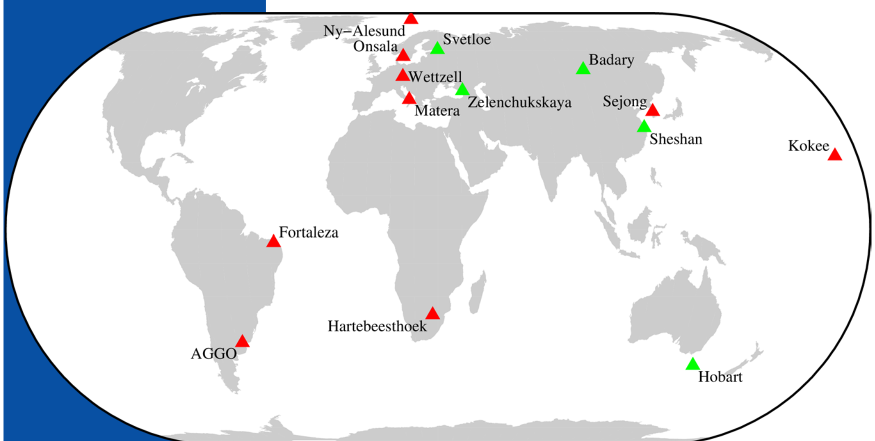
IVS Newsletter
Issue 54, August 2019

Upcoming Changes to the Observing Plan in 2020

– Dirk Behrend, NVI, Inc./NASA GSFC

The recent months have seen a flurry of discussions about the observing activities in 2020. Items that came up in these discussions included a possible continuous VLBI campaign (CONT), the complexion of the legacy S/X observing series, and the introduction of operational VGOS sessions. In this article, I try to summarize the discussions and what to expect in 2020.



One of the currently planned four different extended R1 networks for 2020. Red triangles represent the core network, while green triangles show select five stations for this particular extended R1.

Early in the year, the IVS Coordinating Center looked into the possibility of a CONT20 campaign that could be organized in the late part of 2020. The notion was discussed in the Observing Program Committee (OPC), who was in favor of going ahead with the planning. Hence, the OPC started to look into the scientific rationale for a CONT20 and in what areas it should differ from the CONT17 campaign. In that process, John Gipson came up with the idea for an alternative of the typical CONT campaign. Rather than having two weeks of continuous observing and sampling a specific period of the year only, he suggested to have discontiguous (but evenly spaced) observing days spread over the entire year. With the R1 and R4 sessions already distributed over 52 weeks, they constitute the obvious choice for this type of program.

The OPC looked into the proposal and found it very intriguing. Extending an R1 session from the now typical 9–10 stations to 14 or more stations with a good global distribution would result in R1 EOP results comparable to the CONT17-L1 and CONT11 networks. As past CONT campaigns sampled a short period of time only, they were more or less insensitive to seasonal effects. A program, however, that runs for an entire year would be subject to seasonal effects. It is known that there is seasonal variation in baseline lengths mostly caused by seasonal variations in the local up-components of the station positions. What has not been looked into thus far is how big the seasonal effect is on EOP; while it is likely small, there has been no data set available yet to corroborate this.

The Coordinating Center looked into the feasibility of John's proposal. Cynthia Thomas determined that it would be possible to run 14-station R1 sessions every other week (i.e., 26 sessions per year), while the remaining R1 sessions would typically have some nine stations in them. The 14-station R1s would have a group of nine core stations that would be augmented by five further stations from a pool of nine stations (which have less station days available). This change would go on the expense of the EUROPE session series which would need to be discontinued. Based on this information, the OPC recommended to the Directing Board to not organize a CONT20 campaign in 2020, but to implement the new program with extended R1 sessions and removed EUROPE sessions. We expect that the Directing Board will give the green light for this endeavor.

In addition to the changes with the legacy S/X program, it is foreseen to establish an operational VGOS Intensive series. The current plan is to observe on the baseline between Kokee12m and Wettzell-South; the observation will be done in parallel to the current INT1 sessions between the legacy station counterparts. The cadence still needs to be determined. Further, as the VGOS network of six to seven stations that in 2019 participate in the VGOS Test sessions has matured enough, these sessions will be integrated into the regular 24-hour Master Schedule in 2020 as operational sessions. Other enhancements on the VGOS side depend on the progress of the roll-out of the VGOS correlation and post-processing from Haystack Observatory to the other correlators.

