# A Technical View of the NetSat Mission

NetSat Launch Party, Würzburg, 28.09.2020

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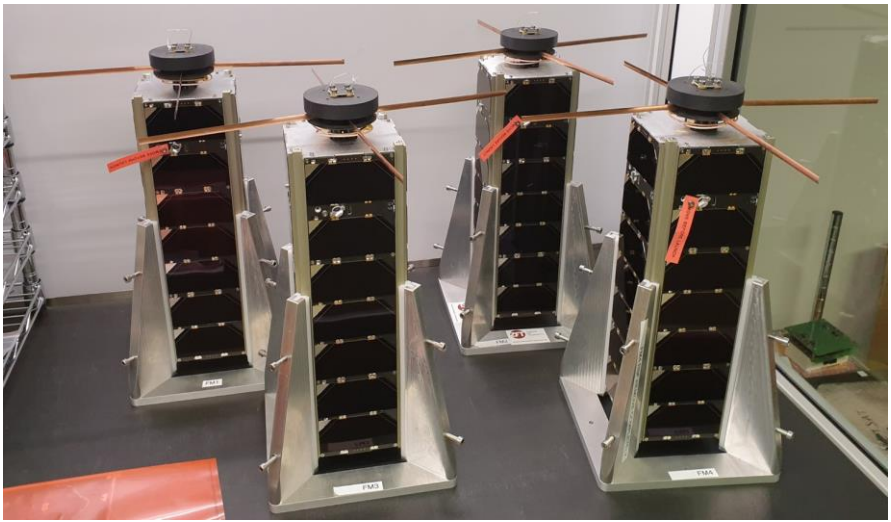
European Research Council
Established by the European Commission

Bayerisches Staatsministerium für
Wirtschaft, Landesentwicklung und Energie

# The NetSat Satellites

Four CubeSats to Demonstrate Autonomous Cooperation of Satellites in Three Dimensions in Space

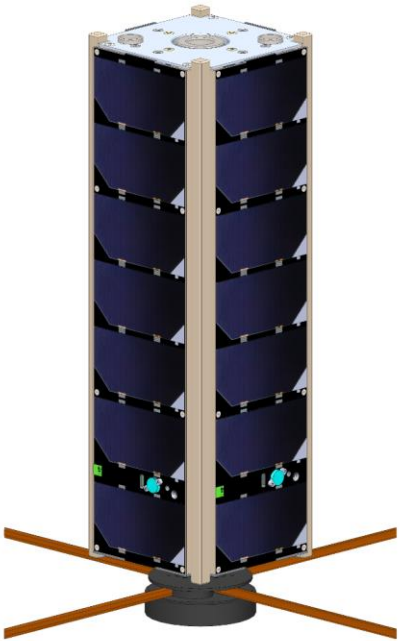


The four NetSat satellites before delivery to the launch site in a cleanroom storage


- 4 identical small satellites
- 3-Unit CubeSats (10 x 10 x 30 cm each)
- 3.9 kg mass
- All typical functionalities on compact volume

