Introduction to EISCAT

What you need to know to run an experiment

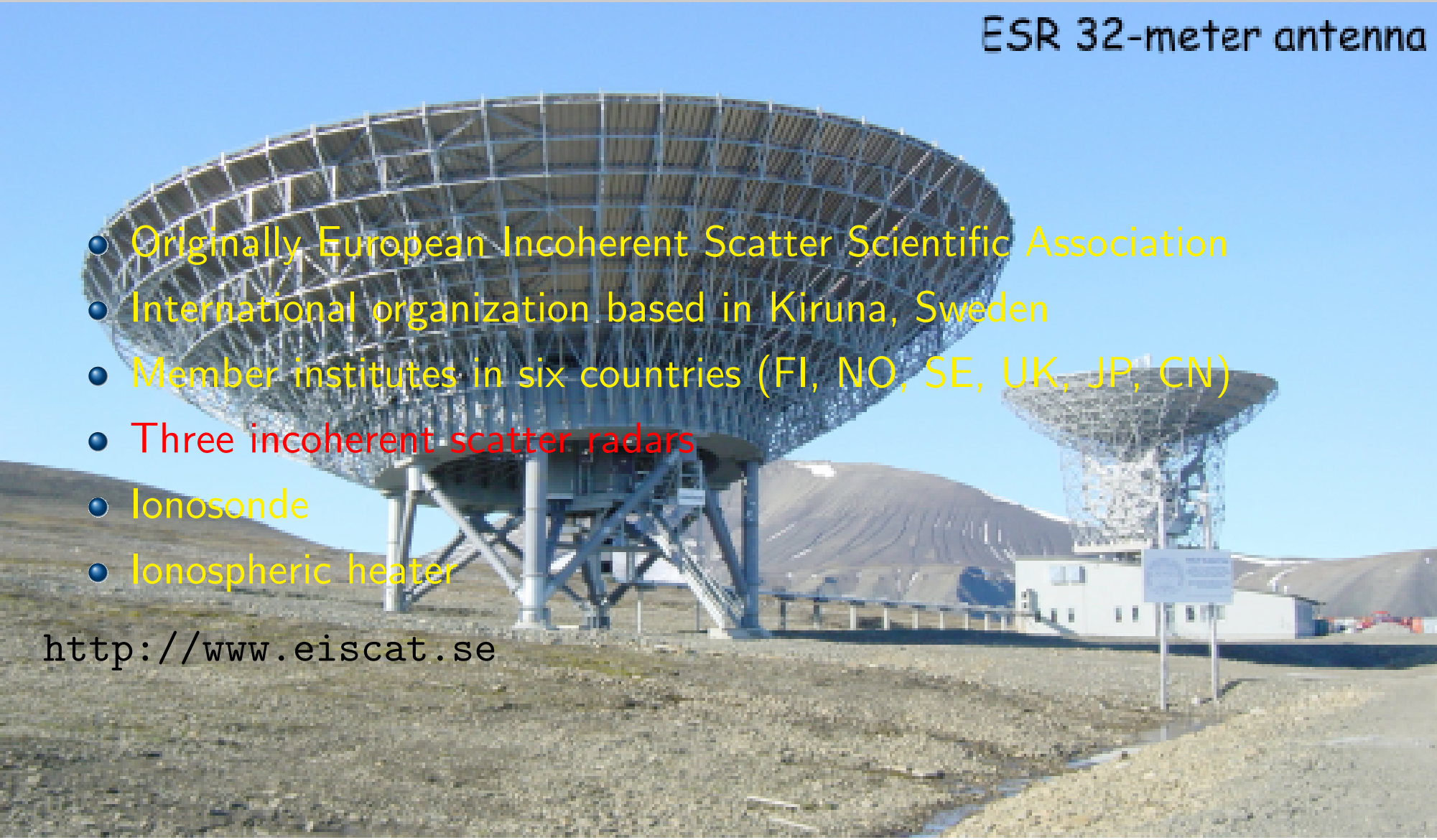
Carl-Fredrik Enell
carl-fredrik.enell@eiscat.se

