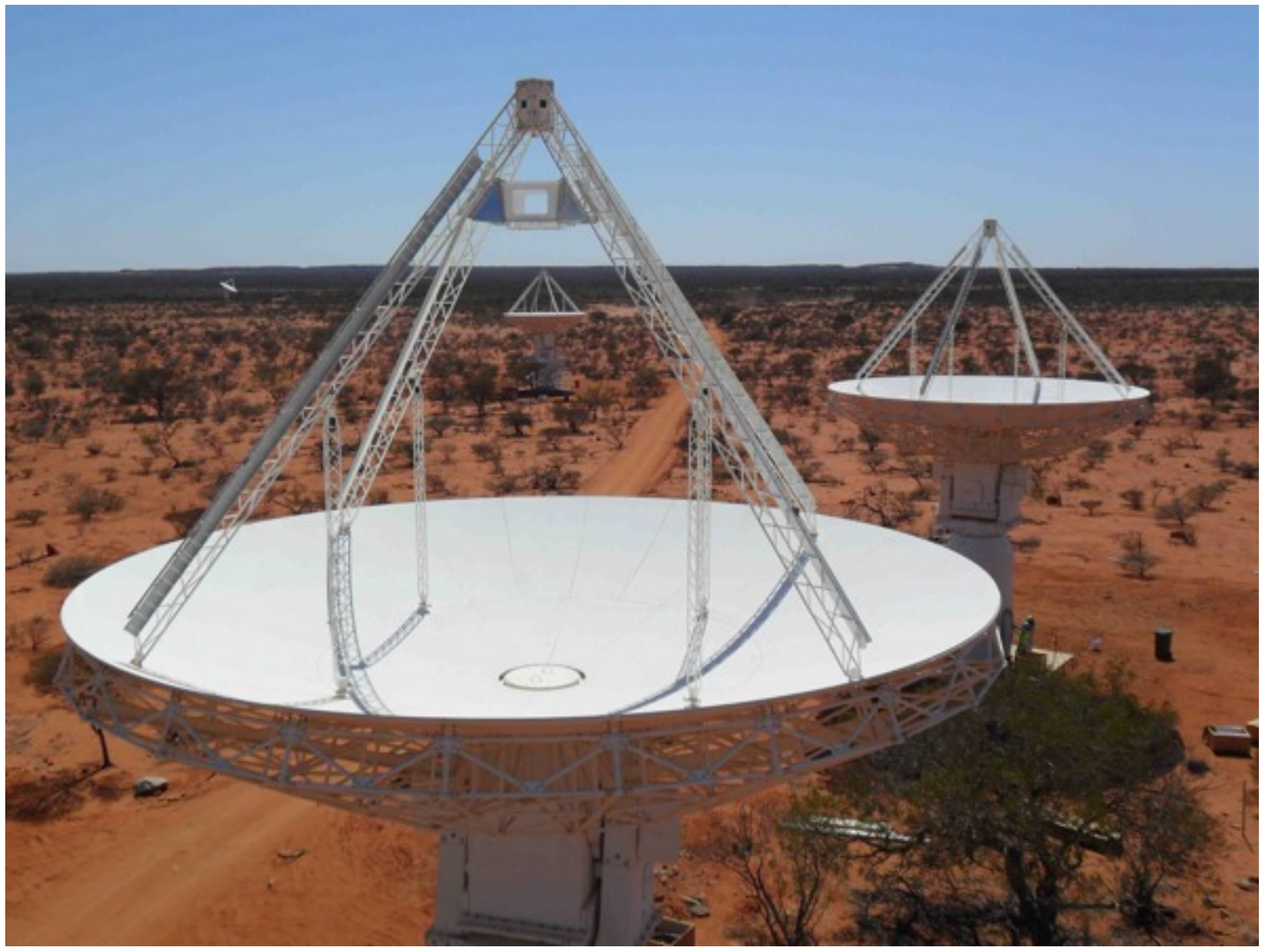
www.csiro.au

# ASKAP Status

**Tim Cornwell, ASKAP Computing Project Lead**
**Australian Square Kilometre Array Pathfinder**

CSIRO

# Australian SKA Pathfinder = 1% SKA

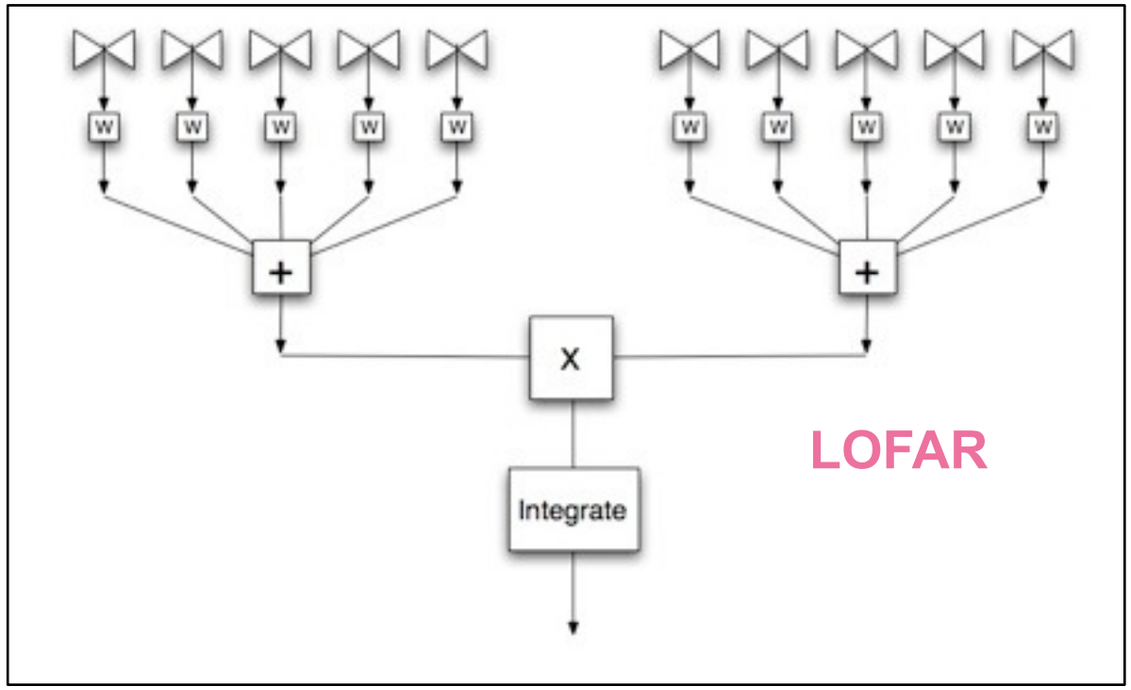


- Fastest survey radio telescope in the world
- Up to 2.4 Tpixel every 8 hours
- Sited at Boolardy, Western Australia
- 36 antennas compared to ~ 3600 for SKA
- First 6 antennas installed now

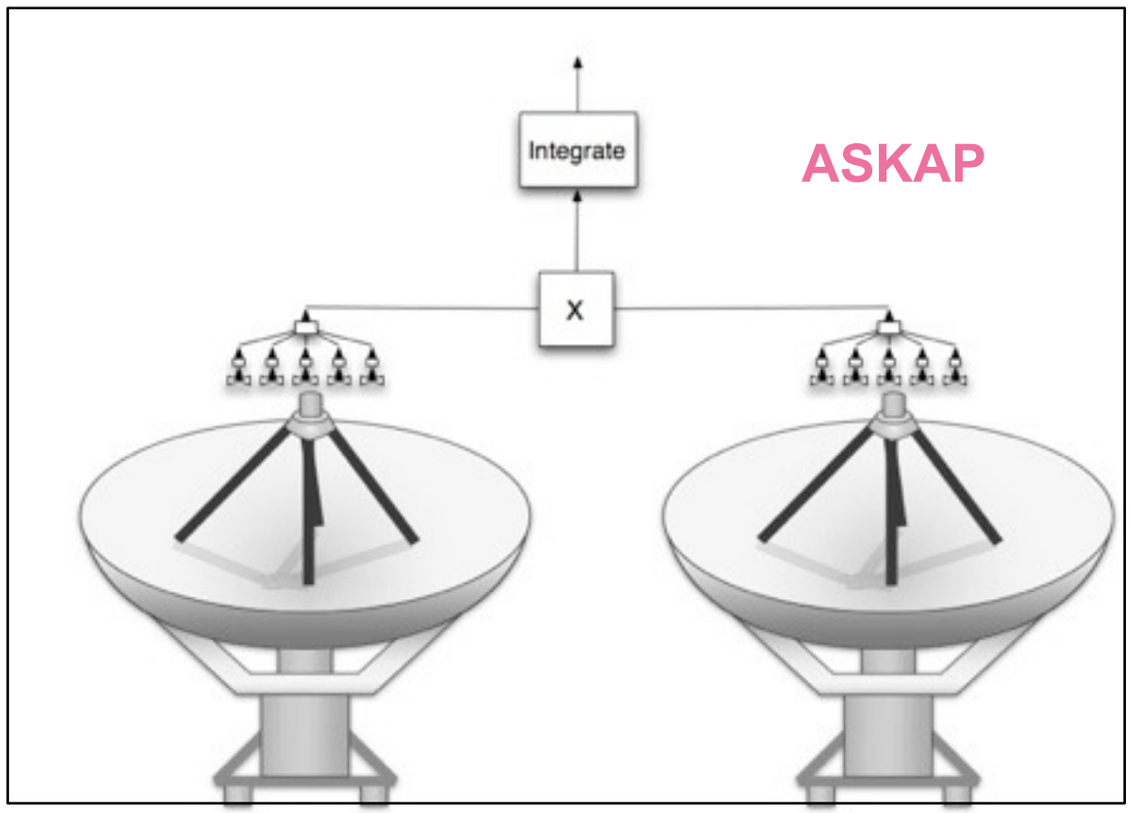
- 150MA$
- Early test observations December 2011
- Full observing 2013
- Demonstrates wide field of view technology for SKA

# Phased arrays for large field of view

- Located on the ground
  - Dense or sparse
  - Coordinate system = Earth
  - Can see whole sky
  - Strong projection effects

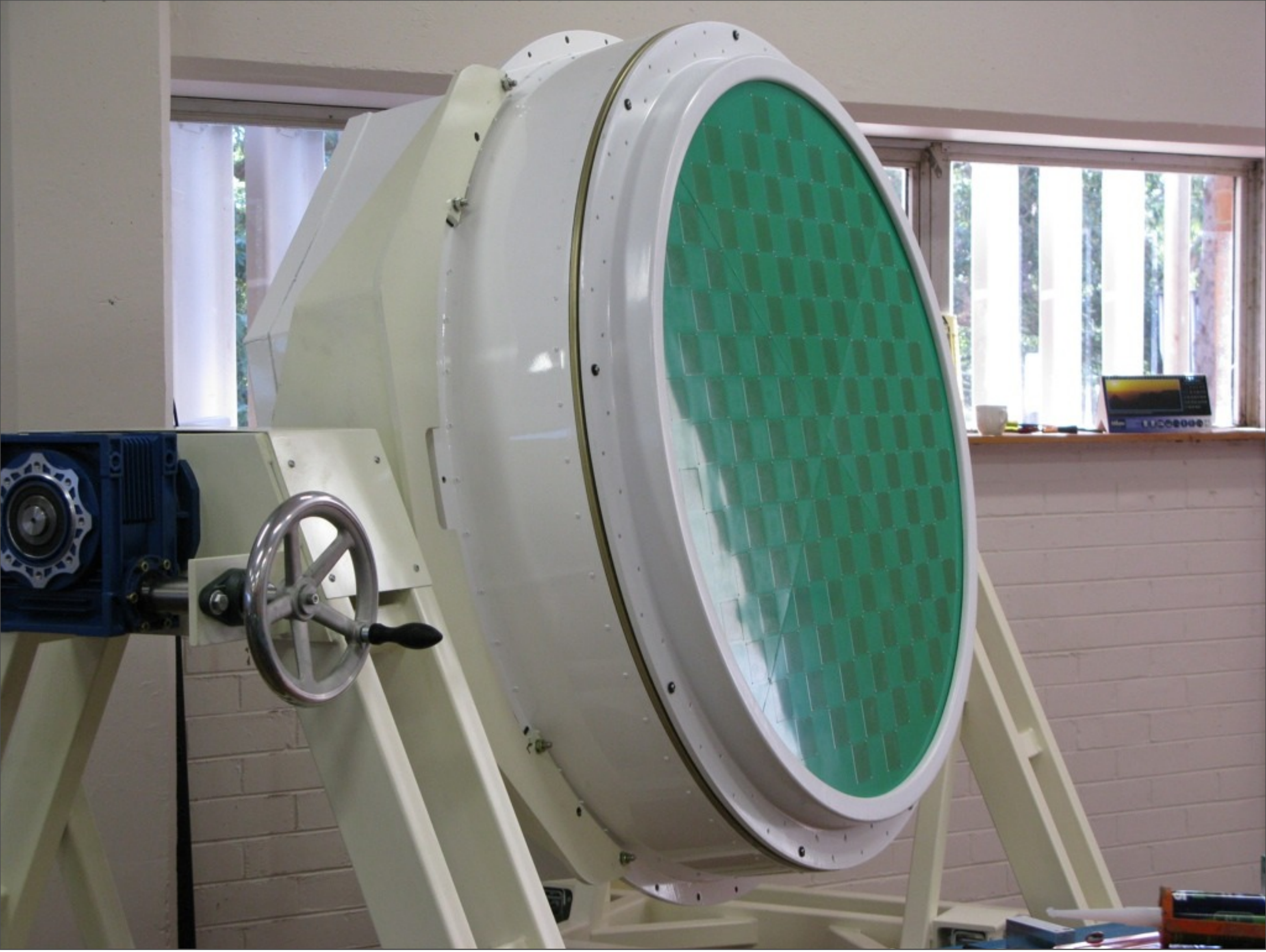



- Located at the antenna focal point
  - Coordinate system = celestial sphere
  - Can only see limited field of view
  - No projection effects
    - With suitable antenna mount



