



Bill Petrachenko Receives Career Service Award!

– Calvin Klatt, *Natural Resources Canada*



Dr. Bill Petrachenko and Ms. Christyne Tremblay, Deputy Minister of Natural Resources Canada, at the Departmental Awards Ceremony on June 15, 2017.

On June 15, 2017, Dr. Bill Petrachenko received a Career Service award from Canada's Department of Natural Resources. The Departmental Achievement Awards recognize people who have made significant contributions in support of NRCan's priorities, objectives and strategic goals.

Dr. Petrachenko has received this award because of his international leadership role to spearhead innovation in VLBI, principally through his work within the IVS as Technology Coordinator. As reported previously (Issue 44), Bill has reduced his workload before a planned retirement next year. He officially handed over his IVS Coordination functions to Gino Tuccari in South Africa last spring.

Bill is very well-known in the VLBI community, having spent his entire career working on many aspects of the systems, from reception of photons to determination of group delay. Four very strong supporting letters from IVS colleagues from three different countries were key to his successful nomination. These letters noted the respect of his peers and collaborators in the international VLBI community, Bill's combination of technical expertise and organizational leadership, and his dedication and steady contributions throughout his career. One support letter even said that "Nobody in the world would deserve such an award more than Bill."

The nomination noted that "Over a period of ten years Dr. Petrachenko worked with a diverse set of international partners to achieve global collaboration and ensure a common understanding of VLBI requirements and how these might be met with new investments. The international scientific community has invested hundreds of millions of dollars in the advanced systems designed under Dr. Petrachenko's leadership. In the coming years this global innovation will improve precise positioning on Earth, a necessity for many advanced scientific projects, such as monitoring global sea-level rise via observations from space."

We, at the Canadian Geodetic Survey and Surveyor General Branch of Natural Resources Canada, are proud to have been Bill's colleagues for many years, and are very pleased that he has received this recognition.



**Natural Resources
Canada**

Natural Resources Canada (NRCan) seeks to enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resources products. NRCan is an established leader in science and technology in the fields of energy, forests, and minerals and metals and uses expertise in earth sciences to build and maintain an up-to-date knowledge base of Canada's landmass.

Matera CGS VLBI Station

At the “instep” of the Italian boot, the Italian Space Agency hosts a VLBI site near the city of Matera. The province of Matera in the Basilicata region of Southern Italy is famous for its “cave dwellings”, which are known as ‘sassi’ in Italian. Matera is one of the founding members of the IVS. Newsletter editor Hayo Hase caught up with long-time station veterans Giuseppe [‘Pippo’] Bianco and Guisepppe [‘Pino’] Colucci via e-mail to learn more about the activities at the site.

The city of Matera is a UNESCO World Heritage Site and, at the same time, it is the location of an important VLBI and SLR site in Italy. Could you explain what the World Heritage Site of Matera is about and where it is located w.r.t. your site?

[Pino] The Centro di Geodesia Spaziale is about 15 km



(from the left) Simona Di Tomaso, Roberto La Notte, Rosa Pacione (data analysis group); Michele Labarile (center back), Pino Colucci (center front), Pino Nicoletti (operations group); Domenico Iacovone (engineering group); and Gianni Nettis (operations group).

from the city center and 20 km from my house. Going to the station every day, I can see some traces of the historic sites and I confess I am often tempted to diverge a bit to have a look at a very beautiful panorama over the sassi (if you do a Google search, you will understand me better).

[Pippo] The Sassi and the Park of the Rupestrian Churches of Matera are the most outstanding, intact example of a troglodyte settlement in the

Mediterranean region, perfectly adapted to its terrain and ecosystem. The first inhabited zone dates from the Palaeolithic, while later settlements illustrate a number of significant stages in human history (cf. <http://whc.unesco.org/en/list/670><http://whc.unesco.org/en/list/670>). We strongly suggest to read the whole page which contains photos and detailed descriptions. The Space Geodesy Centre (CGS) is located about 10 km East with respect to the city of Matera. It's worth mentioning that Matera has recently been selected as the European Capital of Culture for the year 2019.

When did Matera start to do space-geodetic observations and what was the purpose then?

