# IVS Newsletter

Issue 4, December 2002

## What's New in 2003?

*–Nancy Vandenberg, NVI Inc./GSFC, for the Observing Program Committee*

After discussing resources and results and studying numerous simulated schedules, the IVS Observing Program Committee (OPC) approved the observing plan for 2003.

We believe the use of Mark 5 systems will be an overall help for the correlators, as well as making station operations smoother. For 2003 the number of stations in the R1 and R4 sessions increases from six to seven, with the plan to have at least one station in each session use Mark 5. By the end of 2002, the daily Wettzell-Kokee Intensive sessions should be using Mark 5 exclusively.

Although the total number of planned station days is increased by 15% over the number of station days in 2002 (not including CONT02), we still could not use all of the observing days offered by the stations and we cannot increase the R1 and R4 network sizes to eight stations, as planned in the WG2 report. This is because the Mark 4 correlator efficiency remained at the same level throughout 2002. Recent developments indicate that improvements can be made but these were not factored into the schedule because we need to do a conservative plan until improvements are definite.

Summarized by type of session, 2003 will include:

- EOP: weekly sessions Monday (R1) and Thursday (R4), 7 stations; monthly sessions Wednesday (E3) using S2.
- TRF: monthly sessions to monitor the TRF; 8-station networks include each station at least 2-3 times.
- CRF: 8 sessions for mid-south astrometry, three 1-baseline sessions to survey the far south.
- Regional: Europe, Asia-Pacific, Japan, and Antarctica.
- R&D: 10 sessions to study technique improvement.
- RDV: bi-monthly 20-station sessions including the 10-station VLBA network.
- Intensives: hour-long sessions 4 times per week with Wetttzell-Kokee, 20 times per year with Tsukuba-Wettzell using K4.

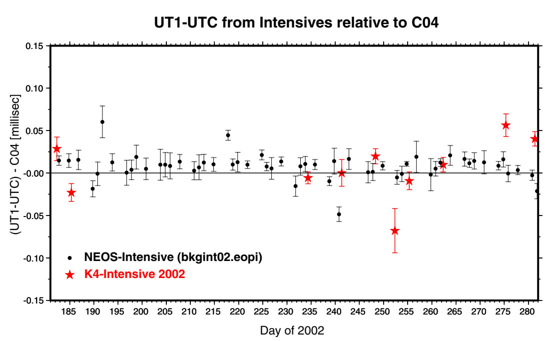
Requests for participation have been sent to the stations by Cynthia Thomas. Sessions and the draft 2003 Master Schedule can be found at http://ivscc.gsfc.nasa.gov/service.

## Towards an Independent UT1 Intensive Series Using K4 Technology

*–Dorothee Fischer and Axel Nothnagel, Geodetic Institute of the University of Bonn*

On July 1st, 2002 the first observations of a new short-duration observing series for the determination of UT1 were carried out on the baseline Wettzell - Tsukuba using K4 technology. An independent monitoring of UT1 will become possible with this new IVS project organized by Bundesamt für Kartographie und Geodäsie (BKG) (Germany), the Geographic Survey Institute (GSI) (Japan) and the Geodetic Institute of the University of Bonn (GIUB) (Germany). This should provide ample scope for comparison and control of independent UT1 series as well as for interpretation of differences between them.

The baseline Wettzell (Germany) - Tsukuba (Japan) shows a geometry similar to the baseline Wettzell - Kokee Park (Hawaii), which is being used routinely for UT1-Intensive observations with Mark 5 systems. Twenty sessions are planned until the end of 2002, each one carried out between 7:30 and 9:00 UT observing 20 scans. Due to limited resources the sessions are currently scheduled in a nearly weekly sequence. The scheduling is done at the Geodetic Institute in Bonn and the correlation is carried out at the GSI K4 correlator at Tsukuba.




So far, the first ten sessions have been observed and analyzed and some first experience with scheduling, recording, shipping, correlation and analysis has been gathered. The results of the first 10 K4 observations (asterisk) are depicted together with the Wettzell - Kokee Park results (circle) with the IERS C04 series subtracted as a reference. Apart from three sessions which need a more detailed analysis the results are very promising fitting quite well to those of the Wettzell -Kokee Park baseline. Negotiations are in progress for a continuation of this series in 2003 aiming at more observing days well distributed over the whole year.

