Introduction to GUISDAP

How to analyze EISCAT data

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Note

During this radar school you will mostly work with analyzed data (Data Level 3), which can be downloaded through Madrigal once the realtime analysis results have been inserted into that system!

`https://www.eiscat.se/madrigal`

Outline

Archived EISCAT data

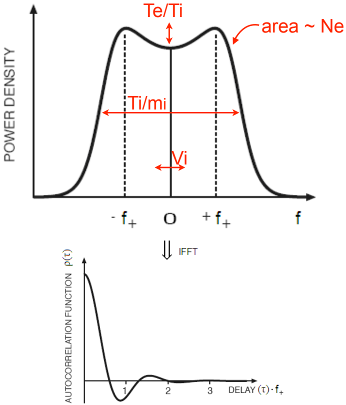
decodump stores Matlab files

- lag profiles **d_data** — autocorrelation domain (Level 2) data, complex vectors, sorted:
  1. lag
  2. range
- metadata **d_parbl**
  - Time
  - Transmitter power
  - Antenna azimuth and elevation
  - and much more: `https://www.eiscat.se/about/experiments2/description-of-eiscat-metadata-sources/at_download/file`
- raw data **d_raw** — available for some experiments: transmitter samples or raw voltage domain (Level 1) data

GUISDAP analysis package

- Originally "Grand Unified Incoherent Scatter Design and Analysis Package", M. Lehtinen et al.
- Maintained by I. Häggström, EISCAT HQ
- Matlab software
- Direct theory of scattering spectrum
  - Electron density
  - Ion temperature
  - Temperature ratio
  - Line of sight velocity
  - etc
- Atmospheric models (IRI, MSIS)
  - Neutral temperature
  - Density / collision frequency
  - Ion composition
- Fitting to lag profiles (following slides)

Standard parameters found by fitting the Ion-acoustic line



Ion temperature (Ti) to ion mass (mi) ratio from the width of the spectra

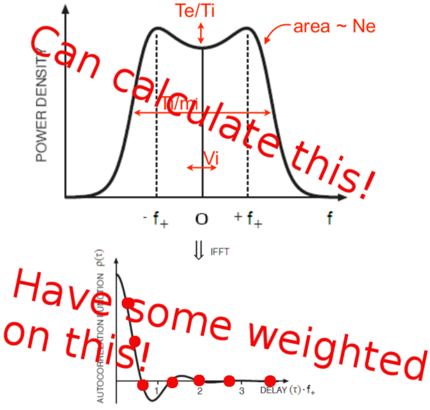
Electron to ion temperature ratio (Te/Ti) from “peak_to_valley” ratio

Electron (= ion) density from total area (corrected for temperatures)

Line-of-sight ion velocity (Vi) from the Doppler shift

52

Standard parameters found by fitting the Ion-acoustic line



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Principle of GUISDAP analysis

- From Fourier transform theory the theoretical spectra can be fitted directly to the lag profiles using

precalculated spectral ambiguity functions (Nygrén 1996, p. 78)

$$LP(t,t') = R \int_r P_z^0(\vec{r}) \left[\int_{-\infty}^{+\infty} W_{tt'}(\nu,\vec{r}) \Sigma(\nu,\vec{r}) d\nu \right] d^3r$$

- Σ=ISR spectrum (parameters N_{e}, T_{i}, T_{r}, v_0 ... not shown)
- ν=frequency
- W=spectral ambiguity function (the Fourier transform of the 2-D pulse ambiguity function)
- P=single scattering power
- R=radar coefficient, with calibration

That's all, in principle

GUISDAP corrects for

- Measured transmitter power
- Geometry
- Receiver chain response — from noise injection in the antenna

Need for calibration

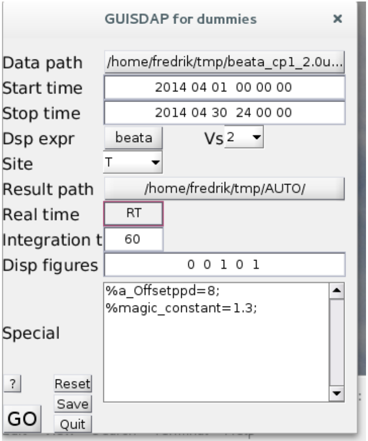
E.g. difference between theoretical or measured and actual antenna gain, due to snow or water in antennas, etc.

