International Laser Ranging Service

Missions SC Meeting

5 pm, 3 Oct 2017

Toshimichi Otsubo

and

Scott Wetzel

Missions SC Meeting Agenda

(1) Opening/Welcome

(2) Membership

(3) GGOS Standing Committee on Satellite Missions (J Mueller → Otsubo)

Under GGOS Bureau of Networks and Observations

(4) Ongoing/Future Missions (5-10 min each)

* TechnoSat (Barschke, TU Berlin)
* S-NET (Yoon, TU Berlin)
* OPS-SAT (Kirchner, Graz)
* Geo-IK-2 (Parkhomenko?)

+ BLITS-M (Sokolov → Otsubo) launch: summer 2018

+ PAZ and GRACE-FO (Grunwaldt)

+ ICESat-2 (McGarry)

+ QZS (Otsubo)

- Others (?)

(5) (Future) Updates on the mission webpages esp for GNSS

(6) Other issue?

(7) Closure

(2) MSC Members

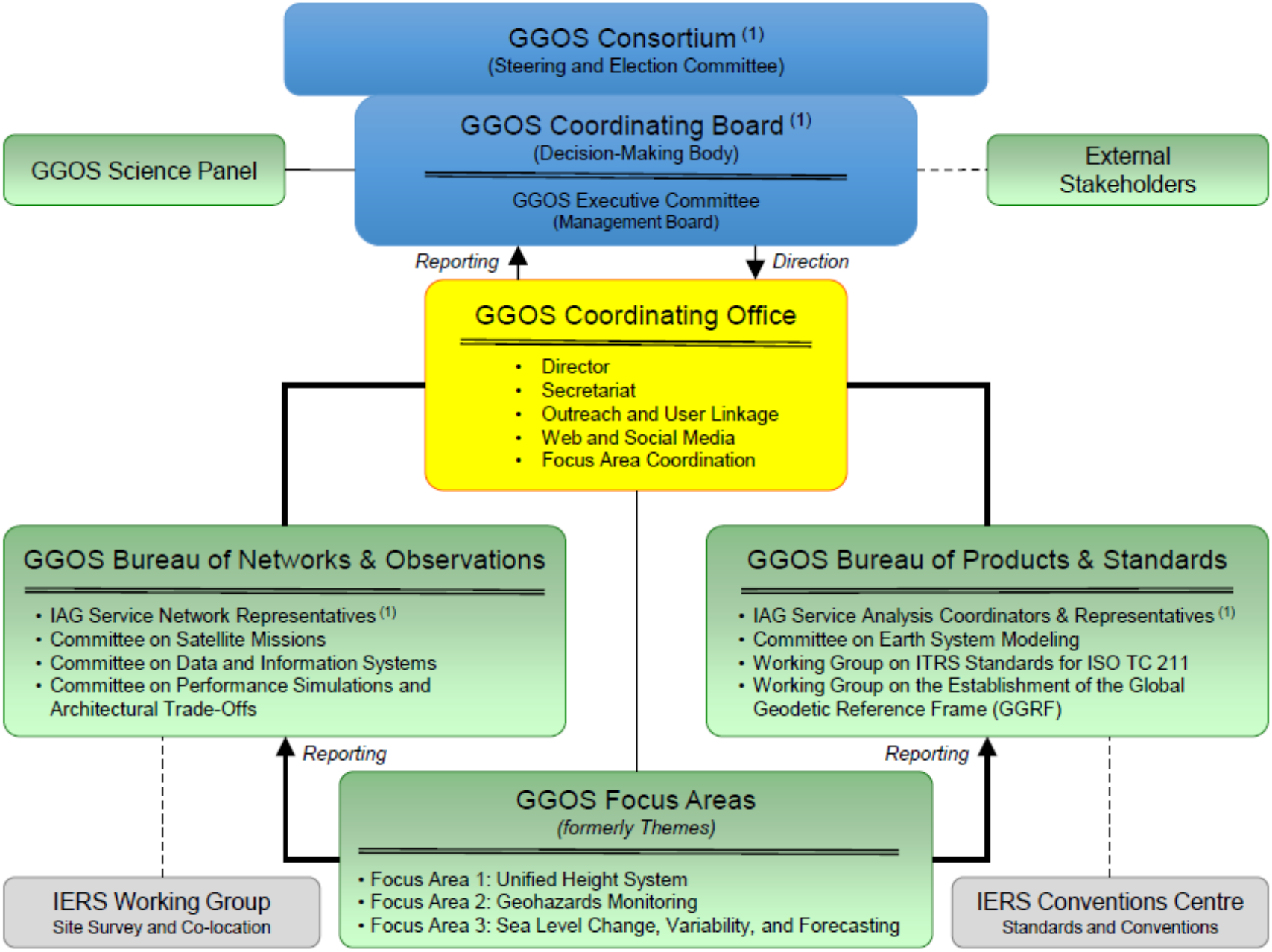
- Dr. Graham Appleby/NERC Space Geodesy Facility
- Dr. Giuseppe Bianco/Agenzia Spaziale Italiana (ASI)
- Dr. John J. Degnan/Sigma Space Corporation
- Julie E. Horvath/KBRwyle/SLR
- Dr. Georg Kirchner/Space Res. Inst., Austrian Acad. of Sci.
- Hiroo Kunimori/NICT
- Dr. John Mck. Luck/.
- David McCormick/NASA GSFC
- Jan F. McGarry/NASA GSFC
- Carey E. Noll/NASA GSFC
- Ron Noomen/Delft University of Technology
- (Chair) Toshimichi Otsubo/Hitotsubashi University
- Dr. Erricos C. Pavlis/JCET/UMBC
- Dr. Michael R. Pearlman/CfA
- Luca Porcelli/Istituto Nazionale di Fisica Nucleare
- Dr. Ulrich Schreiber/BKG/Geodaetisches Observatorium Wettzell
- Dr. Peter J. Shelus/University of Texas at Austin/CSR
- Andrey Sokolov/SRI for Precision Instrument Engineering
- Prof. Vladimir P. Vasiliev/SRI for Precision Instrument Engineering
- (Cochair) Scott L. Wetzel/KBRwyle/SLR
- Zhongping Zhang/Shanghai Data Center

All members are requested to respond when we ask a vote for a mission etc.

→ Silent for > 1 year.

Updated: 11-Sep-2017 08:00:10

https://ilrs.cddis.eosdis.nasa.gov/missions/mwg/mwg_members.html



(1) GGOS is built upon the foundation provided by the IAG Services, Commissions, and Inter-Commission Committees

Standing Committee on Satellite Missions (CSM)

Jürgen Müller

Institut für Erdmessung (Institute of Geodesy) and

Leibniz Universität Hannover (University of Hannover)

Co-chair Roland Pail, TU Munich

Role of CSM

- Advocate, coordinate, and information exchange with satellite missions
- as part of the GGOS space infrastructure,
- for a better ground-based network response to mission requirements and space-segment adequacy
- for the realization of the GGOS goals.

Major tasks of CSM for period 2017/18

- Evaluate the contribution of current and near-future missions to GGOS 2020 goals;
- Revise the inventory/repository of current and near-future satellite missions;
- Website – refinement in agreement with the whole GGOS web representation, *http://176.28.21.212/en/bureaus/bno/committee-satellite-missions/*
- Support and advocate new missions (e.g. E-GRASP);
- Expand the role of CSM beyond gravity field satellites (e.g. altimetry, geodetic satellites, etc.) working with the PLATO Committee.

Inventory of current satellite missions (general part – just web links)

Further satellites equipped with retro-reflectors, GNSS, gravity field missions, altimetry missions, SWARM, LLR reflectors on the Moon, Sentinels, etc. https://ilrs.cddis.eosdis.nasa.gov/missions/satellite_missions/
GNSS missions, GPS, Glonass, Galileo, Beidou, etc. http://www.igs.org/ http://www.gps.gov/systems/gps/space/ https://www.glonass-iac.ru/en/ http://en.beidou.gov.cn/ http://www.esa.int/Our_Activities/Navigation/Galileo/What_is_Galileo
Remote sensing missions, ERS, Envisat, SRTM, Radarsat, Landsat, TerraSAR-X, Sentinels, etc. http://www.satimagingcorp.com/satellite-sensors/
Altimetry missions, ERS, Envisat, Seasat, Geo-Sat, GFO, TOPEX/Poseidon, Jason, IceSat, CryoSat, Saral, HY-2, Sentinel 3, etc. http://www.aviso.altimetry.fr/en/missions.html http://www.altimetry.info/missions/ https://openadb.dgfi.tum.de/index.php?id=143
Missions with a DORIS receiver, Envisat, SPOT, TOPEX/Poseidon, Jason, Cryosat, Saral, HY-2, Sentinel 3, etc. http://ids-doris.org/doris-system/satellites.html
Further satellite missions, all satellites launched since 1957 and upcoming missions http://space.skyrocket.de/directories/chronology.htm

Technische Universität Berlin

The TechnoSat

Technology Demonstration Mission

Merlin F. Barschke | ILRS Technical Workshop | Riga, October 3rd, 2017

The TechnoSat mission

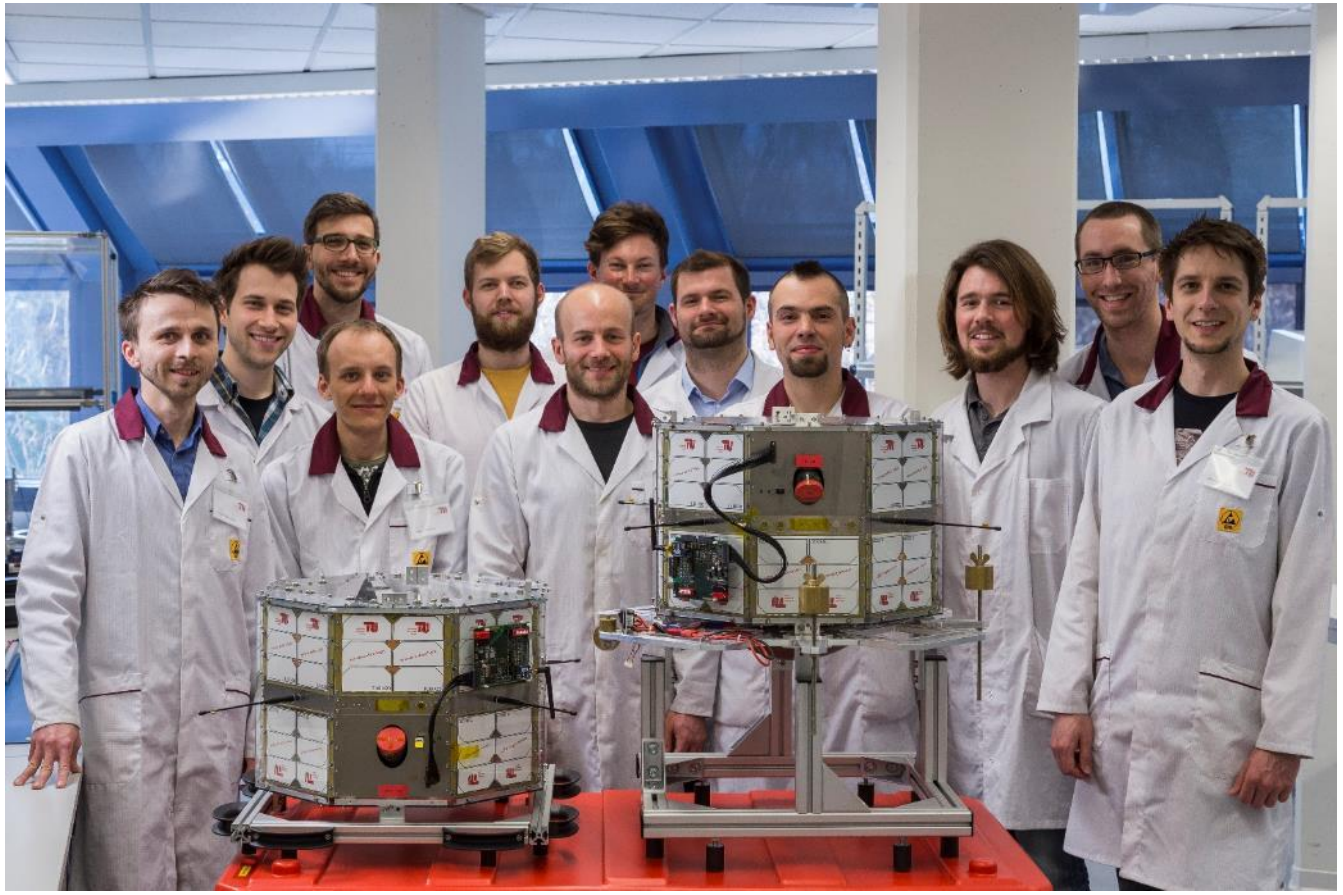
In-Orbit demonstration of seven payloads and the TUBiX20 platform

