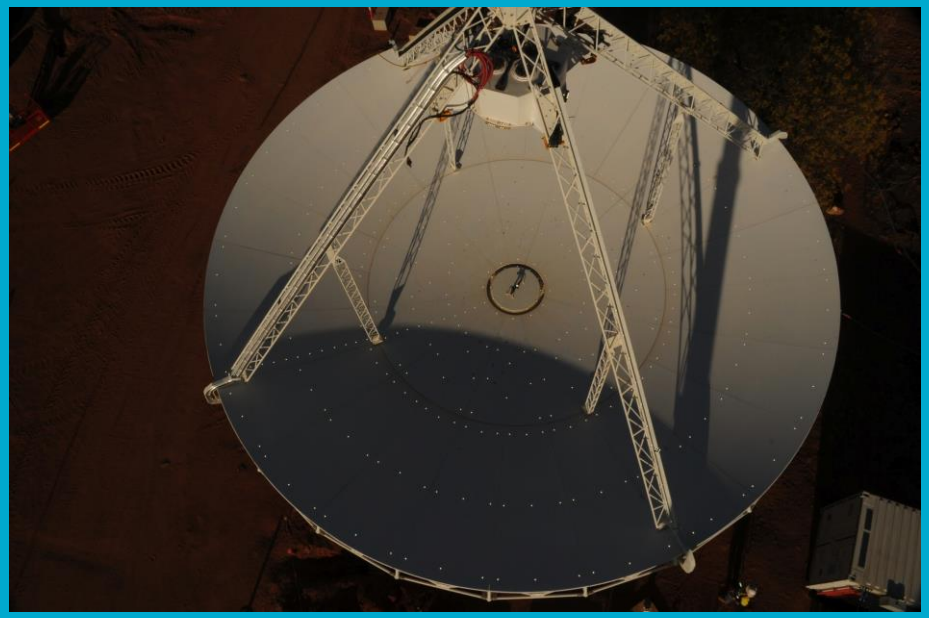


Australian Square Kilometer Array Pathfinder (ASKAP)

Timothy Shimwell

18 June 2013

Outline

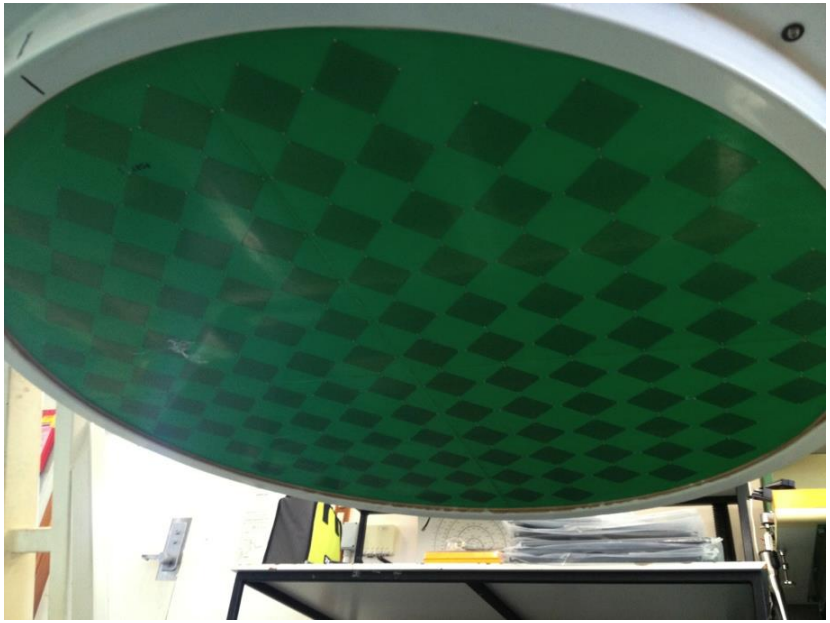
- A summary of ASKAP
- The current system
- Some commissioning tasks
- What's next

