



norden

NordForsk



Nordic e-Infrastructure
Collaboration

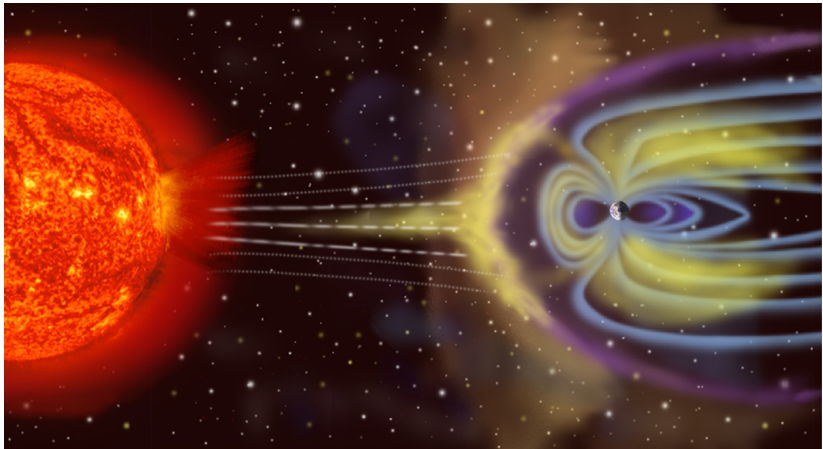
NeIC EISCAT_3D support project: Nordic computing challenge

John White *NeIC*

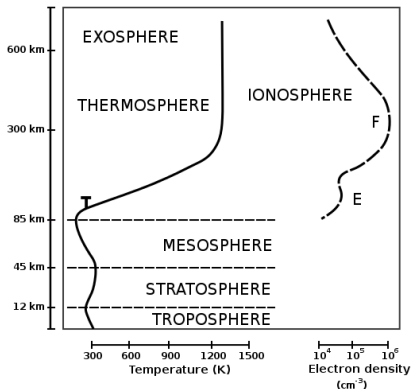
Introduction

- **Solar-terrestrial connection and EISCAT**
- **EISCAT_3D project**
- **Nordic e-Infrastructure Collaboration (NeIC)**
- **EISCAT_3D Support Project (E3DS)**
- **EISCAT_3D Network Plan**
- **EISCAT_3D Computing**
- **EISCAT_3D Data Handling**

Solar wind and magnetosphere



Earth's Atmosphere



Wikimedia Commons

Atmosphere

- “E” region absorbs x-rays.
- “F” region absorbs UV.
- Aurora 90-200 km altitude.

Incoherent scatter radar

- Ionospheric electron density
- Ion and electron temperature
- Doppler velocity of ions

