ATUC Parkes Update *and* Forward Planning

ATUC

Jimi Green | 22nd April 2020

Overview

Parkes Update

- Recent maintenance
- Contract time update
- Documentation & UWL training
- The 2019-2020 heat stows

Forward Planning for Parkes

- The science case
- The ‘new’ receivers (UWL, CRYO-PAF, UWM-H)
- The ‘legacy’ receivers (coverage, demand, status, proposal)

ATUC Parkes Update

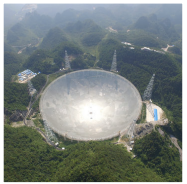
Maintenance Activities

- The Jacks are Back!
- No major shutdowns since last ATUC (2019OCT & 2020APR)
- Planned 2-week maintenance shutdown for telescope drives work in 2020OCT semester

Contracted Time

Breakthrough Listen

- Galactic plane survey completed
- Masters student has analysed pulsar data
- Detected commensal FRB
- Commensed UWL observations
- Potential work on flare stars
- *Asteroid (514107) 2015 BZ_{509} Price et al. 2019*
- *Fast Radio Burst with frequency-dependent polarization Price et al. 2019*
- *Wide-bandwidth digital instrumentation for the CSIRO Parkes 64-m telescope Price et al. 2018*
- ~850 hrs per semester now (has varied between semesters)



FAST/NAOC

- To date, have confirmed 28 of FAST's 157 pulsar candidates (106 of which are visible from Parkes).
- 26 of the confirmed pulsars are now the subject of a long term timing and deep-study campaign.
- UWL used for ~15 confirmations so far, primary receiver used for time
- First major science paper submitted (for first 11 pulsars)
- ~450 hrs per semester across 3 years (~1830hrs to date), current semester ~200 hrs

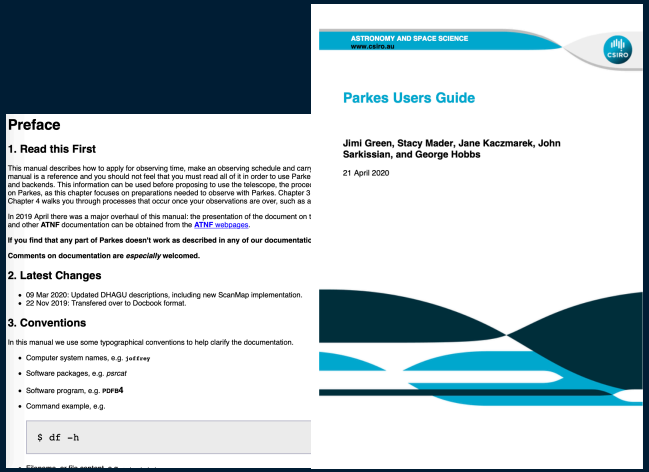
Tracking Proposal Time

	2018 APR	2018 OCT	2019 APR	2019 OCT	2020 APR
Contract	BL+FAST (1220 hrs)	BL+FAST+NASA (1535hrs)	BL+FAST (1472hrs)	BL+FAST (1307hrs)	BL+FAST (1055hrs)
Other	(180 hrs UWL[1])	(213hrs UWL[1])	(87hrs UWL[1])	(153hrs UWL[1])	(137hrs UWL[1])
# Proposals[2]	33 (3400hrs)	36 (2750hrs)	35 (2180hrs)	33 (1902 hrs)	50 (3133 hrs)
Cutoff grade	3.7	3.4	3.0	3.0	3.6
Projects 90-100%	8	20*	21	22	26
Projects 40-90%	7	7	8	3	10
Projects <40%	1	4	0	2	4
Projects 0%	17	5	2	5	8
NAPAs	3	2	2	2	2
Student PI success	50%	69%	100%	71%	67%

[1]This is P960 and P737 project time
[2]This doesn't include P960, P737, PX500/501

Documentation & Training

- Revised users guide
  - Now UWL specific
  - Matches format of ATCA users guide (Docbooks)
  - Being updated regularly (& feedback/requests always welcome)
- Updated links on webpages
  - Addition of Clock Files access



