



SARAO
South African Radio
Astronomy Observatory

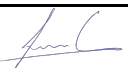


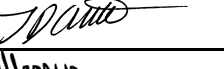
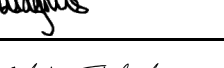

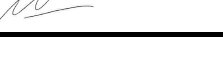
MEERKAT TELESCOPE AND DATA ACCESS GUIDELINES

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ABBREVIATIONS

CfP	Call for Proposals
DDT	Director's Discretionary Time
DSRF	Distinguished SARAO Research Fellow
GRB	Gamma Ray Burst
LSP	Large Survey Project
LST	Local Sidereal Time
MD	Managing Director
OT	Open Time
PI	Principal Investigator
QA	Quality Assessment
RFI	Radio Frequency Interference
SARAO	South African Radio Astronomy Observatory
TOO	Target of Opportunity

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1 Introduction

This document summarizes guidelines relevant to using the South African Radio Astronomy Observatory (SARAO) MeerKAT telescope and to accessing its data for scientific and technical use. MeerKAT is a radio interferometer located in the Northern Cape province of South Africa (at 21 degrees East, 30 degrees South) consisting of 64 antennas with baselines of up to 8 km [\[link\]](#). It was inaugurated in 2018, and while already one of the world's most powerful telescopes at L-band (radio frequencies of approximately 900–1670 MHz), further capabilities (e.g., receivers, correlator modes) continue to be developed. Eventually it will be incorporated into the international SKA-MID telescope. This document will be reviewed and updated as needed.

In developing and applying these guidelines, SARAO seeks to maximize the scientific impact of MeerKAT while contributing to South African scientific leadership and human capacity development.

2 Telescope Access Modalities

This section outlines all modalities through which MeerKAT data can ultimately be obtained. More details about each of these follow in sections 3–5 as relevant.

There are three proposal types (Large Survey Projects, Open Time, Director's Discretionary Time) relevant to obtaining MeerKAT observing time that is awarded through competitive processes. These are described in section [2.1](#). Other telescope observing modalities are described in section [2.2](#).

2.1 Competed Telescope Time

2.1.1 Large Survey Projects (LSPs)

These were originally selected in 2010 following a Call for Proposals (CfP) issued in 2009 by SKA South Africa (the predecessor of SARAO), and eight of these [\[link\]](#) were again reviewed and ranked in 2017 [\[LSP review panel report\]](#). It is expected that these projects (each of which could use up to between approximately 1000 and 5000 hours of telescope time) will use up to 67% of available competed telescope time over a period of 5 years. At this time, no more LSP CfPs are planned.

2.1.2 Open Time (OT)

Up to 28% of competed telescope time is to be awarded via multiple CfPs. Eventually, it is expected that OT CfPs will be made periodically (e.g., once or twice per year). In the meantime, due to fluid telescope development status, CfPs will be made subject to operational requirements (e.g., when new capabilities or substantial blocks of available observing time are predicted to become available).

The first OT CfP was issued in late 2018, was limited to relatively small amounts of telescope time (16 hours per proposal), and was restricted to South African-based PIs [\[link\]](#).

Future OT CfPs will allow for larger time allocations and will not be restricted to South African-based PIs. Nevertheless, meaningful South African leadership and capacity development (of students and young researchers, mindful of underrepresented groups) will remain an important component in the evaluation of OT proposals.

Researchers interested in MeerKAT observing opportunities but lacking meaningful interactions with South African colleagues are encouraged to develop such collaborations. If desired, SARAO can assist with introductions to potentially relevant South African researchers.

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There are two variants of OT proposals: *Regular*, and *Large*. Large OT proposals are currently defined as requiring more than 100 hours of observing time.

All OT proposals can include target-of-opportunity (TOO) observation requests that satisfy clearly defined triggering criteria.

