Introduction to EISCAT

What you need to know to run an experiment

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EISCAT Scientific Association

Incoherent scatter radar school 2016, Sodankylä

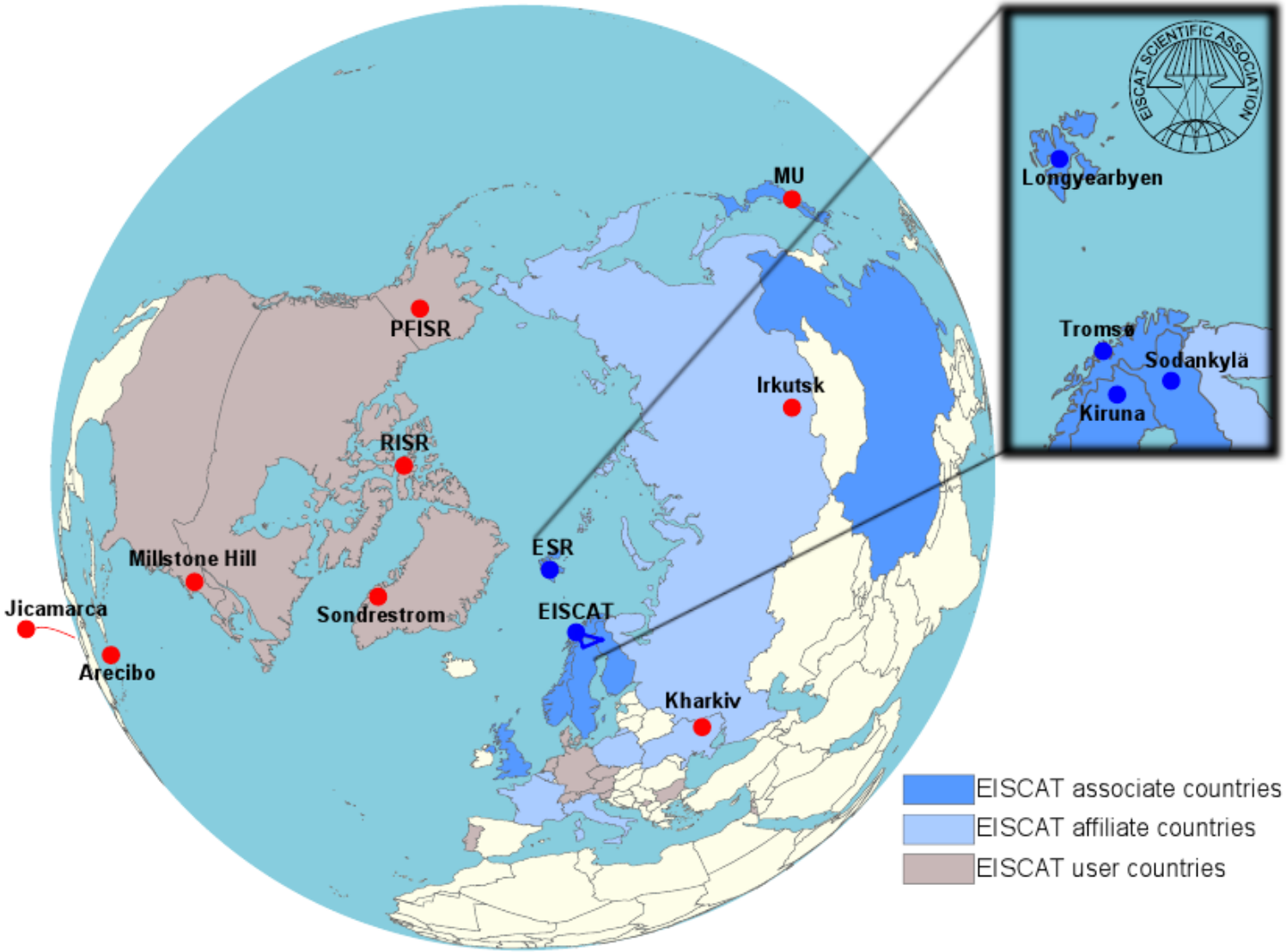
Outline

What is EISCAT?

- Originally European Incoherent Scatter Scientific Association
- International organization based in Kiruna, Sweden
- Member institutes in six countries (FI, NO, SE, UK, JP, CN)
- Affiliate institutes in FR, KR, RU, UA
- Three incoherent scatter radars
- Ionosonde
- Ionospheric heater

`http://www.eiscat.se`

EISCAT in the world



Map Anders Tjulin

EISCAT Svalbard radar (ESR)

- 500 MHz band
- Longyearbyen, Svalbard, 78°09'11" N, 16°01'44" E
- Magnetospheric cusp and dayside auroral oval

From slides by Assar Westman

EISCAT mainland radars

Nightside auroral oval, atmospheric dynamics, active heating. . .