[Pippo] The CGS was dedicated in 1983 following an agreement between NASA and PSN (Italian National Space Plan, which in 1988 evolved into the Italian Space Agency). At that time the Matera site hosted only SAO-1, an SLR station loaned by NASA. SAO-1 operated for more than 17 years before it was replaced by the current Matera Laser Ranging Observatory (MLRO) in 2001. VLBI operations started in the first half of 1990, based on a 20-m diameter antenna

designed and built in Italy by Selenia Spazio. This system is still operational. We started to develop the first national GPS network in 1991, co-locating a few GPS receivers at other space geodetic sites in Italy (Medicina, Cagliari, Lampedusa) or near tide gauges (such as in Venezia). This network is currently being significantly expanded and improved. In 2007, we started to operate an FG-5 absolute gravimeter.

Pippo, when and how did you become the head of the Matera network station? What is your background?

[Pippo] I've always been an astronomy nut since my childhood, and I still observe the sky with my personal telescope when I have the time. I eventually got a doctoral degree in astronomy from the University of Bologna in 1983. I joined PSN in 1985 and then ASI in 1990, and have been working in Matera since the beginning. I was appointed as the head of the Matera station for the first time in 1996. However, only recently the Space Geodesy Centre has been “unified” as a single Department within ASI, and this has changed things quite significantly, also regarding my duties and responsibilities. I'm currently commuting very frequently between Matera and Rome, where the ASI headquarters are located.

You have various activities going on and we would like to know more about your staff and their duties. Who is doing what at Matera?

[Pippo] The operational and data analysis activities at Matera are carried out by a unique service provider, e-Geos S.p.A., which is a PPP between Telespazio (80%) and ASI (20%). All activities are carried out under ASI supervision.

[Pino] My company e-Geos S.p.A. operates the VLBI, SLR, and GNSS network systems on behalf of ASI. Our group consists of 15 people that operates the systems 24/7. In addition, our engineering group is involved in maintenance activities and we also have people doing multi-technique data analysis. So, it is a big effort and we thank ASI for giving us this opportunity.

Pino, you have been operating a legacy VLBI radio telescope for many years. Which IVS sessions are you contributing to?

[Pino] From 1990 to the end of June 2017, we participated in more than 1,100 sessions, almost 100% devoted to geodesy and the IVS. Currently, we participate in R1, R4, and some R&D sessions. But I can still remember the NAVEX/NAVX and EURO sessions back in the 1990ies.

What have been the major concerns of the VLBI instrument at Matera?

[Pino] Matera has been affected by RFI in S-band from the beginning. At the TOW workshops, Brian Corey very often uses Matera in his classes to teach about RFI. :-) Now my biggest concern is the aging of the equipment. Our 23-m antenna is very old and there are no spare parts available. The last failure of the azimuth encoder was fixed finding the

right bulb lamp after a long trial-and-error process: the original model from the encoder manufacturer was not available anymore and we had to try several general purpose models before finding one that worked.

What are your future plans in order to respond to the demands of the Global Geodetic Observing System (GGOS)?

[Pippo] ASI has recently funded several new projects at the CGS, including (1) a new VGOS station; (2) a new SLR station which will uniquely support ILRS' SLR activities, while the MLRO system will be devoted to LLR, free-space quantum telecommunications, and space debris laser tracking; (3) refurbishment of the MLRO system; and (4) optical link with remote atomic frequency standards for time and frequency metrology.

Which organization is funding your projects?

[Pippo] ASI funds the whole spectrum of activities at CGS. We're currently also getting financial support from the European Commission on SST activities.

Living at such a nice place in the south of Italy, what are your leisure activities?

[Pippo] Matera is rapidly becoming a highly regarded touristic place, with a lot of pros and cons. I have several hobbies, like playing drums in a jazz band, touring with my motorbike and sailing. I'm also building a 6-meter plywood sailing trimaran, which is almost complete now, and intend to christen it "Geodetica"!

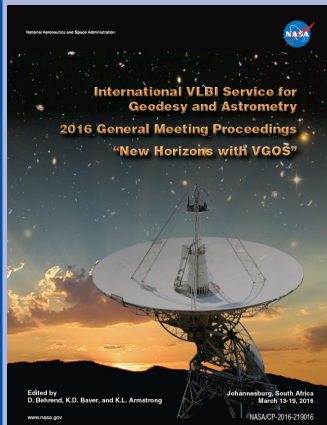
[Pino] For me, simply walking through the city center is a great pleasure. I was born in Matera, actually in the sassi, and saw the town transform from a poor little town to a charming touristic place to being the European Culture Capital in 2019. This is amazing and it sounds incredible to me.

