

# IVS Newsletter

Issue 41, April 2015



## Under African Skies – GM2016 in South Africa

– Glenda Coetzler and Alet de Witt, HartRAO

The 9th IVS General Meeting (GM2016) will be hosted by the Hartebeesthoek Radio Astronomy Observatory (HartRAO) in South Africa. The GM and several side meetings will take place in the period from 9–19 March 2016 at the Ekudeni Lodge in Muldersdrift. There will be (in anticipated order) an IVS VLBI School, 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

The content of the GM2016 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.

The meeting will include a visit to the Hartebeesthoek Radio Astronomy Observatory, which is located 65 km northwest of Johannesburg just inside the provincial boundary of the Gauteng province. Both the 15-m and the 26-m radio telescopes at HartRAO are used for astronomical, astrometric and geodetic VLBI and are currently the only radio telescopes in Africa contributing to the IVS and other VLBI programs.

We hope that the peaceful and beautiful setting of the GM2016 will be conducive to a very successful meeting and that everyone will be overwhelmed by the friendliness, hospitality, and the spirit of “ubuntu” shared by all South Africans.

Registration for the GM2016 will open mid-October 2015. For more information visit:

<http://ivs2016.hartrao.ac.za>

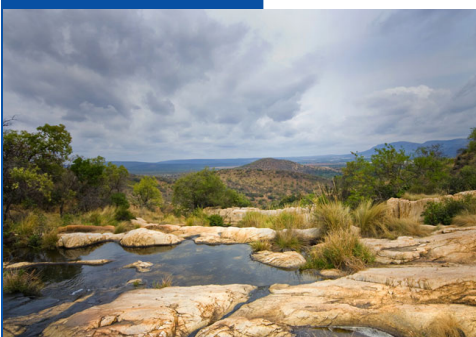


The 26-m and 15-m radio telescopes at HartRAO.

members of the VLBI and Earth science communities as well as for students to interact and share ideas.

Muldersdrift is located only 10 km away from the nearest town of Krugersdorp and only 39 km from Johannesburg. It is a picturesque area in the heart of the Kromdraai Valley, which is home to the Cradle of Humankind, a World Heritage site. Although many small farms still exist in the area, Muldersdrift has now become more of a village with a reputation for being an arts and culture hub, boasting a variety

of galleries, markets, and many interesting cultural attractions and adventure activities. Evenings are tranquil, yet big cities such as Johannesburg and Pretoria are easily accessible by car. Lanseria airport is a mere 15-minute drive away. The GM2016 will take place during the latter part of summer when rainfall and temperatures are moderate with an average monthly precipitation of approximately 8 mm for March and daily temperatures averaging at around 19–25°C. Temperatures seldom drop below 16°C during the month of March.



View from the top of a hill in the Muldersdrift area.

### Ubuntu

a term used in South Africa meaning “human kindness” or “the belief in a universal bond of sharing that connects all humanity”



The Lion and Rhino Nature Reserve as well as Pilanesberg and Krugersdorp Game Reserves provide ample opportunity for game viewing and bird watching.

# Feature

## John the Analyst

*As the lead of the VLBI Analysis Group at NASA Goddard Space Flight Center, John M. Gipson is strongly involved in all aspects of VLBI analysis, among other things. He was the chair of the IVS Working Group on VLBI Data Structures (WG4) and, for two years now, has served as the IVS Analysis Coordinator (having succeeded Axel Nothnagel in that position). Feature editor Hayo Hase interviewed John via e-mail to learn more about the person and to get a glimpse of the challenges that VLBI analysis faces in the future.*



*IVS Analysis Coordinator John Gipson.*

*John, what is your background and how/when did you get involved in VLBI?*

I got into VLBI by accident. I earned my PhD in Theoretical Particle Physics from Yale in 1982, and worked as Post-Doc and Assistant Professor for a few years at VirginiaTech. When I started graduate physics in the late 1970s, Particle Physics was very exciting. The “Standard Model” of particle physics was still young. However, theory is fed by experiment, and by the end of graduate school they were running out of interesting experiments to do. Two years into my career I went to a conference and one of the speakers said: “If we start building the next generation of colliders they won’t be done for 20 years.” I decided that was too long to wait and left to work for a consulting company



*John on his 27th birthday.*

in Washington DC in 1985. The company had a contract to provide VLBI support to NASA and I worked on that contract part-time. In 1991, I was given the opportunity to work on that contract as Chief Scientist and have never looked back.

