International Association of Geodesy
Newsletter

September 2016

Editor: Gyula Tóth
IAG Communication and Outreach Branch
Department of Geodesy and Surveying
Budapest University of Technology and Economics
H-1521 Budapest, Hungary

Information Service of the International Association of Geodesy http://www.iag-aig.org newsletter@iag-aig.org

Contents

The *IAG Newsletter* is under the editorial responsibility of the *Communication and Outreach Branch* (COB) of the IAG.

It is an open forum and contributors are welcome to send material (preferably in electronic form) to the IAG COB (newsletter@iag-aig.org). These contributions should complement information sent by IAG officials or by IAG symposia organizers (reports and announcements). The *IAG Newsletter* is published monthly. It is available in different formats from the IAG new internet site: http://www.iag-aig.org

Each *IAG Newsletter* includes several of the following topics:

I. news from the Bureau Members
II. general information
III. reports of IAG symposia
IV. reports by commissions, special commissions or study groups
V. symposia announcements
VI. book reviews
VII. fast bibliography

General Announcements

Description of the Global Geodetic Reference Frame

Position paper adopted by the IAG Executive Committee, April 2016

Preamble

The United Nations General Assembly adopted the resolution on a Global Geodetic Reference Frame for Sustainable Development (A/RES/69/266) on February 26, 2015. The purpose of this document is a description of the Global Geodetic Reference Frame (GGRF), along with a brief description of its key components, as a realization of the Global Geodetic Reference System (GGRS).

This document forms the basis for a common understanding of the GGRF. It has been prepared by the International Association of Geodesy (IAG), the organization responsible for the science of geodesy. It thus outlines the IAG's perspective of what the GGRF is, and how it is realized through the contributions of the IAG components.

The mission of the IAG is the advancement of geodesy – the Earth science concerned with the size, shape, gravity field, and orientation of the Earth, including their temporal variations. The IAG supports the design of new satellite missions for gravity field determination, ocean and ice altimetry, and Earth observation in general, as well as promoting the importance of modern geodesy for addressing the needs of science and society for a variety of spatio-temporal and gravimetric reference frames. The Global Geodetic Observing System (GGOS) was established by the IAG to be the component that integrates the various geodetic contributions to ensure the quantification of our planet's changes in space and time with the highest accuracy and reliability. This is undertaken primarily through activities such as the maintenance, and continuous improvement of the geodetic instrumentation networks and space geodetic missions, and the combined analysis of geometric and gravimetric observations made by these networks using a variety of space and terrestrial geodetic techniques. In such a framework, the GGRF plays a key role in facilitating the integration of the different geometric and gravimetric observations, with the goal of providing reliable, high quality geodetic products and services.

The GGRF is intended to support the increasing demand for positioning, navigation, timing, mapping, and geoscience applications. The GGRF is essential for a reliable determination of changes in the Earth system, for natural disaster management, for monitoring sea-level rise and climate change, and to provide accurate information for decision-makers. Furthermore, due to globalization and interoperability requirements, there is a growing demand for spatial data infrastructure. Precise spatial information is needed in many areas of benefit to society, including transportation, construction, infrastructure, process control, surveying and mapping, and Earth sciences, and is especially important for monitoring progress towards the UN's Sustainable Development Goals.

General Concept

The GGRF includes the geometry and gravity field of the Earth and the Earth's orientation with respect to the celestial reference frame. It is based on geodetic observing systems, data centers, analysis centers, as well as combination and product centers. While the concept of a GGRF predominantly focuses on infrastructural, operational and technical issues, associated research and innovation activities are also to be considered.

The bases for the realization of the GGRF are the multiple geodetic observation infrastructures. GGOS defines the observation architecture at several levels: terrestrial networks with geometric and gravimetric observation stations, artificial satellites, the moon and the planets, and extragalactic objects (see Fig. 1). The permanent availability of state-of-the-art geodetic infrastructure, and scientific and technical personnel to generate the resultant products and services, is crucial for a sustainable GGRF.