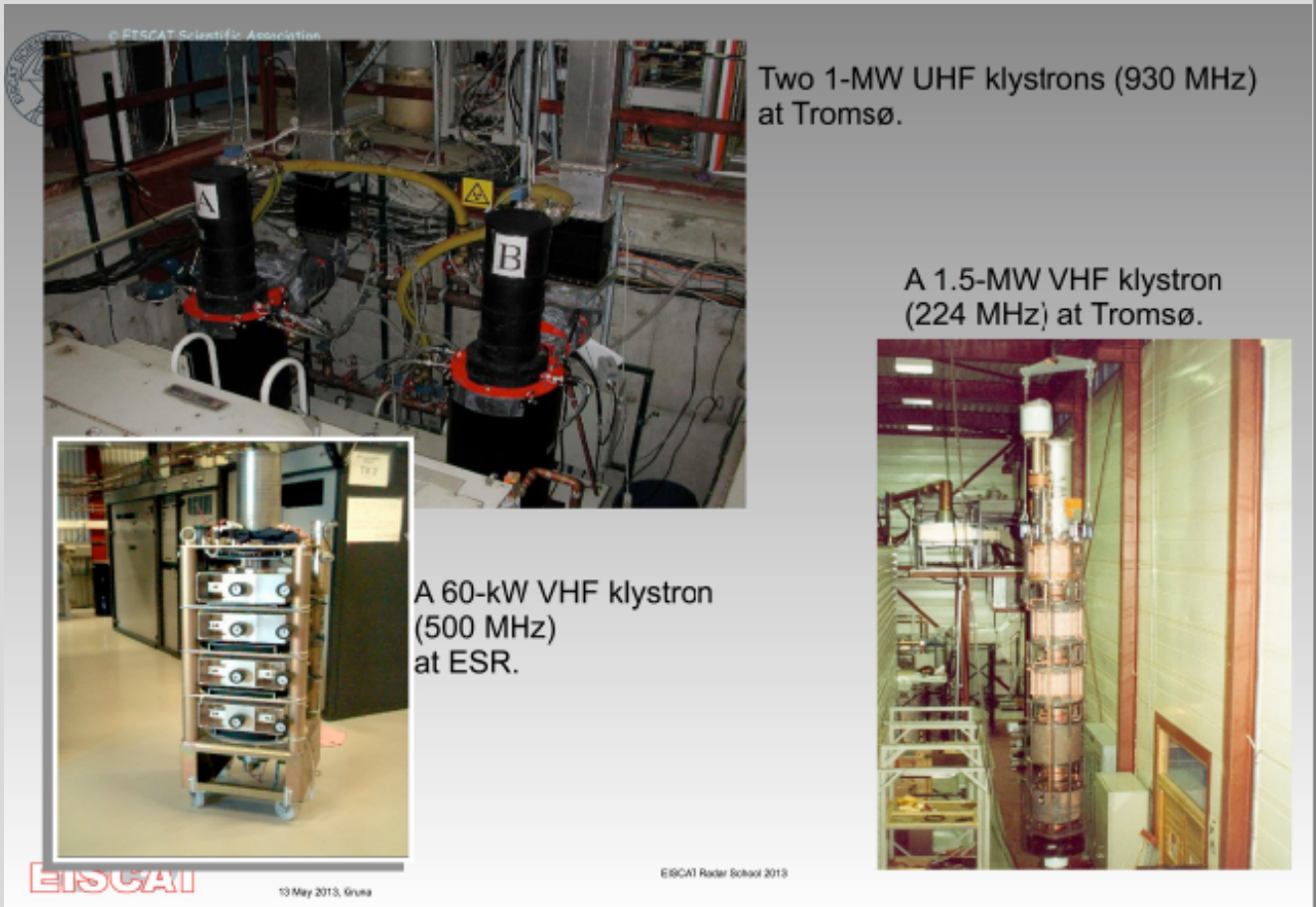
- UHF, 930 MHz
- VHF, 224 MHz, tristatic

Outline

Transmitting a signal

Power amplifiers

- Raise the output power
- Peak output 1 MW or more (average some 250 kW)
- Waveguides to the antennas

