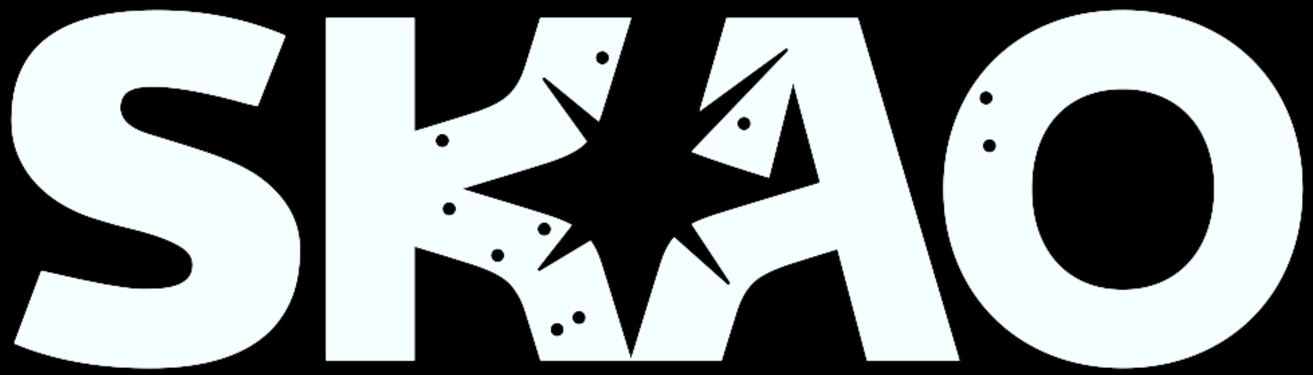

SKAO

The SKA: an Observatory for the 21st Century

Boris Sorokin – Radio Spectrum Engineer
Federico Di Vruno – Spectrum Manager

Almaty: 16 September, 2024

WHO ARE WE?

Who are we?

The SKA Observatory (SKAO)

An inter-governmental organisation, governed by a treaty.
SKAO was born on 4 February 2021.

Only second IGO in astronomy, after ESO

Full membership:

Australia, Canada, China, Italy, Netherlands, Portugal, South Africa, Spain, Switzerland, United Kingdom.

Accession stage:

France, Germany.

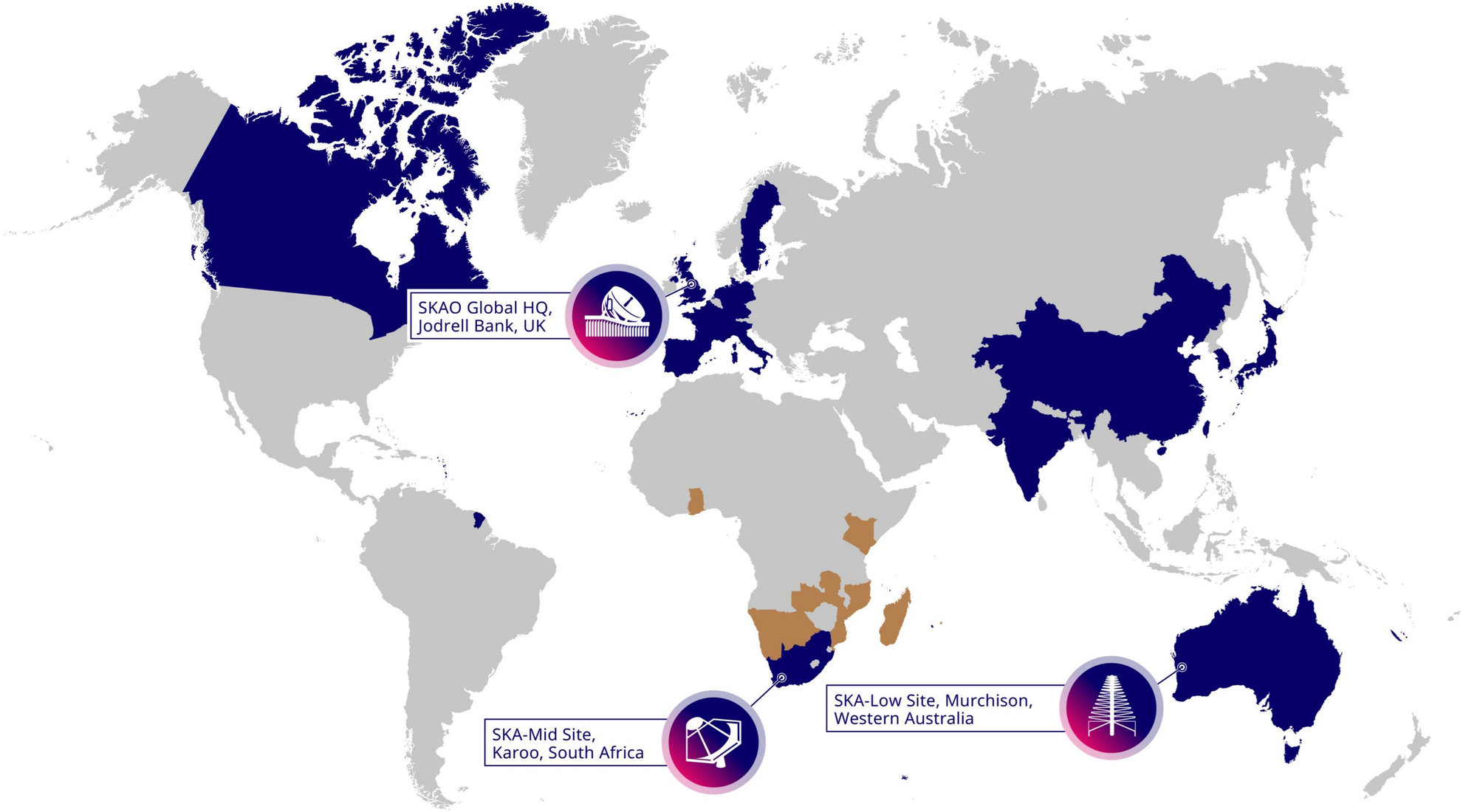
Membership negotiations:

India, Sweden.

Early stages:

Japan, South Korea.

"SKAO's mission is to build and operate cutting-edge radio telescopes to transform our understanding of the Universe and deliver benefits to society through global collaboration and innovation."



