EISCAT

Scientific Association

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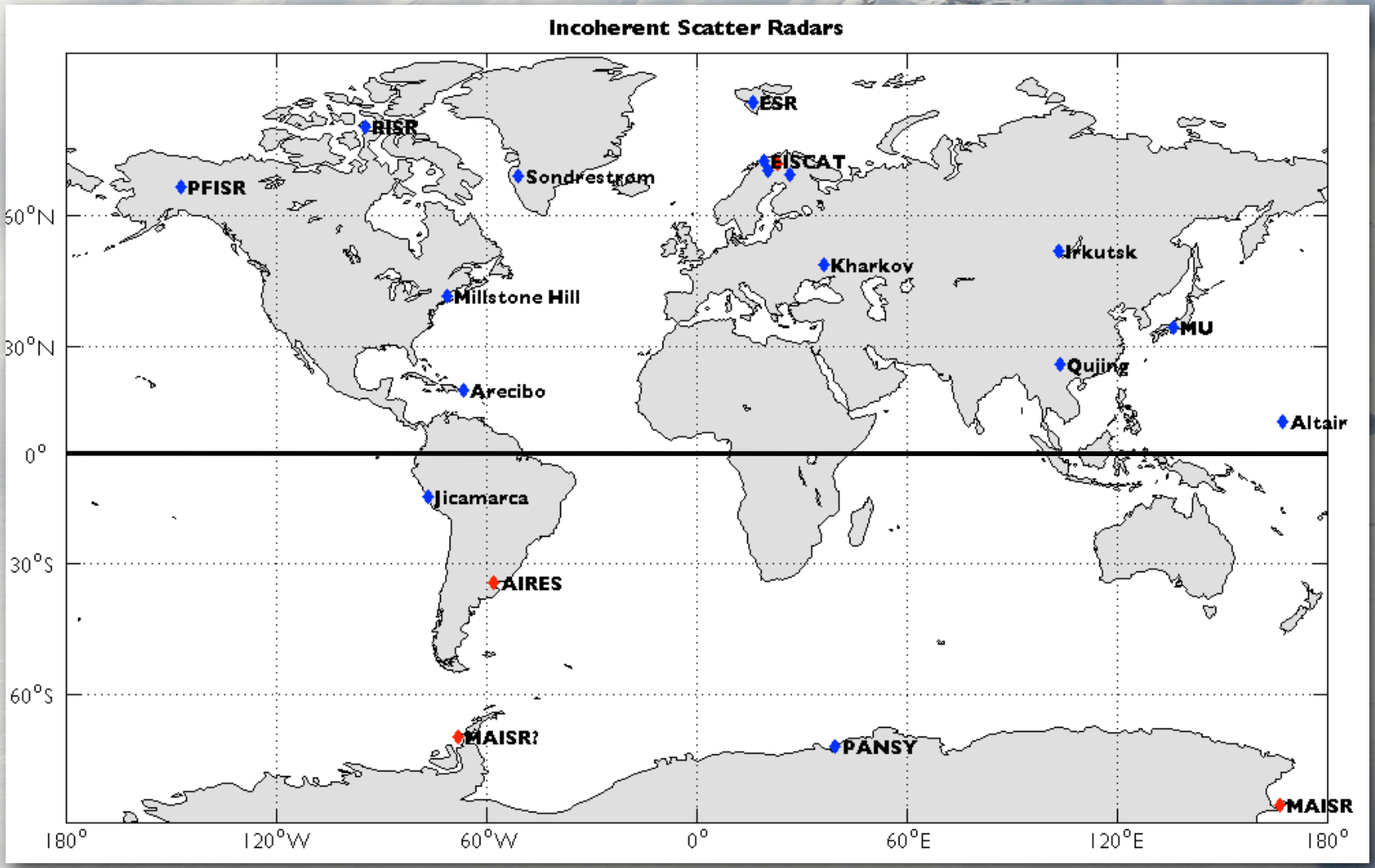
www.eiscat.se • www.eiscat3d.se

Photo: Anja Strømme.

Incoherent Scatter Radars



EISCAT

- Originally: ~~European~~ Incoherent SCATter.
- Since 1975.
- Operates 3 ISRs.
- Locations: Tromsø (NO), Kiruna (SE), Sodankylä (FI), Longyearbyen (Svalbard).
- Founding members: UK, DE, FR, NO, SE, FI.
- Members (2012): UK, NO, SE, FI, JP, CN (+RU, FR, (UA)).
- August 2011: 30 years of measurements.

Photo: Thomas Ulich.

You can get Radar Time!

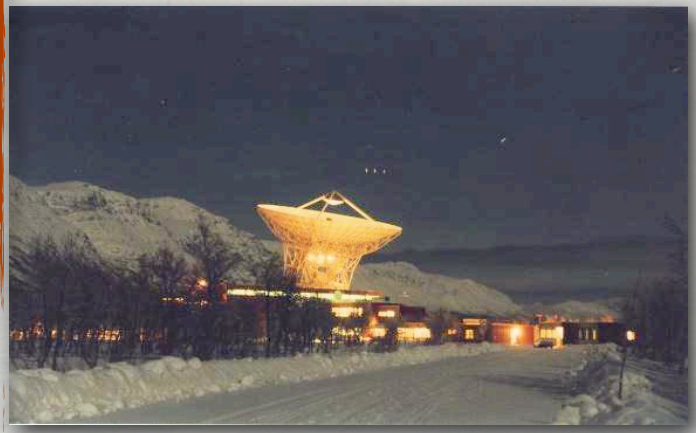
- EISCAT Peer-Review Programme
- EISCAT sets aside 200 hrs of radar time per year (at the moment).
- Everyone can apply!
- Decisions on basis of merit.
- If equal merit, new users and new countries have priority.

ISRs, Heater, Dynasondes

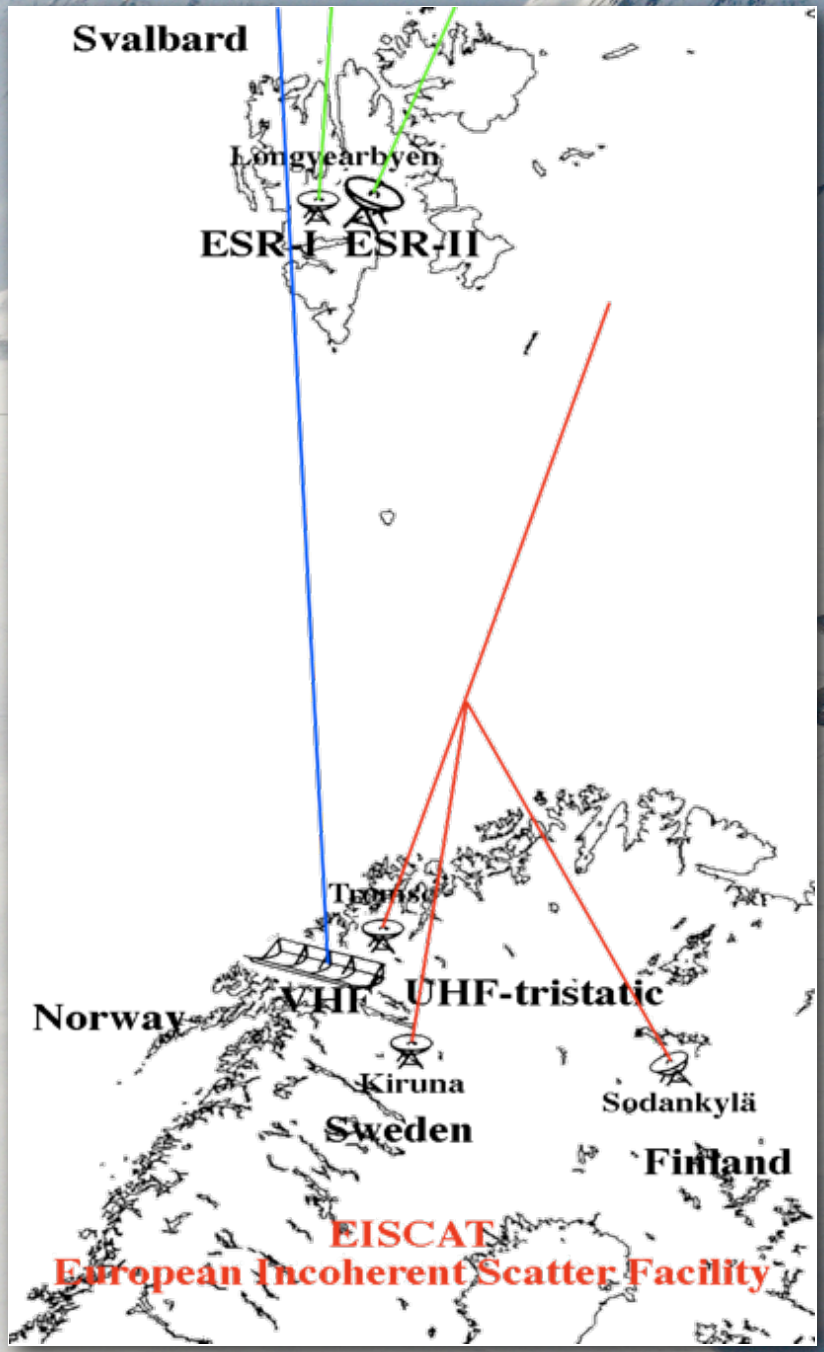

ESR, 500 MHz

Tristatic UHF, 930MHz


VHF, 224 MHz



Current EISCAT installations in Northern Scandinavia and Finland



Unique: tristatic IS radar!