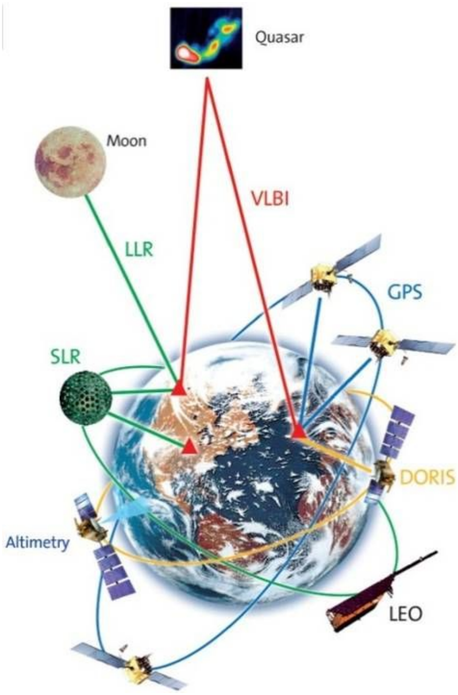

Fig. 1: The geodetic observation infrastructures[1] provide the bases for the determination and maintenance of the Global Geodetic Reference Frame (GGRF).

Global Geodetic Reference System[2]

Geodetic reference systems are the mathematical and physical models necessary to describe physical positions and gravity in a space-time environment. Fundamental geodetic theories and methodologies provide the framework for the definition of geodetic reference systems.

The bases for the realization of the GGRF are the multiple geodetic observation infrastructures. GGOS defines the observation architecture at several levels: terrestrial networks with geometric and gravimetric observation stations, artificial satellites, the moon and the planets, and extragalactic objects (see Fig. 1). The permanent availability of state-of-the-art geodetic infrastructure, and scientific and technical personnel to generate the resultant products and services, is crucial for a sustainable GGRF.

The GGRS comprises terrestrial and celestial components. The terrestrial component is a common reference for the geometry and the gravity field of the Earth[3], where a physical point P has a corresponding coordinate $\boldsymbol{X}$, potential of the Earth gravity[4] field W, physical height H, and gravity vector $\boldsymbol{g}$. The following specifications apply:

- For the physical point P the potential $W_P = W(\boldsymbol{X})$ is evaluated at the coordinate $\boldsymbol{X}$ in the International Terrestrial Reference System (ITRS).
- The unit of time is the SI second. The unit of length is the SI meter.
- The physical height is the difference $-\Delta W_P$ between the potential W_P of the Earth gravity field at the considered point P and the geoidal potential of the level ellipsoid W_0.
- The gravity vector $\boldsymbol{g}$ is the gradient of the potential of the Earth gravity field.
- Geometry and gravity are implicit functions of time.
- Fundamental parameters and conventions for the use of models, for example, the tidal system, and procedures are required.

The International Celestial Reference System (ICRS), based on a kinematic definition, is a quasi-inertial system. The ICRS provides the celestial foundation for the GGRS. The relationship between the ITRS and the ICRS is described by the Earth Orientation Parameters (EOP). The EOP are not only relevant as transformation parameters between the ITRS and the ICRS, but also for relating geometric and gravimetric quantities in a variety of ways.

---

[1] http://www.ggos.org/

[2] The following concept is based on H. Bruns' approach in *Die Figur der Erde* (1878).

[3] $W(\boldsymbol{X})$, $P\{\boldsymbol{X}, W\}$ or $P\{\boldsymbol{X}, W, \boldsymbol{g}\} = P\{\boldsymbol{X}, W, -\nabla W\}$, and $g = -\partial W / \partial H$

[4] Gravity involves gravitation and centrifugal force.

Global Geodetic Reference Frame

The Global Geodetic Reference Frame (GGRF) is the realization of the Global Geodetic Reference System (GGRS), made possible through physical points on the Earth's surface, satellites in near-earth orbit, and celestial objects, along with parameters describing geometry and gravity over time.

The network of terrestrial points is global, with national and regional densification of the geodetic infrastructure. This network of GGRF stations typically comprises:

– fundamental geodetic observatories employing all[5] space geodetic techniques co-located with gravimetric instruments, enabling the connection between $\boldsymbol{X}$, $\boldsymbol{W}$, and $\boldsymbol{g}$;

– other geodetic stations also including reference tide gauges, height datum points, and gravity measurement points co-located where possible with space geodetic instruments.

Fundamental geodetic observatories also include precise and stable time-keeping instruments and should be connected to time reference stations (in future using optical clocks for ΔW determination — relativistic geodesy) and gravity reference stations (equipped with absolute and superconducting gravimeters, see IAG Res. 2015 No. 2).