SKAO Partnership - includes SKAO Member States* and SKAO Observers

* * * * * * * * * *

African Partner Countries

WHAT ARE WE BUILDING?

What are we building?

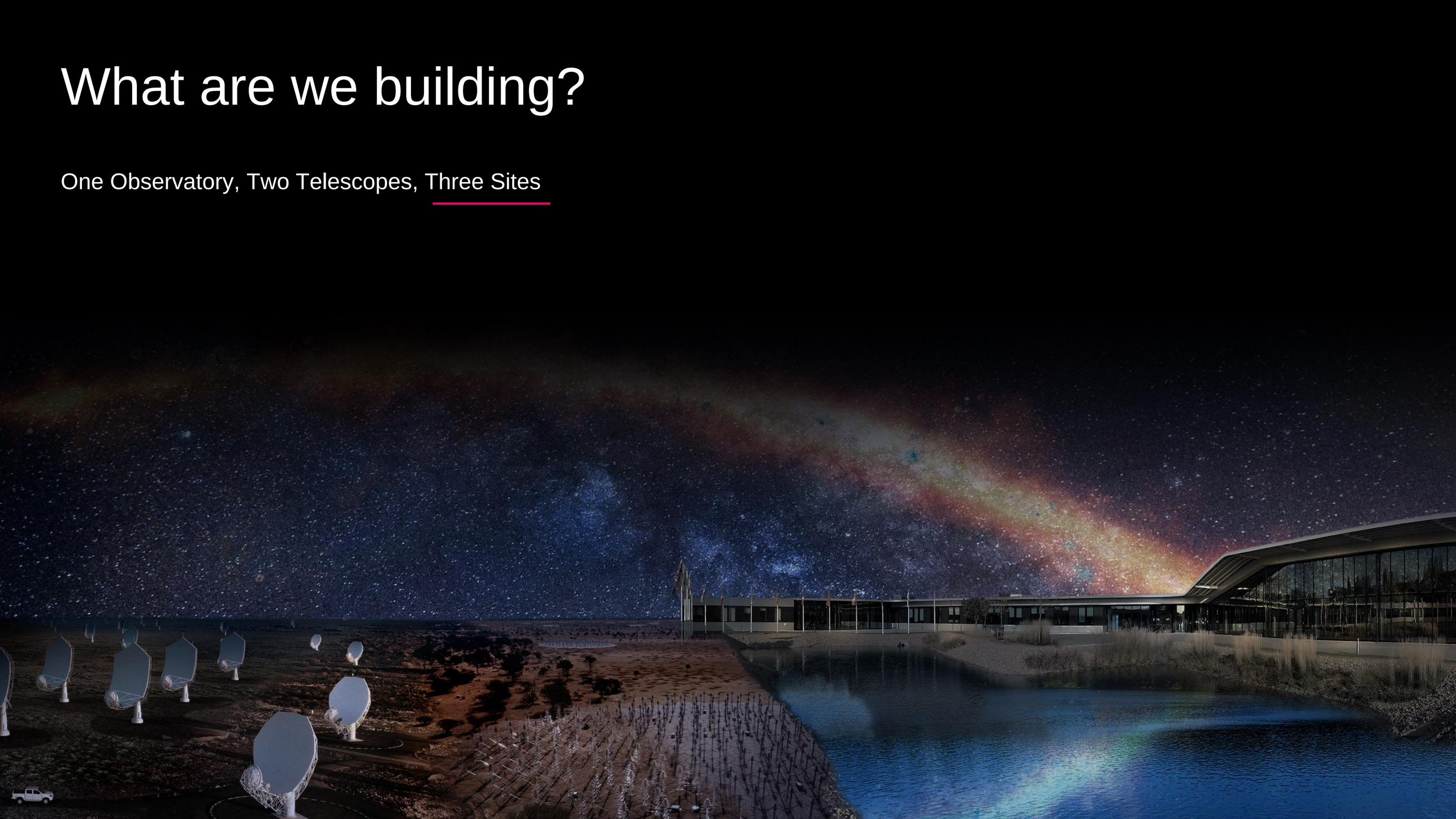
One Observatory

What are we building?

