Chevron

human energy

Borehole Acoustic Wavefield Modeling with a “Cluster-in-a-Box”

Kristoffer Walker
Acoustic Research Petrophysicist

KristofferWalker@Chevron.com
650-814-4452

9/11/2020

© 2019 Chevron

About the Author

- Kristoffer Walker
  - 2 years, Senior Research Petrophysicist, Chevron
  - 5 years, Acoustic Algorithms and Data Processing Team Lead, Halliburton
  - 10 years, Green Scholar and Research Geophysicist, IGPP, Scripps Institution of Oceanography, Univ. of California, San Diego
  - Masters/PhD, Stanford, 2000/03
  - Interests: Borehole Acoustics, Seismology, DAS, Anisotropy, Rock Physics, Geomechanics, Fishing, Running

© 2019 Chevron

Acknowledgements

- Feature advice and feedback: Alexei Bolshakov
- Modeling code development: Thor Johnsen, Robert Mallan
- Sonic3DGUI app development support: Bin Qiu
- Azure cloud-based support: Bhavani Kambham, Raymond Laganao, Xin Dong, Mason Edwards, Bin Qiu, Tony Sutippantupat, and Stefan Hertel
- MATLAB license support: Keith Droge, Dave Blackman, and Anne Draucker

© 2019 Chevron

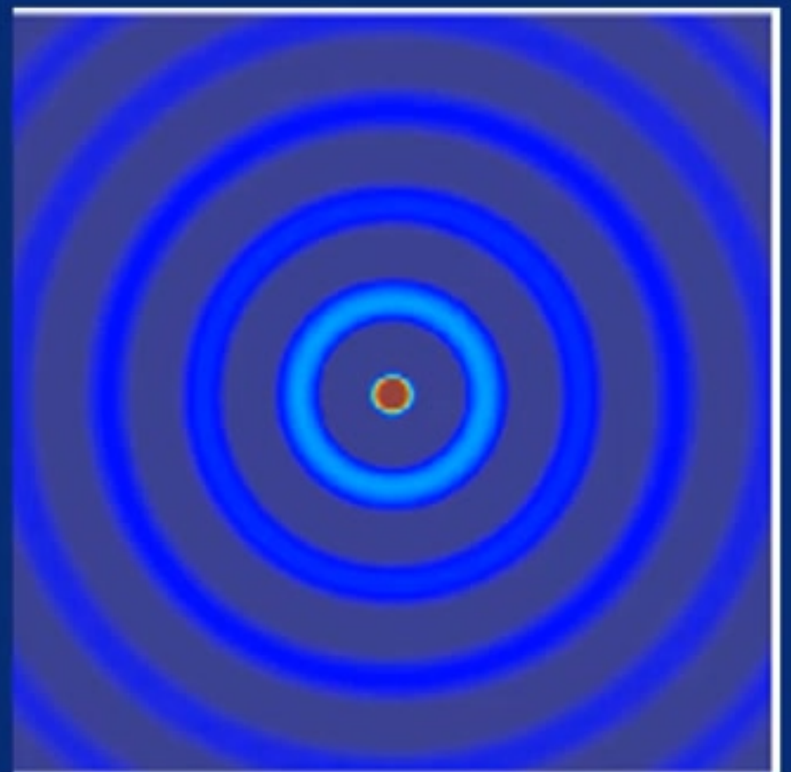
Motivation

- How does Chevron “win in any environment” in Borehole Acoustics?
- We need to know if vendor data products are accurate. This is a challenge!
- So we seek “ground truth” tests that we then feed into their algorithms to evaluate the answers they produce.
- Ground truth data is expensive and sometimes impossible to acquire.
- Numerical wavefield simulation provides the best ground truth and it works in ANY environment

© 2019 Chevron

Important Modeling Features

- Must be able to handle borehole acoustic modeling for frequencies up to 40 kHz
- Hard and soft rocks
- Anisotropy up to orthorhombic symmetry with tilt
- Handles any source/receiver geometry
- Handles any borehole shape (elliptical, circular, rugose)
- Handles interbedding with strike/dip