All GGRF stations must be:

– continuously operated, over the long-term, to ensure the stability of the GGRF;

– equipped with state-of-the-art observation technology so as to produce high quality measurements of geodetic quantities;

– continuously monitored to detect surface deformations of the Earth; and

– connected to height datums to precisely relate their geopotential differences for vertical datum unification.

The ITRS is realized by the International Terrestrial Reference Frame (ITRF) consisting of positions and time variations of network stations observed by space geodetic techniques such as VLBI, SLR, GNSS, and DORIS. Crucial for the integration of the different techniques are globally-distributed co-location sites with accurate local tie vectors.

The ICRF is a realization of the ICRS consisting of the positions of compact extragalactic objects, mostly quasars. These natural radio sources are sufficiently far away such that their expected proper motions are negligibly small. The ICRF is realized by VLBI observations at terrestrial network stations.

Furthermore, the operability of the GGRF requires international standards and specifications for the exchange of measurements and products, and the use of harmonized models, parameters, and procedures.

For the realization and maintenance of the GGRF, an operational infrastructure in the form of international services and scientific organizations is needed. Currently the IAG Commissions and Services are responsible for the implementation of the UN Resolution on a Global Geodetic Reference Frame for Sustainable Development. The development of an integrated mechanism for the establishment and maintenance of the GGRF is one of the key GGOS goals. Hence the IAG will continue to play a leading role in defining the strategies and methodologies for the implementation of the GGRF.

Implementation Steps Towards the GGRF

The GGRF is an integrated geodetic reference frame, incorporating the ITRF and the ICRF, the future International Height Reference Frame (IHRF), and the new global absolute gravity network (IGSNn) according to IAG Resolutions 2015 No. 1 and No. 2, respectively.

The combination of the IHRF and the ITRF requires the Global Gravity Model (GGM). The GGM is derived by measurements from satellite gravity and altimetry missions, complemented with terrestrial gravity data. For the development of the IHRF, an IAG Joint Working Group will be established. To replace the International Gravity Standardization Net 1971 (IGSN71) with the IGSNn, a Working Group will define a geodetic gravity reference system based upon the international comparisons of absolute gravimeters. The globally-distributed reference stations of the IHRF and of the IGSNn, including the stations for international comparisons of absolute gravimeters, have to be linked to the fundamental geodetic observatories for co-location of gravity reference stations with space geodetic instruments.

With the resolution on a Global Geodetic Reference Frame for Sustainable Development the UN Member States are requested to:

– encourage, together with relevant international organizations, global cooperation in providing technical assistance, especially for capacity development in geodesy for developing countries;

[5] The geometric observation techniques are currently: VLBI, SLR, GNSS, and DORIS.

- openly share geodetic data, standards, and conventions, through relevant national mechanisms and intergovernmental cooperation, and in coordination with the IAG;
- maintain, and improve their national geodetic infrastructures;
- engage in multilateral cooperation that addresses infrastructure gaps and duplications; and
- assist in the development of outreach programs that make the GGRF more visible and understandable to society.

The tasks for the IAG and its GGOS in the framework of the GGRF therefore are to:

- organize the IAG Services on a high scientific and technical level;
- support the development of geodetic technologies and products on the basis of open sharing of geodetic data, products, standards, and conventions;
- provide scientific leadership to all scientific organizations, national geodetic agencies, and Member States, on geodetic matters; and
- develop and improve theories and methodologies for the implementation of the GGRF.

IAG EC

Absolute gravity network - Venezuela

USP (Universidade de São Paulo) and IGC (Instituto Geográfico e Cartográfico de São Paulo) are cooperating in the establishment of Absolute Gravity Network in Venezuela. The observations had the collaboration of IBGE (Instituto Brasileiro de Geografia e Estatística), CENEGEO (Centro de Estudos de Geodesia), IGVSB (Instituto Geográfico Venezuelano Simon Bolivar) and PEDVESA (Petroleo Venezuelano SA) . In two campaigns a total of 13 stations have been established with three re-observations (R). The measurements have been undertaken with A-10 Micro-g LaCoste gravimeter, number 032. The stations are identified by the name of the city as follow: CAGIGAL, MARACAIBO, SANTA INÉS, CARACAS, CIUDAD BOLIVAR , EL CALVARIO, ELORZA, JUNQUITO , LA GUAIRA, MATURIN, MERIDA, PUERTO AYACHUCO, SANTA ELENA DE UAIREN.

