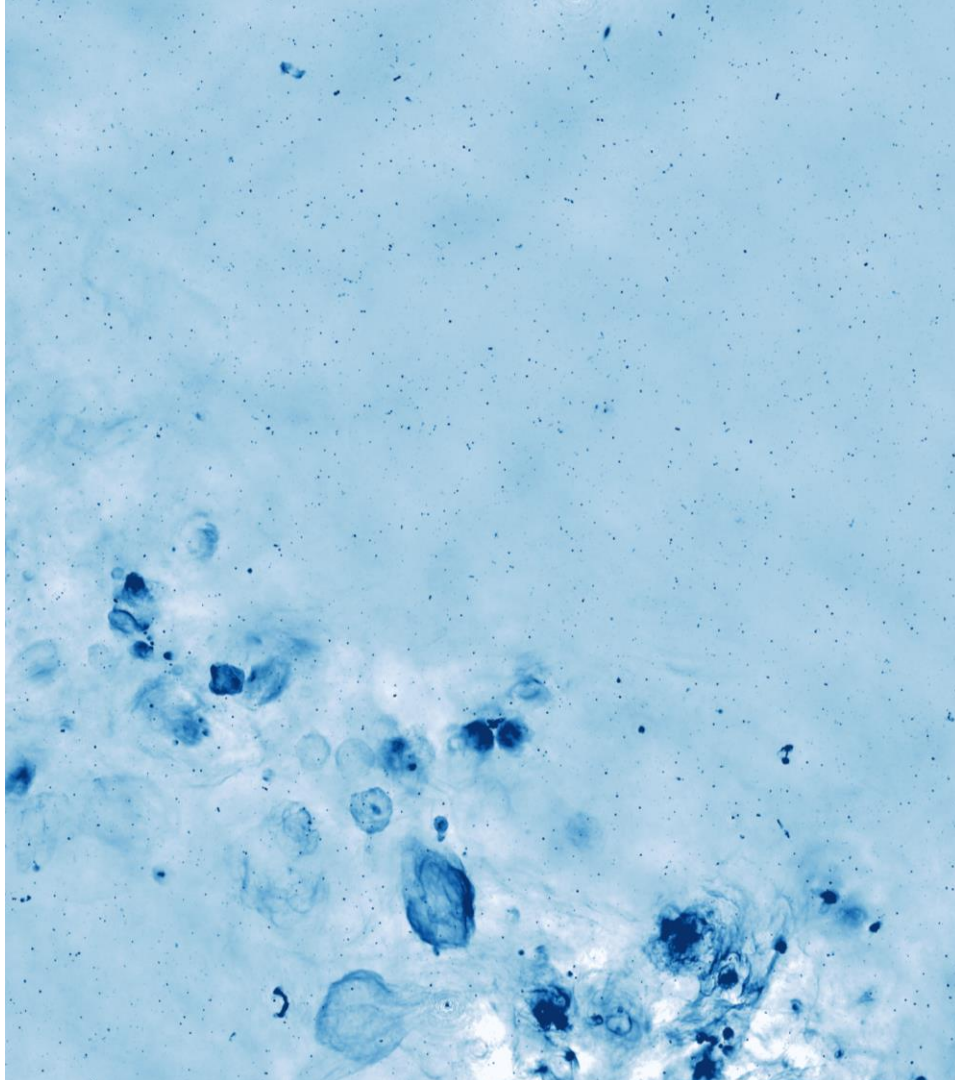
ATUC Open Day Session 2

Science and technology direction



Australia’s National Science Agency

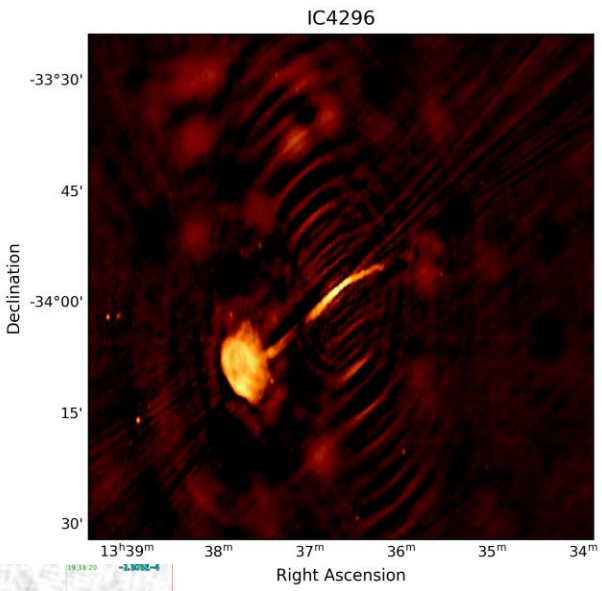
BIGCAT Update + Shared-risk Observing

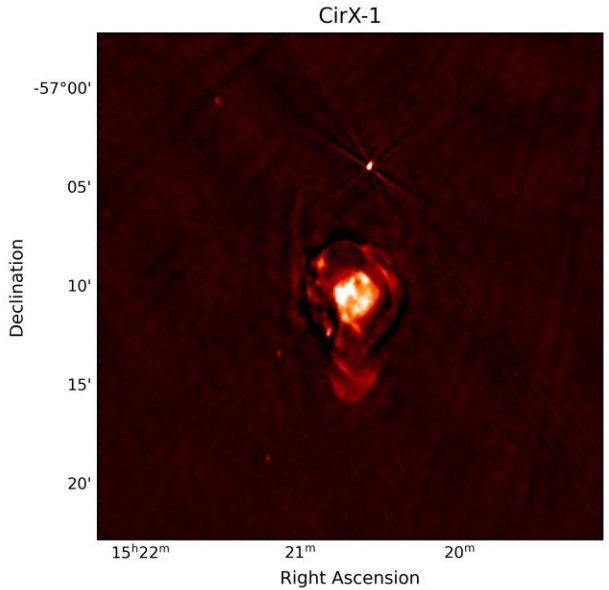
Elizabeth Mahony – BIGCAT Project Scientist
Chris Phillips – BIGCAT Project Lead
Jamie Stevens – ATCA Senior Systems Scientist

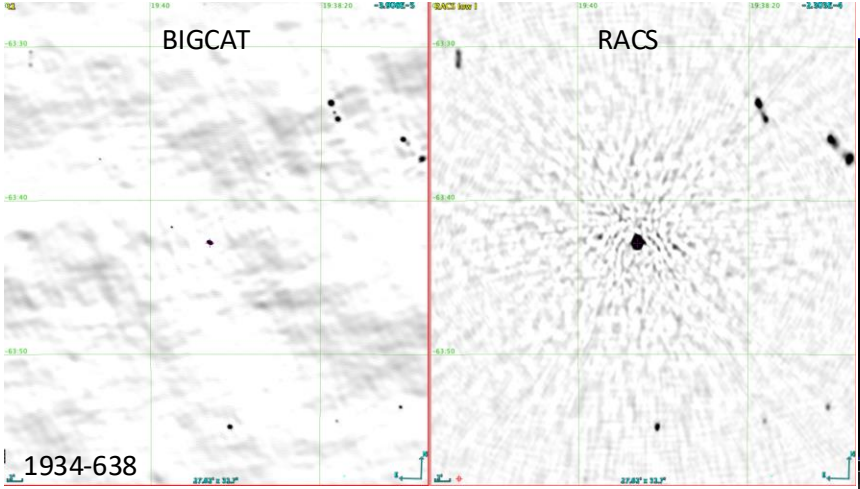
BIGCAT Update

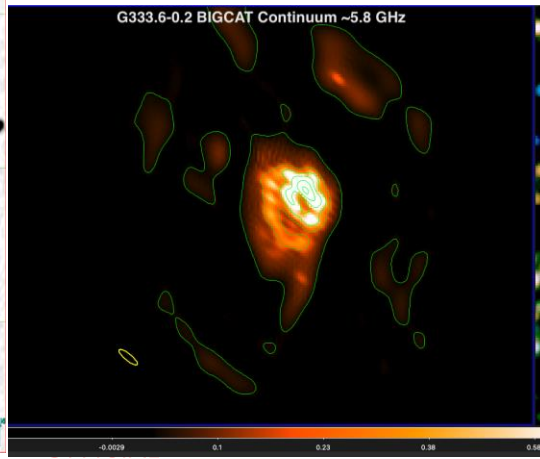
- Installed April 2025
- Engineering commissioning complete
  - ✓ Digital systems working
  - ✓ New control system (CAOBS) working
  - ✓ New GPU correlator working
  - ✓ BIGCAT vs CABB direct comparisons (1IF each)
  - ✓ Consistent phases from each backend
  - ✓ Working ingest pipeline + new output data format
- Science commissioning Aug 11-29
  - ✓ Busy week 11-15th Aug
  - ✓ Tested cont-pol, zooms, mosaicking
  - ✓ End-to-end tests (schedule -> observations -> data reduction)
  - ✓ CASA, miriad, Wsclean all tested

