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SKAO Regional Centre United Kingdom

Developing the UK SKA Regional Centre

Louise Chisholm & Rob Beswick Joint Directors

Ian Collier - Technical Director; **Jack Radcliff** – Community Director; **Jeremy Coles** – Deputy Director

NAM2025

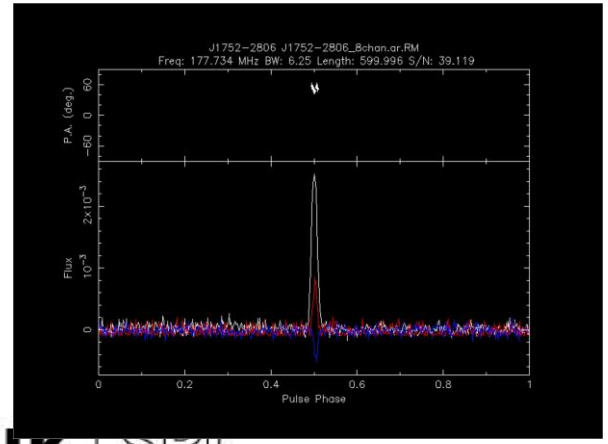
SKA-Low's first glimpse of the Universe

- 17 March 2025
- Image from the international SKA Observatory's telescope in Australia
  - First four connected SKA-Low stations
  - 1,024 of expected 131,072 antennas

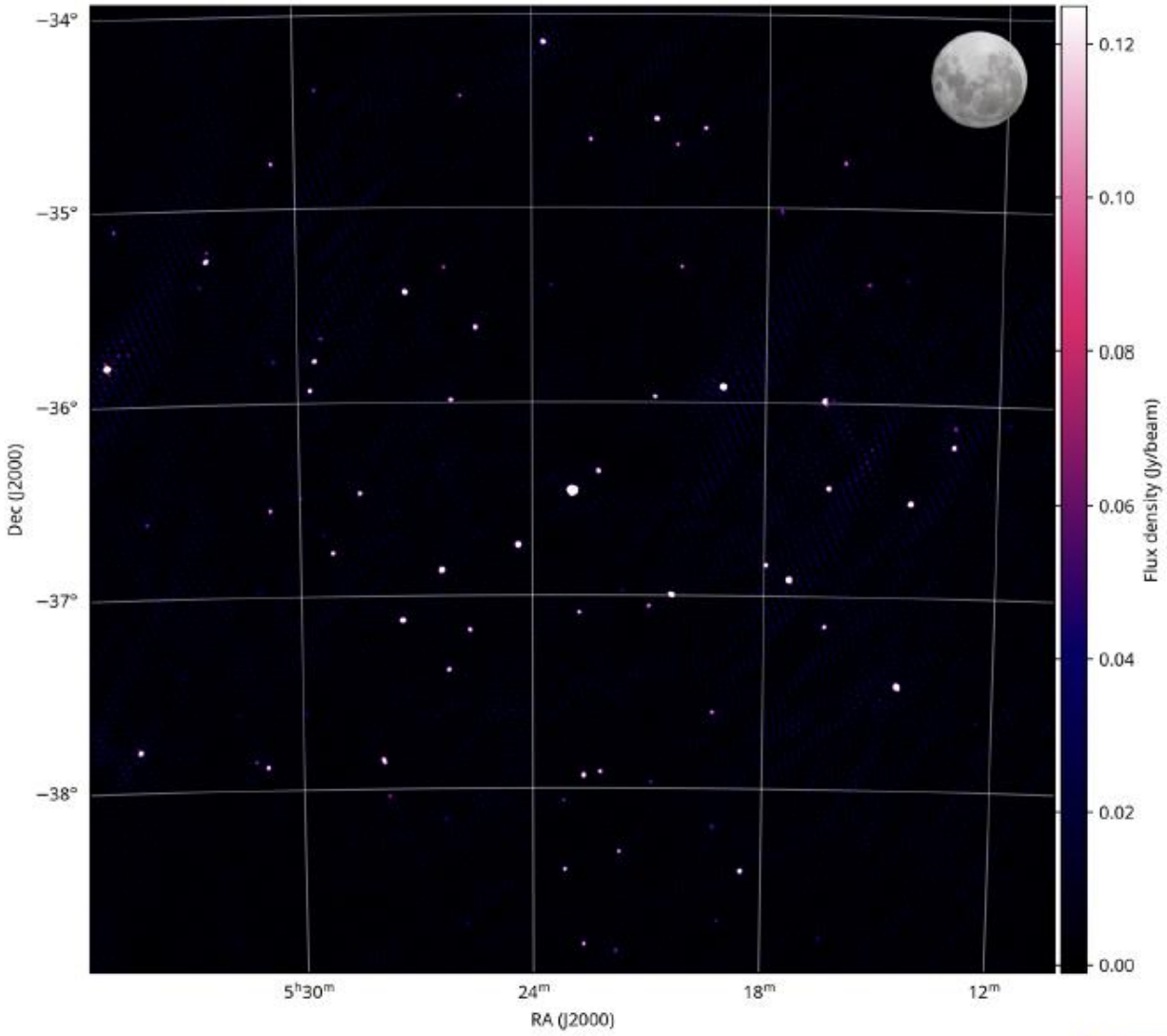
Radio image of ~ 25 square degrees

Each 'dot' a Galaxy, contains a supermassive black hole

- 150,000 pixels in current image to ~ 21 million pixels at final construction



"This image was taken using the first four completed antenna stations at Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory. Produced using only 1,024 of the planned 131,072 antennas – less than one per cent of the full telescope – it shows an area of sky equivalent to approximately 100 full moons. 85 of the brightest known galaxies in the region can be seen. It's calculated that the completed SKA-Low will eventually be sensitive enough to show more than 600,000 galaxies in the same frame."



https://www.skao.int/en/news/621/ska-low-first-glimpse-universe

Construction Activities – Dish Structure – AA0.5

- Commissioning / site acceptance ongoing -Photogrammetry, Feed Indexer commissioning, Control loop tuning, power measurements, Servo Functional
- Official CETC54 Site Acceptance Test will start (April)
- SKAO qualification prior to handover to DISH AIV team

- Cabling in preparation for Power On / electrical Certificate of Compliance
- Sub reflector, Feed Indexer, Azimuth & elevation IO unit installation and encoder adjustment work in progress

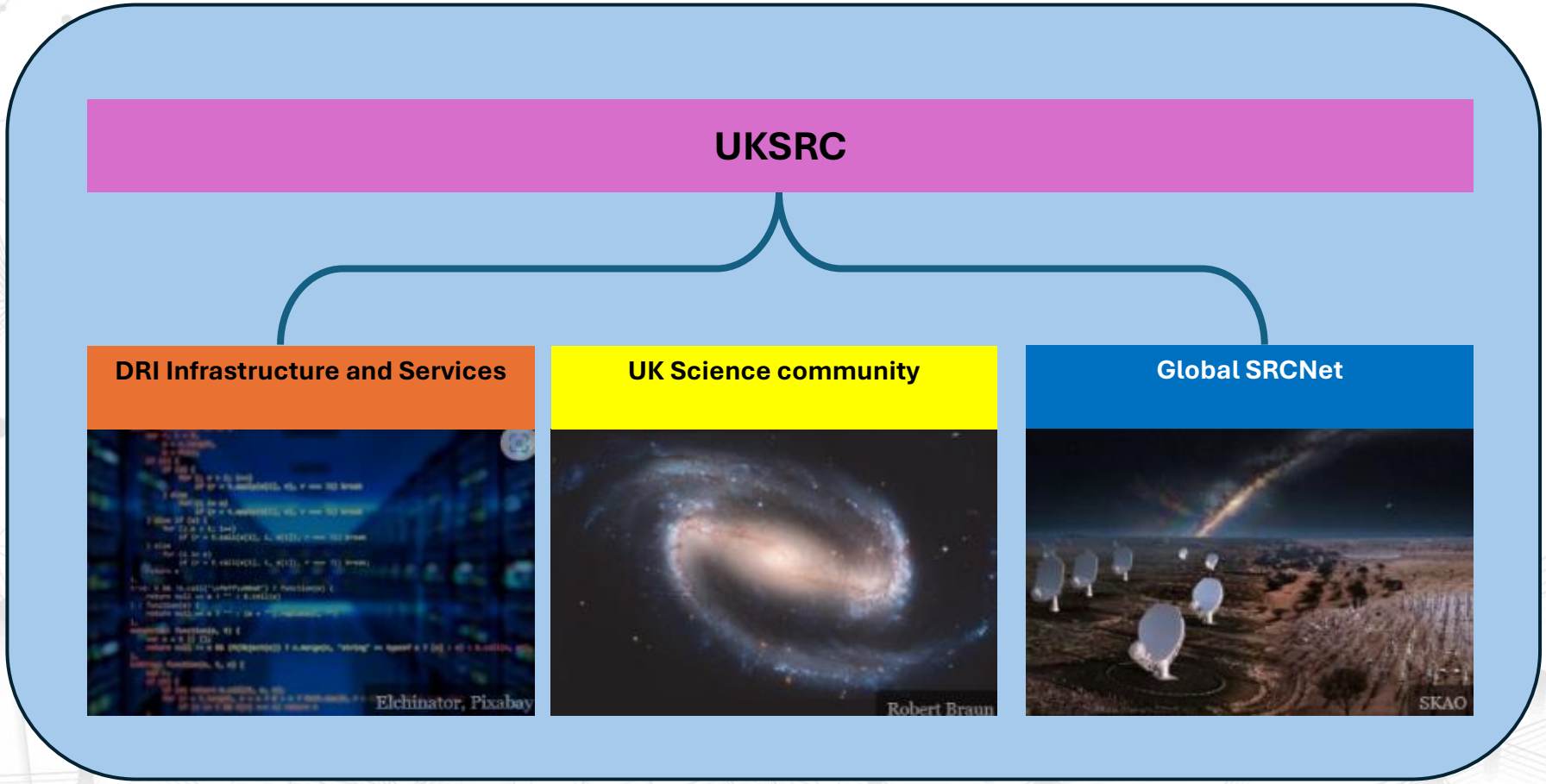
- Jackscrew & Safety net & cabling installation & integration testing complete
- Big Lift