NICT's Kashima Station and TDC

The Kashima Space Research Center in Ibaraki, Japan is home to several VLBI antennas of the National Institute of Information and Communications Technology (NICT). The Kashima 11-m and Kashima 34-m antennas are both IVS Network Stations since the inception of the IVS in 1999. NICT hosts another 11-m VLBI antenna at its headquarters in Koganei (Tokyo). Furthermore, Kashima has been the home of an IVS Technology Development Center (TDC) for the past 20 years. After two decades of significant contributions to the IVS, the Kashima VLBI Group is now facing major changes in the forthcoming year: it is planned that the VLBI facilities of the Kashima site be closed (the satellite communications section will remain). Newsletter Editor Hayo Hase checked in with Mamoru Sekido to shed some light on the recent developments but also to recapitulate accomplishments of the past. The following is what Hayo found out in his e-mail interview.

VLBI Group members of NICT/Kashima at the entrance of the station (from left to right): T. Kondo, M. Sekido, Y. Miyauchi, K. Shinozuka, H. Ujihara, K. Takefuji, E. Kawai, S. Hasegawa, and M. Tsutsumi.

The National Institute of Information and Communications Technology is a world renown institution which covers a wide range of top-level scientific investigations and technical developments. What should we know about NICT?

NICT is part of the Ministry of General Affairs and Communications which oversees the national regulation and policies on radio frequency allocation and telecommunications. NICT is expected to serve citizens in the field of technology development with electromagnetic signals, telecommunications, and information. It is tasked by law with maintaining Japan Standard Time (JST) and its dissemination. NICT is headquartered in Koganei (Tokyo). In total some 1,000 people work at NICT, with around 400 being permanent employees.

When and how did NICT get involved in VLBI?

NICT was founded in 1896 as the national electric research laboratory—the same year Guglielmo Marconi made the first public transmission of wireless signals. The name then changed to the Radio Research Laboratory (RRL) in 1952. The Kashima branch of RRL was founded with a 30-m antenna in 1964 to broadcast the Tokyo Olympic Games to the world via satellite. As is well known, the 1960s were the era of evolutional discoveries in the field of radio astronomy: Quasars, Pulsars, and the 3K cosmic microwave background were discovered. Thus, not only astronomers but also researchers of RRL were interested in radio astronomical observations. In 1971, Dr. F.O. Vonbun (NASA/GSFC) and Dr. C.F. Martin (NASA) visited RRL inviting the lab to join a VLBI project of plate motion measurements and satellite navigation. This was the start of a long history of collaboration with NASA/GSFC in VLBI. Since the development of a Hydrogen maser frequency standard was part of the mission of RRL, it supported having the VLBI project, in which large radio telescopes and Hydrogen maser frequency standards were used jointly.

The detection of the Pacific plate motion in 1986, which is moving towards Japan at a rate of 6 cm/year, had a great impact on the Japanese people. Because Japan is a country frequently impacted by earthquakes, the Japanese people expected that the knowledge about plate motion would help predicting earthquakes. The Kashima 26-m antenna, which was originally built for satellite communications in 1968, played a great role in the measurement of crustal motion and participated in the global VLBI observations for reference frames. The Kashima 34-m antenna was built in 1988 for a project to measure the motion of the Pacific plate in collaboration with the Shanghai Observatory. The subsequent Key Stone Project (KSP) was undertaken to monitor crustal deformation around the Tokyo Metropolitan Area with multiple space-geodetic techniques from 1994–2001. The first operational real-time VLBI observations were successfully used on a daily basis using a dedicated ATM (Asynchronous Transfer Mode) network.

Which division of NICT hosts the VLBI group?

The VLBI group belongs to the Space Time Standards Laboratory of Applied Electromagnetic Research Institute. Because of the relation between Earth rotation and leap seconds, the VLBI group has historically been linked to the frequency standards group that keeps Japan Standard Time. However, physically the VLBI group has been working at Kashima, which is about 100 km east of Tokyo on the Pacific coast.

The Kashima 34-m antenna with rainbow in November 2001.

