

SKAO

SKA SWG Update

SKAO science team

21 May 2024



SKA Science Update

- Construction Update
- SKA Science Meetings
- Science Data Challenges
- SWG Collaboration Facilitation
- Reminders
- AOB



Construction Update – AA0.5

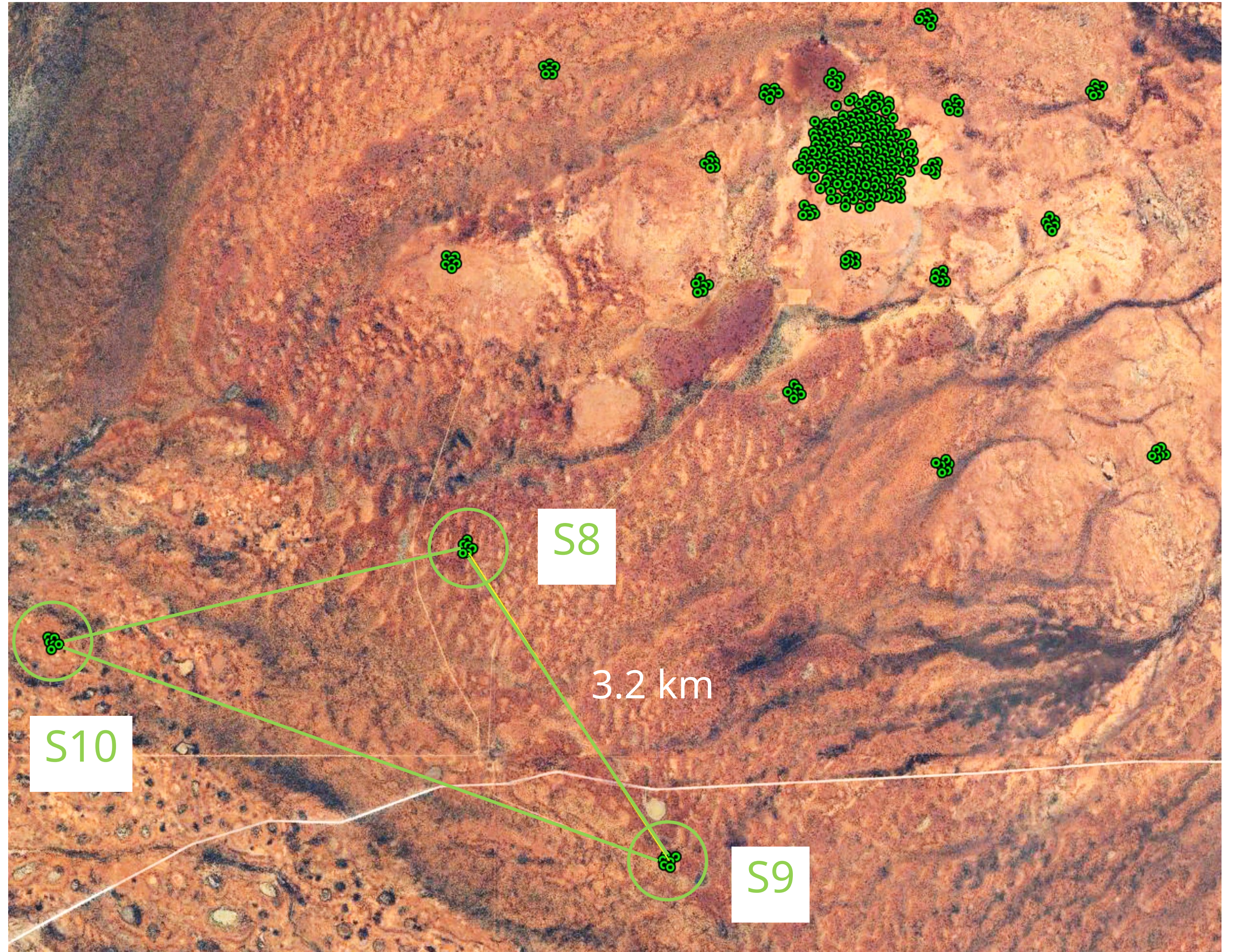
SKA-Low AA0.5

4 Stations

2 x S8

1 x S9, S10

First four SKA stations now being erected on-site!

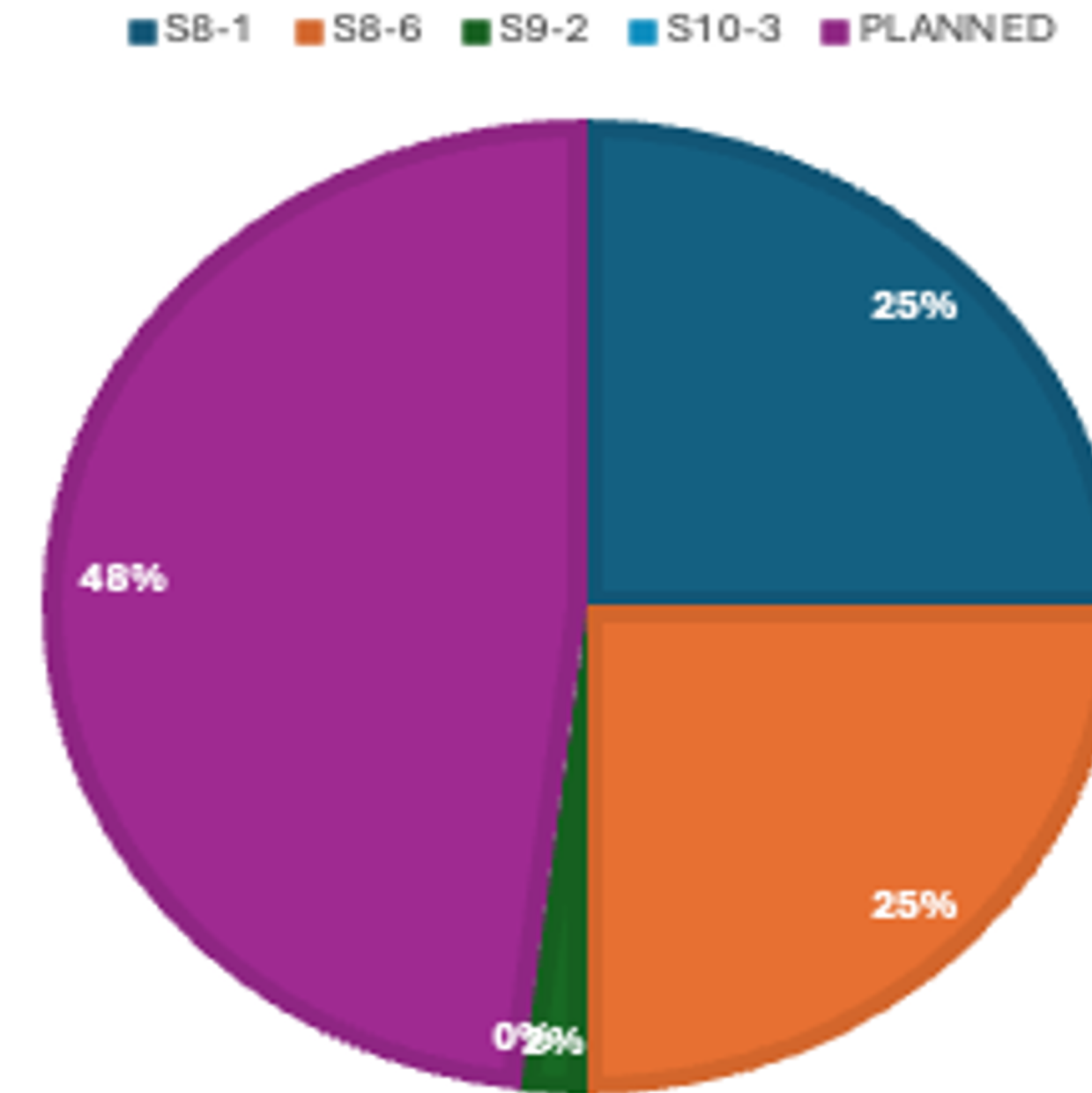


Station by the numbers

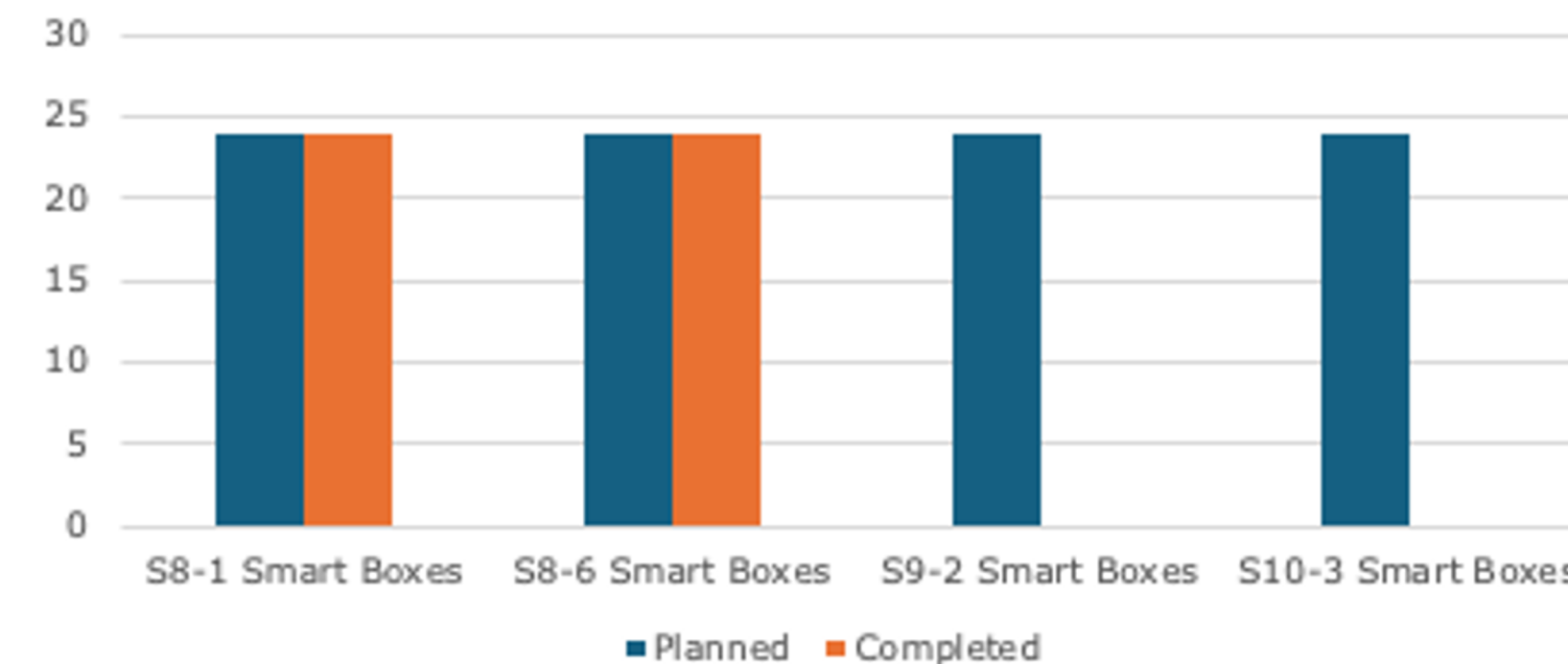
AA 0.5

- 52% of the antennas built.
- 50% of the PaSDs installed.
- Over 4000 human hours already worked.

