



Missionsüberblick und TID Anforderungen für Kleinsatelliten der TU Berlin am Beispiel von SALSAT

February 10th 2020 | HZB Workshop | Strahlenhärtetests

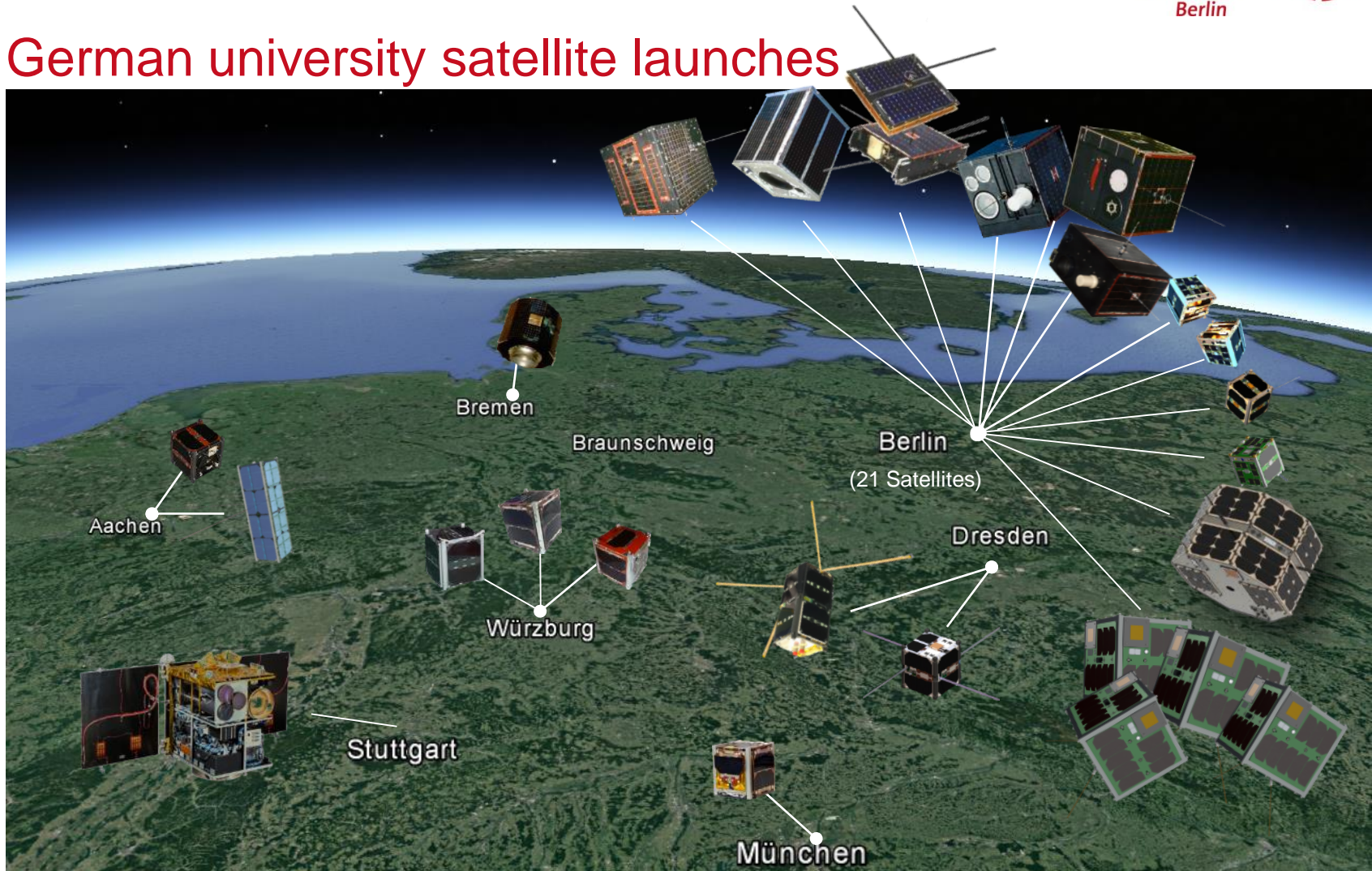
J. Großhans, M. Pust, H.Q. Vu, Klaus Brieß

Institut für Luft- und Raumfahrt
Raumfahrttechnik

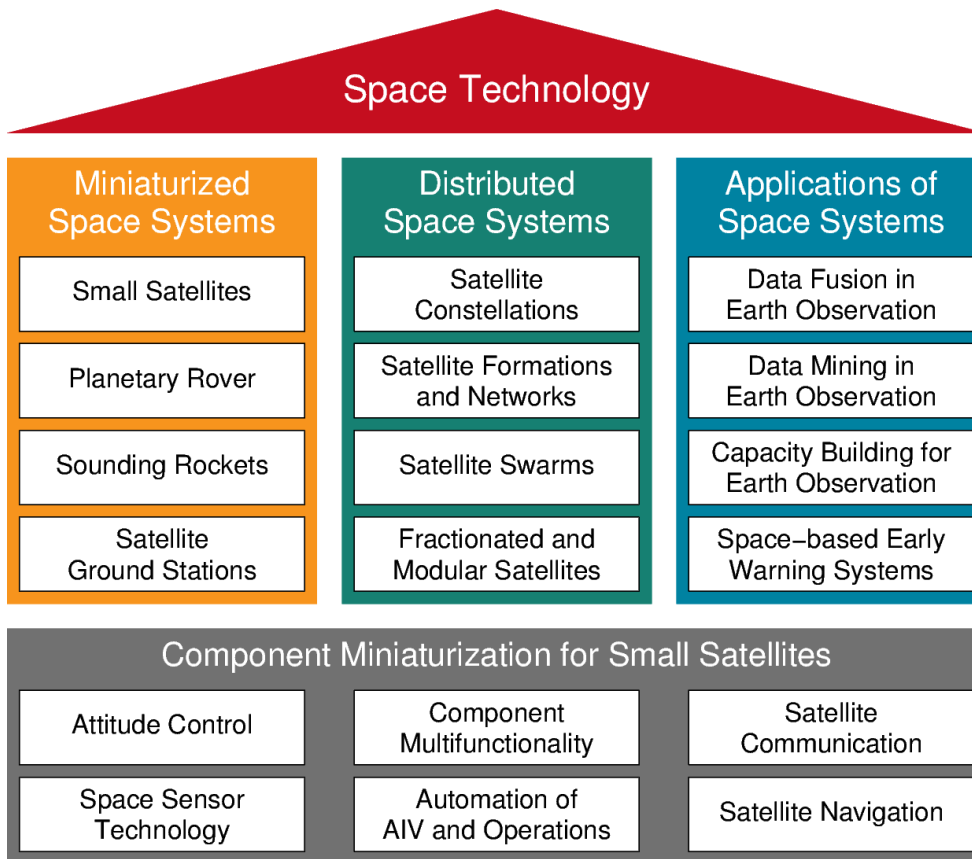


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|--|------------------------|----------------------------------|
| 1 professor | 45 research assistants | 78 employees, including 10 women |
| 4 secretaries & office/ program managers | 28 student workers | |

German university satellite launches



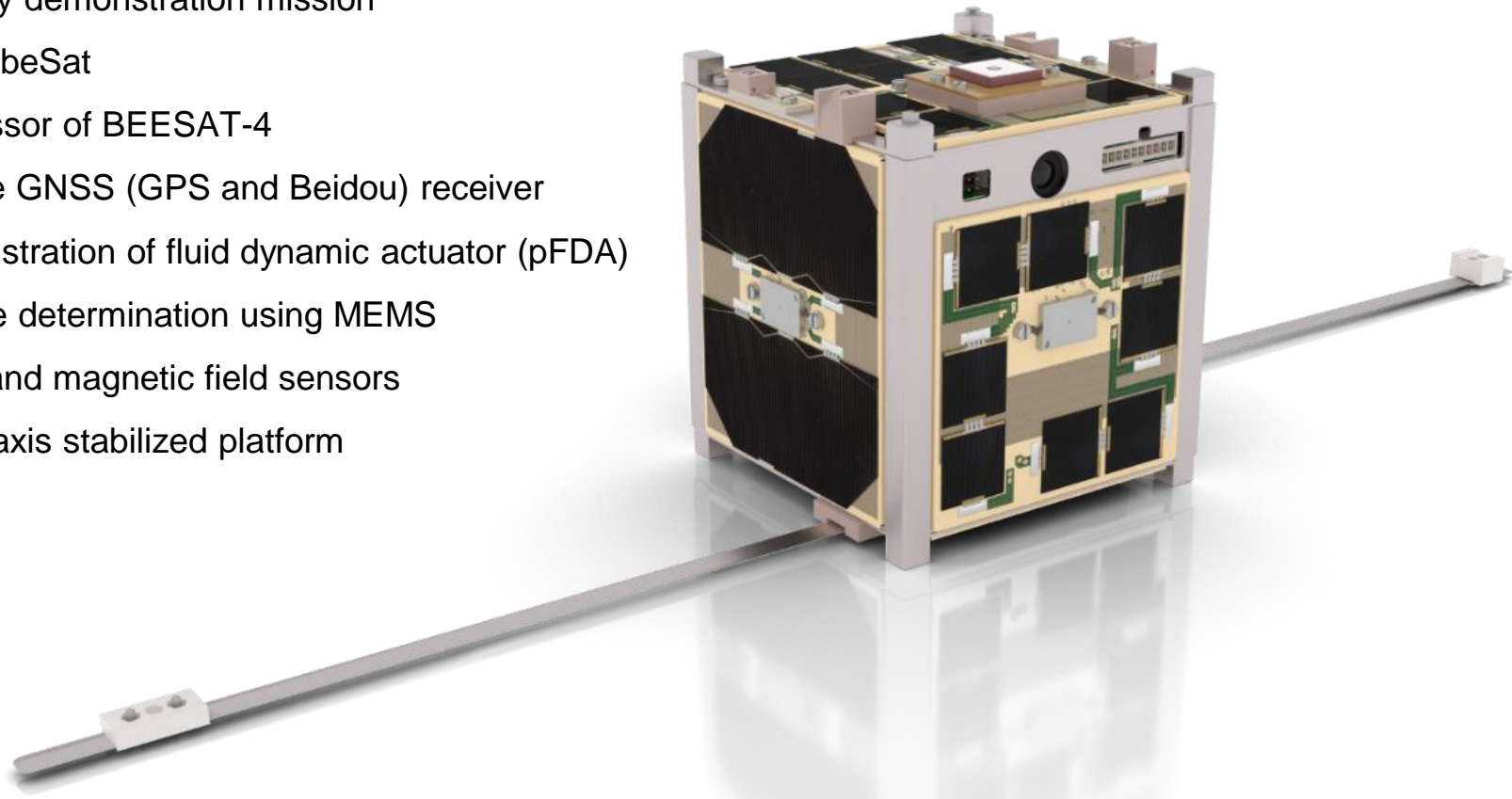
Small satellites at TU Berlin



BEESSAT-9

Technology demonstration mission

- 1-U CubeSat
- Successor of BEESSAT-4
- Precise GNSS (GPS and Beidou) receiver
- Demonstration of fluid dynamic actuator (pFDA)
- Attitude determination using MEMS gyros and magnetic field sensors
- Three axis stabilized platform



