Geodetic Observatory Wettzell: 20-m Radio Telescope and Twin Telescope

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Abstract

In the year 2010 the 20-m radio telescope at the Geodetic Observatory Wettzell, Germany contributed again very successfully to the IVS observing program. But because of a problem with the elevation bearing the workload had to be reduced, and a three-month maintenance shutdown from September to November was necessary. Aside from this, technical changes, developments, improvements, and upgrades have been done to increase the reliability of the entire VLBI observing system. In parallel the construction of the new Twin radio telescope (TTW) has continued.

1. General Information

The 20-m Radio Telescope Wettzell (RTW) is an essential component of the Geodetic Observatory Wettzell (GOW) and is jointly operated by Bundesamt für Kartographie und Geodäsie (BKG) and Forschungseinrichtung Satellitengeodäsie (FESG) of the Technical University Munich. In addition to the RTW also an ILRS laser ranging system, several IGS GPS permanent stations, a large laser gyroscope G (ringlaser), and complementary local techniques such as time and frequency, meteorology, and superconducting gravity meter are operated. Currently also the first fully VLBI2010 compliant Twin telescope is built up on location of the GOW. It should extend the observation possibilities according to the technical suggestions of the International VLBI Service for Geodesy and Astrometry (IVS) Working Group 3 (WG3) and VLBI2010 Committee.

Within the responsibility of the GOW are also the TIGO system in Concepción, Chile, operated mainly together with the Universidad de Concepción (see separate report about TIGO), and the German Antarctic Receiving Station (GARS) O'Higgins in Antarctica, operated together with the German Space Center (DLR) and the Institute for Antarctic Research Chile (INACH) (see separate report about O'Higgins).

2. Staff

The staff of the GOW consists in total of 32 members (excluding students) for operations, maintenance, repair issues, and improvement and development of the systems. The staff operating RTW is summarized in Table 1. One additional engineer is on a position which is funded by the "Novel EXploration Pushing Robust e-VLBI Services" (NEXPReS) project in cooperation with the Max-Planck-Institute for Radioastronomy (MPIfR), Bonn. It was also possible to support student operators to work within development projects and internships.

3. Observations in 2010

The 20-m RTW has supported the geodetic VLBI activities of the IVS and other partners, such as the EVN, for over 25 years. All successfully observed sessions in the year 2010 are summarized in Table 2. Because of a severe problem with the elevation bearing, the observation workload had to be reduced to less than 50% of the normal from March to August. In consultation with the IVS

Table 1. Staff members of RTW.

Name	Affiliation	Function	Working for
Johannes Ihde	BKG	interim head of the GOW (until September 2010)	GOW
Ullrich Schreiber	BKG	head of the GOW (since October 2010)	GOW
Alexander Neidhardt	FESG	head of the RTW group and VLBI station chief	RTW, TTW (partly O'Higgins, laser ranging)
Erhard Bauernfeind	FESG	mechanical engineer	RTW
Ewald Bielmeier	FESG	technician	RTW
Gerhard Kronschnabl	BKG	electronic engineer	RTW, TTW (partly TIGO and O'Higgins)
Christian Plötz	BKG	electronic engineer	O'Higgins, RTW
Raimund Schatz	FESG	software engineer	RTW
Walter Schwarz	BKG	electronic engineer	RTW (partly O'Higgins and WVR)
Reinhard Zeitlhöfler	FESG	electronic engineer	RTW
Martin Ettl	FESG/MPIfR	IT and computer scientist (since August 2010)	NEXPReS
Alexander Bauer	FESG/BKG	student (January to May 2010)	RTW
Thomas Guggeis	FESG/BKG	student (January to December 2010)	RTW, project work
Martin Riederer	FESG/BKG	student (March to December 2010)	RTW, project work
Johannes Vogl	FESG/BKG	student (March to December 2010)	RTW, project work

Table 2. RTW observations in 2010.

program	number of 24h-sessions
IVS R1	29
IVS R4	28
IVS T2	1
IVS R&D	5
RDV/VLBA	1
EUROPE	2
total	**66**
total (in hours)	**1584**

program	number of 1h-sessions
INT1(Kokee-RTW)	175
INT2/K(Tsukuba-RTW)	68
INT3/K(Tsukuba-RTW-NyAl)	33
total (in hours)	**276**

special program	in hours
VENUS (4 obs.)/MARS Express (1 obs.)	5
DBBC tests	1
total (in hours)	**8**

Coordinating Center, the IVS 2010 Master Schedule was adjusted to optimize the combination of R1 and R4 with minimal influence on the time series. The main priority was to participate in all daily one-hour INTENSIVE sessions (INT) in order to determine UT1-UTC. For these sessions the complete data transfer is done with e-VLBI techniques. RTW routinely uses the increased Internet connection capacities of 1 Gbit/sec for the e-transfers to Bonn, Tsukuba, and Haystack. According to the implementation of a Field System extension for remote control, weekend INTENSIVEs were done in the new observation modes by remote attendance, remote control from students at the laser ranging system, or completely unattended (these new modes were suspended in the time of the bearing problems).

