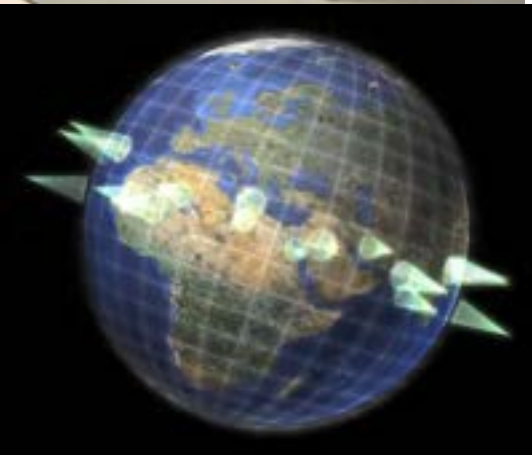
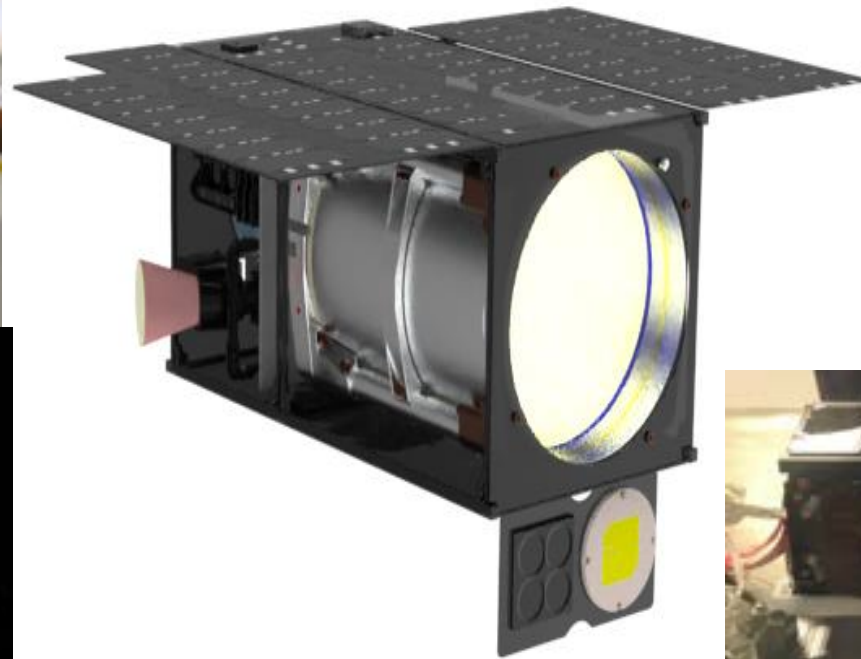
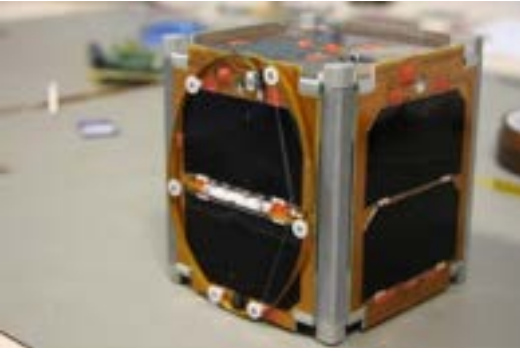


CubeSats in Türkiye



Prof.Dr. Alim Rustem Aslan

Manager and founder, Space Systems Design and Test Laboratory

Istanbul Technical University, Faculty of Aeronautics and Astronautics,

Istanbul, Türkiye, aslanr@itu.edu.tr, <http://usttl.itu.edu.tr>



ITU/FAA

Faculty of Aeronautics and Astronautics

Space Systems Design and Test Laboratory



Prof.Dr. Alim Rüstem ASLAN

Astronautical Engineering Department

Istanbul Technical University, Turkey

National Defense University, Turkiye

- Manager and founder, Space Systems Design and Test Laboratory
- Manager and founder , SmallSat Communication Laboratory
- International Academy of Astronautics Member
- UZTED, President
- UNISEC-GLOBAL SC Member
- NATO CSO-STO AVT National Panel Member
- TA1ALM



Area of expertise: Design, analysis and development of pico- and nanosatellite (9 in orbit – 3 deorbited), manned and unmanned rotorcraft systems (including prototypes), computational fluid dynamics and aerodynamics, propulsion and, defense and education technologies. **Worldwide hands on cansat, cubesat and rocketry course delivery.**

by 360 Degrees by Orhan Durgut



With a history stretching back almost 250 years (1773), providing technical education within a modern educational environment and strong academic staff, **Istanbul Technical University (İTÜ) is strongly identified with architectural and engineering education in Turkey**

- **Department of Astronautical Engineering since 1983**

- ITU, as a modern research University, has a global vision in research and education.
- İTÜ provides Astronautical Engineering education since 1986.
- Applied studies include Development of **CanSats**, **CubeSats** and nano/micro satellites, de-orbiting systems, **environmental tests** of nano satellites and satellites subsystems, and **rocketry** with interdisciplinary team work.
- ITUpSAT1, the first Turkish CubeSat developed by İTÜ is in orbit for over 14 years (Launch 23.09.2009).

- ITU has started practical space studies in late 2005.
- The worldwide CubeSat projects and declared Turkish Space Program were both pivotal in starting practical space projects.
- Space testing facilities were also established, to aid rapid and reliable development of spacecraft components.
- Large scale educational state projects were very helpful in establishing the testing infrastructure, providing the required large budgets for their procurement.
- TUBITAK funding for start up establishment has been essential
- The CubeSats projects have attracted more and more students, first from the department and then from many other related departments, particularly, from electrical and electronics, computers, telecoms and mechanical.

- Establishment 1983 (ITU 1773)
- 60 new ug students per year + Graduate students
- Space related labs
 - Spacecraft Systems Design and Testing
 - Small Satellite communication
- Aim:
 - Research and testing on space systems and components
 - To have engineers with laboratory experience to serve the (inter)national aerospace industry



- Education in space science and Technologies, 2 Space labs, 60 students/year
- Follows AIAA recommendations
- Fully Accredited by ABET till 2030
- Space related undergraduate courses (+ graduate program with advanced topics)
 - **Intro. to Astronautical Engineering&Design (CanSat Application) (1st year)**
 - Aerospace Materials and Structures (2nd year)
 - Orbital Mechanics, (3rd year)
 - Space environment, (3rd year)
 - Spacecraft Attitude Determination and Control (3rd)
 - Spacecraft communications (3rd)
 - Rocket and Electric Propulsion (4th)
 - **Spacecraft system design with application (SSDI-II) (4th)**
- Electives:
 - Basic Astronomy, Space Law, Applic.of Satellite-Based Data

- Established in 2007 in Istanbul Technical University, Istanbul.
- SSDTL includes a net 350lt thermal-vacuum chamber (TVAC), used particularly for testing nano/micro satellites or satellite components smaller than 40x40x60cm.
- Thermal-Cycling and Bake-Out testing are carried out. Ports for RF and electronic system control are available. 25 simultaneous temperature measurements can be taken.
- TVAC opens in to a 25m² class 1000 clean room (capable of class 100) where spacecraft integration is also done. The temperature, pressure and humidity are controlled in the clean room environment.
- The workshop of the SSDTL has devices and capability for integration of the subsystems of nano/micro-scale spacecraft and for operational testing of the subsystems and the whole systems.
- The first Turkish satellite in Turkey has been designed, manufactured and tested in İTÜ-SSDTL and sent to space in September 23rd, 2009 and has been in operation since then successfully.
- Since then, many other CubeSats and larger satellite subsystems have been tested.



İTÜ-SSDTL Space Systems Design and Test Lab



İTÜ-SSDTL CUBESAT PROJECTS





İTÜ-SSDTL

Space Systems Design and Test Lab



INTEGRATION &
TEST at İTÜ



ITU-SSDTL has completed 7 CubeSats in the lab (all launched), and supported many others into orbit.



EDUCATE AND TRAIN ENGINEERS ON SPACE SYSTEMS, SATELLITES AND ROCKETS

DEVELOP NANOSAT SYSTEMS TO ADVANCES KNOWLEDGE SCIENCE AND TECHNOLOGY

Increase capacity of subsystems

- To improve comm speed
- To improve data transfer rates
- To improve agility
- To improve power generation
- To improve lifetime in low orbits
- To improve space Env tolerances

Fault tolerant Software architectures

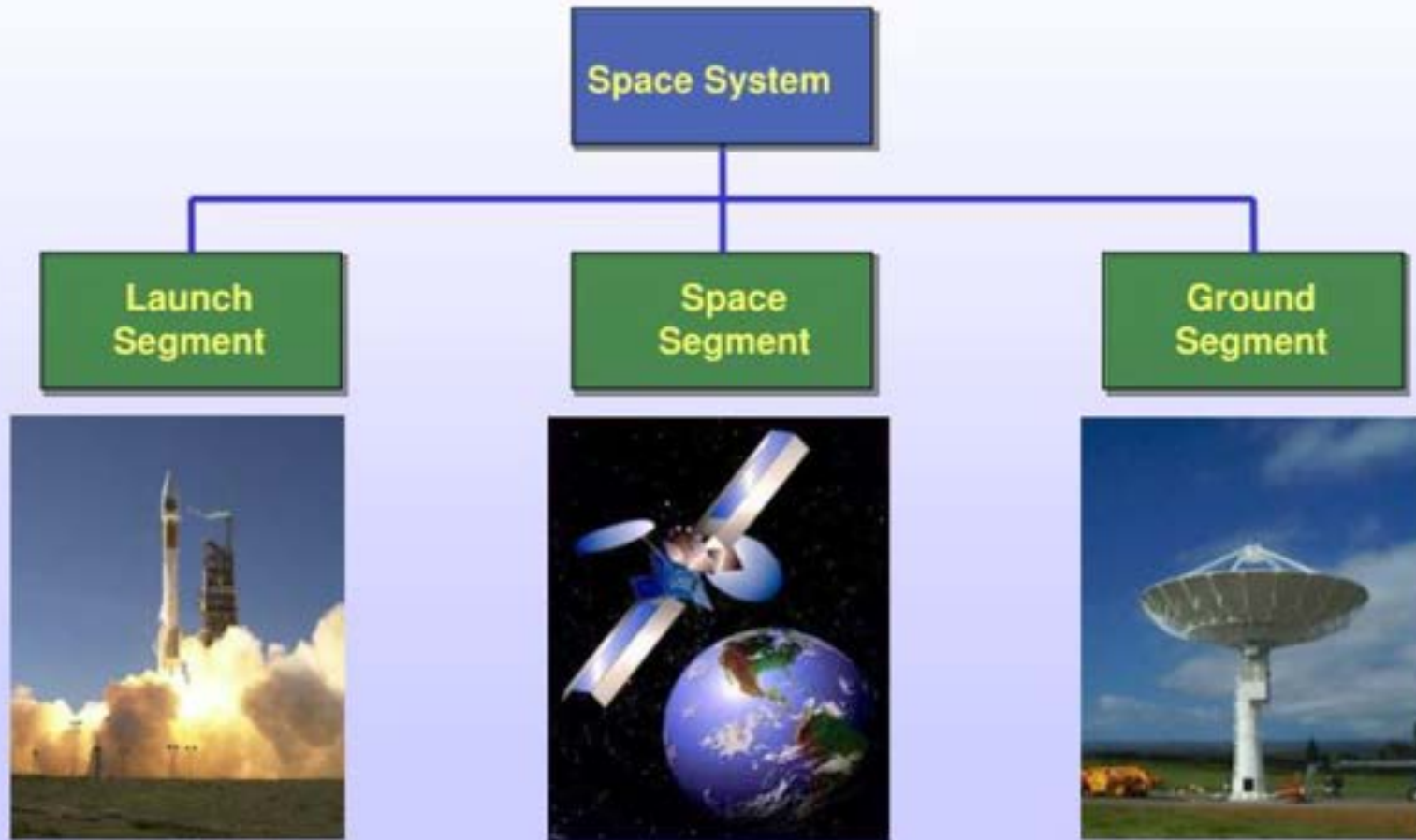
Ground station non amateurs

HELP NATIONAL and REAGIONAL SPACE TECHNOLOGY DEVELOPMENT

KEEP IT MULTIDISCIPLINARY, INTERNATIONAL AND MULTI INSTITUTIONAL

- Analyses of missions
- Earth orbiters
- Travels to moon and Mars
- Randevouz with space objects

• On board propulsion SYSTEMS, Water based SYSTEMS, Hybrid rocket development



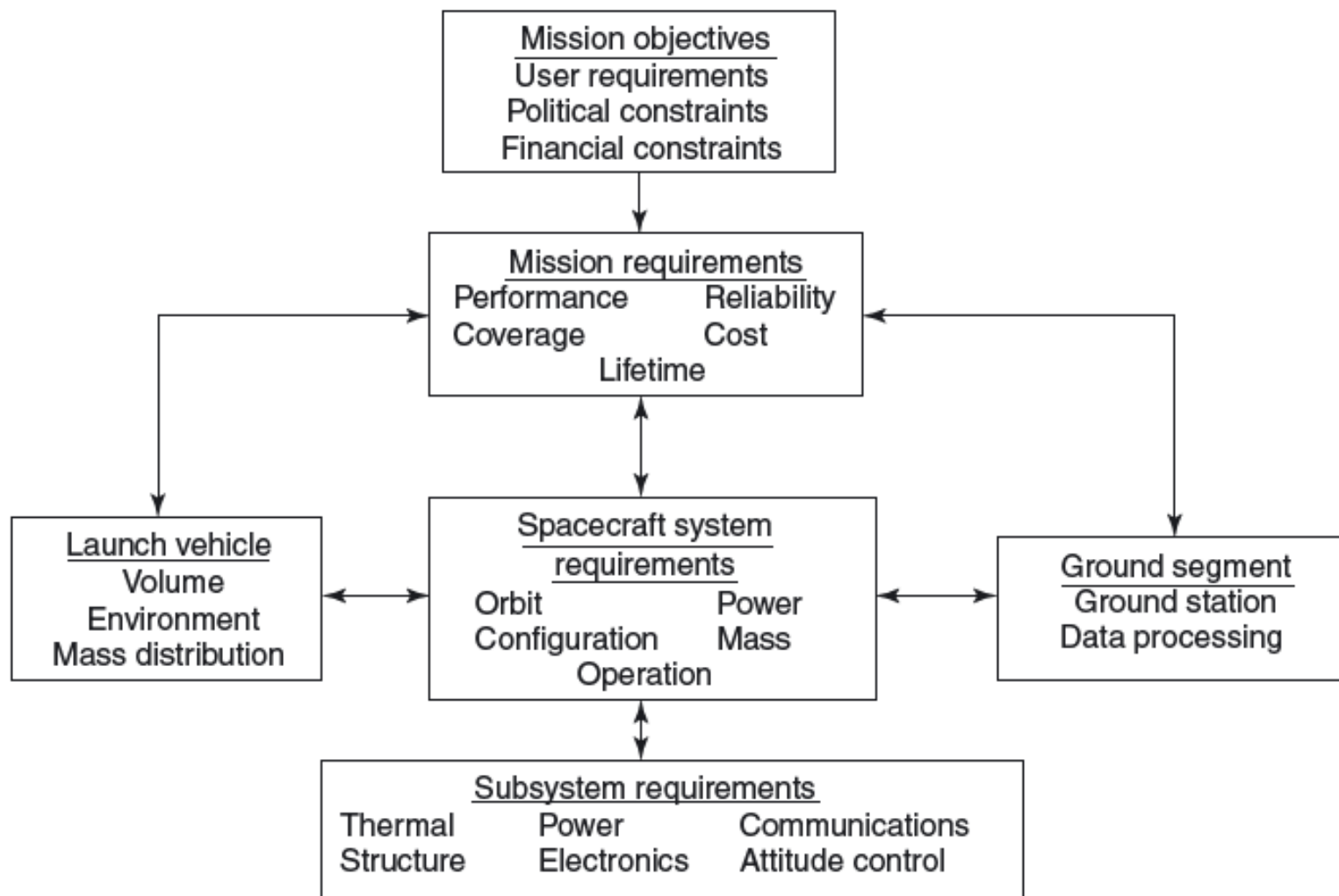
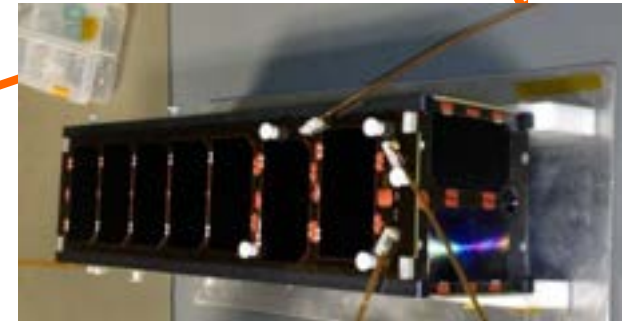
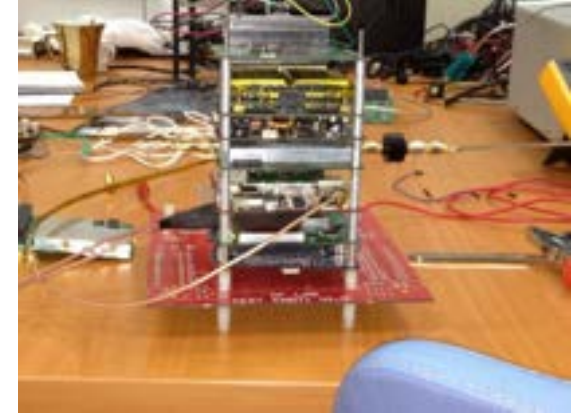
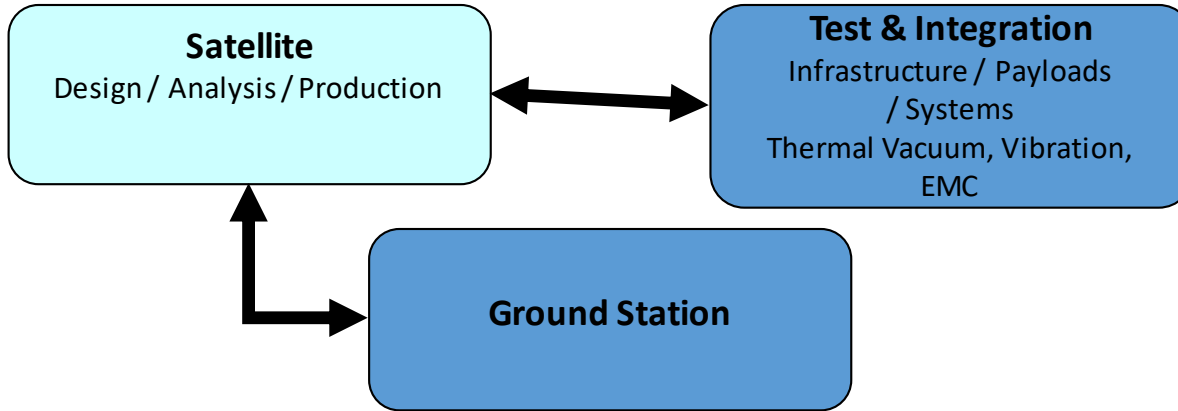
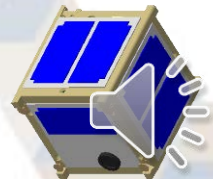


