SPACE-SI

New Ground Station and X-band transmitter for Real Time Earth Observation by MS Camera and HD Video

T. Rodič, H. Fröhlich, L. Pavlovič, J. Hertig, P. Ward

UL-NTF
coordinator
Materials, structure, virtual models/

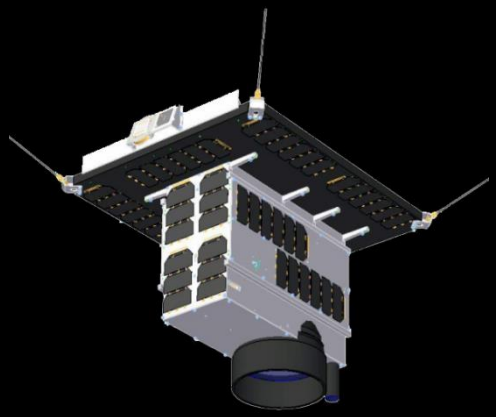
Research institutions:

UL-FMF
Astrophysics, meteorology

UL-FE
Communication, control, processing

IJS
Electornics ceramics

ZRC-SAZU
Remote sensing



ZAVAROVALNICA MARIBOR
End-user of space technologies

Companies:

DEWESOFT
Telemety, data aquisition

SINERGISE
GIS applications

TIC LENS
Laser technologis

IMPOL
Superplastic Al alloys

ISKRA TELA
Antenna systems

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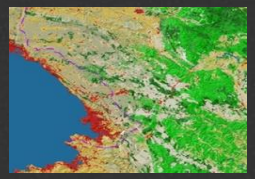
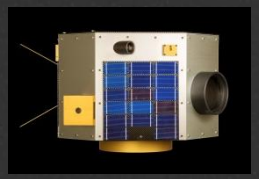
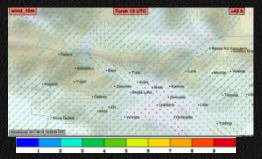
our RTD programme

SCIENCE	TECHNOLOGIES	APPLICATIONS
wp1: remote sensing 	wp4: satellite technology 	wp7: international missions 
wp2: meteorology 	wp5: communications 	wp8: terrestrial applications 
wp3: astrophysics 	wp6: multidisciplinary lab 	wp9: dissemination 

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concept for slovenian micro satellite

70 kg > satellite for earth monitoring and observation.

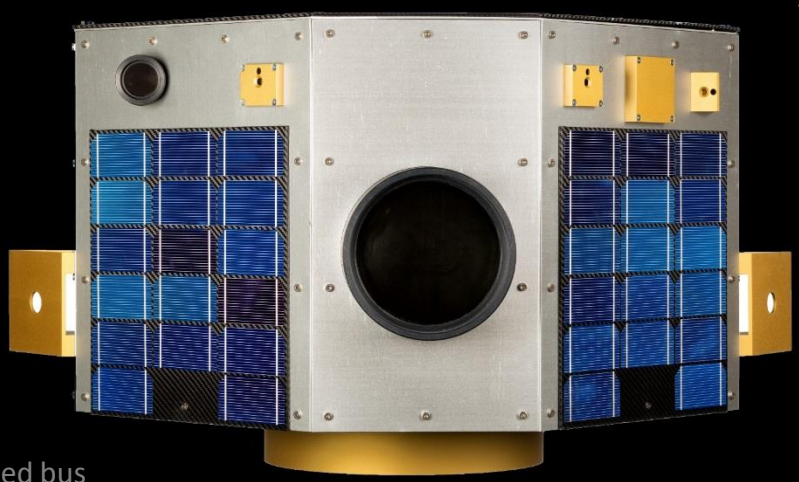
2.8 m gsd from a reference altitude of 600 km

four spectral channels

(420–520 nm, 535–607 nm, 634–686 nm, and 750–960 nm).

high-definition video at 1920 by 1080 pixels.

real-time imaging and video streaming over slovenia



three-axis stabilized bus

50 mbps x-band downlink

279.4 gb of on-board storage,

power system generating 55 w

300 wh li-ion battery.

