

6. Data processing using SeisImager

- Data downloading from Atom
- 1D active/passive surface wave method (data obtained by Atom)
- 2D active surface wave method based on CMP-CC (data obtained by Geode)
- 3D passive surface wave method based on CMP-SPAC (data obtained by Atom)
- Higher modes and inversion using effective mode based on Genetic Algorithm

6. Data processing using SeisImager

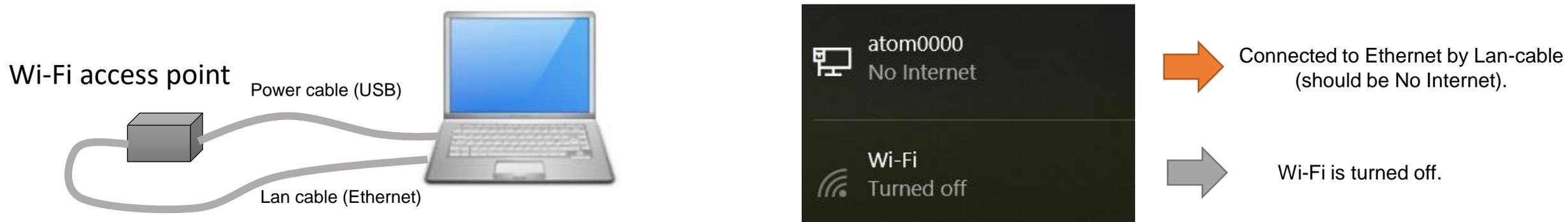
- Data downloading from Atom
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Data downloading from Atom

- A. Copy data from SD card
Remove the SD card from each Atom box and directly copy waveform files. Data files are saved in folders as shown above.
- B. USB
Connect the USB cable from your PC to your Atom and download waveform data files in SPACPlus using the following menu commands:
[File]>>[ATOM(USB)]>>[Download via USB]. Set Baud rate to 3686400.
Download the USB driver from a link shown below and install it at first time.
- C. Wi-Fi
Geometrics Atom Downloader downloads waveform data files via Wi-Fi using a special access point connected to your PC. Wireless downloading is faster than downloading via USB connection with data downloading from several Atom units simultaneously. SPACPlus also downloads waveform data via Wi-Fi if the Atom Downloader is not available (see Appendix A for the details). Follow the procedure shown below to download waveform data using the Geometrics Atom Downloader.

Download waveform data via Wi-Fi using the Geometrics Atom Downloader (1)

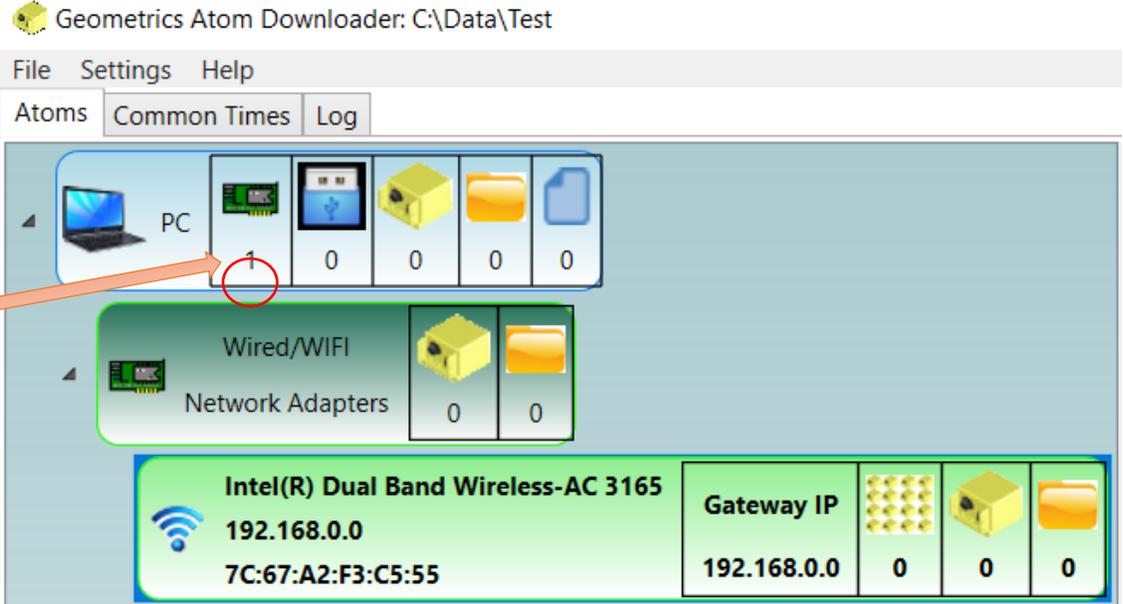
- 1) Turn off each Atom to stop recording data.
- 2) Plug in a Wi-Fi access point (SSID of “atom0000”) to your PC.
- 3) Connect your PC to “atom0000” by LAN cable (strongly recommended) or Wi-Fi. Do not connect both Lan cable and Wi-Fi to the access point. It is better to turn off Wi-Fi to make sure only the Lan-cable is connected to the access point.



Download waveform data via Wi-Fi using the Geometrics Atom Downloader (2)

- 4) Launch Geometrics Atom Downloader 
- 5) Select [Settings]>>[Data Folder Location] and select a folder to which data to be downloaded
- 6) Display shown below appears on the window. Make sure one or two networks were found.

Number of networks 



The screenshot shows the Geometrics Atom Downloader window with the following data:

Category	Networks Found	Wired/WiFi	Network Adapters
PC	1	0	0
Wired/WiFi	0	0	0
Network Adapters	0	0	0

Adapter	Gateway IP	IP	MAC	Wired/WiFi	Network Adapters
Intel(R) Dual Band Wireless-AC 3165	192.168.0.0	192.168.0.0	7C:67:A2:F3:C5:55	0	0

Download waveform data via Wi-Fi using the Geometrics Atom Downloader (3)

7) Turn on all Atom units

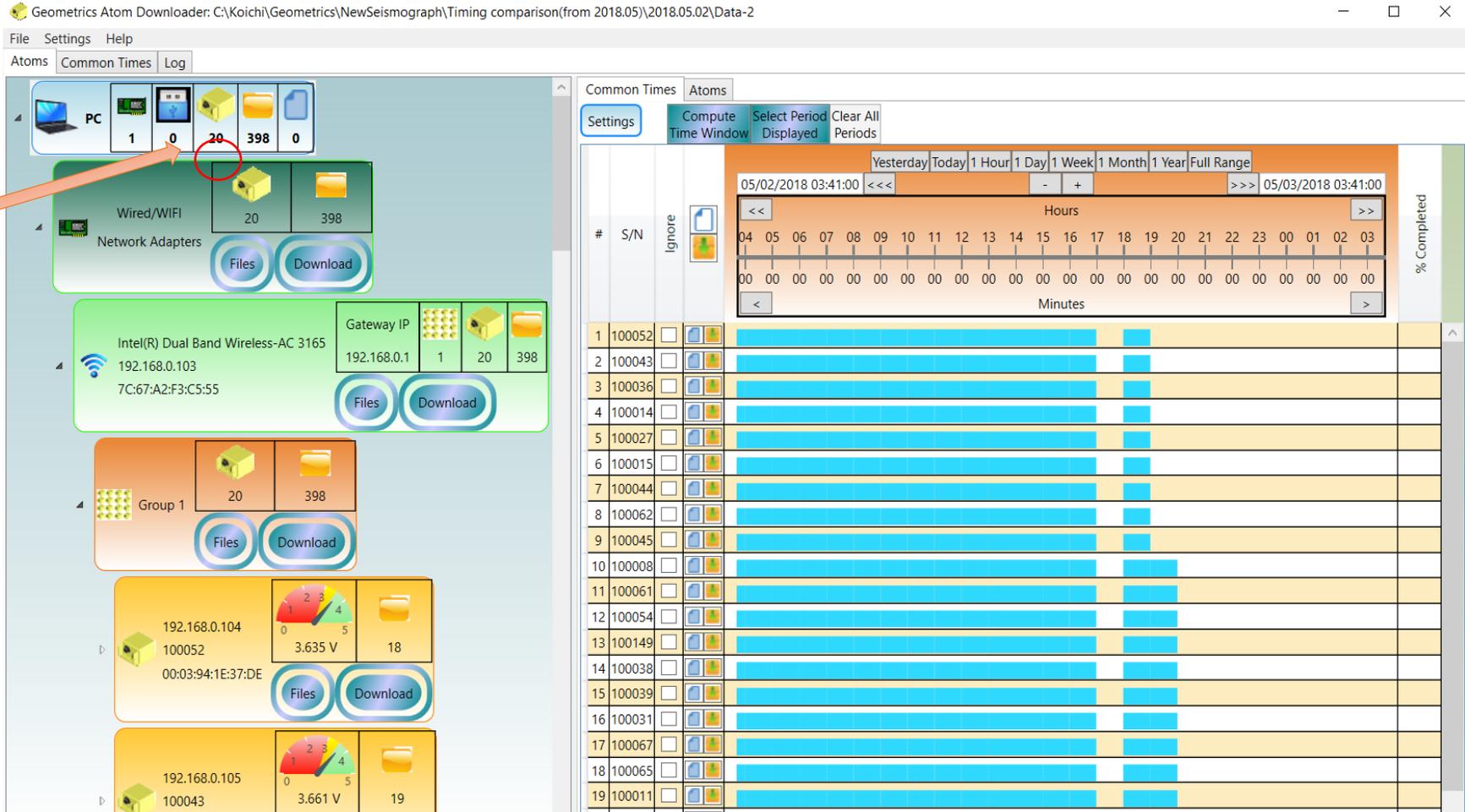
The Atom units enter download mode when they find the access point named “atom0000”. In this mode, the data recording does not start.



Download waveform data via Wi-Fi using the Geometrics Atom Downloader (4)

8) Atom IDs appear on the Atom Tree Window of the Downloader.

Number of Atom units 



#	S/N	Ignore	% Completed
1	100052	<input type="checkbox"/>	
2	100043	<input type="checkbox"/>	
3	100036	<input type="checkbox"/>	
4	100014	<input type="checkbox"/>	
5	100027	<input type="checkbox"/>	
6	100015	<input type="checkbox"/>	
7	100044	<input type="checkbox"/>	
8	100062	<input type="checkbox"/>	
9	100045	<input type="checkbox"/>	
10	100008	<input type="checkbox"/>	
11	100061	<input type="checkbox"/>	
12	100054	<input type="checkbox"/>	
13	100149	<input type="checkbox"/>	
14	100038	<input type="checkbox"/>	
15	100039	<input type="checkbox"/>	
16	100031	<input type="checkbox"/>	
17	100067	<input type="checkbox"/>	
18	100065	<input type="checkbox"/>	
19	100011	<input type="checkbox"/>	

Download waveform data via Wi-Fi using the Geometrics Atom Downloader (5)

- 9) Select a time range from which data will be downloaded by a mouse in the windows at right hand side.

The screenshot shows the Geometrics Atom Downloader software interface. The window title is "Geometrics Atom Downloader: C:\Koichi\Geometrics\NewSeismograph\Timing comparison(from 2018.05)\2018.05.02\Data-2". The interface is divided into two main sections. The left section shows network adapters and their status. The right section shows a table of data points with a time range selector and a progress bar. A red box highlights a column in the table, and an orange arrow points to it with the text "Select by a mouse".

#	S/N	ignore	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	% Completed
1	100052	<input type="checkbox"/>																									
2	100043	<input type="checkbox"/>																									
3	100036	<input type="checkbox"/>																									
4	100014	<input type="checkbox"/>																									
5	100027	<input type="checkbox"/>																									
6	100015	<input type="checkbox"/>																									
7	100044	<input type="checkbox"/>																									
8	100062	<input type="checkbox"/>																									
9	100045	<input type="checkbox"/>																									
10	100008	<input type="checkbox"/>																									
11	100061	<input type="checkbox"/>																									
12	100054	<input type="checkbox"/>																									
13	100149	<input type="checkbox"/>																									
14	100038	<input type="checkbox"/>																									
15	100039	<input type="checkbox"/>																									
16	100031	<input type="checkbox"/>																									
17	100067	<input type="checkbox"/>																									
18	100065	<input type="checkbox"/>																									
19	100011	<input type="checkbox"/>																									
20	100006	<input type="checkbox"/>																									

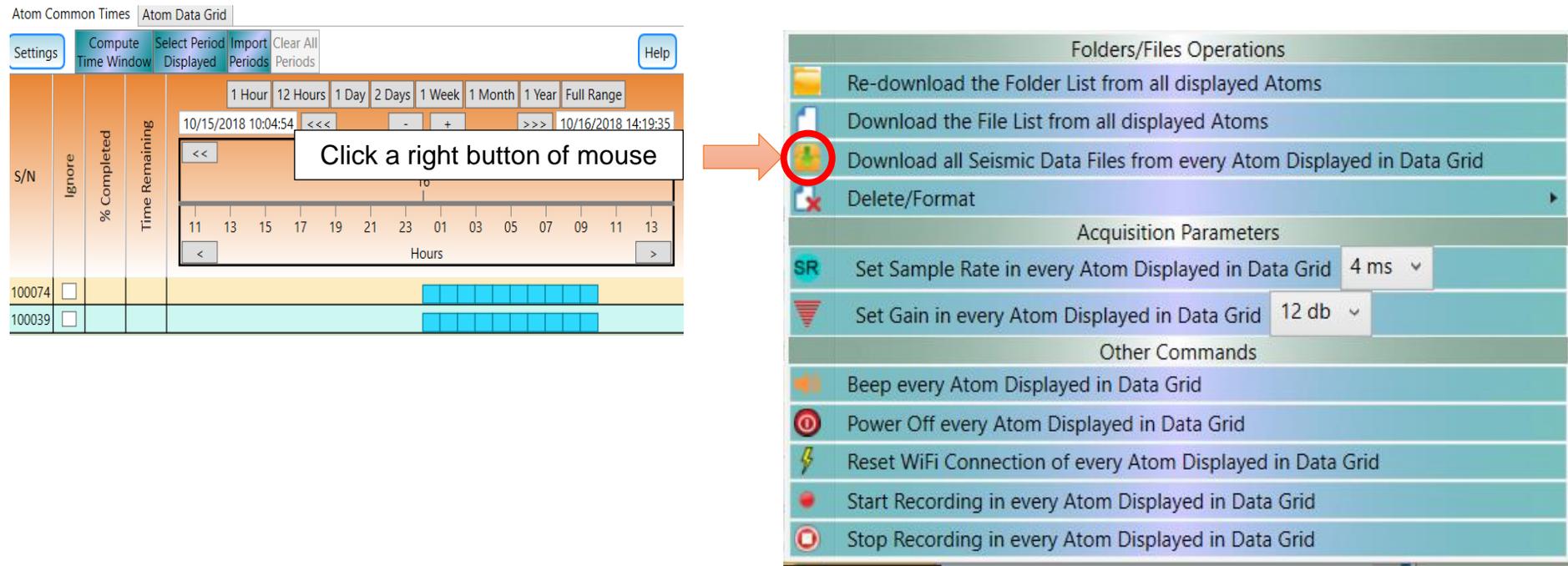
Download waveform data via Wi-Fi using the Geometrics Atom Downloader (6)

10) Click [Compute Time Window] to download common time windows (blocks) or [Select Period Displayed] to download all data displayed in the window.

The screenshot shows the Geometrics Atom Downloader software interface. The window title is "Geometrics Atom Downloader: C:\Koichi\Geometrics\NewSeismograph\Timing comparison(from 2018.05)\2018.05.02\Data-2". The interface is divided into several sections. On the left, there are network adapters listed, including "Wired/WiFi" and "Intel(R) Dual Band Wireless-AC 3165". The main area shows a list of 20 "Atoms" (data points) with columns for S/N, Ignore, and % Completed. A "Common Times" window is open, showing a time range from 05/02/2018 17:26:05 to 05/02/2018 20:56:16. A red box highlights a selected common time window in the table, and a callout box points to it with the text "Selected Common time window".

Download waveform data via Wi-Fi using the Geometrics Atom Downloader (7)

- 11) Click a right button of mouse in time scale above the Atom data grid to show sub menu.
- 12) Select  in the sub menu to start download data.

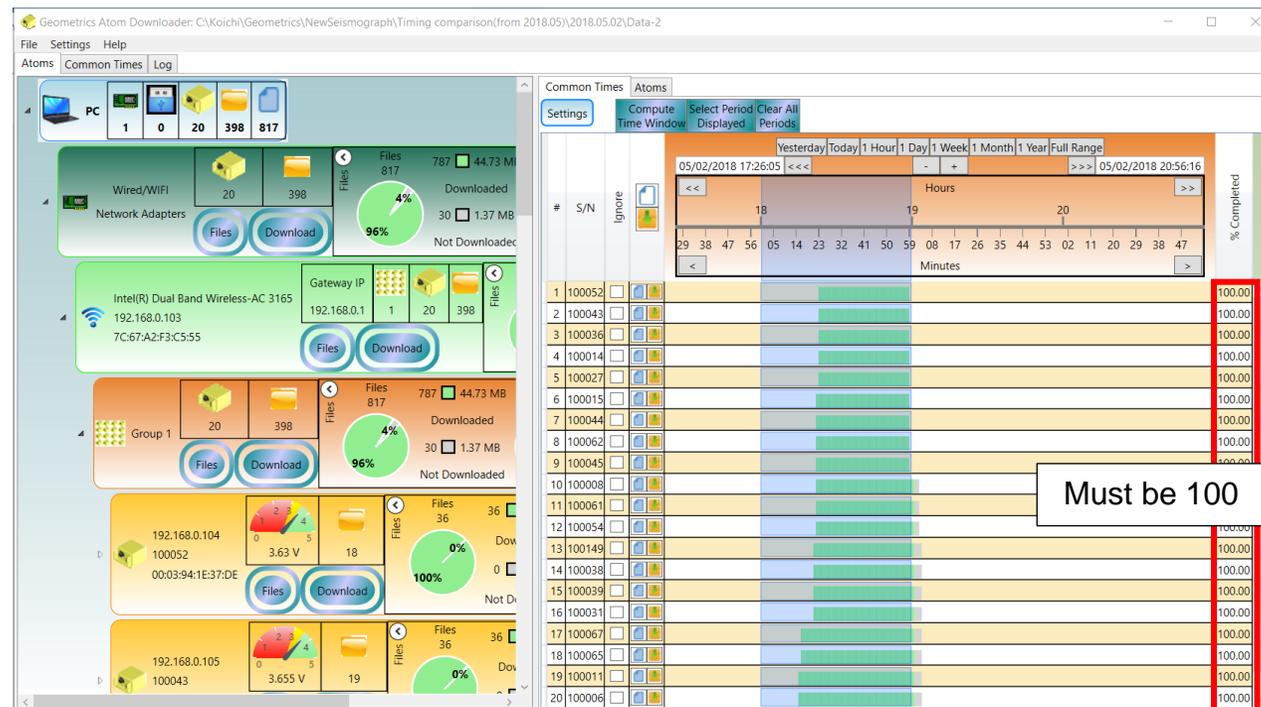


The screenshot displays the Geometrics Atom Downloader software interface. The main window is titled 'Atom Data Grid' and contains a table with columns for 'S/N', 'Ignore', '% Completed', and 'Time Remaining'. The 'Time Remaining' column shows a time scale from 10/15/2018 10:04:54 to 10/16/2018 14:19:35. A context menu is open over the time scale, listing various actions such as 'Re-download the Folder List from all displayed Atoms', 'Download the File List from all displayed Atoms', 'Download all Seismic Data Files from every Atom Displayed in Data Grid', and 'Delete/Format'. The 'Download all Seismic Data Files from every Atom Displayed in Data Grid' option is highlighted with a red circle. An orange arrow points from the text 'Click a right button of mouse' to the context menu.



Download waveform data via Wi-Fi using the Geometrics Atom Downloader (8)

13) During the download process, progress appears on a display similar to the one shown below. After download completed, completion at the far-right column must be 100 at all rows.

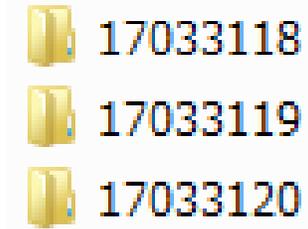


Data format

Downloaded waveform data is saved in binary files with extension “.atm. The files can be opened by Pickwin.

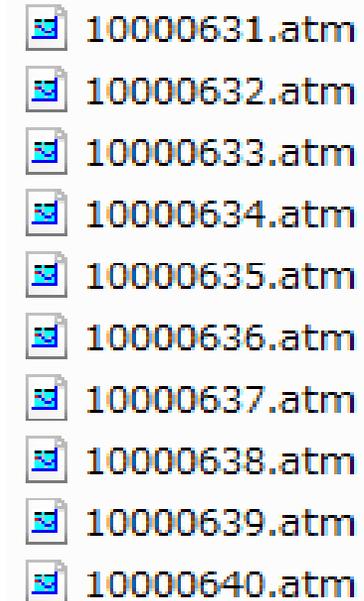
Folder for each hour.

The data files are automatically saved to the date and time (UTC) the data is collected. In the example shown below, the folders represent data collect on March 31st, 2017 between 18:00 and 20:00 UTC.



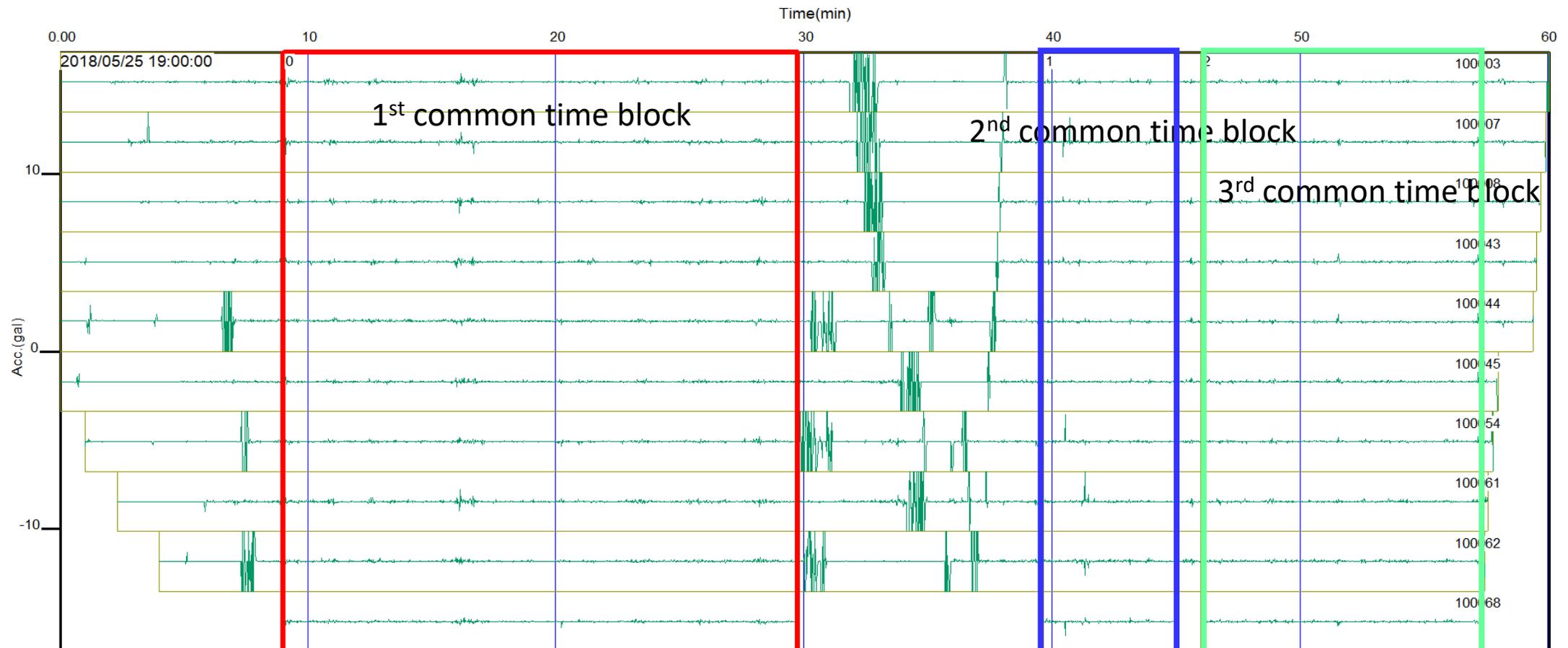
Waveform data file.

Collected data are stored in files named for the Atom unit’s ID and time in minutes. In the example shown below, files are recorded with Atom unit 100006 from 31 to 40 min.



Export waveform data as SEG2 or ASCII file using SPACPlus in SeisImager

Downloaded waveform data can be exported as SEG2 or ASCII file using SPACPlus in SeisImager. Data are exported with each Common Time Block (CTB) during which all Atom units were recording data. An area surrounded by a red rectangle is a “Common Time Block (CTB)”. In SPACPlus, waveform traces appear in order from lower to higher Atom ID numbers.



6. Data processing using SeisImager

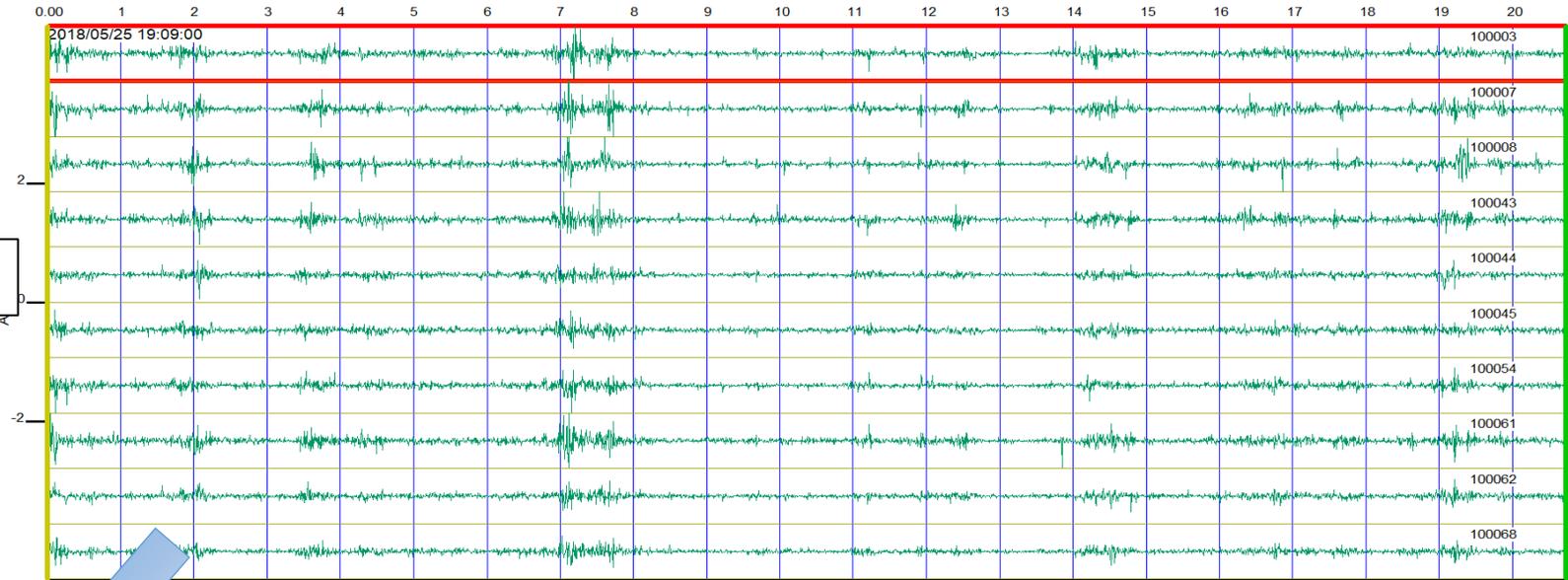
- Data downloading from Atom
- 1D active/passive surface wave method (data obtained by Atom)
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- Higher modes and inversion using effective mode based on Genetic Algorithm

Data processing

CTB Index = 0

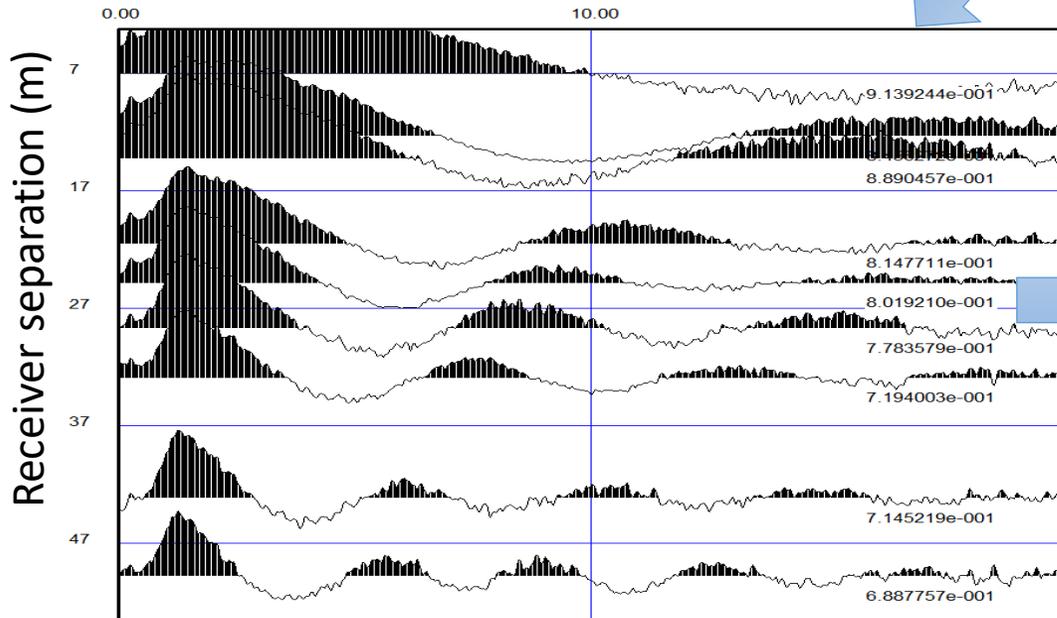
Time (min.)

