

EISCAT Software Discussion Meeting @ UiT

Date: Dec. 7, 2022
Time: 13:00-18:00 CET

Attendees

EISCAT: Axel Steuwer, Harri Hellgren, Simon Brown, Taishi Hashimoto, Anders Tjulin, Esa Wikström, Ingemar Häggström, Juri Katkalov, Jussi Markkanen, Carl-Fredrik Enell

UiT: Devin Huyghebaert, Juha Vierinen, Ingrid Mann, Björn Johan Gustavsson, Patrick Guio, Inger Solheim

IRF: Urban Brändström, Daniel Kastinen, Stephan Buchert, Johan Kero, Evgenia Belova, Tima Sergienko

MISU: Jörg Gumbel

BAS: Andrew Kavanagh, Mervyn Freeman

Oulu / SGO: Thomas Ulich, Ilkka Virtanen, Anita Aiko

Unis: Lisa Baddeley, Noora Partamies

Bergen: Norah Kwagala, Lindis Bjoland

Minutes

Devin Huyghebaert (DH) detailed the agenda for the meeting

Harri Hellgren (HH) introduced his presentation which he hoped would stimulate a good discussion. His presentation described user access to EISCAT_3D through a Jupyter system, with EISCAT providing software for experiment description. He described experiment flow with the topic for meeting being off line analysis. **HH** described how libraries will be used for experiment submission and access to data.

DH asked **HH** to explain more about Rucio and **Carl-Fredrik Enell (CFE)** offered to give a short presentation on data management, EGI Checkin and Perun.

HH explained that Rucio is the data management system used by CERN to transfer data between partner data centres and asked how much data will go to University HPC centres

Juha Vierinen (JV) asked what data he will be able to access.

HH responded that voltage level data will be off limits and that integrated lag profiles are the expected products.

HH discussed meteors and space debris and how such experiments will run in the system

HH described the software environment for experiment description. Experiments will be described using python libraries developed by EISCAT. Users will not develop programs that then perform experiments, instead they will use the software to describe their experiment and the system will convert that into the required commands. As well as describing transmission and reception **HH** showed how computation tasks can be added to experiments, so called on-line computing. The system will take care of all of the timing and triggering.

Urban Brändström (UB) asks how we can integrate EISCAT_3D with external events.

HH explained that it will be possible to have a dormant experiment that is automatically triggered by an external event.

JV asked about latency and **HH** answered that it is expected to be five seconds.
JV responded that five seconds is too slow for meteors but okay for auroral arcs.
HH responded that the hard limit is one second
Ingrid Mann (IM) asked if that is good enough for meteors
JV answered no.

CFE and JV mentioned beam spoiling

DH asked how long it takes to change the TX beam to switch
HH answered 1s and mentions the data network.

UB asked if instead it would be easier for EISCAT_3D to control other instruments.
HH responded that it is not planned, but should be easier.

UB raised Meteors and the required lag profile resolution.
Bjorn Johan Gustavsson (BJG) asked for 0.1s resolution and
JV mentioned a conditional Integration paper at roughly millisecond level. It is mentioned that this is offline analysis, not real time.
JV mentioned that voltage level data is required to measure NEIALs variation on the scale of a single pulse, that similar problems exist with heating experiments and that raw data must be available at some point.
HH responded that the process will be cleaning then lags, to which
JV added that raw data is not incompatible with cleaning.

There was then a discussion of whether to differentiate between missing data and debris,
Daniel Kastinen (DK) proposed marking them both the same.
IM asked how common hard targets will be, how much cleaning must be done and whether part of the height profile will be missing.
CFE mentioned automatic whitelisting of low altitude objects.
JV added that space debris is at 900km and that most will not clutter the F or the E region and that 80% of the time an object will be in the beam.
IM asked about working with objects below 250km.
Jussi Markkanen (JM) suspected that no altitudes are safe and
JV added that range aliasing is the problem with a malicious experiment.

