



MeerKAT+ & SKAO

Marcello Giroletti

INAF Istituto di Radioastronomia, Bologna

Giornate del RSN4 - 29/1/2026 - Auditorium Nazionale INAF, Napoli

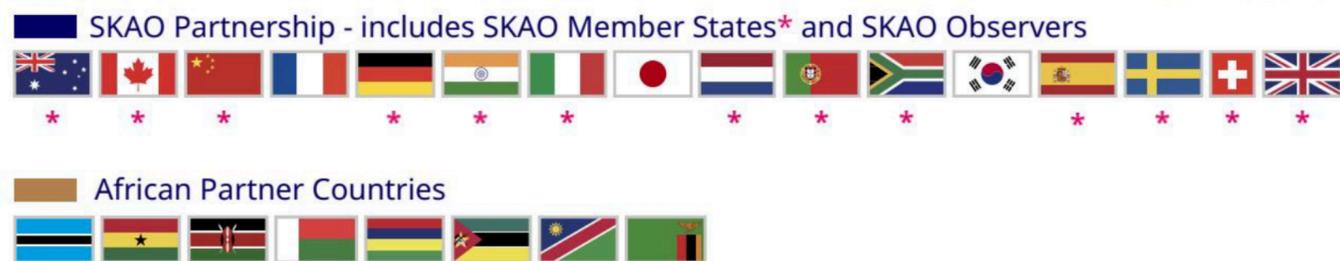
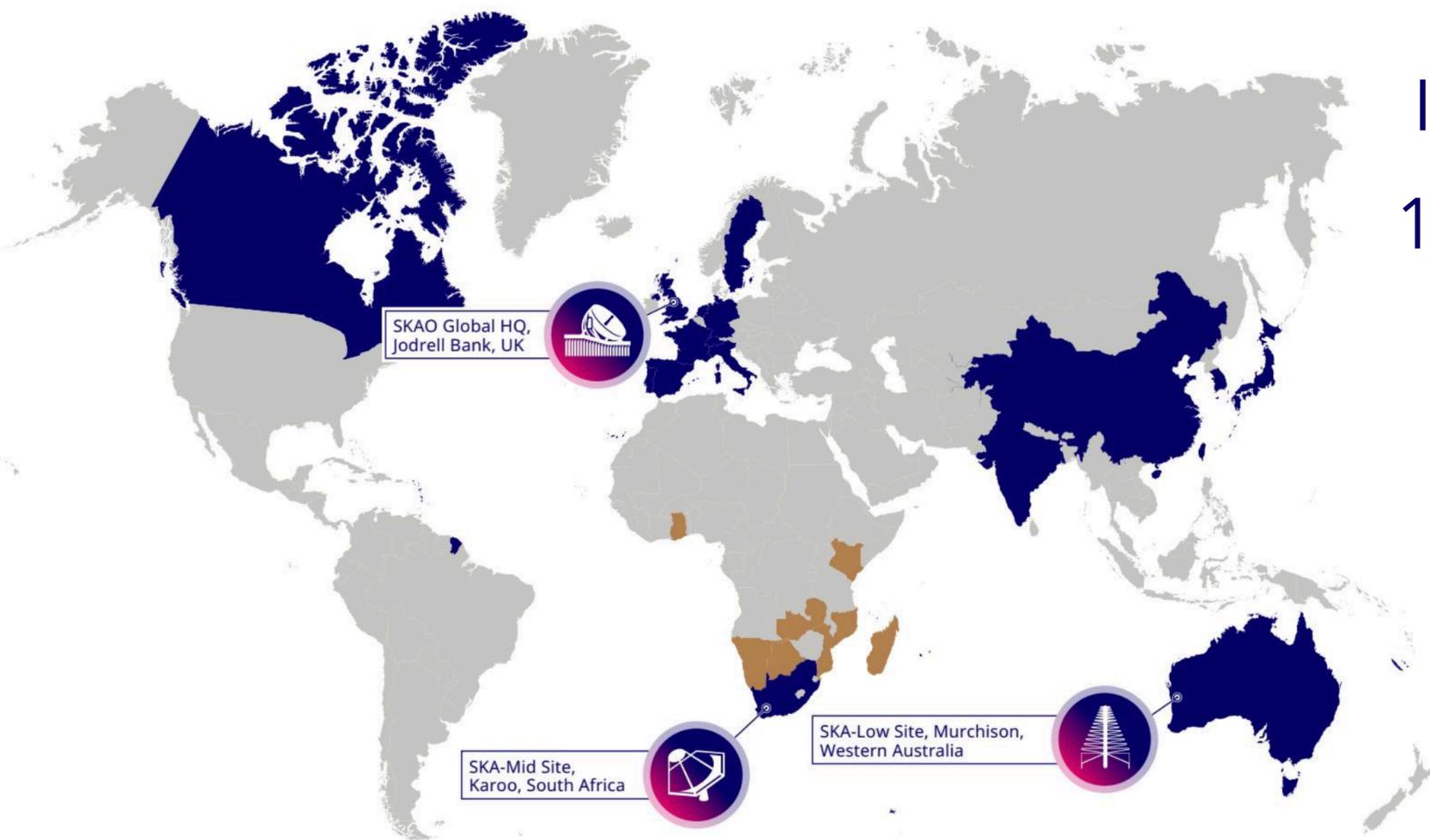
Outline

- Overview of the Square Kilometre Array
 - Project
 - SKA-low & SKA-mid: features and timeline
 - SKAO & RSN4
 - Science with the precursors: **MeerKAT**

The SKA Observatory



1 observatory, 2 radio telescopes, 3 sites
 Intergovernmental organisation since 2021
 13 Full members & 3 observers (as of 12/25)



SKA-LOW

THE SKA'S LOW-FREQUENCY TELESCOPE

LOCATION: AUSTRALIA

FREQUENCY RANGE: 50 MHz–350 MHz

131,072 ANTENNAS
SPREAD ACROSS 512 STATIONS

MAXIMUM BASELINE: ~65km

SKA-MID

THE SKA'S MID-FREQUENCY TELESCOPE

LOCATION: SOUTH AFRICA

FREQUENCY RANGE: 350 MHz–15.4 GHz
WITH A GOAL OF 24 GHz

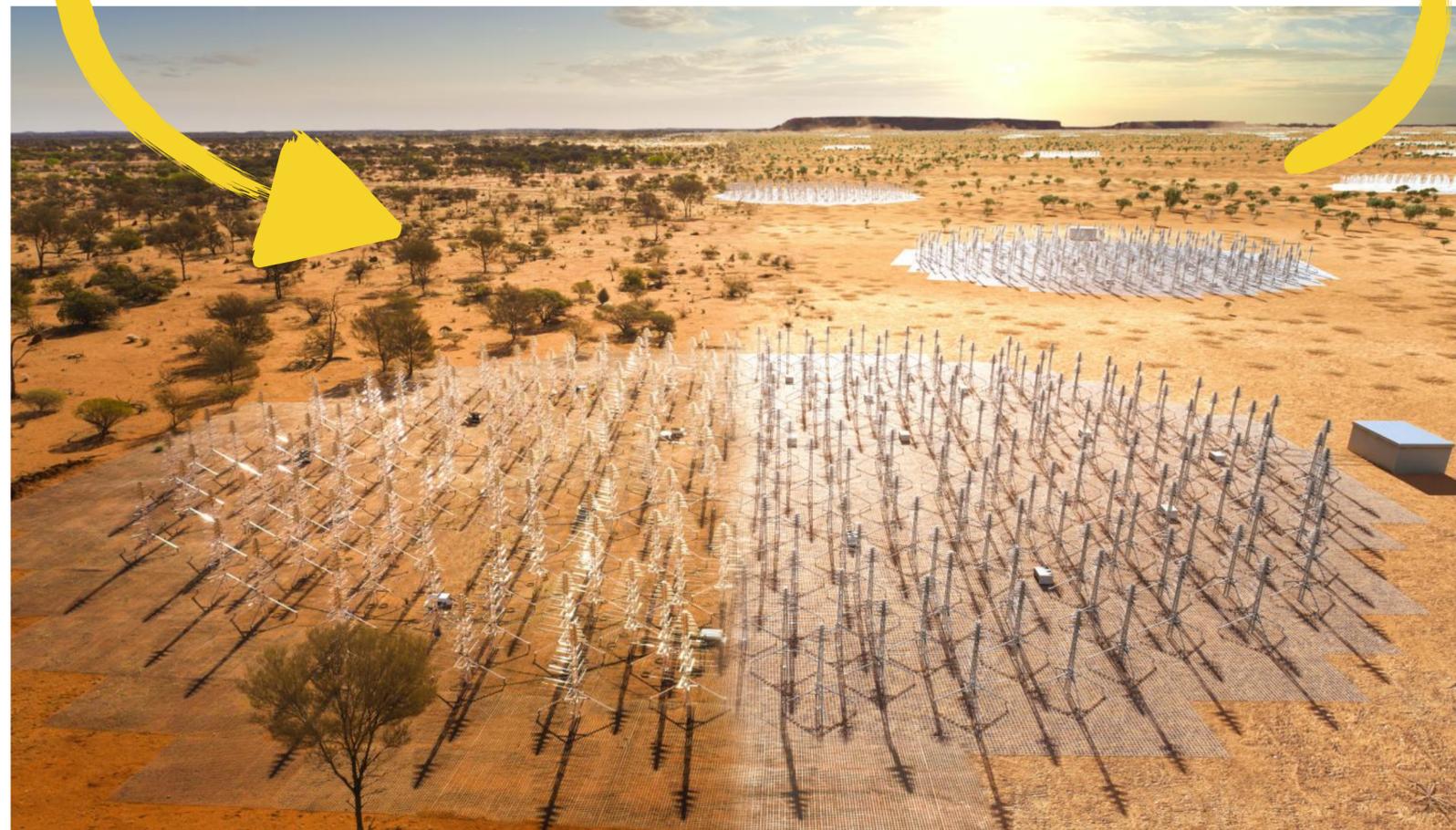
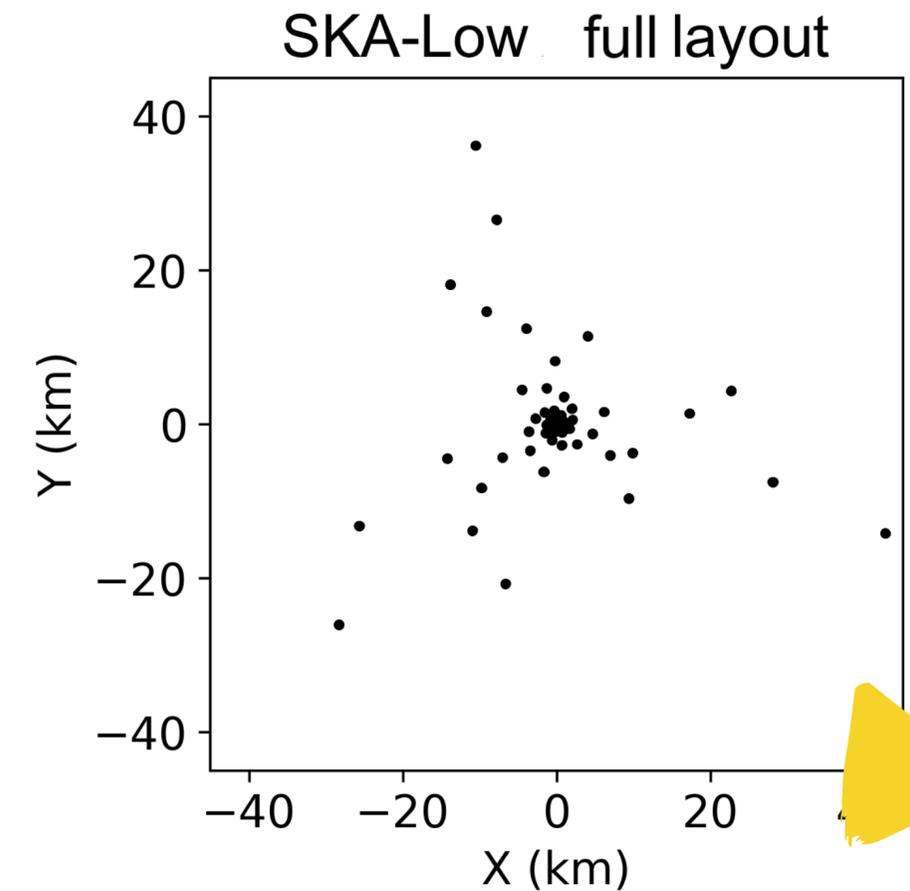
197 DISHES
(INCLUDING 64 MEERKAT DISHES)

