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Legacy, VGOS and mixed-mode observations with the AuScope array

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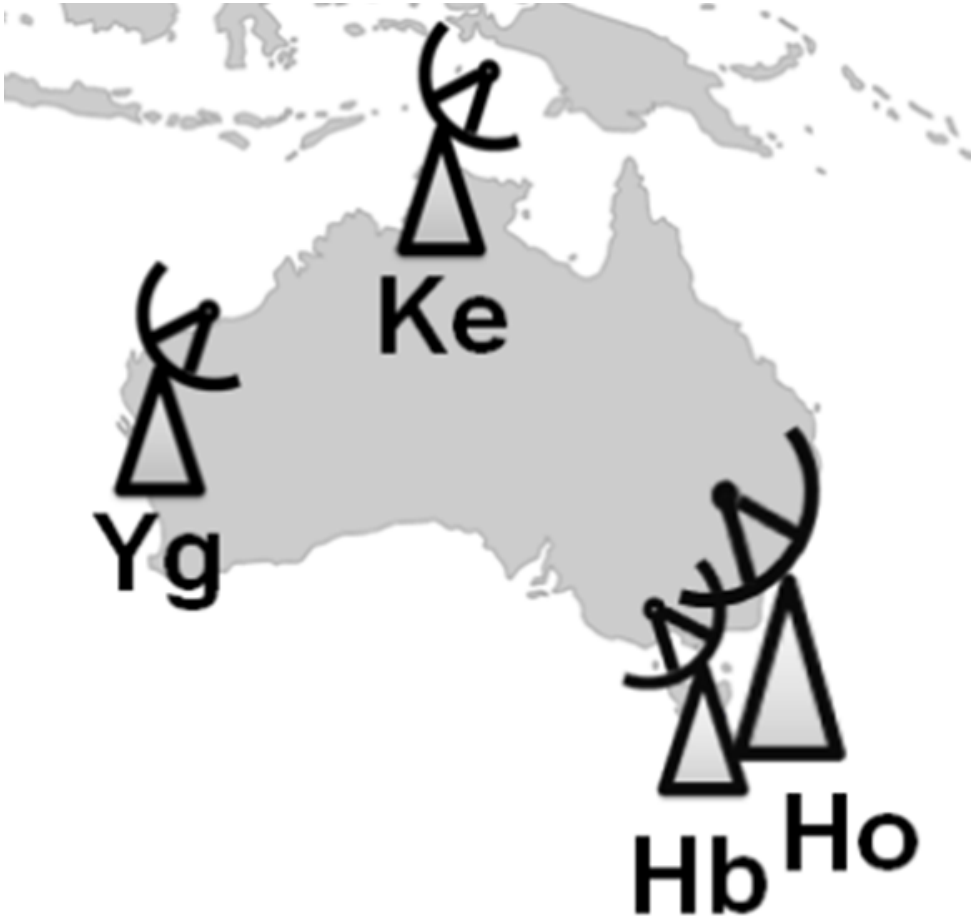
The AuScope Array and Hobart26

- Three dishes built as a dedicated geodetic array
- "Slow" VGOS design (Az/El speeds of 5/1.5 deg/s)
- Operating with S/X receivers at up to 1 Gbps since 2012
- Dense time series of observations since 2014
- Hobart 26m (Ho) regularly used in IVS S/X schedules, also equipped with other feeds (L, S, C, X, Ka, K)



Current Status - “Legacy” S/X

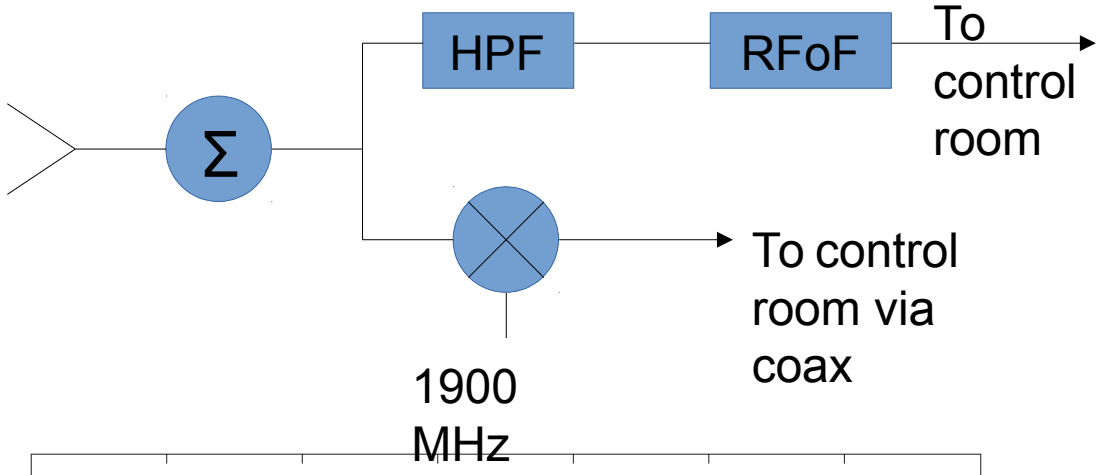
- Stable, working at all sites despite some minor equipment failures (e.g mark5B recorders, now using spares)
- Ke/Yg were originally scheduled for the upgrade to VGOS in this year. This is delayed, pending the final installation design and personnel availability into mid-2019.