[2019 Oct ATUC Report item 9 a)]

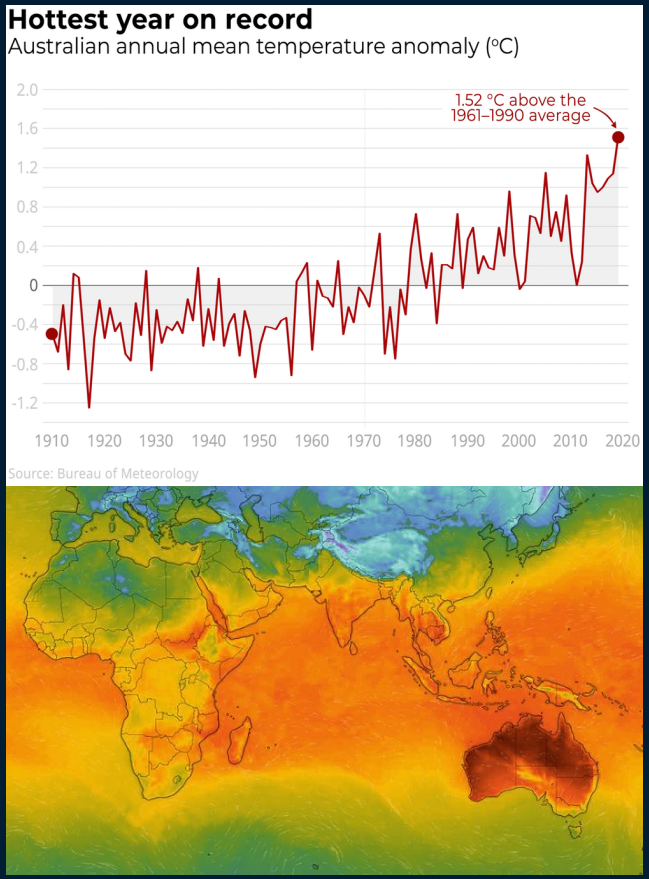
Documentation & Training

- UWL Observer Training Sessions
  - 3 sessions: 13th, 16th and 19th March
  - Perth, virtual Melbourne, virtual Sydney
  - ~50 participants across sessions
  - Experienced users seeking refresher and new users
  - Training checklist under development

[2019 Oct ATUC Report item 9 a) d)]

Heat stows and impact

- Australian Summer 2019-2020 particularly hot and challenging
  - Compressor room struggled to cope, necessitating limited azimuth observing and ‘heat stows’
  - Time made up where possible in 2020APR semester



COVID-19

- No significant impact to observing procedure (as fully remote anyway)
  - Reduced in person training sessions
- Minor delay to UWL reinstallation through mitigating travel and social distancing (avoiding staff travel, although wind and fog also contributed!)

Forward Planning

Revised Science Case 2020-2030

New science case under development

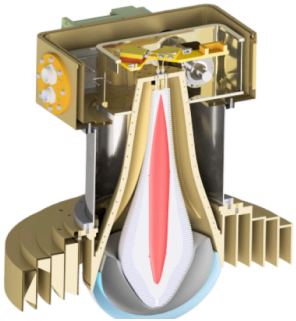
~10 page document to describe

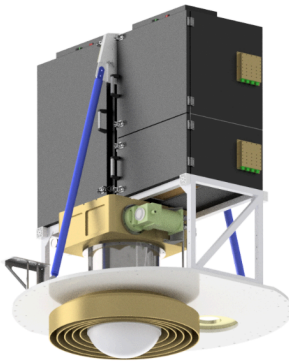
Connected to Cryo-PAF science case, UWMH case and recent Parkes Pulsar workshop

Accurate fluences of FRBs	Wideband pulsar studies	ASKAP single dish complement	Intensity mapping of neutral universe	Spacecraft Tracking / Bistatic Radar	Multi-transition molecular line studies	LBA science

The ‘new’ receivers and where we stand

Ultra-Wideband-Low ‘UWL’

