



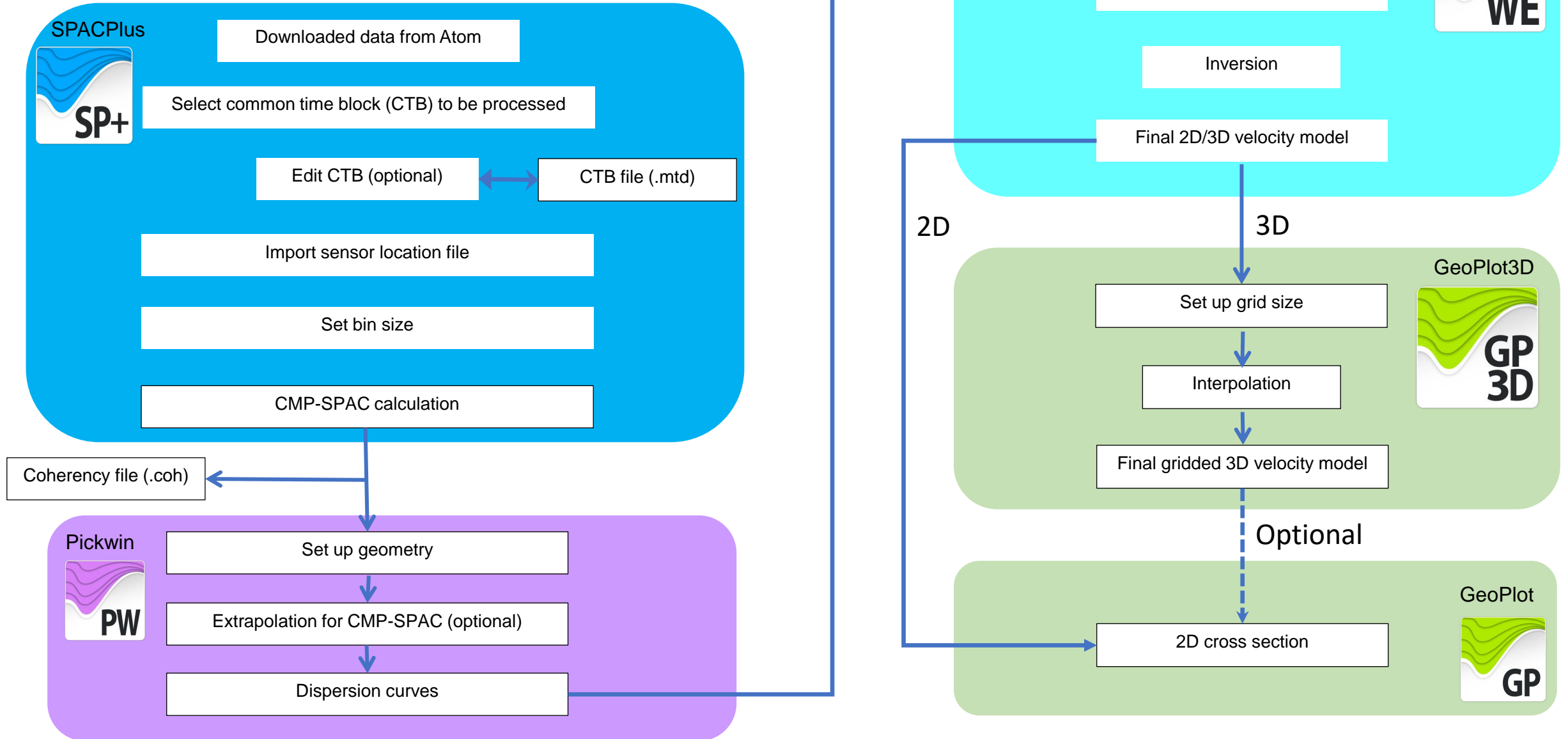
SeisImager/SW-3D

2D/3D ambient noise tomography processing using *SPACPlus* and other SeisImager modules

- Processing ambient noise data obtained by Atom.
- SeisImager/SW3D license is required.
- Download the latest installer from : <http://seisimager.com/download/SeisImager.zip>
- See “*SeisImager/SWTM Manual*”, “*SeisImager/SWTM Manual Addendum (H/V)*” and “*SeisImager/SW-ProTM Manual*” for the detailed analysis of dispersion curves and/or H/V curves.



Processing flow



Processing flow with intermediate and resultant files

You may save intermediate files and resume processing.

ASCII file

Binary file

Waveform files (.atm)

Waveform data obtained by Atom

Waveform files (.mtn)

Waveform data obtained by MT-Neo

SEG2 files (.dat, .sg2)

Waveform data obtained by Geode etc.

Geometry (.txt)

CTB (waveform) files (.mtd)

SPACPlus

File list (.xml)

Coherency files (.coh)

Pickwin

Phase velocity file (.pvs)

WaveEq

2D

3D

2D velocity model file (.geo)

GeoPlot

Optional

GeoPlot3D

Optional

3D velocity model file (.md3)

Topography (.txt)

SW3D option in SeisImager

“SW3D option” should be checked in SeisImagerRegistration to use 2D/3D ambient noise tomography processing functions.

SeisImager Registration

Send the keyword to your sales agent and get a password.

Your keyword is
bm98sezx

Enter the password
[]

SeisImager

Pickwin
☐ None ☐ Lite ☐ Standard ☒ Professional

Plotrefa
☐ None ☐ Lite ☐ Standard ☒ Professional

WaveEq
☐ None ☐ 1D ☒ 2D

GeoPlot
☐ Viewer ☒ Standard

GeoPlot3D
☐ Viewer ☒ Standard

PSLog
☐ None ☒ Standard

SPACPlus
☐ AT ☒ Standard

☐ Rental

☒ SW-Pro option

☒ SW3C option

☒ SW3D option

2D : Pro

SW : Pro3D

DH : Standard

☒ SeisImager server

McSEIS MT-Neo can be used.

Geode can be used.

Kyoto University functions are available.

User information
☒ Send user information to SeisImager.com

Last (family) Hayashi First (given) Koichi

E-Mail address khayashi@geometrics.com

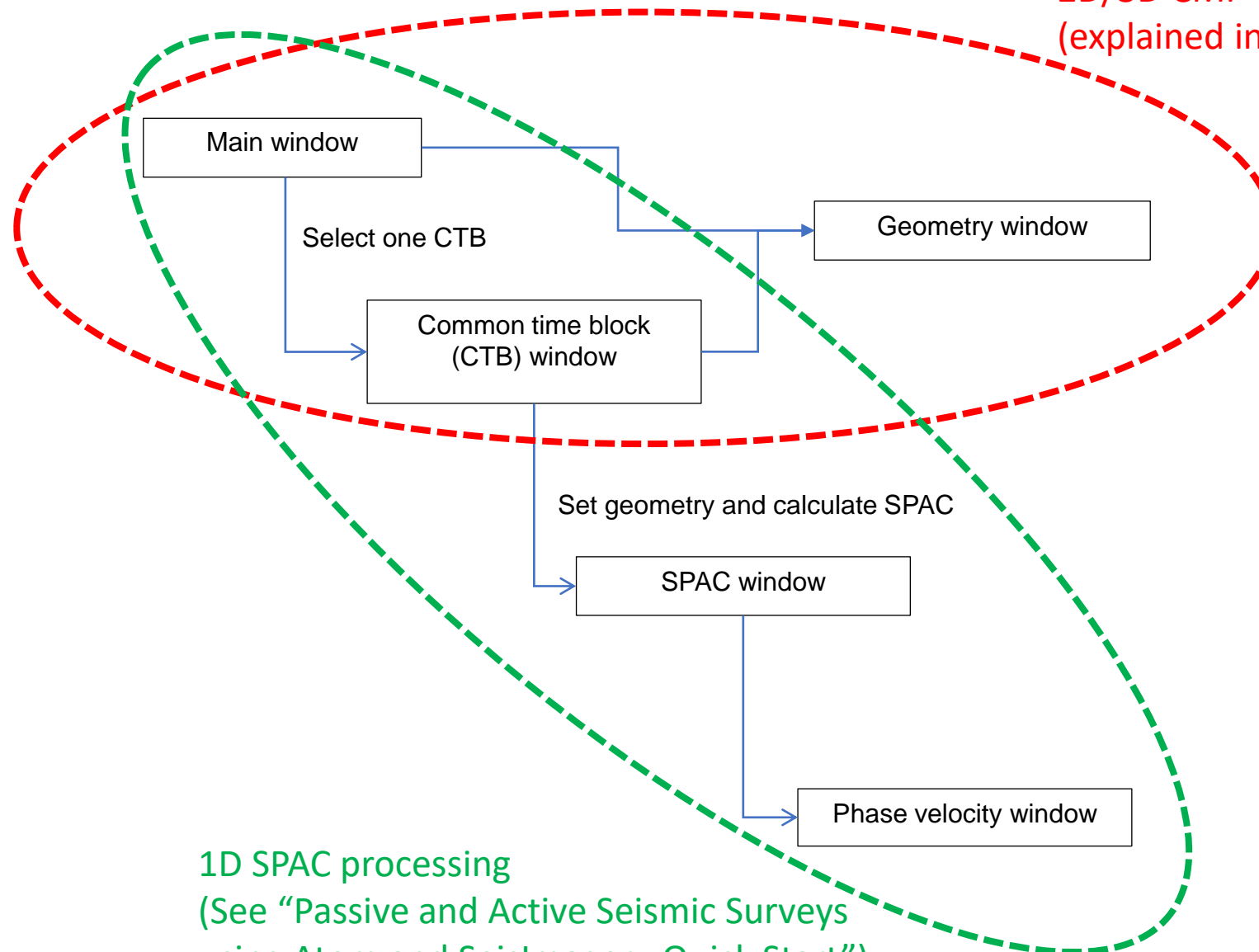
Server URL http://seisimager.com/SeisImager

Advanced options



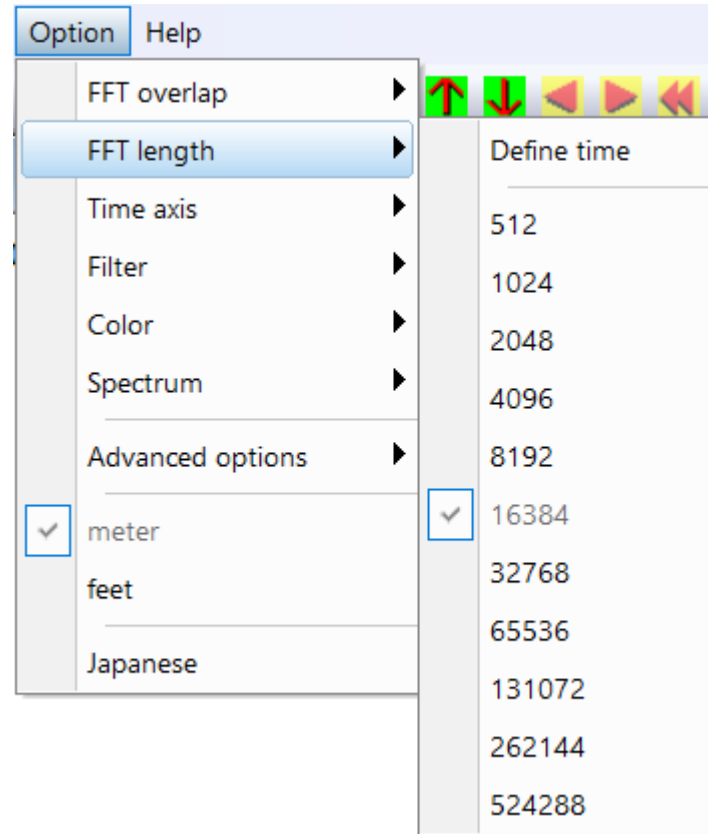
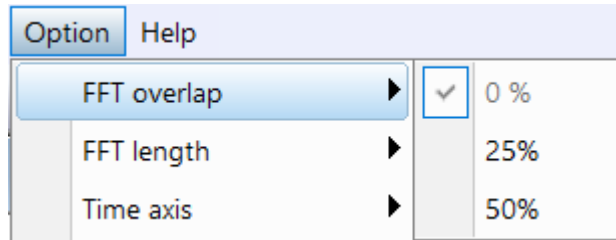
Window structure of SPACPlus

2D/3D CMP-SPAC processing
(explained in this instruction)



1D SPAC processing
(See "Passive and Active Seismic Surveys
using Atom and SeisImager : Quick Start")

Setting of SPACPlus

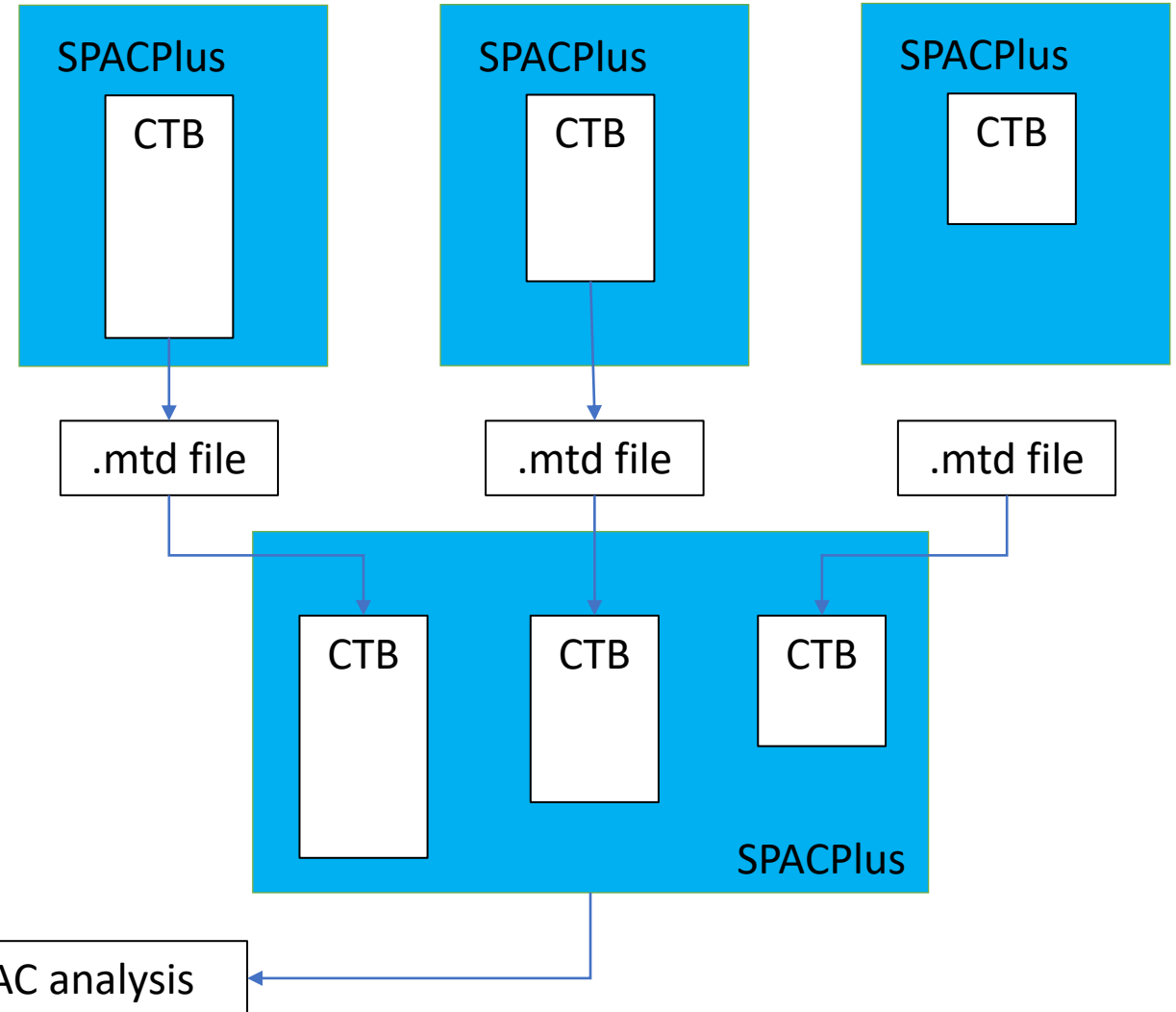
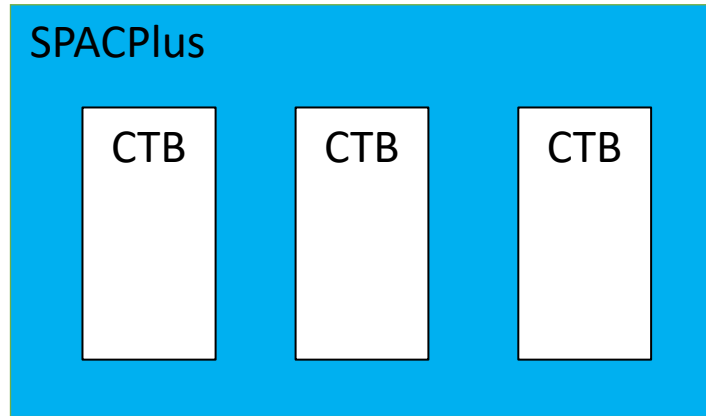


1. Import waveform data files

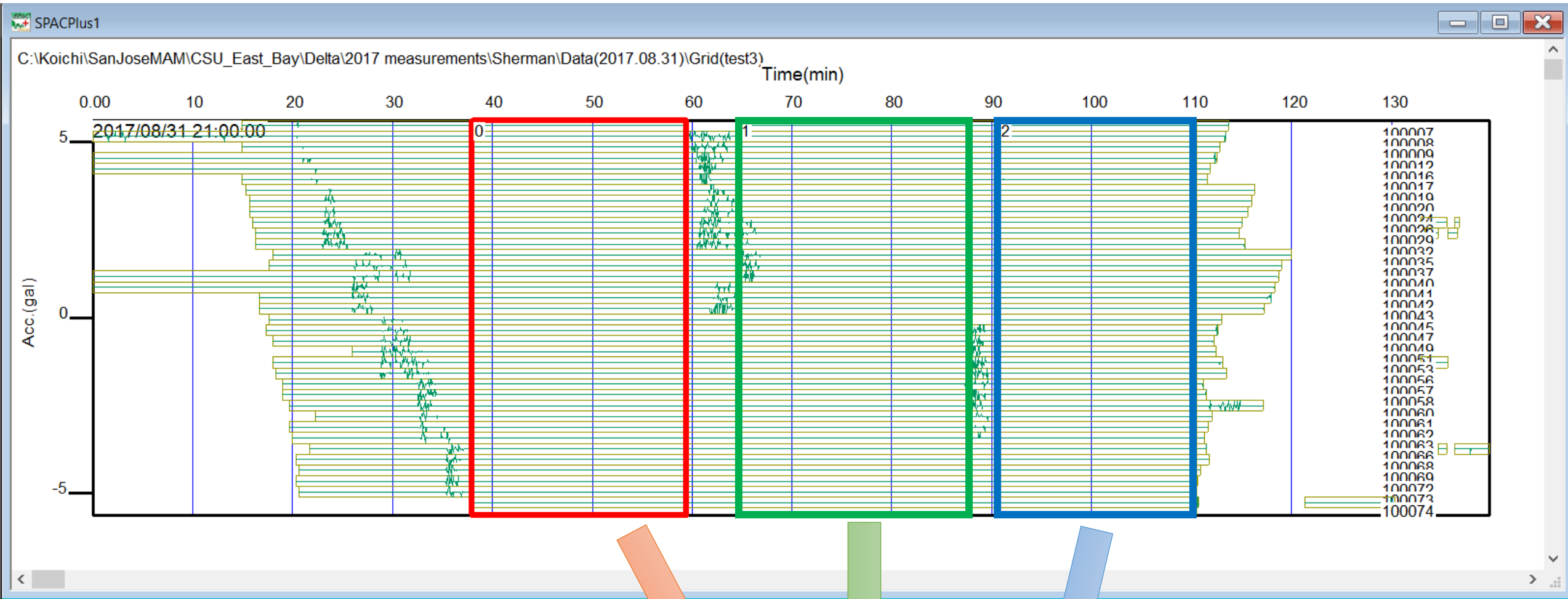
Geometry option of waveform data

A) All CTBs are in one set of data
(number of sensors must be identical)

B) CTBs are in several different sets
(number of sensors can be different)

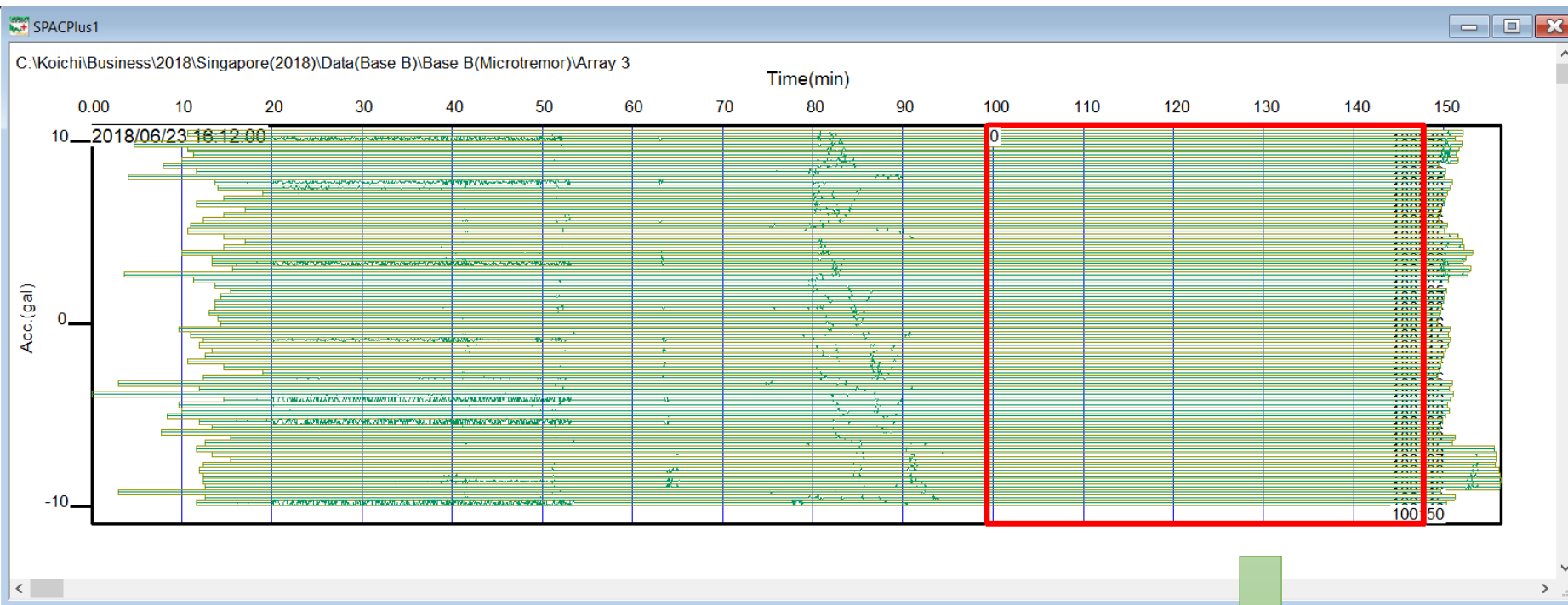


Example of data A

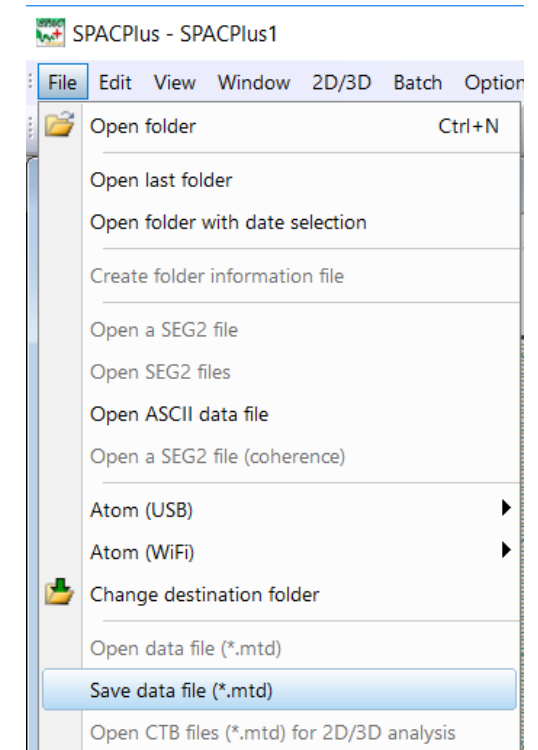


Common Time Blocks (CTBs)

Example of data B : save CTB as .mtd file

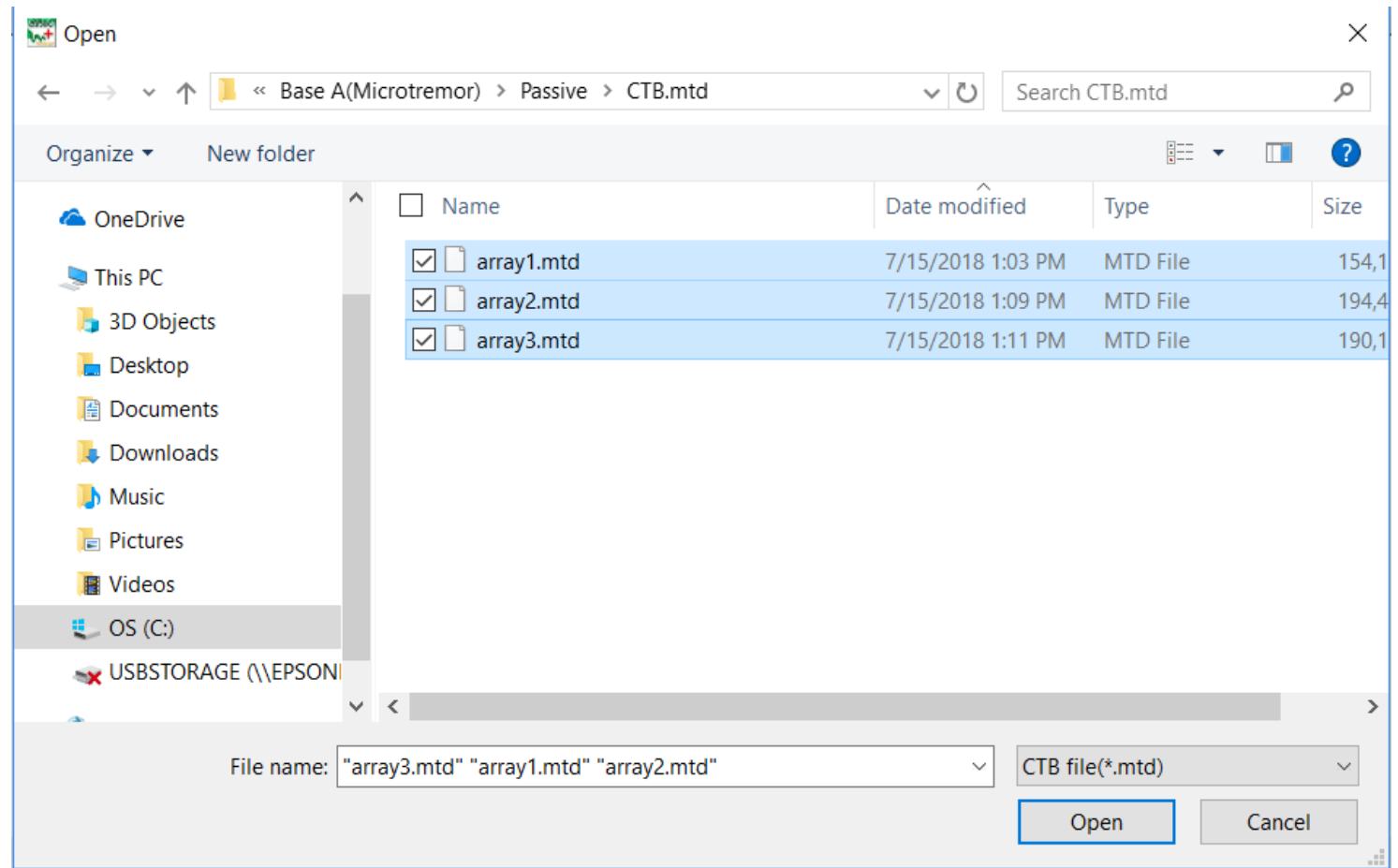
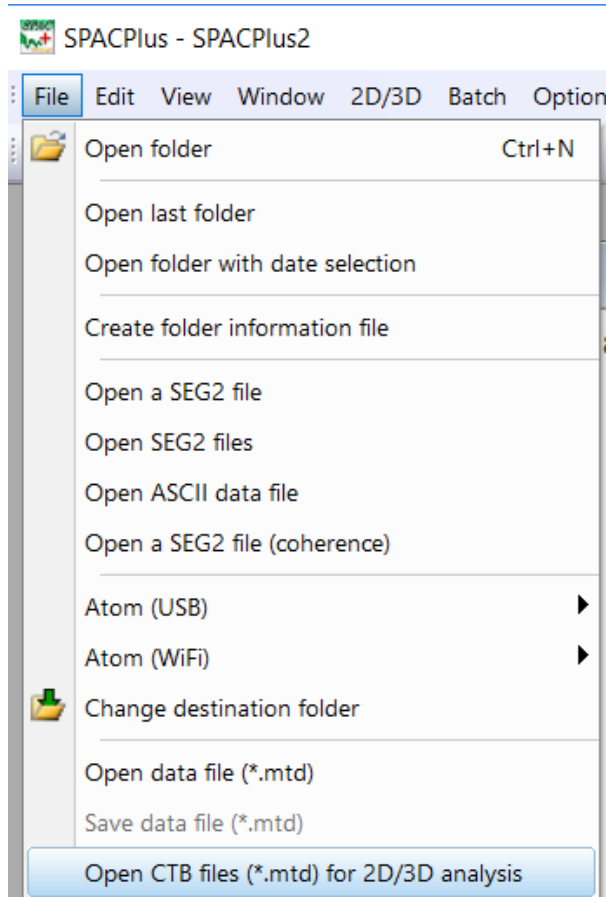


Select “File”, “Save data file (.mtd)” to save a CTB as .mtd file.

