

Department of Aeronautics and Astronautics
Chair of Astronautics



**SPACE TECHNOLOGY
AT
TU BERLIN**

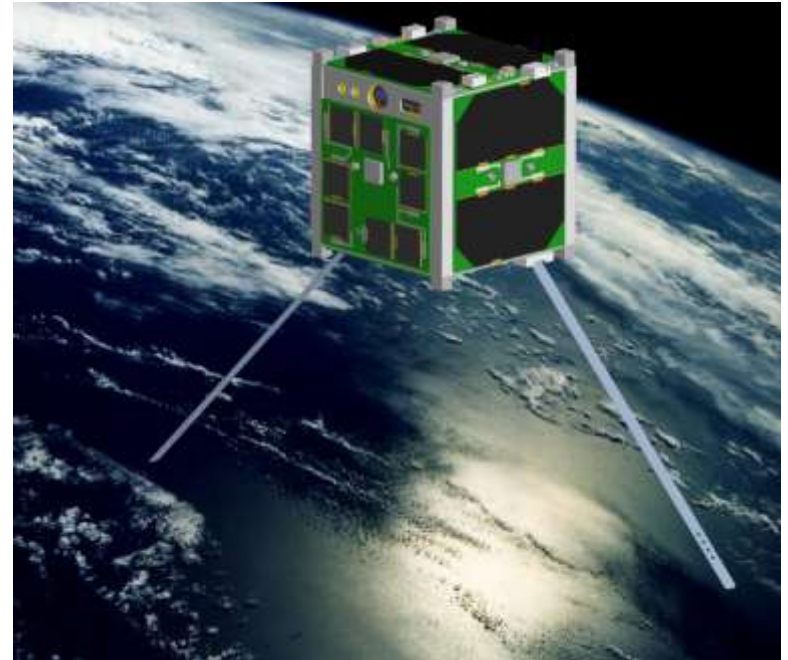
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Overview

The department of Aeronautics and Astronautics at the TU Berlin is the oldest space faculty in Germany. It has a long and very successful tradition in small satellite missions.



Berlin's **E**xperimental & **E**ducational **S**atellite
BeeSat (Launch date: Oct 2008)

TUBSAT Microsatellites Project

Working Group Prof. Dr. U. Renner

Satellite	Main Payload	Mass	Launcher	Launch Date	Operational status
TUBSAT-A	S&F communications	35 kg	Ariane-4	July 17, 1991	Last Contact Spring 2007
TUBSAT-B	Earth observation	45 kg	Tsyklon	Jan. 25, 1994	Failed after 39 days
TUBSAT-N/N1	S&F communications	8 kg, 3 kg	SHTIL	July 7, 1998	Mission ended (re-entry)
DLR-TUBSAT	Earth observation (video)	45 kg	PSLV	May 26, 1999	Operational
MAROC-TUBSAT	Earth observation (image)	47 kg	Zenit	Dec. 10, 2001	Operational
LAPAN-TUBSAT	Earth observation (video)	56 kg	PSLV	Jan. 10, 2007	Operational

TUBSAT-A

Working Group Prof. Dr. U. Renner

TUBSAT-A has been launched 1991/06/17 onboard a Ariane 4. The orbit is a SSO with a height of 780km and an inclination of 98°. It is designed as a cube of 38x38x38cm and has a mass of about 35 kg.

Mission goals:

Scientific Experiments

Store and Forward Communication

Communication via mobile groundstations

Data collecting from mobile transmitters



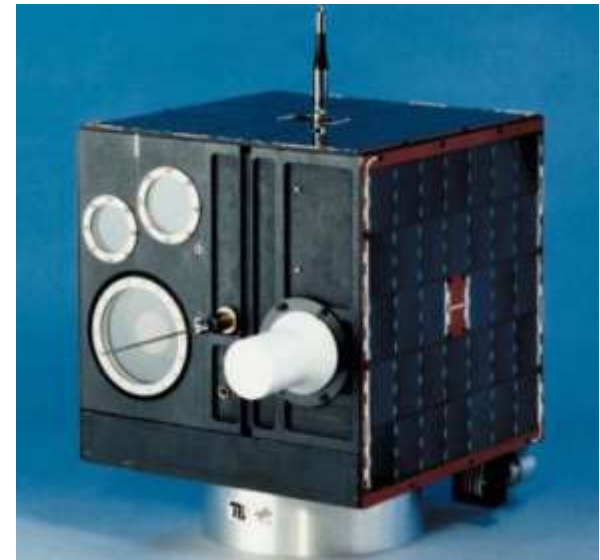
The satellite was 16 Years in operation!

