

# Bonn Geodetic VLBI Operation Center

A. Müskens, A. Nothnagel

**Abstract** The IGGB Operation Center has continued to carry out its tasks of organizing and scheduling various observing sessions of the IVS-T2, IVS-OHIG, IVS-INT3, and EUROPE series. From 2020 onwards, the IGGB Operation Center will transfer its commitment to the Wettzell Geodetic Observatory of the Bundesamt für Kartographie und Geodäsie (BKG).

## 1 Center Activities

The IGGB VLBI Operation Center is part of the Institute of Geodesy and Geoinformation of the University of Bonn, Nußallee 17, D-53115 Bonn, Germany. It has been organizing and scheduling VLBI observing sessions for more than thirty years. The work of the Operation Center is closely related to the Bonn Correlator. For this reason, distribution of the Mark 5 disk units to the stations after correlation and the extension of the Internet connection from previously 1 Gbps to 2 Gbps in the fall of 2016 are the most costly parts of the operations. Below, we describe the activities related to individual observing programs.

- **IVS-T2 series**

This series has been observed roughly every second month (seven sessions each in 2017 and 2018) primarily for maintenance and stabilization of the VLBI terrestrial reference frame as well as for Earth rotation monitoring as a by-product. Each station of the global geodetic VLBI network

is planned to participate in the T2 sessions at least once per year. In view of the limitations in station days, priority was given to strong and robust networks with many sites over more observing sessions. Therefore, generally 15 to 24 stations have been scheduled in each session. The scheduling of these sessions has to take into account that, in view of the large variety in telescope sensitivities, a sufficient number of observations is planned for each baseline of these global networks. The recording frequency setup has always been the greatest common denominator with 16 channels, 4-MHz channel bandwidth, and 360/80 MHz spanned bandwidth at X- and S-band, respectively. Considering that the setup of IVS sessions should cover as wide a spanned bandwidth and as high a sampling rate as possible, it was decided to test which stations of the global IVS network are capable of a 720/140 MHz spanned bandwidth and 256 Mbit/s setup. So, in December 2016 we carried out a test experiment to check a higher recording mode. We observed with 256 Mbps, 16 tracks, and a bandwidth of 8 MHz/channel. Wide-band was used with 720 MHz spanned bandwidth at X-band and 140 MHz at S-band. The sky frequencies were set to

8212.99, 8252.99, 8352.99, 8512.99,  
8732.99, 8852.99, 8912.99, 8932.99 MHz;  
2225.99, 2245.99, 2265.99, 2295.99,  
2345.99, 2365.99 MHz.

It turned out that several stations such as KASHIM11, KOGANEI, NOTO, CRIMEA, and the DSN stations could only observe the 360 MHz spanned bandwidth at X-band. Hence, it was decided to record only the first four channels (i.e., 8212.99, 8252.99, 8352.99, 8512.99 MHz)

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still covering 300 MHz spanned bandwidth and producing a reasonable delay resolution function. The full 140 MHz spanned bandwidth at S-band was not covered in all cases either. This session was analyzed to figure out how to proceed with the T2 sessions in the future.

The results were more or less disappointing. Some stations did not realize the differences in the frequency setup, others were not able to set up the frequencies in the correct way, and others did not observe at all (see the T2115 correlation report). The conclusion was to leave the setup as it was before.

- **Measurement of Vertical Crustal Motion in Europe by VLBI (EUROPE)**

Since the late 1980s, a series of special sessions has been scheduled regularly on the European continent for precise determination of station coordinates and for long term stability monitoring. In the past years, six observing sessions were scheduled every year. Before 2017, all sessions employed the narrow-band frequency setup of 360/80 MHz with 16 channels and 4-MHz bandwidth, identical to the setup of the IVS-T2 sessions. In 2018, we started configuring the network sessions with two different observing modes. The first set of sessions employed the old setup, while for some sessions the spanned bandwidth was increased to 720 MHz at X-band and 140 MHz at S-band with 2-bit sampling recording at 512 Mbps. The latter group of sessions were called EUR-R&D and were observed four times in 2018. The network was built with the telescopes NYALES20, BADARY, MEDICINA, MATERA, ONSALA60, SVETLOE, YEBES40M, ZELECHK, and METSAHOVI in different configurations depending on the availability of the stations. The other two EUROPE experiments continued observing with the frequency setup of 360/80 MHz with 16 channels and 4-MHz bandwidth. In these sessions, DSS65A, NOTO, and CRIMEA were employed in addition to the EUR-R&D telescopes.