EISCAT Scientific Association

Incoherent scatter radar school 2016, Sodankylä

Outline

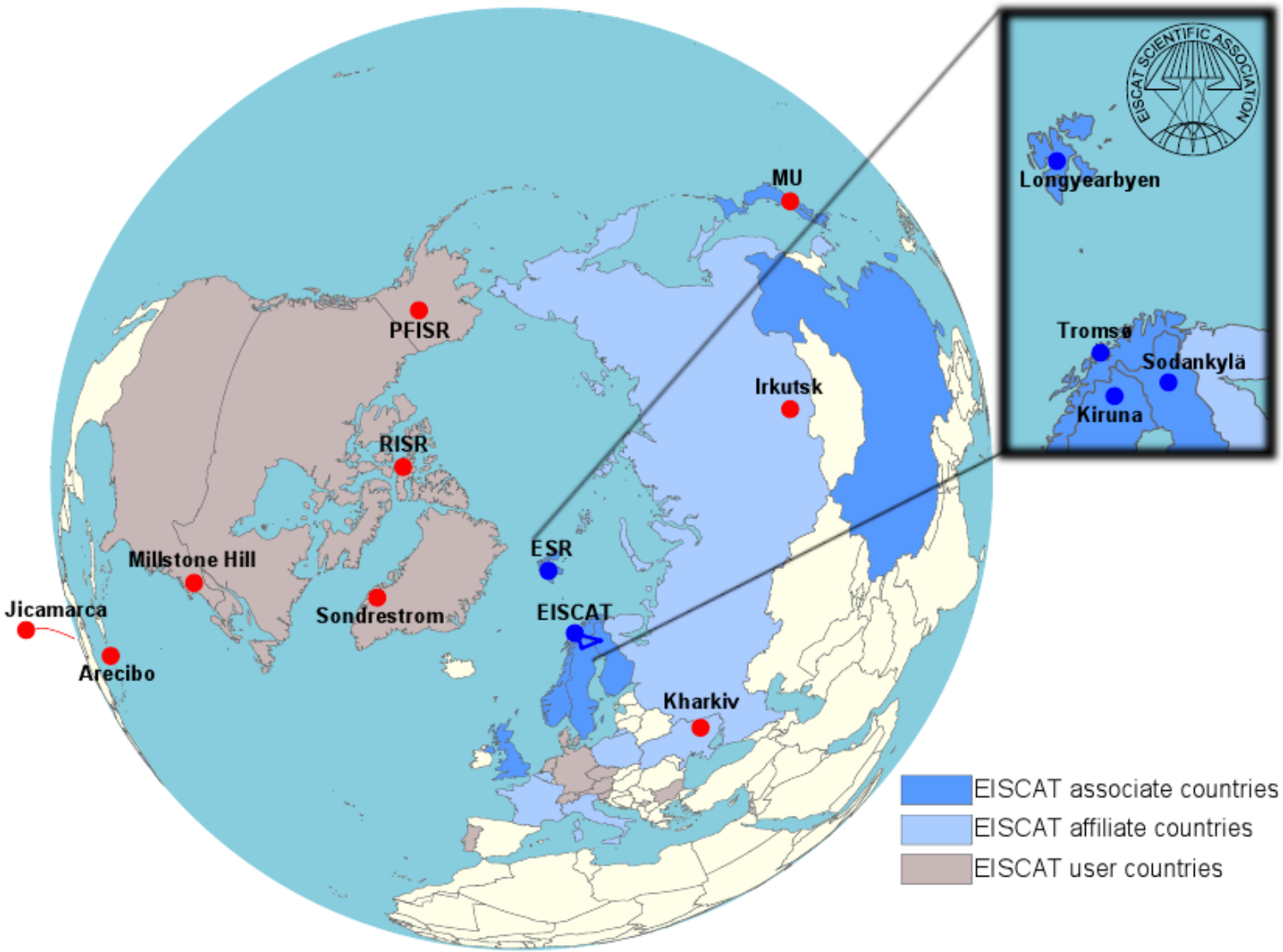
What is EISCAT?



- Orlginally European Incoherent Scatter Scientific Association
- International organization based in Kiruna, Sweden
- Member institutes in six countries (FI, NO, SE, UK, JP, CN)
- 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
- Cusp and dayside auroral oval

