IVS Newsletter

Issue 47, April 2017

Welcome to Svalbard!

– Per Erik Opseth, Norwegian Mapping Authority

The 10th IVS General Meeting (GM2018) will be hosted by the Norwegian Mapping Authority (Kartverket) on the Arctic island archipelago of Svalbard. The GM and several side meetings will take place in the period from 3–9 June 2018 in Longyearbyen on Svalbard. There will be the GM itself with oral and poster presentations, an analysis workshop plus other splinter meetings, and an IVS Directing Board meeting. The meeting will provide a means for members of the VLBI and Earth science communities as well as for students to interact and share ideas.

Per Erik and Anne Kristin at a road sign in Ny-Ålesund.

We would like to welcome the IVS to Svalbard—one of the world's largest areas of untouched nature awaits you at 78 degrees north. In the summer, beautiful colors and contrasts provide the framework for dramatic glaciers, majestic mountain formations, and endless Arctic tundra with its diverse flora and fauna. The light lures us to this unique place in which the midnight sun shines from early spring till autumn.

Longyearbyen, the administrative home seat in Svalbard, is located on the biggest island called Spitsbergen. The city today is a vibrant Arctic hub with a population of 2,100 people from over 40 nations. The society is characterized by active people, living in tough conditions in the wilderness of the High Arctic. Over 100 years of mining has given the city a rough, industrial appearance.

We will introduce you to the wilderness and beauty of the Arctic. On Wednesday, June 6, we plan on visiting Ny-Ålesund by boat and have you take part in the opening ceremony of our new Earth Observatory. We are very proud of our new Observatory, which is being upgraded with new technology and will combine several geodetic measuring techniques: Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR) from 2020, Global Navigation Satellite Systems (GNSS) including GPS, and Doppler Orbitography and Radio positioning Integrated by Satellite (DORIS).

Ny-Ålesund is a center for international Arctic scientific research and environmental monitoring. Ten different countries have permanent research stations in Ny-Ålesund, three of them are staffed year-round. Ny-Ålesund is situated at 78°55' N and 11°56' E on the west coast of Spitsbergen, the largest island in the Svalbard archipelago. The settlement is the permanent home to around 35 persons serving the research stations all year round. Ny-Ålesund is not open to the general public. The distance to the North Pole is 1,234 km. The mean temperature in June is +5°C—remember to bring warm clothes even if it is summer.

The content of the GM2018 will be of interest to the broad spectrum of enthusiastic IVS members as well as to the wider VLBI and Earth science communities. All IVS members and individuals who have interests in the various research fields and applications of VLBI such as geodesy, astrometry, Earth sciences, and related fields are encouraged to attend the meeting and give presentations.

We hope that the peaceful and beautiful setting of the GM2018 will be conducive to a very successful meeting—Welcome to GM2018!

Impressions from Svalbard (Photos: Bjørn-Owe Holmberg).

Feature

Analysis Center at Saint Petersburg University

The Analysis Center at Saint Petersburg University (SPb University) is an IVS member since the beginning of the service. Newsletter editor Hayo Hase corresponded with Prof. Veniamin Vityazev, Head of the Astronomy Department (Chair), and Dmitriy Trofimov, Senior Lecturer at the same Chair, to get some background information as well as a better understanding of the activities undertaken at this venerable institution.

Prof. Veniamin Vityazev (left) and Dmitriy Trofimov (right) of Saint Petersburg University.

Astronomy has a long tradition in Saint Petersburg. When did astronomy start in Saint Petersburg? When was the university founded?

Unlike most universities where it is with the physical departments, the field of astronomy at Saint Petersburg University is part of the mathematical faculty. The origin of this tradition can be traced back to the 18th century to the activities of Leonardo Euler. Euler's fundamental results concerning the motion of the moon and rotation of the earth have determined the principal fields of research at SPb University.

In 1701, Peter the Great issued a decree on establishing the School of Mathematics and Navigation Studies. In 1724, the Academy of Sciences, Academic University, and Academic Gymnasium in St. Petersburg were created. Outstanding scientists, such as Leonardo Euler and Nicola Bernulli, were invited to initiate the Academy and University activities. As part of their efforts the science of astronomy was introduced in Russia. The Astronomy Chair at SPb University was founded in 1819, the year of the University restoration.

