



Kiruna Atmospheric- and Geophysical Observatory (KAGO)

ALIS_4D — status, possibilities and future plans

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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
- ▶ Ozone radiometer (KIMRA) became observatory instrument 2018.
- ▶ Uwe Raffalski is responsible for atmospheric measurements within KAGO



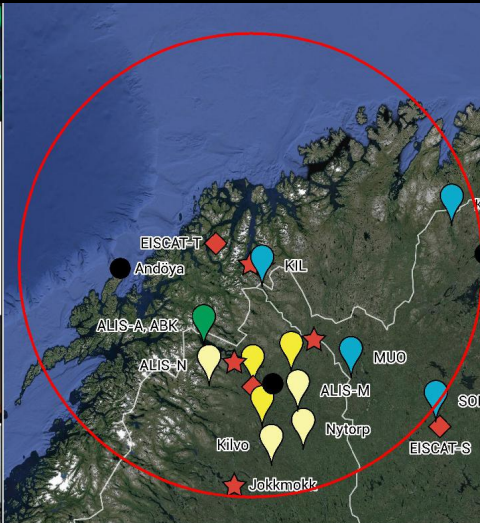
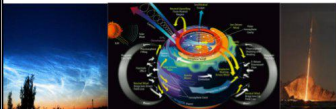
EISCAT_3D Science Case

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EISCAT_3D Preparatory Phase Project WP3

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E3D Complementary instr.

- ▶ High-quality spectroscopic imaging systems (ALIS_4D, MIRACLE and norwegian system) (se, fi, no)
- ▶ 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)



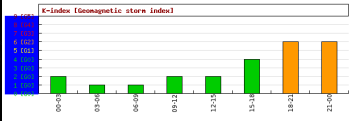
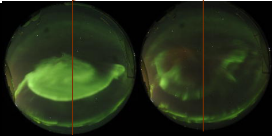
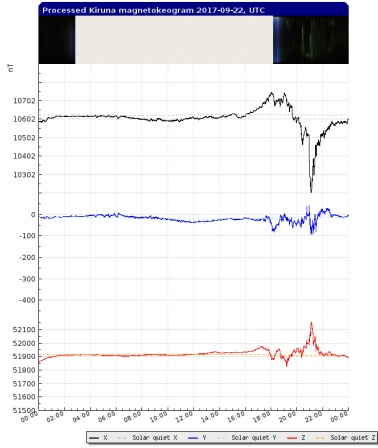
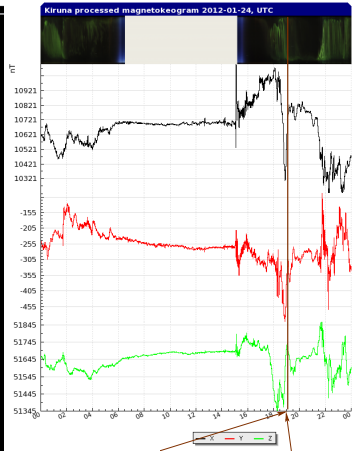
KAGO Instruments

Kiruna Atmospheric and Geophysical Observatory

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



IRF Magnetogram





The need for optics: ALIS_4D

A Swedish contribution to complementary instruments for EISCAT_3D

- ▶ 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!



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*, Department of Physics at UmU and IRF.
- ▶ PIs Urban Brändström (IRF), Asta Pellinen-Wannberg (UmU)

