The IVS Network Station Onsala Space Observatory

Rüdiger Haas, and Gunnar Elgered

Abstract

We summarize briefly the status of the Onsala Space Observatory in its function as an IVS Network Station. The activities during the year 2003, the current status, and future plans are described.

1. Overview

The IVS Network Station at the Onsala Space Observatory (OSO) has been described in earlier IVS annual reports, e.g. [1], [2] [3] [4].

During 2003 a number of maintenance and upgrade activities were performed at Onsala. The Russian Kvarz maser was serviced, amplifiers of the telescope azimuth encoders were exchanged, the VLBI system was upgraded to Mark 5A, and the observatory was connected by a 1 Gbit/s optical fibre link to the Swedish Internet backbone.

2. Staff Associated with the IVS Network Station at Onsala

The staff associated with the IVS Network Station at Onsala remained mainly the same as reported earlier, e.g. in [1]. However, Lubomir Gradinarsky finished his Ph.D. and left the observatory, while two new Ph.D. students, Camilla Granström and Tobias Nilsson, started to work at the observatory during 2003.

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

Function	Name	e-mail prefix	telephone extension
Responsible P.I.s	Gunnar Elgered	kge	5565
	Rüdiger Haas	haas	5530
Ph.D. students involved in VLBI observations	Sten Bergstrand	sten	5566
	Camilla Granström	camilla	5566
	Martin Lidberg	lidberg	5578
	Tobias Nilsson	tobias	5575
	Borys Stoew	boris	5575
Field system responsibles	Biörn Nilsson	biorn	5557
	Michael Lindqvist	michael	5508
VLBI equipment responsibles	Karl-Åke Johansson	kaj	5571
	Leif Helldner	helldner	5576
VLBI operator	Roger Hammargren	roger	5551
Telescope scientists	Per Bergman	bergman	5552
	Lars Lundahl	lundahl	5559

3. Geodetic VLBI Observations During 2003

During 2003 the observatory has been involved in the four regular VLBI-experiment series EUROPE, IVS-R1, IVS-T2, and RDV. In total OSO was scheduled to participate in 18 geodetic VLBI experiments during 2003 (see Table 2).

Table 2. Geodetic VLBI experiments at the Onsala Space Observatory during 2003.

Exper.	Date	Remarks (problems)	Exper.	Date	Remarks (problems)
RDV-37	03.12	o.k., S-band RFI	T2-020	08.12	o.k.
R4-062	03.13	o.k.	R4-084	08.14	o.k.
EURO-67	03.25	o.k.	T2-021	09.16	o.k.
EURO-68	05.06	o.k., encoder problems	RDV-41	09.17	o.k., RFI in Channel 4 X-band
RDV-38	05.07	o.k., S-band RFI	EURO-69	09.23	o.k., first Mark 5A experiment!
RDV-39	06.18	o.k., S-band RFI	T2-022	10.14	o.k., second Mark 5A experiment
RDV-40	07.09	o.k., S-band RFI	R4-093	10.16	o.k., encoder problems
R4-082	07.31	o.k.	EURO-70	12.16	not correlated yet
R4-083	08.07	o.k.	RDV-42	12.17	not correlated yet, encoder problems

Most of the experiments were observed without problems. However, during some of them we unfortunately had technical problems with the telescope's azimuth encoders that caused loss of observational data. In EURO-68 we lost the first 9 scans and later during the experiment nearly 2 hours. During R4-093 about 45 minutes of observations were lost, and during RDV42 two hours of observations were lost due to the encoder problems.

Radio interference in S-band due to UMTS mobile telephone signals was a disturbing factor in 2003 causing disturbing peaks in the band-pass. Many correlation reports mentioned explicitely the radio interference. Also radio interference in X-band was reported for RDV-41.

The two first experiments recorded with the new Mark 5A system at Onsala were EURO-69 and T2-022. Both experiments were correlated successfully.