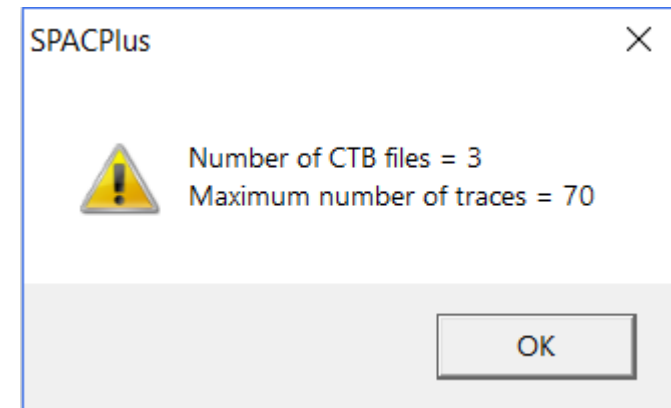
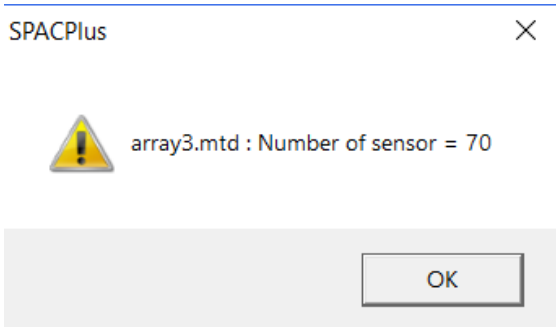
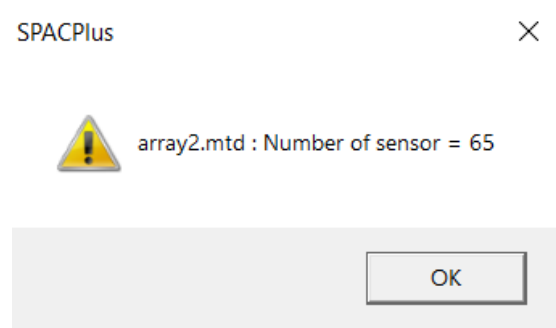
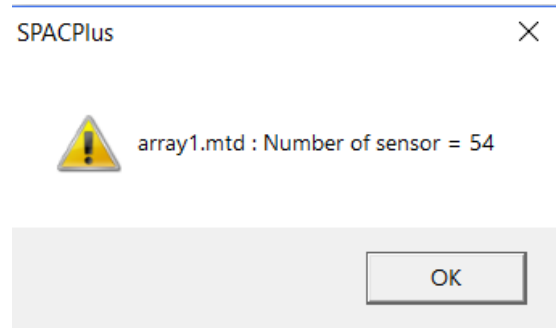


.mtd file

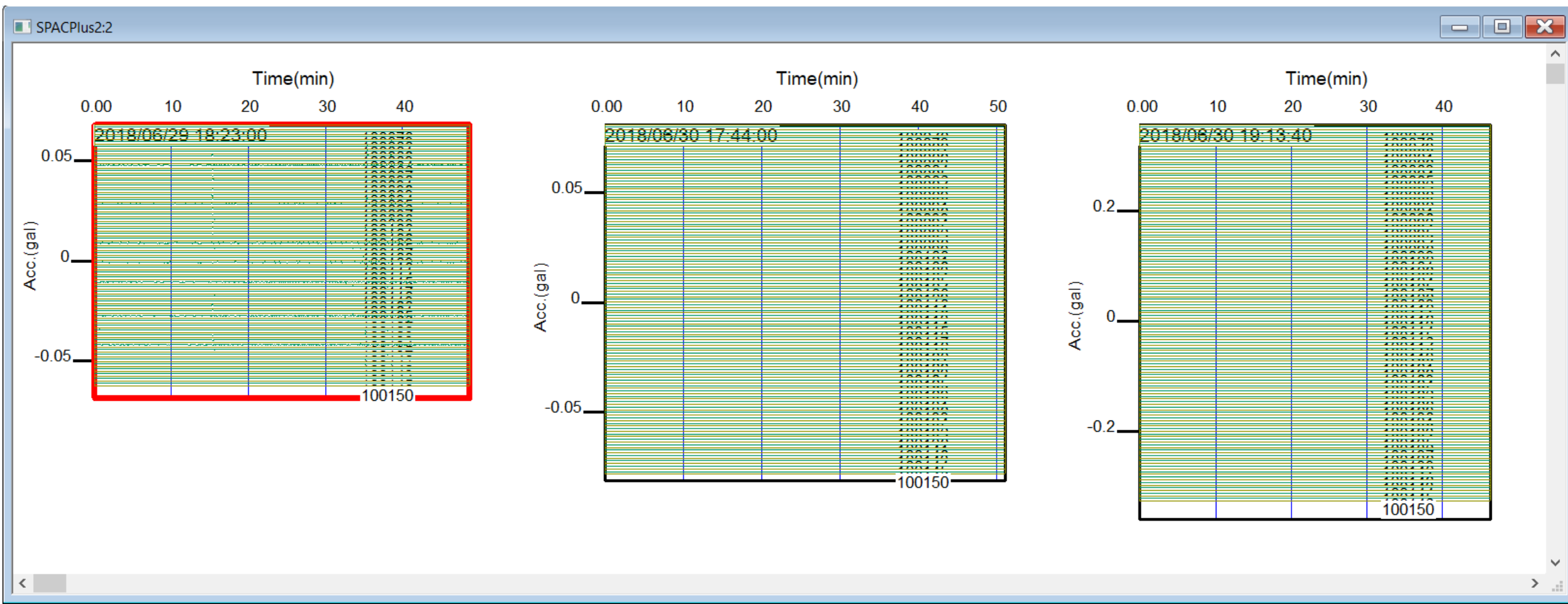
Example of data B : import several CTBs (.mtd files)



Example of data B : import several CTBs (.mtd files)



Example of data B : several CTBs with different receiver numbers



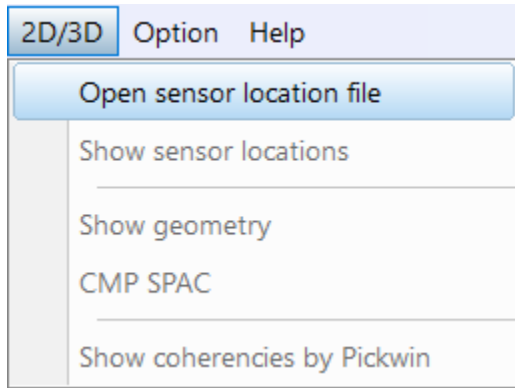
2. Prepare and import a geometry file

Prepare geometry file (ASCII file)

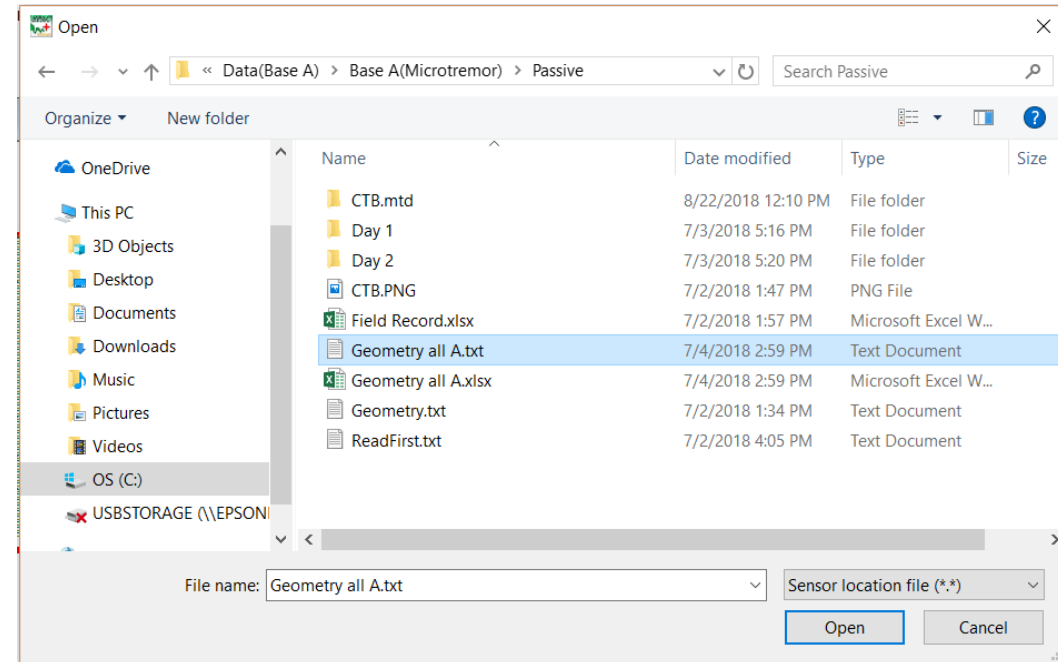
CTB index	Atom ID	X	Y
↓	↓	↓	↓
0	100007	90	0
0	100008	90	9
0	100009	90	18
0	100012	90	27
0	100016	90	36
0	100017	90	45
0	100019	81	0
0	100020	81	9
0	100024	81	18
0	100026	81	27
0	100029	81	36
0	100032	81	45
0	100035	72	0
	.		
	.		
0	100066	45	0
0	100068	45	9
0	100069	45	18
0	100072	45	27
0	100073	45	36
0	100074	45	45
1	100007	36	0
1	100008	36	9
1	100009	36	18
1	100012	36	27
1	100016	36	36
1	100017	36	45
1	100019	27	0
1	100020	27	9

Import geometry file

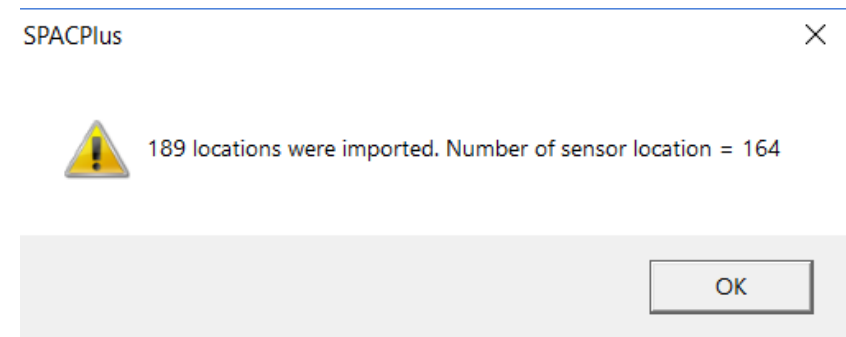
Select “2D/3D”, “Open sensor location file”
Open sensor location file.



Select geometry file.



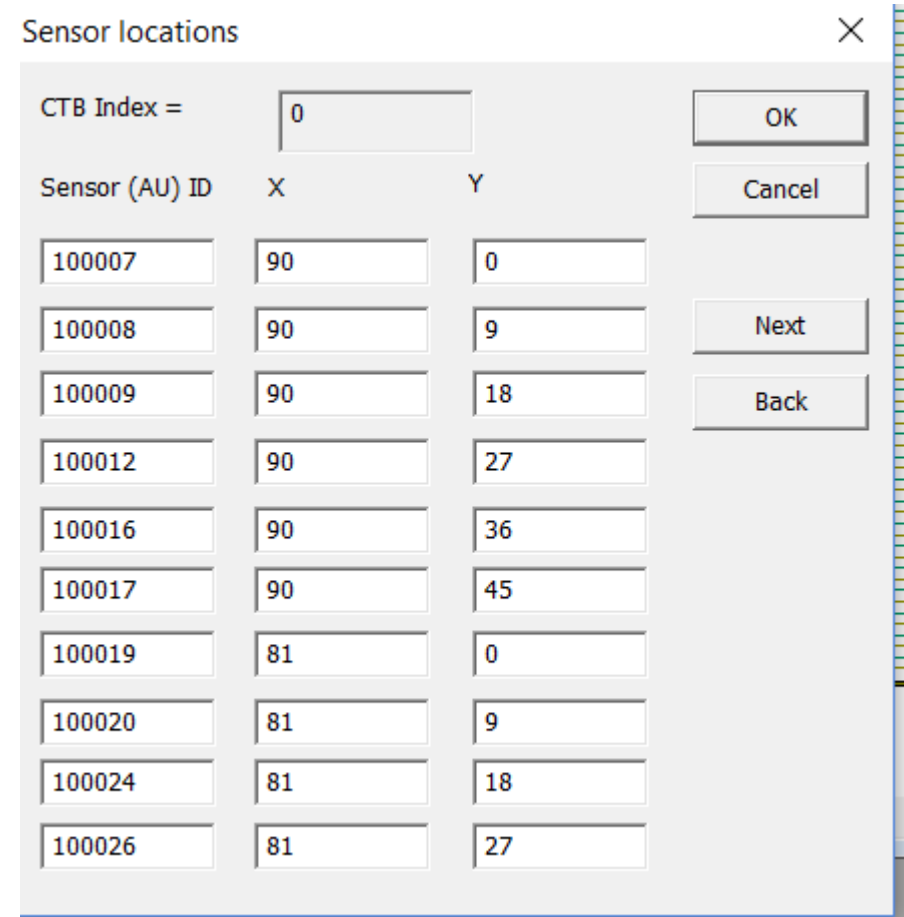
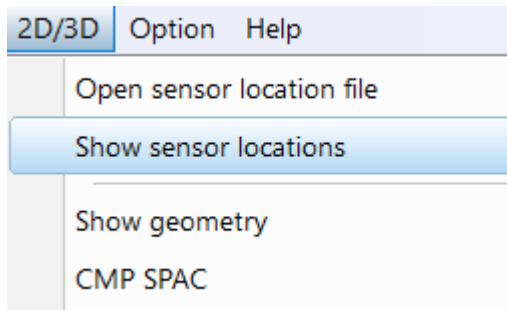
Confirm number of sensor locations.



3. Show and edit sensor locations (geometry)

Show and edit sensor locations

Select “2D/3D”, “Show sensor locations”
to show or edit sensor locations.

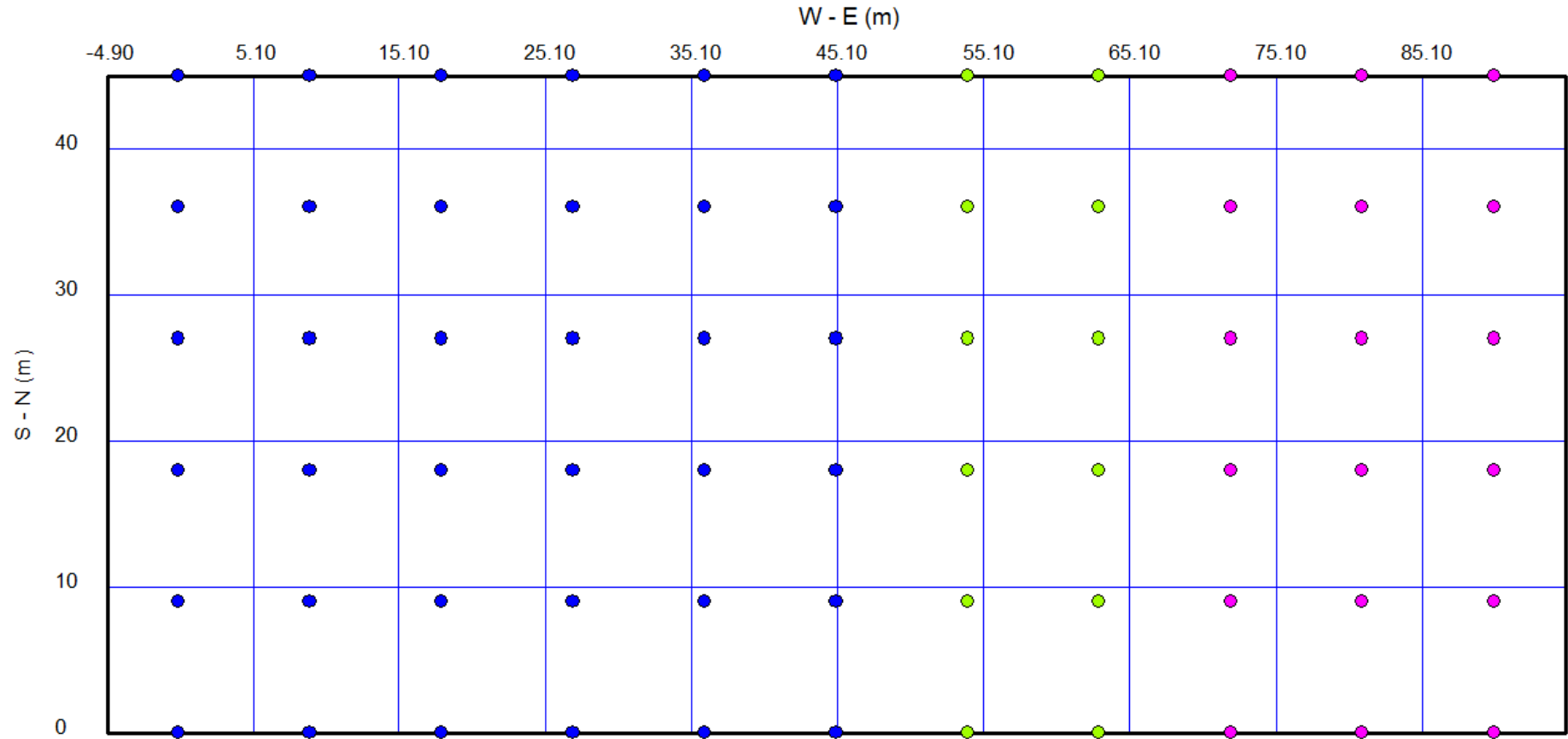
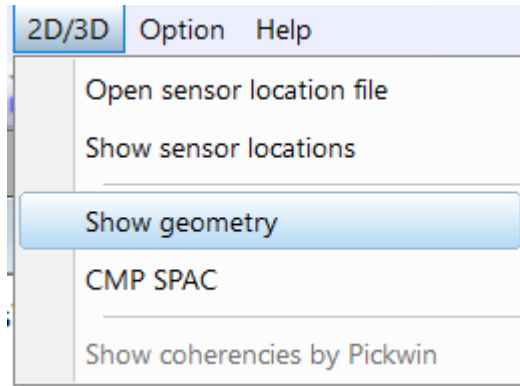


A screenshot of the 'Sensor locations' dialog box. It features a table with columns for 'Sensor (AU) ID', 'X', and 'Y'. The 'CTB Index' is set to 0. Navigation buttons include 'OK', 'Cancel', 'Next', and 'Back'.

Sensor (AU) ID	X	Y
100007	90	0
100008	90	9
100009	90	18
100012	90	27
100016	90	36
100017	90	45
100019	81	0
100020	81	9
100024	81	18
100026	81	27

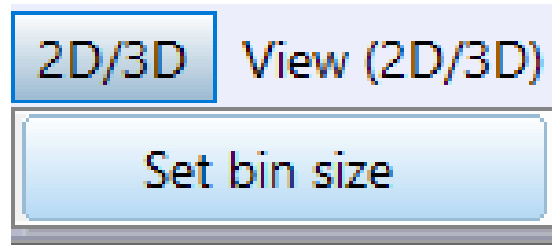
Show geometry

Select “2D/3D”, “Show geometry” to show sensor locations.



