Towards VGOS with the AuScope VLBI Array

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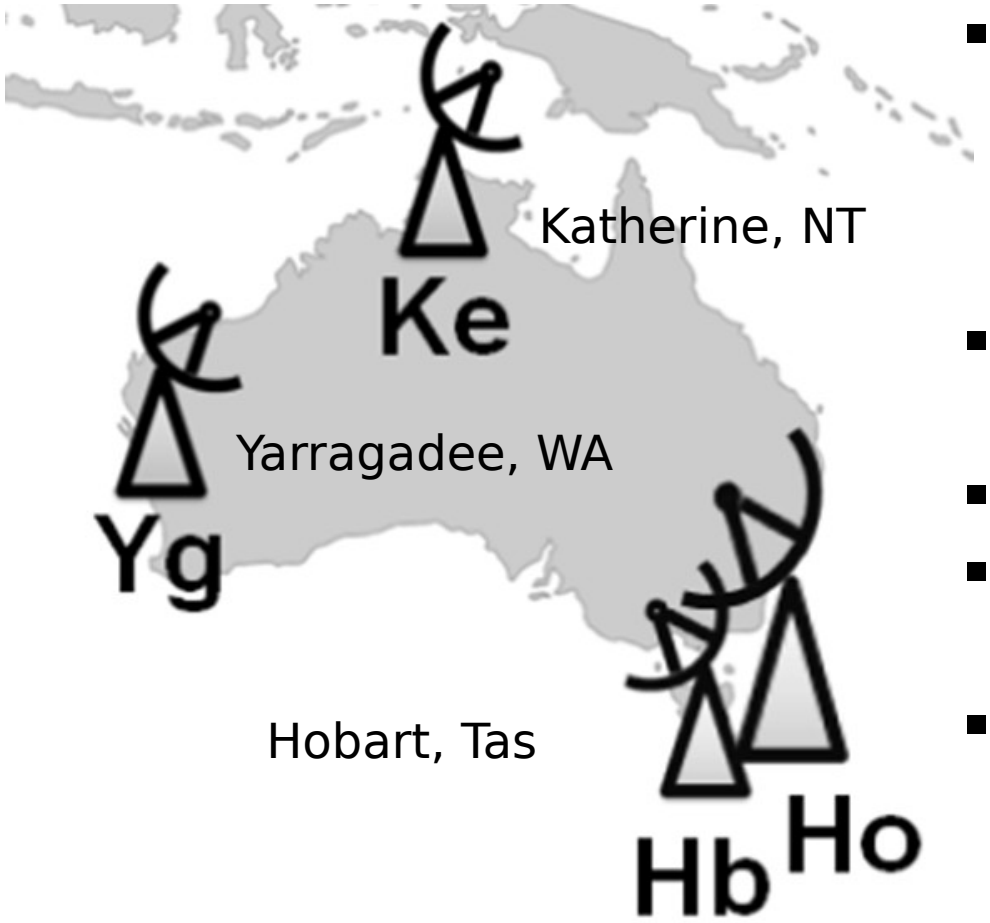
AuScope VLBI

