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. Here we review the characteristics of the 12-m VLBI station and report on a number of activities and technical developments in 2012.

1. General Information

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	$18''$
Mount	alt-azimuth
Azimuth axis range	$90° \pm 270°$
Elevation axis range	4.5° to 88°
Azimuth axis max speed	5°/s
Elevation axis max speed	1°/s

The WARK12M VLBI station is located some 60 km north of the city of Auckland, near the township of Warkworth. 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 at the secondary focus and an L-band feed at the prime focus. Backend data digitizing is handled by a digital baseband 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 through the network. The observatory network is directly connected to the national network KAREN (Kiwi Advanced Research and Education Network) via a 1 Gbps fiber link to the site [1].

2. Component Description

2.1. 12-m Antenna: Progress and Issues

The new L-Band feed was designed by Cobham, USA and installed in May 2012 (Figure 1). It is located behind the secondary mirror at the prime focus, so for L-band observations the secondary mirror has to be removed.

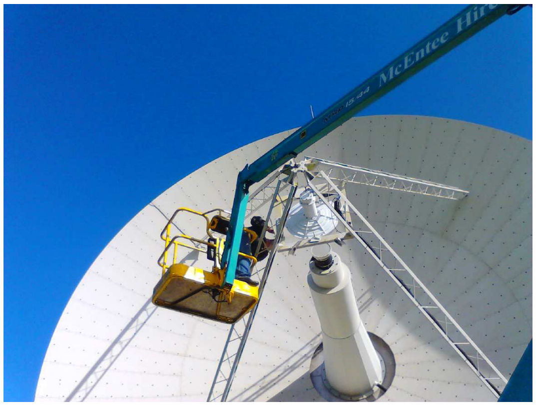

Figure 1: The new L-Band feed installed at prime focus on the 12 m. Credit: S. Weston.

In late 2012, the Hydrogen maser developed a fault, and it had to be returned to Symmetricom. It is expected to be back and operational in February-March 2013. This has severely impacted our station's participation in IVS and LBA observations from late 2012 to date. Another problem was connected with the jack screw elevation bearing; this was finally repaired in early February 2013. This would appear to have been caused by poor initial assembly, with the grease passage way blocked by the protective plastic membrane not having been removed prior to assembly. The DBBC has had new filters installed to the input IF's for the L-band; this will allow the RF to be received directly with no mixing. We are working on finishing the L-band backend for LBA sessions in 2013. We have undertaken a big tidy up of the racks to try to make the systems more manageable; all systems not required in the 12-m system racks have been moved to the 30 m computer room across the road to help reduce the heat sources within the 12-m control room because the maser resides here.

2.2. 30-m Antenna: Progress and Issues

The 30-m Cassegrain beam-waveguide NEC antenna was used by Telecom NZ after construction in 1984. It was handed over to AUT in 2010. Renovation of the 30 m started in 2011. Old azimuth and elevation motors have been removed and replaced with new ones (see Figure 2). A new control system from Control Techniques, UK, very similar to the system used on the 12 m, was installed. A new cable wrap system was installed, and new cables have been pulled through. In mid-February 2013 Mark Godwin will be on-site to commission the new control system. A bolt replacement program by a local rigging contractor has started. We are in the process of negotiating a maintenance contract with them for both the 30 m and the 12 m. Additional DBBC and Mark 5C equipment have been ordered for the 30 m. Work continues on using the existing satellite receiver in C-Band, but we are also talking with other parties about receiver systems. Obviously we would like to have L, S, C, and X but are unsure of the waveguide optics.

2.3. Warkworth Network

We continue to e-transfer data to the correlators. We have installed a new 10Gbit switch in the 30 m computer room. This provides fiber point to point connectivity between the DBBC and Mark 5C via the Fila10G interface and gives us a 10Gbit backbone at the observatory. The network topography was changed so that the 12 m is now a spur from the 30 m KAREN POP. Warkworth now has a direct IP presence on KAREN, so data transfers should no longer go through the University Campus (of mutual benefit to us and campus LAN users). It is hoped with the upgrades taking place with the KAREN network that we will have 10Gbps international connectivity to/from the observatory in the near future. The 30 m building has been wired with cat6 and fiber has been installed from the computer room to the pedestal room beneath the dish where the wave guide terminates. In addition, equipment has been installed for distribution of 1PPS and 10 MHz from

Figure 2: The 30 m: Top left, one of the old azimuth motors being replaced. Top right, Tim and Takiguchi having finished replacing one of the elevation motors. Bottom left, an example of the corrosion we have to get on top of. Bottom right, with the new motors and control system we are now able to move the dish once again. Image Credit: S. Weston.

the maser at the 12 m over to the 30 m pedestal room using a Symmetricom RF via fiber system.

