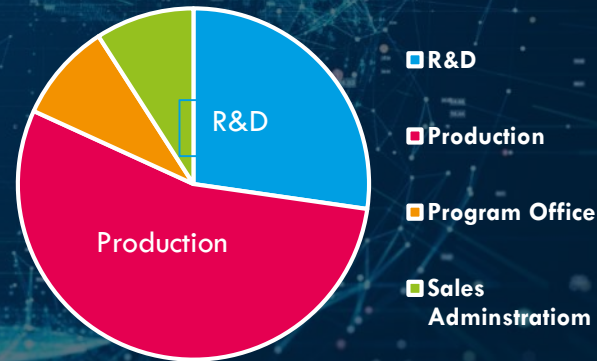
**Clean room area**  17,000 m<sup>2</sup>

**Independent supplier/partner for:**

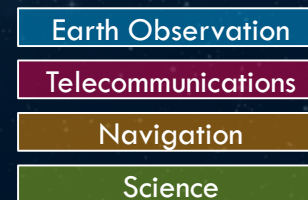
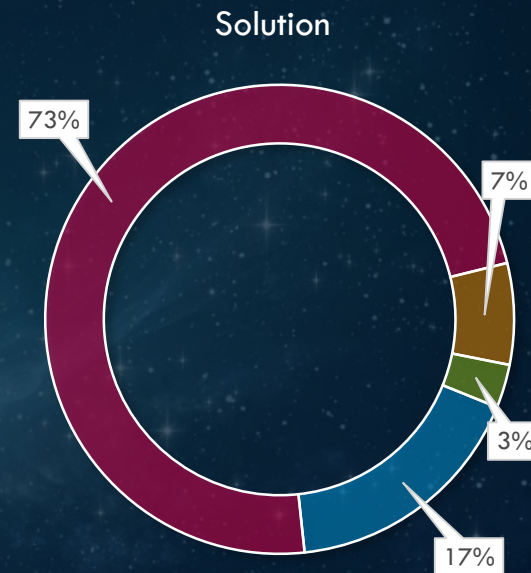
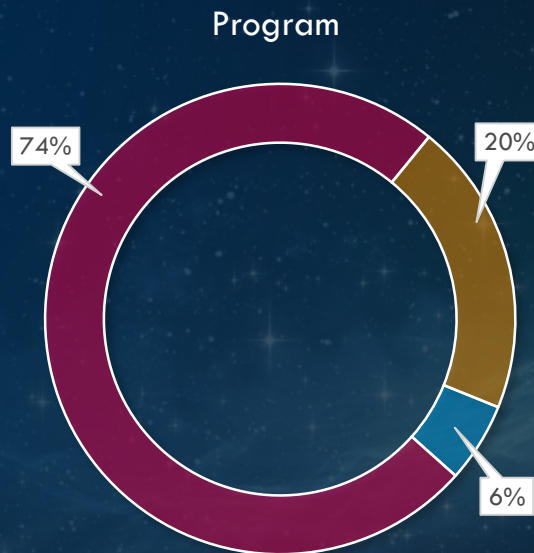
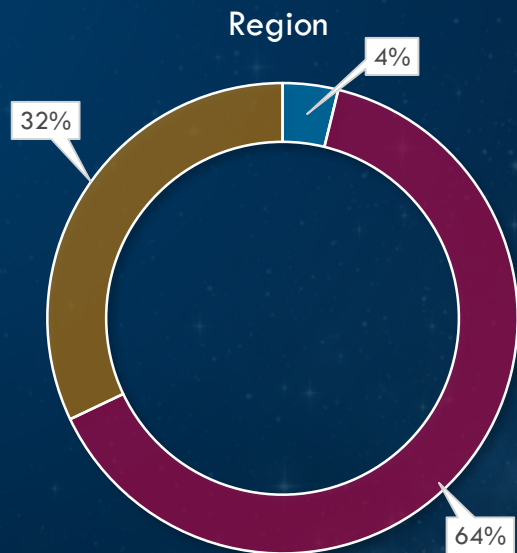
- Space Products
- Satellite Systems
- Cooperation



Location in Backnang, Germany, close to Stuttgart



Tesat is strongly technology and production focused.

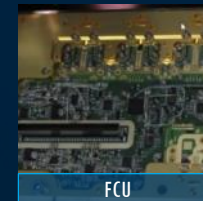
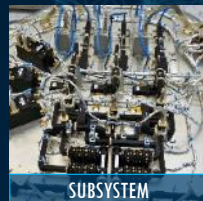




# PRODUCT OVERVIEW

One-Stop-Shop for RF & Optical Payloads

SYSTEMS

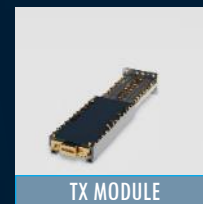
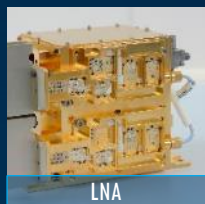
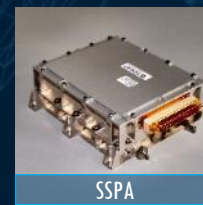
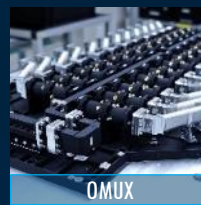
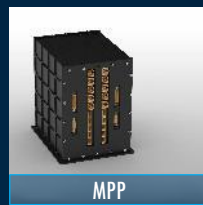


RF RECEIVE EQUIPMENT

ROUTING & SWITCHING

RF TRANSMIT EQUIPMENT

OPTICAL COMMUNICATIONS EQUIPMENT



# OPTICAL COMMUNICATIONS

## Product Overview

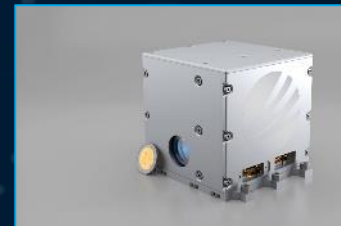
### DATA RELAY & AIRBORNE CONNECTIVITY

Orbit	GEO BACKBONE	LEO ISL USER
Range	80.000 km	45.000 km
Data Rate	1.8 Gbps	1.8 Gbps
Mass	53 kg	30 kg
Power	150 W	130 W
TRL	9, since 2013	8: PFM 2021