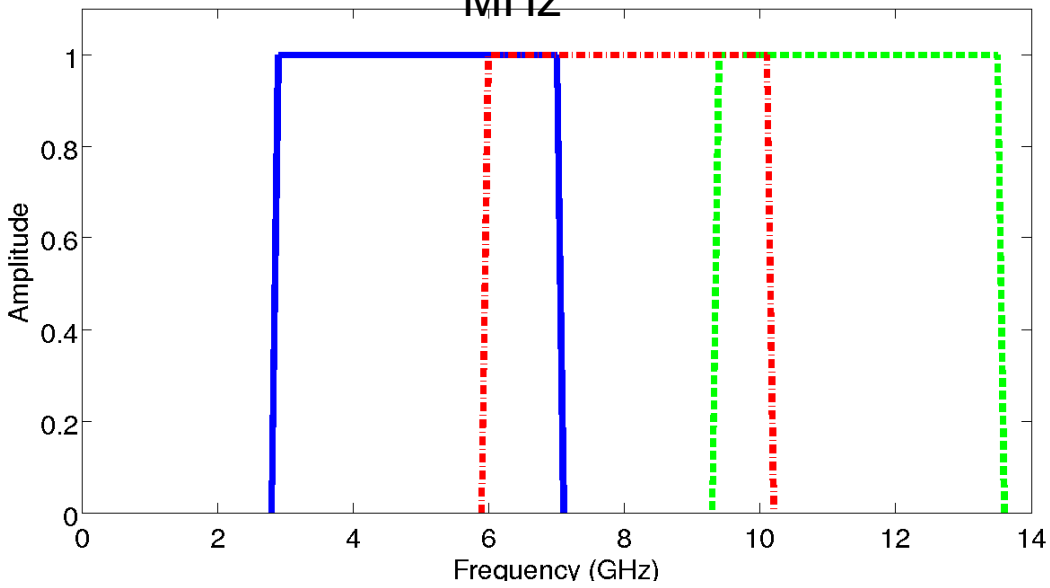
Current Status - VGOS

- Hb equipped with Callisto-designed 2-14 GHz QRFH feed with Stirling-cycle cryogenics (~75K physical temperature).
- A full system is installed for Hb and is in regular use for test observations, calibration and the development of operational procedures
- Tsys/SEFD still worse than expected although much improved through subreflector adjustments and re-focussing. Further improvements likely through RF chain adjustment and DBBC3 calibration
- Since early 2018, system has been sufficient to make wideband fringe tests and begin S/X compatibility testing.

VGOS System @ Hb

- Frequencies < 3 GHz mixed with 1900 MHz LO, sent over coax.
- 3+ GHz HPF used before the RFoF link (RFI)
- Signal split & 4 GHz filters used to provide inputs to our 6-input DBBC3 (3 x dual-pol, to be used with DDC mode)



