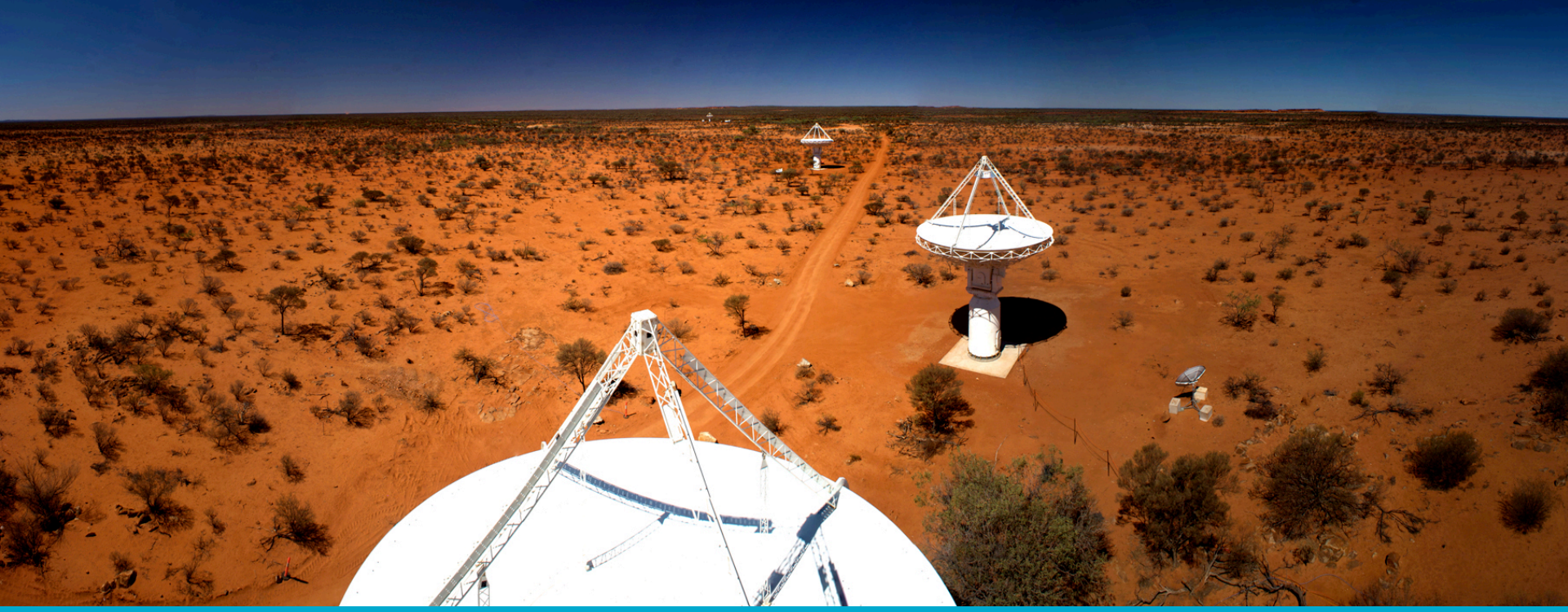


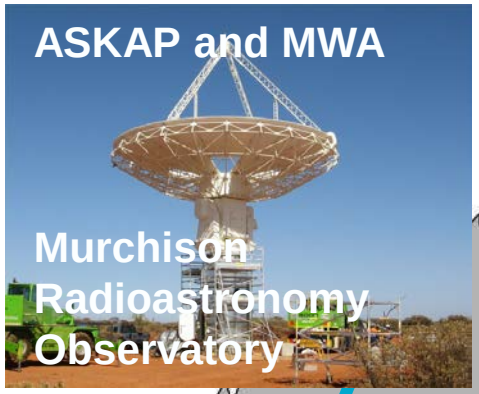
ASKAP/ATNF and SKA

Douglas Bock

2nd ngVLA technical workshop
8 December 2015

CSIRO ASTRONOMY AND SPACE SCIENCE
www.csiro.au

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



Pawsey HPC Centre

Radiophysics Laboratory

ATNF

Outline

Lessons learned (ASKAP/MRO, ATCA, Parkes)

CSIRO Expertise/Technology

- Phased Array Feed program
- Ultra-wideband feeds
- Flexible digital backends

SKA – Concept of Operations

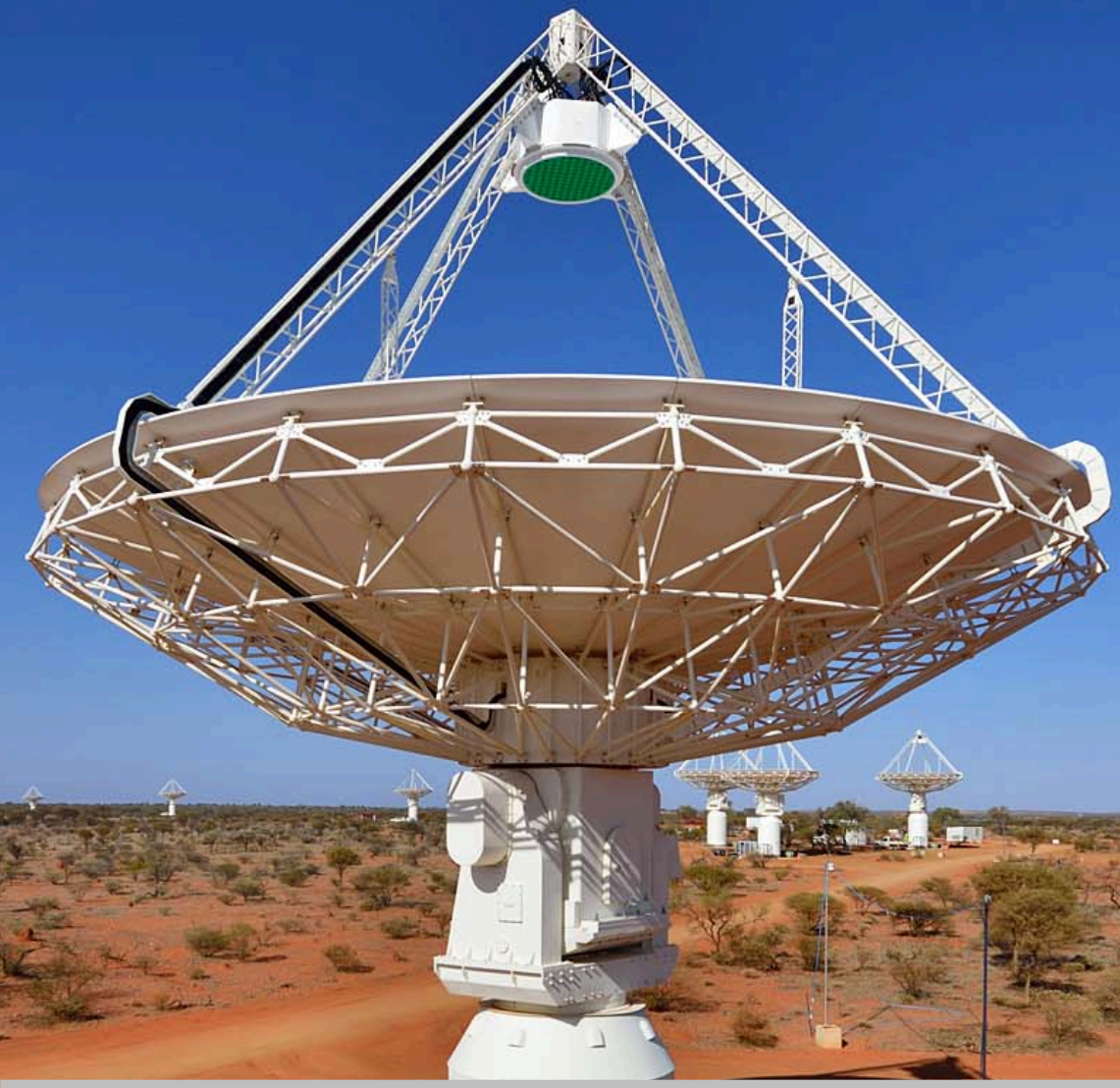
Top level issues

- How can you mitigate technical development conducted in parallel with construction?

