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

Alexander Neidhardt [1], Christian Plötz [2], Gerhard Kronschnabl [2], Torben Schüler [2]

Abstract In 2014, the 20-m radio telescope at the Geodetic Observatory Wettzell in Germany, contributed again very successfully to the IVS observing program. Technical changes, developments, improvements, and upgrades were made to increase the reliability of the entire VLBI observing system. A new controller for the reflector heating was installed, and updates were made in some gears to avoid an oil leakage. In parallel, the new Twin radio Telescope Wettzell (TTW) was brought to operation so that it could observe the INT3 sessions as a tagged-along site. Local analysis shows a very good performance in X-band and a very good repeatability.

1 General Information

The 20-m Radio Telescope in 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 Technische Universität München (Technical University Munich). In addition to the RTW, an ILRS laser ranging system, several IGS GPS permanent stations, a large laser gyroscope G (ringlaser), and the corresponding local techniques (e.g. time and frequency, meteorology and super conducting gravity meters, etc.) are also operated. Currently, the first antenna of the fully VGOS-compliant Twin radio Telescope is in an operational test phase.

Within the responsibility of the GOW are 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 on the Antarctic peninsula, operated together with the German Space Center (DLR) and the Institute for Antarctic Research Chile (INACH) (see separate report about O'Higgins).

1. Forschungseinrichtung Satellitengeodäsie (FESG), Technische Universität München
2. Bundesamt für Kartographie und Geodäsie (BKG)

RTW/TWIN Wettzell Network Station

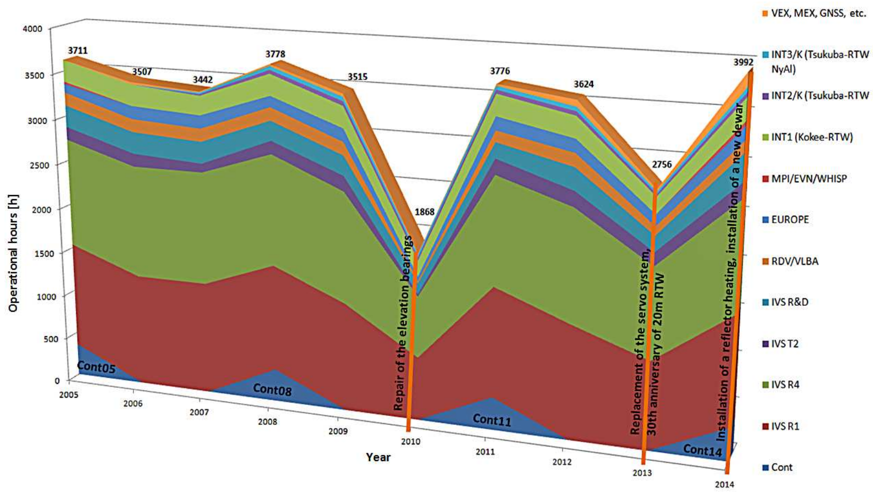
IVS 2014 Annual Report

2 Staff

The staff of the GOW consists in total of 31 members (plus 14 student operators) for operations, maintenance, and repair issues and for improvement and development of the systems. The staff operating VLBI is summarized in Table 1.

3 Observations in 2014

The 20-m RTW has been supporting the geodetic VLBI activities of the IVS and partly other partners, such as the EVN, for over 30 years now. All successfully observed sessions in the year 2014 are summarized in Figure 1. The telescope is in a very good and stable state. The main priority in operations was the participation in all daily one-hour INTENSIVE-sessions (INT) in order to determine UT1-UTC. Using the Field System extension for remote control, weekend INTENSIVEs were partly done in the new observation modes by remote attendance. According to new safety regula-



Observations 2014

Program	Number 24h sessions	Hours
Cont	15	360
IVS R1	49	1176
IVS R4	48	1152
IVS T2	7	168
IVSR&D	12	288
RDV/VLBA	5	120
EUROPE	6	144
MPI/EVN/WHISP	2	48
Total	**144**	**3456**

Program	Hours
INT1 (Kokee-RTW)	230
INT2/K (Tsukuba-RTW)	107
INT3/K (Tsukuba-RTW-NyAl)	47
Venus Express	139
Mars Express	5
GNSS	3
EF026/EVN	5
Total	**152**

Fig. 1 Observation statistics of the last years and observations in the year 2015.

