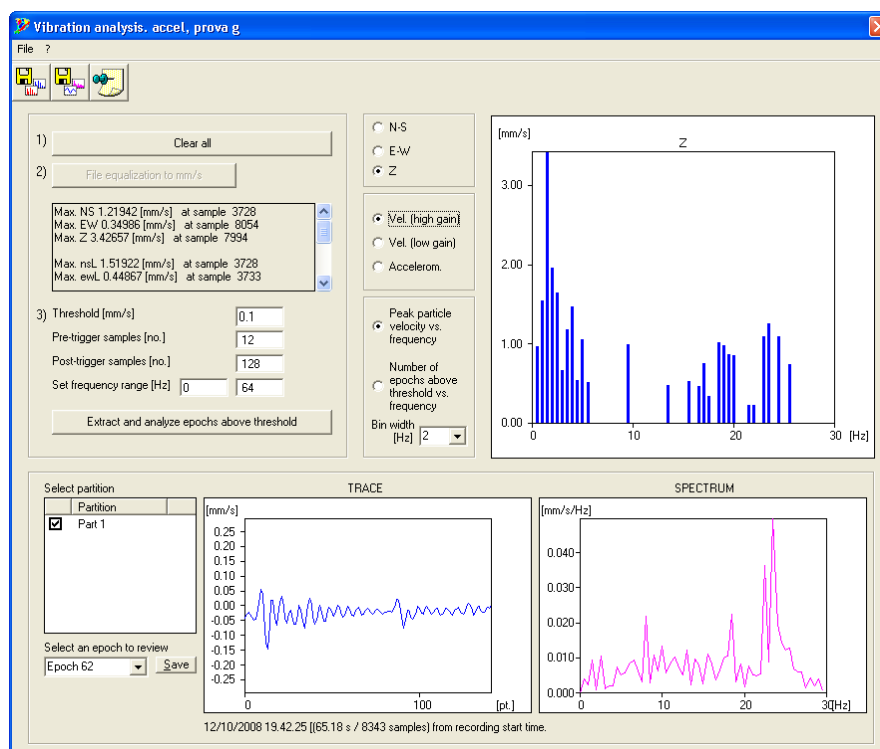


INTRODUCTION TO THE VIBRATION ANALYSIS MODULE IN *Grilla*


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Preface

According to the specific model, TROMINO®s are endowed with different channels, as listed in Table 1.

Measure	Gain (in band)		Orientation	ID_label	First 3 character of the Serial No.
VELOCITY	HIGH	± 1.2 mm/s	Y	NS	All TROMINO®s
			X	EW	
			Z	Z	
VELOCITY	LOW	± 46.8 mm/s	Y	nsL	TEN, TEP, TRY series only
			X	ewL	
			Z	zL	
ACCELERATION	± 5 g		Y	aY	TEP, TRY series only
			X	aX	
			Z	aZ	

Table 1.

In case of *strong* vibration monitoring, you need to enable acquisition also from the LOW GAIN channels (cfr. TROMINO® user's manual).

We recommend to keep also the HIGH GAIN channels always active.

Therefore:



For <i>strong</i> vibration problems	Set TROMINO® acquisition mode from HIGH AND LOW GAIN channels.
For ambient noise acquisition	Set TROMINO® acquisition mode from HIGH GAIN channels only.

Do never acquire from **LOW GAIN** channels only since sensitivity could not be sufficient.



Note that the *Vibration Analysis* routine works only on recordings acquired at 128 Hz or 512 Hz. If you used a different sampling frequency, desample your recording accordingly by using the *File* → *Desampling* tool from the *Grilla* database menu.

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Introduction

The tool for *Vibration Analysis* implemented in *Grilla* is based on the main directions contained in UNI 9916 and DIN 4150-3, according to the following stream:

- 1) signal is equalized to velocity (or acceleration, depending on the sensors used) in the $0.8 - 0.5 f_s$ frequency domain, where f_s is the sampling frequency,
- 2) epochs¹ above the user's defined threshold are extracted,
- 3) each epoch is transformed and analysed in the frequency domain. The peak particle velocity (or acceleration) of each epoch is associated to the dominant frequency in the same epoch (cfr. DIN 4150-3),
- 4) an histogram is plotted representing the peak particle velocity (or acceleration) for each frequency,
- 5) an histogram is plotted representing the frequency-number distribution of peak particle velocity (or acceleration) above the threshold for each frequency.