- Can you afford to operate what you build?
  - Telescopes need to be more like cars
  - But how do you know in advance where to spend the extra cost for operational efficiency? Argues for a scaled approach.

- Who funds commissioning?
- Who conducts commissioning?

ASKAP – a new-technology survey telescope



- 36 x 12 m antennas
- 3 axis movement
- 30 m – 6 km baselines
- Novel PAF receiver
- 700 MHz – 1800 MHz
- Wide field of view
- Fast survey speed

Lessons Learned – ASKAP program

- Aims
  - Open best site for cm+ radio astronomy
  - Technology development for SKA
  - Science instrument in its own right

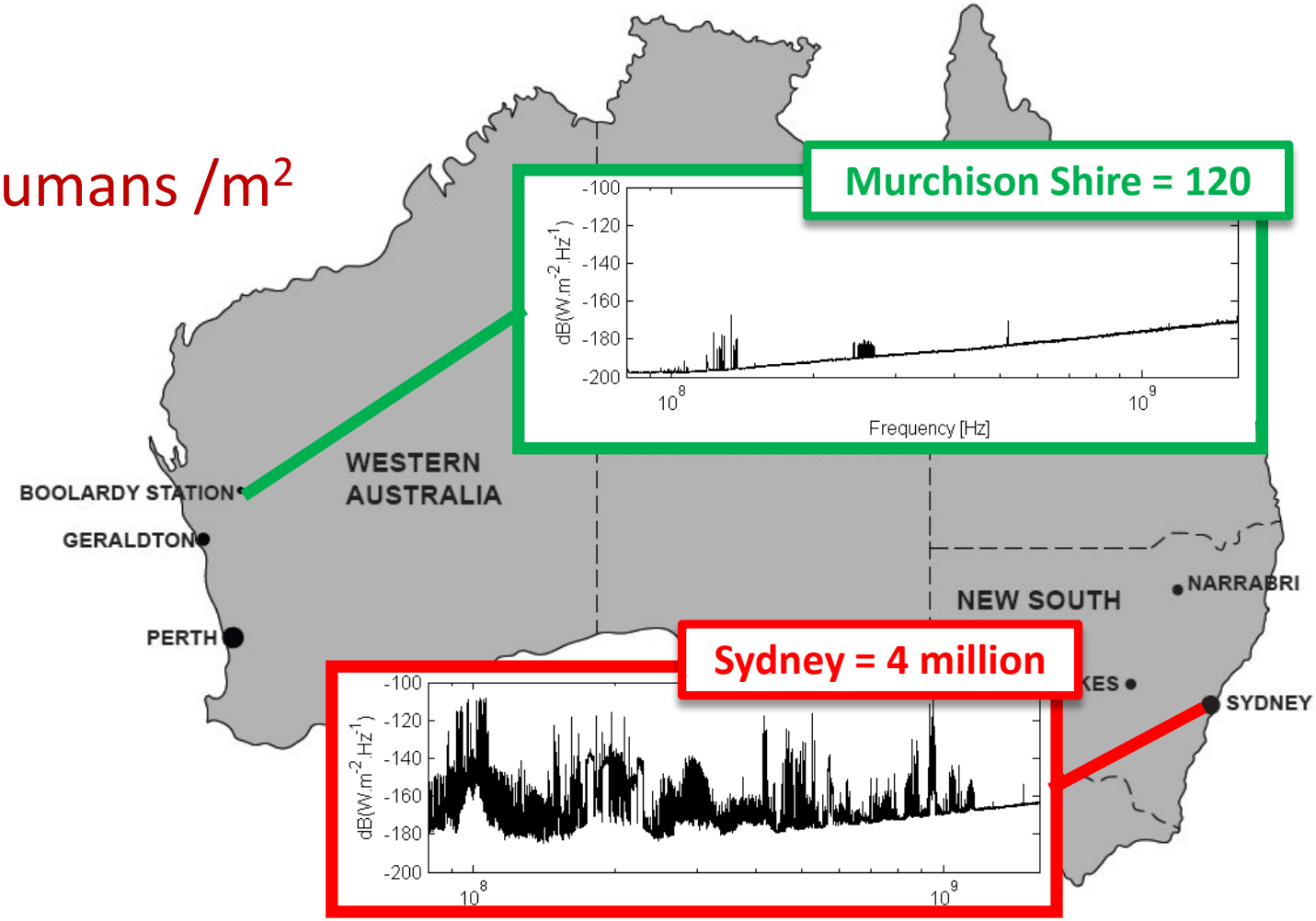
- Funding & Stakeholders
  - SKA
  - Regional development

- Technical development program in parallel with construction had significant risk (schedule & $) … but was there another way?
- Firmware underestimated
- IPTs???

- Organisational
  - ATNF vs SKA/ASKAP [project team vs operations team]
  - Advisory committees

Murchison Radio-astronomy Observatory - Radio quiet

2 n Humans /m^2



ASKAP rollout x N at a remote site

- Prototype well and test locally
- Deploy fully tested and pre-assembled kit
- Cooling one of the most difficult aspects (what can be learned from industry?)
- EMC testing at home
- Benefits of good connection with neighbors

- ASKAP has 6m parts!
- Try to design out maintenance as a first start (cf. SKA low)
- Design engineering vs production engineering teams
- Logistics underestimated!

ASKAP – community engagement

- Decision to build was “strategic”. Took time to build broad community support

- Science Survey Teams added a lot of value, but also had high expectations (we didn’t meet schedule; technical risk)
- Secondment program during commissioning successful in connecting users to CASS and sharing expertise

- Good results from the BETA array (1st generation PAFs)

- Easy to become inward-looking (SKA vs ATNF/ASKAP)