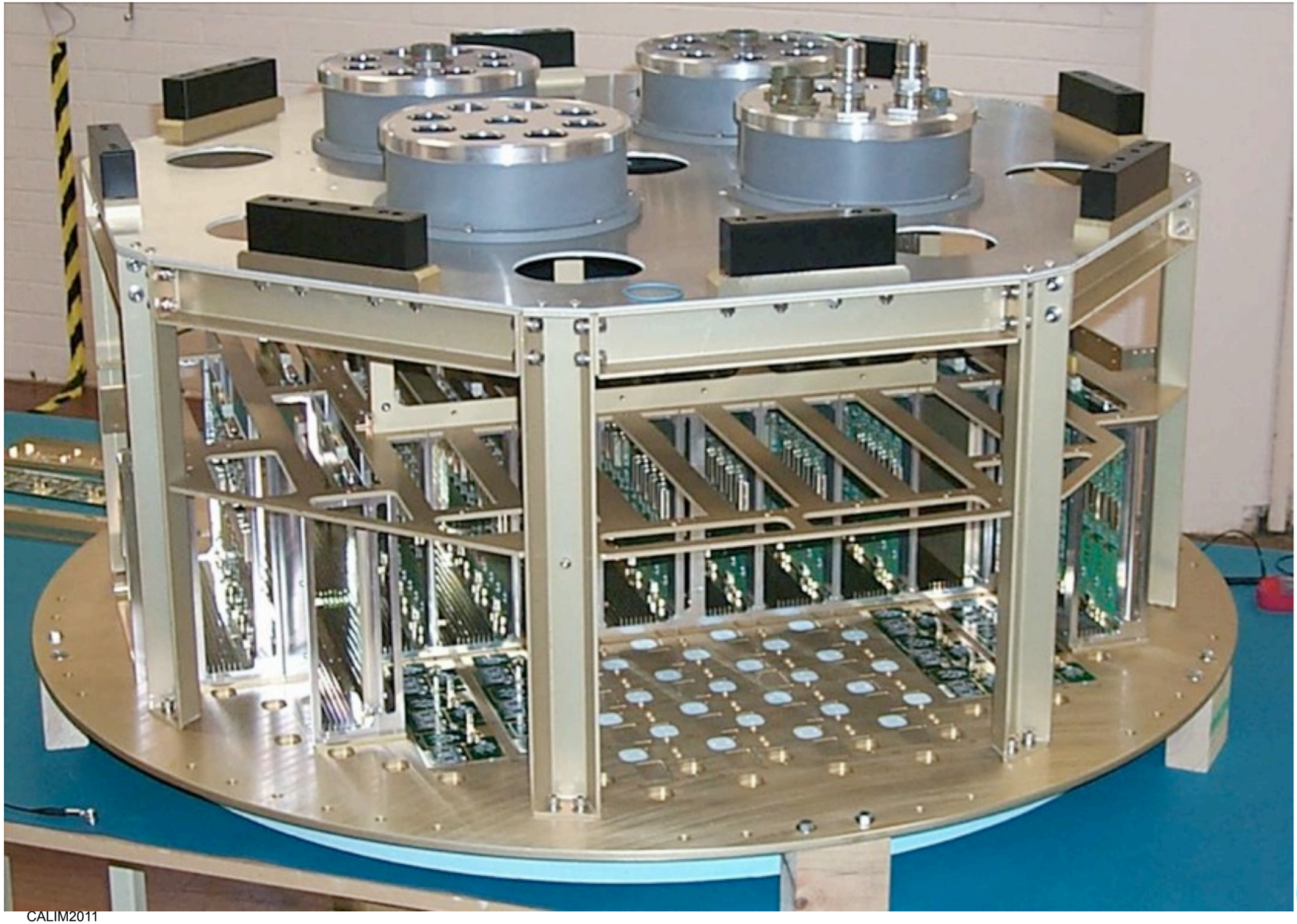
# ASKAP Phased Array Feed

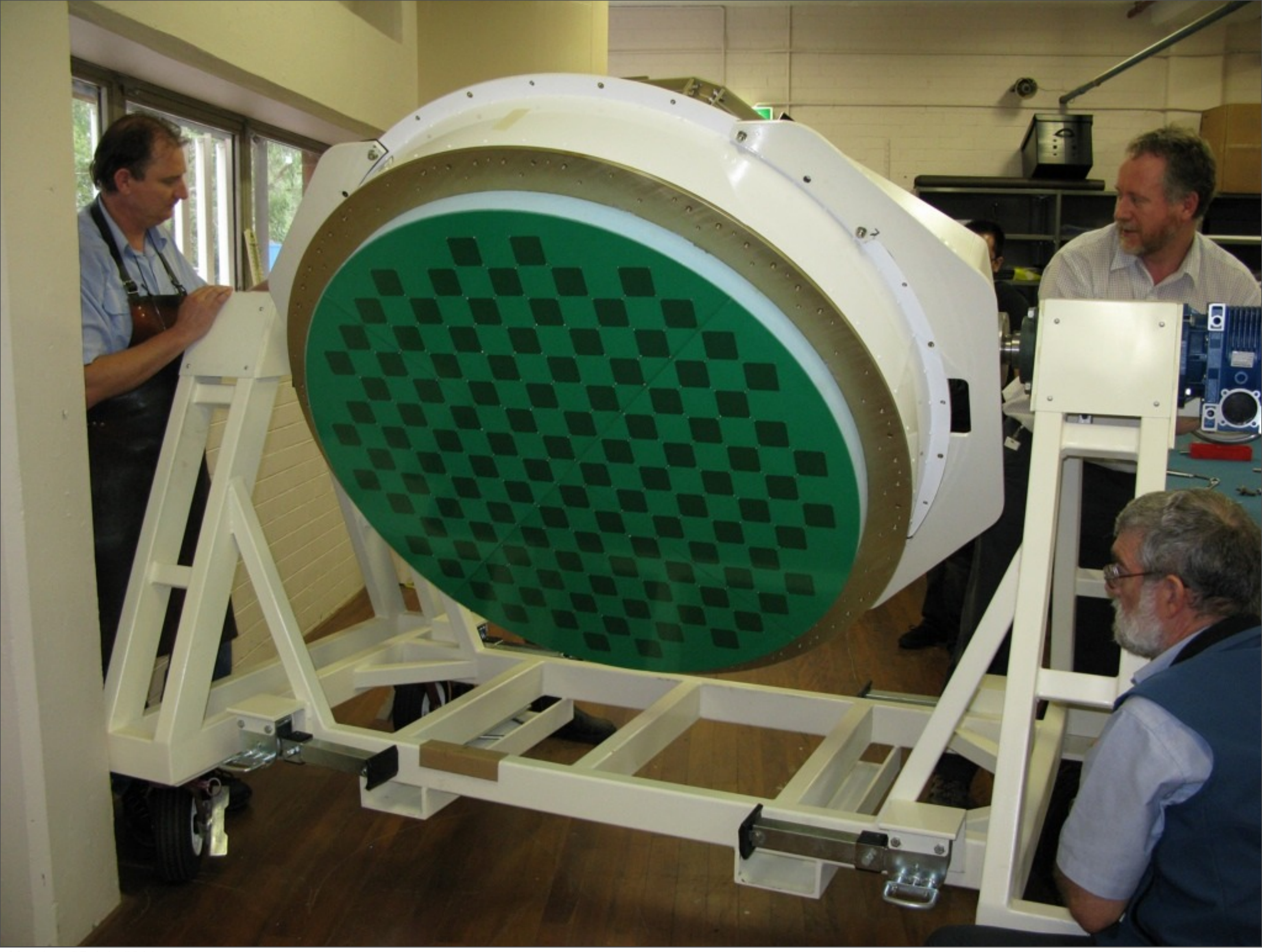
- Major area of R&D for the ASKAP project
- Development of small “proof of concept” article (5x4)
- 1st version of 5x4 at Parkes for testing late 2009, 2010
  - Problems with reliability etc
- 2nd version went to Parkes for further testing (Oct - Nov 2010), Aperture Array
  - Significantly improved performance
  - 60 deg Tsys over 1 – 1.3 GHz
- 9x10 array to Parkes (July 2011)
  - 50 deg Tsys
- Second full size PAF:
  - Scheduled for MRO deployment in early Q3 2011