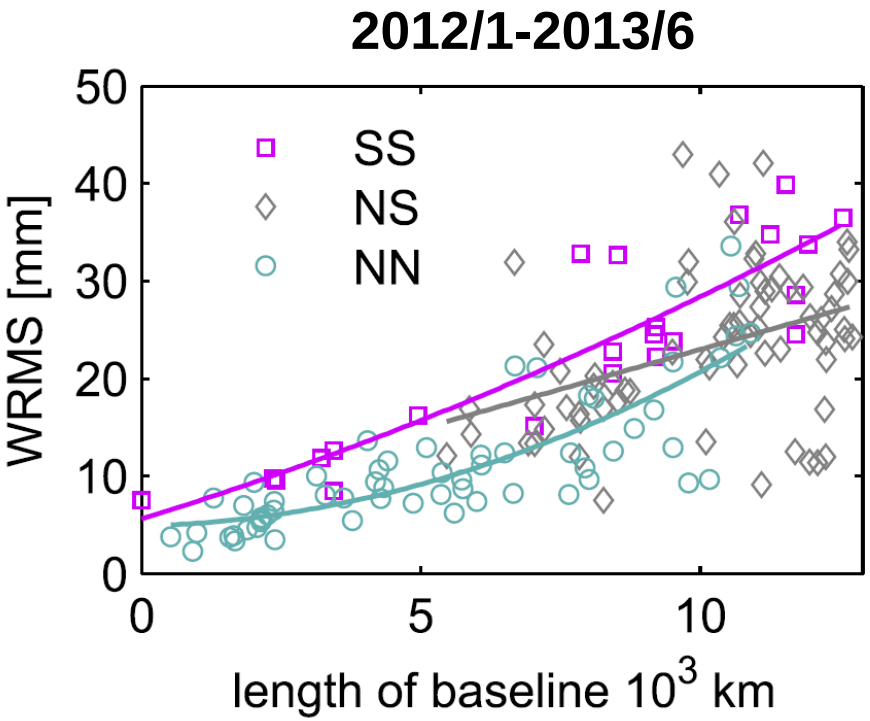


- AuScope VLBI network with the busiest geodetic antennas worldwide (235 experiments in 2015)
- All sites remotely operated from UTAS
- 26m legacy antenna Ho
- AUSTRAL observing program
- Fully independent, from scheduling to analysis

AuScope

Better Results in the South

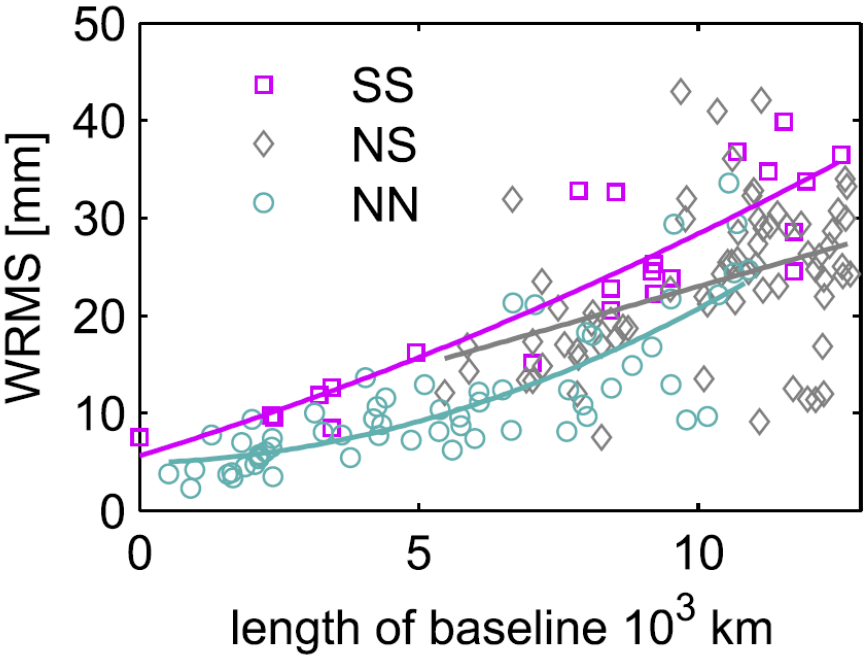
Baseline lengths from IVS R1 & R4 sessions ***[Plank et al., Adv Space Res 2015]***



