

Science with MeerKAT and MeerKAT+

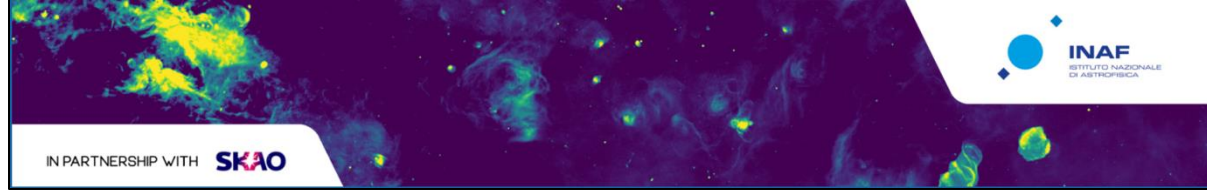
Present involvement of the Italian community and plans for the future

Tiziana Venturi

INAF, Istituto di Radioastronomia

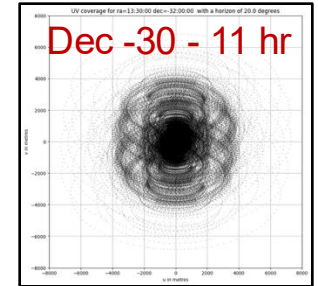


4 SKAO

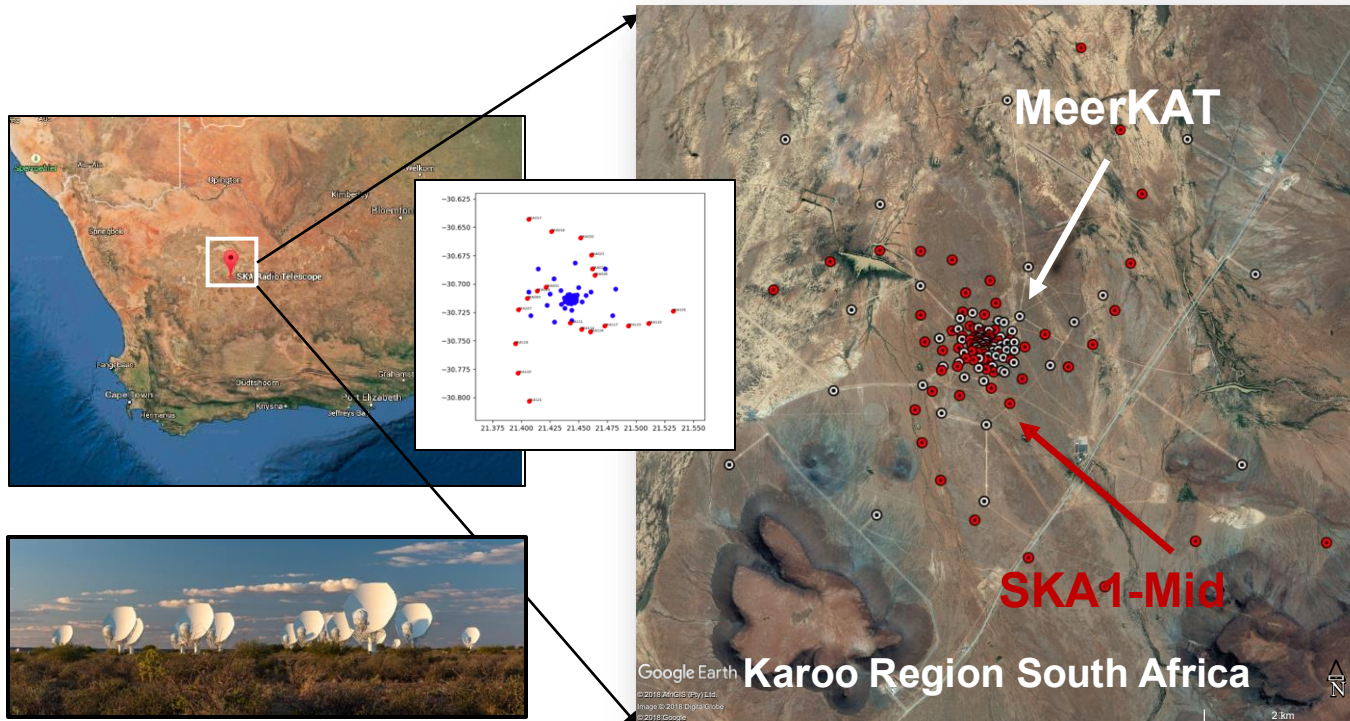


Interests of the Italian community in MeerKAT and its capabilities

- Most sensitive radio interferometer in the Southern Hemisphere in L-band, UHF and S-band
- Visible sky $\delta \lesssim +30^\circ$
- Equivalent to B+C+D simultaneous configurations of the VLA



Operated by SARAO



- **64 dishes with diameter 13.5m** in a “random” configuration
- Maximum baseline 7.7 km

L Band 900-1670 MHz, **UHF** 580-1015 MHz

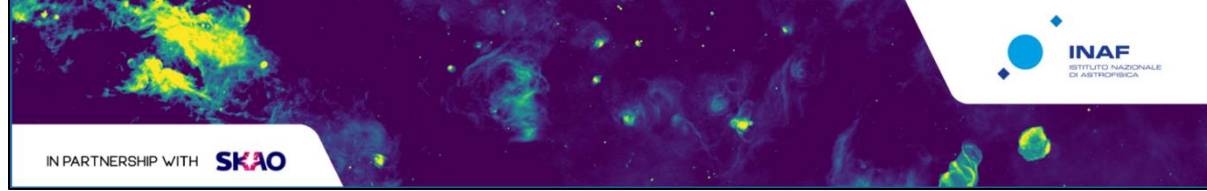
S Band 1750-3500 MHz

4k & 32k channels

Pulsar gating

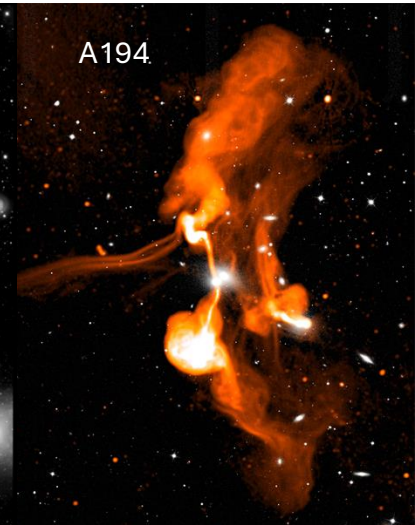
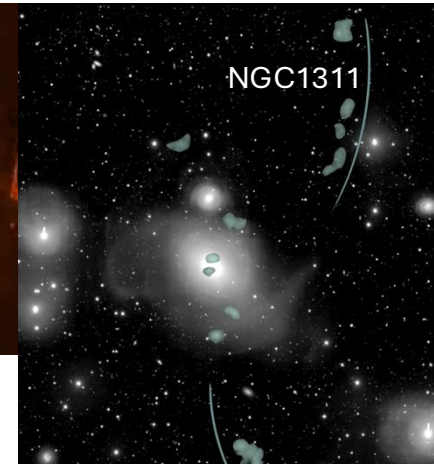
L-band parameters