From slides by Assar Westman

EISCAT mainland radars

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

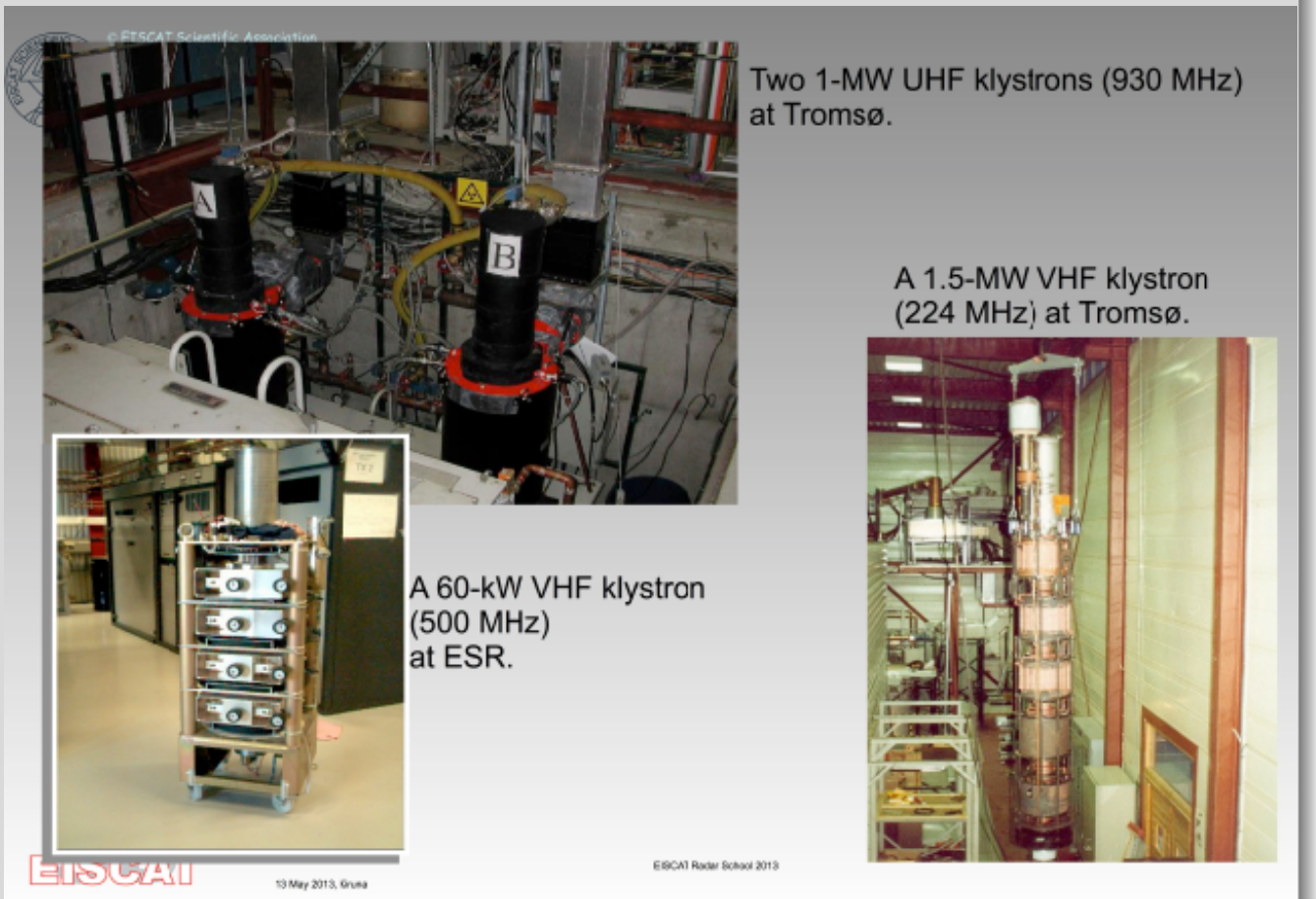
Nightside auroral oval, atmospheric dynamics, active heating. . .