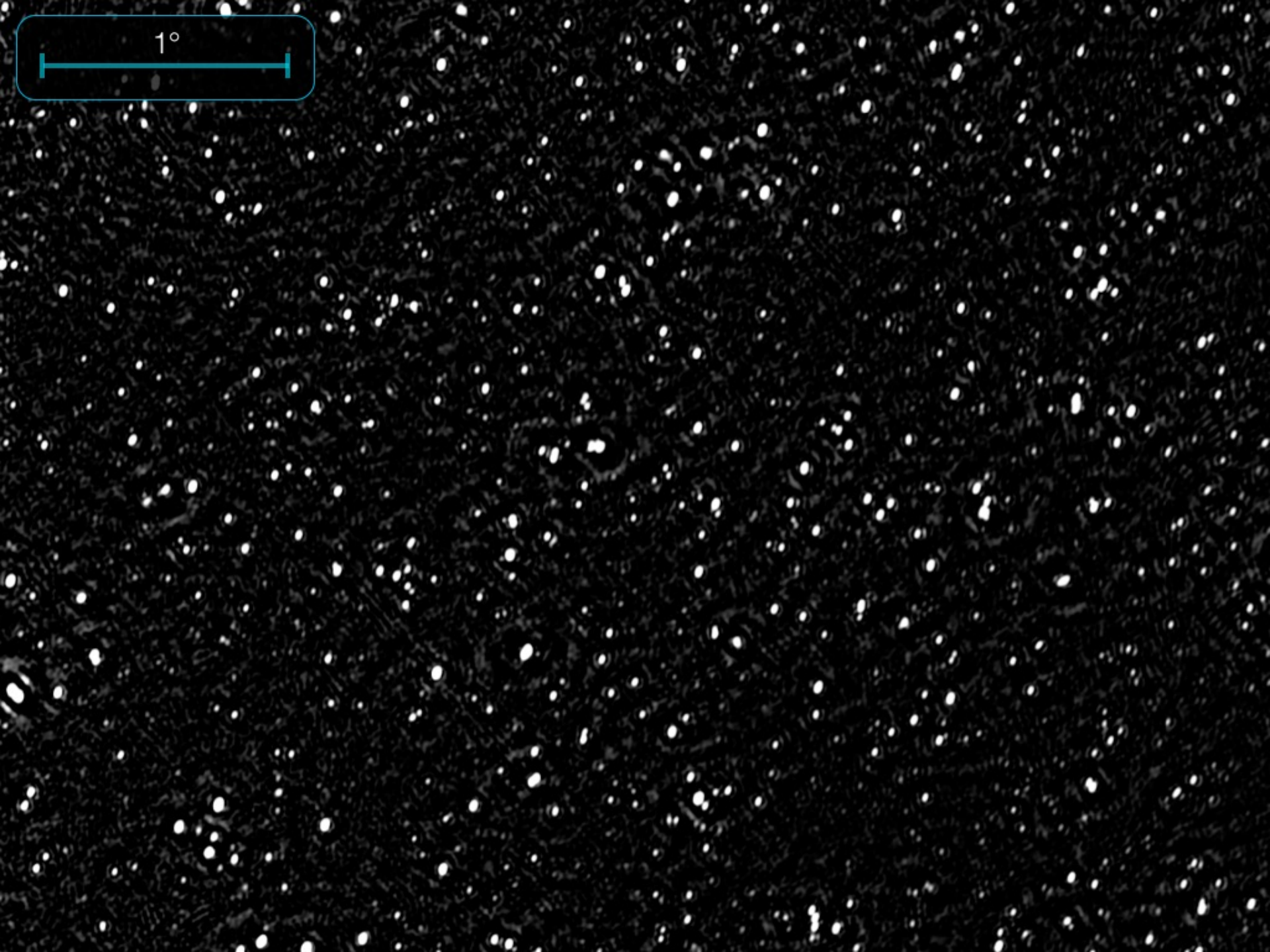
Lessons learned – Parkes and ATCA

- Change and the user community – manage both “positive” and “negative” changes

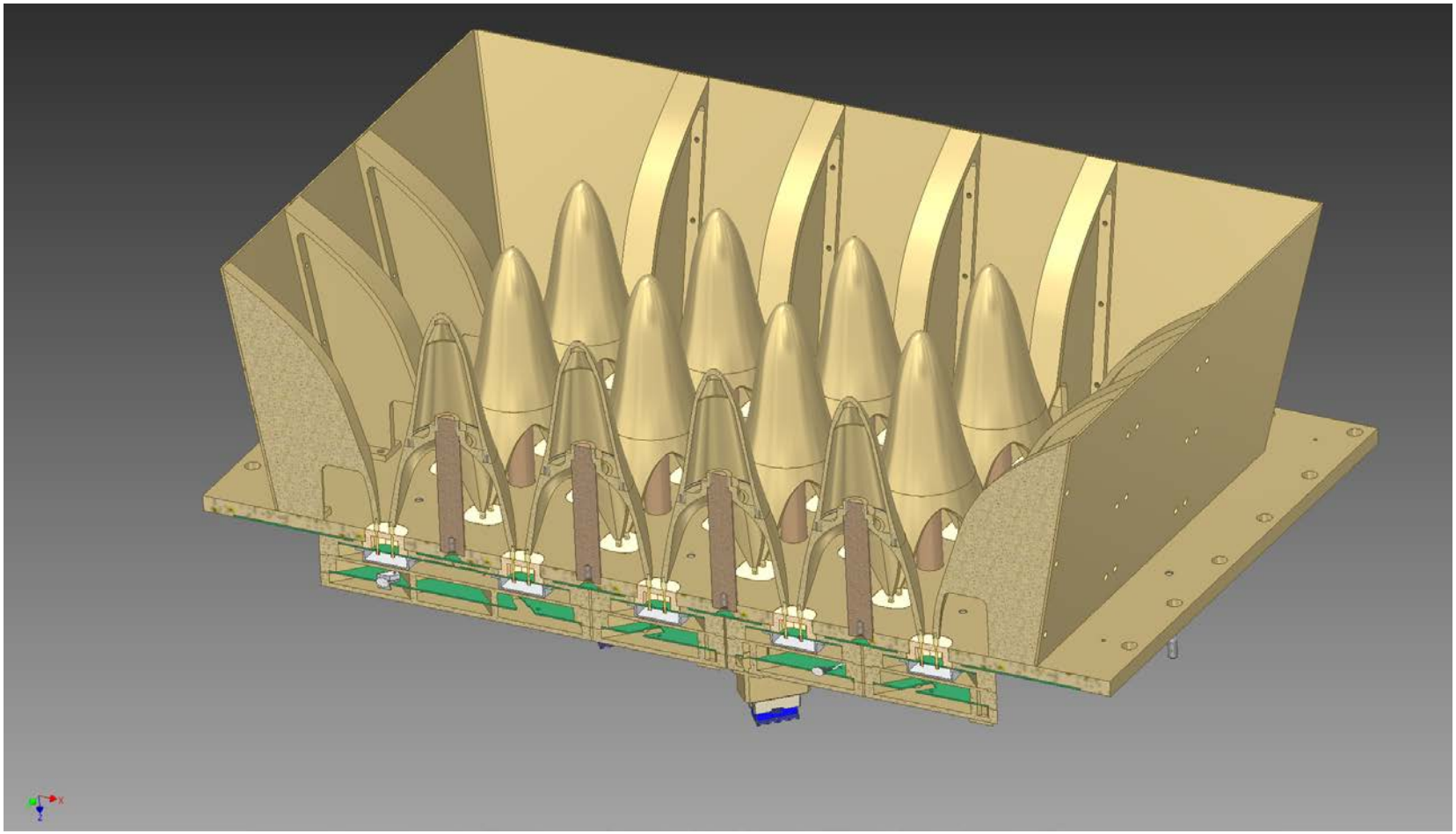
- [System] change control. Becomes more important when staffing is stressed.