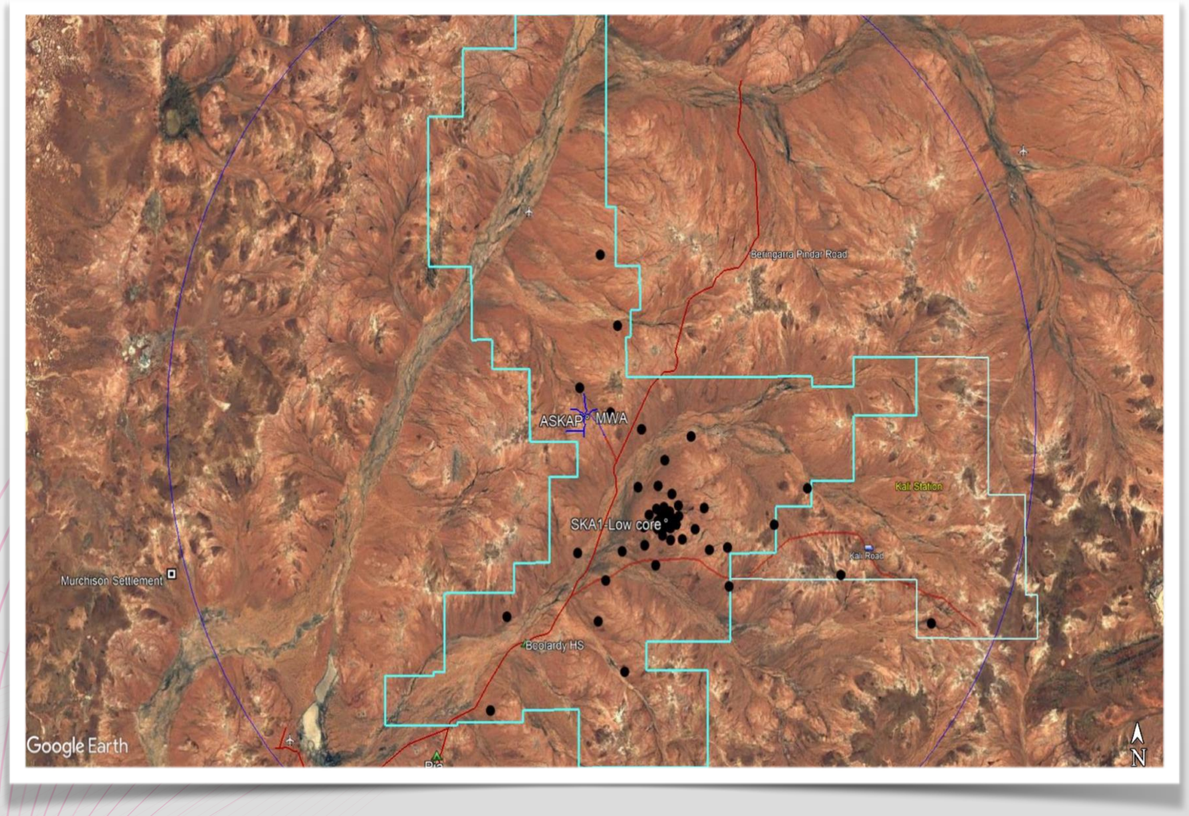
One Observatory, Two Telescopes

What are we building?

One Observatory, Two Telescopes, Three Sites

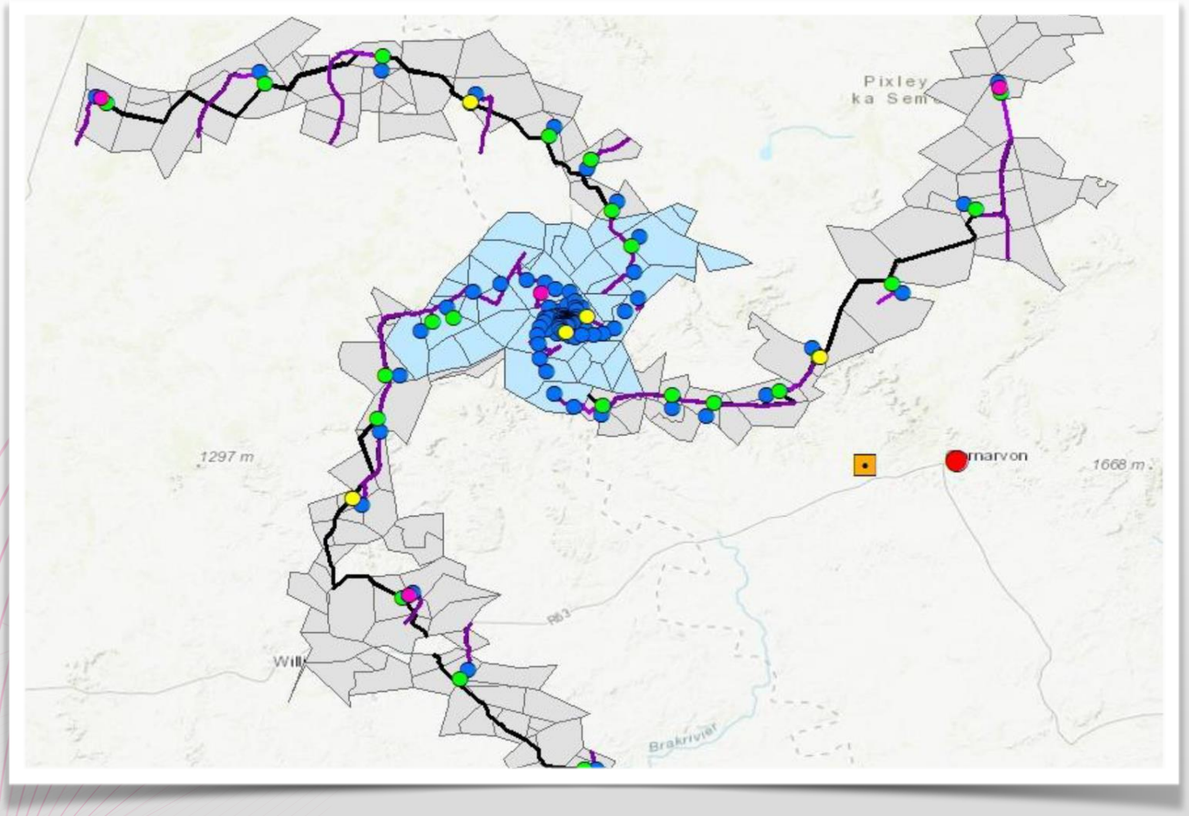


SKA-Low in Australia



- 131,072 log-periodic antennas, spread across 512 stations
- Frequency range: 50 MHz - 350 MHz
- Maximum distance between antenna stations: 74km

SKA-Mid in South Africa



- 197 fully steerable dishes, including the existing MeerKAT dishes
- Frequency range: 350 MHz - 15.4 GHz
- Maximum distance between dishes: 150km

The SKA project in numbers

€1.3 BILLION

CONSTRUCTION COST (2021 €)

131,072 ANTENNAS

IN WESTERN AUSTRALIA

710 PETABYTES PER YEAR

OF SCIENCE DATA DELIVERED TO SCIENCE USERS

€0.7 BILLION

FIRST 10 YEARS OF OPERATIONS COST (2021 €)

197 DISHES

IN SOUTH AFRICA (INCLUDING 64 MEERKAT DISHES)