# IVS PERMANENT COMPONENT

## Hobart VLBI Station, Mount Pleasant Observatory


*The 26-m antenna at Mt Pleasant Observatory (top), location of the Hobart IVS station (right)*

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/.

The Hobart VLBI station in Tasmania joined IVS as a Network Station earlier this year.

The Hobart 26-m antenna was formerly at the Orroral Valley Tracking Station near Canberra. The tracking station was part NASA's worldwide spacecaft tracking and data network. NASA donated the antenna to the University together with extensive support equipment and spares. The antenna has an interesting history. It was completed in 1965 and it supported many of NASA's best-known activities. It was involved in program such as the Orbiting Solar Observatory (OSO), the joint US-USSR manned Apollo-Soyuz mission of 1975 and the Space Shuttle program. It was also responsible for tracking the re-entry of Spacelab over Australia. The antenna was moved from Orroral Valley to Mount Pleasant during the period from July 1985 to February 1986. The antenna was formally presented to the University of Tasmania by the United States Ambassador to Australia in May 1986.

Peter McCulloch, director of the observatory, was interviewed via e-mail by H. Hase.

*Q: Where is the Hobart station located?*

A: The Hobart station is called Mount Pleasant Observatory and is located in the Richmond Valley about 15 km from Hobart in Tasmania, an island south of Australia. It is on top of a small hill, called Mt. Pleasant, about 50 m above mean sea level and about 1 km away from the sea.

Q: *Who operates the Mt Pleasant Observatory?*

A: The observatory is operated by the radio astronomy research group within the School of Mathematics and Physics at the University of Tasmania. We have two academic staff, myself and Dr. Simon Ellingsen, an observatory manager Brett Reid and an electronics technician Eric Baynes as well as a number of Honours and PhD students.

*Q: When did Hobart begin participating in geodetic VLBI measurements?*

A: Hobart has been participating in geodetic VLBI programs since the late 1980s when Bill Carter from NOAA loaned the University of Tasmania a MkIIIa recording terminal and hydrogen maser frequency standard. We operated with support from NOAA for a number of years and more recently from Goddard Space Flight Center.

*Q: Hobart joined the IVS in 2002. What were the reasons for joining?*

A: In 2002 we, in conjunction with AUSLIG, were successful in obtaining a five-year grant from the Australian Research Council to support geodetic VLBI observations at Hobart. At the same time we also got a grant to upgrade the MkIIIa recording system to Mark 4/5. With this financial support we were able to make a longer term commitment to support geodetic VLBI and hence decided to apply for membership of IVS.

*Q: What are your expectations from IVS?*

A: I believe it is important for the School of Mathematics and Physics and the University of Tasmania that we maintain a high international profile and being a member of IVS helps us in this regard. It also provides additional pathways for our staff and students to become involved in international programs and work along side the leaders in the field.

*Q: What are your future plans regarding VLBI in your environment?*

A: We have a second radiotelescope at Ceduna in South Australia (lat.31°52'S, long. 133°48'W). We operate these two antennas as part of an Australian VLBI network for astronomy and astrometry. Both stations are equipped with S2 recording systems and operate of most of standard frequency bands between 2.2 and 22 GHz. We are in the process of completing an upgrade of both sites which has meant modifications to the focal cabin at Hobart which will allow us to keep seven receivers on a feed translator. We have also upgraded all the receivers at Ceduna giving us a typical system noise of around 600 Jy at frequencies between 2 and 12 GHz. In the future we plan to continue with a very significant involvement in astronomical and geodetic VLBI by participation in IVS programs and all astronomical VLBI programs involving Australian antennas.

