The Australian SKA Pathfinder

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CSIRO Astronomy and Space Science
Arniston, 3 May 2010

www.csiro.au

What is ASKAP?

- Australian Square Kilometre Array Pathfinder

- Located near Boolardy, Western Australia
- Precursor telescope of the Square Kilometre Array (SKA)
- Demonstrator for new receiver technologies

Where will ASKAP be located?

MRO Support Facility – Geraldton

- Maintenance
- Operations
- Outreach

Shire of Murchison

Shire of Murchison:

- 50,000 km²
- 0 gazetted towns
- 29 sheep/cattle stations
- 160 population

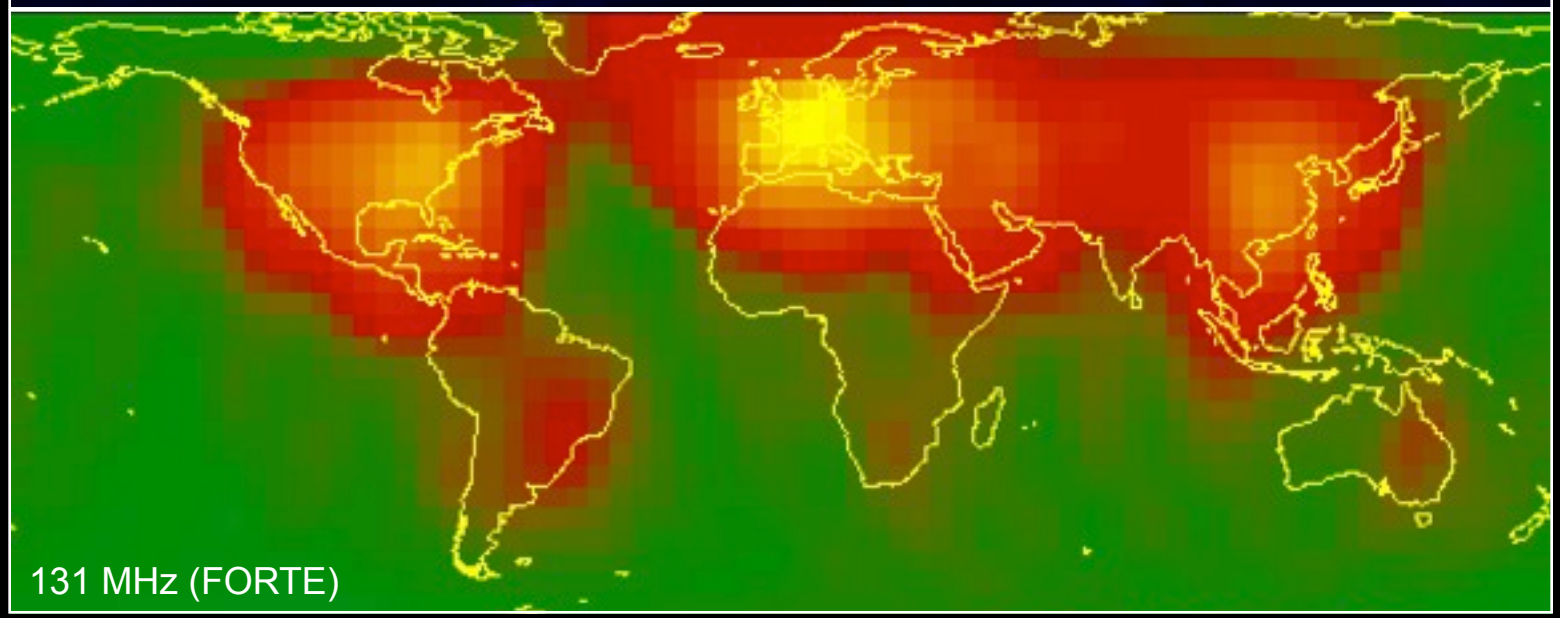
The Netherlands:

- *41,500 km²*
- *431 municipalities*
- *16,493,156 pop.*

Murchison Radio Astronomy Observatory

Murchison Radio Astronomy Observatory

Radio Frequency Interference



Radio Frequency Interference

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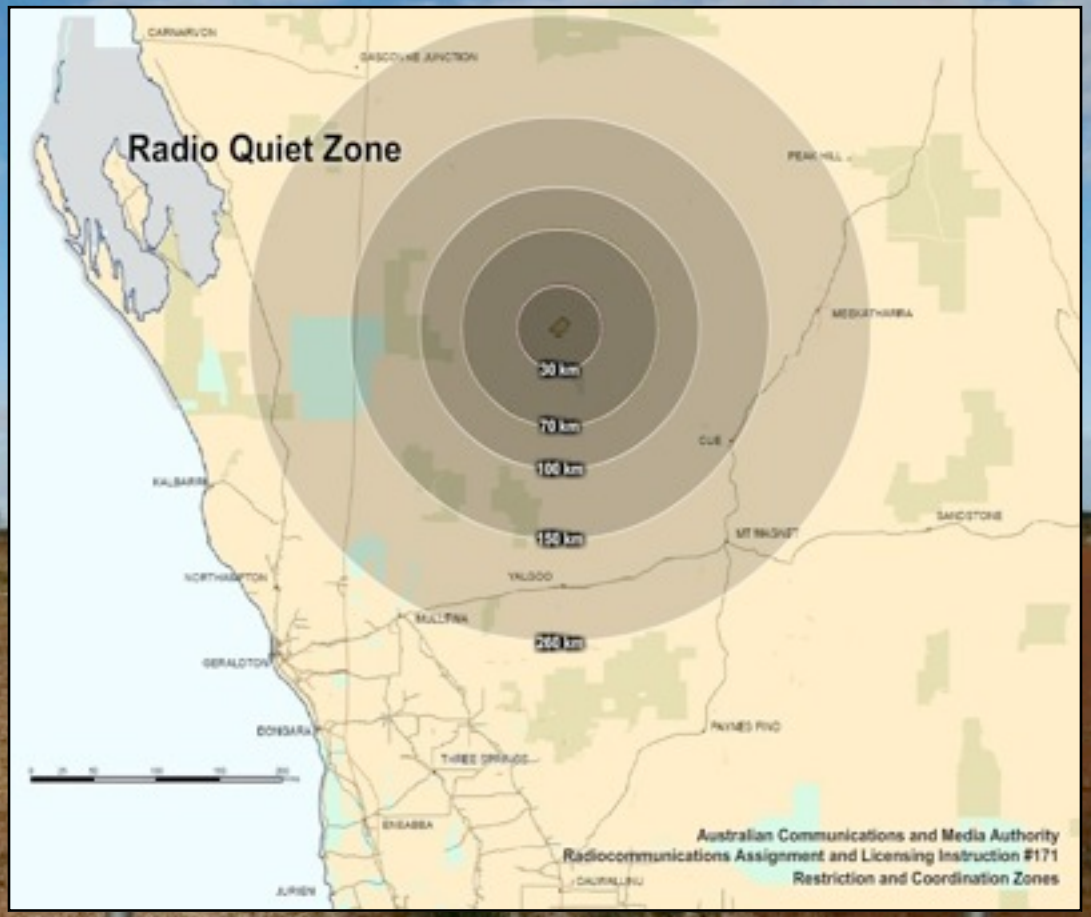
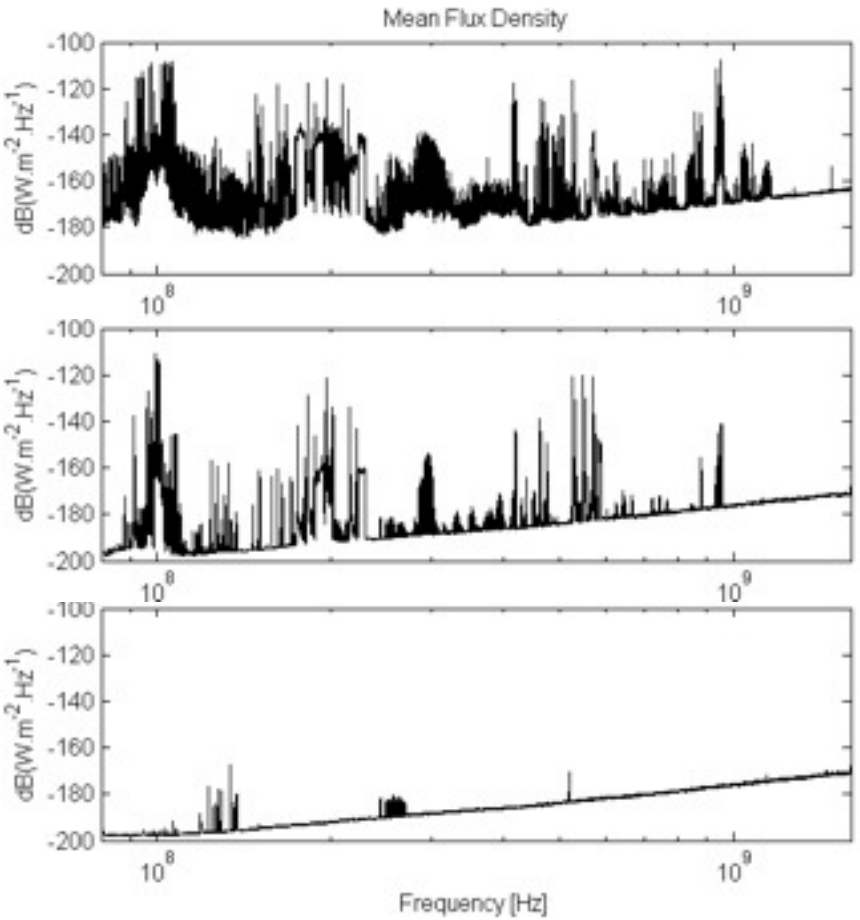