### DATA NETWORK, ISL & DTE

LEO	LEO/MEO/GEO	VLEO
up to 8.000km	up to 80.000km	1.500 DTE / 4.000 km OISL
2.5 Gbps	Up to 10/100 Gbps	Up to 1Gbps DTE / 20Mbps OISL
15 kg	28-40 kg / Config.	0.4 kg DTE / 3kg OISL
80 W	150-280 W (max 40W OPA)	8 W DTE / 30W OISL
9: since 2023	5: FM 2025	9 DTE, since 2021 / 6 ISL, FM 2024

OCT Model



Program

**GEO LCT135:** EDRS (3), COPERNICUS (8), MILSATCOM (3), ROLV

**LEO SMART70:** PLEIADES NEO (2), EU HPCM (6), HRWS (1), COMPASSO (1), NAV

**SCOT80:** DARPA TELESAT, SDA (50), LMS, ...

**SCOT135:** LOCKHEED, HYDRON, ...

**SCOT20:** PIXL, US (2), FRANCE (3)

Operational Products

IO Procedures, Performance & Trend Analysis, IO Anomaly Support, Ground Segment (Link Planning & Monitoring)

Application

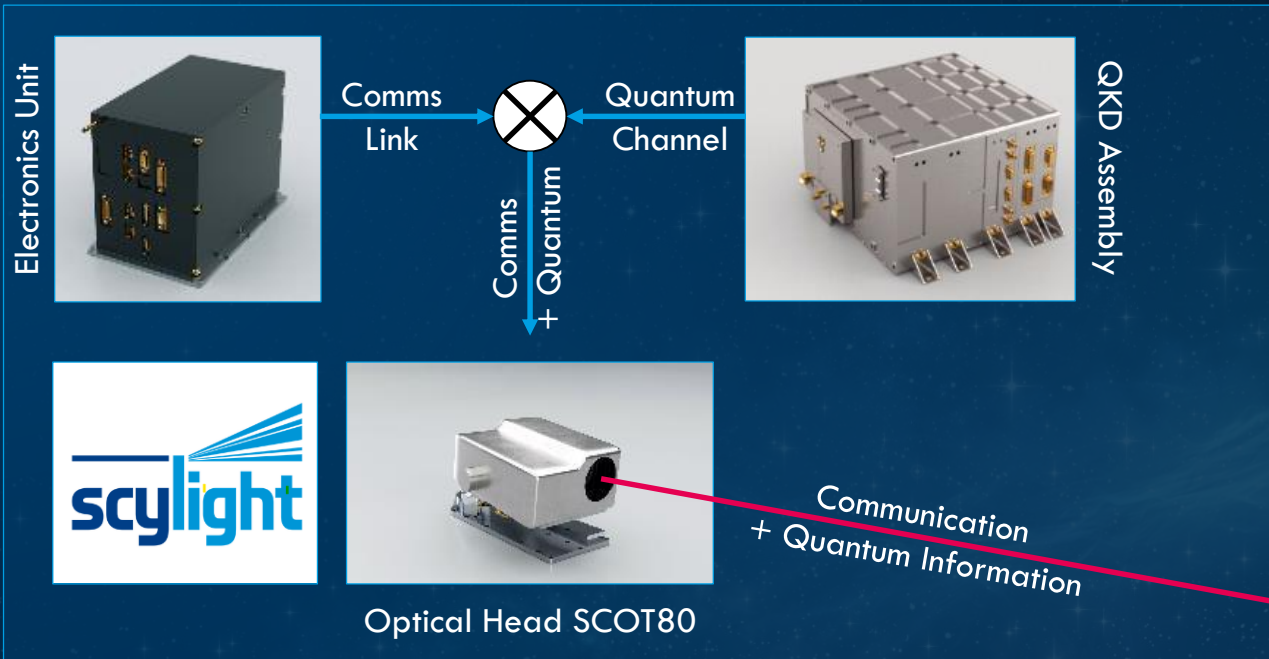
**DATA:** Data Routing & Switching | **PNT:** Positioning, Navigation & Timing | **QKD:** Quantum Key Distribution

1064 nm

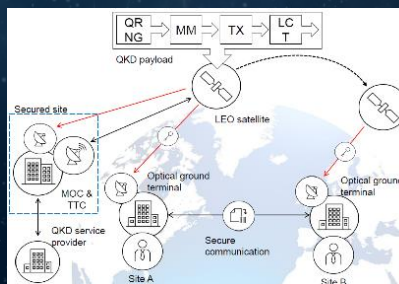
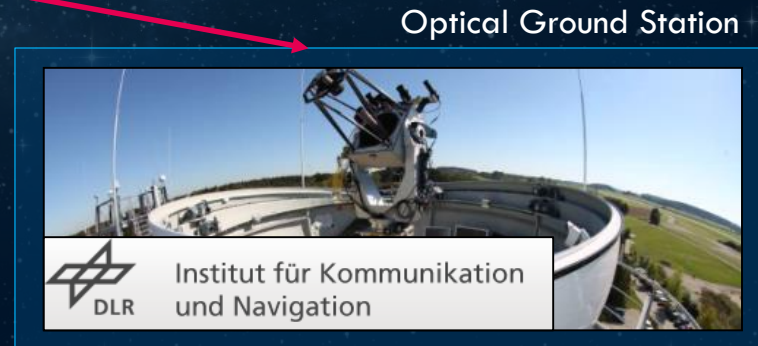
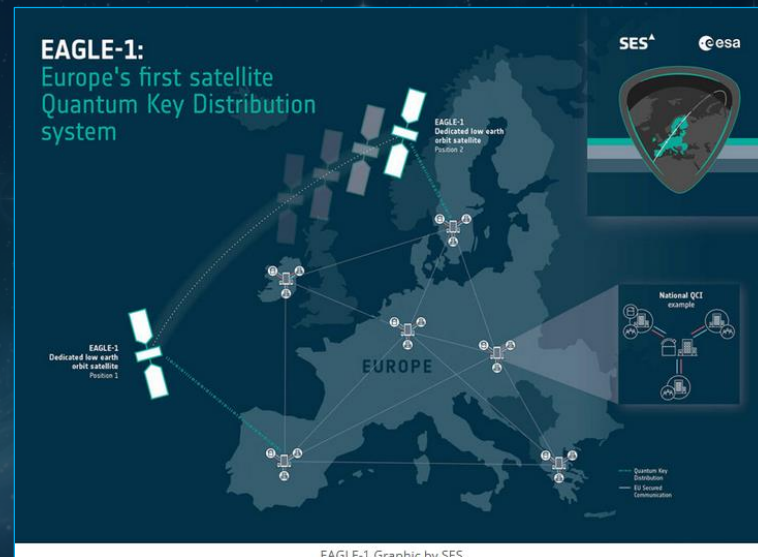
1550 nm

