

IVS Newsletter

Issue 44, April 2016



2nd IVS Training School on VLBI for Geodesy and Astrometry

– Frank Lemoine, NASA Goddard Space Flight Center

The IVS organized its 2nd training school at the Hartebeesthoek Radio Astronomy Observatory (HartRAO), South Africa, 9–12 March 2016. The purpose of the training school was to help prepare the next generation of researchers to understand VLBI systems and inspire them in their future careers. The 45 participants included 32 students from institutions in different countries in Africa and Asia, Europe, and North America as well as 13 professionals (including postdocs) from the VLBI community and other fields of space geodesy. Participants came from Kenya (10), Zambia (9), Germany (7), Austria (4), U.S.A. (4), China (2), Finland (2), France (2), Sweden (2), Ghana (1), Italy (1), and Spain (1). Students were enrolled in M.S. and Ph.D. programs, involved in the use and analysis of VLBI data, and indeed some were second-time VLBI school attendees. Some professionals came from space agencies or geodetic research institutes (ASI, BKG, CNES, NASA) with a view to integrating VLBI into a combined analysis of space-geodetic data. A large group of attendees included students from different countries in Africa with the aim to develop expertise in geodesy and especially VLBI as part of an effort to build new stations in Africa and integrate them into the global VLBI network. We all hope this effort will come to fruition, because it will enhance the accuracy and strength of the geodetic technique and bring new groups and new countries into the VLBI community.

The thirteen lectures (18 hours and 45 minutes over four days) covered the general theory of VLBI, the technical equipment of the stations, data acquisition, data formats and data transfer, experiment scheduling and actually observing an experiment, the use of correlators, and post-correlator analysis, an introduction to geophysical modeling and analysis of VLBI data, the characterization of radio sources, and the development of celestial reference frames. The lectures were complemented with exercises on some of the presentation topics—so the participants had a chance to apply what they had been shown. The lecturers obviously spent a lot of time preparing their presentations and lectures

which was highly appreciated. The lectures were recorded and will be made available on the Web, so they will be an invaluable resource for the attendees to review in coming weeks and months. For many of the attendees, the most exciting part of the VLBI school was to run the “sked” software to schedule a VLBI experiment involving Hartebeesthoek and Wettzell, and then watch Alexander Neidhardt remotely operate the Wettzell telescope via his laptop in the room with the class in South Africa, while the HartRAO 26-m (visible right outside the windows of the classroom) moved in tandem to observe the same radio sources. It gave all the attendees a demonstrable and clear sense of participation and understanding of how VLBI data are acquired.

For all the attendees at the school, the retreat format with the abundant time for interaction and discussion during the class and the coffee breaks were especially useful. It's much easier to approach people with questions in this type of retreat format, than in a crowded conference setting such as the EGU or the AGU with their tsunami wave of attendees (10,000–20,000 people). As a senior researcher, I found the contact and presence of the many students to be invigorating. It bodes well for the future of the discipline.

All the attendees appreciated the organization by school organizers and lecturers, and especially by the HartRAO observatory. HartRAO prepared a room with PCs where everyone could follow directly the presentations, search for reference material on the Web, or run the programs involved in the class exercises. This is a recipe that should be followed for future VLBI schools if at all possible. In the evening of the last day, after the end of astronomical twilight, the northern hemisphere attendees had the pleasure of contemplating Alpha and Beta Centauri as well as the Southern Cross in a setting devoid of light pollution, crowning a truly memorable week.

Acknowledgement. The 2nd IVS Training School was supported by HartRAO (e.g., by providing the lecture room, transportation, coffee, lunches & barbecue). MT Mechatronics (Mainz, Germany), Hat-Lab (an Istituto Nazionale di Astrofisica spin-off company), and Callisto (France/UK space communications company) provided financial support allowing the actual student participants of the school to receive a travel grant in the amount of 2900 ZAR.



