ELOG Field Analyzer
Ver. 1.0.0

User’s Manual

2024 / 9 / 30

NT System Design

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1. Introduction

This software graphs ELOG-MT, ELOG1K, and ELOG-DUAL time-series data files on Windows. It supports low-pass, high-pass, and notch filters.

It also graphs the power spectrum of each channel.

This software enables one to estimate the impedance tensor and tipper from the time-series data. Robust estimators, prewhitening method, and the remote reference method are usable in the response function estimation.

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1. TRACMT

2. ScottPlot

3. CLAPACK

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TRACMT

https://github.com/yoshiya-usui/TRACMT.git

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https://github.com/ScottPlot/ScottPlot

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3. Operating Environment

.NET Framework 6.0 running Windows 10 or higher.

CAUTION

The file and folder names must only consist of ASCII characters. This program will not work properly if you use non-ASCII characters (e.g., Japanese characters).

4. Installation

You should install .NET 6.0 Desktop Runtime and Visual C++ redistributable libraries. Please download from the following download sites and install them.

.NET 6.0 Desktop Runtime:

https://dotnet.microsoft.com/en-us/download/dotnet/6.0

Visual C++ redistributable libraries:

https://learn.microsoft.com/en-us/cpp/windows/latest-supported-vc-redist?view=msvc-170

You can install this software using the installer “ELOGFieldAnalyzerSetup.exe”.

If the installer cannot work, please copy all files under the “bin” folder to an arbitrary install folder on your PC.

CAUTION

The name of the install folder should NOT contain non-ASCII characters (e.g., Japanese characters).

5. Startup

By just executing “ELOGFieldAnalyzer.exe”, you can launch the program. First, the “Select file type” window will be opened.

In this window, you can select the type of the files to be read by this program. Explanations of the options are summarized in Table 1.

After selecting the file type, please press the “Select” button.

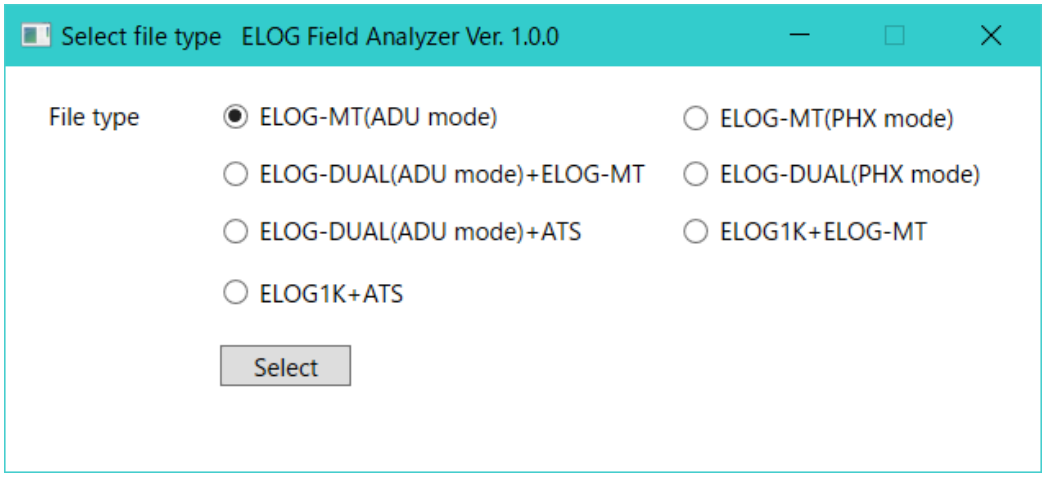

Figure 1: Select file type window

Table 1: Explanation of each file type

File type	Explanation
ELOG-MT (ADU mode)	Five-channel data of ELOG-MT (ADU mode) will be read.
ELOG-MT (PHX mode)	Five-channel data of ELOG-MT (PHX mode) will be read.
ELOG-DUAL (ADU mode) + ELOG-MT	Two-channel data of ELOG-DUAL (ADU mode) will be read. As an option, the magnetic field can also be read from ELOG-MT dat files and used to estimate response functions.
ELOG-DUAL (ADU mode) + ATS	Two-channel data of ELOG-DUAL (ADU mode) will be read. As an option, the magnetic field can also be read from ats files of Metronix instruments and used to estimate response functions.
ELOG-DUAL (PHX mode)	Two-channel data of ELOG-DUAL (PHX mode) will be read. As an option, the magnetic field can also be read from dat files of ELOG-MT and used to estimate response functions.
ELOG1K + ELOG-MT	Two-channel data of ELOG1K will be read. As an option, the magnetic field can also be read from dat files of ELOG-MT and used to estimate response functions.
ELOG1K + ATS	Two-channel data of ELOG1K will be read. As an option, the magnetic field can also be read from ats files of Metronix instruments and used to estimate response functions.

In what follows, the operation for each file type is explained.

6. Operation Explanation for ELOG-MT (ADU mode)

6.1 File Selection Window

Please select a folder where dat files of ELOG-MT are stored. This folder name must be a measurement day (YYYYMMDD).

You need to select the sampling frequency (32 or 1024 Hz) by the radio buttons on the right side.

If you check the box "Remote reference", the magnetic field data is read from ats files of Metronix instruments as remote reference data (H_{rx} and H_{ry}). This reference data will be used in the remote reference method in the response estimation. You only need to select an ats file of the H_x component. The file of the H_y component is automatically selected in the program.

CAUTION

The ats file of the H_x component must contain "_C02_" as the channel index and "_THx_." Otherwise, the program cannot read the ats file.

The times during which the reference magnetic field was measured should overlap with the measurement time of the ELOG-MT at least partly.

Please press the "Read files" button after you properly select sampling frequency and folder and file names.

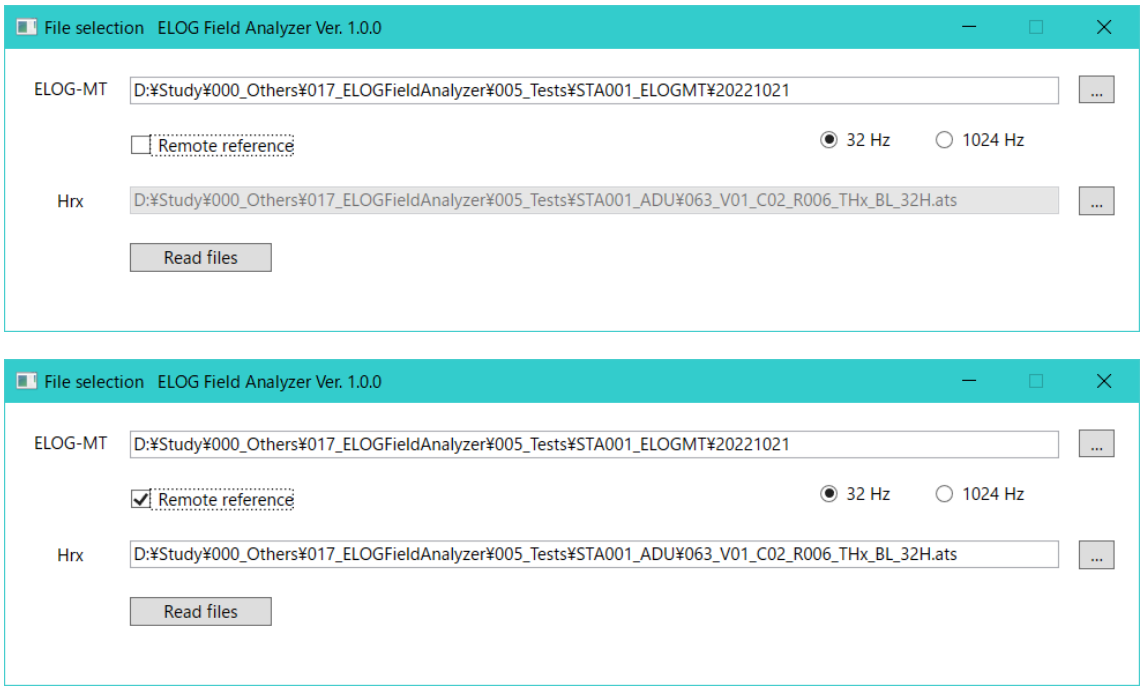

Figure 2: File selection window

6.2 Time Series Window

If dat files (and ats files) are appropriately read, time-series data are displayed.

The explanation of the items on this window (marked in Figure 3) is written below.

EXPLANATION OF EACH ITEM

(1) The time that the cursor pointed in the window is shown in the title bar.

(2) The time series of each channel is displayed. If you double-click the window, the time series will be displayed in a new window, the size of which is changeable.

(3) Star time of the time series displayed in the window.

(4) End time of the time series displayed in the window.

(5) Button to show the tail end of the time series of the previous day.

(6) Button to show the time series of the previous day at the same time range.

(7) Button to show the head of the time series of the next day.

(8) Button to show the time series of the next day at the same time range.

(9) Button to decrement the time range. It is not active if the “Type” is “All”.

(10) Slide bar to change the time range. It is not active if the “Type” is “All”.

(11) Button to increment the time range. It is not active if the “Type” is “All”.

(12) Button to apply a low-pass filter.

(13) Cutoff frequency (Hz) of the low-pass filter.

(14) Button to apply a high-pass filter.

(15) Cutoff frequency (Hz) of the high-pass filter.

(16) Button to apply a notch filter.

(17) Cutoff frequencies (Hz) of the notch filter. You can write multiple frequencies, comma delimited.

(18) Clear all digital filters.

(19) Button to show the information of the applied digital filters.

(20) Type of how to select the time range. If you select “All”, all of the time series of the specified day are displayed. If “Data number” is selected, the number of data is controlled by the selection in (21). If “Data span” is selected, the time span is controlled by the selection in (22).

(21) The number of data shown in this window. This control is active only if “Type” is “Data number”. If you change the number, “Type” is automatically changed to “Data number.”

(22) The time span of the time series shown in this window. This control is active only if “Type” is “Data span”. If you change the time span, “Type” is automatically changed to “Data span.”

(23) Button to show the power spectra.

(24) Button to go to the windows for the response function estimation.

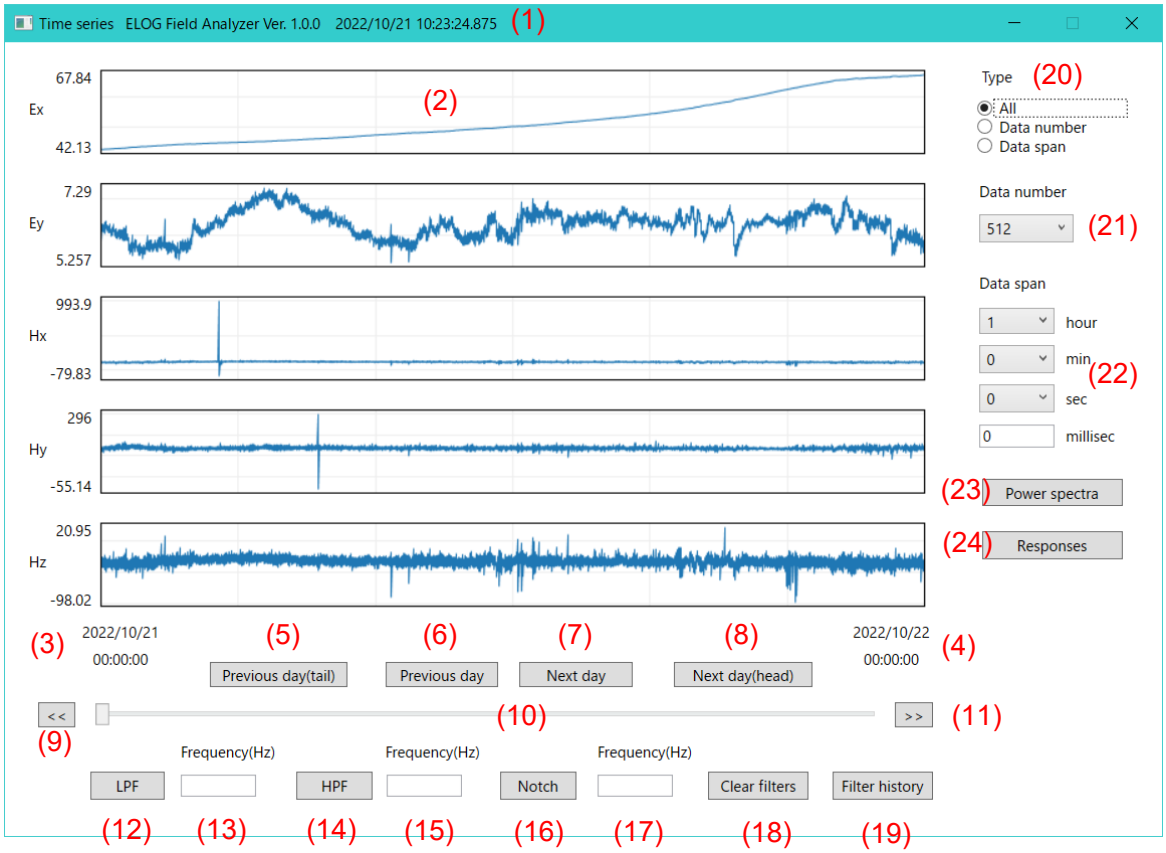

Figure 3: Time series window (in the case where the reference magnetic field is not read)

6.3 Applied Filter Window

When you press the “Filter history” button, the “Applied filter” window is opened. In this window, the amplitude characteristics of the digital filters you already applied are shown (characteristics of all the filters you applied are included).

The information on the filters you applied is listed in the lower left panel.

You can change the range of the upper figure by pressing the “Change range” button after specifying the upper and lower bounds. If you press this button with a blank textbox. Upper and/or lower bounds are automatically determined.

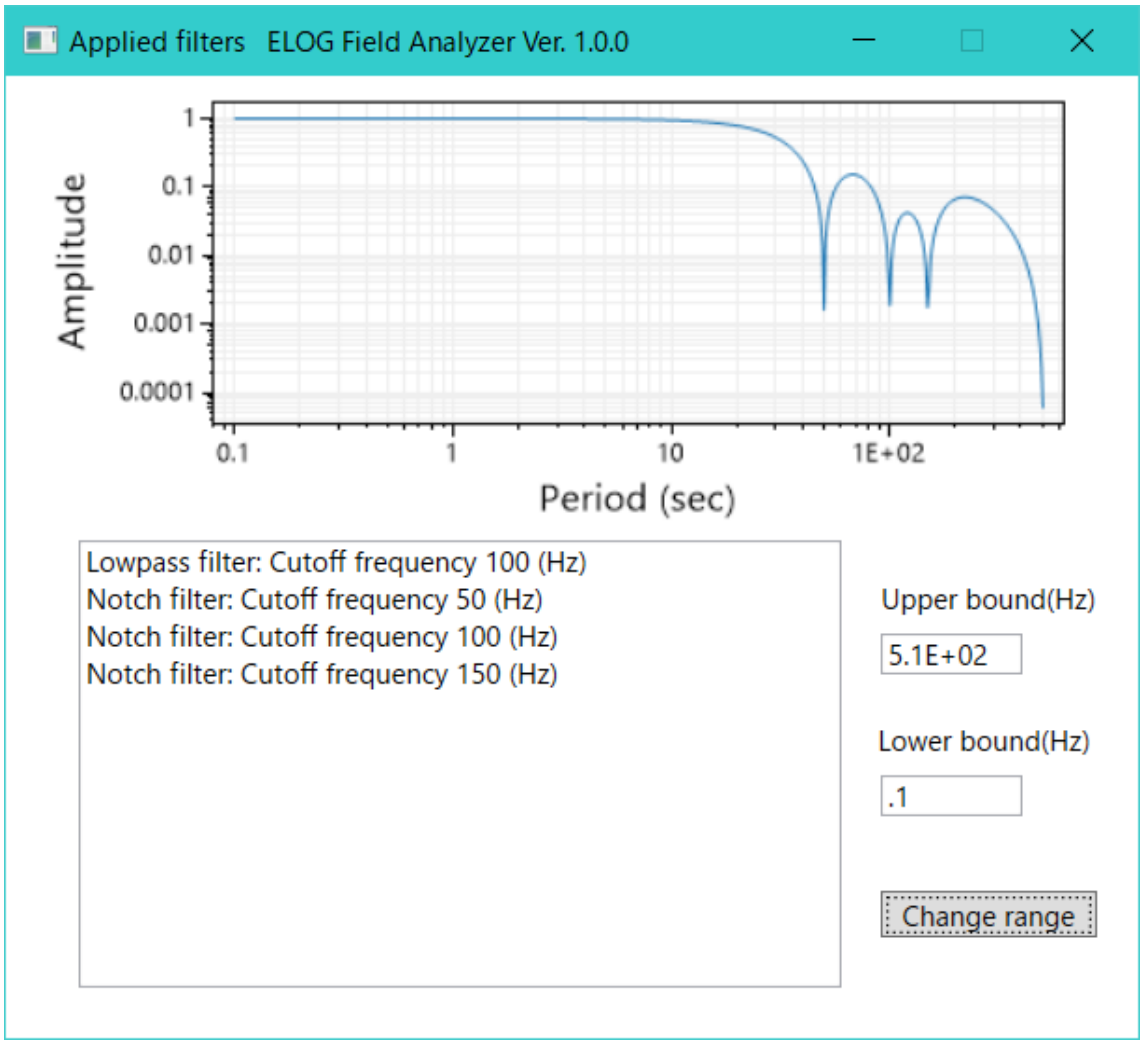

Figure 4: Applied filters window

6.4 Power Spectra Window

When you press the “Power spectra” button, the “Power spectra” window is opened. In this window, the power spectra of all channels are displayed.