The Astronomical Department is in charge of teaching the general astronomical courses, whereas special courses are mainly taught by scientists from Pulkovo Observatory (PO) and the Institute of Applied Astronomy (IAA). Research is an integral part of the graduate program. Students have the opportunity to work with faculty and staff of PO and IAA on a broad range of problems. This educational system was created many years ago, and it has worked quite smoothly for many decades. Each year up to 20 astronomers graduate from the university.

We are particularly proud that two students that graduated from our department later became presidents of the International Astronomical Union (IAU); these two graduates are the academicians V.A. Ambartsumian and A.A. Boyarchuck.

Who introduced VLBI at the university?

In the 1990ies, the lectures on VLBI as well as radio astrometry were given by A.A. Stotskiy and V.S. Gubanov from IAA. Today, these lectures are given by Docent S.D. Petrov and Senior Lecturer D.A.Trofimov from SPb University. In 1999, the SPb University Analysis Center of the IVS was created by Oleg Titov, then a senior researcher at SPb University.

What kind of VLBI analysis work do you provide as IVS Analysis Center?

We process the daily sessions in order to obtain Earth Orientation Parameters (EOP). At the present time, we support two series of EOP: one based on the IAU 2000 model, the other on the IAU1980 nutation model.

What kind of research do you do with your VLBI analysis? Who does this work?

In past years active members of the VLBI group have been: O. Titov, M. Kudryashova, D. Trofimov, and S. Petrov. In particular, M. Kudryashova got her PhD degree (Cand. of Science) for her research on EOP derived from optical and VLBI observations. The current SPb University grant 'Astronomical and Astrodynamical aspects of Asteroidal Hazard Mitigation' includes the determination of EOP for rocket launches to asteroids.

Which VLBI analysis software are you using or developing?

We use OCCAM6.2

How many students learn about VLBI?

All astronomy students (20 people) attend to the lecture on astrometry, which includes a section on VLBI. All students with specialization in astrometry (2–3 students per year) listen to the full course dedicated to VLBI (one year) and take special practical training in processing VLBI observations. In 2011, the Astronomy Chair published the book "Celestial and Terrestrial Coordinates" dedicated to the training of students in all branches of modern astrometry, including VLBI. If desired, these classes can be attended by astronomy students of other specializations.

What are main research topics? Why should a student come to your institute?

Traditionally, the students come to SPb University to study astronomy, because practically all branches of astronomy are covered by the staff. The research fields include, among others, theoretical astrophysics, observational astrophysics, radio astronomy, astrometry, galactic astronomy, active galactic nuclei, and celestial mechanics.

The university is not far away from Pulkovo Observatory and from the IVS Network Station at Svetloe. Do you have a working relationship with your VLBI colleagues?

The Saint Petersburg VLBI community consists of the researchers from the Institute of Applied Astronomy, Pulkovo Observatory, and Saint Petersburg University. The latter is the youngest one. Our graduates work in these organizations and have VLBI positions all over the world. For many decades almost all of the staff of Pulkovo Observatory and IAA were trained at our university. During the last decade about 15 of our graduates found positions in other countries (e.g., USA, Germany, and Australia).

The Astronomical Department of Saint Petersburg University.

After a long day working for VLBI, what are your leisure activities?

Prof. Vityazev likes to play music written by W. Herschel. D. Trofimov spends his leisure time touring the wonderful suburban places of Saint Petersburg.

Members (former and current) of the VLBI group: Oleg Titov, Maria Kudryashova, and Sergei Petrov.

Results of the DB Elections

– Gino Tuccari, IRA/INAF

In late 2016 and early 2017, IVS elections were held to renew the Directing Board. The Election Committee, formed by Gino Tuccari (Chair), Ludwig Combrinck, and Torben Schüler, with fundamental support from Dirk Behrend, carried out the election procedures. In the first phase the IVS Associate Members voted over a period of two weeks for one of the two Networks representatives, for one of the two Analysis and Data Centers representatives, and for the Technology Development Centers representative.