# The NetSat Satellites

Composition of the Subsystems within the Modular Satellite Structure



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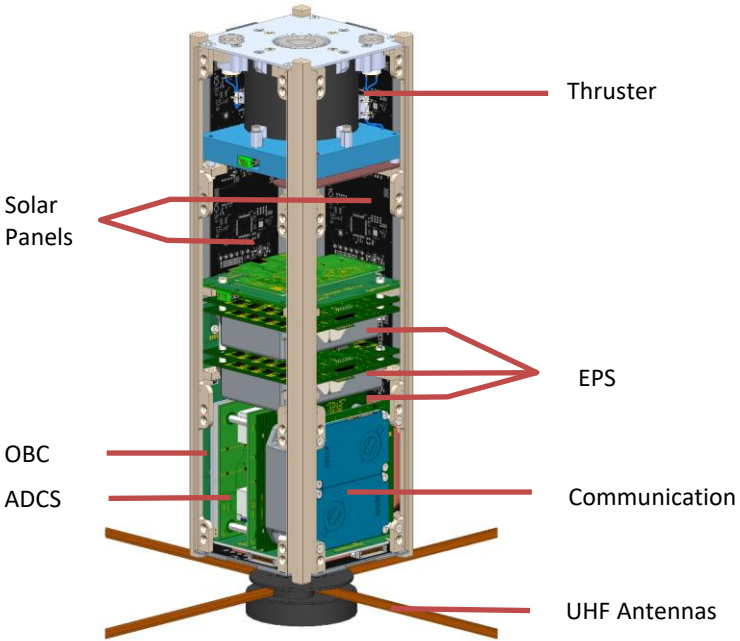
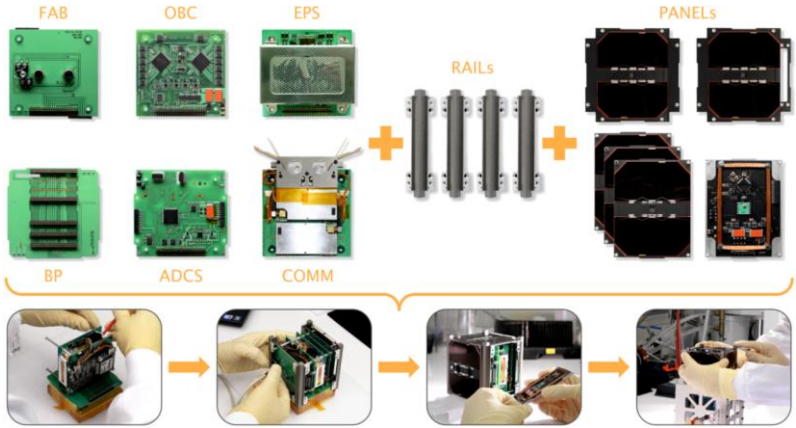


# Modular Satellite Bus

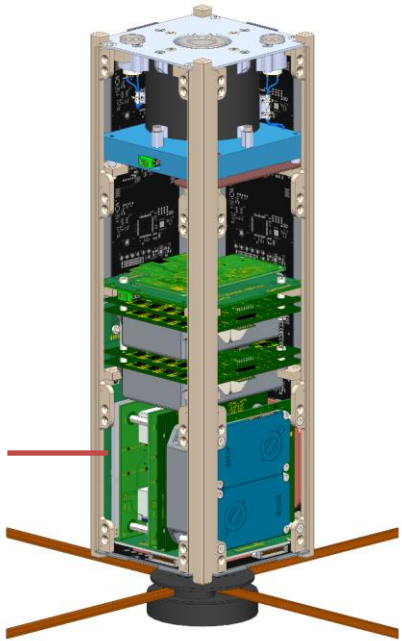
- Modular and flexible satellite system design
- No harness, no wires
- Standardization of electrical and mechanical interface



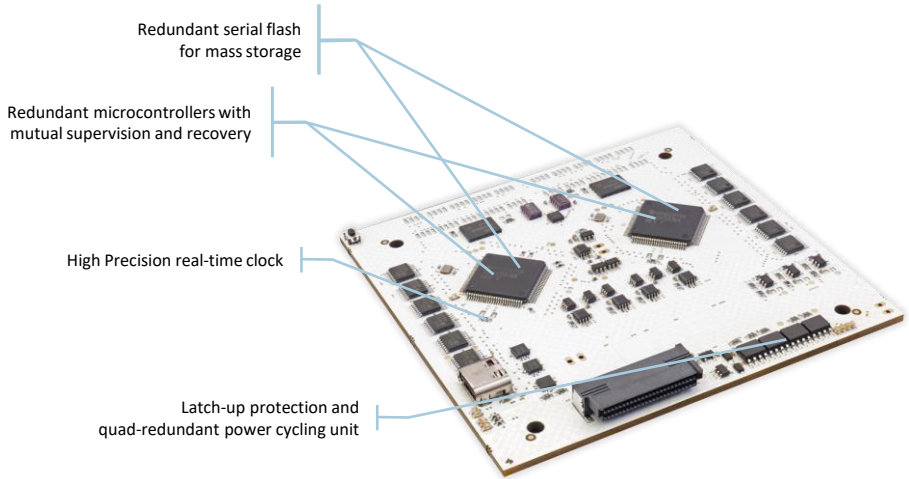

Electrical IF standards supported by UNISEC Europe: http://unisec-europe.eu/standards/bus/