Anita Aikio (AA) asked about the schedule for Developing cleaning.
Axel Steuwer (AS) responded that the conversation is drifting off topic.
AA agreed and added that 5 second integration is okay for plasma parameters.

JV suggested that we try to avoid known hard targets by using space track.
Patrick Guio (PG) commented that this isn't practical for a long running experiment.
JV talked about doing the removal before integration and
JM added that we need more statistics on the data.

DH asked about lag profiles and
Esa Wikström(EW) spoke about his frequency domain decoder FD Dec.

DH asked about interpulse and intrapulse lags and

EW responded that this is possible.

HH commented that EISCAT can clean the data before making the lag profiles.

DH asked about creating custom experiments and it was explained that this has to be done in cooperation with EISCAT.

DK suggested publishing the required algorithm then EISCAT can implement it.

JV talked about pipelines and matlab files for GUIDAP.

HH responded that is a question for part 2.

JV stated that users just want plasma parameters.

HH asked **JV** about adapting GUIDAP for E3D.

JV asked for a new data format with the new version.

Simon Brown (SB) agreed and asks for input.

There was a discussion about data requirements for NEIALs, PSMEs, radar cross sections and how meteor researchers would like higher sampling rates for fragmentation. It was noted that this could be a case for 52 MSps.

Johan Kero (JK) asked about running in campaign mode, where knowing the absolute time of the data is required, but the access to the data can be greatly delayed.

EW asks if EISCAT could do that.

JV explains that developing techniques is tricky and requires trial and error.

Event search algorithms which search for interesting data within a set were raised.

JK added that the E3D instrument is new and we will have to find its limits. We don't know if the meteor head is a point at 52 MSps. He added that overlap with the UHF system would be very useful along with MAARSY.

Ilkka Virtanen (IV) added that data with only relative timing is okay for him and that he too does not like the current data format.

IV asked about the experiment development cycle and checking.

Juri Katkalov stated that the experiment structure is in JSON.

HH showed an experiment description and there was a discussion of pointing directions, dwell times, cycles, beamforming, compute and coherent integration.

JV asked about cluster computing and **PG** about experiment generators.

HH showed the skymap experiment widget as an example of a generator and of an interactive experiment.

HH also explained that the gaps in the data were due to data loss with the FSRU.

PG asked about calibration using Cas-A or another known source which developed into a general discussion about calibration.

HH described the calibration masts and their limitations.

HH asked for ideas from the community.

DH asked if the data from the PET was regarded as safe.

HH responded that it is still unknown whether the PET will be regarded as safe. It was discussed how the PET should be able receive tropospheric echoes along with the DC offset in the PET data due to integer sampling.

JV mentioned how he removed DC offset with USRPs by setting the firmware to round rather than truncate.

HH described the beamforming chain in the FSRU and

JV asked about how the bits are being excited.

HH responded that the current settings are very conservative so we don't saturate.

JV would like more bits of dynamic range.

DH asked about having 5 narrow beams at Skibotn.

HH and **SB** responded that 5 fives is okay.

HH showed how it would be done.

DH and **JV** asked about imaging

A processing node specifically for imaging analysis was discussed during the coffee break

PG asked about MPI architectures, **DK** supported the suggestion adding that it can be used on all architectures and GPUs. **SB** mentioned that it might be possible to make the second stage beam forming nodes available as compute nodes to users.

Coffee break 15:10-15:40

Part II @ 15:40 Analysis

HH listed the priorities

1. Produce lag profiles
2. Adapt GUISDAP interface
3. Port GUISDAP to e3d interface
4. Develop new analysis services

PG mentioned full profile analysis and a C++ version by Ivan Finch at RAL was discussed but expected to be dead.

JV mentioned that **IV** has some multi-static fitting code.

Lisa Baddley (LB) commented that next generation GUISDAP must be multi-platform so that it can be run in University classrooms.

SB asked **IV** about his multi-static fitting code.

