



The SKA Observatory

Science

Cosmic Dawn & Reionization

Cosmology & Galaxy Evolution

Pulsars

Cosmic Magnetism

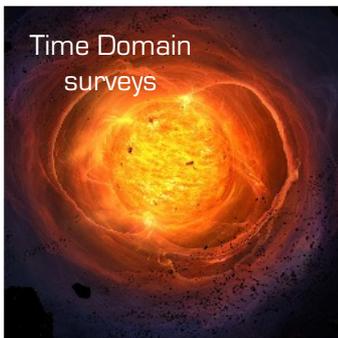
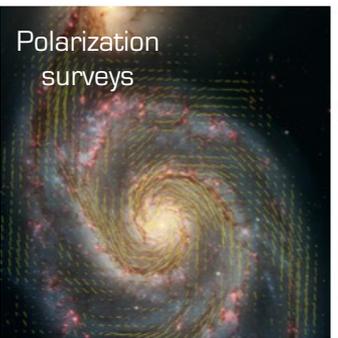
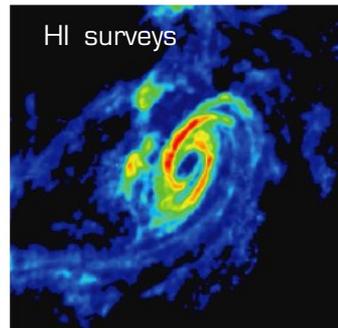
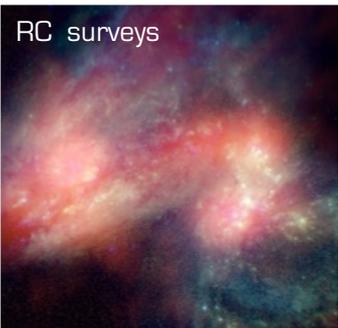
Cradle of Life