Figure 1.2 Objectives and requirements of a spacecraft mission

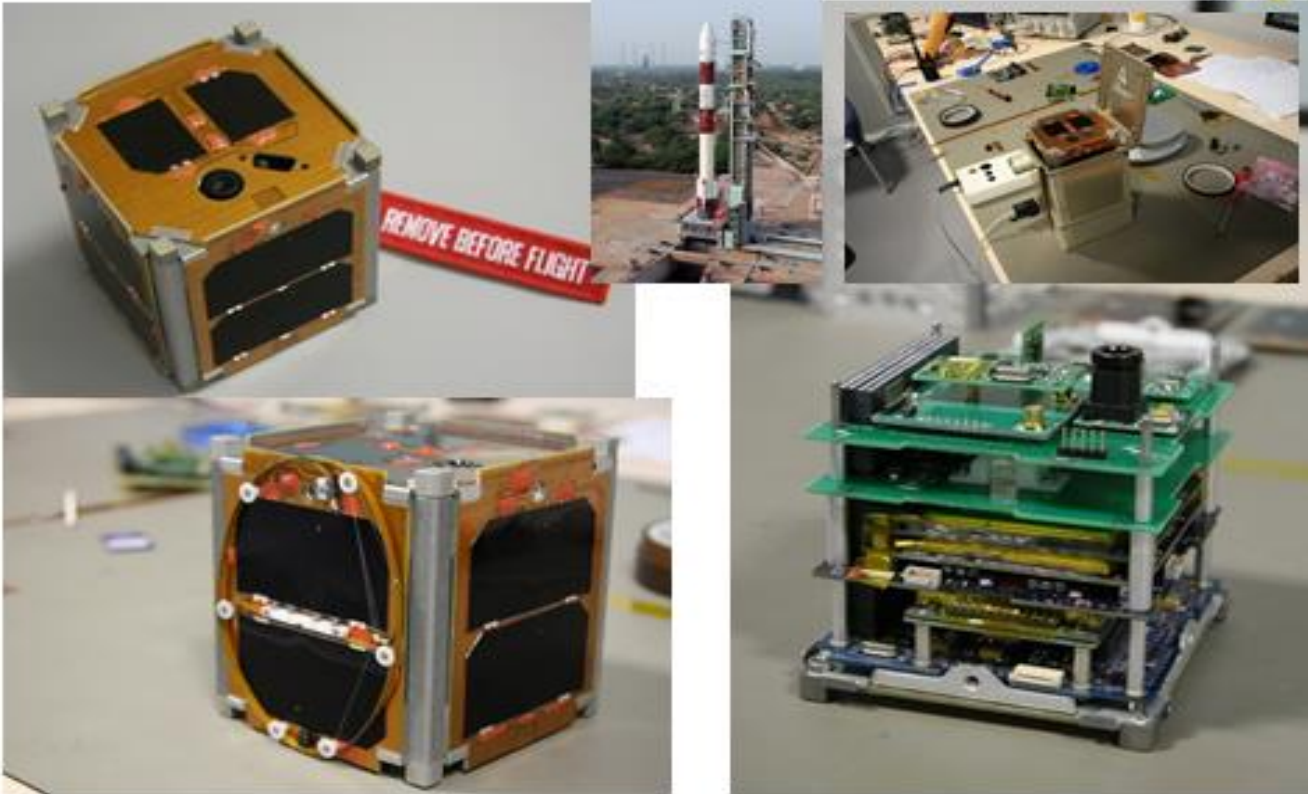
İTÜ-SSDTL Development phases



- Conceptual design
- Desktop model
- Engineering model
- Flight Model
- **Protoflight Model**



İTÜpSAT1 (2009)



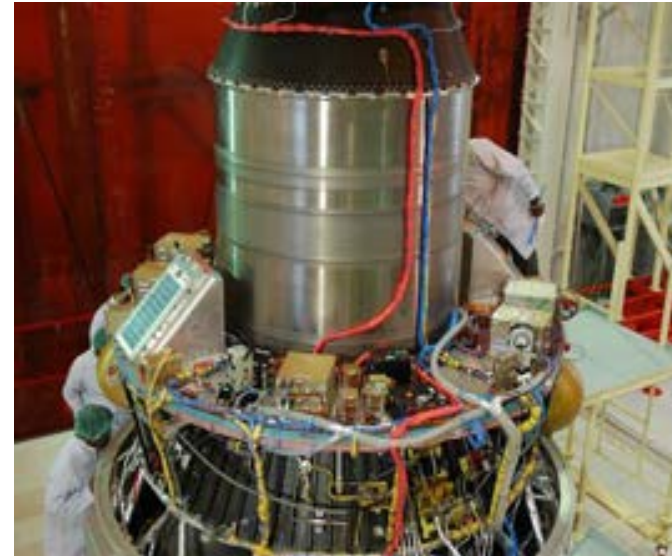
Launched
with
swisscube,
BeeSat and
UWE-2

İTUpSAT1, İTÜ Space Eng. first practical space project. Launched on 23.09.2009, still operational. The project was a major step in increasing space awareness among students. TÜBİTAK 1001, 106M082

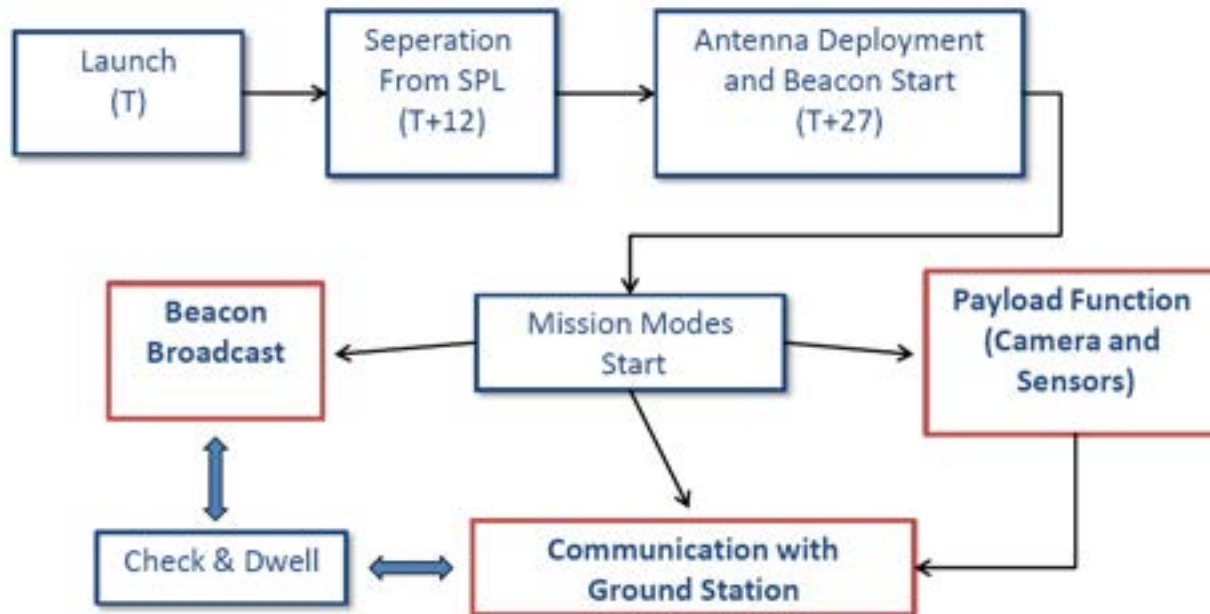


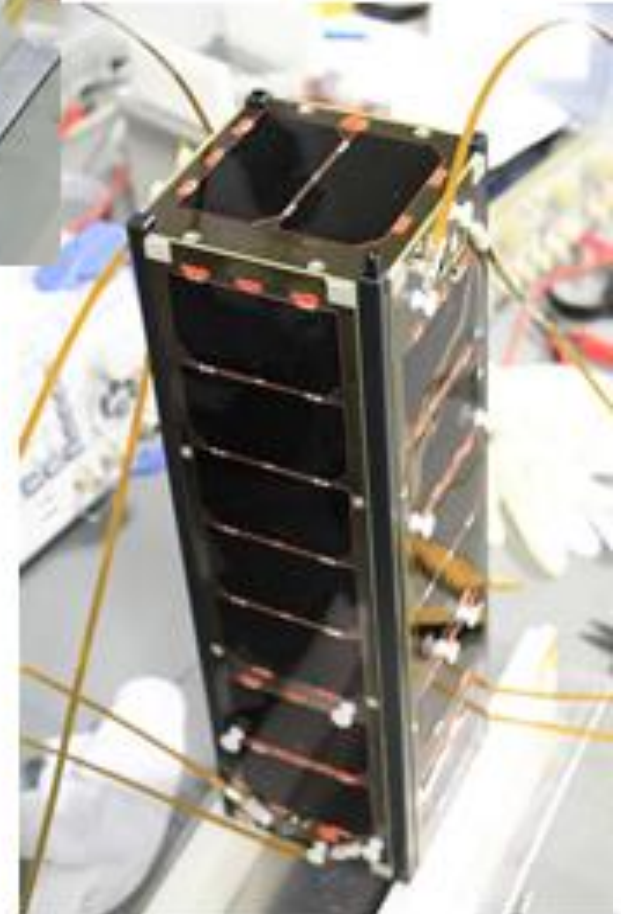
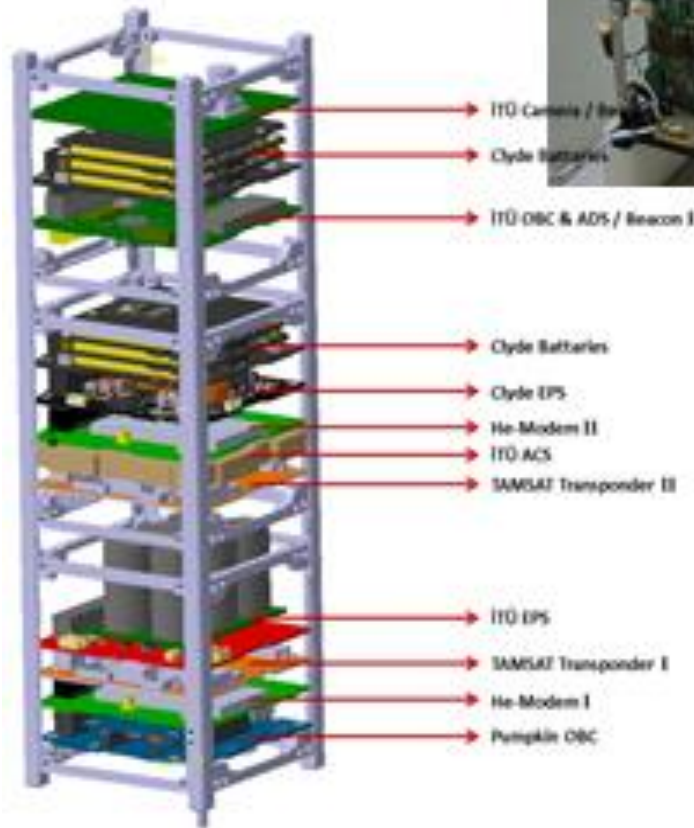
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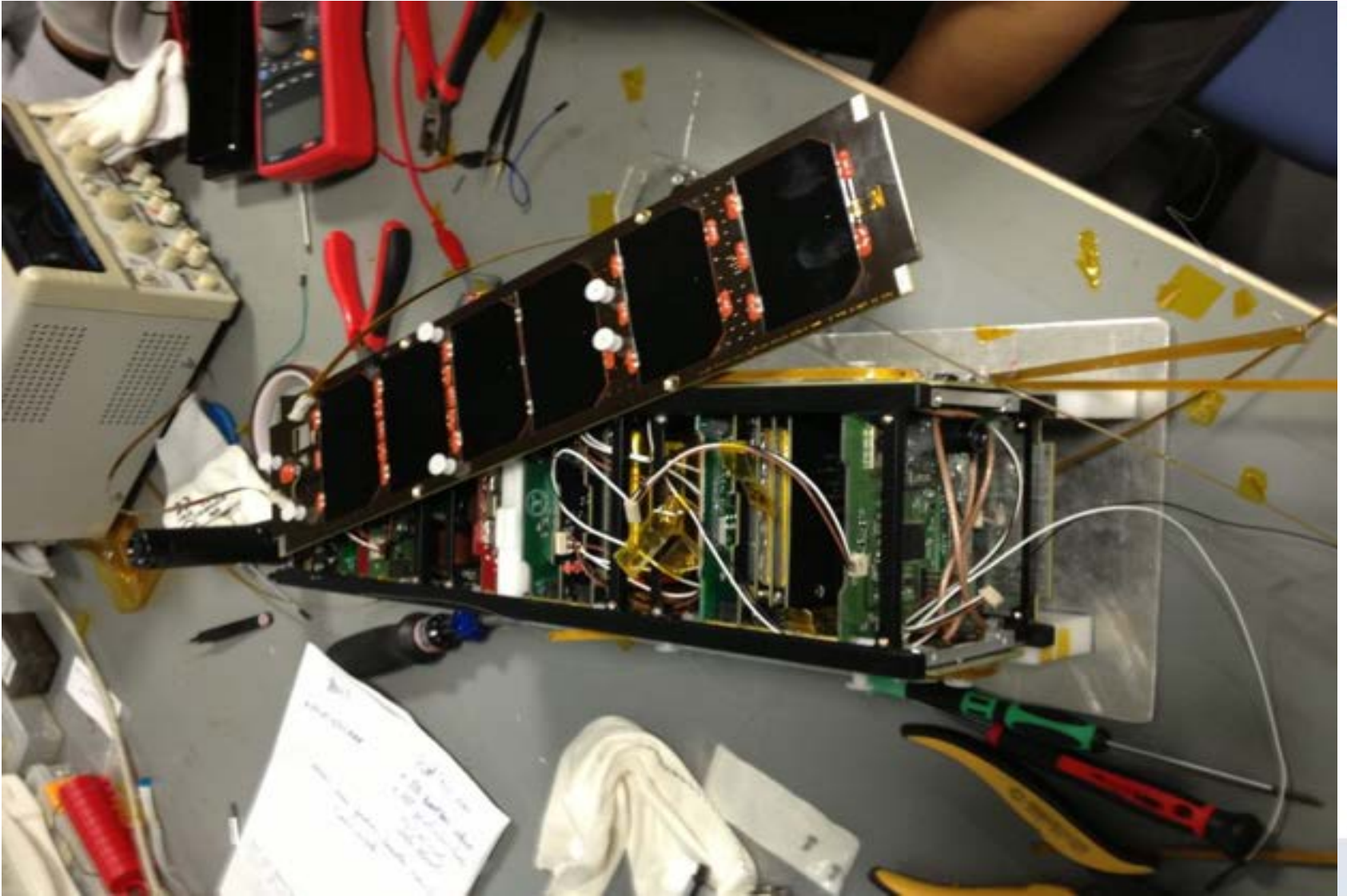


ITUpSAT I Operation Modes





TURKSAT-3USAT, fully industry supported 3 unit communication CubeSat project. Launched on 26.04.2013.