# EAGLE 1 (QUANTUM KEY DISTRIBUTION MISSION)

First QKD System in Europe



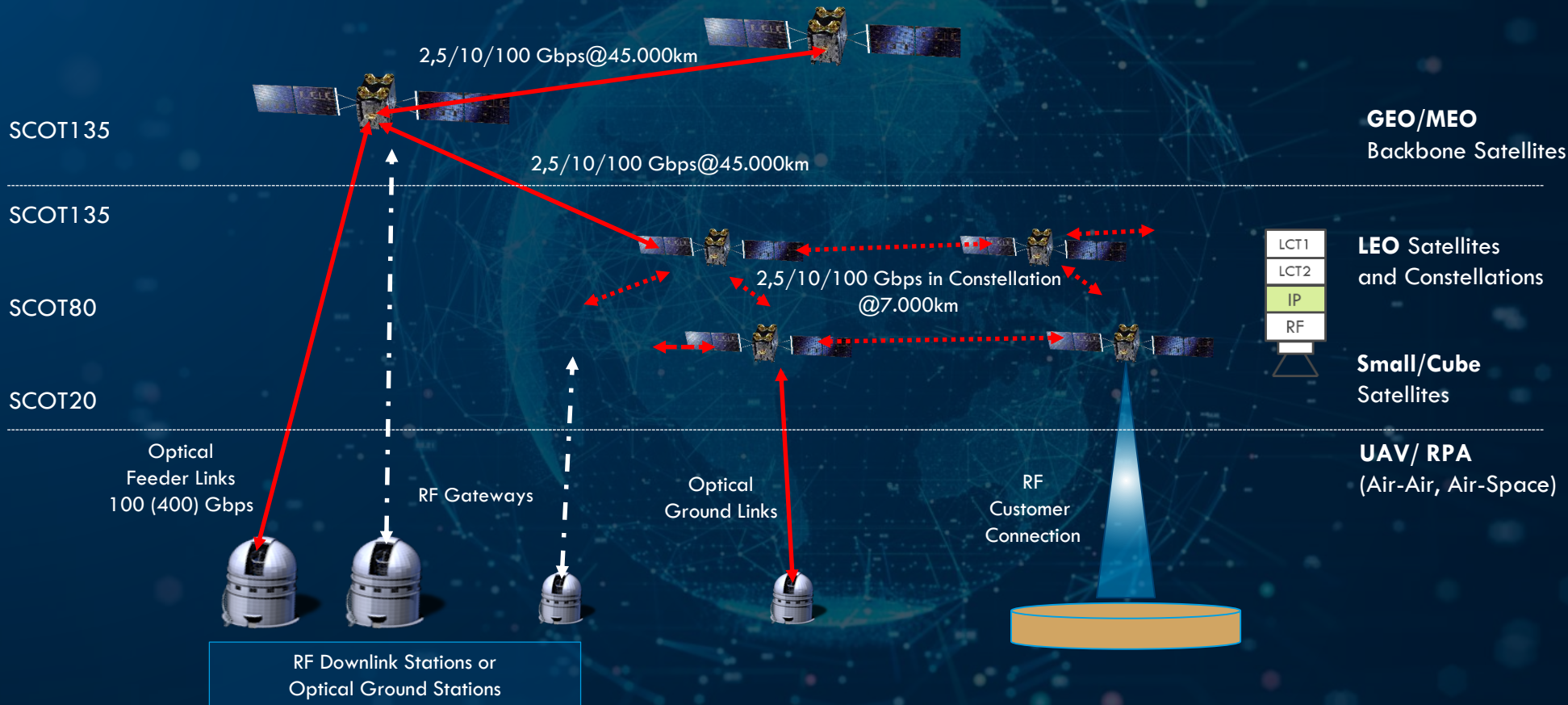
QKD Payload Launch Q4/2024



# TRANSFORMATION OF SATELLITE NETWORKS

Marketplace for SCOT – Scalable Optical Terminals

## Multi-Orbit Connectivity





# LASER COMMUNICATION IN ORBIT MISSIONS - MORE THAN 550,000 OPERATIONAL HOURS



2019 | EDRS-C

2016 | EDRS-A

2013 | ALPHASAT

2017 | SENTINEL-2B

2016 | SENTINEL-1B

2015 | SENTINEL-2A

2014 | SENTINEL-1A

2007 | TERRASAR-X

2007 | NFIRE

SENTINEL-1C | 2018

SENTINEL-2C | 2019

SENTINEL-1D | 2020

SENTINEL-2D | 2021

2x PLÉIADES NEO | 2021

2021 | PIXL-1

48 SCOT80  
US LEO CONSTELLATION | 2022

12 SCOT80  
US LEO CONSTELLATION | 2022

COMPASSO | 2024

TITANIA | 2024

6 CubeLCT/SCOT20  
EUROPEAN SYSTEMS | 2024

2 SCOT135  
US PROGRAM | 2025

180 SCOT80  
CONSTELLATIONS FOR  
DIFFERENT S/C PRIMES | 2023/24

IN ORBIT | 58

DELIVERED | 14

IN PRODUCTION | 190

262 LCTs  
Under Contract

## PROGRAMS OVERVIEW

# LASER COMMUNICATION IN ORBIT MISSIONS - MORE THAN 550,000 OPERATIONAL HOURS



Update 2024-05-28:  
 TESAT [...] selected to deliver  
 792 Optical Communication  
 Terminals (OCT) by MDA  
 Space Ltd. (TSX:MDA).