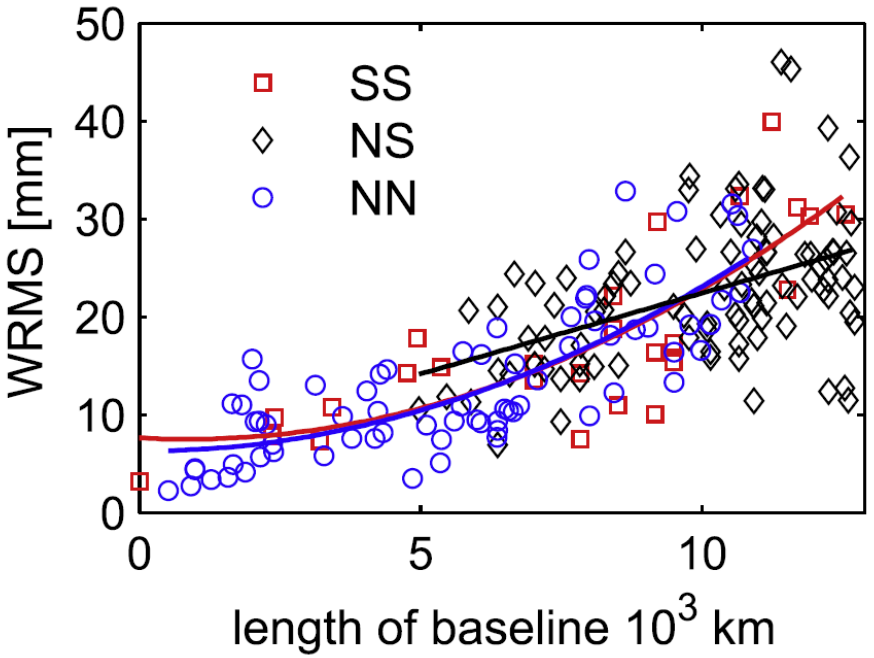
Better Results in the South

Baseline lengths from IVS R1 & R4 sessions ***[Plank et al., Adv Space Res 2015]***

2012/1-2013/6

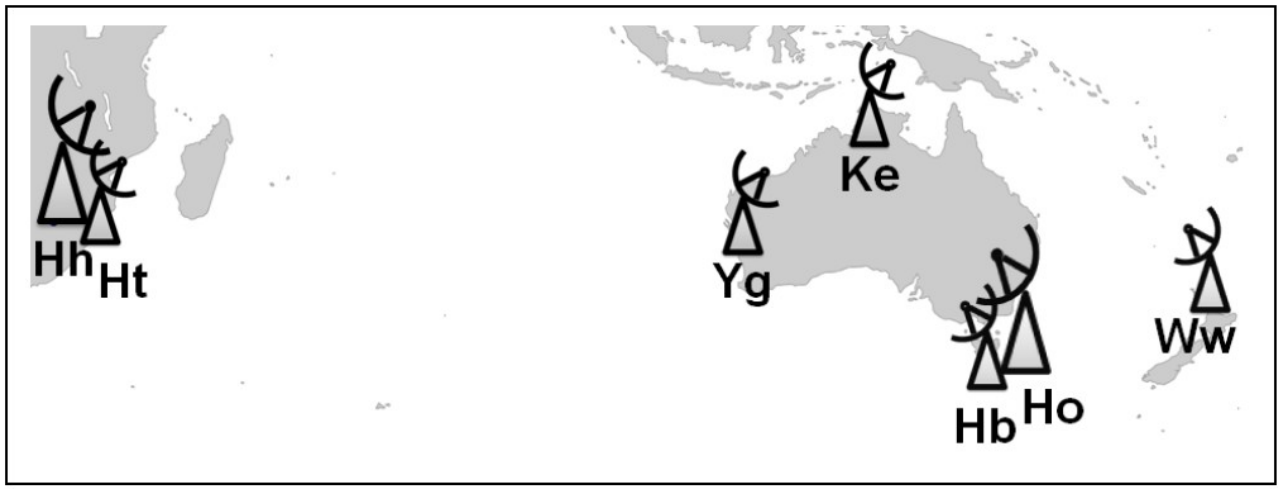


2013/7-2014/12



The addition of more southern stations has significantly improved the results!

Australs



- Experiments with the AuScope array (Hb, Ke, Yg)
  - Plus Ww, Ht, (Ho, Hh)
  - 2011-2015: Aust02-74, AUST13, AUST14, AUST15/1, AUST15/2, AUG001-019, AUA001-008 ⇨ 160 sessions
- Scheduling @ Vienna University of Technology
- 1 Gbps recording
- Correlation @ Curtin University (@ SHAO in 2016)
- Pre-analysis @ UTAS (fringe-fitting, Level1 DB)