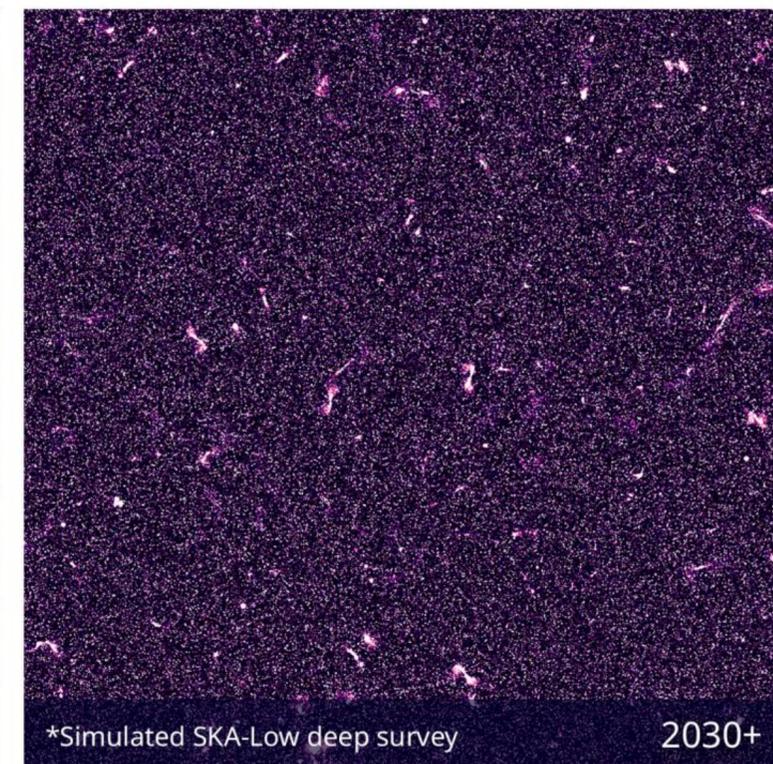
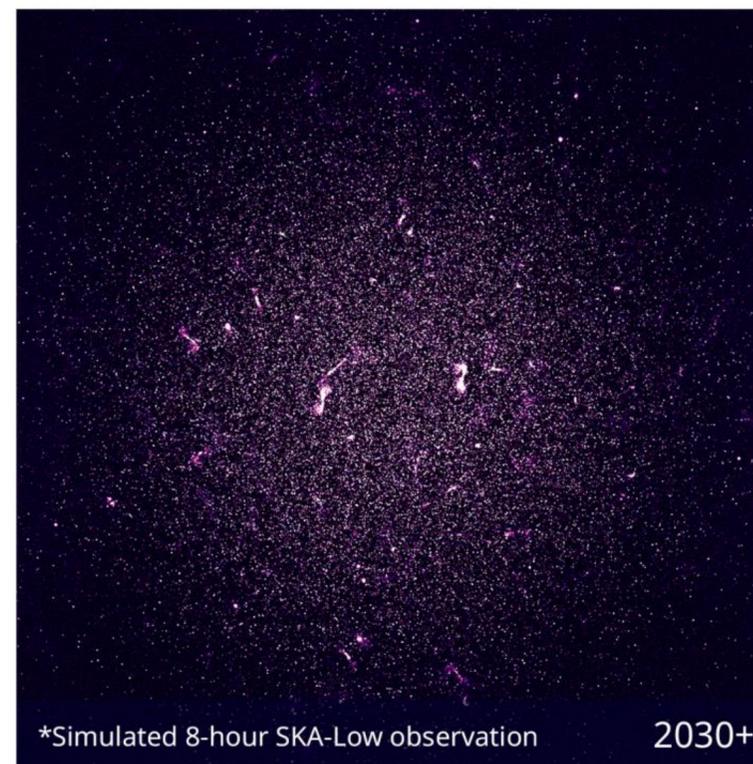
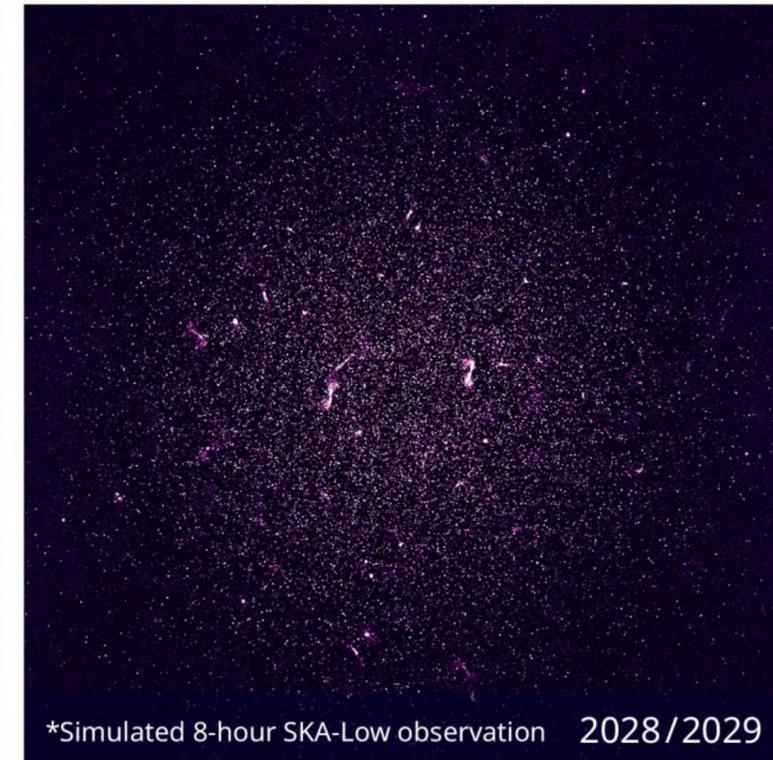
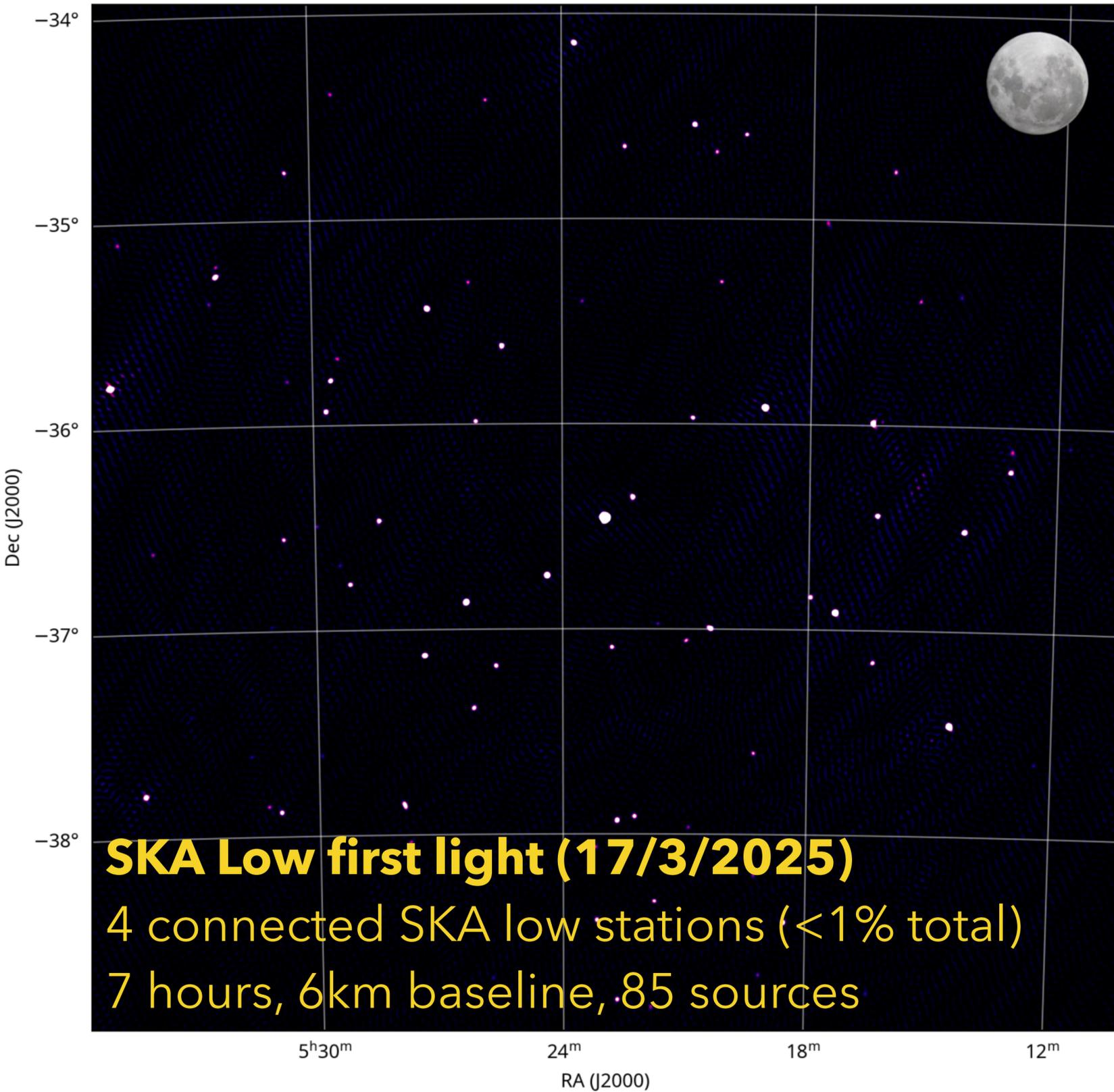
MAXIMUM BASELINE: 150km



SKA-Low

- Location: **Australia**
- Frequency range: **50-350 MHz**
- 131,072 antennas spread across 512 stations (256 2-m tall antennas each)
- Maximum baseline: **65 km**
- Aperture phased array: **no moving parts - digital beamforming**
- Close-packed pseudo-random configuration







SKA-Mid

- Location: **South Africa**
- Frequency range: **350 MHz-15 GHz**
- **133x15m** dishes + **64x13.5m** MeerKAT dishes
- Maximum baseline: **150 km**
- **Fully steerable** offset Gregorian dishes
- Inner core + pseudo-spiral arms