*-interview by H. Hase*

*Dr. Peter McCulloch, director of Mt. Pleasant Observatory, at Hobart, Tasmania. Peter's email address is Peter.McCulloch@utas.edu.au, and their web address is: http://www-ra.phys.utas.edu.au.*

## IVS EOP Series Now Available for 1984 - 2002

*–Axel Nothnagel and Christoph Steinforth, Geodetic Institute of the University of Bonn*

A new IVS EOP series (ivs02002.eops) has been generated which now covers the period from January 1, 1984 to the end of June 2002 (http://giub.geod.uni-bonn.de/vlbi/IVS-AC). The input of the six IVS Analysis Centers has been combined into a single series using the standard IVS combination procedures referred to the ITRF2000 reference frame. In this series all geodetic VLBI sessions suitable for high precision EOP determination have been used. In contrast to the rapid series which is updated weekly (ivs02001.eops) this series also contains most of the sessions which have been observed in addition to the NEOS and the IVS-R1 and -R4 sessions. The IVS EOP data file contains one line per session with the IVS session identifier in field 18. One of the most demanding tasks in the combination process was the bookkeeping for days when two networks observed simultaneously. Here, the correct form of the session identifier is a pre-requisite for automatic identification and some of the analysis centers had to be pushed very hard to provide data files with proper session identifiers. This series will be maintained in addition to the rapid series and will be updated quarterly.

### *A Taste of History....*

Seventeen years ago in December 1985 two large wooden crates arrived at the Hartebeesthoek Radio Astronomy Observatory containing a Mark III data acquisition terminal and tape recorder on loan from NGS. Before it could be used in the first ever African high accuracy geodetic VLBI experiment on January 9, 1986 the staff at HartRAO had to fight the odds of a hitherto unknown piece of equipment. Shortly before the first session was scheduled a connector linking the rack to a video converter did not produce a proper connection and was provisionally stabilized with a push-pin. I wonder if it is still there.

- Axel Nothnagel

**... how things have changed (or have they)?**

*Feeling nostalgic? Send your "taste of history" contributions to ivs-news@gsfc.nasa.gov. If we use your submission, you will receive a free IVS t-shirt (while supplies last).*

### *Upcoming Meetings...*

4th IVS Analysis Wkshp.
Institute Geographique National
Paris, France
April 3-4, 2003

European Geophysical Society Meeting
Nice, France
April 6-11, 2003

16th Working Meeting on European VLBI
Leipzig, Germany
May 9-10, 2003

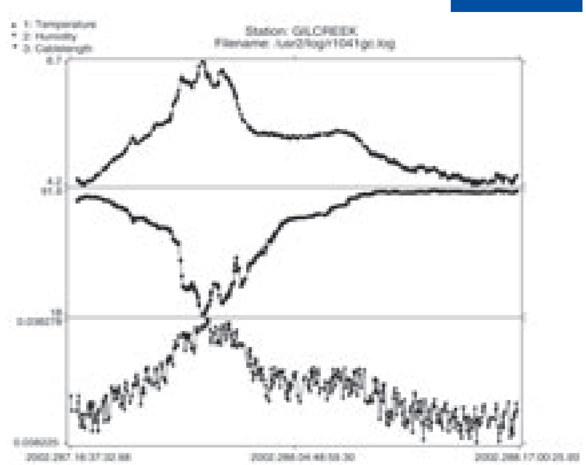
IVS Technical Operations Workshop
Haystack Observatory
Westford, MA.
June 2-5, 2003

## How to "Plot" station performance

*–Rich Strand, Gilmore Creek Geophysical Observatory*

Measurements of accurate Earth motion are dependent on the IVS Network Stations providing quality space geodetic data. Data quality of each station is reported by the correlator after each session on the IVS e-mail reflector. Very detailed reporting is often provided for stations that participate in the RDV sessions. These reports provide valuable feedback to the stations and improve data collection.

*Station post session analysis.* To help maintain high data quality it is useful for the operators to analyze their system's performance post session as well. One process for doing this is extracting data points from the session log and then plot short term trends. Maintaining an archive of these data plots comes in handy as you can quickly refer to any problems mentioned in the correlator's report. Plotting data often is the only tool to find cable problems.




*Plotting tools.* Fortunately all the software is provided by the Field System for the operator's plotting of data points. The FS provides a large amount of flexibility during logging that all aspects of data collection can be monitored and evaluated.

