IVS Newsletter

Issue 45, August 2016

First Transatlantic VGOS Fringes

– Chester Ruszczyk, MIT Haystack Observatory

Set of stations involved in the successful fringe tests across the Atlantic.

In recent months a lot of progress has been made in the roll-out of the VGOS (VLBI Global Observing System) network and system. Having successfully obtained interferometric fringes between the VLBI broadband systems at the Kokee Park Geophysical Observatory (KPGO) in Hawaii, the Goddard Geophysical and Astronomical Observatory (GGAO) in Maryland, and Westford in Massachusetts (see Figure), a VGOS extended family including personnel at those three sites plus Wettzell in Germany, Yebes in Spain, and NVI at the Goddard Space Flight Center (GSFC) has been hard at work systematically verifying and integrating the transatlantic VGOS baselines.

On Thursday, 9 June 2016 (day of year 161), fringes were obtained between GGAO, Westford, and Wettzell in all four VGOS observing bands (a.k.a. bands A, B, C, and D). Since a fringe test with the system at Yebes had previously verified bands B and C, the test on this day focused on bands A and D for Yebes. These also produced fringes, thus verifying all four signal paths for Yebes. It should be noted that the signal chains of Wettzell and Yebes incorporated a DBBC2-Fila10G-Mark6 combination, whereas those at GGAO and Westford operated the RDBE-G-Mark6 backend, and that all VGOS systems were controlled by the Field System (PCFS) using a schedule (skd) file.

Since the intial first fringes, the team has followed up with additional fringe tests with the goal of solidifying the setup, operational procedures, further debugging, and gaining valuable operational experience for their particular systems. Recently, another successful fringe test has also included KPGO as part of the first VGOS Trial session (VGT001) and, as of this writing, VGT002 is running. The bottom line is, VGOS broadband compatibility is starting to shape up across the Pacific and the Atlantic.

This amazing accomplishment required the efforts of many dedicated people, among them, Alexander Neidhardt, Christian Plötz, and Gerhard Kronschnabl at Wettzell; Pablo de Vicente, Laura Barbas, and Javier González at Yebes; Katie Pazamickas and Jay Redmond at GGAO; Mike Poirier and Alex Burns at Westford; Kiah Imai, Lawrence Chang, and Chris Coughlin at Kokee; Ed Himwich at NVI; and Mike Titus, Brian Corey, and Chester Ruszczyk at MIT Haystack Observatory.

There is still a lot of work ahead before reaching the next step with respect to scientific observations, but this represents a wonderful step to achieving the goal of an integrated geodetic broadband VGOS network.

...News Flash...

First Fringes to Southern Hemisphere Telescope

On August 9, 2016 broadband fringes were detected between Australia (Hobart) and Japan (Ishioka) using prototype equipment with a Sterling Cycle cooled feed (at Hobart). These are the first broadband fringes to a southern hemisphere telescope, the first broadband trans-Pacific fringes and the first international fringes for Ishioka. Congratulations to the groups at UTAS, GSI, and NICT for this achievement.

Feature

The Washington Correlator at the U.S. Naval Observatory

Panoramic view of the U.S. Naval Observatory.

The Washington Correlator at the U.S. Naval Observatory (USNO) in Washington, D.C., USA is one of the main correlation facilities of the IVS. As part of NEOS (National Earth Orientation Service), WaCo is in charge of the IVS-R4 and Int1 Intenstive sessions. Hayo Hase caught up with David Hall, the lead of USNO's correlator group, via email to learn more about the activities of the correlator.

David Hall at his workstation at USNO.

What are the main duties of USNO and how does VLBI fit in?

The U.S. Naval Observatory's mission is to:

- Determine the positions and motions of celestial bodies, motions of the Earth, and precise time.
- Provide astronomical and timing data required by the Navy and other components of the Department of Defense for navigation and precise positioning, as well as command, control, and communications.
- Make these data available to other government agencies and to the general public.
- Conduct relevant research and perform such other functions as may be directed by higher authority.

The first and second parts to USNO's mission obviously require well determined and linked terrestrial and celestial reference frames and the Earth's well determined orientation within them. VLBI is the best way to precisely measure Earth orientation parameters and reference frames to achieve that goal.

The Naval Observatory is also the residence of the U.S. Vice President. This prominent location is shared with your offices and correlator. Do you have interactions with the Vice President or could you talk about VLBI with him?