- Mass: 20 kg
- Volume: 465 × 465 × 305 mm

Payloads

- Fluid Dynamic Actuator (FDA) [TU Berlin]
- Reaction wheels [TU Berlin]
- Solar Generator based Impact Detector (SOLID) [DLR Bremen]
- S band transmitter HISPICO [IQ wireless, TU Berlin]
- Star tracker STELLA [University Würzburg]
- Laser retro reflectors [TU Berlin, GFZ, ÖAW, GSOC]
- CMOS camera [TU Berlin]

Launch -3 months: shipping to Baikonur



Launch -2 weeks: final integration

Launch -1 week: encapsulation

[Photograph by Roscosmos]

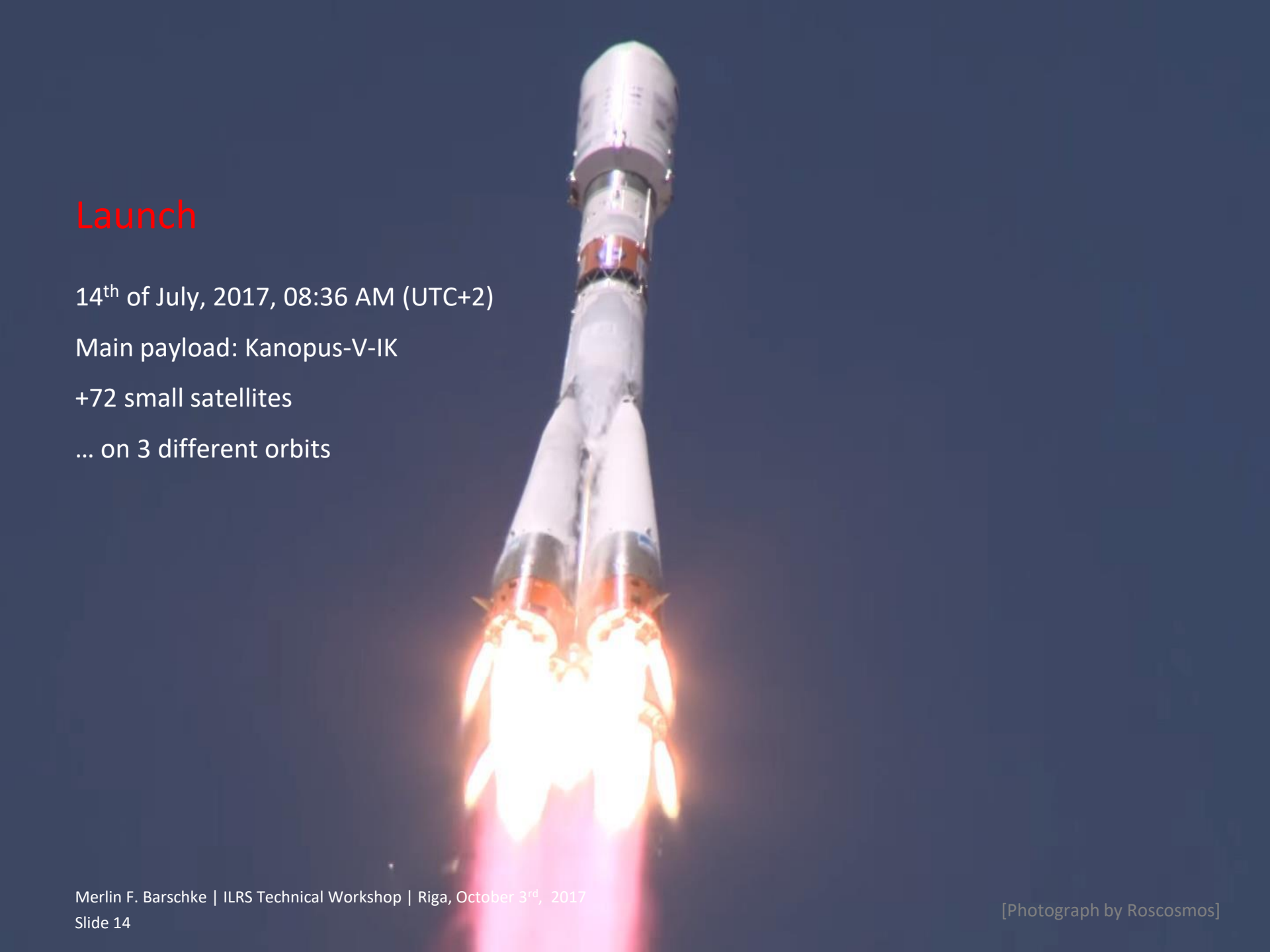
Launch

14th of July, 2017, 08:36 AM (UTC+2)

Main payload: Kanopus-V-IK

+72 small satellites

… on 3 different orbits

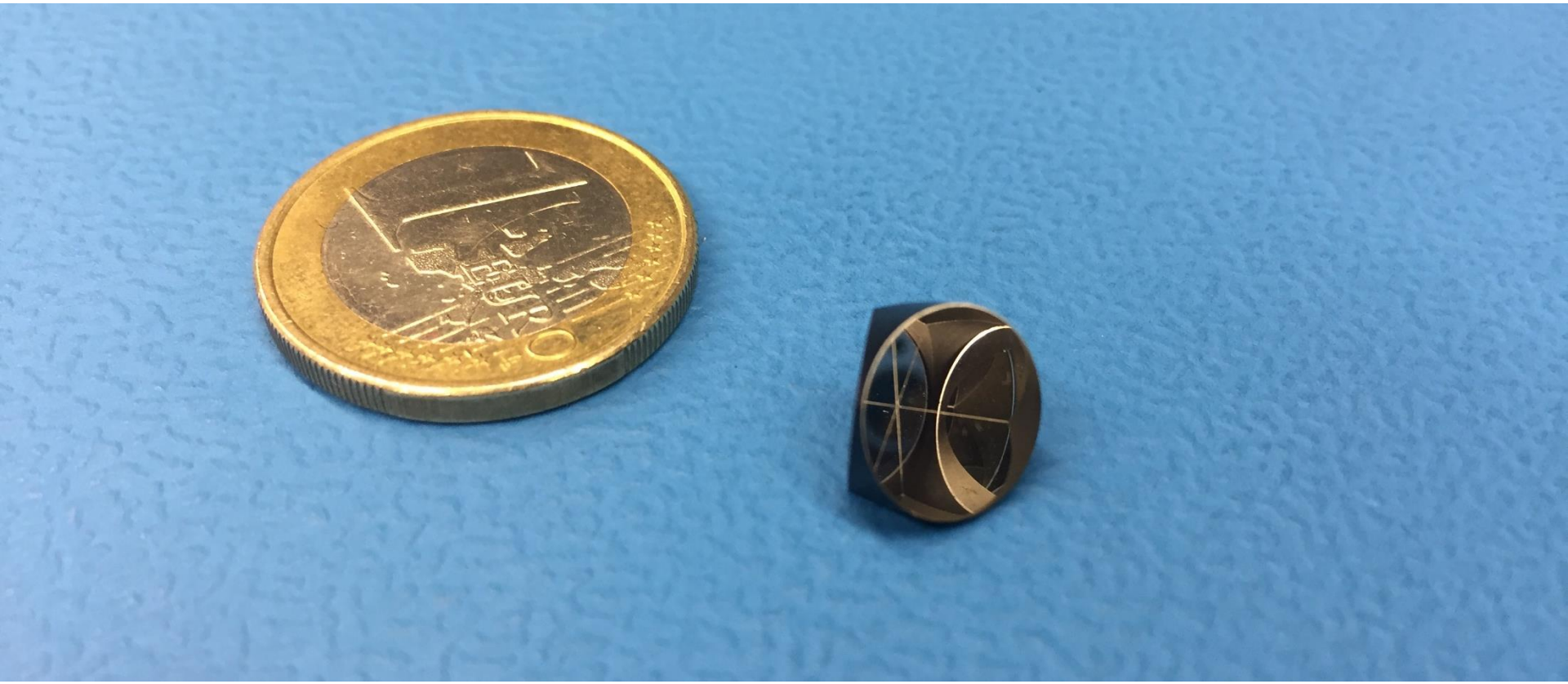


[Photograph by Roscosmos]

TechnoSat‘s first picture

Coast of Corsica around the city of Ajaccio, 24th September 2017, 12:12 PM (UTC +2)

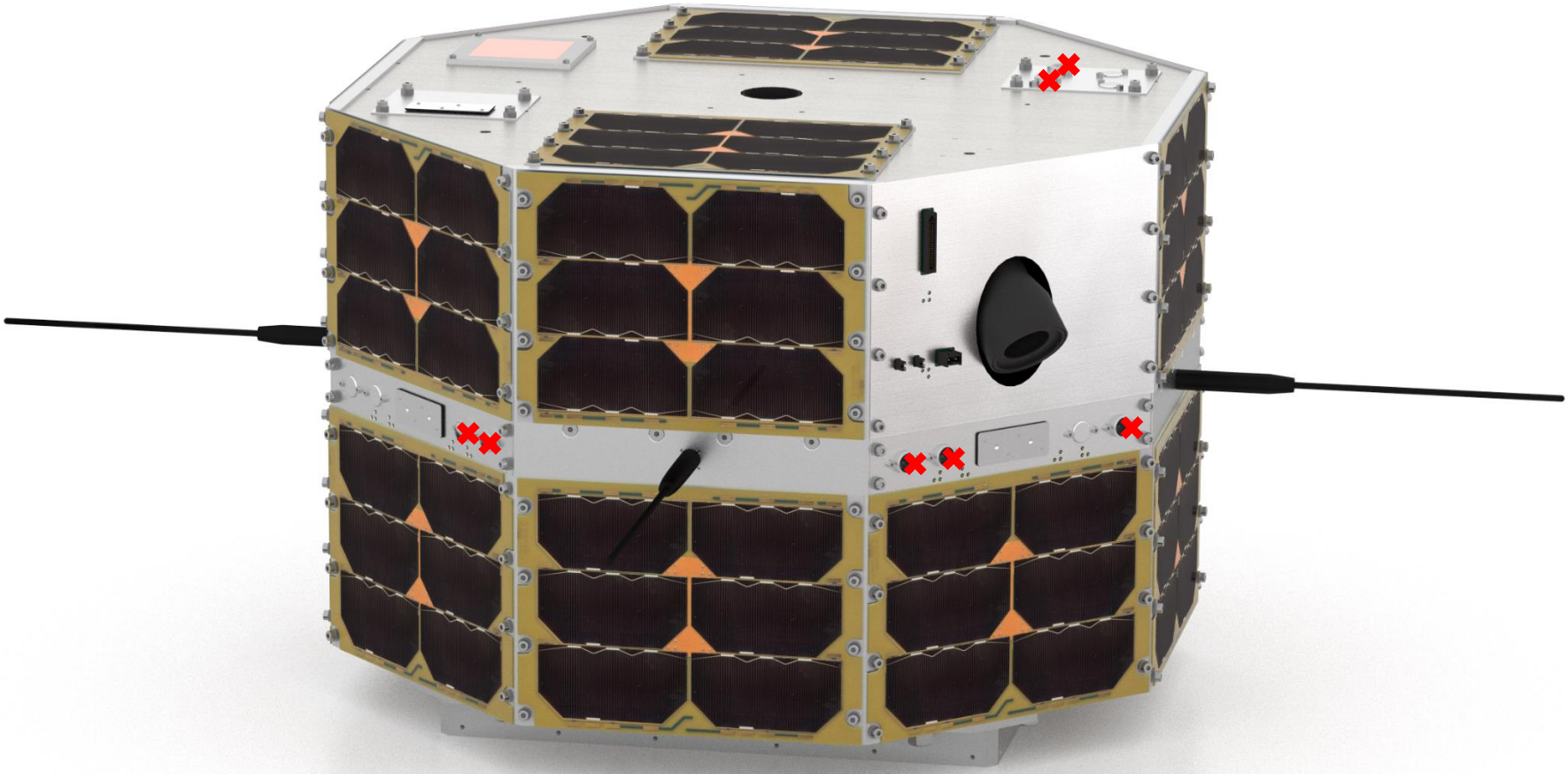
Satellite Laser Ranging (SLR)



Laser ranging on TechnoSat

- Reflectors
  - Fourteen 10mm silver coated fussed silica retroreflectors
  - Commercially available at ~ 50 USD per piece
- Experiment contributors
  - Technische Universität Berlin (TUB)
  - Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum (GFZ)
  - Austrian Academy of Sciences (ÖAW)
  - DLR's German Space Operations Centre (GSOC)
  - International Laser Ranging Service (ILRS)

TechnoSat reflector configuration



Reflector quality

- Far-field diffraction patterns (FFDPs) measured by GFZ
- Grouped by the peak of cross section
  - Green (> 220.000 sqm): 56 (59%)
  - Yellow (> 210.000 sqm and ≤ 220.000 sqm): 14 (15%)
  - Red (≤ 210.000 sqm): 25 (26%)
  - Sum: 95
- TechnoSat reflectors: > 225.000 sqm