- Broad advisory committee successful role in ATCA program/construction
- Prime contractor had responsibility for Site and Telescopes – CSIRO focused on innovative technology

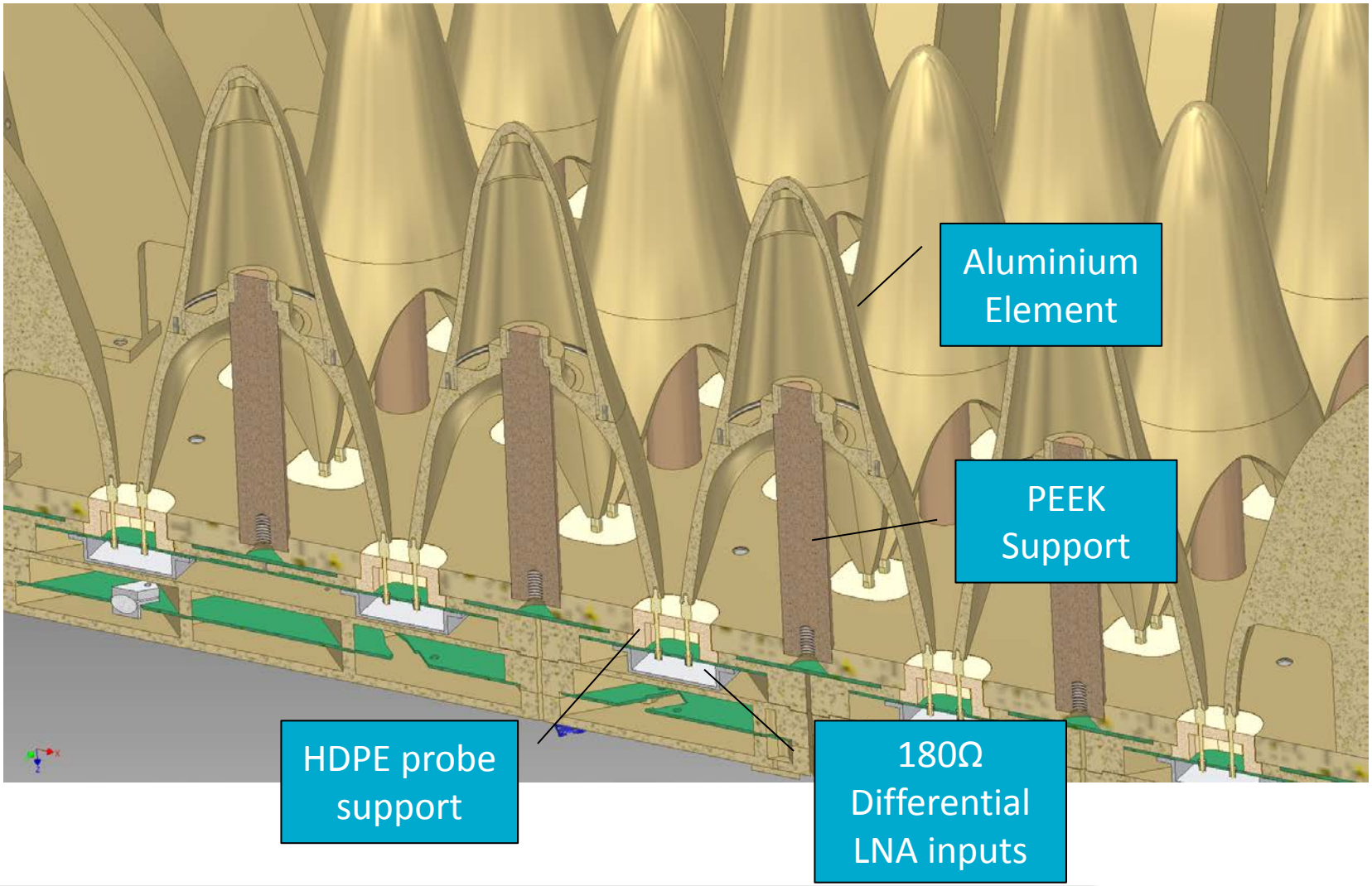
- CABB (~2010 correlator) under-resourced
- Parkes user supplied instrumentation fundamental


