Status of the Onsala Twin Telescopes – One Year After the Inauguration

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Rüdiger Haas, Simon Casey, Gunnar Elgered, Roger Hammargren, Leif Helldner, Thomas Hobiger, Karl-Åke Johansson, Mikael Lerner, Lars Pettersson, Miroslav Pantaleev, Lars Wennerbäck

Abstract We briefly describe the status of the Onsala twin telescopes and the experience gained since the official inauguration in May 2017.

Keywords VGOS, OTT, broadband observations

1 Introduction

The Onsala twin telescopes [1] are two identical VGOS-type telescopes which are named ONSA13NE and ONSA13SW in IVS terminology. They are designed by MT Mechatronics and are equipped with 13.2-m diameter main reflectors and ring-focus subreflectors. The telescopes were built during 2015–2017 [2] and inaugurated in connection with the 23rd Working Meeting of the European VLBI group for Geodesy and Astrometry (EVGA) in May 2017, see Figure 1.

Fig. 1 Picture taken during the inauguration of the Onsala twin telescopes in May 2017, with ONSA13SW on the left and ONSA13NE on the right side. (Photo Onsala Space Observatory)

The telescopes are located at a distance of 70 m. There are two slightly different receiver systems installed on the telescopes. ONSA13NE hosts a receiver with a QRFH-feed covering 3–18 GHz, while ONSA13SW is equipped with an Eleven-feed covering 2.2–14 GHz [3]. Both feeds are dual-linear polarized. The two receiver systems are cryogenically cooled [4] and are connected to one phase and cable delay measurement system (CDMS) each. The two CDMS were purchased from the MIT Haystack Observatory. The H-maser for the time and frequency distribution is located in the maser room at about a 1 km cable distance from the telescopes. Each system has a digital backend of type DBBC3 with eight Core3H boards, which are located in the backend room within about a 15 m distance from the observatory maser room. The signal chain for both the CDMS systems and the received signals from the telescopes to the backend room uses optical fibers that are insulated against temperature variations. The two DBBC3s are connected to a FlexBuff recorder that currently has a capacity of 360 TB and is connected with a 10 Gbps connection to the Swedish fiber backbone. Both telescope towers, as well as the elevation and azimuth cabins, are equipped with numerous temperature and humidity sensors to monitor environmental changes.

Chalmers University of Technology, Department of Space, Earth and Environment, Onsala Space Observatory

2 VGOS Test Observations

We began participating in VGOS test experiments with the two telescopes in the autumn of 2017. These were primarily performed with the current "Haystack VGOS setup", i.e. eight frequency bands of 32 MHz bandwidth each for four RF-bands and two polarizations, e.g. 64 frequency bands in total. First fringes in some of the frequency bands were found with ONSA13NE for session VT7268 on 25/26 September 2017. A couple of days later, first fringes in some RF-bands for ONSA13SW were found in session MC7278 on 5/6 October 2017. Based on the experience gained, the systems were improved, and for VT7317 on 13/14 November 2017, fringes in all bands and all polarizations were found for ONSA13NE. A comparable performance was achieved for ONSA13SW in VT8039, observed 8/9 February 2018.

The ambitious plan to participate also in the CONT17-VGOS sessions could unfortunately not be realized because it had not been proven before CONT17 that the necessary system performance could be achieved.

Figure 2 gives an example of a fringe plot for an observation on the baseline GGAO12M to ONSA13NE. This fringe plot was kindly provided by Mike Titus from the MIT Haystack Observatory, who is correlating the VGOS test sessions. It becomes clear that fringes were found in all frequency channels and both polarizations, but at that time the ONSA13NE system had some variations in the amplitude of the four IF-bands.

Because the DBBC3 backends can be configured flexibly in various different modes, we also started to carry out test observations together with the Kashima 34-m telescope using the "Kashima VGOS setup", i.e. observing and recording complete 1-GHz windows. The first session, OK8051, was performed on 20 February 2018 using one 1 GHz wide band in two polarizations, and fringes were found.