AA 0.5 ANTENNA BUILD

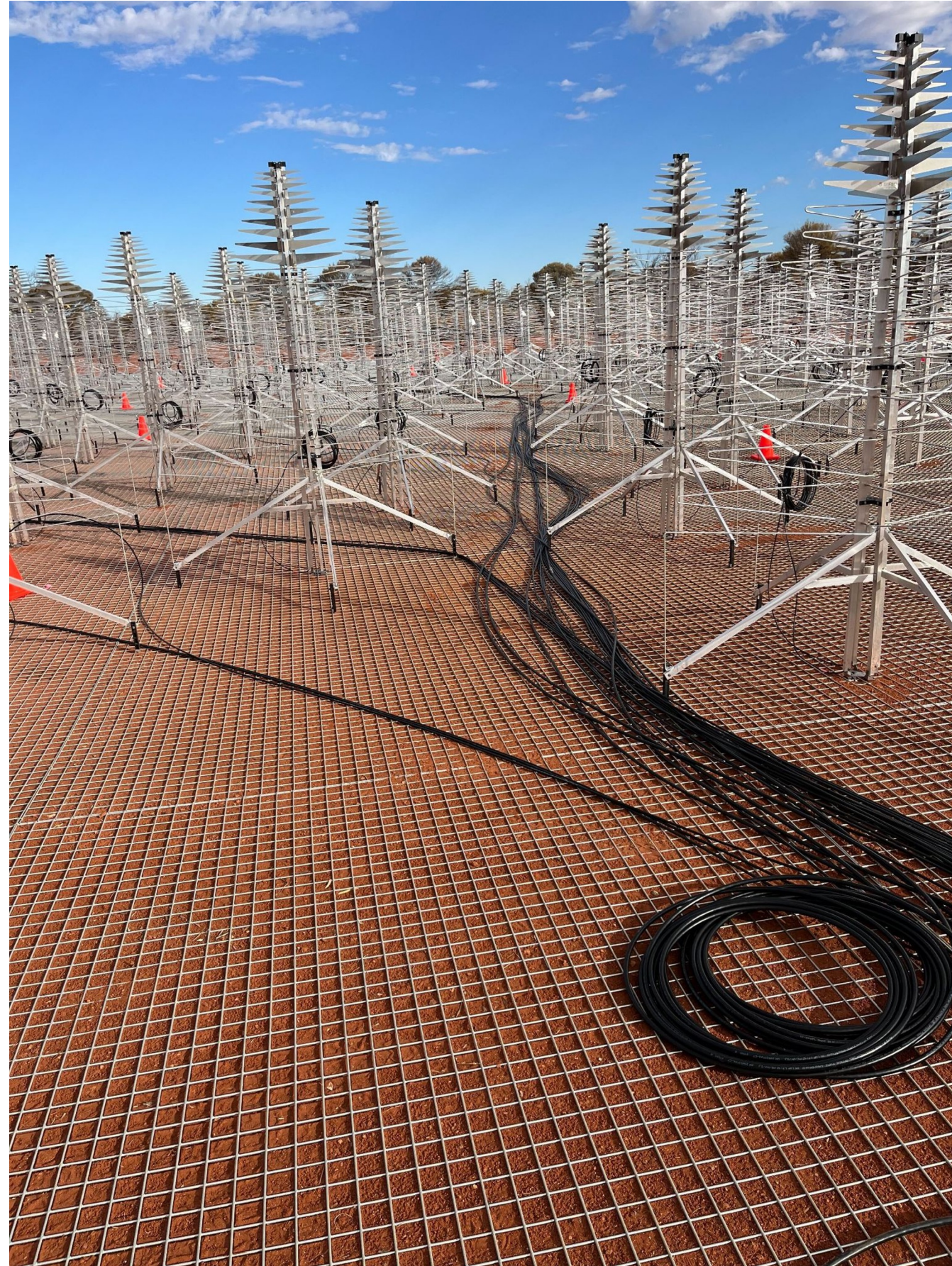


PaSD - Smart Boxes



AA0.5 8-1, 8-6

Slide credit: Angela Teale

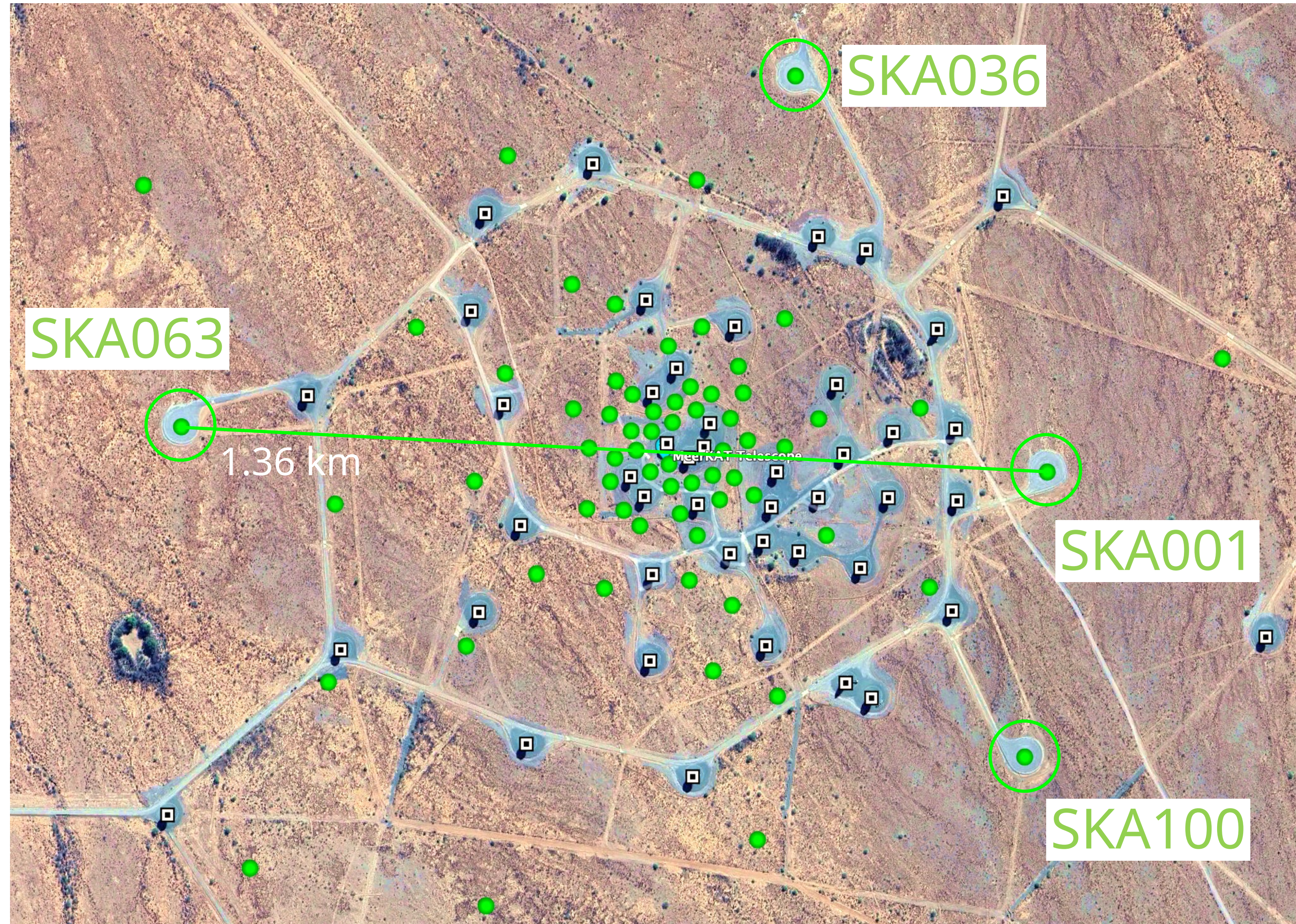


Construction Update – AA0.5

SKA-Mid AA0.5

- ▣ MeerKAT
- SKA dish locations

First two SKA dishes now being erected on-site!



Dish Structure Construction

- Dishes #1 to #3 on site, Dish #1 30% complete. Dish #4 fully assembled in China, used as a test bed.
- Huge RFI testing efforts by SKAO and Contractors. Compliant design meeting MeerKAT specs. Qualification testing to SKA specification will follow.
- All four AA0.5 Dishes being RFI tested, ensuring RFI integrity.



Dish #4 CETC54 in China



Dish #1 Construction in Karoo



Design refinement

- At this point in the project lifecycle where construction has commenced, the following should be mature:
 - Immutable Level 0 requirements and appropriate lower-level allocations.
 - Key Systems Engineering artefacts at a mature level, e.g.:
 - ICDs, PBSs and functional architectures; ECPs closed out.
 - CDRs, DDRs, PRRs with demonstrated compliance to requirements through qualification test procedures.
- At present there is a mixture of design maturity across products, so there is still some need for design refinement.
 - Residual compliance risks for high-innovation products.
 - Emergent behaviour/issues might materialize.



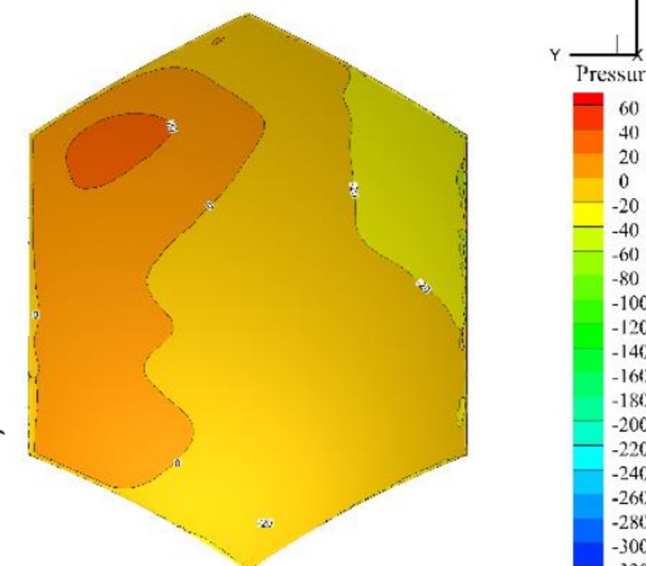
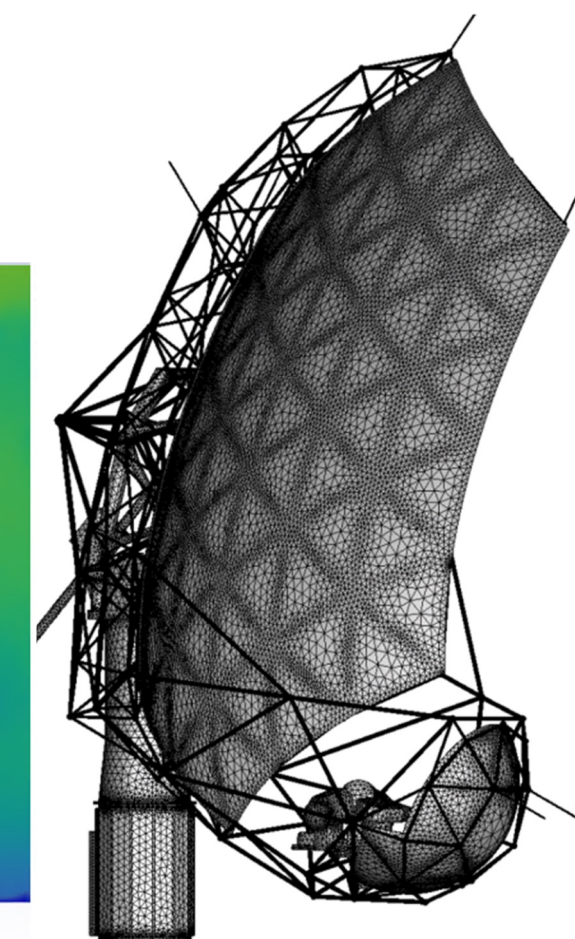
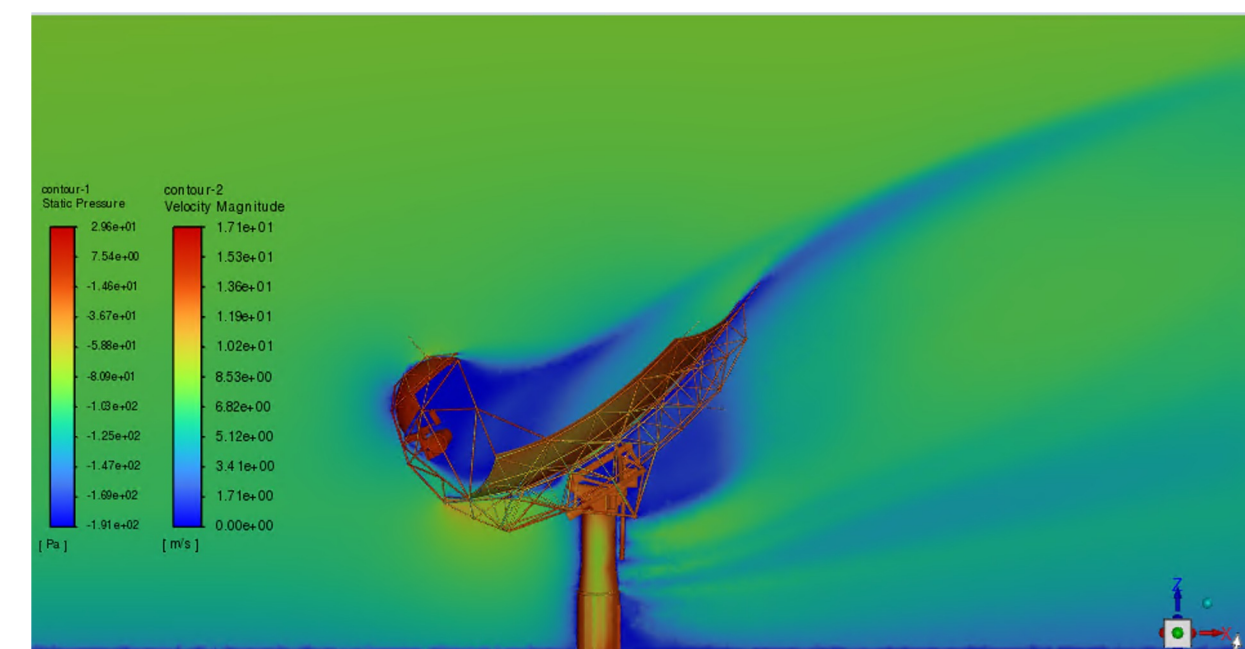
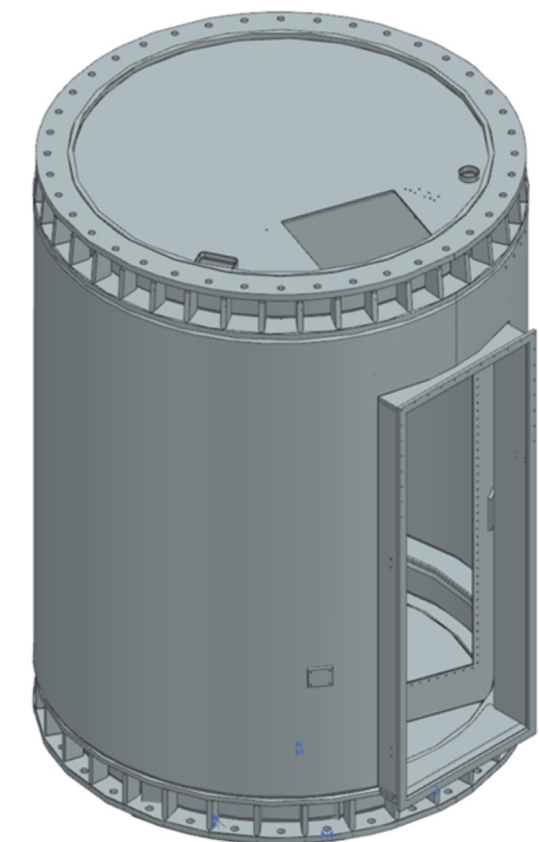
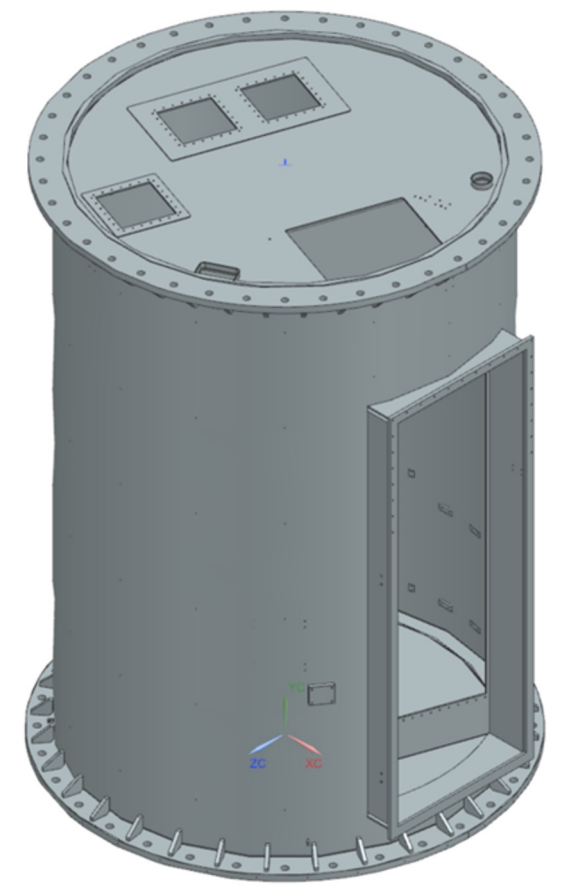
Dish Pointing under wind load