In the past we have had social interactions with the Vice Presidents (VP) and their families. The first Bushes often came to our holiday parties and many of the family would often be seen jogging on the grounds. The Gores were similar, and actually held an open house when they first moved in.

Sadly, the events of September 11, 2001 changed a lot of things in Washington, and the heightened security means we seldom see or interact with the VP or their families.

When and how was VLBI introduced at USNO and why is it still part of it?

Initially, USNO was hosting the correlator for the National Geodetic Survey who had switched from optical instruments and found that the volume of sessions needing correlation were more than the existing correlators could handle in a timely manner. We also hosted an antenna at our alternate time station in Florida. The initial Interagency Agreement eventually evolved as the Navy realized the potential to apply VLBI to its mission to determine UT1-UTC and Polar Motion as well as also providing EOP predictions.

What is the commitment of USNO to the IVS?

As a part of NEOS, USNO maintains and runs the Washington Correlator (WaCo) to process one rapid session (R4) and four to five Intensive sessions (Int1) per week, plus additional 24-hour CRF, CRDS, and APSG sessions as needed. We also supply media to several stations, including the Kokee Park 12- and 20-meter telescopes, which we, along with NASA, help operate. We made quite a large buy of Mark 6 units and media in anticipation of VGOS.

What is your background and how did you engage with VLBI?

My career at USNO started in the Astrometry Department as an observer and analyst on the transit circle and the Double Star program. As the Astrometry Department started to get in to VLBI and reference frames, I was tapped to do some Calc/Solve analysis and schedule some of the CRF sessions. Eventually there was a VLBI group formed in the Astrometry Department and I joined them as the main analyst handling the analysis of the R4, R1, and Int1 sessions.

Eventually in 2006, a position opened in the VLBI division of the Earth Orientation Department, and based on my experience with analysis I applied. We were still using the Mark IV correlator at the time, and while I didn't know a lot about running a correlator I had an excellent mentor in Kerry Kingham.

In 2012, Kerry retired as we were transitioning to the new DiFX correlator. The transition was an interesting one, as I had moved to more of my time being devoted to administrative duties and much of the daily work fell to my team of Roxanne Inniss, Bruce Thornton, and Dan Veillette.

How many staff are working at USNO and in VLBI with you? What are the individual duties?

By the time this article prints, the VLBI division at USNO will be in the midst of a major transition. As mentioned above, for quite some time my team has been Roxanne Inniss, Bruce Thornton, and Dan Veillette, with John Spitzak providing correlator support under contract. After years of trying I have finally convinced the Navy we are understaffed and allowed me to hire. Unfortunately, Dan Veillette has at the same time transitioned to another department at USNO, so I am in the process of hiring two new scientists to help run the correlator. Slightly painful in the short term, but in the long term we are expanding our staff.

I should also mention that we receive tremendous support through contracts with MIT Haystack Observatory and NRAO that allows us to operate with a small staff.

What is your routine duty at WaCo and what are your special correlation runs?

A lot of my duties are now administrative and managerial, but I am still involved with operations and planning. With VGOS on the horizon we need to assure that we can expand our capabilities and upgrade facilities and infrastructure to keep pace with our expanding operations.

From the correlator point of view, what do you consider as highlights or special achievements in your correlation work and why?

I'd have to say, personally for me, getting CONT11 through the old Mark IV correlator while at the same time going through a re-organization of the divisions operations ranks up with one of my most professionally fulfilling times. There probably wasn't a weekend between September and Christmas of 2011 that I wasn't coming in to troubleshoot or re-start the processing or e-transfers. Very busy and at times hectic, but we were able to put out CONT11 in record time.

How does the VGOS concept challenge USNO?

It really hasn't sunk in yet, I suppose, just how much we need to upgrade our infrastructure to handle the coming tidal wave of data. Certainly that is one of my main concerns, that we'll be overwhelmed by the sheer volume of what we'll need to move through the correlator.

We are in the midst of an automation effort to make at least the Intensives an automated process. I suppose that, like many of us who've been in the sciences since pre-Internet days, we'll some day look back and wonder how we got anything done on such primitive equipment.

What is your vision on how the future of VLBI correlation might look like?

