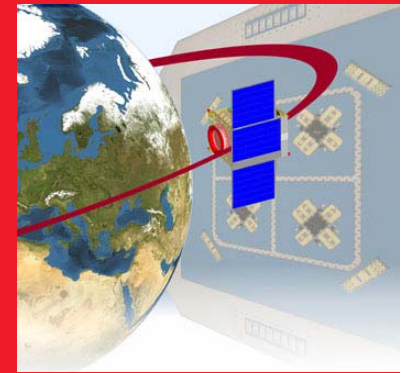


# KERAMIS-2

## Ceramic Microwave Circuits for Satellite Communication



Reinhard Kulke

Presented by Christian Hunscher,

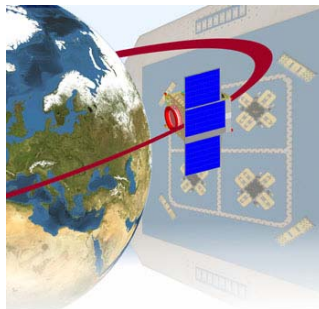


**IMST GmbH**

Carl-Friedrich-Gauss-Strasse 2, D-47475 Kamp-Lintfort, Germany  
President: Prof. Dr.-Ing. Ingo Wolff, Dr. Peter Waldow  
Amtsgericht Kleve HRB 6737, VAT-ID: DE 811348335



