



ASKAP / BETA Overview

SPARCS 2015

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1 July 2015

ASTRONOMY & SPACE SCIENCE

www.csiro.au



The Australian SKA Pathfinder (ASKAP)

The Boolardy Test Array (BETA)

The ASKAP Early Science Program



Murchison Radio-Astronomy Observatory (MRO)

S26° 42' 15", E116° 39' 32"



MURCHISON SHIRE

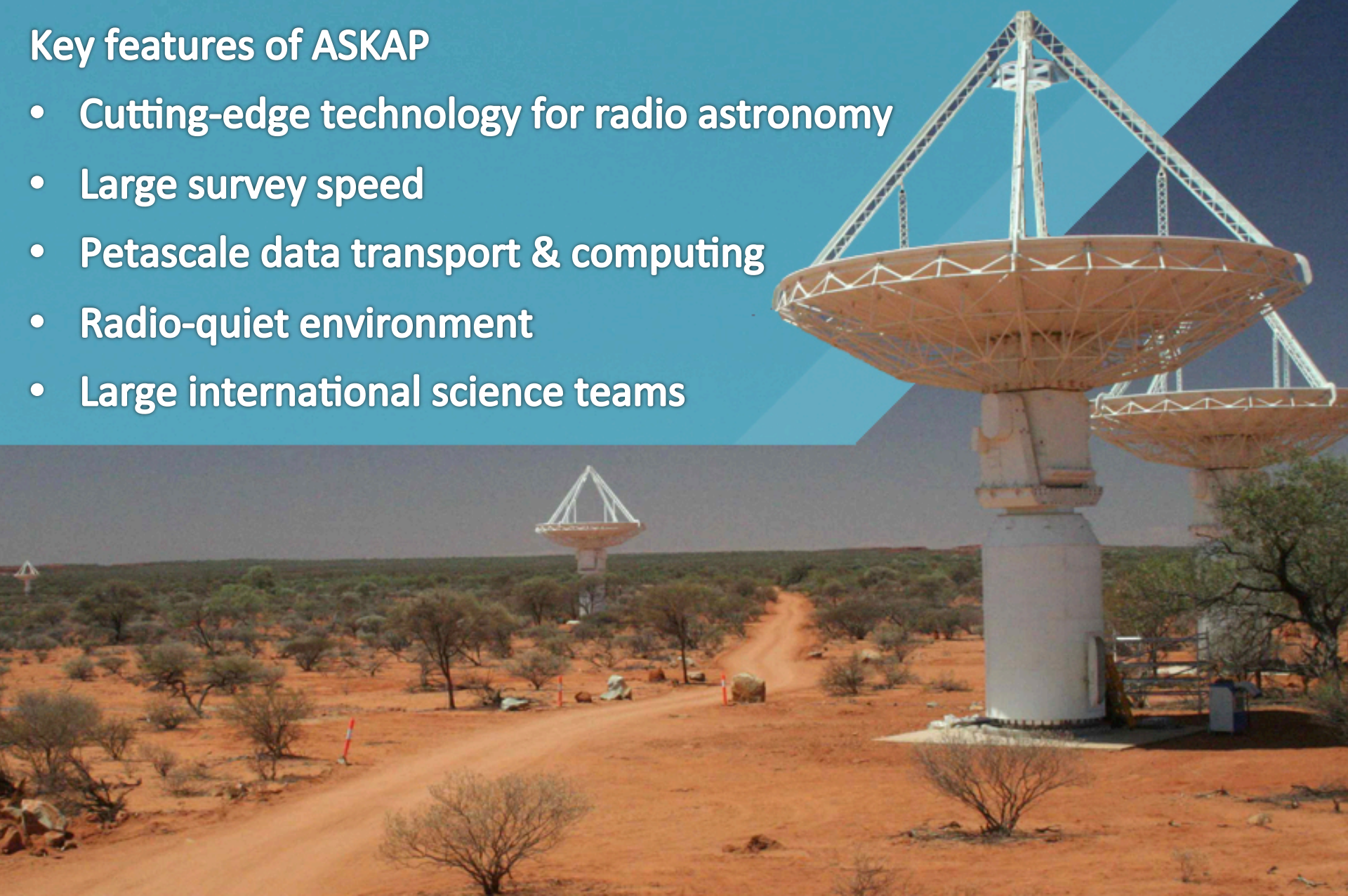
AREA: 1 NL

POPULATION: 114

DENSITY: 2.7 mPeople km⁻²

Key features of ASKAP

- Cutting-edge technology for radio astronomy
- Large survey speed
- Petascale data transport & computing
- Radio-quiet environment
- Large international science teams