Only the data of the times displayed in the “Time series” window are used for calculating the power spectra.

The explanation of the items on this window (marked in Figure 5) is written below.

EXPLANATION OF EACH ITEM

(1) The power spectrum of each channel is displayed. If you double-click the window, the power spectrum is displayed in a new window, the size of which is changeable.

(2) The minimum frequency displayed.

(3) The maximum frequency displayed.

(4) If you check the box, the linear trend in the logarithmic axis is removed from each power spectrum. If you uncheck, the original power spectra are redisplayed.

(5) Lower limit of the frequencies to be displayed.

(6) Upper limit of the frequencies to be displayed.

(7) The button to change the range of the horizontal axes. If you press the button, the range of the frequency is bounded based on the selection in (6) and (7). If (6) and/or (7) are blank, the range is automatically determined.

(8) The frequency that the cursor pointed in the window is shown here.

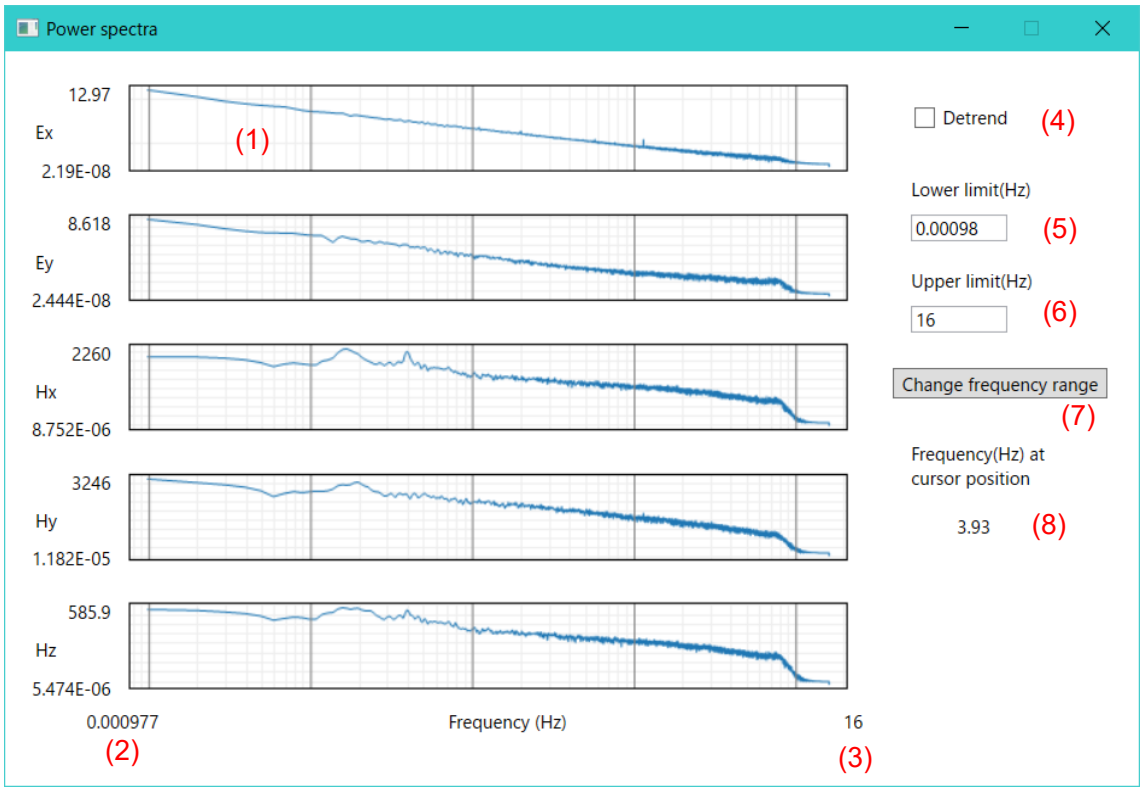

Figure 5: Power spectra window (in the case where the reference magnetic field is not read)

6.5 Response Function Estimation Window

When you press the “Reponses” button, the “Response function estimation” window is opened. In this window, you can select the options for the estimation of the response functions, start the estimation, and plot the sounding curves of the estimated response functions.

Only the data of the times displayed in the “Time series” window are used for the response function estimation.

The explanation of the items on this window (marked in Figure 6) is written below.

EXPLANATION OF EACH ITEM

(1) Work folder. You need to select the work folder for the response function estimation.

(2) Type of the response functions to be estimated.

(3) Dipole length for the N-S component of the electric field (unit: meter).

(4) Dipole length for the E-W component of the electric field (unit: meter).

(5) Measurement direction from the north (unit: degree). For example, the +x direction corresponds to the geomagnetic north in the measurement, and the declination around the station is 7 degrees to the west, you need to write -7 (degrees) in this textbox.

(6) Rotation angle to the coordinate system in which the response functions are estimated (unit: degree). For example, if you write 40 (degrees) in the textbox, the response functions are estimated in the coordinates system whose +x direction is N40°E.

(7) Coil calibration file for the H_x component. This file should follow Metronix's calibration file format.

(8) Coil calibration file for the H_y component. This file should follow Metronix's calibration file format.

(9) Coil calibration file for the H_z component. This file should follow Metronix's calibration file format.

(10) Estimation method. OLS means the ordinary least square. OLS can compute response functions most quickly. If you select “M-estimator” or “RRMS”, outliers are down-weighted. The RRMS estimator is generally the most robust and most time-consuming. “RRMS” can be selected only when the remote magnetic field data are read.

(11) If you check it, the ordinary prewhitening method is used, and the response functions are estimated at longer periods than when it is unchecked. This is because the Fourier transforms at the third and fourth frequencies are used if the prewhitenting is applied (because the prewhitening can suppress the spectral leakage), whereas the Fourier transforms at the eighth and twelfth fourth frequencies are used when no prewhitenting is applied.

(12) If you check it, the original time series data are downsampled.

(13) Rate of downsampling. For example, if you wrote 32 for 32 Hz sampling data, the original time series data are downsampled to 1 Hz sampling data.

(14) Button to make an input file of TRACMT. The input file is created in the work

folder specified in (1). When the input file is successfully made, a message appears at the bottom of the window.

(15) Button to open the created input file with a text editor. You can check and modify the input file with the text editor.

(16) Button to start TRACMT to estimate the response function. If you press the button, a command prompt launches, in which the message from TRACMT is displayed.

(17) Button to plot the sounding curves of the estimated response functions.

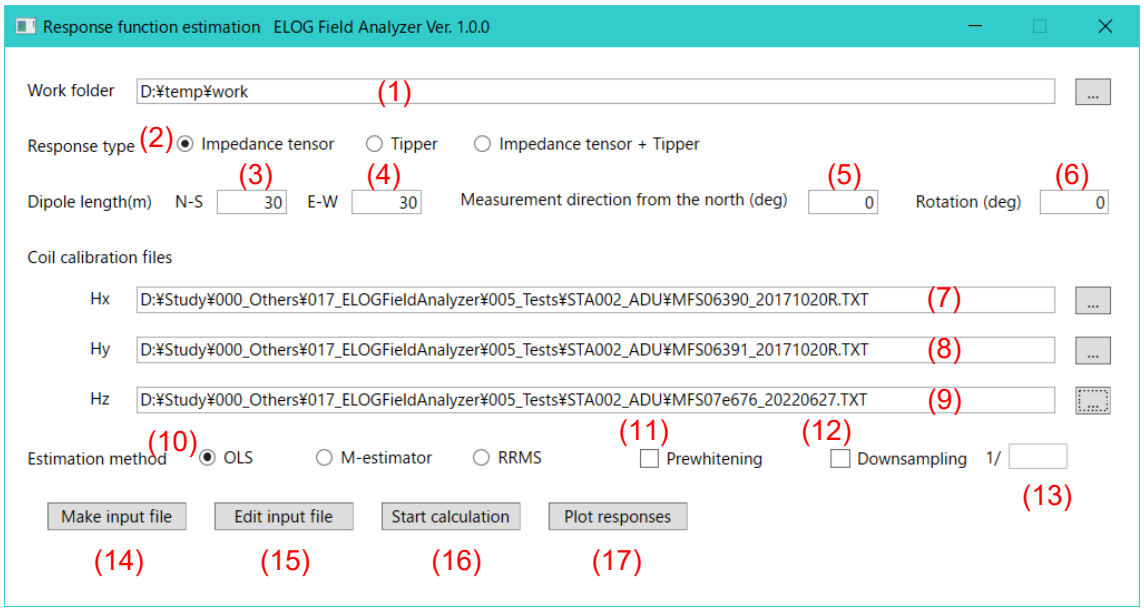

Figure 6: Response function estimation window

6.6 Apparent Resistivity and Phase Window

If you press the “Plot responses” button in the “Response function estimation” window after the calculation of TRACMT is finished, the “Apparent resistivity and phase” window is opened.

In this window, the squared coherence and the sounding curves of the apparent resistivity and phase are depicted.

CAUTION

You need to select “Impedance tensor” or “Impedance tensor + Tipper” in “Response type” to calculate the impedance tensor.

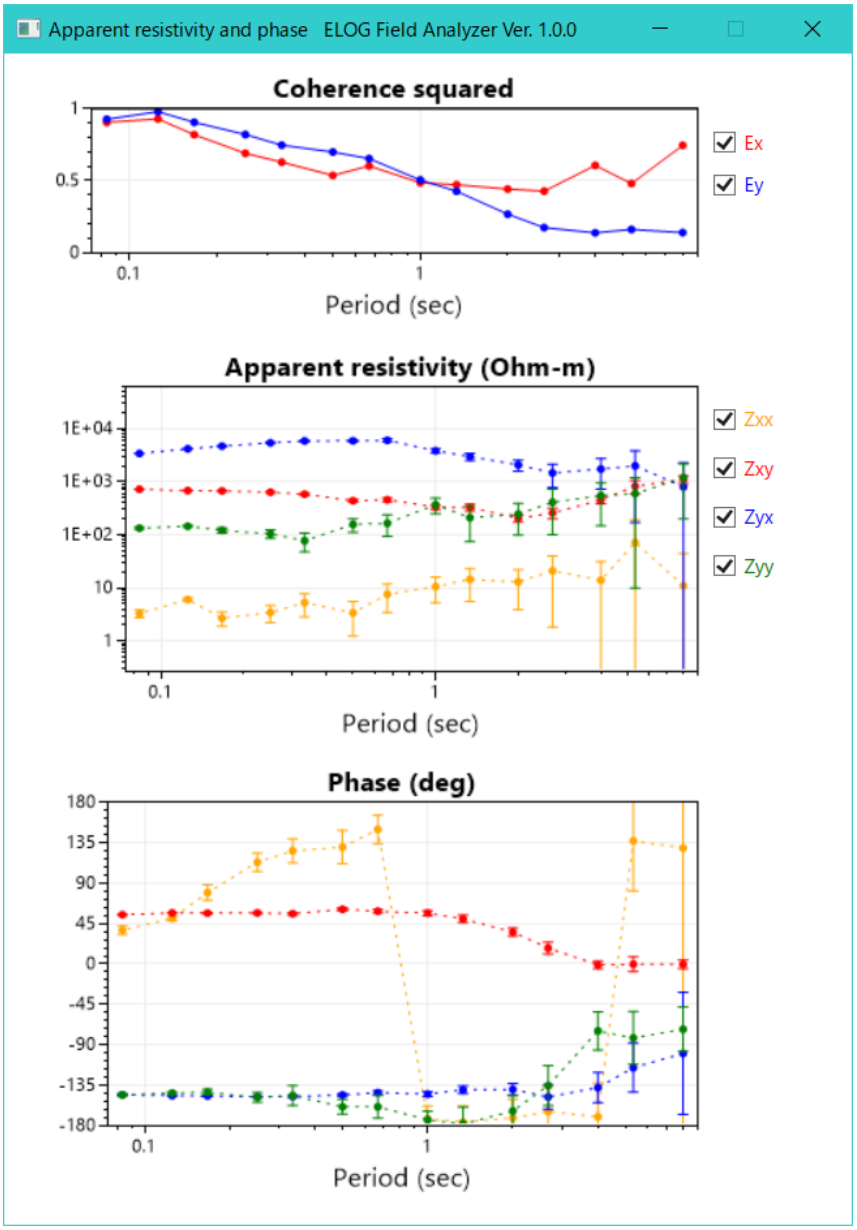

Figure 7: Apparent resistivity and phase window

6.7 Vertical Magnetic Transfer Function (Tipper) Window

If you press the “Plot responses” button in the “Response function estimation” window after the calculation of TRACMT is finished, the “Vertical magnetic transfer function (tipper)” window is opened.

In this window, the squared coherence and the vertical magnetic transfer function (tipper) are depicted.

CAUTION

You need select “Tipper” or “Impedance tensor + Tipper” in “Response type” to calculate the impedance tensor.

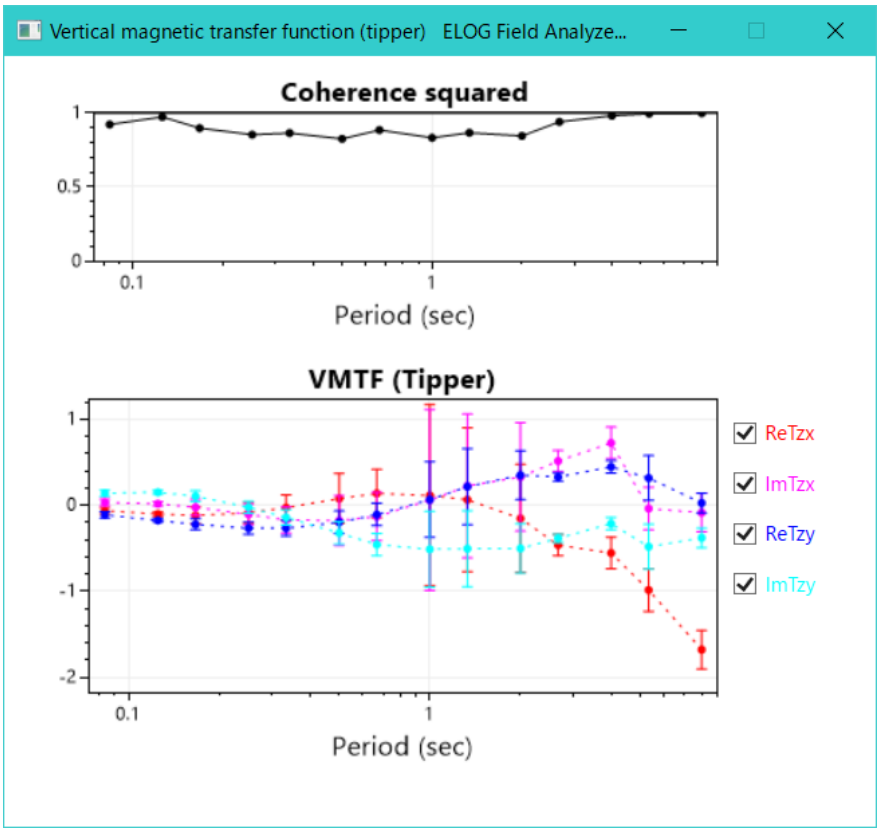

Figure 8: Vertical magnetic transfer function (tipper) window

7. Operation Explanation for ELOG-MT (PHX mode)

7.1 File Selection Window

Please select a folder where dat files of ELOG-MT are stored. This folder name must be the measurement day (YYYYMMDD).

You need to select the sampling frequency (15, 150, or 2400 Hz) by the radio buttons on the right side.

If you check the box "Remote reference", the magnetic field data is read from dat files of another ELOG-MT station as remote reference data (H_{rx} and H_{ry}). This reference data will be used in the remote reference method in the response estimation.

CAUTION

The time period of the local and remote stations should be overlapped at least partly.

Please press the "Read files" button after you properly select sampling frequency and folder and file names.

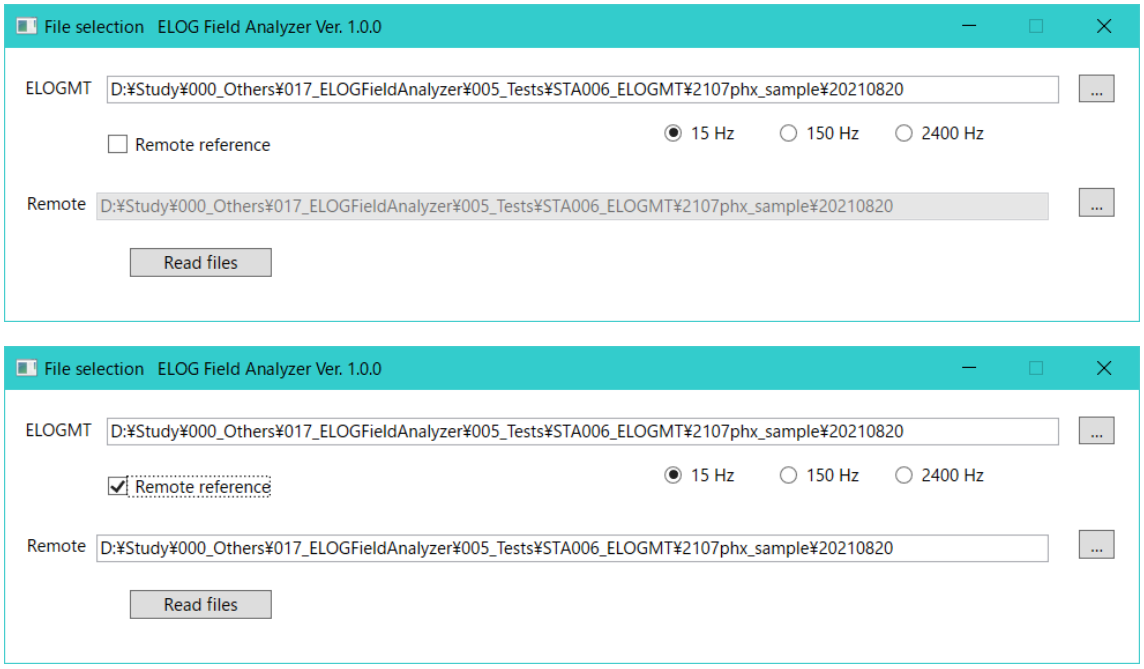

Figure 9: File selection window

7.2 Time Series Window

If dat files are appropriately read, time-series data are displayed.

