

SKAO

SKA SWG Update

Robert Braun, SKAO Science Director

15 October 2024



SKA Science Update

Start Recording!

- Construction Update
- Science Data Challenge 3b (Anna)
- 2025 SKA Science Meeting (Wendy)
- SWG Survey Results (Tyler) Will cover next meeting
- Reminders & Information
- AOB



Construction Update: Low

- AA0.5 Construction Status:
 - S8-1 and S8-6 handed over to sAIV (system Assembly Integration and Verification)
 - S9-2 tested and site audit under way, tentative handover to sAIV next Friday (Oct 25th)
 - S10-3 final equipment heading to site tomorrow. Testing commencing next week with tentative handover Nov 1st.
- AA1 Construction Status :
 - Antenna deployment at S8-2 and S10-5 complete. S8-3 deployment underway.
 - Antenna deliveries continuing to come in.
 - 10 SPS (Signal Processing System) sub-racks at the EOC and under test 15 more arriving soon. All AA1 SPS hardware will be deployed as soon as practical with the goal of testing the S8 RPF (Remote Processing Facility) fully loaded approximately in November.
- Product Deployment:
 - Antennas: All 1024 antennas assembled and deployed for AA0.5. ~600 AA1 antennas deployed making a total of ~1600 antennas
 - PaSD (Power and Signal Distribution): 92 of 96 Smart Boxes deployed (Remaining 4 Smart Boxes to be deployed next week)
 - SPS: All 8 AA0.5 SPS Sub-racks deployed
- Major change in SKA-Low roll out strategy coming via ECP to mitigate CPF (Central Processing Facility) delay - **more next month on this, but positive impact on AA2 science capabilities**



Construction Update: Mid

- Three dish structures delivered to site so far; three more due in November
- Preparing for delivery of MID Correlator Beam Former (AA0.5) and maser later this year and early next year
- Continuing strong progress on the infrastructure rollout
- Band 5 feed and Band 4/5 Receiver procurements closing end of month



Construction Update: Software

- Status of AA0.5 Software:
 - AA0.5 control system able to implement high level state machine commands and status reporting
 - Pending for SKA-Low: Progress being made to implement station pointing and tracking as part of achieving multi station interferometry-due end of PI24 (Dec 2024)
 - Pending for SKA-Mid: Enabled Pointing calibration and Holography modes but not implemented - due end of Q1 2025.
 - Data product sub-systems for AA0.5 are largely ready (with SDP (Science Data Processing) integrated and PST (pulsar timing) soon to be integrated to enable tied array beamforming mode).
 - All OSO (Observatory Science Operations) tools needed for AA0.5 are delivered.
- Status of AA1, AA2+Software:
 - AA1 subsystems functionality uplifts underway
 - Anticipated hardware limitations for AA2+ delivery at scale
 - PSS and PST are lower risk but have not been reviewed yet.
 - OSO tools at various stages of maturity for the different Array Assemblies



SKA Science Data Challenge 3b

EoR Inference

*the first step in bringing together the global
21cm interpretation community*

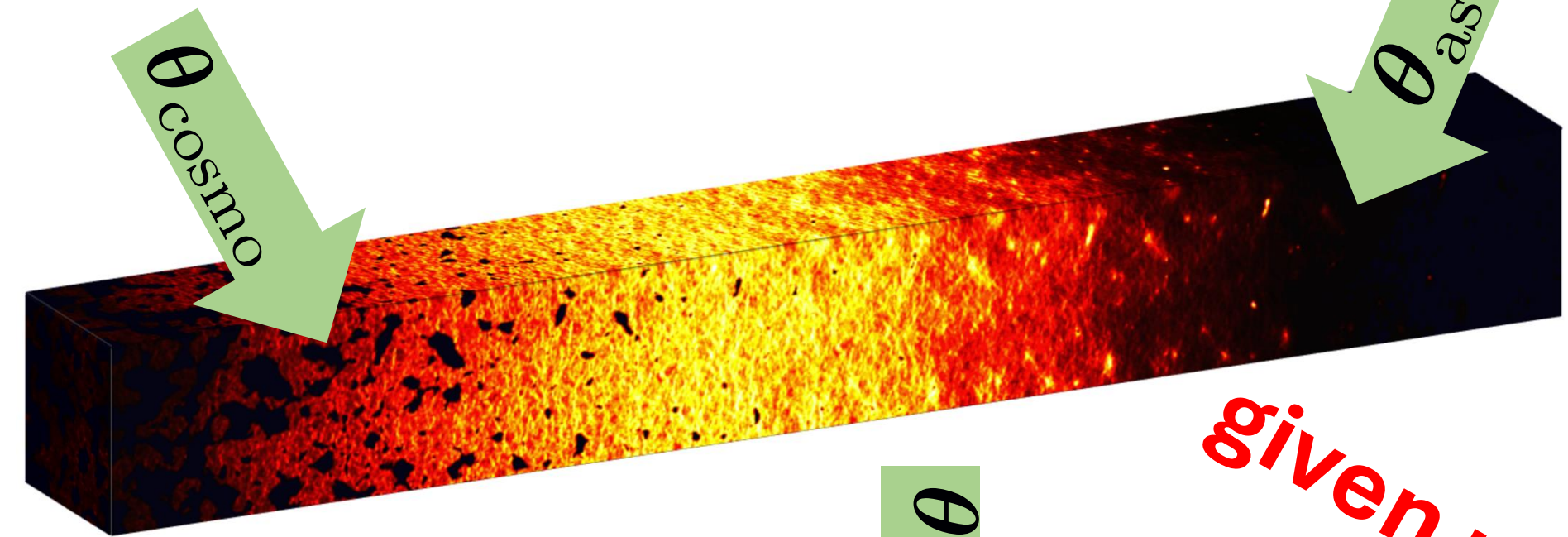


GIVEN
Cosmology

Simulation

Astrophysics

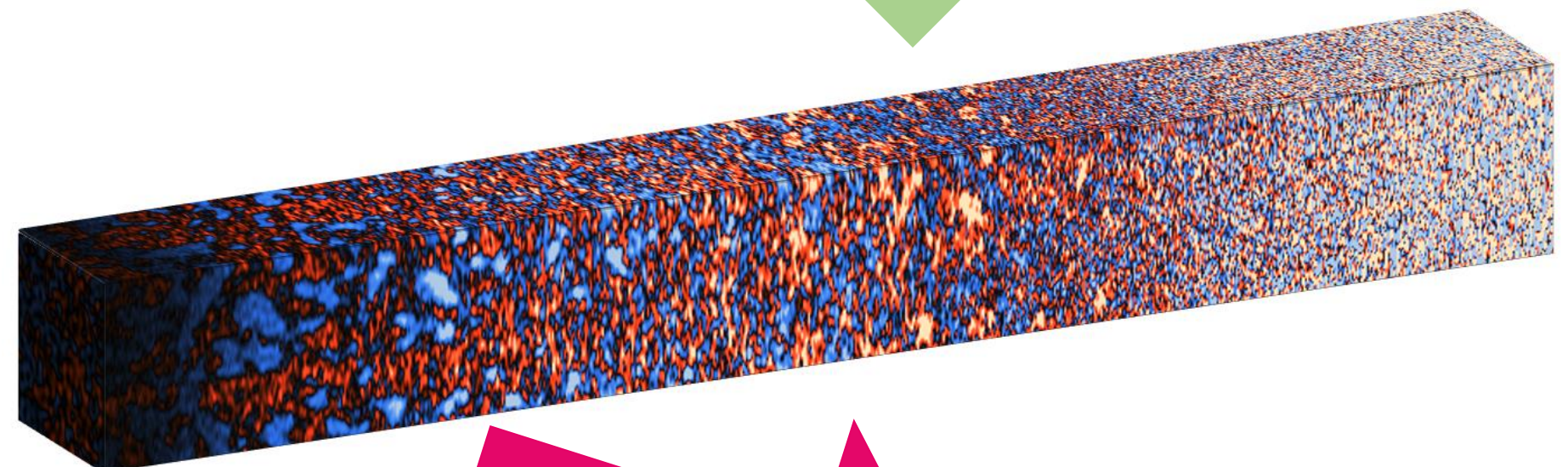
Observation



$\theta_{\text{telescope}}$

Telescope simulator

given noise PS (tbc)