EISCAT

European **I**ncoherent **SCAT**ter
Scientific Association

Current EISCAT radars



Current EISCAT radars

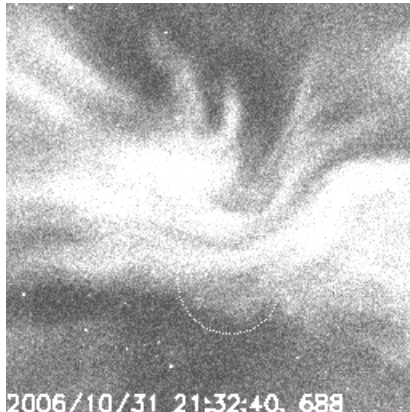


Current EISCAT radars



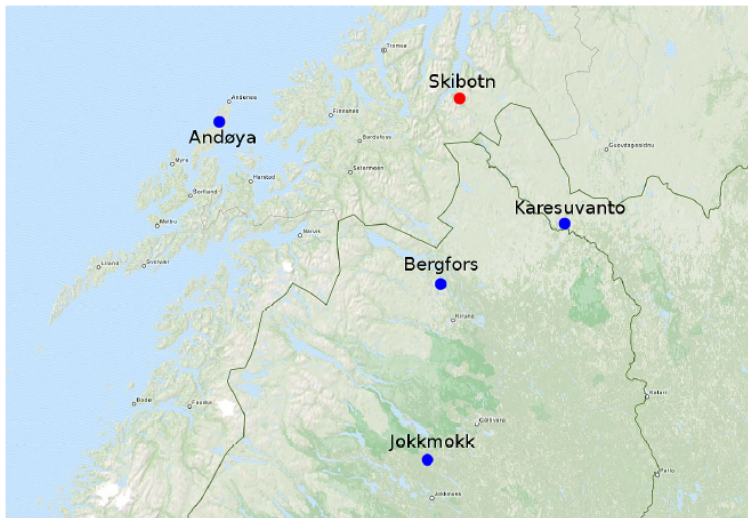
Current EISCAT radars

Fine structure of aurora in real time

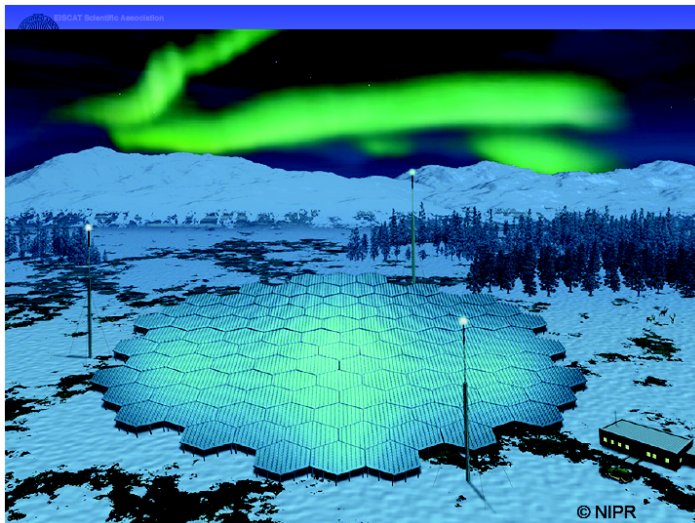


ASK 3×3 degrees 31 Oct 2006 Hanna Dahlgren, KTH

EISCAT_3D Project



EISCAT_3D Project





Nordic e-Infrastructure Collaboration (NeIC)

“The NeIC facilitates the development and operation of advanced IT tools and services in areas of importance to Nordic researchers.”

- **Pool Competencies**
 - Map skills, identify and prioritise needs.
- **Share Resources**
 - Launch pilot projects to establish ambition levels
- **Secure Long-Term Funding**
 - Map funding sources, adapt to unaligned funding periods
- **Strengthen Stakeholder Dialogue**
 - Map stakeholders and partnerships

Nordic e-Infrastructure Collaboration (NeIC)

NeIC 'Owners'



MINISTRY OF EDUCATION,
SCIENCE AND CULTURE



NeIC EISCAT_3D Support Project (E3DS)

- Project started January 15th 2015.
 - Basis: Letters of Interest to NeIC from EISCAT (2012, 2014)
 - Decision to launch project by NeIC Board (2014)
- Resources committed to project: EISCAT and NeIC
Also, CSC, Tromsø and Umeå
- Steering group (representing partners that have committed resources):
 - Yasunobu Ogawa, EISCAT-Japan, NIPR
 - Craig Heinselman, EISCAT
 - Gudmund Høst, NeIC

NeIC EISCAT_3D Support Project (E3DS)

