Using EISCAT AB for space debris monitoring

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Report | 3-2025 – NORCE Energy and Technology

Report title	Using EISCAT AB for space debris monitoring
Project number	109255
Institution	NORCE Research
Client(s)	Norwegian Space Agency
Classification	Open
Report number.	3-2025
ISBN	978-82-8408-406-0
Number of pages	50
Publishing date	2025-07-02
CC-license	CC BY 4.0
Citation	Grydeland, T. (2025). Using EISCAT AB for space debris monitoring. Report no. 3-2025, NORCE Energy & Technology
Image credit	EISCAT Scientific Association
Quality assurance	Kjell Arild Høgda
Keywords	Space Debris; Radar; Space Surveillance

Summary

EISCAT radars have made important contributions to the important task of monitoring the space debris population. This has been made possible with access to raw data. Security concerns have at times made access to raw data for this purpose tricky, even in cases that on the face of it should not be of concern. Neither EISCAT nor its users were happy with this, so EISCAT was reconstituted into as Swedish AB to enable handling of all data products in a secure manner, including raw data.

EISCAT AB is a developing organisation, and the policies and procedures that govern the collection, handling and access to data have only recently become available. Rules for distribution of data to entities not associated or affiliated with EISCAT AB is still “work in progress.”

Rules for access to the new EISCAT_3D system and data collected with it have not yet been decided upon, and EISCAT AB is happy to receive inputs from interested users.

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1 Executive Summary

EISCAT radars have made important contributions to the important task of monitoring the space debris population. This has been made possible with access to raw data. Security concerns have at times made access to raw data for this purpose tricky, even in cases that on the face of it should not be of concern. Neither EISCAT nor its users were happy with this, so EISCAT was reconstituted into as Swedish AB to enable handling of all data products in a secure manner, including raw data.

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Contents

2 Definitions

In this document we will often need to distinguish between the (now dissolved) EISCAT Scientific Association and the (newly formed) EISCAT AB. For brevity, the former will at times be referred to as “E-SA” and the latter as “E-AB”. When the text can refer to either or both, “EISCAT” may be used. Likewise, the legacy EISCAT systems on Svalbard and the Scandinavian peninsula will be referred to by “ESR” and “ESP”, and in aggregate by “ESS”, while the EISCAT_3D system currently under construction by “E3D”.

The term “raw data” means different things in different contexts. Here, we will use it exclusively to refer to amplitude data, *i.e.*, data that correspond directly to the voltages sampled in the receiver system, and from which pulse-to-pulse timing and phase is obtainable. Analogue or digital mixing, filtering and decimation may have been performed, but not correlation, nor coherent or incoherent integration.

3 Background

Space debris --- man-made objects in space which serve no purpose --- has become enough of a problem for all human activities in space to gather significant international interest. Beam-park observation with the ESP have been conducted for near on 20 years. This has been done on a campaign basis, upon requests from interested scientists in EISCAT member countries, and typically in ESA projects.

Data from EISCAT always came with some limitations, but historically these were for reasons of scientific primacy and priority, not from security considerations. Data were under some embargo for one to three years before becoming publicly available. The duration of the embargo and access while embargo lasted depended on how the observations were scheduled and accounted, but the details are not important here. Data would be correlated and integrated over tens of seconds to minutes, meaning that they would be of no use for determining orbits of space objects, even when these were often visible in the data. As computers became more powerful and storage media grew in capacity, it became feasible to record raw data. The signal processing hardware at E-SA had quite limited facilities, but EISCAT made available a port where analogue signal at an intermediate frequency could be recorded by the users’ own hardware. These data were then outside the control of E-SA even as they were formally owned by E-SA along with all other data from the system. Several important scientific results were only made possible by such access to raw data, and several new techniques were prototyped on off-line raw data before being included in the real-time processing. All space debris observations made at ESS have been based on the availability of raw data. In some cases, raw data were collected in dedicated hardware operated alongside EISCAT's own equipment during routine observations, while observations the last several years have been made in a dedicated mode where raw data have been collected in the EISCAT system itself.

A new data policy was introduced by E-SA in response to concerns from national security authorities. Some resident space objects are important for reasons of national security, and information about their orbits is considered sensitive. E-SA was obliged to comply with security-derived requirements that originated outside the organisation, while the exact extent of the measures necessary to comply were uncertain. Therefore, E-SA found it necessary to be very strict in their formulation and interpretation of policies regarding access to data, strict enough to be of grave concern to some users. These were users that made ground-breaking developments based on access to raw data. To facilitate these kinds of break-through, such access should be provided as far as is allowable.

EISCAT AB was created to give the organisation legal standing to make use of “certain security frameworks” not available to E-SA, and which enables it to handle all its data products in a secure manner. The audience and means of distribution of data from E-AB is still “work in progress”, according to EISCAT.

Still, it is fair to say that a principal desired outcome of the reorganisation was to give scientific users a greater freedom to access raw data, which requires systems in place to remove echoes from sensitive objects with very high degree of success. At the same time, enabling E-AB to handle sensitive data implies that they were foreseen to provide data on (non-sensitive) space objects with regularity.

The intention of EISCAT was to have overlapping 3D operations between ESP and E3D, but the timeline for EISCAT-3D has been subject to significant delays. There were problems with deliveries of the antenna modules from China due to the global outbreak of Covid-19, and problems have been identified with the stability of the ground at the main site in Skibotn, Norway, causing many changes in the deployment schedule for E3D. In the meantime, the old tristatic UHF radar has ceased operations. The remotes in Kiruna and Sodankylä were first refitted to work with the VHF radar at 224 MHz, but during the winter of 2024-2025 they have both been demolished.

4 Objective of this study

The study has served two primary objectives:

- Chart the possibilities for using EISCAT instruments (ESS and E3D) for space debris monitoring under EISCAT AB.
- Sketch products that can be obtained from ESS and E3D.

