The EISCAT systems and how to run them

Introduction to hardware, control and data

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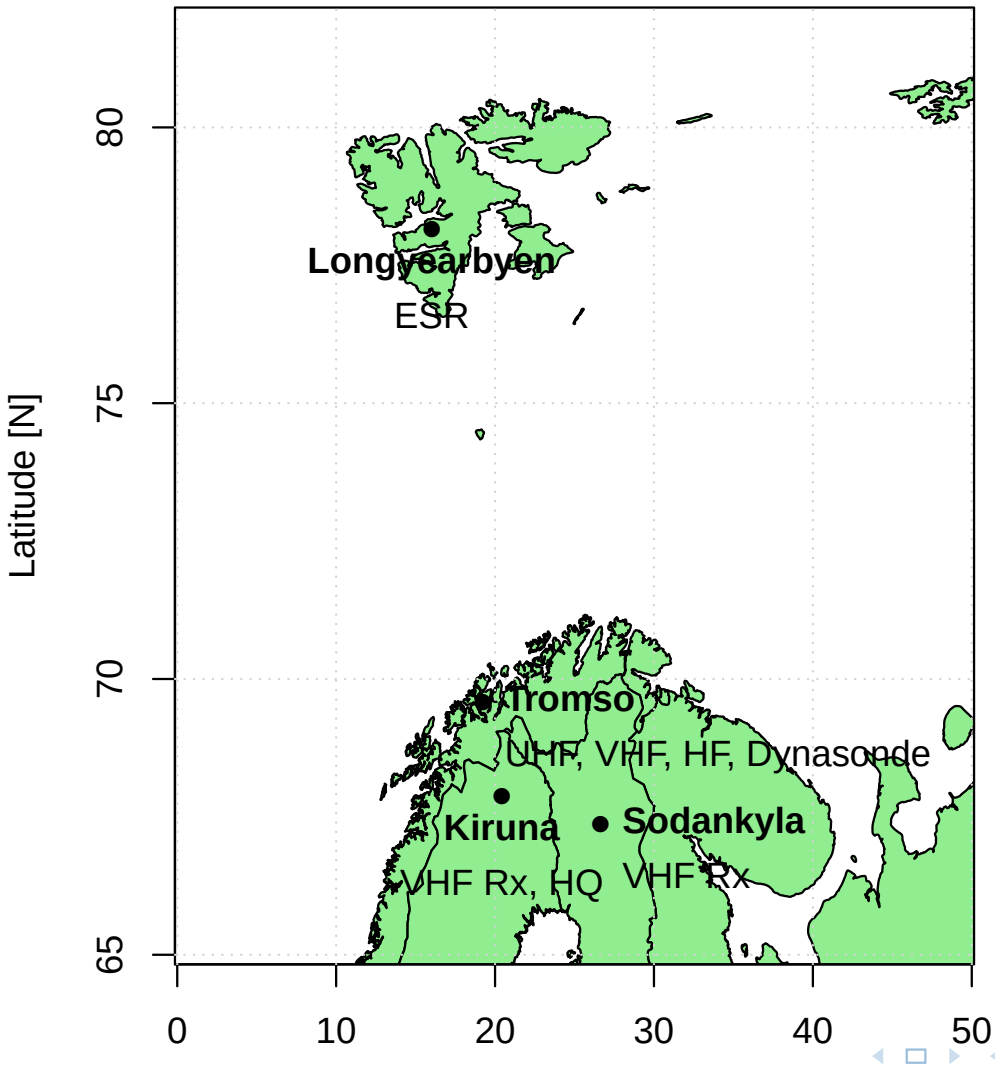
Outline