The explanation of the items on this window (marked in Figure 10) is written below.

EXPLANATION OF EACH ITEM

(1) The time that the cursor pointed in the window is shown in the title bar.

(2) The time series of each channel is displayed. If you double-click the window, the time series will be displayed in a new window, the size of which is changeable.

(3) Star time of the time series displayed in the window.

(4) End time of the time series displayed in the window.

(5) Button to show the tail end of the time series of the previous day.

(6) Button to show the time series of the previous day at the same time range.

(7) Button to show the head of the time series of the next day.

(8) Button to show the time series of the next day at the same time range.

(9) Button to decrement the time range. It is not active if the "Type" is "All".

(10) Slide bar to change the time range. It is not active if the "Type" is "All".

(11) Button to increment the time range. It is not active if the "Type" is "All".

(12) Button to apply a low-pass filter.

(13) Cutoff frequency (Hz) of the low-pass filter.

(14) Button to apply a high-pass filter.

(15) Cutoff frequency (Hz) of the high-pass filter.

(16) Button to apply a notch filter.

(17) Cutoff frequencies (Hz) of the notch filter. You can write multiple frequencies, comma delimited.

(18) Clear all digital filters applied.

(19) Button to show the information on the applied digital filters.

(20) If you select "All", all of the time series of the specified day are displayed. If "Data number" is selected, the number of data is controlled by the selection in (21). If "Data span" is selected, the time span is controlled by the selection in (22).

(21) The number of data shown in this window. This control is active only if "Type" is "Data number". If you change the number, "Type" is automatically changed to "Data number."

(22) The time span of the time series shown in this window. This control is active only if "Type" is "Data span". If you change the time span, "Type" is automatically changed to "Data span."

(23) Button to show the power spectra.

(24) Button to go to the windows for the response function estimation.

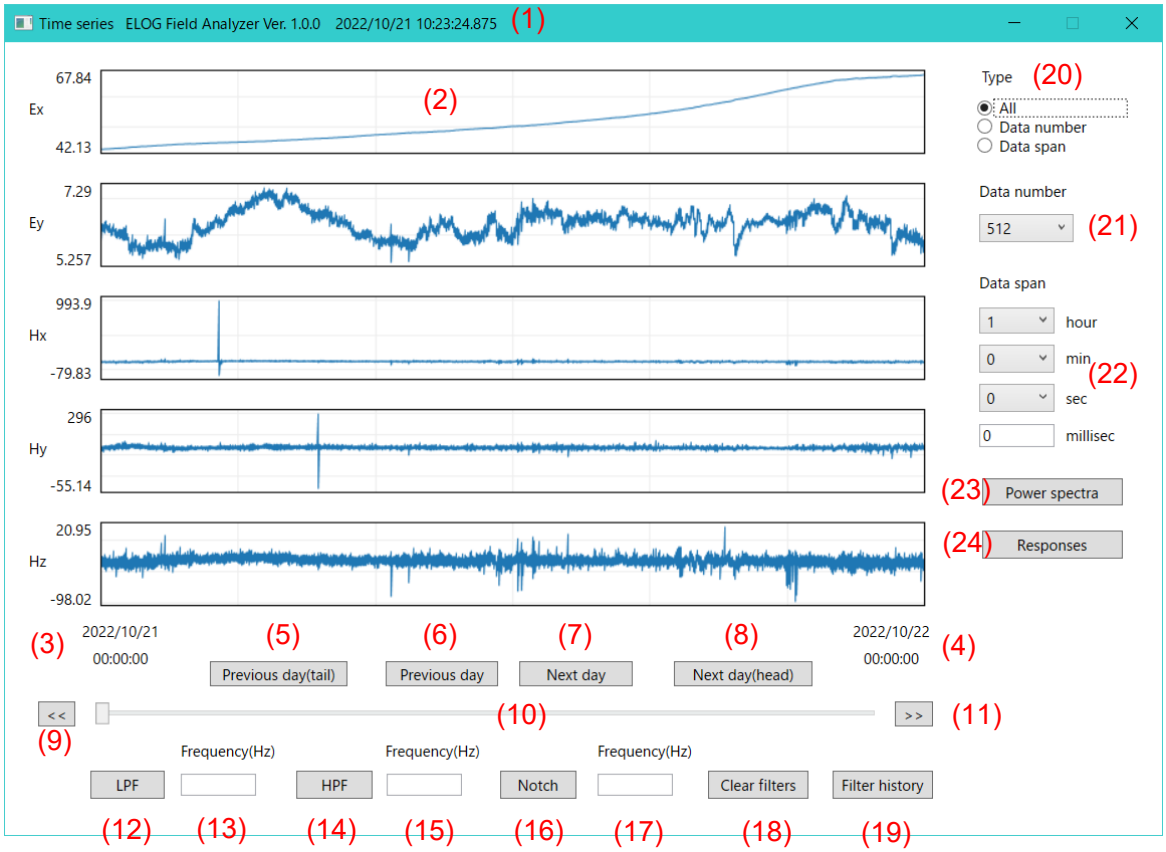

Figure 10: Time series window (in the case where the reference magnetic field is not read)

7.3 Applied Filter Window

When you press the “Filter history” button, the “Applied filter” window will be opened. In this window, the amplitude characteristics of the digital filters you applied are shown (characteristics of all the filters you applied are merged).

The information on the filters you applied is listed in the lower left panel.

You can change the range of the upper figure by pressing the “Change range” button after specifying the upper and lower bounds. If you press this button with a blank textbox. Upper and/or lower bounds are automatically determined.

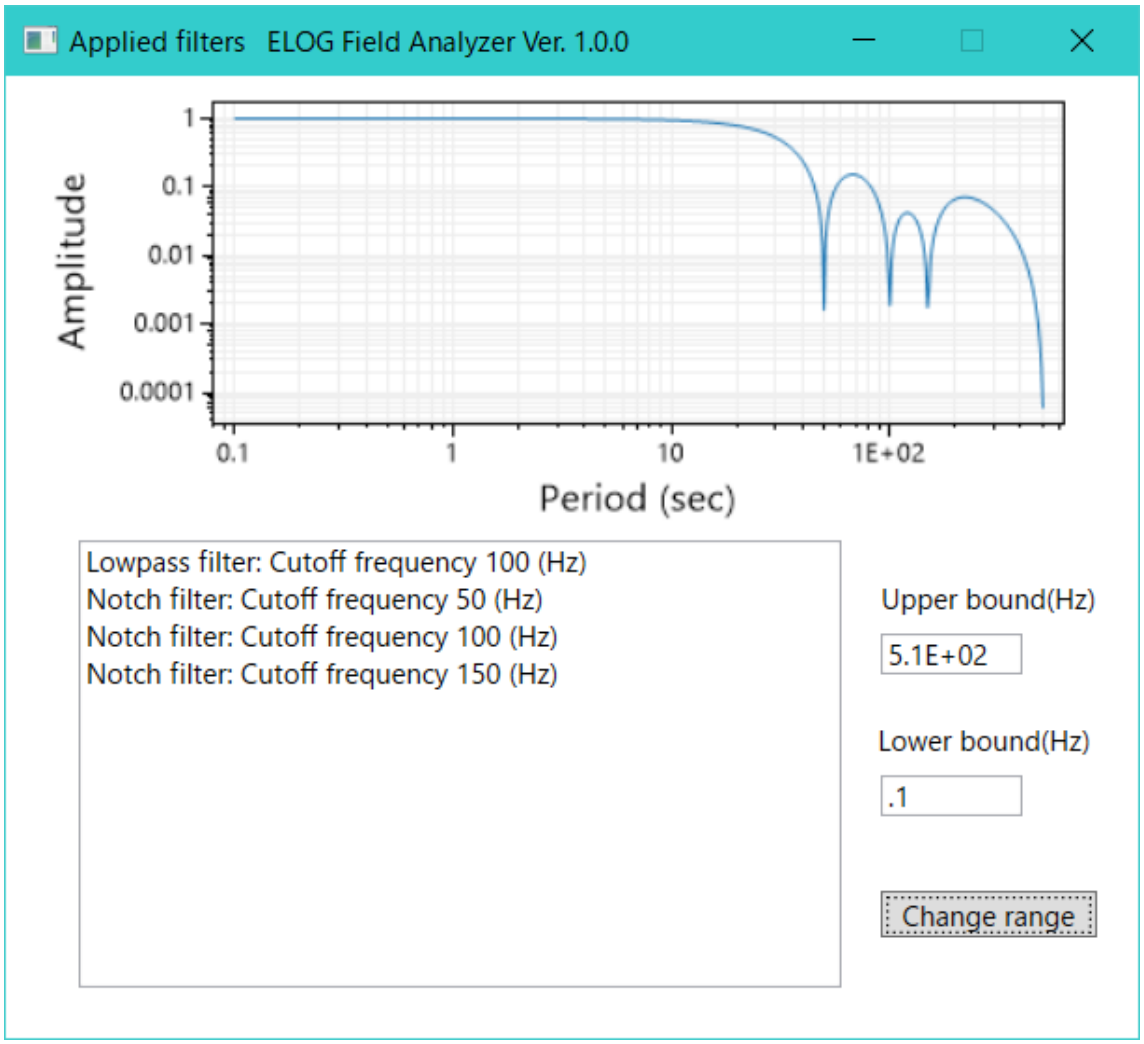

Figure 11: Applied filters window

7.4 Power Spectra Window

When you press the “Power spectra” button, the “Power spectra” window is opened. In this window, the power spectra of all channels are displayed.

Only the data of the times displayed in the “Time series” window are used for calculating the power spectra.

The explanation of the items on this window (marked in Figure 12) is written below.

EXPLANATION OF EACH ITEM

(1) The power spectrum of each channel is displayed. If you double-click the window, the power spectrum will be displayed in a new window, the size of which is changeable.

(2) The minimum frequency displayed.

(3) The maximum frequency displayed.

(4) If you check the box, the linear trend in the logarithmic axis is removed from each power spectrum. If you uncheck, the original power spectra are redisplayed.

(5) Lower limit of the frequencies to be displayed.

(6) Upper limit of the frequencies to be displayed.

(7) The button to change the range of the horizontal axes. If you press the button, the range of the frequency is bounded based on the selection in (6) and (7). If (6) and/or (7) are blank, the range is automatically determined.

(8) The frequency that the cursor pointed in the window is shown here.

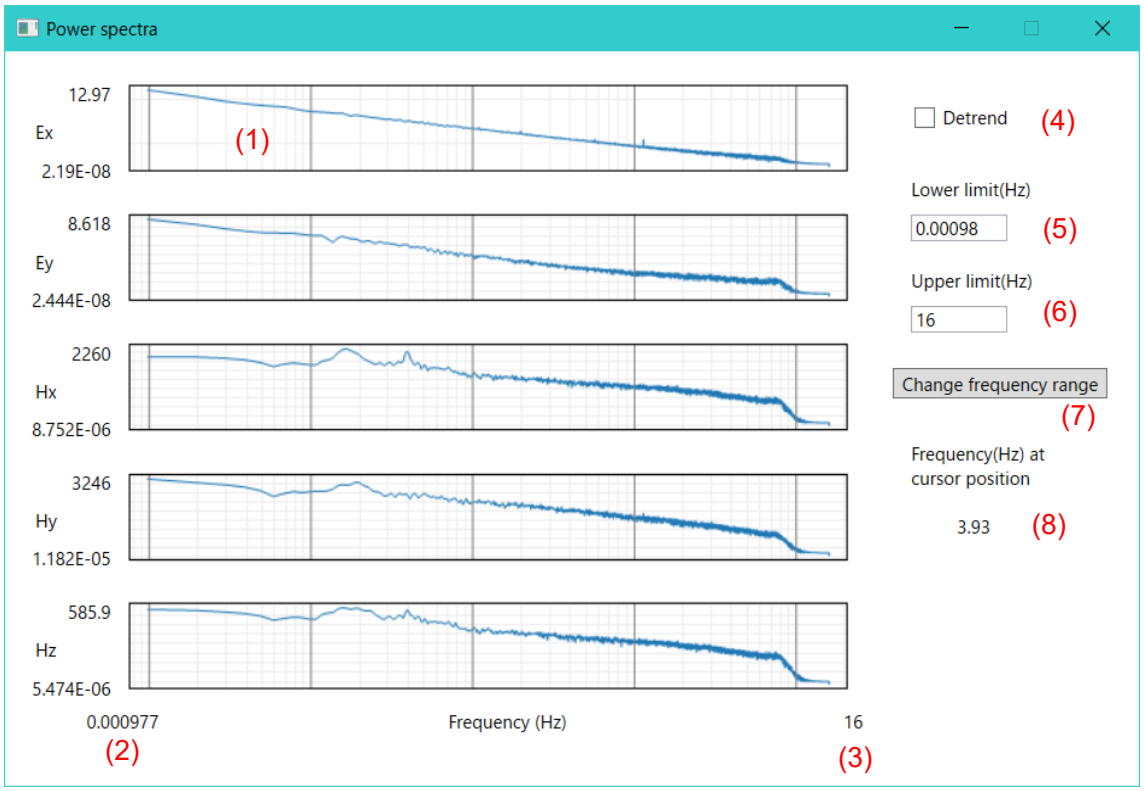

Figure 12: Power spectra window (in the case where the reference magnetic field is not read)

7.5 Response Function Estimation Window

When you press the “Reponses” button, the “Response function estimation” window is opened. In this window, you can select options in the estimation of the response functions, start the estimation, and plot the sounding curves of the estimated response functions.

Only the data of the times displayed in the "Time series" window are used for the response function estimation

The explanation of the items on this window (marked in Figure 13) is written below.

EXPLANATION OF EACH ITEM

(1) Work folder. You need to select the work folder for the response function estimation.

(2) Type of the response functions to be estimated.

(3) Dipole length for the N-S component of the electric field (unit: meter).

(4) Dipole length for the E-W component of the electric field (unit: meter).

(5) Measurement direction from the north (unit: degree). For example, the +x direction corresponds to the geomagnetic north in the measurement, and the declination around the station is 7 degrees to the west, you need to write -7 (degrees) in this textbox.

(6) Rotation angle to the coordinate system in which the response functions are estimated (unit: degree). For example, if you write 40 (degrees) in the textbox, the response functions are estimated in the coordinates system whose +x direction is N40°E.

(7) Coil calibration file for the Hx component. The file should follow the format described below.

(8) Coil calibration file for the Hy component. The file should follow the format described below.

(9) Coil calibration file for the Hz component. The file should follow the format described below.

(10) Estimation method. OLS means the ordinary least square. OLS can compute response functions most quickly. If you select "M-estimator" or "RRMS", outliers are down-weighted. The RRMS estimator is generally the most robust and most time-consuming. "RRMS" can be selected only when the remote magnetic field data are read.

(11) If you check this, the ordinary prewhitening method is used, and the response functions are estimated at longer periods than when it is unchecked. This is because the Fourier transforms at the third and fourth frequencies are used if the prewhitenting is applied (because the prewhitening can suppress the spectral leakage), whereas the Fourier transforms at the eighth and twelfth fourth frequencies are used when no prewhitenting is applied.

(12) If you check this, the original time series data are downsampled.

(13) Rate of downsampling. For example, if you wrote 32 for 32 Hz sampling data, the original time series data are downsampled to 1 Hz sampling data.

(14) Button to make an input file of TRACMT. The input file is created in the work

folder you specify in (1). When the input file is successfully made, a message appears at the bottom of the window.

(15) Button to open the created input file with a text editor. You can check and modify the input file by the text editor.

(16) Button to start TRACMT to estimate the response function. If you press the button, a command prompt launches, in which the message from TRACMT is displayed.

(17) Button to plot the sounding curves of estimated response functions.

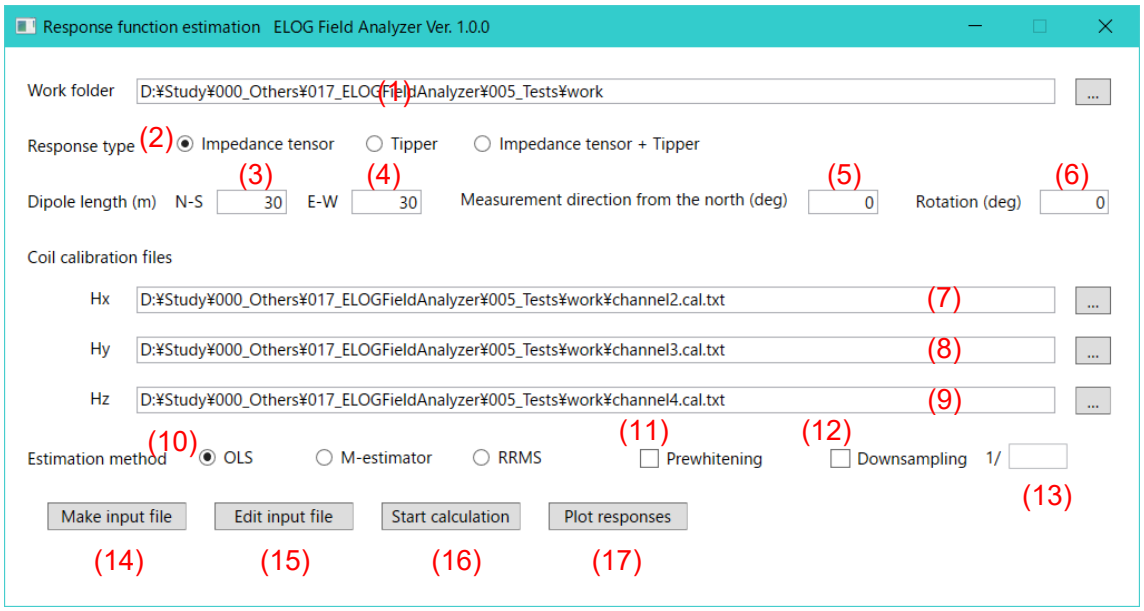

Figure 13: Response function estimation window

FORMAT OF CALIBRATION FILES

Coil calibration files for the magnetic field should follow the following format.