1 GLOBAL NETWORK

OF DATA CENTRES TO DELIVER SCIENCE-READY DATA PRODUCTS TO END-USERS

8 YEARS

TO CONSTRUCT

16 COUNTRIES

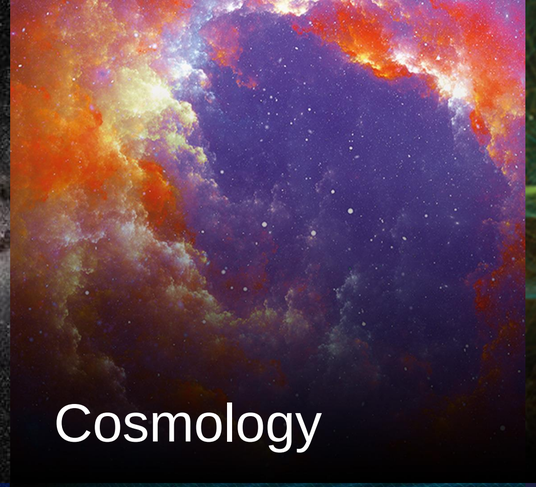
PARTICIPATING IN 2023

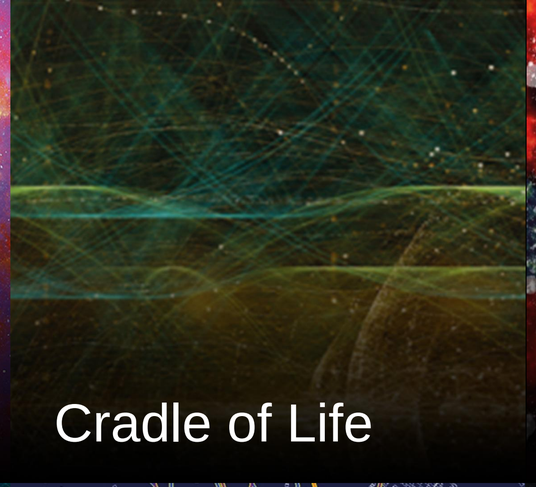
50+ YEARS

OF TRANSFORMATIONAL SCIENCE

SCIENCE CHALLENGES

SKAO Science Working Groups


Cosmology

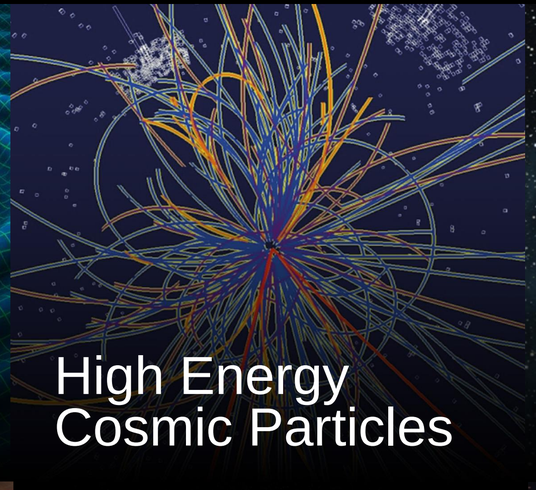

Cradle of Life


Epoch of Reionization

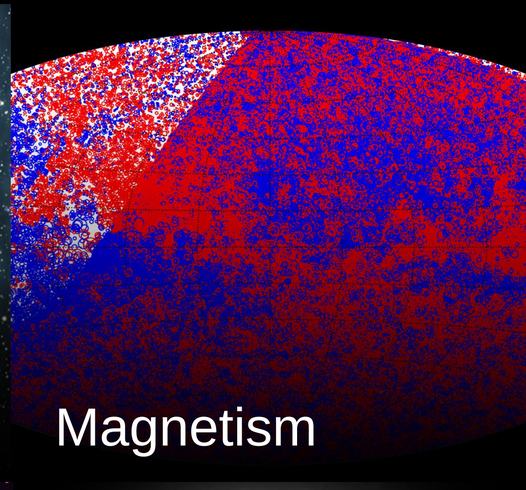

Extragalactic Continuum


Extragalactic Spectral Line


Gravitational Waves

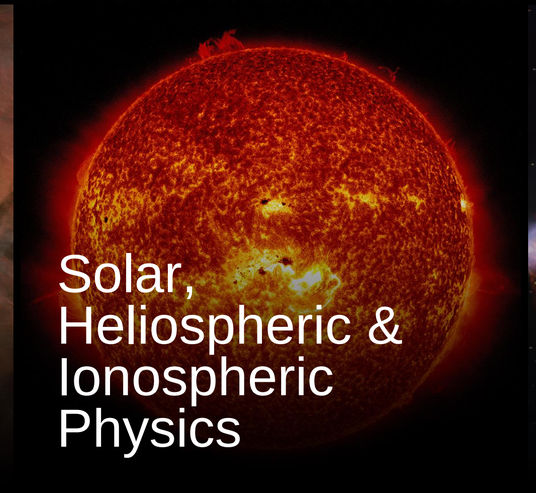

High Energy Cosmic Particles


HI Galaxy Science

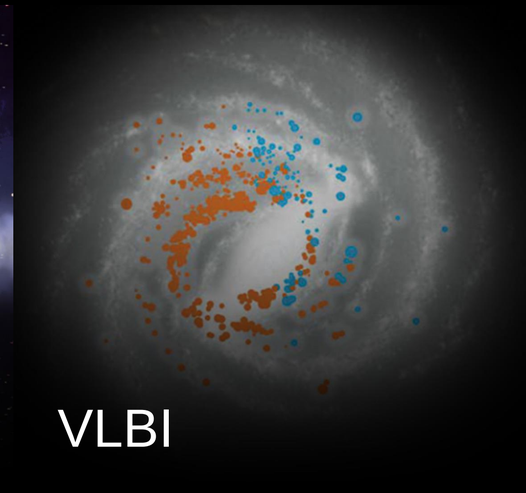

Magnetism


Our Galaxy


Pulsars


Solar, Heliospheric & Ionospheric Physics


Transients


VLBI

SKAO Science Working Groups

Some of the big SKA Science Questions

The Cradle of Life & Astrobiology

How do planets form? Are we alone?

Strong-field Tests of Gravity with Pulsars and Black Holes

Was Einstein right with General Relativity?

The Origin and Evolution of Cosmic Magnetism

What is the role of magnetism in galaxy evolution and the structure of the cosmic web?

Galaxy Evolution probed by Neutral Hydrogen

How do normal galaxies form and grow?

The Transient Radio Sky

What are Fast Radio Bursts and how can we best utilise them? What haven't we discovered?

Galaxy Evolution probed in the Radio Continuum

What is the star-formation history of normal galaxies?

