International Laser Ranging Service

Missions (WG →) SC Meeting

11 Oct 2016

Toshimichi Otsubo

and

Scott Wetzel

Missions SC Agenda

(1) Opening/Welcome/Membership

(2) Renaming; WG->SC

(3) Revised Mission Support Request (MSR) Form

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

- ICESAT-2 (Wetzel)
- QZS (Ohshima)
- BLITS-M (Sokolov)
- Lomonosov (Sokolov)
- GRACE Follow-On (Grunwaldt)
- PAZ (Grunwaldt)
- ACES-ELT (-> transponder+interplanetary session)
- Others (?)

(5) Other issue?

(6) Closure

(1) MWG Members

- Graham Appleby/NERC Space Geodesy Facility
- Giuseppe Bianco/Agenzia Spaziale Italiana (ASI)
- John J. Degnan/Sigma Space Corporation
- Julie E. Horvath/HTSI/SLR
- Georg Kirchner/Space Res. Inst., Austrian Acad. of Sci.
- Hiroo Kunimori/NICT
- 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
- Erricos C. Pavlis/GEST/UMBC
- Michael R. Pearlman/Harvard-Smithsonian Center for Astrophy.
- Luca Porcelli/Istituto Nazionale di Fisica Nucleare
- Ulrich Schreiber/BKG/Geodaetisches Observatorium Wettzell
- Peter J. Shelus/University of Texas at Austin/CSR
- Andrey Sokolov/SRI for Precision Instrument Engineering
- Vladimir P. Vasiliev/SRI for Precision Instrument Engineering
- (cochair) Scott L. Wetzel/HTSI/SLR
- Zhongping Zhang/Shanghai Data Center

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

Updated: 13-Sep-2016 23:00:03

http://ilrs.gsfc.nasa.gov/missions/mwg/mwg_members.html

(2) WG → SC

- **Based on IAG's request**

  Working group: to be used for a short, limited-time body (< 4 years).

  All ILRS Working Groups are now Standing Committees.

- **"Missions Standing Committee"**

  Everything should be updated.

  But the mailing list "ilrs-mwg" unchanged.

(3) MSR Form & Approval

- Revision plan accepted.

  ← Missions WG (Dec 2015), ILRS CB (Mar 2016)

  - Easy to fill in & easy to read.
  - Eliminate ambiguous questions.
  - Incremental submission (for follow-on missions).

- Use the new form!

  - Newest version (April 2016)
  - http://ilrs.gsfc.nasa.gov/docs/2016/ilrsmsr_1604.pdf

- "Automatic approval" for series/follow-on missions restricted.

  - New/Incremental MSRF submission is required for:
    - Different LRA
    - Significantly different mission objectives/parameters

ILRS SLR MISSION SUPPORT REQUEST FORM (version: April, 2016)

SUBMISSION STATUS:

◉ New Submission (default)

○ Incremental Submission (accepted only for a follow-on mission; fill-in new information only)

(provide the reference mission and the date approved by the ILRS: ____________________)

SECTION I: MISSION INFORMATION:

General Information:

Satellite Name: ____________________

Satellite Host Organization: ____________________

Web Address: ____________________

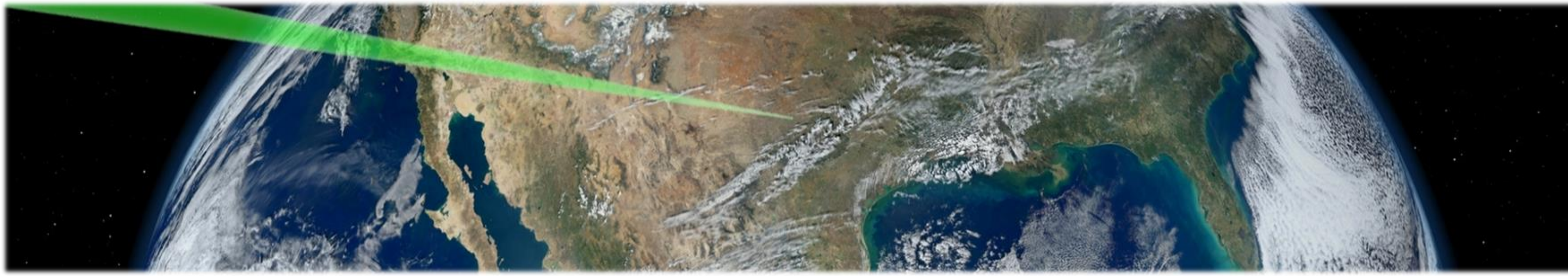
Contact Information:

Primary Technical Contact Information:

Name: ____________________

Organization and Position: ____________________

Address:



Status of ICESat-2 for the Missions Standing Committee

20th International Laser Ranging Workshop
Potsdam, Germany
October 9 – 14, 2016

J. McGarry, S. Wetzel

ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

ICESat-2 Mission Overview

Why Study Ice?

- Understanding the causes and magnitudes of changes in the cryosphere remains a priority for Earth science research. NASA's Ice, Cloud, and land Elevation Satellite (ICESat) mission, which operated from 2003 to 2009, pioneered the use of laser altimeters in space to study the elevation of the Earth's surface and its changes.

Why ICESat-2

- As a result of ICESat's success, the National Research Council's (NRC) 2007 Earth Science Decadal Survey recommended a follow-on mission to continue the ICESat observations. In response, NASA tasked its Goddard Space Flight Center (GSFC) with developing and deploying the ICESat-2 mission - now scheduled for launch in 2017.
- ICESat-2, slated for launch in 2017, will continue the important observations of ice-sheet elevation change, sea-ice freeboard, and vegetation canopy height begun by ICESat in 2003. Together, these datasets will allow for continent-wide estimates in the change in volume of the Greenland and Antarctic ice sheets over a 15-year period, and long-term trend analysis of sea-ice thickness.