10 GHz

1 GHz

100 MHz

50 MHz



Isabella Prandoni – INAF - IRA

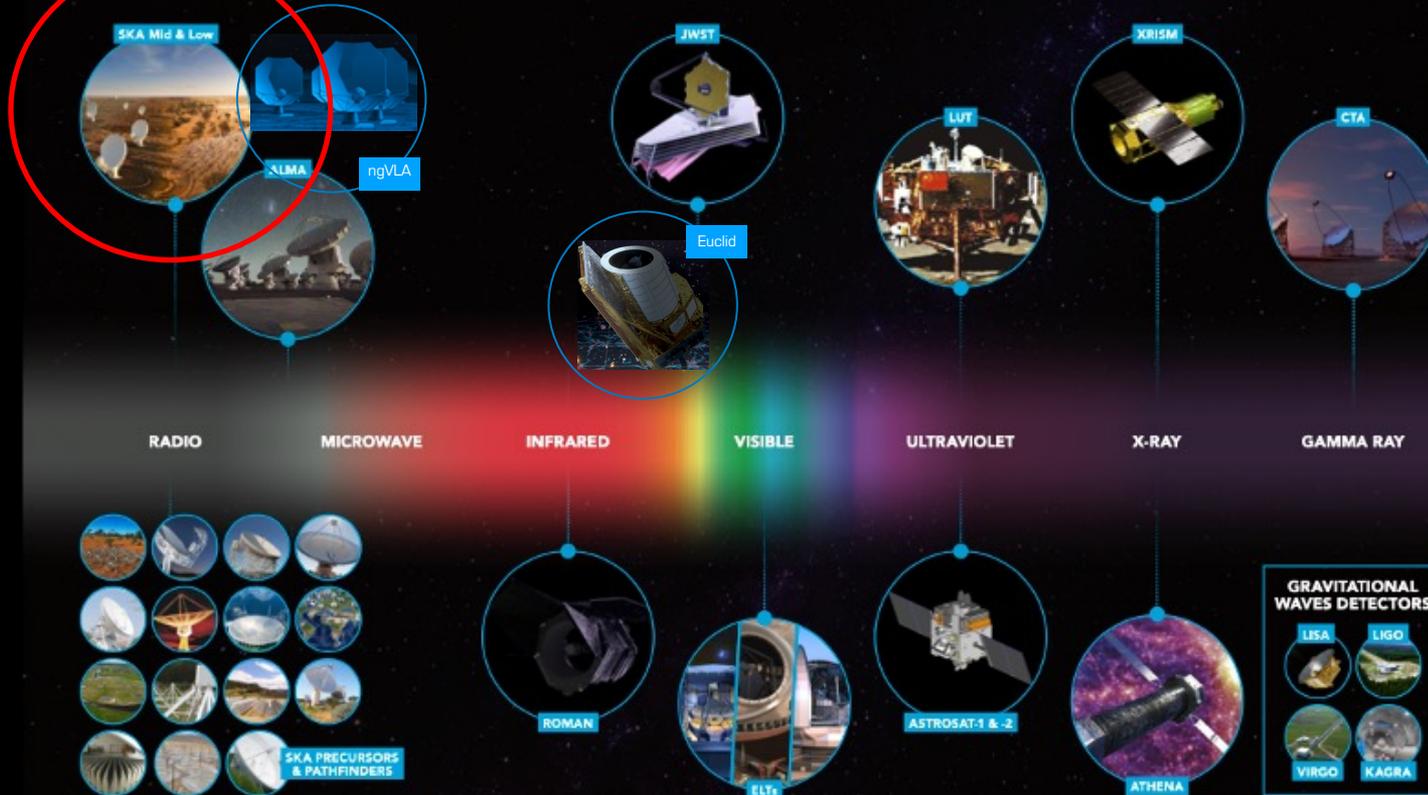
Giornate RSN1, 9 February, 2026



A unique suite of astronomical facilities

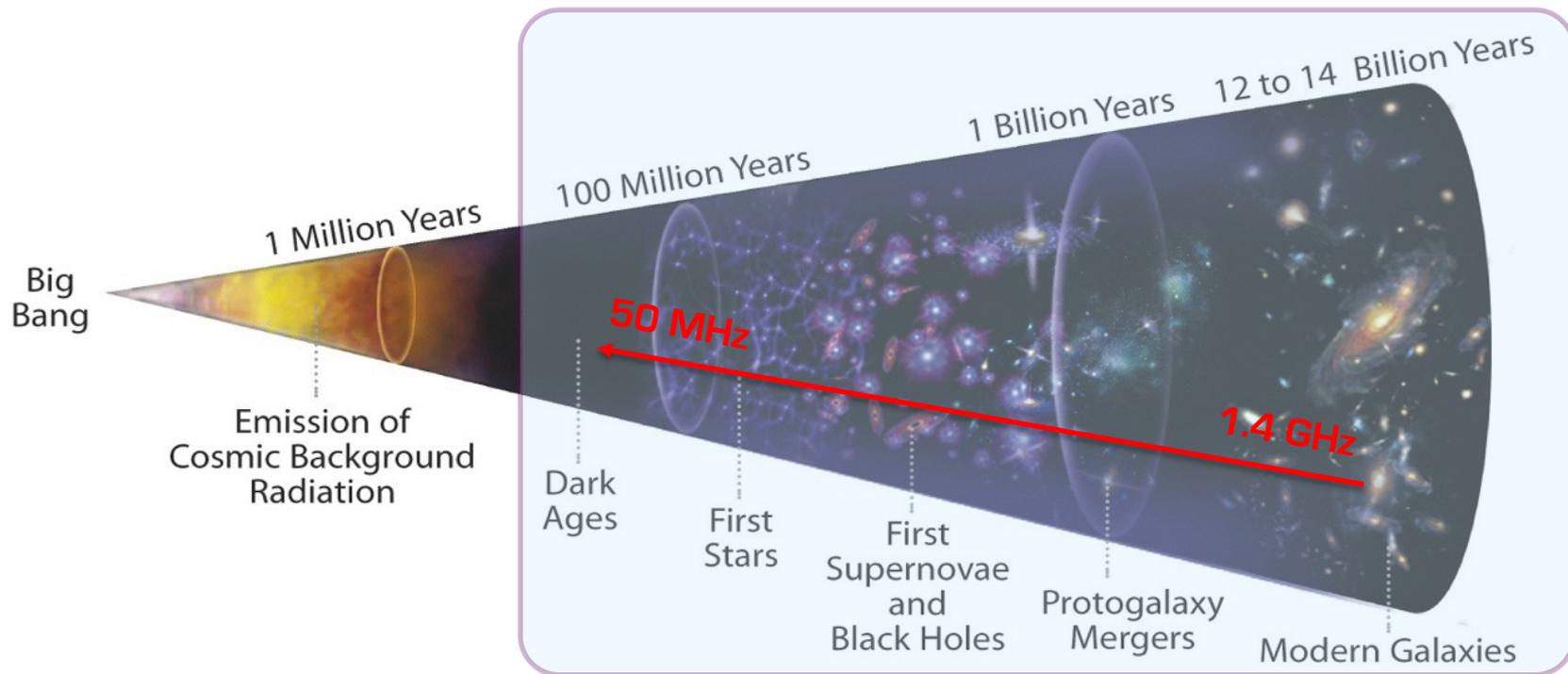
21st century astronomy

As the world's largest radio-frequency interferometer, SKA will establish itself as the radio astronomy component of a suite of major facilities spanning the electromagnetic spectrum, on the ground and in space.



Adapted from SKAO image

The SKA Concept



Tracing the history of the Universe and of its constituents through Hydrogen
Mapping Hydrogen through cosmic time and on a wide range of scales
Super-sensitivity over wide range of frequencies and spatial resolutions

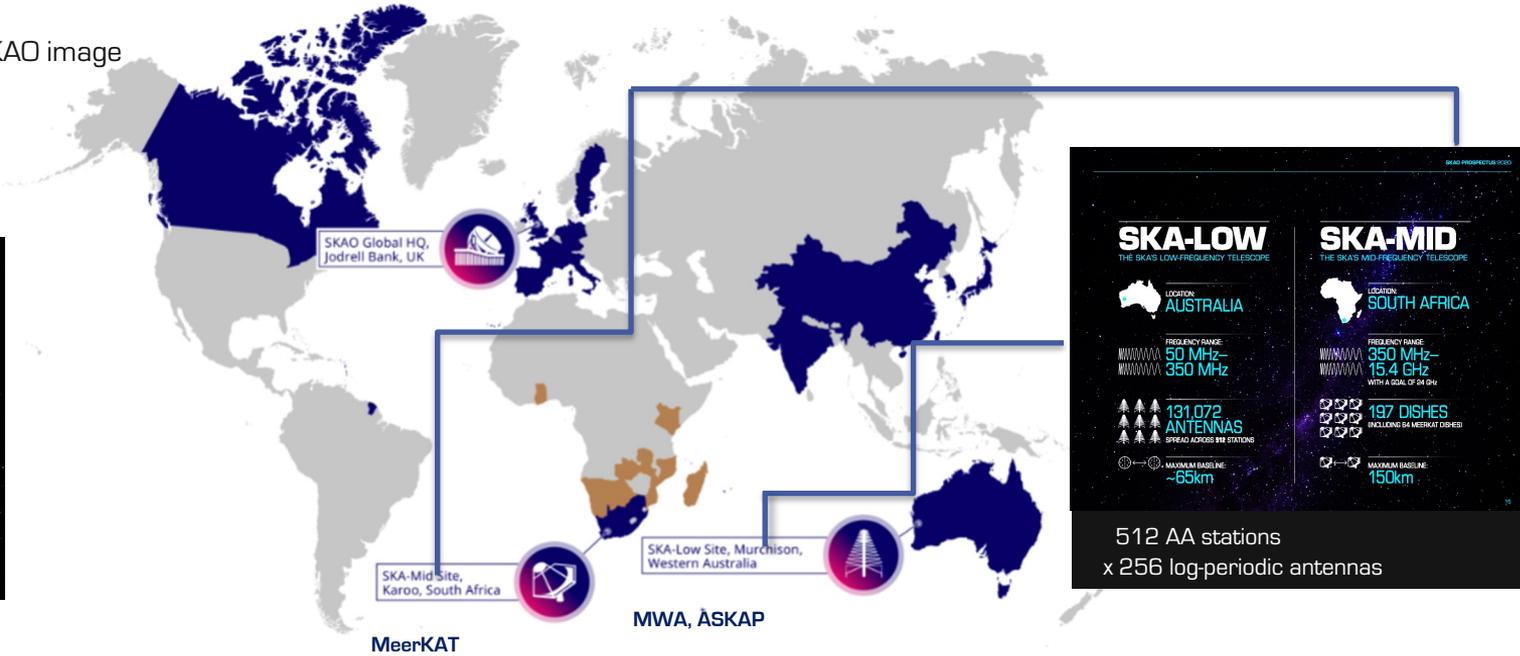
The SKA Observatory in a nutshell

Adapted from SKAO image

SKA in numbers

€1.282 BILLION
CONSTRUCTION COST (2020 €)