Instrumental characteristics are corrected in the frequency domain by multiplying A and $C(f)$ as

$$A \times C(f_1)H_x(f_1) \rightarrow H_x(f_1)$$

$$A \times C(f_2)H_x(f_2) \rightarrow H_x(f_2)$$

...

The calibration function is interpolated for the frequency at which $C(f)$ is not specified.

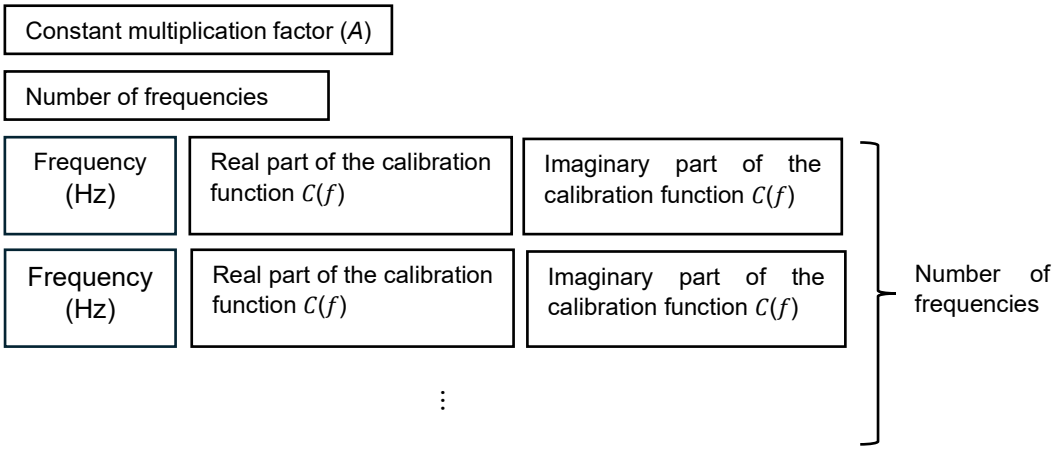

Figure 14: Format of calibration file of TRACMT

7.6 Apparent Resistivity and Phase Window

If you press the "Plot responses" button in the "Response function estimation" window after the calculation of TRACMT is finished, the "Apparent resistivity and phase" window is opened.

In this window, the squared coherence and the sounding curves of the apparent resistivity and phase are depicted.

CAUTION

You need to select "Impedance tensor" or "Impedance tensor + Tipper" in "Response type" to calculate the impedance tensor.

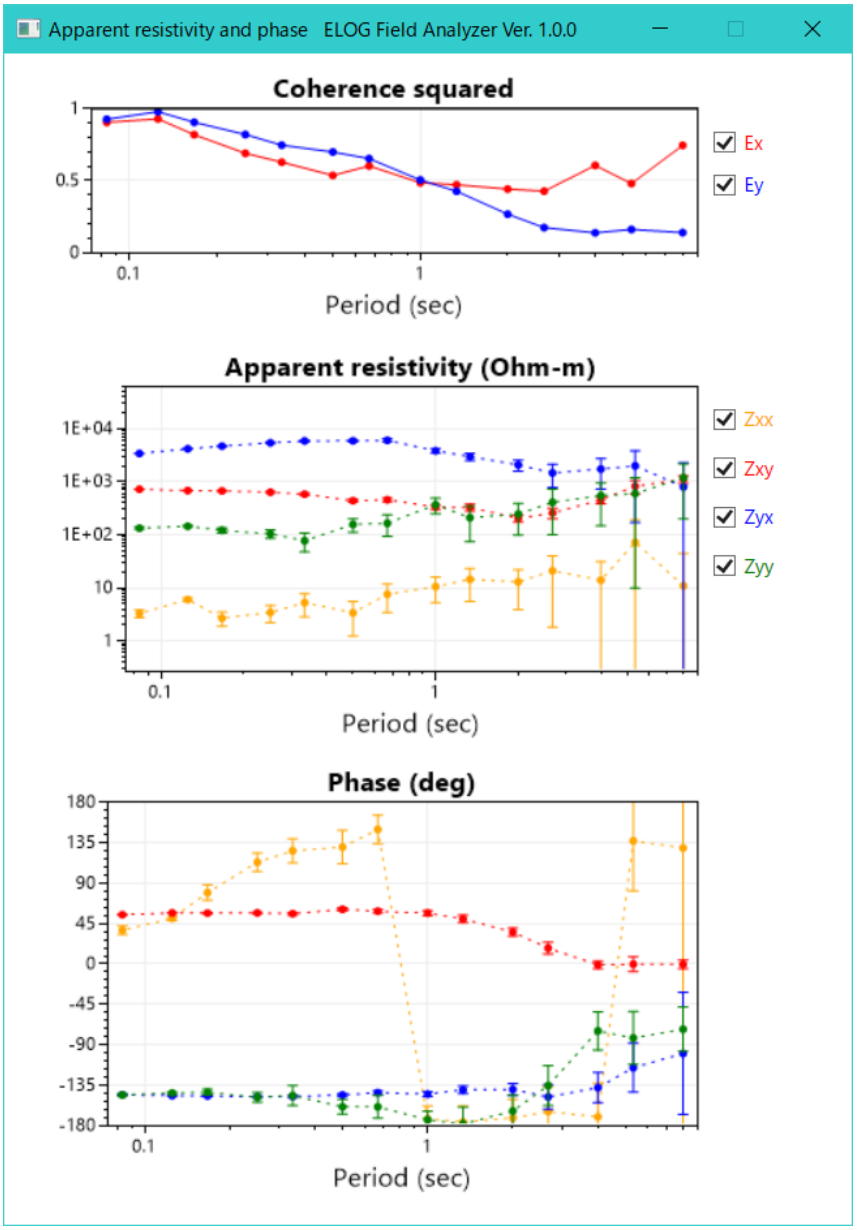

Figure 15: Apparent resistivity and phase window

7.7 Vertical Magnetic Transfer Function (Tipper) Window

If you press the “Plot responses” button in the “Response function estimation” window after the calculation of TRACMT is finished, the “Vertical magnetic transfer function (tipper)” window is opened.

In this window, the squared coherence and the vertical magnetic transfer function (tipper) are depicted.

CAUTION

You need to select “Tipper” or “Impedance tensor + Tipper” in “Response type” to calculate the impedance tensor.

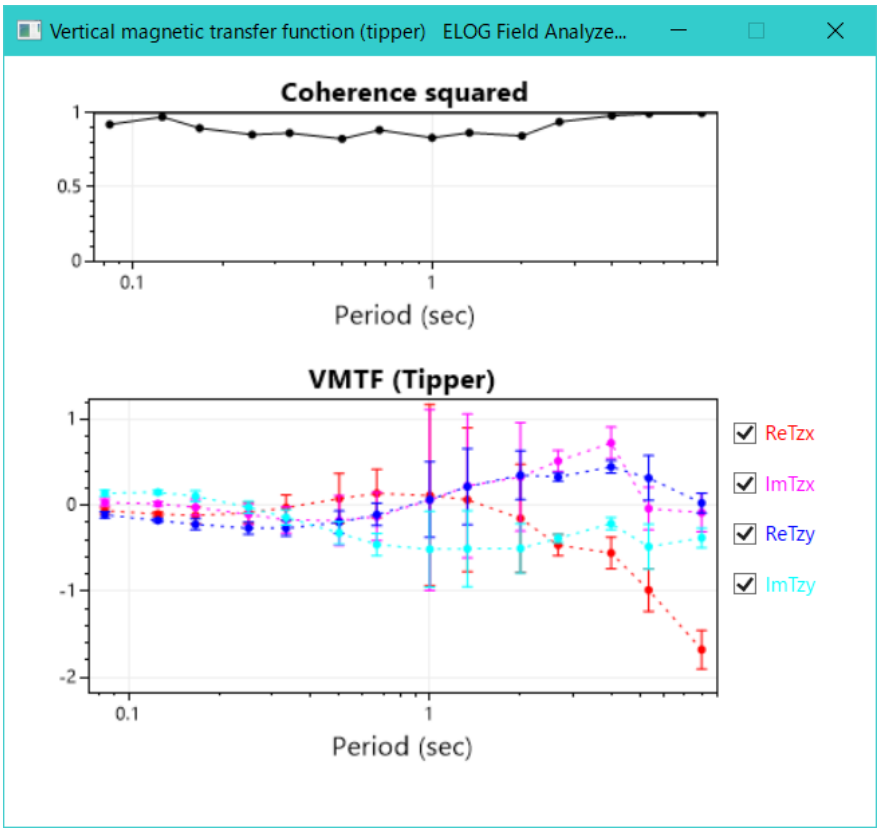

Figure 16: Vertical magnetic transfer function (tipper) window

8. Operation Explanation for ELOG-DUAL (ADU mode) + ELOG-MT

8.1 File Selection Window

Please select a folder where dat files of ELOG-DUAL are stored. This folder name must be the measurement day (YYYYMMDD).

You need to select the sampling frequency (32 or 1024 Hz) by the radio buttons on the right side.

If you check the box "Magnetic field data," the horizontal components (H_x and H_y) of the magnetic field are read from dat files of an ELOG-MT station. These magnetic field data are used to estimate response functions.

If you check the box "Remote reference", the magnetic field data is read from ats files of Metronix instruments as remote reference data (H_{rx} and H_{ry}). This reference data will be used in the remote reference method in the response estimation. You only need to select the ats file for the H_x component. The file for the H_y component is automatically selected in the program.

CAUTION

The measurement times of all channels should be overlapped at least partly.

The ats file of the H_x component must contain "_C02_" as the channel index and "_THx_." Otherwise, the program cannot read the ats file.

Please press the "Read files" button after you properly select sampling frequency and folder and file names.

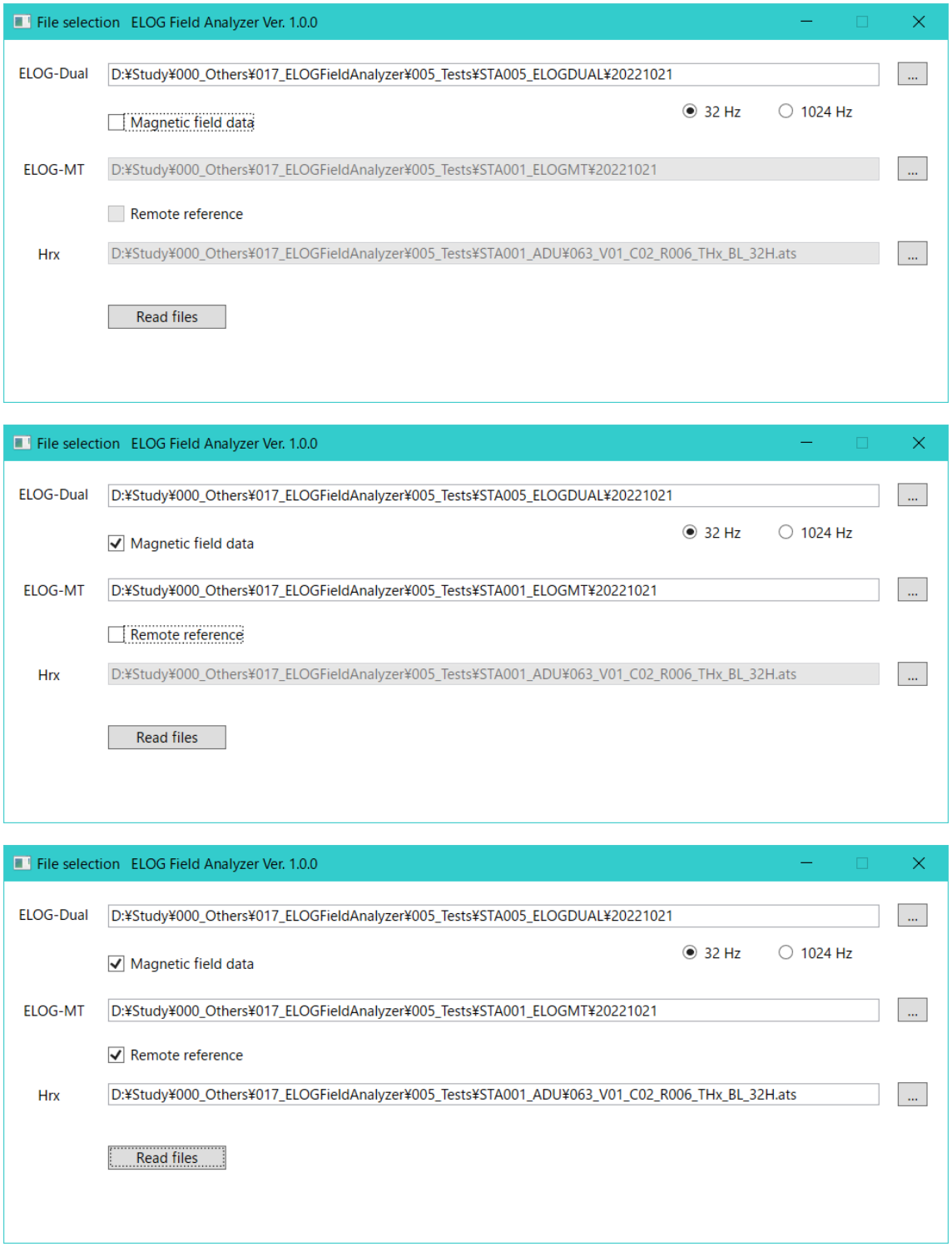

Figure 17: File selection window

8.2 Time Series Window

If dat files are appropriately read, time-series data are displayed.

The explanation of the items on this window (marked in Figure 18) is written below.

EXPLANATION OF EACH ITEM

(1) The time that the cursor pointed in the window is shown in the title bar.

(2) The time series of each channel is displayed. If you double-click the window, the time series will be displayed in a new window, the size of which is changeable.

(3) Star time of the time series displayed in the window.

(4) End time of the time series displayed in the window.

(5) Button to show the tail end of the time series of the previous day.

(6) Button to show the time series of the previous day at the same time range.

(7) Button to show the head of the time series of the next day.

(8) Button to show the time series of the next day at the same time range.

(9) Button to decrement the time range. It is not active if the "Type" is "All".

(10) Slide bar to change the time range. It is not active if the "Type" is "All".

(11) Button to increment the time range. It is not active if the "Type" is "All".

(12) Button to apply a low-pass filter.

(13) Cutoff frequency (Hz) of the low-pass filter.

(14) Button to apply a high-pass filter.

(15) Cutoff frequency (Hz) of the high-pass filter.

(16) Button to apply a notch filter.

(17) Cutoff frequencies (Hz) of the notch filter. You can write multiple frequencies, comma delimited.

(18) Clear all digital filters applied.

(19) Button to show the information on the applied digital filters.

(20) If you select "All", all of the time series of the specified day are displayed. If "Data number" is selected, the number of data is controlled by the selection in (21). If "Data span" is selected, the time span is controlled by the selection in (22).

(21) The number of data shown in this window. This control is active only if "Type" is "Data number". If you change the number, "Type" is automatically changed to "Data number."

(22) The time span of the time series shown in this window. This control is active only if "Type" is "Data span". If you change the time span, "Type" is automatically changed to "Data span."

(23) Button to show the power spectra.

(24) Button to go to the windows for the response function estimation.