From ICESat-2 Web page: http://icesat.gsfc.nasa.gov/icesat2/mission_overview.php

ICESat-2 Status

- ICESat-2 orbit will be ~500km. (ICESat was ~600km)
- There is a delay in the launch date by about a year (now fall 2018) because of issues with the laser.
- The ATLAS instrument will go to Orbital to start Observatory testing with the spacecraft in November 2016 but is expected to come back to Goddard briefly in 2017 to have laser 2 retrofit before it goes back out to Orbital for final testing.
- ILRS laser ranging support is needed and the Mission Support Request Form (MSRF) is in process, awaiting input about the LRA, which is the same as ICESat.
- This will be a restricted tracking mission
  - A maximum elevation angle of about 50 to 60 degrees but the elevation angle will be station-dependent - depending upon the station transmit characteristics (the detectors on ATLAS are 532nm).
  - ICESat-2 will be selecting stations to support laser ranging based on their demonstrated ability to handle both the maximum elevation angle restriction and the Go/NoGo flag.
  - The Go/NoGo flag will be hosted at the ISF (Instrument Science Facility) at Goddard (in the SPOCC). The ICESat-2 predictions will be generated by the ICESat-2 Precision Orbit Determination Team at the Goddard Space Flight Center.

ICESat-2 LRA

LRA is the same as ICESat

ILRS Mission SC Meeting
11 October, 2016

QZSS update 2016

Yoshimi Ohshima, Ph.D.
NEC Corporation
y-ohshima@cb.jp.nec.com

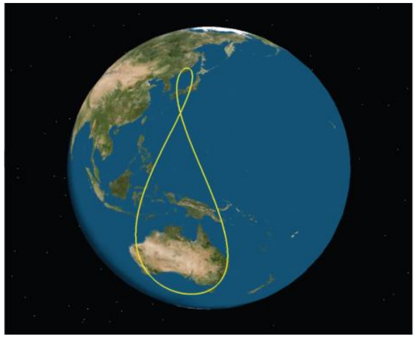
Outline

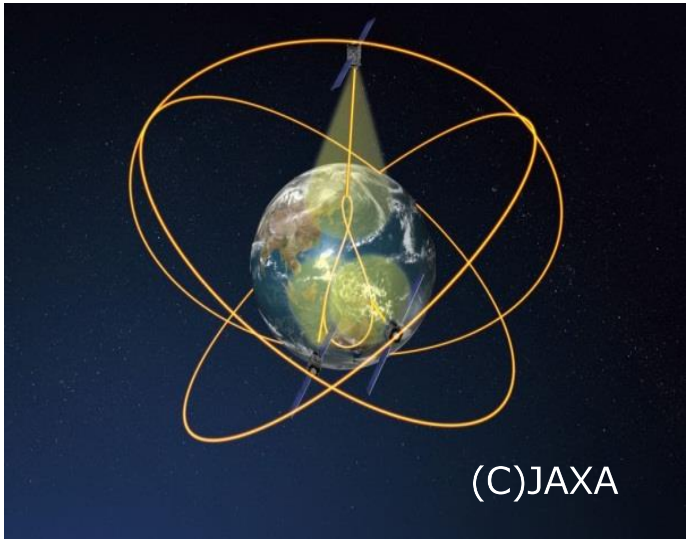
1. Introduction to QZSS
2. On-Orbit Transfer of QZS-1 Control
3. Deployment Schedule
4. Planned Activities regarding Mission Support Request Form
5. LRA for QZS-2, 3 and 4

Introduction to QZSS

Quasi-Zenith Satellite System (QZSS)

- Regional Satellite Positioning System
- Service Area: Asia-Pacific region
- 1st satellite “MICHIBIKI” launched on 9/11/2010





- 3 more satellites under development for 4-satellite constellation
  - QZS-2 and QZS-4: Quasi-Zenith Orbit (inclined geo-synchronous orbit)
  - QZS-3: Geo-stationary orbit
- 7-satellite constellation officially decided by the Government of Japan

On-Orbit Transfer of QZS-1 Control

From:

Launch to Jan. 2017

- Sponsor : JAXA
- Primary Applications: Technology Demonstration Satellite Navigation
- Point of Contact (both technical and Science): From JAXA

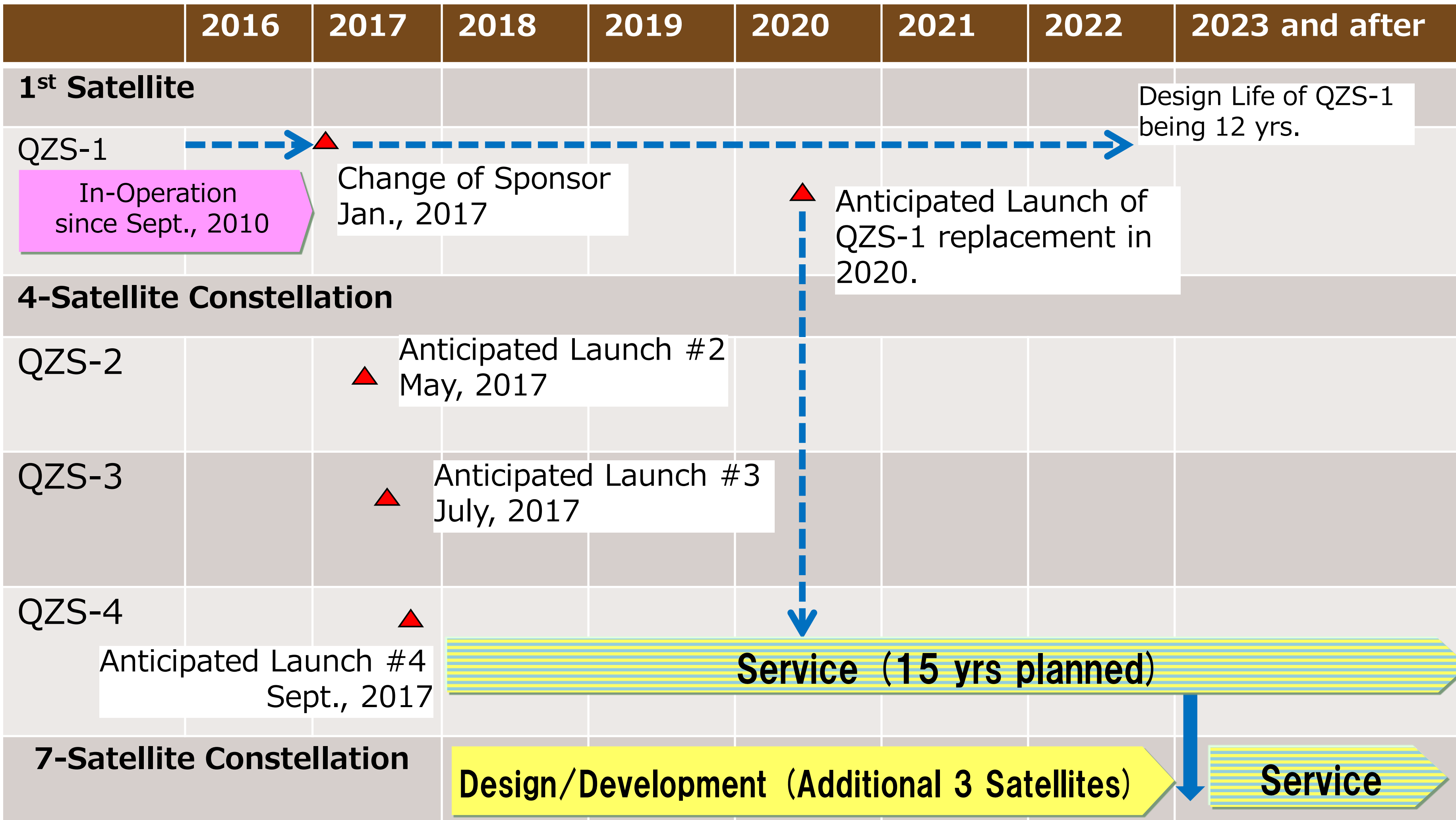
To:

After Jan. 2017

- Sponsor: Cabinet Office (CAO), Government of Japan
- Quasi-Zenith Satellite System Services Inc. (QSS) will be the active operator.
- Primary Applications: Satellite Navigation
- Point of Contact: From CAO or QSS (details TBD)

➢ New Mission Support Request Form is NOT planned to be submitted to ILRS.
➢ CAO/QSS will contact ILRS CB to update information on QZS-1 site.

Deployment Schedule



Planned Activities re: Mission Support Request Form

QZS-1 transfer

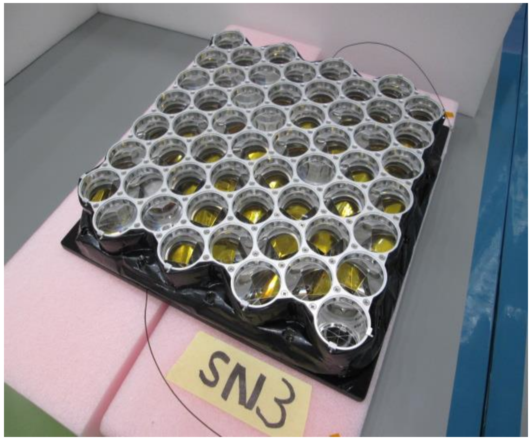
- CAO/QSS will contact ILRS CB to update information on QZS-1 Website (Expected: December, 2016 to January, 2017 timeframe)

QZS-2 and 4

- LRA: Identical to QZS-1 (56 CCR)
- Orbit: Inclined Geosynchronous Orbit (IGSO) similar to QZS-1

QZS-3

- LRA: Identical to QZS-1 (56 CCR)
- Orbit: Geosynchronous Orbit at 127E



CAO/QSS will coordinate with ILRS CB if/when Mission Support Request Form submittal (new or incremental) will be required.

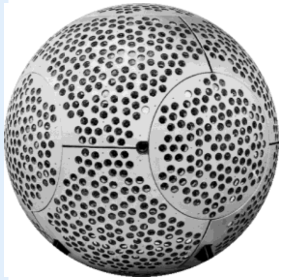
LRA for QZS-2, 3 and 4

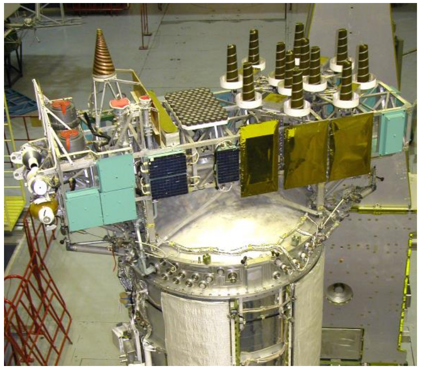
- With successful tracking record with QZS-1, QZS-2, 3 and 4 will be equipped with the same LRA as QZS-1.

Specification	
LRA manufacturer	Honeywell Technology Solutions Inc.
Type of Array	Planar Array
Shape and size of each CCR	Circular 40.6 mm (1.60"), Height - 29.7 mm (1.17")
Dihedral angle offset	0.8 +/- 0.3 arcsec
Flatness of cube's surfaces	λ/10
Coating	Coated with MgF2 anti-reflective
Envelope	400mm x 400mm x 100mm
Number of CCR	56 (7 rows x 8 lines)

LRA for QZS-1

OPEN JOINT-STOCK COMPANY «RESEARCH-AND-PRODUCTION CORPORATION "PRECISION SYSTEMS AND INSTRUMENTS»





SC "BLITS-M"

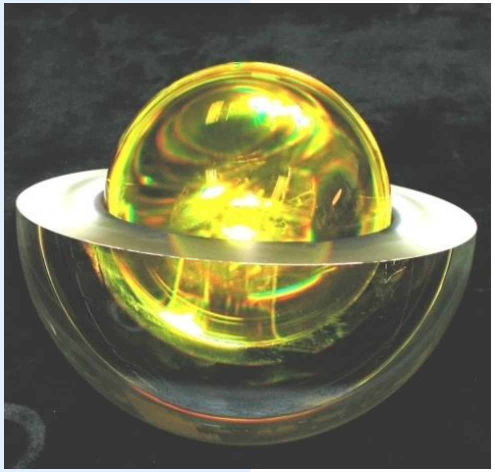
A.L.Sokolov, M.A.Sadovnikov, V.D. Shargorodskiy,
V. P.Vasiliev