# On Board Computer

Robust Data Handling using Commercial of the Shelf Components and Intelligent Software for FDIR

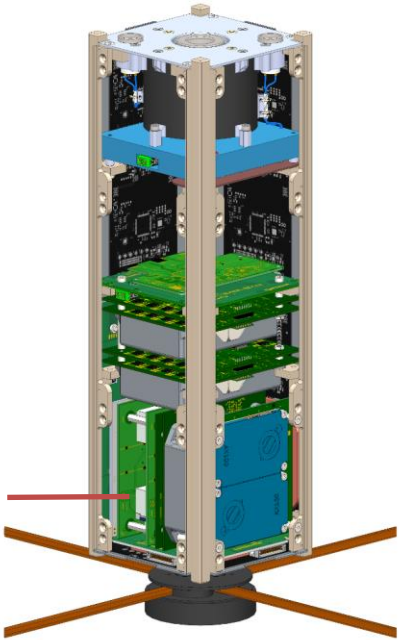



- Complete redundant design including redundant microcontrollers with mutual supervision, memory etc.
- 6.5 years of life time in orbit (shown in UWE-3) without any interruption, despite encountered SEUs and latch-ups

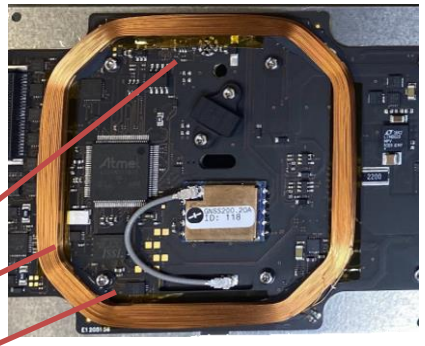


# Attitude Determination and Control System

Distributed ADCS System including Multiple Sensors and Actuators




- Attitude control essential for
  - charging batteries (sun pointing)
  - performing orbit maneuvers (thrust pointing)
- Sensor and actuator set
  - Miniature sun sensor (NanEye)
  - Magnetic air coil
  - Inertial measurement unit (IMU)



- Reaction wheel assembly:
  - Miniature electric motor (20x20x20 mm, 26g)
  - Full redundancy (or double performance) by using 2 wheels in each direction