Raw data (noise)



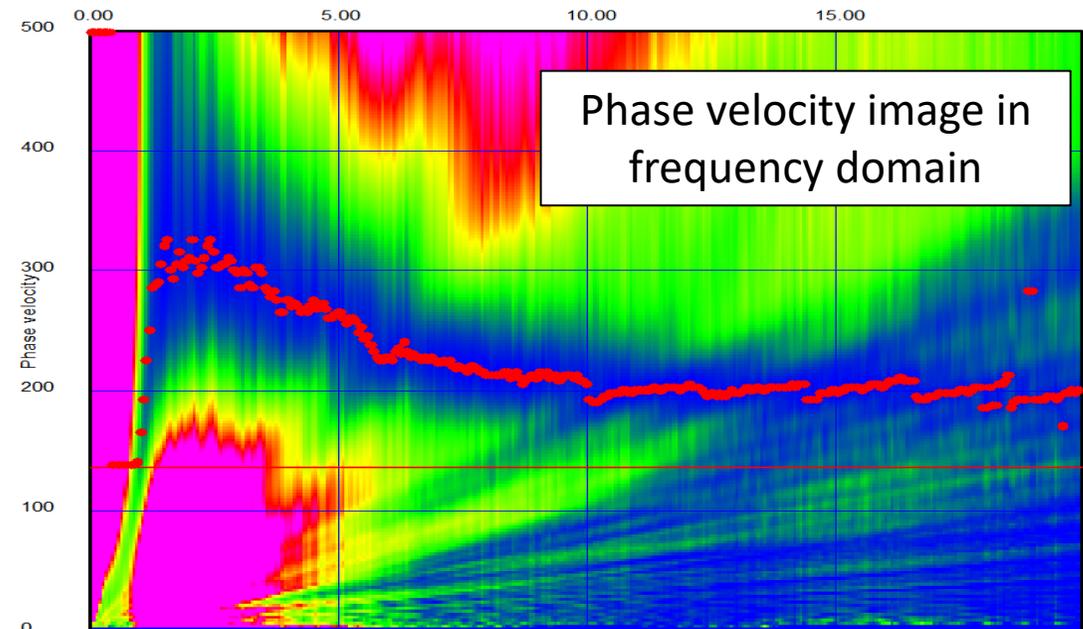
Coherency (cross correlation)

Frequency (Hz)



Frequency (Hz)

Phase velocity (m/sec)



Window structure of SPACPlus

Main window (multi-CTB)

Main window

Geometry window

SPAC window (single-CTB)

CTB window (single-CTB)

Phase velocity window (single-CTB)

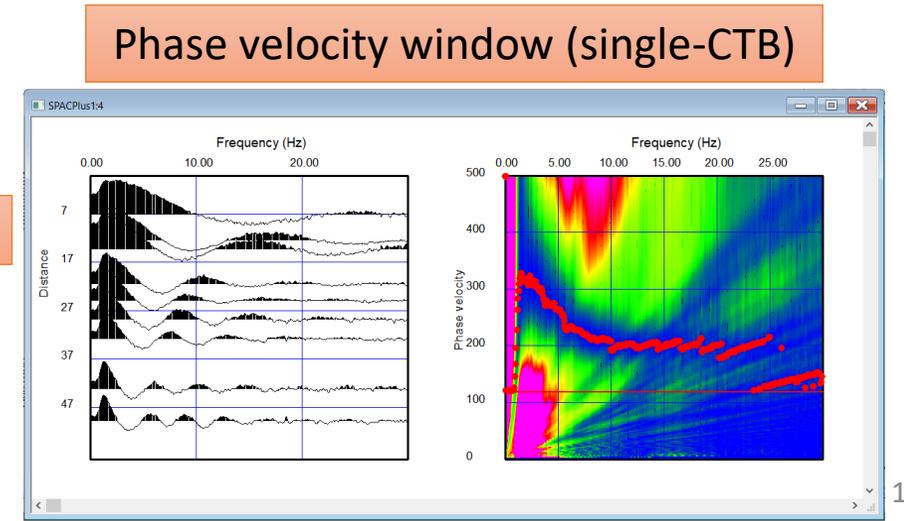
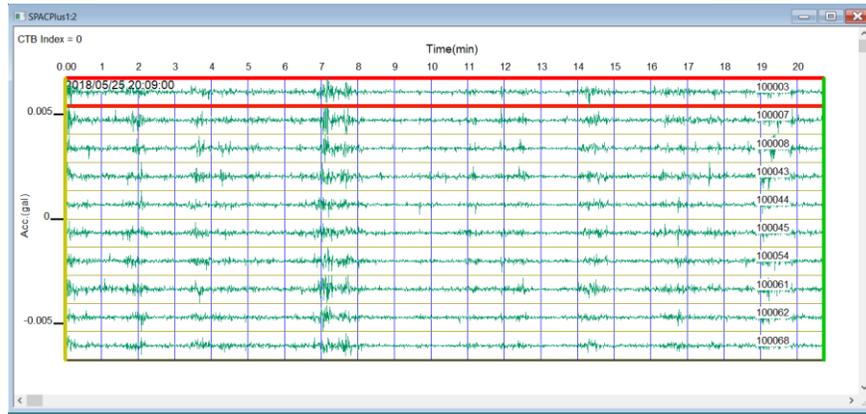
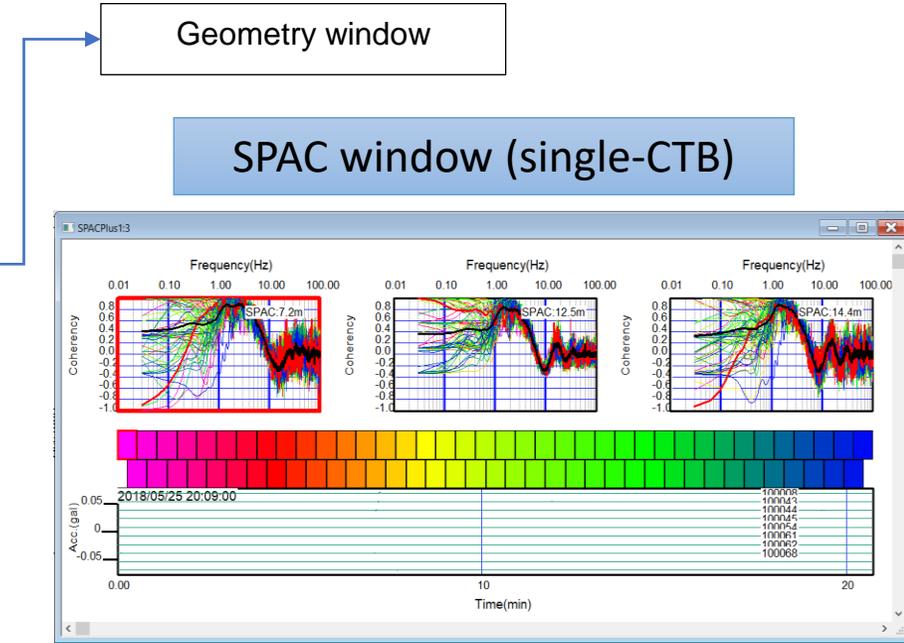
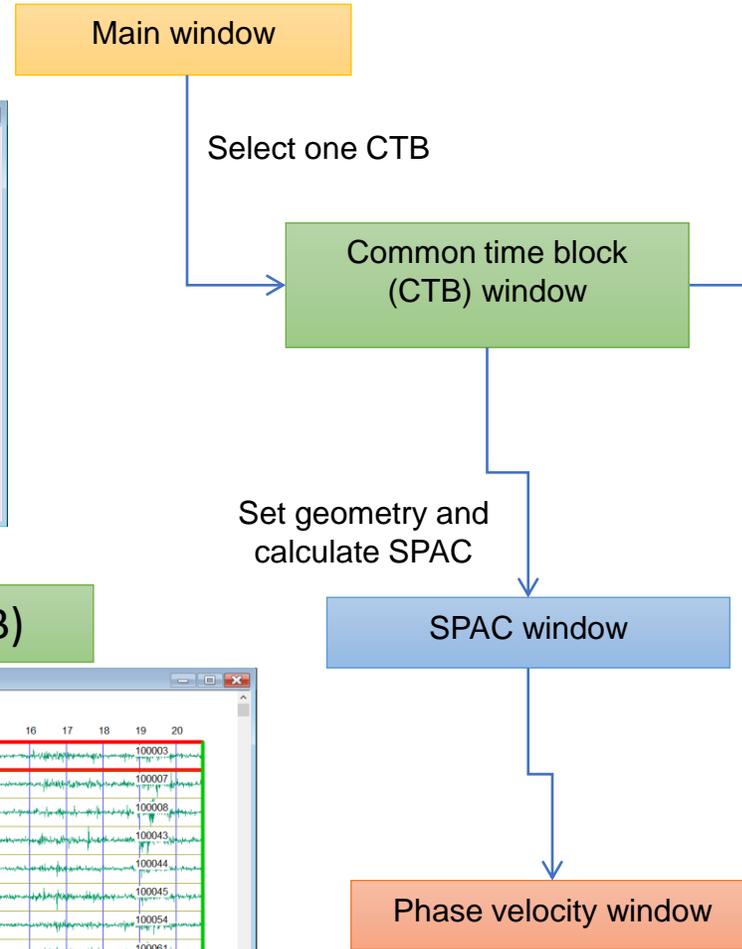
Select one CTB

Common time block (CTB) window

Set geometry and calculate SPAC

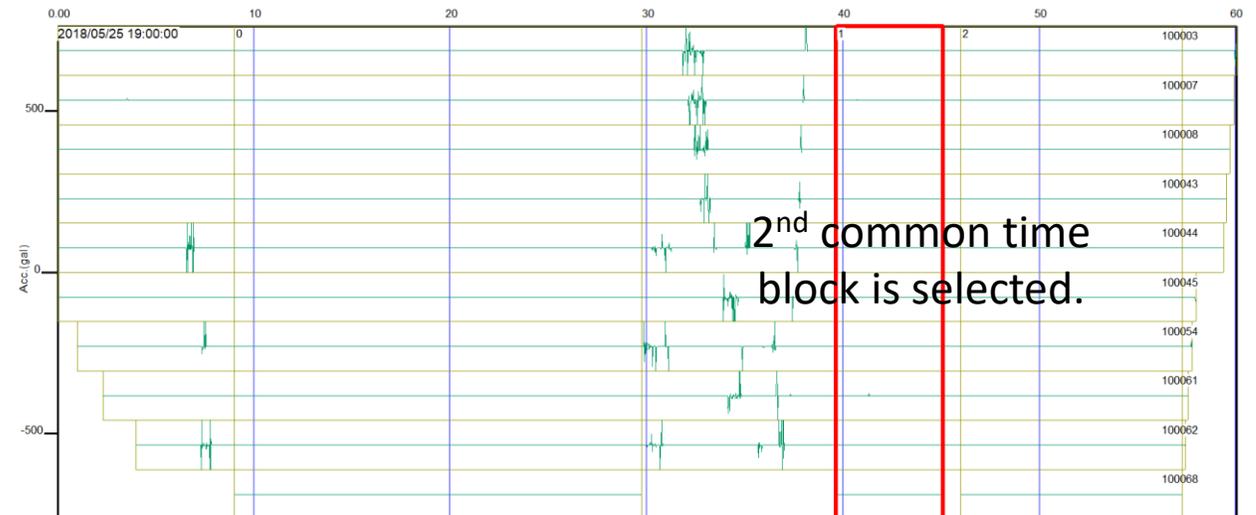
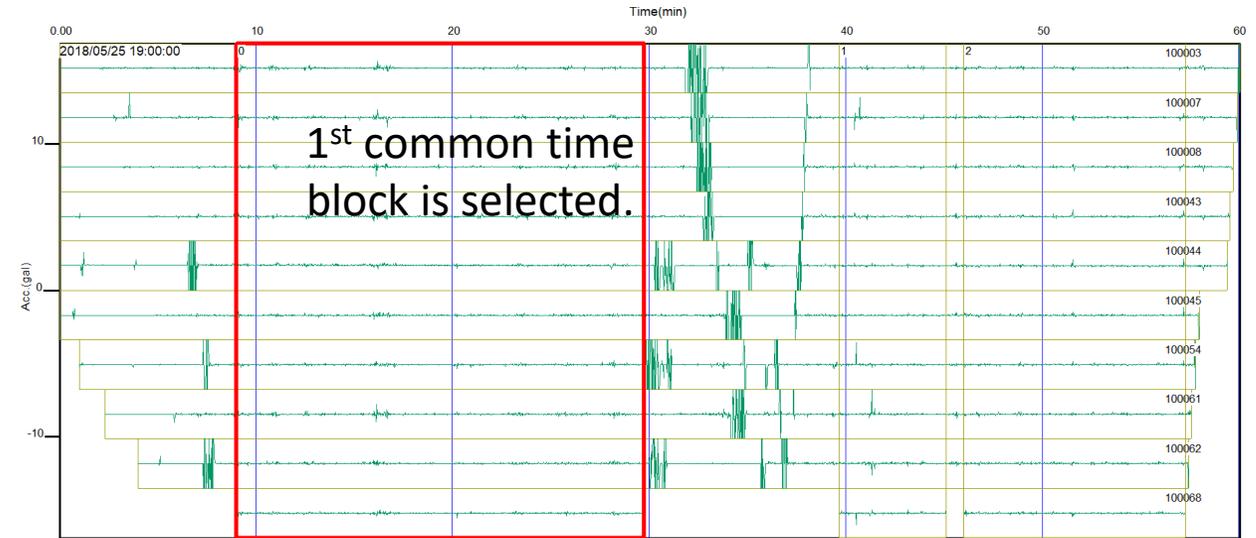
SPAC window

Phase velocity window



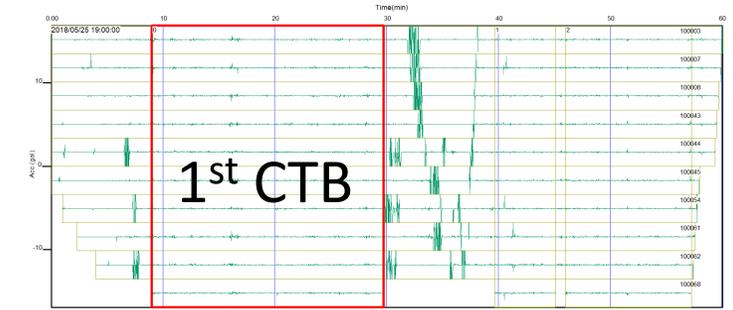
Select a common time block to be processed

Select a common time block (CTB) to be processed, using left and right arrows if several tables are shown.

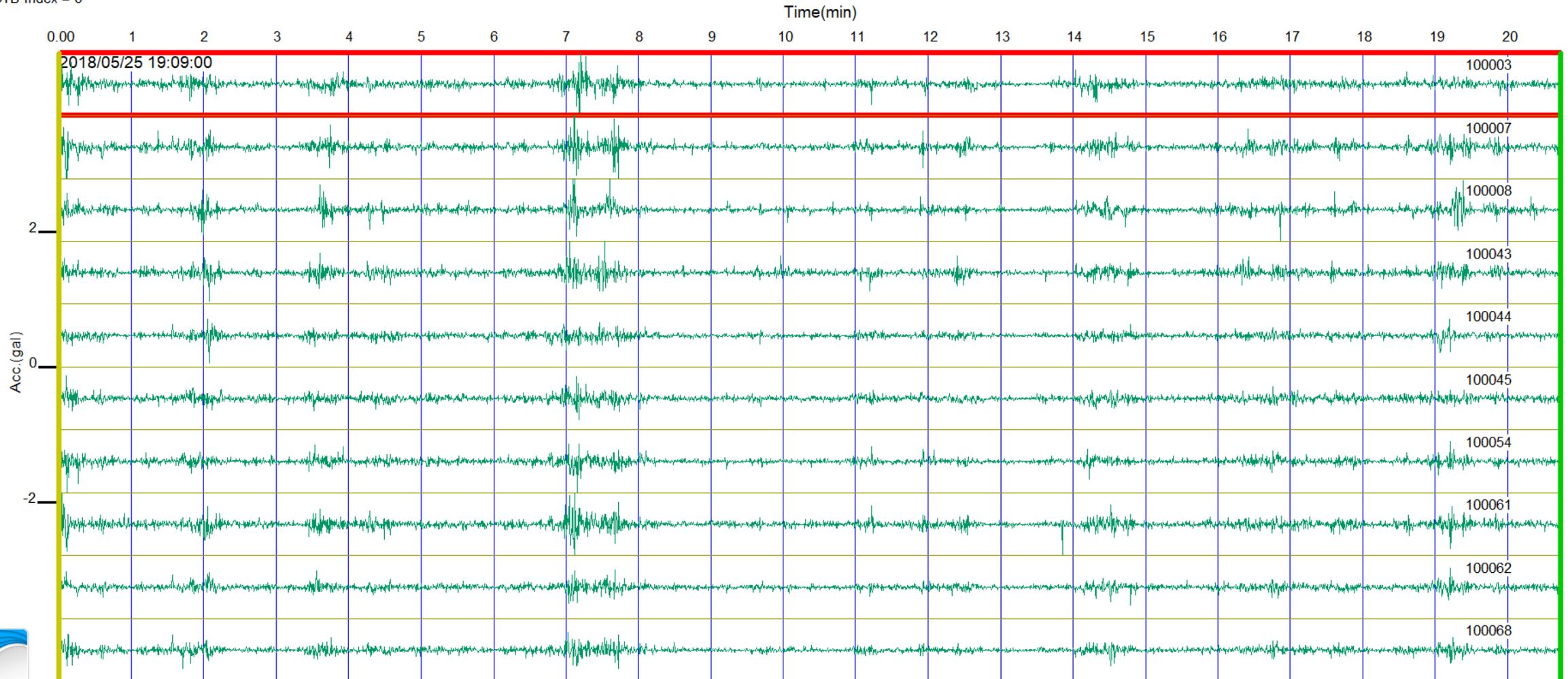


Processing ambient noise data

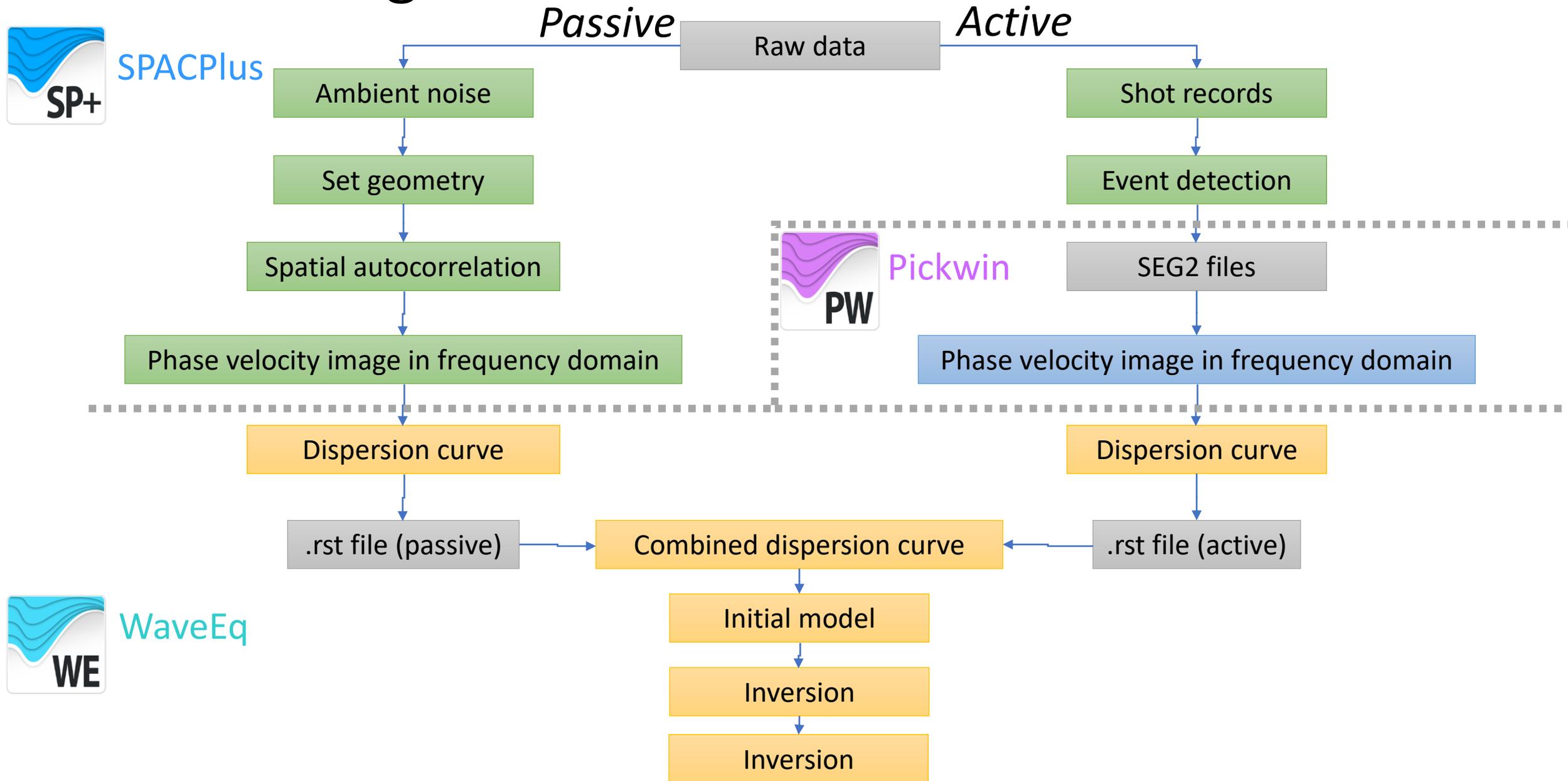
Click  or select [Window]>>[Processing window] and the selected 1st CTB data (in a red rectangle) will appear in another window.



CTB Index = 0

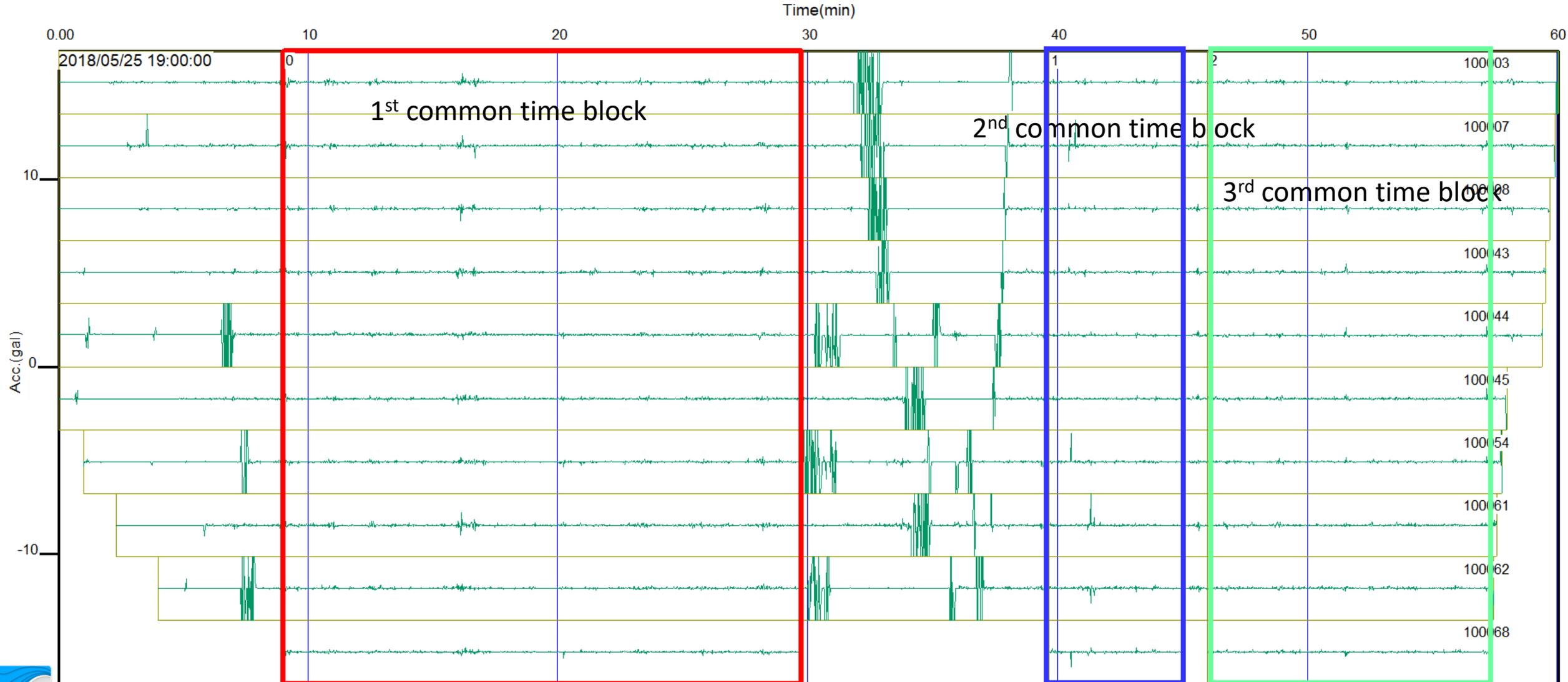


Processing flow



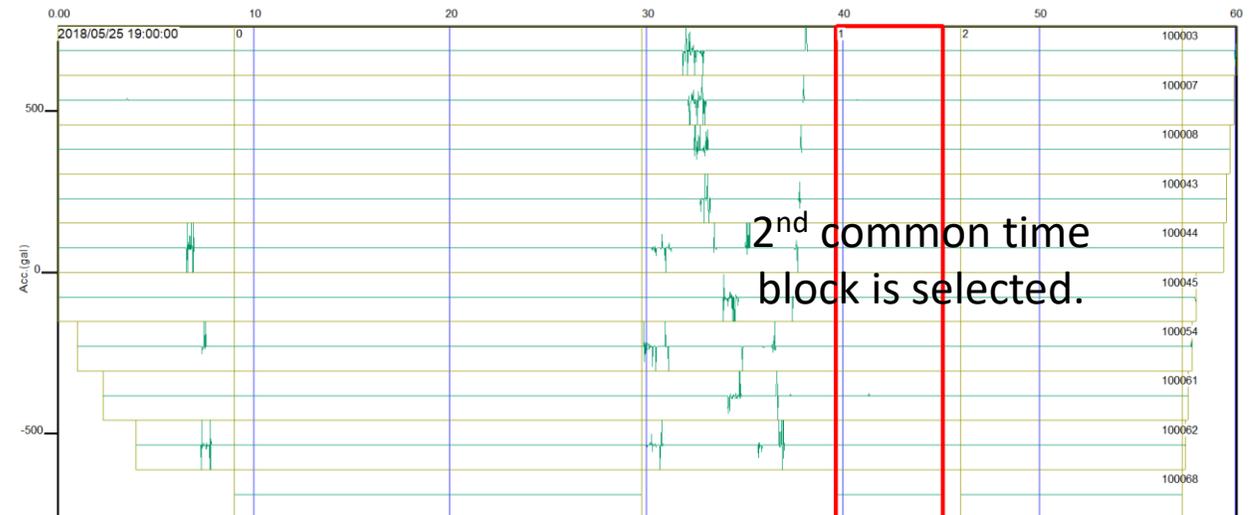
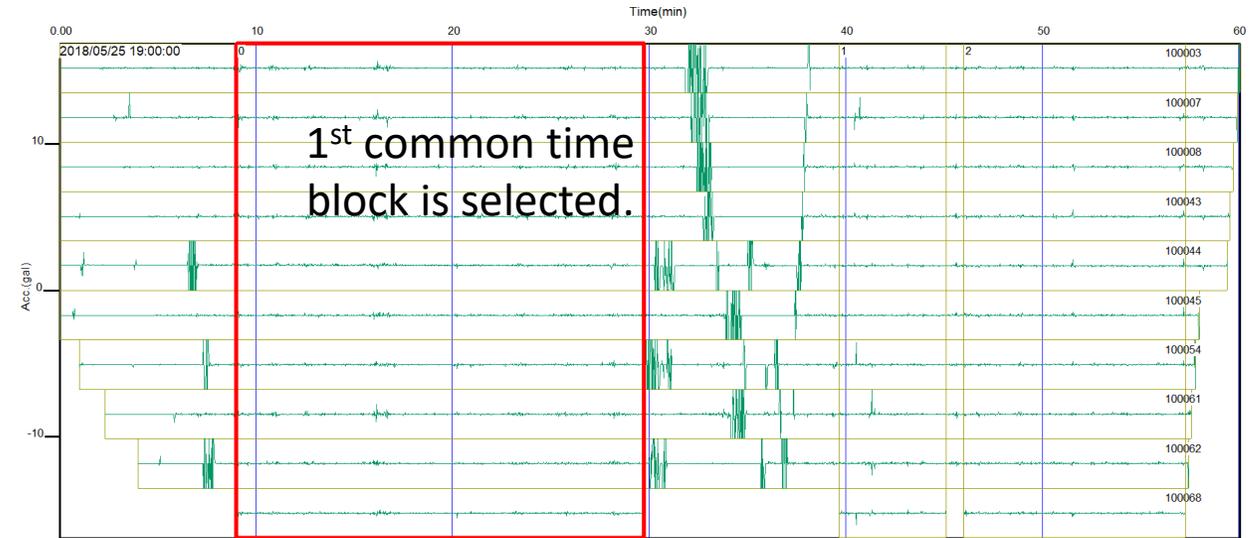
Raw data

In SPACPlus, waveform traces appear in order from lower to higher Atom ID numbers. An area surrounded by a red rectangle is a “Common Time Block (CTB)” during which all Atom units were recording data.



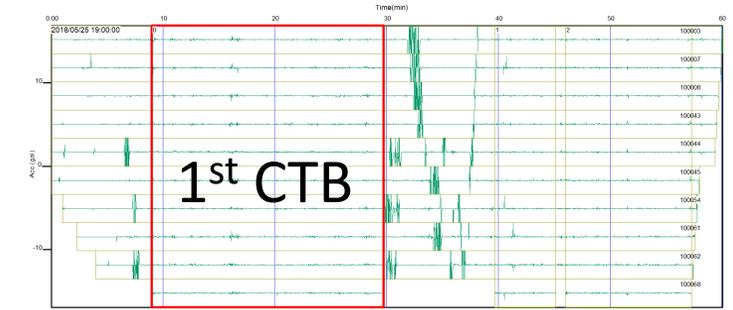
Select a common time block to be processed

Select a common time block (CTB) to be processed, using left and right arrows if several tables are shown.