NICT has a high reputation as an IVS Technology Development Center (TDC). What have been your most prominent developments for VLBI?

We are proud that the first operational real-time VLBI observations were carried out in the KSP. From the viewpoint of contributing to the international VLBI community, I would see the work done for (1) the definition of the VLBI standard interface (VSI-H) and standard data format (VDIF) and (2) the development of a software correlator as the contributions with the most significant impact. The first point—definition of a VLBI standard—was, of course, not done by NICT alone, but was rather a collaborative effort together with Haystack and the international VLBI community. VSI-H and VDIF have been used in the worldwide VLBI community and benefit VLBIers in joint observations. The second point—using a software correlator for routine operational VLBI processing—was not believed to be ready before we demonstrated it around 2000. There were source code requests for the K5 software correlator from around the world. It was an inspiring development that eventually led to the creation of the DiFX as well as other software correlators. Dr. Kondo was the leader of these developments.

After many years of serving the VLBI communities, the VLBI facilities at the Kashima site will be shut down in the middle of next year. Can you say a few words on what's behind this?

Since the mission of NICT requires the development of new technology, running routine measurements are not welcome unless prescribed by law (such as keeping and delivering Japan Standard Time). Therefore, we strived to start new developments which allowed our VLBI group and stations to keep running.

Although the Kashima 34-m antenna has been the primary research tool for our technology development, its maintenance has become more difficult over the years; also, one of our engineering staff members will reach retirement age next year. The maintenance costs and human resources are the main reasons.

What are NICT's future plans concerning VLBI?

We are planning to stay involved in VLBI development with the collaboration with GSI Japan. We have developed broadband VLBI observation systems and transportable stations. The current subject of research, the application of the VLBI technique for intercontinental frequency transfer, is going well. We may be able to continue to use these systems for further contribution to the metrological community, if we could collaborate with VGOS stations. Since the loss of the long history and experience in VLBI development would be a tragedy, we hope that we can provide some of our resources to the VLBI community.

What are your VLBI highlights or fun facts?

The most attractive feature of VLBI is the friendship of the international community. Thanks to the relative nature of VLBI, which necessitates a strong collaboration between institutions to measure long baselines, the people involved in VLBI are very cooperative and kind. I am really very happy to work with VLBI. I have made many friends in the world. Mike Titus is the first foreign friend of mine. Prof. Yuri Petrovich Ilyasov of Lebedev Physical Institute at Puschino Radio Astronomy Observatory was another good friend, who sadly passed away in 2010. I received my PhD by collaborating with him and his supervisor. He was very energetic, strong, and very kind. I will never forget his continued encouragement from Russia.

If you are not working, what are your favorite activities?

I play tennis, soccer, and enjoy running to keep my health. My most favorite thing is doing something with my sons. I spent one year visiting at Crestech Laboratory in Toronto, Canada around 2001–2002. Wayne Cannon, who was the lead of the S2 VLBI system development and supporting Algonquin observatory, was hosting me and my family. It was a wonderful time. My two sons were two and five years old at the time. If I have time, I wish to visit Wayne and Nancy with my family again.

Thank you very much for the interview.

The Kashima 11-m antenna.

Upcoming Meetings...

Implementation of the GGRF in Latin America,
Buenos Aires, Argentina
September 16-20, 2019

Unified Analysis Workshop
Paris, France
October 2-4, 2019

Journées 2019
Paris, France
October 7-9, 2019

GGOS Days 2019
Rio de Janeiro, Brazil
November 11-14, 2019

8th IVTW
Sydney, Australia
November 11-14, 2019

AGU Fall Meeting
San Francisco, CA USA
December 9-13, 2019

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

News...

TOW2019: The 10th Jubilee of a Success Story

– Christian Plötz, BKG Wettzell

The 10th Technical Operations Workshop (TOW) took place at the MIT Haystack Observatory from Sunday, May 5 to Thursday, May 9, 2019. Along with my personal experience with VLBI operations, these are my personal impressions about the evolution, the importance, and, of course, the current TOW—the 10th installment of this successful workshop format.

The participants of TOW2019 in front of the Haystack antenna radome.