4. Set up bin size

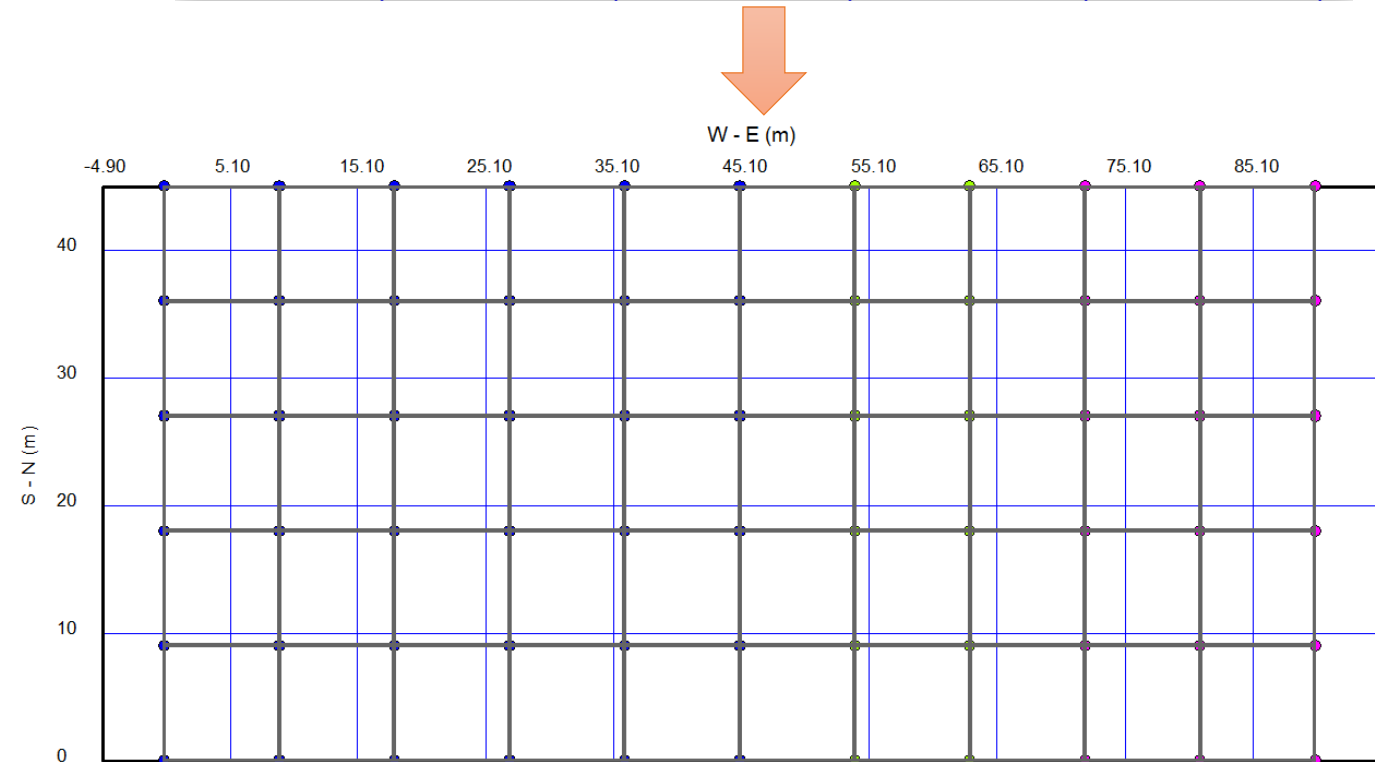
Set up bin size (3D processing)



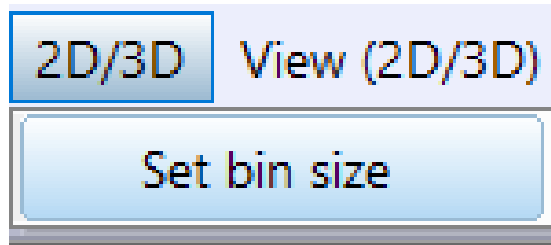
Bin size for CMP calculation

Bin size	X: 9	Y: 9
First distance	0	0
Last distance	90	45

OK Cancel



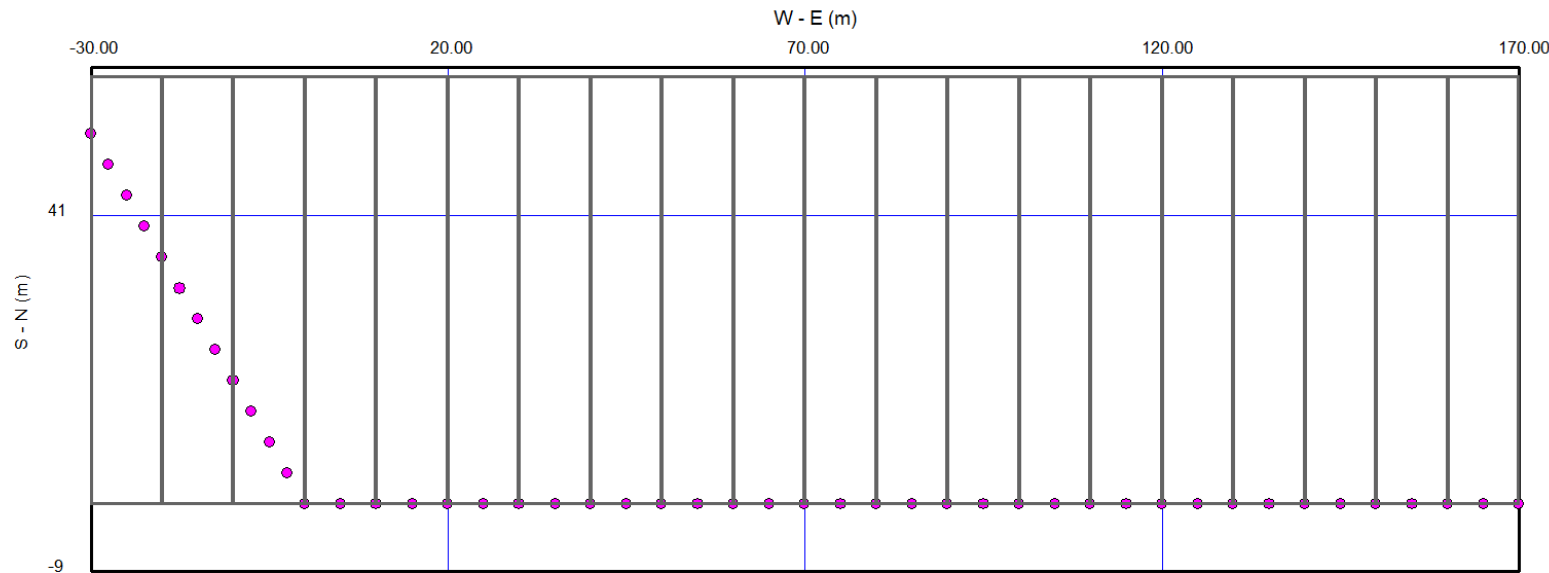
Set up bin size (2D processing)



Bin size for CMP calculation

Bin size	X: 10	Y: 60
First distance	-30	0
Last distance	170	51.9615

OK Cancel



Show geometry

View (2D/3D)

Show SPAC pairs

☒ Show bins

Show CMP pairs in a selected bin

Show number of pairs

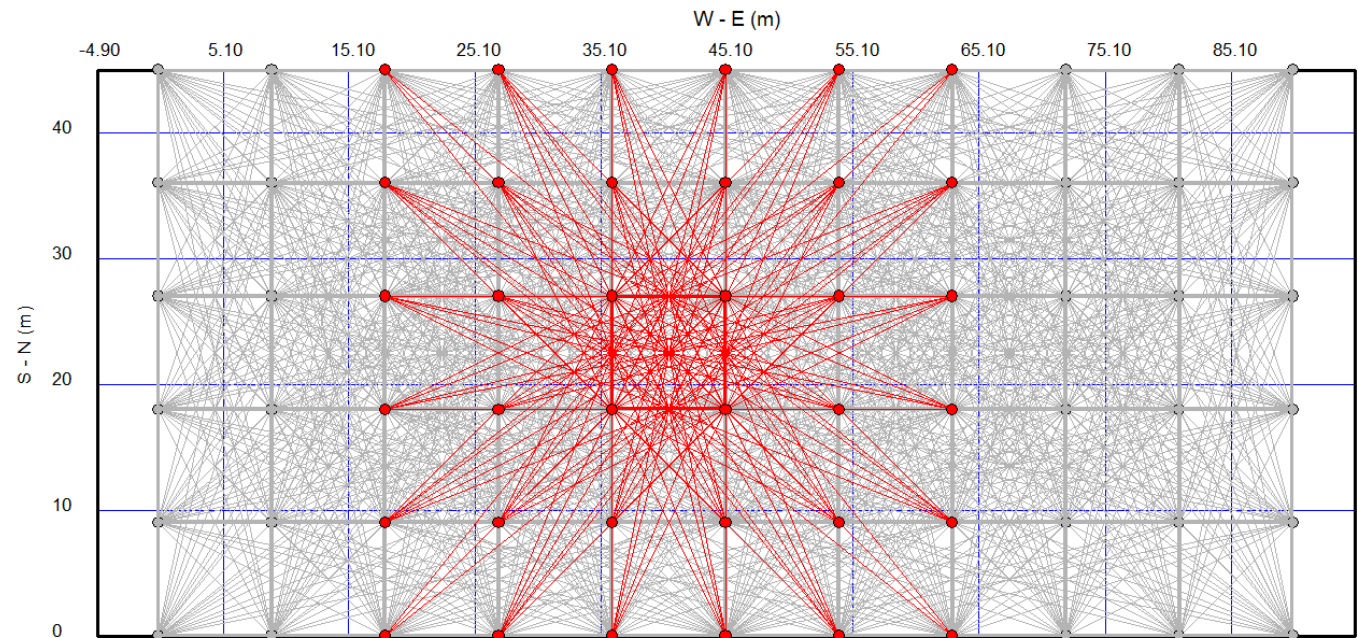
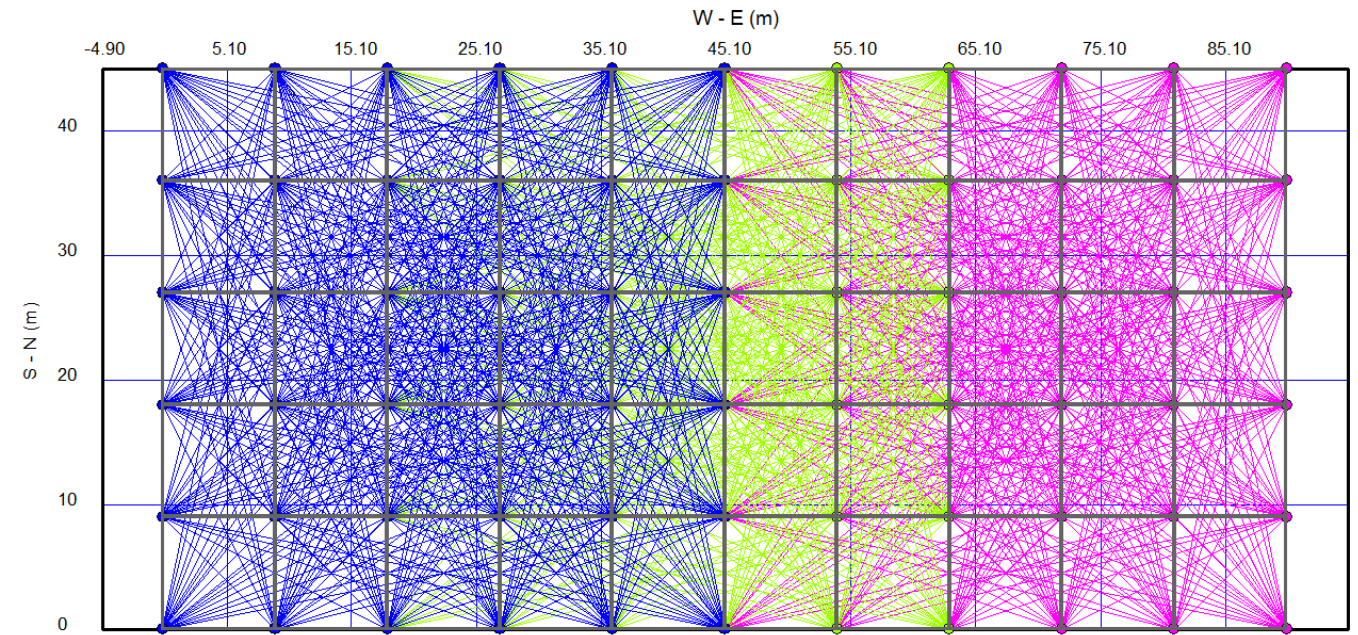
View (2D/3D)

☒ Show SPAC pairs

☒ Show bins

Show CMP pairs in a selected bin

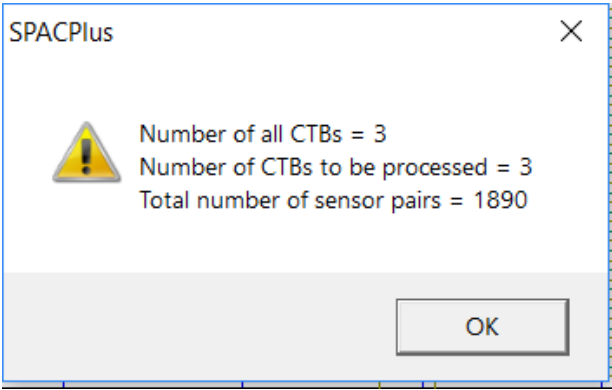
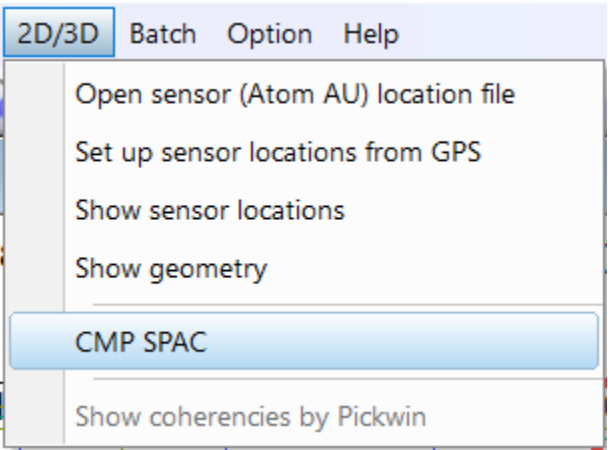
Show number of pairs



5. Calculate CMP-SPACs

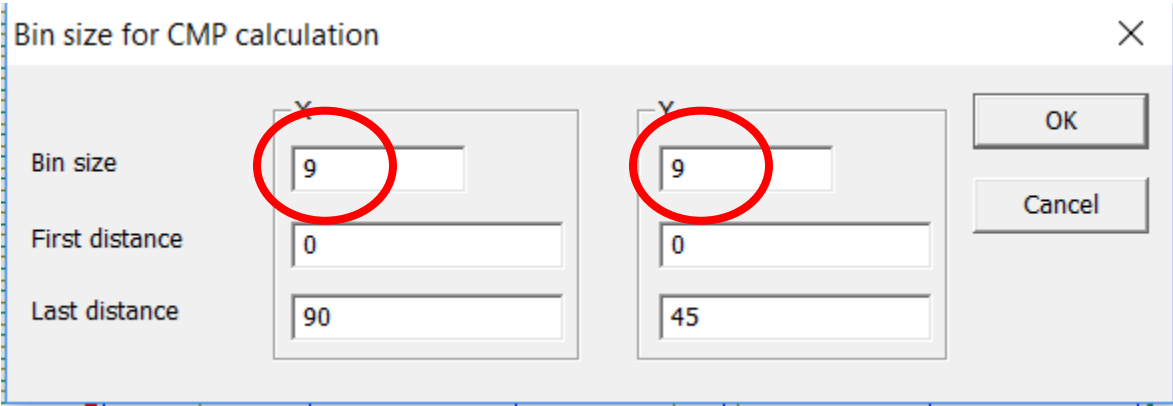
Select “2D/3D”, “CMP SPAC”.

Confirm number of CTBS etc.



Calculation may use 0.5 ~ 3GB of memory.

Set (confirm) Bin size and click “OK” to start calculation.



Task Manager

File Options View

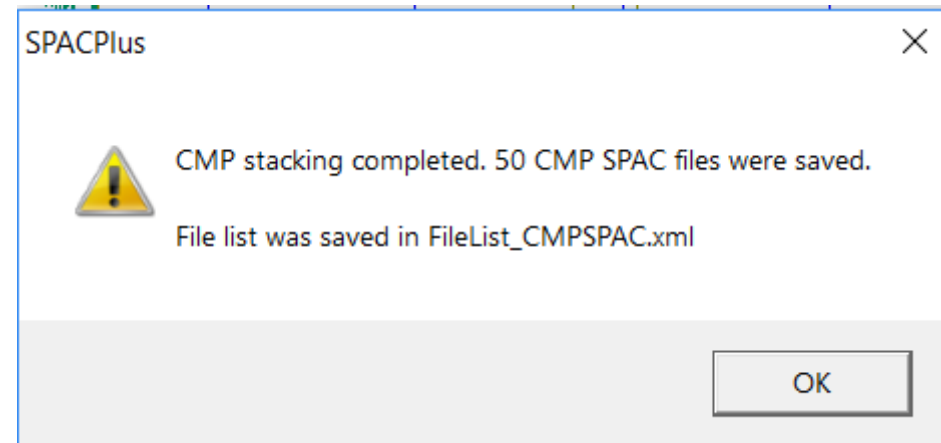
Processes Performance App history Startup Users Details Services

Name	Status	99% CPU	53% Memory	4% Disk	0% Network
Apps (9)					
Google Chrome (16)		1.1%	666.6 MB	0 MB/s	0.1 Mbps
Microsoft Edge (18)		0%	392.0 MB	0 MB/s	0 Mbps
Microsoft PowerPoint (32 bit)		0%	68.3 MB	0 MB/s	0 Mbps
Microsoft Word (32 bit) (2)		0%	62.3 MB	0 MB/s	0 Mbps
Paint		0%	56.2 MB	0 MB/s	0 Mbps
Snipping Tool		0.3%	5.2 MB	0 MB/s	0 Mbps
SPACPlus (32 bit)	Not responding	29.6%	352.3 MB	0 MB/s	0 Mbps
Task Manager		0.6%	28.3 MB	0 MB/s	0 Mbps
Windows Explorer (3)		0.8%	164.7 MB	0 MB/s	0 Mbps



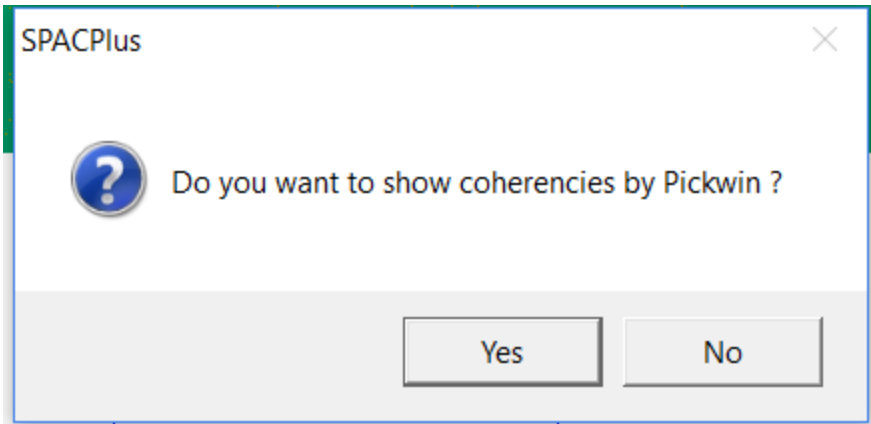
It will take several to several tens of minutes depending on the amount of data.

After the calculation,
SPAC or coherence files (.coh) and their file list (.xml) is saved.

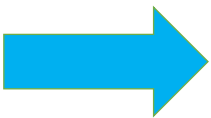
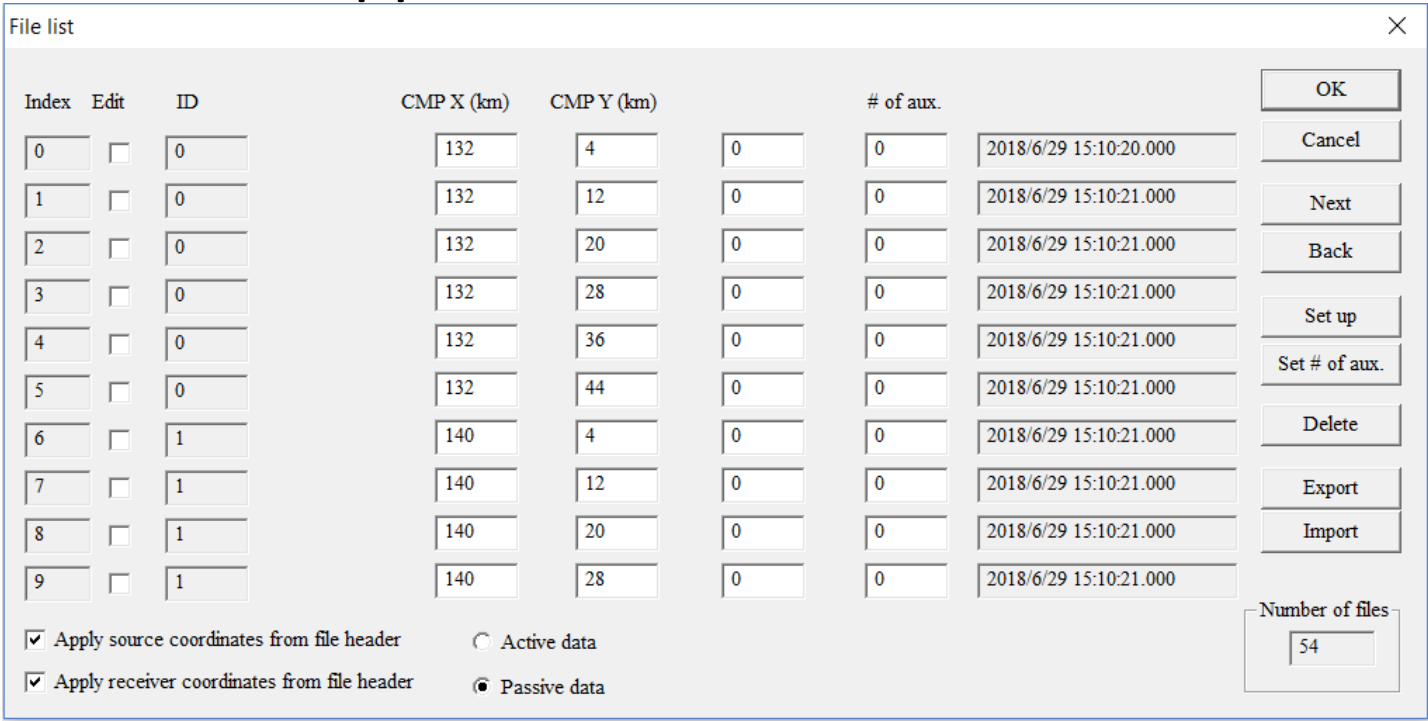


6. Show CMP-SPACs by Pickwin

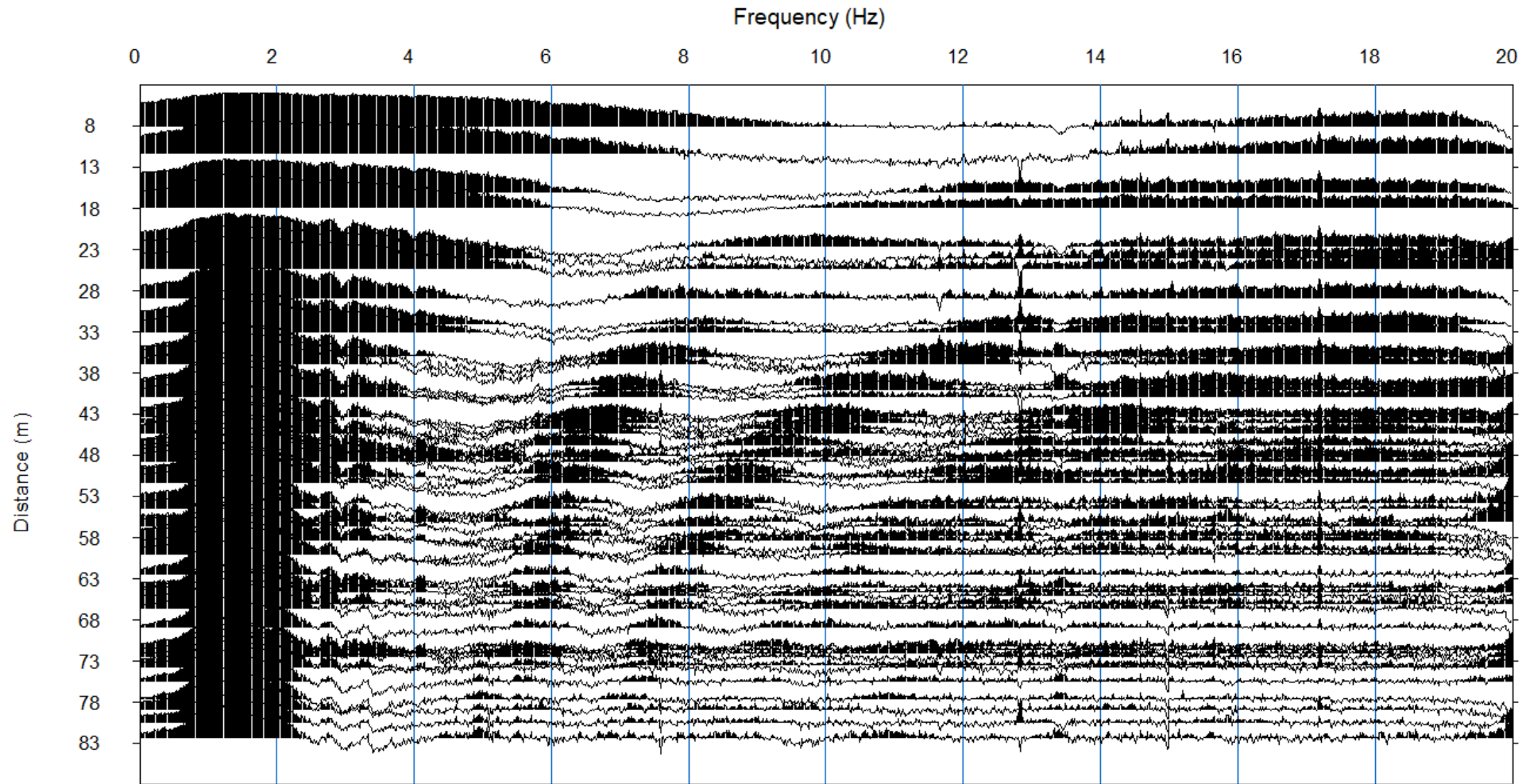
Crick OK to show SPAC by Pickwin.
You can also manually open the file list (FileList_CMPSPAC.xml) by Pickwin.




File list appears and click OK.




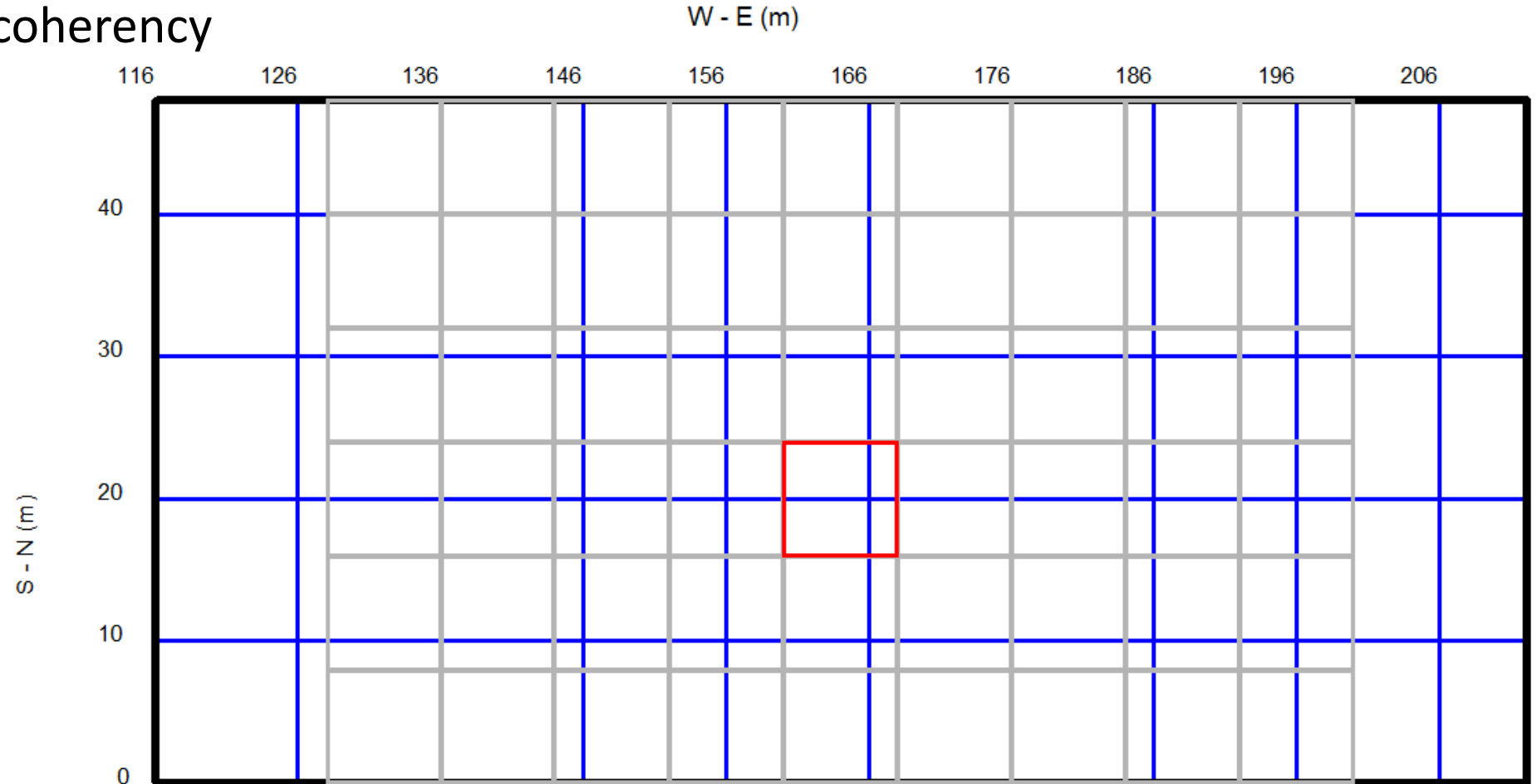
SPAC (coherence) appears. Use  buttons to scroll the bins (SPAC files).



