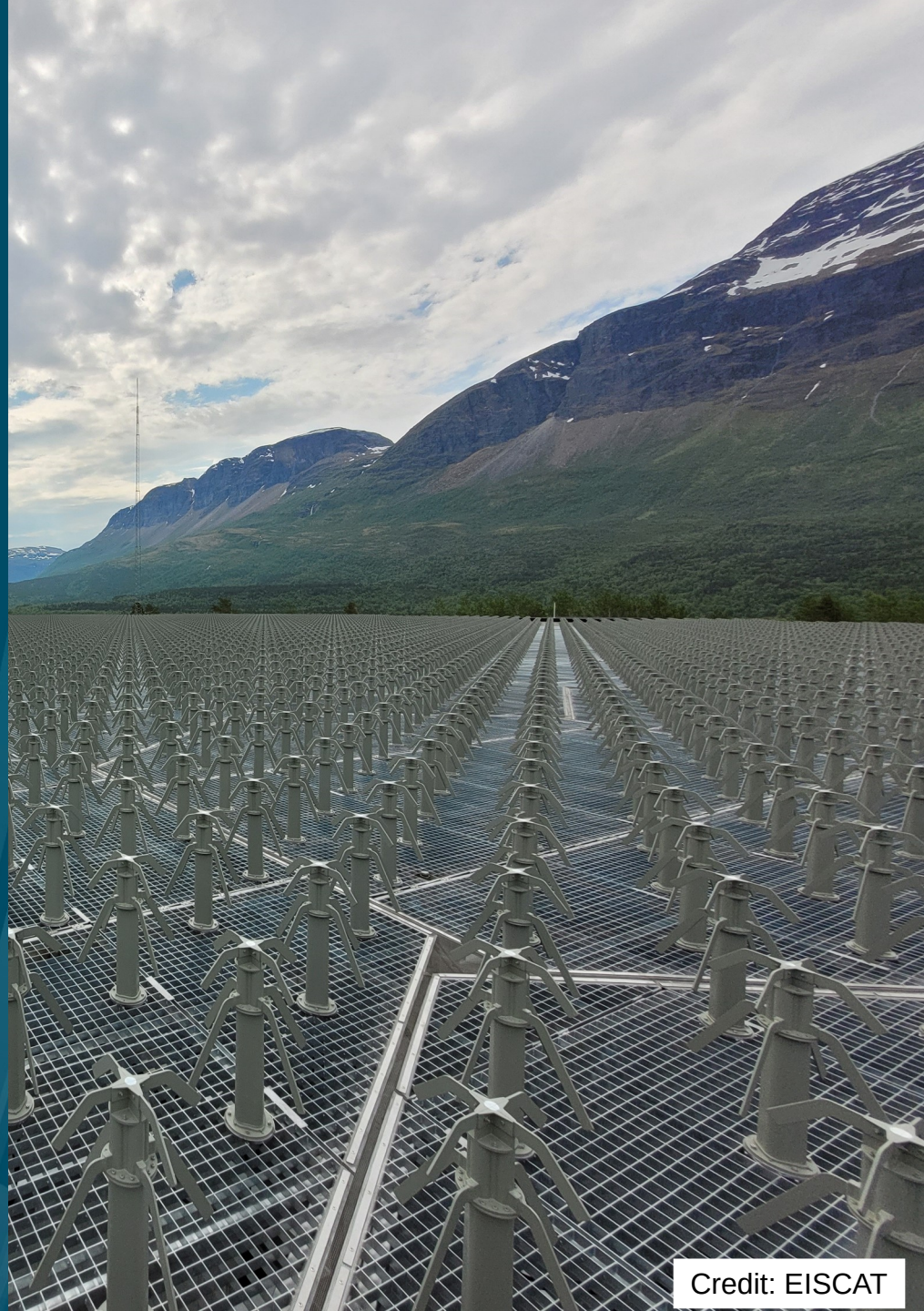
UiT The Arctic University of Norway

Update on EISCAT_3D

EISCAT, UiT The Arctic University of Norway, et al.

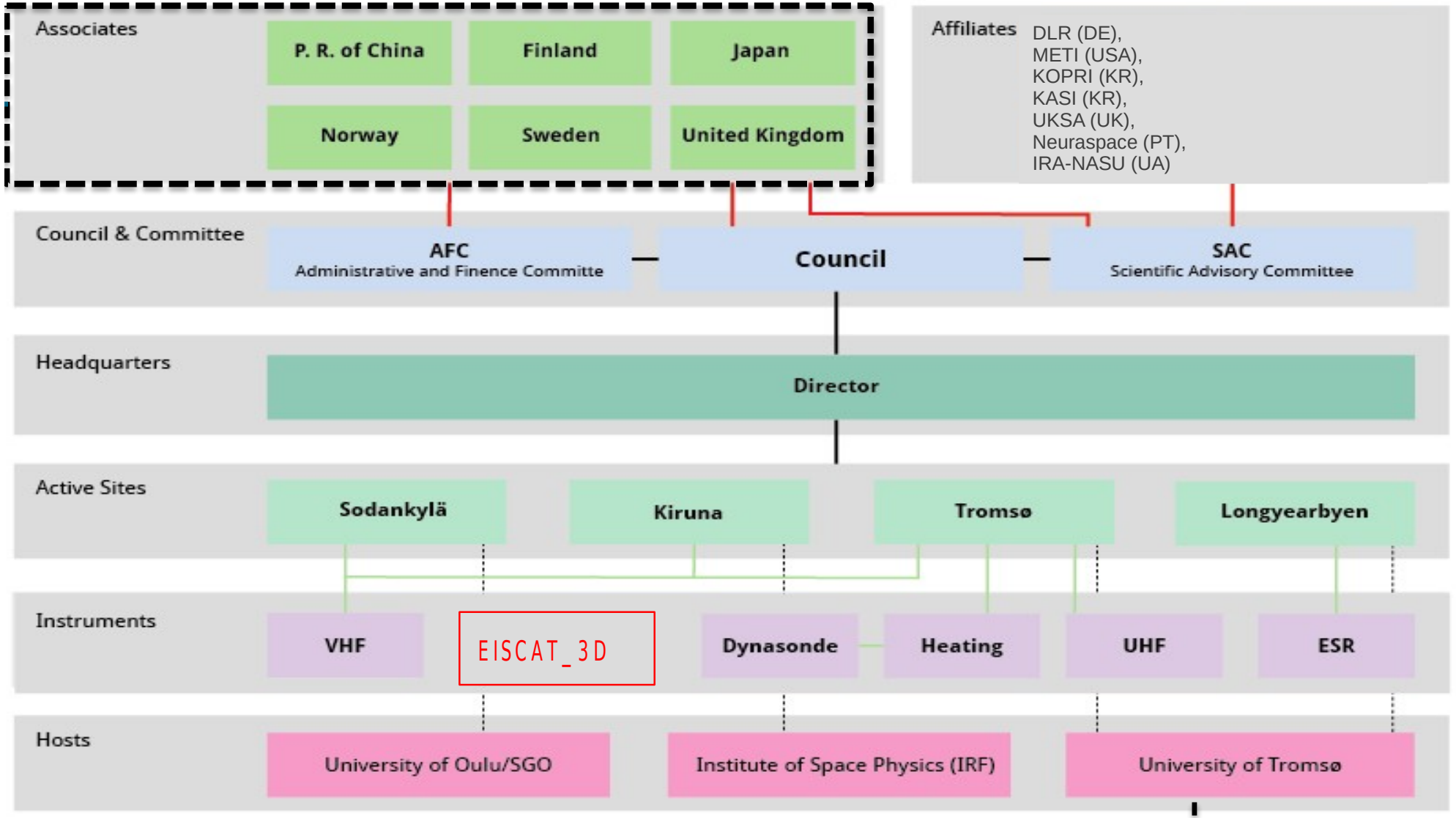
CEDAR 2024, San Diego

June 10-14, 2024



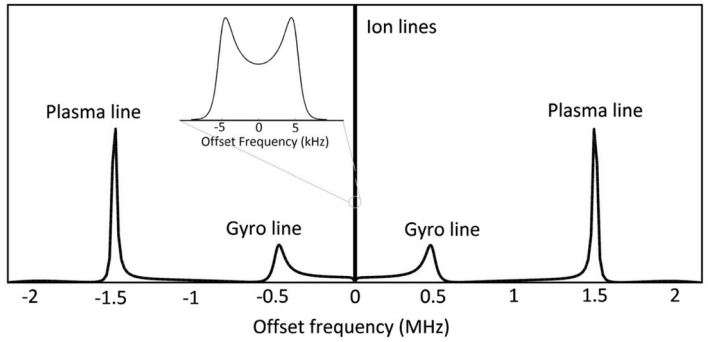
Credit: EISCAT

EISCAT Introduction



EISCAT Introduction

What Is Incoherent Scatter?