€0.704 BILLION
FIRST 10 YEARS OF OPERATIONS COST (2020 €)



SKAO Partnership - includes SKAO Member States* and SKAO Observers (as of Nov 2024)

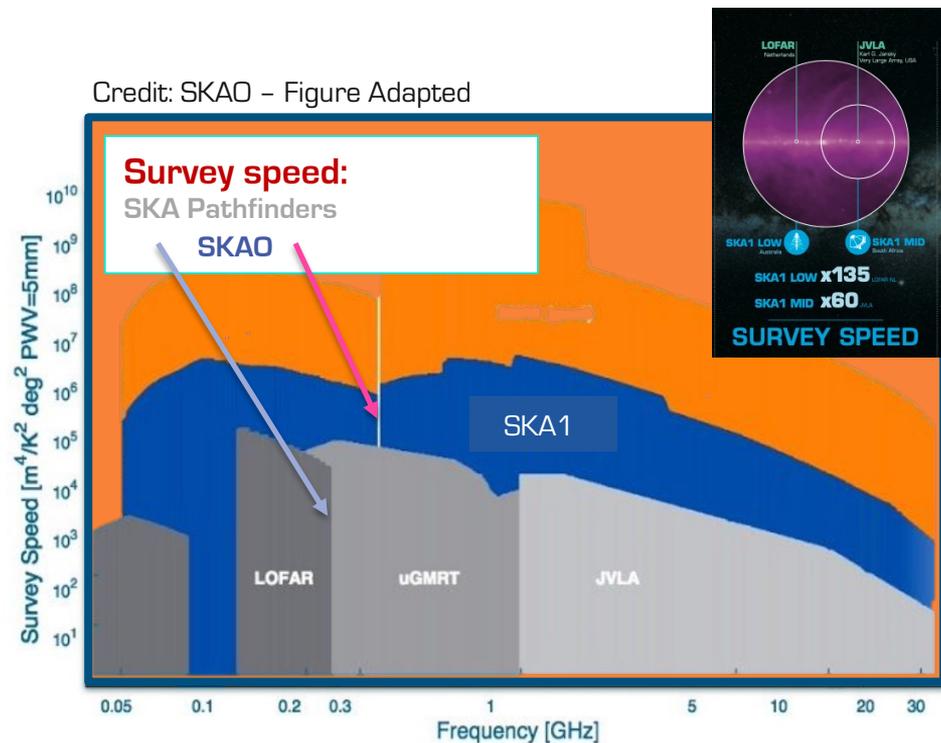


African Partner Countries



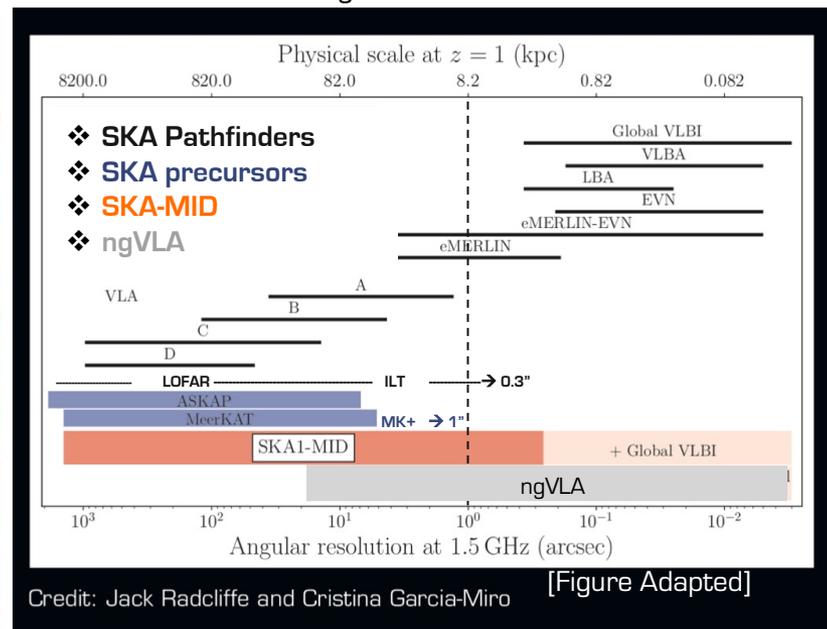
Full members (Updated end 2025): Aus, Canada, China, Germany, India, ITA, NL, Portugal, RSA, Spain, Sweden, Switzerland, UK
France, Japan, South Korea on the path to join