Table 1 gives an overview of all VGOS test sessions that one or both OTT participated in until June 2018.

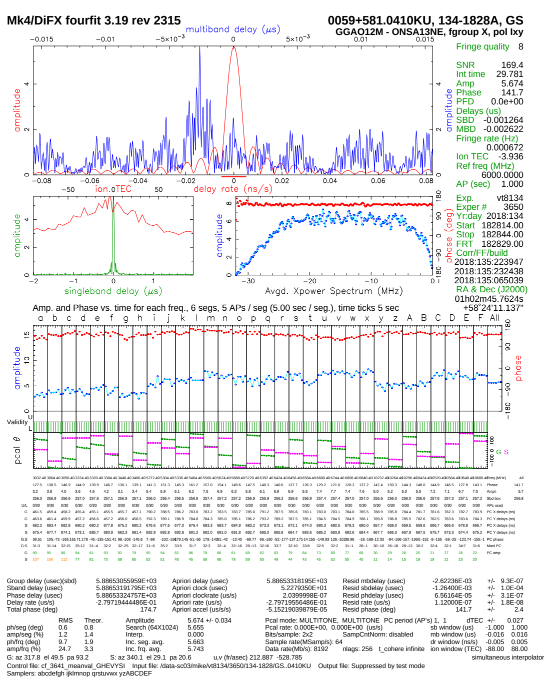

Fig. 2 Fringe plot of a scan observed during VT8134 on baseline GGAO12M-ONSA13NE. (Kindly provided by Mike Titus from the MIT Haystack Observatory.)

Table 1 Overview of the VGOS test sessions in which ONSA13NE (Oe) and ONSA13SW (Ow) participated between September 2017 and June 2018. Both VGOS flavors, i.e. the "Haystack VGOS setup" (VT- and MC-sessions) and the "Kashima VGOS setup" (OK-sessions) were observed.

Session	date	duration	systems	
VT7268	2017-Sep-25	24 h	Oe	–
MC7277	2017-Oct-04	24 h	Oe	Ow
MC7278	2017-Oct-05	24 h	Oe	Ow
VT7303	2017-Oct-30	24 h	Oe	Ow
VT7317	2017-Nov-13	24 h	Oe	Ow
VT7331	2017-Nov-27	24 h	–	Ow
VT8039	2018-Feb-08	24 h	–	Ow
VT8060	2018-Mar-01	24 h	Oe	–
VT8067	2018-Mar-08	24 h	Oe	–
VT8078	2018-Mar-19	24 h	Oe	–
VT8095	2018-Apr-05	24 h	Oe	–
VT8109	2018-Apr-19	24 h	Oe	–
VT8123	2018-May-03	24 h	Oe	–
VT8134	2018-May-14	24 h	Oe	–
VT8149	2018-May-29	24 h	Oe	–
OK051	2018-02-20	1 h	Oe	–
OK065	2018-03-06	1 h	Oe	–
OK074	2018-03-15	1 h	Oe	–
OK086	2018-03-27	20 h	Oe	–
OK136	2018-05-16	1 h	Oe	–
OK141	2018-05-21	20 h	Oe	–

3 Conclusions and Outlook

Since September 2017 we have participated in VGOS test sessions with one or both of the Onsala twin telescopes. We experienced a steep learning curve concerning, for example, the input RF-levels, the level of phase calibration signals (PCAL), interaction between the VLBI Field System (FS) and the DBBC3 backends, and operations as such. In general we achieved a steady improvement of the performance. Nevertheless, there are still aspects to improve, such as improved FS-DBBC3 communication, routine and simple determination and monitoring of system temperature (Tsys) and system equivalent flux density (SEFD), and fine-tuning of the CDMS system.

During the coming months we will thus continue the fine-tuning of the VGOS systems in order to improve the performance. We aim at participating in all possible VGOS sessions using all possible VGOS configurations. Our goal for 2018 is to gradually improve the system performance, as well as reliability, in order to become fully operational in 2019 with both ONSA13NE and ONSA13SW.

Acknowledgements

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