We wish you the best of luck for your projects and thank you for this interview.



Franco Schiavone (foreground), Geo Operations manager for the e-Geos S.p.A. company.

Extra Copies of IVS 2016 General Meeting Proceedings



The Coordinating Center (CC) has extra copies of the printed proceedings volume of the 9th IVS General Meeting that was held in South Africa. Please contact the CC at ivscc@ivscc.gsfc.nasa.gov if you are interested in a physical copy.

Upcoming Meetings...

AOGS 14 Annual Meeting Singapore August 6-11, 2017	6th International VLBI Technology Workshop Bologna, Italy October 9-11, 2017
The Science of Gaia and Future Challenges Lund, Sweden August 30-September 1, 2017	AGU Fall Meeting New Orleans, LA USA December 11-15, 2017
3rd COSPAR Symposium Jeju Island, South Korea September 18-22, 2017	EGU General Assembly Vienna, Austria April 8-13, 2018
Journées 2017 Alicante, Spain September 25-27, 2017	10th IVS General Meeting Longyearbyen, Svalbard, Norway June 3-9, 2018

<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.

The editors reserve the right to edit contributions. The deadline for contributions is one month before the publication date.

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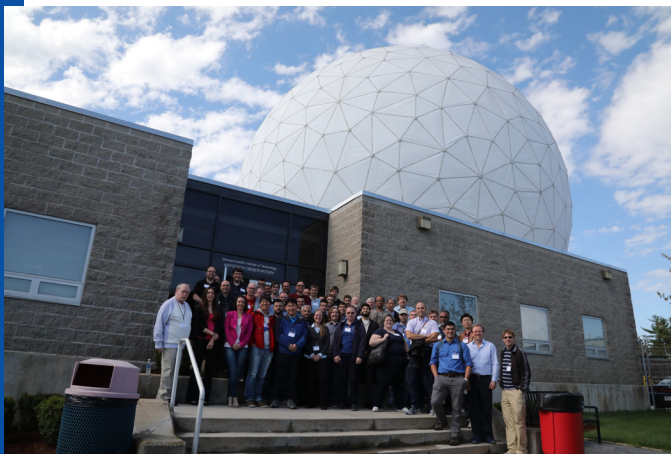
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NEWS...

VLBI Operations, Westford, and Pink Socks \equiv TOW2017

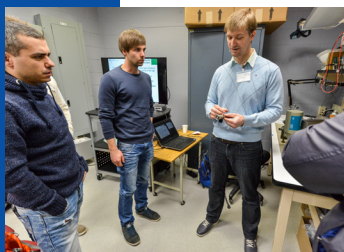
– Karine Le Bail, NVI, Inc.

The 9th IVS Technical Operations Workshop (TOW) was held from Sunday, April 30 through Thursday, May 4, 2017 at MIT Haystack Observatory. This is an account of the personal experiences of my first TOW.



Attendees of the 9th IVS Technical Operations Workshop.

On the Sunday, I was apprehensively searching for the icebreaker reception room at the Radisson hotel. I am usually on the receiving side of the VLBI data, so I am a little bit out of my comfort zone. My knowledge of the VLBI instrumentation is rather limited. I spot Heidi Johnson and Mary Reynolds sitting at a table close to a bar area. This must be the place. The welcoming is very kind and all apprehension goes away quickly. The icebreaker turns out to be a great social event to meet several new faces as well as some familiar faces. The atmosphere is relaxed and friendly, but, at the same time, some groups begin talking right away about station “business”.



Christian Plötz explaining the specifics of the cryogenics system.



Arthur Niell giving a general lecture about VGOS.

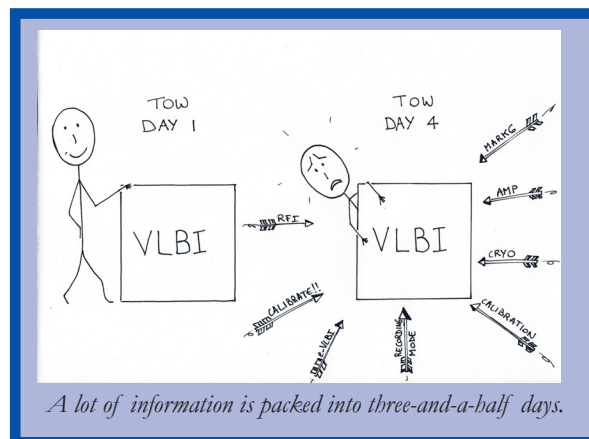
The four following days of the workshop are just the continuation of this outstanding atmosphere. The format of the classes and lectures is just perfectly appropriate: small audiences for specialized classes that allows for plenty of questions and wider audiences for generalized classes and lectures.