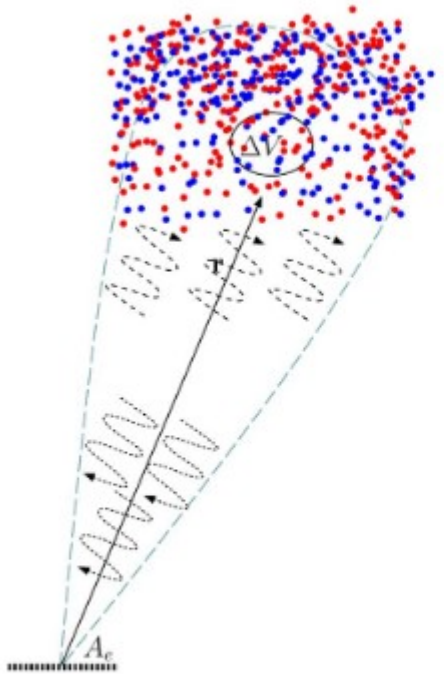


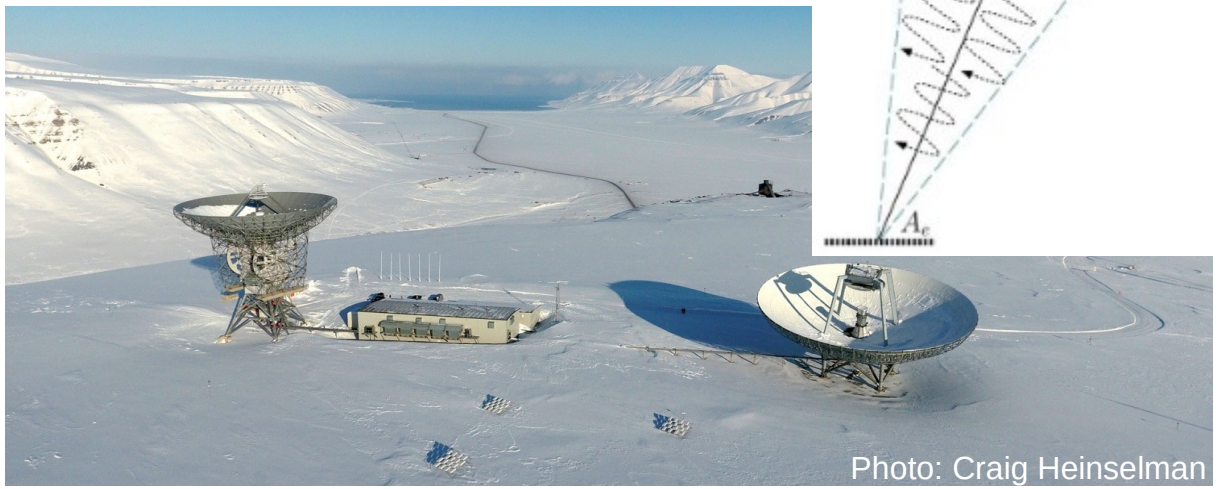
Akbari, H., Bhatt, A., La Hoz, C. et al. Incoherent Scatter Plasma Lines: Observations and Applications. Space Sci Rev 212, 249–294 (2017). https://doi.org/10.1007/s11214-017-0355-7

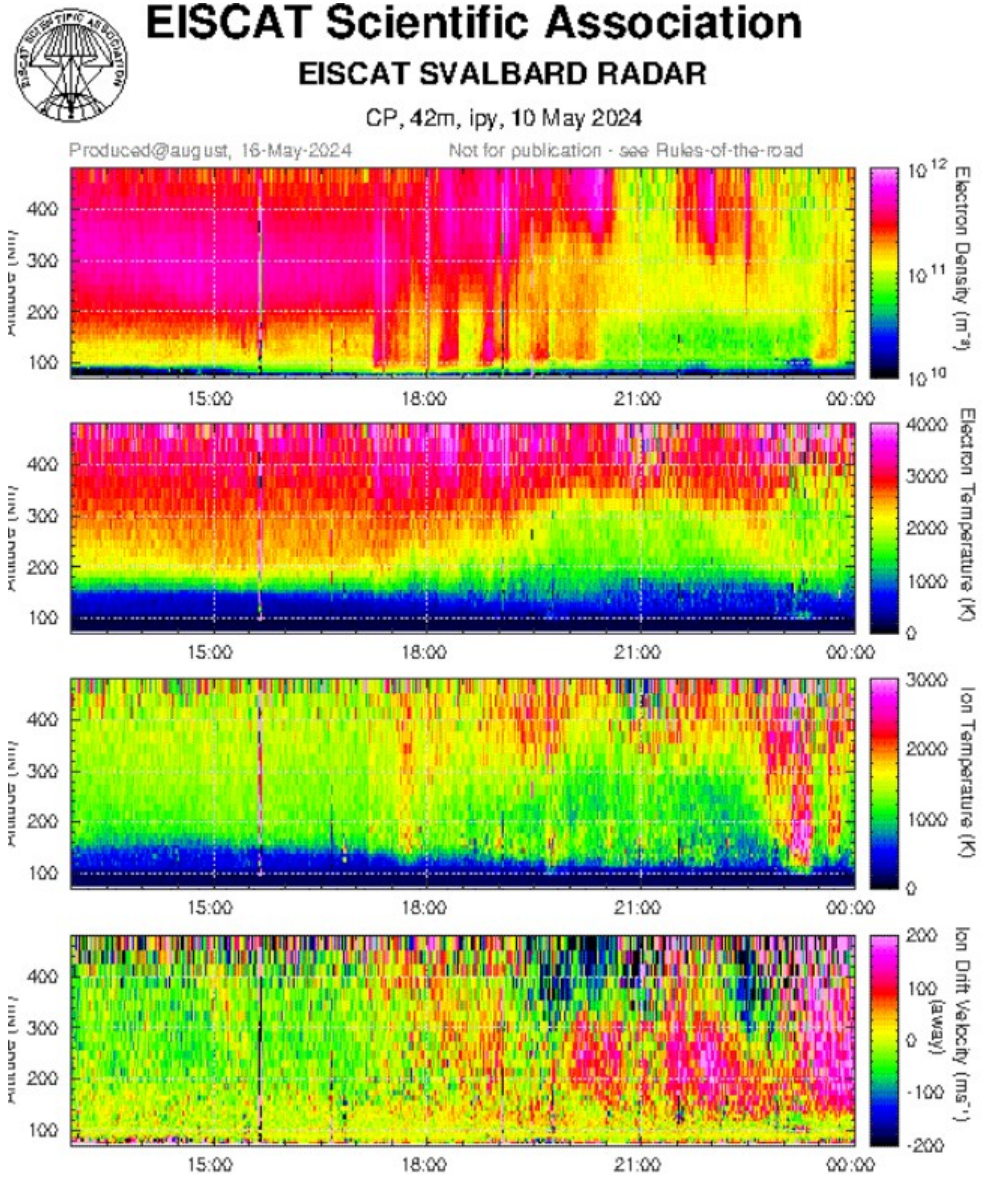
IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 49, NO. 1, JANUARY 2011

Incoherent Scatter Spectral Theories—Part I: A General Framework and Results for Small Magnetic Aspect Angles

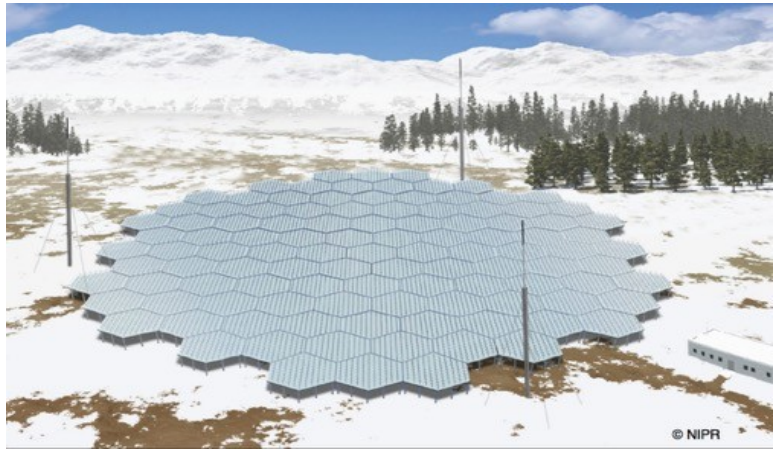
Erhan Kudeki, *Member, IEEE*, and Marco A. Milla, *Member, IEEE*