© 2019 Chevron

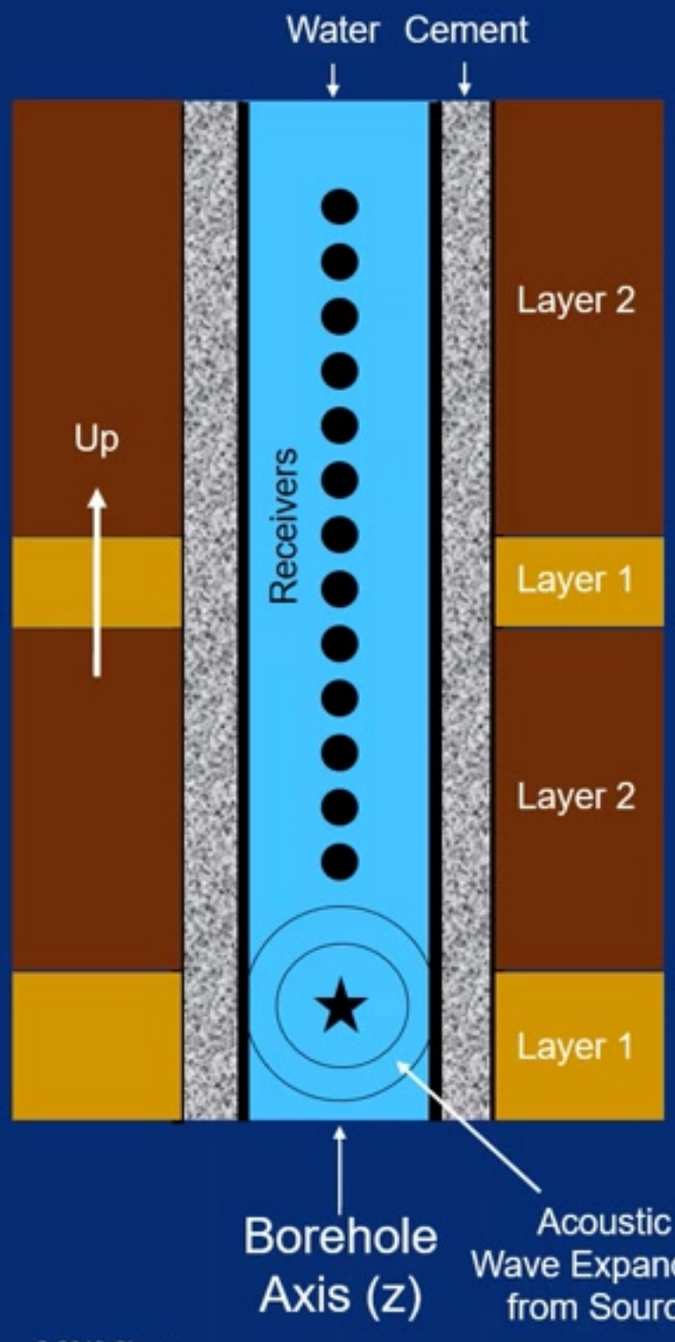
Chevron

Important Solution Features

- Do not “reinvent the wheel”
- Very fast (one simulation within an hour)
- User and computationally scalable
- Generalized for flexible usage
- Point-and-click and one-stop-shopping
- Use cloud’s pay-as-you-go usage model

