



## The Kjell Henriksen Observatory (KHO): Status and highlights - 2018



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### Abstract

The following is a summary for the activity at the [Kjell Henriksen Observatory \(KHO\)](#) in 2018. The current active personnel of the observatory are presented together with the operational instruments. A status report on the Super Dual Auroral Radar Network (SuperDARN) radar incident is given. Highlights and achievements are listed. Near future activity is suspected to be very high due continuous support to the [Grand Challenge Initiative \(GCI\)](#) rocket campaigns.

### (1) The observatory crew

The current crew of KHO is listed below. F. Sigernes headed and had the daily operational responsibility together with Mikko Syrjäsuo.

Name	UNIS position	E-mail
Fred Sigernes	Professor, Optics and atmospheric Research, Head of KHO, Leader Ground-based Instrumentation Group BCSS. Adjunct Prof. NTNU AMOS.	<a href="mailto:freds@unis.no">freds@unis.no</a>
Mikko Syrjäsuo	Head engineer	<a href="mailto:mikkos@unis.no">mikkos@unis.no</a>
Noora Partamies	Associate Prof. Middle atmospheric physics	<a href="mailto:noorap@unis.no">noorap@unis.no</a>
Dag Arne Lorentzen	Professor, Upper polar atmosphere, Head of the Geophysical Department, Head of the SuperDARN radar project, UNIS node leader of the BCSS	<a href="mailto:dagl@unis.no">dagl@unis.no</a>
Lisa Baddeley	Associate Professor, Radar applications, Head of the Doppler Pulsation Experiment CO-Investigator, SuperDARN radar project	<a href="mailto:lisab@unis.no">lisab@unis.no</a>
Emma Bland	Post Doc, Middle atmospheric physics	<a href="mailto:emmab@unis.no">emmab@unis.no</a>
Erkka Heino	PhD candidate, Middle atmospheric physics	<a href="mailto:Erkka.heino@unis.no">Erkka.heino@unis.no</a>
Katie Herlingshaw	PhD candidate, Upper atmospheric physics	<a href="mailto:katie.herlingshaw@unis.no">katie.herlingshaw@unis.no</a>
Lindis Bjoland	Post Doc, Upper atmospheric physics	<a href="mailto:lindis.bjoland@unis.no">lindis.bjoland@unis.no</a>
Fasil Tesema Kebede	PhD candidate, Middle atmospheric physics	<a href="mailto:fasil.tesema@unis.no">fasil.tesema@unis.no</a>

**Table 1.** The Kjell Henriksen Observatory crew (2018).

Ida Asklund is our contact from the Norwegian Construction and Property Management Department in Longyearbyen who owns the building. Lindis and Fasil are welcomed as new members of the crew.

## (2) Teaching and courses

KHO serves as the main laboratory for hands on training and teaching of students in the Space physics group at UNIS.

Fig. 1 shows students on excursion to KHO. Here they are trained on observational techniques, instrument building and were introduced to the state-of-the-art facilities for remote observations of the aurora.

The following 6 courses have used KHO as a part of field work:

Code	Course name	ECTS
AGF-216	The Stormy Sun and the Northern Lights	5
AGF-301/801	The Upper Polar Atmosphere	15
AGF-304/804	Radar Diagnostics of Space Plasma	15
AGF-345/845	Polar Magnetospheric Substorms	10
AGF-210	The middle polar atmosphere	15
AGF-223	Remote sensing and space instrumentation	15

**Table 2.** UNIS courses using KHO as laboratory (2018)

A grand total of **75 ECTS** (European Credit Transfer and Accumulation System) have been taught.

## (3) Operational instrumentation

During the auroral winter season from November to the end of February, 26 optical instruments operate 24 hours a day. The 17 non-optical instruments run all-year-round 24 hours a day.

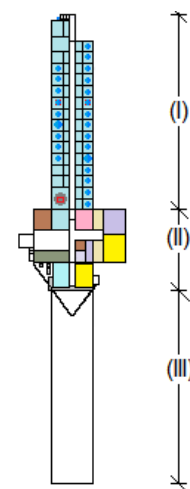
The instruments at KHO are grouped into mainly five categories (#):

- A. All-sky cameras and narrow field of view imagers,
- B. Meridian scanning photometers,
- C. Spectrometers / spectrographs
- D. Scanning / imaging interferometers
- E. Radio or non-optical instruments

A detailed description of the performance and the scientific objective of each instrument are found [online](#). 24 different institutions from 14 nations are present at KHO. Figures 3 and 4 show a map of where the instruments



**Fig.1.** AGF-233 students at Breinosa in October, building and testing Cansats. Here they test the satellite telemetry.



**Fig. 2.** Sketch of KHO: (I) Instrumental section, (II) Service section, and (III) Extended platform.

are located. Table 3 lists all according to institution and category (#). Note that out of 30 instrument domes; 6 are currently not in use.

	Instrument	Institution	#	Country
1	All-sky imager	University of Oslo (UiO)	A	Norway (NO)
2	All-sky intensified video camera	University Centre in Svalbard (UNIS)	A	NO
3	All-sky color camera	University College London (UCL)	A	England
4	All-sky video camera	UNIS	A	NO
5	All-sky DSLR camera	UNIS	A	NO
6	All-sky Airglow Imager	UNIS	A	NO
7	Auroral meridian spectrograph	National Institute of Polar Research (NIPR)	C	Japan
8	Spectrographic Imaging Facility	The University of Southampton/UCL	C	England
9	Meridian-Scanning Photometer	University of Alaska Fairbanks/UNIS	B	USA/NO
10	1m S.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
11	1m G.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
12	1/2m B.Ebert-Fastie spectrometer	University of Alaska Fairbanks/UNIS	C	USA/NO
13	1/2m W.Ebert-Fastie spectrometer	University of Tromsø (UiT)	C	NO
14	Fabry-Perot interferometer	UCL	D	England
15	Scanning Doppler Imager	UCL	D	England
16	Monochromatic Auroral Imager	Polar Research Institute of China (PRIC)	A	China
17	All-sky Airglow Imager	Kyoto University	A	Japan
18	Fluxgate magnetometer	UiT	E	NO
19	2-axis search coil magnetometer	Augsburg College/Univ. of New Hampshire	E	USA
20	Fluxgate magnetometer	PRIC	E	China
21	Auroral Radio Spectrograph	Tohoku University	E	Japan
22	HF acquisition system	Institute of Radio Astronomy/UiT	E	Ukraine/NO
23	64xBeam Imaging Riometer	Danish Meteorological Institute (DMI)/UiT	E	Denmark/NO
24	Balloon Telemetry Station	University of Rome	E	Italy
25	Hyperspectral tracker (Fs-Ikea)	UNIS	C	NO
26	All-sky hyperspectral camera	UNIS	C	NO
27	Narrow field of view tracker	UNIS	A	NO
28	Scintillation and TEC receiver	University of Bergen (UiB)	E	NO
29	Beacon Satellite receiver unit	Finnish Meteorological Institute (FMI)	E	Finland (FI)
30	Automatic weather station	UNIS	E	NO
31	4xWEB cameras (safety)	UNIS	A	NO
32	Celestron 4m Telescope	UNIS	A	NO
33	Internet radio link - Janssonhaugen	NORSAR	E	NO
34	UHF Ground station	National Institute for Aeronautics (LAPAN)	E	Indonesia
35	UHF Ground station	Technische Universität Berlin (TU)	E	Germany
36	All-sky Auroral Imager	Korea Polar Institute (KOPRI)	A	Korea
37	Boreal Auroral Camera Constellation	UNIS (KHO) and UiO (Ny-Ålesund)	A	NO
38	Meridian Imaging Spectrograph	UNIS	B	NO
39	HF Doppler Receiver	UNIS	E	NO
40	3 x GNSS Scintillation Receivers	Nagoya University	E	Japan
41	3 axis induction magnetometer	PRIC	E	China
42	VHF base station	Kongsberg Satellite Service AS (KSAT)	E	NO
43	TESS-W photometer	University of Madrid (UCM)/UNIS	B	Spain/NO

**Table 3.** Instruments at the Kjell Henriksen Observatory (2018).

Three new groups #41-43 installed instruments at KHO in 2018.