- Panel installation and day time photogrammetry
- Working a plan to do filter cabinet installation via door/hatch prior to Big Lift (no Drive System on site)

SKA – Mid – construction is underway!

UK SKA Regional Centre

UKSRC's mission is to maximise that the UK's return on the UK's SKAO investment.



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UK SKA Regional Centre

Support and enable UK radio astronomy research by providing a new UK digital research Infrastructure, science support, and training ecosystem

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SKAO Regional Centre United Kingdom

Contribute to delivery of SRCNet with the necessary capabilities and capacity to support SKAO science.

UK pledges ~20% of the resources needed for the SRCNet globally.

UNIVERSITY OF CAMBRIDGE

THE UNIVERSITY of EDINBURGH

Durham University

University of Hertfordshire UH

MANCHESTER 1824 The University of Manchester

UCL

UKRI Science and Technology Facilities Council | Scientific Computing

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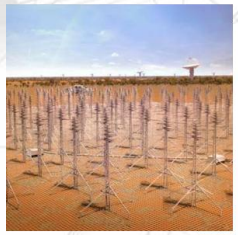
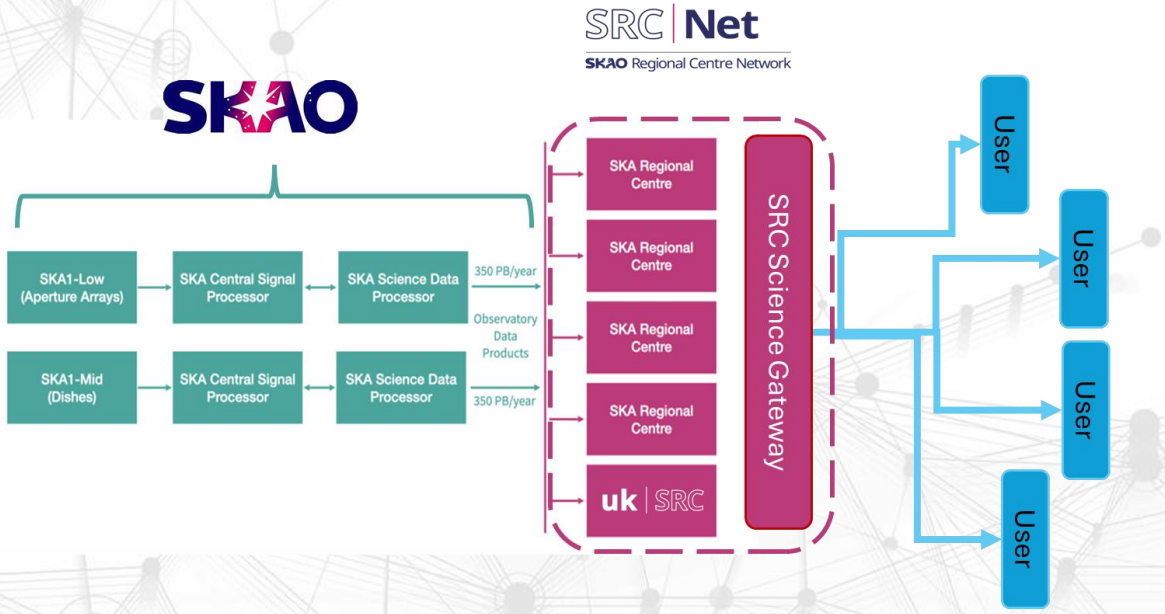
SRCNet work is critical for SKAO delivery

Federated and controlled access to SRCNet services to support data discovery and analysis of SKA data in the global SKA Archive e.g.

- User accounts, single sign on (AAA)
- Provides the portal for scientists
- Delivers Data Products to Science Users
- Global archive of data and enable creation and storage of Advanced Data Products
- Provide the resources needed AKA – Preparing to deliver Science Platforms for science ‘beyond the laptop’





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SRCNet is the only gateway for the science user communities to access the SKAO data and do science…

SRCNet v0.1: initial prototype

SRCNet v0.1 represents the **initial functional prototype release.**

- 8 countries expected to participate in v0.1.

- Minimum goal of 4 deployed Nodes:
  - other Nodes integrated when ready.
- ‘Engineering Prototype’: Internal users only; providing:
  - Common authentication and authorisation
  - Use of Test (i.e random / simulated) data
  - Data ingestion
  - Data discovery
  - Data distribution and replication
  - Data access
  - Basic data analysis (e.g. visualisation / notebooks)
- Also to continue to develop pipelines, workflows, benchmarking and profiling

Milestone	Description	SRC Net Functionality	Scope (users)
SRCNet v0.1 First quarter of 2025	First version of SRCNet sites deploying common services and connecting via SRCNet APIs. **Enable technical tests of the architectural implementation**. [Added c.f. document] (Potentialy Opportunity to engage SRCNet with AA0.5 data transfer and access.)	• Test data (and some precursors data) disseminated into a prototype SRC Net • Data can be discovered through queries to the SRC Net • Data dissemination to SRC nodes • Data can be accessed through a prototype data lake • Data replication. Data can be moved to a local SRC area where non-connected local interactive analysis portals (notebooks) could allow basic analysis • Unified Authentication System for all the SRCs • Visualisation of imaging data	**SRC ART members** Members of SKA Commissioning team **(potentially, but not required)**

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Rosie Bolton

The SRCNet Timeline

SRCNet 0.1
2025

Milestone passed!

7 nodes now, 2 more ready for testing

Test campaigns already taking place

Data movement between sites centrally managed

Data ingestion at SDP location in Perth

Internal version, testing architecture

SRCNet 0.2
Q1 2026

Workflow portability

Federated Execution

Data Access controls

Integration with SKAO user ID proven

Realistic data ingestion and dissemination

Testing SV user workflows at scale

Prove ability to support SV use cases at scale

SRCNet 0.3
Q4 2026

Public version, as an integral part of SV.

SRCNet part of the end to end SKAO system

Access granted to limited number of users, depending on resource availability.

MoUs to govern data and resource sharing

System ready to support SV users

SRCNet 1.0
2028

Full version of SRCNet software

Hardware scale continuing to develop as SKAO science data volumes grow

Access fully integrated with SKAO Proposal System, hand-in-hand with successful proposals.

Full public SRCNet release

SRCNet 0.1 is internal to the project

So why is it exciting? Proof of concept established across many sites

SRCNet 0.1 2025

Milestone passed!