© 2019 Chevron

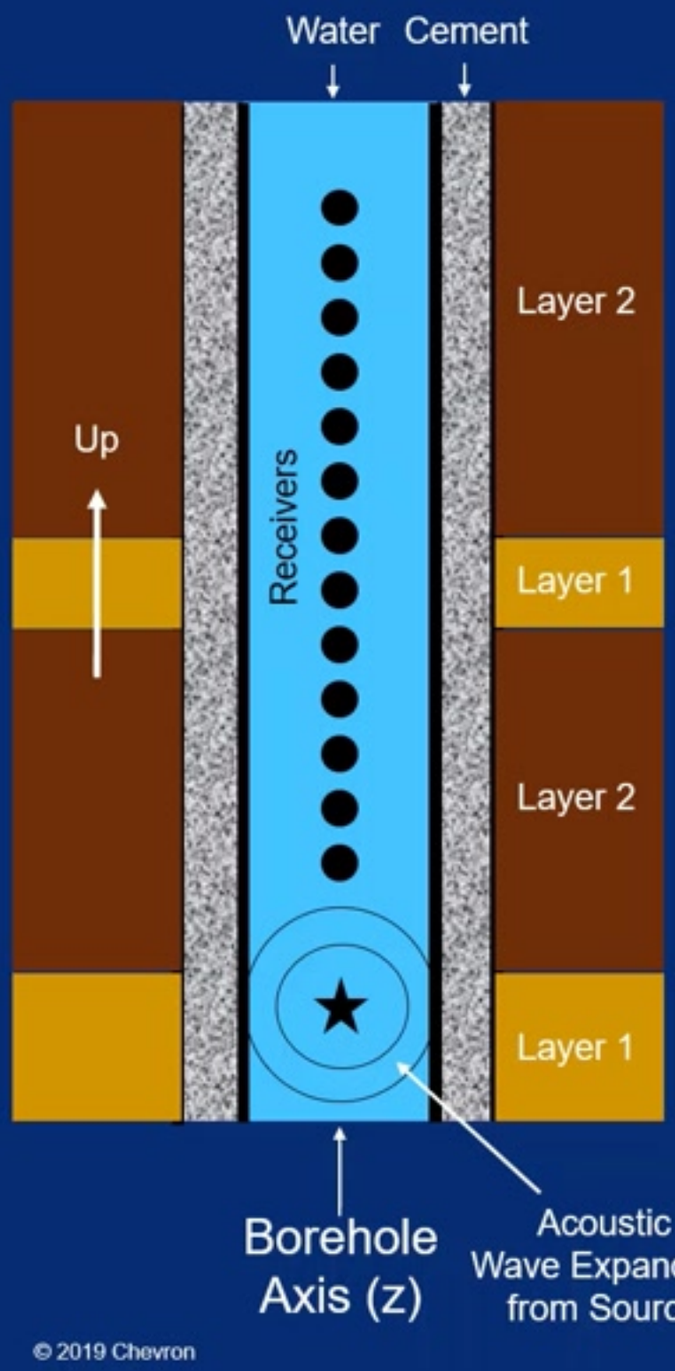
Borehole Acoustic Logging



- Borehole drilled through formations, with or without casing and cement
- Wireline and LWD tools have sources and receiver arrays
- Source fires a pulse into the water, which goes into formations
- Some energy returns to the receiver array
- Array processing techniques are used to measure elastic properties of the formation and its pore fluids
- Relates to drilling safety, borehole stability, formation evaluation, reservoir characterization, and completion planning

