AuScope VLBI Array and Hobart 26-m Antenna

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Abstract This is a report on the activities carried out at the University of Tasmania in support of the three AuScope VLBI observatories and the Hobart 26-m antenna in 2017 and 2018. Our current and completed research programs are outlined, as is our planned development of the array.

1 General Information

The AuScope VLBI array consists of three 12-m telescopes operated by the University of Tasmania as part of the AuScope project (www.auscope.org.au) and has been part of regular IVS observations since 2011. The telescopes span the Australian continental plate, located in Hobart (Tasmania), Katherine (Northern Territory), and Yarragadee (Western Australia). The Hobart 26-m telescope is co-located with the Hobart 12-m.

2 Activities during the Past Years

The AuScope array of telescopes has been participating in the regular IVS sessions, aiming to observe whenever it is possible and useful to do so. In 2017 and 2018 the AuScope and Hobart 26-m antennas participated in 175 and 170 IVS sessions, respectively, (compared to 166 in 2016, 185 in 2014, and 72 in 2012) for a total of 393 and 378 antenna days, respectively. A summary of the sessions is presented in Table 1.

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Hobart 12-m and 26-m, Katherine, and Yarragadee

IVS 2017+2018 Biennial Report

Table 1 AuScope and Hobart 26-m antenna participation (number of experiments) in IVS sessions in 2017 and 2018.

Session	2017	2018
AOV	6	12
APSG	2	2
AUA & AUG	19	13
CONT17	15	0
CONTV17	15	0
CRDS	6	6
CRF	3	6
OHIG	5	6
R&D	10	10
R1/R4	90	101
T2	2	4
VLBA	2	0
AUM	0	10
Total	175	170

The total number of antenna days observed has decreased from 2015/2016, largely due to the Hobart12 having replaced the S/X receiver with the newly supplied VGOS receiver manufactured by Callisto in mid-2017. This has not been removed since its installation, and it has been tested and improved throughout this period.

The transition to VGOS has been slower than hoped, with some unexpected problems and a shortage of personnel at various times. As of 2019, we have confirmed an operational system capable of obtaining fringes across the VGOS frequency range in fringe tests with the Japanese Ishioka telescope. The most critical issues have been resolved, but there is still work to be done to optimize the sensitivity and improve the reliability of the system. Once we have confirmed reliable operation within our network, we look forward to contributing to the VGOS sessions.

3 Current Status

There have been a number of issues related to the timing stability of the Katherine data over 2017–2018, presenting as a large number of clock breaks within a session. The hydrogen maser located on site needed a major service in late 2018, during which time a number of other problems in the timing distribution system were addressed. The performance since the repairs has been much improved.

New cable wrap systems were installed in the Hobart12 and Katherine telescopes in early 2017 and mid-2018, respectively. These replace the existing twister-style cable wraps that may have caused some issues with cable stretching. A new cable wrap is on site at Yarragadee and will be installed in early 2019.

Several of the Mark5B+ units have developed faults over the last year and are to be replaced by a Fila10G/Flexbuff system. This will be installed in 2019 ahead of the upgrade to VGOS. The systems will continue to be used after the transition to VGOS for recording the S-band data.

The Hobart26 has continued participating in IVS sessions throughout 2017 and 2018. There have been a number of issues with the drives over this time though, leading to the cancelation or failure of a number of experiments. Failures of the cryogenic system leading to the warming of the receiver have also reduced the sensitivity of the antenna in several experiments. Ongoing maintenance has improved the situation, but further work will be required in the future.

In late 2018, the correlation facilities at the Hobart observatory were significantly improved with the acquisition of a cluster of 10 Flexbuff-like machines with 10 GbE interfaces and access to fast internal storage arrays. This replaced the existing cluster, which was significantly I/O-bound, particularly when working with data recorded in VGOS modes. The new cluster has not been rigorously benchmarked, but it correlates at better than real-time when processing sessions with a total data rate of 4 Gbps.

A deformation survey of the Hobart 26-m telescope was carried out in late 2018 by David Schunck of Bonn, as part of a research visit. The aim was to investigate some unusual residual errors seen on the short Hobart12–Hobart26 baseline. The results indicate that while the dish surface and focus cabin of the XY-mount telescope are remarkably well behaved, there does appear to be some deformation in the back structure, possibly affecting the stability of the rotation axes. Further work on this matter is required.

3.1 Observing Programs

With the Hobart12 unavailable for regular use in the S/X network, it was no longer practical to carry out the intensive geodetic schedules as part of the AUSTRAL program. However, the regular sessions have been repurposed to support the SOuthern Astrometry Program (SOAP, http://astrogeo.org/soap/) which carries out observations of Southern hemisphere quasars with the aim of improving the source position accuracy by a factor of 5–10. Initial results show improvements, although telescope sensitivity is a severely limiting factor when observing weak sources.

The absence of the Hobart12 for regular use prompted us to investigate the use of the VGOS system in mixed-mode (using the VGOS system to observe the S/X frequencies) observations. In mid-2018, a series of mixed-mode experiments were carried out using the AUSTRAL array. With Katherine and Yarragadee observing in the standard AUSTRAL S/X configuration, Hobart12 used the new DBBC3 to record the X-band frequencies, while the S-band data were captured using the DBBC2 and Fila10G card. The data were then correlated in DiFX and processed through Fourfit to combine the cross-hand polarizations. An initial examination of the results shows this to be apparently successful with no obvious errors or systematic variations. The correlation reports and data will be made available once final checks are complete.

4 Future Plans

The next major development for the AuScope array is the transition to VGOS which has been delayed from our initial expectations. The current timeline is for the upgrade to be made in mid-to-late 2019, with Katherine to be the first remote site to have the new system installed.

The dynamic observing program, where schedules are developed in real-time to suit the available network

of telescopes, will be restarted in 2019. Initially, the main focus will be using the Hobart12 telescope in mixed-mode observations. Frequent experiments will drive further improvements to our observing efficiency and logistical arrangements.