Potsdam, 2016

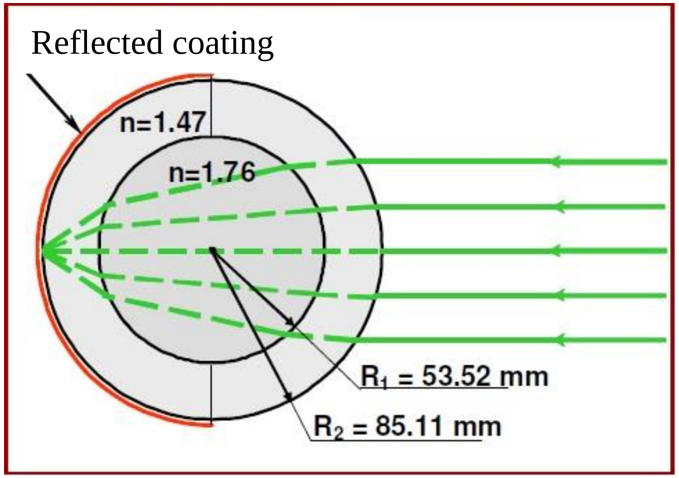
Spherical glass satellite «BLITS»

Basic parameters:

- diameter……………………………………………..170 mm
- mass………………………………..……..7.5 kg
- orbital altitude………………………………….. 835 km
- CS…………………………………….......~ 100000 m^2
- target error…………………………………< 100 micrometers

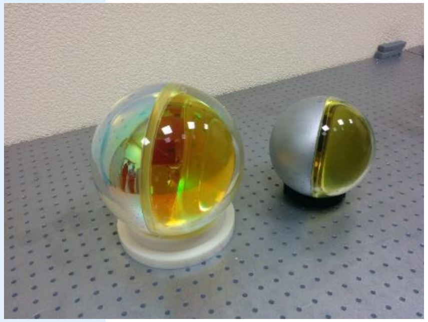


Spherical satellite «BLITS» in details



New decisions for SC «BLITS-M»

1. Increased size and mass.
2. Radiance-resistance glass.
3. Interference dielectric coating.
4. Higher altitude.
5. Stable axis of rotation and increased rotational speed



Goals:

1. Increase the stability of SC orbit.
2. Increase the lifetime of SC.

SC «BLITS-M»

Interference phase-shift coating

Inner sphere radius R_2	~ 64 mm
Inner sphere material	TF105
Outer sphere radius R_1	~ 110 mm
Outer sphere material	K108
Mass	~ 17 kg
Altitude	1500 km
FFDP type	One-spot
CS for velocity aberration 7 – 8 arcsec.	$0{,}3 \cdot 10^6$ m^2
Rotational speed	10 rpm in a minute
Signal type at the spin rate of 10 turns/minute	Clusters with intervals of 3 s
Signature	«zero»

SC «GLASS» (Geodetic Laser Autonomic Spherical Satellite)

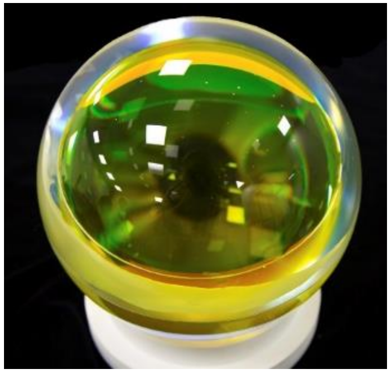
Characteristic	«GLASS»
Diameter	210 mm
Mass	18 kg
Material	**glass**
Target error	0,6 – 1 mm
Signature	Minor extension of a signal
FFDP type	Six minor lobes
CS for velocity aberration 7 – 8 arcsec.	$(1{,}0 \div 1{,}4) \cdot 10^6\ \mathrm{m}^2$
Signal type at the spin rate of 10 turns/minute	Sawtooth signal with period of 0.5 seconds

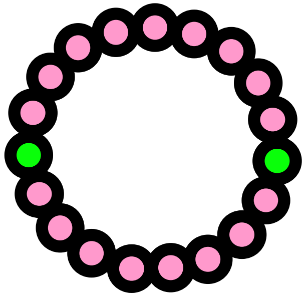
Conclusions

Thus, new technical and technological solutions provide for MEO spacecrafts – the new super accuracy “BLITS-M”.

OPEN JOINT-STOCK COMPANY «RESEARCH-AND-PRODUCTION CORPORATION "PRECISION SYSTEMS AND INSTRUMENTS»

Thank you for your attention!





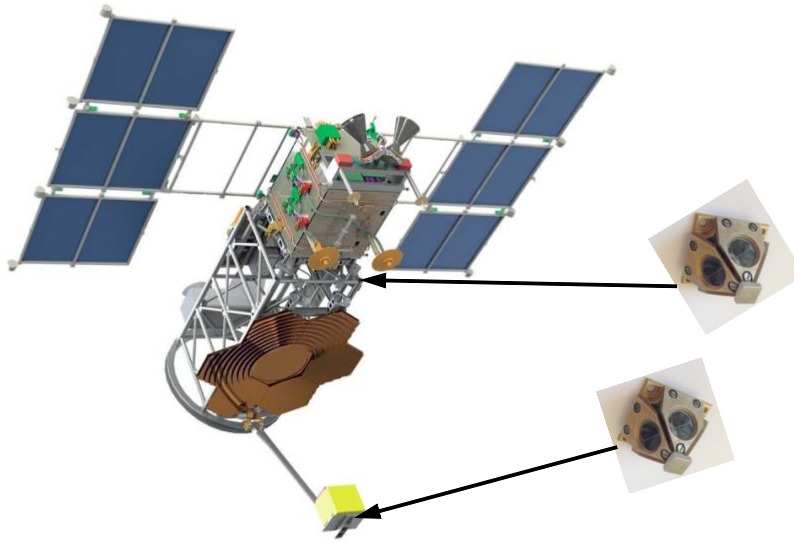
JOINT-STOCK COMPANY «RESEARCH-AND-PRODUCTION CORPORATION «PRECISION SYSTEMS AND INSTRUMENTS»

SC «Lomonosov». Current status of mission.