Attendees of the IVS Training School in front of HartRAO's 26-m antenna.



In the classroom during a Training School exercise.

New Technology Coordinator

Following in the footsteps of Alan Whitney and Bill Petrachenko, Gino Tuccari now has become the third IVS Technology Coordinator. In South Africa, he officially took over the reins from Bill, who is going into phased retirement (reduced working hours) before retiring for good in two years. Gino is well known in the IVS community, but his views on and plans for his new coordination task are largely unknown. To fill this void, Newsletter Editor Hayo Hase interviewed Gino via e-mail.



Gino Tuccari, the new IVS Technology Coordinator.



Noto's radio telescope at night.

Gino, what were your thoughts when you were elected the new IVS Technology Coordinator?

I sensed a mix of different emotions when I was elected. Of course I'm honored because of the previous coordinators. Alan Whitney is a 'reference rock' with his contribution to the VLBI development, with his way to promote standards we use every day, just to mention a few elements. Bill Petrachenko was a great influence in the VGOS definition and development, helping to define rules we are referring to today for building the new generation of geodetic radio telescopes. Following in their footsteps is not an easy task, but it is a great opportunity to give a lasting contribution. I'm strongly motivated to proceed in the existing line of continuity and at the same time I believe the requirements are now streamlined. We have a better glimpse of the future by having the first VGOS stations starting to produce data and the next ones following close behind. It's exciting!

The IVS Technology Coordinator is one of the three coordinator positions in the IVS and is a key figure for making VGOS a reality. What are open technology issues that need to be

resolved?

There are several issues that need to be resolved. Let me just mention a few. In order to have a more sustainable and efficient geodetic VLBI network, automation and remote control are fundamental elements. With the latest available technology applied to sampling and digital data processing

we will produce a huge amount of useful data. A possible bottleneck will be the recording, transfer, and correlation of this massive amount of information. There appears to be a need to devote a strategic development effort to this element in the coming years. Mitigating and robustness against RFI will be essential because of the ever increasing commercial usage of the VGOS frequency band. A real time 'RFI fingerprint' for all the stations can be a starting point to optimize the selection of the observing frequencies. Moreover, we should not lose sight of the possibility to go to higher frequencies.

How do you anticipate to cooperate with the Technology Development Centers?

This point requires a good degree of interaction; but, you know, the IVS community is sort of a big family, with good internal relations and collaborations. There already is quite some personal contact between the various groups. There may be room for improvement; e.g., by having teleconferences on a regular basis or holding occasional face-to-face meetings at regular IVS events (such as General Meetings or TOW workshops). As a first action I plan to revise the VGOS documents and to compile the status of the current trends, achievements, and experience from existing stations. Representatives from the Technology Development Centers, VTC, and VPEG will be called upon to contribute in a virtual round table which I plan to start via e-mail before summer. I think we could call it the IVS Technical Review Forum or something similar.

What is your interaction with other groups like VTC, VPEG, and Working Groups?

I'm VTC member since its inception, so I know pretty well how it works. I was mainly involved for the DBBC development. However, now I plan to play a different role, passing on the task of providing DBBC development updates to some of the other DBBC collaborators. I am happy to be part of VPEG and to become part of any technology-related working groups.

Do you have some personal goals as IVS Technology Coordinator?

I have a number of goals as IVS Technology Coordinator. They may be unrealistic; for that, I try to keep in touch with reality and will tackle them one by one. I gave a first picture of my planned activity in my new role at the recent Directing Board meeting. As already mentioned, I would like to review and update the documents currently used as reference to build and develop the new VGOS network. This will require help and contributions from all involved parties. Moreover, I would like to collect the current status of the existing developments in terms of receivers, backends, observing schemes, and frequencies covered, among others. Indeed, I experienced first-hand the possibility of confusion in these elements, with development groups often understanding only their own part well. I would like to disseminate perti-

nent information in the easiest and clearest way to everyone, making use of interactive Web pages to be published on the IVS Web site. I'll need help from Dirk Behrend and his collaborators in this. Compatibility has a high priority and developments must be within the VGOS guidelines. So I hope an information compilation will help to achieve my goal for the different developers and upcoming observing stations.