Table 1 Staff - members of RTW.

Name	Affiliation	Function	Mainly working for
Torben Schüler	BKG	head of the GOW	GOW
Alexander Neidhardt	FESG	head of the VLBI group and VLBI station chief	RTW, TTW
Erhard Bauernfeind	FESG	mechanical engineer	RTW
Ewald Bielmeier	FESG	technician	RTW
Gerhard Kronschnabl	BKG	electronic engineer (chief engineer TTW)	TTW, RTW, TIGO
Christian Plötz	BKG	electronic engineer (chief engineer RTW)	O'Higgins, RTW, TTW
Raimund Schatz	FESG	software engineer	RTW
Walter Schwarz	BKG	electronic engineer	RTW, WVR
Reinhard Zeitlhöfler	FESG	electronic engineer	RTW
Armin Böer	BKG	electronic engineer	Infrastruct., RTW
Jan Kodet	FESG	appl. phys. engineer	DFG FOR1503 GNSS, time ref.
Katharina Kirschbauer	FESG	student	Development monitoring
Gordon Klingl	FESG/ BKG	student	Operator RTW/SLR
Yvonne Klingl	FESG/ BKG	student	Operator RTW/SLR
Matthias Kronschnabl	FESG	student	Development TWIN
Julia Weber	FESG/ BKG	student	Operator RTW/SLR

tions, unattended observations are not done until additional safety equipment is installed, such as wind sensors to move the antenna automatically into its stow position. Meanwhile, all data are transferred with e-VLBI techniques (except VLBA-sessions together with Soccorro, New Mexico, USA). RTW now routinely uses the Internet connection capacities of 1 Gbit/sec for the e-Transfers with the Tsunami protocol to the correlators in Bonn, Tsukuba, Haystack, and Washington.

In addition to the standard sessions, RTW was active for other special observations such as the tracking of the ESA Venus Express (VEX) spacecraft, the Mars Express (MEX) spacecraft, and the RadioAstron satellite for the EVN. More progress was possible for the tracking of Glonass and GPS satellites. Additional developments of an L-band receiver and a permanent satellite tracking mechanism enabled observations of these GNSS satellites. GNSS observations could be scheduled, commonly observed, correlated, and analyzed in cooperation with the Technical University in Vienna, Austria and the observatory in Onsala, Sweden.

4 Technical Improvements and Maintenance

Regularly, one maintenance day (obtaining replacements for the hardware, eight-pack repair, gear and bearing maintenance, NASA Field System updates, cryo-system maintenance, and repairs of the Mark IV rack) was scheduled for the usual maintenance work per month.

A new controller for the reflector heating was installed to enable the cleaning of the reflector from snow and ice during the winter month (de-icing). The heating rods had already been installed during the maintenance

Fig. 2 A panorama view of the observatory with the 20-m RTW on the right and the two TWIN telescopes in the back.

of the servo system in 2013. Additionally, one azimuth and one elevation gear required a maintenance update within the warranty period, because of an oil leakage problem.

The existing dewar was replaced by a new one to increase the maintenance intervals of the cryo system. The new dewar is an upgraded version of the replaced dewar. The upgrades were done at the IVS Centro de Desarrollos Tecnológicos de Yebes, Spain. The software for the dewar monitoring is also updated to an Ethernet-based realization. The last month of 2014 showed that the pressure stability of the dewar is quite good and keeps a pressure of lower than $10^{-8} mbar$, which kept the temperature stable around 20K.

The NASA Field System is updated to the latest available version, 9.11.6, to enable the DBBC connectivity. The upgrade of the station specific software is still under progress. The goal is the homogenization with the TWIN control software. Additionally, the Mark 5 systems were tested with the new "jive5ab" from JIVE in Dwingeloo, The Netherlands. The software should become the basis for transfering the data to the new TWIN control room in real-time while the scans are recorded.

The usage of the new Digital Baseband Converters (DBBC) was forced, so that the 20-m RTW is in principle DBBC-ready. Additionally a preferred solution with the ADS3000+ from Japan was established and tested (also in preparation for the O'Higgins upgrades). Several test data were correlated at the Bonn Correlator to check functionality and quality (especially in combination with the Twin operation tests). An additional correlator class was held in Wettzell by Alessandra Bertarini from the Bonn Correlator, to enable quality checks and analysis of local baselines with its own correlator-PC (with four (plus four virtual) CPU-cores) with a DiFX installation.