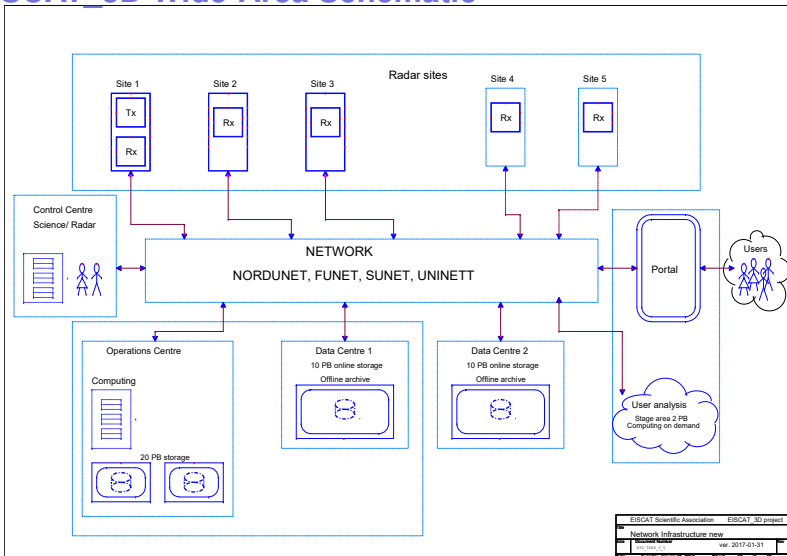
- Project participants:
 - **Project manager (0.5 FTE):** John White, NeIC.
 - Ingemar Häggström, EISCAT, Kiruna
 - Anders Tjulin, EISCAT, Kiruna
 - Assar Westman, EISCAT, Kiruna
 - Carl-Fredrik Enell, EISCAT, Kiruna
 - Sathyaveer Prasad, EISCAT, Kiruna
 - Tor Johansen, University of Tromsø
 - Harri Hellgren, EISCAT, Kiruna
 - Ari Lukkarinen, CSC
 - Sari Lasanen, University of Oulu
 - Mattias Wadenstein, University of Umeå
 - Åke Sandgren, University of Umeå
 - Juha Vierinen, University of Tromsø
 - Ilkka Virtanen, University of Oulu



E3DS Project Goals

- Find workable and cost-efficient solutions for the EISCAT_3D computing, storage and archive.
- Facilitate an effective dialogue on the implementation of EISCAT_3D with the stakeholders in the Nordic countries.
- Make best use of the existing expertise in the Nordic countries for implementing (the e-Infrastructure of) EISCAT_3D.

EISCAT_3D Wide-Area Schematic



EISCAT_3D computing

- On-site computing infrastructure (per radar site):
 - Reduce data rates to manageable levels (**19 Tb/s** → **53 Gbit/s**);
 - Two stages of beam forming.
 - Sub-arrays **109 × 5.0 TFLOPS**. (FPGA)
 - Overall beam former **22 TFLOPS**.
 - **86 TB** RAM/SSD ring buffer.
 - Process computer (standard data products) **55 TFLOPS**.
- Off-site data-processing:
 - Operations Centre will coordinate the radar operations and observation modes;
 - Monitor production of standard data products from sites;
 - Generate non-standard products, multi-static data products and meta-data;
 - Requires \approx **500 TFLOPS**.
 - Located within existing e-infrastructure?
- Control centre located functionally within Operations Centre.
 - At Skibotn during commissioning, subsequently at Kiruna.



EISCAT_3D data

- **Must** transfer at least 2 PB/y (rises to 3.5 PB/y) to archive storage.
- **Must** hold 5 years of data online for user access (≈ 10 PB).
- Scalable storage and computing capacity for standard operation, image processing, search engines and visualisation tools.
- Long term storage for basic ionospheric parameters over two consecutive solar cycles.
- Located in existing e-infrastructure?
- Interface to EISCAT_3D users through a portal.
- **Must** have redundant archives at two locations.
- Additional mirror sites outside Nordic countries.

Data Management System Requirements

- **Must** provide a global namespace over all data archives.
- **Must** scale to the size of the overall EISCAT_3D data set of ≈ 200 PB.
- **Must** dynamically move frequently accessed data to faster access storage.
- **Must** dynamically move less accessed data to slower access storage.
- **Must** accept credentials to authenticate and authorize users to access data.
- The same Data Management system **should** be used at each EISCAT_3D Data Centre and the Operations Centre.

EISCAT_3D Network Traffic Matrix

To (below)	From								Sum
	Ops Centre	Data 1	Data 2	Skibotn	Bergfors	Karesuvanto	Jokkmokk	Andoya	
Ops Centre	N/A	1	1	53	53	53	53	53	267
Data 1	2	N/A	0.5	0	0	0	0	0	3
Data 2	2	0.5	N/A	0	0	0	0	0	3
Skibotn	1	0	0	N/A	0	0	0	0	1
Bergfors	1	0	0	0	N/A	0	0	0	1
Karesuvanto	1	0	0	0	0	N/A	0	0	1
Jokkmokk	1	0	0	0	0	0	N/A	0	1
Andoya	1	0	0	0	0	0	0	N/A	1
UK (RAL)	0	1	1	0	0	0	0	0	2
Japan (NIPR)	0	1	1	0	0	0	0	0	2
Sum (Out)	9	3.5	3.5	53	53	53	53	53	

All numeric values are in Gb/s. A red (green) box indicates a (non) redundant path. Orange data transferred outside the Nordic area.