ASKAP

36x 12-meter antennas

304 MHz instantaneous bandwidth

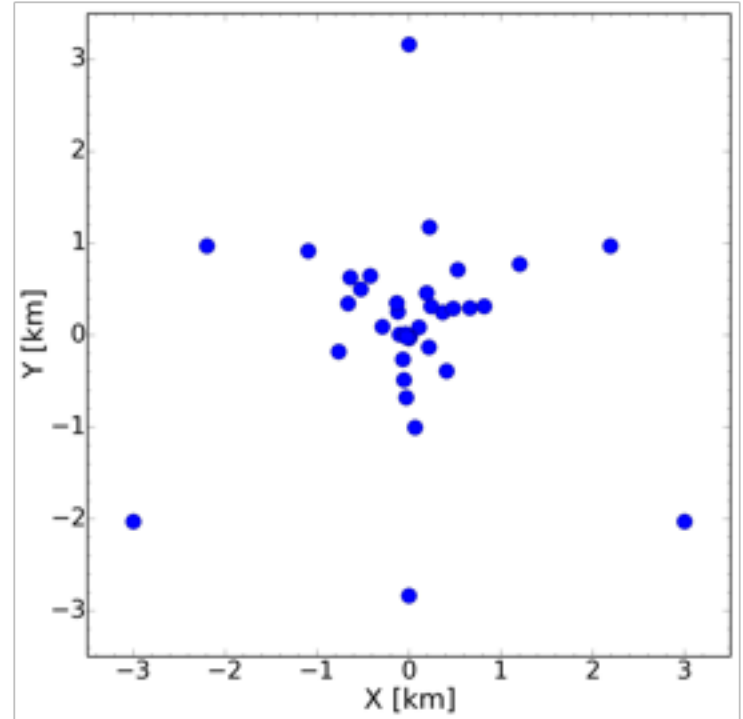
Frequency range: 700 – 1800 MHz

Spectral resolution: 18.4 kHz

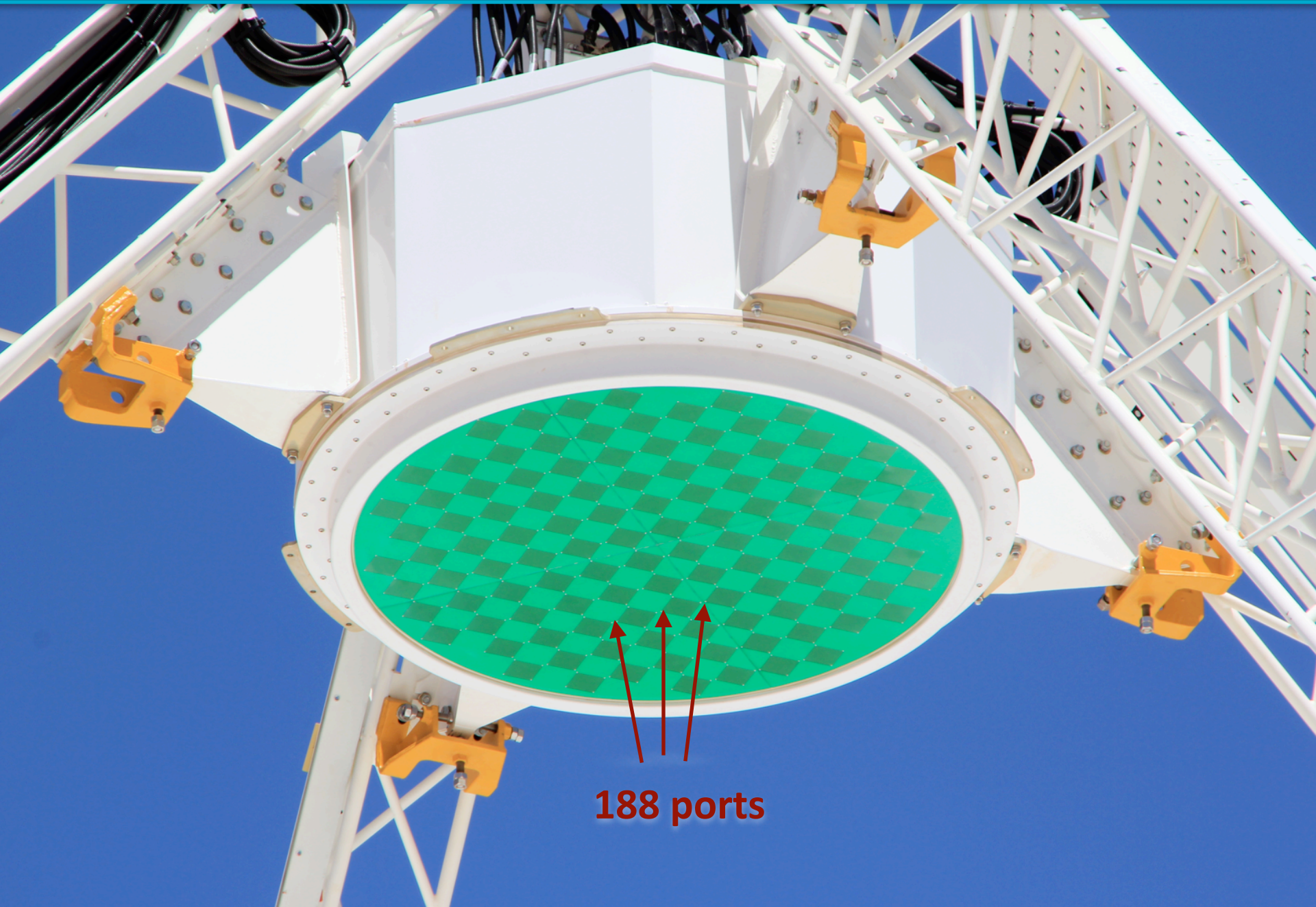
Tsys / efficiency: ~ 85 K

Baseline lengths: 23m – 6km

Up to 36 electronically formed beams

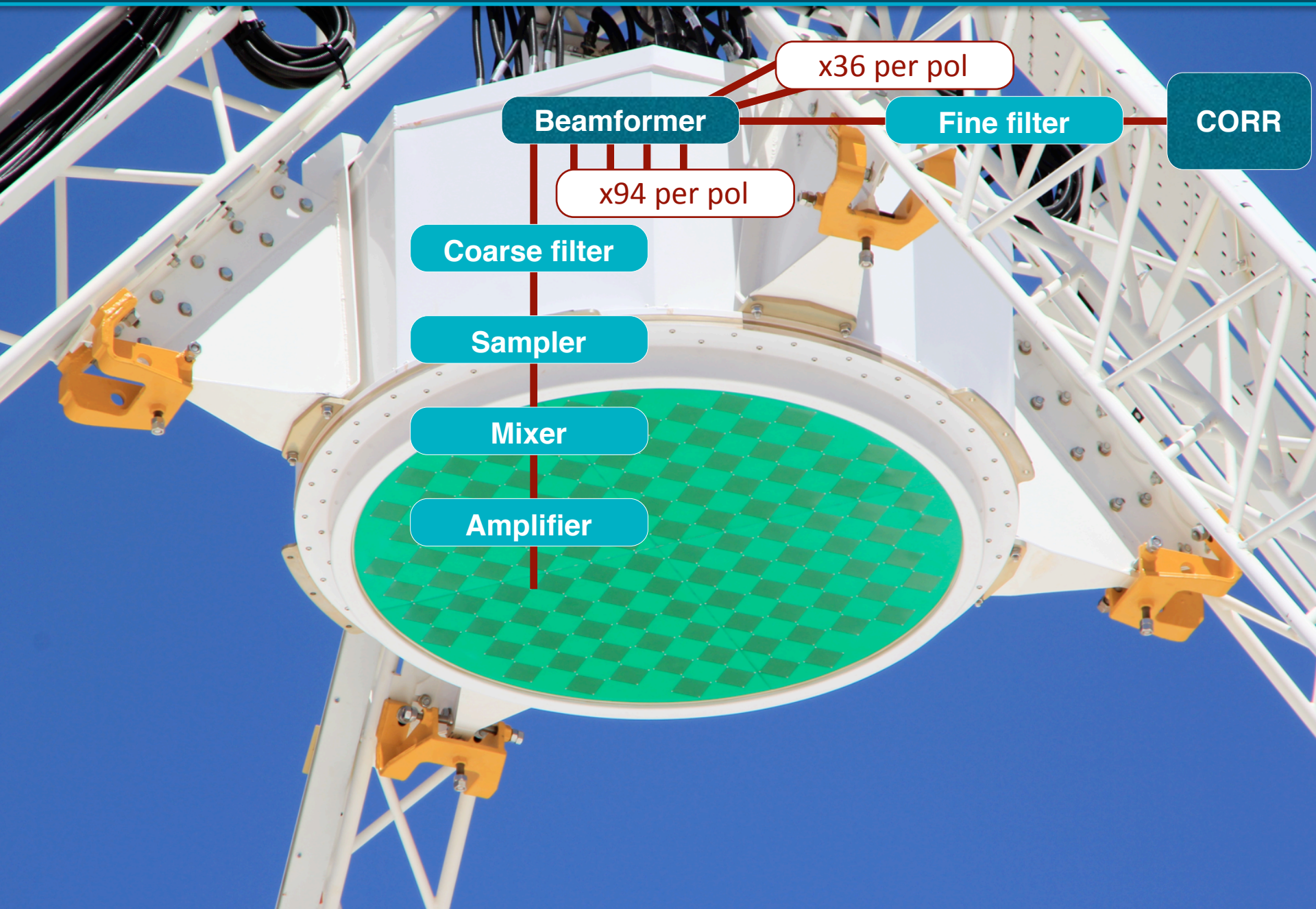


ASKAP's Phased Array Feed (PAF)



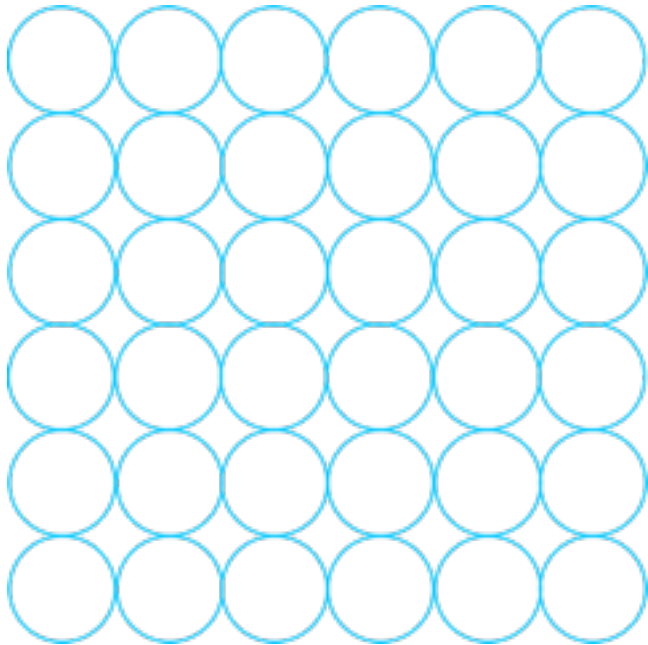
188 ports

ASKAP's Phased Array Feed (PAF)



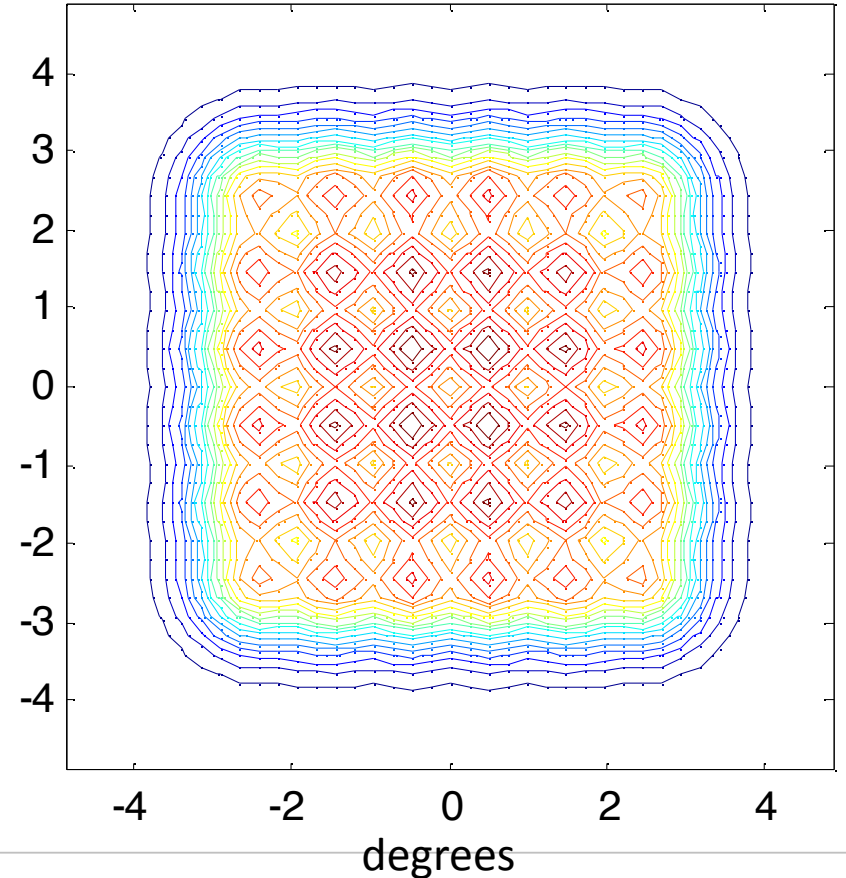
ASKAP's Phased Array Feed (PAF)

36 beams



Instantaneous 30 deg^2 FOV

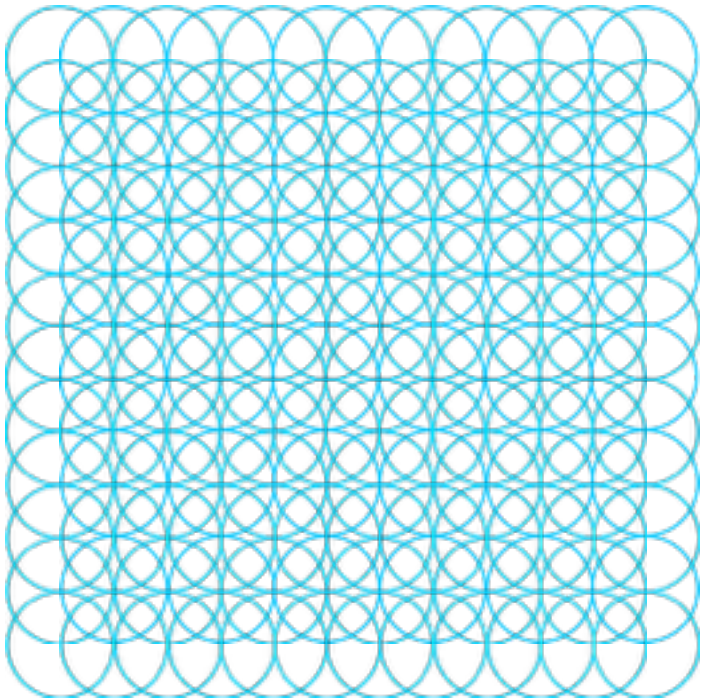
Sensitivity (5% contours)



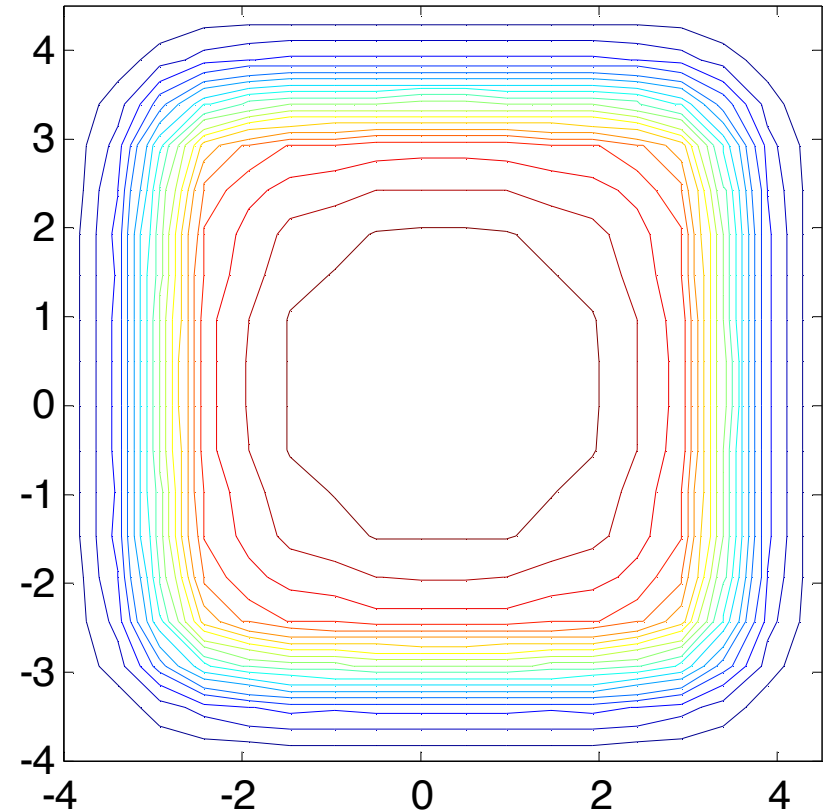
(Bunton & Hay, ICEAA, 2010)

ASKAP's Phased Array Feed (PAF)

