ALIS_4D

and the relation to EISCAT_3D and IRF Observatory

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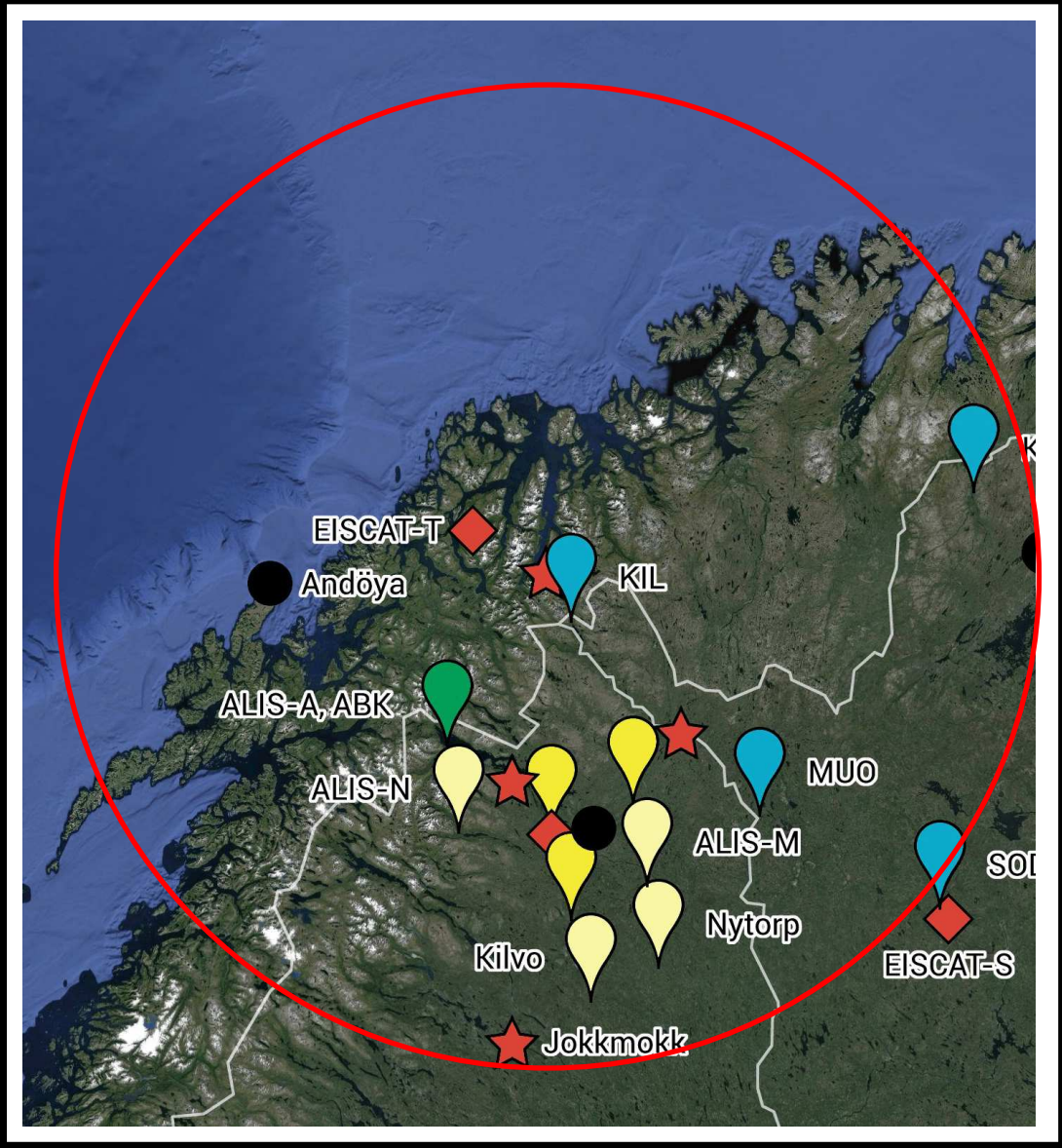
First some background

Facilities in the region



E3D Complementary instr.