We also would like to know some biographical information about you. When and how did you enter the field of VLBI?

I came to VLBI after studying Physics at Catania University, spending half-a-year as post-graduate student, and then working four years at the semiconductor company STMicroelectronics (where I learned how to deal with more complex items at the same time and, to some degree, how to manage people—even having the title of group coordinator). One day at the end of 1988 I heard about the opening of a new VLBI radio telescope at Noto, and it was then that I wanted to be part of the station personnel. I applied a couple of days later and was selected. I left my permanent position close to my home, for a new temporary activity 120 km away, with a lower salary. You can see that it was love!

You arrived as a young physicist at the Noto radio telescope. What were your duties there?

I was selected to handle the radio telescope instrumentation, and probably as someone with at least some managing experience (not too much). Being able to 'touch' things helped in satisfying my scientific and technical interests and curiosities. A radio telescope in the night is like a cathedral: deserving respect and inspiring mystery. That is the same feeling I still have in front of any radio telescope today. My very first job was to write the software (together with Salvo Buttaccio) to run the Noto radio telescope using a personal computer (yes, a PC!), because in the very beginning the antenna was driven by the mainframe computer HP1000. This software is still used to drive the Noto radio telescope and will only be replaced hopefully in the next few months (after 26 years). After that I went through all technical levels of responsibility up to be full Noto INAF Section manager for almost ten years. Finally, in July 2015, I gave up any duty at Noto station. Now I'm working almost entirely at the Max Planck Institute in Bonn, and I will probably spend the next few years there.

The DBBC is now available in the third generation and will be used at various VGOS stations. When and why did you start the development and what are the plans for the future?

I started the DBBC development in the first years of the new millennium. But it had been on my mind for quite some time. I commenced the work, because nobody was doing it and we could not wait anymore! Recently, the DBBC3 was introduced to be used in several VGOS and EVN stations. It represents an impressive platform for collecting and managing VLBI data. The development will continue with the BRAND EVN project, part of the Radionet4 proposal. My hope is that this development will help make the entire EVN

network compatible with the IVS VGOS at the receiver and backend level. BRAND EVN is a receiver covering the range of 1.5 –15.5 GHz in full digital fashion, capable to observe different bands at the same time (L, S, Methanol, X, Ku), offering new and unexplored scientific opportunities in VLBI, spectroscopy, polarimetry, single dish, and keeping an eye on the RFI constraints.

How do you see the rival backend developments in the U.S., Russia, China, and Japan?

The backend developments in the mentioned countries are a precious element for comparisons and enrich everyone. It's a democratic process and the real value of any of these developments lies with the improvement of the other systems. Would you consider it efficient to have a parliament consisting of a single party only?

If you are not working for IVS, VLBI, or DBBC, what kind of leisure interests do you pursue?

I feel as though my life and time are 'unique'. I do not like to let it go to waste but rather prefer to live it in harmony. When I don't work I spend time with my family, my wines (I grow grapes on the Etna slopes), symphonic music, psychology studies, and, yes, with thinking about my work, which probably is my preferred hobby!

Gino, thank you so much for the interview. We wish you great success in your new function as IVS Technology Coordinator.



The Team China II at the Bund in Shanghai in 2000: (left to right) Chopo Ma, Gino Tuccari, Michael Wunderlich, Les Parry, Ralph Spencer, and Ed Himwich.



Gino during a visit to MIT Haystack Observatory in 1998.