36 beams + 4x interleaving



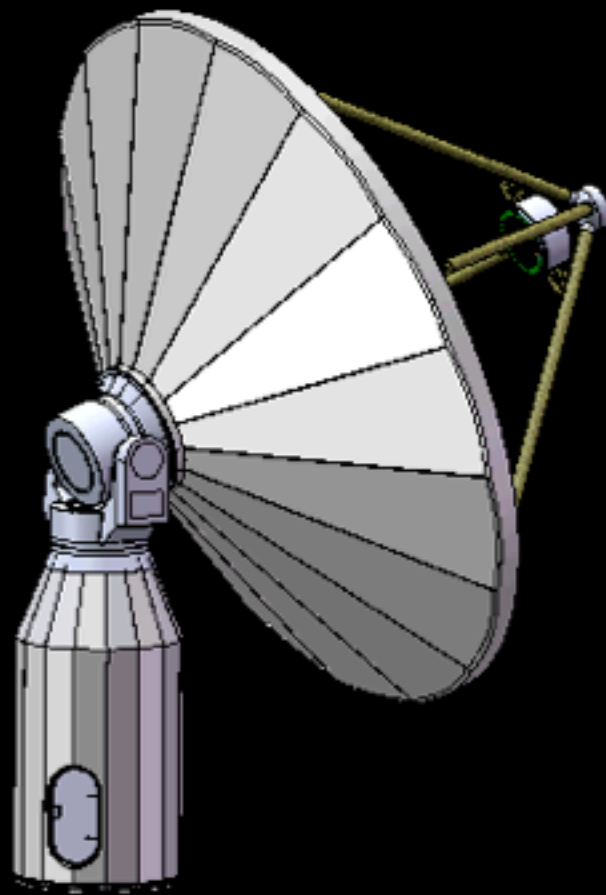
Sensitivity (5% contours)



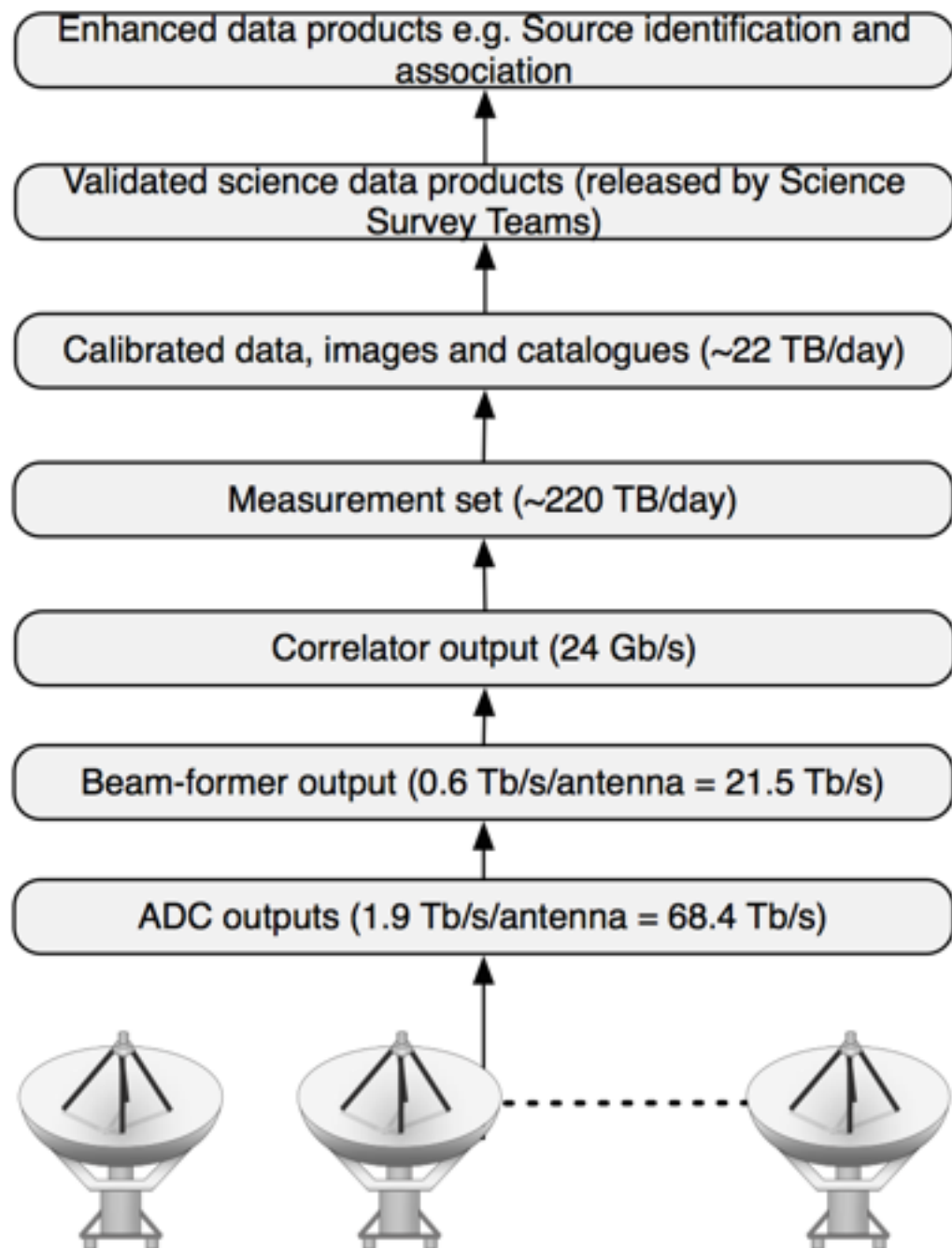
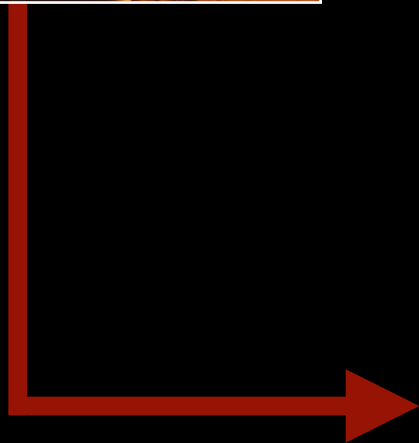
degrees

(Bunton & Hay, ICEAA, 2010)

ASKAP's 3-axis Antenna



ASKAP Data Rates



ASKAP Processing

ASKAP Processing Platform



Pawsey Supercomputing Center



Cray XC30 Series Supercomputer

472 Compute Nodes:

- 2 x 3.0 GHz Intel Xeon CPUs
- 10 Cores per CPU
- 64 GB DDR3-1866
- Cray Aries Interconnect
- Cray Dragonfly Topology
- 200 TeraFLOPS

1.4 Petabytes Lustre Data Storage

ASKAPsoft Data Pipelines

ASKAP Survey Science Projects

- EMU (Norris) — All sky continuum to 10 uJy rms
- WALLABY (Koribalski/Staveley-Smith) — All sky HI survey to $z \sim 0.2$
- GASKAP (Dickey/McClure-Griffiths) — Galactic & Magellanic HI/OH
- VAST (Murphy/Chatterjee) — Transients and variables (>5 sec)
- CRAFT (Hall) — Fast transients (<5 sec)
- FLASH (Sadler) — HI absorption to $z \sim 1$
- POSSUM (Gaensler/Landecker/Taylor) — Polarization / RM grid
- DINGO (Meyer) — Deep HI emission survey
- COAST (Stairs) — Pulsar timing and searching
- VLBI (Tingay) — ASKAP as part of the LBA

Open access call for proposals. 10 Large Projects chosen. Some 350 co-authors. Data to be made immediately public.

BETA

6x 12-meter antennas

304 MHz instantaneous bandwidth

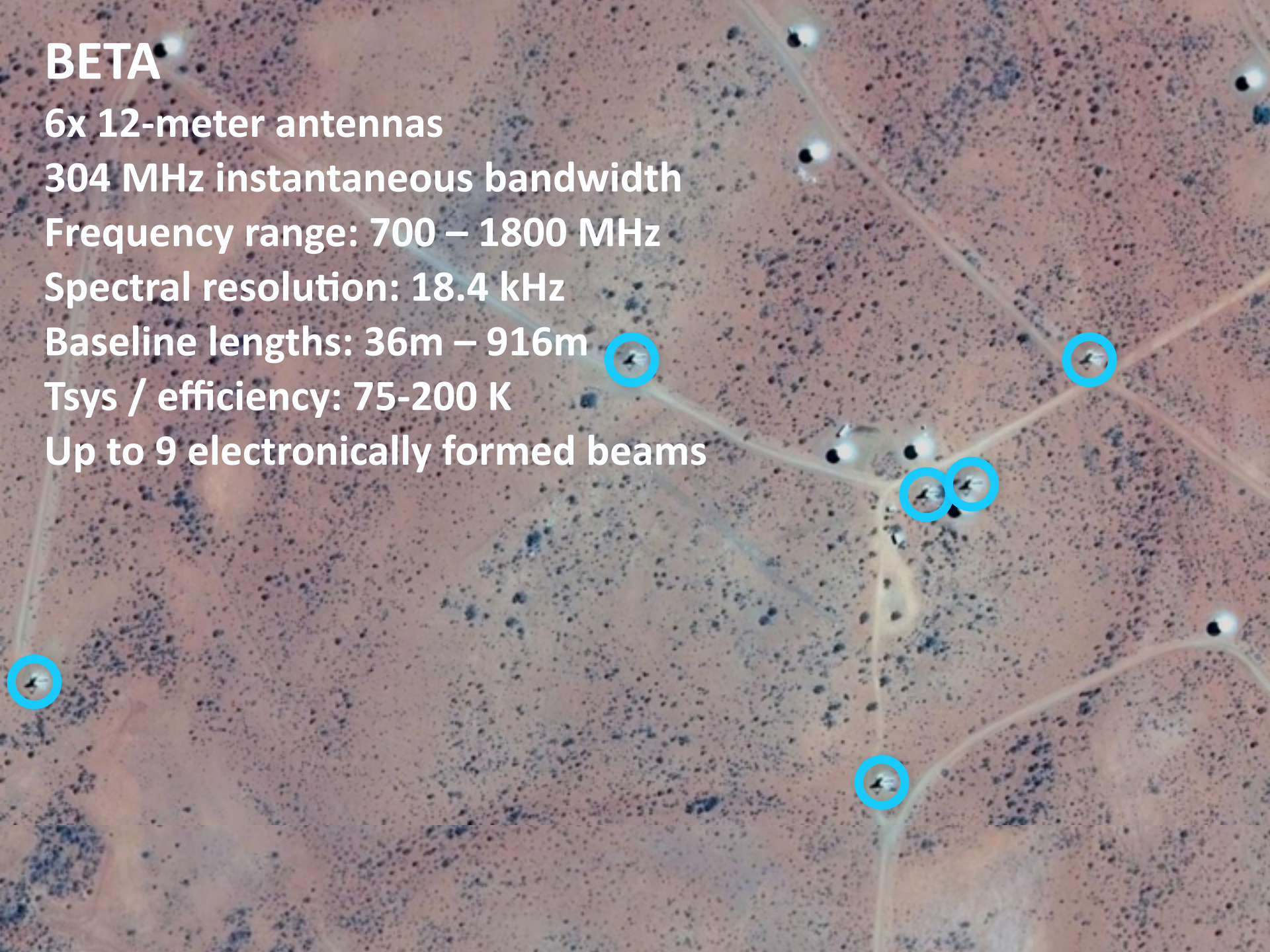
Frequency range: 700 – 1800 MHz

Spectral resolution: 18.4 kHz

Baseline lengths: 36m – 916m

Tsys / efficiency: 75-200 K

Up to 9 electronically formed beams



The ASKAP Commissioning & Early Science Team

James Allison, Keith Bannister, Martin Bell, Hayley Bignall, Aaron Chippendale, Phil Edwards, Lisa Harvey-Smith, Sarah Hegarty, Ian Heywood, Aidan Hotan, Balt Indermuehle, Emil Lenc, Josh Marvil, **Dave McConnell**, Chris Phillips, Attila Popping, Pietro Procopio, John Reynolds, Bob Sault, Paolo Serra, Max Voronkov, Matt Whiting