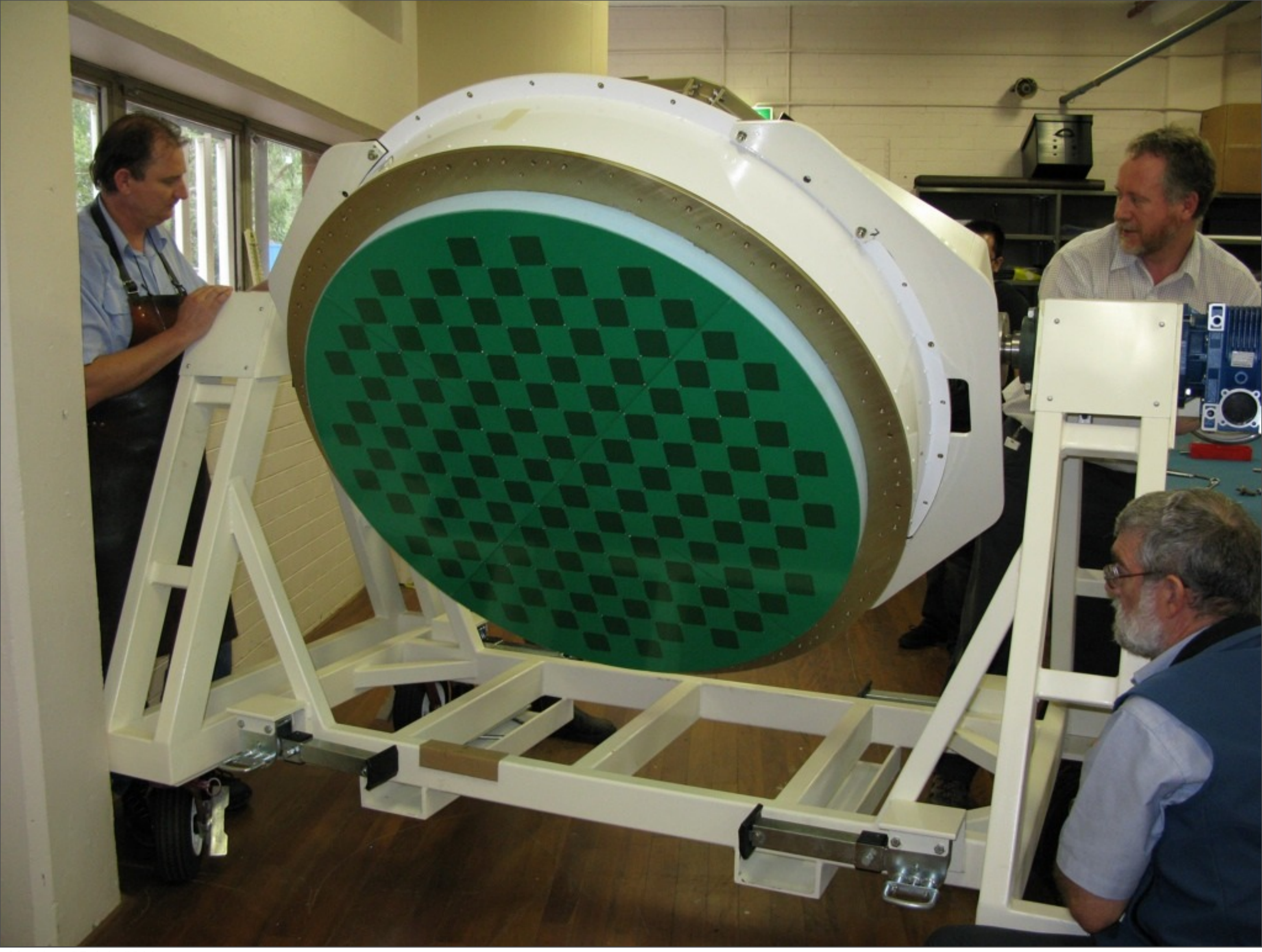
Monday, 25 July 2011

# PAF – dry fit-up

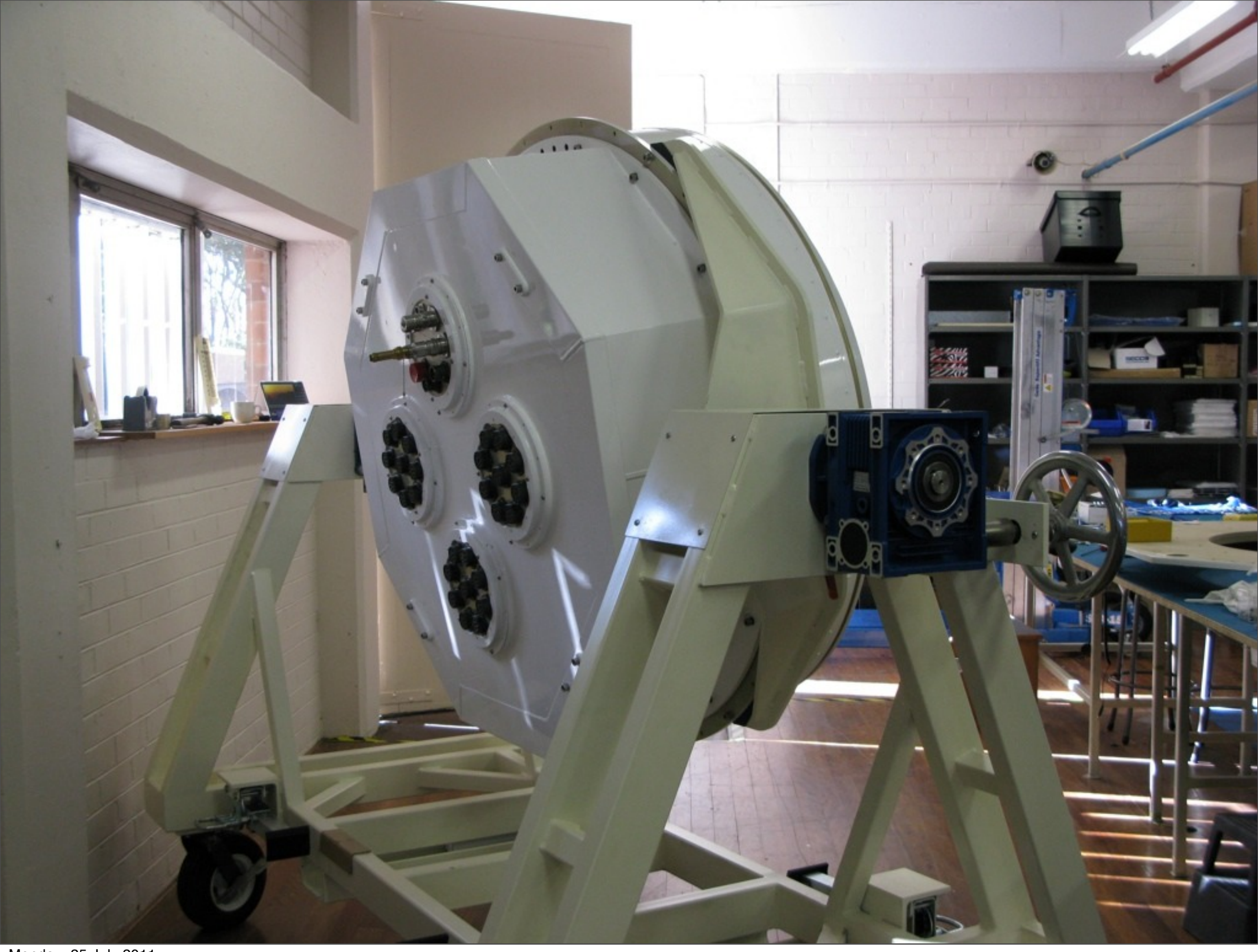




Monday, 25 July 2011



Monday, 25 July 2011

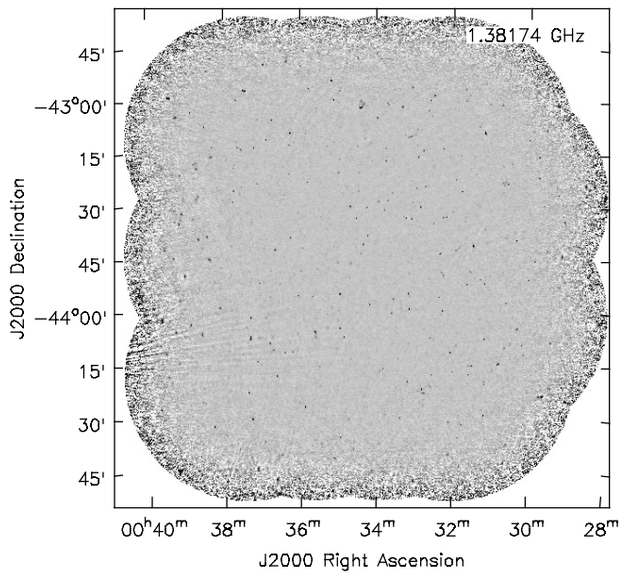


Monday, 25 July 2011

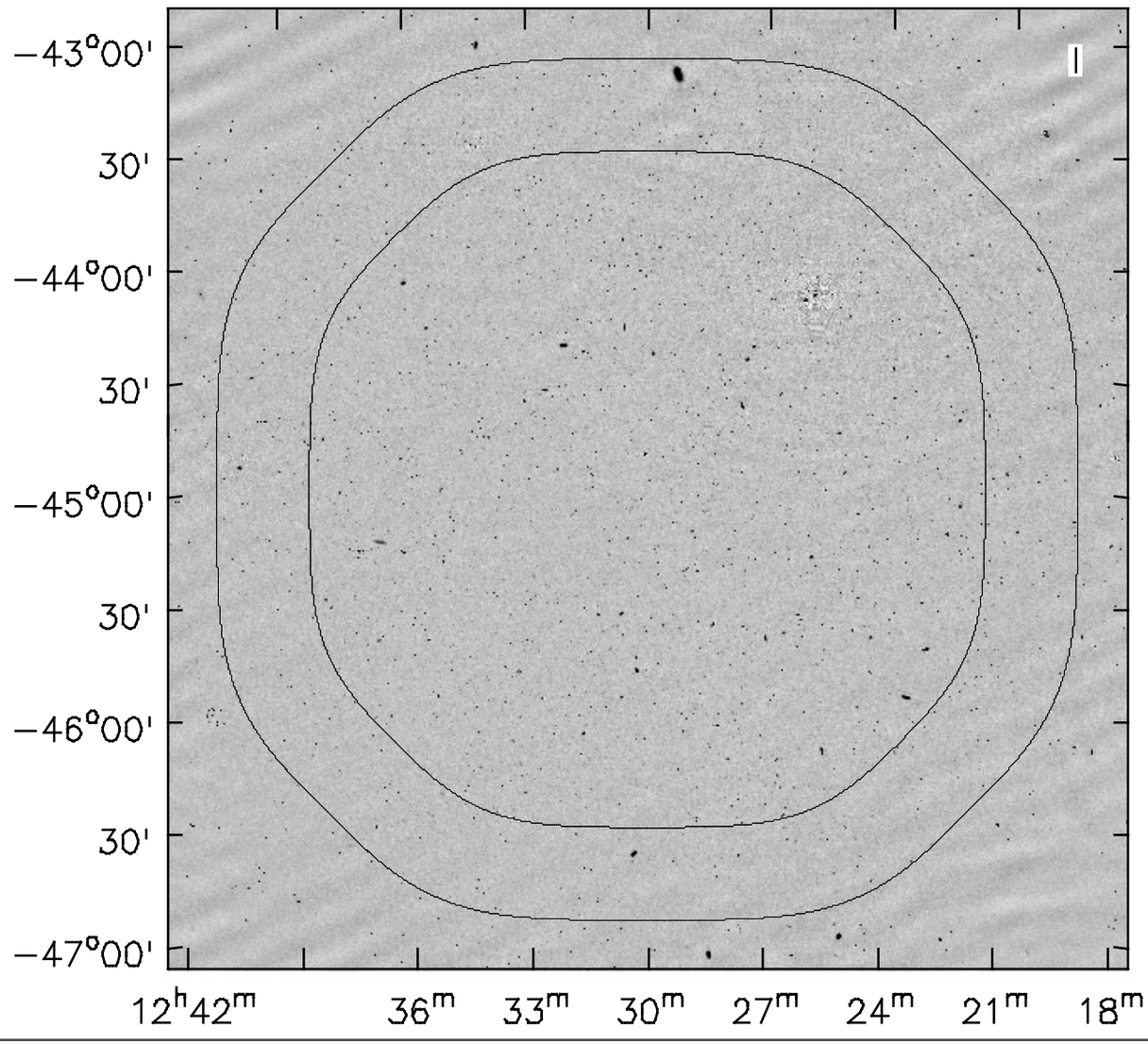
# ASKAP three axis antenna

# Comparison of imaging speed of ATCA and ASKAP

231 hours observing with ATCA




2 hours observing with ASKAP




Survey entire sky to very sensitive HI limits in ~ 1 year

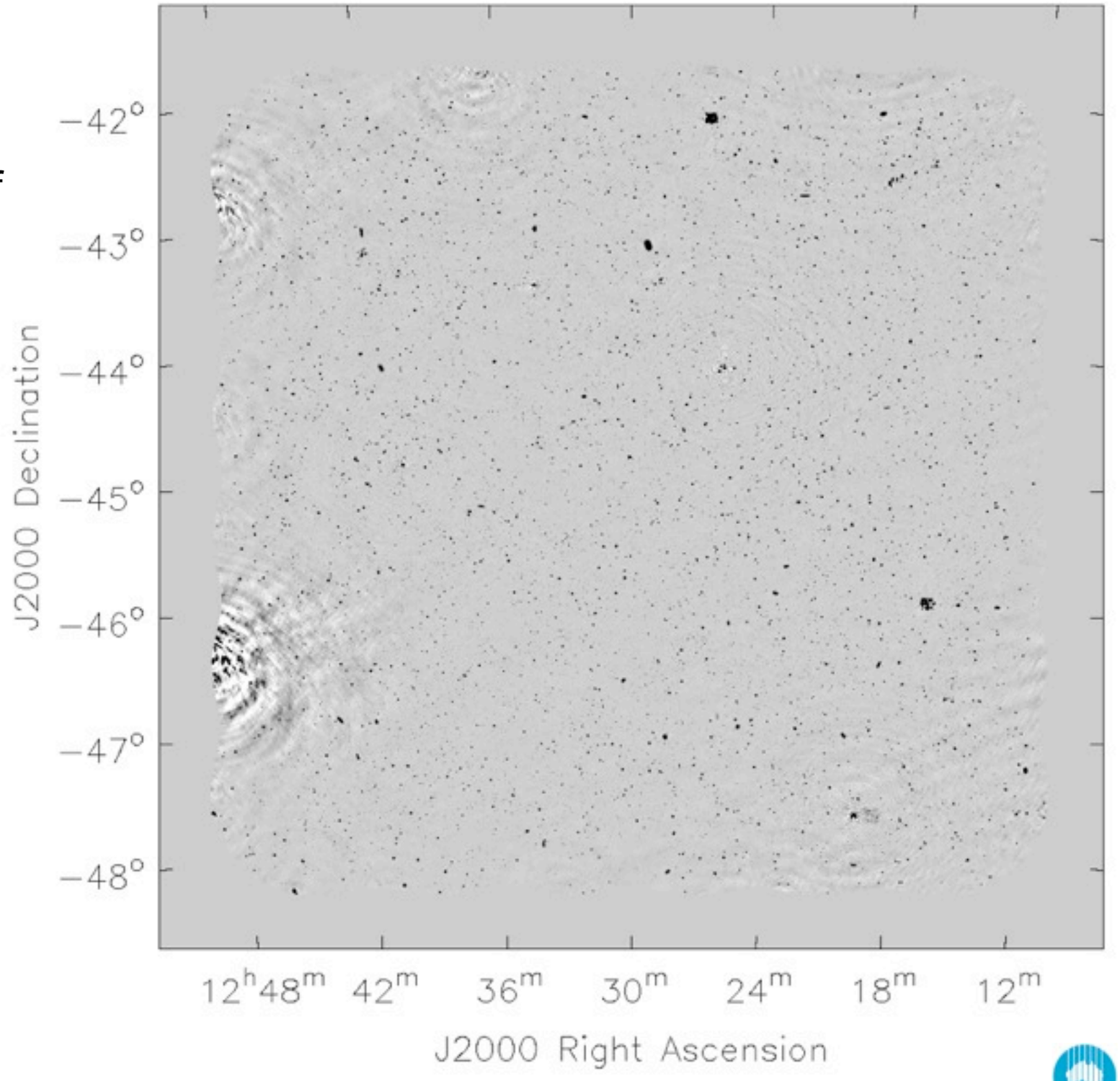
Survey entire sky every day for transient sources in ~ 3 hours

# SST2 (run9)

- 30” 8 hour synthesis
- SKADS model
- Peak = 2.6Jy
- Edge effects due to rolloff in sensitivity