2.1.3 Director's Discretionary Time (DDT)

Up to 5% of competed telescope time is available for small amounts of DDT observing time that fall principally into two categories:

1. Observations of unusual transients that could not have been proposed as TOO at a suitable OT CfP;
2. Observations that will likely lead to high impact publications in short order and/or that will assist with specific important South African capacity development outcomes.

2.2 Non-competed Telescope Time

For all modalities listed below, targets and prospective science if relevant are carefully selected so as to not unduly clash with those in previously approved active proposals.

Time on MeerKAT is scheduled by SARAO teams for a variety of activities (e.g., commissioning; observing for approved proposals), prioritized as needed to optimize a number of developmental and operational requirements.

Currently, a substantial amount of time is used for engineering development of new capabilities, commissioning activities, and science verification work. It is expected that gradually the amount of telescope time dedicated to these activities will decrease.

2.2.1 Commissioning

This focuses on baseline characterization of key capabilities and performance of the telescope with a view to eventually doing science; while science may result from some commissioning observations (and even engineering and integration tests), it is not a substantial consideration in the selection of the targets.

2.2.2 Science verification

Science verification aims to test the telescope under more challenging conditions, seeking to push some limits to demonstrate what science capabilities MeerKAT has under a variety of conditions; certain targets are selected by the SARAO team with the understanding that if the observations substantially work, interesting science could result.

2.2.3 Miscellaneous observing classes

This includes those:

1. That seek to advance LSP or other large proposal readiness (and are not primarily science driven), done as needed in coordination between SARAO and the PIs;
2. Occasionally scheduled to trial new operational models (e.g., multi-wavelength and/or multi-facility coordinated campaigns);
3. Done to advance SARAO strategic goals (e.g., to support the inauguration of the telescope).

2.2.4 SARAO Legacy Surveys

Owing to uncertain timelines while substantial development of the telescope continues, and consequent

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challenges in predicting telescope time available for specific use cases, substantial blocks of time have become available that do not fit into the above categories and that cannot be used by already approved proposals. SARAO has used these opportunities to carry out legacy surveys, identified in a non-conflicted manner, that suitably exploit the available telescope capabilities.

2.2.5 Partner allocations

Substantial amounts of telescope time are to be used for:

1. Projects selected by the Max Planck Institute for Radio Astronomy in exchange for their contribution of S-band receivers to MeerKAT that will also become available to the broader user community;
2. Projects selected jointly by the partners of the MeerKAT extension project.

2.3 Availability of MeerKAT for Observations

Nominally, MeerKAT is considered fully available for imaging science when at least 58 antennas can be used for observations. The array may also be partially available for science. MeerKAT or a part thereof may not be available for observations of any kind for a portion of the time due to maintenance related activities. Other special activities on Site may also curtail time available for observations. SARAO determines which of these states the telescope is in, subject to operational requirements.

3 Obtaining Telescope Time

In order to maximize the impact and diversity of MeerKAT science within its operational constraints, the specific science case of a new proposed project cannot unduly overlap with that of an active already approved project. However, individual proposals are approved for specific science goals using well-defined observing criteria on specific targets or areas (rather than, for instance, being given exclusive access to a particular portion of the sky or target class). There is therefore scope, for instance, for different teams to propose to observe overlapping sky locations for science cases with a different focus.

Prospective proposers should thus be familiar with active projects and their goals. SARAO will maintain a list of active projects [[link](#)], linking to external project web pages as relevant. Any remaining questions should be directed to SARAO (proposals@ska.ac.za) prior to proposal preparation. Potential conflicts identified will be adjudicated by SARAO with expert independent assistance as needed.

3.1 Open Time Proposals

3.1.1 Regular OT proposals

OT proposals can only be submitted following a specific CfP. The documents accompanying the CfP will provide specific details relevant to each particular call as appropriate. In the case of changes or inconsistencies with respect to the contents of this document, the specific CfP details supersede the more general remarks here.

Each CfP document pack will point prospective users to relevant technical documentation and tools to assist in proposal preparation. Prospective users are expected to familiarize themselves with these documents, including for instance to develop an understanding of the relevant RFI environment and how it might impact their observations. Any remaining questions should be directed to SARAO (proposals@ska.ac.za) well before proposal deadlines.