- Most important error source for dynamic range requirements
- Non-compliant based on SKA-MPI measurements
- Analysis and redesign of dish structure
- Finite Element Analysis → higher stiffness
- Improved CFD model of wind loading → worst case loads
- U- and A-frames – more steel
- Pedestal – larger diameter
- Foundation – review of design
- Dynamical analysis incomplete
- Optimisation of tiltmeter mounting (retrofit)



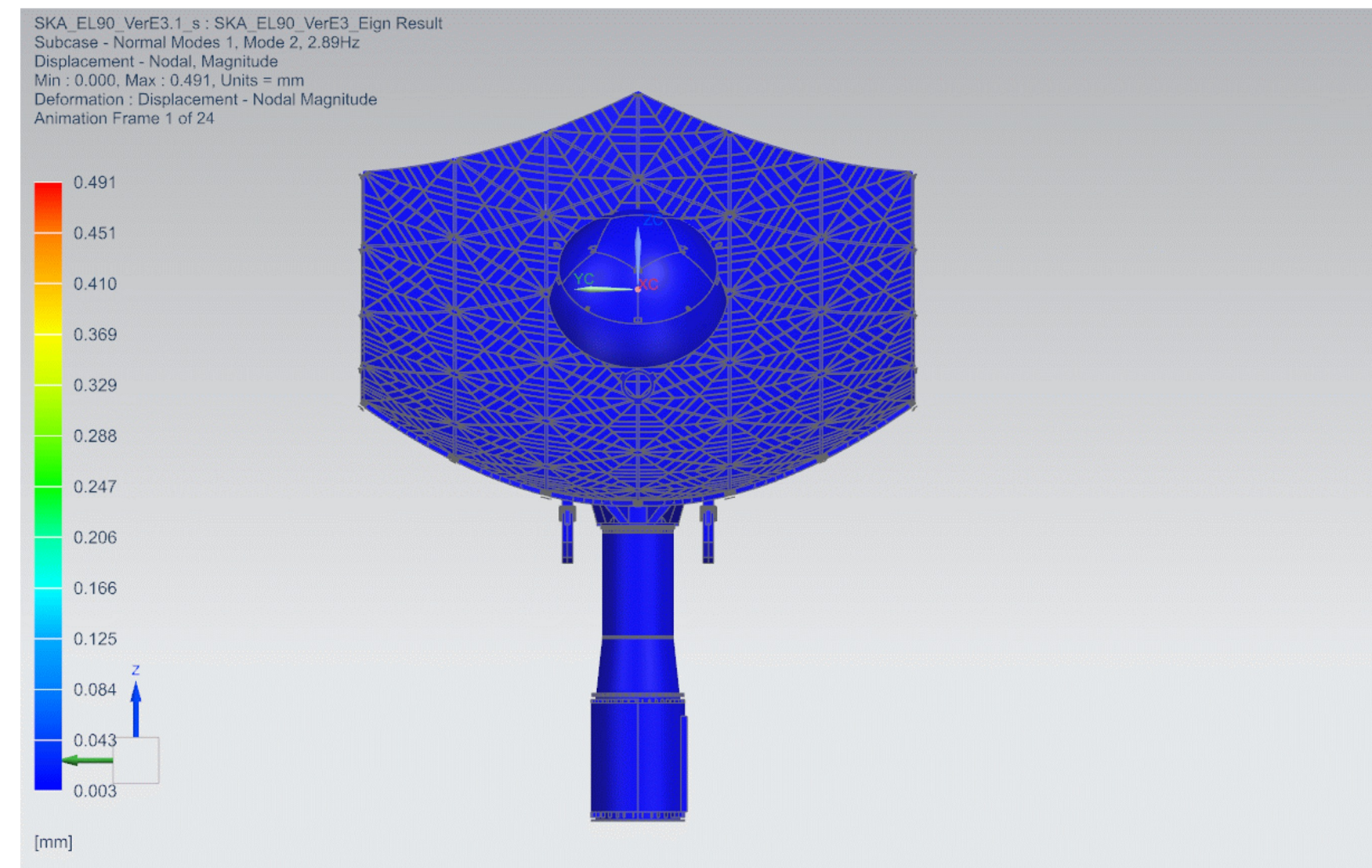
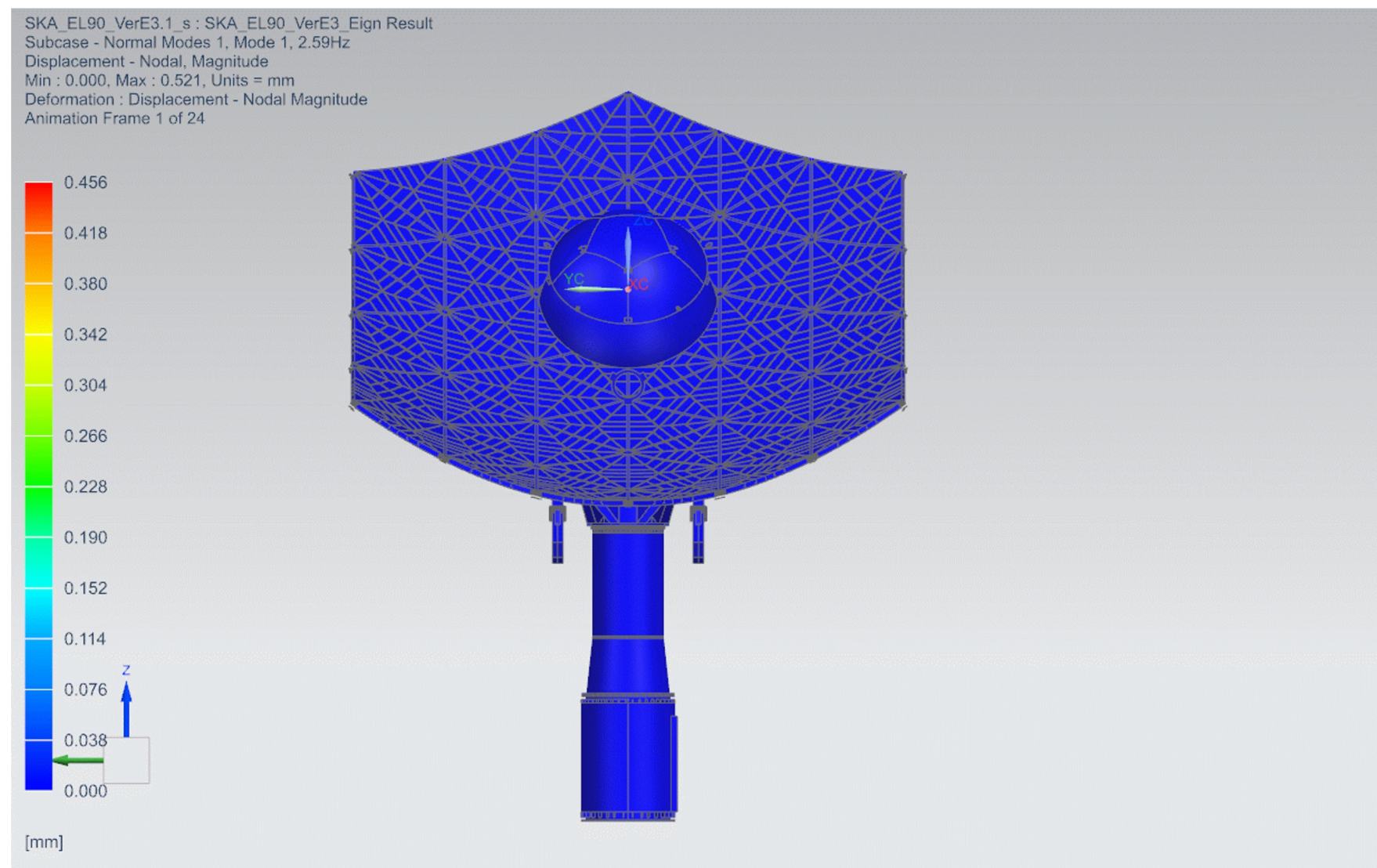
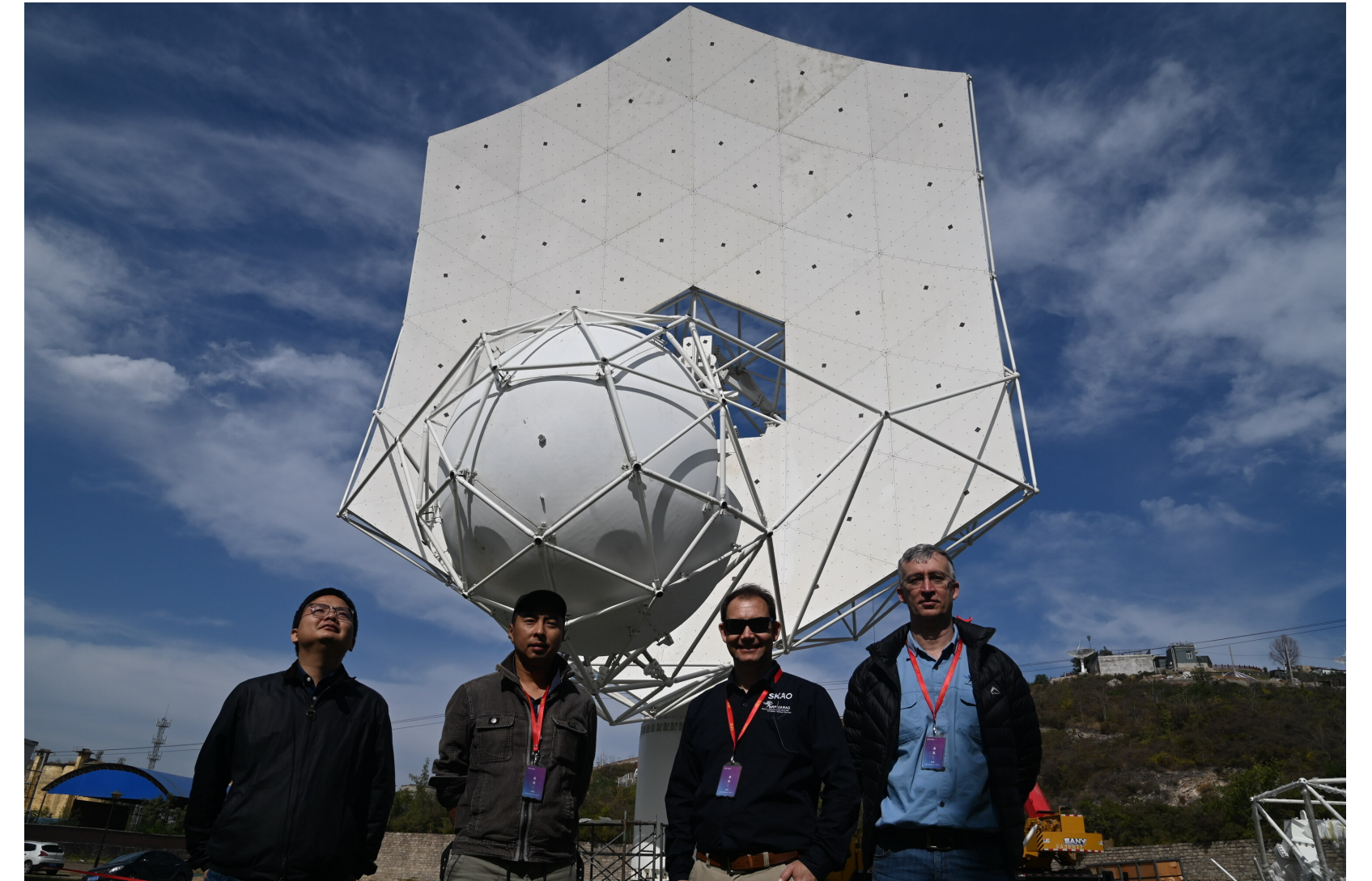
DS Improvements from Prototype to MID