Tri-static Data

Sodankylä

Kiruna

Tromsø

Ne

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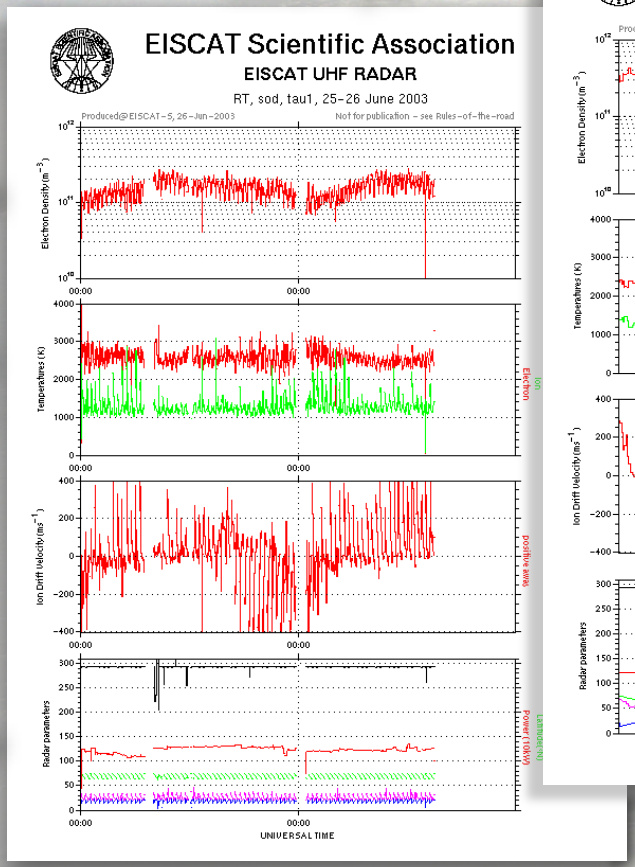
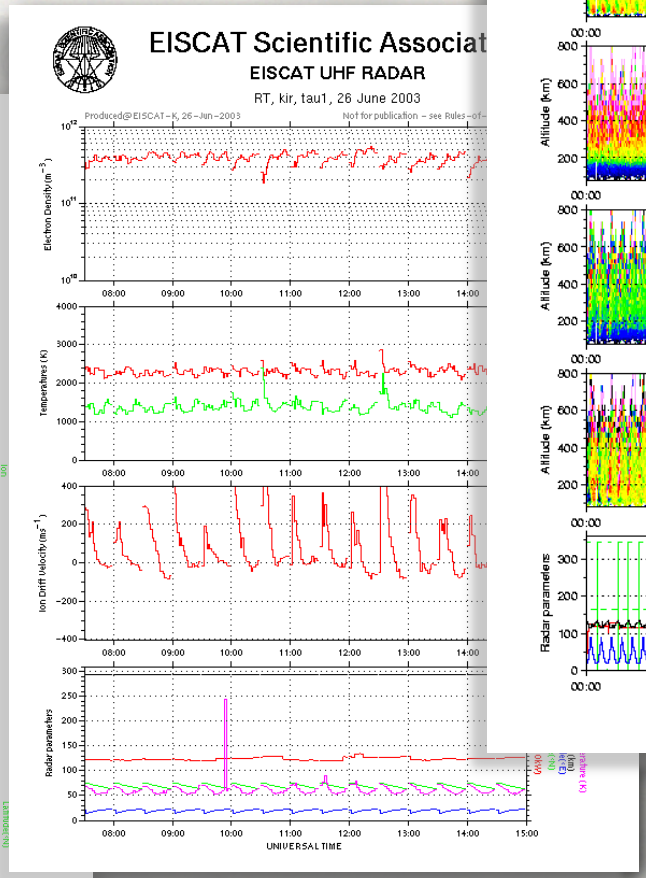
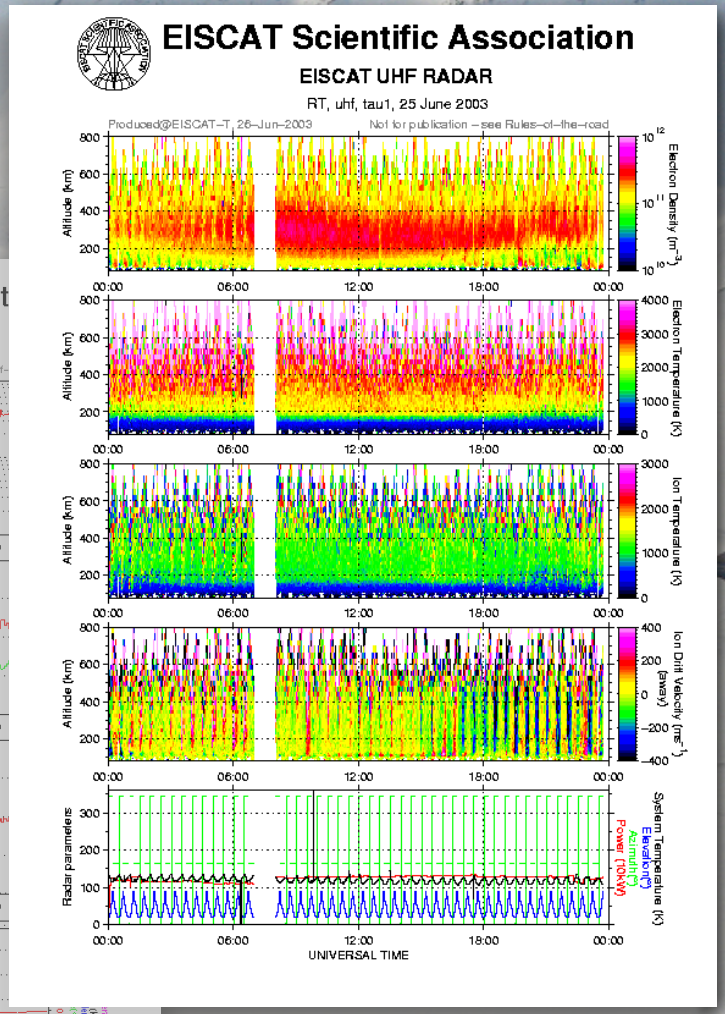
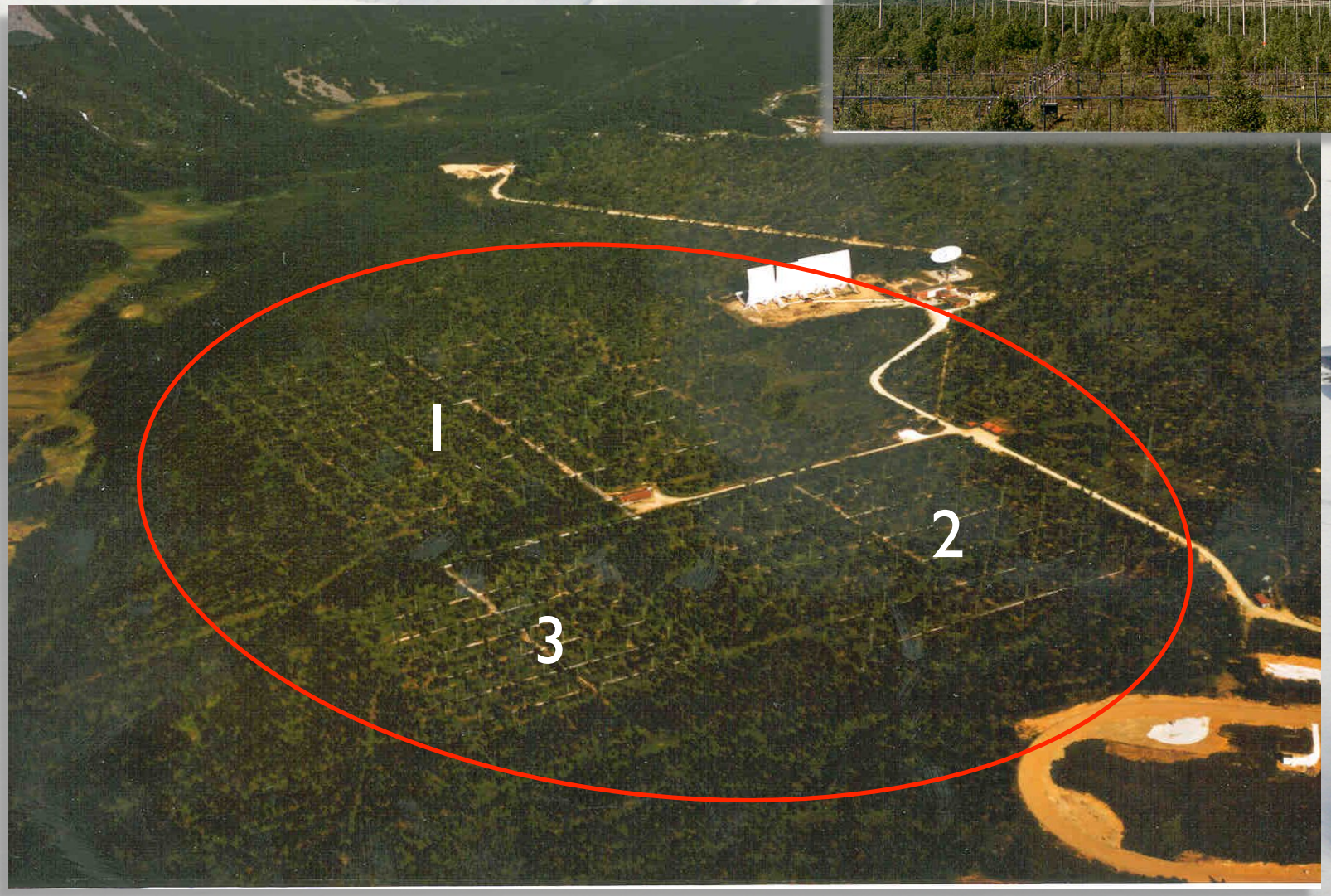