Figure 1 shows the distribution of the points in the country. Figure 2 shows detail of the points in north part of the country. The final results are available on request.

Figure 1 - 13 absolute stations in Venezuela

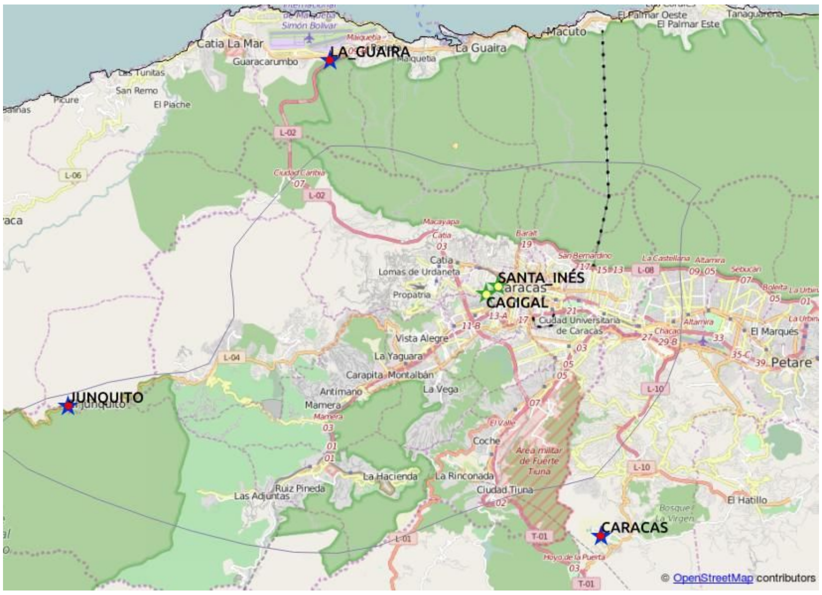

Figure 2 - Broadening of map of Figure 1, showing detail of the north stations

DENIZAR BLITZKOW

Meeting Announcements

Meetings Calendar

First International Workshop on VLBI Observations of Near-field Targets

October 5 – 6, 2016, Bonn, Germany
URL: http://ivscc.gsfc.nasa.gov/meetings/index.html

GRACE Science Team Meeting

October 5 – 7, 2016, Potsdam, Germany
URL: http://gstm2016.gfz-potsdam.de/gstm-2016/

20th International Workshop on Laser Ranging

October 9 – 14, 2016, Potsdam, Germany
URL: http://iwslr2016.gfz-potsdam.de/international-workshop-on-laser-ranging

ICTRS 2016

October 10 – 11, 2016, Milan, Italy
URL: http://www.ictrs.org/

INTERGEO, Geodätische Woche

October 11 – 13, 2016, Hamburg, Germany
URL: http://www.intergeo.de/

5th International VLBI Technology Workshop

October 12 – 14, 2016, Haystack Observatory, Westford, MA, USA
URL: http://www.haystack.mit.edu/workshop/ivtw2016/Index.htm

Fifth UN-GGIM Asia and the Pacific Plenary Meeting

October 16 – 20, 2016, Kuala Lumpur, Malaysia
URL: http://unggim-ap2016.org/

RFI 2016: Coexisting with Radio Frequency Interference

October 17 – 20, 2016, Socorro, NM, USA
URL: http://go.nrao.edu/rfi2016

GGOS Days

October 24 – 28, 2016, Cambridge, MA, USA
URL: http://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

IDS Workshop

October 31 – November 1, 2016, La Rochelle, France
URL: http://ids-doris.org/meetings/ids-meetings.html

SAR Altimetry Workshop

October 31 2016, La Rochelle, France
URL: http://www.aviso.altimetry.fr/en/news/events-calendar.html

OSTST 2016

November 1 – 4, 2016, La Rochelle, France
URL: http://ids-doris.org/meetings/ids-meetings.html

SIRGAS Symposium 2016

November 16 – 18, 2016, Quito, Ecuador
URL: http://www.igm.gob.ec/sirgas/

SIRGAS School on Vertical Reference Systems

November 21 – 25, 2016, Quito, Ecuador
URL: http://www.igm.gob.ec/sirgas/

Gaia Data Workshop

November 21 – 24, 2016, Heidelberg, Germany
URL: http://mintaka.ari.uni-heidelberg.de/gaia-workshop-2016/