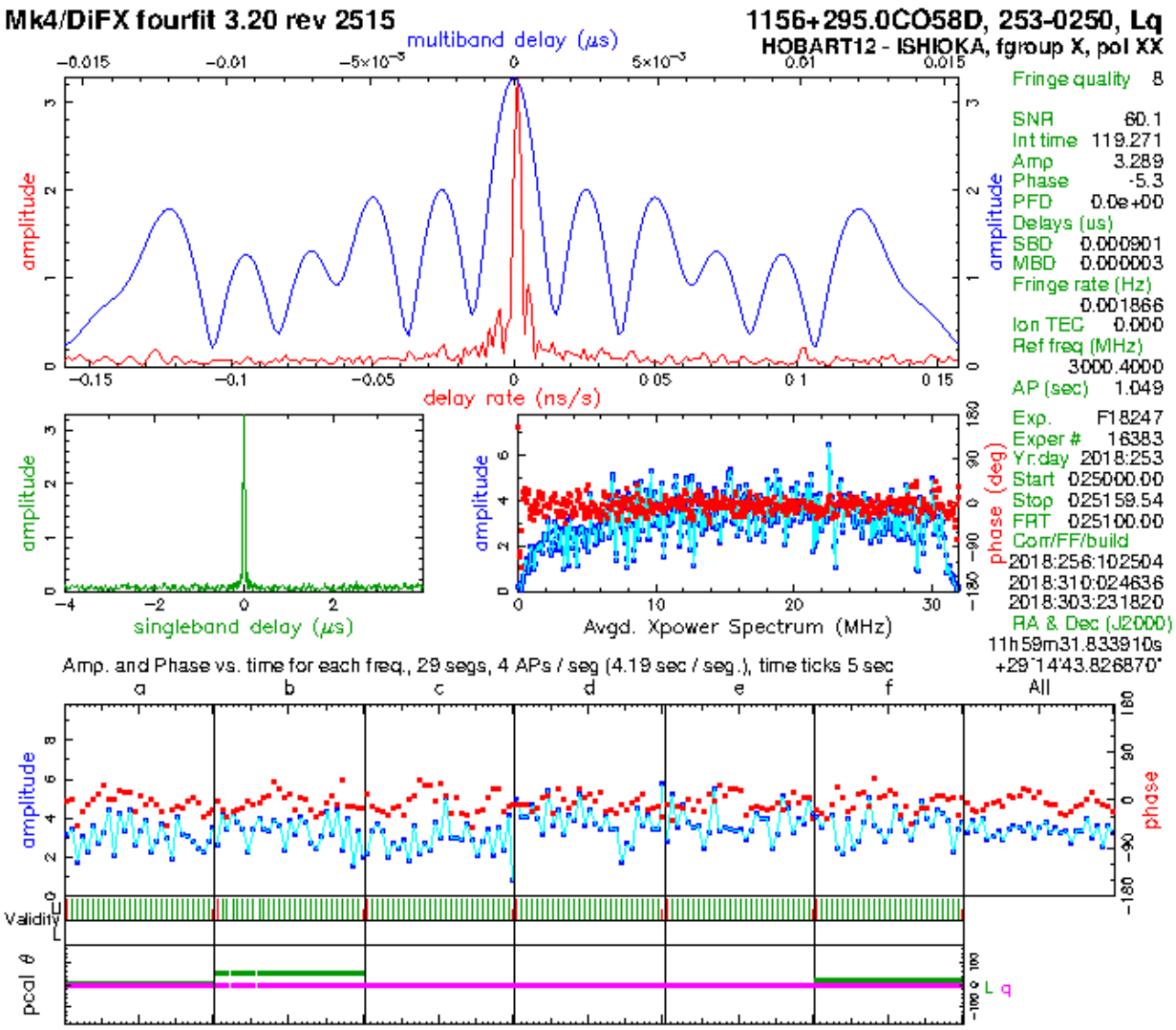


VGOS Fringe Tests (Australia-Japan)

- Wideband fringe tests made to both Kashima and Ishioka telescopes in last 12 months
- Extremely valuable for our receiver development – our thanks to everyone who contributed to this!
- Last series with Ishioka (f18247, f18253) most successful with fringes detected in all VGOS bands, all polarisations.
- Using VT configuration (3, 5, 6 and 10 GHz), correlated at Hobart
- Also confirmed Ishioka's K6/iDAS parallel recordings.

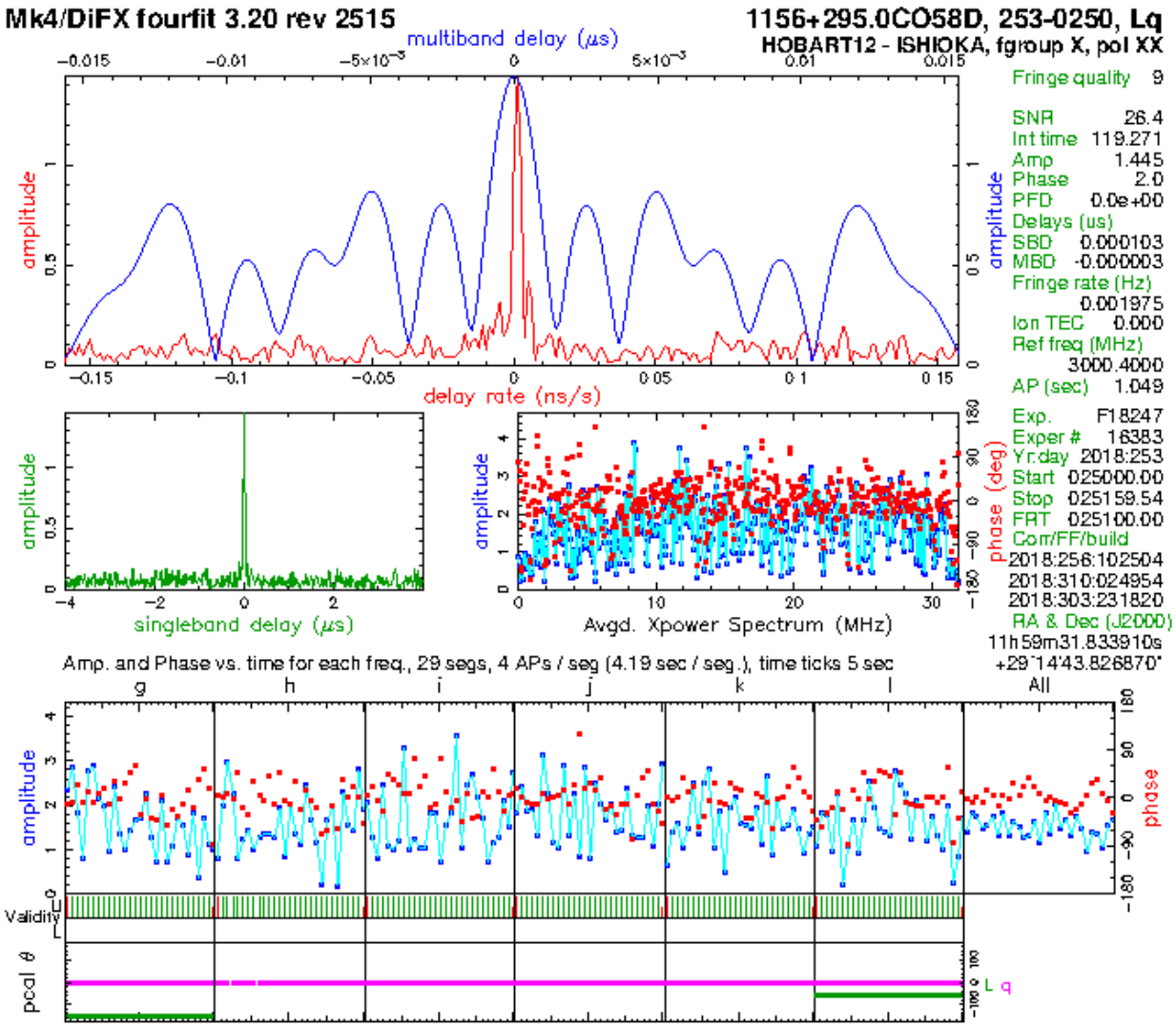
Fringe Tests (Australia-Japan)