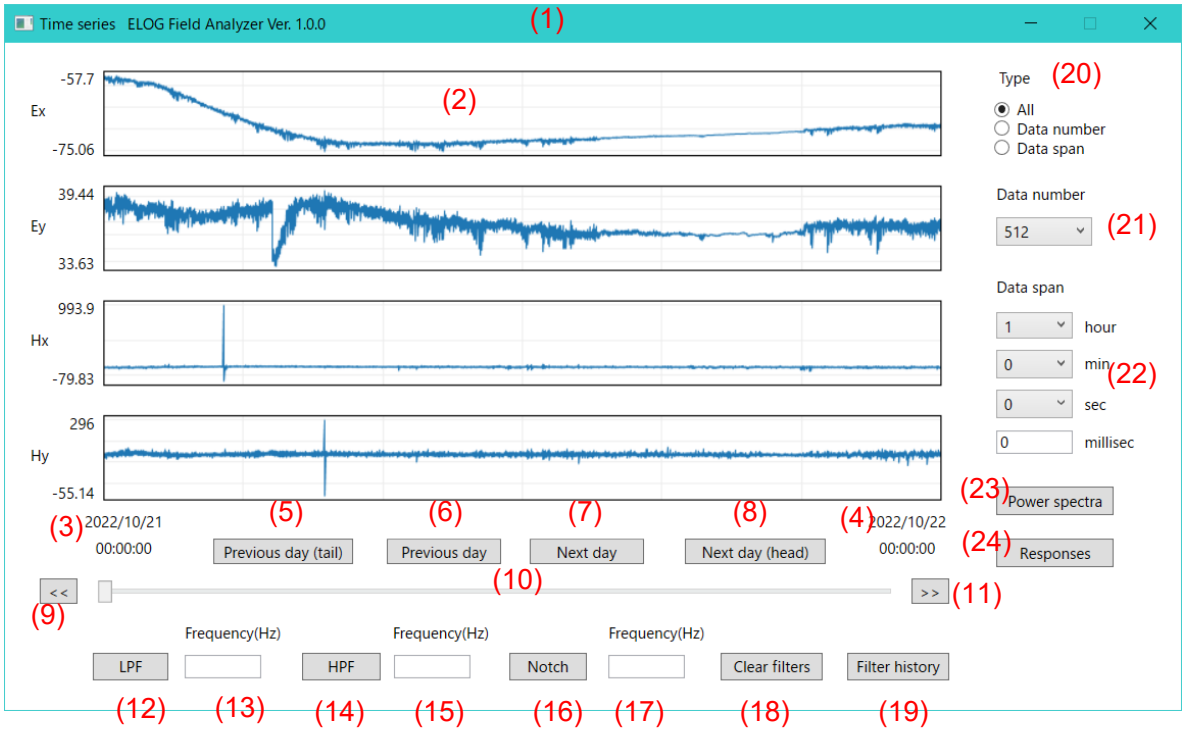

Figure 18: Time series window (in the case where the reference magnetic field is not read)

8.3 Applied Filter Window

When you press the “Filter history” button, the “Applied filter” window will be opened. In this window, the amplitude characteristics of the digital filters you applied are shown (characteristics of all the filters you applied are merged).

The information on the filters you applied is listed in the lower left panel.

You can change the range of the upper figure by pressing the “Change range” button after specifying the upper and lower bounds. If you press this button with a blank textbox. Upper and/or lower bounds are automatically determined.

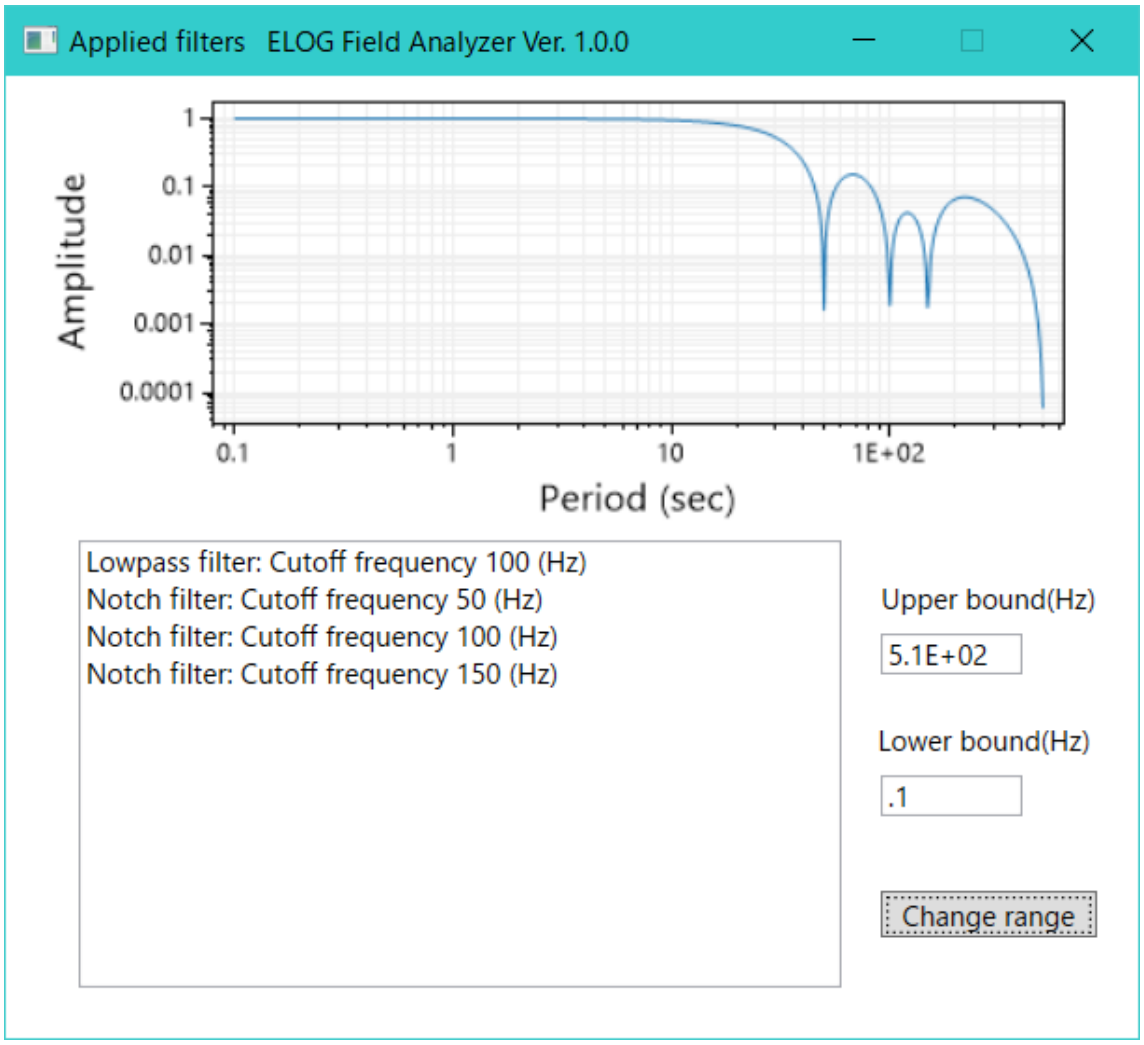

Figure 19: Applied filters window

8.4 Power Spectra Window

When you press the “Power spectra” button, the “Power spectra” window is opened. In this window, the power spectra of all channels are displayed.

Only the data of the times displayed in the “Time series” window are used for calculating the power spectra.

The explanation of the items on this window (marked in Figure 20) is written below.

EXPLANATION OF EACH ITEM

(1) The power spectrum of each channel is displayed. If you double-click the window, the power spectrum will be displayed in a new window, the size of which is changeable.

(2) The minimum frequency displayed.

(3) The maximum frequency displayed.

(4) If you check the box, the linear trend in the logarithmic axis is removed from each power spectrum. If you uncheck, the original power spectra are redisplayed.

(5) Lower limit of the frequencies to be displayed.

(6) Upper limit of the frequencies to be displayed.

(7) The button to change the range of the horizontal axes. If you press the button, the range of the frequency is bounded based on the selection in (6) and (7). If (6) and/or (7) are blank, the range is automatically determined.

(8) The frequency that the cursor pointed in the window is shown here.

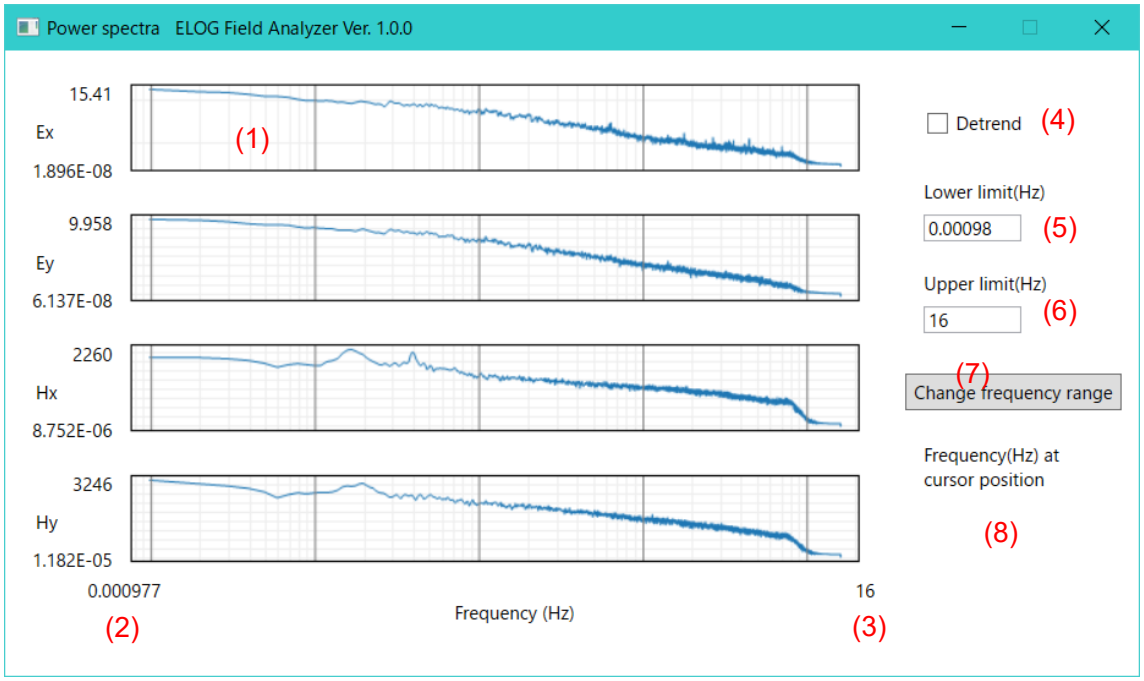

Figure 20: Power spectra window (in the case where the reference magnetic field is not read)

8.5 Response Function Estimation Window

When you press the “Reponses” button, the “Response function estimation” window is opened. In this window, you can select options in the estimation of the response functions, start the estimation, and plot the sounding curves of the estimated response functions.

Only the data of the times displayed in the “Time series” window are used for the response function estimation.

The explanation of the items on this window (marked in Figure 21) is written below.

EXPLANATION OF EACH ITEM

(1) Work folder. You need to select the work folder for the response function estimation.

(2) Dipole length for the N-S component of the electric field (unit: meter).

(3) Dipole length for the E-W component of the electric field (unit: meter).

(4) Measurement direction from the north (unit: degree). For example, the +x direction corresponds to the geomagnetic north in the measurement, and the declination around the station is 7 degrees to the west, you need to write -7 (degrees) in this textbox.

(5) Rotation angle to the coordinate system in which the response functions are estimated (unit: degree). For example, if you write 40 (degrees) in the textbox, the response functions are estimated in the coordinates system whose +x direction is N40°E.

(6) Coil calibration file for the Hx component. The file should follow Metronix's calibration file format.

(7) Coil calibration file for the Hy component. The file should follow Metronix's calibration file format.

(8) Estimation method. OLS means the ordinary least square. OLS can compute response functions most quickly. If you select “M-estimator” or “RRMS”, outliers are down-weighted. The RRMS estimator is generally the most robust and most time-consuming. “RRMS” can be selected only when the remote magnetic field data are read

(9) If you check it, the ordinary prewhitening method is used, and the response functions are estimated at longer periods than when it is unchecked. This is because the Fourier transforms at the third and fourth frequencies are used if the prewhitenting is applied (because the prewhitening can suppress the spectral leakage), whereas the Fourier transforms at the eighth and twelfth fourth frequencies are used when no prewhitenting is applied.

(10) If you check it, the original time series data are downsampled.

(11) Rate of downsampling. For example, if you wrote 32 for 32 Hz sampling data, the original time series data are downsampled to 1 Hz sampling data.

(12) Button to make an input file of TRACMT. The input file is created in the work folder you specify in (1). When the input file is successfully made, a message appears at the bottom of the window.

(13) Button to open the created input file with a text editor. You can check and modify the input file by the text editor.

(14) Button to start TRACMT to estimate the response function. If you press the button, a command prompt launches, in which the message from TRACMT is displayed

(15) Button to plot the sounding curves of estimated response functions.

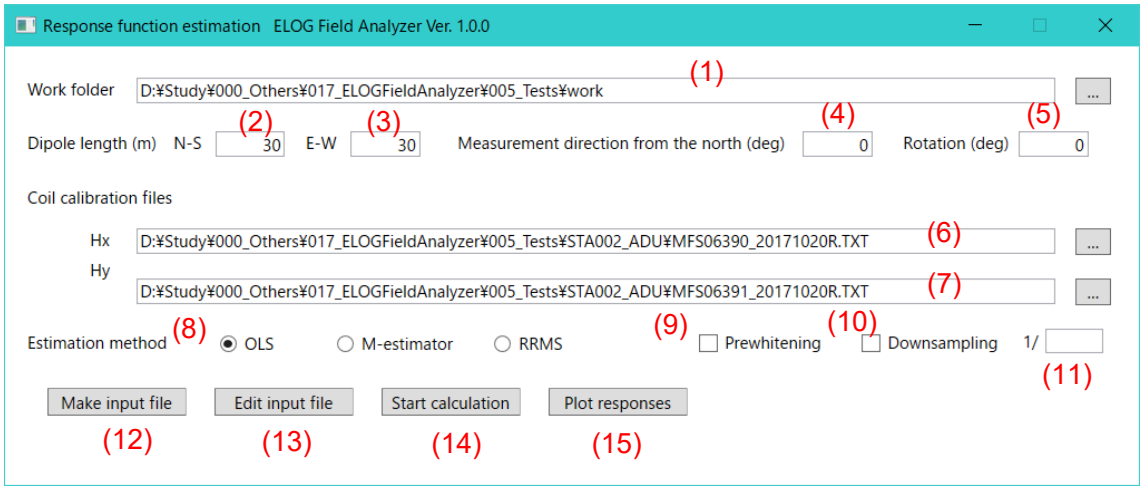

Figure 21: Response function estimation window

8.6 Apparent Resistivity and Phase Window

If you press the “Plot responses” button in the “Response function estimation” window after the calculation of TRACMT is finished, the “Apparent resistivity and phase” window is opened.

In this window, the squared coherence and the sounding curves of the apparent resistivity and phase are depicted

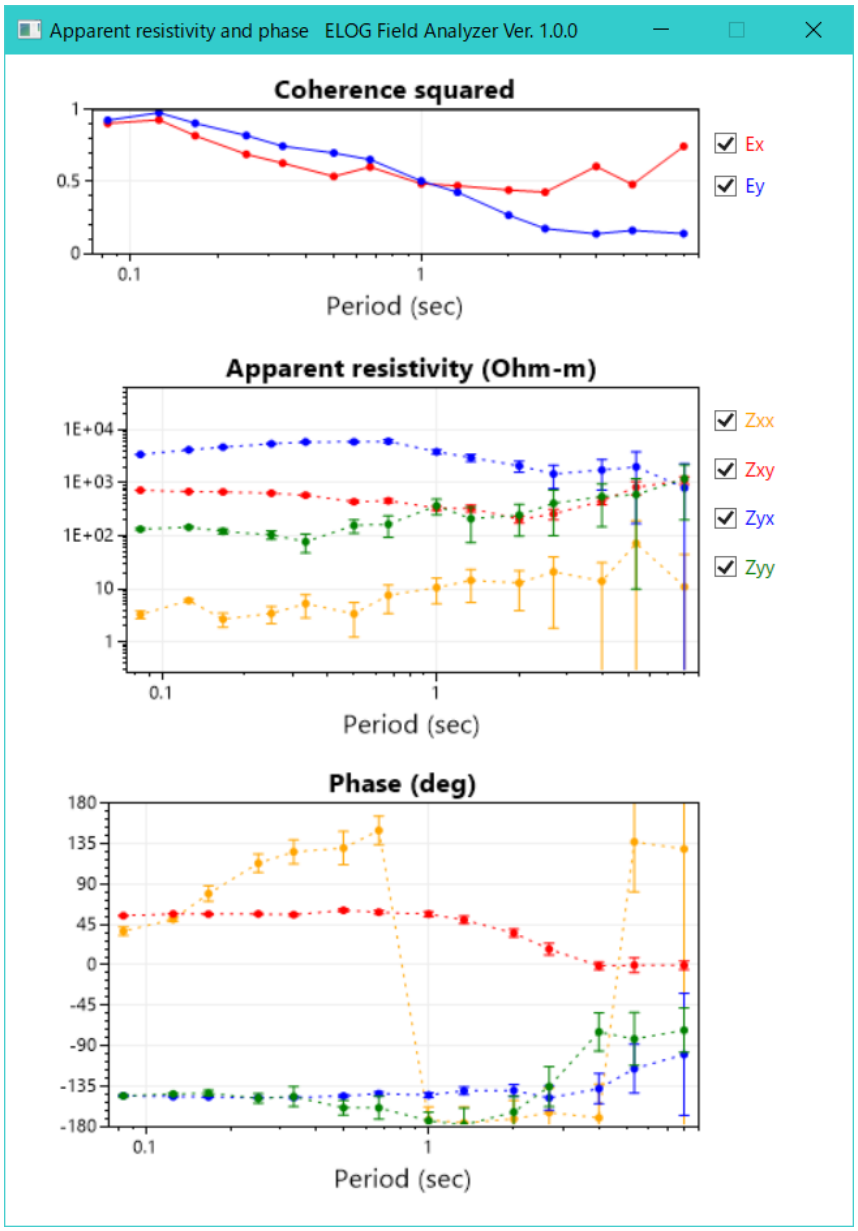

Figure 22: Apparent resistivity and phase window

9. Operation Explanation for ELOG-DUAL (ADU mode) + ATS

9.1 File Selection Window

Please select a folder where dat files of ELOG-DUAL are stored. This folder name must be the measurement day (YYYYMMDD).

You need to select the sampling frequency (32 or 1024 Hz) by the radio buttons on the right side.

If you check the box "Magnetic field data," the horizontal components (H_x and H_y) of the magnetic field are read from ats files of Metronix instruments. These magnetic field data are used to estimate response functions.

If you check the box "Remote reference", the magnetic field data is read from ats files of Metronix instruments as remote reference data (H_{rx} and H_{ry}). This reference data will be used in the remote reference method in the response estimation.