In addition to cover sheets (which will become public for approved projects), proposals will generally consist of the following components (specific requirements will be provided with each CfP documentation):

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1. Science case;
2. Technical (including MeerKAT suitability) and time justification (including triggering criteria for TOOs if relevant; requested observing time must include all applicable overheads including calibration and slewing);
3. Data processing and management plan, including available resources;
4. Human capacity development plan (including theses plans) as relevant;
5. If applicable, the status of previous MeerKAT observations.

Proposals conforming to the applicable constraints of the CfP will be reviewed as follows (any specific details applying to the review of proposals received following an OT CfP will be published with the corresponding CfP documentation):

- I. Anonymous non-SARAO subject-matter expert reviewers (selected by SARAO with relevant community input) will review the science case of each OT proposal according to well-defined terms of reference.
- II. The technical and data management components of each proposal will ordinarily be reviewed by SARAO staff (as needed SARAO will call on external expertise).
- III. A South African-based panel will review the capacity development component of each OT proposal.
- IV. A review panel appointed by the SARAO managing director (MD) according to well-defined terms of reference will incorporate the above inputs and recommend to the MD a rank-ordered list of proposals suitable for scheduling on the telescope in the context of the specific OT CfP parameters.
- V. After further taking into account all relevant constraints (e.g., pressure for particular LSTs or day/night-time observing), SARAO will finally group proposals into three classes: A (will be observed); B (may be observed); C (will not be observed). Following this, all PIs will receive feedback on the disposition of their proposals.

3.1.2 Large OT proposals

The above guidelines for Regular OT proposals also apply to Large OT proposals (see section [2.1.2](#) for a definition). In addition, the following apply to Large OT proposals:

Large OT projects will ordinarily have to first demonstrate technical and/or scientific feasibility through the successful completion of smaller pilot studies. Depending on the details, such projects might be deemed to have already demonstrated readiness by comparison to prior successful suitably analogous projects. Prospective PIs of such projects are *required* to discuss their plans with SARAO (by emailing proposals@ska.ac.za) prior to the submission of proposals, to ensure that they're suitable to be considered as OT proposals under the relevant CfP. Also, Large OT proposals may require a data release plan.

Depending on the details, Large OT proposals may also be subject to an additional layer of review compared to Regular OT proposals.

3.2 DDT Proposals

DDT proposals can be submitted at any time. Such proposals should be initiated by emailing ddt@ska.ac.za with a *brief* request that covers the same five components as for Regular OT proposals outlined in section [3.1.1](#), as relevant.

Due to time pressure, the process of reviewing DDT proposals is delegated to the SARAO chief scientist, who will consult with subject-matter expert reviewers as relevant, and who may request clarifications from the PI.

After review, observations for approved DDT projects will be done as soon as feasible.

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3.3 Commensality and Primary Science Goals

For the purposes of MeerKAT proposals and observing, commensality alludes to multiple science goals that can be addressed in parallel with one set of observations at no extra cost in telescope time, given suitable available technical and support resources. That is, it represents an opportunity for 'free' (aka piggy-back) science.

For instance, if some additional science can be done at the cost of more expensive calibration schemes, in this sense it's strictly not commensal. This doesn't mean that it shouldn't be done: e.g., two different meritorious projects done jointly using 110% of the telescope time that either one alone would require may well represent a good use of telescope time.

One option would be to propose for those two science cases jointly in one proposal requesting all the relevant observing time. Another option, given an already approved project for one science case, would be to consider fitting the second science case within the already approved time allocation, with possible adjustments to observing strategy.

3.3.1 Commensality within one proposal

A proposal may contain several key science goals considered to be of broadly equivalent importance during its review. Ordinarily, such an approved project will not be scheduled for a significant share of its total time allocation until all relevant telescope capabilities (e.g., correlator modes) are available to address the key approved science goals.