SKAO: A Multi-Resolution Survey Infrastructure

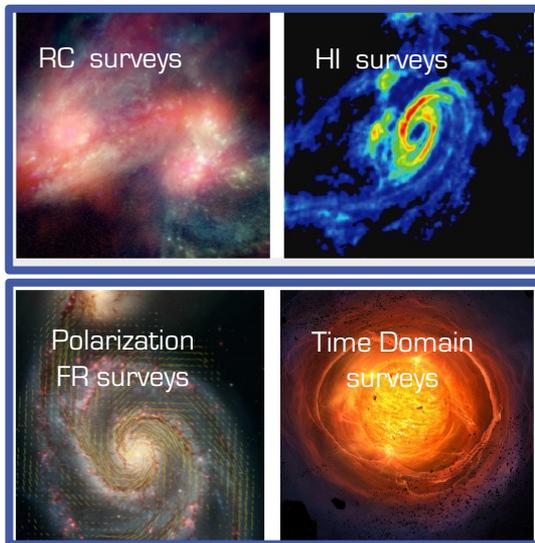


50 MHz ← Frequency range → 15(24) GHz

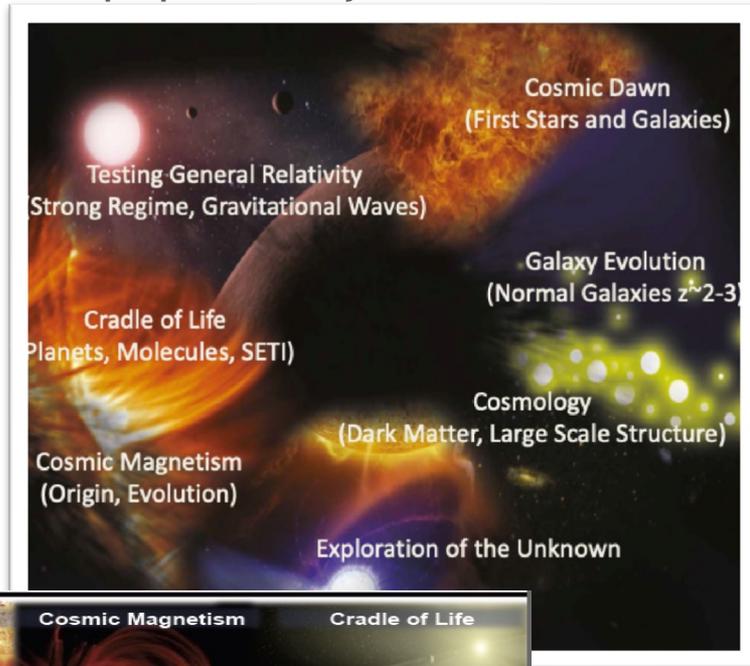
1000 arcsec ← Angular resolution → 0.01 arcsec



The SKAO Science Case



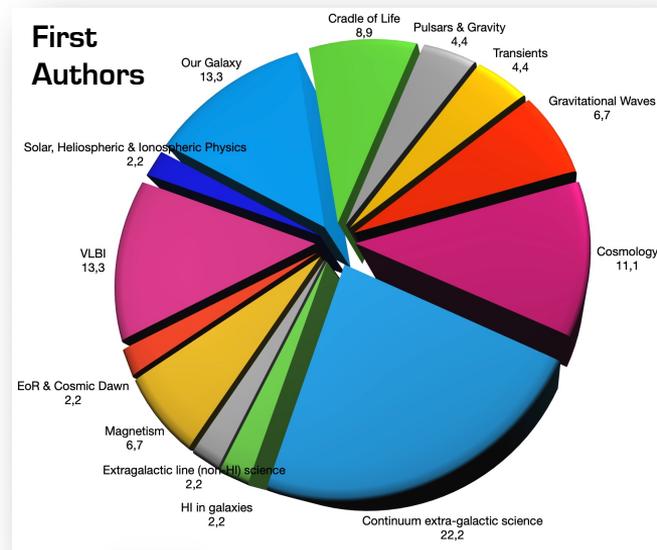
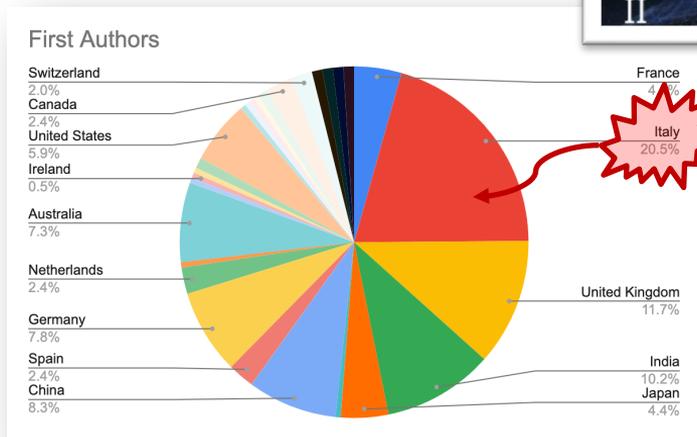
Multi-purpose Facility



The SKAO Science Case: IT Contribution

Several initiatives to engage Italian Community and build a SKA-oriented leadership

- **219 IT members** (11.2%) distributed over 14 Science WGs
- **5 IT chairs (+5 ex-chairs) + 22 IT members with Coordination Roles** in 11 SWG
- SKA Science Book **2015** - 135 chapters: **41% with IT co-authors** (56) – **15% with IT first authors** (20)
- SKA Science Book **2026** – Italy first contributor: **20% of chapters with IT first authors**
- **RSN1 themes:** very well represented

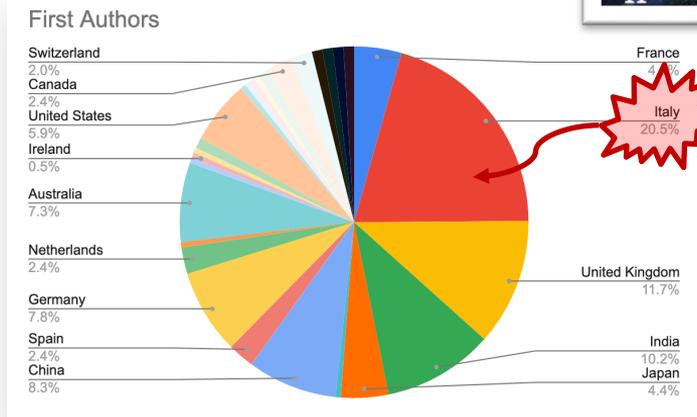


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Advancing
Astrophysics
II



INAF involvement in LOFAR and MK

- ❖ Italy-led SKA precursors KSP/PI-projects
- ❖ ERC/FIS grants to SKA-related projects
 - **ERC (2015-2025):** 7 grants (all on RSN1 themes)
 - **FIS (2024-2025):** 4 Grants (3 on RSN1 themes)