- High-quality spectroscopic imaging systems (best parts of ALIS and MIRACLE) (Finland, Sweden)
- Sensitive spectrographs (UNIS Svalbard)
- Scanning Doppler-Imaging FPI:s with overlapping fields of view. (UCL, ESRANGE, SGO, Norway)
- 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)

EISCAT_3D Science case

- 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) listed science topics .

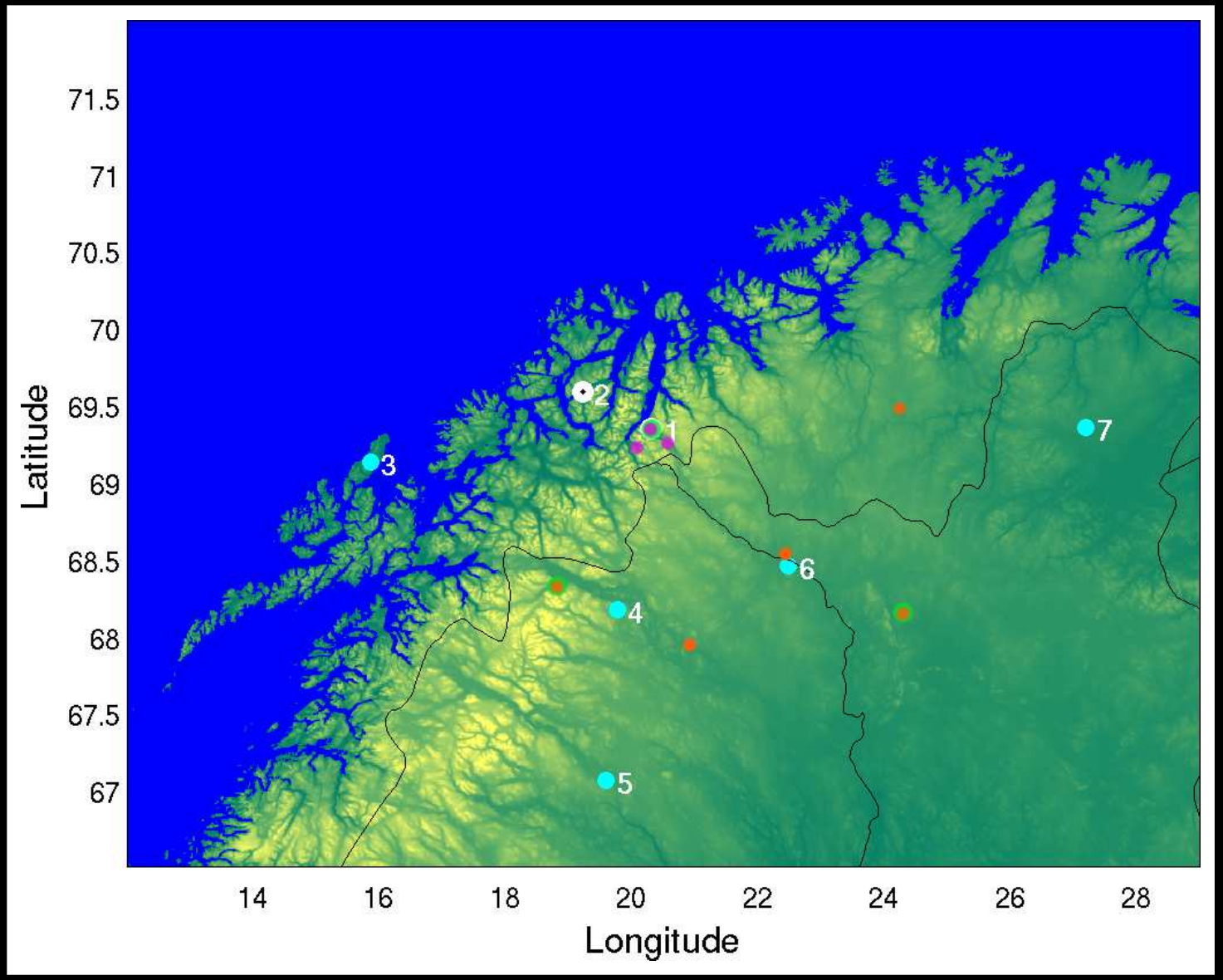
Optical measurements are a requirement for EISCAT_3D!
new-moon periods are popular! (Gustavsson, present EISCAT)
There are clear and solid scientific objectives for optical instruments!

