COMPASS – Frequency-Domain

Interactive Weak and Strong Motion Data Processing Software

Rev 2008.11.19 Document Rev C

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This COMPASS manual provides a detailed overview for using the Frequency-Domain menu of the COMPASS software. It covers signal processing in the frequency-domain.

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Revision History:

Revision	Date	Reason for change	Pages
C	**2008.12.14**	**New version 2008Nov19**	**All**
B	**2008.07.08**	**Updated for COMPASS**	**All**
A	**2007.05.05**	**Update for REF TEK SM**	**All**
0.1	**2007.02.23**	**Initial Draft**	**All**

Notation Conventions

The following notation conventions are used throughout REF TEK documentation:

Notation	Description
ASCII	Indicates the entry conforms to the American Standard Code for Information Interchange definition of character (text) information.
Binary	Indicates the entry is a raw, numeric value.
Hex	Indicates hexadecimal notation. This is used with both ASCII characters (0 – 9, A – F) and numeric values.
BCD	Indicates the entry is a numeric value where each four bits represents a decimal digit.
FPn	Indicates the entry is the ASCII representation of a floating-point number with n places following the decimal point.
<n>	Indicates a single 8-bit byte. When the contents are numeric, it indicates a hexadecimal numeric value; i.e. <84> represents hexadecimal 84 (132 decimal). When the contents are capital letters, it represents a named ASCII control character; i.e. <SP> represents a space character, <CR> represents a carriage return character and <LF> represents a line feed character.
MSB	Most Significant Byte of a multi-byte value.
MSbit	Most Significant Bit of a binary number.
LSB	Least Significant Byte of a multi-byte value.
LSbit	Least Significant Bit (bit 0) of a binary number.
YYYY	Year as a 4-digit number
DDD	Day of year
HH	Hour of day in 24-hour format
MM	Minutes of hour
SS	Seconds of minute
TTT	Thousandths of a second (milliseconds)
IIII	Unit ID number

n, nS	nano, nanoSecond; 10-9 = 0.000000001
u, uS	micro, microSecond; 10-6 = 0.000001
m, mS	milli, milliSecond; 10-3 = 0.001
K, KHz	Kilo, KiloHertz; 103 = 1,000
M, MHz	Mega, MegaHertz; 106 = 1,000,000
G, GHz	Giga, GigaHertz; 109 = 1,000,000,000
Kb, KB	Kilobit, KiloByte; 210 = 1,024
Mb, MB	Megabit, MegaByte; 220 = 1,048,576
Gb, GB	Gigabit, GigaByte; 230 = 1,073,741,824

Related Manuals:

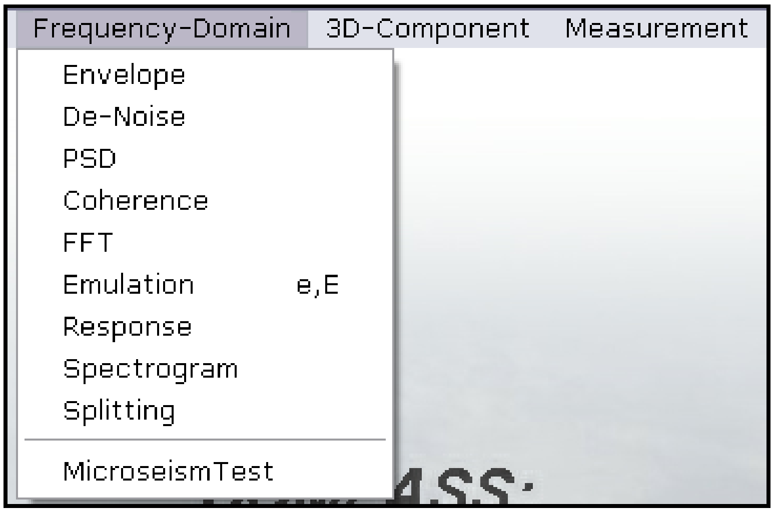
130-SMA System Documents	Number	PDF file
130-SMA Startup (Command Line)	Doc-SMA-Ops	130SMA_startup.pdf
Data Utilities Users Guide	Doc-Datautils	130_utilities.pdf
130-SMA Command Interface	**Number**	**PDF file**
130 Cmd Line - Theory of Operations	Doc-CmdL-Theory	130_CLtheory.pdf
130 Cmd Line - Release Notes	Doc-CmdL-Release	130_CLRN.pdf
130 Cmd Line - Reference	Doc-CmdL-Ref	130_CLcmd.pdf
130 Cmd Line - Recording Format	Doc-CmdL-Record	130_CLrecord.pdf
130-SM GUI Users Guide	Doc-130-SMGui	RT130SM.pdf
Optional Manuals	**Number**	**PDF file**
SNDP Installation and Users Guide	Doc-SNDP-User	SNDPUser.pdf
SNDP Reference Guide	Doc-SNDP-Reference	SNDPRef.pdf
RTCC Command / Control Users Guide	Doc-RTCC	RTCC.pdf
RT_Display Users Guide	Doc-RTD	RTDisplay.pdf
RT_View Users Guide	Doc-RTView	RTView.pdf
RTPMonitor Installation and Users Guide	Doc-RTPM	RTPM.pdf
RTPD Installation and Users Guide	Doc-RTPD	RTPD.pdf
RTP Protocol	Doc-RTProtocol	RTProtocol.pdf
Accelerometers		
131A-02/3 3G Triaxial Accelerometer	Doc-131A-03/2	131A023.pdf
131A-02/2 3G Triaxial Accelerometer	Doc-131A-02/2	131A022.pdf
131A-01/3 4G Triaxial Accelerometer	Doc-131B-01/3	131B013.pdf
131B-01/1 4G Unixial Accelerometer	Doc-131B-01/1	131B011.pdf

Software Version:

Current software and documentation is available on our web site. Some early units may require hardware modifications to use the latest software. Contact REF TEK if you have any queries on the compatibility of your unit(s) and the current software release.

About this manual:

This COMPASS Technical Reference manual provides a detailed overview of using the Frequency-Domain menu of the COMPASS software. It covers the following broad operational topics:



- Envelope
- De-Noise
- PSD
- Coherence
- FFT
- Emulation
- Response
- Spectrogram
- Splitting
- Microseism Test

REF TEK Support and update notifications

As a valued user of REF TEK equipment we would like to provide the best support possible by keeping you up to date with our product updates.

If you would like to be notified of any REF TEK product updates please spend a couple of minutes to register with the REF TEK customer support team.

To register, enter your company information through the Register link on our website at http://support.rteftek.com **.**

Our support team will send you a unique Username and Password allowing secured access to all product documentation and software sold to your company.

Once we register your contact we will only send necessary notifications via email. The same notifications will be shown on our website http://support.reftek.com **notifications page**

Thanks,

Your REF TEK support team

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REF TEK

5 Frequency-Domain

5.1 Frequency-Domain Menu

The **Frequency-Domain** menu is used for signal processing in the frequency domain.

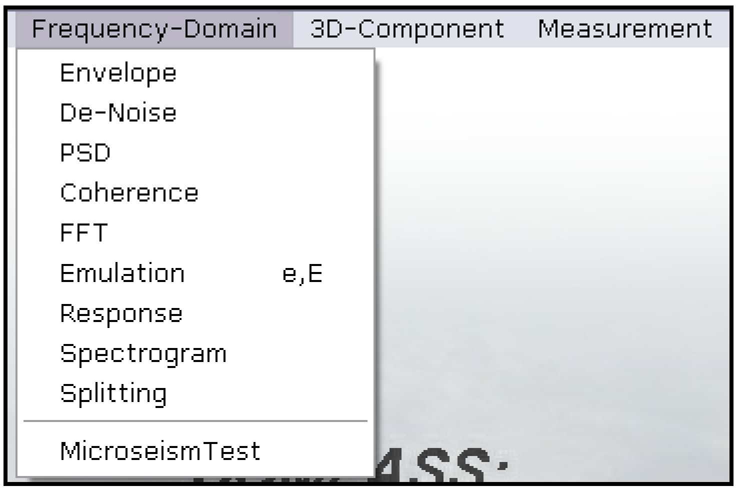


Figure 5-1 Frequency-Domain

5.2 Envelope

The **Envelope** command is used in computing the envelope of the signal in a time domain using the detector method.