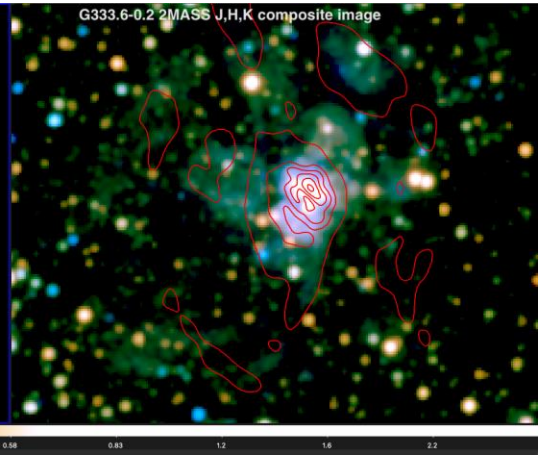
BIGCAT Science Commissioning

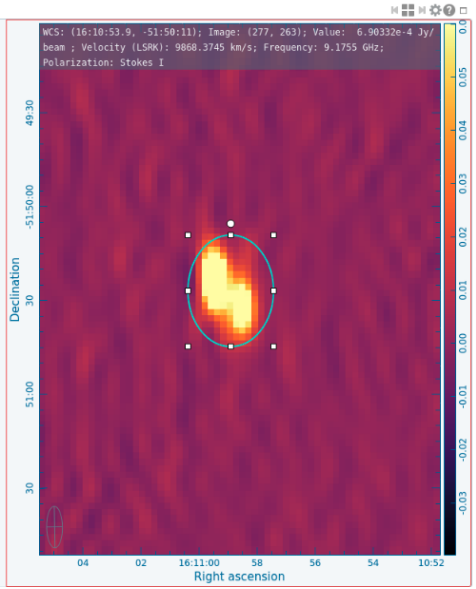


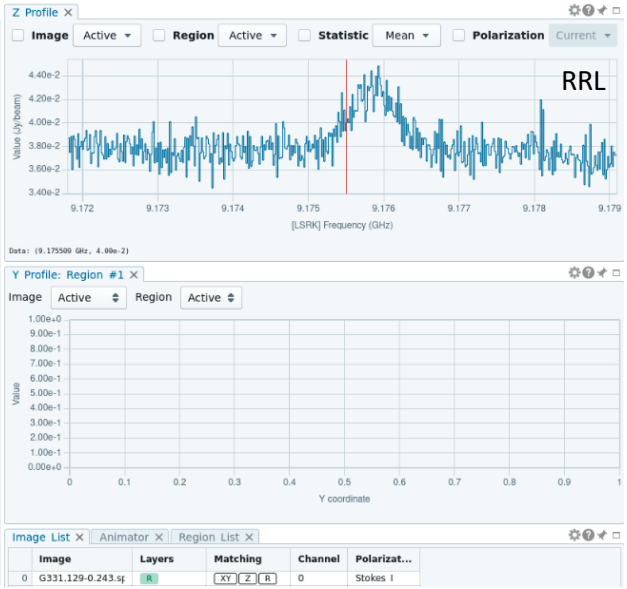


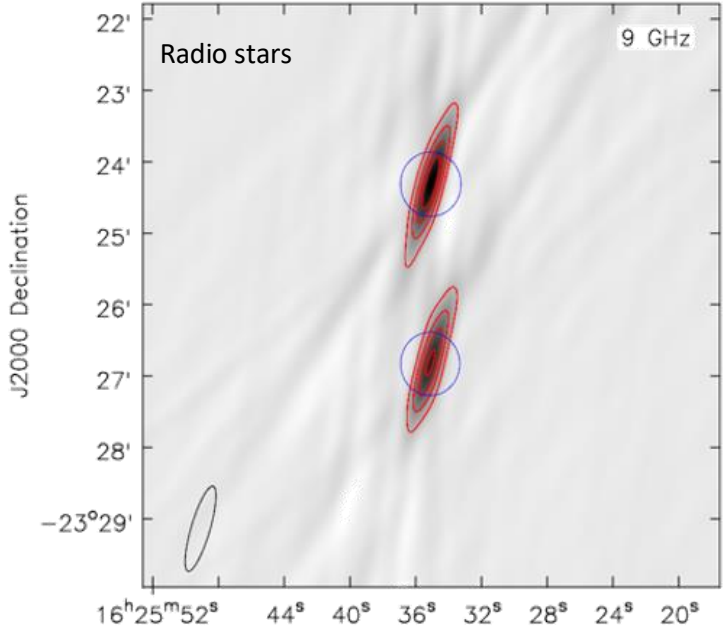


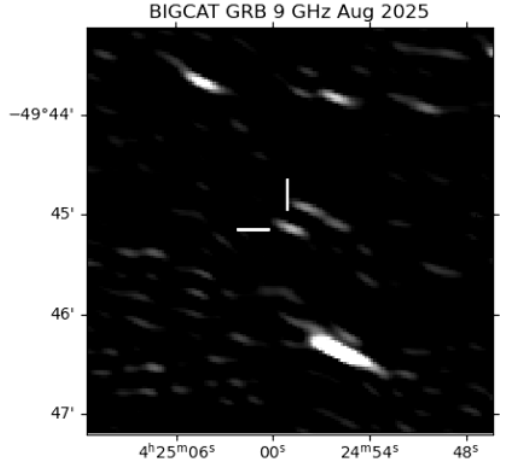


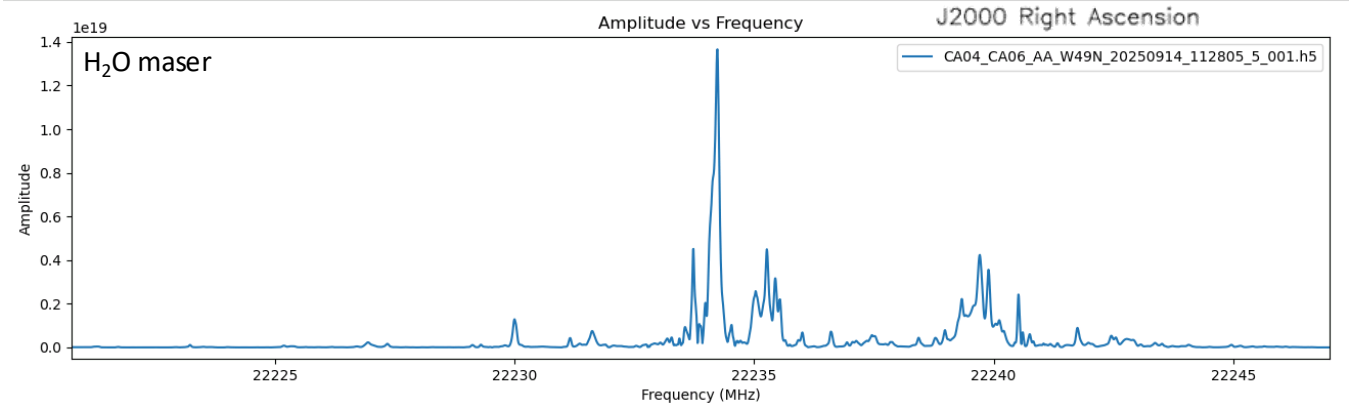



WCS: (16:10:53.9, -51:50:11); Image: (277, 263); Value: 6.90332e-4 Jy/beam ; Velocity (LSRK): 9868.3745 km/s; Frequency: 9.1755 GHz; Polarization: Stokes I
Declination
Right ascension


Z Profile
Image
Region
Statistic
Mean
Polarization
Current
RRL
[LSRK] Frequency (GHz)
Y Profile: Region #1
Y coordinate
Image List
Animator
Region List
Image
Layers
Matching
Channel
Polarizat...
Stokes I


Radio stars
9 GHz
J2000 Declination
J2000 Right Ascension


BIGCAT GRB 9 GHz Aug 2025


Amplitude vs Frequency
H2O maser
CA04_CA06_AA_W49N_20250914_112805_5_001.h5
Amplitude
Frequency (MHz)

BIGCAT timeline

- Now: ATCA offline due to infrastructure upgrade
- Mid Oct: shared-risk scheduled observations (2x2GHz bw)
  - Staged schedule release for 2025OCTS
- Late Nov: RF upgrade
- Dec: science commissioning with 4x2 GHz IFs
- Jan onwards: BIGCAT available with 8 GHz bw (shared-risk)
- Mid 2026: Infrastructure upgrade pt. 2

Observing with BIGCAT

CABB being decommissioned

What's the same

- All observing commands
- CAOBS (rewritten)
- ATCA portal
- Observer/OE qualifications
- CASA and miriad compatible
- All monitoring and safety checks (e.g. MONICA, PMON etc.)

What's different

- Scheduler
- New vnc server
- Data format (ASDM/MS)
- Archived in CASDA
- No vis (but this is coming)

What's gone

- CABB
- No more CACOR
- No more pcal, acal
- No more "focus default"
- No dropped blocks

Observing with BIGCAT

Make schedule

Use new BIGCAT scheduler https://scheduler.bigcat.tools.atnf.csiro.au/

- Create an account
- Set up schedule file
- Deploy schedule

Observing prep

Get vnc password (same as before)

Test vnc connection*

- Now only 1 vnc window -> skull@atnf.csiro.au

Register in ATCA portal

Observe

> set file my_schedule.sch

> start 1/99

That's it! No dcal, no pcal, no "focus default"

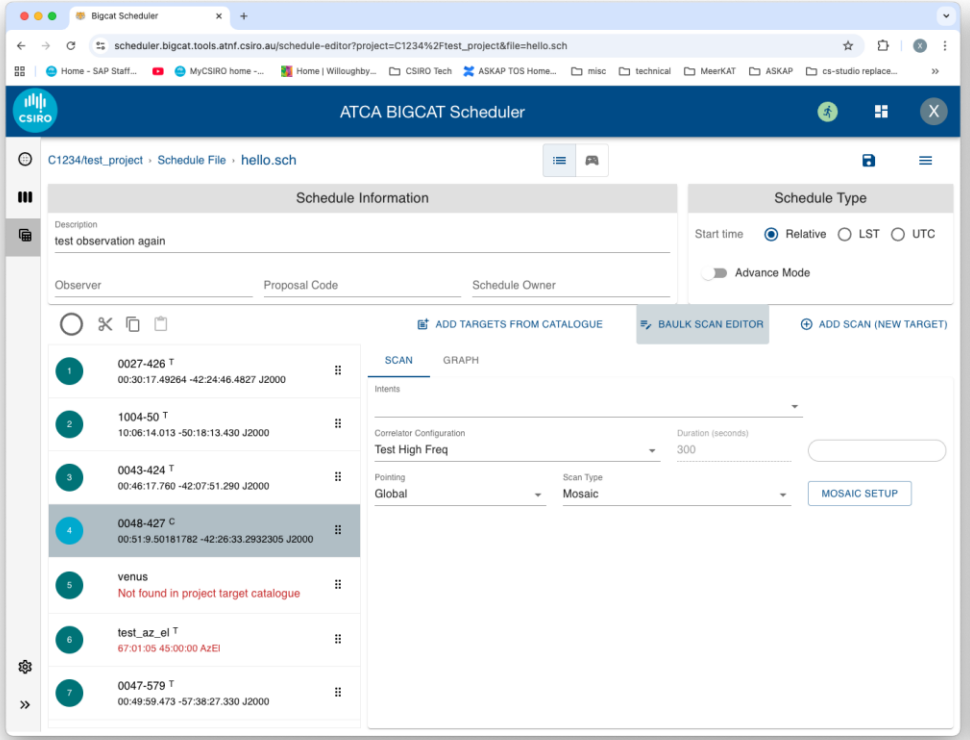
Reduce data

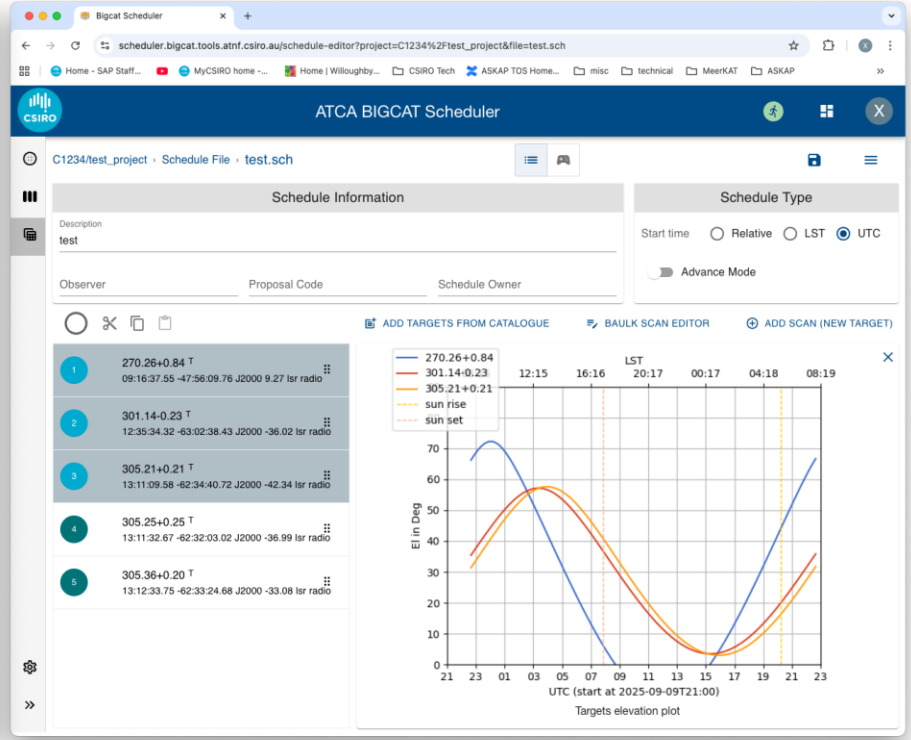
- Data file will be ASDM + converted to MS.
- MS readable by CASA
- To load into miriad: use *exportfits* in CASA, *fits* in miriad