3. Current Status and Activities

In March 2012 we had a visit by Gino Tuccari with Jim Lovell and Jamie McCallum from Hobart for a mini workshop about the DBBC, looking at diagnoses and issue resolution. Later in the year during September Ed Himwich also paid a visit, during which he installed the new Field System DBBC support components. Now when we run Drudg, the generated schedule .prc file contains the appropriate commands to program and setup the DBBC. We have successfully installed SDK 9.2 on our Mark 5B to support disk packs larger than 8 TB. We now have a station pool of five 16 TB disk packs which we will be using for LBA and the AUSTRAL experiments with AuScope antennas in Australia. In addition to the IVS and LBA observations, the WARK12M is now also a tracking station for SpaceX on their supply missions to the International Space Station.

3.1. Co-operative Observation

Co-operative observation for geodetic purposes with NICT (Japan) and University of Tasmania (Australia) started. The baseline of WARK12M and KASHIM11 is a long north-south baseline of over 8,000 km. The first observation of the WARK12M-KASHIM11 baseline was carried out in April 2012 and the baseline length has been determined as 8,075,003,545±150 mm. By repeating the observation, we expect to obtain information about the relative tectonic motion of Japan and New Zealand. Also, we are working to establish the ability to derive EOP ultra-rapidly by utilizing this baseline, existing UT1 products (such as from the IVS INT2 sessions), and data transfers by high-speed network. The University of Tasmania operates three 12-m radio telescopes located in Hobart (HOBART12), Yarragadee (YARRA12M), and Katherine (KATH12M) under the AuScope project [2]. These three telescopes and WARK12M are located on the Australian tectonic plate and consequently are ideally placed for measurements of intra-plate deformation. WARK12M-AuScope observations started in July 2012. Monthly 24-h observations and a series of multi-day observations together with AuScope antennas will be scheduled from early 2013.

Figure 3 shows the baseline length changes of the Warkworth-Hobart baseline derived from both GNSS and VLBI data sources for the epoch 2011-2013. We checked all of the baselines of AuScope and WARK12M. GNSS results indicate a small intra-plate deformation. On some baselines current VLBI results appear to be in disagreement with the GNSS data. At this stage it is not possible to comment further on this discrepancy due to the statistically small number of VLBI observations. Our proposed co-operative observations will add vital data points, reduce the noise, and compensate for this current VLBI weakness.

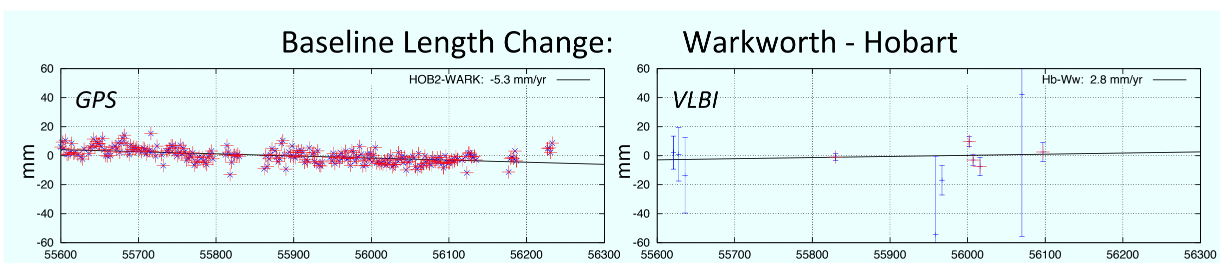

Figure 3: The baseline length changes of the Warkworth-Hobart baseline derived from both GNSS and VLBI data sources for the epoch 2011-2013. GNSS results were produced by analysis of the GNSS data (IGS: alic, auck, hob2, karr, kat1, yarr + PositioNZ: wark) using the GAMIT/GLOBK software package. VLBI baseline behavior was determined from results produced by the IVS analysis center. The difference of color indicates whether these data were used (red) for the calculation of the change rate or excluded (blue).

References

[1] Weston, S., Natusch, T., Gulyaev, S., Radio Astronomy and e-VLBI using KAREN. *In Proceedings of the 17th Electronics New Zealand Conference*, 2010. Preprint arXiv:1011.0227.

[2] Lovell, J. E. J., McCallum, J. N., Reid, P. B., McCulloch, P. M., Baynes, B. E., Dickey, J. M., Shabala, S. S., Watson, C. S., Titov, O., Ruddick, R., Twilley, R., Reynolds, C., Tingay, S. J., Shield, P., Adada, R., Ellingsen, S. P., Morgan, J. S., Bignall, H. E., The AuScope geodetic VLBI array, *Journal of Geodesy*, 1-12. doi:10.1007/s00190-013-0626-3, 2013.