- Data set ~ 1.1 TB

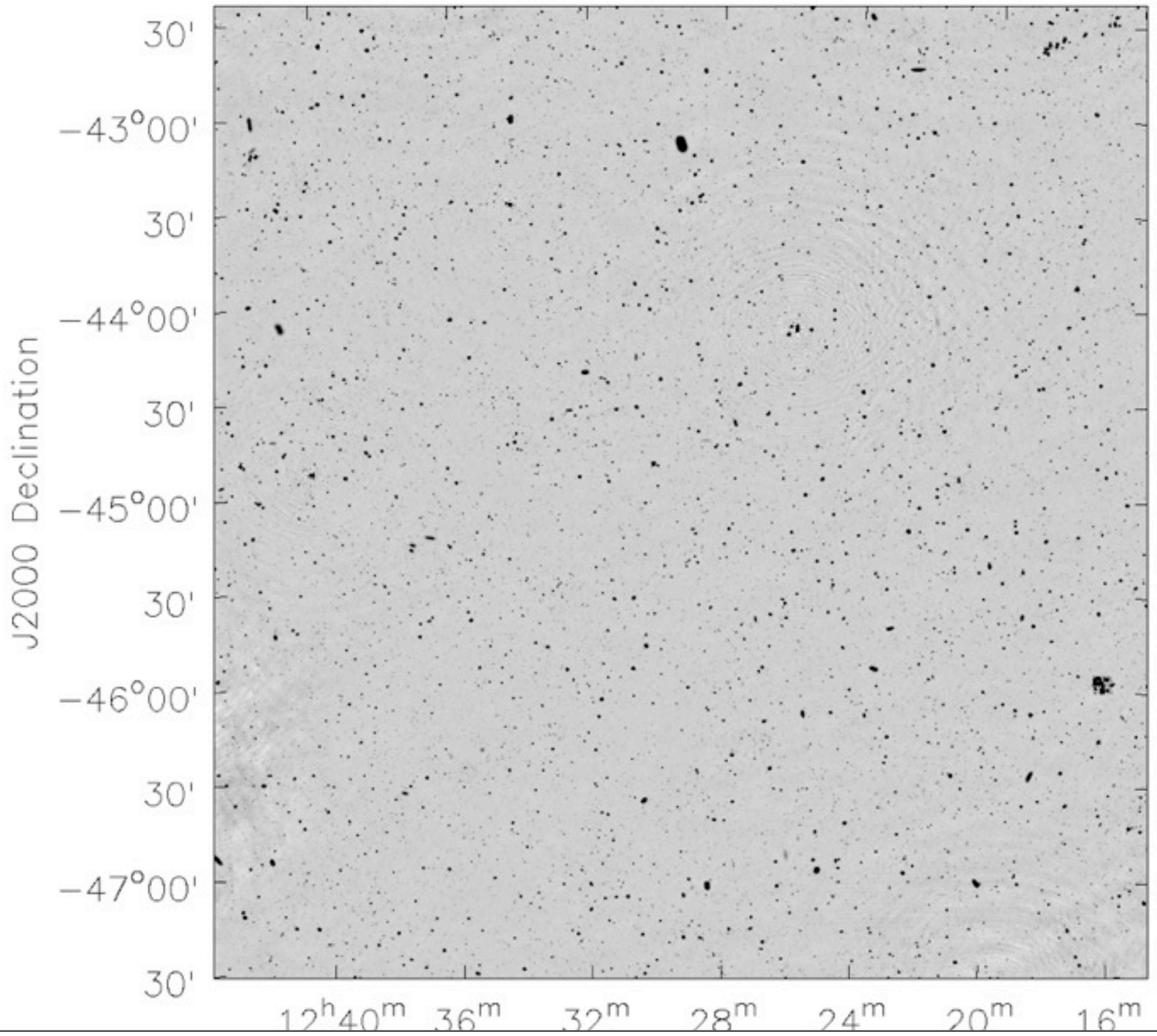
- ~ 1800 CPU-hours
- ~ 190 GB memory





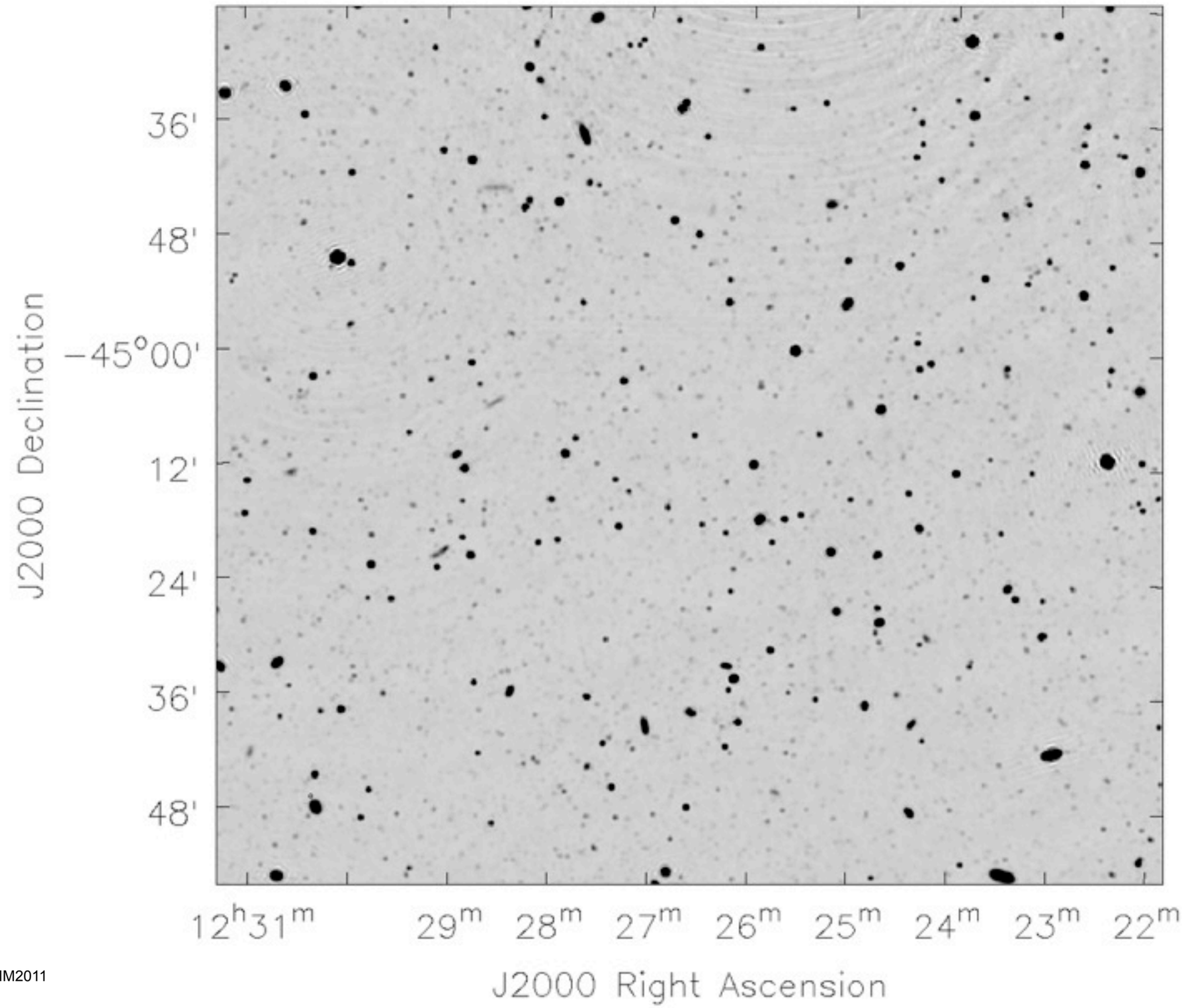

CSIRO

# SST2 (run9) zoomed




CALIM

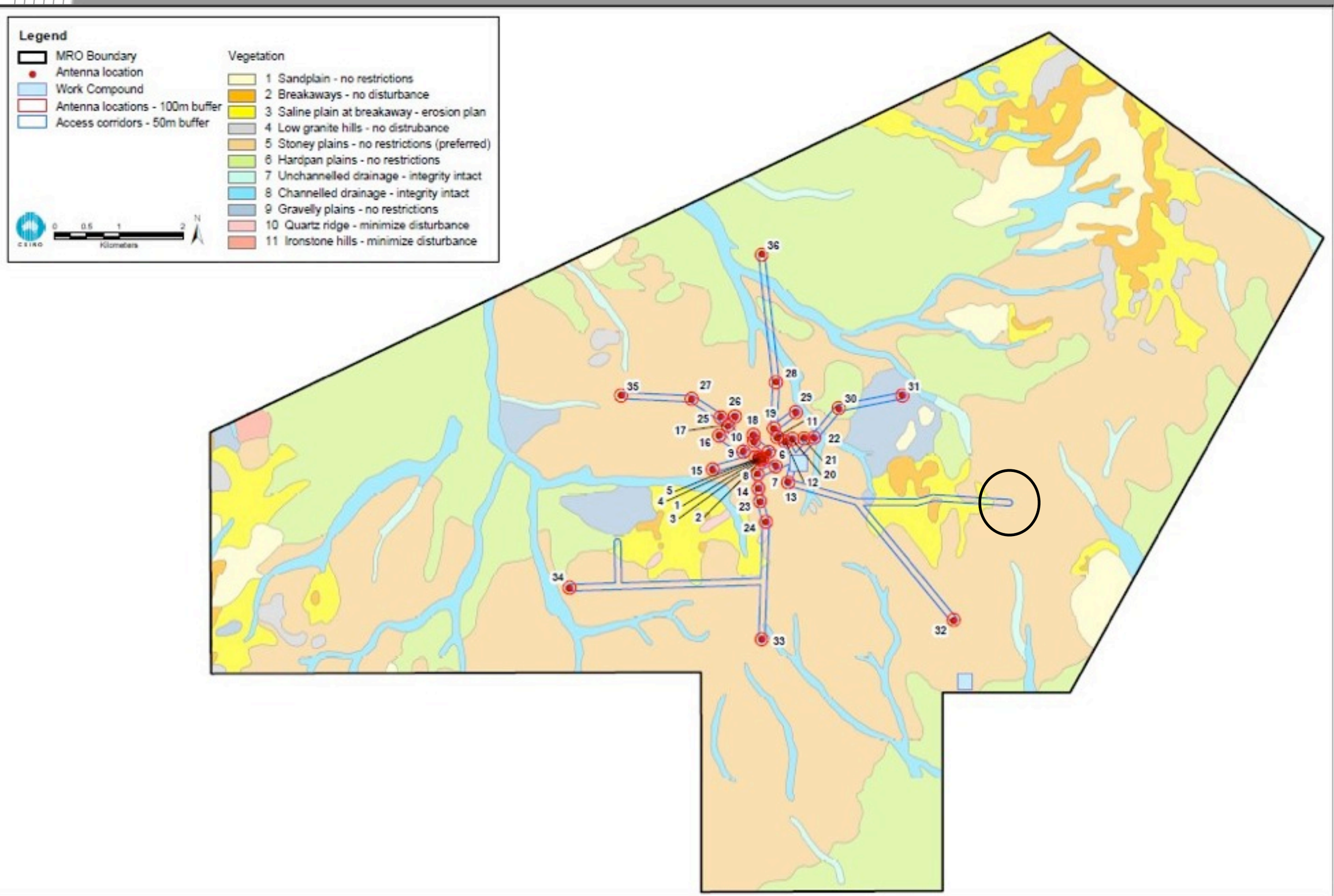
# SST2 (run9) zoomed





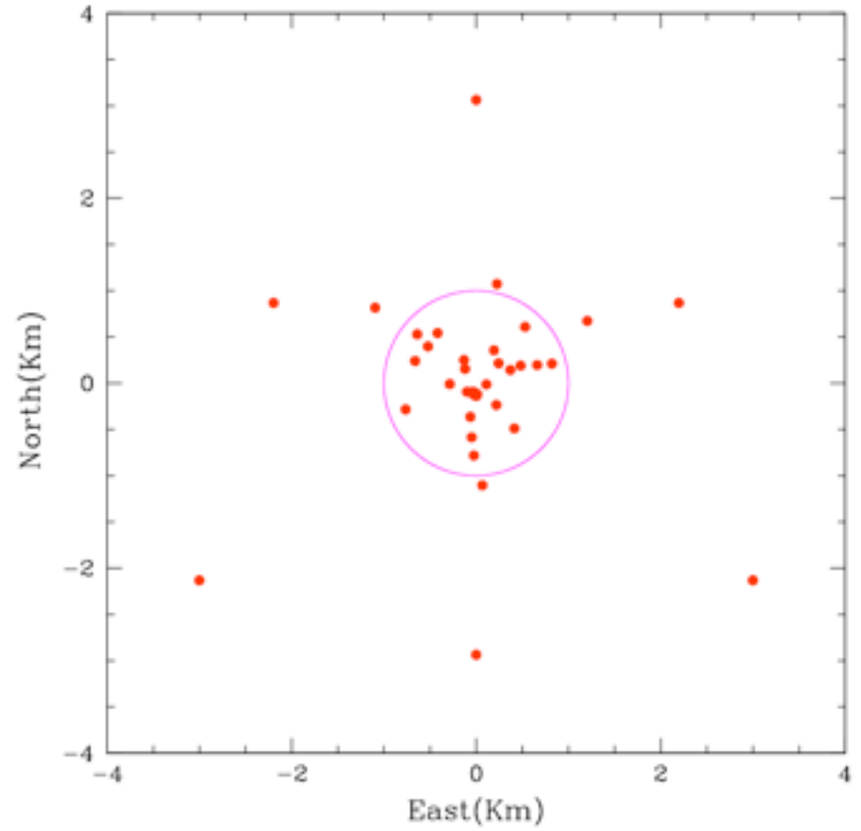

CSIRO

# Site Layout

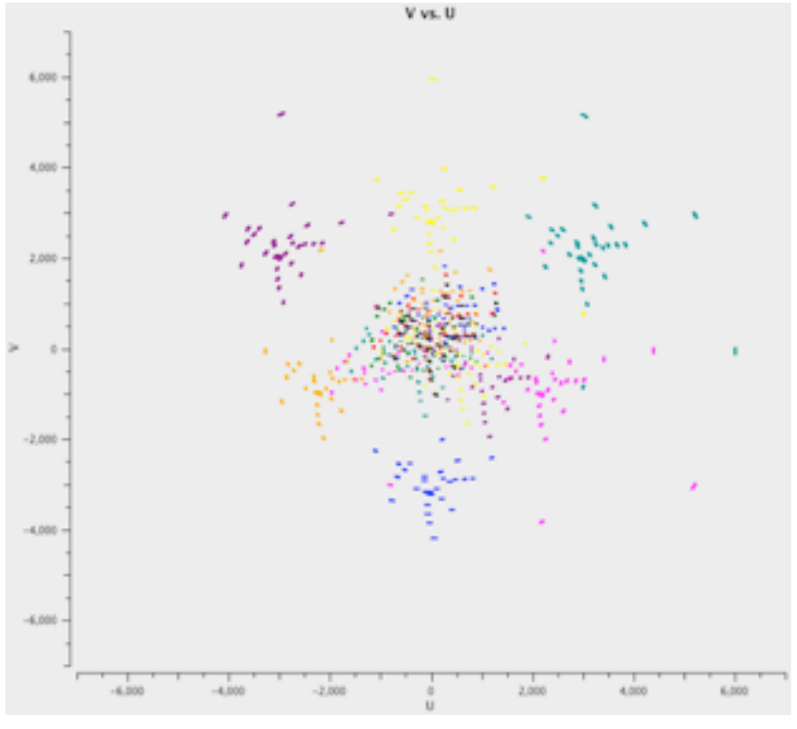

Legend
MRO Boundary
Antenna location
Work Compound
Antenna locations - 100m buffer
Access corridors - 50m buffer
Vegetation
1 Sandplain - no restrictions
2 Breakaways - no disturbance
3 Saline plain at breakaway - erosion plan
4 Low granite hills - no distrubance
5 Stoney plains - no restrictions (preferred)
6 Hardpan plains - no restrictions
7 Unchannelled drainage - integrity intact
8 Channelled drainage - integrity intact
9 Gravelly plains - no restrictions
10 Quartz ridge - minimize disturbance
11 Ironstone hills - minimize disturbance
0 0.5 1 2
Kilometers
N
CSIRO
36
28
35
27
26
25
31
30
25
19
18
11
17
16
10
22
9
6
21
20
15
8
7
12
5
14
13
4
23
1
2
3
24
34
33
32

# ASKAP Antenna configuration

- Compact 2km core for imaging emission from neutral Hydrogen (1.420GHz)
- Extended 6km for imaging broadband emission



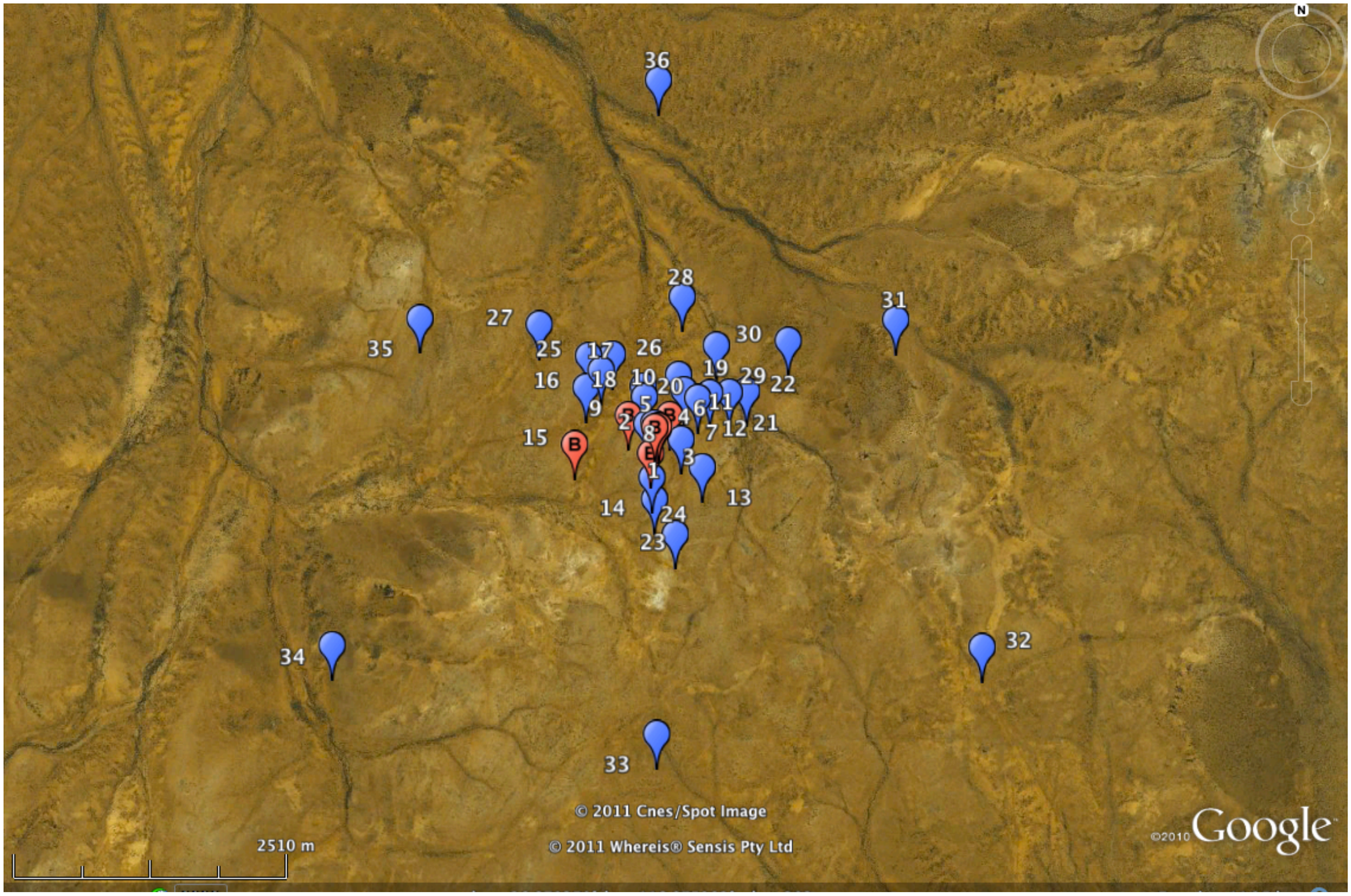

- Fourier plane coverage = set of 2D vector differences between antennas
- Rotates over the day to synthesise ~ full sampling