IGNSS 2016

December 6 - 8, 2016, Sydney, Australia
International Global Navigation Satellite Systems 2016 Conference
URL: http://www.ignss2016.unsw.edu.au

7th Gaia Science Alerts Workshop 2016

December 7 - 9, 2016, Utrecht, The Netherlands
International Global Navigation Satellite Systems 2016 Conference
URL: https://www.ast.cam.ac.uk/ioa/wikis/gsawgwiki/index.php/Workshop2016:main

AGU 2016 Fall Meeting

December 12 – 16, 2016, San Francisco, California, USA
URL: http://meetings.agu.org/upcoming-meetings/

10th Coastal Altimetry Workshop

February 21-24 , 2017, Florence, Italy
URL: http://www.coastalaltimetry.org/

Munich Satellite Navigation Summit

March 14-16 , 2017, Munich, Germany
URL: http://www.munich-satellite-navigation-summit.org/

Fourth SWARM Science Meeting and Geodetic Missions Workshop

March 20-24 , 2017, Banff, Alberta, Canda
URL: http://www.swarm2017.org/

North-American CryoSat Science Meeting and Geodetic Missions Workshop

March 20-24 , 2017, Banff, Alberta, Canda
URL: http://www.cryosat2017.org/

EGU General Assembly 2017

April 23-28 , 2017, Vienna, Austria
URL: http://www.egu2017.eu/

IAU Symposium 330

April 24-28 , 2017, Nice, France
URL: http://iaus330.sciencesconf.org/

Ninth IVS Technical Operations Workshop

April 30 – May 4 , 2017, Westford, MA, USA
URL: https://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

23rd Working Meeting of the European VLBI Group for Geodesy and Astrometry (EVGA)

May 15-19 , 2017, Gothenburg, Sweden

URL: http://iag.dgfi.tum.de/index.php?id=291

EUREF 2017 Symposium

May 24 – 26, 2017, Wroclaw, Poland
URL: http://www.euref.eu/euref_symposia.html

FIG Working Week 2017

May 29 – June 2, 2017, Helsinki, Finland
URL: http://www.fig.net/fig2017/

TransNav 2017

June 21 – 23, 2017, Gdynia, Poland
URL: http://transnav2017.am.gdynia.pl

ICC 2017

July 2 – 7, 2017, Washington, DC, USA
URL: http://icc2017.org/

IGS Workshop 2017

July 3 – 7, 2017, Paris, France
URL: http://kb.igs.org/hc/en-us/articles/216574478-IGS-Workshop-2017

IAG/GGOS/IERS Unified Analysis Workshop (UAW)

July 10 – 12, 2017, Paris, France
URL: https://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

IAG and IASPEI Joint Scientific Assembly

July 30 – August 4, 2017, Kobe, Japan
URL: http://iag.dgfi.tum.de/index.php?id=291

AOGS 14th Annual Meeting

August 6-11, 2017, Singapore, Singapore
URL: http://www.asiaoceania.org/aogs2017/

Workshop on Glacial Isostatic Adjustment and Elastic Deformation

September 5-7, 2017, Reykjavik, Iceland
URL: http://www.polar.dtu.dk/english/Workshop-on-Glacial-isostatic-adjustment-and-elastic-deformation-2017

AGU 2017 Fall Meeting

December 11-15, 2017, New Orleans, LA, USA
URL: https://meetings.agu.org/

EGU General Assembly 2018

April 8-13 , 2018, Vienna, Austria
URL: http://www.egu2018.eu/

AOGS 15th Annual Meeting

June 3-8, 2018, Hawaii, USA
URL: http://www.asiaoceania.org/society/public.asp?view=up_coming

10th IVS General Meeting

June 3-8, 2018, Longyearbyen, Spitsbergen, Norway
URL: http://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

42nd COSPAR Scientific Assembly

July 14-22, 2018, Pasadena, CA, USA

URL: https://www.cospar-assembly.org/

IAU XXXth General Assembly

August 20-31, 2018, Vienna, Austria
URL: http://astronomy2018.univie.ac.at/

21st International Workshop on Laser Ranging

October 27-31, 2018, Canberra, Australia
URL: http://www.iers.org/IERS/EN/NewsMeetings/ForthcomingMeetings/forthcoming.html