BEESAT-5/-6/-7/-8 BEESAT-10/-11/-12/-13



Image credit: N. Korn

Two technology demonstration missions with picosatellites:

- 0.25U CubeSats (0.375 kg)
- Redundant satellite bus
- inter-satellite network
- star sensor and magnetic coils
- Navigation (GNSS receiver)
- X-band transmitter (2 Mbit/s)
- Retroreflectors for laser ranging

BEESAT-10...13: launched 05th July 2019

BEESAT-5...8: to be launched in 2020

Mission TechnoSat

“Demonstrating novel satellite
technology on orbit”

Spacecraft mass: 20 kg

Orbit: 600 km, SSO

Launch: 14th of July 2017 on Soyuz

Platform: TUBiX20



Mission TUBIN

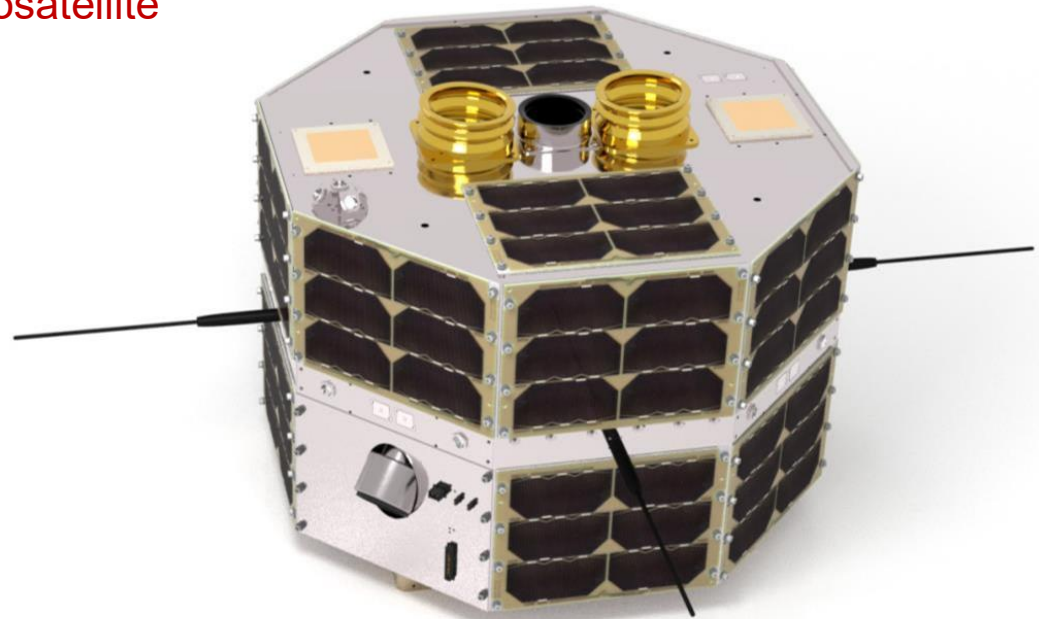
“To demonstrate wildfire detection with
a TIR microbolometer on a nanosatellite”