Out of 309 eligible IVS Associate Members, some 129 members cast their votes via e-mail ballot. That is, the voter turnout was at about 42%. The elected representatives are:

- Networks representative: Francisco Colomer, Instituto Geográfico Nacional (IGN), Spain [replacing Jim Lovell];
- Analysis and Data Centers representative: Axel Nothnagel, Institute of Geodesy and Geoinformation, University of Bonn, Germany (re-elected);
- Technology Development Centers representative: Thomas Hobiger, Onsala Space Observatory, Chalmers University of Technology, Sweden [replacing Rüdiger Haas].

Their terms are for the next four years (2017–2021).

Following the announcement of the results of the representative elections, nominations were sought for the election of Members-At-Large to the Directing Board. The intention of the At-Large positions is to balance representation from as many countries and regions, institutions, and interests as possible.

Under the leadership of IVS Chair Axel Nothnagel, the IVS Directing Board deliberated on these positions and then elected the following three candidates

- Evgeny Nosov, Institute of Applied Astronomy (IAA) of the Russian Academy of Sciences (RAS), Russia;
- Takahiro Wakasugi, Geospatial Information Authority (GSI), Japan; and
- Guangli Wang, Shanghai Astronomical Observatory (SHAO), China

as At-Large members of the IVS Directing Board for the two-year term from February 2017 to February 2019.

The Election Committee would like to thank all candidates for their willingness to serve on the Board and the IVS Associate Members for their participation in the election.

The next Directing Board meeting will be held on May 19, 2017 in Gothenburg, Sweden after the 23rd Working Meeting of the European VLBI Group for Geodesy and Astrometry (EVGA) and the inauguration of the Onsala Twin Telescopes (OTT) with both the outgoing and incoming Board Members. At that meeting, the new Board will elect the IVS Chair for the next four-year period.

NEWS...

Arigato Tsukuba 32-m

– Ryoji Kawabata, GSI

View of the Tsukuba 32-m antenna.

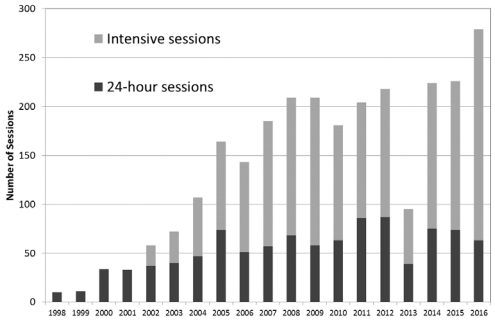
In 2017, the Tsukuba 32-m antenna disappeared from the IVS Master Schedule and from our sight at GSI. However, there remain fond memories and remarkable accomplishments from its 18-year history. The Tsukuba antenna was constructed in 1998 as the successor to the Kashima 26-m antenna. Because of its high sensitivity (through its large dish diameter) combined with the cryogenically cooled receiver and fast slew speed of up to 3 degrees per second, Tsukuba became a core Network Station in the IVS observing program. One notable contribution of Tsukuba to the IVS was the provision of dUT1 values for the weekend days by means of the weekend Intensive sessions (INT2). From the beginning of its operation, Tsukuba has observed more than one thousand 24-hour sessions and 1,600 Intensive sessions in total. Beside its IVS activities, Tsukuba also contributed to many collaborative research efforts with several institutions in Japan, including astronomical VLBI observations and tracking missions for space probes.

Progress of the dismantling of Tsukuba from January 11 through February 10.

Tsukuba experienced a drastic change of its position by more than 60 centimeters in the 2011 Tohoku Earthquake, despite being over 300 kilometers away from the epicenter. Fortunately, there was no damage to the antenna, and the results of the VLBI observations after the earthquake were used to revise the Japanese geodetic datum. Tsukuba faced and overcame a number of incidents; for instance, lightning damage and cracks in the sub-reflector support structure. The biggest challenge was the rail track trouble in 2013 that caused about half a year of interruption of operation to have it repaired.