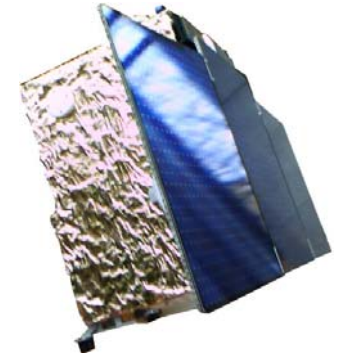
# KERAMIS-2 Project Partners



Funding: DLR / BMWI

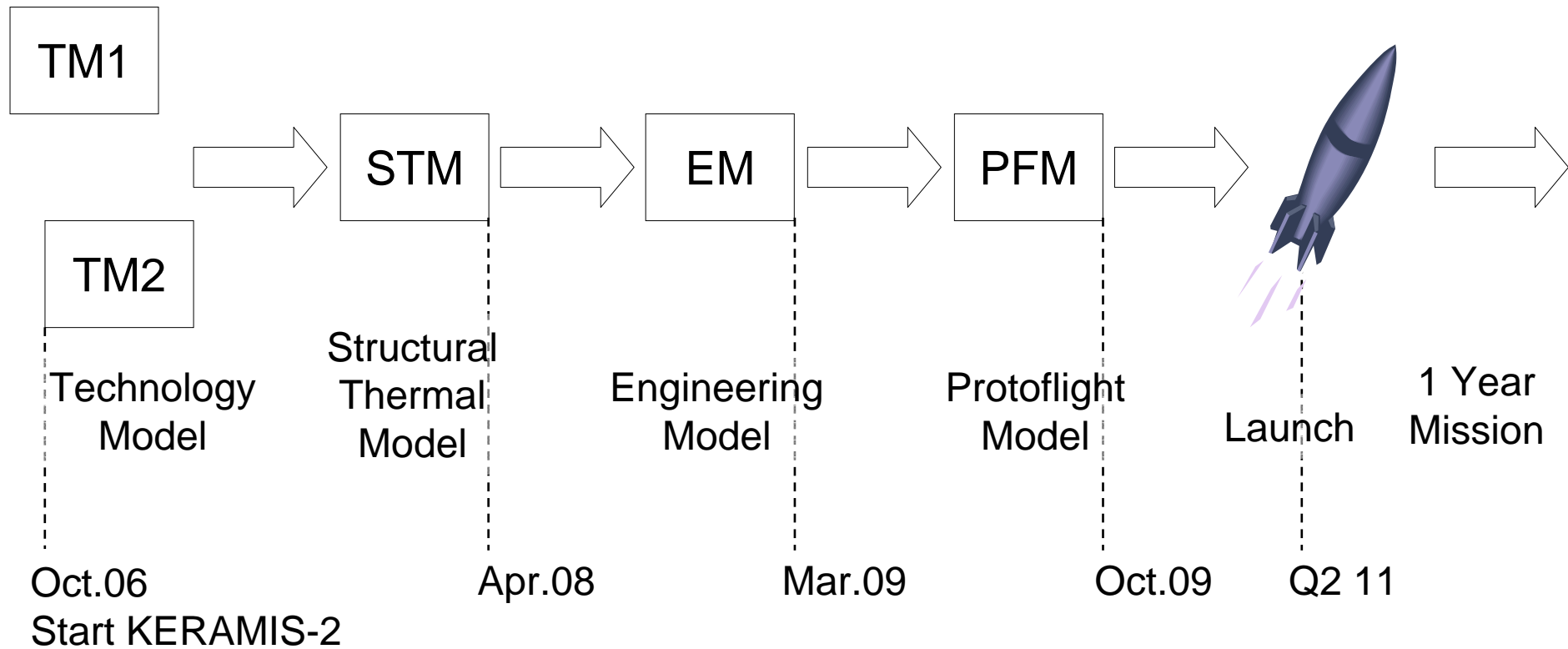


# Overview



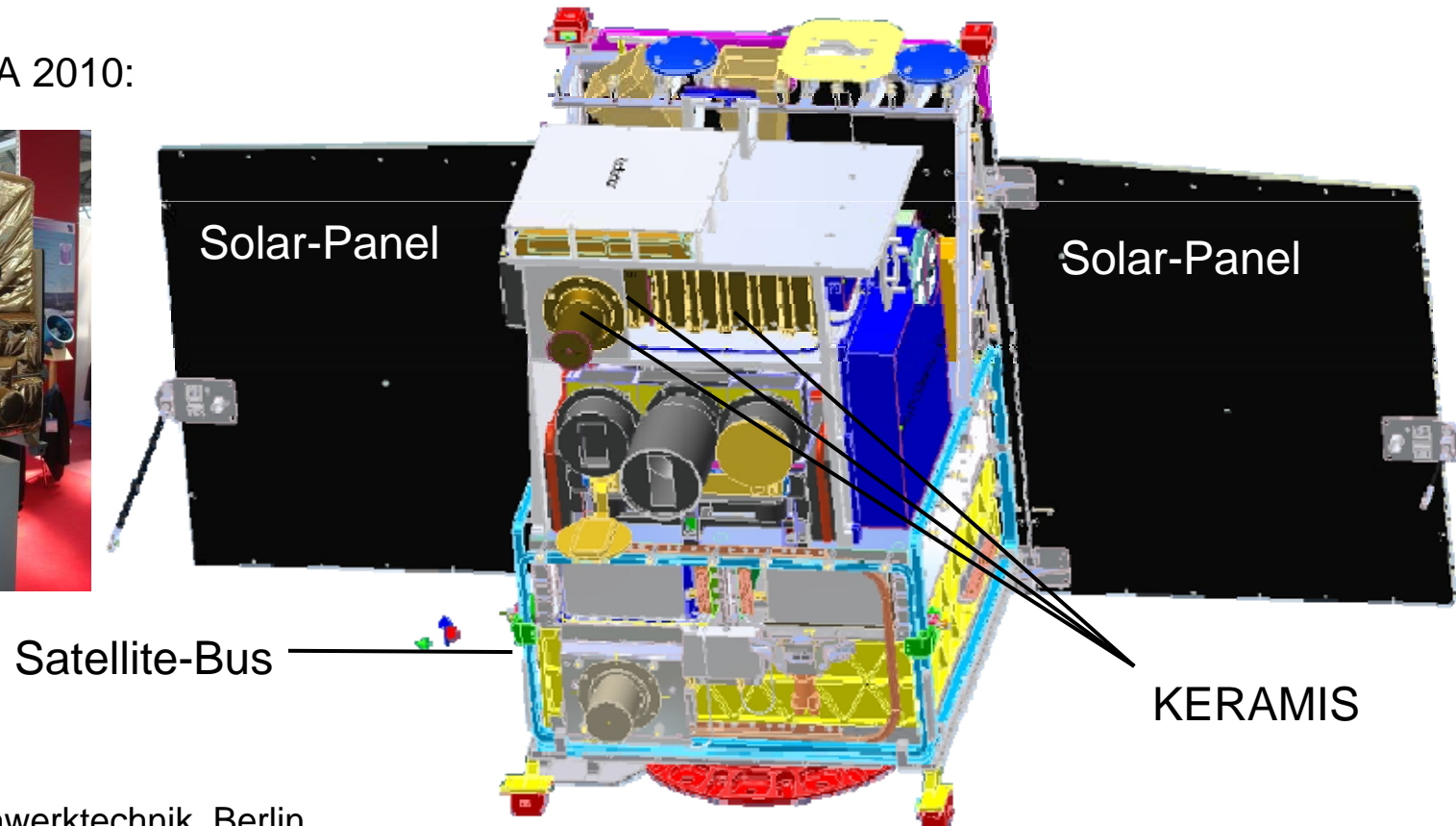
- “KERAMIS-Technology”  
LTCC Modules for 20 GHz Satellite Communication
- 3 RF-Experiments, HW, SW and AIT Development
  - „Switch Matrix“
  - „Synthesizer“
  - „Transceiver“Common Sat.-Payload
- Qualification, Verification
  - OOV: On-Orbit-Verification of DLR
  - TET-1: Technology-Exploration-Sat. (LEO, Start: June 2011)
- Preparation for H2-Sat Mission

# Protoflight Model-Philosophy



# OOV: On-Orbit-Verification TET: Technology Evaluation Sat.

1:1 Model at ILA 2010:



Courtesy of  
Astro und Feinwerktechnik, Berlin  
Kayser-Threde, Munich

Envelope: 0.65m x 0.5m x 0.88m  
Mass: 110 kg  
User: 40 kg

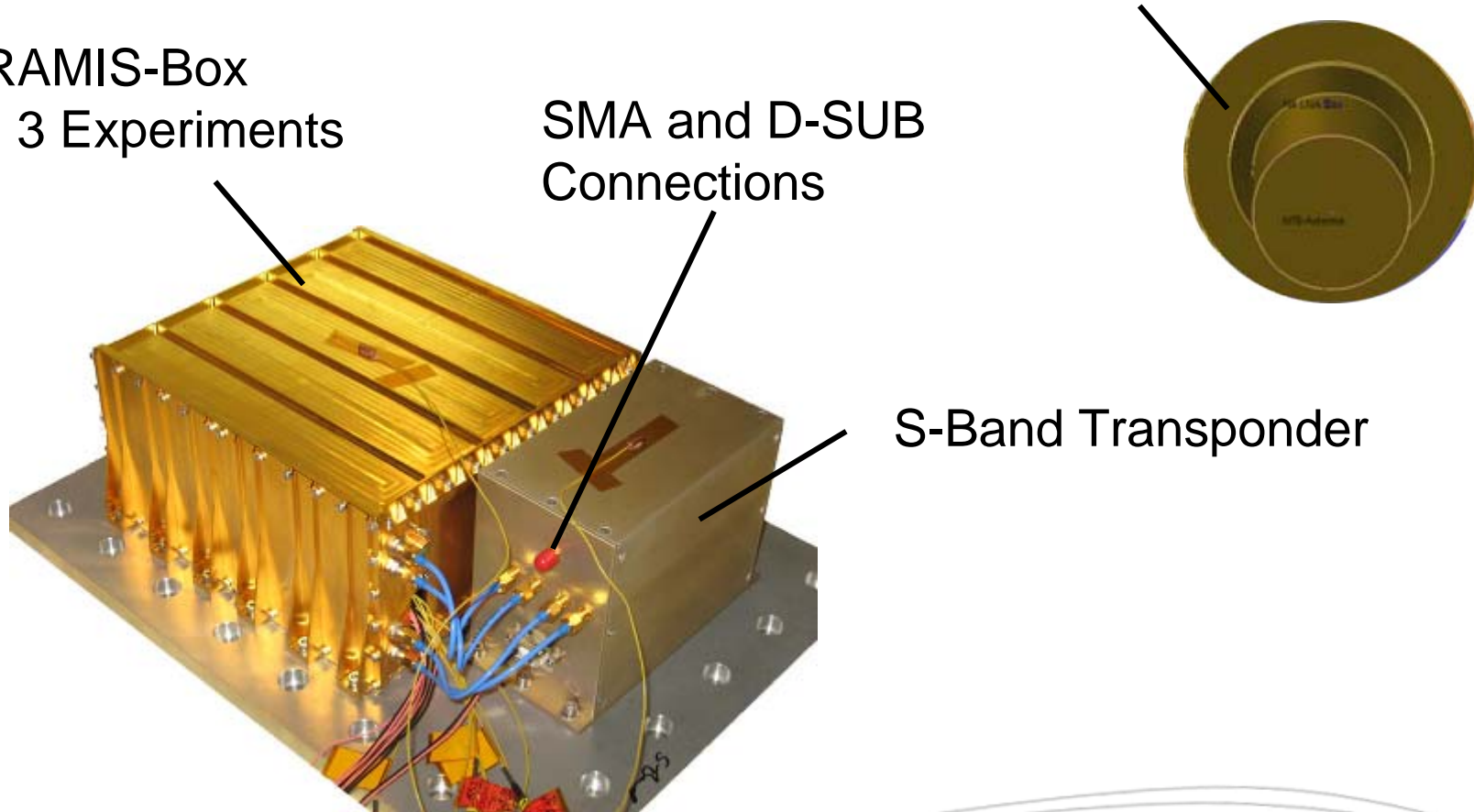
# KERAMIS Payload

KERAMIS-Box  
with 3 Experiments

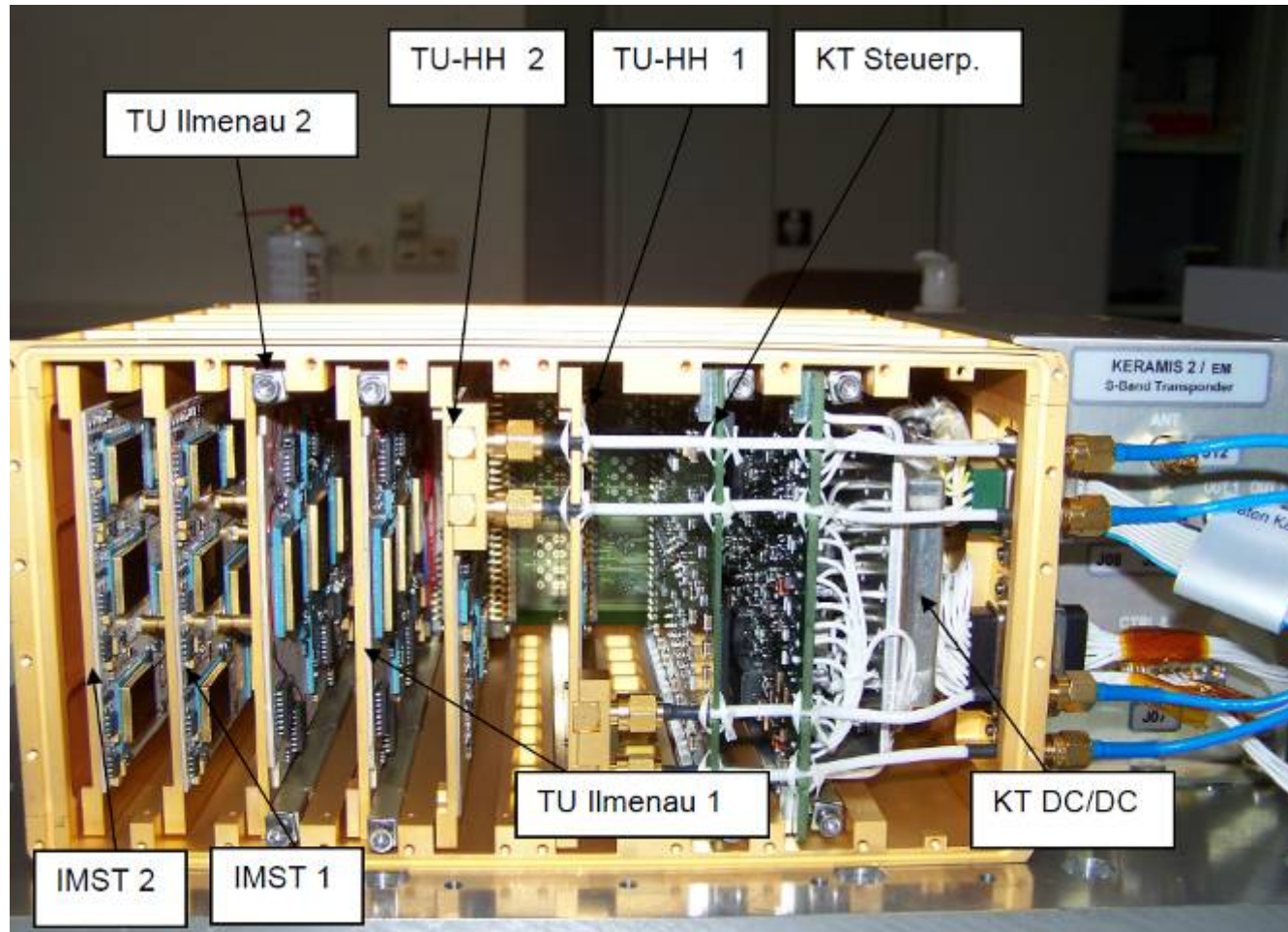
SMA and D-SUB  
Connections

S-Band Antenna

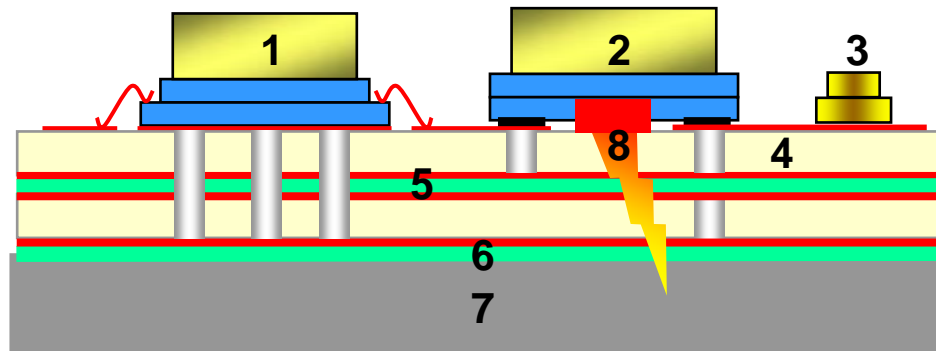
S-Band Transponder



# EM: Keramis-Box



# Keramis Technology = AIT Sat.



1. LTCC module with wire-bond connections