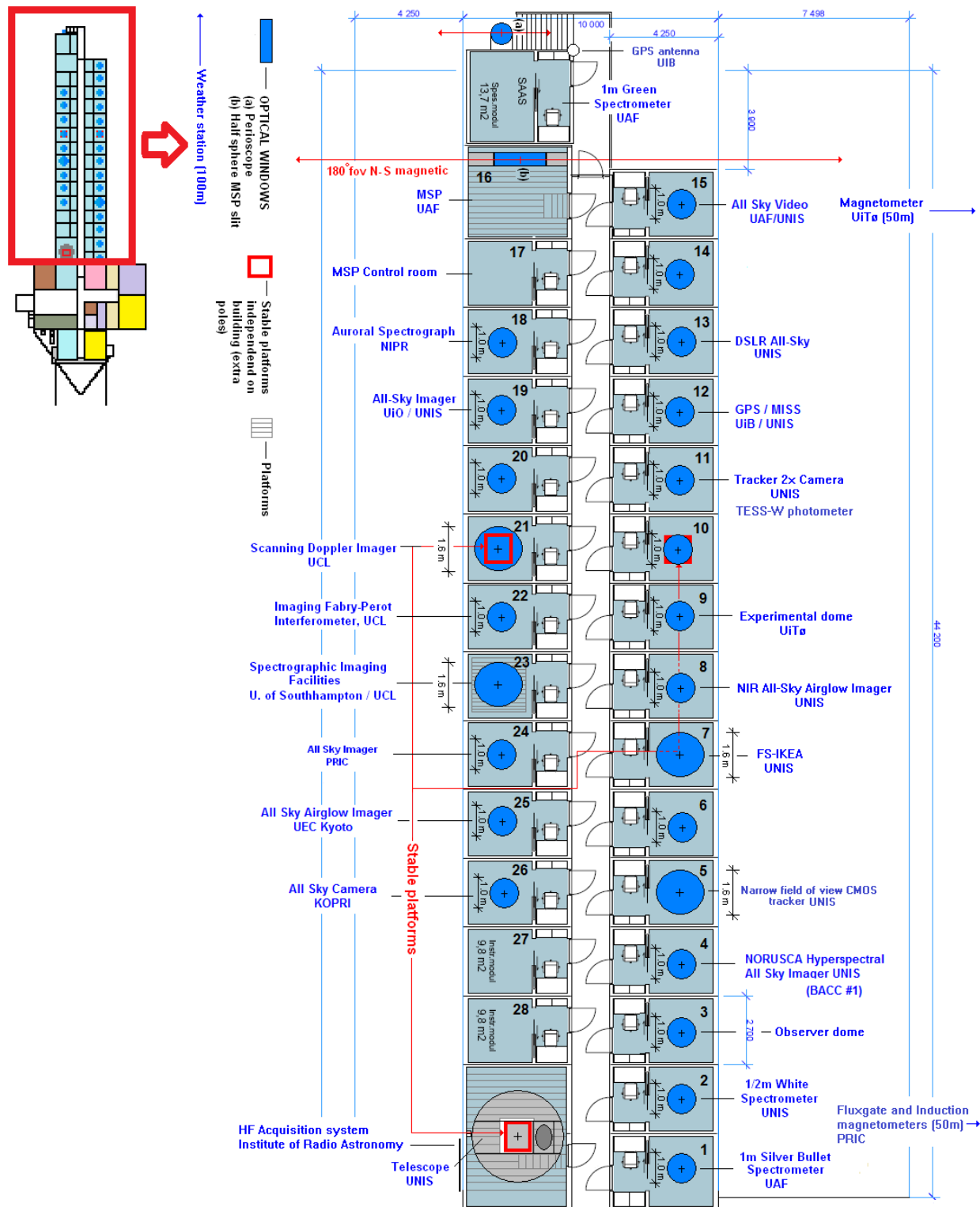


Fig.3. Map of the Instrumental section (I) at the Kjell Henriksen Observatory (2018).