CAUTION

In both textboxes for H_x and H_{ry}, you only need to select the ats file for the H_x component. The file for the H_y component is automatically selected in the program. The ats file of the H_x component must contain "_C02_" as the channel index and "_THx_." Otherwise, the program cannot read the ats file.

The measurement times of all channels should be overlapped at least partly.

Please press the "Read files" button after you properly select sampling frequency and folder and file names.

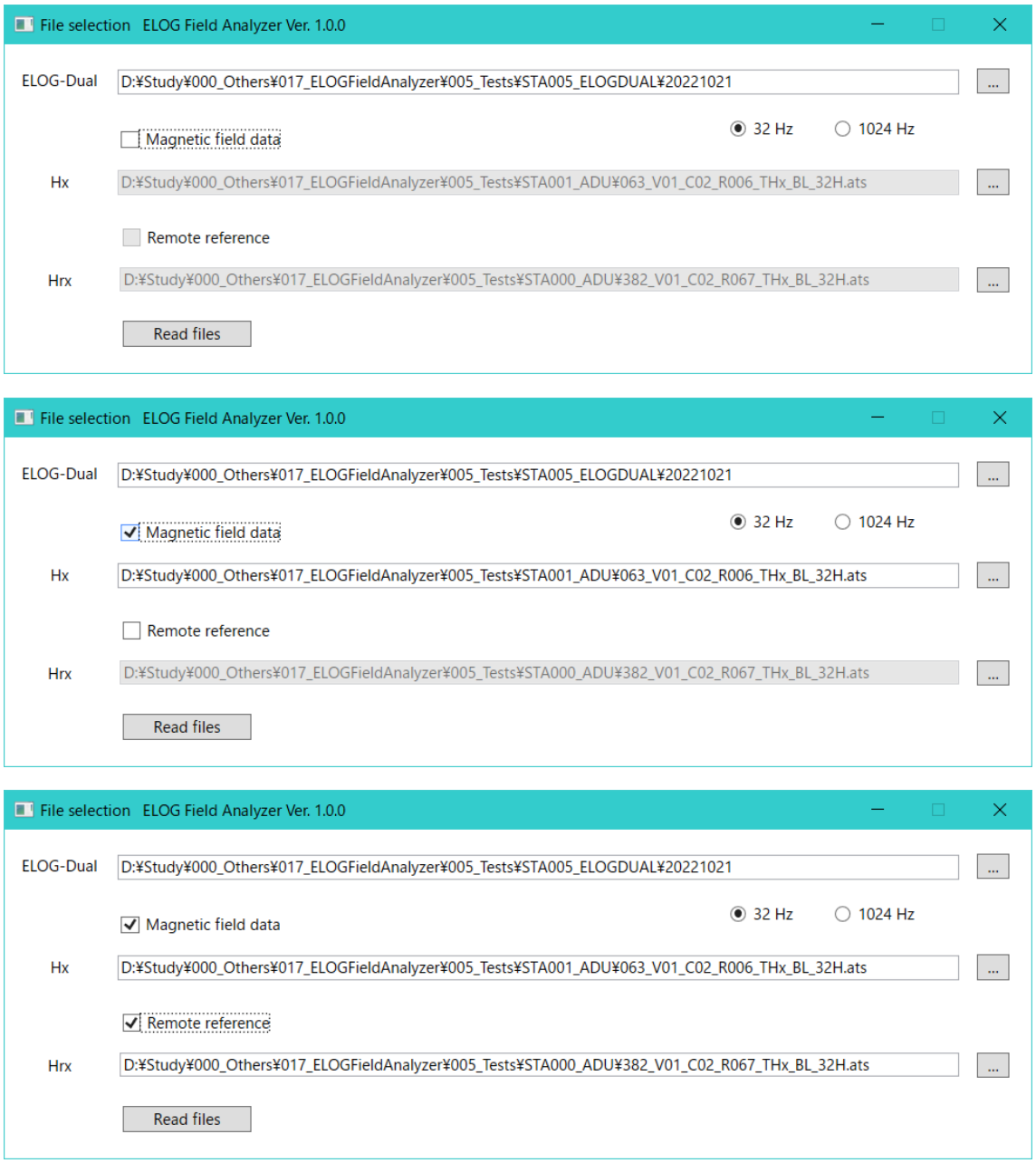

Figure 23: File selection window

9.2 Time Series Window

If dat files are appropriately read, time-series data are displayed.

The explanation of the items on this window (marked in Figure 24) is written below.

EXPLANATION OF EACH ITEM

(1) The time that the cursor pointed in the window is shown in the title bar.

(2) The time series of each channel is displayed. If you double-click the window, the time series will be displayed in a new window, the size of which is changeable.

(3) Star time of the time series displayed in the window.

(4) End time of the time series displayed in the window.

(5) Button to show the tail end of the time series of the previous day.

(6) Button to show the time series of the previous day at the same time range.

(7) Button to show the head of the time series of the next day.

(8) Button to show the time series of the next day at the same time range.

(9) Botton to decrement the time range. It is not active if the "Type" is "All".

(10) Slide bar to change the time range. It is not active if the "Type" is "All".

(11) Button to increment the time range. It is not active if the "Type" is "All".

(12) Button to apply a low pass-filter.

(13) Cutoff frequency (Hz) of the low-pass filter.

(14) Button to apply a high pass-filter.

(15) Cutoff frequency (Hz) of the high-pass filter.

(16) Button to apply a notch filter.

(17) Cutoff frequencies (Hz) of the notch filter. You can write multiple frequencies, comma delimited.

(18) Clear all digital filters applied.

(19) Button to show the information on the applied digital filters.

(20) If you select "All", all of the time series of the specified day are displayed. If "Data number" is selected, the number of data shown in this window is controlled by the selection in (21). If "Data span" is selected, the time span is controlled by the selection in (22).

(21) The number of data shown in this window. This control is active only if "Type" is "Data number". If you change the number, "Type" is automatically changed to "Data number."

(22) The time span of the time series shown in this window. This control is active only if "Type" is "Data span". If you change the time span, "Type" is automatically changed to "Data span."

(23) Button to show the power spectra.

(24) Button to go to the windows for the response function estimation.

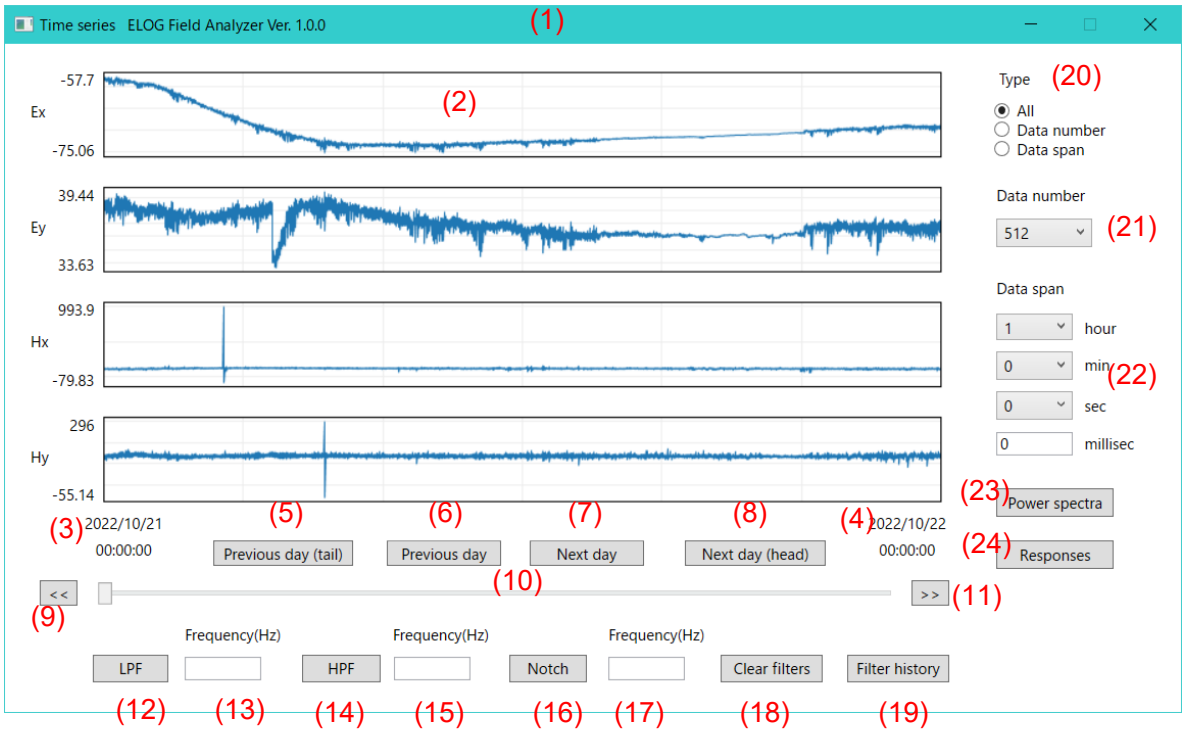

Figure 24: Time series window (in the case where the reference magnetic field is not read)

9.3 Applied Filter Window

When you press the “Filter history” button, the “Applied filter” window will be opened. In this window, the amplitude characteristics of the digital filters you applied are shown (characteristics of all the filters you applied are merged).

The information on the filters you applied is listed in the lower left panel.

You can change the range of the upper figure by pressing the “Change range” button after specifying the upper and lower bounds. If you press this button with a blank textbox. Upper and/or lower bounds are automatically determined.

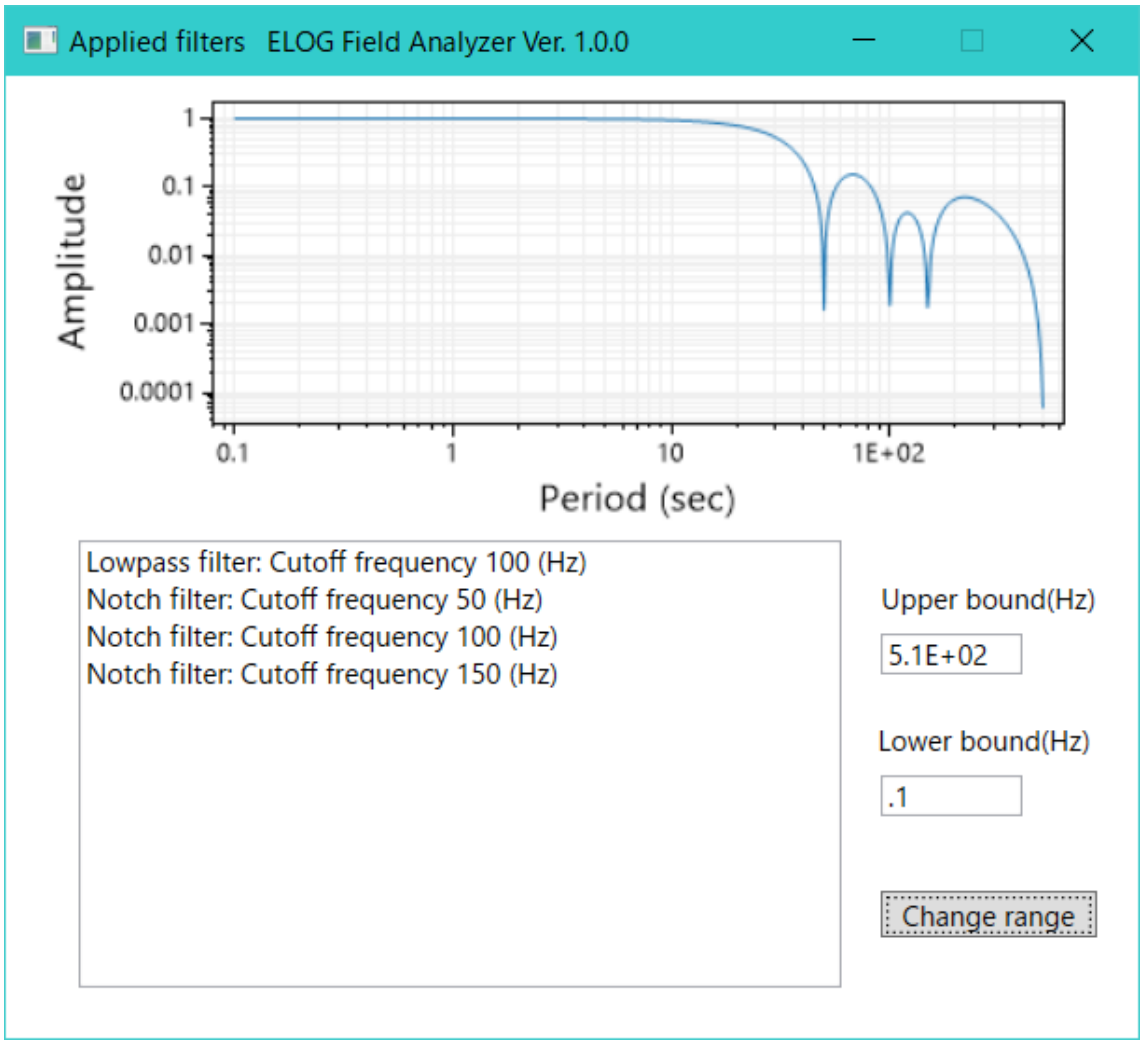

Figure 25: Applied filters window

9.4 Power Spectra Window

When you press the “Power spectra” button, the “Power spectra” window is opened. In this window, the power spectra of all channels are displayed.

Only the data of the times displayed in the “Time series” window are used for calculating the power spectra.

The explanation of the items on this window (marked in Figure 26) is written below.

EXPLANATION OF EACH ITEM

(1) The power spectrum of each channel is displayed. If you double-click the window, the power spectrum will be displayed in a new window, the size of which is changeable.

(2) The minimum frequency displayed.

(3) The maximum frequency displayed.

(4) If you check the box, the linear trend in the logarithmic axis is removed from each power spectrum. If you uncheck, the original power spectra are redisplayed.

(5) Lower limit of the frequencies to be displayed.

(6) Upper limit of the frequencies to be displayed.

(7) The button to change the range of the horizontal axes. If you press the button, the range of the frequency is bounded based on the selection in (6) and (7). If (6) and/or (7) are blank, the range is automatically determined.

(8) The frequency that the cursor pointed in the window is shown here.

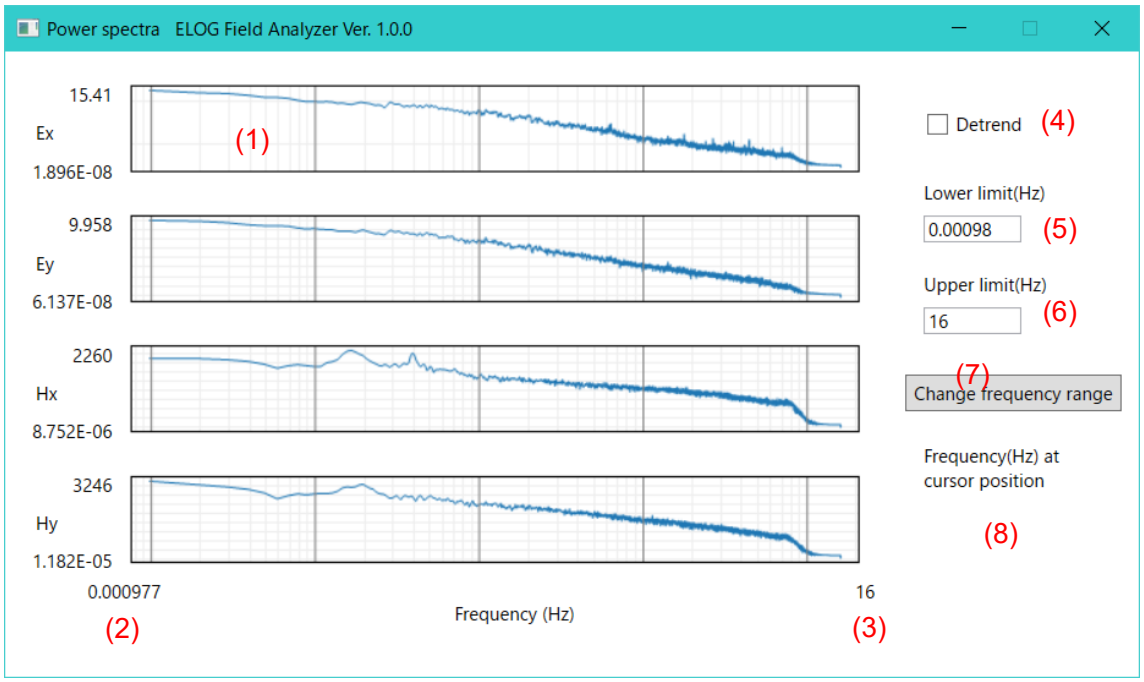

Figure 26: Power spectra window (in the case where the reference magnetic field is not read)

9.5 Response Function Estimation Window

When you press the “Reponses” button, the “Response function estimation” window is opened. In this window, you can select options in the estimation of the response functions, start the estimation, and plot the sounding curves of the estimated response functions.

Only the data of the times displayed in the “Time series” window are used for the response function estimation.

The explanation of the items on this window (marked in Figure 27) is written below.

EXPLANATION OF EACH ITEM

(1) Work folder. You need to select the work folder for the response function estimation.

(2) Dipole length for the N-S component of the electric field (unit: meter).

(3) Dipole length for the E-W component of the electric field (unit: meter).

(4) Measurement direction from the north (unit: degree). For example, the +x direction corresponds to the geomagnetic north in the measurement, and the declination around the station is 7 degrees to the west, you need to write -7 (degrees) in this textbox.