The TOW covers such a broad type of topics that the attending crowd is a motley crew from many countries with a very diverse set of interests. The TOW is instructive at so many levels: appropriate for new individuals who want to learn the basis of VLBI operations, for individuals who need some update on the system, for those who have more detailed and specific questions, and for those who want to develop the system at their own station.

The workshop is very enriching and I personally learned a lot about operations but also the difficulties of operators I did not know about. On the other hand, when presenting the significance of meteorological data in the analysis, a few operators were surprised by the impact of such data. It demonstrates that the flow of information between the different components of the VLBI community needs to be more active. Feedback between the different actors in VLBI is necessary: all levels in VLBI (station operation, correlation, analysis, among others) are connected. Everybody is part of the whole chain of processing VLBI data and exploit it.

The TOW is a wonderful place for sharing and making connections. Beyond the scope of VLBI and the classes, it strengthens the connection between the attendees coming from various places in the world by various social events. Staying onsite for lunch is a good way to continue a discussion about a topic that was just treated in a class. The Red Sox game event was terrific and immersed us into the American way of life: Fenway Park is such a remarkable historic place. Interestingly they sold pink socks for women at the official Red Sox Team Store. And after ten years in the U.S., I finally understood the baseball rules!

My final thoughts will be to emphasize the dedication of the TOW organizers. After nine TOWs, this workshop is still going strong and it is a memorable event. A big thank-you to all the program committee and local organizing committee members for providing such a high quality workshop.



A lot of information is packed into three-and-a-half days.

EVGA 2017 and the Inauguration of the Onsala Twin Telescopes

– Rüdiger Haas, Chalmers University of Technology



The participants of the 23rd EVGA Working Meeting, 14–16 May 2017 (Photo: Joakim Strandberg).

The third week in May 2017 was fully packed with VLBI activities in Gothenburg and at the Onsala Space Observatory. First, the 23rd Working Meeting of the European VLBI Group for Geodesy and Astrometry (EVGA) was held at Chalmers University of Technology in Gothenburg between Sunday, May 14, and Tuesday, May 16. Almost 100 participants (see group photo) from 20 countries, both from inside and outside Europe, contributed with many interesting presentations on the current status of geodetic and astrometric VLBI and corresponding technical development and scientific results. In total there were 52 oral talks and 34 posters. The meeting started with an ice breaker on Sunday evening and ended with the conference dinner on Tuesday evening. The 18th IVS Analysis Workshop and various IVS splinter meetings were held on Wednesday, May 17, also at Chalmers. This included a meeting on compatibility issues concerning the VGOS (VLBI Global Observing System) equipment worldwide, both the existing as well as that under development.

On Thursday, May 18, the new Onsala Twin Telescopes were inaugurated. The weather was sunny and rather windy, as can be expected for a site located right on the coast. More than 200 guests, including the EVGA participants, witnessed this ceremonial inauguration and listened to speeches given by John Conway, Director of the Onsala Space Observatory, Stefan Bengtsson, President of Chalmers University of Technology, Axel Nothnagel, Chair of the IVS, and twin sisters Malin and Josefin Flyckt from the Swedish Astronomical Youth Association. The speeches highlighted the importance of the upcoming VGOS network and the role of Onsala in particular, both for the IVS and for Chalmers. Malin and Josefin stressed the importance of science and research for the future of young people in society, and reminded the audience of the special value of twin pairs. After viewing NASA's cartoon film on the principles of VLBI, simultaneously moderated in Swedish by Maria Sundin, the actual inauguration ceremony was held. The governors of Västra Götaland

and Halland, the two counties that are hosting Chalmers and the Onsala Space Observatory, respectively, Lena Sommestad and Lisbeth Schultze took the lead. They gave speeches reflecting on the importance of the forefront research carried out in West Sweden and specifically that at Onsala and Chalmers. Finally, together they pressed the two starter buttons in order to set the new telescopes into action. Accompanied by Mikael Högdahl's saxophone music, the telescopes began to dance and for the next a couple of minutes they demonstrated their abilities in terms of coordinated telescope motion. This gave the spectators a glimpse of how future VGOS operations at Onsala will look like.