At USNO that is one of the main questions we're trying to answer. With the increased volume of data I think we will be stressing our present infrastructure to the point that we will be doing distributed correlation out of necessity. Right now we strain to get 20-25 TB per session transferred via e-VLBI in a timely manner. When that quadruples, or more, one correlator taking in hundreds of terabytes won't be feasible. A virtualized correlator on some sort of cloud system is also something we're interested in exploring. It solves a lot of problems and would be a lot more flexible than our current hardware.

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

Cooking is probably my main pastime or hobby. I like to try different cuisines and see what I can learn about cooking from each. Right now I'm doing a lot of Thai cooking. I also enjoy hiking in some of the many parks around the Washington DC area, but in August that gets to be a pretty sweaty proposition given the area's weather.

Hardware supporting the new DiFX software correlator at USNO.

Registration of New VGOS Sites by ITU

– Hayo Hase (BKG), Vincenza Tornatore (Politecnico di Milano), and Brian Corey (MIT Haystack Observatory)

Exaggerated depiction of a saturated (or 'fried') frontend of a radio telescope due to an SAR transmission.

A number of new VGOS radio telescopes for observing in the 2-14 GHz range are built or under construction, at old but also at new locations. VGOS radio telescopes are much more receptive to unwanted radio frequency interference (RFI) compared to the legacy S/X sytem curently used in VLBI. Some space-borne devices, especially Synthetic Aperture Radar Systems (SAR), may cause detrimental radiation to VGOS wideband receivers.

A partial solution to this problem is a request for administrative protection through a registration of the new VGOS sites at the Radiocommunication Bureau (RB) of the International Telecommunication Union (ITU). ITU is allocating the global radio spectrum and satellite orbits, developing the technical standards that ensure networks and technologies seamlessly interconnect.

ITU is used to deal with dedicated portions of spectral ranges over the entire electromagnetic spectrum. The VGOS frequency range from 2 to 14 GHz is full of such portions of spectral bands. Each band has allocated primary and secondary uses. Radio Astronomy Services (RAS) have some allocated spectral bands as primary in which astronomers are observing spectral lines of atoms and molecules in the universe. Those allocated bands for RAS are protected and should not be interfered by other users, not even by sidelobes of transmitters from adjacent bands. The RAS bands are usually different from those of the Earth Exploration Satellite Systems (EESS). The VGOS wideband range of 2-14 GHz covers some of the RAS bands as well as the EESS bands.

The list of registered RAS sites should be consulted by space agencies for scheduling their high power SAR systems and hence avoid direct illuminations by strong radars and interferences with VGOS observations. In practice, the location of the registered VGOS telescopes can be taken into account for the planning of satellite missions and those known RAS sites may receive notifications of satellites passing over them.

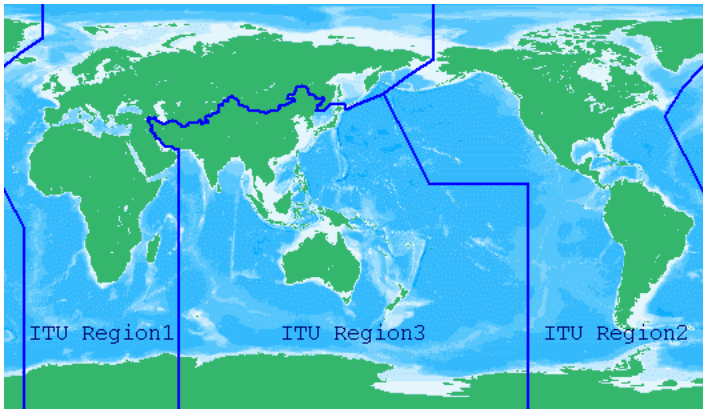
Registration of VGOS observatories as RAS sites must take place through the national telecommunications authority. The required characteristics of the radio astronomy telescope (kinematic and receiving parameters) are easy to provide and described in Annex 2 of Appendix 4 of the Radio Regulations (RR), which are continuously updated according to the outcome of the World Radio Conferences (WRC).

The advantages of being registered are:

- Several footnotes in the Radio Regulations providing protection to radio astronomy stations from unwanted emissions by satellites.
- Examining a satellite system for compliance with footnotes the Radiocommunication Bureau will consider only registered radio astronomy observatories.
- Establishing a chronological priority for the registered station. It may claim protection from unwanted emissions of satellite systems filed for operation in adjacent or nearby bands at a later date.