- Angular resolution $\sim 8''$
- Image sensitivity $\sim 12 \mu\text{Jy/b/hr}$
- Line sensitivity $\sim 184 \mu\text{Jy/b/hr}$ (209 kHz channel)



Interests of the Italian community in MeerKAT and its capabilities

- **2014** - First Antenna & start of KAT-7
- **2016** – 16 antennas and early science
- **2017** – Full array commissioning
- **2019** – First Open Time Call for proposals with SA PI-ship
- **2020** – First Open Time Call for proposals with no limitations to PI



MeerKAT Legacy Surveys and Italian involvement

LADUMA – Looking at the Distant Universe with MeerKAT Array

MALS – MeerKAT Absorption Line Survey

MeerKAT Fornax Survey

MeerTime – MeerKAT KSP on Pulsar Timing

MHONGOOSE – MeerKAT HI Observations of Nearby Galactic Objects

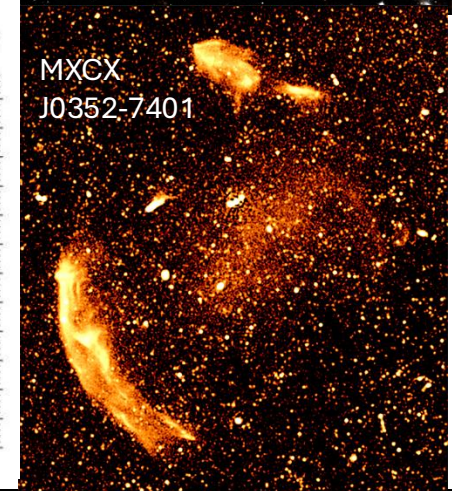
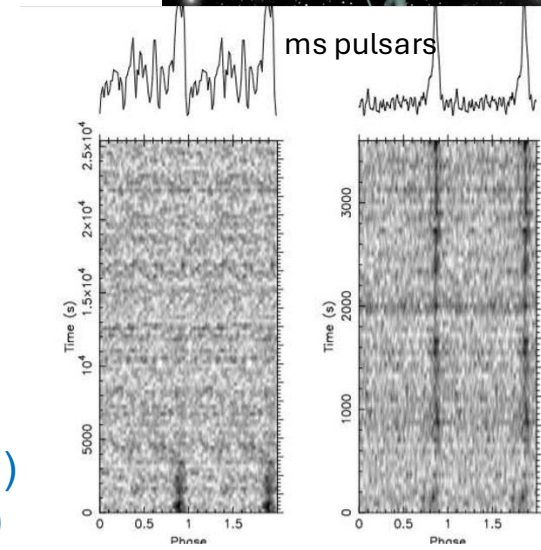
MIGHTEE – MeerKAT International GHz Tuned Extragalactic Exploration

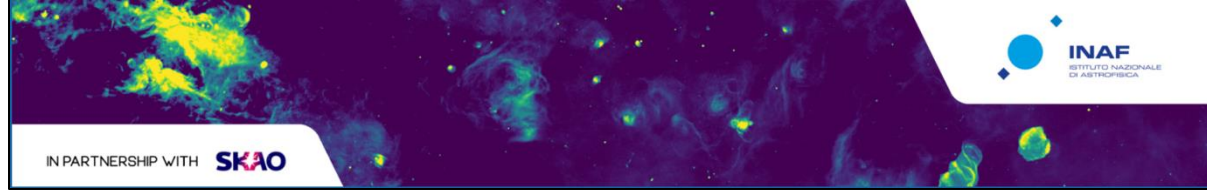
ThunderKAT – Dynamic and explosive transients

TRAPUM – Transients and Pulsars with MKAT

MGCLS – MeerKAT Galaxy Clusters Legacy Survey ([scientific commissioning](#))

SMGPS – SRAO MeerKAT Galactic Plane Survey ([scientific commissioning](#))





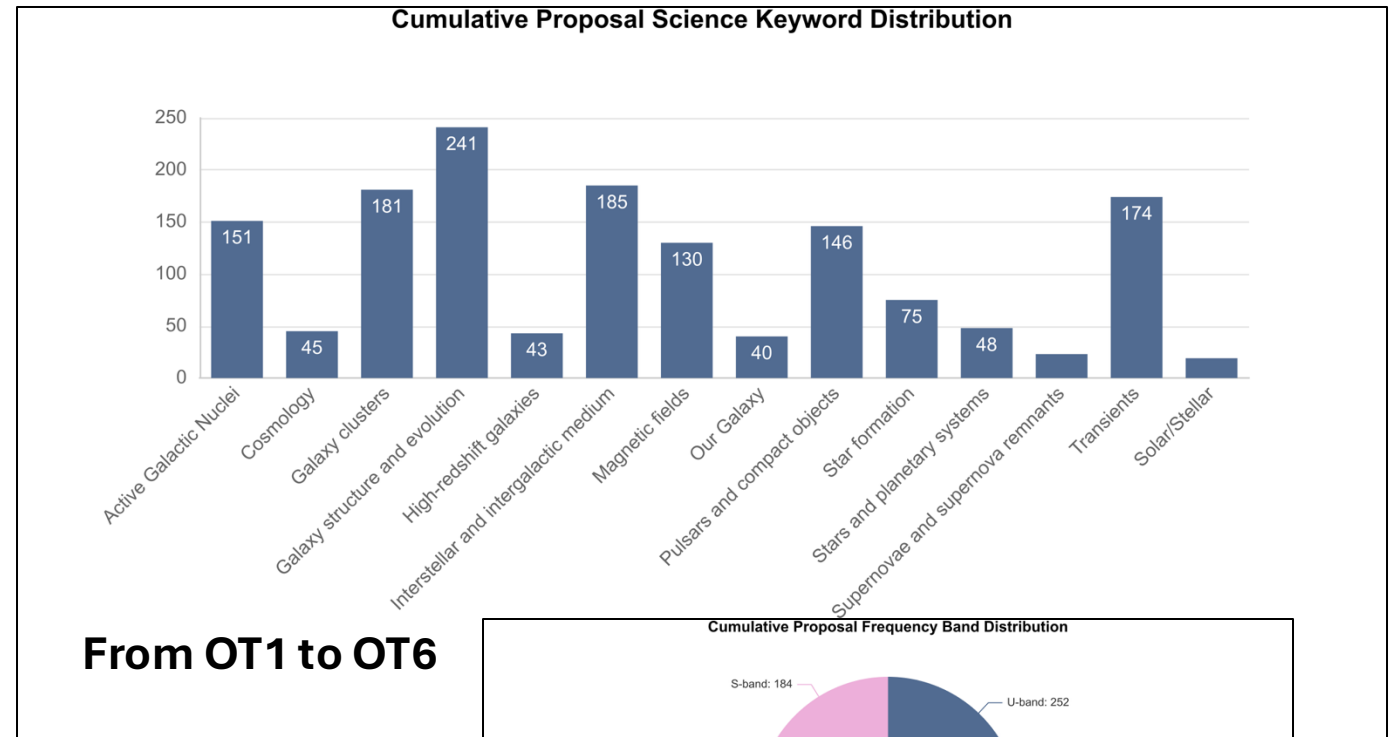
Interests of the Italian community in MeerKAT and its capabilities