Outline

Transmitting a signal

Power amplifiers

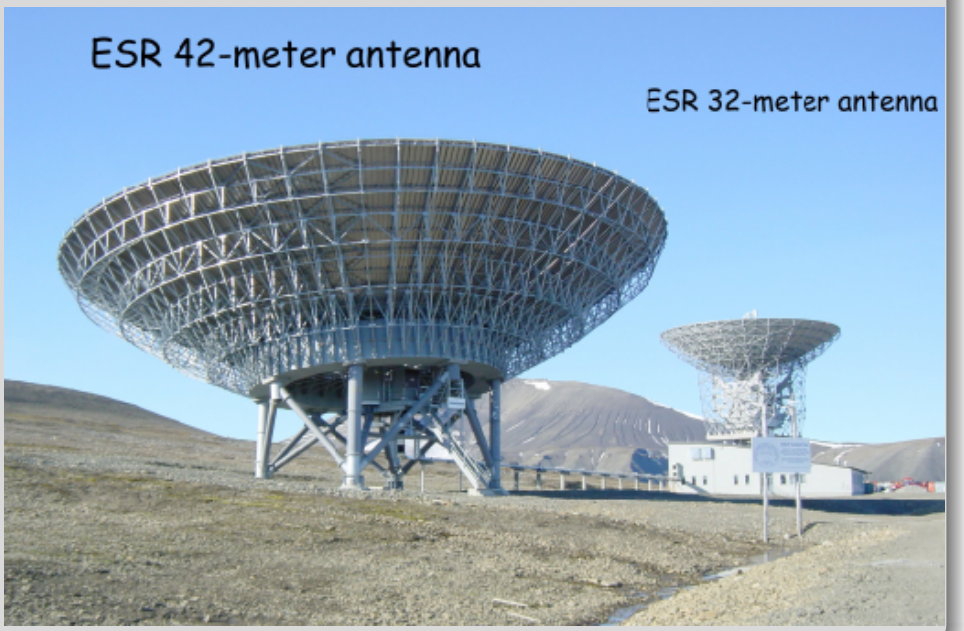
- Raise the output power
- Peak output 1 MW or more (average some 250 kW)
- Waveguides to the antennas



Transmitting a signal

Antennas

- Waveguide from amplifiers
- ESR has antenna switch
- Polarizer, mode converter
- Receiver protection



Receiving the scattered signal

Analog receiver chain

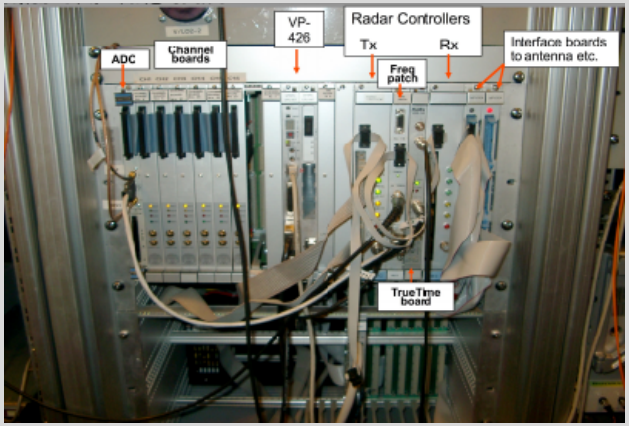
- Antennas: T/R switch, Receiver protector
- Low noise amplifier
- Mixers
- Filters