Observation statistics

Technosat (1704205)

ILRS Tracking Statistics of Normal Point Data (CRD)

Station	First Observation	Last Observation	Passes	Observations	Duration in [s]
18734901, Simeiz	2017-07-31 21:05:31	2017-08-04 21:45:33	3	9	88
18844401, Riga	2017-09-05 22:09:51	2017-09-24 23:42:27	2	4	69
70900513, Yarragadee	2017-07-30 04:09:34	2017-10-02 15:48:35	52	536	9523
71100412, Monument Peak	2017-07-31 19:02:54	2017-09-29 19:19:40	11	291	1874
71191402, Haleakala	2017-08-04 21:15:24	2017-09-27 22:09:52	5	37	511
71240802, Tahiti	2017-09-07 09:57:26	2017-09-13 09:22:26	2	11	73
72371901, Changchun	2017-09-07 16:08:36	2017-09-29 14:58:28	8	45	662
75010602, Hartebeesthoek	2017-09-06 21:06:10	2017-09-07 21:20:01	3	20	159
78259001, Mt Stromlo	2017-09-29 01:14:51	2017-09-29 01:19:50	1	9	300
78393402, Graz	2017-08-08 22:21:25	2017-09-21 23:21:05	4	48	2379
78403501, Herstmonceux	2017-08-01 00:16:59	2017-09-20 00:33:42	7	75	1231
78418701, Potsdam	2017-09-17 09:20:18	2017-09-29 22:59:54	3	38	760
88341001, Wettzell	2017-09-28 22:49:27	2017-09-28 22:50:07	1	3	41

Last update: 2017-10-03 04:01:05

Acknowledgements

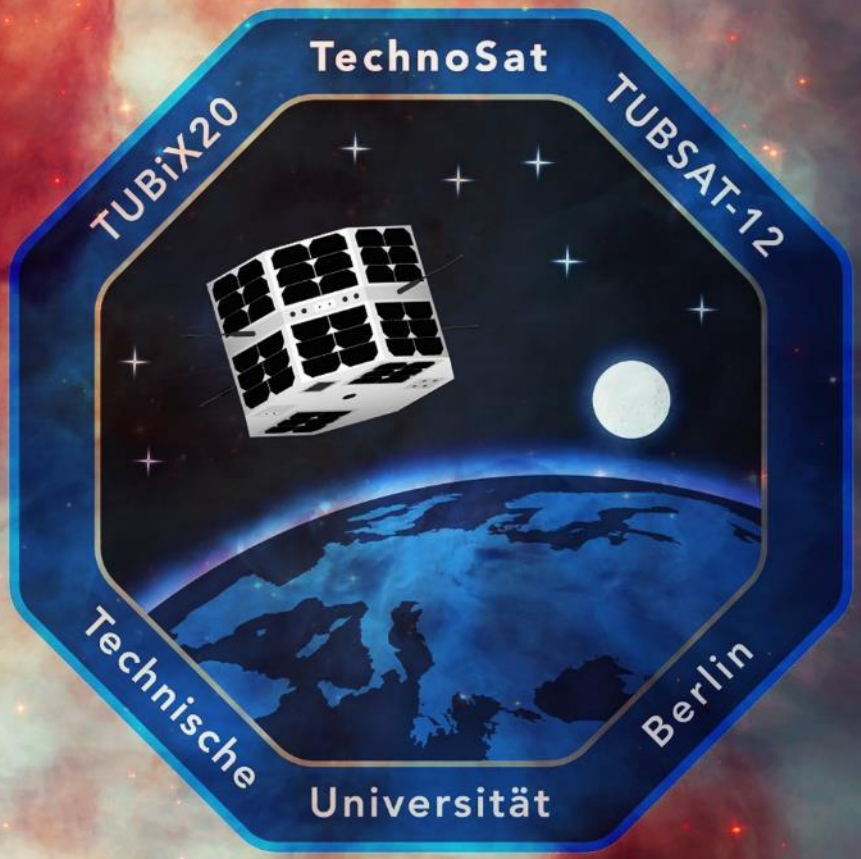
The TechnoSat mission is funded by the Federal Ministry for Economic Affairs and Energy (BMWi) through the German Aerospace Center (DLR) on the basis of a decision of the German Bundestag (Grant No. 50 RM 1219).

Publications

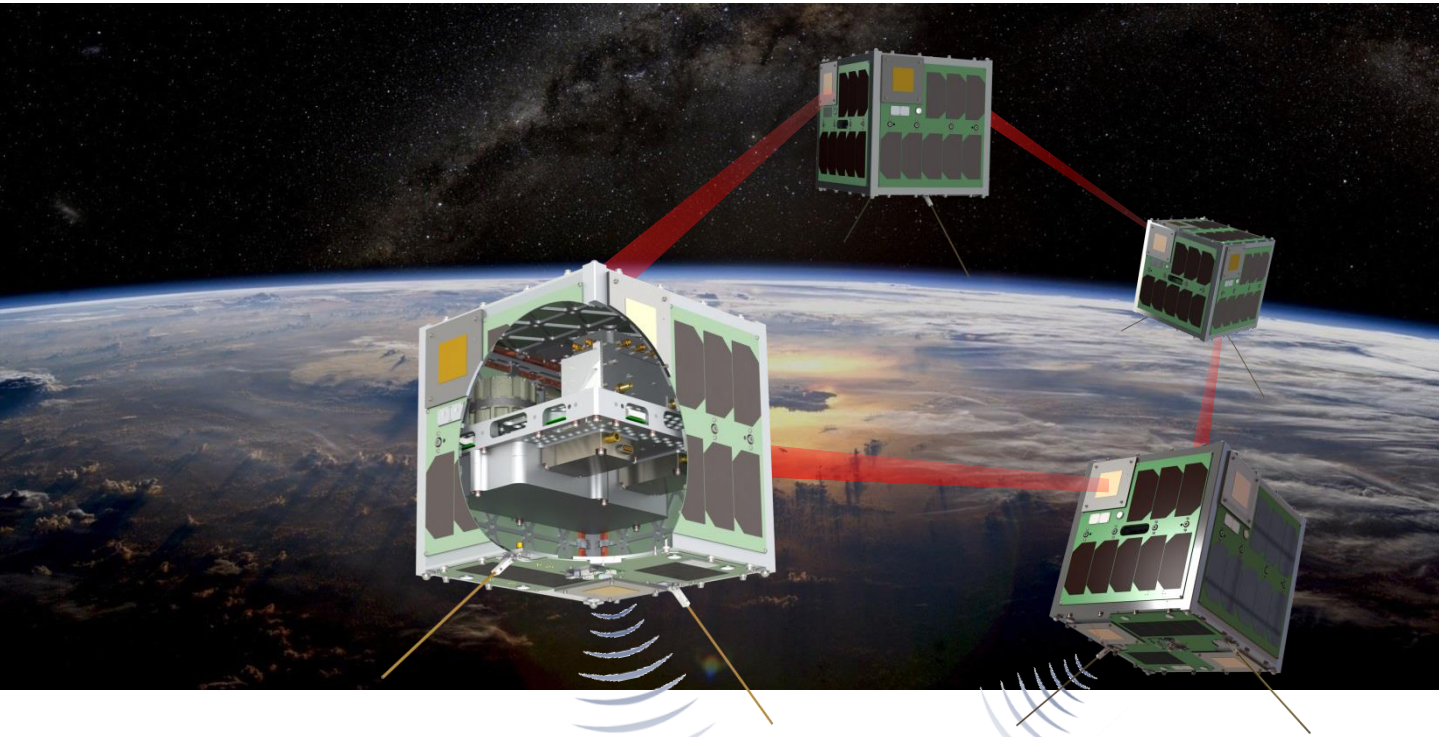
[1] M.F. Barschke, K. Gordon, M. Lehmann and K. Brieß, 'The TechnoSat mission for on-orbit technology demonstration', presented at the 65th German Aerospace Congress, Braunschweig, Germany, 2016.

[2] L. Grunwaldt, R. Neubert, M.F. Barschke, 'Optical tests of a large number of small COTS cubes' presented at the 20th International Workshop on Laser Ranging, Potsdam, Germany, 2016.

[3] G. Kirchner, L. Grunwaldt, R. Neubert, F. Koidl, M.F. Barschke, Z. Yoon and H. Fiedler, 'Laser ranging to nano-satellites in LEO orbits: plans, issues, simulations', presented at the 18th International Workshop on Laser Ranging, Fujiyoshida, Japan, 2013.



[Background photograph by NASA & STScI]



Technische Universität Berlin

Gefördert durch:

Bundesministerium für Wirtschaft und Technologie

aufgrund eines Beschlusses des Deutschen Bundestages

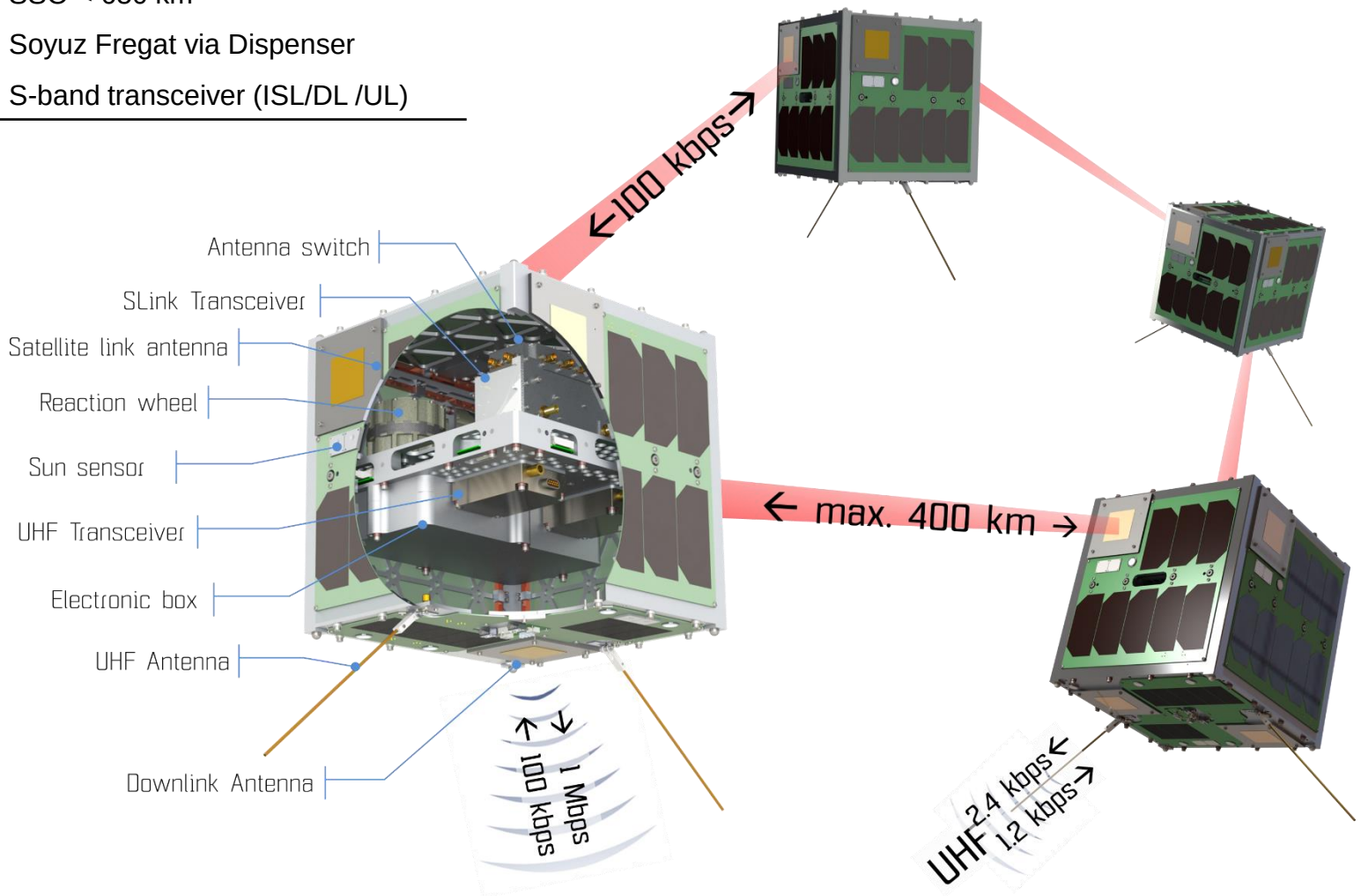
DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.