Radio Frequency Interference



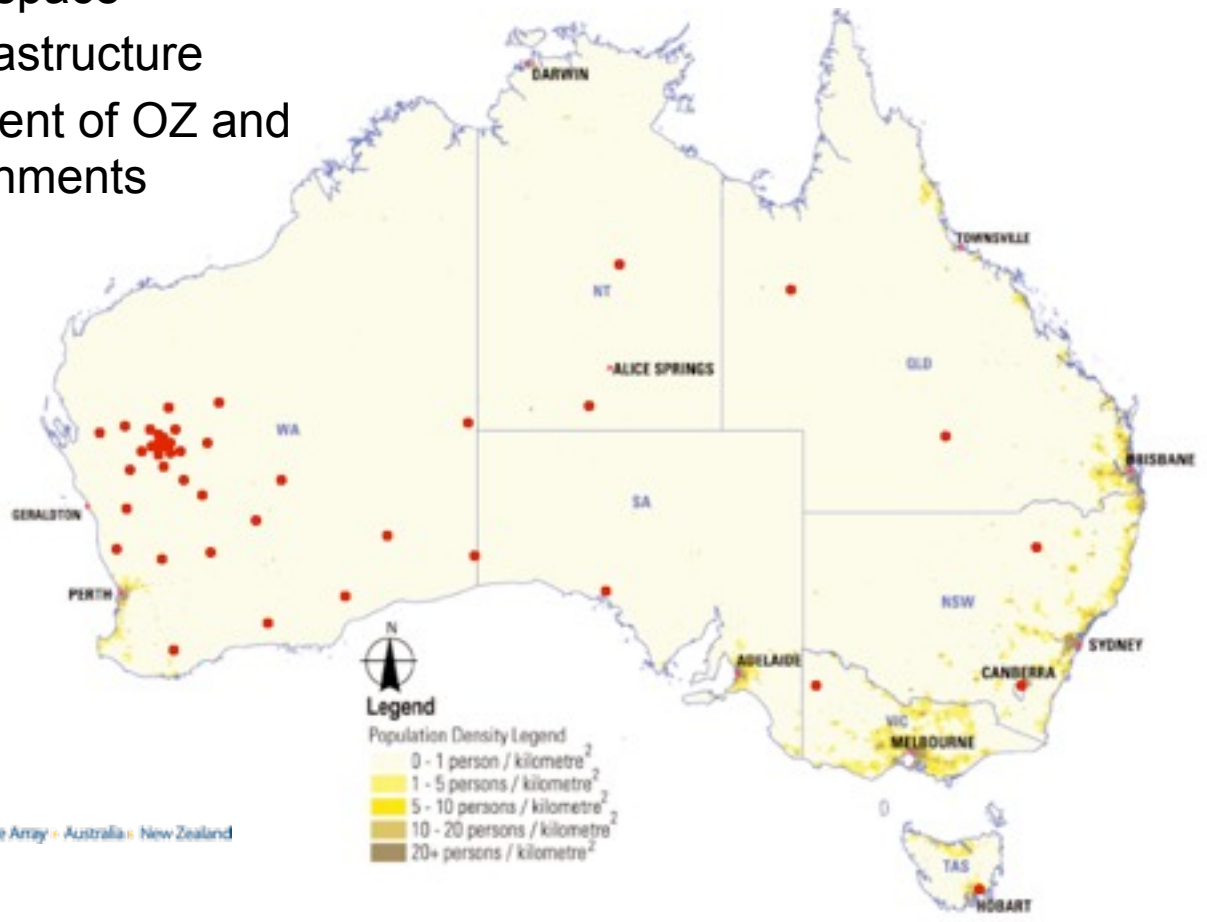
Sydney
Population: 4×10^6

Narrabri
Population: 9×10^3

Boolardy
Population: a few

Proposed Location for the SKA

- Australia ideal for the SKA
  - Low RFI environment
  - Plenty of space
  - Good infrastructure
  - Commitment of OZ and NZ governments



anzska Square Kilometre Array · Australia · New Zealand

CSIRO. ASKAP Simulations

CSIRO

Proposed Location for the SKA

anzska Square Kilometre Array • Australia • New Zealand

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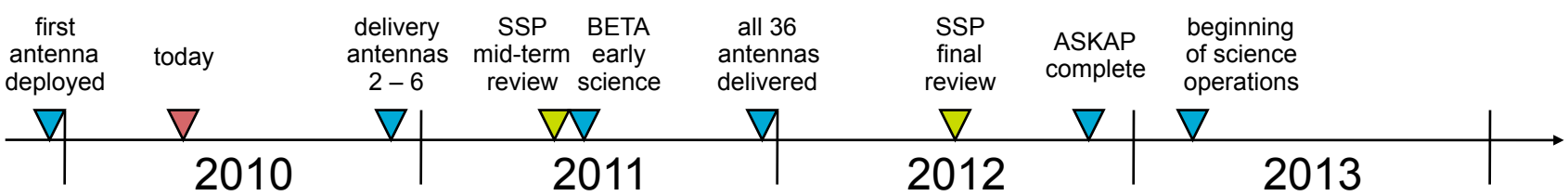
ASKAP Timeline

Dec 2009	Antenna 1 deployed
Nov 2010	Fibre link installed
Nov/Dec 2010	Delivery of antennas 2 – 6
Feb – Sep 2011	BETA installation and commissioning tests
May 2011	Mid-term review of Survey Science Projects
June 2011	BETA early science
Dec 2011	All 36 antennas delivered
Mid 2012	Final review of Survey Science Projects
Q4 2012	ASKAP complete
Early 2013	Beginning of science operations



ASKAP Design Goals

- High dynamic range, wide-field imaging
  - Number of antennas — 36 *(630 baselines)*
  - Antenna diameter — 12 m
  - Maximum baseline — 6 km *(30 antennas inside 2 km)*
  - Angular resolution — 10 arcsec
  - Sensitivity — 65 m²/K
  - Frequency range — 700 – 1800 MHz
  - Focal plane phased array — 192 elements
  - Field of view — 30 deg²
  - Processed bandwidth — 300 MHz
  - Number of channels — 16 384
  - Integration time — 5 s