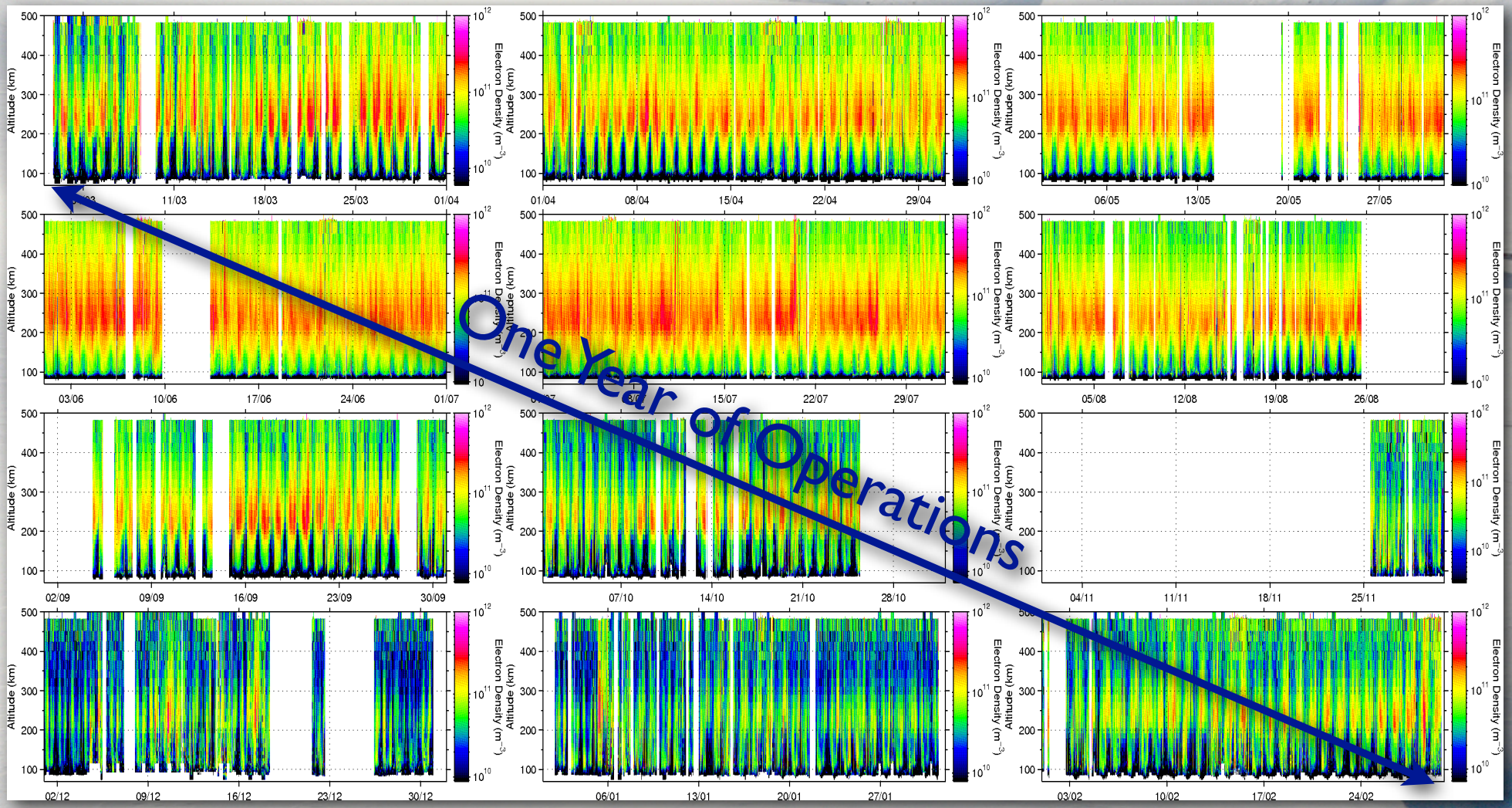


Ionospheric Heater 4-8 MHz

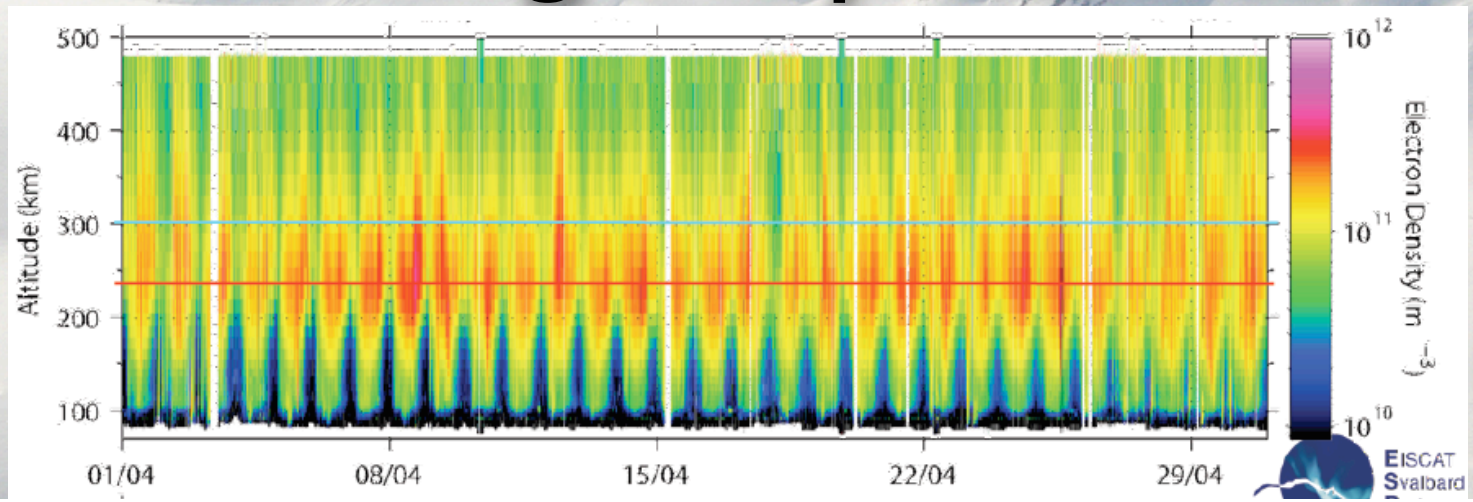


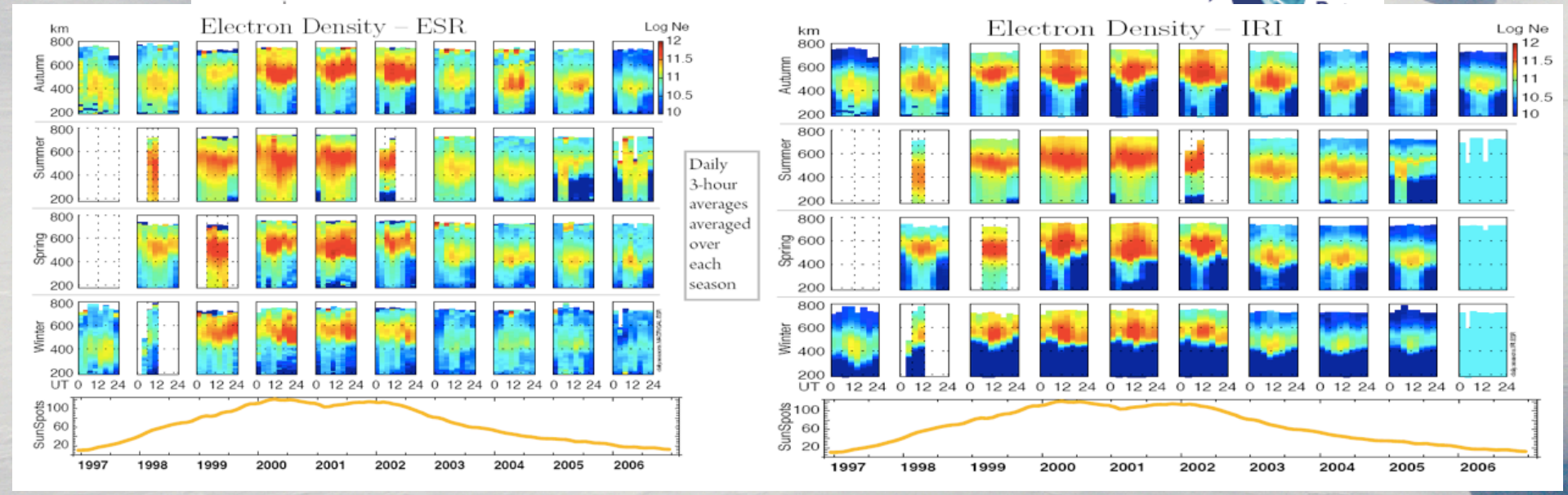
EISCAT VHF

EISCAT Svalbard Radar

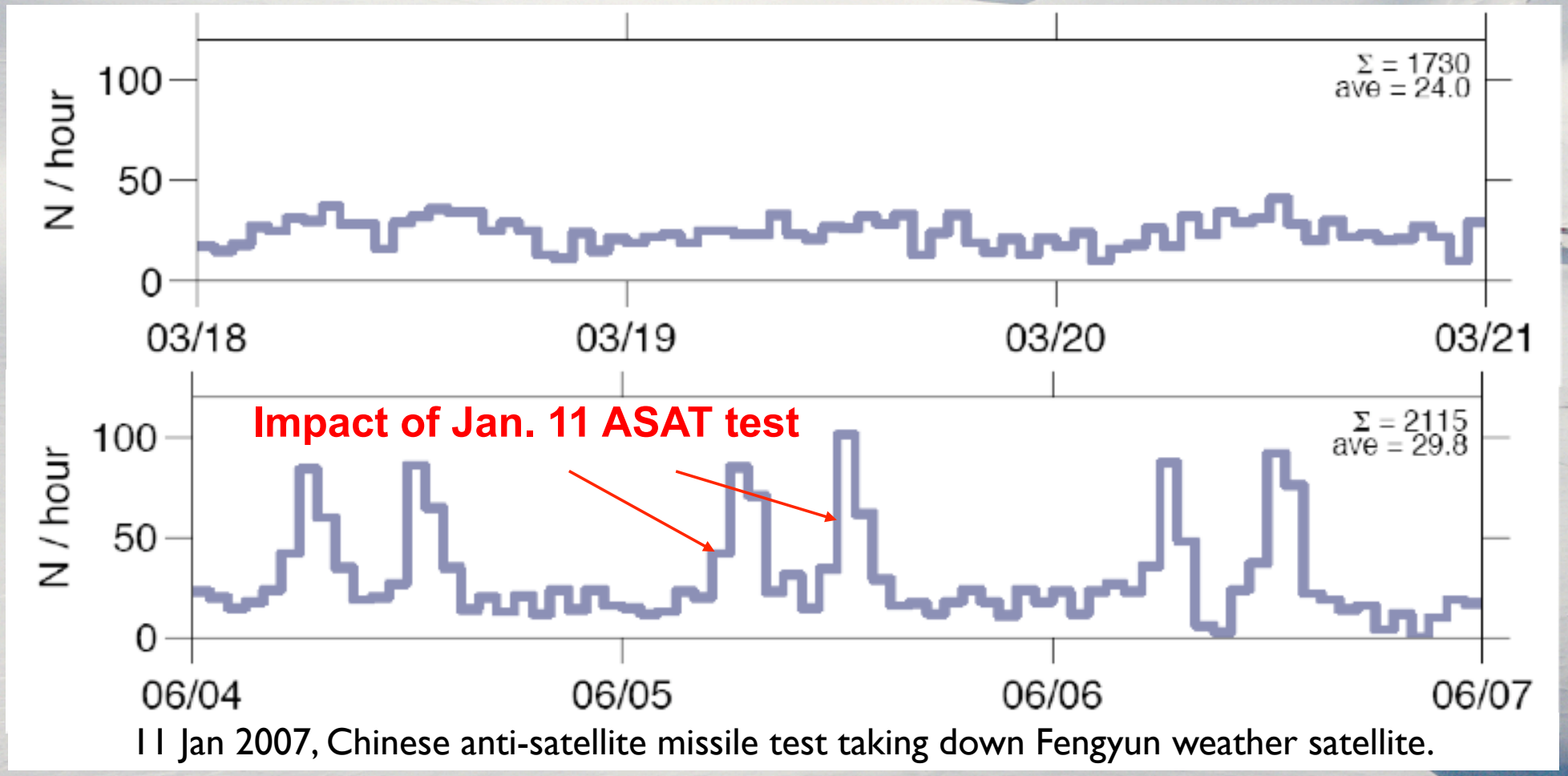


Space Weather: Modelling and predictions



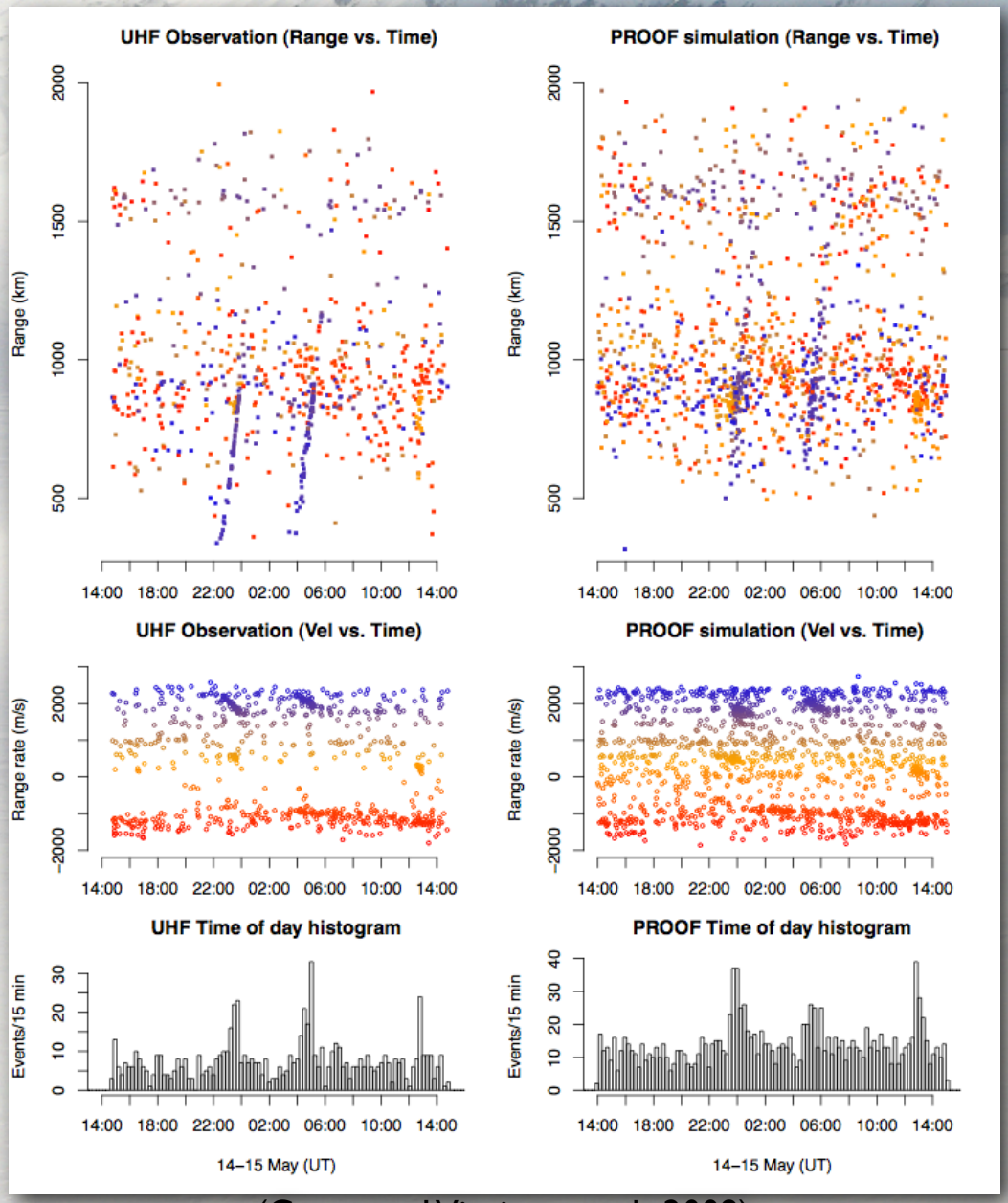


EISCAT & Space Debris



11 Jan 2007, Chinese anti-satellite missile test taking down Fengyun weather satellite.

Iridium-Cosmos Collision seen by EISCAT UHF radar

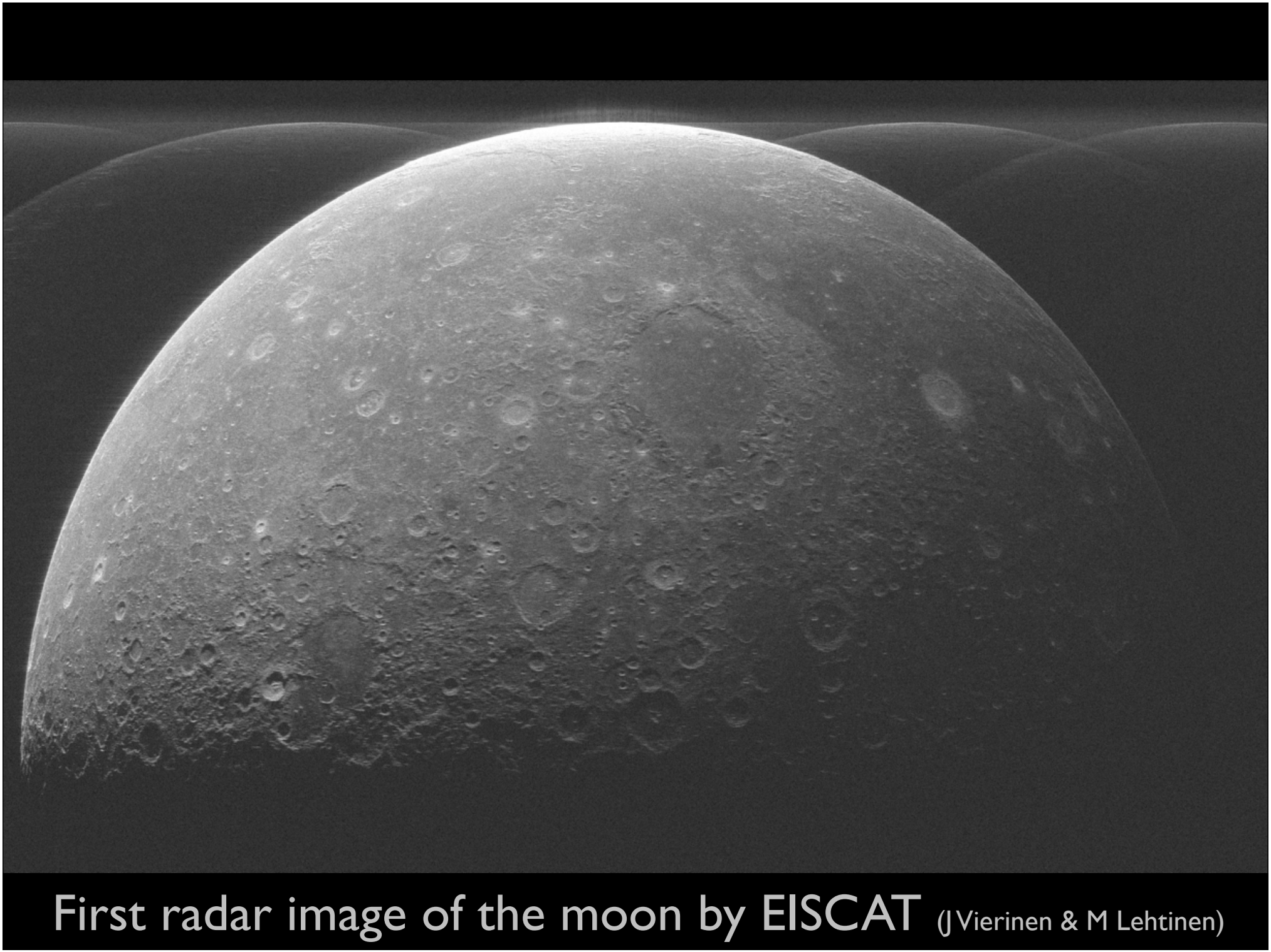


(Courtesy J Vierinen et al., 2009)