*Plotting Log data.* LOGPL is a program that will delog and plot any data point specified. It will plot in real-time as well as run batch files post session. LOGPL provides the station operator an excellent tool to graph data points quickly and efficiently.

*But what to plot*. Many short term trends correlate to the weather. The plot shown here is a good example of the cable length changing to outside temperature. The MIDOB procedure has a good selection of data points to monitor and provides a good source of logged data for troubleshooting many problems.

Although the program LOGPL is intuitive to operate in real-time, the reference manual is necessary to write the batch files and run in non-interactive mode, see ftp://gemini.gsfc.nasa.gov/pub/fsdocs.

Plotting data points is also valuable to determine telescope pointing and PDPLT is available for this purpose. Station operators wishing to learn more of this troubleshooting technique might consider requesting a LOGPL "plotting" class for TOW2003.

## 8th Directing Board Meeting

*–Wolfgang Schlüter, BKG - IVS Chair*

The 8th Directing Board Meeting was held at Haystack Observatory, October 7, 2002; detailed notes are available via the web. This article summarizes the status and the requirements set up by the board to improve our service products. As in previous board meetings the IVS "officials" reported about their activities since the last meeting. The reports and discussions covered all field from coordination, analysis, and network items to technology developments.

*New members.* With great pleasure one new IVS Permanent Component and four IVS Member Organizations were welcomed. The applications of the University of Tasmania for the network station Hobart and the four Chilean partners of BKG for the TIGO system were accepted. In the past Hobart has contributed to IVS but so far (up to May) it was not an official IVS Network Station. TIGO began operations in March, with the support of its local partner organizations. IVS expresses its thanks for the important contributions.

*Improved products.* With the implementation of the new observing program in January 2002 real progress has been made in the improvement of IVS products. We have now two time series, observed weekly, with a complete set of EOPs. Results are delivered with a delay from the observation to the product publication of two weeks or less. Even if it does not meet the 5-day goal set in the WG2 report, it is a real step forward. Improvements are anticipated by shortening the transportation of the data to the correlator – finally using e-VLBI – and by improving the correlator throughput.

*Mark 5 is IVS standard.* As the new program requires more data media than IVS has available in the tape pool, it was decided to accelerate the deployment of digital recording systems at the network stations and at the correlators. As the Mark 5 system is the only development which has demonstrated compatibility with Mark 4 and is operational, the Haystack Mark 5 system was accepted as the IVS standard. A proposal for the further deployment of Mark 5 systems will be released next. With Mark 5 it could be expected that real progress will be made in the data handling, in particular improving the throughput at the correlator and towards e-VLBI. Some experiments have successfully demonstrated this capability. The first candidate for e-VLBI applications will be the Intensives.

*R1/R4 comparisons.* A comparison of the R1 and R4 results shows that both time series have comparable external accuracy, which was surprising as, due to the higher number of scans and the higher bandwidth, R1 should be superior to the classical R4, which is the follow-on NEOS series. Furthermore the comparison between results of various Analysis Centers shows a higher scatter for R1. Thus, the interpretation of the results needs more investigations.

*K4 intensives.* K4 technology was employed in a newly established Intensive UT1 time series using the baseline Wettzell-Tsukuba. First result show good agreement with the long standing Wettzell-Kokee Intensive results. The importance of such an independent measurement was emphasized and the request to continue these measurements on a regular weekly basis was expressed.

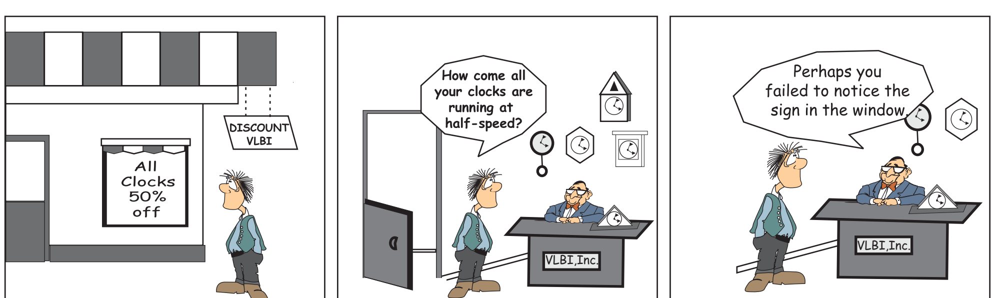
*S2 network.* Employing S2 in the IVS E3 series has also been a success. The results contribute strongly to TRF products, while for the determination of EOPs the network configuration has to be improved. It was proposed to schedule the S2 network for additional support in determination of UT1, as long as the lag in the network configuration exists.