DLR-TUBSAT

Working Group Prof. Dr. U. Renner

DLR-TUBSAT was launched 1999/05/25 onboard a PSLV-C2 into a SSO with 720 km and 98° inclination. It designed as a cube of 32x32x32cm with a total mass of 44.8kg.

Mission goals:
Technology Demonstrators
Earth Observation, 6 m
Attitude Control Experiments



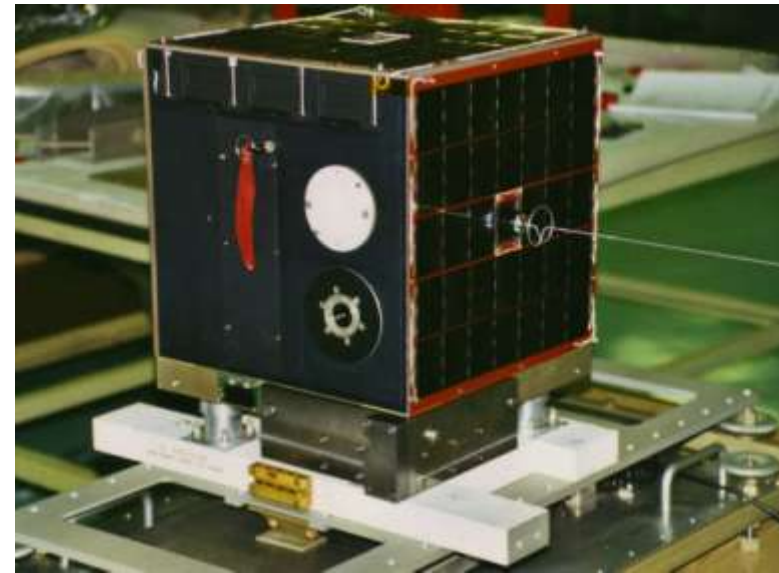
DLR TUBSAT

MAROC-TUBSAT

Working Group Prof. Dr. U. Renner

The MAROC-TUBSAT is a cooperation between CRTS Morocco and the department of aeronautics and astronautics at TU Berlin. The Moroccan side build the payload and handled the launch campaign and whereas the German side was responsible for the satellite bus.

The satellite has been launched 2001/12/10 with a Zenit rocket into sun-synchronous orbit with an altitude of 1000 km and 98° inclination from the Baikonur Cosmodrome.



MAROC TUBSAT

LAPAN-TUBSAT

Working Group Prof. Dr. U. Renner

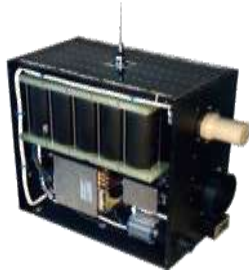
LAPAN-TUBSAT is a cooperation between TU Berlin and the National Institute of Aeronautics and Space of Indonesia. It was launched with an Indian PSLV on Jan. 10, 2007.

Its design follows the TUBSAT family with dimensions of 45x45x27cm and a mass of about 56kg.



