IVS Newsletter

Issue 43, December 2015

Finland Builds VGOS Radio Telescope at Metsähovi

– M. Poutanen, N. Zubko, U. Kallio, J. Näränen, V. Saaranen, J. Virtanen, FGI Finland

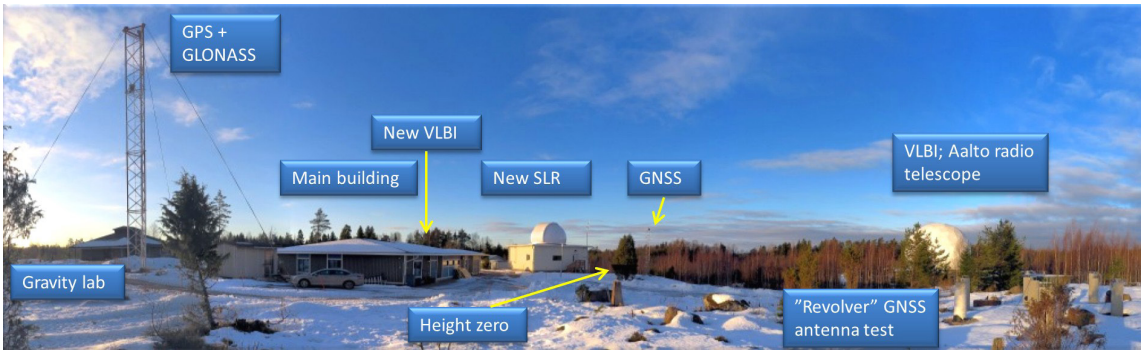
The Metsähovi Geodetic Station is a key infrastructure of the Finnish Geospatial Research Institute (FGI, former Finnish Geodetic Institute). Metsähovi is the basic station for the national EUREF-FIN reference frame, height system N2000, and a part of the National permanent GNSS network FinnRef—all created and maintained by the FGI. The fundamental benchmark of the Finnish gravity system is also placed in Metsähovi.

Internationally, Metsähovi is a part of global network of geodetic stations which is used in maintaining global terrestrial and celestial reference frames, computing precise orbits of satellites, and for geophysical studies. It is one of the few geodetic stations having all major space geodetic observing techniques at the same site, and it contributes to several global services of the International Association of Geodesy (IAG). Metsähovi is among the northernmost geodetic stations, thus playing an essential role in contributing to global reference frames and satellite orbits. The station has been operational since 1978, and due to its long existence it helps to retain sustainability in the maintenance of global reference frames. However, the instrumentation became old and partly obsolete over the years, requiring a renewal of the instruments. In 2012 we started a special investment program, funded by the Ministry of Agriculture and Forestry, FGI, and recently the National Land Survey of Finland (NLS), which FGI has become a part of at the beginning of 2015. The ongoing process to upgrade and renew all major instruments at Metsähovi will be completed by building a new VGOS-compatible radio telescope.

Geodetic VLBI observations have been made since 2004 using the radio telescope of Aalto University Metsähovi station. A few IVS sessions per year have been carried out. The plans for a new VGOS-compatible radio telescope dedicated for geodetic VLBI started in 2012 with the acceptance of the Metsähovi renewal plan. The purchase of the telescope was scheduled at the end of the renewal period (originally 2015-2016). Budget cuts and changes in the funding plans lead to new negotiations which ended successfully in the autumn of 2015. We retained the original renewal plan; the only change was a delay of about one-and-half years compared to the original schedule. When funding for the new telescope for FGI was confirmed in the autumn of 2015, the process of purchasing the system was started. The telescope is funded by the Ministry and the NLS.

The site chosen for the new telescope is on solid bedrock, within 50 m from other facilities at Metsähovi. We aim for a 12-13-m telescope, at the moment without a radome. One concern will be freezing weather conditions in winter time, especially when the temperatures hover around zero with wet snow and/or strong winds. However, such conditions are not so common, and we estimate a loss of only a few days per year due to this reason.

We expect to complete the procurement process during the first half of 2016 and to sign the final agreement with a vendor some time during 2016. The plan is to be operational by the end of 2018. We would like to thank the IVS community for their support and valuable help during the preparation phase of our plan.