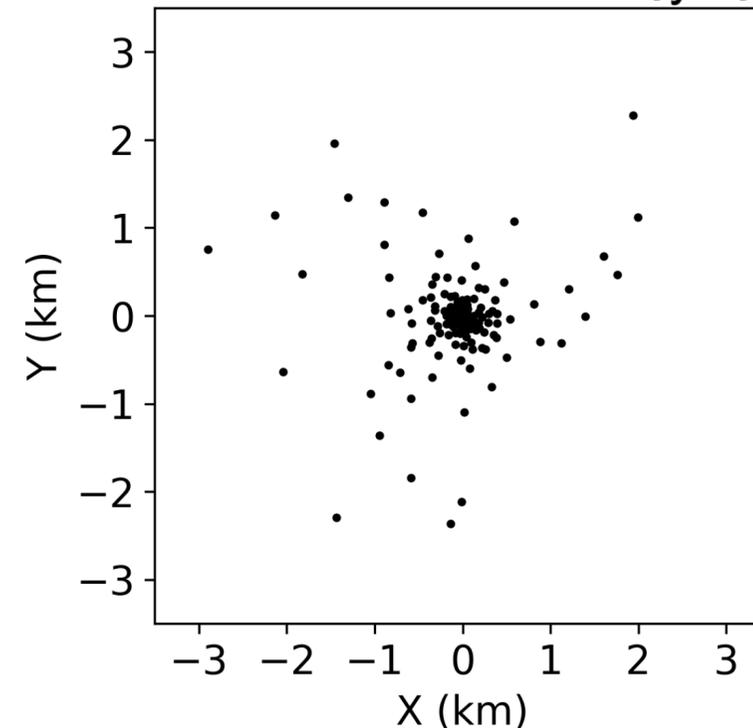
SKA-Mid dish



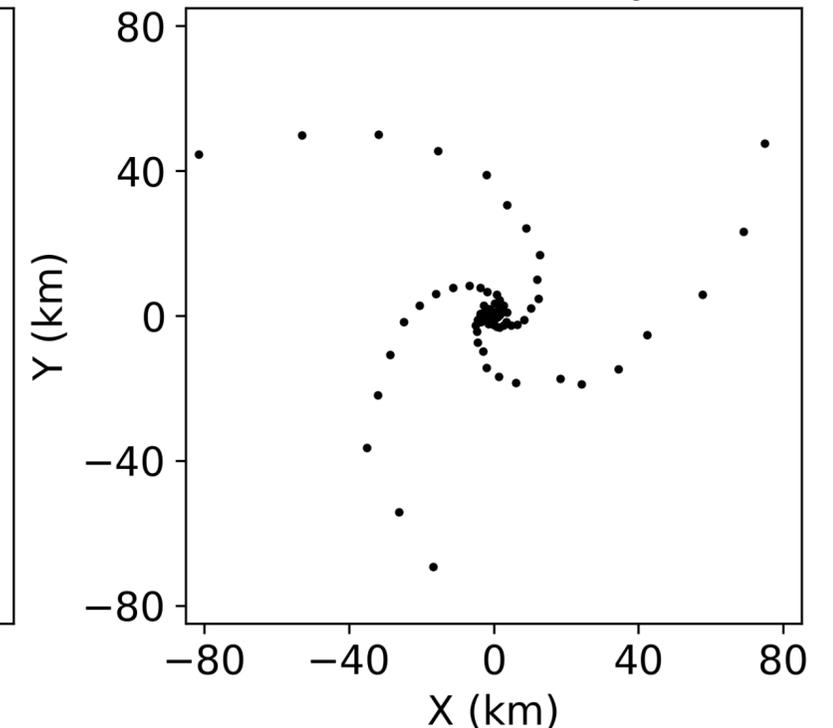
MeerKAT array



SKA-Mid inner core layout



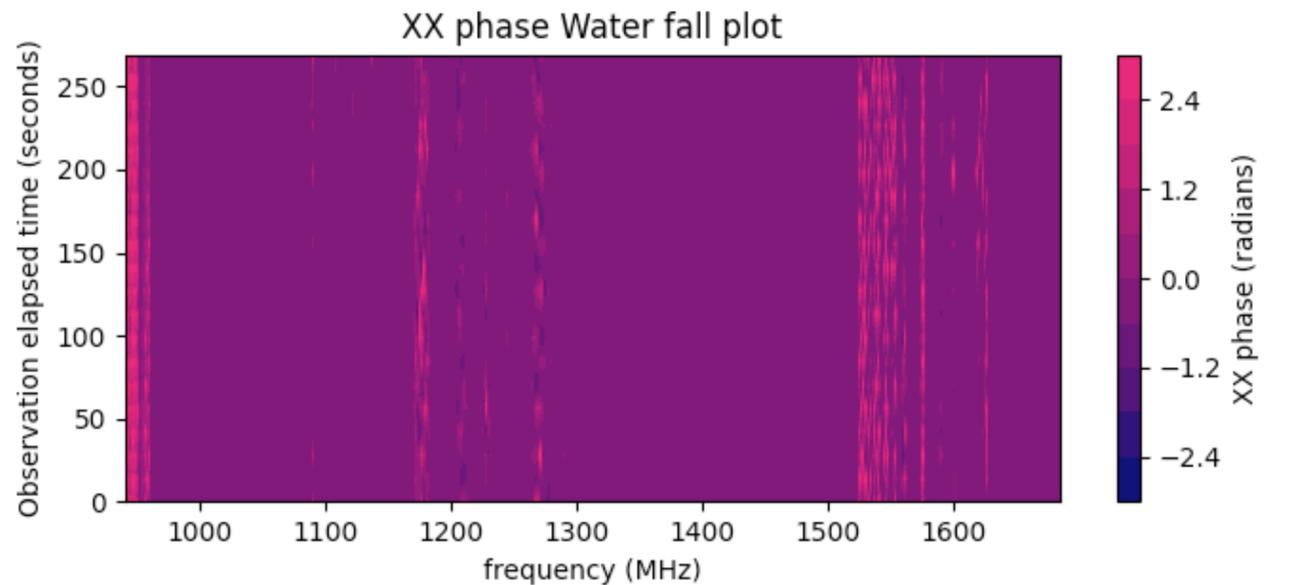
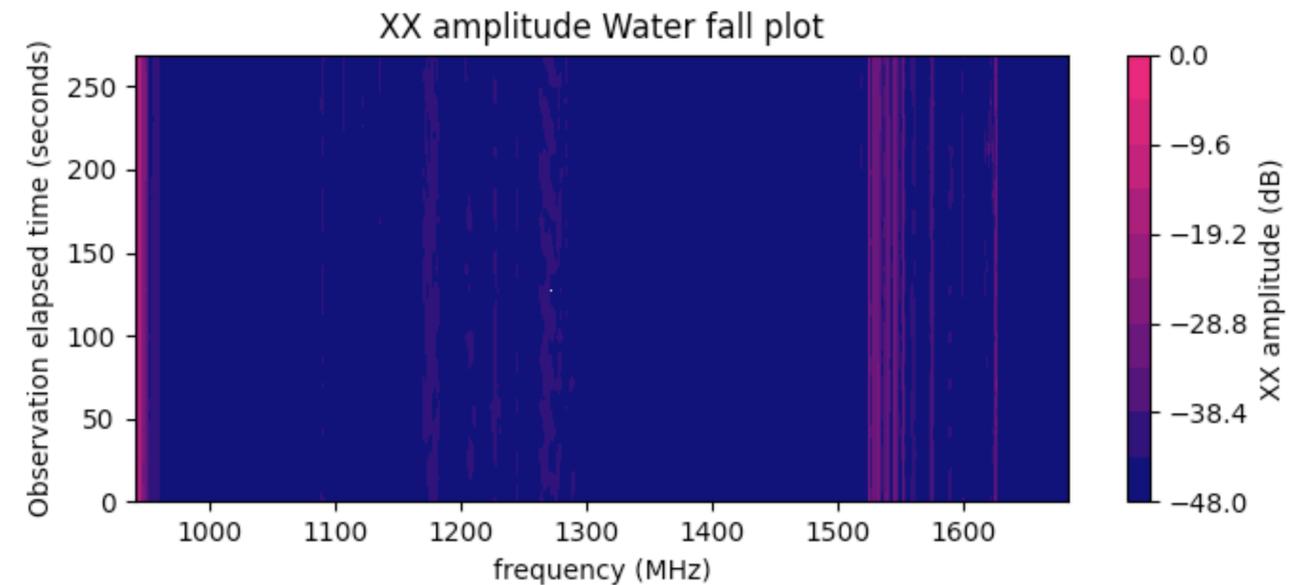
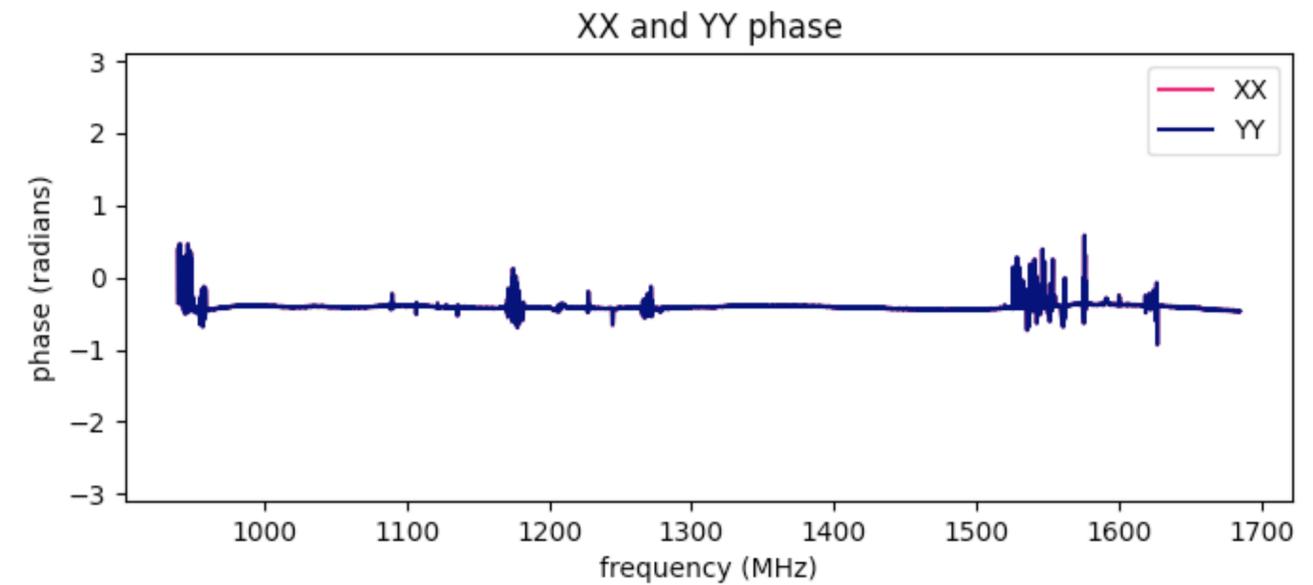
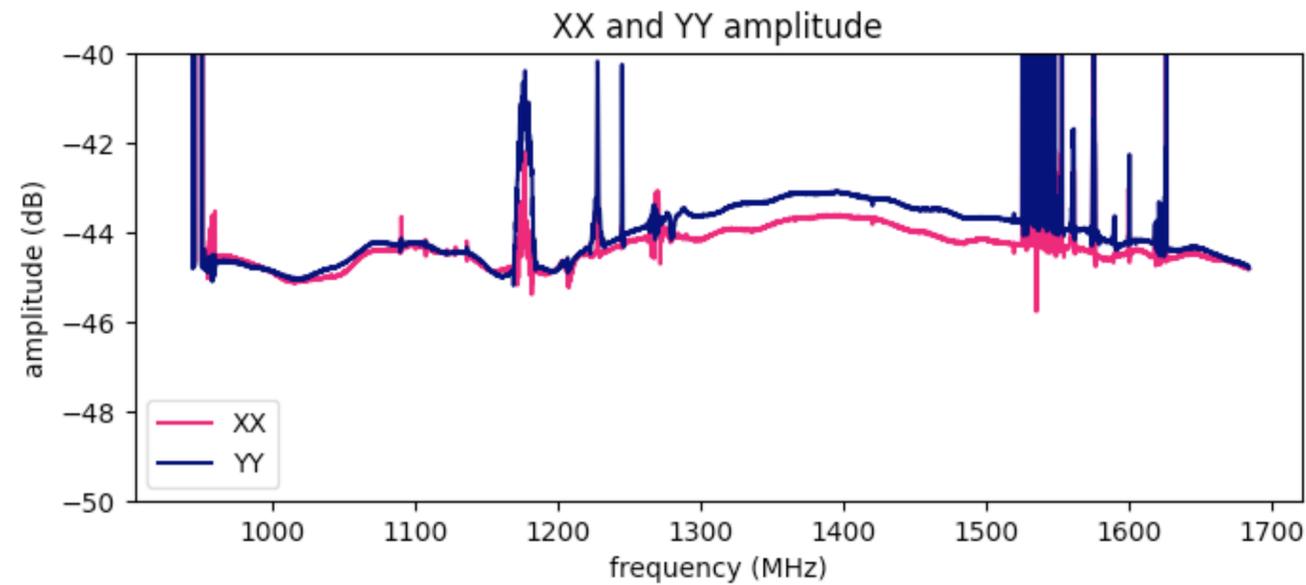
SKA-Mid full layout



SKA-Mid first fringes

Press release **7 Jan 2026** - QSO J1939-634
SKA001-SKA100 (439m bs)

Band 2 SKA001-100 cross-correlation amplitude and phase toward J1939-634 on 5 December 2025