The remote control software "e-RemoteCtrl" was also extended, mainly by the TUM. New features were established in close cooperation with the developers of the NASA Field System and with other test sites at Australia (e.g. Hobart, Katherine, and Yarragadee). The AuScope network and the Wettzell site already use the software routinely. Therefore, a development and research stay was paid by AuScope to extend the software with required utilities in November 2014.

Another new field is the preparation for tracking of global navigation satellites. Therefore, new amplifier and receiver boards were permanently installed. These can be used after the waveguides for S-band to receive the L-band of the satellite. Test experiments were operated together with the TU Vienna, Austria and the Onsala Observatory, Sweden.

Because of new safety regulations, maintenance manuals were established, and risk assessments were started. A main focus is the reestablishment of the unattended observations, which were limited. Therefore Vertex realized additional safety features, such as oscillation detection and a minimum safety elevation. Additionally, the system monitoring software SysMon was extended with additional features to support the monitoring tool Zabbix. This should enable a realization of a general system status display during unattended observations.

According to the experiences from the AuScope network, the saving of all documents, introductions, and manuals in a central, digital document archive has now begun.

5 The TWIN Radio Telescope Wettzell (TTW)

The Twin Telescope Wettzell project is Wettzell's realization of a complete VGOS conformity. The mechanical system is completely functional on both antennas. The controlling system was updated with the same safety features as the 20-m RTW. The receiving and the data acquisition systems for the northern antenna (TTW1) is finished for first VGOS tests with S-/X-/Ka setups. (There is only a cooling problem of one S-band LNA in the receiver chain of the left-hand-circular-polarized signal; it will be exchanged after TTW2 is operative.) The dewar and the cooler have been operating for over nine months now. The new control room is completely set up to control both the Twin telescopes and the old 20-m antenna.

The Twin telescope TTW1 (northern antenna, Wn) started its operational test phase with regular Monday INTENSIVE observations. These operational test sessions were performed together with the 20-m antenna, using DBBCs and also a Japanese ADS3000+ system. Approximately 190 observation hours were recorded in 2014. The scans were correlated in Bonn and analyzed by the analysis group in Bonn and with separate software in Wettzell. The X-band performance is excellent with an efficiency of over 80 percent at a system temperature of 30 K over the bandwidth of 6.4 to 9.6 GHz. The position repeatability after the analysis is also quite good for X-band. S-band suffers from RFI, so that it is not ideal for usage in the analysis. Filters should reduce this problem. The Ka-band performance was tested with a spectrum analyzer and a calibration source and shows suitable results, which need to be verified again after the new tri-band-receiver and up-down converter hardware have been installed in 2015.

The broadband feed horn (Eleven feed) for the second telescope TTW2 (south tower, Ws) arrived in Wettzell and was tested here. The feed is built by Omnisys in Göteborg, Sweden. It was finished in August 2014 after some updates of the gold coating, which originally led to worse system temperatures in higher frequencies. In September 2014, the factory approval in Sweden showed that the results of the test measurements completely meet the specifications now. After the feed was delivered to Wettzell, the system temperatures could be verified, so that the shipment to Mirad in Switzerland could be arranged. There it will be tested again and mounted into the feed cone. The already available feed patterns look quite promising. But a mismatch in the conversion of the digital 3D-drawings caused a mechanical misalignment between feed mounting and cone. This error shifts the final delivery in the timeline to a later date. It should then be used with another broadband up-down-converter rack in combination with a DBBC3 and a FILA10G connection to a Mark 6 or a FlexBuf-system.

In the meantime the permanent survey of the reference point of the TTW2 was continued using total stations on different pillars and 20 to 30 reflectors in the back structure of the antenna. The goal is a continuous monitoring of the reference point over one year.

6 Future Plans

Dedicated plans for 2015 are:

- Update of the safety conformity papers for the 20-m RTW,
- Complete change to the new digital baseband converters for the 20-m RTW,
- Establishment of first real broadband experiments with S/X/Ka with TTW1,
- Development of a new receiver and system monitoring software for TTW2, and
- Installation of the Elevenfeed at TTW2 and first test observations.