UTIAS SFL

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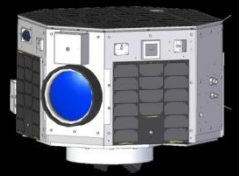
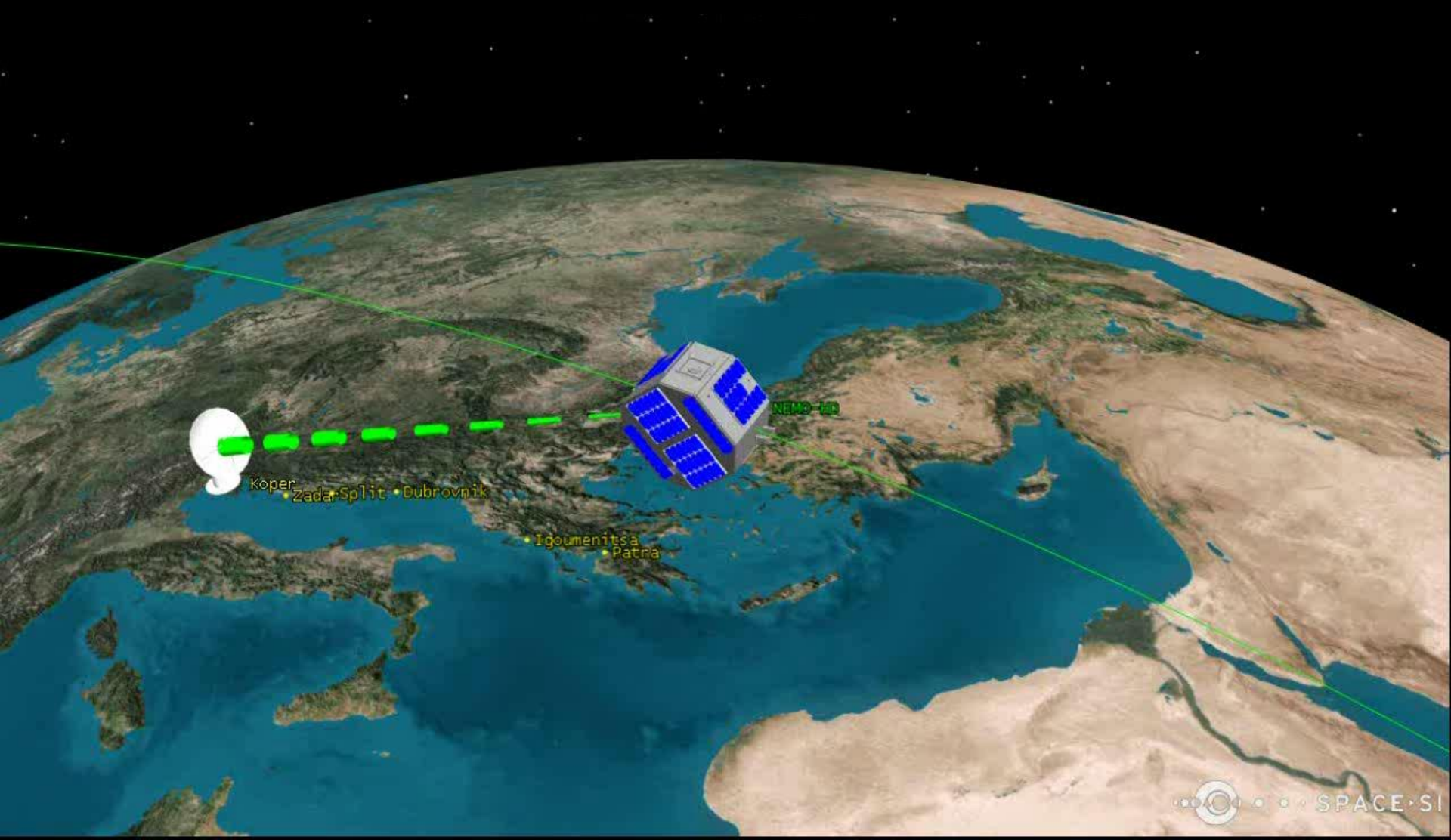
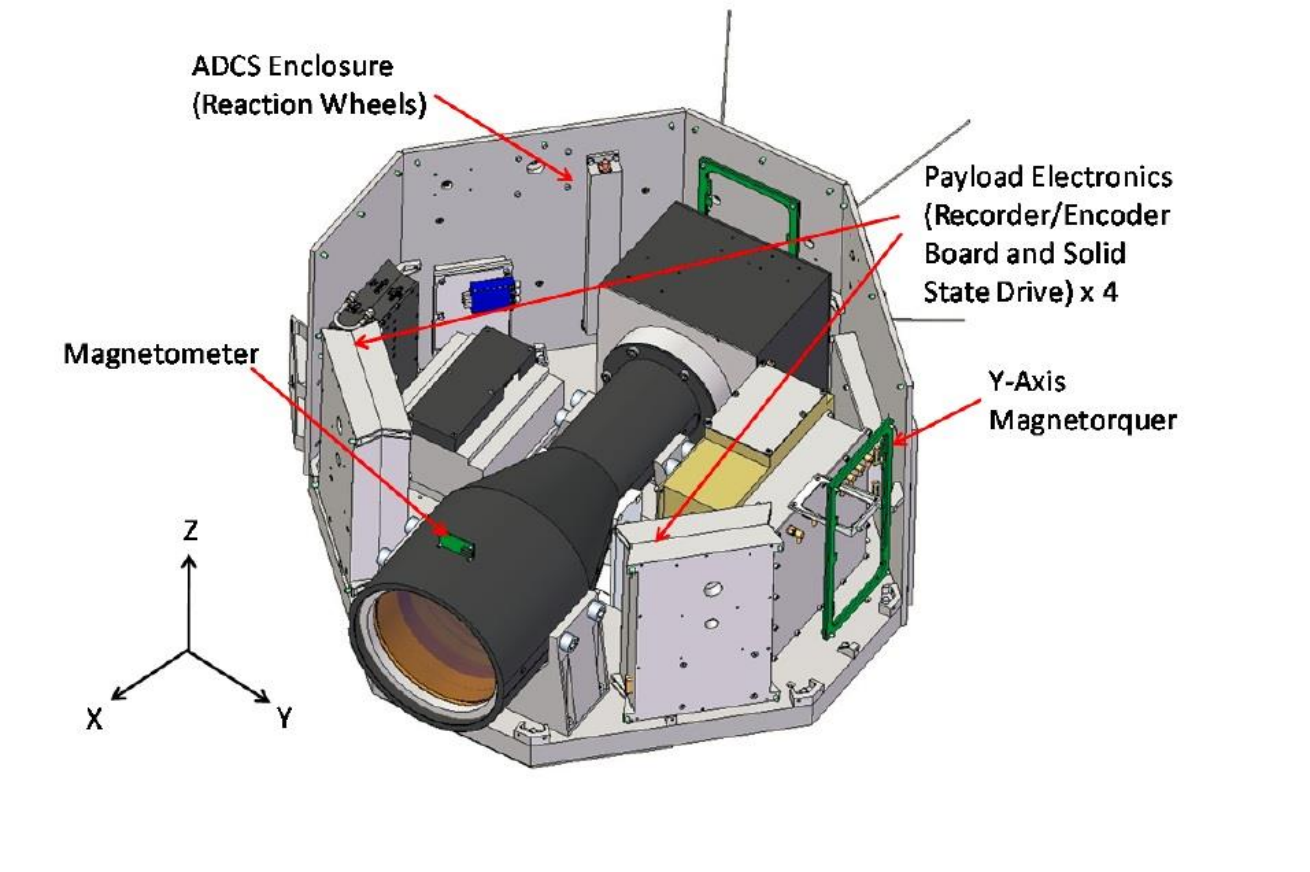
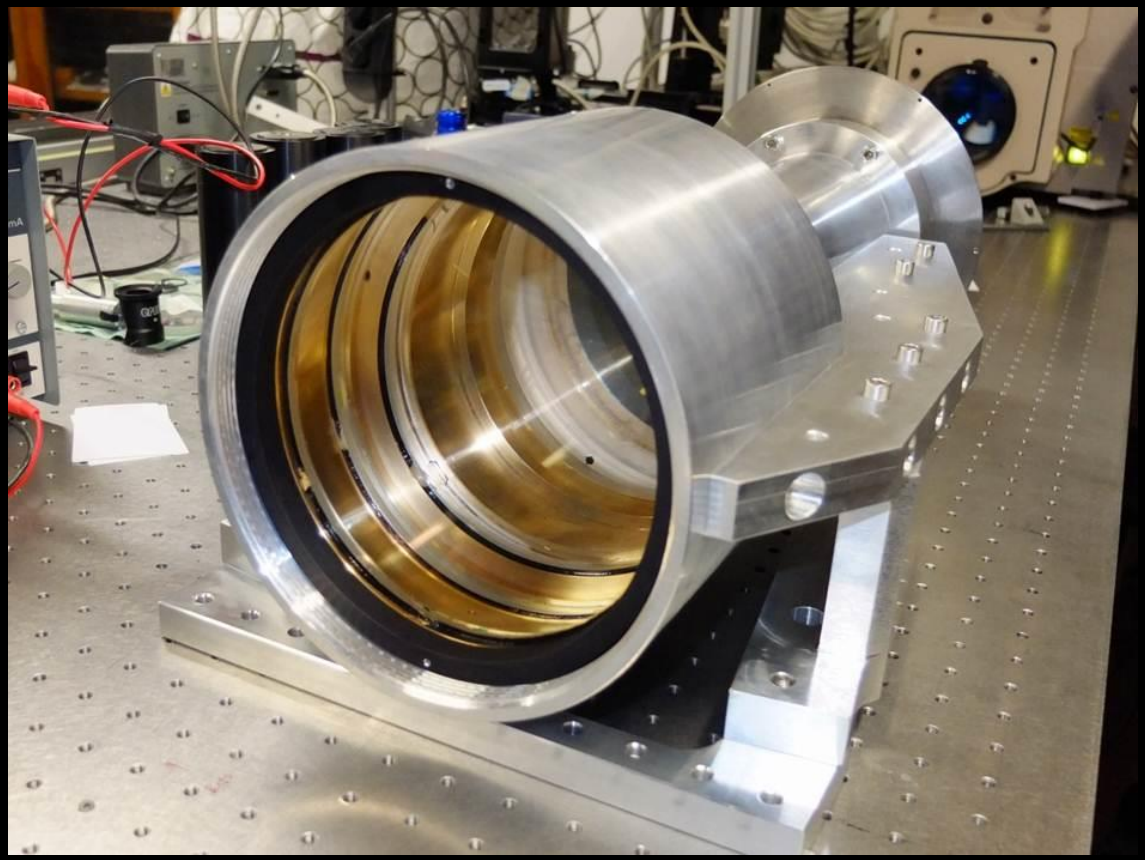