9th IVS General Meeting – A Meeting of Many Firsts

– *Benedikt Soja, GFZ Potsdam*

This year's IVS General Meeting was held in South Africa, close to Hartebeesthoek Radio Astronomy Observatory (HartRAO), signifying the first time the General Meeting was held on the African continent. It was preceded by an IVS School, which meant that a significant part of the participants was already on site and well acclimatized when the meeting commenced. In addition to the usual denizens at IVS meetings, this year several students from other African countries that will be part of the African VLBI Network (AVN) joined the meeting.

South Africa's scientific landscape, particularly highlighting the support of astronomy disciplines (e.g., via the Square Kilometer Array).

The first oral session was chaired by Gino Tuccari and Evgeny Nosov. After an invited talk by Graham Appleby about SLR activities, the VLBI fiesta started with an invited talk by Mamoru Sekido and the following presentations about advances in VGOS stations and technology. During lunch break, a buffet of local specialties was served. The second oral session (chaired by Bill Petrachenko and Brian Corey) about VGOS strategies and expected results featured an invited talk by Roger Cappallo. During the day, strong rain poured down, but the overwhelming noise of the rain hitting the roof could not stop the enthusiastic speakers. It certainly created a unique atmosphere. The same day, the poster session chaired by Dirk Behrend and Stanislav Shabala was held, supported by well-received South African beer and wine, leading to intricate and productive discussions.

The next day, Fengshun Shu and Ed Himwich led through the third oral block about stations, correlators, and operations centers, including an invited talk by Sten Bergstrand of the IERS Working Group on Site Surveys. After lunch at Ekudeni, three shuttle busses transported everyone to HartRAO. The rain had stopped for once, and we enjoyed the guided tours with Ludwig showing us the SLR station, Jonathan Quick the control room, and George the 15-m and 26-m telescopes (the latter was built in 1961!). To keep up with the ever increasing accuracy requirements, a VGOS antenna will be built; we visited the intended site and witnessed the symbolic groundbreaking. Eventually, the event was concluded with local wine and beer tasting. While the vintner gave a philosophical and sophisticated motivational speech, the beer brewers countered it with a simple "just come and have a cold beer." The more than 20 wines and the four kinds of local brews, complemented with plenty of snacks, set the stage for another social mingling in beautiful weather around a bonfire.

Wednesday saw John Gipson and Ludwig guiding through a session about data structures and analysis strategies in the



Mrs. Pandor, Minister of Science and Technology, giving the opening speech.

The Local Organizing Committee (LOC) led by Ludwig Combrinck had picked a clever place as the venue of the meeting. In Muldersdrift, just outside of Johannesburg, nobody had to worry about security issues (also thanks to the comprehensive shuttle services) and could enjoy the wild and original nature of the countryside. Also, I later found that at the time of the meeting the garbage collection in

Jo'burg had been on strike for several weeks, which would not have been a pleasant picture for the participants. From the conference venue at Ekudeni, it was not far to great sightseeing opportunities, such as the Cradle of Humankind (a fascinating World Heritage Site where famous skeletons of hominins had been found) and several game reserves (such as lion and rhino parks), which several of the participants explored during the days before or after the meeting.

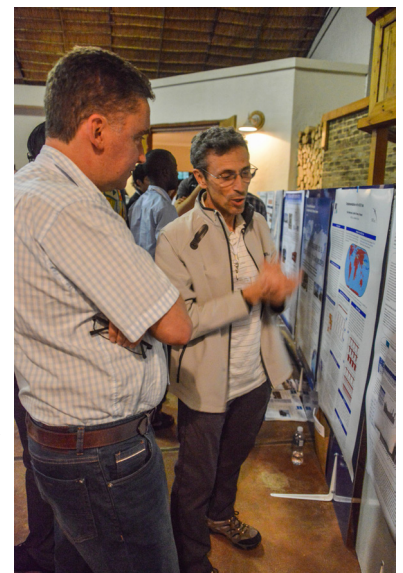
After a fast registration on Sunday, March 13, participants were shuttled to Eduzani, where the icebreaker reception was held. After speeches by Ludwig, Axel Nothnagel (IVS chair), and George Nicolson (former director of HartRAO), we were asked to "mingle" with the others for the evening. And that's what we did, supported by delicious snacks and exhilarating drinks.