2. LTCC module with LGA/flipchip connections
3. mini-SMP connectors
4. RO6002 Multilayer PTFE substrate, 254 $\mu$ m
5. Bonding film
6. Able-Film, conductive epoxy
7. Aluminum-Carrier with gold, 2mm
8. Heat dissipation

## 20 GHz Modules

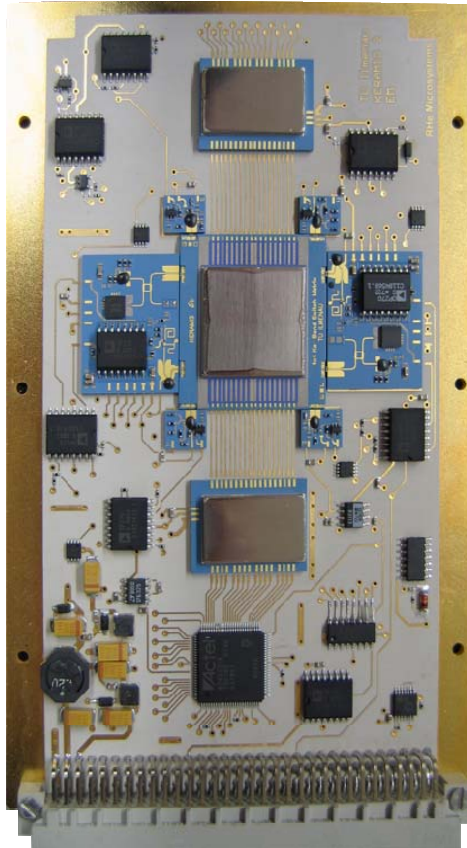
- Switch matrix
- SPDT-Switch
- Synthesizer
- Amplifiers (LNA, MPA, PA)
- Mixers
- Power Detectors
- Driver HW (diodes)