BETA commissioning projects include:

Pointing calibration

Polarimetric characterization

Beam forming methods

Beam stability investigations

Beam shape measurements

Sensitivity & efficiency

RFI environment

Reduction pipelines

Up to 36 electronically formed beams

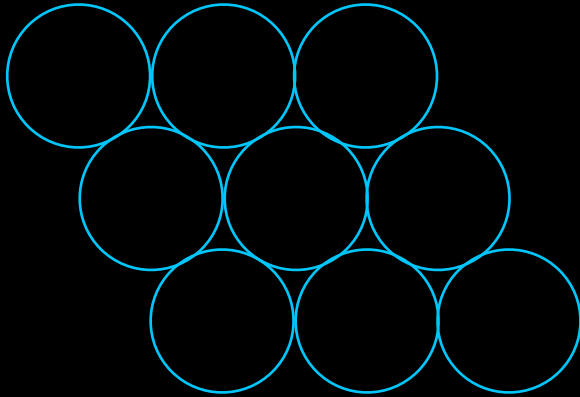


BETA

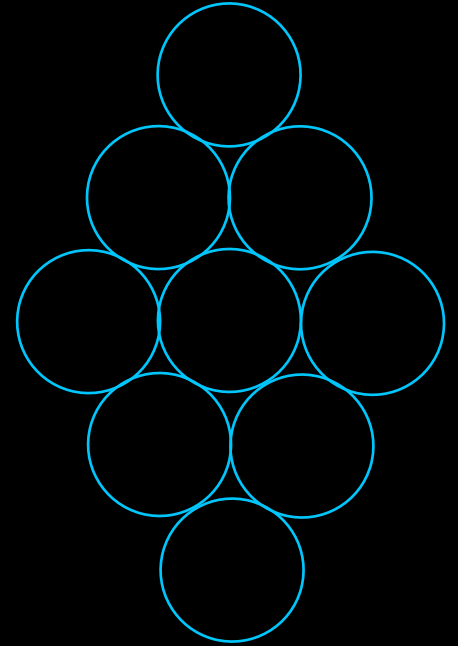
Wide-field Continuum Imaging Examples

by Ian Heywood

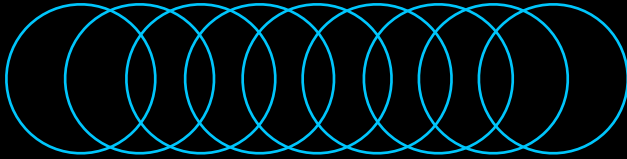
FLEXIBLE FOOTPRINTS



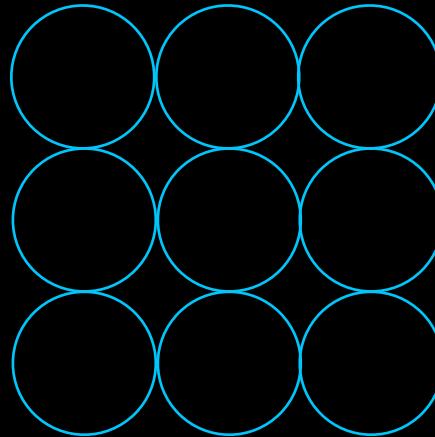
Rhombus



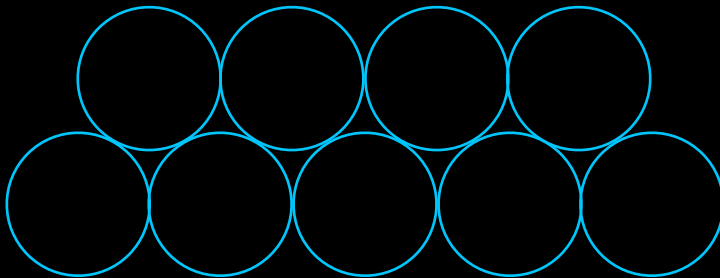
Diamond