*May I call you a professional number cruncher? Is data analysis all about errors?*

I don’t see myself as a number cruncher—lots of people can do this. Rather I see myself as someone who identifies and solves problems. And the first step in solving problems is to realize that there is one! Sometimes this means noticing an anomaly in the data—it doesn’t behave like you expect. Other times it involves seeing how you improve models or data processing. Sometimes we do things the same way for so long that we don’t realize that there might be other, better ways of doing things. That is one reason I think it is so important going to conferences. I am particularly interested in what our sister techniques (GPS, SLR, and DORIS) are doing. Seeing what other people have done might spark an idea for you. As Richard Feynmann used to say: “What one fool has done, another fool can learn!”

*What exactly is so exciting for you to be working in VLBI for so long?*

There is always something new. As the technique has improved, things that were not important error sources become so. In the early days our accuracy was a few centimeters. Now it is a few millimeters. High-frequency Earth Orientation and Pressure loading were introduced into VLBI in the 1990s. (GPS still does not do pressure loading!) In the 2000s thermal deformation was introduced into routine VLBI analysis. At Goddard we are starting to routinely use ray-traced atmospheric delays. Other groups have used VLBI data to verify general relativity or look at the coronal effects of the sun. I think Source Structure is our next major hurdle in analysis.

The other thing that has changed is the quality and quantity of the data. The first CONT, CONT95, involved five stations for one week. CONT14 involved seventeen stations for fifteen days and provides the best geodetic VLBI data to date. As the quality and quantity improve, you can see things that you didn’t before.

*As chairperson of IVS Working Group 4 you introduced the new data structure based on NetCDF to the IVS. For a few years now, these changes are widely accepted. What is your experience with the changes so far?*

The transition to the new format is taking much longer than I hoped or anticipated. So far the only software packages that can use this are Solve and VieVS. This is a shame, because the vgosDB format has so many advantages. I would be happy to work with any group that wants to interface their software to it. In fact, I would encourage these groups to send their young scientists to Goddard to spend some time with us. This is what the Vienna group did and it was very productive.

*You have been the IVS Analysis Coordinator for two years now. What is your daily work in this function? What is your agenda?*

A lot of my daily work involves answering questions such as: does the IVS have recommended models; where can we get such and such data; what do we need to do to become an IVS Analysis Center, and the like. More generally, I worry about how we can improve the VLBI technique. What are the current deficiencies and how can they be addressed? How can we encourage people to develop more VLBI analysis packages? Why do different software packages give different results? Fortunately, I am helped by colleagues at Goddard and elsewhere. A short-term project is developing a Web page that provides a single place to find all the information you need to process IVS data. This will involve descriptions or links of all of the recommended models, and links to the a priori data you need. Lastly, I think the annual IVS Analysis Workshops provide a venue for analysts to share their ideas and concerns. These always lead to new things to do, and it is pleasing to come back a year later and see the progress made.