- **2019** – First Open Time Call for proposals with SA PI-ship
- **2020** – First Open Time Call for proposals with no limitations to PI
- **Since 2020** one CfP/year with the allocation of ~ 3000 hours/year (six so far)

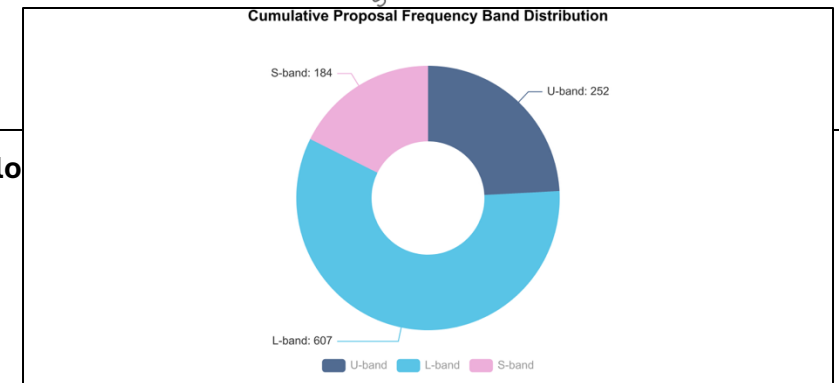
Since 2024 CfP:

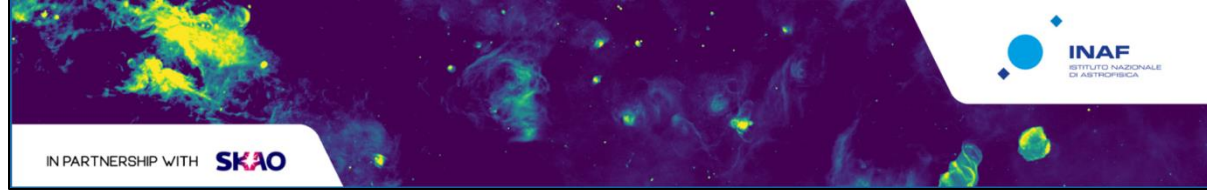
- Regular proposals (100 hours)
- Large proposals (100-300 hours)
- Extralarge proposals (>300 hours)