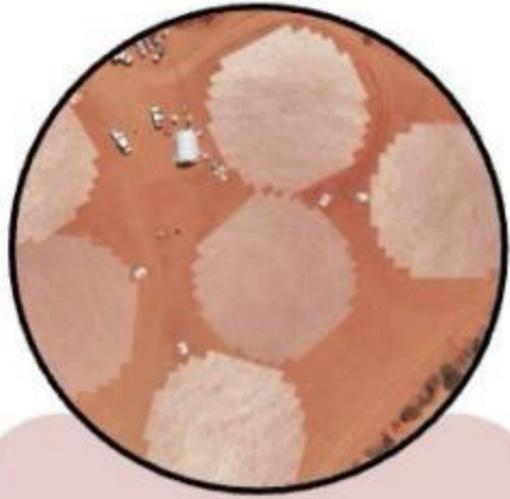


SKAO construction timeline

AA=Array Assembly

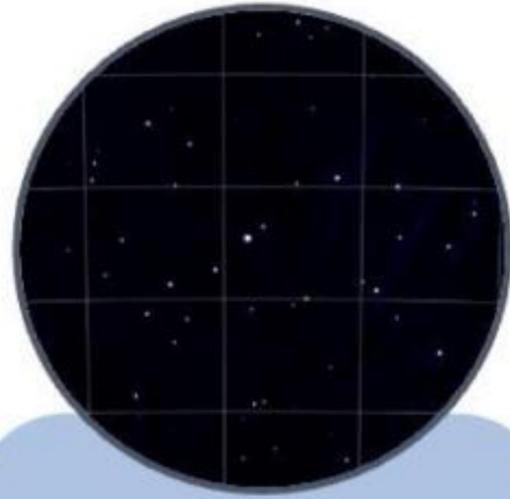
	SKA low 	SKA mid 
AA0.5	4 stations Q4/2024	4 dishes Q4/2025
AA2	64 stations Q4/2026	64 dishes Q4/2028
AA*	307 stations Q2/2029	144 dishes (incl. MK) Q2/2031
AA4	512 stations tbd	197 dishes (incl. MK) tbd





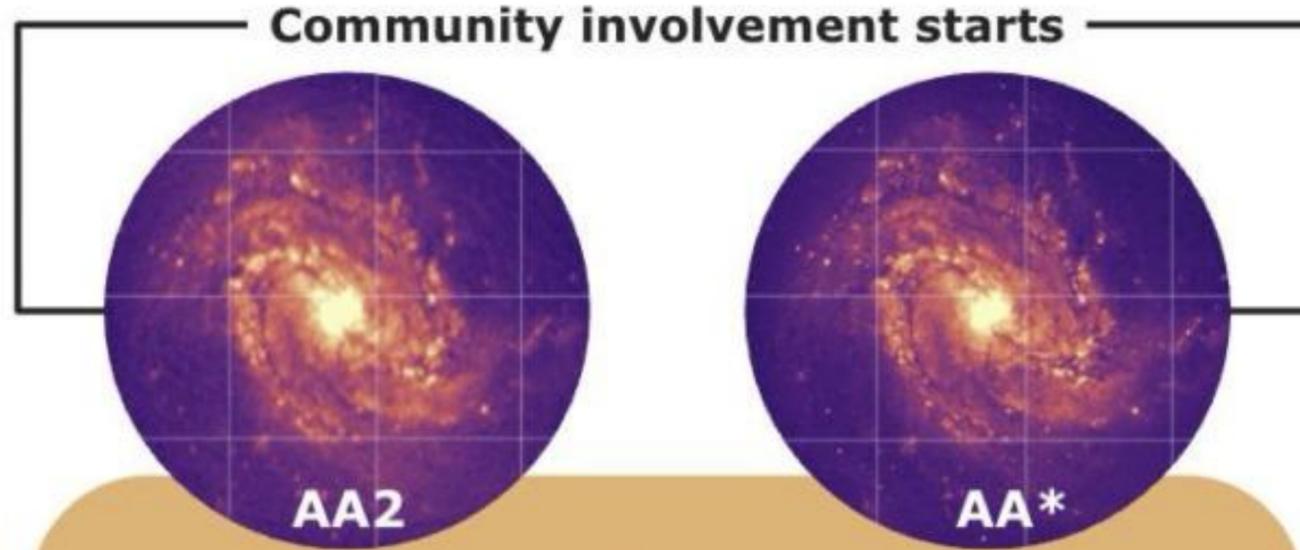
Construction

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



Commissioning

- SKAO activity
- Collaborative across system verification and science commissioning

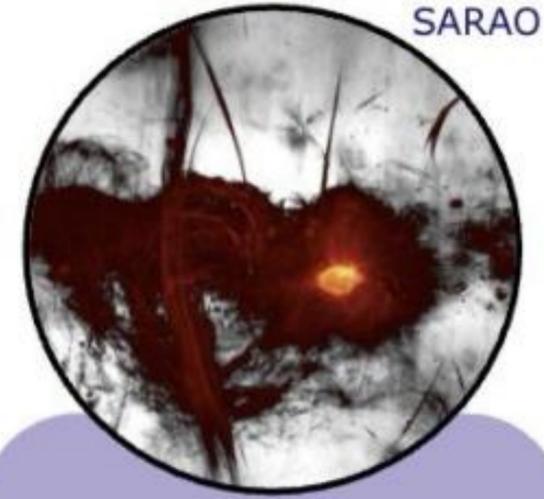


AA2

AA*

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

Credit: I. Heywood, SRAO



Now

Now

First half 2027

First half 2029

2030



Now

Soon

First half 2029

First half 2031

2032

Scientific timeline

*Calls will include available modes and capabilities

SV AA2



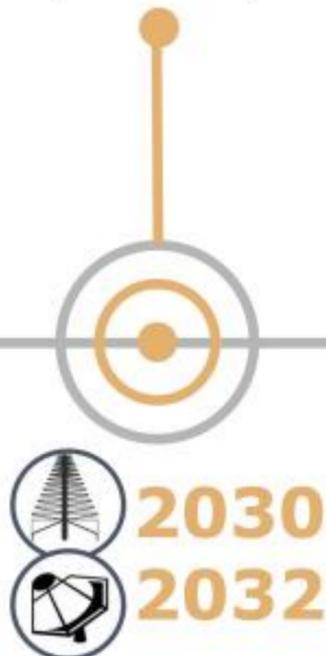
Calls* for Science Verification ideas and PI proposals come 6 months ahead of SV/each cycle



SV AA*

Planning and call* for first KSPs
mid 2030
mid 2032

Cycle 0
Shared risk: PI and DDT with attributes: Joint SKA, coordinated projects (limited), ToO (limited)



Cycle 1
Shared risk: PI and DDT with attributes: coordinated projects (increased), ToO (increased).
Standard Ops: PI and DDT with attributes: Joint SKA

Cycle 2
Standard Ops: PI and DDT with attributes: Joint SKA, coordinated projects, long term projects, ToO



Cycle 3
Standard Ops: KSP, PI and DDT with attributes: Joint SKA, coordinated projects, long term projects, ToO



SKA operations and policies

- **Highly flexible** telescopes to cover a **wide** range of **science** cases
- Imaging (continuum and spectral) and non-imaging (timing) modes
- Expected output rate 700 PB/year
- **Members and non-members** will have access to **different portions** of the **observing time**
 - only Members can be leader of **KSPs**
- **Exact shares** of times and list of KSP still **TBD**