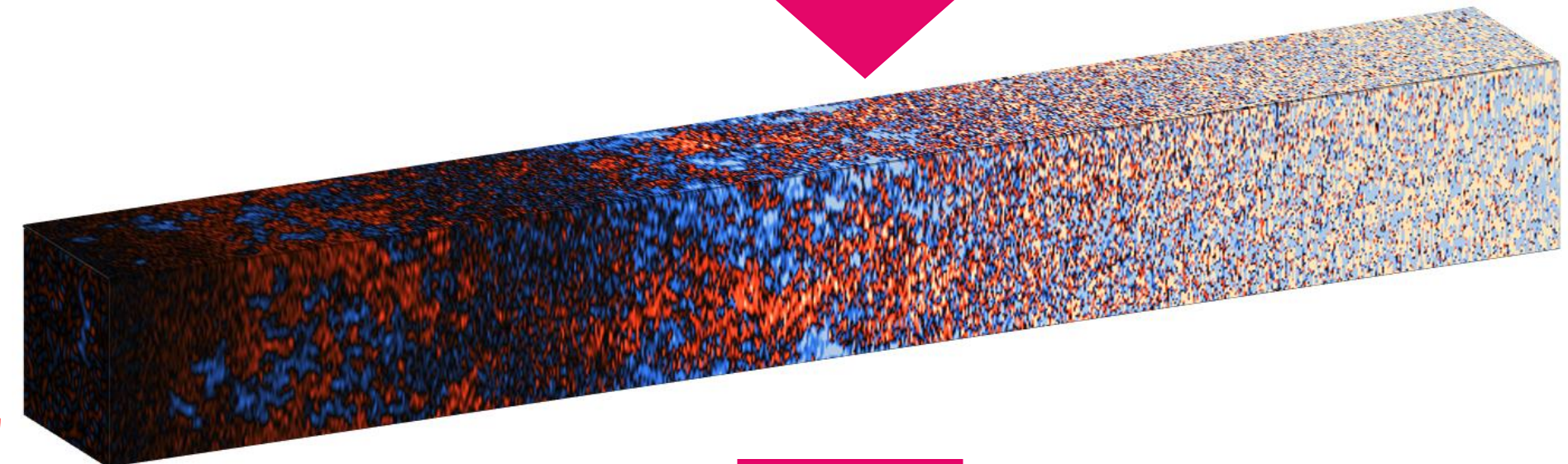
Compression

sim 2D PS

Likelihood (analytic / LFI)

$P(x_{\text{HI}}(z) | \text{data 2D PS})$

Cleaning (backward modeling)



Compression

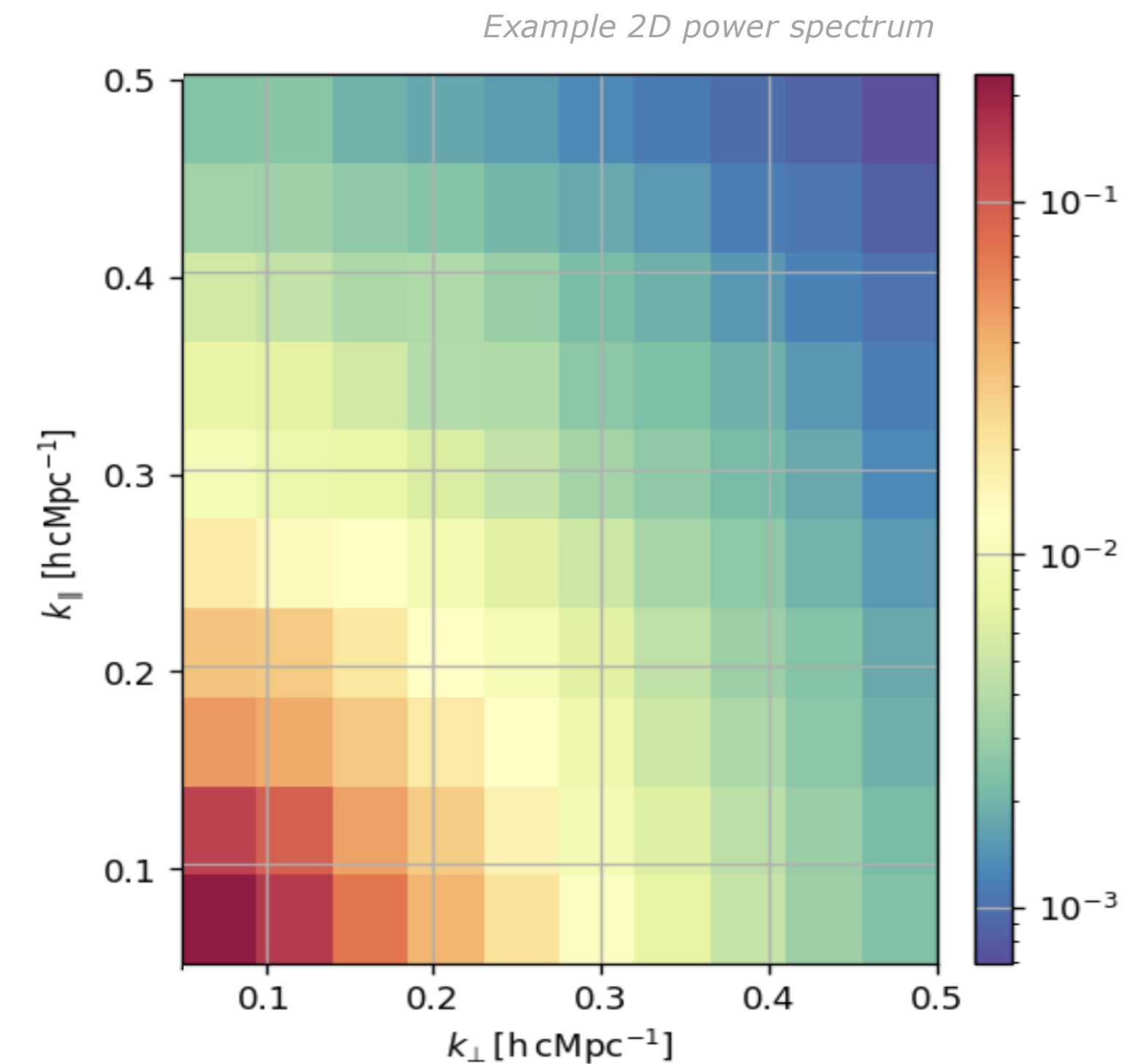
data 2D PS

slide courtesy of A. Mesinger



Science Data Challenge 3b: EoR Inference

- Inference of reionization fraction for EoR
 - 2D power spectra
 - Imaging cubes
- Two simulators used: 21cmfast and C2ray
- Power spectra sets:
 - PS1, PS2: EoR + noise, different simulator and different astrophysical parameters
 - Investigation of effect of different EoR simulators
 - PS3: EoR + noise + residual foreground contamination (TBC)
 - Investigation of effect of residual foreground contamination
- Imaging set (TBC)
 - IM1: EoR + noise + residual foreground contamination
 - Investigation of effect of residual foreground contamination on image-based inference techniques