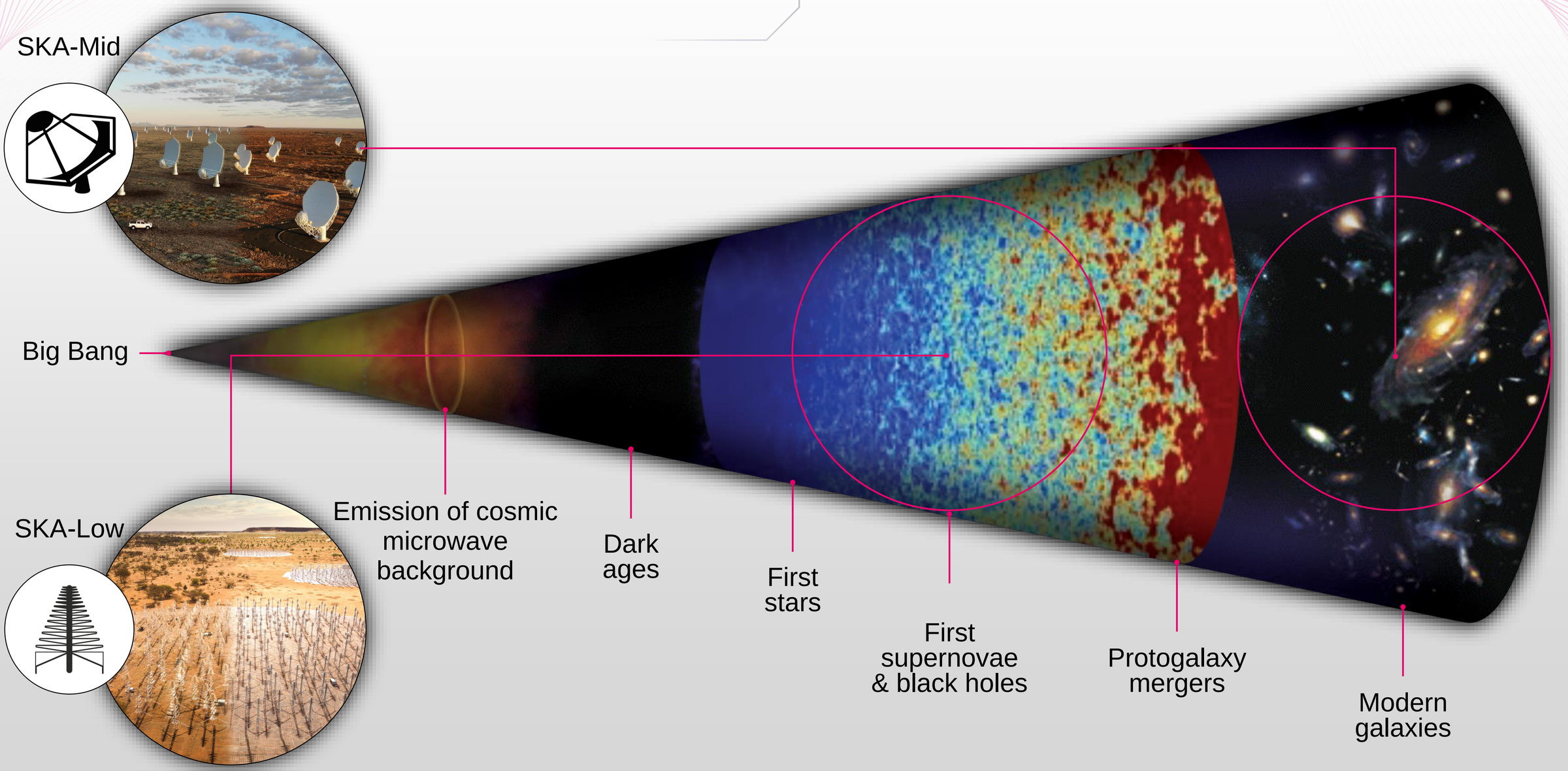
Cosmology & Dark Energy

What is dark matter? What is the large-scale structure of the Universe?

Cosmic Dawn and the Epoch of Reionization

How and when did the first stars and galaxies form?

Evolution of the Universe



DELIVERING THE SKAO

Delivering the SKA Observatory

- Feb 2021: SKAO born
- June 2021: SKAO Council approved the start of construction activities
- July 2021: Construction activities began
- 5 Dec 2022: Construction Commencement Ceremonies
- Apr 2023: 53 contracts awarded, total cost ~€500M; more major contracts being prepared

Construction Strategy

- **Target**: build the SKA Baseline Design (197 Mid dishes; 512 Low stations: AA4)
- Not all funding yet secured, therefore following Staged Delivery Plan (AA*)
- Develop the earliest possible working demonstration of the architecture and supply chain (AA0.5)
- Then maintain a continuously working and expanding facility that demonstrates the full performance capabilities of the SKA Design.

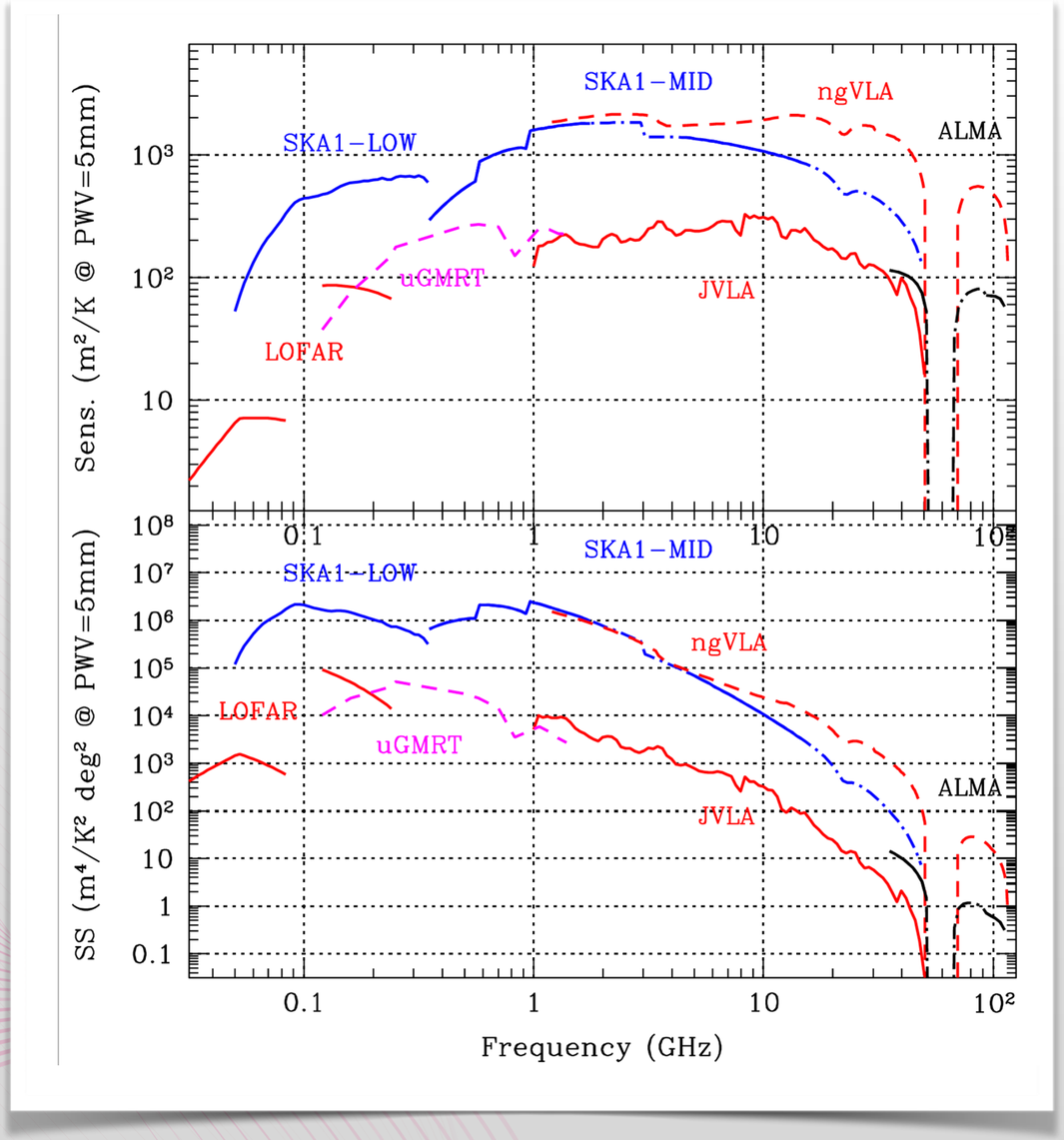
Milestone Event (earliest)		SKA-Mid (date)	SKA-Low (date)
AA0.5	4 dishes 6 stations	2024 Dec	2024 Aug
AA1	8 dishes 18 stations	2025 Nov	2025 Oct
AA2	64 dishes 64 stations	2026 Oct	2026 Sept
AA*	144 dishes 307 stations	2027 Aug	2028 Jan
Operations Readiness Review		2027 Nov	2028 Apr
End of Staged Delivery Programme		2028 Jul	2028 Jul
AA4	197 dishes 512 stations	TBD	TBD