Requirement and Implementation of Laser Tracking capability for

MISSION S-NET

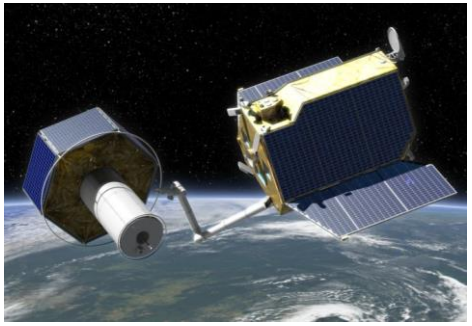
S-NET inter-satellite communication

Satellites	4
Satellite mass	< 9 kg
Satellite size	24 x 24 x 24.5 cm
Orbit	SSO < 650 km
Launch	Soyuz Fregat via Dispenser
Payload	S-band transceiver (ISL/DL /UL)

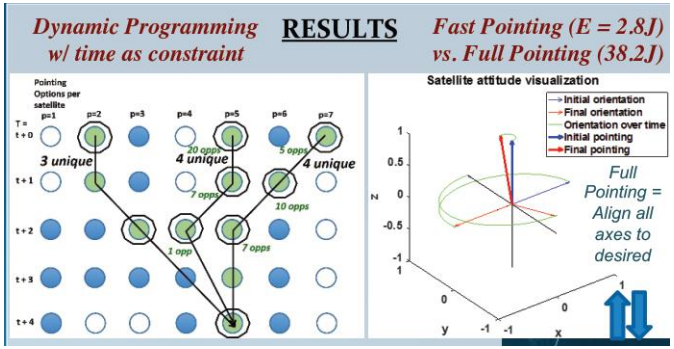


ISL Applications

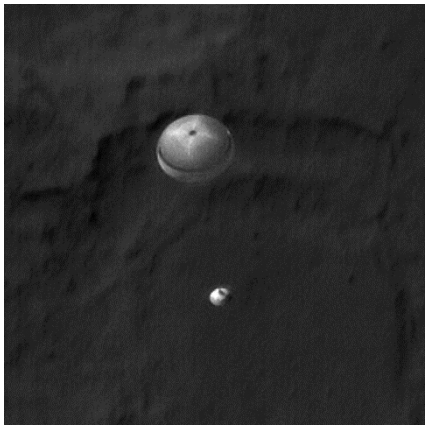
On-orbit servicing / proximity operations



Rapid & autonomous operations



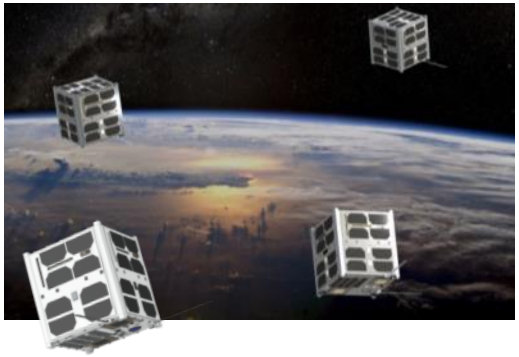
Distributed sensing and processing



M2M communication

Nanosatellite ISL Missions

Name	Org.	Nation	SC no.	SC mass [kg]	ISL payload	ISL Freq.	ISL rate [kpbs]	ISL range [km]	TX Pwr [W]	ISL Data	Launch Year	Status
NetSat - 4G	Telematik	GER	4	3U?		UHF					2019	in development
S-NET	TUB	GER	4	9	Slink	S-Band	100	400	0,5	Status and HK	2017	in development
PinaSys II	TUB	GER	4	0,25		UHF					2018	in development
CPOD	Tyvak	USA	2	3U		S-Band	250	25			2017	in development
GAMASAT		POR			Gamalink	S-Band		1000	3		2017	in development
BEESAT-4	TUB	GER	2	1, 120	Nlink	UHF		80		HK	2016	successful
EDSN	NASA	USA			Microhard MHZ2420	UHF	9,6				2015	launch failure
Tianwang 1	SECM	CHN	3	1x3U, 2x2U	Gamalink	S-Band	2000				2015	part. successfull
CanX 4&5	SSFTL	CAN	2	5		S-Band	10	5			2014	successful
FASTRAC		USA				UHF	9,6	10		relative position data	2010	
PRISMA	SSC	SWE	4	145, 50		UHF				Position and status info	2010	successful
Three-CornerSat		USA	3	30		k.A.	k.A.	30			2004	lauch failure
GRACE	Astrium	GER	2	480		S-Band					2002	successful
SNAP-1	Surrey	UK	2	6,5, 49		UHF	9,6	2		Position, Image	2000	successful



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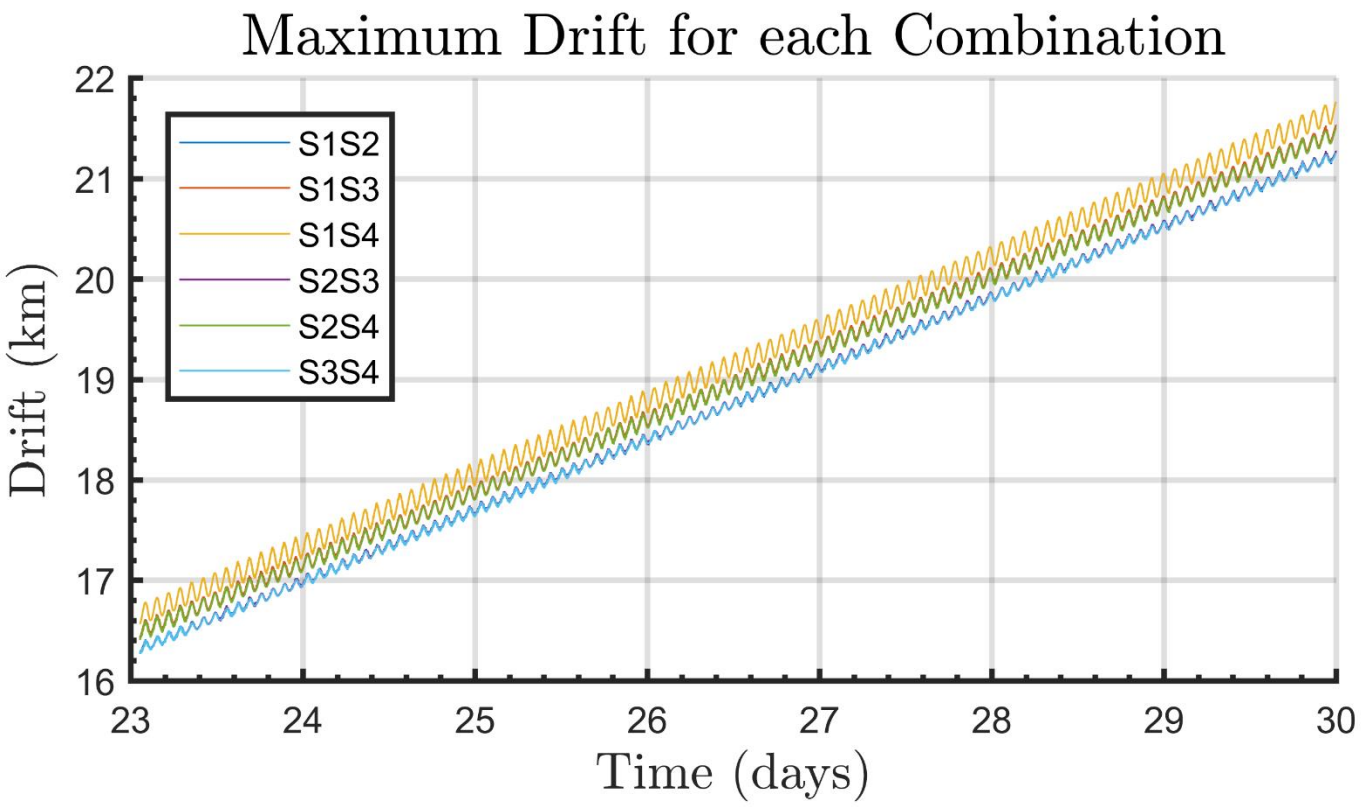
Mission statement:

„Demonstration of inter satellite communication within a nanosatellite network“

- demonstrate multipoint ISL with Sband transceiver
- verify the newly developed / optimized ISL communication protocols (OSI level 3 and above)
- analyze the stability of a nanosatellite formation
- demonstrate the feasibility of nanosatellites as a base for demanding communication missions

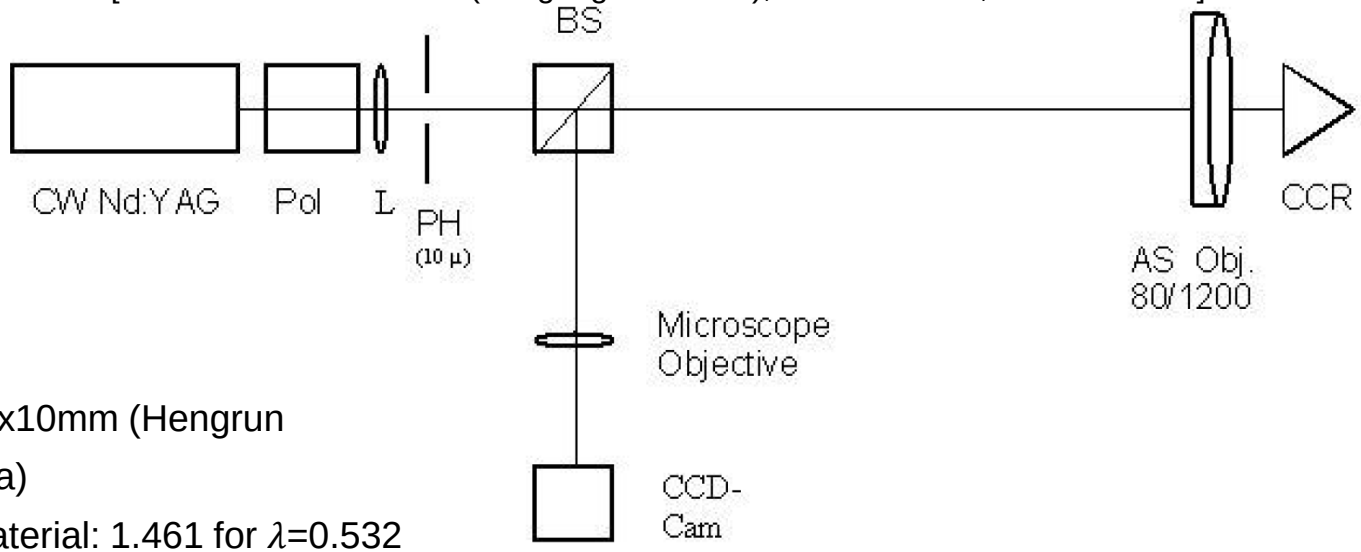
S-NET inter-satellite communication

Orbit relative drift

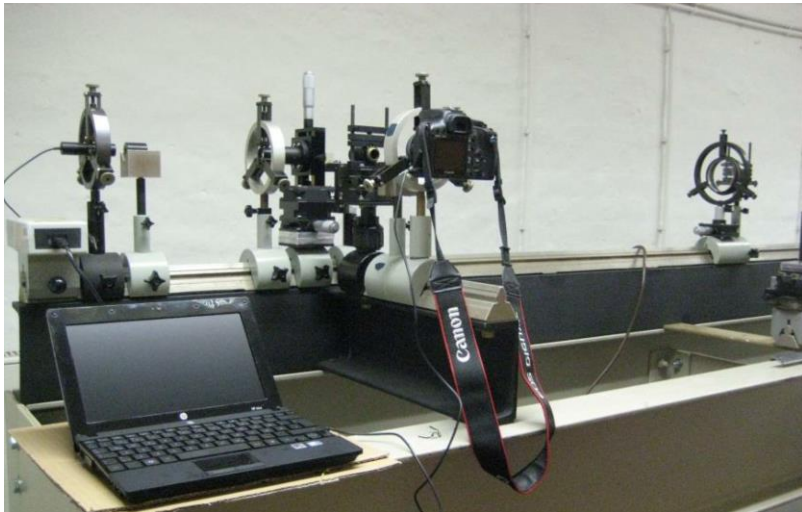


CRR Selection

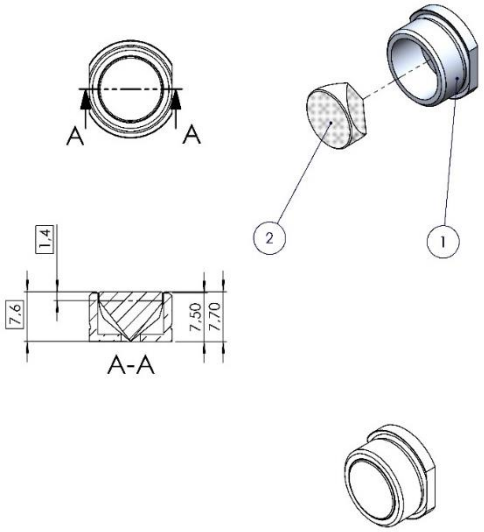
[Test an Retroreflektoren (Beugungs-Fernfeld), L. Grundwaldt, GFZ Potsdam]