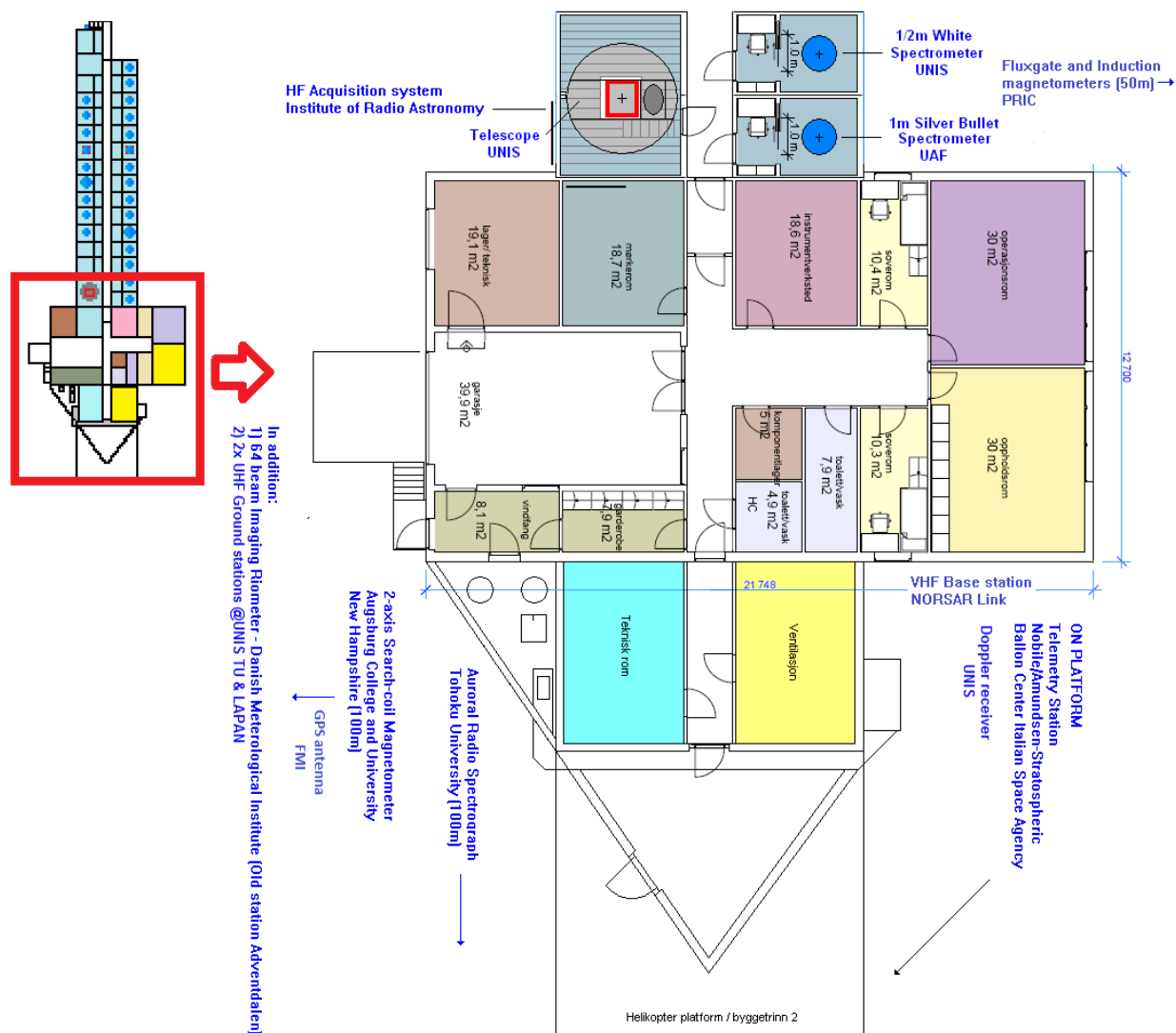


Fig.4. Map of the Service section (II) at the Kjell Henriksen Observatory (2018).

## (4) Major Highlights



**Dr. Norah Kaggwa Kwagala!**

17.08.2018

KHO congratulates Norah Kaggwa Kwagala at the BCSS on successfully defending her PhD titled: ' "Thermally excited 630.0 nm emissions in the polar ionosphere". She has actively used optical data from both us and the Eiscat radar. Prof. Dag Lorentzen at UNIS was her co-adviser.

More info [here](#).



### 10 years anniversary

30.10.2018

KHO celebrates 10 years of operation and studies of the optical aurora and airglow. Thanks to our colleagues/groups that have installed instruments at the observatory. Also thanks to Statsbygg, Longyearbyen and all of our friends that support us.

Svalbardposten [1]

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## (5) Public outreach

A large number of presentations, visits and interviews have been conducted at KHO. Visits from the local school in Longyearbyen and training on tourist guides have been popular activities.

The impacts of the TV shows from NRK about the Nordic winter and NHK (Nippon Hoso Kyokai) - Japan Broadcasting Corporation 360 recordings of dayside aurora are expected to be positive.



Fig.5. AGF-301 student calibration session interrupted by substorm. Photo: Emma Bland (2018).

The Aurora Forecast 3D app is rated as high as 4.22 and has reached over 6109 active installs on Google Play for Android and 599 active users on iOS apple phones. The Facebook page for KHO has 1291 followers. The apps popularity has resulted in good contact with the travel industry in northern Norway. As stated by the Managing Director Trond Øverås in the Northern Norway Tourist Board ([NNTB](#)):

*«Reiselivet i nord har vært i en rivende utvikling de senere år, ikke minst med den utvikling som har skjedd innenfor vinter- og nordlysturisme. Mange snakker om vinteren som den nye høysesongen her i nord, og ikke sommersesongen slik det var tidligere. Det er trafikken fra utlandet som driver veksten, og fra vintersesongen 2005-06 frem til sesongen 2017-18 har Nord-Norge hatt en vekst i utenlandske overnattinger på 537 %. Basert på behovet, og ønske, om en kompetansedrevet utvikling er det viktig for vår næring å ha gode koblinger til høyere utdannings- og forskningsmiljøer i nord. Appen «Aurora Forecast 3D» er et godt eksempel på dette, som et nyttig hjelpemiddel og verktøy for vår næring knyttet til planlegging og gjennomføring av nordlysturer. Det er også svært positivt at de som har utviklet har vært villig til å dele kunnskap gjennom innlegg på konferanser som eksempelvis SNOW 2018 (årlig vinterkonferanse for reiselivsnæringen i Nord-Norge).»*



Managing Director Jan Roger Eriksen at [Sorrisniva AS](#) in Alta states:

*«Sorrisniva AS, har drevet med nordlysturisme siden midten av 1990'tallet. De siste årene har det blitt utviklet flere App'er for å kunne se om det blir nordlys. Sorrisniva er aktiv bruker av KHO sin Aurora 3D app. Den er enkel å bruke og enkel å forstå, både for gjester og ansatte. App'en er i stadig utvikling og kommer med nye løsninger og mer utfyllende informasjon som gjør at våre nordlysguider også vil bruke denne appen.»*

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## (6) Other events



### TRICE-2 rocket campaign!

08.12.2018

Again KHO supported two more sounding rockets launched from Andøya over Svalbard in perfect science conditions into a pulsed reconnection event. The Twin Rockets to Investigate Cusp Electrodynamics-2 (TRICE-2) launched 2 minutes apart on 8<sup>th</sup> of December 2018 at 08:28 UT. ASC Launch [video](#) More info [here](#).



### VISIONS-2 rocket campaign!

07.12.2018

The 7<sup>th</sup> of December 2018, KHO supported the VISualizing Ion Outflow via Neutral atom Sensing-2 (VISION-2) rocket campaign. Its aim is to detect neutral outflow in the upper magnetosphere associated with the dayside aurora. The event was recorded by one of our [BACC](#) cameras. See [[Blog](#), [BACC: Movie](#), [ASC: Info](#)]



### Light pollution network

29.10.2018

KHO has joined the [STARS4ALL](#) project which is a collective awareness platform promoting dark skies in Europe, funded by EU. A [TESS-W](#) photometer is installed to monitor sky brightness in units of star magnitude all year round. Photometer info [here](#).



### SuperDarn radar down!

23.10.2018

The 23<sup>rd</sup> of October 2018 at 10 LT our SuperDarn radar took a hard hit by bad weather conditions and is unfortunately out of operation. Wind gusts up to 20 m/s in combination with icing conditions bended the masts 135 degrees down to the ground. 45 mm diameter ice tubes were super clued around the 6 mm wires, increasing the mass by 1.2 kg per meter wire used in the construction. *A comprehensive study will follow!*



### Mass production!

10.10.2018

Together with [NTNU AMOS](#) and [Moon Labs](#) we are proud to announce that our first serial produced Hyper Spectral Imager (HSI) no. v4J arrived in the mail today. It is based on our work that has been among the top 10 most read papers for six months in Optics Express (2018). Read paper [here](#).



### OSA press release

05.03.2018

Our work on small and lightweight hyperspectral imagers has been awarded a press release by the Optical Society of America (OSA). Drone-based land and ocean spectral mapping is now possible at very low cost.

Read press release and paper [here](#).

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## (7) State of the building - Status quo unchanged!