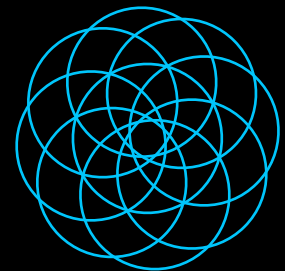
Line



Square

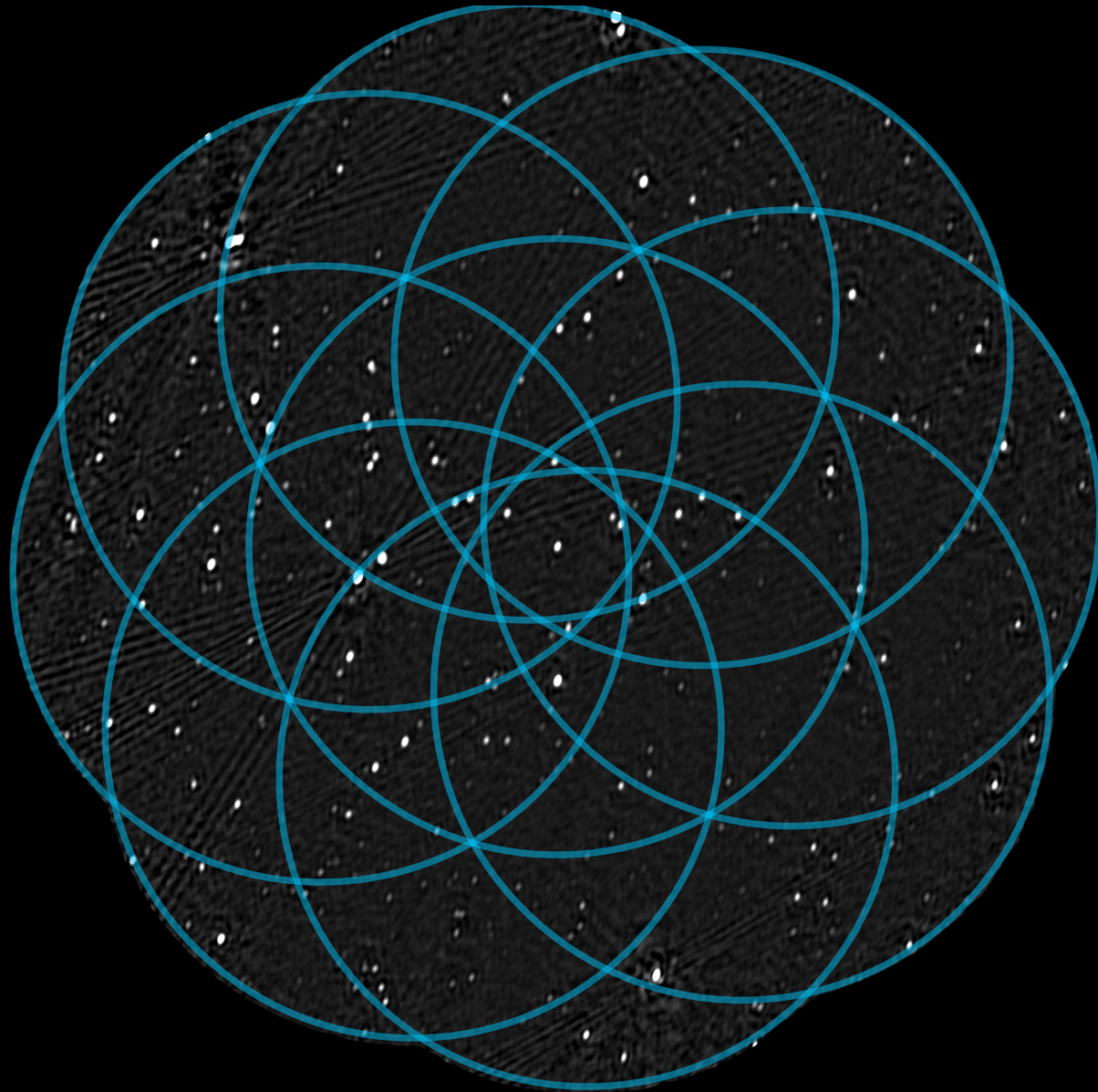


Trapezoid



Spirograph

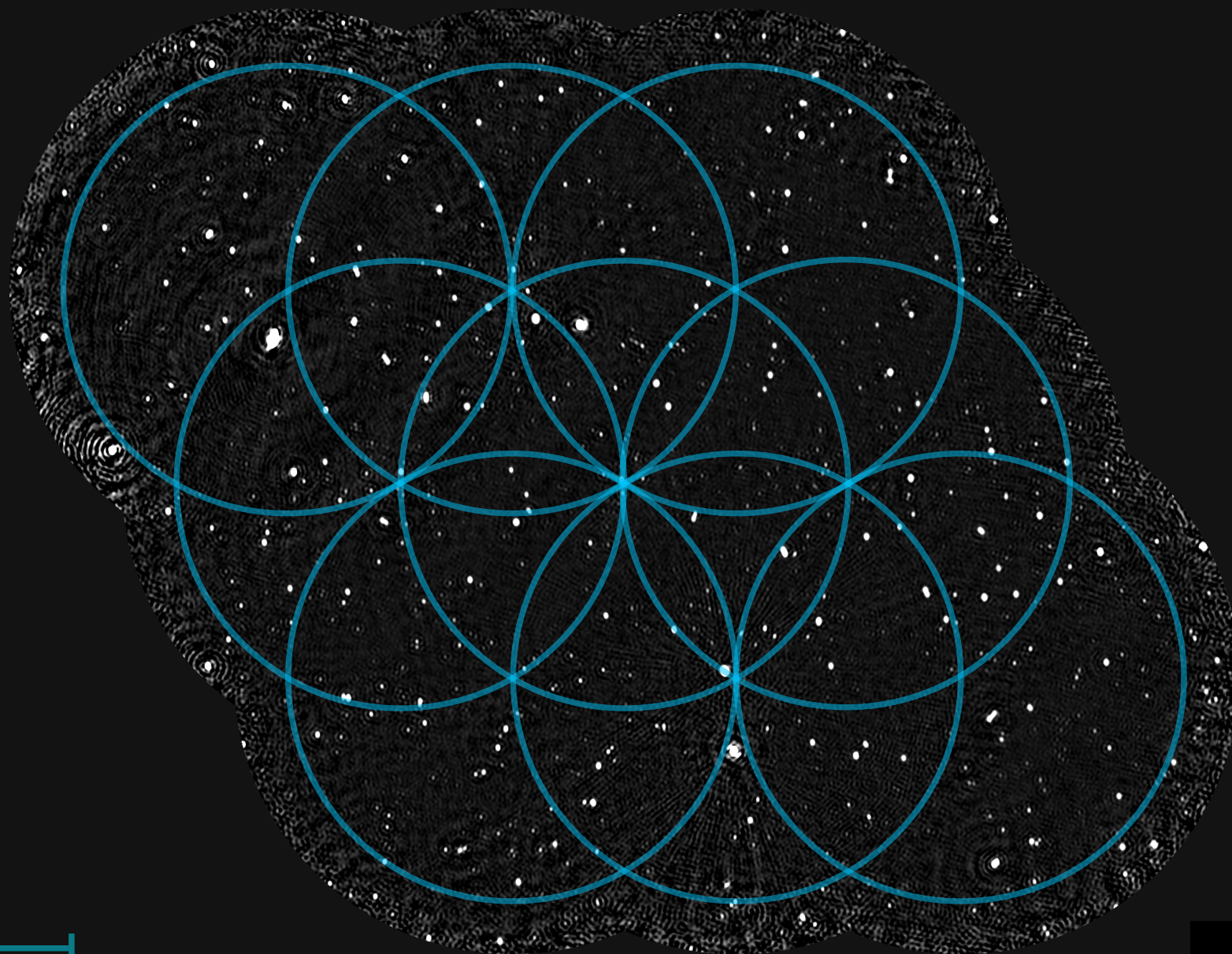
Spirograph



1°



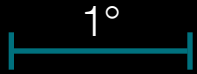
Rhombus



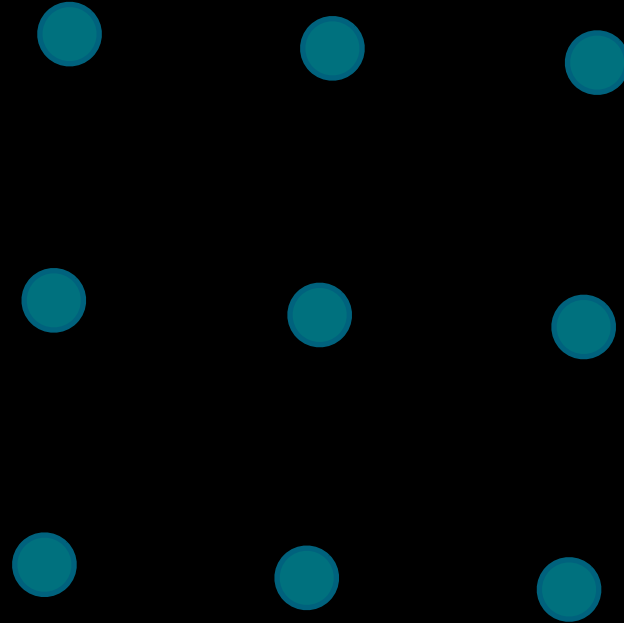
1°



INTERLEAVING AND WIDE FIELD CONTINUUM IMAGING

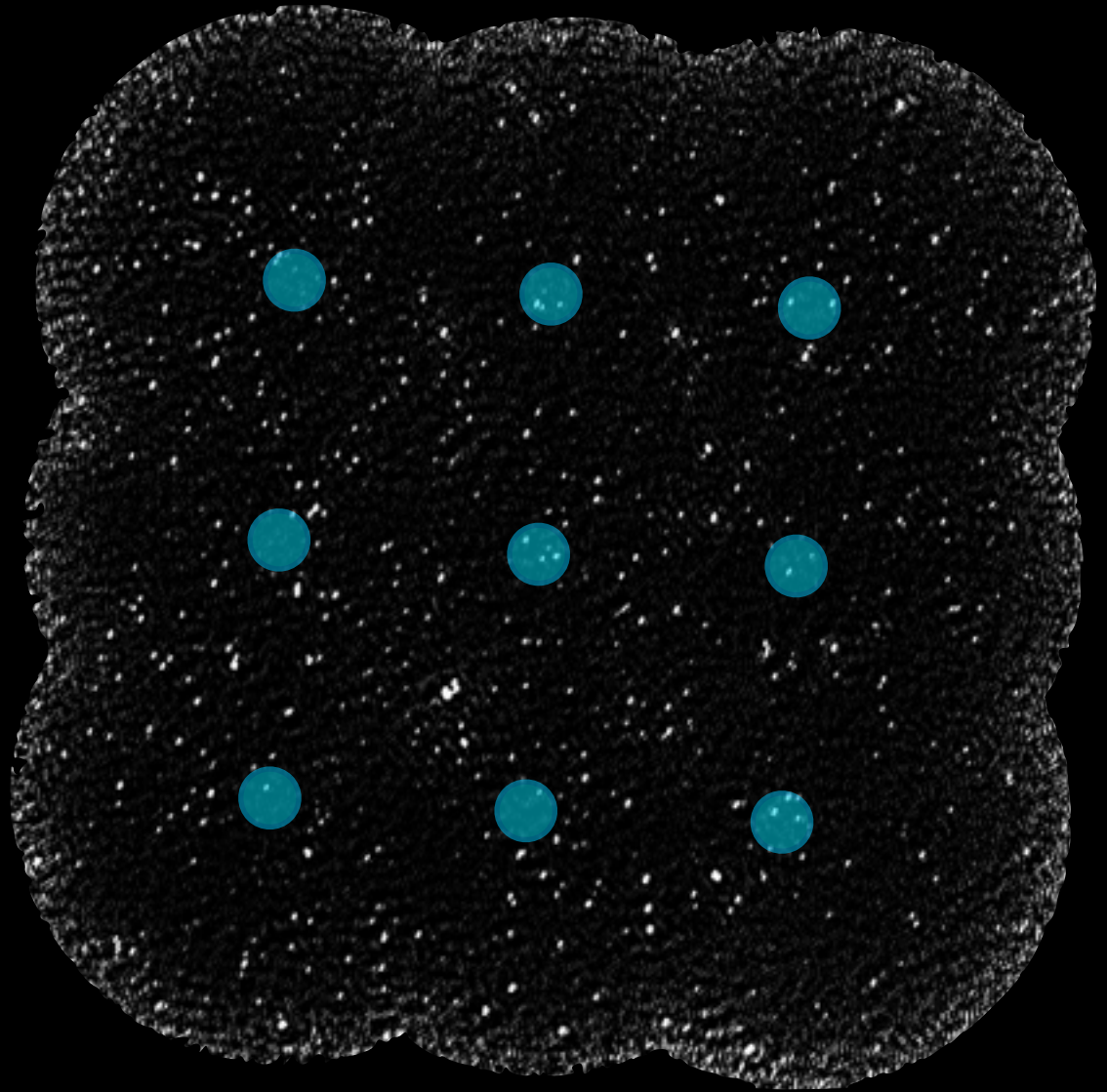


“Square” beam pattern, 1.46° pitch



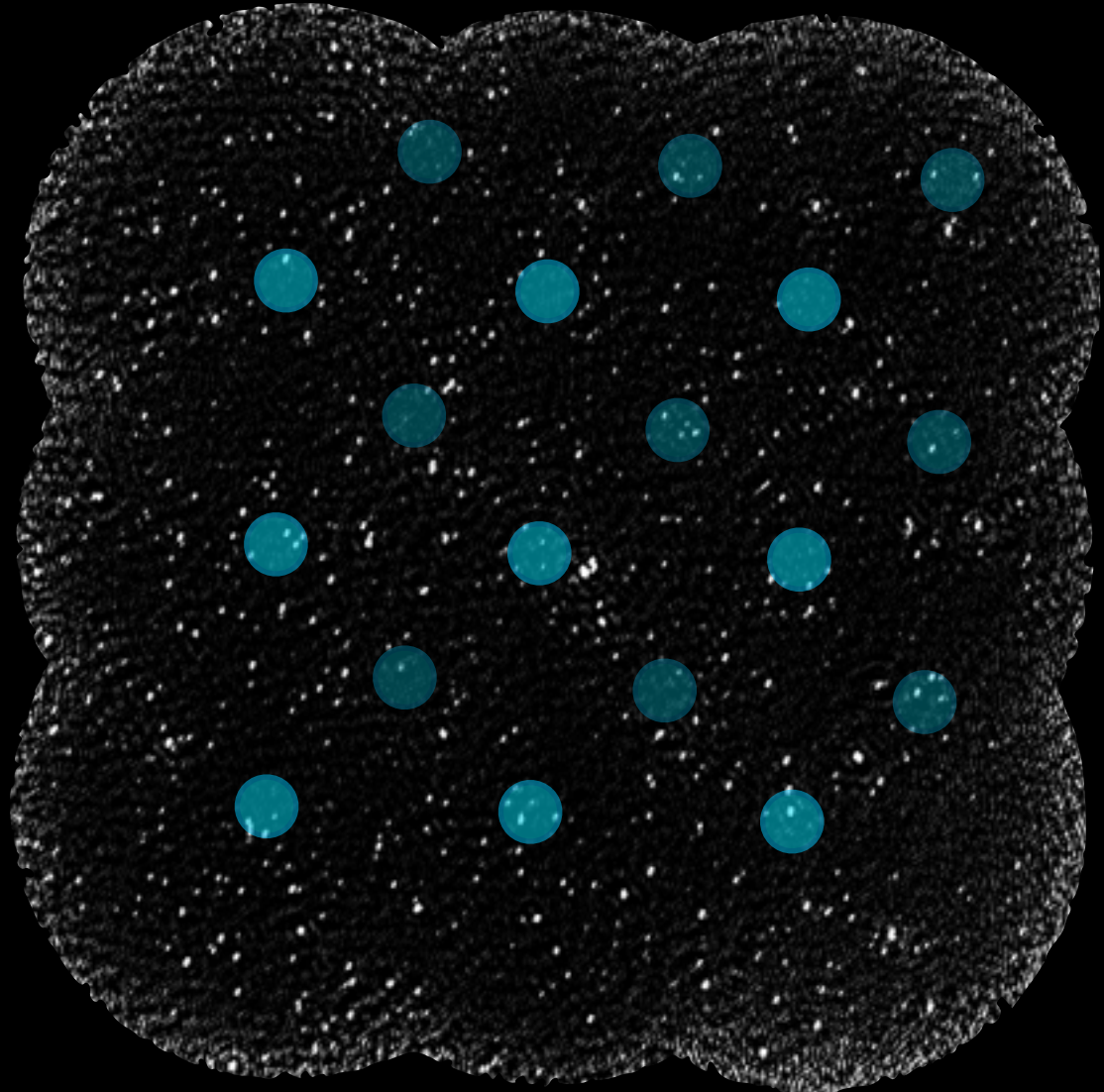
INTERLEAVING AND WIDE FIELD CONTINUUM IMAGING

1°

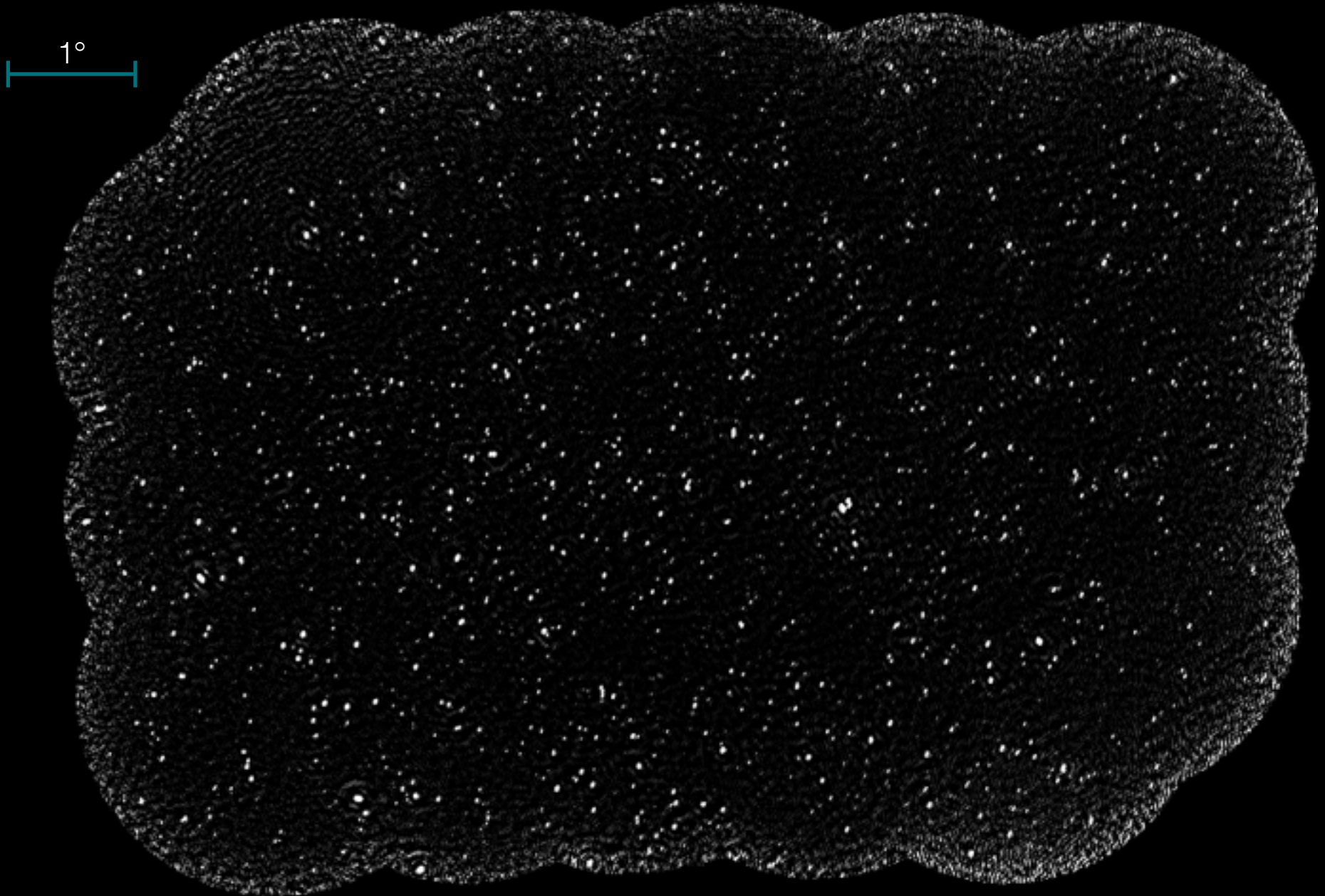
