SKAO

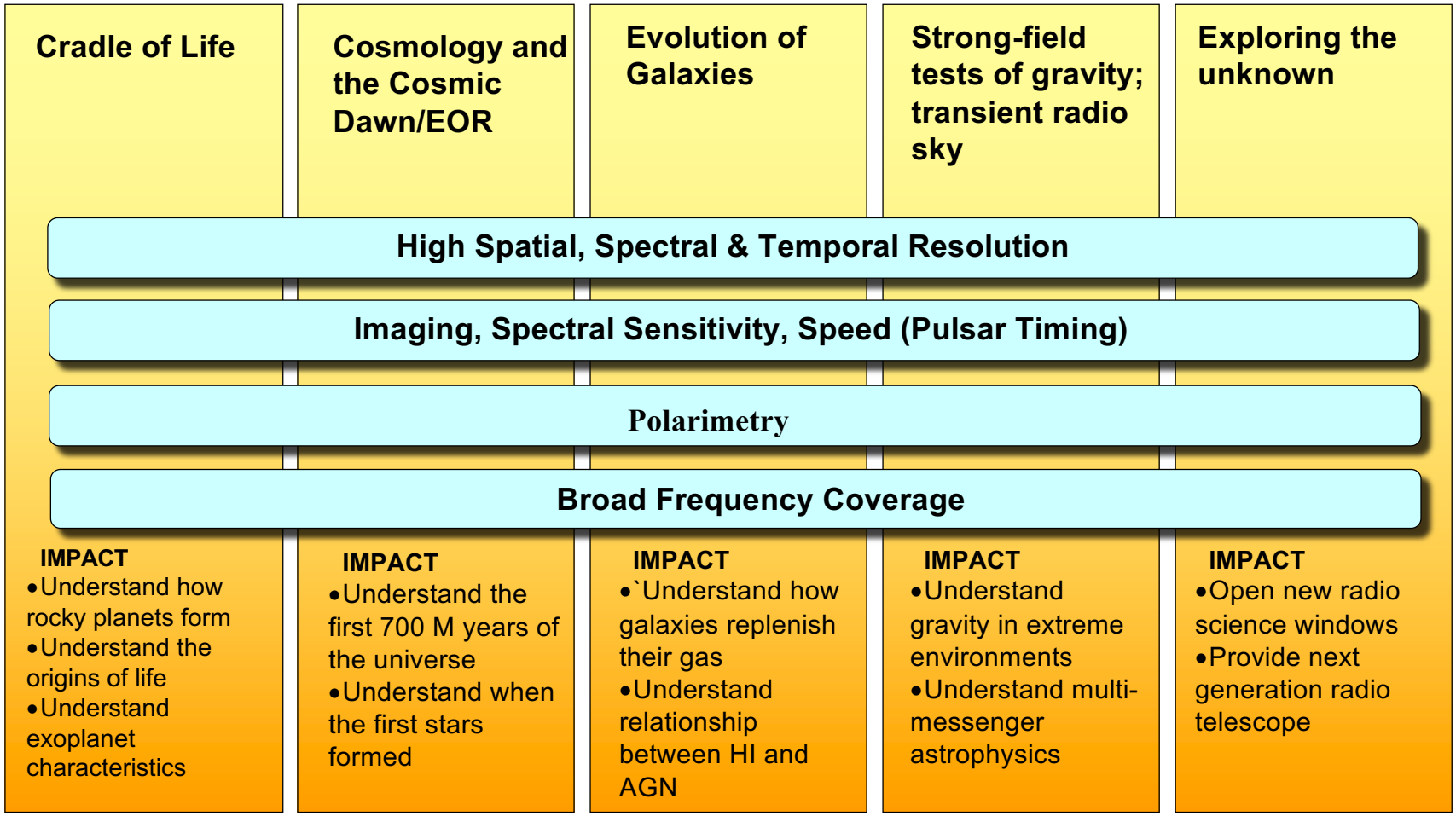
one observatory
two telescopes
three continents

Science with the SKA Observatory

Dr Anna Bonaldi, Senior Scientist

SKA Swiss days, 3/9/24

Science drivers and requirements



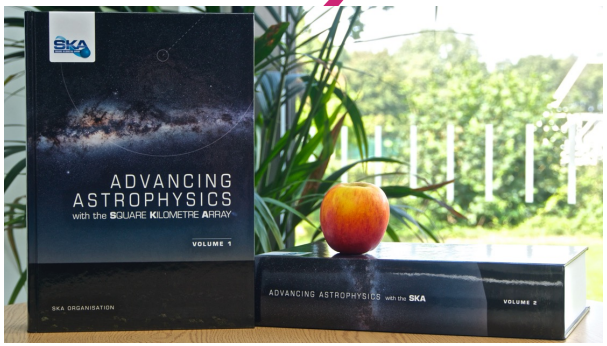

Extragalactic Continuum
Science Working G
Star Formation History
Active Galactic Nuclei
Galaxy Clusters
Strong Gravitational Lensing
Cosmology
Science Working G
Proposed SKA1 Cosmology Surveys
Cosmology Science Goals
Weak Lensing
Radio continuum survey
Cradle of Life
Science Working G
1. Explain planet formation
2. Detect and characterise la
3. Detect existence and study properties of exoplanet magnetic fields.
Pulsars
Science Working
Dense Matter Equation of State
Designed for Pulsar Astrophysics
Epoch of Reionization
Science Working G
Cosmic Reionization:
Image tomography of cosmic reioniz
21cm f
HI Galaxy Science
Science Working G
How do galaxies replenish their gas?
How is the HI in galaxies linked to AGN activity?
Extragalactic Spectral Lines
Science Working G
Masers as tracers of AGN, starburst
Absorption lines in intervening galax
Transients
Science Working G
Fast radio bursts
Long gamma-ray bursts & superluminous supernovae
The SKA as a transients discovery m
What is the structure of the Universe on the largest scales?
Cosmic Magnetism
Science Working G
A dense Faraday Rotation Measure (F
Solar explosions and solar energetic particles
General heating
Turbulence and radio wave scattering
SKA and Solar and Heliospheric Scie
Solar and Heliospheric Physics
Science Working G
Our Galaxy
Science Working G
Stars and their neighbourhood
From Stars to the ISM
Science Goals
High Energy Cosmic Particles
Focus Group
The cosmic-ray spectrum
Radio emission
Ultimate precision – EAS
Extreme energies – lunar
Science Goals
Galactic cosmic rays
High-energy particle physics
Extragalactic sources
SQUARE KILOMETRE ARRAY

Update to the 2015 science book

- Evolution of science cases and priorities
- Larger set of SWGs
- Mature set of telescope specifications, accessible through tools (e.g. sensitivity calculator) as well as documentation

2025 science book

2015 science book



9 -13 June, 2014
Giardini Naxos, Italy

Update to the 2015 science book

How do I get involved?