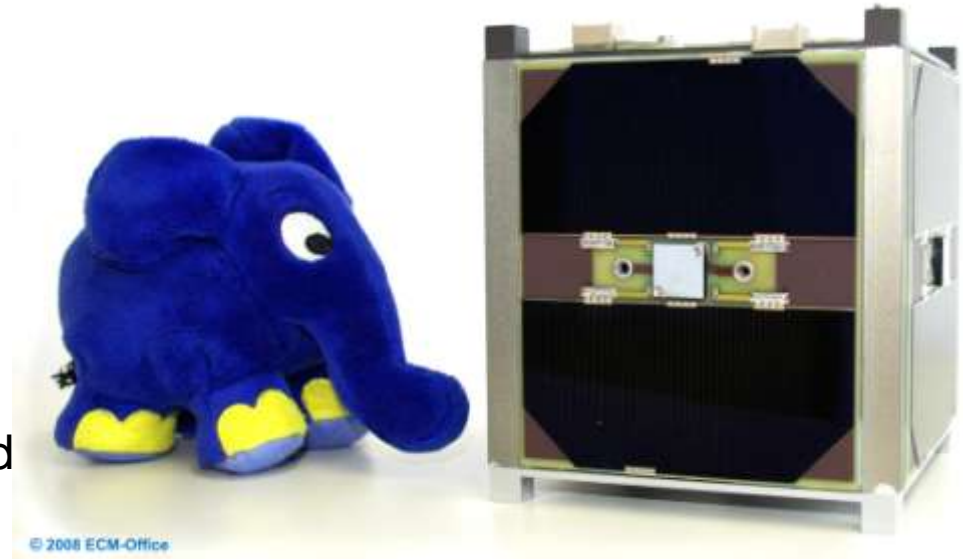
LAPAN TUBSAT

LAPAN-TUBSAT



Objective of chair of Astronautics

- to educate graduate students in the field of astronautics with emphasis of system engineering aspects
- goal: Bachelor and Master Degree
- Research in the fields of spacecraft technologies and space (sensor) system technologies
- Design, assembly and test of nano- and pico satellites
- Mission planning and mission operations of satellite missions