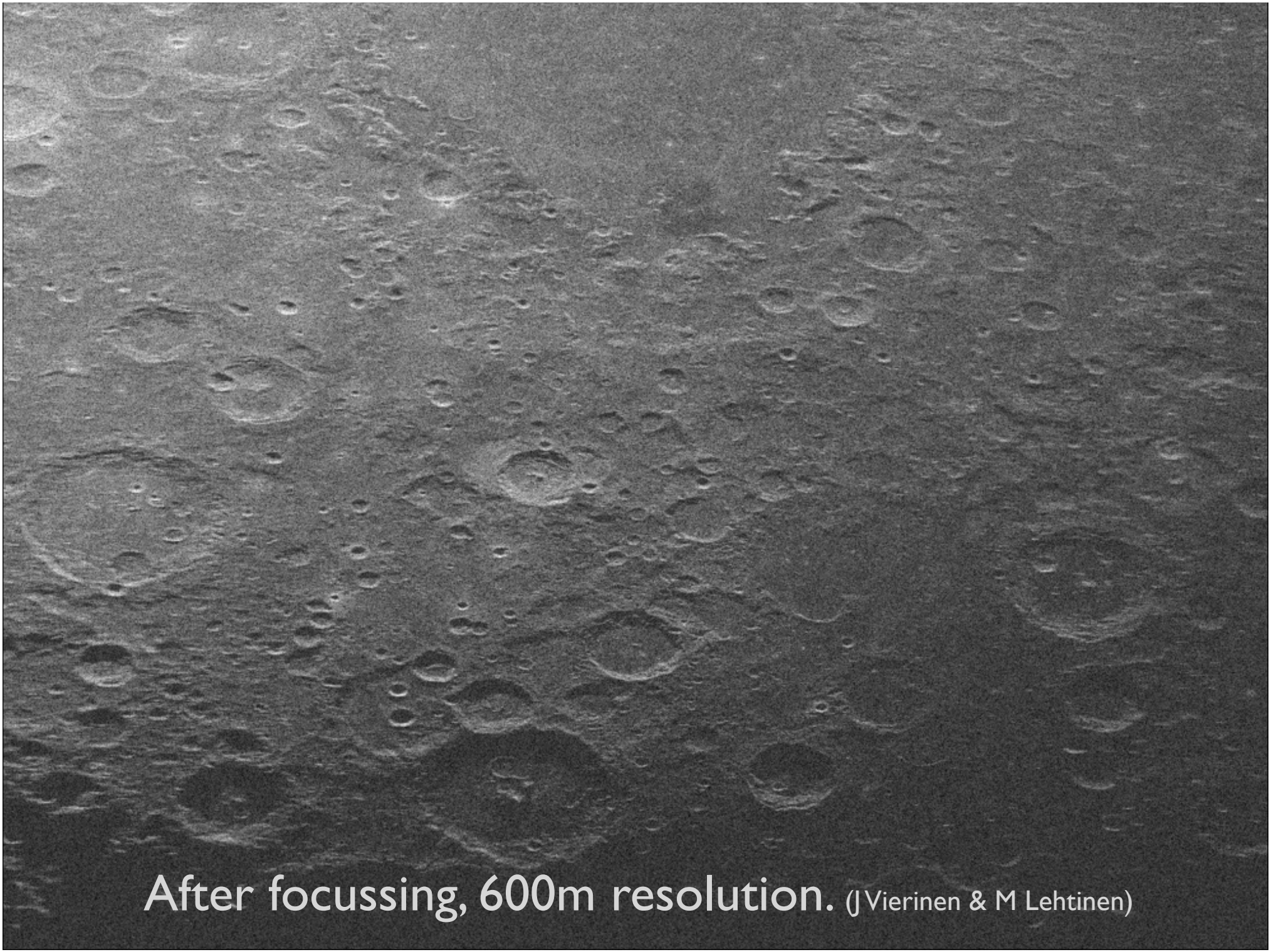
What happens when an unstoppable object hits an indestructible barrier?
Here: 1.7 g Al sphere of 1.2 cm Ø at 6.8 km/s.

EISCAT Reaching for The Moon

Credits: Juha Vierinen and Markku Lehtinen, Sodankyla Geophysical Observatory, Finland



First radar image of the moon by EISCAT (J Vierinen & M Lehtinen)

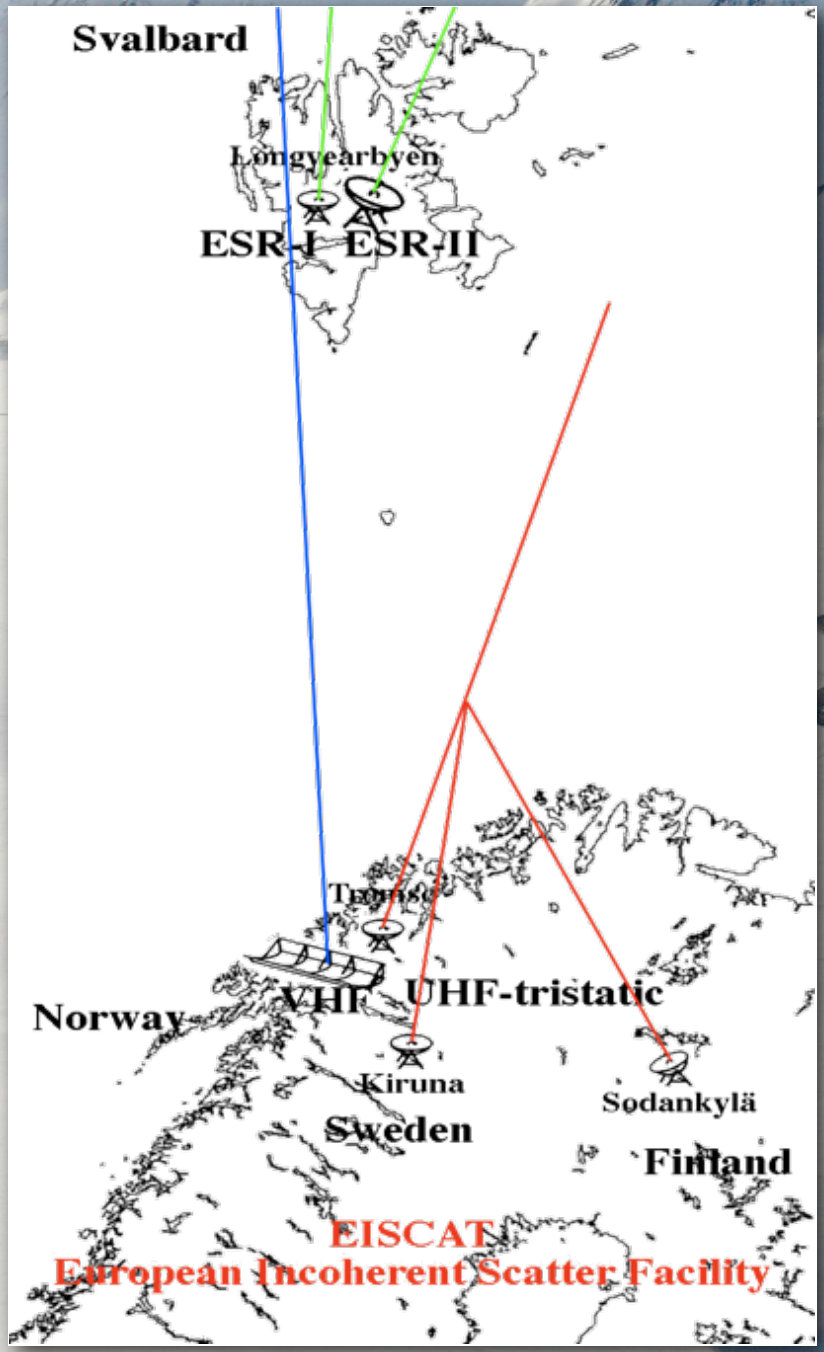


After focussing, 600m resolution. (J Vierinen & M Lehtinen)

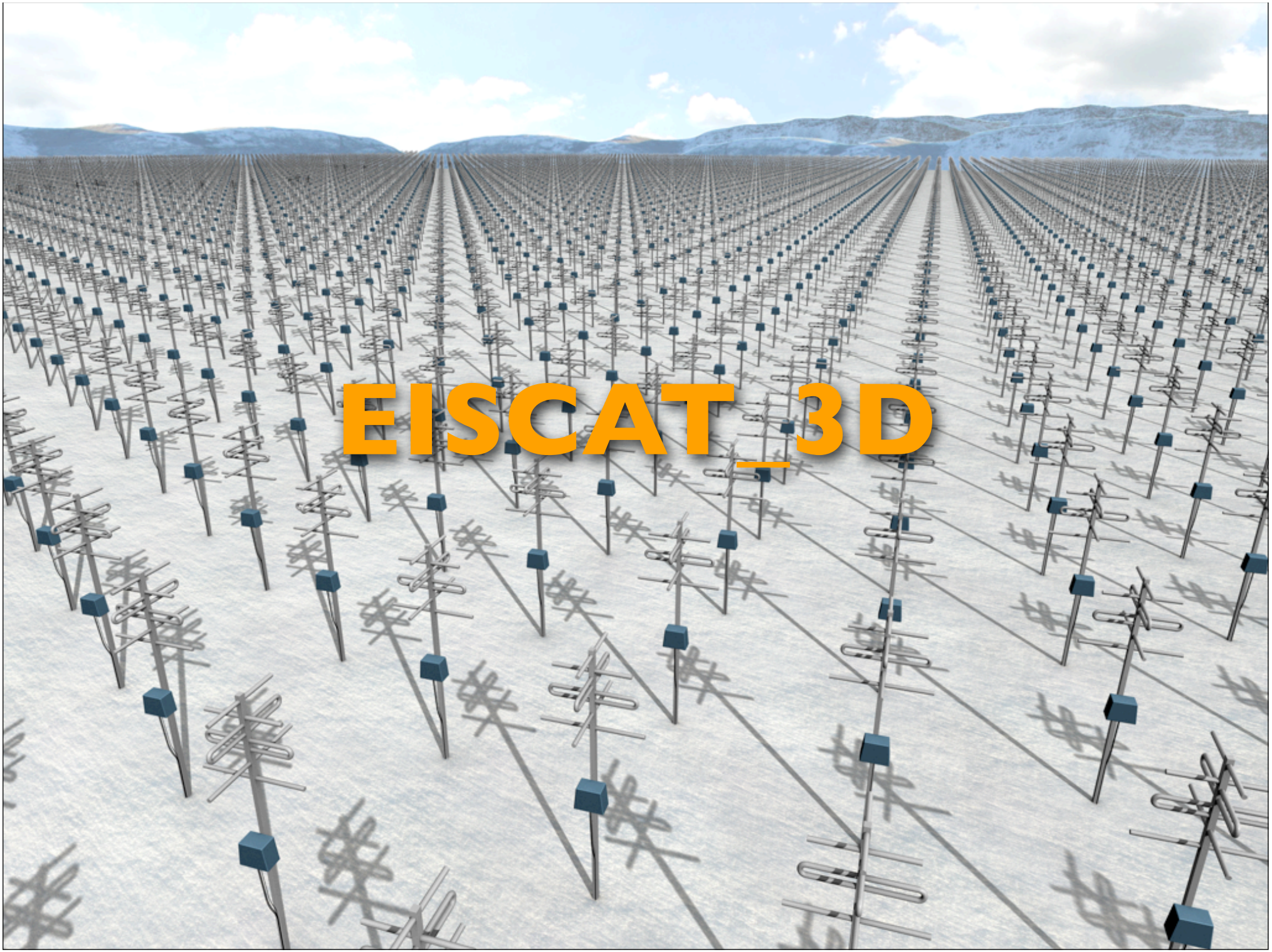
Unique: tristatic IS radar!