Drawing geometry (CMP bins) in Pickwin

Click  to show geometry

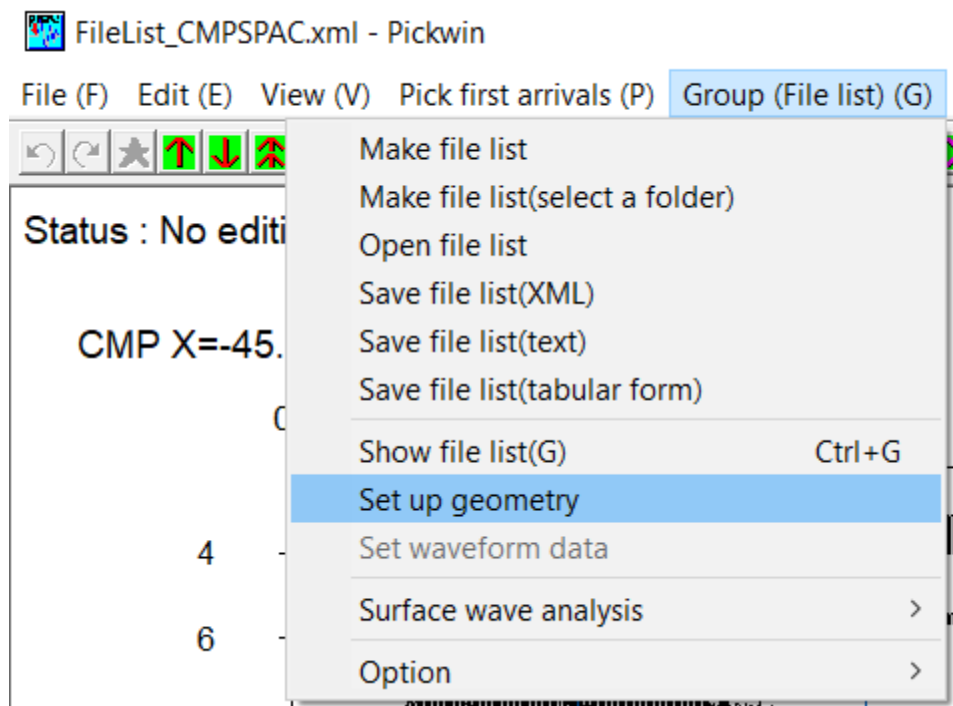
Click  to show coherency



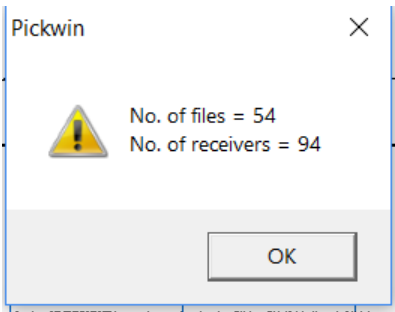
6.1 Set up geometry and extrapolate CMP-SPAC (optional)

If the number of coherencies have large difference among CMP-SPACs, the coherencies can be extrapolated to calculate stable and consistent dispersion curves. If you do not need to do the extrapolation, proceed step 7.

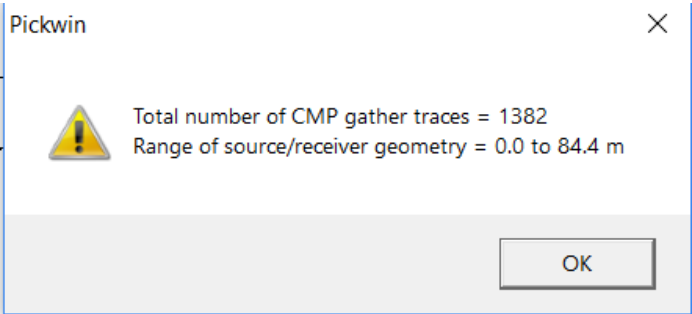
Select “Group (File list)”, ”Set up geometry.



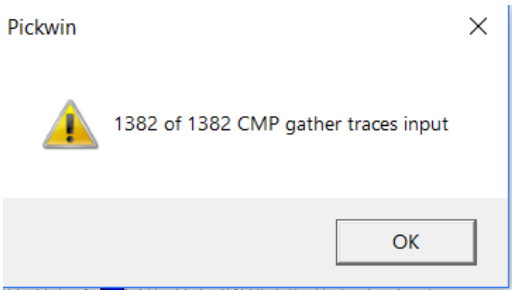
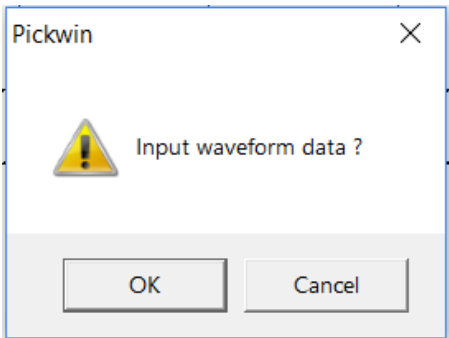
Confirm messages.



Confirm a message.



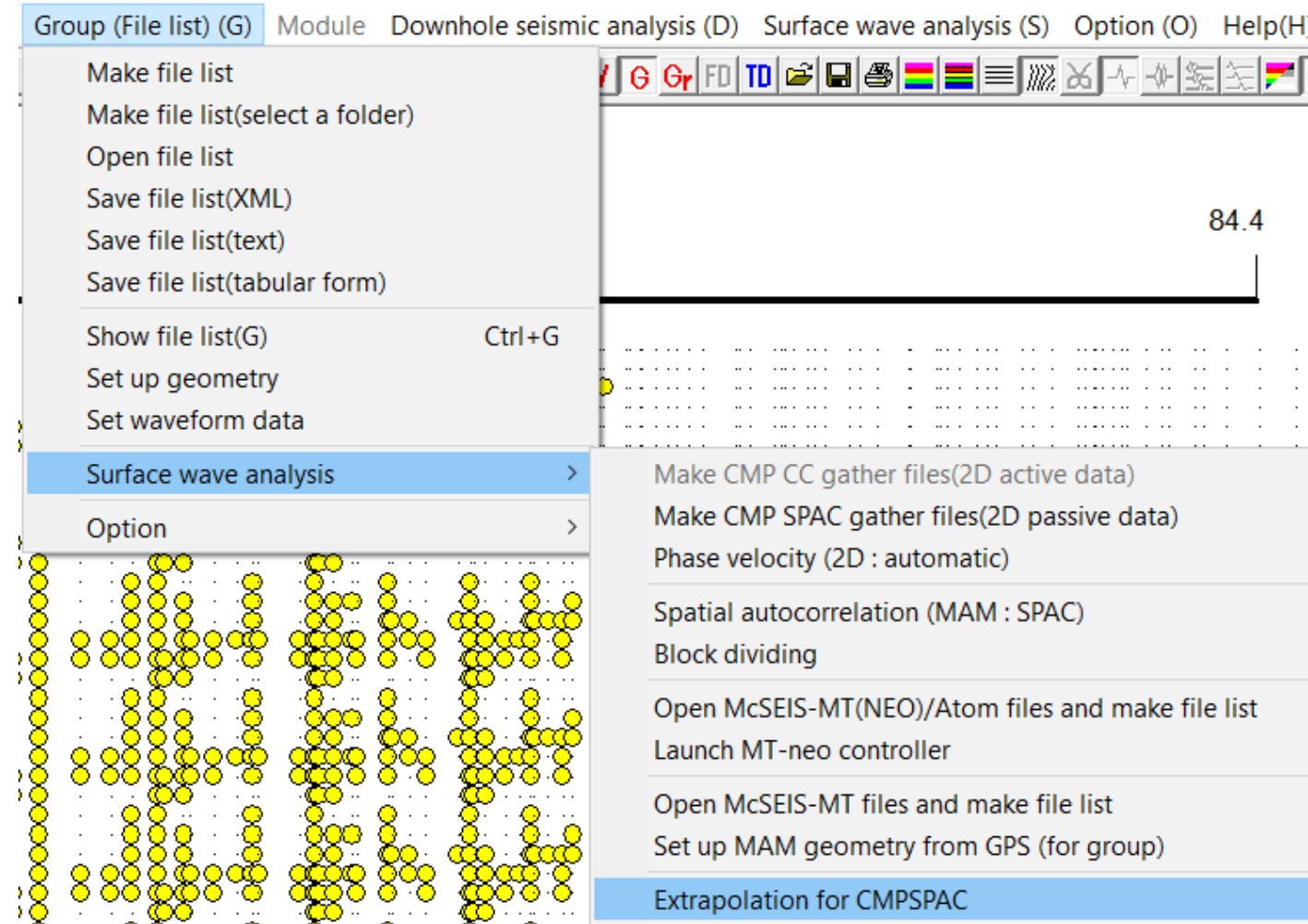
Crick OK to proceed.



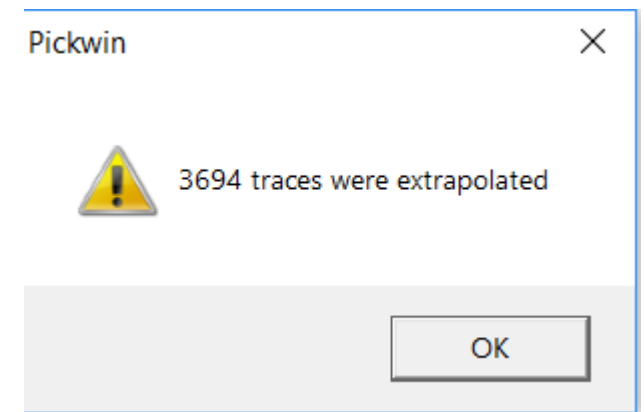
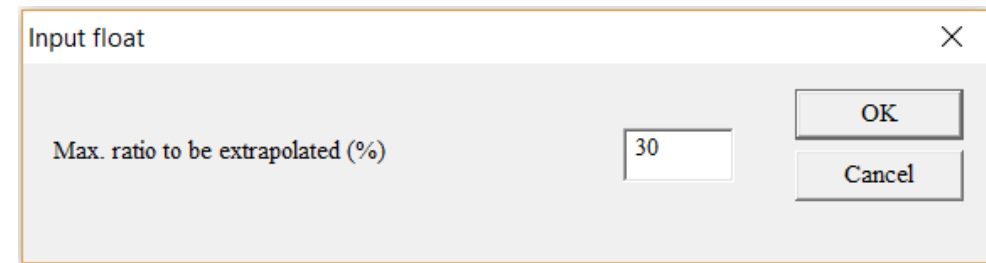
All coherencies are imported and geometry appears.



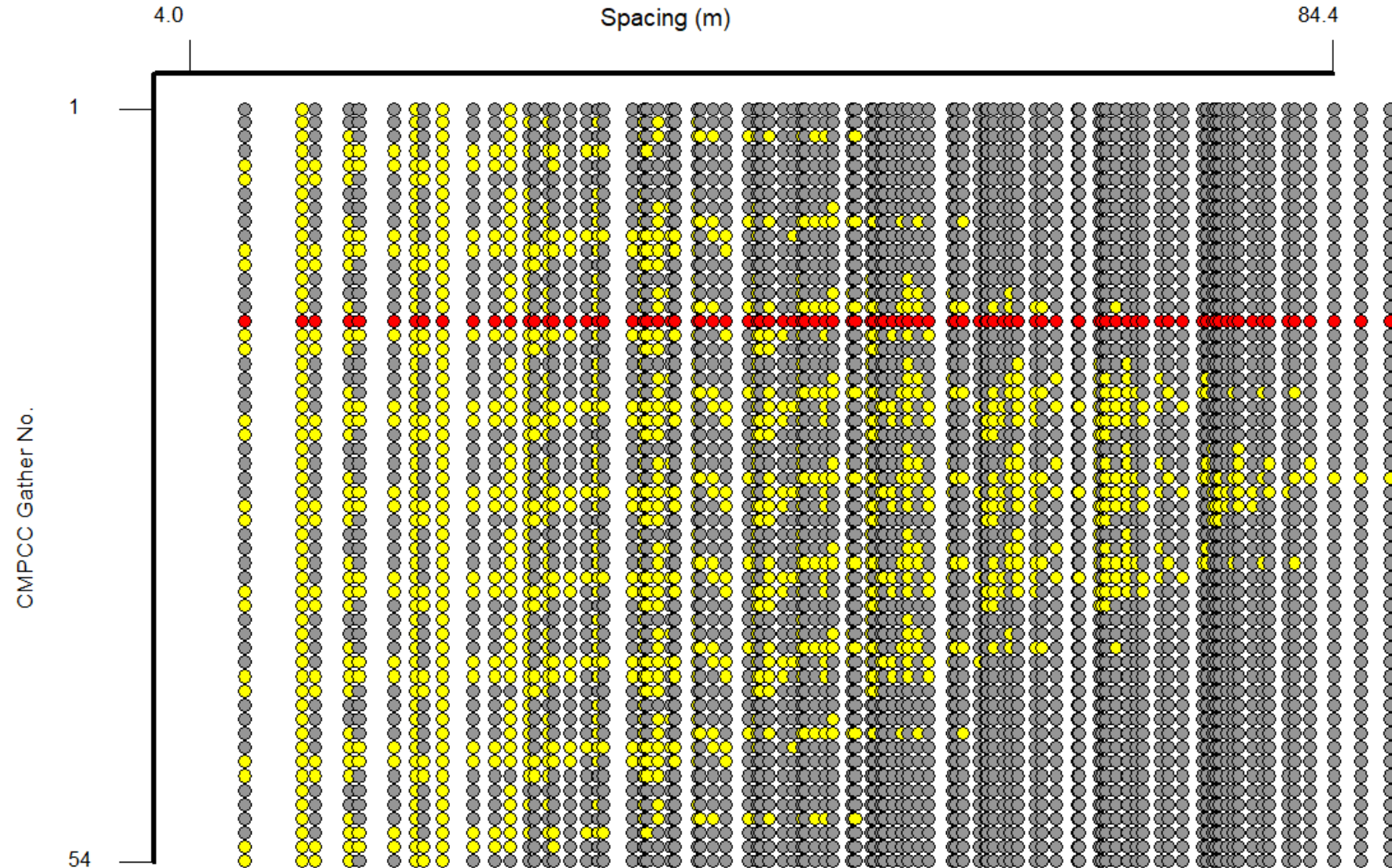
Extrapolation for CMP-SPAC (optional)



Set distance from CMP / receiver separation ratio.
Larger ratio makes more extrapolated traces

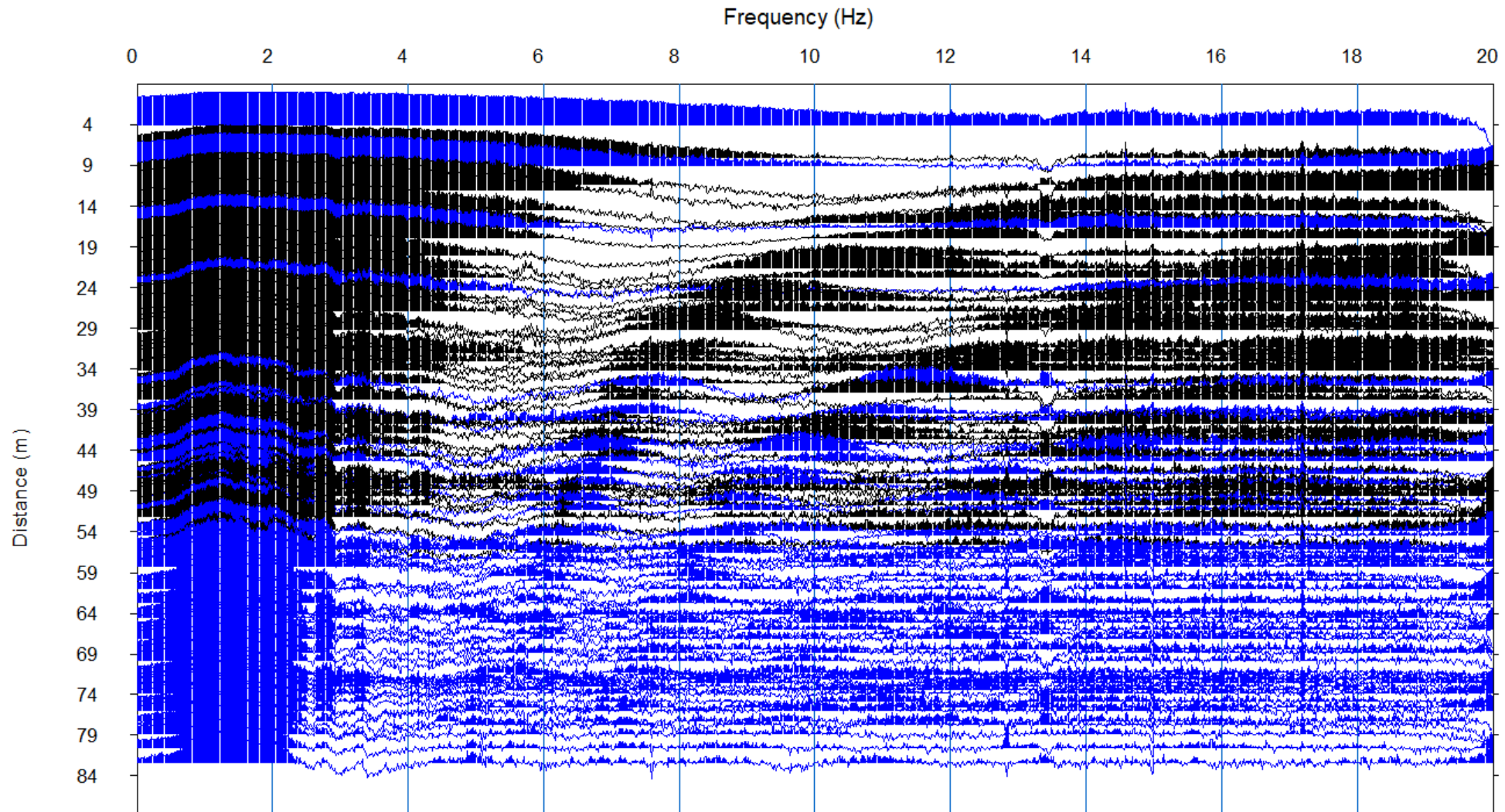


Extrapolation for CMP-SPAC (optional)



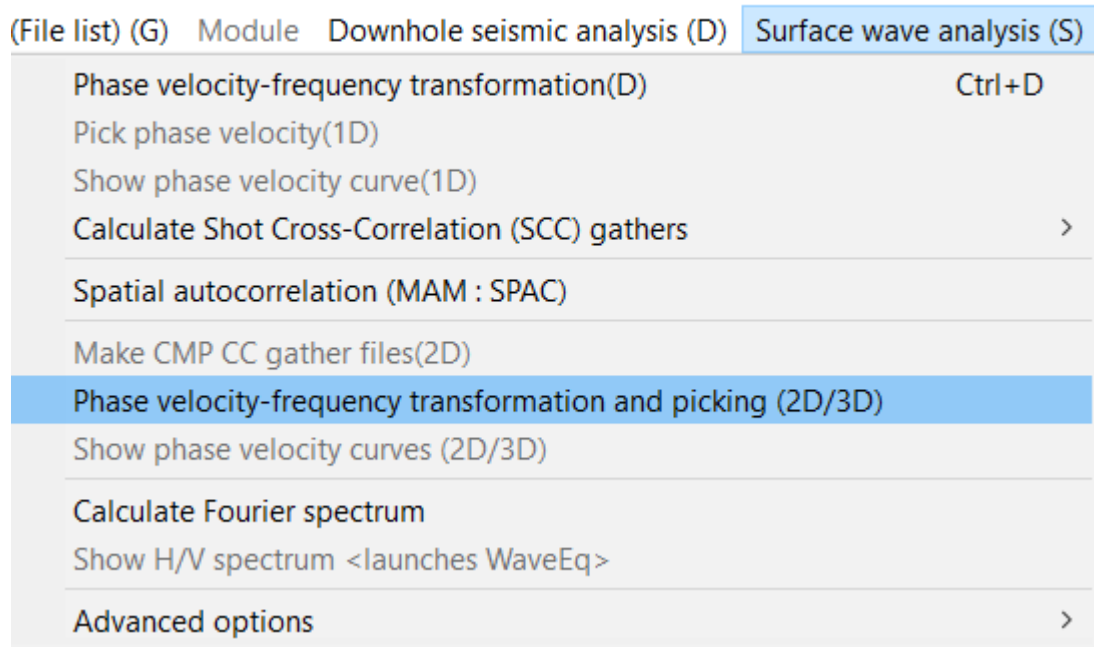
Extrapolation for CMP-SPAC (optional)

Blue color indicates extrapolated traces (SPACs).

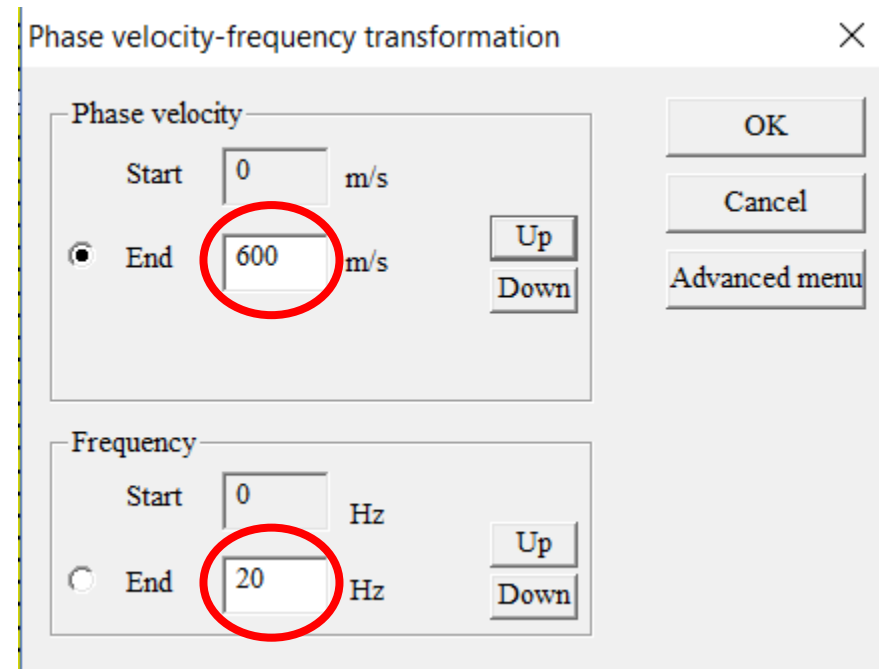


7. Calculate dispersion curves

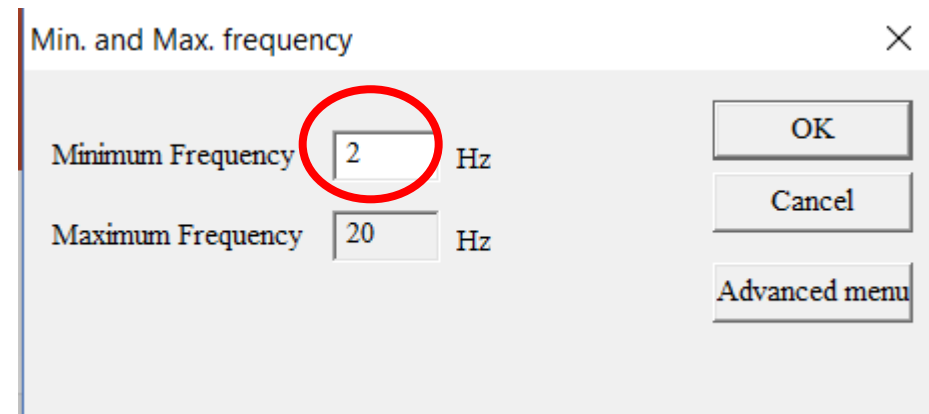
Select “Surface wave analysis”, “Phase velocity-frequency transformation and picking (2D/3D)”. You can apply filter by “Option”, “Frequency domain”, “Parzen window” if you need.



Set phase velocity and frequency.