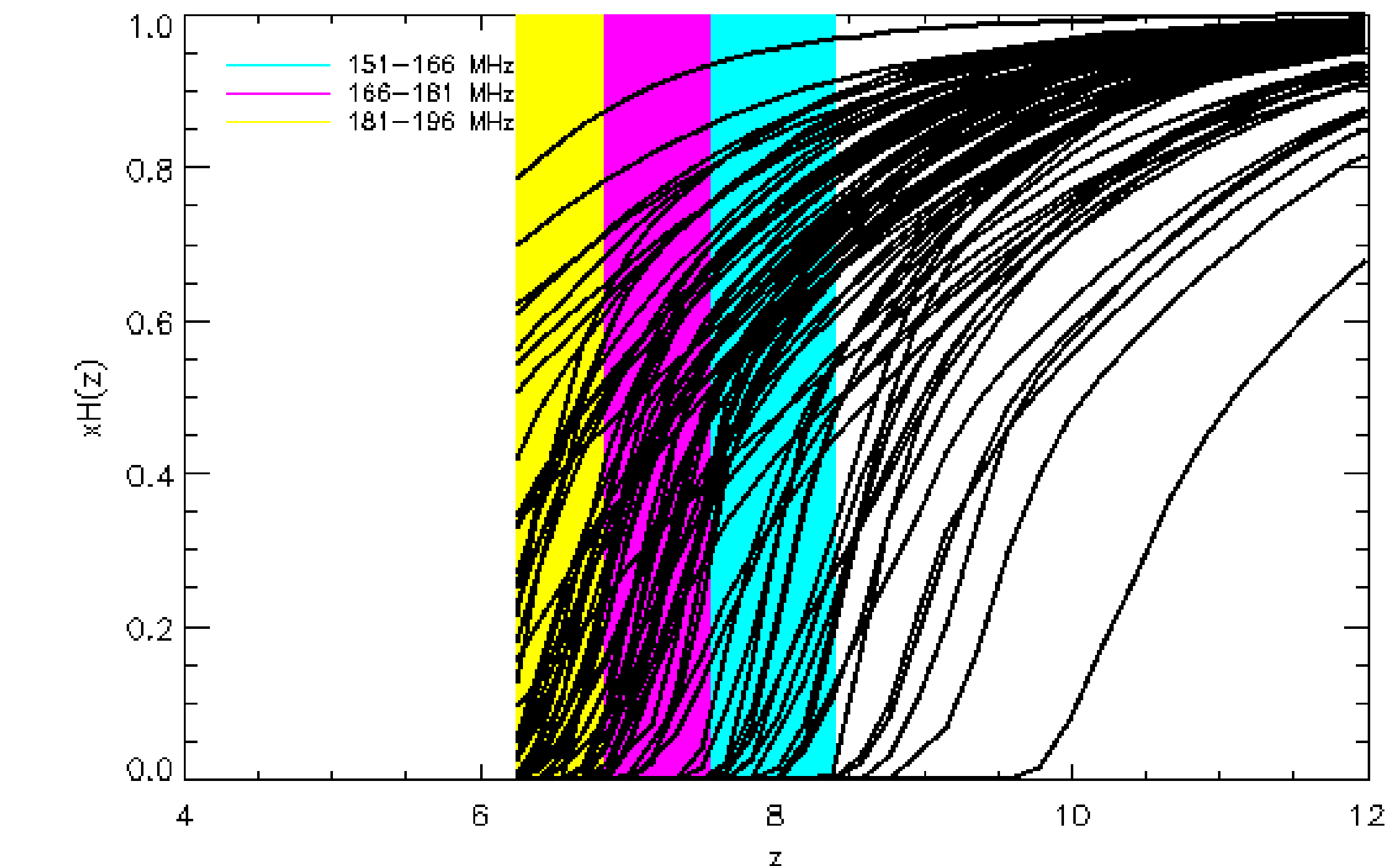
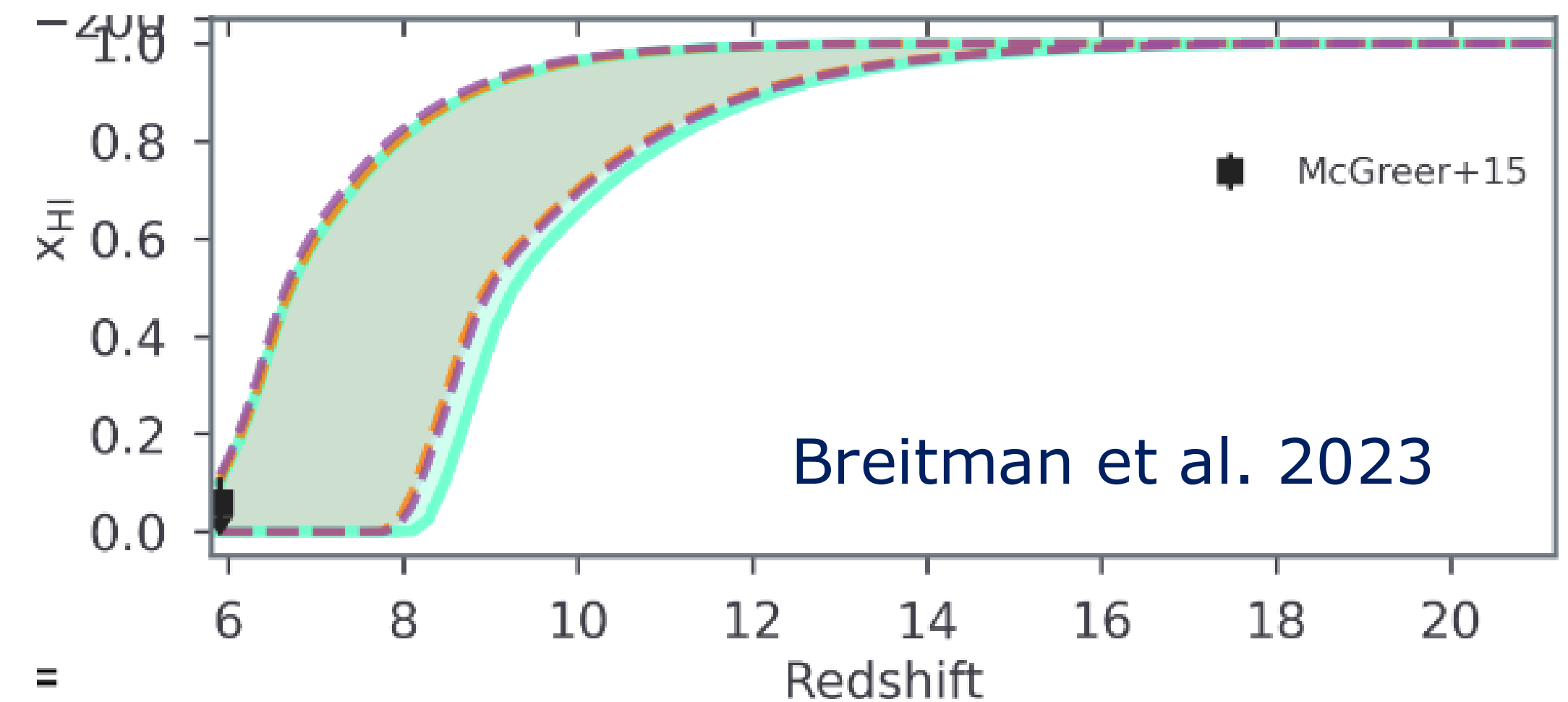


**PS1, PS2
released
today!**



Science Data Challenge 3b: EoR Inference

- Frequency range 151-196 MHz, ($z=6.25-8.4$) where models display large variance
- Three 15 MHz frequency ranges:
 - 151-166 MHz ($z=8.41-7.56$)
 - 166-181 MHz ($z=7.56-6.85$)
 - 181-196 MHz ($z=6.85-6.25$)
- Evolution is present within the 15 MHz frequency range
- 100 h integration for PS sets PS1, PS2, PS3
- 1000 h (TBC) for imaging set IM1
- Ancillary: Average noise bias from a set of 10 noise realisations