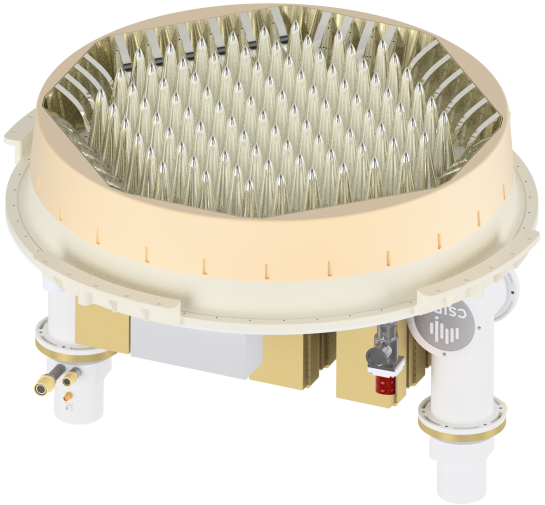




- 700MHz - 4 GHz, ~20 K System Temperature, Linear polarization feeds, Digitisation at focus
- LIEF grant was for $0.7m
- Publications flowing
- Developments:
  - Commensal observing modes
  - Scanning
- Future Developments:
  - RFI mitigation tools (adaptive RFI mitigation, impulsive RFI mitigation, flag tables)
  - Oversampled filterbanks
  - Calibration schemes (pseudo-random noise etc.)
  - Dhagu additional features
  - New observing modes (e.g., fold multiple pulsars simultaneously)
  - Improved PSRCAT
  - new “window on the front of the UWL” for Tsys improvement
  - SDHDF processing software

[2019 Oct ATUC Report item 9 b)]

Cryogenically Cooled Phased Array Feed



Funded and design underway

- 700 MHz - 1800 MHz
- ~20 K System Temperature
- ~3 x Multibeam footprint with Nyquist sampling
- Combined 10-30 fold survey speed increase
- Approximately ~A$3.5m (inc 3 FTE effort), plus further ~ 4 FTE in-kind and R&D costs
  - LIEF successful $1.15M
  - Backend additional costing
- Prototyping underway
  - Structural Thermal Model complete
  - Prototype RFSoC board out for assembly

Ultra-Wideband-Mid/High ‘UWM/H’

Seeking funding

- 4 GHz - ~25 GHz
- ~20 K System Temperature
- Linear polarization feeds
- Digitisation at focus – shares digitisers and backend infrastructure with UWL
- Essentially ‘just’ the frontend – frontend, RF electronics and conversion required
- Approximately A$1.7m (inc 5 FTE effort)
- Single feed for entire range would have sub-optimal feed illumination – engineering preference is for 2 feeds, ~4-18GHz, ~18-32 GHz
  - ATUC feedback on this split?

UWM-H in detail

- Funding
  - Could submit ARC LIEF 2021 application – requires lead university
- Timeline
  - LIEF would require science case and collaboration initiated Sept/Oct 2020
- Operational case
  - Can replace ‘Mars’, ‘old meth’, ‘K-Band’, ‘13mm’, ‘AT Multiband’ (see later)
  - Can provide year-round VLBI capability
    - Increased participation in international VLBI arrays
    - More flexibility for VLBI scheduling

UWM-H in detail continued

- Science cases for future Parkes receivers (October 2012, plus Manchester & McClure-Griffiths Dec 2013 presentations)
  - HOPS++ (Walsh et al.) – H20 and NH3
  - Single-dish ASKAP complement for Diffuse ISM (Hill et al.) – HI and OH
  - Magellanic and Extragalactic HI (Meyer, Westermeier et al.) – HI
  - Maser astrometry and polarimetry (Ellingsen, Green et al.) – OH, CH3OH
  - Continued Parkes Pulsar Timing Array (Hobbs et al.)
  - Transient searches (Bailes et al.) – wideband followups and widefield searches
  - Cosmic Particles (Bray et al.)
  - AGN Physics (Shabala et al.)
  - VLBI Astrometry (Titov et al.)