* Check SSH keys!

https://scheduler.bigcat.tools.atnf.csiro.au/

BIGCAT scheduler

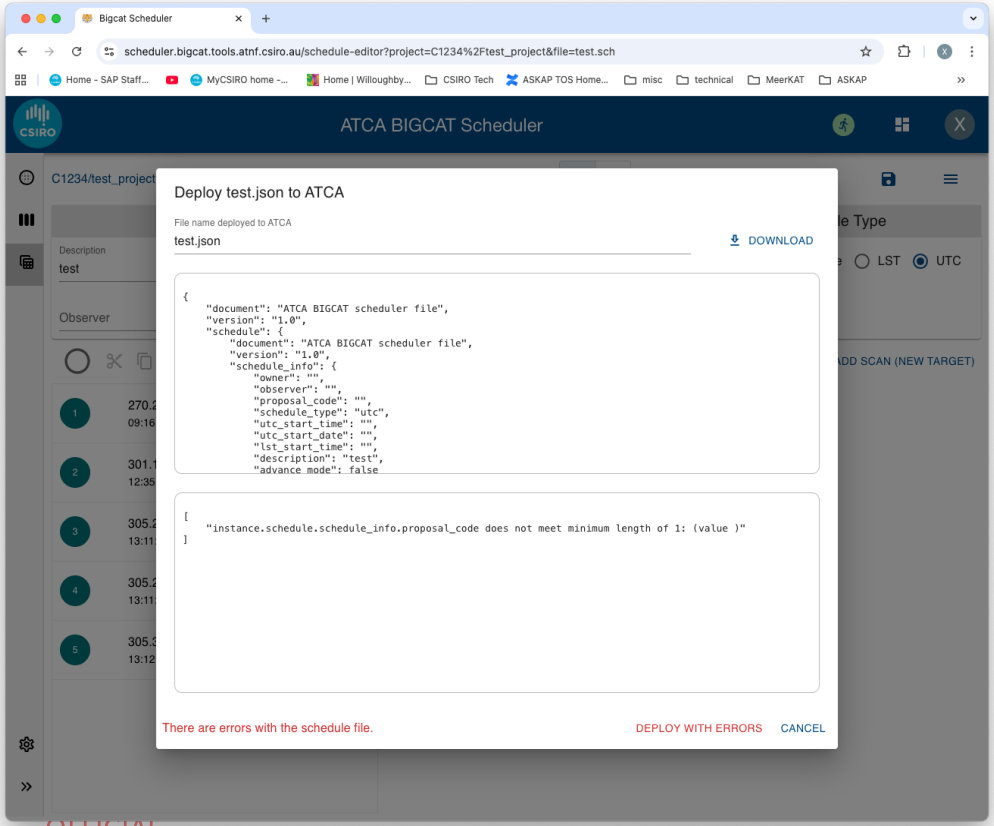




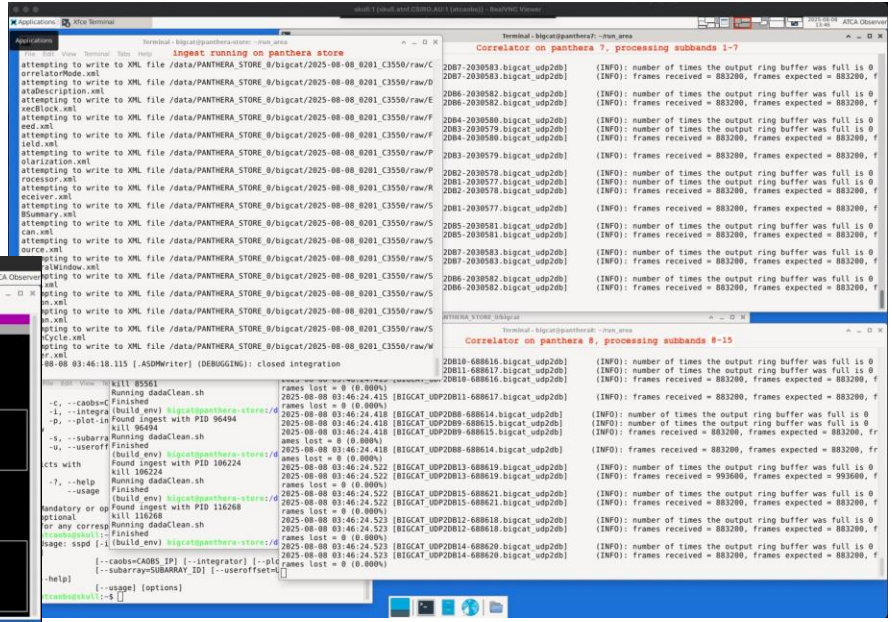
BIGCAT scheduler

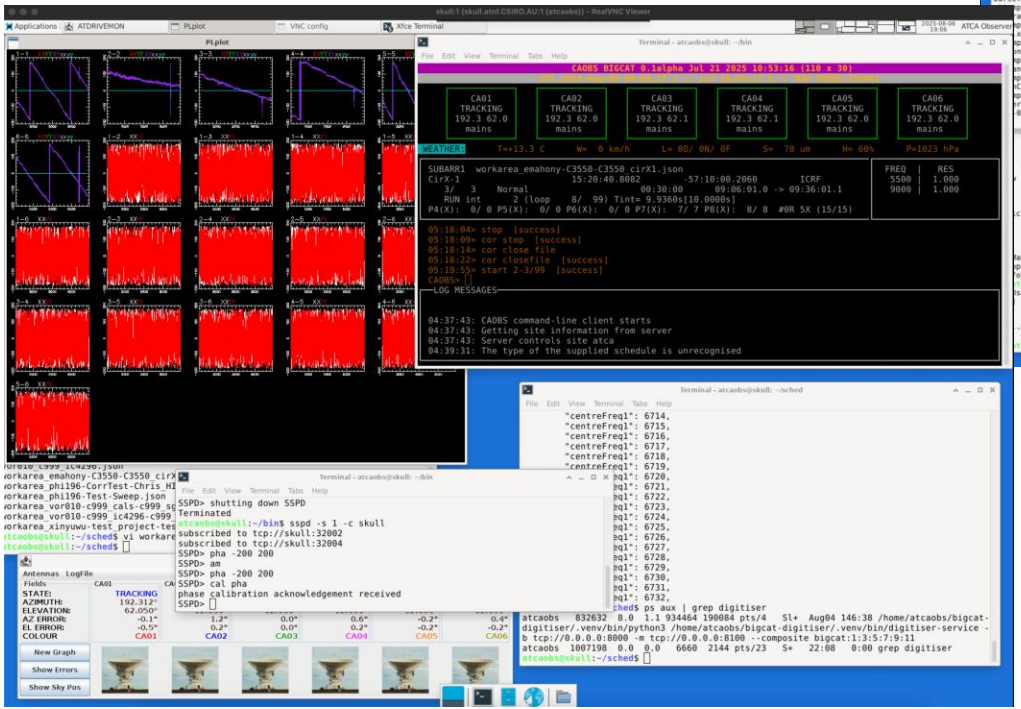
https://scheduler.bigcat.tools.atnf.csiro.au/

- Create an account at first login
- Can create a “Project” which contains multiple sched files
- Option to import CABB schedules or validate schedules made elsewhere
- Need to deploy schedule before observing



BIGCAT observing setup





Using BIGCAT

- Will be very familiar to experienced ATCA users
- Previous ATCA observer and OE training will still be valid
- Observing guides, data reduction guides being written now. Will be shared with users before start of scheduled observing
- Additional support provided during set-up
- Christoph Brem leading ATCA observer + OE training

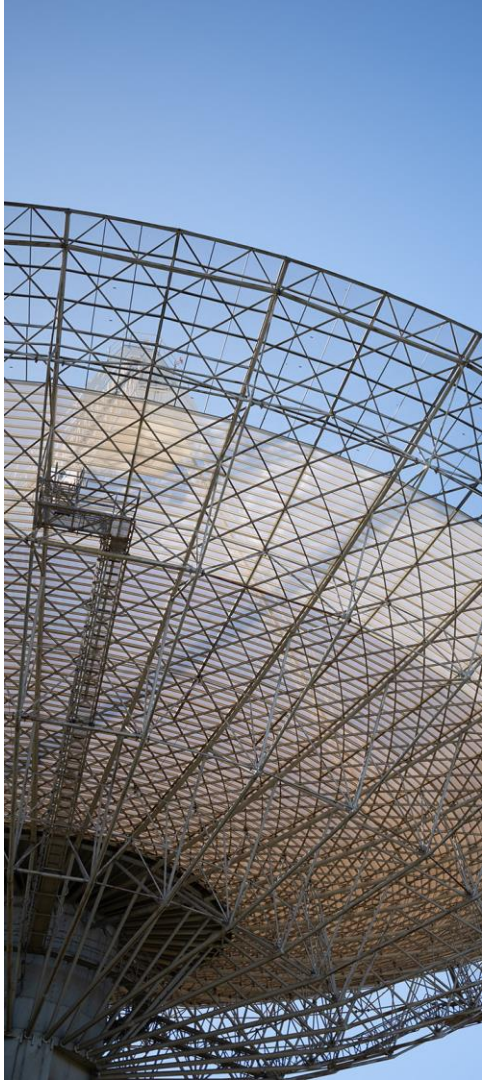
We are all still learning the best way to use BIGCAT. Please be patient with us and expect processes to change over the next ~6months.

-> If you get stuck please reach out to us!