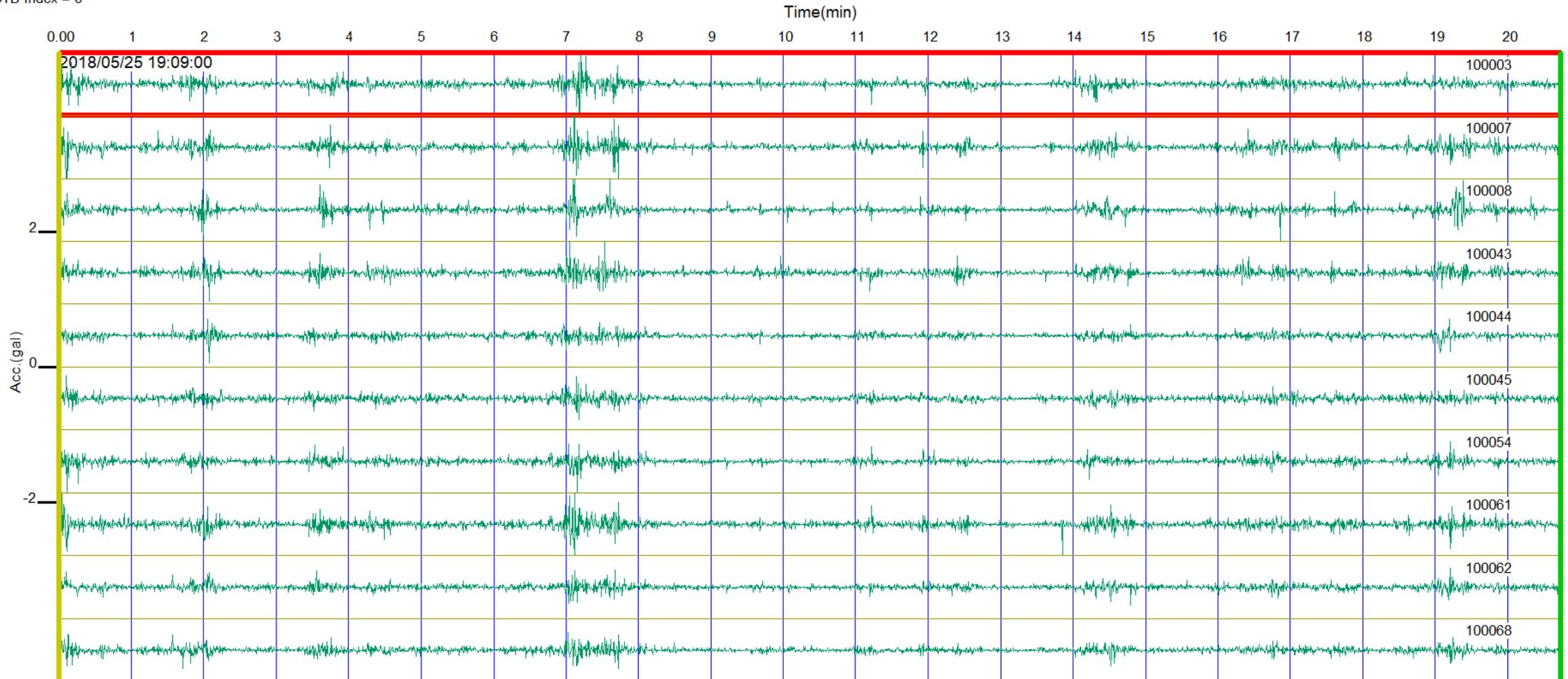


Processing ambient noise data

Click  or select [Window]>>[Processing window] and the selected 1st CTB data (in a red rectangle) will appear in another window.

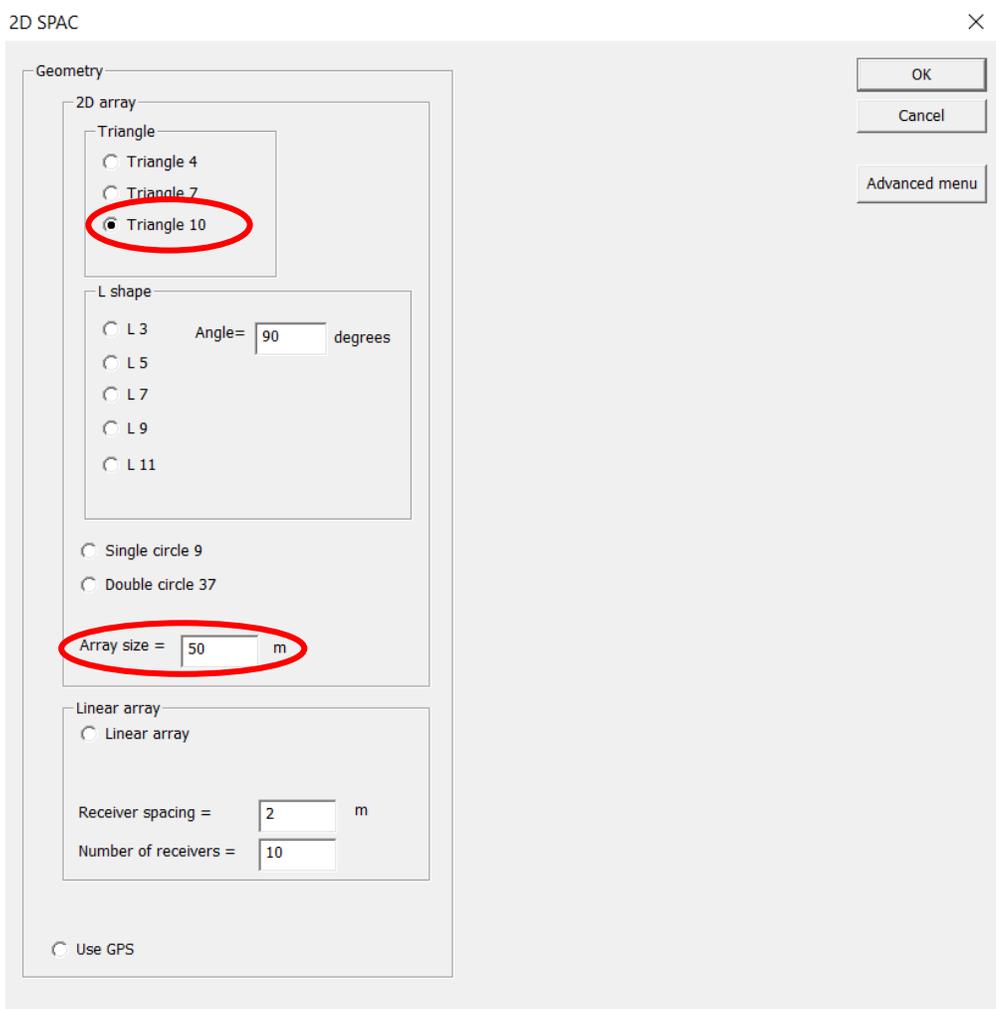


CTB Index = 0



Set up geometry

Click  or select [Analysis]>>[SPAC analysis] to process passive surface wave data in terms of Spatial Auto Correlation (SPAC). A dialog appears for setting the shape and size of the array. Select “Triangle 10” and put “50” for “Array size”. Click “OK” to proceed.



If your geometry is not listed in default arrays, click “Advanced menu” and “Open array file” and select array file. The array file is a simple ASCII file that mentions X and Y coordinate of geophones.

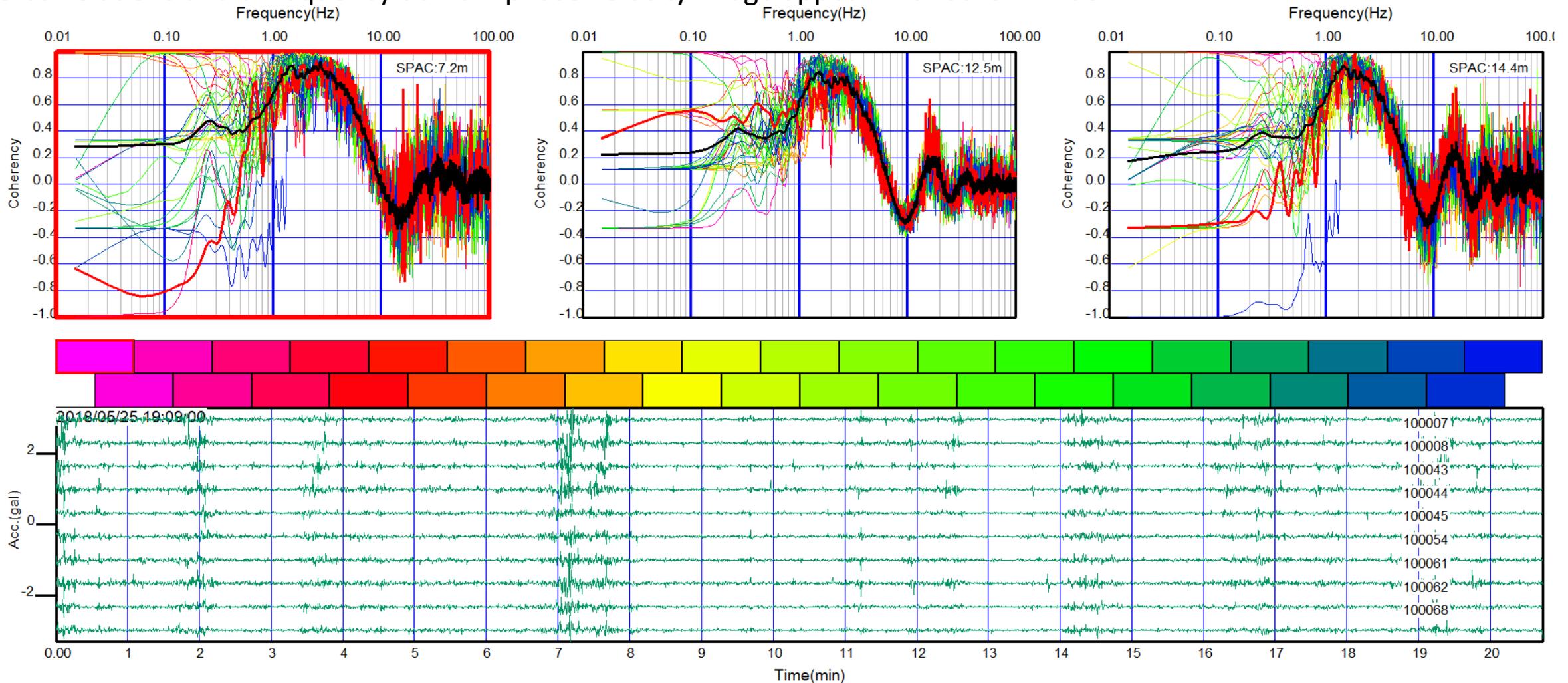


Example of array file.

```
0.000000 0.000000
25.000000 0.000000
50.000000 0.000000
37.500000 21.650635
25.000000 43.301270
12.500000 21.650635
18.750000 10.825317
31.250000 10.825317
25.000000 21.650635
25.000000 14.433757
```

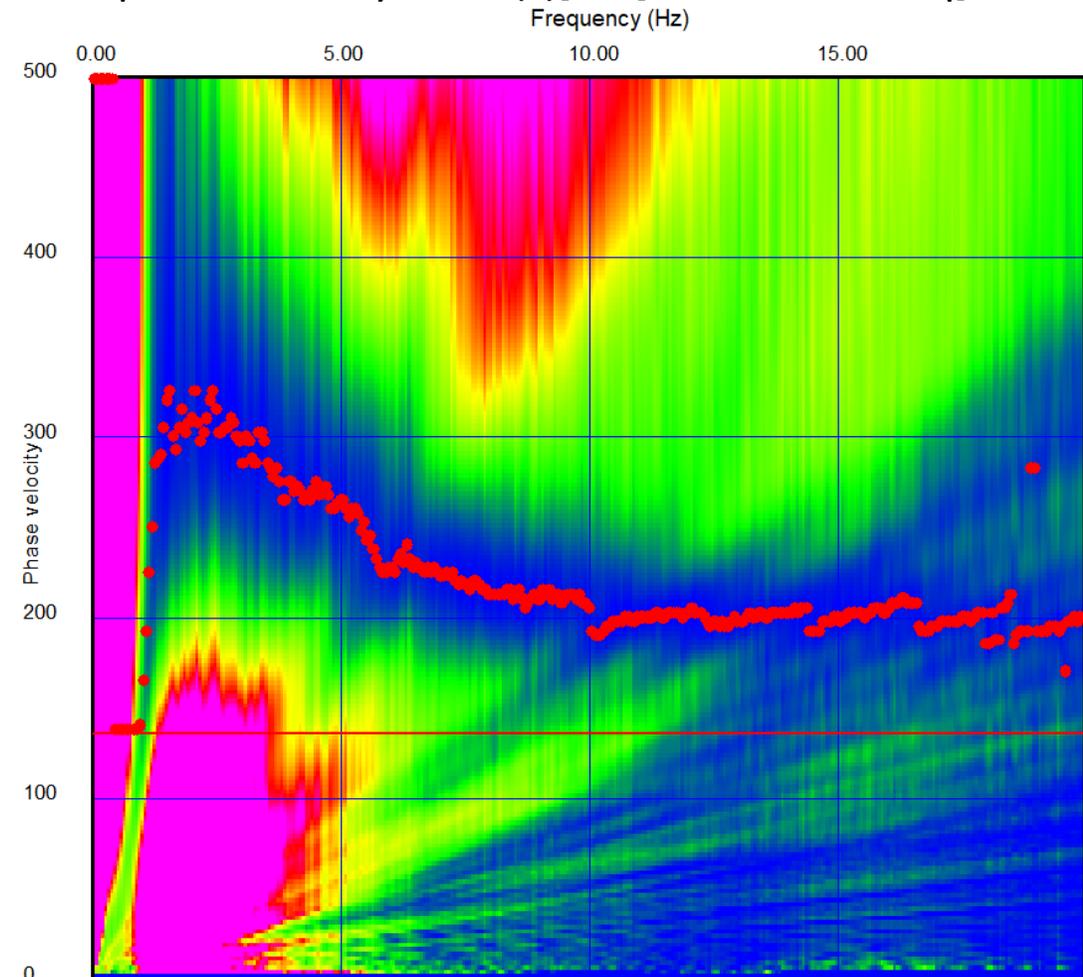
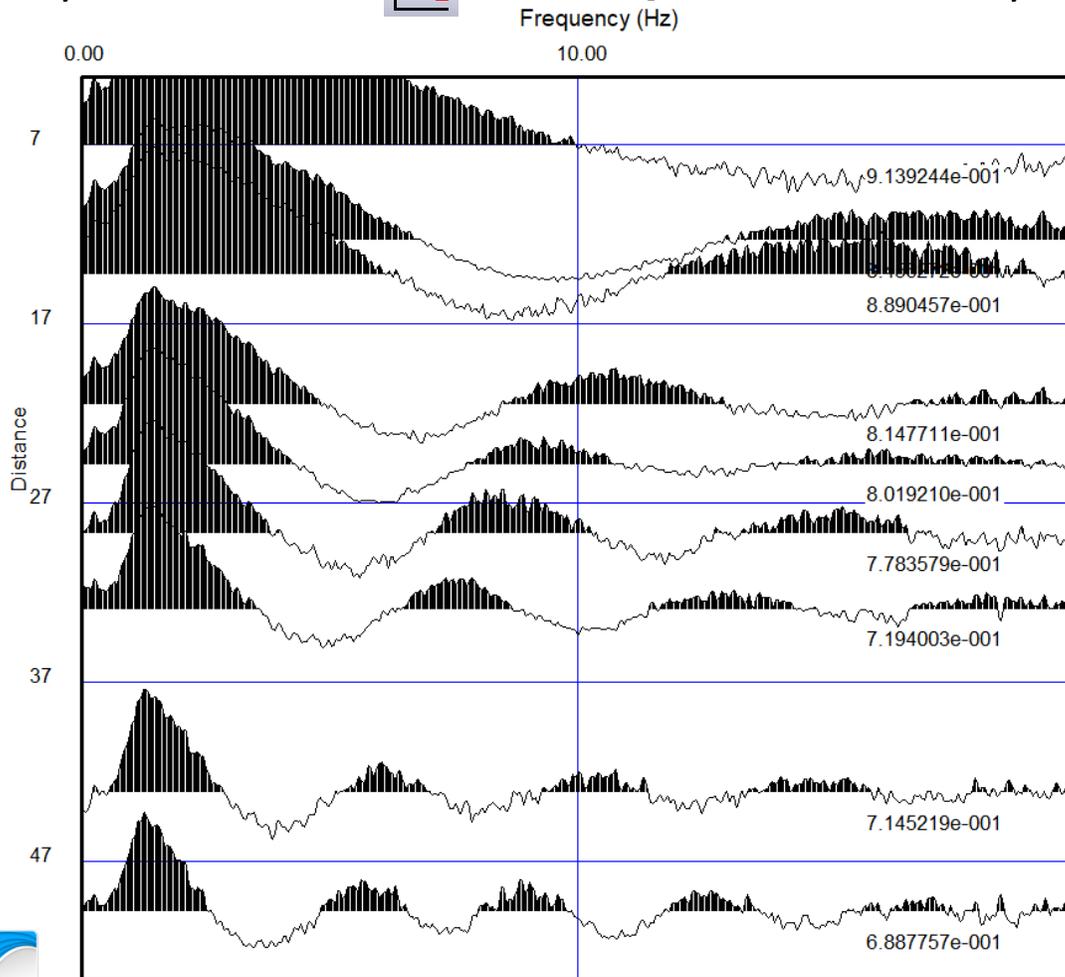
Spatial autocorrelations by frequencies

Spatial auto correlations appear. When number of receiver separation is more than three, use   buttons to scroll receiver separations to be shown. Click  or select [Phase velocity analysis]>>[Phase velocity window] and all spatial auto-correlations and a frequency domain phase velocity image appear in another window.



All spatial autocorrelations and phase velocity image in frequency domain

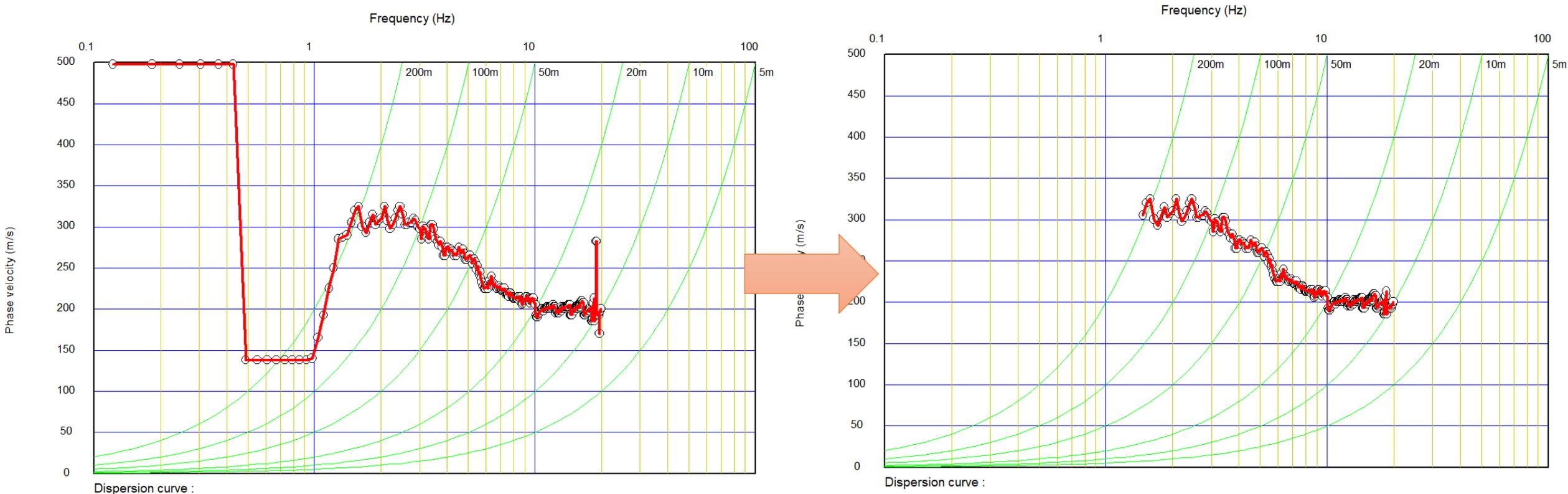
To set the minimum phase velocity to be picked, adjust a red horizontal line in a phase velocity image in frequency domain by a mouse. Click  or select [Surface wave analysis]>>[Show phase velocity curve(s)] >>[Launch WaveEq].



Editing a dispersion curve in WaveEq

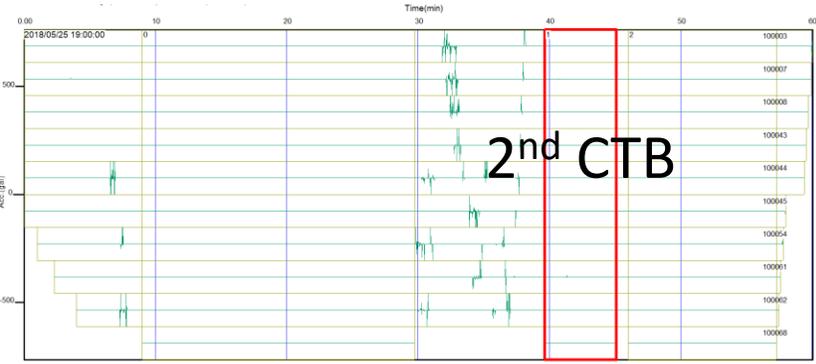
Delete noises or unnecessary frequency range.

Use  or  to select phase velocities.
Hit delete key to delete the selected phase velocities.

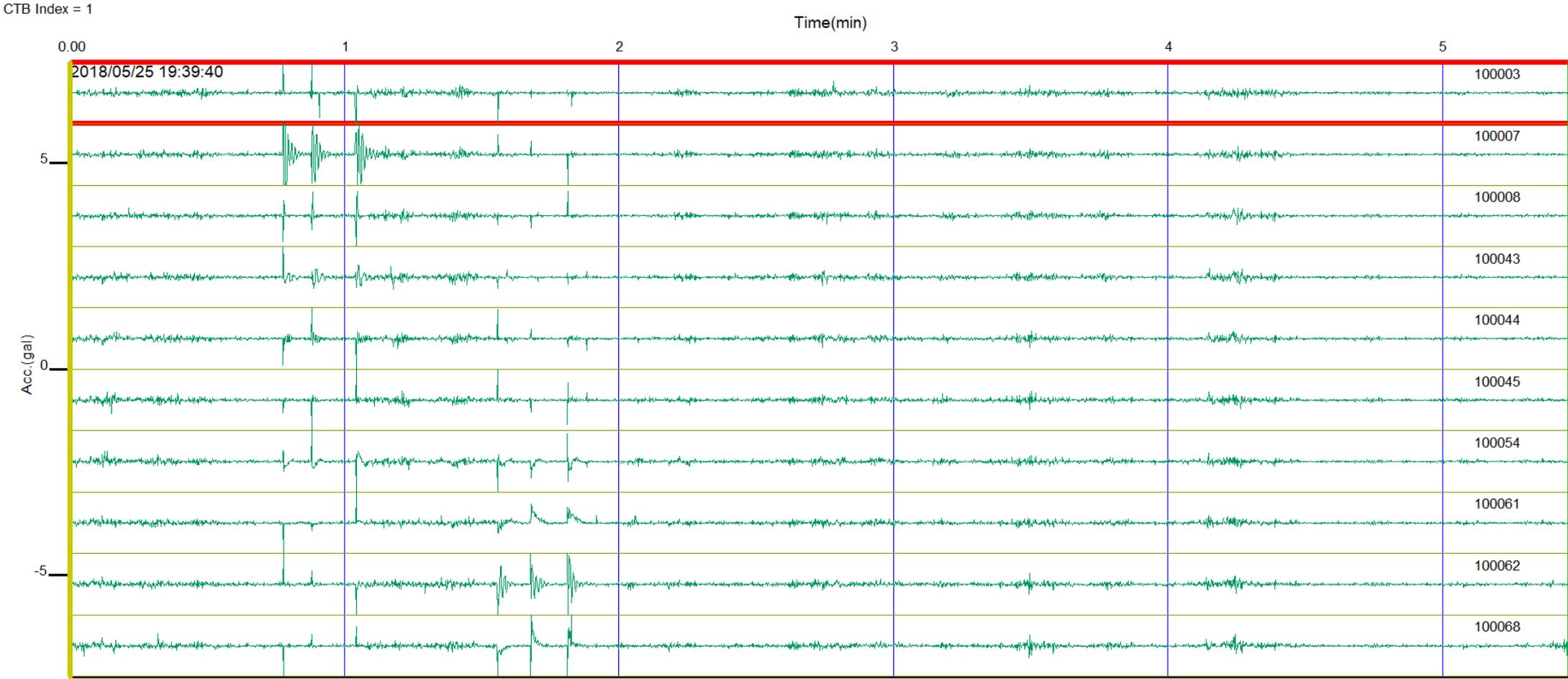


Select [File]>>[Save 1D phase velocity curve or H/V curve (.rst)] to save a dispersion curve to data file.

Processing active data (MASW)

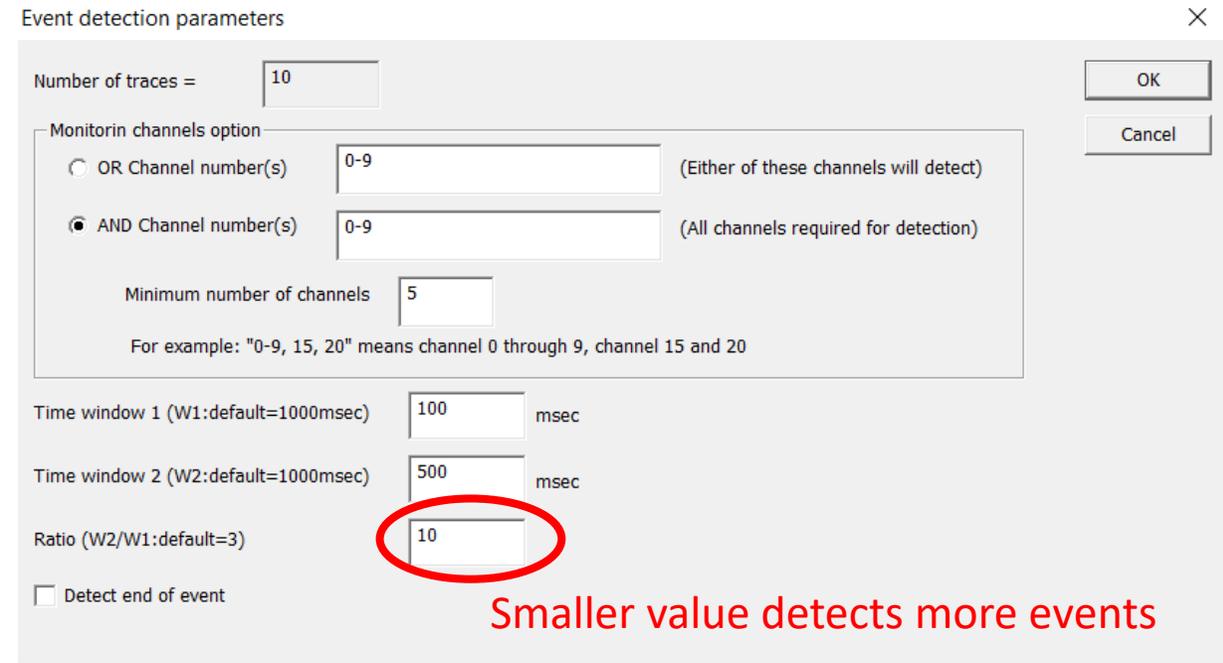
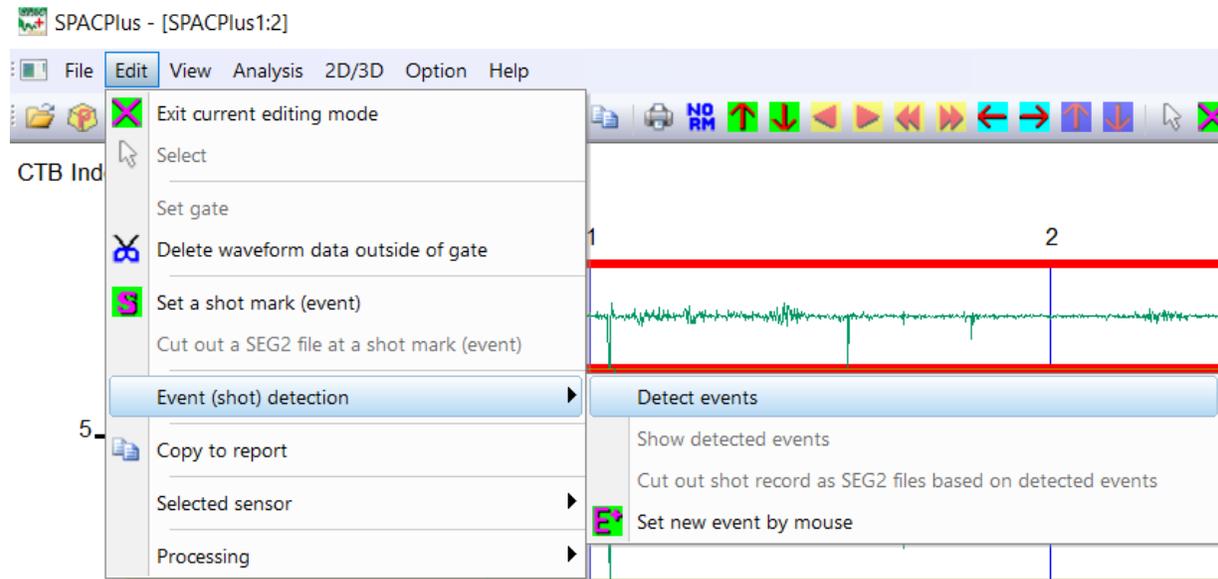


Click  or select [Window]>>[Processing window] and the selected 2nd CTB data (in a red rectangle) will appear in another window.



Detect shots by event detection

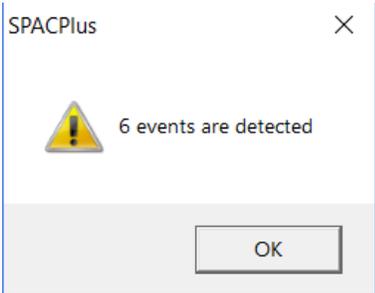
Select [Edit]>>[Event (shot) detection]>>[Detect events] and set event detection parameters.



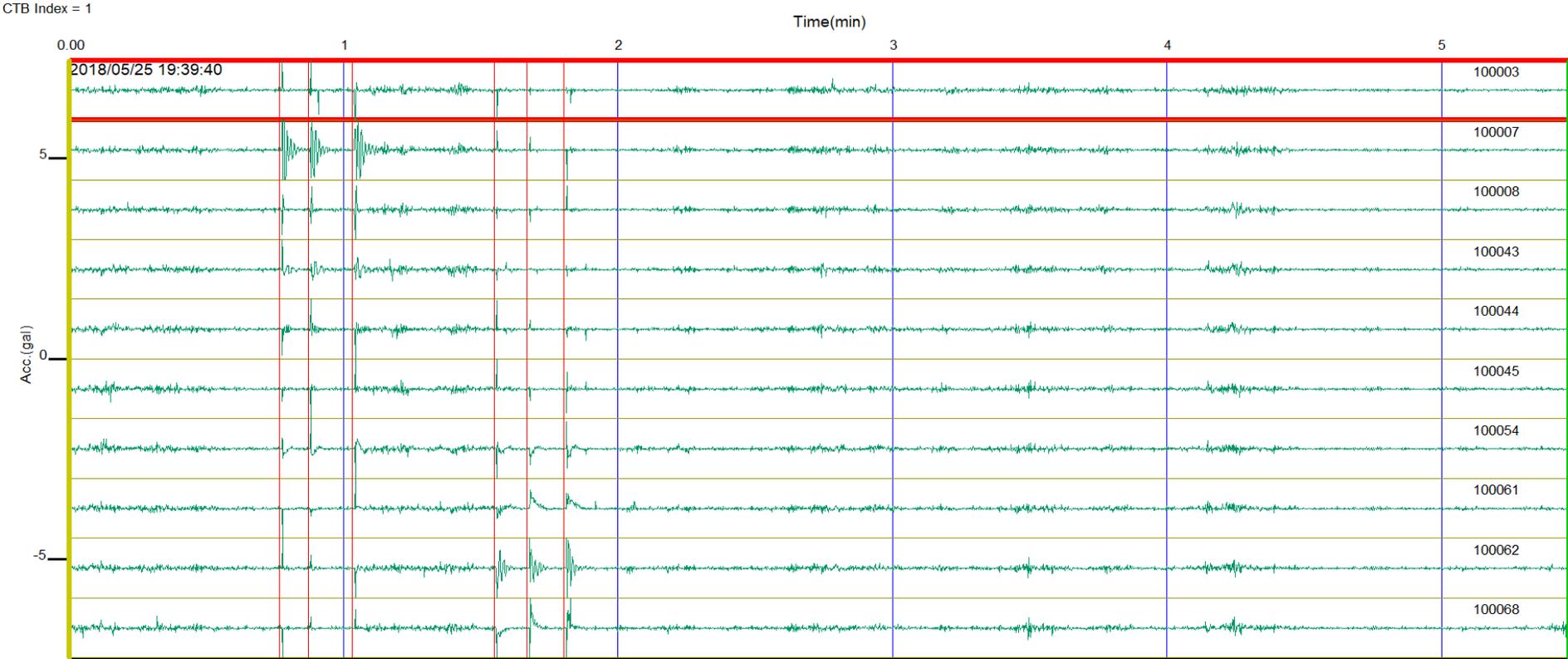
Click "OK" to detect events (shots).