Within SWG

- SWG chairs are inviting proposals for intended contributions
- Answer to the call of your chairs, contribute to chapter list definition and the articles themselves!
- Expression of interest to contribute to a chapter **by 30th September**

Outside SWG

- Expression of interest to contribute to a chapter **by 30th September**
- Submission of title and short abstract
- Indicate relevant SWG (if applicable)
- Option to ask to join relevant SWG
- SWG chairs/SKAO will review your request (check for duplication, etc.) and confirm

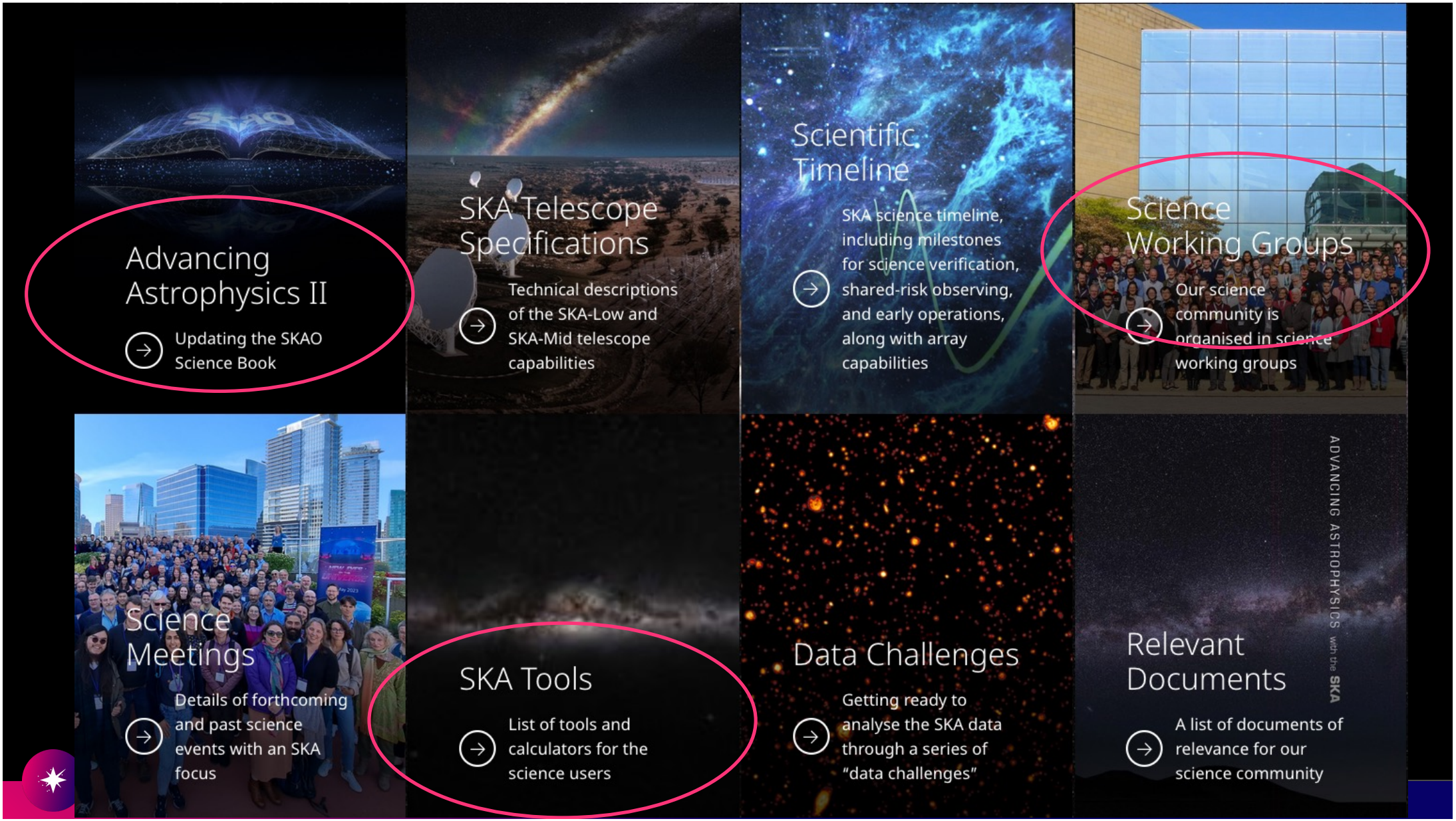
More details available at https://www.skao.int/en/science-users/557/advancing-astrophysics-ii-preparing-science-skao
For all enquiries about the new SKAO science book please contact us at advancingastrophysicsii@skao.int