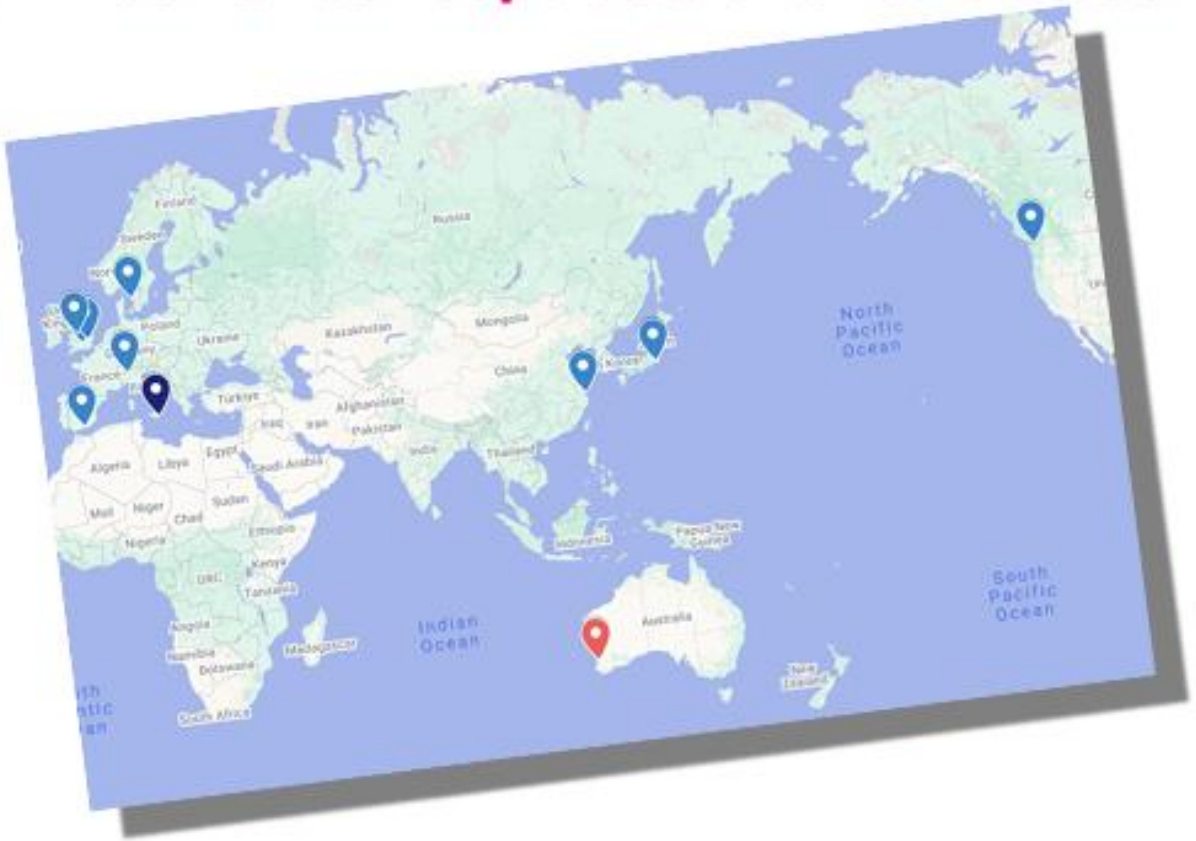
8 nodes now, 1 more ready for testing

Test campaigns already taking place

Data movement between sites centrally managed

Data ingestion at SDP location in Perth

Internal version, testing architecture



Millions of global data transfers made in test campaigns already

Key:

- 0.1 nodes (Spain, Switzerland, SKAO, Sweden, UK, China, Japan, Canada)
- pending node (Italy)
- SKAO ingestion site (Pawsey)

→ **Centrally managed** data archive of 3 PBytes total now

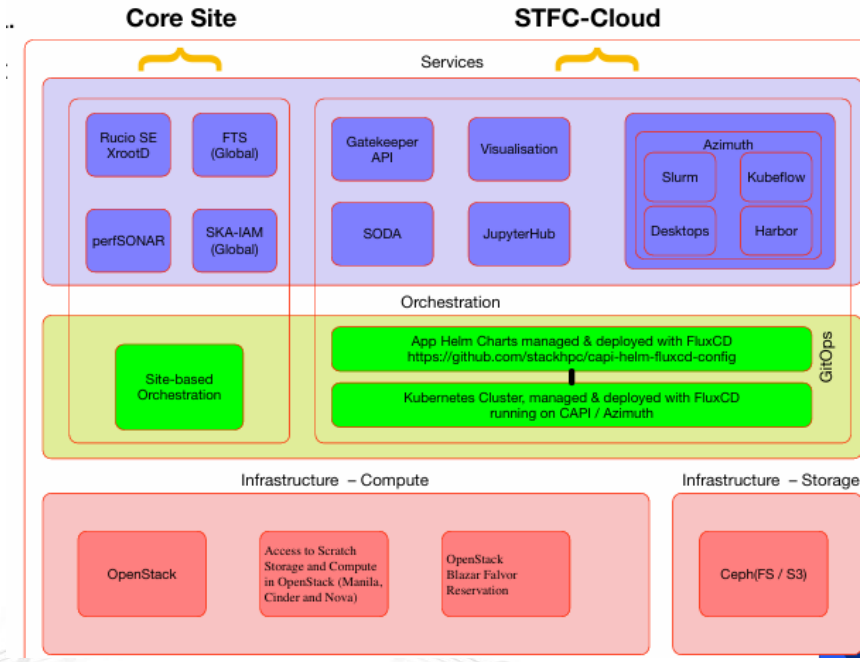
→ Ingestion of data from an SDP site (Pawsey) on SKAO resources

→ **Trust between sites** allowing resources to be integrated

Canada passed tests on 17th June!

SRCNet v0.1: ukSRC Deployment

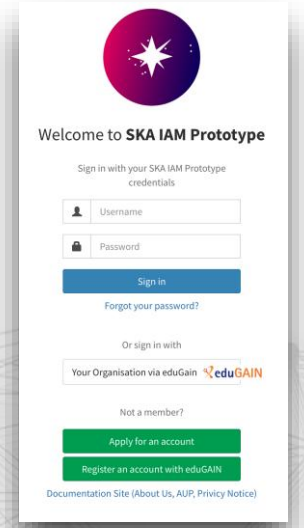
- For v0.1, consolidated the deployment at RAL (4PB usable Ceph storage)
- Supported by teams from across UK
- Use of existing site deployment tooling for xRootD
  - New dedicated hardware, network and Ceph cluster
- For local SRCNet Services: Kubernetes based



UKSRC provides global services which enable federation of SRCNet v0.1

- **SKA IAM** has been increasingly implemented as part of testing processes and workflows, and the service is now up to 174 users.
- The **perfSONAR mesh** is a required service for SRCnet v0.1. This mesh has successfully shown results to and from all the sites deemed for v0.1 readiness and will be used to compare results from the subsequent test campaigns. This mesh currently shows results from seven SRC nodes for bandwidth, latency, and the trace path.
- The **FTS integration with SKA IAM & Rucio** was completed during September 2024. For the past six months since then, FTS has been used throughout SRCNet data movement activities, including the current test campaign - where FTS is a core component.
- SKAO running Rucio on the STFC-cloud

SKA perfSONAR mesh (18/03/2025, Matthias Mayer)



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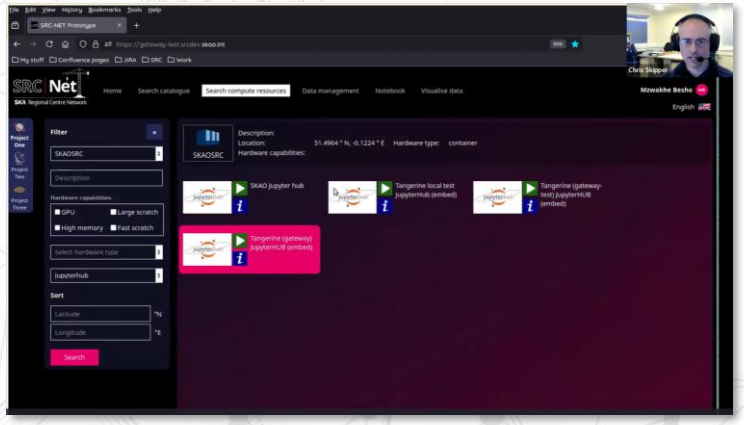
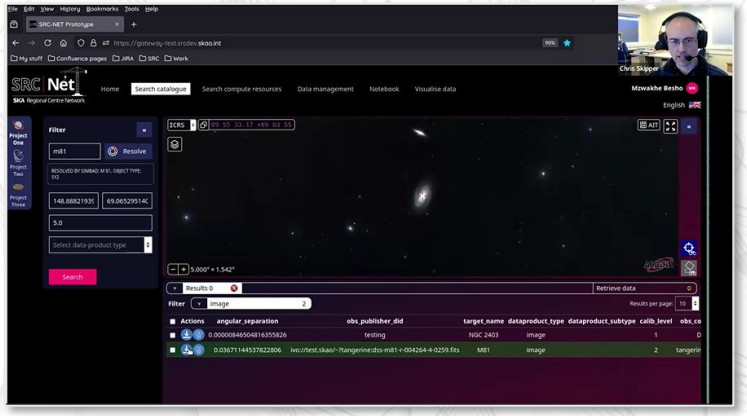
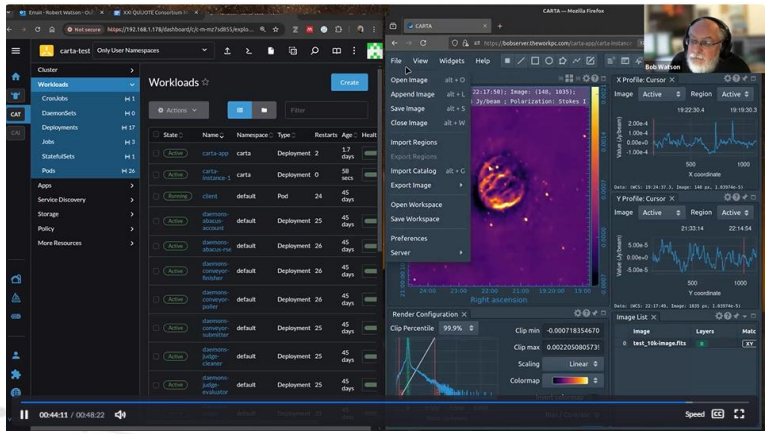
Contributing to SRCNet Software Stack Development