Detect shots by event detection

Number of detected events appears.



Detected events (shots) are shown . Adjust the settings and repeat the detection until appropriate detections were obtained.

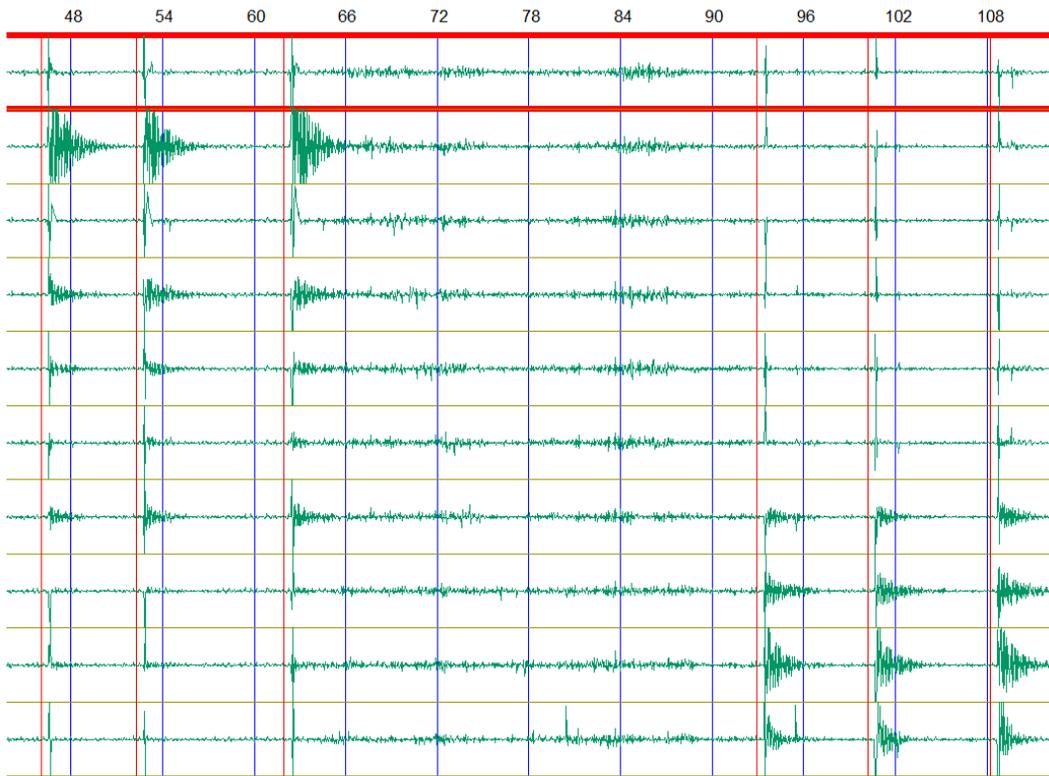


Edit detected shots

 Change horizontal (time) scale.

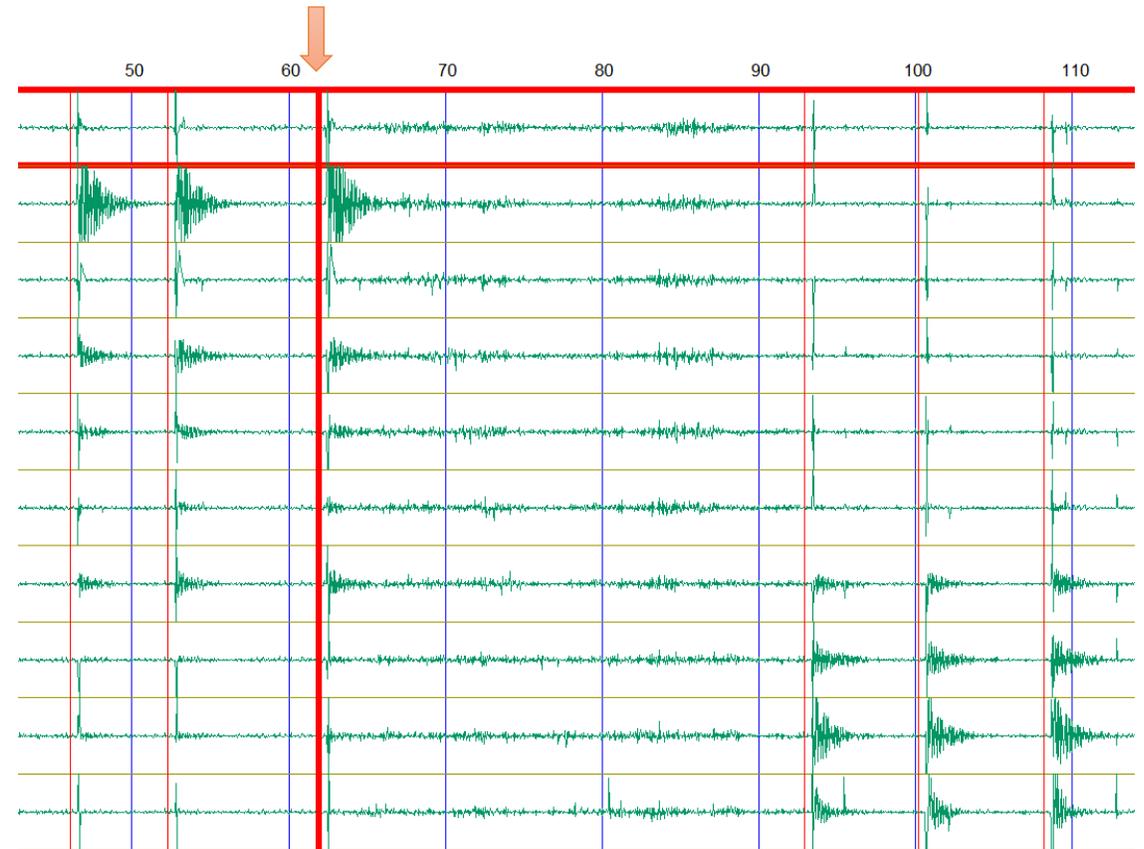
 Change amplitude.

 Add new event by clicking a left button of a mouse.



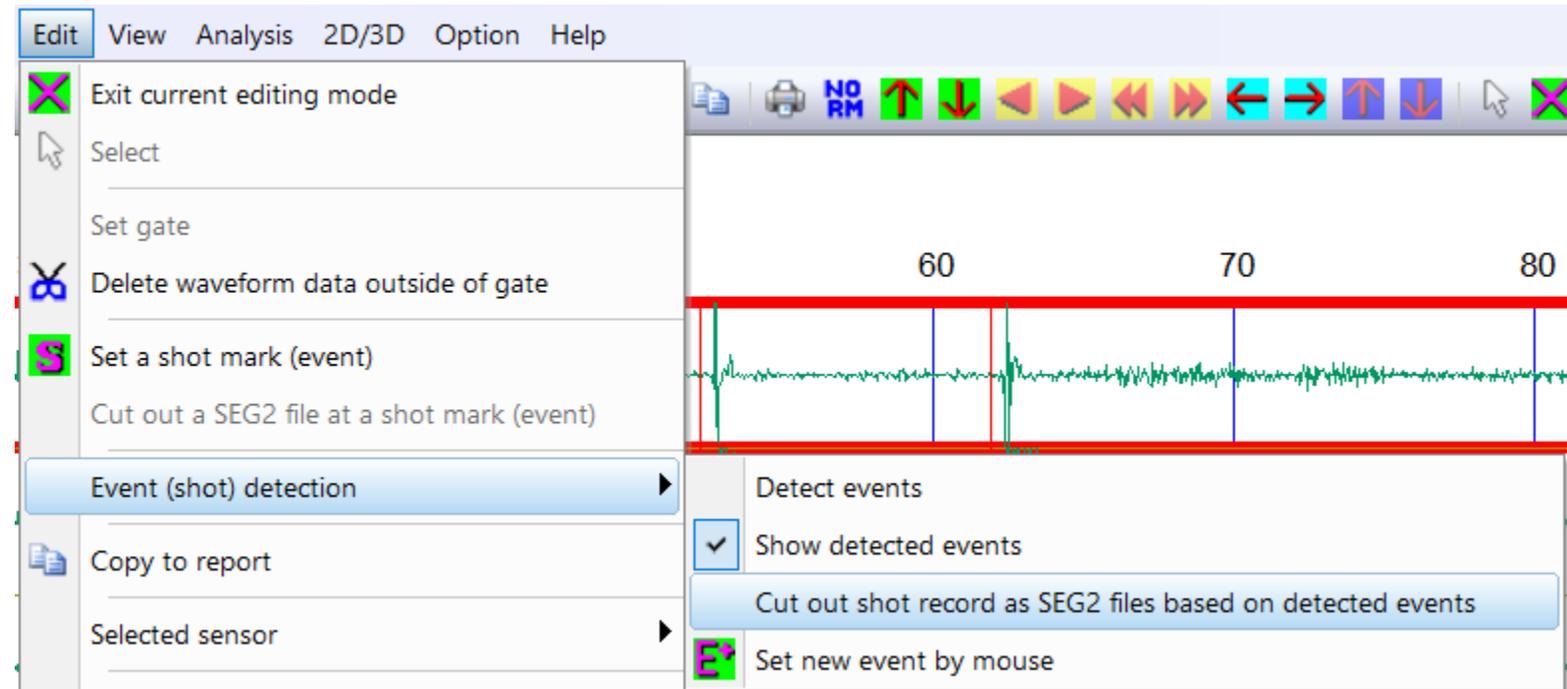
 Select a detected event. Selected event is shown as a red bold line. Hit delete key to delete the detected event. Use a mouse to move the event (left button down).

Selected event

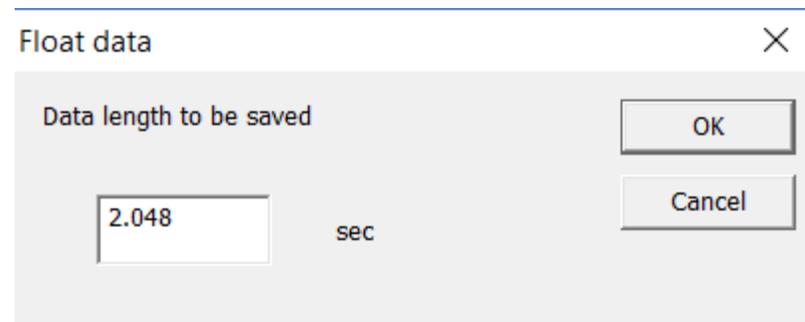


Show detected shots by Pickwin

Select [Edit]>>[Event (shot) detection]>>[Cut out shot record as SEG2 files based on detect events].

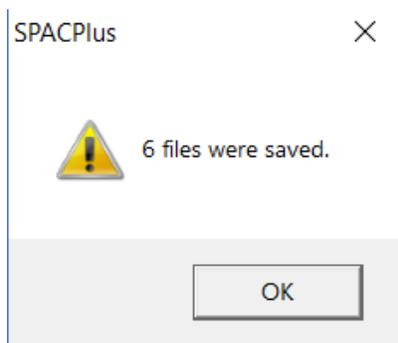


Enter data length.



Shot records are saved as SEG2 files

Number of saved files appears.



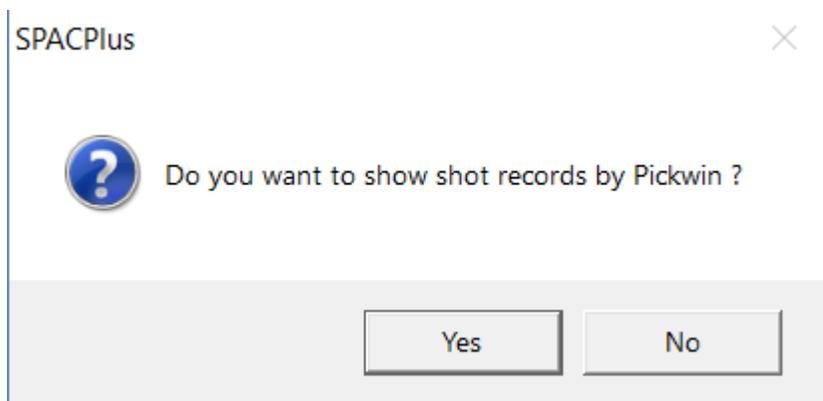
Shot records were saved as SEG2 files (.sg2) in a folder being selected.

 event_0000.sg2	5/28/2018 5:30 PM	SG2 File	30 KB
 event_0001.sg2	5/28/2018 5:30 PM	SG2 File	30 KB
 event_0002.sg2	5/28/2018 5:30 PM	SG2 File	30 KB
 event_0003.sg2	5/28/2018 5:30 PM	SG2 File	30 KB
 event_0004.sg2	5/28/2018 5:30 PM	SG2 File	30 KB
 event_0005.sg2	5/28/2018 5:30 PM	SG2 File	30 KB

A shot and file list was saved in an XML file.

 EventList.xml	5/28/2018 5:30 PM	XML Document	3 KB
---	-------------------	--------------	------

Click “Yes” to continue the processing.



```
<?xml version="1.0" encoding="SHIFT_JIS"?>
- <line>
  <line_name>line_name</line_name>
  <line_id>0</line_id>
  <sxw_menu>0</sxw_menu>
  <geometry_information>4</geometry_information>
  <data_information>0</data_information>
  <file_type>0</file_type>
  <apply_source_position>0</apply_source_position>
  <apply_receiver_position>0</apply_receiver_position>
- <file_list>
  - <file>
    <file_name>event_0000.sg2</file_name>
    <id>0</id>
    <file_type>0</file_type>
    <shot_distance>0.000000</shot_distance>
    <first_receiver>0.000000</first_receiver>
    <receiver_interval>1.000000</receiver_interval>
    <number_of_auxiliary>0</number_of_auxiliary>
    <i_source_component>2</i_source_component>
    <start_date_time>2018/5/25 19:40:26.035</start_date_time>
  </file>
  + <file>
  + <file>
  + <file>
  + <file>
  + <file>
  + <file>
</file_list>
</line>
```

Set up geometry

A list of shot records appear in a dialog box. Set up source location, receiver interval etc.

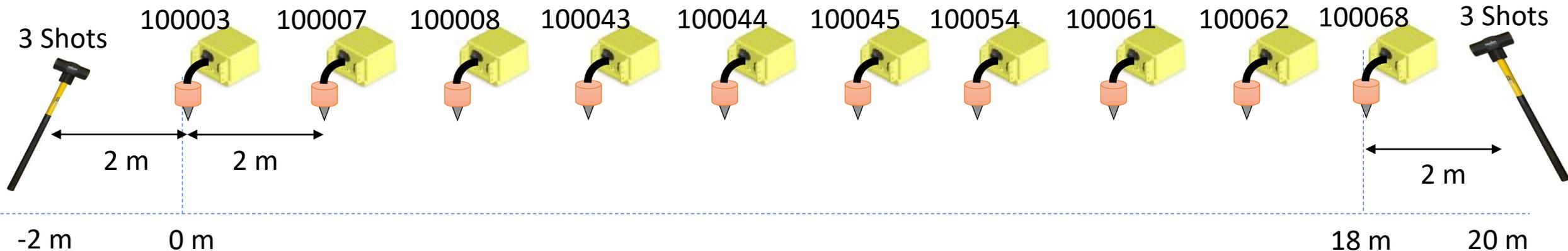
File list

Index	Edit	ID	Source (m)	1st receiver (m)	Receiver int. (m)	# of aux.	
0	<input type="checkbox"/>	0	-2	0	2	0	2018/5/25 19:40:26.035
1	<input type="checkbox"/>	1	-2	0	2	0	2018/5/25 19:40:32.268
2	<input type="checkbox"/>	2	-2	0	2	0	2018/5/25 19:40:41.967
3	<input type="checkbox"/>	3	20	0	2	0	2018/5/25 19:41:12.968
4	<input type="checkbox"/>	4	20	0	2	0	2018/5/25 19:41:20.195
5	<input type="checkbox"/>	5	20	0	2	0	2018/5/25 19:41:28.236

Apply source coordinates from file header Active data
 Apply receiver coordinates from file header Passive data

Number of files:

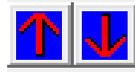
OK
Cancel
Next
Back
Set up
Set # of aux.
Delete
Export
Import



Individual shot record shown by Pickwin



Change horizontal (time) scale.



Change distance scale.

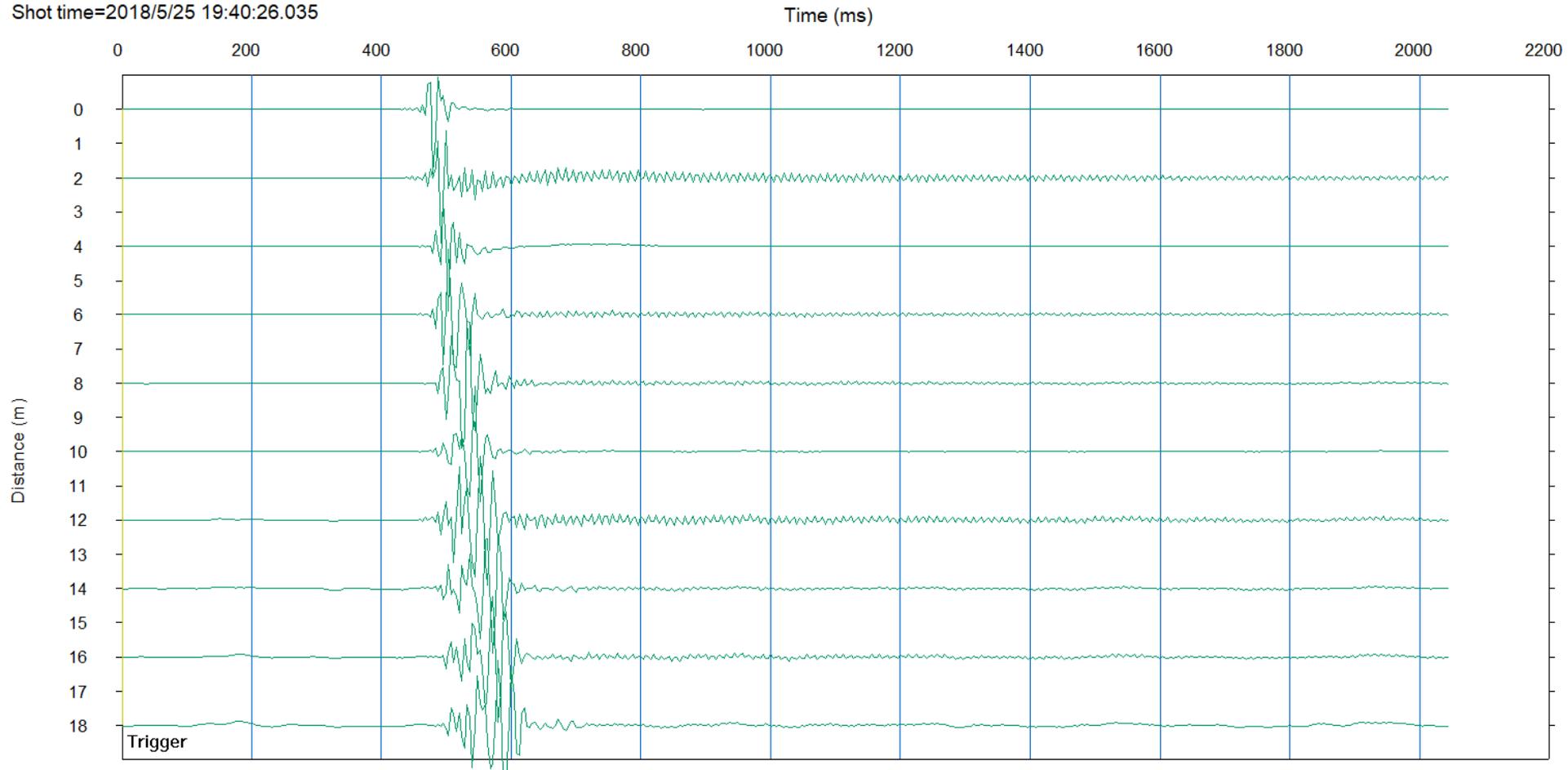


Change amplitude.



Scroll shot records.

Shot time=2018/5/25 19:40:26.035



Transform to phase velocity image in frequency domain

Select [Surface wave analysis]>>[Phase velocity frequency transformation] or press “Ctrl+D” to transform data to a phase velocity image in frequency domain.

Set up max. phase velocity and max. frequency.

A phase velocity image in frequency domain appears.

Phase velocity-frequency transformation

Phase velocity

Start 0 m/s

End 500 m/s

Frequency

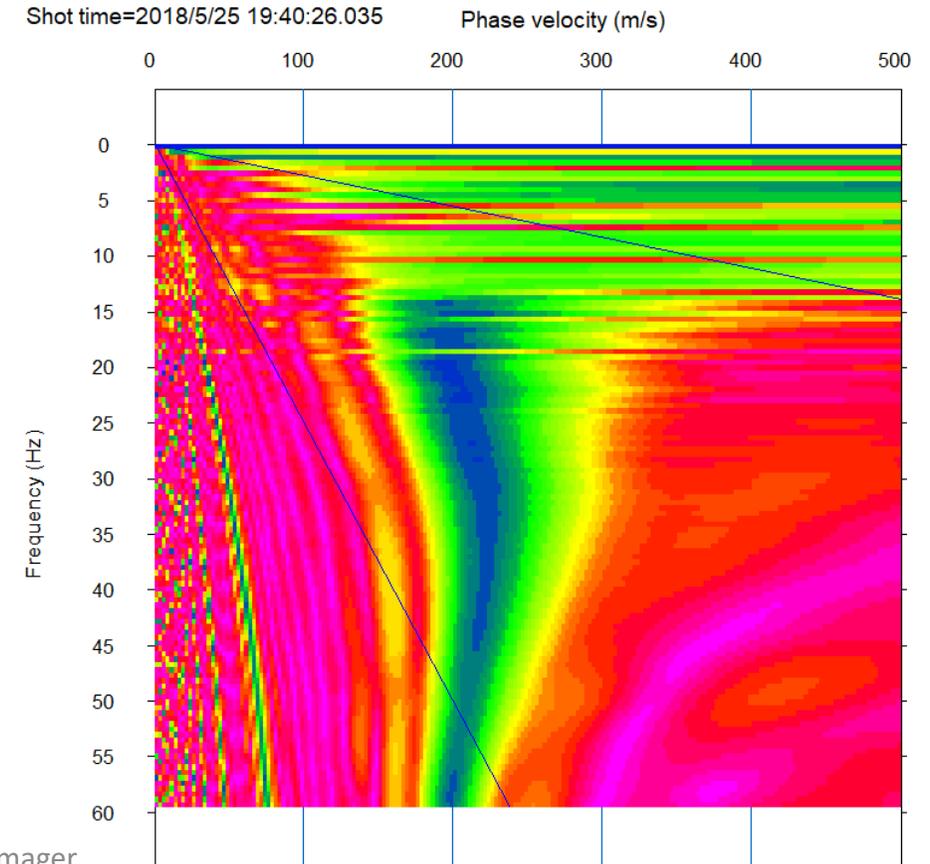
Start 0 Hz

End 60 Hz

OK

Cancel

Advanced menu



Pick phase velocities

Select [Surface wave analysis]>>[Pick phase velocity (1D)] and set up parameters.

Click “Advanced menu” to set up detailed parameters.

Min. and Max. frequency

Minimum Frequency 5 Hz

Maximum Frequency 60 Hz

Use median filter

of sample for median filter = 5

Setup

Wavelength limitation

Maximum wavelength 2 time

Minimum wavelength 2 time

Setup min. and max. phase velocity

Minimum phase velocity = 35 m/s

Maximum phase velocity = 500

Setup area for phase-velocity picking

Use current phase-velocity as minimum velocity for picking

Phase-velocity area 100 m/s

Check off if you want to pick all frequency range

Change minimum phase velocity to be picked depending on data

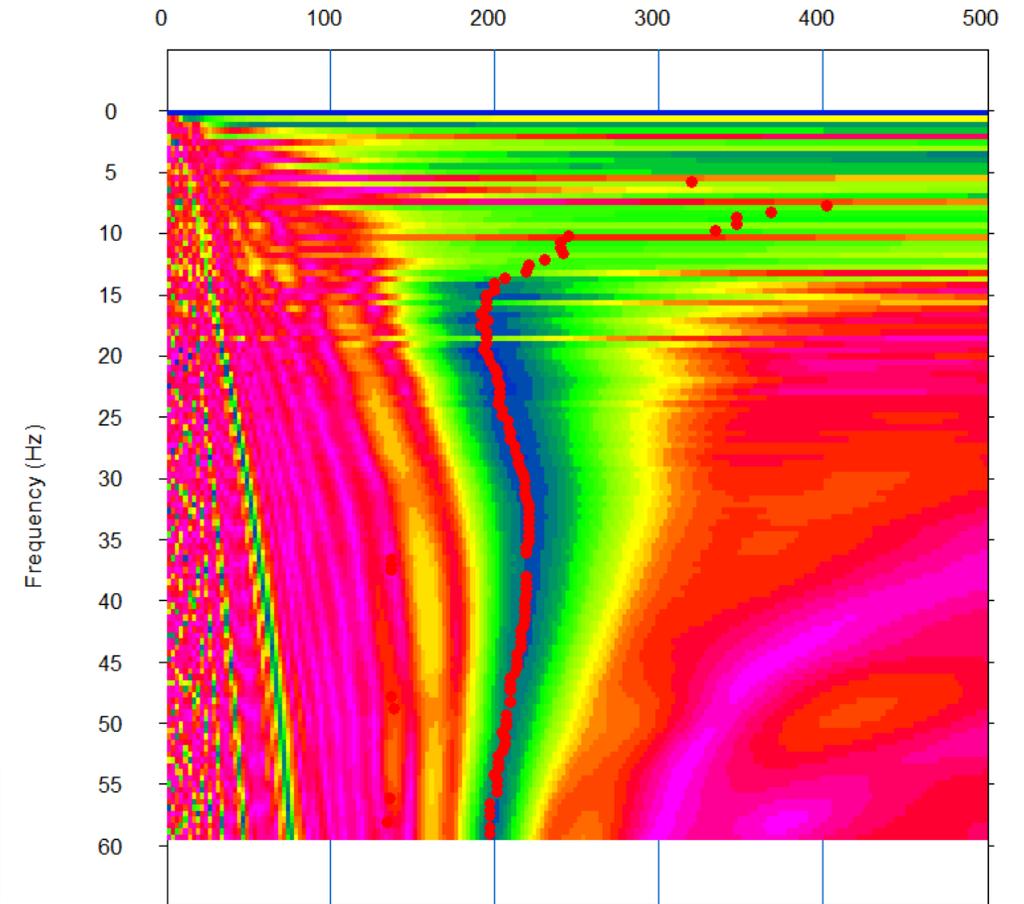
Picked phase velocities appear on a phase velocity image in frequency domain.

Click left mouse button to move one pick or drag to move a range of picks.

Click left mouse button to move one pick or drag to move a range of picks.