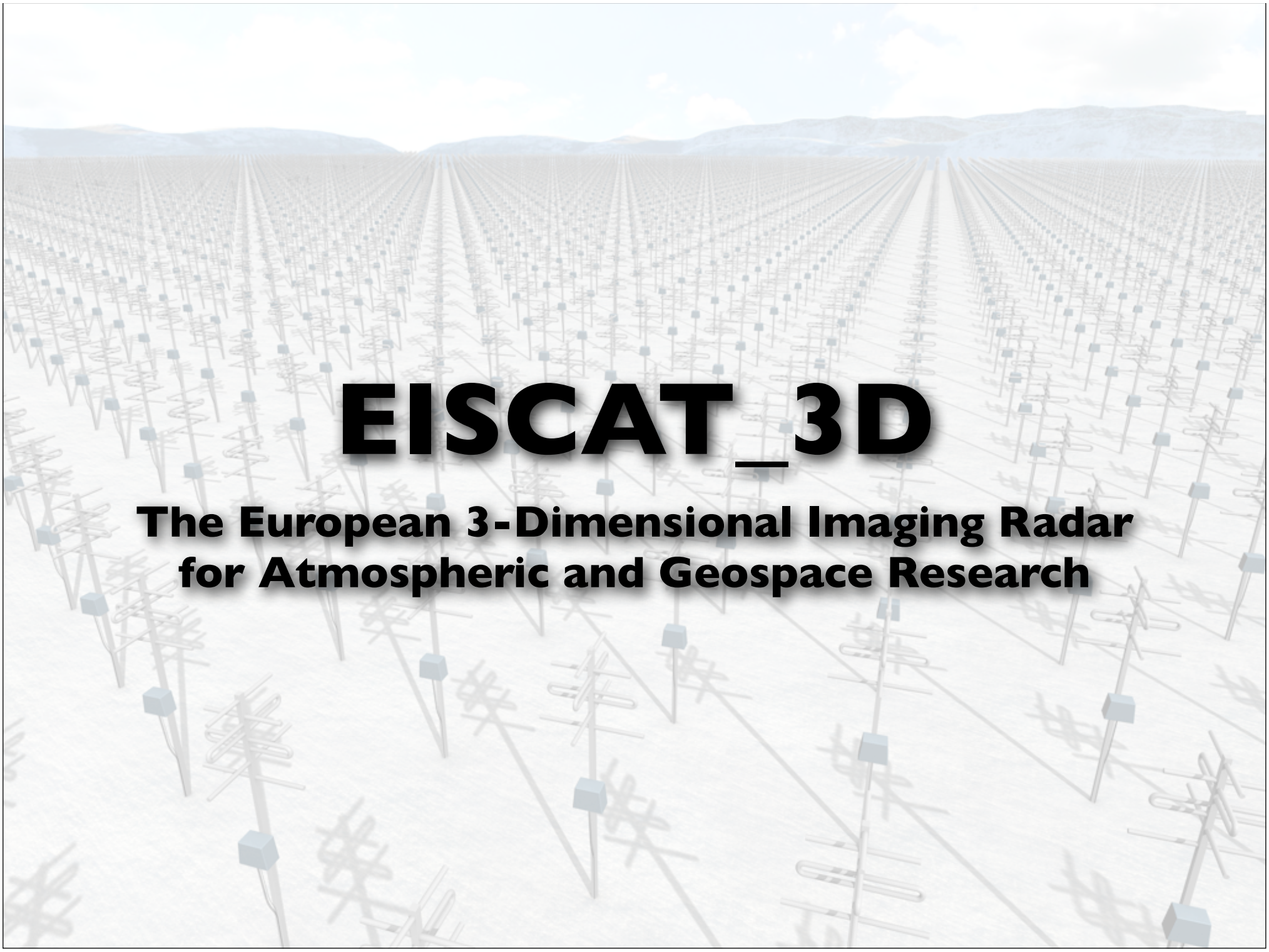
But: UHF at 930 MHz; now too much GSM interference.

Also: single point 3D only, leading to space-time ambiguities.



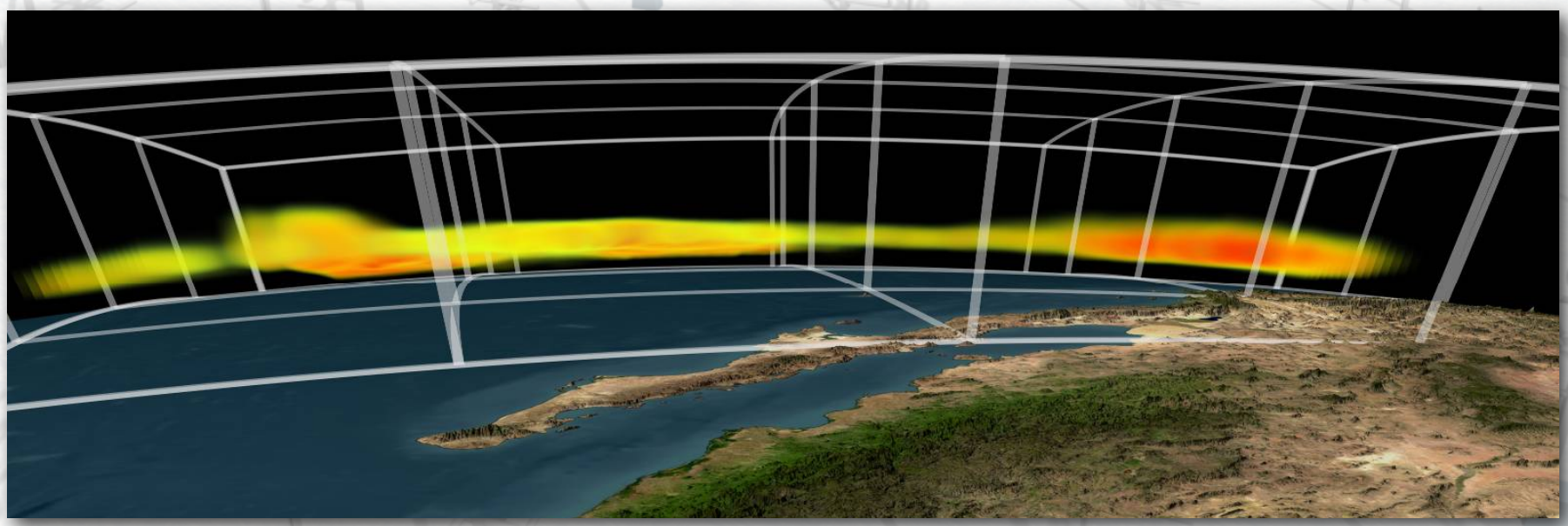

Where to go from here?


EISCAT_3D


EISCAT_3D
The European 3-Dimensional Imaging Radar
for Atmospheric and Geospace Research

EISCAT_3D - The Idea

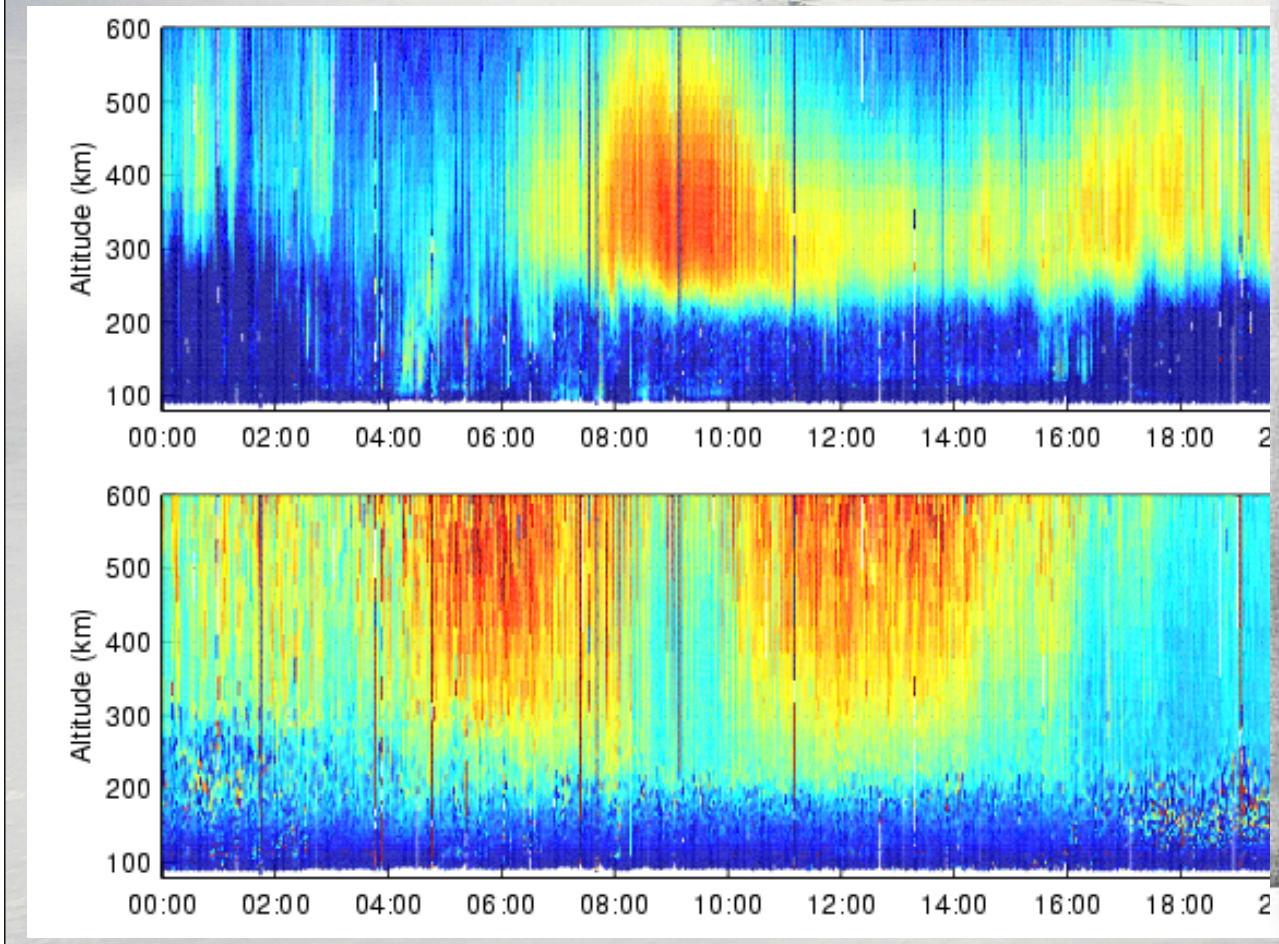
- EISCAT UHF: tristatic, but 1D
- AMISR: 1D volumetric
- EISCAT_3D: 3D volumetric

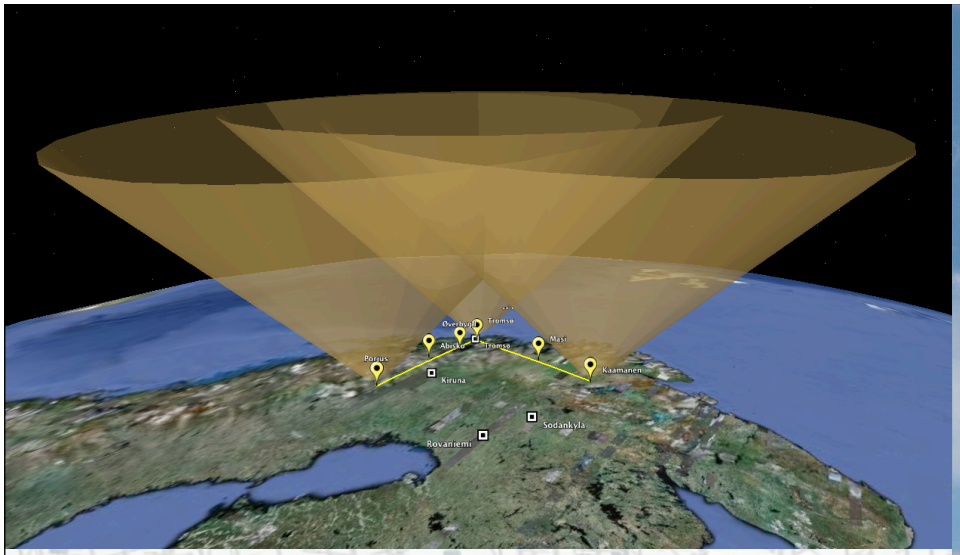


EISCAT_3D - The Idea

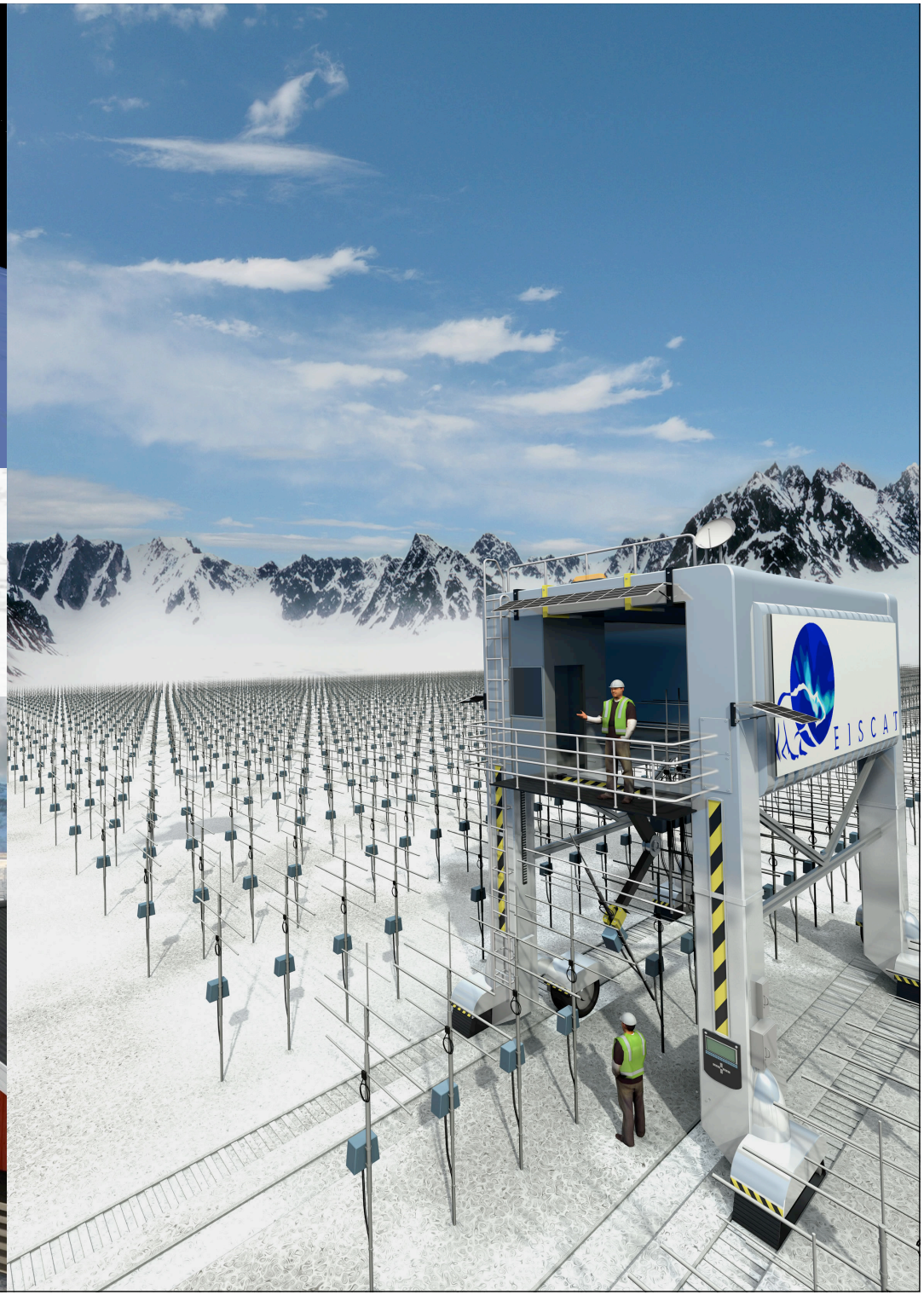
- Volumetric radar, capable of imaging an extended spatial area with
- simultaneous full-vector drift velocities,
- continuous operation modes,
- short baseline interferometry for sub-beamwidth scales,
- real-time data access.