*Pilot Project.* The Pilot Project on the troposphere shows impressive results in the provision of hourly Wet Zenith Delays derived from the IVS R1 and IVS R4. This product can compete with GPS products. It can be regarded as an independent measurement for GPS or water vapour radiometer results. The decision to release the tropospheric parameter as an official IVS product will be made at the next board meeting.

*IAG nomination.* A nomination was required for a representative for the IAG services in the new IAG Executive Committee. The board nominated Harald Schuh.

*IVS board elections.* Elections will take place for the next term on the board: two positions of Network representatives (occupied this term by Shigeru Matsusaka and Wolfgang Schlüter) and the representative for the Correlators and Operation Centers (this term occupied by Kerry Kingham) have to be elected or re-elected. An election committee was set up: Harald Schuh (chair), Arthur Niell, Nancy Vandenberg.

*Vision 2010.* A Working Group (WG3) will be established in order to work on a vision paper: to set goals for the future, to optimise future international collaboration, to improve the quality and increase the efficiency of the existing resources and those which will be developed. Such a vision paper could be used to convince funding agencies to increase their support, as well as to attract young researchers to join our community.



## Is Our World Made Beautiful and Wise?

*–Leonid Petrov, NVI, Inc./GSFC*

I think many of us believe that our world is made beautiful and wise, but some of us would like also to have proof of that. What should we do to get it? Answer: we have to build antennas, make a VLBI correlator, start observing and have a little bit of good luck... I think it is hardly possible to overestimate the importance of the VLBI experiments of the event of September 8, 2002 when Jupiter passed the quasar 0836+182 within 4 arc-minutes. That time, the purpose of the experiment was not to improve the position of the quasar or the station or to learn where the Earth's axis pointed at a specific moment of time, but to answer the question of how our world is made. Contrary to the theory of electromagnetism or classical mechanics, general relativity was invented not as a generalization of empirical facts, but rather as an extrapolation of our belief that the physical world is based on simple principles which can be described by simple and beautiful equations, demonstrating that our world is made beautiful and wise.

> Я повторять готов, живущий трудно,
> Что мир устроен празднично и мудро,
> Да, мир устроен празднично и мудро.
>
> А. Городницкий
>
> "I live hard laboring, but I'll repeat
> That our world is made solemn and wise,
> Yes, our world is made beautiful and wise."
>
> *A. Gorodnitsky, Russian poet and geophysicist, from the poem and song "Shadows on the Tundra."*

Although equations of general relativity were published almost a century ago, solving these equations is still a difficult task. S. Kopeikin recently published his solution of the problem of light propagation in the gravitational field of arbitrary moving bodies. One of the consequences of his findings was that the equation for path delay can be inverted and the speed of propagation of gravity can be determined. In the stationary field case, gravitational retardation depends only on the distance from the ray path to the center of mass of the gravitating body. If the gravitating body moves, the retardation depends also on the speed of the body and the speed of propagation of gravitational interaction. The difference between the case when gravity propagates with the same velocity as light and the case when gravity propagates instantly reached a tiny but still measurable quantity of 10 psec during the September 8, 2002 event. Is our world really pseudo-Euclidean, harmonic and beautiful? VLBI technology promises to answer this question.

More details about this topic can be found at
http://gemini.gsfc.nasa.gov/development/gravity

## First Intercontinental e-VLBI Fringes Achieved

*–Alan Whitney, MIT Haystack Observatory*
*–Yasuhiro Koyama and Tetsuro Kondo, CRL*

On 15 October 2002 an e-VLBI first was achieved with fringes between Kashima, Japan and Westford, MA using data transmission via e-VLBI. At Kashima a K5 disk-based recorder system was used to collect data at 256 Mbps, while at Westford a Mark 5P system was used. Data were exchanged in two directions via e-VLBI, with the Kashima K5 data being sent to Haystack Observatory while the Westford Mark 5 data was transmitted to Kashima. The data were transmitted over a combination of Glownet and Abilene in the U.S. and GEMnet for the trans-Pacific hop to Japan; data rates were very modest at ~1.5 Mbps, but this will dramatically improve in the future. The data were correlated both at Kashima and Haystack with normal results.

