

**SEISAN tutorial**  
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## 1 Introduction

The SEISAN distribution includes 2 test events, a local event and a distant event. The intention with this tutorial is to explain a bit how SEISAN works and to demonstrate the most often used functions in SEISAN without having to install the test data set and follow the much more extensive SEISAN training course.

In this tutorial a Windows OS is used to describe the SEISAN commands and file system.

Linux users can use the same SEISAN commands but the file system is clearly a bit different.

It is assumed that SEISAN is installed under C:\seismo, readings and other parameters are in S-files under test database TEST in the directory named C:\seismo\REA, waveform files are in C:\seismo\WAV, calibration files are under C:\seismo\CAL and other parameter files under C:\seismo\DAT. The examples will be for Windows, but they look more or less the same under Linux. All work is done in a DOS command window in Windows or a terminal window under Linux. SeisanExplorer uses in addition its own window.

Since there are two events, there are also two S-files. The events' S-files (files with locations, readings etc, see example below) are already installed in the test database TEST under REA in directory se C:\Seismo\REA\TEST\_\1996\06 and the files are

```
03-1955-40D.S199606
25-0337-31L.S199606
```

One file has D in front of the '.' and is distant event, the other has an L and is a local event.

## 2 Get access to the events, EEV

In order to get access to the events directly from any directory, the command eeV is used. It is also possible to use the GUI SeisanExplorer (section 13), however it is easier to understand the use of SeisanExplorer when standard SEISAN commands have been used so SeisanExplorer will be used later.

EEV normally works with one month at a time so the command to connect to the two events is

```
eev 199606
```

When the system is installed, the default database (a named directory in REA) is TEST, so EEV will automatically connect to the TEST database. After giving the above command you should see

```
1996 6 Reading events from base TEST_ 2
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ?
```

First there is a message telling how many events there are for June 1996, in this case 2 but it could be up to 200 000. Then follows origin time, 'D' for distant event, latitude, longitude and depth, 'N' to indicate a new event, rms of travel time residuals (1.1), magnitude 5.6 Mw from Harvard. 12 is the number of stations with observation listed in the S-file.

Go the second event (local) by pressing enter and you get

```
1996 6 Reading events from base TEST_ 2
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ?
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ?
```

### 3 Inspect the content of the S-file

Enter again will go back to the first event. List the file by typing 't' and you get:

```
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ? t
File name: C:\Seismo\REA\TEST_1996\06\03-1955-40D.S199606

1996 6 3 1955 35.5 D 47.760 153.227 0.0 TES 12 1.1 5.6WHRV 5.6bPDE1
1996 6 3 1955 35.5 D 47.760 153.227 0.0 TES 12 1.1 5.6WHRV 5.6bPDE1
GAP=348 2.88 999.9 999.99999.9 -0.1404E+08 -0.3810E+08 0.1205E+09E
1996 0603 1955 31.8 D 46.787153.722 33.0 PDE 5.6bPDE 1
ACTION:SPL 08-10-02 10:19 OP:jh STATUS: ID:19960603195540 I
1996-06-03-2002-18S.TEST_012 6
1996-06-03-1917-52S.TEST_002 6
Wavform file names
STAT SP IPHASW D HRHM SECON CODA AMPLIT PERI AZIMU VELO AIN AR TRES W DIS CAZ7
Station Component
KBS BZ EP 20 4 40.63 23 -1.3210 5724 351
TRO SZ EP 20 5 32.5 21 1.7510 6471 343
LOF SZ IP C 20 5 46.68 21 -0.1110 6729 344
JNW SZ EP 20 5 49.5 21 1.1910 6755 353
JMI LZ I 20 8 27.35 6768 353
JMI LZ I Phase 2014 41.56 6768 353
JMI LZ I 2021 25.49 6768 353
MOL SZ IP C 20 6 25.49 19 -1.7410 7408 343
FOO SZ EP 20 6 35.99 19 0.1210 7559 344
HYA SZ EP 20 6 36.91 19 -0.1410 7580 343
SUE SZ IP C 20 6 39.07 19 -0.2810 7621 344
KOMO BZ IP C 20 6 40.72 19 -0.7010 7657 341
Azimuth
Residual Weight Epicentral distance
Return to continue, q to return to EEV
```

The most important explanations are given. The same file can also be edited using command 'e'. Note there are several hypocenter lines but the first one is the main line used, the others are for added information. Note also that the event has two waveform files associated with the event.

Where are the waveform files ?

SEISAN will look for the waveforms in the current directory and in WAV. To check where the waveform files used are, type 'w' and you get:

```
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ? w
Full path name : C:\Seismo\WAV\1996-06-03-2002-18S.TEST__012
Full path name : C:\Seismo\WAV\1996-06-03-1917-52S.TEST__002
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ?
```

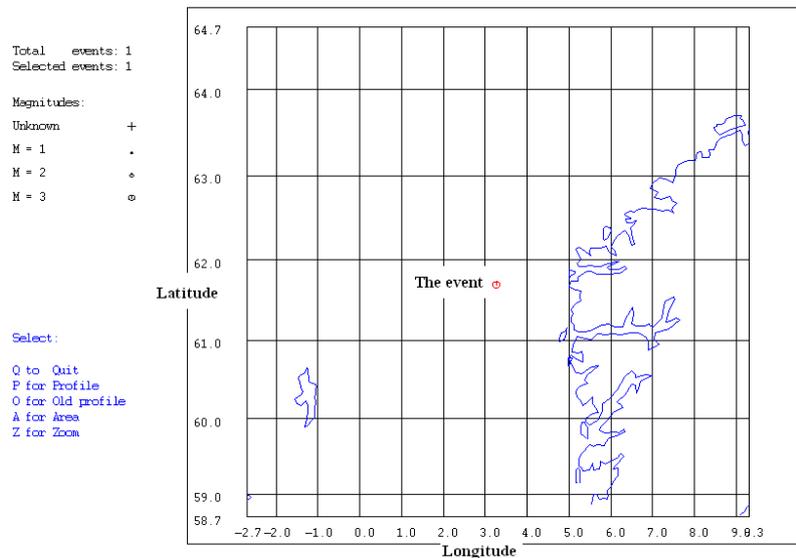
and it is seen that the 2 waveform files used in WAV.

List of commands in EEV

Type '?' and enter and the list of EEV commands are given

## 4 Plot the epicentre

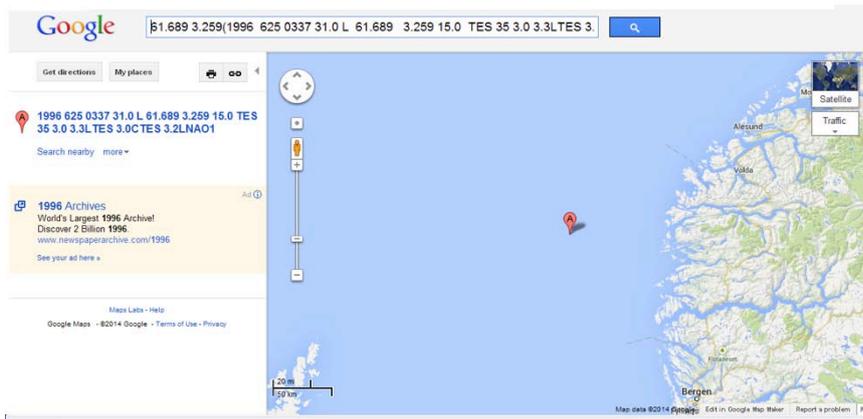
Go to the second event, type 'map' and you get



The map used is not very detailed. It can be replaced with a more detailed map, changed in file C:\seismo\DAT\SEISAN.DEF. If there is access to Internet, Google can be used. Type 'gmap'

```
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? gmap
Location map is generated for maps.google.com
Open gmap.html with your favorite browser
you will find it here : c:/seismo/WOR
```

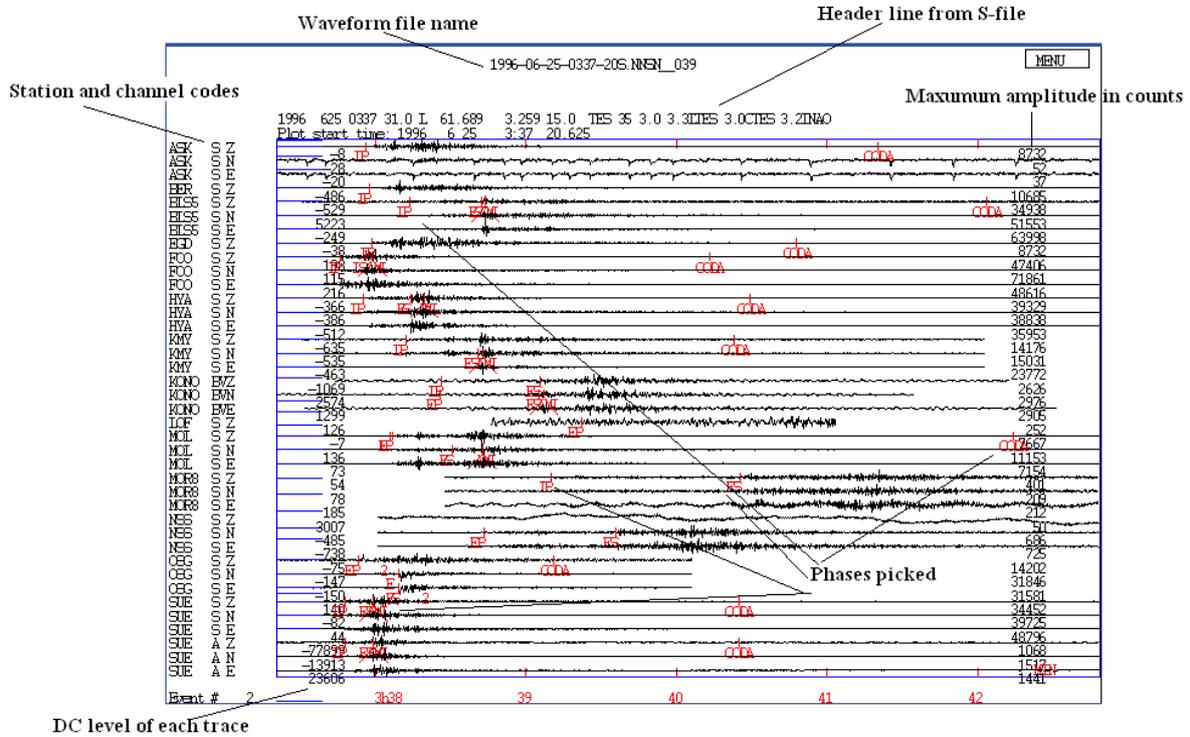
Double click on file C:\seismo\WOR\gmap.html and you get



Many events can be plotted outside EEV with EPIMAP, W\_EMAP or GMAP.

## 5 Plot waveforms

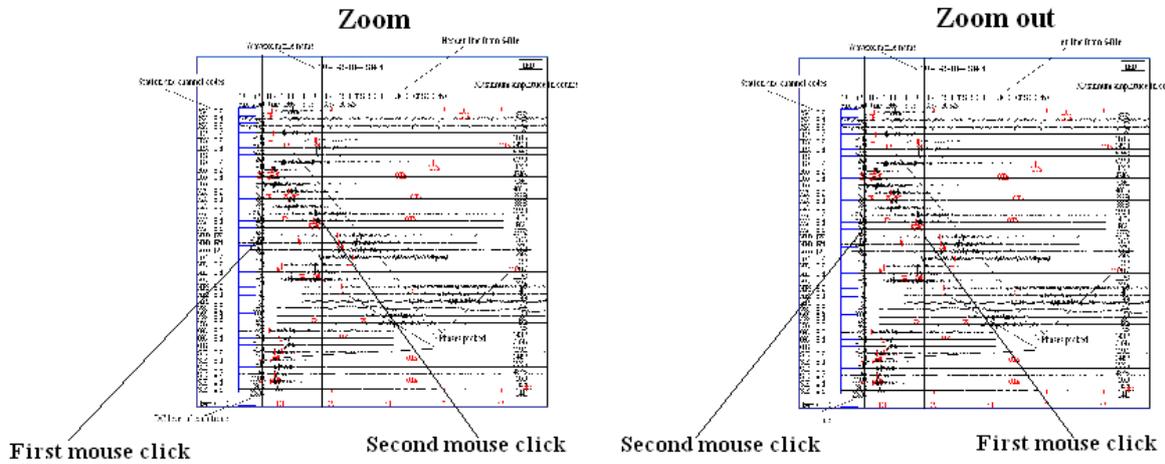
Go to the second event, type 'po' and you will see:



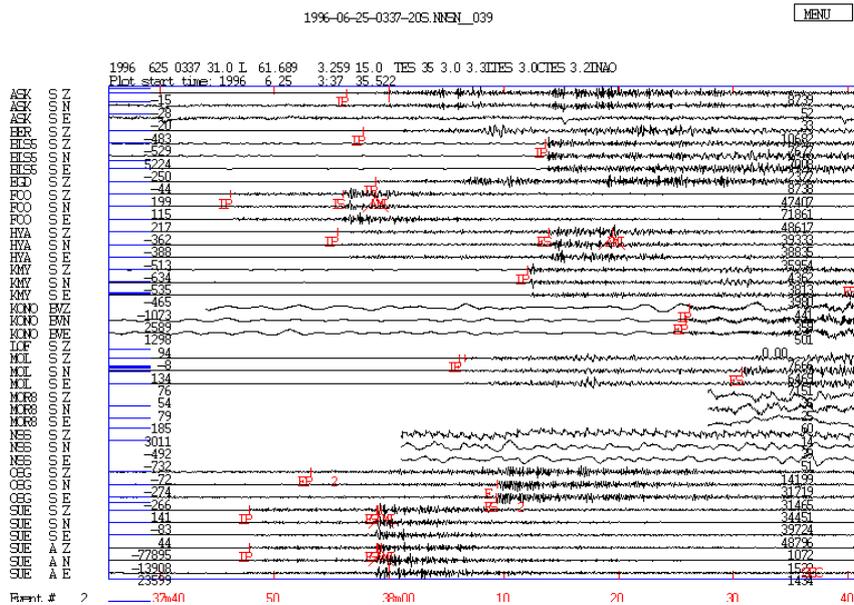
Command 'p' will also plot events but then there are more choices so it is simplest to use 'po'.

## 5.1 How to zoom

**Zoom:** Put cursor among the traces at position for start of zoom, click on end of zoom. To zoom out, do the opposite. See illustration below.

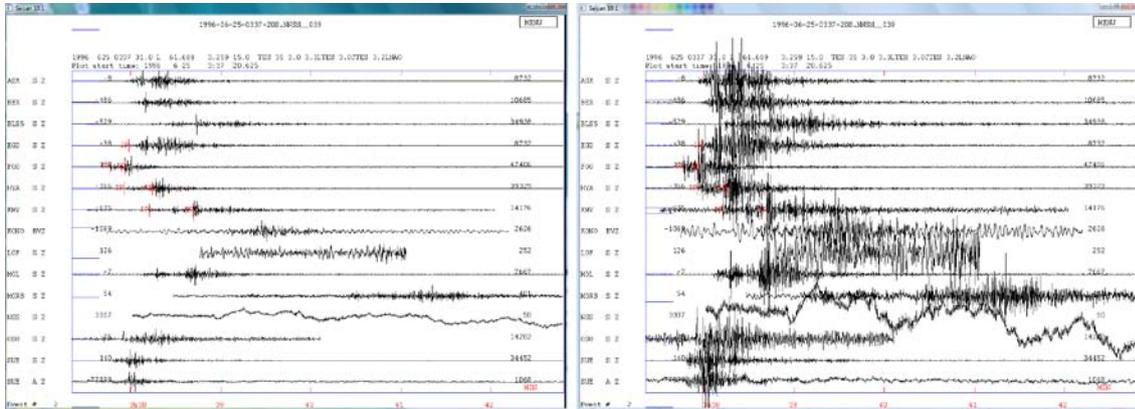


The zoomed traces



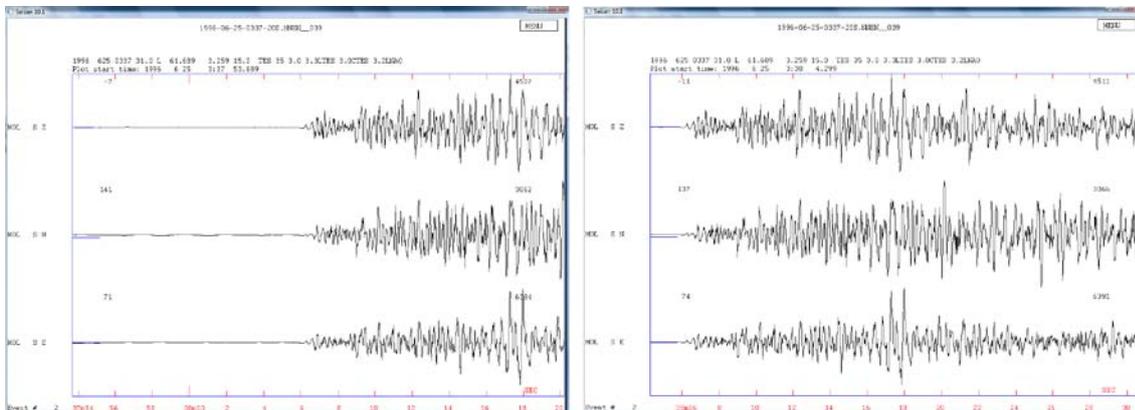
## 5.2 How to change amplitude, up down arrow keys

The amplitude on the plot can be made larger or smaller with the arrow keys up and down. The example below shows the effect of pressing the arrow key up two times.



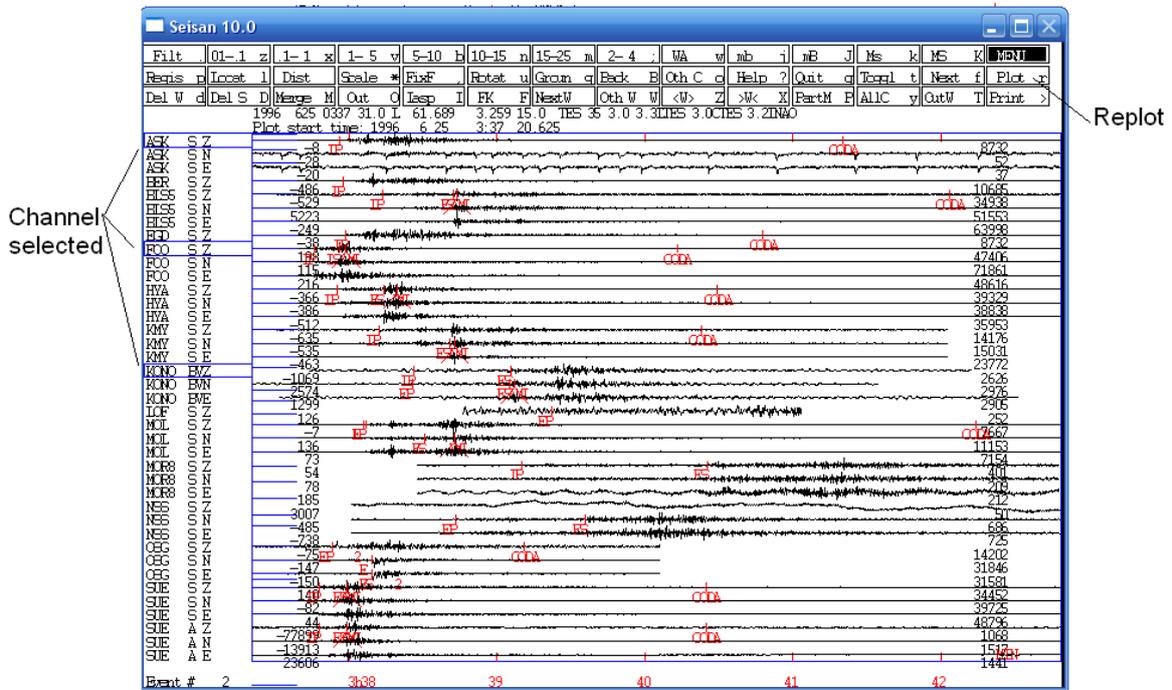
## 5.3 How to scroll the plot left and right, horizontal arrow keys

The first plot below shows a zoom of 3 traces. In order to see the rest of the signal zoomed, the whole plot can be moved left and right with the horizontal arrow keys. The plot below left shows the original zoom and the plot right, the plot after pressing the right arrow keys times.

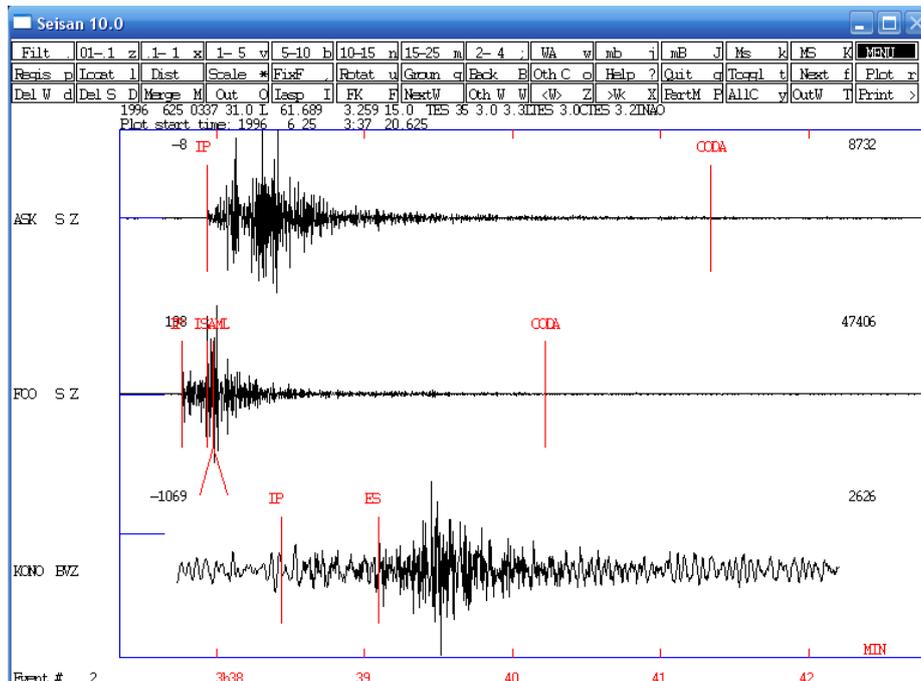


## 5.4 Select channels on plot

Select the channels by clicking on the channel name and then click on Plot, see figure below



and the plot with the 3 channels will follow. A range of channels can also be selected by using left-mouse click on the first channel and right-mouse click on the last channel.



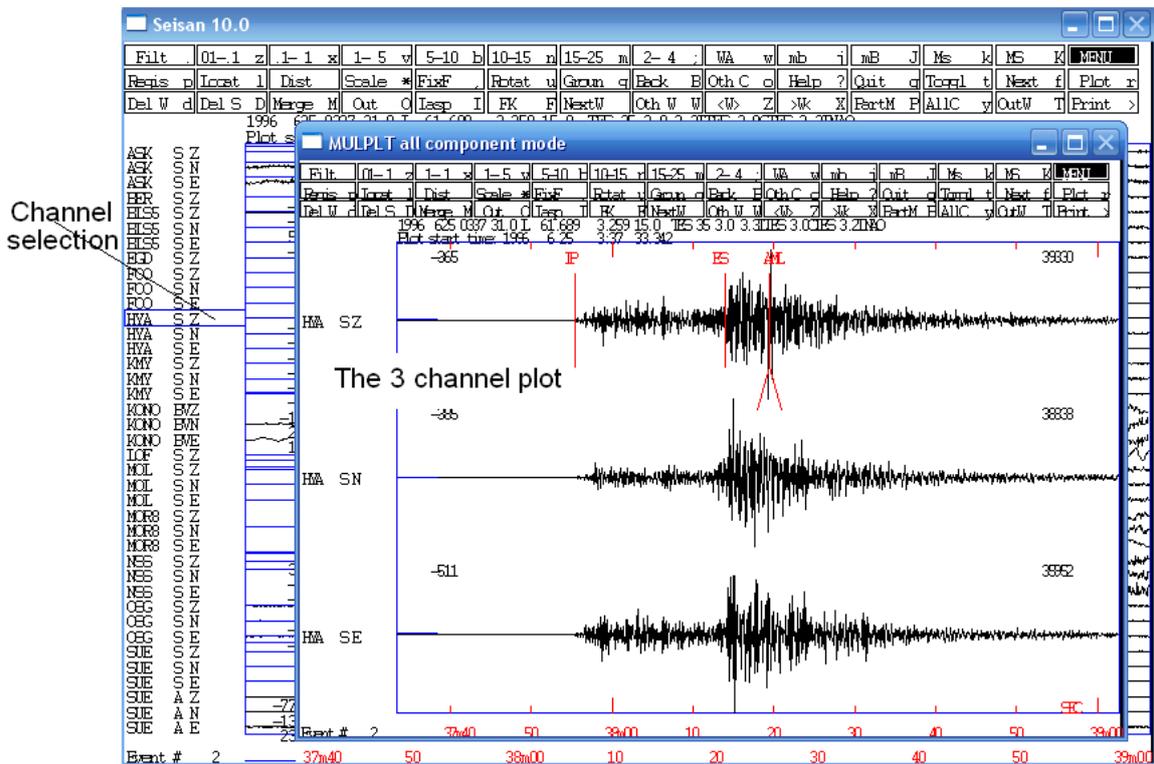
Select channels by using the list of channels: On menu, press Oth C (or 'o' on keyboard) and channel selection list comes up:



It is now possible to select and deselect channels. All channels with readings can be selected or only Z-channels. Press ok or 'f' on keyboard and the multi trace plot comes up again. This menu will also come up if you press 'p' from EEV.