5.2.1 Example of envelope computation

- The original signal (top)
- It's envelope (bottom)

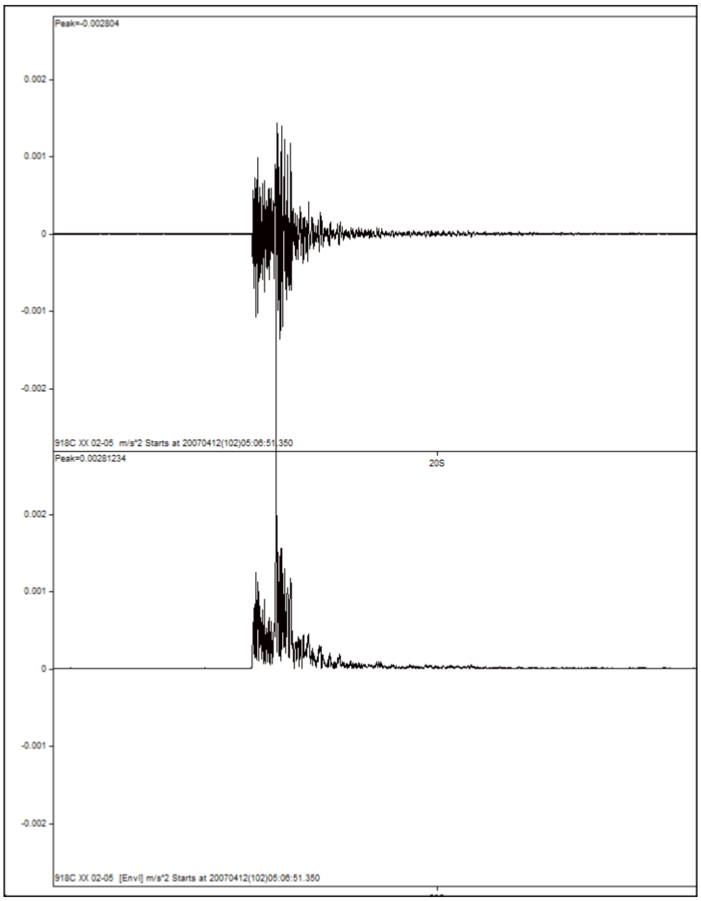
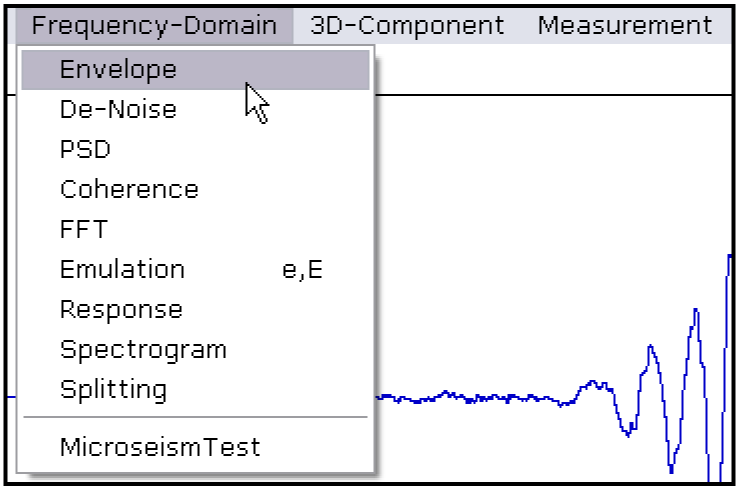


Figure 5-2 Envelope

5.2.2 To apply an envelope:

1. Select the **Envelope** command from the **Frequency-Domain** pull-down menu.



2. The envelope command results display.

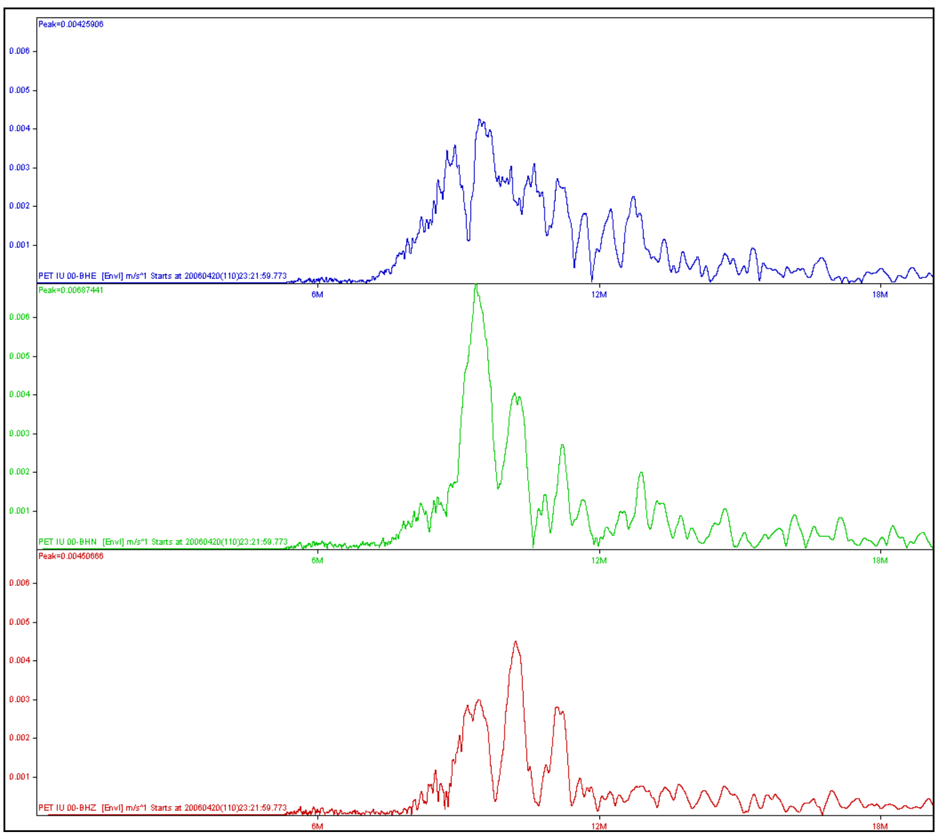
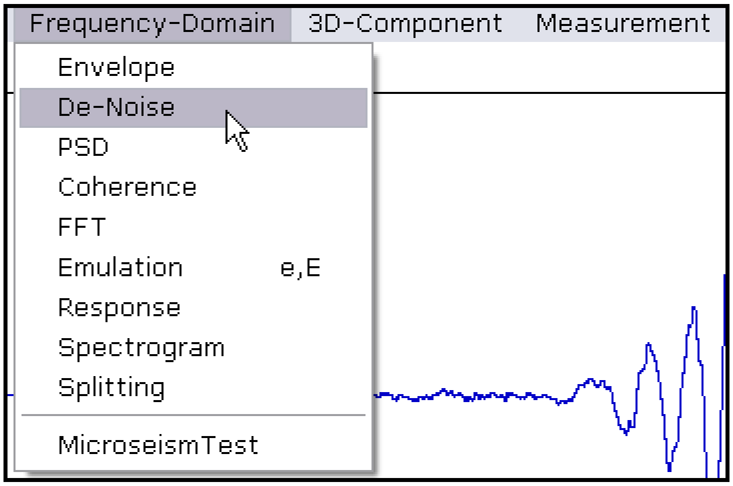


Figure 5-3 Envelope

5.3 De-Noise

The **De-Noise** command is used to apply a De-noise filter to the data stored in an array

1. Select the **De-Noise** command from the **Frequency-Domain** menu.



2. To apply the De-Noise filter click the vertical mouse cursor two times with the left mouse button (T1<T2).

   (T1 and T2 time clicks should contain the part of the ground noise without signals).

3. Click the left mouse button an additional two times (T3<T4).

   (T3 and T4 time clicks should contain the part of the ground noise with useful signal).

The signal for all channels on the display will be modified as shown on the picture.