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High-Tech education

programme segment



space segment



all 4 segments of a space mission

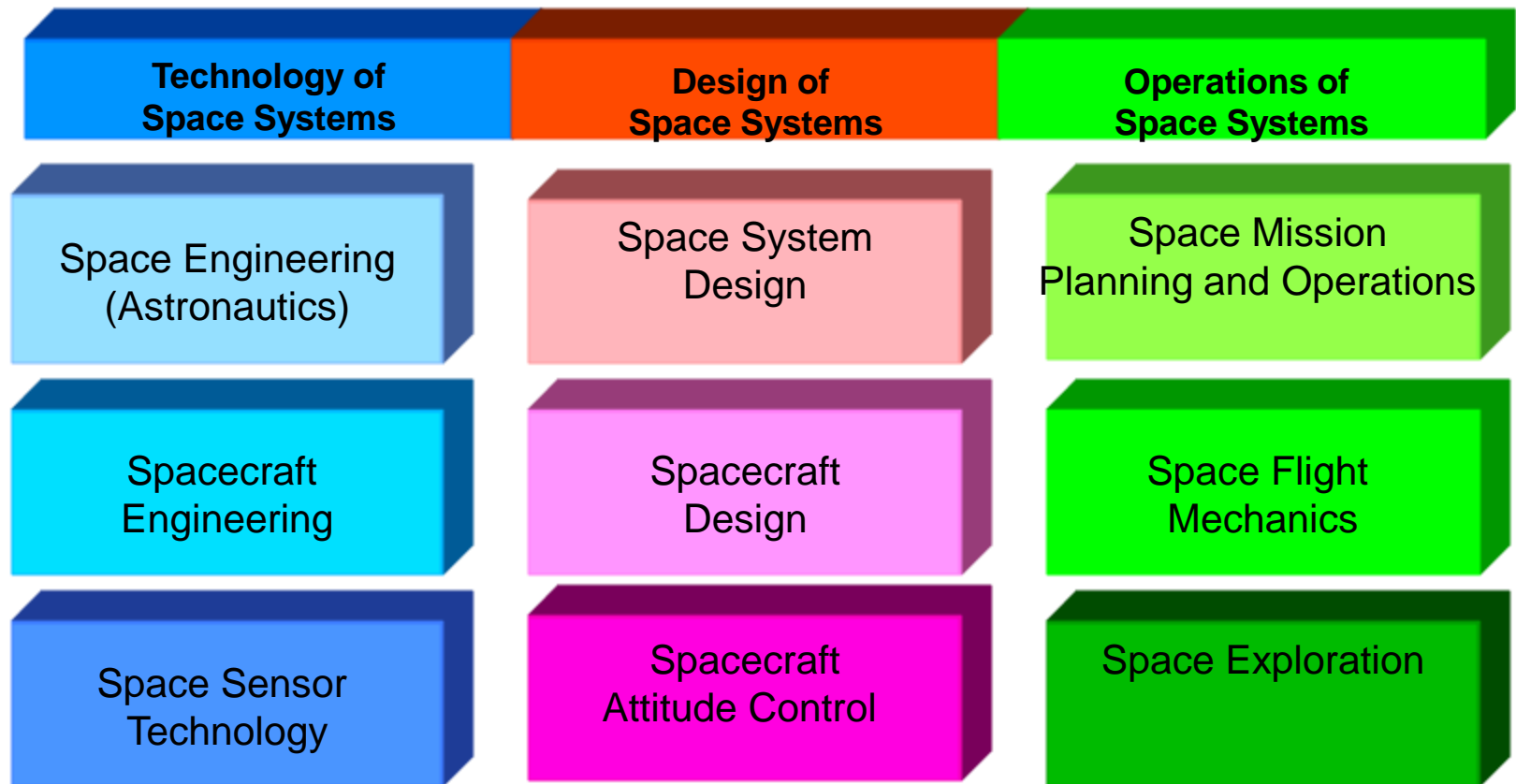
ground segment



communications architecture



Lecture Courses of chair of Astronautics



Research

Active participation in research projects is an essential part of education at the department of astronautics.

Main topics of research

- earth remote sensing
- space systems technology
- space sensor technology
- nano and pico satellite missions



Beesat

BeeSat (Berlin Experimental and Educational Satellite) is a pico satellite project of Berlin Institute of Technology. The main objective of BeeSat is the on orbit verification of newly developed micro reaction wheels for pico satellite applications. (Launch: Mai. 2009)



BeeSat engineering qualification model

Goals:

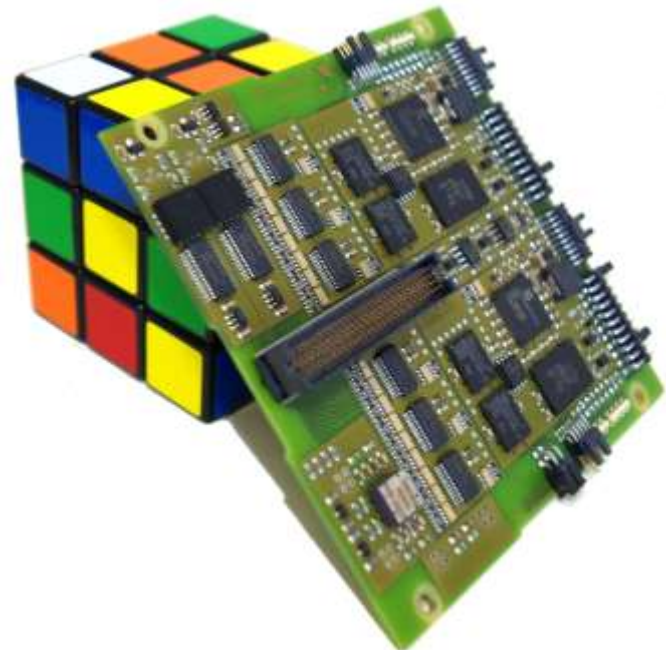
- on orbit verification of newly designed reaction wheels
- verification of additional pico satellite technologies
- education of students

Beesat

<u>Characteristic</u>	<u>Meaning</u>
Kind of the orbit	LEO 450-850 km
Radio communications	Frequency band: UHF, 435...436 MHz Operation mode: half duplex Transmit power: 0.5 W Modulation: GMSK Downlink Baudrate: 9600/4800 bits/s Uplink Baudrate: 4800 bits/s
Dimensions	10 x 10 x 10 cm ³
Mass	1 kg
Attitude determination and control	6 sun sensors 2 three axis magnetic field sensors 3 gyros 6 magnetic coils 3 reaction wheels
Effective power	Solar array 1.36W min
On board computer:	Processor: ARM-7 based CPU, 60 MHz RAM: 2 MByte SRAM Flash (program): 16 MByte Flash (telemetry): 4 MByte
Micro reaction wheels	mass incl. WDE: 150g wheel dimensions: 20x20x15 mm min. angular momentum: 1.5E-4 Nms min. torque: 1.5E-6Nm
Operating period	1 year

Verification of additional pico satellite technologies

The combination of highly sophisticated miniaturized technologies and the advantage of forming swarms or clusters of pico satellites will result in completely new applications at very low cost.



BeeSat board computer engineering
qualification model

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Space Mission Planning and Operations

Joint operation of the satellite using the University Control Centers and the ground station.