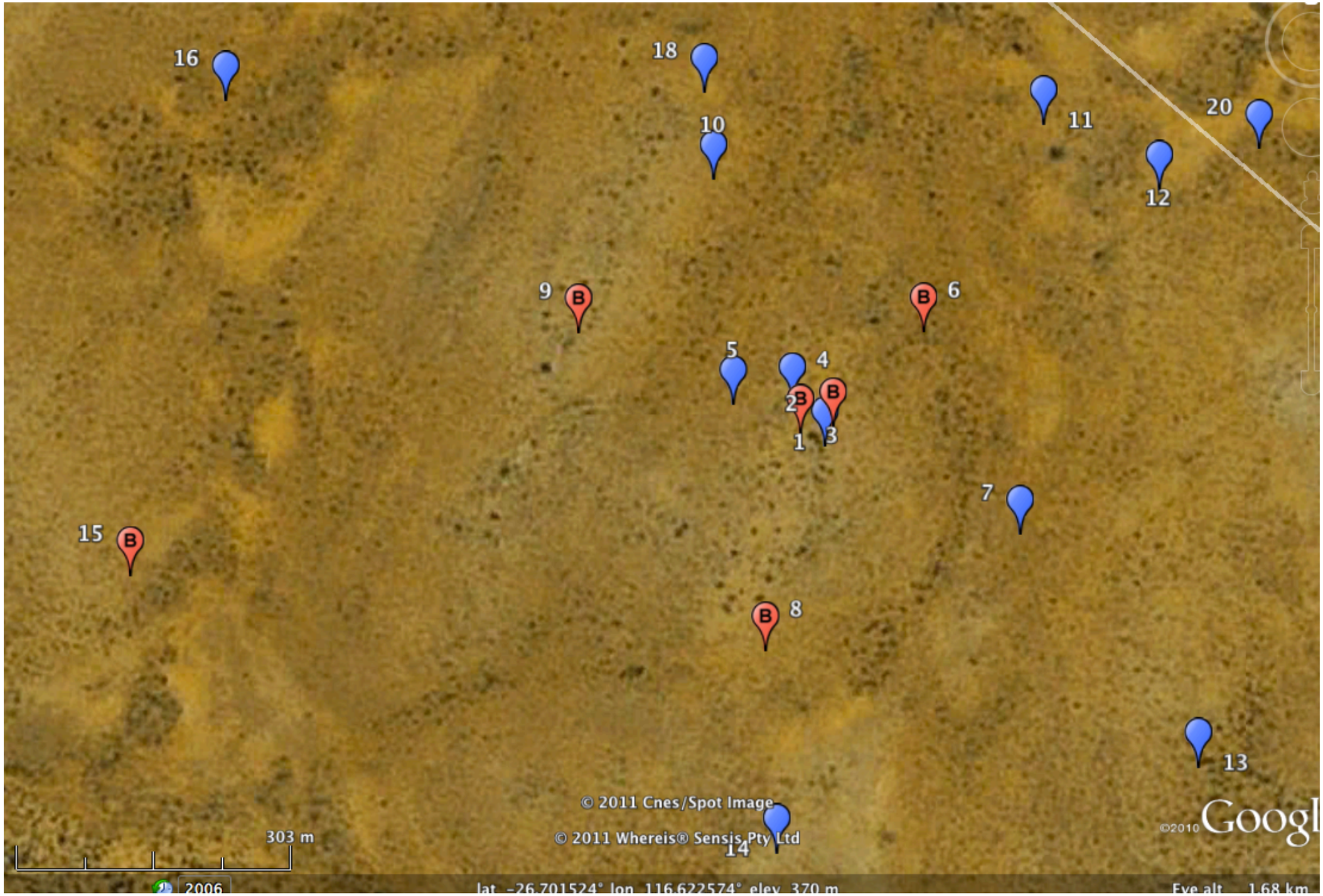



CSIRO

# ASKAP configuration

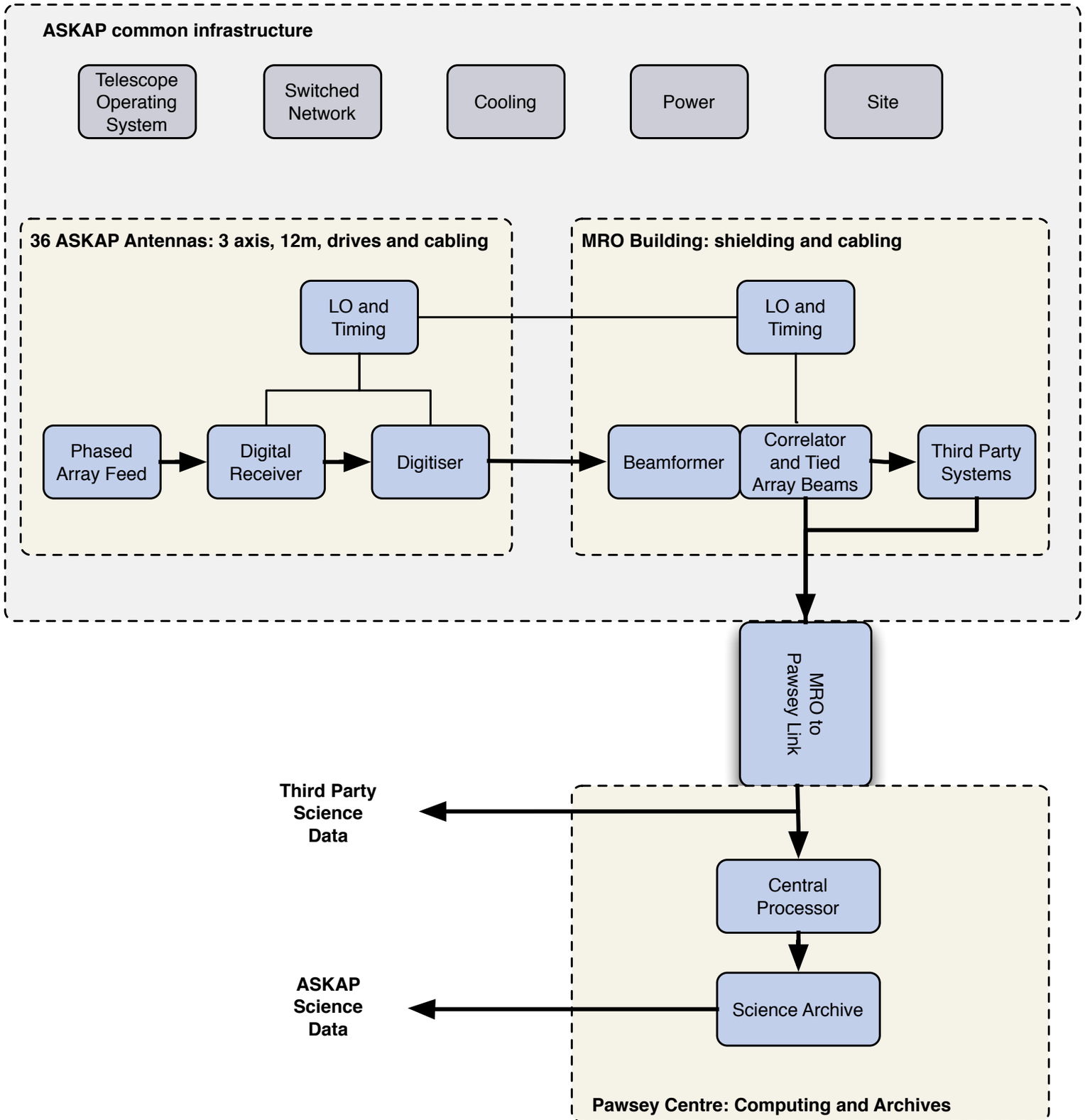


# BETA configuration

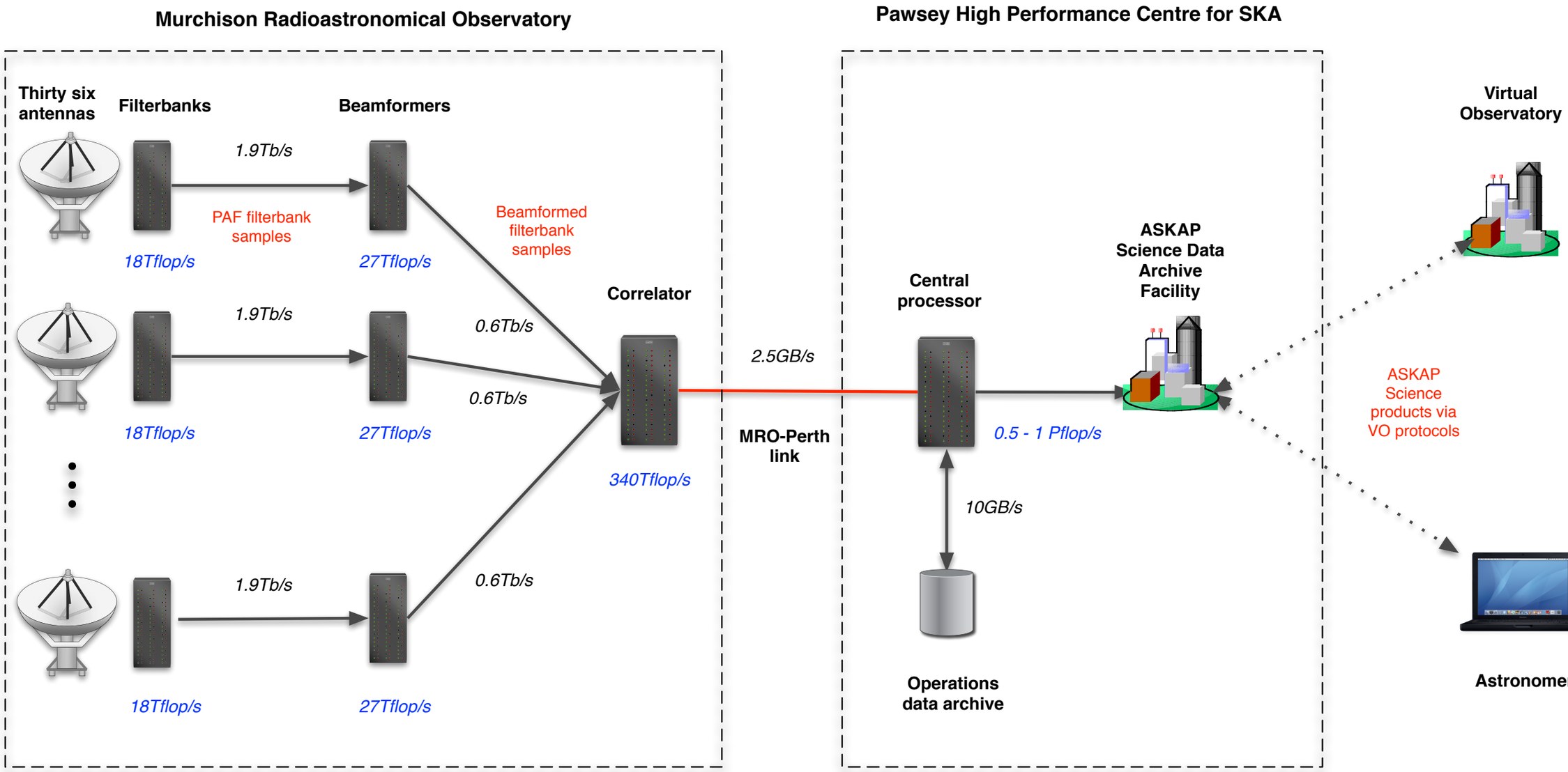


# A day in the life of an ASKAP antenna

# ASKAP System Architecture



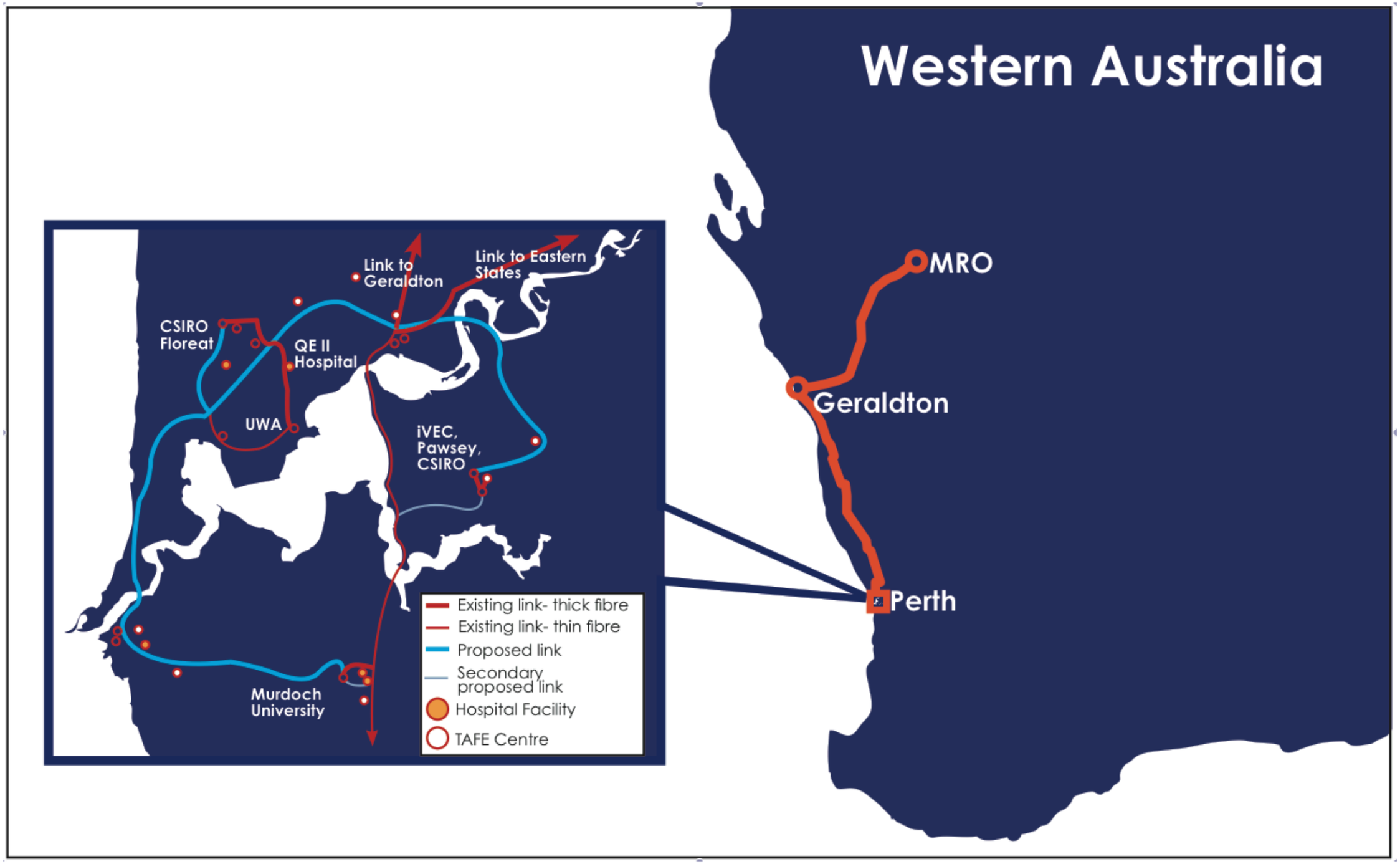
# ASKAP data flow




- From observing to archive with no human decision making
  - Calibrate automatically
  - Image automatically ~ 80 TB per 8 hour observation
  - Form science oriented catalogues automatically

T. Cornwell, July 9 2010

# Networking in Western Australia

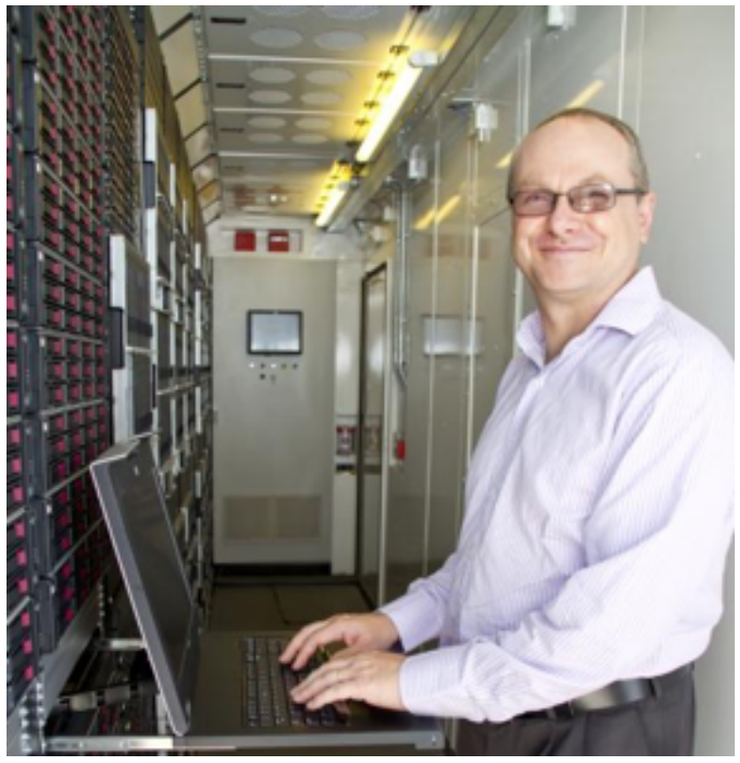





CSIRO

# Pawsey High Performance Computing Centre for SKA Science, Perth, Western Australia

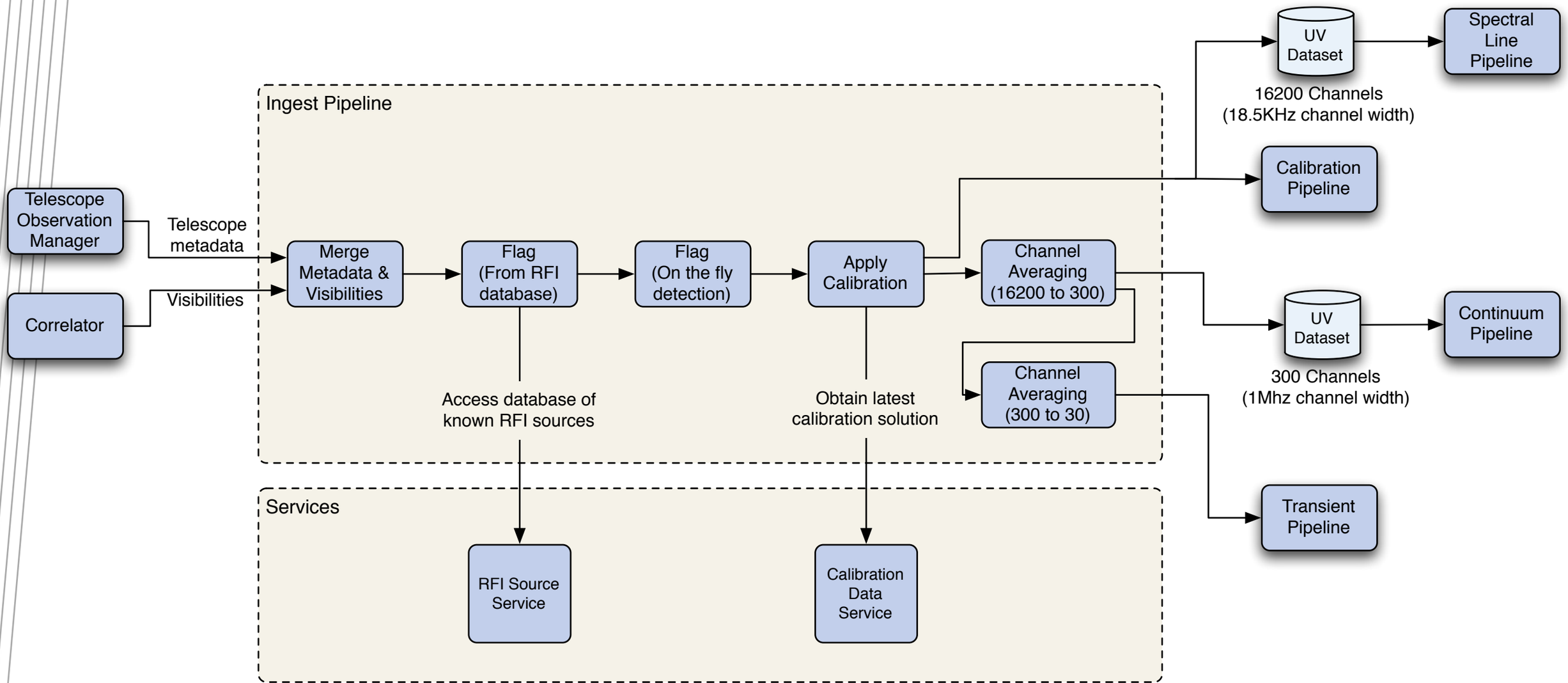
- A$80M, funded by Australian Federal government