This experiment is the first in a series of international and intercontinental e-VLBI experiments that we plan to undertake over the next few years. The early success of this experiment gives us good hope for future success. As a measure of how quickly things are moving, e-VLBI fringes between Metsahovi and Kashima were achieved on data taken 16 October 2002 using the European PC-EVN and Japanese PC-VSI systems in a similar manner.

## High-Data-Rate e-VLBI Experiments Between Westford and GGAO

*–Alan Whitney, MIT Haystack Observatory*

A near-1Gbps e-VLBI experiment was successfully accomplished on 6 October 2002 between the Westford antenna in Massachusetts and the GGAO antenna in Maryland, a distance of ~700 km. Though our Japanese colleagues have already successfully done 1 Gbps e-VLBI experiments in Japan, this is believed to be the first using ordinary shared-network facilities for a significant part of the path. Approximately a dozen switches and routers are in the path between Westford and GGAO and the path had to be carefully tuned to achieve the desired performance. Non-VLBI test measurements showed a sustained performance of ~960Mpbs over several hours.

The actual VLBI measurements were conducted with Mark 5 systems at both antennas with data recorded on disks and then transmitted to Haystack Observatory at ~788 Mbps for re-buffering on disk and correlation with the Mark 4 correlator. All fringes were normal.

On 24 Oct 2002 this work was extended by transmitting data in real-time from GGAO to Haystack with disk buffering only at Haystack. Due to constraints on observing at Westford, which was conducting the CONT02 experiment at the time, the direct-transfer data was limited to 256 Mbps. Correlation with the Westford data on the Mark 4 correlator was normal.


*Group photo taken at the IVS symposium in Korea.*

## Korean Meeting Summary

*–Hayo Hase and Alan Whitney*

The Korean Astronomy Observatory (KAO) hosted an international conference on "New Technologies in VLBI" in the magnificent ancient city of Gyeongju in South Korea on 5-8 November 2002. KAO has obtained funds for the construction of a Korean VLBI Network (KVN) consisting of 3 radiotelescopes with observing capabilities for geodetic (2/8 GHz) and astronomy (22, 43, 86 GHz) frequencies. This new instrument is expected to be complete in 2008 and may eventually be expanded to six telescopes, including two in North Korea.

The meeting goal was to present an overview of recent VLBI technological achievements, current development projects and future instrumentation with respect to to both astronomy and geodesy. During the conference 3 review talks, 29(!) invited talks and 15 posters were presented. Another three open discussions enriched the symposium. The high quality of the contributions will be documented in a book on "New Technologies in VLBI", which will become available soon. It is likely to be a valuable reference for years to come.

The general impression from that meeting is that both the astronomy and geodetic VLBI communities are undergoing a strong transition period:

- From large-telescope VLBI to phased-array VLBI which promises an order of magnitude more sensitivity and a much broader field of view
- From avoiding RFI by frequency selection to RFI mitigation with adaptive filters
- From analog receiver techniques to digital filter banks at the front ends
- From megabit to gigabit A-to-D-converters
- From tape-based recordings to hard disk recordings, and eventually to e-VLBI
- From fringe rotation at the hardware correlator to station-based fringe rotation and delay correction with eVLBI data transport to a software correlator
- From labor intensive VLBI operation to remotely controlled data collection and processing

The IVS must face these new developments and adapt to these new technologies to improve the accuracy, reliability and timeliness of it products and research goals.

The organizers from KAO, especially Young Chol Minh, did a great job of bringing the representatives from VLBI technology development laboratories and the various VLBI user communities together for in-depth presentations and challenging discussions that were very valuable to all.

Information on the recent IVS Symposium can be found under http://www.trao.re.kr/~ntiv/.

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