A.S Akentyev, A.L. Sokolov, M.A. Sadovnikov, V.D. Shargorodskiy

Potsdam. 2016

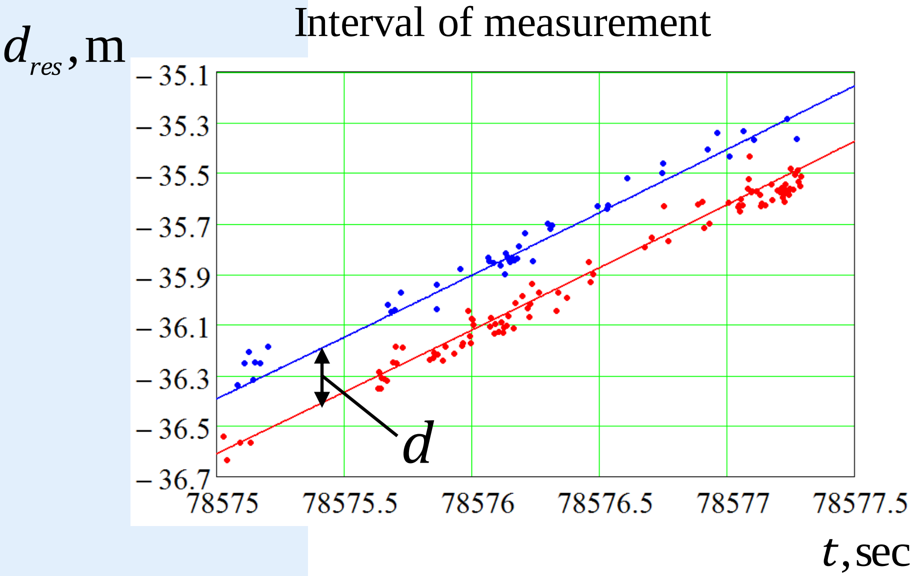
SC «Lomonosov»

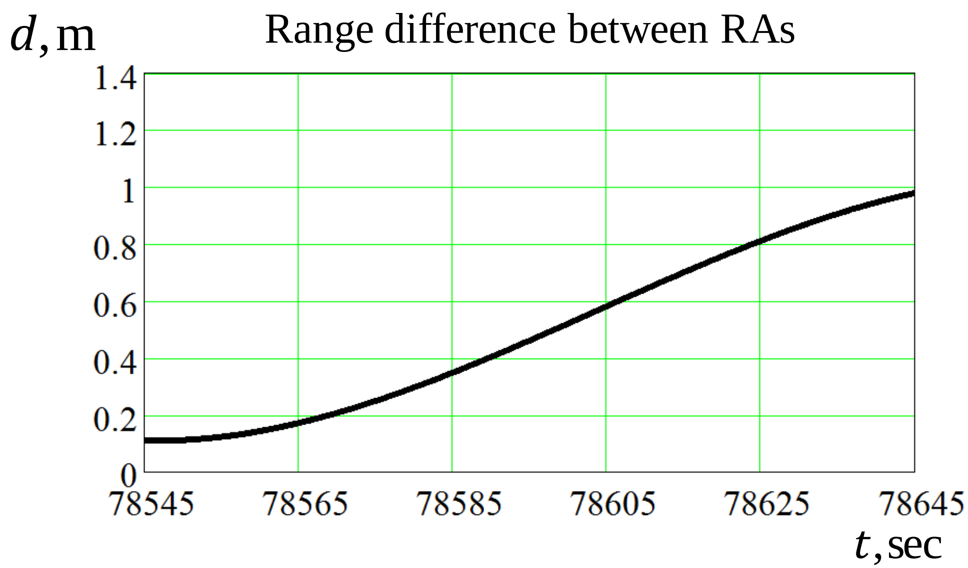


Orbit type	sun-synchronous
Orbit altitude	500 km
Inclination	97,6°
Spacecraft mass	620 kg
Exploitation period	3 years

Mission	**Lomonosov**
Launch date	28 April 2016
Application	Studies of the transient luminous phenomena in the upper atmosphere
Sponsor	Scobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Russia
Prediction center	JSC «VNIIEM Corporation», Russia
Prediction provider (CPF provider)	Mission control center, Russia
ILRS mission support requirement	Precise orbit determination

Peculiarity of ranging SC «Lomonosov»





t – time of measurement (UTC) from the beginning of the day
$d_{res} = d_{pred} - d_m$
d_{res} – range residuals
d_{pred} – prediction range
d_m – measurement range
d – range difference between RAs

Ranging of SC «Lomonosov» must carried out in a single photon counting mode!

List of stations participates in ranging SC «Lomonosov»

Location name	Station number	Location country	Results of ranging sessions		
			Full-rate data	Normal points	
				number	bin size
Altay	1879	RF	2	0	-
Arkhyz	1886	RF	2	0	-
Baikonur	1887	Kazakhstan	0	0	-
Zelenchukskya	1889	RF	0	0	-
Mendeleevo 2	1874	RF	4	2	15 s
Irkutsk	1891	RF	2	2	15 s
Katzively	1893	RF	3	1	15 s
Svetloe	1888	RF	1	0	-
Yarragadee	7090	Australia	1	1	5 s
Haleakala	7119	USA	1	1	5 s
Herstmonceux	7840	United Kingdom	0	0	-
Matera	7941	Italy	0	0	-
Greenbelt	7105	USA	0	0	-
Monument Peak	7110	USA	0	0	-
Zimmerwald	7810	Switzerland	0	0	-
Changchun	7239	China	0	0	-
Mt Stromlo	7852	Australia	0	0	-
Graz	7839	Austria	0	0	-

Sessions of laser ranging SC «Lomonosov»