Mass: 20 kg

Launch: 2020

Project status: Phase D

Platform: TUBiX20





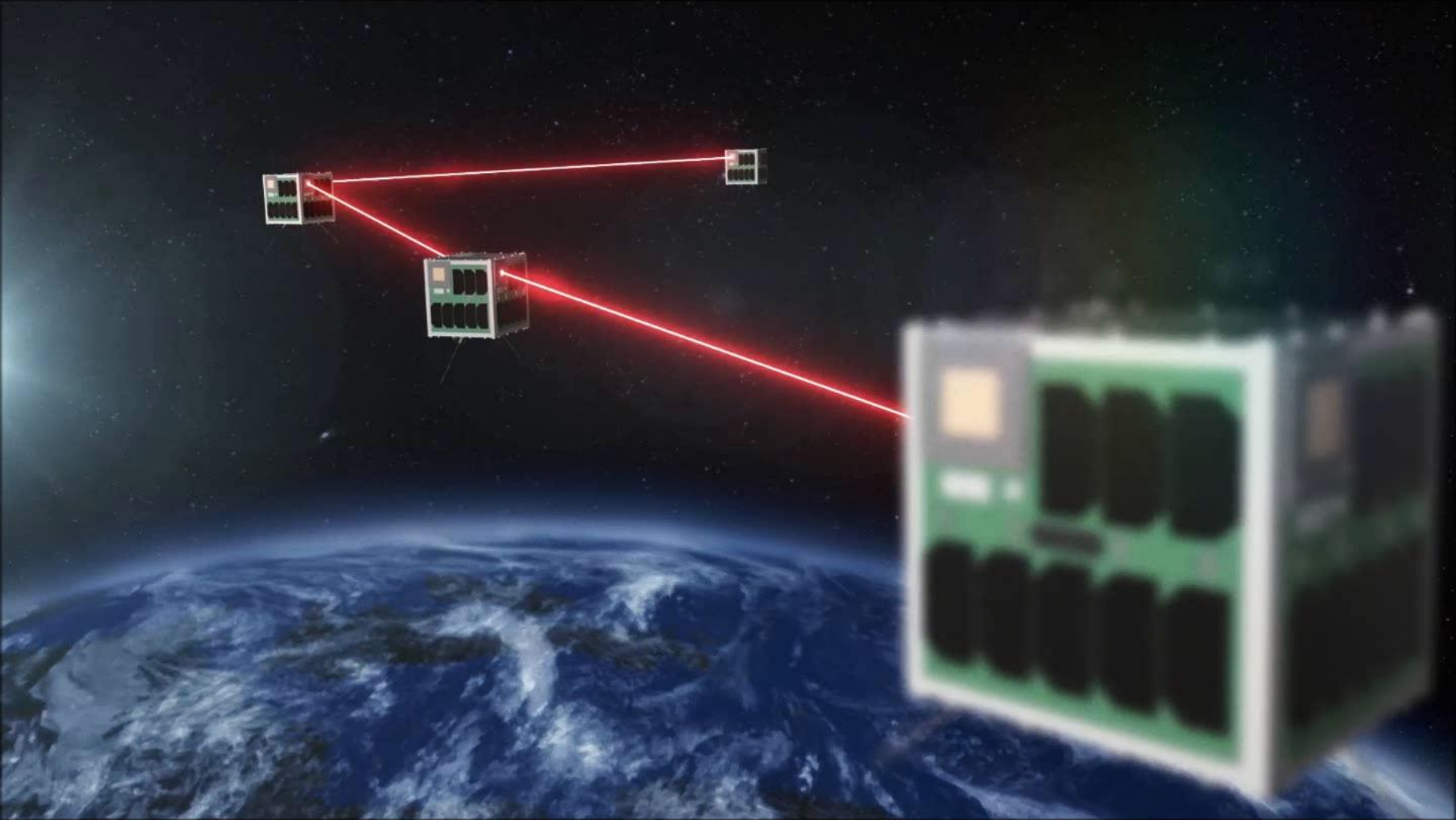
Egypt and Israel

Image Credit: TU Berlin, TechnoSat Team



Eye of Sahara

Image Credit: TU Berlin, Technosat Team



Facilities – Ground Station



Facilities – Mission Control Center



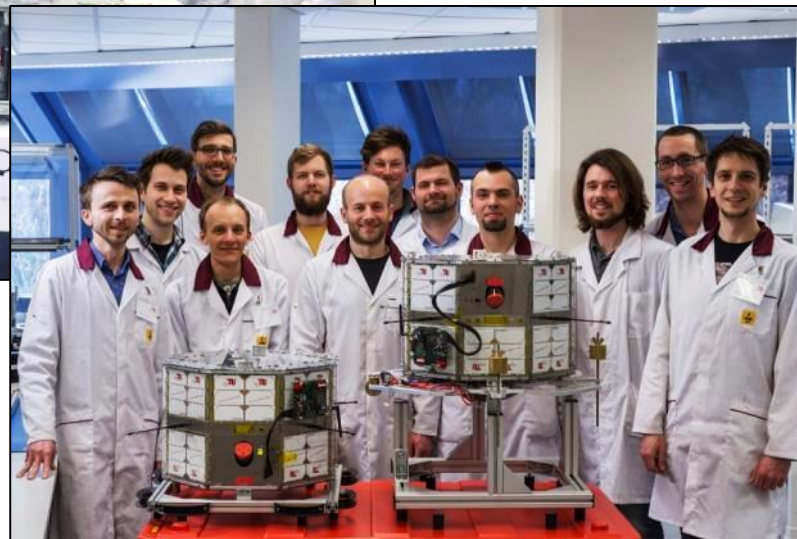
Student Projects



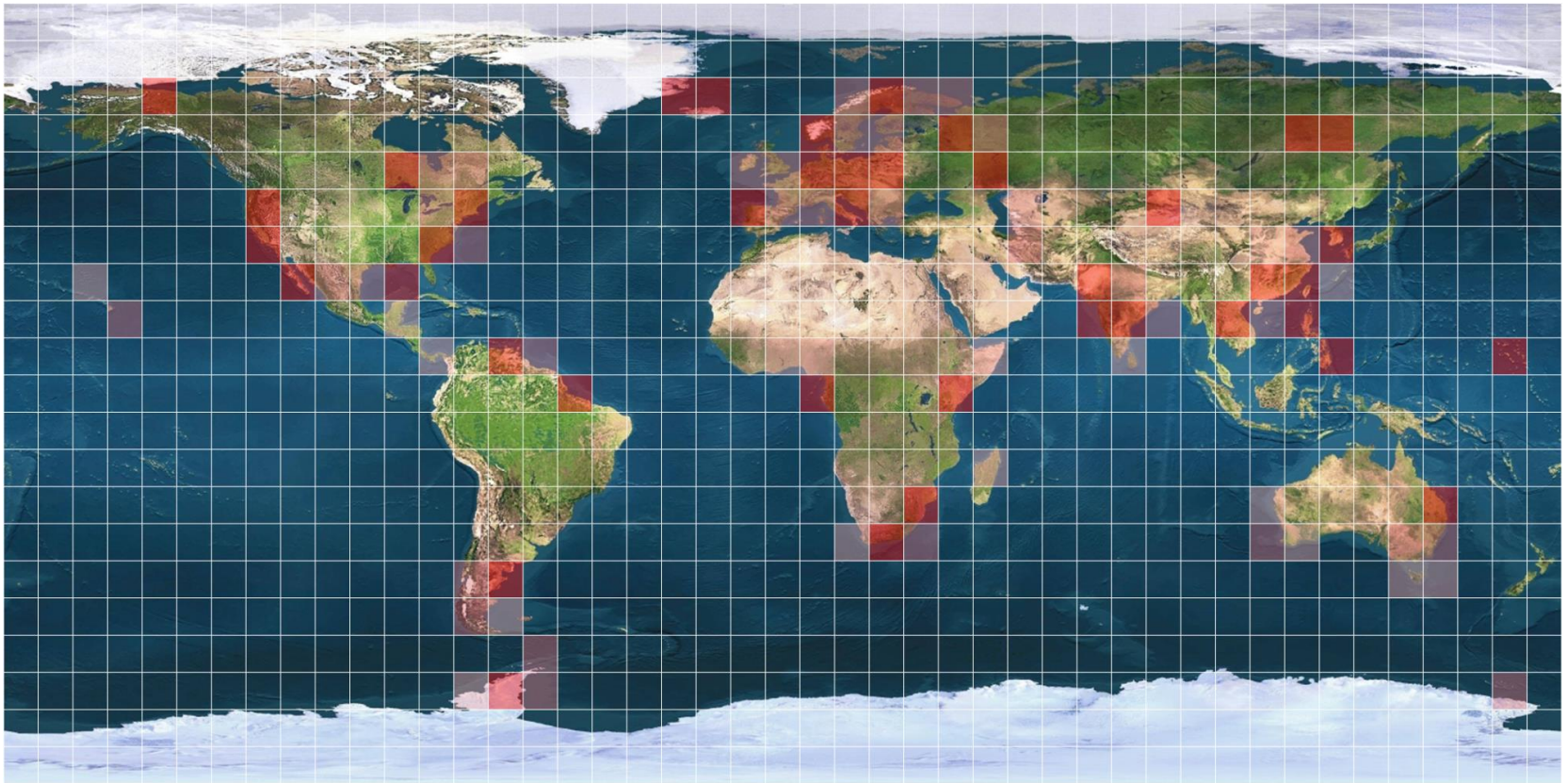
Student Projects



Facilities – Assembly, Integration, Verification & Test Lab



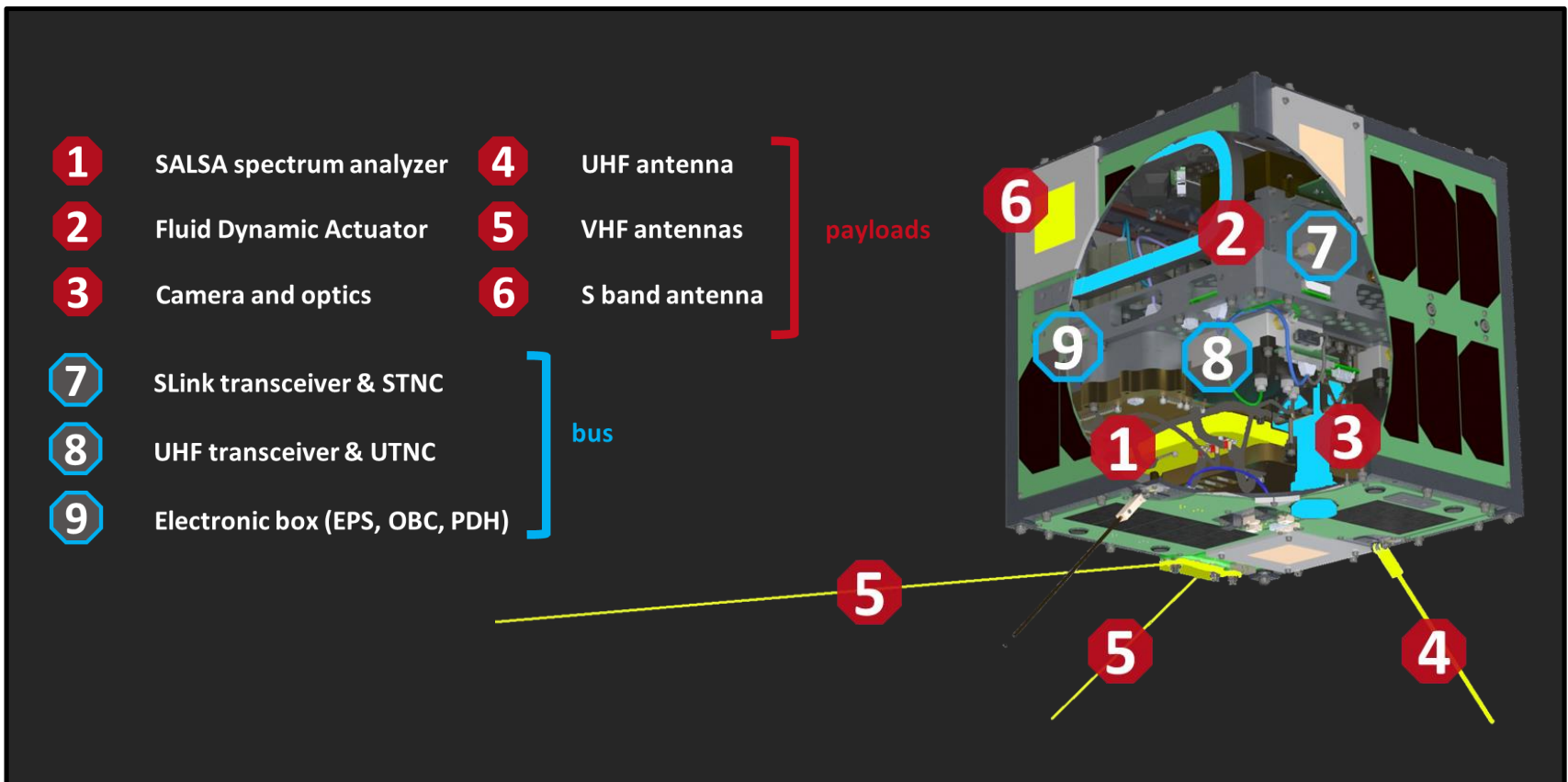
SALSAT: Mission overview



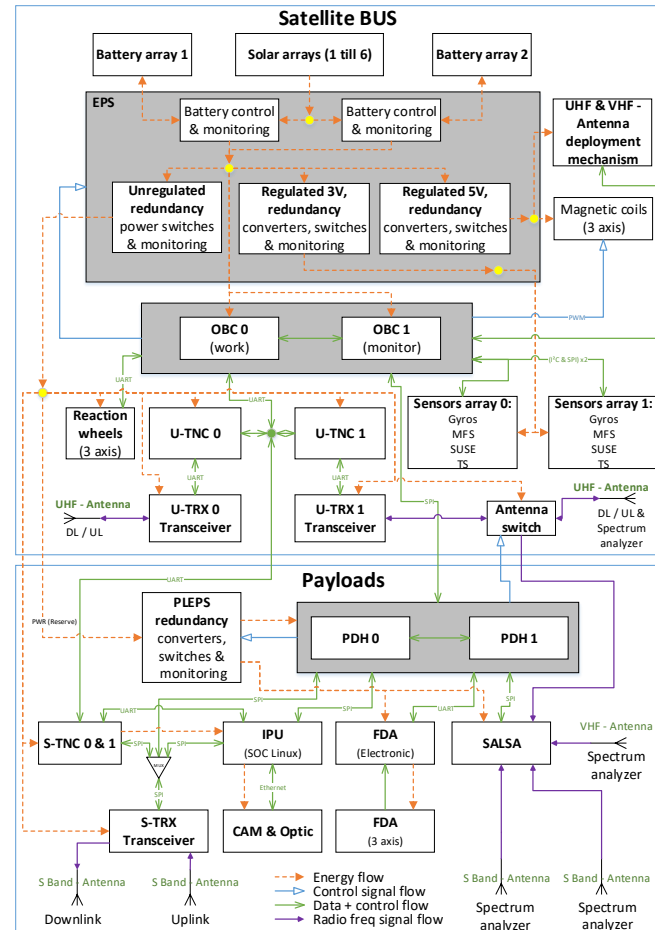
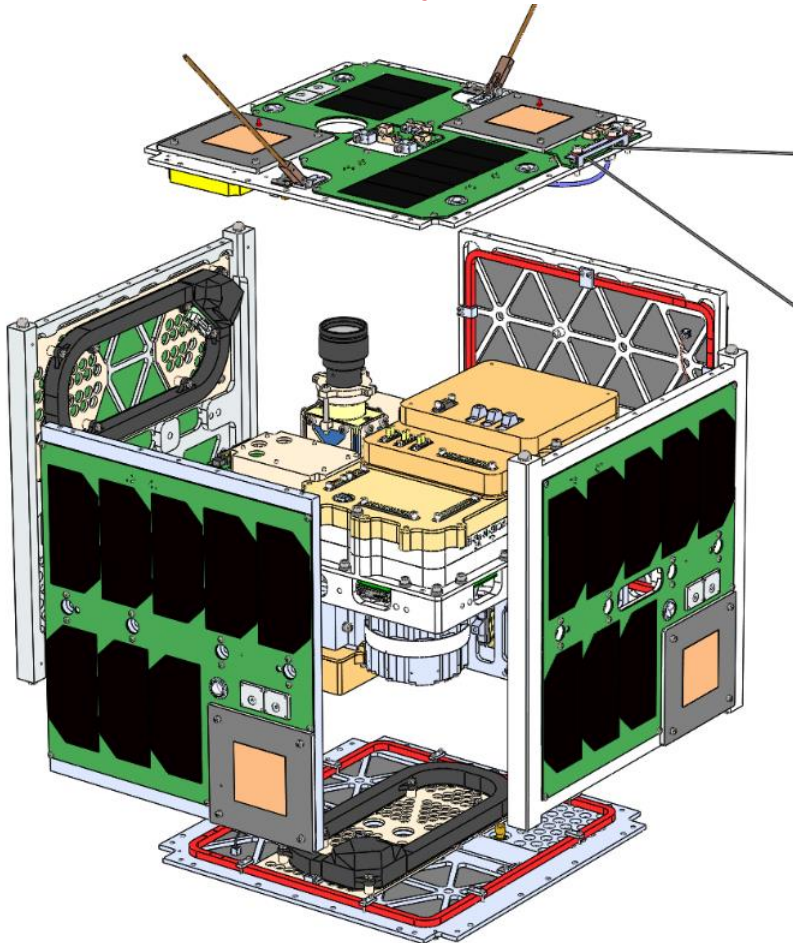
Background source: <https://wiki--travel.com/images/map-of-earth-jpg/map-of-earth-jpg-2.jpg>