2025 conference and book dates

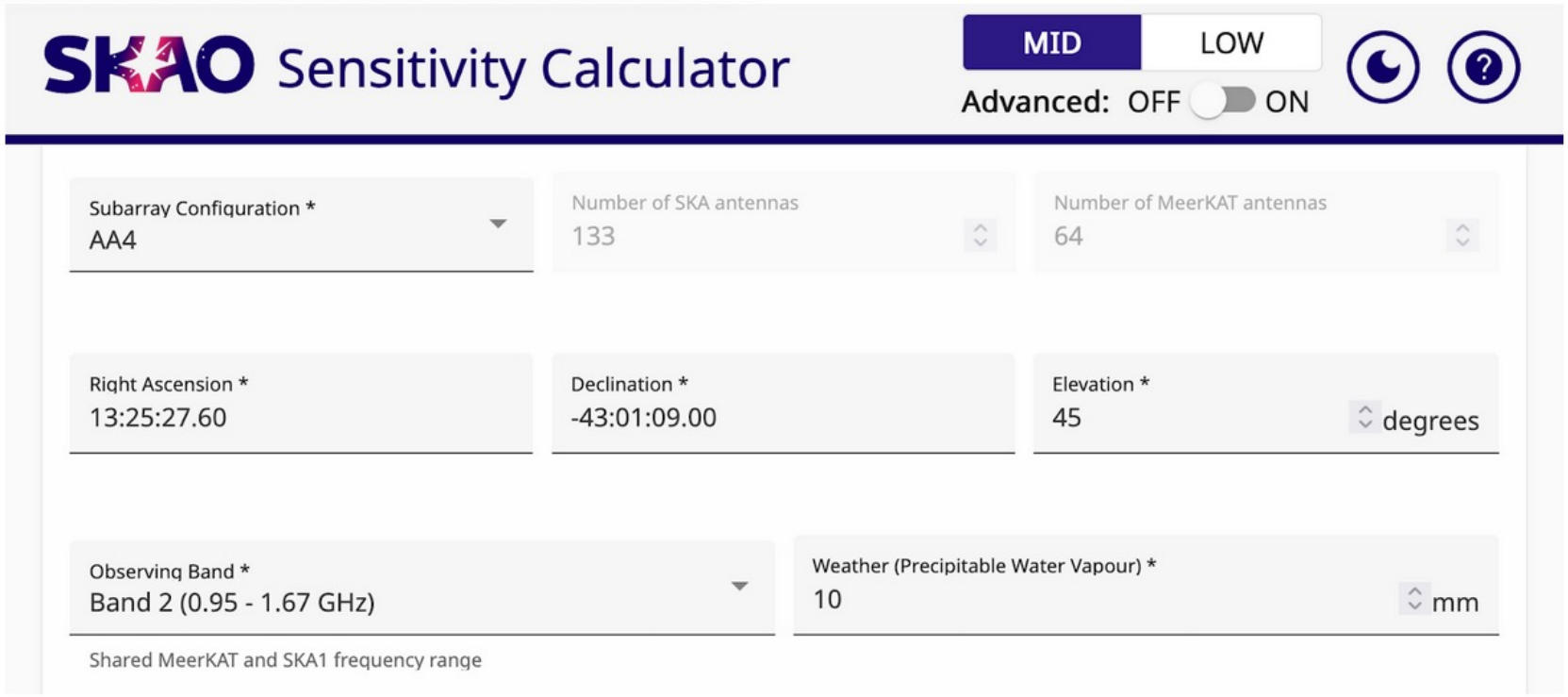
- 30th Sept: deadline for expression of interest
- 1st Oct - 31st Jan: advanced chapter drafts submission
- Jan 2025: registration open for the conference
- Feb-March: selection of talks/posters for the 2025 science meeting from the draft chapters
- Mid-March: speaker notification
- March-May 2025: science meeting registration
- 16-20 June 2025: science meeting
- Final chapter submission and peer review after the meeting

More details available at https://www.skao.int/en/science-users/557/advancing-astrophysics-ii-preparing-science-skao

For all enquiries about the new SKAO science book please contact us at advancingastrophysicsii@skao.int

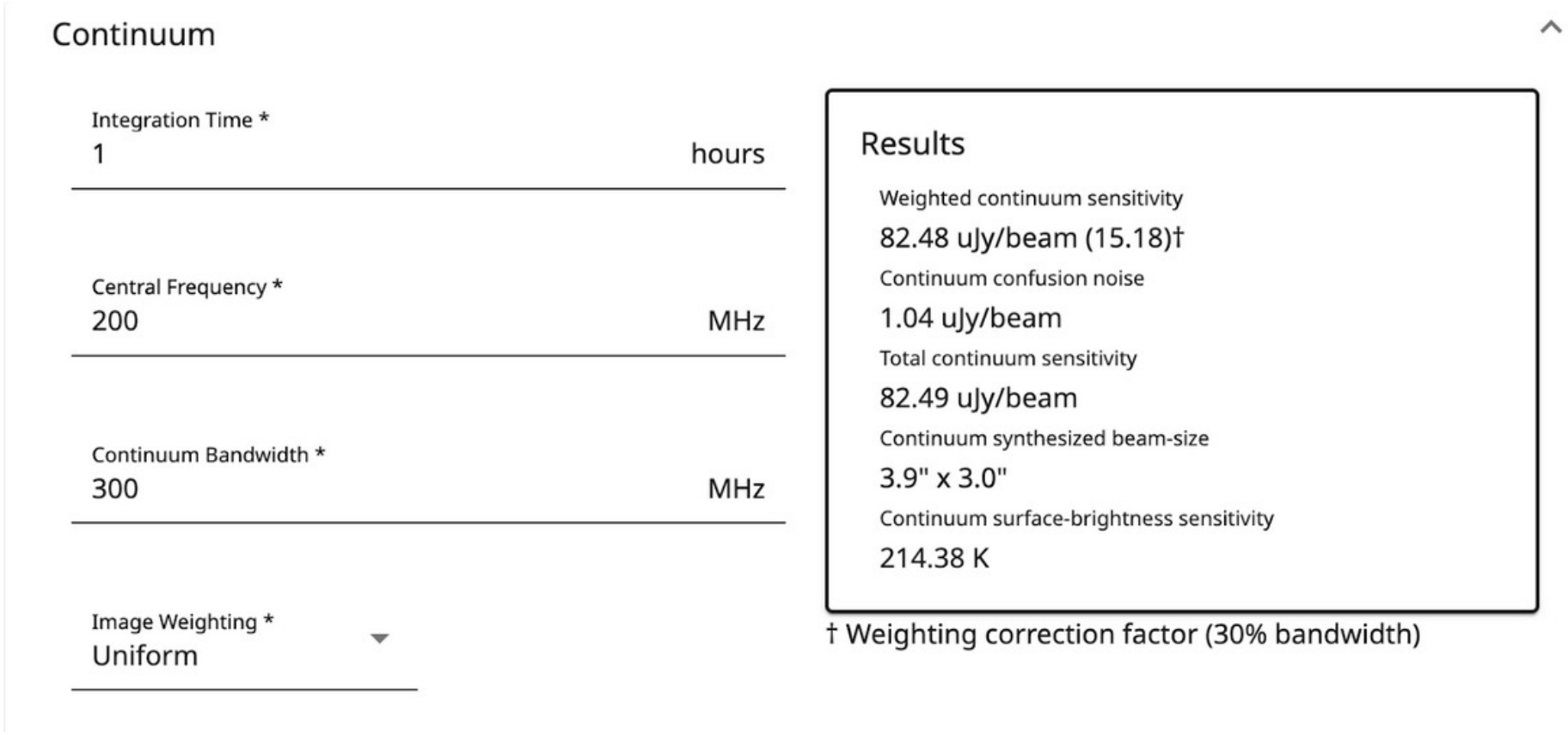

Advancing Astrophysics II
Updating the SKAO Science Book
SKA Telescope Specifications
Technical descriptions of the SKA-Low and SKA-Mid telescope capabilities
Scientific Timeline
SKA science timeline, including milestones for science verification, shared-risk observing, and early operations, along with array capabilities
Science Working Groups
Our science community is organised in science working groups
Science Meetings
Details of forthcoming and past science events with an SKA focus
SKA Tools
List of tools and calculators for the science users
Data Challenges
Getting ready to analyse the SKA data through a series of "data challenges"
ADVANCING ASTROPHYSICS with the SKA
Relevant Documents
A list of documents of relevance for our science community