¹ *Epoch* is a part of the trace in the time domain. The length of each epoch in *Grilla* is selected by the user.

Step 1. Enter the *Vibration Analysis* module

To enter the *Vibration Analysis* module, select the trace you want to analyse from the *Grilla* database (click CTRL + left mouse button until the row of interest is green highlighted) and select *Analysis tools* → *Vibration* from the menu or the corresponding button on the toolbar (red framed in Figure 1).

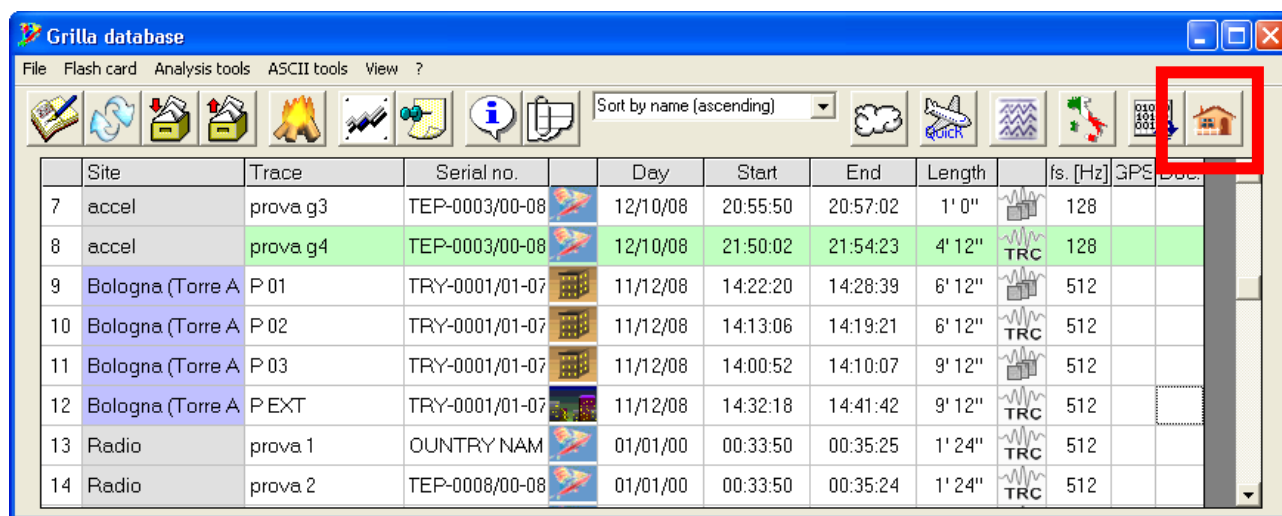


Figure 1. Select the recording to analyse (CTRL + left mouse button) until it is green highlighted and click the toolbar button indicated by the red frame.

The main window of the *Vibration Analysis* module will open (Figure 2). In case an analysis of the same recording is already present, data will be loaded and plotted on the screen. To clear all and perform a new analysis click the *Clear all* button.