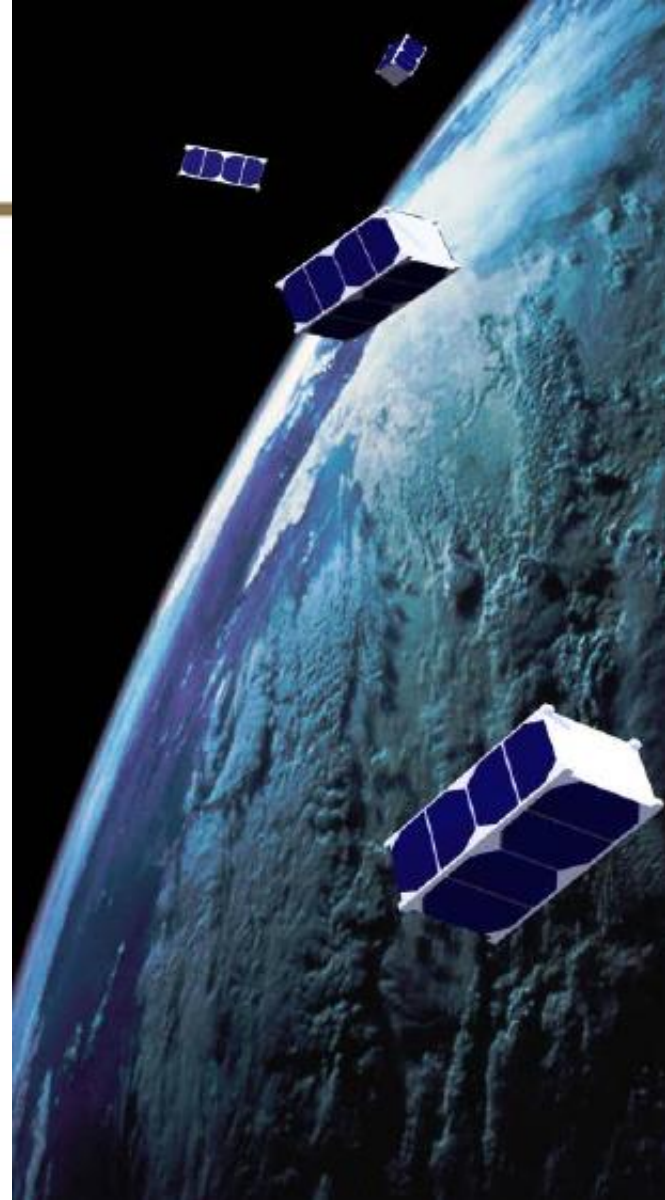
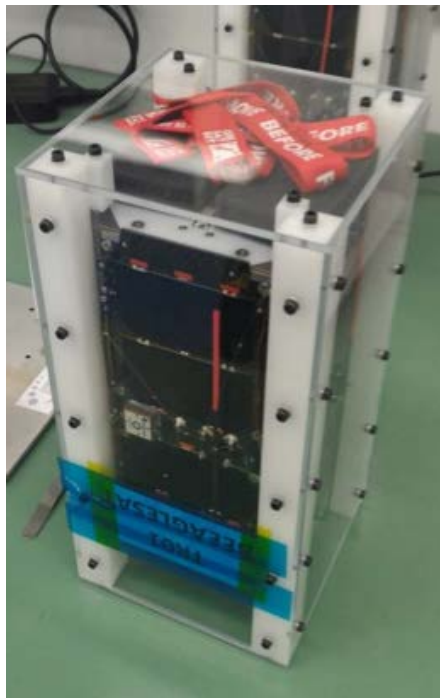
JiGuan Space Center - China May 2013

TAMSAT 3U-SAT TRANSPONDER LAUNCH

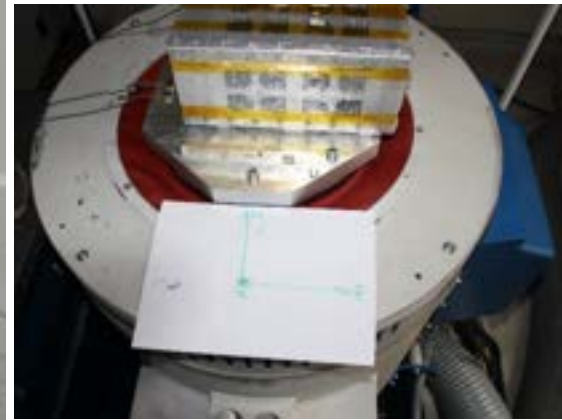
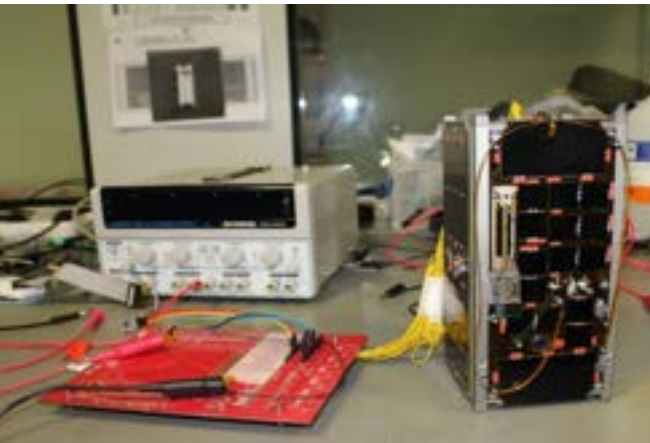
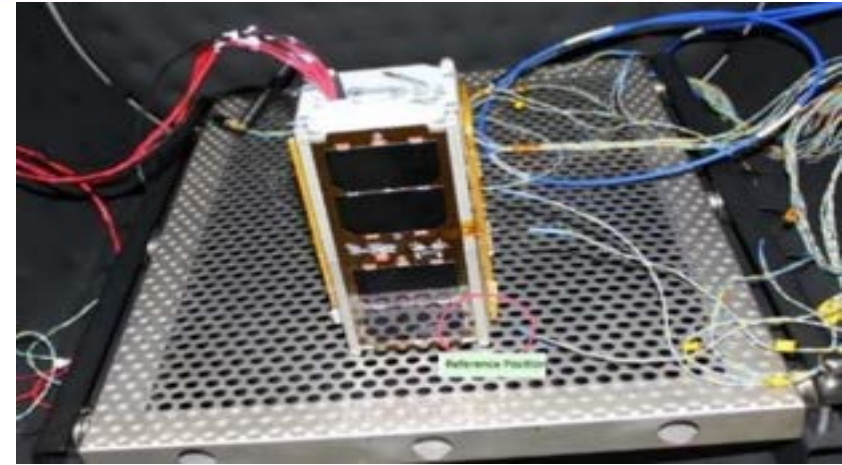
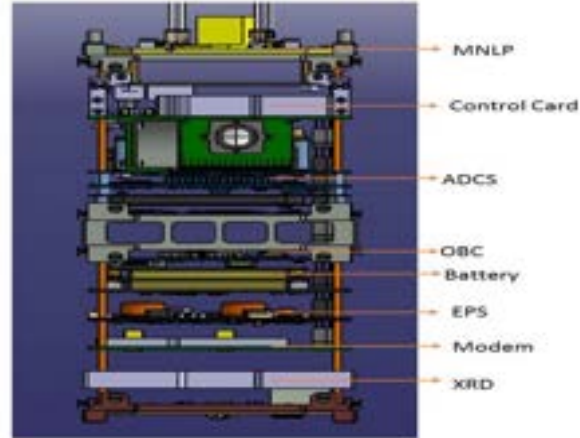
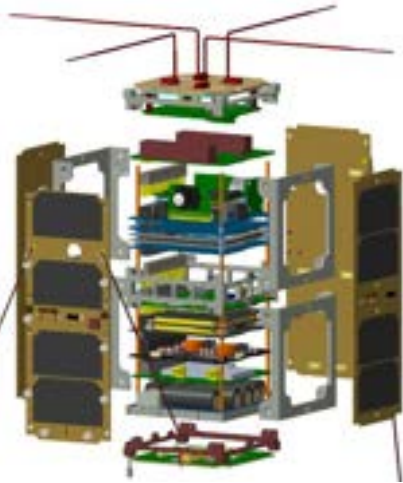


BeEagleSAT and HavelSat

- BeEagleSAT: İTÜ, HHO, SU, SMEs, HavelSan (UTEB Project).
- 2 CubeSats of 32 2U in QB50
- HavelSat: ITU and HavelSan

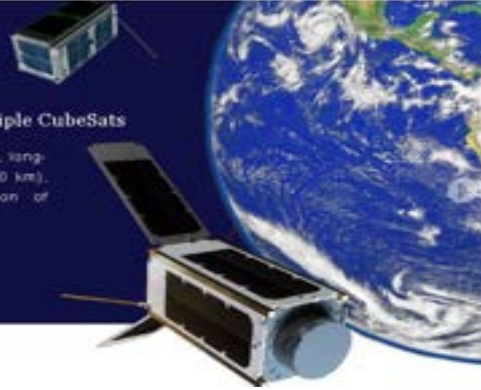



BEEAGLESAT



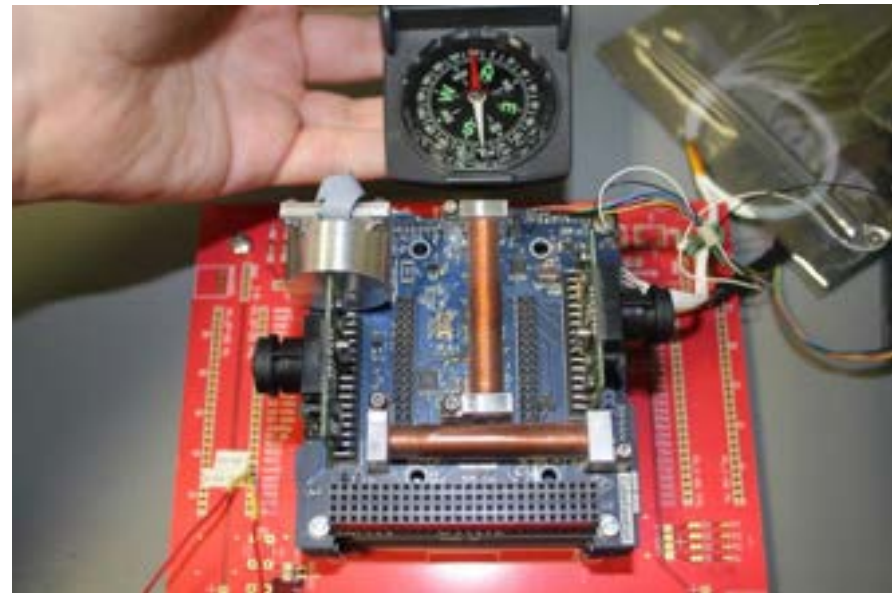
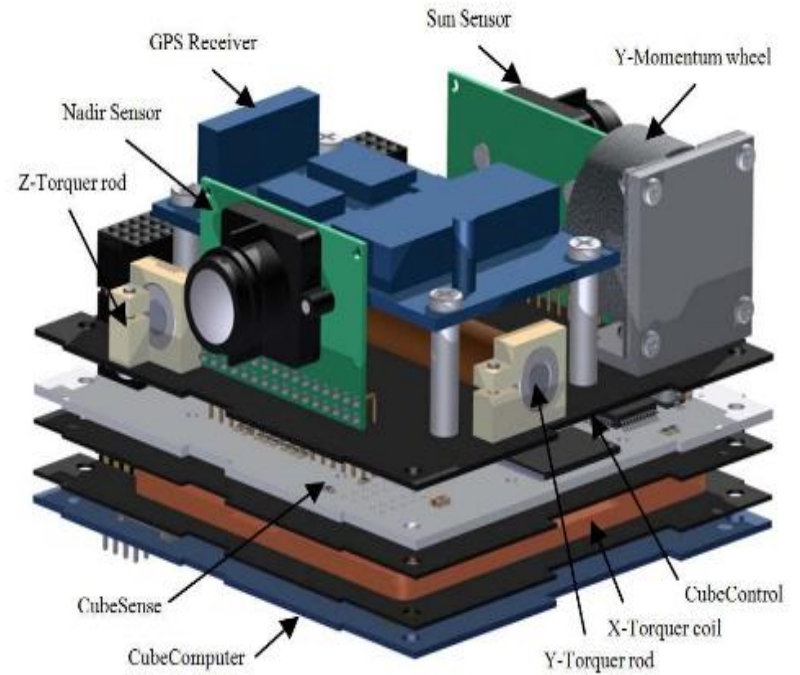
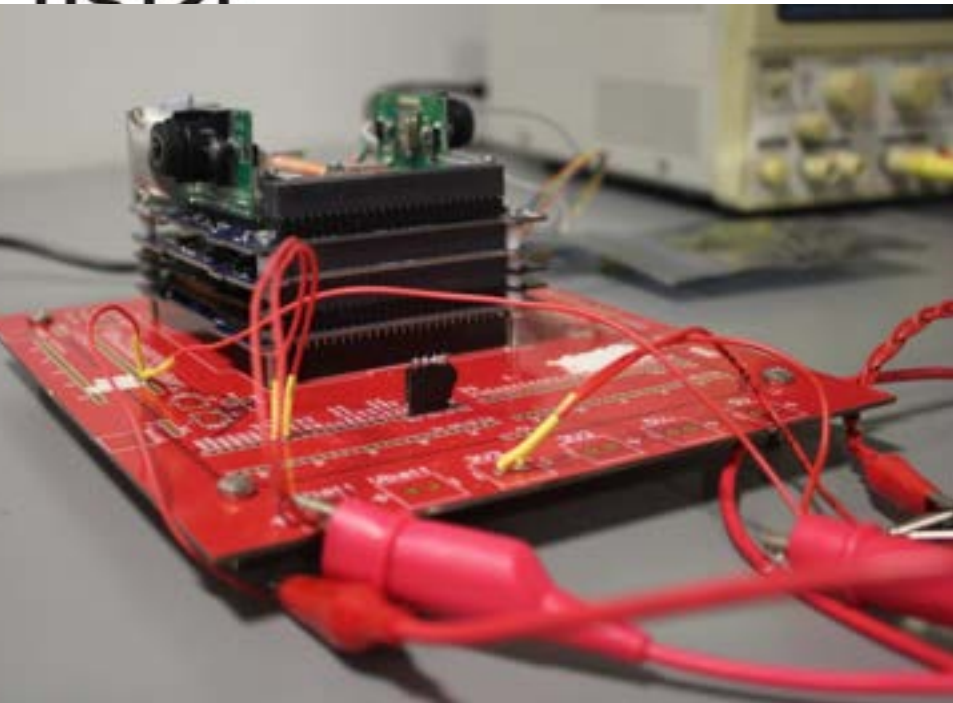
An International Network of 50 double and triple CubeSats

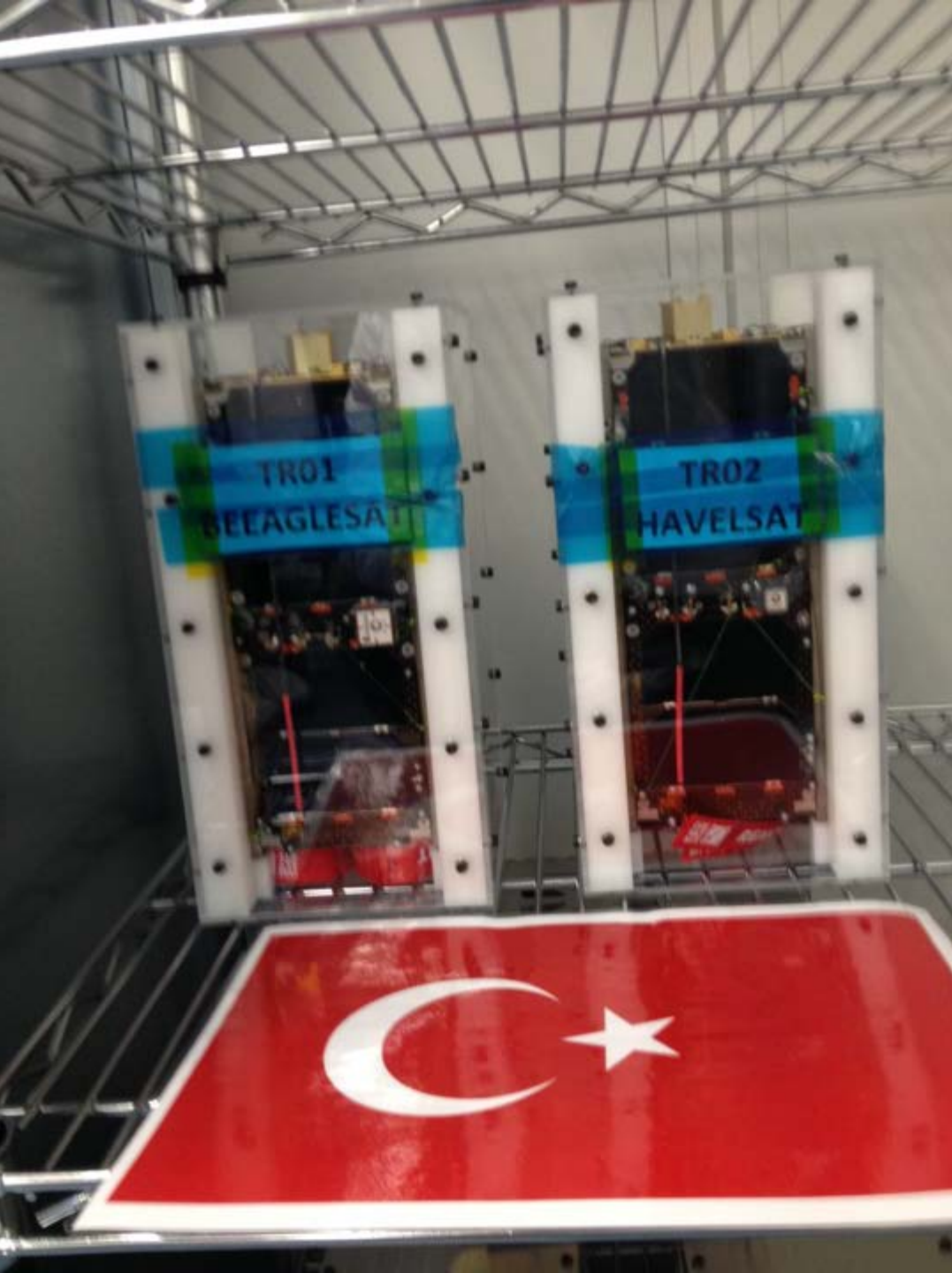
In a string-of-pearls configuration for multi-point, in-situ, long-duration exploration of the lower thermosphere (90-300 km), for re-entry research and for in-orbit demonstration of technologies and miniaturised sensors.