Site, Operations Centre and user computing

- Site computing:
 - 2nd beam former: ≈ 22 TFLOPS
 - Beam forming performed in software.
 - Process computer: ≈ 55 TFLOPS
 - Discussions so far: no need for specialized HW (FPGA,GPU etc).
- Operations Centre computing:
 - Estimated at: ≈ 500 TFLOPS
 - 3-D operations: tightly coupled cluster.
 - Discussions so far: no need for specialized HW (FPGA,GPU etc).
- User analysis computing:
 - Estimated at: ≈ 50 TFLOPS
 - Discussions so far: usage of GPU possibly beneficial.
 - Analysis computing profiles vary widely.

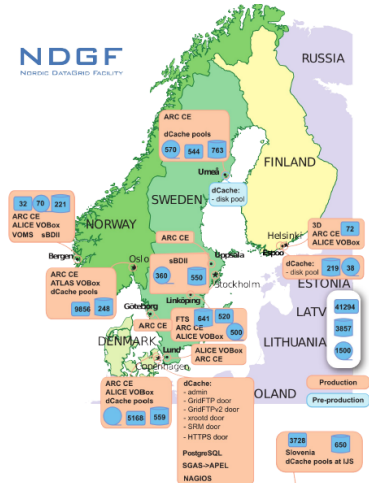


EISCAT_3D Integrated computing

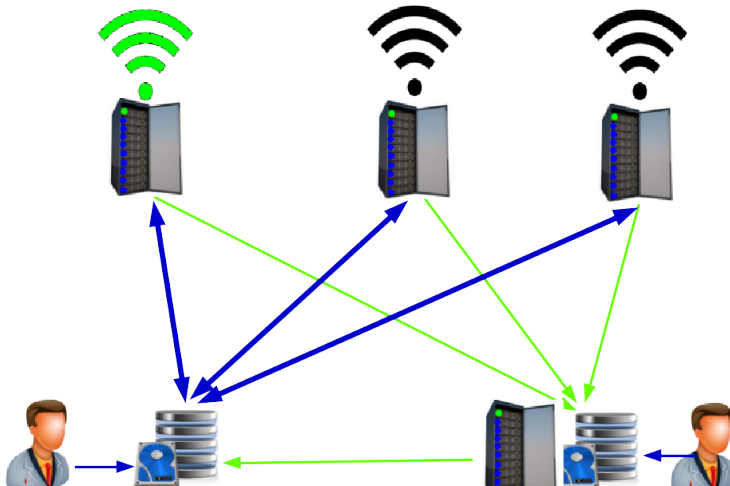
- **Site computing:**
 - Virtualized cluster: ≈ 80 TFLOPS
 - Beam forming containers/VMs.
 - Process computing containers/VMs.
 - User analysis computing containers/VMs.
- **Operations Centre computing:**
 - Virtualized cluster: ≈ 500 TFLOPS
 - 3D operations containers/VMs.
 - User analysis computing containers/VMs.
 - “Controller” node for virtualized cluster.
- **User analysis computing:**
 - User analysis containers/VMs distributed through Operations Centre and sites.
 - User analysis jobs interruptible by radar state.
 - Analysis computing profiles matched by container/VM.
- **Virtualized e-infrastructure run by national provider(s).**

Nordic Tier-1 (NT1)

