ALIS_4D

a Swedish complementary instrument for EISCAT_3D

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many more...

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Swedish Space Plasma meeting, 2018

Swedish Institute of Space Physics

New organisation from 2018

- PAF + STP $\Rightarrow$ STAR, Solar Terrestrial and Atmospheric Research (Head: Johan Kero)
- KGO $\Rightarrow$ KAGO Kiruna Atmospheric and Geophysical Observatory: Urban Brändström (head), Daria Mikhaylova, Lars-Göran Vanhainen and Uwe Raffalski
- Uwe Raffalski is responsible for atmospheric measurements within KAGO
- Ozone radiometer (KIMRA) became observatory instrument 2018.

KAGO Instruments

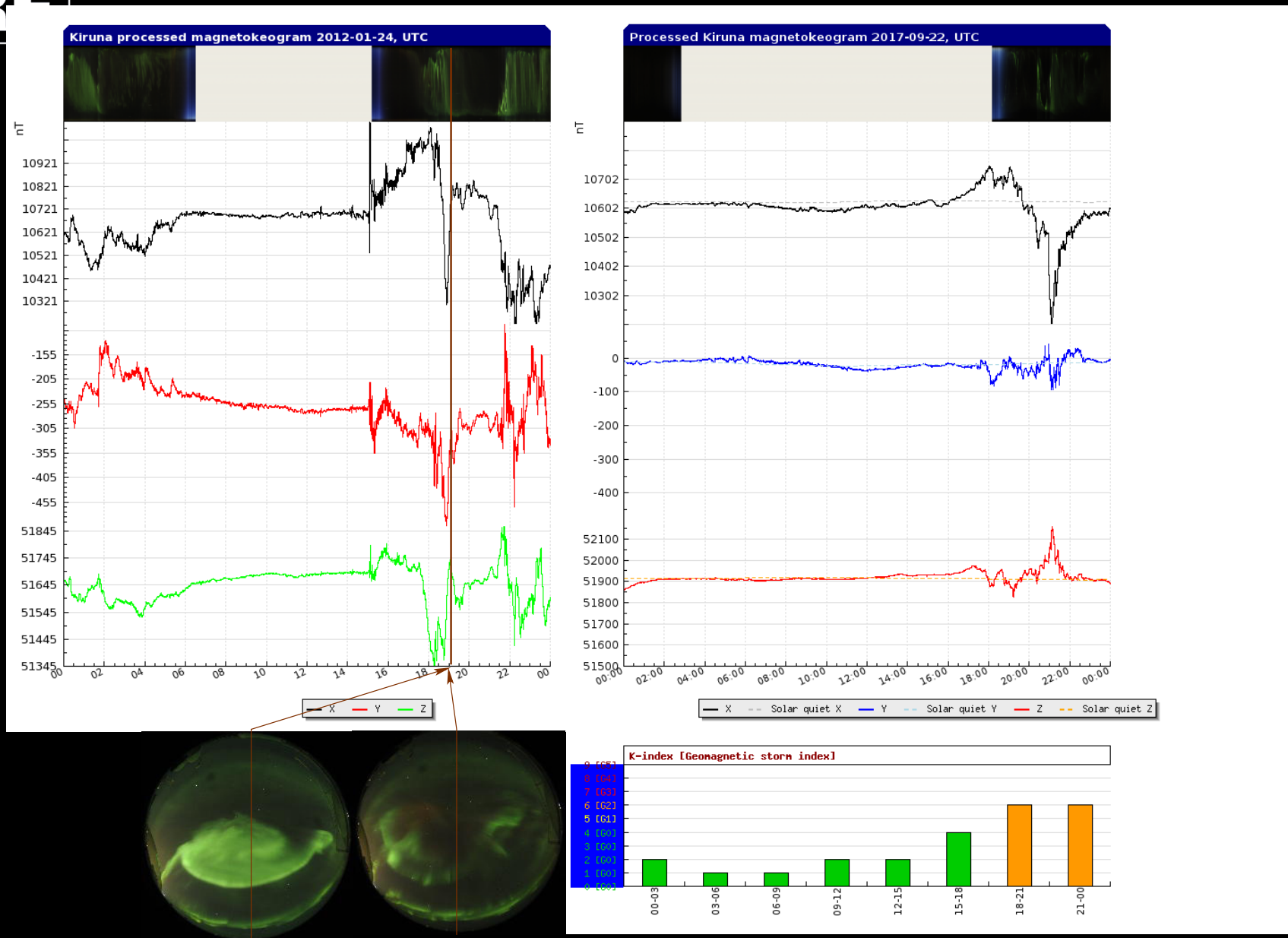
Kiruna Atmospheric and Geophysical Observatory