SKA Mid sensitivity calculator

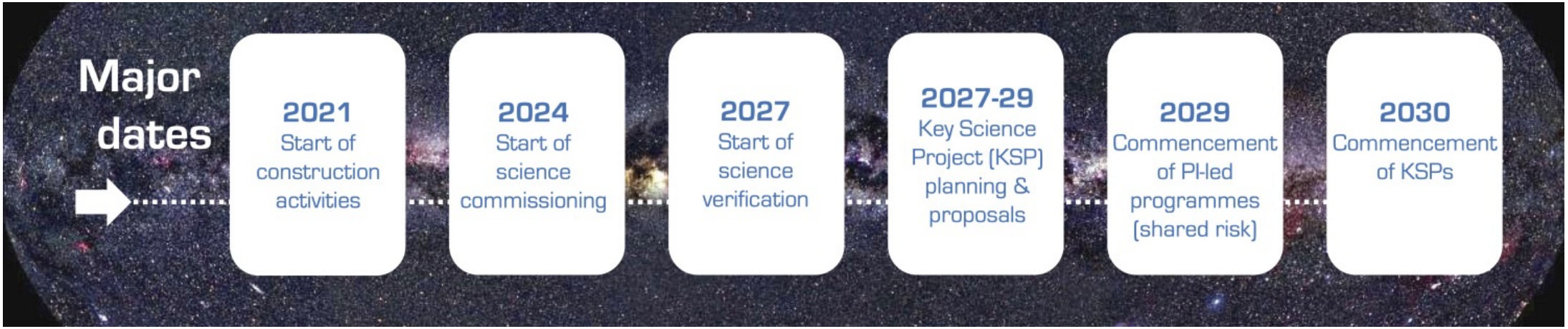


SKA Mid sensitivity calculator

SKA Low sensitivity calculator



SKAO Construction timeline



Science Data Challenges: What are we trying to achieve ?

- Prepare Science Community
  - Science extraction from SKA Observatory Data Products (ODPs)
  - Stimulate advance of state-of-the-art data analysis techniques that are relevant for SKAO
  - Promote reproducibility and analysis pipeline sharing
- Provide test cases for SRCNet development
  - Test increasingly realistic data transfer, user access and customised user processing
- Constrain SDP Pipeline development
  - Identify gaps in sky, telescope and error models
  - Determine necessary calibration quality and identify any other factors that might inhibit science extraction from ODPs

Reproducibility awards/badges – SDC2 onwards

Reproducibility

Is the pipeline:

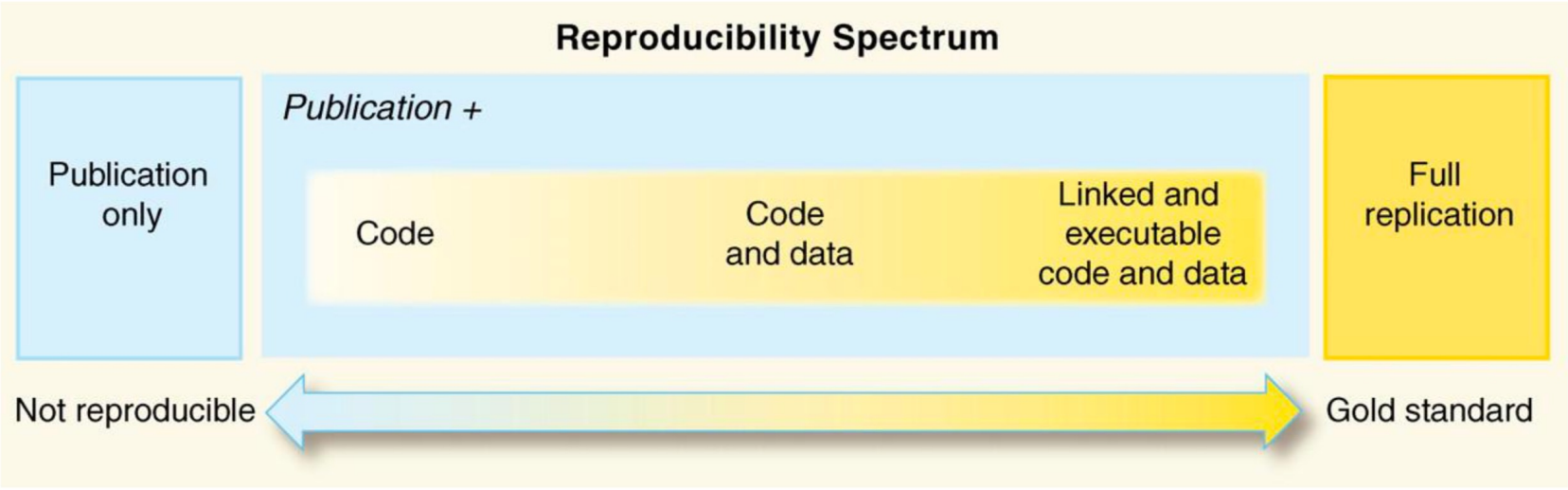
- Well-documented
- Easy to install
- Easy to use

Reusability:

Does the pipeline:

- Use an open licence
- Have findable code
- Use code standards
- Use built-in tests