Outline

EISCAT sites

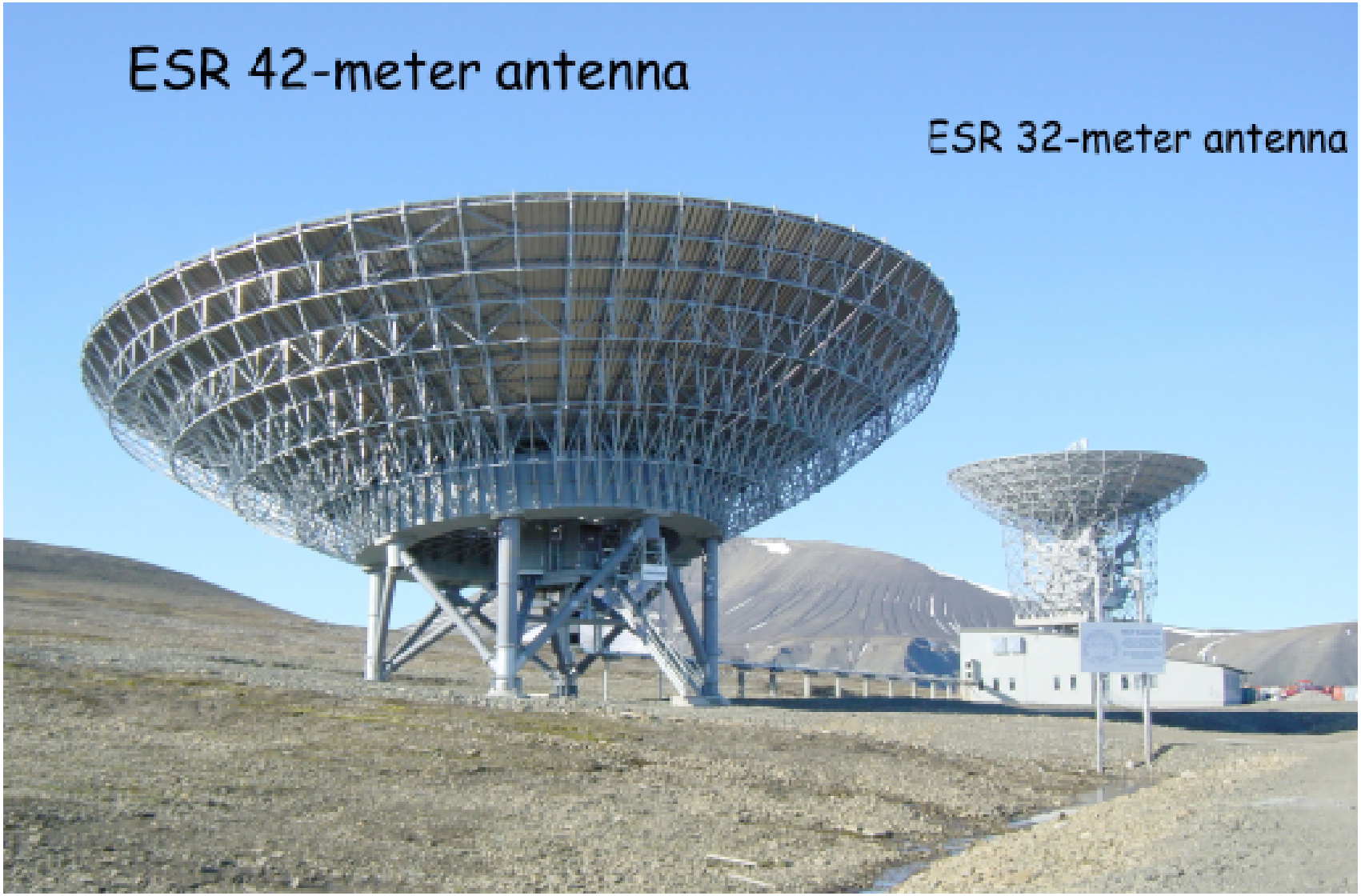


EISCAT mainland radars

VHF 224 MHz

UHF 930 MHz

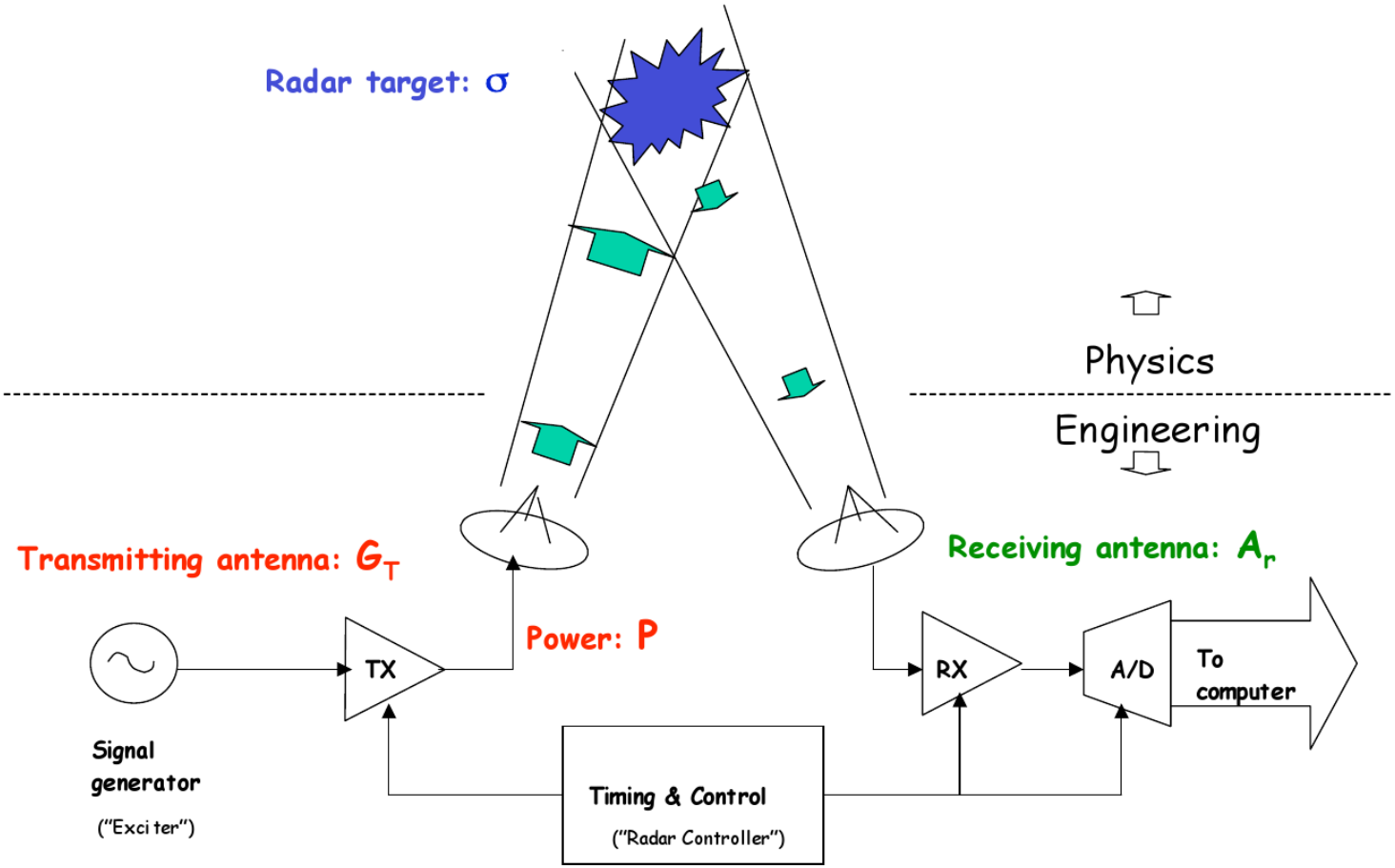
EISCAT Svalbard radar site near Longyearbyen 78° N