© 2019 Chevron

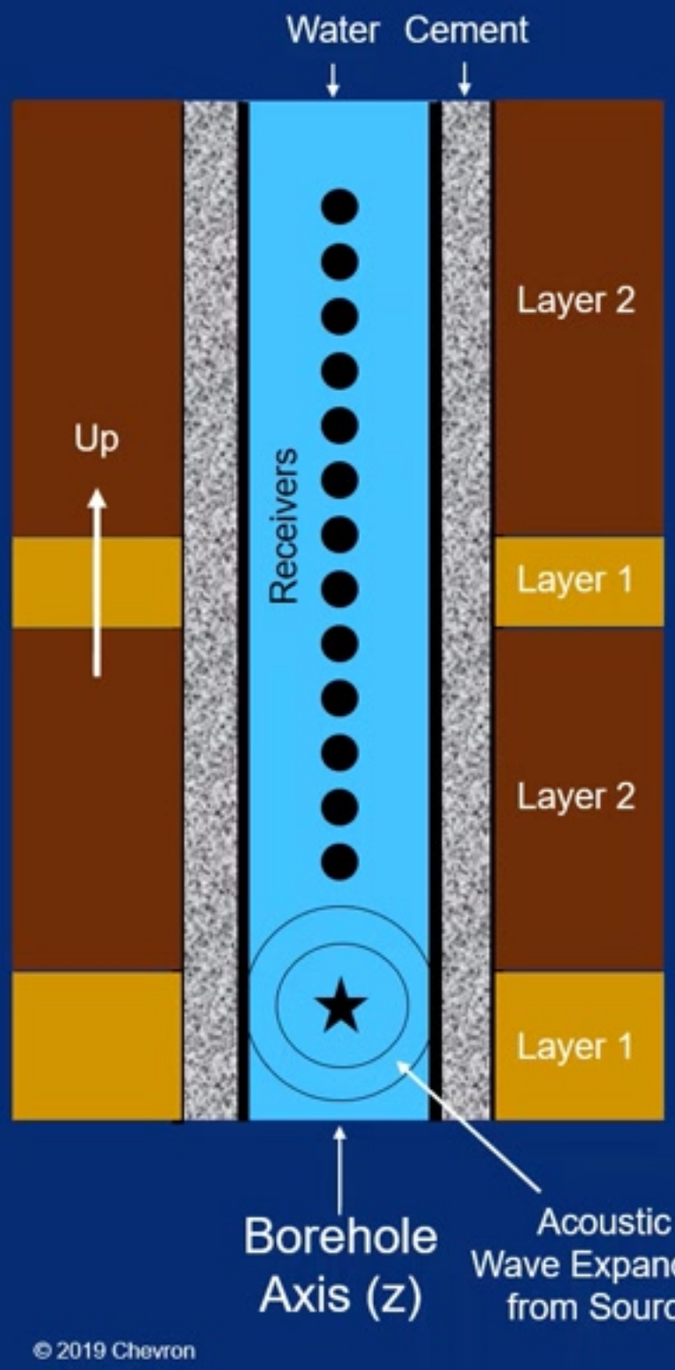
Sonic3D Description



- Create 3D models of compressional velocity, shear velocity, and density
- Discretization of model into tens of “mega pixels”
- Impart receivers at specific location(s)
- Impart source(s) at specific location(s)
- Create source function(s) that will be transmitted at each source location
- Solve full elastic wave equation for stresses and particle velocities using an explicit method (finite difference time domain)
- Iterate for tens of thousands of time steps
- Absorb the reflections that would normally occur at the model boundaries