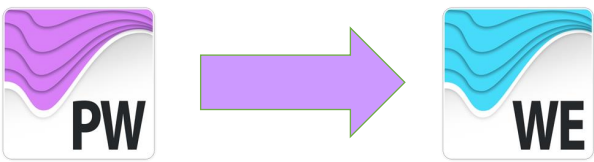
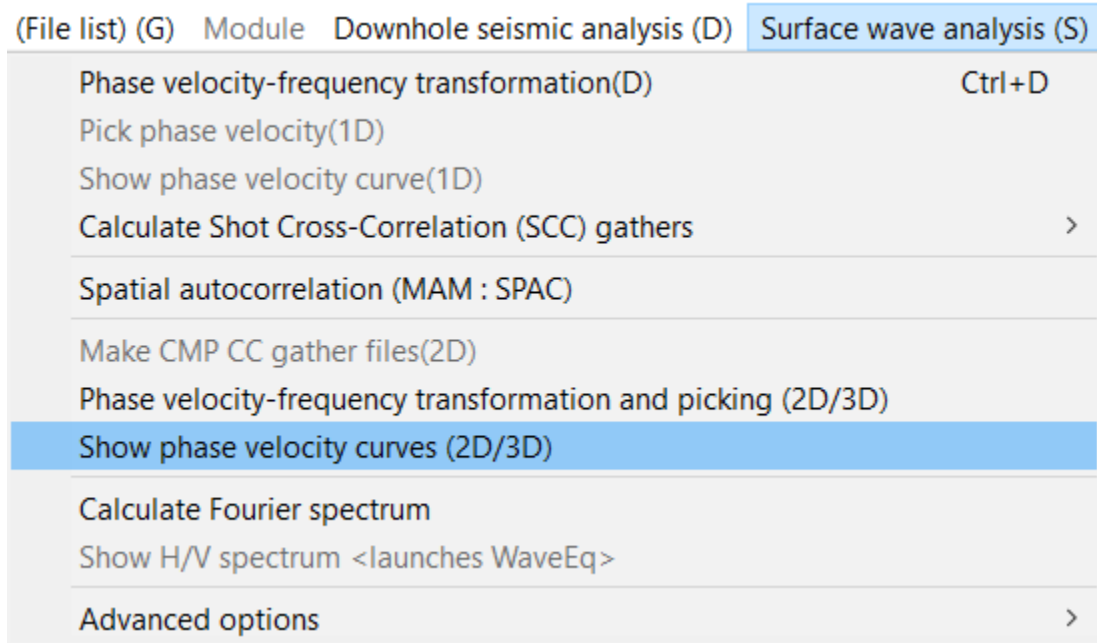


Set minimum frequency.



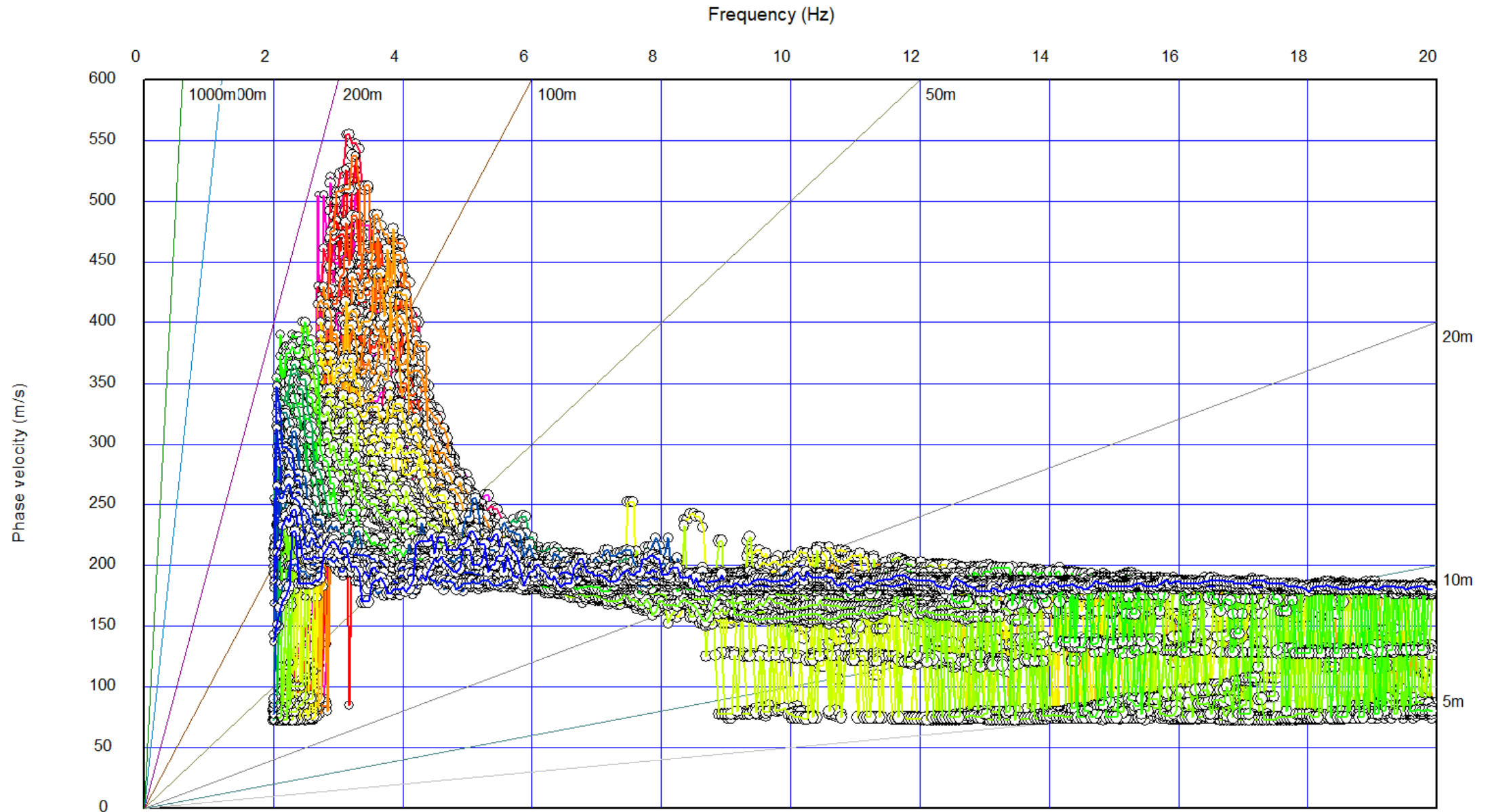
It will take a while.

Select “Surface wave analysis”, “Show Phase velocity curves (2D/3D)”.




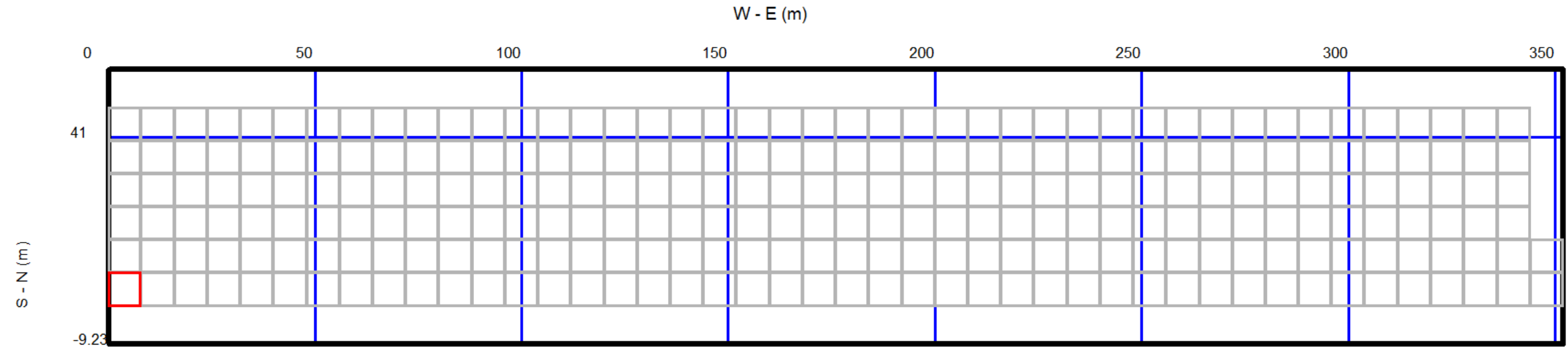
8. Show and edit dispersion curves by WaveEq

WaveEq is automatically launched and phase velocity curves appears.



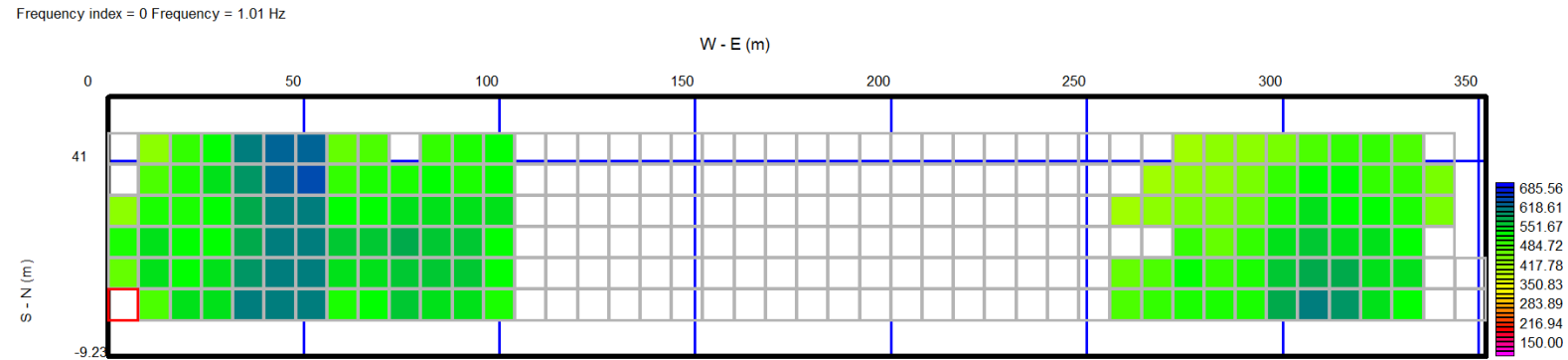
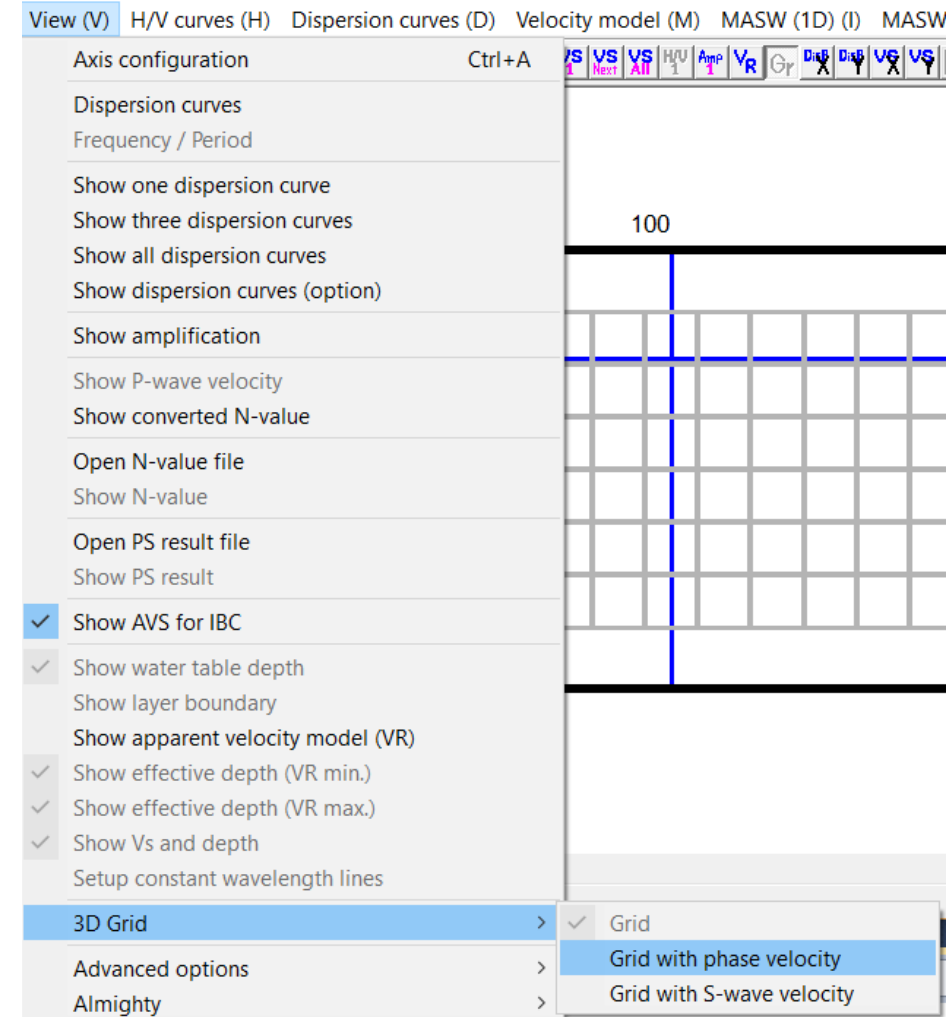
Drawing geometry (CMP bins) in WaveEq

Click  to show geometry



Select “View”, “3D Grid”, “Grid with phase velocity”.

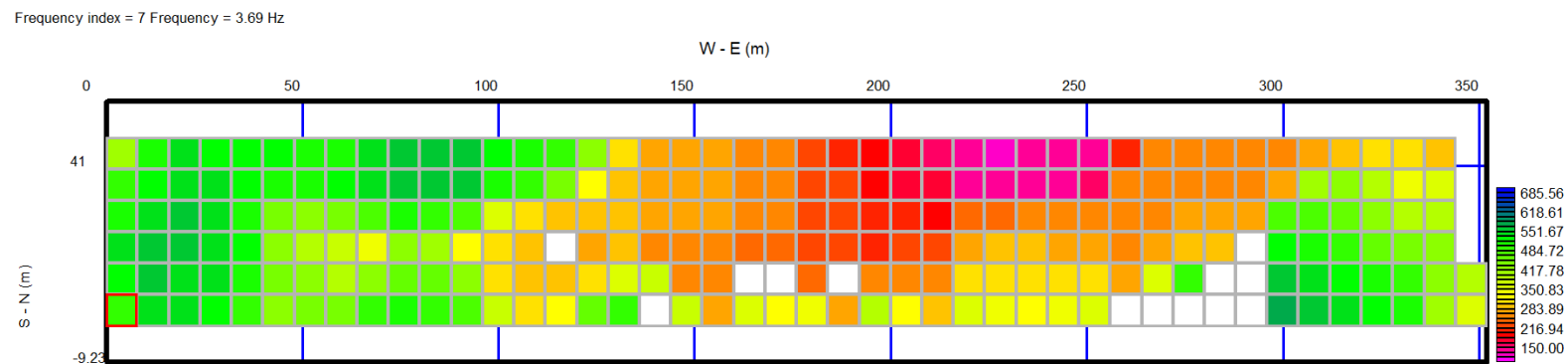
Select “View”, “3D Grid”, “Grid with phase velocity”.



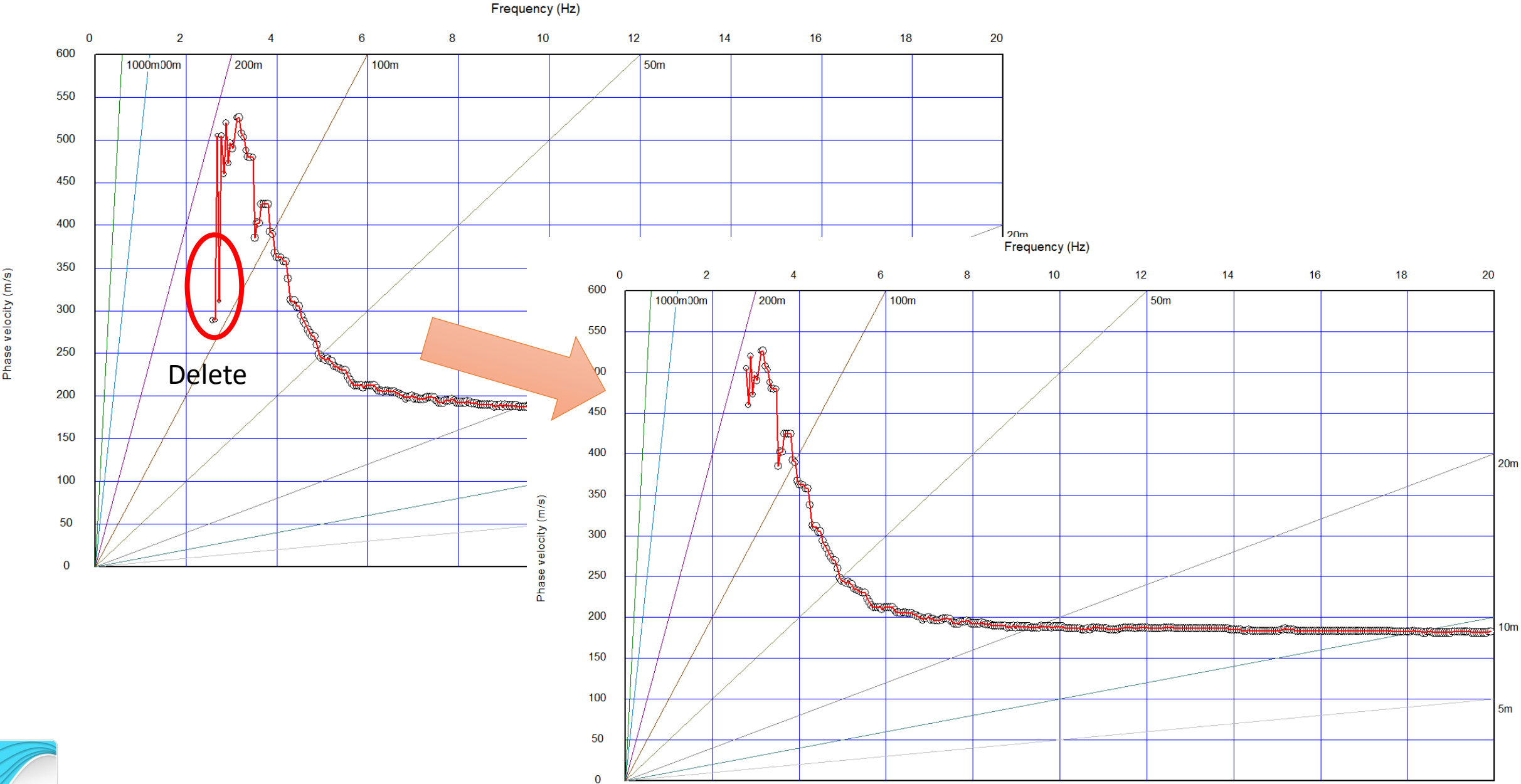
Use



to scroll a frequency to be shown.



Edit dispersion curves as 2D data.

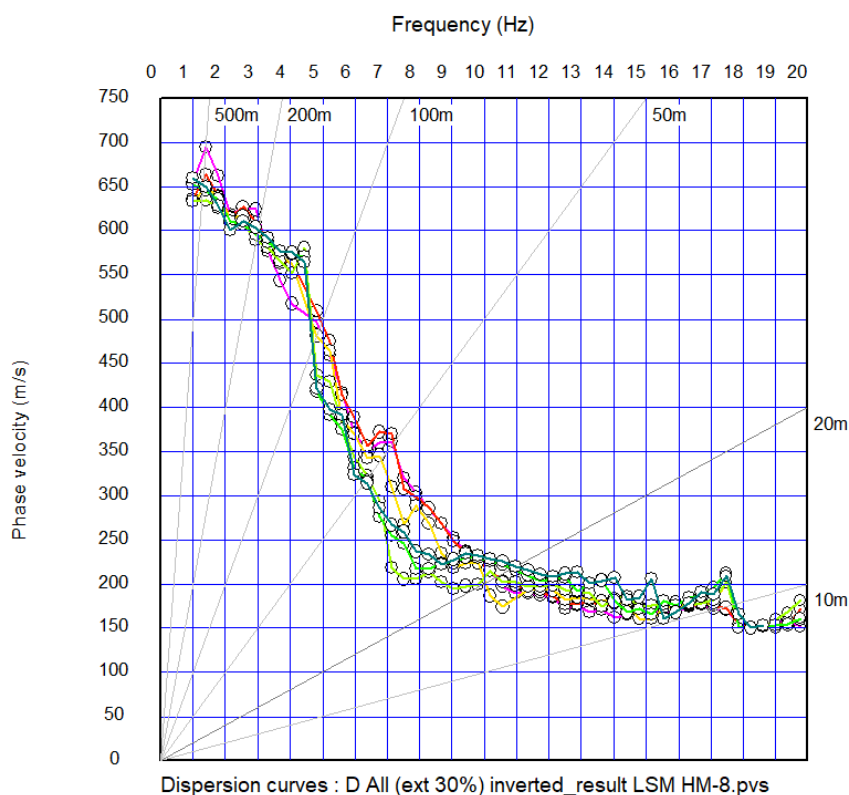


Dispersion curves in X or Y direction

Use  to show dispersion curves in X or Y direction.

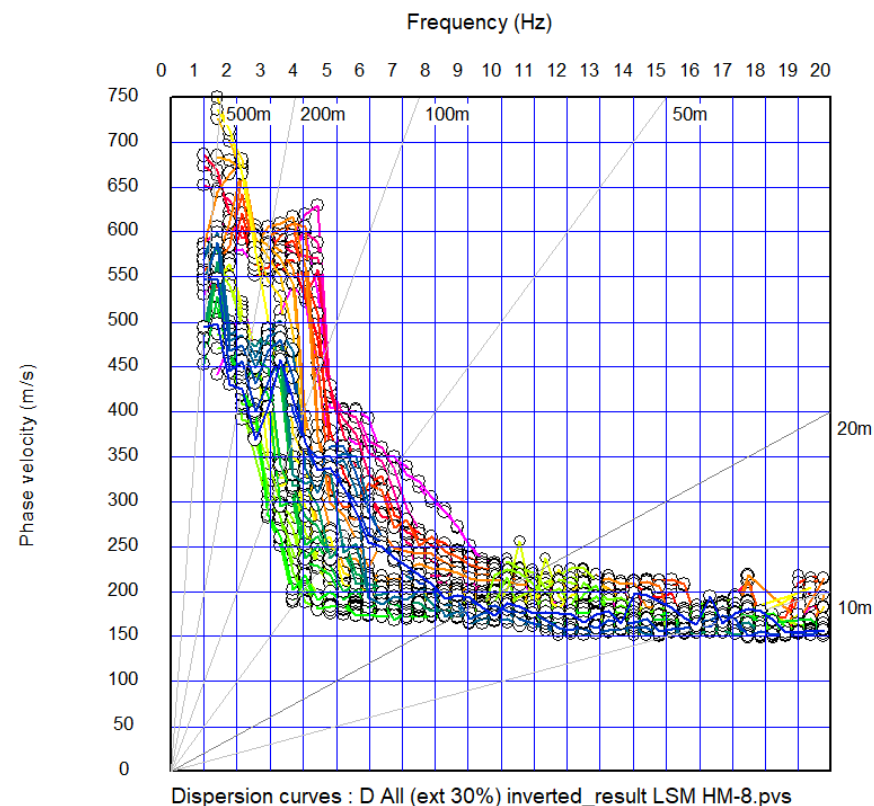
X direction (vertical direction)

X = 36.0 m



Y direction (horizontal direction)

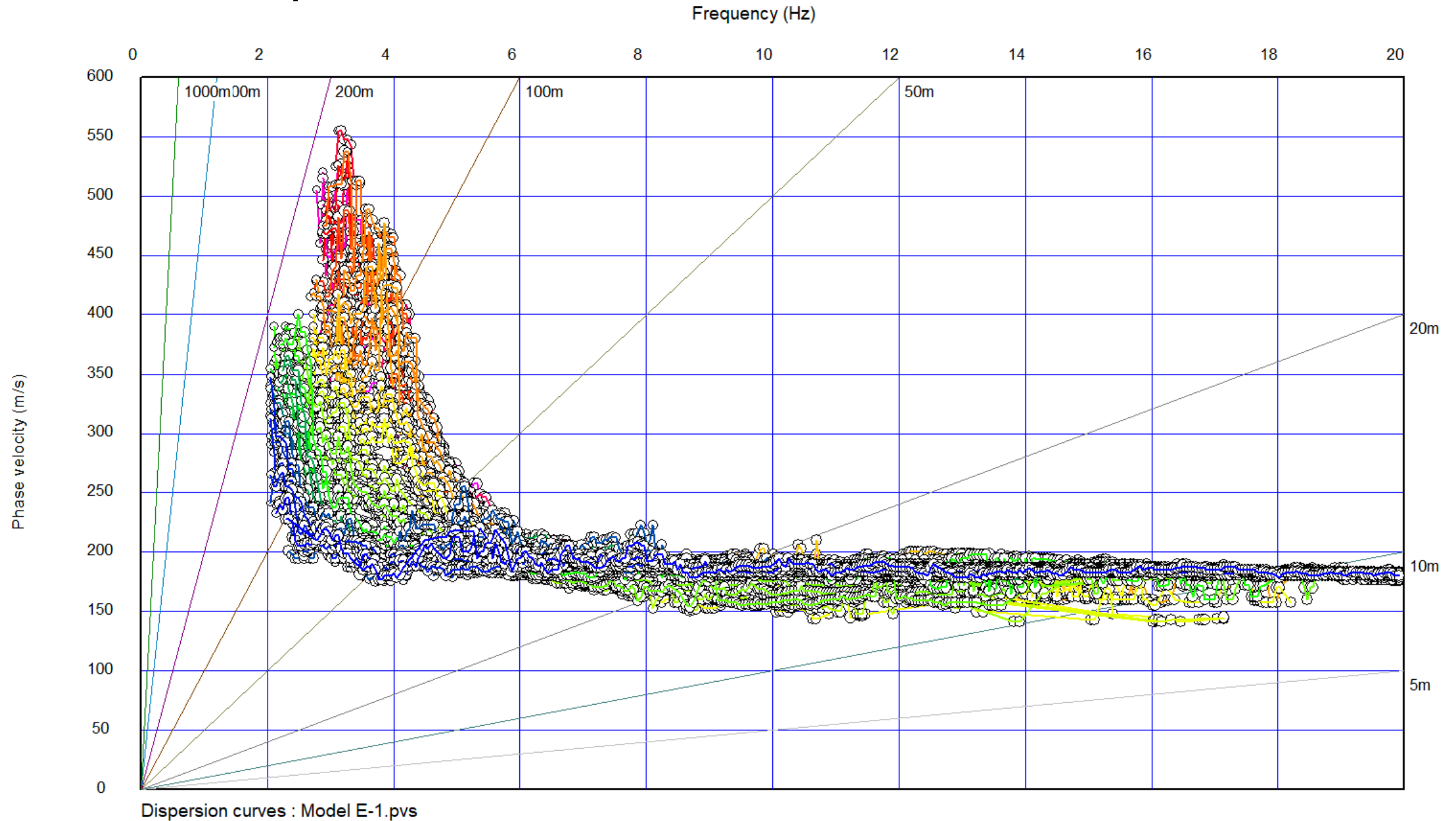
Y = 36.0 m



Use  to scroll dispersion curves to be shown.