E-AB is still being formed, so the reader should take the conclusions drawn here as a “snapshot” of an emerging state. The rules enacted now apply to the legacy (ESS) systems, and a different set of rules is anticipated for E3D. Interested users and communities are encouraged to voice their concerns and submit their wishes to E-AB.

5 Activities undertaken

The activities in the project comprise reviews of documents and informal interviews with key people. In addition, we believe our experience in ongoing projects space debris projects is relevant, and such experiences are also summarised here.

5.1 Requests for information

5.1.1 Initial request for information

A request was made to EISCAT for the rules and guidelines that will govern the use of EISCAT_3D for space debris purposes.[1] The reply stated that "[...] inte skett några ändringar gällande tillgång till data." but does not rule out that changes may come, which we will then have to talk to the company about. At the time, our experience was that the rules were less than clearly formulated, and (perhaps as a consequence), their interpretation and application inconsistent, as set out in the appendix. Therefore, the assurance that "nothing has changed" was not very reassuring.

5.1.2 First draft

The response from EISCAT to the initial request for information was understood to mean that the policies and documents that existed for E-SA would remain in force for E-AB. Based on this understanding, a report was drafted based on these existing documents and policies.

5.1.3 Written feed-back and new policy documents

After the distribution of the draft to informants and correspondents, E-AB made the author aware of newly created policy documents regarding data and access to the EISCAT instruments, and also raised some concerns regarding the interpretations made and conclusions drawn in the draft. Most of the report had to be rewritten in light of these new documents. The review of the previous set of documents has been retained for historical purposes, and can be found as an appendix.

[1] Mail sent to Viktoria Mattson (Vetenskapsrådet) on 2024-12-09, with reminder 2024-12-12. Reply received that day, containing no useful information. Request for further clarification and/or supplemental documents sent 2025-01-03, no further replies have been received.

5.2 Document review

5.2.1 E-AB documents

The project plan included an activity to review the constitutional documents of EISCAT AB. In the initial document review, we obtained the registration of EISCAT AB by Swedish authorities, but this document only enumerates the stock capital and board members.

The documents provided to us after circulation of the first draft of this report have been attached to this report. These documents are:

1. "EISCAT AB Rules of procedure AF v1 published.pdf"
2. "EISCAT AB Rules of procedure SAC v1 published.pdf"
3. "EISCAT AB Accesspolicy v1 published.pdf"
4. "EISCAT AB Datapolicy v1 published.pdf"

The first two of these set out the Rules of procedure for the Associate Forum and the Scientific Advisory Committee, two bodies created to advise and assist the Board on matters within different areas of concern: The AF on "*scientific and financial matters*" and "*other matters referred to it by the board*", and the SAC on "*matters related to science directions and observation programmes*" and "*science-related matters referred to it by the Board or the Associate Forum*".

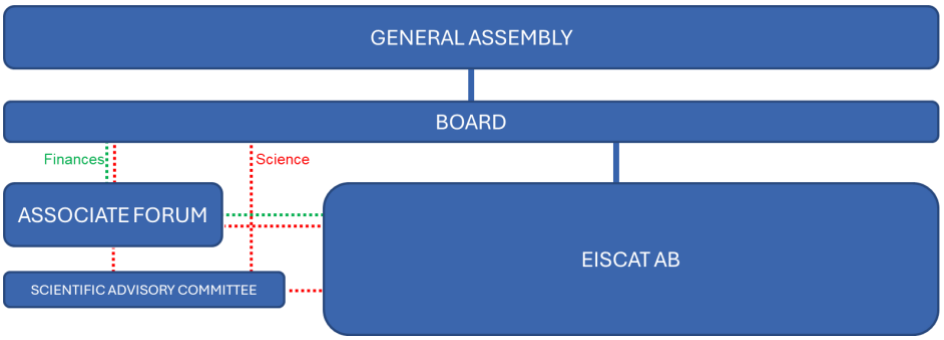

Figure 1: *Governing structure of EISCAT AB (taken from* Rules of Procedure SAC*)*

The "Accesspolicy" document describes the different types of users and programmes.[2] "Associates" are entities that have entered into an Associate Agreement with EISCAT. Associates can nominate representatives to EISCAT's Associate Forum (AF) and the Scientific Advisory Committee (SAC), see figure 1. "Affiliates" by the same document, are

[2] A "programme" in EISCAT parlance refers to the set of rules that govern scheduling and accounting for a particular observation. "Common Programme" operations are scheduled and run by EISCAT on behalf of all users, while "Special Programme" operations are observations made at a time and in a mode requested by a user, and where that user is given privileged access to the results. E-AB has expanded on this model by defining several types of special programmes available to the different types of users.

entities that contribute to EISCAT funding year by year. This means they have less of a long-term commitment to EISCAT than associates, and they do not nominate representatives to AF or SAC. Associates and Affiliates are allotted a portion of the total available observation time on EISCAT radars in relation to their contribution to EISCAT budgets, and they are given access to data collected not on their behalf after a shorter embargo period than other users. In addition, “Time buyer” users are users that buy operational time at the facilities for a specific project. Any requests for observations undergo a security review and can be rejected for security reasons.

The “Datapolicy” document defines the different processing levels of data, the procedures for handling and archiving these, and defines all data as the property of EISCAT.

The documents do not establish rules for distribution of data (mechanisms or access control) outside EISCAT, nor do they discuss the possibility that data can be considered sensitive. We will return to this below.

5.3 Informal interviews and correspondence

The key informants of this project are listed below, with the contact points used for the purpose of this activity. The information contributed is mostly summarised in aggregate, as there is a lot of overlap, and it does not appear necessary to attribute the points to any specific person.

Director of EISCAT AB, Philip Påhlsson
Mr. Påhlsson began his position as CEO of EISCAT AB on 2025-04-01. The first chance for discussing the present topics with him was during an informal discussion by teleconference, joint with Dr. Thomas Ulich on 2025-04-11, less than two weeks after stepping into the position. A second teleconference with Mr. Påhlsson, Dr. Ulich and Mr. Andersson took place on 2025-05-28, after having reviewed the initial report draft.