remote sensing micro satellite

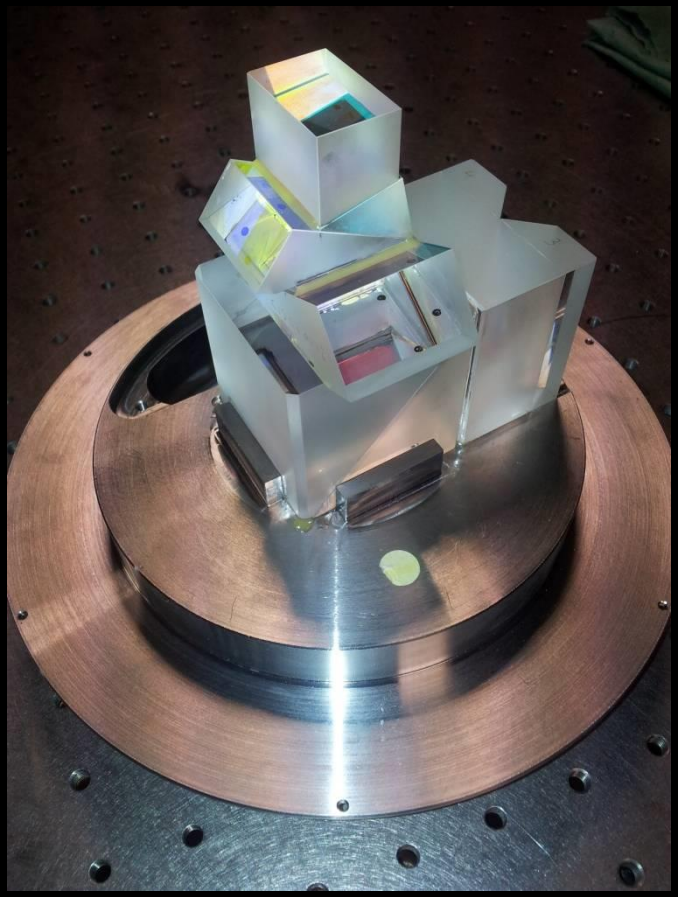



ADCS Enclosure
(Reaction Wheels)
Payload Electronics
(Recorder/Encoder
Board and Solid
State Drive) x 4
Magnetometer
Y-Axis
Magnetorquer
Z
X
Y