1°

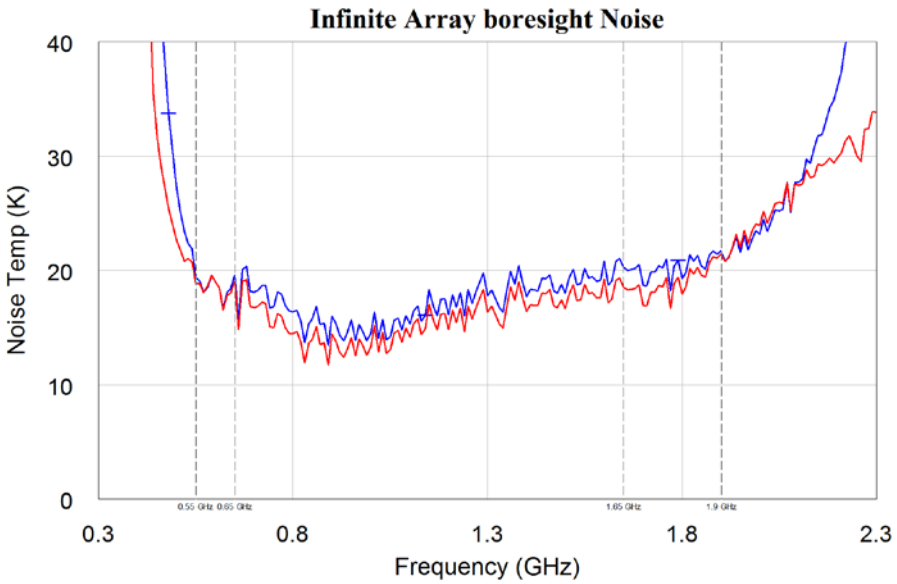
Hybrid Array Design with Edge Elements

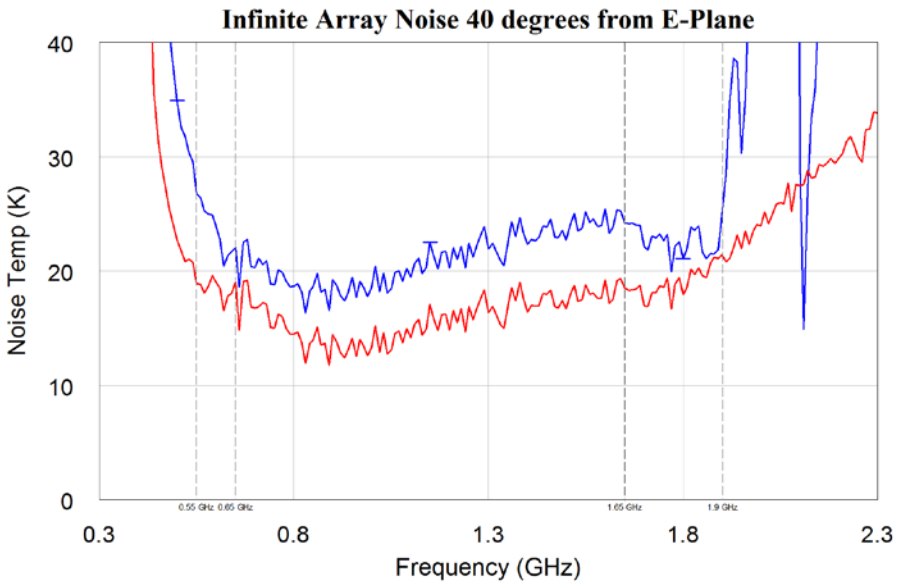


Hybrid Array Design with Edge Elements



Infinite Array Noise Temperature



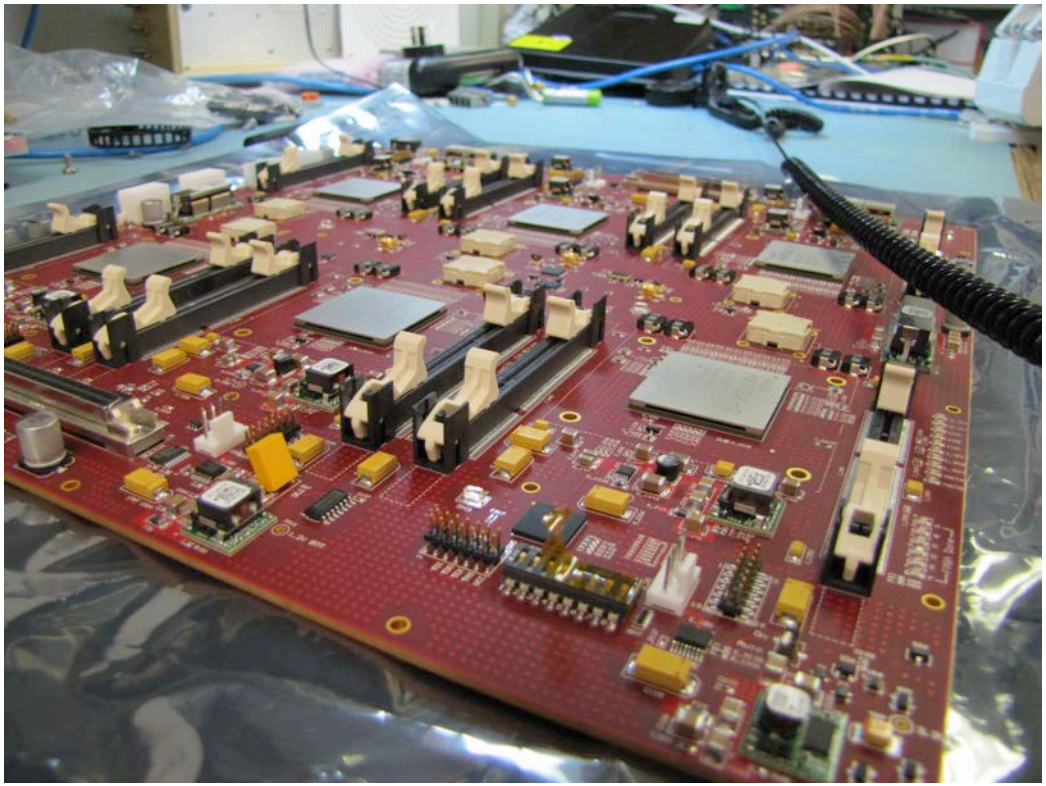


- Simulated infinite array noise temperature using measured LNA noise parameters

CSIRO PAF Development Strategy

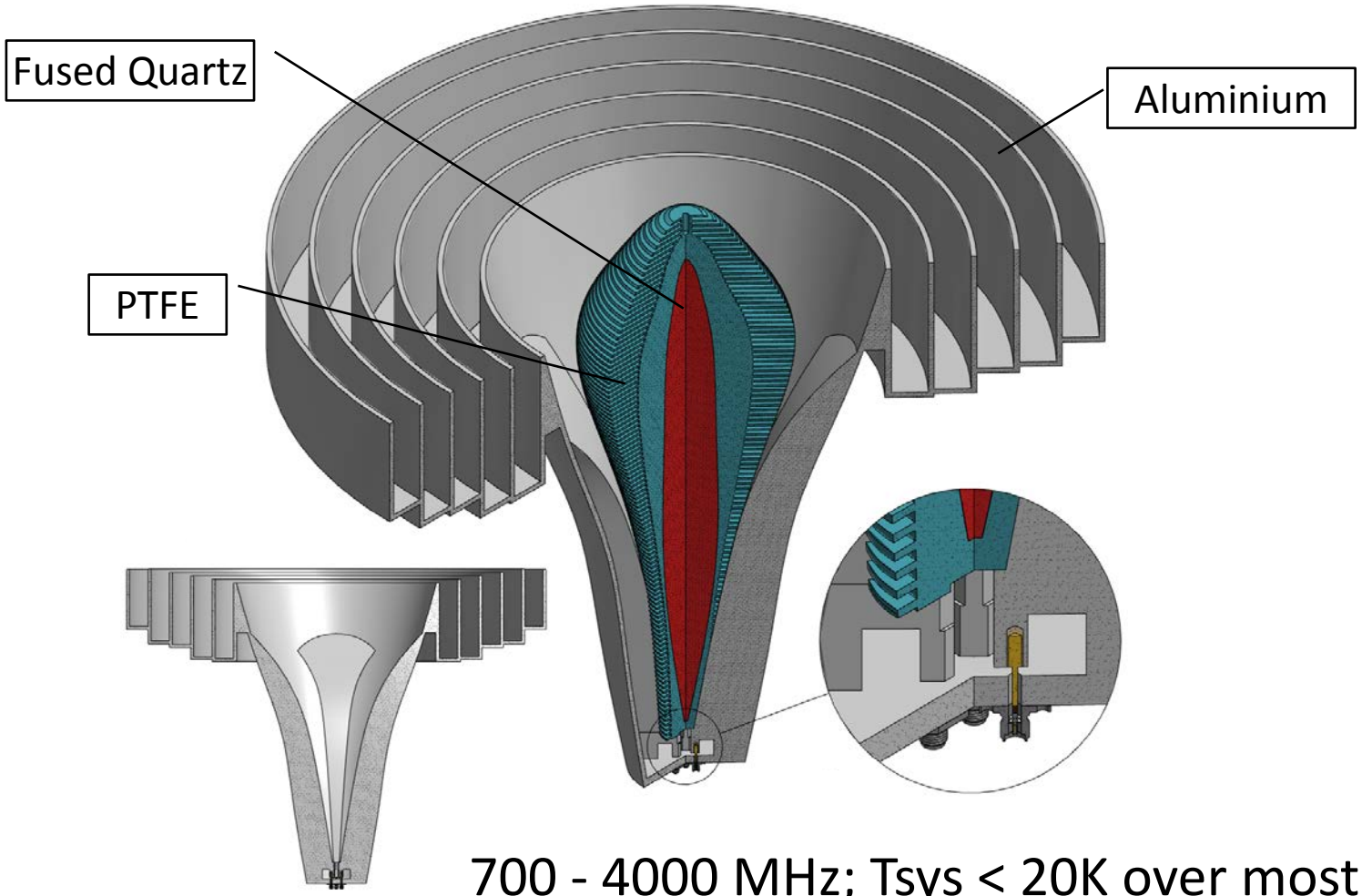
- Enhance existing Australia Telescope National Facility (ATNF) Instruments
- ASKAP Mk. II PAF on the Parkes radio telescope (MPIfR) – 2016
- Reduction in PAF Tsys achieved in SKA work incorporated into ASKAP
- Continue collaborative measurement program (NRC, ASTRON)
- Engagement with broader PAF community
- Cryogenically cooled PAF for Parkes
  - Pawn array element geometry
  - RFI/EMI considerations
  - Sampling at the focus
- Increase bandwidth >2.5:1
- High frequency PAF – 22GHz

ASKAP – Digital Systems (Redback-3)



- Xilinx V7 FPGAs (28 nm technology)
- 10,000 multipliers (3 Tera Ops/sec)
- 750 Gbps optical I/O bandwidth
- 24 Gbytes memory
- Approximately 5x power of ROACH-2 board
- 12 per beamformer
- Same card used in Correlator (96 cards, 12 per chassis)