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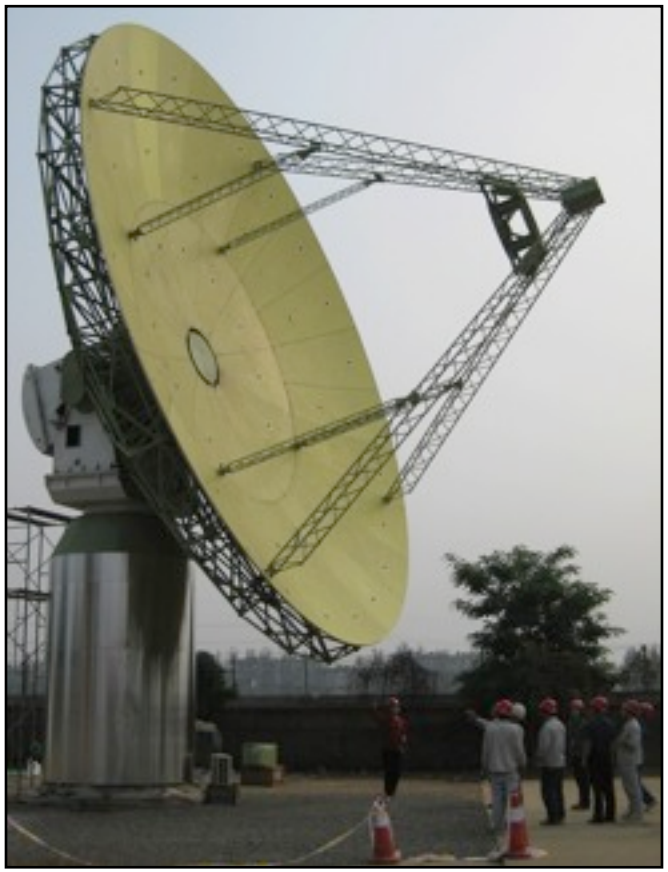
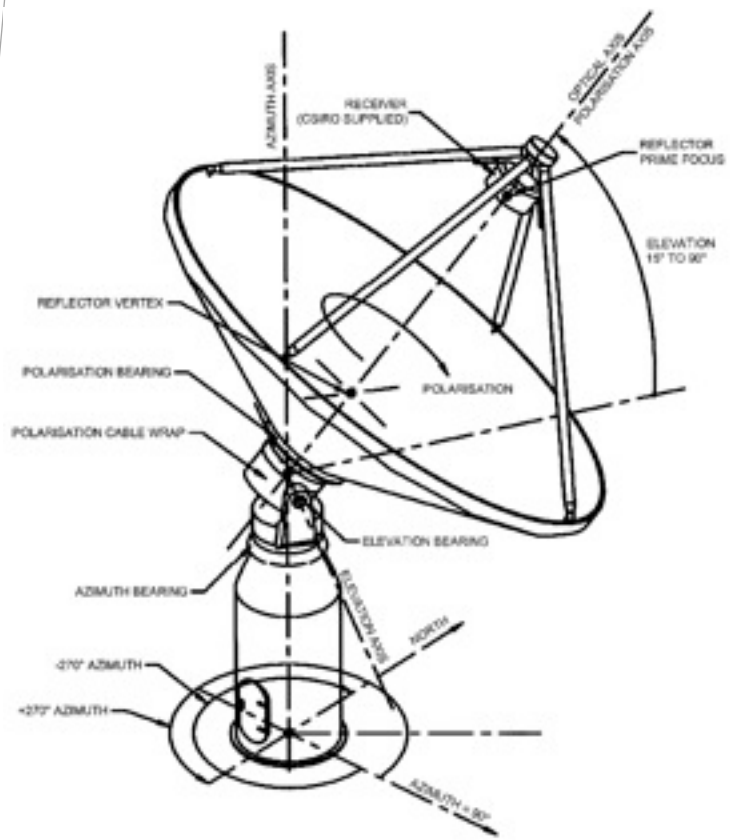
First ASKAP Antenna Deployed

- First ASKAP antenna shipped to Australia and installed on site in December 2009.



First ASKAP Antenna Deployed

Antenna Design



- Antennas built by 54th Research Institute of China Electronics Technology Group Corporation (CETC54).
- Azimuth / elevation mount with elevation range of +15° to +89°.
- Third (polarisation) axis: dish can rotate by ±180° to keep orientation fixed w.r.t. the sky.
- Slender support legs to minimise aperture obstruction.

Antenna Design

▲ Installation of the receiver housing

◄ The polarisation axis in action

First VLBI Fringes

- First VLBI fringes on 22 April between ASKAP and Mopra!
- First trans-Tasman fringes (ASKAP–Warkworth) on 23 April!

More to come soon!

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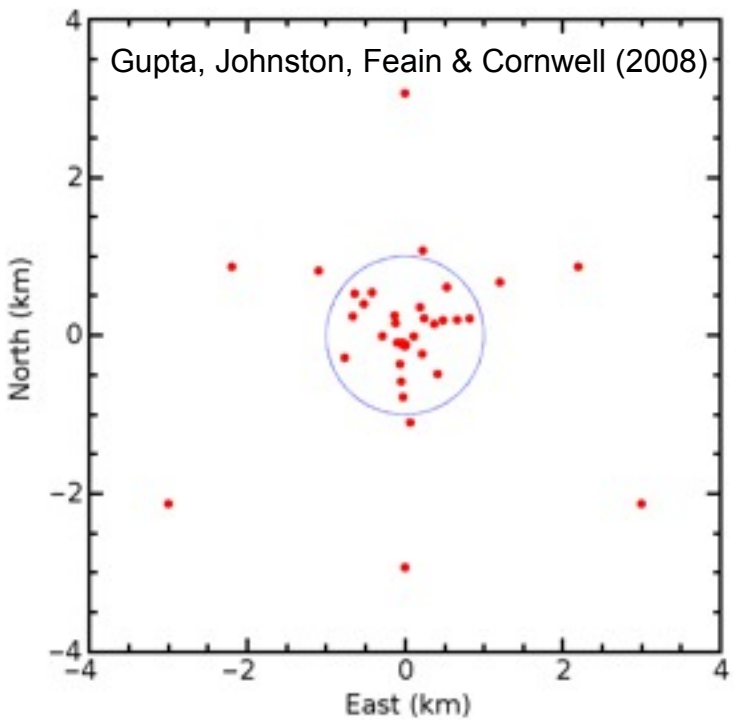
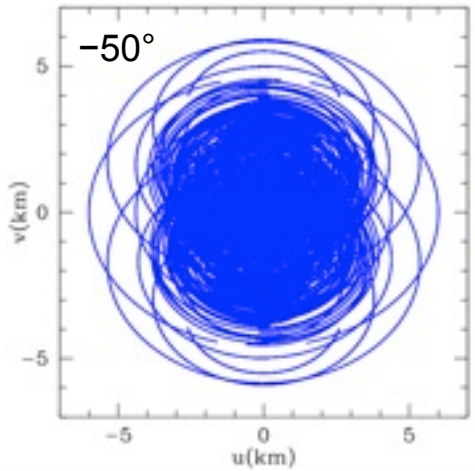
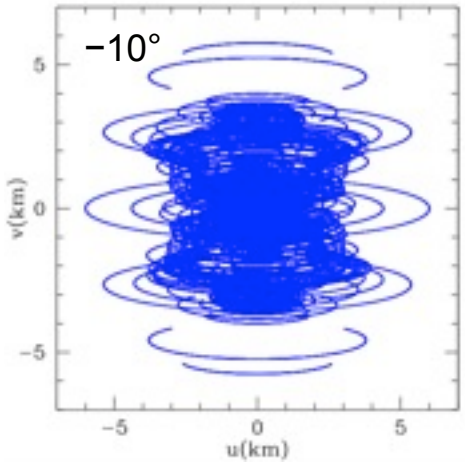
ASKAP Array Configuration

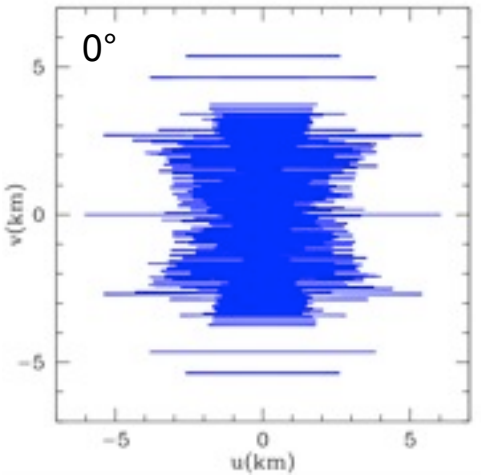
- Initial array configuration
  - Spectral line:
    - Inner 30 antennas only, max. baseline 2 km.
    - Resolution: 30 arcsec at 1.4 GHz.
  - Continuum:
    - 36 antennas in 6 km array.
    - Resolution: 10 arcsec at 1.4 GHz.