telescope of the slovenian micro satellite



prism for multispectral images



vibration testing of the optical system

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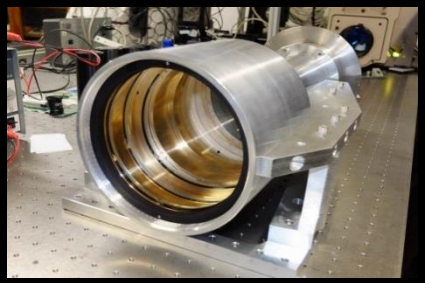
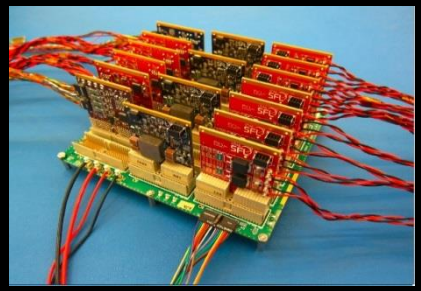
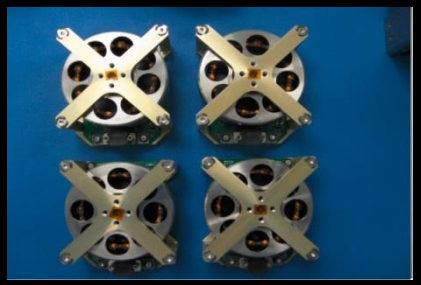
components