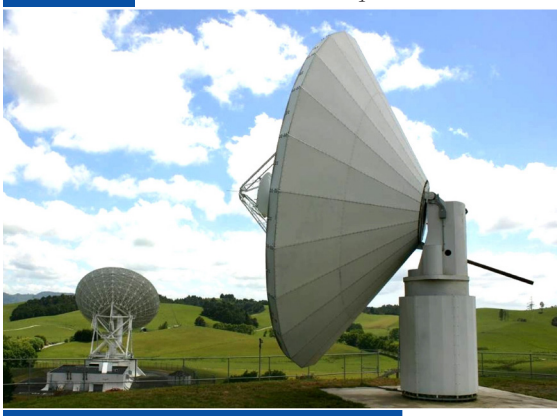


Panorama of the Metsähovi Geodetic Station. The place for the new VGOS telescope will be behind the main building in the center of the picture.

Feature

Warkworth Station on the North Island of New Zealand

Auckland University of Technology (AUT) operates an IVS Network Station at Warkworth on the North Island of New Zealand. Warkworth is about an hour's drive (60 km) north of the city of Auckland. The telescope is almost identical to the Australian AuScope antennas. The station was accepted as an IVS Network Station in June 2009. Newsletter editor Hayo Hase caught up with the "kiwi group" and interviewed Tim Natusch and Stuart Weston remotely via e-mail to learn more about the history, present, and future of this site.



The Warkworth 12-m (foreground) and Warkworth 30-m (background) antennas.

Tim, you have been the technical pioneer at the Warkworth site, putting all the hardware together and making VLBI at Warkworth a reality. How did you become involved in VLBI? When did you start at Warkworth?

I first became involved with VLBI in 2004 through a (happy?) set of circumstances. Although he had been at AUT for some years, by then I only became aware around this time that Sergei Gulyaev had been involved with Radio Astronomy in Russia; at last there was someone to talk to about my long held interest in Radio Astronomy. In the same year Steven Tingay, then at Swinburne University in Melbourne, Australia, passed through Auckland and gave a talk on the SKA project that caught our interest. One thing led to another and we decided with Steven's help to attempt to do the first VLBI in New Zealand. A few minor problems—no antenna, no receivers, no frequency standard… no anything—had to be worked on. In the end we managed it using a 6-m antenna operated by Brent Addis, a local Ham radio operator who just happened to have a fully steerable antenna in his back yard built for EME work, a PC-EVN digitizer and recorder, a Rubidium frequency standard, and a receiver operating at 1650 MHz. We got fringes to the Compact Array in Narrabri, Australia after several attempts, arguably with the worst ever system G/T, but fringes nonetheless. I should point out the pivotal role that the team at Hobart played in this; they generously hosted us at Mt. Pleasant and allowed us to install our equipment for testing and validation.

Tim Natusch with the 12-m antenna in the back.

How long did it take, from the beginning until the first (regular) VLBI observations could be made?

Following this success and a huge effort on Sergei's part, AUT University provided the money for our first antenna, the 12-m Patriot antenna. We then had to find somewhere to put it and embarked on an RFI survey of a number of sites. None of the university's campus sites proved suitable, with what I think can only be described as truly appalling levels of RFI observed. We were fortunate to have interest in our project from Charles Jarvie, then at Telecom NZ. Through his intervention and the cooperation of others in the management at Telecom we were granted the use of spare land (read farm paddock) at their Warkworth Satellite Earth Station. The antenna arrived and was erected by the later part of 2008. It took about another 18 months before we had all the back end equipment sorted and could start doing VLBI on a regular basis in 2010.

What have been the problems and how did you solve them?

Problems? What are they? I have never had one of those! Ok, I am not a convincing liar. Truth is we have probably encountered all possible problems, in retrospect many a function of ignorance on my part. We started from zero, a radio astronomy vacuum, I have had to learn along the way and have discovered that enthusiasm is a necessary but not sufficient condition for success. I feel fortunate, indeed, to have been rescued from this state of affairs by so many in the international VLBI community who have generously assisted with answers and practical assistance. From my point of view this is a particularly noteworthy feature of the VLBI community. I have not seen this degree of cooperation and sheer willingness to help in other fields of work.