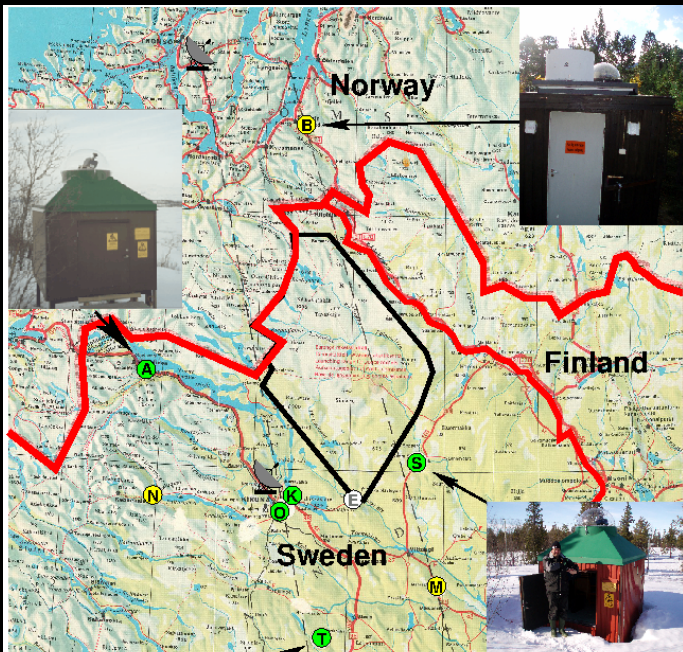


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Umeå universitet

ALIS_4D sites





ALIS/ALIS_4D

Comparison

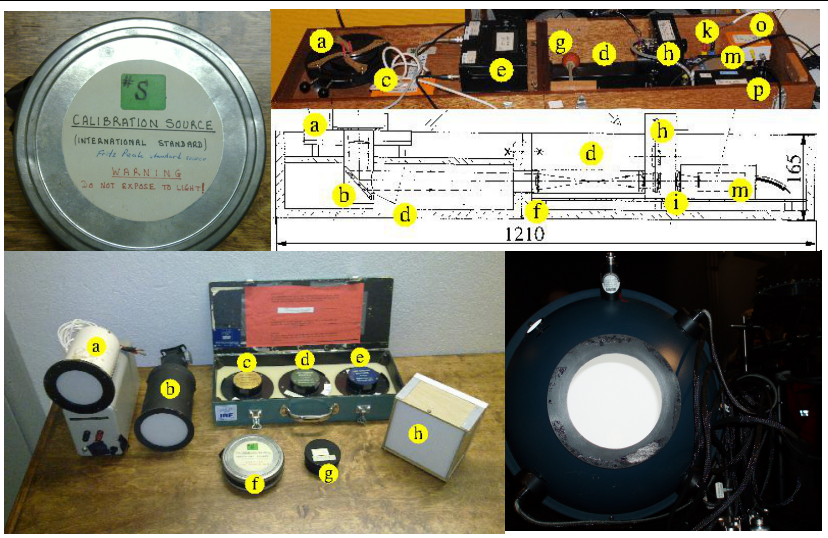
| | ALIS | ALIS_4D phase II |
|------|---|--|
| FoV | 4 CCD $\approx 60^\circ$ 1 EMCCD $\approx 30^\circ$ (1 EMCCD $\approx 15^\circ$) | 4 EMCCD $\approx 150^\circ$ 1 EMCCD $\approx 30^\circ$ (1 EMCCD $\approx 15^\circ$) |
| Res | $1024^2 \approx 100\text{m}$ $256^2 \approx 500\text{m}$ | $1024^2 \approx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

Sort of an Àttje



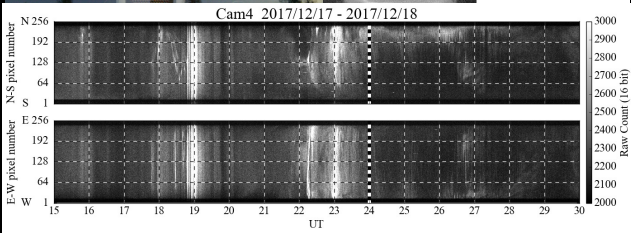
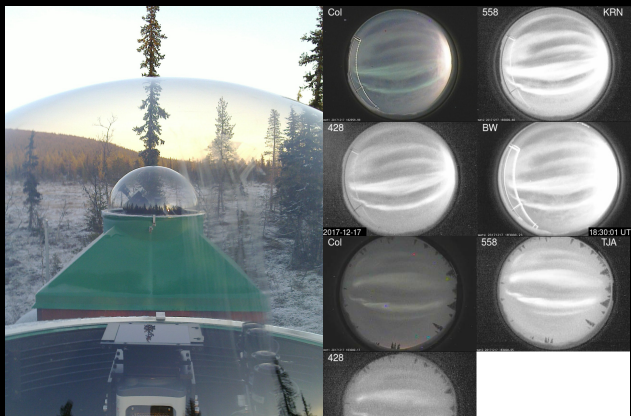


Optical absolute calibration





ISEE/NIPR





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)



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).



We need to discuss

- ▶ EISCAT_3D complementary instruments and dedicated science case?
- ▶ I think the EISCAT_3D complementary instruments should be easily accessible 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 is essential!