- Increase in stiffness 1.7 Hz to 2.5 Hz which required:
 - Larger diameter but shorter pedestal
 - Stiffer A-U Frame which supports the Main Reflector
 - Stiffer Bearing supports
 - Bearings EL: $\varnothing 90\text{mm}$ to $\varnothing 150\text{mm}$, Az: 4-point contact to Crossed Roller Type
 - Larger EL ball screw $\varnothing 120\text{mm}$ to $\varnothing 180\text{mm}$
 - Stiffer Az Gearboxes
- Improved Pointing control
 - Thermal shielding of the Turnhead
 - Alternate position of the Tilt Sensor to reduce unmeasured errors
 - Improved connection between EL Encoder and EL Assembly
 - Faster, PLC based motion controller
- Improved modelling
 - Highly detailed CFD, FEA and EM



Dish Pointing: Current Status

- FEA: first two eigenfrequencies $>2.5\text{Hz}$ as required
- Initial results of sweep tests on AA0.5 dish in China confirm this result
- Optical pointing tests to be done on Dish #1 in South Africa



SKA-Low Station Layout

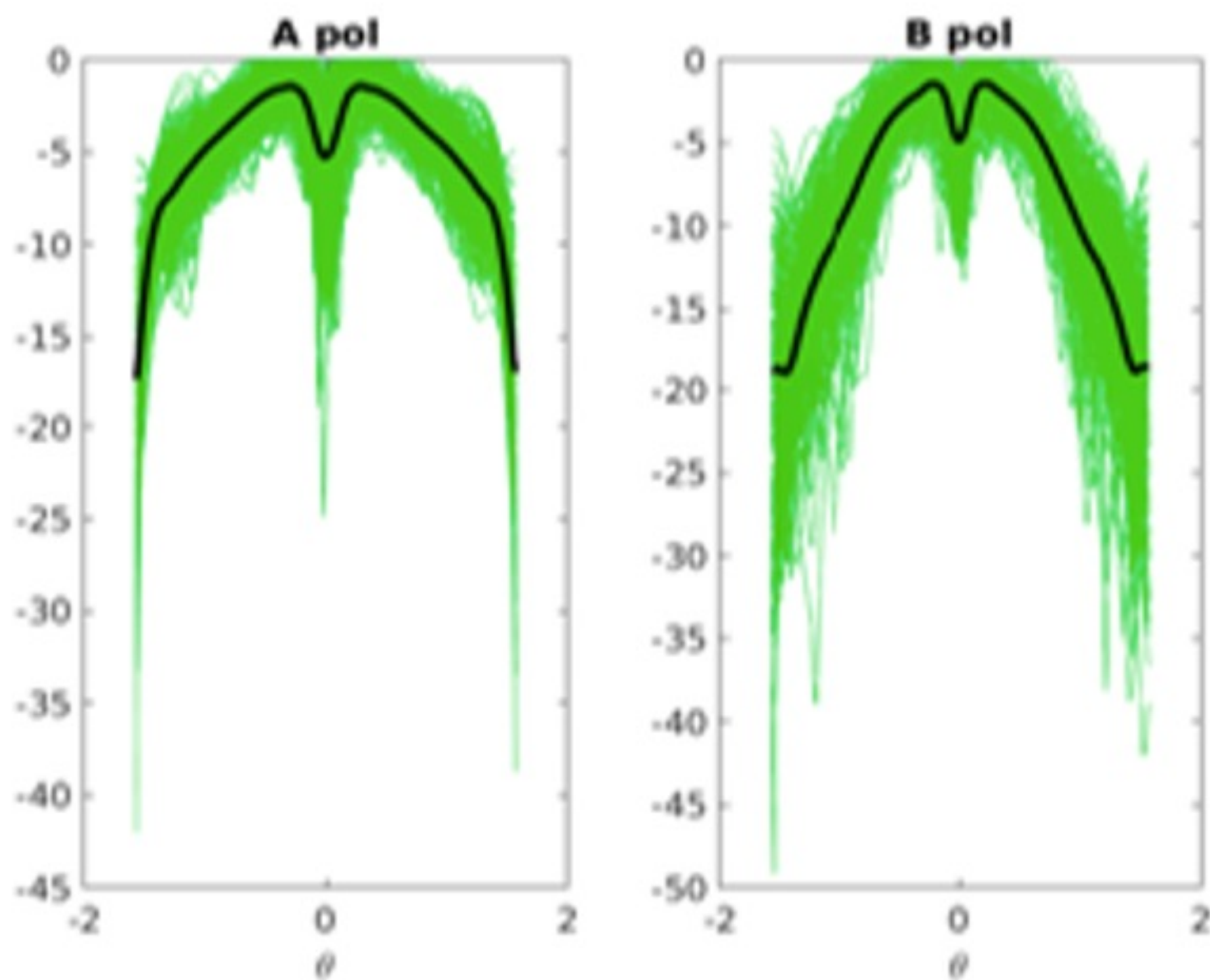
- Original plan was to have 512 realisations of a pseudo-random layout, antennas all orientated NS-EW
 - Diversity → lower far-sidelobe noise, but calibration requires computation and storage of embedded element patterns (EEPs) for each realisation
 - Investigations for System CDR suggested that ~ 32 independent realisations would be enough
- Resonances due to coupling between close pairs of SKALA4.1 antennas at ~ 55 and ~ 78 MHz (Bolli et al.)
- Motivated the Vogel (“sunflower”) layout, which has fewer aligned close pairs
 - For this, must achieve diversity by rotating stations, keeping the same intrinsic layout
 - Either keep antennas NS-EW or rigidly rotate the entire station: come back to this later



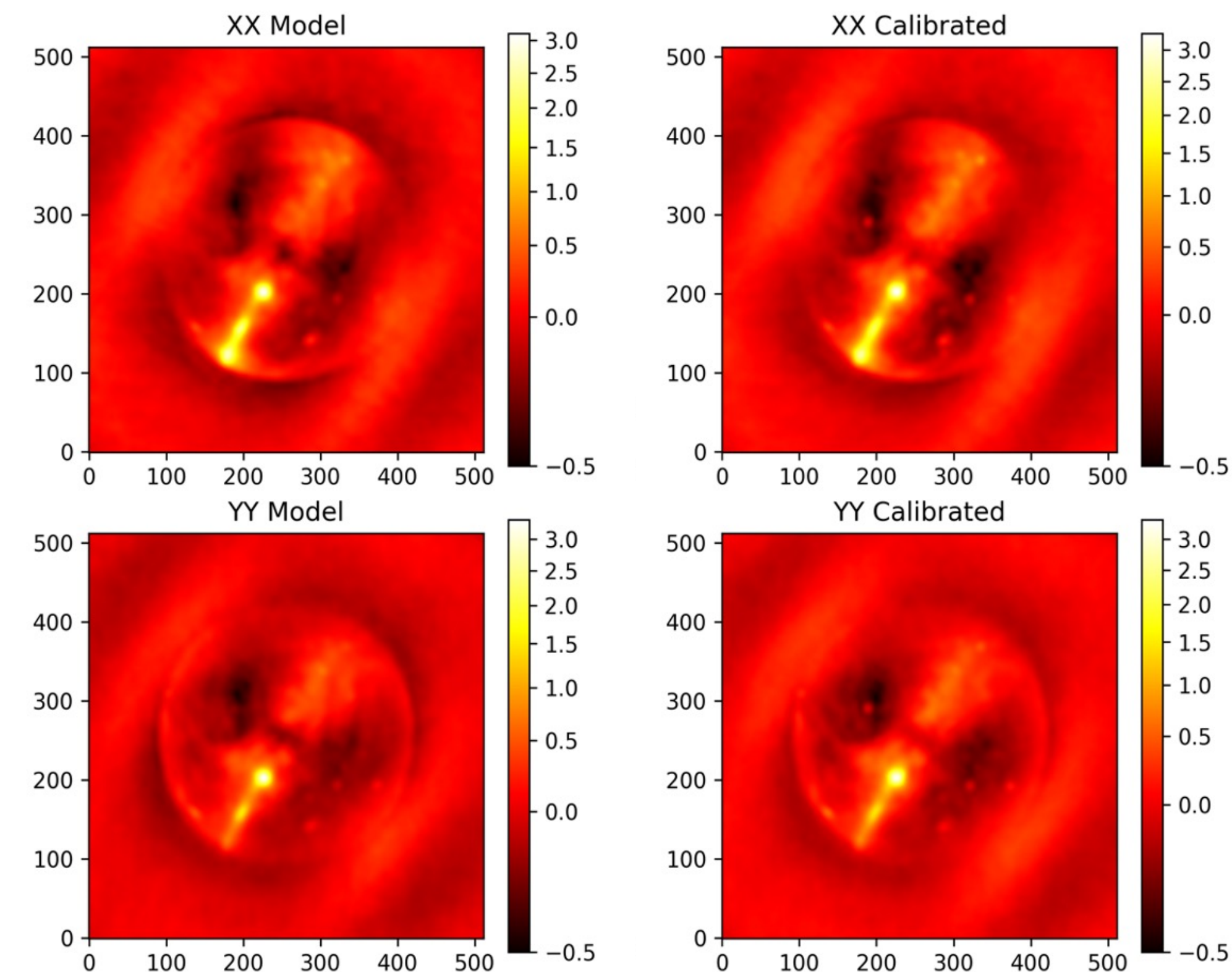
The problem with Vogel

Slide credit: Justin Jonas

- Narrow resonance at 125MHz, causes a very large gain dip close to the zenith (Davidson)
- Traced to residual regularity in the layout (repeated spacings of $\sim 2.4\text{m} = 1\lambda$ at 125MHz)



All-sky interferometric images from AAVS3 (2024 Jan 10). Galactic plane at transit (Giulia Macario, Shin'ichiro Asayama).

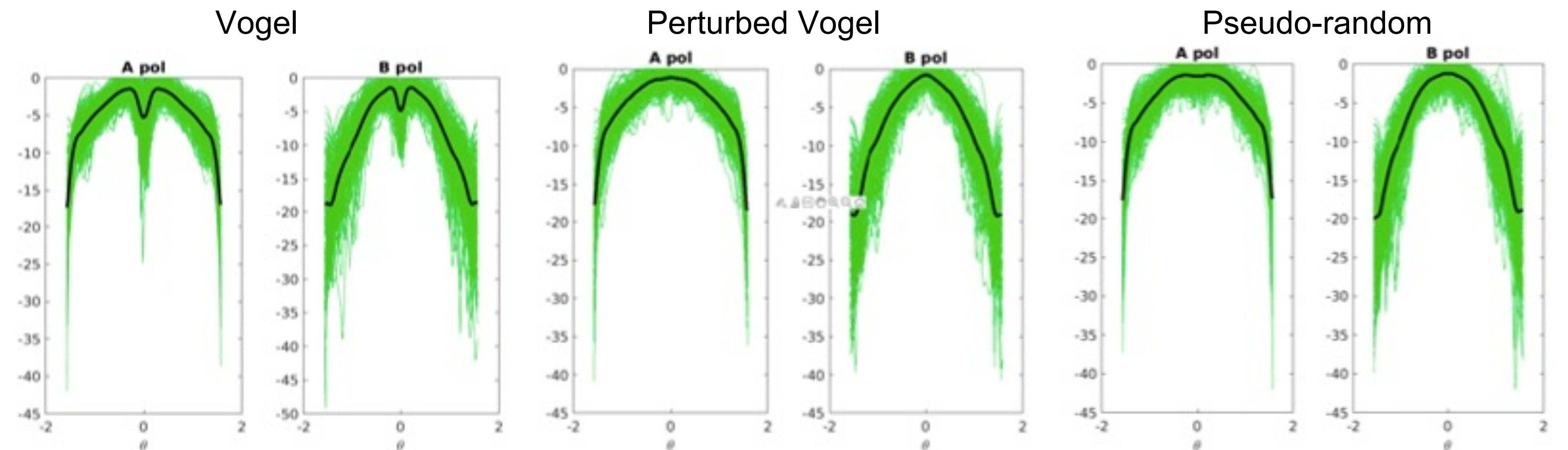
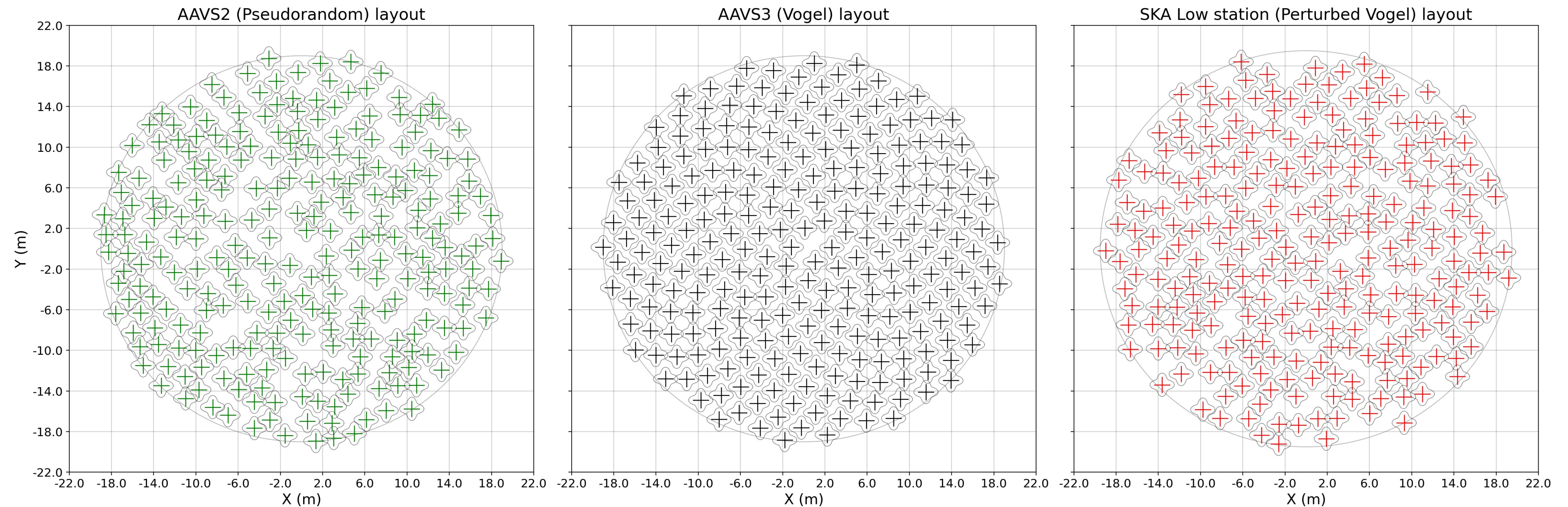