3 GHz



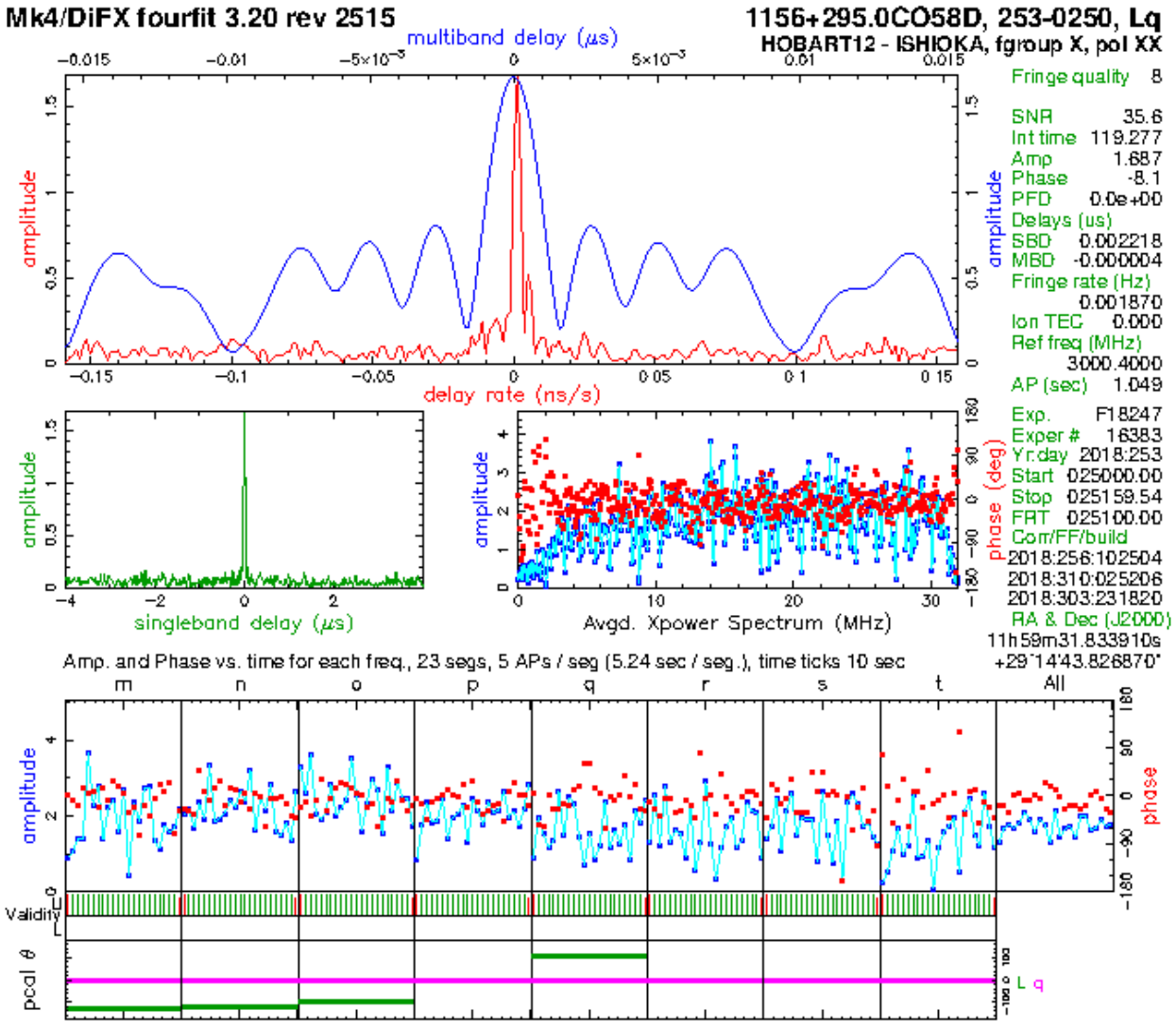
Fringe Tests (Australia-Japan)