- Magnetometers, 1950–: IRF [Yamauchi]: Kiruna, Lycksele, Tormestorp;
  SGU[Schwarz]: Abisko, Uppsala and operation of Lycksele
- Allsky cameras, 1956– [Brändström]: Kiruna, Abisko, Tjautjas
- Ionosondes, 1952– [Leyser]: Kiruna, Lycksele, Uppsala.
- Riometers, 1958– [Sergienko]: Kiruna, Lycksele
- Infrasound, 1973– [Kero]: (In observatory since 2015) (Kiruna, Jämtön, Lycksele, Sodankylä)
- Ozone radiometer (KIMRA), 2001– [Raffalski]: (In observatory since 2018) (Kiruna)
- ALIS_4D [Brändström] (Observatory measurements from fall 2019) Abisko, Kiruna, Silkkimuotka, Tjautjas
- (Weather station, ALIS, guest instruments, etc.)

Near future

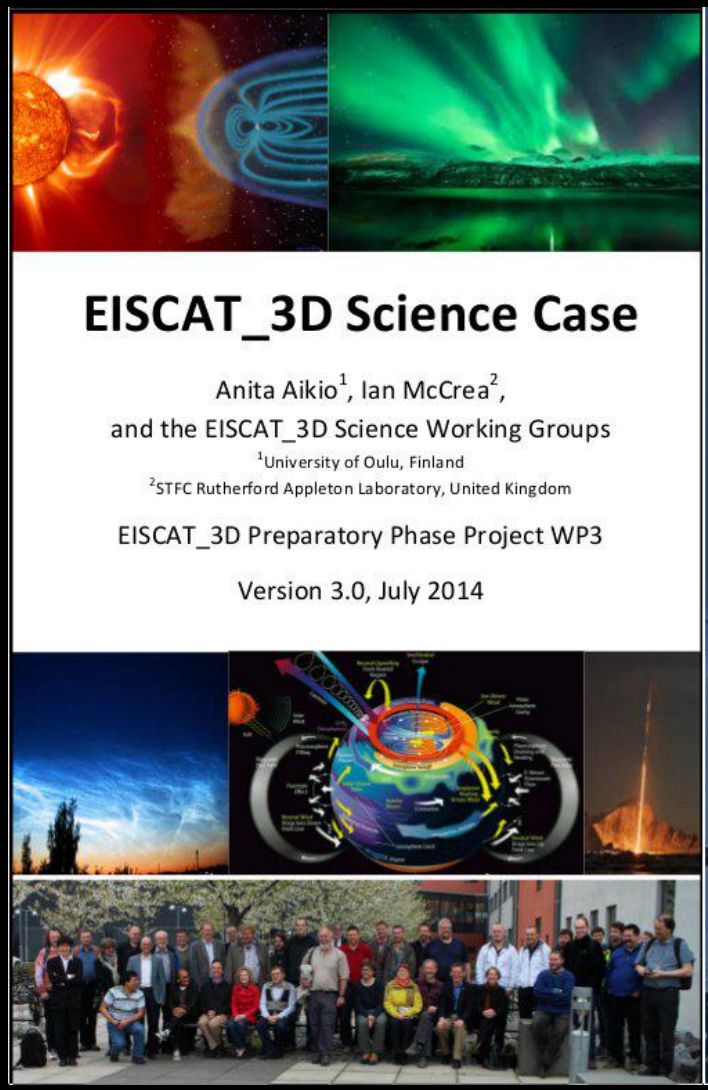
- ALIS_4D operational in fall 2019.
- New ionosondes in Uppsala (2019) and Lycksele (TBD)
- Upgrade Kiruna geomagnetic observatory to INTERMAGNET 1 s standard. New variometer (2019).