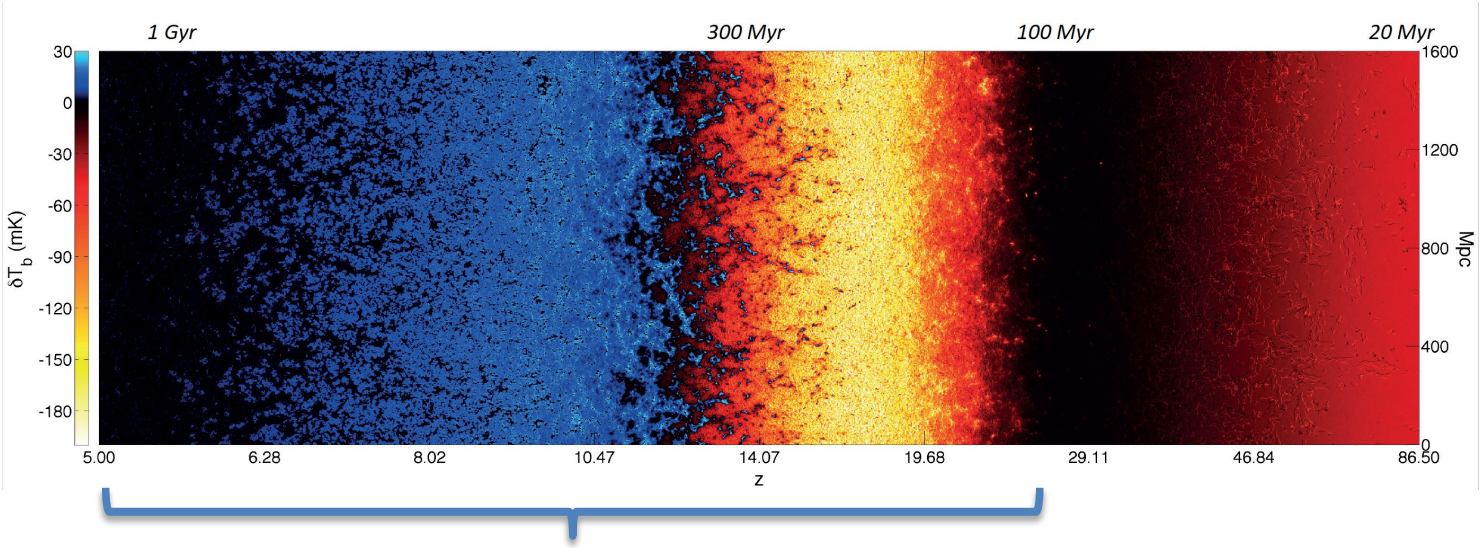
- Teams are evaluated on the reproducibility of their results
- Separate evaluation from the main challenge score



Science Data Challenge 3 2023+

Cosmic Dawn and Epoch of reionization

Exploring the formation of the first stars and galaxies in the Universe



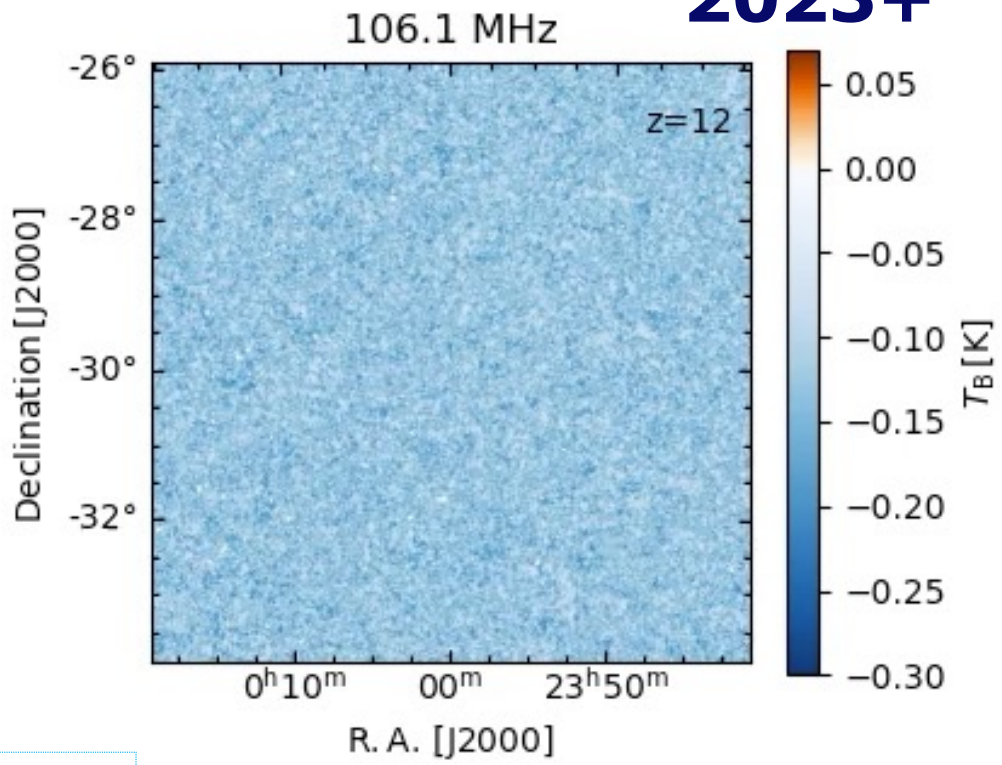
230-50 MHz, SKA Low

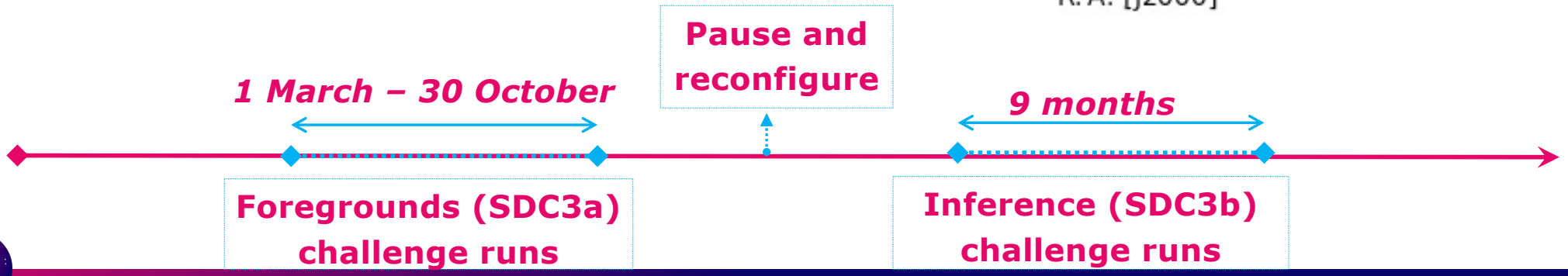
Science Data Challenge 3

2023+

Epoch of reionization

- SDC3a "**Foregrounds**" (SDC3a; SWG Coordinators: C. Trott, V. Jelic)
  - **Foreground removal** exercise
  - SDC3a started 1 March 2023, closed 30 Oct 2023
- SDC3b "**Inference**" (SDC3b; SWG Coordinators: A. Mesinger, G. Mellema)
  - Extraction of **cosmological parameters**
  - SDC3b ongoing





