New Zealand VLBI Station, Warkworth

Stuart Weston, Tim Natusch, Lewis Woodburn, Ben Hart, Sergei Gulyaev

Abstract The Warkworth Radio Astronomical Observatory is operated by the Institute for Radio Astronomy and Space Research (IRASR), AUT University, Auckland, New Zealand. Here we review the characteristics of the VLBI station facilities and report on a number of activities and technical developments in 2015/6.

1 General Information

The Warkworth Radio Astronomical Observatory, for which a panorama photo is shown in Figure 1, is located some 60 km north of the city of Auckland, near the township of Warkworth. Specifications of the Warkworth 12-m and 30-m antennas are provided in Table 1. The 12-m 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 base band converter (DBBC) manufactured by the HAT-Lab, Catania, Italy. The 30-m radio telescope is currently equipped with an uncooled C-band dual-circular polarization receiver. 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. The observatory network is directly connected to the national network provided by Research and Education Advanced Network New Zealand Ltd. (REANNZ) via a 10 Gbps fiber link to the site [1].

Institute for Radio Astronomy and Space Research, Auckland University of Technology

IVS 2015+2016 Biennial Report

2 Component Description

2.1 The 12-m Antenna: Progress and Issues

In late 2016, the 12 m was out of commission due to the jack screw boot being ingested by the elevation bevel gear mechanism. Repair was effected by a local rigging firm that engineered a device using hydraulic rams. This can now be used in the future to support the dish at any elevation.

2.2 The 30-m Antenna: Progress and Issues

In cooperation with Lyrebird Antenna Research Pty Ltd., a new X-band feed for the 30 m that fits inside the existing C-band feed was designed [3], see Figure 2. We hope to have received this in the second quarter of 2017 and to start testing.

An L-band capability for the 30 m was experimented with over the last year. By removing the bottom three sections of the C-band feed and fitting an L-band feed horn with room temperature LNA to the opening, some success in receiving signals was achieved. At present the efficiency is very poor, of order 10%, but nonetheless may well prove adequate (given the 30 m's

Fig. 1: Photo of the two radio antennas at Warkworth on a frosty winter morning; on the left the 30 m and on the right the 12 m. In the background on the left hand side are the antennas belonging to Spark (formerly Telecom New Zealand). (Image courtesy of Stuart Weston).

Table 1: Specifications of the Warkworth 12-m and 30-m [2] antennas.

	12-m	30-m
Antenna type	Dual-shaped Cassegrain	wheel-and-track, Cassegrain beam-waveguide
Manufacturer	Cobham/Patriot, USA	NEC, Japan
Main dish Diam.	12.1 m	30.48 m
Secondary refl. Diam.	1.8 m	2.715 m
Focal length	4.538 m	10.380 m
Surface accuracy	0.35 mm	1.2 mm
Mount	alt-azimuth	alt-azimuth
Azimuth axis range	$90^\circ \pm 270^\circ$	-179° to $+354^\circ$
Elevation axis range	7.2° to 88°	6.0° to 90.1°
Azimuth axis max speed	5°/s	0.37°/s
Elevation axis max speed	1°/s	0.36°/s

collecting area) for some projects. GPS signals (L1, L2, and L5) were detected, and fringes to PKS 1921-293 between the Warkworth 30 m and the Hobart 26 m were detected. Useable bandwidth is from approximately 1.1 to 1.8 GHz. A noise diode system is currently being fitted that will allow more precise determination of efficiency, Tsys, and SEFD, and attempts to further optimize the system's performance will be ongoing.

2.3 Warkworth Network

In September 2016, the international circuits from New Zealand provided by REANNZ were upgraded to 100 Gbps bi-directional to the USA west coast and Australia. All Mk5s and DBBCs are being interconnected with fiber at 10 Gbps.

3 Current Status and Activities

2015 and 2016 have seen us settle into a steady number of IVS sessions on the 12 m. A break down of session types (i.e. OHIG, CRDS, APSG, R, and AUST) observed over this two year period is presented in Table 2.

In addition, both antennas are now active for Australian LBA sessions each semester, the choice of antenna being dependent on frequency. With the addition of the X-Band feed to the 30 m we would expect to see the LBA workload shift more to the 30-m antenna in the future. Also, cooperation with SpaceX and JAXA

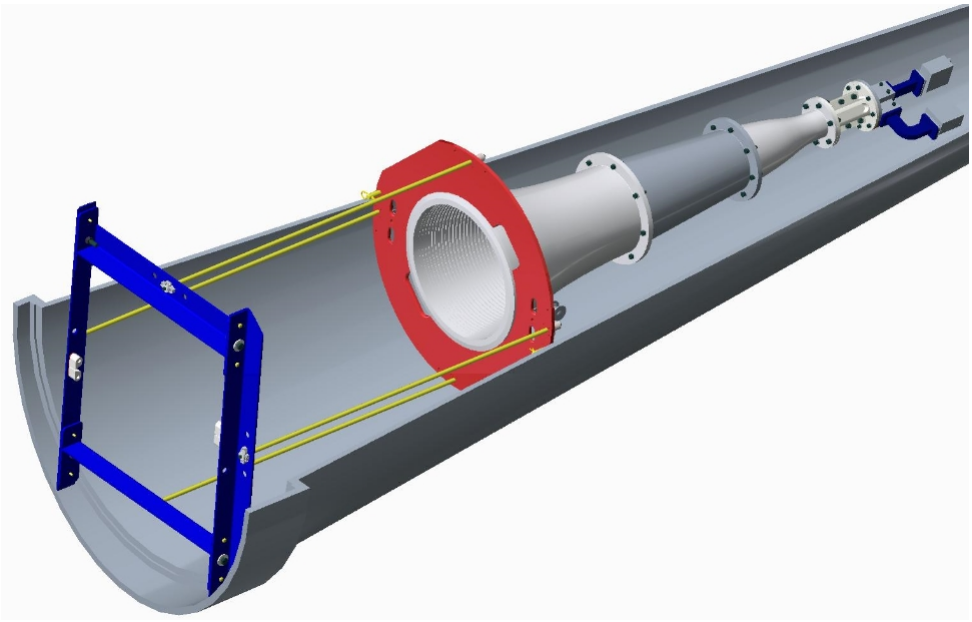

Fig. 2: The new X-Band feed and mechanism to lower it inside the existing C-Band feed. This is shown as horizontal in this paper, but it would be vertical in the actual installation. (Credit: Lyrebird Antenna Research Pty Ltd.).

Table 2: The 12 m IVS 2015/6 session participation.

Experiment	Number of sessions	
	2015	2016
APSG	1	2
AUG	6	3
AUV	6	5
AUA	6	6
CRDS	6	5
OHIG	6	3
R1	21	26
R4	29	28
T	1	2
Total	82	80

for spacecraft tracking has continued using the 12-m antenna.

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. Woodburn, L., Natusch, T., Weston, S., Thomasson, P., Godwin, M., Granet, C., Gulyaev, S., Conversion of a New Zealand 30 metre Telecommunications antenna into a Radio Telescope, Publications of the Astronomical Society of Australia, Published, 2015.
3. Granet, C., Kot, J. S., Natusch, T., Weston, S., Gulyaev, S., Design of an X-Band Feed System for the Auckland University of Technology 30m Diameter Warkworth Radio Telescope, EUCAP2017, Accepted, 2017.