As reported in 2017:

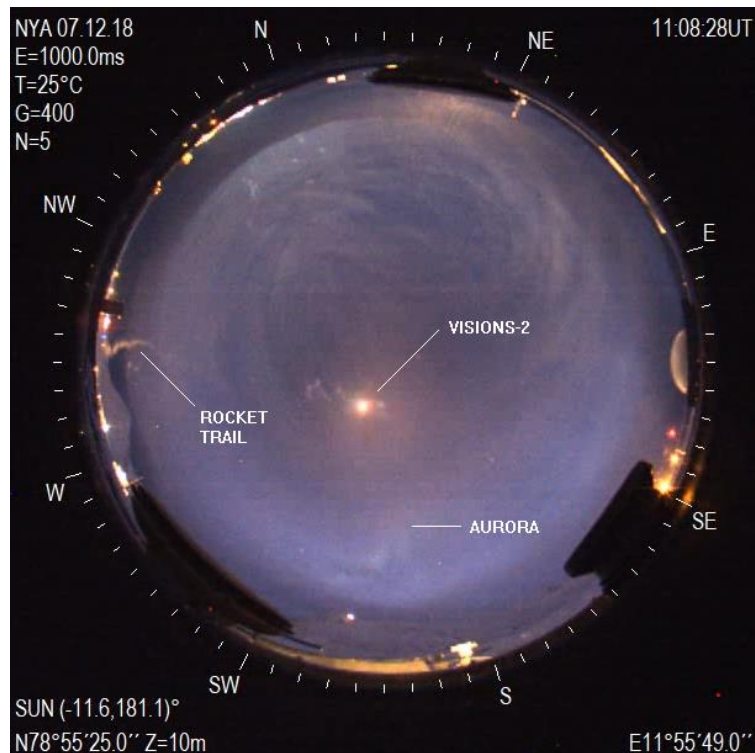
*«The most important and urgent thing that needs attention is the water leaks from the domes. The domes need to be re-mounted with proper weather proof in-between rings between dome and roof (hatch plate). According the Svalbard Bygg AS who fixed the roof that blew off the service section in 2016, the dome mounting screws are in addition losing their grip due to waterlogged hatch plates. The leaks have caused one personnel accident due to water damage of a power supply leading to electrical shortcut and shock.»*

Silicon based glue is used as a temporary solution from the outside, between the domes and the hatch plate, to prevent water leaks. New space in the tool shop has been cleared to handle electrical repairs safely.

## (8) 1-2-3- 4 -5 rockets!

KHO has actively supported 5 rocket launches this auroral season connected to the [Grand Challenge Initiative \(GCI\)](#). The optimal launch time to study the dayside cusp aurora has been provided to the Primary Investigators (PIs) of the rockets in cooperation with Prof. Kjellmar Oksavik (BCSS) whom operated the EISCAT radars and the PI of GCI Prof. Jøran Moen (UiO).

The first two rockets were launched from Ny-Ålesund on 7<sup>th</sup> of December 2018. The campaign named VISualizing Ion Outflow via Neutral atom Sensing-2 (VISION-2) was headed by Dr. Doug Rowland from NASA. The launch conditions were mainly based on the radars and clear weather on Ny-Ålesund.



**Fig.6.** VISIONS-2 rocket launched Ny-Ålesund 7<sup>th</sup> of December 2018. Snapshot from Ny-Ålesund BACC camera.



The event was recorded by one of our [BACC](#) cameras at the launch site. Watch movie [here](#). Already, the next day two more rockets were launched from Andøya Space Centre (ASC). The Twin Rockets to Investigate Cusp Electrodynamics-2 (TRICE-2) launched only 2 minutes apart. PI of the campaign was Prof. Craig Kletzing from the University of Iowa. The weather conditions at KHO were again not optimum for our optical instruments. But on 4<sup>th</sup> of January 2019 the weather was finally clear, and the CAPER-2 (Cusp Alfvén and Plasma Electrodynamics Rocket-2) launched from ASC by PI James LaBelle from Dartmouth College, flew into perfect cusp conditions over Svalbard.

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**Fig. 7.** CAPER-2 target cusp aurora. Composite image by the NORUSCA II hyperspectral camera. See movie [here](#).



**Fig. 8.** CAPER-2 rocket heading towards Svalbard. Photo by Lufttransport pilot Eivind Trondsen.

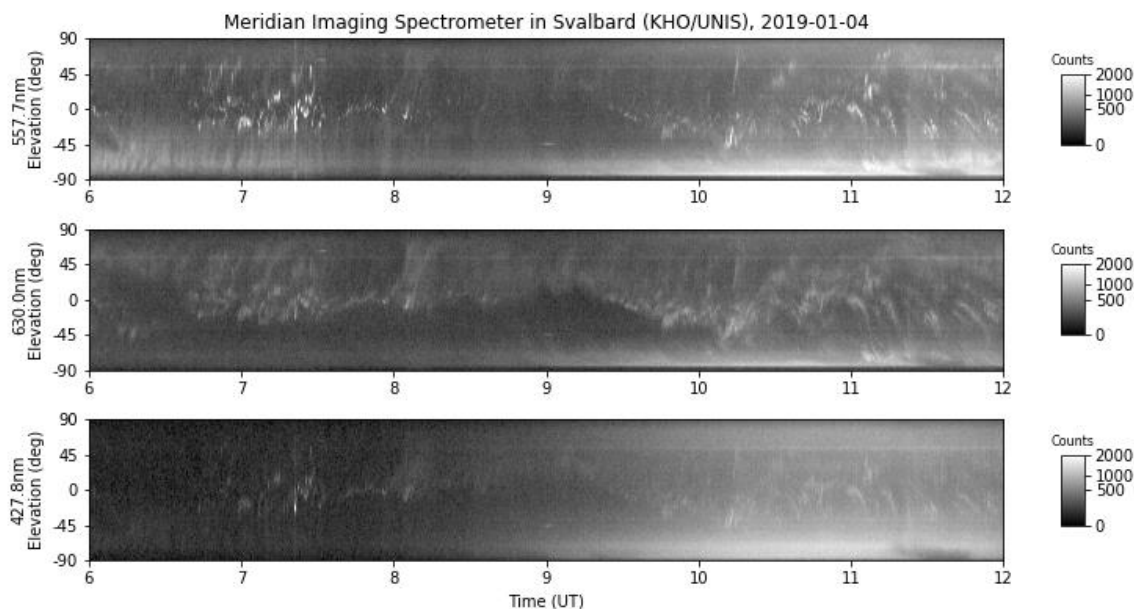
The target of the CAPER 2 rocket was the dayside cusp aurora. Figure 7 shows a composite RGB image from the NORUSCA II hyperspectral camera at KHO. The red, green and blue color planes represent the auroral atomic Oxygen [OI] 630 nm, [OI] 557.7 nm and Hydrogen 486.1 nm emissions. The cusp aurora has intensity up to 5 kR and is predominantly red in color due to low energy electron impact with atomic Oxygen releasing the [OI] 630 nm emission.

The cusp aurora was stable for several hours just north of zenith as seen from KHO. The geomagnetic activity was low at Kp index = 2 with IMF Bz negative. Note that our Aurora Forecast 3D app matched the size and location of the aurora oval as predicted. The rocket was launched from Andøya at 09:27:00 UT with a flight time of only 8 minutes and 49 seconds to apogee at 774.2 km altitude above Svalbard (09:35:49 UT). Total flight time was 957 seconds or splash down at 09:42:57 UT.

The event was also captured by pilot Eivind Trondsen on Lufttransport Dornier 228 flight from Ny-Ålesund to Longyearbyen. See the snapshot in Figure 8. The sun illuminated rocket trail is seen towards the south horizon as the rocket penetrates the upper layers of the atmosphere. These trails may extend high into the stratosphere and mesosphere. High altitude winds may deform, twist and blow them long distances.