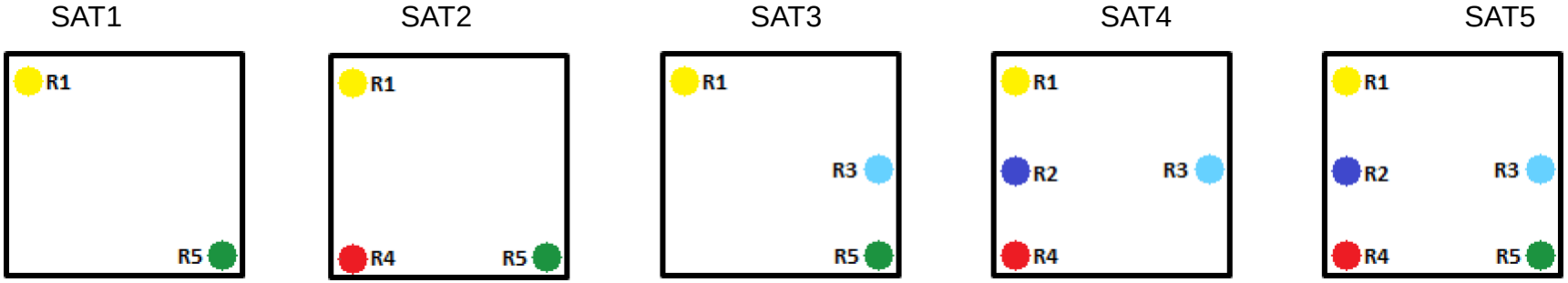


- Fused silica cubes 10x10mm (Hengrun Optoelectronics, China)
- Refractive index of material: 1.461 for λ=0.532
- Tolerance: no offset, +/-3 arcsec accuracy
- Silver coating
- Far Field Diffraction Patterns Measurement by GFZ Potsdam



CRR configuration





Measurements

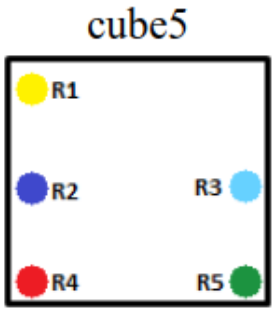
Altitude profile from Graz to the SNET Modell

Modell of the satellite on a tripod driven by a step motor

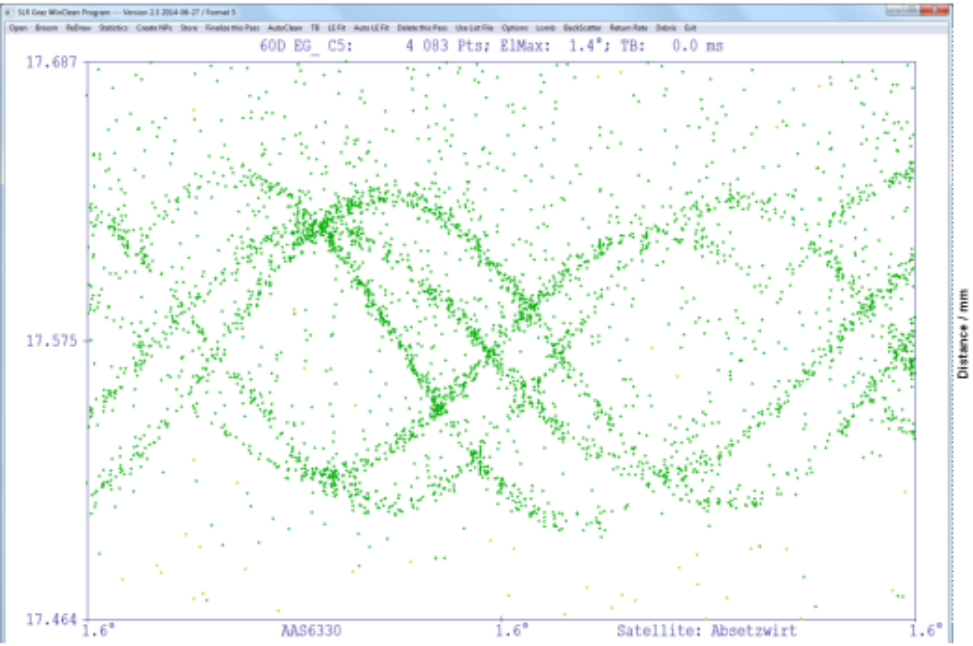
- Align the modell to our LASER-station in Graz
- Let the modell spin while LASER is shooting to the modell
- Repeat that for different scenarios

Measurements VS Simulation

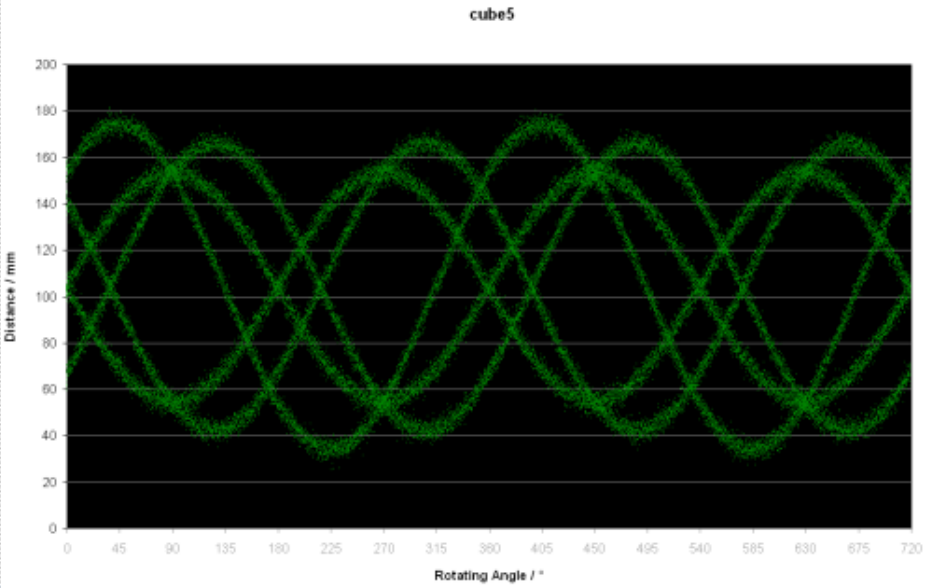
- Angle: 60°
- Signaltrace of spinning motion of the bottom side



Measured data



Calculated data



Measurements VS Simulation

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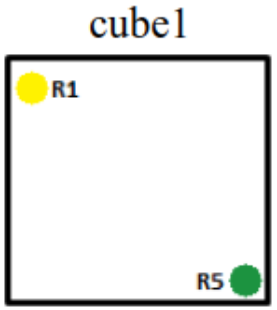
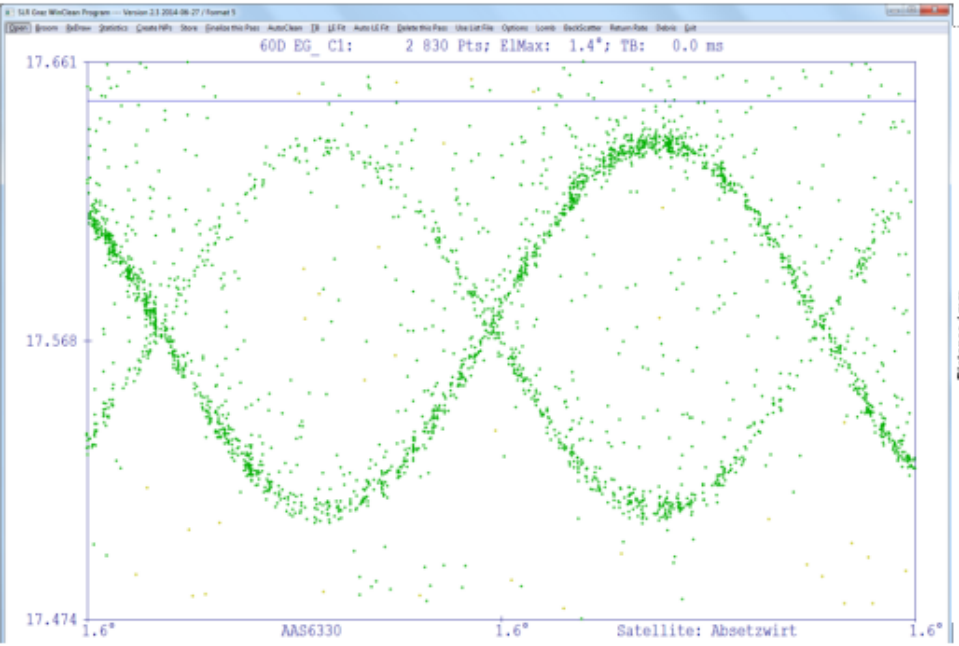
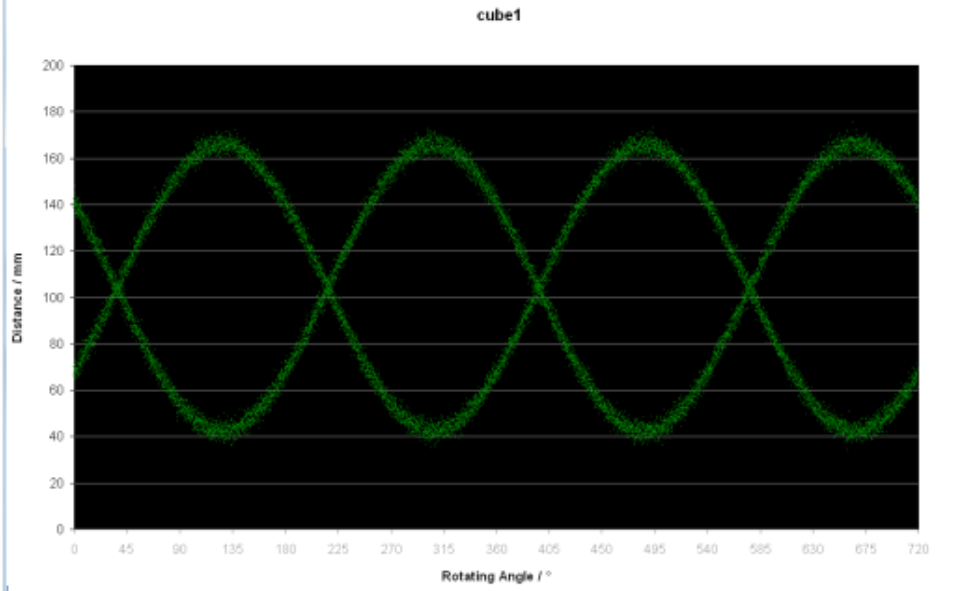


Measured data



Calculated data



First conclusions of field measurement

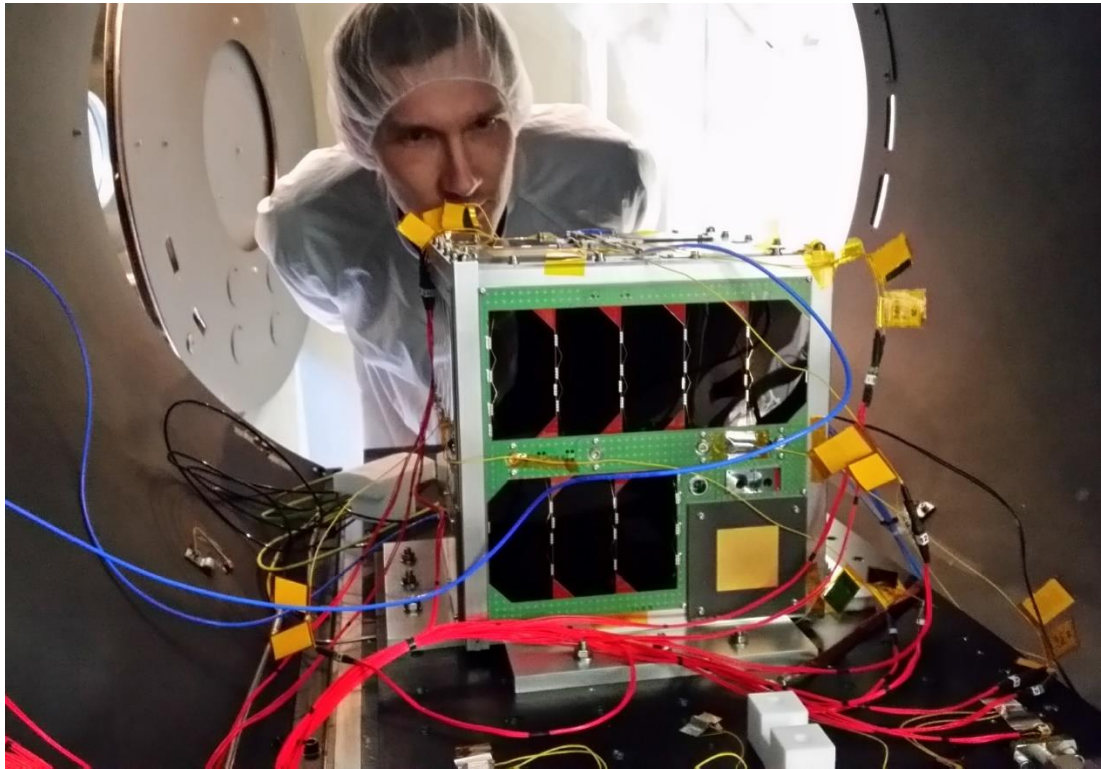
- Measurements confirm simulation
- Identification of satellites easily possible
- Angle of satellite can be determined by measuring the distance between top and low peak of amplitude of signal trace
- Spin rate of satellite can be determined by measuring peak-to-peak time