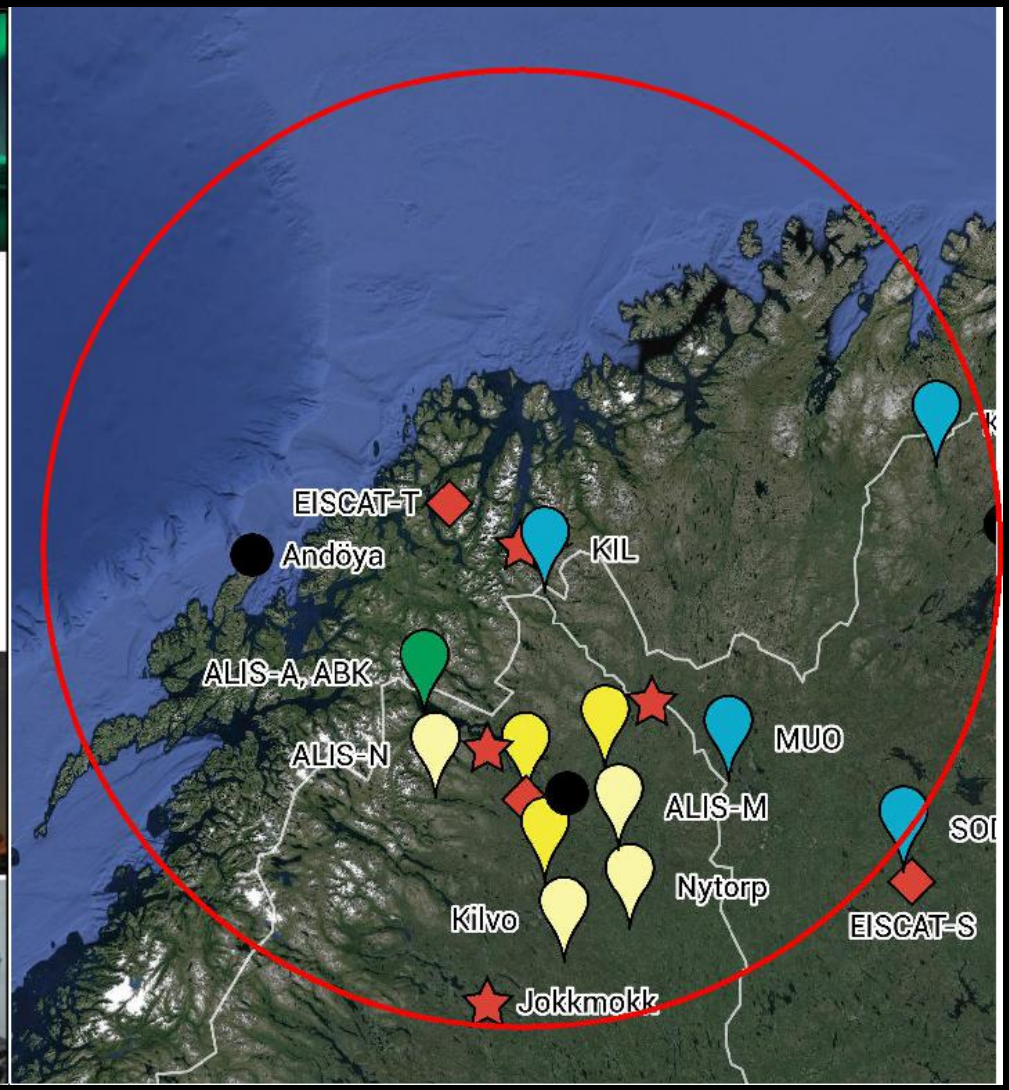
IRF Magnetokeogram



EISCAT_3D science case

Infrastructures and geographical advantages





Do EISCAT_3D need optics?

- High-speed narrow-band imaging of aurora, RIOE, meteor trails, . . .
- Observatory modes (long-time monitoring)
- The string “optic” occurs 46 times in 122 pages
- Table 1 “EISCAT_3D radar performance requirements” p. 107–109: Optics required in 70 % (16 of 23) science topics .

Optical measurements are a requirement for EISCAT_3D!

new-moon periods are popular! (Gustavsson, present EISCAT)

There are many clear solid scientific objectives for optical instruments!

The need for optics: The science case

1(2)

- A Atmospheric Physics and Global Change p9–28: 2
  - A3 Solar-terrestrial effects on middle atmosphere chemistry.
- B Space and Plasma Physics p29–50: 11
  - B2 Plasma convection and multiscale coupling
  - B4 Auroral dynamics and NEIALS
  - B5 Structures and boundaries in the ionosphere
  - B8 Ionosphere modelling
- C Solar system research p51–57: 4
  - C2 Meteoroids
  - C3 Planets and asteroids

The need for optics: The science case

2(2)

D Space Weather and Service Applications p58–74: 2

- D3 Space weather effects on the high-latitude. . .
- D5 Modelling and forecasting of space weather

E Radar Techniques, New Methods for Coding and Analysis p75–85: 3

- E3 Radar coding and data analysis methods

References p86–106 6 (references) Gustavsson, Knudsen, Kosch(2) Pellinen-Wannberg, Rietveld

Appendix A 107–121: 16 Table 1 "EISCAT_3D radar performance requirements" p. 107–109: Optics required in 70 % (16 of 23) science topics .

