Japan-Norway/UiT cooperation & EISCAT_3D

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UiT – The Arctic University of Norway

with contributions by
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Dr Satonori Nozawa, ISEE, Nagoya University
Dr Yasunobu Ogawa, NIPR, Tokyo
Dr Tac Nakajima, ISEE, Nagoya University

2016 June 3 Tokyo
Several optical instruments (NIPR/ISEE/UiT)
Meteor radar (NIPR/UiT)
MF radar (STEL/UiT/….)

Ny-Ålesund
Collaborative Rocket observations (ICI-4 UiO, etc.)

Bjoernoeya
Meteor radar (ISEE/UiT)

Andøya
Collaborative Rocket observations (DELTA-1, -2, etc.)

Longyearbyen

Kiruna
EISCAT UHF radars

Sodankylä

EISCAT UHF radars

UHF radars
EISCAT Tromsø site

Goals:
• Physics of the polar atmosphere and ionosphere
• Physics of the Aurora
• Applications to space weather

Close collaboration between UiT and Japanese institutes
ISEE/Nagoya Lidar Observatory in Tromsø

5 Lidar beams

Lidars control receivers

5 telescopes/receivers
Development of Superconducting Millimeter Wave Radiometer for Observation of Minor Molecules in the Middle Atmosphere

Tac Nakajima
Nagoya University Japan
(Visiting Scientist – University of Tromsø)
Nov 2015 – Aug 2016
Development of Superconducting Millimeter Wave Radiometer for Observation of Minor Molecules in the Middle Atmosphere

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Nov 2015 – Aug 2016
Our Observatories

Coming soon to
Tromsø/Norway

Syowa station/Antarctica
Rikubetsu/Hokkaido
Rio Gallegos/Argentina
Atacama/Chile
Measurement of O₃ & NO

Nitric Oxide NO destroys Ozone O₃

* O₃ and NO in Antarctica (Syowa Station)

Isono et al. GRL, 41, 7, 2568 (2014)
Visits to the EISCAT Tromsø/Svalbard & UNIS from Japan

Purpose of the visits: Conducting EISCAT special observations, installing and maintenance of optical/radar instruments at the sites, discussion about collaborative, ... 

Year 2013: 20 scientists in total (including 4 students)
Year 2014: 21 scientists in total (including 4 students)
Year 2015: 25 scientists in total (including 3 students)

Visits to Japanese institutes from Norway

Purpose of the visits: Collaborative studies, education, ...

Sep. 2006-June 2007: 1 exchange PhD student to STEL Nagoya Univ. from UiT.
March-May 2007: Prof. Moen (UiO) as a visiting professors of STEL Nagoya Univ. and 1 exchange PhD student to STEL Nagoya Univ. from UiO.
June, 2007: Prof. Moen et al. (6 scientists (UiO/UNIS) in total), study and observation of optical lab in NIPR and scientific discussion in a meeting
March-May 2010: Prof. Brekke (UiT) as a visiting professors of STEL Nagoya Univ.
March 2015- Feb 2015: 1 exchange PhD student to NIPR from UiT.
Starburst Galaxy M82: 12 million lightyears away

VLBI – Very Long Baseline Interferometry
European VLBI Network – EVN
EISCAT_3D will use same technology:

Aperture Synthesis Imaging Radar – ASIR

Radar transmitter as a camera flash

need: Phased Array Technology
Phased Array Technology
10,000 Antennas per site
3x10,000 antennas in 3 Nordic countries
+ 5,000 dual transmitters in Norway
Antenna Metal Support
Equipment Cabinets

crossed-dipole antenna
The Holographic Radar
Lind et al.

EISCAT_3D key capabilities:

- Local Volumetric Imaging
- Remote Volumetric Imaging
- Aperture Synthesis Imaging
- Sensitivity
- Transmitter agility

3-D space Coverage scalars
3-D Vectors & Tensors anisotropy
3-D space resolution fine structure
Low SNR & time resolution
Arbitrary modulation/polarisation
1. EISCAT_3D Radar Array
- 109 Sub-arrays
- 91 Antenna elements/Sub-array
- Dual polarization, crossed dipoles
- 182 dipoles/Sub-array

2. Front end
- Power Supply
- Exciter
- SSPA
- T/R
- LNA
- Ant
- RF in Fc 233.3 MHz
- Anti-aliasing
- RF 233.3 +/- 15 MHz

3. Sub-array Beam former (BW 30 MHz)
- ADC 16 bits
- 60 Ms/s
- x 182
- Subarray Beam Former 5.4 Tflops/s

4. Transmit unit
- High power transmitters
- Digital electronics
- Timing control systems
- RF Electronics
- Network hardware
- Computers
- Storage
- Services
- Metal structures
- 10,000 – 30,000 units

5. Pulse & Steering Control
- Start
- Ctrl
- Ctrl

6. Operations center
- 20 PB storage
- 500 Tflop/s

7. Time and Frequency
- WR Slave
- Clock & trig gen
- Clock
- WR
- x 109
- WR
- White Rabbit Master
- Frequency Std

8. Computing System (BW 5 MHz)
- Process Computer 55 Tflops/s
- Ring Buffer 86 TB RAM
- Overall Beam Former 22 Tflops/s
- 6.3 Gbit/s (BW 5 MHz)
- 38 Gbit/s (BW 30 MHz)

9. Network
- VPN
- 8.5 Gbit/s (BW 5 MHz)
- 18 Gbit/s (BW 30 MHz)

10. National e-Infrastructures
- Archive
- 2 PB disk
- 2 x 10 PB tape
- 50 Tflops/s

Procurement by international tender
PANSY Radar in Syowa Antarctica

Made in Japan:
- Distributed Transmitters for phased arrays
- Operation in extreme polar conditions
### Funding status 1

Oct. 2015

**Table 3. Investment by Item (kSEK)**

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<tr>
<th>Stage #</th>
<th>Item</th>
<th>kSEK</th>
<th>Totals</th>
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<td><strong>Stage 1</strong></td>
<td>Project management</td>
<td>42 250</td>
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<td>Project engineering</td>
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<td></td>
<td>Ramfjordmoen test array (PET)</td>
<td>16 420</td>
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<td>Skibotn TX1 5 MW</td>
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<td></td>
<td>Bergfors R1</td>
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<td>Karesuvanto R2</td>
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<td>Science data products</td>
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<td><strong>Stage 2</strong></td>
<td>Upgrade transmitter to 10 MW</td>
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<td><strong>Stage 3</strong></td>
<td>Andøya R3</td>
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<td><strong>Stage 4</strong></td>
<td>Receiver R4</td>
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<td><strong>Total in kSEK: Stages 1, 2, 3, 4</strong></td>
<td>1 170 649</td>
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(*) kSEK 34 885 spread over the other posts.

Implementation in 4 Stages

74 M€ 9.1 BY

1 170 649
## Funding status 2

**Oct. 2015**

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<th>Finland</th>
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<td>192 MSEK</td>
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</table>
Acknowledgement

Many people have contributed to the success of the Japan-Norway/UiT collaboration over more than 25 years. I consider justified to single out three great pioneers:

- Prof. Em. Ryoichi Fujii, Nagoya University
- Prof. Em. Takahiko Aso, NIPR
- Prof. Em. Asgeir Brekke, University of Tromsø
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arigatou gozaimasu!