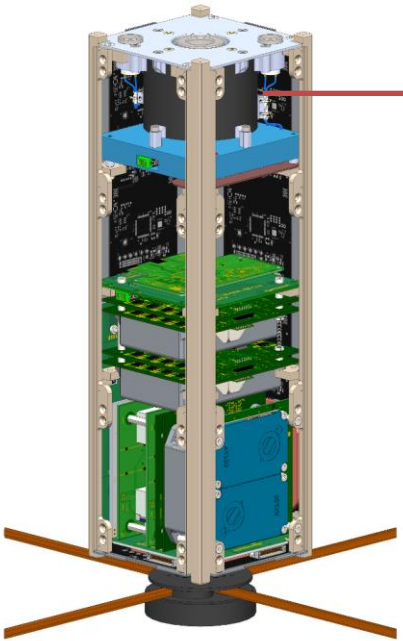
WITTENSTEIN | cyber motor

Smart Small Satellite Systems S4 GmbH

# Orbit Determination and Control

GNSS Based Relative Navigation and Control Using Electric Propulsion

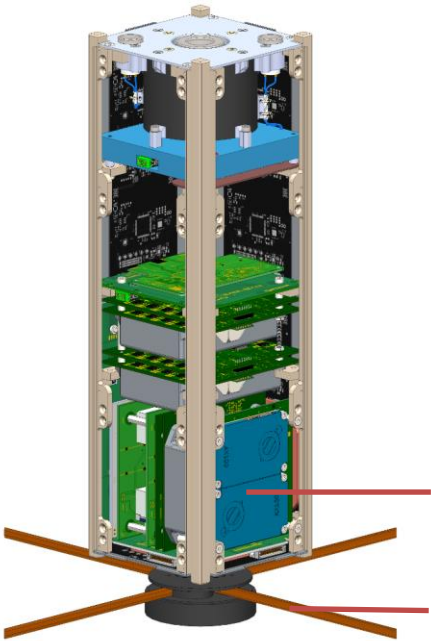
HYPERION TECHNOLOGIES



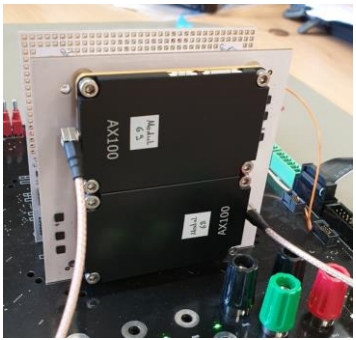

- Orbit determination using miniature GNSS receiver (20x15x3 mm)
- Orbit control using electric propulsion
  - 10 - 350 µN thrust
  - Total impuls: > 5000 Ns
  - Δv: > 1000 m/s (5 kg CubeSat)
  - Inert non-pressurized propellant (Indium)

# Communication System

Ground and Inter Satellite Communication Enabling Autonomous Formation Flying



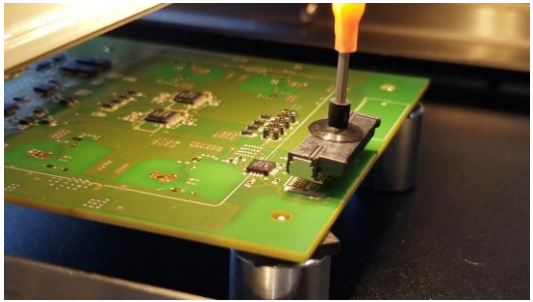

- Amateur UHF antennas
- λ/2 redundant dipoles
- Redundant transceivers



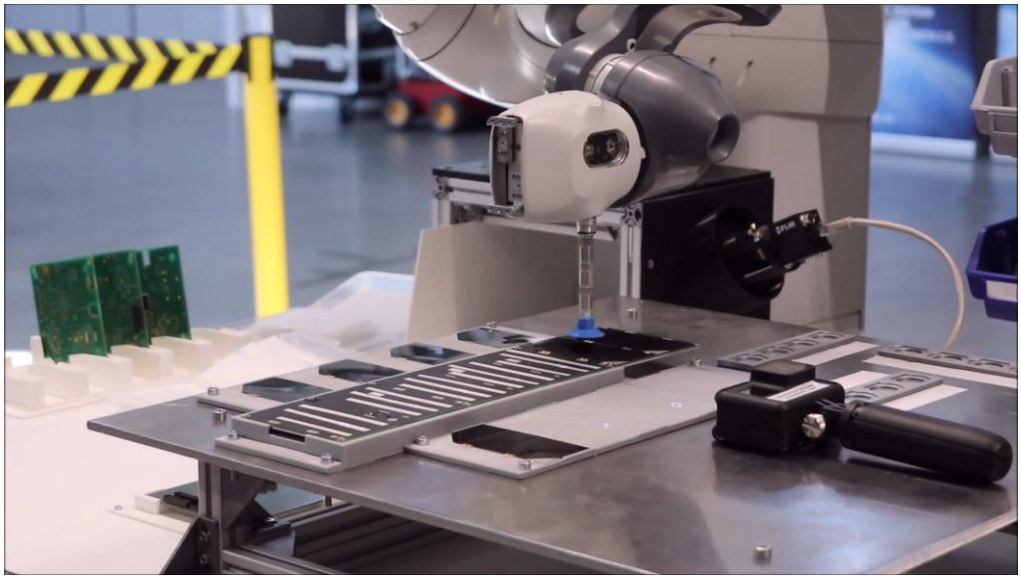

- Self-developed antenna deployment mechanism

# Satellite Manufacturing at ZfT

- Many manufacturing steps performed in house
  - Pick & placement of electronics components
  - Soldering
  - Solar cells assembly