primary payload

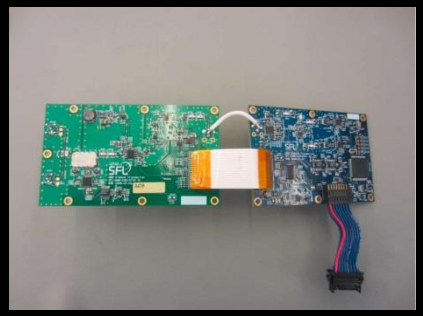


power system

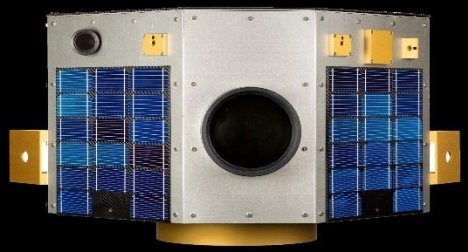


reaction wheels

X-band

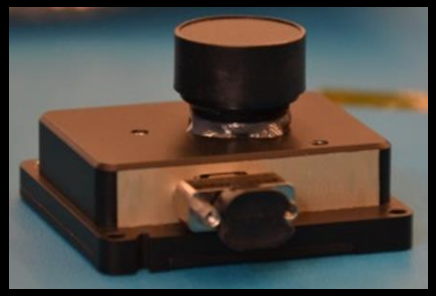


S-band

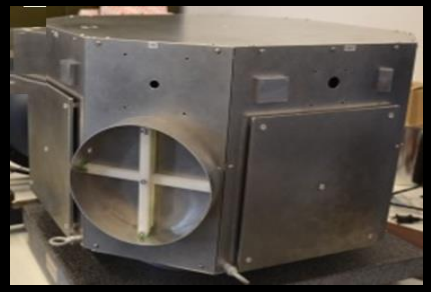


UHF

secondary payload

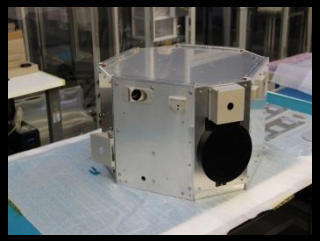


star tracker

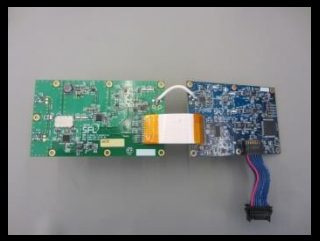


structure

sun sensors

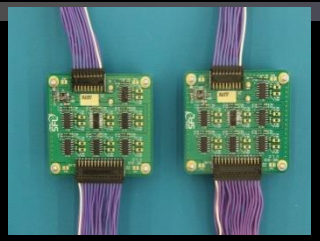

Structure

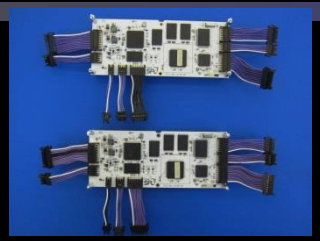

UHF Receiver

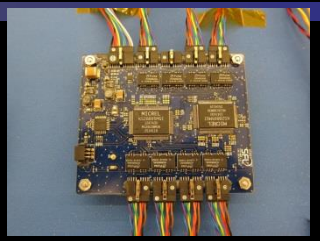

S-band Transmitter

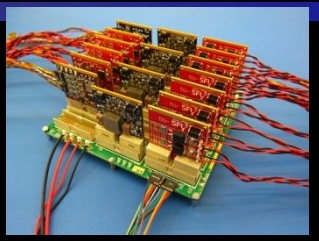

X_band Transmitter

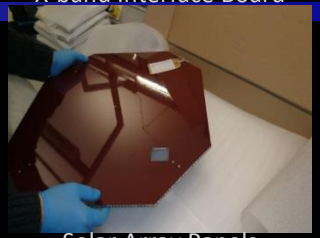

X-band Interface Board


Serial Interface Boards

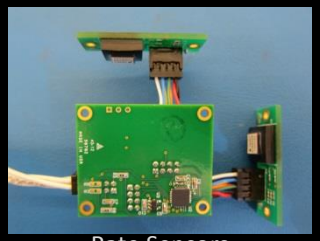

OBC

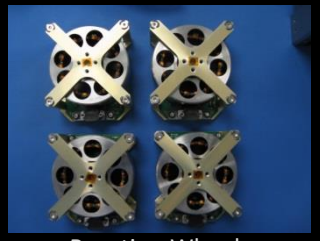

Ethernet Switch


Power System

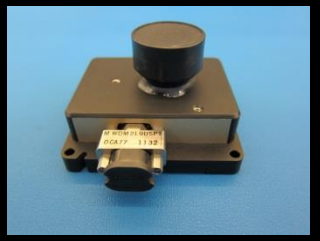

Solar Array Panels


Magnetometer


Rate Sensors

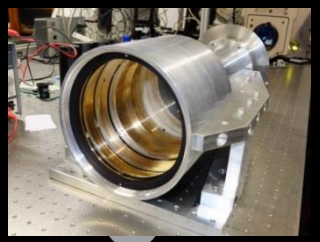

Reaction Wheels


Magnetorquers

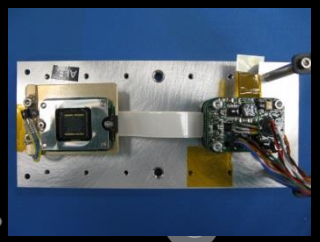

Star Tracker


Sun Sensors

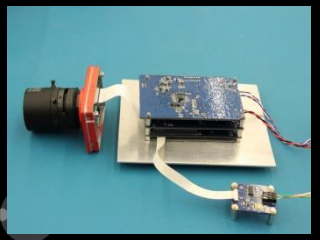

GPS


Telescope


HRS-PAN Camera


HRS-MS Camera


HR-HD Camera


LR-HD Camera

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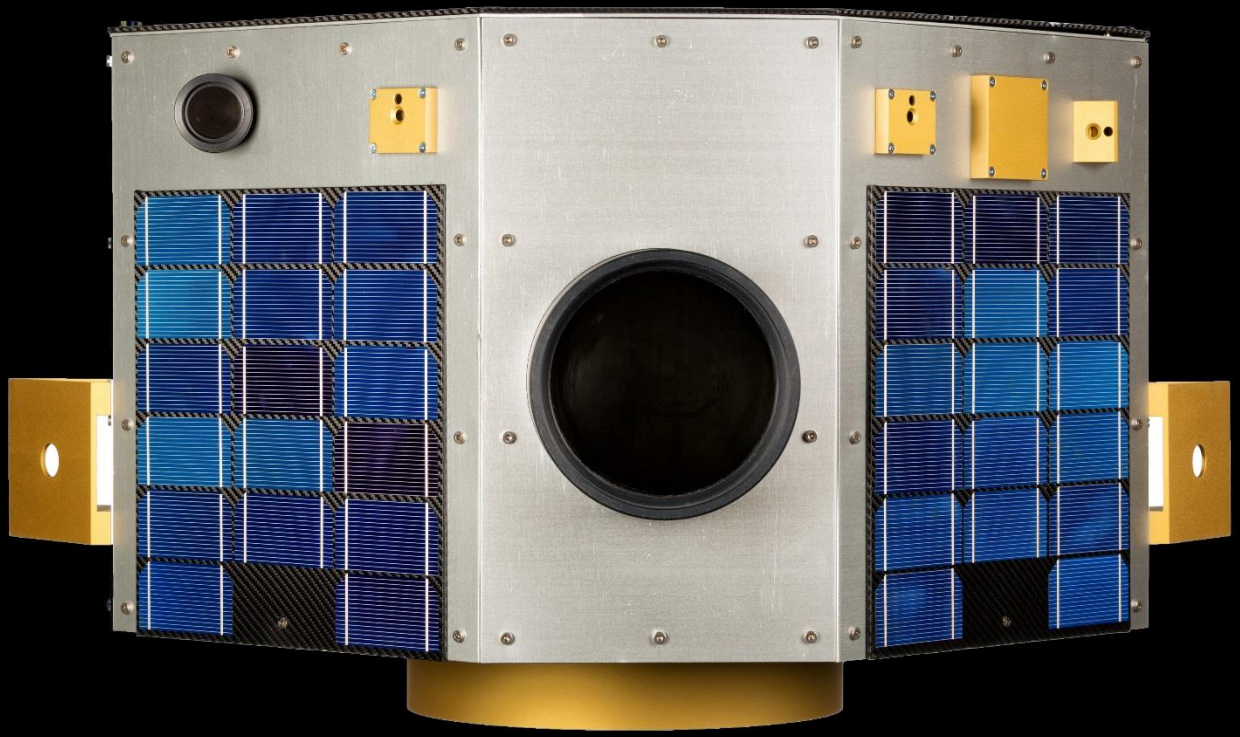
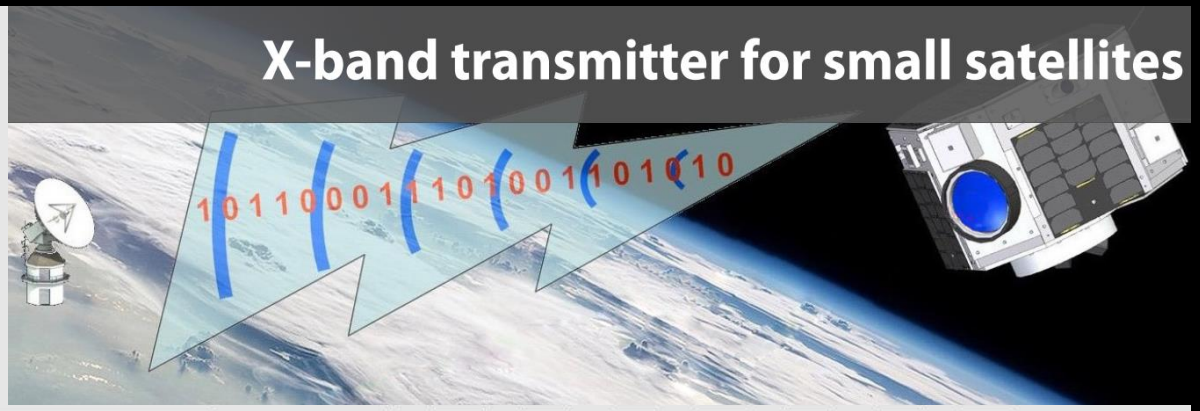