Following the formal program the observatory staff offered guided tours of the facilities. The main attraction was, of course, the twin telescopes, which by the way caused some visitors to miss the transport back to Gothenburg. Other facilities that were shown included the 20-m telescope, the tide gauge station using conventional pneumatic, radar, and laser sensors, the GNSS tide gauge, and the GNSS reference installations.



The county governors Lena Sommestad and Lisbeth Schultze pressing the buttons to start the dance of the Onsala Twin Telescopes (Photo: Onsala Space Observatory).



The dance of the Onsala Twin Telescopes has begun (Photo: Onsala Space Observatory).

Unified Analysis Workshop Held in Paris

— John Gipson, NVI, Inc.



Group photo of the participants of the Unified Analysis Workshop (UAW).

The fifth IAG/GGOS/IERS Unified Analysis Workshop was held 10–12 July 2017 in Paris, France. This is a chance for representatives from all of the services to gather and discuss technique specific issues as well as problems common to several techniques. There were 42 attendees. The IVS was represented by (in alphabetical order) John Gipson, Robert Heinkelmann, Hana Krásná, Dan MacMillan, Axel Nothnagel, and Minghui Xu. There were special sessions, devoted to each technique, and more general sessions of a broader interest. In the following paragraphs I touch on some issues of special interest to the IVS or areas which will result in changes in how we do things.

The IVS session of the UAW began with Minghui giving a summary of work that he and James Anderson have done on source structure effects in CONT14. Those of you who were at the EVGA meeting heard talks by Xu and Anderson on this subject. There is no doubt that source structure is an important topic. The attendees of the workshop urged Anderson and Xu to continue their work. I want to encourage other VLBI groups and individuals to develop expertise in source modeling because this will become more important going forward.

An outstanding issue is the scale difference between VLBI and SLR which is about 1.4 ppb. VLBI and SLR are responsible for setting the scale of the ITRF, and this scale difference is currently handled by ‘splitting-the-difference’ between the techniques. Some recent work on the SLR side suggests that some of the contribution might be due to range-bias effects—in any case, if a range bias is estimated in SLR, the scale difference is reduced. On the VLBI side there were several talks somewhat related to this. Dan gave an overview of the impact of changing modeling on VLBI scale, for example, using NMF as opposed to the VMF. For the most part effects are too small to account for the scale difference. Axel gave a review of the effects of gravitational deformation of antennas. The shape of an antenna var-

ies with elevation, which results in changing the geometric path length through the system. This, in turn, can result in a change in the estimate of the station Up position, which feeds directly into scale. The functional behavior of the antenna must be measured or modeled using finite-element analysis, and so far only a few antennas have had this done. One recommendation from the meeting is that the IVS measure more of our antennas, giving a priority to antennas that are frequently used and antennas that may be decommissioned. Axel has volunteered to gather data for the antennas that have been measured and put them in a consistent form. As IVS Analysis Coordinator, I recommend that the various VLBI software packages be modified to model the effect of gravitational deformation.

Motivated by the issue of scale, I compared the IVS consensus relativity model with a new relativity model of Soffel, Kopeikin and Han which was published last year. The good news is that the two models are consistent at the picosecond level. The new model has a few terms which are absent in the consensus model, but these are too small to significantly affect scale.

In both the GPS and VLBI sessions there were presentations on HF-EOP. Aurore Sibois presented work she had done with Shailen Desai. They derived an HF-EOP from new tidal models and demonstrated that it reduced residuals (when compared to the IERS model) in GPS processing. I presented an empirical model derived from VLBI. Tim Springer demonstrated that using this VLBI model also improved the processing of GNSS satellites. Tim’s work involved not only GPS, but Galileo and GLONASS satellites. As a result of these presentations we are forming an ad hoc working group to evaluate various HF-EOP models in the different space-geodetic techniques and to make recommendations to the IERS about updating the HF-EOP model. I volunteered to be the chair of this group.