SKAO Science
Working
Groups



Cosmology



Cradle of Life



Epoch of
Reionization



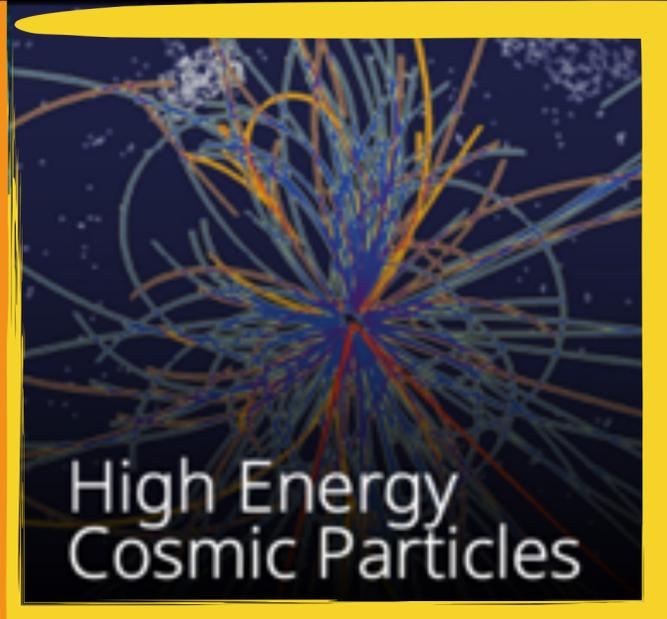
Extragalactic
Continuum



Extragalactic
Spectral Line



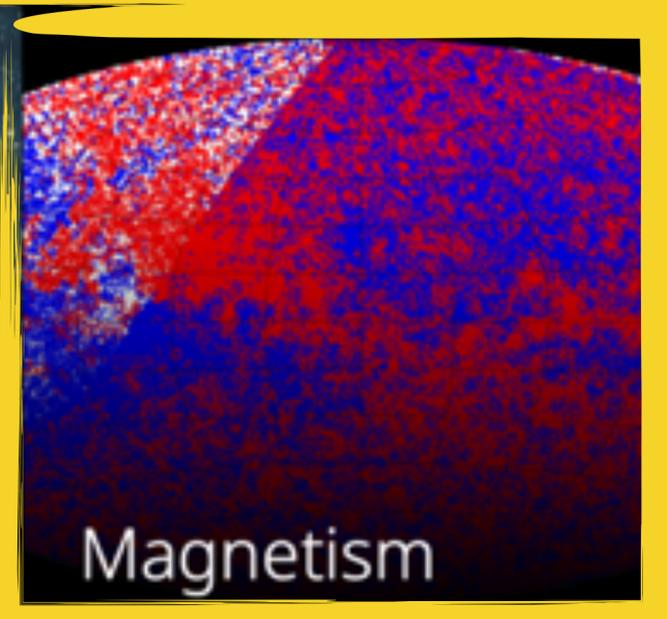
Gravitational
Waves



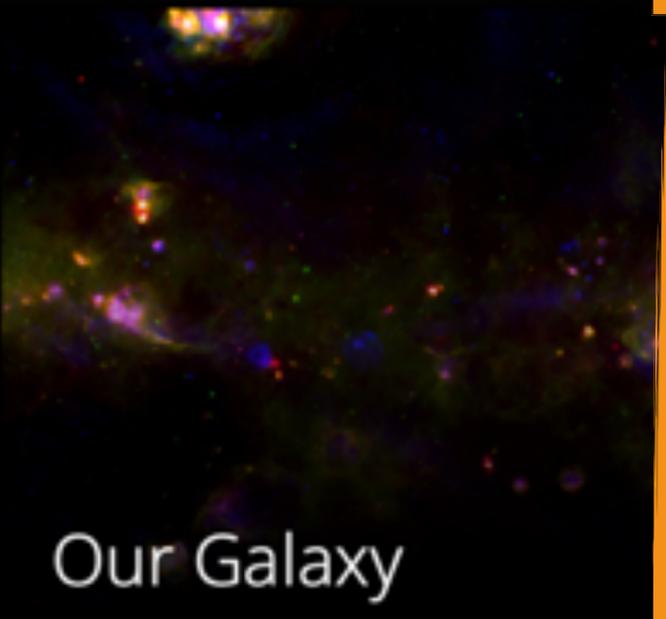
High Energy
Cosmic Particles



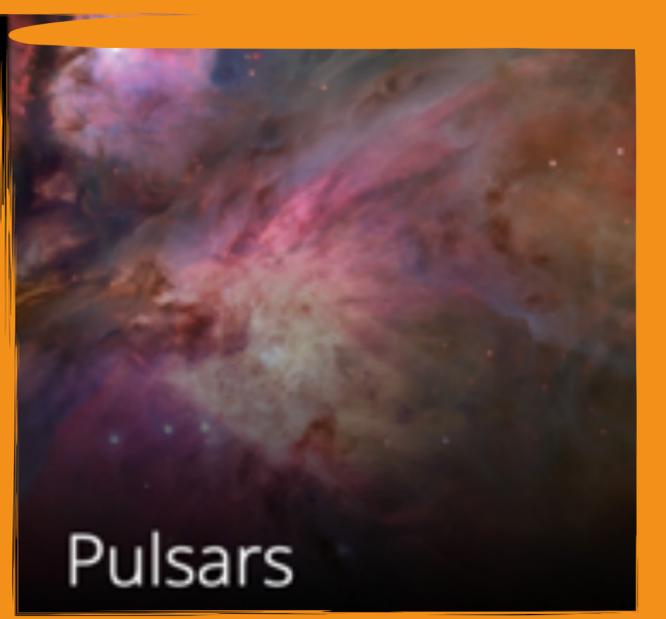
HI Galaxy
Science



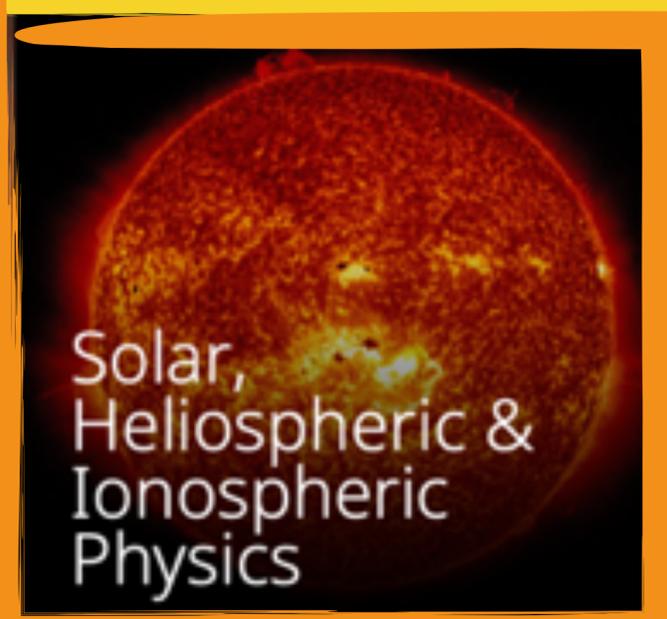
Magnetism



Our Galaxy



Pulsars



Solar,
Heliospheric &
Ionospheric
Physics



Transients



VLBI

2025 science activities

- 2nd SKAO science meeting in Goerlitz (600+ participants)
 - Submission of **Chapters** for new **Science Book**
- Fifth Italian SKA workshop (180+ participants); **RSN4:**
 - 18 talks and 5 posters
 - 7 on AGNs/lensing, 16 on time-domain
 - IRA, IAPS, OAS, OACa, OABr, OAR
 - 10 staff, 9 postdocs, 4 students

FROM
PRECURSORS
TO SKAO:
SHAPING THE
FUTURE OF
ITALIAN
RADIO
ASTRONOMY



SKAO Science book

- ~250 total chapters submitted across 16 topics
- 75 on RSN5 topics (~30%), 34 with INAF lead (~14%), **12 on RSN4 topics with INAF lead** (5%)
 - 5 different structures (IRA, OACagliari, OABrera, OAS, IAPS)
 - AGNs/jets, transients (GRBs, FRBs, XRBs, novae), gamma-ray and multi-messenger (GW) synergies

INAF RSN4 leadership in Science book Chapters

- Three-dimensional Tomography of the Galactic and Extragalactic **Magnetoionic Medium** with the SKA - **OABrera**
- Observing **Radio Pulsars in the Galactic Centre** with the Square Kilometre Array - **OACagliari**
- **Gamma-ray Bursts** and **Kilonovae** from **Gravitational Wave** Events - **IRA**
- **Novae and Symbiotics** with the Square Kilometre Array - **IRA**
- **Gamma-ray bursts** in the radio sky: the role of the SKA - **OABrera**
- Compact **radio galaxies**: the case of FR0s - **IRA**
- The emerging population of **high-energy radio galaxies** - **IAPS RM**
- SKA-VLBI view of **AGN radio** activity in the **early Universe** - **IRA**
- SKAO and **Gamma-Ray Synergies** - **OAS**

MeerKAT

- **64 x 13.5m** dishes with **6-km** max baseline, **0.8-3 GHz** freq. range
- Now MeerKAT **VLBI** with EVN



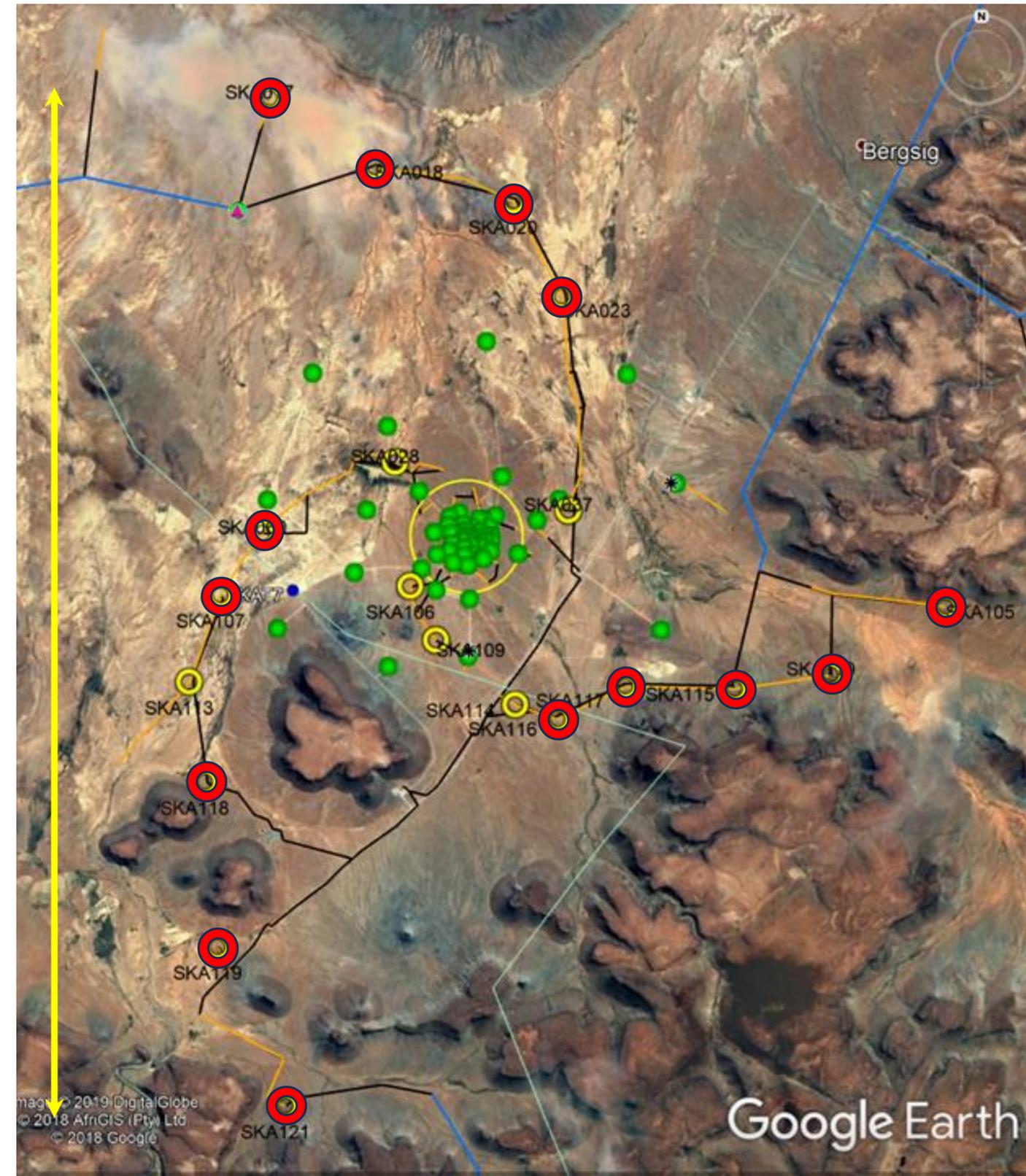
The banner features the NRF (National Research Foundation) and SARAO (South African Radio Astronomy Observatory) logos on the left. The text reads: "June 2025 Press release" in red, followed by "An Earth-sized radio observatory just got better: South Africa's MeerKAT telescope joins forces with the European VLBI Network of telescopes".



- Two major upgrades with **INAF participation** before transition to SKA1-Mid
 - **MeerKAT+** - enhancing angular resolution and sensitivity
 - **Band5B** - increasing observing wavelength and angular resolution

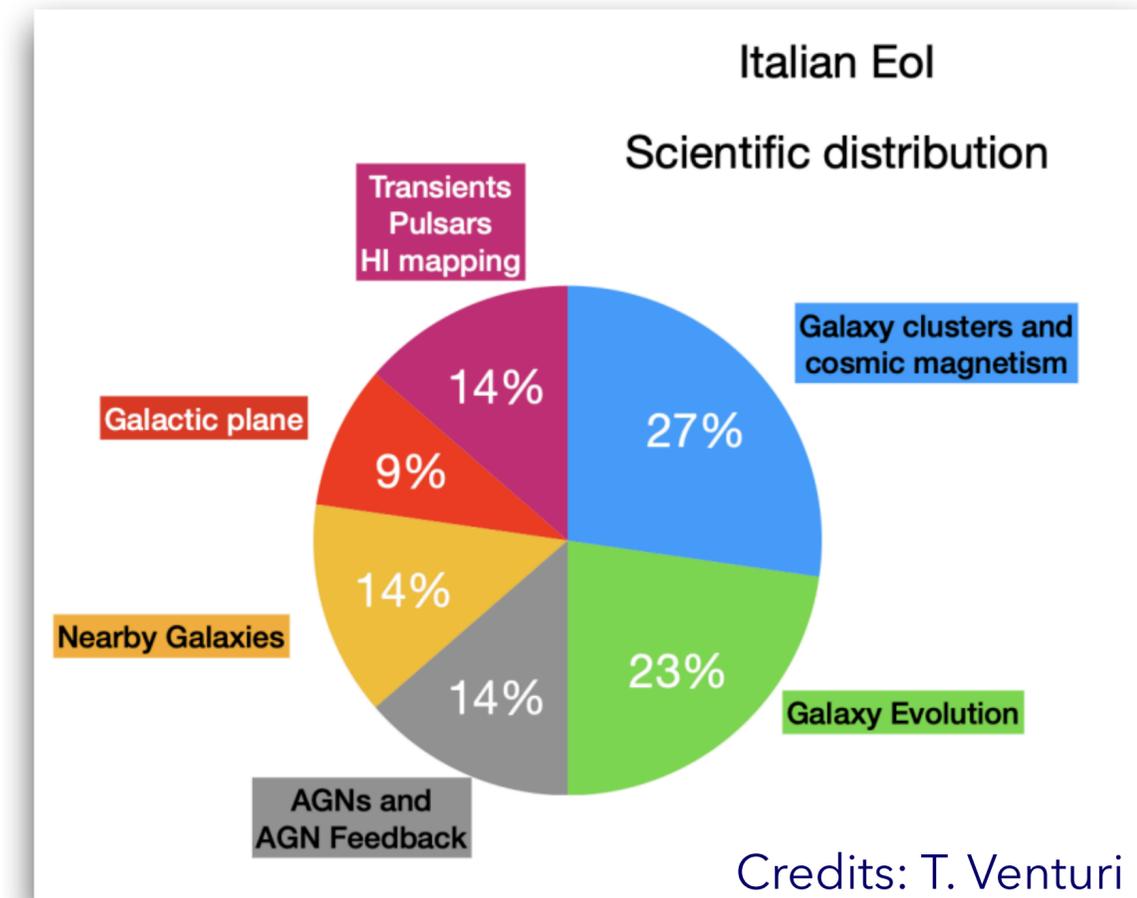
MeerKAT+

- MeerKAT+ is an enhancement of MeerKAT through **installation of 14 additional SKA1-compliant** dishes
- Longer baselines (**up to 18km**) and additional **sensitivity** (~1.4x)
- Approved and funded by SARA0 (SA), MPG (D), and **INAF** (I)
- Installation and engineering commissioning through 2026
- Science commissioning and new correlator **after 2026**



MeerKAT+, INAF, and RSN4

- **136 INAF authors** involved in **definition of science ideas** through internal process in 2021-23 (white paper, call for proposals, workshop)
 - Full-Stokes S-band southern sky survey
- ~10% of total **reserved time** for consortium (~**500 hr/yr**) up to integration in SKA1
- Technological involvement (dish monitoring and control, new correlator)



MeerKAT - Band 5B

- SKA1 Band 5B = **8.3-15.4 GHz** - not planned for MeerKAT retrofit
- PNRR-STILES funds for installation of **64 receivers** (PI G. Umana)
- Kickoff meeting: 7/2024, 1st receiver accepted: 10/2024, 52 **receivers on site in 11/2025**, the others on the way (by ship)
- Integration in MeerKAT will start in 2026, commissioning in 2027

MeerKAT Band 5 Scientific Roadmap

Strategic Science and Observation Planning

INAF – Istituto Nazionale di Astrofisica
SARAO – South African Radio Astronomy Observatory

January 29, 2026

Prebiotic molecules in Solar system precursors

VLBI

Pulsars in the Galactic centre

Cluster shocks

Accretion and ejection in AGN

Census of HCHII and UCHII regions

Transient science.