Science Data Challenge 3b: EoR Inference

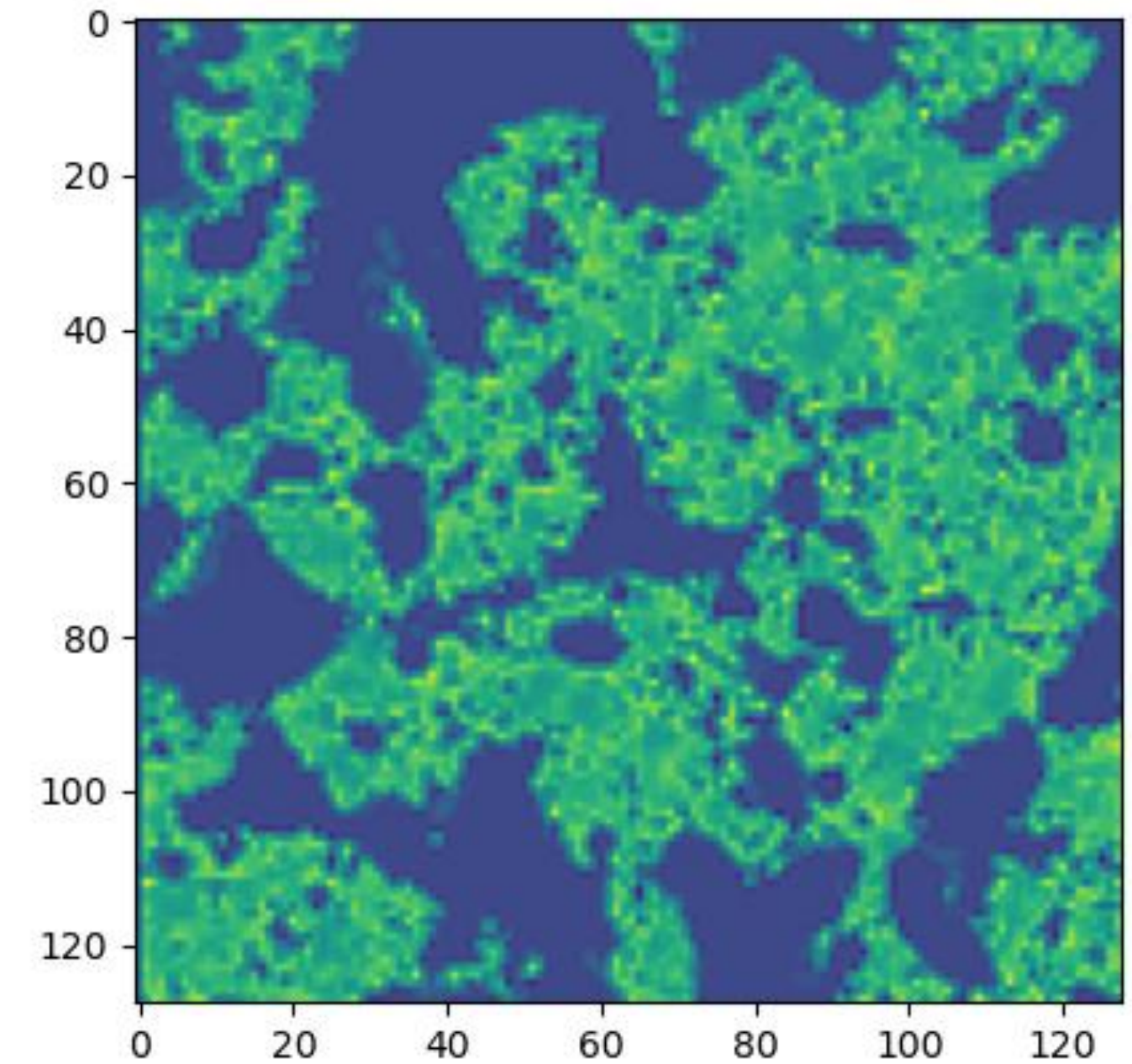
- 21cm simulation specs:
 - 700 x 700 cMpc on 350 X 350 box
 - Planck18 cosmology



21cmFast v4
(Davies, AM et al. in prep)



pyC2Ray
(Hirling, Bianco et al. 2024)



In collaboration with M. Bianco, James Davies, A. Mesinger, Sambit Giri, and the rest of [theory_challenge_skao](#) slack channel!

- Park+2019 astrophysical parametrization w. scatter
- Only ionizing radiation: $T_s \gg T_{\text{cmb}}$
- Vary BOTH astrophysical parameters AND simulators



Scoring

- For each data set, \mathbf{d}_i , submit posteriors, $\mathbf{p}(\mathbf{x}_{\text{HI}}(\mathbf{z}_1), \mathbf{x}_{\text{HI}}(\mathbf{z}_2), \mathbf{x}_{\text{HI}}(\mathbf{z}_3) \mid \mathbf{d}_i)$: a 3D array with pre-specified bins (tbc)
- Score of that data set will be the value of the *truth* in the posterior:

$$\mathbf{p}(\mathbf{x}^{\text{true}}(\mathbf{z}_1), \mathbf{x}^{\text{true}}(\mathbf{z}_2), \mathbf{x}^{\text{true}}(\mathbf{z}_3) \mid \mathbf{d}_i)$$

- Score is not important! Goal is international participation, and testing pipelines on “out-of-distribution” data.



Science Data Challenge 3b: EoR Inference

40 teams/53 methods have registered!

SDC3 receives generous support from our international HPC partner facilities, who will provide computational resources to teams for processing the challenge data.



SKAO Science Meeting and new Science Book



Coordination of book chapters

(see [Coordination of chapter submissions](#))

The coordination of chapter submissions is led by our SWG chairs: [thank you to all our chairs for dedicating your time and effort to this process](#)

Chapter Call Phase 1:

- Within SWGs: SWG chairs to invite abstracts describing intended
 - Aiming for full representation of a group's science, with updated versions of all chapters from Advancing Astrophysics 2015 included
 - [SWG only](#)
- Outside SWGs (see call for [Expressions of Interest](#)):
 - Within this call, authors were be requested to tag one or more relevant SWGs (or none, if brand new area).
 - Deadline date for abstracts: **September 30th**
 - 216 Submissions collated: [Oxford Abstracts](#)
- Please let WW know if you do not yet have access to the google sheets



Coordination of book chapters

(see [Coordination of chapter submissions](#))

Chapter Call Phase 2:

- SWG chairs will compile a list of chapter titles based on abstracts received (both internally and externally) and on internally-identified updates, evaluating for overlaps, duplication and any gaps.
 - Coordination between SWG chairs on overlaps
 - [SWG only](#)
 - [Oxford Abstracts](#) (many submissions indicated multiple SWGs)
 - [All submissions](#)
- Chairs to invite authors to prepare draft chapter manuscripts.
 - We encourage all viable science ideas to be submitted as chapters for the book; note that we are not bound at this stage by a maximum number of submissions.
 - At this stage we will request **advanced drafts** for submission
 - Full instructions for authors and a LaTeX template have been [shared](#)
 - Submissions to be made by draft authors to online submissions platform
 - Deadline date for advanced drafts: **February 28th**



Coordination of book chapters

(see [Coordination of chapter submissions](#))

Talk/poster selection in March 2025:

- The 2025 Science Meeting Scientific Organising Committee will select a set of draft chapters for presentation at the meeting.
- Authors invited to focus presentations on the early science opportunities from the first few years of Operations (AA*)
- Presentations to be given in the form of plenary talks, splinter session talks, and posters (accompanied by 'lightning' talks).

Final submissions and publishing

- Chapter reviewing will take place *after* the meeting
- SWG chairs to suggest reviewers for individual chapters
- Editing by SWG chairs and SKAO Science Team