There was a special session devoted to the mean pole and the handling of the pole tide. The consensus is that the current way of doing things is wrong. As a result the IERS is going to modify the definition of the mean pole. For VLBI this will have an impact in how we model the pole-tide, which in turn will result in changes of station position by up to a few millimeters. This is another area where we will need to modify VLBI analysis software.

The workshop was well organized. As a direct result of recommendations made at the workshop I can see improvements in how we model VLBI data. I will share further details via the IVS analysis e-mail exploder.

Find a UAW summary report at the URL

<http://176.28.21.212/en/meetings/2017/unified-analysis-workshop/general/>

FROM THE VGOS WORLD...

The New VGOS Antennas of the Russian “Quasar” VLBI Network

– Dmitry Marshalov



Foundation and antenna tower of the new radio telescope at the Svetloe Observatory.

In a state-sponsored modernization program, the Russian “Quasar” VLBI network is being augmented by fast rotating, 13.2-m class radio telescopes (RT13) with multi-band systems at the existing sites of the network. This will improve the accuracy, reliability, and efficiency of providing Earth orientation parameter data to users both within the Russian Federation and abroad. The first

stage of the program was successfully completed in 2015 with the installation of RT13 radio telescopes at Zelenchuk-skaya and Badary. Currently these two antennas are operating routinely in the Russian domestic VLBI programs and meet all VGOS requirements. The foundation stone ceremony for the third VGOS radio telescope was held at the Svetloe Observatory of the “Quasar” VLBI network near St. Petersburg on April 17, 2017. The ceremony was attended by representatives of ministries and departments of the Russian government (Federal Agency for Scientific Organizations, Russian Academy of Sciences, ROSSTANDART, Russian Defense Ministry, and ROSCOSMOS). Work on pouring the foundation and the antenna tower was finalized on July 5. It is planned that the installation of the new RT13 at Svetloe will be completed in early 2018.

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AuScope Goes VGOS

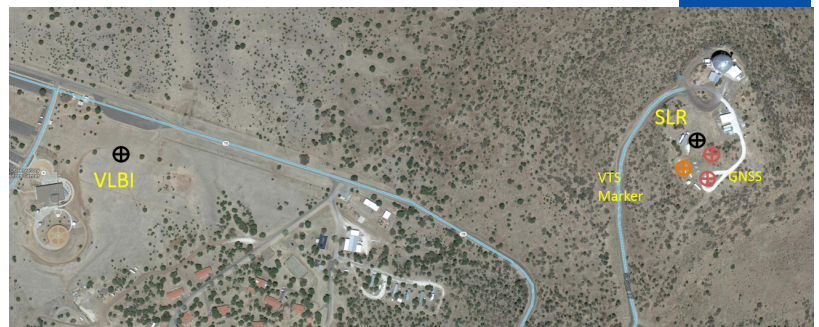
– Lucia and Jamie McCallum

After two years of testing and prototyping, in June 2017 three Callisto production receivers arrived at Hobart. It is now up to us to install them on the existing 12-m AuScope telescopes in Hobart, Katherine, and Yarragadee, replacing the existing S/X receivers. Our plan is to start with Hobart and follow with the two remote sites in 2018. While the Hobart receiver itself is already mounted



The Callisto VGOS receiver mounted with preliminary weather protection on the Hobart 12-m antenna.

(although with preliminary weather protection), final work on the antenna optics and the backend signal chain is currently undertaken. The DBBC-3 has been newly upgraded and the FlexBuff system was just successfully tested for a sustained data rate of 16 Gbps. Next steps are extensive local Hobart–Hobart tests as well as broadband test VLBI experiments towards VGOS observations with our Japanese colleagues from NICT at Kashima and from GSI at Ishioka. It is then our aim to join the IVS VGOS sessions as soon as possible and get Hobart ready for a VGOS site in CONT17. All going well, the upgrades in Katherine and Yarragadee are planned for the first half of 2018. This of course means that all Australian sites will stop their S/X observing load in this time frame. On the other hand, first tests showed that the new feed has decent sensitivity in S-band, showing promise for backward compatibility with the S/X system.



Aerial view of the proposed locations for the VLBI and SLR instruments at McDonald Observatory, Fort Davis, Texas.