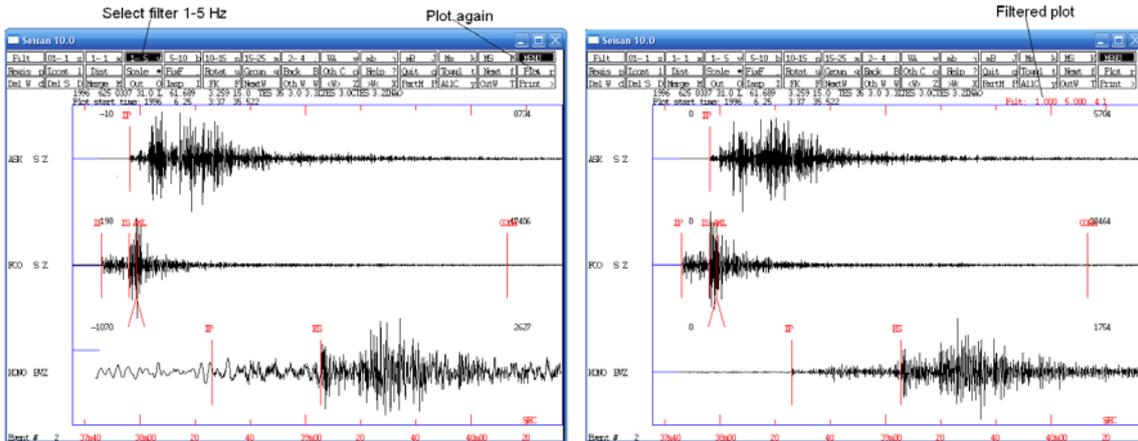
### 5.5 Plot all components for a selected station

Select one channel as shown above, press 'y' and the plot comes up with 3 channels. In this case some zooming was done before pressing 'y'. To return to the multi trace plot press 'y' or 't'.



## 5.6 How to filter traces

We will use the example above where stations ASK, FOO and KONO were selected. On the menu, select a filter or use the corresponding keys on the keyboard. Press Plot or 'r' and the filtered plot appears. Plot again and the filters are removed. Notice how the filter has removed the low frequency noise on the 3rd channel, broad band station KONO.



## 5.7 Plot an event directly with MULPLT without using EEV

The waveform files are in the WAV directory. Go to the WAV directory, make a list of the waveform files and plot one of them:

```

C:\seismo\WOR>
C:\seismo\WOR>wa
C:\seismo\WOR>cd /d C:\Seismo\wav
C:\seismo\WAV>dirf 19*
# 1 1996-06-03-1917-52S.TEST_002
# 2 1996-06-03-2002-18S.TEST_012
# 3 1996-06-25-0337-20S.NNSN_039
C:\seismo\WAV>mulplt
Filename, number, filenr.lis (all)
Continuous SEISAN data base: cont
Large SEED volume: conts
Archive: arc
Make a choice
2
Read headers from files:
1996-06-03-2002-18S.TEST_012

Plot options: Interactive picking      Return
Multi trace plot on screen, def (0)
Multi trace plot on screen          (1)
Multi trace plot on screen+laser(2)
Multi trace plot on laser           (3)
Continuous on screen                (4)
Continuous on screen + laser        (5)
Continuous on laser                  (6)
Stop                                 (q)
0
Low and high cut for filter, return for no filter

```

You are in WOR

Give command wa to go to WAV

Make a list of files starting with 19

The list, is in file filenr.lis

Start MULPLT

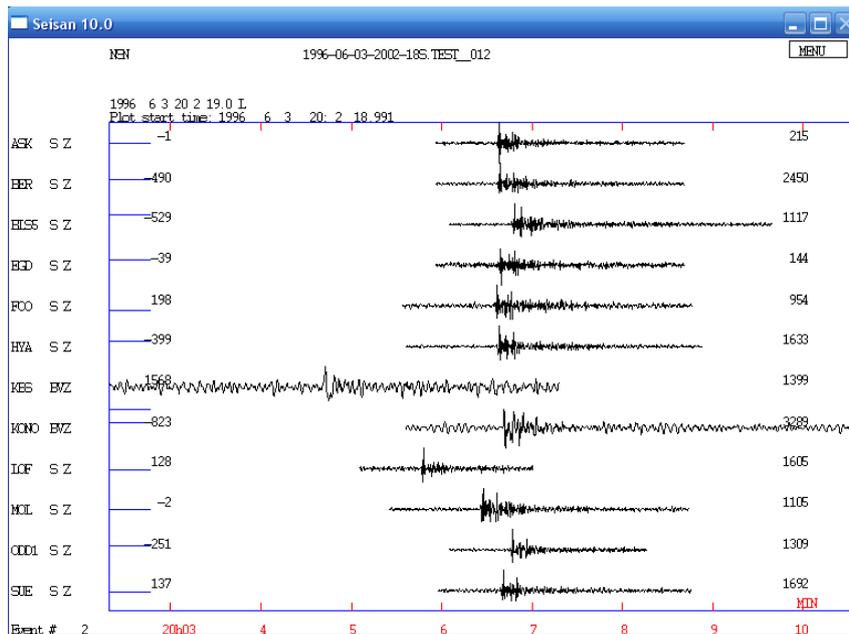
Select to plot file #2

Use option 0 for all defaults

No filter, just enter

Now plot comes up

Notice that now there are no phase arrival readings indicated on the plot since the plot is not made from EEV and therefore it is not referenced to the S-file with the readings.



## 6 Locating events

### 6.1 Locate a local event using phases in S-file

Select the local event in EEV. Use command 'l' (note this is lower case L and not the number one '1') and the result is

	Distance (km)	Location	Phase given by user	Phase used by program	Residual	
#	2 25 Jun 1996 03:37 31	L	61.687	3.259 15.0	N 3.0 3.3LTES	35 ? 1
Azimuth	date hrmm sec	lat	long depth	no m	rms damp erln erlt erdp	Error in location
Angle of incidence	96 625 337 31.14	6141.21N	3 17.0E 15.0	84 3	1.98 0.000 89.2 35.0 62.0	Observed arrival time
Station	stn dist azm ain w phas	calcpchs	hrmm tsec	t-obs t-cal	res wt di	Weight
Hypocentral distance	FOO 94 95.3 92.0 0 P	PG	337 46.1	14.90 14.90	0.00 1.00 3	Listing of different magnitudes from different stations
Amplitude (nm)	FOO 94 95.3 92.0 0 S	SG	337 56.0	24.07 25.92	-1.06 1.00 4	
Period (s)	SUE 106 131.0 92.4 0 P	PG	337 47.8	16.70 16.69	0.01 1.00 3	
	SUE 106 131.0 92.4 0 S	SG	337 58.9	27.81 29.04	-1.23 1.00 5	
	SUE 106 131.0 0 0 AML		337 59.0	27.8		
	SUE 106 131.0 0 0 AML		337 59.3	28.2		
	OSG 134 189.6 55.1 2 P	2 PN4	337 53.2	22.03 20.63	1.40 0.50 1	
	OSG 134 189.6 55.1 2 S	2 SN4	338 9.3	38.18 35.89	2.28 0.50 2	
	HWA 166 109.2 55.1 0 P	PN4	337 55.5	24.32 24.51	-0.19 1.00 0	
	HWA 166 109.2 55.1 0 S	SN4	338 13.9	42.80 42.64	0.15 1.00 3	
	HWA 166 109.2 0 0 AML		338 19.4	48.3		
	ASK 169 141.6 55.1 0 P	PN4	337 56.3	25.14 24.97	0.17 1.00 1	
	BER 183 141.7 55.1 0 P	PN4	337 57.8	26.65 26.64	0.01 1.00 1	
	EGD 190 145.5 55.1 0 P	PN4	337 58.8	27.64 27.50	0.14 1.00 1	
	MOL 243 64.3 55.1 0 P	PN4	338 6.2	35.01 34.18	0.83 1.00 1	
	MOL 243 64.3 0 0		338 6.7	35.5		
	Return to continue, q to end listing q					
	SUE SZ hdist:	107.1	coda:	157.0	mc = 2.8	Location just made
	SUE SZ hdist:	107.1	amp:	1243.7 T:	0.5 ml = 3.4	
	OSG SZ hdist:	134.8	coda:	78.0	mc = 2.1	
	EGD SZ hdist:	190.6	coda:	169.0	mc = 3.0	
	MOL SZ hdist:	243.5	coda:	248.0	mc = 3.5	
	MOL SN hdist:	243.5	amp:	684.7 T:	0.4 ml = 3.5	
	LHM SN hdist:	297.4	amp:	87.0 T:	0.2 ml = 2.8	
	LHM SE hdist:	297.4	amp:	80.0 T:	0.2 ml = 2.8	
	KMY SZ hdist:	296.4	coda:	131.0	mc = 2.8	
	KMY SN hdist:	296.4	amp:	354.2 T:	0.2 ml = 3.4	
	BLS5 SZ hdist:	306.4	coda:	230.0	mc = 3.4	
	BLS5 SZ hdist:	306.4	amp:	481.2 T:	0.2 ml = 3.5	
	KONO BN hdist:	414.3	amp:	79.2 T:	0.2 ml = 3.0	
	NSS SN hdist:	540.2	coda:	288.0	mc = 3.9	
	RSK SZ hdist:	167.7	coda:	204.0	mc = 3.2	
	HWA SZ hdist:	166.7	coda:	154.0	mc = 2.9	
	HWA SZ hdist:	166.7	amp:	1660.5 T:	0.7 ml = 3.7	
	FOO SZ hdist:	95.1	coda:	147.0	mc = 2.7	
	FOO SZ hdist:	95.1	amp:	1481.9 T:	0.3 ml = 3.4	
	1996 625 0337 31.1 L 61.687 3.283 15.0 TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO					
	OLD: 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3LTES 3.0CTES 3.2LNAO					
#	2 25 Jun 1996 03:37 31	L	61.689	3.259 15.0	N 3.0 3.3LTES	35 ? 1

The most important output values are explained. Note that the location made currently is slightly different from the location in the S-file. The location in the S-file will remain until updated with command 'u'.

#### Update S-file

```
# 2 25 Jun 1996 03:37 31 L 61.687 3.283 15.0 2.0 3.3LTES 31 ? u
Give operator code, max 4 characters
jh

date hrmm sec lat long depth no m rms damp erln erlt erdp
96 625 337 31.04 6141.39N 3 15.7E 15.0 82 3 1.99 0.000 89.8 35.9 65.2
stn dist azm ain w phas calcpchs hrmm tsec t-obs t-cal res wt di
FOO 95 95.4 92.7 0 P PG 337 46.1 15.08 15.08 0.00 1.00 1
FOO 95 95.4 92.7 0 S SG 337 56.0 24.97 26.24 -1.27 1.00 2
.
.
BLS5 SZ hdist: 307.4 coda: 230.0 mc = 3.4
BLS5 SZ hdist: 307.4 amp: 481.2 T: 0.2 ml = 3.5
KONO BN hdist: 414.3 amp: 79.2 T: 0.2 ml = 3.0
NSS SN hdist: 541.2 coda: 288.0 mc = 3.9
1996 625 0337 31.0 L 61.690 3.261 15.0 TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO
OLD: 625 0337 31.1 L 61.687 3.283 15.0 TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO
```

You are now about to overwrite the current event in the database. with the solution just shown

```

The catalog is not updated !!!!!
Sure you want to update, (y/n) ?
Y
# 2 25 Jun 1996 03:37 31 L 61.690 3.261 15.0 2.0 3.3LTES 31 ?

```

The old location and residuals in S-file have now been overwritten.

## 6.2 Locate a distant event using phases in S-file

Select the distant event in EEV. Use command 'l' and the result is

```

# 1 3 Jun 1996 19:55 20 D 45.736 154.919 1.0 N 2.2 5.6BPDE 15 ? l

date hrnm sec lat long depth no m rms damp erln erlt erdp
96 6 3 1955 20.07 4544.24N 154 54.9E 0.2 14 3 2.15 0.000999.9999.9999.9
stn dist azm ain w phas calcphs hrnm tsec t-obs t-cal res wt di
KBS 5966 351.7 22.5 0 P P 20 4 40.6 560.56 562.55 -1.99 1.00 26
KBS 5966 351.7 0 IAMs_20 2026 45.9 1885.8
TRO 6725 343.8 20.9 0 P P 20 5 32.5 612.43 610.95 1.48 1.00 20
LOF 6981 344.8 20.4 0 P C P 20 5 46.7 626.61 626.55 0.06 1.00 8
JNW 6993 354.0 20.3 0 P P 20 5 49.5 629.43 627.23 2.20 1.00 30
JMI 7007 354.0 0 20 8 27.3 787.3
JMI 7007 354.0 0 2014 41.6 1161.5
JMI 7007 354.0 0 2021 25.5 1565.4
MOL 7660 344.5 19.0 0 P P 20 6 25.6 665.56 666.02 -0.46 1.00 0
FOO 7811 345.2 18.6 0 P P 20 6 36.0 675.92 674.39 1.53 1.00 1
FOO 7811 345.2 0 IAmb 20 6 36.9 676.8
HYA 7833 344.5 18.6 0 P P 20 6 36.9 676.84 675.58 1.26 1.00 1
SUE 7873 345.2 18.5 0 P C P 20 6 39.1 679.00 677.78 1.22 1.00 1
KONO 7911 342.2 18.4 0 P C P 20 6 40.7 680.65 679.96 0.69 1.00 3
ASK 7924 344.7 18.4 0 P P 20 6 37.2 677.17 680.57 -3.40 1.00 2
BER 7931 344.6 18.4 0 P P 20 6 37.4 677.36 680.97 -3.61 1.00 2
EGD 7945 344.6 18.4 0 P P 20 6 38.4 678.35 681.72 -3.37 1.00 2
ODD1 7952 343.8 18.3 0 P P 20 6 45.6 685.50 682.24 3.26 1.00 2
Return to continue, q to end listing
BLS5 8006 343.7 18.2 0 P P 20 6 46.3 686.26 685.15 1.11 1.00 2
BLS5 8006 343.7 0 IAmb 20 6 48.0 688.0

KBS LZ dist: 5966.0 amp: 1454.7 T: 18.0 Ms = 5.1
BLS5 SZ dist: 8006.0 amp: 94.2 T: 0.9 mb = 5.9
FOO SZ dist: 7811.0 amp: 213.1 T: 1.1 mb = 6.2
1996 6 3 1955 20.1 D 45.737 154.914 0.2 TES 15 2.2 5.1sTES 6.1bTES 5.6BPDE
OLD: 6 3 1955 20.2 D 45.736 154.919 1.0 TES 15 2.2 5.6BPDE

```

The explanation is the same as for the local event above. However the magnitudes calculated are now Ms and mb and the distances are much larger. The model used for location is the global IASP91 model.

## 7 Pick phases

### 7.1 Delete all old phases

Before picking phases, for the purpose of this tutorial, all the phases for the event should be deleted. Select the local event. The phases can be deleted with the editor or with an EEV command. The EEV command is 'dels', see example below, where all phases have been deleted.

```

1996 6 Reading events from base TEST_ 3
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRV 12 ?
# 2 25 Jun 1996 3:37 31 L 61.690 3.261 15.0 2.0 3.3LTES 31 ? dels
Give line to delete or keep, terminate with 0
1: Lines with P-phase Not delete
2: Lines with S-phase Not delete
3: Lines with SPEC-phase Not delete

```

```

4: Lines with IAML-phase      Not delete
5: Lines with IASP-AMP phase  Not delete
6: Lines with any phase       Not delete
6
Give line to delete or keep, terminate with 0
1: Lines with P-phase         Not delete
2: Lines with S-phase         Not delete
3: Lines with SPEC-phase     Not delete
4: Lines with IAML-phase     Not delete
5: Lines with IASP-AMP phase  Not delete
6: Lines with any phase       Delete
0
1996  625  337 31.0 L  61.690   3.261 15.0  TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO1
Give operator code, max 4 characters
jh

Number of events in input file          1
Number of deleted lines                  68
Output file name is dels.out
#   2 25 Jun 1996  3:37 31  L  61.690   3.261 15.0   2.0 3.3LTES   31  ?

```

All phase lines have now been deleted, see content of S-file below

```

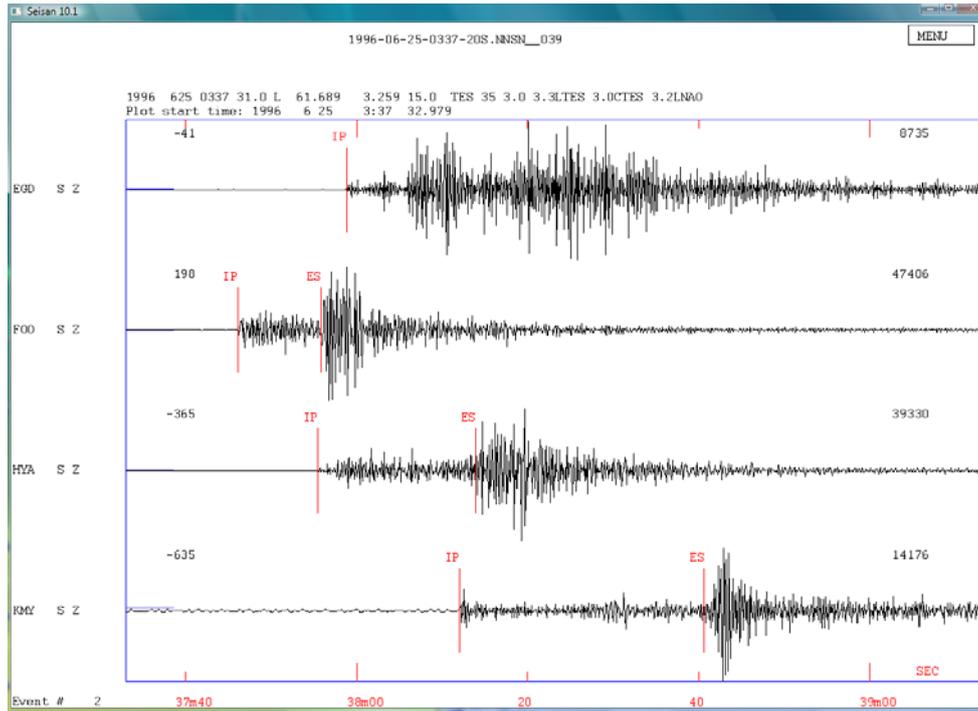
1996  625  337 31.0 L  61.690   3.261 15.0  TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO1
GAP=153      21.23      35.9      89.8 65.2 -0.6139E+03  0.8616E+03  0.3554E+00E
1996  625  337 31.9 L
1996-06-25-0337-20S.NNSN__039
327.2      62.0      -11.2      0
ACTION:DPH 14-02-12 16:57 OP:jh  STATUS:          ID:19960625033731  I
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO AIN AR TRES W  DIS CAZ7

```

The 'ACTION' line now indicate DPH, delete phases, by operator (OP:jh).

## 7.2 Pick new phases

In order to make it simple, plot only the Z-traces for 4 stations (figure below). In order to pick the P-phase, move the cursor to P and press '1' and the phase appear on the plot. The phase is indicated with IP, where the 'I' indicates impulsive. Similarly pick S by moving the cursor to the S and press '8' and the S-reading appear. Normally, S-phases should be read on the horizontal components, if available. Here it is done on the Z-components for the simplicity of learning how to do it. For picking other phases, see later.



From the plot, phases have now been read for P and S for 3 stations and for P only for one station (EGD). Quit plot with 'q' and the S-file now has the readings. List the S-file with 't':

```
# 2 25 Jun 1996 3:37 31 L 61.690 3.261 15.0 2.0 3.3LTES 31 ? t
File name: C:\Seismo\REA\TEST_\1996\06\25-0337-31L.S199606
1996 625 337 31.0 L 61.690 3.261 15.0 TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO1
GAP=153 21.23 35.9 89.8 65.2 -0.6139E+03 0.8616E+03 0.3554E+00E
1996 625 337 31.9 L BER 3.1WBER 1
1996-06-25-0337-20S.NNSN_039 6
327.2 62.0 -11.2 0 3
ACTION:DPH 14-02-12 16:57 OP:jh STATUS: ID:19960625033731 I
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO AIN AR TRES W DIS CAZ7
EGD SZ IP 337 58.55
HYA SZ IP 337 55.38
HYA SZ ES 338 14.40
FOO SZ IP 337 46.03
FOO SZ ES 337 56.09
KMY SZ IP 338 12.02
KMY SZ ES 338 41.42
```

### 7.3 Locate event

The event can now be located with command 'l'

```
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? l
date hrmm sec lat long depth no m rms damp erln erlt erdp
96 625 337 31.48 6135.62N 3 23.0E 4.9 7 3 0.31 0.000 12.0 9.0 6.7
stn dist azm ain w phas calcphs hrmm tsec t-obs t-cal res wt di
FOO 88 89.0 93.2 0 P PG 337 46.0 14.55 14.25 0.31 1.00 11
FOO 88 89.0 93.2 0 S SG 337 56.1 24.61 24.79 -0.18 1.00 23
HYA 157 106.4 50.4 0 P PN4 337 55.4 23.90 24.48 -0.58 1.00 10
HYA 157 106.4 50.4 0 S SN4 338 14.4 42.92 42.59 0.33 1.00 23
EGD 178 145.1 50.4 0 P PN4 337 58.6 27.07 27.05 0.02 1.00 4
KMY 285 158.0 50.4 0 P PN4 338 12.0 40.54 40.29 0.26 1.00 8
KMY 285 158.0 50.4 0 S SN4 338 41.4 69.94 70.10 -0.16 1.00 22
HYA SZ gdist: 125.3 mom: 14.4 mw = 3.5
1996 625 0337 31.5 L 61.594 3.383 4.9 TES 4 0.3 3.5WTES 3.2LNAO
OLD: 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3LTES 3.0CTES 3.2LNAO
```

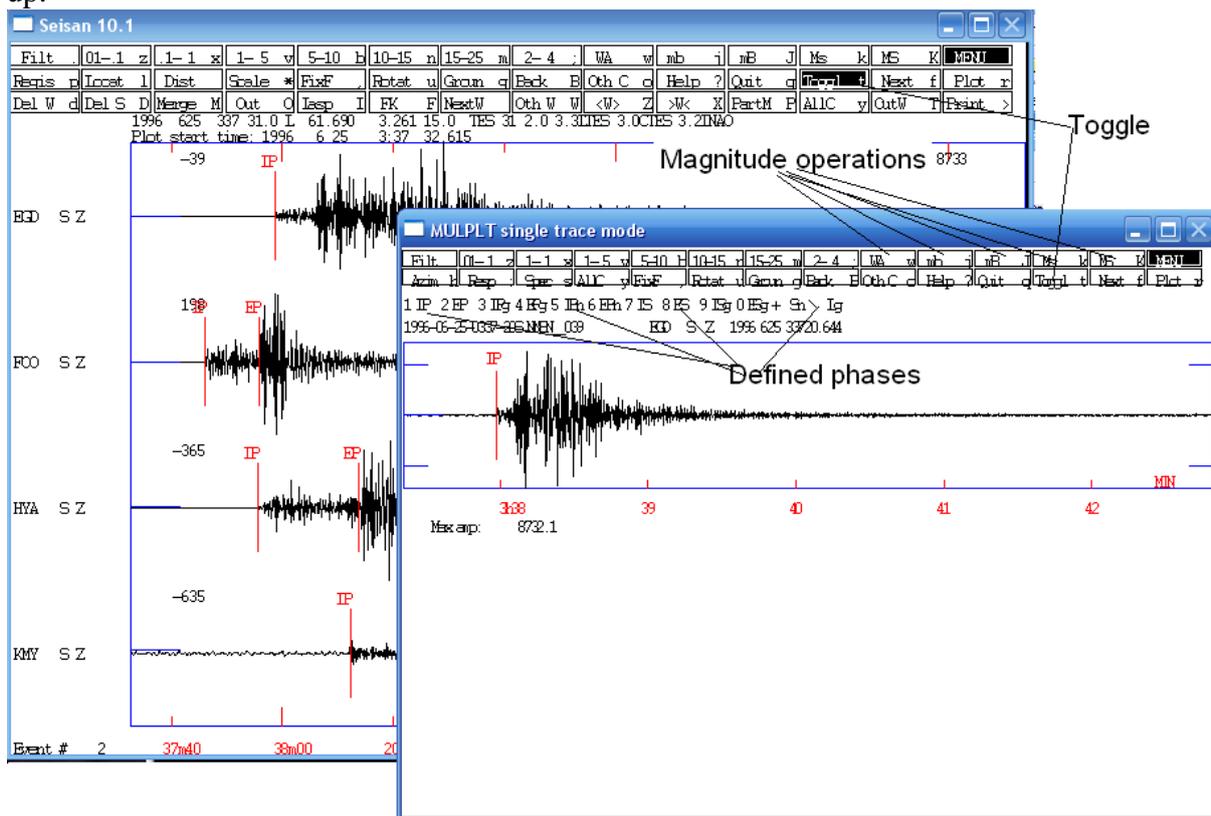
Notice that the location has changed about 11 km due to using fewer stations. The magnitudes 3.3L<sub>TES</sub> 3.0C<sub>TES</sub> from agency TES (the default set up with the test data) have also disappeared since no amplitude or coda lengths were read, see later. The magnitude 3.2L<sub>NAO</sub> is still there. This is a magnitude from a different agency (NAO) and since it is written in 3. magnitude position, it will not be deleted. This is a way for SEISAN to keep a magnitude from other agencies for comparison.