Conversely, a proposal may contain one or more primary science goals, with additional goals that are considered to be of secondary importance during the review process. In that case, such an approved project will start to be scheduled on a regular basis as soon as telescope capabilities are available to address the primary science goal(s), and will not be unduly delayed until all capabilities are available to address all science goals.

Individual proposals seeking to address multiple science goals commensally must be clear on which constitute primary versus secondary goals, if the distinction is relevant. Should questions arise in this regard following the review process, SARAO will seek clarity by engaging with the PIs and if necessary independent expert opinion.

3.3.2 Commensality across different projects

It is also possible that multiple projects (at least some of which have already been approved) could, together, form a commensal set, using the same set of observations to address multiple science goals by different teams. Such cases may require particularly close coordination between the different teams, and possibly with SARAO to discuss the availability of all required resources. SARAO welcomes inquiries in this regard.

4 Data Access, Proprietary Periods, and Reporting Requirements

4.1 Data Quality Assessment and the MeerKAT Archive

In general a minimum data quality assessment (QA) threshold must be met before any science observations are released for distribution to end users. QA metrics are under development and will evolve.

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Also, the telescope is still in development, and its characterization continues. Any performance expectations beyond those already characterized are on a best-effort/shared-risk basis.

Observations that fail to meet the minimum data QA threshold will be repeated on a best-effort basis. SARAO will work with end users to understand marginal cases and how these can be improved upon. Users are expected to do their part in interacting with SARAO operations teams to maximize the chance of successful observations.

In general, the status of all completed observations will be visible through the public MeerKAT data archive interface [\[link\]](#). Within relevant proprietary periods, data will be available for transfer from the archive by the PIs or their designates. After proprietary periods expire, the relevant datasets will be available to anyone. Some data (e.g., commensally collected with specialized user supplied equipment) may not be in the standard MeerKAT archive, and special data access constraints may apply.

The MeerKAT data archive is the intended long-term repository for a variety of MeerKAT data products. Currently, the imaging data products provided consist of visibilities with calibration solutions and reports. Eventually, it is expected that continuum and spectral image cubes will also be available. These are primarily generated for QA purposes but are also expected to be useful for several science applications.

4.2 Data Use and Proprietary Periods

Relevant SARAO technical teams always have access to all data for QA purposes.

4.2.1 Competed telescope time

For PI-led proposals (LSP, OT, DDT; section [2.1](#)), PIs or their designates have exclusive access to the data within the relevant proprietary period for the purposes for which it was collected (see also section [5](#)).

PIs at their discretion always have the option to waive proprietary rights for observations of immediate interest to a wider community. SARAO requests that in such instances PIs contact the observatory to discuss these opportunities.

4.2.1.1 Single-year OT proposals

These, whether Regular or Large, in general will have a 12-month proprietary period counting from the time at which the data corresponding to the last scheduling block of the project is made available to the PI.

Well-motivated longer proprietary periods (e.g., 18 months) will be considered by SARAO on a case-by-case basis where students are planned to use the proposed data as a significant part of their thesis. In such instances, the proposals must be accompanied by theses plans.

4.2.1.2 LSPs and multi-year OT proposals

These, whether Regular or Large, in general are expected to have periodic data releases. All data releases should be advertised/hosted through relevant project web pages. Proprietary periods are 12 months by default but well-motivated exceptions will be considered on a case-by-case basis by SARAO following discussion with the PIs.

4.2.1.3 DDT projects

By default DDT projects will have a 3-month proprietary period, but for transient objects the period may be set to as short as 0 (i.e., data is immediately available to anyone), and in exceptional circumstances (e.g., relating to student projects) it may be increased.

4.2.2 Non-competed telescope time

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For non-competed telescope time datasets (section [2.2](#)), proprietary periods are considered on a case-by-case basis, with the general goal to hew close to a 1-year period following release to the end users, while mindful of the underlying aims of each type of observation (for certain datasets there may be no proprietary period). During the proprietary period, if any, data access and publication are governed by the following guidelines.