I will have to resist naming names due to the risk of leaving someone out from what would be a very long list, but I would like to take this opportunity to mention the team at Hobart who assisted with our initial experimentation and receiver construction, the people at Haystack for help with recorders, Ed Himwich (bother, just broke my rule about names) for assistance with the Field System, Gino Tuccari for support with our DBBCs, Tasso Tzioumis and Chris Phillips at ATNF/CASS for help with too many things to mention, the team who organize the TOW series (keep them going, they have been a lifeline), Peter Thomasson at Jodrell Bank,… everyone else. I feel that the VLBI community is in great shape and I look forward to continued involvement. There is never a dull moment and always something new to learn or discover.

Stuart, how did you enter the VLBI business and what is your main duty?

My undergraduate degree was in Physics from Manchester University many, many years ago. I did my Master's at AUT in VLBI while still working for a software company five years ago. Having completed my Master's, unfortunately the company I was employed by laid me off, but I was fortunate to obtain a position with AUT as a software engineer. This started off with getting the Field System, Mk5's, and DBBC going and has developed to cover networking, correlation, and so on. I am also a part-time PhD student here at AUT researching large area surveys and statistical methods of cross identifying sources between different wavelength surveys.

Stuart Weston with the 30-m antenna in the back.

I look after the computer systems used at Warkworth: hardware, software, and networking. I also assist elsewhere as required even with a spanner in my hand to fix things on the 12-m and 30-m telescopes we now have.

How many VLBI sessions per year are you running and how are they done?

The 12-m antenna is primarily used for IVS but does also observe with the Australian Long Baseline Array (LBA) for sessions in S- or X-band. Our IVS involvement has increased each year: in 2013 we observed 48 IVS sessions, in 2014 this increased to 111 with a large number of AUST sessions with UTas, and this year we will observe 117 IVS sessions. We also do space craft tracking and some cooperation with Jive.

We can and do operate the two telescopes at Warkworth remotely. Recently, for an LBA session, I operated both antennas from Sydney, Australia while performing ATCA Duty Astronomer duties as well as operating Parkes and ATCA. This was a busy morning!

Celebrating first fringes at Mt. Pleasant in 2005: (from left) A. Deller, S. Gulyaev, T. Natusch, B. Reid, and E. Baynes.

Do you have any students from the university helping or working in VLBI?

We have one Honors student, Ben Hart, who helps with the observing of the IVS sessions.

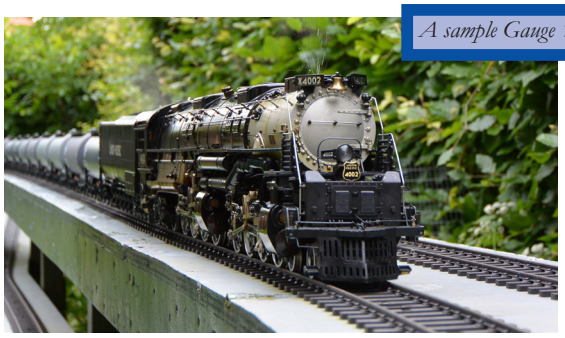
Your institute will host the VLBI Technology Workshop in November 2015 in Auckland. What is your motivation for this? Do you have plans to upgrade your telescope to become VGOS compliant?

We have only ever shipped a handful of diskpacks since Warkworth started in the IVS; our aim was e-transfer from the start using the New Zealand Education & Research Network (REANNZ). We are now working with Harro Verkouter (Jive) and Simone Bernhart (Bonn) on real-time e-transfer of R1 sessions to Bonn for correlation. We started this with R1702 in August this year and it already has become our preferred method. Last week we tried an R4 session to WACO for the first time. We got very good network performance to stream the data in real-time. We have FILA10G units for the DBBC, which we hope to get operational very soon, and then, yes, we can/will go to higher data rates.

Finally, New Zealand is known for its famous rugby players. What are your favorite leisure activities?

My [Stuart's] hobby is Model Engineering with Gauge 1 Live Steam Locomotives. :-)

Thank you very much for this interview.