4. Maintenance and Upgrade of the Onsala VLBI System

During 2003 the VLBI equipment at Onsala was maintained and upgraded, see Table 3 for an overview. The highlights are the installation of a Mark 5A unit and the connection to the Swedish Internet backbone by an optical fibre link with 1 Gbit/s capacity.

The Mark 5A unit was installed at the observatory in August. After thorough testing of the equipment the first VLBI experiment with Mark 5A was EURO-69 recorded on September 23. The data were correlated succesfully at the Bonn correlator. In December 2003 five Mark 5A units were assembled at the observatory and are now dedicated to the IVS disk pool. These Mark 5A units are equipped with 8 disks of 160 Gigabyte each.

In November the Mark 5A unit was connected to the Swedish internet backbone with an optical fibre link of a capacity of up to 1 Gbit/s. The Mark 5A unit had to be upgraded to be able to handle this data rate. First tests sending data have been perfomed.

The calibration of the Onsala pressure sensor using a reference barometer provided on a long term loan by the Swedish Meteorological and Hydrological Institute (SMHI) was continued throughout the year 2003. The largest offset observed between the two sensors was 0.5 hPa

[5].

Table 3. Maintenance and upgrade work of the Onsala VLBI system during 2003.

February	Maintenance of Onsala's Kvarz maser and exchange of the disociator.
April	Installation of a new temperature and humidity sensor at the NASA weather station and installation of new cables.
August	Installation and tests of Mark 5A equipment.
November	Installation of two new amplifiers for the telescope's azimuth encoders.
November	Connection of the Mark5 unit to the Swedish internet backbone with an optical fibre link of up to 1 Gbit/s capacity.
December	Maintenance of all video converter filter cards and checks of offset levels and gains.

5. Telescope Stability, Reference Point Determination, and Local Tie

We continued to monitor the vertical changes of the telescope tower by an invar monitoring system [6], see Figure 1. We fitted a simple model to express the relative vertical height changes measured with the invar rod as a function of the mean value of the temperatures measured with 16 temperature sensors located at 4 different levels and 4 different directions in the concrete foundation of the telescope. The empirically determined expansion coefficient for the concrete foundation of the telescope is $9.6 \cdot 10^{-6} \pm 0.2 \cdot 10^{-6}$ (1/°C). Here we corrected for an expansion of the invar rod using the theoretical expansion coefficient of invar which is $1.5 \cdot 10^{-6}$ (1/°C). The rms of the model fit is 0.056 mm. The empirically determined expansion coefficient is slightly smaller than the theoretical one for dry concrete which is $12 \cdot 10^{-6}$. One reason might be that the mean value calculated from all temperature sensors does not provide the effective temperature of the concrete.

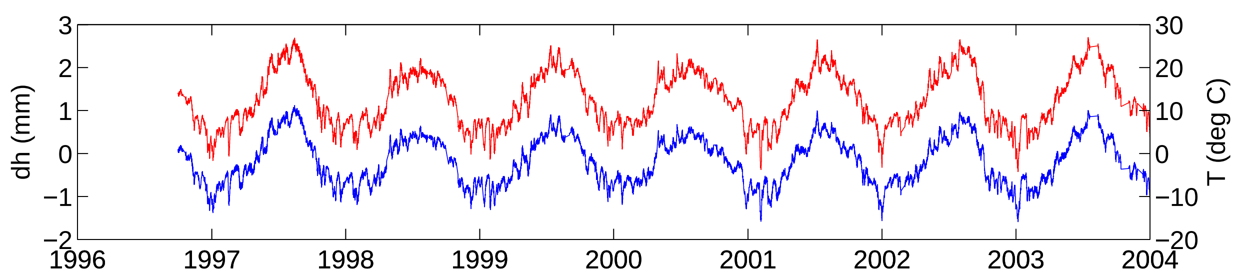

Figure 1. Lower blue curve, left scale: relative vertical height dh in (mm) of the OSO telescope tower. Upper red curve, right scale: mean temperature T in (°) C of the concrete foundation of the telescope.