- 2019 | EDRS-C
- 2016 | EDRS-A
- 2013 | ALPHASAT
- 2017 | SENTINEL-2B
- 2016 | SENTINEL-1B
- 2015 | SENTINEL-2A
- 2014 | SENTINEL-1A
- 2007 | TERRASAR-X
- 2007 | NFIRE
- SENTINEL-1C | 2018
- SENTINEL-2C | 2019
- SENTINEL-1D | 2020
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- 2x PLÉIADES NEO | 2021

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## PROGRAMS OVERVIEW

NEW BUILDING FOR LEO  
CONSTELLATION MARKET.  
INDUSTRY 4.0: MATRIX PRODUCTION



A large, abstract graphic composed of a dense field of small grey dots of varying sizes, arranged in a pattern that resembles a satellite constellation or a stylized map. The dots are more concentrated in the center and fade out towards the edges.

## CONSTELLATION LCTs SCOT80

# SPACE ARCHITECTURE WITH OPTICAL INTER SATELLITE LINKS FROM TESAT

Application for US Government



Copyright: SDA

Connectivity provided by Optical Communication Terminals from TESAT (Transport and Tracking Layer)

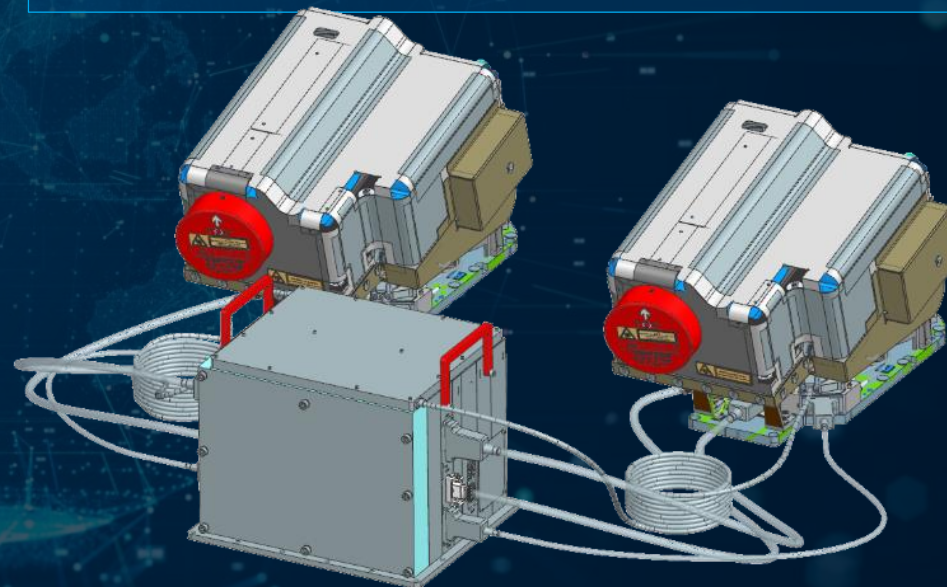
# SCOT 80 DESIGN FOR T1

Single and dual Units for different customer needs

## Key facts on TESATs SCOT80 T1 (dual EU):

- » Data electronics will serve two channels
- » control board will serve two channels
- » OH drive electronic will serve two OHs
- » Optical output power: 4W/5W
- » Data rate: 2.5 Gbps
- » FoR (same as T0):  $\pm 160^\circ$  in azimuth and  $\pm 55^\circ$  in elevation.
- » Power consumption per opt. channel: 63.5 W
- » Mass per opt. channel:  $< 12$  Kg

- » Developed as modular scalable systems
- » Compliant to SDA T0 and T1, data rates up to 10Gbps OOK
- » 100Gbps in preparation

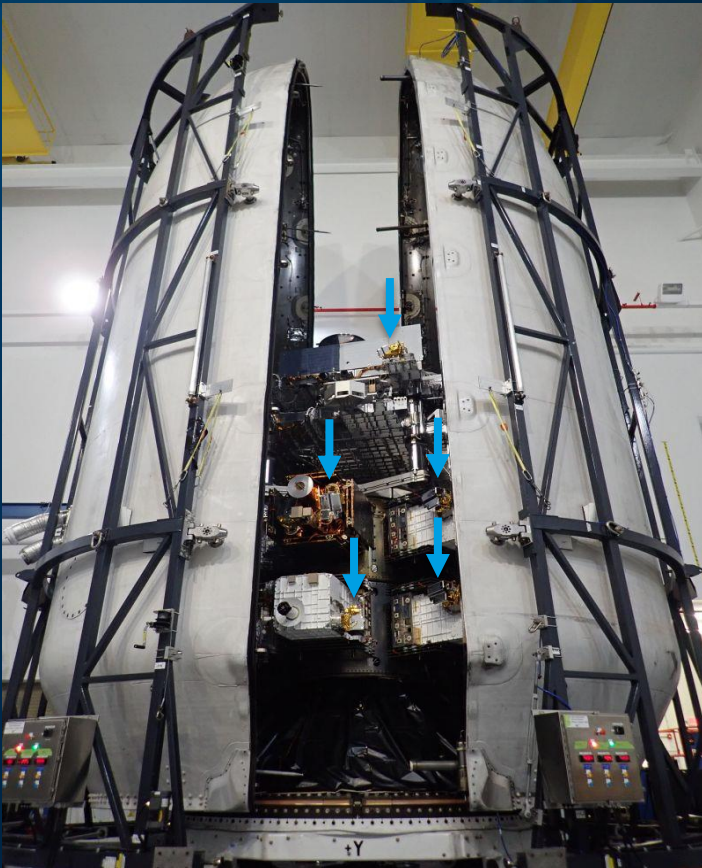


# High Production Output

SCOT80 weekly output



# SCOT80 READY FOR SDA TRANSPORT & TRACKING LAYER



60 SCOT80 Flight Units  
delivered

20 SCOT80 Flight Units  
launched April 2<sup>nd</sup>, 2023

26 SCOT80s  
launched September 2<sup>nd</sup>, 2023

2 SCOT80s  
launched November 4<sup>th</sup>, 2023



## 48 SCOT80 in-orbit

13 satellites for the Space Development Agency's  
second Tranche 0 in the Falcon 9 payload fairing.