Use  to scroll dispersion curves to be shown.

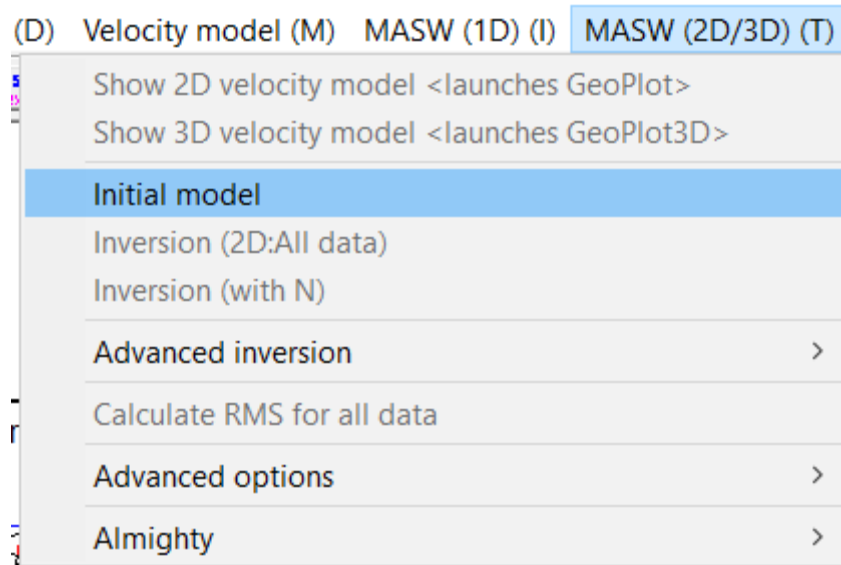
Edited dispersion curves



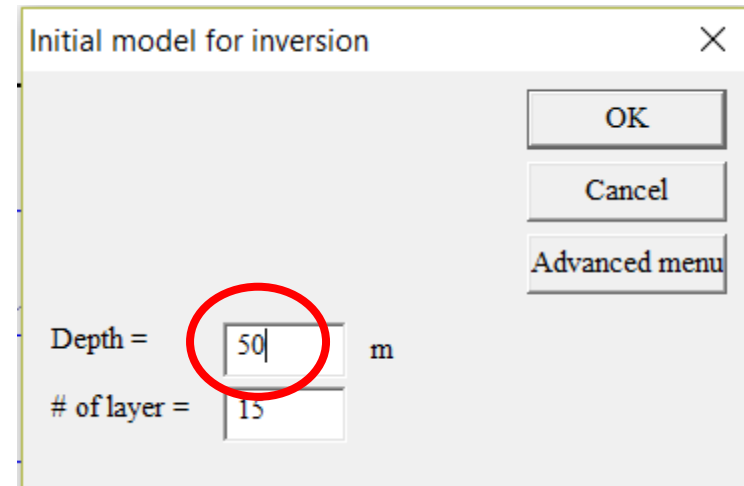
9. Create initial velocity model

Initial velocity model

Select “MASW (2D/3D)”, “Initial model”.

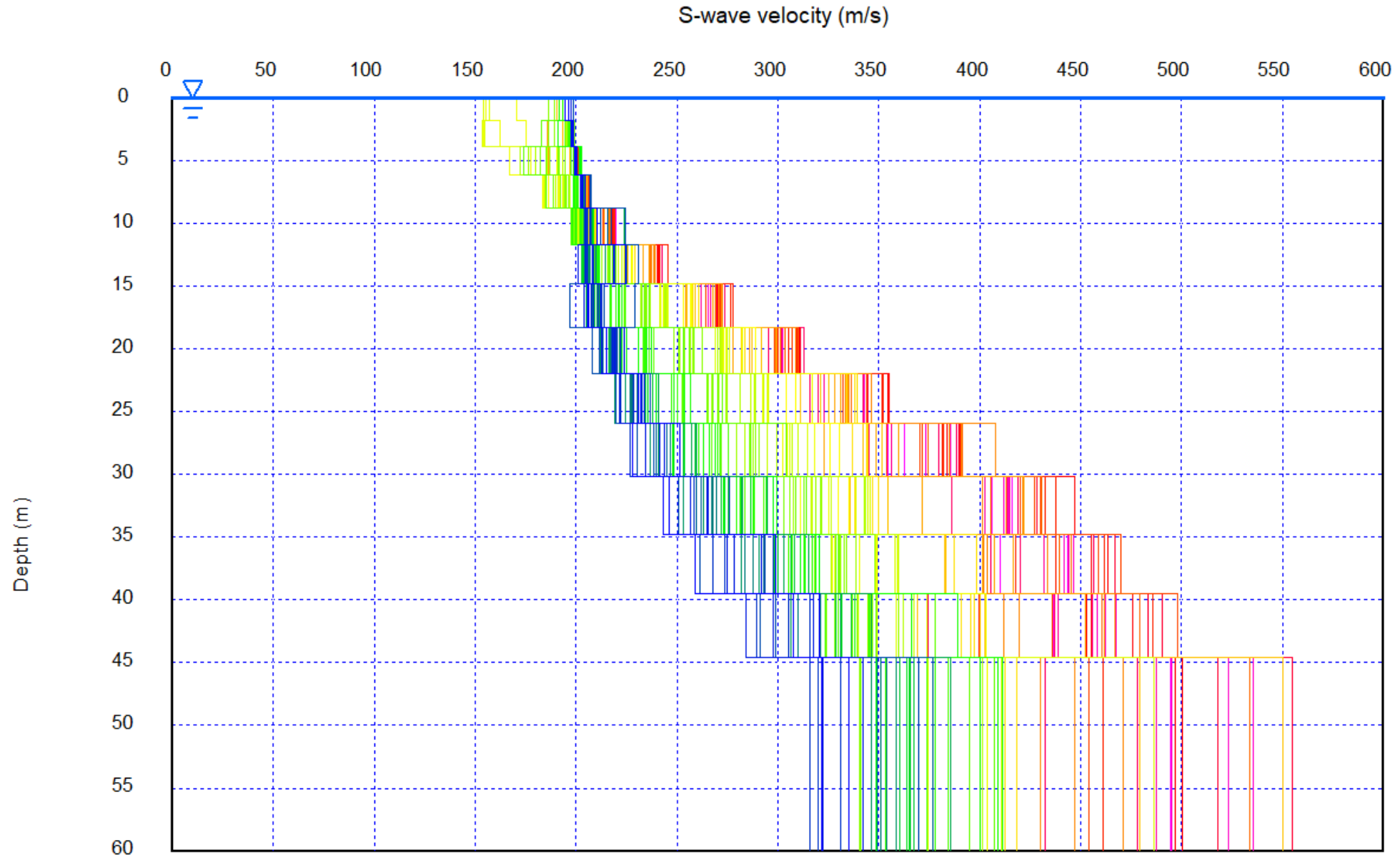


Set depth of model.



Note that horizontal regularization is just 2D.
3D has not completed yet.

Initial velocity model appears. You can apply inversion if you like.
Note that horizontal regularization is just 2D. 3D has not completed yet.



S-wave velocity models (initial) : Model E-1.pvs

Drawing S-wave velocity on CMP bins in WaveEq

Select “View”, “3D Grid”, “Grid with S-wave velocity”.

View (V)H/V curves (H)Dispersion curves (D)Velocity model (M)MASW (1D) (I)MASW

Axis configurationCtrl+ASVSNextVSAllH/V1Amp1VRGrDisXDisYVSXVSY

Dispersion curves

Frequency / Period

Show one dispersion curve

Show three dispersion curves

Show all dispersion curves

Show dispersion curves (option)

Show amplification

Show P-wave velocity

Show converted N-value

Open N-value file

Show N-value

Open PS result file

Show PS result

☒ Show AVS for IBC

☒ Show water table depth

Show layer boundary

Show apparent velocity model (VR)

☒ Show effective depth (VR min.)

☒ Show effective depth (VR max.)

☒ Show Vs and depth

Setup constant wavelength lines

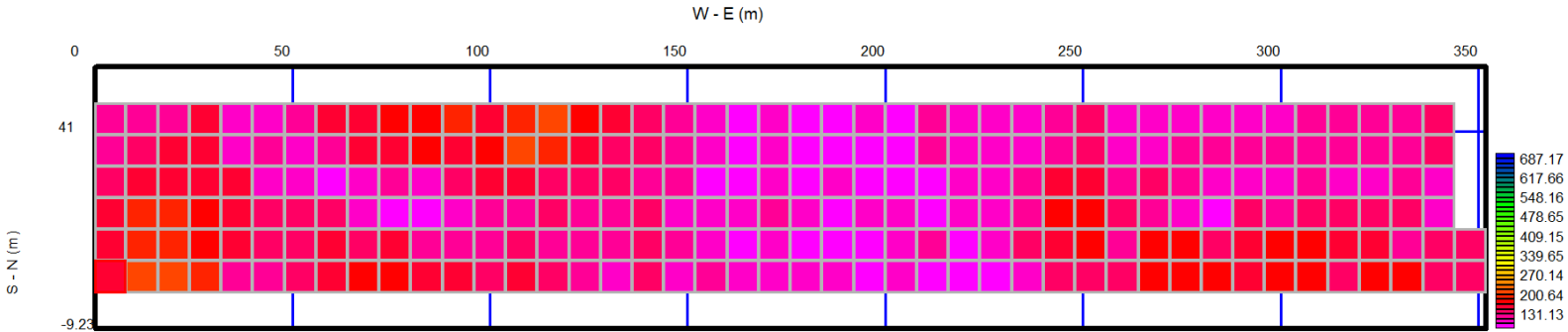
3D Grid>☒ Grid

Advanced options>Grid with phase velocity

Almighty>Grid with S-wave velocity

100

Layer index = 0 Depth = 0.0 to 1.8 m

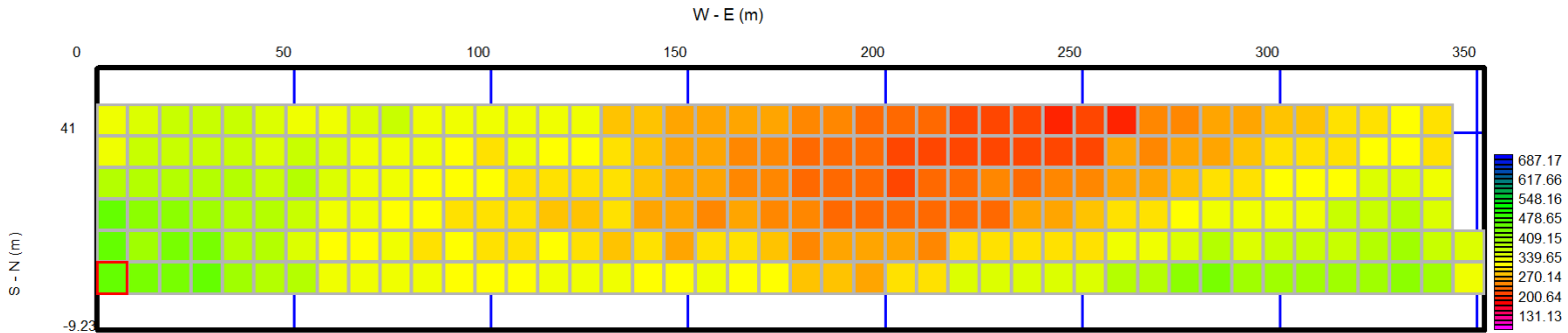


Use



to scroll a depth to be shown.

Layer index = 9 Depth = 23.9 to 27.6 m

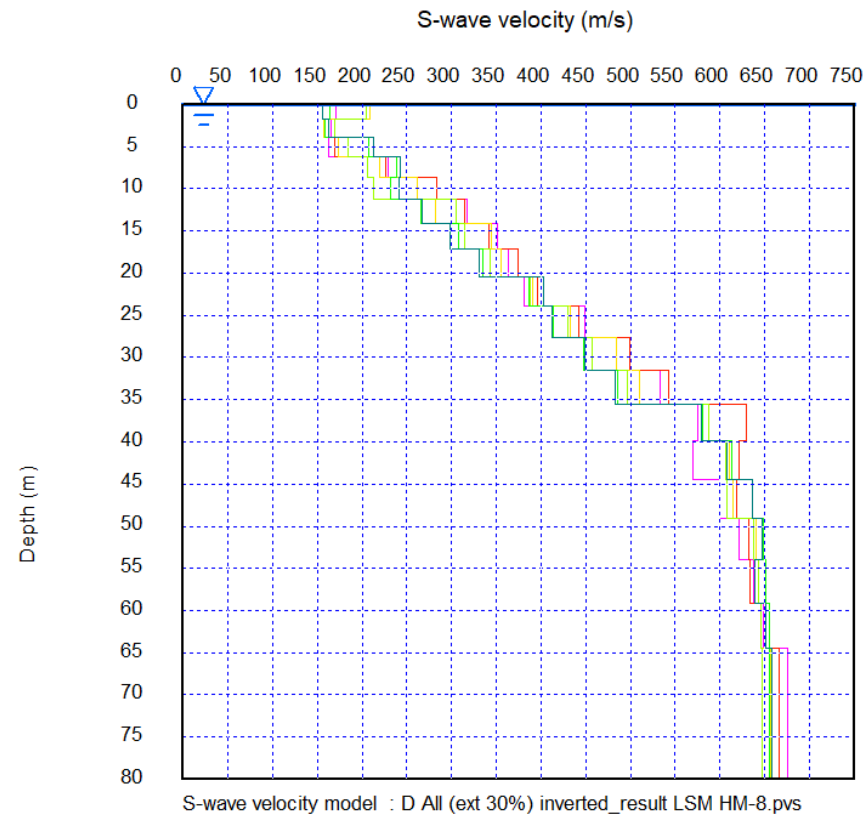


Velocity depth profiles in X or Y direction

Use  to show velocity depth profiles in X or Y direction.

X direction (vertical direction)

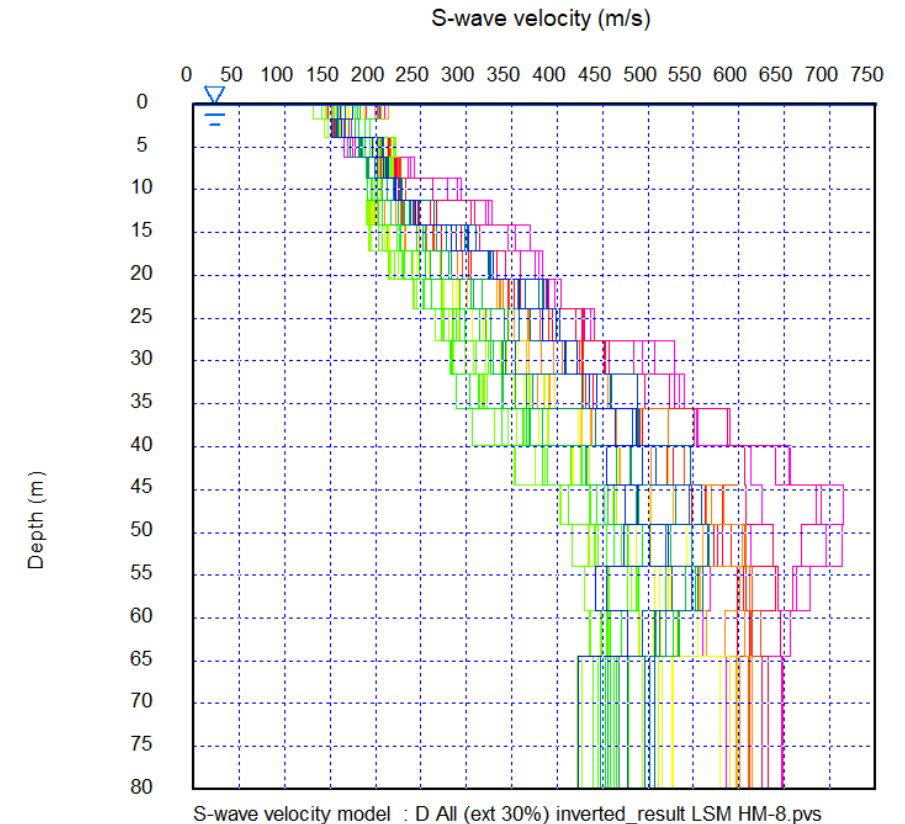
X = 36.0 m




Use  to scroll dispersion curves to be shown.

Y direction (horizontal direction)

Y = 28.0 m



Use  to scroll dispersion curves to be shown.

10. Show 3D velocity model by GeoPlot3D

Select “MASW (2D/3D)”, “Show 3D velocity model <launches GeoPlot3D>”.

D) Velocity model (M) MASW (1D) (I) MASW (2D/3D) (T)

Show 2D velocity model <launches GeoPlot>

Show 3D velocity model <launches GeoPlot3D>

Initial model

Inversion (2D:All data)

Inversion (with N)

Advanced inversion >

Calculate RMS for all data

Advanced options >

Almighty >

Confirm messages and click OK.

GeoPlot3d

!

of models = 100 # of layers = 15

OK

Confirm messages and click OK.

GeoPlot3d

!

Number of grids : X = 10 Y = 10

OK

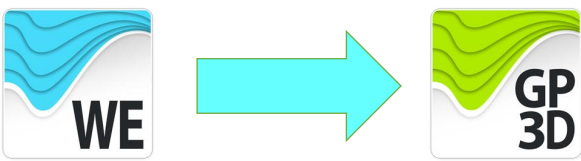
Click OK.

GeoPlot3d

!

Angle=0.000000

OK



Click OK.

Min. and max. area

X= m m

Y= m m

Max. elev.= m

OK

Cancel

Change cell size if you need. Click OK.

Model size

NX= DX=

NY= DY=

NZ= DZ=

OK

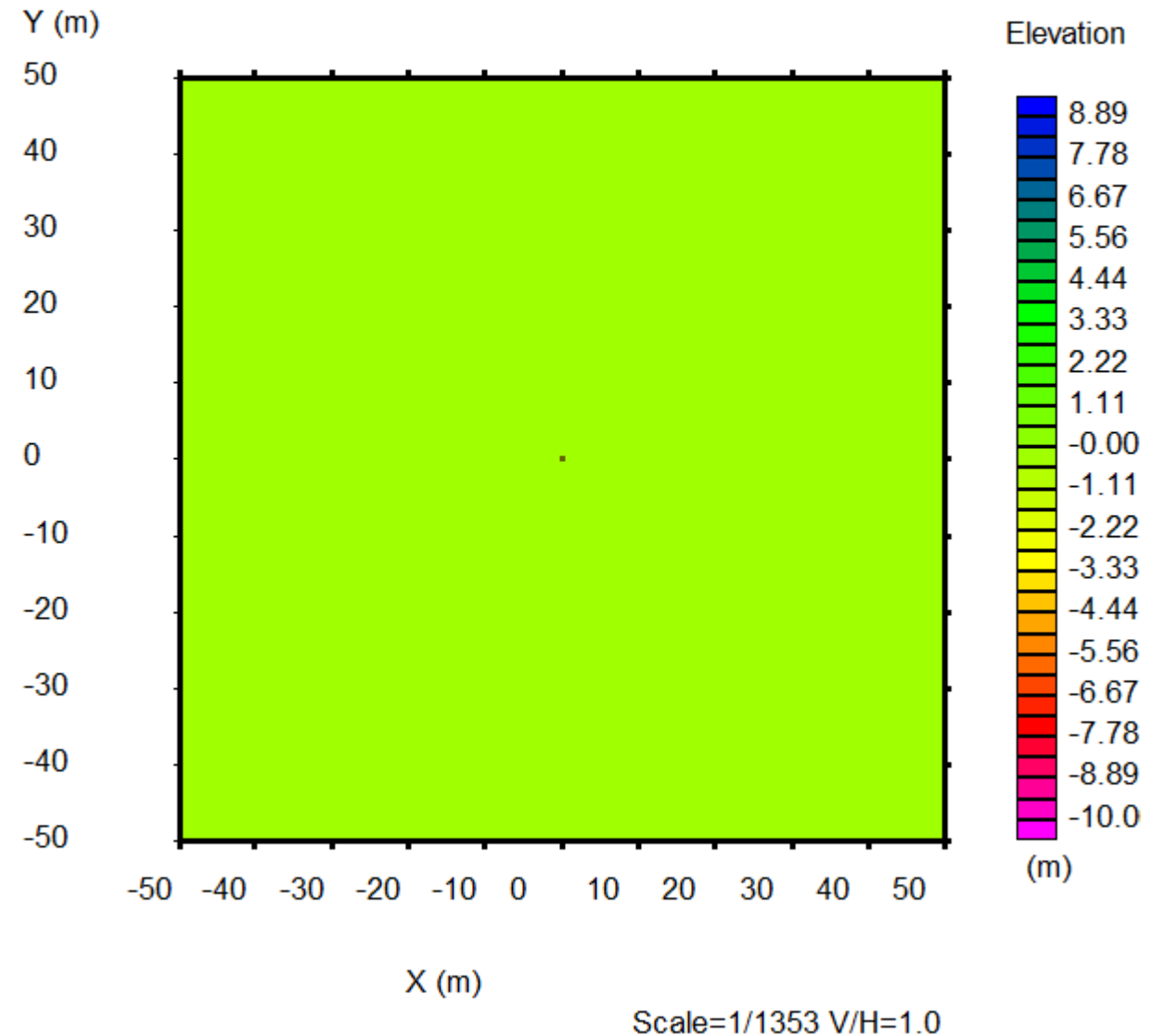
Cancel

Refresh

Surface topography

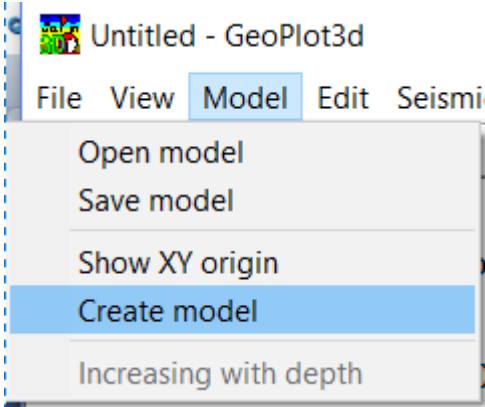
If surface topography is not flat,
see page 31 to include surface topography.

Topography
X cells = 40 Y cells = 40 # of planes = 0
NX = 40 NY = 40 NZ = 0
Min. = 0.000000 Max. = 0.000000 n = 36 (0)
Number of section = 1

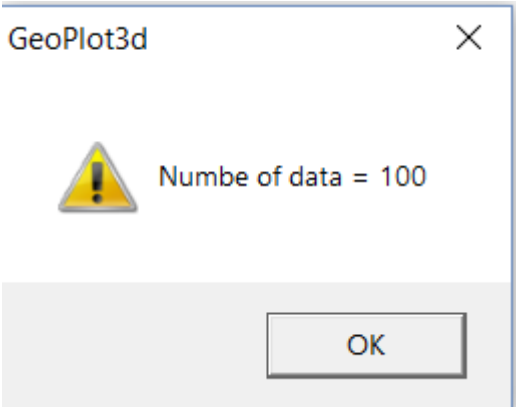


10.1 Create 3D velocity model by GeoPlot3D

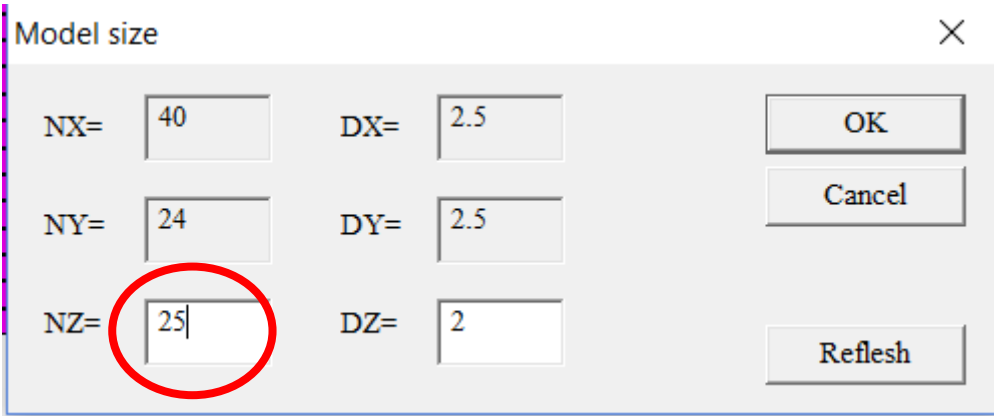
Select “Model”, “Create model”.



Confirm messages and click OK.



Set number and size of cells.



Use **Z** **Y** **X** buttons to change slice direction and  buttons to scroll the position of slice.