Space-Time Ambiguity





EISCAT_3D - Visions



European Strategy Forum
on Research Infrastructures

ESFRI

December 2008

EISCAT_3D, the European Next Generation Incoherent Scatter Radar was accepted on the ESFRI Roadmap of Large-Scale European Research Infrastructures for the next 20-30 years.

The Svalbard Integrated Arctic Earth Observation System SIOS was also accepted to the ESFRI Roadmap. The EISCAT Svalbard Radar is an essential part of SIOS.

EUROPEAN ROADMAP
FOR RESEARCH
INFRASTRUCTURES

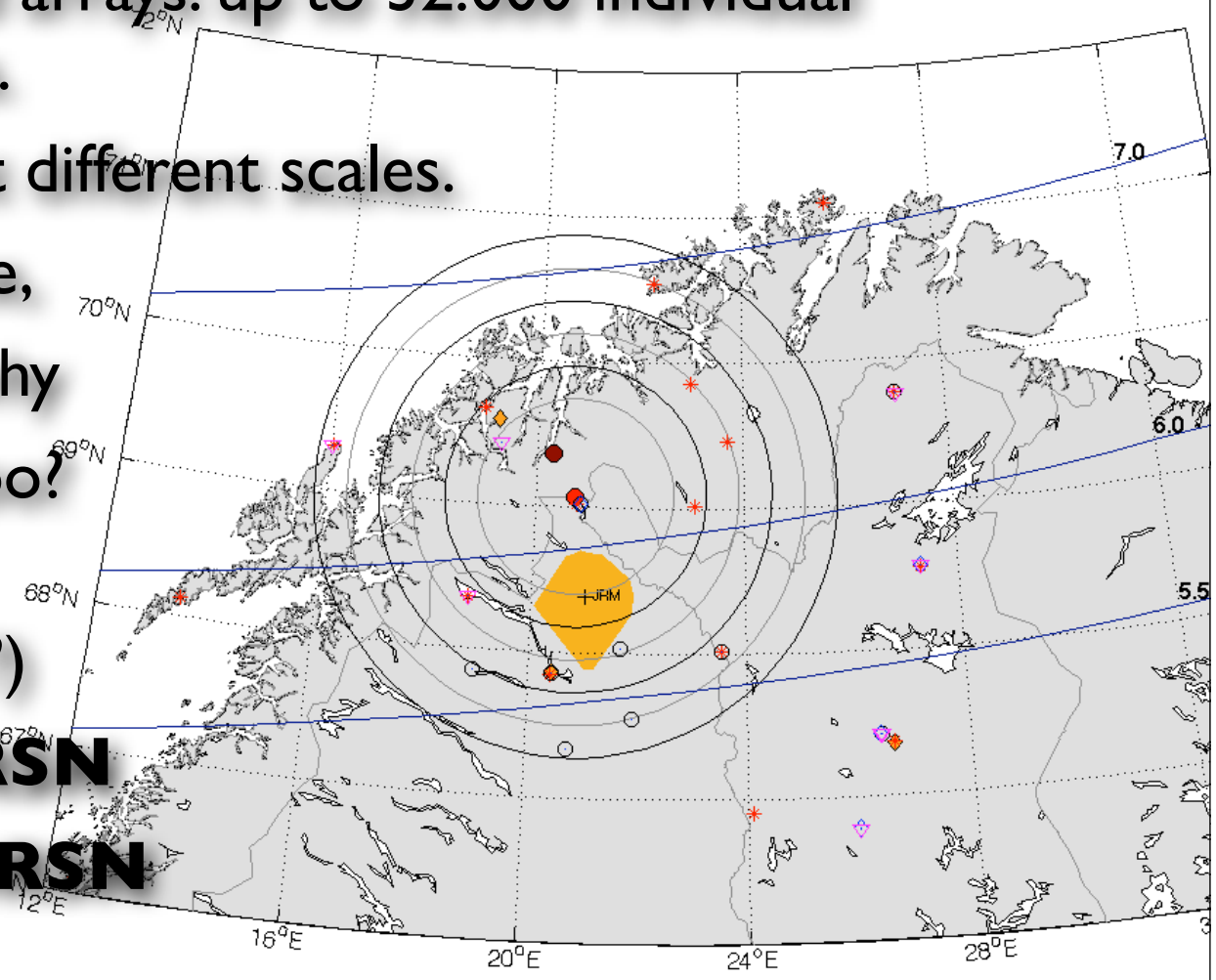
Roadmap 2008

Current Projects

- **FP7 Preparatory Phase Study:**
  4.5 M€, began October 2010, 4 years
- **European Regional Development Funds:**
  Sodankylä Geophysical Observatory has received 400k€ for EISCAT_3D theoretical development.
- **University of Oulu Infrastructure Funds:**
  SGO was granted a 635k€ project to build a remote VHF receiver. Construction summer 2011/12.
- **Swedish research council planning grant:**
  EISCAT has been granted 760k€ over 2 years for establishing a project office for E3D

EISCAT_3D - System

- Very large phased arrays: up to 32.000 individual antenna elements.
- Modular design at different scales.
- Central Tx/Rx site, remote Rx, but why not remote Tx, too?
- VHF ≈230MHz (and MF for MST?)
- Locations **TBDRSN**
- Tech Specs **TBDRSN**



Think big! Think extendable! Think modular!

EISCAT_3D - Science

- Influence of natural solar-terrestrial variability on climate.
- Long-term anthropogenic change.
- Coupling between atmospheric layers.
- Space plasma physics, including active experiment.
- Measurements of the solar wind and solar corona.
- Effects of meteors and energetic particles on atmospheric chemistry.

EISCAT_3D - Science

- Monitoring of space weather.
- Space situational awareness.
- Ground-based support for future space missions.
- Orbit determination of space debris and meteors.
- Radar-mapping of near-Earth objects.
- Development of radar and information technology.

EISCAT_3D - Timeline

- 2005-2009: Design Study (completed)
- 2010-2014: Preparatory Phase
- 2014-2015: Start of Construction
- 2016-2045: Operation

EISCAT_3D 2015-2045+

- Continuous development.
- World-class high-latitude space science, space weather, radar technology and radio science.
- State-of-the-Art Education of Space Scientists, Electrical & Radio Engineers, IT Engineers, Mathematicians at all levels.

A Finnish Radio Receiver in Support of EISCAT_3D

Th Ulich, M Lehtinen, D McKay-Bukowski, M Postila,
J Vierinen, T Iinatti, T Raita, L Roininen

•

Sodankylä Geophysical Observatory
University of Oulu, Finland

KAIRA

Kilpisjärvi Atmospheric Imaging Receiver Array

KAIRA banner: Juha Vierinen, SGO.

- Dual VHF radio receiver array.
- Uses LOFAR technology.
- Funded by University of Oulu and European Regional Development Funds. (Total ≈ 1.3M€).
- Receiver for EISCAT VHF.
- Prototyping for EISCAT_3D.
- Many applications in geophysics.

Leverage from the EU 2007–2013

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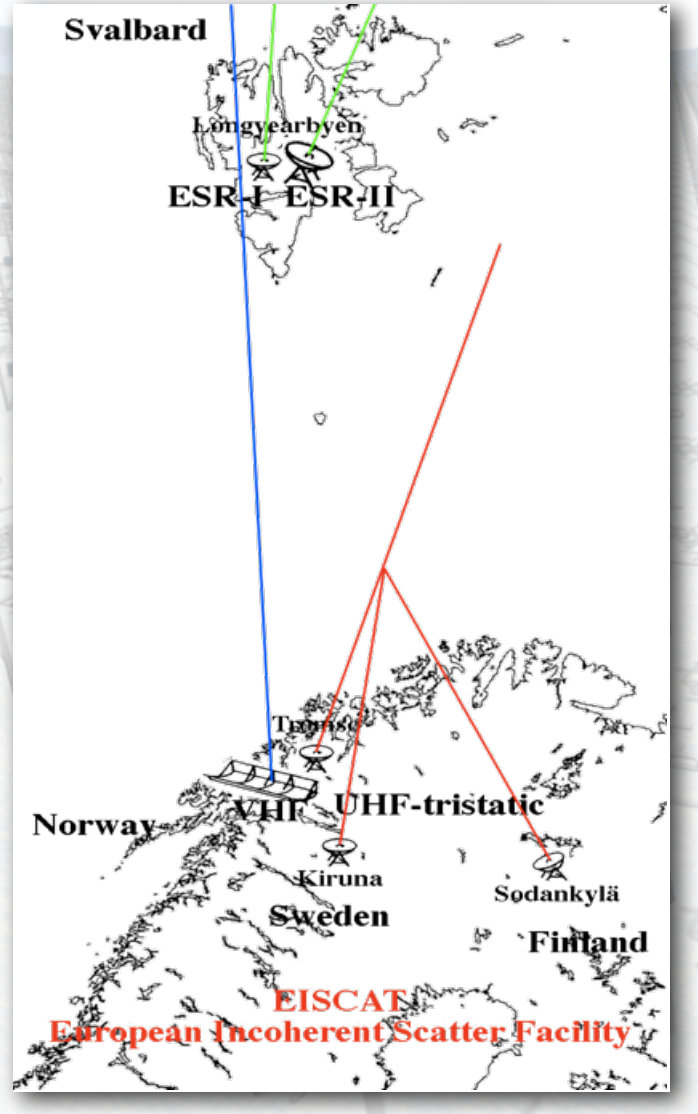
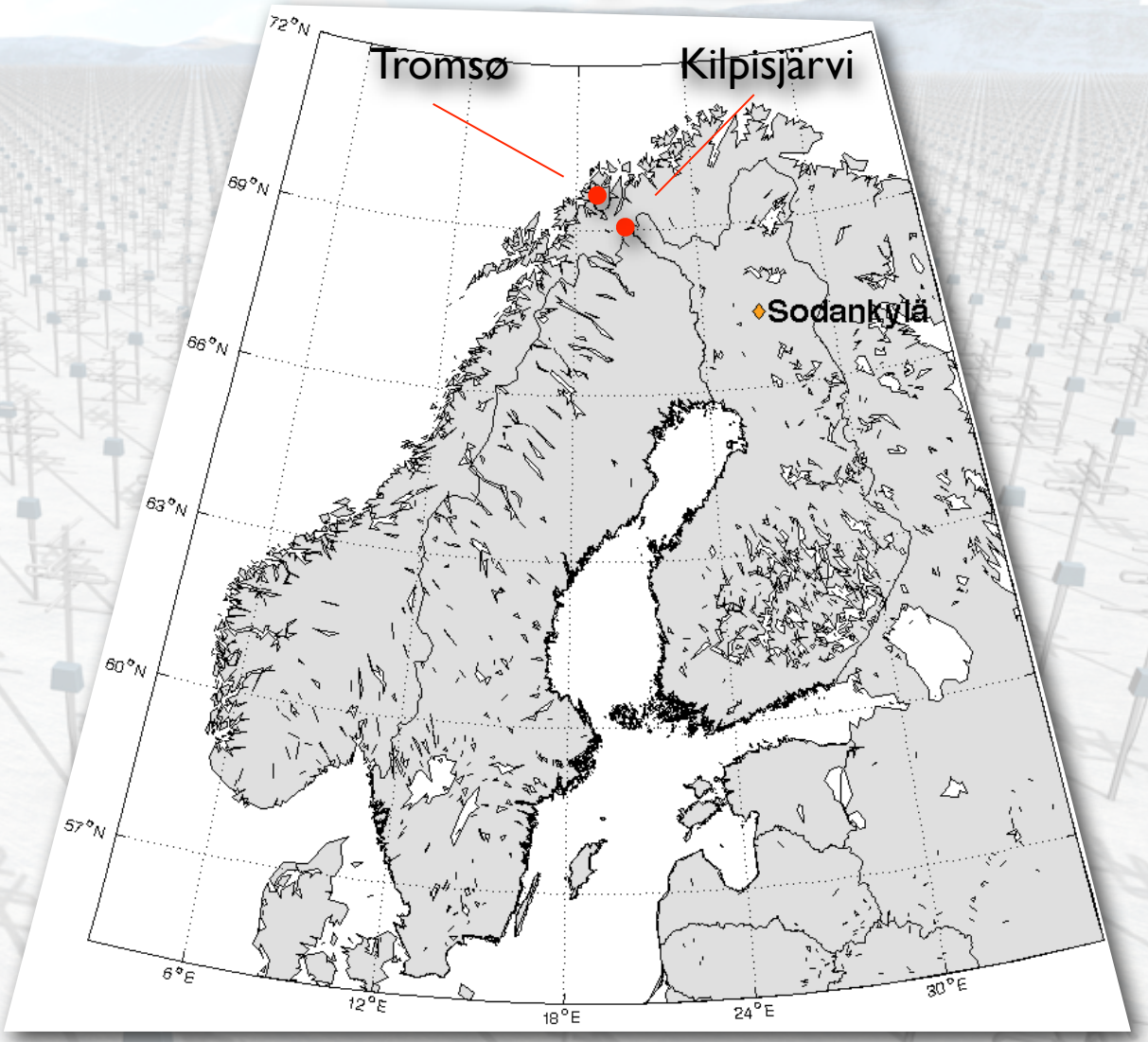
Closest inhabited place on Finnish territory