5 GHz



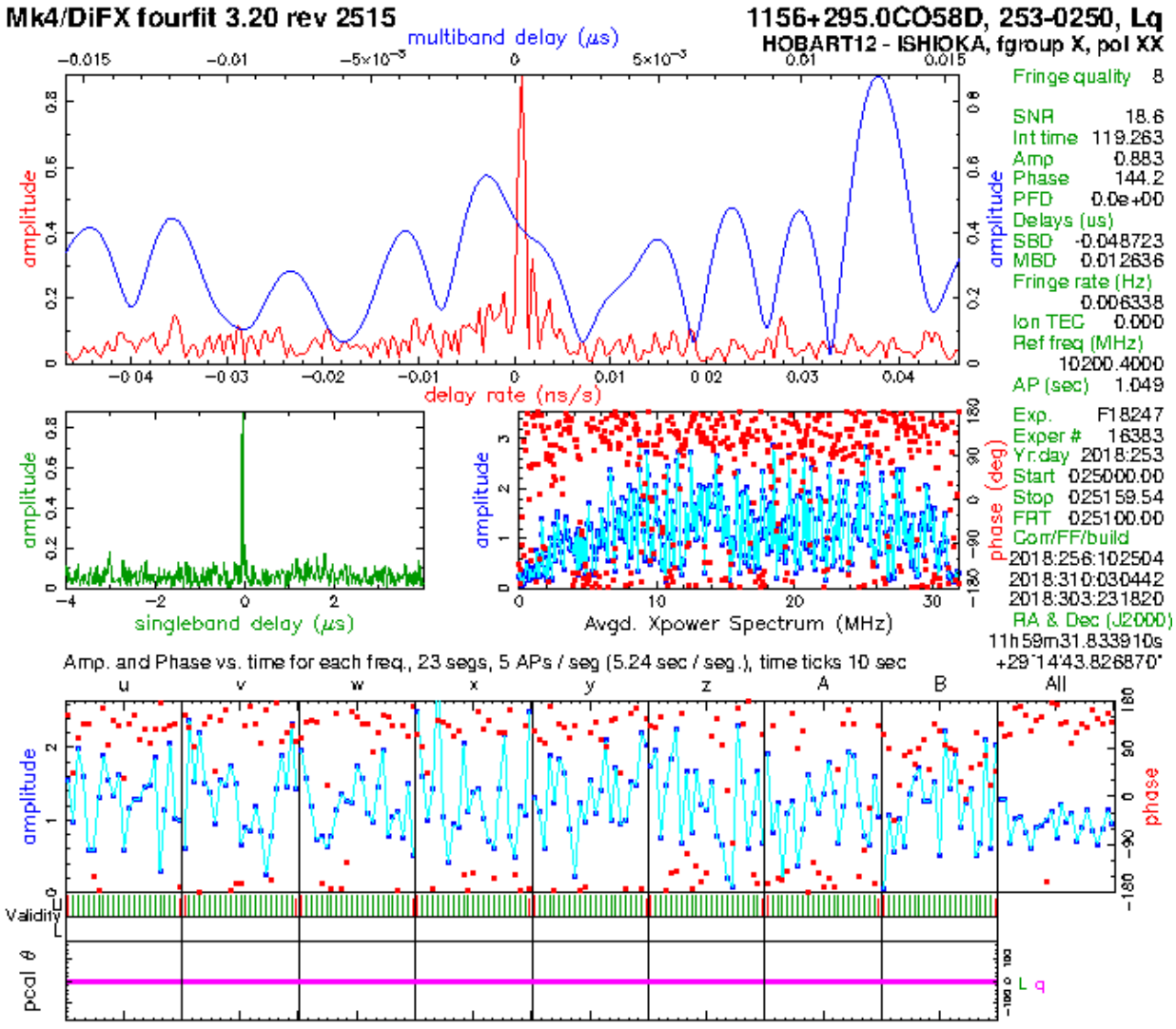
Fringe Tests (Australia-Japan)

6 GHz



Fringe Tests (Australia-Japan)