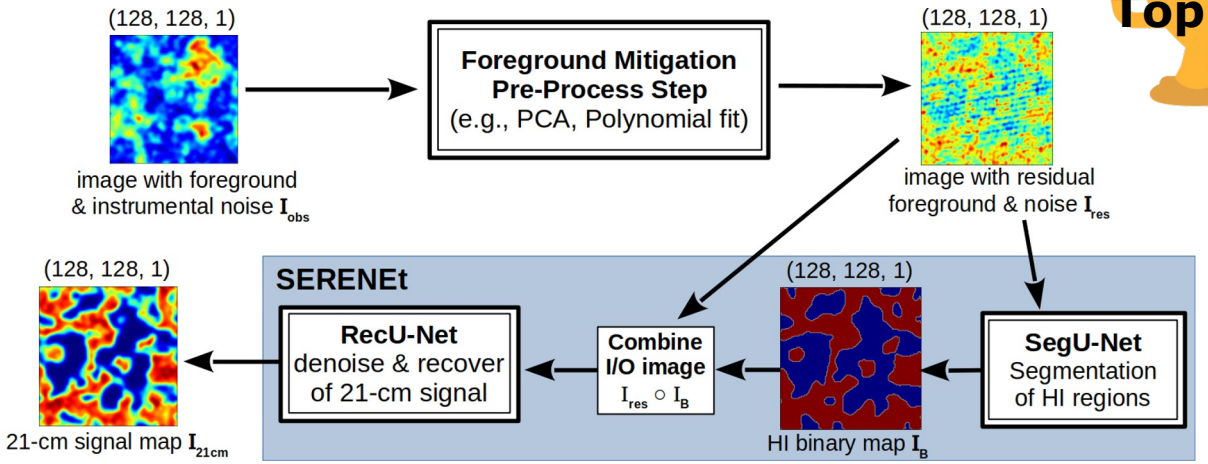
Slide credit: M. Bianco

Swiss contribution at the SDC3a

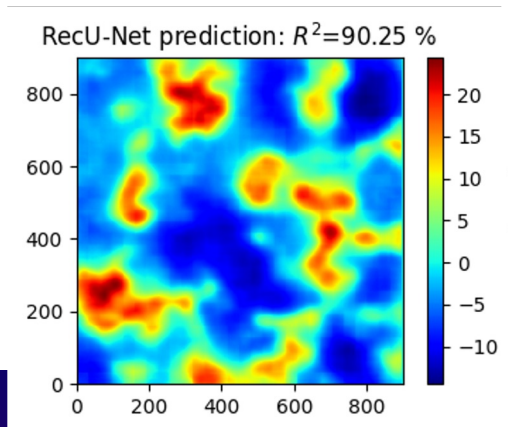
Michele Bianco
Tianyue Chen
Shreyam P. Krishna
Rohit Sharma
Sambit K. Giri
Hatem Ghorbel
Massimo de Santis
Philipp Denzel
Chris Finlay
Viraj Nistane

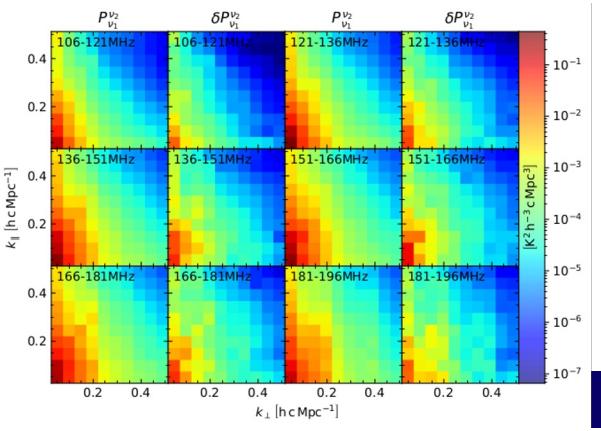
SEgmentation and **RE**cover **NE**t**w**ork (**SERENEt**)
for EoR 21-cm interferometry observations