Perturbed Vogel layout

Slide credit: Justin Jonas

- Starting from Vogel layout, optimize in order to get rid of 125MHz resonance while maintaining improvement at 78MHz (Cambridge Group; Anstey et al. 2024)

- **“Perturbed Vogel” layout (ECP-210113)**



We will develop and deploy a collaborative and federated network of SKA Regional Centres, globally distributed across SKA partner countries, to host the SKA Science Archive. The SRC Network will make data storage, processing and collaboration spaces available, while supporting and training the community, **to maximise the scientific productivity and impact of the SKA.**

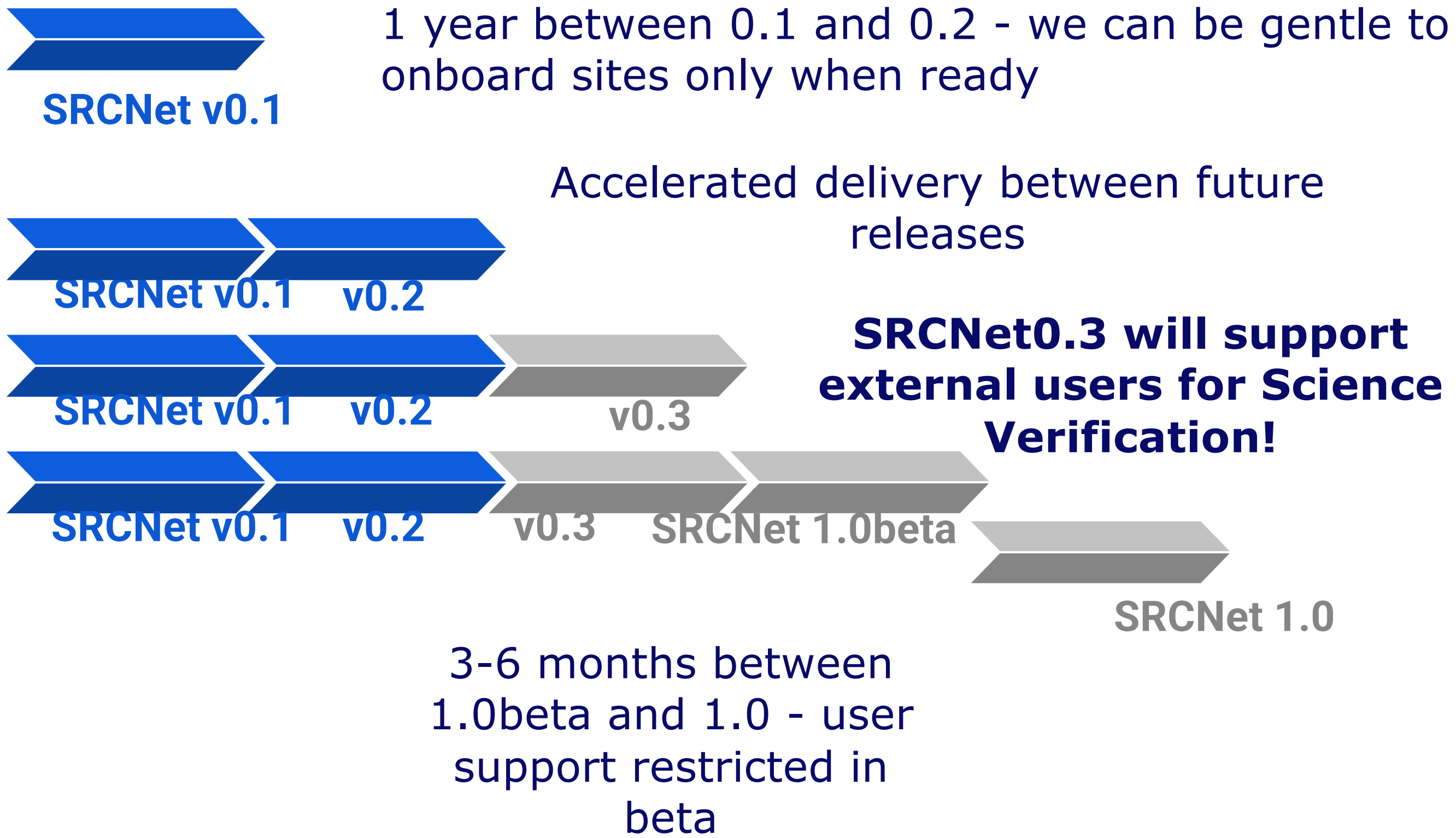
Initially, we will do this by:

- developing a scalable, prototype SRC Network that allows authorised users and teams to access and analyse SKA data;
- developing the software, architecture, policies and processes necessary for SRC Network operations;
- growing the prototype SRC Network, as new SRCs become available and expanded or new functionalities are developed, leading towards a fully operational and global Network.



Staged Delivery and SRCNet releases side by side

Milestone event (earliest)		SKA-Mid (end date)	SKA-Low (end date)
AA0.5	4 dishes 6 stations	2025 May	2024 Nov
AA1	8 dishes 18 stations	2026 May	2025 Nov
AA2	64 dishes 64 stations		
AA*	144 dishes 307 stations		
Operations Readiness Review			
AA4	197 dishes 512 stations		



Slide credit: Rosie Bolton

SRC Network Principles (highlighted for SRCNet0.1)

Slide credit: Rosie Bolton

- There will be a **common SKAO/SRC Network user account** that allows users access to SRC Network resources

Single AAI System used by all SRCNet0.1 sites and services

Common policies for SRCNet sites (in addition to local policies)

- Security of the SRC Network is the responsibility of the SRC Network.

Ensure good user experience, for all users - Science Gateway UX

- The SRC Network will be committed to providing, and abiding to, **accessible and equitable tools, practices and processes**.

Implement IVOA standards and easy data and service discovery

- The SRC Network will **embrace FAIR and Open Science principles** whenever possible and appropriate.

- Resources pledged into the SRC Network will enter, and be allocated from, **a global federated pool**.

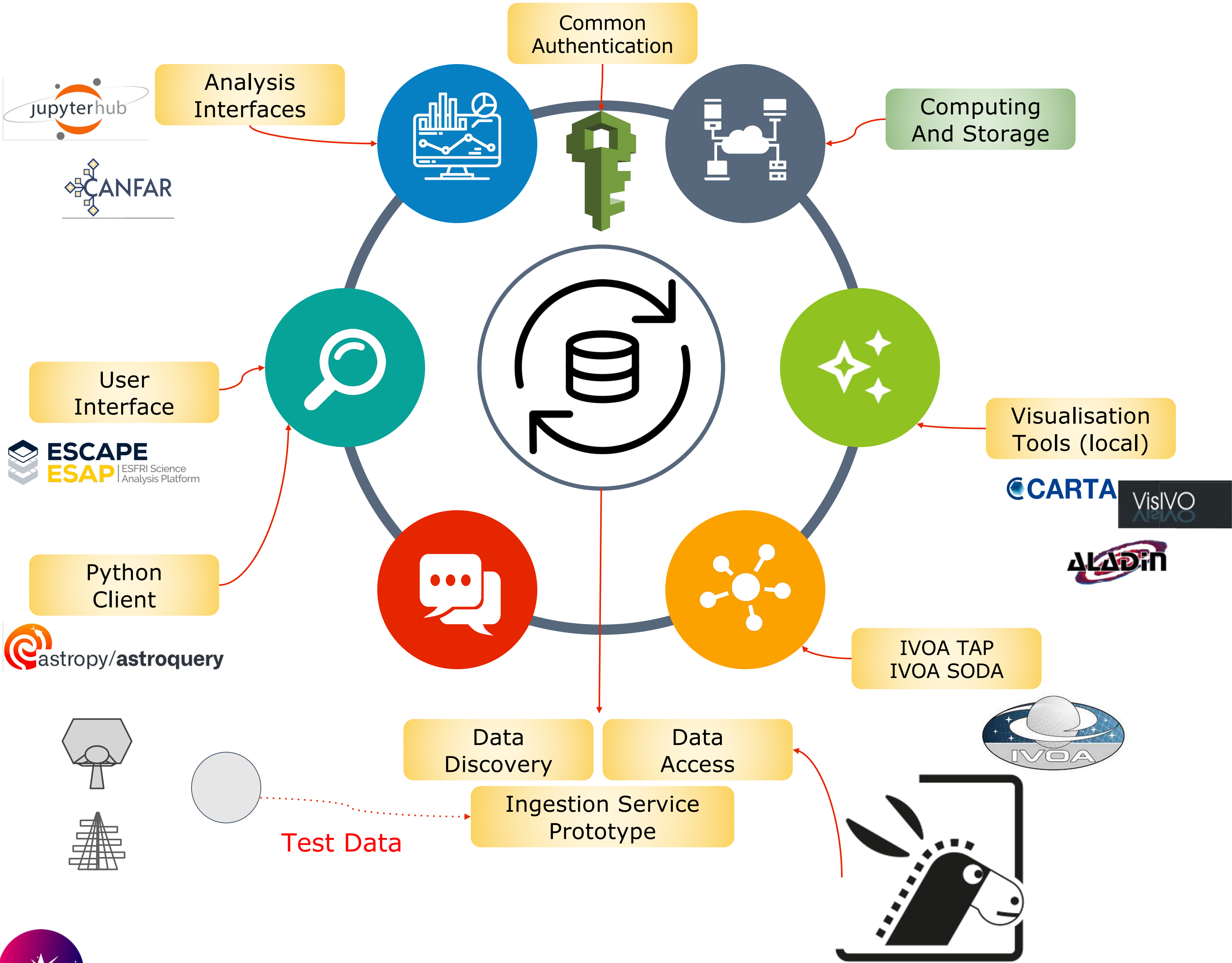
These two are related; users go to best location depending on data location and appropriate available services, replicas centrally planned / moved to optimise global access

- The **physical location of SKA data** products will be determined to **optimise access and minimise data redistribution** within the Network, as much as is feasibly possible.



Basic Functionality Covered by v0.1

Slide credit: Rosie Bolton



- Common Authentication
 - IAM
- Visualisation Tools (local)
- IVOA Protocols
 - TAP, SODA
- Data Discovery and Access from Data Lake
- Ingestion Service Prototype
- Python Client
 - Astroquery Module
- User Interface
 - ESAP
 - <https://esap.srcdev.skao.int/>
- Analysis Interfaces
 - JupyterHub
 - CANFAR Science Platform