ToO and multi-year proposals accepted
DDT time can be applied for at any time



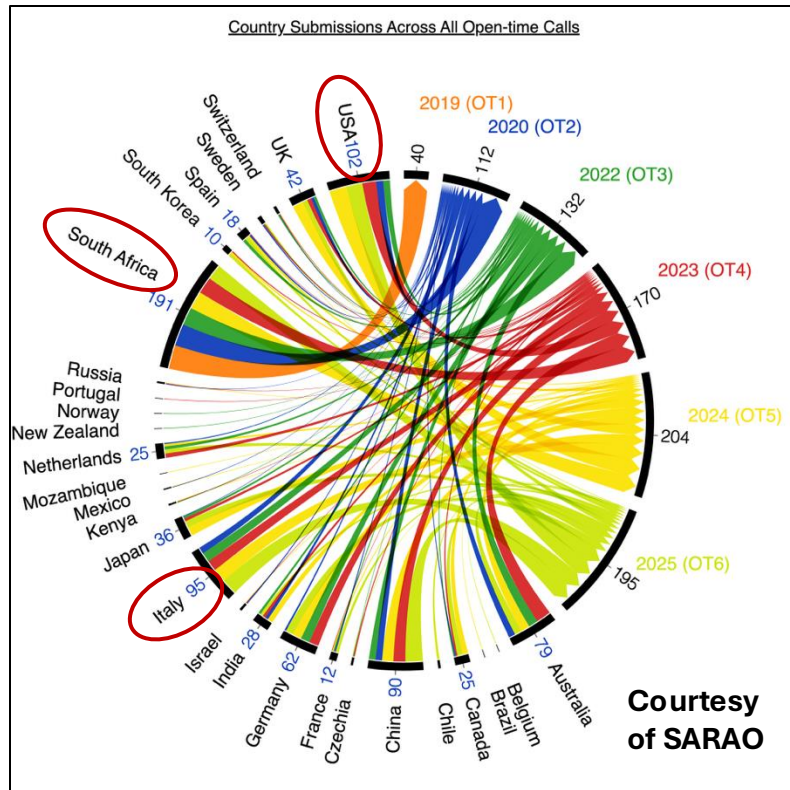
Courtesy of F. Camilo



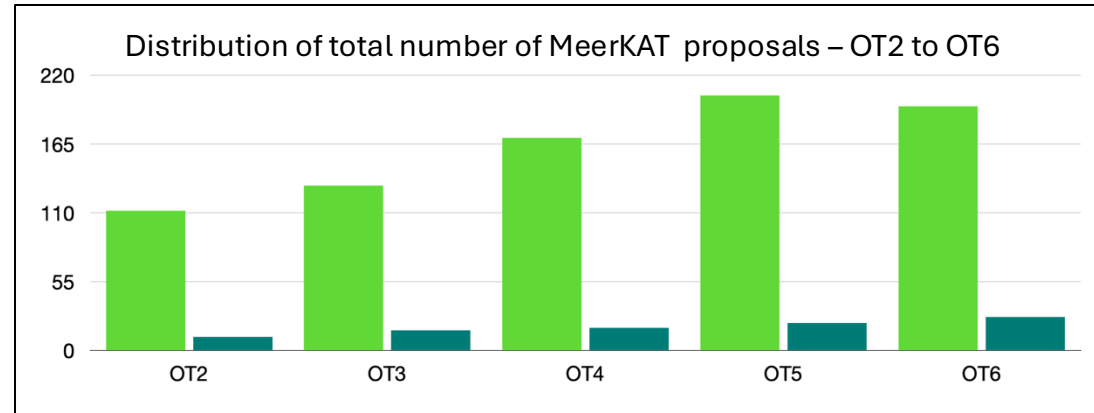


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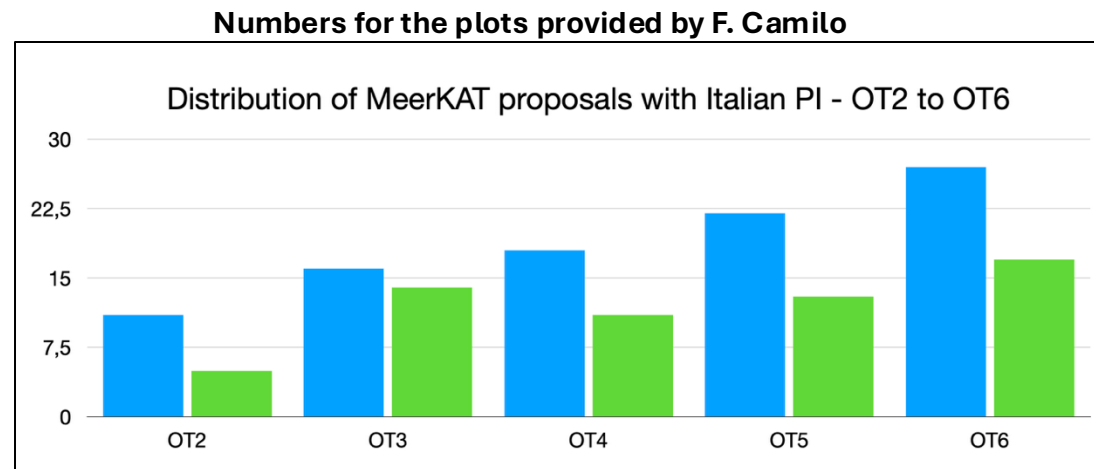
Proposal trend (regular +LP)



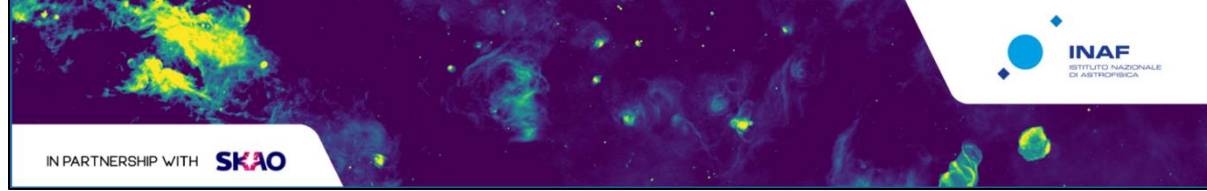
Distribution of proposal number by country - OT2 to OT6
Italy third after South Africa and US



