Bonn Correlator Status

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Abstract We report on the status of the Bonn Correlation Center, focusing on geodesy. As well as technical aspects of the cluster and its performance, we introduce our duties as one of the IVS correlators and recent progress.

Keywords VLBI correlation, DiFX, VGOS

1 Introduction

The Bonn Correlation Center is operated jointly by the Max Planck Institute for Radio Astronomy (MPIfR) in Bonn and the Federal Agency for Cartography and Geodesy (Bundesamt für Kartographie und Geodäsie, BKG) in Frankfurt. The MPIfR hosts the correlator facility and shares the costs of the cluster, most of the staff, and the internet connectivity with the BKG. Since January 2017, the personnel responsible for the correlation of geodetic sessions are employed by the BKG via a private contractor, the Reichert GmbH.

2 Correlator Capabilities

The Distributed FX software correlator (Deller et al., 2011) in various versions is available at the Bonn correlator. For geodetic production we currently use DiFX-2.6.3 for S/X Legacy sessions, and we use DiFX-2.5.4 for VGOS observations.

The correlator runs on a high-performance computing (HPC) cluster, which was renewed in 2015 to match both VGOS and mm-VLBI requirements. It consists of 1) 68 nodes with 20 compute cores each, for a total of 1,360 cores, 2) three head nodes that allow execution of several correlations in parallel, 3) 2.5 PB disk space in RAID units, combined in a BeeGFS parallel cluster file system, 4) 14 Mark 5 playback units, and 5) 11 Mark 6 playback units, each with four bays.

The raw data are recorded at the stations either on modules (Mark 5 or Mark 6) or on storage servers, usually referred to as Flexbuffs. For geodetic experiments, the data are mostly e-transferred to the HPC cluster that is connected to the Internet through a 10-Gbit commercial line or a 1 Gbit line, part of the German Research Network (Deutsches Forschungsnetz – DFN). Various data formats have been already correlated in Bonn: Mark IV, Mk5, DVP, and various versions of VDIF. The correlated data (SWIN files) can be exported to FITS and HOPS (Mark IV) formats. For post-processing, the following software packages are available: AIPS, CASA, PIMA, and HOPS (Haystack Observatory Postprocessing System), the last of which is the standard tool for geodesy. The correlator outputs and other important files (e.g., VEX and v2d files) are backed up daily on the HPC cluster. The final products are archived on the MPIfR archive server, where they will be kept for at least ten years. The EXPAD and COMEDIA tools are used for bookkeeping of experiments and corresponding media correlated in Bonn. They are the frontends to a local database that records all relevant information such as the observation date, participating stations, modules, and status of the experiment.

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3 Activities in Bonn

3.1 IVS Correlation

Our duties include the correlation of the weekly INT3 and R1 series, as well as OHIG and T2 sessions for the IVS S/X sessions and VGOS 24-hour sessions. In 2021 we correlated 43 INT3 (one-hour, weekly on Monday) sessions, 52 R1 (24-hour, weekly) sessions, seven T2 (24-hour, bimonthly) sessions, six OHIG (24-hour, bimonthly) sessions, and eight VGOS (24-hour) sessions (with ten sessions planned in 2022).

3.2 EU-VGOS

In March 2018, on the initiative of W. Alef of the Bonn Correlation Center, a collaboration with the three European stations of Wettzell, Onsala, and Yebes, equipped with both standard S/X and VGOS systems, was launched to carry out a VGOS proof-of-concept study. The aim of the project is to verify the processing chain for VGOS experiments end-to-end, from the scheduling to the geodetic analysis of the derived observables. The total number of sessions planned to date was 41 (three aborted/canceled). Twenty-four sessions were processed in Bonn: nine of the ten schedules in 2018 (one was aborted, mostly two stations only), 14 of the 16 scheduled in 2019 (two were aborted/canceled), and one of the 15 scheduled in 2020. Other sessions in 2020 were correlated in Vienna or Yebes, and ev0034 was processed in Russia. There were no observations in 2021, but we plan to restart observations this year. Correlated sessions have partly been post-processed in single band and pseudo Stokes I mode, the latter based on the Haystack VGOS post-processing chain. Some sessions were also used to test the polarization conversion for VGOS data based on the PolConvert software for VGOS developed by I. Marti-Vidal (Marti-Vidal et al. 2015).

3.3 DiFX-2.5.4

In addition to our EU-VGOS correlations, we started correlating 24-hour IVS VGOS sessions in 2021. Each correlator has its own local patches and different versions of DiFX to correlate and difx2mark4 to convert the data. In August 2021, in order to regain a cross-site consistent DiFX-2.5 installation for VGOS correlation, as opposed to the local patches at correlator sites, Jan Wagner gathered necessary patches and backported certain features from mainline DiFX-2.6, and together with Haystack-provided HOPS 3.22, released DiFX version 2.5.4 to the DiFX community.

3.4 Multi-Datastream Correlation

Recorded bands are spread across several files, and previously these VGOS data had to be vmux-ed to "merge" them for single-datastream correlation under DiFX-2.5.3. This occupied disk space doubly and needed extra time/work. In Bonn we carry out DiFX multi-datastream correlation, possible under DiFX-2.5.4 and 2.6.3 using multi-datastream configuration. Onsala (Oe/Ow) and Ishioka now observe with multi-files and e-transfer their files without prior "merging".

3.5 10 Gbps Upgrade

Previously, we used two 1 Gbps NREN (DFN) links (BONN, RZBONN Servers). In October 2021, we upgraded to a commercial 10 Gbps link (NetCologne) for e-VLBI and replaced the "BONN" server. " RZBONN" is still working. Transfer protocols that we use are JIVE jive5ab/m5copy and JIVE e-transfer etc/etd[1]. After the upgrade, the transfer speed is much faster than before. For example, in the case of Onsala VGOS data, a transfer (of 23 TB) takes two days instead of two weeks.

[1] https://github.com/jive-vlbi/etransfer

References

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