uv Coverage and Beam Size

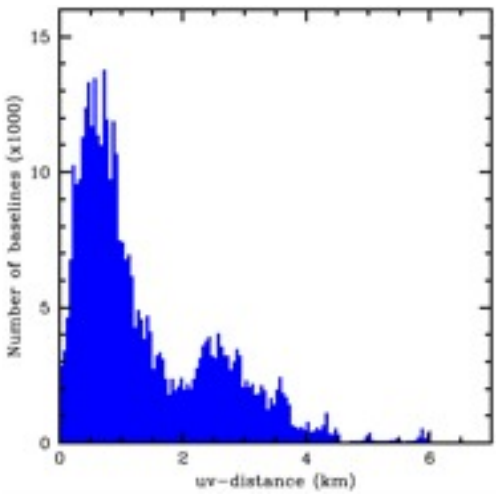




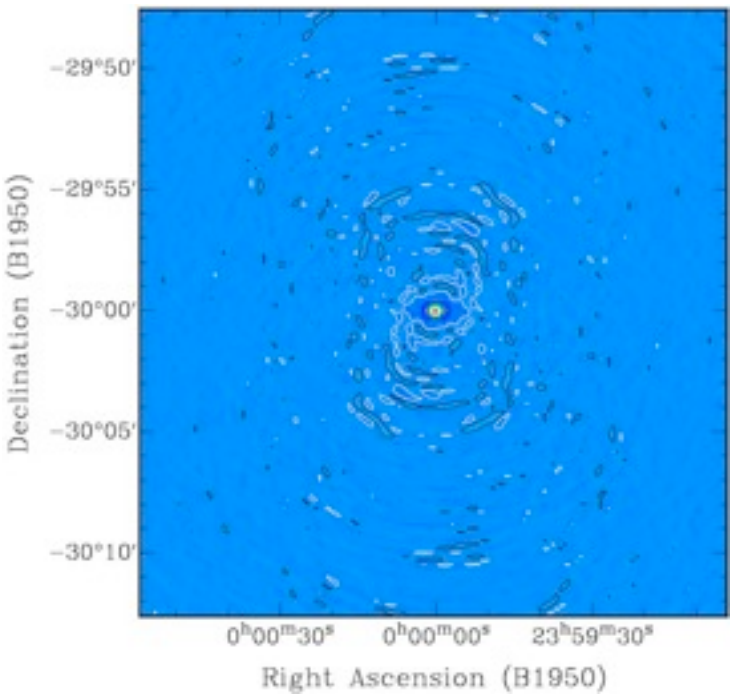


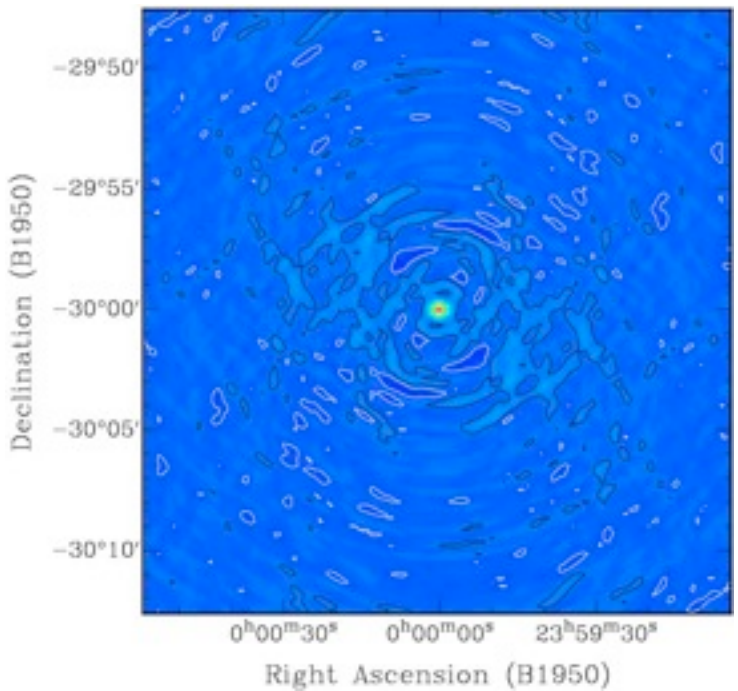
Beam size of full array at natural weighting.

Declination (deg)	Snapshot beam (arcsec x arcsec)	10 hr beam (arcsec x arcsec)
−50	19.1 x 15.4	19.4 x 15.9
−30	17.6 x 15.2	18.9 x 17.5
−10	17.9 x 15.3	19.6 x 18.2
0	18.4 x 15.3	19.5 x 19.3
+10	21.5 x 15.1	20.1 x 19.2



Synthesised Beam at 1.4 GHz and $\delta = -30°$





Uniform weighting

FWHM:	18.9 arcsec
Sidelobes:	−5.5%…+3.1%

Natural weighting

FWHM:	27.5 arcsec
Sidelobes:	−2.4%…+4.9%

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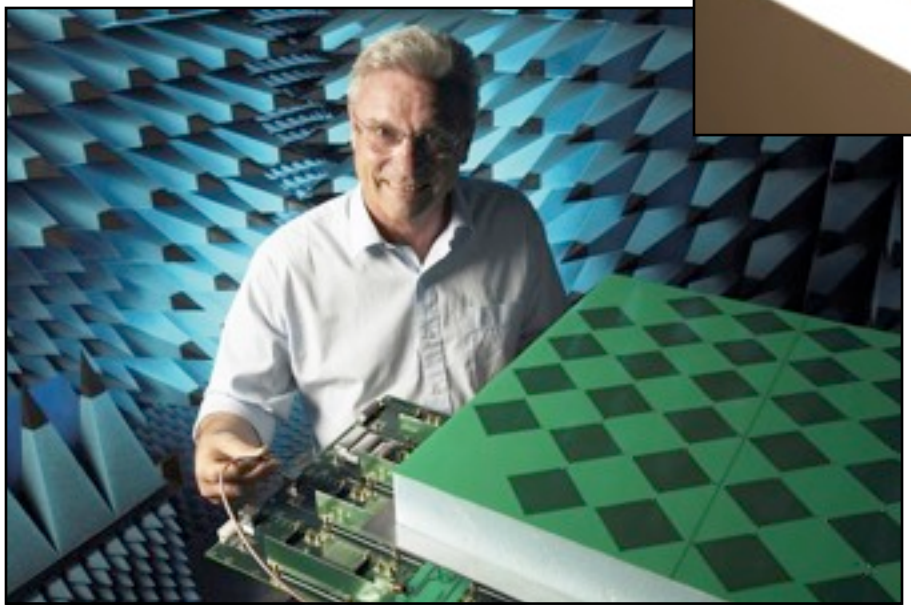
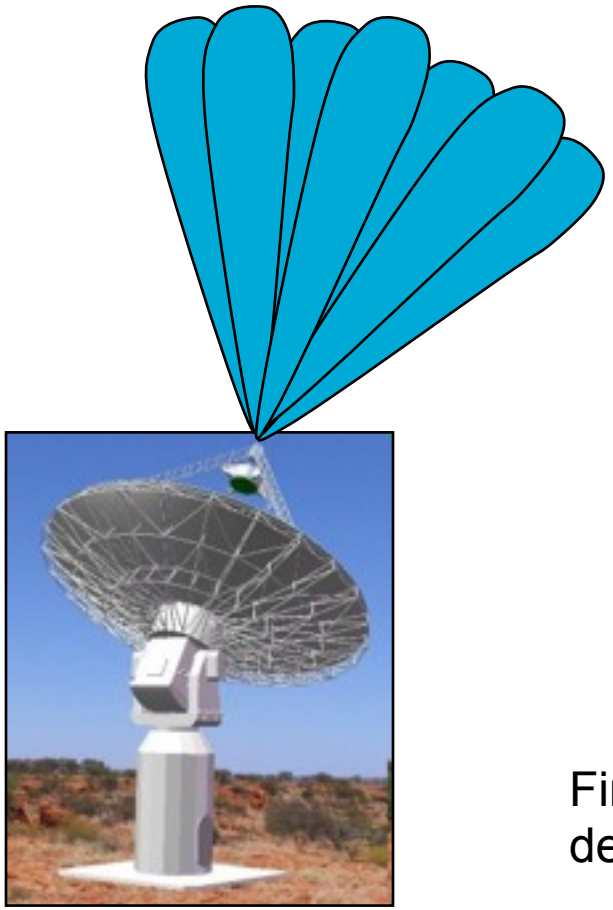
Phased Array Feed