Laser Ranging Operation

- Nominal mode: nadir pointing:+/- 20 °
- No restrictive attitude or angle
- Normal point bin size (time span): 5 sec
- CPF by DLR
- Position measurement by HF signal propagation: 100m accuracy

Special thanks to

- Austrian Adacemy of Sciences (Dr. Georg Kirchner, Hannes Almer)
- GFZ Potsdam (Dr. Grundwaldt)
- DLR SSA (Dr. Hauke Fiedler, Benjamin Schlepp)
- ILRS committee (Prof. Toshimichi Otsubo)



ESA‘s OPS-SAT: With CCR and detector

OPS-SAT (ESA):

A 3-Unit CubeSat with:

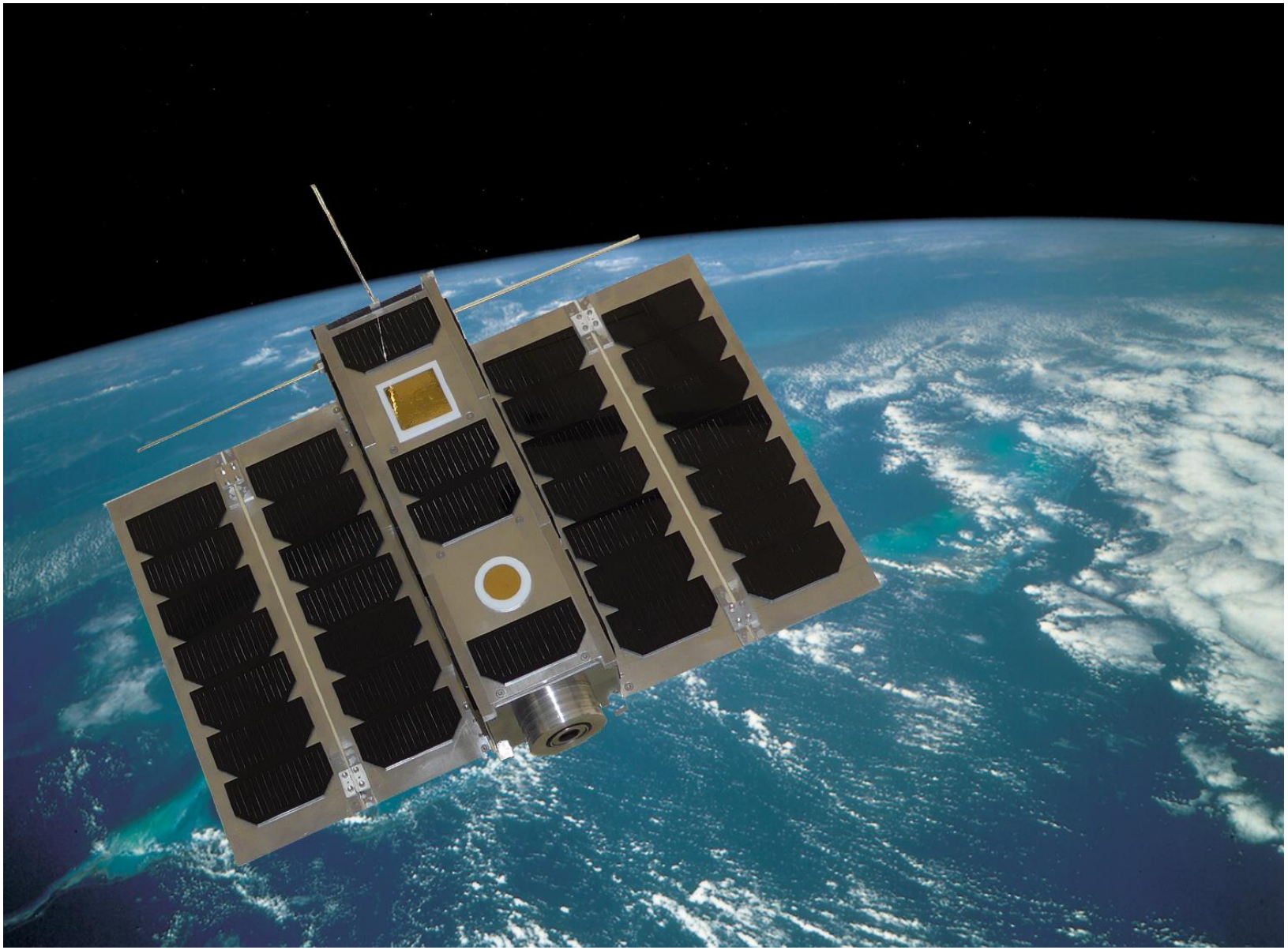
=> Laser Reflectors

=> PPM Data Transmission

Georg Kirchner

Ludwig Grunwaldt

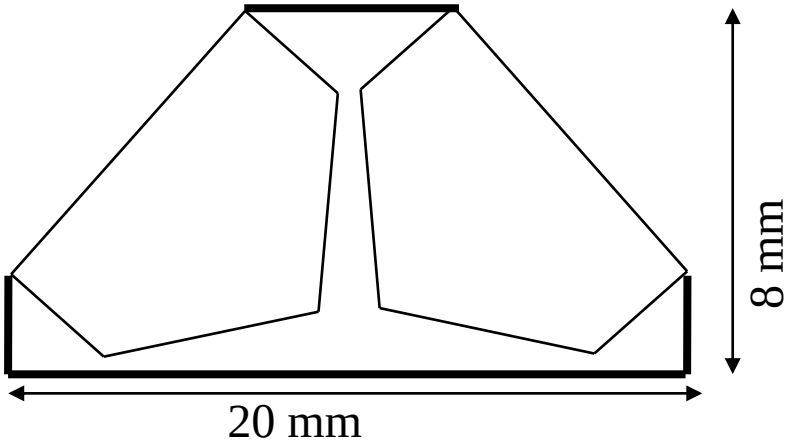
ESA‘s OPS-SAT: With CCR and detector

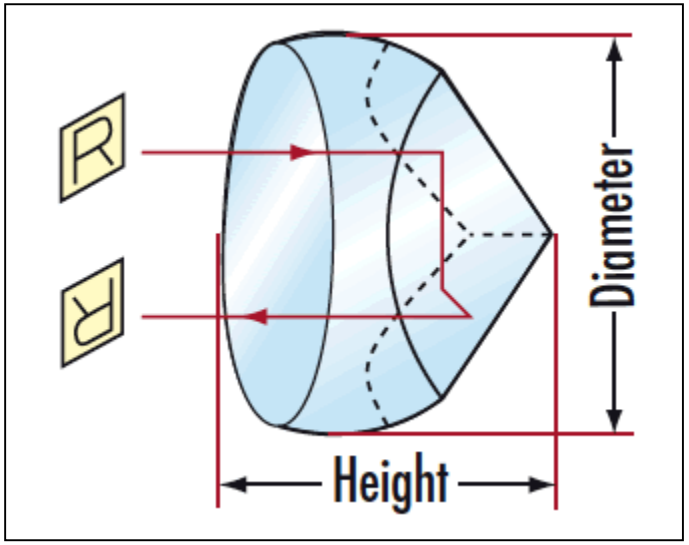


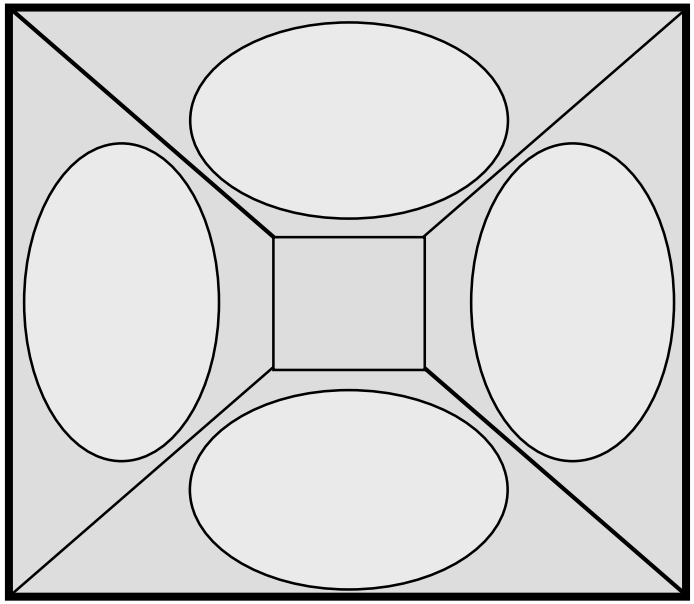
- Platform for Software Experiments
- Allows Exchange / Test of Software, including OS, File Transfers etc…
- Circular Orbit; ≈600 km
- CubeSat: 30 x 10 x 10 cm
- Attitude: Stabilized
- Low-Cost mission; OTS parts
- Retro Pyramid, PPM data transmission
- Launch planned 2015 (as of 2013 ☺)
  Now scheduled for early 2019 …

Nadir Pointing

OPS-SAT: 180° Panel, minimized size

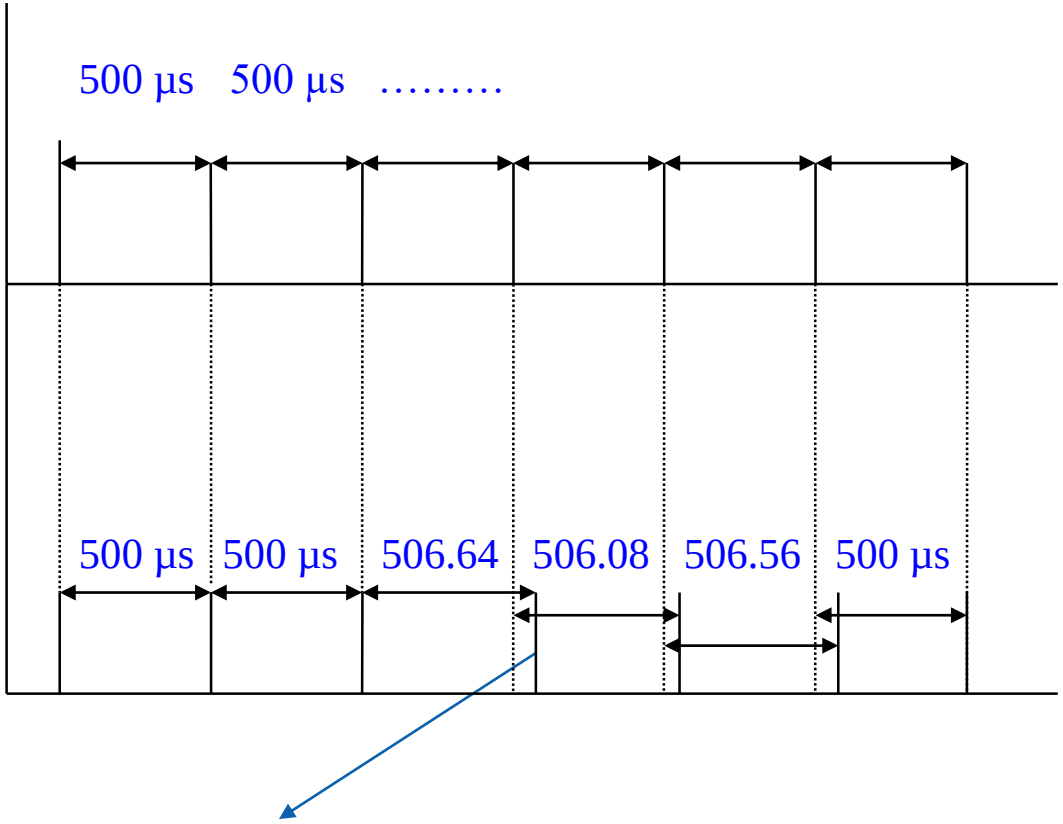






- Pyramid with 4 x 10 mm CCR‘s
- Covers 180°
- Pyramid size: 20 x 20 x 8 mm

Data Transmission via Pulse Position Modulation (PPM)



Standard SLR (Graz): 2 kHz

Constant Intervals of 500 µs

Basic grid; pulses ± 7 ns

PPM: 500 µs + N*80ns;
with N=1,255 (ASCII Coding)

80 ns: Basic Encoding Step
⇒ Includes ± 7 ns Laser
⇒ Includes Orbit Motion

Sync: ≥ 100 intervals of 500 µs

500 µs + N*80ns = 506.64 µs; N = 083 => „S“
500 µs + N*80ns = 506.08 µs; N = 076 => „L“
500 µs + N*80ns = 506.56 µs; N = 082 => „R“

Example: ASCII Coding ...