## (9) Instrumental development

One of the key activities at KHO is to develop instruments and seek opportunities as new technology is being developed. Especially, the rapid development in sensors fuels the imagination and creation of designs that does not require moving parts. The Meridian Imaging Svalbard Spectrograph (MISS) and the Boreal Auroral Camera Constellation (BACC) is now operational and has proven to provide valuable data to the rocket campaigns.

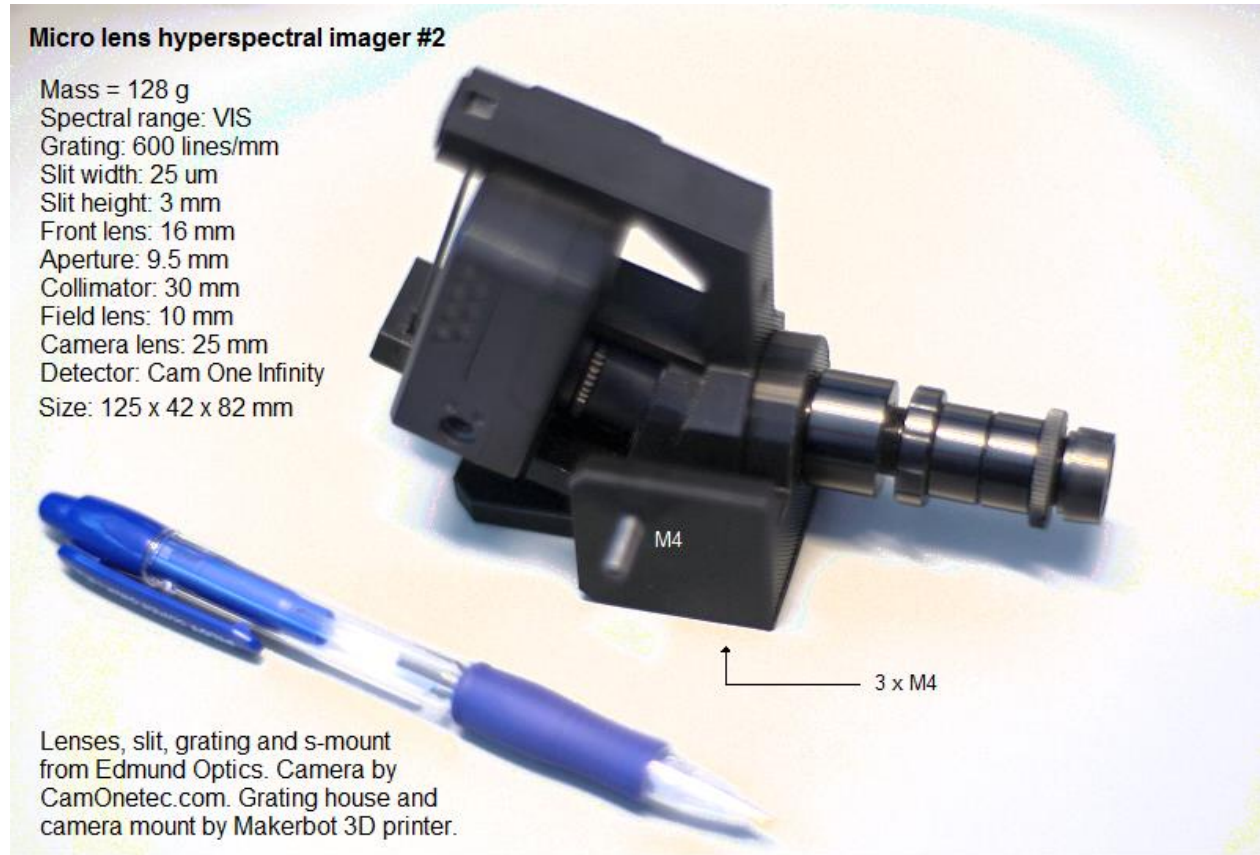


**Fig. 9.** Meridian Imaging Svalbard Spectrograph (MISS) keograms during the CAPER-2 rocket launch. The top, middle and bottom panels correspond to auroral emission intensities at wavelengths 557.7, 630 and 487.2 nm, respectively. Hemispheric geomagnetic North to South slices of sky intensities are stacked as a function of time to get an overview of auroral activity. The region from approximately 08 to 10 UT is the dayside cusp.

The MISS is close to the performance of our old Meridian Scanning Photometers (MSP). A study to compare these instruments will be conducted together with sensitivity calibration to obtain a complete evaluation. The MISS is hyperspectral and records the entire visible spectrum with a spectral bandpass close to 2 - 3 nm.

Two new BACC cameras have been shipped to the Finnish Meteorological Institute (FMI) to be installed at Kevo and Muonio in northern Finland. One new possible BACC partner is Statnett in Alta. This will support and extend our forecast service in latitude.

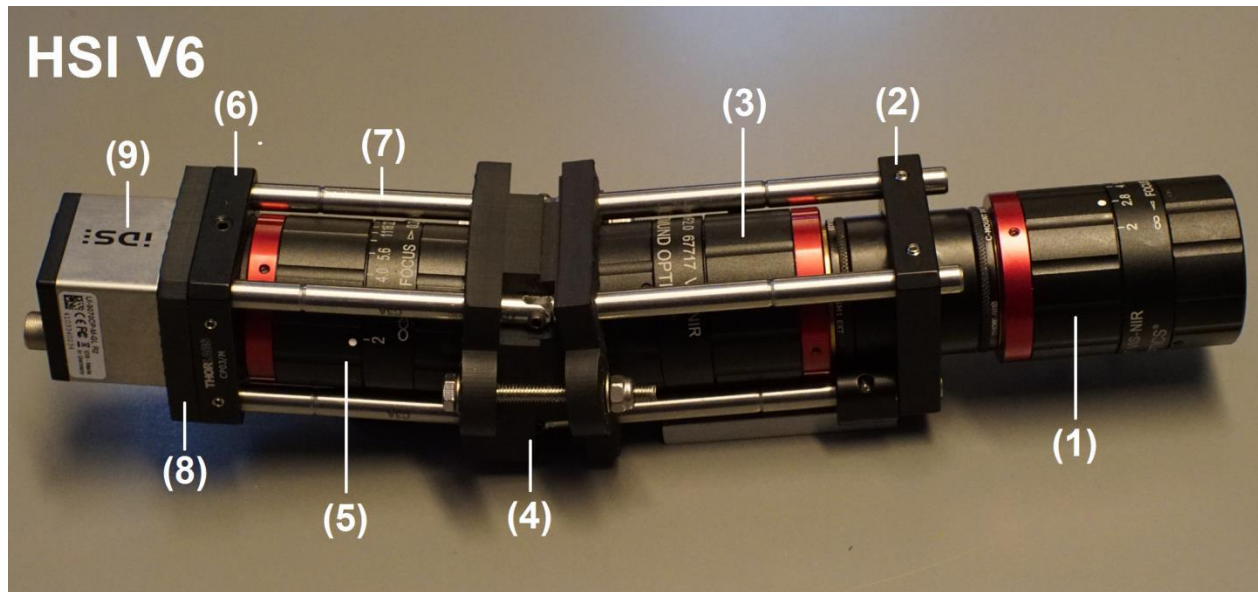
In cooperation with the Norwegian Centre of Excellence named [NTNU AMOS](#) we have successfully, applying our knowledge of spectroscopy, constructed a small light weight push broom Hyper Spectral Imager (HSI) for drone operations. The instrument is low cost and prototyped by using commercial available optical parts and 3D printing.