SWG Survey – to be discussed next time



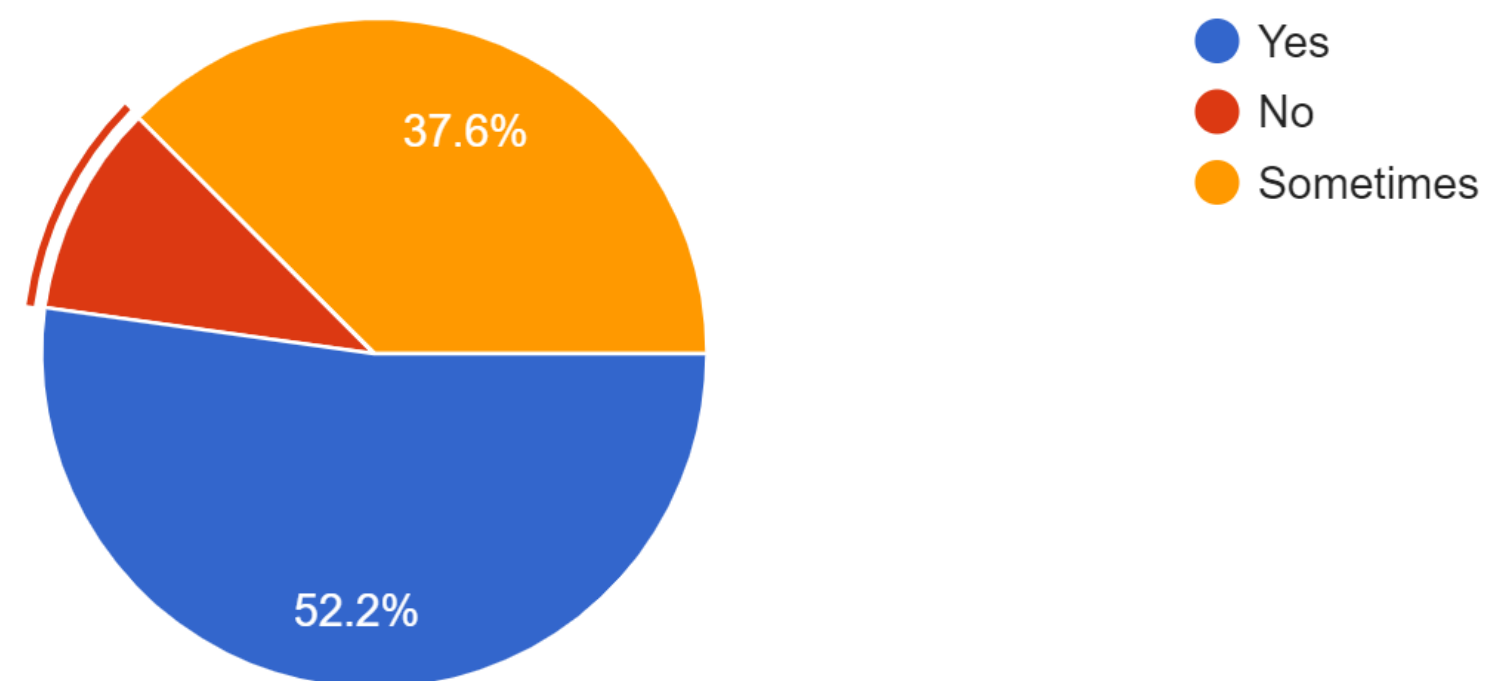
SKA SWG Survey

- Survey sent to swg-all in June 2024
- Aimed to gauge the current level of SKAO engagement with the science community
 - Is the current level of engagement working? (Section 1)
 - What other forms of engagement might we try? (Section 2)
- 205 responses (Thank you!)
- Feedback taken on board, now considering how to implement main recommendations

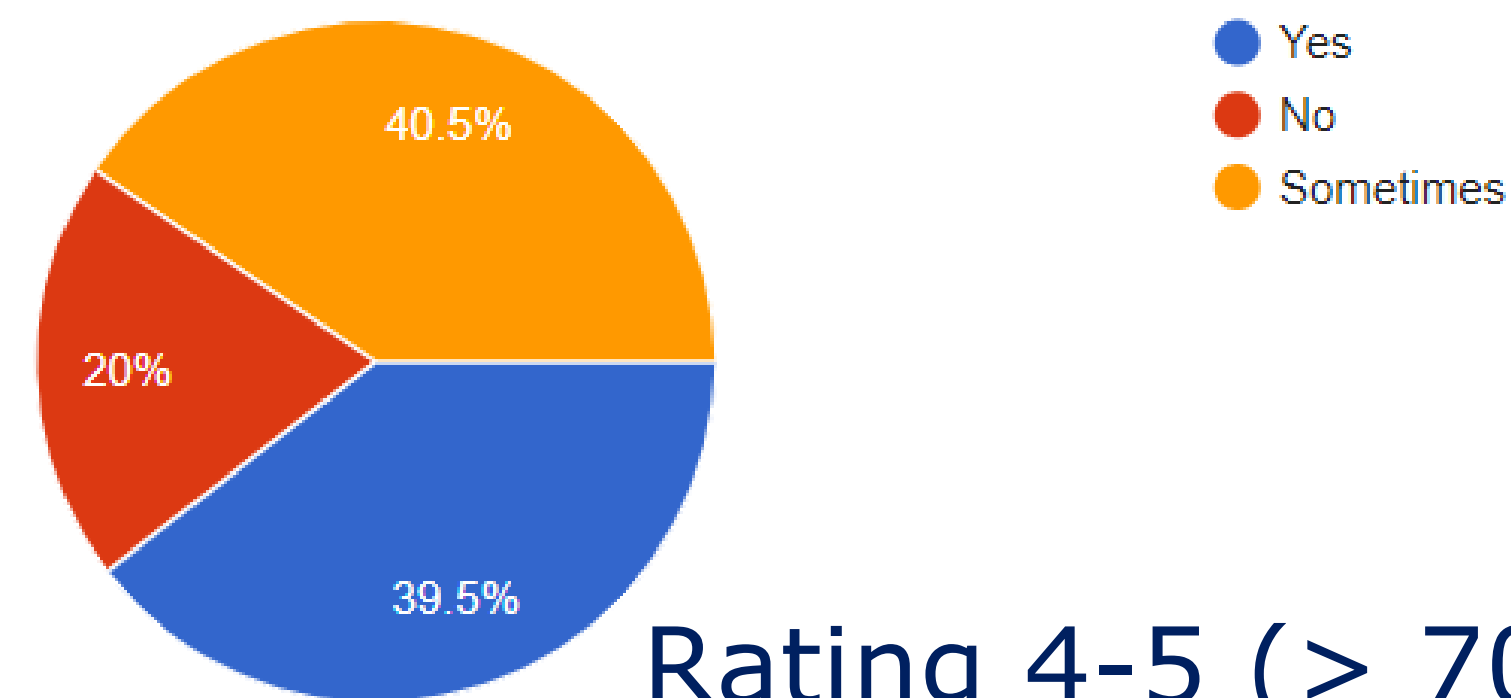


SKA SWG Survey

Do you usually open the monthly email?

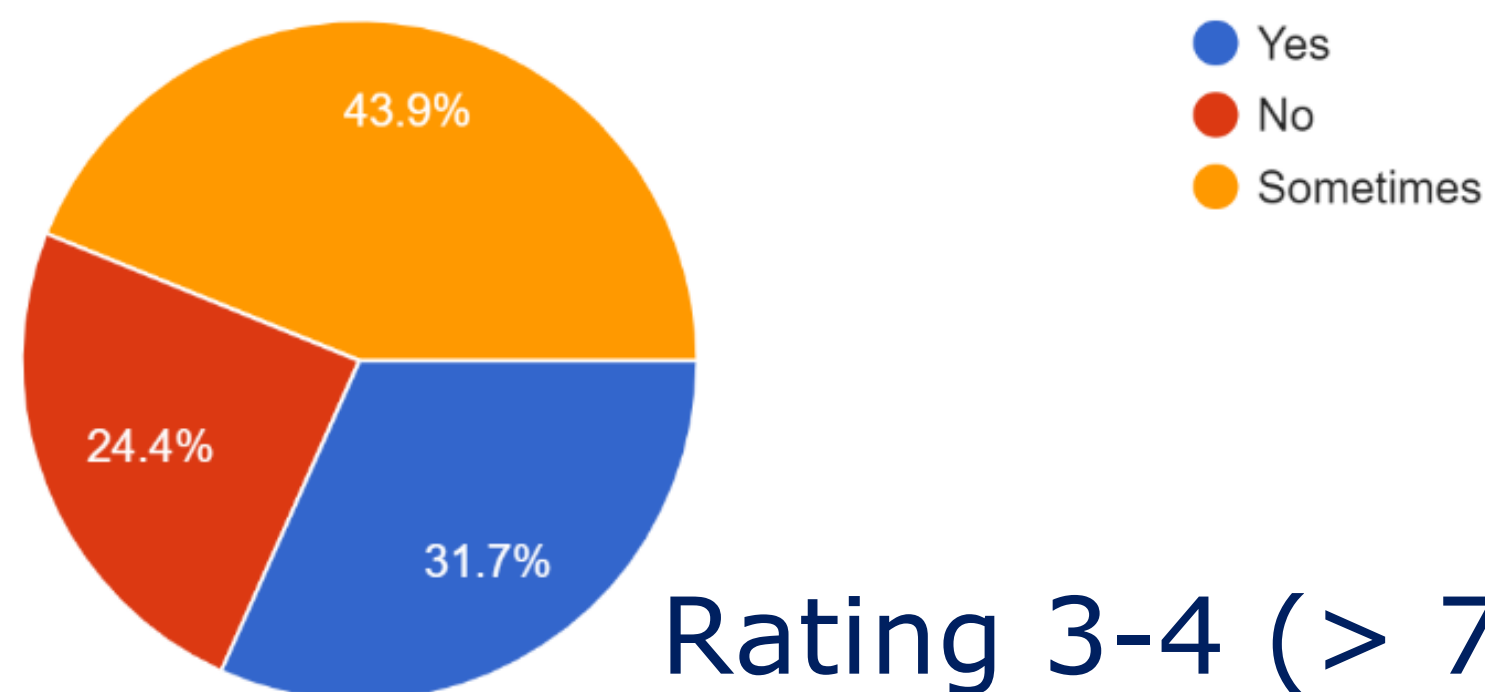


Do you usually view the slides?