Science Gateway: query catalogue, perform Data management, access notebooks

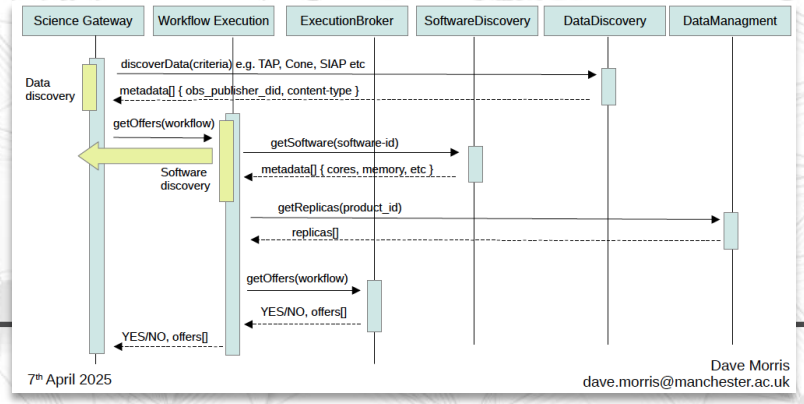




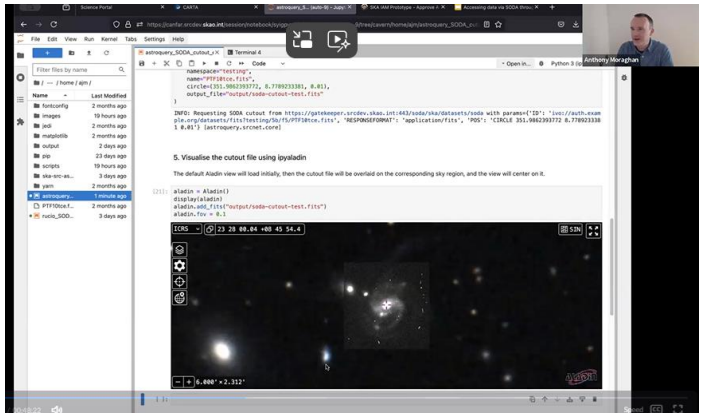
Containerized science app

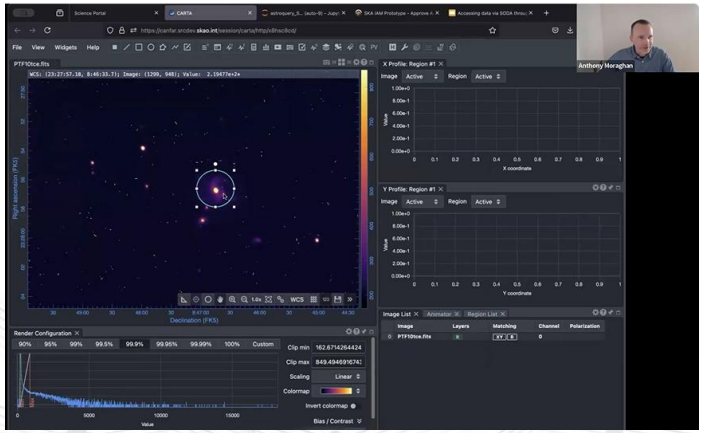


Execution Broker: common interface for job submissions across various compute platforms.



Use of SODA Cutout service, and further analysis in CARTA ([Cube Analysis and Rendering Tool for Astronomy](#))





Dave Morris
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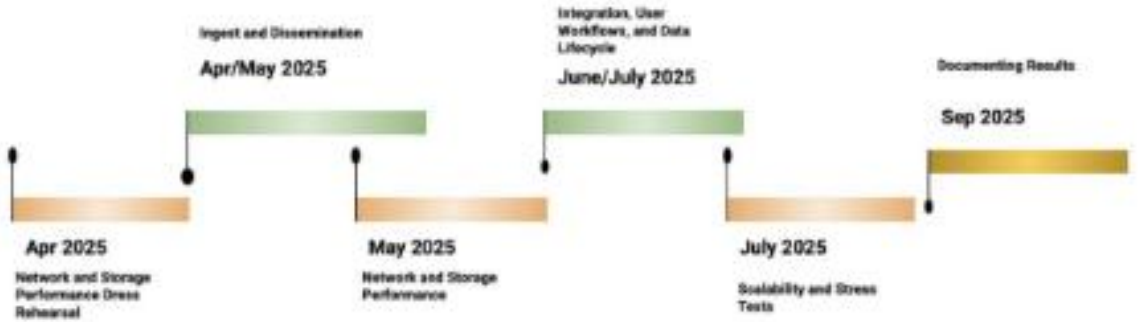
Next steps

- SRCNet v0.1 Data movement campaigns
  - capture and inform current and future architectural decisions
- SRCNet v0.2
  - Adds in Federated job execution
  - User Storage
  - Preparations for Science Verification:
    - Workloads
    - Data dissemination
  - Selected scientists have access
- SRCNet v0.3
  - Increased sets of functionalities
  - Increased usage by Science communities
  - More Science verifications and additional workloads



Milestone	Description	SRC Net Functionality	Scope (users)
SRCNet v0.2 First quarter 2026	AA1 and Commissioning	• **Data dissemination using telescopes sites interface** • First version of federated execution. Access to remote operations on data using services and the possibility to invoke execution into a relevant SRC • Subset of SDP workflows runnable in the SRCs • First Accounting model implementation. • User storage areas • Visualisation of imaging and time series data through remote operations • Preparation of SRCNet User Support	Selected scientists from community Members of Science Operations SRC ART members

Milestone	Description	SRC Net Functionality	Scope (users)
4th quarter 2026	Cycle 0 proposals, AA2 and Science Verification	• Improved data dissemination. Use of available storage • **SKA preliminary data (and some precursors data) disseminated into a prototype SRCNet** • Upgraded federated computing. Basic execution planner implementation and move execution to a selected SRC • Upgrade of subset SDP workflows runnable in the SRCs • Provide access to the first set of workflow templates for science analysis (light ADPs) • ADPs ingestion system • Spectral data visualisation and manipulation • Implementation of SRCNet User Support	Science verification community (**public access**) Members of Science Operations SRC ART members