Image: SDA

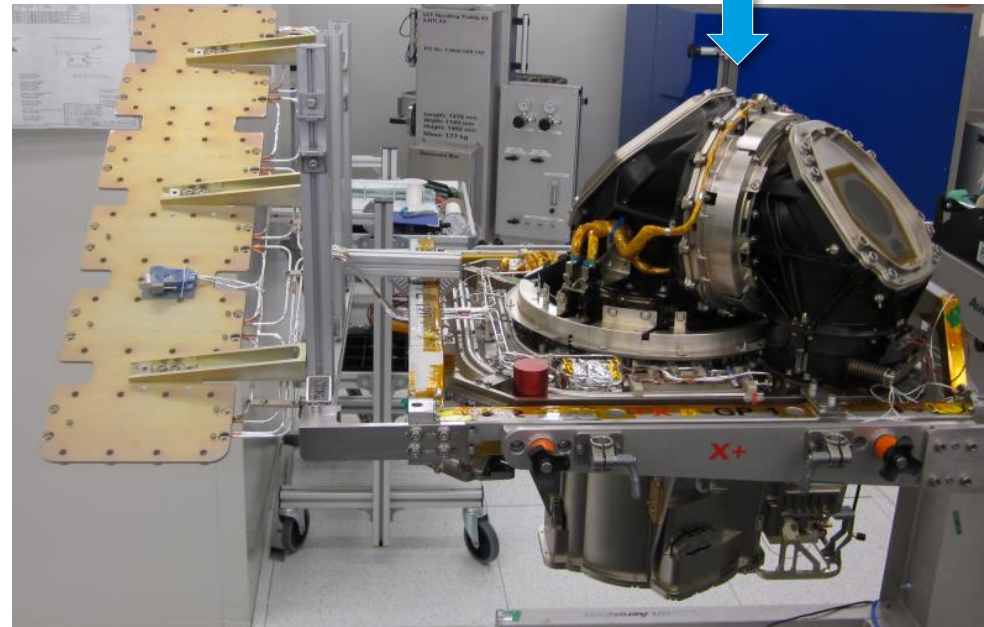
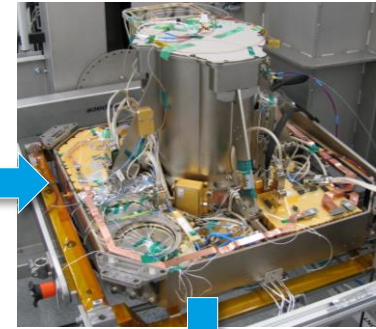


A large, abstract graphic composed of a grid of dots of varying sizes and opacities, creating a sense of depth and movement. The dots are arranged in a way that suggests a map or a complex network, with some areas being more densely populated than others.

## OPPORTUNITIES FOR PICs

# LCT135 AIT

... more than 7500 different electronic parts



- » LCT135: individual modules, e.g. laser pump module, laser head, modulators, ...
- » SCOT80: transceivers
- » QKD payload: PICs?

