Small Satellites – Tools for Affordable Access to Space

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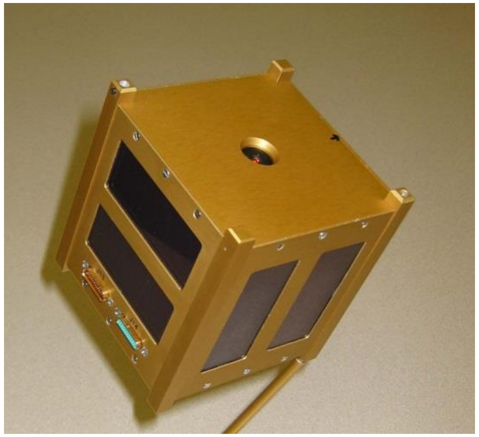
CubeSats



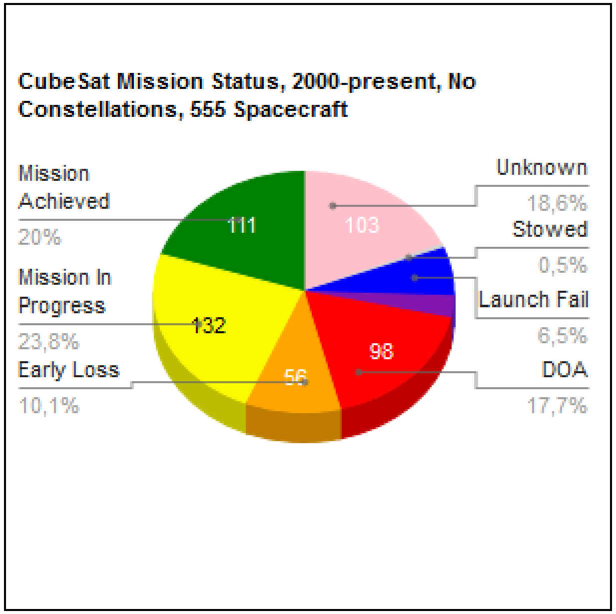
Cubesat concept invented
at Stanford University in 1999

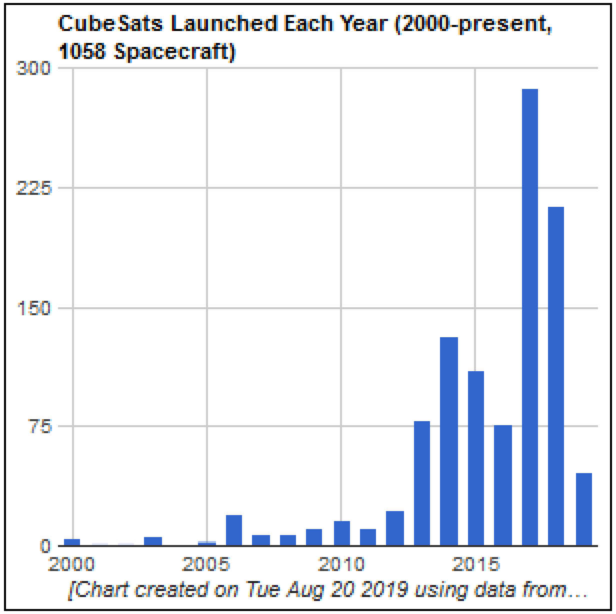
- small (1 l volume, 1 kg mass = 1 U)
- low cost
- short development time
- ideal for education.
- involvement in all phases of a Space project

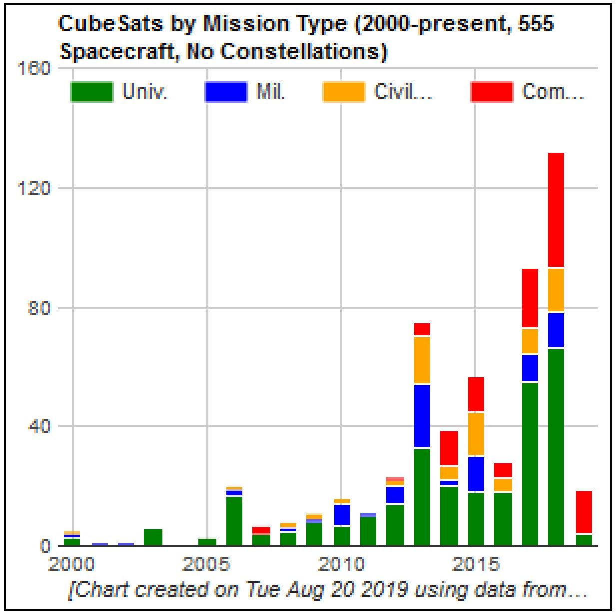
Evolution of CubeSats:

- larger systems (2U, 3U, 6U, 12 U)
- more powerful
- industrial/commercial, scientific & technological missions

CubeSat Launches







By now: > 1100 nanosatellites launched

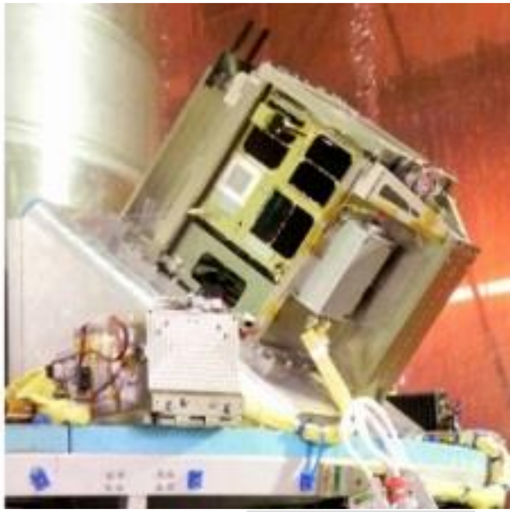
Source:https://sites.google.com/a/slu.edu/swartwout/home/cubesat-database

Co-Passengers on Launchers

Courtesy: ISRO

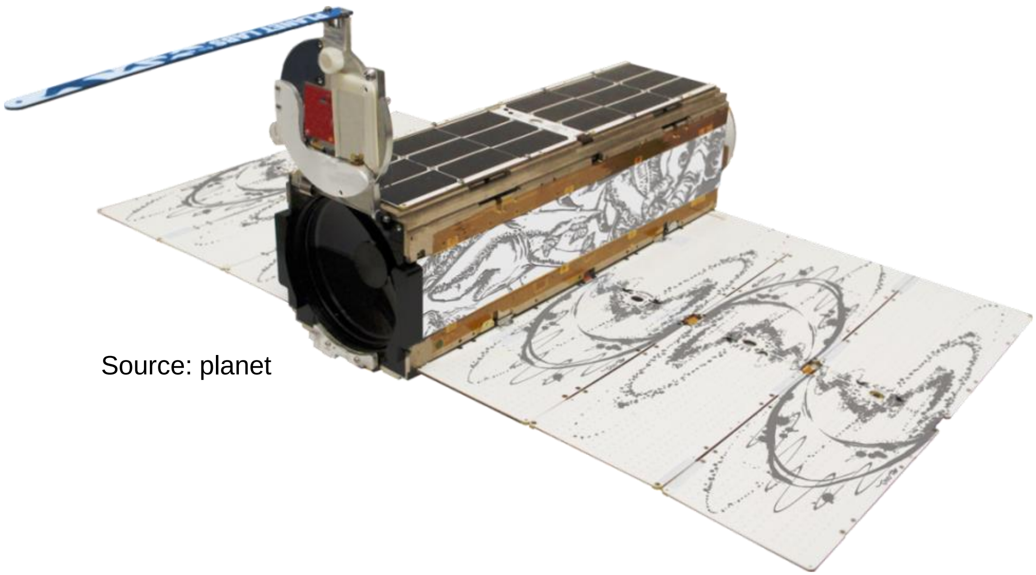
DNEPR, wikipedia

Standardised Deployment Mechanisms



Courtesy:ISRO

Commercial Constellations



Source: planet

Source: SPIRE

Planet: Remote Sensing with high revisit times

SPIRE: AIS, ADS-B, GNSS Occultation

~ 400 Launches

BRITE – BRight Target Explorer

World's first nanosatellite constellation dedicated to asteroseismology

Country	Satellite Name	ID	Launch	Orbit-P(min)	Filter
AUT	TUGSAT-1 / BRITE-A	Bab	2013-02-25	100.36	blue
AUT	UniBRITE	UBr	2013-02-25	100.37	red
POL	BRITE-PL2 'Heweliusz'	BHr	2014-08-19	97.10	red
POL	BRITE-PL1 'Lem'	BLb	2013-11-21	99.57	blue
CAN	BRITE-CA1 'Toronto'	BTr	2014-06-19	98.24	red
CAN	*BRITE-CA2 'Montreal'*	*BMb*	*2014-06-19*	*n/a*	*blue*