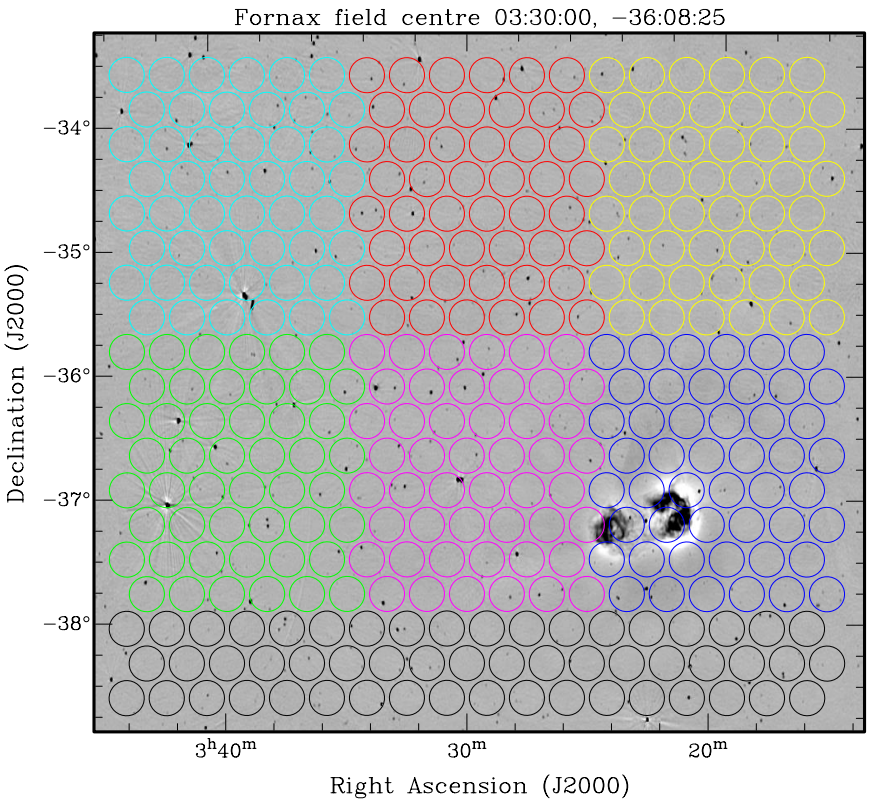
ASKAP

- Antennas: 36 parabolic 12m 3-axis prime focus dishes
- Field of view: 30 square-degrees
- Frequency range: 700-1800MHz
- Bandwidth: 304MHz
- System temperature: 50K
- Aperture efficiency: 0.8
- Natural resolution: 20”
- Channels: 16416 (18.52kHz)

ASKAP Highlights

- Deep and wide surveys
- Development of phased array technology
- Radio quiet site

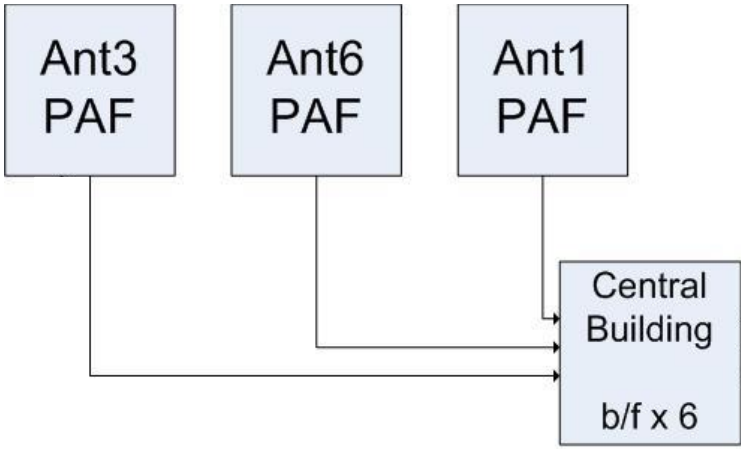




Fornax field with 342 ATCA pointings. ASKAP will cover this with a single pointing