4.2.2.1 The MeerKAT Builders List

This refers to those people who over an extended period of time have contributed significantly to the planning, design, construction, operation, and commissioning of MeerKAT. The builders list is updated as needed by SARAO.

A limited number of key publications based on non-PI-led data (cf. sections [2.2.1](#)–[2.2.4](#)) will be open to opt-in co-authorship by members of the builders list (*Nature* **573**, 235, is the first such example). The SARAO chief scientist and the lead author of a proposed publication based on such data will jointly determine whether it qualifies as a key publication for this purpose.

4.2.2.2 Commissioning and science verification observations

Commissioning and science verification observations, including engineering and integration tests (sections [2.2.1](#)–[2.2.2](#)), following relevant analysis and internal reports, may be available for science exploitation.

1. Suitable SARAO team members (including as relevant external colleagues involved in the development of the telescope) have precedence. At any given time, each will typically be leading the analysis and preparation for publication of no more than one such dataset. This process is coordinated within the SARAO science division.
2. Otherwise, such datasets are available to external-led teams, with the possible participation by relevant SARAO staff (see *Astronomy & Astrophysics* **628**, A122, for a publication resulting from such analysis). Interested colleagues should contact SARAO, and details are to be agreed with SARAO on a case-by-case basis.
3. Some of these datasets may be used to support strategic partnerships (e.g. development in African partner countries), and to assist with South African capacity development.

4.2.2.3 Miscellaneous observing classes

Access to data acquired under miscellaneous observing opportunities (section [2.2.3](#)) depends on the details underlying those observations.

For example: (i) access to data resulting from LSP preparatory observations (section [2.2.3-1](#)) is restricted to LSP and SARAO commissioning teams, and any resulting science exploitation would be led by LSP team members with possible participation by relevant SARAO science team members; (ii) anyone contributing significantly towards data analysis related to SARAO strategic goals (section [2.2.3-3](#)) has the opportunity to lead in its scientific exploitation (see *Nature* **573**, 235, for a publication resulting from such analysis).

4.2.2.4 SARAO legacy surveys

The exploitation of SARAO legacy surveys (section [2.2.4](#)) will in general be done over several years by diverse teams from the community at large. In developing the appropriate parameters to address such datasets, SARAO will first consult with relevant South African-based teams to establish local interest, expertise, and availability, and then consult more widely as needed. Full or partial datasets may be made publicly available after only limited exploration, in order to encourage broader exploitation.

4.2.2.5 Partner allocations

Access to data from partner allocations (section [2.2.5](#)) is limited to members of the respective collaborations, within their applicable proprietary periods.

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4.2.3 Calibrator data

Datasets available to users can contain a number of visits to a variety of calibrator targets and fields. Depending on details, some of the calibrator data may be useful in its own right for science exploitation that is not directly linked to the approved goals of any specific proposal. The following guidelines apply to users interested in exploiting such data for scientific purposes:

1. If the time spent on the relevant calibrator visits was charged to the associated project time allocation, the PI team in principle has priority to access these data for science exploitation, after coordinating with SARAO as noted in section 5.
2. Other users wishing to use any calibrator datasets for science exploitation should discuss their requests with SARAO.

4.2.4 Technical use of data

1. After approval by SARAO, suitable observations may be shared with external teams for technical purposes (e.g., development of imaging algorithms that will eventually aid multiple science users). Resulting publications should be coordinated with SARAO, and may include relevant SARAO staff members.
2. SARAO staff members who lead projects to characterize specific aspects of the telescope or its environment (e.g., holography; RFI) can lead resulting technical publications.
3. MeerKAT sensor data may be made available for technical studies.
4. Serendipitous scientific discoveries arising from data shared for technical use must be discussed with SARAO prior to publication.

Those interested in the above use cases should contact SARAO at data_access@ska.ac.za to discuss details.