In house electronics pick & placement



In house automated solar cell assembly using robot manipulator

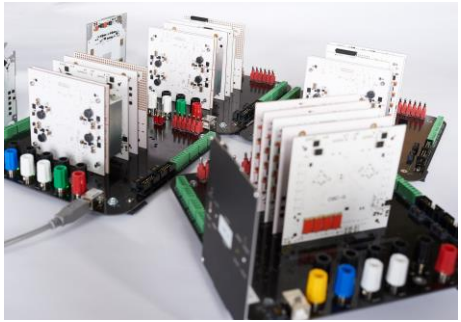
# Satellite Integration at ZfT

- Satellite integration completely done in house at ZfT using modular UNISEC concept


Satellite integration within 2-3 hours due to modular setup

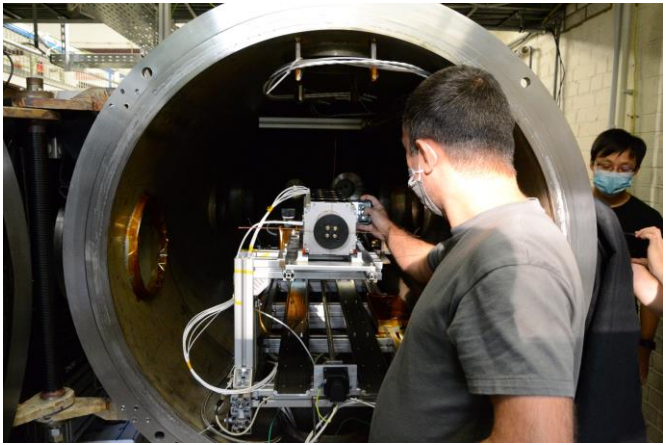
# Testing

- Modular UNISEC based DevKit used for in house tests at ZfT
- In house system tests on the satellites
- Environmental tests performed at external test facilities
  - Thruster tests at IRS
  - Thermal-vacuum tests at IABG