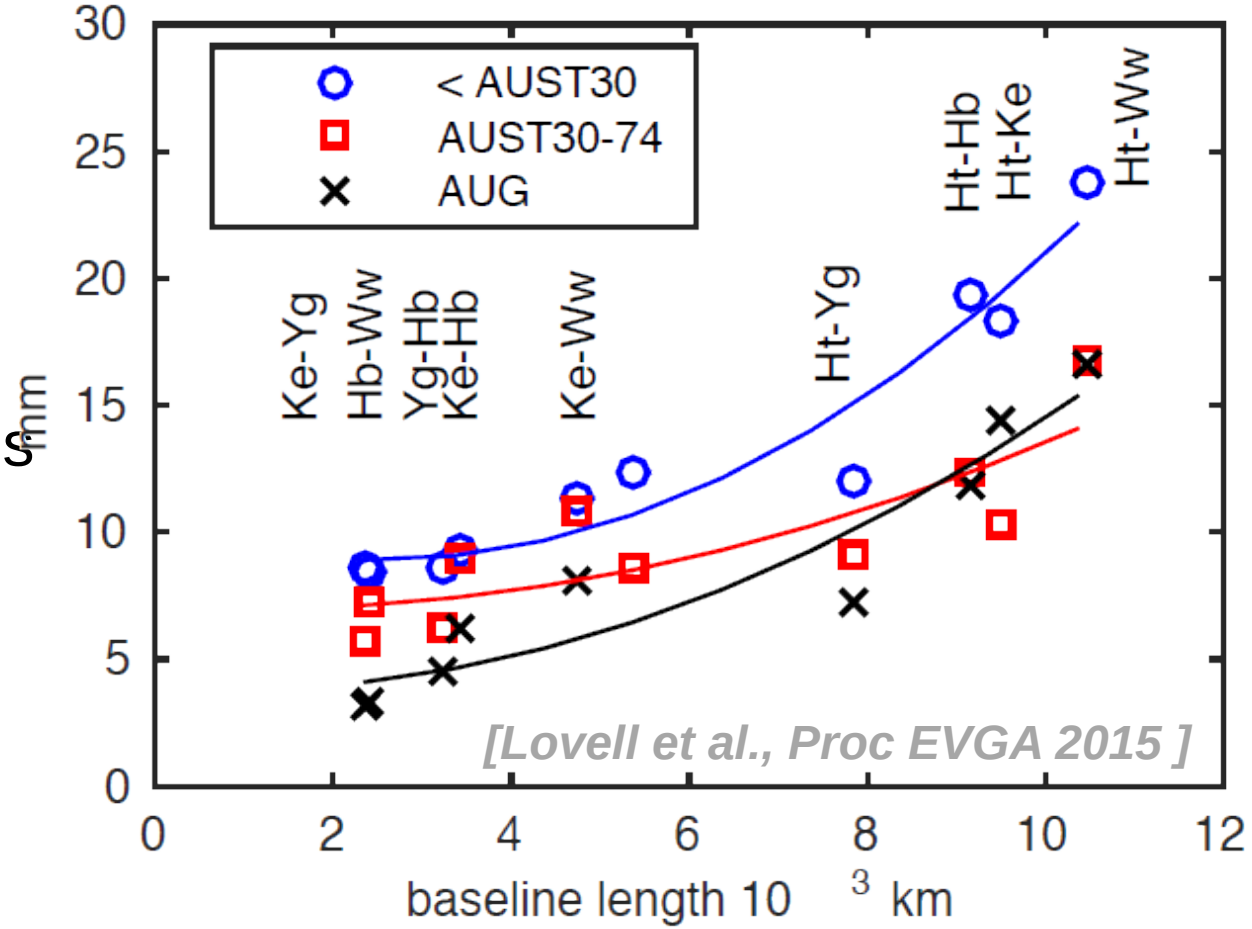
Australs: Science

- Pre-VGOS observing
  - High recording rate, small and fast antennas
  - Remote operations, towards 24/7
  - VGOS operation; FS modifications
  - Data logistics (shipping + e-transfer)
- Scheduling
- Geodesy: improved baselines
- Astrometry: new sources, more sources
- Relativity
- Siblings (Hb+Ho, Ht+Hh) Lucia's talk

Scheduling

Results show a factor of ~2 improvement in baseline wrms.

- 1 Gbps (16x16 MHz IFs and 2-bit digitisation)
- 2 sub-networks
- Only strong sources (>0.8 Jy) – VieVS simulations
- Latest antenna SEFD levels
- 20” min. scan lengths
- Shorten ‘calibration time’