*What do you see as great challenges in the analysis of VLBI data? Which efforts are necessary by the IVS community to advance in these directions?*

The transition to VGOS is a sea-change and will involve changing all aspects of VLBI—from scheduling, to data acquisition, to data transmission, to data analysis. Right now the number of data points in an R1 or R4 session is about 5,000, and the total from all VLBI sessions since 1979 is around 10 million. In contrast, it is conceivable that a typical 24-hour VGOS session with 30 stations can generate 200,000 data points. It is obvious that we cannot do things the same way. Let me just mention a few issues. Getting this data to the correlator will involve logistical challenges, since each station will record around 40 TB of data (currently they record around 1 TB). I don't think the pipes are currently big enough to e-transfer this data, although they may be in a few years. Correlating this amount of data will strain the correlator resources—and they need to begin to prepare for this. Analyzing this amount of data will be like drinking from a firehose. We need to develop ways of automating the processing and analysis of VLBI data because we will not have the resources to do so otherwise. I am happy to see that many groups are taking steps in this direction, and we need to continue doing so. Fortunately the VGOS transition is not going to happen overnight, and we have time to work on it.

*VLBI is a very complex technique. How important are VLBI analysis schools for the analysis centers and young scientists?*

I think analysis schools are crucial in developing the next generation of VLBI scientists. There are many moving parts, and no-one has a deep understanding of all areas of VLBI. Geodetic VLBI is such a specialized technique that I don't think there are many graduate level courses on it. A lot of the training is done 'on-the-job'. These VLBI schools are a great way for the younger scientists to learn from the older scientists. And I think the social interactions at these schools are as important as the classroom learning. I congratulate Rüdiger Haas on organizing the school at Helsinki, and look forward to participating in the next one in South Africa.

*You are also the president of NVI, Inc., a very important contractor for the VLBI program at NASA. What is your business model to survive in a competitive, market-oriented economy with duties for a non-profit organization like the IVS?*

I must say that I view myself primarily as a scientist, and as a businessman second. NVI's slogan is "Scientific and Technical Excellence". Our business model is very simple—hire the best people that we can to provide the best service that we can. Because of the caliber of people that we hire, we are not cheap. But I think that NASA recognizes that you get what you pay for. There is no company in the world that has the breadth and depth of VLBI knowledge as NVI, Inc does. The PC Field System, Sked, and Calc/Solve, all of which are widely used in the IVS in their current form, are maintained, and in many cases developed, by NVI scientists under contract to NASA. The second part of our business model is

to treat our employees well. We must be doing a good job here, because our median hire date is in the 1990s.

*When a long working day comes to an end, what kind of non-VLBI, leisure activities do you pursue?*

One of my favorite activities is playing Go, which I do almost every day. This is an ancient strategy game popular in China, Japan, and Korea. I got introduced to Go in college, but did not have much opportunity to play until the late 1990s when I could play online with people from all over the world. What I love about Go is how such simple rules lead to such a deep and complex game. I keep on achieving new levels of understanding. Go ranks run from 30 kyu to 1 kyu, with 30 kyu being a beginner, and then from 1 dan to 9 dan. I am currently 5 kyu, which is an intermediate amateur. My goal is to make 1 dan in the next couple of years.

I enjoy live theater and attending classical music concerts with my wife. Seeing things in the flesh is much more exciting than recordings! Six years ago I fulfilled a long-term dream and learned how to ride a motorcycle. When the weather is good, I ride it to work. After the IVS General Meeting in Hobart, I spent a couple of days riding around Tasmania on a motorcycle. And I still retain a deep interest in the philosophy and foundations of math and science—which is probably not surprising for someone trained in theoretical physics.



*John at the inauguration of the VGOS antenna in Isbioka.*



*John playing his favorite game—Go.*



*John standing at the welcome sign in the entrance area of NASA Goddard Space Flight Center.*

## TIGO becomes AGGO

– Hayo Hase, BKG

The Transportable Integrated Geodetic Observatory (TIGO) of the German Federal Agency of Cartography and Geodesy (BKG) has been operated jointly with the University of Concepción (UdeC) and the Chilean Military Geographical Institute (IGM) as part of a scientific-technical cooperation between Chile and Germany during the period 2002–2014. However, after the megathrust earthquake (M8.8) on February 27, 2010 a sustainable financing of the TIGO operation could not be continued. As a consequence, Germany had to look for a new project partner.