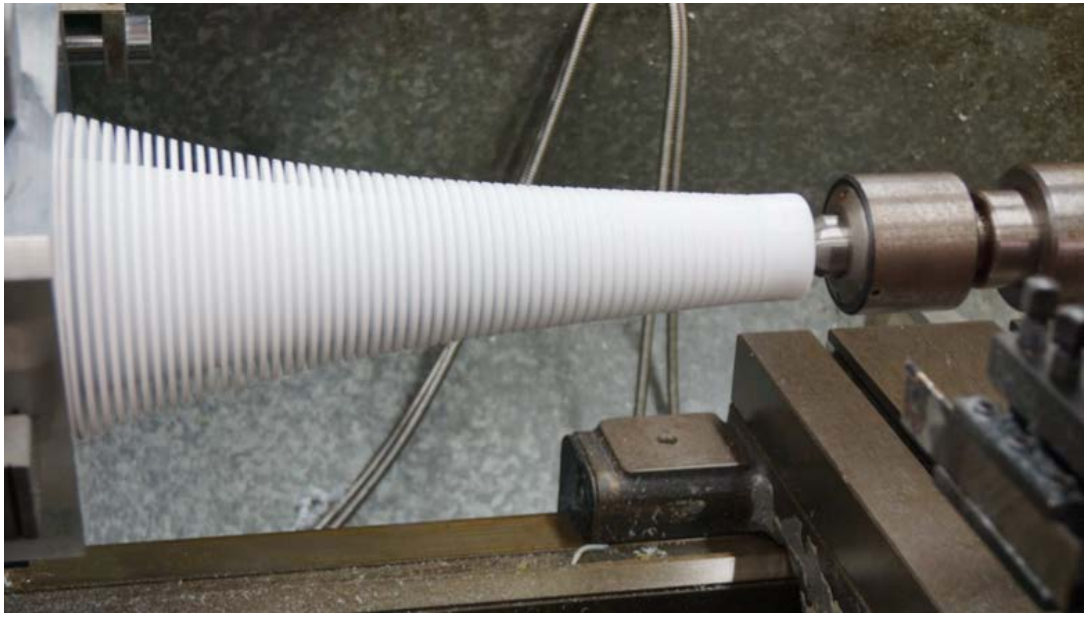
The Dielectrically Loaded Feed Design



700 - 4000 MHz; Tsys < 20K over most of band

Prototype UWB Feed Progress

Feed Horn Outer rings

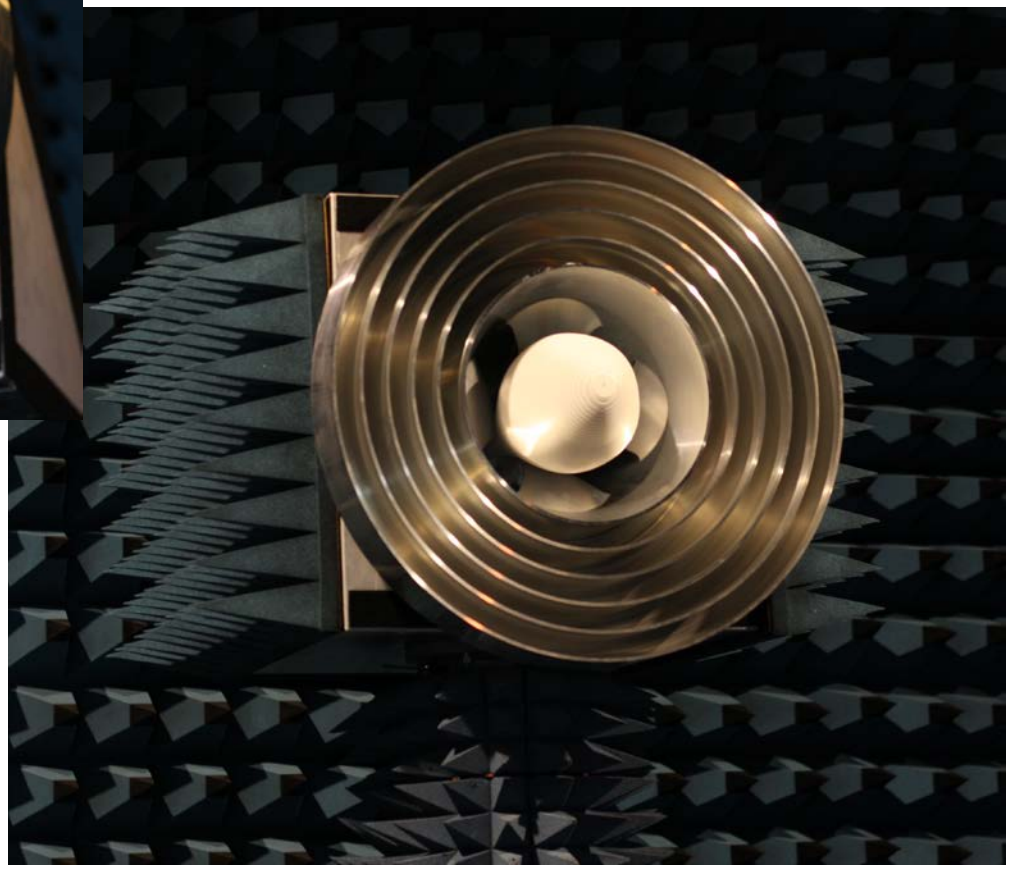


Teflon dielectric

- Prototype feed developed at CSIRO → MUST test and “retire risk”
- Feed tested in June 2015 – Room temperature
- → Paper published! Patents by CSIRO.
- Next steps: Cryo testing.

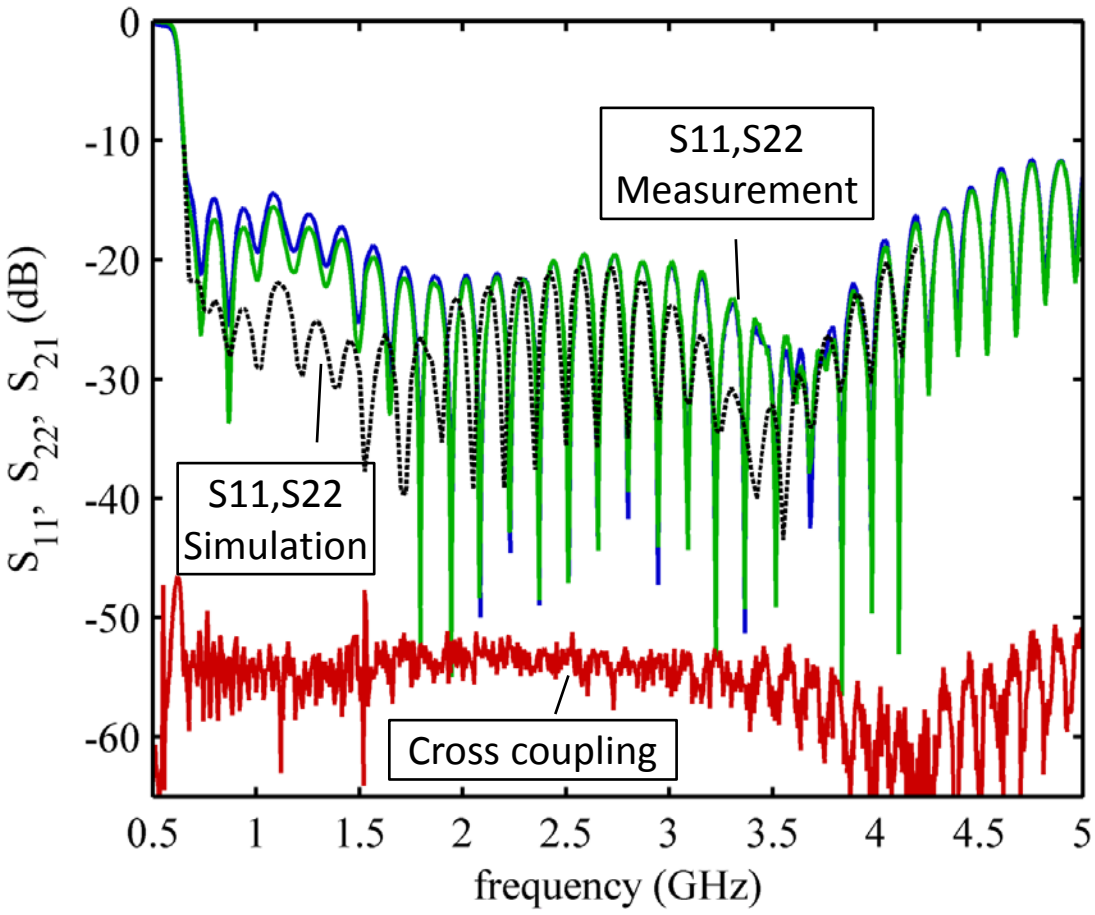
M. Bourne and A. Dunning Installing UWB Feed
Credit: Alex Dunning

- Technological Challenges
  - Cryogenic cooling - Materials
  - Vacuum window
  - Wideband LNA development
  - System integration