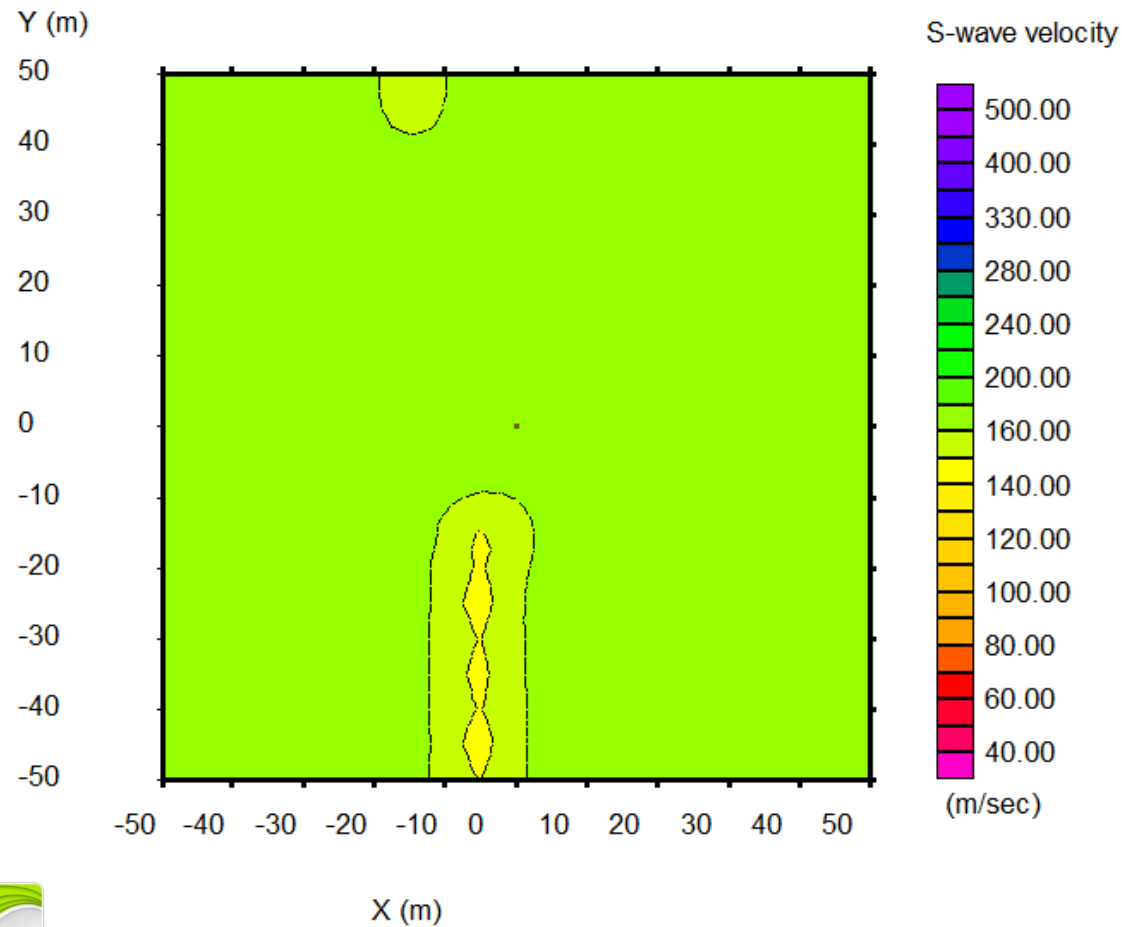
Z plane : N = 0 (0.0 to 2.0 m)

Number of section = 1

X cells = 40 Y cells = 40 # of planes = 25

NX = 40 NY = 40 NZ = 25

Min. = 0.000000 Max. = 0.000000 n = 26 (1)



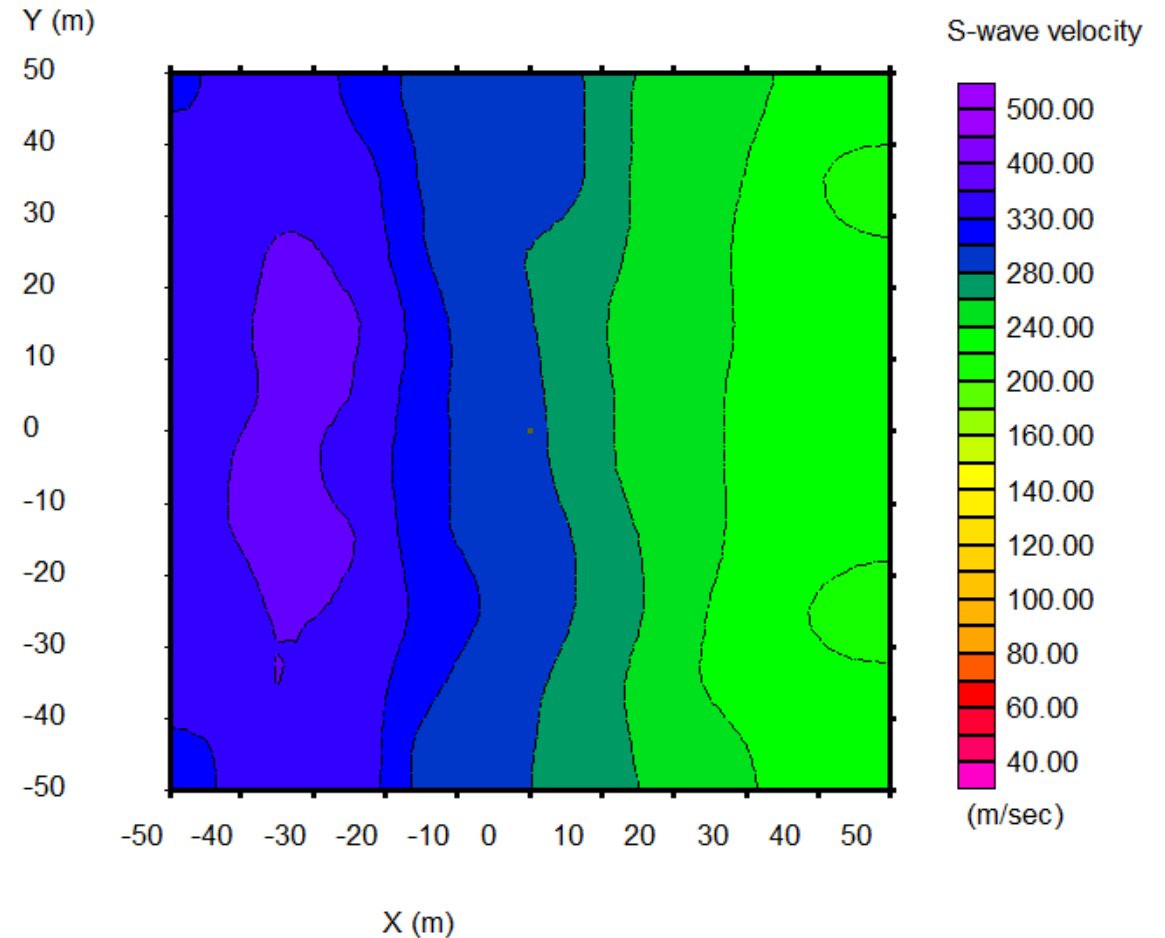
Z plane : N = 15 (30.0 to 32.0 m)

Number of section = 1

X cells = 40 Y cells = 40 # of planes = 25

NX = 40 NY = 40 NZ = 25

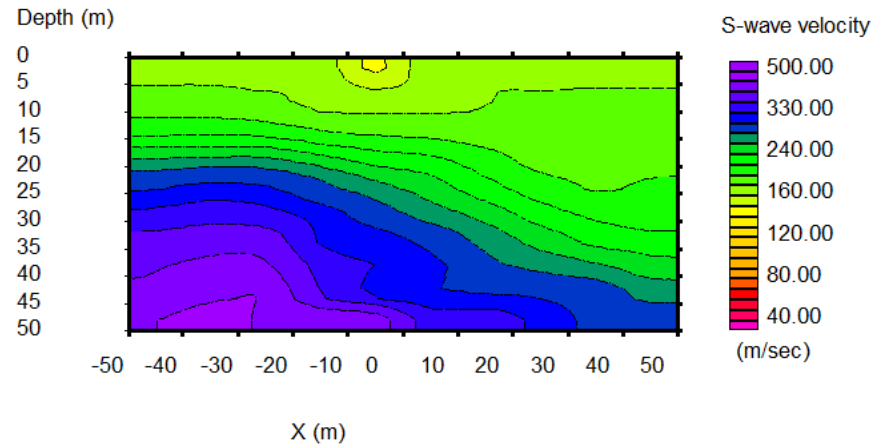
Min. = 0.000000 Max. = 0.000000 n = 26 (1)



Use **Z Y X** buttons to change slice direction and  buttons to scroll the position of slice.

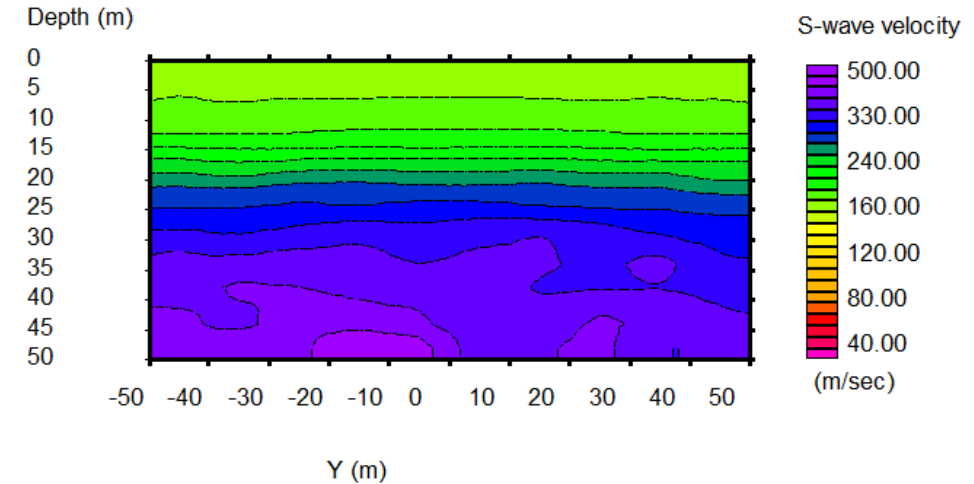
Y plane : N = 10 (-25.0 to -22.5 m)
X cells = 40 Y cells = 25 # of planes = 40
NX = 40 NY = 40 NZ = 25
Min. = 0.000000 Max. = 0.000000 n = 26 (1)

Number of section = 1



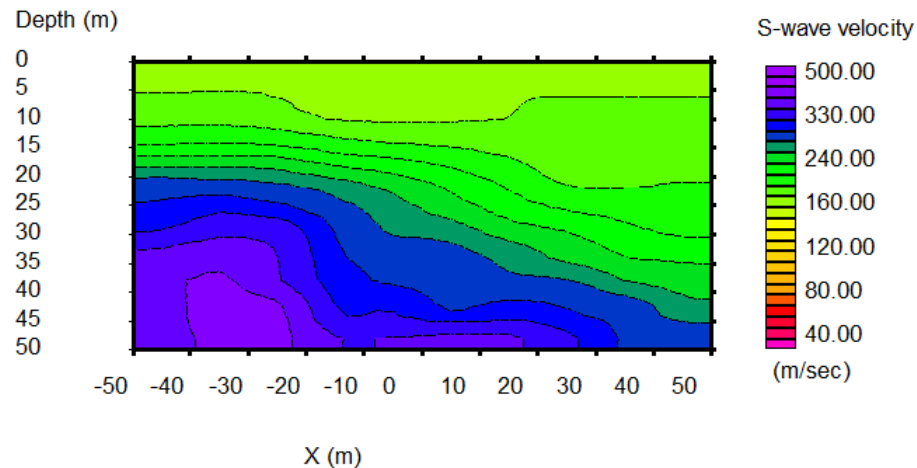
X plane : N = 10 (-25.0 to -22.5 m)
X cells = 40 Y cells = 25 # of planes = 40
NX = 40 NY = 40 NZ = 25
Min. = 0.000000 Max. = 0.000000 n = 26 (1)

Number of section = 1



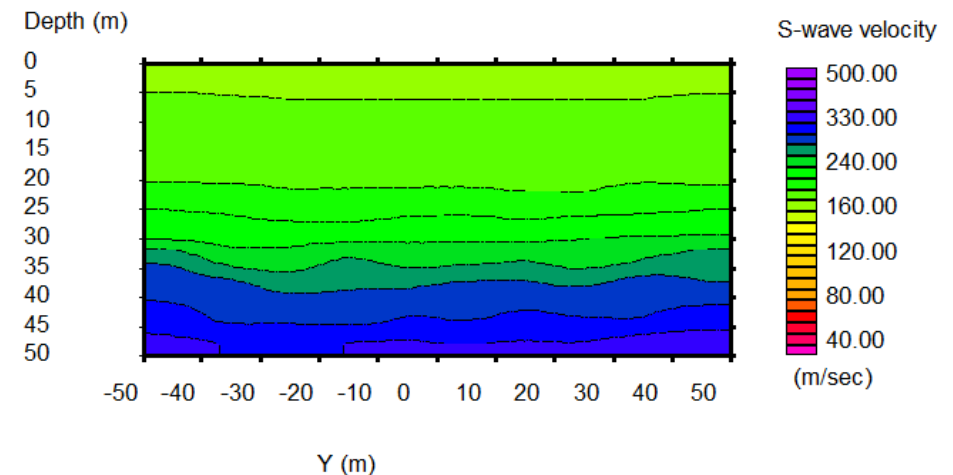
Y plane : N = 30 (25.0 to 27.5 m)
X cells = 40 Y cells = 25 # of planes = 40
NX = 40 NY = 40 NZ = 25
Min. = 0.000000 Max. = 0.000000 n = 26 (1)

Number of section = 1



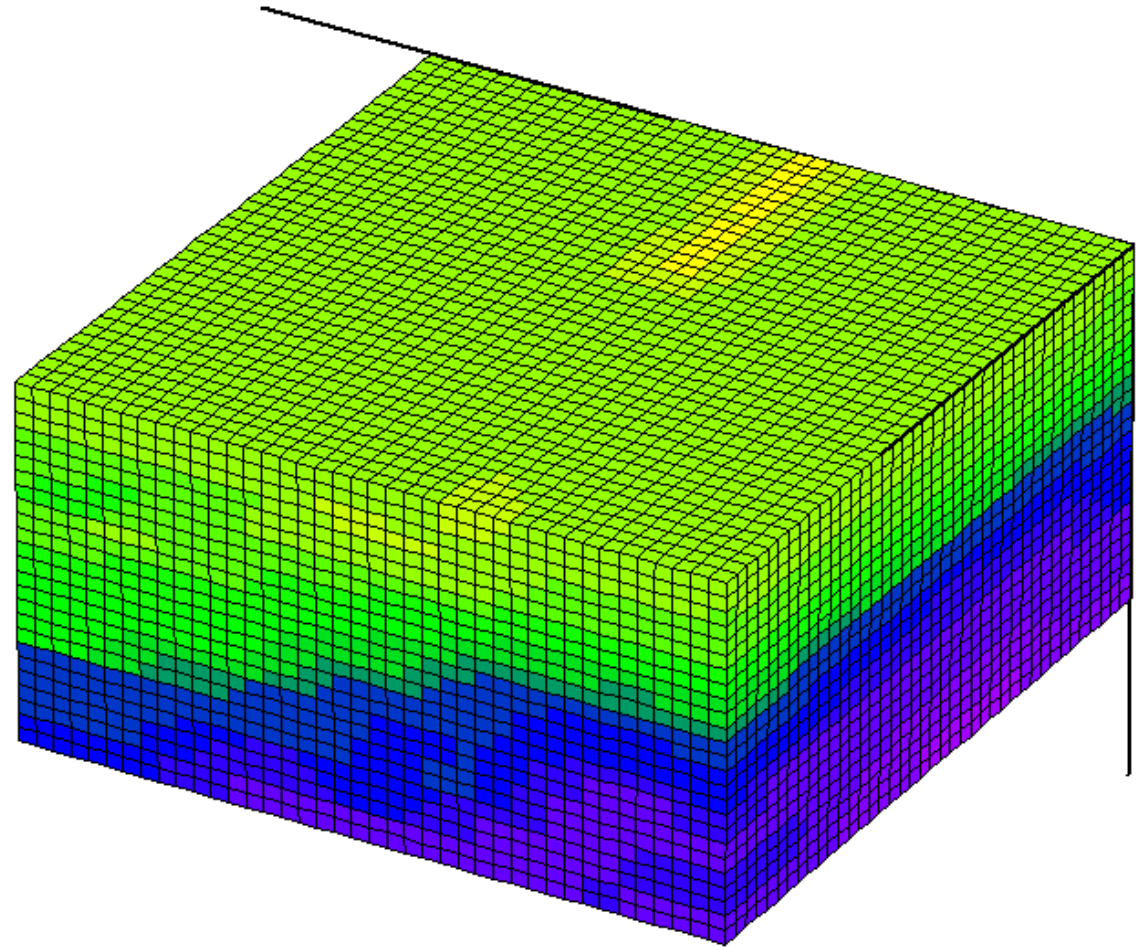
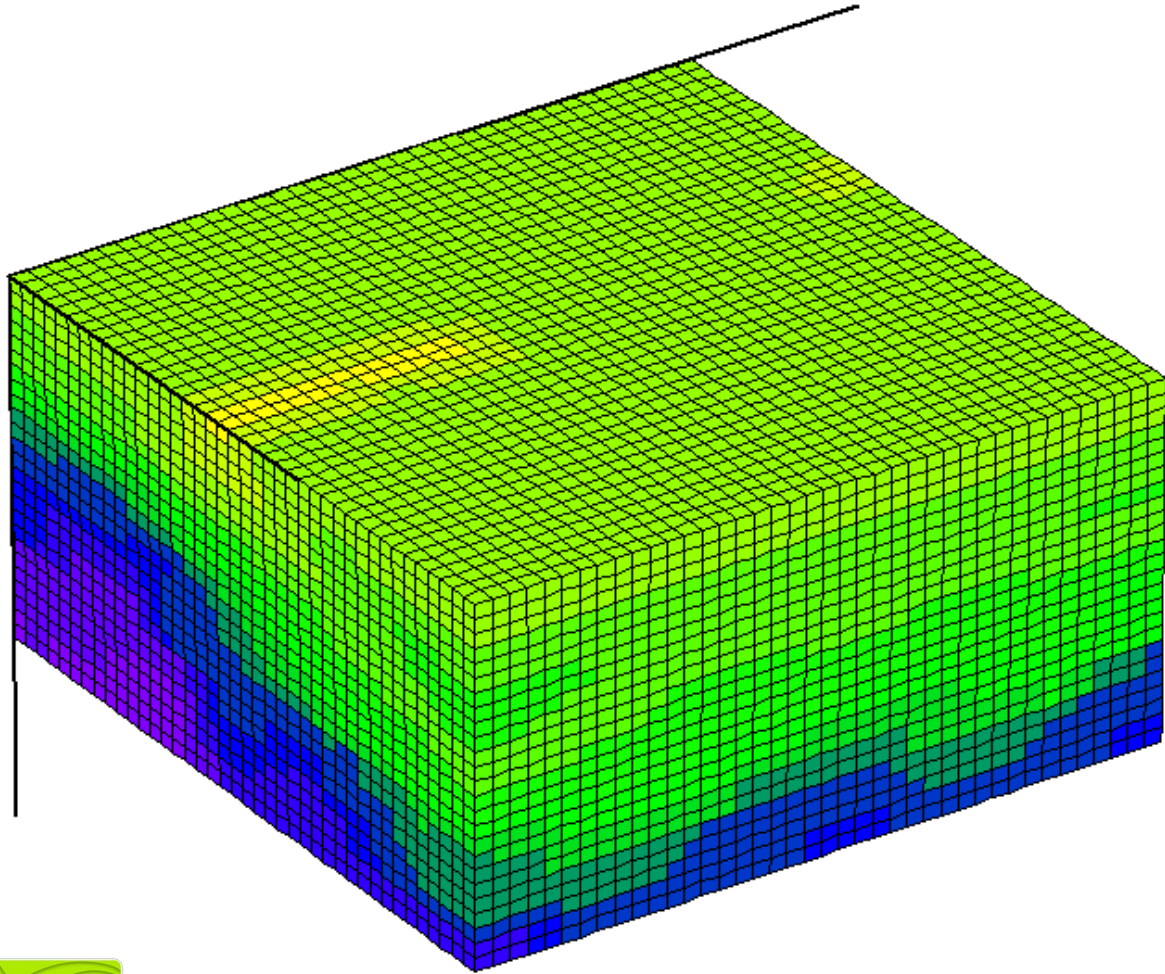
X plane : N = 30 (25.0 to 27.5 m)
X cells = 40 Y cells = 25 # of planes = 40
NX = 40 NY = 40 NZ = 25
Min. = 0.000000 Max. = 0.000000 n = 26 (1)

Number of section = 1

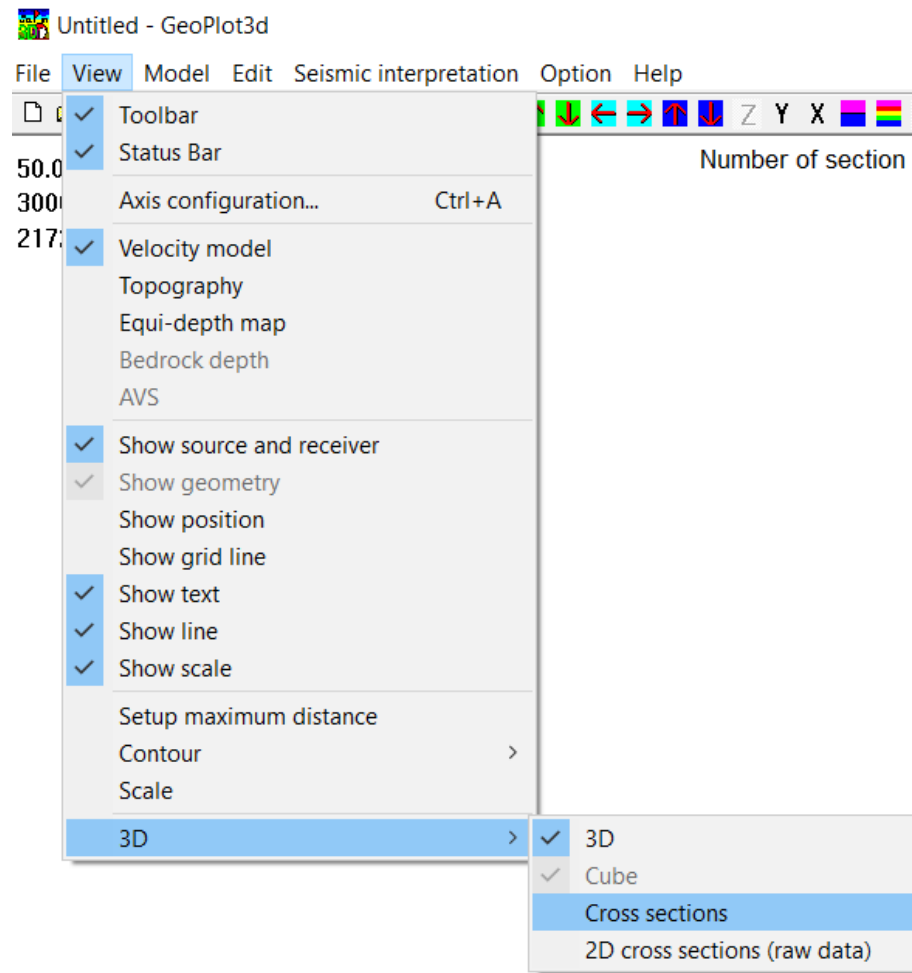




Click **3D** to draw 3D images.

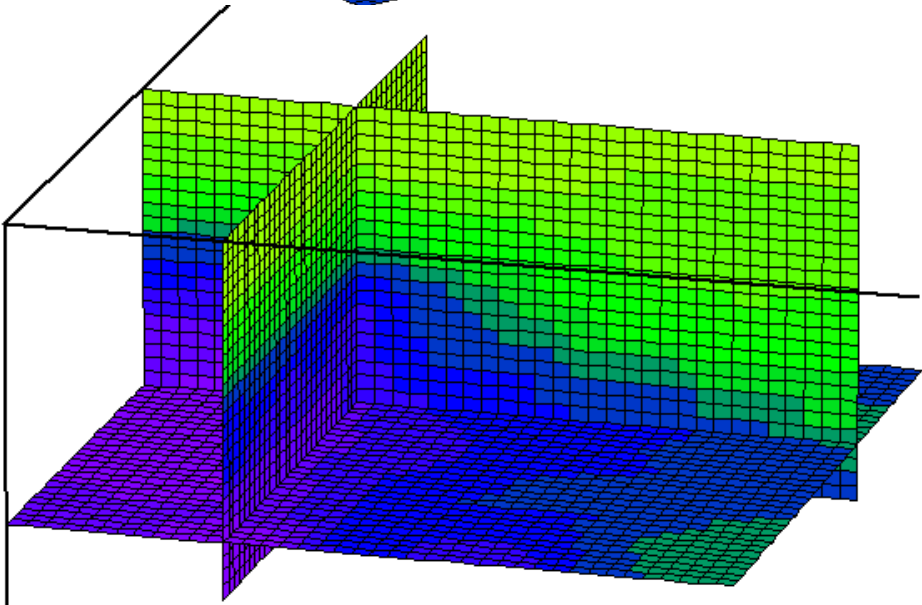
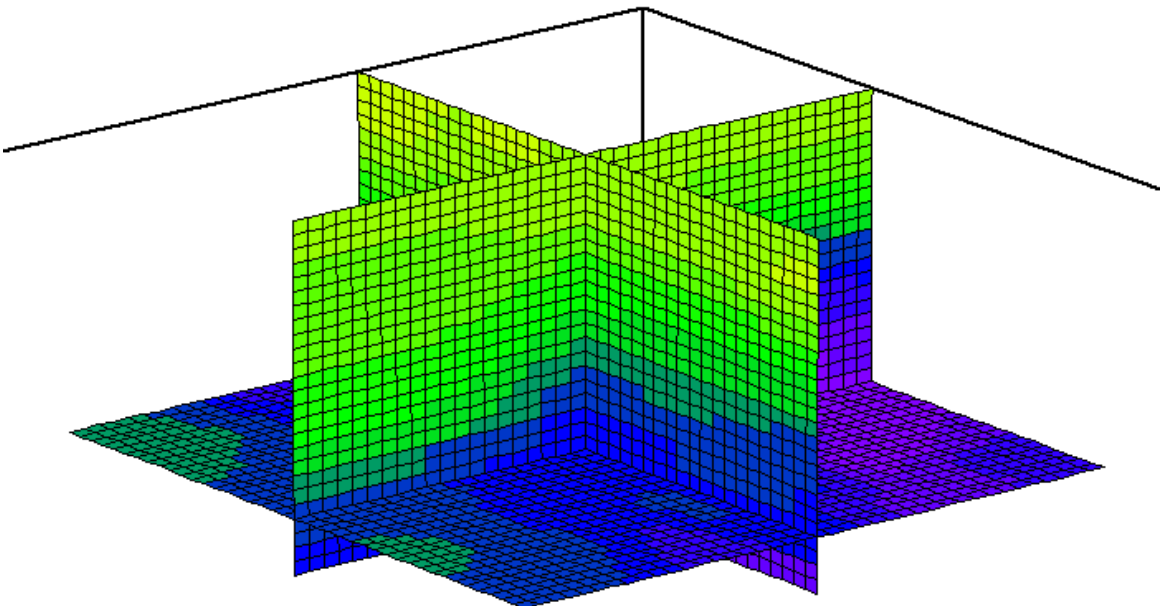
Use  to rotate a model.