Filamentary structures in the Milky Way.

Jet-ISM interaction structures around X-ray binaries

Molecules at high redshifts

Radio stars

Radio Recombination Lines (RRLs)

Supernova Remnants

Synergies with high-energy facilities

The interplay between star formation and nuclear activity in the distant Universe.

Largely thanks to MeerKAT we have **the first statistically robust results** on the **properties of jets** from low mass XRBs

Fast Jets

$> 0.7 c$

Exclusively
from black holes

Propagate along the
same direction

Locked to the black hole
spin axis

Slow Jets

$< 0.7 c$

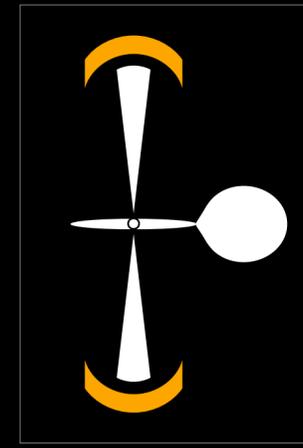
From both black holes and
neutron stars

Slow jets can precess or
change angle

Launched from the
precessing disk

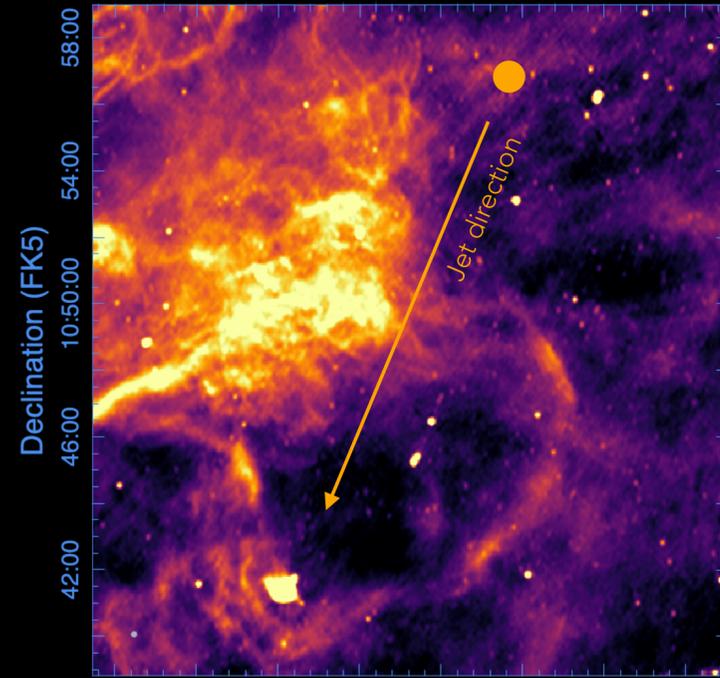
No correlation between **jet speed** and the **spin**

EXTENDED JET STRUCTURES



"THE microquasar"

GRS 1915+105

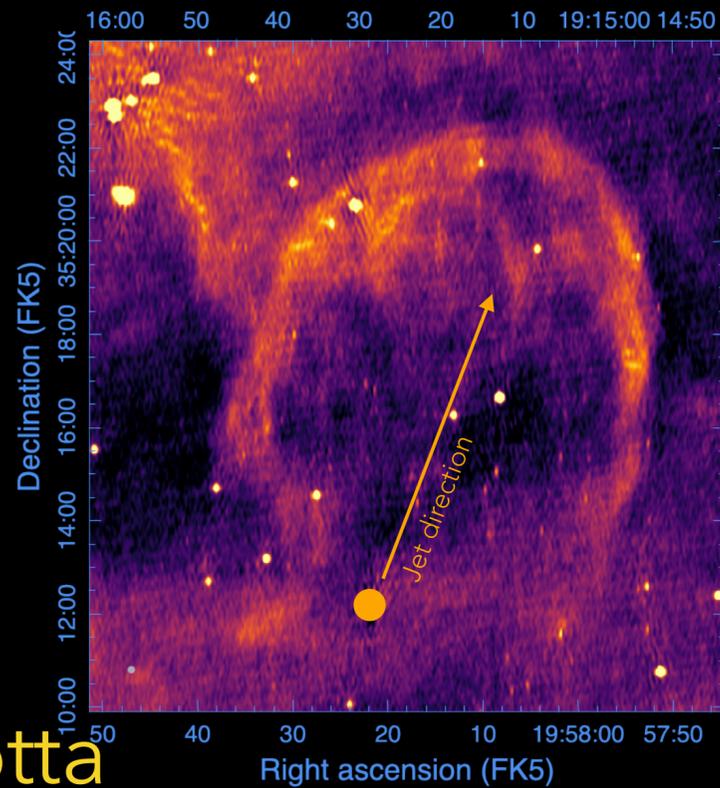


Motta, Atri et al. 2025

Jets from **XRBs** carve huge cavities (> pc) in the ISM, aged kyr to Myr

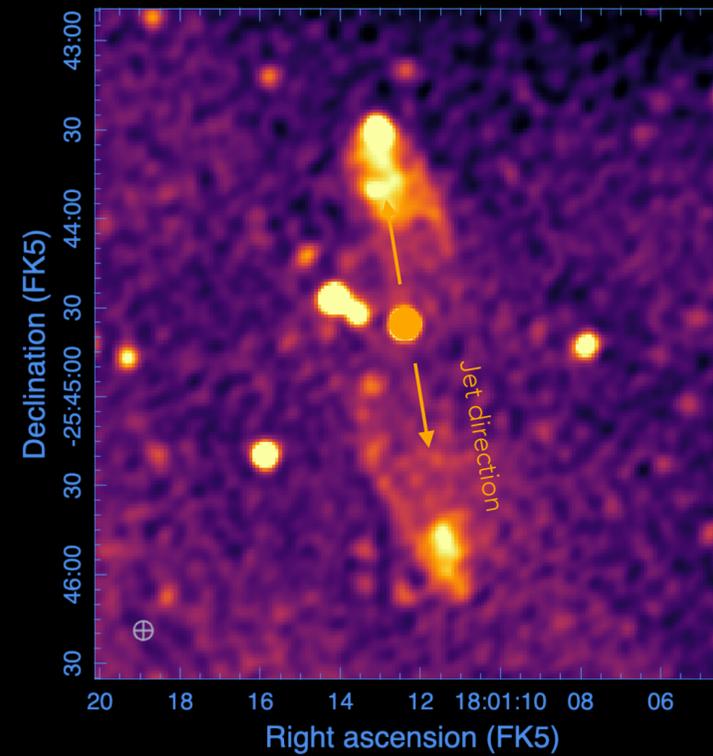
The **energy transferred** is comparable with the **accretion energy** $\sim 10^{34} - 10^{40}$ erg/s