Expect the unexpected

- High-latitide RIOE [**Brändström** *et al.*, 1999]. Tomography of RIOE [*Gustavsson et al.*, 2001]
- Water in leonid meteor trail [*Pellinen-Wannberg et al.*, 2004]
- RIOE in all emissions [*Gustavsson et al.*, 2005, 2006]
- X-mode optical effects (*Sergienko et al.* [2013]; *Blagoveshchenskaya et al.* [2014])

EISCAT is used in nearly all publications using ALIS data (≈ 44)

Gustavsson 2013



After Gustavsson 2013

ALIS_4D

ALIS_4D objectives

- Scientific objectives: See EISCAT_3D Science case! (Aurora/RIOE/Meteors and more, Appendix A1 and A3 if lazy.)
- A Swedish contribution to complementary instruments for EISCAT_3D
- ALIS is old and in urgent need of replacement, will be decomissioned spring 2019, infrastructure re-used for ALIS_4D.
- _4D: Much improved temporal resolution > 25 FPS, and the tight connection to EISCAT_3D (but also ESRANGE!).
- (ALIS_4D is a name, not an acronym).

ALIS_4D

- Phase I (done): Replace CCD heads, increased temporal resolution, continous measurements. (Skipped re-use of old ALIS optics which would lead to a reduction in the FoV from $\approx 60^\circ$ to $\approx 30^\circ$).
- Phase II (now): New optical systems, increase FoV $\approx 150^\circ$. Early operations with EISCAT, sounding rockets, etc. from $\approx$ fall 2019
- Total investment for phase I–II is ≈ 2 MSEK. Generously funded by Kempestiftelserna, department of Physics at Umeå University and IRF.
- Phase III (2020?): More stations in coordination with EISCAT_3D and Norway/Finland.