- 8800 core machine now in operation
  - HP cluster in a box at Murdoch University: EPIC
  - ~ 88 on Top 500
  - ASKAP used EPIC as early adopters
  - Now regular use - 1 Mhour till end of 2011
  - Use 10TF partition in late 2011 for early telescope testing
- Petascale system by 2013
  - 25% for radio astronomy



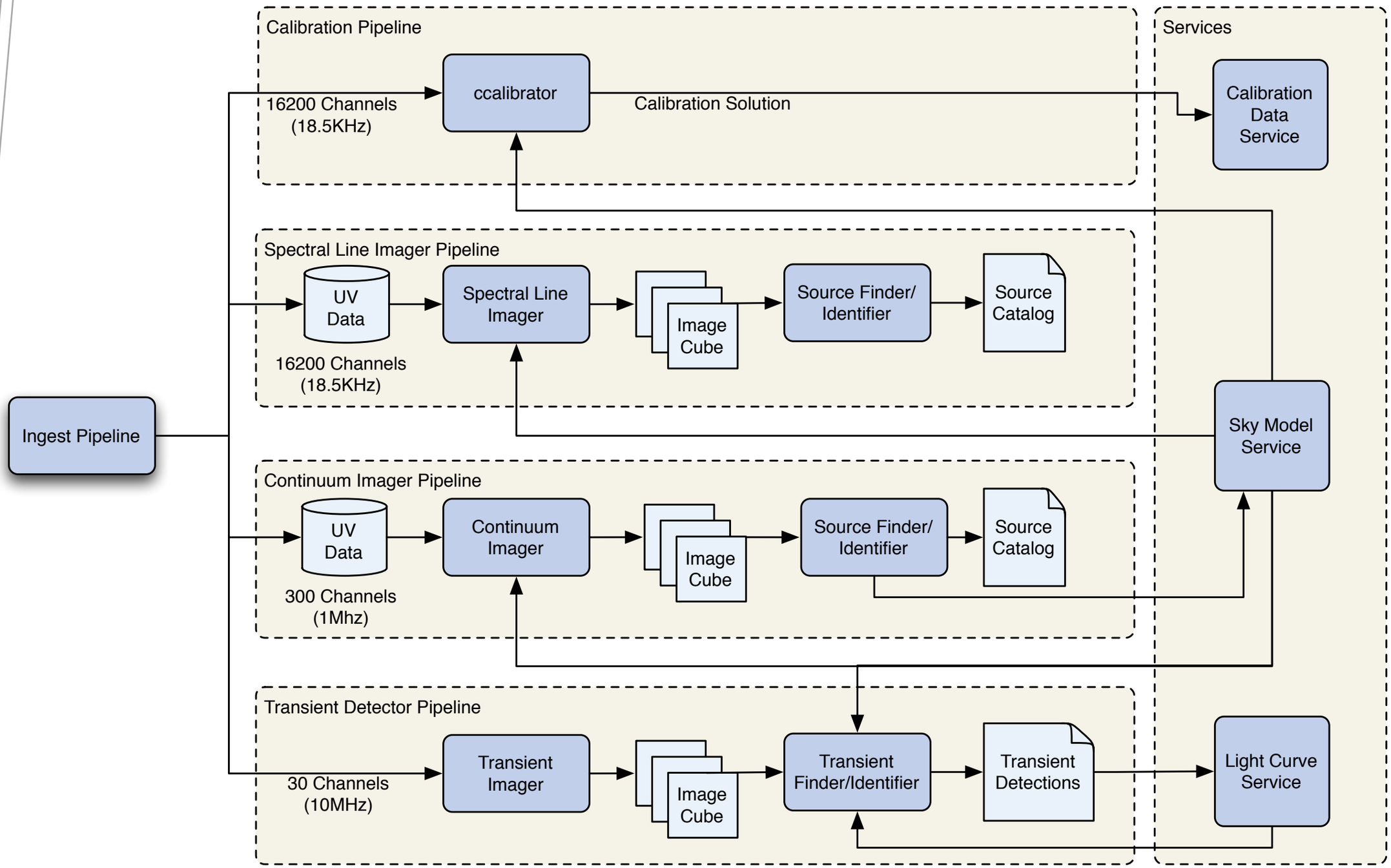
# ASKAPsoft

- Reuse of 3rd party software
  - Spent large effort facilitating reuse
  - 72 3rd party packages in use
- Telescope Operating System
  - Built using EPICS
- Central Processor
  - Designed to support parallel, distributed processing using MPI
  - All new synthesis code
  - Duchamp source finder
  - Built using large number of 3rd party libraries: casacore, boost, wcs, LOFAR, etc.
  - For ASKAP, must scale to ~ 9000 cores