Murriyang and CryoPAF update

2025APR Semester

- 6-week shutdown (June and July): zenith gearbox refurbishment completed
- UWL GPU backend upgrade: Migration from Medusa to Apollo completed
- UWL digitiser issue (July and August): caused ~220 hours of downtime or observations affected
  - ✓ This has been resolved in August
- CryoPAF commissioning: ~350 hours allocated
- Spacecraft tracking: ~165 hours used to date

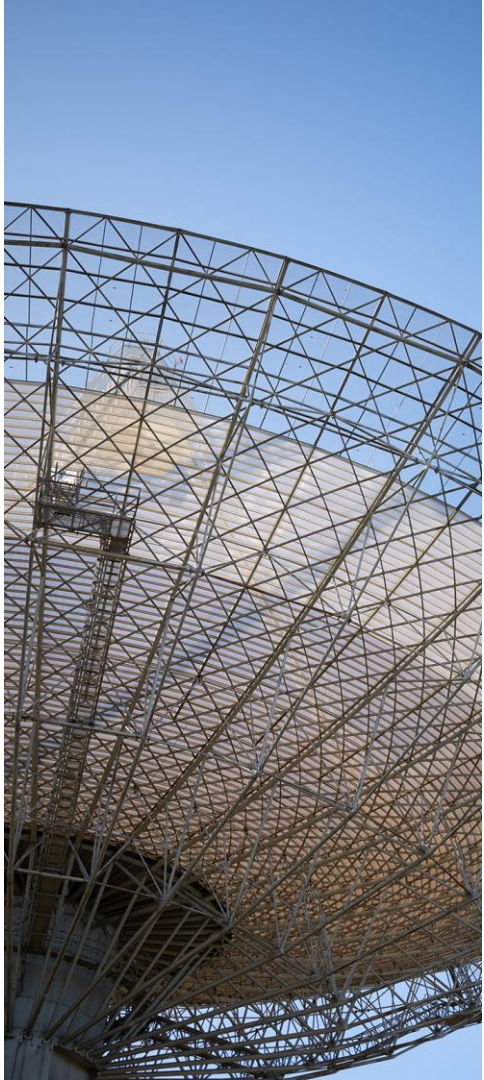


Murriyang and CryoPAF update

2025OCT Semester

- No major maintenance or shutdown planned
- Spacecraft tracking will continue; Currently, no large tracking program in the schedule
- CryoPAF commissioning is expected to resume in November
- Staged schedule releases to accommodate cryoPAF installation and commissioning

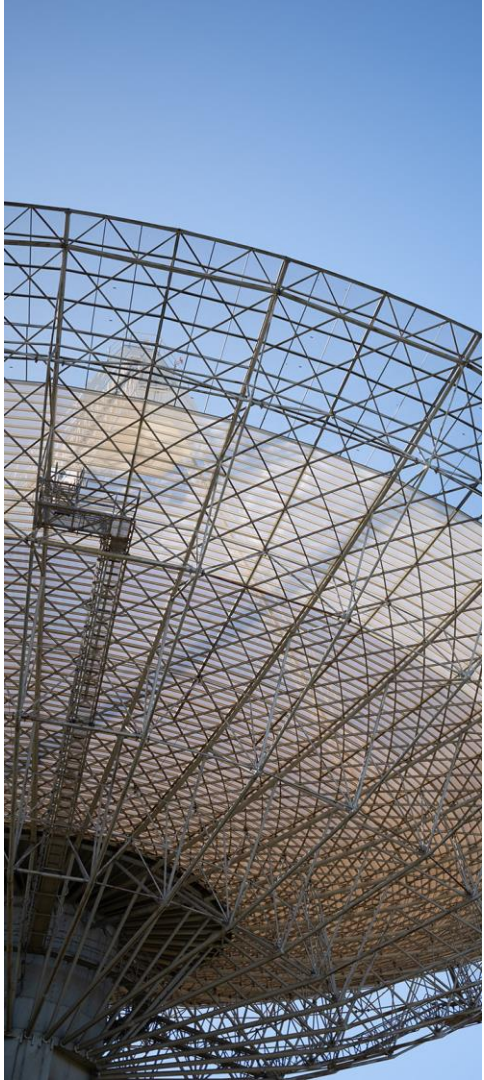
- Polarisation calibration and RFI
  - Making more Polarization Calibration Modeling (**pcm**) solutions available to Murriyang users
  - Monitoring the evolving RFI environment at Parkes and sharing updates with Murriyang users



Murriyang and CryoPAF update

CryoPAF update

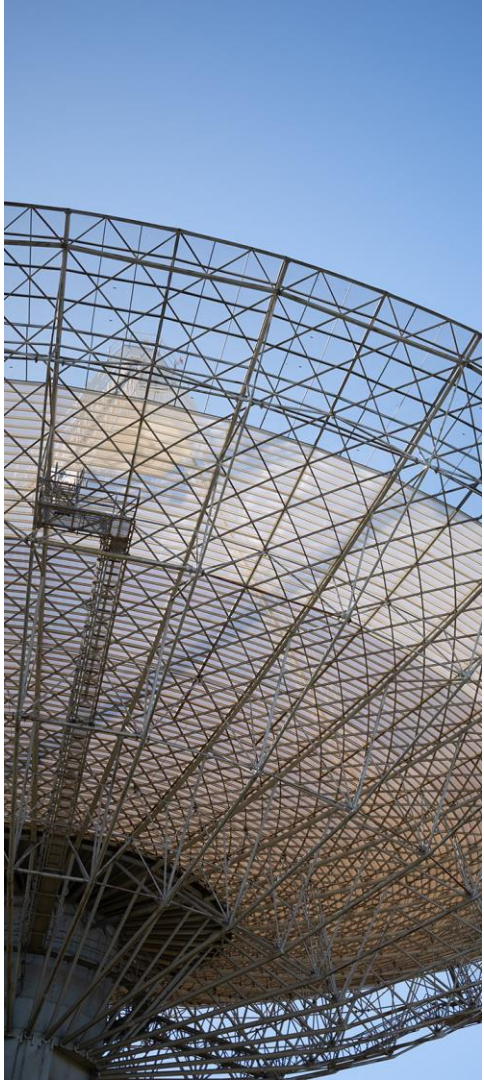
- The cryoPAF was at Parkes from February to August 2025 for science commissioning, spending most of this time in the focus
  - Commissioning and verification have been completed for three astronomy modes (pulsar fold, transient, spectral line) at230MHz bandwidth
  - The Jimble firmware was upgraded and additional beamformers were installed, extending the observing bandwidth from 230MHz in February to 614MHz
  - Progress has been made on integrating the operation and scheduling system, as well as preparing of metadata
  - The SETI mode is currently under development and is expected to be tested in November. Ingest test using the Breakthrough Listen existing backend system was successfully carried out



Murriyang and CryoPAF update

CryoPAF update

- Top layer foam was replaced in May to address the cryogenic issue. However, this led to a significant leak in the PAF's vacuum system.
- New foam and vacuum windows have been secured and will be replaced in October. We expect the cryoPAF to return and be installed in November.
- Commissioning is expected to resume in November and December
  - Verifying all the modes with 614MHz bandwidth
  - Integrating and commissioning the new Garawang observing system
- Shared-risk observations in early 2026
- Cryogenic issues may continue once its back in the cabin requiring (frequent) vacuum regenerations. We are considering potential solutions such as reducing the heat load by replacing the LNAs with lower powered devices



ASKAP software and firmware updates

Firmware updates for spectral line observing

Pipeline updates, reference field calibration and offset field imaging

CASDA – Status and future

ASKAP Software, Firmware and Archiving Update

- Firmware updates for spectral line observing
- Pipeline updates, reference field calibration and offset field imaging
- CASDA – Status and future

Firmware Updates

Background Info:

- ASKAP FPGA Firmware is notoriously challenging to test thoroughly for several reasons:
  - Massive scale of system
  - Limited testing time due to continuous observing
  - FPGA code changes can manifest problems in very subtle ways
  - Only one real/full telescope (problems often don't show up on MATES)
- So, for the above reasons, for the past few years we have not been able to release new FW very regularly, and the "production" FW has gotten a bit "stale".

Slide credit: Mike Pilawa

Firmware Updates

Background Info continued:

- Common-code improvements made during the CRACO firmware development (correlator FW) were gradually introduced to other parts of the system (beamformer & digital receiver FW), however not released straight away.
- New FW builds gradually get tested on the array, and some get accepted as “production”.
- However, as with any firmware or software, subtle bugs do sometimes slip through testing and may not get detected for some time.

Slide credit: Mike Pilawa

Firmware Updates

A problem is detected (and fixed):

- Mid-August 2024, DINGO & WALLABY observations started noticing small steps every 24MHz in spectral power plots. (see AXE-946: lots of nice plots there)
- Problem was quickly confirmed to be based in beamformer FW, and several rounds of FW debugging were initiated.
- The root cause was found in 10G link transport code, and a fix was produced by mid-November 2024. ☺
- However, upon testing the fixed FW, other data artifacts were noticed. ☹
- This was possibly due to the FW fix, but even more likely due to having lots of unreleased (and limitedly tested) changes in the code base.

Slide credit: Mike Pilawa

Firmware Updates

A long road of bug fixing:

- Several months of slow bug-fixing progress.
- Then, recently (from ~June 2025?), a much more concerted effort (with lots more on-array testing time!) produced a much more rapid-fire and tighter debug cycle was initiated (add debug capability, deploy on array, test, analyze, repeat)
- During this time a few notable defects were detected and patched.

Slide credit: Mike Pilawa

Firmware Updates

Corrupted calibration correlator (cal-corr) data, which is used during ODC updates, found to be part of the “low-amplitude” problem. However, the root cause was found to be in the 10G link transport

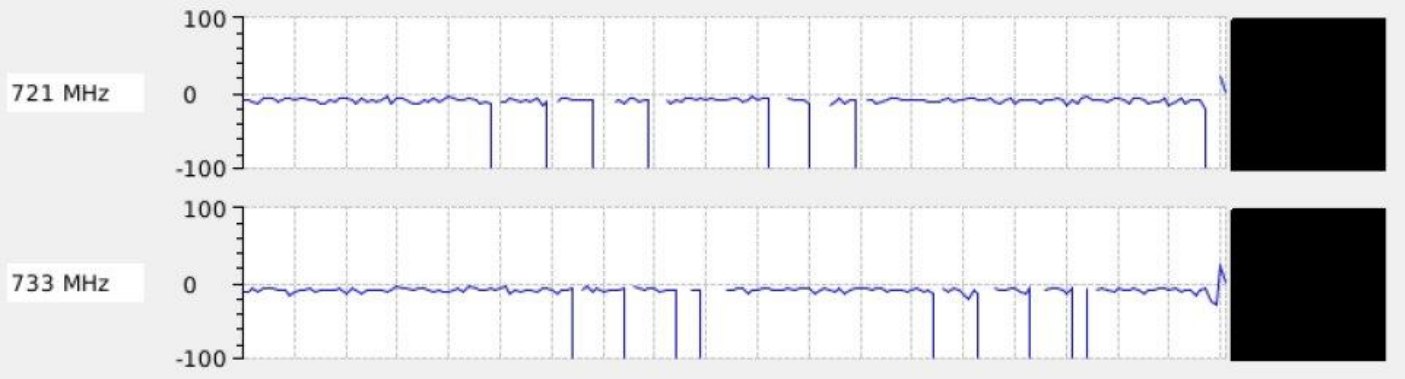


Image Credit Mike Pilawa

Slide credit: Mike Pilawa

Firmware Updates

Also spotted a similar (and related) corruption in ACM data (-∞ ports).