## Industrial manufacturing

- MSE, Berg
- RHE, Radeberg

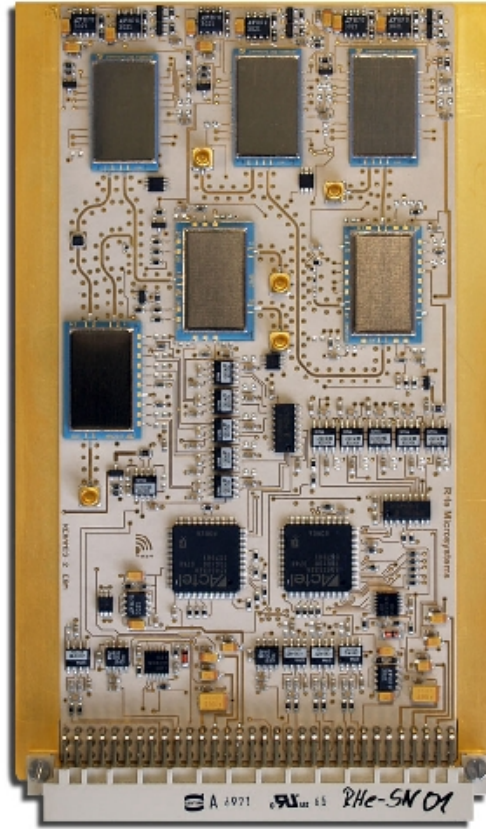
# Overview: 3 Experiments

I



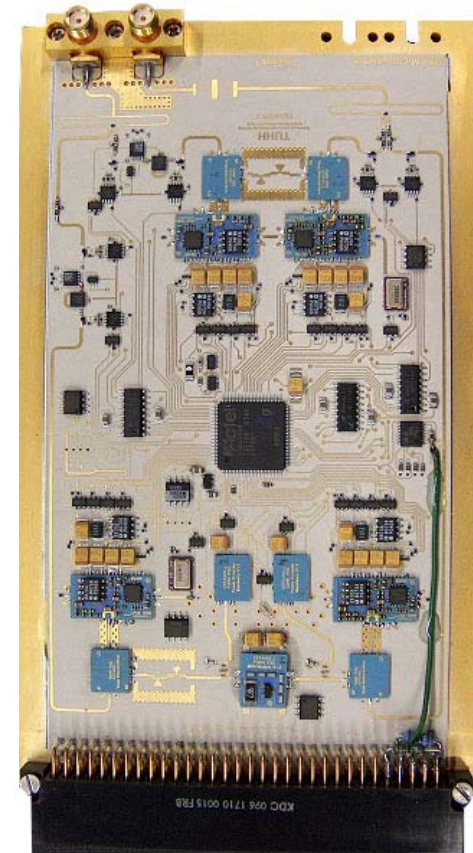
4x4 Switch Matrix  
TU-Ilmenau

II



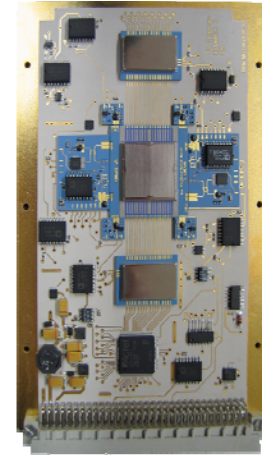
Synthesizer  
IMST

III



Transceiver  
TU-Hamburg-  
Harburg

# Exp.-1: 4x4 Switch Matrix



RF-Connections

VCO

Detector

Detector

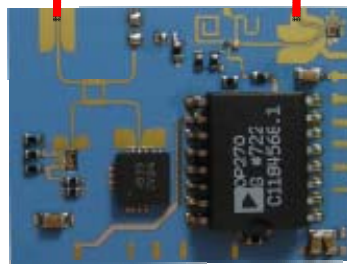
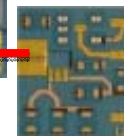
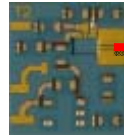
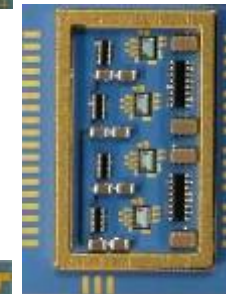
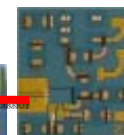
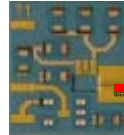
Diodes Driver

Diodes Driver

Detector

Detector

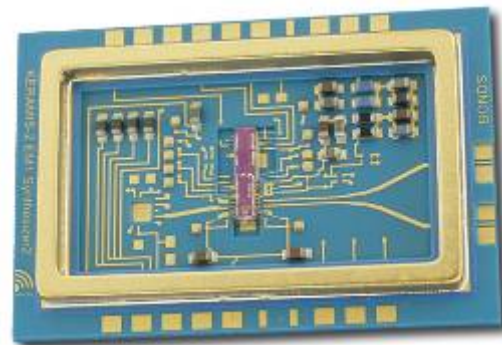
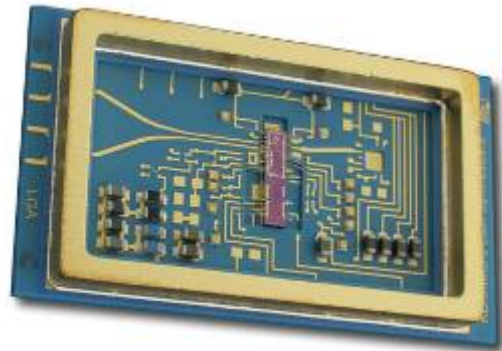
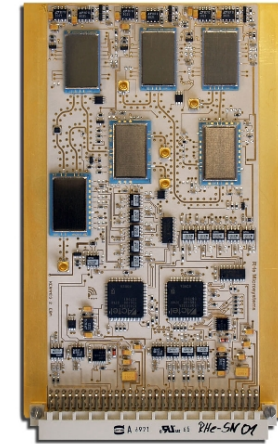
VCO