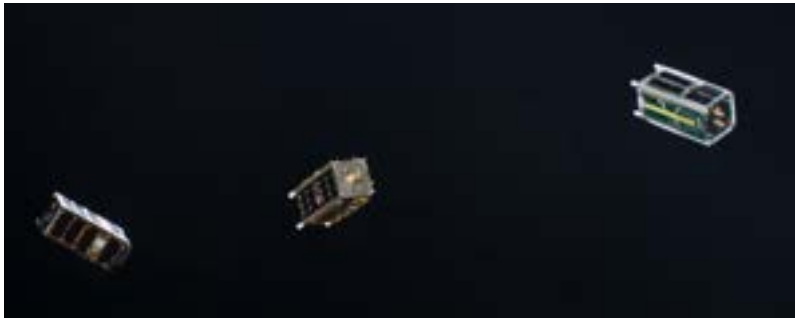
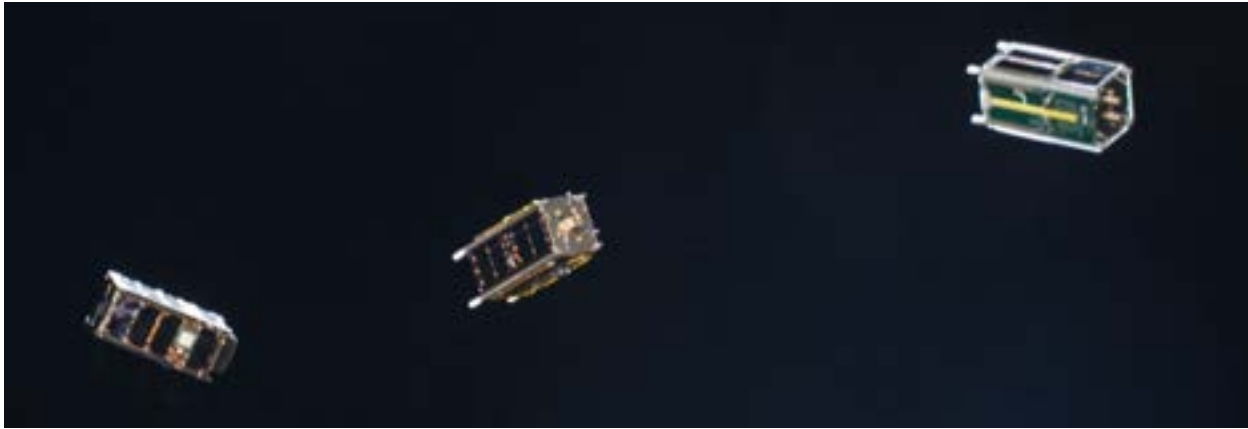
 NANORACKS











- HAVELSAT deployed on 16 May 2017
- BEEAGLESAT deployed on 26 May 2017
- Both were heard by many amateur stations
- Followed by ITU GS
- First few weeks HAVELSAT was usually in eclipse, issues with voltage values, frequent resets, Then recovered normal values
- BEEAGLESAT had good sun shine!
- High tip off rates for both CubeSats about 15-20 deg/sec



T.C.
ULAŞTIRMA DENİZCİLİK
VE HABERLEŞME BAKANLIĞI

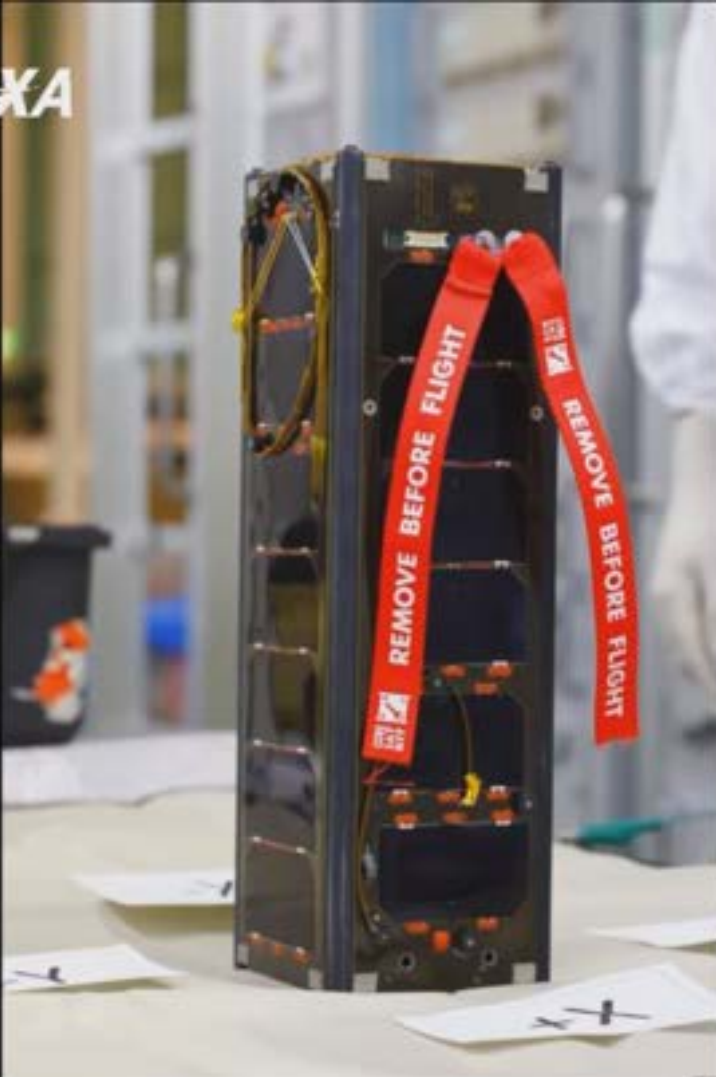
HAVACILIK VE UZAY TEKNOLOJİLERİ GENEL MÜDÜRLÜĞÜ

MEXT, JAXA, KIT,
ITU, AMSAT-TR, ERTEK, GUMUSH

UBAKUSAT



JAXA



Cooperation in the field of space
and aeronautics
(宇宙・航空分野に関する協力)



JAXA and Republic of Turkey's Ministry of
Transport, Maritime Affairs and Communications
(JAXAとトルコ共和国 運輸海事通信省)

- Provision of opportunity for long duration material exposure
(材料などの長期曝露実験機会)
- Deployment of one cubesat (3U)
(超小型衛星1機 (3U) の放出)

TURKEY

- Ministry of Transport Maritime Affairs and Communications
- Istanbul Technical University
- TAMSAT/AMSAT-TR
- Ertek Ltd. (SME)
- Gumush Space(SME)
- TURKSAT INC
- Turkish Aerospace Industry
- UNISEC-TR

JAPAN

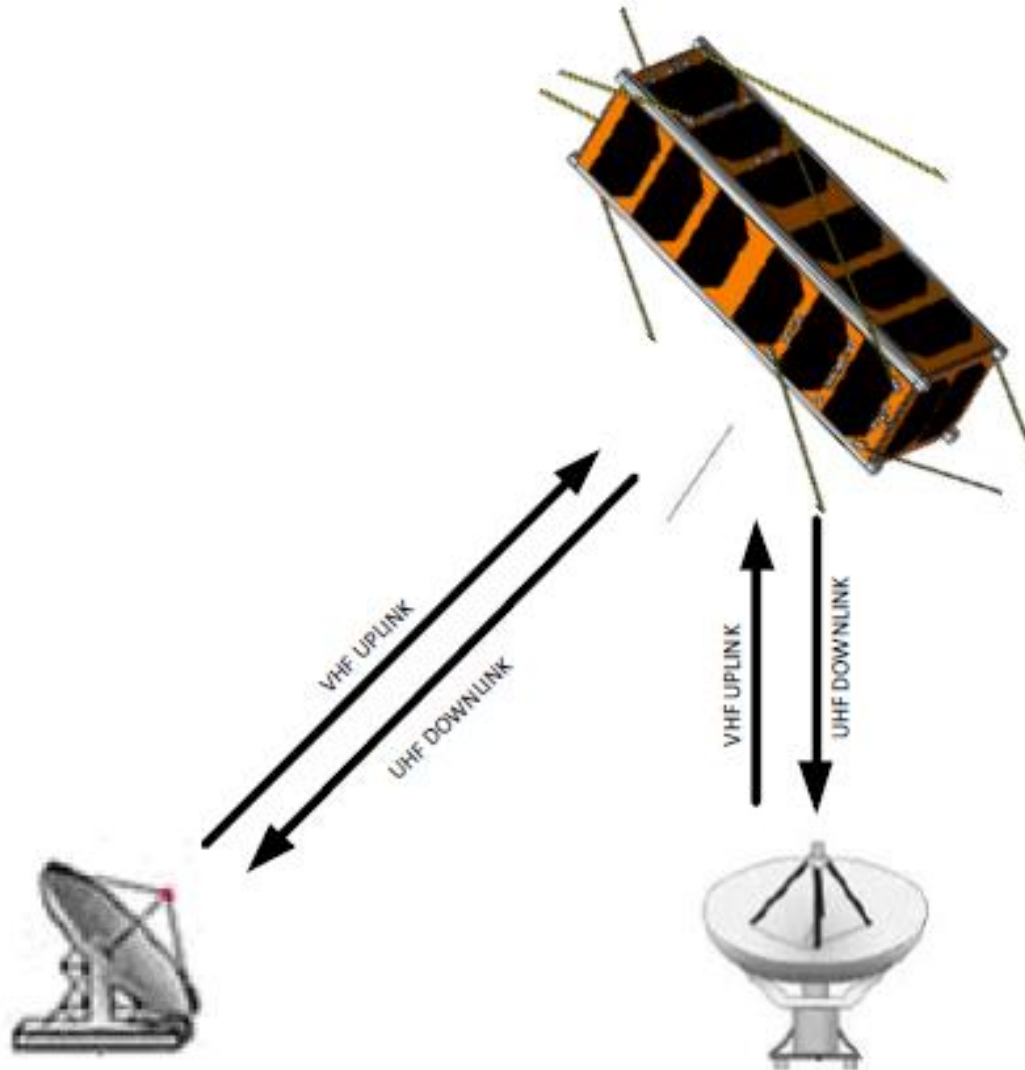
- Ministry of Education, Culture, Sports, Science and Technology(MEXT)
- Japan Aerospace Exploration Agency(JAXA)
- Kyushu Institute of Technology

TURKEY

- Develop and test 3U CubeSat, UBAKUSAT
- Compliance with JEM Payload Accommodation Handbook
- Transport to KIT/Japan
- Transport to JAXA/Japan

JAPAN

- Further Testing of UBAKUSAT
- Assist in document preparation for Launch
- Launch



Mass 3.2 kg
10*10*34cm, 3U CubeSat

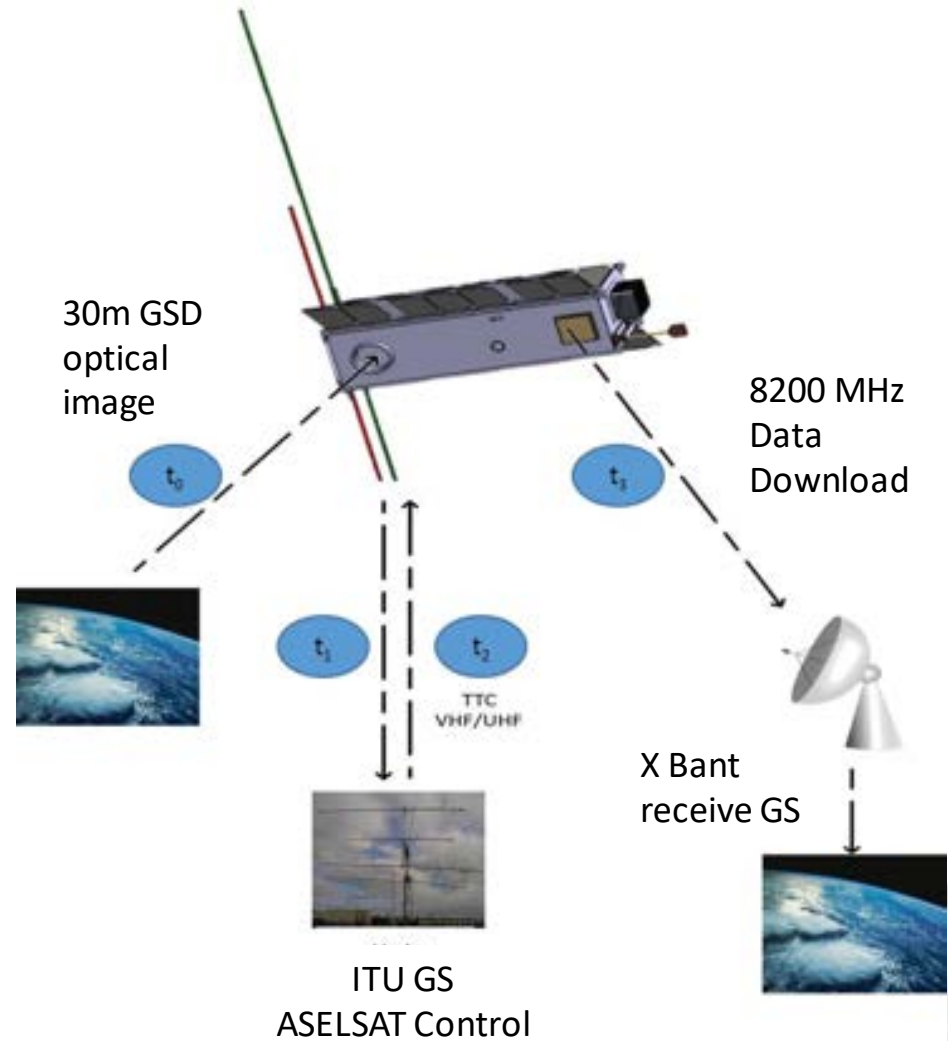
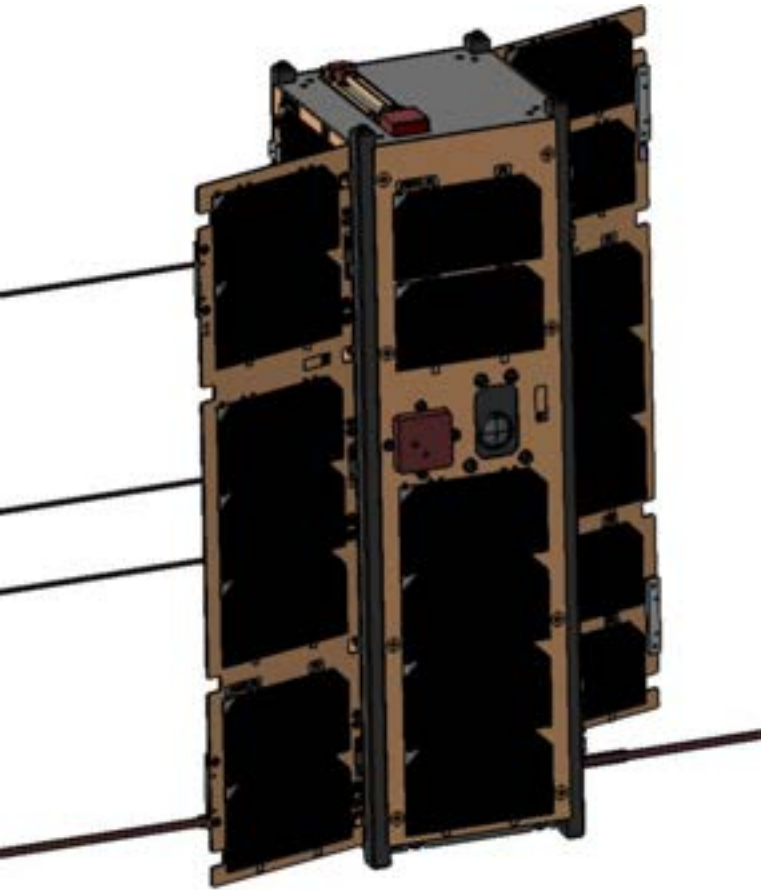
- Main payload a VHF/UHF Transponder

Input Frequency	145.940 – 145.990 MHz
Output Frequency	435.200 – 435.250 MHz
Transponder Type	Inverting – Linear
Modulation	All Mode (AM, FM, SSB, CW, FSK,etc.)
Bandwidth	50 KHz
RF Power (max)	1 Watt - 30 dB

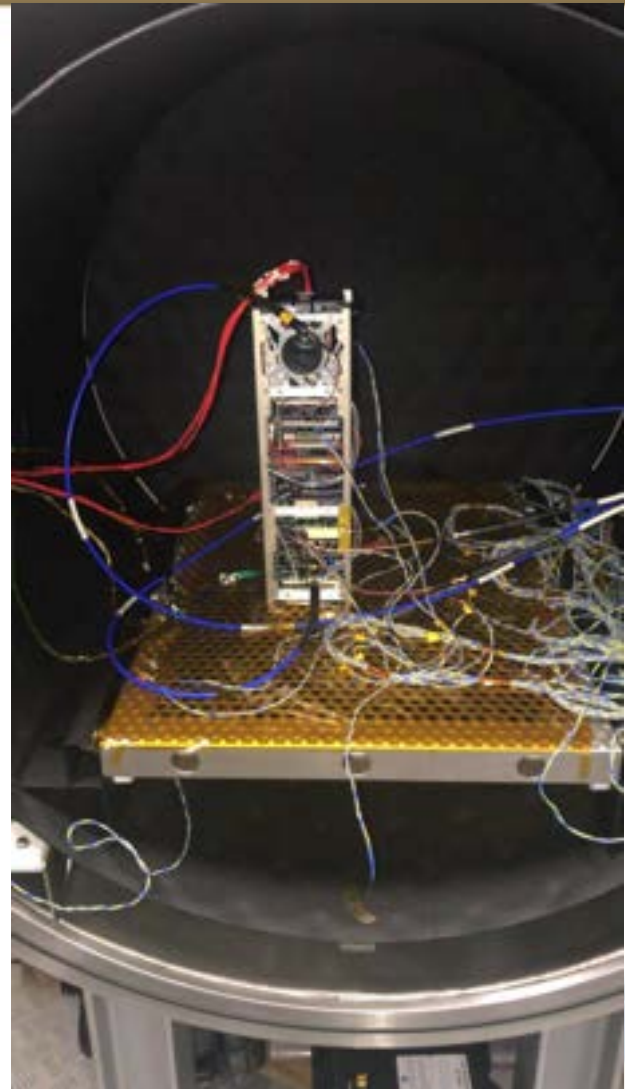
- Battery 30Whr
- Passive Magnetic Stabilization system