The TOW at the Haystack Observatory was established as a fixed event for getting in touch with the operators of VLBI stations worldwide. This workshop, with its emphasis on practical operations, a hands-on approach, and the inclusion of all facets of this involved complex technology, gives an invaluable opportunity for the VLBI operators from many countries to exchange experiences, learn about new developments, and of course get in contact with other colleagues around the world. For successful VLBI operations, improving the quality of the measurements, and introducing new technologies and new VLBI observation schemes (like VGOS) this event provides a sound foundation. In particular, the attendance of the hosts with all involved VLBI experts and the hospitality of the organizers form the basis of this success story, which enables the worldwide VLBI community to get successful observations. My personal TOW history starts with attending the second TOW in 2003 and several in between prior to this one. Thus, I would like to take this opportunity to thank the hosts at the Haystack Observatory for their great effort over so many years.

The Groton Inn in Groton, MA was the conference hotel.

First discussions were held during the icebreaker event.

From the first Technical Operations Workshop in 2001, the VLBI stations have seen a great change of advances in VLBI technology. While, for instance, 18 years ago magnetic tape recorders and their peculiarities were a subject matter for stable VLBI operations, gradually the magnetic hard disk drive recorders (Mark 5A, Mark 5B(+), and eventually Mark 6 and Flexbuff) with current full VGOS data rates of 16 Gbit/s or more became a topic of the classes. The same is true for the common backends, where the evolution went from analog ones, with its great analog engineering details, to the nowadays used digital backends (RDBE and DBBC2, and their future counterparts R2DBE and DBBC3). The operators need to be quite flexible with each technological advancement and the TOW has always been a great help and inspiration, with the station folks returning to their stations with a better understanding of what good VLBI operations mean.

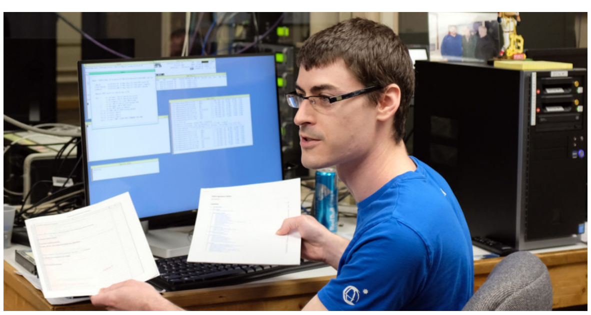
The TOW is an excellent forum to get into the new era—especially in these exciting VLBI times when frequently new VGOS sites are being planned, built, and then finally observe operationally in the VGOS test network—as there are plenty of technical details to get familiar with as VLBI operator. A special focus at the TOW is now the aspects of VGOS operations. The VGOS test network has reached some seven stations and operational experience has developed at these stations. Therefore, the dedicated classes that focus on special VGOS-related equipment gave important information; e.g., topics on Mark 6, Flexbuff, R2DBE, and DBBC3 gave new insights into how to handle these equipment types. This also constitutes a challenge for the lecturers, because many items are new in the field and it is an ongoing process to re-evaluate and revise traditional ways of thinking and operations. The emphasis of the knowledge of VLBI operators has also slightly changed. While in the past a good portion of electronic knowledge was advantageous, the advent of the digital backends extended the range of skills to the understanding of digital signal processing and the administration of hard-disk-drive-based recording systems like Mark 6 and Flexbuff.

The opening of the TOW 2019 was held at the Groton Inn and was as close to Haystack as never before. At this event the participants could register, receive their workshop badge, and "break the ice" with the other 74 registered attendees from 16 countries. Among them there were some colleagues that have been dealing with VLBI operations for many years; but fortunately, also younger VLBI operators, who are relatively new in this area, were welcomed at the icebreaker event on Sunday.

On Monday morning, the technical part of the workshop started with the eloquent introduction of the VLBI basics to everyone by Pedro Elosegui. The organizers assigned each person an individual schedule from the offered class list based on the personal preferences. In general, the teaching topics were divided into four different categories: Operations, Maintenance, Seminars, and Lectures. The lectures were intended to be presented to the whole group. For the other classes, however, everybody followed their individual class schedule finding their way to one of the six classrooms. There was such a variety of topics that anyone could find classes that piqued their personal interest.

