Warkworth 12-m VLBI Station: WARK12M

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Abstract

The Warkworth 12-m Radio Telescope is operated by the Institute for Radio Astronomy and Space Research (IRASR) at AUT University, Auckland, New Zealand. This report briefly reviews the characteristics of the 12-m VLBI station. We report on a number of technical developments; integration of the station DBBC with the Field System pointing algorithm, installation of a MET4 weather sensor and an experimental phase calibration system. We discuss work being done to improve the determination of ocean tide loading effects for the site and report on efforts to develop the capability to participate in EOP experiments.

Figure 1. Warkworth 12-m (left) and Warkworth 30-m (right) antennas at the AUT's Warkworth Radio Astronomical Observatory. Photo: Sergei Gulyaev.

1. Station Equipment and Characteristics

The WARK12M radio telescope is located some 60 km north of the city of Auckland, near the township of Warkworth (Figure 1) [1]. Specifications of the Warkworth 12-m antenna are provided in Table 1. The radio telescope is equipped with an S/X dual-band dual-circular polarization feed. Backend data digitizing is handled by a digital base band converter (DBBC) developed by the Italian Institute of Radio Astronomy. The station frequency standard is a Symmetricom Active Hydrogen Maser MHM-2010 (75001-114). Mark 5B+ and Mark 5C data recorders are used for data storage and streaming of recorded data off site by computer network. The radio telescope is directly connected to the regional network KAREN (Kiwi Advanced Research and Education Network) via a 1 Gbps fiber link to the site [2].

2. Technical Developments

2.1. DBBC Integration with Field System

Software has been written that allows the Field System pointing routines (fivept, onoff, and acquire) to access power measurements from the DBBC. The TCP socket interface to the DBBC

Table 1. Specifications of the Warkworth 12-m antenna.

Antenna type	Dual-shaped Cassegrain
Manufacturer	Cobham/Patriot, USA
Main dish Diam.	12.1 m
Secondary refl. Diam.	1.8 m
Focal length	4.538 m
Surface accuracy	0.35 mm
Pointing accuracy	18″
Frequency range	1.4—43 GHz
Mount	alt-azimuth
Azimuth axis range	$90^\circ \pm 270^\circ$
Elevation axis range	4.5° to 88°
Azimuth axis max speed	5°/s
Elevation axis max speed	1°/s
Main dish F/D ratio:	0.375

control program is used for this inter-device communication. With this new capability we have been able to dramatically improve the pointing of Wark12M and finally obtain reasonable results in X band. Further work in this area is planned that will result in the determination of SEFD, Tsys, and Gain curves for the telescope.

2.2. MET4 Meteorological Sensor

Properly calibrated data on local atmospheric conditions is now available following the installation of a MET4 sensor at the telescope site. At present the MET4 directly connects to the station Field System computer via an RS 232 physical interface. With optimization of the measurements in mind an RS 485 interface is currently being investigated that would allow the sensor to be positioned in closer proximity to the antenna and further away from the influence of buildings and other structures. Data from the MET4 is continuously monitored and automatically written into the Field System log for IVS experiments. It is anticipated that this data will be used to improve the compensation for atmospheric effects at the station.

2.3. E-transfer

We have made extensive use of our connection via KAREN (Kiwi Academic Research Education Network) to international research networks for data transfers to correlators. In the last year only one diskpack, bound for Haystack, was physically shipped. Considerable savings on shipping costs have been realized as a result of this capability. We have used Tsunami, gridFTP, and UDT protocols as appropriate for the requirements of the correlator site to which we are sending data [3, 4].

2.4. Experimental Phase Calibration System

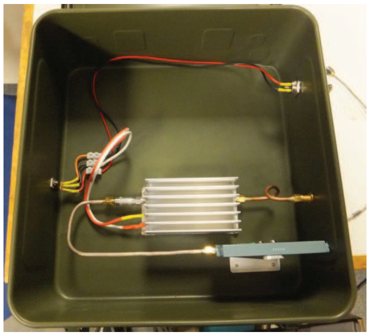

Figure 2. Experimental phase calibration system.

By kind offer from the National Institute of Information and Communications Technology, Kashima Space Research Center, we installed an experimental phase calibration system which was assembled by NICT on the 12-m antenna. The unit is fed a 5 MHz signal from the station Maser, and its output is coupled into the antenna feed by 30 dB loop couplers located immediately prior to the LNA in both S and X band paths (Figure 2).

After considerable engineering effort it has been possible to adjust the phase calibration signal level observed at the backend of the receivers to suitable levels. Phase calibration signals have been detected in both S and X band channels using K5 software [5].

We have carried out fringe tests on the WARK12M-KASHIM11 baseline several times, finally obtaining fringes and succeeding with bandwidth synthesis and analysis of the data (Figure 3).