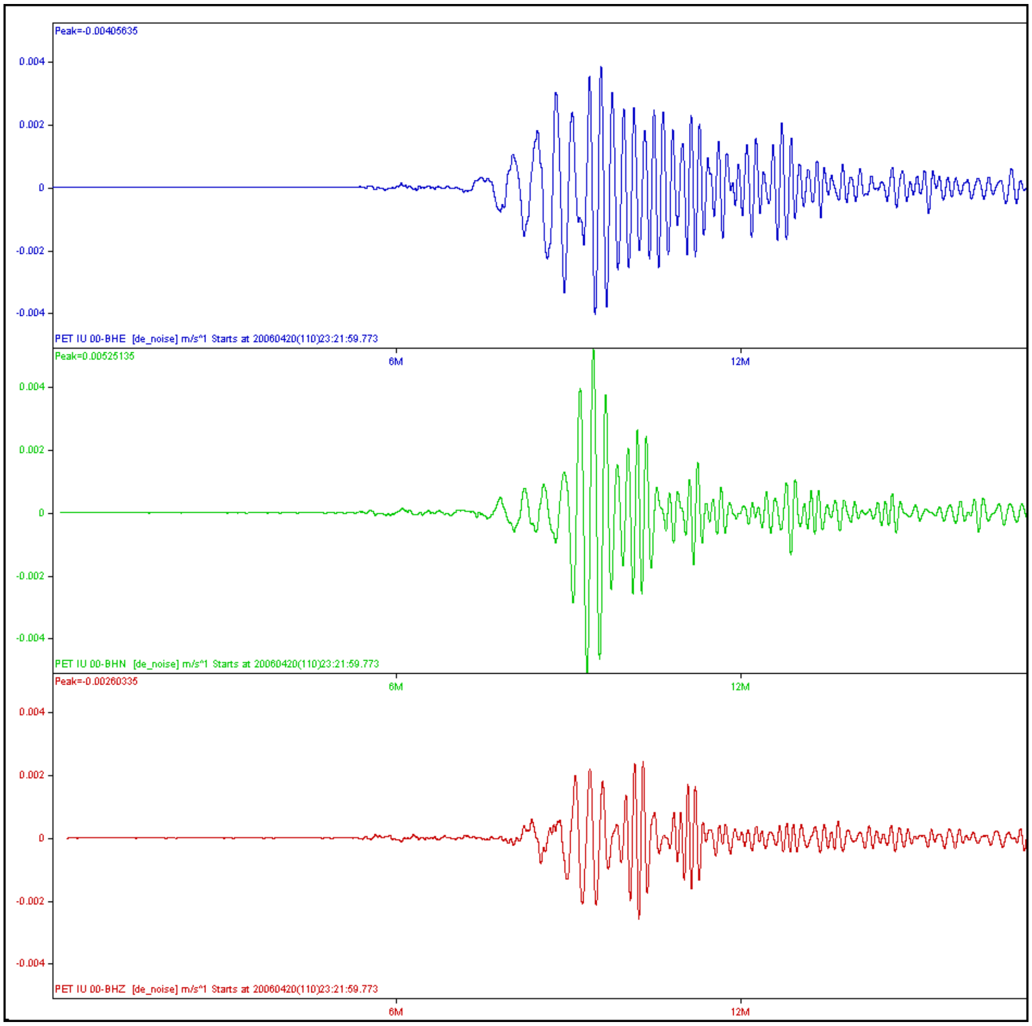


Figure 5-4 De-Noise Example

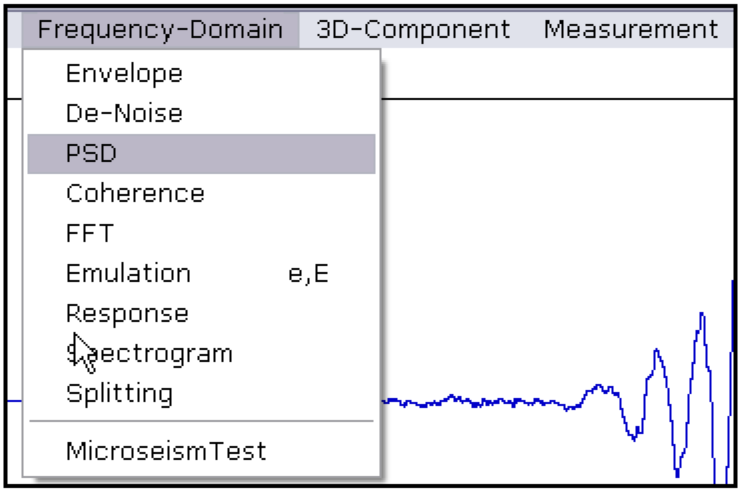
5.4 PSD

The **PSD** command does Power Spectrum Density using an options dialog box to specify:

- Clip limits:
  - Adjust plot axes range (Hz Min) (Hz Max)
  - Adjust X-Axes frequency limits in Hz (DB Min) (Db Max)
- Check box options:
  - Smooth-apply smoothing to PSD plot
  - Low, High noise model
  - Add the Peterson's noise model to the PSD
  - Plot Instrument Correction
  - Correct the PSD plot for instrument transfer function

5.4.1 To apply an envelope:

1. Select the **PSD** command from the **Frequency-Domain** pull-down menu.



2. The display opens with the options dialog box.
3. Enter the **Clip Limits** to adjust plot axes range (HZ Min) and (HZ Max) value.
4. Enter the X-Axes frequency limits in hz (Db Min) and (Db Max).
5. Approve the options with the **OK** button.

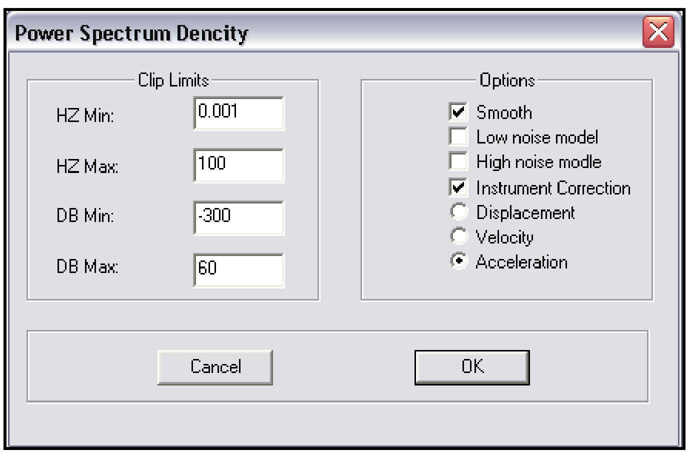


Figure 5-5 Power Spectrum Density Options

The screen redraws to show the effects of the options.

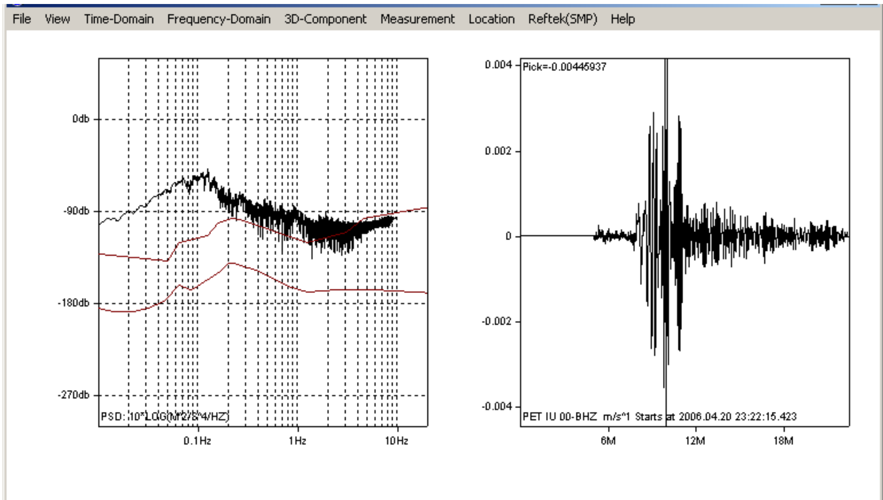


Figure 5-6 PSD Example

5.5 Coherence

To estimate coherent noise between two similar channels.

1. Select the **Coherence** command from the **Frequency-Domain** pull-down menu.

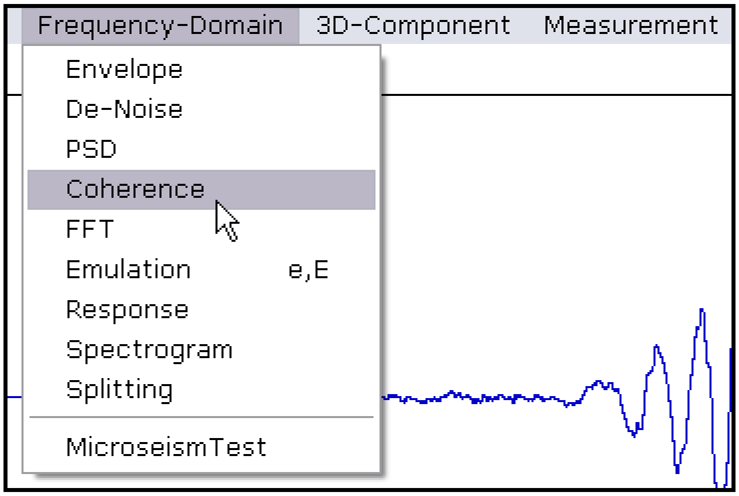


Figure 5-7 Coherence

2. An option box opens to select the pair of channels from the drop-down list.
3. Enter the plot option and select the **OK** button to accept the parameters.