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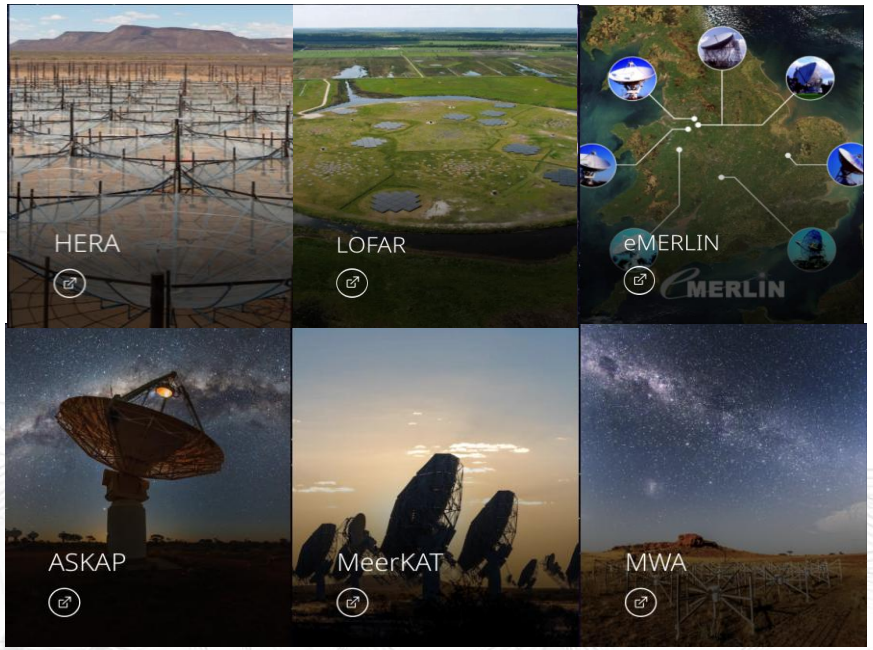
UKSRC supporting the UK community

- SKAO is under construction, and SRCNet has no data yet
- The UKSRC wants to help support and prepare the **UK astronomy community** to develop a facility informed by our future-users and **maximise the science return from SKA**.
- **Supporting** UK researchers using data from SKAO precursors and pathfinder telescopes

SKA-MID

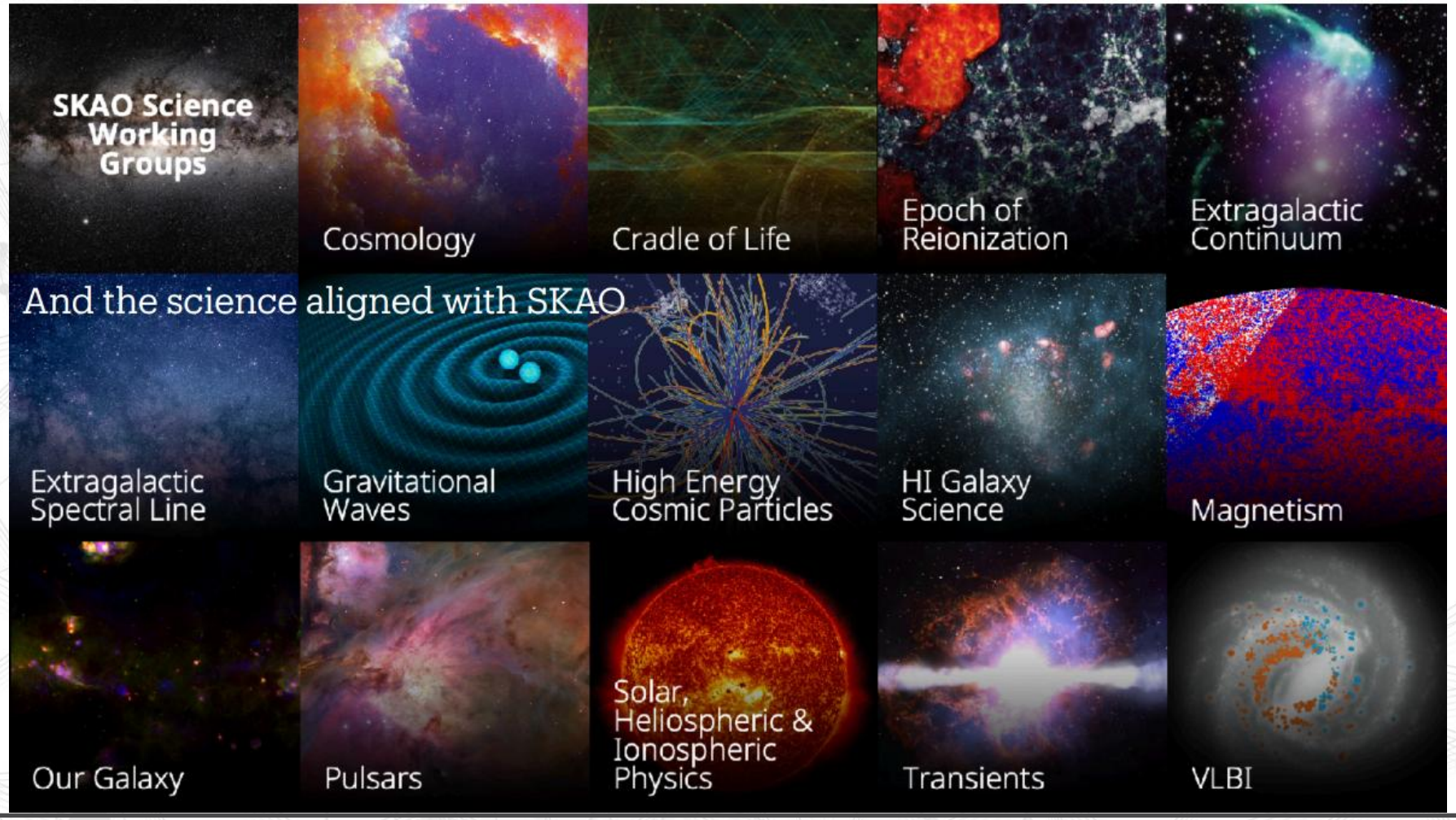
SKA-LOW



SKA pathfinder & precursor telescopes

Credit: SKA Observatory

Supporting the UK Science Community



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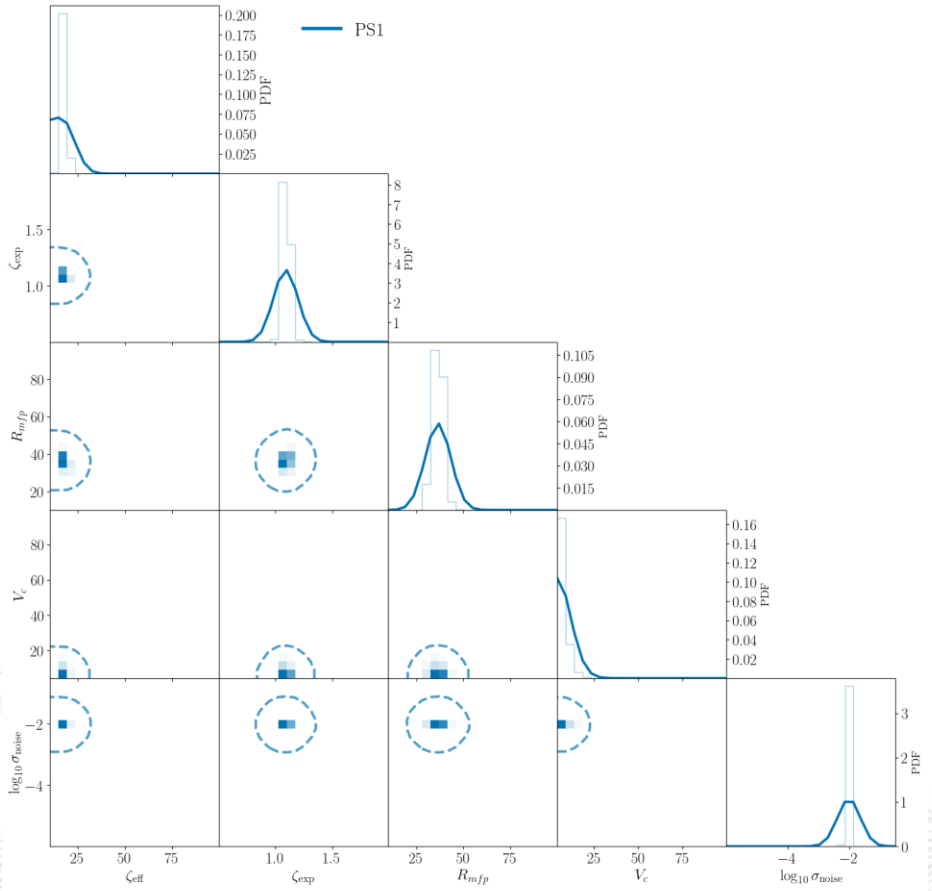
UKSRC led team wins the Science Data Challenge 3b

- Charlie Walker led the *Cantabrigians,* who scored top in the analysis of two synthetic data sets released by the SKAO
- SDC3b challenge focused on inferring the reionization properties of the Universe from power spectra of the hydrogen-21cm signal during the Epoch of Reionization, across various redshift ranges.
- They developed robust methodology that can be applied to real-world SKAO-Low observations once the telescope is operational
- This is a key step in preparing the global community to tackle fundamental astrophysical questions using the SKA-Low telescope.