ESR 500 MHz

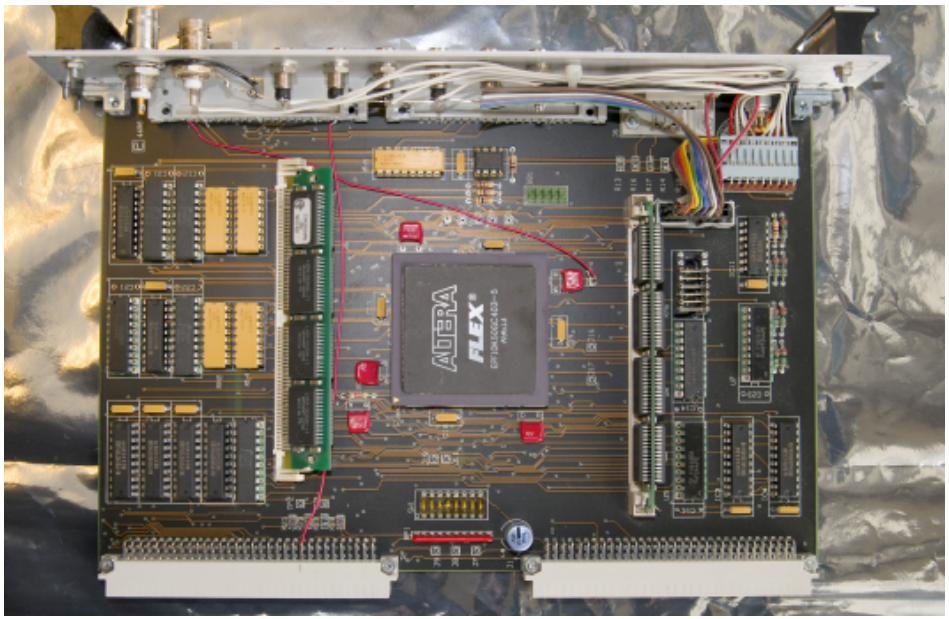
Outline

A generic radar system



Transmitting a signal

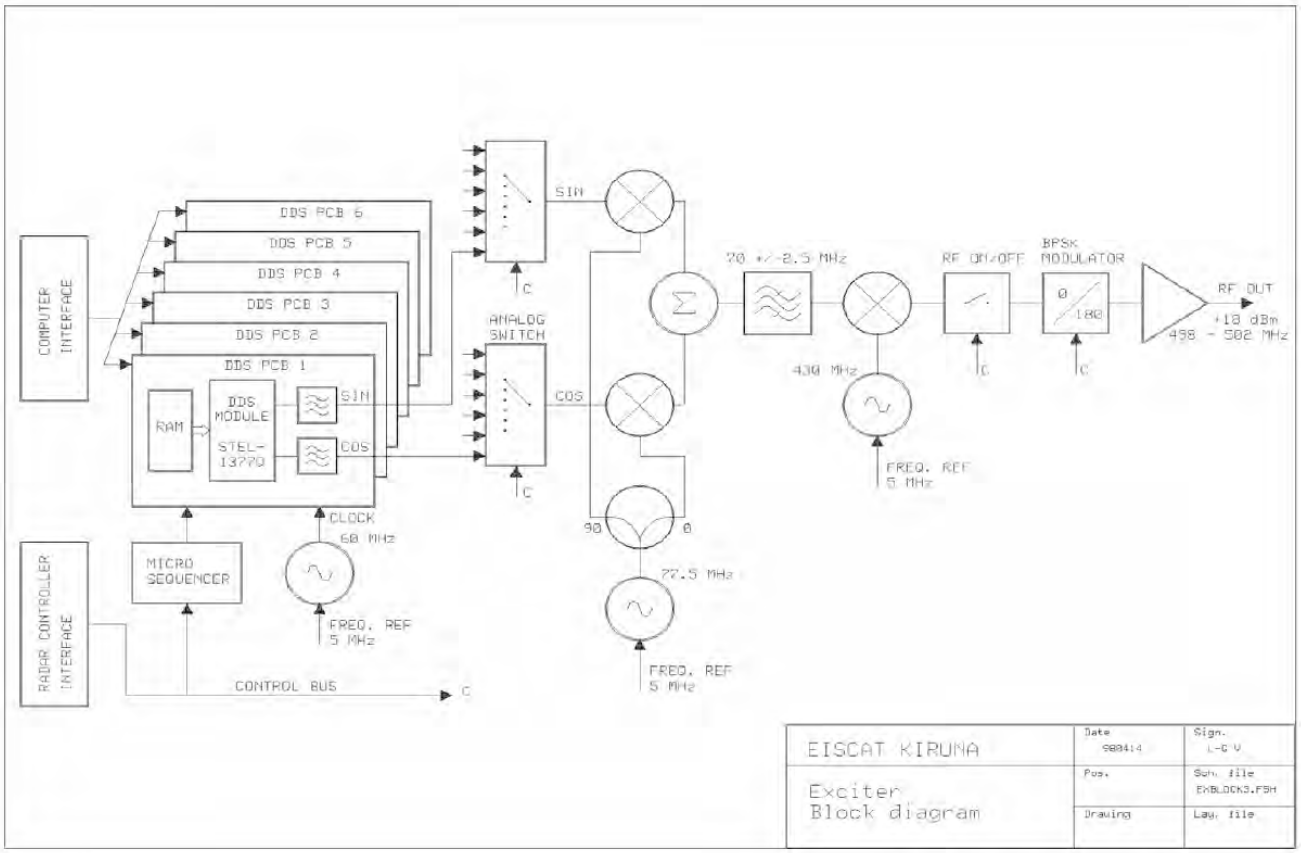
Radar controllers



- The hearts of the radars
- Handle fast synchronizations
- Memory banks containing sequences of bits
- 10 MHz resolution
- One for Tx and one for each Rx