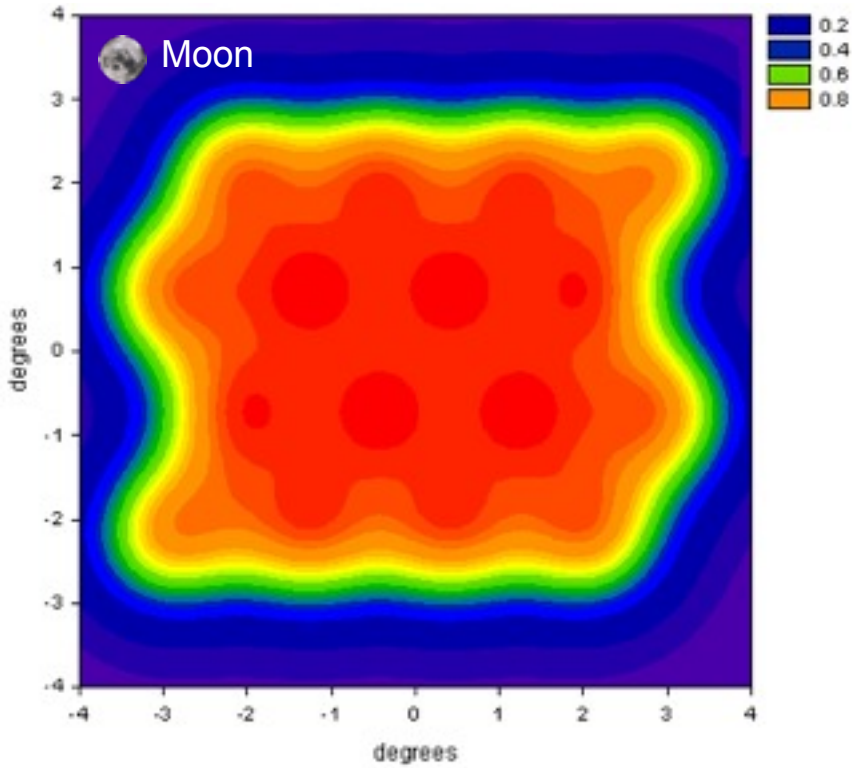
PAF prototype installed on the 12-m Parkes testbed antenna