■ Total
■ Italian PI

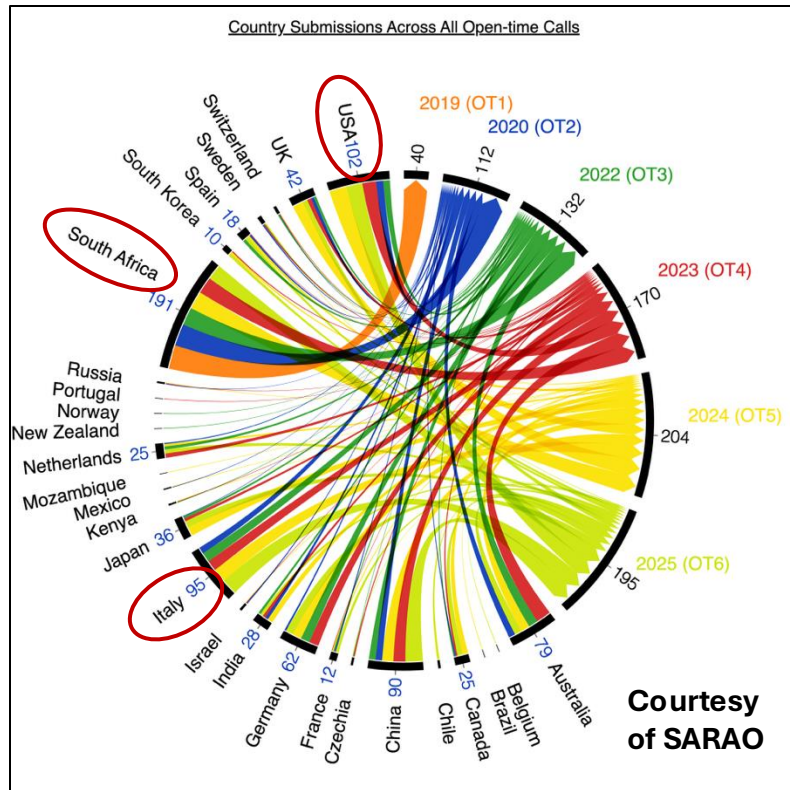


■ Accepted
■ Submitted

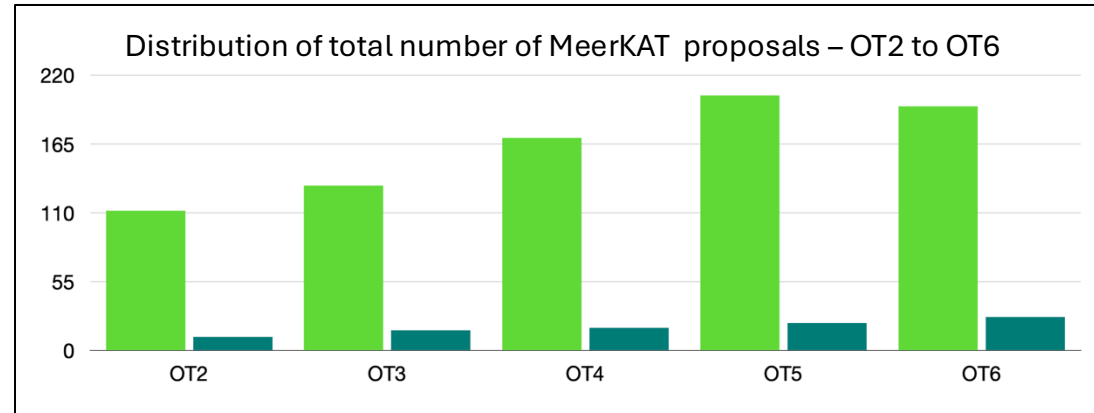


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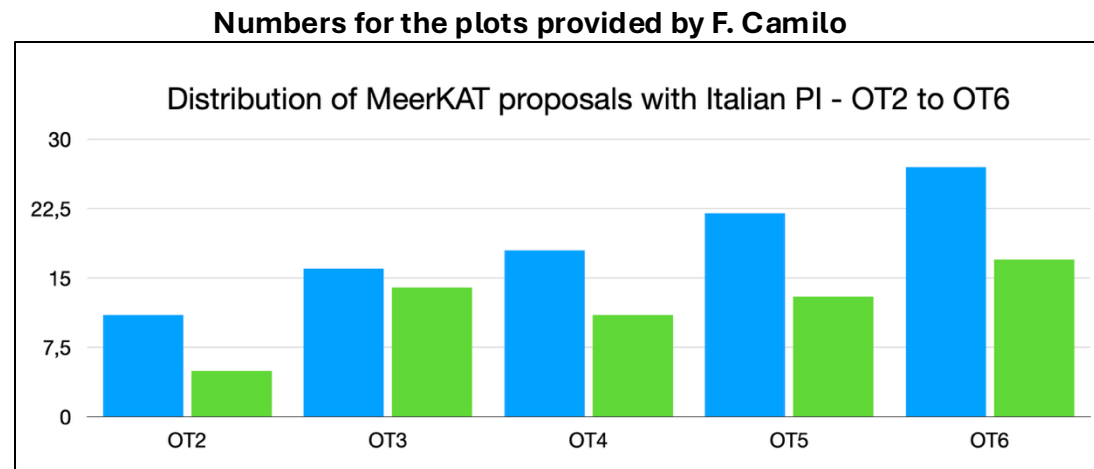


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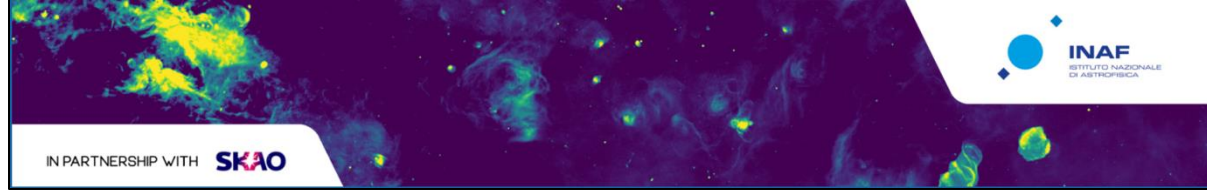
■ Total
■ Italian PI

11 XLPs in OT5
5 accepted
1 Italian PI



■ Accepted
■ Submitted

5 XLPs in OT6
Under review
No Italian PIs



Interests of the Italian community in MeerKAT and its capabilities

Scientific outcome

Publications based on data from the MeerKAT Legacy Surveys, Commissioning Surveys and access to open time

MeerKAT Fornax Survey

MeerTime – MeerKAT KSP on Pulsar Timing

MHONGOOSE – MeerKAT HI Observations of Nearby Galactic Objects

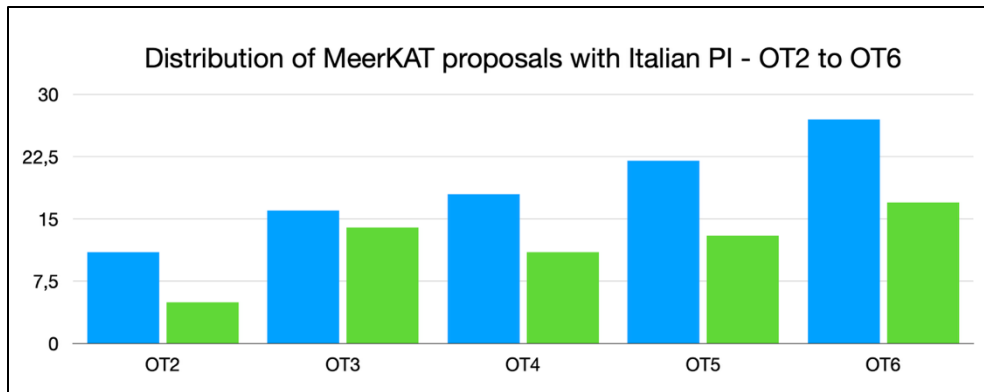
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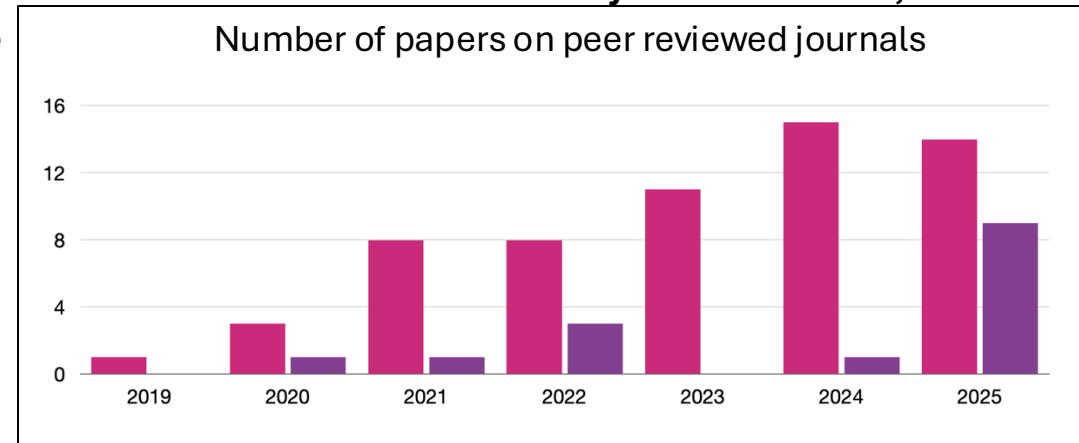
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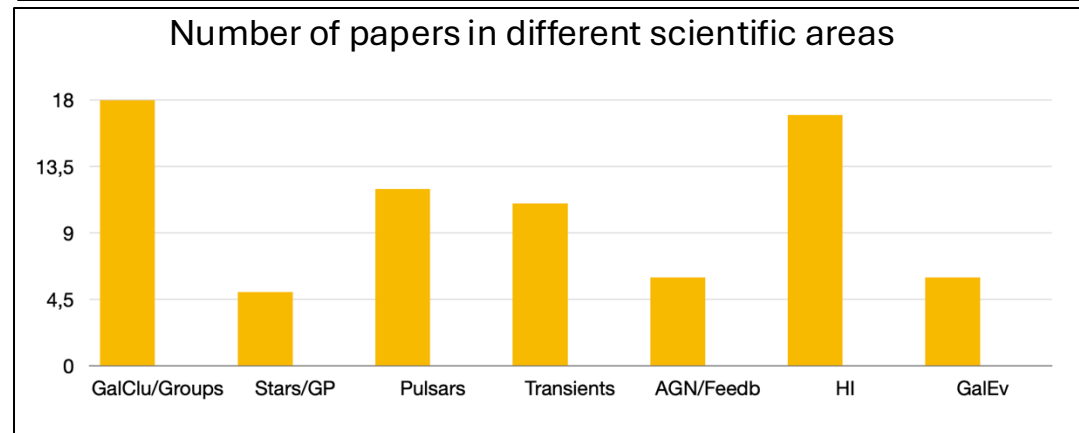