In addition to the standard sessions, RTW was also active for Digital Baseband Converter (DBBC) tests and for spacecraft tracking. Within these additional one-hour observations the ESA Venus Express and the Mars express spacecraft were observed at X-band with the Wettzell radio telescope, using a framework of the assessment study for possible contributions in the European VLBI network to the upcoming ESA deep space missions. The first goal of these observations was to develop and test the scheduling, data capture, transfer, processing, and analysis pipeline.

The high dynamic range of the detections allowed achievement of a milliHz level of the spectral resolution accuracy and extraction of the phase of the spacecraft signal carrier line. Apart from other important results, the measured phase fluctuations of the carrier line at different time scales can be used to determine the influence of the Solar wind plasma density fluctuations on the accuracy of the astrometric VLBI observations.

4. Technical Improvements and Maintenance

VLBI observations require high reliability of all participating stations. Therefore careful maintenance of all components is essential to ensure successfully performed VLBI measurements through the year. Within the maintenance work, the repair of the bearing was one of the big events of the year. The radio telescope team became aware of emerging elevation bearing problems about a year ago. In early spring the problem increased, when squeaking noises forced the operators to stop observing sessions. In March a special inspection done by the Wettzell group and a team from Vertex Antennentechnik GmbH brought to light that the elevation bearings were severely damaged. The right side of the elevation axis was lowered by 2 mm and the left side by 0.5 mm in comparison to the original state. In consultation with the Coordinating Center, Wettzell's observing load was reduced while technical solutions were investigated. In order to change the defective bearings, a disassembly of the antenna was unavoidable. Luckily a sufficient amount of money was put aside by FESG over the past several years so that the repair could be funded by the FESG. Then the repair itself was scheduled for September to November. A 400-ton crane lifted the 40-ton main reflector and the counterweights (each 35 tons) off the pedestal. After inspection the gear wheels and the new elevation bearings were installed a few days later. Following a couple of photogrammetric surveys the dish surface could be re-adjusted to 0.15 mm RMS. Almost as planned, the 20-m radio telescope went back into operation on 29 November 2010. Within the whole maintenance the RTW team, the administration of the TUM (especially FESG), and, of course, the whole team of Vertex Antennentechnik GmbH did an excellent job.

Figure 1. Repair of the bearings of the 20-m radio telescope.

The Twin Telescope Wettzell (TTW) project has been planned for the period 2008-2011. As the construction of the tower foundations was finished at the end of 2009, where the main driver was the high stability requirement of the reflector for several load scenarios (with snow, ice, and wind), the structures of the main reflectors were assembled from their single parts at the beginning of 2010. The elevation cabins (40-ton-per-piece steel construction) had to be trucked from Italy

to Wettzell on a heavy load transport. As the 400-ton crane was already ordered for the repair of the 20-m telescope, it was cost-effective to also use it for the mounting of the "Twins". On 19 October 2010 the lift of the reflectors became a media event with television and reporter teams on location. The installation worked flawlessly and after the last of the 280 screws at each reflector was tightened, the silhouettes of the new instruments were visible for the first time. First functionality tests of the new radio telescopes are scheduled for 2011. Together with the existing 20-m antenna, the Twin Telescope offers many new possibilities for satisfying future geodetic needs.

Figure 2. The new "skyline" of the observatory with the Twin telescopes in the background.

In July the NEXPReS project started. Wettzell participates in Task 3 of Work Package 5 mainly together with MPIfR. The goal is to support the identification and repair of failures of the systems during e-VLBI correlations in near real-time. Therefore the software implementations for a remotely controllable extension to the NASA Field System (FS) will be continued. An appropriate authentication, a dedicated role management for different user types, different remote access states to shared telescopes, and sophisticated graphical user interfaces should be developed. In 2010 the project started with the engagement of Martin Ettl as project engineer and with first preparations to release the existing software for future FS packages.

Additionally, the 20-m RTW has to be kept on a high technical standard and has to be improved according to technological advancement. In 2010 the following additional developments and maintenance tasks have been done:

- Test setup of the new Digital Baseband Converter (DBBC), including observations with test schedules to record data for system evaluations, maintain parts of the controlling code to run the DBBC via Ethernet.
- Regular tasks and maintenance days (obtaining replacements for the hardware, 8-pack repairs, gear maintenance, FS updates, cryo-system maintenance, servo replacements, improvements by using EVN-PCs for e-VLBI issues).

5. Plans for 2011

For 2011, dedicated plans are:

- Usage of the digital baseband converters (DBBC)
- Continuing NEXPReS
- Continuing construction of and first tests with the Twin telescopes
- Investigations on VLBI2010-conforming radar systems for laser ranging.