Corner plots obtained using the Cantabrigians SDC3b pipeline, showing the constraints on cosmological parameters which inform the two simulated SKA power spectrum datasets (denoted PS1 and PS2) which were provided for the SDC3b challenge

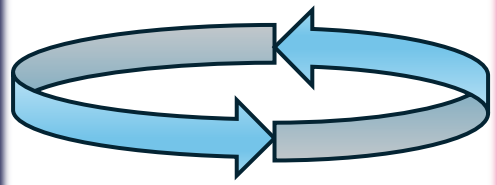
https://sdc3.skao.int/overview

Science Data Challenge 4 focuses on Magnetism

Demonstrator cases / early adopter projects

Users benefits

- Access to compute resources
- Workflows within UKSRC architecture
- Science/development/tech support from UKSRC
- Participate in the future direction and features in UKSRC/SRCNet
- New science using UKSRC resources



Community Cocreation

UKSRC Benefits

- Inform development of UKSRC architecture & development
- Incorporate new workflows
- Ability to stress-test system with new workflows and users
- Develop science support models

- Informing science user support services & community engagement
- High memory servers deployed and are in use in UCL, Durham, Manchester and Cambridge
- Opportunity to “stress test’ the UKSRC facility as it develops
- Develops various reusable workflows and tools for now and future

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https://zenodo.org/communities/uk_skarc

Early access… supporting pathfinder & precursor science

Teams

- Gain experience of anticipated SRCNet ways of working : compute is cloud resources, storage is transient
- Generate workflows that make use of cutting edge large datasets from pathfinders and precursors
- Knowledge gained is directly transferrable to the processing or analysis of SKA data
- New science along the way!

Phase	Acronym	Description
1	**LOFARINT**	Processing and delivery of LOFAR2.0 international station data
1	**21CMMAP**	Late-time 21cm intensity mapping in autocorrelation mode
1	**MULTIWAVE**	Multi-wavelength datasets for radio continuum and HI surveys
1	**SKAEOR**	SKA-EoR analysis demonstrator
2	**PSRFAST**	Discovering Pulsars and Fast Transients through Candidate Identification, Classification and Machine Learning
2	**PLANET**	Planet-Earth Building Blocks
2	**CHEETARA**	Incoherent Radio Transients

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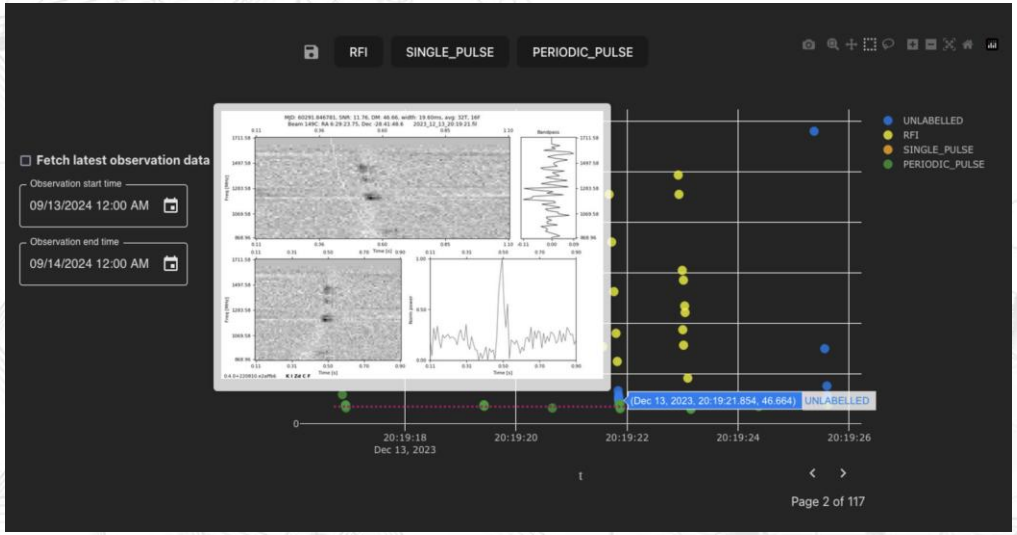
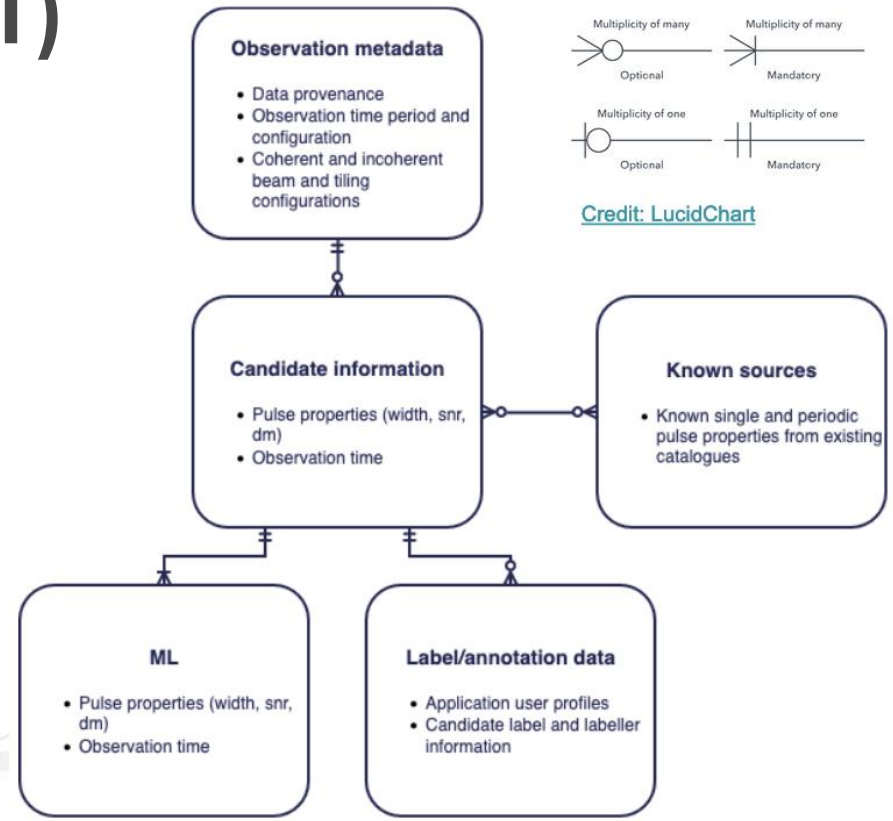
Example: Create A Machine Learning Toolkit for Pulsars and Fast Transients (MALTOPUFT)

- Delivery of a prototype single pulse candidate labelling web application (see screenshot below)
- Integration with SKA IAM for authentication, user identity management and integration with SRC Net services
- Prototype data pipeline to load SKA precursor archival data





- Designed a relational database schema to support all current and some future requirements
- Efforts to adhere to IVOA TAP service standards to enable data discovery

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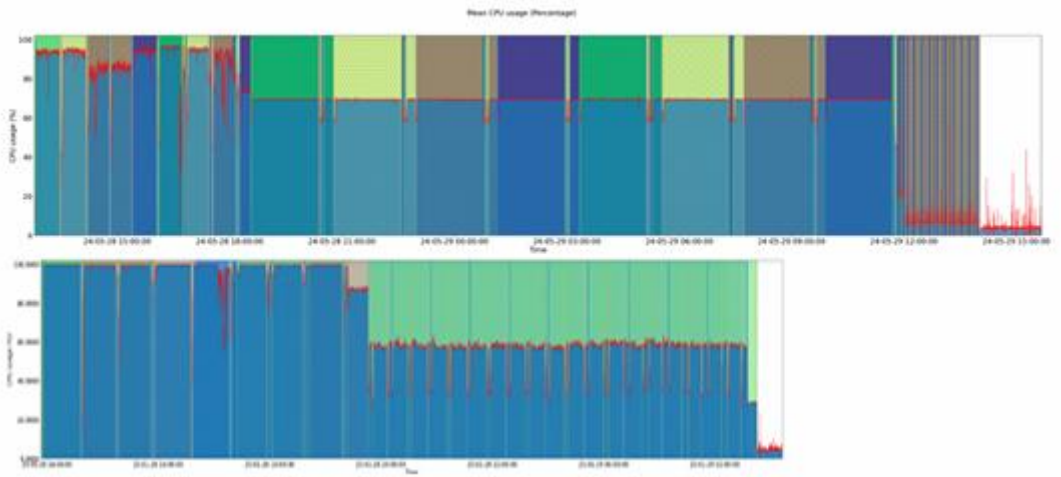
Sustainability: Profiling & Benchmarking