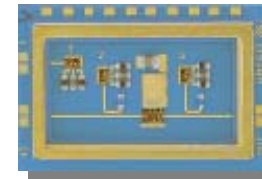
# Exp.-2: Synthesizer Module

→ 1-Chip SiGe Fractional-N Synthesizer

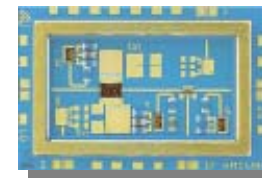
→ LGA- and Wire-Bond Type



SPDT PIN Diodes Switch



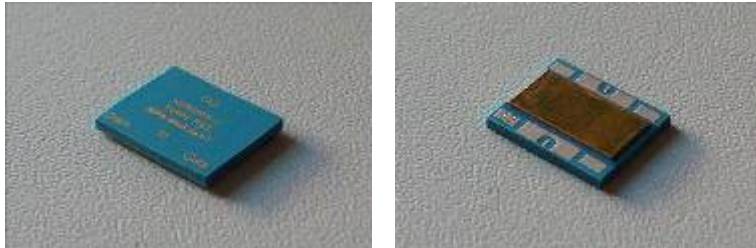
Low Noise Amplifier



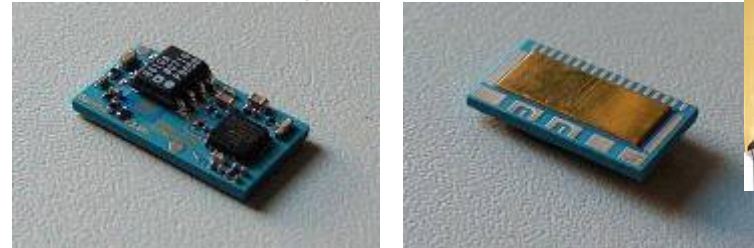
Medium Power Amplifier, Mixer

# Exp.-3: Transceiver

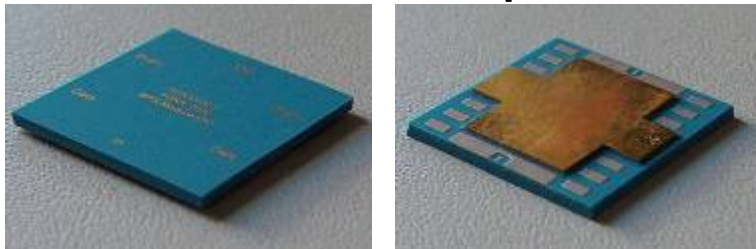
## Medium Power Amplifier 1



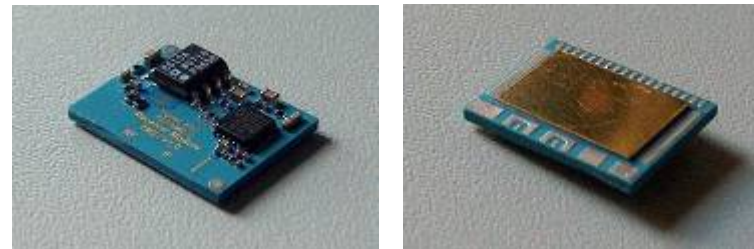
## Synthesizer



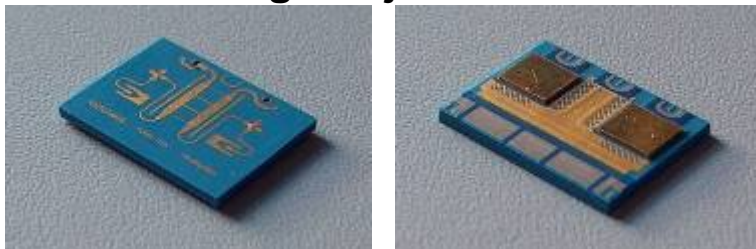
## Medium Power Amplifier 2



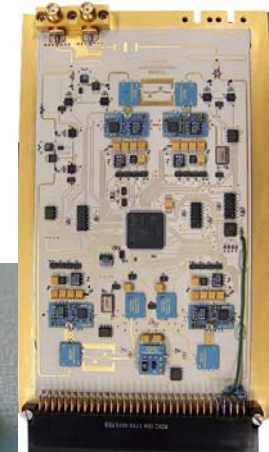
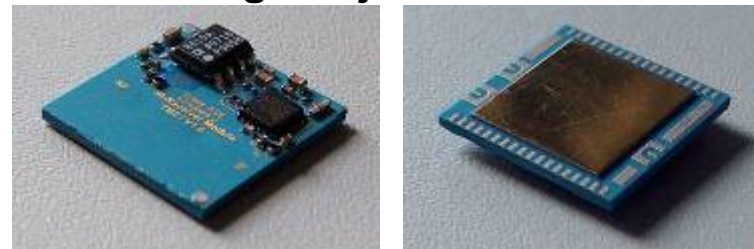
## Receiver