A horizontal scale bar with vertical end caps, indicating a width of 1 degree.

INTERLEAVING AND WIDE FIELD CONTINUUM IMAGING

1°

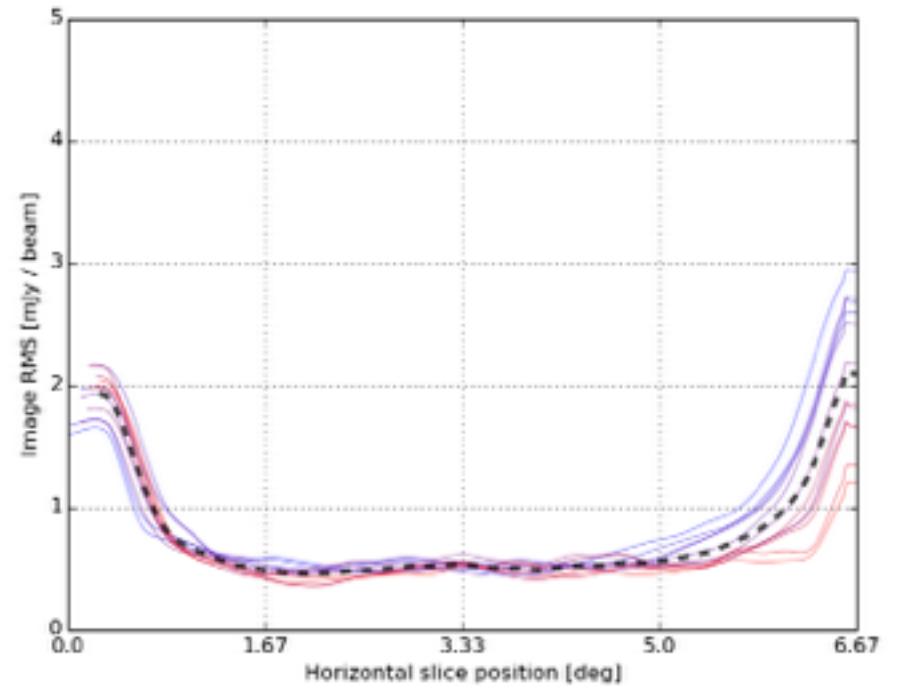
A horizontal scale bar with vertical end caps, indicating a width of 1 degree.

INTERLEAVING AND WIDE FIELD CONTINUUM IMAGING



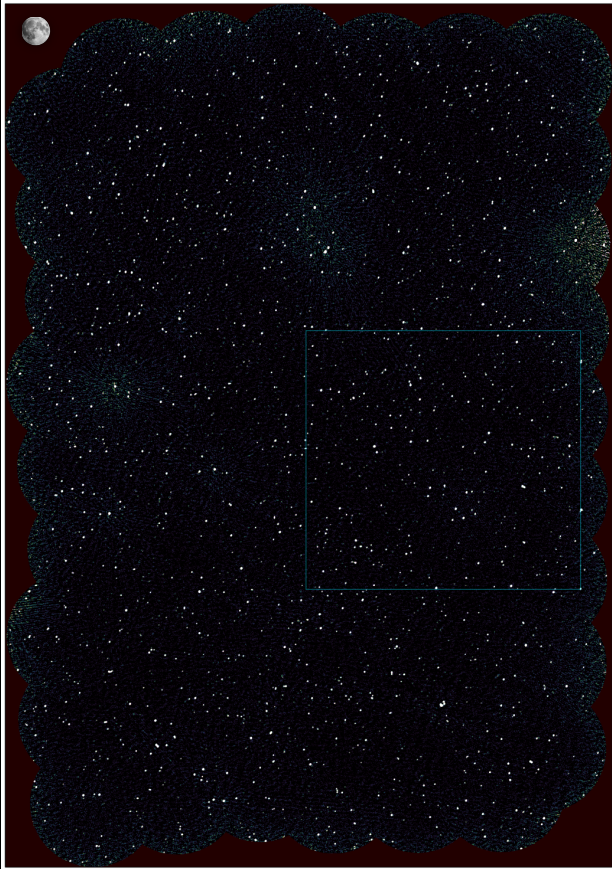
INTERLEAVING AND WIDE FIELD CONTINUUM IMAGING

1°



TUCANA 'WIDE'

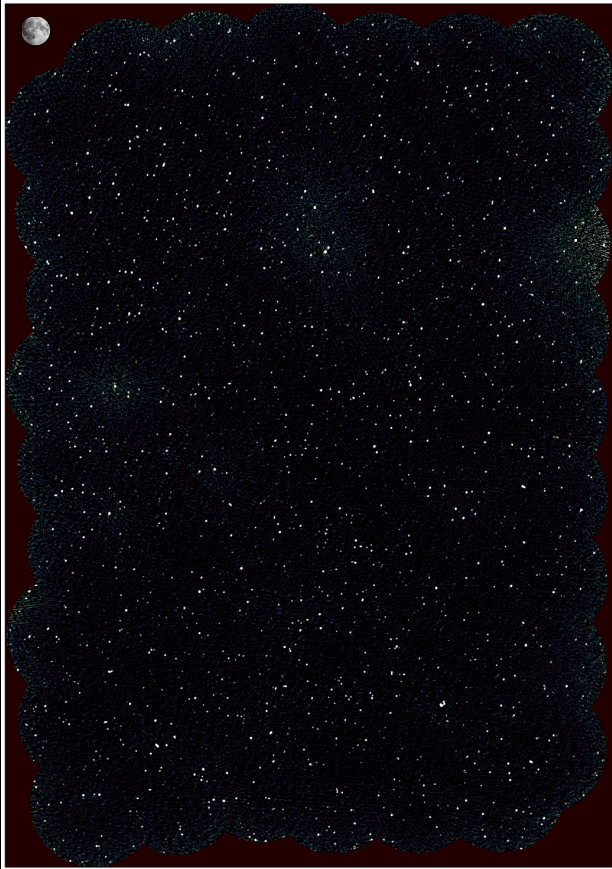
SB 1206



1 SB • 12 pointings • 150 sq. deg. • 12 hours • <1 mJy RMS • $\sim 2,000$ sources $>5\sigma$

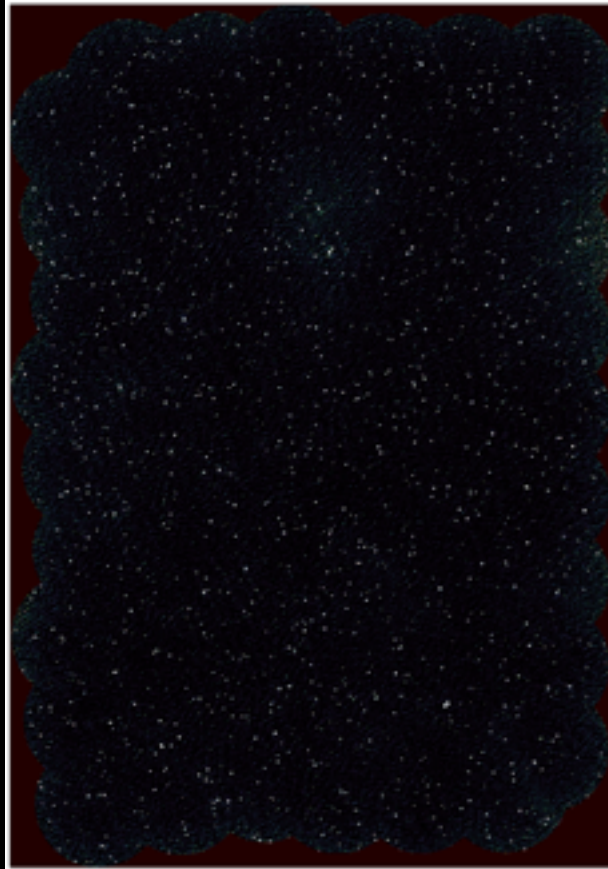
TUCANA 'WIDE'