Absolute calibration — Compare electron density

1. Plasma lines
2. Electron density maximum and ionosonde foF2
3. EISCAT Svalbard radar: match the two antennas

Reanalysis with calibration

- Uncomment and set the "magic_constant"
- This will scale the measured transmitter power
- foF2 and plasma line calibration routines exist — will suggest a new magic constant



Outline

1. Basics of analysis

2. How to download and analyze EISCAT data

Getting your data

- As mentioned, archived data are time integrated lag profiles
- Compressed Matlab compatible format (.mat.bz2) — libraries exist for most programming languages
- Can be downloaded through EISCAT schedule page
  `http://www.eiscat.se/schedule/schedule.cgi`

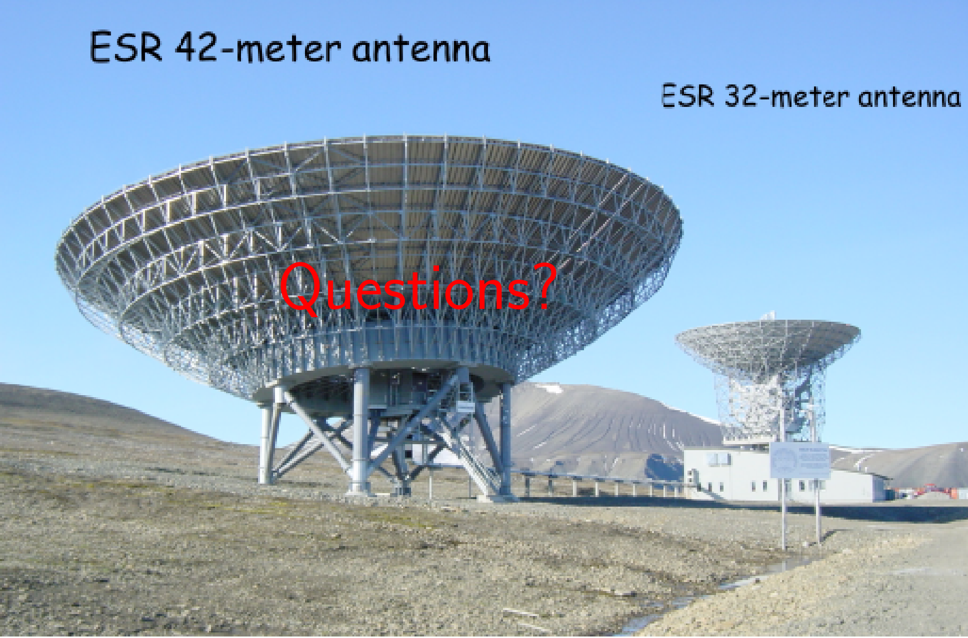
Analysis method 1: Online

1. Browse to your data on EISCAT schedule page `http://www.eiscat.se/schedule/schedule.cgi`
2. Select time intervals
3. Click Analyse
4. Enter email address, select GUISDAP settings (e.g. integration time, magic constant), and click GO

Analysis method 2: Run GUISDAP yourself

Once you become an EISCAT user, you will encounter this procedure

1. Install GUISDAP:
   `https://www.eiscat.se/groups/Documentation/UserGuides/GUISDAP/gup88.html`
2. Browse to your data on EISCAT schedule page
   `http://www.eiscat.se/schedule/schedule.cgi`
3. Select time intervals
4. Click Download
5. Save and untar the data
6. Start GUISDAP: **guisdap -a**
7. Enter the path to the data in the GUISDAP window, check parameters, and click GO


ESR 42-meter antenna
ESR 32-meter antenna
Questions?