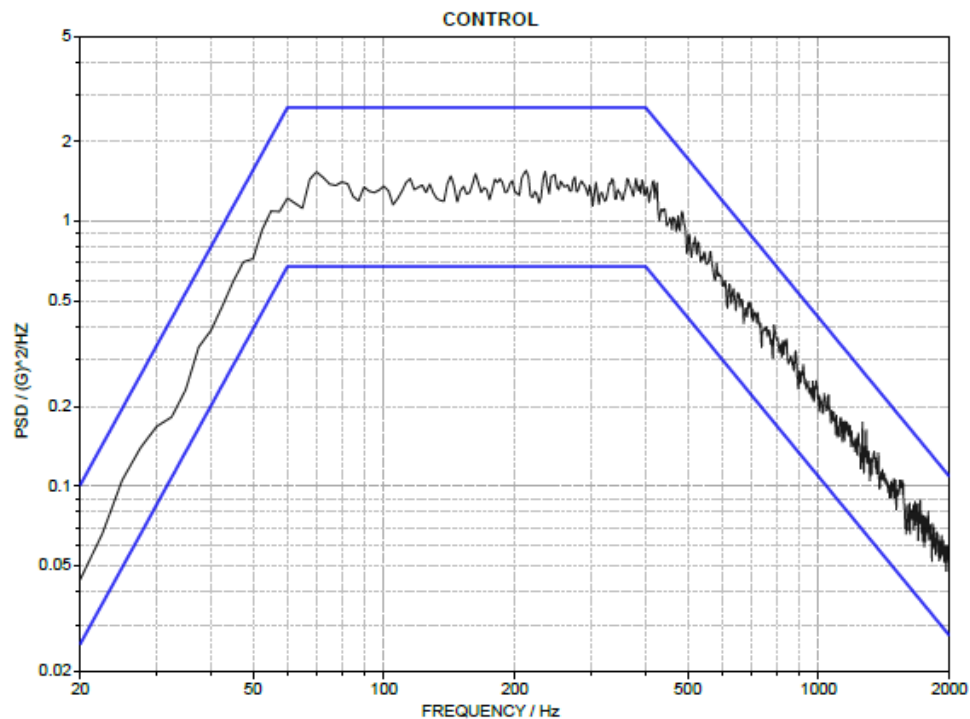
# TYPICAL MODULE PROPERTIES & ENVIRONMENTAL LOADS FOR SPACE EQUIPMENT



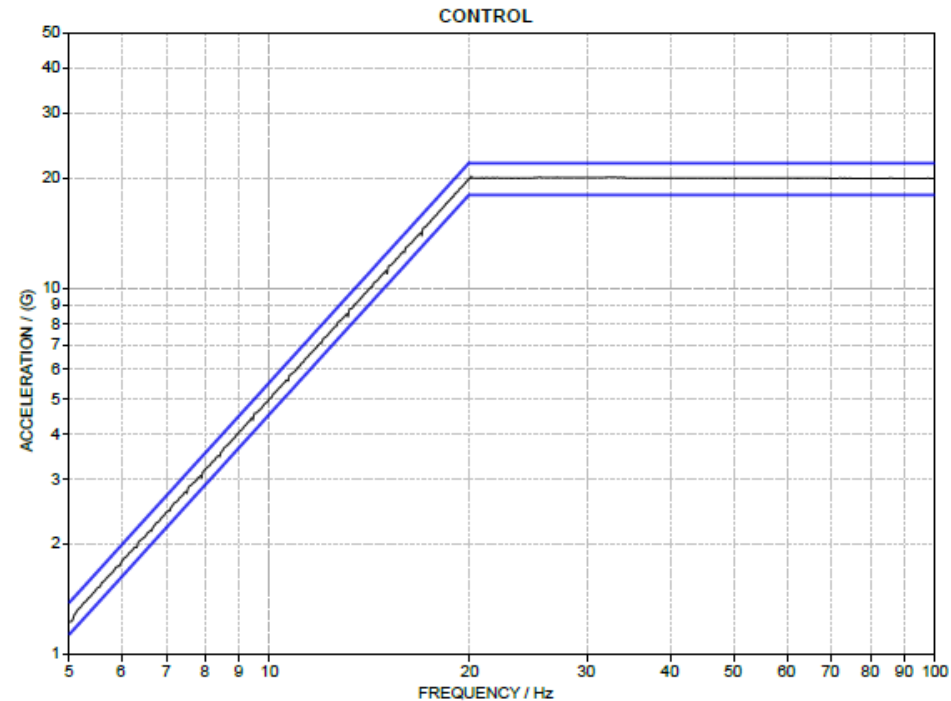
» hermeticity: leakage rate  $< 1 \times 10^{-7}$  mbar $\times$ liter/s

»

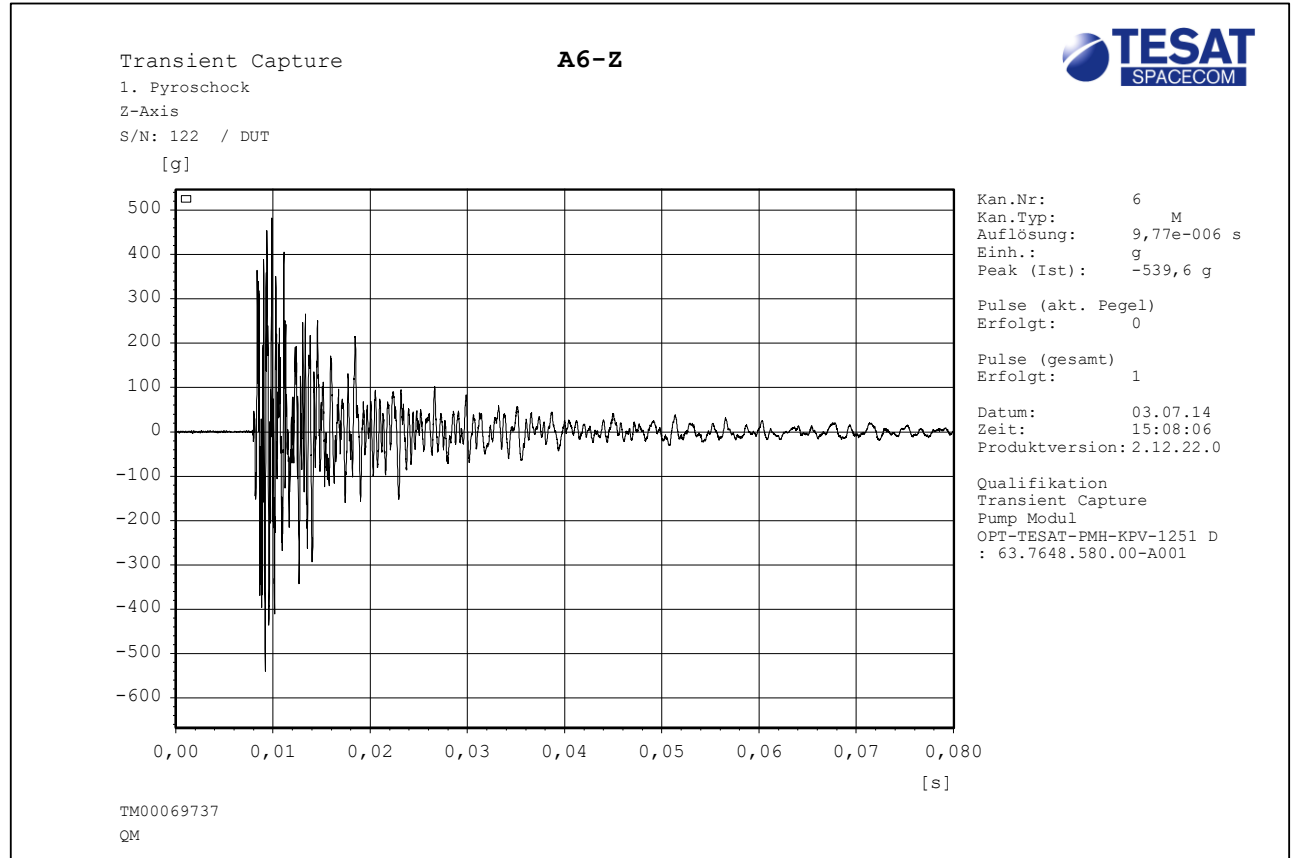
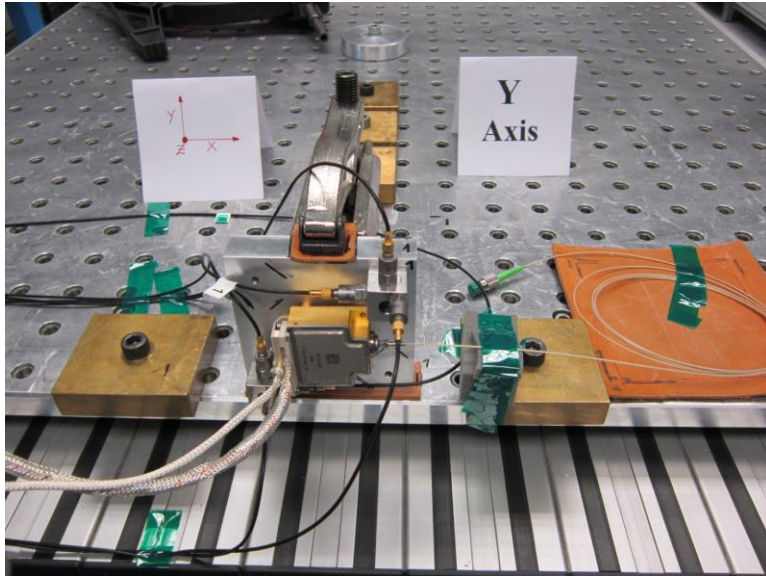
Test No.	Test	Test Sample		
		A	B	C
1	IFT	X	X	X
2	Random Vibration Test	X	—	—
3	Sine Vibration Test	X	—	—
4	PT	X	—	—
5	Mechanical Shock	X	—	—
6	PT	X	—	—
7	TV Cycling Test	X	—	—
8	Radiation Test (incl. annealing)	—	X	—
9	PT	—	X	—
10	Operating Life Test	—	X	—
11	On-Off Cycles	—	—	X
12	FFT	X	X	X