3 countries – 5 (6) satellites – ONE MISSION

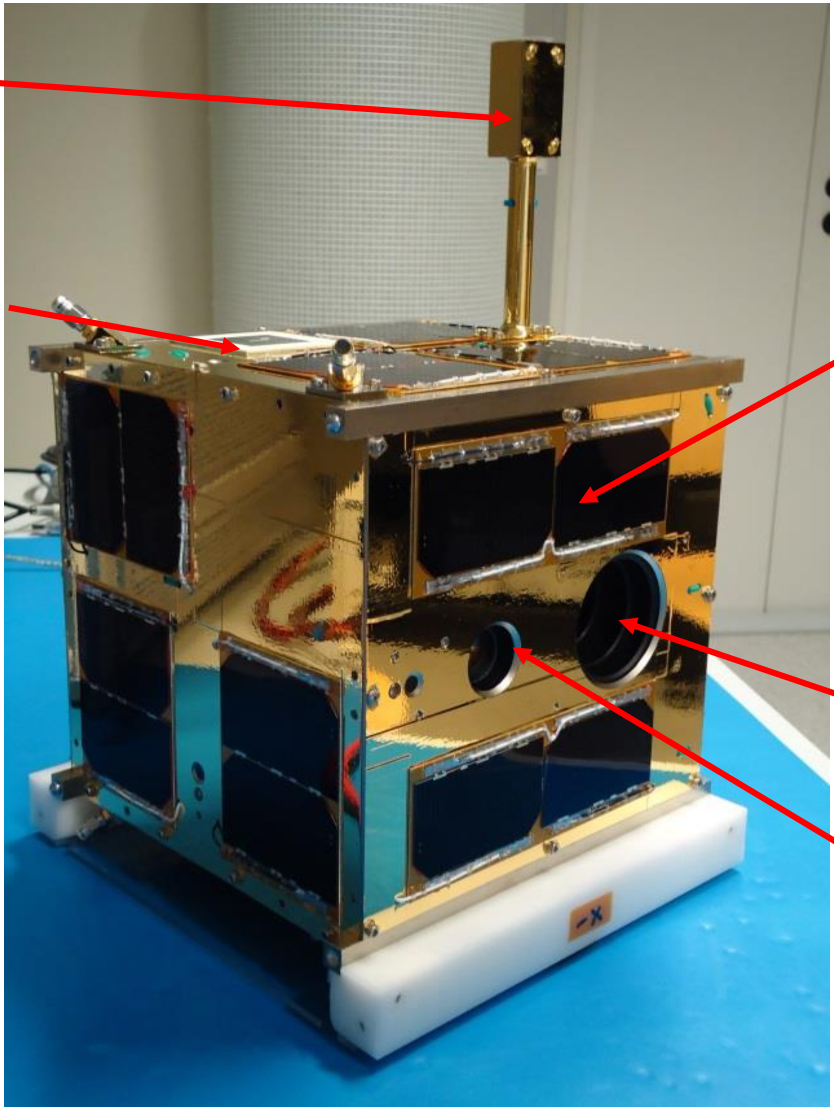
TU Graz

TUGSAT-1/BRITE-Austria Flight Model

magnetometer

S-band antenna

solar cells



telescope

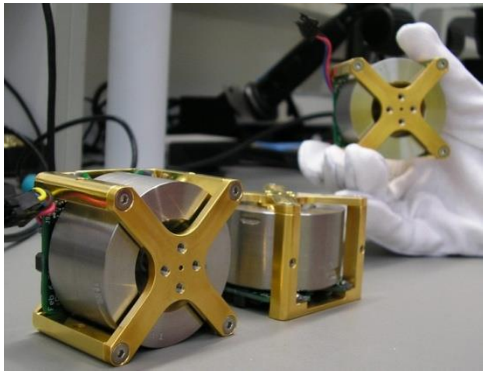
star tracker

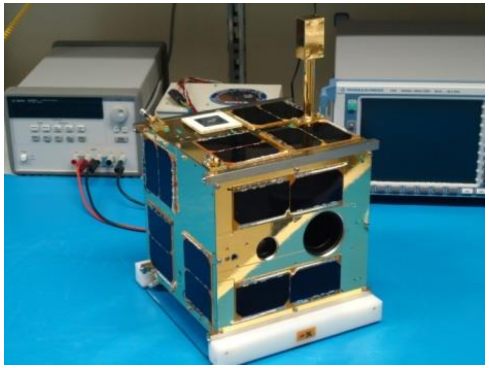
Generic
Nanosatellite
Bus
by

UTIAS SFL
Space Flight Laboratory

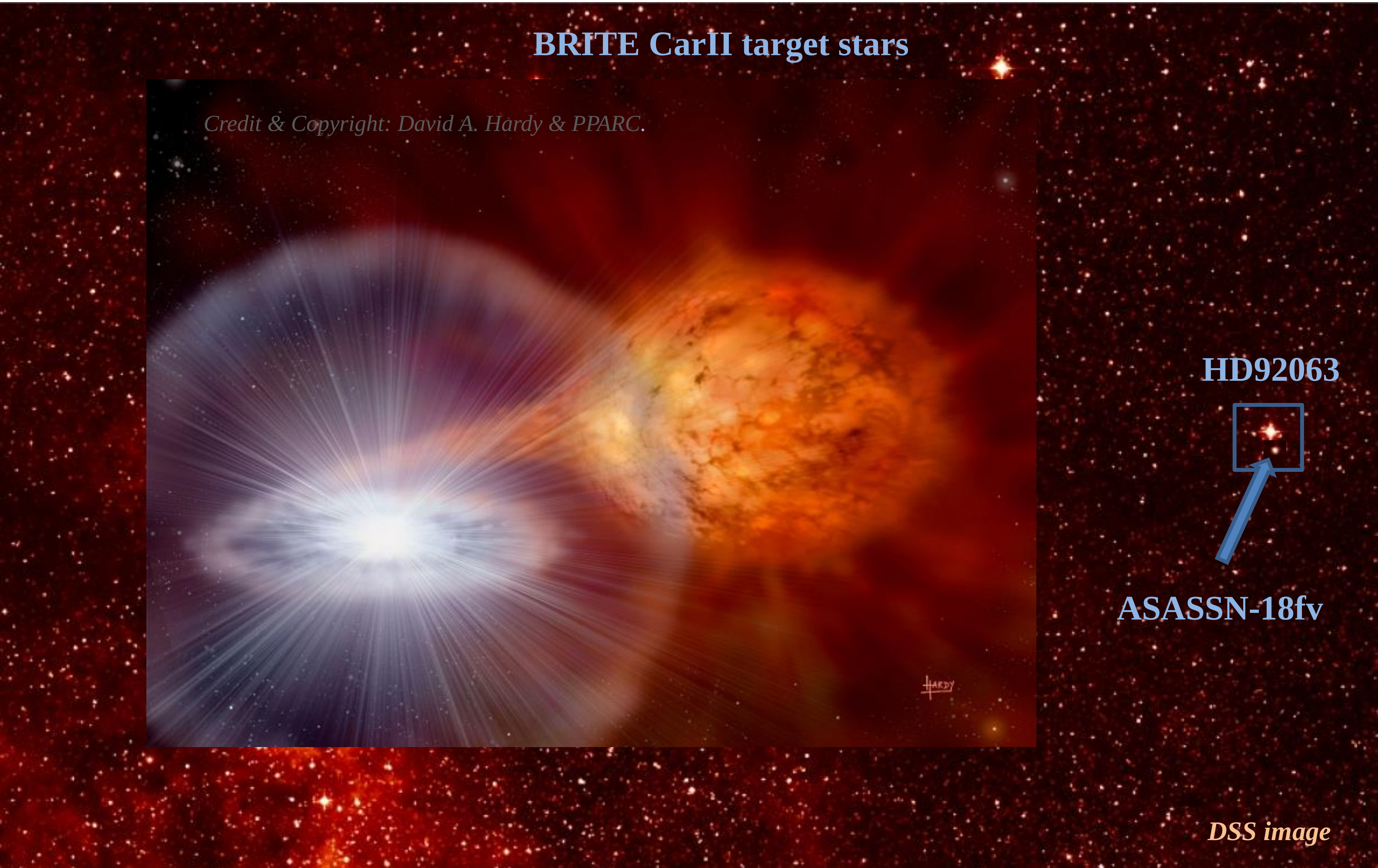
BRITE Characteristics

- Nanosatellite: 20 x 20 x 20 cm
- Mass: 7 kg
- Electrical power: 6…11 W
- Transmit power: 0.5 W
- Frequency bands: S-band downlink / UHF uplink
- Data rates: 32…256 kbit/s downlink, 9.6 kbit/s uplink
- Pointing accuracy: 1 arcmin.
- Science data volume: ~ 20…40 MB / day per satellite





BRITE Nova Carinae 2018 (ASASSN-18fv)