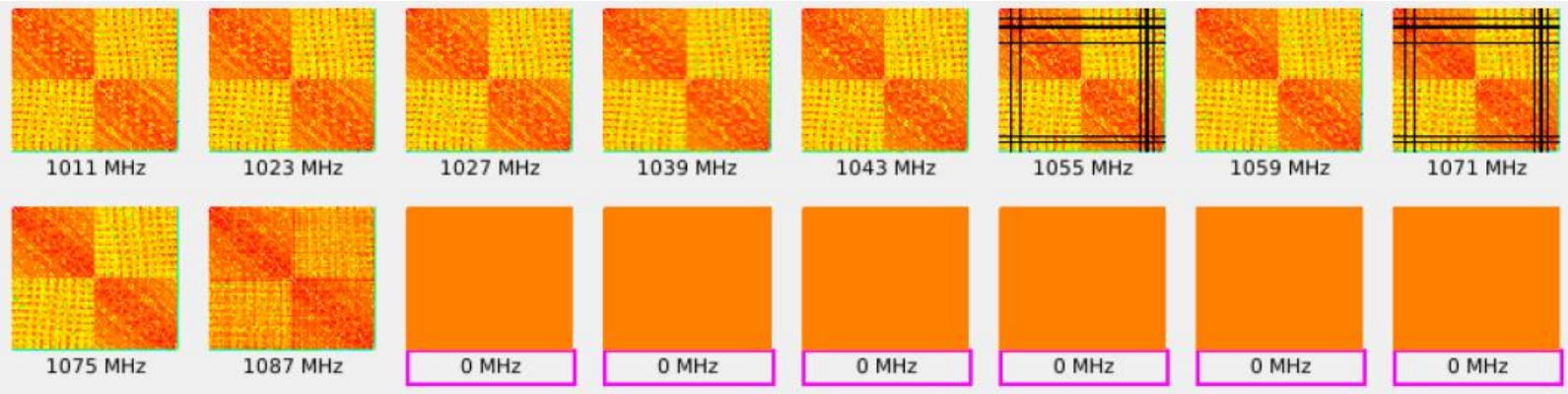


Image Credit Mike Pilawa

Slide credit: Mike Pilawa

Firmware Updates

New Firmware:

The 24 MHz discontinuity is fixed (blue to orange plot). There are some residual (possibly new) “dropouts” (see orange plot, left of 1340MHz) that are currently under investigation (see AXE-1016).

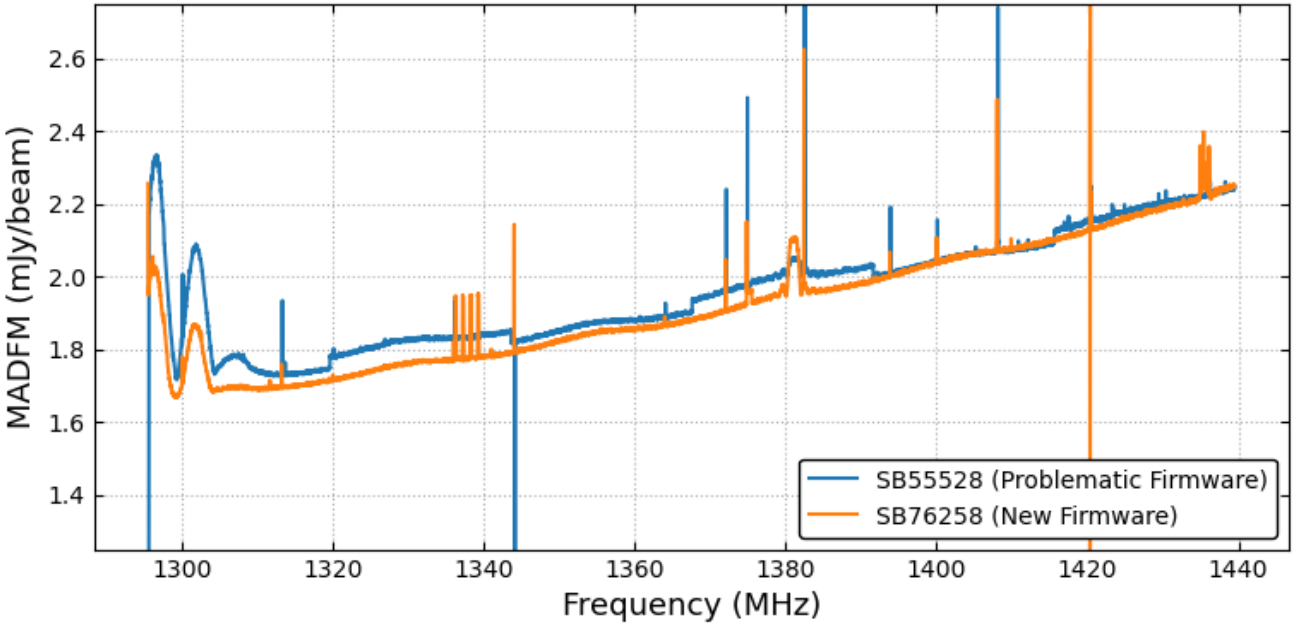


Image Credit: Jonghwan Rhee

Pipeline Updates

Also as part of the Key Capabilities Project there has been a huge amount of work by the CALIM, Science Data Processing and Archiving Team, plus heaps of help from ASKAP Operations and ATNF Science – to finally add reference field calibration and offset source imaging to the ASKAP pipeline.

Problem:
Observations involving a mode change result in a delay change that requires a new calibration observation. Also some observations need to be made at a time that is a long way away from the latest bandpass observation.

Reference Field Calibration

Solution:

carefully select several reference fields to enable simultaneous calibration for all beams

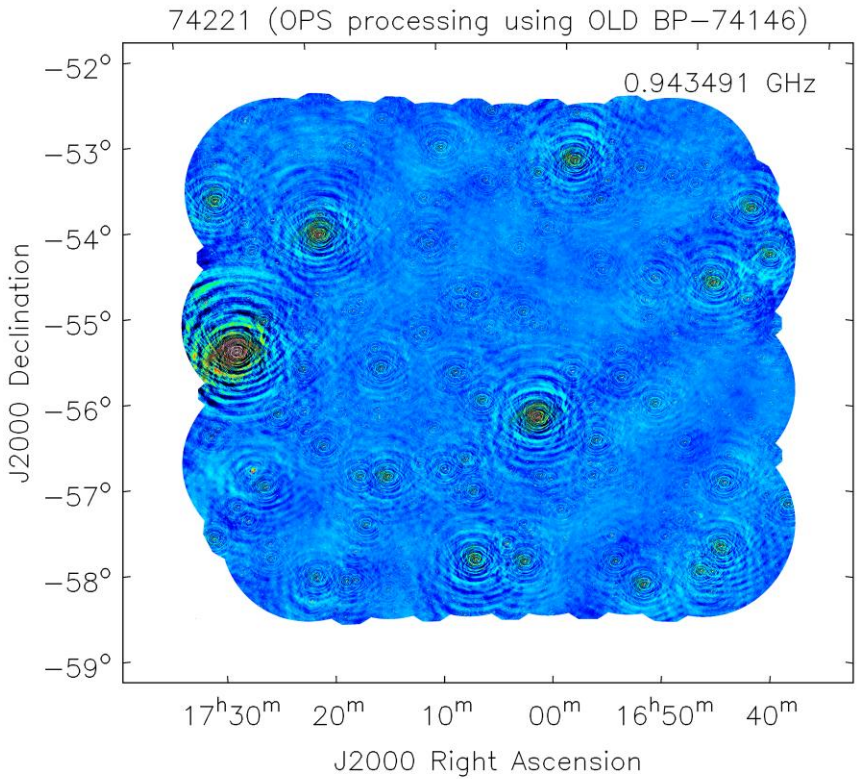
- A reduced set of calibration parameters (e.g. delays, amplitude scale factors) is derived and used to update a static PKS 1934-638 bandpass table
- New 1934-638 bandpass tables are generated whenever new PAF beamformer weights are formed

Lessons learnt (so far)

Summary from Daniel Mitchell:

- Delays are close, but we can do better
  - There are phase residuals across the band
  - There are phase jumps at beamforming intervals
- Delay & phase changes are very consistent across beams
  - This is being exploited to reduce the noise in higher-order phase updates
  - But there is more to understand …
- Amplitudes also vary, however often in a constant way across the band

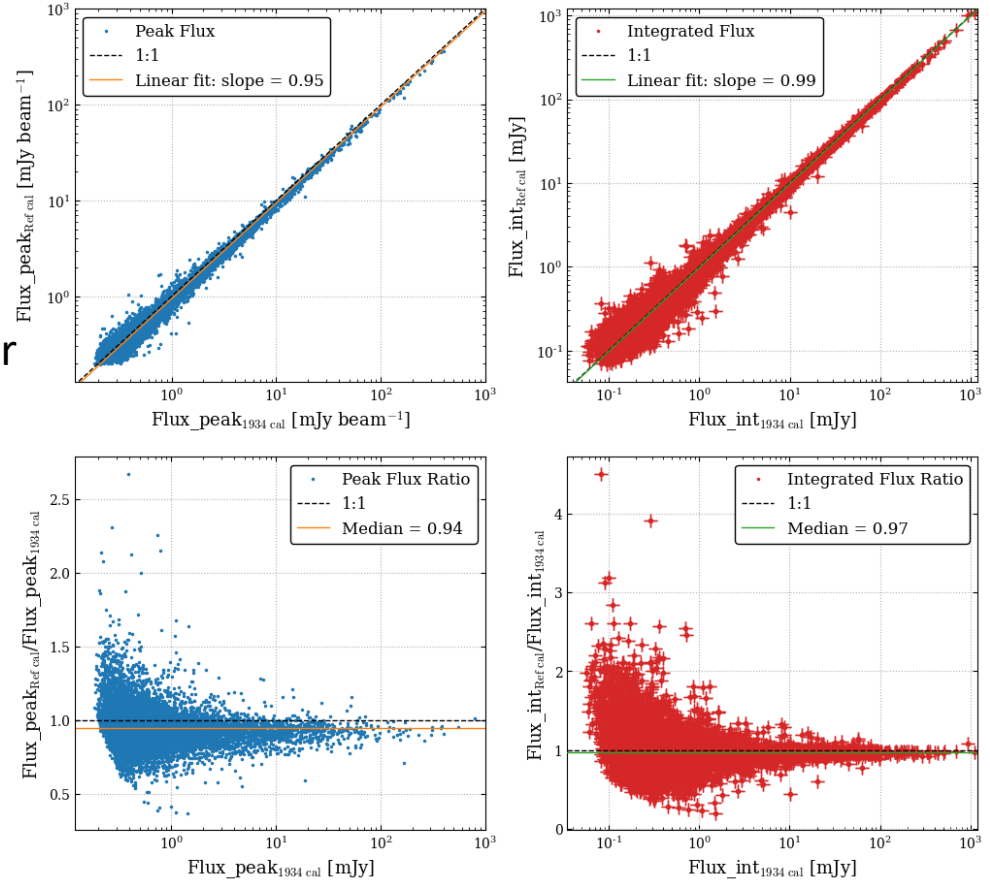
Old cal vs old + delay



Lessons learnt (so far)

Summary from Jongwhan Rhee:

Since DINGO has been observing the same field, the data used for the firmware test (SB 76258) is also useful for checking if the flux scale is consistent with previous data (SB 65665). Using the continuum data from the Selavy catalog, I compared the peak and integrated fluxes between the two datasets.
The attached figure shows the fluxes are consistent, which suggests the reference calibration is working well



Offset Imaging

Problem:

Bright sources are not properly cleaned and residuals corrupt observations.