Ground Station UHF-VHF

A small satellite communication ground station is specifically designed for small satellites in LEO

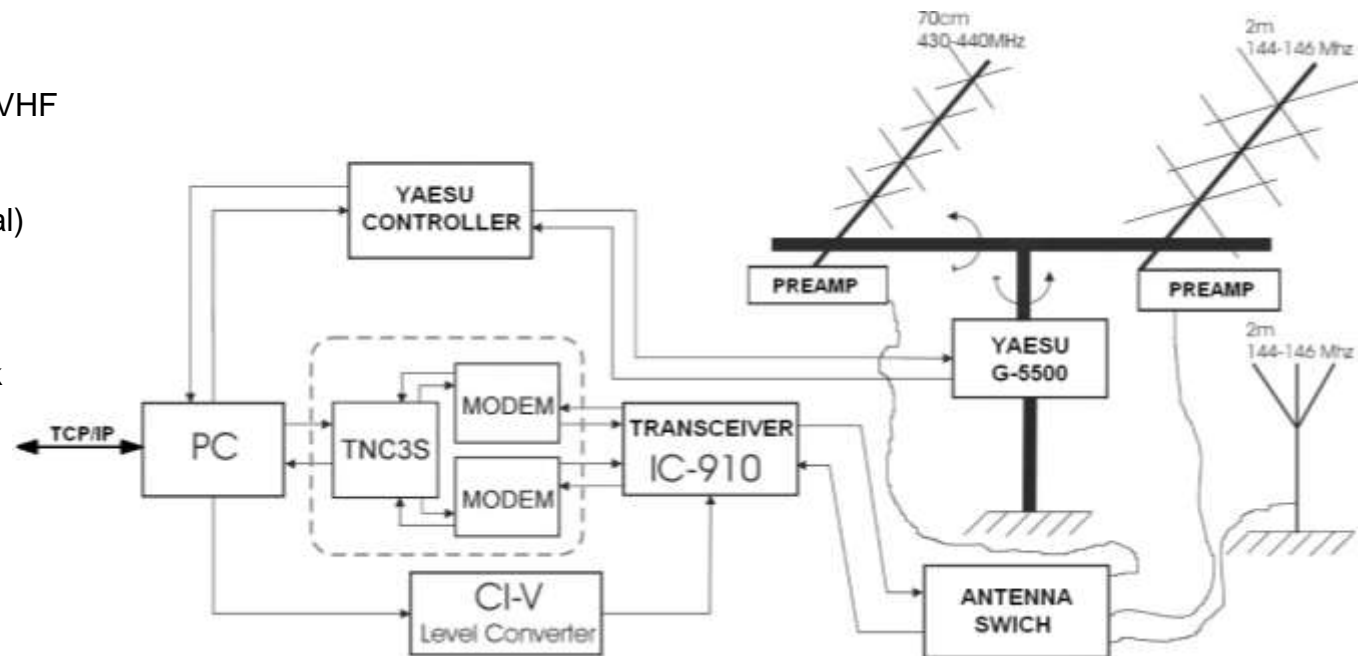
The satellite ground stations are suited for a number of different applications:

- Satellite command ground station
- Telemetry and tracking station
- HAM radio activities
- Educational projects