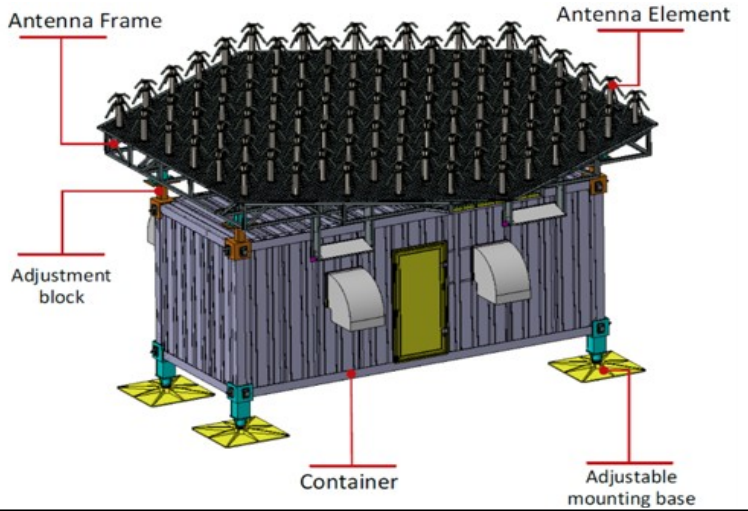






EISCAT_3D





An extremely versatile and largely **software-defined** instrument

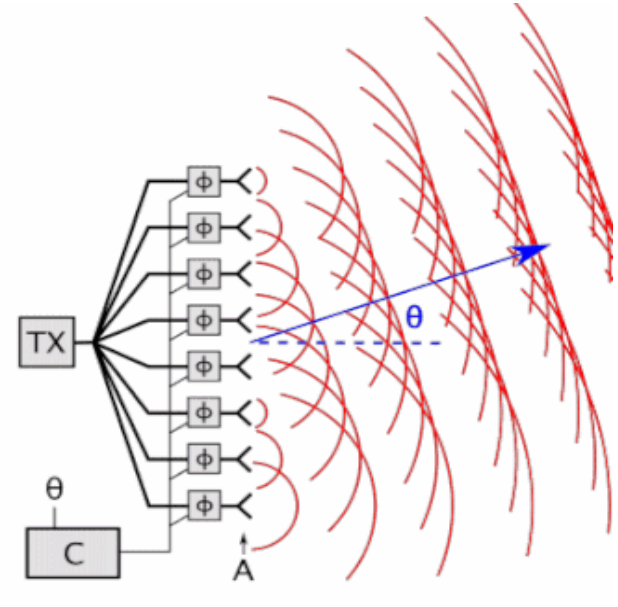
Multi-user capability

Easy expansion to new fields

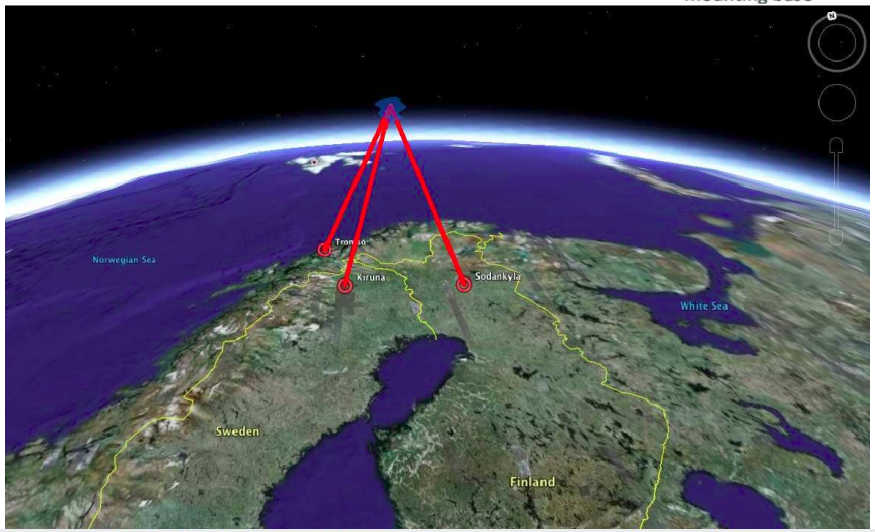
Tri-static, 3.37 MW peak power, 233 MHz

10k (Tx/Rx) + 5k (Rx) +5k (Rx) antennas

ESFRI Landmark Facility

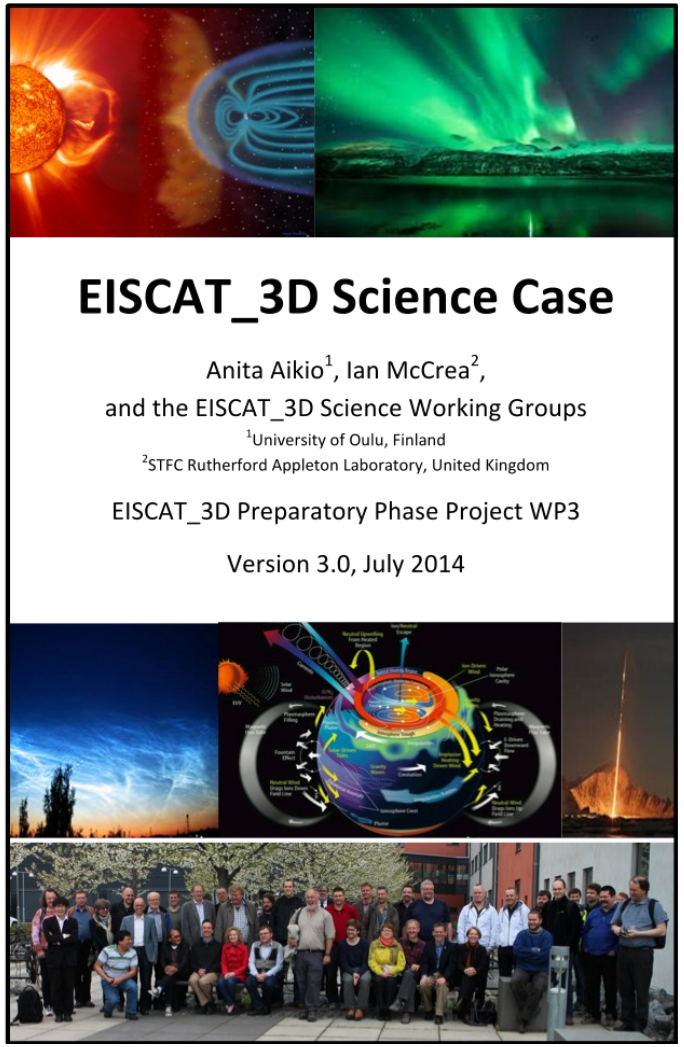


User “Chetvorno”, Wikipedia, CC0.



EISCAT_3D EISCAT 3D Radar Receiver/Antenna Subsystem Report

J. Johansson, Gustav Johansson, J. Borg, Mikael Larsmark, T. Lindgren less • Published 2009 • Engineering, Physics



EISCAT_3D Science Case

Anita Aikio[1], Ian McCrea[2],
and the EISCAT_3D Science Working Groups
[1]University of Oulu, Finland
[2]STFC Rutherford Appleton Laboratory, United Kingdom

EISCAT_3D Preparatory Phase Project WP3

Version 3.0, July 2014

Science Case document from Preparatory Phase:
www.eiscat.se -> EISCAT_3D -> Document Archive -> 2005-2017 -> Preparatory Phase -> WP3

Science Case as a paper:
https://doi.org/10.1186/s40645-015-0051-8

EISCAT_3D Science

1. Resolution of space-time ambiguity: EISCAT_3D will have simultaneous multiple-beam capability. This will resolve outstanding issues of spatial-temporal ambiguity (e.g. the dynamics of dusty plasmas in the mesopause region and rapidly moving auroral structures, tracking space debris and meteors).
2. 3D volumetric capability: EISCAT_3D will have 3D volumetric imaging capability throughout its field of view. Such capability is important for studying the variability, coupling, and energy dissipation between the solar wind, magnetosphere, and atmosphere (e.g. Joule heating and field-aligned currents) as this coupling is a function of altitude, latitude, and longitude.
3. Sub-beam width measurements: The spatial scale of micro-physical processes is much less than the current EISCAT UHF radar beam half-width of 0.5° (e.g. NEIALs, small-scale and black auroras, meteor head echoes, PMSE). EISCAT_3D will have the needed capability to perform interferometry with multiple baseline angles and lengths, a technique already proven by the EISCAT Svalbard Radar, which can be used to investigate these phenomena.
4. Increased sensitivity and the resulting temporal resolution: With its improved sensitivity and temporal resolution, EISCAT_3D will be able to reach down to the sub-second timescales that are known to exist in auroral features from optical measurements. As Appendix B of Lehtinen et al. (2014) makes clear, EISCAT_3D will be able to measure auto-correlation functions at sub-second

(McCrea et al., 2015)