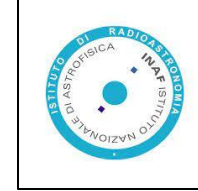
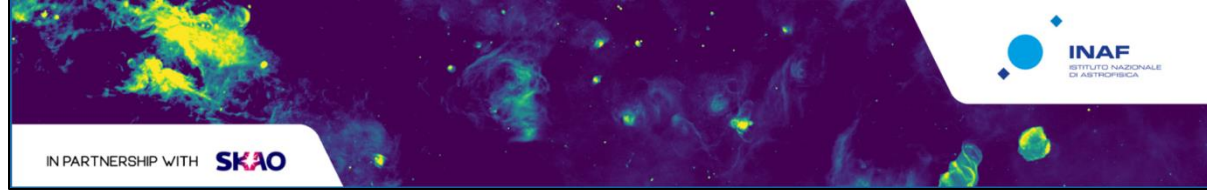
From the MeerKAT ADS Library – as of Nov. 18th, 2025



60 Italian first author

15 Italian 2nd author





Near future perspectives – Science with MeerKAT+

A project aimed to extend MeerKAT adding 14 SKA-compliant dishes to the MeerKAT
 Big improvement of the MeerKAT capabilities in term of sensitivity (better u-coverage and more dishes) and angular resolution (double baseline length)

- South African Radio Observatory (**SARAO**)
- Max-Planck Gesellschaft (**MPG**)
- **INAF**

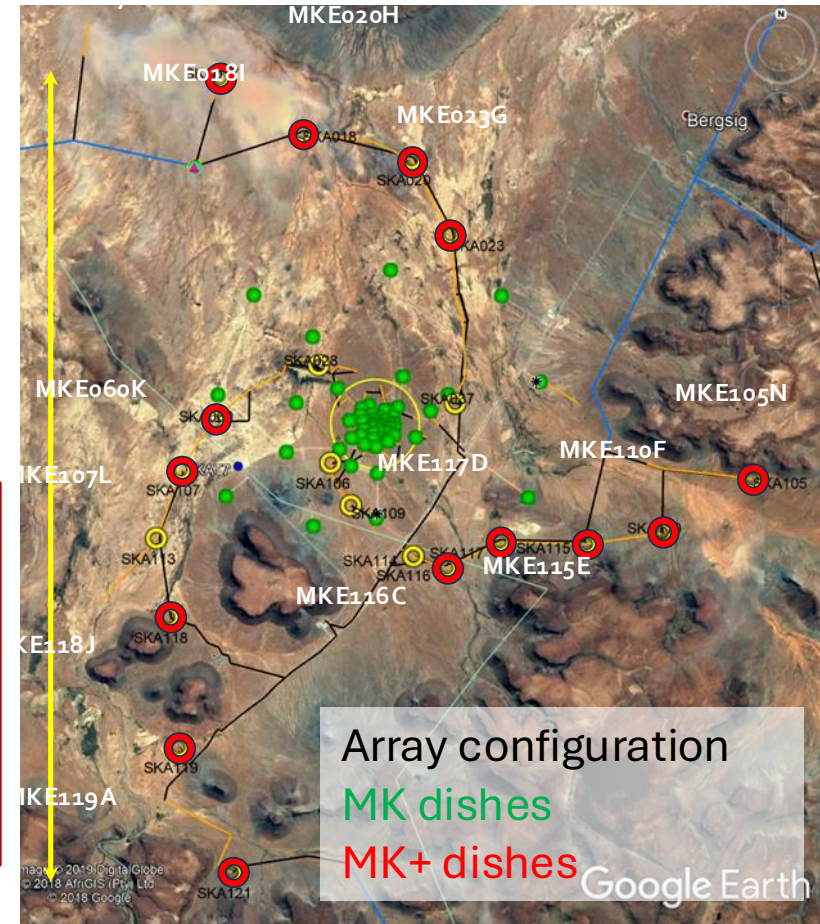
<https://www.meerkatplus.tel>

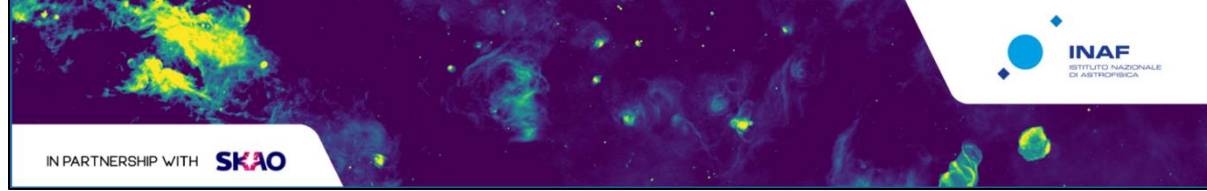
Collecting area +30% (14 antennas)

- Sensitivity (1 hr): 12mJy/b \rightarrow 9mJy/b
- L-band angular resolution: $8'' \rightarrow 3.4''$
- L- and S-band receivers (no UHF)
- Backend to process all 78 antennas simultaneously
- Initial wideband correlator mode with 8k channels
- Full polarisation

Access policy

- Open Time
- **Legacy Surveys** with access reserved to **SARAO, MPG, INAF** (~500 hr/yr until integration in SKA1-Mid)





Guiding principles for the legacy survey programme

- Maximize the scientific outcome for the three communities
- Community-led not PI-led programmes
- Use of MeerKAT+ unique capabilities
- Scalability
- Compelling science with longlasting legacy value (beyond the SKA era)