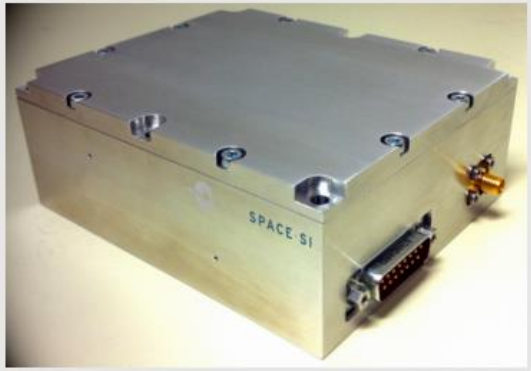
SPACE SI

X-band transmitter for small satellites

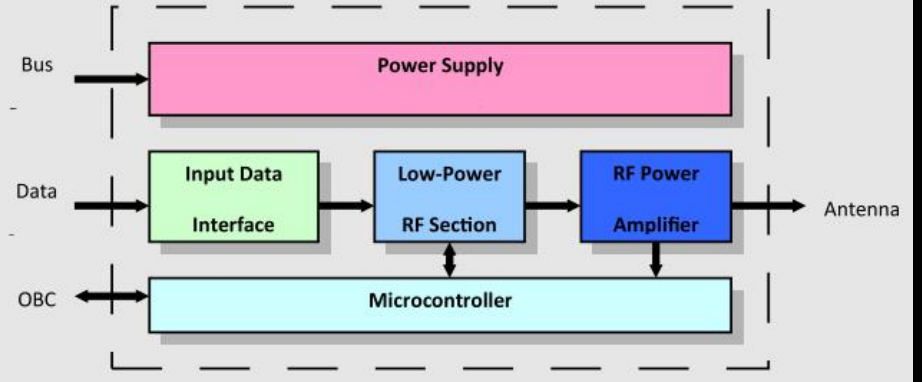
Features

- RF output power: min 1 W (typically 2 W)
- O-QPSK modulation
- frequency range X: 8.025 GHz - 8.400 GHz (programmable)
- data transfer rate: up to 50 Mbit/s
- dimensions: 100 x 120 x 45 mm (in development is also a CubeSat version: 95 x 95 x 50 mm)
- low power consumption: up to 15 W (for CubeSats up to 10 W)
- supply voltage: +18 V to +36 V



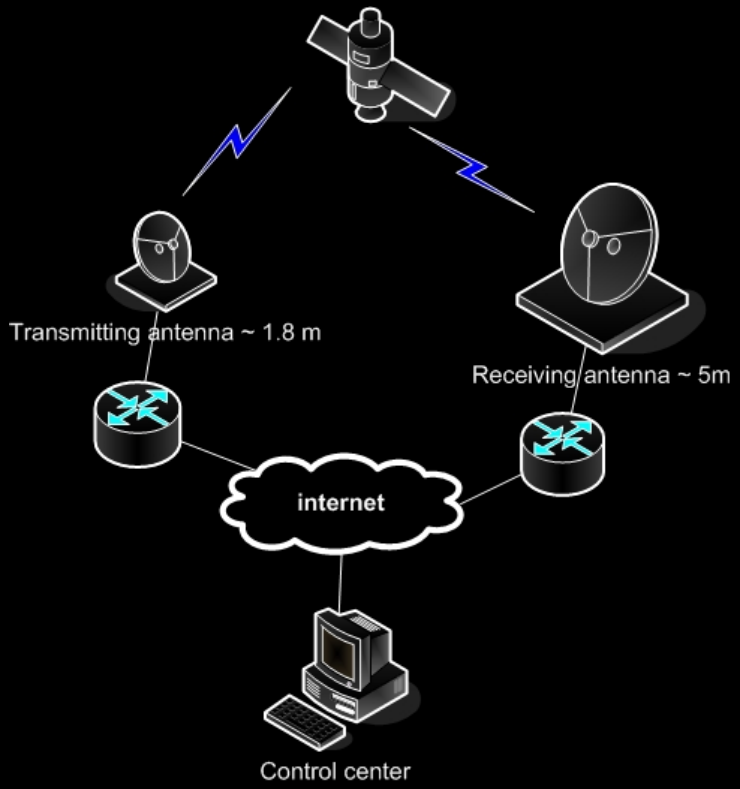


Housing (left) and block diagram (right) of the X-band transmitter.



ground control station

Transmitting antenna
reflector 1,8 m, 40dB gain,
X-Y positioning, frequency bands
VHF/UHF/S
(Opetaronal since 2011)



Receiving antenna
reflector 5m, 40-50 dB gain, X-Y positioning, monopulse tracking system, horn antennas for primary feed: left-circular and right circular polarisation, frequency bands L/S/C/X/Ku/Ka, G/T 20 dB/K (installed in 2012)