(5) Rotation angle to the coordinate system in which the response functions are estimated (unit: degree). For example, if you write 40 (degrees) in the textbox, the response functions are estimated in the coordinates system whose +x direction is N40°E.

(6) Coil calibration file for the Hx component. The file should follow Metronix's calibration file format.

(7) Coil calibration file for the Hy component. The file should follow Metronix's calibration file format.

(8) Calibration file for ELOG-DUAL.

(9) Folder in which the calibration files for loggers are stored.

(10) Estimation method. OLS means the ordinary least square. OLS can compute response functions most quickly. If you select "M-estimator" or "RRMS", outliers are down-weighted. The RRMS estimator is generally the most robust and most time-consuming. "RRMS" can be selected only when the remote magnetic field data are read

(11) If you check it, the ordinary prewhitening method is used, and the response functions are estimated at longer periods than when it is unchecked. This is because the Fourier transforms at the third and fourth frequencies are used if the prewhitenting is applied (because the prewhitening can suppress the spectral leakage), whereas the Fourier transforms at the eighth and twelfth fourth frequencies are used when no prewhitenting is applied.

(12) If you check this, the original time series data are downsampled.

(13) Rate of downsampling. For example, if you wrote 32 for 32 Hz sampling data, the original time series data are downsampled to 1 Hz sampling data.

(14) Button to make an input file of TRACMT. The input file is created in the work folder you specify in (1). When the input file is successfully made, a message appears at the bottom of the window.

(15) Button to open the created input file with a text editor. You can check and modify the input file by the text editor.

(16) Button to start TRACMT to estimate the response function. If you press the button, a command prompt launches, in which the message from TRACMT is

displayed.

(17) Button to plot the sounding curves of estimated response functions.

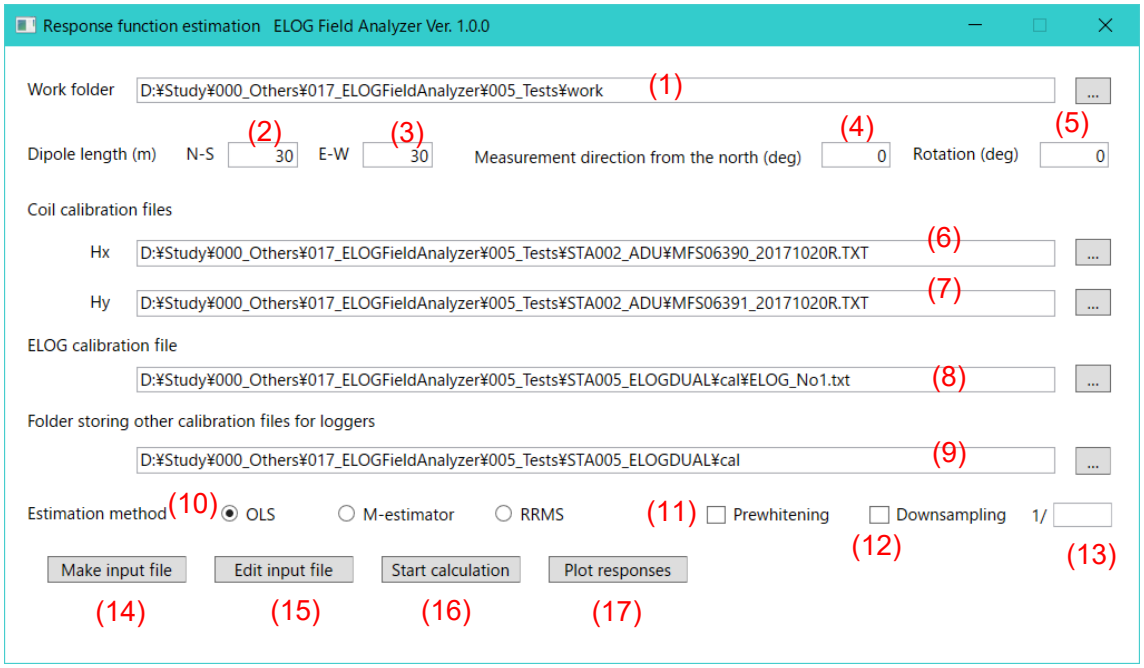

Figure 27: Response function estimation window

9.6 Apparent Resistivity and Phase Window

If you press the “Plot responses” button in the “Response function estimation” window after the calculation of TRACMT is finished, the “Apparent resistivity and phase” window is opened.

In this window, the squared coherence and the sounding curves of the apparent resistivity and phase are depicted.

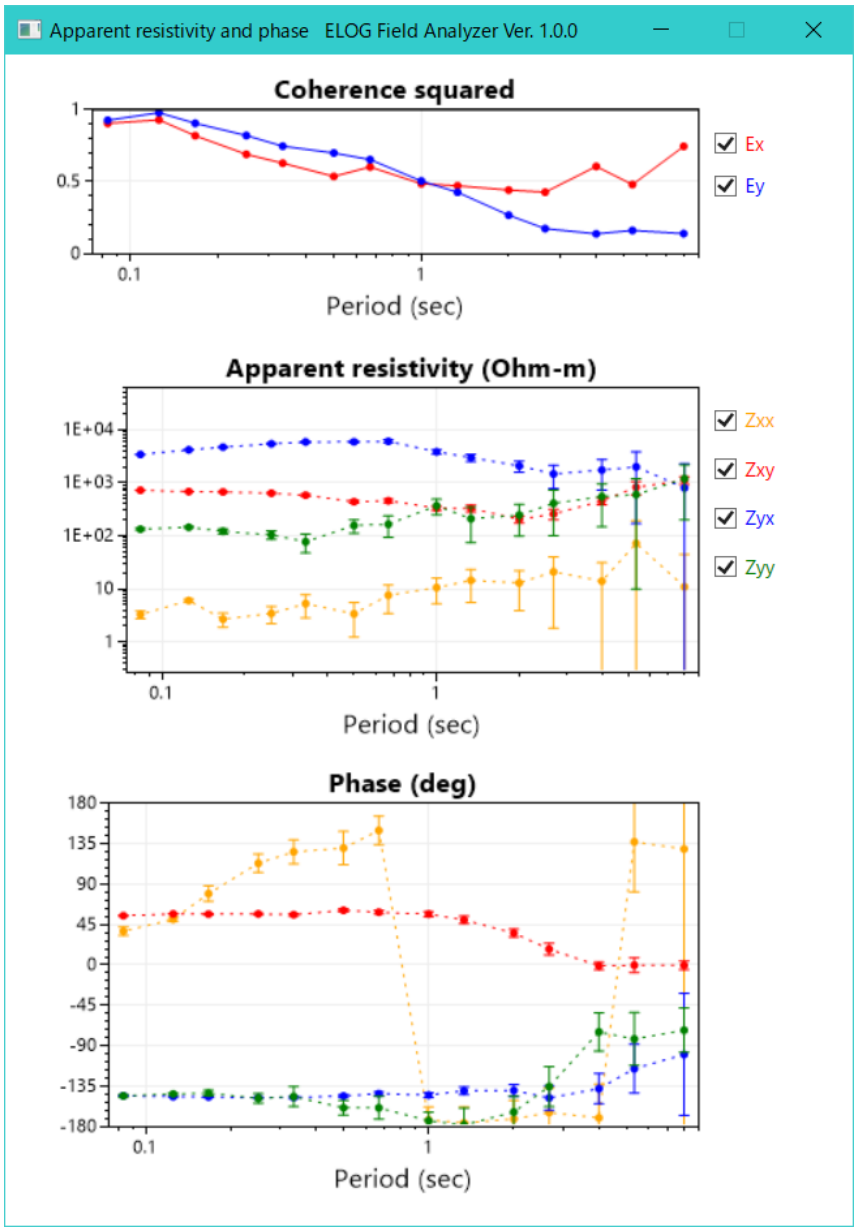

Figure 28: Apparent resistivity and phase window

10. Operation Explanation for ELOG-DUAL (PHX mode)

10.1 File Selection Window

Please select a folder where dat files of ELOG-DUAL are stored. This folder name must be the measurement day (YYYYMMDD).

You need to select the sampling frequency (15, 150, or 2400 Hz) by the radio buttons on the right side.

If you check the box "Magnetic field data," the horizontal components (H_x and H_y) of the magnetic field are read from dat files of an ELOG-MT station. These magnetic field data are used to estimate response functions.

If you check the box "Remote reference", remote reference magnetic field data (H_{rx} and H_{ry}) are read from dat files of another ELOG-MT station. This reference data are be used in the remote reference method in the response estimation.

CAUTION

The measurement times of all channels should be overlapped at least partly.

Please press the "Read files" button after you properly select sampling frequency and folder and file names.

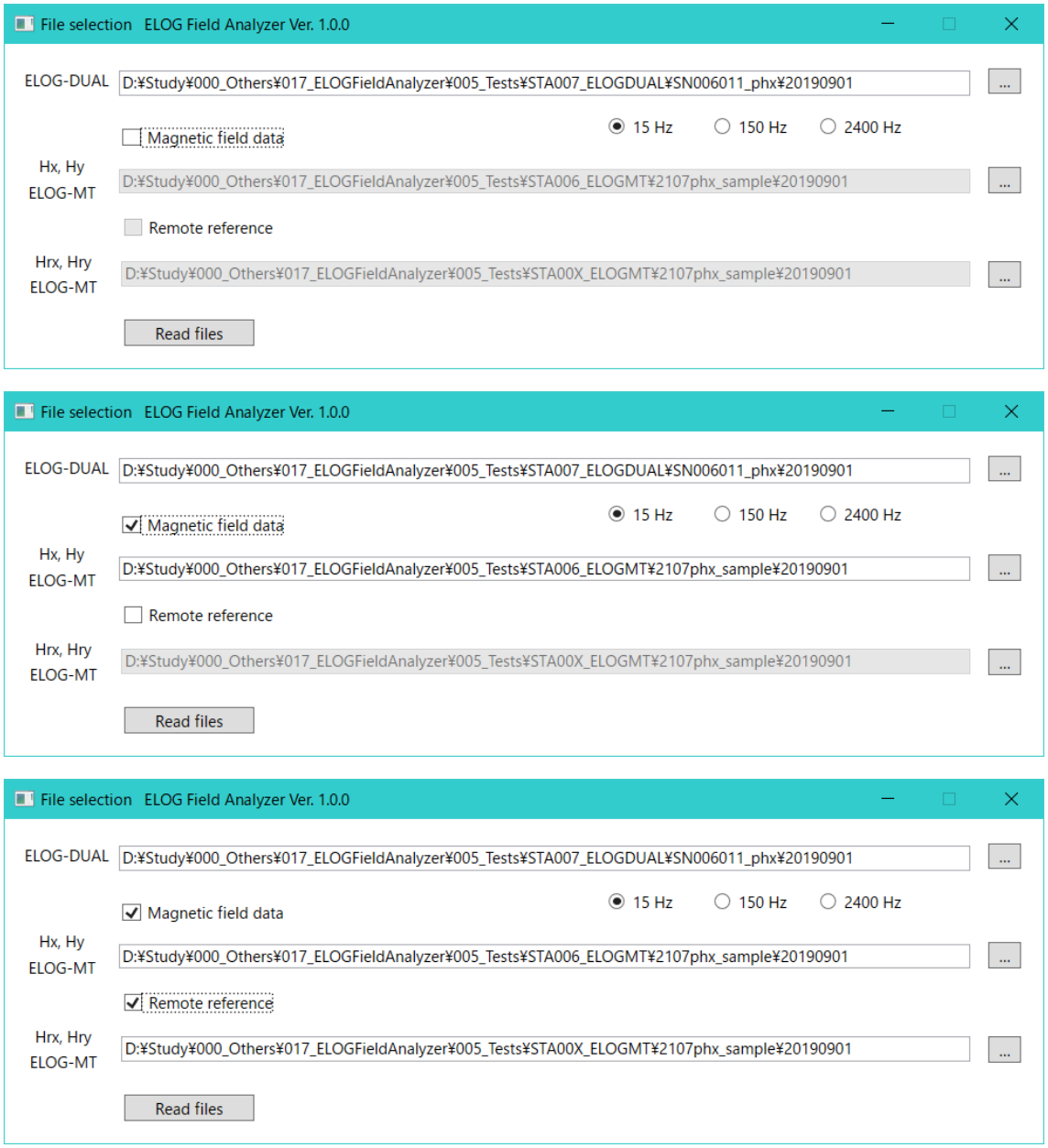

Figure 29: File selection window

10.2 Time Series Window

If dat files are appropriately read, time-series data are displayed.

The explanation of the items on this window (marked in Figure 30) is written below.

EXPLANATION OF EACH ITEM

(1) The time that the cursor pointed in the window is shown in the title bar.

(2) The time series of each channel is displayed. If you double-click the window, the time series will be displayed in a new window, the size of which is changeable.

(3) Star time of the time series displayed in the window.

(4) End time of the time series displayed in the window.

(5) Button to show the tail end of the time series of the previous day.

(6) Button to show the time series of the previous day at the same time range.

(7) Button to show the head of the time series of the next day.

(8) Button to show the time series of the next day at the same time range.

(9) Botton to decrement the time range. It is not active if the "Type" is "All".

(10) Slide bar to change the time range. It is not active if the "Type" is "All".

(11) Button to increment the time range. It is not active if the "Type" is "All".

(12) Button to apply a low-pass filter.

(13) Cutoff frequency (Hz) of the low-pass filter.

(14) Button to apply a high-pass filter.

(15) Cutoff frequency (Hz) of the high-pass filter.

(16) Button to apply a notch filter.

(17) Cutoff frequencies (Hz) of the notch filter. You can write multiple frequencies, comma delimited.

(18) Clear all digital filters applied.

(19) Button to show the information on the applied digital filters.

(20) If you select "All", all of the time series of the specified day are displayed. If "Data number" is selected, the number of data shown in this window is controlled by the selection in (21). If "Data span" is selected, the time span is controlled by the selection in (22).

(21) The number of data shown in this window. This control is active only if "Type" is "Data number". If you change the number, "Type" is automatically changed to "Data number."

(22) The time span of the time series shown in this window. This control is active only if "Type" is "Data span". If you change the time span, "Type" is automatically changed to "Data span."

(23) Button to show the power spectra.

(24) Button to go to the windows for the response function estimation.

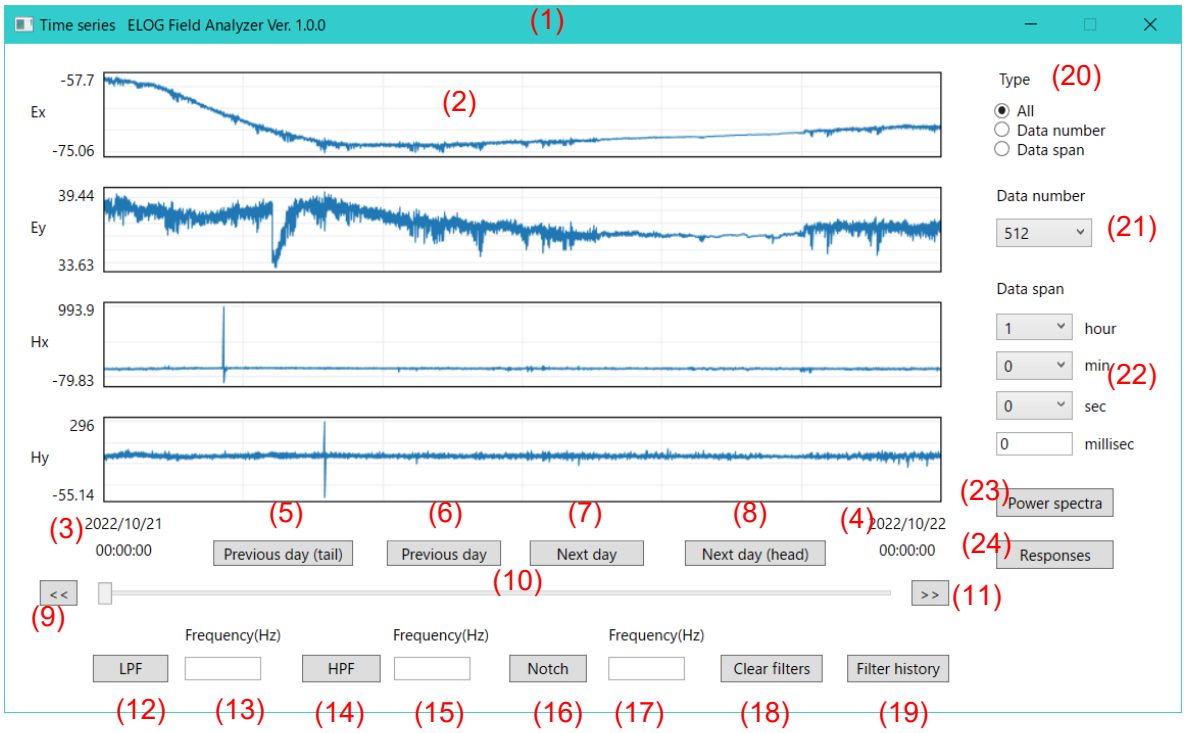

Figure 30: Time series window (in the case where the reference magnetic field is not read)

10.3 Applied Filter Window

When you press the “Filter history” button, the “Applied filter” window will be opened. In this window, the amplitude characteristics of the digital filters you applied are shown (characteristics of all the filters you applied are merged).

The information on the filters you applied is listed in the lower left panel.

You can change the range of the upper figure by pressing the “Change range” button after specifying the upper and lower bounds. If you press this button with a blank textbox. Upper and/or lower bounds are automatically determined.

