Onsala Space Observatory – IVS Network Station Activities during 2014

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Abstract We participated in 39 IVS sessions, including CONT14. Eleven out of the initially planned sessions could not be observed due to the installation of a new radome for the 20-m radio telescope. As in the previous six years, we used several of the sessions that involved both Onsala and Tsukuba to perform ultra-rapid UT1-UTC sessions together with our colleagues in Tsukuba. This included the complete CONT14 campaign where near real-time UT1-UTC on the baseline Onsala—Tsukuba could be determined. The procurement of the telescopes for the Onsala Twin Telescopes was started in the summer of 2014. The contract to buy two VGOS radio telescopes was signed at the end of the year.

1 General Information

The Onsala Space Observatory is the national facility for radio astronomy in Sweden with the mission to support high-quality research in radio astronomy and geosciences. The geoscience instrumentation at Onsala includes equipment for geodetic VLBI, GNSS, a superconducting gravimeter with a platform for visiting absolute gravimeters, several microwave radiometers for atmospheric measurements, both GNSS based and pressure based tide gauges, and a seismometer. The Onsala Space Observatory can thus be regarded as a fundamental geodetic station. Figure 1 shows an aerial photo taken during the replacement of the radome enclosing the 20-m radio telescope that is currently the instrument that is used for geodetic VLBI observations. In the next two years the Onsala Twin Telescopes (OTT) will be installed at the observatory, consisting of a pair of two new antennas following VLBI2010 recommendations.

Fig. 1 The replacement of the upper part of the radome enclosing the 20-m radio telescope on 15 September 2014.

The staff members associated with the IVS Network Station at Onsala are listed in Table 1.

2 Geodetic VLBI Observations

In total, 50 IVS sessions including Onsala were planned for 2014, including the CONT14 campaign. But because the radome of the 20-m radio telescope had to be replaced and the telescope could not be used during this time, we could not participate in 11 of the planned sessions. For the majority of the 39 sessions that we observed, including the complete CONT14 campaign, we performed parallel recordings with the old Mark IV/Mark 5A and the new DBBC/Mark 5B+

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Table 1 Staff members associated with the IVS Network Station at Onsala. All e-mail addresses have the ending @chalmers.se, and the complete telephone numbers start with the prefix +46-31-772.

Function	Name	e-mail	telephone
Responsible P.I.s for geodetic	Rüdiger Haas	rudiger.haas	5530
VLBI observations	Thomas Hobiger (2014.08.01–)	thomas.hobiger	5549
Observatory director	John Conway	john.conway	5503
Head of department	Gunnar Elgered	gunnar.elgered	5565
Ph.D. students and postdocs	Niko Kareinen	niko.kareinen	5566
involved in geodetic VLBI	Johan Löfgren (–2014.06.30)	johan.lofgren	5566
	Tong Ning (–2014.06.30)	tong.ning	5578
Responsible for the	Michael Lindqvist	michael.lindqvist	5508
VLBI Field System	Rüdiger Haas	rudiger.haas	5530
Responsible for the	Karl-Åke Johansson	karl-ake.johansson	5571
VLBI equipment	Leif Helldner	leif.helldner	5576
Responsible for the VLBI operators	Roger Hammargren	roger.hammargren	5551
Telescope scientist	Henrik Olofsson	henrik.olofsson	5564
Software engineer	Mikael Lerner	mikael.lerner	5581
Responsible for gravimetry	Hans-Georg Scherneck	hans-georg.scherneck	5556

data acquisition systems, see Table 2. Zero-baseline tests with the two types of recording systems were done both at Onsala and the Bonn correlator. The Bonn correlator also produced several databases with two Onsala stations, using both recording types. These databases were systematically analyzed, and no significant differences in the derived geodetic results were found. Finally, in the summer of 2014, the old Mark IV rack was removed and placed in the observatories' museum. Since then, the DBBC/Mark 5B+ system has been the primary data acquisition system.

In the fall of 2014 a second data acquisition system was installed, including a second DBBC and a Mark 5C recorder. Several tests with parallel recordings of the two systems were performed and are still under investigation. Also tests with a Fila10G/FlexBuff system were done and are under investigation.

Three observing sessions failed, see Table 2, because the wrong polarization for X-band was connected.

In addition to the IVS sessions, we observed test experiments together with Wettzell to observe signals from several GLONASS satellites.

3 Monitoring Activities

We continued with the monitoring activities as described in previous annual reports:

Local tie vector at Onsala.