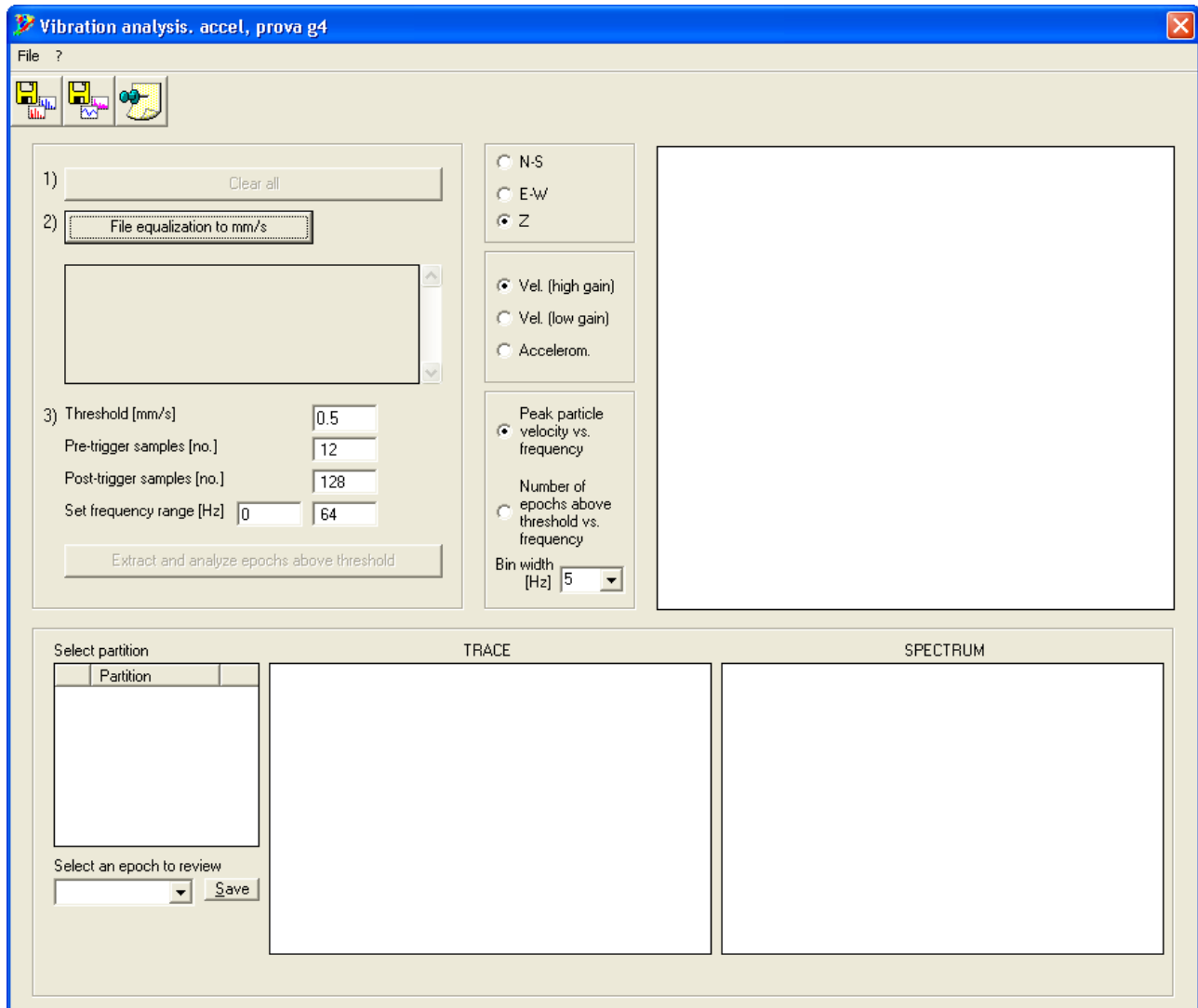


Figure 2. Vibration Analysis module. Main window.

Step 2. Signal equalization.

The first step to perform on a not yet analysed recording is to equalize data and convert them from digit or Volt to mm/s or mm/s². Equalization is performed in the standard engineering domain of interest for strong vibrations, that is above 0.8 Hz and up to half the sampling frequency. Grilla will automatically recognize the type of channels used (velocimetric or accelerometric, high or low gain) and will automatically apply the best suited equalization.

To start signal equalization, click the *File equalization* button (Figure 2). Depending on the file length, this operation could take some minutes.

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The list of the peak particle velocities (or accelerations) found on the recording for each component will appear on the text box below the *File Equalization* button (Figure 3).

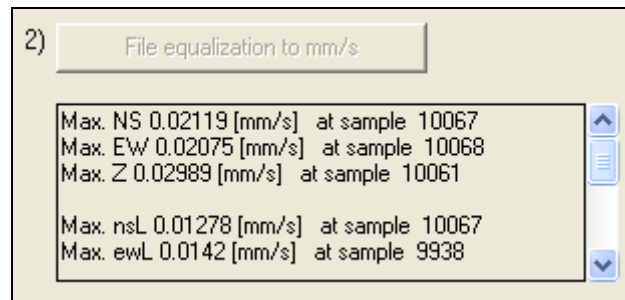


Figure 3. Peak particle velocity (or acceleration) for each component.