SALSAT: Satellite overview



SALSAT: Payload Overview



1 Satellite BUS

2 Payloads



SALSAT: Payload Overview

Primary Payload:

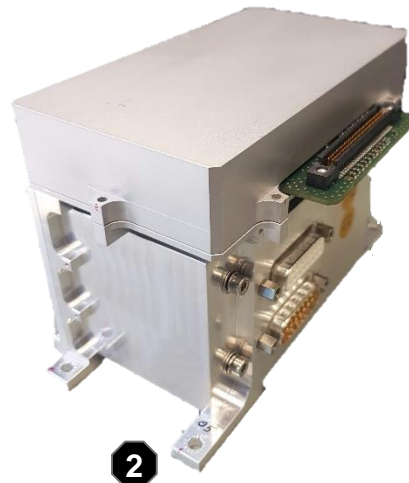
- 1 Spectrum analyzer SALSA



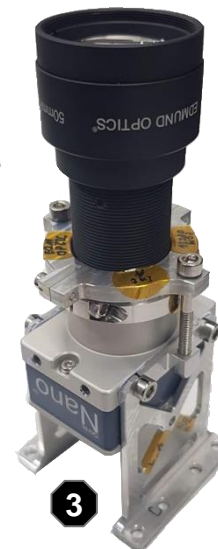
1

Secondary Payloads:

- 2 Full duplex S band transceiver (SLink)
- 3 Camera & Optic with image processing unit
- 4 Three-axis fluid dynamic actuator (FDA)
- 5 Passive laser ranging reflectors



2



3



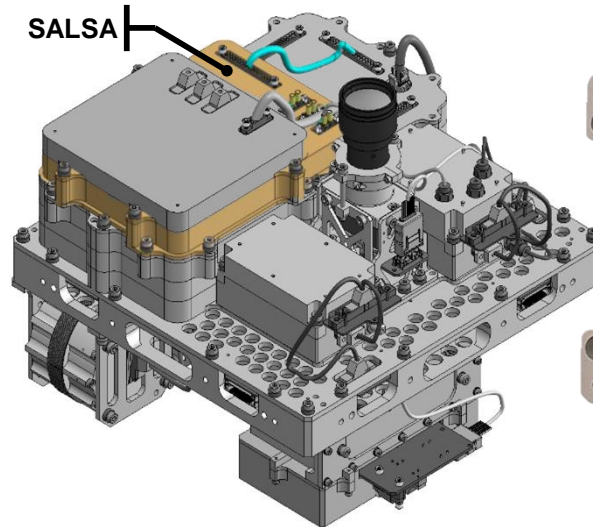
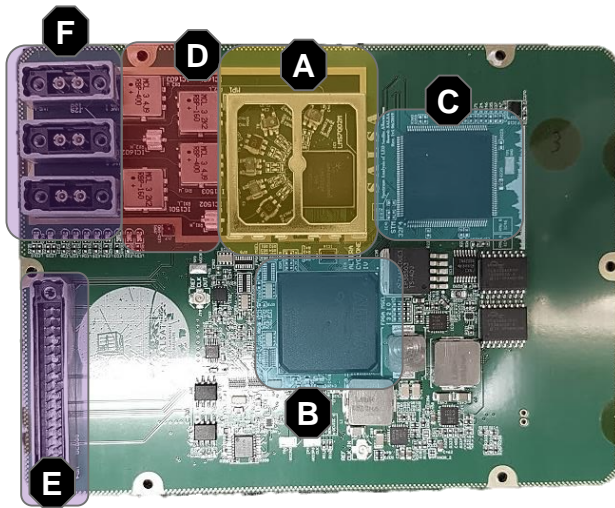
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5



SALSAT: Primary Payload “SALSA”



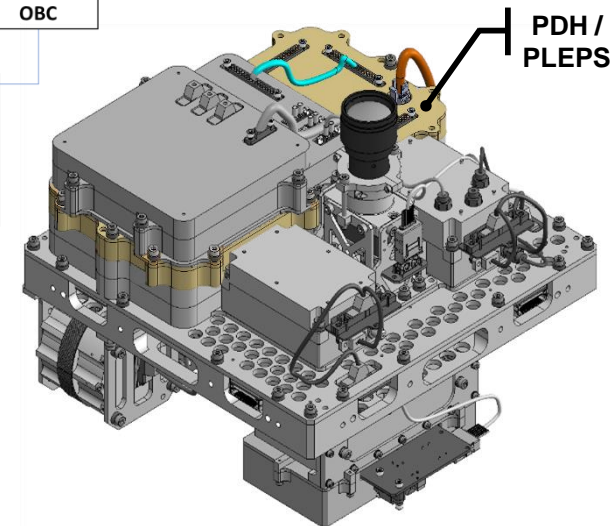
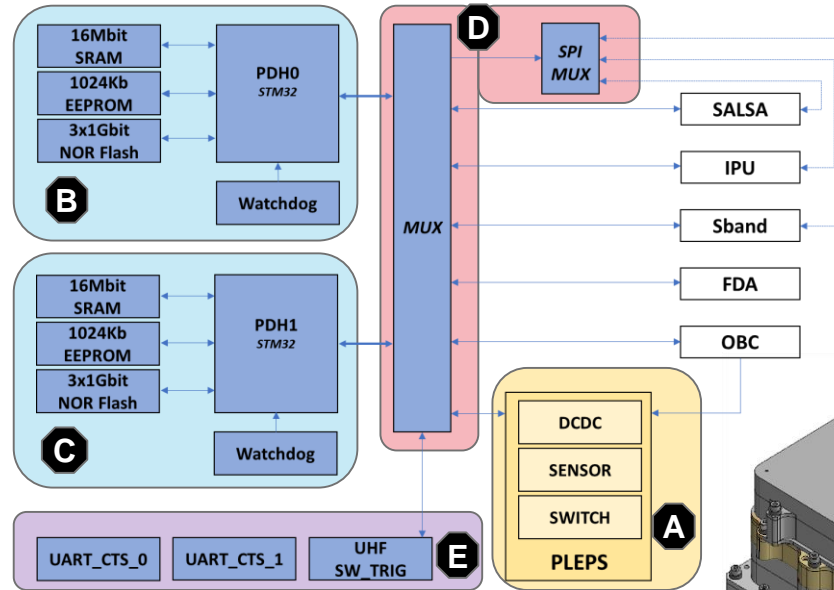
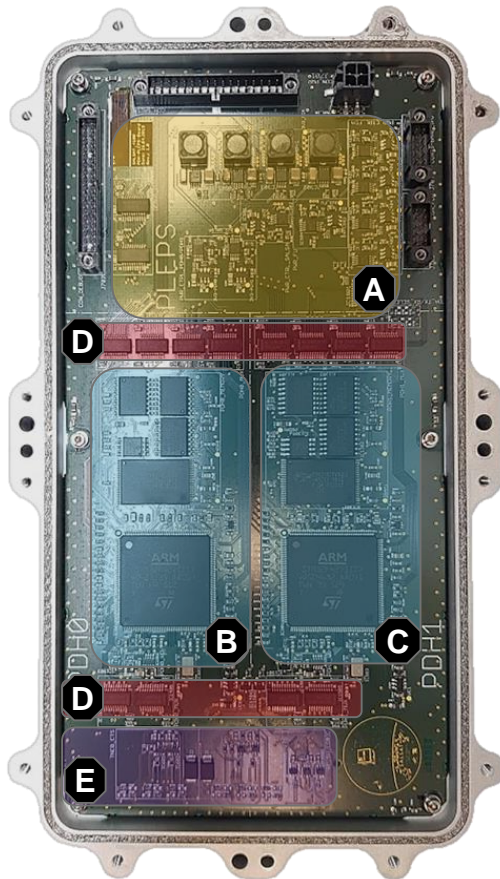
- A** LMS7002M RF Transceiver
- B** Intel Cyclone IV FPGA
- C** STM32F4 ARM
- D** S band, UHF, VHF Bandpass Filter
- E** PDH Connector
- F** S band, UHF, VHF COAX Connector

Filter FM

- Sband (BFCV-2610+) range from 2000 to 3220 MHz
- UHF (RBP-400+) ranges from 292 to 490 MHz
- VHF (RBP-160+) from 120 to 210 MHz



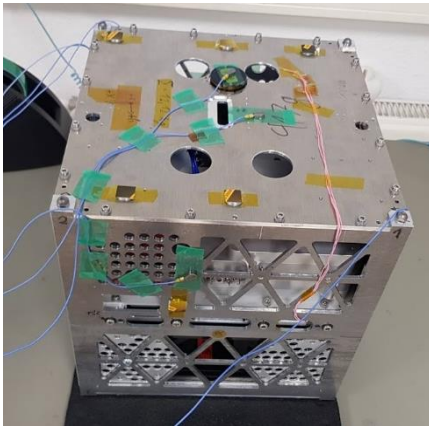
SALSAT: Payload Data Handling (PDH) & Payload Electrical Power Supply (PLEPS)