Ground Station UHF-VHF

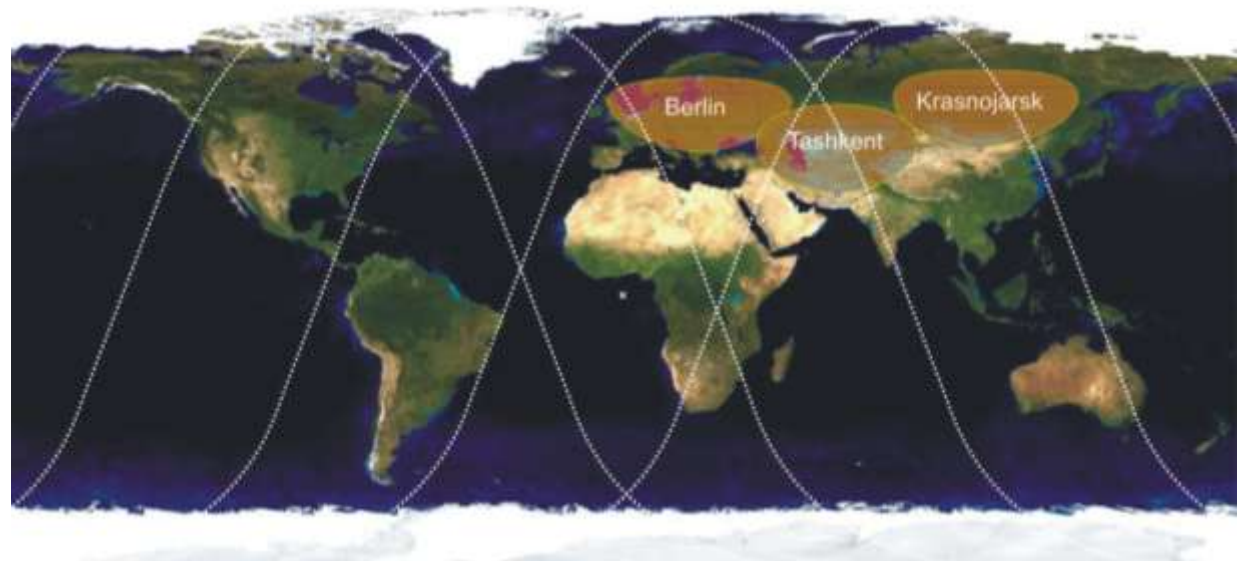
- All-Mode Transceiver UHF/VHF
- Steerable antenna
- Compact setup
- Remote operations (optional)
- Educational value
- All-Weather-Rotator
- Compatible to TU Ground Station Network



Ground Station Network

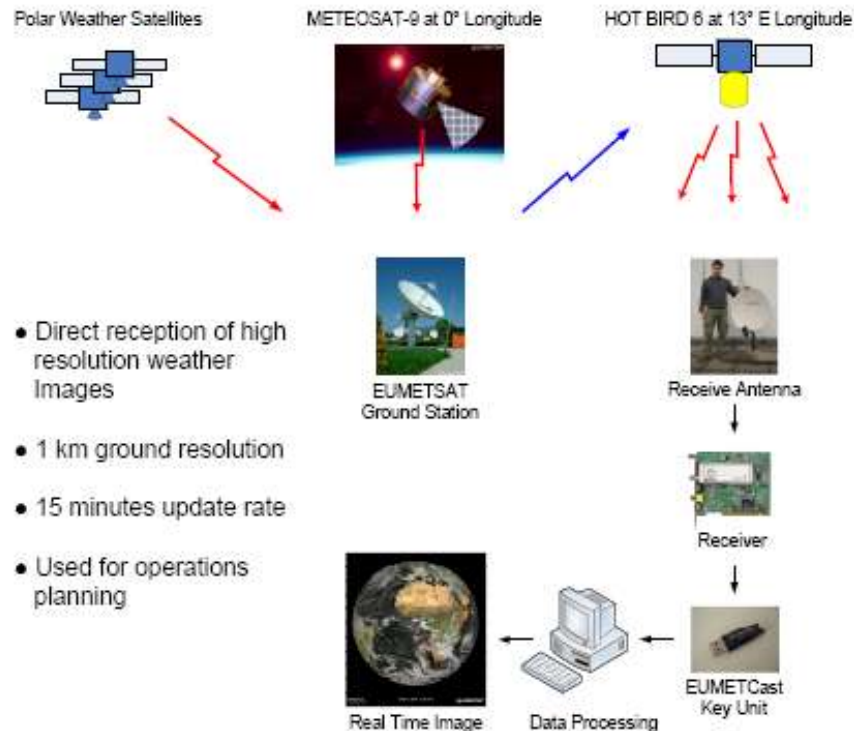
Joint development with SME “ECM-Office” from Berlin at the frame TEMPUS-2006 and TEMPUS-2008.

Mission operations will be performed by the mission control center at the TU-Berlin and a network of cooperative ground stations will be connected to exchange satellite data.