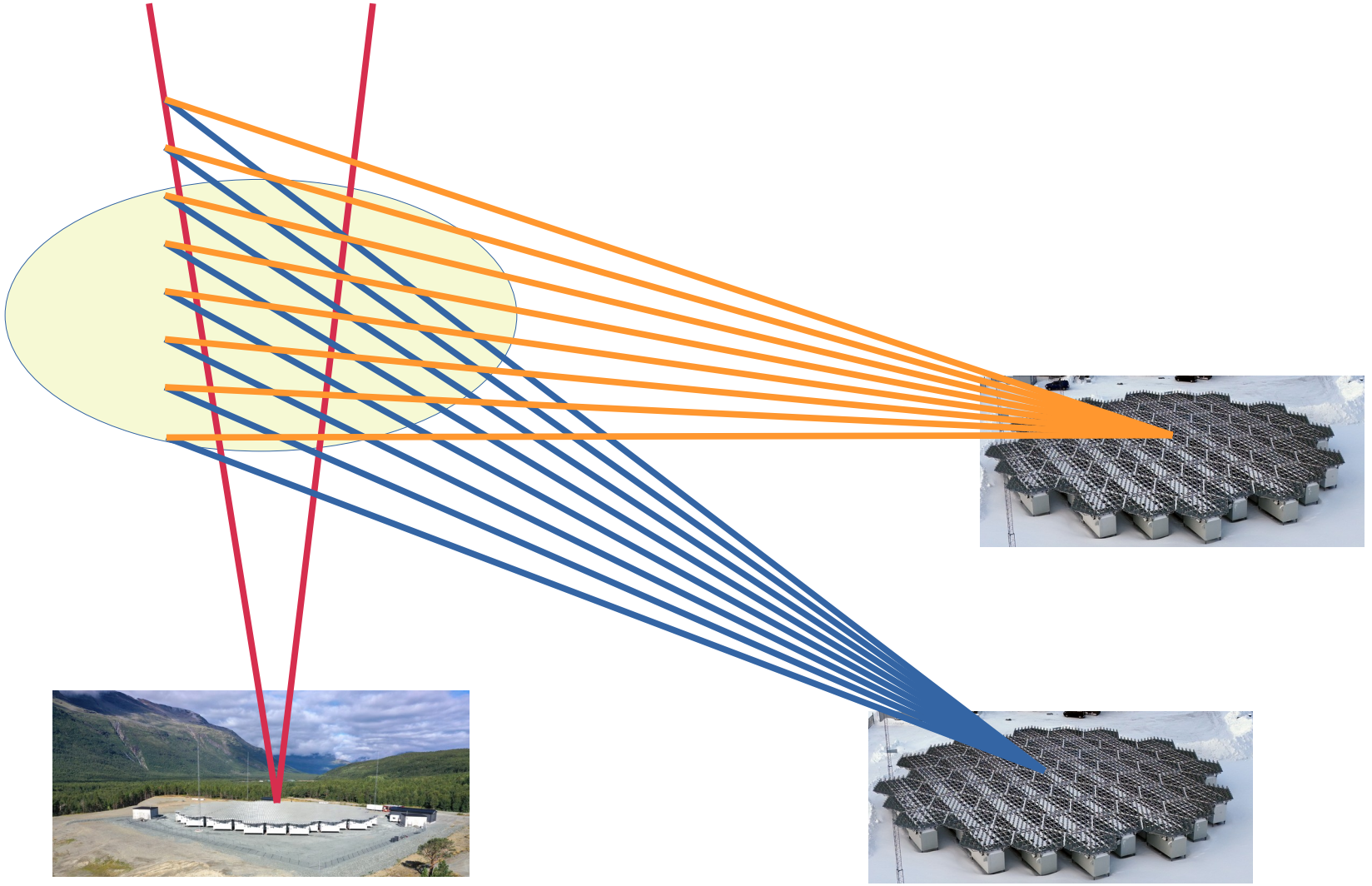


Photo: Johan Svensson

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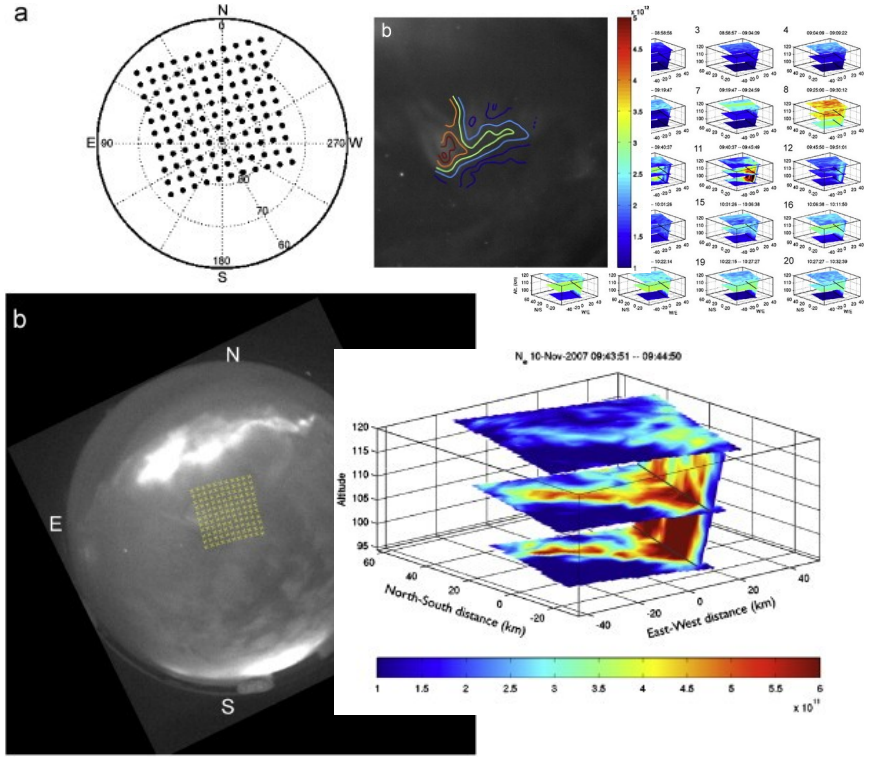
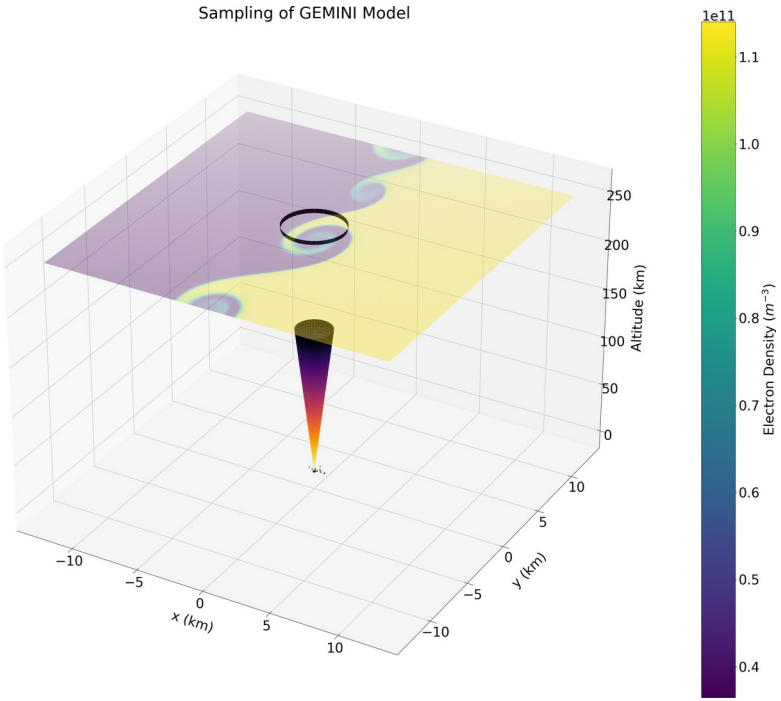
Inter-Beam / Volumetric Imaging



J. Semeter et al. (2009) Volumetric imaging of the auroral ionosphere: Initial results from PFISR, Journal of Atmospheric and Solar-Terrestrial Physics, 71, 738–743

In-Beam Imaging



Huyghebaert, et al.. (2024): Interferometric Imaging with EISCAT_3D for Fine-Scale In-Beam Incoherent Scatter Spectra Measurements, pre-print

With EISCAT_3D it will be possible to combine both!

EISCAT_3D Science

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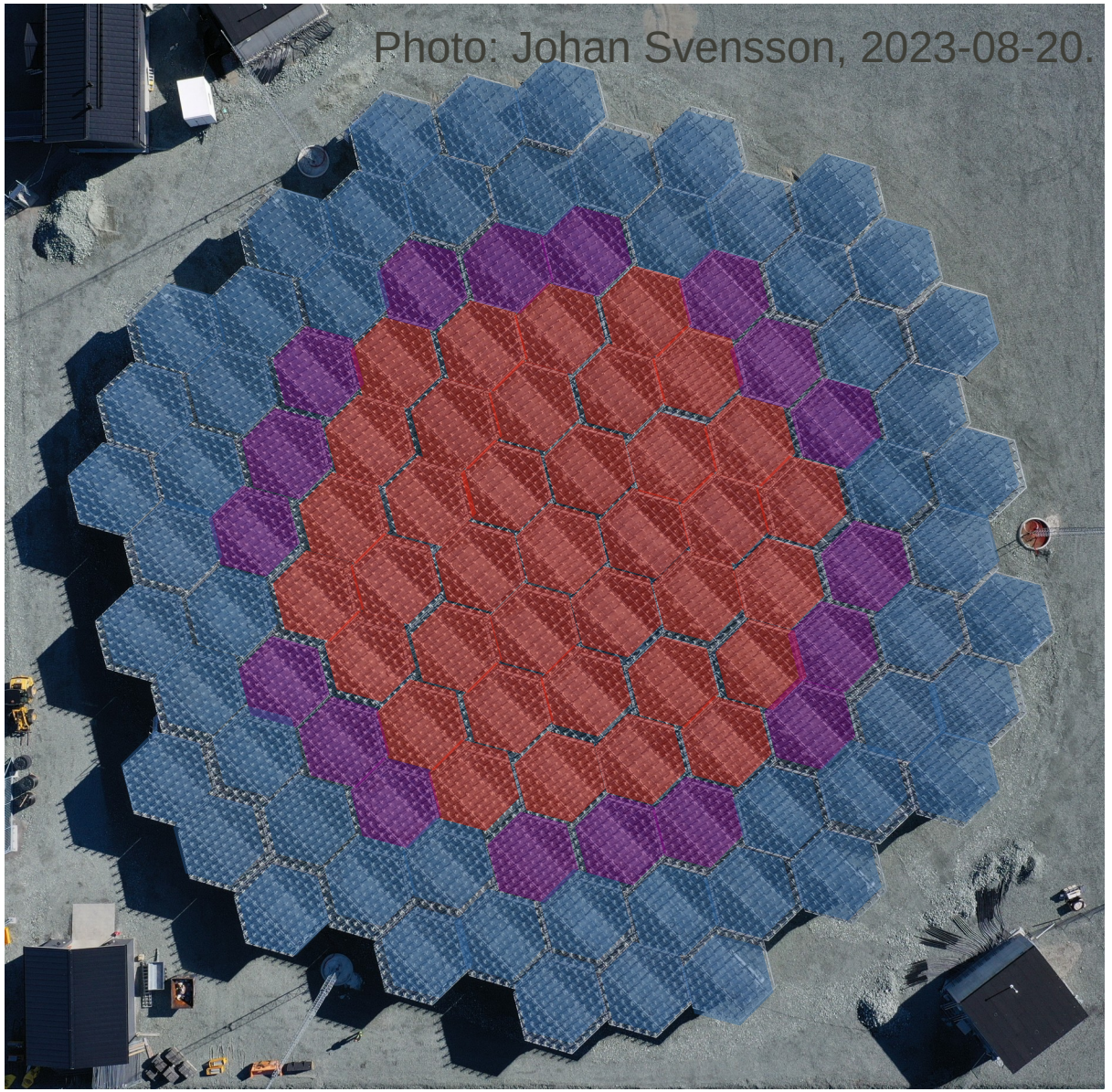
(McCrea et al., 2015)