Dr. Thomas Ulich
I made a visit to Sodankylä Geophysical Observatory in January 2025, during the annual “Observatory days” as this is an opportunity to meet relevant people away from their busy schedule. Dr. Thomas Ulich was employed in a senior technical role in E-SA, and is also on the staff of E-AB.

Interim CEO of E-AB Henrik Andersson
Our communication with Mr. Andersson has been by way of comments referred to in other email correspondence, and he also took part in the last teleconference with Mr. Påhlsson, referred to above.

Former director of E-SA Dr. Anthony P. van Eyken
Email correspondence during March 2025.

Former director of E-SA Dr. Axel Steuwer
Several informal discussions conducted prior to the dissociation of E-SA.

Former director of E-SA Dr. Craig Heinselman
Several informal discussions during his tenure as director, as well as an informal telephone interview on 2025-03-24.

Members of the board of E-AB Toril Johansson and Aslak Tveito
Teleconference with the members of the board of E-AB appointed from Norway, on 2025-01-16. The purpose of the conference was primarily to inform the board members of the previous and ongoing activities on ESS for the purposes of monitoring space debris, and also of our intentions for continuing such activities on E3D.

6 Summary of discussions

As outlined in the background section, a major part of the rationale for creating E-AB in place of E-SA is the requirement to handle data that can be considered sensitive within the bounds set by national security legislation. E-SA had a requirement for full transparency in its operations, which made this difficult. This is a requirement which does not exist in E-AB.

The policies of E-SA were not always easily understood or consistently applied. They don't apply to E-AB, however. The presentation of these documents is therefore only of historical interest, and it has been deferred to an appendix.

EISCAT AB has defined a new set of policies, and in the discussions, they have stressed that these apply to observations using the legacy ESS systems only. The capabilities of E3D will be of quite a different nature, and policies for access to this instrument, its data and products have not yet been decided upon.

In addition, E-AB management is looking at the possibility of allowing radar access on a commercial basis to help fund the science programme. Whether this will be implemented is a decision for the Board of E-AB which has not been made yet. There is a commercial opportunity for provision of space debris observations on a regular basis from facilities like ESS and (especially) E3D. Multiple entities have expressed or demonstrated interest in providing such services from ESS, including Neuraspace and NORCE.

Finally, while the policy documents of E-AB do not discuss sensitive data, we have been informed that none of the observations possible with the legacy ESS systems are considered "tracking", and that access to data from observations made on these systems will not be restricted. This is a very positive development which removes the uncertainty that permeates the discussion of the previous policy documents in the appendix.

In their written response, EISCAT has pointed out that very few of their regular users are interested in space debris observations, and that time spent on this is of no value to them since these data are not easily used for ionospheric research purposes. Such observations are therefore given a correspondingly low priority vis-à-vis other modes of observation in Common Programmes.

In discussions and in the written response, E-AB expressed support for our suggestion that hard target processing should be done alongside processing for ionospheric parameters in as many modes as possible, and shared the opinion that this would be of benefit to both areas of application.

6.1 Our interpretation and conclusion

Most of the questions which prompted the investigation reported on herein have been answered, and for the purpose of continued use of EISCAT radars for space debris observations, the answers are quite satisfactory.

A significant argument against such usage in EISCAT's Common and Special Programmes is that the SST data cannot currently be used for ionospheric research (but see recommendations). EISCAT will have to decide whether they want to allow access to EISCAT radars on a commercial basis or not, and how such access is accommodated alongside the usage for scientific purposes. E-AB management are looking at this, but the decision will be made by the board. The owners and associates have an opportunity here to convey their views, if they have any, to E-AB through their appointed representatives on the board and/or AF and SAC.

While access on commercial terms has not been implemented, time allocation must be handled in one of two ways:

- Request to be scheduled as Common Programme. This can be considered relevant, especially if observations are to be made as part of international collaborations such as the Inter-Agency Space Debris Coordination Committee (IADC).
- In Special Programmes by way of the Associate/Affiliate allocations, to be requested through the mechanisms of the respective Associate or Affiliate.

In the meantime, we have been assured that whenever SST observations have been made with the ESS systems, access to raw data from these observations will not be impeded, in accordance with the assessment made back in 2015 that the orbit information that can be obtained from these systems is rudimentary.

7 Data Products

The reference here is *System Requirements Document* from the ESA project P3-SST-XXV: EISCAT 3D Processing Chain.[3] The emphasis for ESS observations is on TDM messages (tracklets) using the CCSDS TDM XML format, and (for detections that can be correlated

[3] Kastinen, D., Vierinen, J., Kero, J., and Grydeland, T., *System Requirements Document*, Technical Report, ESA/ESOC Technical Management, May 2021, ESA Contract P3-SST-XXV.

with a catalogue), ODM messages using the CCSDS ODM XML format. Both of these XML formats were expanded with fields that quantify the uncertainties in the estimated quantities: positions, velocities and orbital elements.

The processing chain prototyped in that project was developed for E3D. It is built from generalised components, so making a version from the same components for an ESS radar should be a manageable effort. The quality of available orbit estimates will be different, since ESS radars do not have the tristatic geometry of the E3D. In particular, IOD cannot be performed. When an observation can be correlated to a catalogued object, its orbit can be updated.

An important outcome of space surveillance is conjunction warnings and guidance for collision avoidance manoeuvres. We recognise the importance of this outcome but believe it should be considered a downstream outcome. That is, tracklets and orbits from EISCAT should be made available for further processing and higher-level products. This is both to limit the scope of the activity and to provide opportunity for innovation in an area where there seems to be significant room for improvements in propagation accuracy, atmospheric modelling and the quantification of conjunction uncertainties.

8 Recommendations

Recommendation 1: To influence EISCAT policy and operations, RCN and NoSA should coordinate and agree on a common purpose.