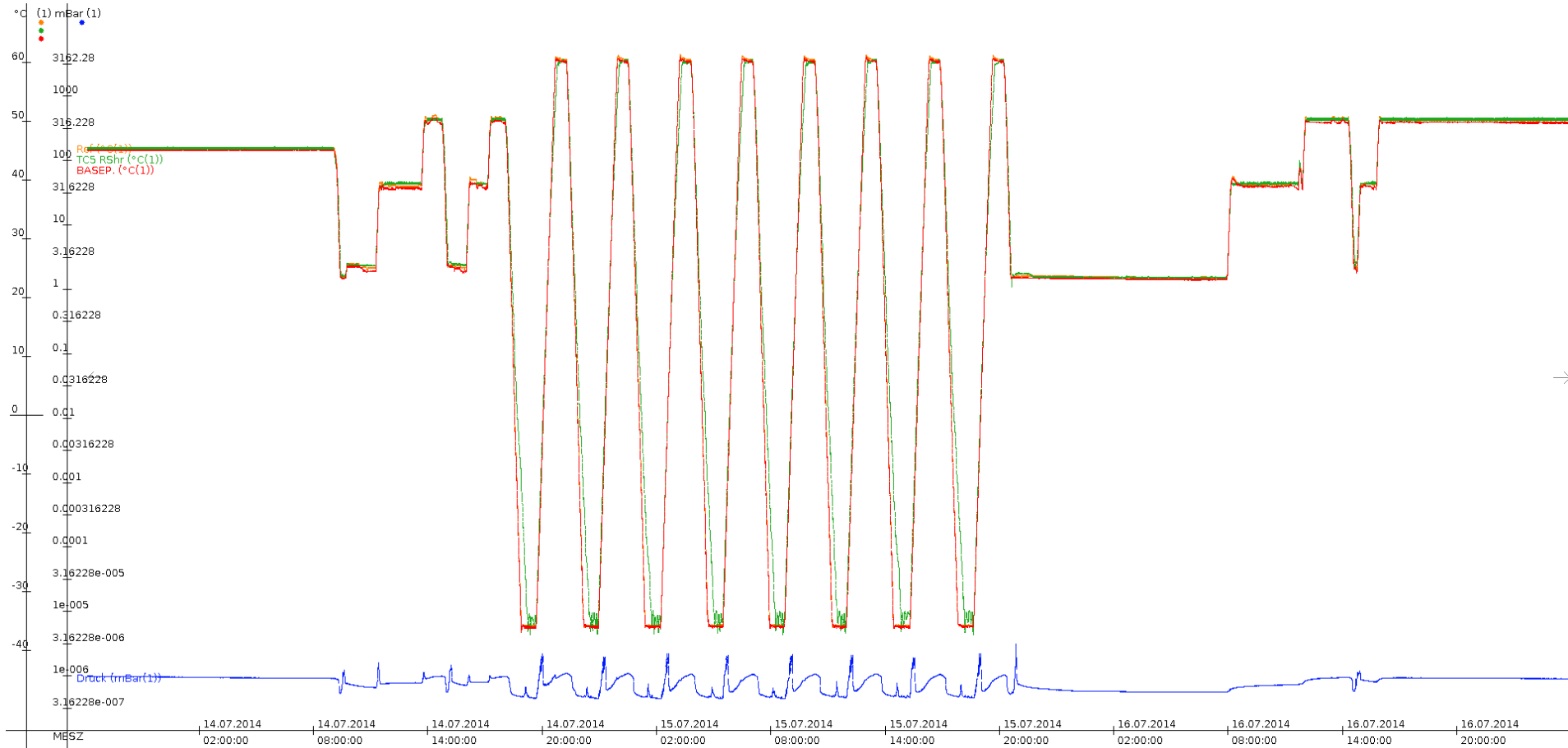
Channel type	Control	Channel	0
Test Level [dB]	0		
Test Time [hh:mm:ss]	00:03:00	Test Range [Hz]	20 .. 2000
Reference RMS [g]:	30.216	Resolution [Hz]	2.5
RMS [g]	30.131 / -0.3%	DOF:	280
Filename:	X-6-random-run-031440.001		