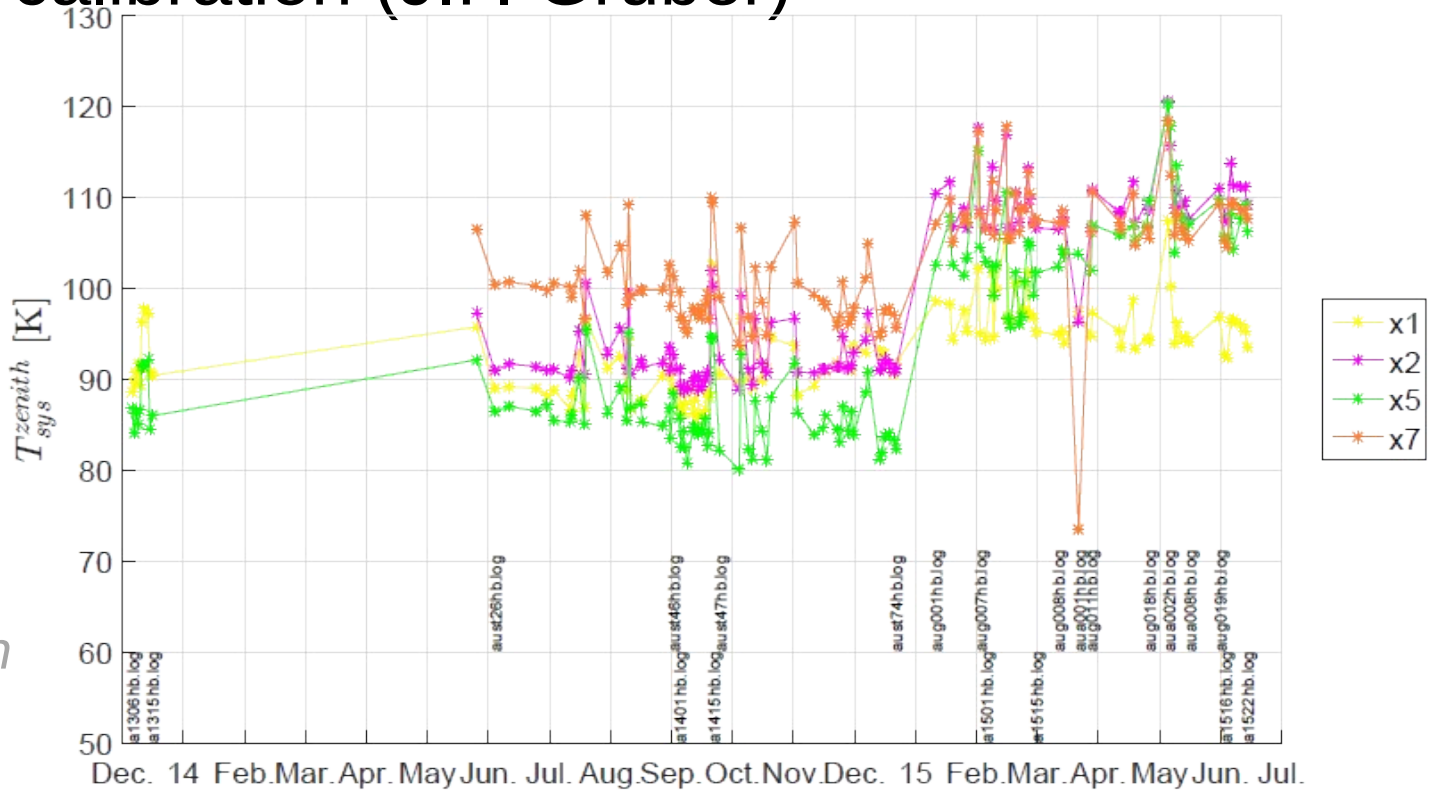


Remote Operations

- All sites remotely operated from the UTAS observing room
- e-remote control (A. Neidhardt, Wettzell)
- MoniCA for system logging
- Ke:
  - Limited local support, no on-site technical staff
  - 20 Mbps network
- Yg:
  - Co-located with SLR
  - 1 Mbps

Data Galore

- Continuous logging of system though MoniCA
- We have plenty of data which can now be studied
- E.g. Tsys calibration (J.F. Gruber)



X-band Tsys measurements of Hobart12 during the Austral experiments: jump coincides with recabelling event.