AGU 2018 Fall Meeting

December 10-14, 2018, Washington, D.C., USA
URL: https://meetings.agu.org/

EGU General Assembly 2019

April 7-12 , 2019, Vienna, Austria
URL: http://www.egu2019.eu/

27th IUGG General Assembly

July 8 – 17, 2019, Montreal, Canada
URL: http://www.iugg.org/assemblies/

AOGS 16th Annual Meeting

July 28 – August 2, 2019, Singapore, Singapore
URL: http://www.asiaoceania.org/society/public.asp?view=up_coming

Reports

Executive Summary of the SGI 2016 Workshop

8-9 August 2016, Berlin, Germany

The second Satellite Geodesy and Ionosphere research workshop (SGI2016) was held at the Technical University of Berlin during 8 and 9 August 2016 as an activity of IAG Joint Working Group 4.3.3 “Combination of Observation Techniques for Multi-dimensional Ionosphere Modeling” and several research projects related to ionospheric studies. The workshop initially aimed at bringing together geodesists and other scientists from all over the world to one meeting, dealing with geodetic sciences and ionospheric research. The SGI2016 was organized by the Institute of Geodesy and Geoinformation Science of the Technical University of Berlin, K.N.Toosi University of Technology at Tehran, Iran and Department 1 'Geodesy and Remote Sensing' of the German Research Centre for the Geosciences (GFZ) Potsdam. The workshop provided a great opportunity for scientists to meet in a friendly atmosphere and to share their research and latest findings.

The workshop began with a welcome note from Prof. Harald Schuh, the President of the International Association of Geodesy (IAG). Dr. Mahdi Alizadeh, chair of the organizing committee of the workshop also welcomed the participants and explained the motivations and aims of the workshop. Afterwards the scientific session was held in with the main focus on ionosphere monitoring and modeling. The second session was dedicated to general discussion.

In discussion session, Dr. Michael Schmidt from DGFI, TU Munich presented the activities of the IAG Sub-Commission 4.3: "Atmosphere Remote Sensing” during the last year and explained the study, working, and joint working groups established during this time. Some information was given about the GGOS-Days in Frankfurt in October 2015 and that GGOS, the Global Geodetic Observing System of the IAG, has already developed three focus areas. These are: Focus Area 1: Unified Height System, Focus Area 2: Geohazards Monitoring, Focus Area 3: Sea Level Change, Variability and Forecasting. Discussions were carried out about establishment of a *fourth*

Focus Area related to Atmosphere, including impact of both troposphere and ionosphere on modern society, long term variations of the atmosphere, and role of atmosphere in gravity missions.

On the second day of the workshop the presentations were mainly focused on physics of the ionosphere and ionospheric scintillation. After the workshop, the interested participants made an excursion to the German Aerospace Center (DLR) in Neustrelitz.

In total the workshop had more than 20 participants from 10 different institutions and 11 different countries, namely Germany, Poland, Spain, Iran, Argentina, Taiwan, Vietnam, China, Nigeria and Bangladesh.

SGI 2016 workshop participants from left to right: Armin Forouharfard from TU Berlin, Claudio Brunini from UNLP Argentina, Manuel Hernandez-Pajares from UPC Barcelona, Dietrich Ewert from TU Berlin, Chinh Nguyen Thai from GFZ Potsdam, Jens Wickert from GFZ Potsdam, Mrs. Tsai, Lung-Chih Tsai from NCU Taiwan, Michael Schmidt from DGFI TU Munich, Pawel Wielgosz from UWM Poland, Mahdi Alizadeh from KNToosi Univesity of Technology Iran, Harald Schuh from GFZ Potsdam, Sadegh Modiri from GFZ Potsdam, Oluwadare Seun from GFZ Potsdam, Kinga Wezka from TU Berlin, Lyubka Pashova from NIGGG Bulgaria, Roman Galas from TU Berlin, Mainul Hoque from DLR Neustrelitz, and Shin-Yi Su from NCU Taiwan.

Prof. Schuh welcomes SGI2016 participants

SGI2016 workshop participants

German Aerospace Center (DLR) at Neustrelitz

Excursion to DLR Neustrelitz after SGI2016 workshop

MAHDI ALIZADEH