Ground Station 2012

Pomjanu near Koper

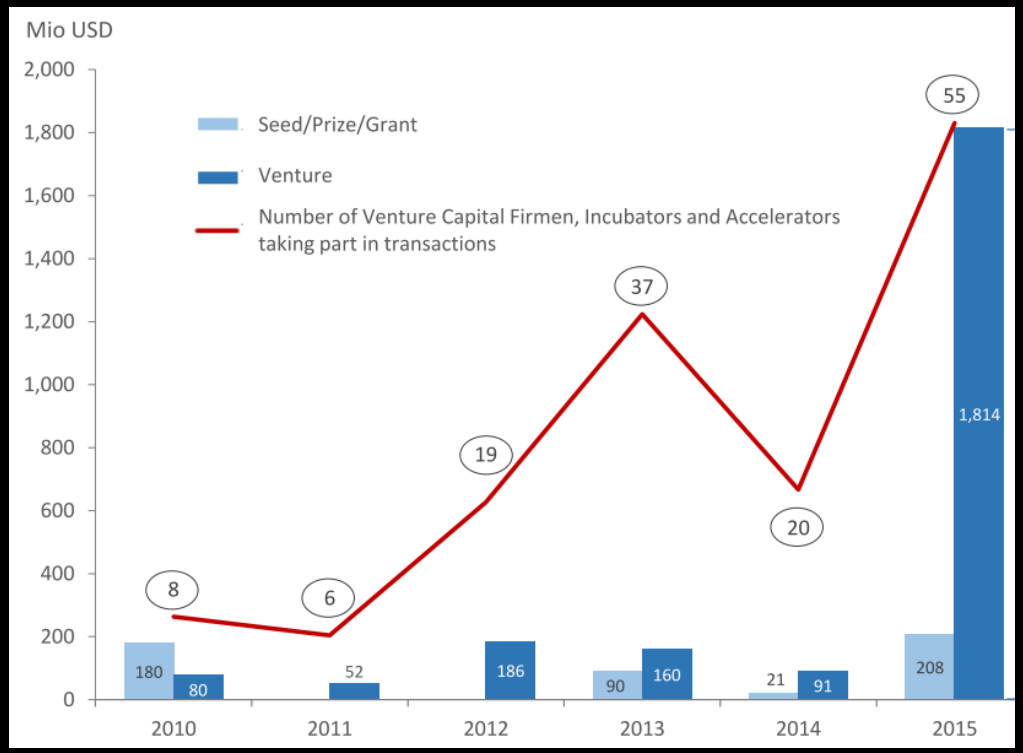
Ground Station 2012

Pomjanu near Koper

2013/2014 Contract to support Planet Labs constellation

2014/2015 Design of a new Ground Station optimised for NewSpace (mega constellations, new countries)

NewSpace Missions



NewSpace Missions

- Remote Sensing
  - Optical (19)
  - SAR (7)
- Communication/ Data Relay Satellites (11)
- Atmosphere/Weather (4)
- Internet of Things (13)
- AIS (6)
- NewSat Launchers (14)

48 Constellations are planned by 2018

3290 satellites require 768 antennas if they need one pass per orbit

- 1.4 Million passes per month
- 60 daily passes per antenna

Year	2015	2016	2017	2018
No. of Satellites	131	427	1221	3290

3290 satellites*14 passes/day) / 60 daily passes per antenna

≈ 768 antennas

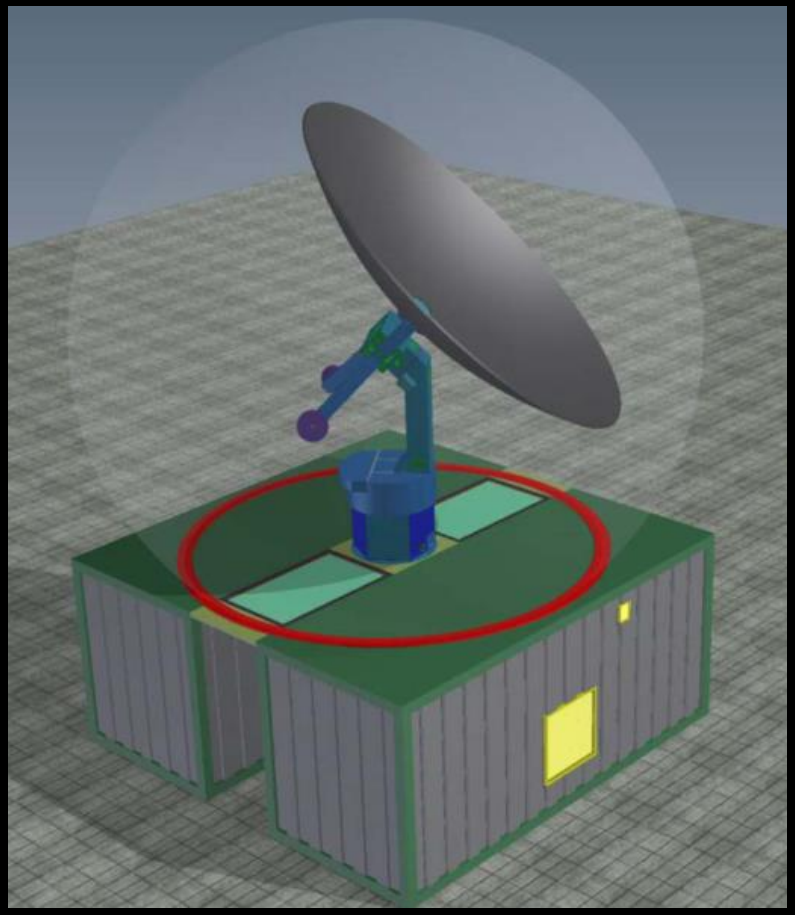
Design goals I.

- Feed/auto track selection.
- Decrease positioner cost and increase performance and reliability.
  - Commercial Off the Shelf parts (COTS).
  - Eliminate complex servo systems.
  - Eliminate bias-drive systems.
  - Use high gear reduction systems to increase precision.
  - Two axis vs three axis system.
  - High integration and reducing parts count.
  - COTS ACU.
  - SDR.

Design goals II.

- High mechanical accuracy.
- Support for LEO and
- decaying orbits.
- Web based.
- Interoperability.
- Minimum setup time.
- Weight.
- Power consumption.
- Radomes.
- Reflector.
- Portable/Rapid installation.
- Mobile.
- Producible.