## 7.4 Picking phases with more accuracy

Picking phases with using multi-trace screen is often not very accurate since it is difficult to zoom on several traces at the same time. So phases are mostly picked in single trace mode or three-component mode (see 5.5), where it is also easy to pick S on horizontal components. The other option is to use scrolling with the arrow keys to continue to use multi trace mode, see 5.3. In all cases, it might also be an advantage to amplify the amplitude with the vertical arrows, see 5.2.

### 7.4.1 Single trace mode

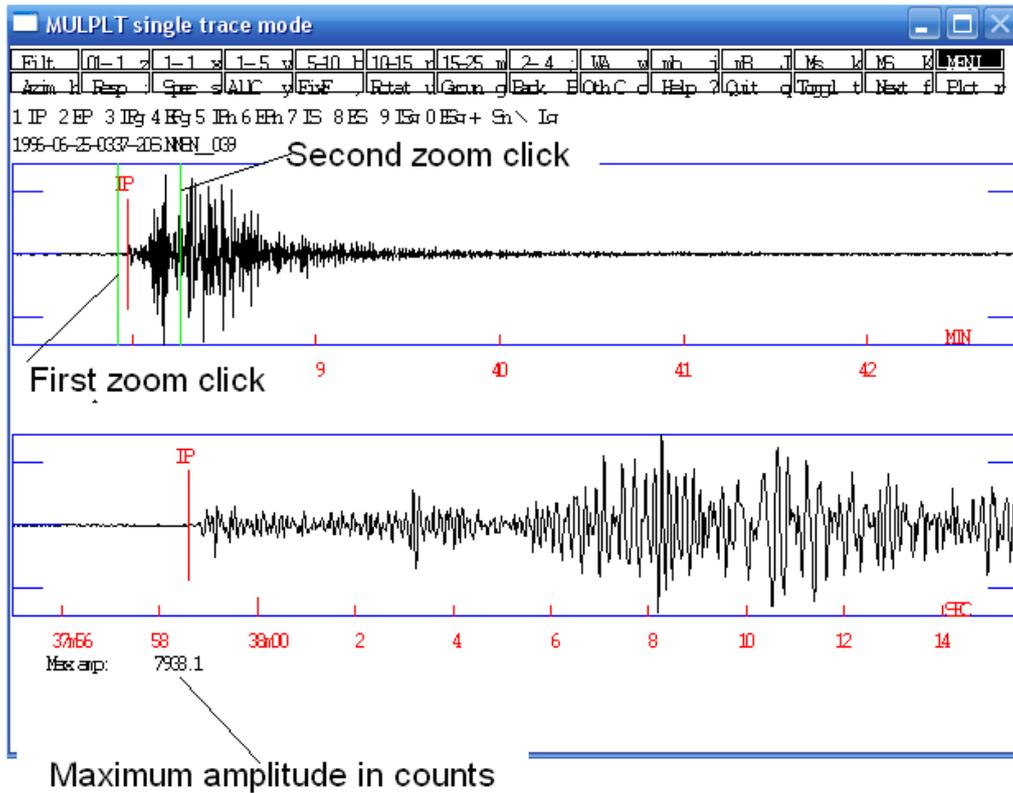
From the multi-trace mode, press ‘Togl’ (or ‘t’) on the menu and a single trace window comes up.



This window has different options in the menu as compared to the multi-trace window and is meant to be used for operations taking place with a single trace. The phases defined on the keyboard are shown (all also defined in multi-trace mode). Some magnitude operations are also indicated, see 8. To go back to multi-trace mode, press Togl again.

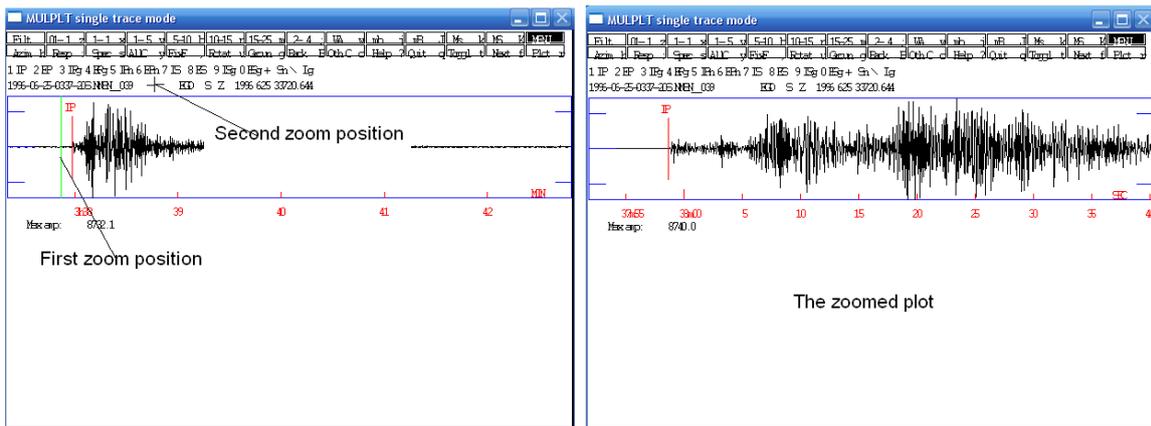
## 7.4.2 Zoom in single-trace mode

Zoom can be done in 2 ways. The first method is to zoom on the top trace and zoomed signal are shown on the bottom trace. The zoom clicks are done *inside* the top plot:



To un-zoom or re-plot the top trace again, pres 'Plot' or 'r' on keyboard.

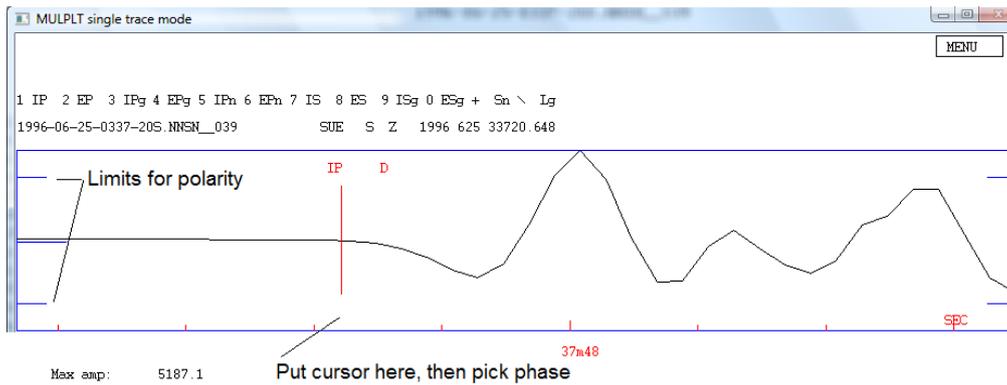
The second method is to zoom on the top trace only. The first zoom click is inside frame with the plot and the second is *outside*:



Phases can be read on all plots in single-trace mode, however if a lower plot is shown, readings can only be done there. On the top trace several zooms can be done until the desired resolution is obtained.

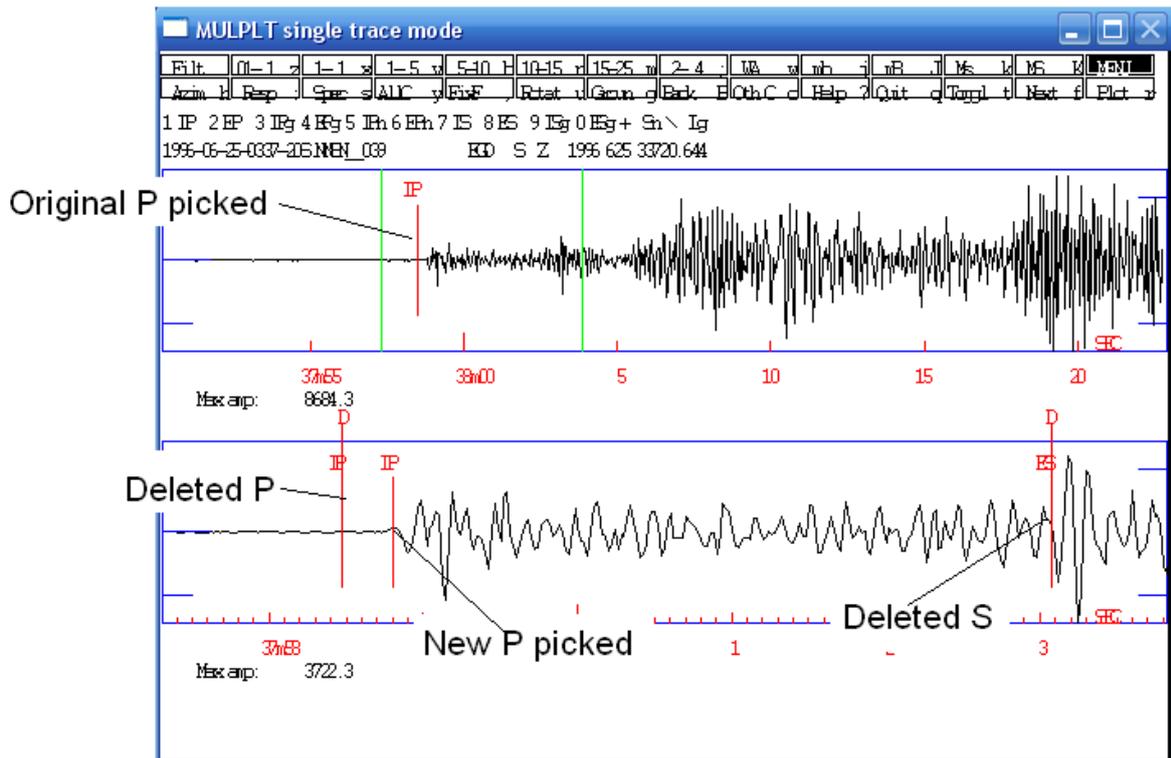
### 7.4.3 Pick polarity in single trace mode

Polarity can be picked at the same time as a phase is picked. Polarity can be picked in multi-trace and single-trace mode but is simplest in single trace mode. Below is a zoomed signal in single-trace mode so the polarity is clearly seen. For the polarity to be picked, the cursor must be above or below the “Limits for polarity” marker. Put cursor as indicated below, press ‘1’ and the result is as shown. If there is a reading from before without polarity, just repick the same phase.



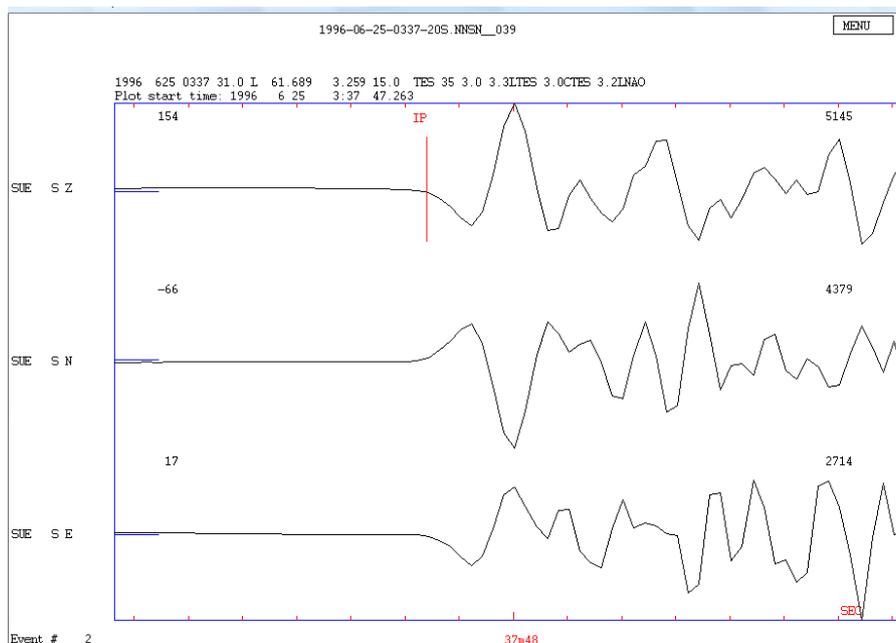
### 7.4.4 Deleting and re-picking phases

A phase can be re-picked without deleting the old pick, the old phase will automatically be deleted when the same phase is re-picked on the same channel, see P-phase below. A phase can also be deleted by putting the cursor near the phase and pressing ‘d’ on keyboard as illustrated with the S-phase below.

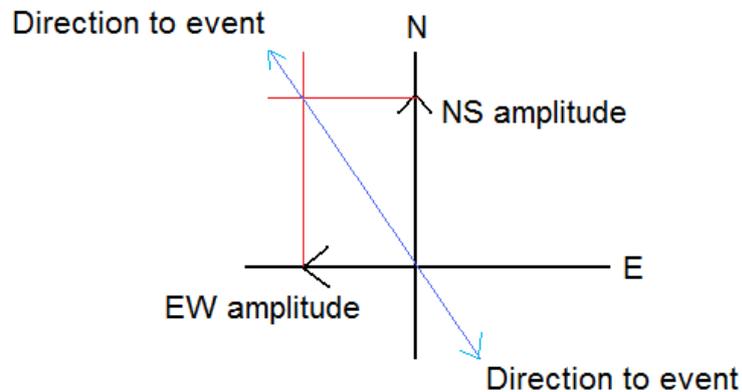


## 7.5 Locating an event with one station, three component method

It is sometimes useful to get a location with only one station. This requires good three component data where the P-waves of the 3 components correlate well. Plot the 3 SP components of the station SUE for event 2:

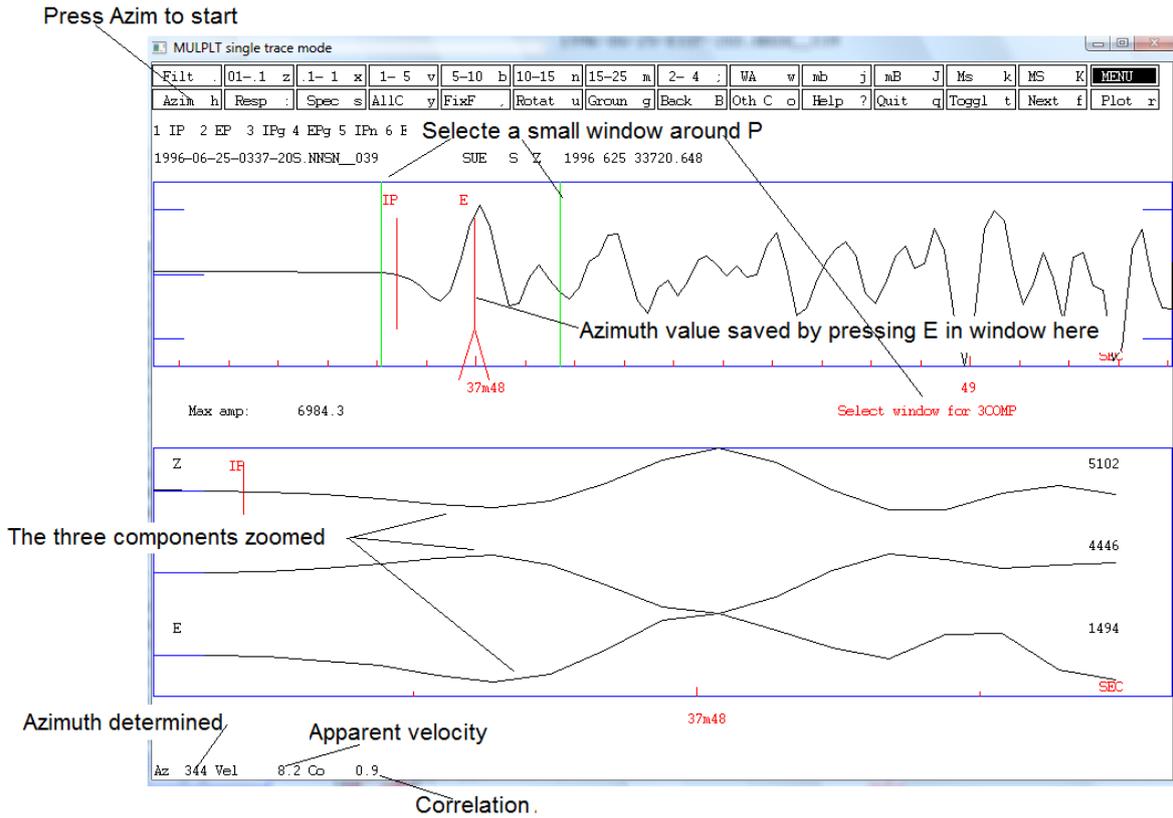


You can see that the P-phases on the 3 components look similar. The NS amplitude is positive and the EW amplitude negative, of similar amplitude as the NS so the direction to the event from the station is either between 90 and 180 degrees or 270 and 360 degrees:



From the polarity of the Z it is seen that the direction to the event is NW. With the direction to the event and the P and S-time, the location can be calculated, however the depth will be fixed. The azimuth from the station to the event (normally called back-azimuth but here we will use azimuth for simplicity) can be determined in single trace mode by correlating the 3 traces.

- Select the local event.
- Plot station SUE in single trace mode.
- Zoom on top trace to see the P clearly.
- Press Azim and then select a small window around the P.
- A plot will appear and it shows the 3 components and the results of the correlation.
- If acceptable (correlation must be positive and as large as possible), press 'e' on top trace and the value are save as an E-phase.



Traces are not always so nice, so the procedure might have to be repeated a few times to get a good result. Many times the signal must also be filtered to get good results and a shorter window used. Press the filter before Azim in that case. The S-file now has the added line:

```
SUE SZ E          337 48.00          343.7  8.2
```

where the result has been stored. Locate the event:

date	hrmn	sec	lat	long	depth	no	m	rms	damp	erln	erlt	erdp	
96 625	337	31.21	6141.93N	3 17.3E	15.0	83	3	1.95	0.000	89.0	35.5	65.0	
stn	dist	azm	ain	w	phas	calcp	hrmn	tsec	t-obs	t-cal	res	wt	di
FOO	94	96.1	92.8	0	P	PG	337	46.1	14.91	14.87	0.04	1.00	1
FOO	94	96.1	92.8	0	S	SG	337	56.0	24.80	25.88	-1.08	1.00	2
SUE	106	131.6	92.3	0	P	PG	337	47.8	16.63	16.79	-0.16	1.00	2
SUE	106	131.6	92.3	0	S	SG	337	58.9	27.74	29.21	-1.47	1.00	3
SUE	106	131.6					337	48.0		16.8			
SUE	106	131.6			AZ				343.7	312.9	30.79	0.20	1

Azimuth phase

Azimuth observation

Residual

and it is seen the 'error' in the azimuth is 30 degrees, a bit large. The event can now be located with only SUE (removing all other phases in S-file) and we get

date	hrmn	sec	lat	long	depth	no	m	rms	damp	erln	erlt	erdp	
96 625	337	32.84	6152.25N	4 15.4E	15.0	3	2	0.00	0.000	5.4	3.7	0.0	
stn	dist	azm	ain	w	phas	calcp	hrmn	tsec	t-obs	t-cal	res	wt	di
SUE	95	163.3	92.8	0	P	PG	337	47.8	15.00	15.01	-0.00	1.00	25
SUE	95	163.3	92.8	0	S	SG	337	58.9	26.11	26.11	0.00	1.00	25
SUE	95	163.3			AZ				343.7	343.7	-0.01	0.20	50
SUE	95	163.3					337	48.0		15.2			
SUE	95	163.3			AML		337	59.3		26.5			

```

SUE SZ hdist:      95.8   coda:      150.0           mc =   2.8
SUE SZ hdist:      95.8   amp:       1243.7 T:   0.5     ml =   3.3
1996 625 0337 32.8 L 61.871  4.257 15.0  TES  1 0.0 3.3LTES 2.8CTES 3.2LNAO
OLD:  625 0337 31.2 L 61.699  3.289 15.0  TES 31 1.9 3.3LTES 3.0CTES 3.2LNAO

```

And it is seen that the location has changed substantially. The exact change in km is given in output file `print.out`. There are many sources of error in determining the azimuth: bad s/n, wrong sensor orientation and different gain of the 3 components.

## 8 Magnitude

Magnitudes are usually calculated using maximum amplitudes on the Z-channels although amplitude for MI, by definition should be read on the horizontal components. However the practice is mostly to read on vertical channels for MI. Magnitudes can also be calculated from the coda length if no response function is available or the spectrum of the P and S waves. For all amplitude bases magnitudes, the amplitudes are read on a trace which has been corrected for the instrument response and then simulating a classical instrument. Response functions for the channels used must therefore be present, usually in the CAL directory. For the two test events, the following response files are available:

```

TRO__S__Z.1993-08-06-1200
KONO_BV_Z.1991-06-24-1800
KONO_L__Z.1991-06-24-1800
HYA__S__Z.1994-02-09-1200

```

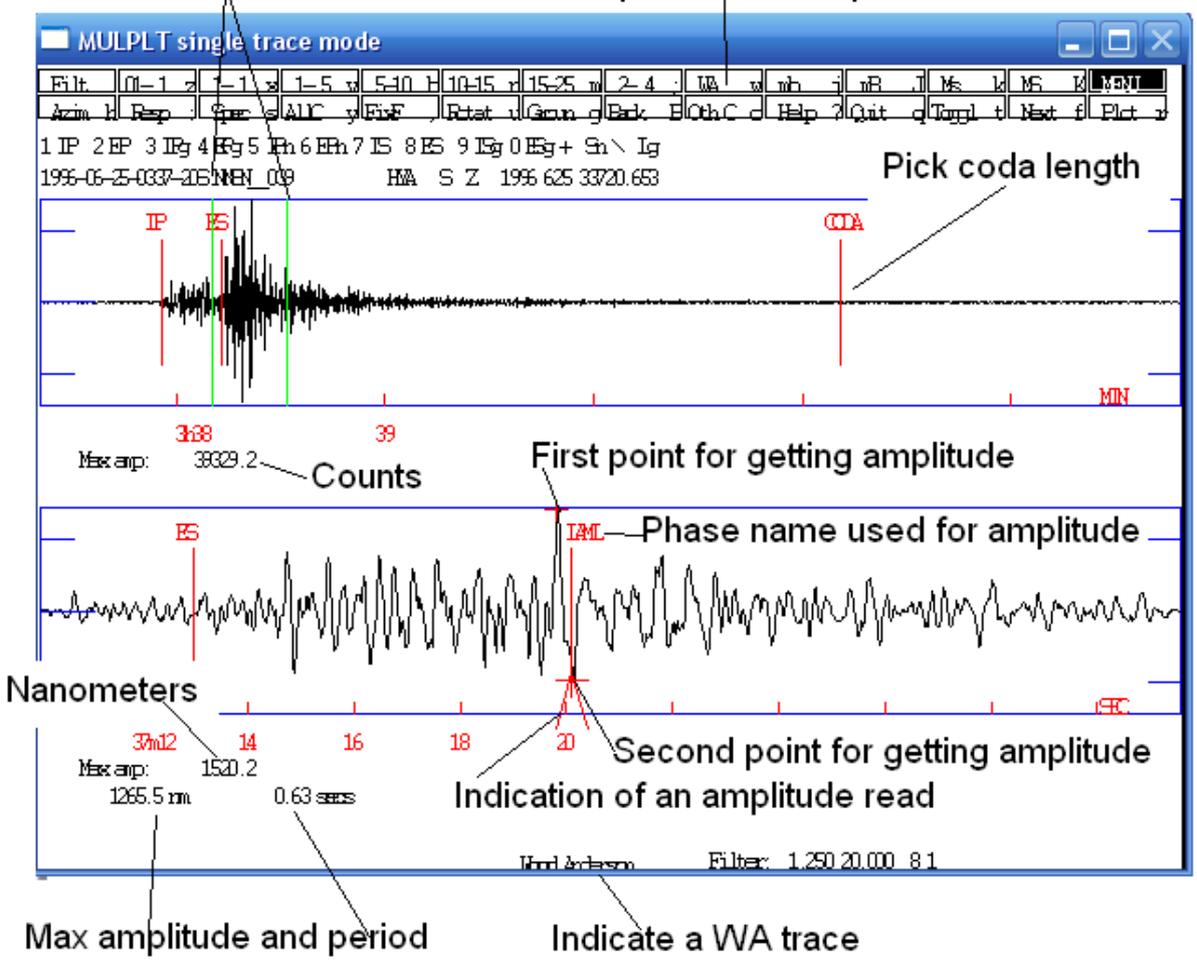
The first 5 characters is the station, the following 4 the component and then follow the data from which the response is valid.