4.3 Reporting Requirements and Reviews

All multi-year projects, including LSP and OT, are *required* to submit periodic reports to SARAO indicating progress against approved scientific and capacity development goals. Ordinarily these reports will be submitted approximately yearly, but their specific timing and contents will be discussed with the PIs by SARAO. The reports will be reviewed with external expert assistance provided to SARAO as relevant, and the outcome of these reviews will be used as one input in determining subsequent time allocations. Ultimately, it is possible that following such reviews some multi-year projects or some of their components could be curtailed.

For multi-year OT projects, these reports and their reviews may be used to evaluate the relative merit of continuing such projects against newly submitted OT proposals.

In addition, SARAO welcomes feedback from its users regarding any MeerKAT data, and requests reports from PIs upon completion of any projects.

5 Serendipity and Coordination

Data are provided to PIs primarily for specific approved science goals. MeerKAT's relatively large field of view and great sensitivity make it reasonably likely that in some instances data collected for a particular project with specific science goals will be useful for another team working (or proposing to work) on a different project.

For instance, a DDT project observing a GRB might by happenstance collect imaging data in an OT

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proposal field that could be useful for the OT team. In that case, the OT team could have access to the DDT data for their specific approved purposes (and the DDT team may not analyze the data for such purposes). On the other hand, if the DDT team detects a transient unrelated to the GRB, provided that it doesn't unduly clash with another already approved project, the DDT team is encouraged to exploit that serendipity, in cooperation with other teams as relevant.

In order to encourage the exploration of serendipity while being protective of all approved projects and users, PIs are *required* to contact SARAO before they exploit or consider sharing their datasets for purposes beyond those previously explicitly approved. They should do so by emailing serendipity@ska.ac.za and explaining the request. SARAO will consider the request in light of active projects with a view to approving it if no specific clash is identified or foreseen.

6 Distinguished SARAO Research Fellows

Distinguished SARAO Research Fellows (DSRFs) are very experienced radio astronomers who can contribute significantly to the development or improved understanding of MeerKAT, and who are willing to contribute substantial time for these activities over extended periods of time. Suitable interested candidates will be appointed by SARAO.

While active, DSRFs will at a minimum have data access rights equivalent to those of SARAO staff as outlined in section [4.2.2](#). Additional access is possible, to be discussed as relevant on a case-by-case basis.

SARAO welcomes contact from anyone who may have the experience and availability to contribute to improving MeerKAT, to discuss relevant opportunities for collaboration.

7 Publications, Acknowledgements, and Advanced Data Products

7.1 Publications Using MeerKAT Data

Users are required to provide SARAO with bibliographic details concerning published articles and completed theses that contain or are based on MeerKAT data, by emailing publications@ska.ac.za. If papers are deemed to have potential interest for the general press, authors are requested to contact SARAO in advance of publication.

7.2 Acknowledging MeerKAT Data in Publications

All authors are requested to include the following acknowledgement statement in any publication containing MeerKAT data:

The MeerKAT telescope is operated by the South African Radio Astronomy Observatory, which is a facility of the National Research Foundation, an agency of the Department of Science and Innovation.

7.3 User-Generated Data Products and the MeerKAT Archive

SARAO wishes to collaborate with MeerKAT users to ingest user-generated data products into the public MeerKAT archive, ordinarily once their primary exploitation of the data is complete. This will enhance the legacy value of MeerKAT. Interested users can contact SARAO (data_access@ska.ac.za) at any time to initiate relevant discussions.

8 Feedback Regarding MeerKAT

Users and prospective users of MeerKAT with questions or comments are encouraged to contact SARAO or the SARAO Users Committee as relevant.

8.1 SARAO

SARAO welcomes questions and feedback regarding any matters relating to MeerKAT. Any feedback concerning these guidelines can be addressed to the SARAO chief scientist. Relevant matters will be referred to the SARAO MD, whose decision concerning any disputes is final.

8.2 The SARAO Users Committee

The SARAO Users Committee was established in order to advise the SARAO MD and staff on all aspects of SARAO activities that affect the users and potential users of its facilities, including MeerKAT [\[link\]](#).