Digital receiver chain

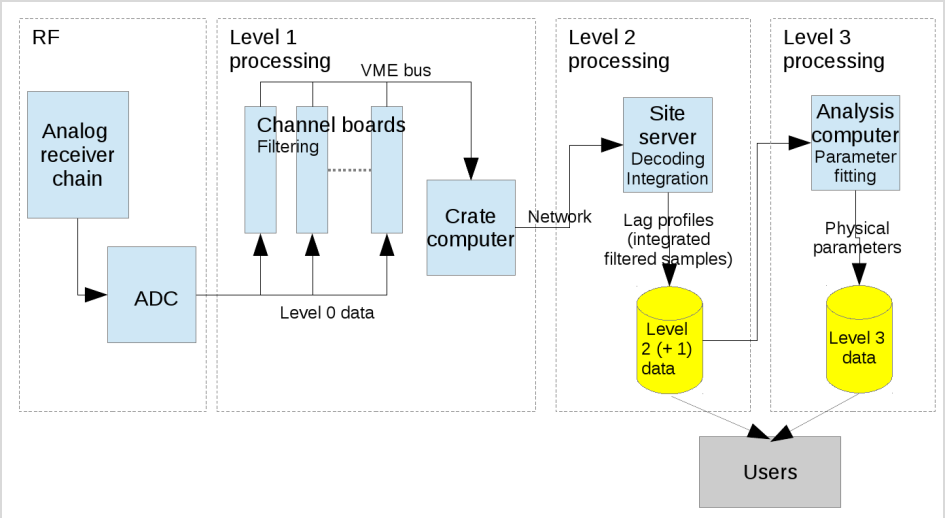
- A/D converter
- DSP boards
- Software

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

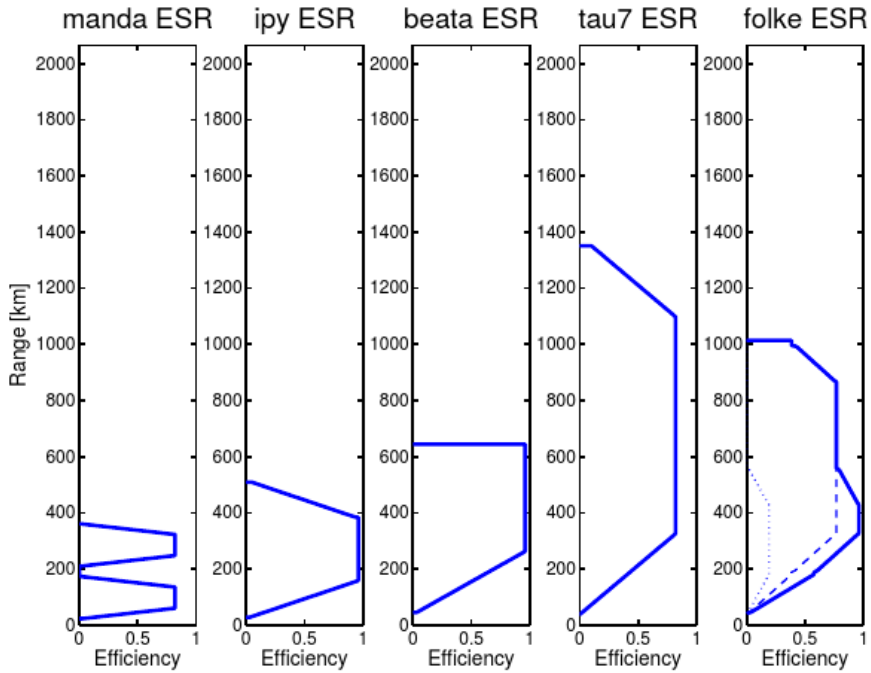


Figure 3: Overview of the ranges covered at the EISCAT ESR radar by the experiments used in the common programmes.

See document at URL above, courtesy Anders Tjulin

Experiment considerations

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

Antenna scan patterns

- UHF, ESR 32 m antenna: fixed or scans
  - Latitude coverage
  - Vector velocity, electric field
- 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 about 15 minutes!

This means: if VHF is to be moved, do so in advance before experiment night or during UHF experiment

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

EISCAT Realtime Operating System (EROS)

http://sgo.fi/~jussi/eiscat

- Handles all “slow” configurations
- Consists of several UNIX processes
- Based on **Tcl** script language
- Loads all configurations; VME crate computer talks to
  - antenna control unit
  - VME boards
  - ESR exciters

EROS programs

ELAN (extended Tcl/Tk) files

1. Main program
   - Loads all radar configurations including pulse code program
   - Synchronization
   - Starts experiment but not data recording

   Names are usually acronyms: **beata, bella, manda...**
2. Antenna scan program
   - ELAN subroutine loaded from main program
   - Runs pointing commands in a synchronized manner