### 8.1 Local magnitude MI and coda magnitude Mc

The local magnitude is picked on a trace simulating the Wood-Anderson seismograph. Select station HYA in single trace mode. Pressing WA in menu and then selecting a window and the corrected trace (amplitudes in nm ground motion) will come up:

Window for picking amplitude

Request a WA response



The amplitude is then picked manually by moving the cursor to one extreme, press 'a' on keyboard, move to the opposite extreme, press 'a' on keyboard. The amplitude and period is then printed on the bottom of the plot and the phase IAML is indicated on the plot. The phase has an indication on the bottom (a hat) indicating that this phase has an amplitude associated. The max amplitude can also be measured automatically by only pressing 'A' with the cursor anywhere on the plot. If using automatic picking, check carefully that the automatic determination seems reasonable (automatic pick will be plotted). The coda length is picked by pressing 'c' on keyboard at the location where the event trace disappears into the noise. A coda label will appear on the plot when 'c' is pressed. Coda magnitude should only be used if there is no calibration available. The content of the S-file is now:

Coda length from P-time to end of event

STAT	SP	IPHASW	D	HRMM	SECON	CODA	AMPLIT	PERI	AZIMU	VELO	AIN	AR	TRES	W	DIS	CAZ?
FOO	SZ	IP		337	46.14											
FOO	SZ	EP		337	55.84											
KMY	SZ	IP		338	12.27											
KMY	SZ	EP		338	41.58											
EGD	SZ	IP		337	58.80											
HVA	SZ	IP		337	55.54	195										
HVA	SZ	ES		338	12.98											
HVA	SZ	IAML		338	19.84		1289.0	0.60								

Phase associated with amplitude      Amplitude      Period

and locating (using 'l') gives the following result:

```
# 2 25 Jun 1996 3:37 31 L 61.690 3.261 15.0 2.0 3.3LTES 31 ? 1

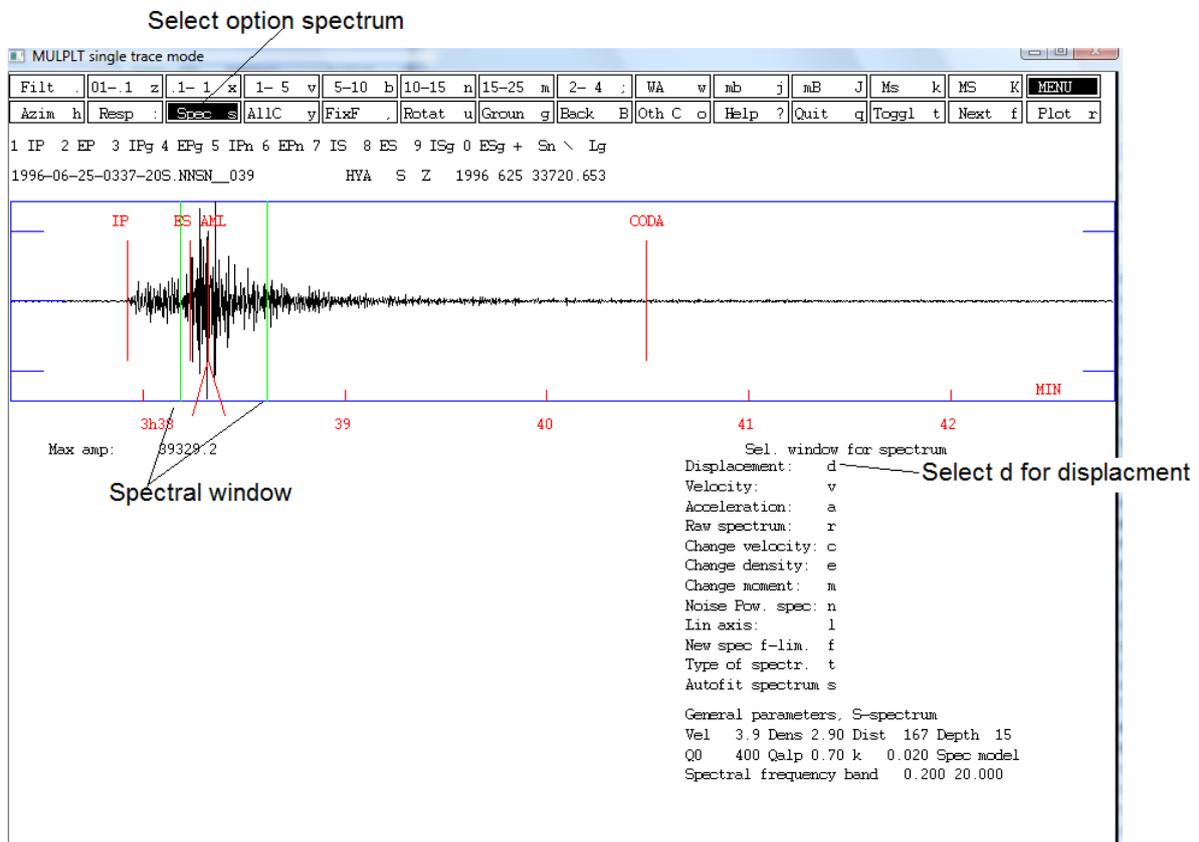
date hrmn sec lat long depth no m rms damp erln erlt erdp
96 625 337 31.98 6141.79N 3 23.1E 19.2 5 3 0.03 0.000 10.0 9.0 4.9
stn dist azm ain w phas calcphs hrmn tsec t-obs t-cal res wt di
FOO 89 96.4 97.1 0 P PG 337 46.1 14.16 14.16 0.00 1.00 27
FOO 89 96.4 0 P 337 55.8 23.9
HYA 161 110.3 55.1 0 P PN4 337 55.5 23.56 23.56 0.00 1.00 27
HYA 161 110.3 55.1 0 S SN4 338 13.0 41.00 41.00 0.00 1.00 26
HYA 161 110.3 0 IAML 338 19.8 47.9
EGD 187 147.1 55.1 0 P PN4 337 58.8 26.82 26.88 -0.05 1.00 7
KMY 295 158.9 0 P 338 41.6 69.6
KMY 295 158.9 55.1 0 P PN4 338 12.3 40.29 40.25 0.04 1.00 13

HYA SZ hdist: 162.1 coda: 195.0 mc = 3.1
HYA SZ hdist: 162.1 amp: 1289.0 T: 0.6 ml = 3.6
1996 625 0337 32.0 L 61.697 3.385 19.2 TES 4 0.0 3.6LTES 3.1CTES 3.2LNAO
OLD: 625 337 31.0 L 61.690 3.261 15.0 TES 31 2.0 3.3LTES 3.0CTES 3.2LNAO
```

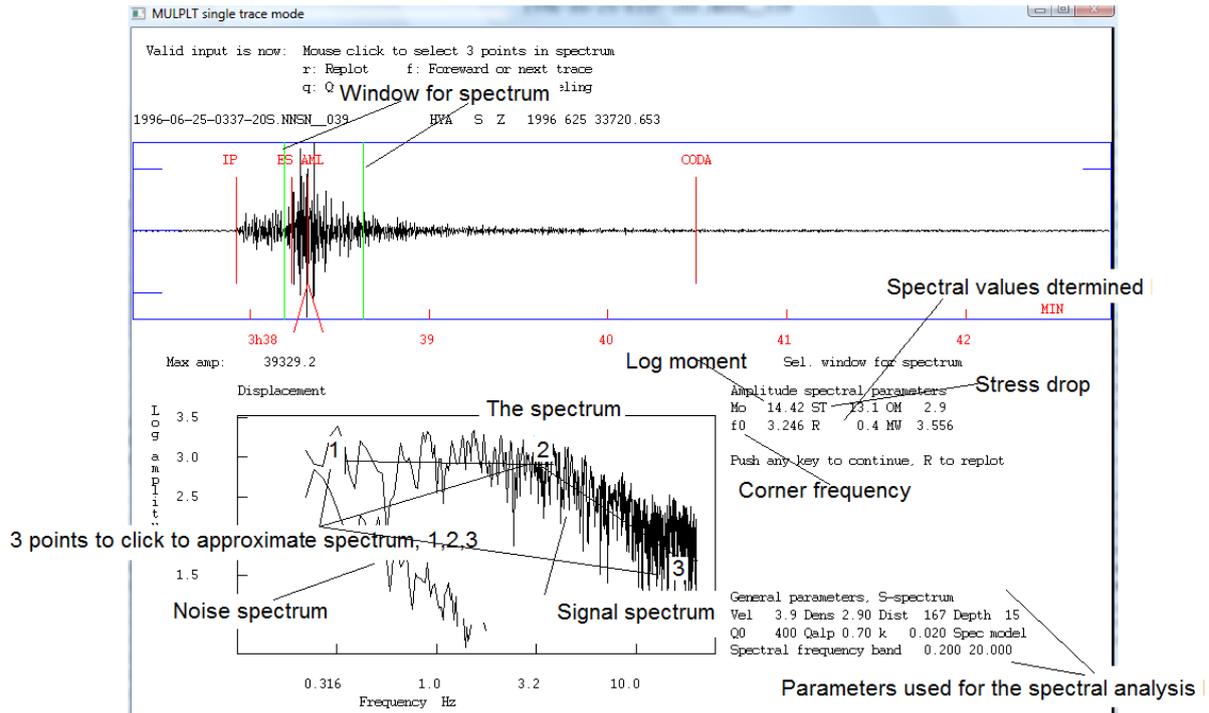
Ml and Mc are now calculated, for explanation of output, see section 6.1. If magnitudes are calculated for more than one station, the event magnitudes are the averages.

## 8.2 Spectral magnitude Mw for a local event

The spectral magnitude determined the spectral level of the S or P-wave spectrum, calculates the seismic moment from which the moment magnitude Mw is calculated. Select the local event and plot station HYA S Z in single trace mode. We will now make the displacement spectrum of the S-wave:



After pressing 'd', the following window comes up from where the spectral parameters can read manually:

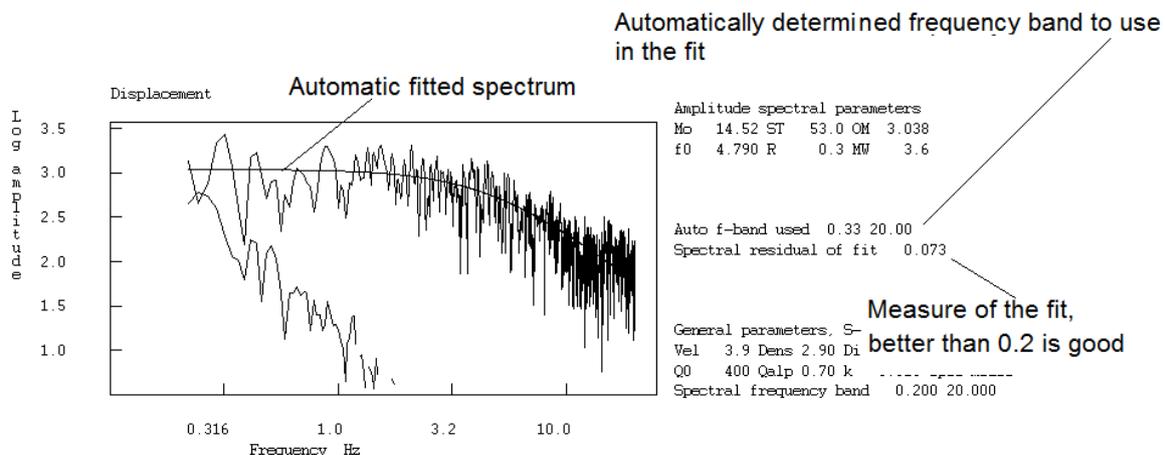


After pressing the 3 points for the spectrum, press 'f' and the spectral values determined are displayed. They are also now saved in the S-file as SPEC lines:

```
1996 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3LTES 3.0CTES 3.2LNAO1
SPEC HVA S Z MO 14.4 ST 13.1 OM 2.94 f0 3.25 R0.4446 AL 1.70 WI 25.7 MW 3.6 3
SPEC HVA S Z T 33811 K 0.020 GD 167 VS 3.90 DE 2.90 Q0400.0 QA 0.70 VS 3.90 3
```

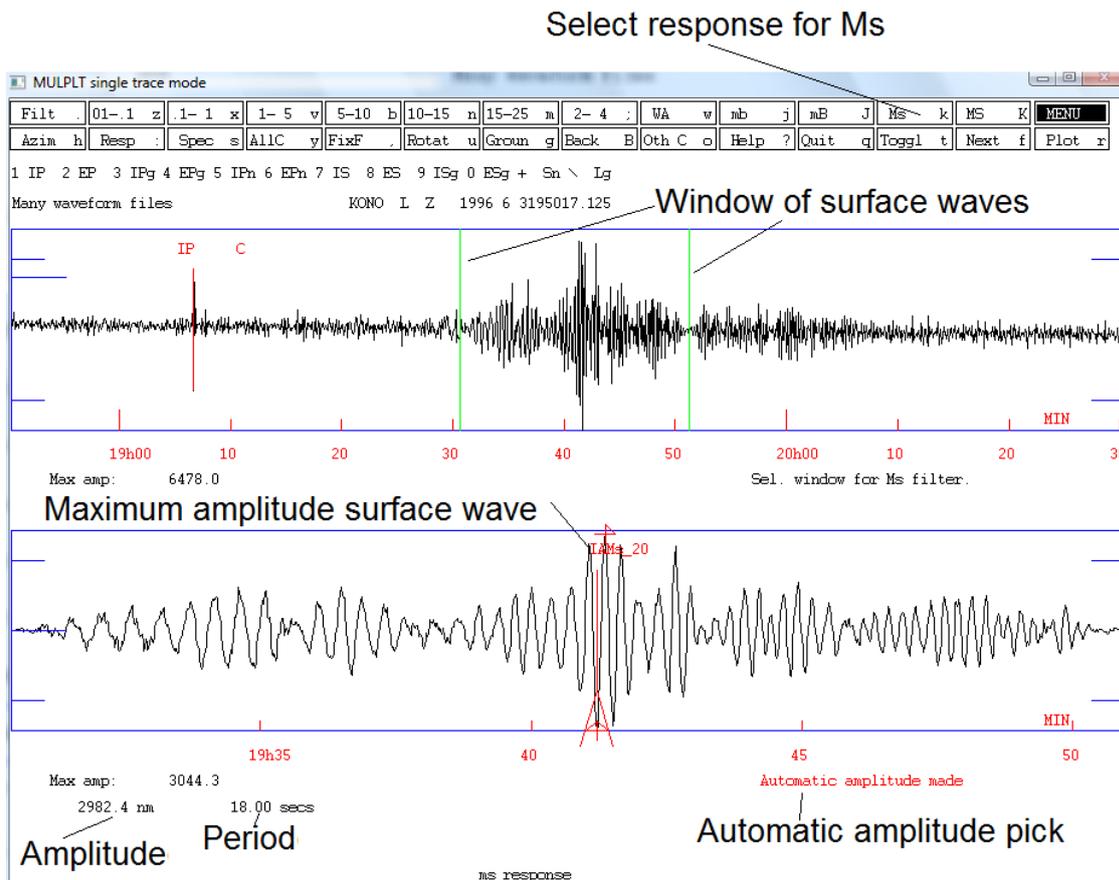
Spectral parameters used for the analysis are mostly found in file MULPLT.DEF in DAT.

The spectrum can also be fitted automatically by giving option Autofit spectrum ('s') instead of 'd' just before the spectrum comes up. This will often be more reliable than the manual fit but must be checked, particularly for correctness of the automatically selected frequency band used.



### 8.3 Pick amplitude for surface wave magnitude Ms

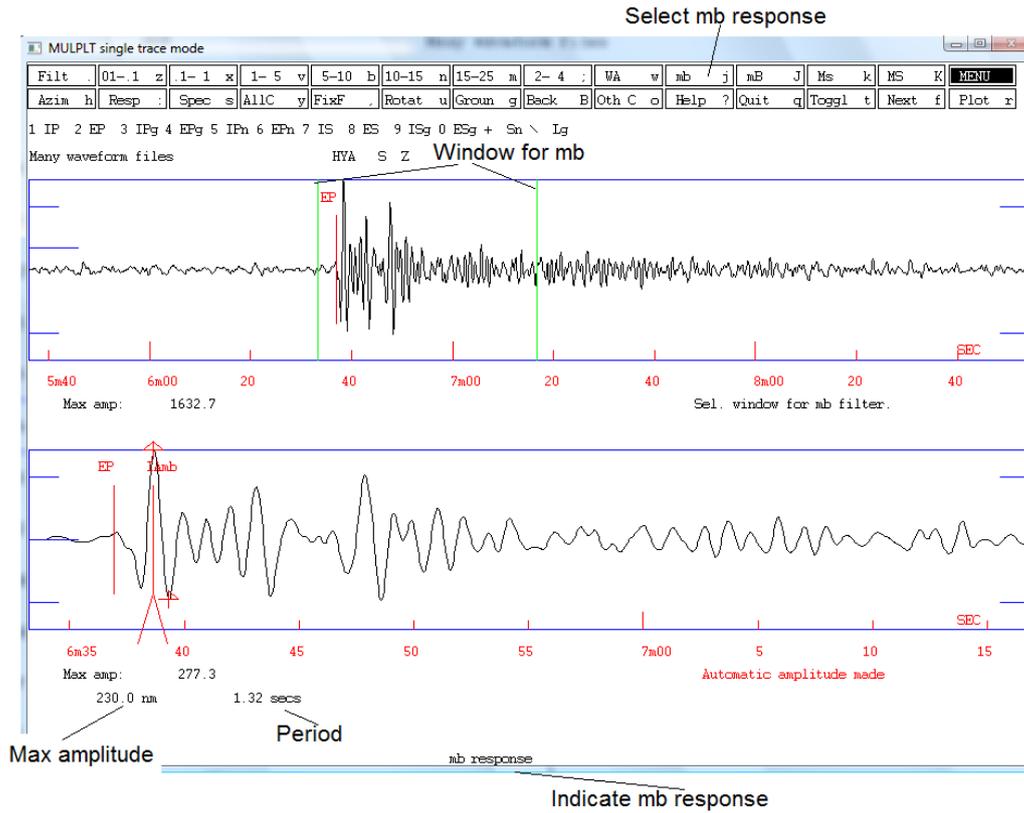
The amplitude for Ms magnitude is picked on a trace simulating the World Wide Standard long period seismograph. Ms is used for distant events and read in the surface wave train. The distance must be at least 20 degrees. Select station KONO in single trace mode for the first event. Pressing Ms in the menu and then selecting a window and the corrected trace (amplitudes in nm ground motion) will come up:



The period is supposed to be in the range 18-22 s, if not select another part of the surface wave train. The amplitude might not be the largest in the surface wave train, but usually it is.

### 8.4 Pick amplitude for body wave magnitude mb

The amplitude for mb magnitude is picked on a trace simulating the World Wide Standard short period seismograph. mb is used for distant events more than 20 degrees away and read on the P-wave. Both broadband and short-period records can be used. Select station HYA in single trace mode for the first event. Pressing mb in the menu and then selecting a window and the corrected trace (amplitudes in nm ground motion) will come up:

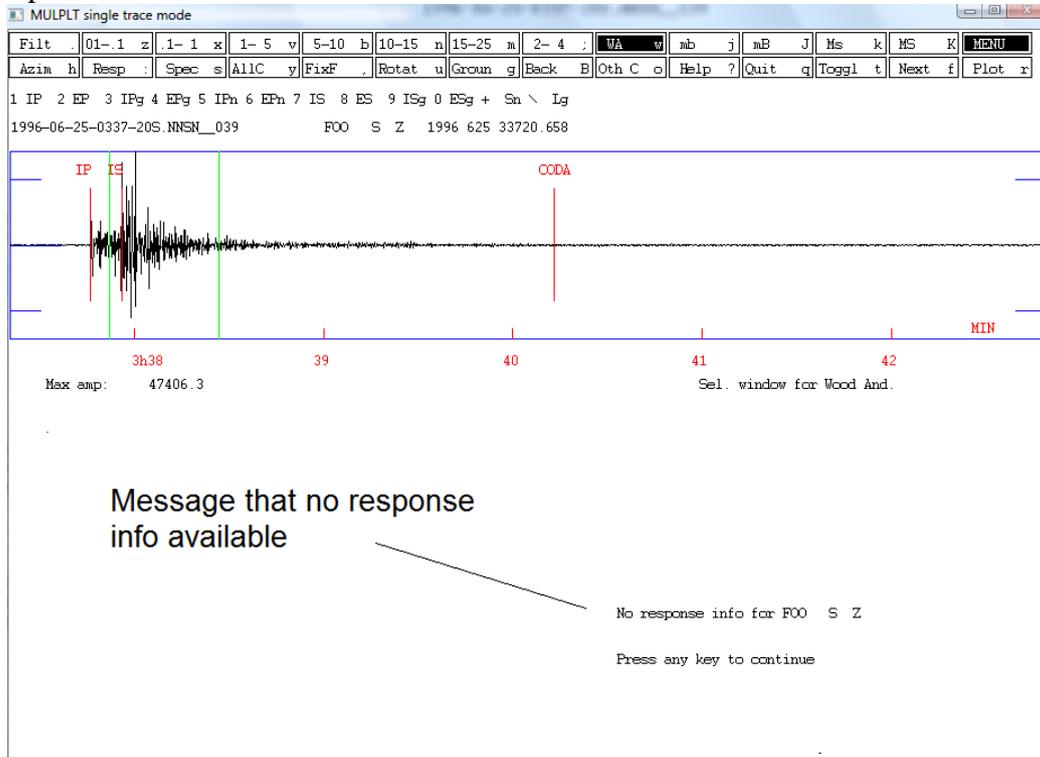


## 8.5 Amplitude for mB and MS

Both are used with distant events. The mB amplitude is picked in the P-wave train and the MS amplitude in the surface wave train. For MS, the maximum is always used irrespective of the period. The two amplitudes are picked with similar steps as amplitudes for Ml, mb and Ms. mB and MS are not so standard as mb and Ms but are considered more reliable since they do not depend on the use of old WWSSN filters.

## 8.6 What happens if no response file

Plot FOO S Z in single trace mode and try to make a reading for M1. The following response comes up:



So if the response file is not available, it is simply not possible to get an amplitude corrected reading (only in SEISAN version 10.1 and higher). This is also the case for any other amplitude used for magnitudes.

## 9 Putting in new waveform data

This section will show you how to put in your own data into SEISAN. It will be illustrated with the data already there and we will pretend it is new.

- Go to WOR directory: `wo`
- Make a directory under WOR called e.g. new: `mkdir new`
- Move the events to new: `move C:\seismo\wav\1996* new`
- Go to new directory: `cd new`

We are now pretending that one or several new events are present in directory named 'new' and they should now be processed in SEISAN. The first thing needed for this is to create S-files corresponding to the waveform files so that phase readings etc. can be stored. When working with new events there are 2 choices for how to organize them in a SEISAN database: if many events, it is best to store the S-files in a regular database as already illustrated with the TEST database. If few events or events scattered over several years, it is simpler to use a so-

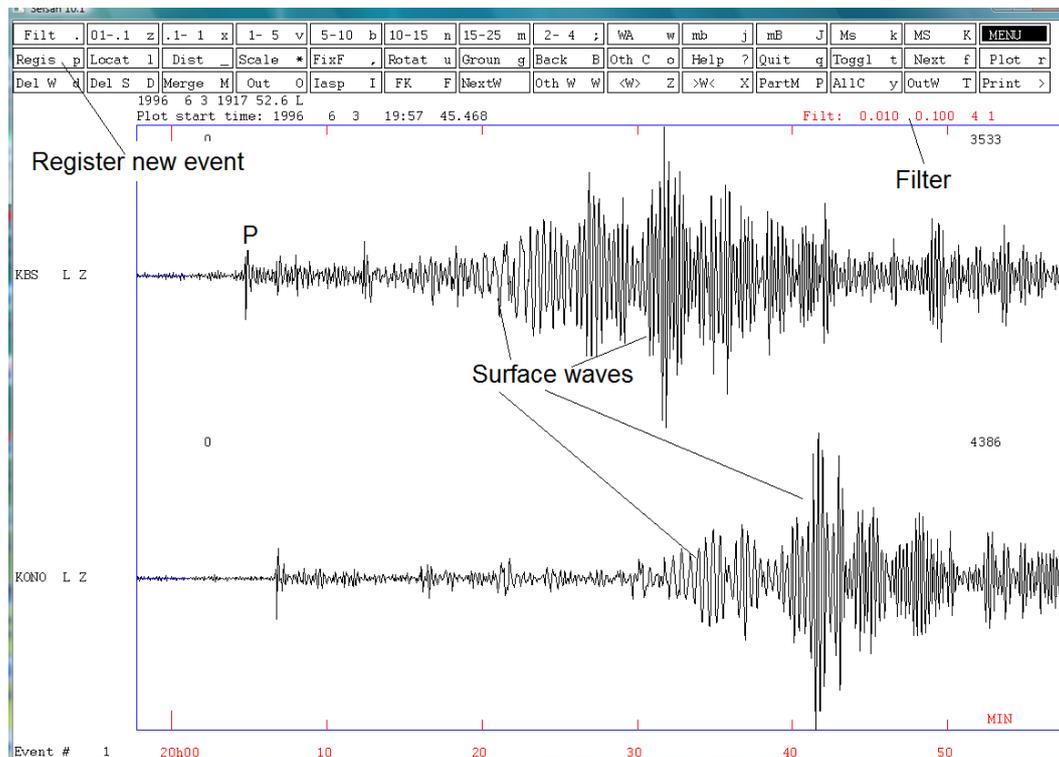
called “local” database meaning all S-files are in a single directory. Both cases will be illustrated.

## 9.1 Putting data in a local database, one event at a time

In the ‘new’ directory make a list of the ‘new’ waveform files with dirf. dirf make a file, `filenr.lis`, with the list of files also listed on the screen:

```
C:\seismo\WAV\new>dirf 1996*
# 1 1996-06-03-1917-52S.TEST__002
# 2 1996-06-03-2002-18S.TEST__012
# 3 1996-06-25-0337-20S.NNSN__039
```

Now plot the first event with MULPLT, see 5.7 how to do that. The idea is to inspect each event to see if it is an event (in this case we know it is), decide which kind of event (local, regional or distant) and create an entry into the database (an S-file) corresponding to each event (waveform file). Since it is a local database, there is no need for a REA structure, all S-files will end up in the working directory, here ‘new’.



The event has been filtered and zoomed (see 5.1) to better see the signals. Notice that you can tell from the low frequency surface waves and the long duration of the signal that this is a distant event. Now register the event by pressing ‘Regis’ (or ‘p’ key) and control goes back to the text window where three prompts are made (for type of event, database to store it in, and operator initials):

The S-file name to create in local directory

Event type given

Operator given

Data base given, is ','

Confirm

Waveform file copied to WAV

Next event will be plotted automatically

```

ENTER EVENT TYPE L, R OR D
Second, optional character for event ID (e.g. E)
Third optional character for model ID (e.g. J) D
Give operator code (max 4 char)
jh
Give 2-5 letter data base, ,, for local dir, return for default base
,,
S-file name: 03-1917-52D.S199606
GO AHEAD (Y/N)
y
copy 1996-06-03-1917-52S.TEST_002 C:\Seismo\WAV\1996-06-03-1917-52S.TEST_002

1 file(s) copied.
File transferred to WAV *****
File number 2
Read headers from files:
1996-06-03-2002-18S.TEST_012

```

An S-file has now been created in the local directory and the corresponding waveform file has been copied to WAV. The idea behind the copy is that if the user is inspecting a series of waveform files of which many might be false triggers, only the 'real' events are going to the WAV database and at the end all waveform files in the local directory can be deleted.

At the end of the registration process, the next event is plotted automatically. Register that one also as a distant event. The last waveform file is the local event, so register that as local (L or l) when prompted for event type. MULPLT then stops. A total of 3 waveform files events have been registered as events.

## 9.2 How to work with the newly registered events in a local database

There are now 3 S-files and the original waveform files in the 'new' directory:

```

Directory of C:\seismo\WOR\new

21.02.2014  18:54    <DIR>          .
21.02.2014  18:54    <DIR>          ..
21.02.2014  18:36                410 03-1917-52D.S199606
21.02.2014  18:54                410 03-2002-18D.S199606
18.02.2014  18:29                 51 168 1996-06-03-1917-52S.TEST_002
18.02.2014  18:29                356 128 1996-06-03-2002-18S.TEST_012
18.02.2014  18:29                 2 228 488 1996-06-25-0337-20S.NNSN_039
21.02.2014  18:54                410 25-0337-20L.S199606
21.02.2014  16:14                 239 filenr.lis
21.02.2014  18:54                 328 mulplt.out
                8 File(s)      2 637 581 bytes
                2 Dir(s)  175 247 822 848 bytes free

```

In order to access these events, simply with 'eev':

```

C:\seismo\WOR\new>eev

Local directory
Reading events from base ,, 3
# 1 3 Jun 1996 19:17 52 D ?

```

Since there is no database directory structure, EEV will work with all events (S-files) in the local directory so there is no need to give year and month. The waveform files can then be deleted from 'new' since they are now also in WAV.

## 9.2.1 Content of a newly registered S-file

The content of the file can be seen by either editing it ('e') or typing the file ('t'):

```

# 1 3 Jun 1996 19:17 52 D
File name: 03-1917-52D.S199606
1996 6 3 1917 52.6 D
ACTION:REG-14-02-21 18:36 OP:jh STATUS: ID:19960603191752
1996-06-03-1917-52S.TEST 002
STAT SP 1PHASW D HRMM SECON CODA AMPLIT PERI AZIMU UELO AIN AR TRES W DIS CAZ7
# 1 3 Jun 1996 19:17 52 D
  
```

Time of first sample in waveform file

Operator code

Action was to register

Time of registration

Name of waveform file associated with this S-file

Type the S-file

ID line

Header lines for phases

The S-file is now ready for reading phases.

## 9.2.2 Merging events

We now have new S-files in the local database but there are only 2 different events. This is because the first teleseismic event has two waveform files and each has been registered as a new event while it should only be one event (S-file). In EEV the events can be merged together. Position the cursor at the events you want to move another event into:

```

C:\seismo\WOR\new>eev
Local directory
Reading events from base ..
# 1 3 Jun 1996 19:17 52 D
# 2 3 Jun 1996 20: 2 19 D
Event # 1 appended to event # 2 Appended event still present
Do you want to delete appended event(y/n=return)
y
File deleted without backup copy
Deleted file 03-1917-52D.S199606
2099 12 Reading events from base ..
# 1 3 Jun 1996 20: 2 19 D
  
```

3 events

Append event 1 to event 2

There are now 2 events

## 9.3 Putting new data into a named SEISAN database

### 9.3.1 Making the database structure

The difference with the local database is that the S-files are in a hierarchical structure of directories, which is better than the local database for organising a large number of events. The TEST database is such a database. The first step is to create the structure. This is done with program MAKEREA. Note that databases in SEISAN are limited to 5 characters. Assuming the new database will be called NEWBA, here is a run of MAKEREA:

Name of data base

Data base made for all of 1996

```

C:\seismo\WOR\new>makerea
Give 1-5 letter base name, UPPER CASE
NEWBA
Give start time, year month, e.g. 198302
199601
Give end time, year month, e.g. 198303, blank for one month
199612
Create REA or WAU structure or BOTH
REA
Making directory C:\Seismo\REA\NEWBA
Making directory C:\Seismo\REA\NEWBA\LOG
Making directory C:\Seismo\REA\NEWBA\CAT
Making directory C:\Seismo\REA\NEWBA\1996
Making directory C:\Seismo\REA\NEWBA\1996\01
Making directory C:\Seismo\REA\NEWBA\1996\02
Making directory C:\Seismo\REA\NEWBA\1996\03
Making directory C:\Seismo\REA\NEWBA\1996\04
Making directory C:\Seismo\REA\NEWBA\1996\05
Making directory C:\Seismo\REA\NEWBA\1996\06
Making directory C:\Seismo\REA\NEWBA\1996\07
Making directory C:\Seismo\REA\NEWBA\1996\08
Making directory C:\Seismo\REA\NEWBA\1996\09
Making directory C:\Seismo\REA\NEWBA\1996\10
Making directory C:\Seismo\REA\NEWBA\1996\11
Making directory C:\Seismo\REA\NEWBA\1996\12
Making directory C:\Seismo\REA\DELET
Making directory C:\Seismo\REA\DELET\LOG
Making directory C:\Seismo\REA\DELET\CAT
Making directory C:\Seismo\REA\DELET\1996
Making directory C:\Seismo\REA\DELET\1996\01
Making directory C:\Seismo\REA\DELET\1996\02
Making directory C:\Seismo\REA\DELET\1996\03
Making directory C:\Seismo\REA\DELET\1996\04
Making directory C:\Seismo\REA\DELET\1996\05
Making directory C:\Seismo\REA\DELET\1996\06
Making directory C:\Seismo\REA\DELET\1996\07
Making directory C:\Seismo\REA\DELET\1996\08
Making directory C:\Seismo\REA\DELET\1996\09
Making directory C:\Seismo\REA\DELET\1996\10
Making directory C:\Seismo\REA\DELET\1996\11
Making directory C:\Seismo\REA\DELET\1996\12
C:\seismo\WOR\new>

```

Only make a REA structure

Directory with logs

Directory with catalogs

Also make structure for deleted events

The structure for putting S-files of the year 1996 is now in place. A similar structure can be made for waveform files. This is used if very many events are used so to avoid having a lot of files in WAV, the waveform files would then be in a WAV structure.

### 9.3.2 Putting in events in a named SEISAN database

The procedure is just like putting in events in a local database, (see 9.1), the only difference is that instead of using database name ‘,’ , the named database name (NEWBA) is used.

### 9.3.3 Registering many events with one command

In many cases you will get many waveform files which are already known to be events, there is no need to inspect each individually. All the S-files corresponding to the waveform files can then be made in one go with program AUTOREG. Assuming that the database NEWBA has been created (section 9.3.1) the procedure is, using the test data in C:\seismo\WOR\new:

- Got to ‘new’ directory
- Make a dirf of 19\* files
- Run the program autoreg

```

C:\seismo\WOR\new>dirf 19*
# 1 1996-06-03-1917-52S.TEST_002
# 2 1996-06-03-2002-18S.TEST_012
# 3 1996-06-25-0337-20S.NMSN_039

C:\seismo\WOR\new>autoreg
Event type for all events: Local: L (default)
                          Regional: R
                          Distant: D
Assume all events are local

Move (m) or copy (c) waveform files to WAU (enter=n) ?
Do not move events

1-5 letter base name, return for standard base, ,, for local base
NEWBA
Operator, max 4 chars
jh
1996-06-03-1917-52S.TEST_002
sfile: C:\Seismo\REA\NEWBA\1996\06\03-1917-52L.S199606
C:\Seismo\REA\NEWBA\1996\06\03-1917-52L.S199606
1996-06-03-2002-18S.TEST_012
sfile: C:\Seismo\REA\NEWBA\1996\06\03-2002-18L.S199606
C:\Seismo\REA\NEWBA\1996\06\03-2002-18L.S199606
1996-06-25-0337-20S.NMSN_039
sfile: C:\Seismo\REA\NEWBA\1996\06\25-0337-20L.S199606
C:\Seismo\REA\NEWBA\1996\06\25-0337-20L.S199606

C:\seismo\WOR\new>_

```

When using AUTOREG, all events must be given the same distance indicator (L, R or D). In our case there were both a local and a distant event, so the events types must be corrected manually using EEV:

```

C:\seismo\WOR\new>eev 199606 NEWBA
1996 6 Reading events from base NEWBA 3
Data base log file updated with a new data base
# 1 3 Jun 1996 19:17 52 L
Change event type to L,R or D ?
Second character for event ID (e.g. E or P)
Return for no change ?
d
New file C:\Seismo\REA\NEWBA\1996\06\03-1917-52D.S199606
Deleted file: C:\Seismo\REA\NEWBA\1996\06\03-1917-52L.S199606
1996 6 Reading events from base NEWBA 3
# 1 3 Jun 1996 19:17 52 D
# 2 3 Jun 1996 20: 2 18 L
Change event type to L,R or D ?
Second character for event ID (e.g. E or P)
Return for no change ?
d
New file C:\Seismo\REA\NEWBA\1996\06\03-2002-18D.S199606
Deleted file: C:\Seismo\REA\NEWBA\1996\06\03-2002-18L.S199606
1996 6 Reading events from base NEWBA 3
# 2 3 Jun 1996 20: 2 18 D

```

## 10 Taking out and putting in data in a SEISAN data S-file database

A SEISAN database is the S-files, either in a named database or a local database. There are tools for taking one or many events out of the database and putting them in again, either in the same database or another database somewhere else.

## 10.1 Taking out individual events with EEV

It is of course possible to copy directly from the directory where the S-file is. However, EEV can do it more easily. The command 'c' will start the copy process:

```

1996 6 Reading events from base TEST_ 2
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRU 12 ?
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? c
Copy event: Other data base, give 1-5 letter name
Local data base, type
Working directory in file eev.out: return

```

Copy the event to another named data base

Copy event

Copy event to a local data base in working directory

Copy event to a file called eev.out

The copy can be repeated so the eev.out file can contain many events. Next time EEV starts up, eev.out is deleted.

## 10.2 Taking out many events with COLLECT

If many S-files in a given time interval are to be extracted, the program COLLECT can be used. If selected events (like all the largest ones) are to be extracted out, the program SELECT can be used. Using COLLECT:

```

C:\seismo\wor>collect
Base name, .. for local directory, name of index file
or return for default base
NEWBA
Start time : 199606
End time, return for end of month:
Compact output file (Y/N=default)

1996 6 Reading events from base NEWBA 3
C:\Seismo\REA\NEWBA\1996\06\03-1917-52D.S199606
C:\Seismo\REA\NEWBA\1996\06\03-2002-18D.S199606
C:\Seismo\REA\NEWBA\1996\06\25-0337-20L.S199606
Output file
Output file is collect.out
Total number of events 3
Total number local events 1
Total number of regional events 0
Total number of distant events 2
Total number of records 15
C:\seismo\wor>_

```

Do not output a compact file

Data base to use

Start time

End time

Number of events in time interval

Output file

The collect.out file will contain all S-files selected with one blank line between them. A compact file is a file with only the first header line for all events.

## 10.3 Putting data from a multiple S-file into the database with SPLIT

Data collected in a file with many events (S-files), also called a CAT file, can be split up and distributed in the database structure or placed in a local database. The collect.out file from above can be used:

```

C:\seismo\wor>split
INPUT FILE NAME
collect.out
BASE NAME FOR OUTPUT FILES:
TEST_ FOR STANDARD DATA BASE:
1-5 LETTER CODE FOR OTHER BASE
RETURN FOR SPLIT UP IN LOCAL DIRECTORY
OPERATOR ID, MAX 4 CHARS
jh
1996 6 3 19:17 52.0 D RECORDS: 5
1996 6 3 20: 2 18.0 D RECORDS: 5
1996 6 25 3:37 20.0 L RECORDS: 5
NUMBER OF LOCAL EVENTS: 1
NUMBER OF REGIONAL EVENTS: 0
NUMBER OF DISTANT EVENTS: 2
NUMBER OF EXPLOSIONS: 0
NUMBER OF PROB. EXPLOSIONS 0
TOTAL NUMBER OF EVENTS: 3
TOTAL NUMBER OF RECORDS: 15
C:\seismo\wor>

```

File to split

Default data base

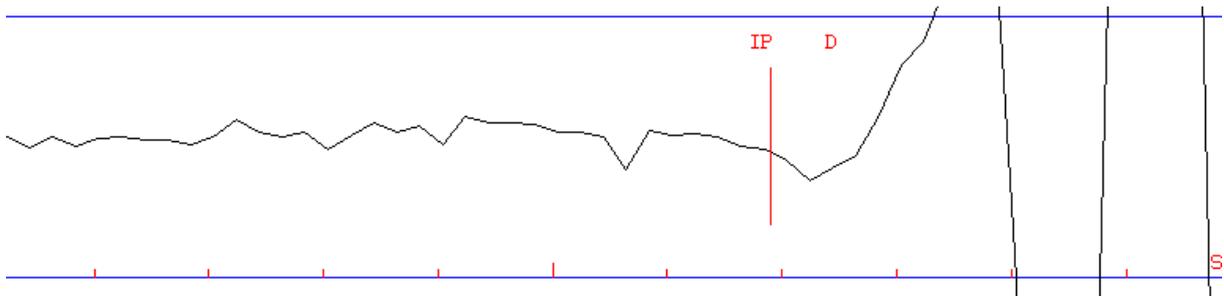
Operator

Split in a local data base

## 11 Fault plane solution

SEISAN has 4 different programs for fault plane solutions, two of which also work with amplitudes. Here we will demonstrate two popular programs with polarities, FOCMEC and FPFIT.

Select the local event and pick all the possible polarities on the Z-channels (select as shown in 5.4), see 7.4.3 how this is done. Some traces are not so clear so use a lot of zoom and maybe amplify trace amplitudes (see 5.2). In the example below for station ASK, Z-component, both zoom and amplification has been used to clearly see the polarity.



Before attempting a fault plane solution, make sure the depth is reasonable and not zero. For this event it should be between 10 and 25 km. If not ok, the depth should be fixed in the S-file by putting an 'F' in column 44 on header line.

First the FPFIT program is used. It will automatically find a solution in a least squares sense. It does not mean it is correct solution but the best with the available data. Use command 'fp'.

```

Command Prompt - eev 199606
1996 625 0337 31.0 L 61.686 3.268 15.0 TES 31 2.0 3.3LTES 3.1CTES 3.2LNAO
OLD: 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3LTES 3.0CTES 3.2LNAO
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? e
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? fp
*** now locating with hyp as a preparation ***
# 0 1996 625 0337 31.0 L 61.686 3.268 15.0 TES 31 2.0 3.3LTES 3.1CTES
If location not ok, result might be unpredictable
Return to continue (y=return/N)
Number of phases 32
Fpfit uses 3-letter LOWER-CASE commands, which can be followed by
parameters in free-format, or which display current values & generate prompts.
Type "hel" for information on available commands.
yes? # ORIGIN TIME LOCATION DEPTH MAG DDR DIP RA
-----
1 20 STN DIST AZ TOA PRMK HRMN PSEC TPOBS 139 88 -162
MULTIPLE SOLUTION 228 55 58
yes? =====
Fit 0.090
Errors in strike, dip and rake 8.0 9.0 10.0
Strike+90 dip rake
... updating database with FPFIT fault plane solution
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ?
Saving in S-file

```

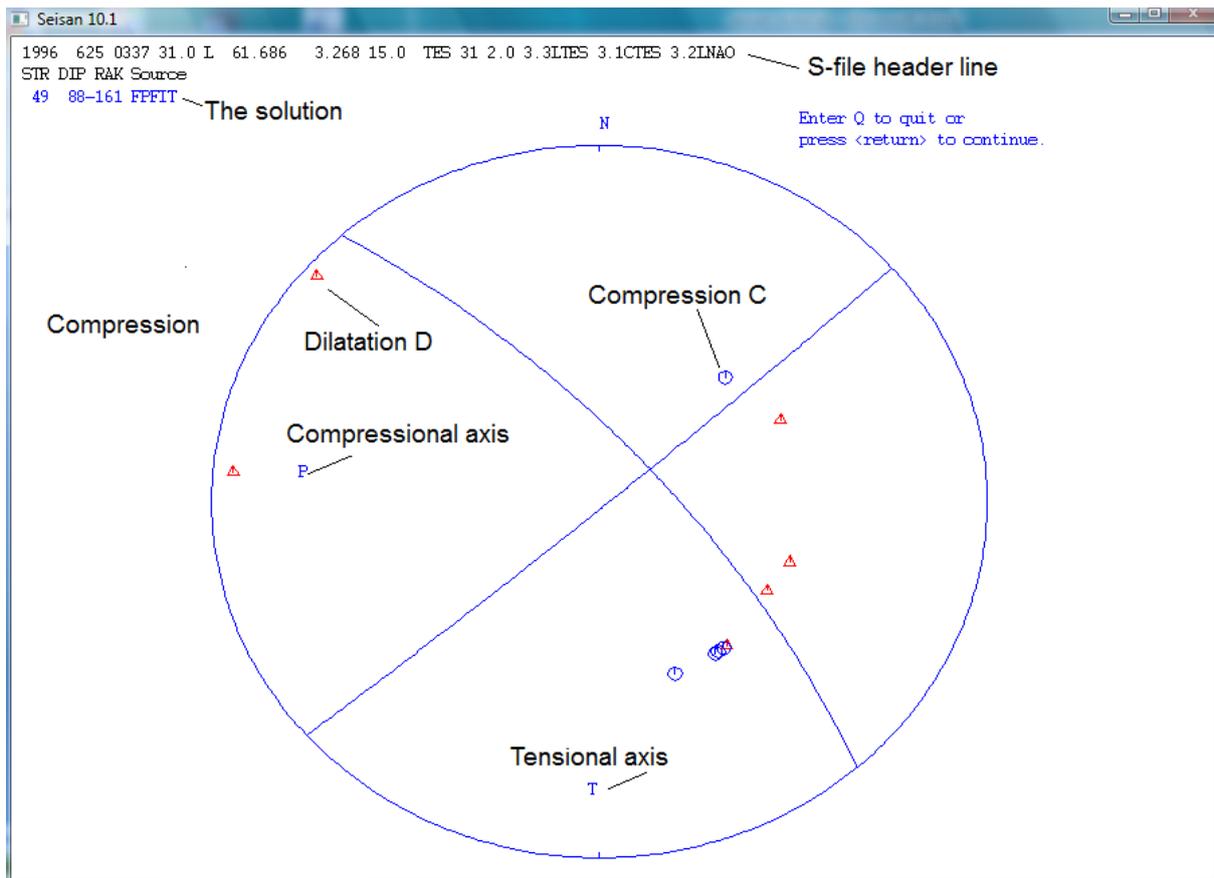
In this case multiple solutions are found and the first is saved in the S-file. Below is part of S-file with the solution.

```

25-0337-31LS199606 - Notepad
File Edit Format View Help
1996 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3LTES 3.0CTES 3.2LNAO1
49.0 88.0 -162.0 8.0 9.0 10.0 0.1 0.1 TES FPFIT F
GAP=153 21.09 35.7 89.2 64.7 -0.6060E+03 0.8503E+03 0.5203E+00E
1996 625 0337 31.9 L 35.7 89.2 64.7 BER 3.1WBER 1

```

We can now plot the solution with command 'fo'. It is seen below that all polarities but one fits the solution and it is also seen that other solutions are possible.



It is possible to see which stations belong to which polarities, give command 'f'.

```

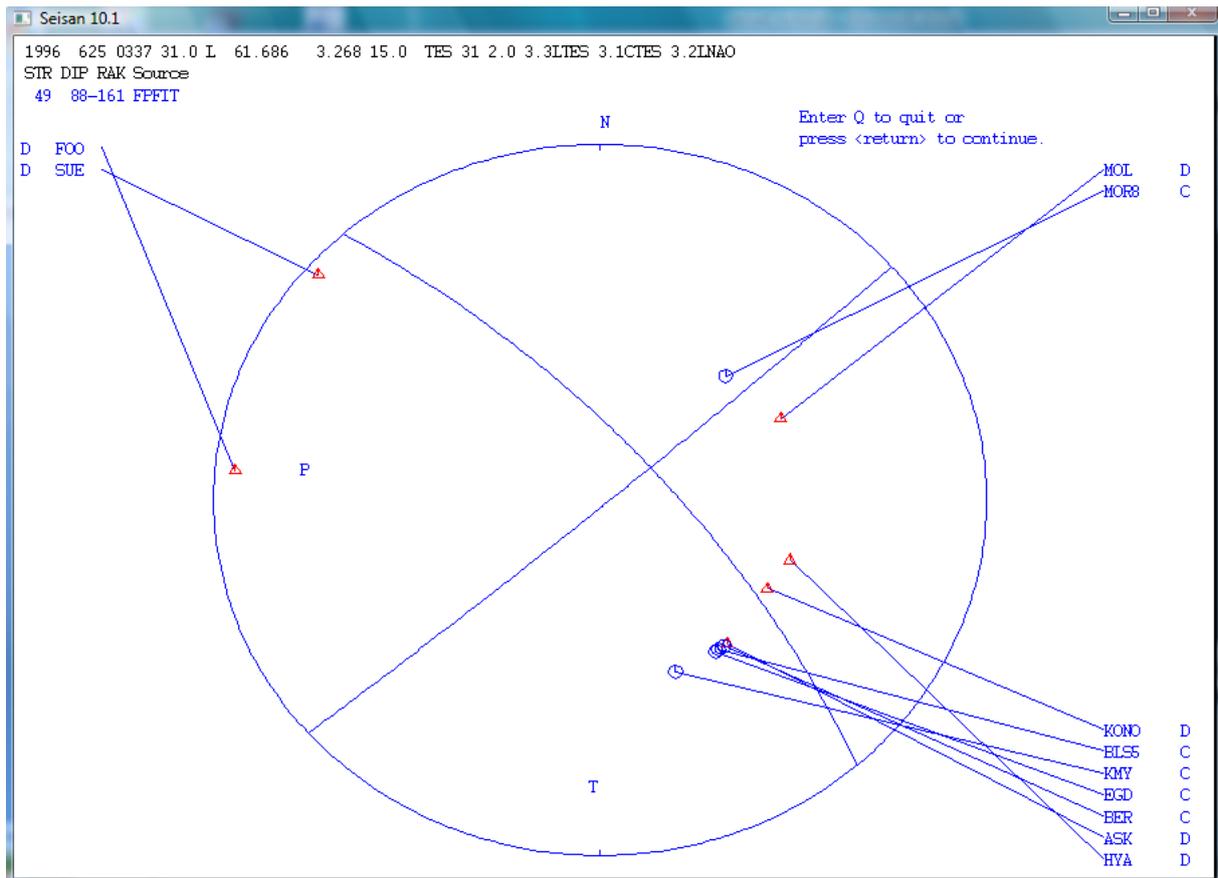
Command Prompt - eev 199606
Stop (0)
Plot saved solution(s) (1)
Plot new solutions (2)
Plot selected solution (3)
Find new solutions (4)
-1, -2, -3 also plot station
-1

Plot file is called focmec.eps
Input for GMI pspolar is called pspolar.inp
=====
... updating database with any saved fault plane solution
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? f

*** now locating with hyp as a preparation ***
# 0 1996 625 0337 31.0 L 61.686 3.268 15.0 TES 31 2.0 3.3LTES 3.1CTES
If location not ok, result might be unpredictable
Return to continue (y=return/N)

===== FOCMEC =====
Q: Local: Qp= 470.0**0.70 Qs= 470.0** 0.7 Global: t*(P)=1.10 t*(S)=4.20
STAT C PH AMP PER IRTIME QCOR ANGINC ANGEMG Fcor AZ DIST
STAT Ratio type T Amp 1 Amp 2 Fcor LogRat
Stop (0)
Plot saved solution(s) (1)
Plot new solutions (2)
Plot selected solution (3)
Find new solutions (4)
-1, -2, -3 also plot station
-1
  
```

and the following plot comes up showing stations and polarities.



We will now try the FOCMEC program. This program will not automatically find a solution but show all the solutions possible within some given criteria. FOCMEC can also work with amplitude ratios but here only polarities will be used. Start with command 'f'.

```

1996 6 Reading events from base TEST_ 2
# 1 3 Jun 1996 19:55 35 D 47.760 153.227 0.0 N 1.1 5.6WHRU 12 ?
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3LTES 35 ? f
*** now locating with hyp as a preparation ***
# 0 1996 625 0337 31.0 L 61.686 3.268 15.0 TES 31 2.0
If location not ok, result might be unpredictable
Return to continue (y=return/N)

===== FOCMEC =====
Q: Local: Qp= 470.0**0.70 Qs= 470.0** 0.7 Global: t*(P)=1.10 t*(S)=4.20
STAT C PH AMP PER TRIME QCOR ANGINC ANGEMG Fcor AZ DIST
STAT Ratio type T Amp 1 Amp 2 Fcor LogRat
Stop (0)
Plot saved solution(s) (1)
Plot new solutions (2)
Plot selected solution (3)
Find new solutions (4)
-1, -2, -3 also plot station
4

```

and this follows

```

4 There are 11 polarity readings
Maximum number of allowed polarity errors is only
0 Degree increment in search
5 Do you want to edit focmec.run (y/n) ?
n focmec_exe < focmec.run > focmec.log
...Minimum number of bad fits are 0
Tue Sep 09 16:58:35 2014 for program
-----
Input from a file focmec.dat
1996 625 0337 31.0 L 61.686 3.268 15.0 TES 31 2.0 3.3LTES 3.1CTES 3.2LMA
Polarities/Errors: P 011/00 SU 000/00 SH 000/00
There are no amplitude ratio data
The minimum, increment and maximum B axis trend are 0.00 5.00 355.00
The limits for the B axis plunge are 0.00 5.00 90.00
The limits for the angle of the A axis are 0.00 5.00 85.00
1)
Strike Dip Rake Pol: P SU SH Rat Err RMS RErr RErr (A1
162.6000 51.6200 70.7200 0 0.0 0.0
331.1800 76.0000 14.4300 0 0.0 0.0
329.9300 78.5600 9.7700 0 0.0 0.0
332.0200 75.0600 1.3400 0 0.0 0.0
325.4100 84.2800 8.2200 0 0.0 0.0
328.0700 81.3500 5.0400 0 0.0 0.0
327.7400 80.9500 -4.2600 0 0.0 0.0
325.3600 84.2800 -8.2200 0 0.0 0.0
322.4600 88.2700 9.8500 0 0.0 0.0
324.9800 85.0200 -0.4400 0 0.0 0.0
139.9300 88.2900 -4.7000 0 0.0 0.0
There are 11 acceptable solutions.
Stop (0)
Plot saved solution(s) (1)
Plot new solutions (2)
Plot selected solution (3)
Find new solutions (4)
-1, -2, -3 also plot station
2

```

Number of polarities available

Require all ok

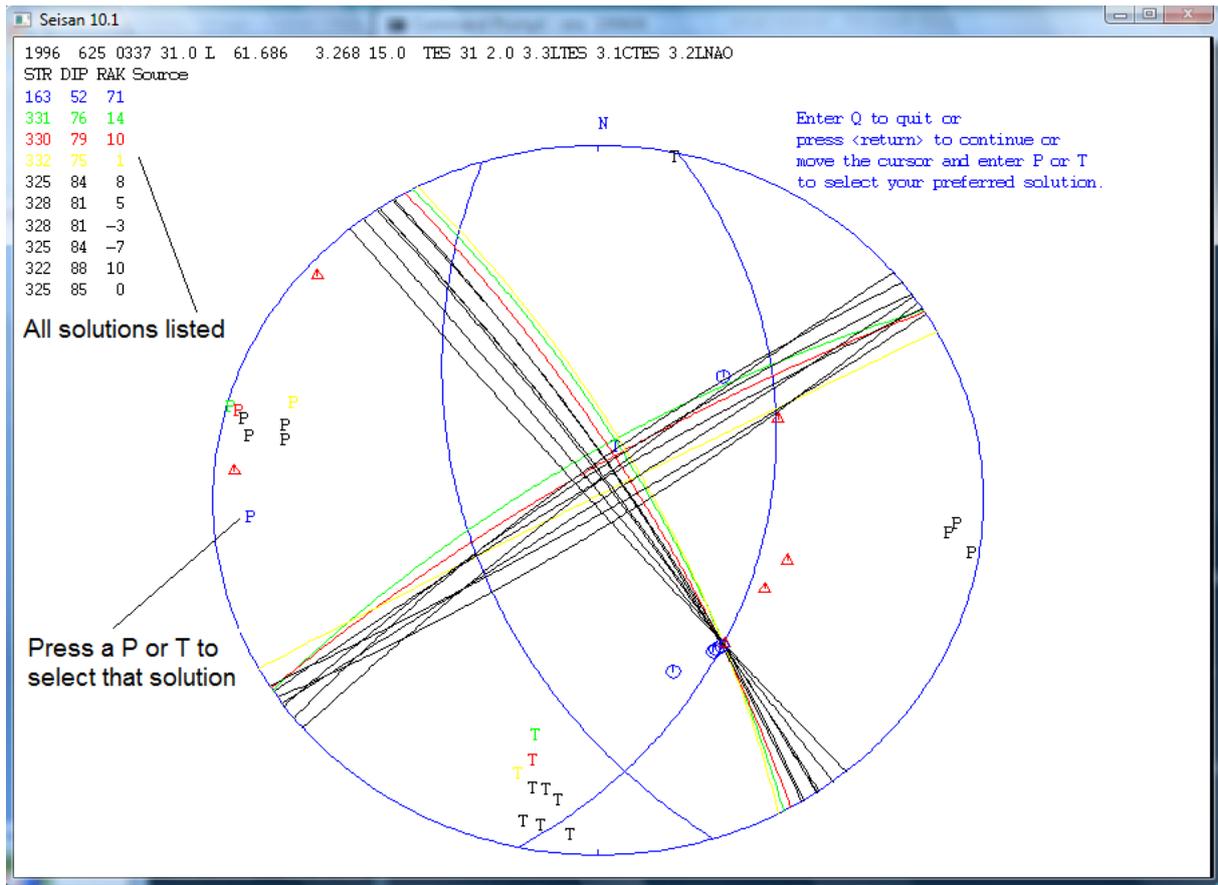
Search in this degree interval

n or enter for no edit

This gives 11 solutions

Plot the new solutions

The search is limited to a requirement that all polarities are ok, however, often there are no solutions without allowing some bad polarities. The search is in a 5 deg grid, allowing a finer grid will find more solutions and a courser grid fewer. The solutions found are seen below. It is seen that the majority of the solutions are similar to the FPFIT solution. However searching with a smaller grid size will give hundreds of solutions so obviously the fault plane solution is not very constrained.



One of the solutions can be selected by moving the cursor to the corresponding P or T and pressing 'p' or 't'. The solution should then be saved:

```

Save solution (y/n)
y
Stop
Plot saved solution(s)
Plot new solution(s)
Plot selected solution(s)
Find new solution(s)
-1, -2, -3 also plot stations
0
Plot file is called focmec.eps
Input for GMT pspolar is called pspolar.inp
=====
.... updating database with any saved fault plane solution
# 2 25 Jun 1996 03:37 31 L 61.689 3.259 15.0 N 3.0 3.3L TES 35 ?

```

Answer 'y' to save the solution in the S-file and '0' to exit

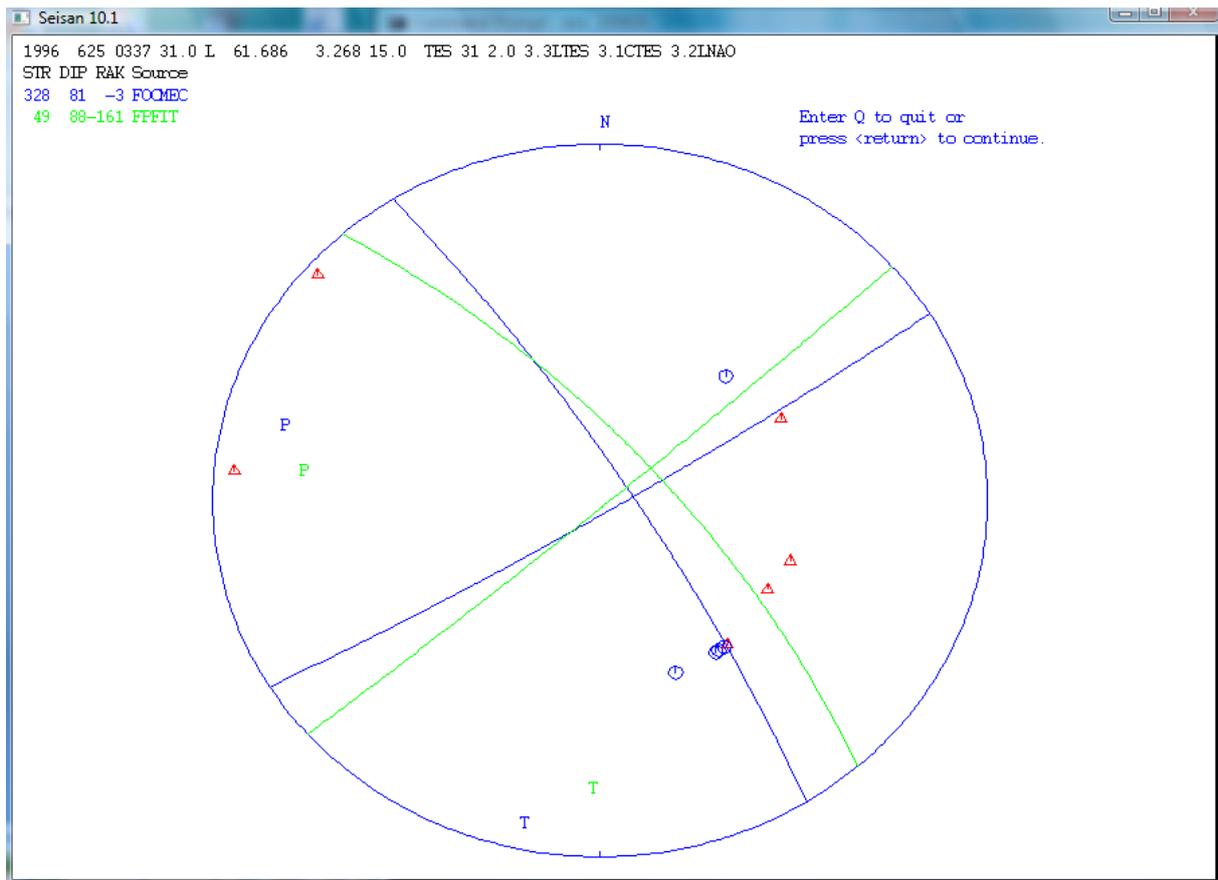
and there are now 2 fault plane solutions in S-file, indicated by the F-lines:

```

25-0337-31LS199606 - Notepad
File Edit Format View Help
| 1996 625 0337 31.0 L 61.689 3.259 15.0 TES 35 3.0 3.3L TES 3.0CTES 3.2LNAO1
| 327.7400 80.9500 -4.2600 0 TES FOCMEC F
| 49.0 88.0 -162.0 8.0 9.0 10.0 0.1 0.1 TES FPFIT F
| GAP=153 21.09 35.7 89.2 64.7 -0.6060E+03 0.8503E+03 0.5203E+00E

```

The 2 solutions can be plotted with command 'fo' as before and we get:



It is seen that the two solutions are similar but FOCMEC also had very different solutions. It is always useful to compare solutions from different programs. Doing the exercise yourself might result in quite different solutions since some polarities are uncertain.

## 12 Parameters the user must modify to work with his/her new data

### Local earthquakes

A few parameters must be entered or modified for local use:

- Coordinates for the stations, found in STATION0 .HYP in C:\seismo\DAT
- Crustal model, see parameters in STATION0 .HYP
- Magnitude scales for local earthquakes, see parameters in STATION0 .HYP Response files for all channels needed for magnitudes and other types of analysis. The response files are in C:\seismo\CAL.

### Distant earthquakes

- Coordinates for the stations, found in STATION0 .HYP in C:\seismo\DAT

- Response files for all channels needed for magnitudes and other types of analysis. The response files are in C:\seismo\CAL.

## **13 Using Seisan Explorer (SE)**

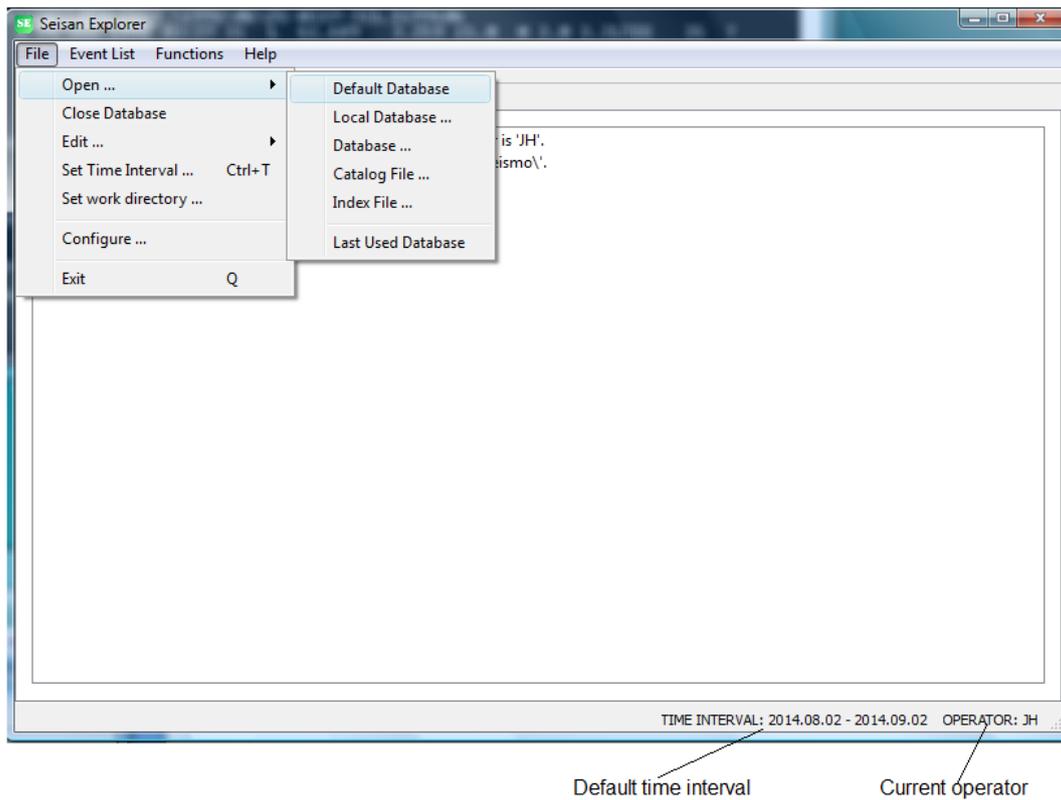
The GUI interface Seisan Explorer, hereafter called SE, is intended to replace EEV and expand the graphical options in SEISAN. The most basic EEV commands have been implemented with addition of some commands not present in EEV.

SE loads S-files from a SEISAN database. Only the S-files that falls within a user specified time interval are read. You may also load an index file, a local database or a CAT file (like collect.out). In this case, the currently set time interval is ignored, and time interval is adjusted automatically to fit the loaded data. All information in the S-files is stored in memory for fast access. For more information, see the SEISAN manual. In the following, some of the exercises done with EEV will now be done with SE as well as some which cannot be done with EEV.

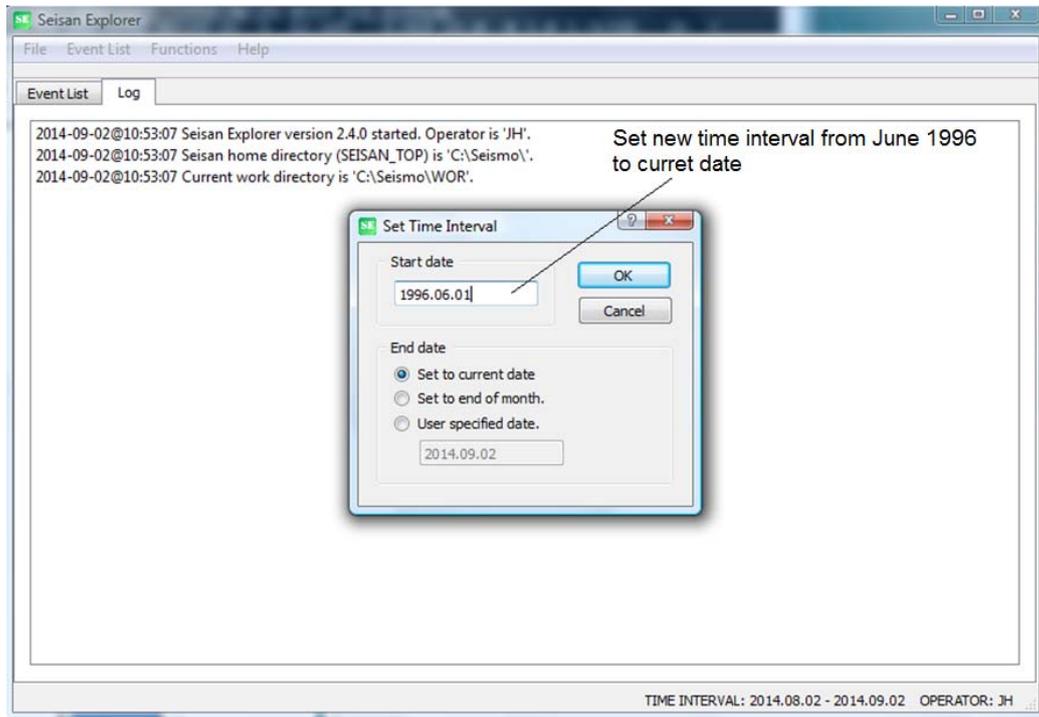
When doing these SE exercises, we assume that you have done most of the previous exercises (at least until 7.3), and are familiar with SEISAN basics.

### ***13.1 Get access to the events, open data base***

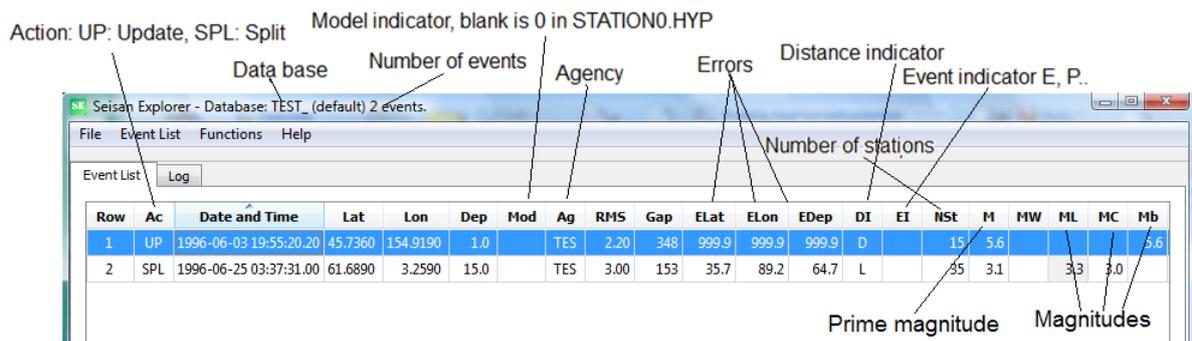
SE is started by using the SE icon or writing 'se' on prompt line. The first task is to read in data in SE. Here we will read from the default data base. This is done by pressing File/Open/Default Database as shown below.



The next step is to select the time interval. Here we only have data from June 1996, so that will be used as a start date. End date is by default the current date, but can be set to any other date. The Log window (below) shows current status and possible error messages.



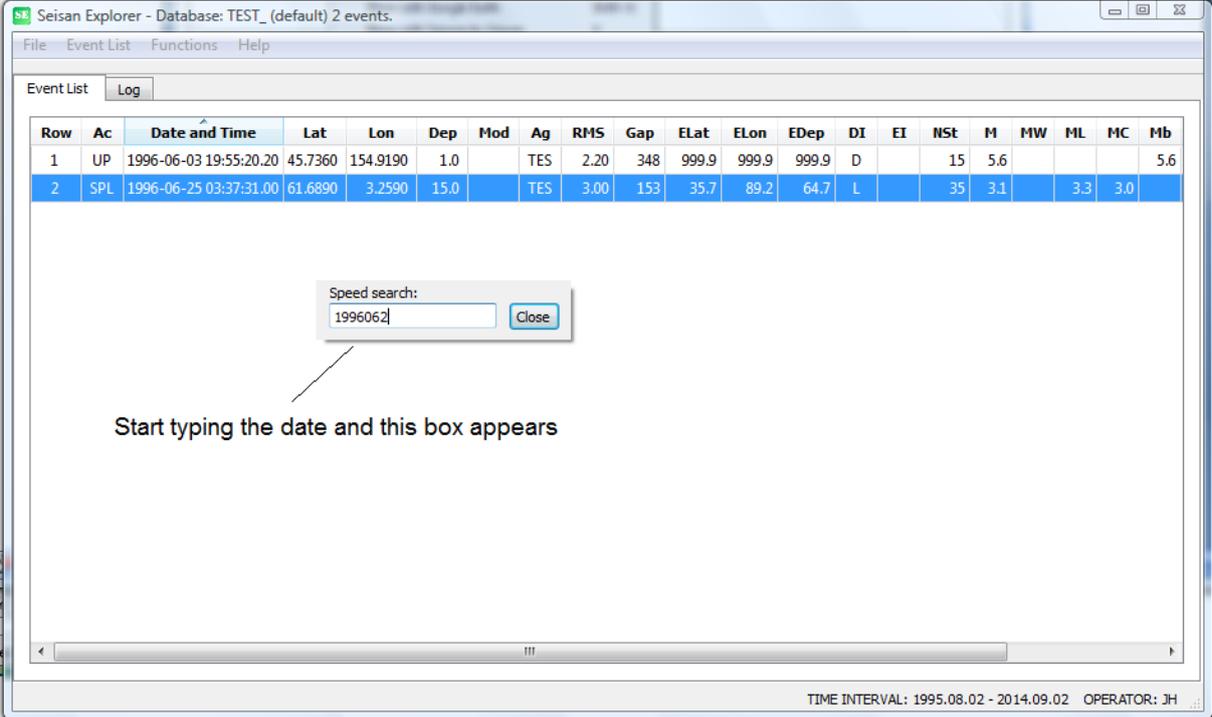
The 2 events from the database are now loaded, and some information is displayed for each event (figure below). The amount displayed can be defined in Event List/Select Columns. Note that in contrast to EEV, all magnitude types can be displayed. There is also a prime magnitude ‘M’, which is the preferred magnitude of the available magnitudes. The preference is set in SEISAN.DEF, see SEISAN manual, section “Magnitudes in SEISAN”. Once the events have been read in, one or several events can be selected for operation. A single event is selected by clicking on its line and the line is highlighted. Several events can be selected by ctrl+left-click.



The Log window may show after events have been loaded. This indicates that one or more errors occurred during database load. Errors will be listed in red, warnings in blue. Click the Event List tab (next to Log) to switch back to Event List view.

## 13.2 Navigate in SE

An event can be selected by clicking on the event. For many events, move down or up with Page Down or Page Up. An event can also be found by date. Start writing a date, like 1996 and the active event closest to the date will be highlighted. Below, 19960625 has been entered to go to the second event. The Speed search function expects the input to be formatted as 'yyyymmddhhmmss'. You may also jump to a specified row number by pressing '0' and then enter the row number.



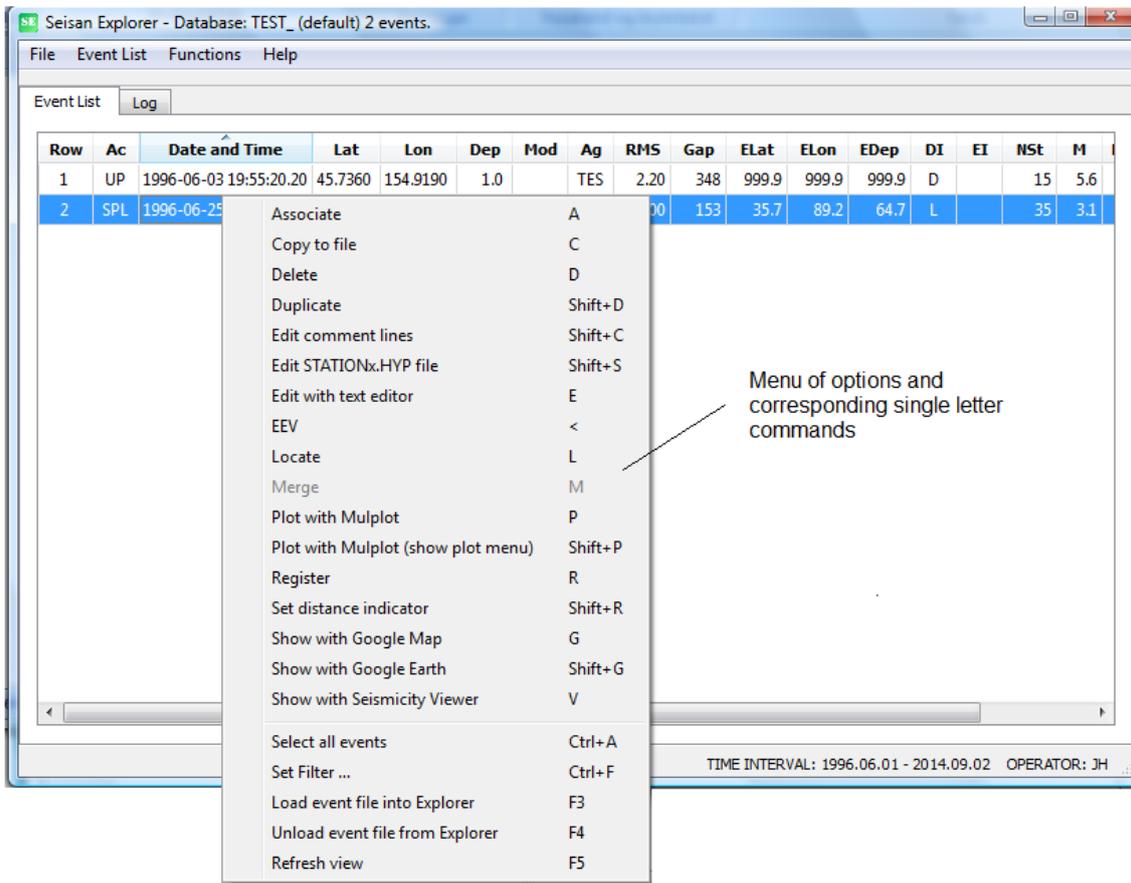
The screenshot shows the Seisan Explorer interface. At the top, the title bar reads "Seisan Explorer - Database: TEST\_ (default) 2 events." Below the title bar is a menu bar with "File", "Event List", "Functions", and "Help". The main window is titled "Event List" and contains a table with the following data:

Row	Ac	Date and Time	Lat	Lon	Dep	Mod	Ag	RMS	Gap	ELat	ELon	EDep	DI	EI	NSt	M	MW	ML	MC	Mb
1	UP	1996-06-03 19:55:20.20	45.7360	154.9190	1.0		TES	2.20	348	999.9	999.9	999.9	D		15	5.6				5.6
2	SPL	1996-06-25 03:37:31.00	61.6890	3.2590	15.0		TES	3.00	153	35.7	89.2	64.7	L		35	3.1		3.3	3.0	

Below the table, a "Speed search:" dialog box is open, containing a text input field with "19960625" and a "Close" button. An arrow points from the text "Start typing the date and this box appears" to the dialog box. At the bottom right of the window, the status bar displays "TIME INTERVAL: 1995.08.02 - 2014.09.02 OPERATOR: JH".