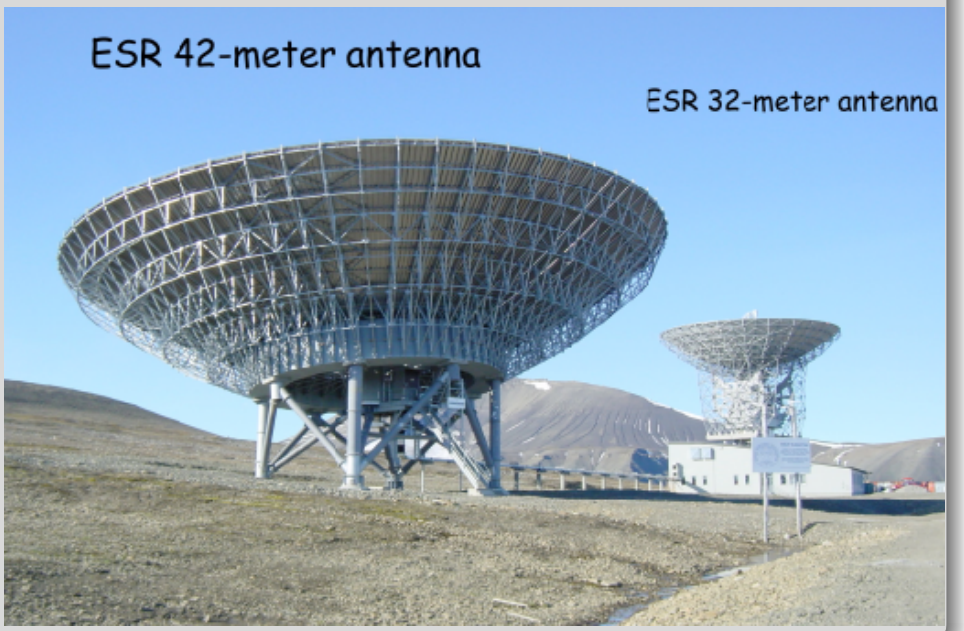


NB: an operator must be on duty to turn on the transmitters!

Transmitting a signal

Antennas

- Waveguide from klystrons
- ESR has antenna switch
- Polarizer
- Receiver protection



Receiving the scattered signal

Analog receiver chain

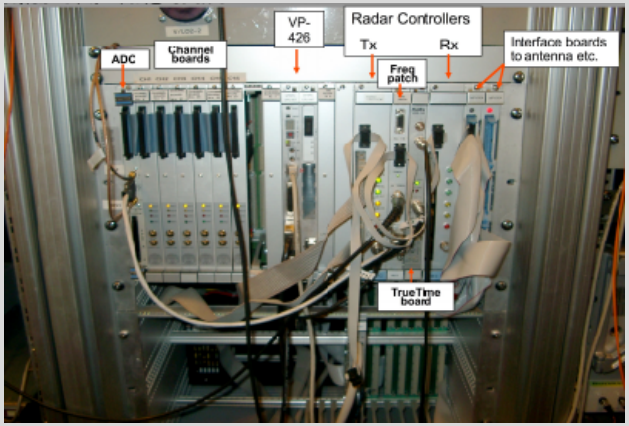
- Antennas: T/R switch, Receiver protector
- Low noise amplifiers
- Mixers
- Filters

Digital receiver chain

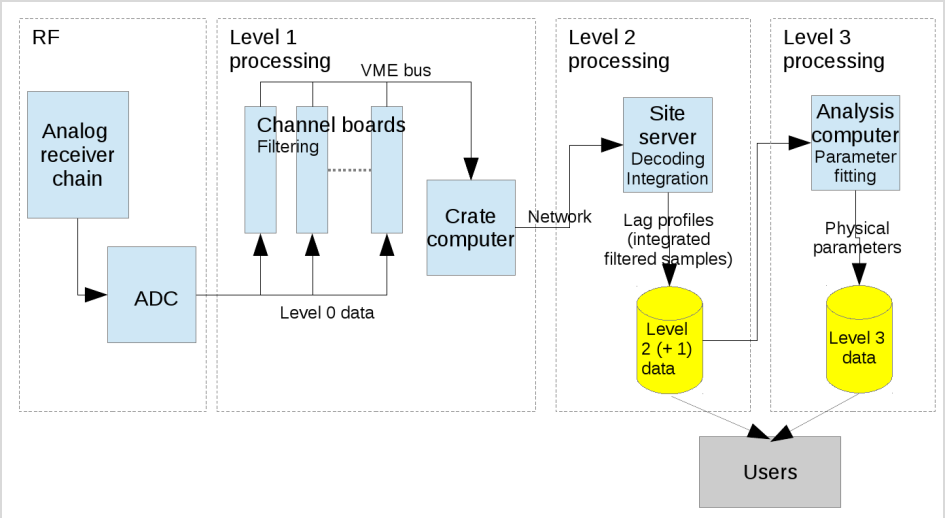
- A/D converter
- DSP boards
- Software

Receiving the scattered signal

Digital receiver (and radar controllers): the VME crate



Schematic summary



Outline

Experiment considerations

https://www.eiscat.se/groups/Documentation/UserGuides/eiscat-experiments/at_download/file