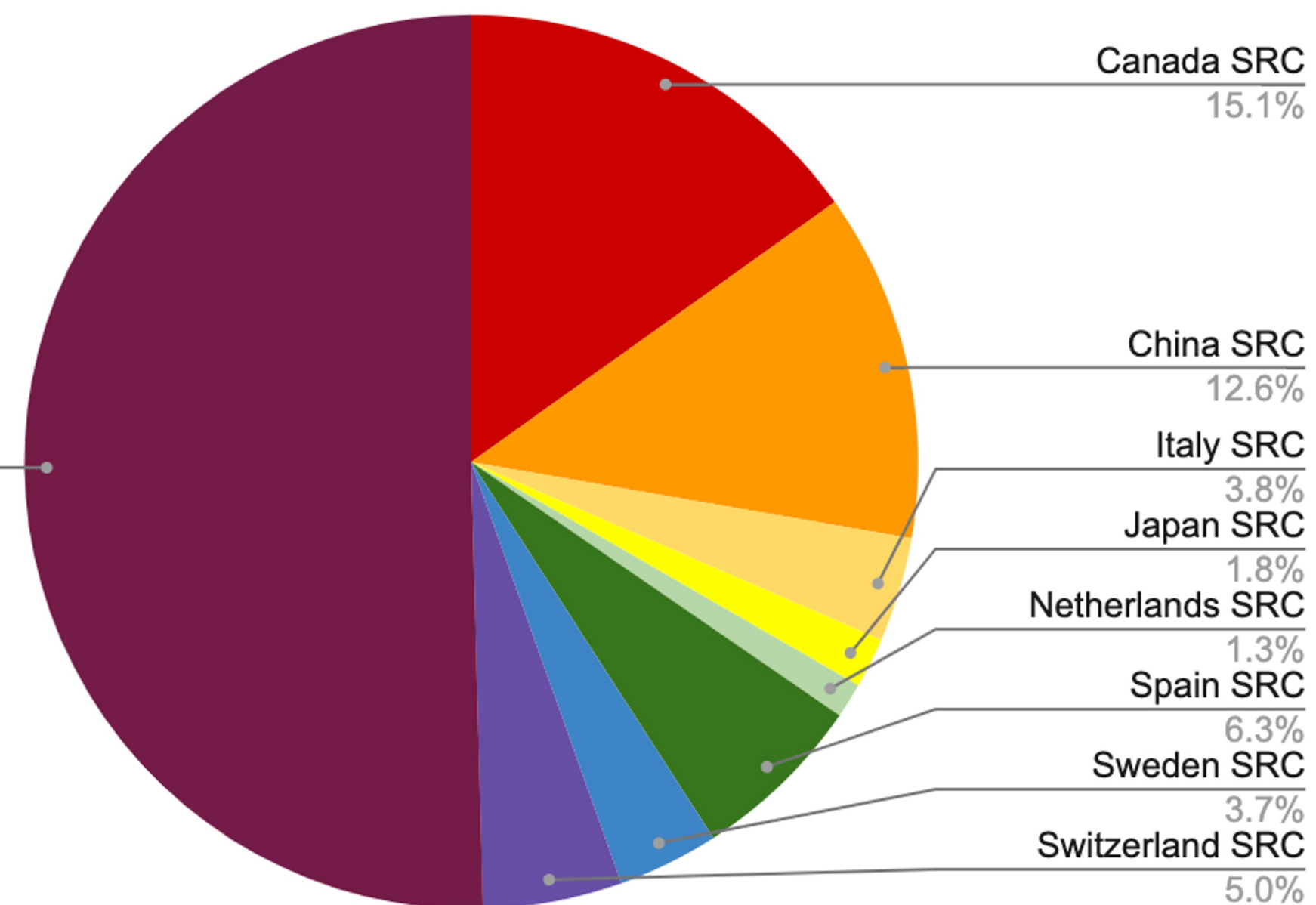
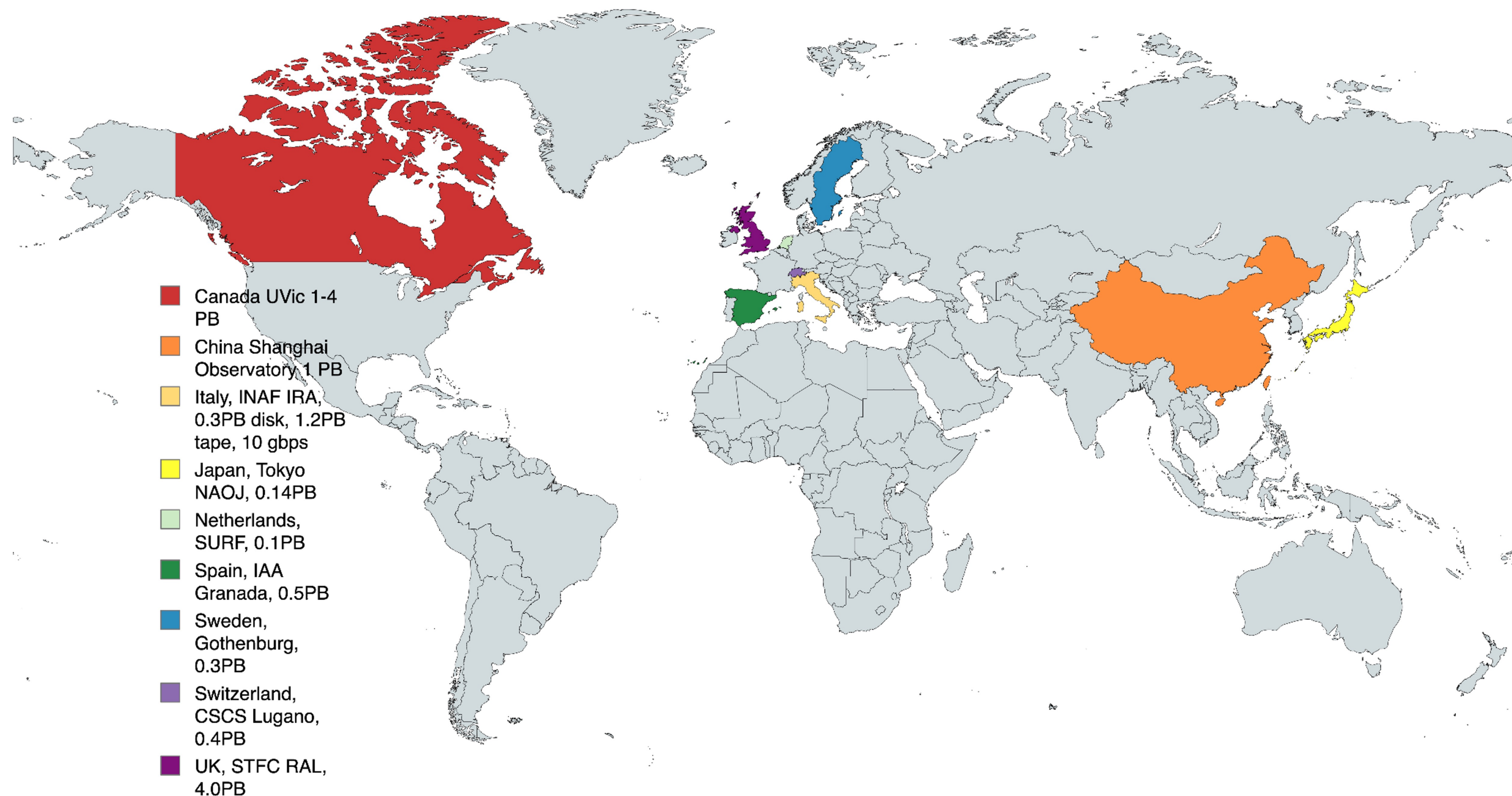


SRCNet0.1 intended sites

8 PBytes total storage offered for SRCNet0.1 (c.f stated target of 20 PB)

Potentially more subject to usage

Storage (PB)



Worldwide LHC computing grid experience at some sites (Canada, Netherlands, Sweden, Switzerland, UK)

Some sites quite new and teams will learn by being involved

Slide credit: Rosie Bolton

Science Meetings

- [New Telescopes and major upgrades to existing telescopes](#): URSI AT-RASC, 19-24 May, Gran Canaria, ES
- [Cosmic Magnetism in the pre-SKA Era](#): 27-31 May, Kagoshima JP
- European Astronomical Society (EAS) 1-5 July Padova.
 - [EAS SS31](#): The SKAO: pathway to science operations, 5 July
- [IAU GA](#): 6-15 August, Cape Town.
 - **SKAO Session 9 August**, and various SKA-related Symposia
- East Asia SKA Workshop, week of November 18, Thailand
- [Cosmic Ecosystems in Radio & Optical](#) – ESO-SKA, 9-13 Dec, near Perth, AU (abstract deadline June 20)
- **SKA Science Conference, June 2025**, Gornitz Germany, see next slides

Presentations from most past SKAO-(co)led science meetings are [available online](#)



SKAO General Science Meeting 2025

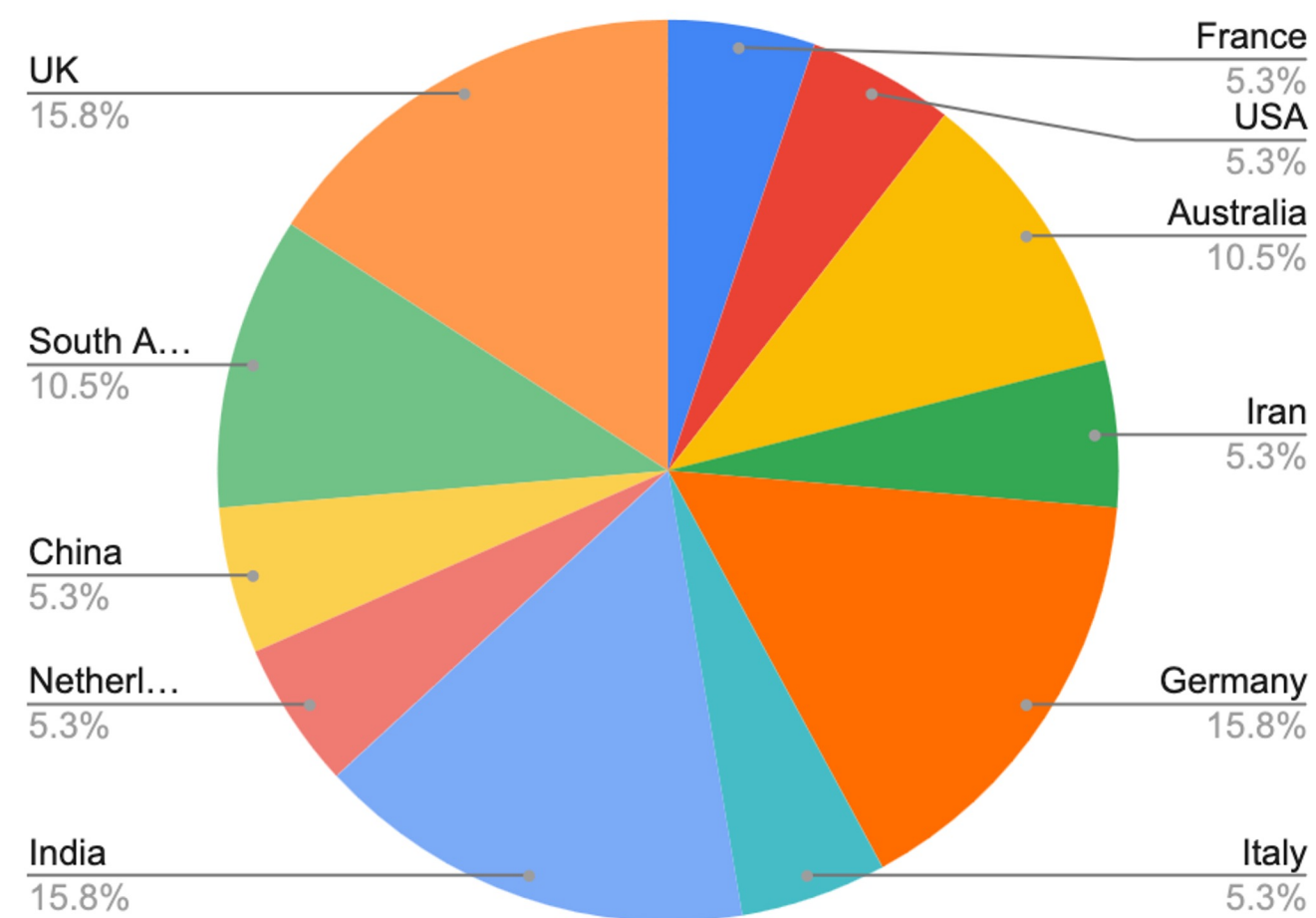
- Dates: 16th-22nd June 2025 (note change from previous provisional date).
- Location:
 - Görlitz, on the Polish border in Germany.
 - Görlitz will be the location for the German Center for Astrophysics (Deutsches Zentrum für Astrophysik, DZA), a brand new large-scale research centre that will enable top-level astronomical research, the processing of gigantic data streams from next-generation telescopes such as the SKAO, and the development of novel technology.
- Themes:
 - Facilitating updates to the SKA Science Book
 - SKAO Operations: Observing with SKAO



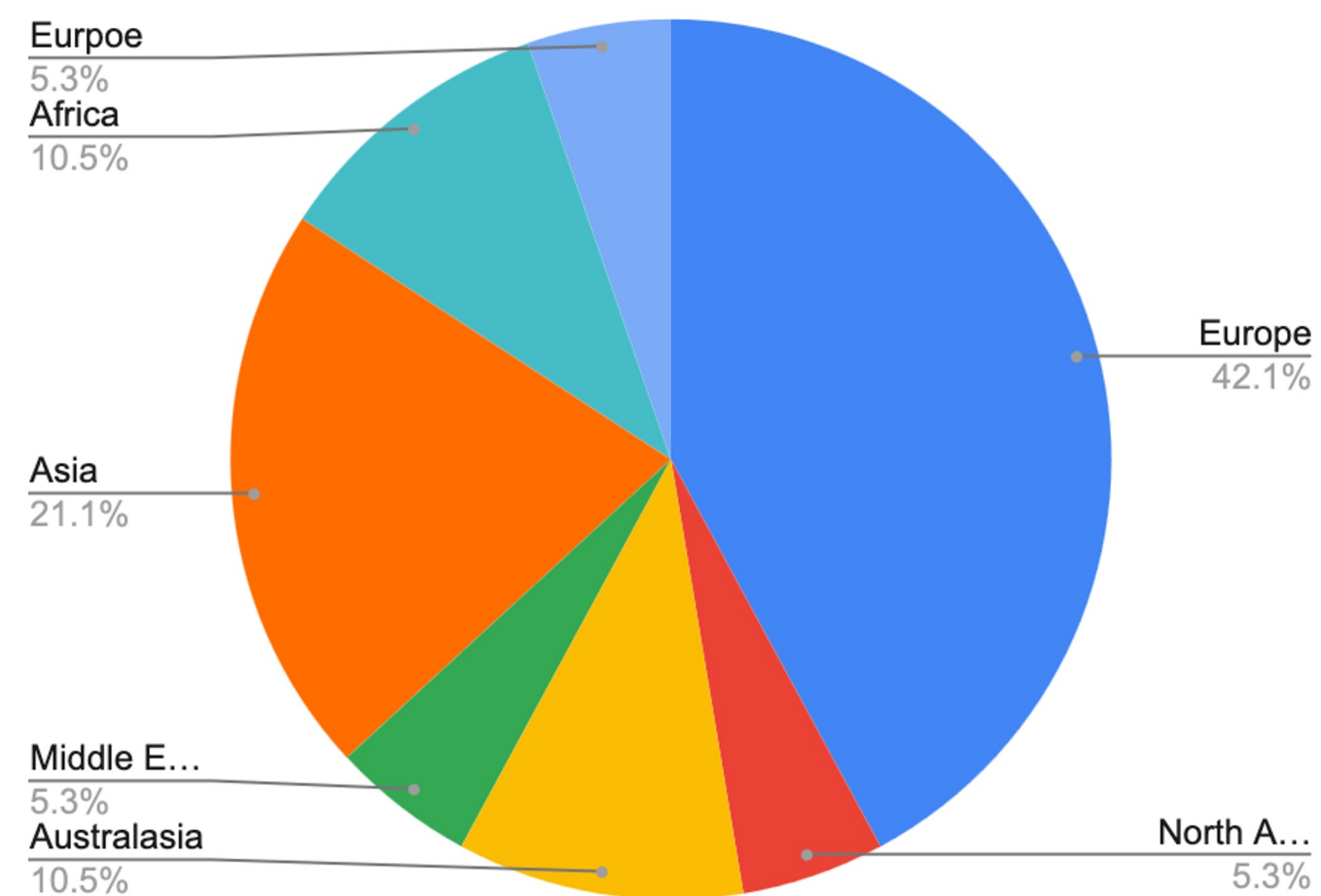
Science Meeting 2025 SOC

- Aim is for the SOC to represent all 14 Science Working Groups, plus geographical representation and gender balance, and balance of prior experience serving on SKA Science Meeting SOC
- SOC will work closely with all SWG co-chairs