The establishment of a global VGOS network signified a turning point for the future of Tsukuba. In order to fulfill VGOS requirements, GSI constructed a new station at Ishioka in 2014 and decided to cease operations of Tsukuba at the end of the calendar year 2016 following an overlap in operations of both stations. Tsukuba was dismantled soon after the end of its operation. The process was reported on our Facebook page published for people interested in the antenna as the landmark of GSI. Most parts of the antenna were removed in about two months (by the end of February), with only the base layer remaining.

Our new station, Ishioka, has taken over the role of Tsukuba and is regularly observing in IVS sessions, including the Intensive sessions. Ishioka will play an important role for the IVS in the upcoming VGOS era. Sayonara (good-bye) and Arigato (thank-you) Tsukuba 32-m!



Annual number of observing sessions (Intensives and 24-hour sessions) of Tsukuba.

The base layer of Tsukuba right after the antenna structure was removed.

DORIS@Wettzell: Mitigating RFI in VLBI

– Thomas Klügel, Geodetic Observatory Wettzell

Final installation of the Wettzell DORIS beacon behind the ring laser hill.

The co-location of various space-geodetic techniques at one site is an important objective of the Global Geodetic Observing System (GGOS). While VLBI telescopes, Laser Ranging systems, and GNSS receivers do not interfere with each other, the simultaneous operation of VLBI and DORIS at one site could generate problems with electromagnetic compatibility (EMC). While the VLBI system is designed to receive extreme weak signals down to –110 dBm, the DORIS beacon emits a 401-MHz frequency of 38 dBm and a 2036-MHz frequency of 40 dBm output power. There is the potential of a coupling between the DORIS signals and the VLBI S-band receiving chain—generating spurious signals and, in the worst case, overloading the Low Noise Amplifiers (LNAs) with the risk of damaging them. The recorded S-band frequencies between 2.1 and 2.4 GHz are not expected to be directly influenced; however, the LNAs in the front end could saturate. In order to find a solution for a common operation, RF interferences at the LNA inputs of the 20-m radio telescope (RTW) and the classical S/X/Ka-band TWIN telescope (TTW-1) were investigated by varying the telescope azimuths and elevations and testing different locations and RF blocking structures.

The received power strongly depends on the orientation of the VLBI telescope. It reaches a maximum when pointing towards the DORIS antenna at elevations below 15°. However, also at high elevations an increased power is noticeable due to spillover or reflections at the subreflector, in particular at the TWIN telescope. We found that, in direct line-of-sight, the received power at the VLBI system may exceed the LNA saturation point, which is on the order of –50 dBm, anywhere at the station. In these cases the original polarization (right-hand circular polarization or RHCP) dominates.

The introduction of RF barriers (like absorber plates) or obstacles (such as buildings or hills) reduces the received power by up to 20 dB; however, at dedicated orientations the power is still at the upper limit. In these cases the percentage of LHCP and RHCP is equal indicating that the signal is reflected many times before entering the receiver.

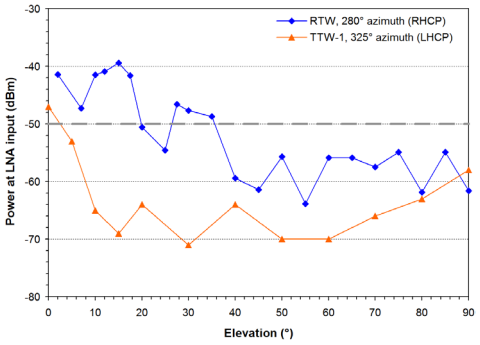
When the measured power in direct line-of-sight is combined with common path loss models for open or suburban terrain (giving a loss of about 12.5 dB when doubling the distance), a distance of 300–400 m between the VLBI and DORIS antennas is sufficient to achieve the required attenuation. However, it has to be ensured that the DORIS antenna is never within the maximum gain lobe of the VLBI antenna. This additional gain could overload or even destroy the LNA.