Area of satellite receive for DLR-TUBSAT

GEONETCast Data Reception System



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Tempus: Modernising higher education






Tempus (The Trans-European mobility scheme for university studies) supports the modernization of higher education and creates an area of co-operation in countries surrounding the EU. TU Berlin is a grand holder on the two Projects: TEMPUS 2006 (Uzbekistan) und TEMPUS 2008 (Russia, Ukraine and Kazakhstan).
Coordinator of this projects is ECM-Office (Berlin)

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Tempus IV: Neues Curriculum in Raumfahrttechnik (Uzbekistan)




 Education and Culture
TEMPUS - Uzbekistan

„Koinot texnika sohasida yangi o'quv fani“
„Новый учебный курс в области космической техники“

Konsortium

- 


- ✓ Technische Universität Berlin, Institut für Luft- und Raumfahrttechnik (DE) - Grandholder www.ilr.tu-berlin.de
 ✓ ECM-Office, Berlin (DE) - Koordinator www.ecm-office.de
- ✓ Hogeschool voor Wetenschap en Kunst, De Nayer Instituut (BE) - Partner www.wenk.be





Partner in Uzbekistan:

- ✓ Fakultät für Luftfahrttechnik, Staatliche Technische Universität Taschkent - Zieluniversität
- ✓ Ministry of Higher and Secondary Special Education
- ✓ Staatliche AG „die Luftfahrtproduktionsvereinigung von V.P. Tschkalov“
- ✓ Zentrum für Raumfahrtforschungen der Wissenschaftsakademie

www.ncr-tgai.eu 2009 - zweites Projektjahr

„Neues Curriculum in Raumfahrttechnik / NCR“

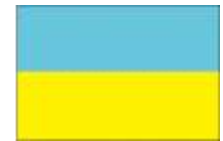
- ★ Entwicklung und Implementierung des neuen Bachelor Curriculums „Raumfahrttechnik“ und „Satellitentechnik“
- ★ Ausarbeitung des neuen modularen berufsbezogenen Studien-angebotes CAD/CAM/CAE
- ★ Einrichtung eines Satellitenbau-labors und einer Satellitenbodenstation in TSTU
- ★ Einrichtung eines berufsorientierten Computer-zentrums für CAD/CAM/CAE

TEMPUS IV

Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine

-CRIST-



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Tempus IV: Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine



Europäische Kommission
TEMPUS

Curricula Reform in Space Technology in KZ, RU, UA
Реформирование образовательных программ в области космических технологий в республиках Казахстан, Россия, Украина



Projektkonsortium

Projekt finanziert von TEMPUS

- ✓ **Grundholder:** Technische Universität Berlin, Institut für Luft- und Raumfahrttechnik (DE)
- ✓ **Koordinator:** ECM-Office, Berlin (DE)
- ✓ **Partner:** Leuven Hogeschool, De Nayer Instituut (BE) • Fontys International Hogeschool Economics (NL)
- ✓ **Zielveritäten:** KZ: Eurasische Nationale Universität • Karaganda Staatliche Technische Universität
 RU: Baikunam Staatliche Technische Universität • Samara Staatliche Universität für Luft- und Raumfahrttechnik
 Sibirische Staatliche Universität für Luft- und Raumfahrttechnik
 UA: Dnipropetrovsk Nationale Universität • Nationale Technische Universität der Ukraine • Nationale Universität für Luft- und Raumfahrttechnik
- ✓ **Unterstützende Organisationen und Partner:**
 DE: Deutsche Gesellschaft für Luft- und Raumfahrt Lilienthal-Oberth e.V.
 KZ: Ministerium für Bildung und Forschung • Nationale Raumfahrt Agentur • Industrie und Handelskammer • Engineering Center "Technology Transfer"
 RU: Bildungsmaterialium • Bildungsagentur • Zentrales Sibirisches Industrie und Handelskammer • State Research & Production Space Centre "ISSK-Program"
 Information Satelliten Systeme "ISS" • Reshetnev Company
 UA: Industrie und Handelskammer • "Yuzhnoye" Staatliches Konstruktionsbüro für Raumfahrt • Nationales Raumfahrtbildungszentrum der Ukrainischen Jugend



Projektziele

- ★ **Neue Curricula:** Micro- und Picosatelliten, Funkkommunikation für Raumfahrt, CAD/CAM/CAE für Satelliten, Elektronik und Elektrotechnik, Raumfahrtmanagement & International Business
- ★ **Infrastruktur:** Labore für Satellitenbau, Satellitenbodenstationen
- ★ **PC-Pool:** Satellitendesign, Businessplanung und -Modellierung
- ★ **Netzwerke:** Satellitenbodenstationen, Regionale Koordinations- und Technologiebüros (K&T)

CRIST
www.crist-kru.eu

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Tempus IV: Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine



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Tempus: Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine