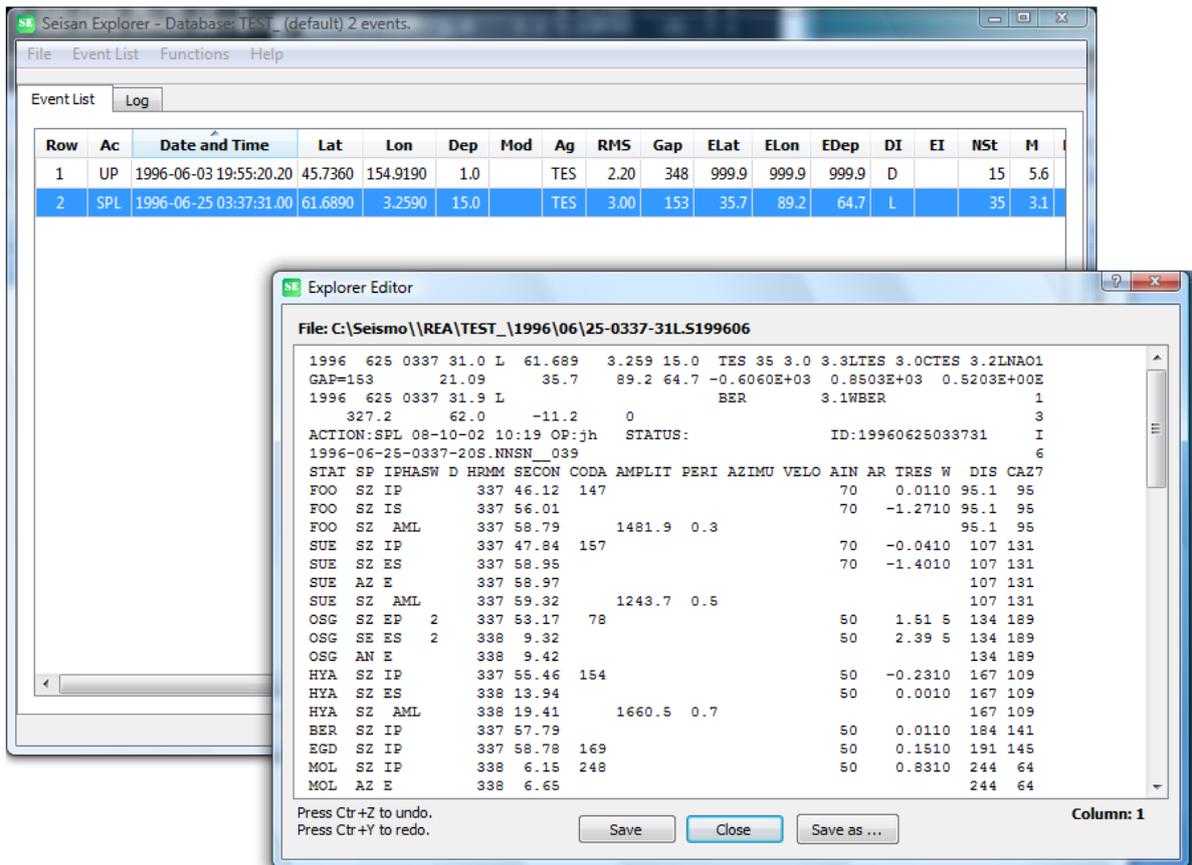
## 13.3 Operations in SE

Once an event (or several events for some options) has been selected, a right-click on the event will show the options as shown below. All options have a one-letter key as a shortcut.



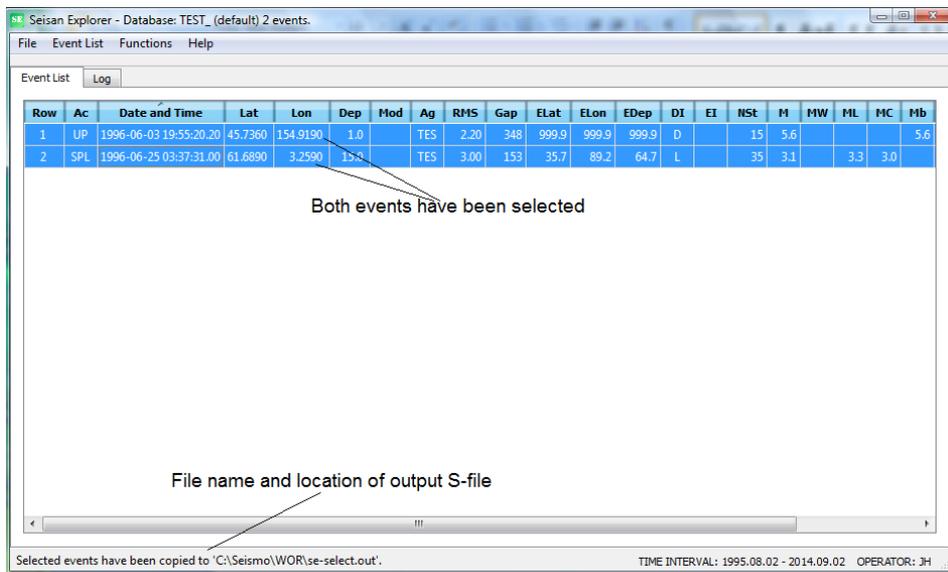
### 13.3.1 Edit or display content of S-file

Edit with text editor, 'e'. Note that you cannot use SE while giving control to another action or program like the editor. Control returns to SE when the editor is closed. Below is an example.



### 13.3.2 Export data

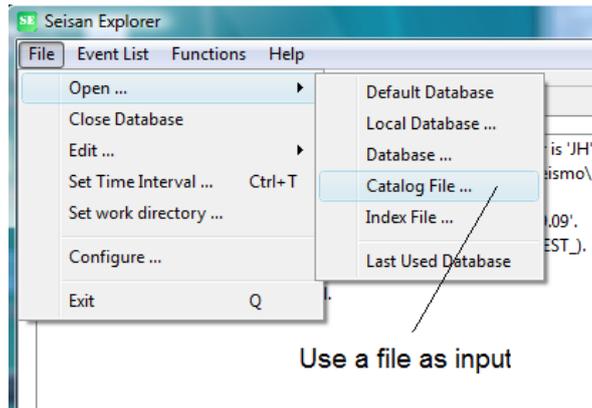
The events highlighted can be copied out to an S-file with option 'Copy to file' or key press 'c'. The output file has a fixed name, and will be written to the work directory. The work directory can be set under File/Set work directory. The message of the location and name of output file appears briefly at the bottom of SE box, see below.



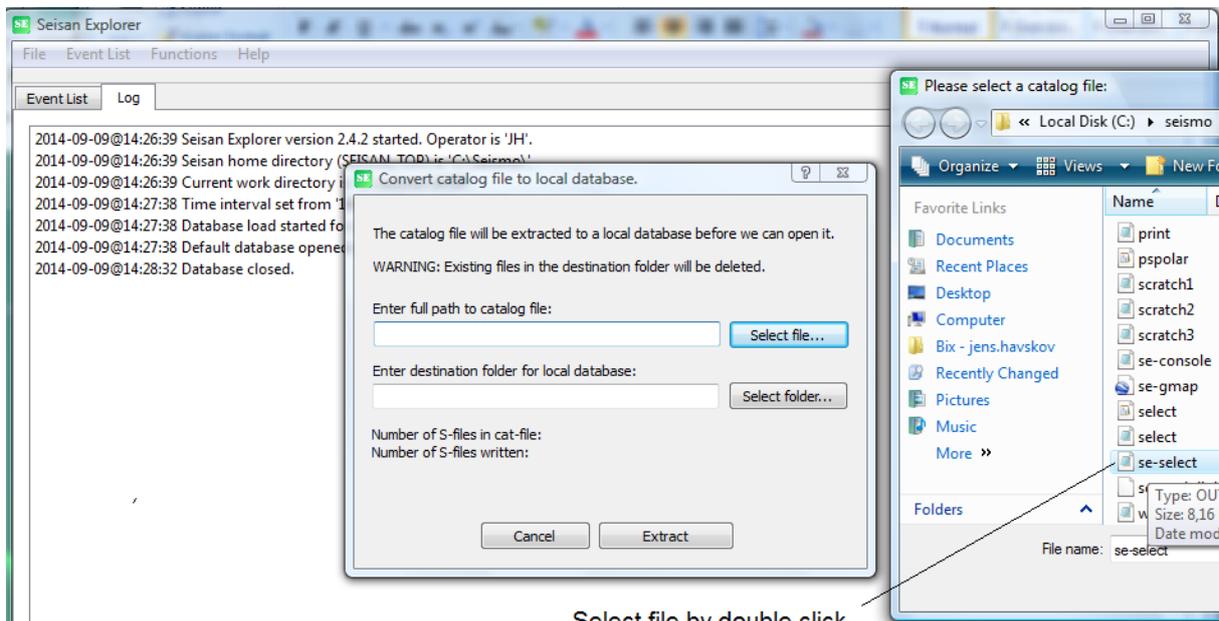
### 13.3.3 Import of data

It was shown above how to open a data base. SE has the added capability (compared to EEV) that it can work directly with a catalog file (file with many S-files). An example above was the exported file se-select.out. We will use this file as an example.

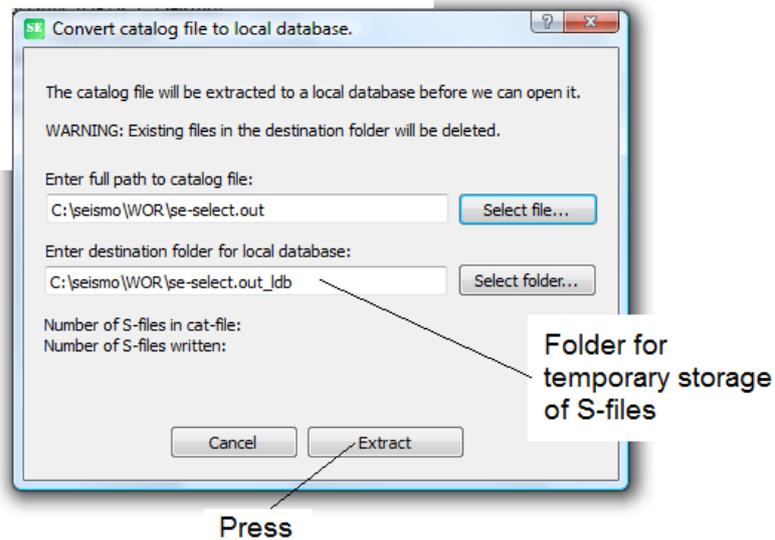
First select option Open/Catalog file:



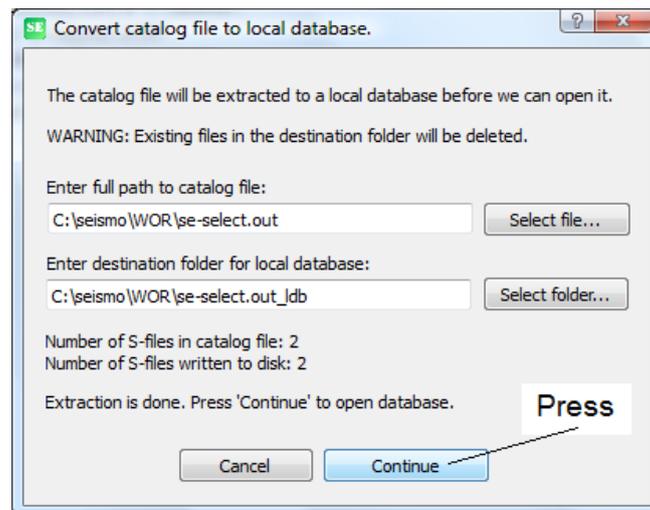
Then use the file browser to select the file:



The file has now been selected. At the same time an output directory where the temporary S-files will be placed has been suggested. SE will take the input catalog file and split it up in the temporary folder.



The message is now that there were two events (2 S-files). Press Continue to open the database.



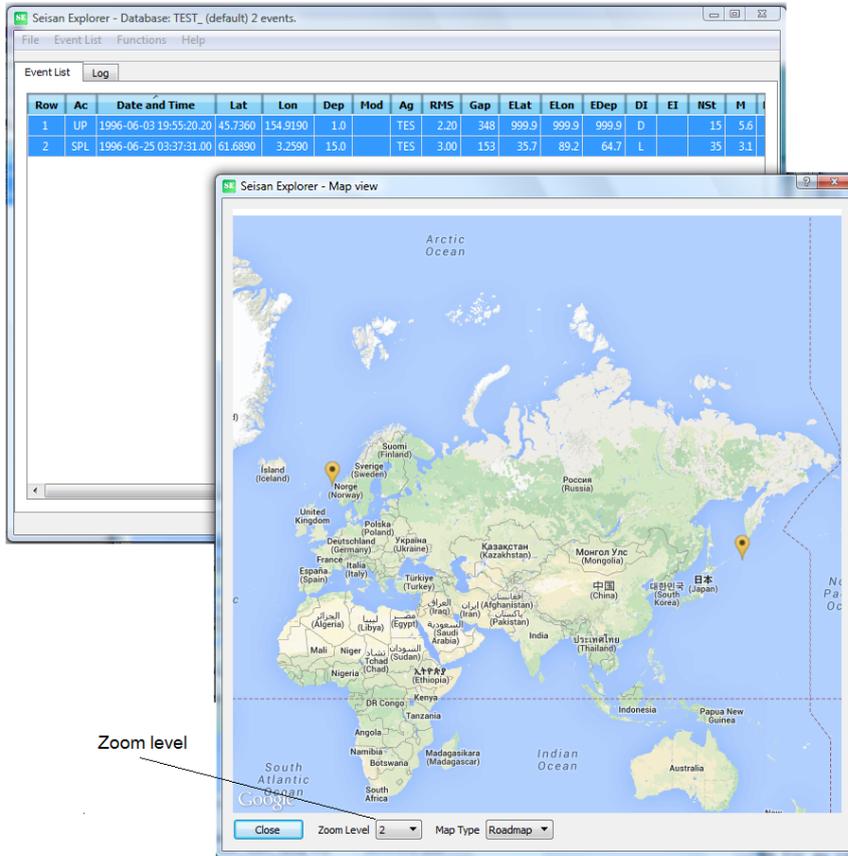
The Event List will now appear, and normal work can be done.

Row	Ac	Date and Time	Lat	Lon	Dep	Mod	Ag	RMS	Gap	ELat	ELon	EDep	DI	EI	NST	M	MW	ML	MC	Mb
1	SPL	1996-06-03 19:55:35.50	47.7600	153.2270	0.0		TES	1.10	348	999.9	999.9	999.9	D		12	5.6	5.6			5.6
2	SPL	1996-06-25 03:37:31.00	61.6890	3.2590	15.0		TES	3.00	153	35.7	89.2	64.7	L		35	3.1		3.3	3.0	

When SE is closed, the data (changed or not) is optionally stored back into the original catalog file. The temporary directory with S-files remain until deleted by the user.

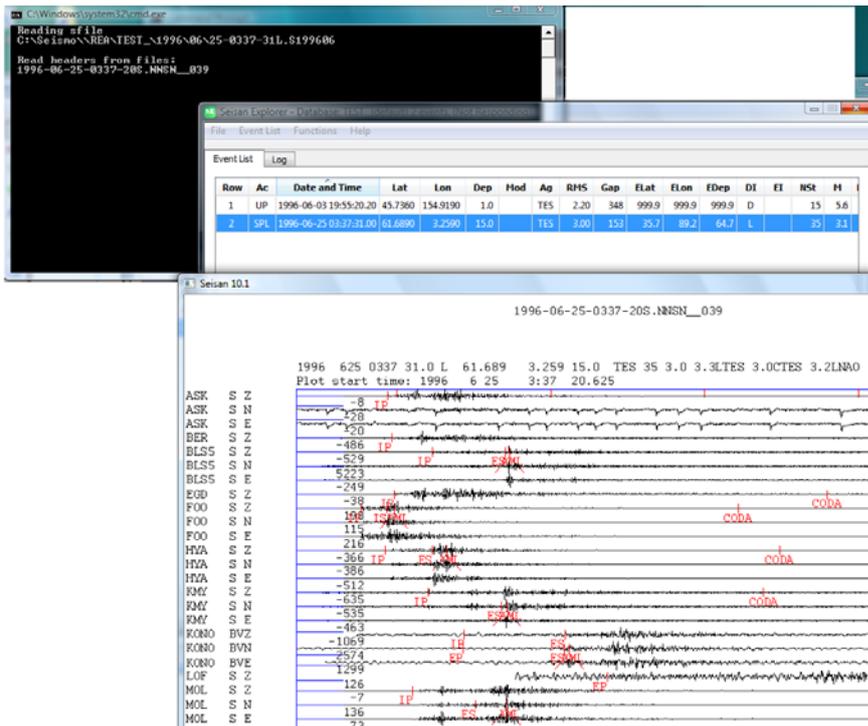
### 13.3.4 Plot epicentres

The Google map function can be used as in EEV (assumes a working Internet connection). However, here it is just one key press ‘g’, or select from options menu. One or several events can be displayed (there is an upper limit set by Google Static Maps). See example below. In order to see all events on one map, the Zoom level might have to be set manually.



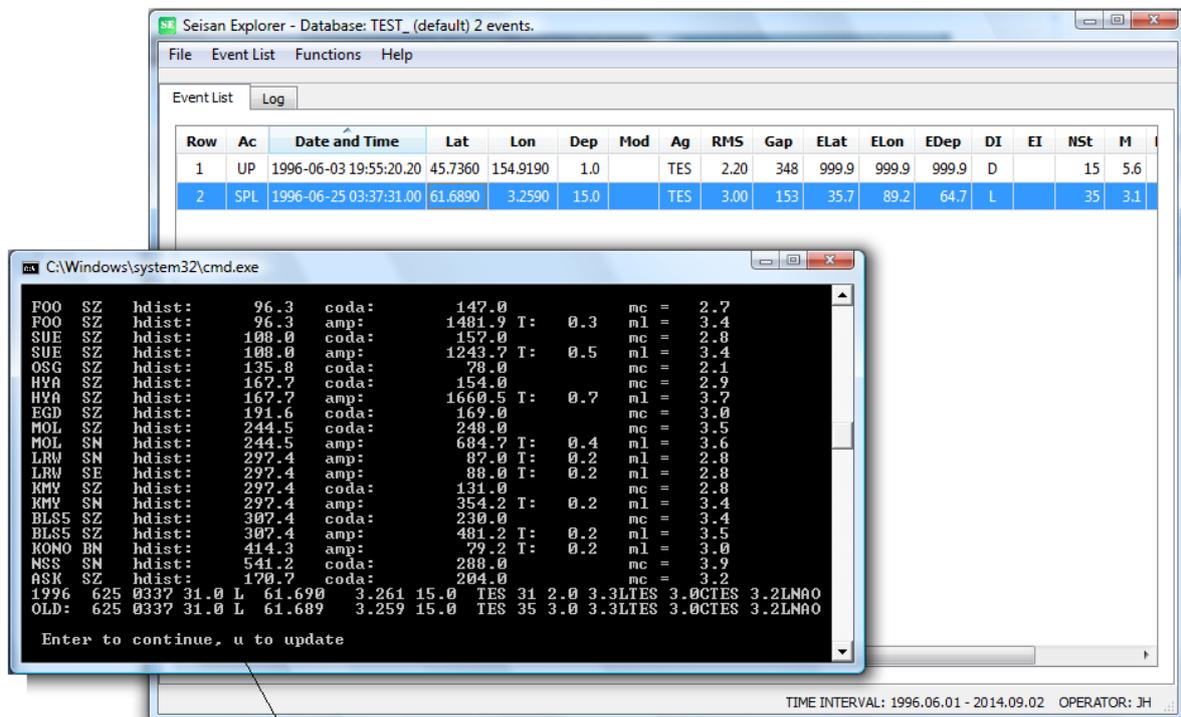
### 13.3.5 Plot waveforms

Option 'Plot with Mulplt' is 'p'. The old MULPLT comes up with all defaults (like 'po' in EEV) and the DOS message window (terminal window under Linux) is also shown. A quit in MULPLT returns control to SE. New picks or changes are automatically saved in data base on return to SE.



### 13.3.6 Locate an event

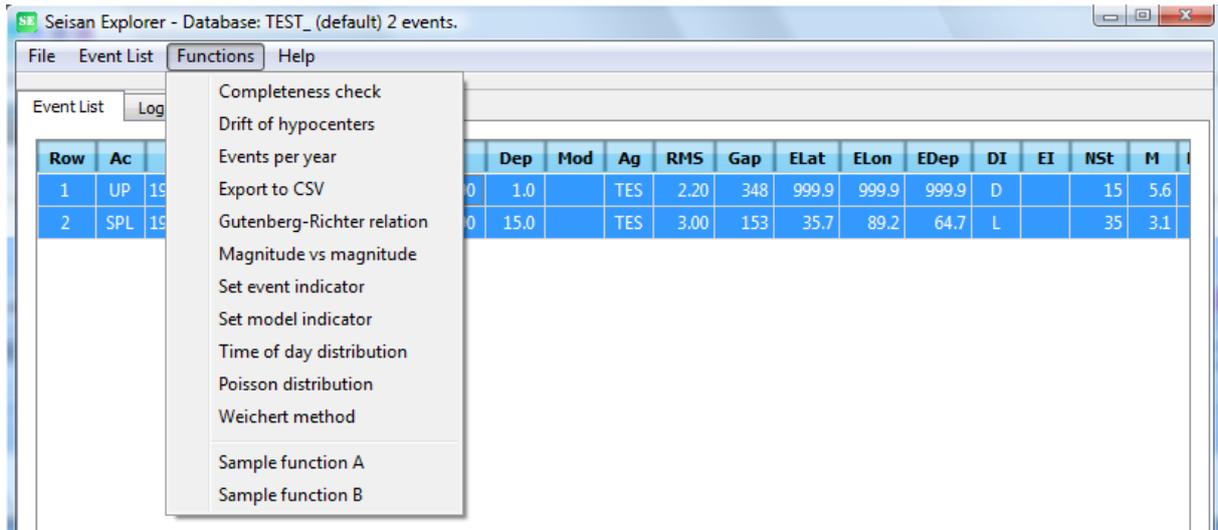
The event is located with Locate or key press 'l'. The location takes place in the DOS window or a terminal window. Note that when using SE, the update command is not a separate command but part of the location process.