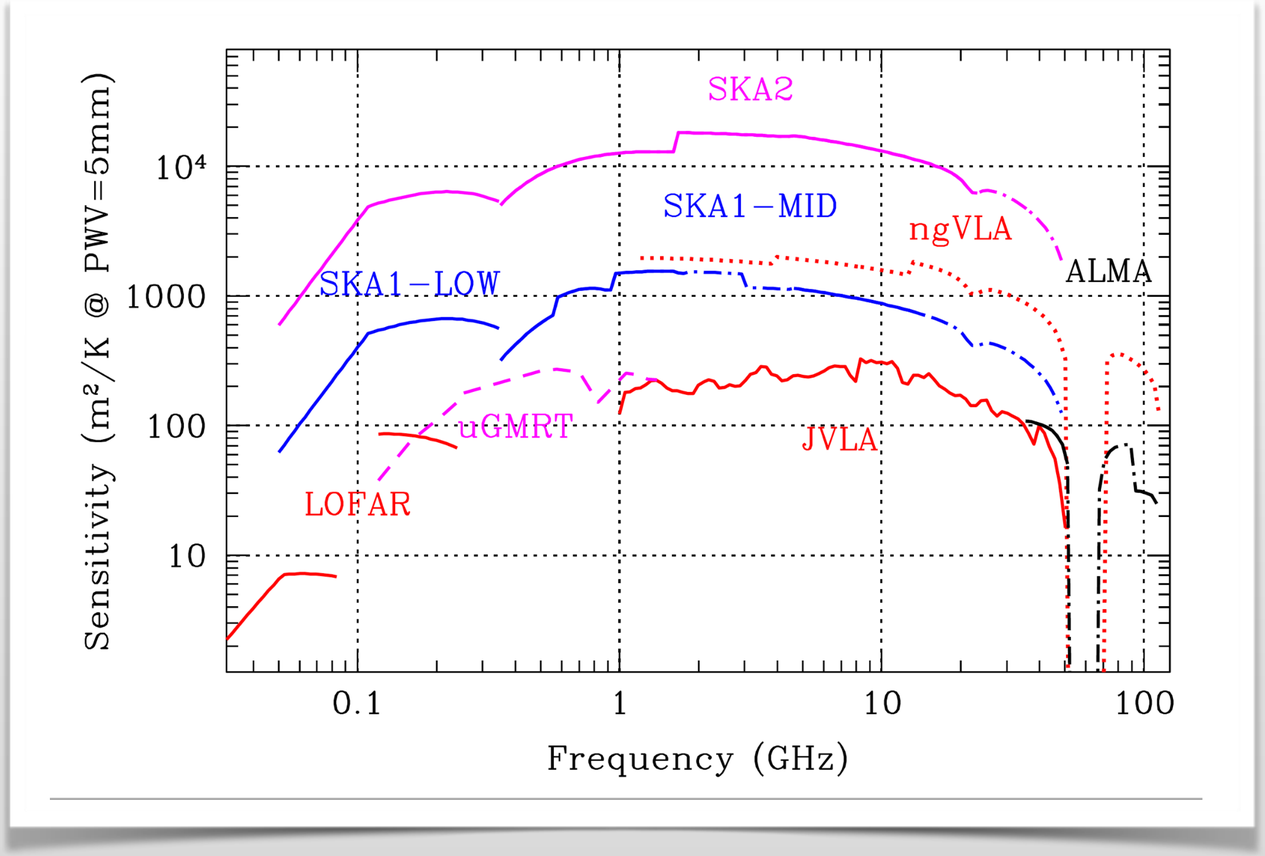
First data release to the community expected in 2026/27 (for science commissioning and verification)