NASA Takes Next Step for a New VGOS Antenna in Texas

– James Long

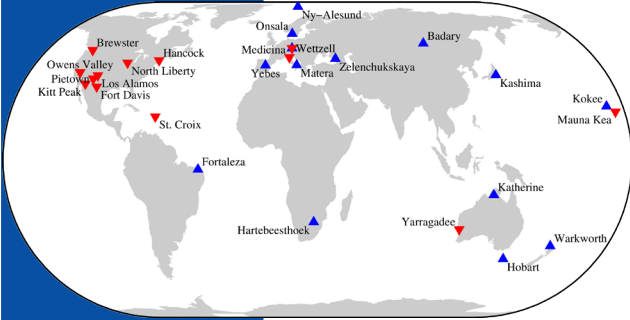
The NASA Space Geodesy Project (SGP) is taking the next step in expanding the NASA Space Geodesy Network (NSGN) with the procurement of a VGOS 12-m radio telescope for a new core site to be located at the McDonald Observatory, near Fort Davis, Texas. NASA recently awarded a contract to InterTronics Solutions, Inc for a 12-m VGOS radio telescope to be installed in the fall of 2018. The proposed McDonald Geodetic Observatory (MGO) is being developed by NASA and the University of Texas-Austin Center for Space Research and will be hosted by the University of Texas McDonald Observatory. MGO will also include the NASA next-generation Satellite Laser Ranging (SLR) system and permanent GNSS receivers. The VGOS signal chain will be furnished by MIT Haystack Observatory, under a separate NASA contract. The MGO VGOS station will be the fourth broadband-capable station in the NASA network.

CONT17: A Three-Network Continuous VLBI Campaign

– Dirk Behrend, NVI, Inc.

This Christmas season we plan on observing another continuous VLBI campaign (CONT). While the previous CONTs of the IVS era were organized as single networks with increasing network size over the last fifteen years, the latest installment will sport three separate networks. The main reasons behind this can be traced back

The three networks will be correlated at three different correlators. The VLBA correlator at Socorro will handle the network consisting of the VLBA plus three geodetic stations. Bonn will correlate the S/X network of geodetic stations. And, lastly, Haystack will perform the correlation of the VGOS data. Socorro anticipates a very fast turnaround with correlation results available by mid-to-end January 2018. Bonn and Haystack expect the correlation work to last significantly longer, from a few months up to half-a-year. While not doing CONT correlation per se, the Washington correlator will assist the Bonn and Haystack correlators by reducing their work load in the regular IVS observing program prior to and after the CONT17 campaign.



Legacy-1 S/X network of fourteen geodetic IVS stations (blue triangles) and Legacy-2 S/X network of ten VLBA stations plus three geodetic IVS stations (red inverted triangles).

to mostly two items: (1) the advent of the VGOS network and (2) the participation of the VLBA. For CONT17 the plan is to record data from 0 UT on November 28 until 24 UT on December 12, 2017 using two legacy S/X networks and one VGOS broadband network. The VGOS network will have a smaller size and will only be observed for about a third of the CONT17 period. The use of the

In order to get an idea of the quality of the data to be expected from CONT17, simulations were run for all three networks. A covariance analysis yielded formal errors for the EOP as compiled in the table. These numbers are put into perspective by listing as well the actuals of the EOP formal errors for the 13-station CONT11 campaign. If all works out as planned, we will have an excellent data set for further studies. More info about CONT17 will be compiled on the IVS Web site at the URL: <https://ivscc.gsfc.nasa.gov/program/cont17/>.



VGOS broadband demonstration network of up to eight VGOS stations.

two legacy networks will allow to probe the accuracy of VLBI estimates of EOP and to investigate possible network biases. Hence, the main focus of CONT17 remains the legacy S/X system; the VGOS portion will mostly serve demonstration purposes.

Network	X-pole	Y-pole	dUT1	PSI	EPS
CONT11	12.9 μ s	13.1 μ s	0.7 μ s	33.5 μ s	13.8 μ s
Legacy-1	12.5 μ s	12.9 μ s	0.7 μ s	33.0 μ s	12.3 μ s
Legacy-2	14.9 μ s	17.3 μ s	0.8 μ s	37.5 μ s	14.2 μ s
VGOS	22.1 μ s	22.4 μ s	0.8 μ s	43.2 μ s	18.1 μ s

EOP formal errors of the CONT17 networks based on a covariance analysis without velocity estimation as well as actuals for the CONT11 campaign.

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