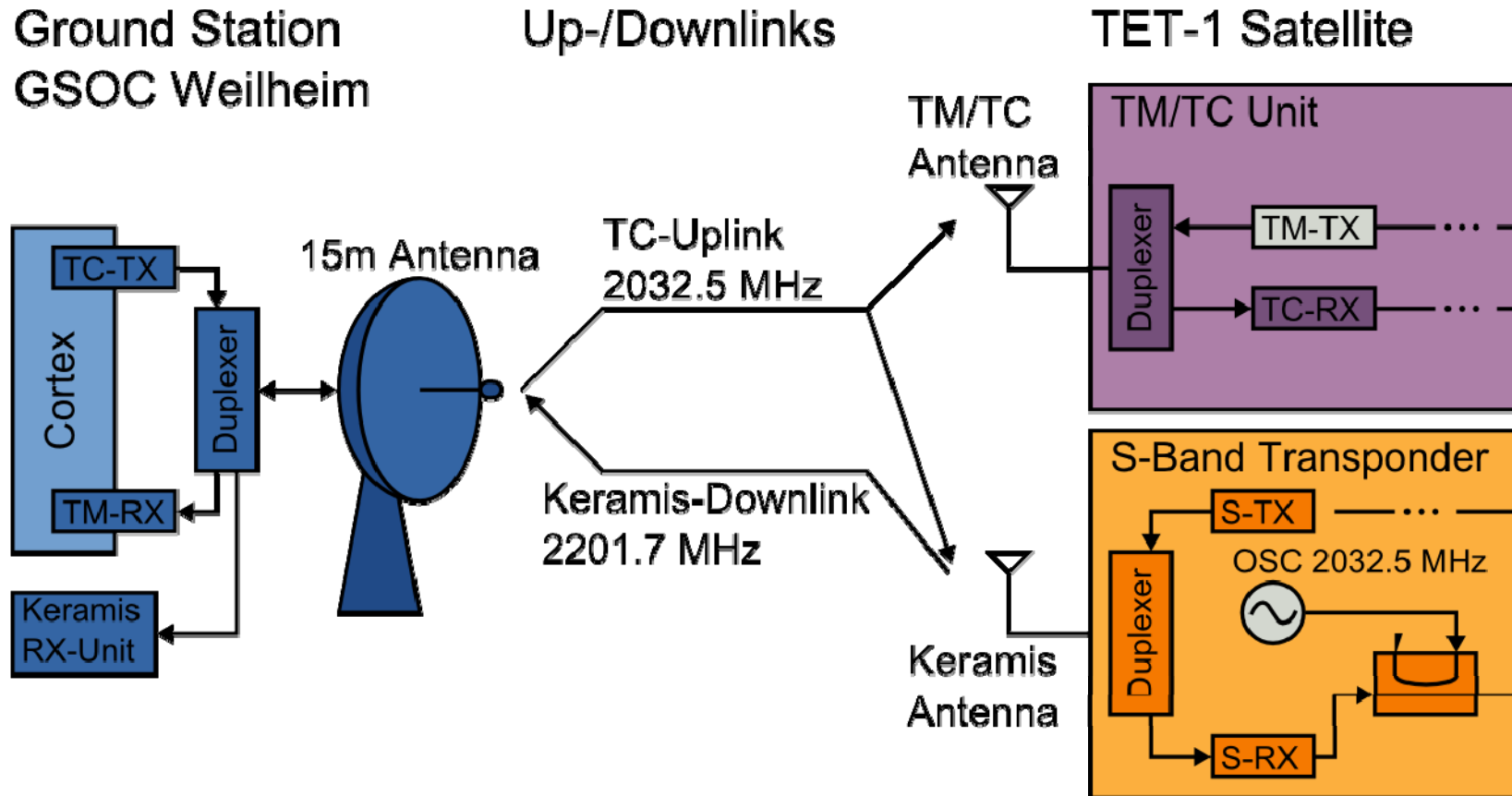
## Image Reject Mixer



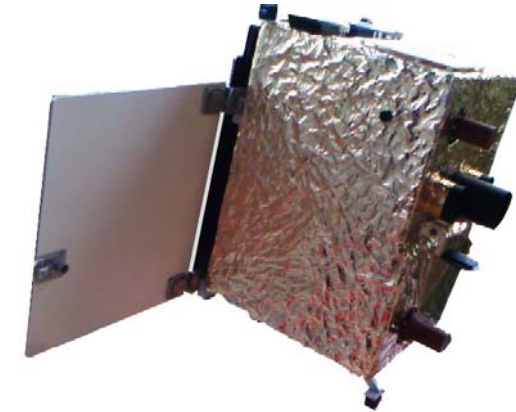
## Image Reject Receiver



# Exp.-3: TM Blockdiagram



# Qualification Matrix



	Analysis	TM1	TM2	STM	EM	PFM
<b>Verification</b>						
Dimensions				I	I	I
Mass				T	T	T
Center of Gravity				T	-	T
Mechanical I/F				I	I	I
Sinusoidal Vibration		T	T			T
Random Vibration		T	T			T
Shock Susceptibility		T	T			
Thermal Vacuum /Thermal Cycling		T	T	T A		T
Thermal Test					T	
Connector Verification				I	T	T
Signal Characterization					T	T
Bonding					T	T
Grounding/ Isolation					T	T
Conducted Emission					T	T
Conducted Susceptibility					T	T
Radiated Emission					-	T
Radiated Susceptibility					-	T
Magnetic Moment	A					
HW/SW Functions					T	T
Performance		T	T		T	T
Space Debris	A					
Single Point Failure	A					
Components List	A					
Materials, Process List	A					