Rating 4-5 (> 70%)

Do you usually read the minutes?



Rating 3-4 (> 70%)

Why not?

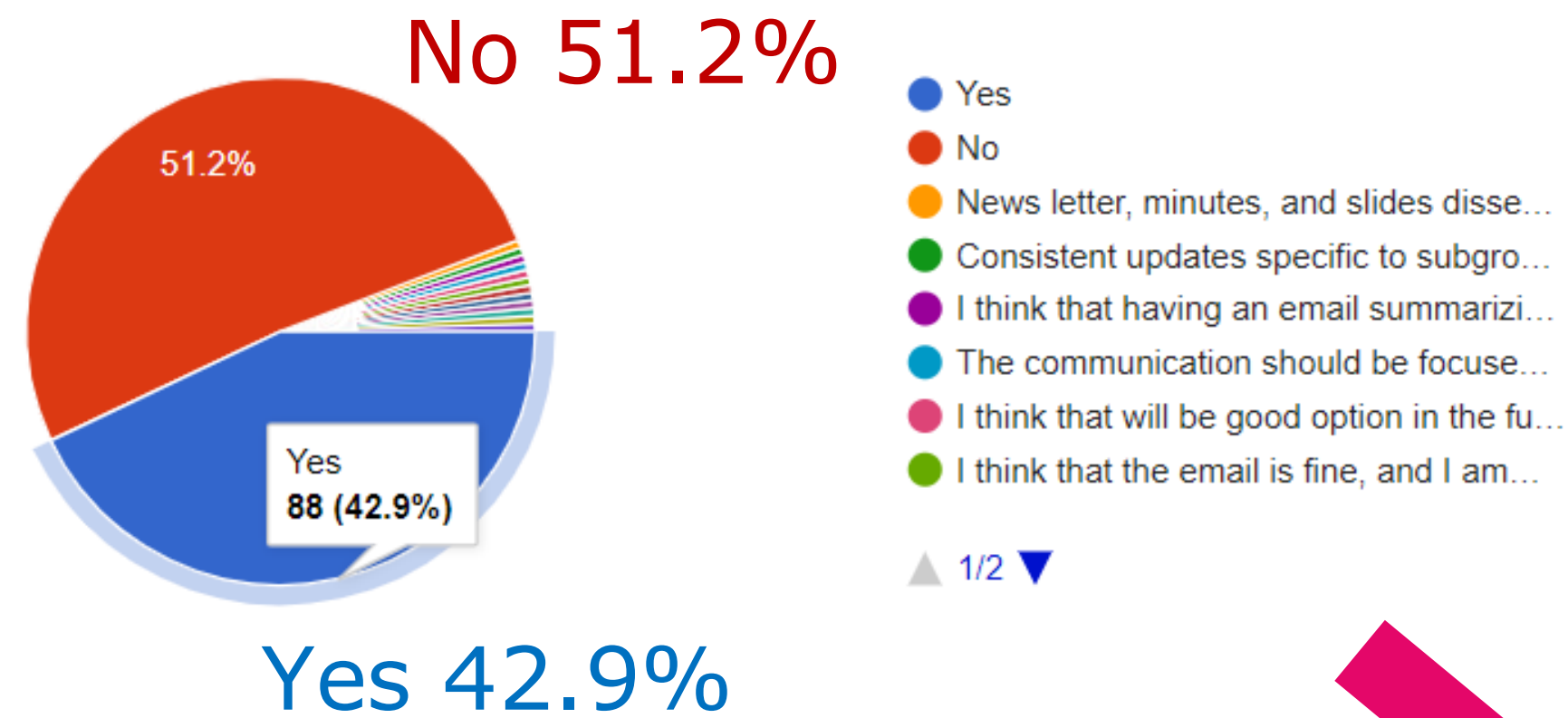
- lack of time ~75%
- not relevant ~28%
- not presented in accessible way ~15%

Main feedback: (1) provide more relevant information in body of the email, (2) include precursor/pathfinder science updates, (3) send out important news when available



SKA SWG Survey

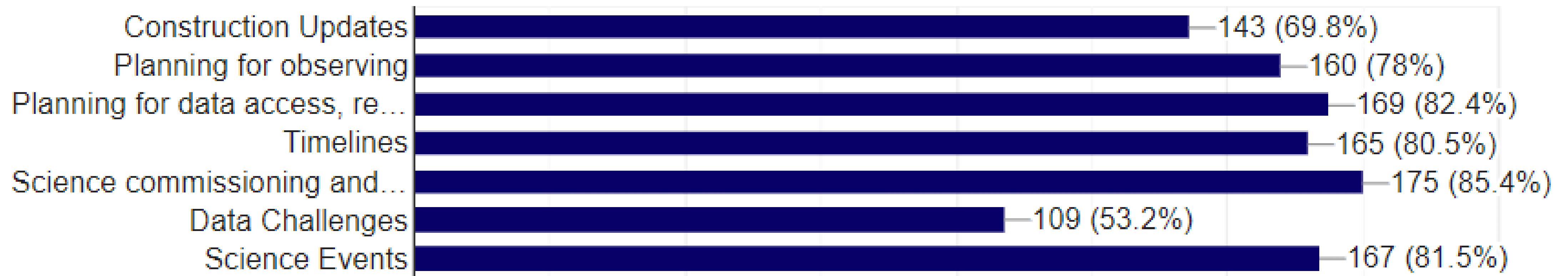
Would you prefer a more comprehensive newsletter?



Other suggestions for a newsletter:

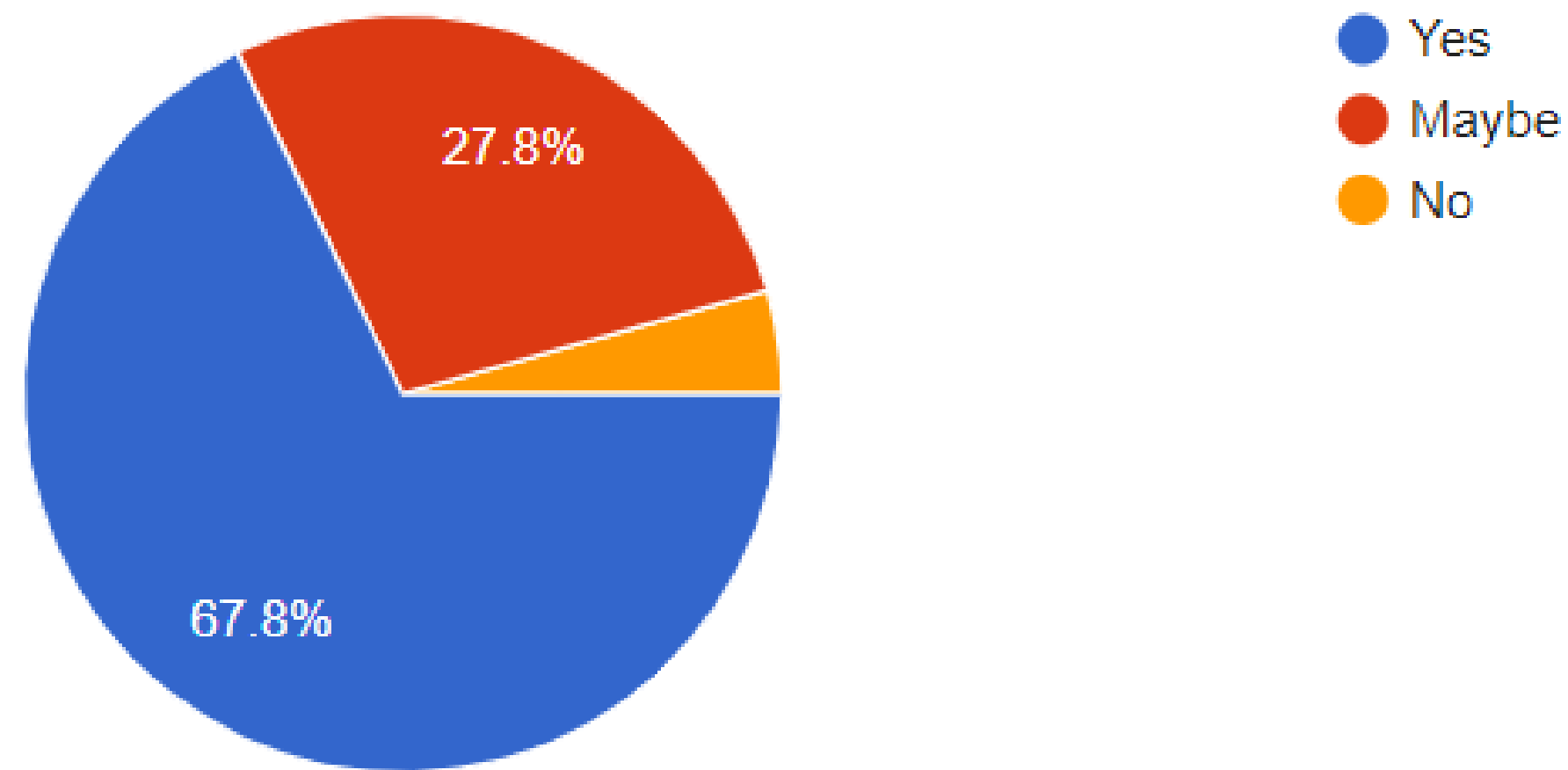
- Outreach events
- Training and support activities, workshops, collaborative information
- Science capabilities, less construction
- Plans on how to organise science teams
- Funding opportunities (consortium/individual)
- More clarity on design changes (e.g. SKA-Low)
- ESO-like