1. Radar and antenna
   - location
     - ★ Svalbard
     - ★ Mainland
   - frequency
     - ★ UHF
     - ★ VHF
2. Pulse code program
   - Altitude interval
   - Range resolution
   - Time resolution
   - Plasma lines or not
   - Raw data or not
   - Svalbard: antenna switching

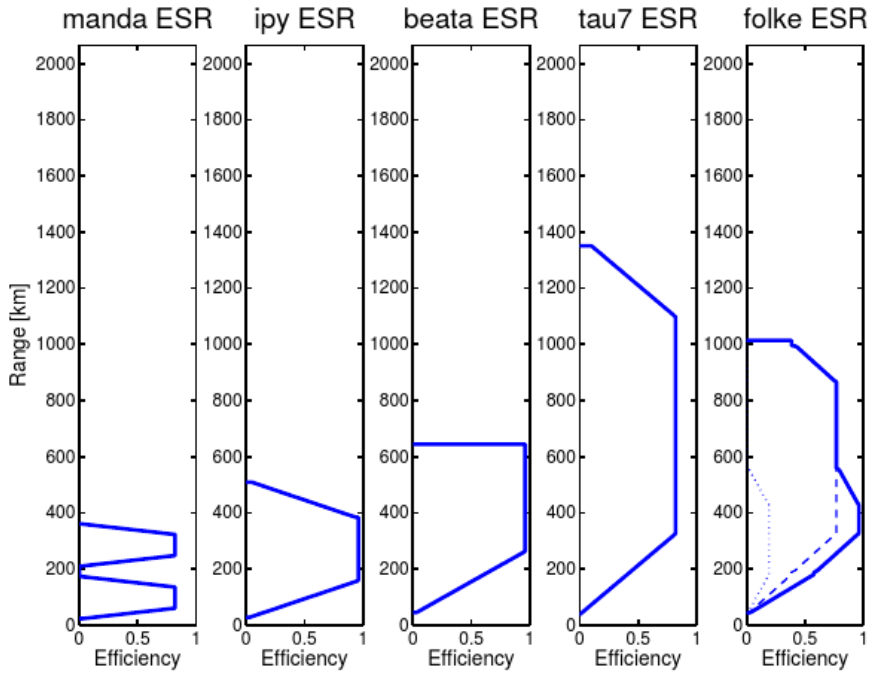


Figure 3: Overview of the ranges covered at the EISCAT ESR radar by the experiments used in the common programmes.

See document at URL above, courtesy Anders Tjulin

Experiment considerations

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Antenna scan patterns

- UHF, ESR 32 m antenna: fixed position or scan (if possible)
  - Field aligned vs latitudinal coverage
  - Vector velocity: neutral wind or electric field

  A fixed position highly recommended for your first experiment
- ESR 42 m antenna: fixed field aligned
- VHF tilt NB controlling this antenna is like moving a football field — time to change from vertical to low elevation is up to 20 minutes!

This means: if VHF is to be moved, we will have to do so in advance before the experiment night