Test: T  
Analysis: A  
Inspection: I

Geometry  
Interface

Vibration and Shock

Thermal

Function / Performance

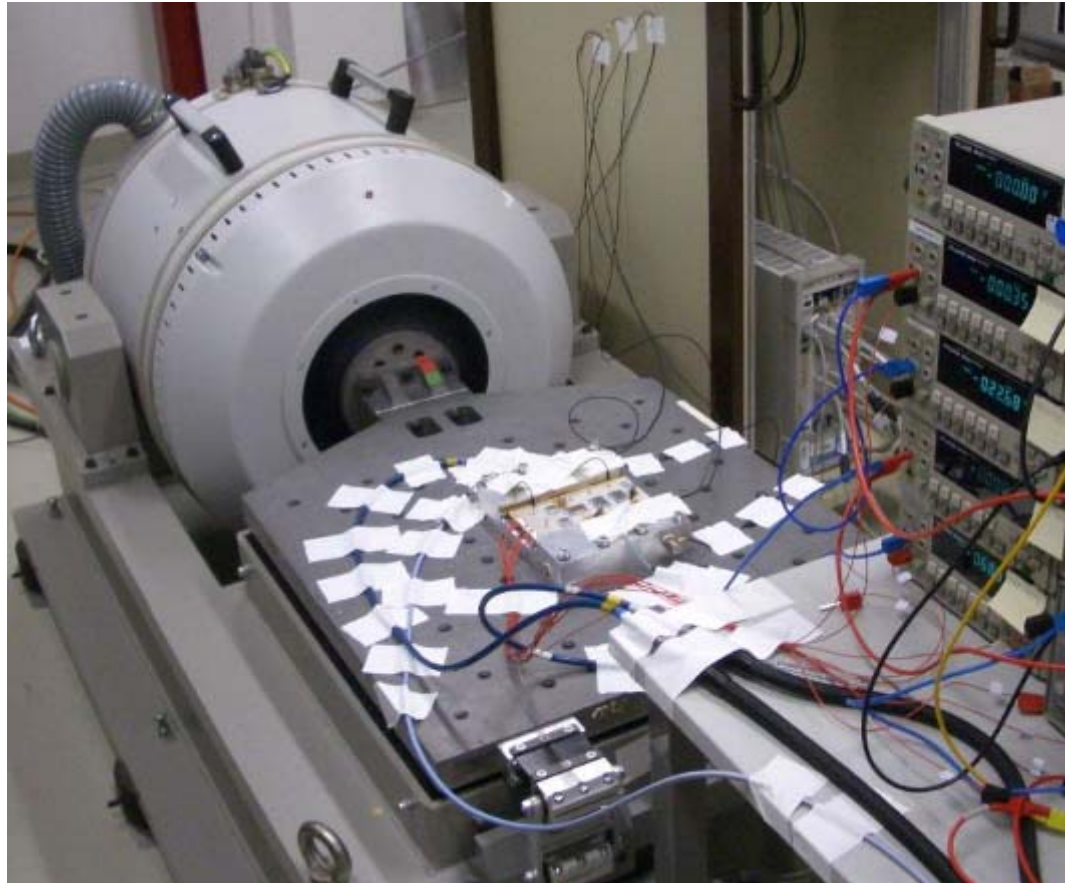
EMC

Analysis / Documentation

# Vibration Tests

→ Sinus: 20 g  
from 5 to 100 Hz in  
X, Y and Z direction

→ Random:  
3 g ..15 g



Astro, Berlin

# Pyro-Shock

→ Pyro-shock:  
up to 1800 g  
in X, Y and Z direction



Astro, Berlin

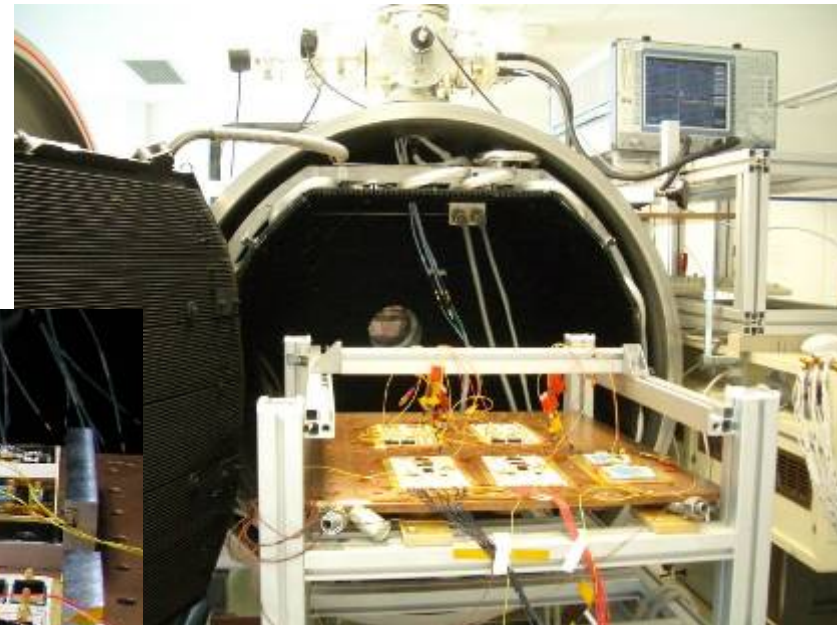
# Thermal Vacuum Tests

→ Thermal Balancing

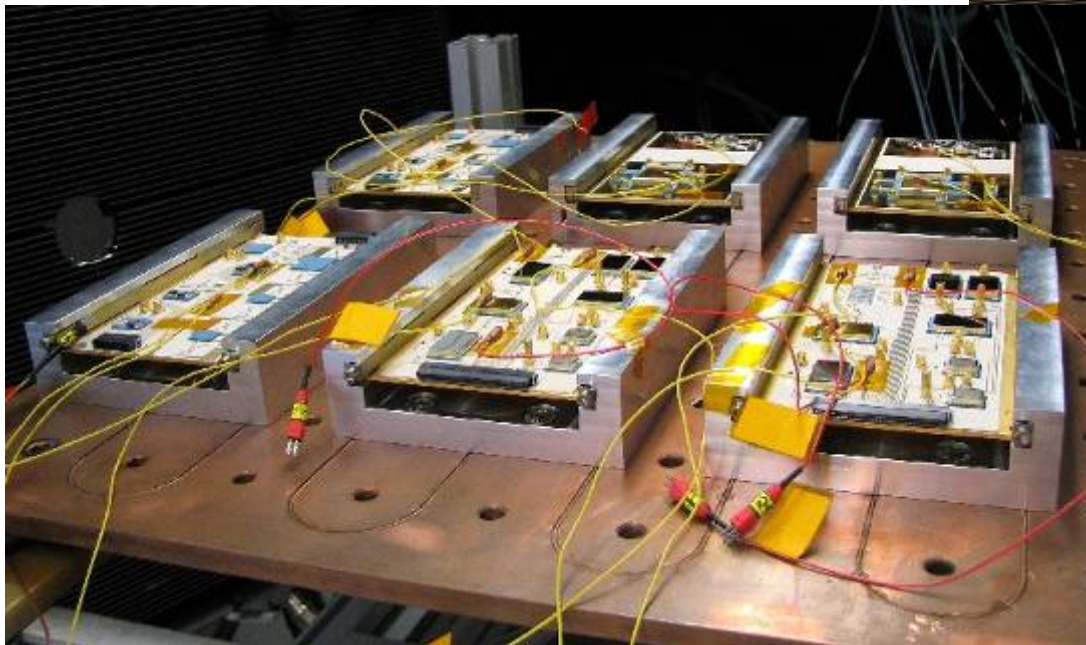
from 90°C to -40°C

→ Thermal Cycling

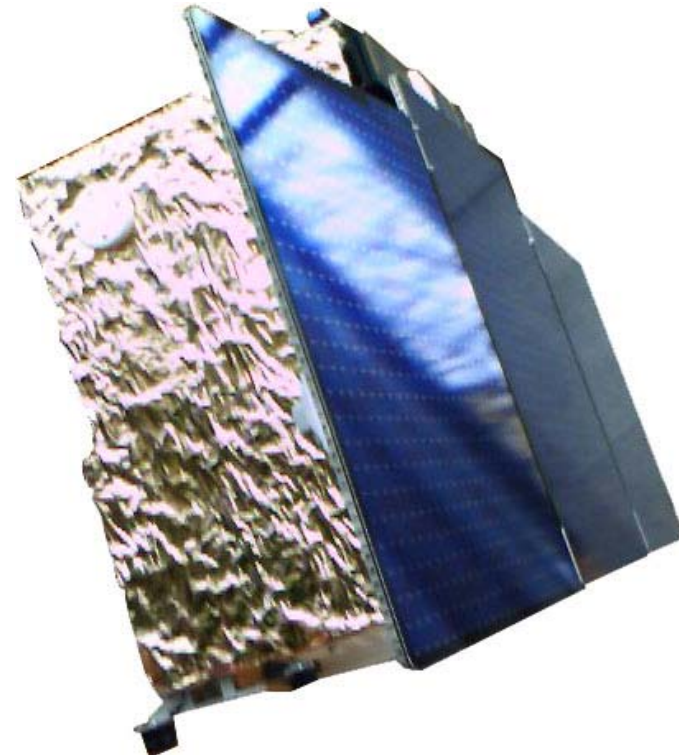
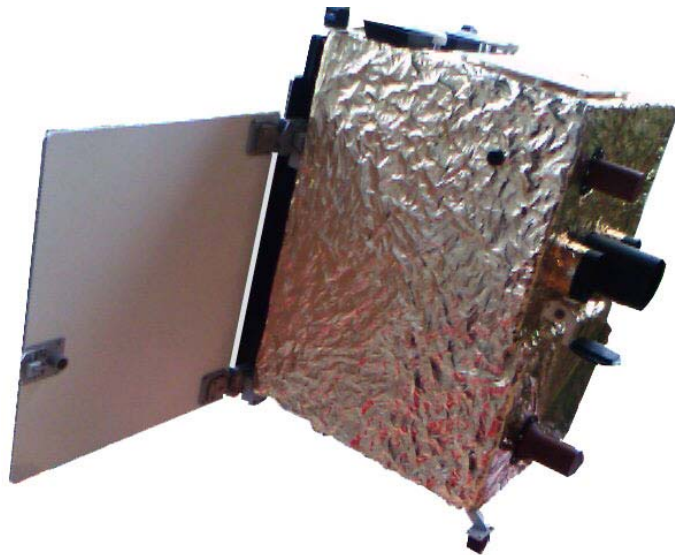
16 Cycles from 80°C to -20°C



Astro, Berlin



# LEO: 550 km Orbit



Thank you!