First and Future Generation Feeds/Receivers

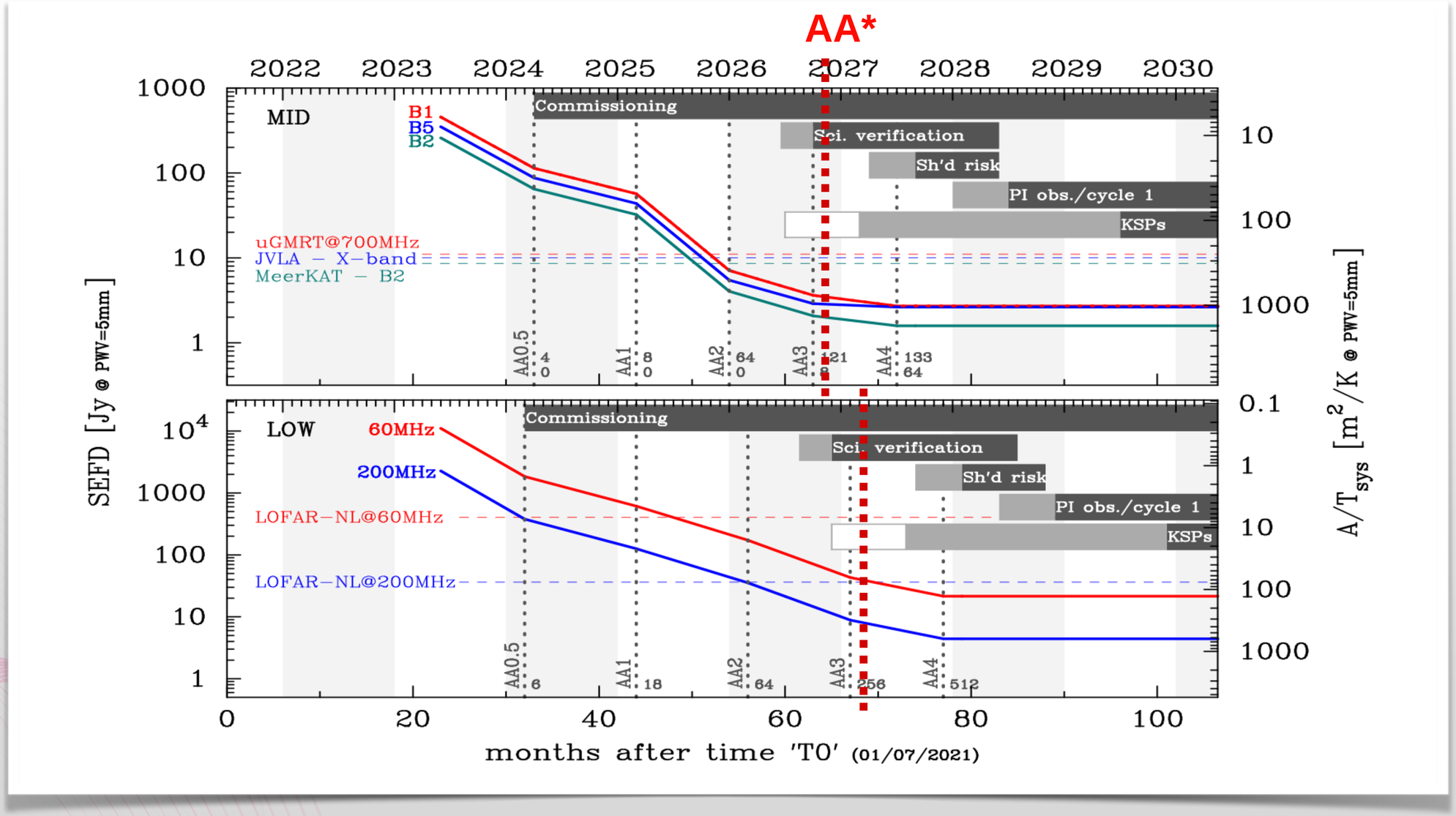
Band	Frequency Range	Bandwidth
Low	**50 – 350 MHz**	**2 x 150 MHz**
Mid Band 1	**0.35 – 1.05 GHz**	**700 MHz**
Mid Band 2	**0.95 – 1.76 GHz**	**810 MHz**
Mid Band 3	1.65 – 3.05 GHz	1.4 GHz
Mid Band 4	2.80 – 5.18 GHz	2.4 GHz
Mid Band 5a	**4.6 – 8.5 GHz**	**3.9 GHz**
Mid Band 5b	**8.3 – 15.3 GHz**	**2 x 2.5 GHz**