   Names are typically intended Common Program use: **cp1, cp2, cp3...**

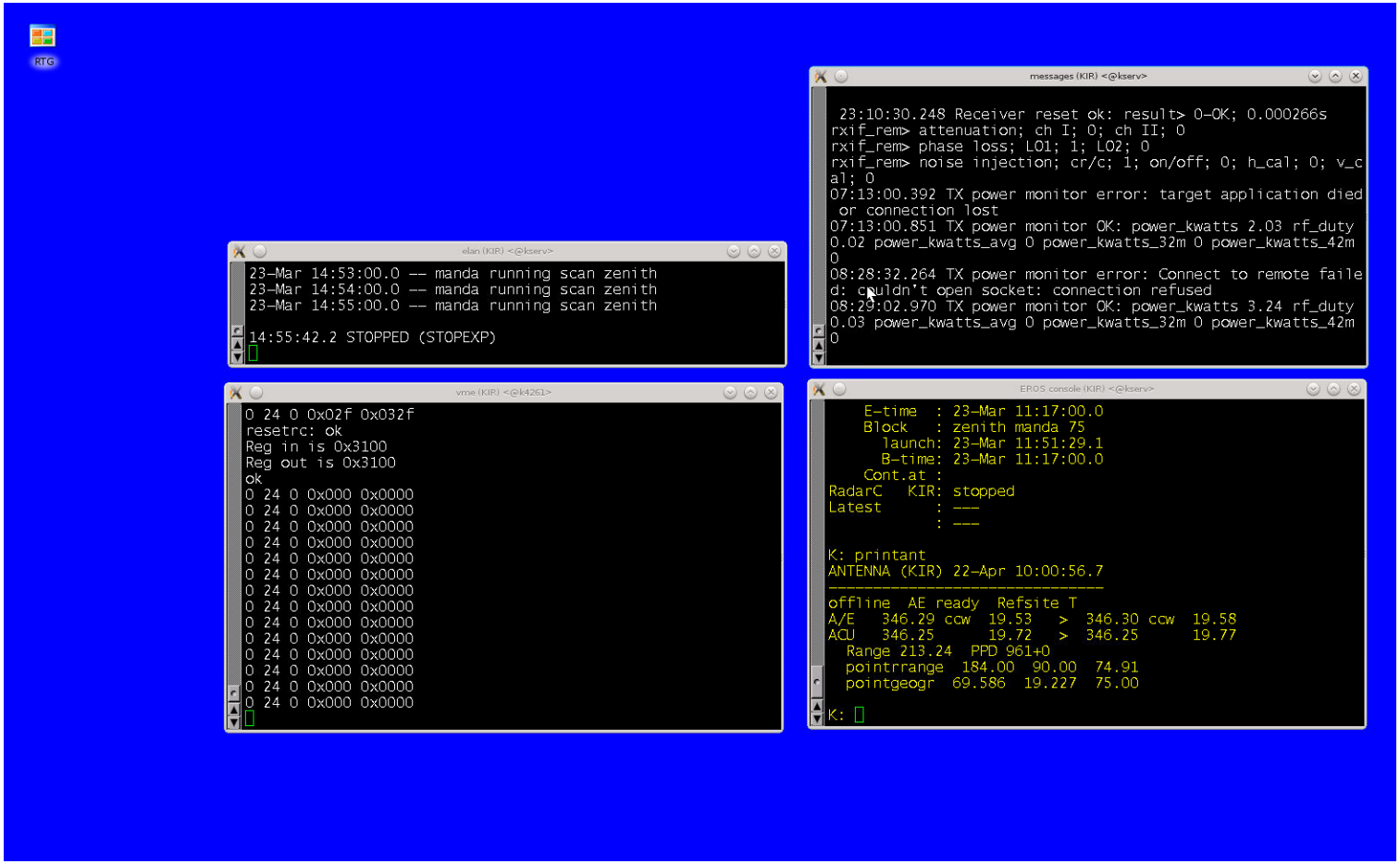
Data processing in software

Data correlation (voltage to ACF domain)

- VME crate computer: **lag_wrap**
  - Configuration: `.fil` file
  - Reads out data from channel boards
  - Sorting, preformatting, cross products
  - Reads transmitter power
- Main computer: **decodump**
  - Decoding: configuration `.DECO` file
  - Other processing also possible
  - Final time integration
  - Adds parameter block
  - Stores to files compatible with Matlab

Outline

The EROS console (Kiruna site)



The window titled **EROS console** is a command line interface where you run all EROS commands.