John O'Sullivan with the PAF prototype

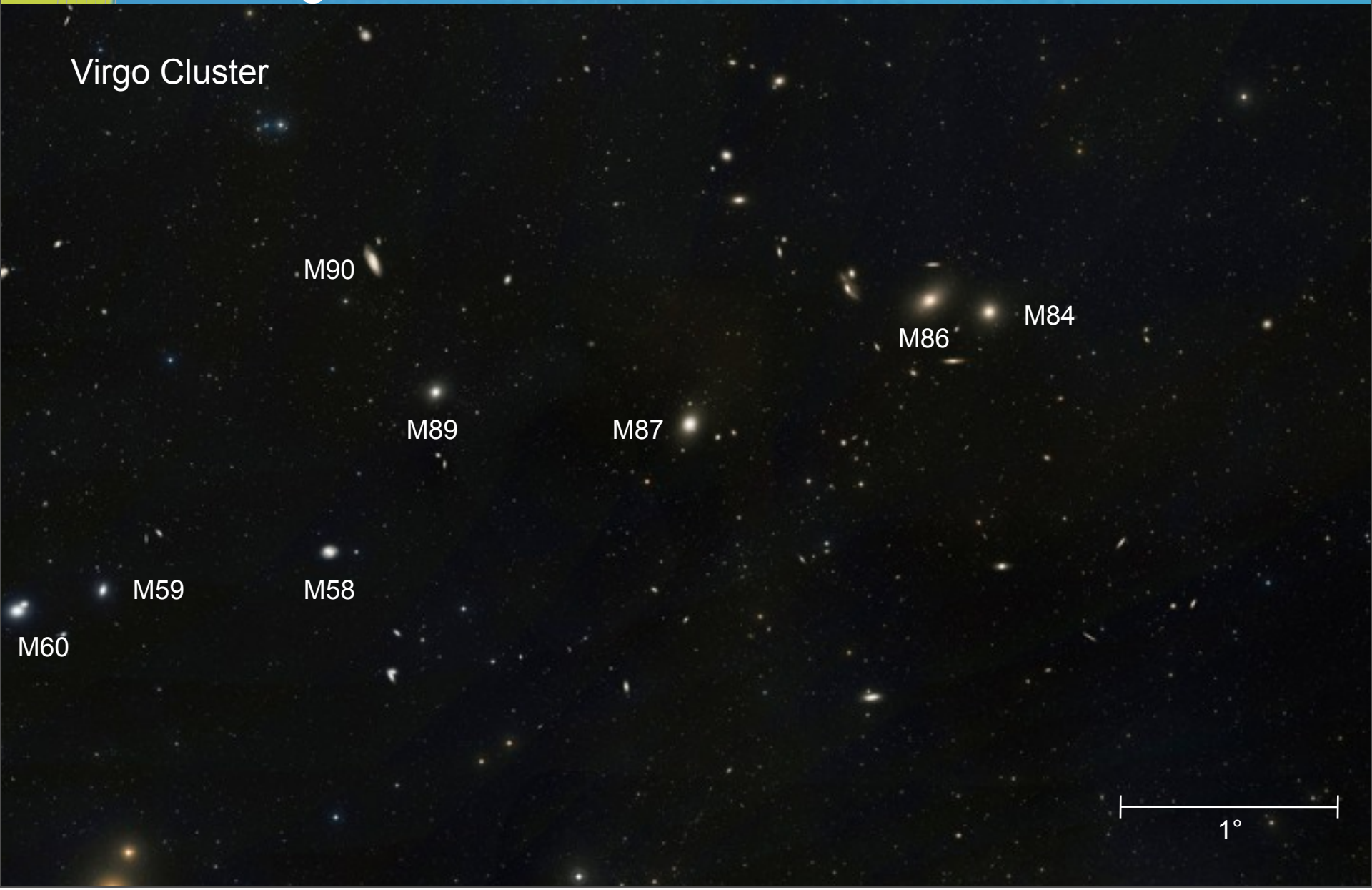
Phased Array Feed



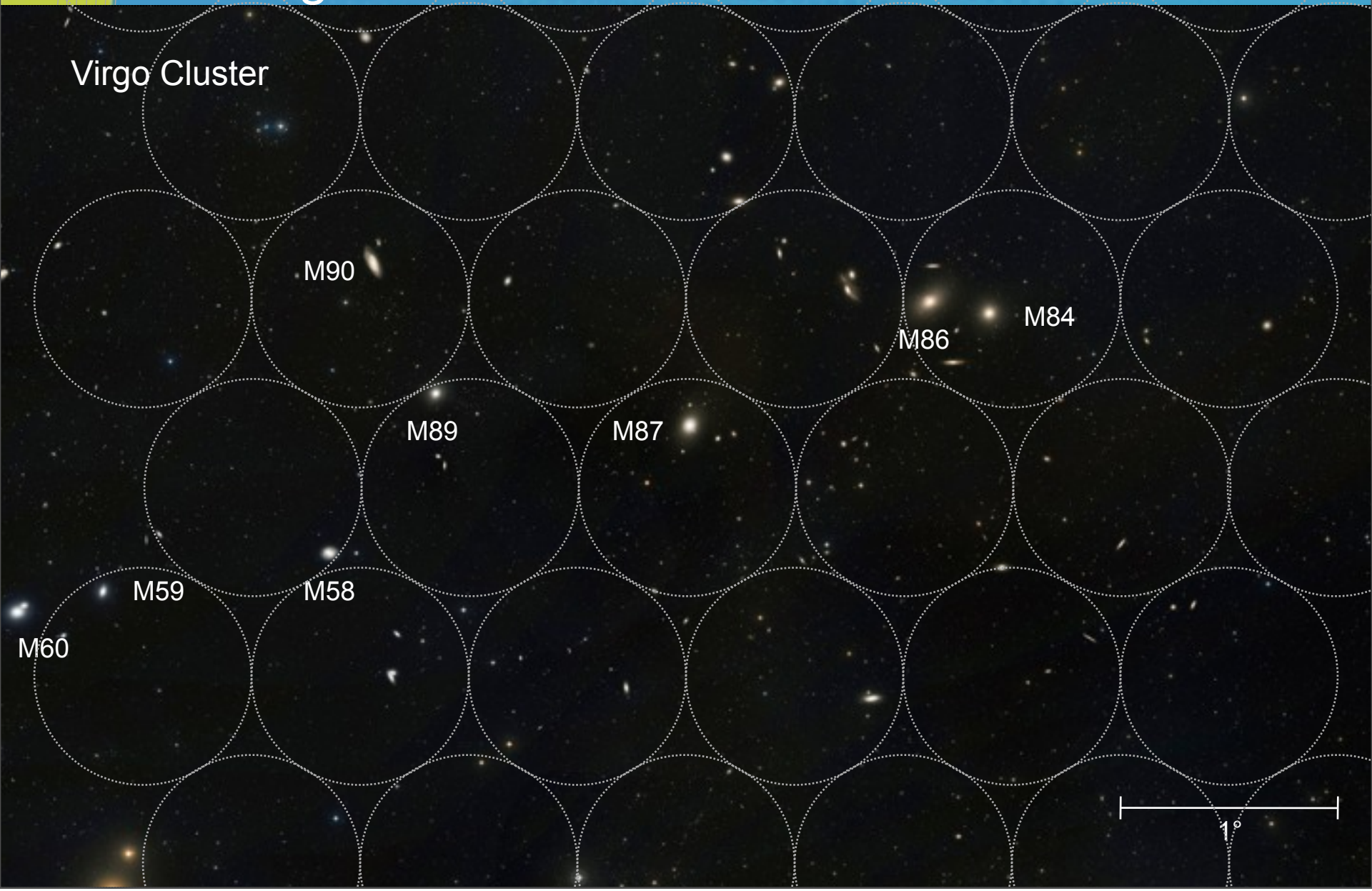


Final FoV and sensitivity will depend on details of beam-forming.

30 deg² Field of View



30 deg² Field of View



30 deg² Field of View

Survey Science Projects

- 30 deg² field of view → ASKAP will be a survey machine.
- Over the first 5 years of operation
  - 75% will be devoted to large *survey science projects* (SSPs).
  - 25% will be given to smaller *guest science proposals*.
- Survey science projects are large projects with > 1500 h.
- Open, international, competitive process set up for submission of expressions of interest and proposals.
- SSP proposals were evaluated by committee of international experts with a broad range of proficiencies.
- A total of 10 SSPs were invited to work with ATNF through the design study phase.
- Origin of SSP team members:
  - 30% Australia, 30% Europe, 30% North America, 10% other.

SSPs “A Group”

- WALLABY *(PIs: B. Koribalski, L. Staveley-Smith)*
  - Widefield ASKAP L-band Legacy All-sky Blind Survey
  - Extragalactic neutral hydrogen survey
  - 75% of the entire sky
  - Up to 500,000 galaxies out to a redshift of 0.26
  - Aims: H I properties and large-scale distribution of galaxies, galaxy formation, missing satellites problem, evolution and star formation, mergers and galaxy interactions, H I mass function, distribution and evolution of cool gas, cosmological parameters, nature of the cosmic web

- EMU *(PI: R. Norris)*
  - Evolutionary Map of the Universe
  - Deep radio continuum survey (10 μJy/beam rms)
  - 75% of the entire sky
  - Aims: probing star forming galaxies to redshift 1, powerful starbursts to even greater redshifts, AGN to the edge of the universe, discovering new classes of rare objects, trace the evolution of star forming galaxies and massive black holes throughout the history of the universe, explore large-scale structure

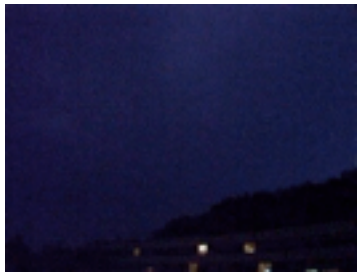
SSPs “A− Group”

- GASKAP *(PIs: J. Dickey, N. McClure-Griffiths)*
  - Galactic ASKAP Spectral Line Survey
  - H I and OH in Milky Way and Magellanic System
  - 10 × improvement in brightness sensitivity and angular resolution
  - Aims: OH masers from evolved stars and star formation regions, diffuse emission from molecular and atomic clouds, H I absorption towards background continuum sources and the structures in the gas that trace the effects of stellar winds and supernova explosions, stunning images of the ISM

- DINGO *(PI: M. Meyer)*
  - Deep Investigation of Neutral Gas Origins
  - Evolution of H I from the current epoch to $z \approx 0.5$
  - Legacy dataset spanning cosmologically repre-sentative volumes
  - Aims: key cosmological distributions, including $\Omega_{\mathrm{H\,I}}$, H I mass function and halo occupation distribution function, combined with optical data to enable study of co-evolution of stellar, baryonic and dark matter content of galaxies

SSPs "A– Group"

- FLASH *(PI: E. Sadler)*
  - The First Large Absorption Survey in H I
  - Blind H I absorption-line survey of background radio continuum sources
  - Aims: neutral gas content of galaxies, cosmic H I mass density in the redshift range $0.5 < z < 1.0$, 100 × increase in total number of absorption line systems



- POSSUM *(PIs: B. Gaenser, T. Landecker, R. Taylor)*
  - Polarisation Sky Survey of the Universe's Magnetism
  - Radio source polarisation, RM synthesis
  - Wide-field survey for RM grid across the sky
  - Aims: ordered components of the Milky Way's magnetic field, test dynamo and other models of magnetic field generation in galaxies and clusters, carry out comprehensive census of magnetic fields as a function of redshift in galaxies, AGN, galaxy clusters and the IGM

SSPs "A– Group"

- VAST *(PIs: T. Murphy, S. Chatterjee)*
  - ASKAP Survey for Variables and Slow Transients
  - Search for transients with timescales > 5 s
  - Aims: study of flare stars, intermittent pulsars, X-ray binaries, magnetars, extreme scattering events, intra-day variables, radio supernovae and orphan afterglows of *γ*-ray bursts

- CRAFT *(PI: P. Hall)*
  - Commensal Real-time ASKAP Fast Transients Survey
  - Survey for transient sources with timescales < 5 s
  - Aims: study the most energetic and brightest single events in the universe, high brightness temperature objects, extreme states of matter, physics of strong gravitational fields, sensitive probe on the huge reservoir of baryons in the IGM

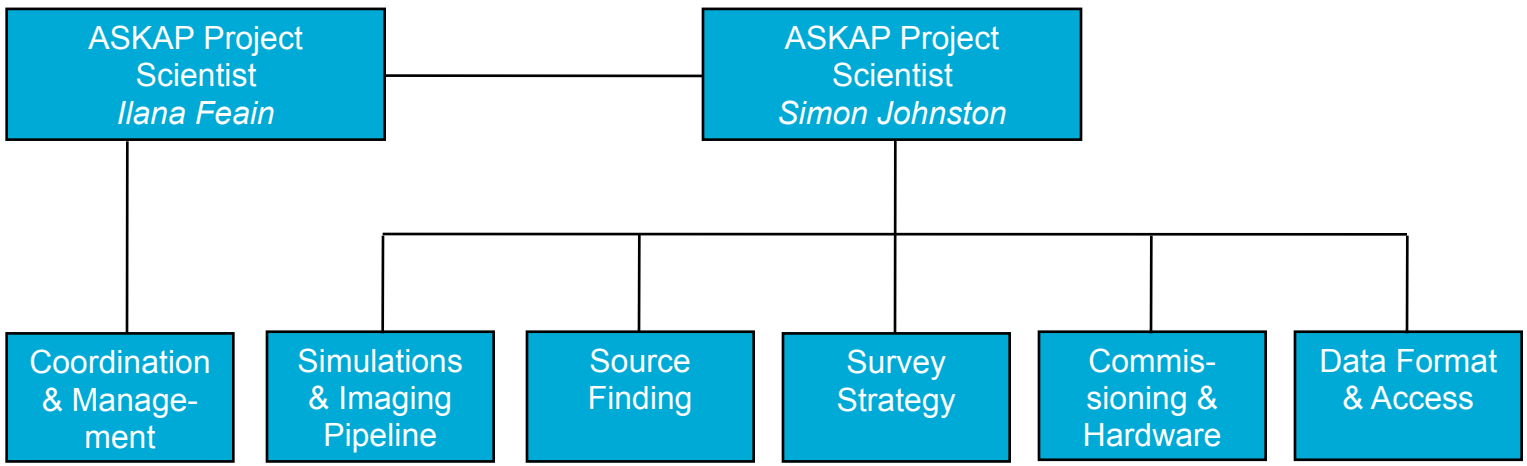
SSPs “Strategic Priorities Group”

- VLBI *(PI: S. Tingay)*
  - The High-resolution Components of ASKAP: Meeting the Long Baseline Specifications for the SKA
  - ASKAP + Australian Long Baseline Array, high-speed data recording equipment, software correlation facilities and high speed data transport networks
  - Aims: proper motion and parallax of pulsars, high-resolution imaging of AGN, follow-up of transient radio sources, distances and proper motions of OH masers