**Fig. 10.** Second prototype of Hyper Spectral Imager (HSI) for drone operations.

Our knowledge has been transferred to NTNU and 10 units have been serial produced by Moon Labs. The work was awarded a [press release](#) by the Optical Society of America (OSA) in May and the [paper](#) published in Optics Express was ranked by the journal to be among the 10 most read papers for six months.

The next step has been to design, develop and test a new prototype HSI for CubeSat satellites aimed at detecting various oceanic targets. F. Sigernes has signed a two year contract as adjunct professor at the Department of Engineering Cybernetics at NTNU to carry out this work including training students through the course named Hyperspectral remote sensing (TTK20).



**Fig. 11.** Assembled HSI V6 instrument using a standard USB 3.0 iDS camera head. (1) front lens, (2) CP12 cage plate, (3) collimator lens, (4) 3D printed grating holder, (5) camera lens, (6) CP03/M cage plate, (7) steel rods, (8) 3D printed camera mount insert and (9) iDS CMOS camera head.

The design named HSI V6 is based on a 300 grooves/mm blazed transmission grating. It is blazed at 17.5 degree and the efficiency is above 50 % for the wavelength range 400-800 nm. The only part that needs to be constructed (3D printed) is the grating holder. All other components are mainly off-the-shelf from Thorlabs and Edmund Optics. The detector is an industrial camera using a CMOS image sensor (Sony IMX147/IMX252). The effective aperture is 18.14 mm with an input F/value of 2.8. The input slit width is fixed with no magnification of the slit height ( $h = 7.0$  mm). A slit width of  $w = 50 \mu\text{m}$  will result in a spectral bandpass ( $FWHM$ ) of approximately 3.3 nm.

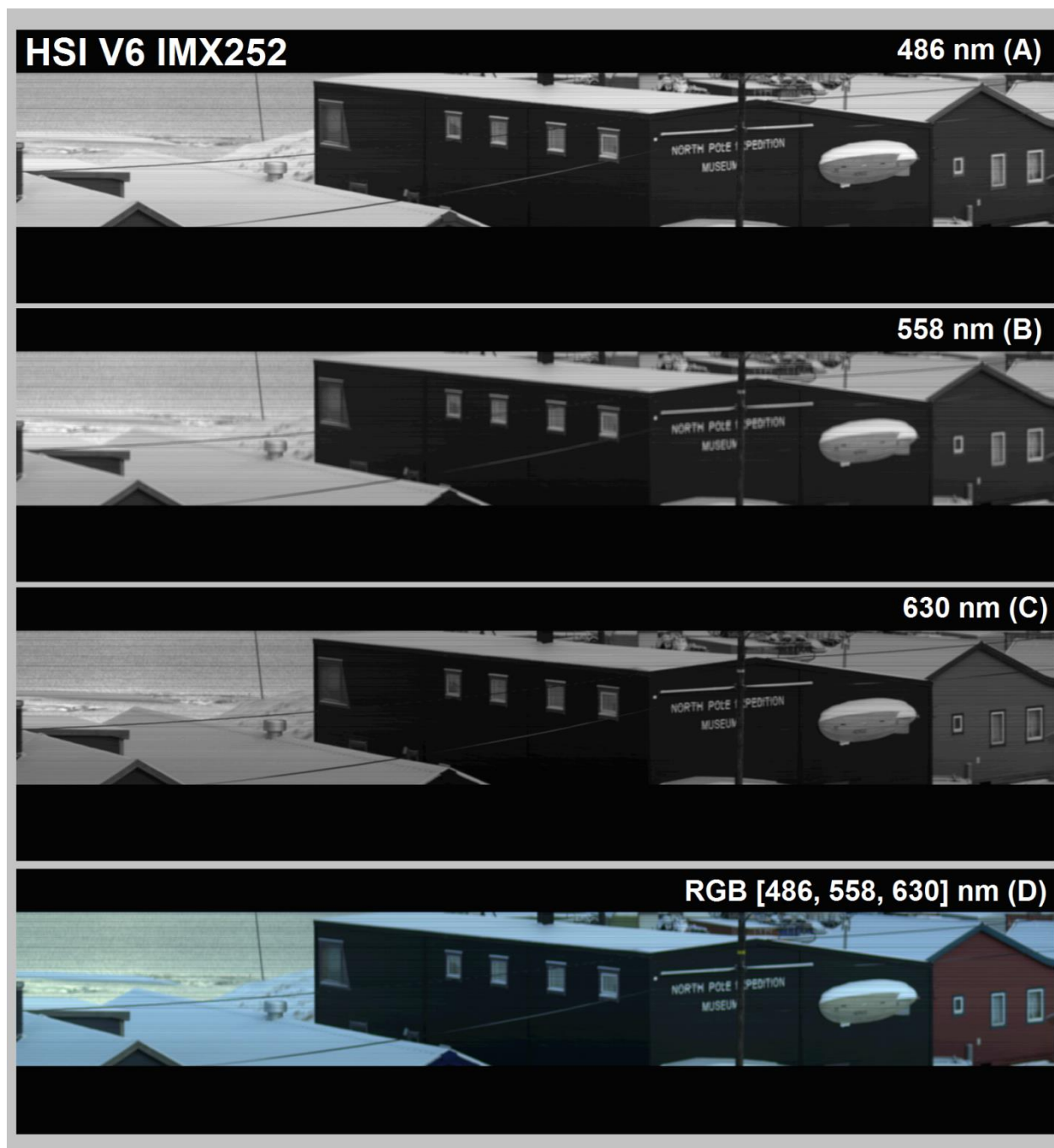
The main challenge in constructing the instrument was to maintain optical image quality at low F/value = 2.8. The use of a single collimator lens did not match the front lens field of view, causing the instrument to be overfilled with light. Baffles were tried out with no success. The solution turned out to be as simple as to use the same lens objective on both sides of the entrance slit. First test is shown in Figure 13.

The instrument will fit inside a 6U satellite bus provided by the company Nano Avionics. The satellite team consists of 20 students, 6 PhDs and 2 Post Docs from several departments at Mechanical Engineering, and from Department of Electronic Systems and Department of Engineering Cybernetics at NTNU. The project is named the [HYP SO](#) (HYPER-SPECTRAL SMALLSAT FOR OCEAN OBSERVATION).