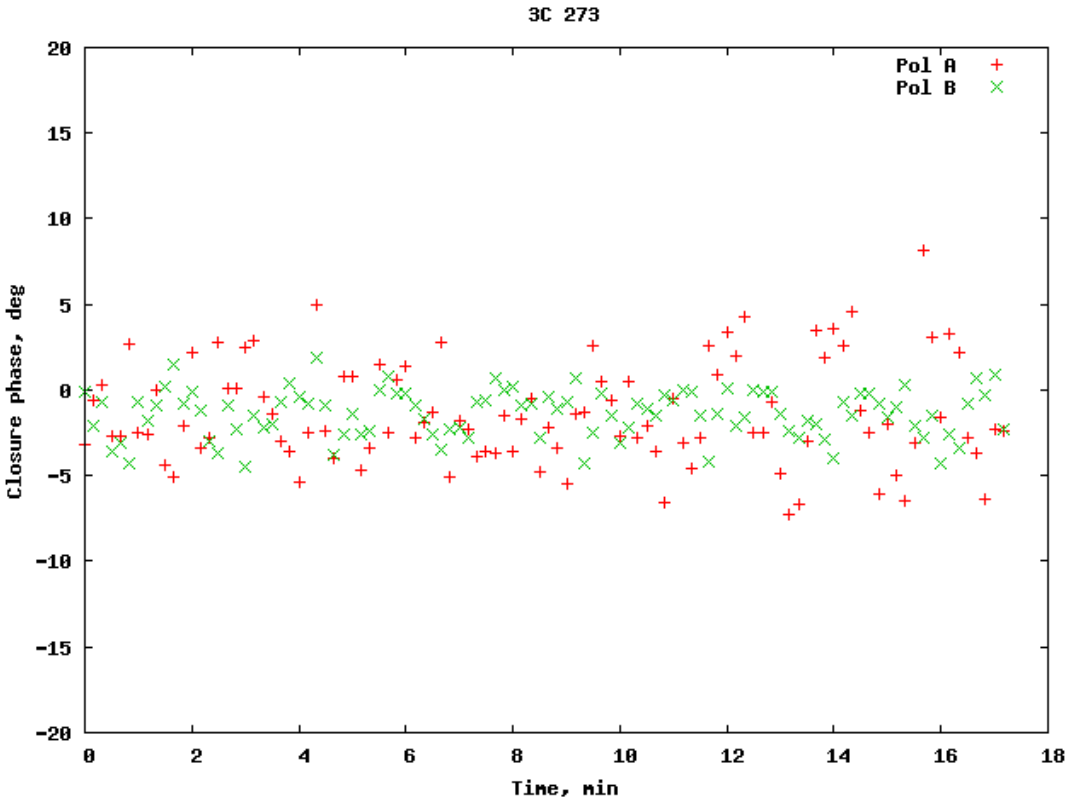
The Current Test System

- 3 antennas with first generation PAFs
- Down conversion and digitisation in antenna pedestal
- Digitised signal taken to control building on fibre optics
- Beam-formers operate on the signals from each antenna in a central location
- Software correlator (16MHz total bandwidth with 1MHz resolution)
- In-house software for imaging



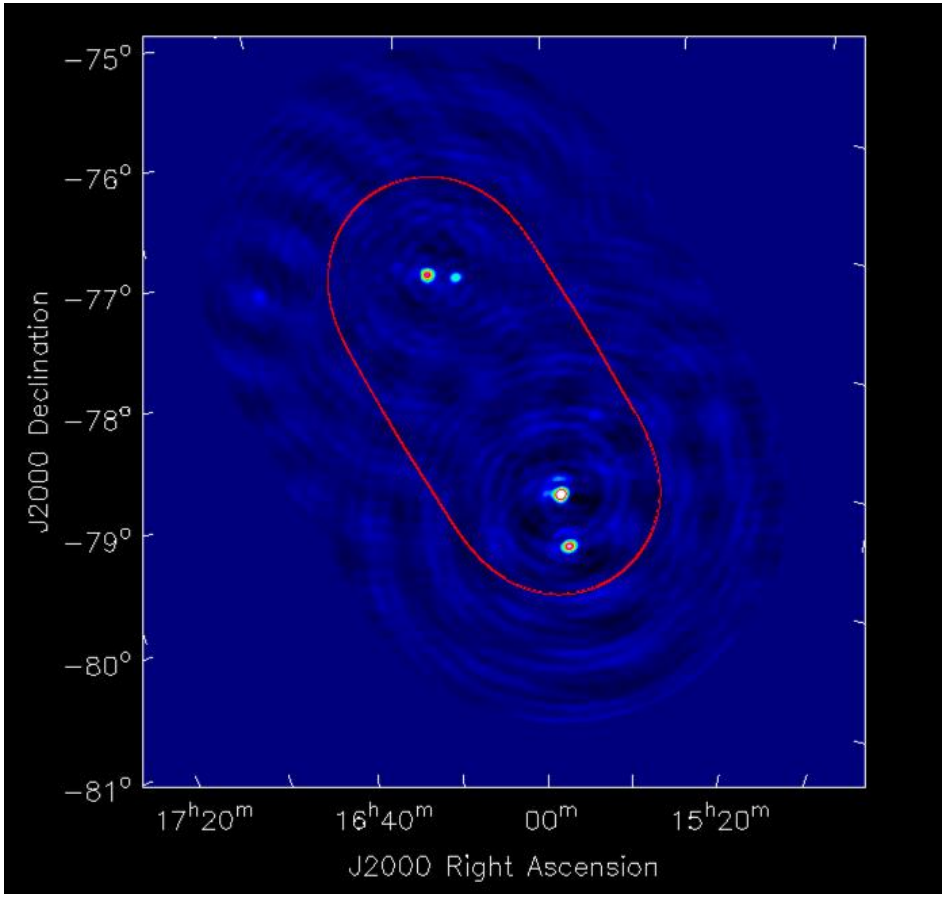
System Tests: PAF Closure Phase

- Observations of 3C273 at 880MHz with the 16MHz bandwidth provided by a software correlator
- Central PAF beam formed on 3 antennas
- World's first fringes on PAF-PAF baseline
- Closure phase obtained
- Closure phase is unaffected by phase errors at any of the antennas