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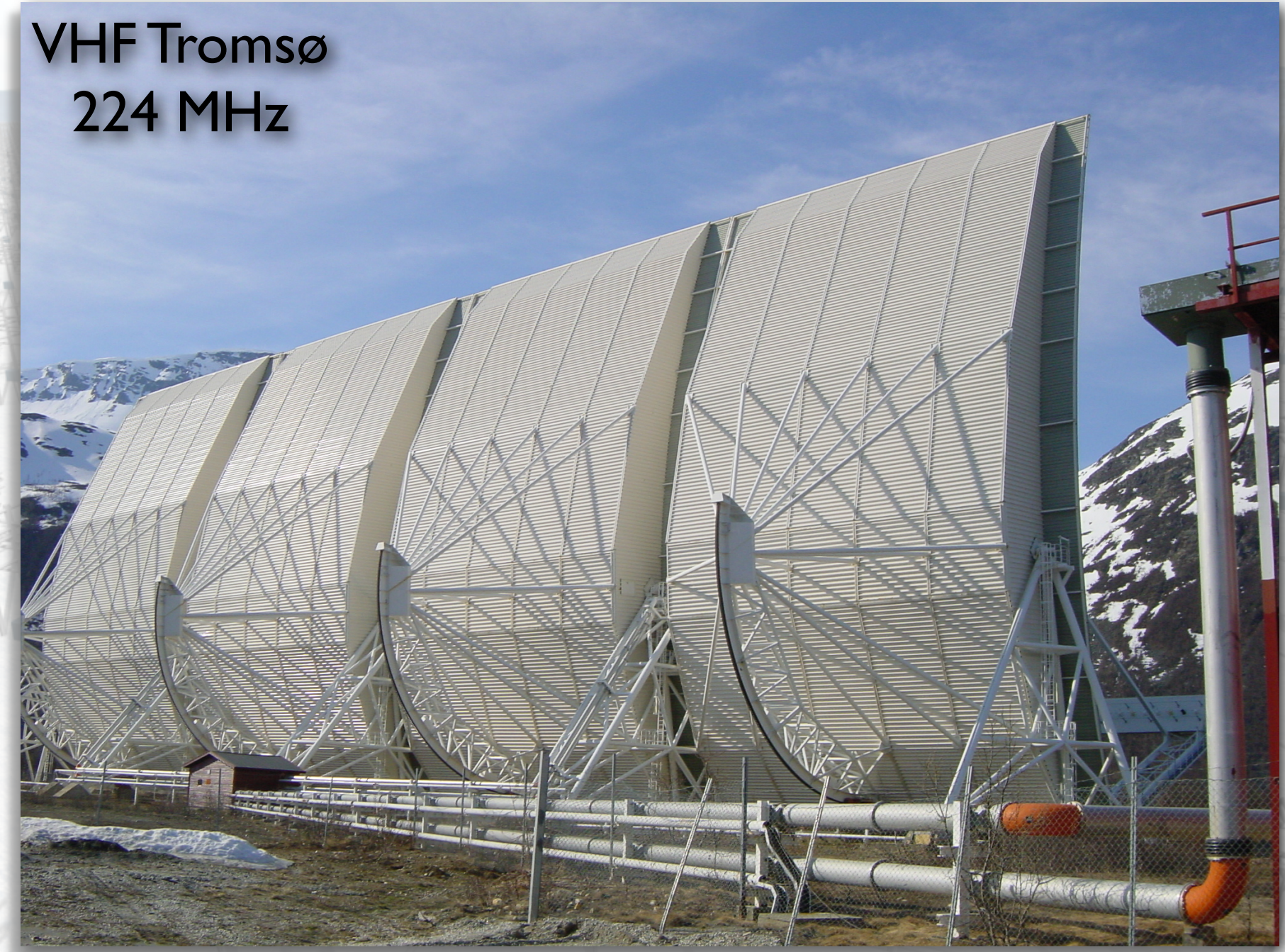
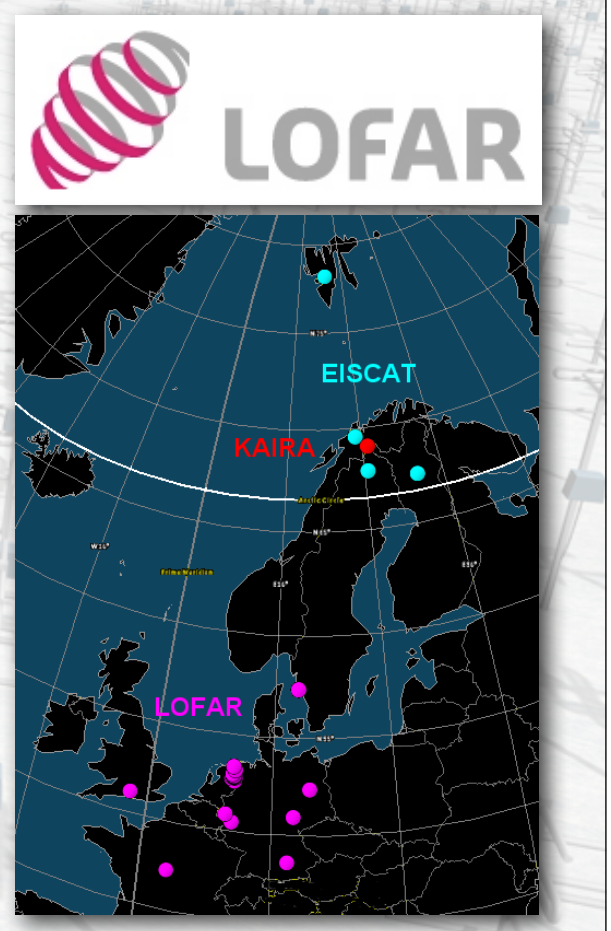

VHF Tromsø
224 MHz

LOFAR?

- LOFAR — Low Frequency Array.
- Pan-European Radio telescope.
- Observe universe at VHF frequencies.
- Designed, built and operated by ASTRON, the Netherlands Institute for Radio Astronomy.
- Multiple stations across Europe each of which typically has two arrays of antennas.



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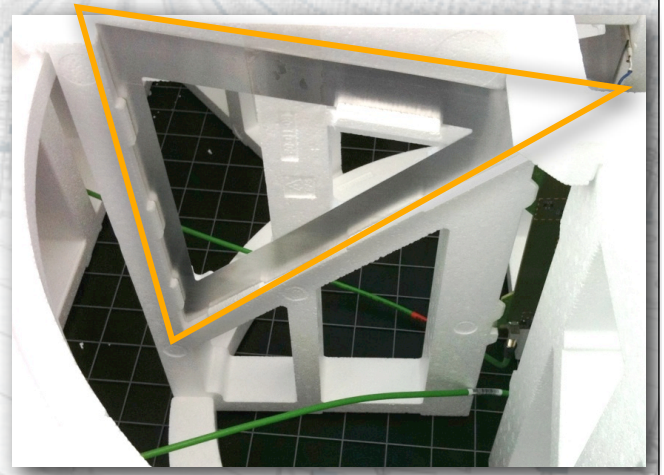
LOFAR Technology

- LOFAR receiver array for the frequency range 120-250 MHz.
- Adaptable to work also as radar receivers.
- Advantages:
  - production channels exist, optimised for mass production.
  - several new applications (e.g. in astronomy) possible
- University of Oulu has bought and deployed a "LOFAR remote station" for evaluation.

LOFAR Station



- **High Band Array** (HBA)
  - 120 MHz - 240 MHz and more
  - 96 or 48 tiles (intern./remote station)
  - Polystyrene: 5m x 5m x 0.6m, ≈300 kg
  - 16 cells per tile with crossed bowtie antennae
  - KAIRA: 48 tiles = 768 cells = 1536 aerials
- **Low Band Array** (LBA)
  - 30 MHz and below - 80 MHz
  - 96 crossed dipoles in pseudo-random array

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High Band Array (120-240MHz)

(Chilbolton, UK)

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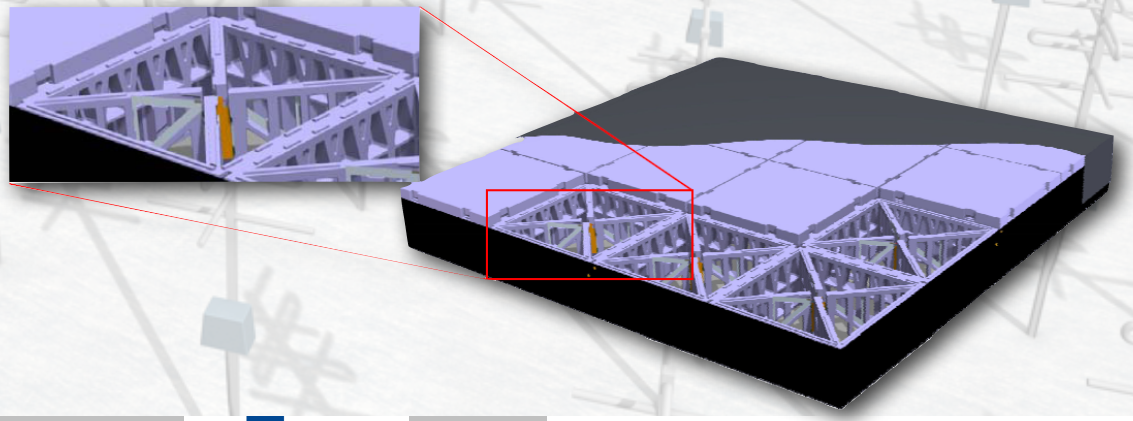

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Low Band Array (30-80MHz)

(Chilbolton, UK)

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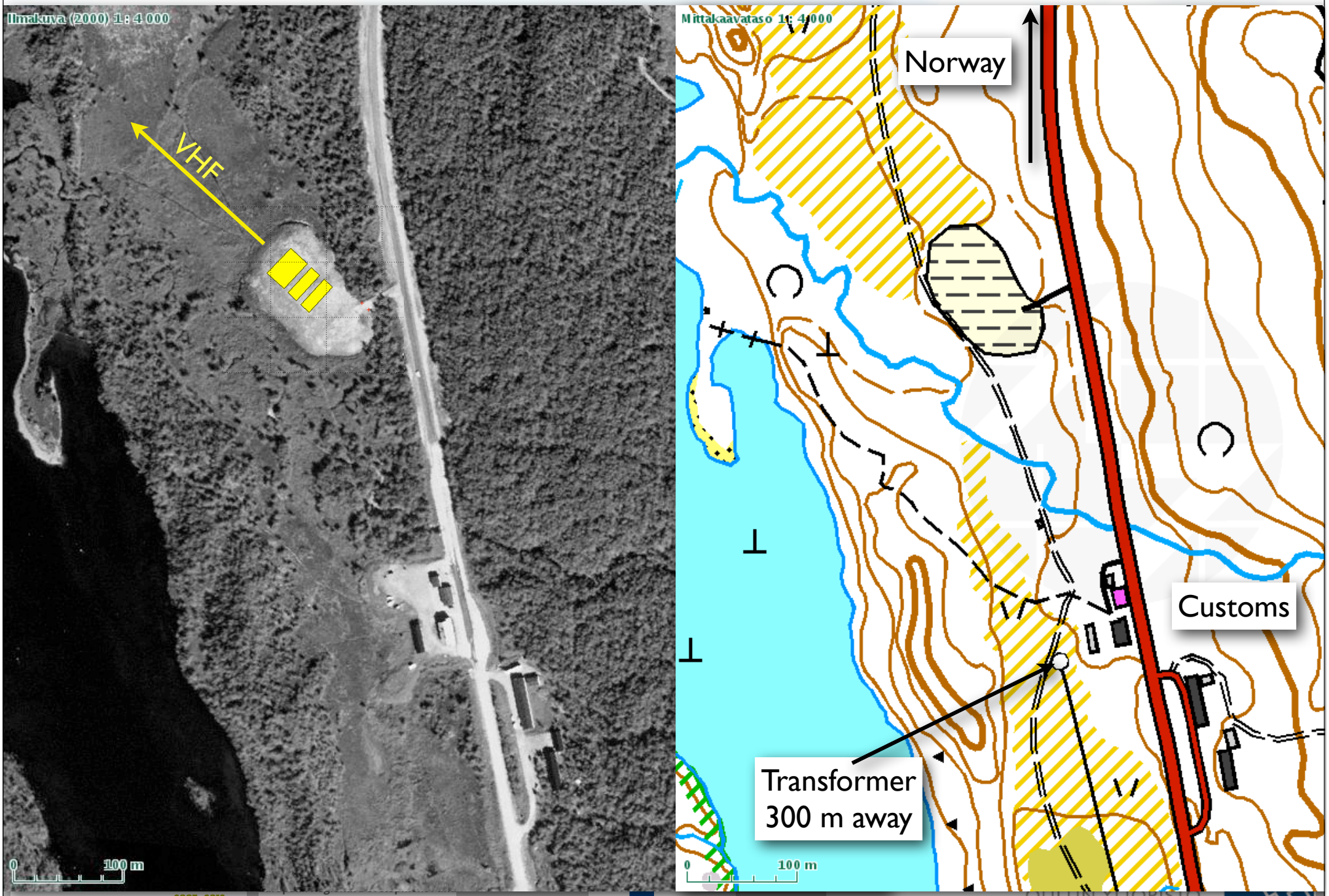
Ilmakuva (2000) 1 : 4 000
VHF
0
100 m
Mittakaavataso 1: 4000
Norway
Customs
Transformer
300 m away
0
100 m