Transmitting a signal

Exciter

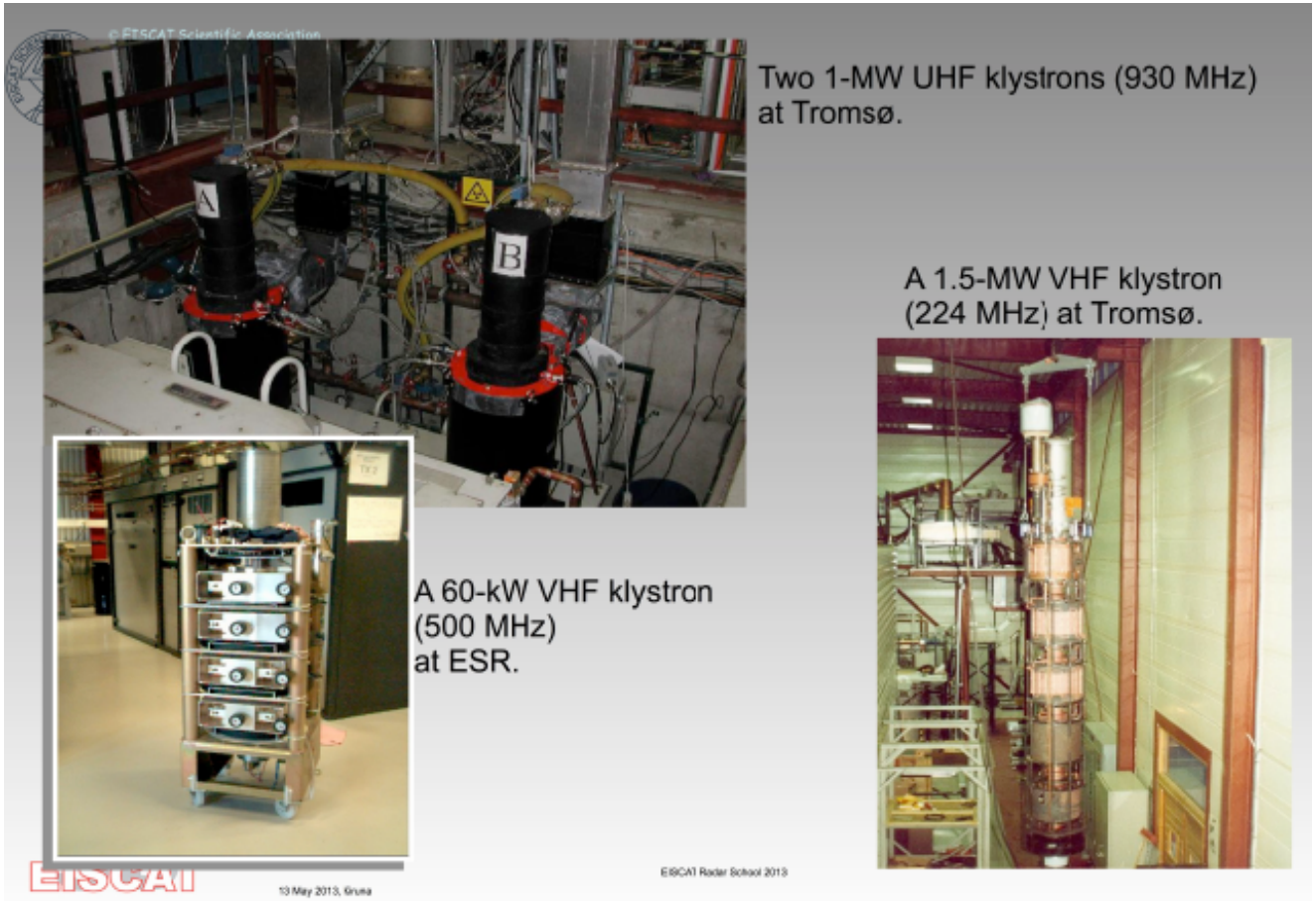


- Generates the signal
- 0 and 180 degree phase flips

Transmitting a signal

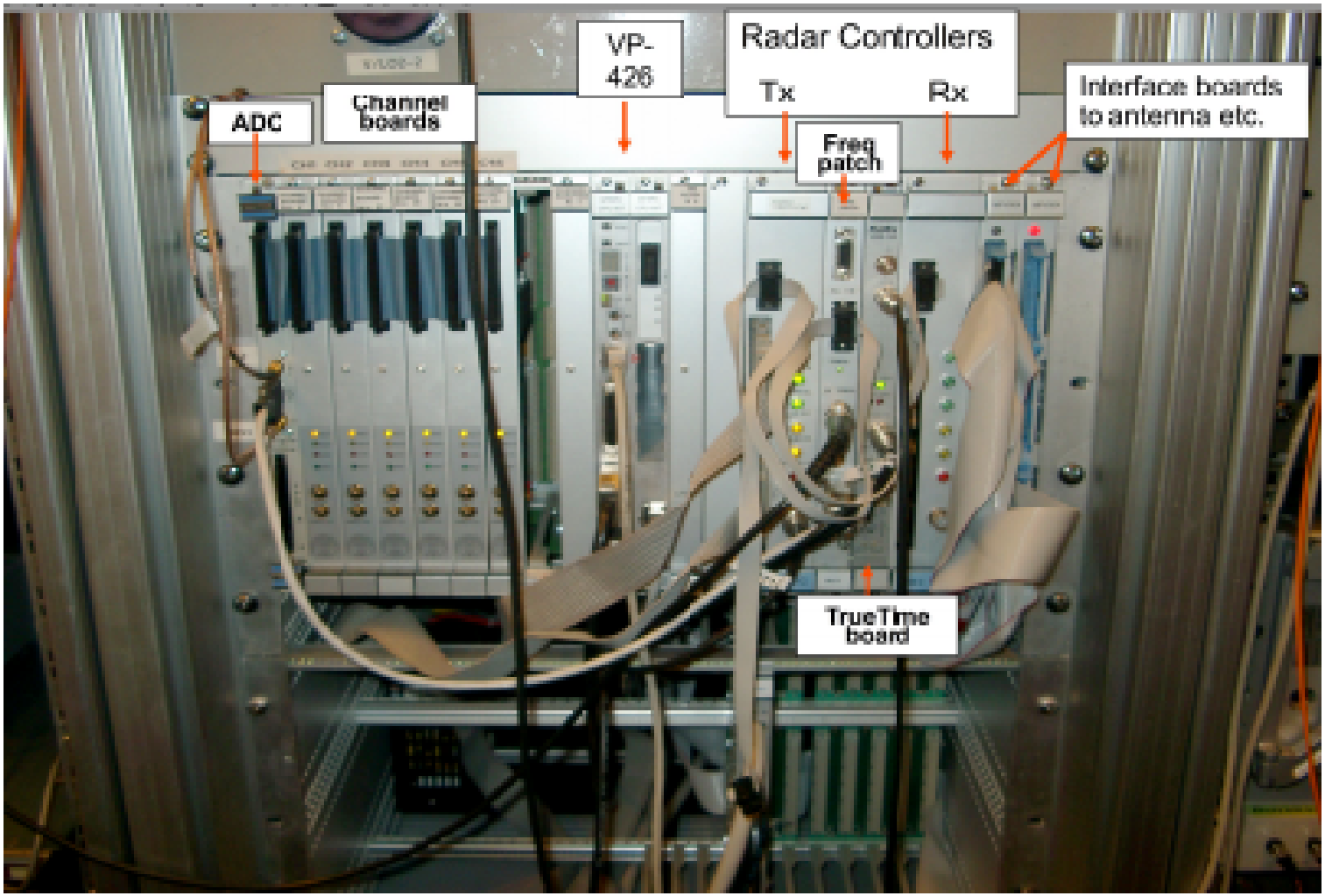
Power amplifiers

- Raise the output power
- ESR peak output 1 MW (average 250 kW)
- Waveguides to the antennas



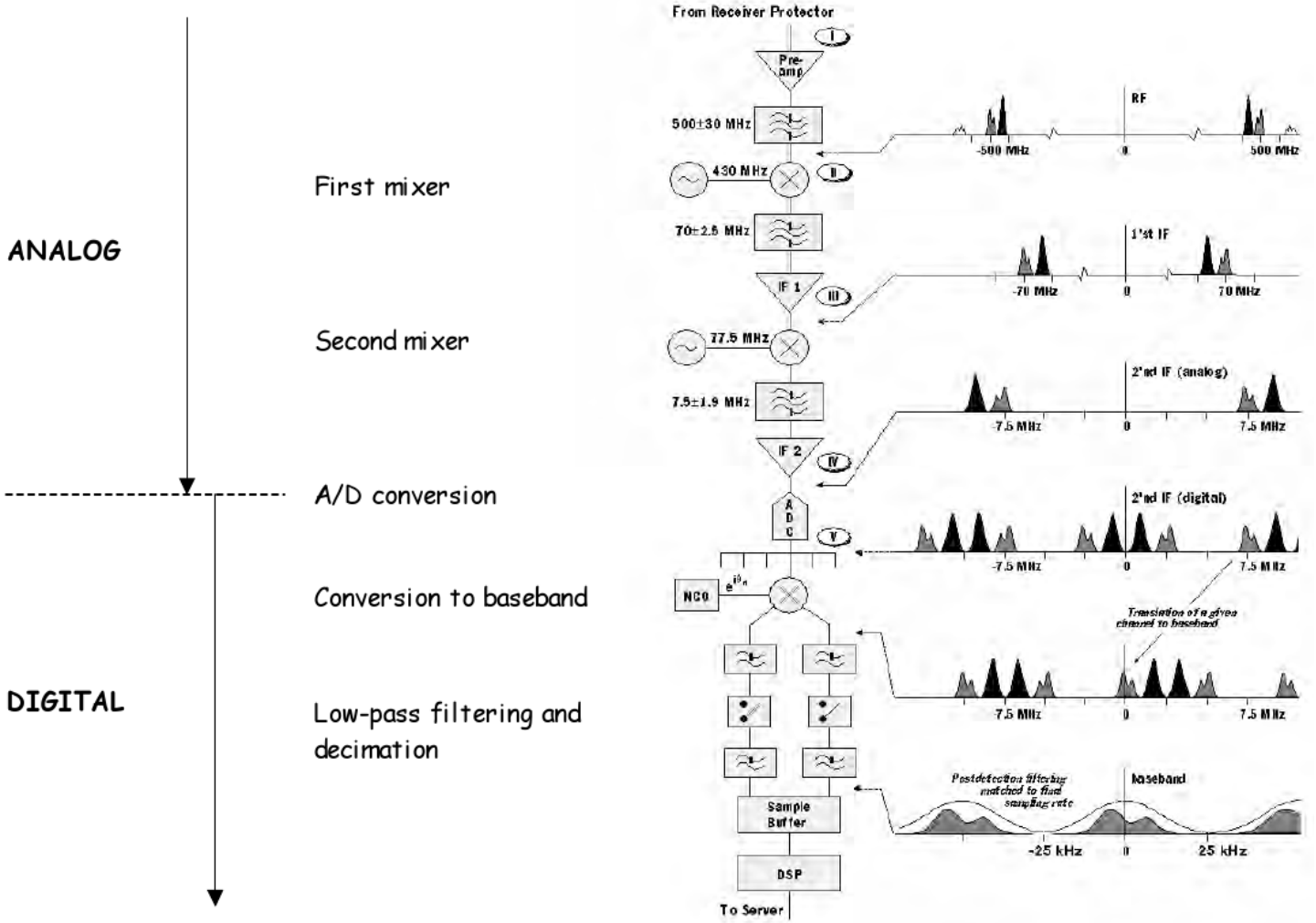
Receiving the scattered signal

Digital receiver (and radar controllers)