During CONT14 an automated classical geodetic survey of the reference point of the 20-m radio telescope was performed. Together with additional measurements in the local network, thus the local tie vector between the VLBI and GNSS reference points could be determined in a local system. This was followed by a several week long GNSS campaign in the local network. Finally, the combination of the classical survey results and the results from the analysis of the GNSS campaign gave a new realization of the local tie vector which will be used for ITRF2014.

Additionally, data observed with two gimbal-mounted GNSS antennas on the dish of the 20-m radio telescope were used to determine a purely GPS-based local tie vector. A manuscript on this topic has been submitted and is under revision.

Vertical height changes of the telescope tower.

We continued to monitor the vertical height changes of the telescope tower using the invar rod system at the 20-m telescope. The measurements are available at `http://wx.oso.chalmers.se/pisa/`.

Calibration of pressure sensor.

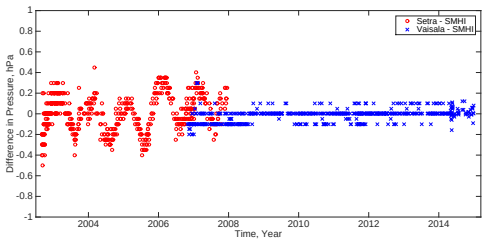

Fig. 2 Time series of pressure differences between the VLBI pressure sensors and the calibrated pressure sensor from SMHI.

We continued to calibrate the Onsala pressure sensor using a Vaisala barometer borrowed from the Swedish Meteorological and Hydrological Institute (SMHI). This instrument was installed at Onsala in late 2002. It has been calibrated regularly at the SMHI main facility in Norrköping since then. The latest calibration was on October 11, 2011.

Since the installation of a new VLBI pressure sensor in 2008, the agreement between the Onsala VLBI pressure and the pressure read by the calibrated sensor is on the level of ± 0.1 hPa. Unfortunately, this VLBI pressure sensor failed on Christmas evening 2014 and needs to be replaced by a new sensor.

Microwave radiometry.

The water vapor radiometer Astrid was operating continuously during the year, although it was suffering from a failure of the 31 GHz channel until September 2014. Hence, its data until then are only useful during atmospheric conditions with no significant amount of liquid water. Konrad was operating continuously during the first six months of 2014. During the second half of the year Konrad had a failure of the mechanical waveguide switch used for calibrations.

Sea-level monitoring.

The GNSS-R based tide gauge was operated continuously. Additionally, a tide gauge based on pressure sensors was operated next to it throughout the year.

The construction of the new tide gauge, a collaboration project with SMHI, was completed (see Figure 3). It is equipped with a radar sensor and a bubbler sensor inside the tide gauge well, and another bubble sensor outside nearby. The first test measurements were started in the autumn of 2014.

Superconducting gravimetry.

The superconducting gravimeter operated continuously and produced a highly precise record of gravity variations. The data loss in 2014 was 0.52% in the one-second record, confined to one single event at the end of February, a failing Flash Card memory in the data buffer of the ADC converter. Since September 2014, tide solutions have been prepared on a weekly basis and results made available on the SCG homepage (http://holt.oso.chalmers.se/hgs/SCG/toe/toe.html).

Fig. 3 The new tide gauge station at the Onsala Space Observatory, operated together with SMHI.

Absolute gravimetry.

We supported a visiting absolute gravity measurement campaign with two gravimeters operating in parallel, one from Lantmäteriet, the Swedish mapping, cadastral and land registration authority, and one from Leibniz University, Hannover, Germany.

Seismological observations.

The seismometer owned by Uppsala University and the Swedish National Seismic Network (SNSN) was operated throughout the year.

4 Future Plans

- For 2015 we plan to observe a total of 44 IVS sessions. Additionally, we plan for further sessions during EVN observing campaigns.
- We strive to restart operating ultra-rapid UT1-UTC sessions with our colleagues at GSI in Japan.
- In parallel to the regular DBBC/Mark 5B+ operations, we will do tests with the DBBC/Fila10G/FlexBuff system.
- We will continue the usual monitoring activities at the observatory.

Table 2 Geodetic VLBI observations at Onsala during 2014. Information is given on which VLBI backend was used, whether data were e-transferred in real-time (RT) and/or off-line (OL) and to which correlator, whether modules were shipped to a correlator, and whether Ultra-rapid UT1-UTC results were produced. The last column gives some general remarks and information on the percentage of the scheduled Onsala (On) observations that were used in the analysis (as reported on the Web pages for the IVS session analyses), compared to the station average (StAv) percentage per experiment. Three sessions were unsuccessful (R1-642, R1-657, and RV-107) because unfortunately, the wrong polarization for X-band was connected. The Mark 5B+ module for C14-02 failed at the correlator, so the production had to be done with the Mark 5A data. During C14-03 the FS terminated during the night, and this was not discovered in time because no operator was at the site, so two hours of data were lost.