Top 10

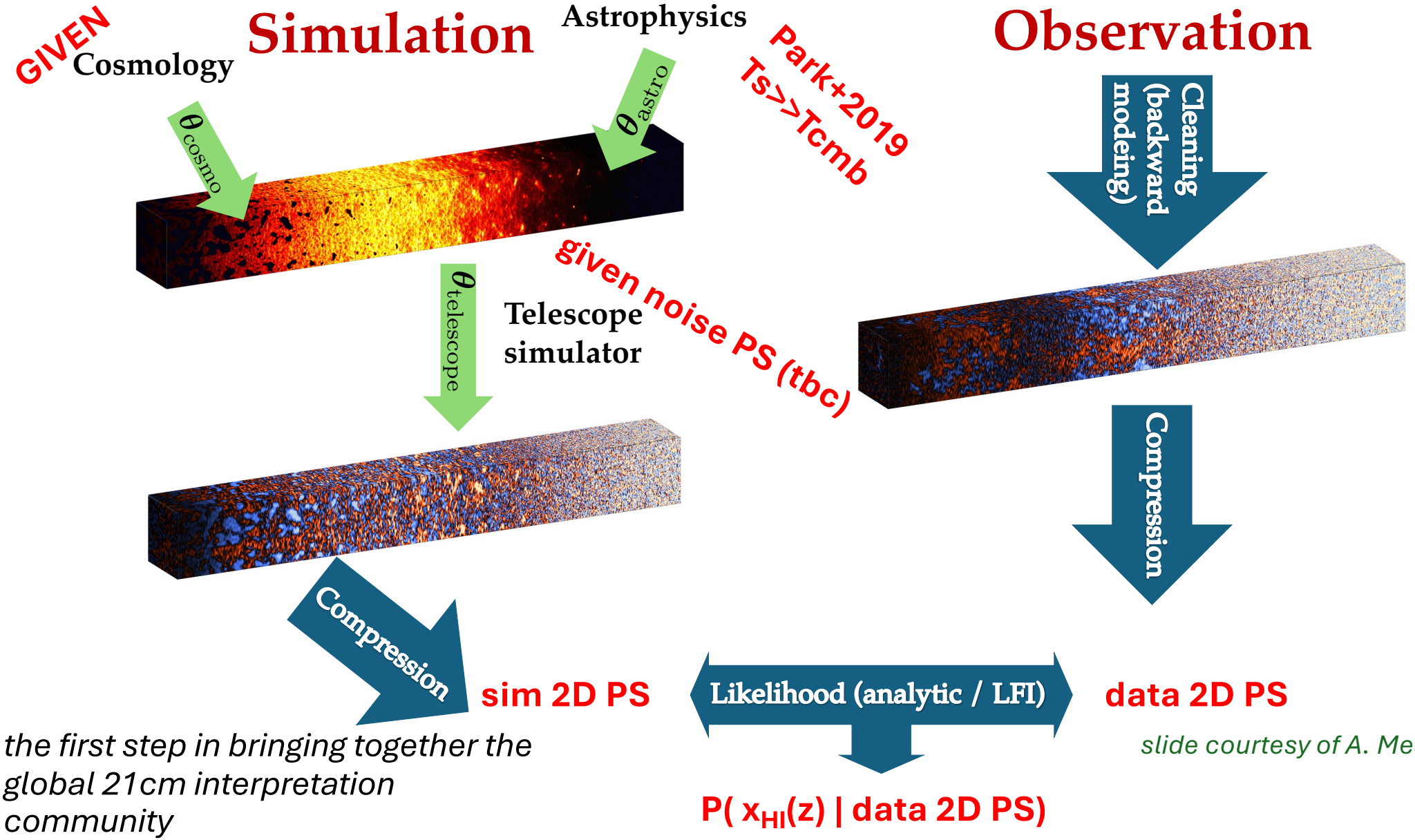


Preview results:





Paper on arXiv from **~Sept 2024**
https://github.com/micbia/serenet

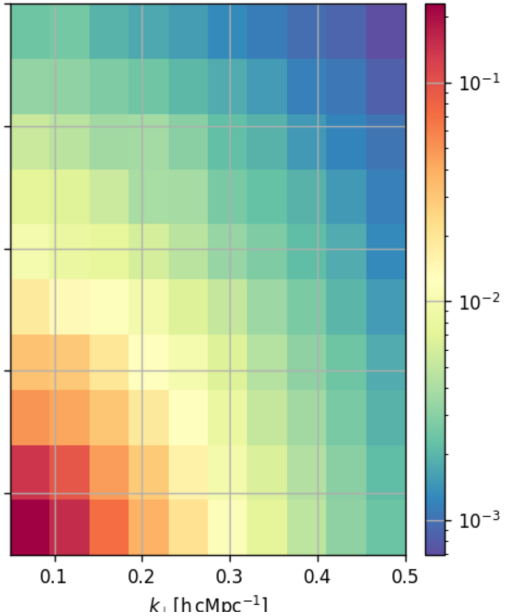


the first step in bringing together the global 21cm interpretation community

slide courtesy of A. Mesinger

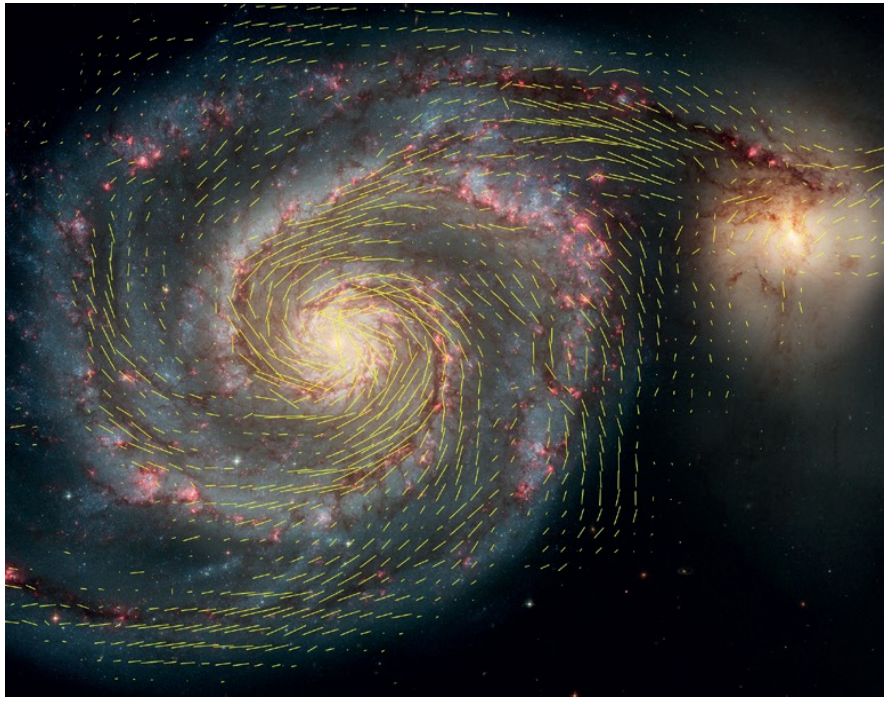
Science Data Challenge 3b: EoR Inference