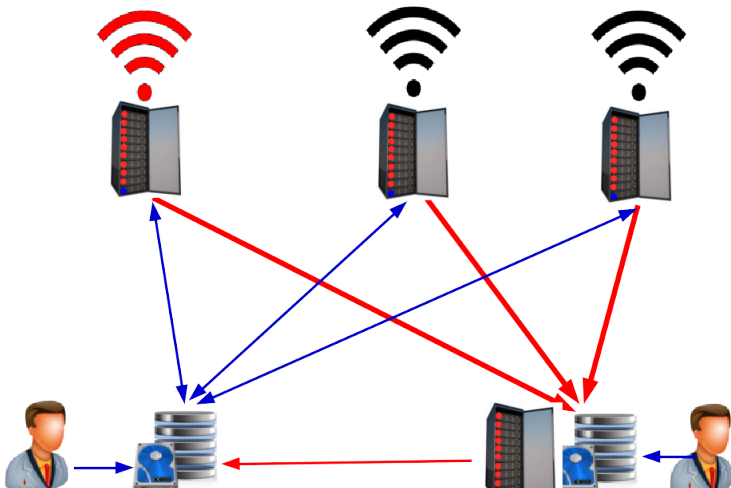
- CERN/LHC Tier 1 computing in the Nordic countries. Distributed site.
 - Bergen, Oslo
 - Umeå, Linköping
 - Copenhagen, Helsinki
- Project hosted within **NeIC**.
 - \approx 12 people. 50% average.
 - Since 2010, part of **EGI**.
 - Serves ALICE, ATLAS.
 - **Compute** and **Storage** resources.
 - Networking by NorduNet.



e-infrastructure 3-D Operations: Low power



e-infrastructure 3-D Operations: High power



Concluding Remarks

- **EISCAT_3D project on schedule.**
 - Test sub-array this summer 2017
- **E3DS project has aided in requirements for:**
 - **Operations Centre**
 - **Data Centre**
 - **Site and Operations Centre computing:**
 - Take advantage of virtualization to operate as single cluster.
 - Cluster operations by national provider(s).
 - EISCAT_3D relieved from cluster operations.
 - Spare cycles used for EISCAT_3D user analysis or other.
- **Use existing expertise to aid EISCAT_3D to perform science.**

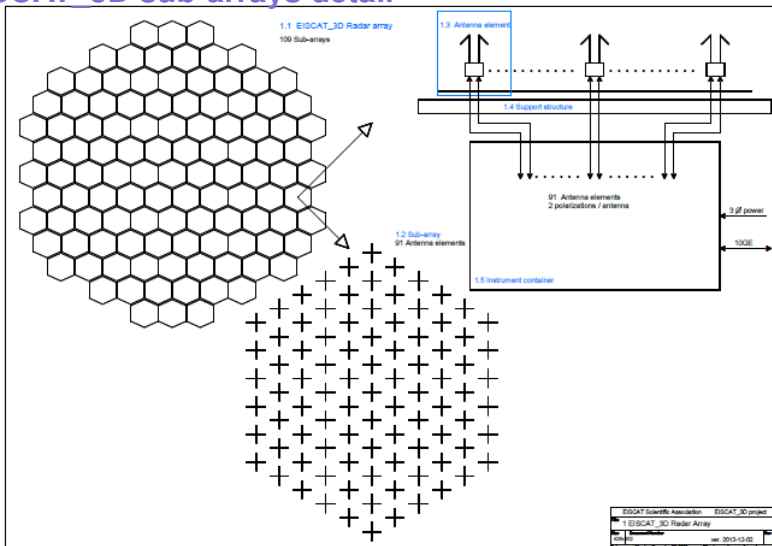
Thank you



Questions?

Written in \LaTeX

EISCAT_3D sub-arrays detail





E3DS Project Documents

- Project documents released:

https://wiki.neic.no/wiki/EISCAT_3D_Support#Documents

- MA-1: Requirements and their implications for EISCAT_3D data handling and processing at the operations centre
- MA-2: Requirements and their implications for EISCAT_3D data handling and processing at the data centre
- MA-3: EISCAT_3D Wide-Area Network Plan
- MA-4: Recommended solutions for the operation and data centres.
- MB-1: On-site computing requirements for EISCAT_3D test sub-array
- MB-2: Consultation on selecting architecture/technology for the on-site computing related to a test-subarray
- MB-4: Consultation on the procurement plan for EISCAT_3D core site test-subarray in particular to ensure its compliance with the overall high level computing architecture of the EISCAT_3D system.
- MC-1: Test sub-array sub-systems and interfaces
- MD-3: "Report on solutions for the data archive, including a description on how users can get access to adequate computing facilities".