The campaign based GPS measurements using an antenna mounted on top of the VLBI telescope [7] have also been continued.

The classical geodetic measurements performed in the spring and the early summer 2002 at the observatory were further analysed [8]. Several geometric properties of the telescope were determined: The divergence of the telescope's azimuth axis with respect to the local vertical was found to be to 13" ± 6". A non-orthogonality of the telescope's azimuth and elevation axis on the order of 40" ± 8 " was detected. Furthermore, an axis offset of 6 mm ± 0.4 mm was determined.

The local tie between the IVS and the IGS reference points at the observatory was determined in the local network. Additional GPS observations performed in the local network at the observatory allowed us to transform this local tie also into a global reference system. The new local tie information was submitted together with its complete covariance information to the International Earth Rotation Service (IERS). This information is also available from us on request.

6. Outlook

The Onsala Space Observatory will continue to be an IVS Network Station and to participate in the IVS observation series. For the year 2004 a total of 22 experiments in the series EUROPE, RDV, IVS-R and IVS-T are planned.

The Onsala Mark 5A system is now connected to the Swedish Internet backbone by a 1 Gbit/s optical fibre link and we plan to participate in international e-VLBI activities.

The monitoring of the relevant system parameters will be continued in order to detect possible error sources as early as possible and to maintain a high quality of the observation data. The stability of the telescope, its vertical height changes and the local tie to other monuments will be monitored also in the future.

References

[1] Haas, R. Elgered, G. and Scherneck, H.-G.: Onsala Space Observatory – IVS Network Station. In: N. R. Vandenberg (ed.): *IVS 1999 Annual Report*, NASA/TP–1999-209243, 90–93, 2000.

[2] Haas, R., Elgered, G., Bergstrand, S., Gradinarsky, L., Stoew, B., and Johansson, K.-Å.: The IVS Network Station Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (Eds.): *IVS 2000 Annual Report*, NASA/TP–2001-209979, 113–116, 2001.

[3] Haas, R., Johansson, K.-Å., Elgered, G., Bergstrand, S., Gradinarsky, L., Stoew, B., Bouma, H., and Lidberg, M.: The IVS Network Station Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (Eds.): *IVS 2001 Annual Report*, NASA/TP–2002-210001, 108–111, 2002.

[4] Haas, R., Johansson, K.-Å., Elgered, G., Bergstrand, S., Gradinarsky, L., Stoew, B., Bouma, H., and Lidberg, M.: The IVS Network Station Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (Eds.): *IVS 2002 Annual Report*, NASA/TP–2003-211619, 136–139, 2003.

[5] Elgered, G., and Haas, R.: The Geodetic VLBI Network Station at the Onsala Space Observatory – Activities During 2002. In: W. Schwegmann and V. Thorandt (Eds.): *Proc. of the 16th Working Meeting on European VLBI for Geodesy and Astrometry*, Bundesamt für Kartographie und Geodäsie, 61–66, 2003.

[6] Elgered, G., and Haas, R.: Geodetic Very-Long-Baseline Interferometry at the Onsala Space Observatory 1997–1998. In: W. Schlüter and H. Hase (Eds.): *Proc. of the 13th Working Meeting on European VLBI for Geodesy and Astrometry*, 60–64, 1999.

[7] Bergstrand, S., R. Haas, and Johansson, J. M.: A new GPS-VLBI tie at the Onsala Space Observatory. In: N. R. Vandenberg and K. D. Baver (Eds.): *IVS 2000 General Meeting Proceedings*, NASA/CP-2000-209893, 128–132, 2000.

[8] Eschelbach, C., and Haas, R.: The IVS-Reference Point at Onsala – High End Solution for a Real 3D-Determination, In: W. Schwegmann and V. Thorandt (Eds.): *Proc. of the 16th Working Meeting on European VLBI for Geodesy and Astrometry*, Bundesamt für Kartographie und Geodäsie, 109–118, 2003.