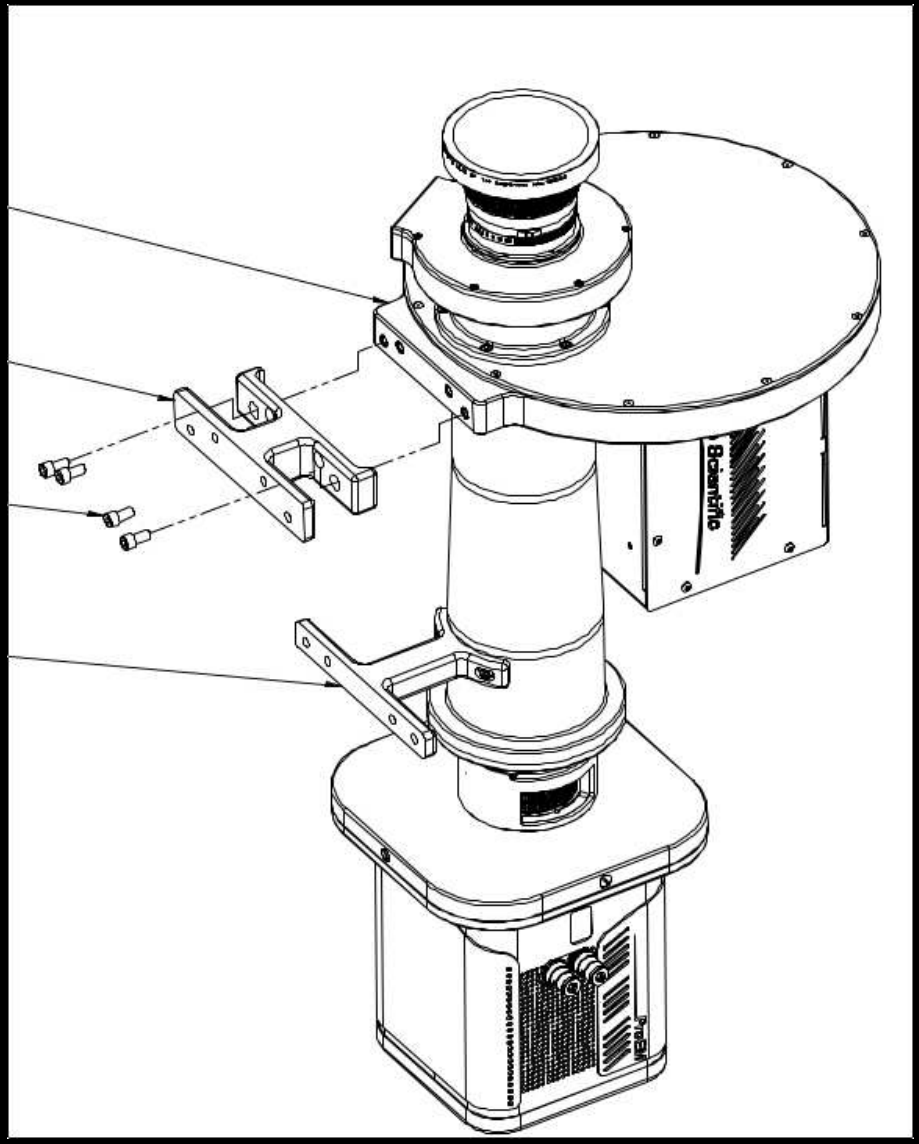
ALIS_4D timeline (1)

Jun 2016	First ideas (UB/APW)
Sep 2016	Applications to Kempe/UmU
Nov 2016	Investment funding granted
Mar 2017	Procurement of imager heds begins
May 2017	Order for four Andor EMCCD imager heads Andor DU-888U3-CS0-#BV (Azpect AB)
Jun 2017	Procurement of optical systems begins
Sep 2017	Delivery of 4 EMCCD imager heads acceptance tests begins Order for 4 optical systems FoV $\approx 150^\circ$

ALIS_4D timeline (2)