UWB Feed Installed in Antenna Test Range
Credit: Alex Dunning

Return Loss and Cross Coupling

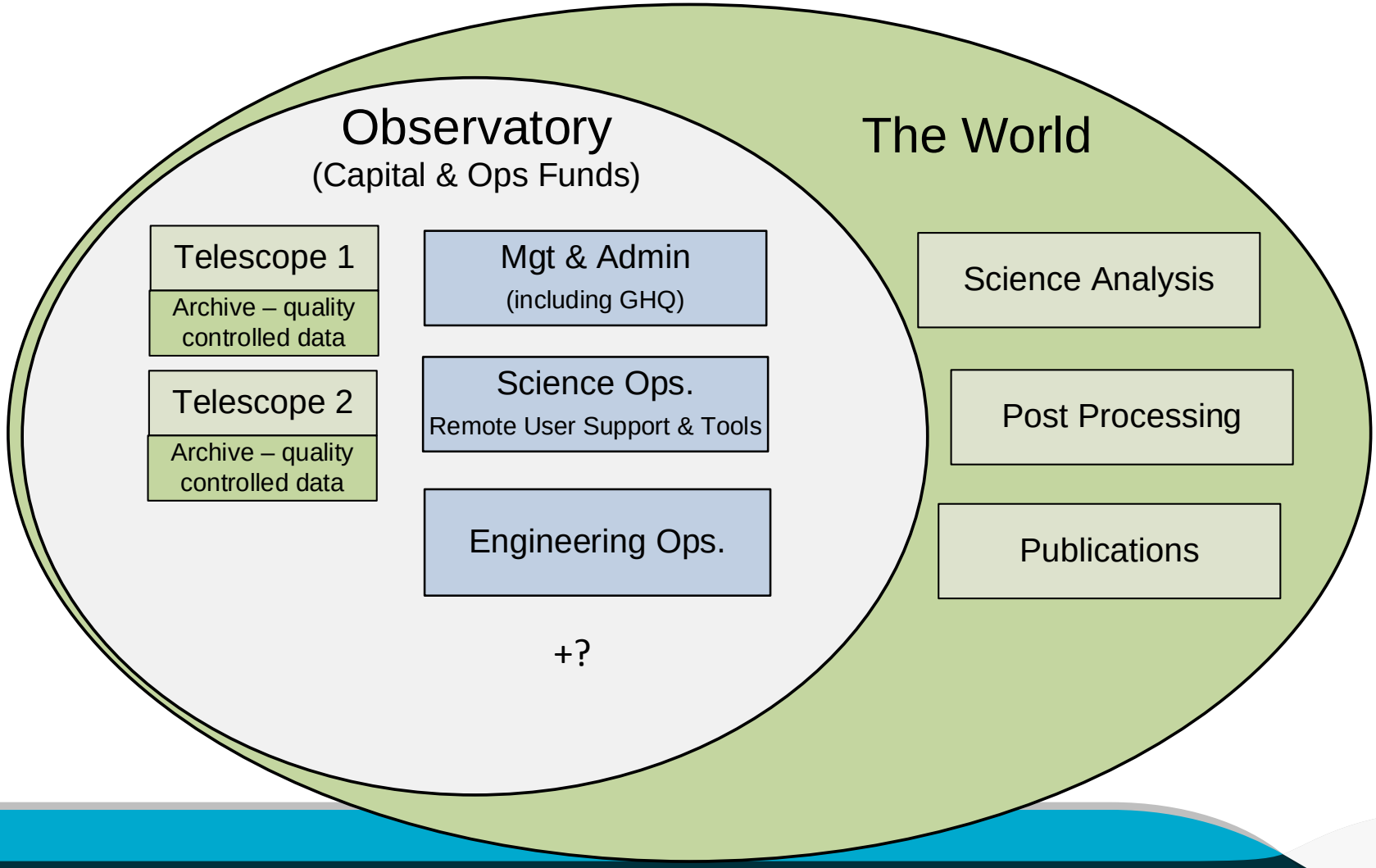


The SKA Observatory

- A **single organisation** consisting of telescopes, necessary local activities, data processing & archive, Global HQ
- Purpose
  - Enable scientists to pursue world-leading programs with SKA
  - Organise and conduct upgrades
  - Ensure protection of SKA sites (SKA and future)
- Scope
  - Provide, commission, maintain, upgrade SKA Telescopes
  - Deliver, support, curate data
- Primary success metric
  - Significance of role in making fundamental scientific discoveries and facilitating overall scientific progress

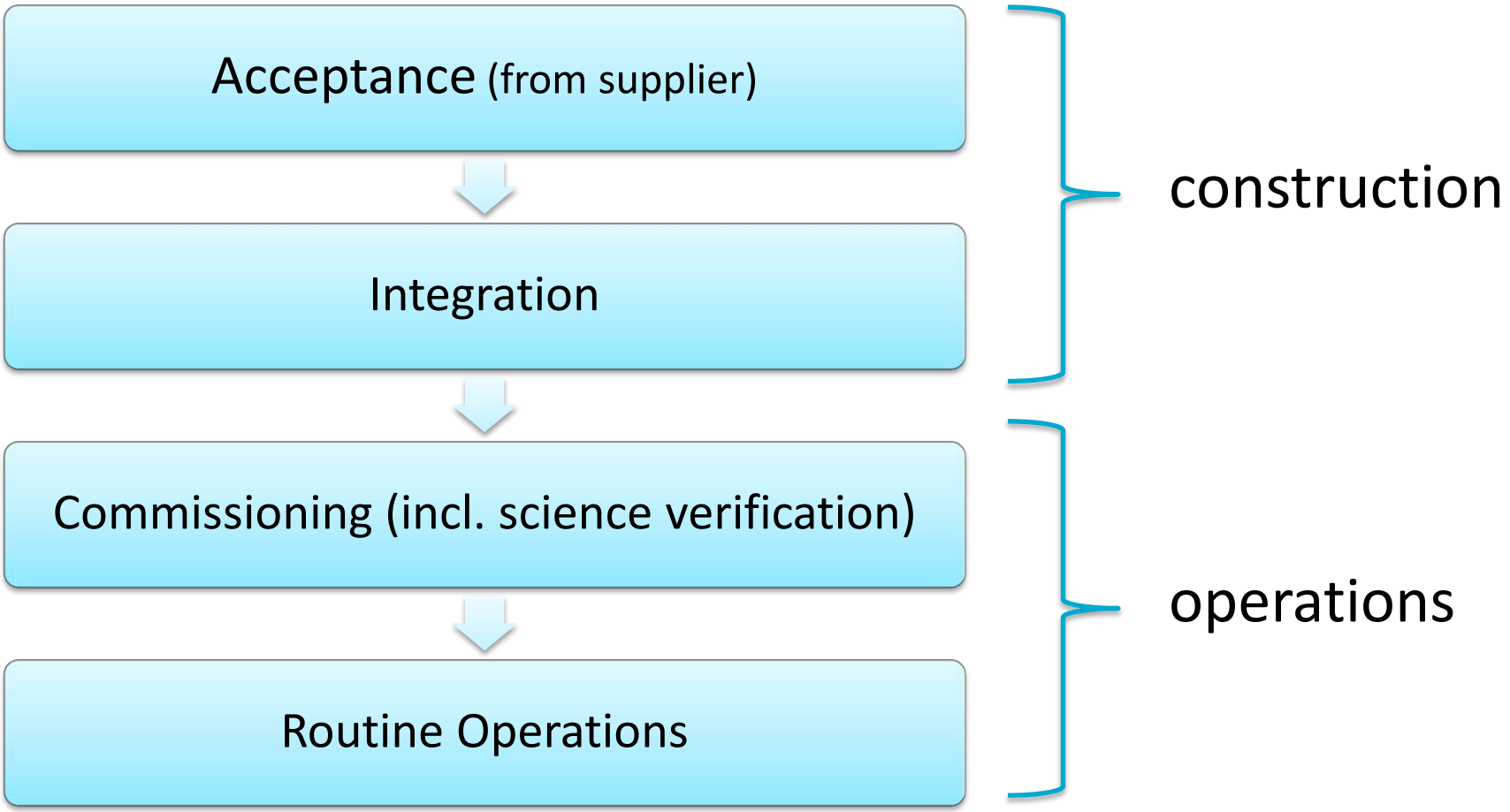
*SKA Concept of Operations (Bock+): Google **SKA ConOps (rev 02)***

Telescope vs Observatory (scope of Ops)