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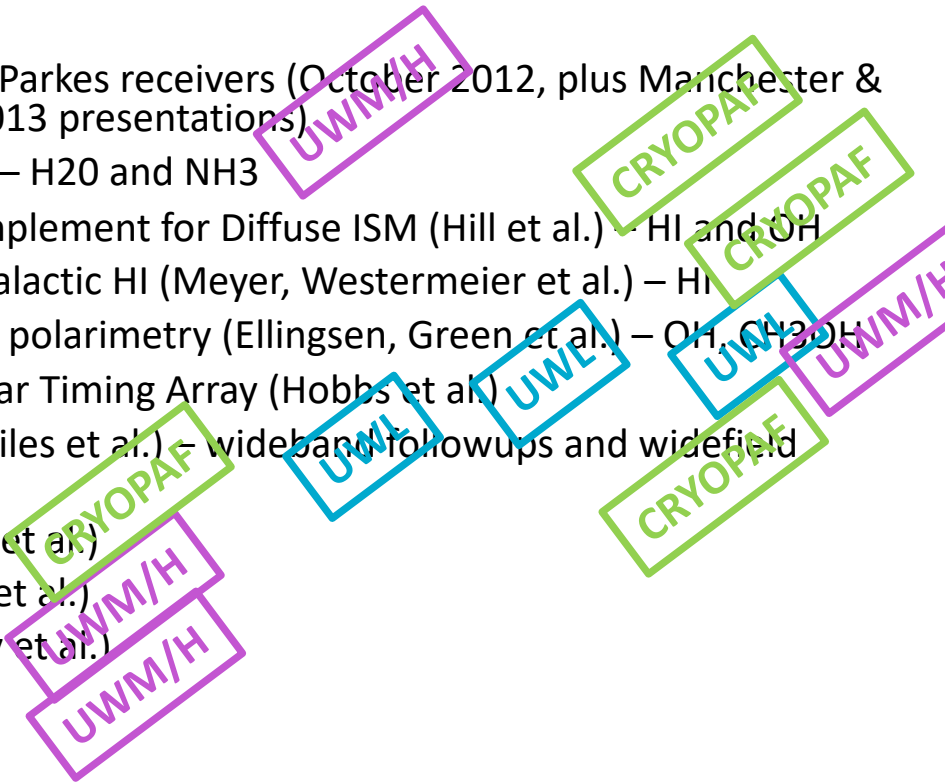
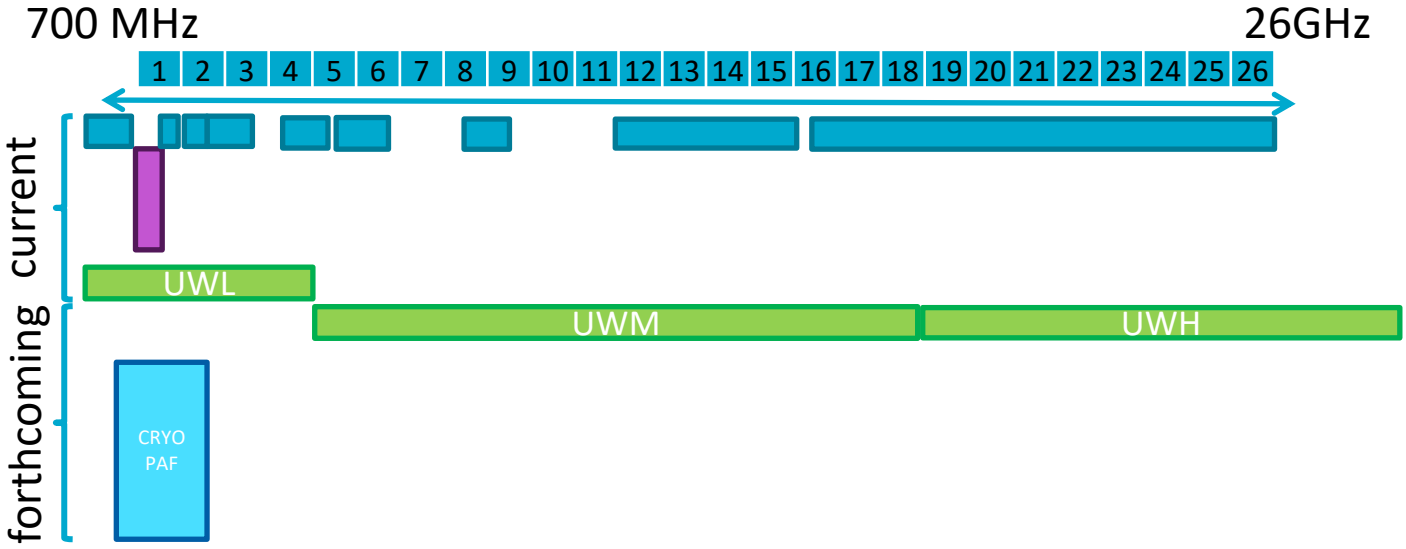