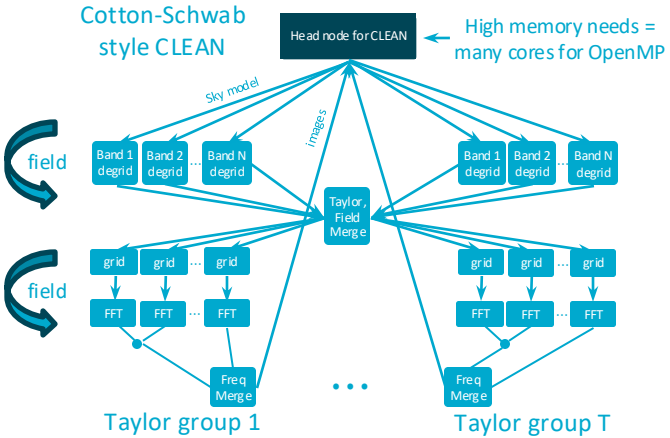
Solution:

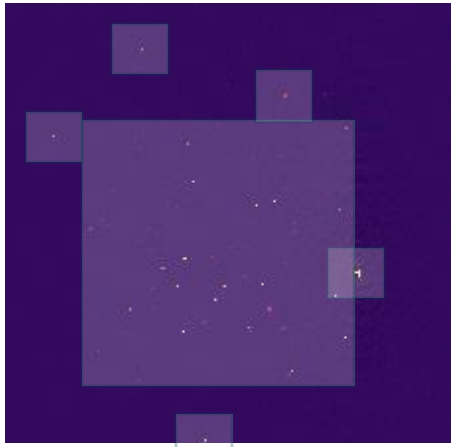
ASKAP team especially Mark Wieringa, Wasim Raja and Daniel Mitchell have worked hard to include a scheme to directly image bright sources using facets and add them to the sky model

Slide credit: Daniel Mitchell

ASKAP Offset imaging / self-calibration

- Handle bright offset radio sources like facets
  - Use different tangent planes per field, and a different distribution, but otherwise processing is much the same.





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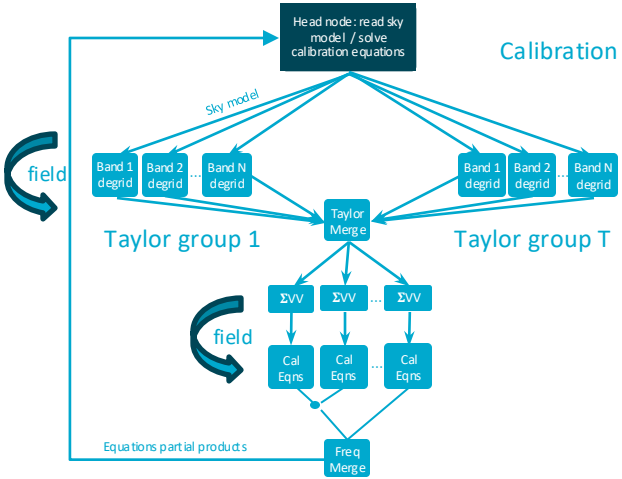

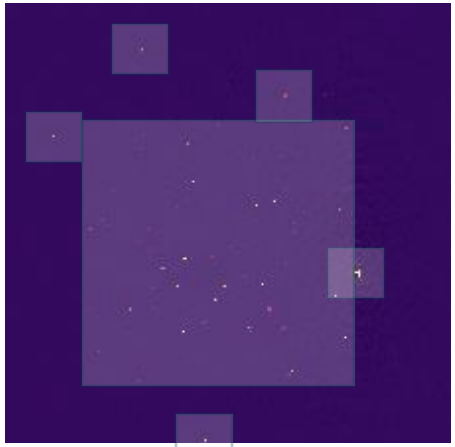

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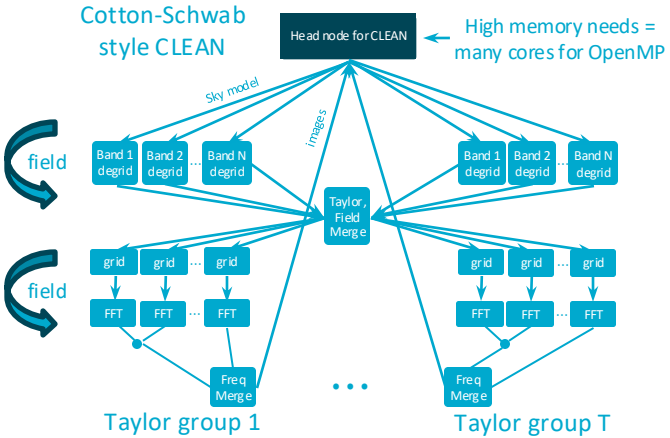

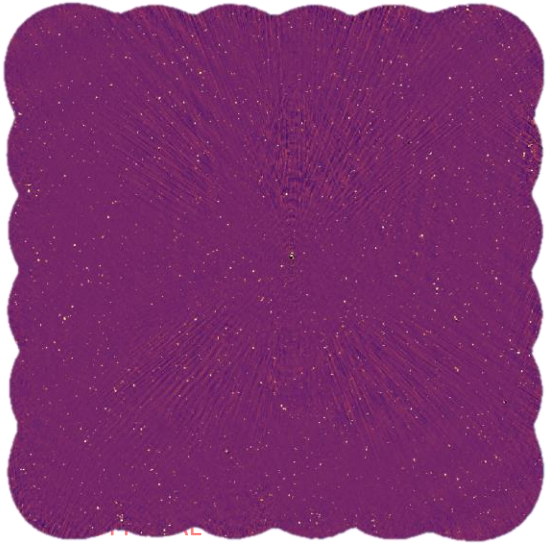

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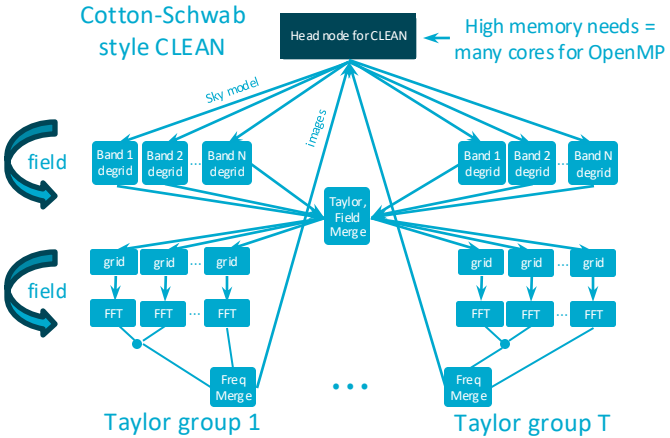

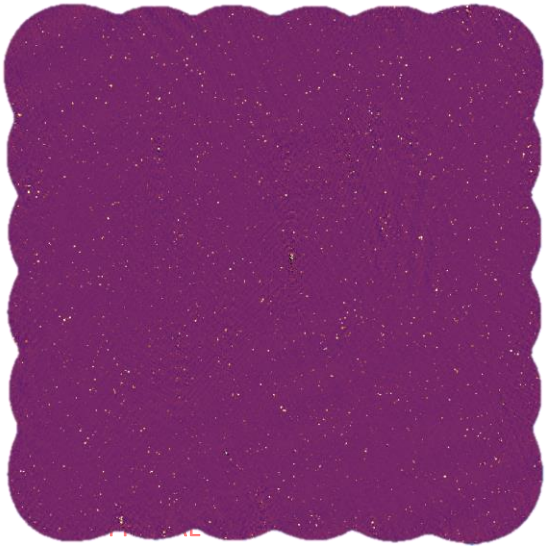

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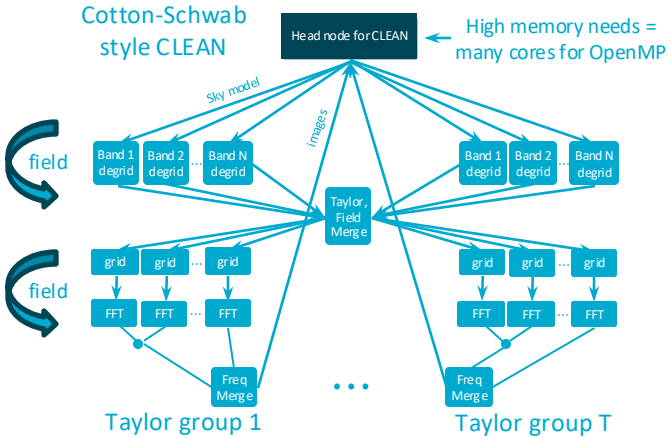

