

Molonglo - Path to the Future



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Existing limitation

- Fixed Frequency 843MHz
- Narrow band 3MHz
- No Spectral data
- Data not compatible with AIPS++, Myriad
 - no progress in data processing
 - no self calibration

Technology changes

- Correlator cost decreasing
 - Moore's law
 - Newer correlator designs (FX)
- Digital beamforming practical
- Fibre optics for signal transport
- High performance A/D at low cost
- LNA developments

The Dream Machine

Parameter	1420 MHz	300 MHz
Frequency Coverage	300–1700? MHz	
Bandwidth (BW)	250 MHz	
Resolution ($\delta < -30^\circ$)	26" x 26" csc $ \delta $	123" x 123" csc $ \delta $
Imaging field of view	1.5° x 1.5° csc $ \delta $	7.7° x 7.7° csc $ \delta $
UV coverage	Fully sampled	
T_{sys}	< 50K	< 150K
System noise (1σ) 12 hr: 8 min:	11 $\mu\text{Jy}/\text{beam}$ 100 $\mu\text{Jy}/\text{beam}$	33 $\mu\text{Jy}/\text{beam}$ 300 $\mu\text{Jy}/\text{beam}$
Polarisation	Dual Linear	
Correlator	I and Q (Full Stokes at 125 MHz BW)	
Frequency resolution	120–1 kHz (FXF mode: 240 Hz)	
Independent fanbeam	1.3' x 1.5°	6.2' x 7.7°
Indep. fanbeam offset	$\pm 6^\circ$	$\pm 27^\circ$
Sky accessible in < 1 s	180 deg ²	1000 deg ²

Stage 1- Standard Processing

- Replace existing beamformer with a 88 station 6.25MS/s correlator
 - Hardware cost ~\$2000
- Wide field mapping
 - Part bay operation for 2 and 4 degree field
 - or time multiplexed pointings
- Self cal - high dynamic range
- Higher sensitivity- all info in beam used

Stage 2 - Digital System

- 50MHz BW single polarisation at 843MHz
- Use current feeds and LNAs, new IF
- Digitise at bay or half bay level (cheap)
- Filterbank ~\$50k in 18months (100MHz)
- Fibre to centre ~\$50k?
- Correlator ~\$32k
- Interference mitigation reference antenna
- Labour ???

Stage 3 - Analogue System

- All bells and whistles
- New wideband feeds and LNAs
- First level analogue beamforming
- New LO, downconversion and IF system
- Digital beamformer
 - Imaging and fanbeams
- Full complement of Filterbanks etc

The major challenges

- At 1.4GHz - 6400 dual polarisation feeds and 12800 LNAs
 - Must be low cost possibly MMIC (Dutch 47K)
- Analogue beamformer
- Low cost digital beamforming and filterbanks
 - Race between
“Window of Opportunity” and Moore’s law
- Fibre optics - need wideband VCSEL