10 GHz

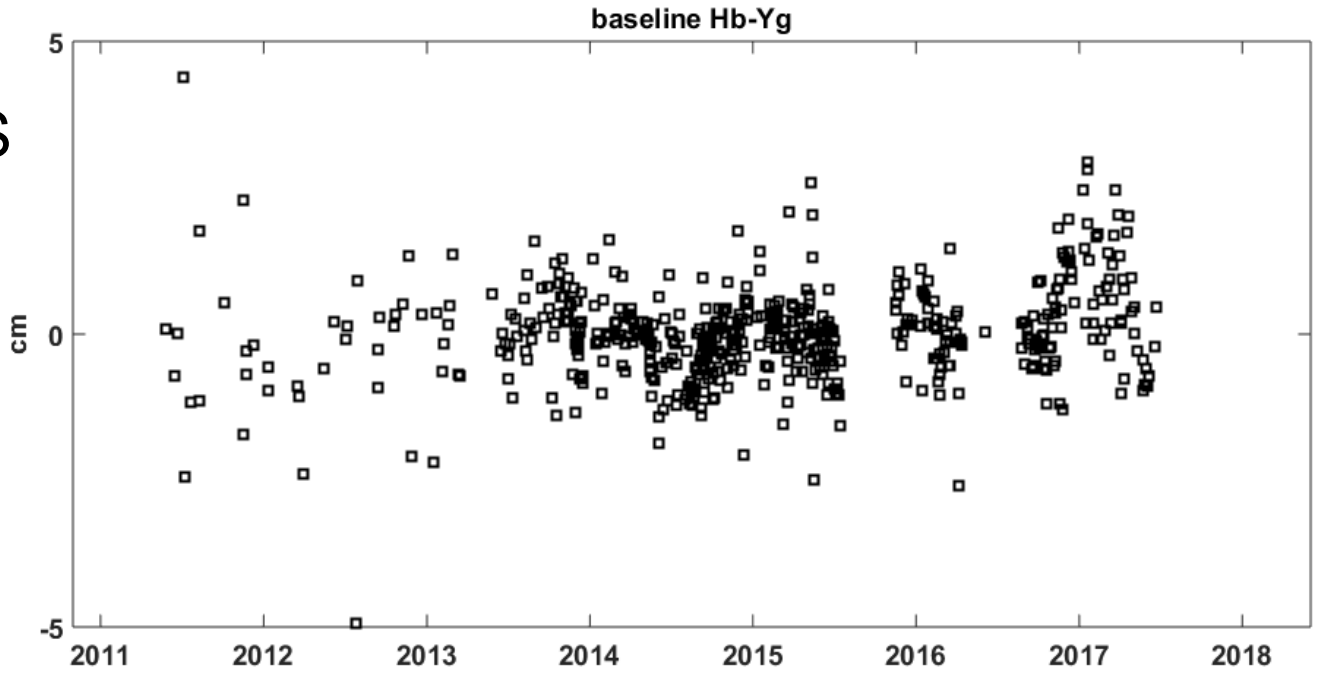


Fringe test results

- Wideband fringe fitting with fourfit is still to be finalised
- Hampered by current issue with difx2mark4 not passing phase-cal information due to multiple datastreams in the recorded data.
  - → Raised at DiFX developer's meeting, solution hopefully soon.
- Similar issue with polarisation calibration, although single-band combinations work well.

The AuScope Array – VGOS compatibility with S/X

- Hb12 has been removed from IVS schedules for the past 18 months
- Loss of continuity in the time series
- VT tests still at relatively low cadence.

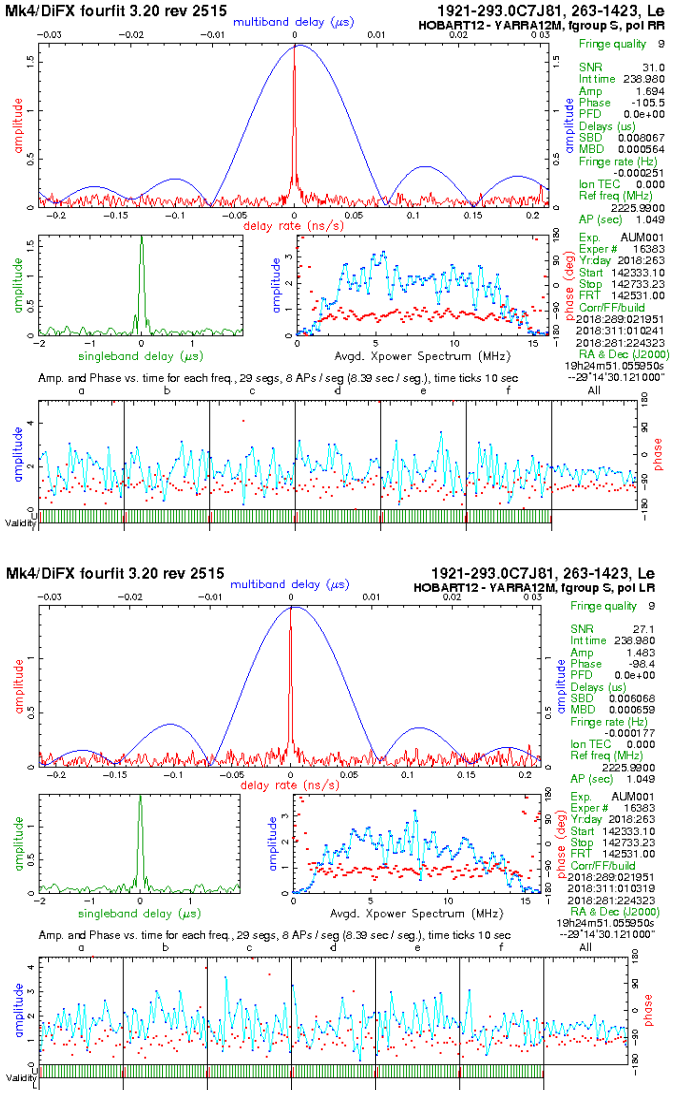


- Using the VGOS feed in “Legacy” S/X observations would give continuity and more practice in operating the systems.

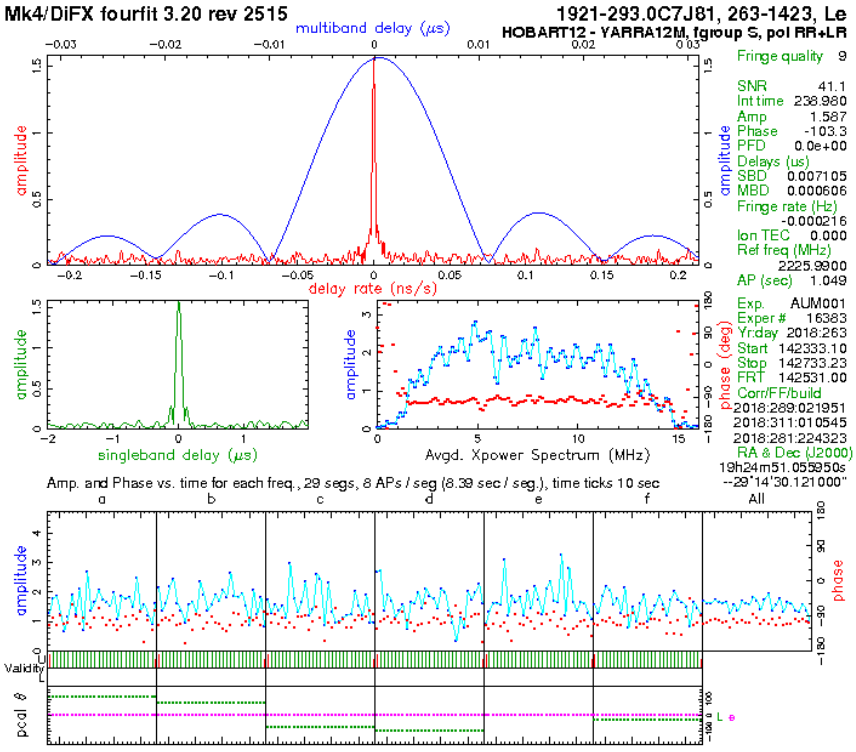
The AuScope Array – S/X test observations