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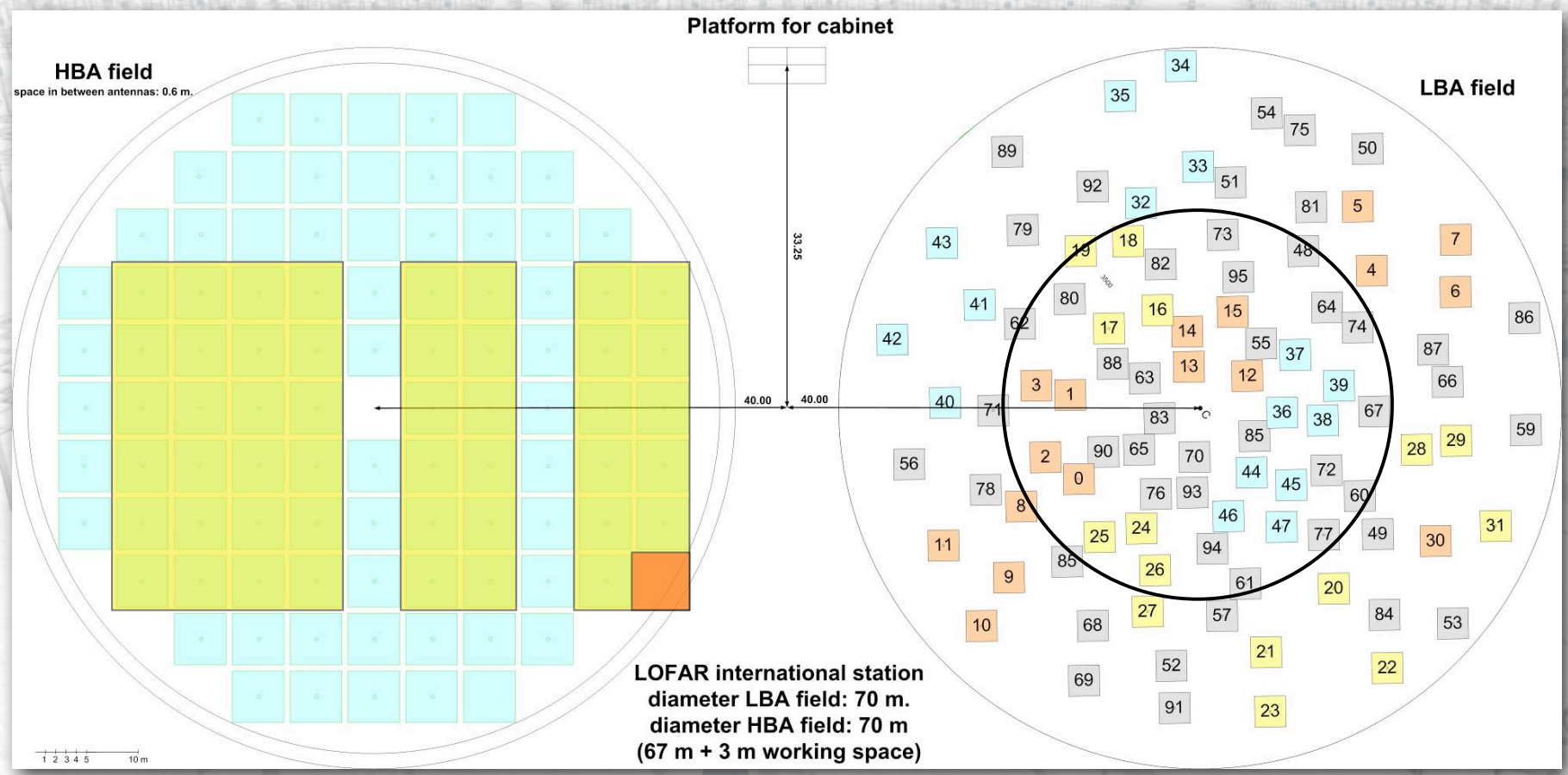
LOFAR Station



Full "international" station: 96 HBA + 96 HBA

KAIRA: 48 HBA + 96 LBA

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Winter Testing

Photos: Tero Raita, SGO.

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How much snow?

Levera

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ment Fund
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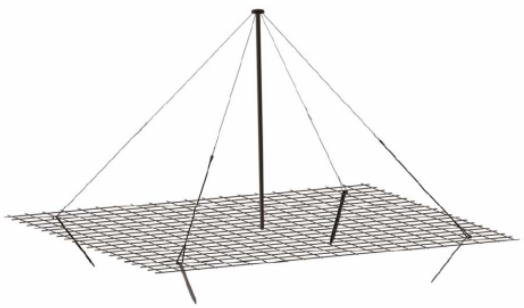
P&O
VOLVO

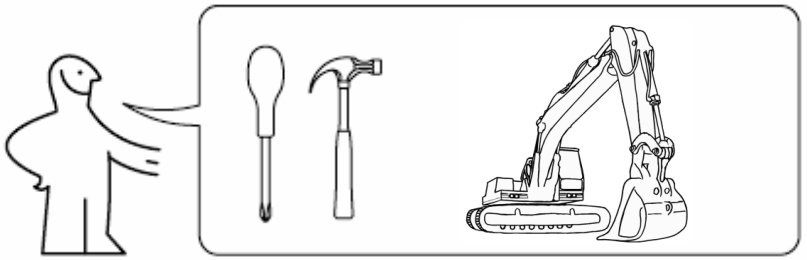

CGI-853

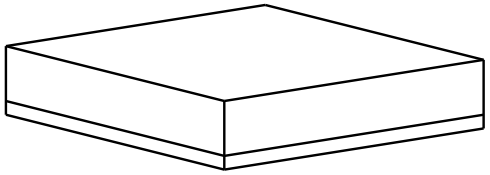

RKP
CGI-853
RASKASSARJA

LÖFÅR

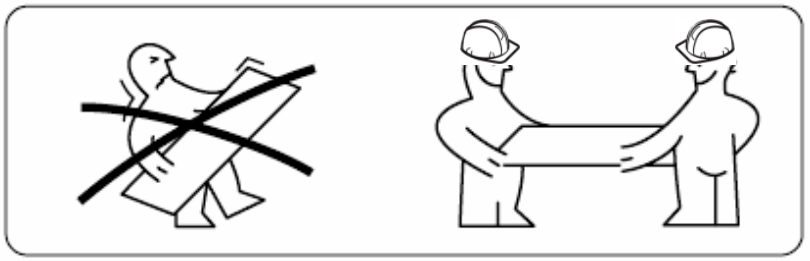


96x

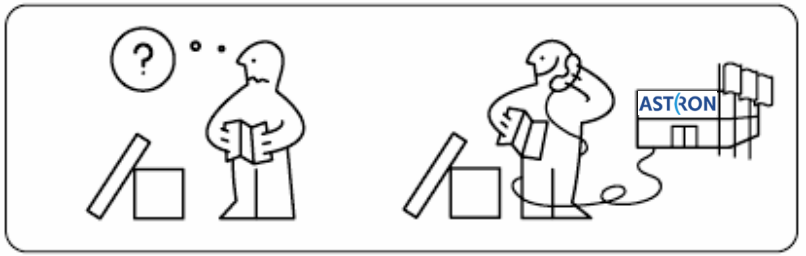




48x



1x



48 unfolds later...

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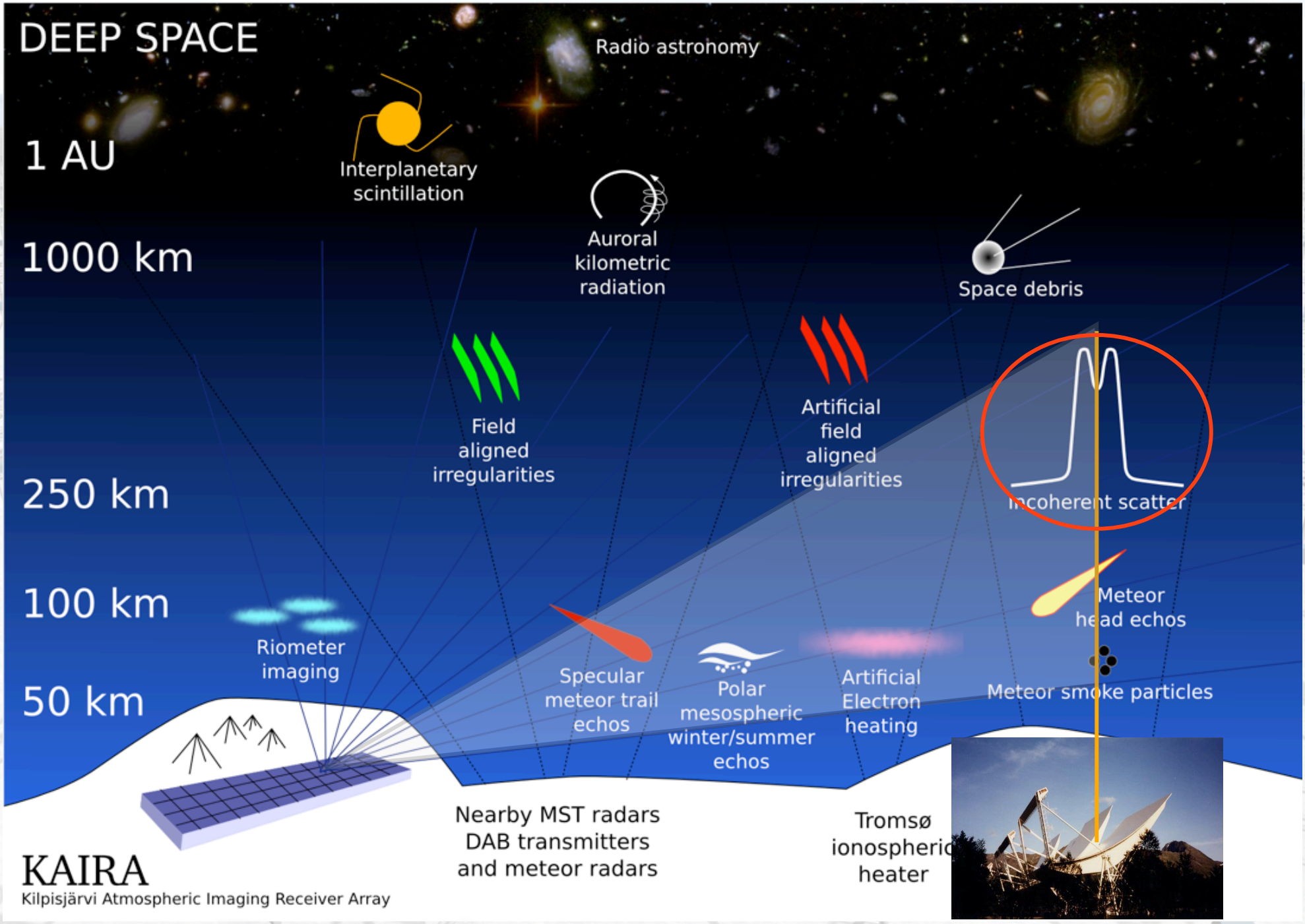

Diagram by Juha Vierinen, SGO. Download: `kaira.sgo.fi`.

Outreach

- **KAIRA**
  - Blog: kaira.sgo.fi
  - Twitter: twitter.com/KairaProject
- **EISCAT_3D**
  - Blog: blog.eiscat3d.org
  - Twitter: twitter.com/EISCAT_3D
  - Facebook: facebook.com/EISCAT3D

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Do you want to be part of the future?

EISCAT Radar School

27th August — 1st September 2012

Sodankylä, Finland

www.sgo.fi/Events/RS2011

www.eiscat3d.se

Do you want to be part of the future?

Get in touch now!

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Facebook:
facebook.com/EISCAT3D

It's <u>YOUR</u> radar!