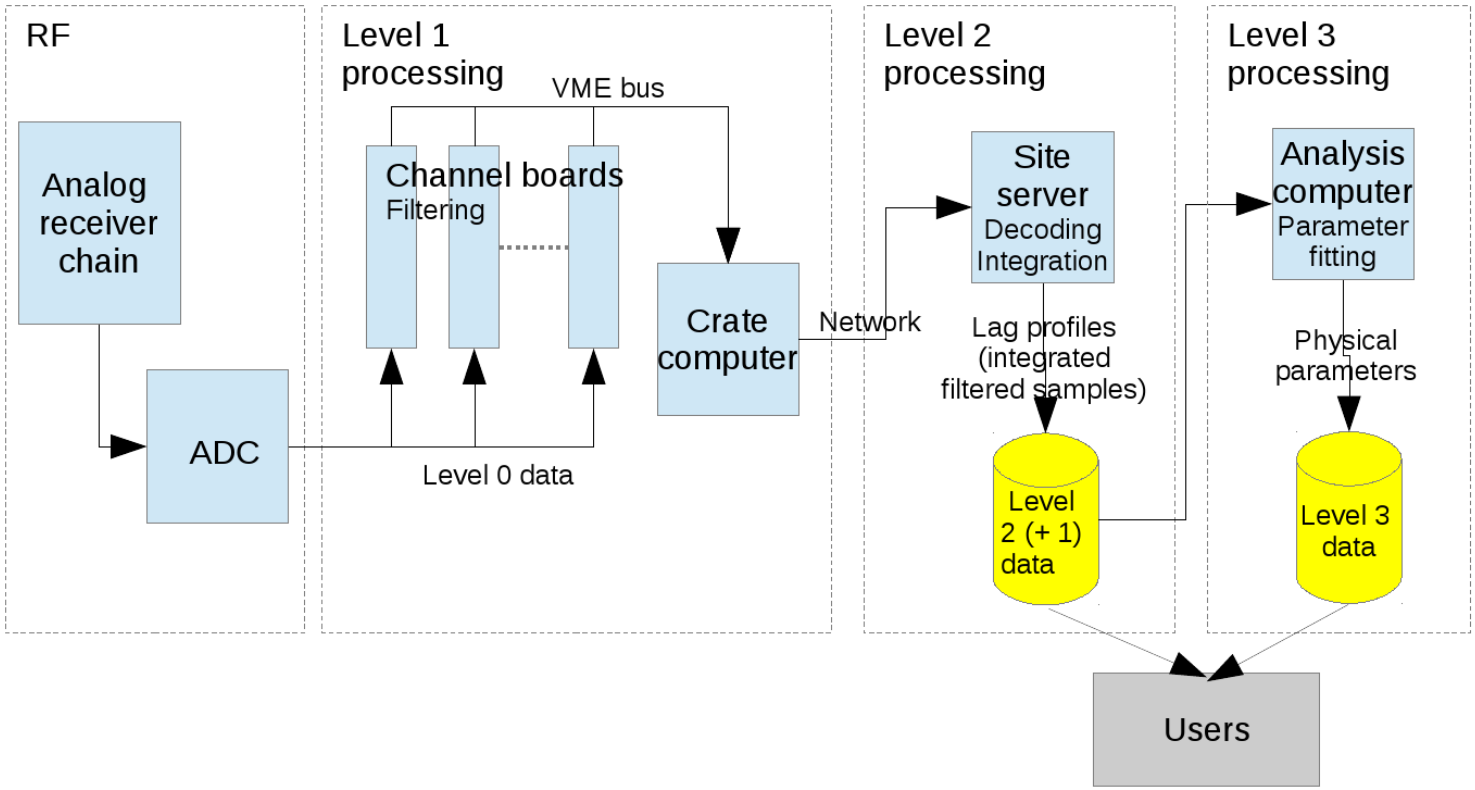
Receiving the scattered signal

Overview of EISCAT signal processing



Receiving the scattered signal

Schematic summary



Outline

Definitions needed for an experiment

Pulse code

- Range resolution
- Time resolution
- Maximum range

Transmitter configuration

- Frequency/frequencies

Receiver configuration

- Channels (Ion line, Plasma lines?, Background . . .)
- Filters

Antenna scan

- Fixed or moving
- ESR single or dual antenna

EISCAT programs

EISCAT Experiments

Anders Tjulin
EISCAT Scientific Association

5th December 2018

Manda alternating code

https://www.eiscat.se/scientist/document/experiments/

- Transmitter, pulse code, receiver, decode → Radar program
  - manda
  - beata
  - folke
  - ...
- Antenna pattern (and ESR "slow" antenna switching) → Scan program
  - cp1
  - cp2
  - ...

Selecting a pulse code program

Mainland VHF

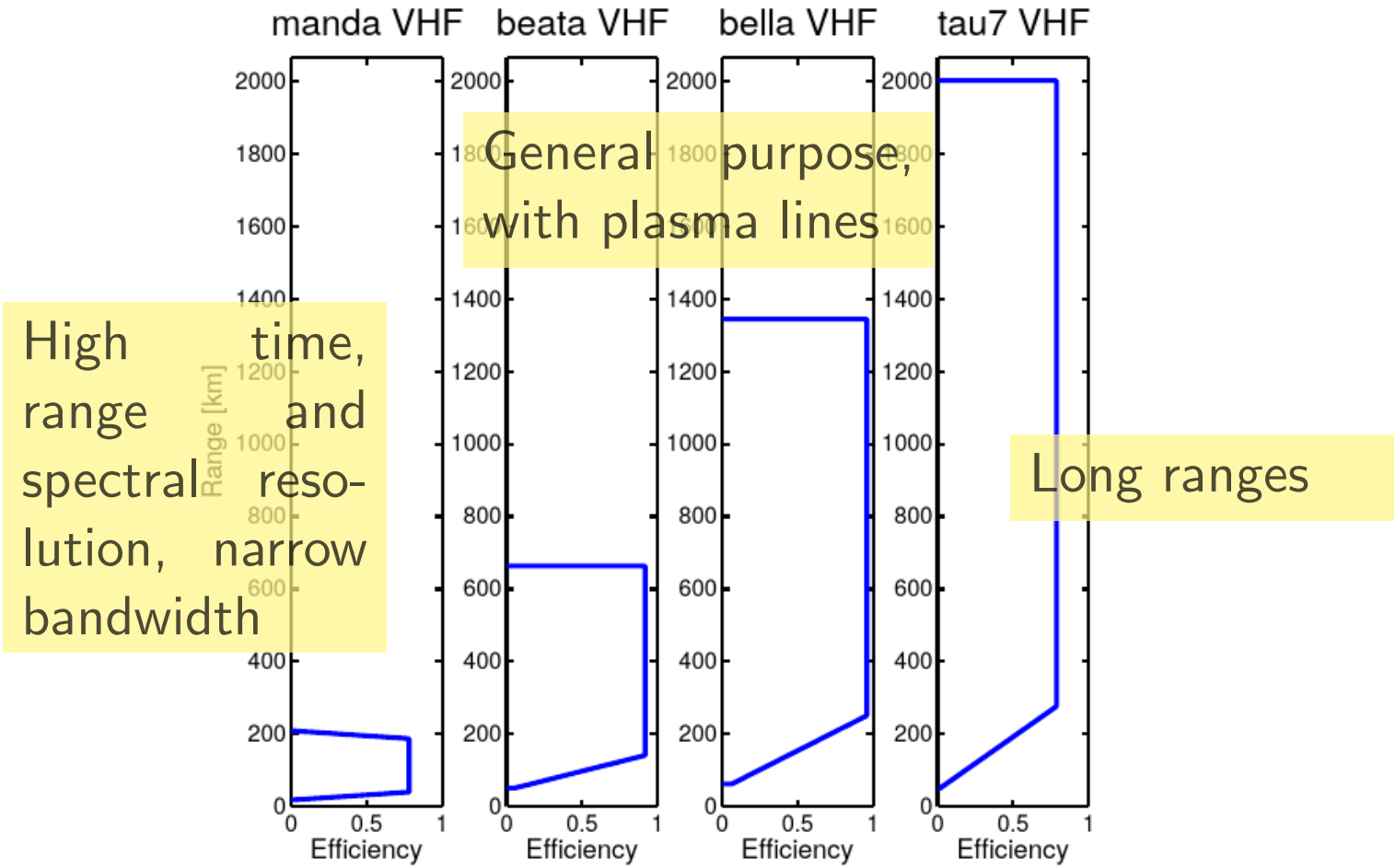


Figure 2: Overview of the ranges covered at the EISCAT VHF radar by the experiments used in the common programmes.