- First tests reported at the IVS GM in Svalbard
- 10 AUM (Austral Mixed-Mode) experiments were carried out over August and September using Hb, Ke and Yg.
- Scheduled by Matthias Schartner (Vienna), using strong sources.
- All correlated and fringe-fit, analysis under way. Databases will be made available through the IVS soon.
  - Polarisation combination (XR + YR) apparently successful and stable
  - No systematic difference between S-band (over co-ax) and X-band (using RfoF).
  - No phase-cal information due to difx2mark4 issue
  - High SNR scans essential for good calibration, especially at S-band.

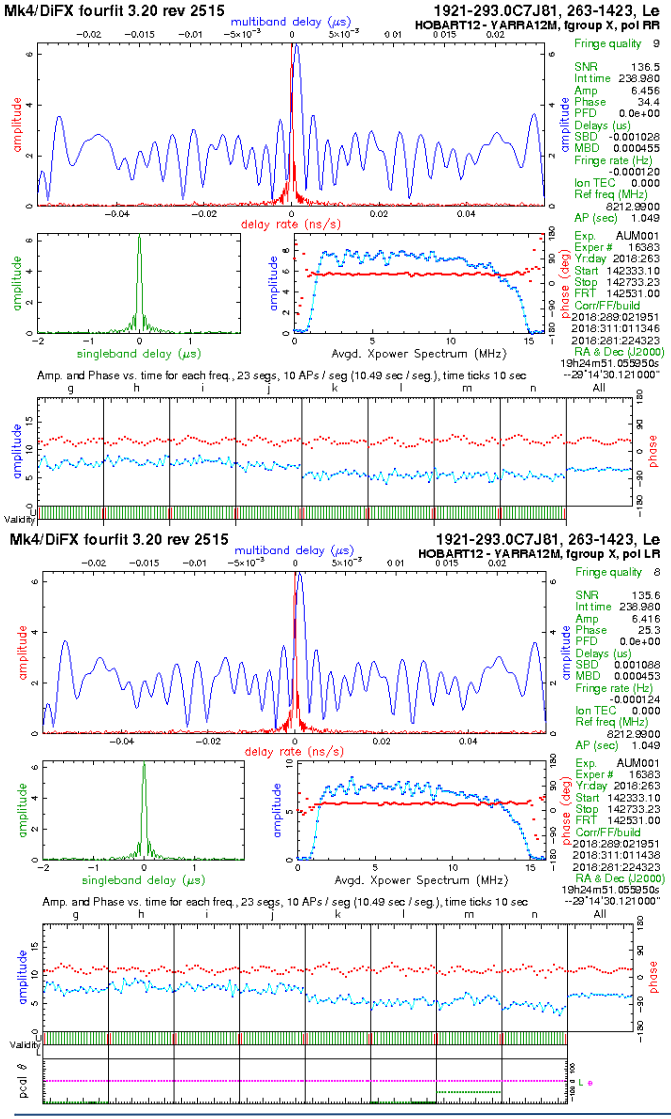
The AuScope Array – Fringe fitting



- NB – Hb polarisations are mislabelled as LCP and RCP for FITS compatibility
- Polarisation combination (XR+YR) gives the expected improvement in SNR.