TU Graz

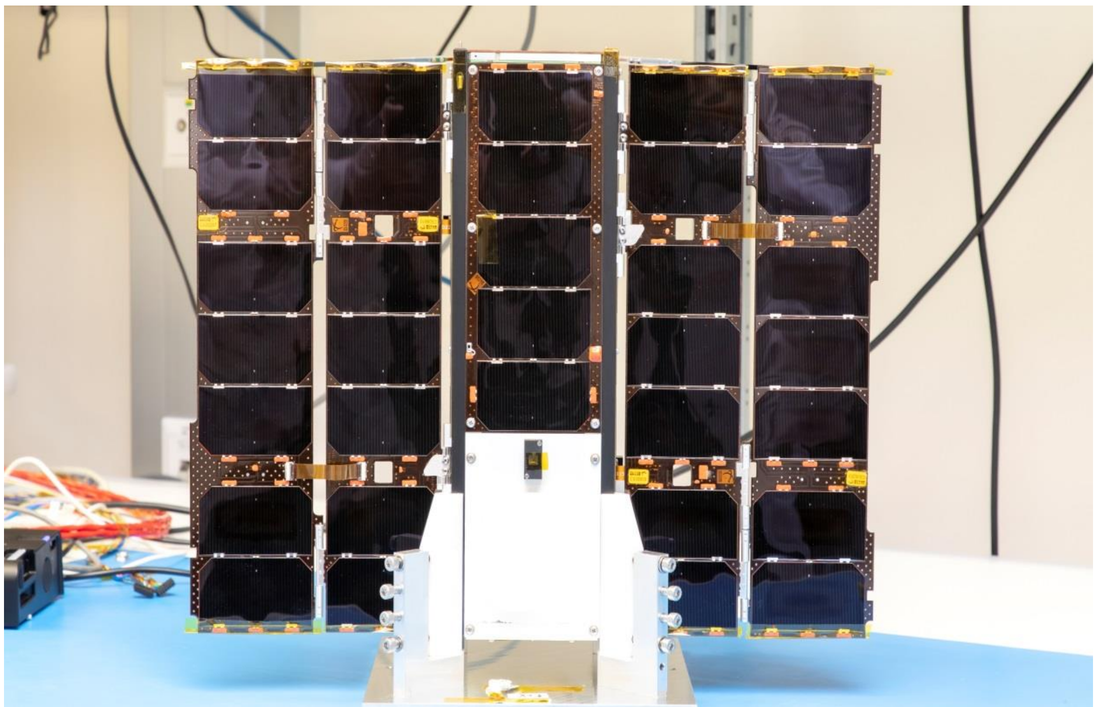
esa

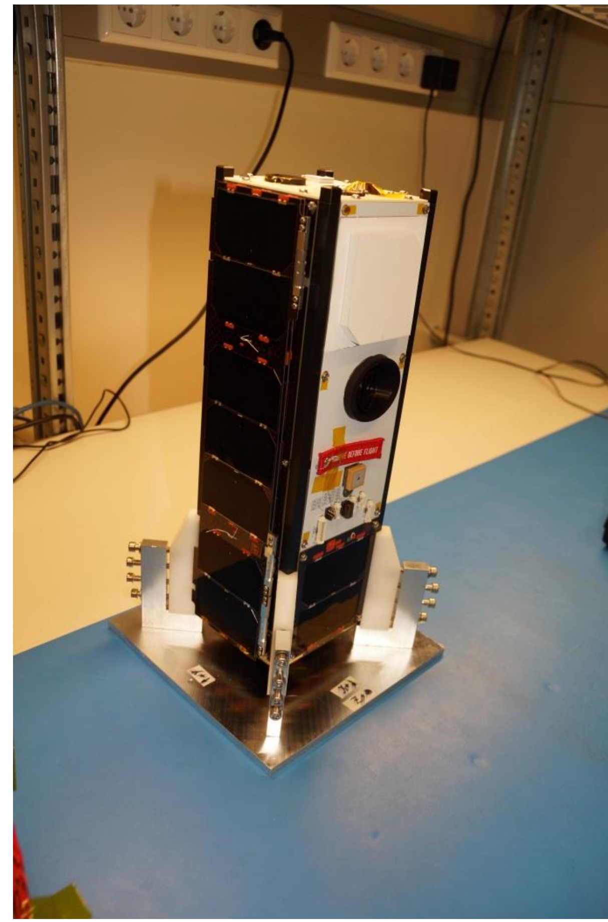
ops-sat

OPS-SAT

3U CubeSat: 10x10x30 with deployable solar arrays

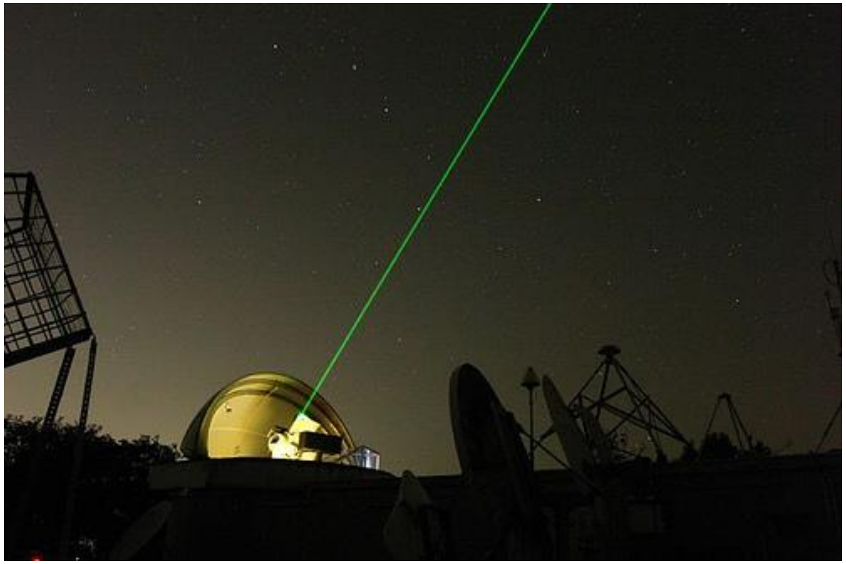
Power: 24 W





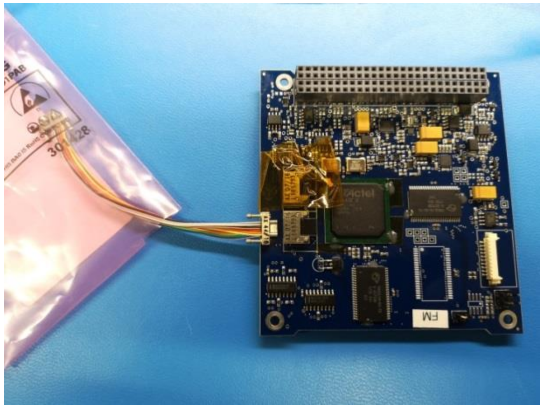
Mission Goals

- Demonstration of novel operational concepts
- Hardware / software experiments, e.g.
  - optical and radio communications
  - attitude control
  - remote sensing with on-board processing
  - on-board autonomy



Communications

- Behaves like any other ESA spacecraft
- Fully compatible with ESA‘s ground infrastructure