Which of the following topics would you like to hear about?



SKA SWG Survey

Would you be interested in a regular (twice/year) Webinar?



Please provide feedback on the Science Users webpages



Webinar Suggestions:

- Significant Q&A component
- Multiple times zones (repeat each webinar 2-3 times) and recorded
- Include updates from individual SWGs
- Science-led
- Science topics (KSPs, data,) not bulldozers
- Science capabilities
- Observing, data access, KSP planning, PI-led timelines

Webpages Feedback:

- Include info on data related topics (SDP, SRC, data access, pipelines, data products)
- Good! Tools are great!
- Precursor/pathfinder page?
- Summarise the technical information in one place (? Information sheets, landing page)



SKA SWG Survey

Feedback on SWGs:

- A few comments received on lack of information/engagement from and within the SWGs (we note that many SWGs are active and engaged)
- We (SKAO) rely on you, the SWG Chairs, to assist us with science engagement of the SKA community in your science areas
- Now is an opportunity for new chairs to set the tone for ongoing SWG engagement

From the Terms of Reference (link below), SWG Chairs are expected to:

- Organise and lead regular core member telecons (at least once every quarter)
- Facilitate the organisation of science-focused sub-groups
- Participate in the monthly SWG Chairs telecons, organised by SKAO
- Provide regular updates to their entire SWG, via the SWG mailing lists

Let's gooooooooo SKA!

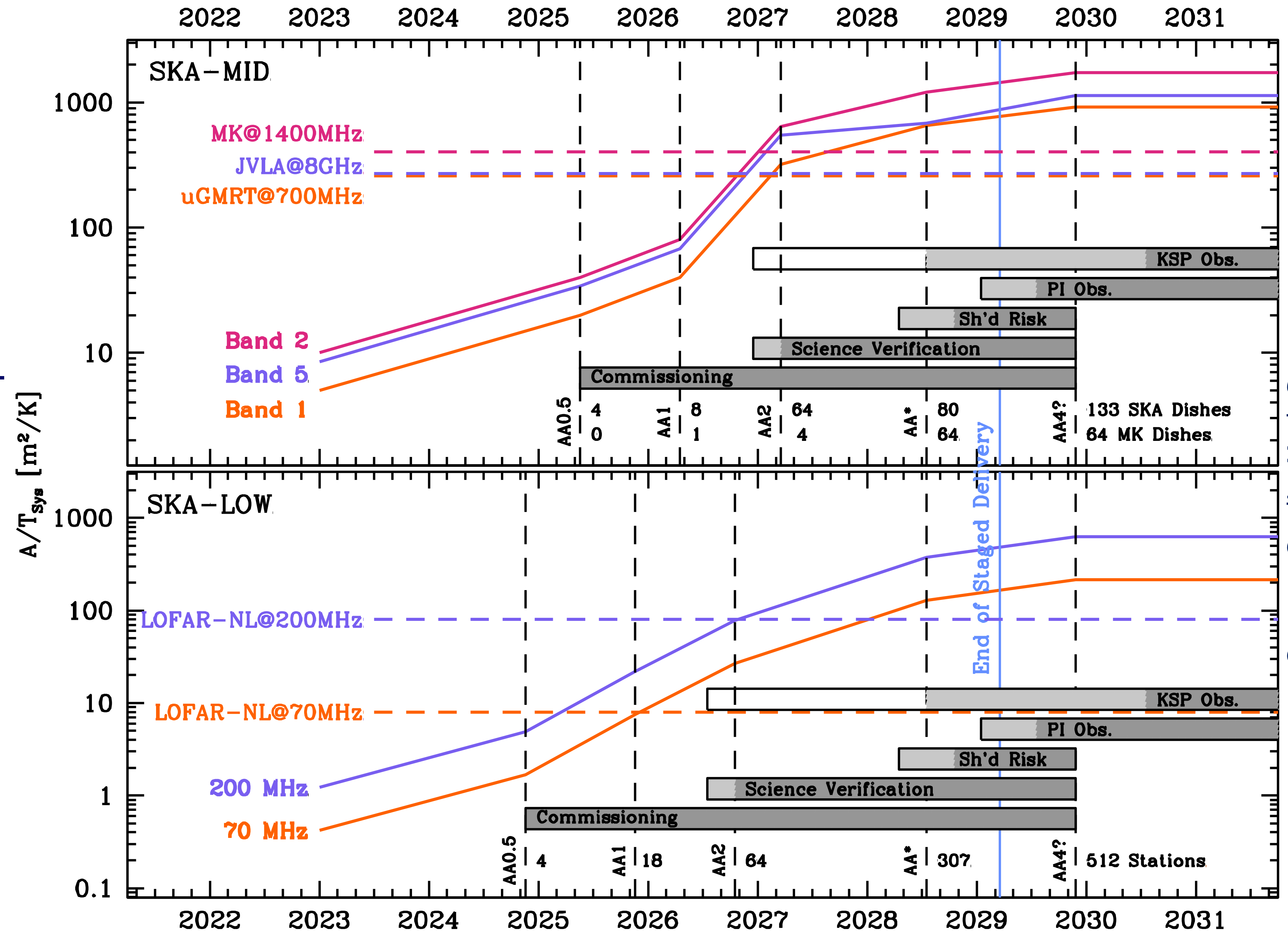




Reminders & Information

Commissioning Timeline

- AA0.5
 - Basic imaging and Tied-Array Beams
 - Off-line reduction
 - Limited BW/ N_{Chan}
- AA1
 - Plus multiple beams/sub-stations
- AA2
 - Plus pipeline reduction, more BW/ N_{Chan}
 - Science verification!
- AA*
 - Full BW, N_{Chan} , zooms
 - Shared Risk Cycle 0
 - PI (and KSP) Proposals!