System Tests: Imaging

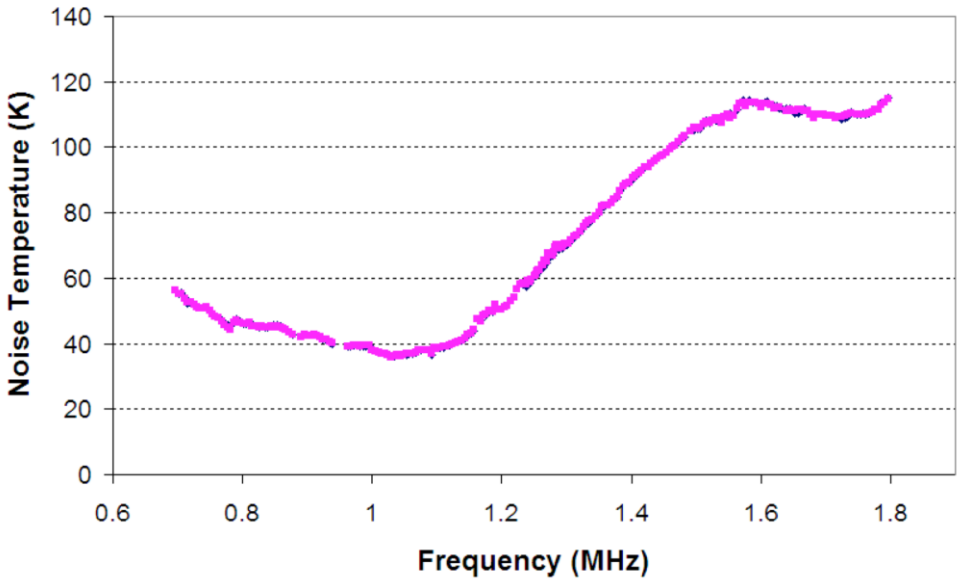
- Only 3 antennas and 16MHz bandwidth makes imaging challenging
- Single-beam and multi-beam imaging is useful test of the system
- This 3 beam image at 928MHz with a 16MHz bandwidth contains the bright sources 1637-771 (5.8Jy),1549-790 (5.4Jy), 1610-771 (3.7Jy) and 1606-772 (1.5Jy).

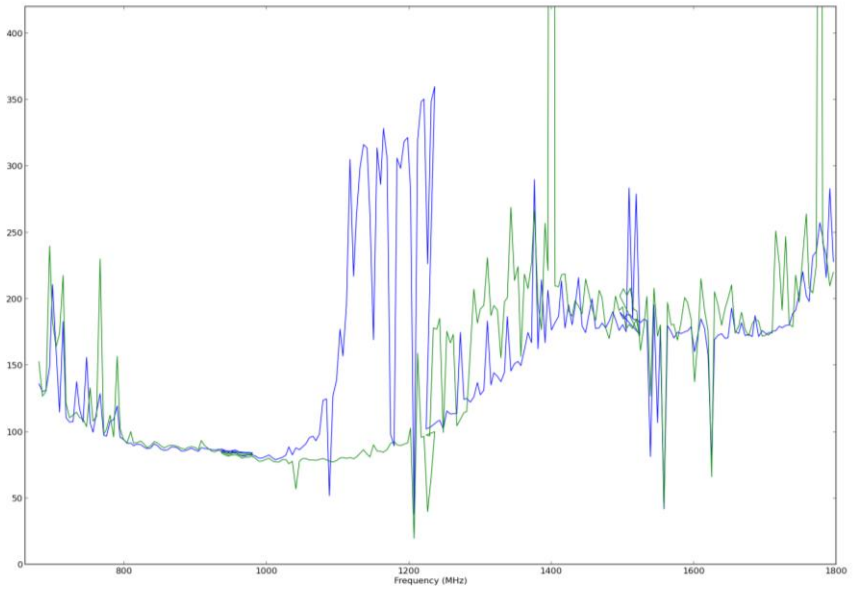


ASKAP image of the 1637-771 region

System Tests: Sensitivity of the First Generation PAFs

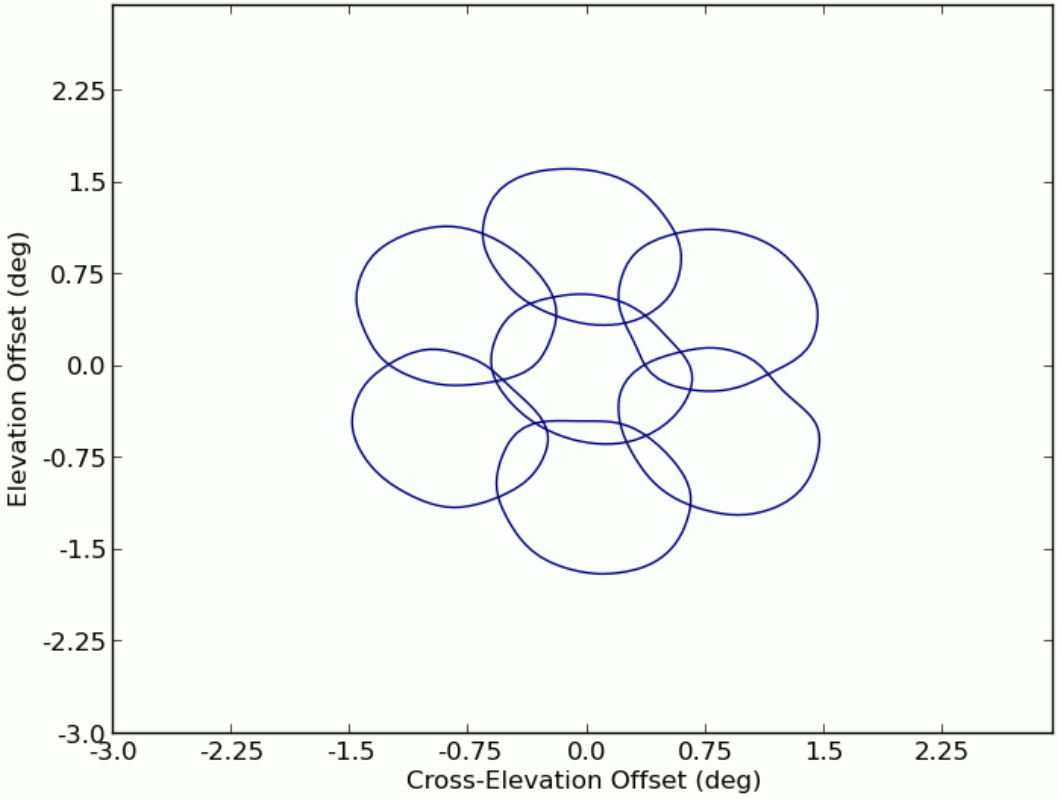
System temperature of the first generation PAF