The ‘Legacy’ receivers and where we stand

Parkes Frequency Coverage and Receivers



Receiver Coverage and performance

Receiver	Freq. range (GHz)	Tsys (K)	Bandwidth (MHz)	Native Pol.
10/50	0.700-0.764/2.600-3.600	35/40	64/1000	Linear
Multibeam (13)	1.23-1.53	28	384	Linear
UWL	0.70-4.20	21	3500	Linear
H-OH	1.20-1.80	25	500	Linear
Galileo	2.15-2.27/2.20-2.50/2.29-2.30	18	120/300/10	Circular
Old Meth	5.90-6.80	55	300	Circular
Mars	8.10-8.50	25	1000	Circular
K/Ku-Band	21.00-24.00/12.00-15.00	105?/80	500	Linear
13-mm	16.00-26.00/21.00-22.30	90	1000/1000	Linear/Circular
AT Multiband (S, C, X)	2.20-2.50/4.50-5.10/8.10-8.70	80/50/120	300/500/500	Linear/$\frac{1}{2}$Circular

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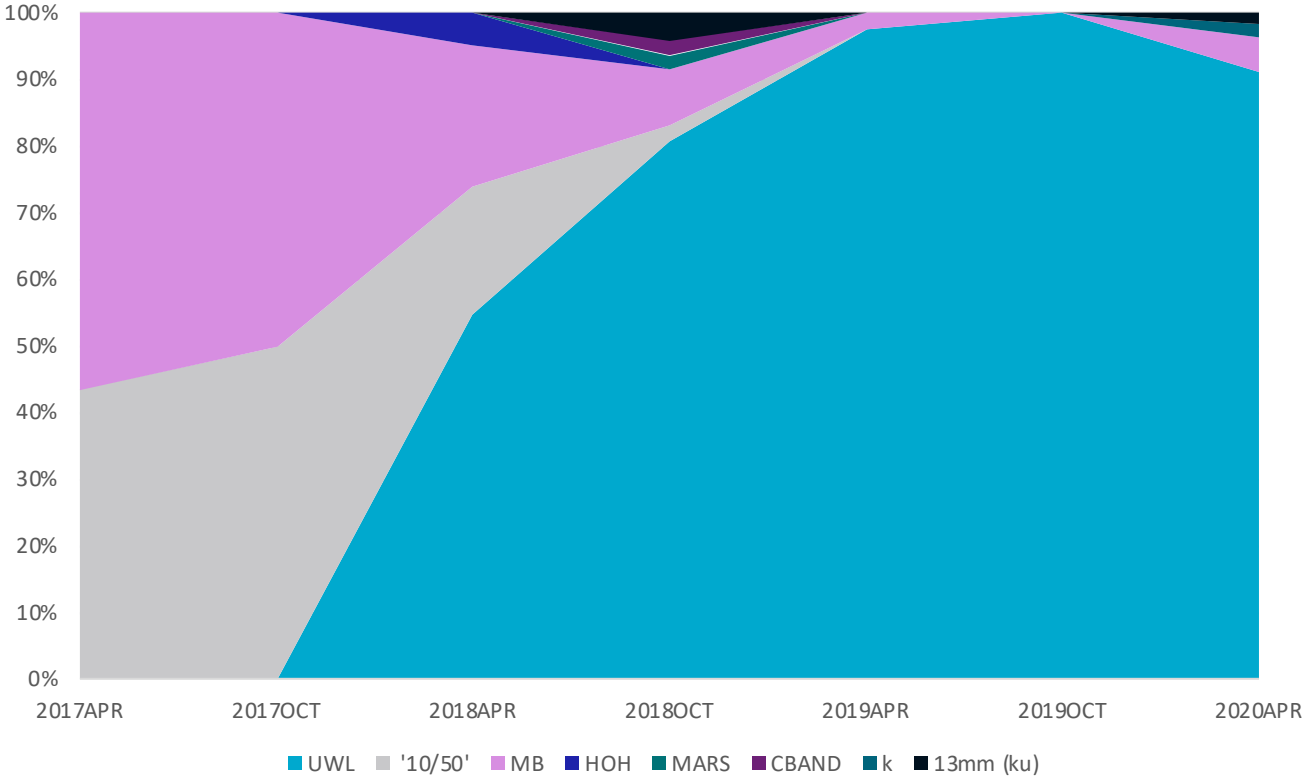
Receiver Demand