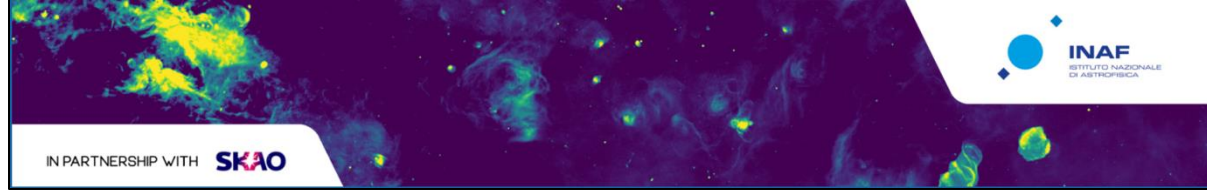
Approach

- ✓ Science meeting in South Africa (1-4 Feb 2023)
- ✓ INAF science meeting (22 June 2023)
- ✓ Expression of Interest for INAF (submitted by September 2023)
- ✓ Revision of the MeerKAT+ white paper with the inclusion of INAF

Implementation and benefits

- ❖ Active involvement of all three partner countries in the commissioning
- ❖ Periodic reporting and retiring risks
- ❖ Key to MeerKAT+ community to maximise MeerKAT+ open time science
- ❖ Successful delivery key goal in preparation of SKA-mid



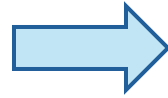


Near future perspectives – MeerKAT+ Legacy Surveys

Three MeerKAT+ legacy survey proposals

1. All-sky S-band polarimetry survey ($\delta \leq -40^\circ$)
2. HI legacy survey
3. Intensity mapping

Evaluation panel



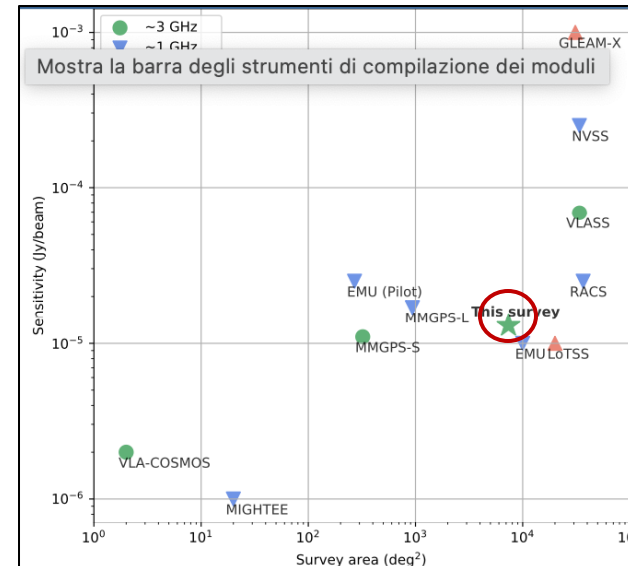
- S-band polarimetry survey – 80% first two years then 100%
- HI+IM – shared remaining 20% first two years
- **Redesign for HI+IM ongoing**

Accepted

Each survey has one coordinator from each member country (for INAF 1. Ingallinera, 2. Serra/Maccagni, 3. Bernardi)

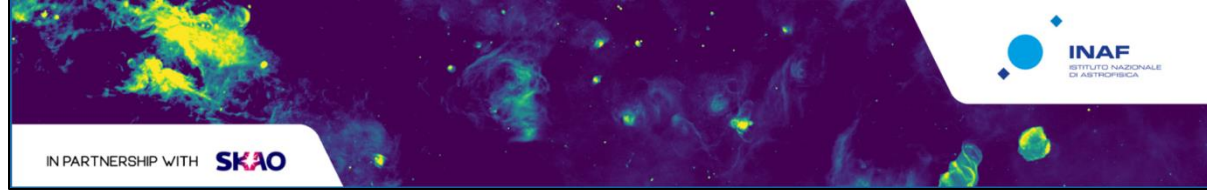
Contribution of the Italian community

- 20 Expressions of Interest received,
- PIs and co-Is from 10 INAF institutes/observatories, and 5 universities
- Some EoI with interest in more than one survey
- Total of 26 proposed topics



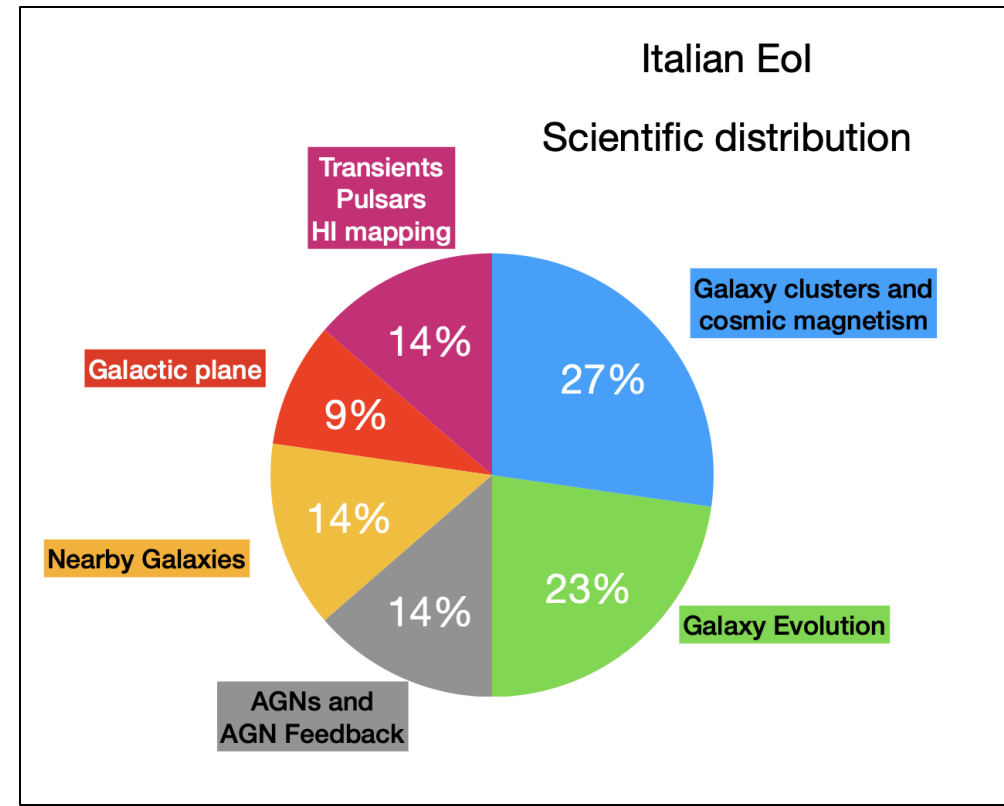
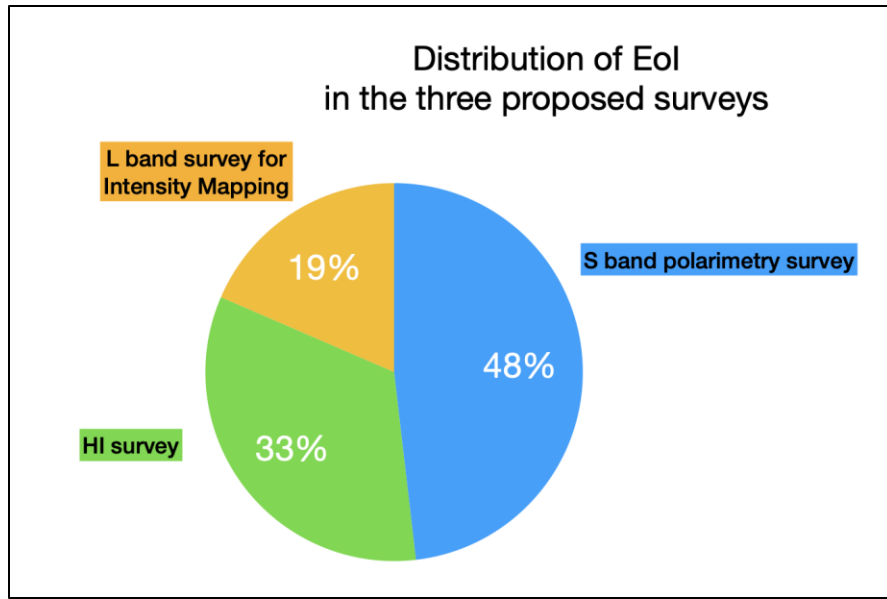
S-band survey
sensitivity vs
survey area