Experiment considerations

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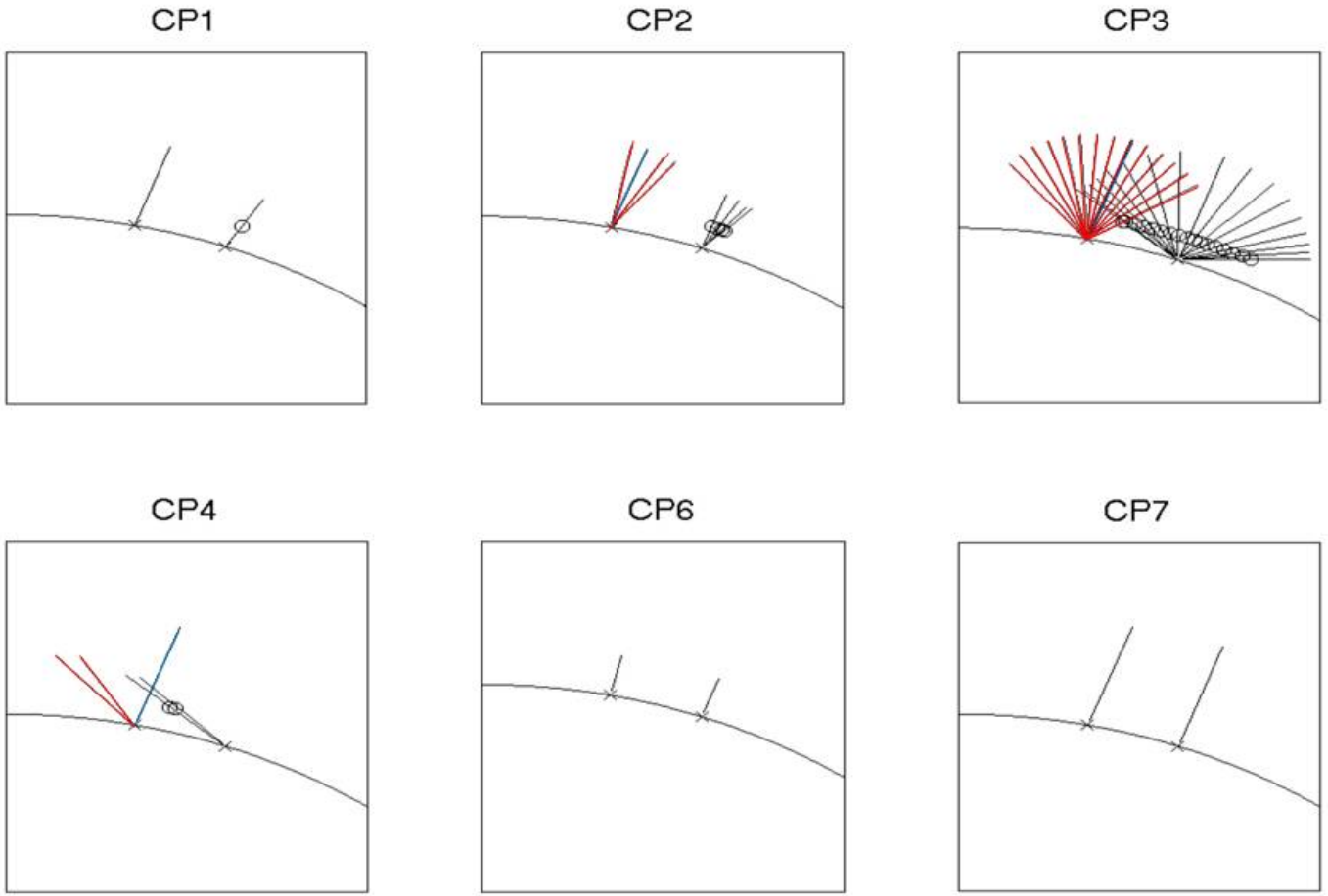
CP scan patterns