Shot time=2018/5/25 19:40:26.035

Phase velocity (m/s)

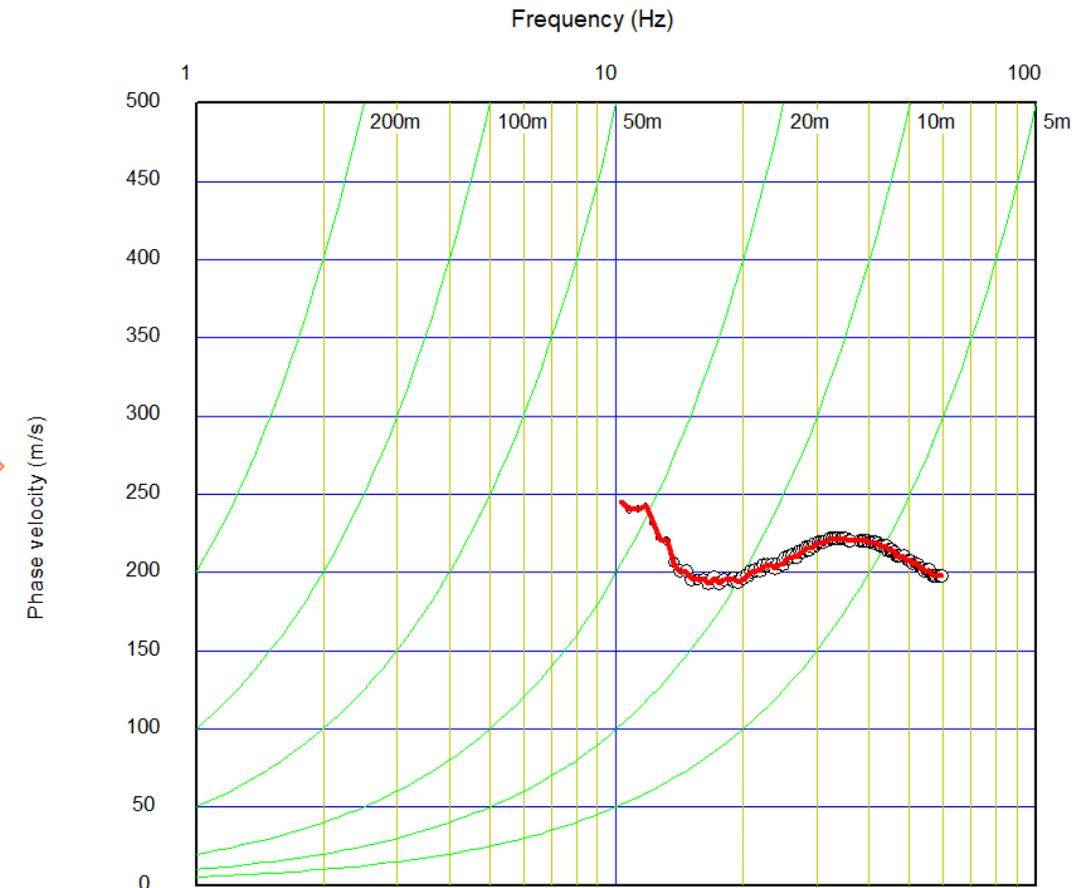
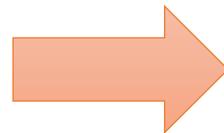
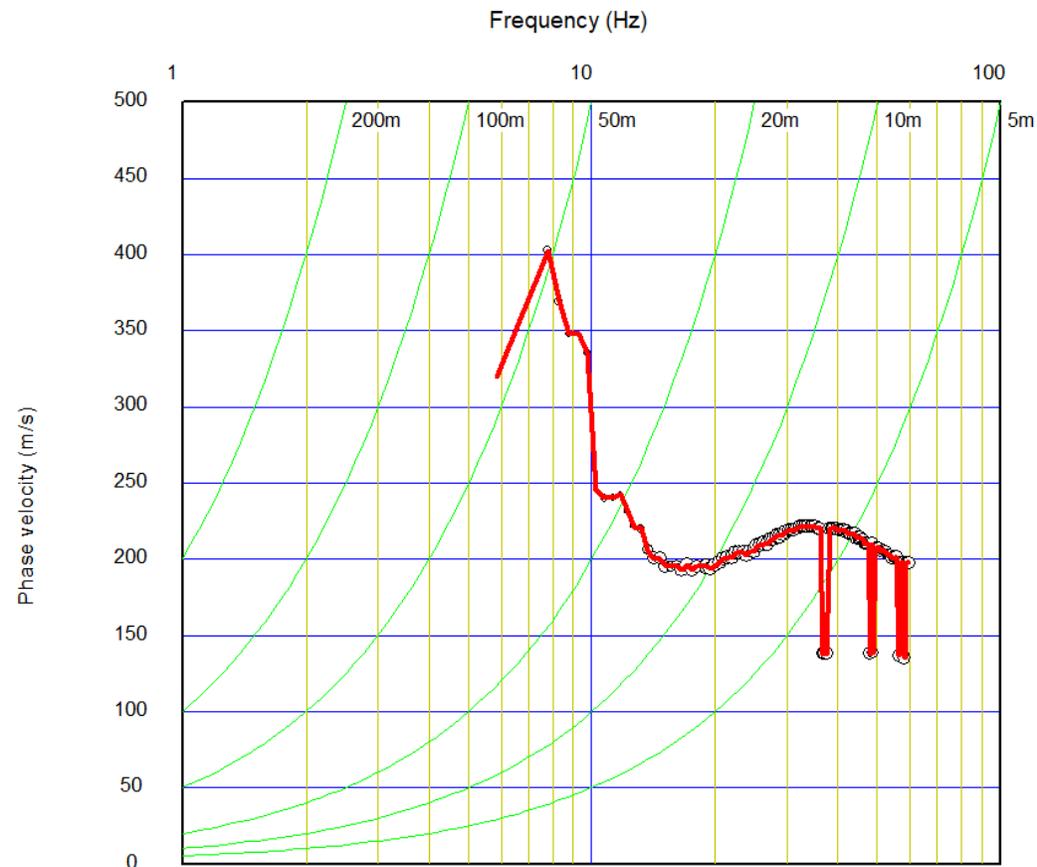


Select [Surface wave analysis]>>[Show phase velocity curve (1D) <Launch WaveEq>].

Editing a dispersion curve in WaveEq

Delete noises or unnecessary frequency range.

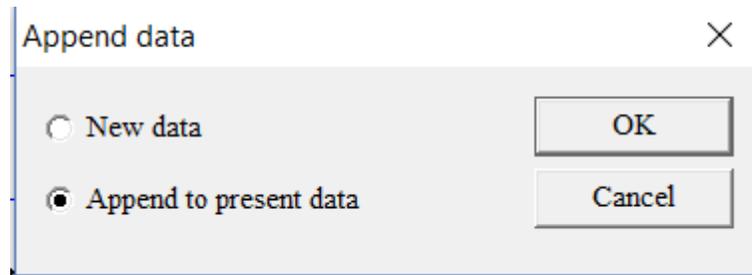
Use  or  to select phase velocities.
Hit delete key to delete the selected phase velocities.



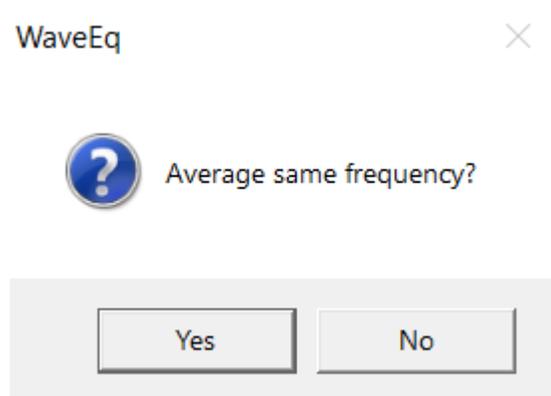
Select [File]>>[Save 1D phase velocity curve or H/V curve (.rst)] to save a dispersion curve to data file.

Combine active and passive dispersion curves

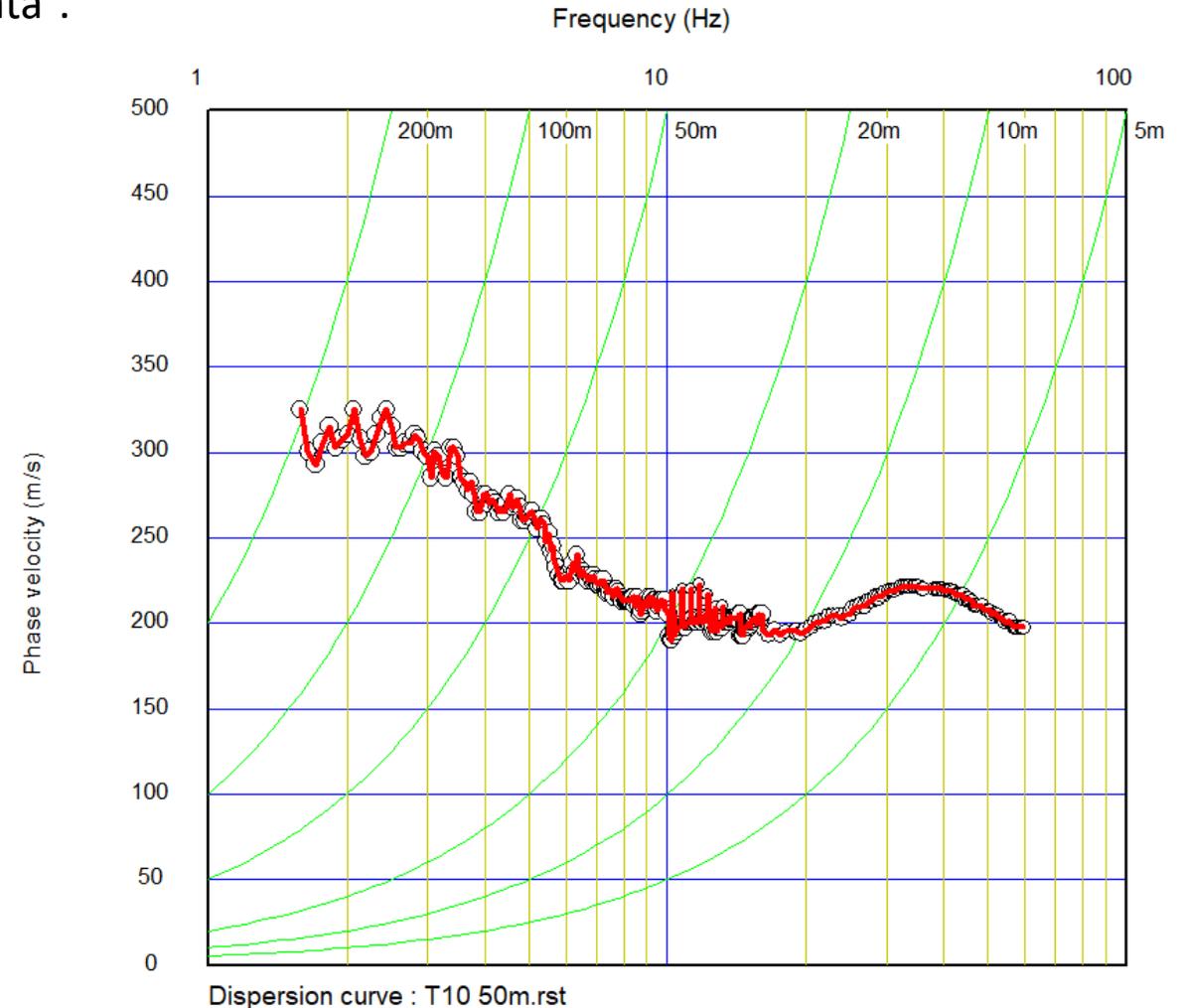
Select [File]>>[Open 1D phase velocity curve or H/V curve (.rst)].
Select a passive data file (.rst) and choose “Append to present data”.



Data will be automatically averaged if “Yes” is chosen.
Choose “No” if you want do not want to average automatically.



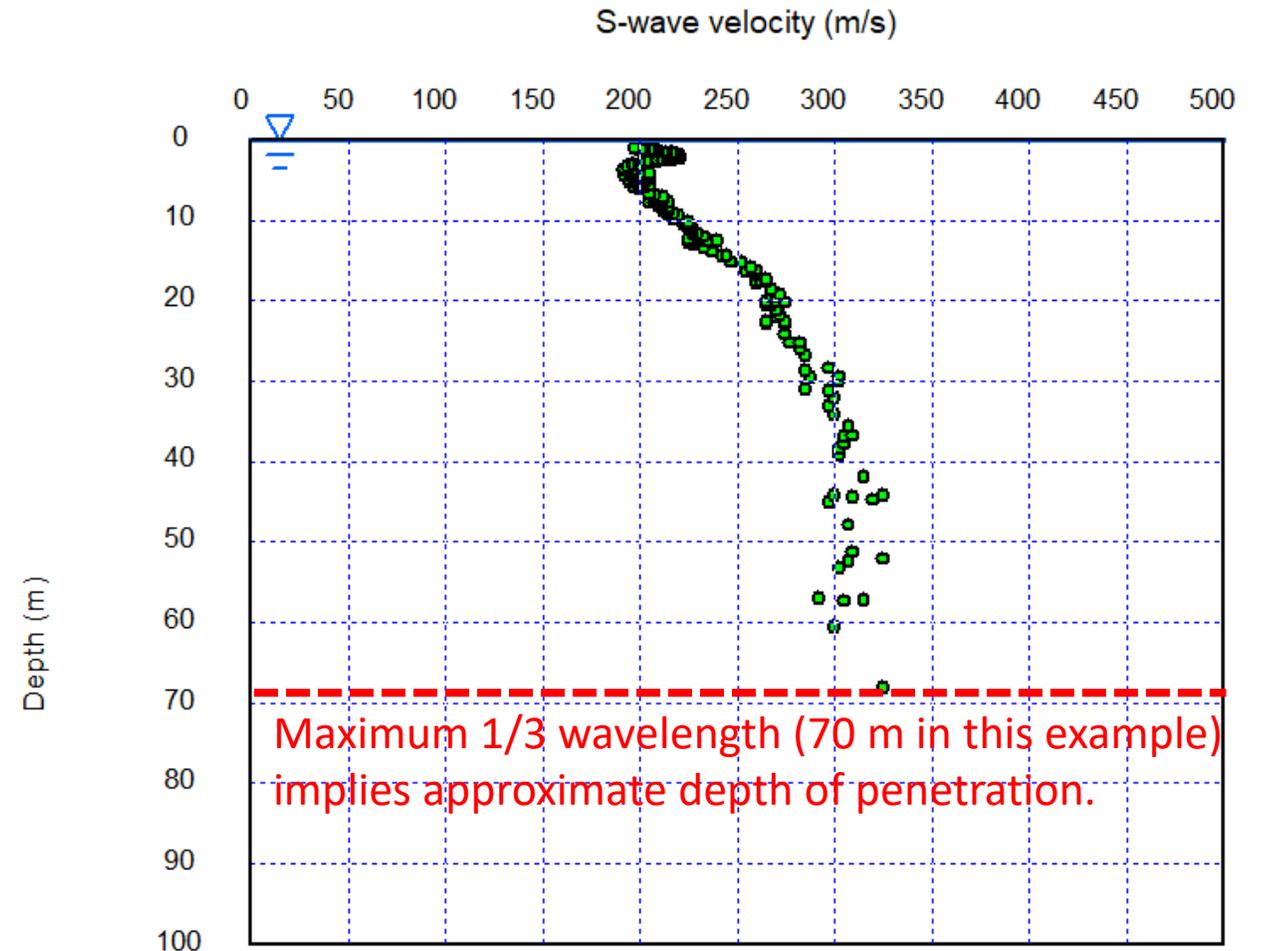
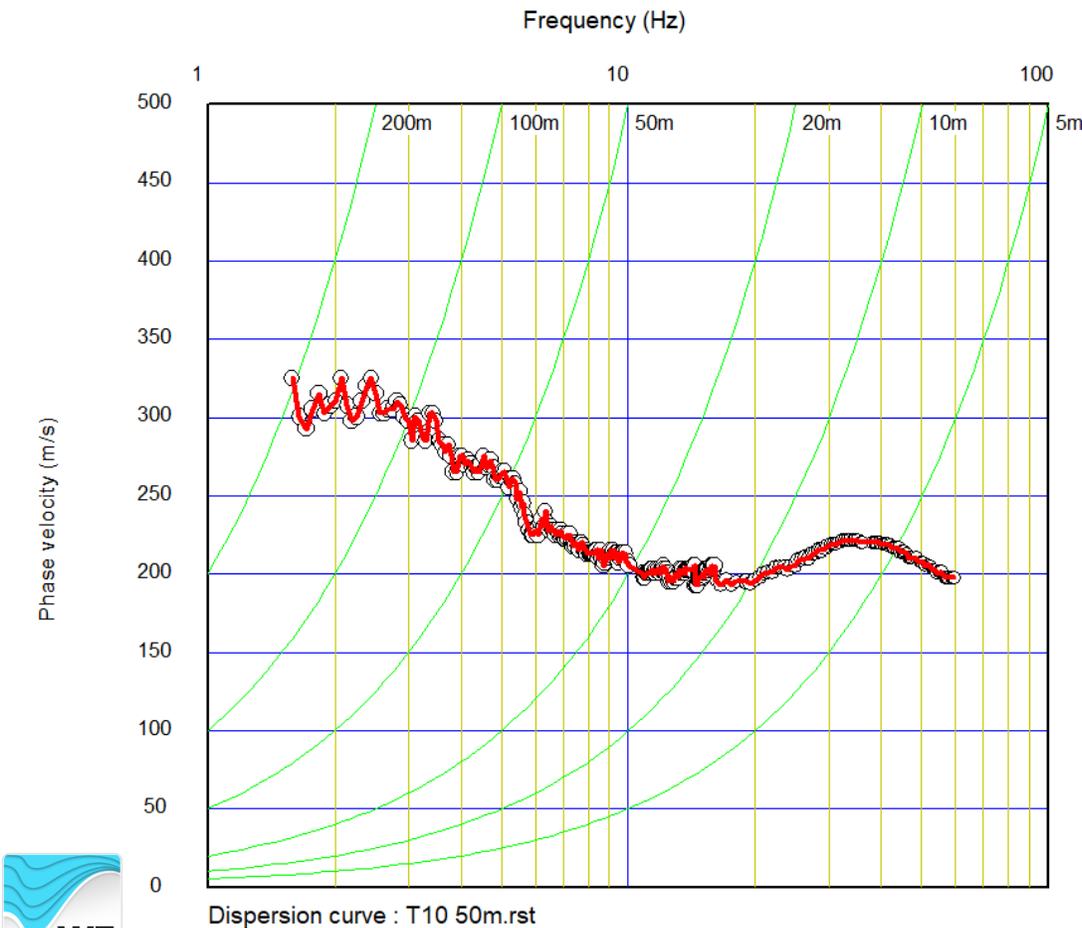
Active and passive phase velocities are shown together.



Editing active and passive dispersion curves in WaveEq

Delete noises or unnecessary frequency range.

Crack  to evaluate approximate depth of penetration. Green circles indicates 1/3 wave length.

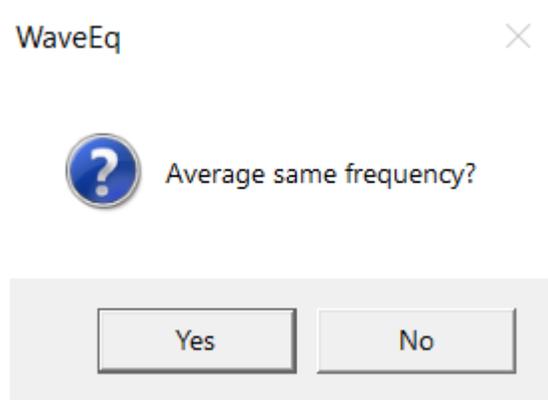


Combine active and passive dispersion curves

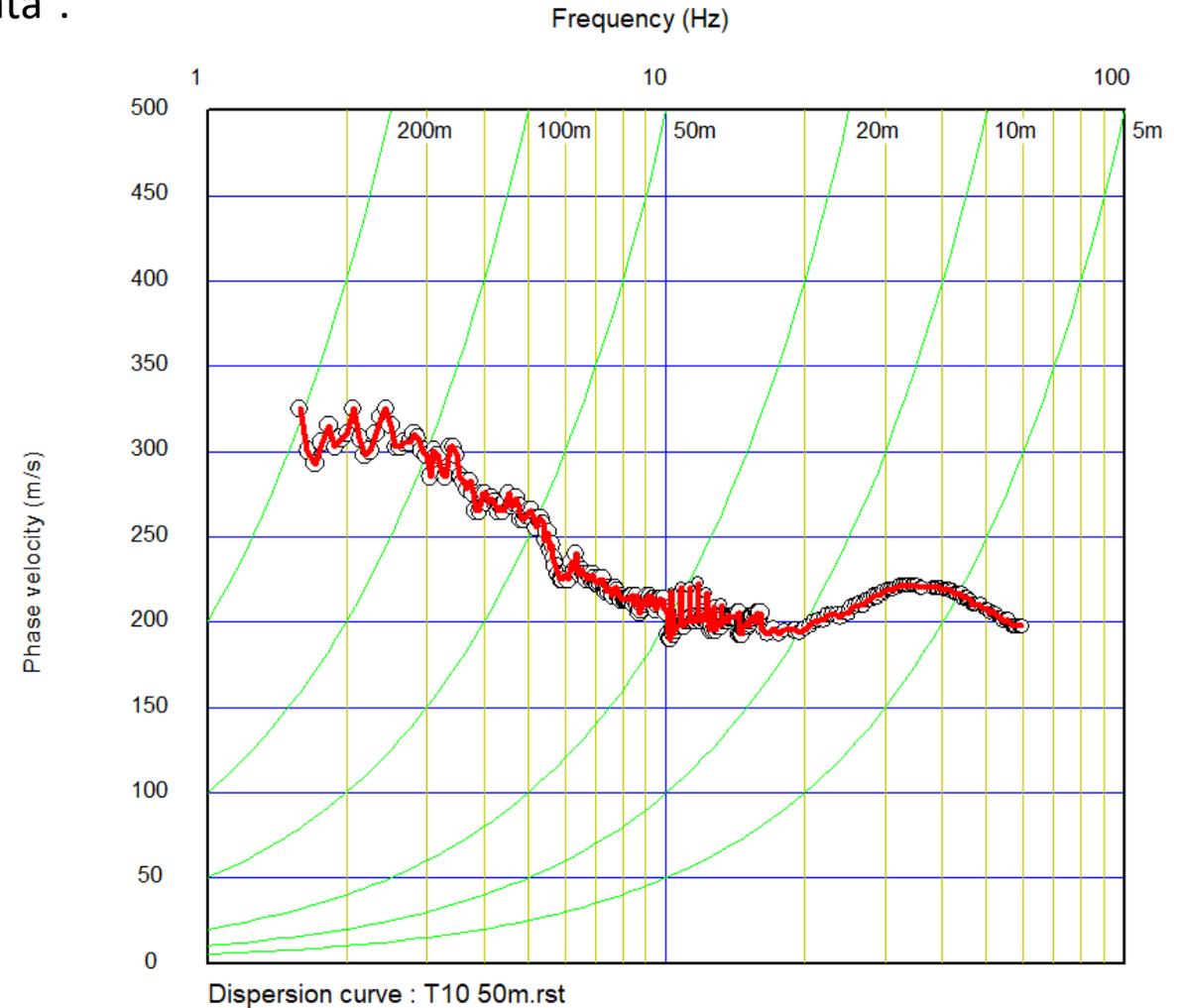
Select [File]>>[Open 1D phase velocity curve or H/V curve (.rst)].
Select a passive data file (.rst) and choose “Append to present data”.



Data will be automatically averaged if “Yes” is chosen.
Choose “No” if you want do not want to average automatically.



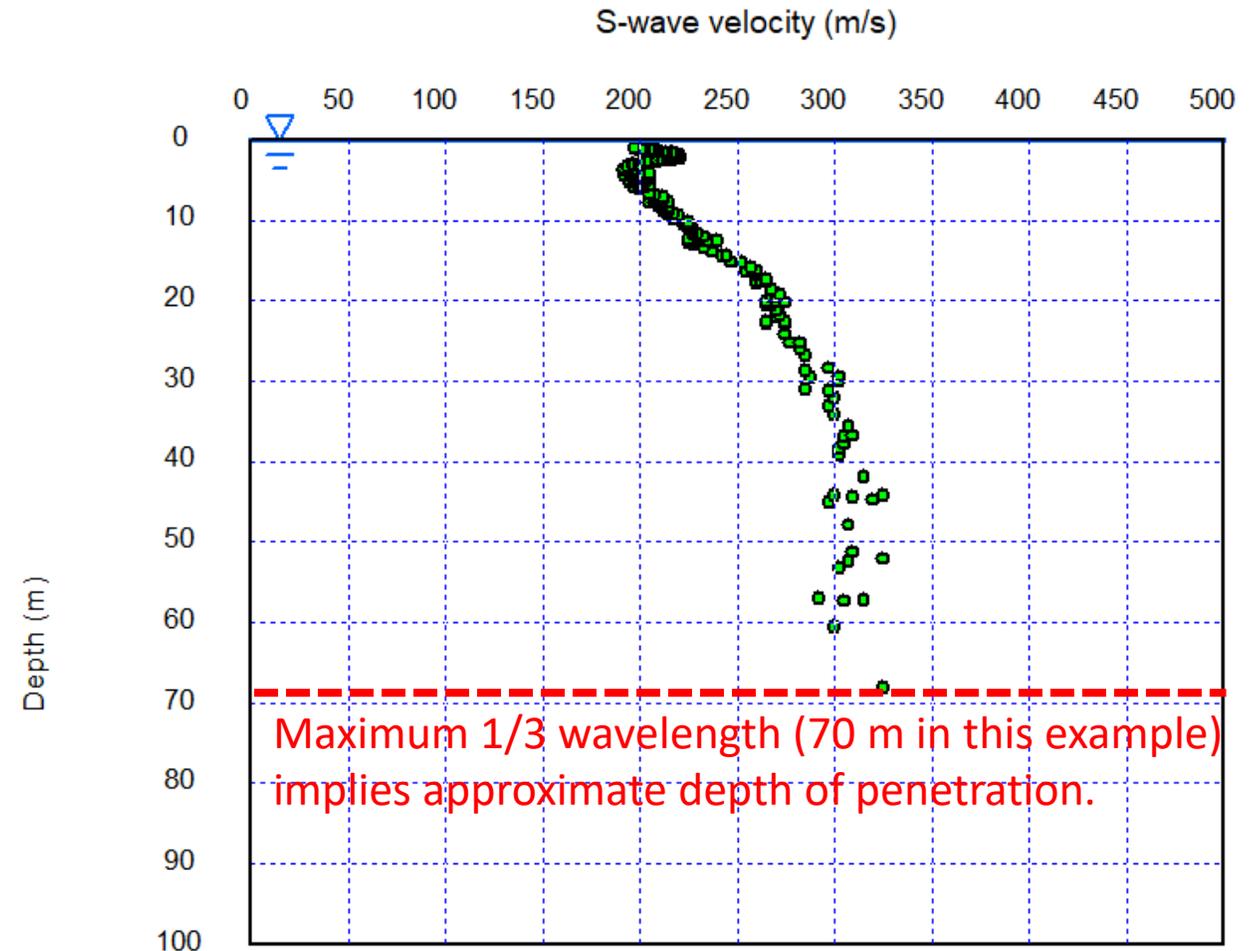
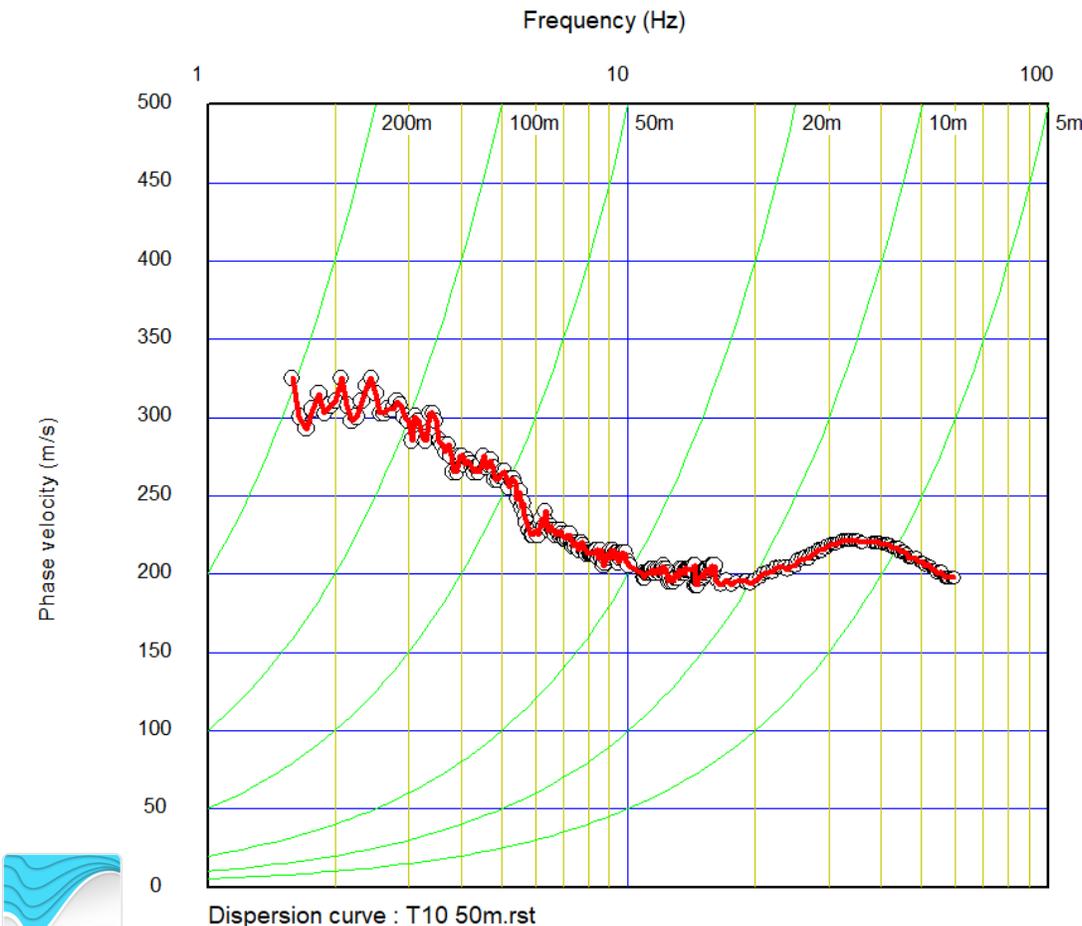
Active and passive phase velocities are shown together.



Editing active and passive dispersion curves in WaveEq

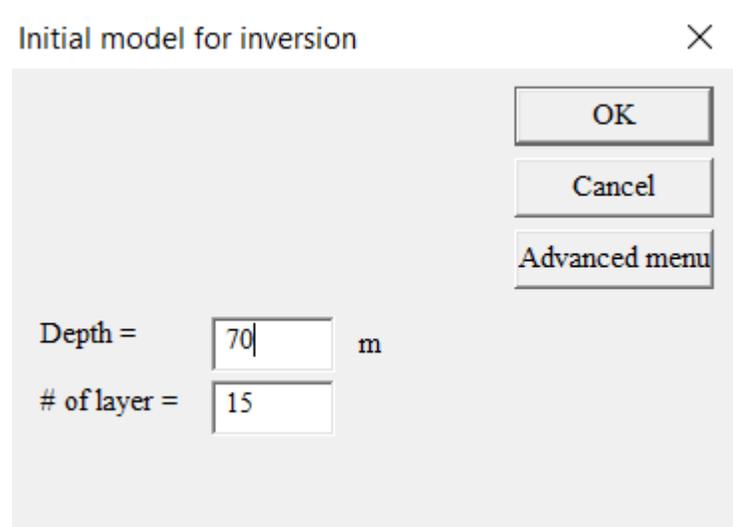
Delete noises or unnecessary frequency range.

Crack  to evaluate approximate depth of penetration. Green circles indicates 1/3 wave length.



Initial model

Select [Surface wave analysis]>>[MASW (1D)]>>[Initial model] to built an initial model.
Set "Depth" based on a penetration depth implied by 1/3 wave length for example.



Initial model for inversion

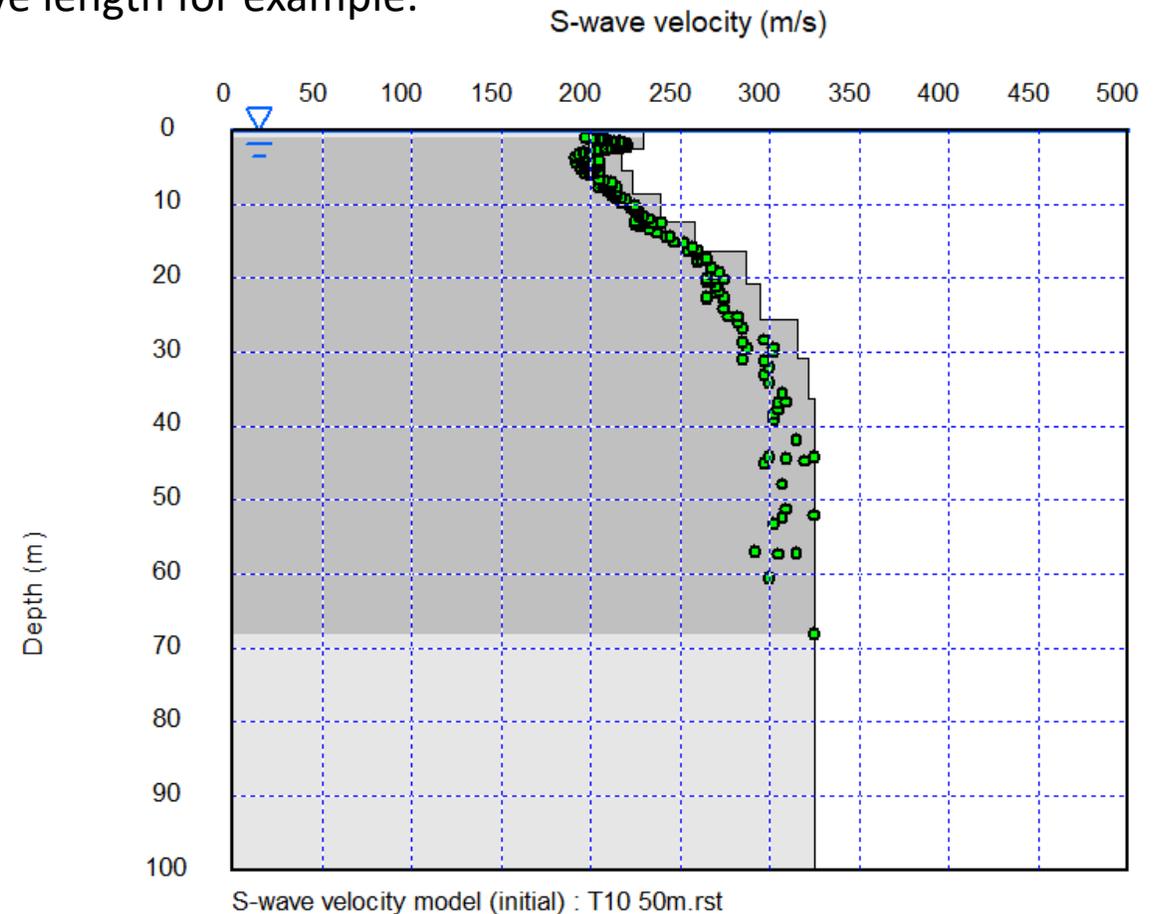
OK

Cancel

Advanced menu

Depth = 70 m

of layer = 15



Comparing observed and theoretical dispersion curves

Click  to compare observed and theoretical dispersion curves.