Exper.	Date	VLBI-backend		E-transfer		Module	Ultra-rapid	General remarks and % of scheduled observations used in the
		Mark IV	DBBC	RT	OL	shipment	UT1-UTC	analysis as reported in the IVS Web pages' analysis reports.
R1-619	01.06	yes	yes	–	Bonn	–	–	Mark IV/Mark 5A in production, On: 93.3% (StAv: 89.9%)
R1-621	02.21	yes	yes	–	Bonn	–	–	Mark IV/Mark 5A in production, On: 94.6% (StAv: 89.2%)
R1-624	02.10	yes	yes	Tsuk	Bonn	–	yes	Mark IV/Mark 5A in production, On: 85.7% (StAv: 81.9%)
RV-103	02.12	yes	–	–	Socc	yes	–	Mark IV/Mark 5A in production, On: 84.8% (StAv: 88.3%)
RD-14-02	03.26	yes	yes	Tsuk	Hays	–	yes	Mark IV/Mark 5A in production, not correlated / analyzed yet
R1-631	03.31	yes	yes	Tsuk	Bonn	–	yes	Mark IV/Mark 5A in production, On: 85.4% (StAv: 77.0%)
RV-104	04.01	yes	yes	–	Socc	yes	–	Mark IV/Mark 5A in production, On: 38.2% (StAv: 48.9%)
R1-632	04.07	yes	yes	–	Bonn	–	–	Mark IV/Mark 5A in production, On: 83.0% (StAv: 71.5%)
RD-14-03	04.23	yes	yes	–	Hays	–	–	Mark IV/Mark 5A in production, not correlated / analyzed yet
C14-01	05.06	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 86.7% (StAv: 83.7%)
C14-02	05.07	yes	yes	Tsuk	Bonn	yes	yes	Mark IV/Mark 5A in production, On: 76.7% (StAv: 83.4%)
C14-03	05.08	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in prod., 2 h lost, On: 82.5% (StAv: 86.9%)
C14-04	05.09	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 88.8% (StAv: 85.3%)
C14-05	05.10	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 90.8% (StAv: 86.2%)
C14-06	05.11	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 80.7% (StAv: 74.5%)
C14-07	05.12	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 86.2% (StAv: 83.3%)
C14-08	05.13	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 91.7% (StAv: 87.5%)
C14-09	05.14	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 91.7% (StAv: 87.2%)
C14-10	05.15	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 91.9% (StAv: 91.1%)
C14-11	05.16	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 90.3% (StAv: 84.9%)
C14-12	05.17	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 89.0% (StAv: 83.5%)
C14-13	05.18	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 88.9% (StAv: 85.3%)
C14-14	05.19	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 87.1% (StAv: 80.8%)
C14-15	05.20	yes	yes	Tsuk	Bonn	yes	yes	DBBC/Mark 5B+ in production, On: 88.1% (StAv: 82.3%)
RV-105	06.25	yes	yes	–	Socc	–	–	DBBC/Mark 5B+ in production, On: 86.2% (StAv: 78.1%)
R1-642	06.30	yes	yes	–	Bonn	–	–	failed, X-band wrong polarization
R1-643	07.07	yes	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 91.9% (StAv: 90.1%)
RD-1405	07.08	yes	yes	–	Hays	–	–	DBBC/Mark 5B+ in production, not correlated / analyzed yet
R1-656	10.06	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 75.8% (StAv: 64.9%)
R1-657	10.13	–	yes	–	Bonn	–	–	failed, X-band wrong polarization
RV-107	10.14	–	yes	–	Socc	–	–	failed, X-band wrong polarization
R1-661	11.10	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 84.8% (StAv: 73.6%)
R1-663	11.24	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 77.0% (StAv: 64.5%)
RV-108	12.03	–	yes	–	Socc	–	–	DBBC/Mark 5B+ in production, On: 95.5% (StAv: 91.2%)
R1-665	12.09	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 82.3% (StAv: 72.9%)
R1-666	12.15	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 82.3% (StAv: 73.9%)
T2-101	12.16	–	yes	–	Hays	–	–	DBBC/Mark 5B+ in production, not correlated / analyzed yet
RD-14-12	12.17	–	yes	–	Hays	–	–	DBBC/Mark 5B+ in production, not correlated / analyzed yet
R1-667	12.22	–	yes	–	Bonn	–	–	DBBC/Mark 5B+ in production, On: 92.4% (StAv: 87.3%)

- The new tide gauge station in collaboration with SMHI will be inaugurated.
- We will begin construction work for the Onsala Twin Telescopes.