Station	Station number	Time of measurement (UTC)				Number of returned pulse	Elevation angle, degrees
		mm.dd.yy	Begin	Parameter	End		Begin/ parameter/ end.
Mendeleevo 2	1874	06.30.16	21:28:25	-	21:32:03	134	34,57/-/48,81
Altay	1879	07.06.16	18:48:55	-	18:50:42	1446	20,29/-/39,73
Arkhyz	1886	07.06.16	20:24:46	-	20:27:39	2255	11,99/-/ 38,12
Mendeleevo 2	1874	07.08.16	21:05:41	-	21:06:40	683	41,45/-/45,03
Irkutsk	1891	07.08.16	03:29:34	03:30:15	03:32:27	25 710	52,93/74,06/21,64
Katzively	1893	07.08.16	21:06:37	-	31:07:46	134	26,57/-/46,98
Katzively	1893	07.11.16	21:20:50	-	21:21:29	21	34,17/-/52,1
Katzively	1893	07.14.16	21:33:58	-	21:35:47	64	21,46/-/59,00
Irkutsk	1891	07.20.16	17:17:19	17:20:05	17:20:57	240	22,12/45,34/25,62
Altay	1879	07.21.16	18:27:37	-	18:28:56	578	29,19/-/66,16
Mendeleevo 2	1874	07.21.16	21:34:54	-	21:36:25	245	61,88/-/24,39
Arkhyz	1886	07.24.16	20:16:28	20:17:15	20:18:36	916	22,37/29,51/26,83
Mendeleevo 2	1874	08.09.16	23:55:36	23:56:52	21:58:32	2 627	24,80/44,80/31,69
Svetloe	1888	09.13.16	22:31:27	22:32:02	22:35:16	392	24,91/48,07/20,53
Yarragadde	7090	09.21.16	04:09:53	-	04:11:29	106	21,31/-/33,75

Summary

1. Laser ranging of SC «Lomonosov» should carried out with the following restrictions:

   - No tracking above 80 degrees altitude at the station;
   - Tracking only in daylight time.

2. For the separation of two reflected signal laser ranging must carried out at a single photon counting mode.

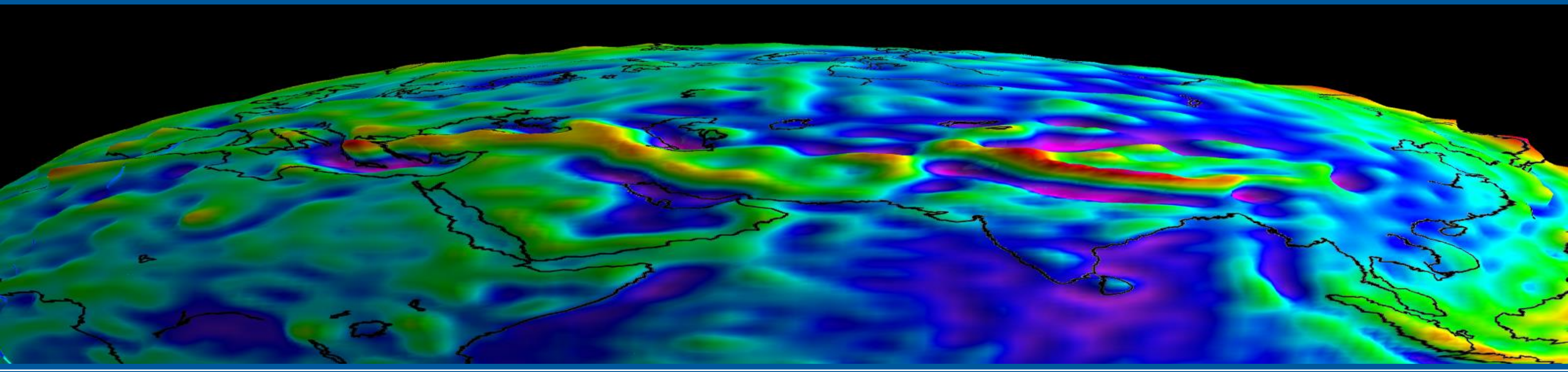
3. For formation of a region precise SC orbit is must to obtain measurement sessions with following conditions:

Time:
10 session (2 minutes duration) at time interval 12 hours

Station:
4 station (distance > 4 000 km) must to take a part in laser ranging at time interval 12 hours

Mission Status „GRACE-Follow On“ and „PAZ“

Ludwig Grunwaldt
GeoForschungsZentrum Potsdam



GRACE Follow On

The mission's **primary objective** is *to continue* the high-resolution monthly global models of Earth's gravity field of the original GRACE mission, for nominally 5 years, with launch by 2017/2018

- Evolved versions of the GRACE K/Ka-band microwave interferometer, GPS, and accelerometer will be used

A **secondary objective** is to demonstrate *the effectiveness of a laser ranging interferometer* (LRI) in improving measurement performance

- This will be the first ever inter-spacecraft laser interferometer
- This system should lead to improved spatial resolution for future gravity missions, such as GRACE-II (although the final spatial resolution will depend on aliasing, number of satellite pairs, etc)

and to continue measurements of GRACE radio occultations for operational provision of e.g. vertical temperature / humidity profiles to weather services.