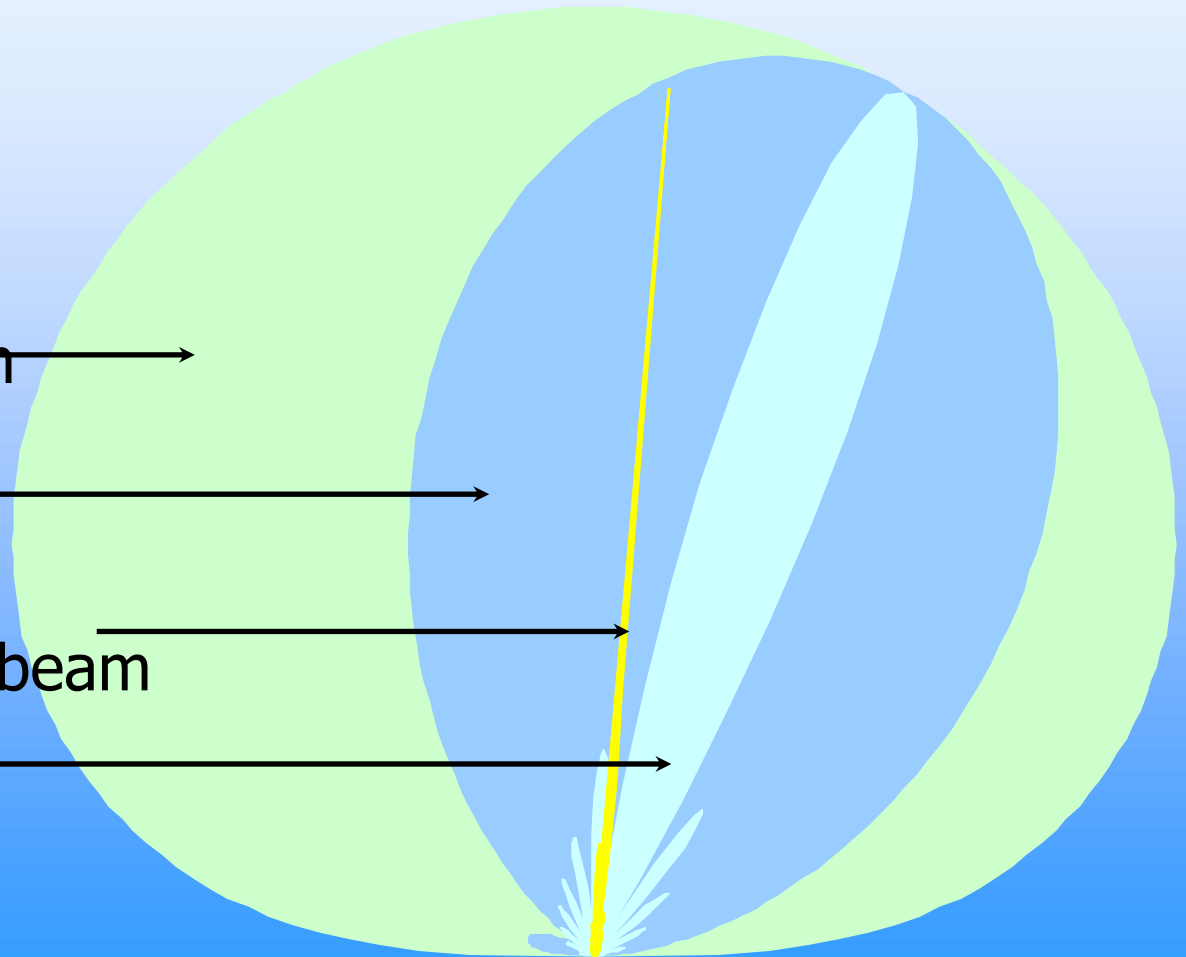
Hierarchy of beams

Single feed beam →

Delay line beam →

Independent fanbeam →

Imaging beam →



Imaging beam

- 88 half bays each about $1.5^\circ \times 1.5^\circ$ @ 1.4GHz
- FX correlator
- Digital filter bank ~1000 channels at full BW
 - Higher resolution modes
 - Reduced bandwidth ATNF design
- Cross multiply Accumulates
 - Channel reordering approach will lower cost-\$64k

Fanbeam

- Offset from imaging beam in meridian distance
 - offset 0 to 5 beamwidths
 - during 12 hours 100 square degrees @ 1.4GHz
- SETI interested in 3 fanbeam system $> 1\text{GHz}$
 - Anti-coincidence method
- Also flux monitoring and pulsars
- Tradeoff between cost and BW

Path to the Future

1. Low cost correlator upgrade (\$2k)
2. IFs, Filterbanks, Fibre and Correlator (\$200k)
 - 50MHz bandwidth @ 843MHz
 - Hardware useable in full upgrade
3. Wideband feeds, LNAs (\$2m)
Analog and Digital Beamforming
and more Filterbanks, Fibre and Correlator