Some recommended pulse code experiments

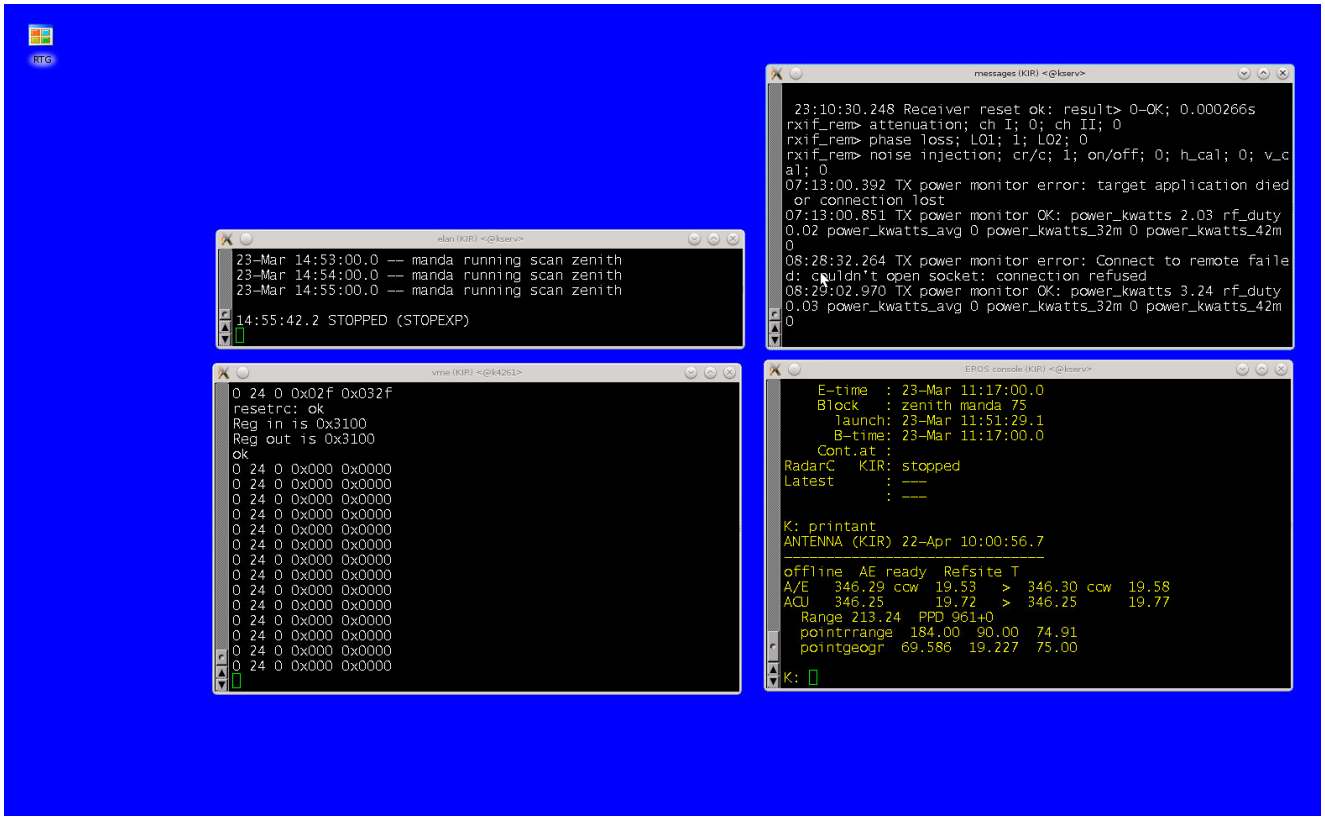
See documentation for which experiments available on which radar