**Fig. 12.** 6U satellite bus type M6P from Nano Avionics.

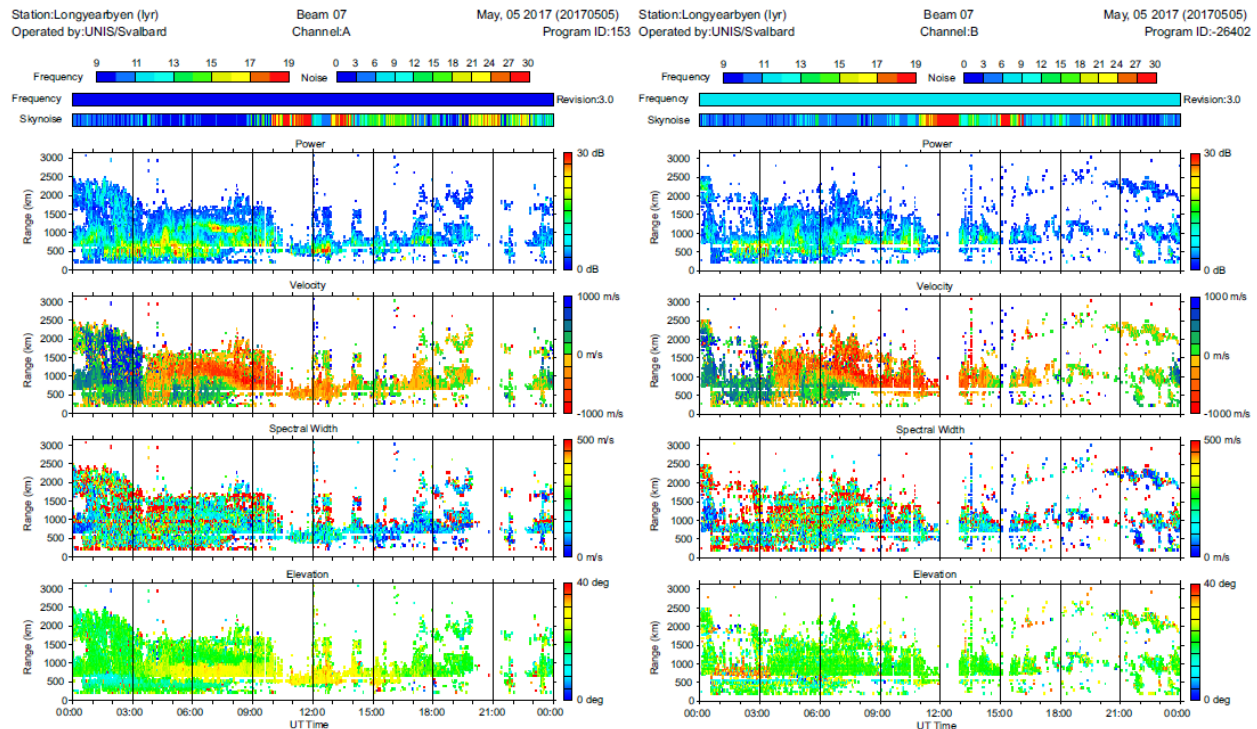




**Fig. 13.** First test of HSI V6 using the iDS IMX252 sensor. Target is out an office windows at UNIS in Longyearbyen on 08.10.2018 in Solar twilight conditions and new snow. The lower RGB composite in Panel (D) is constructed by combining images at center wavelengths 486 nm (blue) panel (A), 558 nm (green) panel (B) and 630 nm (red) panel (C). The individual images have a bandpass of 3.3 nm. The front lens is at F/value 2.8. The sweep range and period were set to 30 degrees and 60 seconds, respectively. The framerate was 30 frames per second. The gain of the sensor was zero.



## (10) The Svalbard SuperDARN (Super Dual Auroral Radar Network) HF Radar

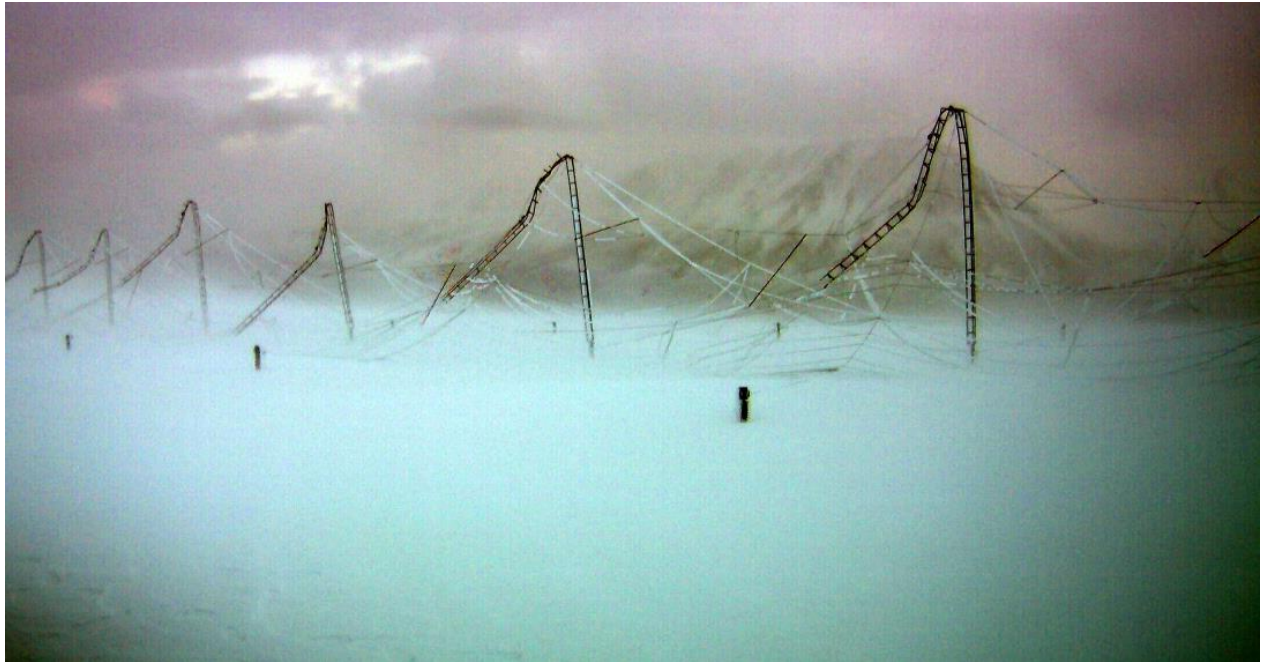


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**Fig. 14.** Range-Time diagram showing 24 hours of stereo data from channel A and channel B using beam 7 (of a total of 16 beams). The panels show from top to bottom, received radar power, particle line of sight velocity, spectral width and the elevation of the return signal using the interferometer array. The high velocity component seen in both channels from about 06 to 10 UT is the cusp region.

The Svalbard SuperDARN radar is a so called stereo radar, which means that it operates on two frequencies – or channels – simultaneously (see Figure 14). It consist of a main antenna array, used for send and receive, and an interferometer array, used for calculating the return signal elevation angle. It has a 52 degree field of view looking North-East, with a typical range of more than 3000 km, thus covering a large portion of the Arctic Ocean. The radar is a part of a global network of similar radars, and data – apart from being stored locally - are streamed to two international servers on a daily basis, one located at the British Antarctic Survey (BAS) in Cambridge UK, and the other at Virginia Tech in Blacksburg, VA, USA. One of the main data products from the combined set of radars are global convection maps of the ionosphere.

On the 23<sup>rd</sup> of October 2018 an unfortunate incident occurred where all masts in both the main and interferometer array broke down due to high winds and ice loading. Although having withstood two Svalbard winters, the combined icing and wind conditions where enough to break the masts. The actual radar electronics located in a custom made shipping container appears to be undamaged. The space physics group at UNIS will rebuild the SuperDARN radar, and the planning for the new radar antenna system has already started. This includes purchase



**Fig. 15.** The Svalbard SuperDARN on 23<sup>rd</sup> of October 2018 collapsed due to severe icing. High Wind gusts in combination with icing conditions bended the masts down to the ground.

of a new antenna, as well as ice and wind load calculations/modelling that will be conducted by an external company. A new type of masts will then be constructed based on the results from the ice and wind load calculations.