- COAST *(PI: I. Stairs)*
  - Compact Objects with ASKAP: Surveys and Timing
  - Pulsar timing aimed at high-profile issues in astro-physics
  - Aims: gravitational waves, tests of General Relativity and other theories of strong gravity, studies of binary stellar evolution, blind searches for pulsars, Galactic neutron star population, pulsar emission mechanism, structure and magnetic field of the Galaxy

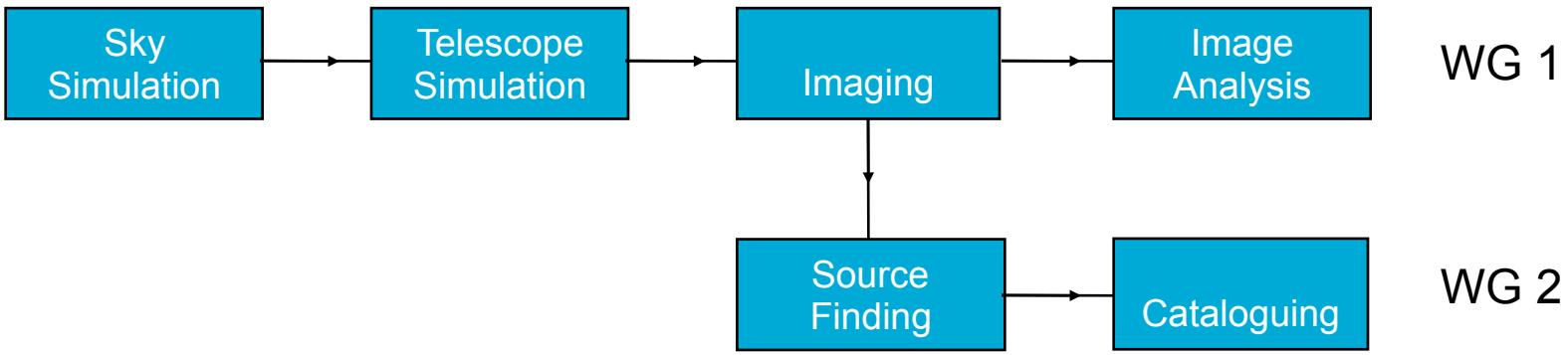
Survey Science Project Management

- Interaction between SSPs and ASKAP through
  - 5 technical working groups
  - Coordination and Management group



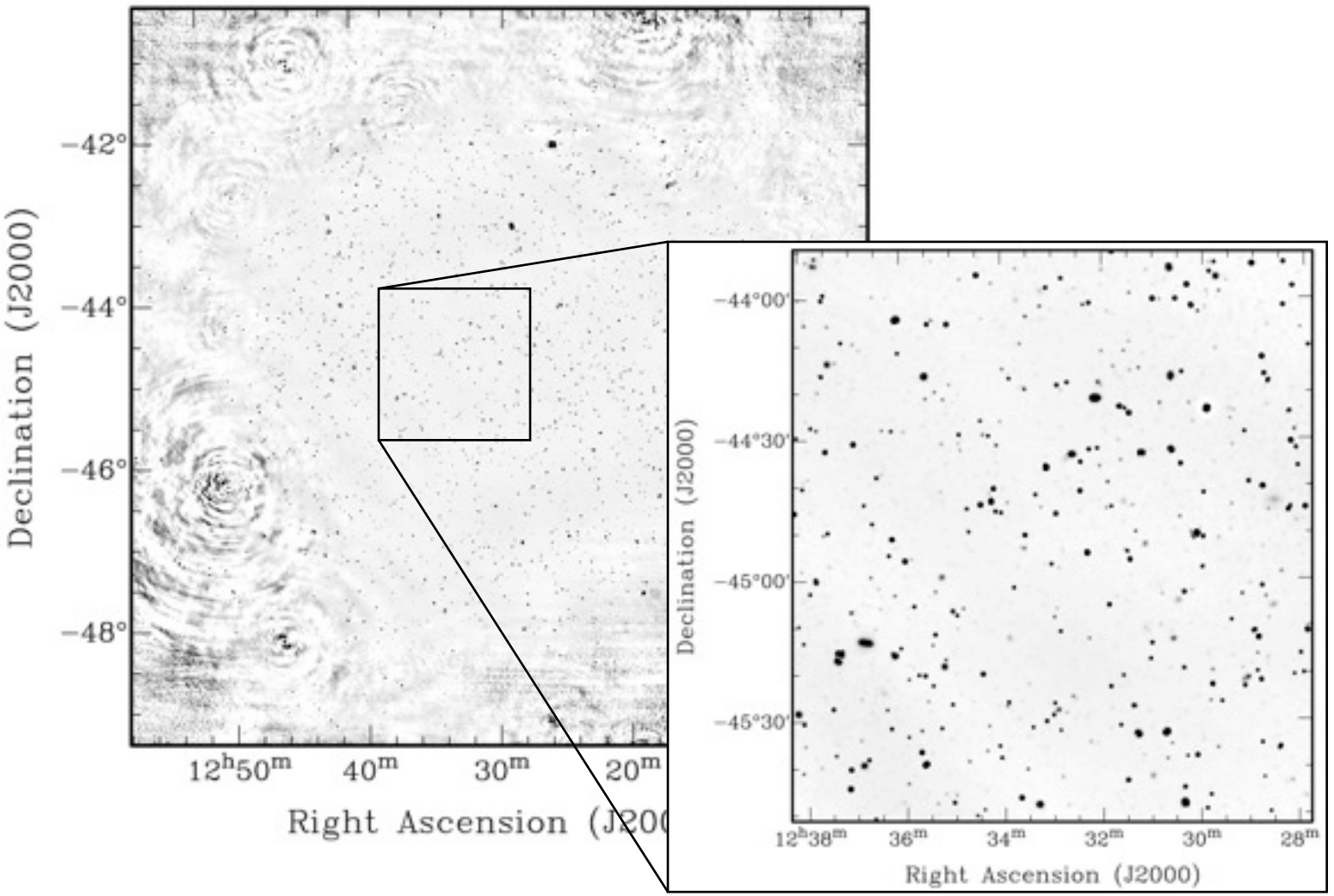
- Coordination and Management group
  - SSP PIs meet with ASKAP staff on a bi-monthly basis
- Technical working groups
  - Meetings between SSP WG chairs and ASKAP staff as needed