manda	Middle atmosphere and D region, ion line only, high resolution, raw data
beata	Standard experiment with plasma lines
bella	Long baud length, for topside or low elevation, with plasma lines
tau7	Longest baud length, topside or low elevation
taro	Svalbard dual antenna
folke	Svalbard dual antenna

Outline

The EROS console (Kiruna site)

EISCAT Realtime Operating System



The window titled **EROS console** is a command line interface where you run all EROS commands. The programs are written in an extension of the Tcl/Tk script language, called ELAN.

Important EROS commands (see http://sgo.fi/~jussi/eiscat/erosdoc/eros_commands.html)

runexperiment Load and execute experiment ELAN file at specified time with specified parameters:
<experiment file> <start time> <scan pattern> <associate code / CP> <any additional parameters>

Example

`runexp /kst/exp/beata/beata fm ip2 CP`
Note: commands can be abbreviated!

enablerecording Important: enable data storage

printexperiment Show experiment status

pointdir (and other similar commands) Change antenna pointing

printantenna Show antenna pointing

stopexperiment Stop the experiment

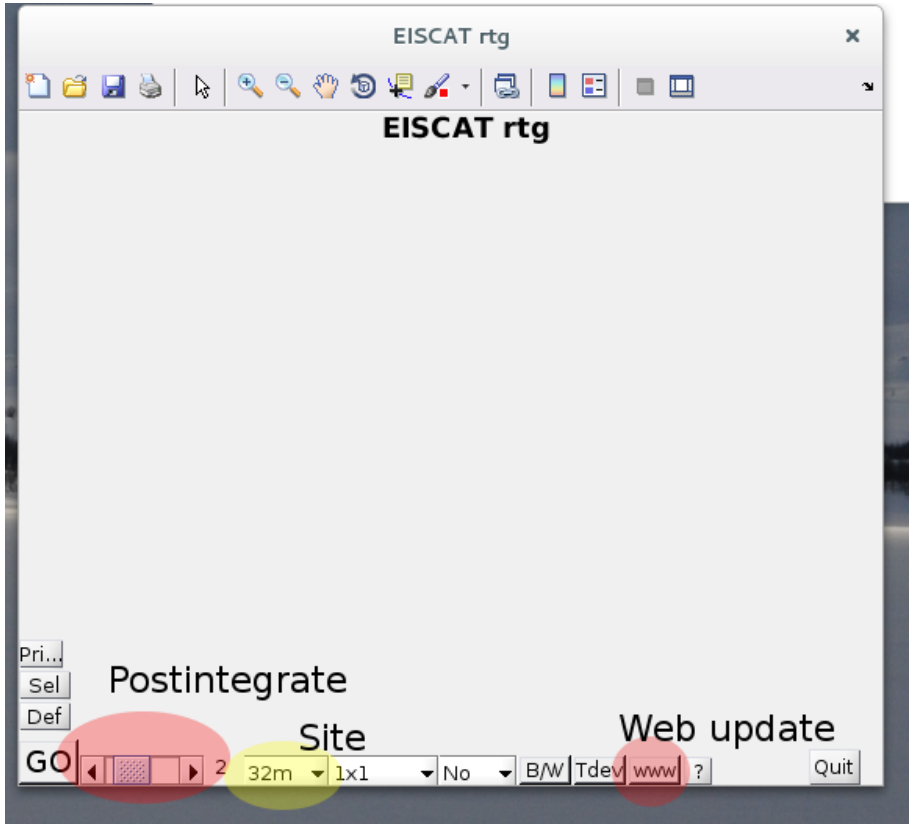
Real-time graph

RTG overview

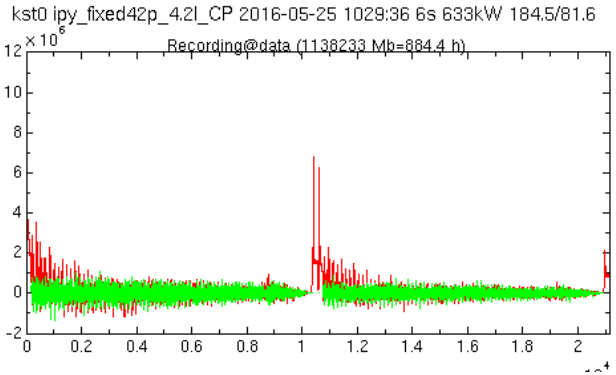
- Matlab software
- Reads data files
- Plots spectra and overviews
  - Selected in experiment's **rtg_def.m**
- Plots can go to EISCAT web page

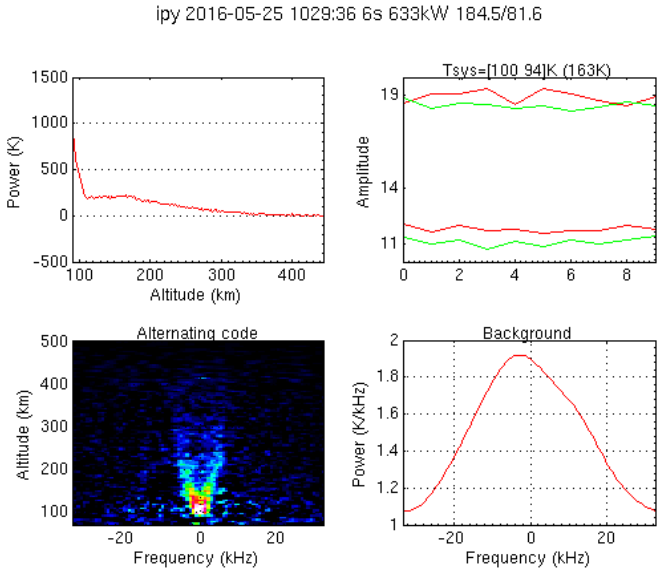
RTG user interface

- Post-integration of data
- Site and other settings
- Plot geometry
- Enable WWW update