Select “View”, “3D”, “Cross sections” to show cross sections.



Use  and  to change positions of cross sections.



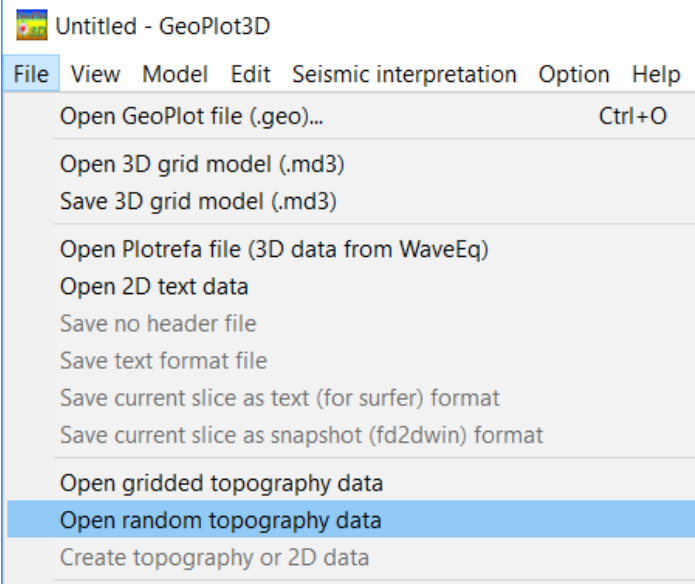
Include surface topography (optional)

Prepare ASCII file of surface topography. X and Y can be random.

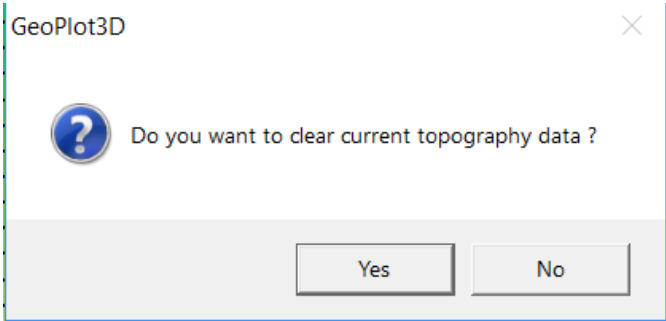
X	Y	Z	-10	30	0	.	.	.
			-10	40	0			
-50	-50	0	-10	50	0			
-50	-40	0	0	-50	10	40	-30	20
-50	-30	0	0	-40	10	40	-20	20
-50	-20	0	0	-30	10	40	-10	20
-50	-10	0	0	-20	10	40	0	20
-50	0	0	0	-10	10	40	10	20
-50	10	0	0	0	10	40	20	20
-50	20	0	0	10	10	40	30	20
-50	30	0	0	20	10	40	40	20
-50	40	0	0	30	10	40	50	20
-50	50	0	0	40	10	50	-50	20
-40	-50	0	0	50	10	50	-40	20
-40	-40	0	10	-50	20	50	-30	20
-40	-30	0	10	-40	20	50	-20	20
-40	-20	0	10	-30	20	50	-10	20
-40	-10	0	10	-20	20	50	0	20
-40	0	0	10	-10	20	50	10	20
-40	10	0	10	0	20	50	20	20
-40	20	0	10	10	20	50	30	20
-40	30	0	10	20	20	50	40	20
.	50	50	20



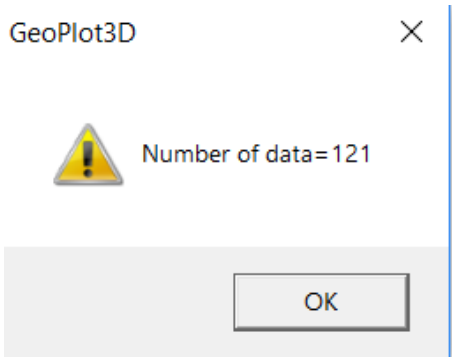
Select “File”, “Open random topography data”.



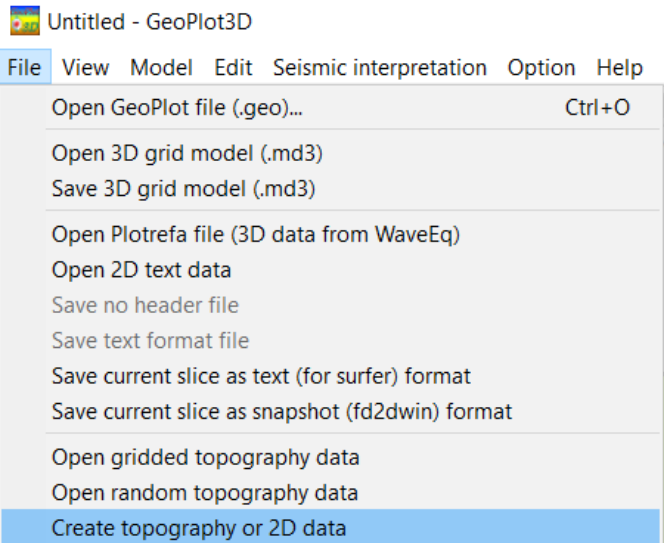
Click “Yes”.



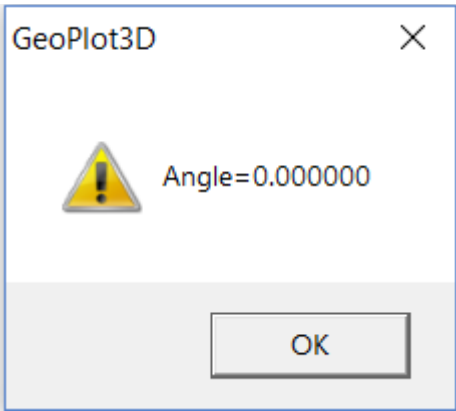
Open an ASCII topography file and confirm a number of data.



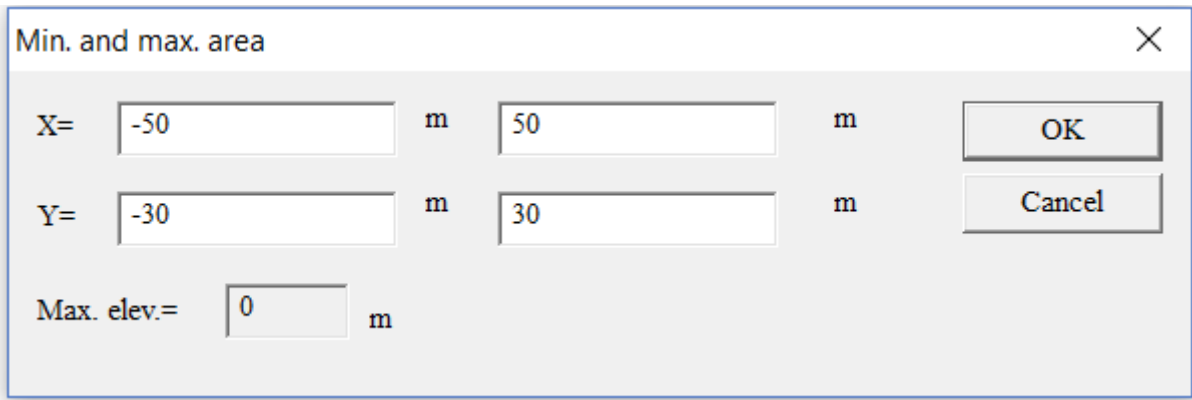
Select “File”, “Create topography or 2D data”.



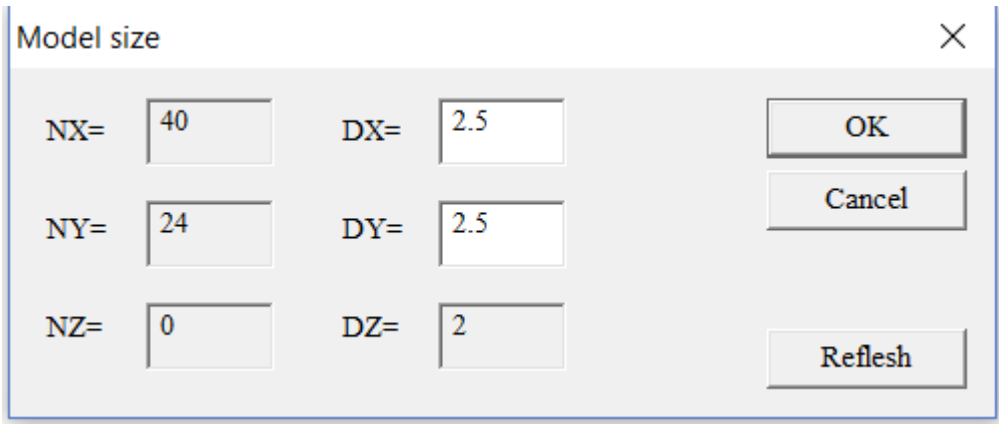
Click OK.



Confirm messages and click OK.

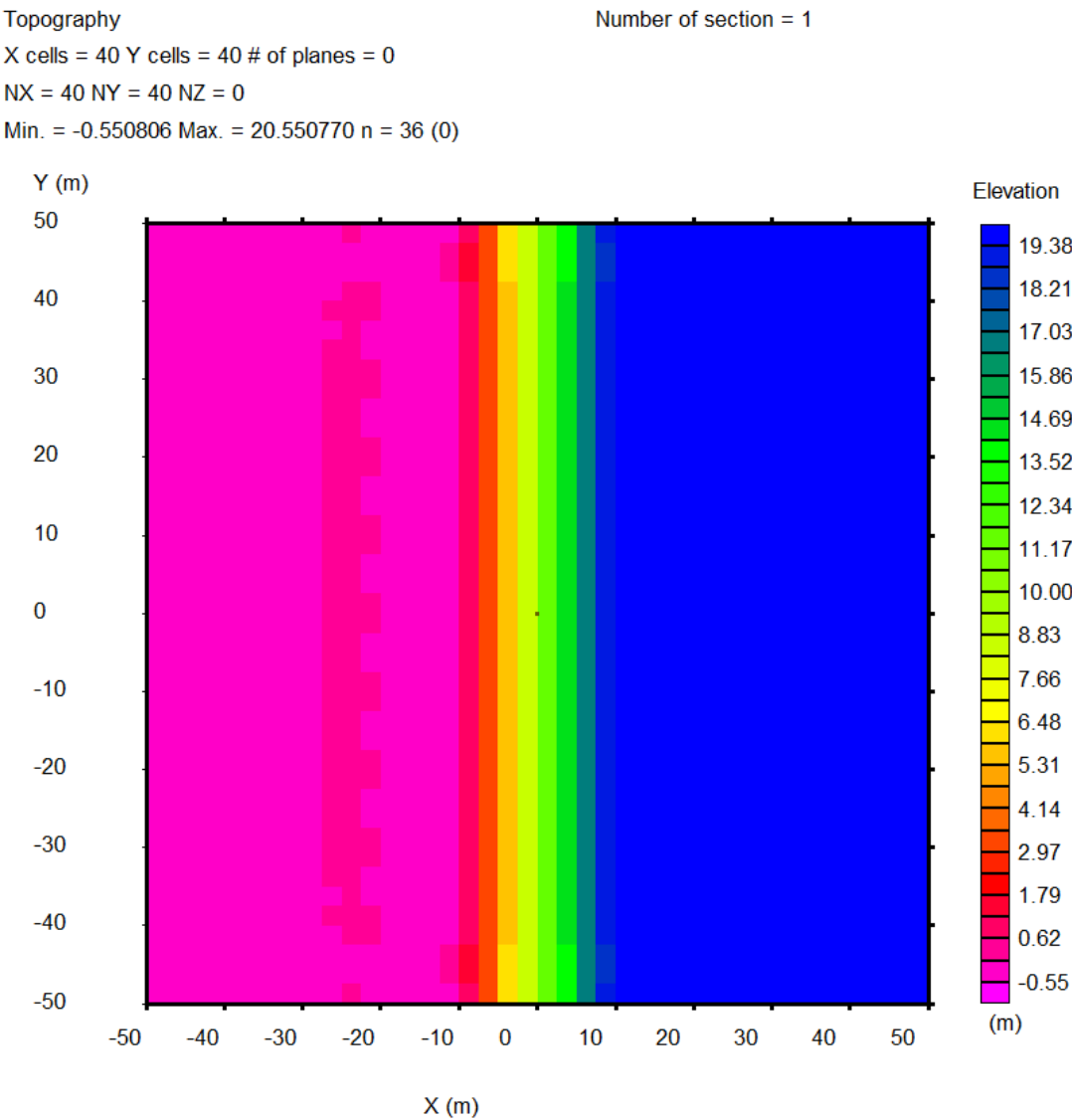


Confirm messages and click OK.



Surface topography appears.

Select “Model”, “Create model” to create 3D velocity model taking into account the surface topography.



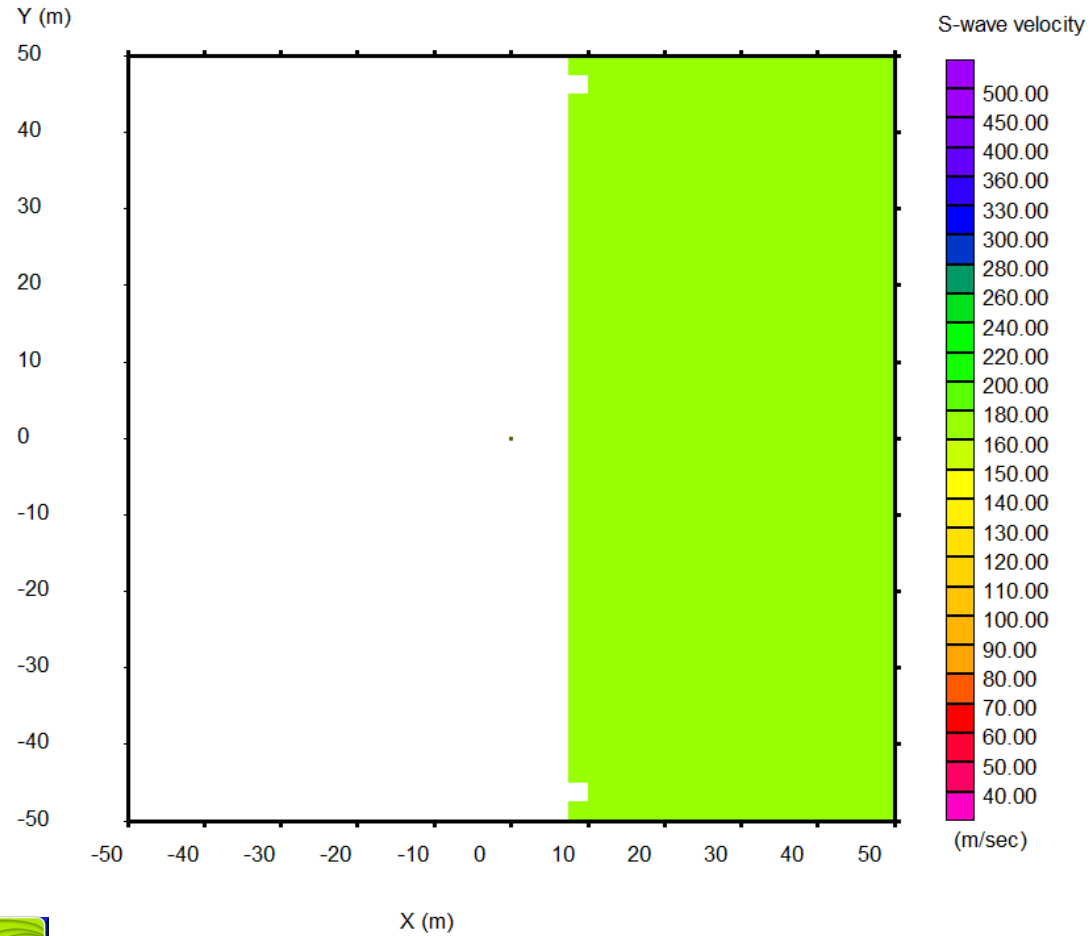
Z plane : N = 0 (0.0 to 2.0 m)

Number of section = 1

X cells = 40 Y cells = 40 # of planes = 25

NX = 40 NY = 40 NZ = 25

Min. = -0.550806 Max. = 20.550770 n = 26 (1)



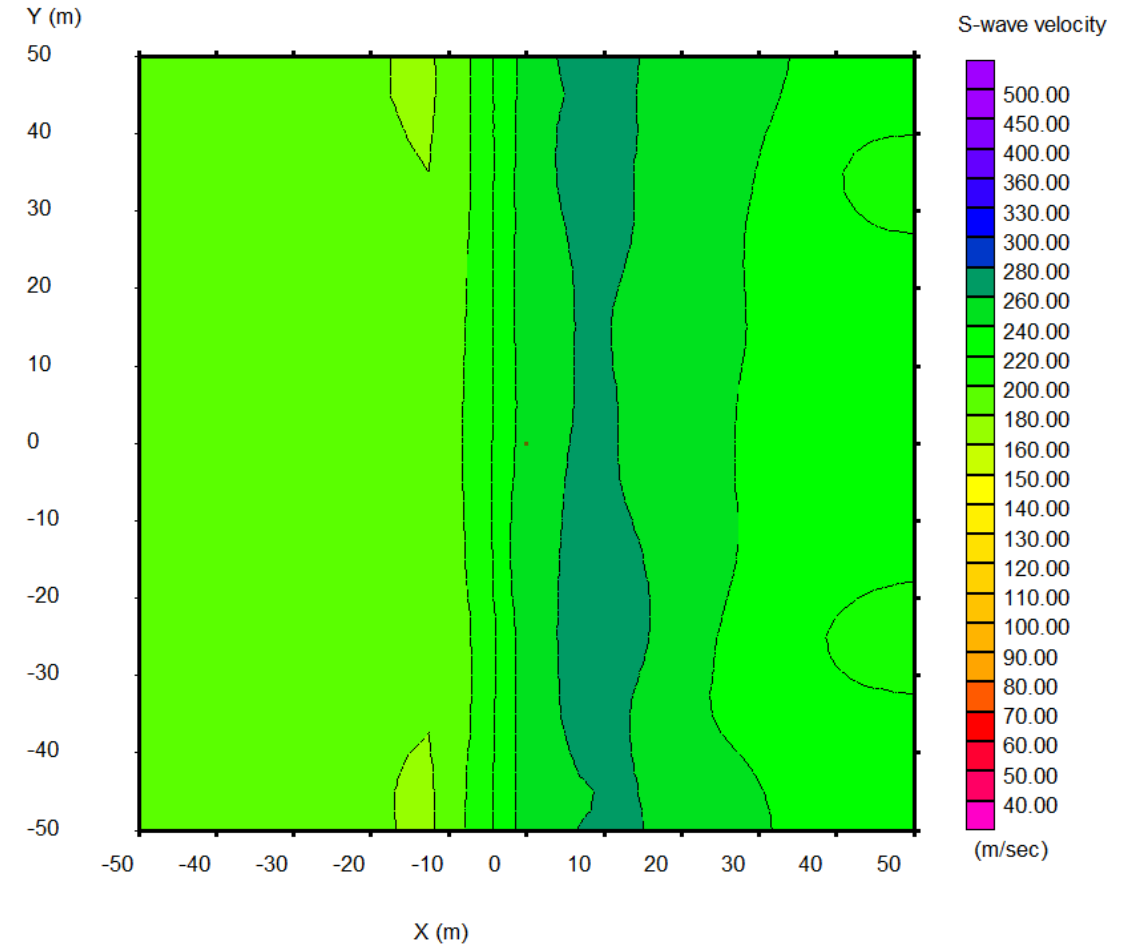
Z plane : N = 15 (30.0 to 32.0 m)

Number of section = 1

X cells = 40 Y cells = 40 # of planes = 25

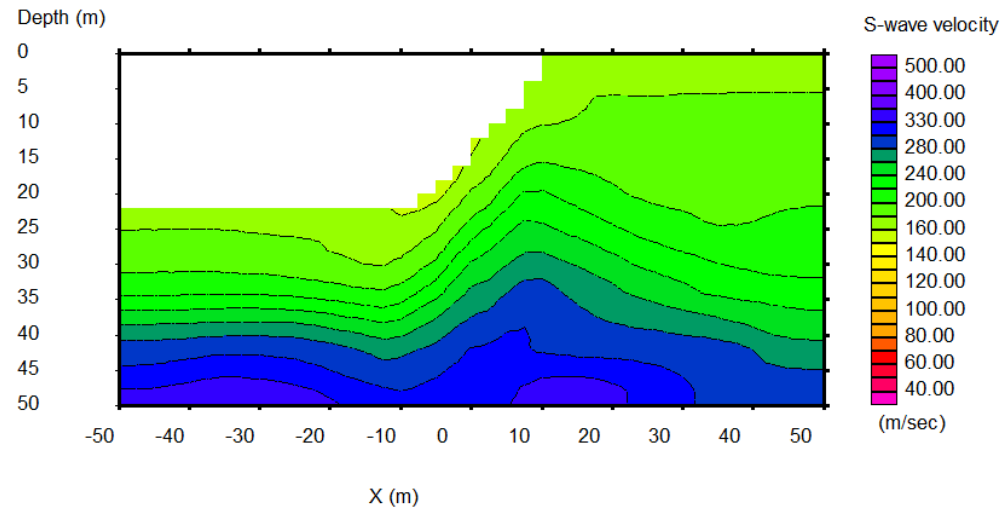
NX = 40 NY = 40 NZ = 25

Min. = -0.550806 Max. = 20.550770 n = 26 (1)



Y plane : N = 10 (-25.0 to -22.5 m)
 X cells = 40 Y cells = 25 # of planes = 40
 NX = 40 NY = 40 NZ = 25
 Min. = -0.550806 Max. = 20.550770 n = 26 (1)

Number of section = 1



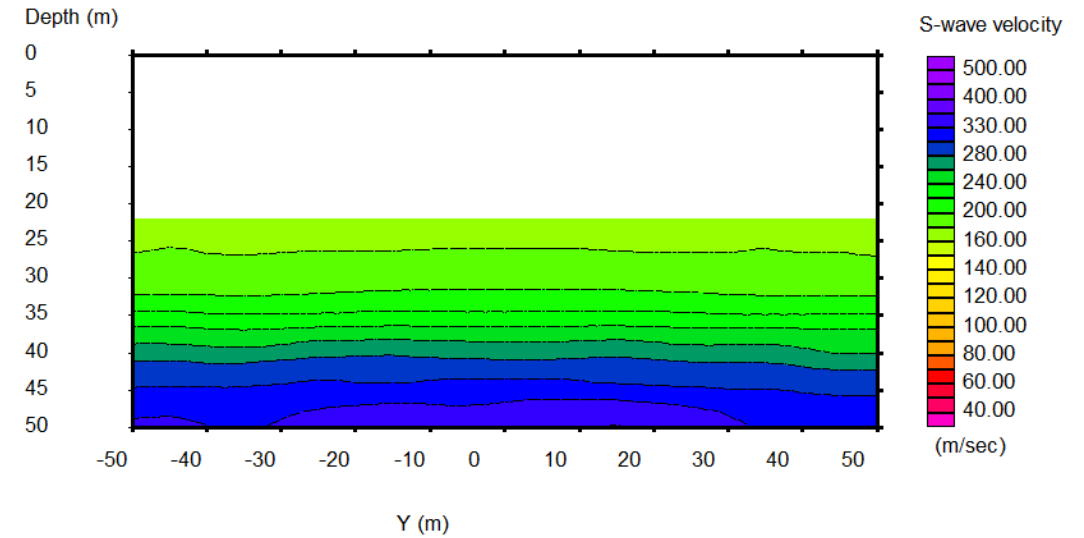
X plane : N = 10 (-25.0 to -22.5 m)

Number of section = 1

X cells = 40 Y cells = 25 # of planes = 40

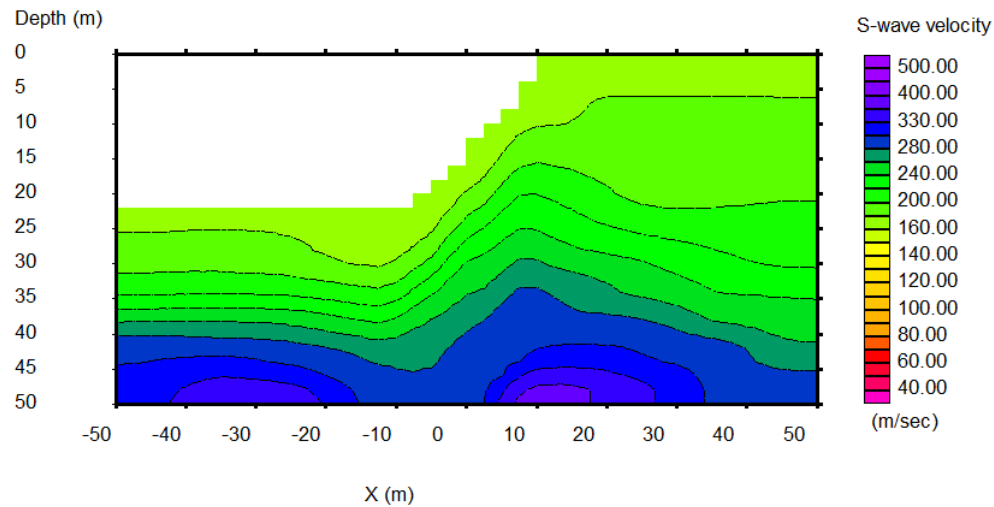
NX = 40 NY = 40 NZ = 25

Min. = -0.550806 Max. = 20.550770 n = 26 (1)



Y plane : N = 30 (25.0 to 27.5 m)
 X cells = 40 Y cells = 25 # of planes = 40
 NX = 40 NY = 40 NZ = 25
 Min. = -0.550806 Max. = 20.550770 n = 26 (1)

Number of section = 1



X plane : N = 30 (25.0 to 27.5 m)

Number of section = 1

X cells = 40 Y cells = 25 # of planes = 40

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Min. = -0.550806 Max. = 20.550770 n = 26 (1)