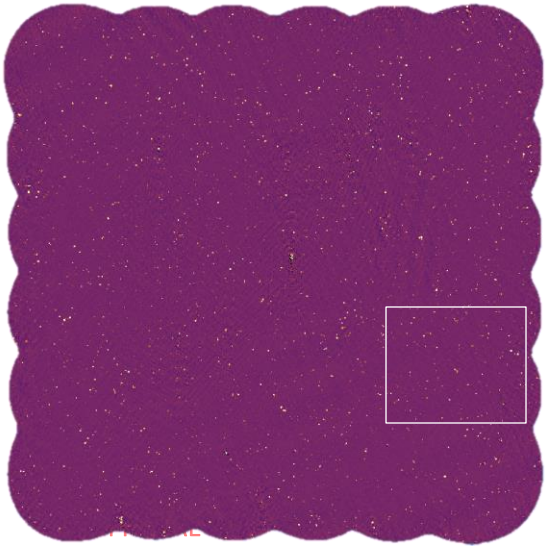

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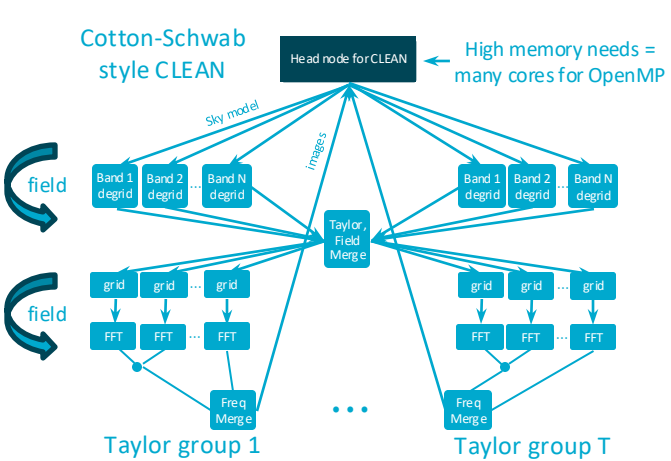
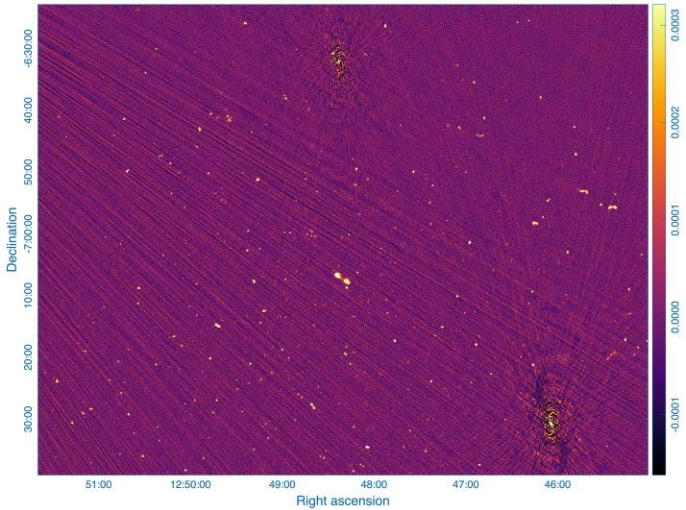
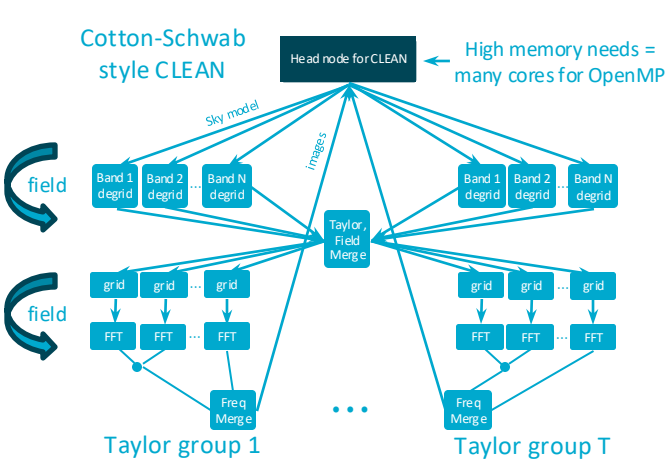


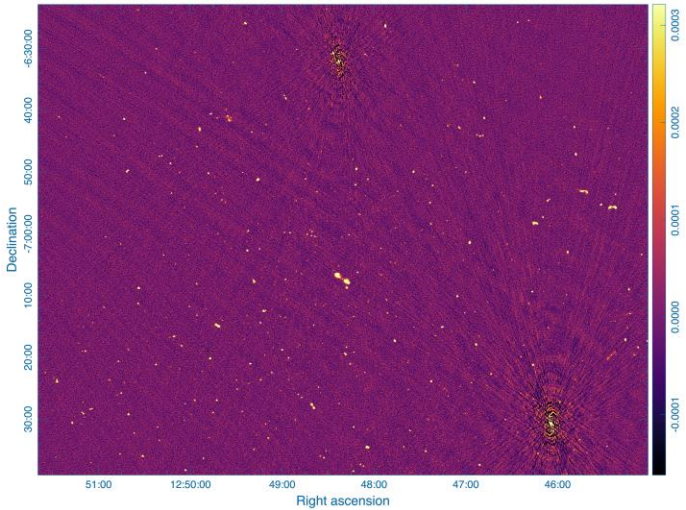


Slide credit: Daniel Mitchell

ASKAP Offset imaging / self-calibration

- Handle bright offset radio sources like facets
  - Use different tangent planes per field, and a different distribution, but otherwise processing is much the same.





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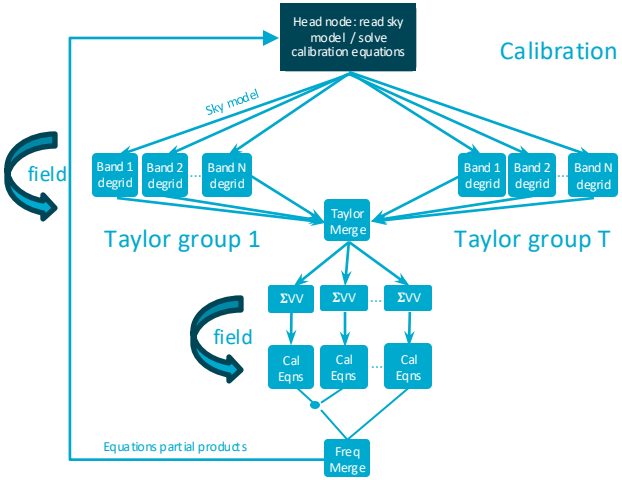

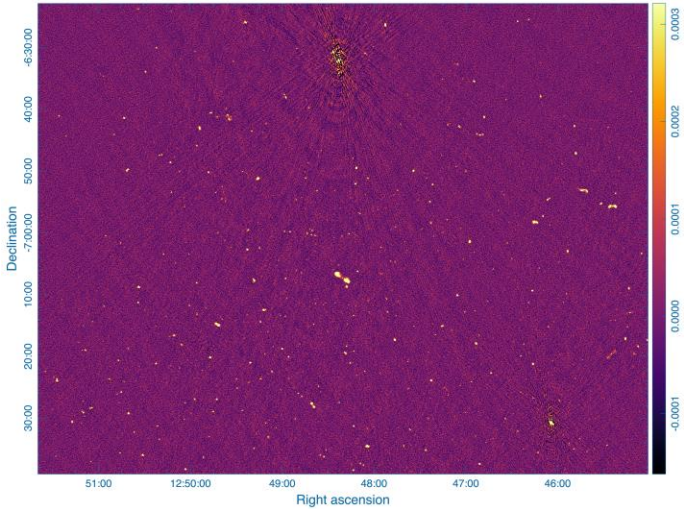

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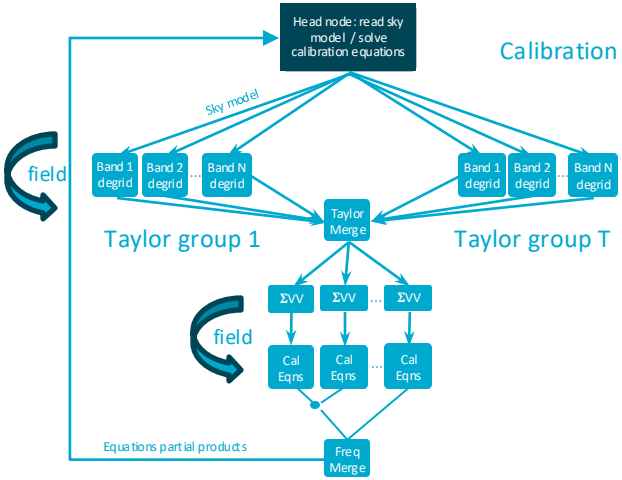
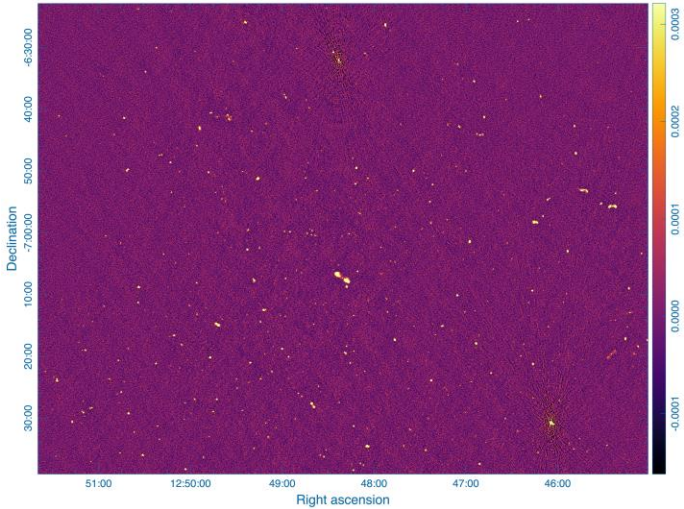




CASDA Status and Future

On behalf of Minh Huynh

CASDA is currently fully supported by Pawsey and stores ~ 10 PB of survey science data products. CASDA is growing at ~4PB/yr so by the end of the surveys will contain ~24 PB of survey science. Pawsey never really signed up to store 20-30 PB from ASKAP.

CASDA ingest now we are processing multiple spectral line observations every day needs to average > 300MB/s to archive the spectral line cubes. This is currently not being achieved – hence our backlog -- but we are working hard to fix this.

ATNF are very aware of the importance (and cost) of long term storage and are investigating options.

CASDA Status and Future

CASDA ongoing software development support is provided by CSIRO IM&T. The resources of which are funded by an AAL contract. We are attempting to continue this support via the latest round of NDRI data infrastructure support via an AAL supported application.

CASDA hardware support is provided by Pawsey, who are applying to NDRI to renew the current storage facilities.