A sample Gauge 1 train.

Sergei Gulyaev (center) giving an interview to local media at the Warkworth site during the SKANZ 2010 conference.

A Roadmap for the Enhancement of Geodesy

– Anne Jørgensen, Norwegian Mapping Authority

The United Nations Global Geospatial Information Management (UN-GGIM) Working Group on the Global Geodetic Reference Frame (GGRF) is now drafting a roadmap for the enhancement of the Global Geodetic Reference Frame. Most importantly, the roadmap will also address factors affecting the sustainability of the GGRF.

The GGRF Working Group co-chair Gary Johnston (Australia, from left) at a GGRF Workshop with participants from Norway (Kristiansen), Germany (Craddock), France (Altamimi) and Finland (Poutanen) in Vienna working in groups on the roadmap.

"The Global Geodetic Reference Frame (GGRF) Roadmap will be built with passion and involvement," says Working Group co-chair Gary Johnston from Australia.

In February 2015, the UN General Assembly adopted its first geospatial resolution – "A global geodetic reference frame for sustainable development" – recognizing the importance of a globally coordinated approach to geodesy.

Momentum for GGRF

"The momentum the adoption of this resolution has created will position the global geodetic community well for the complex task ahead, developing a roadmap for GGRF enhancement," says Johnston.

Significant response rate

After the UN General Assembly adopted the resolution on 26 February, a global questionnaire was sent to the countries in the UN for the purpose of gathering opinions on the key elements of the GGRF and its sustainability. The questionnaire resulted in 92 responses from 84 countries, which is a significant response rate.

Governmental commitment is key

The questionnaire reports that the key elements to achieving a sustainable GGRF are governmental and country commitment and funding, common standards, and international obligations. The most important key elements reported for development of the GGRF are to maintain and build infrastructure, common standards, and internationally coordinated policies.

Joint international governance

"The [questionnaire] clearly identifies that a joint international governance effort is needed in order to meet the objectives of the GGRF resolution. It does not, however, give any details as to how this can best be achieved. The Working Group will test some ideas and concepts for possible governance arrangements," Johnston explains.

Final roadmap in August 2016

In August 2015, the UN-GGIM requested the Working Group to continue its efforts, building on global and regional experiences and initiatives, and report back to the Committee at the next session in August 2016.

Involvement and consultations

"We are in the process of developing the first draft roadmap by mid-December this year. The involvement of UN-GGIM regions and consultation with the IAG, FIG, GEO, and CEOS is in progress and is important for the final outcome. The first draft will be sent out for comments in January," says Johnston.

Outcomes of roadmap

The roadmap will address five broad issues: governance, infrastructure, policy (standards and conventions), education (training and capacity building), and communication and outreach.

"Five groups with lead authors are now working on the first draft," says Johnston. "The roadmap will have strong cross references to the operational paragraphs from the UN General Assembly resolution."

Learn more about the GGRF Working Group on the web at *http://unggrf.org* or at *Twitter @unggrf*.

"Looking forward to seeing this GGRF Roadmap," said Peni Suveinakama (left), the Permanent Mission of Fiji to the United Nations to Zuheir Altamimi (center), France and Gary Johnston (right), Australia at the UN-GGIM 6th Session in August 2015 in New York.

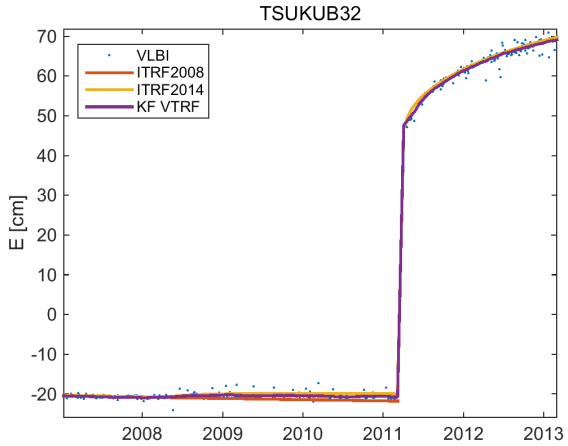
Evaluating the Preliminary ITRF2014

– *R. Heinkelmann, S. Glaser, M. Karbon, T. Nilsson, B. Soja, K. Balidakis, and H. Schuh, GFZ Potsdam*