*Nov 4, 2014: The TIGO radio telescope is partially disassembled and ready to be stored into a container. In front, the team that prepares the move to Argentina.*

In 2012 the future cooperation partner of BKG was identified in the National Research Council of Argentina (CONICET) of the Ministry of Science in Argentina. The signing of an agreement of cooperation between BKG and CONICET in 2013 was the signal to begin construction work



*Jan 6, 2015: The TIGO containers are ready to be picked up, but await progress in administrative paperwork (e.g., export and import permissions, contract with shipping company).*

on the platform to host TIGO in La Plata. The selected site is about 500 m away from another research institute of CONICET: the Argentinean Radio Astronomy Institute (IAR). The construction work includes the erection of a new building that will take over the operation room function from the containers, a necessary step to replace the more than 20-year-old structures. The platform has been completed as of yet and is ready to receive the TIGO containers.

In parallel to the activities in Argentina, in Chile TIGO was prepared for its move across the Andes. All equipment and facilities were disassembled and stored by the company MT-Mecatronica. Some parts, including the 6-m radio telescope, received an overhaul. The convoy will consist of eleven trucks, which will move eight standard containers (40 feet), three half-size containers (20 feet), and one maintenance cart. Two accompanying cars will escort the delicate freight.



*The anticipated 2.924-km route of TIGO from Concepción via Pino Hachado to San Juan and then on to La Plata.*

The loading procedure in Concepción is scheduled for April 9, 2015. Consequently the move will start on April 10. The transportation route is 2.924 km long and will lead from Concepción to the low Andes pass at Pino Hachado (1884 m) in order to avoid risks of high altitude passes above 3.500 m (i.e., beyond hard disk drive specifications) and dangerous switchbacks at the northern passes. On the Argentinean side, the route will go straight north to the town of San Juan, where CONICET is able to perform the importation of scientific goods. From there the convoy will go on to La Plata.

Upon arrival the acronym “TIGO” will become history. At La Plata the TIGO components will be used to construct the Argentinean-German Geodetic Observatory (AGGO). In other words, TIGO will become AGGO.

The reassembly is scheduled for the following months. While MT-Mecatronica is responsible for putting the radio telescope together again, the majority of the tasks will be performed by the new Argentinean staff—Fernanda Camisay, Florencia Toledo, Augusto Cassino, Federico Salguero, and Jose Vera (CONICET)—under the supervision of Hayo Hase and Michael Häfner (BKG). Additional expert support will be provided by BKG staff in Germany.

TIGO, or rather AGGO, will be an important contribution of Argentina and Germany to the global geodetic observation infrastructure. The observatory will be one of two fundamental stations for geodesy that BKG provides for the realization of the Global Geodetic Observing System (GGOS).



## The Birth of the Asia–Oceania VLBI Group for Geodesy and Astrometry

– Jim Lovell, UTAS; Ryoji Kawabata and Shinobu Kurihara, GSI; Jungbo Cho, KASI; Fengchun Shu, SHAO; and Sergei Gulyaev, AUT

Over the past decade, the Asia-Oceania region has seen a significant increase in representation within the IVS. Several organizations from Australia, New Zealand, and South Korea have become IVS Member Organizations, and the number of geodetic and astrometric facilities in the region has increased with new telescopes at Warkworth, Sejong, Ishioka, Kunming, Tianma, Hobart, Katherine, and Yarragadee.

Countries in the Asia-Oceania region are also linked by challenges particular to the region, which is highly dynamic in geophysics and climate, with a large number of destructive earthquakes, tsunamis, typhoons, and cyclones. In order to better understand the risks and reduce the effects of these phenomena, VLBI has an important role to play through the measurement of tectonic plate motions, the atmospheric variations, and the determination of the Geodetic Reference Frame for the region.