It was great to see old friends again and get to know new VLBI enthusiasts. Like every day, the shuttles safely brought everyone home.

On Monday morning, participants gathered in an impressive thatch-roofed hall, and Axel officially opened the meeting. This was followed by a speech by the Minister of Science and Technology, Mrs. Pandor, dealing with



Stunning performance by tribal dancers at Lesedi.



Poster session at the IVS General Meeting.

NEWS...

VGOS era, followed by the fifth oral session, titled geodetic and astrometric results (chaired by Johannes Böhm and Stanislav). Here, Sabine Bachmann gave an invited talk about the IVS contribution to the ITRF2014. Active discussions were stirred up by the talk of Richard Gross on the Kalman filter approach for the ITRF determination followed at JPL. The last invited talk was given by Patrick Charlot on the roadmap to the next incarnation of the ICRF, in particular going into the connection to Gaia.

Then, Per Erik Opseth had the honor to announce that the next IVS General Meeting will be held in Longyearbyen, Svalbard, Norway, showing an impressive trailer video. The program will include a visit to and the opening of the new observatory at Ny Ålesund. As the IVS meeting thus moves from the far South to the (really really) far North, we were reminded not to forget bringing warm clothes.

For the evening, the traditional conference dinner was scheduled. Busses transported everyone to the Lesedi Cultural Village. We were given a warm welcome with chants by tribal dancers as well as a drink. The dinner speech was given by Harald Schuh, former IVS chair and current IAG president. Harald celebrated his 60th anniversary, delivering a personal retrospective of his involvement in VLBI during the last 38 years, culminating in a “toast to VLBI.” Subsequently, the audience could enjoy a performance by tribal dancers, covering the styles of many cultures in and around South Africa. To thundering drums and vivid chants, the dancers showed incredibly acrobatic movements, making one wonder about their highly stretchable hamstrings.

After this overture, the main act followed: the dinner with a delicious buffet from the local cuisine, including specialties like crocodile, ostrich, caterpillars, and chicken feet. Ludwig wittily led through the evening and moderated addresses by the Deputy Director-General of Research Development and Support, Thomas Auf der Heyde, and Axel. The great band motivated quite a few of the meeting participants (many of the older generation!) to shake a leg to the funky grooves. Also in this respect, it was truly “a meeting of many firsts” as Axel noted. Finally, a huge cake was presented with an image of the HartRAO radio telescope, celebrating the 30th anniversary of the observatory. This way, everyone got the chance of tasting a piece of the iconic telescope (a first, yet again!).



The beautiful landscape of the Swartkop Mountain Range.

The last oral sessions commenced on Thursday, with the final topic “VLBI observations of space vehicles” (chaired by Vincenza Tornatore and Rüdiger Haas). Ludwig wittily led through the evening and moderated addresses by Thomas Auf der Heyde (Deputy Director-General, Department of Science and Technology) and Axel. While the regular meeting had ended, the next two days saw the analysis workshop and other splinter meetings, including, for the chosen ones, the Directing Board meeting.

All in all, the 9th IVS General Meeting was a huge success, with presentations of outstanding research, productive splinter meetings, diverse social activities, and all of that in a very friendly atmosphere and unique venue. The organization was flawless for which the LOC cannot be thanked enough. The bar is definitely set high for the next meeting in Svalbard.



Eye-to-eye with South African wildlife: sable antelope, white lion, and giraffe.



Groundbreaking for HartRAO's future VGOS telescope.



Participants discussing VLBI in the lecture hall during a session break.