Selecting a pulse code program

EISCAT Svalbard radar

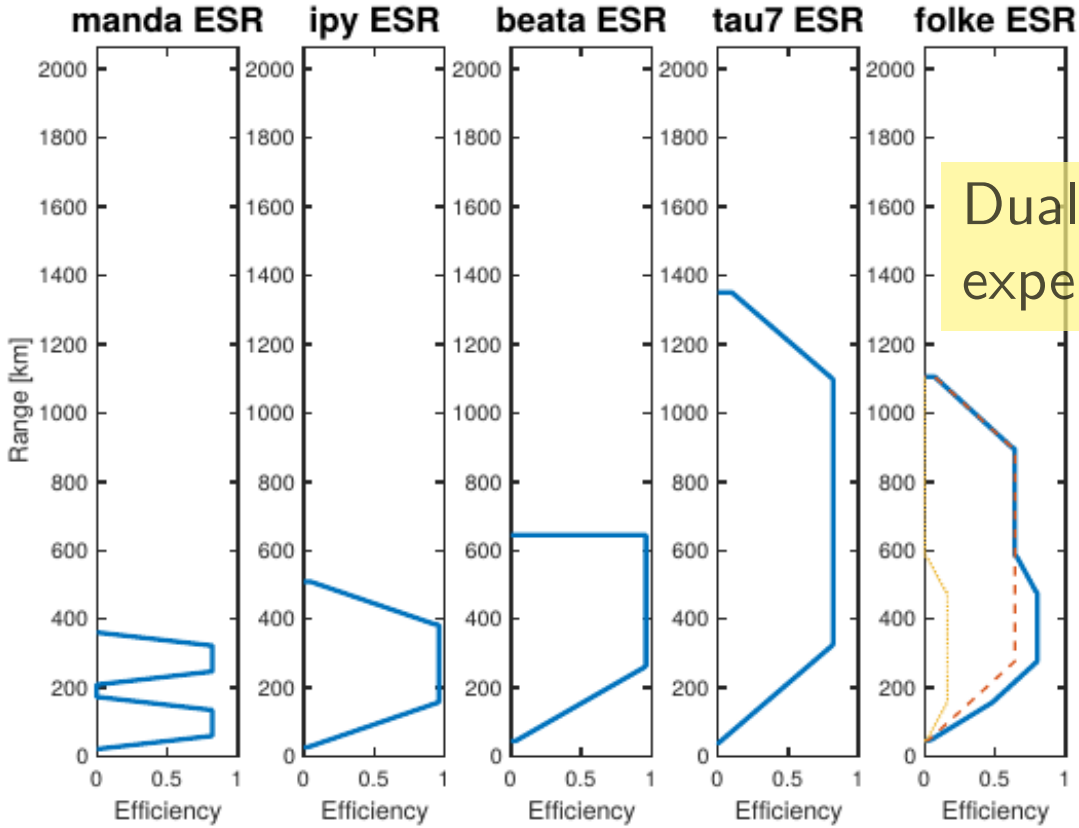


Figure 3: Overview of the ranges covered at the EISCAT ESR radar by the experiments used in the common programmes.

Outline

The EISCAT Realtime Operating System (EROS)

- Tcl programming language with extensions
- Command line console
- Experiment definition file **experiment.elan**
- Antenna scan file(s) **scan.elan**
- Radar controller file **experiment.tlan**
- Channel board and decoder control: **.fil, .par** etc

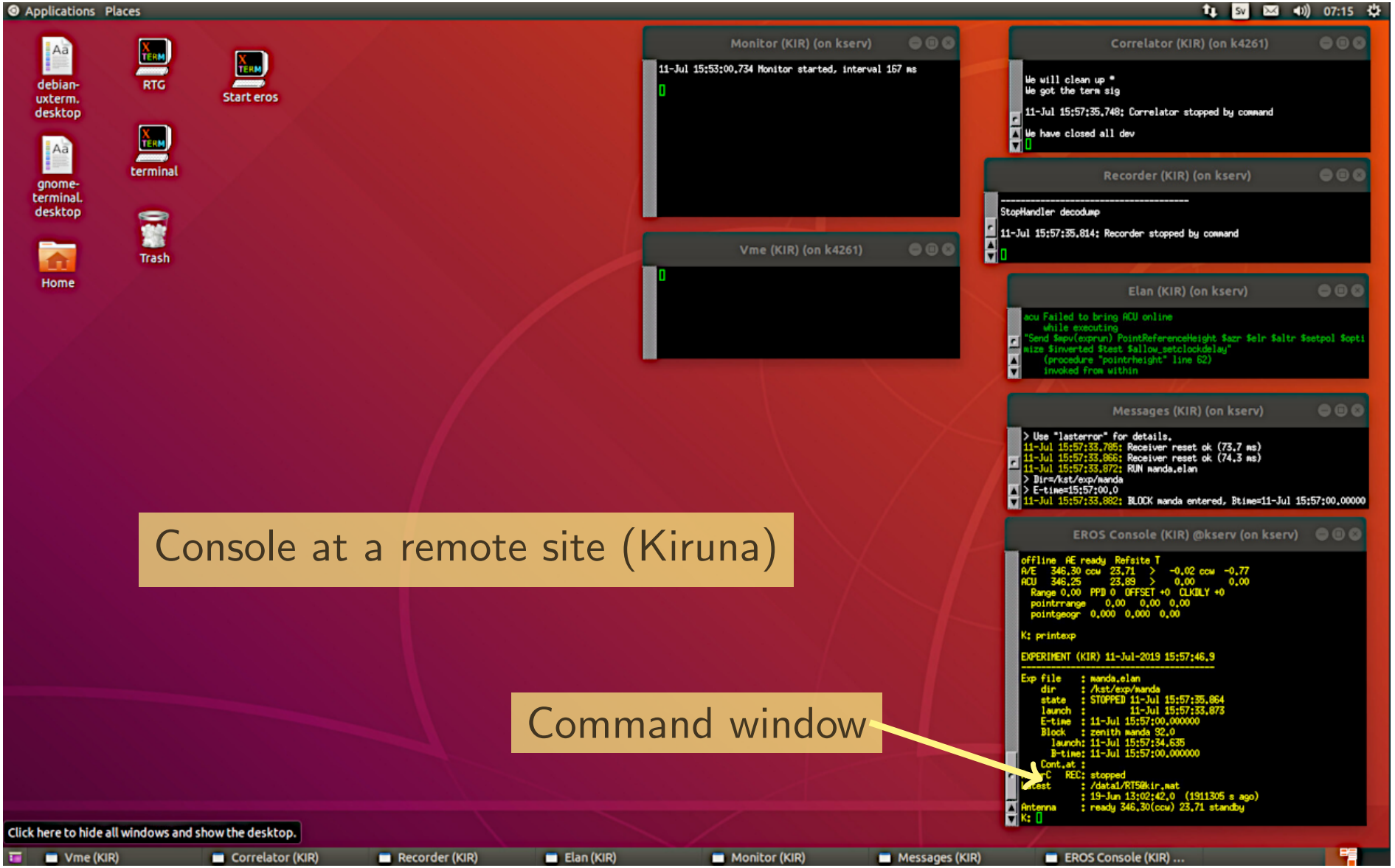
Experiment file example

```
# bella.elan
...
BLOCK bella {{scan cp1} {owner CP} {height 270.0}} {
    # For ESR bella {{scan fixed42p} {owner CP} {ant 42m}}

  ... lots and lots of definitions ...

    # Stop receiver --
    SYNC -10
    stopradar -rec
    if {[ISUHF]||[ISVHF]||[ISESR]} {
if {$enatra} {stopradar -trans}
    }
    if {[ISESR]} {
stopradar -pla
stopdata pla
    }
    stopdata
    # Load radar controller --
    if {[ISESR]} {
if { $ant=="42p" } {
    loadradar rec -loopc $Loopc -sync $Sync -file ...
    loadradar pla -loopc $Loopc -sync $Sync -file ...
    if {$enatra} {
loadradar trans -loopc $Loopc -sync $Sync -file  ...
}
...
```