The AuScope Array – Fringe fitting



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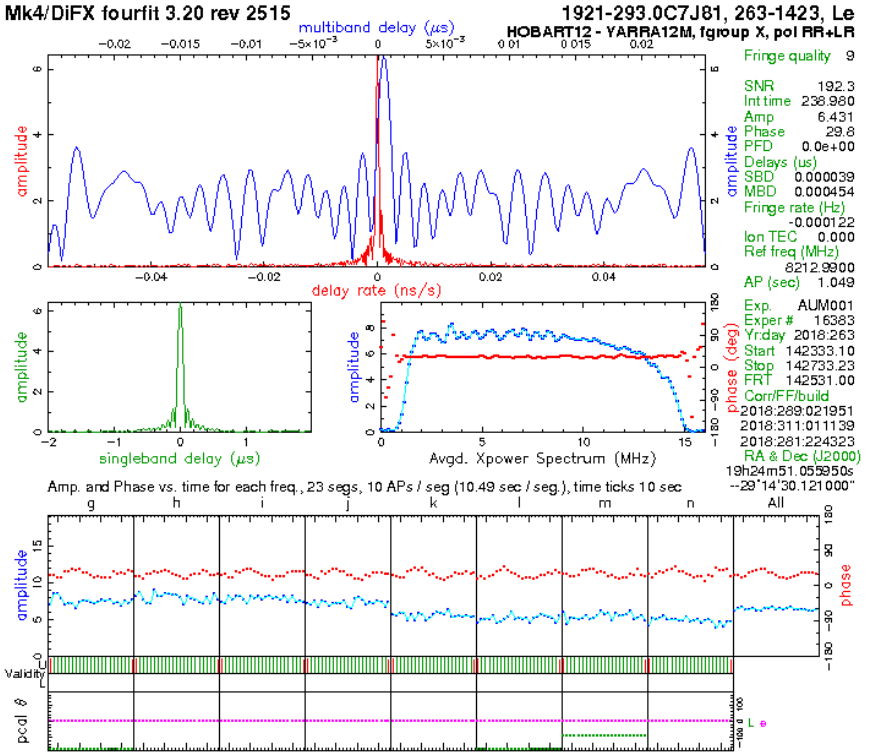
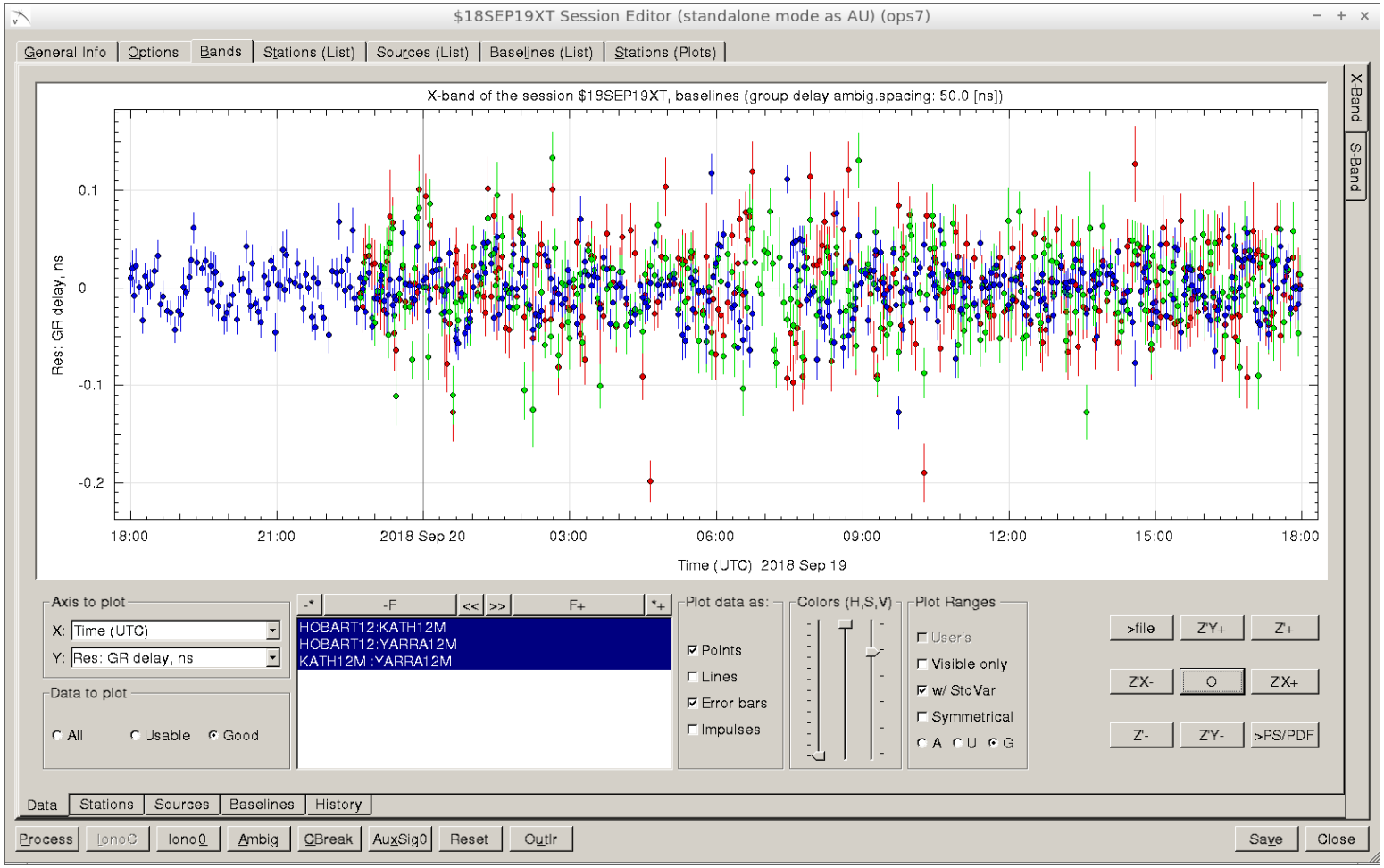


The AuScope Array – AUM results



AUM009, analysed in nusolve. Session WRMS ~ 26 ps

The AuScope Array – Mixed mode summary

- Simple case of 1 VGOS (linearly-polarised) station in the network seems relatively easy to support
- Provides a way to tie new or upgraded telescopes into the current S/X network
- AUM series limited by absence of phase-cal and lower sensitivity during these experiments
- The AuScope array is available and happy to contribute to AOV efforts towards VGOS and mixed-mode observations and we look forward to this.