SKAO: Science Drivers

Science Drivers

Cosmic Dawn and the epoch of reionisation	Cosmology and dark energy	Forming stars through cosmic time	Galaxy evolution	Cosmic magnetism	The bursting sky	The cradle of life	Challenging Einstein: gravitational waves
WHERE DID IT ALL BEGIN? HOW AND WHEN DID THE FIRST STARS, GALAXIES AND BLACK HOLES FORM?	CAN WE UNCOVER THE MYSTERIOUS NATURE OF DARK ENERGY? HOW AND WHY HAS IT BECOME THE MAJOR PLAYER IN OUR UNIVERSE?	HOW AND WHEN WERE THE FIRST STARS BORN? HOW HAS THE RATE OF STAR FORMATION CHANGED OVER TIME, AND WHY?	WHAT IS THE LIFE-CYCLE OF A GALAXY? WHERE DO THEY COME FROM, WHERE DO THEY GO? WHAT ARE THE PROPERTIES OF THE MYSTERIOUS DARK ENERGY?	HOW DID THE UNIVERSE BECOME MAGNETIC? WHERE AND WHEN DID MAGNETISM ORIGINATE? HOW HAS IT EVOLVED?	WHAT ARE THE COUNTERPARTS OF THE FAST AND FURIOUS BURSTS OF RADIO WAVES? WHAT CAN THEY TELL US ABOUT THE CONSTITUENTS OF THE UNIVERSE?	HOW DO YOU MAKE A PLANET FROM SPACE PEBBLES? ARE WE ALONE IN THE UNIVERSE? The SKA will have sufficient resolution to watch the assembly of planets in Earth-like orbits about their parent stars.	WAS EINSTEIN RIGHT ABOUT GRAVITY? CAN WE FIND AND UNDERSTAND WHERE GRAVITATIONAL WAVES COME FROM? The SKA will use our entire galaxy to

Credit: SKAO

Relevant to RSN1

2015
135 Chapters
2 Volumes



2026



See also reviews/talks on:

- Galaxy clusters: Andrea Botteon; Francesca Loi
- Cosmology: Vincenzo Cardone; Massimo Meneghetti
- HI role in galaxy assembly in nearby Universe: Antonino Marasco

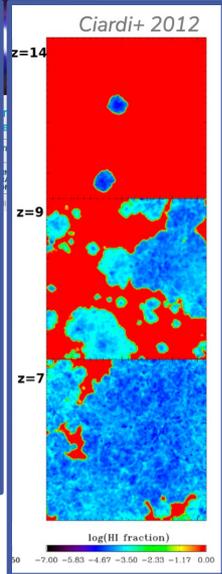
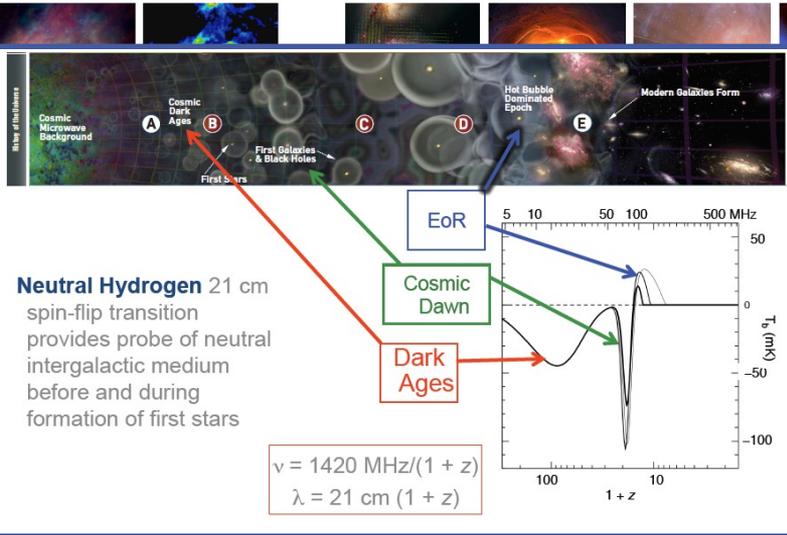
Cosmic Dawn & Epoch of Reionization

Science Drivers

Cosmic Dawn and the epoch of reionisation

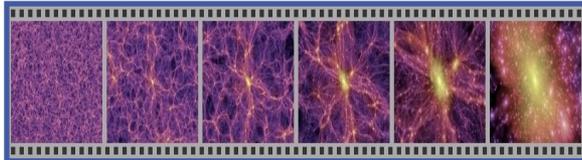
WHERE DID IT ALL BEGIN?

HOW AND WHEN DID THE FIRST STARS, GALAXIES AND BLACK HOLES FORM?



Redshifted 21 cm signal:

- Astrophysics regulating formation of first stars, galaxies & AGN
- underlying fundamental physics & cosmological parameters



Cosmic Dawn & Epoch of Reionization

Science Drivers

Cosmic Dawn and the epoch of reionisation

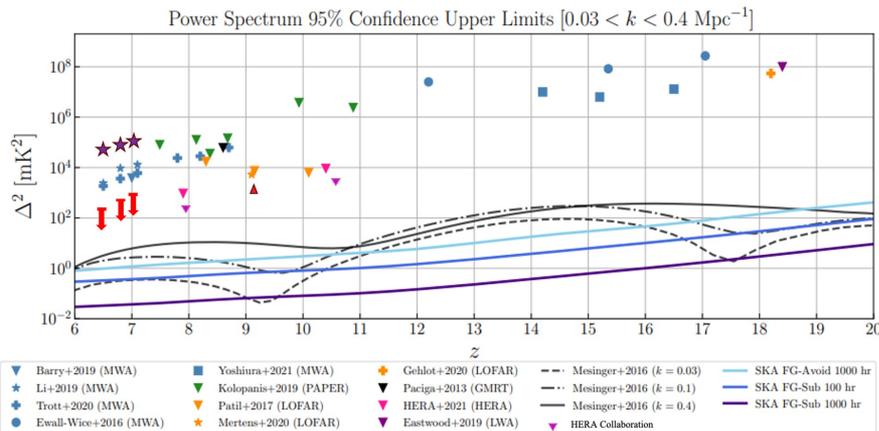
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SKA objectives [CD and EoR]:

- 1) Statistical Detection (Power spectrum vs z) $z=5.5-27$
- 2) Imaging of IGM transition vs z (Tomography) $z=5.5-15$