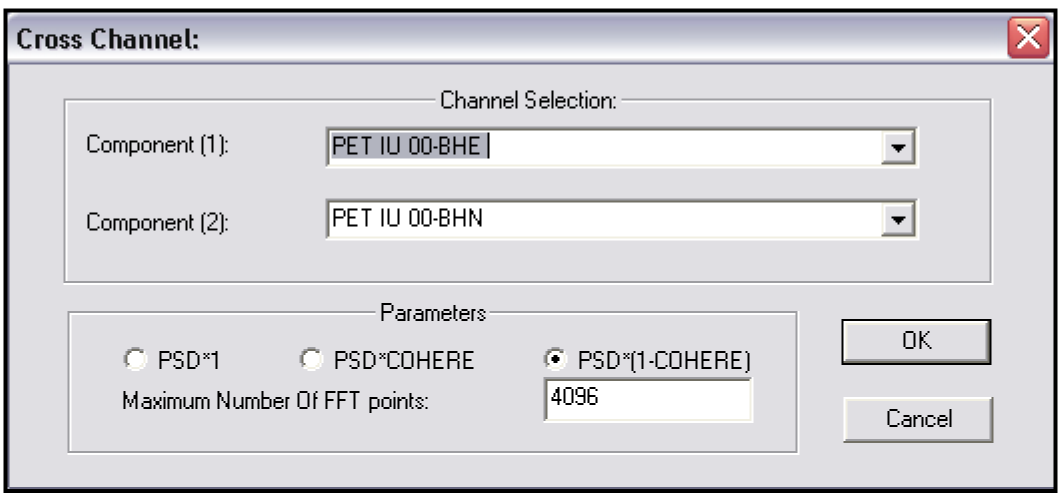


Figure 5-8 Cross Channel Parameters

4. Enter the Clip Limits.
5. Check the required options.
6. Select the **OK** button to process the comparison.

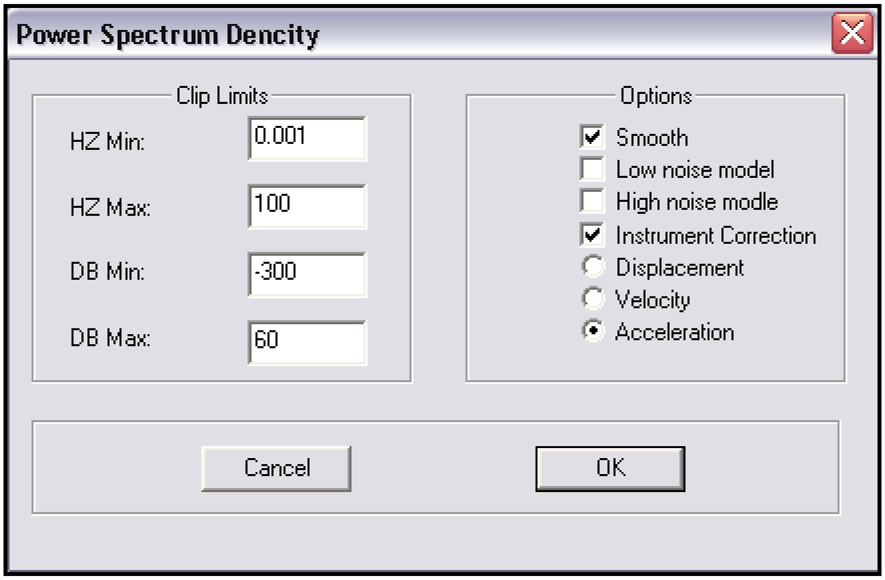


Figure 5-9 PSD

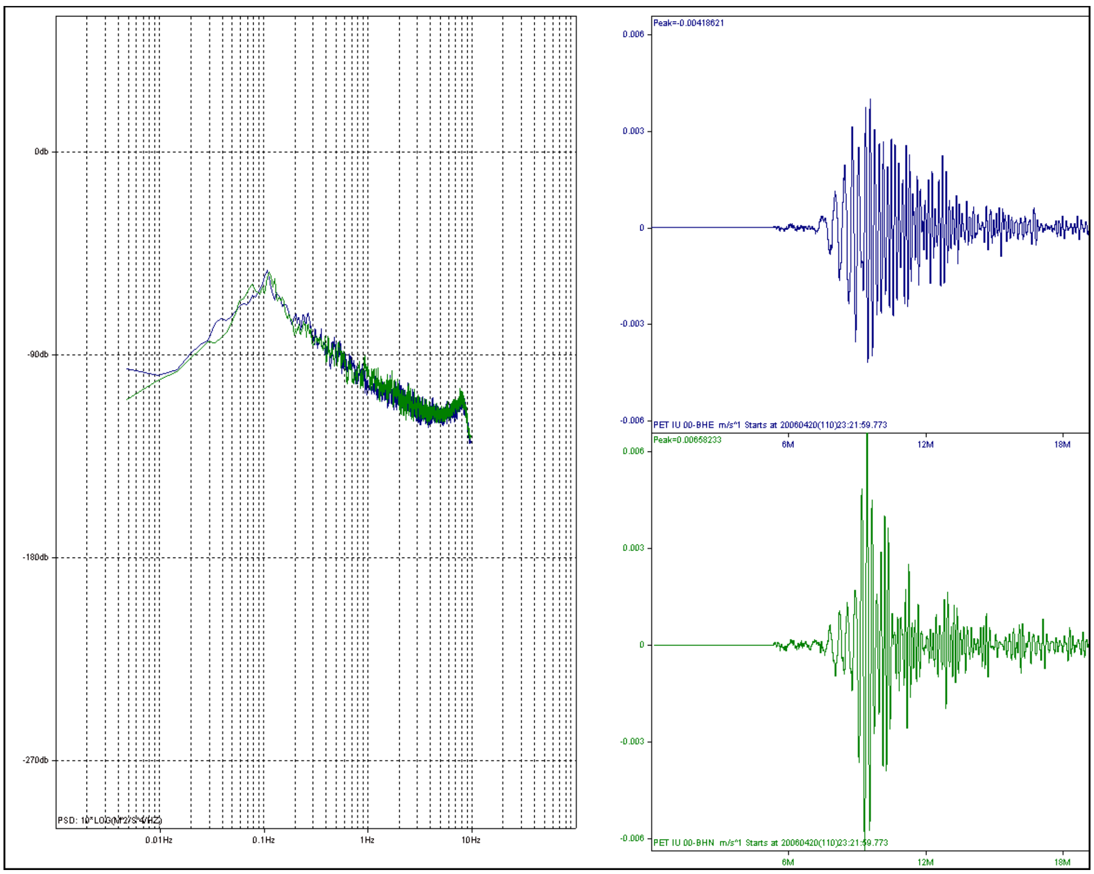


Figure 5-10 Coherence

5.6 FFT

To apply an FFT filter:

1. Select the **FFT** command from the **Frequency-Domain** pull-down menu.

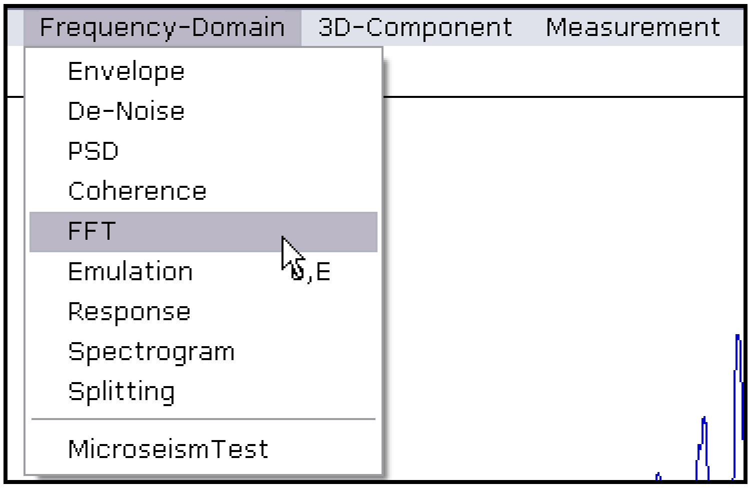


Figure 5-11 FFT

2. Fill in the filter options for Axes values.
3. Select the **OK** button to approve the options.

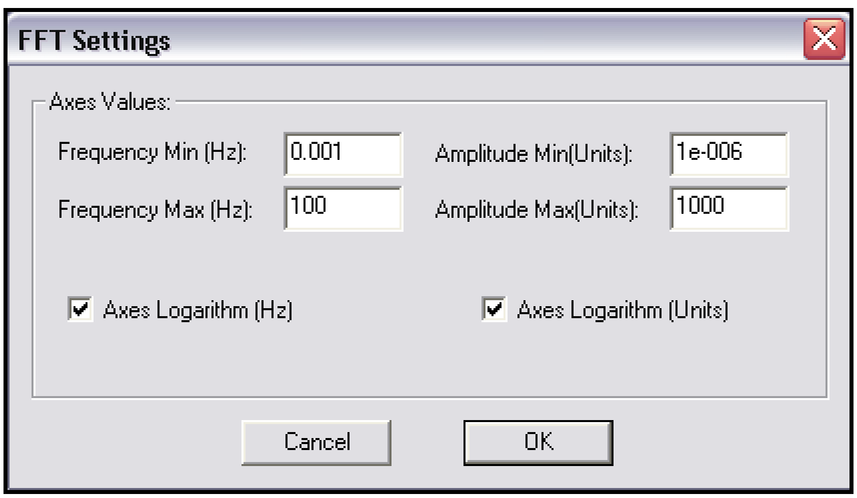


Figure 5-12 FFT Options

4. The display redraws to show the filter results.

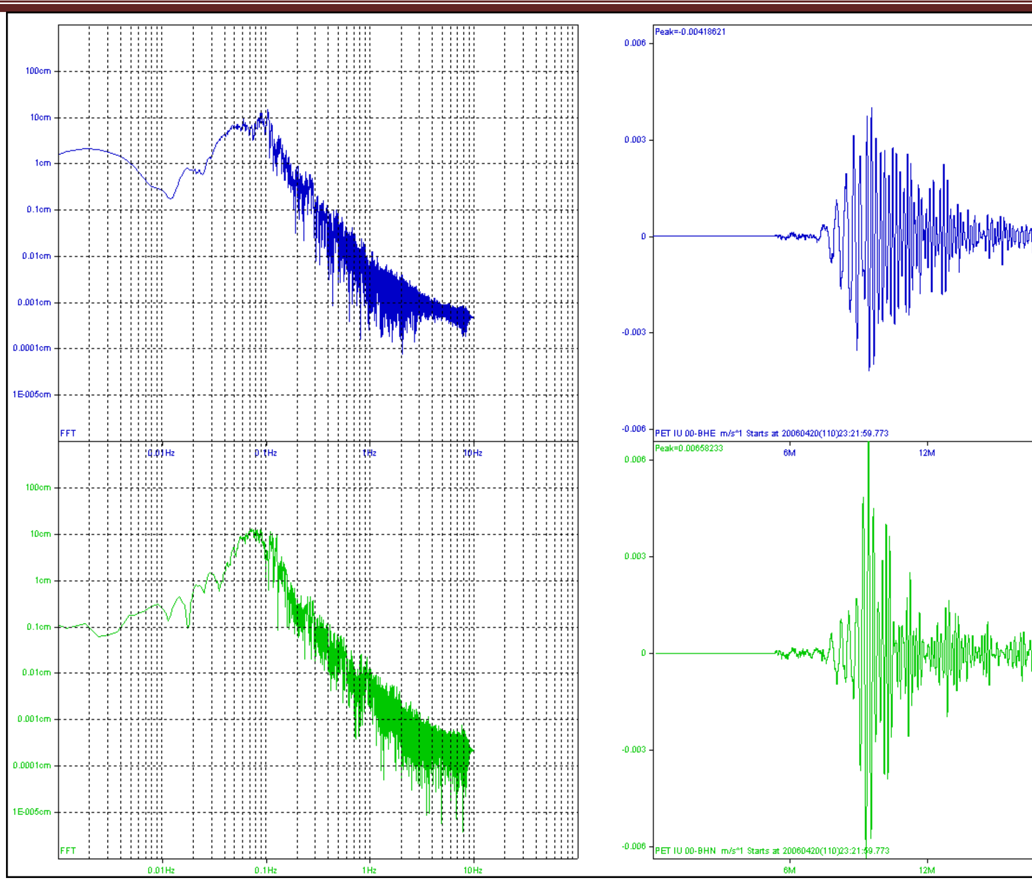


Figure 5-13 FFT Results

Note: It is possible to return to the original traces by selecting the Select Channels command under the View menu and selecting the same (highlighted) traces.