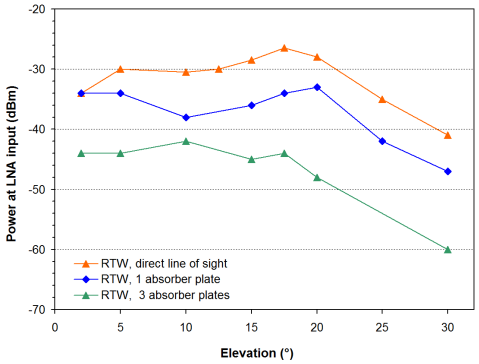
In the case of Wettzell an installation behind the ring laser hill, where there is no direct line-of-sight to any of the VLBI telescopes, was the preferred choice giving the best compromise to meet the different demands:

- installation on the observatory grounds (good local ties, low installation costs, and atomic clock option),
- use of the ring laser hill as an existing RF blocking structure,
- DORIS beacon significantly below the VLBI antenna 0° horizon,
- operation on demand, i.e., the beacon is in stand-by mode when no satellite is visible.

A long-term test over one month showed no degradation of the correlation results when the DORIS beacon is switched on, even on the short baseline WETTZELL–WETTZ13N, which is very sensitive to local RFI.

The DORIS beacon at Wettzell has been in nominal operation with a duty cycle of 25–30% since September 28, 2016. Neither the reception of the DORIS signal at the satellites nor the quality of the VLBI correlation has been affected by this operation mode.





(left) Elevation dependence of the received power at the LNA inputs of RTW and TTW-1. Both telescopes pointing towards the DORIS antenna. (right) Attenuation effect of absorber plates on RTW. Three plates (type COMTEST MT65) reduce the signal by 12–20 dB.

From the VGOS World.....

State of the Sheshan VGOS RT

– *Guangli Wang*

Construction work at the Sheshan VGOS site.

The Sheshan VGOS station is located in the area of the Tianma 65-m telescope. In mid-March the station piling and underground foundation work was completed. The tower construction will be started around the end of March. The antenna installation will be started in May, and first test observations are expected by the end of this year. There are two broadband receiver systems being under development at SHAO. Both of them will be equipped with QRFH feeds but with a different frequency span (one is from CalTech, the other is developed by CETC 54 as part of the antenna contract). The receivers' factory acceptance tests (FAT) are planned for the month of April, but just one of them will be installed. For the UDC a FAT is also planned to be done in early April. The UDC was developed by a company in Xi'an, a city in western China. The CDAS and Mark 6 are already on site; the meteorological as well as the time and frequency systems are shared with the Tianma 65-m telescope. However, funding was obtained to purchase an imported Hydrogen maser for the VGOS system around the end of this year.

Putting South Africa on the VGOS Map

– *Philip Mey*

HartRAO VGOS site in March 2017.

The new VGOS radio telescope at HartRAO is well on its way to becoming operational within 2017. The site preparation and subsequent construction works have been completed in February 2017 with the final painting of the telescope structure being finished. We will monitor the telescope structure with a Leica MS50 total station to see how the temperature differs over the different parts of the concrete structure before making a decision as to cladding the concrete with aluminum panels. The first containers are expected to arrive in April 2017 and assembly of the reflector will then continue till June/July 2017. Final adjustments and site acceptance tests are scheduled for September 2017, after which we will start testing the capabilities with an in-house receiver. At this moment we are still undecided as to the choice of broadband receivers.

View of Metsähovi station.