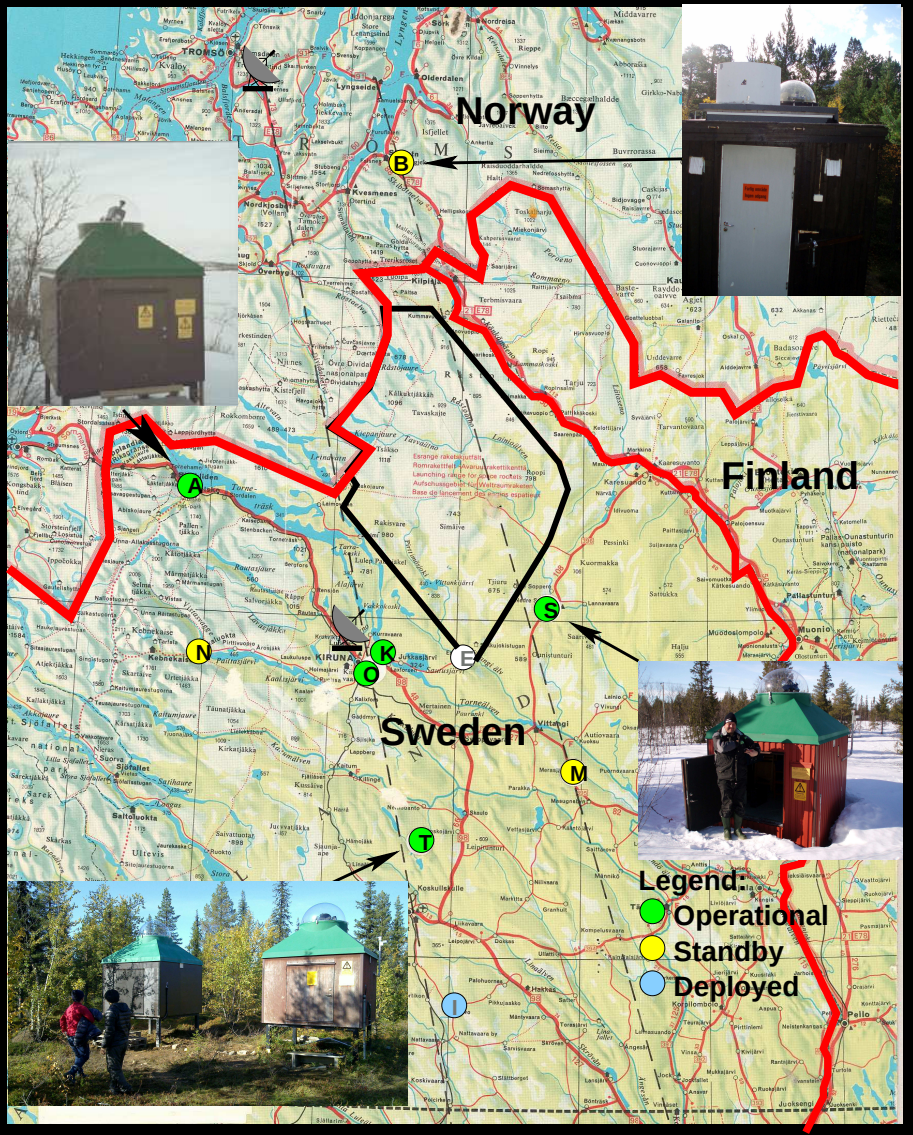
Oct 2017	First light, lab. tests Hardware/Op. software work begins
Mar 2018	Delivery of 4 optical systems Integration begins (filterwheels) Op. software/analysis code
Fall 2018	Calibration/qualification Early operations?
Sep 2019	Operation begins (preliminary) EISCAT/Heating/BROR/SPIDER2
2021	EISCAT_3D operations begins

The ALIS_4D imager



Modified Keo Scientific Sentry 3 imager

ALIS_4D sites



ALIS/ALIS_4D

	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	$1024^2 \approx 100\text{m}$ $256^2 \approx 500\text{m}$	$1024^2 \approx 750\text{m}$ $512^2 \approx 1.5\text{km}$
Time	12 FPM	> 25 FPS
Mode	Campaign only	monitoring/campaign

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

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

"Harddisks are either new or full" [Gustavsson]

Conclusions ALIS_4D

- Yes! Finally!
- Faster, more sensitive and easier to handle than ALIS
- Compatiple with Norwegian (UiT) and Finnish (SGO/FMI) efforts
- Long time monitoring (similar to MIRACLE) and dedicated campaign operations.
- EISCAT_3D is a strong scientific focus for STP and Observatory at IRF
- Some data storage and handling challenges
- Still there (funded) when EISCAT_3D starts?
- Funding! Long term operations, upgrades, more stations, positions, . . . VR Behovsinventering 2017, application 2019? (if on roadmap)

Complementary instruments for EISCAT_3D

Hoping for synergies

- One integrated system, one set of data and meta-data formats
- One user interface!
- Integrated scheduling
- Integrated and (semi-) automatic data analysis.
- Funding and operations simplified. Everything does not depend on a single reserach group.
- Scientific capabilities are HUGE compared to investment cost!
- Integrated data-analysis (standard data-products)

Conclusions (complementary)

- Coordination/Collaboration Norway, Sweden, Finland, Japan, U. K. and others?
- Should be complementary for rockets and balloons too?
- Responsibility? Who makes sure that we have complementary instruments? Somebody else?
- Funding: The funding landscapes is very unclear!
- Staff: We are very few! Urgent need for positions now! (young scientists)!
- Observatory mode vs. campaign mode
- Same infrastructure can be used for different instruments

Thank you!

Work in progress!

References

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