AILS_4D

A Swedish contribution to complementary instruments for EISCAT_3D

- High-time resolution (> 25 FPS)
- Continuous operation (observatory modes)
- Status
  - 2016: (summer) Funding application (granted in November)
  - 2017: Procurement procedures, four imagers delivered, optics ordered
  - 2018: Optics delivery (April) Main development work. Tests in fall.
  - 2019: Continuous operations from fall. Ground support for SPIDER2 rocket.
- Funded by *Kempestiftelserna*, Faculty of Science and Technology at UmU and IRF.
- PIs Urban Brändström (IRF), Asta Pellinen-Wannberg (UmU)

INSTITUTET FÖR RYMDFYSIK
Swedish Institute of Space Physics

Umeå universitet

ALIS_4D sites

ALIS/ALIS_4D

Comparision

	ALIS	ALIS_4D phase II
FoV	4 CCD $\approx 60°$ 1 EMCCD $\approx 30°$ (1 EMCCD $\approx 15°$)	4 EMCCD $\approx 150°$ 1 EMCCD $\approx 30°$ (1 EMCCD $\approx 15°$)
Res	$1024^2 \approx 100\mathrm{m}$ $256^2 \approx 500\mathrm{m}$	$1024^2 \approx 750\mathrm{m}$ $512^2 \approx 1.5\mathrm{km}$
Time	12 FPM	$>$ 25 FPS
Mode	Campaign only	monitoring/campaign
	 Sort of an Àttje	

ALIS/ALIS_4D

Available filters

λ [Å]	$\Delta\lambda$ [Å]	Line	Remarks	#
3950	92	Ca, Fe	Meteors	1
4227	280	Ca, Fe, H_2O, ...	Meteors	1
4340.5	25	H_γ, Balmer series	Meteors	1
4278	50	N_2^+ 1Neg.	Aurora/Airglow	6
4861.3	25	H_β, Balmer series	Meteors	1
5100	40		Background	4
5577	40	$O(^1S)$	Aurora/Airglow	6
5893	200	Na, ...	Meteors	1
6230	40		Background	4
6300	40	$O(^1D)$	Aurora/Airglow	6
6562	70	H_α	SPIDER	4
6562.8	25	H_α, Balmer series	Meteors	1
6750	200	$N_2 1P$	SPIDER/LEEWAVES	4
8000	1000	OH Meinel	Airglow LEEWAVES	4
8446	40	$O(3p^3P)$	Aurora/Airglow ($O(3p^3P)$)	4

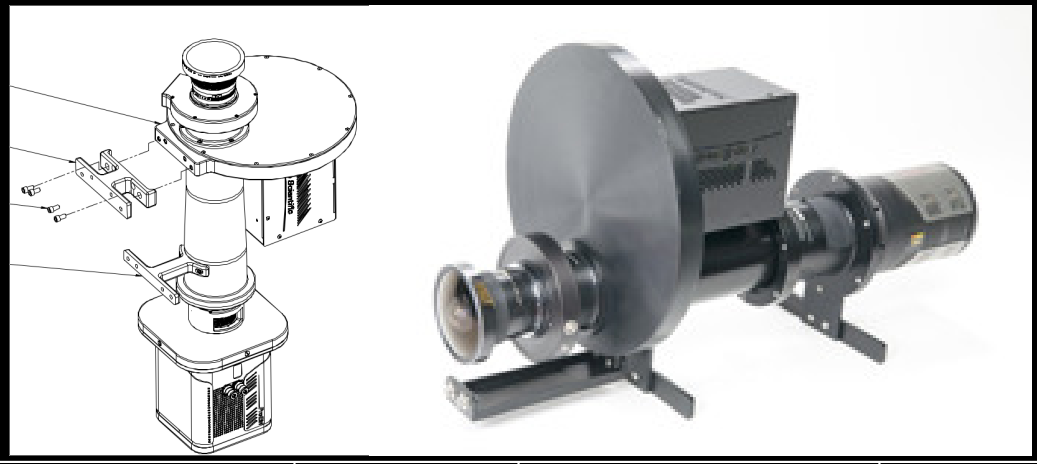
ALIS_4D

Sensitivity and speed

	Res.	Hz	R/count	λ_c
ALIS (CCD)	1024^2	0.04	13.4	5577Å
ALIS (CCD)	256^2	0.2	0.78	5577Å
ALIS (CCD)	256^2	0.2	1.74	4278Å
ALIS_4D (EMCCD)	1024^2	16.5	6	5577Å
ALIS_4D (EMCCD)	1024^2	25	0.5	5577Å