Step 3. Set parameters for epoch extraction

The user is now asked to set:

- the threshold value (in velocity) above which time-epochs will be extracted and analysed (Figure 4, *Threshold [mm/s]*).  Please note that this value must be lower than the maximum peak particle velocity found on any channel and listed in Figure 3, otherwise no epoch will be extracted. The default threshold value is 0.5 mm/s,
- the number of pre-trigger samples (Figure 4, *Pre-trigger samples [no.]*), that is the number of data to be retained before the threshold limit is passed. To convert this number (*no.*) into seconds just divide it by the sampling frequency ($no. / f_s$). The default pre-trigger length is one tenth of second,
- the number of post-trigger samples (Figure 4, *Post-trigger samples [no.]*), that is the number of data to be retained after the threshold limit is passed. To convert this number (*no.*) into seconds just divide it by the sampling frequency ($no. / f_s$). The default post-trigger length is 1 second,
- the frequency-range of analysis (Figure 4, *Set frequency-range [Hz]*). The default range is $0 - f_s / 2$, where f_s is the sampling frequency. Low frequencies are automatically cut according to the epoch length set on item b) and c) above.

3) Threshold [mm/s]	<input type="text" value="0.1"/>
Pre-trigger samples [no.]	<input type="text" value="12"/>
Post-trigger samples [no.]	<input type="text" value="128"/>
Set frequency range [Hz]	<input type="text" value="0"/> <input type="text" value="64"/>
<input type="button" value="Extract and analyze epochs above threshold"/>	

Figure 4. Parameters for epoch extraction.

Click *Extract and analyze epochs above threshold* to start the analysis. This operation could take some minutes, depending on the recording length.

⚠ Note. If an epoch above the threshold is found on, e.g., the Z-component, the same epoch will be extracted and analysed also for the other components (NS and EW), even if it is not above the threshold on these channels. This does not affect the result interpretation, as will be explained later.

Graphical output

Single epochs and spectra.

To review the single epochs above threshold extracted by the system use the list *Select an epoch to review* (Figure 5). The time-trace and its spectrum will appear on the bottom panels, on the left and on the right, respectively.

To view different channels select different options as indicated by the red arrows in Figure 6.

Select *File* → *Save picture...* → *trace/spectrum* or the toolbar button  to save the time-epoch and its spectrum as .bmp files.

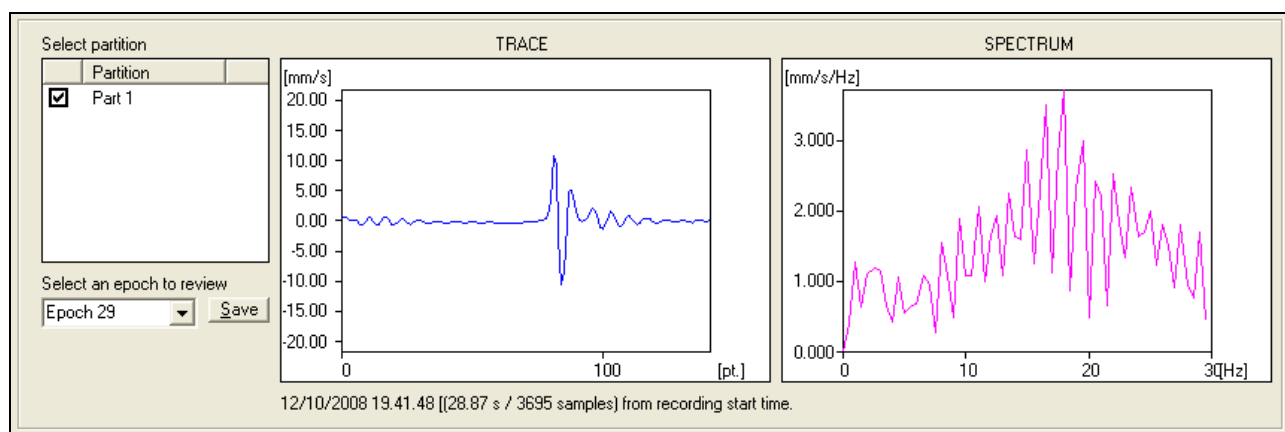


Figure 5. Plots showing a time-epoch (left) and its spectrum (right).

Frequency-peak particle velocity.

The frequency-peak particle velocity plot can be viewed by enabling the option *Peak particle velocity vs. frequency* (blue arrow in Figure 6). To select different channels set different options (red arrows in Figure 6).