AELSAT MISSION for AELSAN Company



TVAC TESTING

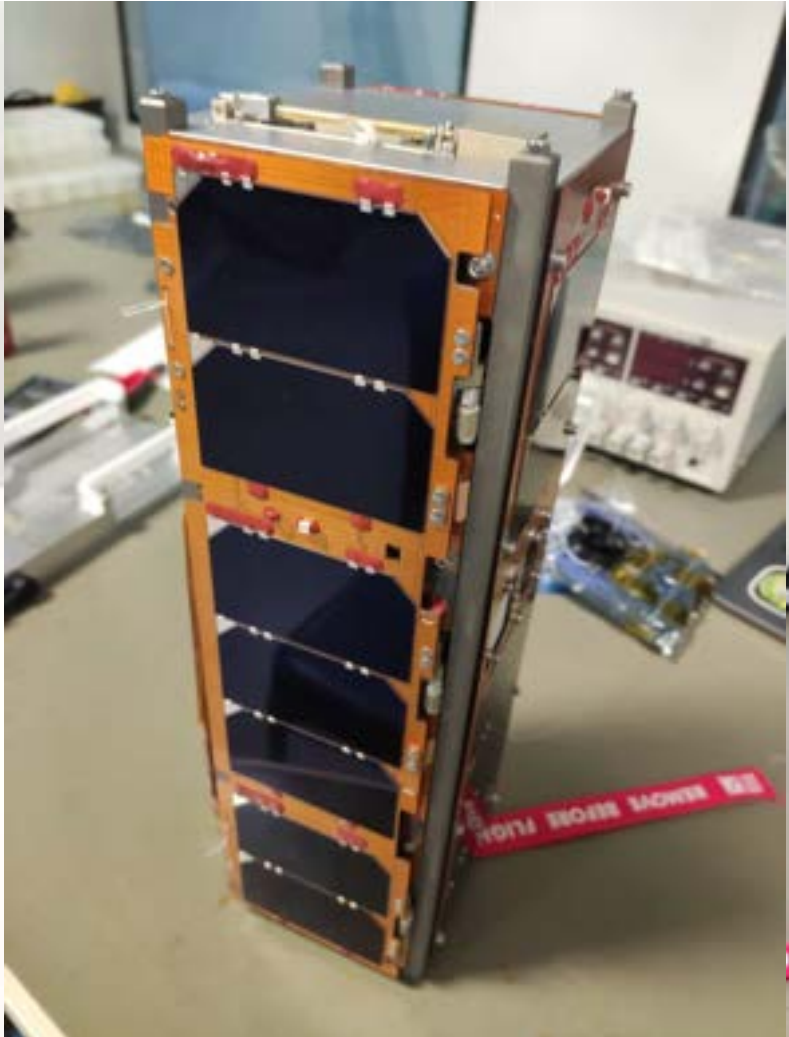




ASELSAT, January 2021

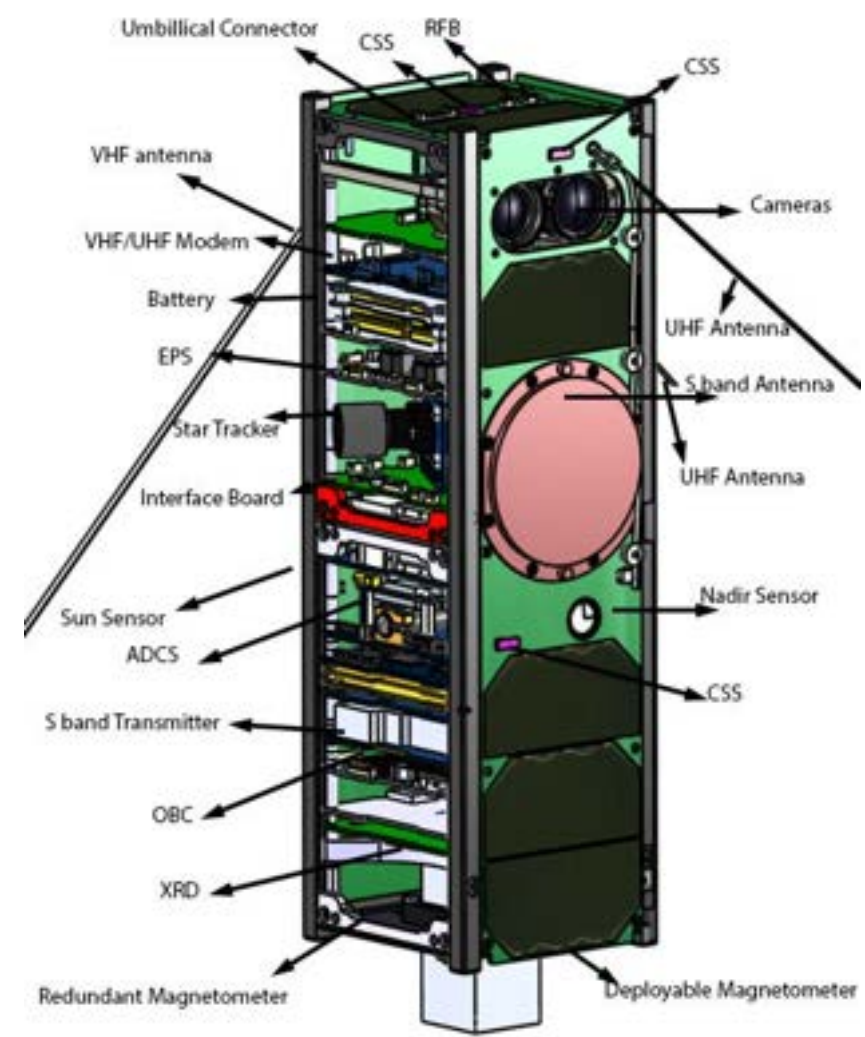
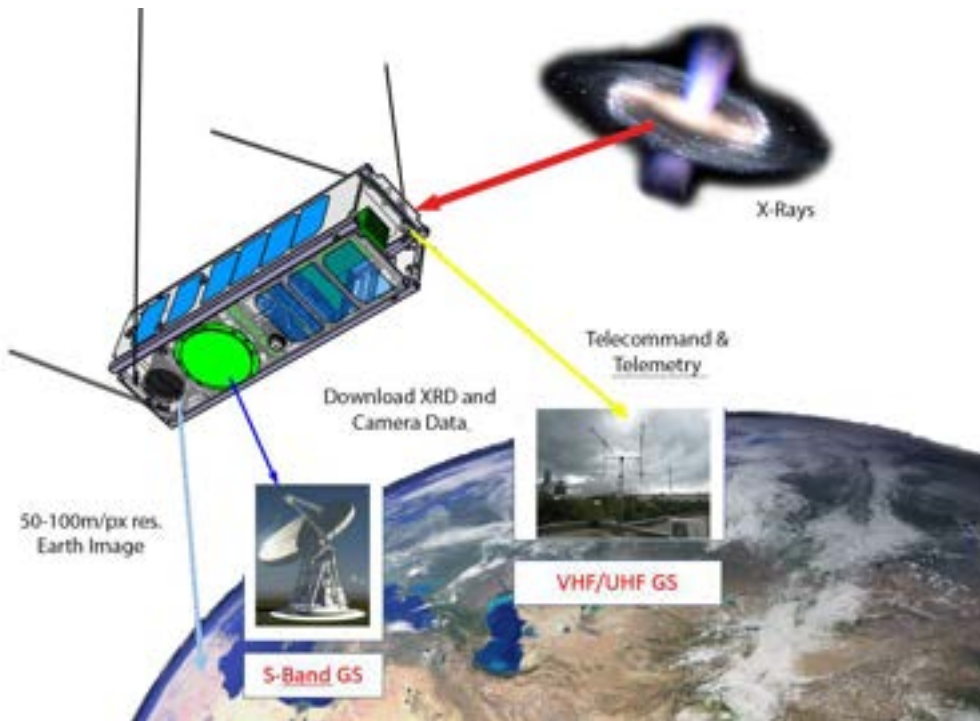


ASELSAT



- UNIVERSITY of SHARJAH, UAE
- Istanbul Technical University
- Sabancı University
- Capacity development through (create cubesat ecosystem)
 - Science mission: star detection and sun observation
 - Imaging mission: earth and Space
 - Knowledge transfer
 - Infrastructure development (GSs and Lab facilities)
- Payload
 - X Ray detector
 - Optical camera
- Launched 3 January 2023,
- placed in to orbit on 16.2023 by D-Orbit OTV

SHARJAH SAT -1



CubeSat Training at SAASST in Sharjah, Clean Room and CubeSat Design Lab



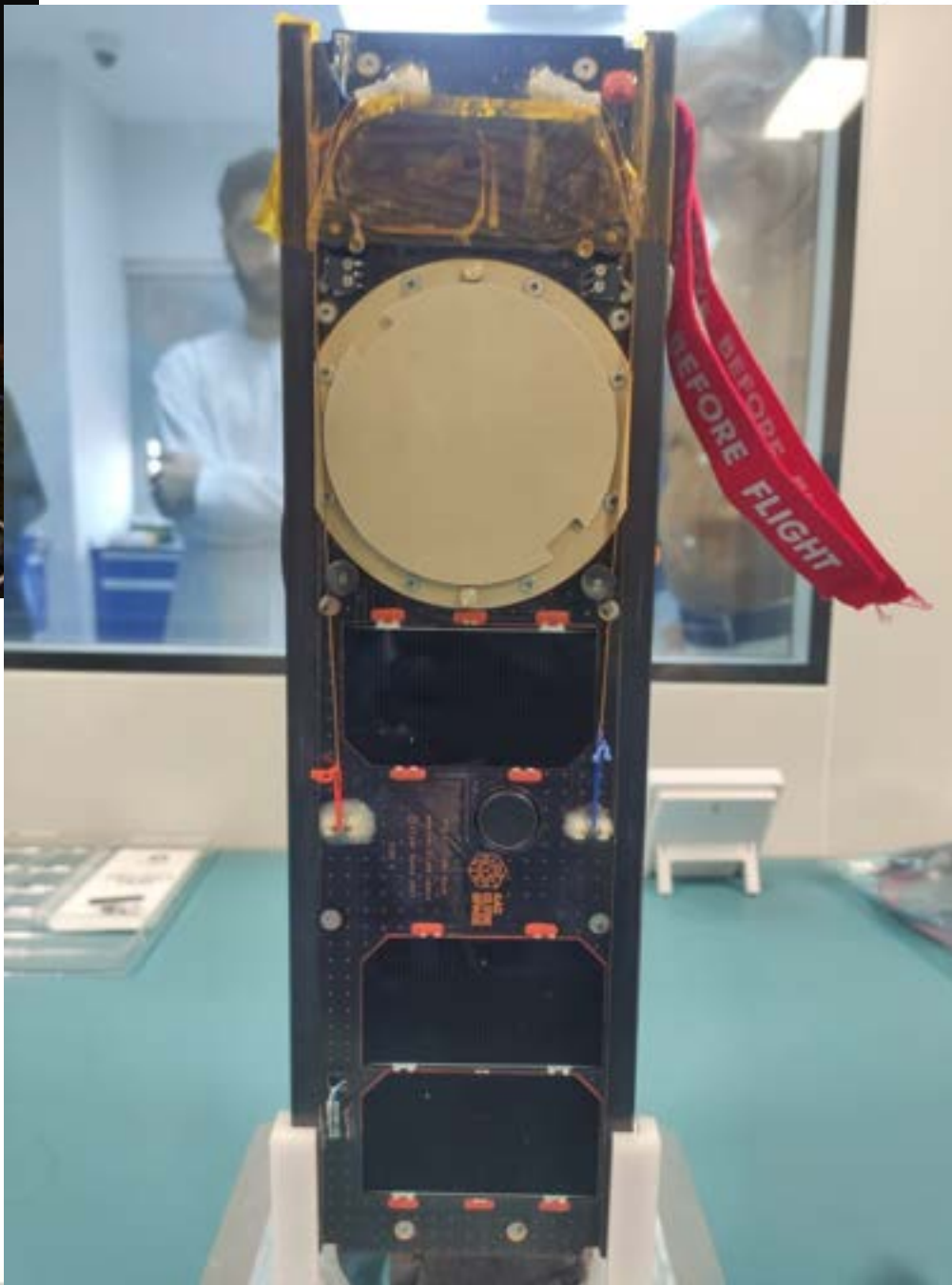
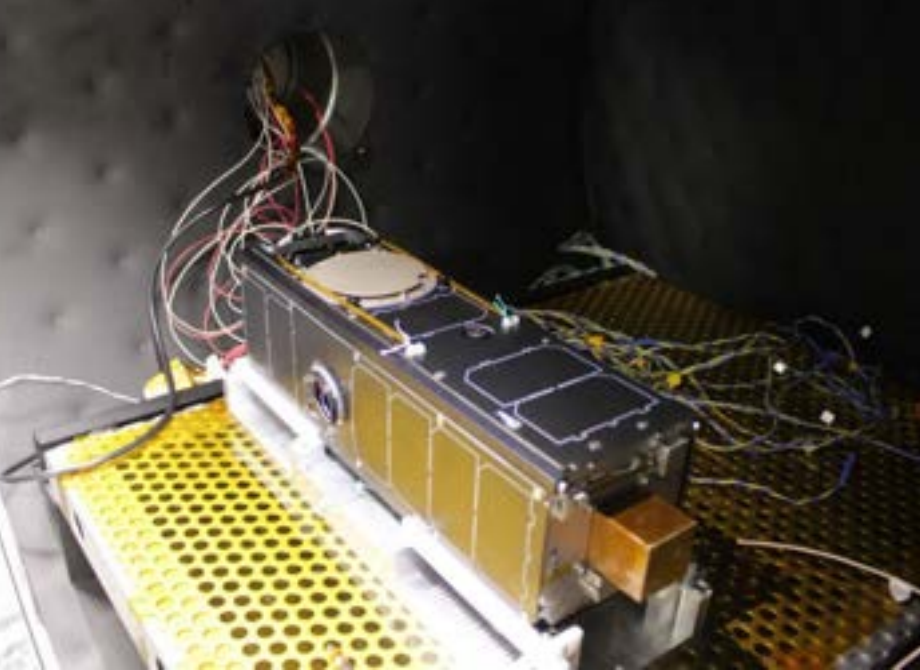
UoS VHF/UHF GS Established March 2020