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

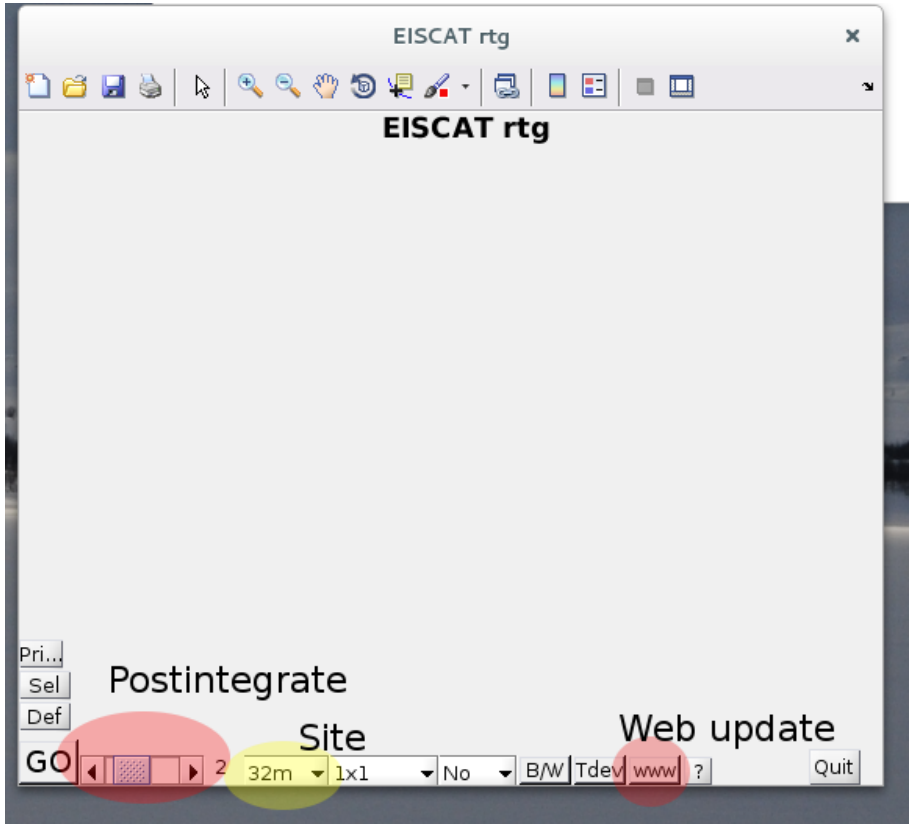
Real-time graph

RTG overview

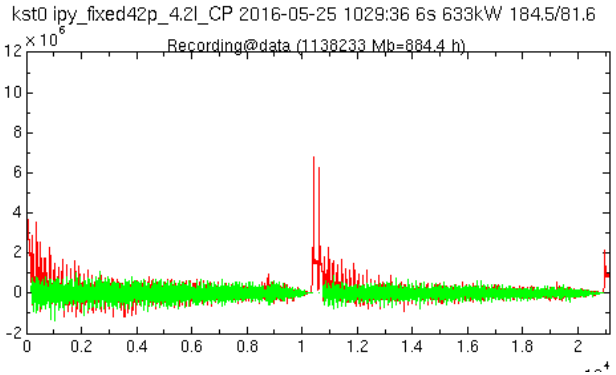
- Matlab software
- Reads data files
- Plots spectra and overviews
  - Selected in experiment's **rtg_def.m**
- Can update web page