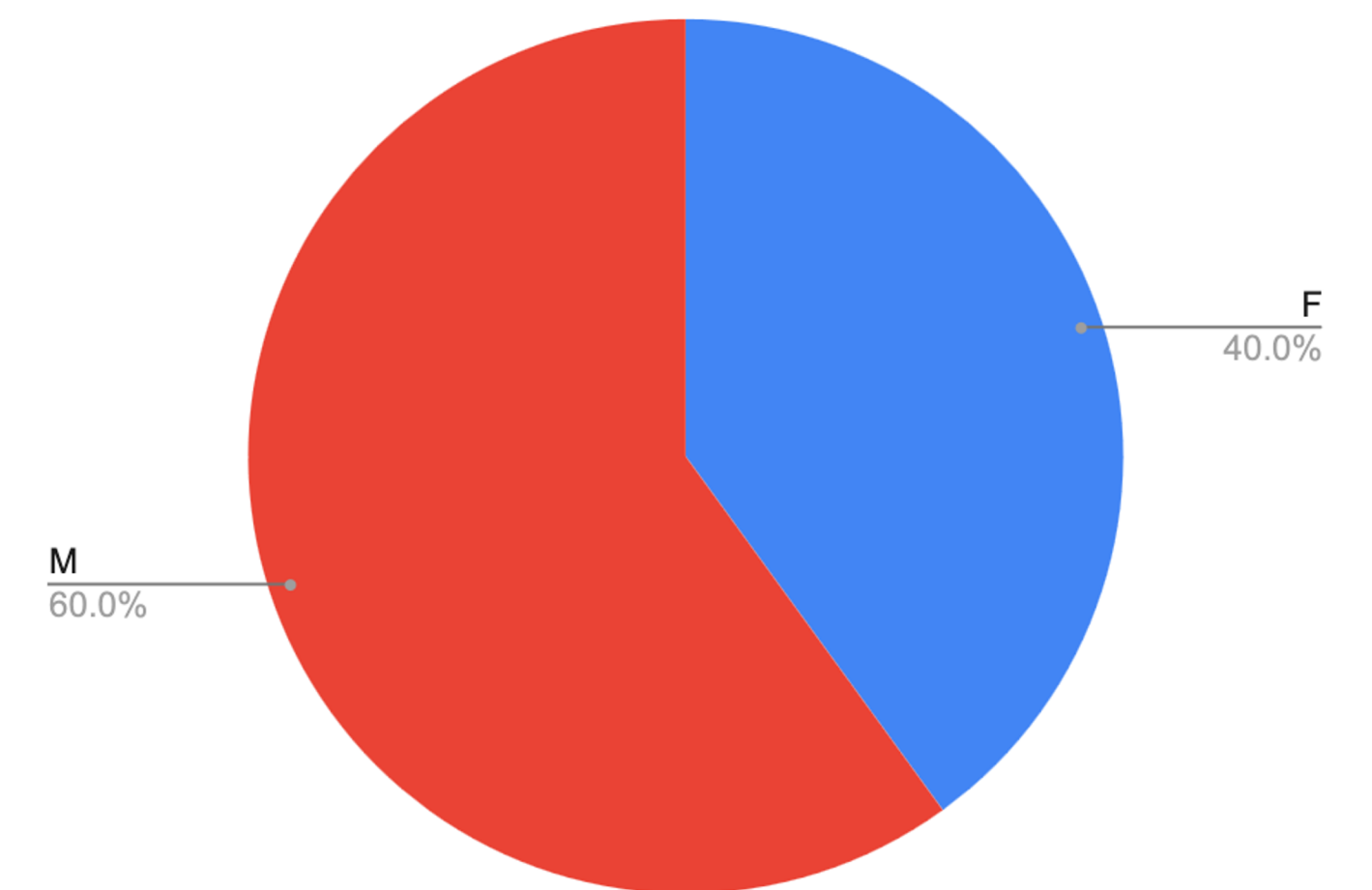
Count of Country



Count of Region

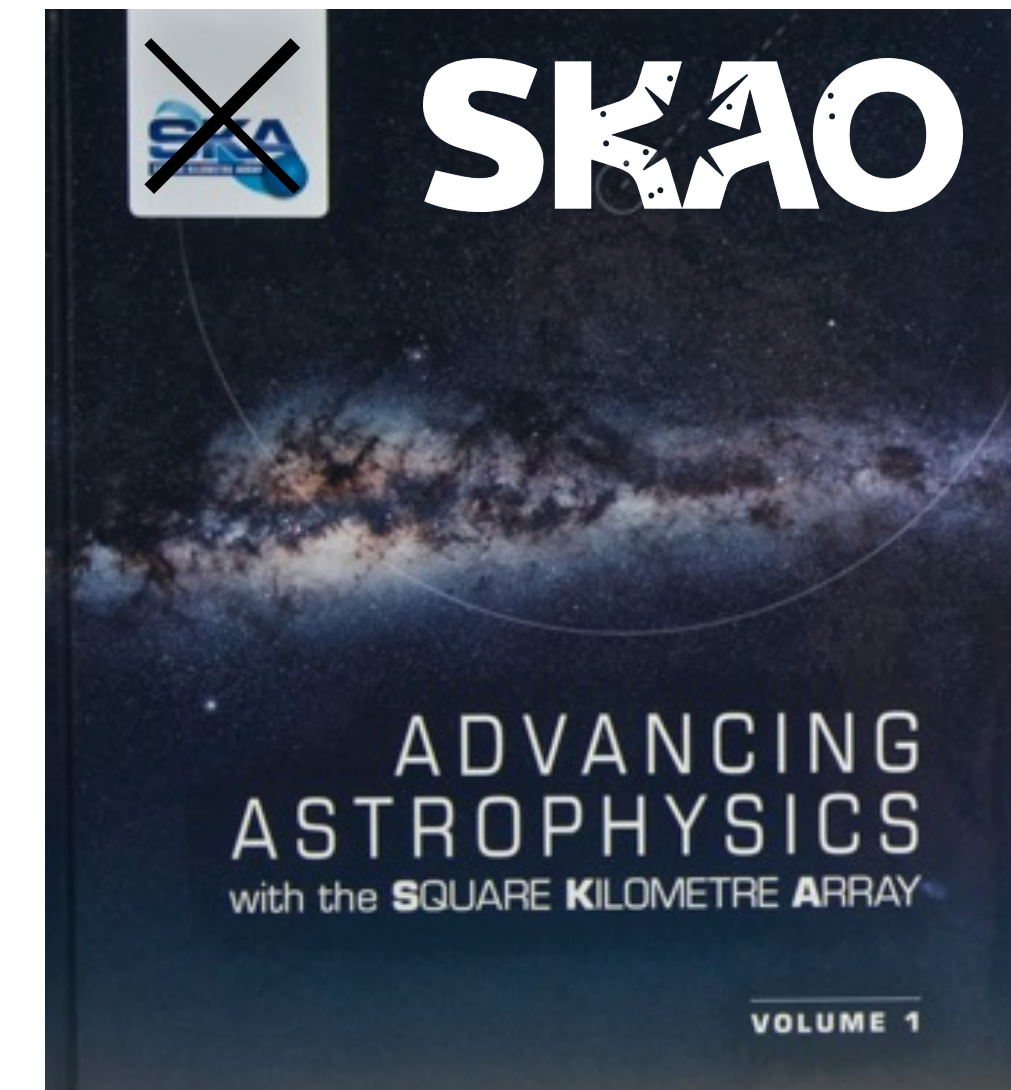


Count of Gender



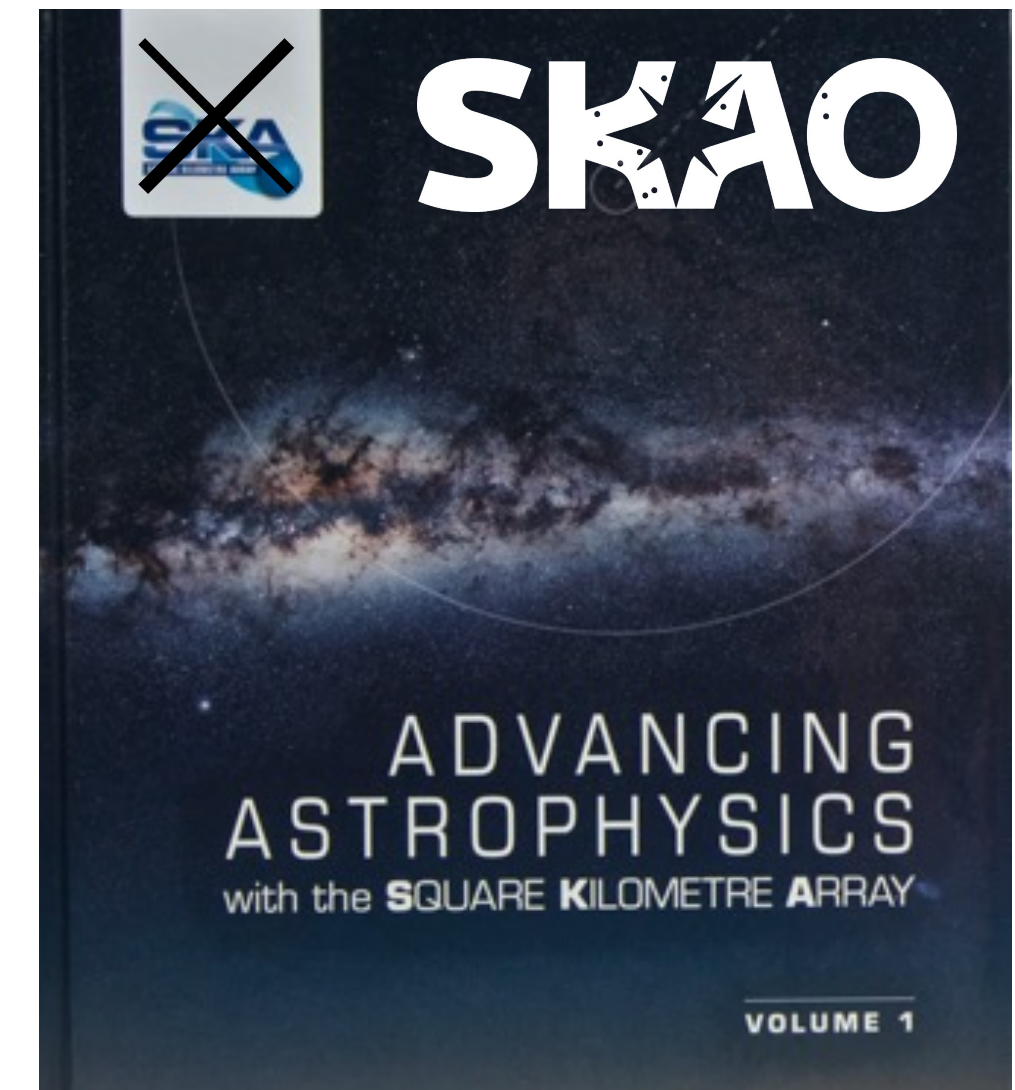
SKA Science Book

- Propose to make a general update of SKA Science Book part of the 2025 meeting process 2014: <https://pos.sissa.it/215/>
- Invite draft chapter submissions from which the talks for the meeting programme will be assembled
- Can be updated chapters from 2014 or brand new, although fresh lead authors will be encouraged throughout
- Submission period of five months (September to January)
- Propose to use [Oxford Abstracts](#) for submissions
- Final chapter submissions and peer review will take place in the second half of 2025
- Possibility of some hard copies of books - maybe split into science areas.
 - People might prefer to access online. Also environmental impact of physical book.
- Book name suggestions welcome!