Joint-stock Company
«Research-and-Production Corporation
«Precision Systems and Instruments»

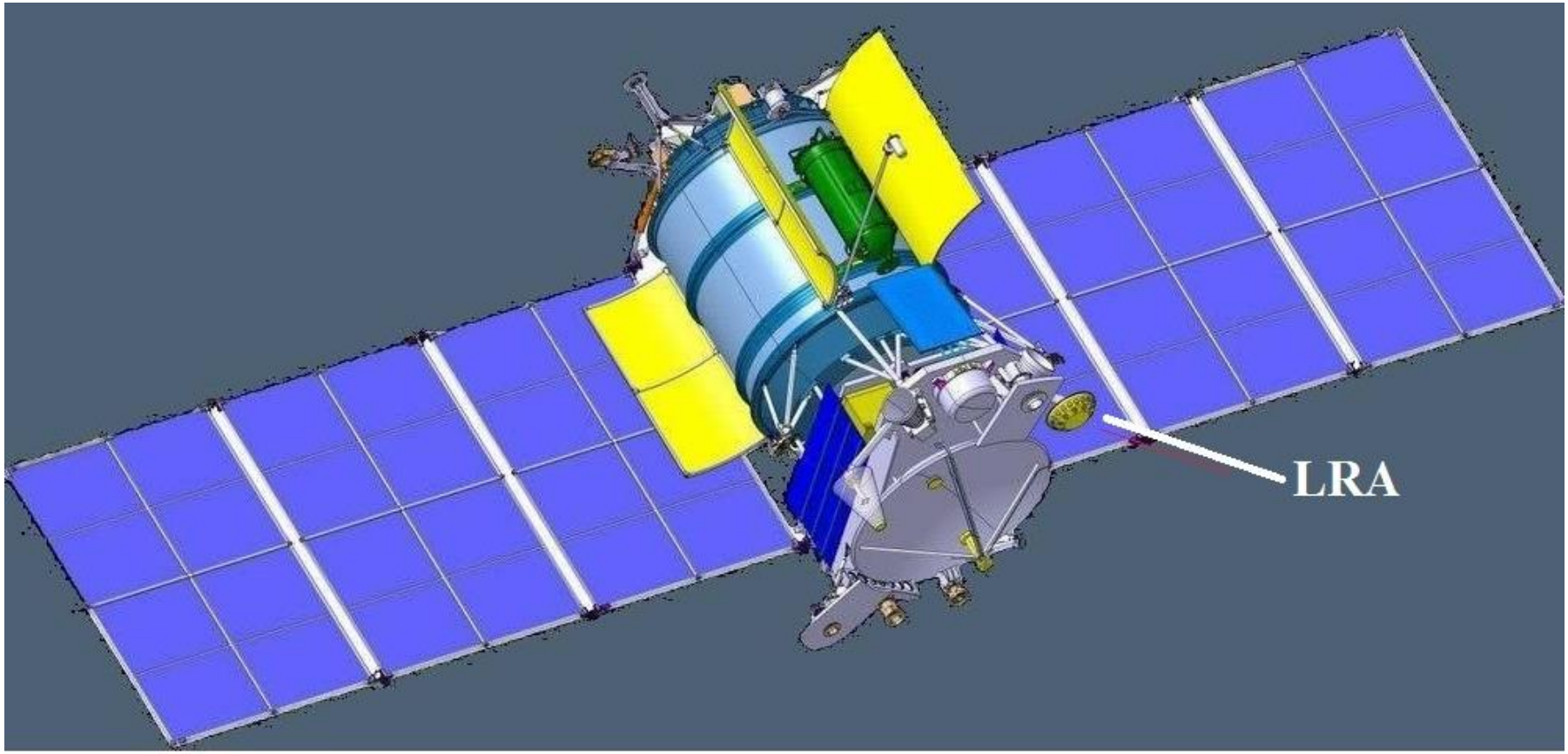
Geo-IK-2 Mission

N. Parkhomenko, E. Titov., V. Shargorodskiy

**ILRS Missions Standing Committee Meeting:
1700-1800, Tue 3 Oct 2017**

Riga, 2017

Geo-IK-2



www.lenta.ru 18:10, 2 февраля 2011

General information of the GEO-IK-2 mission

Geo-IK-2 — is a Russian satellite system, which was planned to consist of two spacecraft, designed to take high precision geodetic measurements. Development and production of the system was performed by JSC "Information Satellite Systems" named after the Academician M.F. Reshetnev. With the launch of the first "Geo-IK-2" satellite after a long break between launches, the execution of the Russian space geodetic program began. The launch of the first satellite in February 2011 failed, the satellite had been launched into an incorrect orbit.

Scientific and engineering objectives of mission

- determination of parameters of the Earth's gravity field;
- building up a high-precision geodetic network in a geocentric reference frame;
- determination of movement of continental plates;
- determination of the Earth’s tides;
- determination of changes in the Earth's rotation speed and pole coordinates, completion of a number of applied tasks that require operative determination of the coordinates of ground stations, including:

  a) development of regional geodetic networks;

  b) remote probing of the Earth;

  c) definition of the marine geoid;

  d) ice monitoring.

Orbital parameters of Geo-IK-2 and miscellaneous

Orbital parameters of Geo-IK-2

Altitude: 958.5 ± 15km

Inclination: 99.47 grad.

Eccentricity: 0.001

Orbital period: 6216.5 sec

Purpose of requesting for ILRS SLR support of the Geo-IK-2 mission – POD

Mission duration – 1 year

Prediction Center

The branch "Precision Navigation and Ballistic Support («PNBS»)" of JC "RPC "PSI".

Prediction Technical Contacts:

Evgeniy Titov

E-mail addresses:

titov@spnav.ru

parknataliya@yandex.ru

Geo-IK-2 satellite equipment

- **SADKO radar altimeter produced by Thales Alenia Space;**
- **Doppler ranging system;**
- **GLONASS/GPS receiver;**
- **Laser retroreflector array.**

Laser Retroreflector Array

Laser Retroreflector Array of Geo-IK-2 satellite

LRA description

The Laser Retroreflector Array (LRA) is a system of 30 quartz Cube Corner Reflectors (CCR) mounted on two conical body belts, with an equivalent diameter of the light aperture (entrance facet) of 28.2 mm.

The holder in which the CCR are installed is equipped with a protective thermostabilizing screen with an additional function equivalent to the introduction of cylindrical blends on the CCR.

The reflecting CCR faces are coated in aluminum. Far Field Diffraction Pattern (FFDP) of CCR is double-spot, oriented along the SC velocity vector to compensate for light velocity aberration.

LRA description

One conical belt holds 10 CCR, another one holds 20 CCR.

The angle between the normal to the input faces of the group of 10 CCR and the LRA axis oriented to the Earth's center is 30°. This CCR group is designed to provide sufficient energy at the near-zenith and mid-zenith angles.

The second group of 20 CCR, with the inclination angle of 52°, provides the best power at maximum ranges close to the horizon.

Thank you for approval

of our request

for SLR tracking support

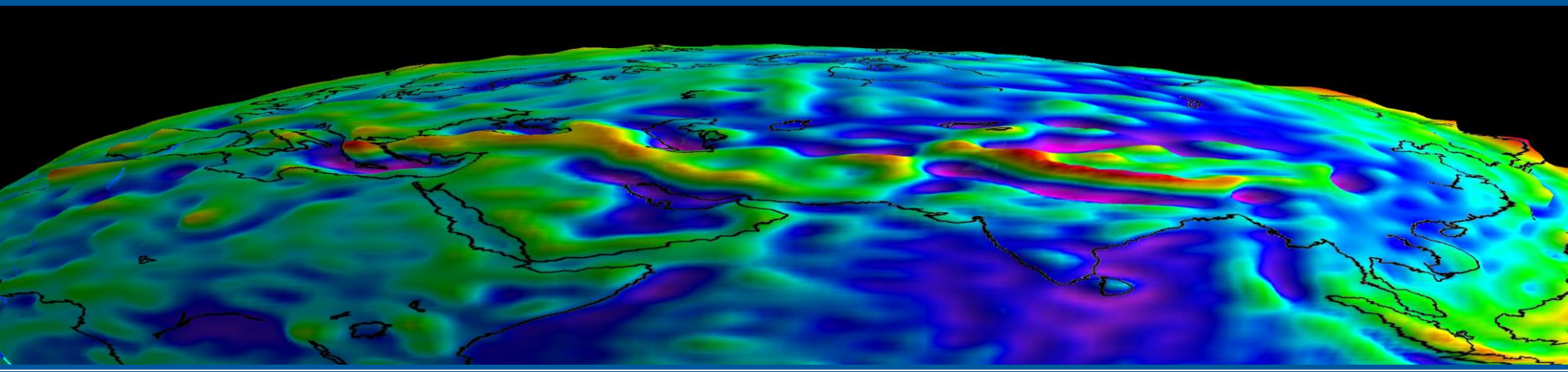
of the Geo-IK-2 mission!

Joint-stock Company
«Research-and-Production Corporation «Precision Systems and Instruments»
(JC «RPC «PSI»)

53 Aviamotornaya Street, Moscow 111024, Russian Federation
phone: +7 (495) 707-1348, fax: +7 (495) 234-9859
www.npk-spp.ru

Mission Status „GRACE-Follow On“ and „PAZ“ – Update October 2017

Ludwig Grunwaldt
GeoForschungsZentrum Potsdam



GRACE Follow On

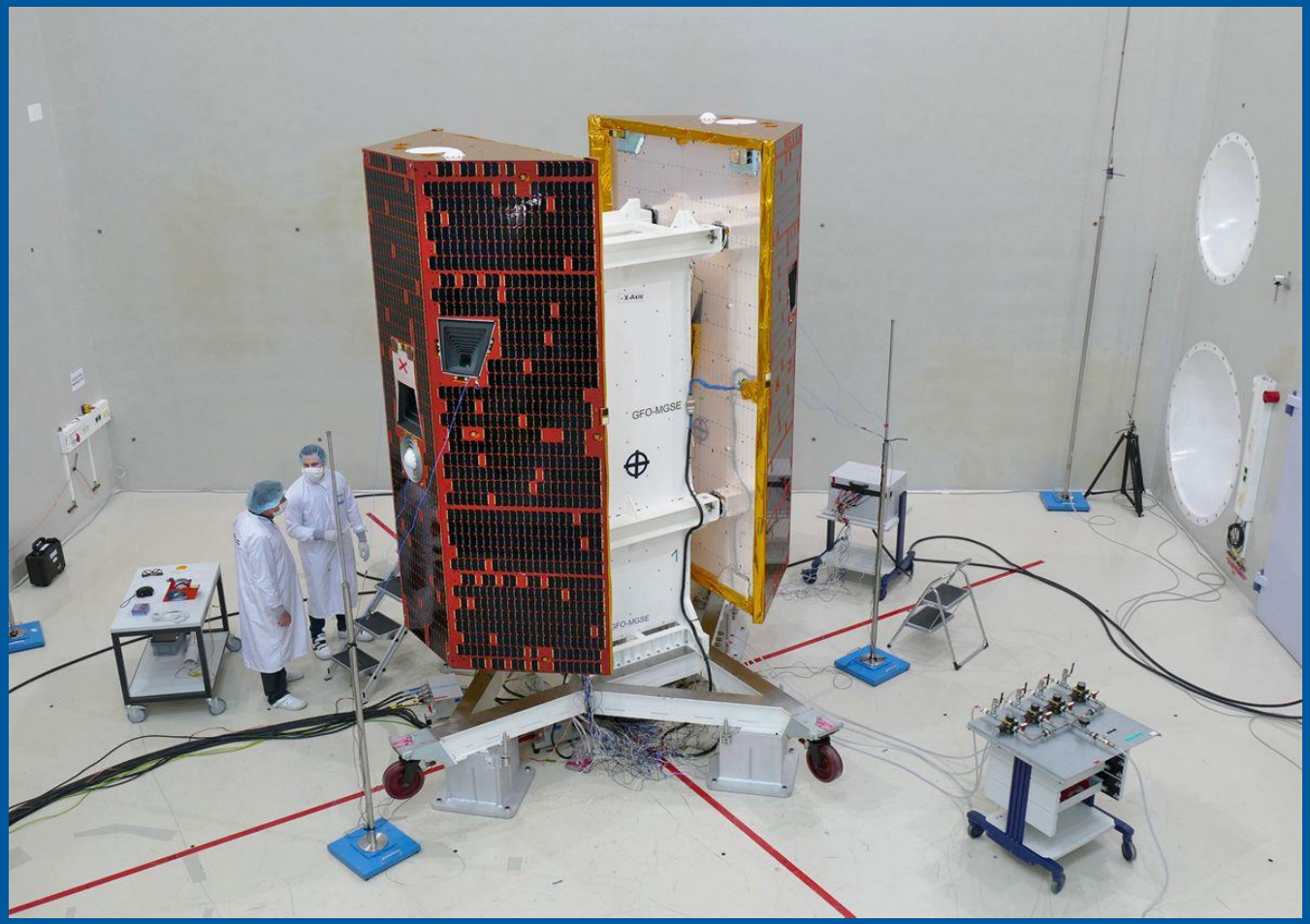
The original GRACE mission will be terminated soon. The GRACE-B satellite shows serious degradation of its power system and is running out of fuel for attitude and orbit maintenaince.