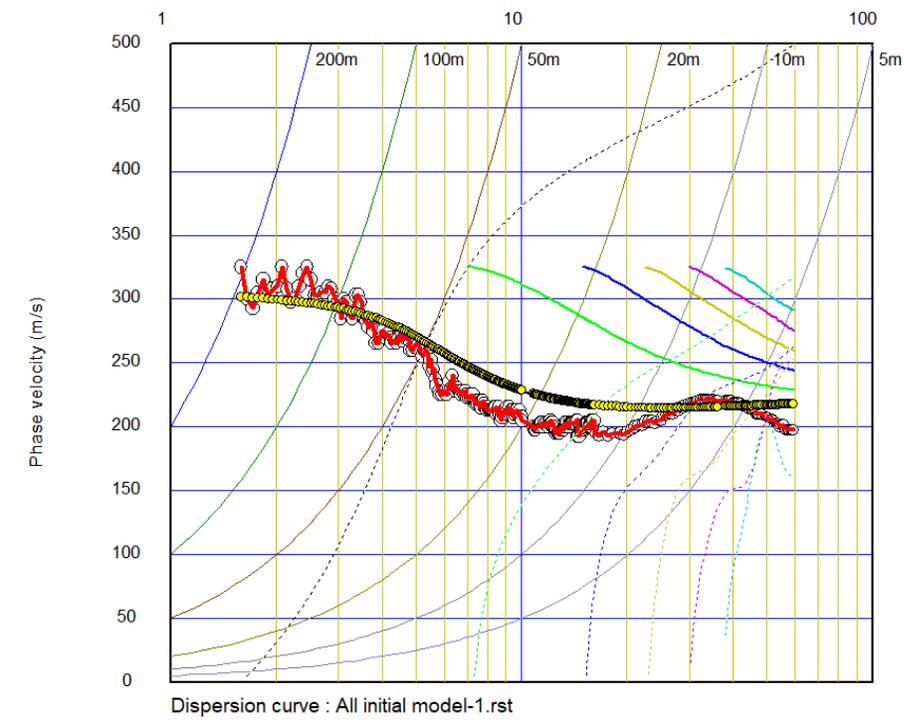
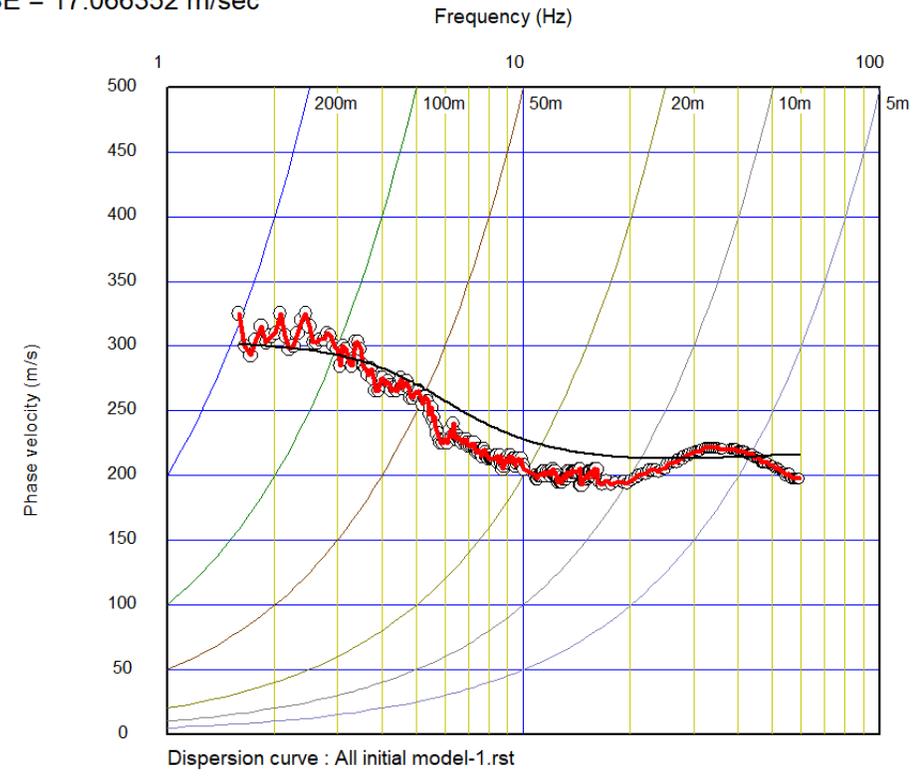
Fundamental mode 

Higher mode (effective mode) 

	Velocity	Amplitude
Observed		
Average (effective)		
Fundamental		
1st		
2nd		

RMSE = 17.066352 m/sec

RMSE = 17.618916 m/sec



Selection of inversion method

Fundamental mode

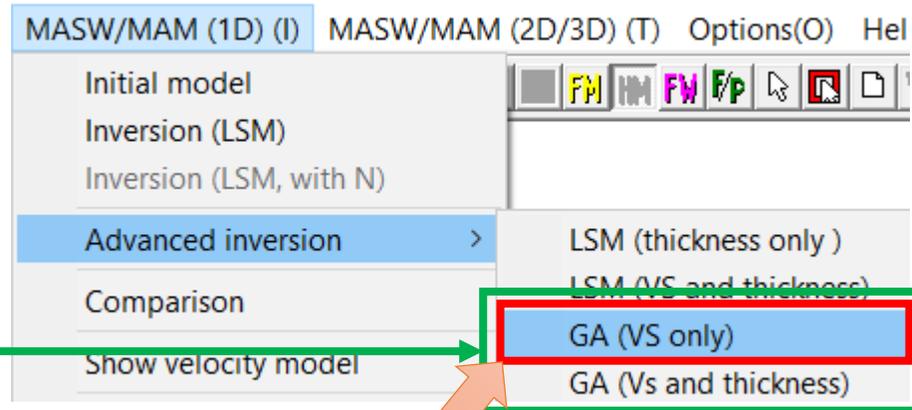
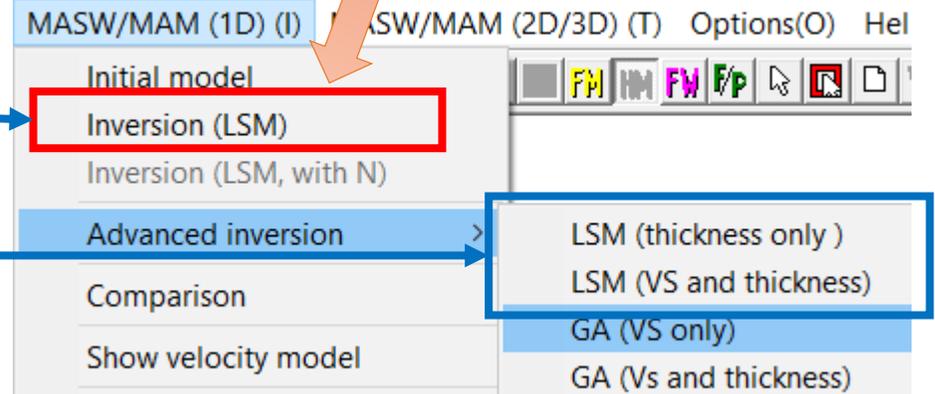
Dispersion curve is smooth and continuous

Higher mode
(effective mode)

Dispersion curve may be discontinuous

Least squares method (LSM)

Genetic algorithm (GA)

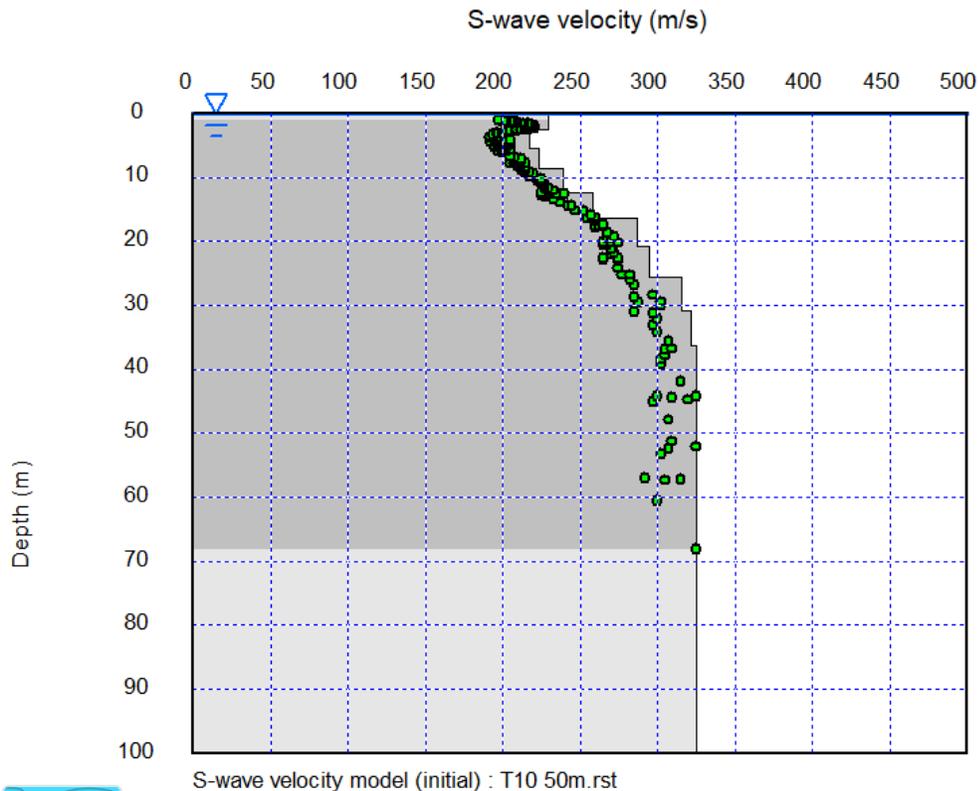


Use this one (change only VS) when number of layer is large (> 5)

Use "VS only" when number of layer is large (> 5)

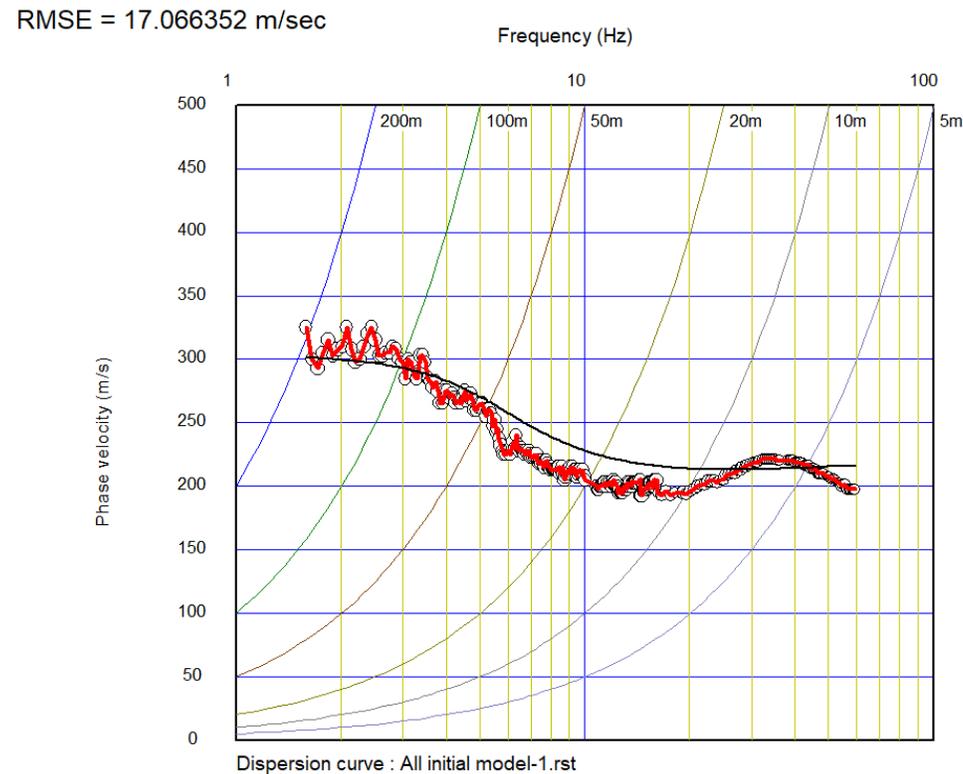
Inversion using fundamental mode based on least squares method (LSM)

Initial S-wave velocity model

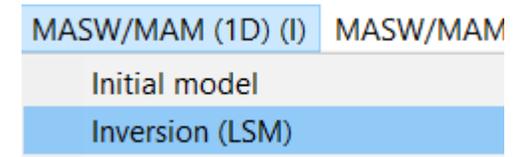


Comparison of observed and theoretical (fundamental mode) dispersion curves

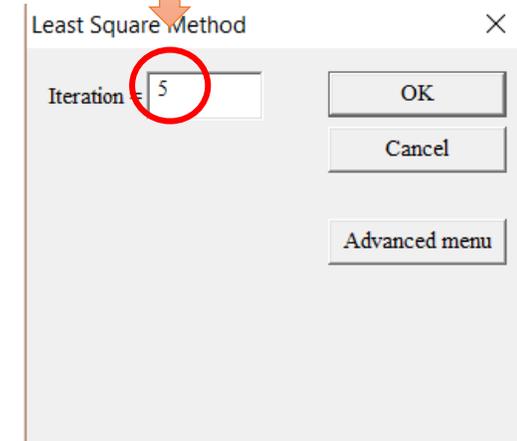
Fundamental mode **FM**



Select “MASW/MAM (1D)”, “Inversion LSM” to start the inversion.

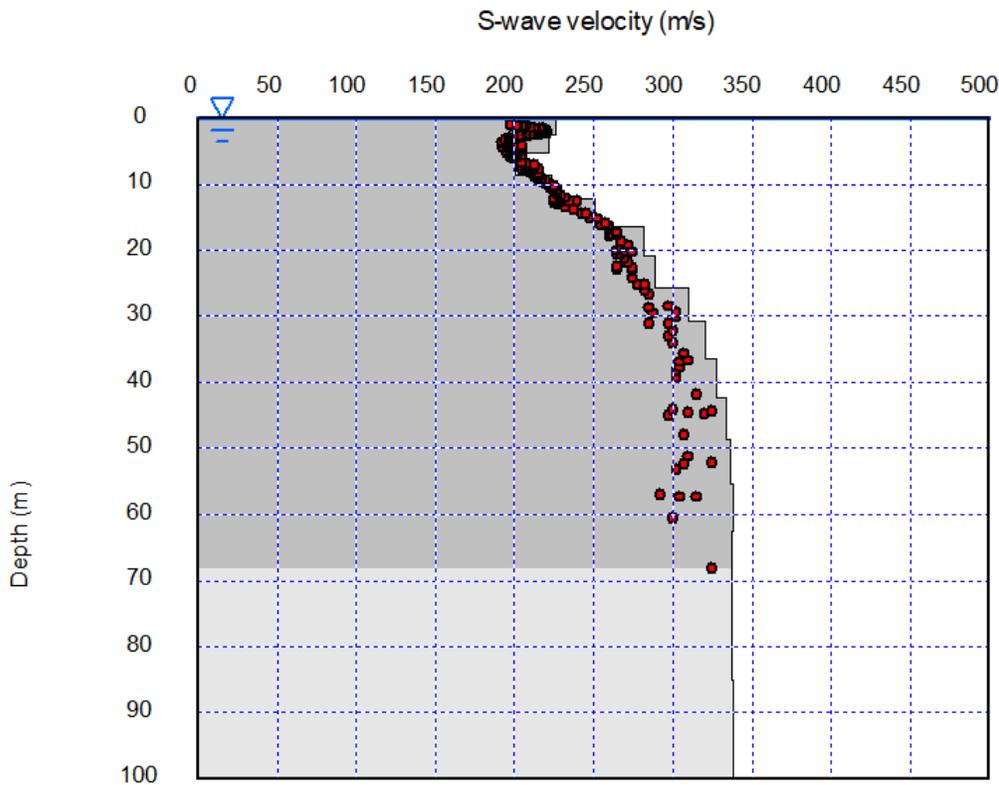


Number of iteration



Inversion using fundamental mode based on least squares method (LSM)

Inverted S-wave velocity model

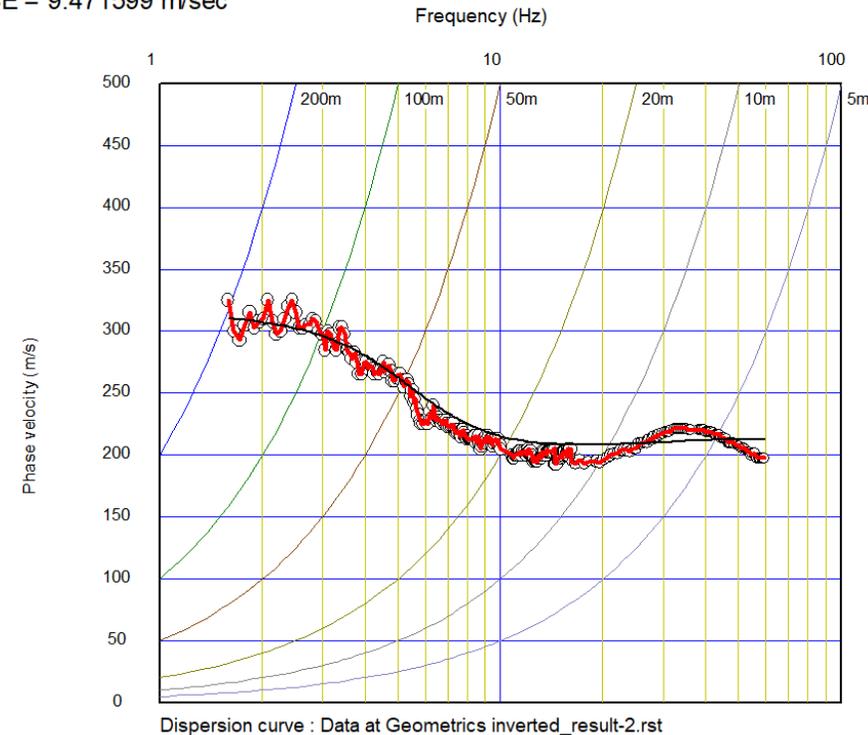


S-wave velocity model (inverted) : Data at Geometrics inverted_result-2.rst

Average V_s 30m = 251.2 m/sec

Comparison of observed and theoretical (fundamental mode) dispersion curves

RMSE = 9.471599 m/sec



Conversion process is automatically saved in "RMSE.txt"

RMSE.txt

Iteration=0 RMS=17.066352 m/s (7.017373%)
Iteration=1 RMS=14.895001 m/s (6.135052%)
Iteration=2 RMS=13.102761 m/s (5.401269%)
Iteration=3 RMS=11.647438 m/s (4.792031%)
Iteration=4 RMS=10.462912 m/s (4.280407%)



6. Data processing using SeisImager

- Data downloading from Atom
- 1D active/passive surface wave method (data obtained by Atom)
- 2D active surface wave method based on CMP-CC (data obtained by Geode)
- 3D passive surface wave method based on CMP-SPAC (data obtained by Atom)
- Higher modes and inversion using effective mode based on Genetic Algorithm

Tutorial for 2D MASW processing
using SeisImager/SW-2D

6. Data processing using SeisImager

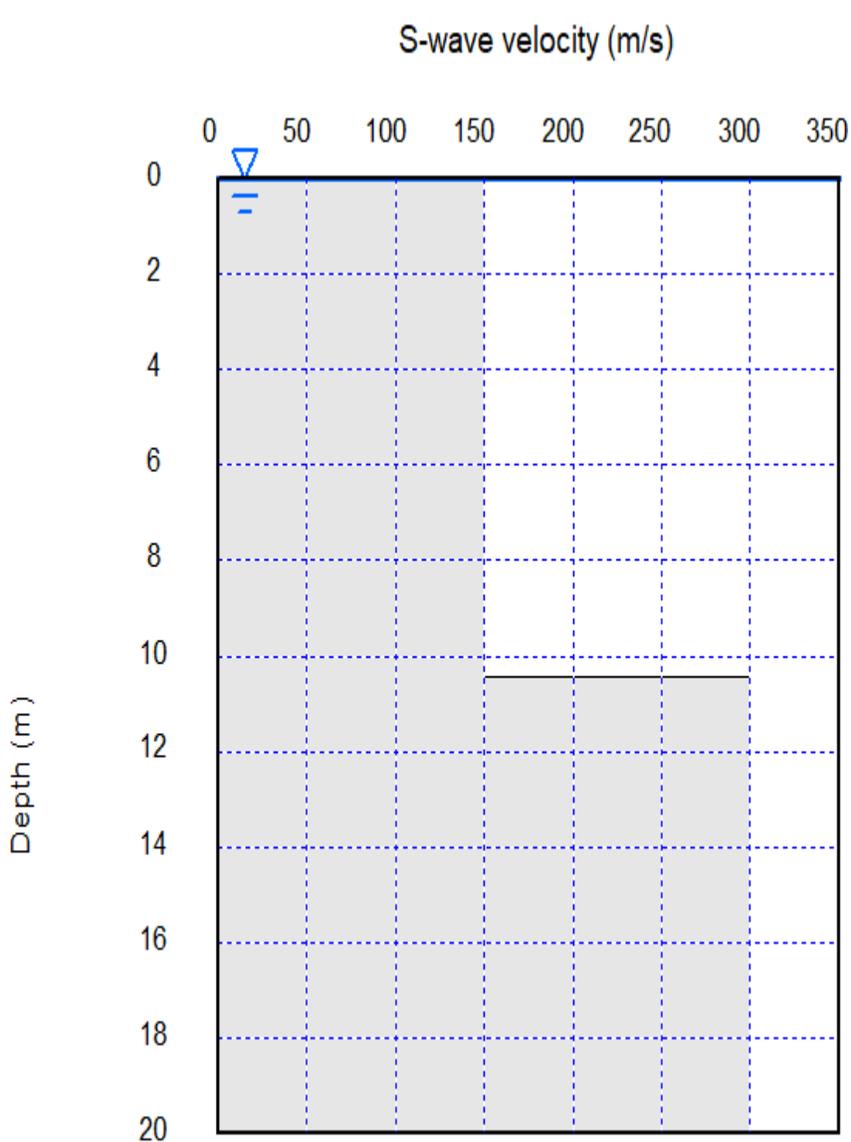
- Data downloading from Atom
- 1D active/passive surface wave method (data obtained by Atom)
- 2D active surface wave method based on CMP-CC (data obtained by Geode)
- **3D passive surface wave method based on CMP-SPAC (data obtained by Atom)**
- Higher modes and inversion using effective mode based on Genetic Algorithm

Tutorial for ambient noise tomography
processing using SeisImager/SW-3D

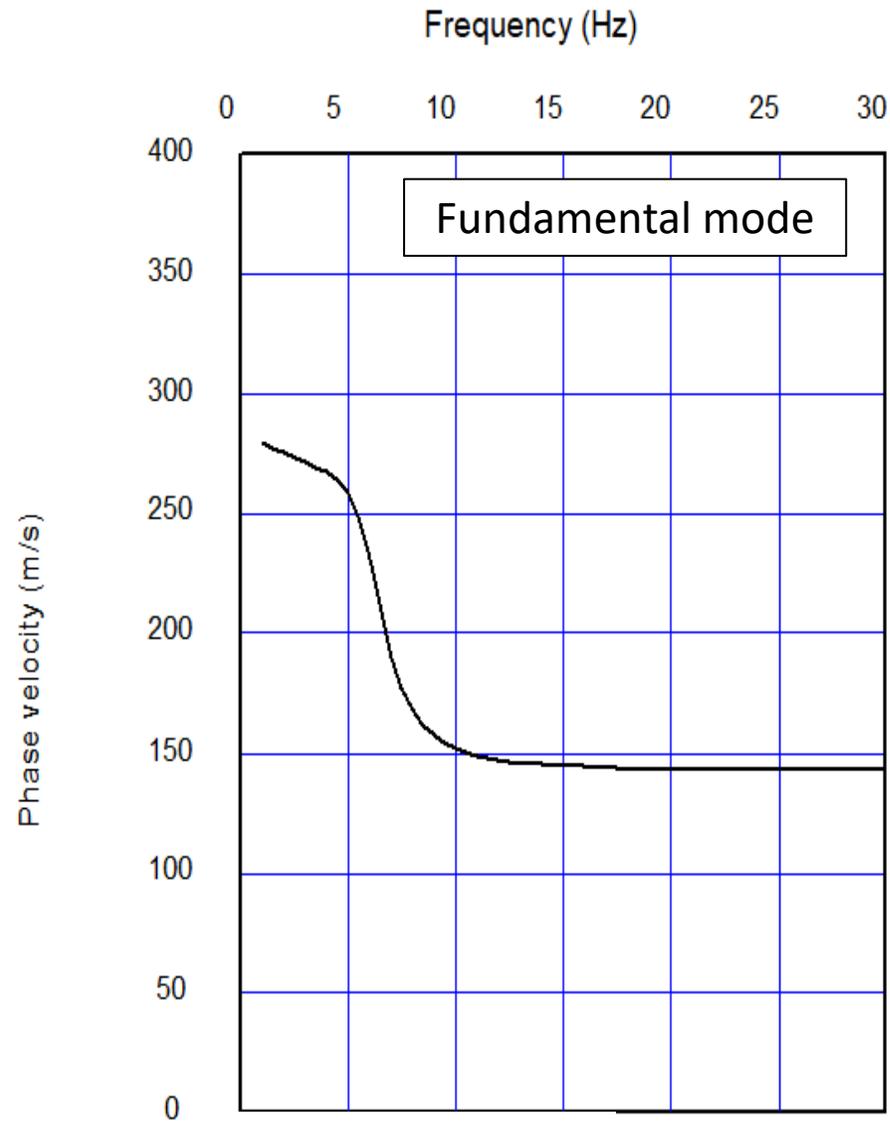
6. Data processing using SeisImager

- Data downloading from Atom
- 1D active/passive surface wave method (data obtained by Atom)
- 2D active surface wave method based on CMP-CC (data obtained by Geode)
- 3D passive surface wave method based on CMP-SPAC (data obtained by Atom)
- Higher modes and inversion using effective mode based on Genetic Algorithm

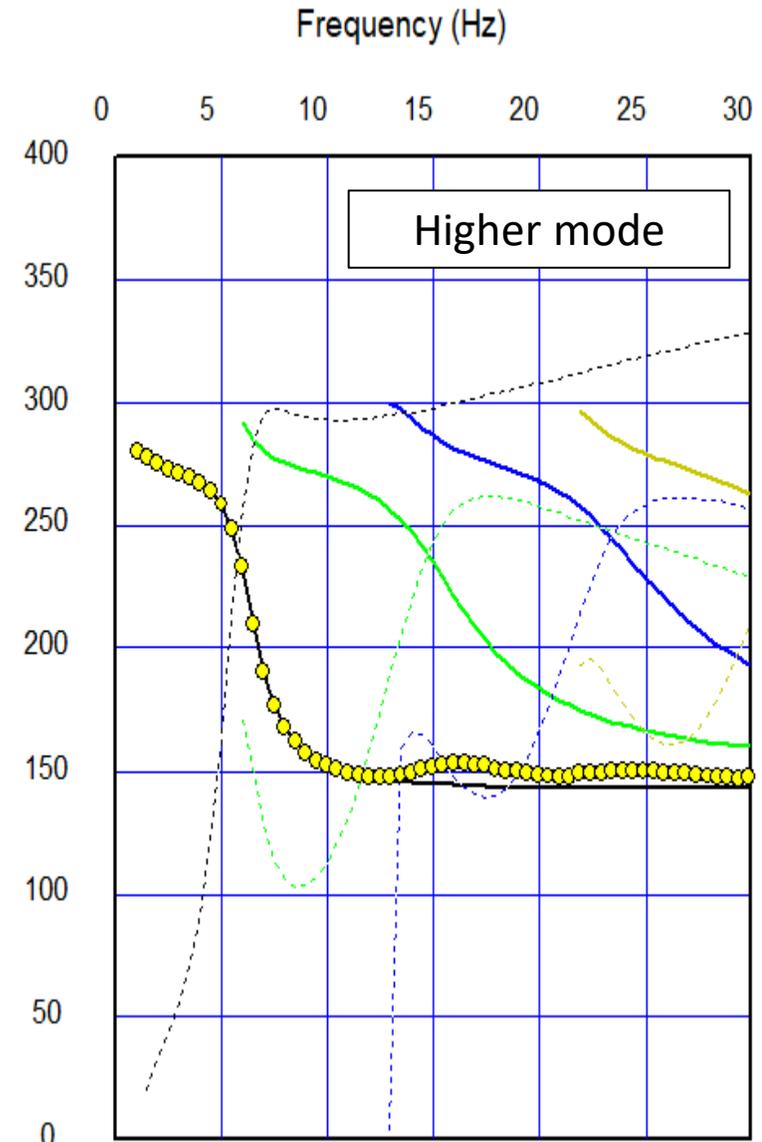
Higher mode (active and passive)



S-wave velocity model :