SB 1206



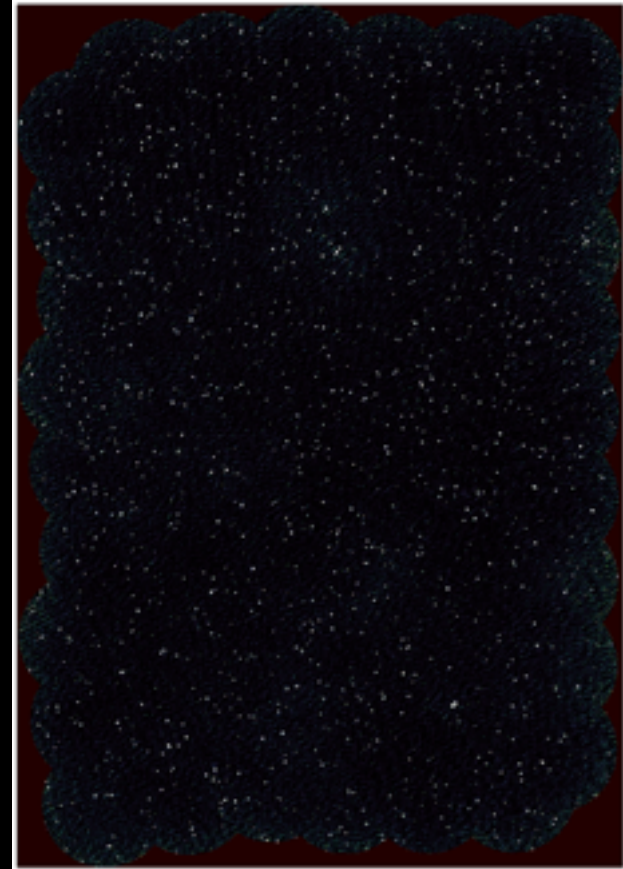
02 / 12 / 14

SB 1229



07 / 12 / 14

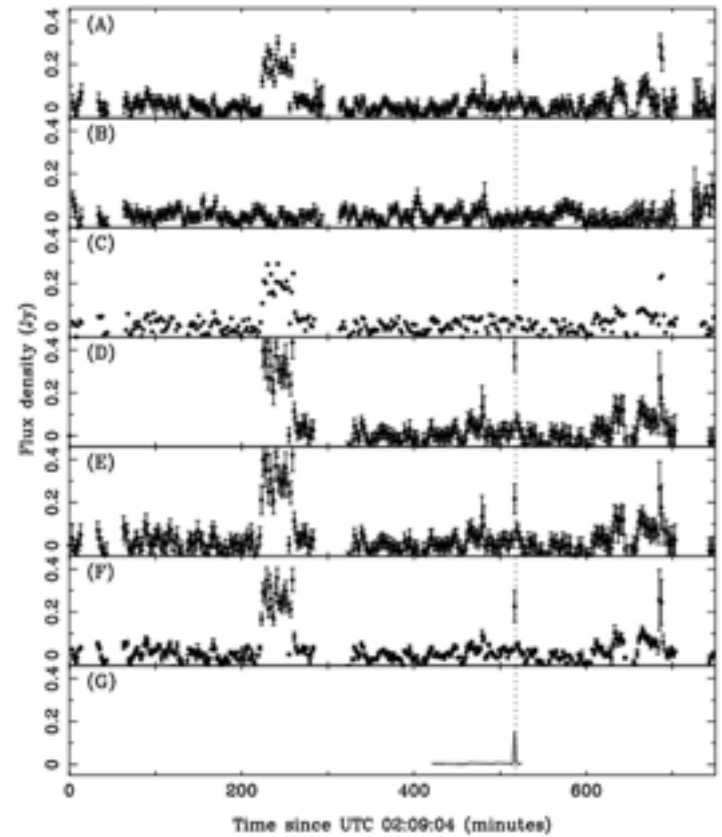
SB 1231



08 / 12 / 14

Same SB executed on three different nights • excellent stability • VAST analysis underway

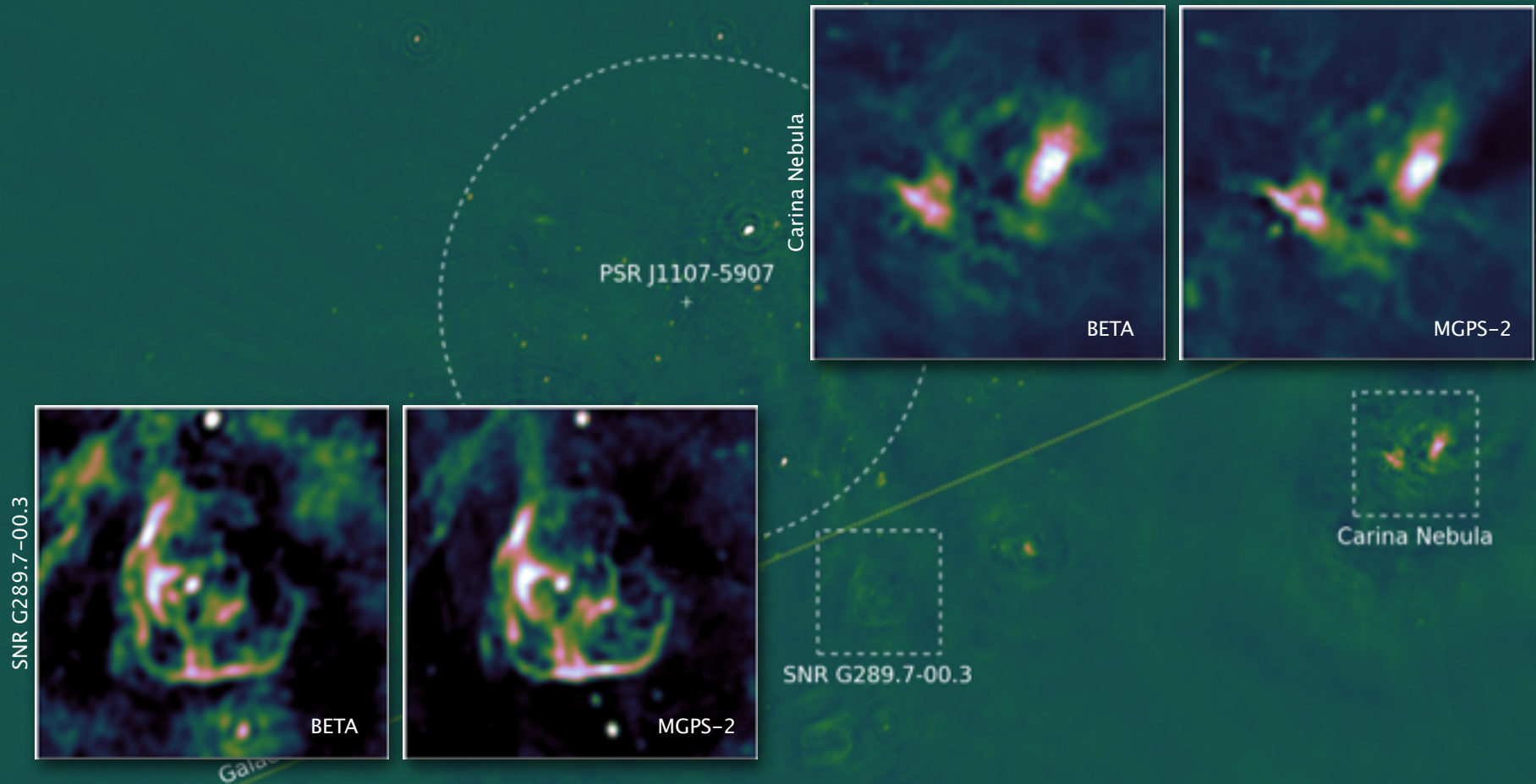
GALACTIC PLANE OBSERVATIONS / AN INTERMITTENT PULSAR



1°

Hobbs et al. (MNRAS, submitted)

GALACTIC PLANE OBSERVATIONS / AN INTERMITTENT PULSAR



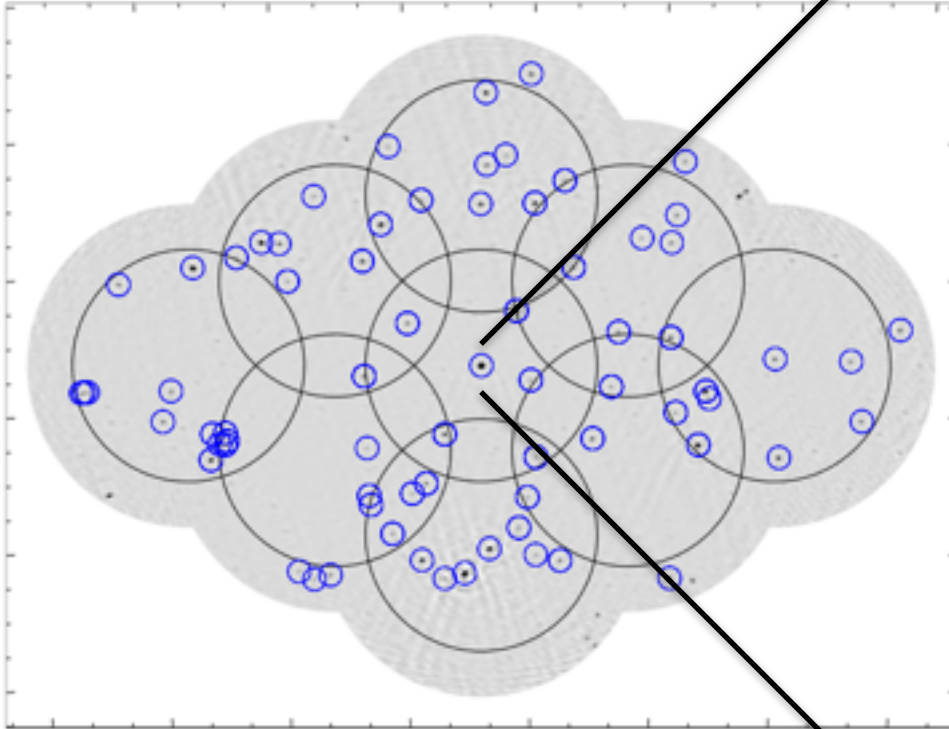
1°

Hobbs et al. (MNRAS, submitted)