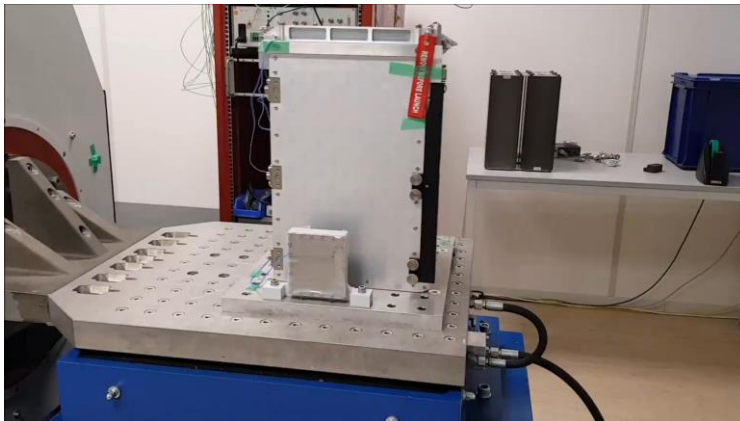
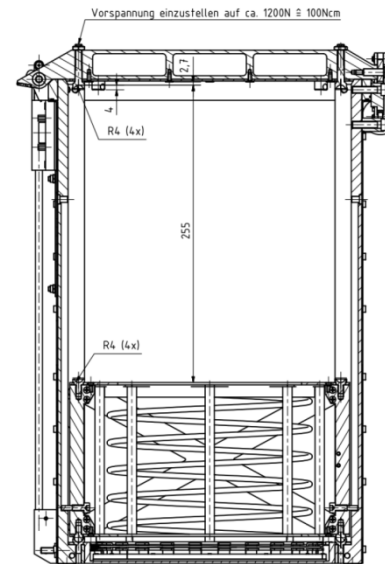
- A** Payload Electrical Power Supply
- B** Payload Data Handling 0
- C** Payload Data Handling 1
- D** Multiplexer
- E** UART CTS Circuit Node & RF Switch Trigger Logic



SALSAT: Mechanical Test – Resonance



- Frequency: 5 – 2000 Hz
- Acceleration: 0,35 g
- Sampling Rate: 2 oct/min (one upsweep)

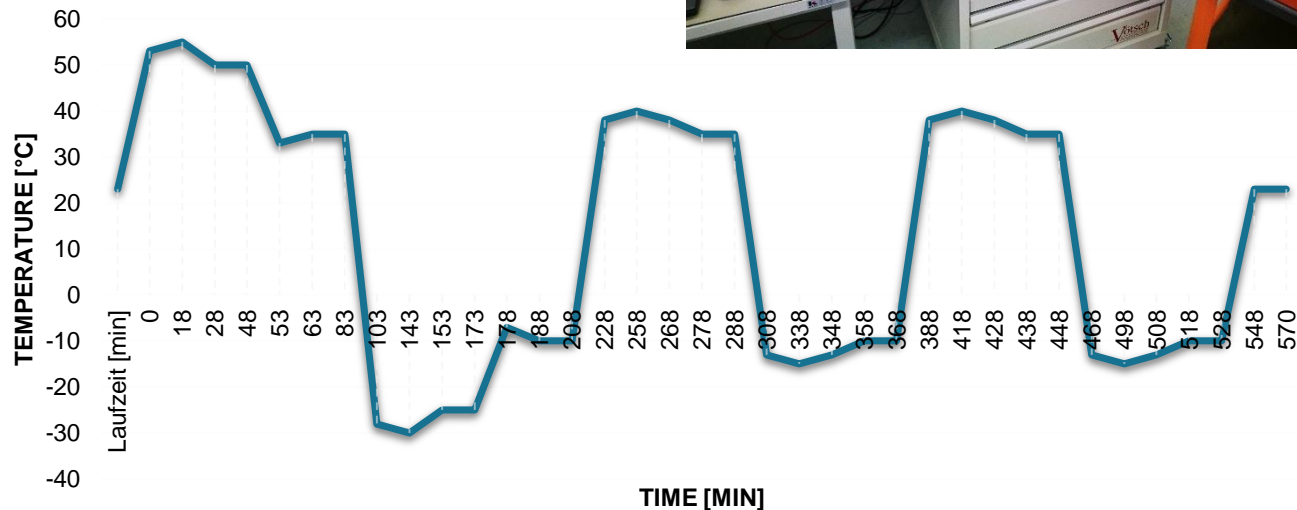


SALSAT: Thermal Cycle Test

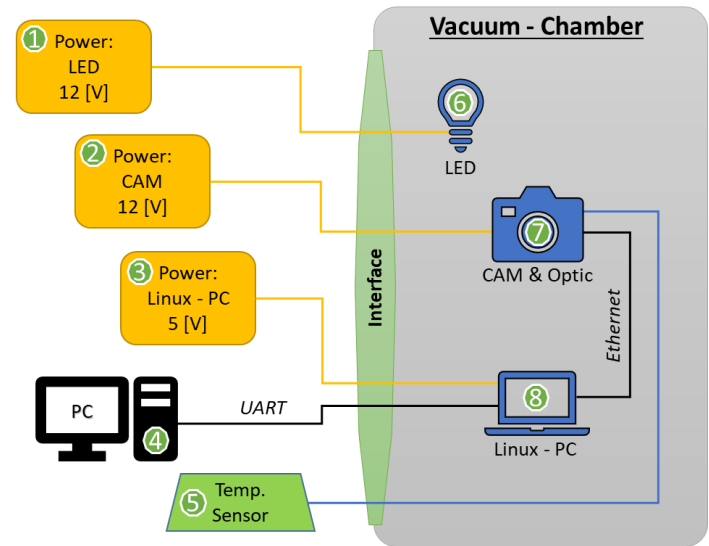
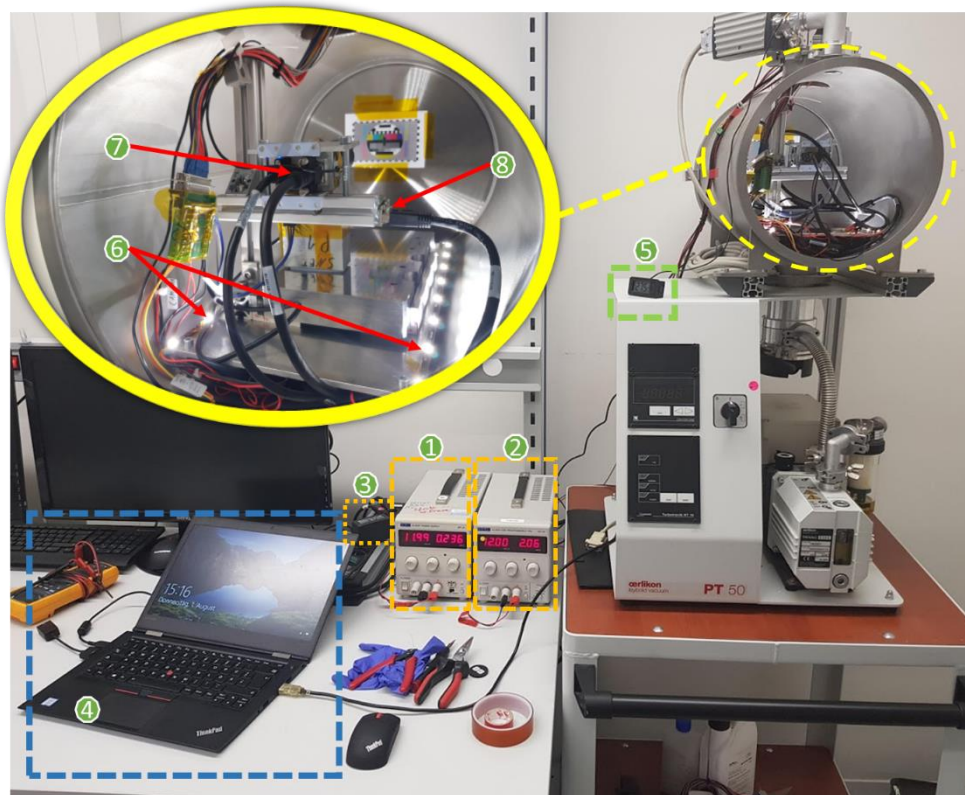
Test Parameters	Qualification Level
T_{NO-max}	60 °C
T_{SU-max} und T_{Q-max}	50 °C
T_{SU-min} und T_{Q-min}	-20 °C
T_{NO-min}	-40 °C
Dwell Time	min. 1/2 h
Cycles	4



Thermal Cycle Qualification



SALSAT: Vacuum Testing



SALSAT: TID Testing

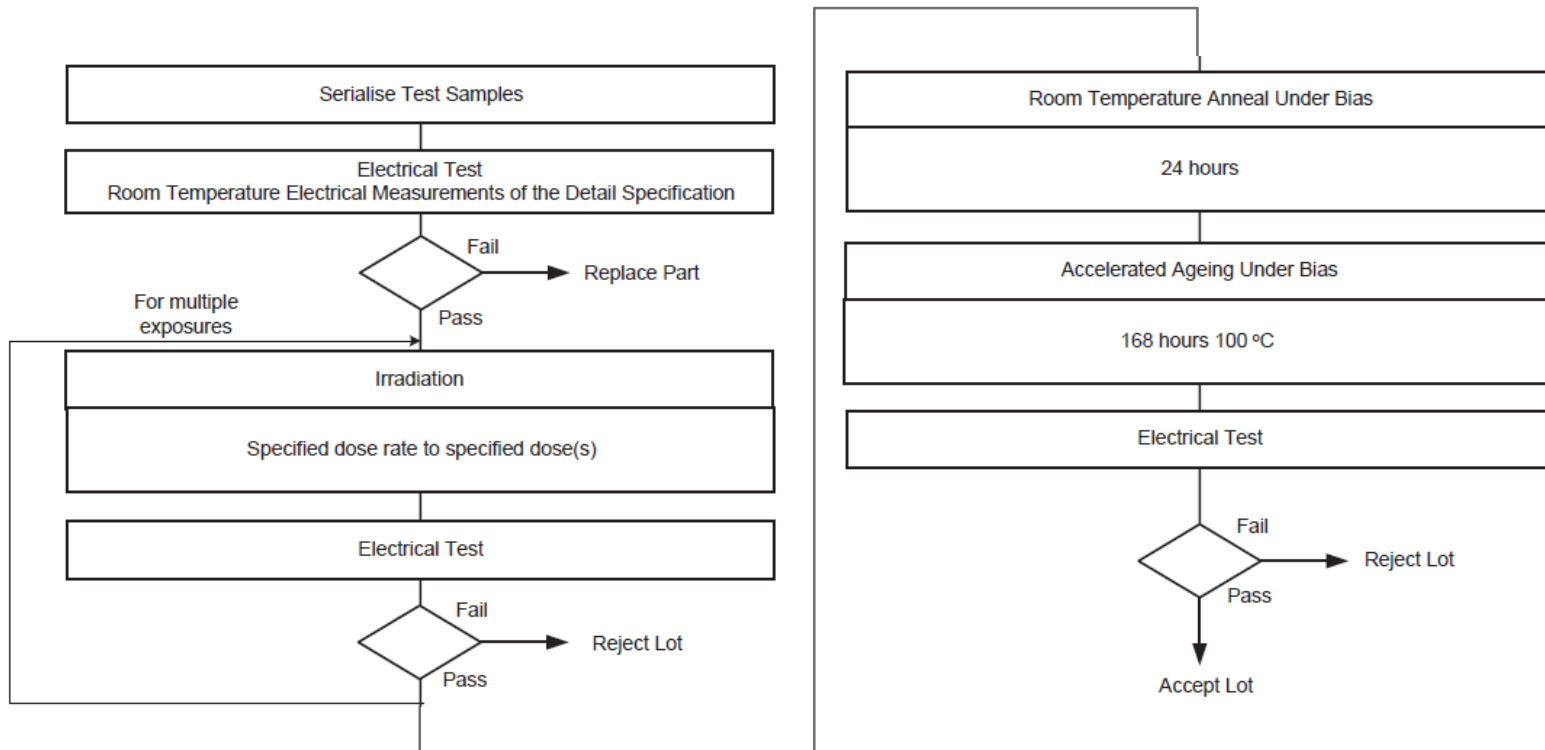
MR-01	SALSAT shall have a mission lifetime of at least 1 year.
ER-02	The space segment shall withstand the accumulated radiation loads over the entire lifetime in orbit without loss of functionality.