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- Invite draft chapter submissions from which the talks for the meeting programme will be assembled
- Propose to coordinate submissions primarily through SWGs
 - Newer SWGs might like to share an open call
 - Aiming to encourage new members and new participation within SWGs
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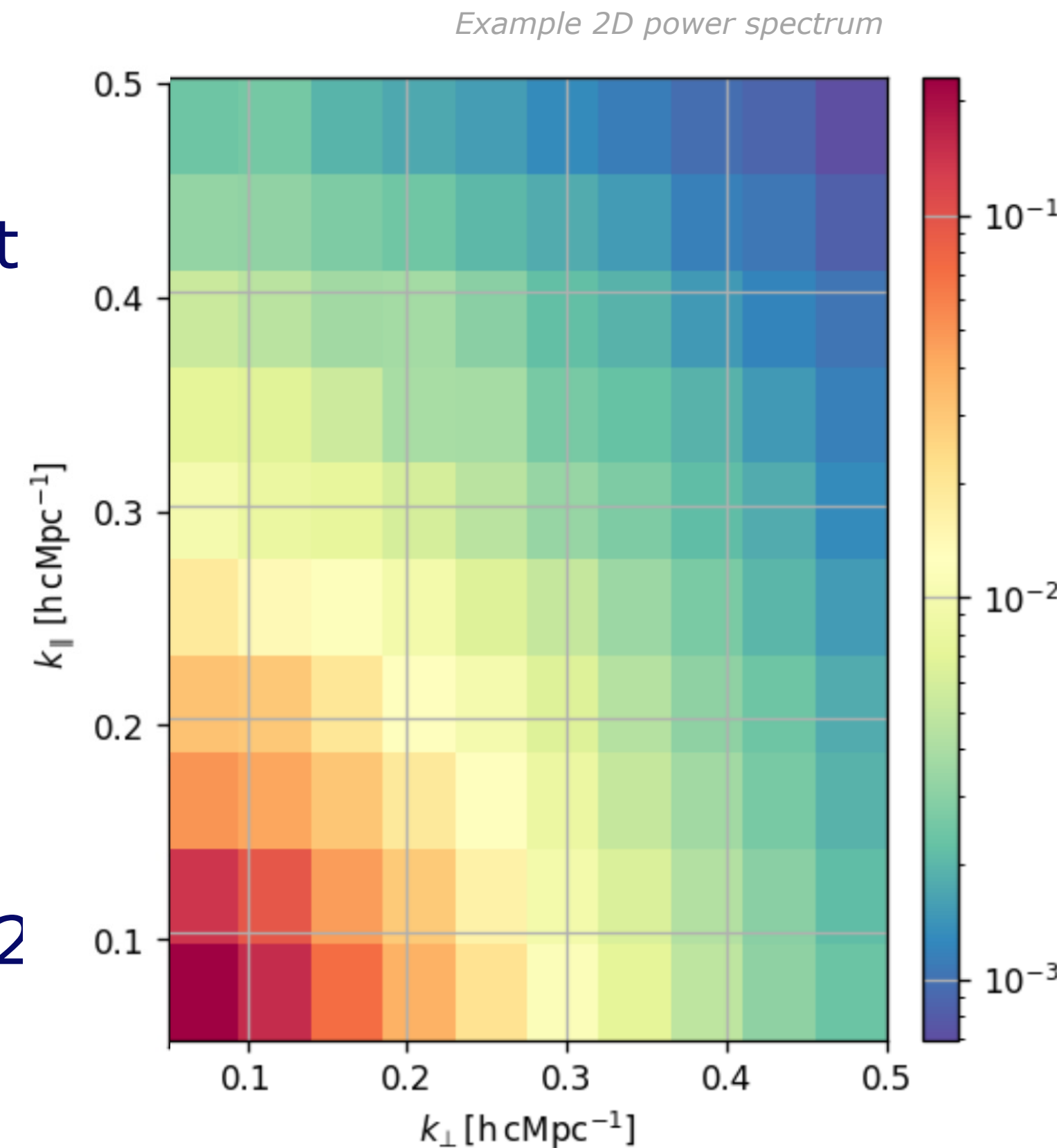
SKAO Operations: Observing with SKAO

- Half day of plenary sessions dedicated to “Observing with the SKAO”
 - detailed telescope capabilities
 - operational policies
 - The user experience (tools, SRCNet etc)
 - Timeline to science (SV, cycle 0)
- SKAO Operations team will also hold interactive sessions with each SWG
 - Tailored capability presentations and Q&A sessions



Science Data Challenge 3b: EoR Inference

- The datasets:
 - The data for the SDC3 Inference challenge will consist of two datasets, for two different EoR reionization models EoR1 and EoR2:
 - Power spectra of EoR1 + noise + SKA-Low telescope simulation for 3 (TBC) frequencies ranges, each corresponding to a redshift interval within the possible reionization history.
 - Power spectra of EoR2 + noise + foreground residuals + SKA-Low telescope simulation for 3 (TBC) frequencies, each corresponding to a redshift interval within the possible reionization history.
 - Power spectra will be cylindrical (2D) power spectra. Dataset 1 will allow testing of the intrinsic performance of the EoR inference codes in the absence of any bias in the data. Dataset 2 will investigate the robustness of the approaches against foreground residuals.
 - A further, image-based, power spectrum can be supported pending feedback



Science Data Challenge 3b: EoR Inference

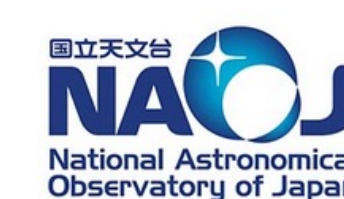
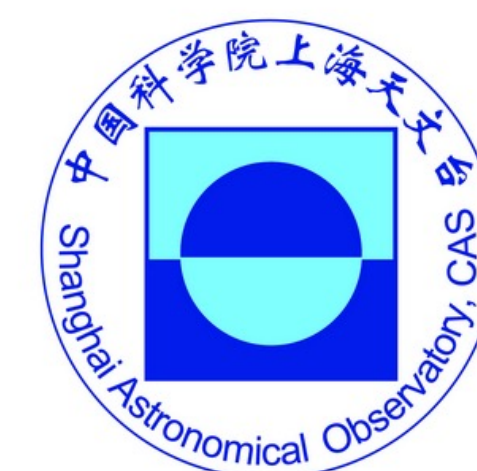
- The challenge:
 - Infer the reionization properties of the Universe from power spectra of the hydrogen-21cm signal from the Epoch of Reionisation corresponding to different redshift ranges.
 - Challenge will involve more than one code to simulate the EoR signal, thus allowing us to start investigating the intrinsic differences in the physical modelling of the EoR.
 - Submission will consist of inferred reionization fraction of the Universe for all the redshifts for which power spectra have been provided, and the associated uncertainty.
- Computational support
 - SDC3 receives generous support from our international HPC partner facilities, who will provide computational resources to teams for processing the challenge data.



ASTRON



CSIC



Science Data Challenge 3b: EoR Inference

- Status:
 - HPC resources currently being matched to teams who have requested computational support
 - Final SDC3b datasets in production
 - SDC3b 'data description document' in preparation



SWG Collaboration Facilitation

- Confluence
 - Provides a 'wiki' style solution to support information storage and sharing for multiple groups under one umbrella
 - Proof of concept tests completed by SKAO IT team
 - Next steps:
 - Propose to give access to co-chairs for testing and setting up SWG areas
 - Then roll out to all SWG members
 - Propose to give edit access to core SWG members only
 - Core group set-up/refresh might be required



Reminders

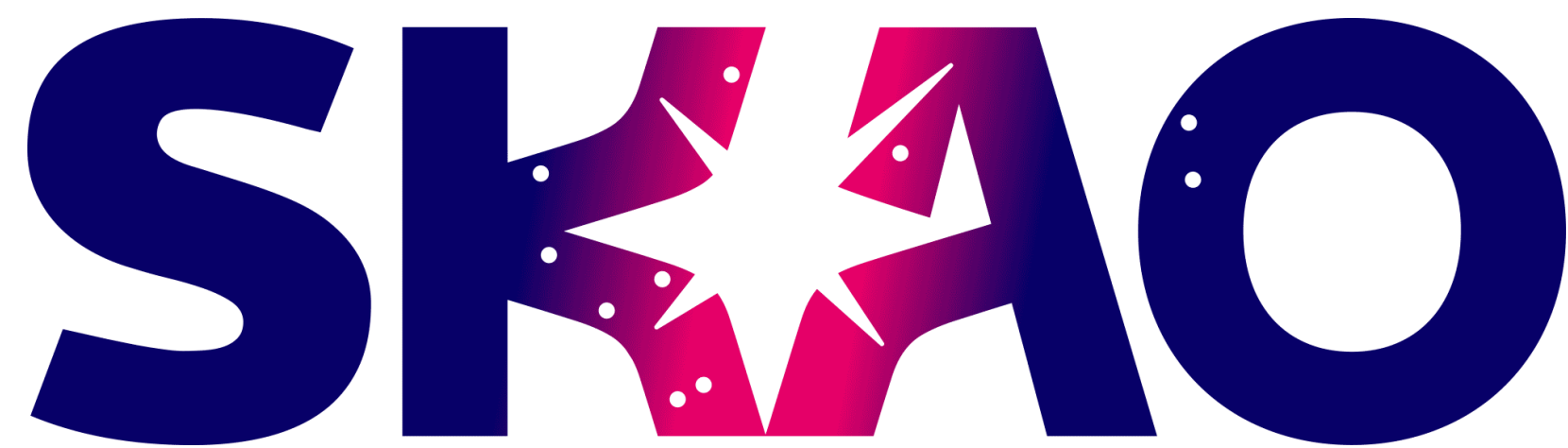
Outreach & Engagement

- **CONTACT** is the SKAO magazine aimed at the entire SKA community
- Ideas for articles for CONTACT are always welcome (email Tyler). These include:
 - Let's Talk About (Feature length ... science focussed)
 - Pathfinders & precursors. Short pieces on recent results
 - SKA-related events (e.g. SPARCS, etc)
 - any other news of SKA relevance (award/honours, job openings, ...)
- Encourage your SWG members to [sign up](#)



SKA Positions

- SKAO positions (HQ Manchester UK, Australia-Low, South Africa-Mid) [LINK](#)
- SARAQ employee SKA positions (Cape Town, Canarvon) [LINK](#)
- CSIRO employee SKA positions (Perth, Geraldton) [LINK](#)



SKA Speaker Series

- SKA Speaker Series

- series of interesting talks, accessible to all within the broader SKA community, covering a wide range of topics, from astronomy to physics, engineering, big data and computing, EDI, and more.
- Encourage your SWG members to sign up to give a talk (and consider giving a talk yourself).
- Talks recorded – all available for reviewing via the [Speaker Series](#) page (2020+)



SKAO Speaker Series

My personal journey as a female astronomer of colour



Cherry Ng

Permanent Astronomer
Centre National de la Recherche Scientifique (CNRS)
Laboratoire de Physique et Chimie de l'Environnement et de l'Espace (LPC2E)
Orléans, France

This talk is a collection of reflections on my career: from X-ray binaries to exoplanets, from pulsars to Fast Radio Bursts and SETI; on the challenges of motherhood and how it shapes my personality, and on the search for my cultural identity moving through six countries.

Wednesday 13 March 2024

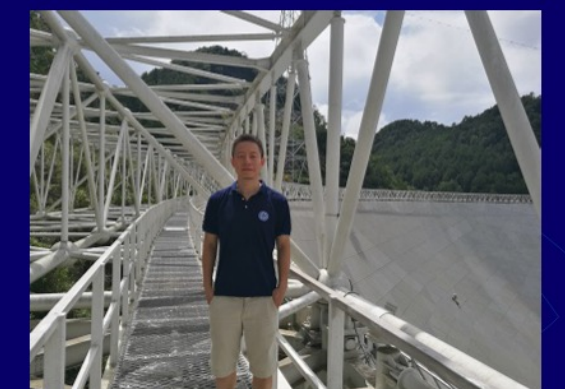
10.00am UTC

[Click to access the Speaker Series talk here](#)



SKAO Speaker Series

Establishing an Evolutionary Picture of Fast Radio Bursts



Di Li

Chief Scientist - FAST

With FAST, the largest single-dish telescope ever built, we have designed the Commensal Radio Astronomy FAST Survey (CRAFTS), which realizes, for the first time at any major facility, simultaneous data recording of pulsar search, HI imaging, HI galaxies, and transients (FRB and SETI). CRAFTS has discovered ~200 pulsars, ~10 FRBs including the only persistently active repeater FRB 20190520B, and ~5000 d² HI images with 1% calibration consistency, 5-10 times better than what is available from Arecibo.

Based on CRAFTS, we derived a FRB event rate ~ 120K per day per 4pi. We find universal frequency-dependent depolarization among repeating FRBs, which can be well fitted by multi-path scattering and a single free parameter sigma_RM that described the complexity of the magnetized environments of FRBs. We have published in 2021 the first complete energy distribution toward any FRB, which is clearly bimodal between 10³⁷ and 10⁴⁰ erg. Such bimodality was borne out in the subsequent monitoring of active repeaters. Recently, 10% drop of FRB 121102's DM on a decade time scale, is being robustly detected. I am proposing an evolutionary picture of FRBs, which aims to unify not only repeating FRBs, but most if not all non-repeaters.

Tuesday 23 April 2024

11.00am UTC (12noon BST)

[Click to access the Speaker Series talk here](#)



Any Other Business

- News from SWG Chairs?
- ...

We recognise and acknowledge the Indigenous peoples and cultures that have traditionally lived on the lands on which our facilities are located.



www.skao.int

www.skao.int/en/science-users