First Asia-Oceania VLBI Meeting

— Lucia Plank and Jim Lovell, UTAS; Ryoji Kawabata, GSI

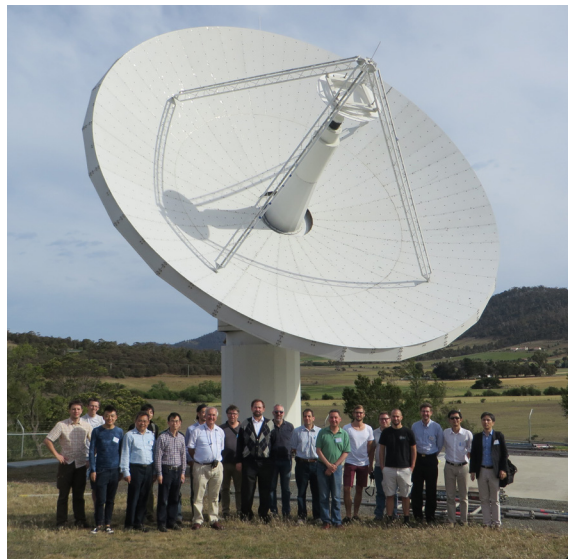
A little more than a year after its approval by the IVS Directing Board, the Asia-Oceania VLBI Group for Geodesy and Astrometry (AOV) held its first meeting in Hobart on November 19–20, 2015. 18 participants representing eleven institutions from six countries gathered to discuss ‘A Vision for Science and Technology with the AOV.’ The program began with reports from each member institution, going counter-clockwise around the Pacific from New Zealand (AUT) to Japan (GSI, NCIT, NAOJ), to South Korea (KASI) and China (SHAO), and eventually to Australia (CSIRO, UTAS). It was a great pleasure to see that each representative took the Chair’s directive to build a vision to heart as well as specific plans for the future of the AOV. An infectious sense of enthusiasm emerged.

The late afternoon of November 19 was spent on a tour of the Mt. Pleasant Radio Observatory, the home of the Hobart 26-m and 12-m antennas—some readers may still remember the red double-decker bus from the GM2010; it is still going! The day found its end in the conference dinner with local wine and seafood on Hobart’s waterfront. The second day began with more talks, this time concentrating on the specific research areas of the AOV members. This was also a time for our AOV guests to present their ideas; for instance, Phrudth Jaroenjittichai from the National Astronomical Research Institute of Thailand told us about radio astronomy in Thailand.

Once the formal part of the meeting concluded with a sushi and pizza lunch, it became abundantly clear that this had been quite a special meeting. Perfect conditions for the AOV Business Meeting and open discussions. Our highest priority was given to the AOV sessions, a new type of IVS observing sessions that began in 2015, with sessions all being planned, scheduled, observed, and correlated within the AOV. It was emphasized that this is essential to maintain knowledge and build experience in these tasks within the individual groups. Six AOV sessions are planned for 2016, with 9–13 participating antennas per session. These will be scheduled and correlated by four different AOV institutions.

Emphasis is also high on increased collaboration within the region, sharing results and progress on an informal basis, and supporting test observations or other special sessions as flexibly as possible. The complete list of agreed priorities for the group, including the minutes of the meeting as well as links to the presentations can be found on the AOV Web site: <http://www.spacegeodesy.go.jp/vlbi/AOV>.

Besides learning much more about the work, aims, and priorities at other institutions, my personal best experience of these two days was different: the fact that, although I have met most of my AOV colleagues at several meetings before, I have never talked with them as much as during these two days. And, it is well known that talking brings people together. Go AOV and see you at the upcoming AOV splinter meeting at the IVS General Meeting in South Africa!



Participants of the First AOV Meeting in front of the Hobart 12-m antenna.

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

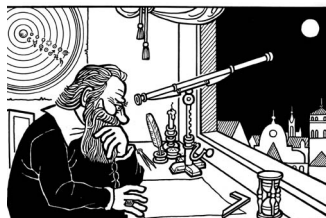
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The newsletter is published in color with live links on the IVS web site at

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



The sun, with all those planets revolving around it and dependent on it, can still ripen a bunch of grapes as if it had nothing else in the universe to do.