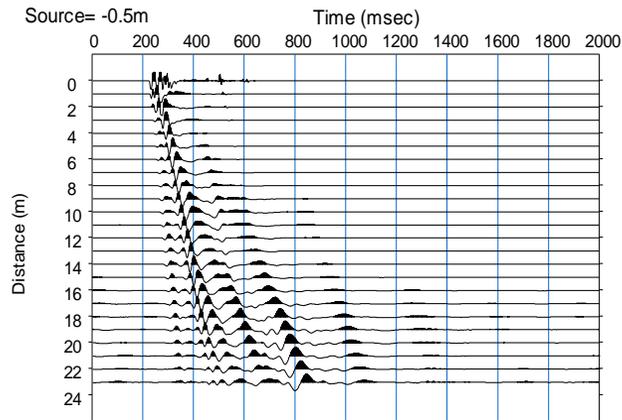


6. Data processing using SeisImager

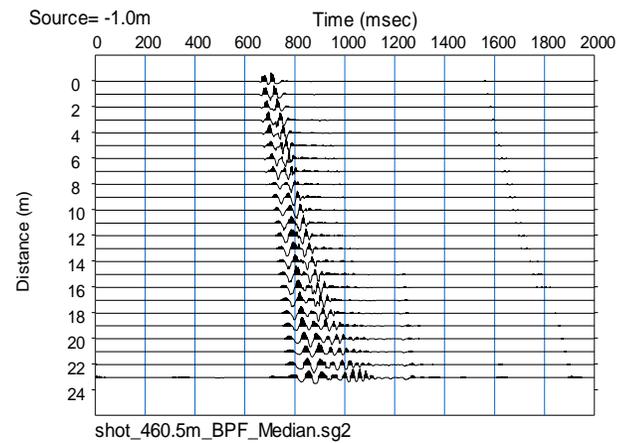


Example of observed waveform data including higher modes

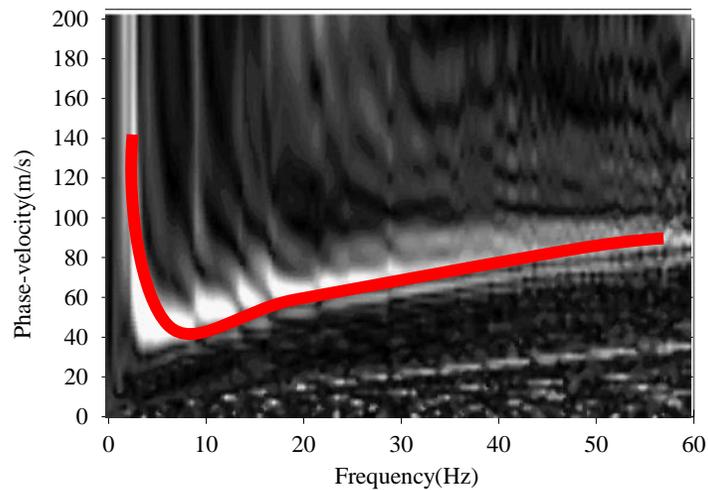
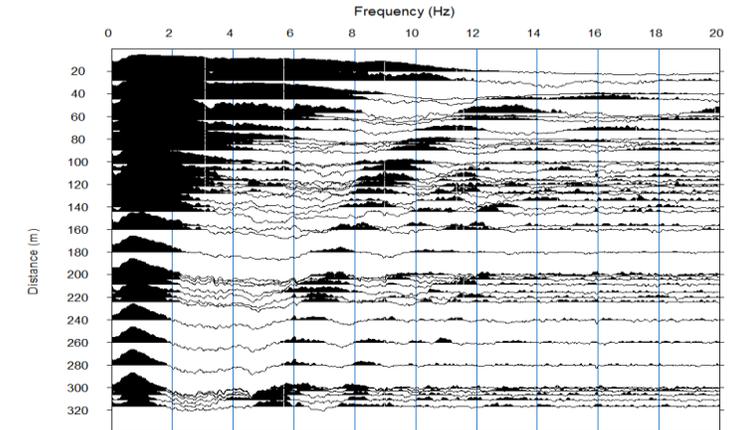
Case-1 (active)



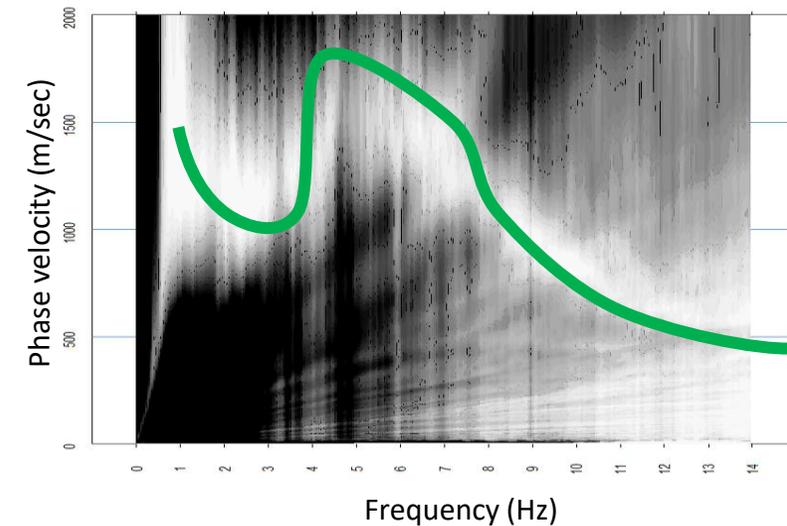
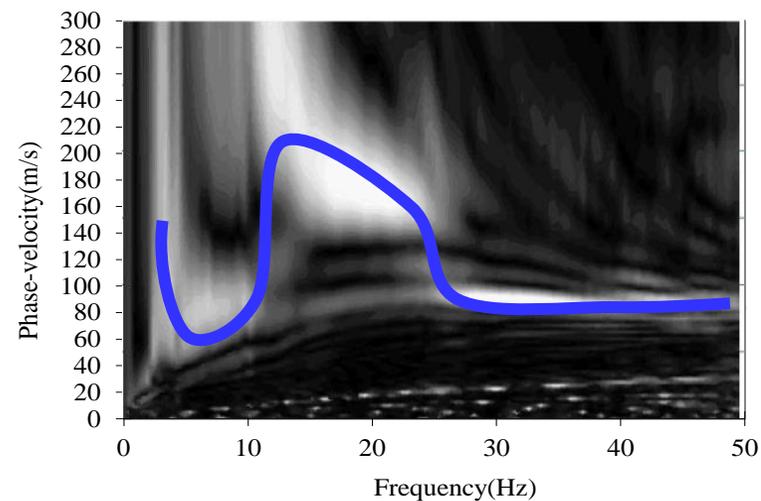
Case-2 (active)



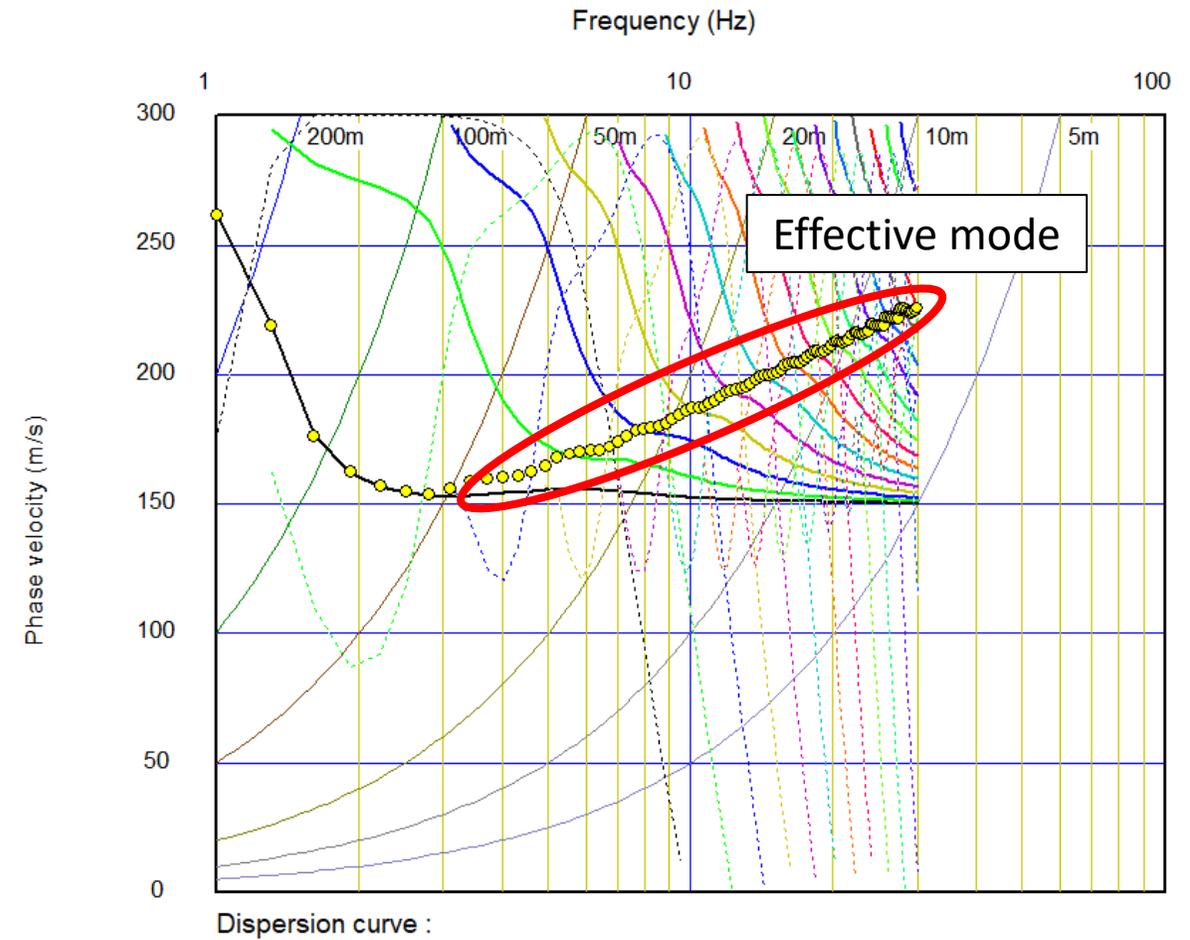
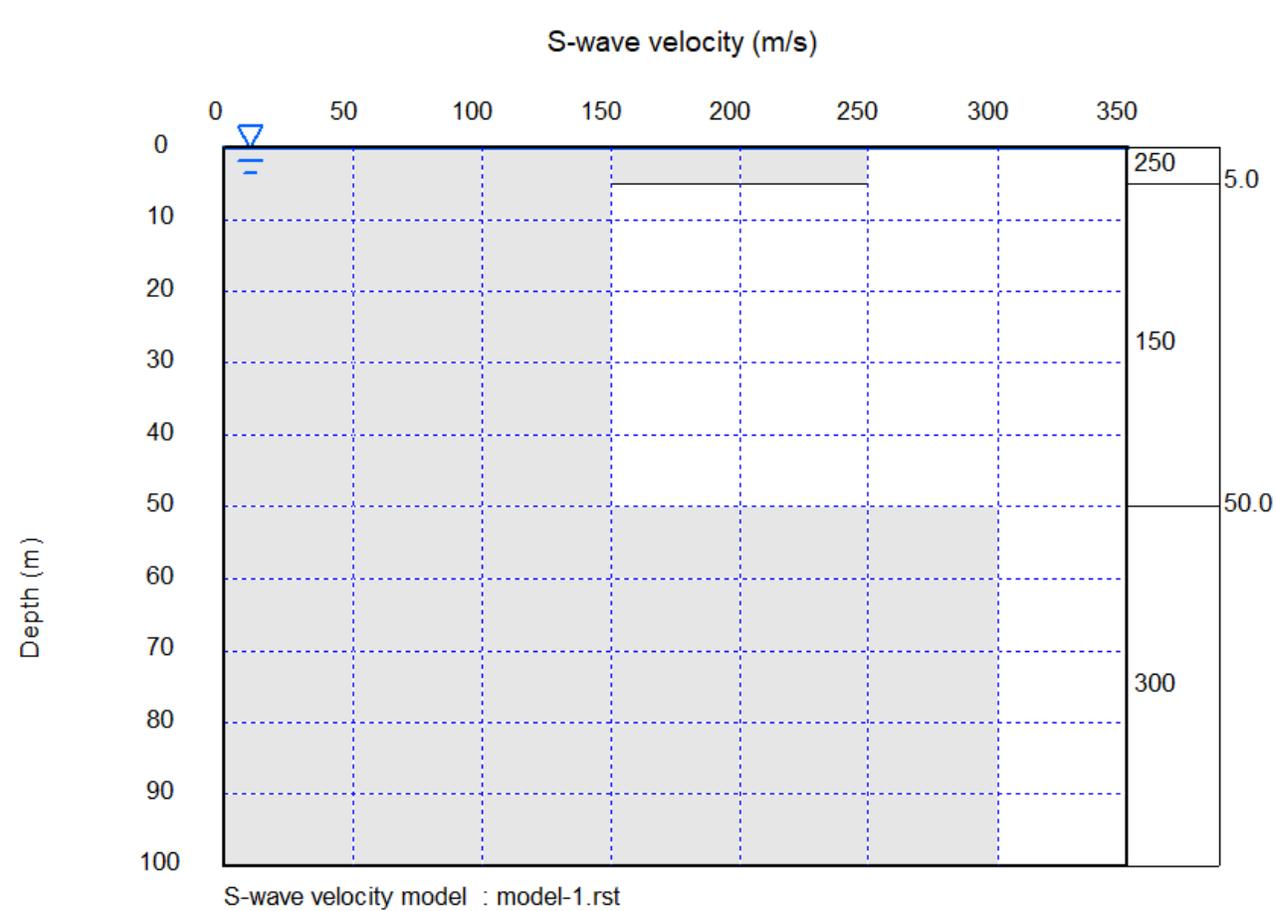
Case-3 (passive)



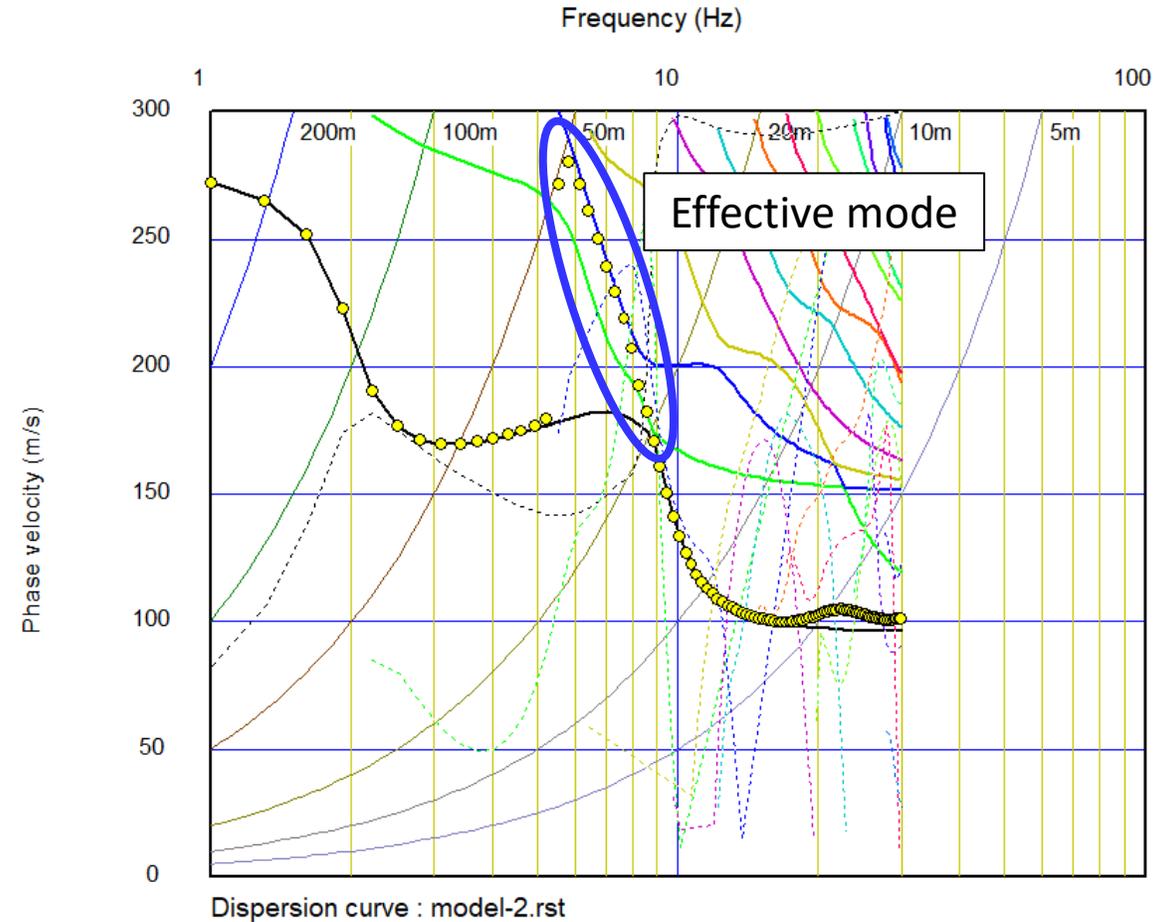
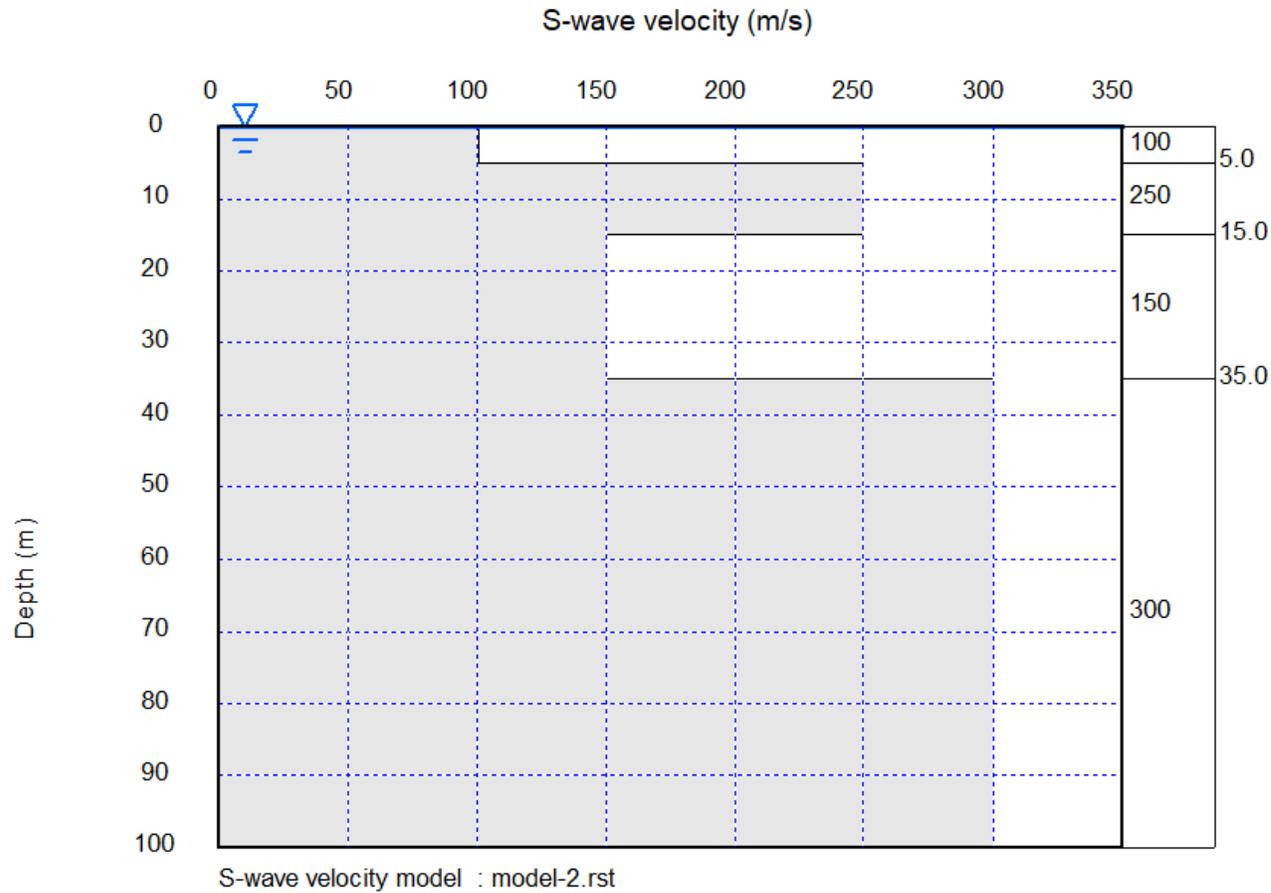
b)



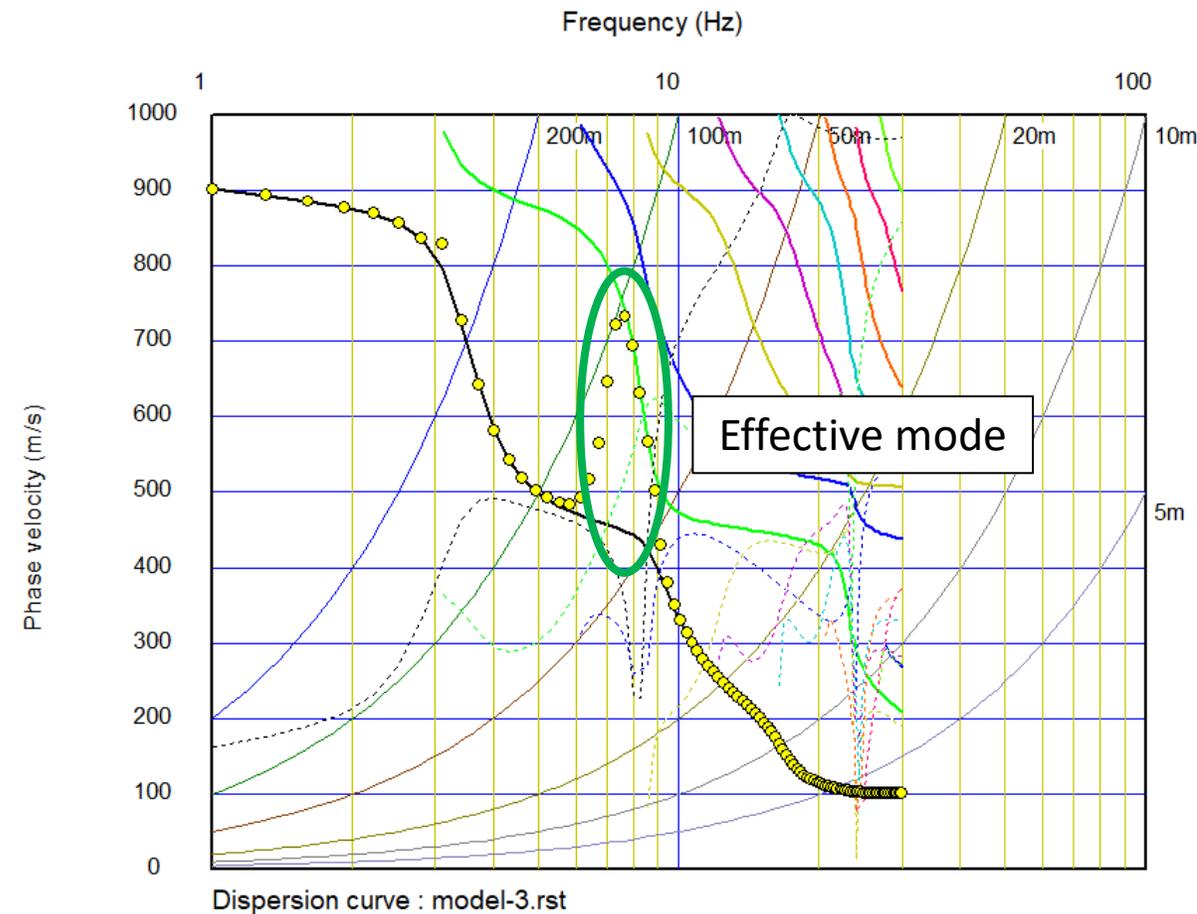
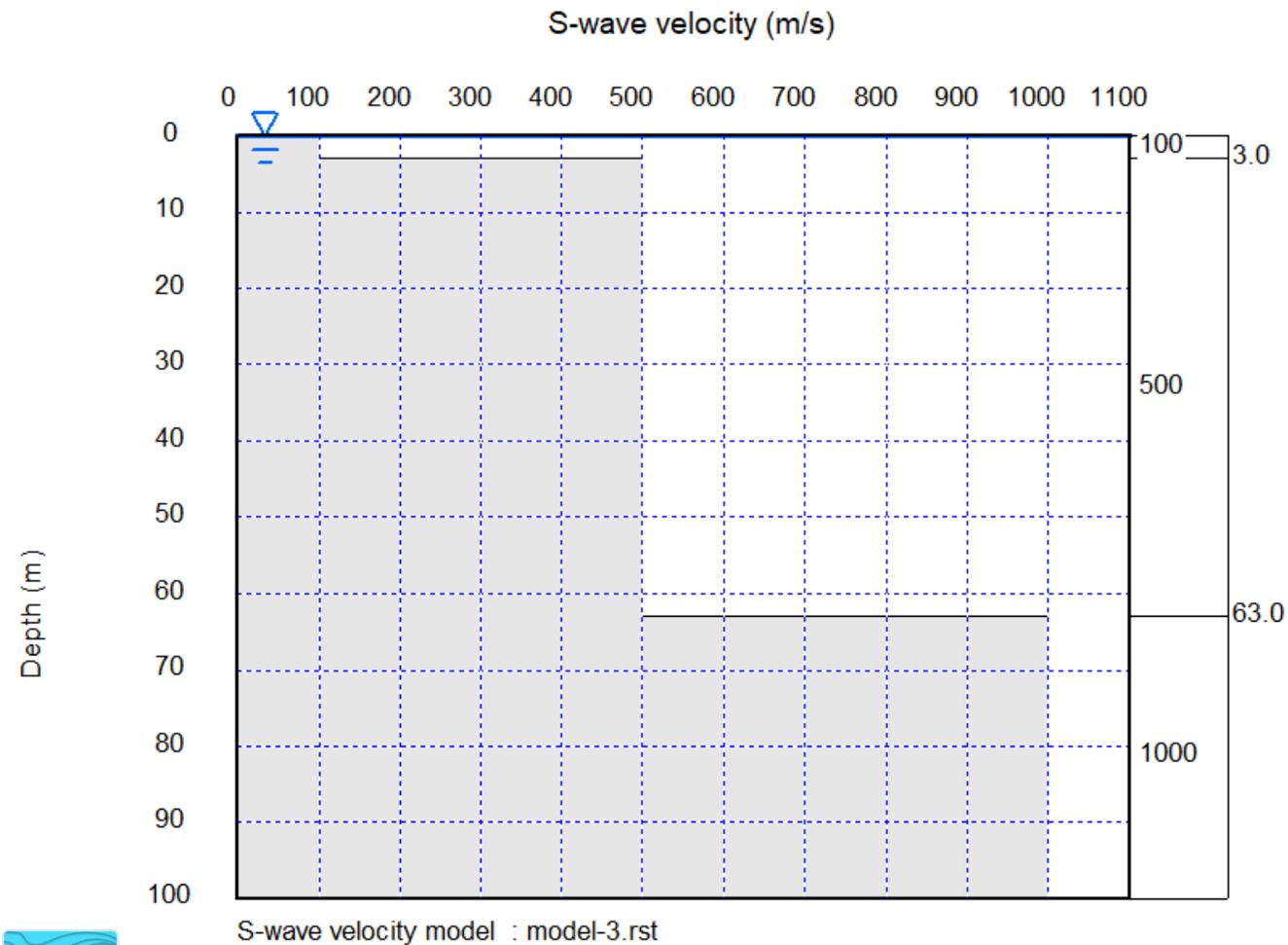
Case 1 : Higher mode example (High velocity on top)



Case 2 : Higher mode example (Reversed layer)



Case 3 : Higher mode example (large velocity contrast at surface)



Inversion using effective mode based on Genetic Algorithm (GA)

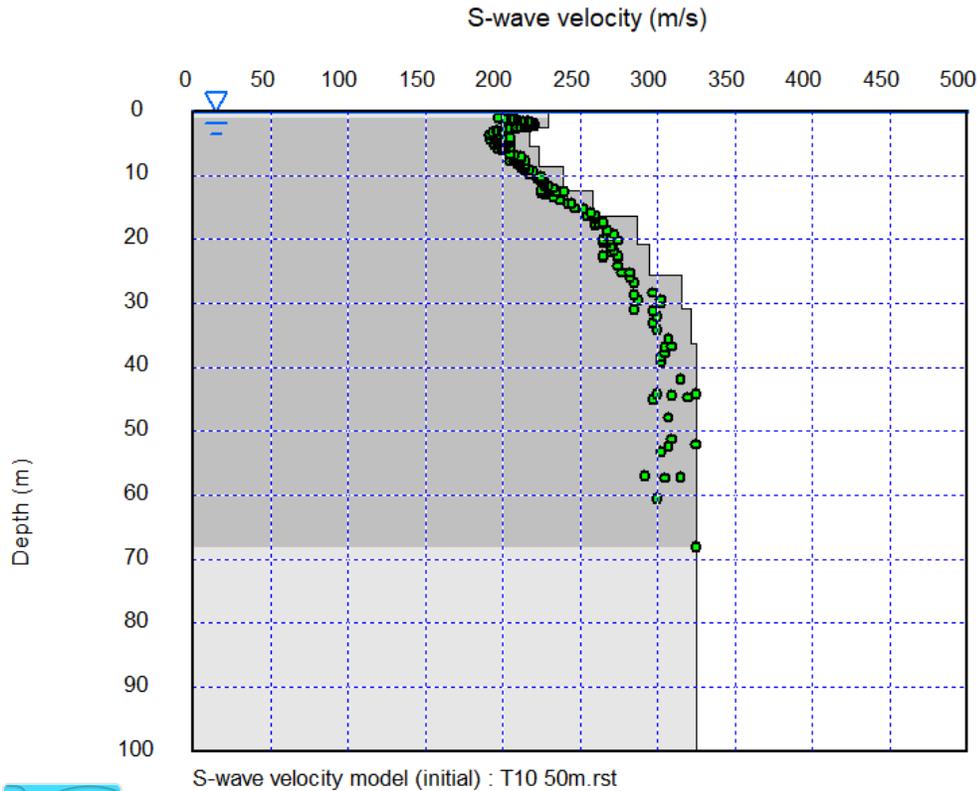
Initial S-wave velocity model

Comparison of observed and theoretical (fundamental mode) dispersion curves

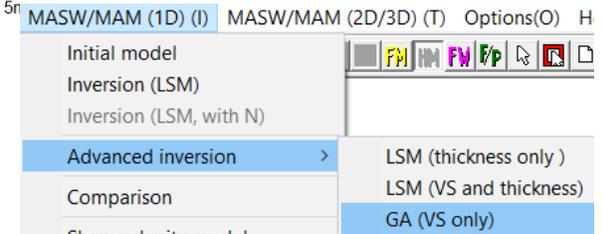
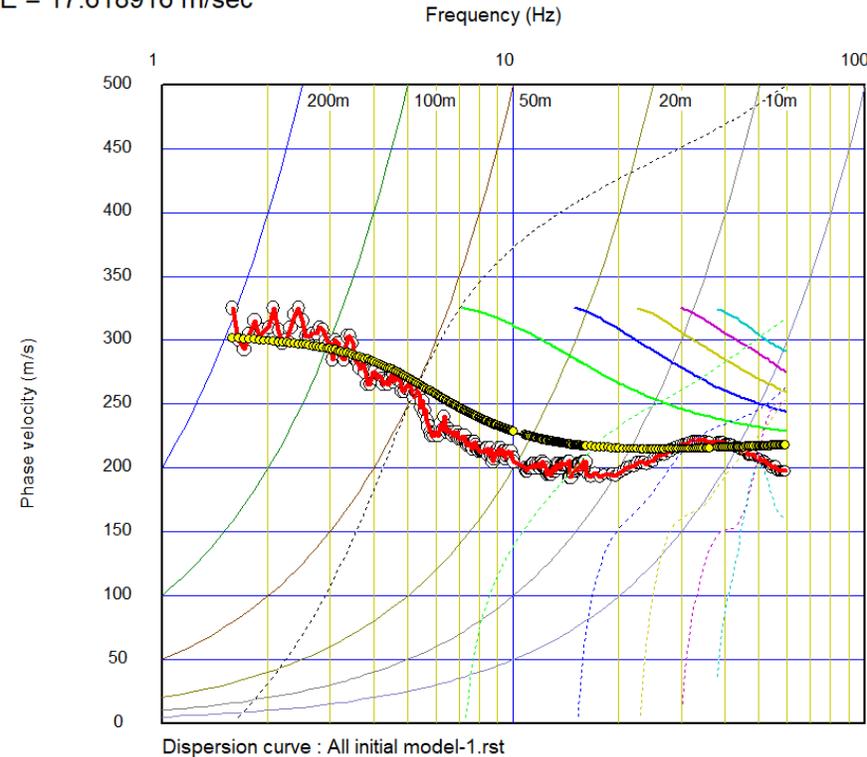
Effective mode



Select "MASW/MAM (1D)", "Advanced inversion", "GA (VS only)" to start the inversion.