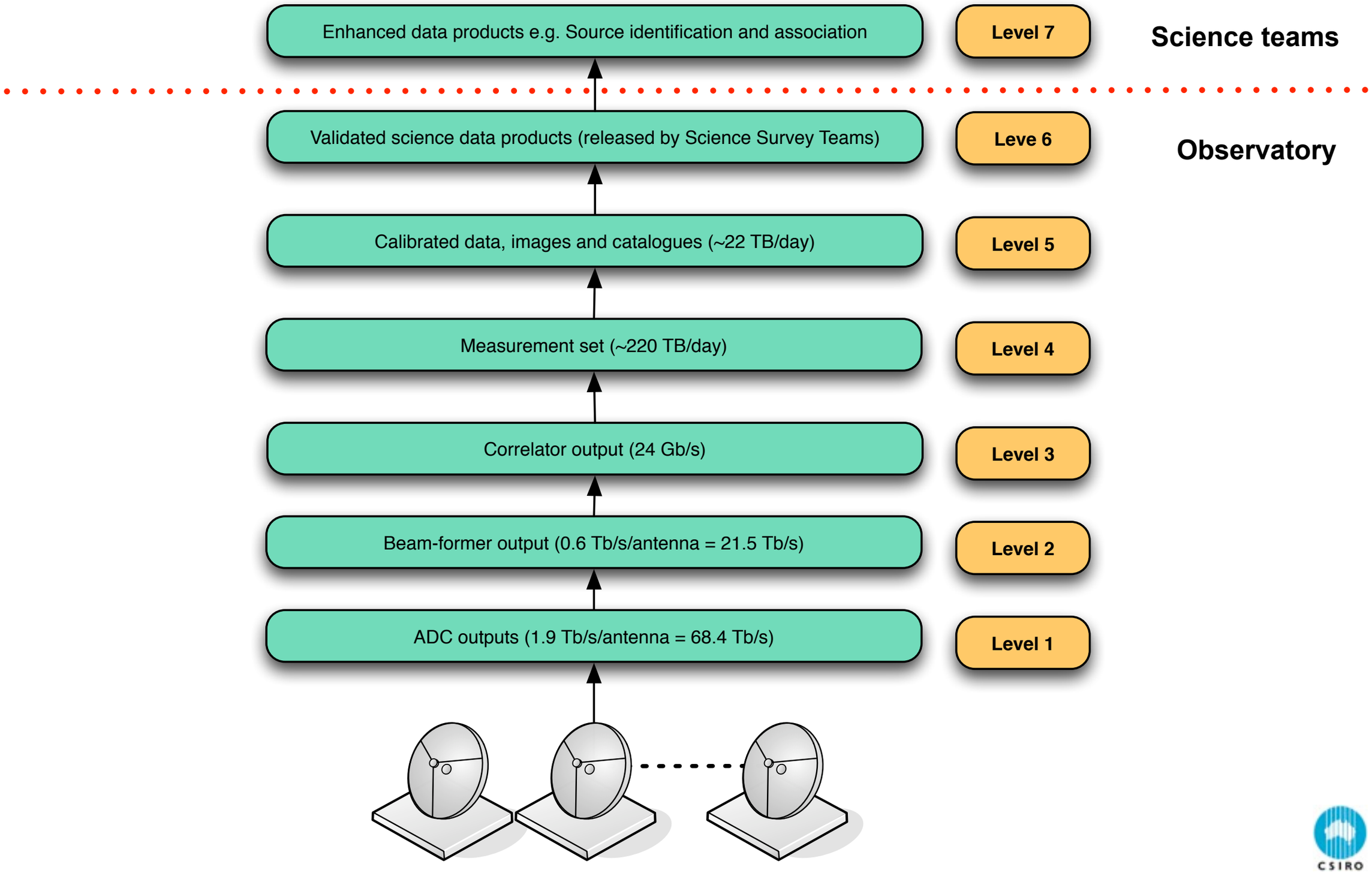
# Ingest pipeline



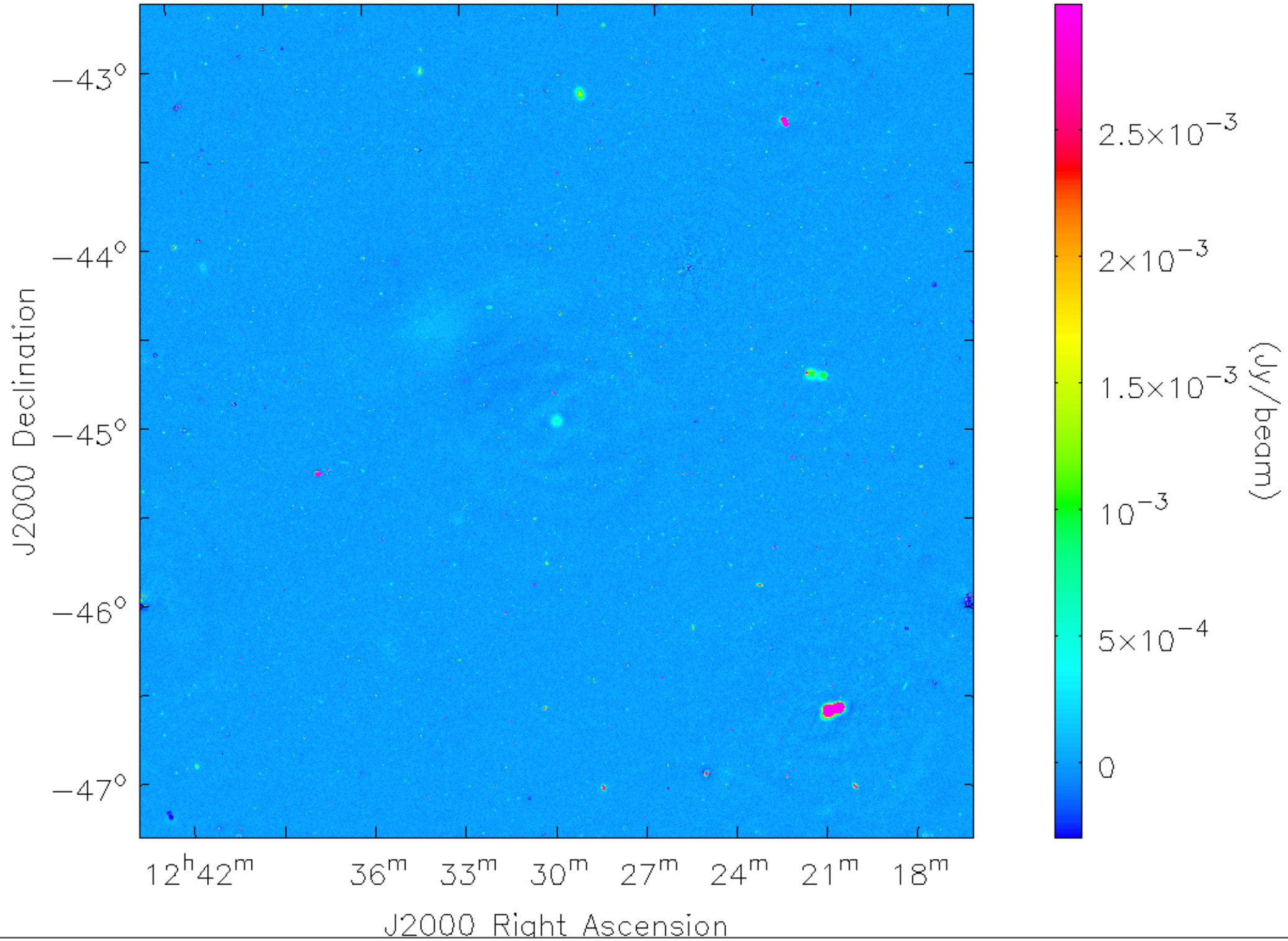
# ASKAP science processing pipelines



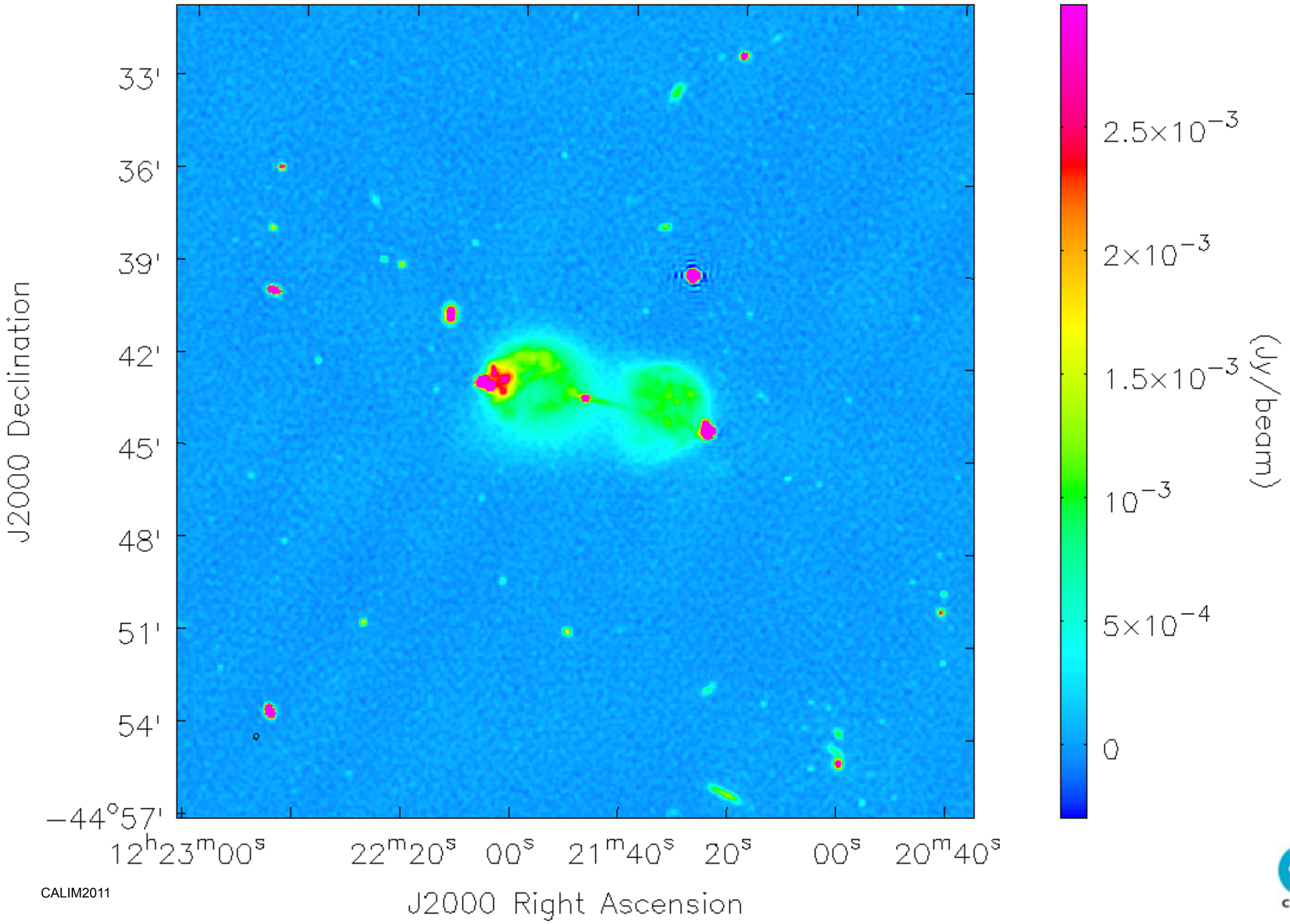
# ASKAP data levels



# EMU simulations of extended sources



# EMU simulations (zoomed)

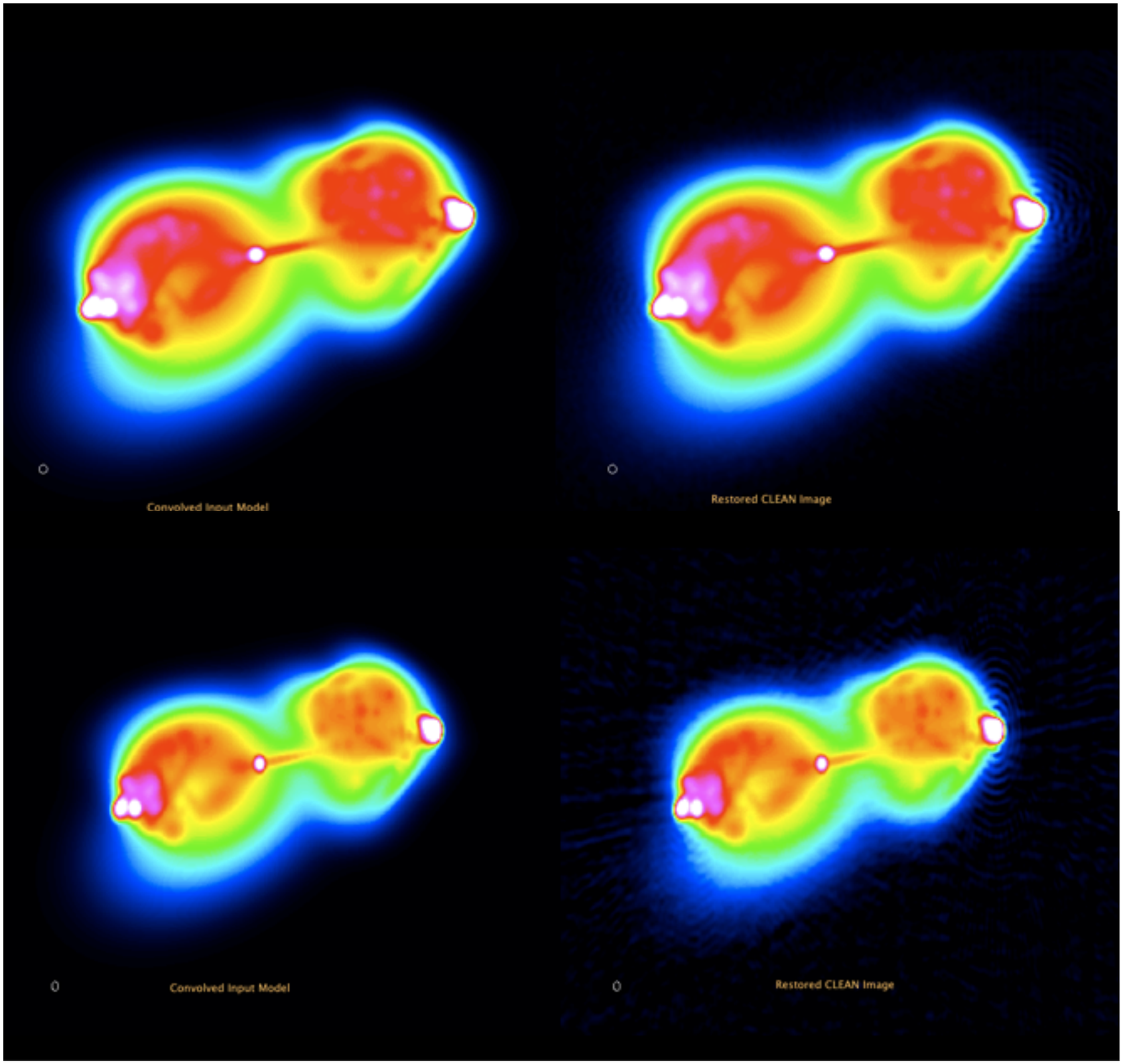



CALIM2011

# Pictor A simulations

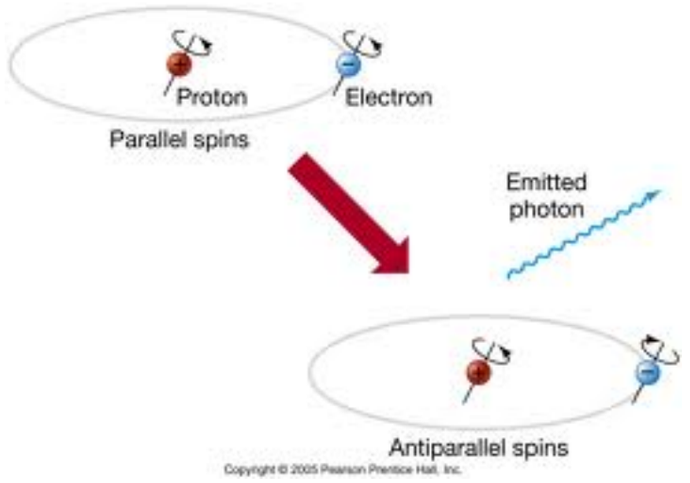
- ASKAP
  - +/- 3h
  - DR ~ 38000
  - Ringing around hotspots