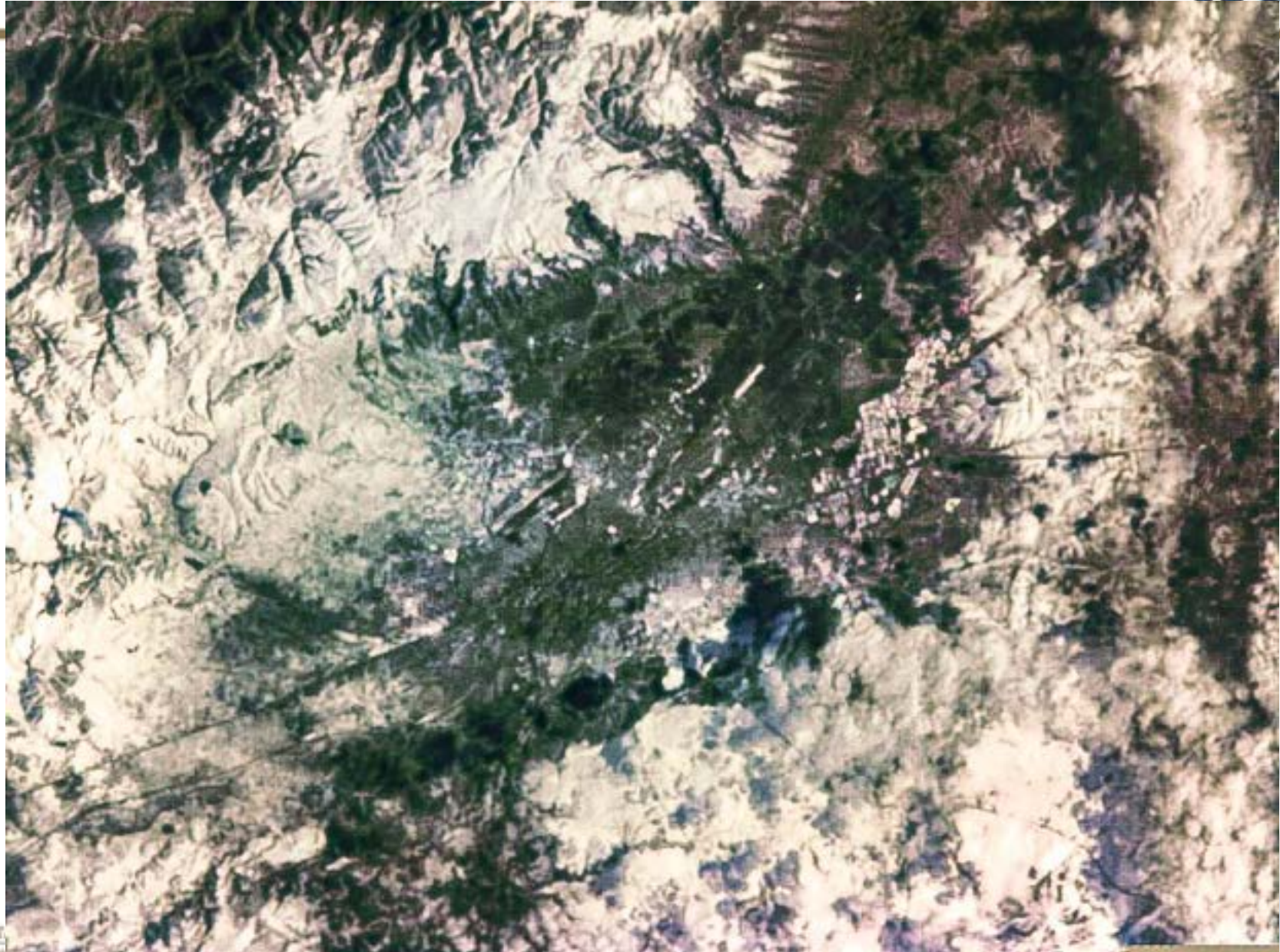




CubeSat on a table

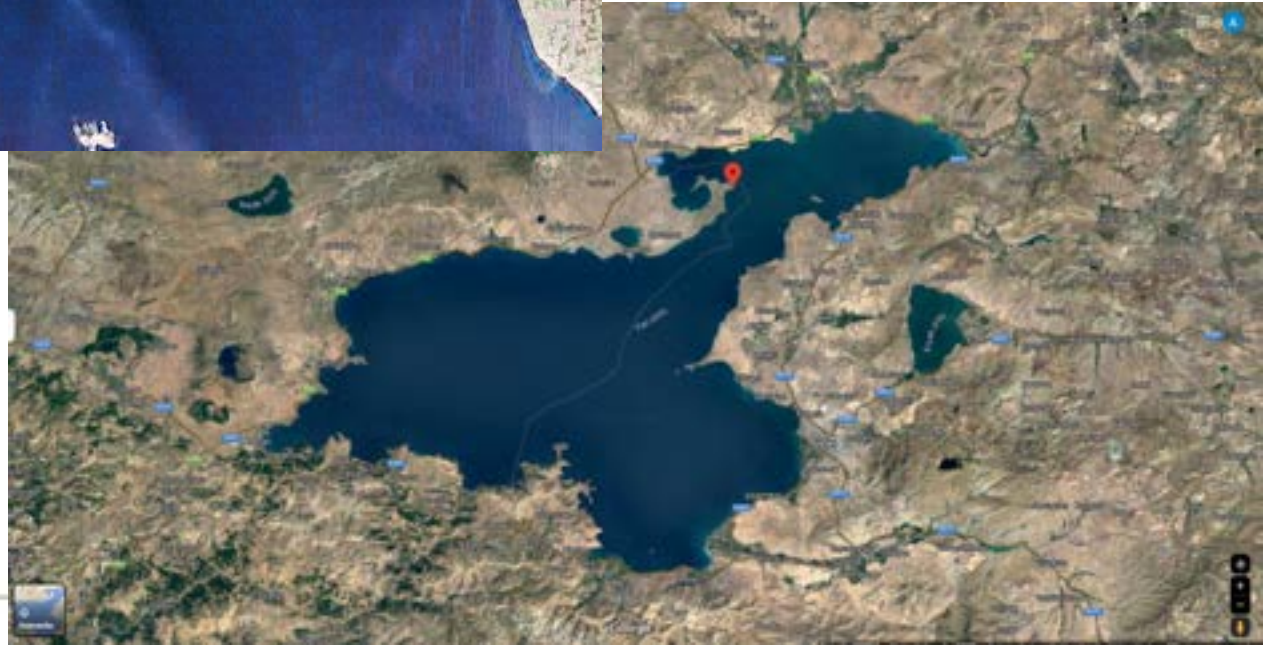






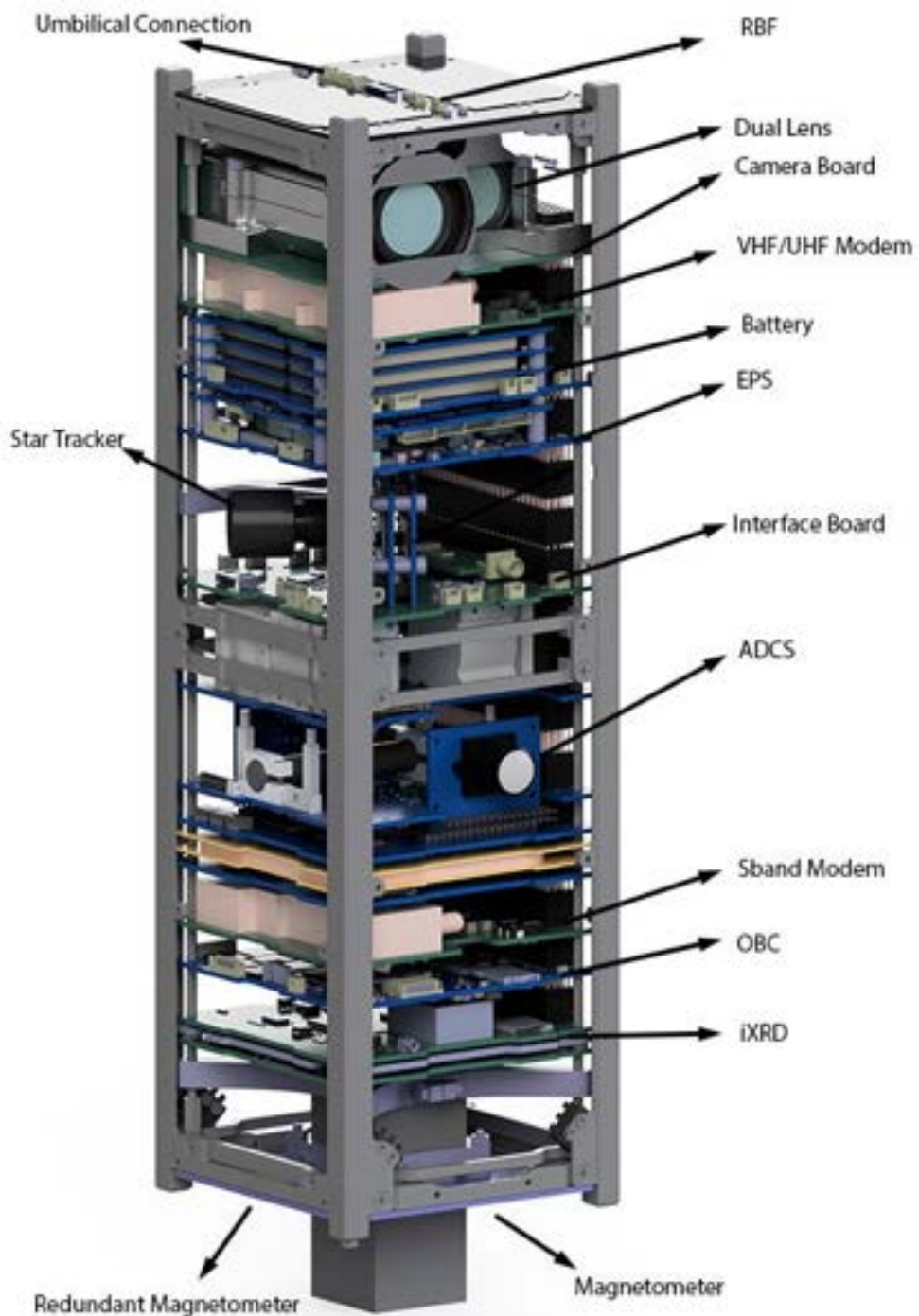


VAN LAKE TURKIYE

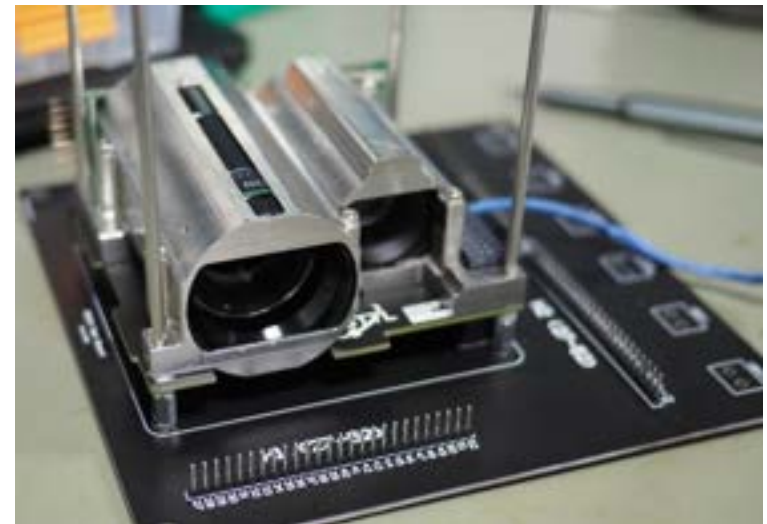




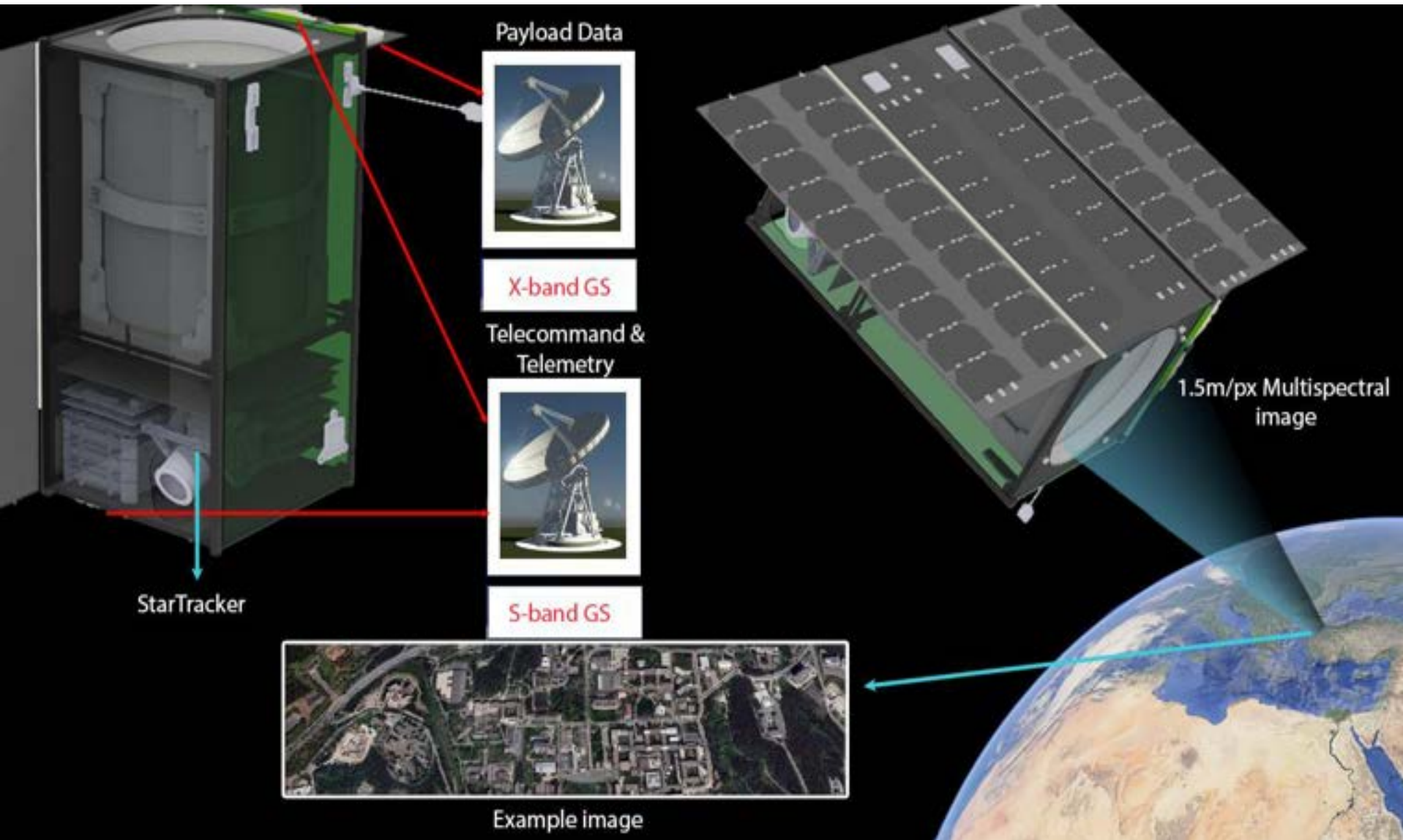




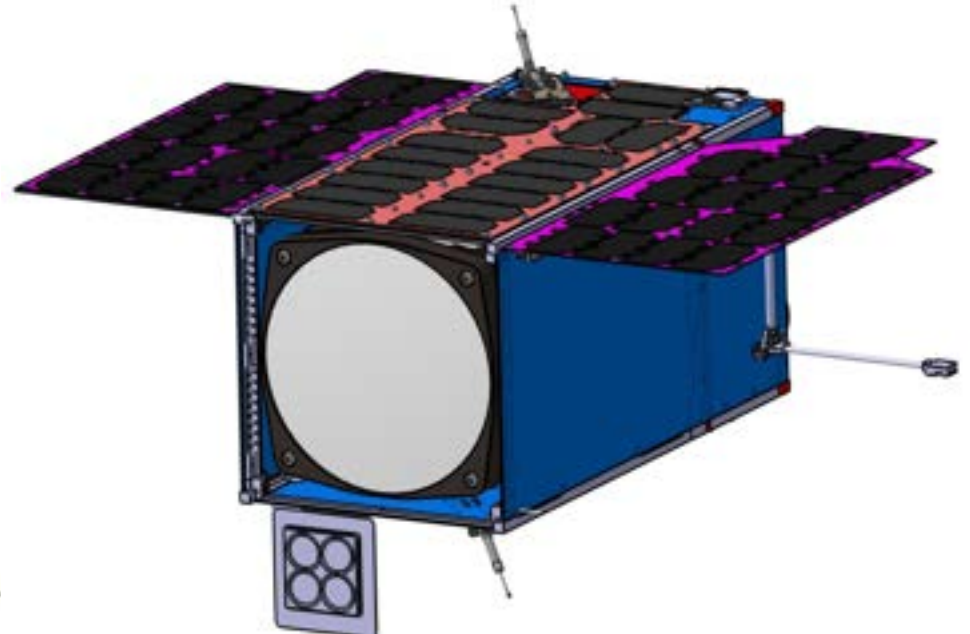
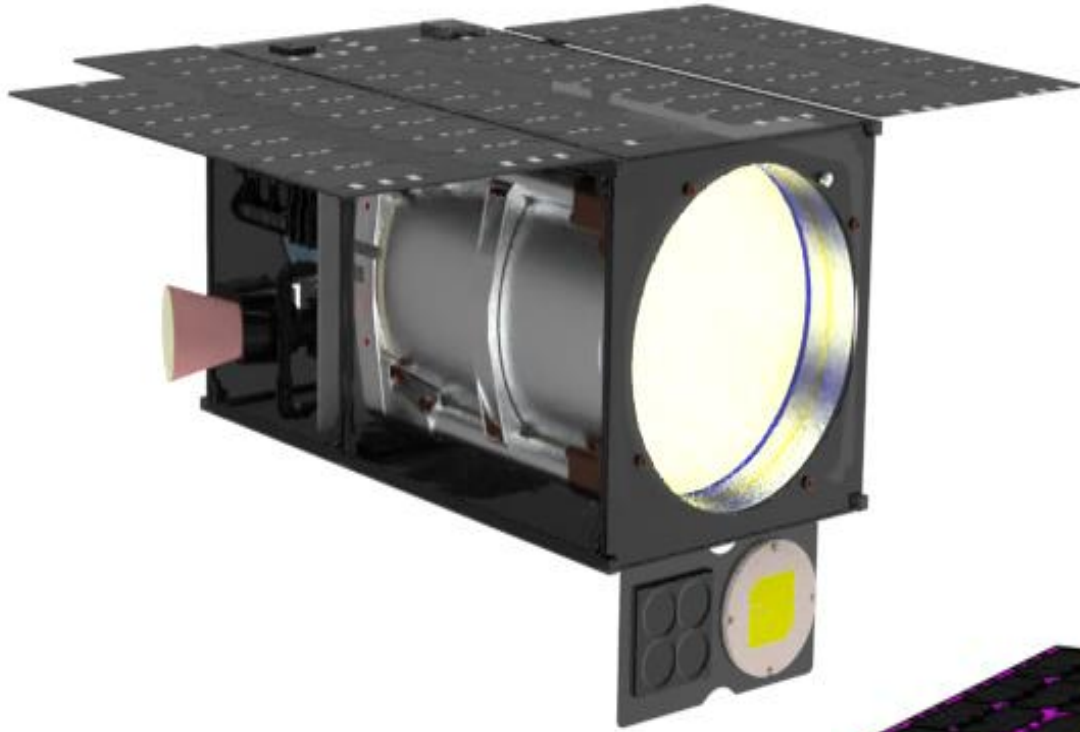
- Full ADCS
- Good power budget
- SW



