Geodetic Observatory Wettzell: Status of the Twin Radio Telescopes and the VLBI Correlator

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Abstract The radio telescope Wettzell-South (Ws) has been part of the IVS VGOS network since 2016. It uses an Eleven feed broadband receiving system. On the other hand, the radio telescope Wettzell-North (Wn) was initially equipped with an S/X/Ka-band feed system and contributed to the IVS legacy S/X network until 2022. In November 2023, a technical upgrade to a VGOS VLBI system was completed. This upgrade mainly involved replacing the cryogenically cooled receiving system with a QRFH feed at the frontend and the use of a DBBC3 together with a Flexbuff server as backend. This upgrade enables full VGOS Twin radio telescope capability. Within this contribution, we will give a high-level overview of the most recent developments and achievements. Furthermore, we briefly report about the IVS VLBI correlation facility at the Geodetic Observatory Wettzell. The radio telescopes together with the VLBI correlator provide a solid foundation for future IVS tasks at Wettzell.

Keywords VGOS, Twin radio telescope, Wettzell, VLBI correlator

1 Introduction

The Geodetic Observatory Wettzell has been contributing to the international VLBI community since 1983 with the first network component, the 20-m radio telescope Wettzell (Wz), which is still a main contributor to the legacy S/X VLBI network. The Twin radio telescopes Wettzell-North and Wettzell-South were first commissioned in 2012, to implement the new VGOS VLBI standard at Wettzell. The Wettzell-South Twin radio telescope was initially equipped with a VGOS capable receiving system, whereas Wettzell-North had an S/X/Ka band compatible one. Nowadays, there are also important constraints due to radio interference. In 2021, a VLBI correlator was established at Wettzell, and it has been assigned to several correlation programs.

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2 Twin Radio Telescope Wettzell

The radio telescopes Wettzell-North and Wettzell-South are operated from a common operation building centered between both telescopes. The diameter of their main dishes is 13.2 meters. The sub-reflector's position, designed as ring focus, can be finely regulated by a hexapod mount. However, the position is set to an optimized position and kept constant for maintaining a fixed time delay in the radio signal path. An important contribution for the modeling of the gravitational deformation was done by a photogrammetry survey, realized with a copter-based camera system. The gravitational deformation of the radio reflector system causes variations of less than 0.3 mm RMS in the signal path [Lösler et al. (2022)].

The Twin radio telescope Wettzell-North had the first VLBI session in 2014. Initially, it was equipped with a dual circular polarized S/X/Ka-band feed [Schüler et al. (2015)]. A time series of legacy S/X sessions is available between 2014 and 2022. Most sessions were simultaneously observed with the 20-m

Fig. 1 Twin radio telescope Wettzell with operations building in the center: Wettzell-South (left) and Wettzell-North (right).

radio telescope Wettzell (Wz). In 2022 there was an upgrade to full VGOS capability, which was completed in November 2023. The new frontend system consists of a QRFH feed in linear polarization, and the frequency range covers 2 GHz to 14 GHz. Initial problems had to be solved regarding radio interference sensitivity. Optionally, there is also an independent hardware with a circularly polarized S/X-band signal path available. The backend system consists of a DBBC3-8L8H with a (current) firmware version v.125. The Flexbuff server of Wn has a 100 Gbps network interface card and a 400 Terabyte (TB) storage capability. The NASA Field System currently is at version 9.12.0. However, a CDMS cable calibration unit needs to be installed.

The Twin radio telescope Wettzell-South was tested with first VLBI sessions in 2015. Initially, it was equipped with an Eleven feed with eight low noise amplifiers (LNAs). The frequency range covers 1 GHz to 14 GHz. The initial backend system consisted of a stack of two DBBC2s with an external formatter (FILA10G) and a Mark 6 data recording unit. In October 2023, a DBBC3-8L8H was reinstalled after a hardware upgrade with a (current) firmware version v.125. The hardware of the Flexbuff server of Ws is identical to that of Wn, but it shares the same storage server of 400 TB. The current NASA Field System version for Ws is 9.12.0. As a current degradation, there is an LNA failure inside the Eleven feed. The first occurrence was from November 2022 until March 2023, and a second occurrence of this failure was from November 2023 until now. This means that the horizontally polarized signal path receives only half of the power. At Wettzell-South there is an important task to repair the defective LNA, and the transition of the DBBC2 backend system to the DBBC3 system is ongoing. Additionally, test measurements with a new CDMS system from Yebes, Spain are continued.

In general, a coordination zone for 5G radio communication in the frequency range from 3.4 GHz to 3.6 GHz within a 120-km radius around Wettzell is established. However, administrative coordination is necessary to prevent a direct sight between the Geodetic Observatory Wettzell and a planned cellular base sta-

tion. Therefore, frequency regulation and management gets more and more crucial to safeguard future VGOS VLBI operations.

3 VLBI Correlator

The hardware topology was specified as a High-Performance-Cluster (HPC) configuration. Three head nodes (one of them is used for data transfers) and 24 compute nodes are available. The data flows over an Infiniband bus system, which interconnects all related hardware units. The HPC-storage capacity with an amount of 834 TB was upgraded at the beginning of 2023 with a new storage server unit. This extended the total available correlator capacity to a level of 3.1 Petabyte (PT). A dual-UPS protects against power failures and more frequent power line transients.

Ansible is the software tool used for provisioning, configuration management, and application deployment of the HPC. As the software correlator application, DiFX is used [Deller et al., (2011)], and for the subsequent fringe-fitting process the Haystack Observatory Post-processing System (HOPS) is installed. To manage different users and configurations for all correlation duties, the SLURM (Simple Linux Utility for Resource Management) workload manager was introduced. Currently, two basic configuration sets are in use: one for VGOS (DiFX version 2.5.4, HOPS 3.24) and another one for legacy S/X correlation (DiFX 2.6.3, HOPS 3.24).

Currently, several IVS session types are assigned to the Wettzell correlator. The one-hour VGOS-INT-S Intensive series between McDonald (Mg) in the US and Wettzell (Ws) in Germany is observed weekly (on Tuesdays at 19:45 UT). Further sessions are the 24-hour VGOS-24INT-S sessions and the 24-hour VGOS-OPS sessions (with network sizes of 10 stations or more).

4 Conclusions

The Wettzell-North radio telescope is close to being used operationally with the regular VGOS observation program of the IVS. The Wettzell-South radio telescope needs repair of a defective LNA to be realized as soon as Wettzell-North gets regularly operational. The change to the DBBC3 needs to be qualified and adopted. Integration tests with a CDMS calibration unit are in preparation. The RFI interference problem is an emerging problem in the future. The VLBI correlator was established with the currently assigned IVS observation program. Quality monitoring was set up as a continuous process.

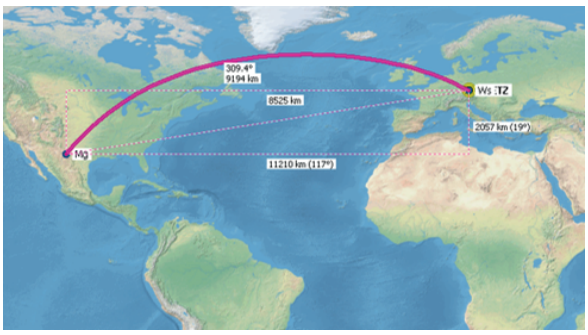

Fig. 2 VGOS Intensive baseline between McDonald (Mg) and Wettzell (Ws).

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