. . . and so on

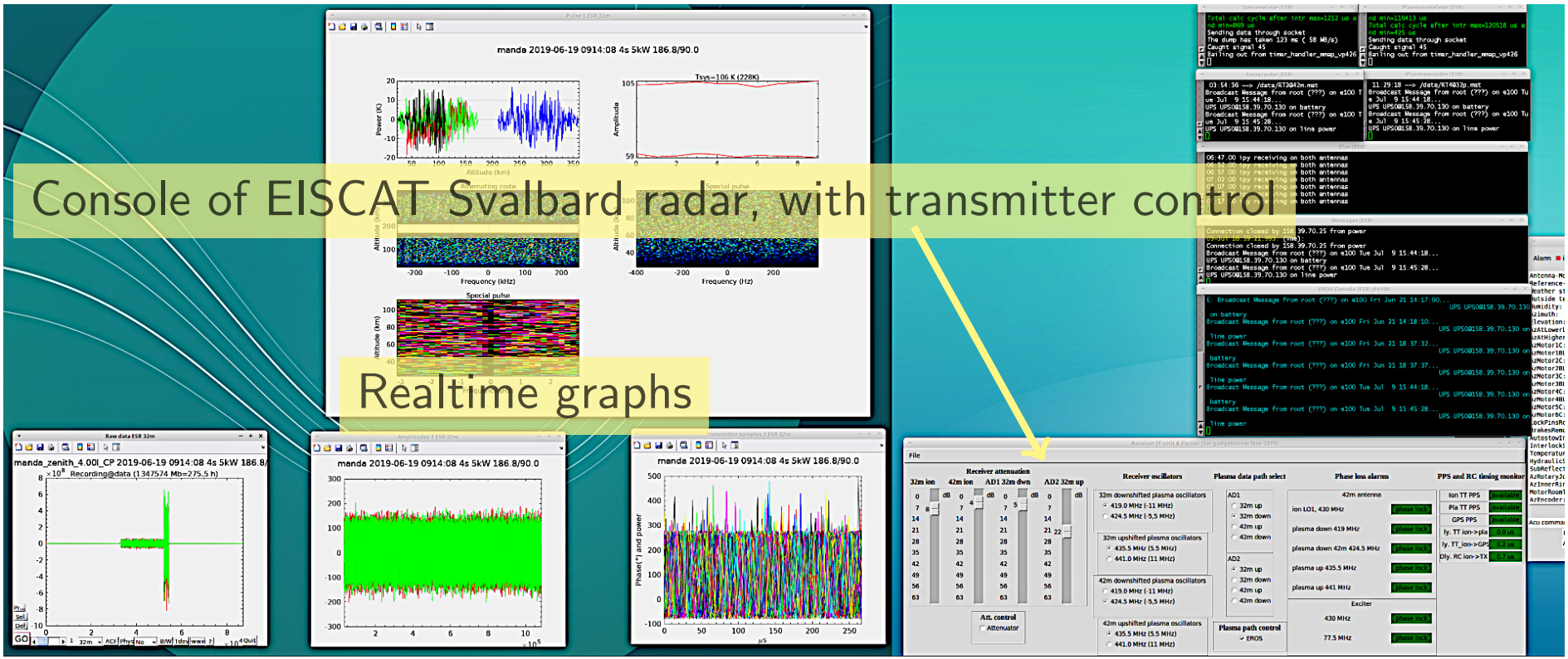
```
SETTCR 0
%%%% SUBCYCLE 1 %%%%
AT 0.9 CHQPULS,RXSYNC,NCOSEL0,AD2L,AD1R,STFIR
AT 1.9 1LOCH1SEL1,1LOCH2SEL1,2LOCH1SEL2,2LOCH2SEL2
AT 2 RXPROT,LOPROT
AT 32 BEAMON,F6
%%%% RF TRANSMISSION %%%%
AT 88 CH1,CH4,RFON,PHA180 %++
AT 178 PHA0 %--
AT 268 PHA180 %+
AT 313 PHA0 %-
AT 358 PHA180 %++++
AT 538 PHA0 %--
AT 628 PHA180 %+
AT 673 PHA0 %----
AT 853 PHA180 %+
AT 898 PHA0 %--
AT 988 PHA180 %+
AT 1033 PHA0 %-
AT 1078 PHA180 %+++
AT 1213 PHA0 %---
AT 1348 PHA180 %+
AT 1393 PHA0 %-
AT 1438 RFOFF,PHA0,BEAMOFF
AT 1528 CH1OFF,CH4OFF
AT 1538 RXPOFF
AT 1558 LOPOFF
%% SIGNAL RECEPTION: 192 samples
AT 1810 CH1,CH4,CH2,CH5,CH3,CH6
...
```

The EROS console



The EROS console

and the EISCAT realtime graph (RTG)



The RTG windows are where you monitor data during a run.
It is Matlab software, start separately from EROS (desktop icon)

Important EROS commands

runexperiment Load an experiment and start at specified time

enablerecording Start saving data

printexperiment Show experiment status

printantenna Show pointing

stopexperiment

- Commands can be abbreviated
- Online help is available
- EISCAT staff will assist you

EROS command cheat sheet

Start

ELAN file Start time

runexperiment /kst/exp/beata/beata fm cp1 G1 [85] Associate code

Scan [Tristatic altitude]

enablerecording (When transmitter is up)