In this kind of plot peak particle velocities below the threshold level can be present. The reason is explained in the **Note** on pag. 8: each epoch must be above the threshold for at least one (but not necessarily all) the motion components (NS, EW, Z).

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Select *File* → *Save picture...* → *histograms* or the toolbar button  to save the histograms as .bmp files. Histograms will automatically be saved for all motion components and channels (velocimetric, accelerometric, high and low gain).

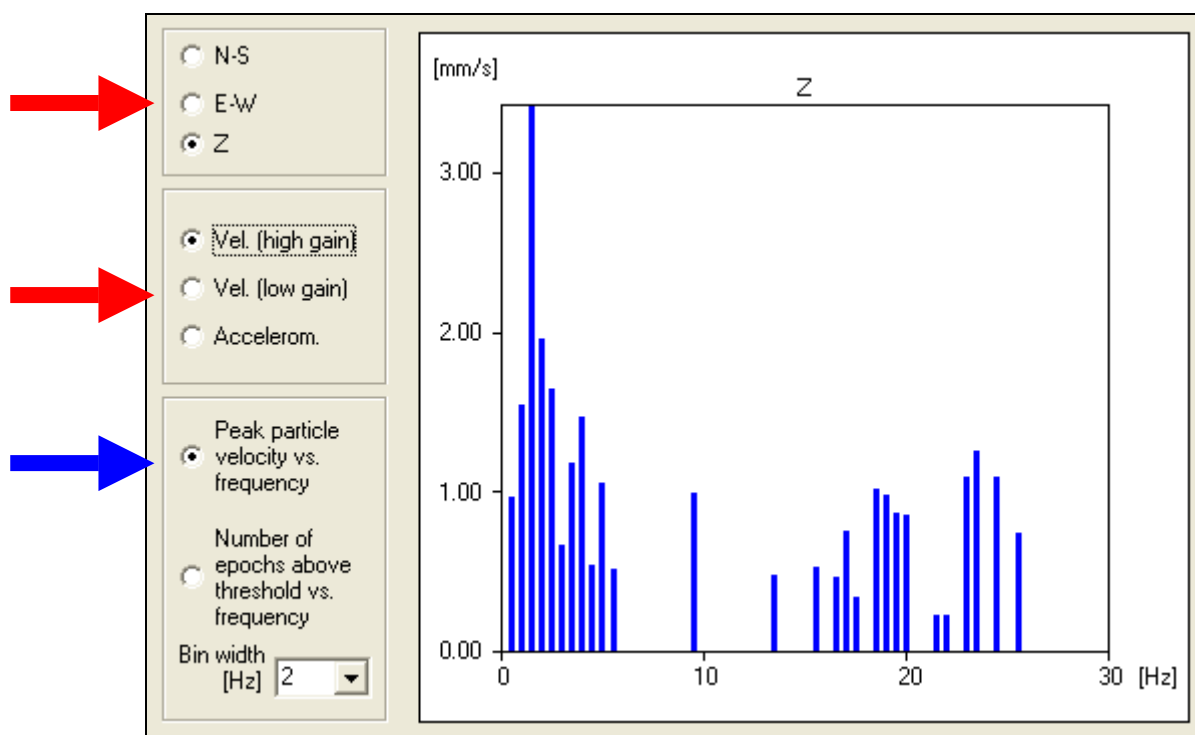


Figure 6. Frequency vs. peak particle velocity (or acceleration) plot.

Frequency-number of epochs above threshold.

The frequency-number distribution of epochs above threshold can be viewed by enabling the option *Number of epochs above threshold vs. frequency* (blue arrow in Figure 7). The frequency axis (x) will be divided into bins spanning 5 Hz as default value. To modify the bin size select different values from the *Bin width [Hz]* list (Figure 7).

To view different channels set the corresponding options (red arrows in Figure 7).

 Only epochs which are really *above* the threshold on the *selected* channel are visualized in this kind of plot (compare **Note** on pag. 8).

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Select *File* → *Save picture...* → *histograms* or the toolbar button  to save the histograms as .bmp files. Histograms will automatically be saved for all motion components and channels (velocimetric, accelerometric, high and low gain).