## **(11) Summary**

The Kjell Henriksen Observatory (KHO) is part of The Birkeland Centre for Space Science (BCSS) and the activity has been high 2018 with several events. Five rockets have been launched as part of the Grand Challenge Initiative (GCI). During the last one CAPER-2, high quality optical data were recorded by several instruments. The major highlight was Norah Kaggwa Kwagala's defense in August. The SuperDARN (Super Dual Auroral Radar Network) radar at Breinosa unfortunately crashed due to extreme icing conditions after providing almost two year of successful operation real time data to the rest of the world. The plans for rebuilding the radar are now ongoing. Three more instrumental groups have joined KHO in 2018. The Boreal Auroral Camera Constellation (BACC) continues to grow. Our knowledge of spectroscopy is about to be space-born through the cooperation with NTNU AMOS. Six UNIS courses have used KHO as the main laboratory for teaching and 1 PhD student has graduated with flying colors using our data.

## (12) New plans KHO – near future

KHO gives vital support to the GCI. Multiple rockets will be launched in to the cusp over Svalbard over the next 2-3 years. Ground-based data is essential in order to provide the Primary Investigators (PIs) with the right launch decision criteria.

The planned rocket mission time tables gives us time to tune up our existing instruments and plan for new ones. A new background filter to our airglow imager needs to be installed to improve the temperature derivation technique. The Meridian Imaging Svalbard Spectrograph (MISS) is now finished and only needs fine tuning of the operational software. Our tracker system still need to be tuned up and tested. For the CREX 2 sounding rocket campaign, it is essential to select the optimal center wavelengths for the NORUSCA cameras.

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## (13) General strategy statement

The main purpose of KHO is to study processes in the magnetospheric cusp and how it connects to interactions between the Sun and our atmosphere. The unique location and the multi-disciplinary instrumental infrastructure such as radars and optics enable us to study the whole atmospheric vertical column to obtain a better understanding of space- and planetary weather. A vital key in this concept is to upgrade, develop and compare instruments as novel technology and knowledge emerge. Therefore, the aim is to strengthen the co-operation with our existing groups and invite new ones. We wish to be upfront as an attractive partner to large scale rocket and satellite campaigns both on the instrumental and observational side.

### NOTE

The internal research funding of UNIS is of vital importance in future plans. It enables us to preserve the instrumental momentum and helps us keep track of new technology as it arrives. It seeds our research plans and proposals and is as a consequence strategically important to us. This must not be underestimated compared to our external funding which is more tied up or locked to predefined proposal tasks.

## Graduated students

1. Norah Kaggwa Kwagala, PhD, Thermally excited 630.0 nm emissions in the polar ionosphere, University of Bergen, Norway, August 24, 2018.

## External Courses

1. L. Baddeley, The Arctic Space TRaining ([ASTRA](#)) on Auroral Phenomena winter school, Department of Physics, University of Oslo, August, 2018.
2. F. Sigernes, Hyperspectral remote sensing ([TTK20](#)), Department of Engineering Cybernetics, Norwegian University of Science and Technology (NTNU), Fall 2018.

## Presentations 2018

1. F. Sigernes, M. Syrjäso, R. Storvold, J. Fortuna, M. E. Grøtte, J. Veisdal, E. Honoré-Livermore and T. A. Johansen, The DIY hyperspectral imager experiment, The 45th Annual European Meeting on Atmospheric by Optical Methods, Kiruna, Sweden, 27-31 August, 2018.
2. Aurora Forecast 3D, Svalbard museum lecture, Longyearbyen, 25 April, 2018.
3. Aurora Forecast 3D (*invited*), SNOW18, Arctic 365, Alta 14-15 May, 2018.
4. Aurora Forecast 3D, Birkeland Space Weather Symposium, 15-16 June, Oslo, 2018.
5. Bland, E.C., E. Heino, M.J. Kosch, and N. Partamies, SuperDARN radar measurements of HF radio attenuation during the September 2017 solar proton events, HEPPA-SOLARIS, Roanoke, USA, 2018 (*invited talk*).
6. Bland, E.C., E. Heino, M.J. Kosch, and N. Partamies, SuperDARN-derived HF radio attenuation during the September 2017 solar proton events, Banyuls-sur-Mer, France, June 3-8, 2018.
7. Bland, E.C., Ponomarenko, P.V. and Waters, C.L., An Evaluation of FITACF3, Banyuls-sur-Mer, France, June 3-8, 2018.
8. E. Heino, P. T. Verronen, A. Kero, N. Kalakoski and N. Partamies, Middle Atmospheric Ionization During Solar Proton Events in WACCM-D and Riometer Observations, European Space Weather Week, Leuven, Belgium, 5-9 November 2018.
9. N. Partamies, D. Whiter, K. Bolmgren, A. Kadokura, K. Kauristie, Pulsating aurora — why should we care?, The 45th Annual European Meeting on Atmospheric by Optical Methods, Kiruna, Sweden, 27-31 August, 2018.
10. N. Partamies, J. Weygand and L. Juusola, Auroral omega bands, The 45th Annual European Meeting on Atmospheric by Optical Methods, Kiruna, Sweden, 27-31 August, 2018.
11. L. Baddeley, Space Physics Research on Svalbard, Global Seed Vault 10 year anniversary meeting, UNIS, February 2018

## Publications 2018\*

1. Fred Sigernes, Mikko Syrjäso, Rune Storvold, João Fortuna, Mariusz Eivind Grøtte, and Tor Arne Johansen, "[Do it yourself hyperspectral imager for handheld to airborne operations](#)," Opt. Express 26, 6021-6035 (2018).
2. Bland, E.C., E. Heino, M.J. Kosch, and N. Partamies (2018), SuperDARN radar-derived HF radio attenuation during the September 2017 solar proton events, Space Weather, 16, 1455-1469.
3. Shi, X., Ruohoniemi, J.M., Baker, J.B.H., Lin, D., Bland, E.C., Hartinger, M.D., and Scales, W.A. (2018), Survey of ionospheric Pc3--5 ULF wave signatures in SuperDARN high time resolution data, J. Geophysical Research: Space Physics, 123, 4215-4231.

4. McKay, D., Partamies, N., and Vierinen, J.: Pulsating aurora and cosmic noise absorption associated with growth-phase arcs, *Ann. Geophys.*, 36, 59-69, <https://doi.org/10.5194/angeo-36-59-2018>, 2018.
5. Kwagala N., K. Oksavik, D.A. Lorentzen, M.G. Johnsen, How Often Do Thermally Excited 630.0 nm Emissions Occur in the Polar Ionosphere? *JGR*, DOI: 10.1002/2017JA024744, 2018.
6. V.A. Pilipenko, O.V. Kozyreva, D.A. Lorentzen, , L.J. Baddeley, The correspondence between dayside long-period pulsations and the open-closed field line boundary, *JASTP*, DOI: 10.1016, 2018.
7. Kwagala N., K. Oksavik, D.A. Lorentzen, M.G. Johnsen. K. Laundal, Seasonal and Solar Cycle Variations of Thermally Excited 630.0 nm Emissions in the Polar Ionosphere, DOI: 10.1029/2018JA025477, *JGR*, 2018.

\*Listed presentations and publications do not include all instrumental groups at KHO, only from the KHO crew.