Multibeam

Status:

- Demand for receiver has dropped and is now low/minimal
  - 2019OCT semester: Used by Breakthrough Listen for Galactic Plane survey, 0 OPAL proposals
  - 2020APR semester: No longer actively used by Breakthrough Listen, 3 OPAL proposals (HI mapping – much slower but possible with UWL)

Condition:

- Beam 6, Polarisation b faulty
- (current cable equalization issue)

Question:

- retain until Cryo-PAF available

OR

- Decommission (including all cables etc) to allow for early & simplified cryo-PAF testing & commissioning
- *and* to allow for high freq. receiver installation for VLBI in interim

10/50

Status:

- UWL has replaced capability
- Only purpose would be as back up for UWL
- Not directly requested since 2018 OCTS

Condition:

- Ok

Suggestion:

- keep as back up for one more semester (OCT20 semester) then decommission and remove from fleet
- May be linked to Multibeam decommissioning (keep in reserve longer if Multibeam decommissioned).

H-OH

Status:

- UWL has replaced capability
- Only 2 proposals have requested since 2016 (in 2018APRS)
- (significant weight to receiver 40-60kg)

Condition:

- Ok

Suggestion:

- decommission & remove from receiver fleet

Galileo

Status:

- UWL has replaced frequency capability
- Native circular polarization ideal for space craft tracking, therefore simple to use (circular polarization conversion needed post sampling for UWL to replicate)
- Not requested directly (>4yrs)
- (significant weight to receiver 40-60kg)

Condition:

- Ok.

Suggestion:

- retain for potential space craft tracking (if native circular polarization strictly required) and only decommission & remove from receiver fleet once UWL can fully replicate performance (demonstrated generation of circular polarizations*)

*Chris Phillips keen to test this

‘old meth’

Status

- Frequently requested for VLBI sessions – V255 (maser astrometry, “highly ranked for many years”)
- HSE issues with installation (awkward access, physical strain for frames and plates)
- Site staff not prepared to reinstall in current state
- Not requested directly (>4yrs)

Condition:

- Sub-optimal performance

Suggestion

- Either needs resources (potentially redirected from UWMH) to re-work package (estimate needed) to meet HSE needs
- Is installed once/few times with assistance from Marsfield staff in place of multibeam

OR

- decommission and remove from fleet

Mars

Status

- Frequently requested for VLBI sessions
- Potential space craft tracking use (used for ~900 hrs voyager tracking in 2018 OCTS)
- 1 direct request in last 4 years (2018OCT)

Condition

- Note no LNA on/off control

Suggestion

- Retain in fleet until a UWH has been commissioned and in National Facility use.