During experiment

printexperiment

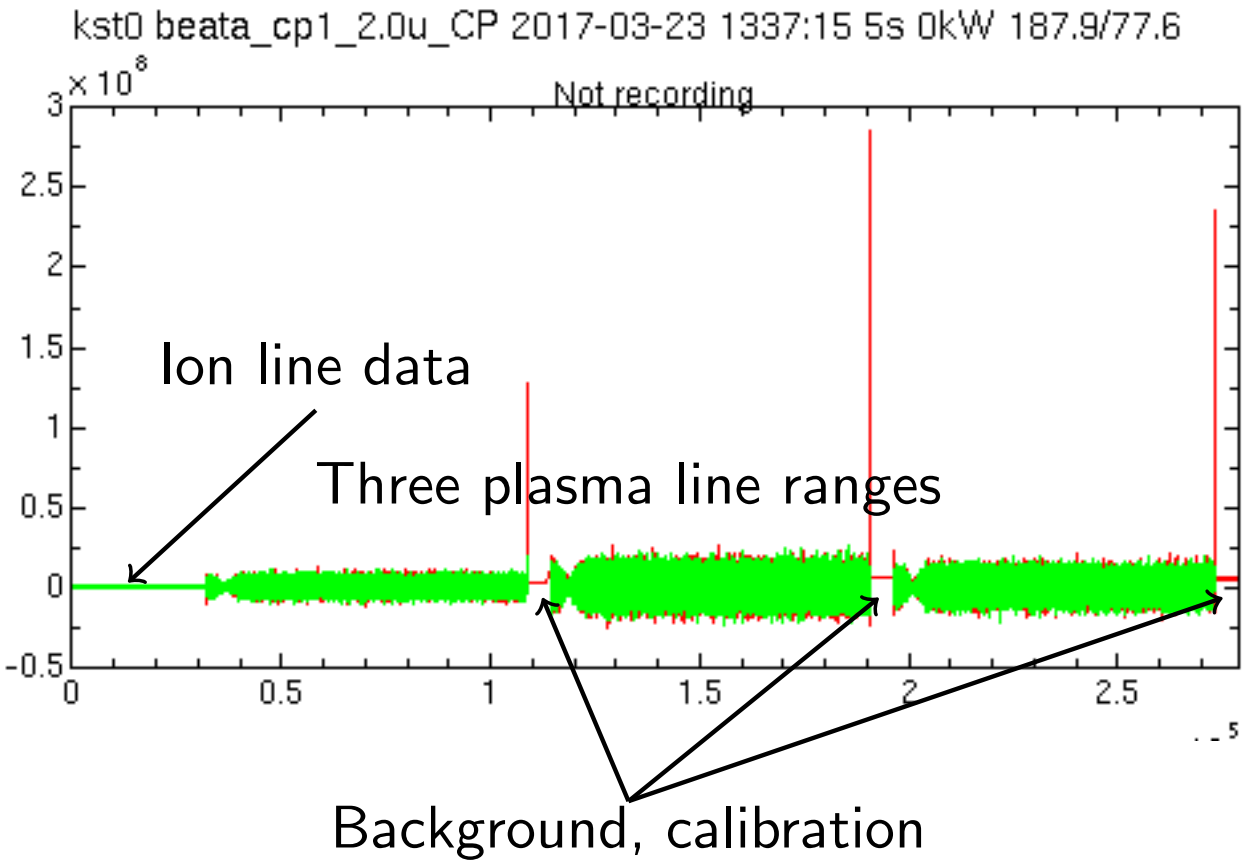
printantenna

stopexperiment [22:00]

Outline

Decoded data: The lag profile

Data in autocorrelation domain (lag, range)



How to access your data

Lag profile data EISCAT database of lag profile data

Analyze data 1 Download data and run GUISDAP

Analyze data 2 Online GUISDAP

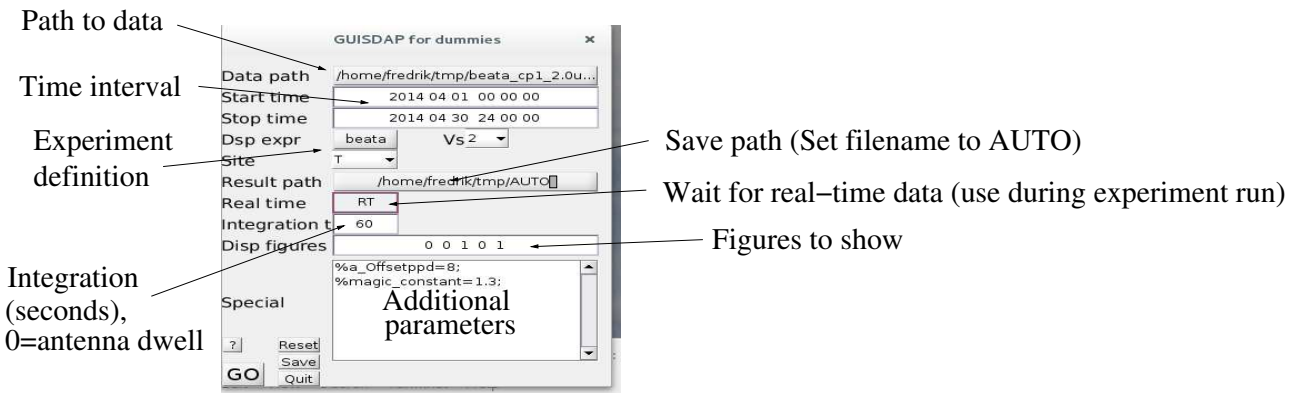
Standard analysis Get from Madrigal

All the above accessible from EISCAT Schedule
`https://www.eiscat.se/schedule/schedule.cgi`

GUISDAP analysis basics

More in a later lecture

- Matlab software
- Will run online tonight
- guisdap -a



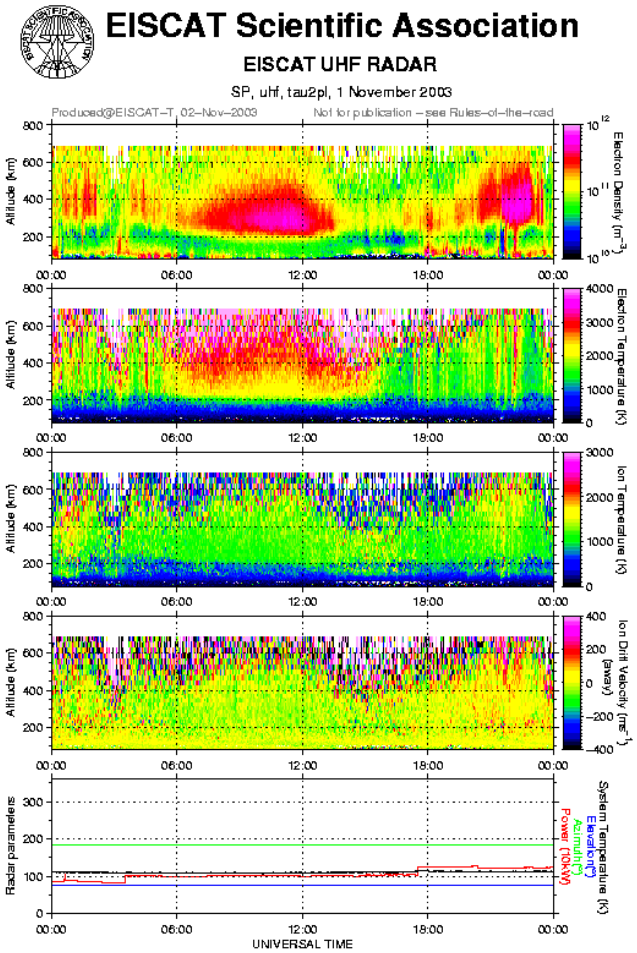
- Fits theoretic spectrum to data
- Uses atmospheric composition models: MSIS, IRI
- Takes care of transmitter power, geometry

GUISDAP use, cont.

- If you have Matlab, you can run GUISDAP on your laptop — Download available from EISCAT web
- Otherwise, online analysis or analyzed data from Madrigal
- During the experiment and group work, EISCAT staff will assist you
- More details on Thursday

GUISDAP results

vizu plot



Electron density m^{-3}

Electron temperature K

Ion temperature K

Line of sight velocity m/s

Parameters

To create new plot: vizu new VERBOSE at GUISDAP prompt

Current status and limitations of EISCAT radars

NB!

Tromsø UHF Antenna cannot move. Fixed at field-aligned position.

Tromsø VHF Antenna pointing is a manual operation. By default vertical. Low elevation northward possible and has to be announced $\approx$ 1 h in advance.

EISCAT Svalbard radar Power line maintenance has been going on, but should be ready now

Experiment night planning

- Two groups will run in parallel
- Experienced EISCAT users and staff will assist
- The radar not used by the students will run a standard mode

Questions?

https://www.eiscat.se
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