SKA Telescopes' Anticipated Sensitivity





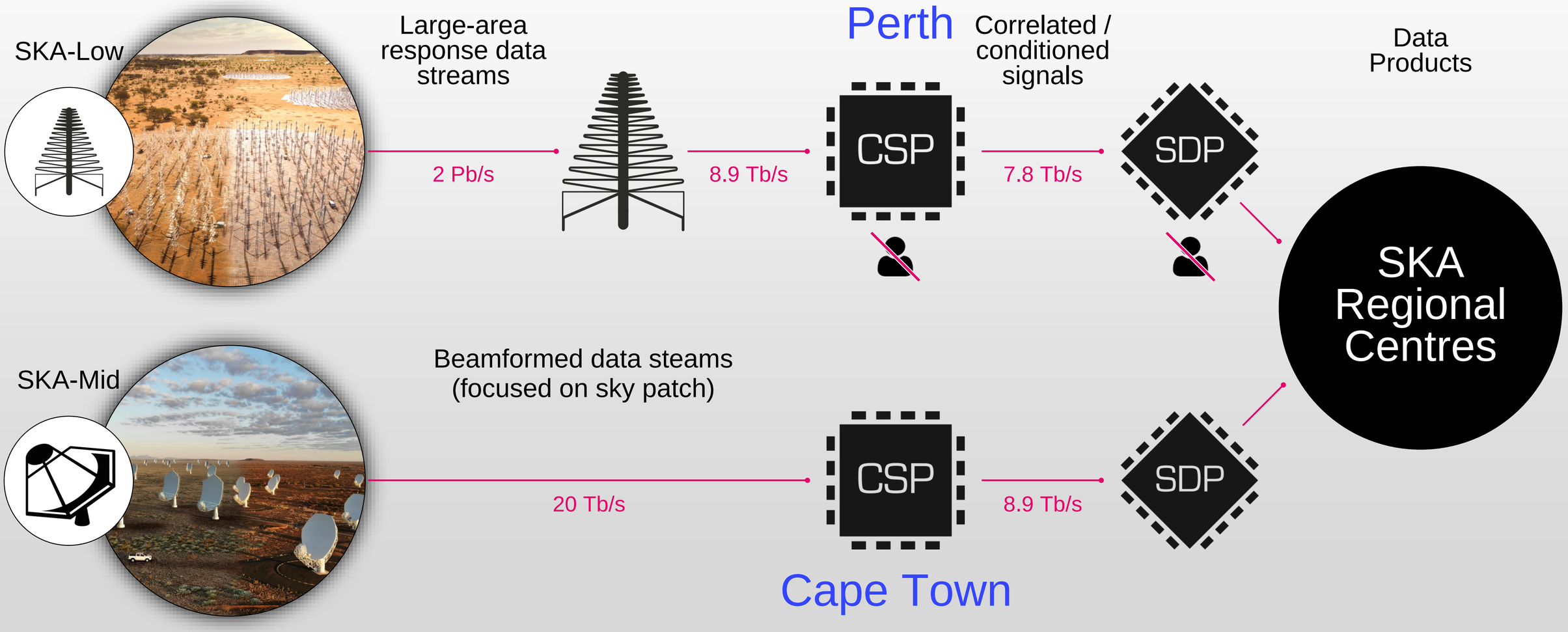
The Evolution of Performance



Credit:
Mark Sargent

Anticipated Science Performance: https://arxiv.org/abs/1912.12699

SKA Regional Centres:
SKAO data processing stages



Telescope Access, science driven, based on contribution level

Key Science Projects (KSPs)

- Large programs (>500 h ?) performed over multiple cycles
- PI & leadership team from SKA-member countries; co-Is from any country (latter may be limited)

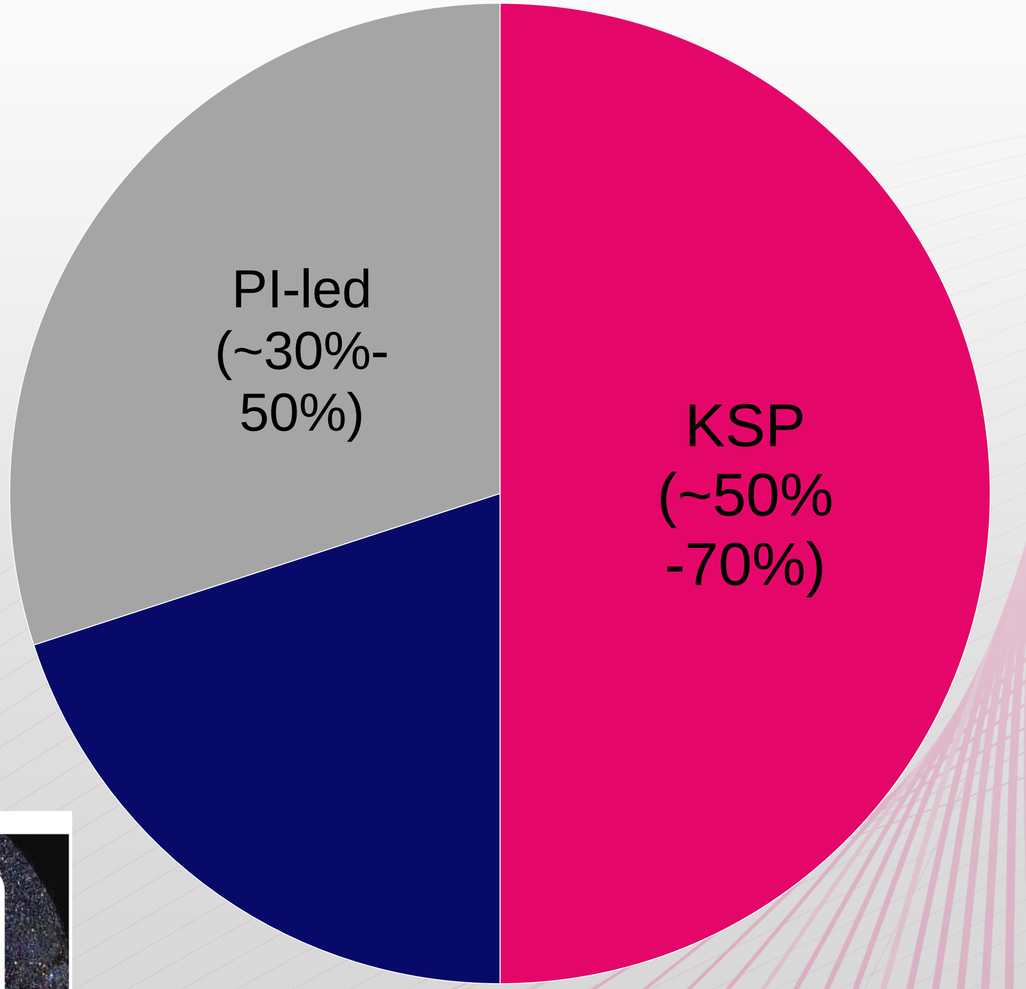
Principal Investigator (PI) Projects

- Small programs (<500 h ?) performed within a single cycle

Director-General's Discretionary Time

- Time allocated by the D-G outside of the normal TAC process

International time – fraction TBD



CONSTRUCTION BEGINS

Delivering the SKA Observatory

Delivering the SKA Observatory

South Africa: 36 staff as of end April 2023; ~150 for operations

Interim Science Operations Centre, Cape Town

Engineering Operations Centre, Klerefontein

Delivering the SKA Observatory

Australia: 41 staff as of end April 2023; ~150 for operations

Interim Science Operations Centre at the ARRC in Perth

Interim Engineering Operations Centre, Geraldton

Protection of the Dark and Quiet Sky

Credits:
Photo by: Trevor Dobson CC BY-NC-ND 2.0

Protection of the Dark and Quiet Sky

Address through:

- Work with satellite companies
- SKAO is a Sector Member of ITU
- SKAO is a permanent Observer in UN COPUOUS

- SKAO and US NOIRlab formed Centre for the Protection of Dark & Quiet Skies (IAU CPS)

Credits: Satellites Behind Pinnacles

Image credit and copyright: Joshua Rozells

Summary

- SKAO Construction activities are proceeding at pace; residual design issues are being dealt with professionally and expeditiously
- Level of risk for the project has increased due to the global situation; mitigations are underway, but they require the commitment of additional resources from Members and the accession of new Members.
- SKAO presence in the site host countries is a major positive milestone
- SKAO science is now clearly on the horizon.

WE HAVE BEGUN

Thank you for your time…

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

SKAO

www.skao.int