What to do?

1. Contact your national telecommunication administration.
2. Supply to the national authority the information required for the ITU registration of the VGOS radio telescope according to the recent Radiocommunication Regulations.
3. Check via national telecommunication administration about the successful registration at ITU.



The ITU divides the world into three regions to manage the global radio spectrum. Each region has its own set of frequency allocations.

News...

On the Way to Making VGOS Operational

– Dirk Behrend, NVI, Inc.

It is generally expected that VGOS (VLBI Global Observing System) will be operational by the year 2020. In this article we address how we plan on getting there and touch on some of the implications of VGOS for VLBI operations.

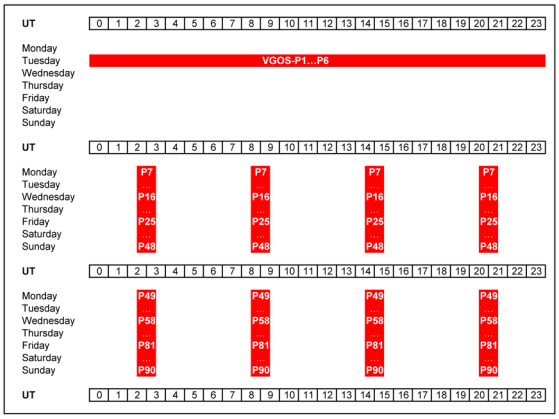
The VGOS concept foresees a network of 16 or more stations, which are distributed globally, to record broadband VLBI data in a continuous fashion (24/7/365). The stations should typically be very fast slewing radio telescopes capable of recording four observing bands at a high data rate (16 Gbps and up). The large number of scans (and observations) together with the high data rate offsets the slightly lower sensitivity of the smaller dishes (as opposed to the more sensitive large dishes used for the legacy S/X system), while the fast source switching allows to beat down atmospheric errors. In addition to the 12-m class antennas, larger dishes (perhaps four per hemisphere) continue to be valuable for astrometric observations of the sources.

The continuous observing by itself constitutes a quantum leap in VLBI operations, as we move away from session-oriented observing, which currently accounts for about 3.5 days of VLBI observing per week on average, i.e., a duty cycle of 50%. With the VGOS system this will be doubled, at least for the VLBI network as a whole (individual stations will continue to have maintenance days). While this opens up the opportunity to increase the product palette such as providing tiered EOP products (e.g., very fast, fast, and final EOP sets), it increases the burden on the VLBI stations and subsequent processing components necessitating a high level of automation.

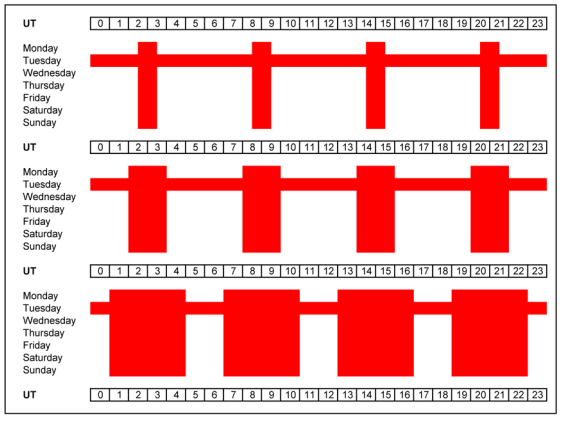
To ease in the new modus operandi, the VGOS Project Executive Group (VPEG) prepared the VGOS Observing Plan, which outlines steps to go from initial broadband tests to intermediate observing scenarios to the fully operational VGOS system. The document introduced VGOS trial campaigns as the initial means to accustom the VGOS stations and the subsequent component types to the VGOS processing load (scheduling, data taking, data transport, correlation, and analysis). Following a successful completion of the trial campaigns, a pilot project will commence, whose purpose will be to gain experience with the operational mode but without making a full commitment to product delivery.