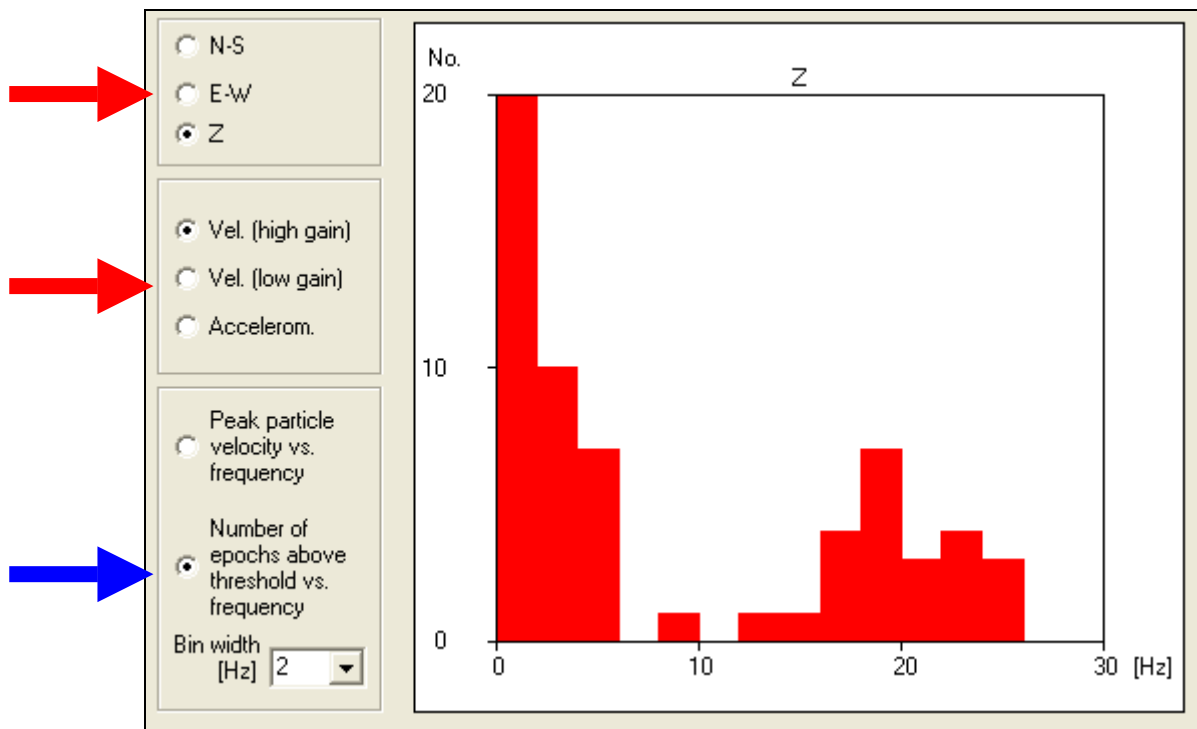


Figure 7. Frequency vs. number of epochs above threshold plot.

Textual output

Select *File* → *Automatic report* or the toolbar button  to create an automatic report as a .doc file (Microsoft Word™ is required).

A number of textual files is created in the *[your path to Grilla database] \ GrillaDB \ Traces \ [working folder] \ Tracemm_s* folder.

MAXIMA STRING.TXT contains the maximum velocities found on the recordings for each channel, as described in Figure 3.

MAXIMAHISTORY(NS, EW, Z,...).DAT is a text file listing for each component (NS, EW, Z... ,):

- 1) for each row a different “epoch above threshold”,
- 2) for each column:
 - a. the peak particle velocity (or acceleration),
 - b. the associated frequency,
 - c. the date (dd:mm:yy),
 - d. the time (hh:mm:ss),
 - e. the number of seconds (and samples) elapsed from the recording start time.

[mm/s]	[Hz]	[dd:mm:yy]	[hh:mm:ss]	
000.80000	0000.50	12/10/2008	19.41.20	[(0.11 s / 14 samples) from recording start time.
000.05199	0009.00	12/10/2008	19.41.21	[(1.15 s / 147 samples) from recording start time.
000.13288	0002.00	12/10/2008	19.41.22	[(2.16 s / 276 samples) from recording start time.
000.14482	0002.00	12/10/2008	19.41.23	[(3.16 s / 405 samples) from recording start time.

Figure 8. Example of MaximaHistory#.dat file content.