The IERS has made strides in producing the next version of the International Terrestrial Reference Frame (ITRF). Zuheir Altamimi and his team combined the input from the four space-geodetic techniques in a rigorous way and computed a preliminary version of the new frame. The IVS, like the other technique services, was asked to evaluate this preliminary version of ITRF2014, called ITRF2014P. A contribution to this evaluation was made by the GFZ Analysis Center. We evaluated ITRF2014P against VLBI analysis and against ITRF2008 via the following items of comparison: station positions and velocities, parameters of a Helmert transformation, post-seismic deformation models (PSD), and Earth Orientation Parameters (EOP).

In general, the coordinates from the VLBI analysis show good agreement with ITRF2014P. The baseline length repeatability improves for 54% of the baselines by 0.57 mm on average when compared to ITRF2008 (see figure). The largest unexpected effect on coordinates was found at the O'Higgins station in Antarctica. Here, unlike ITRF2008, ITRF2014P introduces a vertical offset of about 30 cm at the beginning of 2010. This jump can only partially be seen in the VLBI estimates with reasonable agreement until 2012.

The VLBI parts of ITRF2014P and ITRF2008 were compared against each other using a 14-parameter Helmert transformation for the epoch 2005.0. The transformation parameters show a very good agreement: the translations agree at the mm-level and the stability of the origin is on the sub-mm level. Remarkable is the relatively large z-shift of 4.7 mm. The origin of ITRF is conventionally realized by SLR only; hence, only an evaluation of the SLR part of ITRF2014P can explain the observed z-shift. The relatively large x-shift of 2.8 mm may be masked by the Y-rotation of 70 µas, because these parameters customarily show significant correlation. The scale agreement with 0.15 ppb and 0.02 ppb/yr is quite good. The ITRF scale is currently realized by VLBI and SLR.



East coordinates of antenna TSUKUB32 before and after the break in 2011.

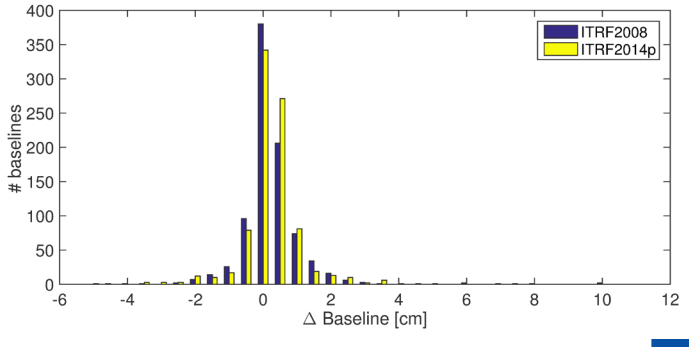
The post-seismic displacements were evaluated against a Kalman-filter TRF solution based on the VLBI data of the GFZ contribution to the ITRF2014. We found that most of the PSD are captured well in ITRF2014P. Exemplarily, we show the east component of antenna TSUKUB32 in Japan from 2007 until early 2013. In this graphic the ITRF2008 coordinate (red line) is predicted beyond the involved data span of ITRF2008 until the break point in early 2011. ITRF2014P (yellow line) shows, particularly during the PSD, a very good agreement with our Kalman-filtered VLBI results (purple line).

	ITRF2008		ITRF2014P	
	wm	wrms	wm	wrms
x-pole	-60.6	280.8	-52.8	276.4
y-pole	-15.3	306.7	-19.0	298.2
DUTI	5.7	16.8	1.9	16.9
dX	47.8	281.8	47.8	281.9
dY	45.5	252.7	45.5	252.7

Statistics of the EOP estimated by VLBI data analysis when applying ITRF2014P or ITRF2008 w.r.t. USNO finals as obtained by the GFZ VLBI solution.

The table gives the weighted mean (wm) and weighted root mean square (wrms) of the EOP values as obtained by our GFZ VLBI solution based on either ITRF2014P or ITRF2008 w.r.t. USNO finals. While the corrections to the celestial pole offsets (dX, dY) remain practically unaffected (as expected), the quantities that refer to the ITRF (the pole coordinates and the Earth rotation angle) are on average slightly smaller when using ITRF2014P coordinates.