As a consequence of these challenges and the increased involvement in geodetic and astrometric VLBI in the region, the Asia-Oceania VLBI Group for Geodesy and Astrometry (AOV) was formed. Presently, it includes members and facilities from five countries in the Asia-Oceania region: Australia, Japan, South Korea, China, and New Zealand. The purpose of the AOV is to foster and encourage closer collaboration in the science, technology, and education aspects of VLBI in the region, to establish an observing program, and to meet regularly to facilitate these activities.

*Genesis of AOV:* Informal discussions on the need for the AOV began with Jungbo Cho, Fengchun Shu, and Shinobu Kurihara over dinner during the 21st EVGA Meeting in Finland in 2013. Following a positive and enthusiastic response at their home institutions, the discussions were expanded to include colleagues from other organizations in the region with another informal meeting at the IAG Scientific Assembly in Potsdam in September 2013. A name and acronym for the new group was tentatively agreed and work began on the Terms of Reference. Support for the establishment of the AOV was received from the IVS Directing Board at their meeting on September 7.

Work continued over the following months, culminating in the first meeting of the AOV prior to the 8th IVS General Meeting in Shanghai in March 2014. More than 30 people attended the inaugural meeting. The final draft of the Terms of Reference was agreed shortly after and the process of electing a Chair and Secretary was put in place. Voting in the election was institute-based and was managed by the AOV Election Committee comprising of Shinobu Kurihara, Stas Shabala, Fengchun Shu, Sergei Gulyaev, and Jungbo Cho. Jim Lovell (University of Tasmania) was subsequently elected as Chair and, in accordance with the Terms of Reference, he appointed Ryoji Kawabata (GSI) as Secretary.

*Start of AOV Activities:* The highest priority within the AOV is to establish an observing program focused on the region and where member organizations manage all aspects of the program from scheduling through to analysis, research, and publication. Presently, the only IVS observing program optimized for the Asia-Oceania region is the Asia-Pacific Space Geodynamics program (APSG) which is scheduled for two days per year. Following consultation with the AOV Membership, we have arranged for six more sessions in 2015 for which scheduling will be carried out at the University of Tasmania, GSI, or SHAO, and correlation will be shared (two sessions each) between SHAO, GSI, and NGII. Seventeen telescopes will participate in AOV observations in 2015 (see Figure). The observed data will be e-transferred to the correlators as much as possible and, during the observations, the data from Hobart and Tsukuba will be transferred in real-time to the Tsukuba Correlator for near-real-time processing.



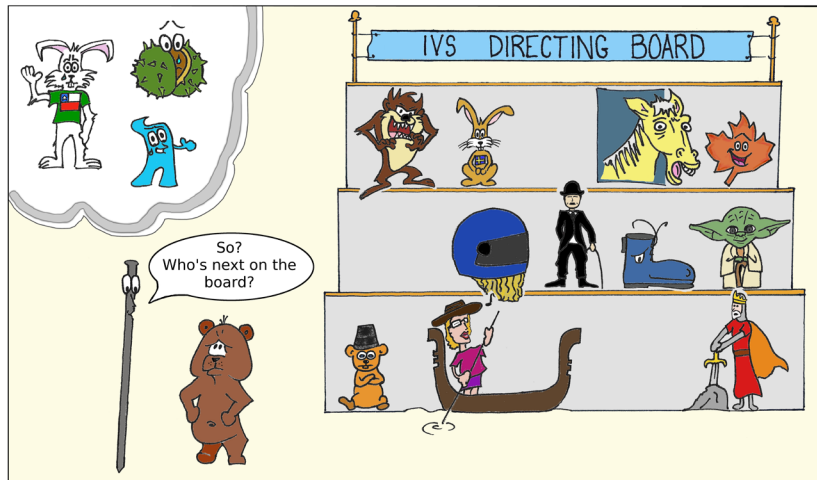
The 18 telescopes participating in the first year of AOV observations. All five countries are represented.

The correlated data from AOV sessions will be analyzed and compared by two or more analysis centers in the region. Results will be used to help improve the schedules of future AOV sessions and consequently the quality of the final data products. Most of the sessions will be geodetic with attention given to improving the measurements of the terrestrial reference frame in the region, but one session will include the large sensitive telescopes at Tianma (65 m) and Parkes (64 m), and this will be focused on improving the celestial reference frame.