Joshi et al. 2021

Galaxy Formation & Evolution

Science Drivers

RC surveys

HI surveys

Galaxy evolution

Forming stars through cosmic time

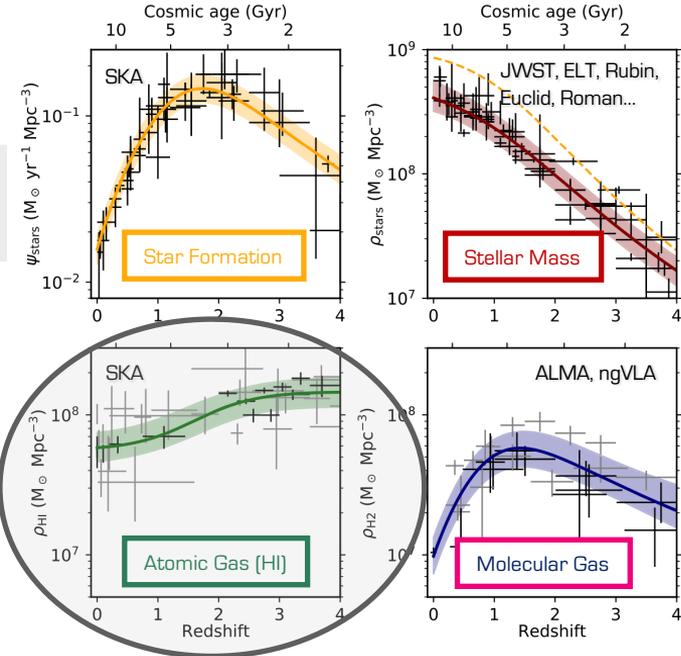
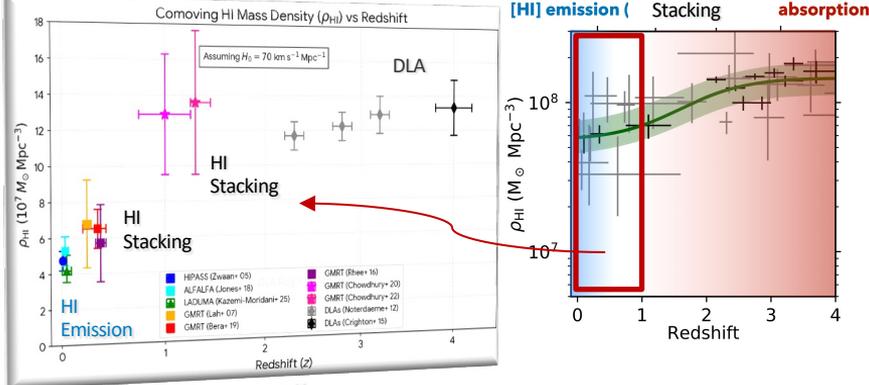
Galaxy evolution

WHAT IS THE LIFE-CYCLE OF A GALAXY?
WHERE DO THEY COME FROM, WHERE DO THEY GO?
WHAT ARE THE PROPERTIES OF THE MYSTERIOUS DARK ENERGY?

HOW AND WHEN WERE THE FIRST STARS BORN?
HOW HAS THE RATE OF STAR FORMATION CHANGED OVER TIME, AND WHY?
There is evidence that star formation

WHAT IS THE LIFE-CYCLE OF A GALAXY?
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Based on MeerKAT and GMRT



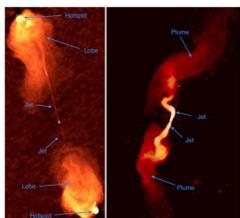
HI role in galaxy assembly beyond local Universe

Adapted from Walter+2020

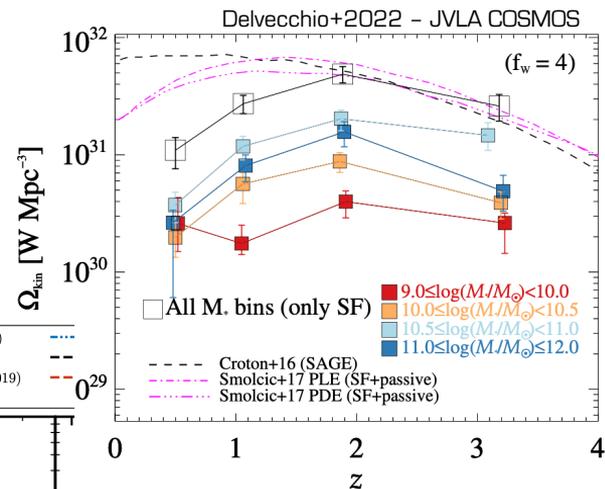
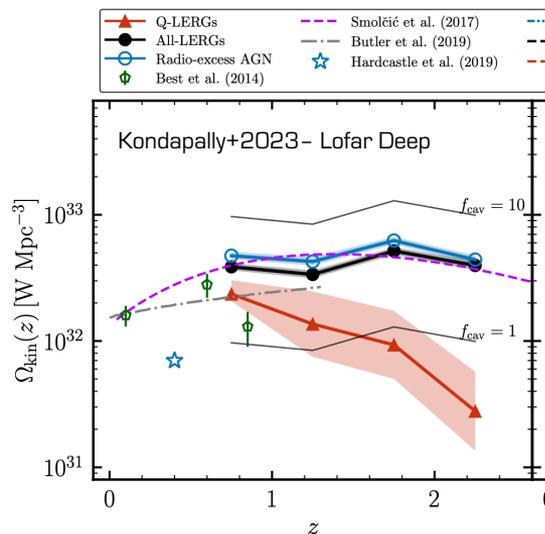
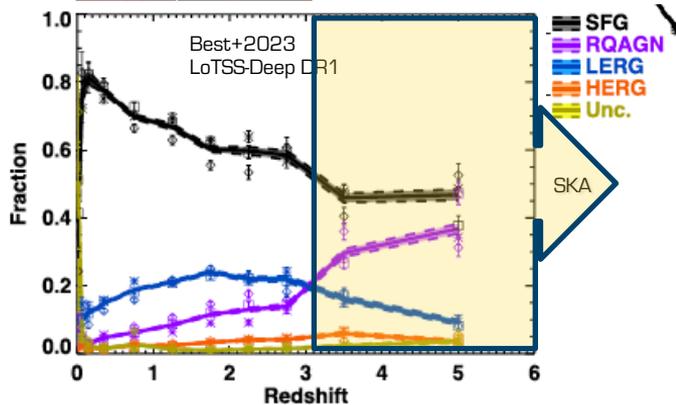
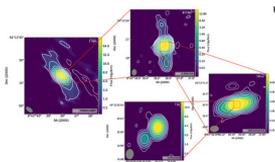
SFRD & role of AGN Feedback in galaxy evolution

Deep radio continuum surveys:

- Complete and unbiased census of SFG & AGN populations **down to RQ regime** up to high redshifts (unaffected by dust/gas)
- **Role of jetted AGN in galaxy evolution**



Is jet-induced feedback relevant in high-z SFG?