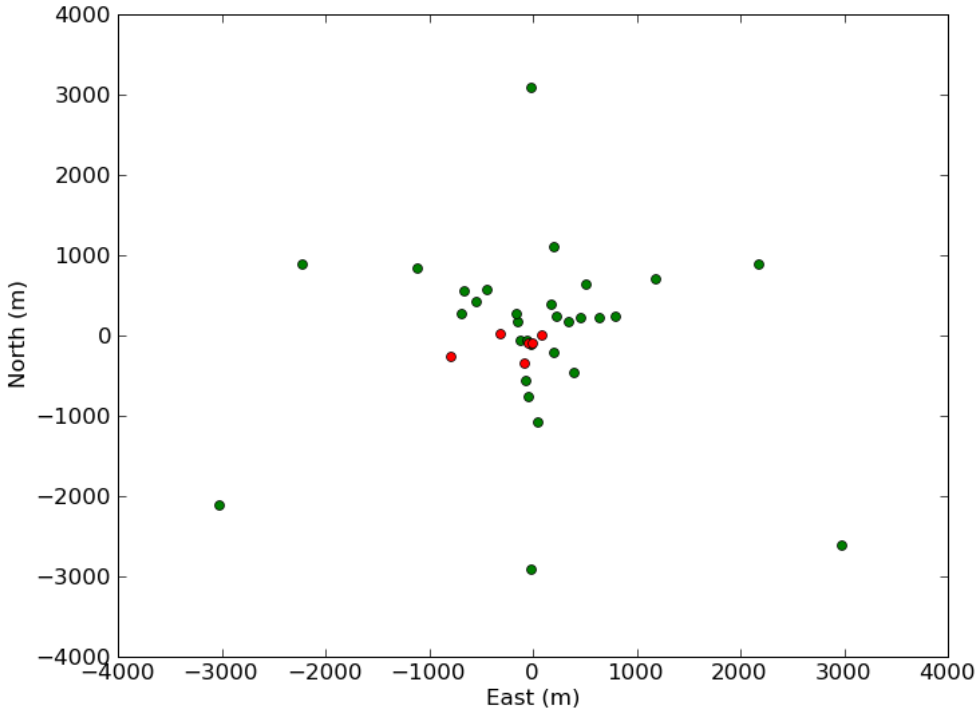
System Tests: Beam Forming

- The animation shows the FWHM of seven beams as a function of frequency.
- Beams are from 1.2-1.5GHz data and are for 1MHz channels.



Next

- Further multi beam imaging
- Integration of next 3 MkI PAFs
- Integration of hardware correlator (150MHz bandwidth with 9 beams)
- Perform simple test field observations



Science Commissioning

- Science commissioning will begin with the six antenna system and hardware correlator
- First task is the imaging of two 30 square-degree complex regions
- Comparison data obtained from 342 Australia Telescope Compact Array pointings
- Testing the ASKAP calibration and imaging pipeline