Concept Credit: Mark Sargent



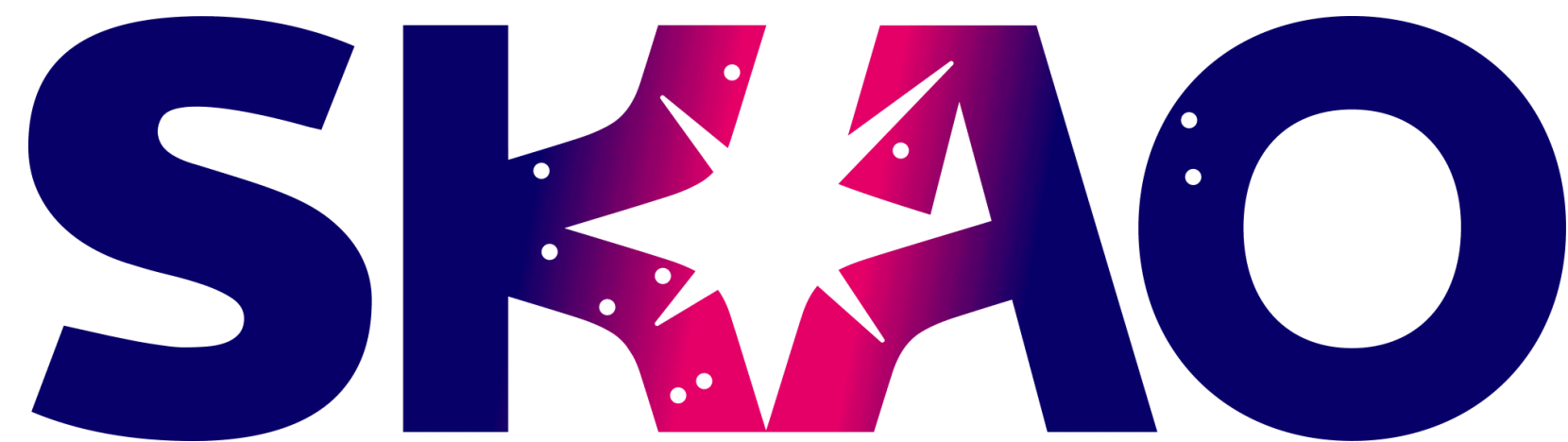
Outreach & Engagement

- **CONTACT** is the SKAO magazine aimed at the entire SKA community <https://www.skao.int/en/news-events/contact-skao-magazine>
- 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)
<https://recruitment.skao.int/vacancies.html>
- SARAQ employee SKA positions (Cape Town, Carnarvon)
<https://www.sarao.ac.za/vacancies/>
- CSIRO employee SKA positions (Perth, Geraldton)
<https://www.csiro.au/en/careers/career-opportunities/skao>

The SKAO logo features the letters 'SKAO' in a bold, dark blue font. The 'K' and 'A' are stylized with a red-to-white gradient and contain white starburst patterns.The logo for the South African Radio Astronomy Observatory (SARAQ). It features the word 'SARAQ' in a large, grey, sans-serif font. Below it, the full name 'South African Radio Astronomy Observatory' is written in a smaller, black, sans-serif font.

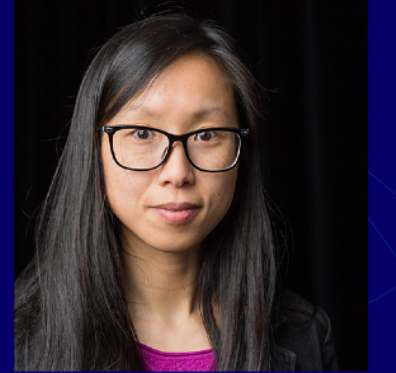
SKAO Speaker Series

- SKAO 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 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 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

SKAO Science Meeting and new Science Book – Extras



2025 Science Meeting: overview

- **Name:** Advancing Astrophysics II: Preparing for Science with the SKAO
- **Dates:** 16th-20nd June 2025
- **Location:** Görlitz, soon to be the home of the brand new German Center for Astrophysics (Deutsches Zentrum für Astrophysik, DZA)
- **Numbers:** In person: ~300 (Virtual attendance to be supported for all sessions)
- **Themes:**
 - *Noting the transition from SKAO commissioning to science verification and observing*
 - The science meeting will feature presentations from authors of the new SKA Science Book. **While the book will provide an up-to-date coverage of the science questions that will be addressed by AA4 (and beyond), at this meeting we will hear about the opportunities for early SKA science: presentations will focus on AA* capabilities**
- **Plenary sessions**
 - Organised by broad Science theme, following book section themes
 - Plus “Observing with SKAO” special plenary session
- **Parallel sessions**
 - In order to facilitate SWG interaction and collaborations, organise into SWGs
 - Will also enable Operations to be able to tailor talks for different technical requirements
 - 1.5 days dedicated to parallel sessions
- **Posters (with lightning talks)**



Science Book: overview

- “Advancing Astrophysics II: Preparing for Science with the SKAO”
- This will be an updated version of the existing SKAO Science Book
- Some chapters may not have changed much; some will have evolved; some brand-new chapters based on new science cases
- Aim is two-fold:
 - Facilitate SWG-coordinated chapters (both new and updated)
 - Opportunity for researchers to connect with and join the SWGs
- *The new book will provide an up-to-date coverage of the science questions that will be addressed by the full design baseline (and beyond).*



Science Book content

Goal of individual chapters

- Self-contained description of a science application including background and motivation
 - Main focus of a chapter:
 - Demonstrate the science outcomes that are enabled by the capabilities of a particular component of the **SKA design baseline, Array Assembly 4 (AA4)**
 - Supplementary focus:
 - Document the extent to which scientific outcomes might be achieved by the **end of staged delivery (AA*)**
 - Document the types of **enhancements to the design baseline** that could further support the science goals
- Also consider:
 - Highlight **synergies** with other instruments
 - *Guidance on SKAO commensal observing to be provided to chapter authors*



Science Book structure

Science book editorial board

- SKAO Science Team and SWG chairs

Book sections

- SKAO introduction
- A set of SWG introduction chapters
 - A high-level overview of the activities of each SWG
 - Describing how the various science chapters fit into the work of the SWG
 - Also looking at the technical aspects of the group's work, particularly for the more technically-themed SWGs
 - Page length TBD
 - The introductory chapters will be written once all science chapters are available
- A set of sections based on broad science themes
 - Sections made up of science chapters: each chapter a single paper
 - Overview science chapters will not be needed



Science Book structure: science sections

broad categories confirmed; lay questions will be added to/modified according to chapter submissions

Section title

Lay "big questions"
(Related SWGs)

Planetary systems

How do planets form? Are we alone?
(All relevant SWGs)

Sun and Stars

How do galaxies turn gas into stars? How do stars behave at the centres of galaxies?
(All relevant SWGs)

Galaxies

How do normal galaxies form and grow? What resides in the space between galaxies? Why do galaxies have huge black holes at their centres? Why do only some quasars produce powerful jets?
(All relevant SWGs)

The Cosmos

How and when did the first stars and galaxies form? What is the large-scale structure of the Universe? What are dark matter and dark energy? What is the role of magnetism?
(All relevant SWGs)

The Extreme Universe

Was Einstein right about gravity? How does matter behave at extreme densities? What are cosmic rays? What new physics will particle cascades unveil? What are Fast Radio Bursts? How do supermassive black holes collide?
(All relevant SWGs)



A flexible, two-phase approach

Phase 1: Call for chapter abstracts, deadline September 30th

Phase 2: Authors invited to prepare advanced drafts of chapter manuscripts, deadline February 28th

- Flexible approach:
 - Recognising that work on chapter updates has been ongoing in some SWGs since early 2024 or before, some authors might be invited to begin preparing draft manuscripts prior to the Phase 1 deadline
 - Remaining authors might be invited after the September 30th deadline
- For reference:
 - [Coordination of chapter submission](#)
 - *Includes plan for coordination of contributions; timeline; SOC members, FAQs*



Science Book: final submissions and publishing

- Chapter reviewing will take place *after* the meeting
- SWG chairs to suggest reviewers for individual chapters
- Editing by SWG chairs and SKAO Science Team
- Publish online versions with some hard copy
 - Hard copy versions: could be printed as individual sections
 - Mindful of the environmental impact and cost of physical books
 - Online version: facility to update over time (as is possible on ArXiv, for example)
 - Looking at *either Proceedings of Science* <https://pos.sissa.it/> or SKAO hosting



Current status (Science Book):

Updates from SKAO

- External Expressions of Interest call closed end September
 - 216 Submissions collated and shared with SWG chairs via google sheet
 - *Please let WW know if you do not yet have access to the submissions*
- Second google sheet to collate all chapter titles (internal to SWGs and external in one place)
- Instructions for Authors and LateX template shared
- Suggest a further meeting of SWG chairs, facilitated by SKAO, end Oct, to take a look together at the collated list of abstracts and identify gaps and crossover (noting that the number of working groups has grown since 2015)



Timeline

June 2024

July 2024

September 30th 2024

October 1st 2025

October 2025

Mid December 2024

February 28th 2025

Mid/late Jan 2025

Feb to mid-March 2025

Mid March 2025

March 2025

May 2025

June 16th 2025

Second half of 2025

Save the Date announcement

Chapter abstracts sought

Chapter abstract deadline

Submission platform open for advanced drafts of chapters

Conference poster launch

Launch website

Submission period ends

Registration open

Talk/poster selection

Speaker notification

Early bird registration close

Registration close

Meeting begins

Final book chapter reviews and publication