Cyg X-1



Atri, Motta et al. 2024

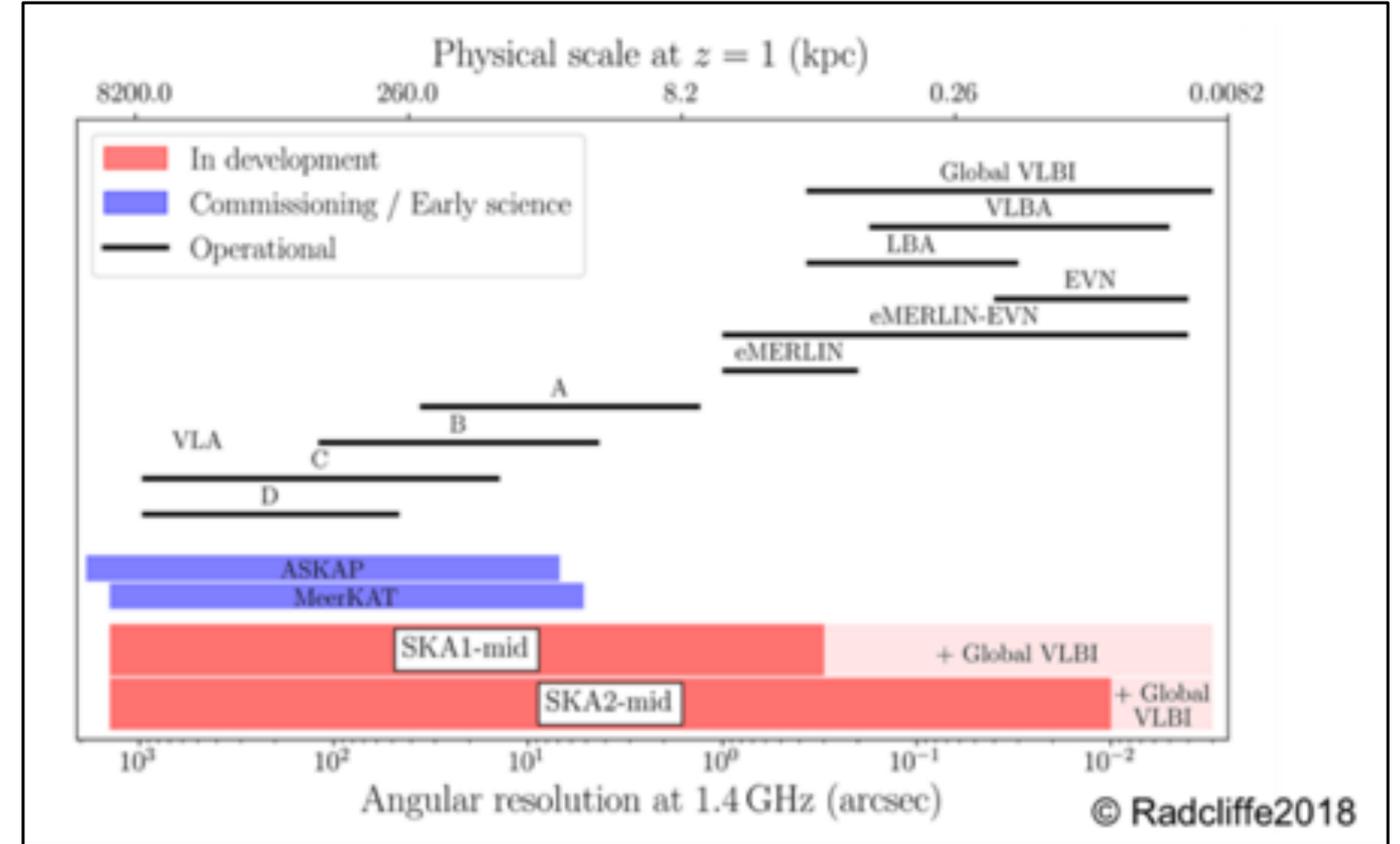
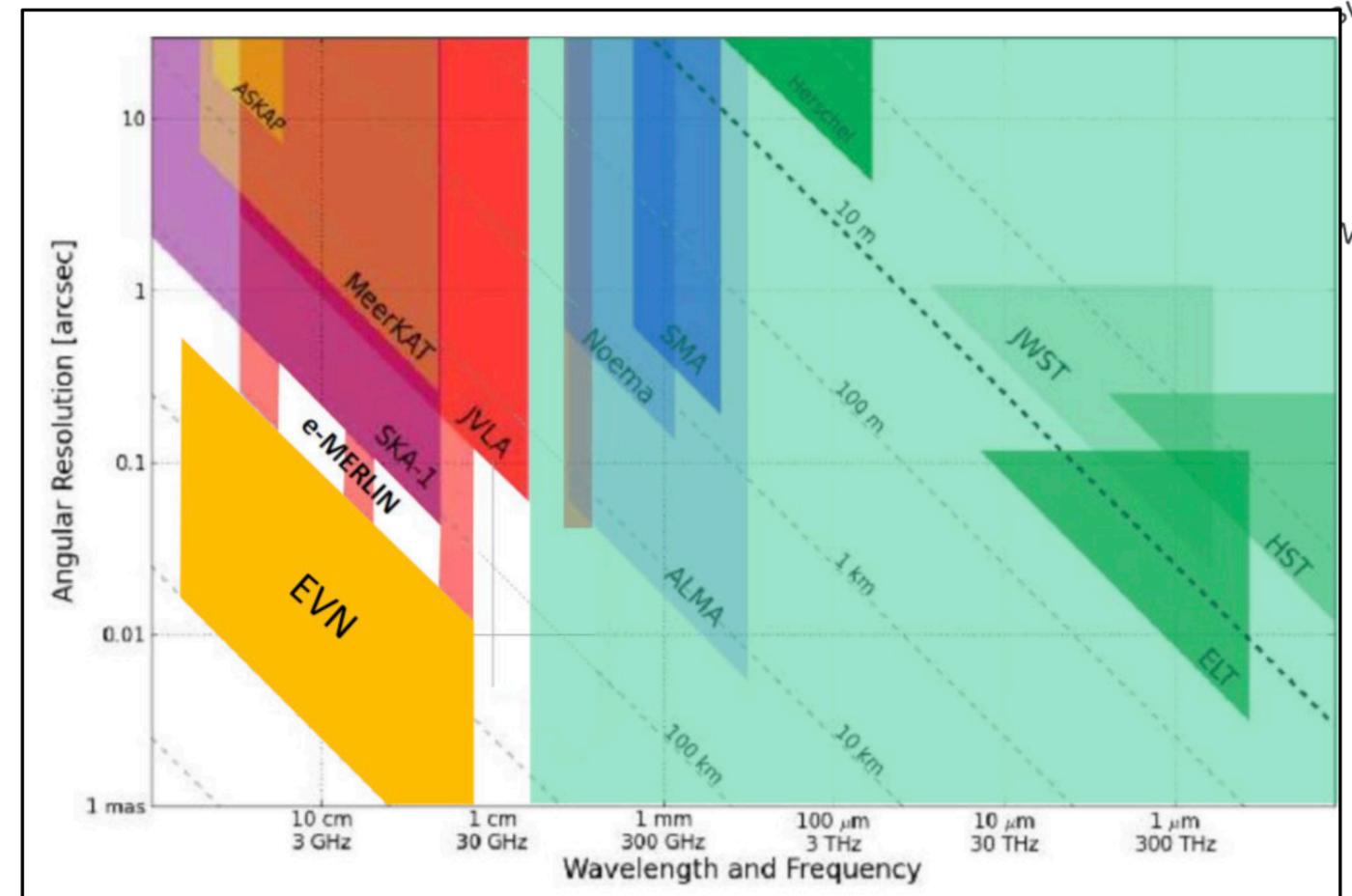
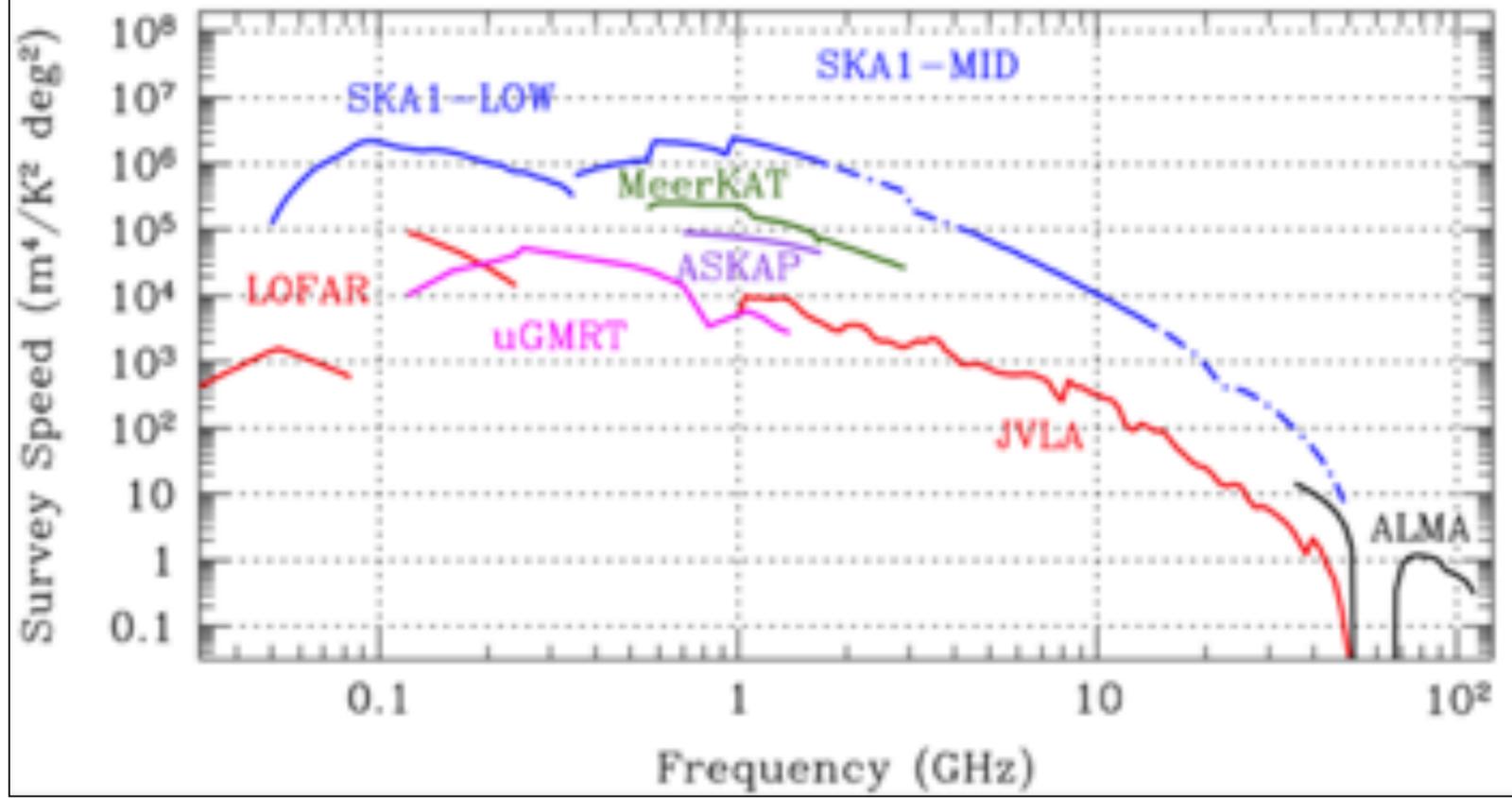
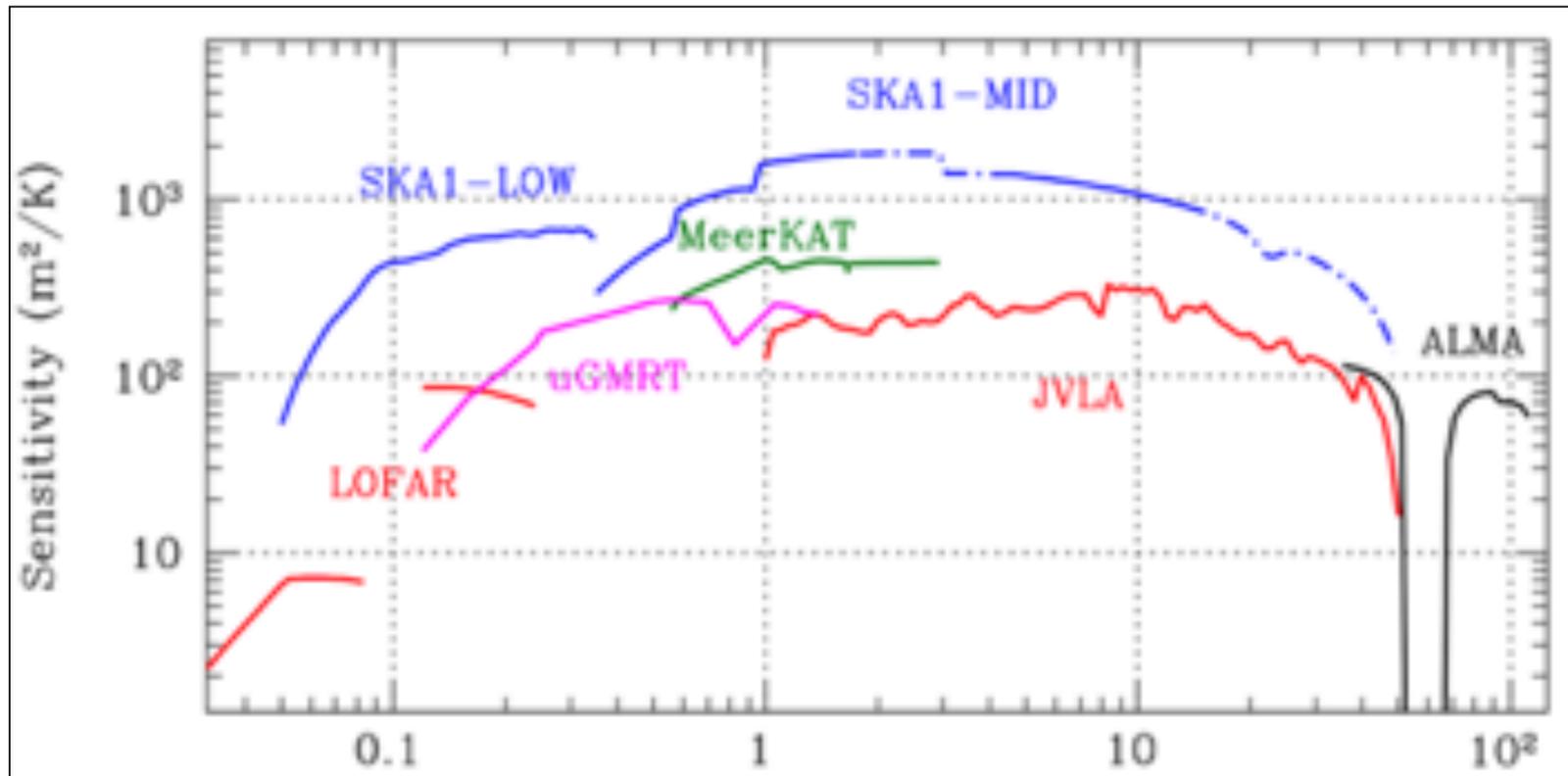
GRS 1758-258