All in all, we can claim that ITRF2014P does not exhibit any significant contradictions w.r.t. VLBI data. Due to the inclusion of new models, PSD models as well as seasonal signals, we expect on average minor improvements in the analysis of VLBI data when using this frame.



Differences of baseline lengths between VLBI solutions based on ITRF2014P (yellow) and ITRF2008 (dark blue).

NEWS...

ICRF3 at the IAU Meeting in Honolulu

– David Gordon, NVI Inc.

Attendees at the ICRF3 Working Group Meeting, Aug. 6, 2015, at the IAU meeting in Honolulu.

For two weeks this past August, approximately 3,000 astronomers from 74 different countries met at the Hawaii Convention Center in sunny Honolulu, Hawaii for the 29th General Assembly of the International Astronomical Union (IAU). About a dozen IVS members were in attendance, many to participate in activities related to the upcoming third realization of the International Celestial Reference Frame (ICRF3). I was fortunate to be among those IVS members. The ICRF3 is being developed by an IAU Working Group (WG) which was formed in 2012 and currently has 18 members, most of them also IVS members. The IAU's description of the Working Group is, "to oversee the generation, validation, and utility of the third generation ICRF in the radio domain by 2018 with special care to provide for a frame tie and accuracy comparisons with the anticipated *Gaia* optical catalog." Nearly half the WG members attended the IAU and participated in a WG meeting on August 6, along with other interested individuals from the astrometry and *Gaia* communities.

Chris Jacobs chaired the Working Group for its first three years. During this period, the emphasis was on addressing the weaknesses of ICRF2. Considerable progress has been made towards that goal, including the completion of a second epoch VLBA Calibrator Survey in which some 2,000+ VCS sources from ICRF2 were re-observed to significantly reduce their position uncertainties, and the observing of many more southern sources from the southern hemisphere with the new antennas in Australia, New Zealand, and South Africa. Work has also focused on extending the future ICRF3 to higher frequencies. New K-band observations are being made on the VLBA and in the southern hemisphere to densify the K-band catalog constructed during the previous decade and extend it to the southern sky. And ongoing Ka/X band observations with DSN antennas are building up a catalog approaching 700 sources. Patrick Charlot will be the WG chairman for the next three years, where there will be a greater emphasis on comparisons and alignment between the VLBI radio and the *Gaia* optical frames. The ICRF3 will be released by the August 2018 IAU meeting in Vienna. It is expected to contain precise positions for some 4,000+ sources at X/S band, as well as precise catalogs of hundreds of sources at K and Ka/X bands.

Several WG members presented papers or posters during the IAU Division A (Fundamental Astronomy) session on various aspects of the ICRF3, including Chris Jacobs, Patrick Charlot, Chopo Ma, David Gordon, Oleg Titov, and Ralph Gaume. Also of interest were sessions on the *Gaia* project, which is approximately one year into its five-year mission. *Gaia* is situated at the L2 Lagrangian point, around 1.5 million km from Earth. It will catalog a billion stars in our galaxy, giving precise positions, parallaxes, and proper motions. It will also catalog up to 500,000 quasars. The first release of *Gaia* results is expected in mid-2016, with additional releases through 2022. The ICRF3 is very important to *Gaia's* success. A strong link between the VLBI radio reference frame and the *Gaia* optical reference frame is necessary to maintain the continuity of celestial coordinates, and the alignment with the quasars provided through ICRF3 will insure that *Gaia's* frame will be an inertial reference frame. Among other things we heard that *Gaia* has already detected ~2,700 ICRF2 sources. The ICRF3 Working Group has held formal meetings at various scientific gatherings, such as the IVS meeting in Shanghai and the EVGA last May in the Azores. This past meeting was very memorable as it was held on the island of Oahu, a beautiful paradise in the Pacific, home to many scenic areas such as Diamond Head and Pearl Harbor. IAU attendees stayed at hotels along Waikiki Beach. The weather was tropical, warm and sunny most days, and there was a strong temptation to lay out on the beach instead of attend meetings. It was a tough assignment, but we had to do it.