Another high priority within the AOV is to establish a program of regular scientific and working meetings along similar lines to the EVGA. We hope to arrange a meeting toward the end of 2015 to discuss research programs, technical developments, compare results from the 2015 observing campaign, and plan future activities. More importantly, this and other meetings will help strengthen collaborations within the region.

## New Directing Board Members Elected

— Shinobu Kurihara, Geospatial Information Authority of Japan



From November 2014 through February 2015, elections for the representative and at-large positions on the IVS Directing Board were held to fill the vacant seats of the Board.

An Election Committee consisting of Dirk Behrend (NVI, Inc./GSFC, USA), Hayo Hase (BKG, Chile), and Shinobu Kurihara (GSI, Japan; Committee Chair) was appointed and tasked with conducting the elections. In these elections, one representative position each for the Network Stations, for the Correlators and Operation Centers, and for the Analysis and Data Centers as well as three at-large positions were up for election. Three of the current position holders were not eligible for re-election due to their completing two consecutive full terms on the Board.

In order to attract the interest of the IVS Associate Members and to improve the voting rate, the Election Committee prepared a flyer for the elections with a humorous cartoon. The flyer was distributed together with the December Newsletter and in a reminder message of the call for nominations.

The representative elections ended up with an excellent set of candidates: two for the Network Stations representative, two for the Correlators and Operation Centers representative, and three for the Analysis and Data Centers representative. In addition, 180 of the 291 eligible Associate Members cast their vote (61.9%). This was one of the highest voter turnouts in the history of the IVS.

Torben Schüler (BKG, Germany) was elected to be the new Network representative taking over for Hayo Hase (BKG, Germany/Chile) who finished out his term. Alessandra Bertarini (Bonn Correlator, Germany) and Arthur Niell (MIT Haystack Observatory, USA) were re-elected as the Correlators and Operation Centers representative and the Analysis and Data Centers representative, respectively.

Subsequent to the representative election, the Directing Board selected three at-large members, considering the balance of representation from countries, regions, institutions, and interests. Alexander Ipatov (IAA, Russia) was re-elected, and Ryoji Kawabata (GSI, Japan) and Guangli Wang (SHAO, China) became the new Board Members for the at-large positions.

The Election Committee would like to thank all of the candidates who participated in the elections and all of the Associate Members who exercised their privilege to vote. The next Directing Board Meeting will be held at Ponta Delgada, Azores, Portugal on 22 May 2015 with both the outgoing and incoming Board Members.

### Upcoming Meetings...

EGU General Assembly 2015 Vienna, Austria April 12-17, 2015	IUGG XXVI General Assembly Prague, Czech Republic June 22 - July 2, 2015
Eighth IVS TOW Westford, MA, USA May 4-7, 2015	XXIXth IAU General Assembly Honolulu, HI, USA August 3-14, 2015
22nd EVGA Working Meeting Ponta Delgada, Azores, Portugal May 17-21, 2015	AGU Fall Meeting San Francisco, USA December 14-18, 2015

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

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](mailto: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.

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

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

## Why Should I Care about System Temperature?

– Rich Strand, NVI, Inc.

Operators for the IVS who are running an observing session using a single-dish station have the disadvantage of actually not knowing for certain if the data will produce observables or fringes with another station. The data acquired requires processing by the correlator and then careful analysis to produce the measurements used in the IVS product. The best the operator can do is to complete their check-off sheet during the pre-checks phase, to verify that the system is operational, the time is correct, and the telescope is sensitive, has gain, and is on source. The end results are often weeks or months away.