IV responded that the code is 10 years old and needs time and funding to develop, it needs polish before it can be released.

IV continued that its advantage over GUISDAP is that it's volume based rather than beam based, lag profiles are the input data, it has a simple internal format and that multi static analysis should be better for 3D due to the high power and noise at the transmit site.

Stephan Buchert commented that GUISDAP now has magnetic field model integration using IGRF.

IV responded that his software does account for the magnetic field.

AA commented that multi-static analysis is important for anisotropic temperatures.

Andrew Kavanagh (AK) stated that the UK needs some form of GUISDAP for 3D data very soon and that laptop analysis may not be practical.

IV talked about his tool Puffin for high time resolution parameter fitting which he has kept independent of GUIDAP. It offers full profile analysis, not just gate by gate and is coupled with a chemistry model, flipchem.

Stephan B asked which platform should we use for the large E3D data volumes, should they be transferred to HPC centres?.

AK would like a modular HPC system.

LB reminded everyone not to forget the Svalbard radar, to which

AK added that we cannot forget the old data either as it will be used for long term studies, to which

AA agreed

AA continued by asking whether the Quick Looks currently available in madrigal will continue and what the plans are for data visualisation.

BJG recommended Vis5D.

LB has looked at the Visa project data and it looks promising.

CFE asked about provenance for diagrams.

LB added that real time visualisation is needed for rocket launches.

AA added that she was concerned about loss of meta data, everything must be saved.

AK asked how xMISR do 3D visualisation and offered to contact them.

JV asked who will take over from Ingemar to which

AS responded that a position will be advertised soon.

JV added that the new Ingemar will have a lot of sway over what is done, to which

AS responded that it will not just be the new Ingemar, the whole community will have sway and that new analysis software is required as GUIDAP is end of life.

JV new Ingemar will be the interface for future development.

AS raised resources and states that **JV** can contribute code.

DH asked if EISCAT can provide a proposed data format.

HH responded that data will come from an exporter service.

JV asked how EISCAT will calibrate E3D without an ionosonde. He is concerned that the system may never see any plasma.

AA is also concerned about calibration.

IH has been looking at what they do at xMISR.

AS proposed a discussion at EISCAT HQ.

PG pointed out that calibration is not stable.

BJG asked if **JV** can sell EISCAT an ionosonde, to which

JV responded that they cost 300k SEK and he provides open source software.

Anders Tjulin (AT) added that an ionosonde would be required in the measurement volume. **AT** showed examples of plasma lines observed through DAB interference, so plasma line calibration should be possible.

Thomas Ullich (TU) talked about how in Russia they have an oblique sounding network of ionosondes and that the bare minimum is that Skibotn has one, but the more the better.

IV mentions Faraday rotation will be significant, to which

IH adds that more than 180 degrees and less than 360 is expected and that getting plasma lines from the remotes may be easier.

JV added that he is still concerned about DAB.

CFE presented Rucio

AS asks how we should carry on and

HH requested something more modern than email.

AA mentioned the slack channel and there is a discussion about the need to pay for it.

DH added that emails still have a place.

TU recommended Discord (<https://discord.com/>) and

CFE recommended Mattermost (<https://mattermost.com/>).

AS stated that EISCAT will investigate and get back to the community.

TU asked that a summary of this meeting is given as a presentation at the Sodankylä observatory days in January.

End of Meeting @ ~ 17:45

Outcomes

- OpenMPI appeared popular with the group and EISCAT will research how it could be used for data analysis
- EISCAT will attend the Sodankylä Observatory Days meeting
- Using web based notebooks for analysis and experiment design is much better for classroom teaching.
- Python will be the user language for the new analysis software
- Missing data and cleaned data will be indistinguishable in the data.
- The new analysis system must not neglect Svalbard data or data from the current mainland system.
- EISCAT will provide a version of GUISDAP that is adapted for E3D.
- There should be more regular Software Group Meetings, there was enthusiasm for hackathon type meetings as well.