From R. Deane



Near future perspectives – MeerKAT+ Legacy Surveys

Scientific interest of the Italian community





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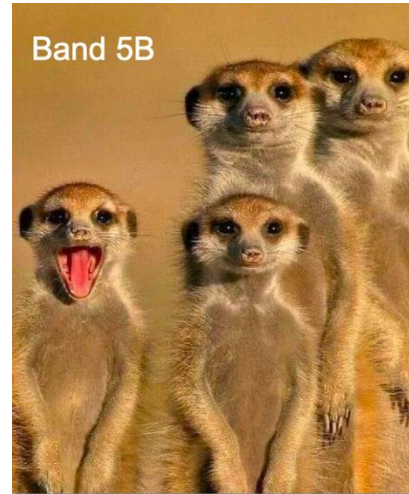


Near future perspectives – Science with MeerKAT Band 5B

- 8.3 – 15.4 GHz receiver on all 64 MeerKAT dishes
- $\theta \sim 1.2''$ to $0.6''$
- Continuum array sensitivity $\sim 3 \mu\text{Jy/b}$ ($\Delta\nu=800$ MHz and 1 hour integration)



- Considerably broaden the scientific potentials of MeerKAT
- Enhanced sensitivity and uv-coverage for SKA-mid in Band 5





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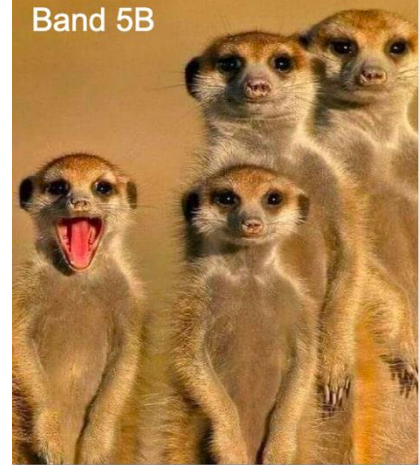


- Considerably broaden the scientific potentials of MeerKAT
- Enhanced sensitivity and uv-coverage for SKA-mid in Band 5

Band 5B Science White Book

- ✓ Consultation with the Italian and South African community through a call for ideas
- ✓ Broad involvement of INAF
- ✓ National workshop held in Catania in May 2025 **Maximizing MeerKAT's full potential: the scientific roadmap for Band 5B**
- ✓ 12 high-impact areas identified

Band 5B





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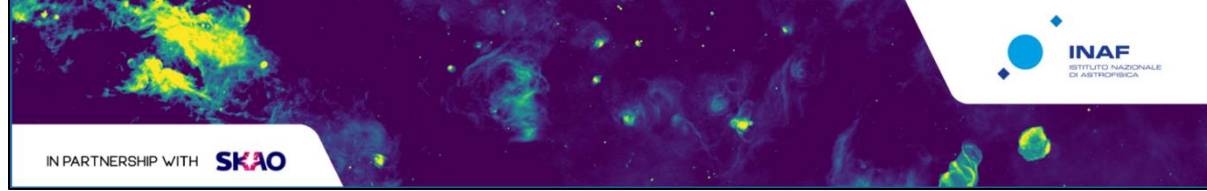
Band 5B High-impact science	PI
Complex organic molecules in Solar System precursors	E. Bianchi
The Galactic Centre	C. Trigilio
Pulsars in the Galactic Centre	A. Possenti
Star formation and census of HII regions	A. Traficante
Molecules at high redshift	G. Bernardi
Nearby galaxies	V. Casasola
Transient science	P. Woudt
Synergy with high energy facilities	M. Giroletti
Radio galaxies	G. Migliori
Band 5B on MeerKAT and prospects for VLBI	C. Spingola/J. McKean
MeerKAT Band 5B spectro-polarimetric extragalactic survey	R. Deane
Galaxy clusters	A. Botteon



New science areas in addition to those covered by Italian community with MeerKAT and MeerKAT+

Preparation of the Science White Book in progress
(deadline for final submission of papers today!)

Access to MeerKAT Band 5B time for INAF under negotiation with SARAO



Final considerations

The INAF investment in MeerKAT and MeerKAT+ is paying off

- Italian radio astronomers have been involved in the scientific exploitation of MeerKAT since the very beginning
- The number of MeerKAT Italian users is increasing steadily and so is the number of publications using MeerKAT data
- The scientific coverage of the Italian community using MeerKAT is broad and a good representation of the whole science range MeerKAT can address
- The interest in the potentials of MeerKAT+ is high, INAF has been very active in shaping the final version of the three legacy surveys and the community is engaged to ensure the best scientific outcome
- The capabilities of the Band 5B receivers on MeerKAT pave the way to advances in even more (new and hot!) science areas