PAUSAT1: 1.5M GSD at 500 km Earth Observation Mission

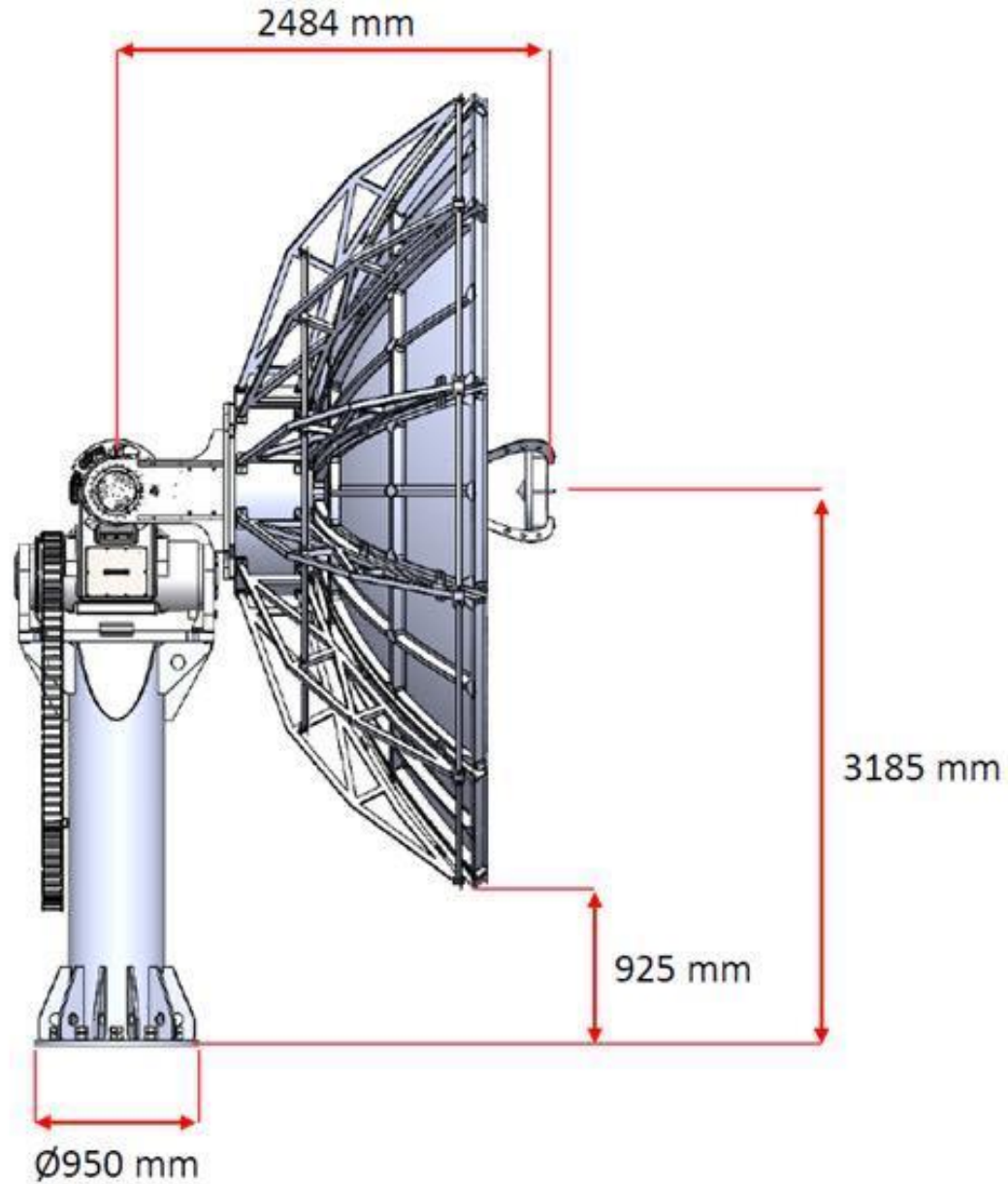


1.5 m GSD MS 16 U 25 kg

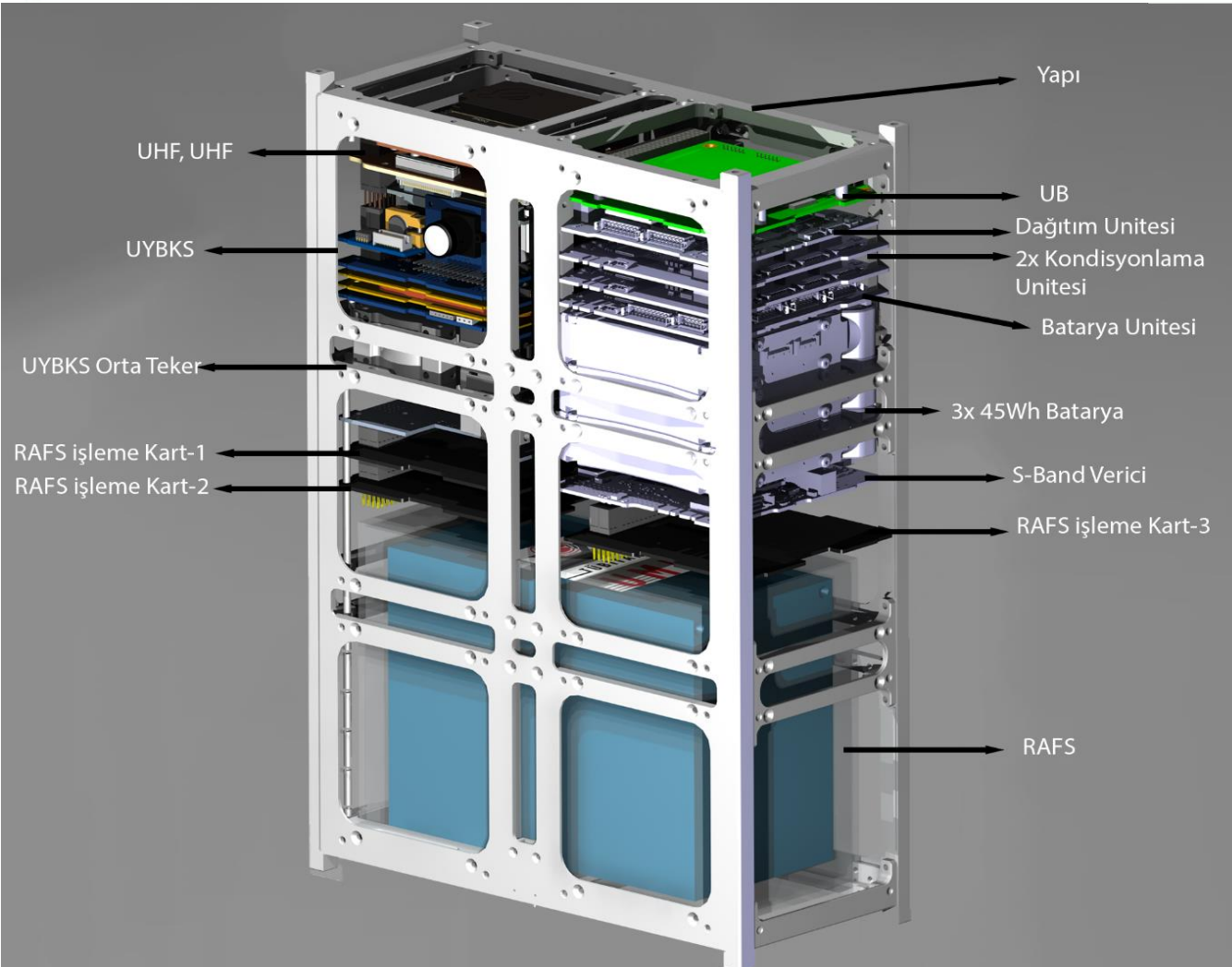








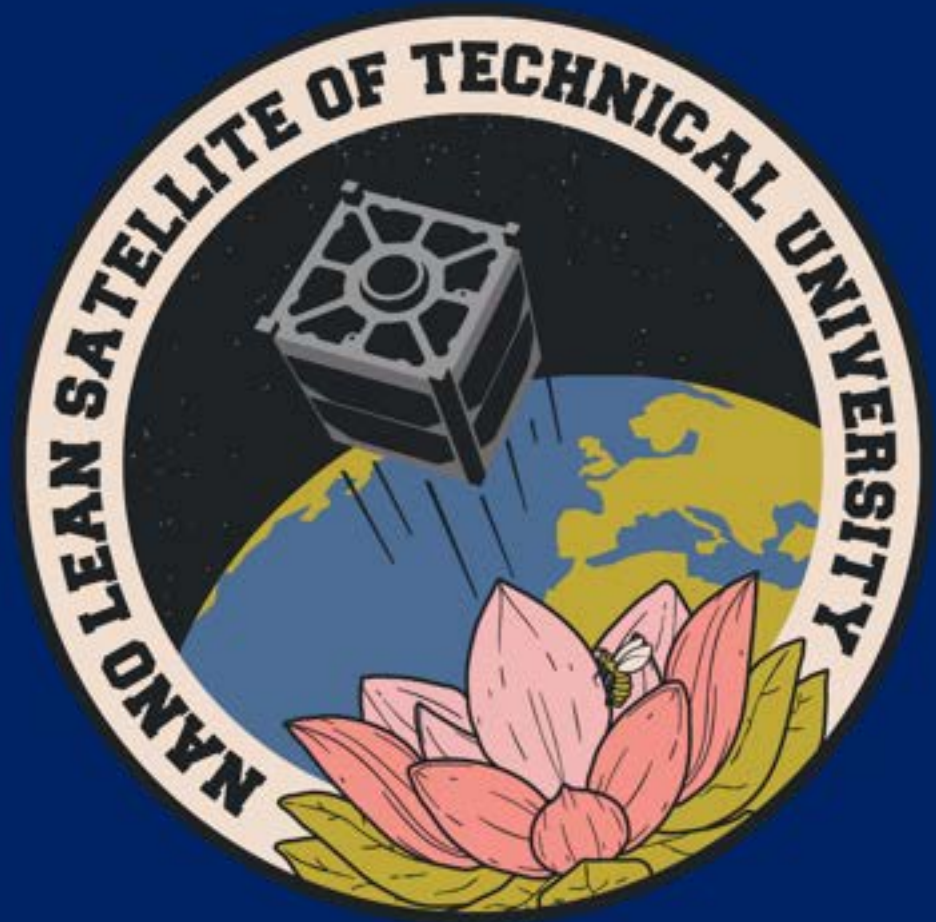




- RAFS Payload
- RAFS
 - RAFS signal transfer
- RAFS ve Sat thermal management
- 6U Structure
- OBC and interfaces
- EPS
 - Battery
 - Panels
 - PDCU
- Comm
 - UHF-UHF trcv, antenna
- ADCS, wheels

n-LOTUSat

A 1U CUBESAT PROJECT



WHO ARE WE?

- "Nano Lean Satellite of Technical University"
- 1U cubesat project
- Developed by undergraduate students from with CanSat experience





OUR GOALS

- To gain interdisciplinary experience in the development stages of a cubesat
- To practise aerospace engineering in undergraduate level
- To develop our own electronic systems & designs, and gain flight heritage to them



MISSION

MAGNETOMETER PRODUCTION

- designing and manufacturing our own sensor

DOSIMETER

- COTS
- data analysis after launch

MAGNETOMETER PRODUCTION

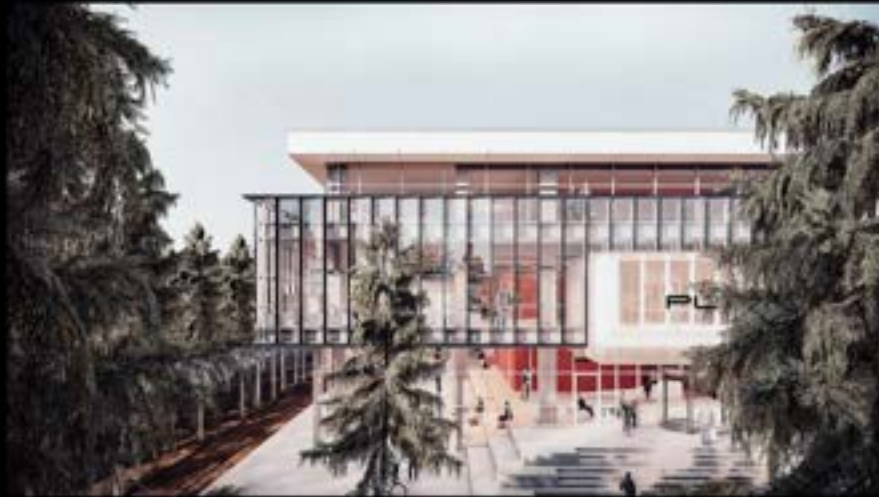
- COTS
- software & algorithm development



PLAN-S SATELLITE & SPACE TECHNOLOGIES



INVESTMENTS

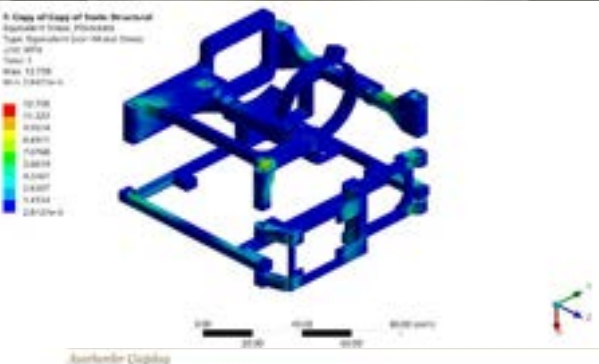
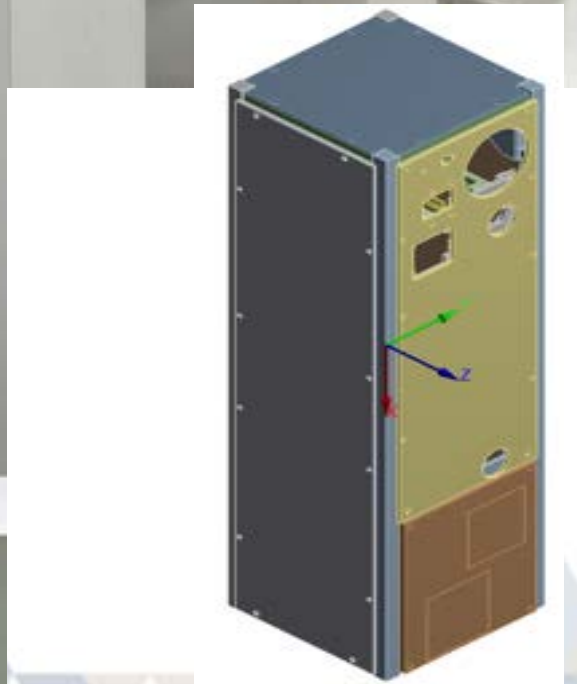
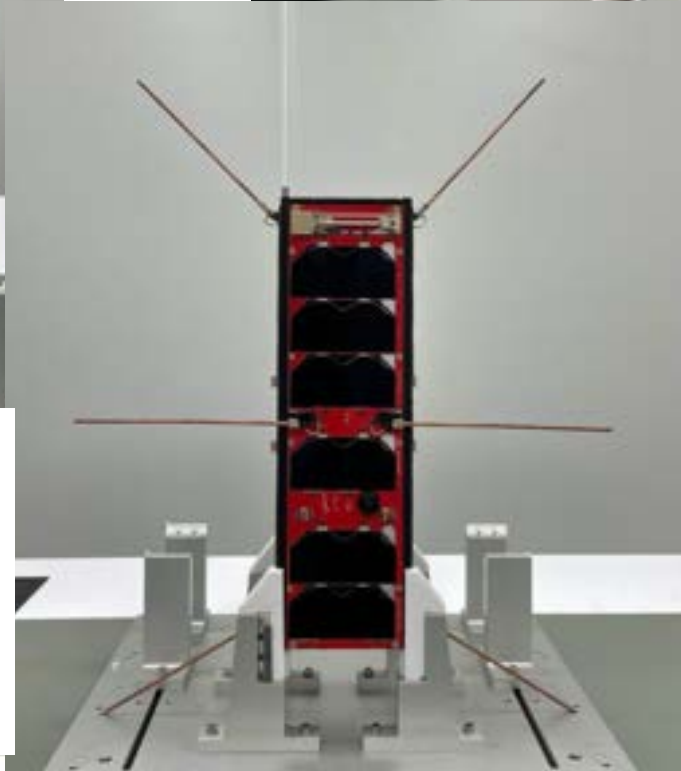
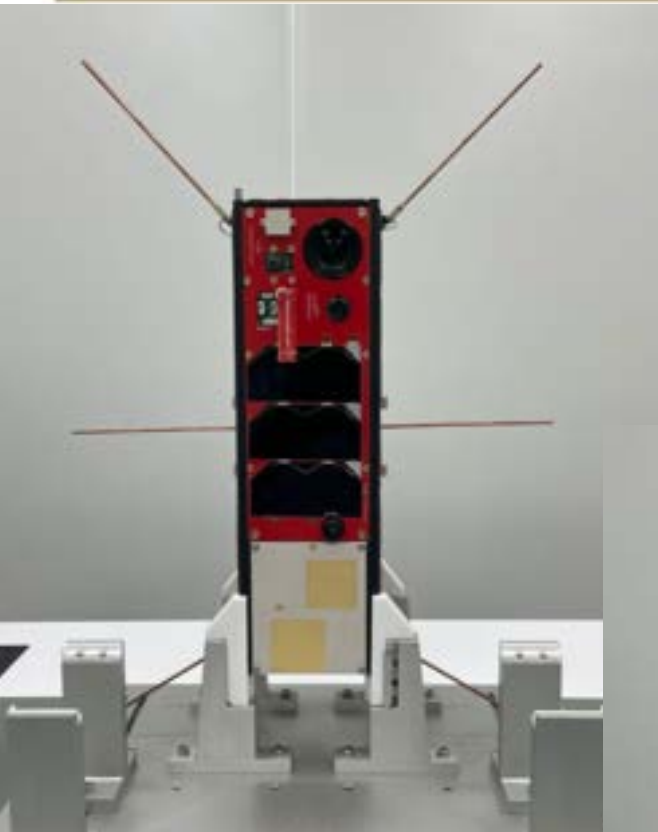