A highlight, which is true for every TOW, is the operations workshop held at the impressive Westford radio telescope site. Besides the visit of another VLBI radio telescope, I found it very useful to go and see a real VGOS station with practical experience and a hands-on lesson with the system, taught by Mike Poirier, Roger Hammargren, and Alex Burns. This is very valuable for beginners, but also for experienced VLBI operators, as there are always technical details to be checked and improved. The step-by-step walk through a VGOS operation is useful, particularly for VLBI operators, who have never dealt with VGOS equipment before, to get a good impression. On the other hand, it is also of value for more experienced VLBI operators, because the specifics of VGOS operations are on hand for a short period of time only and the interaction with other operators allows to clarify and improve existing procedures. The included tour of the pressurized radome and the views from the gallery around the radio telescope left a lasting impression.

As the first VGOS correlation workshop directly followed the TOW, there were also attendees from several VLBI correlators. It turned out that a direct exchange between actors from different stages of the VLBI processing chain, having a chance of sharing experience and knowledge, was very fruitful. It helped to make us aware of potential problems that might have a high impact on data quality.



Alex Burns explaining VLBI operations at the Westford site.

Beyond the technical scope of this four-day workshop, the general set-up provided a relaxed and pleasant atmosphere. The fact that breakfast, lunch, coffee breaks, and the conference dinner were directly located on-site enabled a high degree of interaction and socialization between the attendees, teachers, and the resident Haystack experts.

Finally, the TOW gave an excellent opportunity to learn about VLBI operations in general, as well as getting knowledge of the new technical developments that are and will be important for the VGOS operations. Last but least, the organization was, as always, simply excellent. Many thanks to the local TOW organizers of the Haystack Observatory, especially Heidi Johnson and Mary Reynolds, and the IVS Coordinating Center director Dirk Behrend. The format of the Technical Operations Workshop and its classes will continue to be essential for successful VLBI operations also in the VGOS era.

Author Christian Plötz (middle) during a break.

Ed Himwich explained automated pointing models using the FS.

VGOS @ Matera

Funding for a new VGOS station at the Matera Space Geodesy Centre (CGS) of the Italian Space Agency (ASI) has been approved by the ASI Board of Directors. A bid for a turn-key system is expected to be issued within next September. We expect the new system to be available for operations within 2021, but further details will be available as the project proceeds.

– Giuseppe Bianco

News…

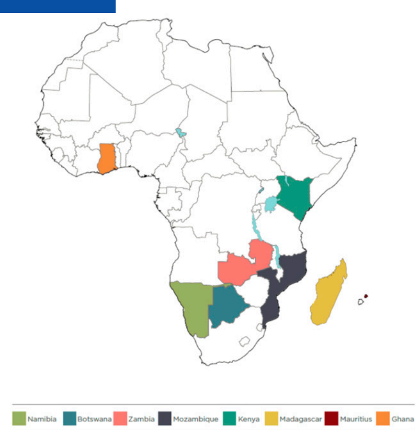
Teaching the Next Generation of African Researchers about VLBI

– Aletha de Witt and Marisa Nickola, SARAO @ HartRAO

During June 2019 the South African Radio Astronomy Observatory (SARAO) hosted its 5th successful African VLBI Network (AVN) training school (http://avntraining.hartrao.ac.za). The training school took place at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) site.

Group photo of the 2019 AVN training. Closing ceremony at the Forum Homini restaurant near HartRAO.

The AVN will be a network of VLBI-capable radio telescopes on the African continent comprised of refurbished satellite Earth-station antennas and new purpose-build radio telescopes. The AVN will not only strengthen existing VLBI networks but is a vital part of the effort towards building the Square Kilometre Array (SKA) on the African Continent.



Map of Africa showing the African SKA Partner Countries. Image credit: SARAO

Currently, the 15-m and 26-m radio telescopes at HartRAO are the only VLBI-capable telescopes in Africa and are extremely valuable in providing long baselines to radio telescope arrays on other continents. The AVN telescopes will greatly improve present VLBI networks for both astronomy and geodesy. The AVN would not only increase the distribution and density of radio telescopes on the African continent, but it would substantially increase the uv-coverage between HartRAO and telescopes in the north and it would greatly facilitate VLBI observations of southern objects. These telescopes will also provide a focus for the development of radio astronomy in each SKA partner country ahead of the SKA phase 2 expansion into other African countries. Not only will it provide the skills and knowledge needed to build, maintain, operate, and use these radio telescopes, but it will also bring new science opportunities to Africa. Moreover, the aim is to establish astrophysics and related research communities in these countries as a springboard for wider development. The SKA African partner countries are Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, and Zambia.