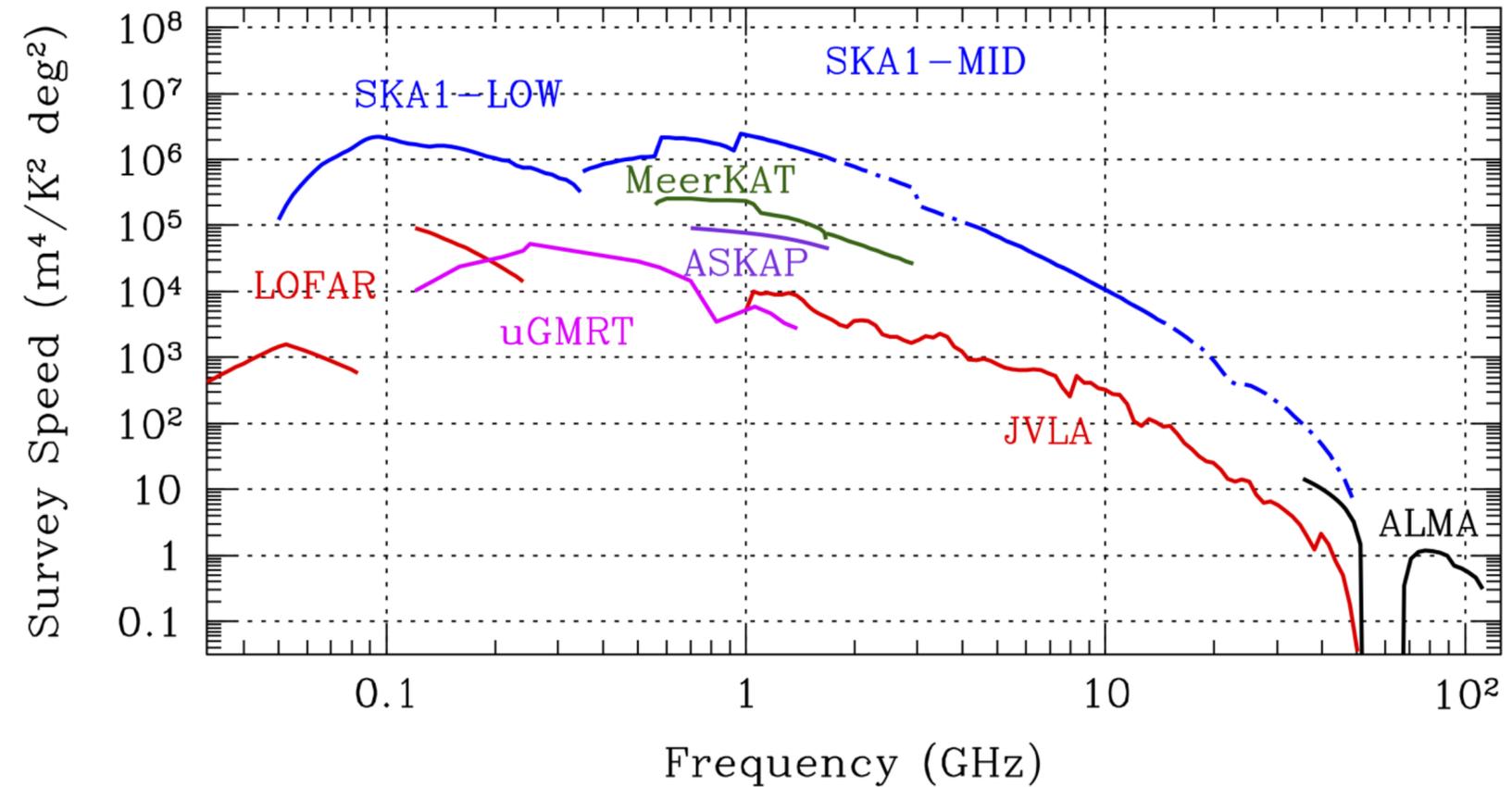
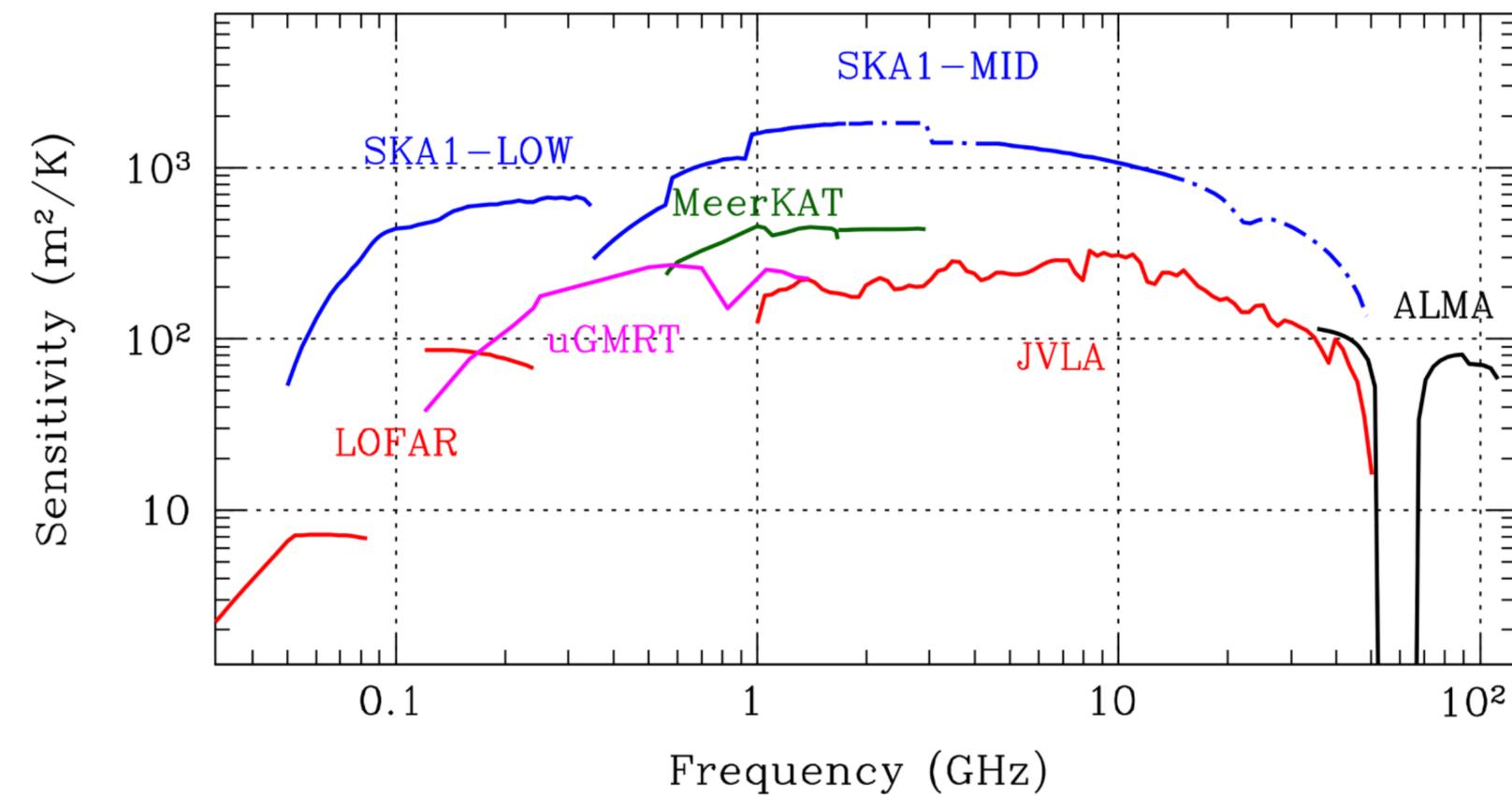
Mariani, Motta et al. 2025

Outlook

- Pathfinders and precursors have already significantly expanded INAF's RSN4 expertise towards SKAO in terms of science topics, structures, career stage
 - Room for further expansion (more science topics, more international visibility/leadership)
- SKAO construction is making progress, science will come soon
- MeerKAT+/Band5B is **now!**



SKAO features



- Major improvements with respect to existing facilities on:
 - Sensitivity
 - Survey speed
 - Frequency coverage

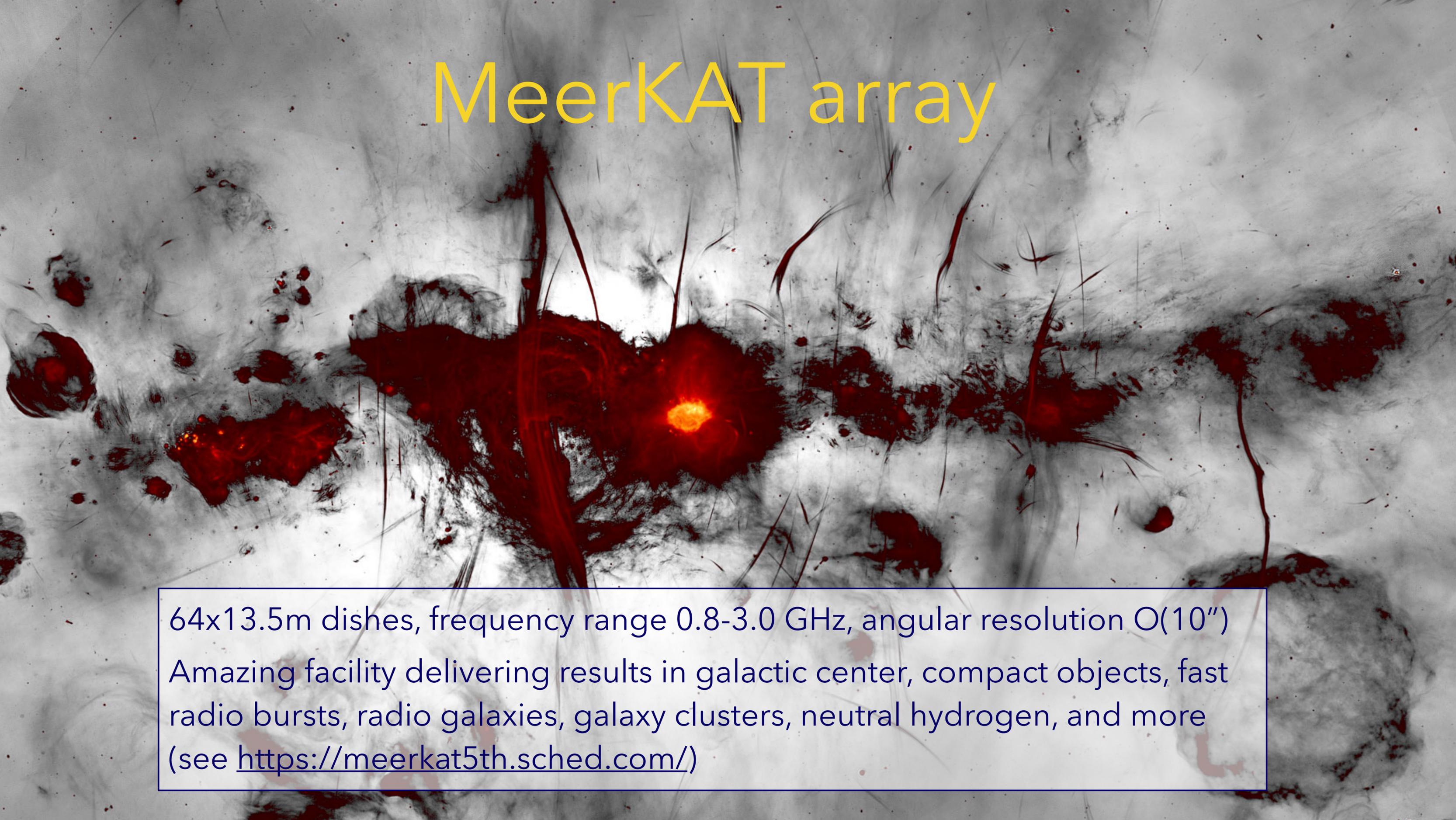
SKA science



<https://www.skao.int/en/science-users/skao-science-meeting-2025>

- 14 science working groups (SWG; see next slide)
- Provide a forum of discussion on possible SKAO science projects
- Engage with the community at large (open - anyone can join)
- Facilitate collaborations on future Key Science Projects (KSP)
 - but SWGs are not precursors of KSP - and no KSP defined yet
- Convey the information on the updates and developments to the community
- **Milestones in 2025:**
 - Science meeting in June 2025 (under the AA* configuration)
 - Science case book in >September 2025 (full AA4 configuration)

MeerKAT array



64x13.5m dishes, frequency range 0.8-3.0 GHz, angular resolution $O(10'')$
Amazing facility delivering results in galactic center, compact objects, fast radio bursts, radio galaxies, galaxy clusters, neutral hydrogen, and more
(see <https://meerkat5th.sched.com/>)

From MeerKAT to SKA1-Mid

- Number of dishes: 64 -> 197
- Size of dishes: 13.5m -> 15m diameter
- Max baseline length: 6km -> 150km
- Frequency coverage: 0.8-3 GHz -> 0.35-15 GHz
- Improved correlation modes, **including VLBI**
- Overall, more sensitivity, angular resolution, spectral coverage, and observing modes
- Intermediate steps: MeerKAT plus (more dishes, longer baselines);
Band5 receivers on MeerKAT dishes

~1 μ Jy/beam sensitivity
~0.1" angular resolution