The period of full-sun illumination condition about mid October 2017 will be used to resume nominal operations for a limited period of time.

THANKS A LOT TO THE ILRS FOR EXCELLENT MISSION SUPPORT FOR ABOUT 15 YEARS !!!
(The design lifetime of GRACE was 5 years only …)

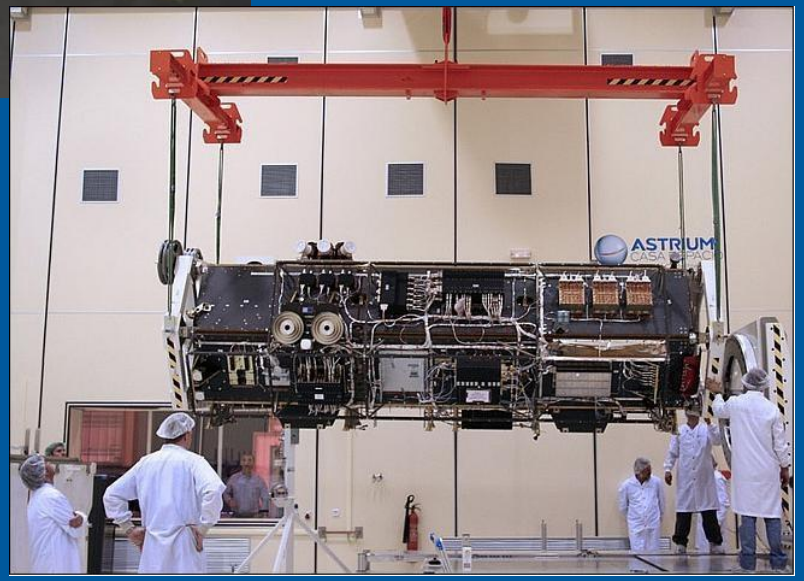
The launch date (shared ride on a Falcon-9 Series V together with 5 IRIDIUM NEXT satellites from Vandenberg AFB) is tentatively scheduled for 21 March 2018.

GRACE Follow- On



The GRACE-FO satellites prepared for acoustic noise test

PAZ (Formerly SeoSAR)

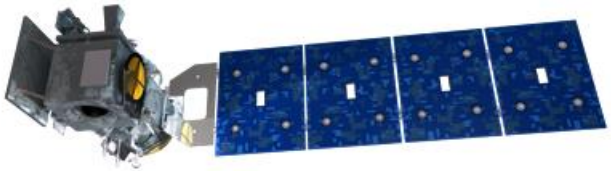


Spanish radar satellite based on the TerraSAR-X satellite bus (HISDESAT)

The launch of PAZ on a Falcon-9 carrier is anticipated for the 4th quarter of 2017, but no dedicated date is available as of today.

ICESat-2

- ATLAS (6-spot laser altimeter at 532nm) is the instrument on ICESat-2.
- Majority of Observatory testing at Orbital in Gilbert AZ is complete.
- Launch is September 2018.
- Mission Support Request has been turned in but needs update.
- Predictions will be generated by ICESat-2 POD (Scott Luthcke, GSFC).
- Predictions will be hosted on the ICESat-2 Instrument Support Facility (ISF) – Peggy Jester, GSFC. Only selected stations get predictions – will use either individual dropboxes with passwords or scp/sftp with key.
- Randy Ricklefs, MLRS, will be performing prediction testing with ISF shortly.
- This will be a restricted tracking mission. We are currently still in discussions with ATLAS Instrument Scientist but anticipate an elevation restriction and potentially also an energy density restriction.
- Go/NoGo hosted by ISF.



ILRS GNSS pages: updates required

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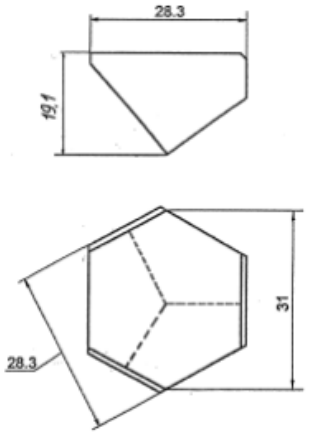
GLONASS: Reflector Information

RetroReflector Array (RRA) Characteristics:



Drawing of corner cube, all units in mm. Courtesy of IPIE

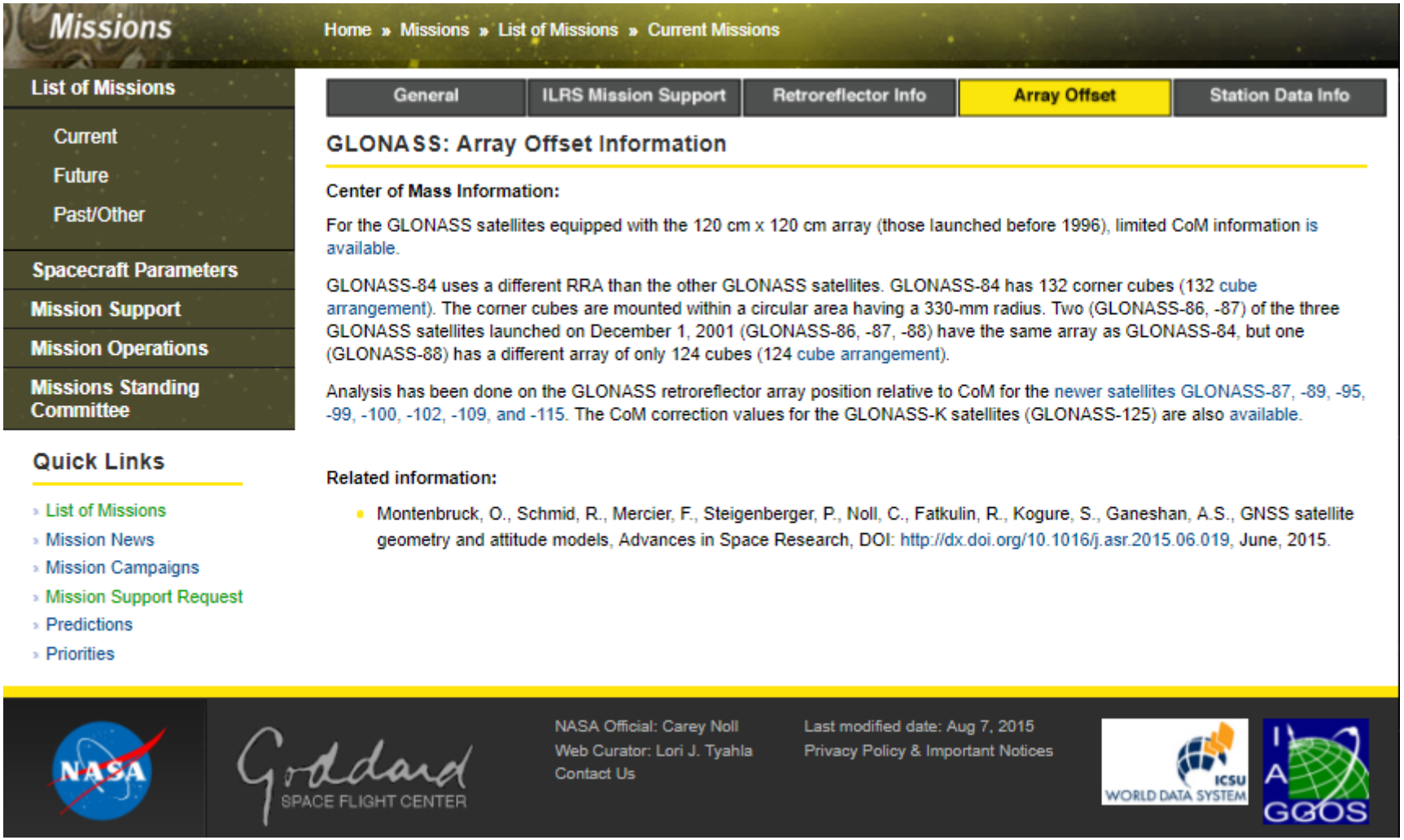
Each GLONASS satellite is equipped with a laser retroreflector array built by the Institute for Precision Instrument Engineering (Russia). The retroreflector array is a 120 centimeter by 120 centimeter planar array with 396 fused-quartz corner cubes (center of mass relative to the RRA, arrangement of corner cubes). Such an RRA array is on each GLONASS satellite launched before 1996. A similar but much smaller designed Russian array is used on GPS-35, -36. There is no masking and no obstacles to the CCR arrays with respect to the laser beam incidence angle. The refractive index for various wavelengths is in the table below.

wavelength (microns)	refractive index
0.350	1.4769
0.400	1.4701
0.532	1.4607
0.800	1.4532
1.064	1.4496
1.540	1.4438

Newer GLONASS satellites have different RRA than other GLONASS satellites:

- GLONASS-84 has 132 corner cubes (132 cube arrangement). The corner cubes are mounted within a circular area having a 330-mm radius.
- Two (GLONASS-86, -87) of the three GLONASS satellites launched on December 1, 2001 (GLONASS-86, -87, -88) have the same array as GLONASS-84, but one (GLONASS-88) has a different array of only 124 cubes (124 cube arrangement).
- GLONASS-95, -99, and above up to -115 have 112 corner cubes (112 cube arrangement).
- All corner cubes on the GLONASS satellites have a metal coat on their back faces, except for those satellites carrying uncoated retroreflectors.
- GLONASS-115, -122, -123, and -124 all have uncoated retroreflectors. All future GLONASS M and K series spacecraft (launched after GLONASS-125) will also have the LRR arrays without coating.
- GLONASS-125 is a new GLONASS-K satellite with a 123 corner cube arrangement; CoM values have been provided for the satellite. The LLR array on GLONASS-125 is the last satellite with an array with aluminum coating.

ILRS GNSS pages: updates required



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GLONASS: Array Offset Information

Center of Mass Information:

For the GLONASS satellites equipped with the 120 cm x 120 cm array (those launched before 1996), limited CoM information is available.

GLONASS-84 uses a different RRA than the other GLONASS satellites. GLONASS-84 has 132 corner cubes (132 cube arrangement). The corner cubes are mounted within a circular area having a 330-mm radius. Two (GLONASS-86, -87) of the three GLONASS satellites launched on December 1, 2001 (GLONASS-86, -87, -88) have the same array as GLONASS-84, but one (GLONASS-88) has a different array of only 124 cubes (124 cube arrangement).

Analysis has been done on the GLONASS retroreflector array position relative to CoM for the newer satellites GLONASS-87, -89, -95, -99, -100, -102, -109, and -115. The CoM correction values for the GLONASS-K satellites (GLONASS-125) are also available.

Related information:

- Montenbruck, O., Schmid, R., Mercier, F., Steigenberger, P., Noll, C., Fatkulin, R., Kogure, S., Ganeshan, A.S., GNSS satellite geometry and attitude models, Advances in Space Research, DOI: http://dx.doi.org/10.1016/j.asr.2015.06.019, June, 2015.

NASA Goddard SPACE FLIGHT CENTER

NASA Official: Carey Noll
Web Curator: Lori J. Tyahla
Contact Us

Last modified date: Aug 7, 2015
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ICSU WORLD DATA SYSTEM

IAG GGOS

ILRS GNSS pages: Re-organised to something like this?

“Retroreflector info” or “Array Offset” page

GLONASS-125	--> details (a link to its LRA & CoM correction)
GLONASS-128	identical to GLONASS-125
GLONASS-129	identical to GLONASS-125
GLONASS-131	identical to GLONASS-125
GLONASS-133	identical to GLONASS-125
GLONASS-134	--> details (a link to its LRA & CoM correction)
GLONASS-136	identical to GLONASS-134

Subset of MSR (Section III: LRA)

Subset of MSR (Section III: LRA)

Note: The table above is not based on real information. Shown just as a template.

- **To Do: Ask the GNSS host institutes in (US,) Russia, ESA, China, India and Japan**

  whether the current webpage well updated or not

  to provide the updates in the format above?

(6) Other issues?

(7) Closure

- **MSRF should be submitted to ILRS CB at least 3-6 mo before the launch.**
- **Next meeting**

  Very likely: in conjunction with Canberra LW21, 5-9 Nov 2018.