Data Galore

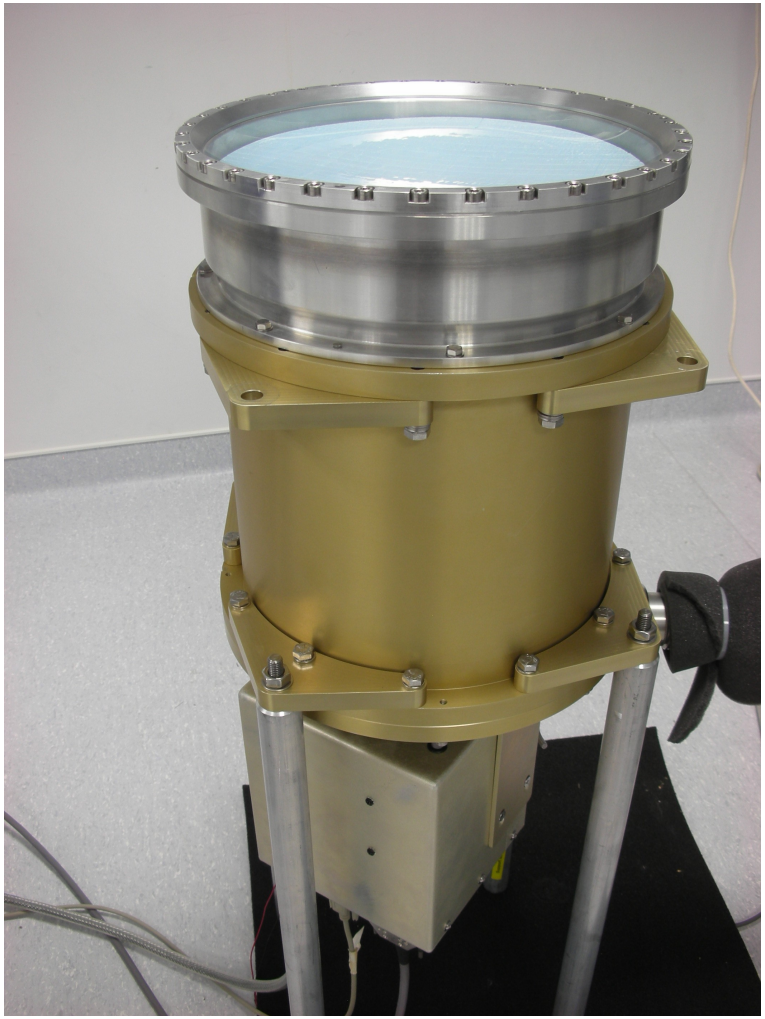
- Austral experiments generated ~5-10 TB per station per day.
- Modules shipped from remote sites to Hobart for e-transfer to Curtin.
- Also R1s to Bonn, R4 to Washington, LBA to Curtin...
- Peak data rate out of Mt. Pleasant in 2015 was ~6 Gbps, rarely less than ~200 Mbps.
- Using tsunami, gridFTP, m5copy
- Access to PB-scale data store and ~200 TB of local RAID space.
- Some in-house correlation too (AuScope-only Australs, imaging experiments with Ho & Cd, Wark30m fringe tests).

AuScope towards VGOS

- Telescopes are “fast” (5 deg/s in Az, 1.5 deg/s) in El. S/X feeds were intended as an interim measure
- Upgrade to cryogenic broadband feeds and broadband backend systems for all three telescopes funded for 2016.
- Prototype cryogenic feed under testing at the moment. (Callisto)
- Cryogenically cooled (Stirling Cycle) broadband receiver (2.3-14 GHz) with noise, phase and delay calibration systems
- RF over Fibre/Downconverter
- DBBC3 in Hobart now
- Flexbuff recorder ready for use.
- Correlation facilities able to handle high data volumes for testing.

Wideband Backend

- Design chosen is a QRFH being developed by Callisto.
- Frequency range ~2-14 GHz
- Cryogenically cooled, but using Stirling cycle cryogenics (~70K) rather than typical He-system (20K).