Mission Requirements

ESCC (European Space Components Coordination) No. 22900 by ESA (Chapter 4)

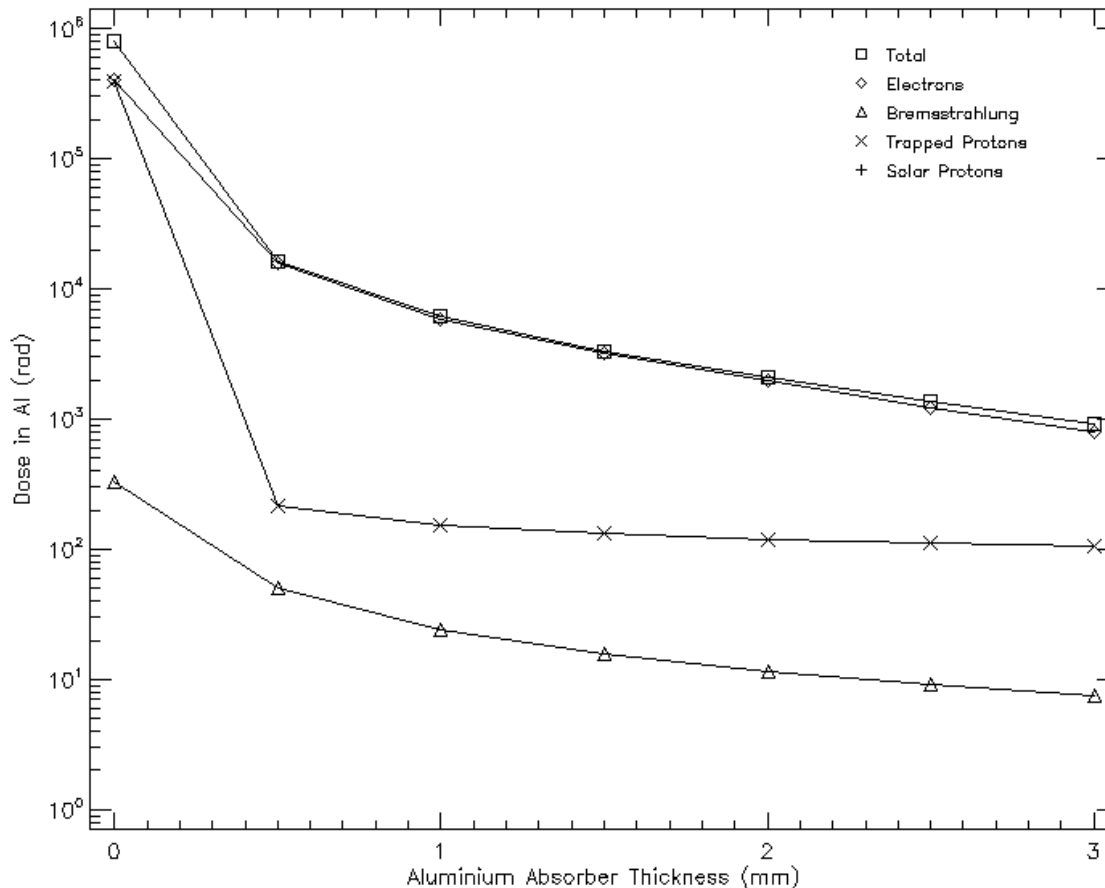
- Radiation Source: Cobalt 60 **or** electron accelerator beam
- Accuracy & non-uniformity: +/- 10%
- Radiation Level: M = 30 Gy(Si) **up to** H 10.000 Gy(Si)
- „standard“ / „low“ rate: 36 – 360 Gy/h **or** 0.36 – 3.6 Gy/h
- ambient temperature: +20 ± 10°C
- Exposure time: < 96 h
- Test steps & exposure: 3 steps: $\frac{1}{3} \cdot D_{TID}$ | $1 \cdot D_{TID}$ | $3 \cdot D_{TID}$

SALSAT: TID Testing



ESCC No. 22900 (Fig. 2, cpt. 8.2)

SALSAT: TID Testing

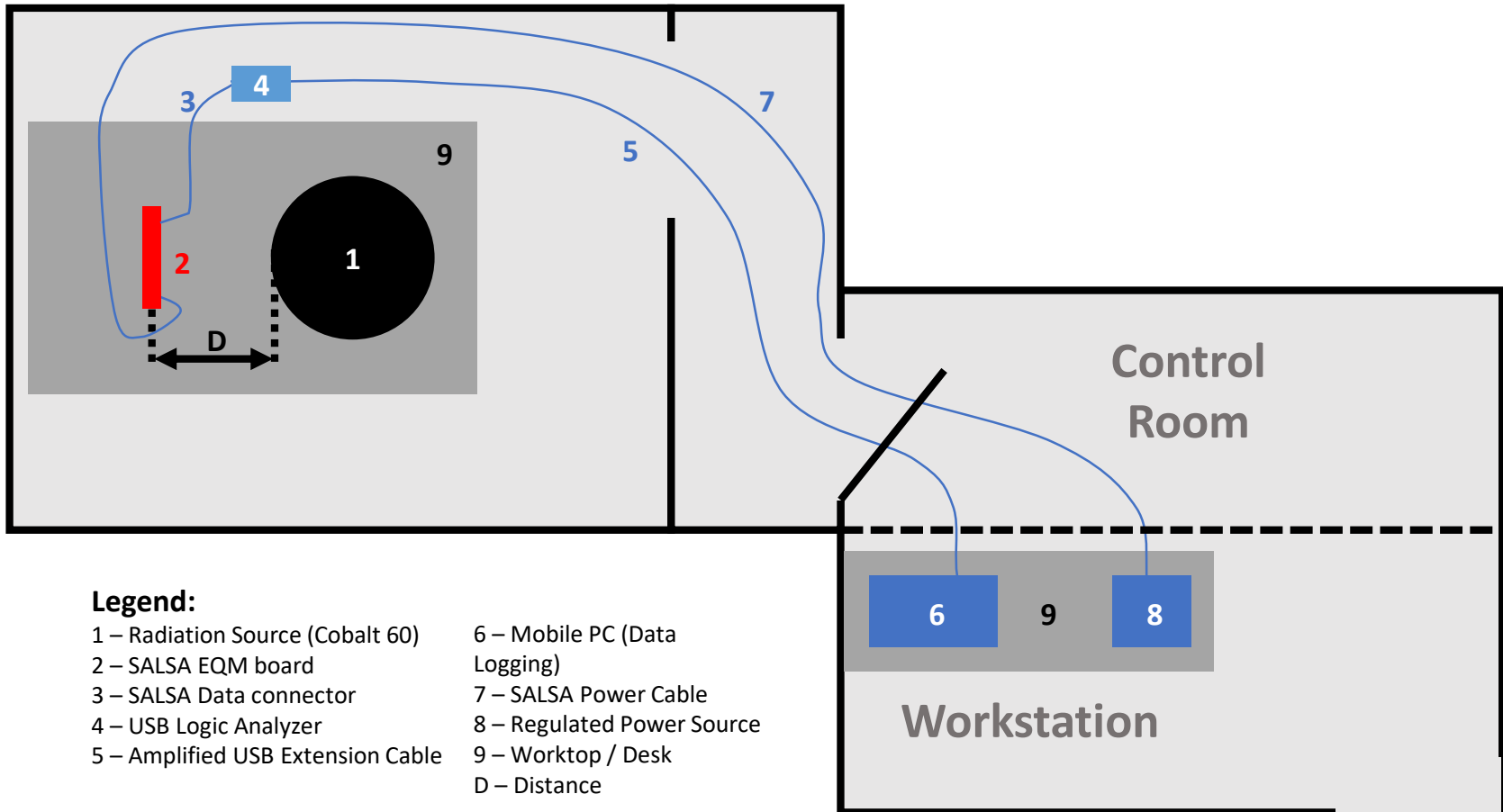


Parameter	Input
Trapped electron and proton fluxes	AE8 (solar maximum)
Solar particle flux	ESP-PSYCHIC (worst event fluence)
Galactic cosmic ray fluxes	GCR ISO 15390 (solar minimum)
Shielding model	SHIELDOSE-2 (2 mm aluminum)

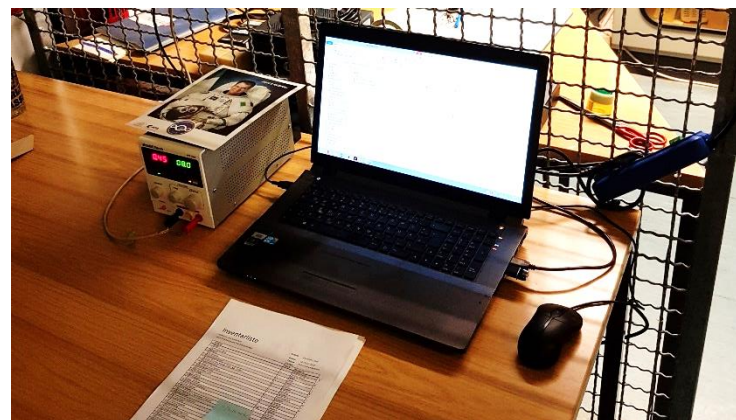
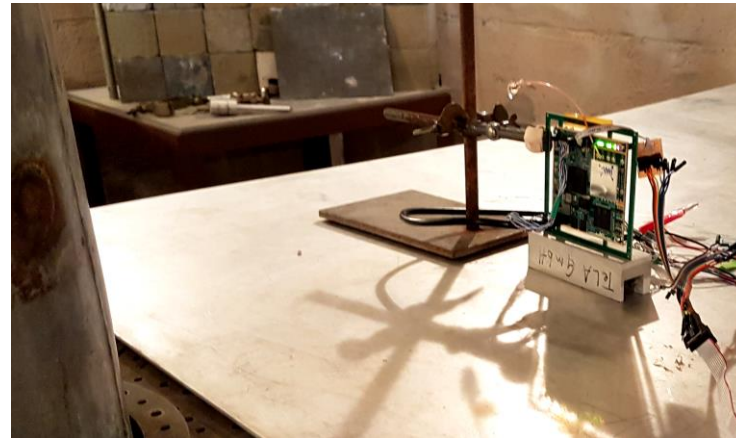
Source: SALSAT, S-Net internal project documentation