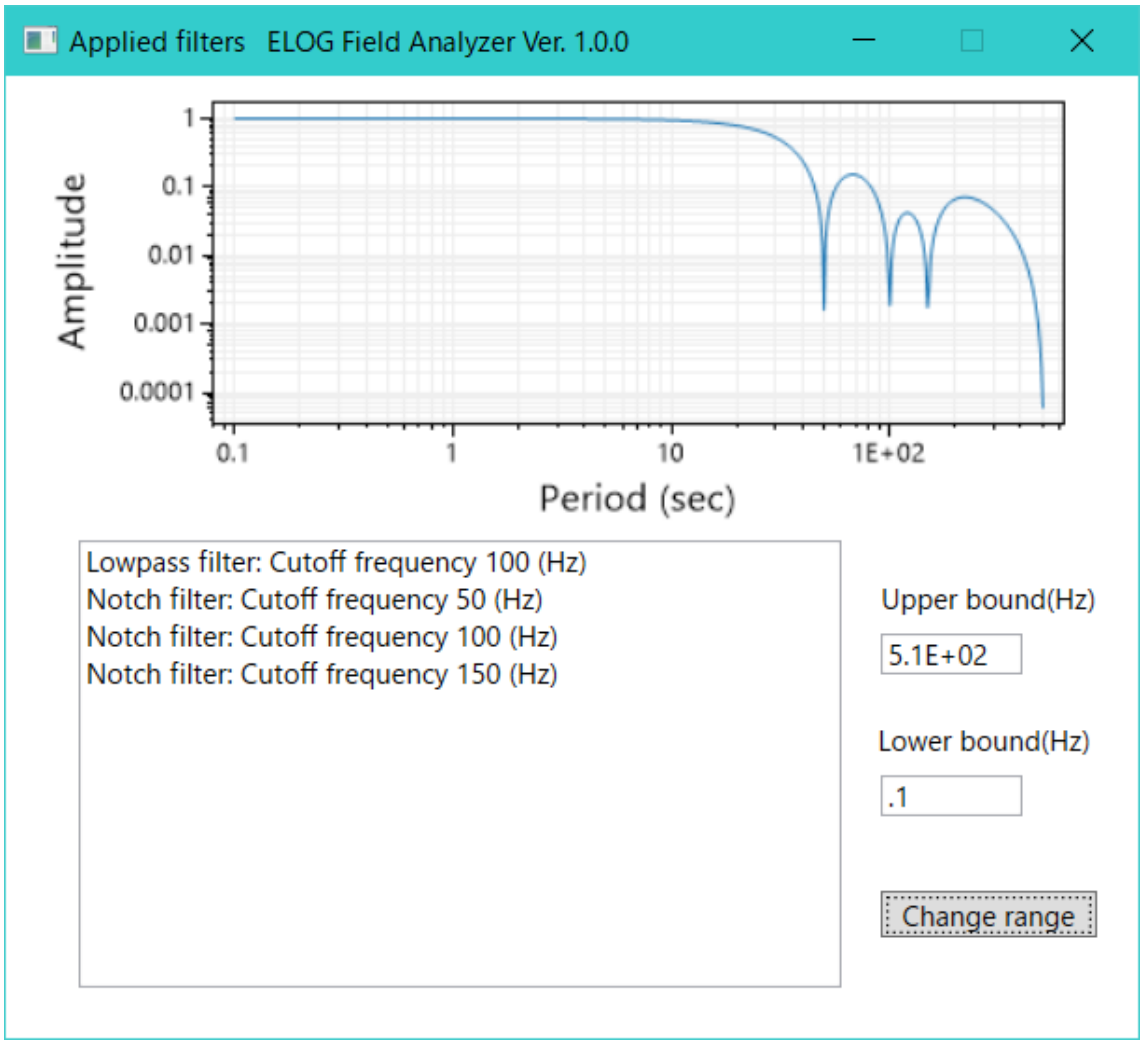

Figure 31: Applied filters window

10.4 Power Spectra Window

When you press the “Power spectra” button, the “Power spectra” window is opened. In this window, the power spectra of all channels are displayed.

Only the data of the times displayed in the “Time series” window are used for calculating the power spectra

The explanation of the items on this window, marked in Figure 32, is written below.

EXPLANATION OF EACH ITEM

(9) The power spectrum of each channel is displayed. If you double-click the window, the power spectrum will be displayed in a new window, the size of which is changeable.

(10) The minimum frequency displayed.

(11) The maximum frequency displayed.

(12) If you check the box, the linear trend in the logarithmic axis is removed from each power spectrum. If you uncheck, the original power spectra are redisplayed.

(13) Lower limit of the frequencies to be displayed.

(14) Upper limit of the frequencies to be displayed.

(15) The button to change the range of the horizontal axes. If you press the button, the range of the frequency is bounded based on the selection in (6) and (7). If (6) and/or (7) are blank, the range is automatically determined.

(16) The frequency that the cursor pointed in the window is shown here.

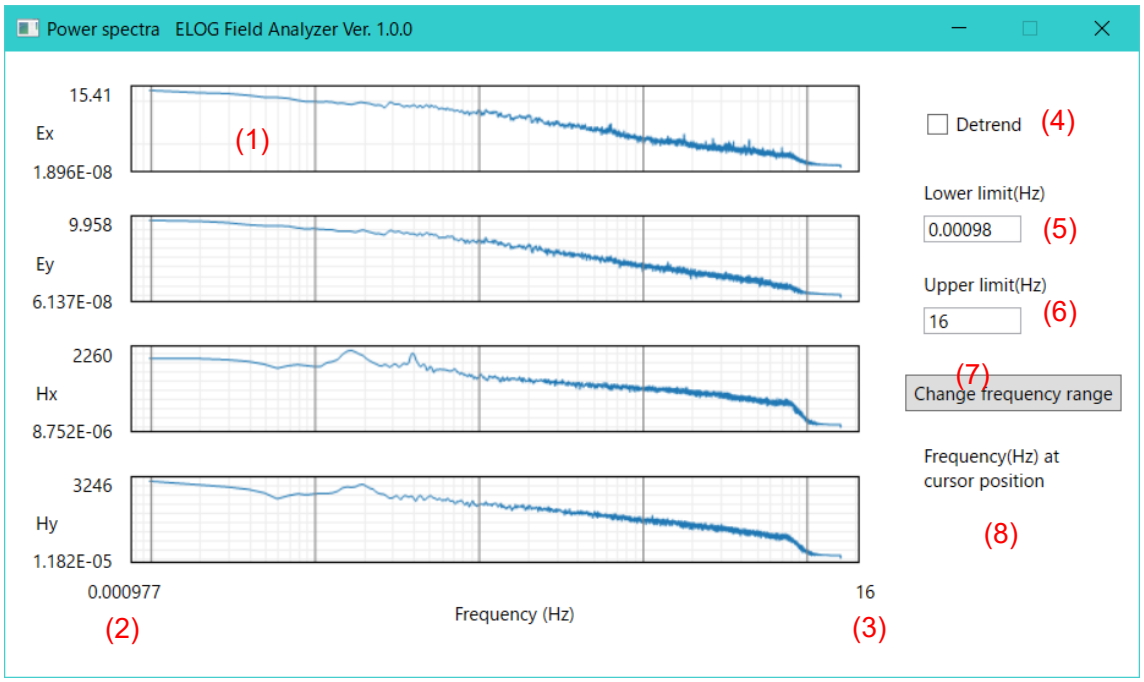

Figure 32: Power spectra window (in the case where the reference magnetic field is not read)

10.5 Response Function Estimation Window

When you press the “Reponses” button, the “Response function estimation” window will be opened. In this window, you can select options in the estimation of the response functions, start the estimation, and plot the sounding curves of the estimated response functions.

Only the data of the times displayed in the “Time series” window are used for the response function estimation

The explanation of the items on this window (marked in Figure 33) is written below.

EXPLANATION OF EACH ITEM

(1) Work folder. You need to select the work folder for the response function estimation.

(2) Dipole length for the N-S component of the electric field (unit: meter).

(3) Dipole length for the E-W component of the electric field (unit: meter).

(4) Measurement direction from the north (unit: degree). For example, the +x direction corresponds to the geomagnetic north in the measurement, and the declination around the station is 7 degrees to the west, you need to write -7 (degrees) in this textbox.

(5) Rotation angle to the coordinate system in which the response functions are estimated (unit: degree). For example, if you write 40 (degrees) in the textbox, the response functions are estimated in the coordinates system whose +x direction is N40°E.

(6) Coil calibration file for the Hx component. The file should follow the format described below.

(7) Coil calibration file for the Hy component. The file should follow the format described below.

(8) OLS means the ordinary least square and can compute response functions most quickly. If you select "M-estimator" or "RRMS", outliers are down-weighted. The RRMS estimator is generally the most robust and most time-consuming. "RRMS" can be selected only when the remote magnetic field data are read

(9) If you check this, the ordinary prewhitening method is used, and the response functions are estimated at longer periods than when it is unchecked. This is because the Fourier transforms at the third and fourth frequencies are used if the prewhitenting is applied (because the prewhitening can suppress the spectral leakage), whereas the Fourier transforms at the eighth and twelfth fourth frequencies are used when no prewhitenting is applied.

(10) If you check it, the original time series data are downsampled.

(11) Rate of downsampling. For example, if you wrote 32 for 32 Hz sampling data, the original time series data are downsampled to 1 Hz sampling data.

(12) Button to make an input file of TRACMT. The input file is created in the work folder you specify in (1). When the input file is successfully made, a message appears at the bottom of the window.

(13) Button to open the created input file with a text editor. You can check and modify the input file by the text editor.

(14) Button to start the response function estimation by TRACMT. After you press the button, a command prompt launches, in which the message from TRACMT is displayed.

(15) Button to plot the sounding curves of estimated response functions.

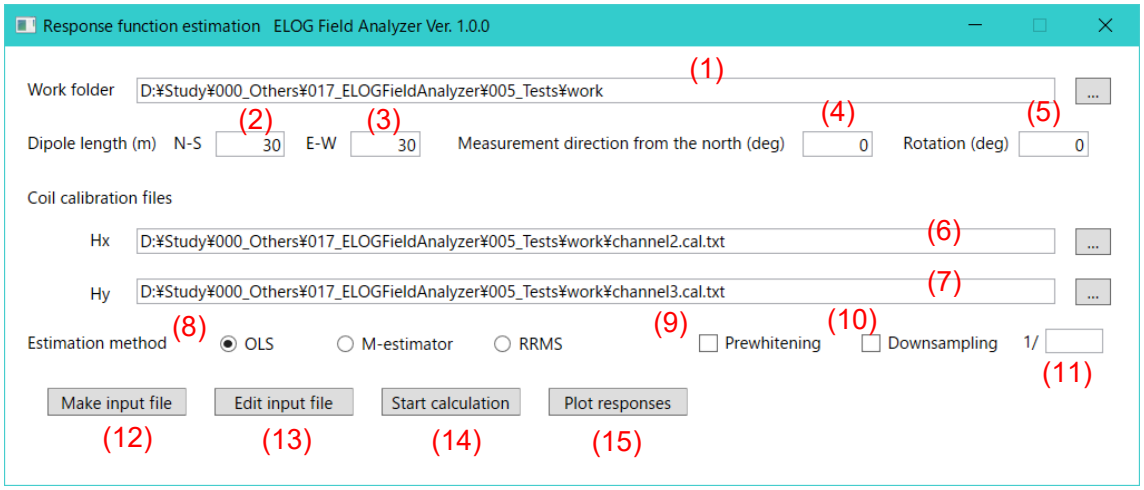

Figure 33: Response function estimation window

FORMAT OF CALIBRATION FILES

Coil calibration files for the magnetic field components should follow the following format.

Instrumental characteristics are corrected in the frequency domain by multiplying A and $C(f)$ as

$$A \times C(f_1)H_x(f_1) \rightarrow H_x(f_1)$$

$$A \times C(f_2)H_x(f_2) \rightarrow H_x(f_2)$$

...

The calibration function is interpolated for the frequency at which $C(f)$ is not specified.

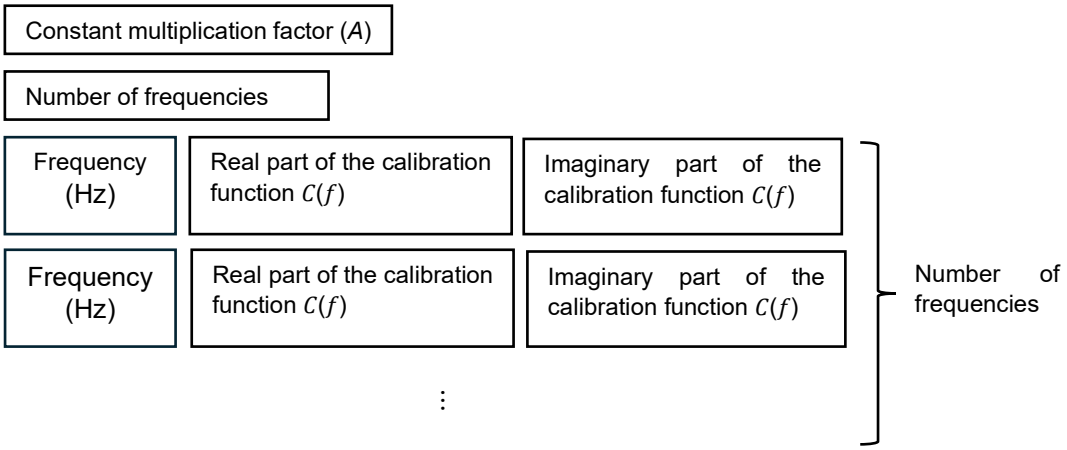

Figure 34: Format of calibration file of TRACMT

10.6 Apparent Resistivity and Phase Window

If you press the "Plot responses" button in the "Response function estimation" window after the calculation of TRACMT is finished, the "Apparent resistivity and phase" window is opened.

In this window, the squared coherence and the sounding curves of the apparent resistivity and phase are depicted

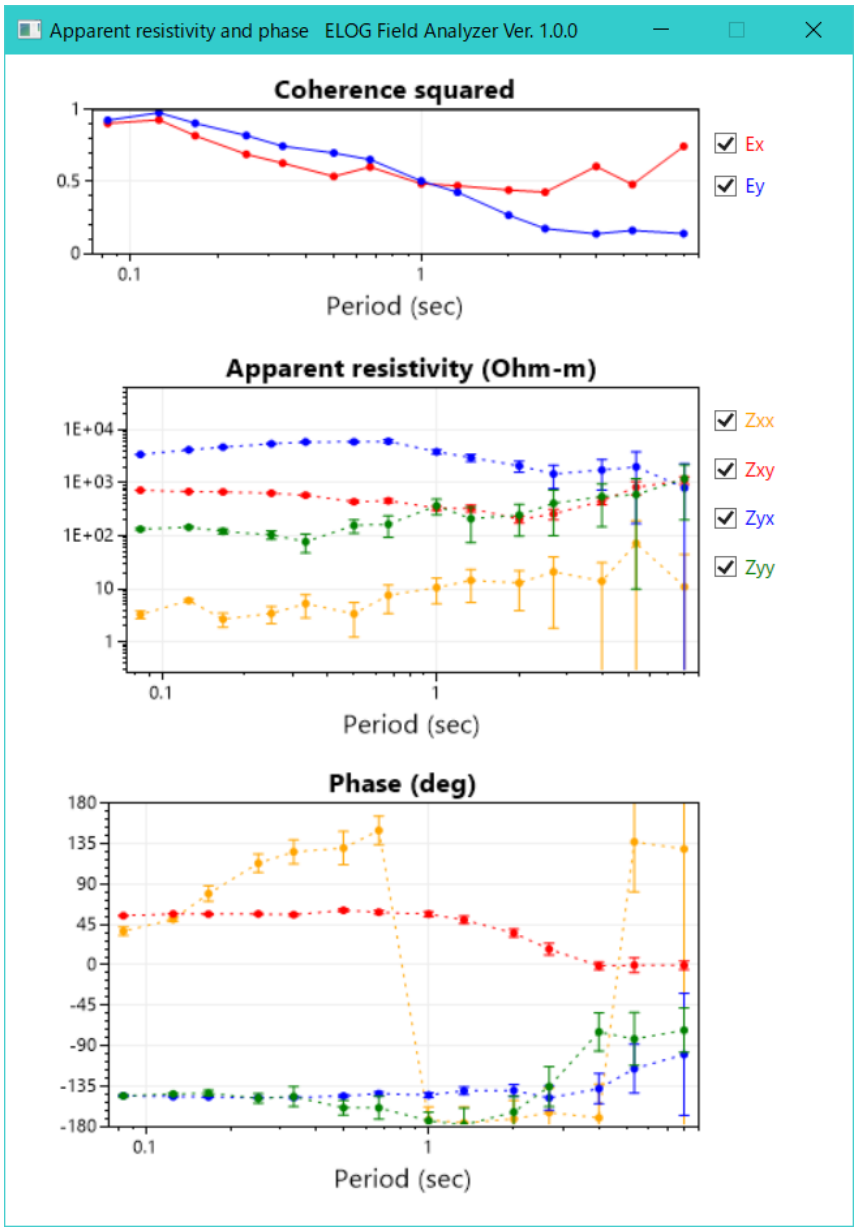

Figure 35: Apparent resistivity and phase window

11. Operation Explanation for ELOG1K + ELOG-MT

Operation for ELOG1K + ELOG-MT is similar to that for ELOG-DUAL (ADU mode) + ELOG-MT. Please read Section 8.

12. Operation Explanation for ELOG1K + ATS

Operation for ELOG1K + ATS is similar to that for ELOG-DUAL (ADU mode) + ATS. Please read Section 9.

13. Q & A

In preparation.

14. Change History

Ver 1.0.0

Initial release.