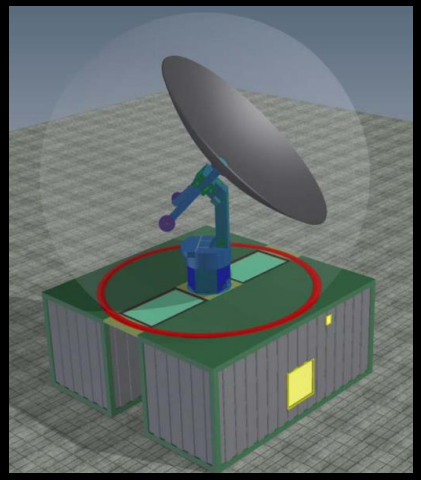
Concept



Low loss radome

No frequency tuning

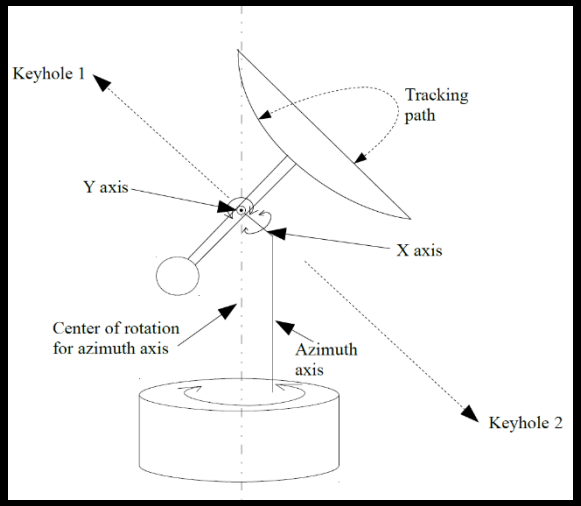
X to Ku/Ka bands



Highly accurate positioner

Full hemispherical coverage

No keyholes



Single motor per axis

Zero backlash gear drives

High gear reduction

Highly integrated COTS

STREAM innovations

- New thin wall membrane Radome
- New prime focus Monopulse feed
- New never before used Geometry
- New cascaded axis gear reduction system
- Very highly integrated design using COTS components
- New high frequency signal acquisition methodology
- New Carbon fiber reflector
- Optimized CNC Precision Production techniques
- New Antenna Control Unit (ACU

Dish diameter:	**3.7 – 9 m**
Radome loss:	**< 0.2 dB (up to 40 GHz)**
Pointing accuracy:	**< 0.01 degree**
Max. wind:	**250 km/h (operational)**
Power (antenna):	**< 1kW**
Max. axial tr. speed:	**3.6 deg/s**
Max axial acc.:	**3 deg/s^2**

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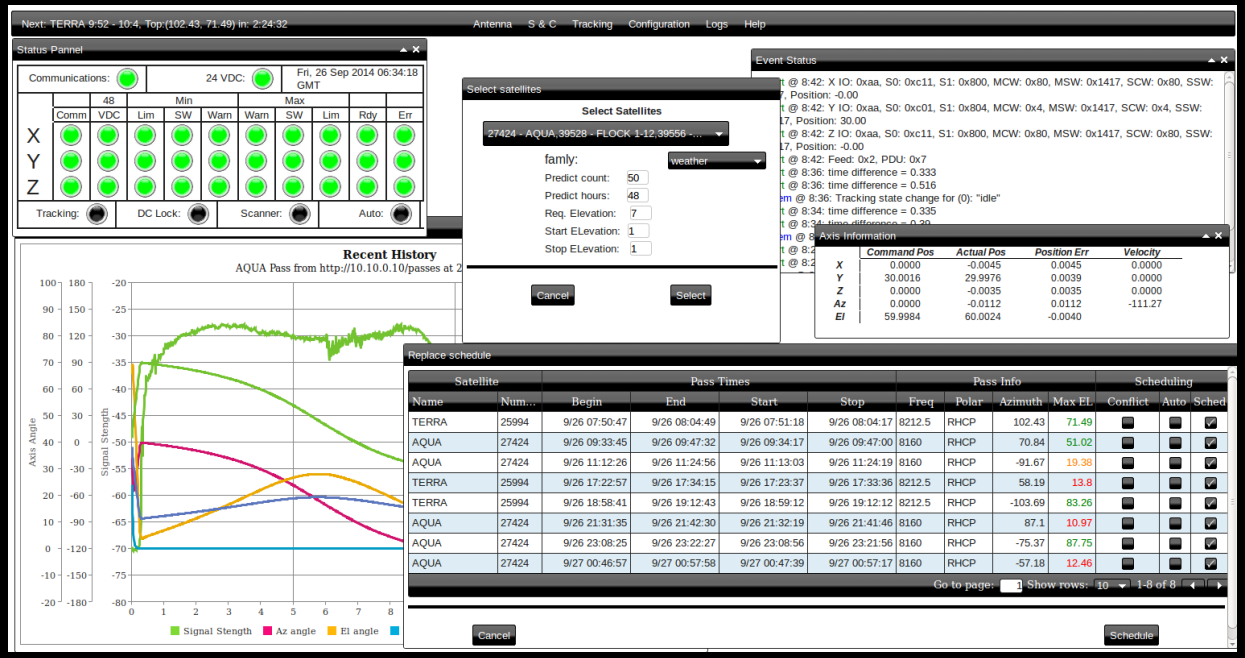
Easy to integrate into GS networks

Published API to support third party software



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H2020 Space Info Day, Ljubljana, april 2016

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Sodelovanje s slovensko industrijo

Thermal Vacuum Chamber


SPACE·SI
dynaso
DUOL
Albatross Fly

SPACE·SI

Conclusion

Extremely low-loss radome

Full hemispherical coverage

Fully automated

High precision LEO tracking

Easy installation

Ultra wide-band radome

Ka/Ku-band ready

No keyholes

Easy to integrate in the network

Published API

Carbon fibre dish