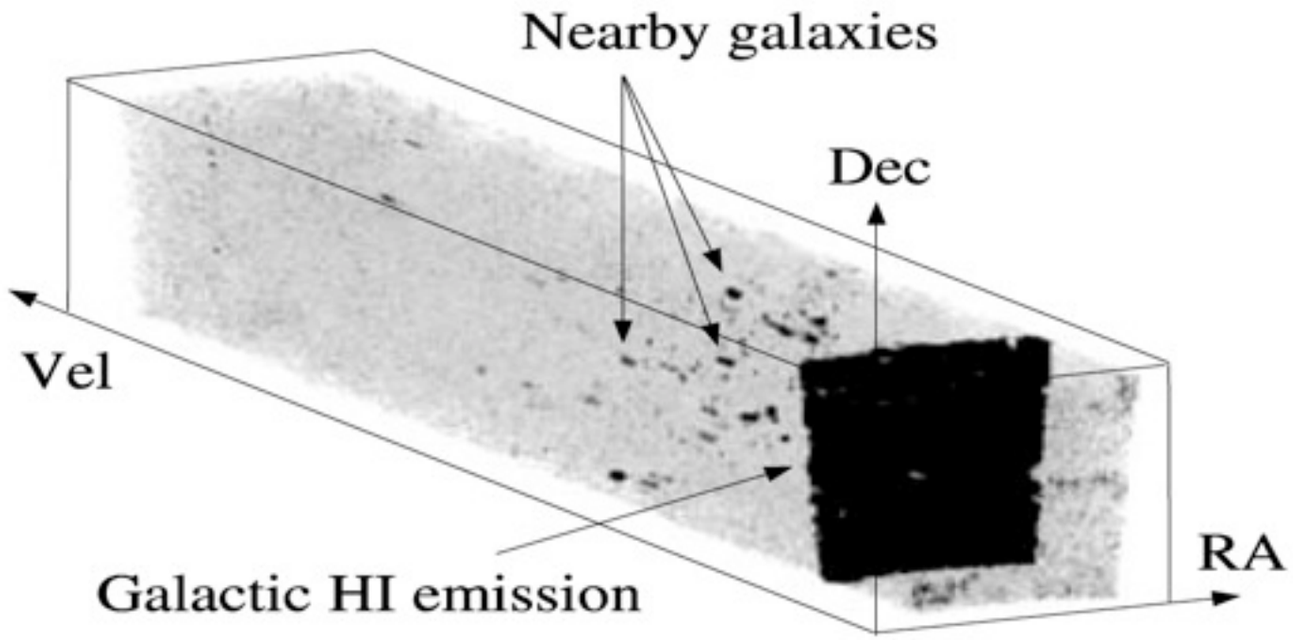
- ATCA pre CABB
  - CDFS coverage
  - DR ~ 15000

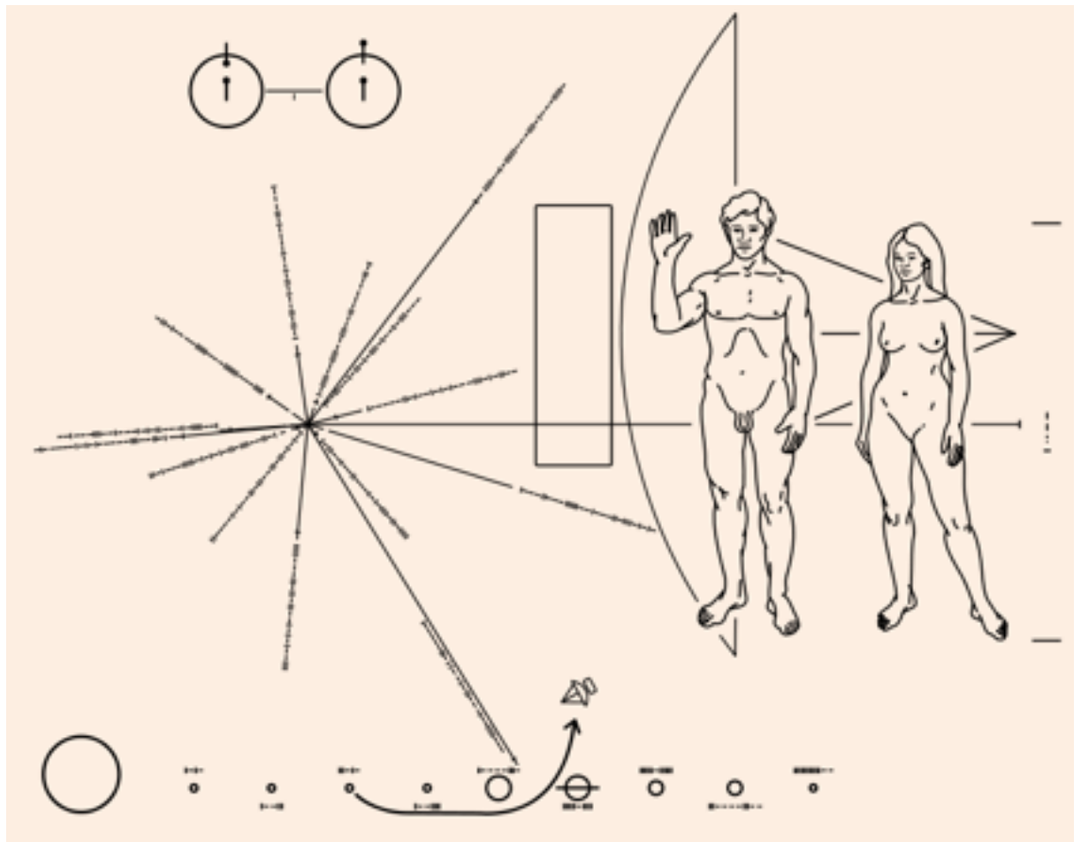


# Duchamp: finding galaxies

- Most galaxies emit radiation from neutral hydrogen
  - 1420.40575177 MHz
- Search in frequency
- Derive distance using Hubble Law
  - Velocity of recession = $H_0$ Distance

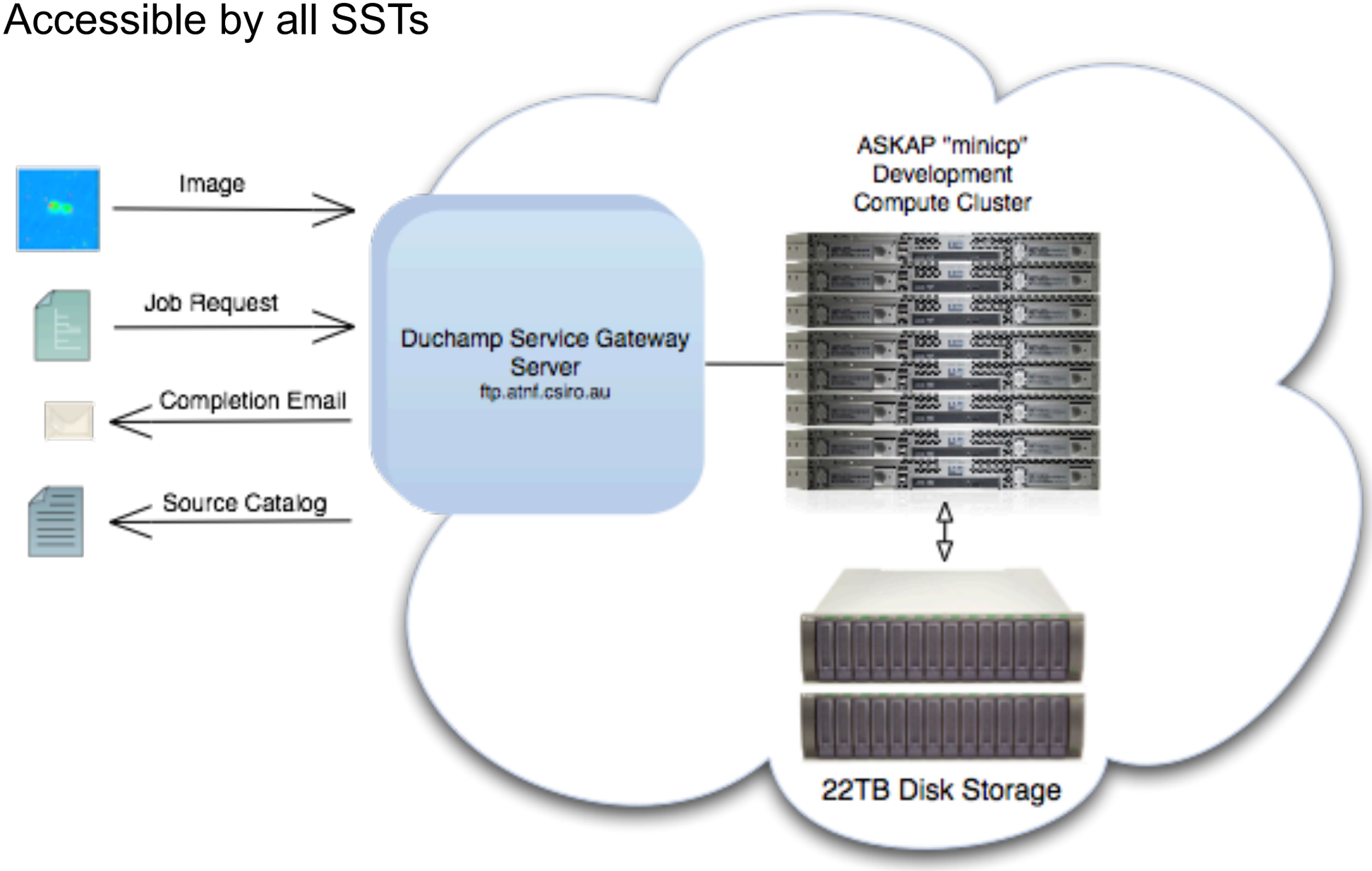


# Duchamp service

- Response to SST requests for access to current ASKAPsoft Duchamp
- ftp-based service to upload images and download results
- Runs on ASKAP cluster
- Accessible by all SSTs



# ASKAP Science Processing memo

## ASKAP Science Processing

ASKAP-SW-0020

Version: 0.1
Date: 10/02/2011
Project: ASKAP

Prepared by: Tim Cornwell, Ben Humphreys, Emil Lenc, Maxim Voronkov, Matthew Whiting
Reviewed by:
Review reference (3240):
Approved by: Date:

Keywords:

- Complete description of all steps in science processing
- SSTs are the target audience
- First version was released 28 February
- Not all areas finalised
- Will be updated regularly

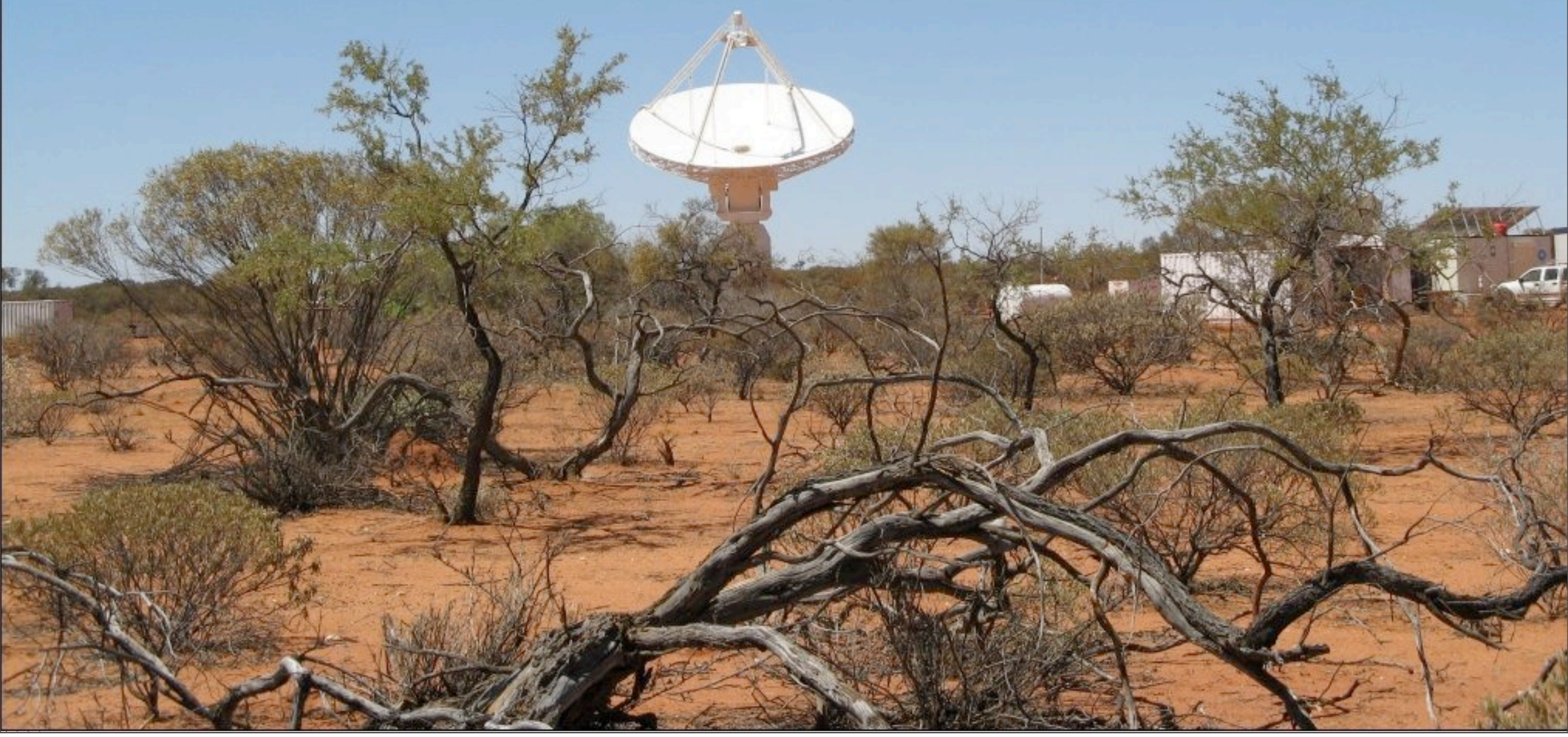
# SKA2011 Forum in Banff


# ASKAP Design Enhancement

- Insufficient funds to build out to 36 antennas
- Can afford to build out to 12
- In search of full funding for 36
- Meanwhile
  - Redesign PAF, analog systems, and digital backend
  - Goal is to reduce costs (mainly for SKA)

- Concentrating on demonstration of PAF Imaging
  - With 6 antenna system (BETA)
  - End of 2011

*We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site.*



**ATNF/ASKAP**
Tim Cornwell
ASKAP Computing Project Lead

Phone: +61 2 9372 4261
Email: tim.cornwell@csiro.au
Web: www.atnf.csiro.au

www.csiro.au

# Thank you

**Contact Us**
Phone: 1300 363 400 or +61 3 9545 2176
Email: enquiries@csiro.au  Web: www.csiro.au

CSIRO