5.6.1 An example FFT

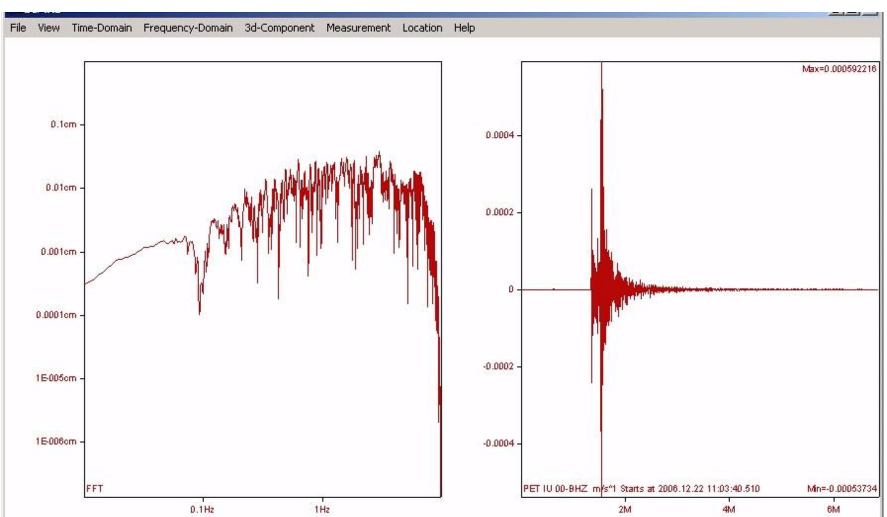


Figure 5-14 FFT Example

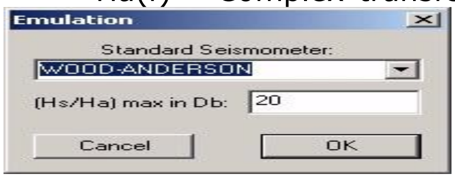
5.7 Emulation

Emulation of standard seismometer types and real ground motions are defined in the RESPONSE/emulation file.

Note: To prevent increasing of unwanted noise at an out-of-band frequency - use an appropriate Hs/Ha Db ratio.

Emulation is computed in the frequency - domain, where

- Hs(f)= Complex-transfer function of the Standard Instrument
- Ha(f) = Complex-transfer function of the Original Recorder



Example Seismometers: from top - to bottom:

- Broad Band STS-1 VBB Seismometer record
- Short Period Geotech GS-13 Seismometer record
- Accelerometer Kinemetrics FBA-23 Low-Gain Sensor
- Emulated WOOD-ANDERSON seismometer record from STS-1
- Emulated WOOD-ANDERSON seismometer record from GS-13
- Emulated WOOD-ANDERSON seismometer record from FBA-23

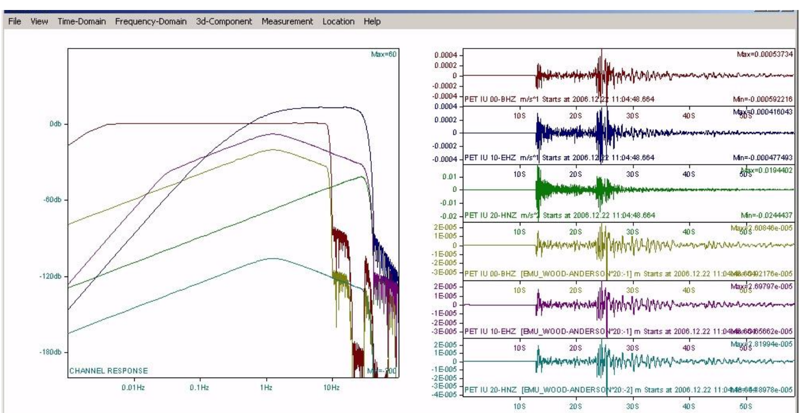


Figure 5-15 Emulation

5.7.1 To emulate a seismometer:

1. Select the **Emulation** command.

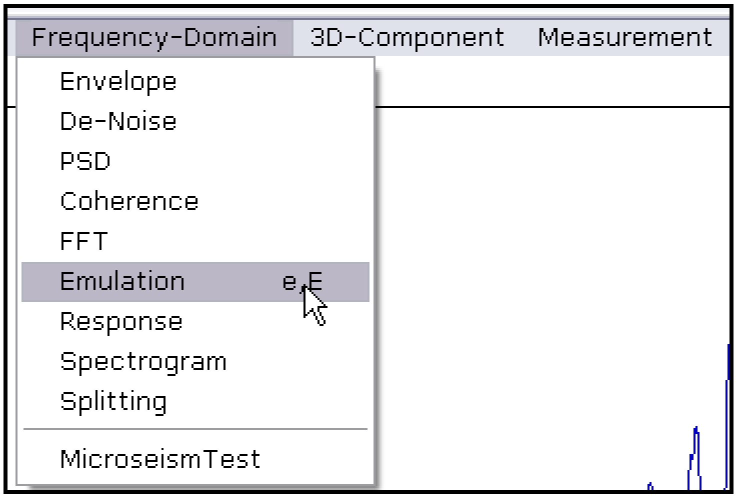


Figure 5-16 Emulation

2. Select a seismometer from the pull-down menu in the dialog box.

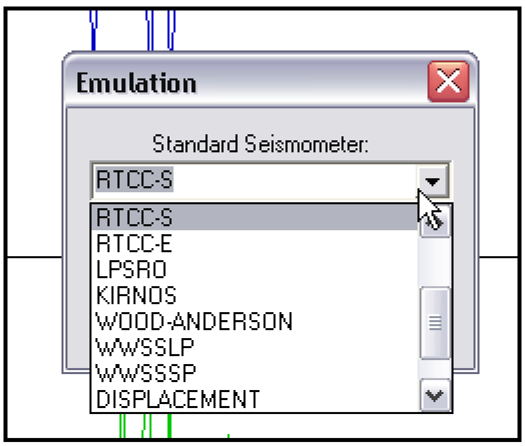
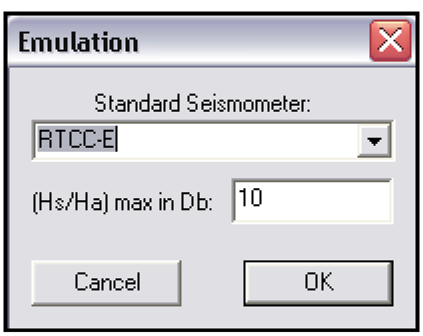
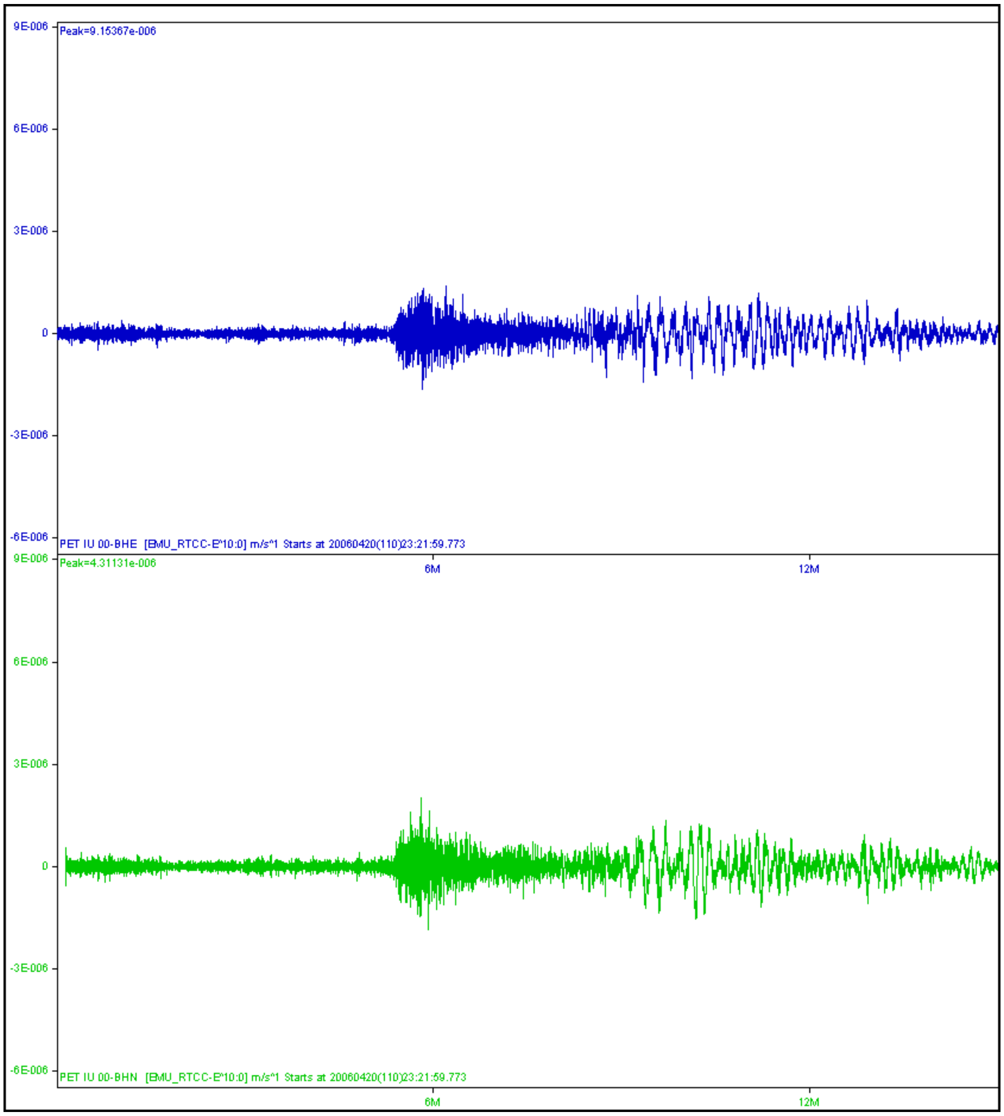