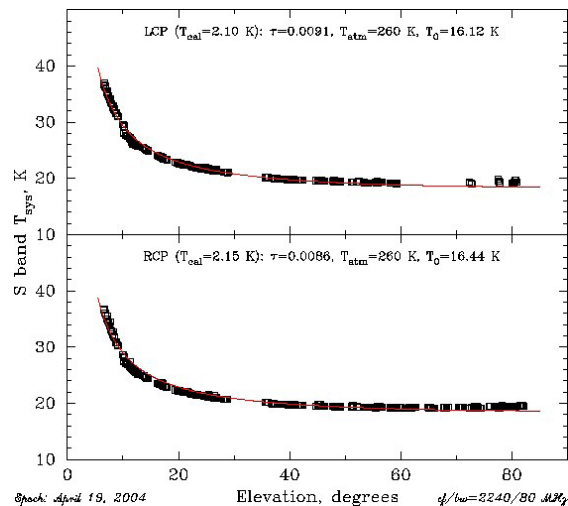
System temperature measurements are taken every scan and this column will discuss ‘How-To’ understand what the numbers are telling us, how they are derived, and how operators can use this measurement to their advantage to provide high quality data for the final IVS product.

VLBI receivers use total power detectors to measure power levels. Because the temperature and the noise power have a one-to-one relationship, it allows us to express the noise from the receiver as a temperature, which then allows us to measure ground noise and sky noise such as atmosphere, the cosmic background (2.7 K), and radio sources. When the receiver is mounted in a dish, the temperature is called the total temperature or Tsys.

The Field System makes the measurements for us. In order to do this, the program sets full attenuation on for each channel’s total power integrator to establish a baseline voltage, which then fires a noise diode to produce heat that has been calibrated in the lab. The ratio of levels with the diode on and off is then calculated with the baseline correction. This produces a system temperature that can detect weather, RFI, and sources of noise that may interfere with the overall telescope’s sensitivity. A lower value is better; often this measurement is from 30 K to 130 K, depending on the dish size and other variables.

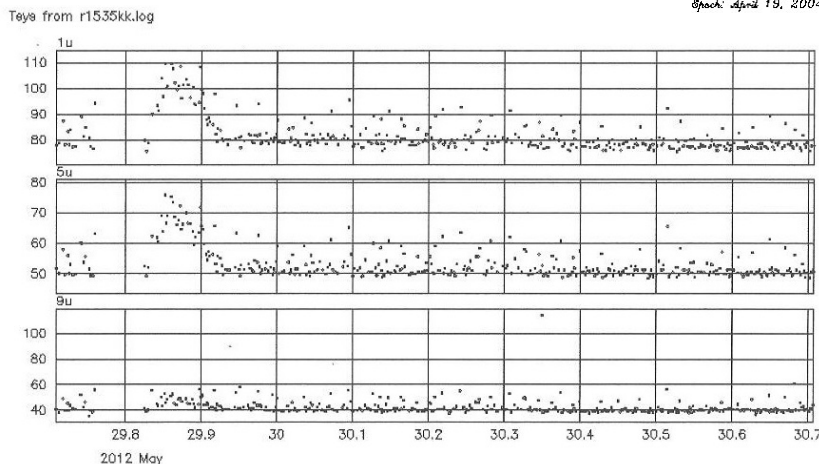
Each station should have a Tsys-versus-Elevation plot showing the normal Tsys curve as the telescope moves away in elevation from the ground noise scatter. This is a valuable baseline to detect problems in the future or changes in the telescope’s performance. The diagnostic is to run the CALTSYS procedure while moving the dish in elevation steps. These plots are valuable when having to troubleshoot the receiver or any changes made to the data acquisition system. Below is an example of a very good Tsys/elevation curve.

During the session Tsys measurements are done in every scan. Many things can cause the Tsys to jump up and it may be benign such as a cloud or a very low elevation scan. Still, it is a tool to indicate a problem and something the observer should keep visible on the PCFS screen. Another available option to the operator is that the Tsys measurement can be plotted in real-time by the program “logpl” found in the Field System library. For example, plotting Tsys might show a graph over time with a normal Tsys scatter and then a very high burst of excessive temperature due to RFI or the weather. Using this plot the operator can detect when the event happened and has a possible clue to what it was. The plot below shows an example of a rain shower.