AGN kinetic power density
Vs
redshift

Magnetogenesis

Science Drivers



Magnetic fields permeate the Universe, but poorly constrained

- How they grow and propagate (amplification mechanisms, role of CRs)?
- How they affect galaxy evolution?

Magnetic fields in filaments should carry memory of the initial field

SKA traces the magnetic fields through polarization / Rotation Measure (RM) grid surveys

Key requirement: Dense RM grid → better statistics

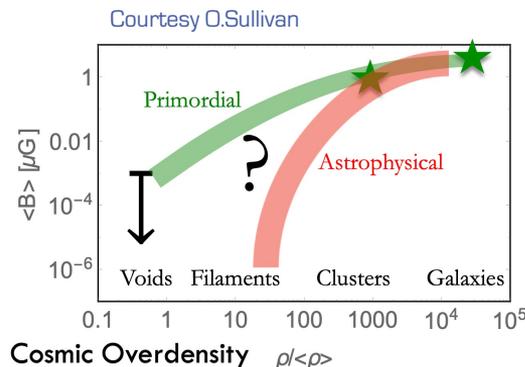
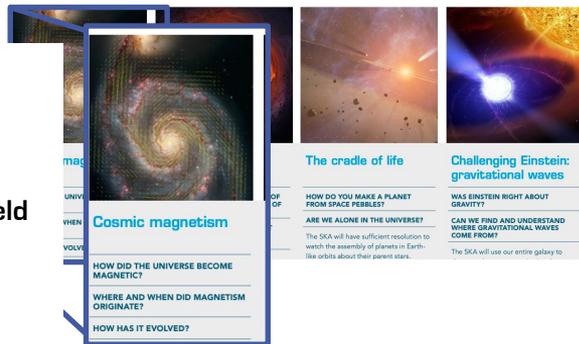
$$SKA \approx 230-450 \text{ sources} / \text{deg}^2$$

Upper limits from CMB temperature anisotropies:

$B < \text{few nG}$ on Mpc scales

Lower limits from TeV γ -ray observations:

$B > 10^{-7} \text{ nG}$ on Mpc scale



A-Primordial Scenario:

Turbulent amplification and compression of weak cosmological fields (seed 10^9 G)

B-Astrophysical Scenario:

Magnetization by galactic winds and outflows powered by star formation feedback, SN, AGN (seed 10^{11} G)

Magnetogenesis

Science Drivers



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Measure [RM] grid surveys

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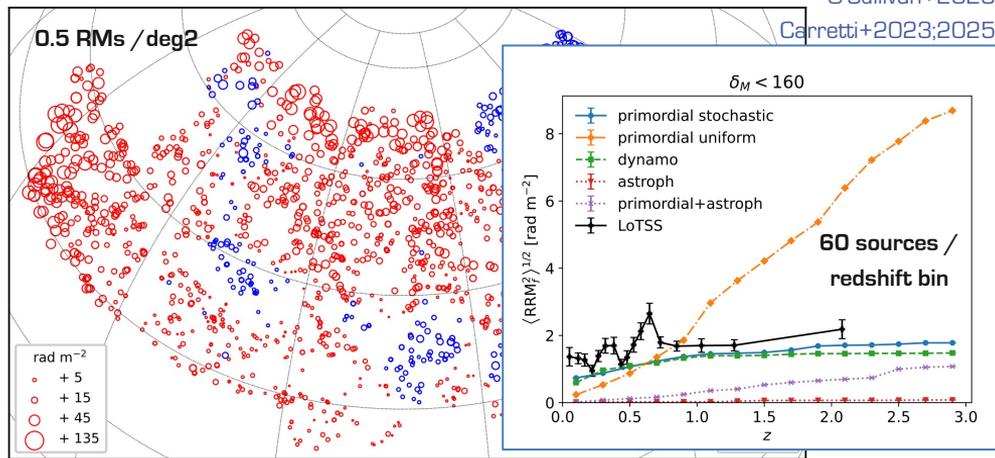
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Cosmic magnetism

HOW DID THE UNIVERSE BECOME MAGNETIC?
WHERE AND WHEN DID MAGNETISM ORIGINATE?
HOW HAS IT EVOLVED?

The cradle of life
HOW DO YOU MAKE A PLANET FROM SPACE PEBBLES?
ARE WE ALONE IN THE UNIVERSE?
The SKA will have sufficient resolution to watch the assembly of planets in Earth-like orbits about their parent stars.

Challenging Einstein: gravitational waves
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CAN WE FIND AND UNDERSTAND THESE GRAVITATIONAL WAVES COME FROM?
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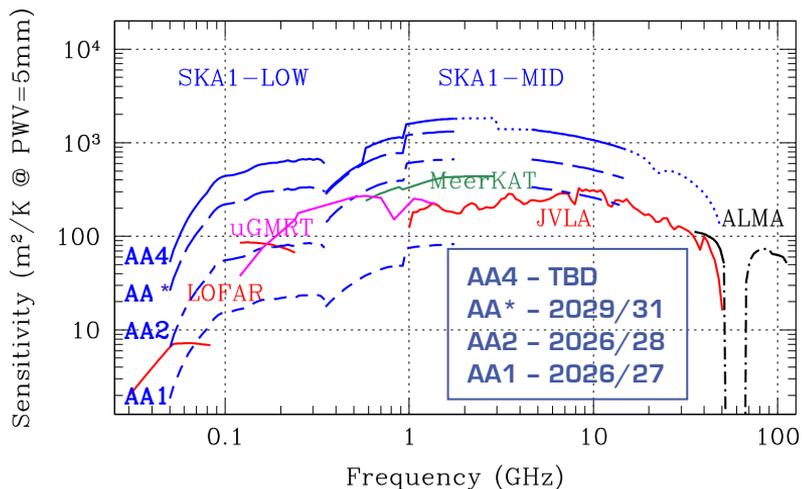
LoTSS