Figure 5-17 Emulate Seismometer

3. Supply the desired ratio.



4. Select the **OK** button to approve the options and display the results.

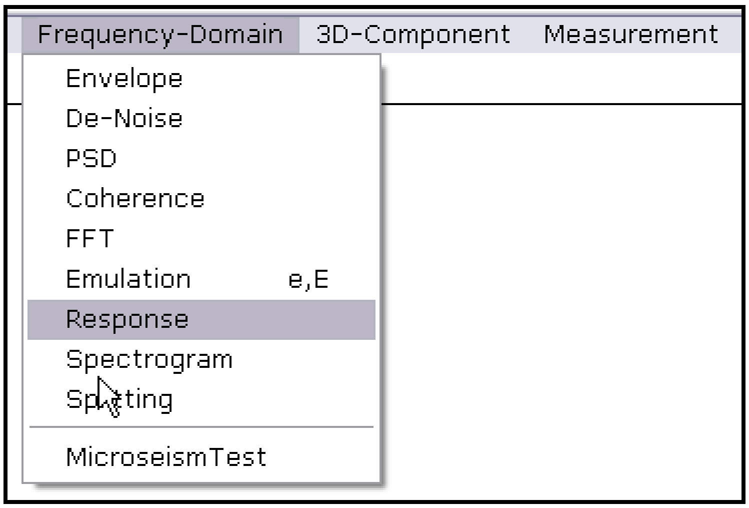


5.8 Response

Use the **Response** command to compute the Amplitude of Transfer Function for a Seismometer Transfer Function. Usually this is given in complex "poles and zeroes", added by the FIR coefficients of digital stages of the Acquisition system.

This information is appended to each waveform data from dateless SEED volumes, rt#DAS#.rtu files, or general ascii files.

1. Select the **Response** command from the **Frequency-Domain** pull-down menu.



2. Fill in the seismometer options.
3. Enter the Clip Limits to adjust plot axes range (HZ Min) and (HZ Max) value.
4. Enter the X-Axes frequency limits in Hz (Db Min) and (Db Max).
5. Enter the Response type.
6. Select the **OK** button to approve the settings.

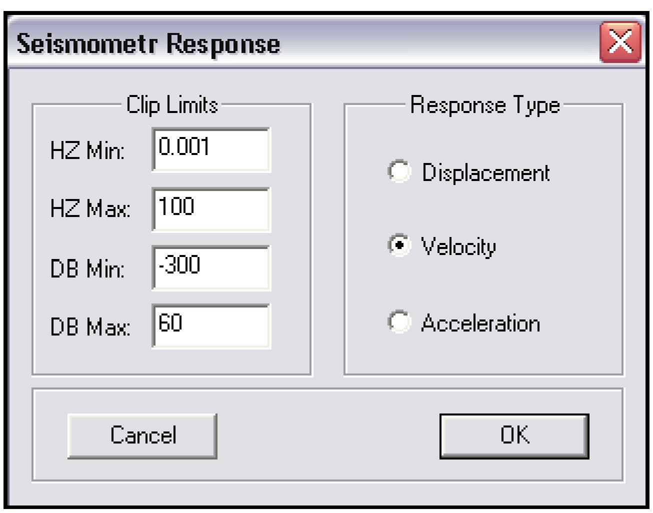
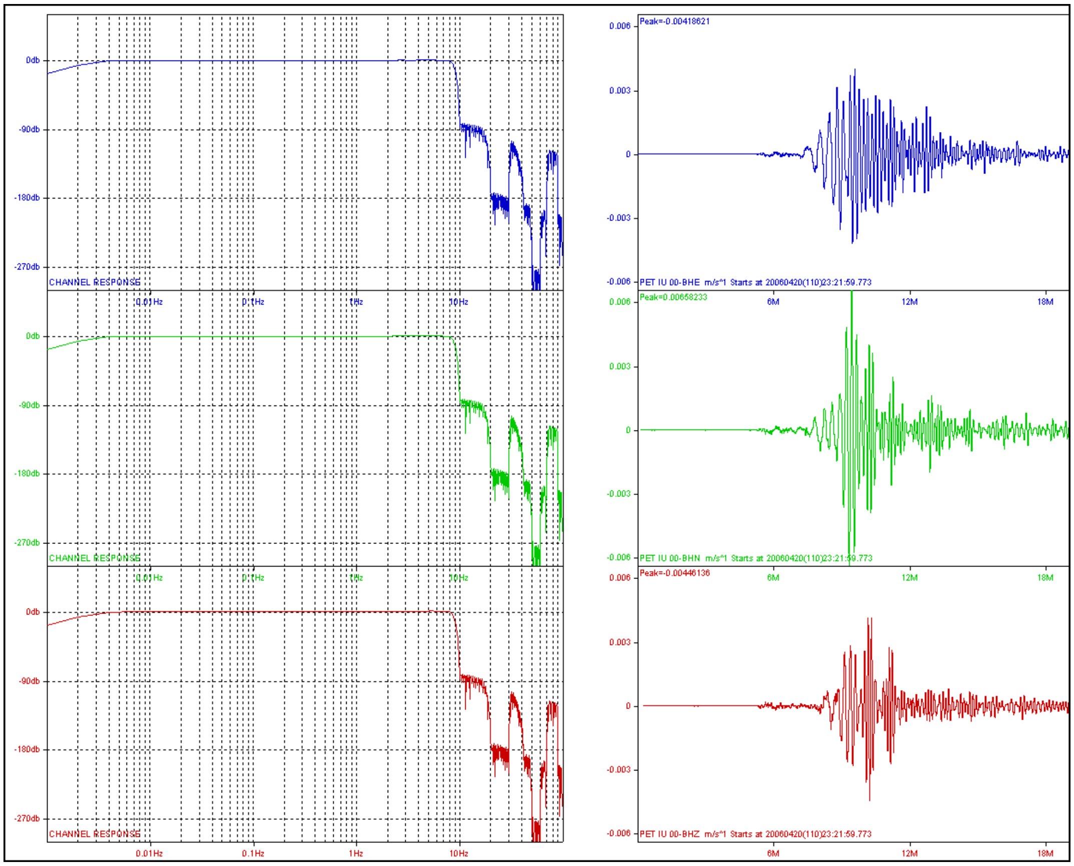


Figure 5-18 Seismometer Response

7. The screen redraws to show the response.



5.9 Spectrogram

Computation of a color spectrogram is accomplished with the Spectrogram command.