Diagram generated with SPENVIS (Space Environment, Effects, and Education System), NASA

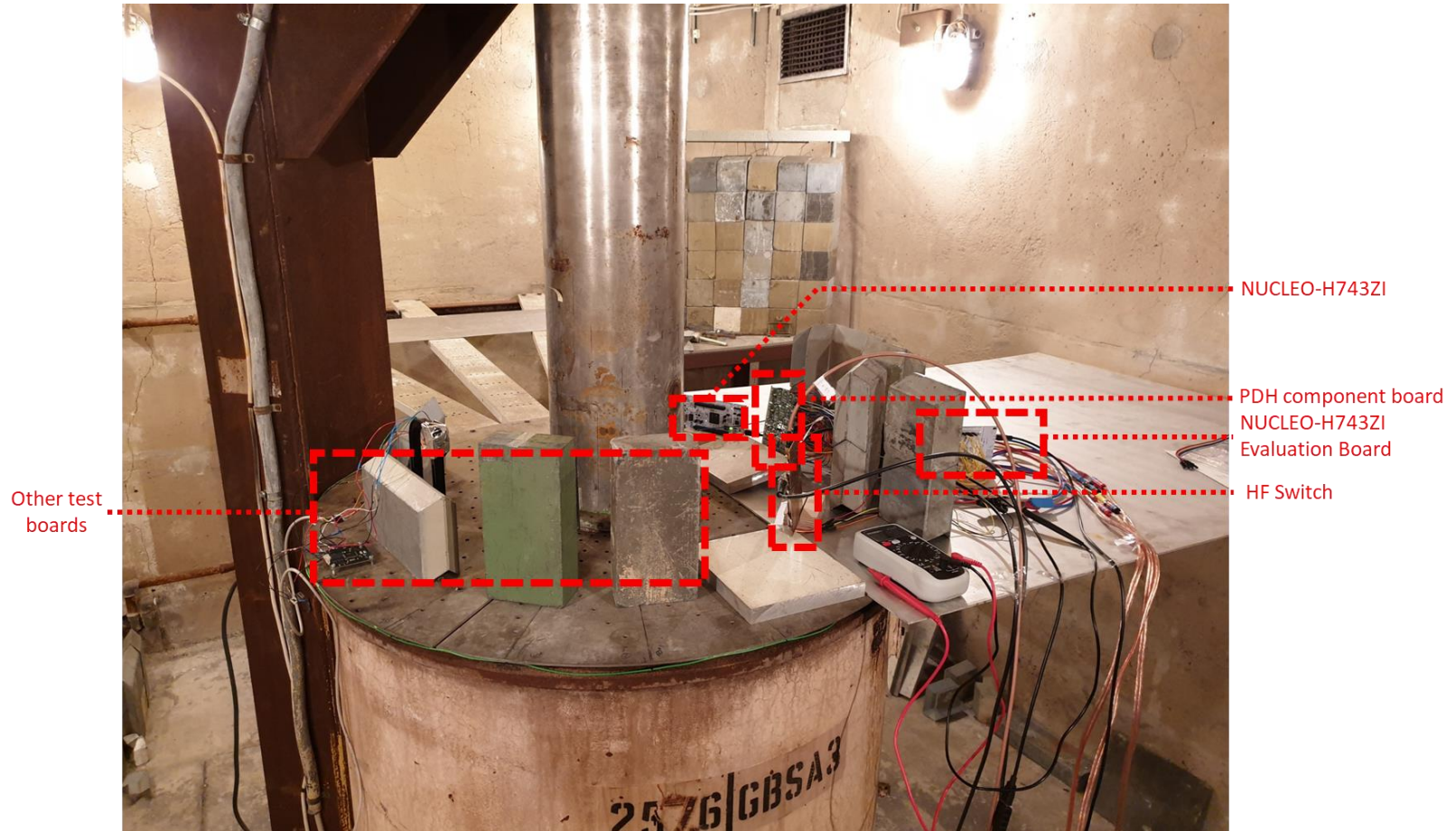
SALSAT: TID Testing



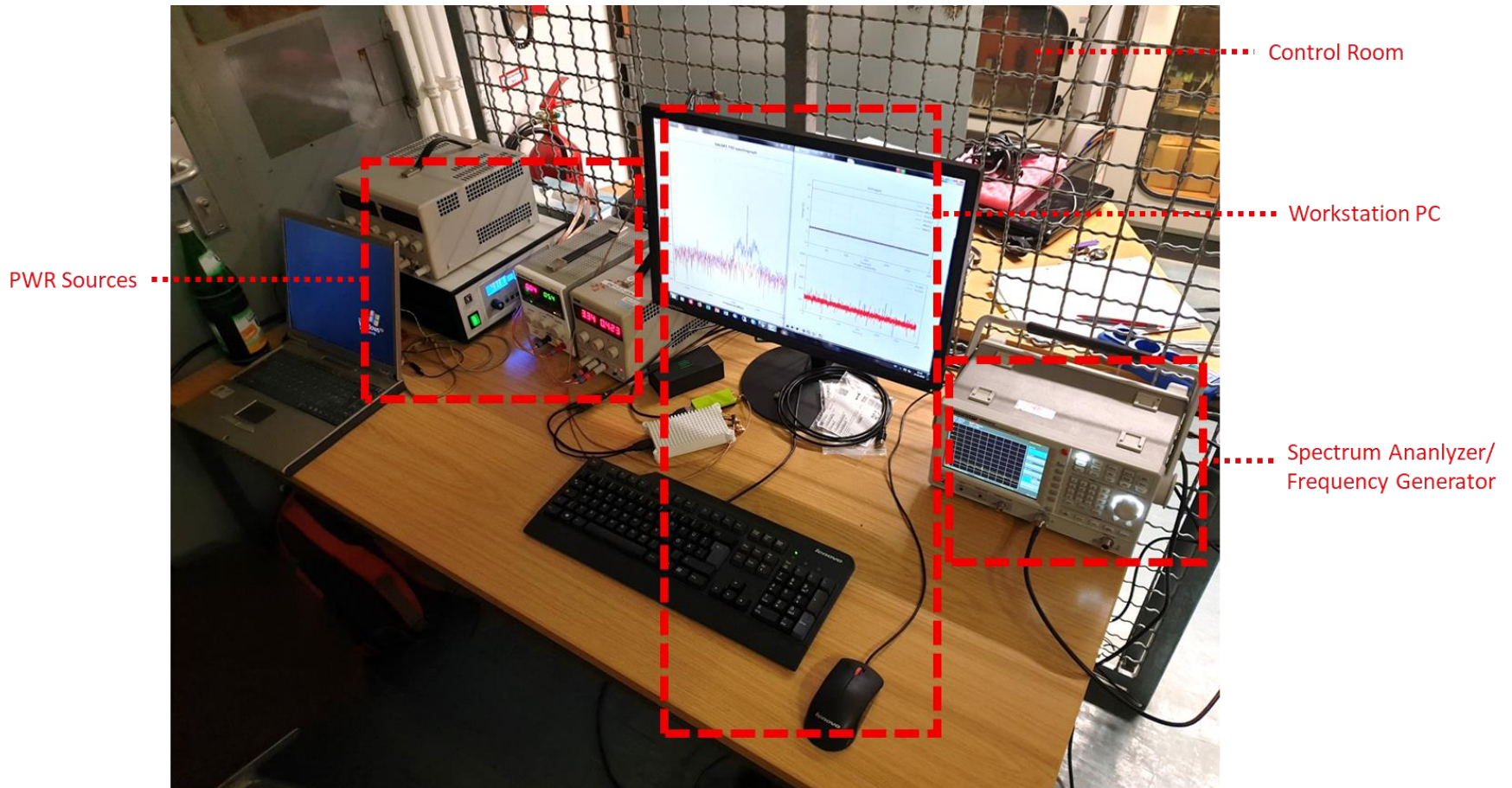
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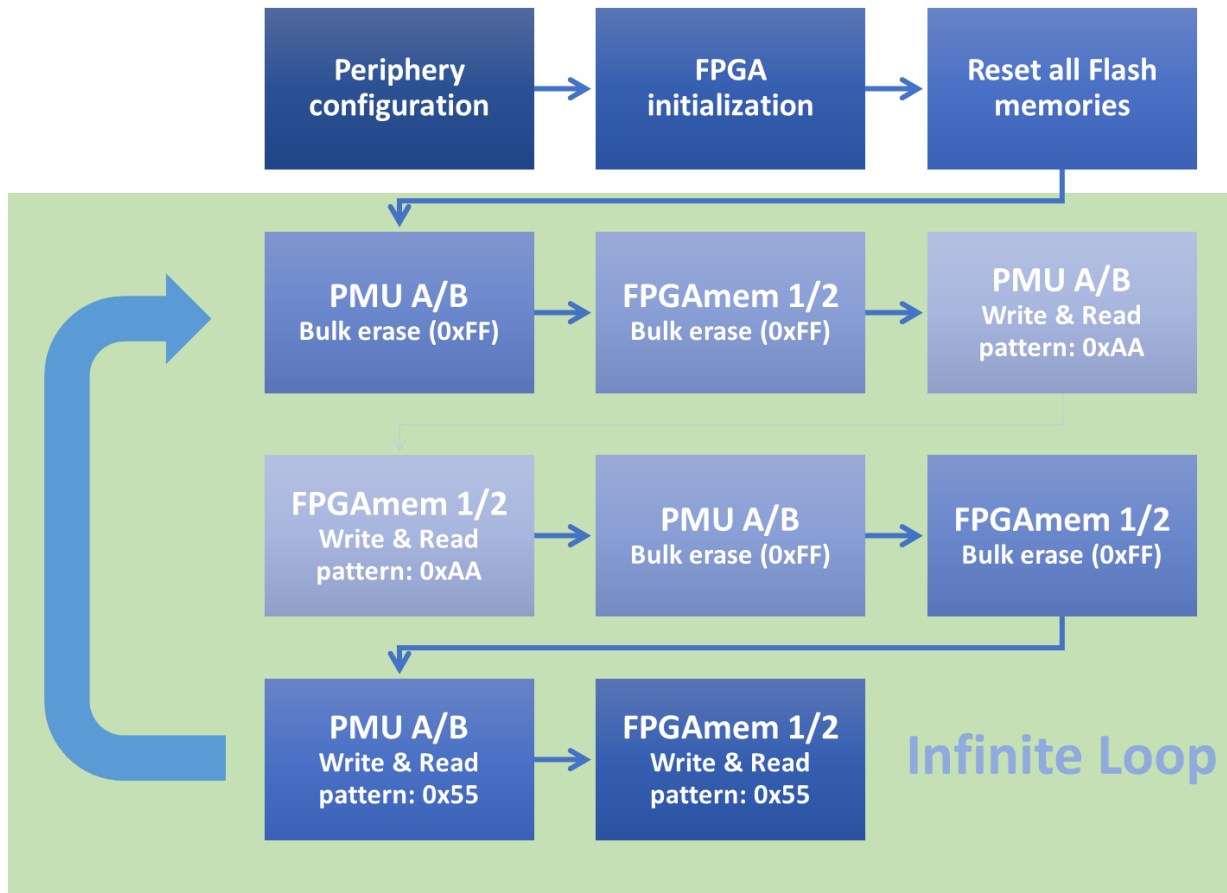
SALSAT: TID Testing