- Developing tools (ProfPyQueue) to lower the barrier for using profilers with batch systems - such as Prometheus, likwid, and Linaro Forge. And provides plotting functions for results from the slurm profiling plugin
    - Optimisations in code leading to better parallelism less wait times and overall shorter execution
    - Building monitoring into the platforms to allow users to understand / develop for better use of resources



- Old code (top) vs new code (bottom).
- Mean CPU utilisation in blue
- Colours represent different workflow steps

Demonstrator case LOFARINT **:** developing at-scale workflows to process international LOFAR2.0 data.
Profiling identified opportunities for optimization:
→ Reduced time required to complete the microbenchmark on the same hardware (24h → 13h)

https://github.com/uksrc-developers/PyProfQueue

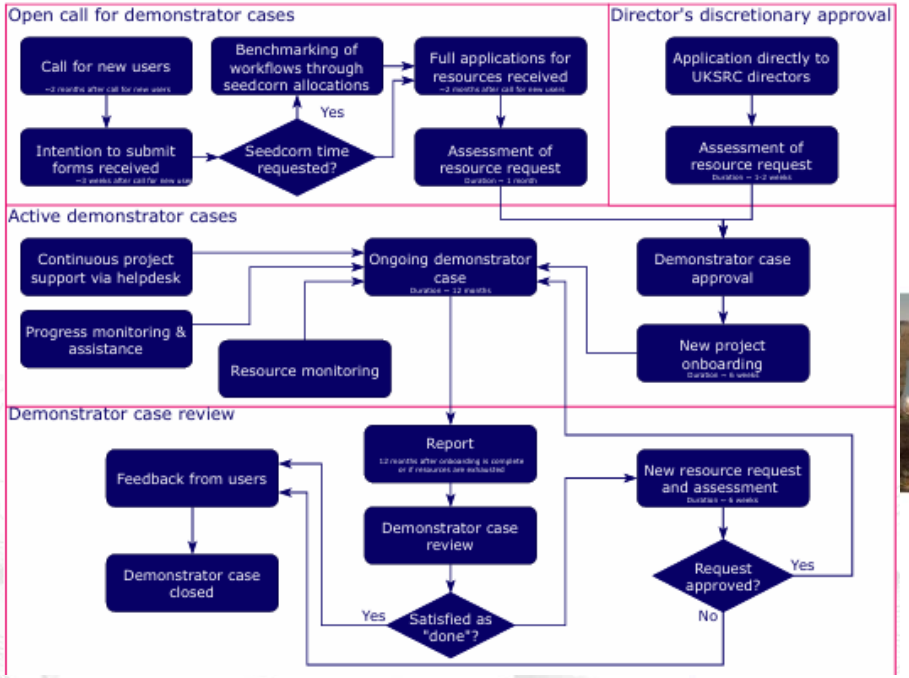
Developing UK science enabling services: Phase 3

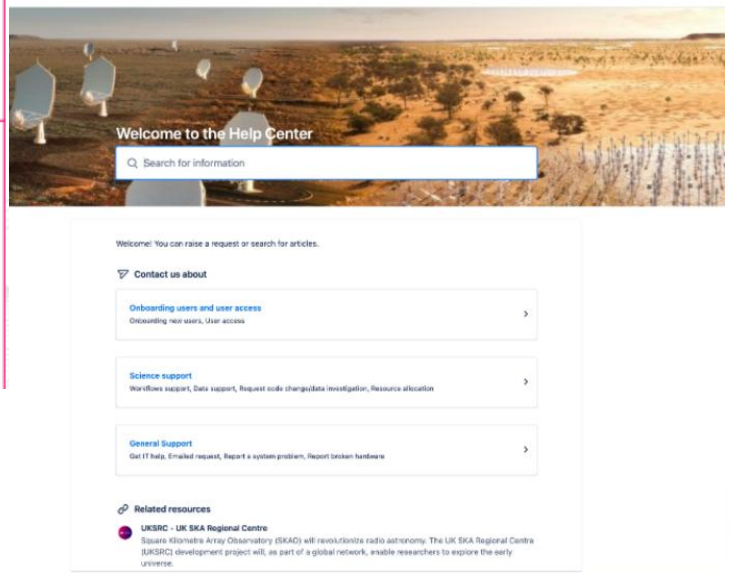
Expanding Demonstrator cases / early adopter scheme

1. Calls for cases
2. Application and Approval
3. Active project phase
4. Review and closure

Open call – cycle 1
Closed 6 June 2025

9 new demonstrator cases/ early adopter teams





A prototype UKSRC user support helpdesk and ticketing system (credit I. Cimpan)

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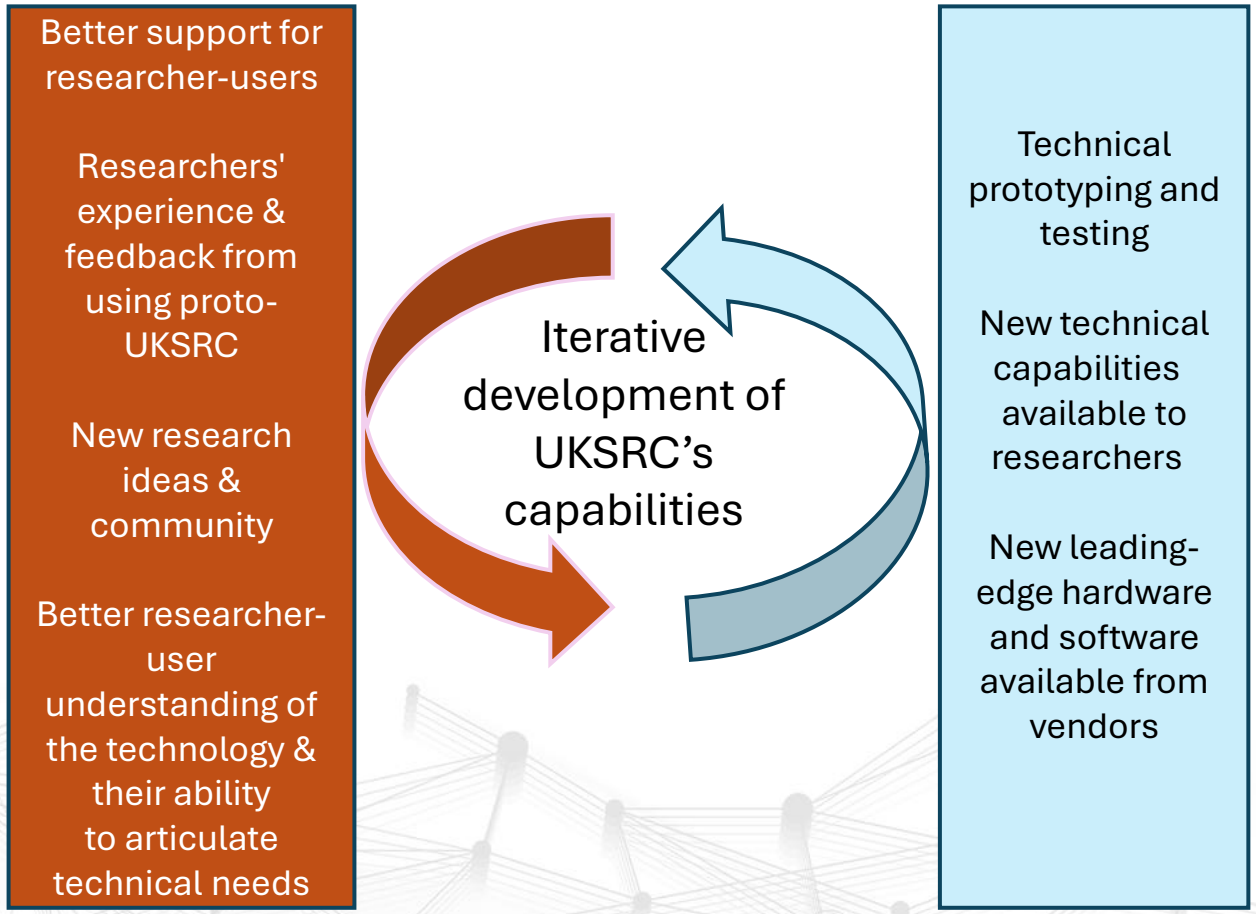
Summary

UKSRC will provide infrastructure and services for UK radio astronomy in the exabyte era.