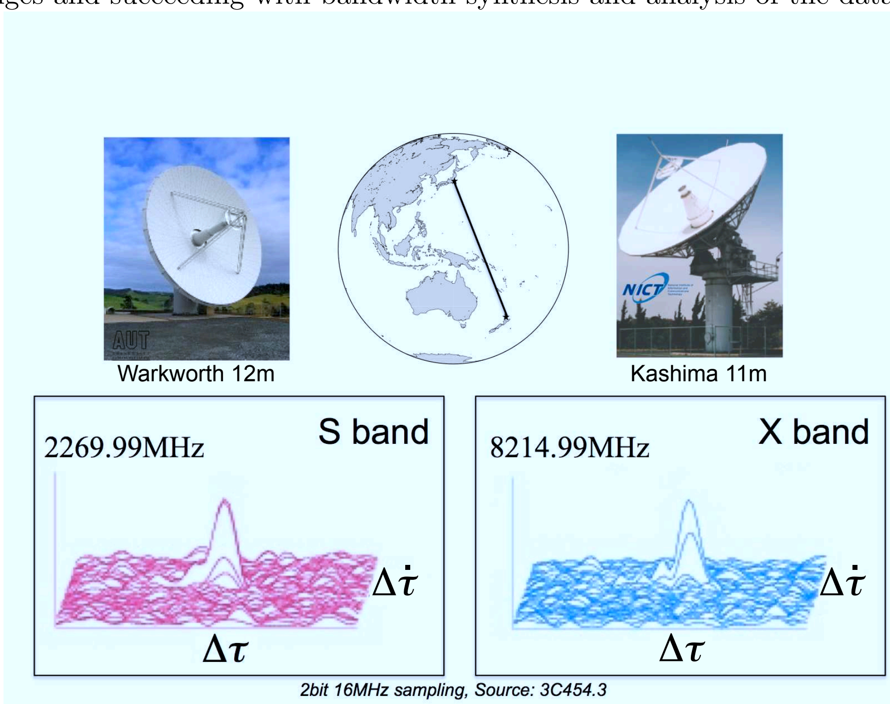

Figure 3. Warkworth 12-m (left) and Kashima 11-m (right) baseline. The fringes of this baseline for both S and X band are presented.

2.5. Improving the Determination of Ocean Tide Loading Effects

We are preparing appropriate models for our station to use in geodetic analysis. Firstly we checked the ocean tide loading effects and determined that the coastline data used by the Ocean

Tide Loading Provider [6] is not sufficiently accurate for our station. Therefore, we have constructed a more accurate coastline model from SRTM (the Shuttle Radar Topography Mission) [7] data sets. We calculated the site-dependent tidal coefficients of the 11 main tides by using GOTIC2 software [8] with this new coastline data. To compare the result we obtained the standard tidal coefficients from the Ocean Tidal Loading provider. The differences of the ocean tidal loading displacement at Warkworth calculated from both site-dependent tidal coefficients were about ±1 mm in the horizontal components and ±2 mm in the vertical component, respectively (Figure 4). These differences are large compared with our aim of 1 mm accuracy for baseline measurements. As a next step we are going to apply this result to geodetic analysis and evaluate the effect.

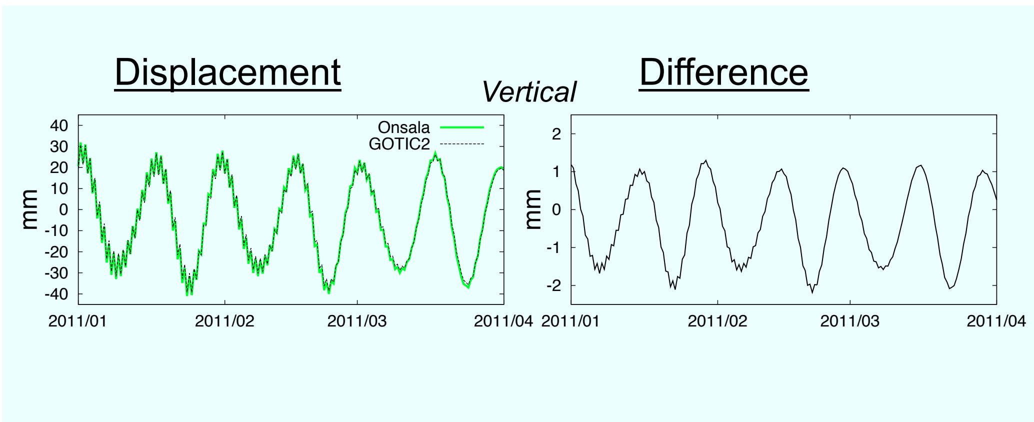

Figure 4. The ocean tidal loading displacement (vertical) at Warkworth in millimeters (left) and the difference between two OTL models (right).

References

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