The Development in Africa for Radio Astronomy (DARA) project began an ambitious human capital development program for the AVN in 2015. The DARA project is a joint UK–South-Africa Newton Fund project to help drive economic development in the African SKA partner countries (https://www.dara-project.org). The DARA project aims to provide for a significant boost to the human capacity development currently available in the African partner countries. The research and skills enabled by DARA through the AVN training schools is focused around the utilization of the AVN and the envisioned key science areas thereof. DARA currently runs a series of AVN training schools to help the next generation of researchers in the African partner countries to understand and learn more about the technical details of radio astronomy and VLBI systems and to inspire them in their future careers.

The "Technical and Observational Radio Astronomy" component of the DARA AVN training schools were developed and are hosted by HartRAO. The first of these schools took place in 2016 for 21 participants from Botswana, Kenya, and Zambia. The second school took pace in 2017 with 16 participants from Botswana, Namibia, and Zambia. In 2018, there were two schools: one for 20 participants from Botswana, Namibia, and Zambia and another for 20 participants from Madagascar, and Mozambique. For the 2019 school, we hosted 39 participants and for the first time combined both groups into one school with parallel sessions. The school ran from 6 to 31 May 2019, for selected students from Botswana, Madagascar, Mozambique, Namibia, and Zambia.

The first week of the AVN school was dedicated to introductory Linux and Python training. This was followed in the second week by various lectures, demonstrations, and practicals on antenna basics, radio astronomy equipment and instrumentation, microwave receiver systems, digital signal processing, and coordinate systems. The third week was focused on single-dish instrumentation as well as observational aspects of single-dish radio astronomy and also covered radio frequency interference (RFI).

The last week of the training was dedicated to radio interferometry and VLBI. The training started with an introduction to interferometry and VLBI, including practicals using the HartRAO two-element interferometer and a tour of the HartRAO control room. This was followed by an overview of geodesy and geodetic VLBI, including various exercises using the Vienna VLBI and Satellite Software (VieVS). Afterwards there was an overview of astrometric VLBI and celestial reference frames, including exercises using ICRF data. We followed a very interactive and hands-on approach to the training and most topics covered include demonstrations, practicals, and exercises using data, equipment, and instrumentation available at the observatory.

The following IVS members have dedicated much of their time and efforts towards the success of the AVN training at HartRAO: Sayan Basu, Roelf Botha, Glenda Coetzer, Ludwig Combrinck, Aletha de Witt, Marisa Nickola, and Jonathan Quick from SARAO, Chris Jacobs from the Jet Propulsion Laboratory, California Institute of Technology/NASA, Andreas Hellerschmied and David Mayer from the Federal Office of Metrology and Surveying in Austria, Matthias Schartner from the Technische Universität Wien, Patrick Charlot from the Université de Bordeaux, and Maria Karbon from SYRTE/Observatoire de Paris.

Through the combined efforts of SARAO, DARA, and our IVS colleagues as well as the hard work of the students, the AVN school has prepared the next generation of workers for VLBI in Africa.

Chris Jacobs in action during the 2018 AVN training at HartRAO.

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 the General Editors (see below).

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

https://ivscc.gsfc.nasa.gov/.

Group photo of the VLBI lecturers who participated in the 2018 AVN training school at HartRAO.

Hands-on activities during the 2019 AVN training school at HartRAO.

First VGOS Fringes at McDonald

July 19th, 2019 saw the emergence of the newest NASA VGOS antenna at McDonald Geophysical Observatory (MGO) Fort Davis, Texas. The first fringes were found in all baselines, all bands, and both vertical and horizontal linear polarizations with Westford and Goddard Geophysical and Astronomical Observatory (GGAO) on quasar 0059+581, thus confirming MGO's interferometric detection and performance. Expectations are high for MGO to join the other VGOS stations for observations shortly.

– Chet Ruszczyk

From the VGOS World...