GRACE Follow- On

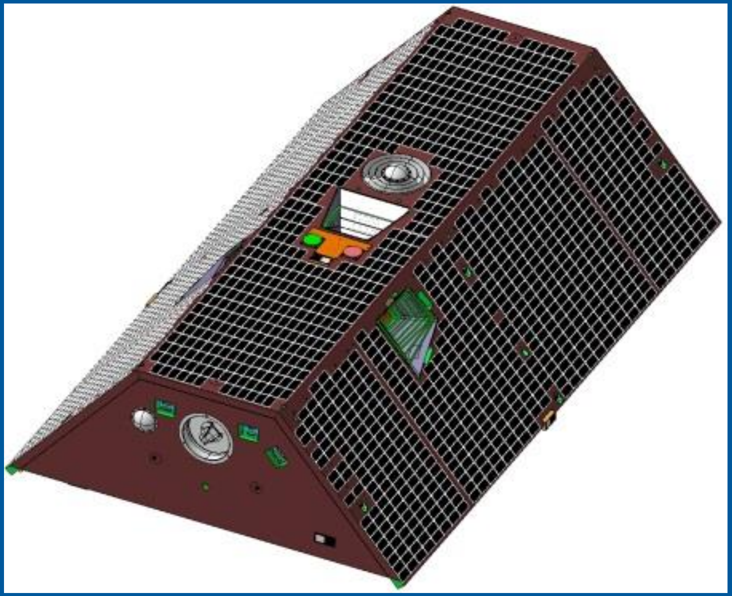
2 identical spacecraft

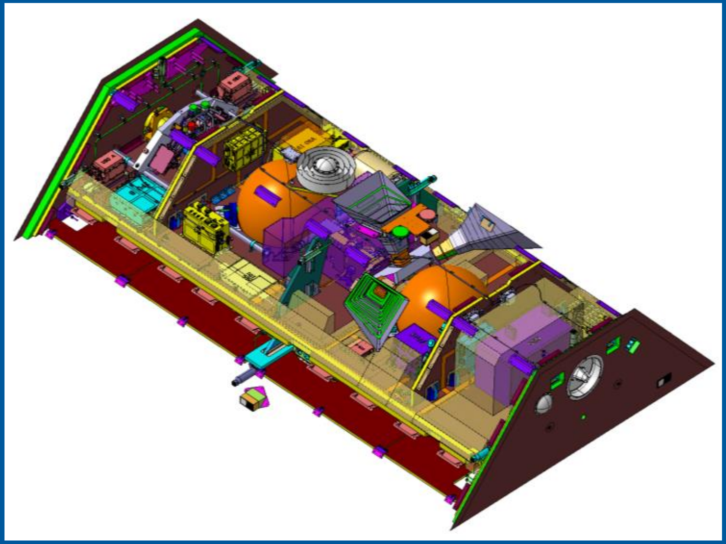
Orbit altitude 490 km +/-10 km (BoL) and 415 km (EoL)
5 years in orbit lifetime
3 baseline instruments

1 tech demo instrument

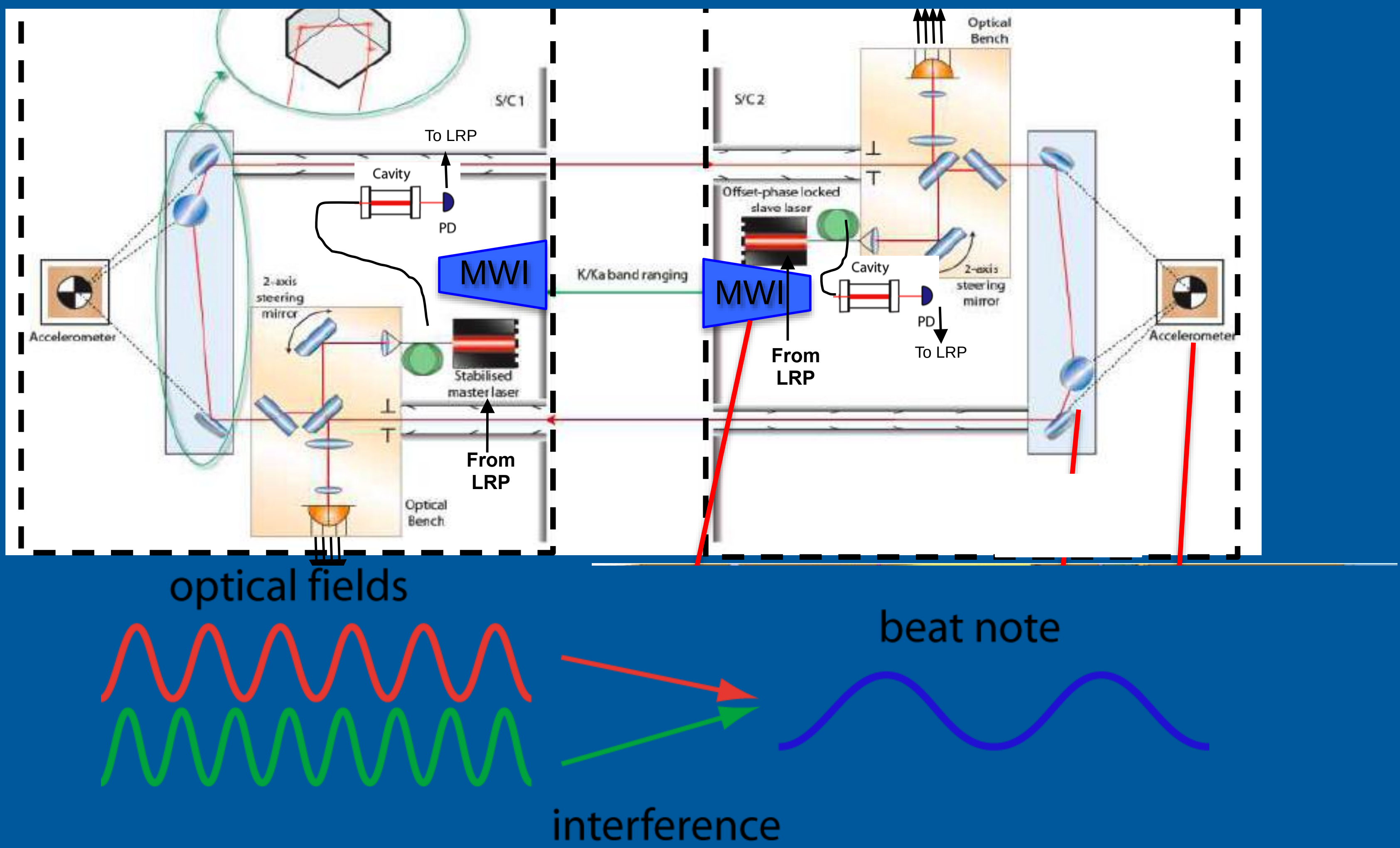
GRACE and SWARM design heritage

3-axis stabilized
body-mounted solar array
Critical on-ground alignments
Critical in-flight stabilities