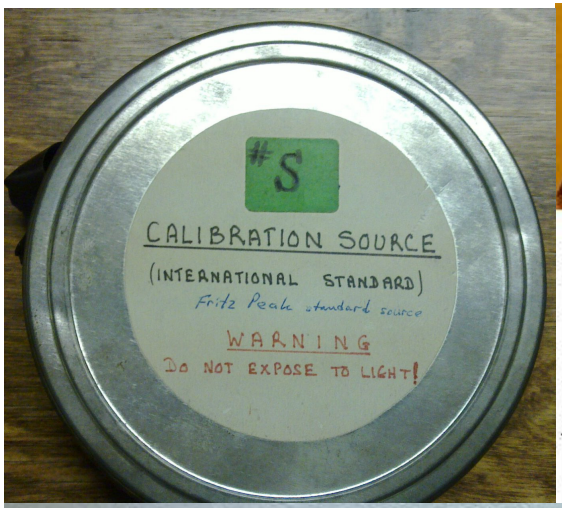
Data production

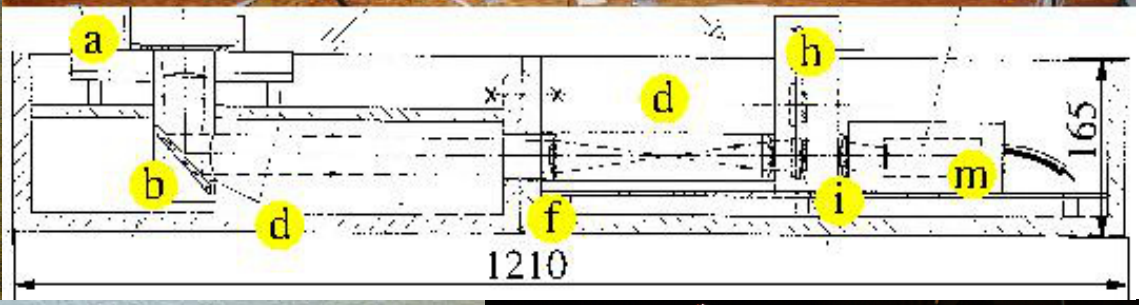
"Harddisks are either new or full" Gustavsson

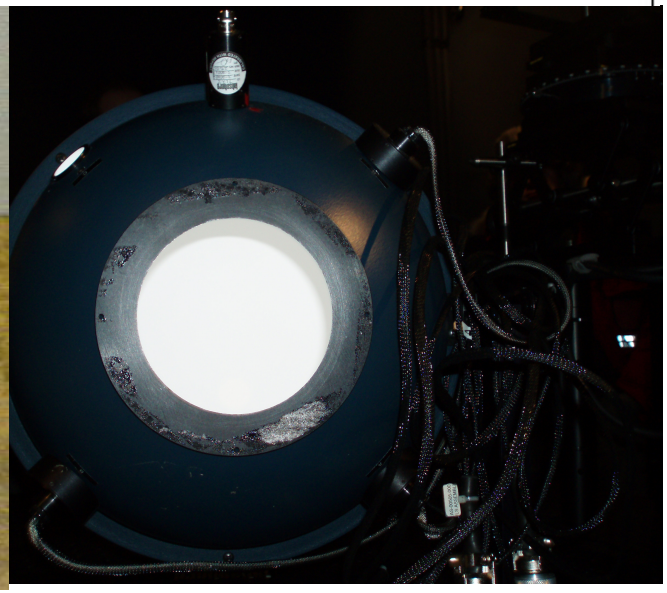


Hz	resolution	GiB/h	total GiB/h	GiB/night
0.1	256^2	0.02	0.09	1
0.1	512^2	0.09	0.4	6
0.1	1024^2	0.35	14.1	22
1	256^2	0.22	0.88	14
1	512^2	0.9	3.51	56
1	1024^2	3.5	14.06	225
25	256^2	11	44	352
25	512^2	44	176	1406
25	1024^2	176	703	5625