- **Southern Hemisphere and Antarctica Series (OHIG):**

In 2017, five sessions and in 2018 six sessions of the Southern Hemisphere and Antarctica Series were organized. The purpose of these observations is the maintenance of the VLBI terrestrial reference frame (TRF) and monitoring of Earth rotation as

a by-product. The recording frequency setup is 16 channels with 4-MHz channel bandwidth and a data rate of 128 Mbps spanning 360/80 MHz. Due to the fact that SYOWA is not able to deliver the recorded data for nearly one year after the observations, the correlation and the generation of the databases is always delayed considerably.

In the OHIG sessions, the two Antarctic stations OHIGGINS (Germany) and SYOWA (Japan) were mostly scheduled with KATH12M (North Australia), YARRA12M (West Australia), HOBART12 and HOBART26 (Tasmania), WARK12M (New Zealand), HARTRAO and HART15M (South Africa), KOKEE (Hawaii, USA), and FORTLEZA (Brazil). Three sessions were observed in February 2017, two in November 2017, three in February 2018, and three in November 2018. One in November 2017 was not scheduled due to the CONT17 campaign. The next step for a higher frequency setup and up to 512 Mbps observing mode in these OHIG experiments is planned for 2020 when SYOWA should have upgraded its system.

- **UT1 determination with near-real-time processing (INT3):**

The basic INT3 network initially consisted of NYALES20, TSUKUB32, and WETTZELL for rapid UT1 determinations on Monday morning at 7:00 a.m. UT. SESHAN25 takes part on a monthly basis. By now, ISHIOKA has replaced TSUKUB32, and WETTZ13N has joined the sessions in addition to WETTZELL. In 2017 and in 2018, more than 40 INT3 sessions were observed. In May 2017, we changed the standard frequency setup of 512 Mbps with 8 MHz/channel (16 tracks), 2-bit sampling, and 720/140 MHz spanned bandwidth to the higher 1-Gbps frequency setup, increasing the channel bandwidth to 16 MHz (32 tracks). The analysis reports document a slight improvement of around 20% in the UT1 formal errors for many of these sessions.

The operations part of the INT3 sessions also includes rapid data transmission and correlation. The raw VLBI observation data of the sites are transferred to the Bonn Correlator by Internet connections directly after the session is completed. The transmission rate is about 300–800 Mbps from all stations. Three transfers at a time may occupy the available data lines of 2 x 1 Gbps.

In the last two years, around 98% of the sessions were correlated, and the databases delivered, within the first four hours after the end of the observations. A further 2% were completed within the next 24 hours due to difficulties with networking hardware and/or station and processor problems.

on January 1, 2020, the staff at the Wettzell Geodetic Observatory of the Bundesamt für Kartographie und Geodäsie (BKG), Germany, will take over the responsibilities for operating the sessions mentioned above. In the time until then, the two groups closely cooperate in phasing in the duties of the new center, benefitting from the long experience of the old one.

## 2 Staff

**Table 1** Personnel at IGGB Operation Center.

Arno Müskens	+49-228-525264	mueskens@mpifr.de
Axel Nothnagel	+49-228-733574	nothnagel@uni-bonn.de

## 3 The Future

On December 31, 2019, the IVS Bonn Operation Center, maintained by the VLBI research group of the Institute of Geodesy and Geoinformation of the University of Bonn, will terminate its activities. Taking effect

## Acknowledgements

For the last three decades, two of them within the IVS, we have been operating the IVS Bonn Operation Center. This would not have been possible without the many individuals helping us to straighten out organizational difficulties and technical hurdles. There have been many steps back and forth, causing a lot of communications which went extremely well considering the widespread range of issues and global distances. We thank all of you involved for this always friendly relationship between colleagues.