RMSE = 17.618916 m/sec



Inversion using effective mode based on Genetic Algorithm (GA)

Number of calculation is iteration by population (50 x 50 = 2500 in this example). More calculation takes longer computation time.

Genetic Algorithm

Iteration: 50

Population: 50

Binary digits: 5

Crossover probability: 0.5

Mutation probability: 0.5

Buttons: OK, Cancel

No need to change default parameters.

Constraint is quite important and will be described in next pages

Search area of GA is defined based on initial model

Velocity model inversion with GA

Constraint

- No constraint
- Setup allowed velocity reverse (default)
 - Allowed velocity reverse (default=20%): 10 %
 - Current velocity reverse: 3 %
- Increasing with depth
- Decreasing with depth

Search area

Search area for velocity (default=20%): 25 %

Min and max. velocity

Define min. and max. velocity

Min. velocity: 192.5 m/sec

Max. velocity: 325 m/sec

Search method

- Layer velocity
- Layer thickness
- Layer velocity and thickness:

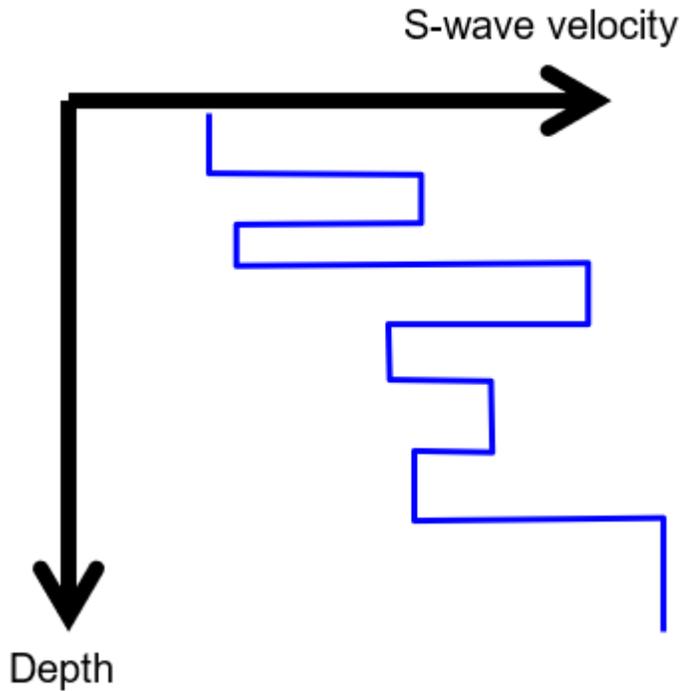
Fix bottom layer velocity

Buttons: OK, Cancel

Constraint in Genetic Algorithm (GA)

No constraint

Usually unstable and keep search area to be small.

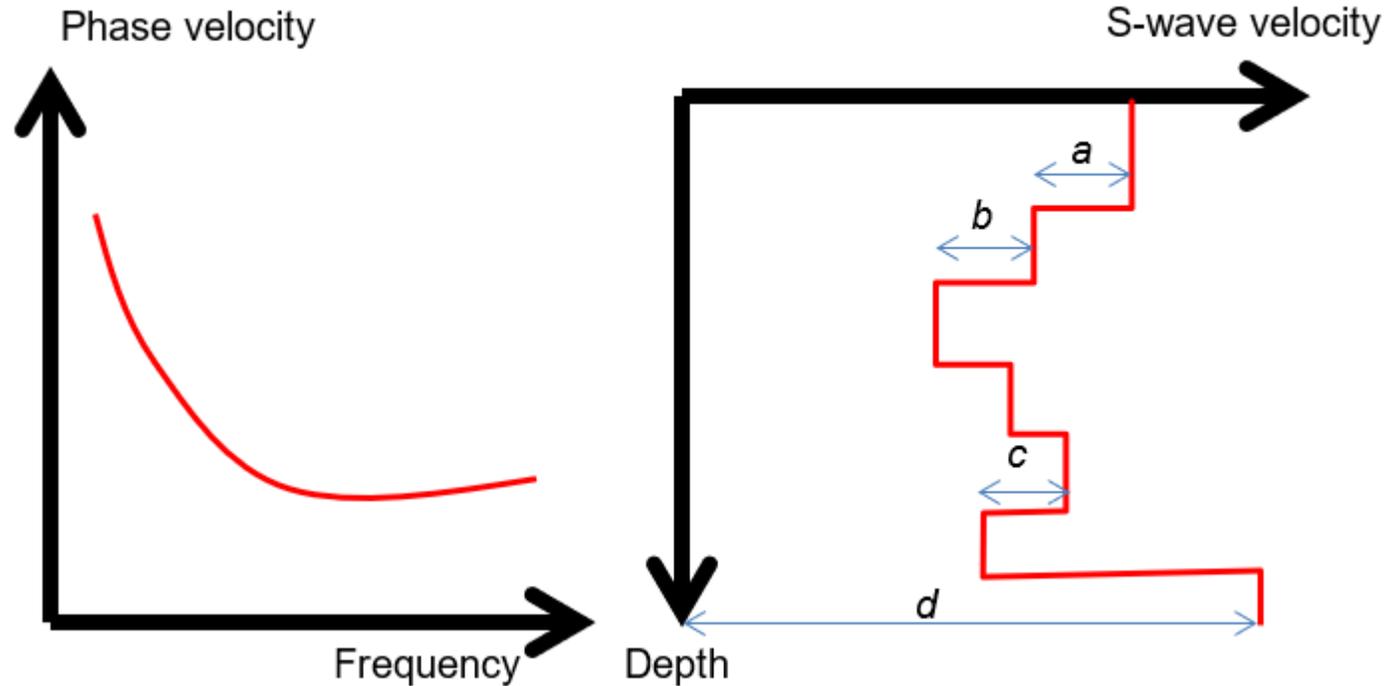


Use this one when dispersion curve has slight velocity reverse.

Setup allowed velocity reverse (default)

Allowed velocity reverse (default=20%) %

Current velocity reverse %



$$P(\%) = \frac{a + b + c}{d} \times 100$$



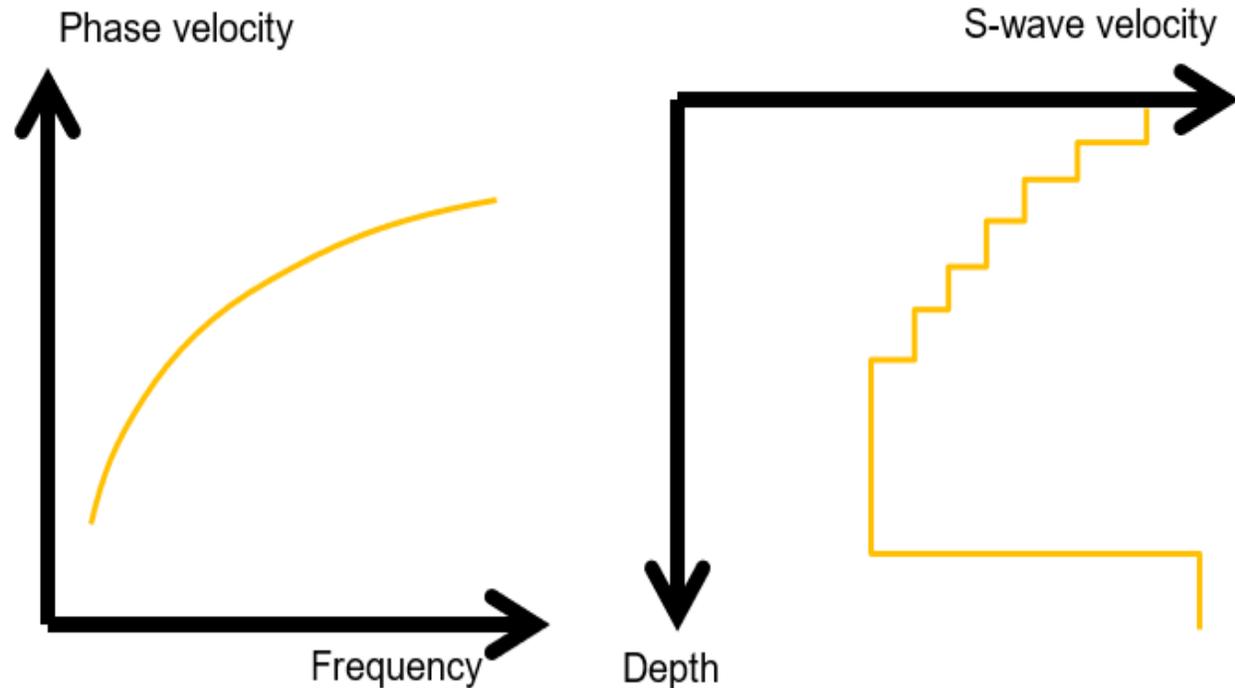
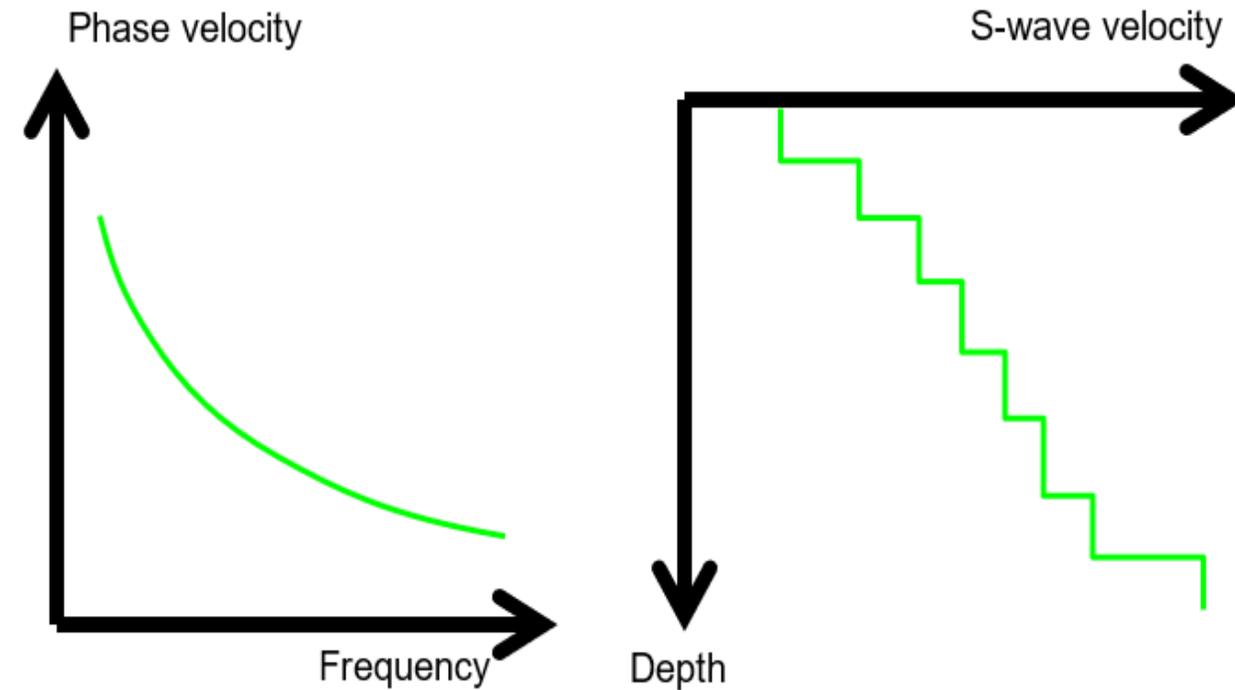
Constraint in Genetic Algorithm (GA)

☉ Increasing with depth

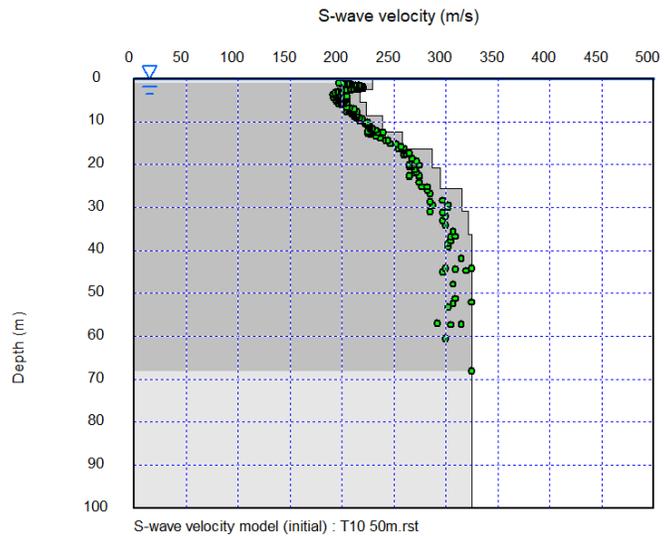
Use this one when dispersion curve has no velocity reverse.

☉ Decreasing with depth

Use this one when dispersion curve has significant velocity reverse.



Calculation example of Genetic Algorithm (GA)



Genetic Alogorithm

Iteration: 50

Population: 50

Binary digits: 5

Crossover probability: 0.5

Mutation probability: 0.5

OK

Cancel

Velocity model inversion with GA

Constraint

No constraint

Setup allowed velocity reverse (default)

Allowed velocity reverse (default=20%) 10 %

Current velocity reverse 3 %

Increasing with depth

Decreasing with depth

OK

Cancel

Search area

Search area for velocity (default=20%) 25 %

Min and max. velocity

Define min. and max. velocity

Min. velocity 192.5 m/sec

Max. velocity 325 m/sec

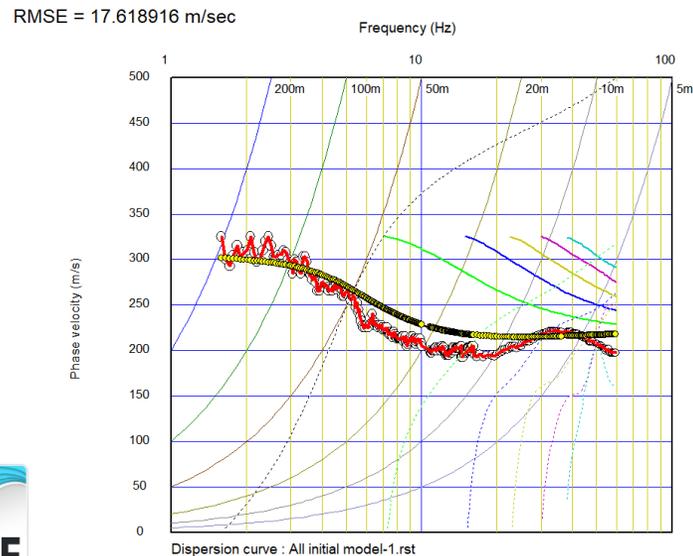
Search method

Layer velocity

Layer thickness

Layer velocity and thicknes:

Fix bottom layer velocity



During inversion the latest error is saved in "CurrentError.txt".

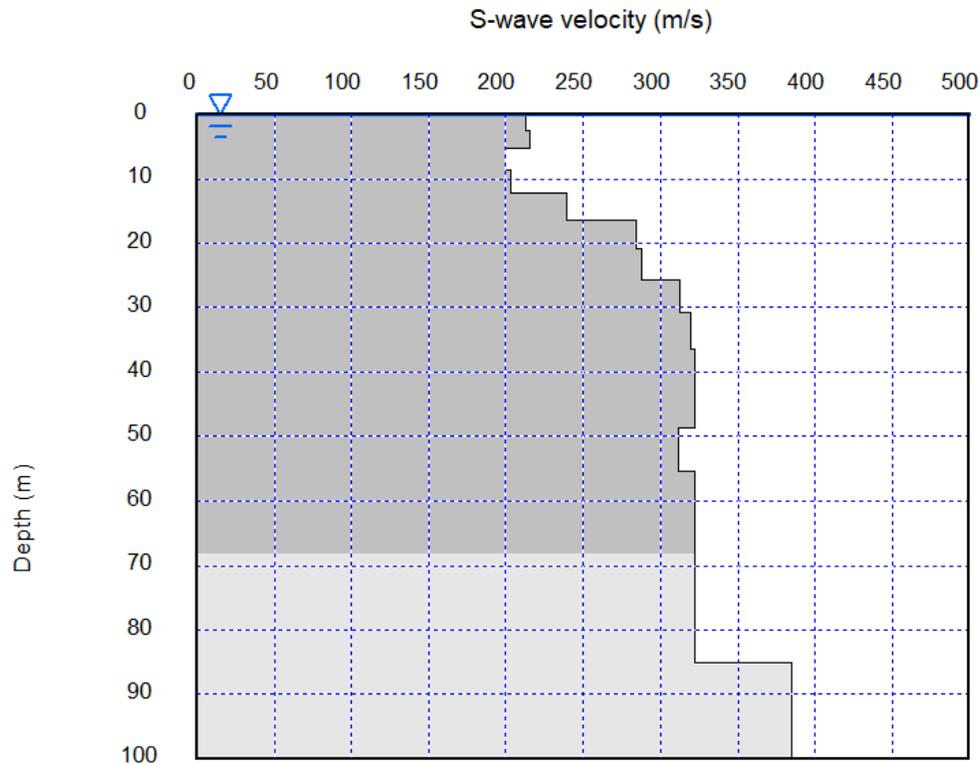
CurrentError.txt

Iteration= 35 Minimum RMS= 7.139146 in 15 Average RMS= 10.344242 Reject= 10

Calculation example of Genetic Algorithm (GA)

The best model obtained from GA

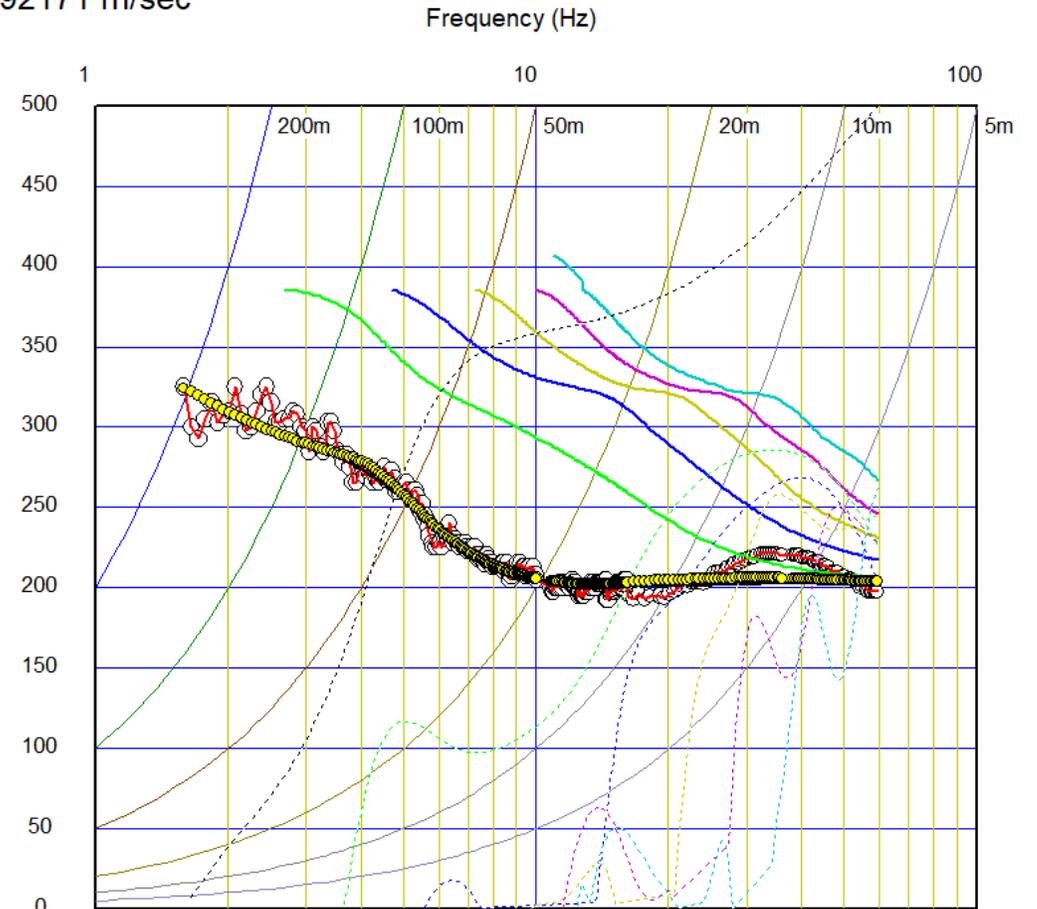
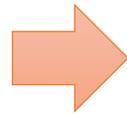
Index=0 Total error=0.007392



S-wave velocity model : Data at Geometrics inverted_result-2.rst

Average Vs 30m = 244.3 m/sec

Index=0 Total error=0.007392
RMSE = 7.392171 m/sec

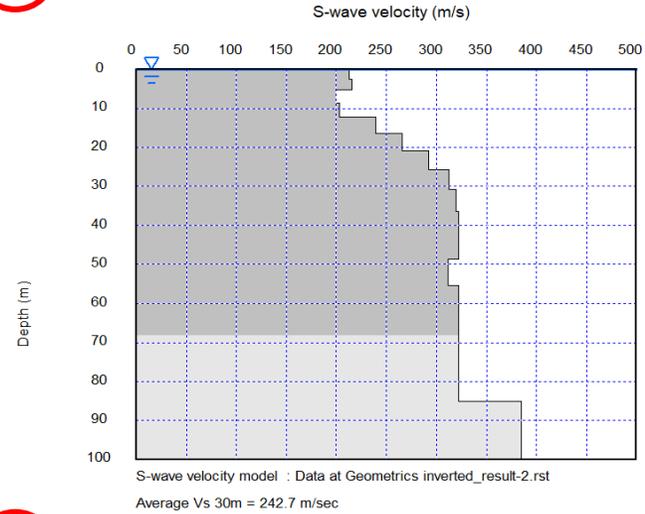


Solution members obtained from GA

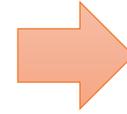
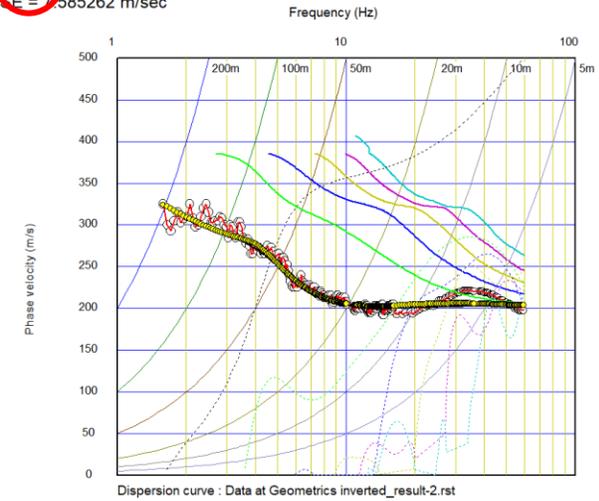
GA provides candidates of model (population or member).

2nd place

Index=2 Total error=0.007585

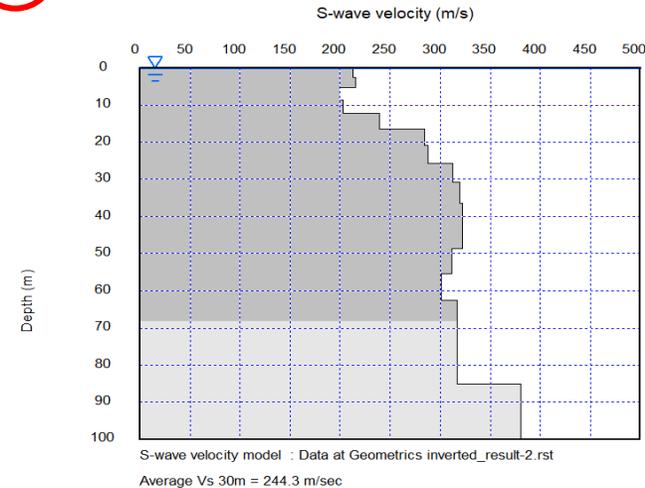


Index=2 Total error=0.007585
RMSE = 7.585262 m/sec

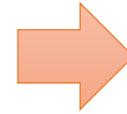
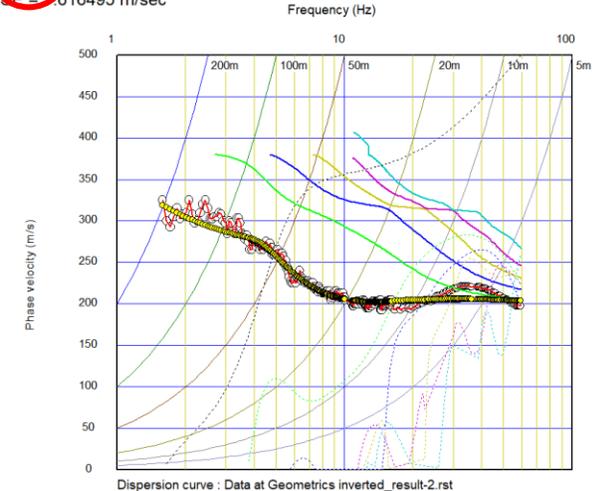


3rd place

Index=3 Total error=0.007616



Index=3 Total error=0.007616
RMSE = 7.616495 m/sec

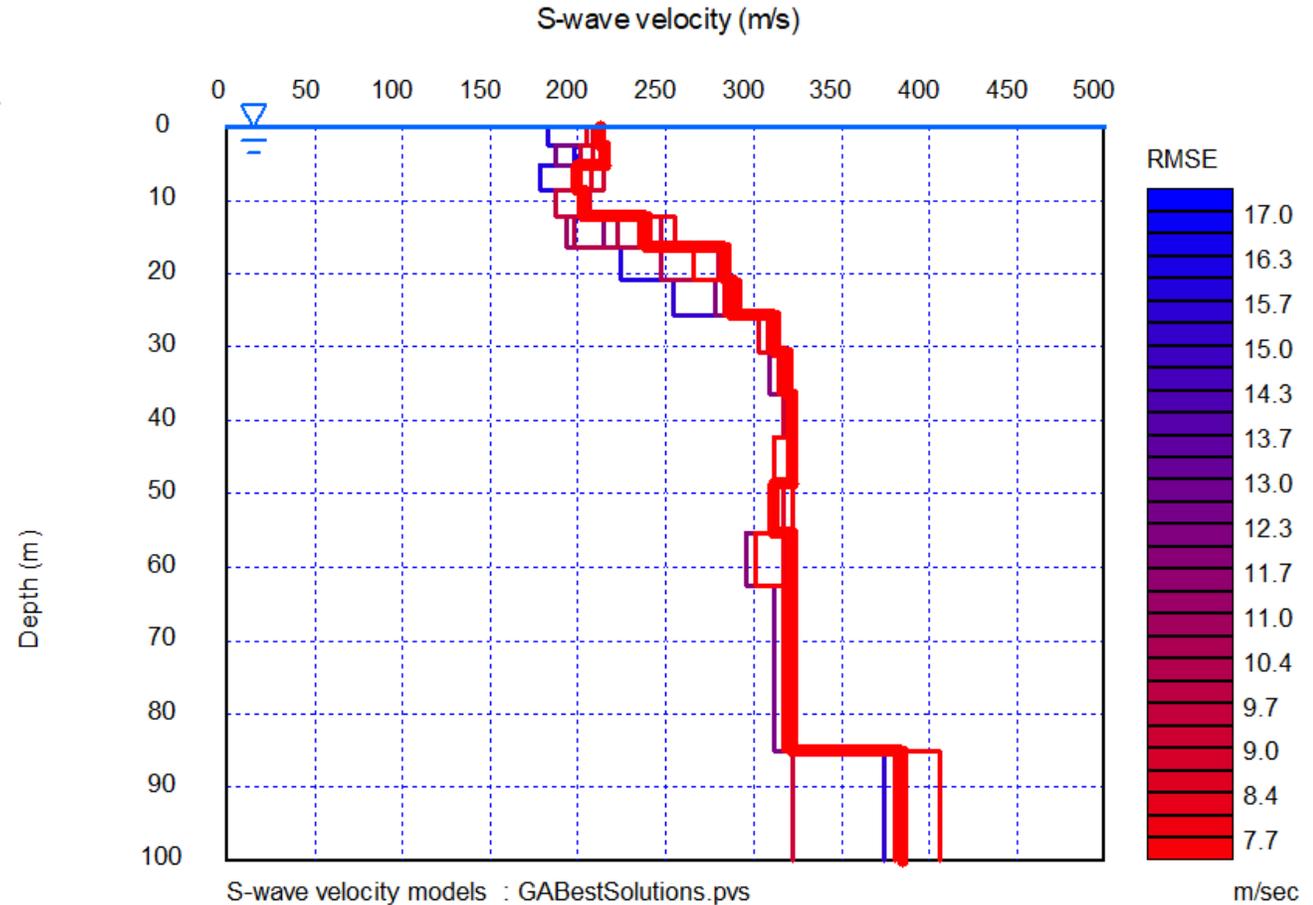


Use  buttons to scroll solution members.



Solution members obtained from GA

Click  to show all solution members.



Speed up calculation

To speed up calculation, check “Options”, “Advanced options”, “Parallel processing” to on.
WaveEq uses all processors in a PC.