The first VGOS trial campaign will be observed over about three months (likely September through November 2016) with sustained fortnightly 24-hour sessions in UT days. After a couple of months of digesting the experience (e.g., performance assessment, recommendations for improvements), the second trial campaign will be recorded. Trial #2 will focus on sustained daily VGOS sessions with a reduced duty cycle of four one-hour bursts per UT day (see figure). The media requirement will be similar to one 24-hour session per week. Given a successful completion, a third trial campaign may be observed, where the emphasis will be put on the timely transmission of the data (e-transfer as much as possible); otherwise Trials #2 and #3 are identical. Trial #2 will be observed in the first half of 2017. With a CONT17 campaign planned for the latter part of 2017, it is likely that VGOS Trial Campaign #3 will be tackled in the first half of 2018.

With the successful completion of the VGOS trial campaigns (perhaps in mid-2018), the pilot project can be started as a combination of the observing scenarios of the trials. By steadily increasing the observing load over time, a complete observing coverage of 24/7/365 can be achieved in a 1.5–2-year time period so that by 2020 actual production work might begin, that is, the pilot project will eventually culminate into full VGOS operations by 2020. At that time some 18 VGOS sites should be available.



Observing scenarios of the VGOS trial campaigns: Trial #1 (upper panel), Trial #2 (middle panel), and Trial #3 (lower panel). The numbers indicate session names; e.g., session P25 consists of four one-hour bursts to be observed on a Friday.



Pilot project with increasing the burst lengths. Three stages are depicted. The next stage would be fully continuous operations around the clock.

Get Ready for TOW2017!

– Ed Himwich and Kyla Armstrong, NVI, Inc.

For the ninth time, the MIT Haystack Observatory at Westford, MA, USA will be hosting the IVS Technical Operations Workshop (TOW). From April 30 through May 4, 2017, VLBI station operators will gather under the auspices of the IVS. Very successful in previous years, the TOW is where the station operators can meet the experts and attend classes. The TOW ensures that the IVS community is provided with well-trained observing staff at each station.

At the last TOW in 2015, 74 participants from 14 different countries across the globe gathered to learn about the operations and maintenance of their prospective stations as well as listen to various lectures and participate in seminars led by VLBI's most prominent station operators and technicians. This time you can expect more classes concentrating heavily on the new VGOS broadband network. The teachers, registration fees, and specific classes will be revealed later.

In addition to new VGOS classes, a special memorial will be held to honor the late Rich Strand, a fixture of VLBI and TOW for over 30 years. Rich passed away unexpectedly in November 2015.

The TOW workshop will run over three-and-a-half days with classes, lectures, and workshops. On Sunday evening, an icebreaker will be held to meet the teaching staff and all the students attending from each radio observatory in the program. The icebreaker will also get you acclimated to the beautiful scenery in Westford, Massachusetts, where the TOW will be held.

It has been demonstrated that station performance improves when their staff have attended a TOW workshop. Operational guidelines are important to learn, but TOW also allows operators to have a chance to ask questions one-on-one with the VLBI design team and scientists as well as correlator and software experts.

For further information or suggestions, please contact Dirk Behrend (Dirk.Behrend@nasa.gov). You can also visit the TOW Web site, http://ivscc.gsfc.nasa.gov/meetings/tow2017/, which will be up and running soon.

Rich Strand (left) during a station operations class at the previous TOW.

Main building of MIT Haystack Observatory with the radome of the 37-m antenna and the typical coffee/lunch break tent in the front.

New Skyline at Onsala

The reflectors of the Onsala Twin Telescopes (OTT) in Sweden have been mounted significantly changing the skyline at this IVS station south of Gothenburg. It is planned to officially inaugurate OTT in May 2017 during the next EVGA Working Meeting. Congratulations to the OTT team!

More info:
http://www.oso.chalmers.se/ottcams/showcams.html
http://www.chalmers.se/en/centres/oso/earth-sciences/vlbi/Documents/OnsalaTwinTelescope_ENG.pdf

Mark 6: It looks a little like a Mark 5…but it's not!

– Mike Poirier and Alex Burns, MIT Haystack Observatory

The Mark 6 operational system supporting VGOS is very different from the Mark 5B/C system. With a Mark 6, the disk modules, connections, and controls are different.

Disks and conditioning. With the huge record rate (16 Gbits/second) capability in the Mark 6, most of the time you will be recording to larger-capacity multiple-disk modules. These modules look similar, but you will notice that there are connections on the front of the modules unlike the Mark 5 modules. During recording, the green LEDs flash on the Mark 6 modules where the Mark 5 modules' LEDs stay on steady. Conditioning is accomplished by a utility called 'hammer' and basically writes over all bits, the same as Mark 5 conditioning. Be aware that this procedure takes many hours to complete.