—Galileo Galilei

VGOS: Development into Operations

– Alex Burns and Michael Poirier, MIT Haystack Observatory

In 2015 at the Westford antenna site we started the full and complete hardware implementation of the VGOS system. We began the transition from engineering and development testing to all facets of schedule-based operations using the Westford and 12-m GGAO telescopes. Throughout this period we have continually improved our quality by detecting and identifying VGOS station specific issues that would possibly jeopardize successful operations. This included stabilizing the hardware configurations, implementing software controls, learning the individual subsystems, and the PCFS controls which make up the whole VGOS VLBI system. This information is continually passed forward within VGOS operational documents to new sites as they come online. We are presently using what we have learned to assist in the testing and commissioning of the new Kokee 12-m antenna in Hawaii.

In our opinion, this has been the largest and most comprehensive technology change of the VLBI system since the inception of this technology in the 1960's. Within the next few How-To articles we will address the individual pieces that make up our new VGOS system. We will look at these pieces through operational eyes and pass on our experiences. We aim to hopefully smooth the transition and understanding for those of you who have yet to transition and experience this operational technology.



The 12-m radio telescope at NASA Goddard Space Flight Center.



Westford Dewar housing the QRFH broadband feed.

Upcoming Meetings...

EGU General Assembly Vienna, Austria April 17-22, 2016	SciDataCon 2016 Denver, CO, USA September 11-13, 2016
The Science of Time Cambridge, MA, USA June 5-9, 2016	1st Int'l Wksp on VLBI Observations of Near-field Targets Bonn, Germany October 5-6, 2016
18th Int'l Symposium on Geodynamics and Earth Tides Trieste, Italy Jun 5-9, 2016	5th Int'l VLBI Tech.Wksp Westford, MA, USA October 12-14, 2016
GAGER2016 Wuhan, Hubei, China July 18-23, 2016	GGOS Days Cambridge, MA October 24-28, 2016
AOGS 13th Annual Meeting Beijing, China July 31-August 5, 2016	AGU Fall Meeting San Francisco, CA, USA December 12-16, 2016
WDS Members' Forum Denver, CO September 11, 2016	

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



VGOS racks meet legacy Mk4 rack.

9th DiFX User Meeting

– Lucia Plank, UTAS; Chris Phillips, CSIRO



Participants of the Ninth DiFX User Meeting in front of the Hobart 26-m antenna.

The major difference between a software and a hardware correlator is the fact that software can be modified, amended, improved, and kept up-to-date with most recent developments, whereas the hardware is basically static. A good reason for holding annual DiFX User Meetings, the most recent one being held in Hobart from 16–20 November 2015.

Run in a relaxed and informal atmosphere, we began with some presentations about people's interests in DiFX, recent problems that have occurred, successful troubleshooting, and reports about ongoing development. For me as geodesist (and a newbie in correlation), it was very interesting to hear Walter Brisken explaining the necessary changes for the Mark6 data and Roger Cappallo (via Skype from

the U.S.) reporting about his work on the DiFX-to-HOPS pathway, the post-correlation procedures applied in geodetic VLBI. For the interested reader, all presentations are available on the DiFX Wiki at <http://www.atnf.csiro.au/vlbi/dokuwiki/doku.php/difx/meetings/hobart2015>.

Another topic of discussion was licensing: with the number of users and developers of DiFX growing constantly, it was decided to re-license the software under an open source GPLv3 license. This process is ongoing and will be announced soon.

After two days, complete with heaps of opportunities to ask all your questions about this 'magic box' called DiFX, the masters of DiFX began their real work: sometimes you have to travel to the other side of the world just to make sure you have these three days with time dedicated to do the programming and debugging that has been on your to-do list for ages. And this will be the reason for the 10th DiFX User Meeting in 2016.

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