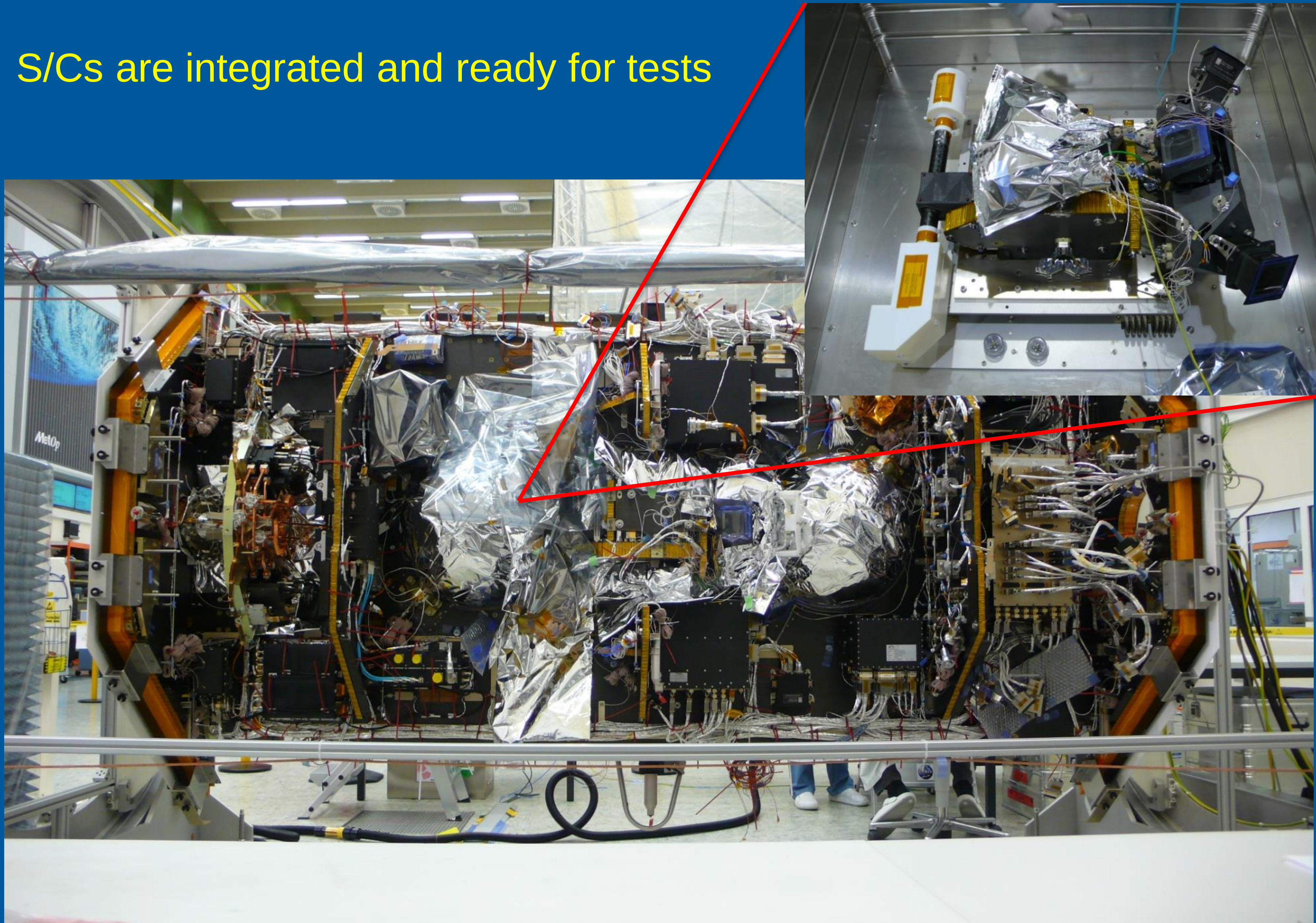




New on GRACE-FO: Laser Ranging Interferometer (Tech Demo Experiment)

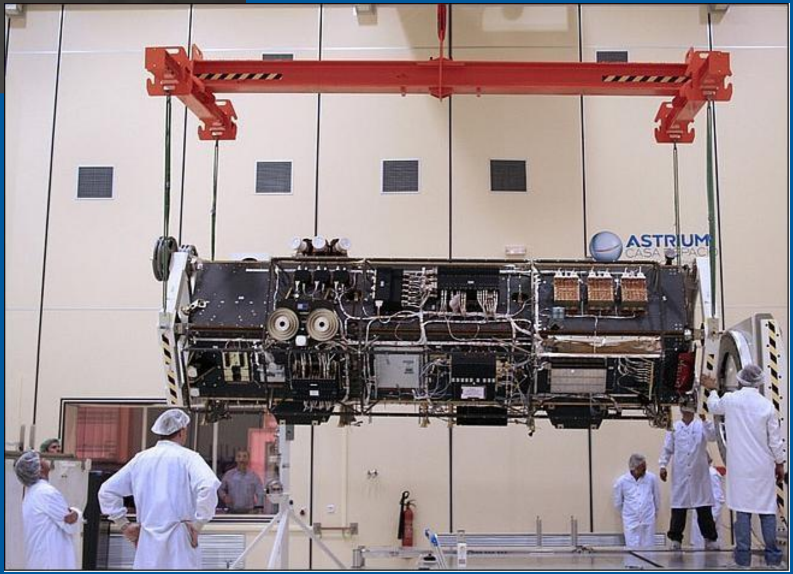


S/Cs are integrated and ready for tests



PAZ (Formerly SeoSAR)

LRR and GPS antenna choke rings manufactured and delivered by GFZ under Âirbus D&S contract



Spanish radar satellite (HISDESAT)

Satellite bus adapted from TerraSAR-X and TanDEM-X, bulit by Airbus DS

LRR for purpose of external calibration / validation of dual-frequency IGOR™ GPS receiver

Both missions were booked on a DNEPR launch vehicle (as for TerraSAR-X, TanDEM-X)

Launch Vehicle with Space Head Module

Launch Complex with the Launch Control Center

Launch Vehicle, Spacecraft and Space Head Module Processing Facilities

Set of Telemetry, Data Collection and Processing means

Recent Development of Launch Services

- GFZ was informed on February 22 by the Russian Ministry of Foreign Affairs that a launch of GRACE-FO with a Dnepr by ISCK is definitely not possible any more!
- Joint NASA-GFZ Steering Board agreed to change to new baseline launch vehicle: Space-X Falcon-9, launching out of Vandenberg Air Force Base, California.
- Launch will be a Rideshare with Iridium-Next (5 satellites) with a new launch window 12/2017 – 02/2018

Status of PAZ launch still not settled as of October 2016.