Connections. The next big change is the connections. The plug in the rear of the disk module no longer handles data; it only provides power. The data is sent via the high-speed connectors on the front. It is important that the cables are in the proper orientation to ensure that disk 0 (the first disk in the module) is the same disk at the station when recorded and at the correlator during playback!

Controls. In the place of dimino—the long standing Mark 5 software interface between the Field System and the disk module—we now have two programs: dplane and cplane. These are named for the job they perform, with dplane (data plane) handling 1's and 0's that are written on the disk module, and cplane (control plane) dealing with the interface to the Field System. Local control on the Mark 6 is also available through a terminal window using the da_client similar to the old tstDIMino in Mark 5.

The biggest change as a user is getting used to the new functions regarding grouping of the modules. This would be similar to running a Mark 5 in dual-bank mode, but with the Mark 6 you can have quad-bank mode. This is necessary due to the hardware architecture (each module can sustain 4 Gbps of writing over the entire disk) that determines scan length. Some sessions have longer scan lengths, which requires two or four modules to be recorded to in parallel.

Front panel view of the Mark 6 recording system.

Upcoming Meetings...

WDS Members' Forum
Denver, CO
September 11, 2016

SciDataCon 2016
Denver, CO, USA
September 11-13, 2016

1st Int'l Wksp on VLBI Observations of Near-field Targets
Bonn, Germany
October 5-6, 2016

5th Int'l VLBI Tech.Wksp
Westford, MA, USA
October 12-14, 2016

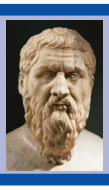
RFI 2016: Coexisting with Radio Frequency Interference
October 17-20, 2016
Socorro, NM, USA

GGOS Days
Cambridge, MA
October 24-28, 2016

AGU Fall Meeting
San Francisco, CA, USA
December 12-16, 2016

EVGA Working Meeting 2017
Gothenburg, Sweden
May 15-19, 2017

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



Astronomy compels the soul to look upwards and leads us from this world to another.
– Plato

It is not knowledge, but the act of learning, not possession but the act of getting there, which grants the greatest enjoyment.
– Carl Friedrich Gauss

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

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

Directing Board Elections Coming in Fall/Winter

– Gino Tuccari, IRA-INAF (Chair of the Election Committe)

In an important and revolutionary phase, there are new challenges on the horizon for the IVS. The observational network is going to face VGOS requirements for the new stations together with the inclusion of the legacy stations. For this the upcoming Board elections at the close of the year have an elevated importance. After two years it is time for the next IVS elections in order to get prepared for the next two-year period, which will begin in February 2017.

For the next governing period, six positions need to be renewed in the Representative and At-Large areas. In the Representative category, the positions to be renewed for the next four years are: one of two Network Representatives, one of two Analysis Representatives, and the Technology Development Representative. In addition to these, the three At-Large positions are to be elected for a two-year term.

The elections have an important phase that is devoted to nominating the candidates. In this phase, those IVS members who can be elected by the community to fill the positions have to be proposed. This part of the election process is anticipated for November 2016 in order to be ready for the actual elections which will be divided into two parts: Representative elections (voting by the Associate Members) probably in December 2016 and then, about one month later, the At-Large elections (by the Directing Board). The At-Large members are selected with the aim to balance out the Board as wide and best as possible.

The positions to be renewed are (including incumbents):

- three Representative positions with four-year terms:
  - one Network Representative (currently held by Jim Lovell)
  - one Analysis Representative (currently held by Axel Nothnagel)
  - the Technology Development Representative (currently held by Rüdiger Haas)
- three At-Large positions with two-year terms (currently held by Alexander Ipatov, Ryoji Kawabata, and Guangli Wang).

Both Rüdiger Haas (Representative position) and Alexander Ipatov (At-Large member) cannot be re-elected, having already been elected the maximum of two consecutive times for the same position.

The Election Committee will prepare and distribute a call for nominations by October 2016. The IVS community should begin thinking and getting ready for that time to nominate their favorite candidates and to take part in the decision process. Take into account, though, that any nominee needs to be an IVS Associate Member. So, be sure to get in contact with the Coordinating Center if your choice is not currently listed as an IVS Associate Member.

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