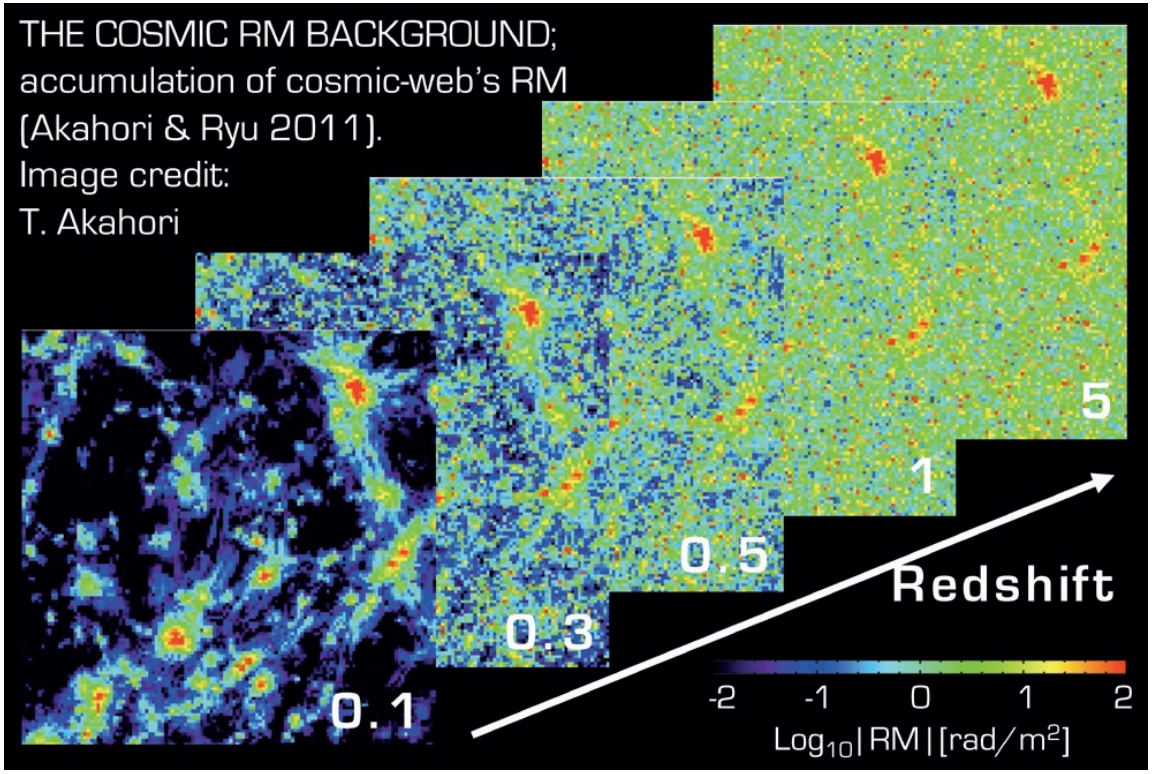
- The challenge:
  - Infer the reionization properties of the Universe from power spectra of the hydrogen-21cm signal from the Epoch of Reionisation corresponding to different redshift ranges.
  - Submission will consist of inferred reionization fraction of the Universe for all the redshifts for which power spectra have been provided, and the associated uncertainty.
- Computation support
  - SDC3 receives generous support from our international HPC partner facilities, who will provide computational resources to teams for processing the challenge data.



SDC4: Cosmic magnetism

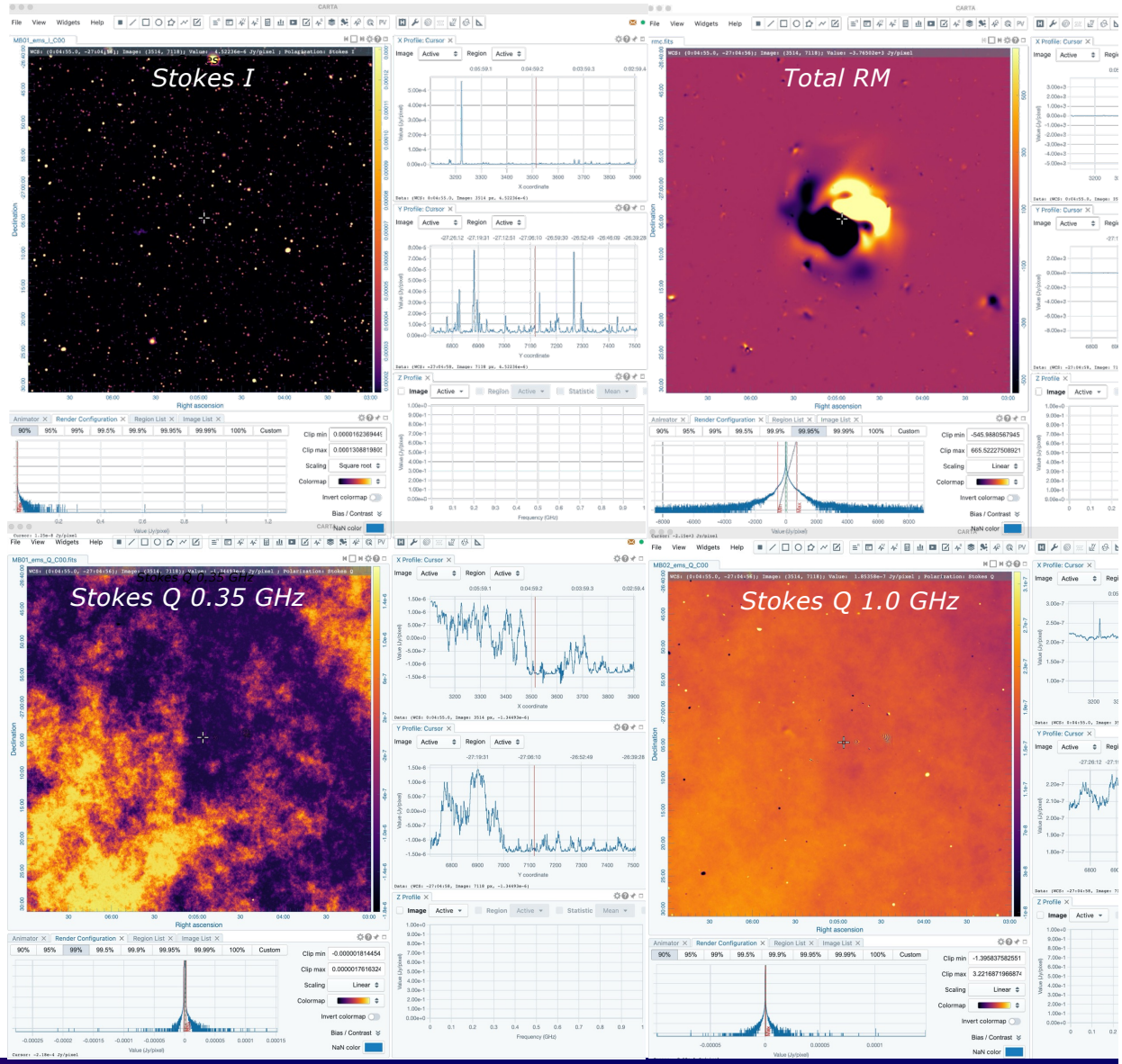
We can measure the magnetic fields in galaxies and clusters





SDC4: Magnetism

- Developed in collaboration with Magnetism SWG (Akahori, Vernstrom, Vacca, …)
- Source finding and characterization in polarization. SKA Mid and Low.
  - Full Stokes compact plus diffuse sky model with IGM, ISM, and ionosphere propagation
  - Thermal noise equivalent few 1000 h
- Telescope and Error Models



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