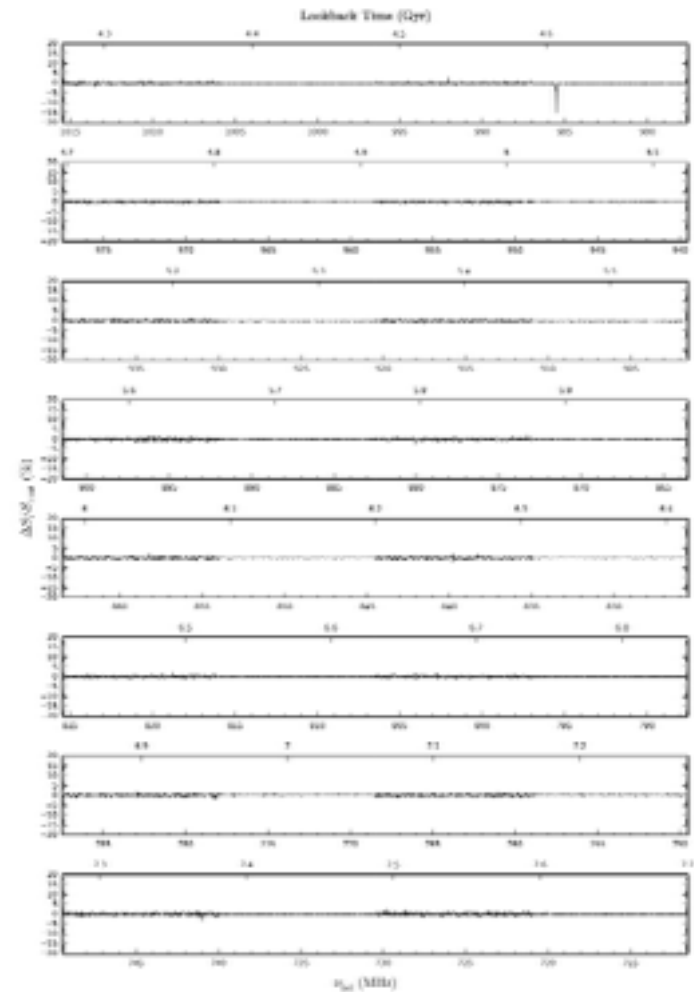
PKS B1740-517 – first blind detection of HI

(Allison et al., MNRAS, accepted)

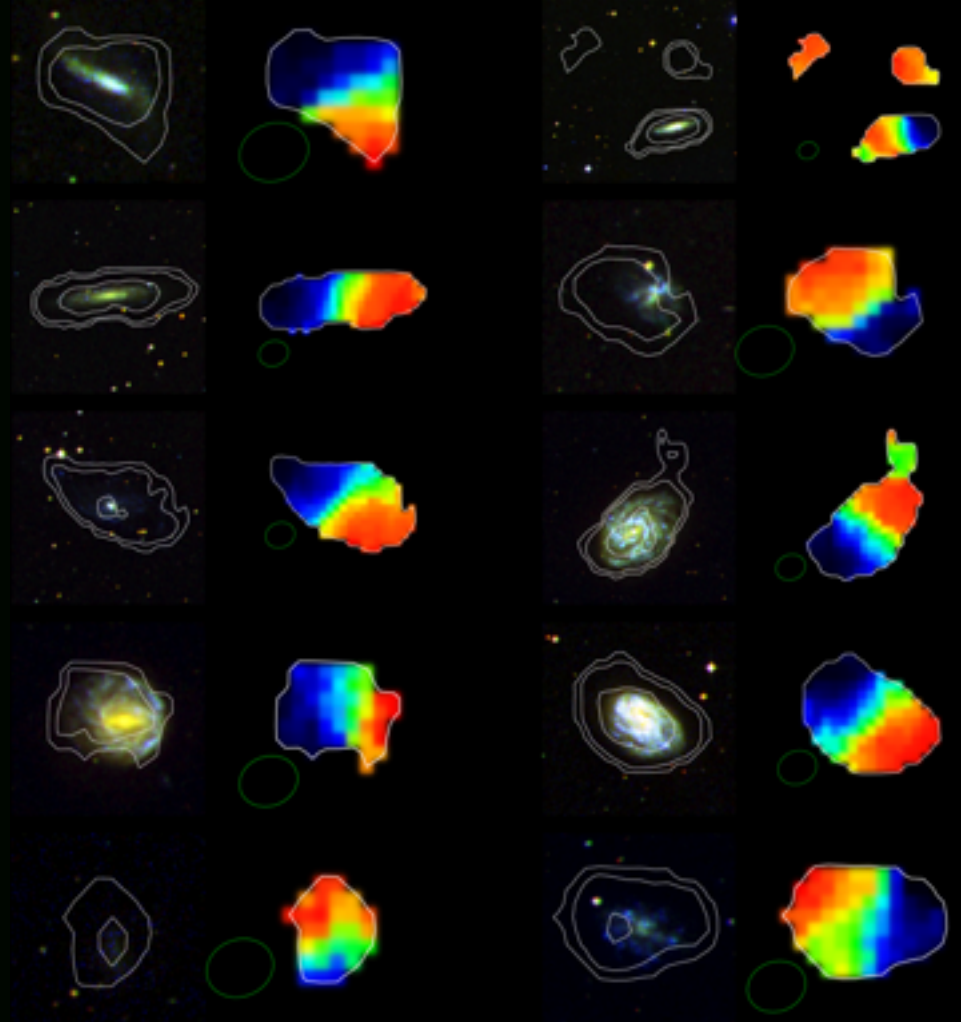
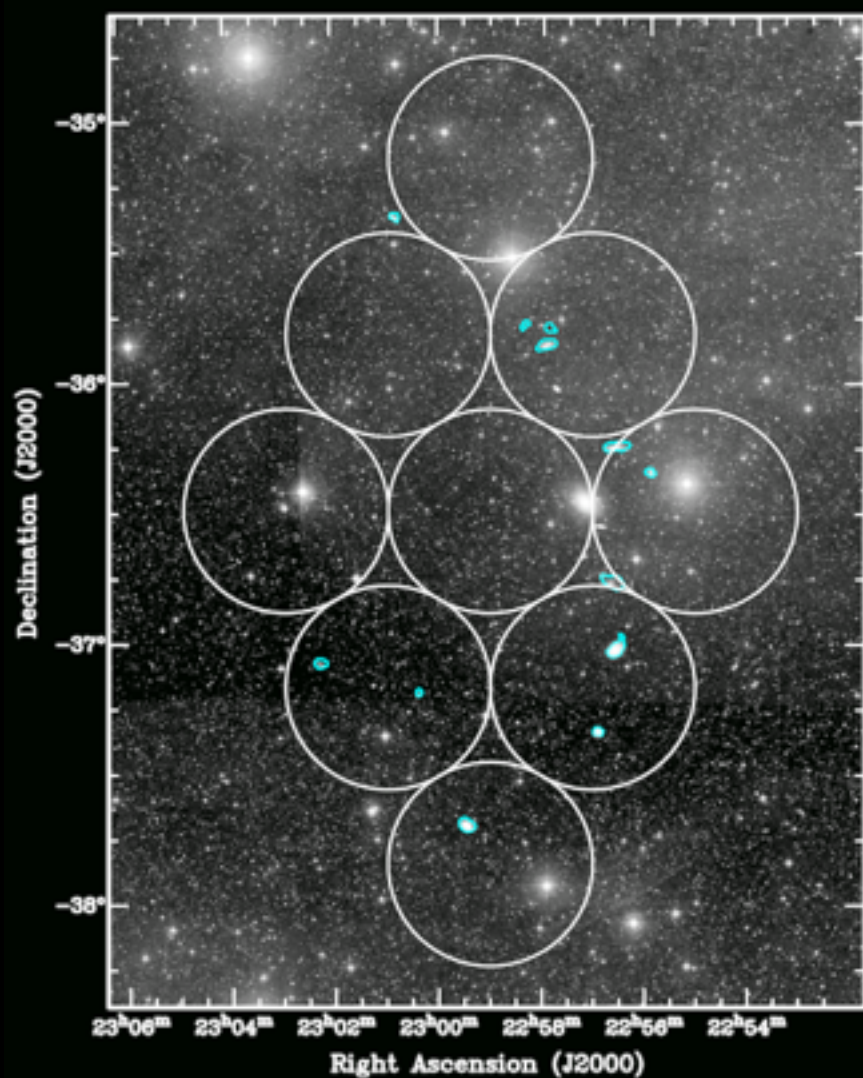
- 711.5 - 1015.5 MHz Band $\rightarrow z = 0.4 - 1$
- 16,416 x 18.5 kHz (~ 5 km/s) channels



8Jy compact radio source, redshift unknown, close to the galactic plane and centre



NEUTRAL HYDROGEN IN EMISSION



HI in the galaxy group IC 1459 (Serra et al., MNRAS, accepted)

ASKAP-12 Early Science (2016-17)

Wide area continuum observations in full stokes.

700 -1800 MHz with 6 - 12 hrs integration per field.

1000+ deg² to 40 uJy at 30".

Targeted spectral line observations over 1150-1450 MHz
towards ~10 fields, with 50-60 hours per field.

All-sky shallow continuum survey to construct an initial sky
model for the ASKAPsoft calibration pipeline.



Science topics include:

Radio Statistics

Cosmology

Star-Forming Galaxies

Discovering the Unknown

Variables & Slow Transients

Fast Transients

AGN Luminosity

AGN Kinematics

Galaxy Clusters

Local Galaxies

Deep HI observations

EOR Foregrounds



Possible fields include:

SPT

CDFS

GAMA

ELAIS-S1

COSMOS

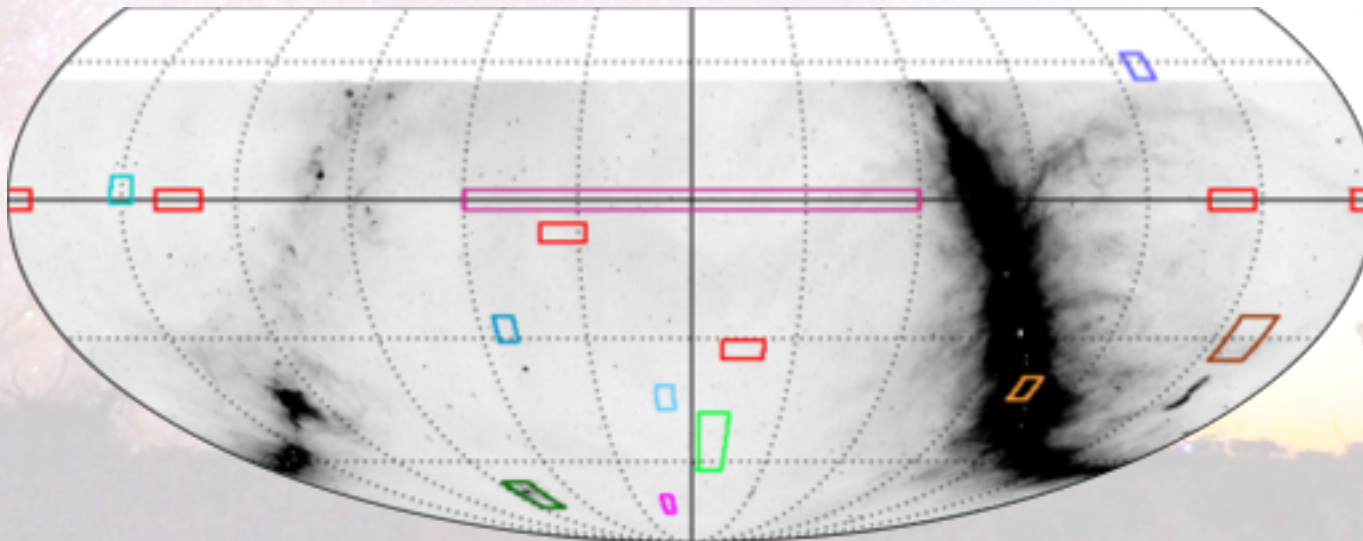
Stripe 82

Scorpio

Shapley

SPARCS-N

SMC & LMC



CSIRO acknowledges the Wajarri Yamatji people as the traditional owners of the land on which the observatory lies

Thank you

CSIRO Astronomy & Space Science

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