Plot of Tsys vs. Elevation at S-band.

Tsys showing rain at Kokee Park during R1535 around May 29.85, 2012.

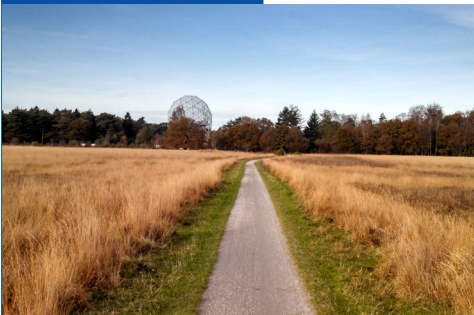




## 3rd International VLBI Technology Workshop Held

– *Chester Ruzsyczke, MIT Haystack Observatory*

The 3rd International VLBI Technology Workshop was hosted by the Joint Institute for VLBI in Europe (JIVE) from 10–13 November 2014 in Groningen, the Netherlands. The workshop encompassed research and development relevant to VLBI and was attended by community members from Africa, the Americas, Asia, Australia, and Europe.



*The Dwingeloo 25-meter antenna which is now maintained and used by radio amateurs and amateur astronomers together with Paul Boven of JIVE.*

The meeting started—as all previous meetings in this series (including the e-VLBI workshops)—with an ice-breaker where old and new acquaintances were made and technical support debts were paid. After the workshop opening by Arpad Szomoru and welcome words by Huib van Langevelde, the actual presentations started. Of interest to the IVS community were topics in the areas of VGOS, correlators, VEX2, frontend and backend developments, global VLBI developments, time-and-frequency transfer and data transport challenges, and the EVN NREN updates. Additional presentations on mm-VLBI as well as space science technology and capabilities were provided. The complete program and presentations for the workshop is available online at <http://www.jive.nl/ivtw2014/programme.php>.

For VGOS, updates were presented on the status of the KPGO signal chain build-out by Haystack, the status of the VGOS system under test at Westford and GGAO, and the complete end-to-end geodetic system, including a new 16-Gbps data recording system, backend, and correlator (GPU based) developed by the folks at the Institute of Applied Astronomy of the Russian Academy of Sciences (IAA RAS). The groups from Japan presented their VGOS receiving system and the Chinese introduced their recent developments. The session ended with an update on the VLBI frontend from Omnisys.

Under correlation (besides GPU work), work performed at JIVE and in China on their hardware and software correlators were introduced. A VEX2 Committee member presented the VEX2 schedule format and asked the audience to get their feedback on the proposal to the committee members. Hopefully everyone has provided their input by the 19-November-2014 deadline. The frontend and backend session saw a wide range of work on wideband developments by the Russians, NASA JPL, the Europeans, and the Mark-6 system status. The folks at NICT presented their first light results on their VLBI broadband system.

For the global VLBI work in Africa, China, and on the HSA and GLOBAL VLBI Network were presented. I have to admit I have never thought I would hear Jon Romney announce that the NRAO VLBA was finally NOW FULLY OPERATIONAL and that the “last bug” was corrected more than four months before the meeting. John even admitted that we were the first audience to ever hear him say this.

The time-and-frequency distribution session was very interesting in focusing on hardware, research and ongoing methods for distributing time and frequency over Wide Area Networks (WANs). The White Rabbit project and implementation of the research in present WANs was presented along with tests using VLBI as the application for time distribution at JIVE.

Overall, it has been a very good meeting. I would like to thank the folks at JIVE for their hospitality as well as their sponsors. It was wonderful to see so many friends from the VLBI community and to sync up on developments from around the world. The next technology workshop will be hosted by Auckland University of Technology (<http://www.irasr.aut.ac.nz>) in a joint effort with the University of Tasmania from 23–27 November 2015.

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