5.9.1 Brief Theory:

1. The waveform is passed through a set of bandpass filters: similar to the idea of **Splitting**.
2. In the each band the Envelope of the signal is computed

- None - The maximum amplitude of the signal is found for all times and bands
- Frequency - The amplitude maximum at every time-sample for all bands
- Time - For each band the amplitude maximum is found or

3. The color plot is normalized on either:

5.9.1.1 Global (a) maximum

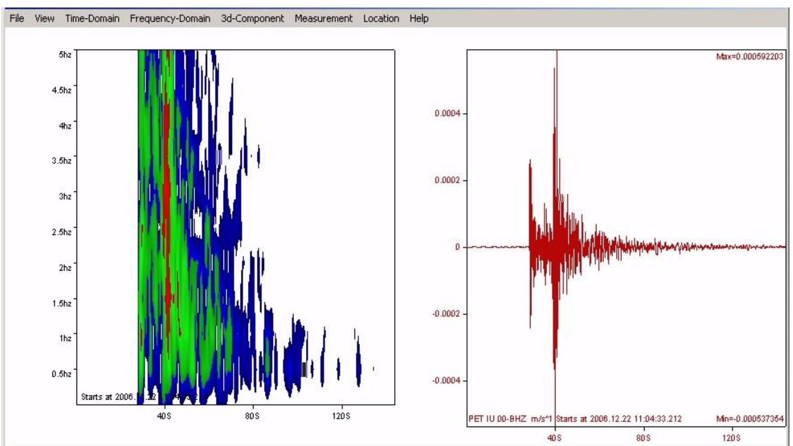


Figure 5-19 Global Maximum

- OR-

5.9.1.2 Local time (b) maximum (to view what frequencies have priority at the time)

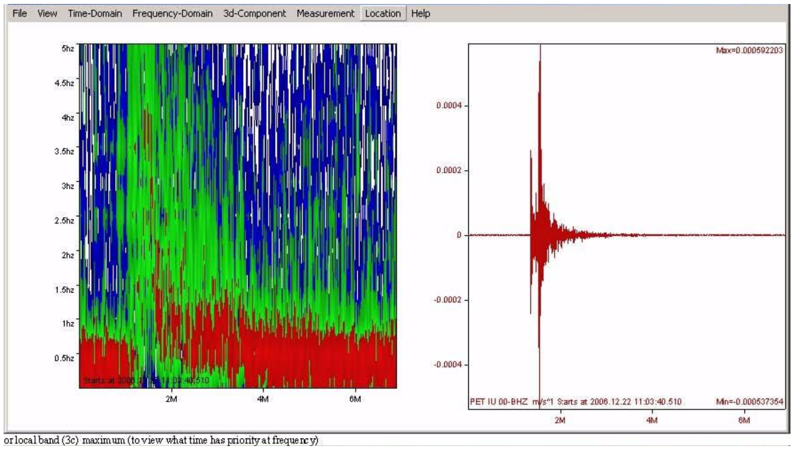


Figure 5-20 Local Time Maximum

5.9.1.3 Local band (c) maximum (to view what time has priority at the frequency)

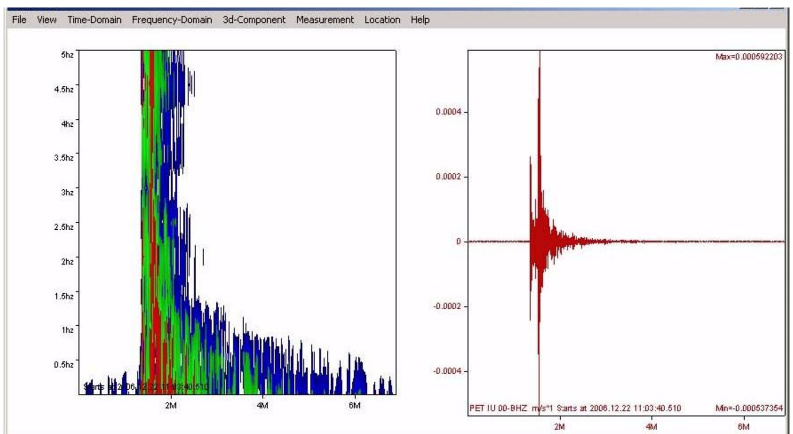


Figure 5-21 Local Band Maximum

5.9.2 To use the Spectrogram command:

1. Select the **Spectrogram** command.

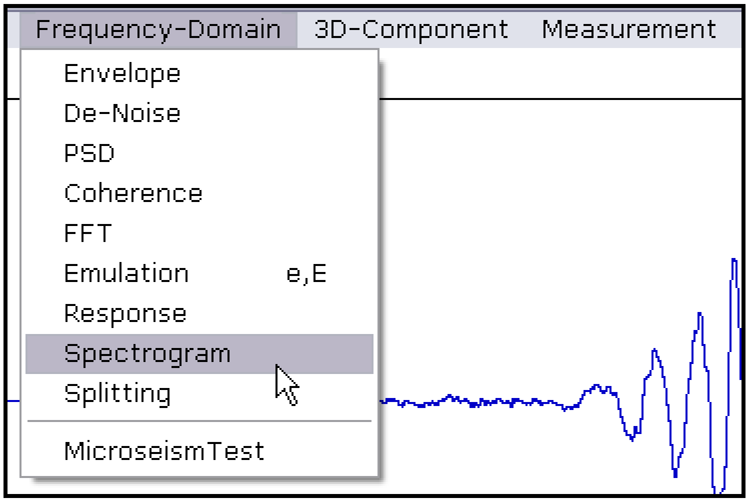
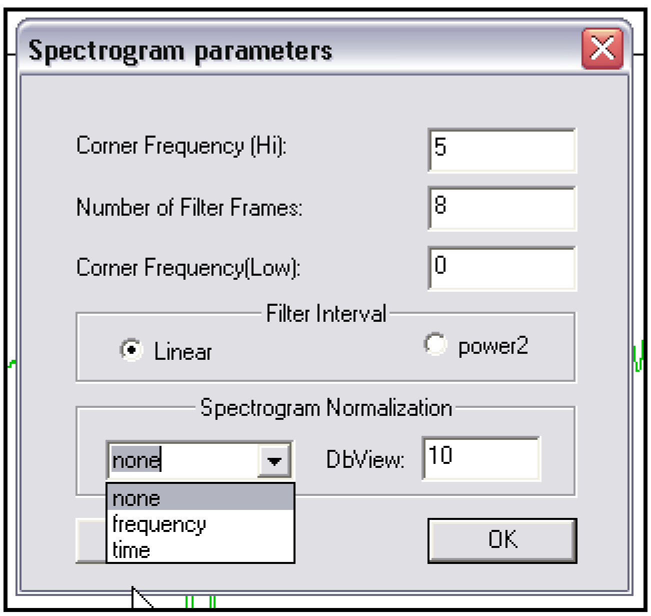


Figure 5-22 Spectrogram Command

2. Fill in the **Spectrogram** parameters.



3. Approve the results with the **OK** button.

4. The screen updates to show the spectrogram.

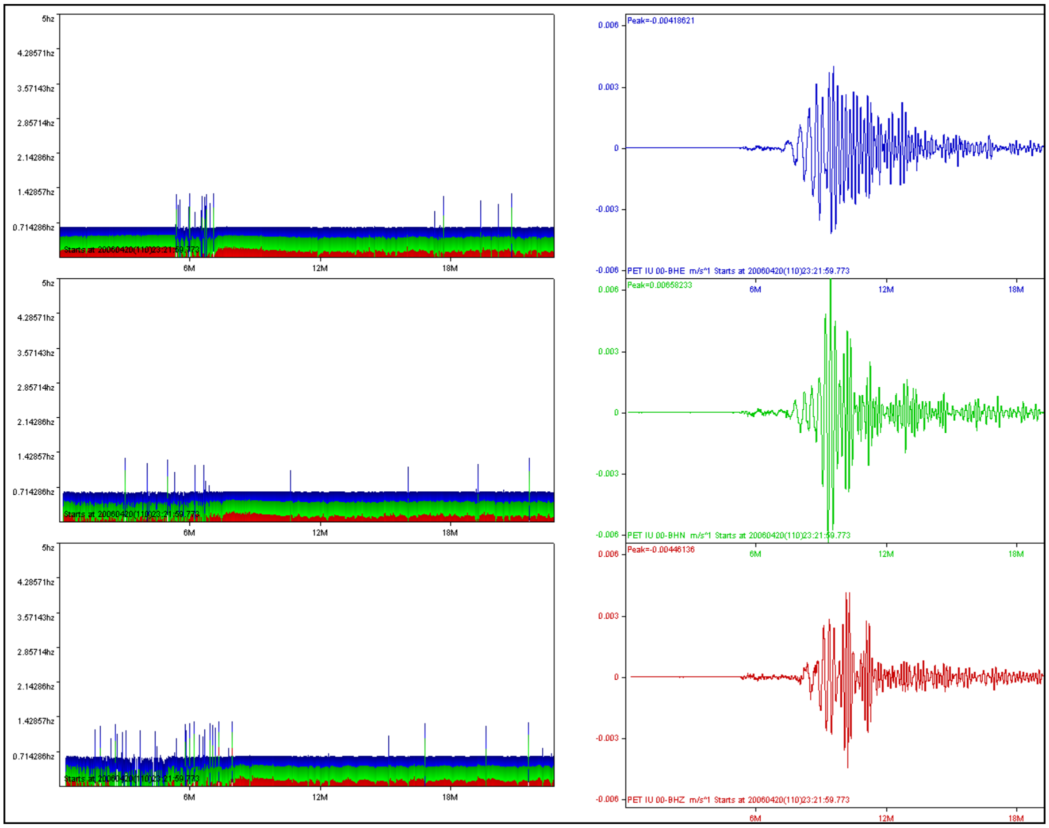


Figure 5-23 Spectrogram

5.10 Splitting

Splitting involves passing the waveform through a set of band-pass filters by adjusting the filter parameters.