- 50 Mbit/s downlink data rate in X-band
- 256/1000 kbit/s data rate in S-band



Syrlinks

SRC/Creotech

Ground Stations

Darmstadt

Graz

Processor Core
(Satellite Experimental Payload Processor - SEPP)

2 x System on Module

Altera Cyclone V SoC

in cold redundancy

2 x ARM-9 processor

Memory

- 1 GB DDR3 RAM (ECC)

Mass Memory

- 8 GB

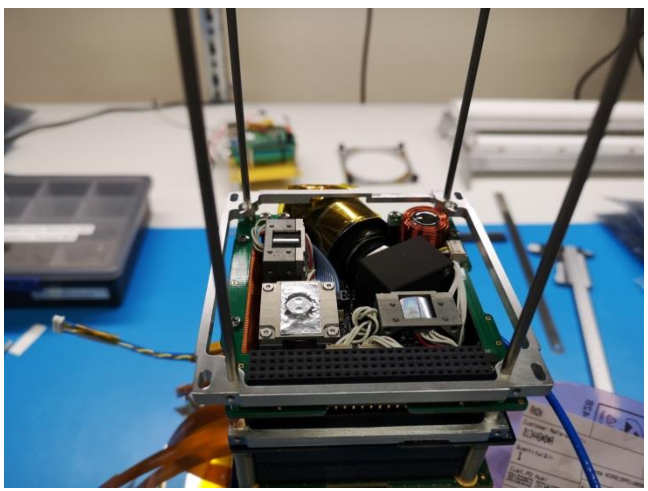
For on-board processing

Developed by TU Graz and Unitel IT Innovationen

Payloads

Optical Receiver (MEW Aerospace/TUG)

Software-defined Radio Receiver (MEW Aerospace/TUG)



