

# The AUT 12 metre Telescope Characterisation and Calibration



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### Warkworth 60 km North of Auckland



elev 59 m

Eve alt 159.04 km

### **Baselines to Australia**



### Antenna

Cobham / Patriot > 12m Cassegrain Maximum Slew rates: • Azimuth =  $5 \text{ deg s}^{-1}$ • Elevation =  $1 \text{ deg s}^{-1}$ Currently equipped with dual polarisation dual frequency S/X feed





Coaxial S/X
 S band 2.1 to 2.4 GHz
 X band 8.1 to 9.1 GHz
 RCP & LCP both bands
 ¼ wave plate

> Septum OMT
 polariser X Band





### Receivers

- > Room temperature un-cooled design
- > Superheterodyne receiver (powers in 1 MHz bandwidth)



- ≈ 4000 Jy @ S Band
- ≈ 5000 Jy @ X Band
- Improvements expected; feed redesign
- Thanks to Peter McCulloch and UTAS for generous assistance with receiver development!

### **Frequency Standard**

Hydrogen Maser
 Symmetricom MMH2010

 5, 10, 100 MHz outputs
 Allan deviation
 1s 2.0E-13
 1000s 3.2E-15
 Floor 3.0E-15
 Long term drift : <2.0E-16 per day</li>

 Temperature stabilised room: currently

system holds temperature to within 2 deg C swing, working on getting this down to <1 deg.



### Data Recorder

### > Haystack MIT Mk 5 B+



## Digitiser

DBBC (HAT Lab INAF/IRA)
Ordered, delivery expected March 2010
Geodetic configuration

4 channel recording
2 x 1 GHz @ X band
2 x 500 MHz @ S band

## Primary surface alignment

Surface alignment conducted by extensive Photogrammetric testing; rms  $\approx 0.35$  mm > Plan RF holography on surface in future to confirm the Photogrammetry results and further refine if possible





El = 10 deg

rms = 0.0148"



El = 50 deg

#### rms = 0.0142"



El = 88 deg

#### rms = 0.0145"



El = 10 deg

rms = 0.0148"



El = 50 deg

#### rms = 0.0142"



El = 88 deg

#### rms = 0.0145"

#### 10 Deg Elevation, surface deviations in mm



### Pointing models and calibration

> Work in progress> S band observations



#### Nine term pointing model built into control system

dXEl = p1 + p2\*cos(E) + p3\*sin(E) + p4\*sin(E).\*cos(A) + p5\*sin(E).\*sin(A)

dEl = -p4\*sin(A) + p5\*cos(A) + p7 + p8\*cos(E) + p9\*cot(E)

#### Least squares fit of model and X band data to 25 measurements

p1 p2 p3 p4 p5	0.1218 -0.4861 -0.0576 0.1266 -0.0254	Az encoder offset
p7 p8	0.5119 0.0586	Elevation encoder offset
p9	-	
0.0173		
dAfit_error = 0.0328 dEfit_error =	0.0344	
	515511	

Have not combined S + X measurements due to S band beam squint



### S Band squint

 > Detected offset of S band beams relative to X band
 > Elevation offsets dominate
 > S band RCP ≈ -0.15 deg. LCP ≈ +0.07 deg.
 > No detectable offset X<sub>RCP</sub> to X<sub>LCP</sub>

### **RFI** situation

#### Initial RFI measurements (thank you to staff of ATNF for assistance)



I problem identified in S band subsequent to antenna construction

- 2.11 GHz; Vodafone NZ inter cell site data link #@\$!!!
- Notch filter to suppress
- X Band clean

### Site plans and detail











### Network connectivity

- Expect 1 Gbps connectivity to KAREN March 2010
- KAREN = Kiwi Academic Research Network
  - 10 Gbps backbone
  - 155 Mbps connection to Australia
  - 625 Mbps connection to Seattle

## Control System interface

Manufacturer supplied simple HMI program

POWER/STATUS COORD SYS AZ/EL LOAD TRACK SETTINGS DIAGNOSTICS COMMS CURRENT POSITION				
STOP STOW	9.9972 88.0001			
POSITION AZ 90 EL 45	POS ERROR POS ERROR			
VELOCITY SETPOINTS (deg/sec) AZ 0.0000 EL 0.0000	CURRENT VIRTUAL AXES VALUES			
TRACK Tracking in EQUATORIAL COORDINATES	57.8480 5.1733			
	RA 83.6300 DEC 22.0200			
AZ START TURN  -1  BA/DEC SETPOINTS  RA 83.63 DEC 22.02  RA/DEC OFFSETS	CURRENT TIME         MJD       Seconds         55233       16147.0         SNTP SERVER OK			
+1  AUTO  OK  RA/DEC OFFSETS  RA  0.0000 DEC  0.0000	SOFT LIMITS Azimuth Elevation LOW LOW LOW LOW HIGH HIGH HIGH			
	HARD LIMITS Azimuth Elevation			
POSITION OFFSETS (deg) POSITION ×-EL 0.0000 EL 0.0000	LOW     LOW     DISPLATOPDATE       INTERVAL ms     ENABLE       HIGH     HIGH			
VELOCITY OFFSETS (deg/sec) AZ 0.0000 EL 0.0000	MOTOR CURRENTS (% of Rated) AZIMUTH MASTER SLAVE ELEVATION 000 000 000 EXIT			

### **Development of AUT Software interface**

- Java + Modbus-TCP
- All basic control functions implemented
- Adding features to interact with data recording, system calibration and logging systems
- Probably won't use this, want to use AUSCOPE interface for compatability

2m Telescope control 222.155.256.227				لكالك	
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AzTrackStartTurn 1, N = 0	Azimuth Azimuth Slave Elevation	on Azimuth	Azimuth Slave	Elevation	
AzTrackStartTurn 2, N = 1					
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Azimuth	HIGH HIGH	HIGH HIGH			
degree minute second re-initialized		LOW	Equator	ial	
Elevation 0 0					
Day Track Point (MJD) 0 Loaded by File Array	Brake Status	Drive, Permit and Dem Azimuth	and Speed Limit Sta	itus Elevation	
Time Track Point		Drive Enabled	Drive Enabled	Drive Enabled	
Tracking Data Status Number of tracking data	Energized Energized	Dormittad		Permitted	
Total Memory is 1000	Not Energized Not Energized	Permitted	Permitted		
>=10 tracking points Number of Tracking Point	Main Brake Contact	Speed not exces	I not excess Speed not exce		
humber of free memory	Brake Released				
Number of free memory	Azimuth/Electrics Motor Status				
Check Memory Flush Track Array	Azimuth Master Motor				
	Azimuth Slave Motor			Connected	
	Elevation Mater				
	Cievation motor 7	0		Exit	

### Acknowledgements

UTAS for assistance with Receiver design
 ATNF for help with RFI investigations
 Steven Tingay for supporting development of VLBI capability in NZ