We started building our R&D facility and it will be ready by the Q4 of 2022;

- 9000 m² in total
- 10.000 class clean room
- 100.000 class clean room
- TVC, Vibration and Climatic Test Chambers/Equipments
- EMI/EMC & Antenna Measurement Laboratories
- Electronic and Mechanical Laboratories

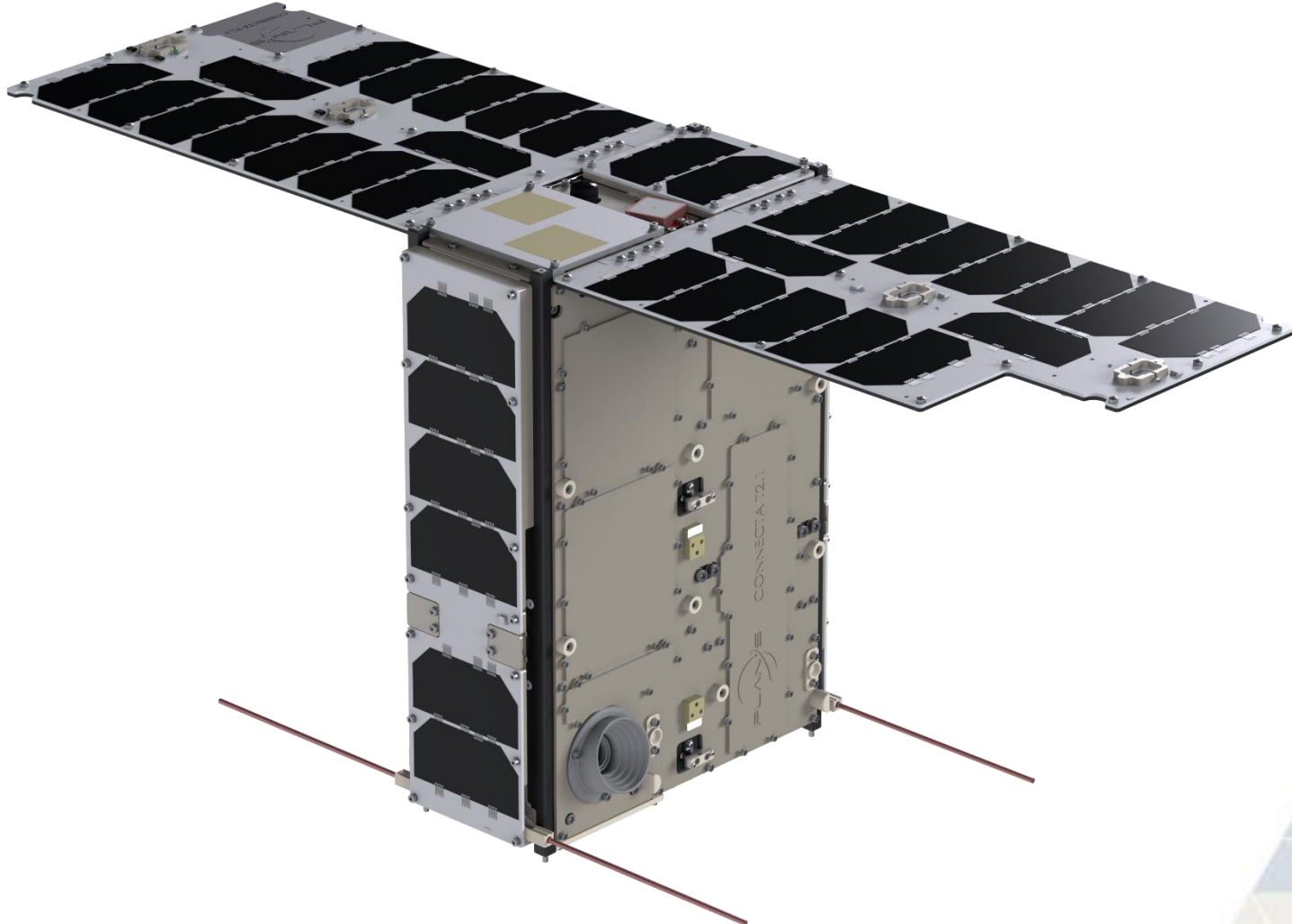
- Establishment Summer 2021
- IoT and EO Constellations
- Building tech demo missions
- 3U and 6U CubeSat







[Post | LinkedIn](#)





P
A
2023-06-21 U



PLA
Jumeirah Palm Island
2023-07-08 UTC: C

Beijing/China
2023-06-15 UTC: 02:20:59



Izmir/Turkey
2023-06-29 UTC: 08:19:16



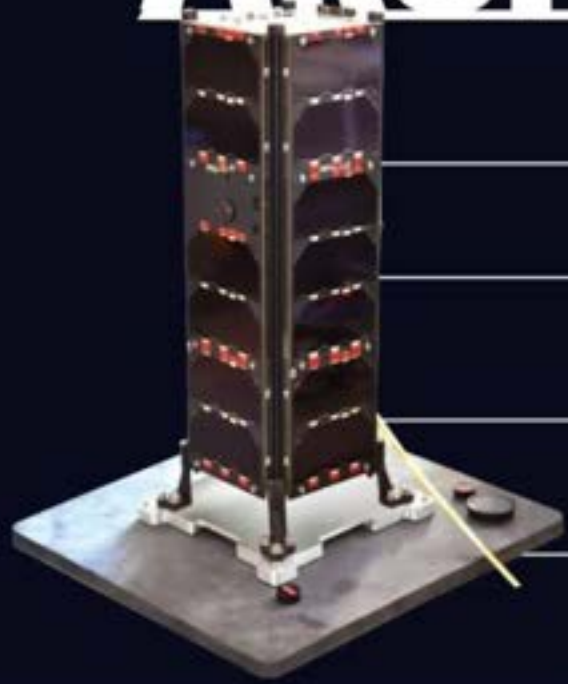
Warroo/Australia
2023-07-31 UTC: 01:01:00





- 5 cubesat development and launches in 2 years
- All successful, operational
- Self funded
- Own missions
- Utilize all the past knowledge available
- Employe the best in their field
- Test in orbit
- Improve as develop and operate
- Space X approach with all the external support and collaborations
- Commercial goals, using Space to enhance current ongoing operations

AKUP



KILIÇSAT

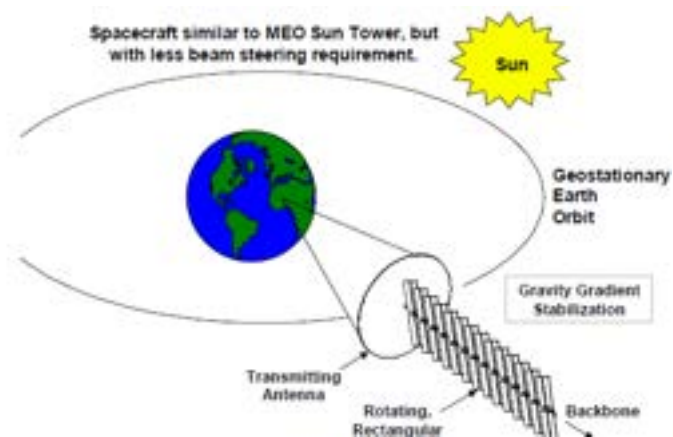


‘All civilizations become either spacefaring or extinct’

- Since, in the long run, every planetary civilization will be endangered by impacts from space, every surviving civilization is obliged to become spacefaring--not because of exploratory or romantic zeal, but for the most practical reason imaginable: staying alive... If our long-term survival is at stake, we have a basic responsibility to our species to venture to other worlds.

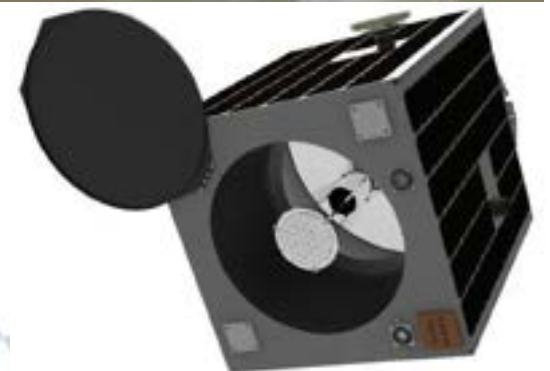
Get ready for space

- Space Fusion Plants established
- Electricity from space to earth
- Mining from moon and asteroids
- Colonies, Industrial centers at LEO
- **Main goal: To be a civilization living in the Solar System: develop reliable, capable, affordable spacecraft and space access to space (DO NOT STAY BEHIND!)**



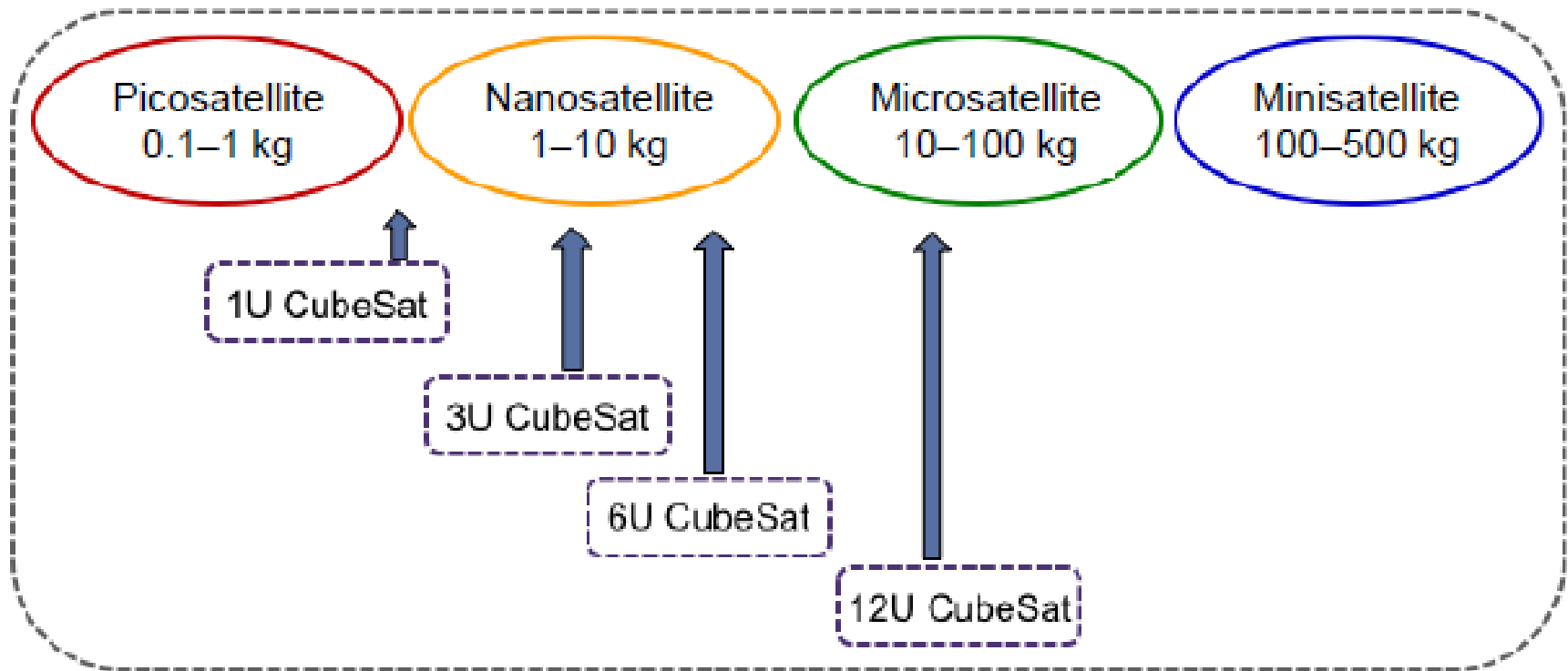
- Communication (most of the market, GEO-LEO)
- Earth Observation (most of the market, LEO)
- Navigation (GNSS)
- Meteorology, weather
- Space Observation, astronomy
- Biological
- **Research, test** (increased importance)
- Space Stations, manned spacecraft
- Planetary exploration
- **CONSTELLATIONS**

Satellite	MASS (kgs)	COST Millions	TIME (years)
Large	1000+	\$ 300 M+	10 +
Medium	500-1000	\$ 100 M+	4--6
Mini	100-500	\$ 10-100 M	3--5
Micro Sat	10-100	\$ 2-10 M	2--4
Nano Sat	1.0-10	\$ 0.1-2 M	1--3
Pico Sat	0.1- 1	\$ 100 k	<1-2
Atto Sat	0.01 - 0.1	\$ 100 k	<1
Zepto Sat	0.001 - 0.01	\$ 100 k	<1



CANSAT 0.3-0.9 100-900 0.1-0.5

Small Satellite Nomenclature



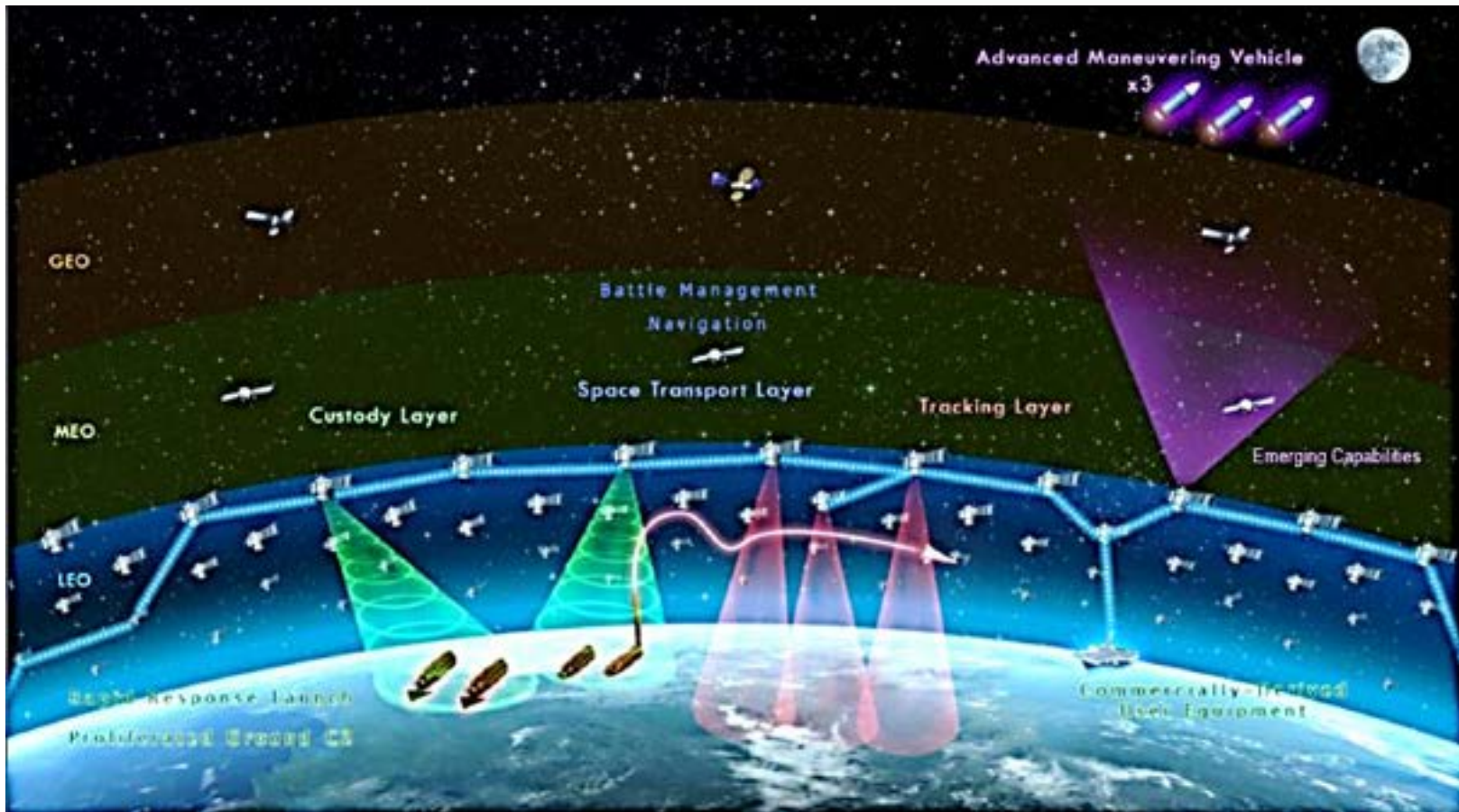
Solid ovals refer to mass categories



Dashed rectangles refer to volume categories

- Small Sat is one or more spacecraft produced to serve an operational mission
 - with an affordable (as small a a possible) budget
 - constellations
 - In a acceptable timeframe (as quick as possible as mission requires)
 - Acces to Space !
 - Modularity, what is on the shelve
 - Mass manufacturing
 - Resiliency

- Layered constellations with small satellites -

- **7 Layers with 1000+ satellites**

- Transport layer (datalink for inter-satellites and satellite-ground),
- Tracking layer (tracking of missiles), Custody layer (monitor)
- Large number of satellites realize mission assurance, responsibility



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TURKIYE





Established as a legal society
23 Members from
13 Universities (7 Public + 6 Private)
G. Assembly 19.09.2021
18.01.2023

We Look Forward To a Fruitful Cooperation

Towards being a civilization living
in the Solar System

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