UNISEC DevKit

ZfT staff performing in house testing

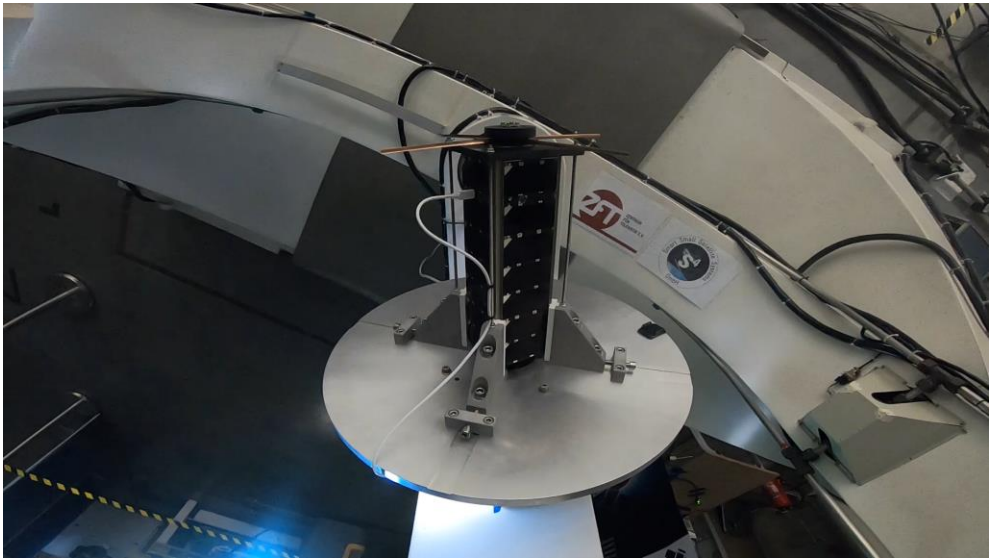


ZfT collaborator preparing engineering model in vacuum chamber

# Testing

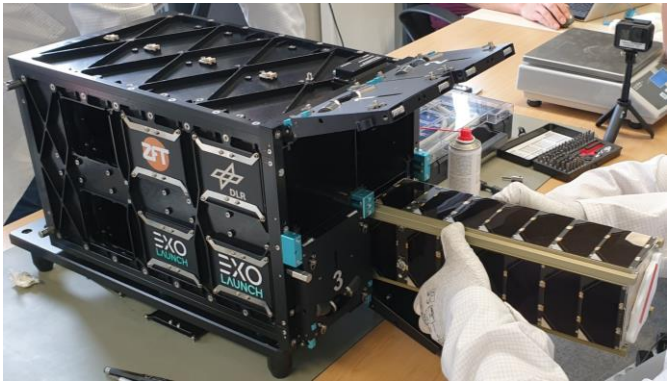
- Sun sensor calibration performed with high precision dynamic bench test facility from S4 GmbH

S4 dynamic test bench facility



NanEye sun sensor calibration on turn tables

# On the Way to Russia




Insertion of NetSat satellites into deployer


Integration of deployers into upper stage

Soyuz rocket on the way to the launch pad

- Launch site: Plesetsk, Russia
- Launch date: 28.09.2020 13:20:07 (CET)
- Orbit insertion of the 4 NetSat satellites at 16:52:12 (CET)

# Many Supportive Partners



cyber motor







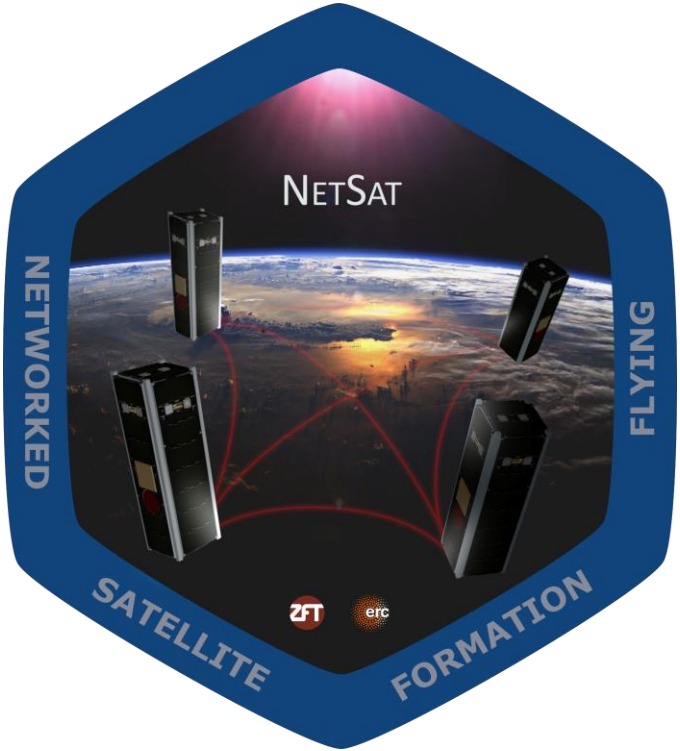



And many many more…

# A Highly Motivated Team


| | |
|---|---|
| Back row: | Philipp Wolf, Ilham Mammadov, Eddy Contreras, Julian Scharnagl, Oliver Ruf, Marcel Pörner, Alexander Kleinschrodt |
| Intermediate row: | Dennis Wellenzohn, Anna Aumann, Prof. Klaus Schilling, Slavi Dombrovski, Roland Haber, Eric Jäger |
| Front row: | Panagiotis Kremmydas, Florian Kempf |

Not on this picture, but no less involved: Daniel Garbe, Dieter Ziegler, Frederik Dunschen, Florian Leutert, Ursula Scherm and many more…

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