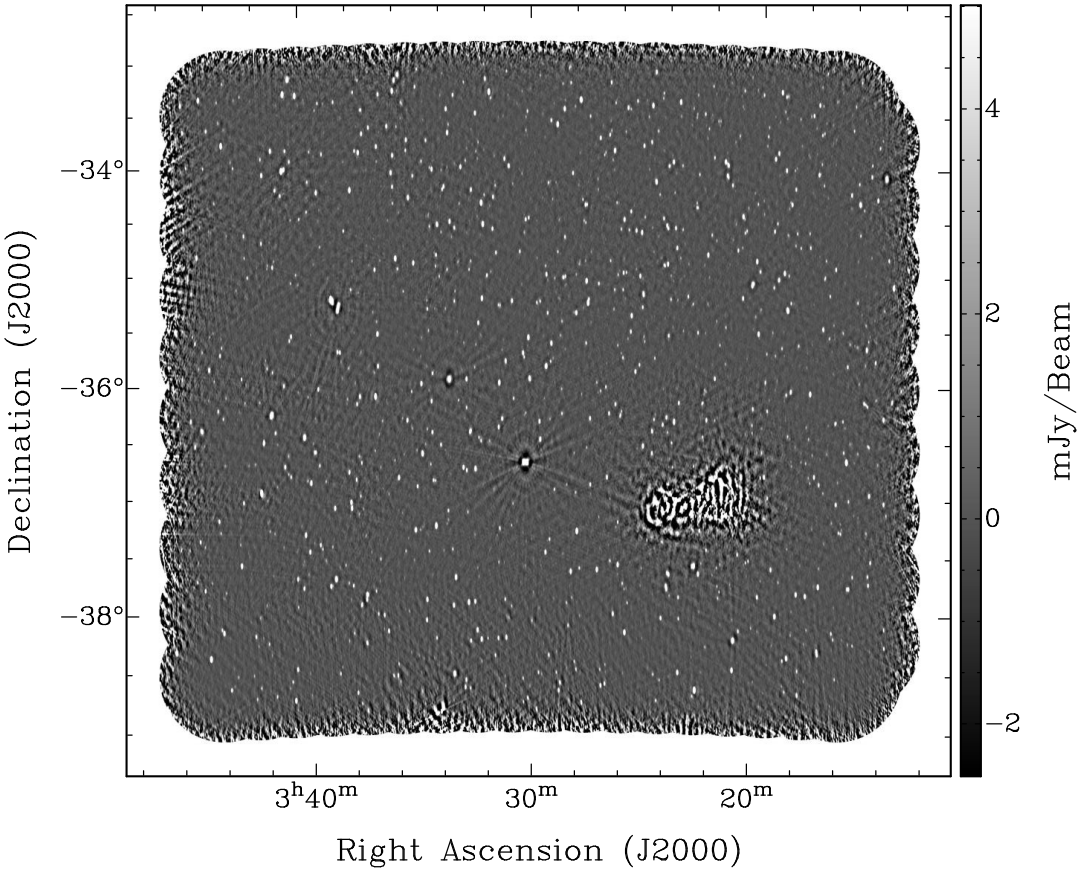
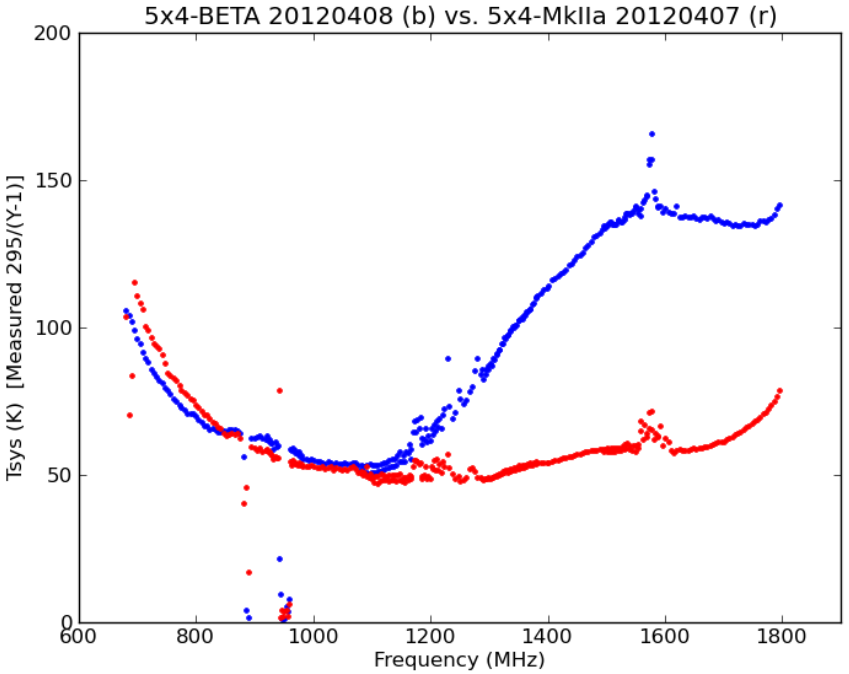


Image of the ATCA test data courtesy of Thomas Franzen. Beam size 85x40". Typical rms of 0.25mJy. 7x24hours of observations. About 1300 sources at >5sigma

From the Test Array to ASKAP

- New PAFs
- New system architecture
- New supercomputer in Perth for data processing and archive



We acknowledge the Wajarri Yamatji people as the traditional owners of the Murchison Radio-Astronomy Observatory site.