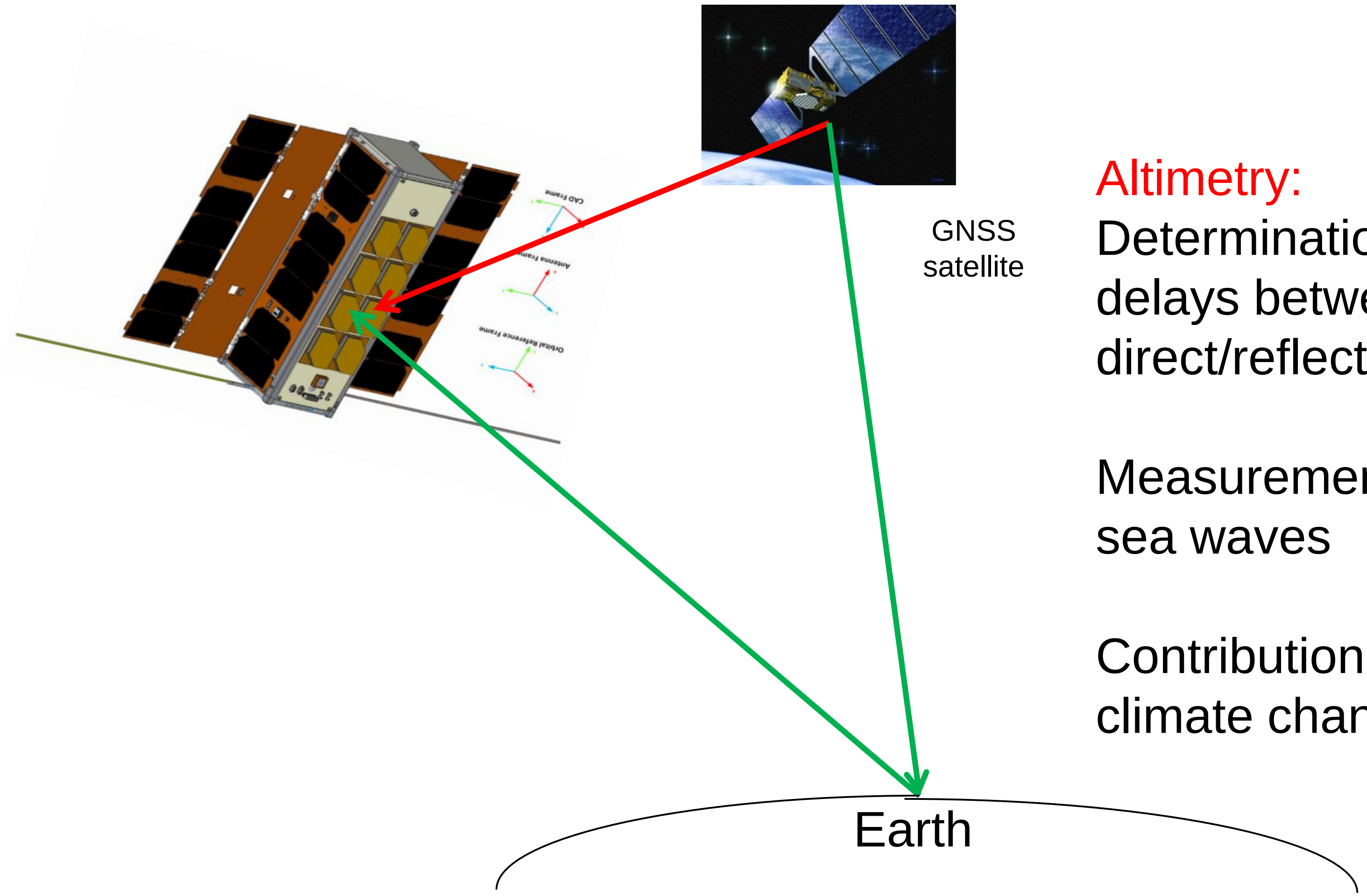
Fine ADCS (BST)

Camera (BST)

Passive Reflectometry and Dosimetry

RUAG Austria – TU Graz – Seibersdorf Laboratories

Passive Reflectometry



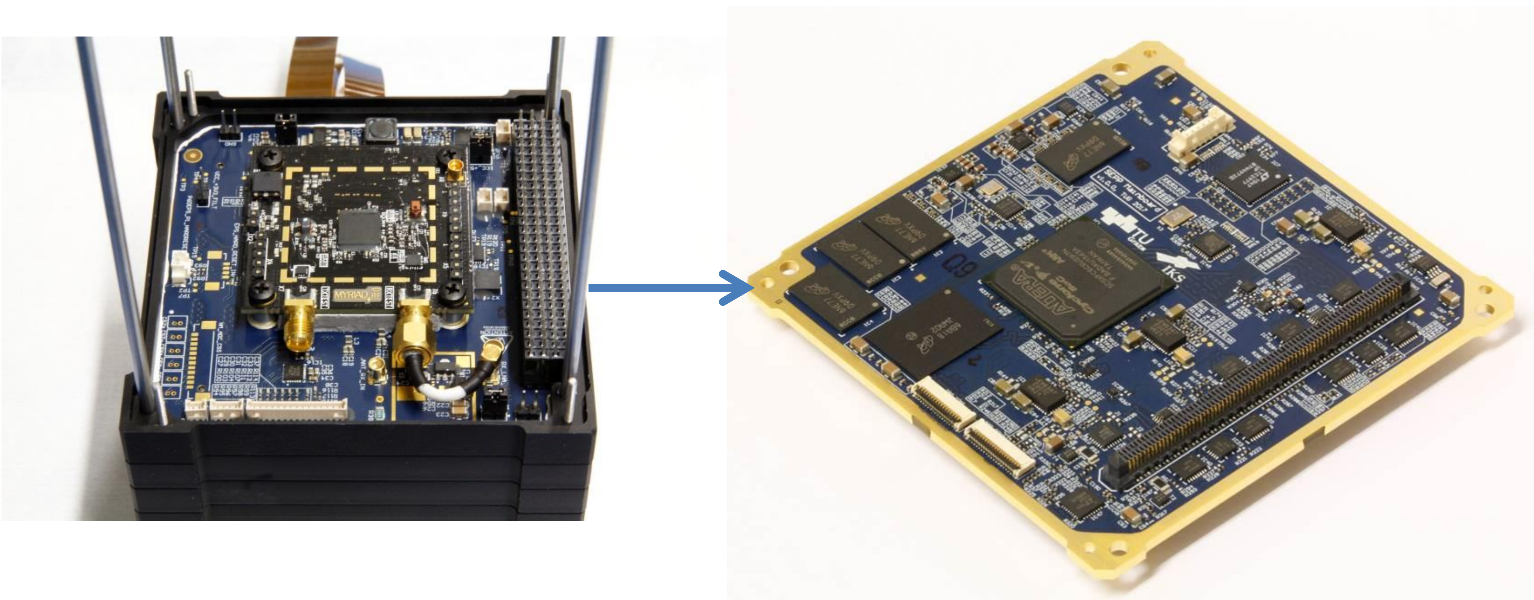
Altimetry:

Determination of relative delays between direct/reflected signal

Measurement of glaciers, sea waves

Contribution to research on climate change

GNSS Receiver on Board



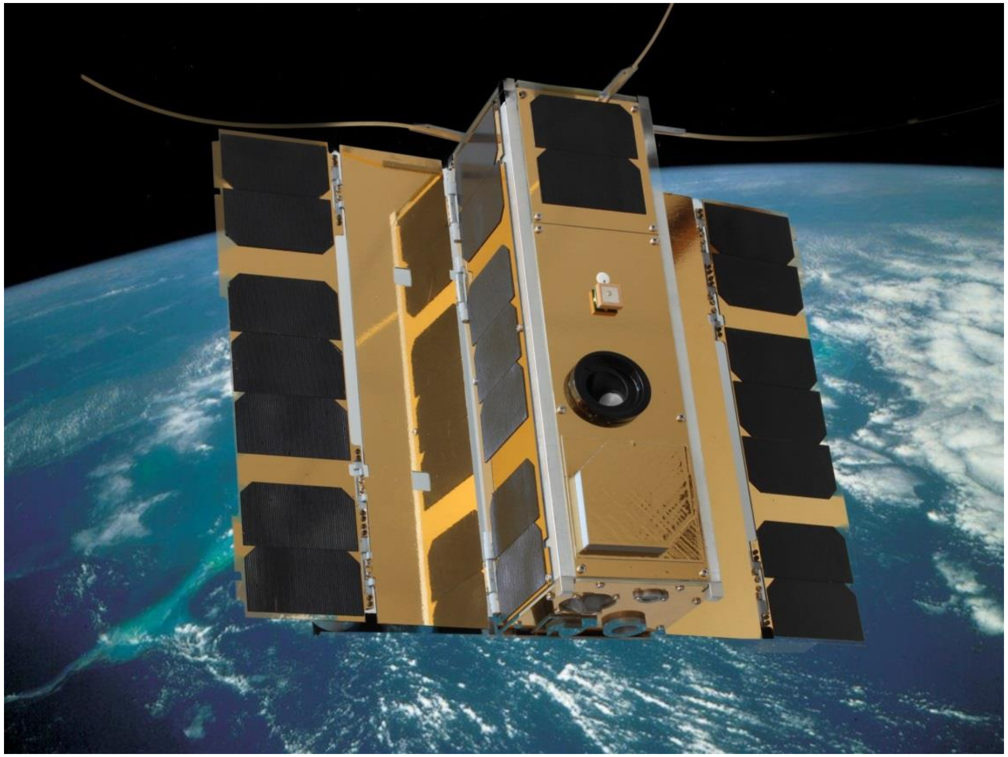
Software-defined radio front-end   Field-programmable array in SEPP

Summary

- Nanosatellites and CubeSats have matured from pure educational projects to in-orbit validation and operational systems
- Demanding scientific and technological missions can be carried out with small satellites at low cost and within short timescales (BRITE)
- Industry and Space agencies are increasingly using nanosatellite technology
- Commercial services are already in place using nanosatellite constellations
- Reliability increased: professional implementation
- „New Space“ approach

Summary (2)

- Industry already deploys large LEO constellation of small satellites (minisatellites), main application: Internet access (OneWeb, Space-X Starlink,…)
- Deorbiting after mission lifetime vital to avoid space debris
- Large number of spacecraft require strict adherence to existing rules and procedures to avoid harmful interference and space-debris problems
  - Authorisation
  - Registration
  - Frequency coordination
  - Compliance with „Code of conduct“



Thank you for your attention!