K/Ku-band

Status

- 1 direct request in last 4 years (2020APR, but possibility to shift to ATCA proposal), otherwise 2015 Chiral molecule observation
- K/Ku Band receiver has integral feeds, similar to Mars and 13mm. Has basic monitoring via Datasets.

Condition

- KU: LNA response quite impacted < 12.6 GHz
- K: superseded by 13MM

Suggestion

- decommission and remove from fleet

13mm (Ku-band)

Status

- Frequently requested for VLBI sessions
- 3 requests in last 4 years (one proposal in 2020APR, 2 unscheduled ones in 2018OCTS)

Condition

- ok

Suggestion

- Keep in service for VLBI

‘Multiband’ S/X, C

Status:

- Occasionally requested for VLBI, not anymore for standard astronomy (1 in 2018OCT)
- Interest from USNO in S/X
- HSE issues with installation (awkward access, physical strain for frames and plates)
- Site staff not prepared to reinstall in current state

Condition:

- C-band, B polarization – suboptimal

Suggestion:

- Either needs resources (potentially redirected from UWMH) to re-work package to meet HSE needs and fix up issues

OR

- decommission and remove from fleet

Summary of Receivers: Potential Proposal

Remove (permanently) multibeam after current semester (2020APR)

Install pair of high frequency receivers in place (old meth and 13mm/S/X?)

Remove once cryo-PAF ready for testing (prioritise cryo-PAF)

Decommission H-OH, 10/50, K and multiband (subject to left) after 2020OCT semester

Keep Mars & Galileo in reserve until capability replicated with wideband receivers.

- Prioritises Cryo-PAF installation in order to achieve most efficient commissioning
- Provides provision for LBA and potential spacecraft tracking opportunities
- Minimizes receiver changes, strongly preferred by staff, noting also UWL installation has its own challenges
- Pair of receivers on multibeam pan does have focus limitations for one of the pair.

Legacy Down Conversion

Maintaining the legacy down conversion contingent on the decisions of the legacy receiver fleet and the use of the UWL with the DFB4 backend (Still required for high frequency receivers through to medusa as well currently)

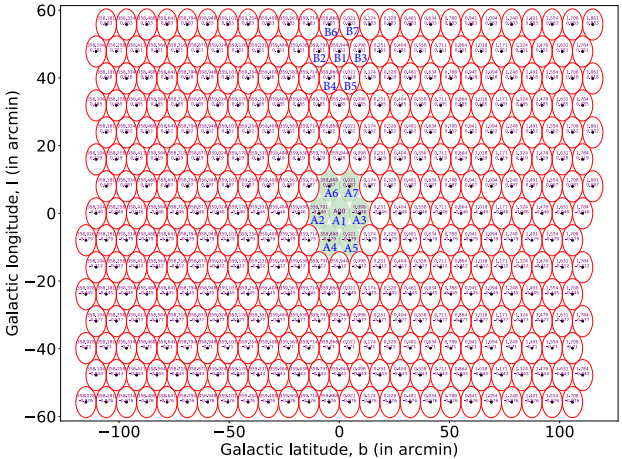
Will be required if Mars and Galileo receivers are kept in service for spacecraft tracking.

Costing: ~1 FTE for 1 week maintenance per annum, minimal/negligible power cost per annum (~3600kWh).

[2019 Oct ATUC Report item 9 c)]

Breakthrough Listen Community Project (PX600)

- 2 x 4 degree region around GC
  - Beam size = 9' (corresponding to the centre of the UWL band).
  - Number of pointings = 375
  - on-source / off-source = 30 min (3 x 10 min scans) / 30 min (3 x 10 min scans)
- Deep Survey
  - Full region: 30' x 30' (Lowest frequency of UWL band)
  - Number of pointings: 7 (A1 to A7)
  - On-source time per pointing = 24 hours (several 3 to 4 hours long scans every week to scrutinize intermittency).
- Data to be flowed to DAP as PX600



BREAKTHROUGH
LISTEN

Thanks

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