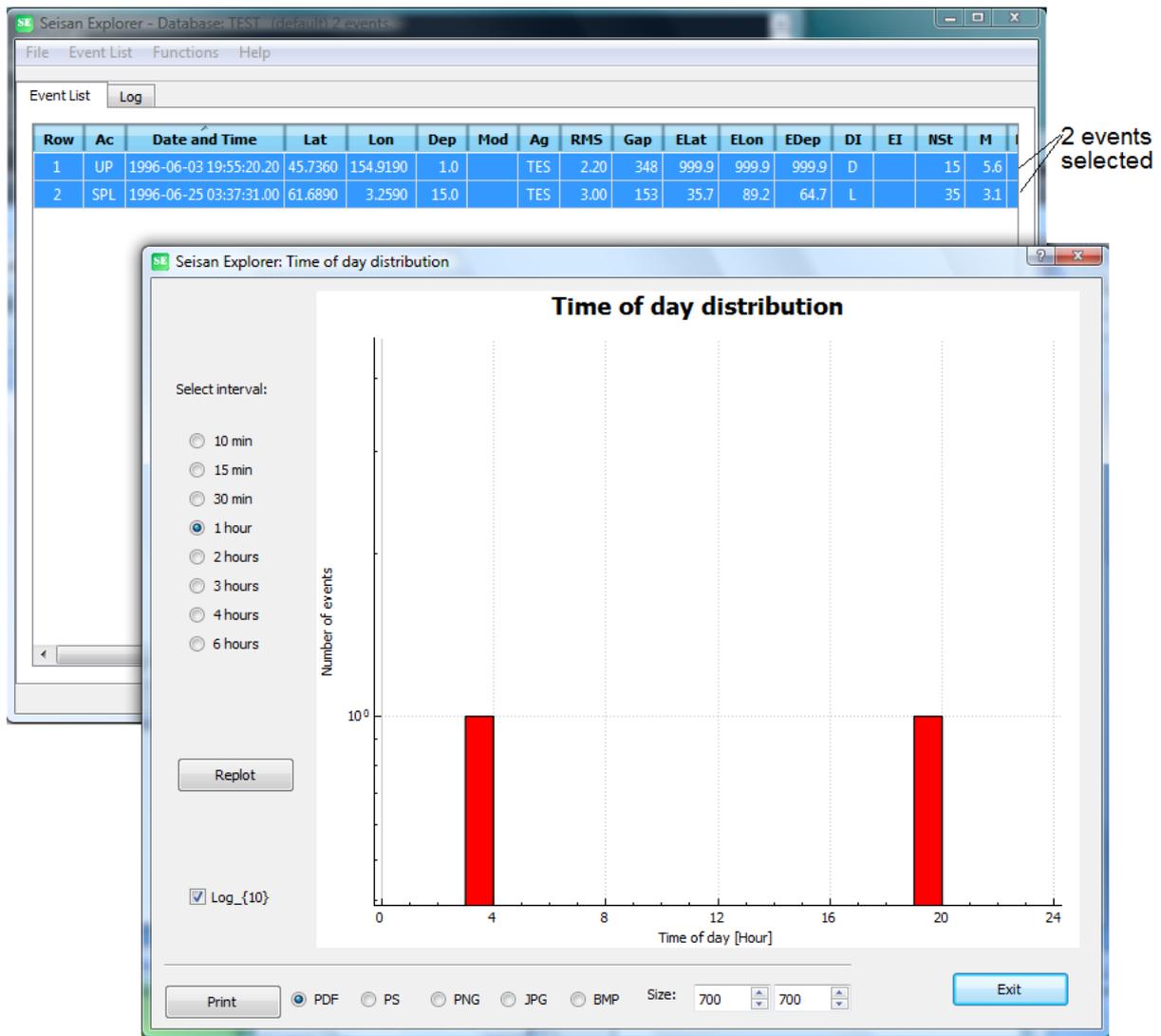
Update event, enter u

## 13.4 Functions in SE

SE has a series of functions. Many of these are not found elsewhere in SEISAN. There are, in particular, options useful for seismic hazard analysis. The functions are located under main menu 'Functions' (see below). Please note that these functions work on ALL events in the event list, whether they have been selected or not. Functions can be applied to a subset of the events list, by first applying a filter to the Event List view.

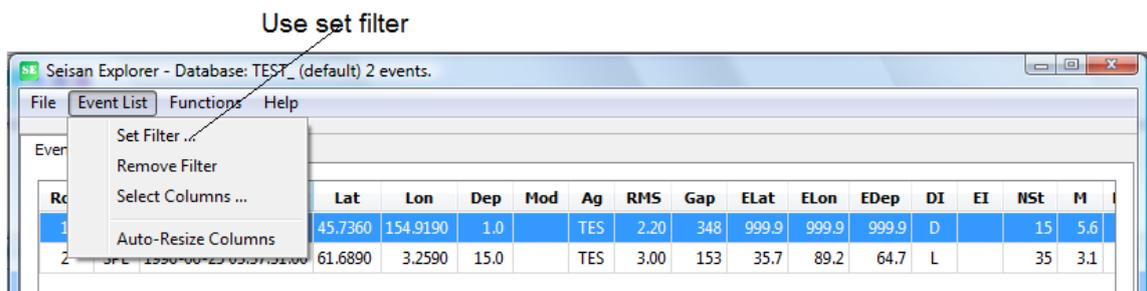


Two events is hardly enough for most functions, however we can demonstrate the time of day distribution for the two test events:

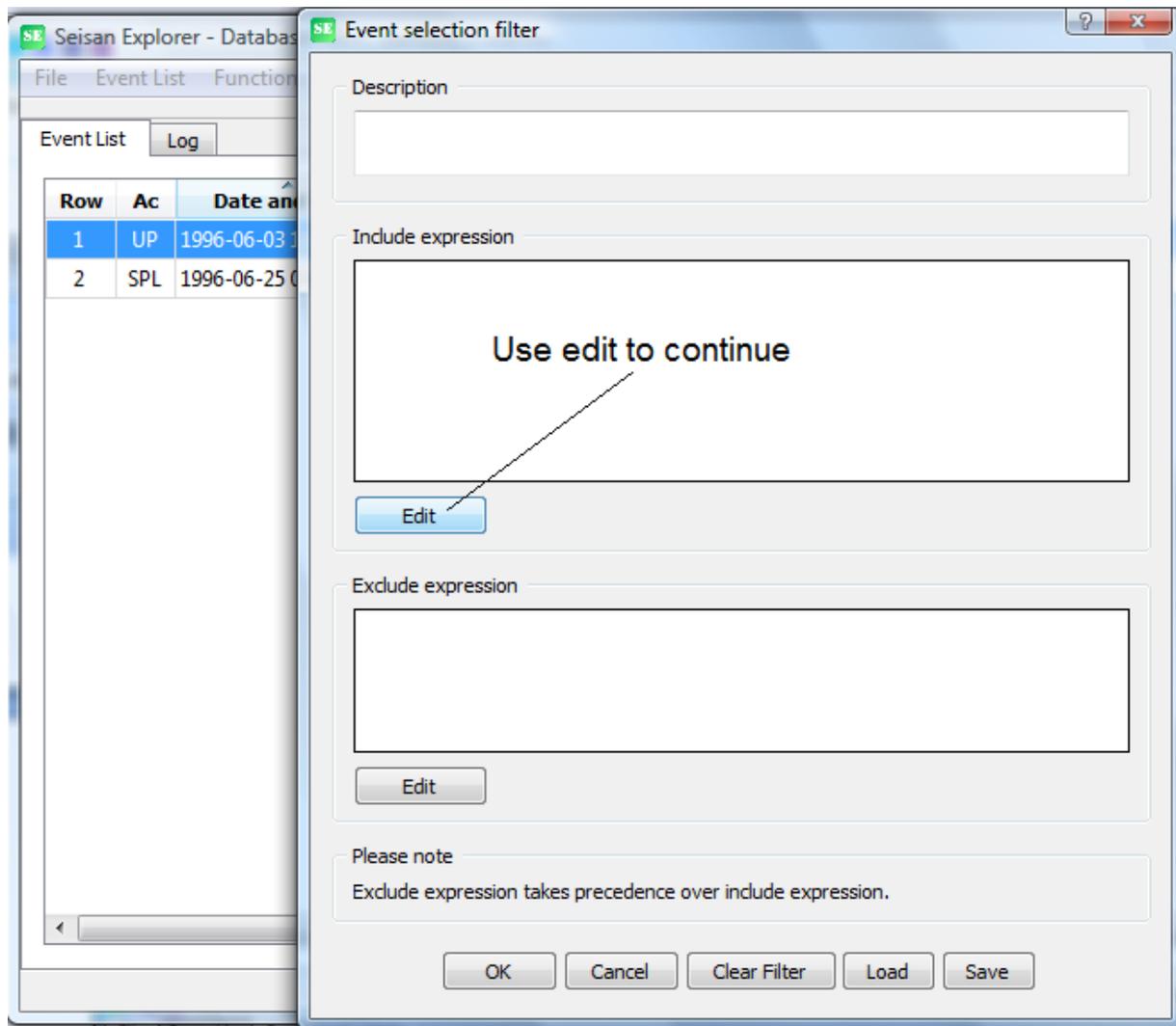


### 13.5 Event selection filter

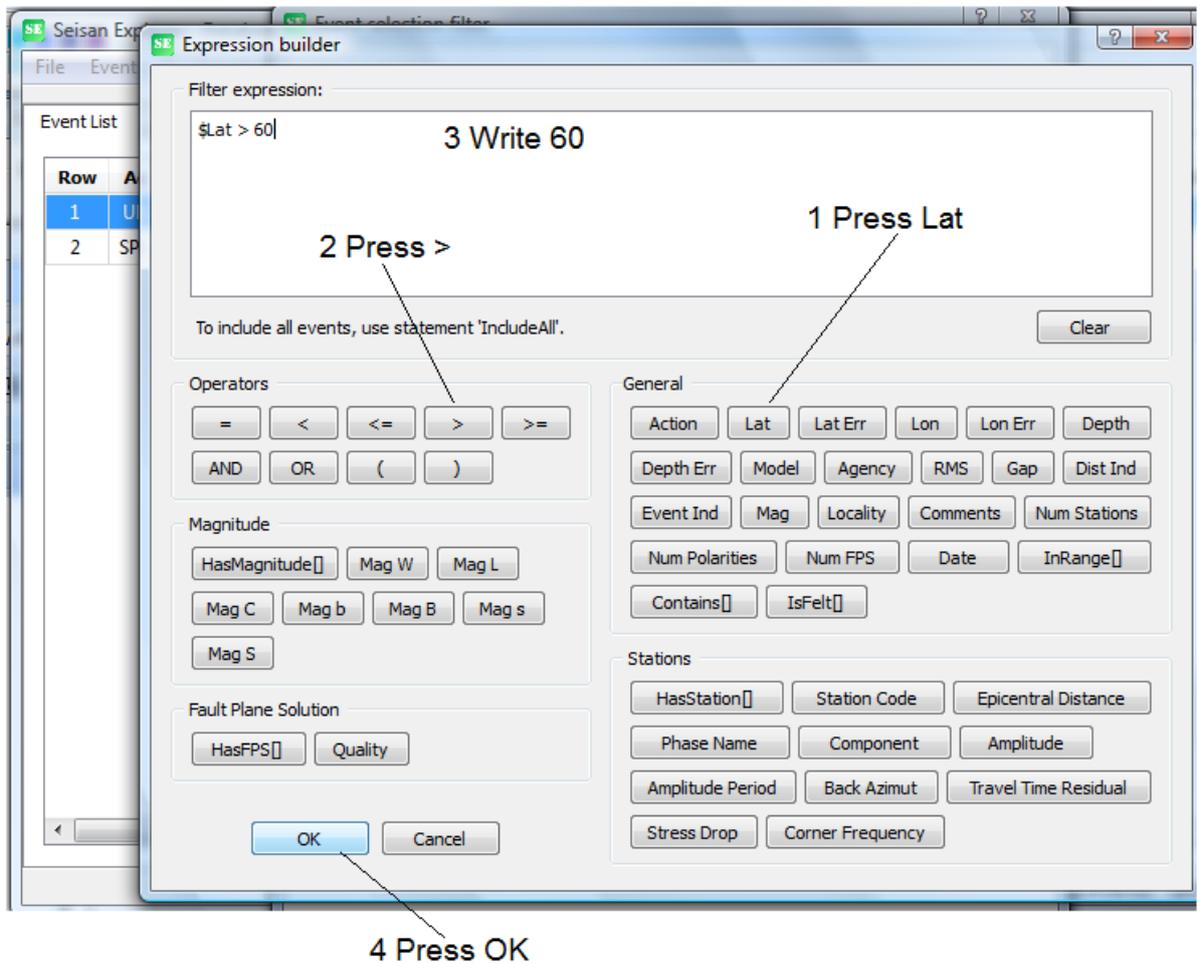
SE has a very sophisticated event selection filter whereby a subset of loaded events can be selected according to user set criteria. Both include and exclude filters can be used, and there is a large number of parameters that can be used in the selection criteria. The filter is found under Event List/Set Filter (see below).



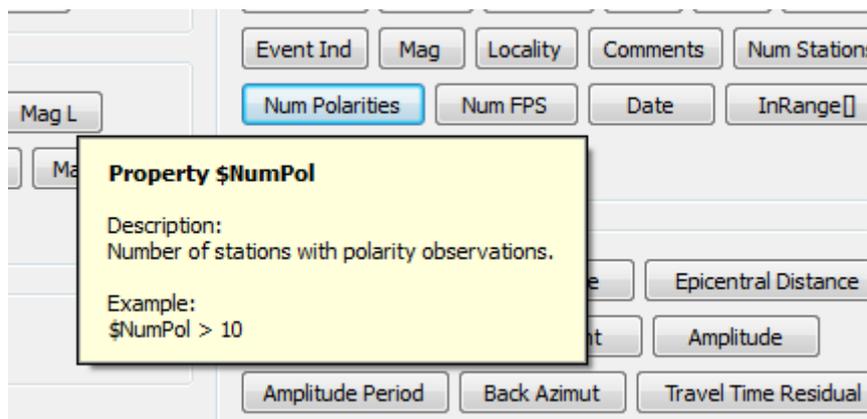
The filter selection box now appears, and the user has to choose if an include or an exclude filter is to be defined. Here we will use only include (see below).



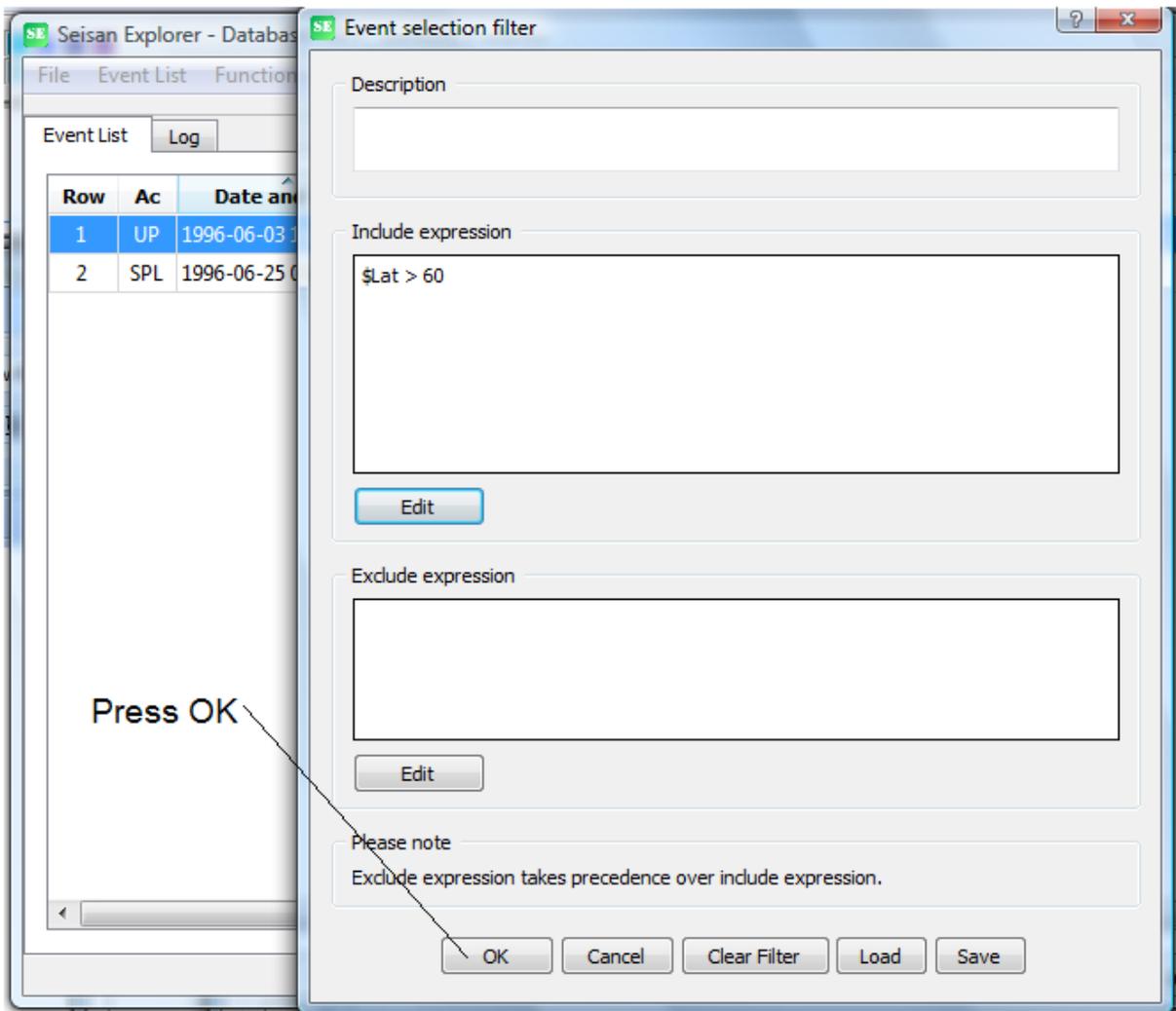
Once Edit has been clicked, the parameters which can be selected are shown. In the example here, all events with latitude > 60 deg will be chosen (see below).



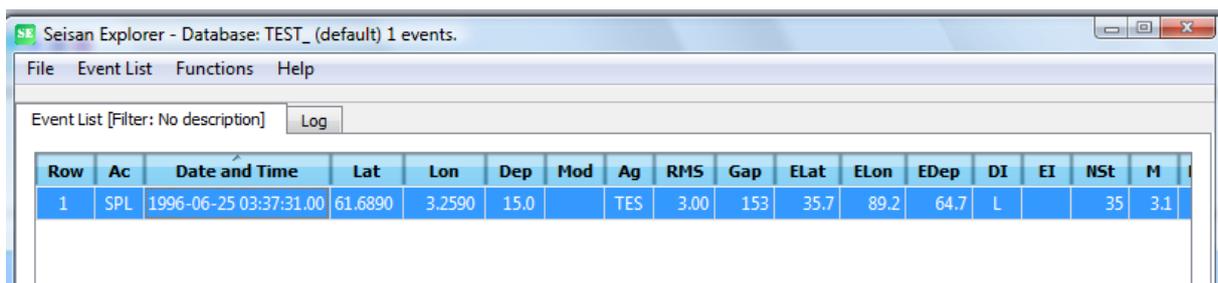
The selection parameters have help boxes. Right click on parameter to get help. Below is an example of the explanation for minimum number of stations with polarity readings.



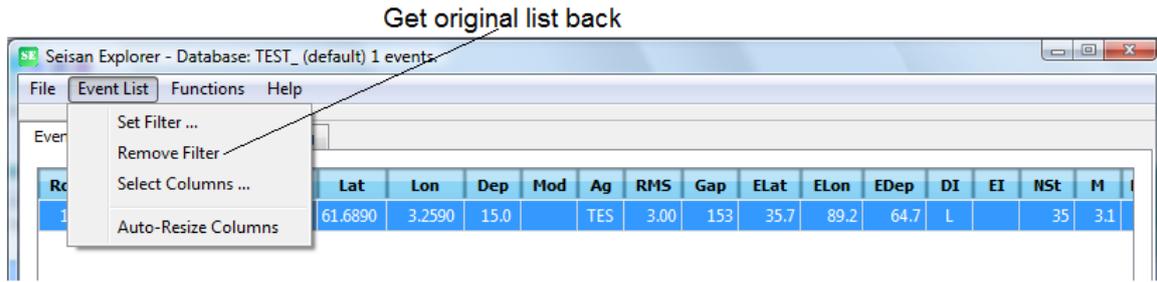
Once selection is finished, press OK and OK to apply the filter to the Event List.



Now there is only one event left. A function can now be used on the listed events, or the events can be written out with the Copy to File option.

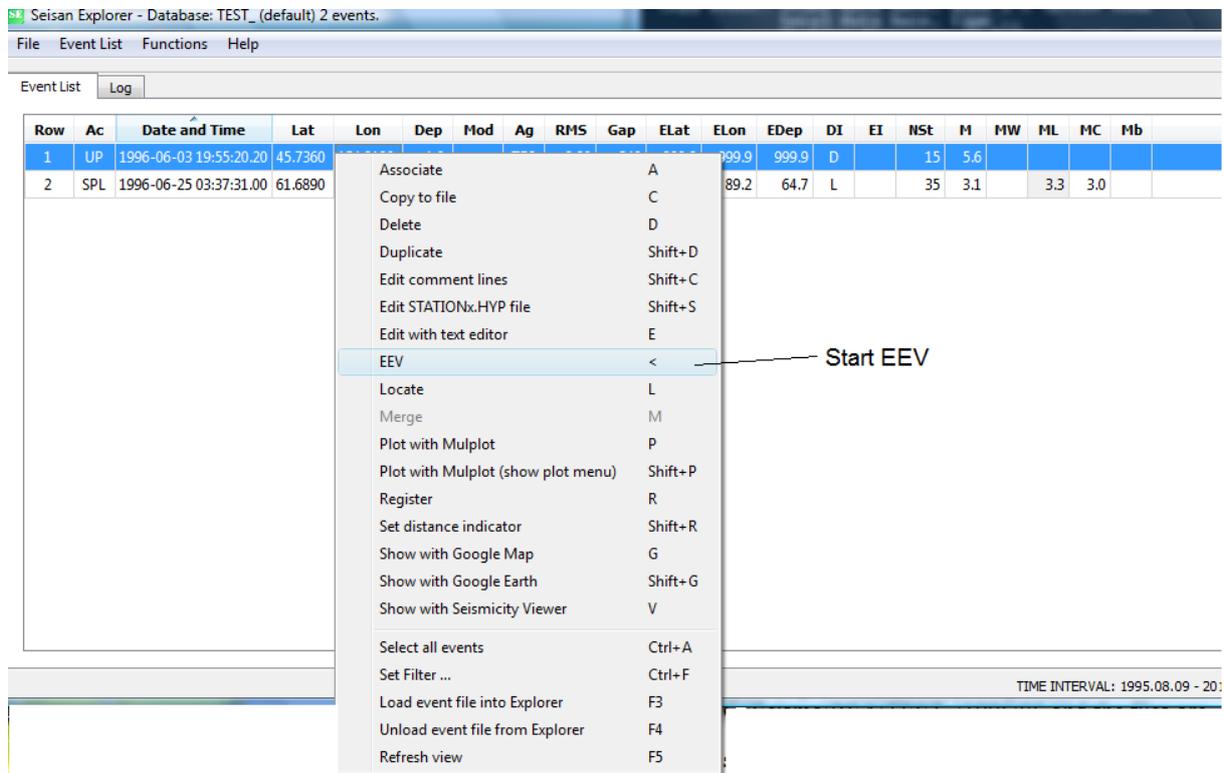


The full event list can be restored by using Event List/Remove filter.

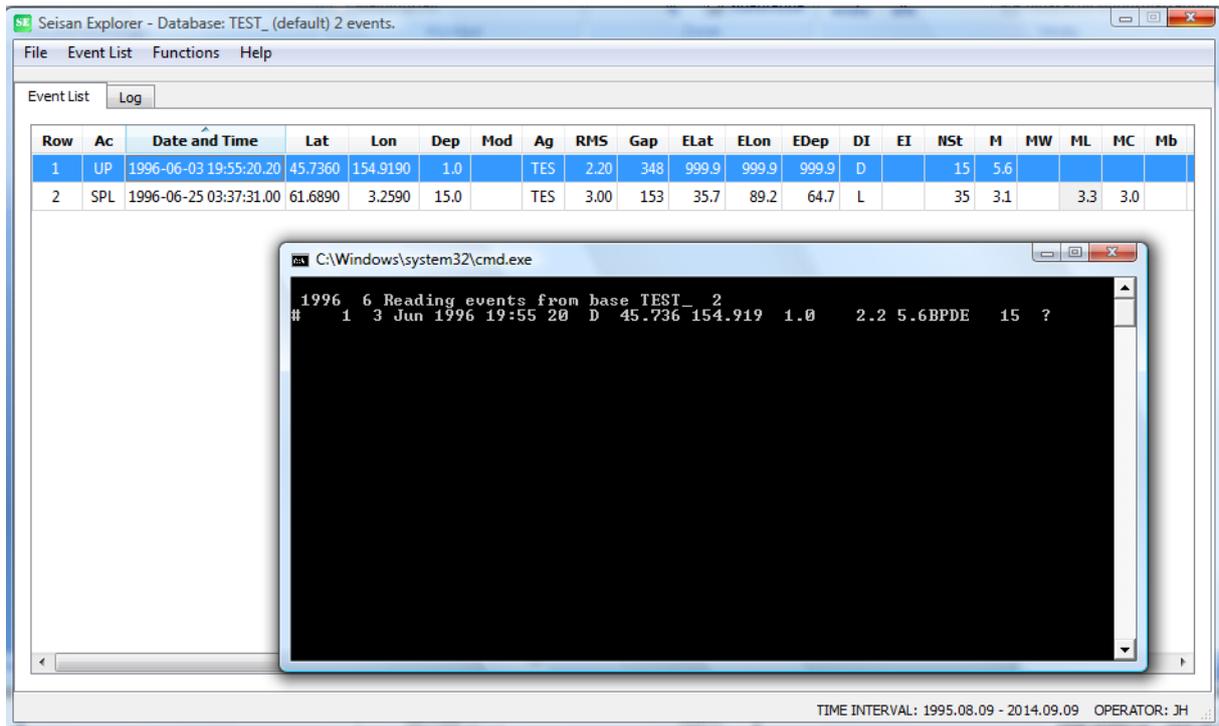


### 13.6 How to get the remaining EEV commands in SE

The commands not yet implemented in SE can be executed via the EEV interface.



You get



All the usual EEV commands are now available. When quitting, control goes back to SE and the data base read into SE is updated.

Acknowledgement: Paul Friberg and Øyvind Natvik corrected this document.