Norway is one of three national owners of E-AB, and have a significant influence over how the company should conduct its business, through its members on the board and also their nominated representatives in AF and SAC. The primary purpose of EISCAT is scientific research, and the management of the Norwegian interest in E-AB rests with the ministry of research and higher education, through the Research Council of Norway (RCN). Space surveillance in the civilian sector rests with the ministry of commerce, through the Norwegian Space Agency (NoSA). NoSA objectives are more likely to be considered if they can be aligned with the objectives of RCN. Such alignment is possible, and mutually beneficial. It means integrating the processing of EISCAT data for hard target echoes in regular EISCAT data handling.

Recommendation 2: RCN and/or NoSA should fund an activity to enable joint extraction of ionospheric parameters and hard target echoes from EISCAT modes.

Space debris observations are currently made in a dedicated mode from which ionospheric parameters are not being estimated. This makes EISCAT reluctant to dedicate much time to this mode, since it detracts from the time available to serve its primary purpose. This can be remedied by 1) extracting hard target products from ionospheric modes; 2) extracting ionospheric parameters from the space debris mode, or both of the above. Of these, 1) has the highest enduring value, since it means production of hard target observations on a regular basis. It is probably better to start with 2), since it is an easier mode to serve as a demonstration. The hard target processing should also have the ability

to filter out the hard target echo from the data before proceeding with processing for ionospheric parameters. This has the potential to add significant value to the ionospheric science activities of EISCAT. As reported above, this is a development which will be welcomed by E-AB.

Recommendation 3: NoSA should facilitate commercial exploitation of hard target products from EISCAT AB.

Products from a hard target processing chain integrated with EISCAT have commercial potential, both on open and restricted markets. Information on debris and commercially operated satellites is of interest to the owners and operators of satellites and surveillance systems such as EUSST; while information on sensitive objects is of interest in a very different marketplace. Exploiting this potential will require work unrelated to the science activities of EISCAT. A separate business-oriented organisation could be established for this activity. The entity can serve as a single point of contact for those interested in SST products, and act as an intermediary to EISCAT. They can be responsible for developing and maintaining the necessary processing, and for interaction with users and customers, including vetting for access to sensitive data. The interests of EISCAT and its associates, as well as the developers of the hard target processing should be represented in the new organisation. NoSA should consider activities towards setting up this organisation and engage relevant user communities.

9 Appendix A: Example TDM in XML format


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version="2.0" xsi:noNamespaceSchemaLocation="./e3dxml-2.0.xsd">
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```

10 Appendix B: Documents of EISCAT SA

The documents of EISCAT AB only became available to us at the very end of this project. Prior to that, the documents of EISCAT SA were described and discussed. These documents no longer apply to EISCAT AB or to any data taken in the future. We choose to include the discussion and interpretation here, as a historical reference and as a point of comparison vis-à-vis the current set of documents.

In order of priority, the relevant documents of E-SA are:

1. "*EISCAT BlueBook*",[4] containing the EISCAT agreement, appendices, statutes and an annex. The annex contains several independently titled documents including ones that elaborate on the purposes and scopes for E-SA's governing bodies, and the EISCAT Data Policy.

2. "*EISCAT Data Policy*",[5] a document in the Annex of EISCAT BlueBook.

3. "*Data Policy Procedures*",[6] a separate document outlining the procedural, technical, organisational, and formal steps taken to enforce the data policy.

10.1 Key excerpts

The EISCAT BlueBook lists the "Objects and Means" of the E-SA. In this context, the relevant Objects and Means are as follows:

a. The aim of the Association is to provide access to radar, and other, high-latitude facilities of the highest technical standard for non-military scientific purposes.
e. The Association may contribute to the international task of tracking objects in space (natural or man-made). For this activity, an agreed list of objects shall be maintained and the Association shall only conduct tracking of objects from this list.
k. All use of observation time must be in line with the aims of the Association. Users shall not use the facilities for collecting data on military sensitive objects.

The EISCAT Data Policy, section 4. Transparency and Logging of EISCAT Operations contains the following items:

1. EISCAT shall strive to have full transparency in its operations and with respect to the data generated. All observation campaigns shall be clearly documented and the

[4] https://eiscat.se/wp-content/uploads/2022/07/BlueBook_Edition2021.pdf
[5] https://eiscat.se/wpcontent/uploads/2022/07/BlueBook_Edition2021.pdf#page=40
[6] https://eiscat.se/wpcontent/uploads/2018/04/BlueBook2015_Data_Policy_Procedures_Document_2017-06-28b.pdf

campaign log shall be available for inspection in accordance with the EISCAT Agreement.
2. *Generally, data segments containing radar echoes from resident space objects shall be filtered out at a low processing level. When such filtering is not adequate to reach the objectives of the approved observation campaign, special care must be taken to avoid a breach of the Objects and Means of the association as laid down in the EISCAT Agreement.*
3. *EISCAT raw data containing radar echoes from satellites shall not be distributed to other agencies.*

where the "Objects and Means" referred to in point 2 are the ones quoted above.

The EISCAT Council's Expert Group on Satellite and Space Debris Observations noted, in their report from October 2015:

> *"Although some high-precision measurements of satellite range and velocity can be made using the EISCAT radar, the capabilities of the present system in terms of orbit accuracy are such that tracking capabilities can be considered rudimentary compared to the open Space-Track catalogue. The statistical surveys that can be done with EISCAT are not restricted."*

The Policy Procedures document quotes this statement and continues:

> *"As a result, some of the Data Policy Procedures are not implemented on the legacy EISCAT systems (particularly those procedures requiring specialized technical solutions). Other procedures are, however, more generally applicable for all observations."*

The procedures are then described. They are in four steps, briefly summarised below:

1. Experiment request procedures. The stated reasons for an experiment are inspected, and if they are not clearly acceptable, they will undergo expert review.
2. Technical enforcement. Hard target echoes will be identified and removed at a low level of processing for E3D. For experiments specifically targeting space debris, this will be disabled, but then the raw data will be tagged and subject to stricter regulation.
3. Transparency of operations. Since every step of processing and all results will be open to all associates and users, and to all relevant authorities, it will be very difficult to subvert these systems to extract restricted information without attracting notice. Detection of any such breach will cause the user experiment to be terminated and the data rendered inaccessible.
4. Data ownership retained by EISCAT, with stipulation that "Raw data shall not be disseminated to other agencies, either automatically or individually." although it goes on to saying "Raw data can be accessed by the scientists who requested the experiments or, after the embargo period, by all Associates and Affiliates, but only processed results will be made openly available."