Transition to Operations

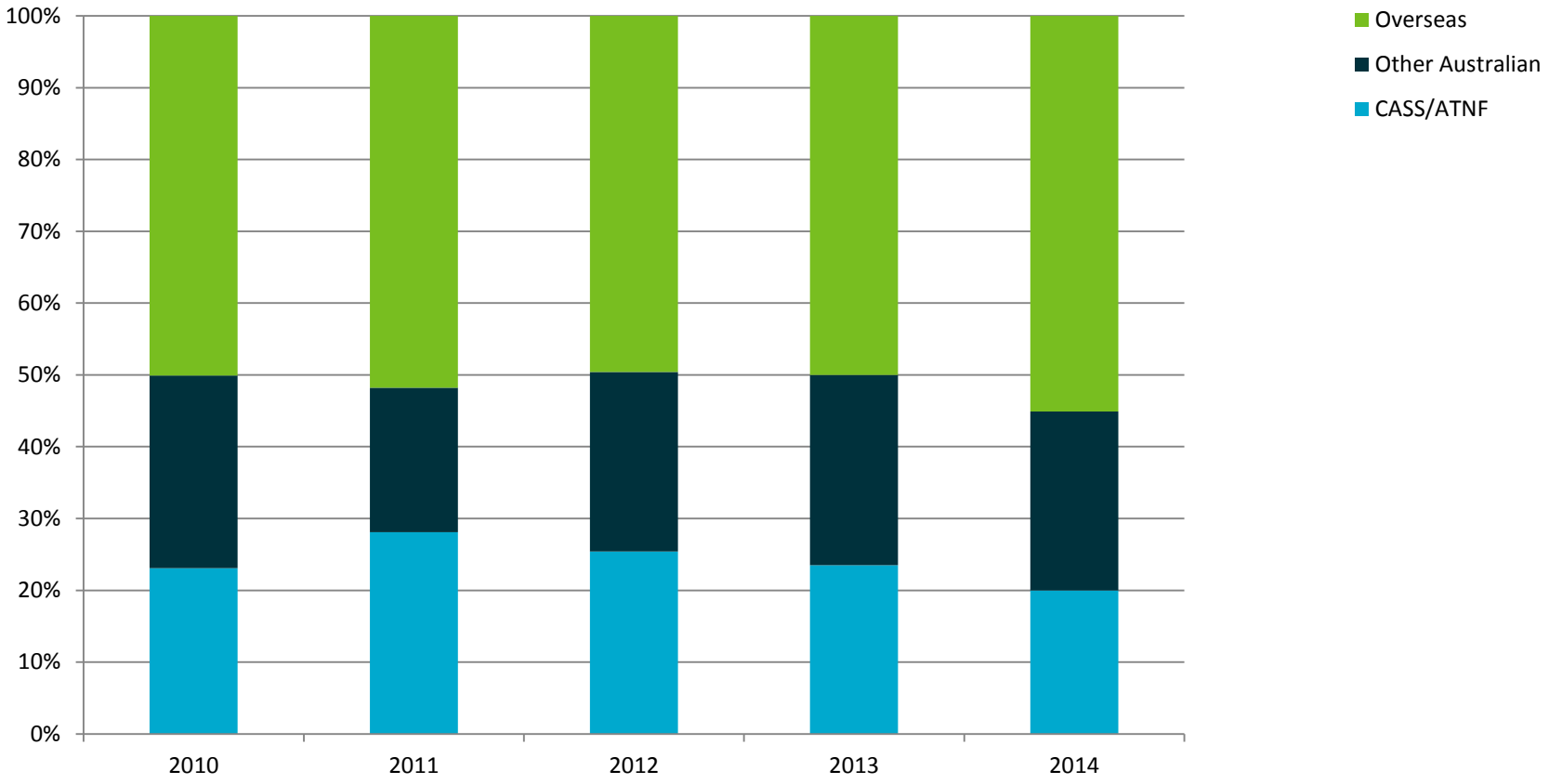
Operations begins early in construction period



SKA Access Policy

- That access should be based on **scientific merit** for scientists **within Member states**, evaluated via a **single time assignment process**
- That there should be a mechanism to ensure **access is proportional to contribution level** for each Member state
- That provision should be made to enable **access for non-member states** at a level TBD
- That all **data/data products are to be made globally available** after a suitable proprietary period
- That the D-G will formally allocate time

ATCA time by all investigators – 2014



Key Science Projects

- Substantially address the key science objectives identified for the SKA

- Require large observing time allocations (commonly > 1000 hrs) over a period longer than one year but no more than five years

- Require substantial dedicated or customised observatory resources. [and team resources]

User Support – (ConOps)

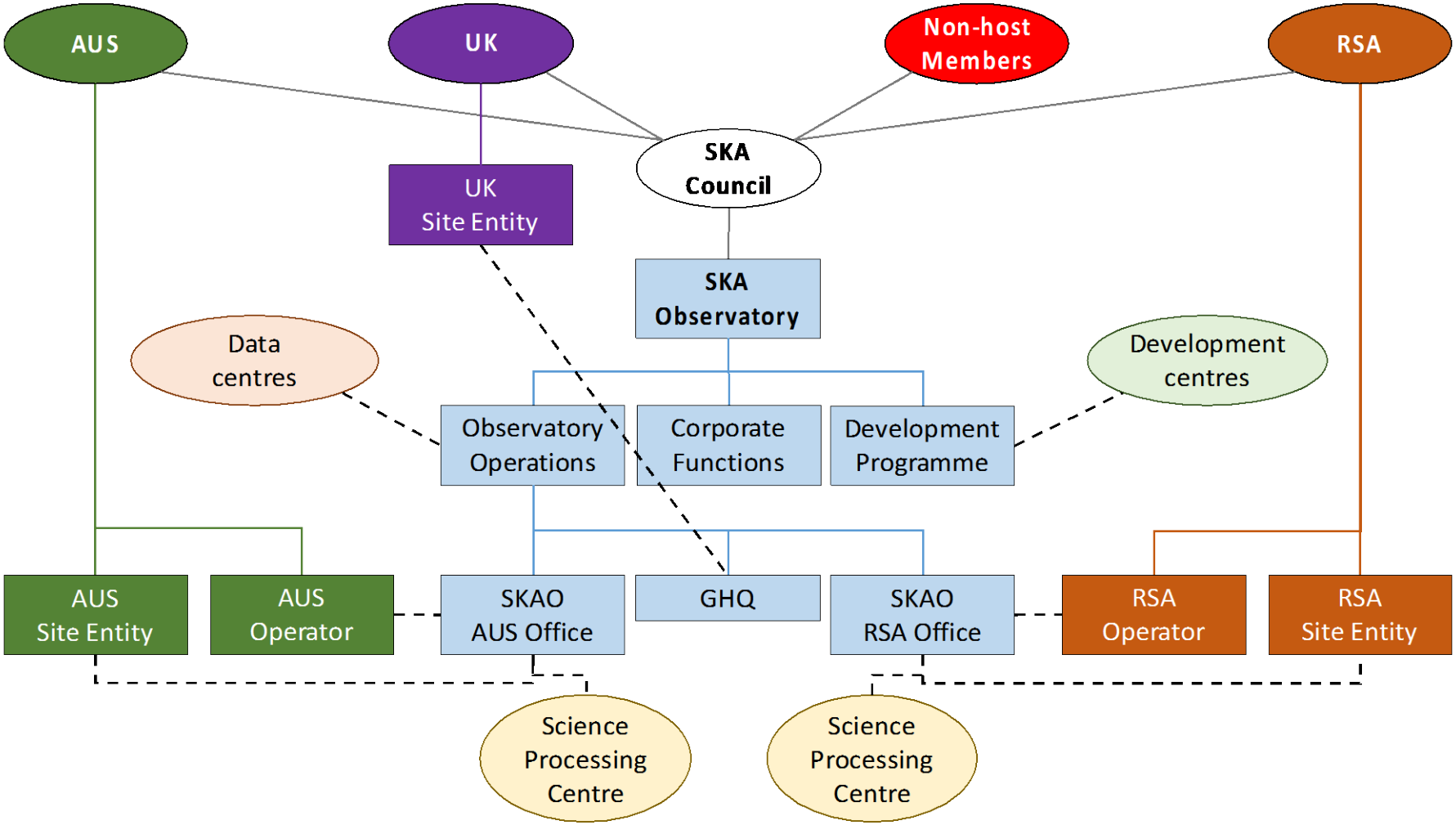
The **SKA Observatory will provide user support and tools** to enable exploitation of SKA data….. Tools, documentation and support will **assume an understanding of the principles of radio astronomy and interferometry**, but not an in-depth knowledge of the SKA design and performance.

General-purpose analysis tools not uniquely required for SKA data will not normally be provided by the Observatory. The tools will be operable from anywhere, via the Internet. “

“Helpdesk” support for the tools will be provided, but not tutorial-style training.

Training, in-person support, and detailed help for non-radio-astronomers to turn their scientific goals into observational programs **could be provided in a regional model** [or by & for KSPs], not funded through SKA Operations.

Current “working” structure



Cost 75m€ p.a.?

Benchmark: ASKAP Operations

Engineering Operations	14 FTE	Mostly Geraldton
Science Operations and Research Astronomers	10 FTE	Sydney/Perth
Software and Computing	6+ FTE	Sydney/Perth
Observatory Operations	4 FTE	distributed
Energy	$2–3m	AUD (=0.72 USD)
Total ATNF Direct Costs	$9m	AUD
PLUS **Pawsey Supercomputer, Property management, CSIRO Corporate costs**		

SKA low **adds** about twice this – mostly in WA

“Remote work cannot be done remotely”

(Mary D’Souza, ASKAP mechanical engineer)

Douglas Bock
Program Director
Australia Telescope National Facility Operations

+61 2 9372 4276

douglas.bock@csiro.au
www.atnf.csiro.au

CSIRO ASTRONOMY AND SPACE SCIENCE
www.csiro.au

CSIRO

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