O'Sullivan+2023

Carretti+2023;2025

The SKAO Timeline

Construction Strategy: Staged Delivery 5 Array Assembly (AA) phases

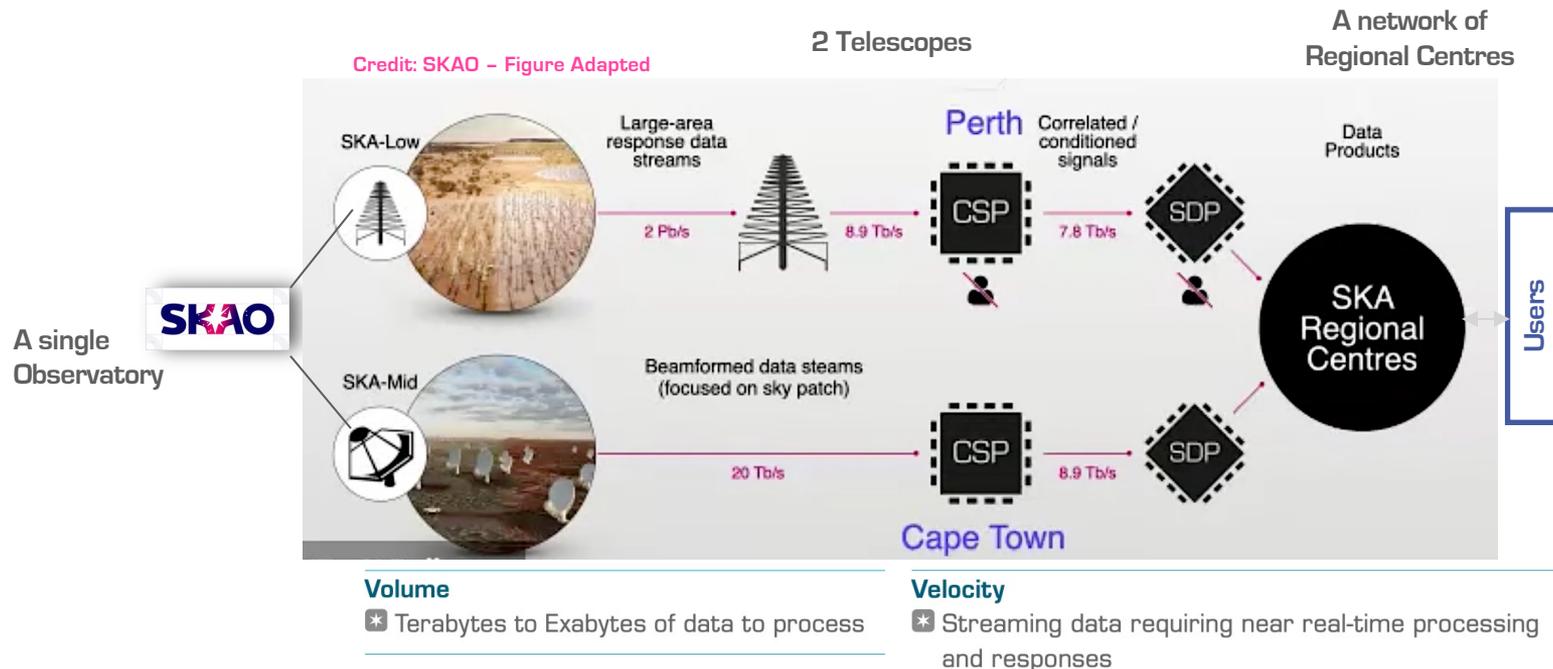


Milestone Event (earliest)		SKA-Mid	SKA-Low
AA0.5	4 dishes 4 stations	2026 Q2	2025 Q3
AA1	8 dishes 16 stations	2027 Q1	2026 Q1
AA2	64 dishes 68 stations	2029 Q1	2027 Q1
Science Verification begins		2029 Q2	2027 Q2
AA*	144 dishes 307 stations	2030 Q2	2028 Q2
Operations Readiness Review		2030 Q3	2028-Q3
Science Verification AA*		2031	2029
Cycle 0 (Shared Risk)		2032	2030
AA4 (Design Baseline)	197 dishes 512 stations	TBD	TBD

AA = Array Assembly

Updated **June 2025** (Construction Report)

The SKAO Operational Model



Only SKA Regional Centres will provide data access, data analysis, data archive, user support interfaces with user community

Italian node at Technopolo (Bologna)

Telescope Access

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

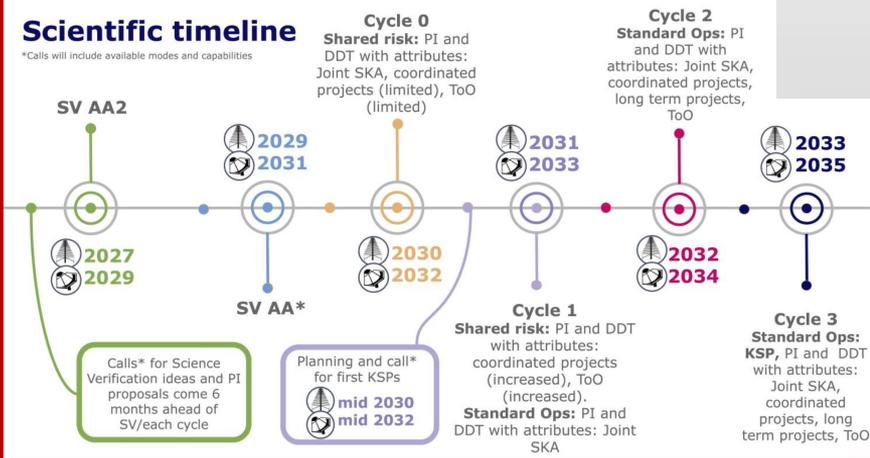
International time – fraction TBD



Credit: SKAO

Scientific timeline

*Calls will include available modes and capabilities



Science driven, based on contribution level

Take home messages:

- Radio future is bright! SKA in behind the corner and SKA precursors are already transforming our understanding of the radio Universe
- SKA science drivers relevant to RSN1 – high degree of complementarity and synergy with other wavebands
- Italian community - high level of engagement and leadership
- **Important to maintain and increase scientific leaderships into SKA Era**