10.2 Our interpretation and comments

Several key concepts in these documents are not clearly defined, and (depending on interpretation) are contradictory. For instance: The objects and means refer to “tracking” of space objects; the data policy procedures document states that “statistical surveys [...] are not restricted”. “Tracking” is a term normally used when a radar specifically attempts to (re)acquire a previously known target, with the intention of keeping it under prolonged observation; while “survey” is used when no particular target is sought, and one only registers the detections that occur incidentally. By this use of the terms, it seems clear that an incidental detection, whether it is made in a beam-park mode or as part of routine ionospheric observations, should not be considered “tracking”.[7]

When discussing the ESS radars, none of them have the pointing agility necessary to follow an orbiting object across the sky. The closest analogue is to park the beam in the predicted path of the object, possibly multiple times during a pass, a usage which must reasonably be termed “tracking”. Apart from this case, it is arguable whether any ESS observations can be considered “tracking” at all.[8]

But then what happens when a detection is unambiguously linked to an identified object, e.g., by correlation against a catalogue of orbital data for known objects -- does this constitute tracking or not? The answer is not obvious, but it is fundamentally important in the context of deciding what kind of modes and processing are allowed.

The expert group statement quoted in the policy procedures document states that the quality of ESS data for the purpose of orbit estimation is considered rudimentary, and that the technical protections used for E3D are not used on these legacy systems. They also state that “Raw data can be accessed by the scientists who requested the experiments”, while also repeating the BlueBook statement that "EISCAT raw data containing radar echoes from satellites shall not be distributed to other agencies."

The rules for distribution of data are less than perfectly clear. As we have seen, the wording “other agencies” is used both in the BlueBook and in the policy procedures, but neither document specifies what is meant or intended by this wording. The requesting user shall have access to the data, but raw data containing echoes from satellites shall not be distributed to “other agencies”. When is a requesting user only a user, and when are they considered an agent for an other agency?

The technical protection procedure specifies that raw data must be filtered in all cases except when detection of space objects is the purpose of the experiment. In those cases only, filtering is disabled, but severe limitations are imposed on when and how these raw data can be distributed and stored. The filtering is described, and specified to work on

[7] EISCAT has agreed to this interpretation, and concluded that ESS raw data from such observations therefore are available without restrictions.
[8] EISCAT has concluded that even this is not tracking, since it does not mean “prolonged observation”. They also point out that while such observations were attempted once, they placed inacceptable strain on the system and will not be allowed again.

module-level data, i.e., after the first-level beamforming operation when the data stream comprises data from around 1% of the total array. At this level, hard target detection sensitivity is about 20 dB lower than if data from the full array are considered. Perhaps for this reason, the data policy attaches limitations on the distribution, use and dissemination of raw data even when filtered: the procedures do not state that filtered raw data are considered safe to distribute, so the stipulation that “raw data containing radar echoes form satellites shall not be distributed to other agencies” seemingly still applies after filtering. The procedures therefore seemingly fail to accomplish either of their two purposes: 1) to remove the possibility of using EISCAT data to detect space objects, and 2) restore users' free access to raw data.

11 Appendix C – Eiscat documents

- “EISCAT AB Rules of procedure AF v1 published.pdf”
- “EISCAT AB Rules of procedure SAC v1 published.pdf”
- “EISCAT AB Accesspolicy v1 published.pdf”
- “EISCAT AB Datapolicy v1 published.pdf”

EISCAT AB

Rules of procedure

Associate Forum

Document Name: Rules of procedure Associates Forum		**Document:** Regulatory document	**Concerns:** EISCAT AB
Document Owner: CEO	**Responsible:** Board Chairperson	**Availability:** Public	
Adopted on: 2025-03-04	**To be revised at the latest:** As needed	**Decision-making body:** Board	**Version/Revision:** See below

Document History:

Version/ Revision	Date	Changes	Notes
0.1	2025-01-26	New document	
0.2	2025-02-04	After comments	First considerations by EISCAT Board
0.3	2025-02-18	Further edits	
0.4	2025-02-20	After comments	Internally reviewed
1.0	2025-03-04	Adopted version	Approved by the EISCAT Board. Published

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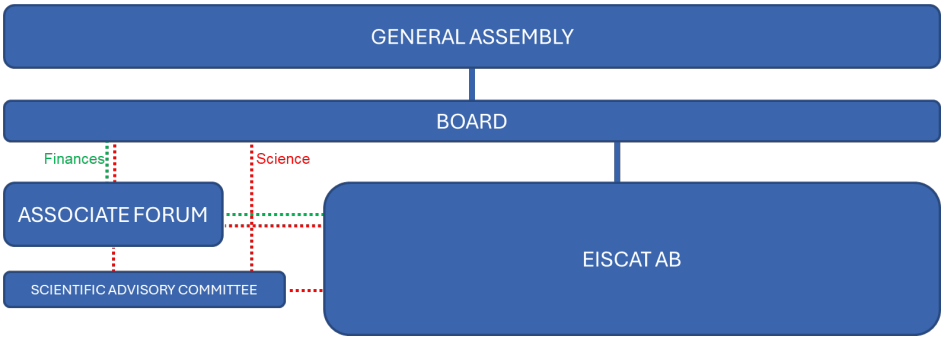
1 ORGANISATION OF THE ASSOCIATE FORUM

Each Associate may nominate two individuals to the Associate Forum (AF), funded by the respective Associate, to be appointed by the Board.

The company will arrange a common on-line work area for communications, sharing calendars, meeting related matters and documents.

The Rules of procedure for the Associates Forum shall be approved by the Board.