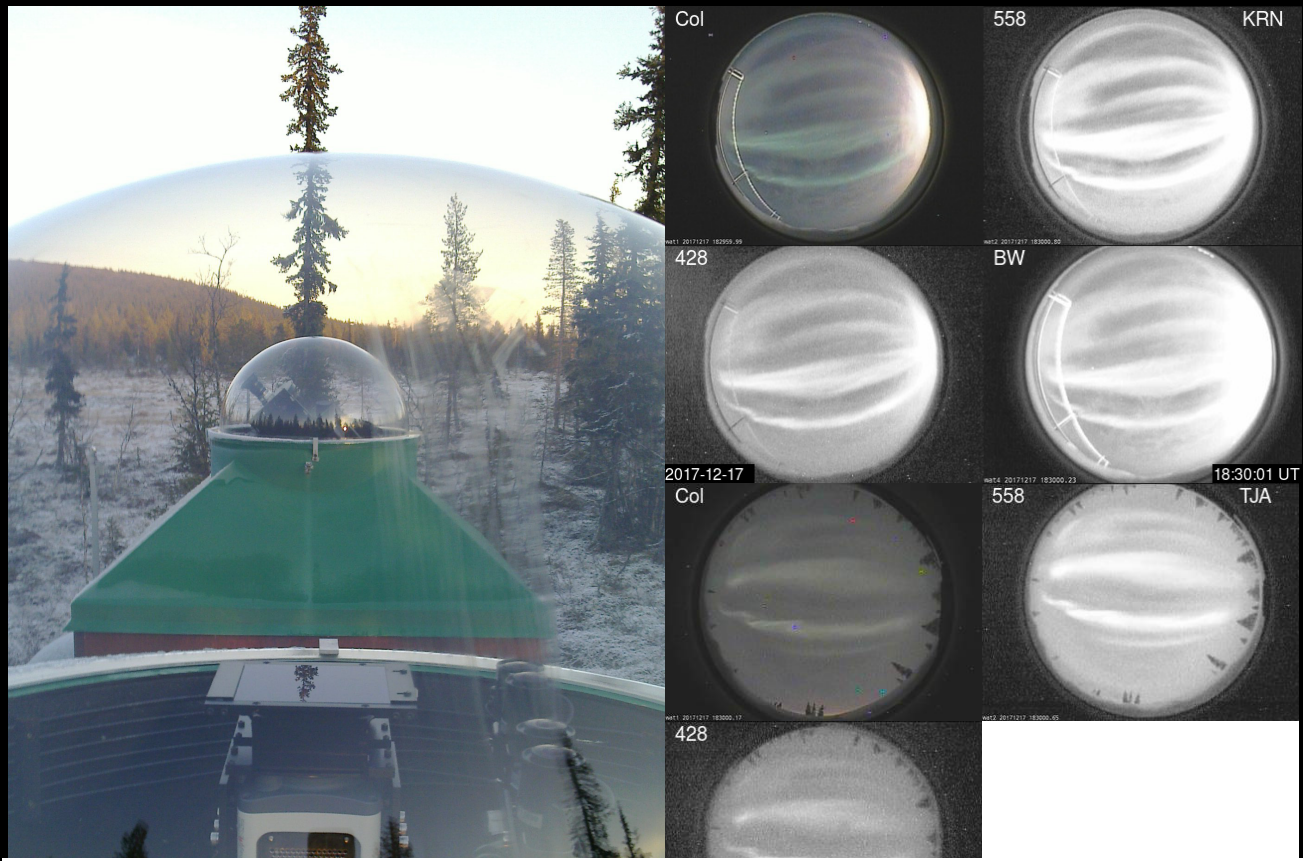
Optical absolute calibration

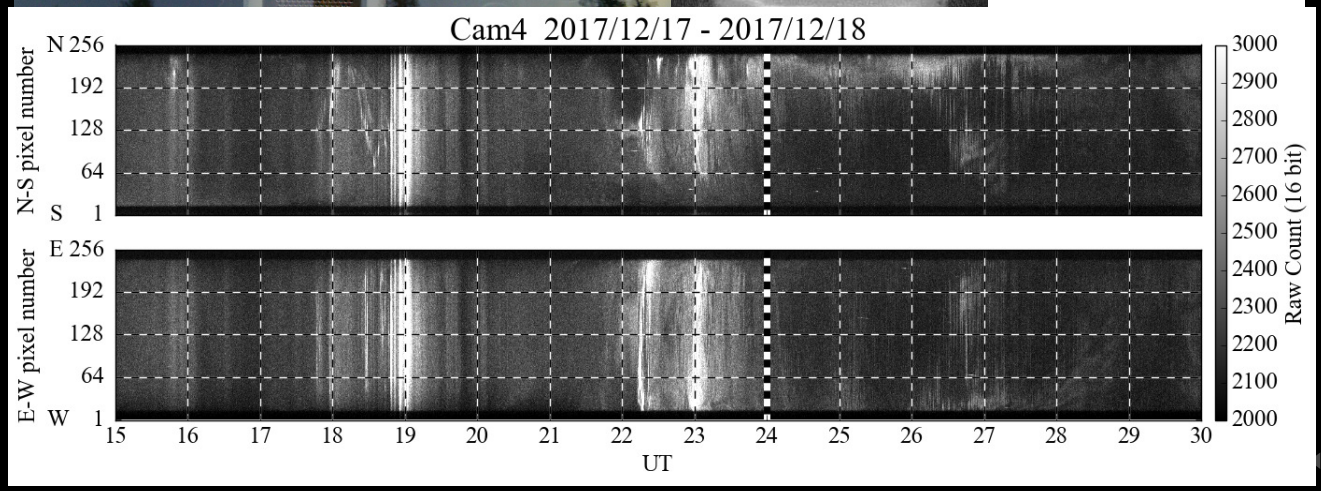






ISEE/NIPR


Col
558
KRN
428
BW
2017-12-17
18:30:01 UT
Col
558
TJA
428


Cam4 2017/12/17 - 2017/12/18
N-S pixel number
N 256
192
128
64
S 1
E-W pixel number
E 256
192
128
64
W 1
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
UT
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
Raw Count (16 bit)

EISCAT_3D Complementary instruments

List extracted from the EISCAT_3D Science Case

- High-quality spectroscopic imaging systems: SE: ALIS_4D, FI: MIRACLE and NO: BIFROST
- Sensitive spectrographs (UNIS Svalbard)
- Scanning Doppler-Imaging FPI:s with overlapping fields of view. (UCL, ESRANGE, SGO, Norway, Japan (Oyama-san et al))
- Heating-facility (EISCAT, Norway)
- Standard monitoring instruments: Magnetometers, All-sky cameras, Riometers, Ionosondes (Finland, Norway, Sweden)
- VLF/HF/GPS receivers (SGO, Finland and nearby)
- Backscatter radars (CUTLASS: Finland, Iceland Norway)
- Sounding rockets?