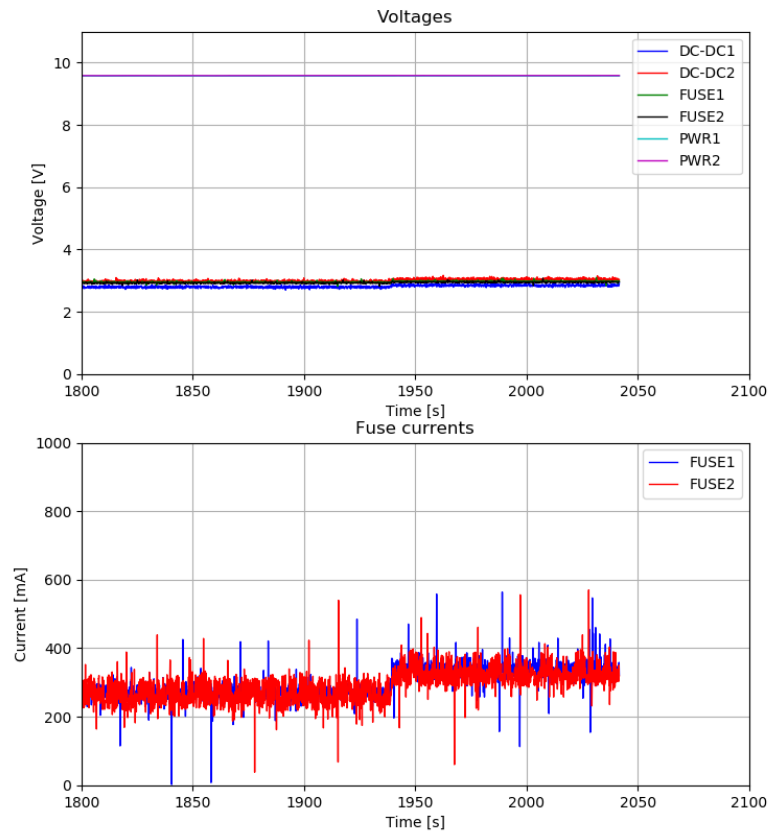
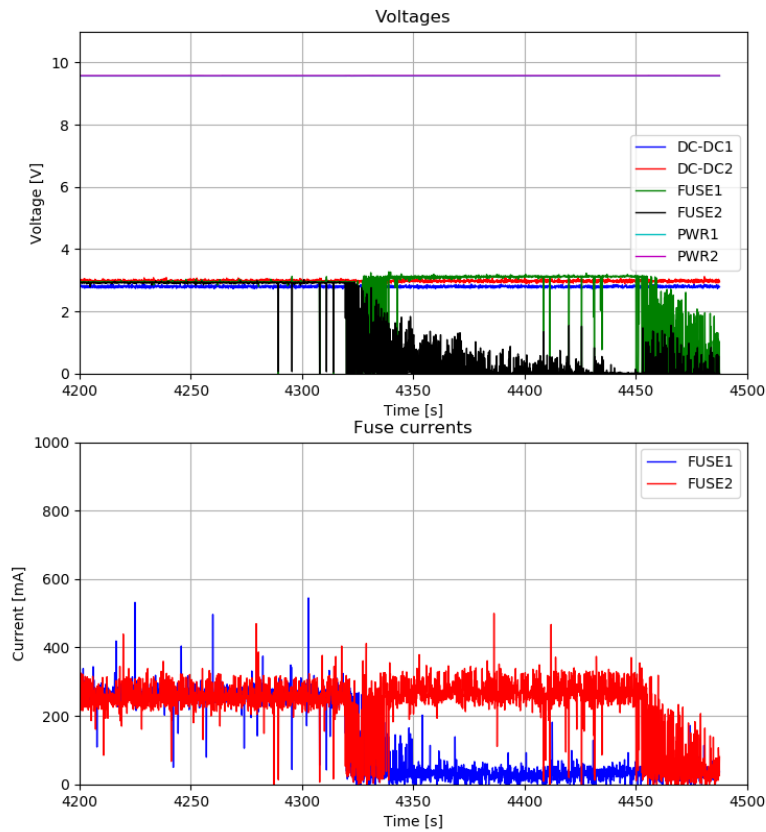
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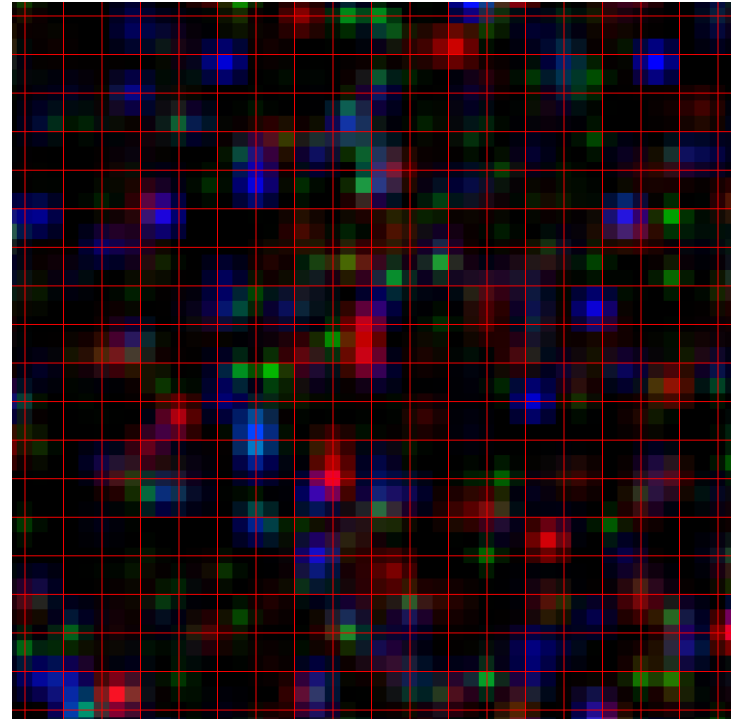
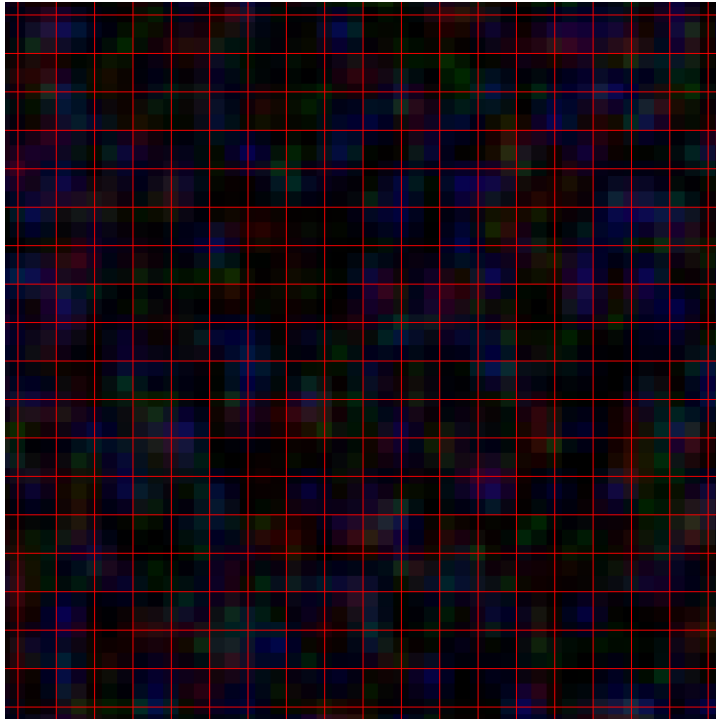
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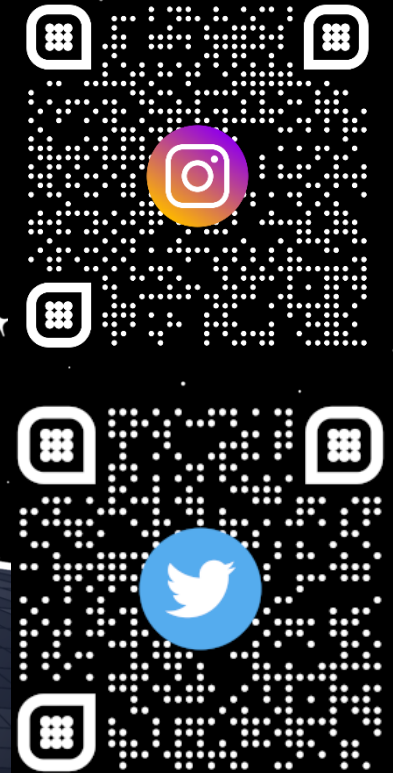
SALSAT: TID Testing



#salsatquestions

@SALSATmission

SALSAT



Acknowledgements



Supported by:



on the basis of a decision
by the German Bundestag

SALSAT: BMWi grant No.: 50 YB 1805
in cooperation with the German
Space Administration (DLR)

FDA: BMBF/DFG grant No.: BR 3539/5-1



Thank you for your attention!