1. Select the **Splitting** command from the **Frequency-Domain** menu.

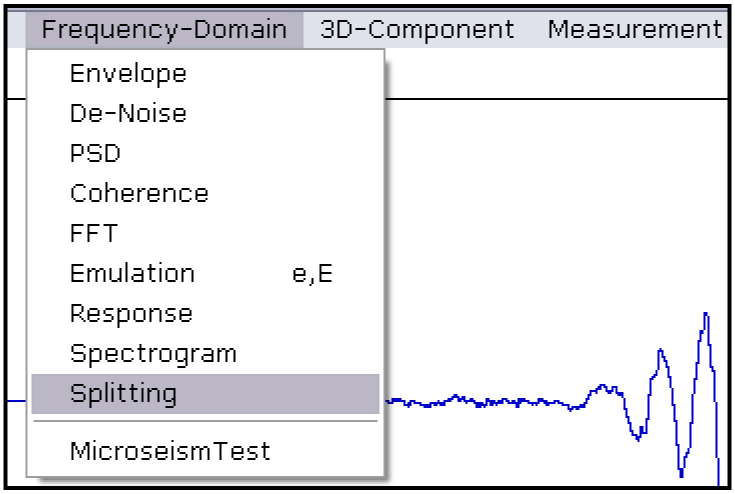


Figure 5-24 Splitting Command

2. Fill in the dialog options.

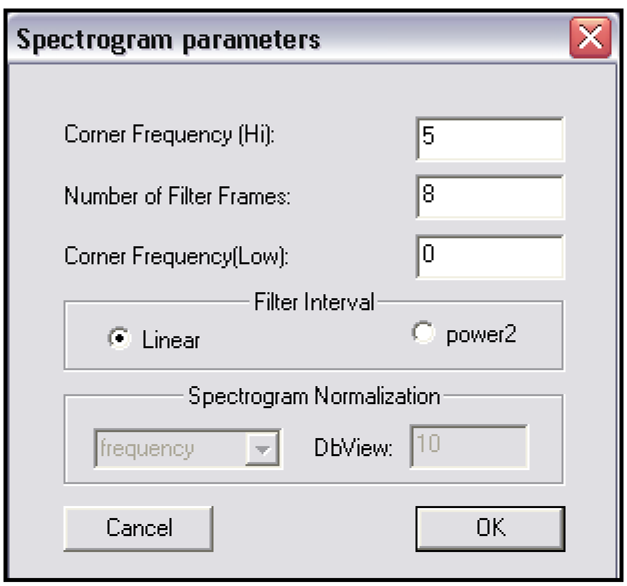
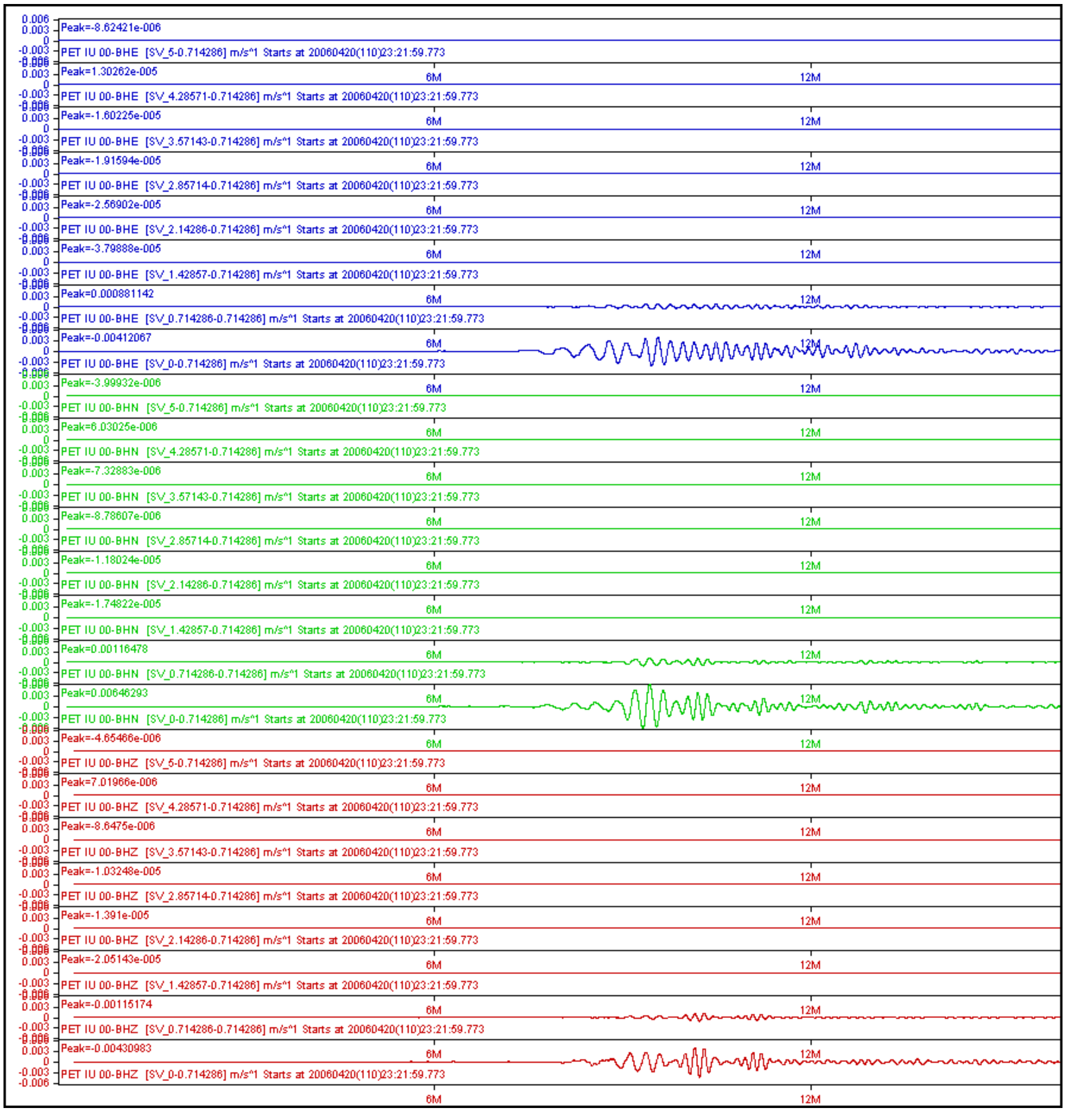


Figure 5-25 Splitting Options

3. Approve the setting with the **OK** button.



5.10.1 An example of splitting is shown below:

- On the left is the response of power2 filter types.
- On the right from top to bottom is the original trace followed by traces passed through band-pass filters.

The screen updates to show the splitting update:

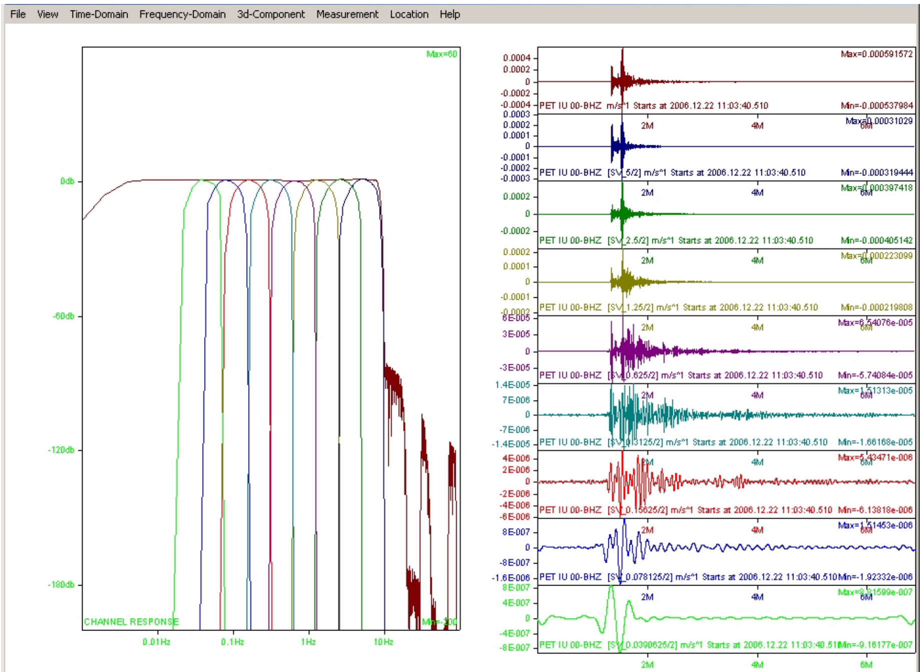


Figure 5-26 Splitting Result

5.11 Microseism Test

This test was developed to check for weak, almost continuous background seismic waves, (Earth "noise") that can be detected only by seismographs. These are often caused by surf, ocean waves, wind or human activity.

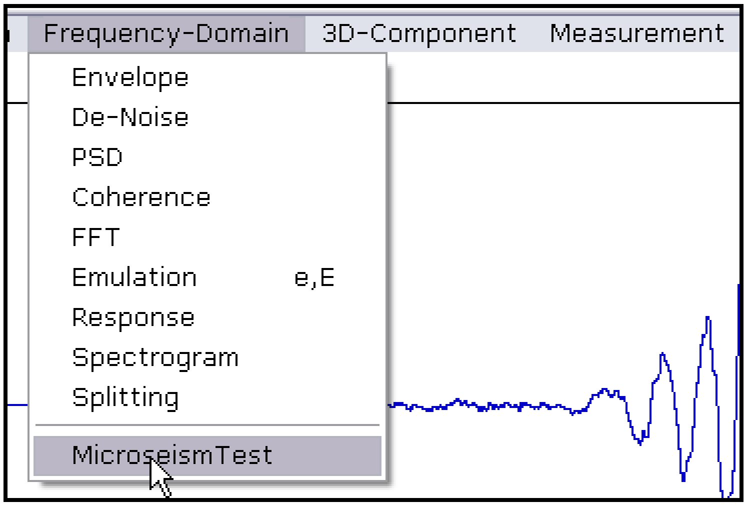


Figure 5-27 Microseism Test

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