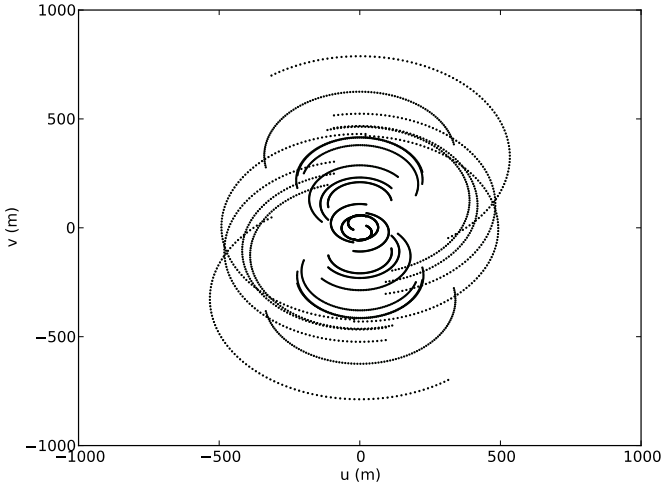
Thank you

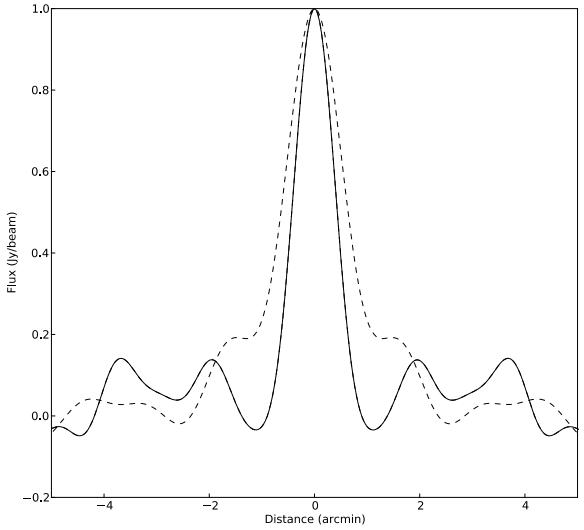
Timothy Shimwell

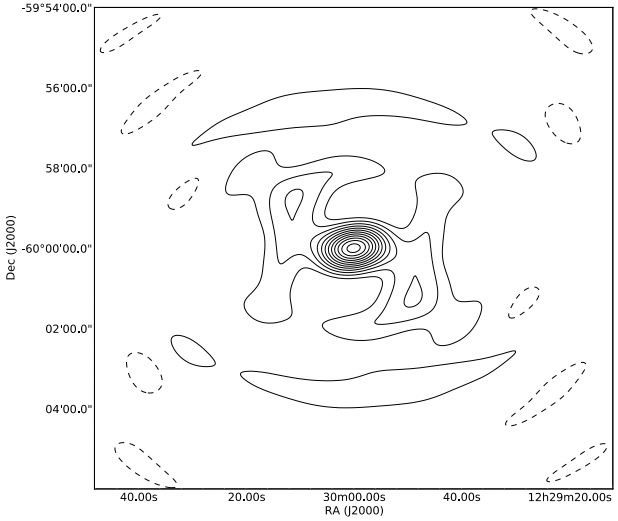
t +61 2 9372 4319
e Timothy.Shimwell@csiro.au
w www.atnf.csiro.au/people/Tim.Shimwell

From the Test Array to ASKAP

- Proposed build order for the next six antennas – not finalised





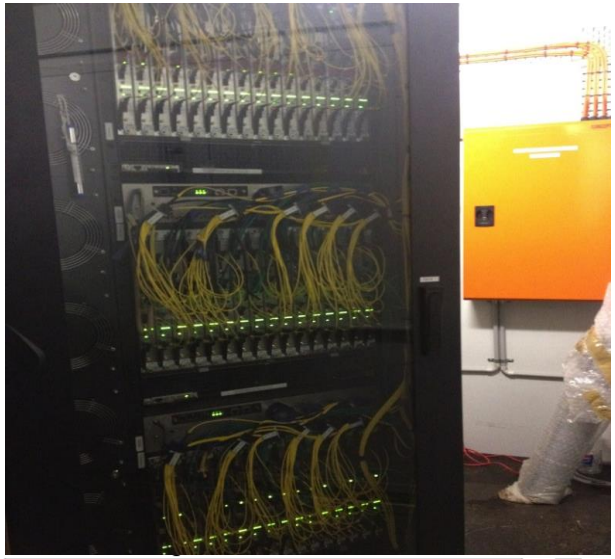


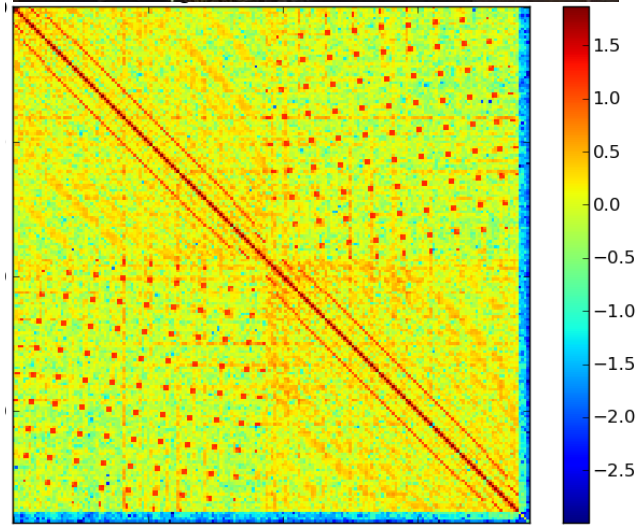
Background: Pedestal Electronics

- Signals from 188 active PAF elements (94 for two orthogonal polarisations) are downconverted to 420-720MHz using a double down conversion method.
- Signal is digitised at 768Msamples/s
- Coarse polyphase filter bank outputs 304x1MHz channels for each PAF element.