Progress on the Finnish VGOS RT

– Nataliya Zubko, Jyri Näränen, and Guifré Molera Calvés

The practical implementation of building a new VGOS radio telescope in Finland started in 2016. Within this project, which has been in the planning stage for several years, the Finnish Geospatial Research Institute (FGI) will install a new radio telescope at the Metsähovi Geodetic Research Station during the summer of 2018. The tendering process for the acquisition of the radio telescope was successfully accomplished in late 2016 and MT Mechatronics GmbH (MTM) was selected to construct the new telescope at Metsähovi. Currently, FGI and MTM are going through the preliminary and critical design reviews of the telescope system. The telescope with a 13.2-m antenna dish and a steel tower is expected to be delivered to Finland in the spring of 2018. At the moment, we are working on the selection of the signal chain components for the radio telescope. We recently visited several IVS stations in order to learn from their experience and to find out solutions for our signal chain. We are receiving a lot of support from the IVS community, for which we are very grateful. For instance, we have close collaborations with the Onsala, Yebes, and Haystack observatories, which have some of the most recent experiences in setting up VGOS telescopes. We plan on selecting the signal chain components for our telescope in spring 2017. Some of the site preparation work has been done already; for example, the area assigned for the new telescope has been cleared from the surrounding forest. The major bulk of the work, however, needed to improve Metsähovi's infrastructure to be ready for the installation of the new telescope, will be done some time this year.

Got "fmout-gps" right?

– Ed Himwich, NVI, Inc. and Brian Corey, MIT Haystack Observatory

Once we get fringes most of the other measurements made at the station have relatively little impact on actual VLBI results. The major exception to this is the "fmout-gps" value. This value directly affects the estimated value of UT1. If the value of "fmout-gps" changes by a magnitude of 1 μs, the UT1 value will change by a magnitude of 1 μs. UT1 is one of the most important, and unique, products that geodetic VLBI produces, so we want to make sure it is correct. Fortunately, it is relatively easy to get it right if a few things are kept in mind.

1. The "fmout-gps" measurements are usually made with a time interval counter between two 1PPS signals. The label used to record the measurement, "fmout-gps" (or "gps-fmout"), indicates which signal starts the measurement and which stops it. If the label is of the form "a-b" then the "a" signal starts the measurement and "b" stops it. The correct label should be used in the FS log entry to record the value every scan, usually in the MIDOB procedure. It is natural to interpret the "-" as "minus". However, that results in the opposite sign convention to the order of the names in the label. It is more consistent to consider the "-" as "dash" or "to". You may notice that some newer devices use "dot" in place of "fmout" and "2" in place of "-", such as in "dot2gps".

2. Either order of signals can be used, but the signal that leads should be used to start the measurement. This will keep the measured interval small, on the order of a few microseconds. Compared to a value near one second, this will improve the accuracy and stability of the measurement and will also reduce the time it takes the device to respond. Some counters can perform arithmetic on the measured value, for example, to subtract one second from it. It is recommended to not use such processing; just the raw (small positive) value should be reported.

3. The signal used for "fmout" (or "dot") must be directly tied to the sampler clock. The idea of the name is that it is the 1PPS output of the formatter, not the 1PPS input. You can also report the offset for other 1PPS signals (e.g., input of the formatter, Maser, Cesium, other devices), but you should use appropriate names (e.g., fmin, maser, cesium). The name "fmout" should be reserved for the formatter 1PPS output only

4. If the order of the signals changes, for instance due to drift of the Maser, the counter inputs and the order of the names in the label should be swapped. It should be easy to avoid this if the "IVS Recommended Maser Timing Practices" found at ftp://ivscc.gsfc.nasa.gov/pub/memos/ivs-2014-001v01.pdf are followed. (When the counter inputs are swapped, the trigger set-ups will have to be swapped as well, see #5 below.)

5. The counter should be set up so that the trigger level and sensitivity produce reliable and consistent triggering for both signals. Typically, this will mean triggering near the mid-point of the leading edge of the 1PPS signals. The appropriate input termination should be used on the counter, usually 50 Ohms. It is very helpful to examine the 1PPS signals with a dual-channel oscilloscope to verify the profiles of the 1PPS signals (including that there is no "ringing") and compare their difference to the counter-measured value. Once the correct settings have been determined, it is recommended that they be programmed with FS commands so that they are repeatable.

6. The counter should not be set up to average the measurements. While averaging can give a less noisy measurement, the noise in single-shot measurements is typically on the order of 30 nanoseconds. The single-shot measurements are sufficiently precise. Averaging may smear out a clock jump and also may delay the counter's response or cause an old value to be returned.

If these few points are kept in mind, it should be easy to get accurate "fmout-gps" data and UT1 results.