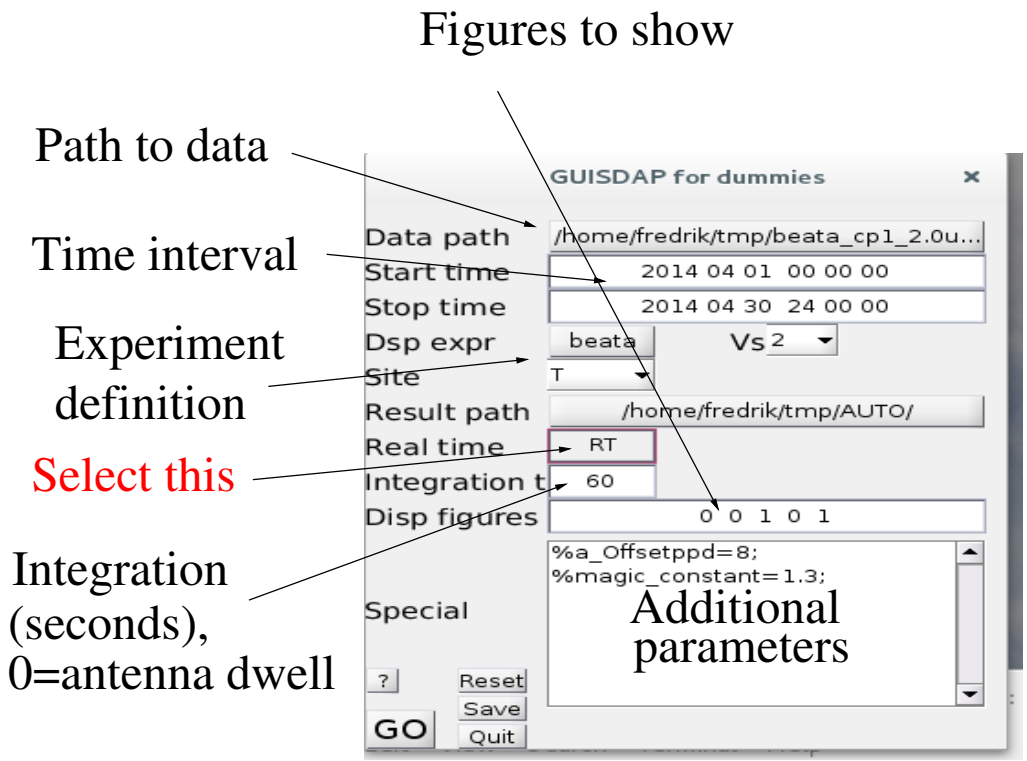
Example of RTG output





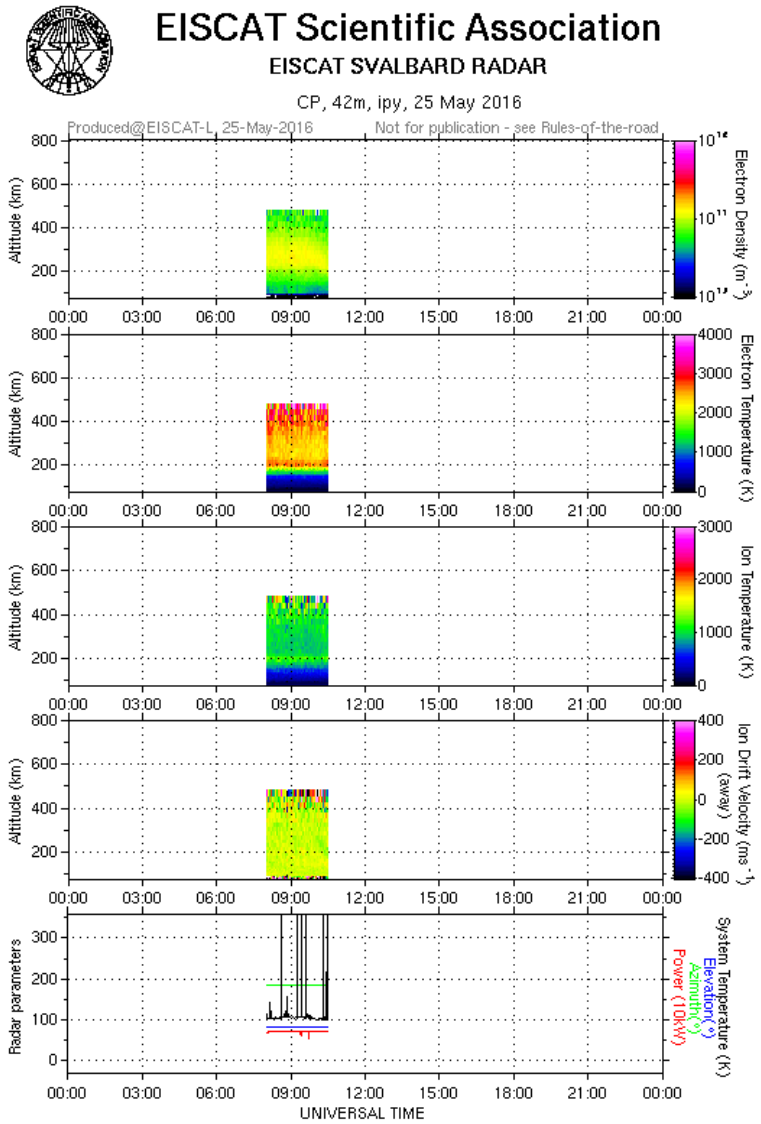
Real-time analysis

- GUISDAP: Matlab software package
- `guisdap -a`
- Set parameters and go



GUISDAP output (vizu)

Realtime output also on EISCAT web page



Outline

Designing **your** experiment

What to do next

Design your experiment

1. Decide on a scientific objective
2. Select a site and radar
3. Decide whether a certain time slot is preferred (when is "my" phenomenon most likely to occur?)
4. Required range, time resolution, etc. determine what pulse code to use
   - Consider e.g. **manda, beata, bella, tau7**
   - Check documentation for what code programs are available on "your" radar
5. Choose antenna pointing (or scan if required and possible)
6. Write a short proposal
   - Proposal is evaluated
   - Time is allocated (scheduling)

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Run your experiment

- Be in Polaria lecture hall well in advance before your allocated radar time!
- EISCAT and SGO staff will assist you how to
  - start your experiment
  - contact the on site transmitter operators
  - save and analyze the data
- Be prepared to have a plan B!

More information

- http://www.eiscat.se
- https://www.eiscat.se/groups/Documentation/UserGuides/eiscat-experiments/at_download/file
- http://sgo.fi/~jussi/eiscat/erosdoc/eros_commands.html)