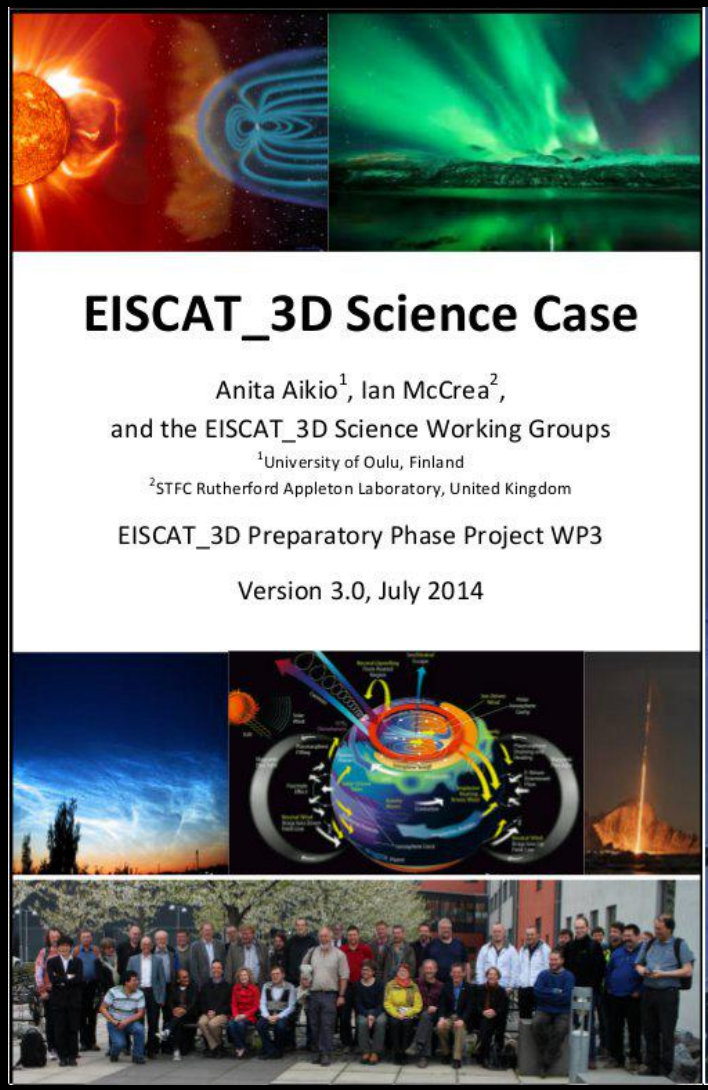
Funding issues

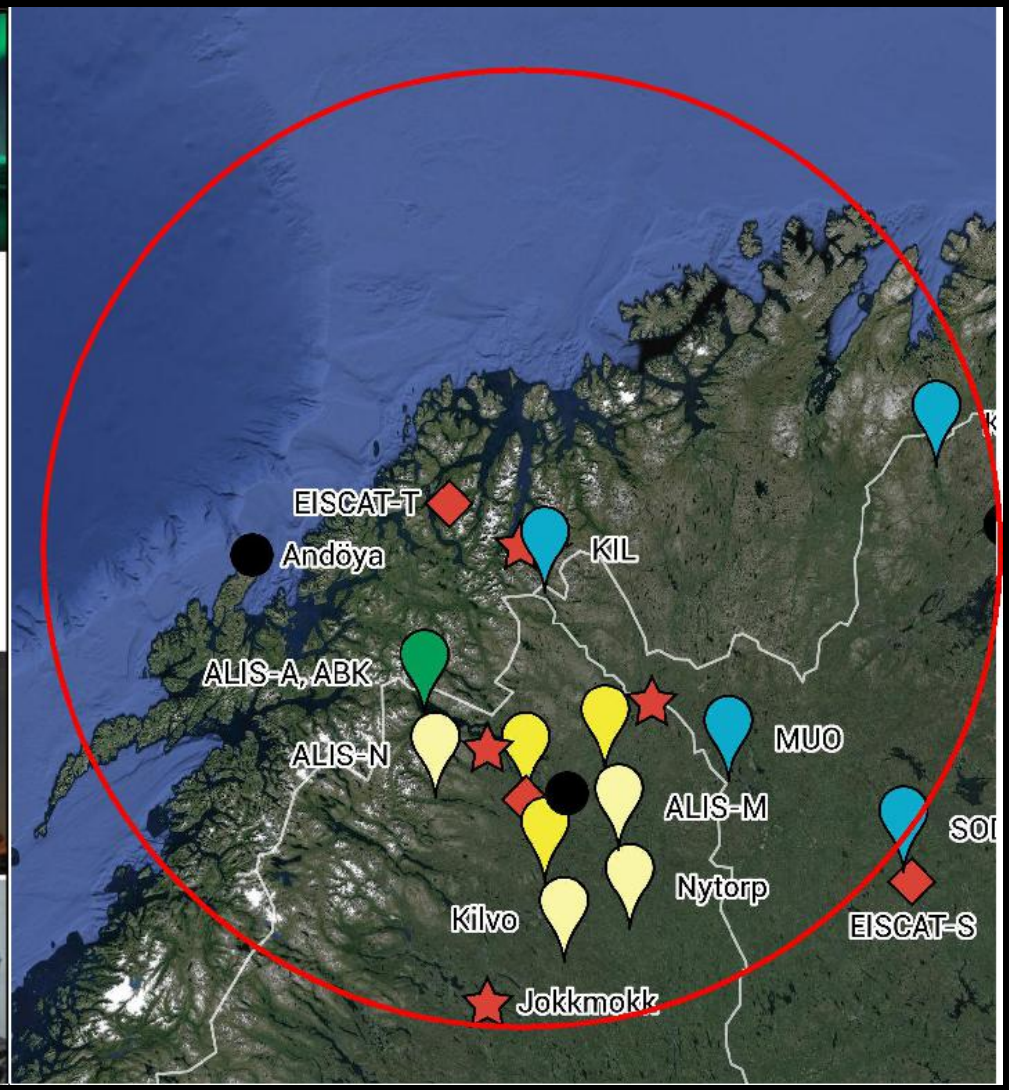
Inventory of research infrastructure needs

- 2015 Failed. (application in 2017 if priority A1)
- 2017 Pending... (application in 2019 if priority A1)
- We need better national and international coordination!
- We need a targeted science case for complementary instruments. (Expand it?)
- 2019...? (application in 2021 if priority A1)

EISCAT_3D science case

Infrastructures and geographical advantages





We need to discuss

- EISCAT_3D complementary instruments and dedicated science case?
- I think the EISCAT_3D complementary instruments should be easily accessable and simple to request and use for an E3D user.
- Need for increased nordic cooperation! Norway-Sweden-Finland. National infrastructures that can be easily combined over the borders whenever desired.
- For example: ALIS_4D compatibility matters (MIRACLE, Norway)?
- Data flow from production via conditioning to users.
- Most observatories produce and provides free and open data. This is good! How is the data used? Publications? Need for data citations! Rules of the road?
- How do we make funding resources flow back to data producers?

Summary

- ALIS_4D will be a powerful swedish contribution to complementary instruments for EISCAT_3D.
- Extensive upgrades of the observatory instrumentation underway at IRF. New Ionosonde (Uppsala), Riometer and variometer Kiruna (Also including atmospheric measurements)
- Increased Nordic collaboration