The ASKAP PAF upgrade (Alex Dunning)

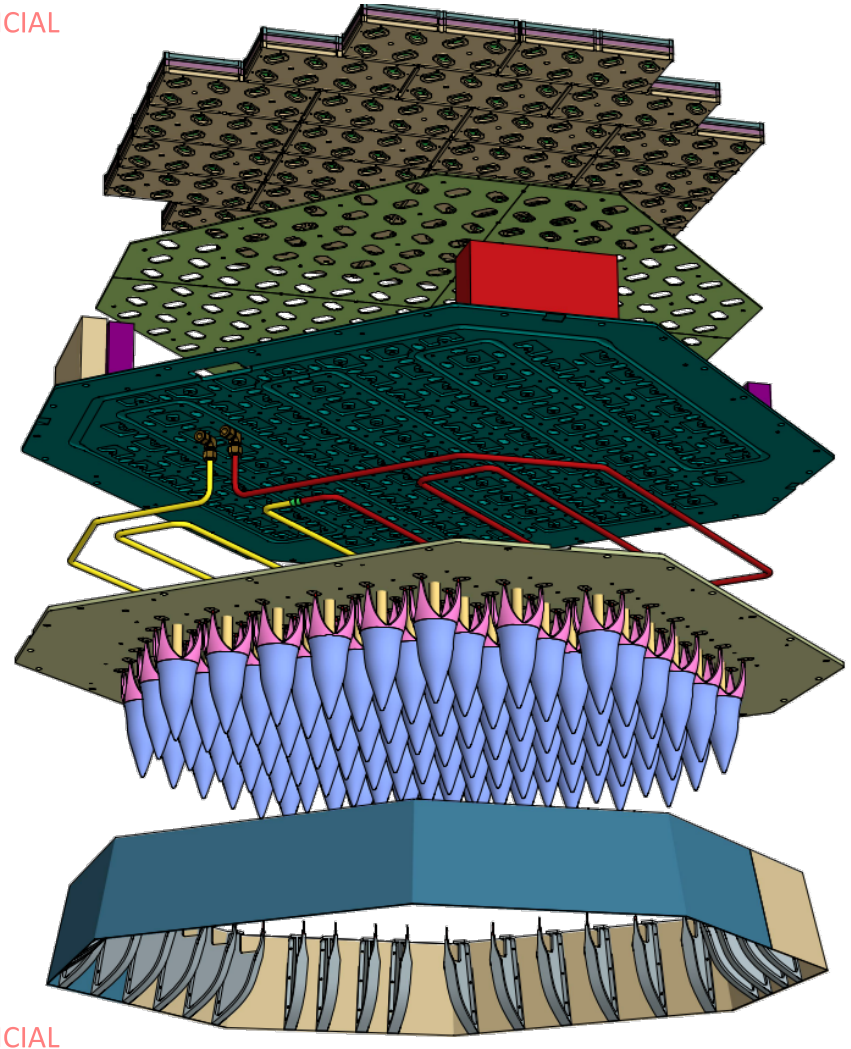
ASKAP Phased Array Feed Upgrade

Alex Dunning (Project Engineer)
Simon Mackay (Project Lead/Manager)
Aidan Hotan (Project Scientist)
Mark Bowen (Project Sponsor)

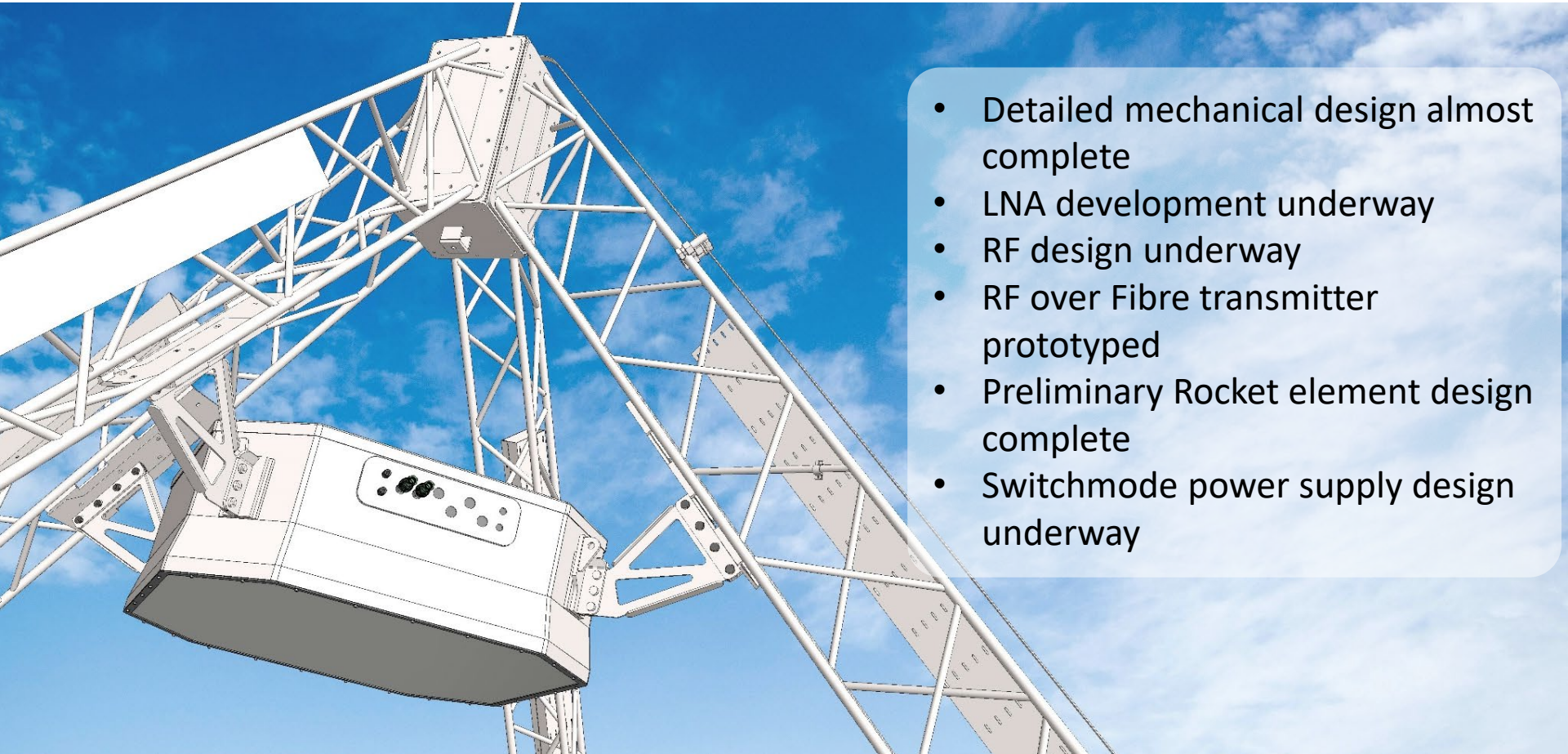
16th September 2025

New ASKAP PAF features

- State of the art LNAs
- Rocket elements for wider bandwidth and lower noise
- Integrated calibration system
- Reduced power consumption
- Efficient chilled-water cooling system
- Enhanced environmental and RFI shielding
- Reduced overall weight
- Simplified maintenance
- Compatible with existing PAF

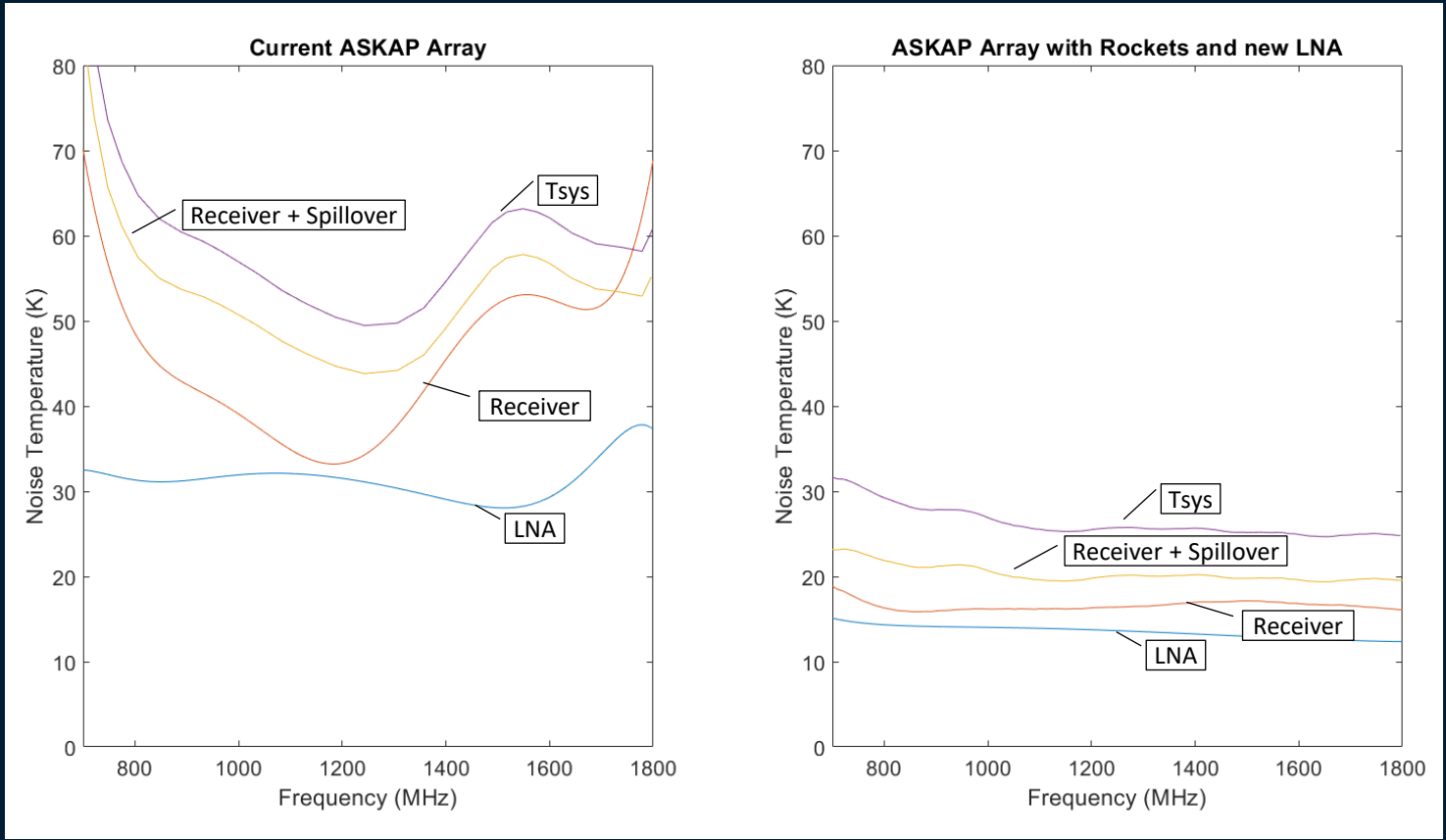


ASKAP Phased Array Feed progress



- Detailed mechanical design almost complete
- LNA development underway
- RF design underway
- RF over Fibre transmitter prototyped
- Preliminary Rocket element design complete
- Switchmode power supply design underway

Projected system temperature improvement



Summary

- A single prototype is being produced to evaluate effectiveness and cost
- Good progress is being made but it is just one of several projects currently underway
- Plan to install on the telescope first quarter 2027