The UKSRC will increase the capacity of the UK research community by providing:

- data access and curation
- software and tools for analysis
- support, training and careers pathways

This will maximise UK's return on investment in SKAO construction



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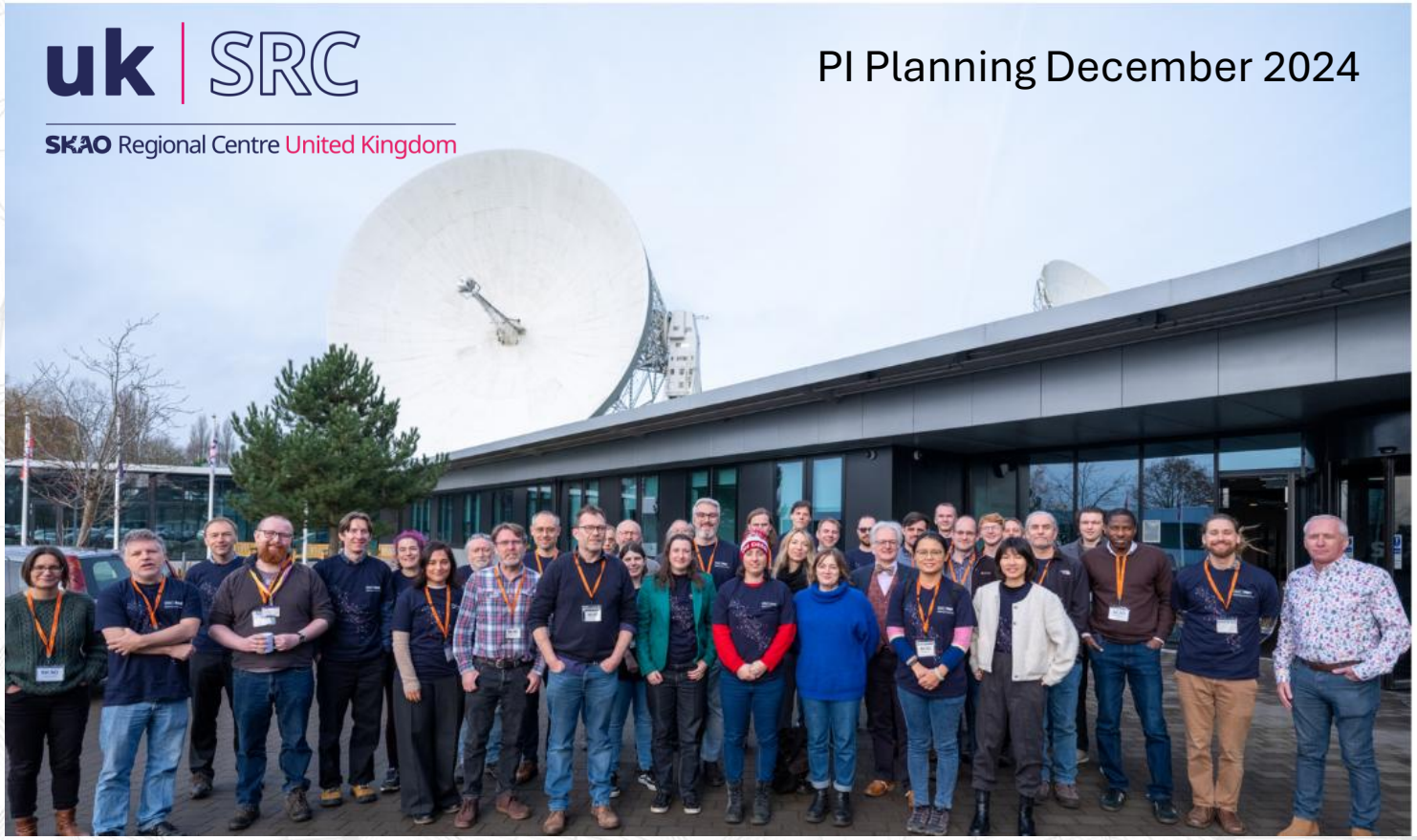
Science and Technology Facilities Council | Scientific Computing



Visit our stand!

Mailing List: UKSKA-SCIENCECOMMUNITY@JISCMAIL.AC.UK

https://www.uksrc.org/

https://www.skao.int/en/science-users
Register for SKAO updates

Join a SKAO Science Working Group
- PhD students welcome

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l.chisholm@ucl.ac.uk

linkedIn: uk-ska-regional-centre-uksrc

SKA-Low

AA*

SKA-Mid

307
Stations

Up to **48**
station beams

Up to **1440**
substations

74 km
Max Baseline

Up to **16** subarrays, commensal Observations
Two telescopes, frequency coverage of 50 MHz and 15.4 GHz

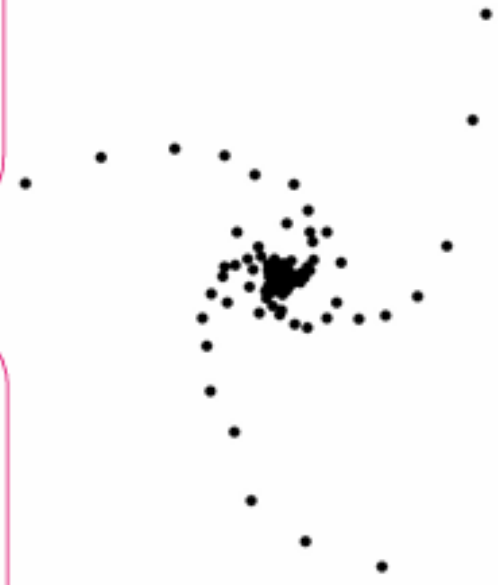
Continuum | Spectral Line | Pulsar Timing | Pulsar Search | Transient Buffer | VLBI

Observing modes

SKA will be highly flexible, complicated and delivered on an enormous scale. Plan to deliver highly processed Observatory Data Products adds to this complexity → we expect to build up to the full set of capabilities over time

Delivery of capabilities

144
Antennas



36 km
Max Baseline

*108 km including SKA008

Shari Breen

https://www.skao.int/en/647/timeline-science

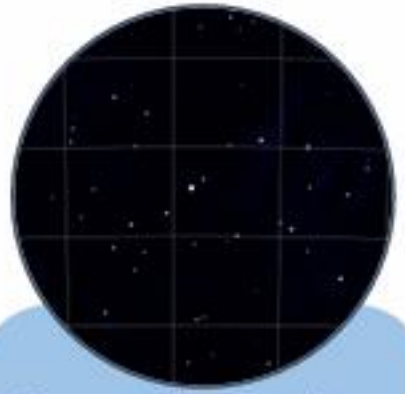
SKAO milestones

Community involvement starts

Credit: I. Heywood, SARAO

Construction

- Building antennas, dishes, roads etc!
- Followed by Assembly, Integration and Verification

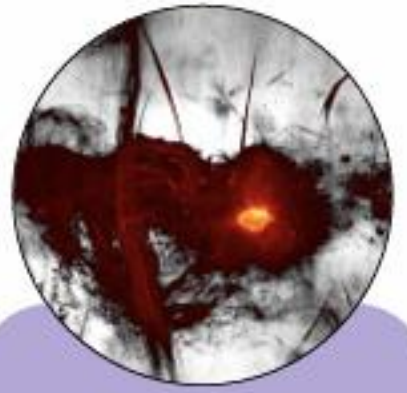


Commissioning

- SKAO activity
- Collaborative across system verification and science commissioning

Science Verification

- A full dress rehearsal of the end-to-end system for every mode of operation
- Once modes and pipelines are working, the community can submit target ideas
- Data will be publicly available for scrutiny
- Build trust and fostering an early science return



Cycle 0

- Shared-risk PI projects
- SRCNet resources ready for user
- Proprietary periods

Now — Now — First half 2027 — First half 2029 — 2030

Now — Soon — First half 2029 — First half 2031 — 2032

SKAO Operational Model holds

Operational model is to deliver (mostly) highly processed data products to the user community

This will hold through the rollout of capabilities

- Users may be tempted to request less processed data products as we build towards full capability
- Anticipating placing a cap on the delivery of "under-processed" data products as we rollout the full complement of capabilities

Data products

Observatory Data Products (SKAO responsibility)

Observation-level data product

Calibrated data products generated by SKAO pipelines based on data from a single execution of a Scheduling Block.

Project-level data product

Calibrated data products generated by combining several related observation-level data products, delivering the requirements of the PI as outlined in their original proposal.

Advanced Data Products (created by users within the SRCNet)

User-created products from detailed analysis of Observatory data, often involving visualization and comparison with other data.