The IVS Newsletter is published three times annually, in April, August, and December. Contributed articles, pictures, cartoons, and feedback are welcome at any time.

Please send contributions to
ivs-news@ivscc.gsfc.nasa.gov.
The editors reserve the right to edit contributions. The deadline for contributions is one month before the publication date.

General Editors: Dirk Behrend (Dirk.Behrend@nasa.gov), Kyla Armstrong (Kyla.L.Armstrong@nasa.gov)
Feature Editor: Hayo Hase (hayo.hase@bkg.bund.de)
Layout Editor: Heidi Johnson (hjohnson@haystack.mit.edu)

The newsletter is published in color with live links on the IVS web site at

http://ivscc.gsfc.nasa.gov/.

Upcoming Meetings...

9th IVS TOW
Westford, MA, USA
April 30-May 4, 2017

23rd EVGA Working Mtg
Gothenburg, Sweden
May 15-19, 2017

JpGU–AGU Joint Meeting
Chiba, Japan
May 20-25, 2017

Detection and Measurement of RFI in Radio Astronomy
Guadalajara, Spain
June 8-9, 2017

http://ivscc.gsfc.nasa.gov/meetings

Jim Moves On

– Dirk Behrend, NVI, Inc.

At the end of June 2017, Jim Lovell will step down from his position as Project Manager for the AuScope VLBI Project and move on to other endeavors. As a consequence he will also discontinue his involvement in the IVS and AOV (Asia-Oceania VLBI Group for Geodesy and. Astrometry), relinquishing his positions as lead of the VGOS Technical Committee (VTC) and as inaugural chair of the AOV. We can only thank Jim for his strong dedication to and his many contributions to the geodetic/astrometric VLBI cause. We wish him all the best for wherever his future path will lead him. It remains to be seen whether his decade with VLBI will later lend itself to be made into a movie (perhaps with Tom Hanks Jr.) as was done for his namesake of Apollo 13 fame; let's call it 'Hobart 12'.

A schematic of the Hobart 12-m antenna as drawn by Patrick Lovell for a paper in the IVS 2014 General Meeting Proceedings.

Jim is well-known and well-respected in the IVS world. He took on the AuScope management position in March 2007. It was under his leadership that the Australian radio telescopes at Hobart, Katherine, and Yarragadee were constructed and put into operation. Many of you will remember him as the master of ceremonies at the inauguration of the Hobart 12-m antenna in 2010 as part of the IVS General Meeting. The construction of the array was completed on time and on budget. The operation of the AuScope array has contributed significantly with observations in the southern hemisphere since 2010. Currently, work is underway to upgrade the legacy S/X system of the telescopes to a VGOS broadband system—an activity that is anticipated to be completed by the end of the year.

We will remember Jim as someone who had a knack for inspiring and motivating others (including his family, see figure). We will miss his positive attitude. We wish you the best of luck, Jim!

Response

Ten years ago I moved from a job in radio astronomy with CSIRO back to my home state of Tasmania to work on the AuScope project. It's a rare opportunity to be given the task of building a continent-spanning array of telescopes and I'd like to thank the IVS community for their advice, support, and encouragement, without which the AuScope VLBI array would never have been a success. Some time ago Harald Schuh pointed out to me that a great advantage the IVS has is the necessity for close and harmonious cooperation and communication given that we depend on each other for our long baselines. This is a particular aspect of my job that I will miss. It's been a great privilege to have worked with so many talented and dedicated people over the past decade. Thank you!

I'm not sure what the future holds for me at this stage but I will definitely maintain an interest in VLBI and look forward to seeing continued progress with VGOS as new facilities come online.

I'm not sure how well the movie would do in the box office, but I'd like George Clooney to play me. The resemblance is uncanny.

– Jim Lovell

http://ivscc.gsfc.nasa.gov
ivscc@ivscc.gsfc.nasa.gov
phone: 301-614-5939
fax: 301-286-0239

IVS Coordinating Center
NASA GSFC
Code 61A.1
Greenbelt, MD 20771