2 MISSION OF THE ASSOCIATE FORUM

The Associate Forum shall:

1. advise the Board on scientific and financial matters
2. advise the Board on other matters referred to it by the board
3. without prejudice to the above, act as a source of support and advice to the EISCAT CEO and senior management staff
4. Evaluate in kind contributions in terms of their financial and operational consequences for the company and in terms of their contribution to fulfilling the scientific goals of the company ("priority research").

3 CHAIRPERSON

The Associate Forum shall, from among the appointed representatives, elect a Chairperson and a Vice-Chairperson for terms of two years (starting on 1 January), which may be renewed for one additional term. The Chairperson and Vice-Chairperson may not be drawn from the same Associate. The Chairperson chairs the meeting of the Associate Forum and shall discharge the tasks which it assigns. If the Chairperson is unable to discharge the functions of the Chair in particular cases, the Vice-Chairperson shall assume the responsibility.

4 MEETINGS

In preparation for an Associate Forum meeting, the Chairperson needs to coordinate with the Board about schedule and what topics are intended to be handled. Notice of meetings shall be made through electronic means no later than four weeks before a meeting. Meetings of the Associate Forum shall preferably be conducted via digital communication methods. A secretary is appointed among the representatives for taking the minutes. In case the Associate Forum decides to meet in person, efforts should be made to keep travel costs and time down. At least one Board representative and the EISCAT CEO shall attend Associate Forum meetings. Others may attend meetings with the agreement of the Associate Forum Chairperson.

5 REPORTING

After an Associate Forum meeting, the Chairperson summaries the outcome in a written short report within 7 days, followed by meeting minutes within 30 days, which shall be sent to the Chairperson of the Board and the EISCAT CEO.

EISCAT AB

Rules of procedure
Scientific Advisory Committee

Document Name: Rules of procedure Scientific Advisory Committee		**Document:** Regulatory document	**Concerns:** EISCAT AB
Document Owner: CEO	**Responsible:** Board Chairperson	**Availability:** Public	
Adopted on: 2025-03-04	**To be revised at the latest:** As needed	**Decision-making body:** Board	**Version/Revision:** See below

Document History:

Version/ Revision	Date	Changes	Notes
0.1	2025-01-26	New document	
0.2	2025-02-04	After comments	First considerations by EISCAT Board
0.3	2025-02-18	Further edits	
0.4	2025-02-20	After comments	Internally reviewed
1.0	2025-03-04	Adopted version	Approved by the EISCAT Board. Published

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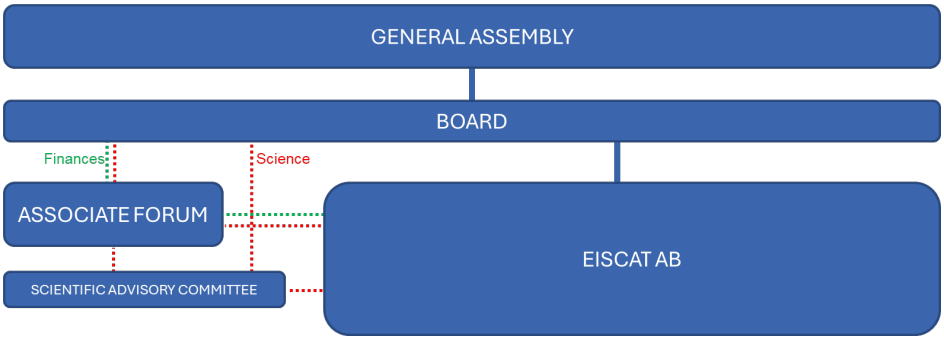
1 ORGANISATION OF THE SCIENTIFIC ADVISORY COMMITTEE

Each Associate may nominate one individual to the Scientific Advisory Committee (SAC), funded by the respective Associate, to be appointed by the Board.

In addition to the individuals from the Associates, the Board may appoint up to three independent persons to supplement the skills and experiences of the other SAC members. These independent experts will be funded by the company.

The company will arrange a common on-line work area for communications, sharing calendars, meeting related matters and documents.

The Rules of procedure for SAC shall be approved by the Board.



2 MISSION OF SAC

The Scientific Advisory Committee shall:

1. advise the Board on matters related to science directions and observation programmes of the company
2. advise on science-related matters referred to it by the Board or the Associate Forum
3. without prejudice to the above, act as a source of support and advice, on science matters, to the EISCAT senior management staff

3 CHAIRPERSON

SAC shall, from among the appointed members, elect a Chairperson and a Vice-Chairperson for terms of two years (starting on 1 January), which may be renewed for one additional term. The Chairperson chairs the meeting of SAC and shall discharge the tasks which it assigns. If the Chairperson is unable to discharge the functions of the Chair in particular cases, the Vice-Chairperson shall assume the responsibility.

4 MEETINGS.

In preparation for a SAC meeting, the Chairperson needs to coordinate with the Board about schedule and what topics are intended to be handled. Notice of meetings shall be made through electronic means no later than four weeks before a meeting. Meetings of SAC shall preferably be conducted via digital communication methods. A secretary is appointed among the members for taking the minutes. In case SAC decides to meet in person, efforts should be made to keep travel costs and time down. One or more EISCAT senior management staff shall attend meetings. Others may attend meetings with the agreement of the SAC Chairperson.

5 REPORTING

After a SAC meeting, the Chairperson summaries the outcome in a written short report within 7 days, followed by meeting minutes within 30 days, which shall be sent to the Chairpersons of the Board and the Associate Forum and the EISCAT CEO.

EISCAT AB

Access Policy

EISCAT AB

Document Name: Access policy		**Document:** Policy Document	**Concerns:** EISCAT AB
Document Owner: CEO	**Responsible:** Board Chair	**Availability:** Public	
Adopted on: 2024-12-20	**To be revised at the latest:** As needed	**Decision-making body:** Board	**Version/Revision:** See below

Document History:

Version/ Revision	Date	Changes	Notes
0.1	2024-11-01	New document	
0.8	2024-12-12	After comments	
0.9	2024-12-20	After board meeting	Approved by board 2024-12-20
1.0	2024-12-20		Published version

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1 INTRODUCTION

This policy defines the science programmes at EISCAT which involves Common, Special, Open, Affiliate and Time Buyer programmes and sets out the principles for access to these programmes.
All EISCAT experiments and programmes shall be conducted to the highest technical standard for non-military scientific objectives.