Experience with VGOS Correlation and Fringe Fitting at USNO

– Andy Sargent and Phillip Haftings, U.S. Naval Observatory

The USNO Washington correlator (WACO) received partial data from VGOS-T9050, a 24-hour VGOS test session. Data were included on Mark 6 diskpack from GGAO12M (Gs), KOKEE12M (K2), and WETTZ13S (Ws). Data were recorded using the VGOS setup at 8 Gbps per station. WACO correlated on all baselines, but only the Gs-K2 baseline, where all data were complex-valued, produced fringes. The baselines with a mix of complex-valued and real-valued data correlated but produced no fringes. DiFX 2.5.2 and HOPS 3.20 were used for correlation and fringing of VGOS data. WACO followed the setup and procedures from an early version of the VGOS correlation guide presented at the IVS Technical Operations Workshop (TOW) 2019.

WACO does not correlate directly from diskpack, so it was necessary to pre-process, or "gather", the scattered Mark 6 data for DiFX. The native Mark 6 gather/gator tool suite made gathered copies of the data on a separate Mark 6 diskpack, which we later copied to another volume for correlation. WACO tried several combinations and configurations of the gator tools and a few DiFX setups, but HOPS never found fringes on baselines with mixed real-valued and complex-valued data. We were unable to try correlating directly from a Mark 6 unit, and we did not have a second set of real-valued data to test a dual real-valued data baseline.

WACO also developed a Python module for manipulating VDIF and Mark 6 scatter/gather data to aid in debugging. It allowed detailed inspection and comparison of ingested data and gather results. The module also has its own gather capabilities. WACO tried using it to gather the real-valued data set, but met with no more success in finding fringes than the native Mark 6 gather/gator routines.

WACO found that VGOS correlation and fringing were much slower than S/X correlation and fringing. Exact differences are highly dependent on the number of baselines. VGOS correlation requires faster disk access than S/X. When correlating 8-Gbps data off of a single Mark 6 diskpack, data can only be processed at slightly below real-time speed, because a single Mark 6 diskpack only supports reading at ~8 Gbps after accounting for overhead and syncing. Distributed disk systems can feed data to the correlator much faster, with no real limit to throughput, but require either e-transfer or data gathering from the Mark 6 diskpack first. VGOS correlation CPU usage is about 64 times higher than S/X, which is in line with expectations. VGOS has a four times higher sampling rate (64 MHz vs. 16 MHz), four times as many channels (64 channels vs. 16 channels), and four polarization combinations (XX/XY/YX/YY vs. CC). Fringing requires two pre-passes to establish calibrations, which each take on the order of half as long as the full fringe fitting. The full fringe fitting takes a little more than 64 times as long as S/X fringe fitting due to additional calculations, but the difference is marginal. At least one and possibly both fringe fitting pre-passes can be skipped under certain circumstances, such as when correlating sessions observed close together in time. VGOS fringing takes long enough to require multiple fringing nodes (servers) to perform in a timely manner, even if the pre-processing is skipped.

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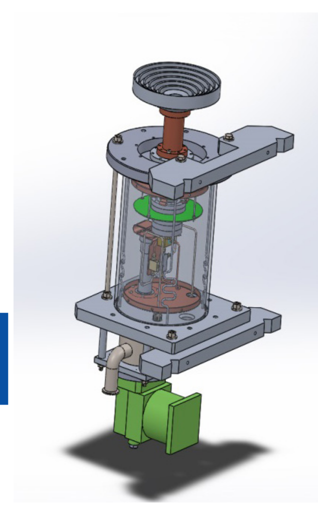
HartRAO VGOS — One for the Southern Hemisphere

While pursuing millimeter accuracy, the VLBI community is well aware of the delays associated with cutting-edge technology and its realization. A year and a half after site acceptance we have worked out all of the teething problems and are now at a point where we can regularly run test schedules on the antenna, albeit without a receiver and associated signal chain. Work is currently underway to interface the Field System with our VGOS ACU and we have started developing a single circularly polarized test receiver, which will cover around 5 to 10 GHz. This can be seen as a phased approach to a full broadband system and enables us to get the signal chain up and running using our existing, older generation backend interfaced with our Mark 6 recorder. At the same time, we will continue evaluating the receivers and backend systems being used by the other observatories.

– Philip Mey



Preliminary test receiver design as of June 2019.