The view of Waikiki Beach from the Sheraton Hotel.

Upcoming Meetings...

AGU Fall Meeting
San Francisco, USA
December 14-18, 2015

2nd VLBI Training School
Hartebeesthoek,
South Africa
March 9-12, 2016

9th IVS General Meeting
Johannesburg, South Africa
March 13-17, 2016

EGU General Assembly
Vienna, Austria
April 17-22, 2016

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

FAREWELL...

Rich Strand (1945–2015)

– Dirk Behrend, NVI, Inc.

On this page you would normally find the VLBI How-To column written by Rich Strand. The column would outline ways on how to improve operations at the VLBI stations and provide useful tips for operators on how to go about it. But not this time. Instead, it is my sad duty to inform you that Rich passed away on November 20, 2015 in Anchorage after a brief illness.

Rich was the long-time station chief at Gilmore Creek being a major factor in the success of this station. After his official retirement in 2002, he nonetheless continued to assist and mentor many operators in the IVS world. Notably he paired up with Mike Poirier to teach the anchor stations-operations classes at the Technical Operations Workshops (TOW). He became the right hand to the IVS Network Coordinator Ed Himwich and was in e-mail contact with many stations on how to fix surfacing problems. He truly established himself as the friend of the VLBI stations.

We remember Rich as a very funny and generous person, who was determined and sometimes stubborn but always sharing and inspiring the world around him. Rich's passing is a big loss and the gap that he is leaving behind will be hard to fill. R.I.P. my friend.

Rich in his ham radio environment.

Mike Poirier and Rich giving a class on station operations at TOW2015.

IVS Retreat Held at DRAO

– Dirk Behrend, NVI, Inc.

On October 7–8, 2015 the IVS Directing Board and six invited guests participated in an IVS Retreat held at DRAO (Dominion Radio Astrophysical Observatory), Penticton, BC, Canada. The event was well organized by Axel Nothnagel in form and content and logistically by Bill Petrachenko; it has to be considered a great success. The participants discussed the current and future challenges for the IVS based on an evaluation of the current state. The main points of discussion were focused on correlation, product lines, institutional relations, a business plan as well as operations details with concepts for the future. Critical items included the aging workforce of the IVS, the preparation of the correlators for the large increase in data throughput for VGOS, an emphasis on the service aspect of the IVS, and the need for increased public relations work, among other items. It is envisioned that following the findings of the Retreat a Strategic Plan will be developed for the IVS. A summary report of the Retreat has already been drafted and will be distributed soon. Then work on the Strategic Plan can commence.

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/.

Going From A to B: The IVS Report Goes Biennial

– Dirk Behrend, NVI, Inc.

At its recent meeting in Penticton, the IVS Directing Board decided to move away from publishing an Annual Report (AR) each year. Instead, in the future the Coordinating Center in cooperation with the IVS components will work on Biennial Reports (BR). It is planned to have the two-year reports published in the odd numbered years; the first Biennial Report will thus be published in 2017 covering the calendar years 2015+2016. The even numbered years will see the publication of the General Meeting Proceedings volumes. Hence, we will be alternating between a "Proceedings year" and a "Biennial Report year." Both publication types will continue to be produced in printed and electronic versions.

The transition to Biennial Reports closes a successful chapter of IVS reporting. A look at the collection of reports on the IVS Web site at http://ivscc.gsfc.nasa.gov/publications/annualreport.html shows that, altogether, sixteen Annual Reports have been published since 1999. They provide a nice historic overview of the development of the IVS as a service and function as a reference to all matters IVS. So, many thanks to all who contributed to the success of the AR! The production and reproduction costs have increased significantly over the years. Coupled with the fact that only minor updates are typically done for a number of components, the step from AR to BR seems reasonable. It also helps disentangle some overlap with the content of the Proceedings.

We anticipate to continue using the same format in the BR as used in the AR, but with an extended page limit (likely five pages) to account for the two-year period. And, finally, we hope that the BR will be as successful as the AR.

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

IVS Coordinating Center
NASA GSFC
Code 698.2
Greenbelt, MD 20771