To ensure this, any experiment shall undergo three prior reviews regardless of programme:

1. A scientific peer review to ensure that experiments are of a high international scientific standard as defined by SAC. Associates and Affiliates reviews the scientific merit of their own experiments.
2. A technical review by EISCAT AB to ensure that experiments will not damage the EISCAT systems and that resources are used in an efficient and meaningful way.
3. A security review by EISCAT AB where EISCAT AB may reject an experiment or require changes to an experiment for security reasons.

This policy follows the non-regulatory principles and guidelines of the European Charter for Access to Research Infrastructures (hereinafter the Charter).
EISCAT AB recognises the benefits, financial needs, and ESFRI requirement to provide access to the wider scientific community and to civil government and commercial users.

2 USERS

2.1 Associates and associate users

Associate partner or Associates comprises of national research councils, major national research institutions, or equivalent entities, each committed to funding EISCAT AB long term. The admission of Associates will be determined by a decision of the EISCAT AB General Assembly and is subject to an 'Associate Agreement' to be entered into between EISCAT AB and the relevant Associate. An Associate user is defined here as an individual or group recognized by the Associate as eligible to use EISCAT facilities.

2.1.1 The Associate Forum (AF)

The Associate Forum (AF) consists of up to two representatives nominated from each Associate to be appointed by the Board of EISCAT AB.
The AF shall advise the Board of EISCAT AB on scientific, technical and financial matters.

2.1.2 The Scientific Advisory Committee (SAC)

The SAC consists of internationally recognised experts appointed by the Board of EISCAT AB. Each Associate may nominate one individual to the SAC to be appointed by the Board of EISCAT AB.
In addition to the nominees from the Associates, the Board shall appoint up to three independent individuals to the SAC.

The SAC shall advise the AF and the Board on matters relating to the scientific programme and development.

2.2 Affiliates and affiliate users

Affiliate users comprises of national research councils, major national research institutions, or equivalent entities, funding EISCAT AB year by year.

2.3 Time Buyers

Time Buyers comprise of any entity buying operational time at the facilities for a specific project.

3 PROGRAMMES

The balance of Common and Special programme quotas shall be proposed annually to the board of EISCAT AB, by the AF in consultation with SAC. As guidance, the Common Programme quota for the old system, should be approximately equal to the Special Programme quota.

EISCAT AB shall provide the following programmes

3.1 Common Programme

The Common Programme is proposed by AF in collaboration with SAC.

The Common Programme comprises of a limited set of routine experiments that are each designed to provide a long-term homogenous data set of general benefit to the EISCAT user community.

To ensure data homogeneity, substantial changes to Common Programme experiments should be avoided except where major changes in EISCAT facilities or scientific objectives make them desirable.

Internationally coordinated experiments are part of the Common Programme comprising of coordinated experiments with other radars around the world. Experiment selection and scheduling is organised by the URSI Incoherent Scatter World Days working group.

In terms of the Charter, the Common Programme is a wide access mode that guarantees broad access to EISCAT data.

3.2 Special Programme

The Special Programme comprises of novel research experiments proposed by Associate users coordinated by Associates.

For a Special Programme experiment, the scientific peer review shall be arranged by each Associate for their users. A ranked list of the approved experiments shall be submitted in good time to EISCAT AB for scheduling.

AF in collaboration with SAC sets the framework for scheduling and cancellation.
Each Special Programme experiment is designed to provide data of specific benefit to the proposer's scientific research.

The All-Associate Programme is a subset of the Special Programme in which Associates pool part of their Special Programme allocation for a specific but common benefit, such as supporting a satellite mission.

3.3 Affiliate Special Programme

The Affiliate Special Programme comprises of novel research experiments proposed by Affiliate user who wishes to access EISCAT for scientific research outside of the Open Programme.

For an Affiliate Special Programme experiment, the scientific peer review shall be arranged by each Affiliate for their users. A ranked list of the approved experiments shall be submitted in good time to EISCAT AB for scheduling.

AF in collaboration with SAC sets the framework for scheduling and cancellation.

3.4 Open Programme

The Open Programme comprises of novel research experiments proposed by any researcher. Experiment selection is proposed by AF in collaboration with SAC. AF in collaboration with SAC also sets the framework for scheduling and cancellation.

In terms of the Charter, the Open Programme is both a wide-access and excellence-driven access mode.

3.5 Time Buyer Programme

The Time Buyer Programme comprises of specific experiments designed and requested by the time buyer.

In terms of the Charter, the Time Buyer Programme is a market-driven access mode where access is defined through an agreement between the user and EISCAT AB that will lead to a fee for the access that covers its full economic cost.

AF in collaboration with SAC sets the framework for scheduling and cancellation.

4 ACCESS

4.1 Access unit for associate and affiliate special programmes

EISCAT AB shall determine an EISCAT access unit (EAU) to measure the access provided to associate and affiliate users in the special programmes.

The Associate Forum (AF) will review the formulas annually.

4.2 Access share for all programmes

The share of the annual Special Programme quota (measured in EAUs) allocated to each Associate and affiliate shall be determined by the following share formula, designed to encourage a balance of contributions to EISCAT AB for CAPEX and OPEX and to incentivise long-term commitments to OPEX :

$$S_i = \frac{(C_i + O_i)}{\sum_i (C_i + O_i)}$$

where:

i = an index representing the individual Associate
C_i = sum of Associate i's annual contributions to capital investment, depreciated over 30 years from the date when the investment becomes operational, plus the sum of annual contributions to capital operating, depreciated over 5 years, plus any Joining Fee (or other additional voluntary contributions), depreciated over 30 years.
O_i = sum of annual subscriptions committed by Associate i over the next five years, $O_i = \sum_{y=1}^{5} A_{i,y}$, where $A_{i,y}$ is the annual subscription y years into the future. The annual subscription $A_{i,y}$ may be fixed, or variable over time (e.g., increasing each year with inflation). For example, for a fixed annual subscription A_i then $O_i = 5A_i$ for a 5-year rolling agreement or $O_i = 2A_i$ at the beginning of the fourth year of a fixed 5-year agreement

An Associate/affiliate may trade special programme EAUs with other EISCAT associates/affiliates.