Peak Power

3.3 MW

5 MW

10 MW



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EISCAT_3D Arrives

Tromsø, September 2022

EISCAT_3D - Skibotn

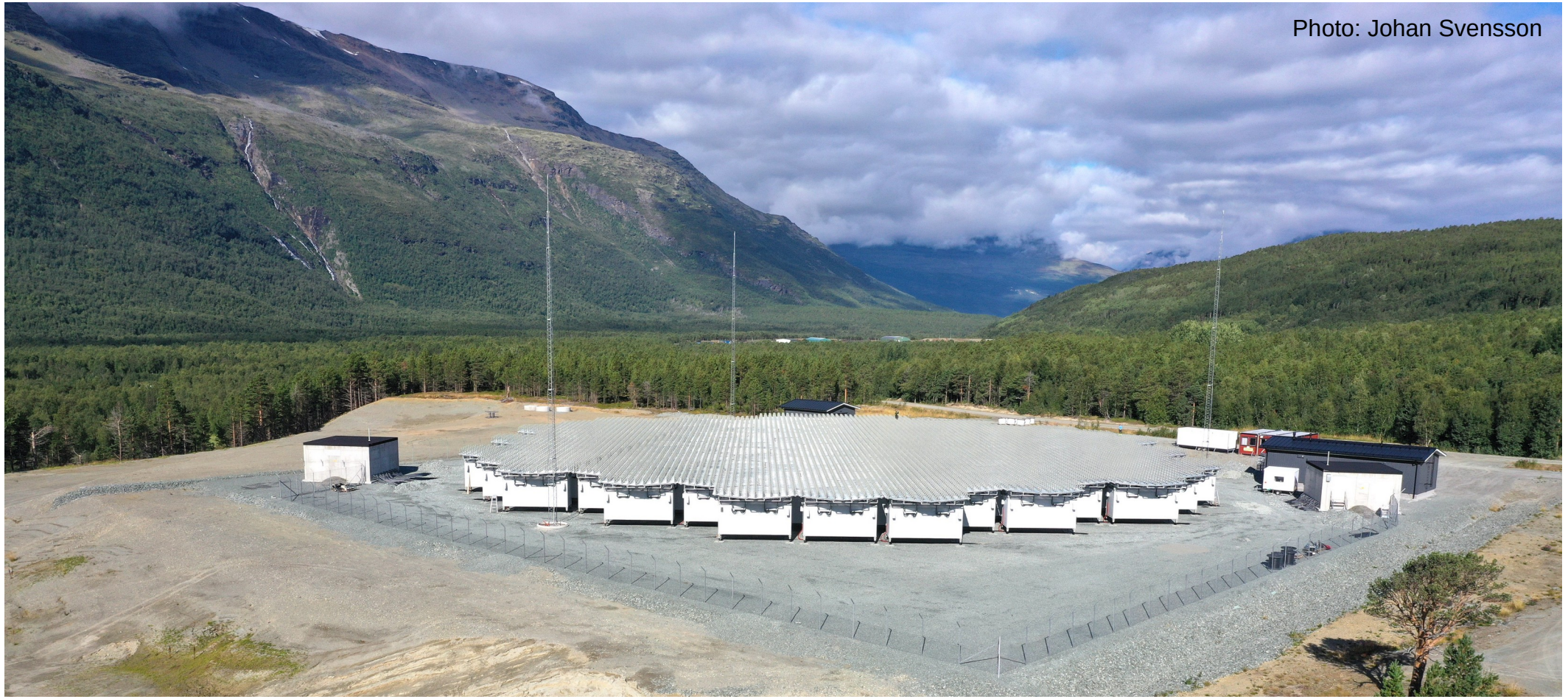


Photo: Johan Svensson

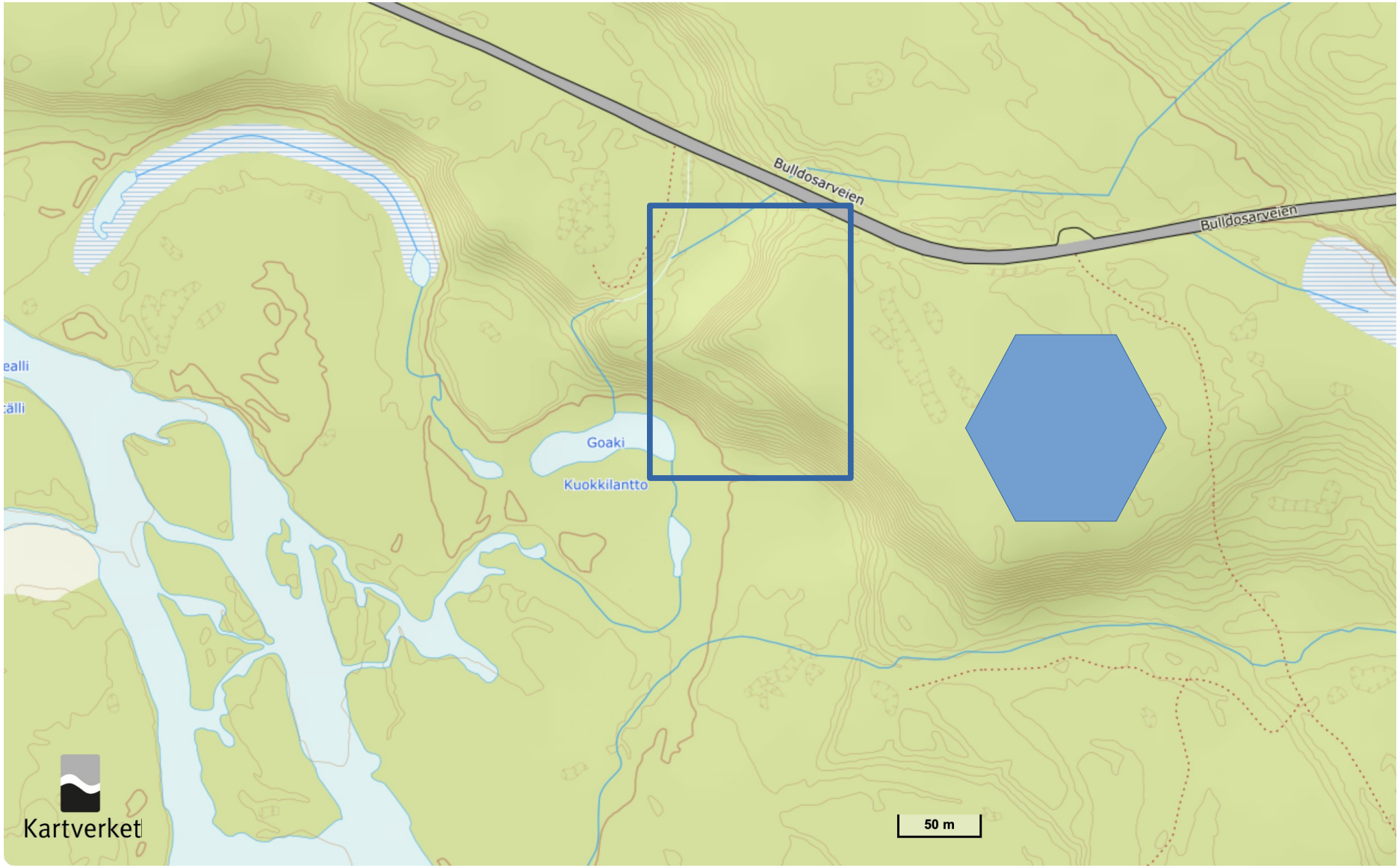
Completed:
All 109+10 Antenna Units are installed
Site buildings and calibration towers completed
Power and fibre distribution completed
Start permit missing

On-going:
RF-fence detailed design. Installation starts in June.
Next steps
NO-7 installation: 7 Transmit/Receive AUs, 637kW