Background: Central Site Electronics

- Beamformer performs multiply and accumulate operations to create up to 36 primary beams for each 1MHz channel and antenna
- To assist commissioning the beamformer also calculates the covariance between signals in each PAF ports
- Fine filter bank – splits the 1MHz channels into 54 18.5KHz channels
- Hardware FX correletor expected soon
- Software correlator used for testing – capable of 16 1MHz channels, 3 baselines and up to 9 beams





Survey speed

Table 2. Sensitivity and survey speeds for ASKAP for different angular resolutions, assuming a 50 K system temperature.

Parameter	10”	18”	30”	90”	180”	unit
Continuum survey speed (300 MHz, 100 μJy)	220	361	267	54	17	$\mathrm{deg}^2/\mathrm{hr}$
Continuum sensitivity (300 MHz, 1 hr)	37	29	34	74	132	μJy/beam
Line survey speed (100 kHz, 5 mJy)	184	301	223	45	14	$\mathrm{deg}^2/\mathrm{hr}$
Line sensitivity (100 kHz, 1hr)	2.1	1.6	1.9	4.1	7.3	mJy/beam
Surface brightness survey speed (5 kHz, 1 K)	–	–	1.1	18	94	$\mathrm{deg}^2/\mathrm{hr}$
Surface brightness sensitivity (5 kHz, 1hr)	–	–	5.2	1.3	0.56	K

Johnston et al. 2009ASPC 407 4J -- Science with the Australian Square Kilometre Array Pathfinder (ASKAP)

Background

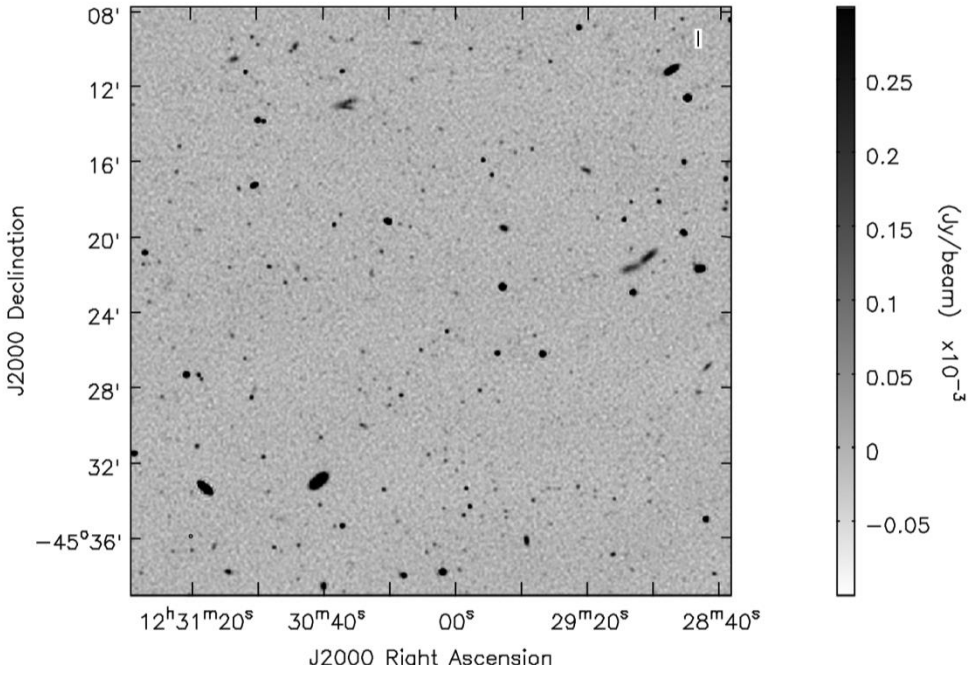
- Radio quietness of the site secured (protection up to 260km away)
- Fast data link from site (1Gbit/s but soon to be 40Gbit/s)
- Data transported around site at 10Gbit/s per cable. Large data transfer possible, e.g. 192x10Gbit/s into each beamformer.
- Control building completed
- Reliable telescope operating system

Surveys with ASKAP

- 75% of ASKAP time dedicated to surveys
- 10 surveys
- Two highest priority:

Evolution Map of the Universe (EMU)

Widefield ASKAP L-Band Legacy All-Sky Blind Survey (WALLABY)



ASKAP data simulated by Matthew Whiting.
http://www.atnf.csiro.au/people/Matthew.Whiting/

Configuration

- The ASKAP configuration was designed to achieve the science goals
- EMU requires high resolution to overcome confusion but also requires high surface brightness sensitivity to avoid resolving out extended objects (optimal ~10”)
- WALLABY requires high surface brightness sensitivity and an excellent PSF to minimise deconvolution (optimal ~30”)