5 ACCESS PROCESSES FOR ALL PROGRAMMES

1. Where special programme proposals from two or more users are identical, or nearly identical, EISCAT AB may suggest the users agree to share their activities. The EAUs allotted to each user for such a shared effort shall be a matter of mutual agreement.
2. Each Associate shall appoint a contact person (Schedule Representative) with whom EISCAT shall discuss any matters concerning proposals submitted by their Associate users.
3. The scheduling of Common Programme experiments (both which ones and when) shall be agreed between SAC, AF and EISCAT AB based on scientific need and operational feasibility.
4. EISCAT AB shall endeavour to schedule special programme experiments as requested. If that is impossible then EISCAT AB will suggest alternatives to the Associate user and the Associate user's scheduling representative.
5. In the event of an unresolvable scheduling conflict between an Associate user's experiment and another experiment the Associate user's experiment will take precedence. For scheduling conflicts between Associate/affiliate users, EISCAT AB shall decide on the priorities.
6. Common Programmes can be interrupted for scheduling that requires short notice such as the support of rocket launches. Such interruptions shall be kept to a minimum and must be approved by the EISCAT staff in charge of the programme. Such data shall form part of the Common

Programme. The circumstances of such interruptions shall be reported at the next meeting of the SAC.

7. If an unexpected or unusual phenomenon, natural or otherwise, occurs, observation of which would be so valuable as to warrant interruption of scheduled programmes or starting the system(s) at short notice, the EISCAT AB staff in charge of operations may take the initiative. The data collected in this mode shall belong to the Common Programme and all Associate users shall be notified as soon as possible of such observations. The SAC shall discuss any such occurrences at its next meeting.

Data Policy

EISCAT AB

EISCAT AB

Document Name: Data Policy		**Document:** Policy Document	**Concerns:** EISCAT AB
Document Owner: CEO	**Responsible:** Board Chair	**Availability:** Public	
Adopted on: 2024-12-20	**To be revised at the latest:** As needed	**Decision-making body:** Board	**Version/Revision:** See below

Document History:

Version/ Revision	Date	Changes	Notes
0.1	2024-12-12	New document	
0.6	2024-12-20	After board meeting	Approved by board 2024-12-20
1.0	2024-12-20		Published version

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1 DESCRIPTION OF DATA PRODUCTS

The chain of data levels described here starts from the digital signal processing in the receiver system.

Level 1.
Voltage-level data samples.

Level 2
The time integrated power spectral data, decoded from the voltage data. The data obtained from passive observations or the data from other EISCAT instruments are also Level 2 data.

Level 3
The physical parameters that are derived from the level 2 data. At present these are the profiles of physical parameters of the ionospheric plasma (electron density, electron temperature, ion temperature, ion velocity).

Level 4
External value-added data products. They are normally derived by the users in a process that combines EISCAT data with data from other sources.

Metadata
The operational parameters accumulated at all sites, like antenna pointing, output power, radar pulses and data processing used are stored and denoted here as metadata.

2 DATA COLLECTION, STORAGE, AND ACCESS

1. All data collection, storage, and access are made or arranged by EISCAT AB through the EISCAT staff.
2. Level 1 data
    a. Level 1 data are not stored at wide bandwidth, though band-limited measurements are stored as resources permit.
    b. EISCAT also stores wide-bandwidth Level 1 data for limited time to generate further data products.
    c. For well-defined research or development projects users can apply for specific sets of wide-bandwidth Level 1 data to be stored. Such applications will undergo technical and scientific reviews before final consideration. When approved, an agreement must be formulated on the life span of the collected data with a scheme of what data products will be delivered to the EISCAT data archive including a time line for this delivery.
3. Level 2 data
    a. Level 2 data are archived by EISCAT AB. These data are for exclusive use of the user who carried out the observation during year 1, and the affiliate and associate users of EISCAT AB the following two years.
    b. In the case of newly developed data products, these are for exclusive use for the user who carried out the observation during year 1 and the affiliate and associate users of EISCAT AB for two years after final production.
    c. Users can apply for extended time of exclusive use. Those users carrying out the observations can also reduce the period of exclusive use.
4. Level 3 data
    a. Level 3 data is archived by EISCAT AB. Preliminary, un-validated level 3 data is normally generated in real time and are made available as quick-look plots. These plots are not intended for scientific publication or presentation.

   b. Validated level 3 data are made available and archived by EISCAT AB as workforce permits. These are for the exclusive use of the user that carried out the observations until 1 year after the observation.
   c. Users can reduce the period of exclusive use if they wish.
5. Level 4 data
   a. Level 4 data is normally not archived by EISCAT AB.
   b. When level 4 data is published by the users, reference to the origin of the data and to the company needs to be given and EISCAT always needs to be informed of the publication.
   c. Any usage of data that is not intended for basic research resulting in scientific publications needs to be negotiated with EISCAT AB in advance.

3 DATA OWNERSHIP AND ACKNOWLEDGEMENT

1. All EISCAT-produced data are owned by EISCAT AB.
2. Published papers in which data from the EISCAT facility have been used shall always contain an acknowledgement of the support provided by EISCAT AB, preferably in the standard form available from EISCAT AB.
3. Authors are required to send reprints of papers in electronic form to EISCAT AB where a file of EISCAT publications will be kept. Authors are also encouraged to send pre-prints of papers in advance of peer review and publication.
4. Statistics and available data sets will be published on a regular basis.

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