EISCAT_3D - Skibotn

EISCAT_3D - Skibotn

EISCAT_3D - Skibotn



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EISCAT_3D – Interferometry Outlier Panels

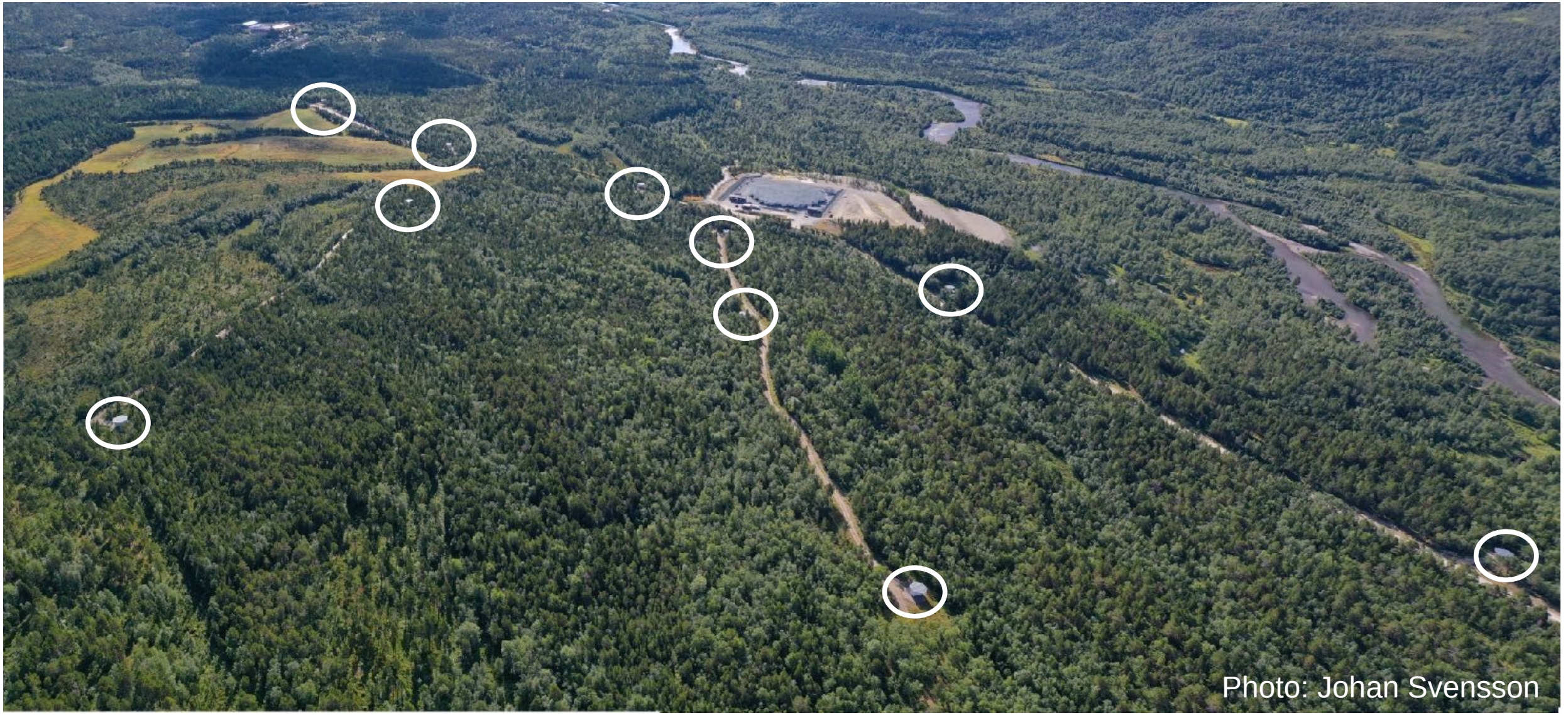
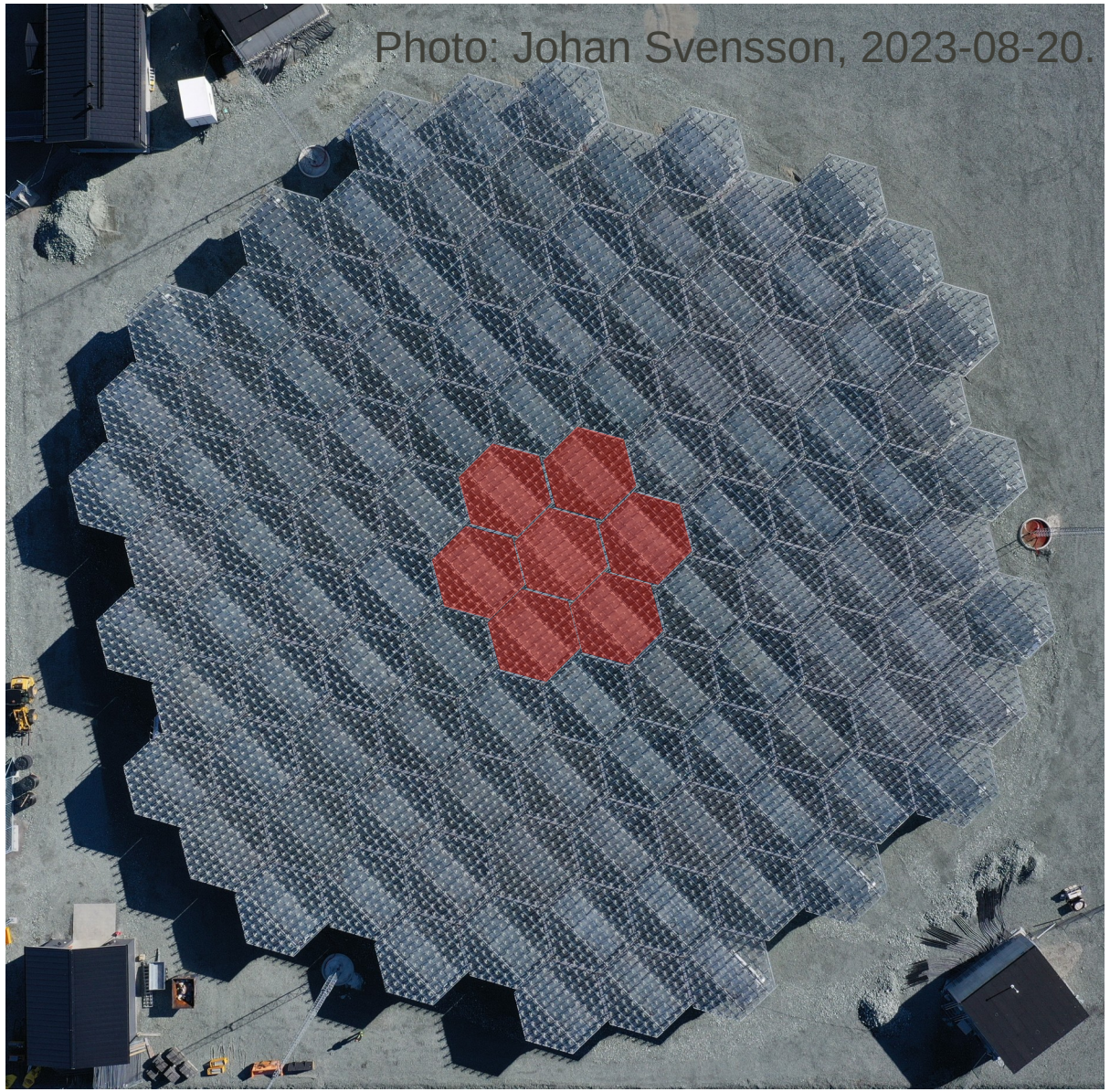


Photo: Johan Svensson

EISCAT_3D Initial Operations

- **PET–7**:
  - 7 x 91 antennae x 2 channels
  - 500 W per channel
  - total: 637 kW
  - transmit–receive
- New code name: **NO–7**
  - Distinguish from **SE–7** and **FI–7**