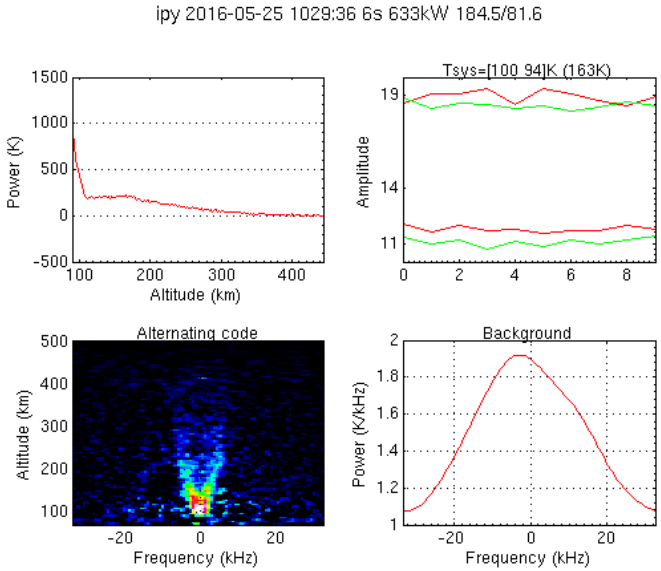
RTG user interface

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



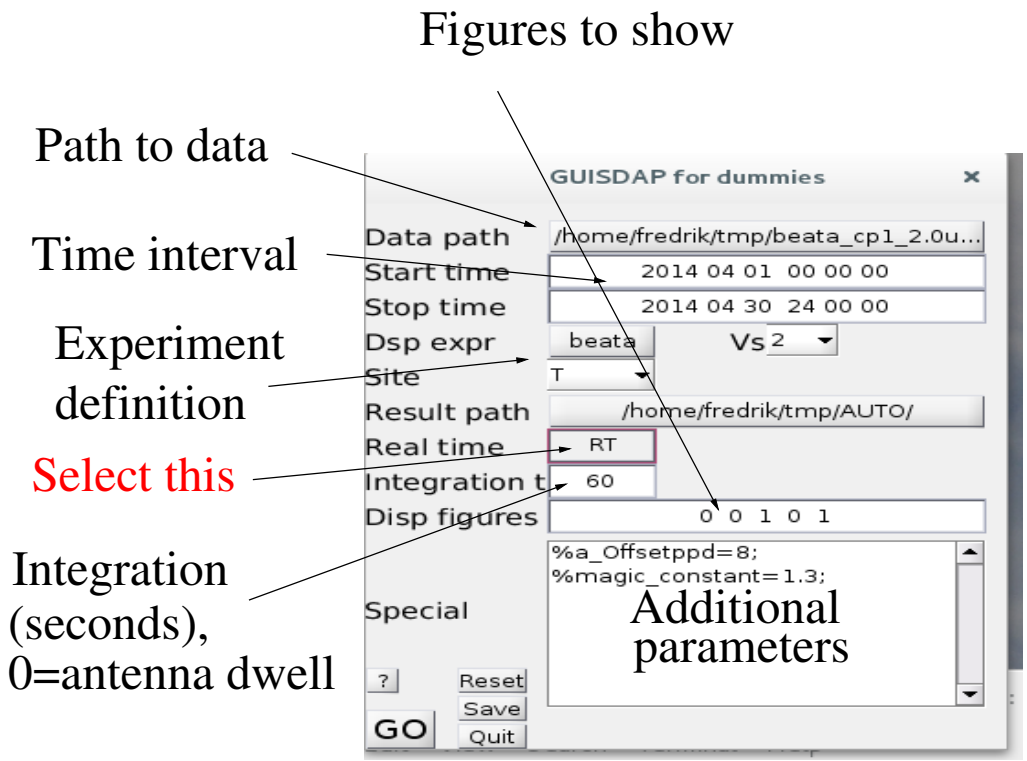
Example of RTG output



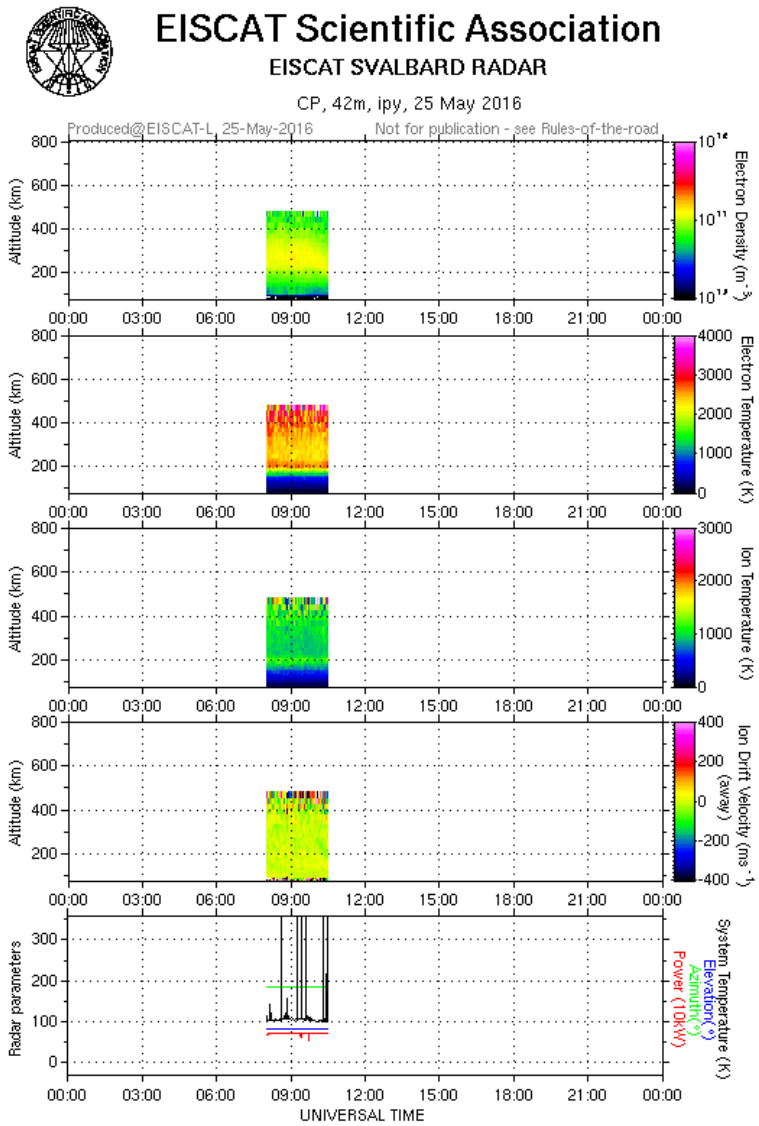


Real-time analysis

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



GUISDAP output (vizu)



More information

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- http://sgo.fi/~jussi/eiscat/erosdoc/eros_commands.html)