Channel type	Control	Channel	0
Test Level [dB]	0		
Test Time [hh:mm:ss]	00:02:09	Test Range [Hz]	5 .. 100
DOF:		Sweep rate [oct/min]	2
		Test Sweeps:	1
		Points per Sweep:	966
Filename:	X-3-sine-run-03143E.001		



C:\VcpNT\Daten\m+p\MOH\_PM\_QM\_SN\_122\_XYZ\_003.rtc



# RADIATION (TOTAL IONIZING DOSE)

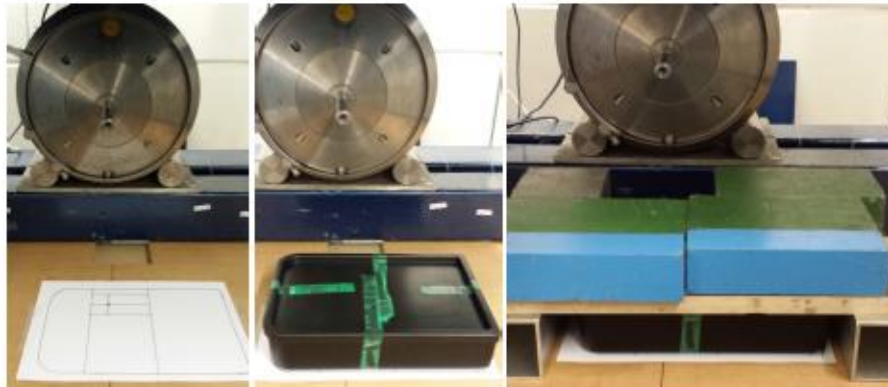
## 2. Irradiation conditions

All irradiations were done in air at  $23.4^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$  in non-condensing conditions and ambient light. The distance between the source and the top of the sensitive volume was 24.6 cm. The mean dose rate was  $5.0 \text{ krad(Si)/h} \pm 5.5\%$  ( $k=2$ ) with a non-uniformity of 16%. This total dose was  $55 \text{ krad(Si)} \pm 5.5\%$  ( $k=2$ ).

## 3. Irradiation steps

Step	Start	Stop	Duration
1	2013-04-23 16:10	2013-04-24 03:12	39747 Seconds

## 4. Pictures of the sample at the irradiation spot

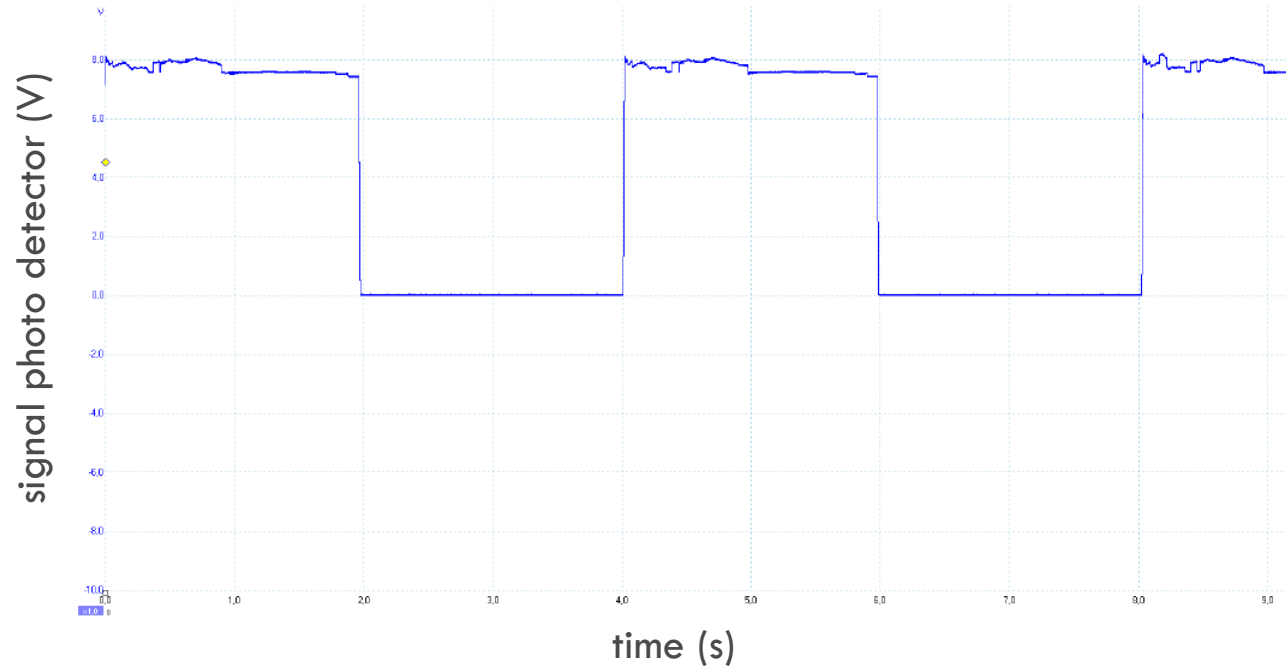


I.10.

4:54

# OPERATING LIFE TEST & ON-OFF CYCLES

- » 2000 h, 3A, 50°C
- »  $> 1.5 \times 10^6$  on-off switching cycles (0 to 2.5A, 2s on, 2s off, rise & fall times  $< 10$ ms, 45°C)





## SUMMARY

- » PICs have great potential to reduce complexity, size & cost of optical space equipment.
- » Growing constellation LCT market requires large numbers of units.
- » Special applications, e.g. QKD, demand for integrated approaches.
- » Needed:
  - » (hybrid) PICs
  - » space-compatible packaging (analogue to classical space-module packaging)



STAY TUNED. MORE TO COME...!

THANK YOU FOR YOUR ATTENTION!

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