EISCAT_3D – Kaiseniemi

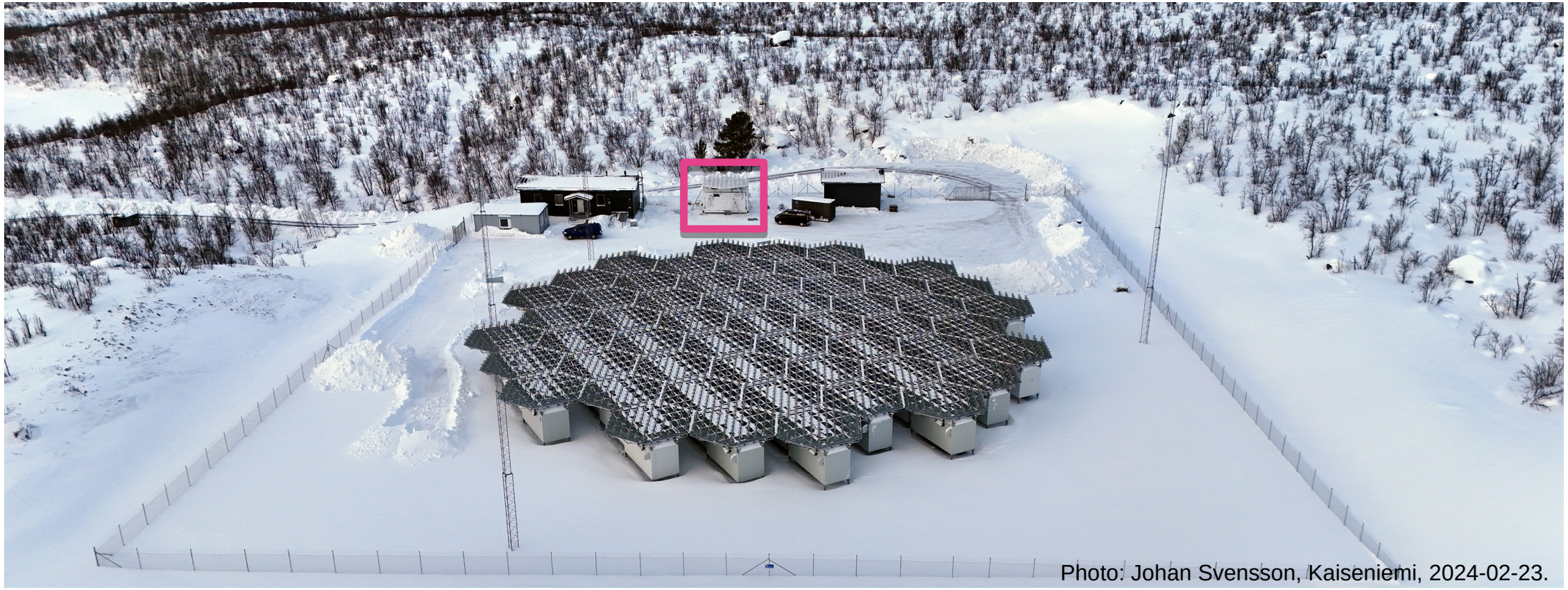


Photo: Johan Svensson, Kaiseniemi, 2024-02-23.

Completed:

All 55, 54 Antenna Units (AU)

Site buildings

Transformer installations

Calibration towers

Kaiseniemi: 1 First-Stage Receiver Unit (FSRU) installed

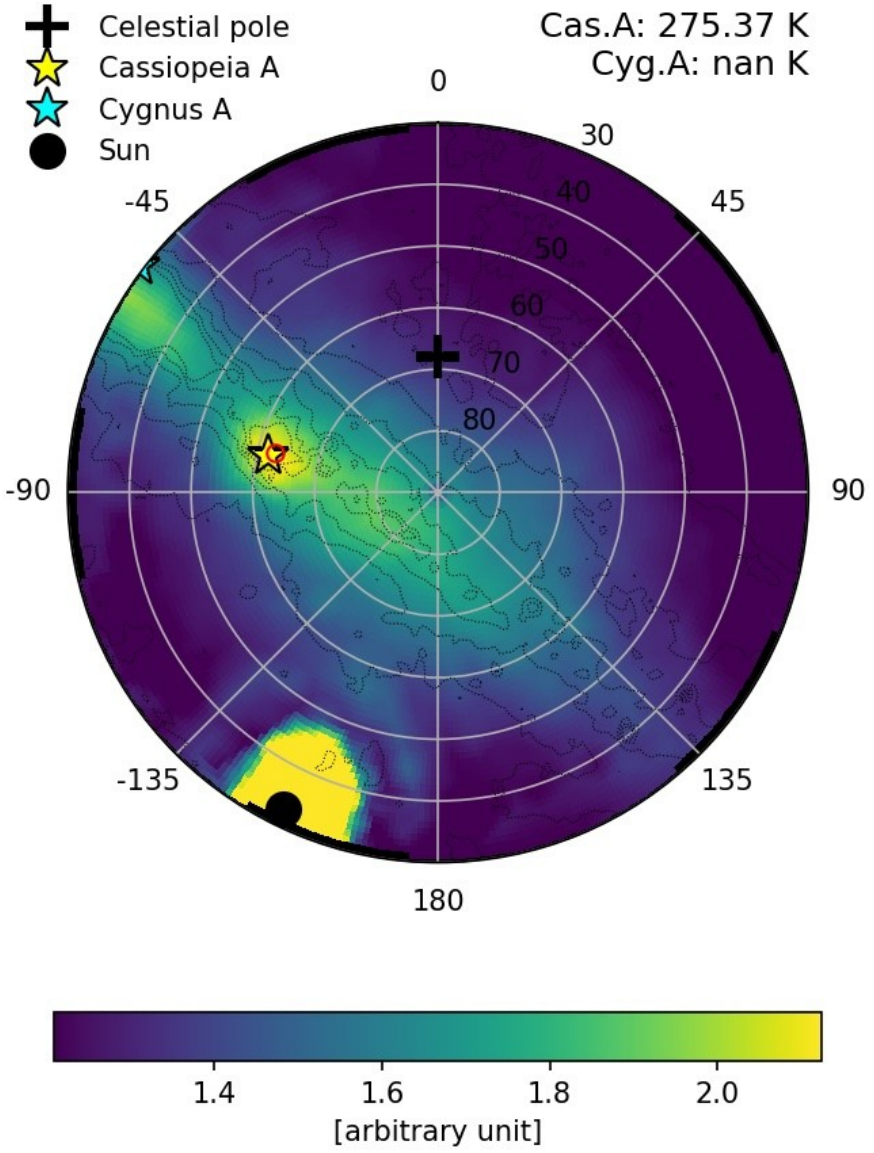
PET transferred from Kiruna to Kaiseniemi

AU power and fibre connections

Next:

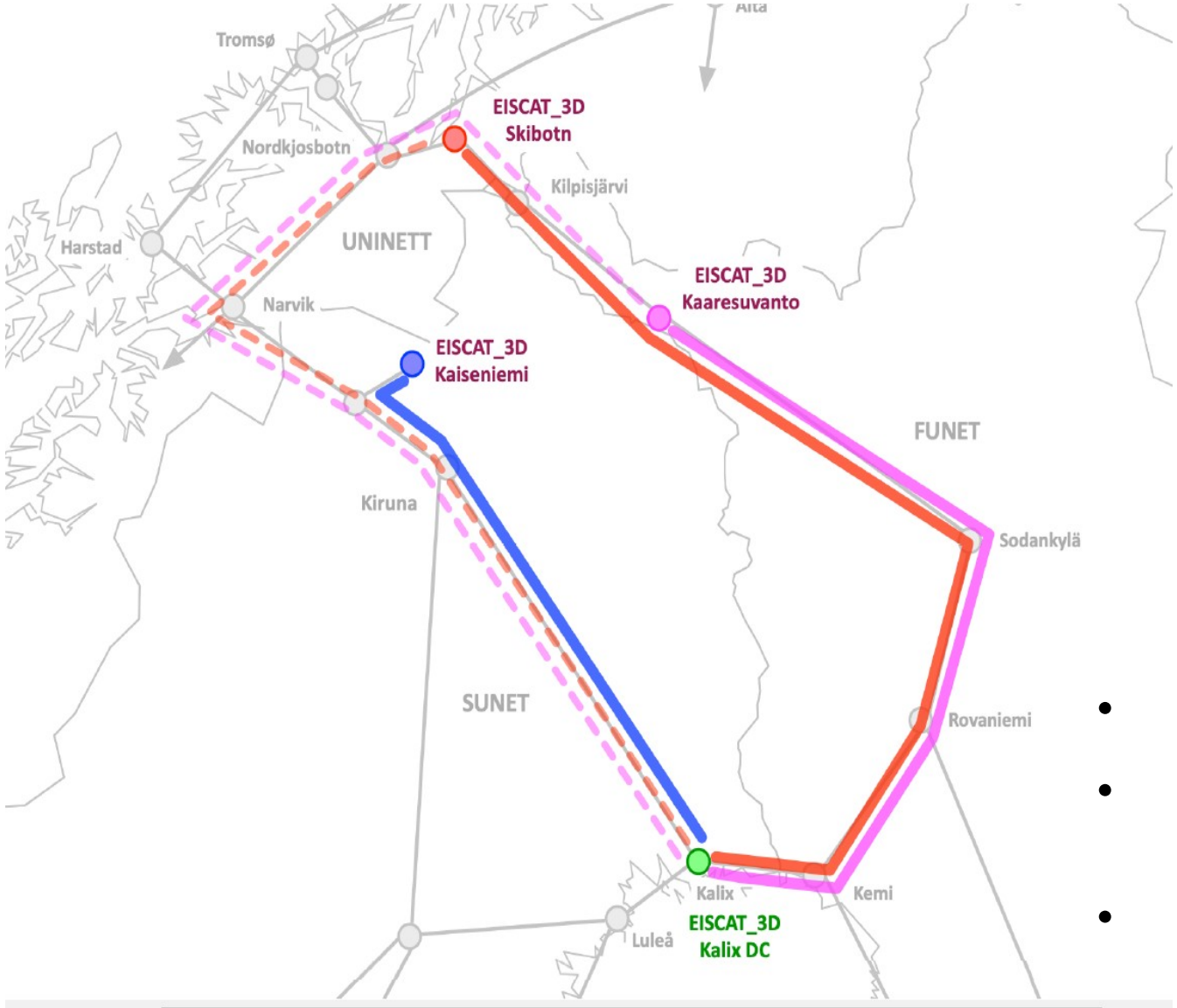
Local SE–7 receiver configuration

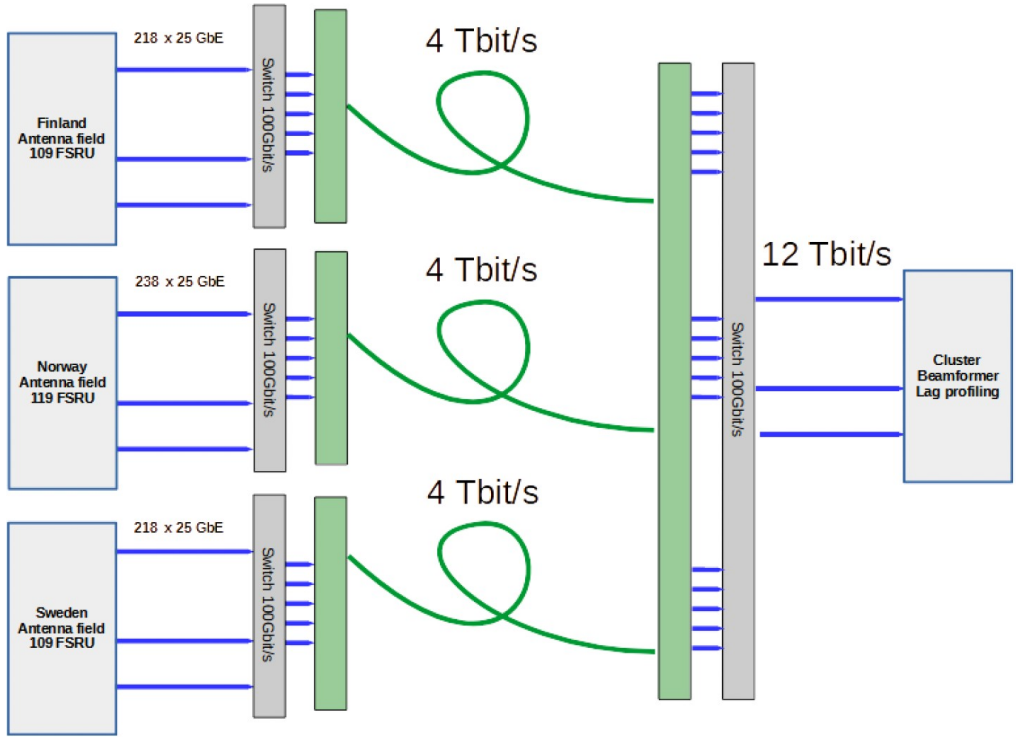
Installation of First-Stage Receiver Units (FSRUs; on-going)



Skymap using two antenna units with second-stage beam forming.

EISCAT_3D – Network





- 4 Tbit/s from each site to DC Orion (Kalix, SE).
- Network can be equipped with filters so that White Rabbit signal can transfer through network.
- Now GNSS clocks at each site but future maybe synchronize to external White Rabbit source.

EISCAT_3D – Planned Commissioning

PET (Tx/Rx)	NO–7	SE–7	FI–7	VHF
Tx/Rx				
Rx				Tx
Tx		Rx		
		Rx		Tx
			Rx	Tx
		Rx	Rx	Tx
	Rx			Tx
	Tx/Rx (first light)			

Requesting EISCAT Radar Time

Peer Reviewed EISCAT Radar Time Applications
https://eiscat.se/scientist/schedule/eiscat-peer-reviewed-program/

- Up to 200 hours experiment time per year
- Open to all international scientists

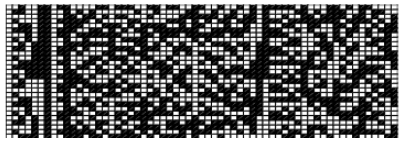
Deadlines: 1st of May
1st of November

https://eiscat.se/scientist/schedule/experiments/

EISCAT Experiments

Anders Tjulin
EISCAT Scientific Association

3rd February 2022



Questions when requesting an experiment? Don't hesitate to contact EISCAT!
https://eiscat.se/contact/

https://eiscat.se/scientist/schedule/eiscat-facility-status/

EISCAT Facility Status

Tromsø VHF Radar

Last update: **2024-03-20**
Status: OK

Tromsø UHF Radar

Last update: **2024-03-20**
Status: OK

EISCAT Svalbard Radar (ESR)

Last Update: **2024-03-20**
Status:
32-m dish: Due to gearbox failure, the **32-m dish** cannot move and can be operated only in the zenith position (elevation 90°). New gearbox and new motor have arrived and have been installed.
Next steps: fill oil and grease as outside temperature allows, then run tests, then implement a new emergency stop procedure.

42-m dish: OK

Tromsø Heating

Last update: **2024-03-20**
Status: Array 2 operational with 8 transmitters.

UiT The Arctic University of Norway

Recent EISCAT Youtube Video

New technology is uncovering more about the northern lights

RAZOR Science Show
12.9K subscribers
Subscribe

https://youtu.be/zY0DVqXY9Fg?si=Tog_Vs4PmEdXxOz7

Future of EISCAT

EISCAT AB

EISCAT Scientific Association will be reformed into a company owned by the Swedish, Norwegian, and Finnish research councils

The goal is for this to be completed in early 2025

Priority is to minimize disruptions to operations

A further update will be provided at the EISCAT Symposium: Tromsø, Norway, 29 Jul – 2 Aug, 2024

Progress is ongoing with the installation of electronics and testing of EISCAT_3D

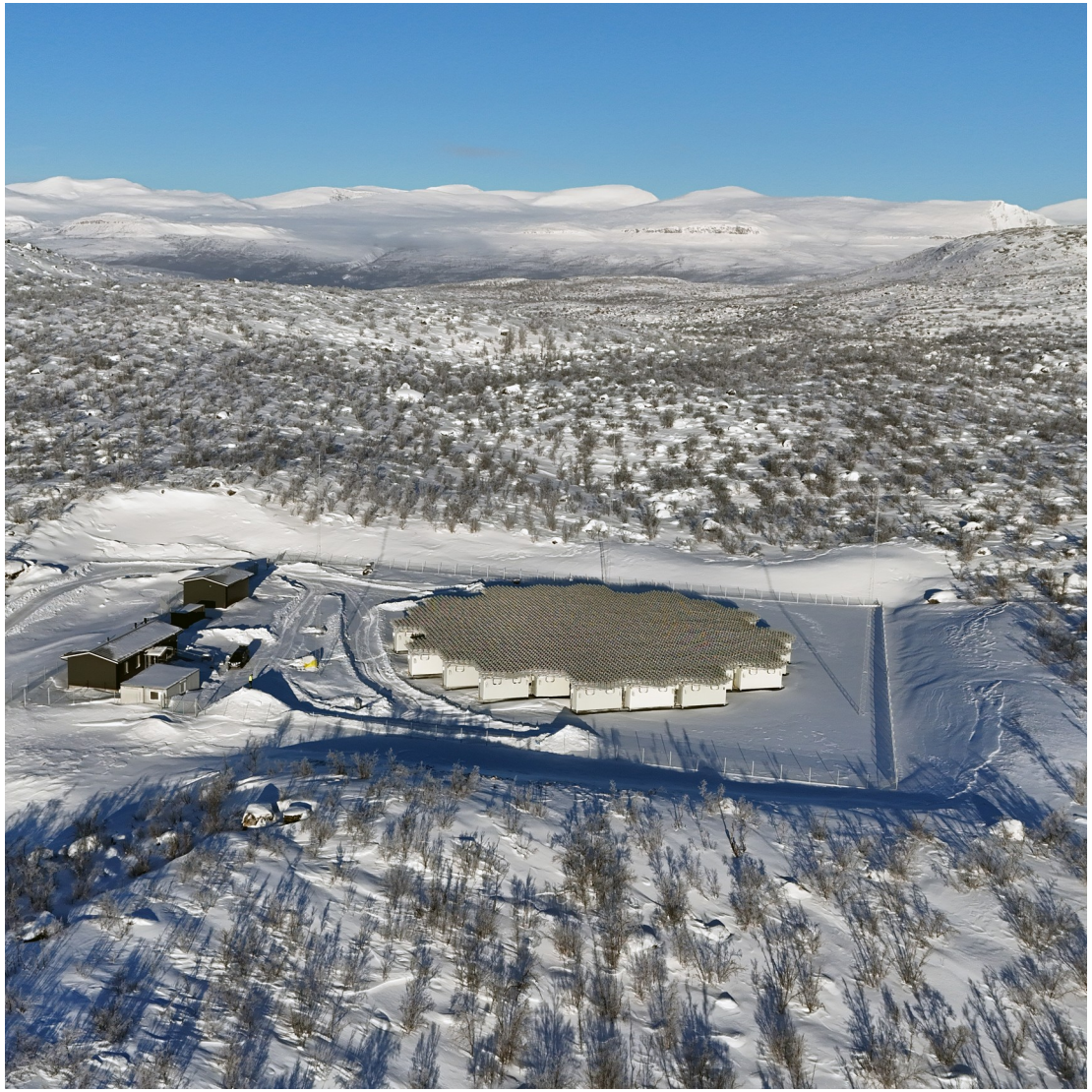


Photo: EISCAT