ASKAP Simulations

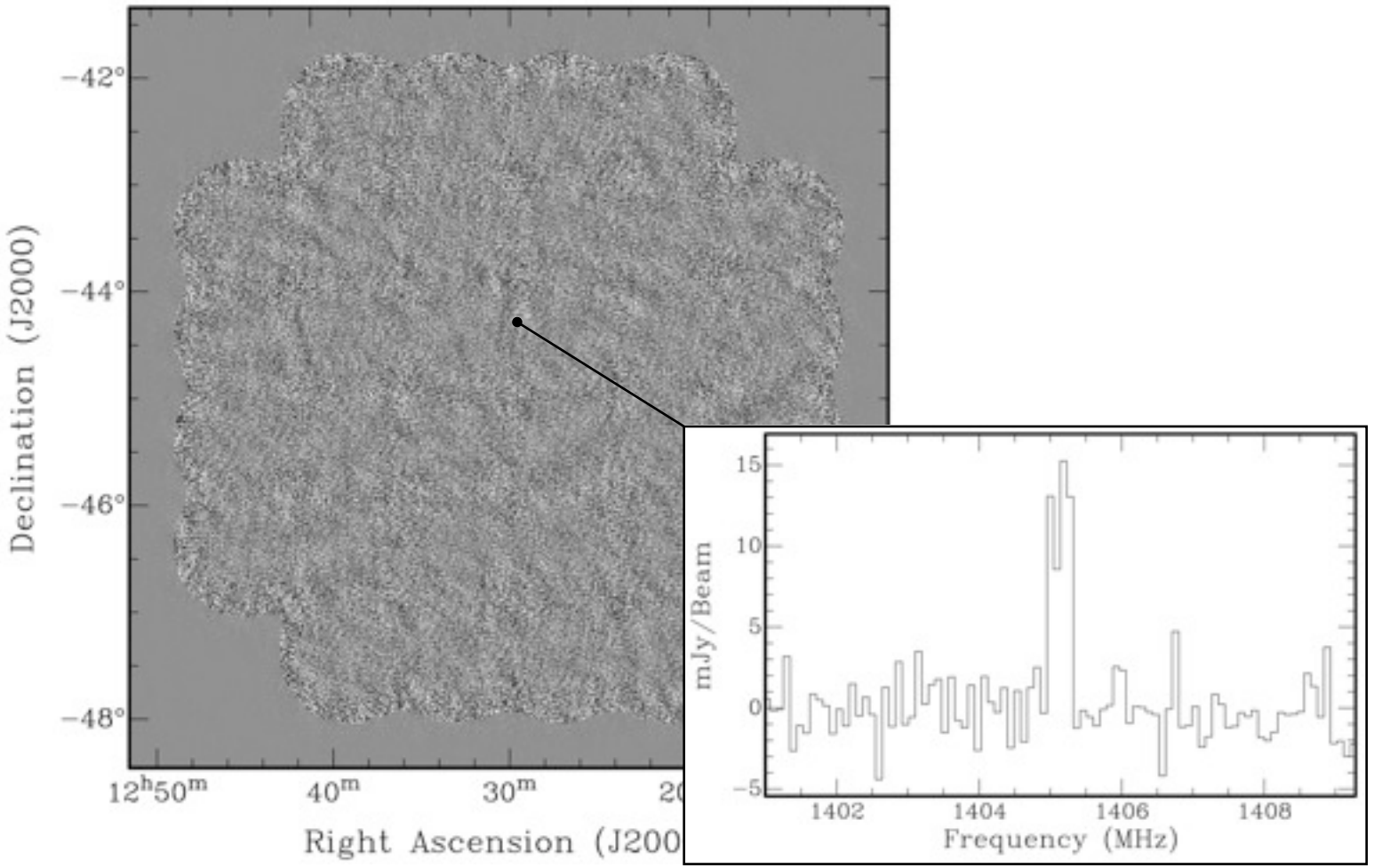


- Sky simulation based on
  - SKADS S3-SAX sky (Obreschkow et al. 2009) for spectral line
  - SKADS S3-SEX sky (Wilman et al. 2008) for continuum
- 30 antennas in the 2 km core configuration
- 32 idealised beams on a 1° grid
- Total integration time of 8 h
- Continuum simulations have been deconvolved using multi-scale CLEAN

ASKAP Continuum Simulations

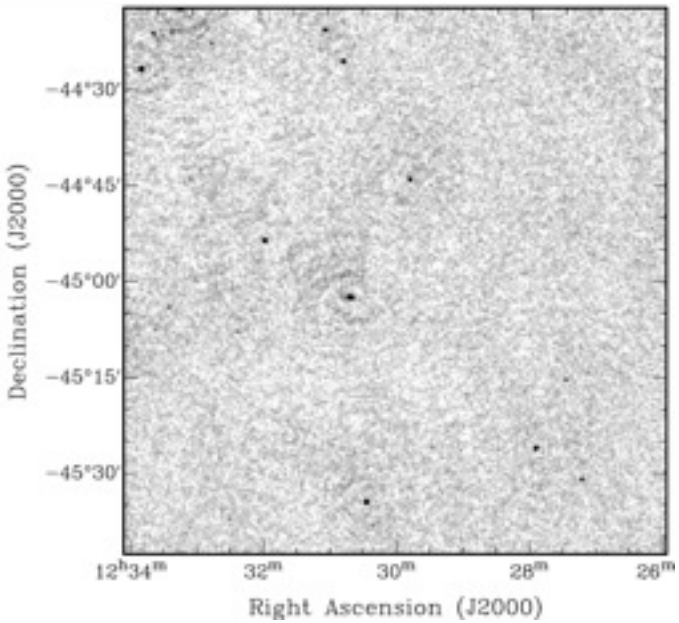


ASKAP Spectral Line Simulations



ASKAP Simulations

- New simulations released on 16 April.
  - Fully-sampled beams for homo-geneous noise levels.
  - Correction of flux error in previous continuum simulations.
  - Spectral cube with lower noise for source finding tests.
- Next release due end of May, focussing on
  - Transient sources
  - Polarisation
- ASKAP simulations are publicly available:
  - http://www.atnf.csiro.au/people/Matthew.Whiting/ASKAPsimulations.php



Committment of Australian Government

- Super Science Initiative of the Australian Government

Super Science Fellowships

Key Points

- The Government will provide $27.2 million over four years to run two rounds of three-year early-career fellowships, to ensure our most promising young researchers continue to have opportunities to work in areas of national significance during the global recession.
- Fellowships will be offered in three areas of existing research strength:
  1. Space science and astronomy;
  2. Marine and climate science; and
  3. Future industries research – biotechnology and nanotechnology.

Facts and Figures

- The scheme will offer 100 fellowships in total (50 fellowships per round), each worth up to $72,500 per annum.
- The first round of fellowships to commence funding in 2010, with applications called in the second half of 2009.
- Fellowships will be available to researchers in universities and publicly funded research agencies within the targeted science fields.

The scheme will offer 100 fellowships in total (50 fellowships per round), each worth up to $72,500 per annum.

- Super Science Fellows will be expected to participate in science engagement and education activities over the life of their Fellowship, to share their scientific achievements with the community and inspire the next generation with the wonder of scientific discovery.
- The new fellowships will be administered by the Australian Research Council under the existing Discovery Scheme of the National Competitive Grants Program.

Committment of Australian Government

- Outcome
  - Announced by the Minister for Innovation, Industry, Science and Research, Senator Kim Carr, during a ceremony held at ATNF on 8 April 2010.
  - 1st round commencing in 2010

Targeted Discipline Area	No. of requested fellowships	No. of approved fellowships	Success Rate
Space science and astronomy	36	17	47.2%
Marine and climate science	53	17	32.1%
Future industries	60	16	26.7%
Total	**149**	**50**	

  - 2nd round commencing in 2011

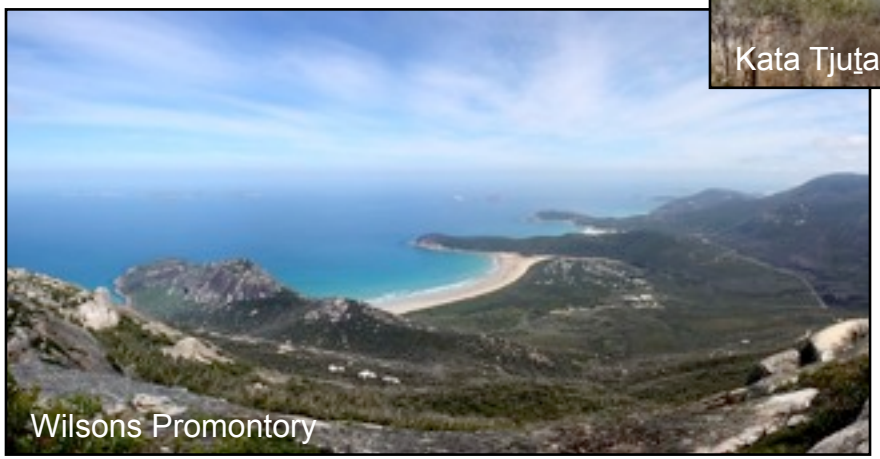
Targeted Discipline Area	No. of requested fellowships	No. of approved fellowships	Success Rate
Space science and astronomy	38	16	42.1%
Marine and climate science	43	17	39.5%
Future industries	43	17	39.5%
Total	**124**	**50**	

Job Opportunities

- Total of 33 Super Science Fellowships in Astronomy and Space Science all across Australia over the next 4 years.
- About 10 of these will be directly related to ASKAP.
- Positions will be advertised in May for commencement in mid/ late 2010.
- Great opportunity for early-career researchers within 3 years of a PhD.


Kata Tjuta


Canberra


Wilsons Promontory

For more Information...

- Public ASKAP website:
  - http://www.atnf.csiro.au/projects/askap/
- ASKAP Science/Technical Updates:
  - http://www.atnf.csiro.au/projects/askap/science_update_newsletter.html
  - http://www.atnf.csiro.au/projects/askap/technical_update_newsletter.html
- ASKAP Project Scientists:
  - Simon Johnston
  - Ilana Feain
    (acting: Tobias Westmeier)
  - atnf-askap-ps@csiro.au
- anzSKA websites:
  - http://www.ska.gov.au/
  - http://www.ska.edu.au/

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Thank you

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