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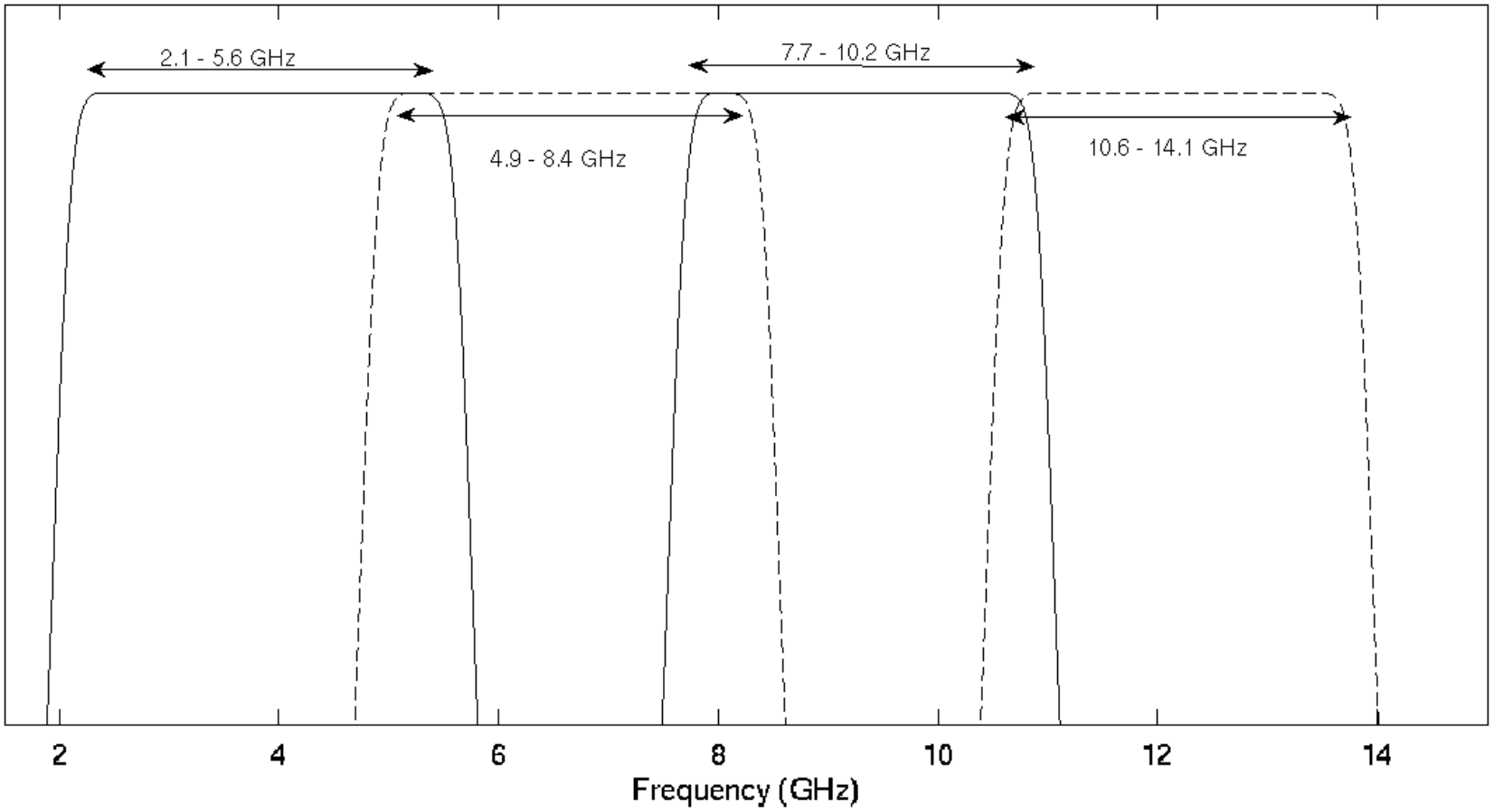
Downconversion

- Analogue downconverter built to enable use of wideband feed with existing DBBCs



Flexbuff

- Built and installed November 2014
- Dual Xeon processor, 64 GB RAM, 36 drives (currently 4 TB each)
- Two 28 TB RAID-5 arrays, remaining disks for VBS recordings.
- 4x 10 GbE interfaces

Flexbuff

- Successfully recorded a month of AUSTRAL experiments (1Gbps) with no issues.
- Also used in astronomical observations with Australian LBA (256/512/1024 Mbps)
- 10 Gbps link to University of Tasmania and data allocation on a shared PB-scale data store.
- 10 Gbps link to the observatories correlation cluster (Hex).
- Also has external SAS capabilities for use with mark6 modules but this has not been tested.

Dynamic (VGOS) Observing

- In today's IVS observations, we usually lose 10-20% of the planned observations (station loss, bad sources, data failure) we can do better!
- Schedules are made like 30 years ago, typically 1-2 weeks in advance.
- *Question: can we improve operations by dealing better with actual conditions?*
- Real-time correlation, source monitoring, antenna performance monitoring…
- Pooled resources: telescopes, operations, correlation

Future Work

- AuScope array upgraded to wideband, high data rate capable.
- Within the AOV:
  - AUSTRALs with 2 Gpbs using current systems (DBBC-2)
  - Fringe test and full operations with broadband systems in Japan (and China)
  - Real time observations between Hb and Ww (10 Gbps link)
  - Sibling telescopes and local tie investigations
- Use current AUSTRAL dataset to investigate systematic errors
- Make VGOS happen.

! LAST SLIDE !

Thank You For Your Attention!