© 2019 Chevron

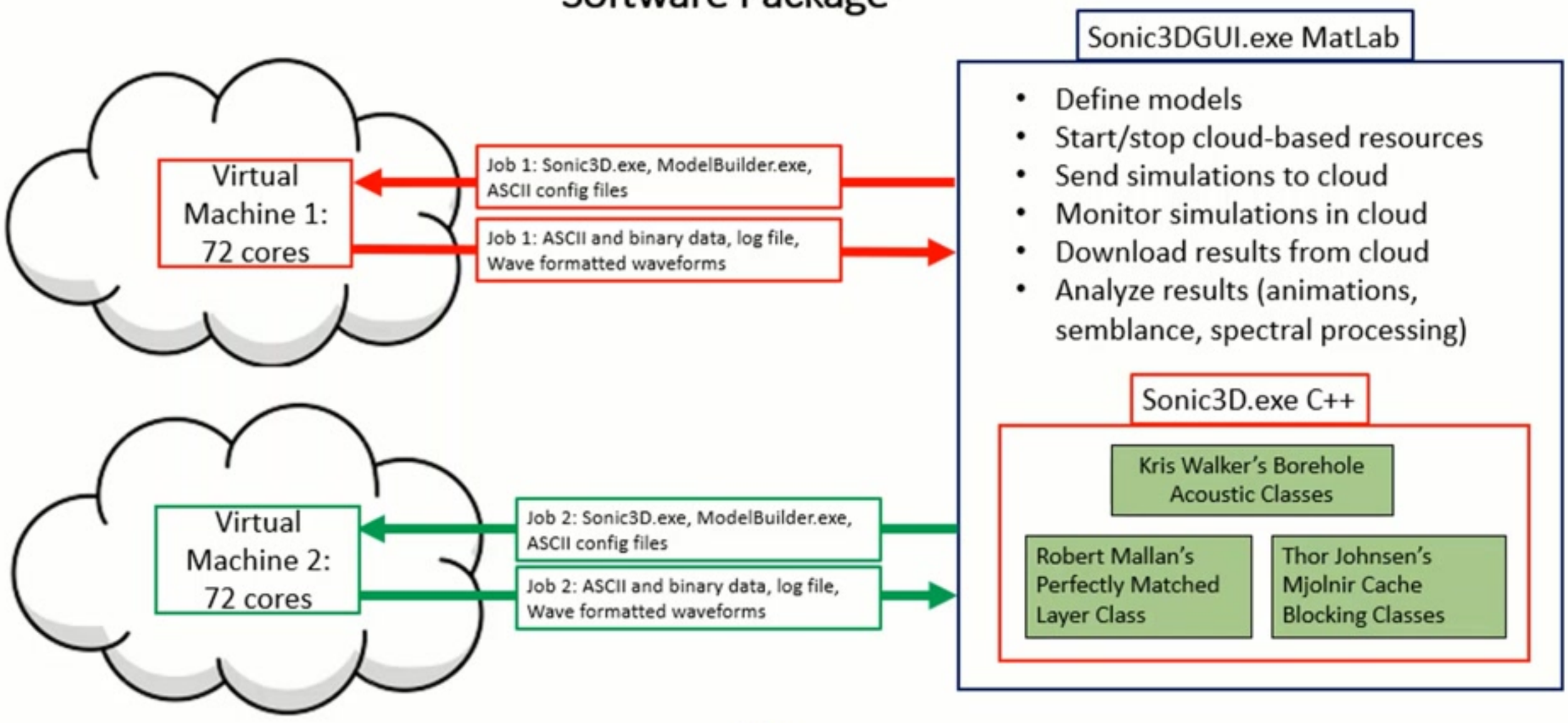
Sonic3D Description



- Create 3D models of compressional velocity, shear velocity, and density
- Discretization of model into tens of “mega pixels”
- Impart receivers at specific location(s)
- Impart source(s) at specific location(s)
- Create source function(s) that will be transmitted at each source location
- Solve full elastic wave equation for stresses and particle velocities using an explicit method (finite difference time domain)
- Iterate for tens of thousands of time steps
- Absorb the reflections that would normally occur at the model boundaries

© 2019 Chevron

Sonic3D Borehole Acoustic Wavefield Modeling Software Package



© 2019 Chevron

Programmatically Starting/Stopping Cloud-Based Resources with MATLAB's System Command

- To start/stop resources, you first need to acquire your Access Token (also called Authentication Token)
- We send a REST POST command to the VM manager using the ubiquitous "Curl" program to get the Access Token as well as start/stop the VM's
- We execute the following "Curl" command via MATLAB's system command to obtain the Access Token:

```
curl -X POST -d
"grant_type=client_credentials&client_id=[APPLICATION_ID]&client_secret=
[PASSWORD]&resource=https%3A%2F%2Fmanagement.azure.com%2F"
https://login.microsoftonline.com/[TENANT_ID]/oauth2/token
```

© 2019 Chevron

Programmatically Starting/Stopping Cloud-Based Resources with MATLAB's System Command

- To start/stop resources, you first need to acquire your Access Token (also called Authentication Token)
- We send a REST POST command to the VM manager using the ubiquitous "Curl" program to get the Access Token as well as start/stop the VM's
- We execute the following "Curl" command via MATLAB's system command to obtain the Access Token:

```
curl -X POST -d
"grant_type=client_credentials&client_id=[APPLICATION_ID]&client_secret=
[PASSWORD]&resource=https%3A%2F%2Fmanagement.azure.com%2F"
https://login.microsoftonline.com/[TENANT_ID]/oauth2/token
```

© 2019 Chevron

Programmatically Starting Cloud-Based Resources with MATLAB's System Command

- In the curl command you pass your Access Token as a header (with -H)
- You pass the Application ID and Password as data variables (-d)
- Lastly, you pass the Subscription ID, Resource Group, and VM Name as part of the URL string.
- You keep a map between IP address and VM Name
- The command is shown below. The key command being executed here is called "start".

```
curl -X POST -H "Authorization: Bearer [TOKEN]" -d
"grant_type=client_credentials&client_id=[APPLICATION_ID]&client_secret=
[PASSWORD]&resource=https%3A%2F%2Fmanagement.azure.com%2F"
https://management.azure.com/subscriptions/[SUBSCRIPTION_ID]/resourceGro
ups/[RESOURCE_GROUP]/providers/Microsoft.Compute/virtualMachines/[VM_NAM
E]/start?api-version=2019-07-01
```

© 2019 Chevron

Programmatically Stopping Cloud-Based Resources with MATLAB's System Command

- Shutting down your VM also requires the Access Token, as well as the other parameters described in Starting your VM.
- Only difference is instead of executing a "start", you are executing a "deallocate"
- Warning: if you use "powerOff", machine will remain "allocated" and continue to incur usage costs

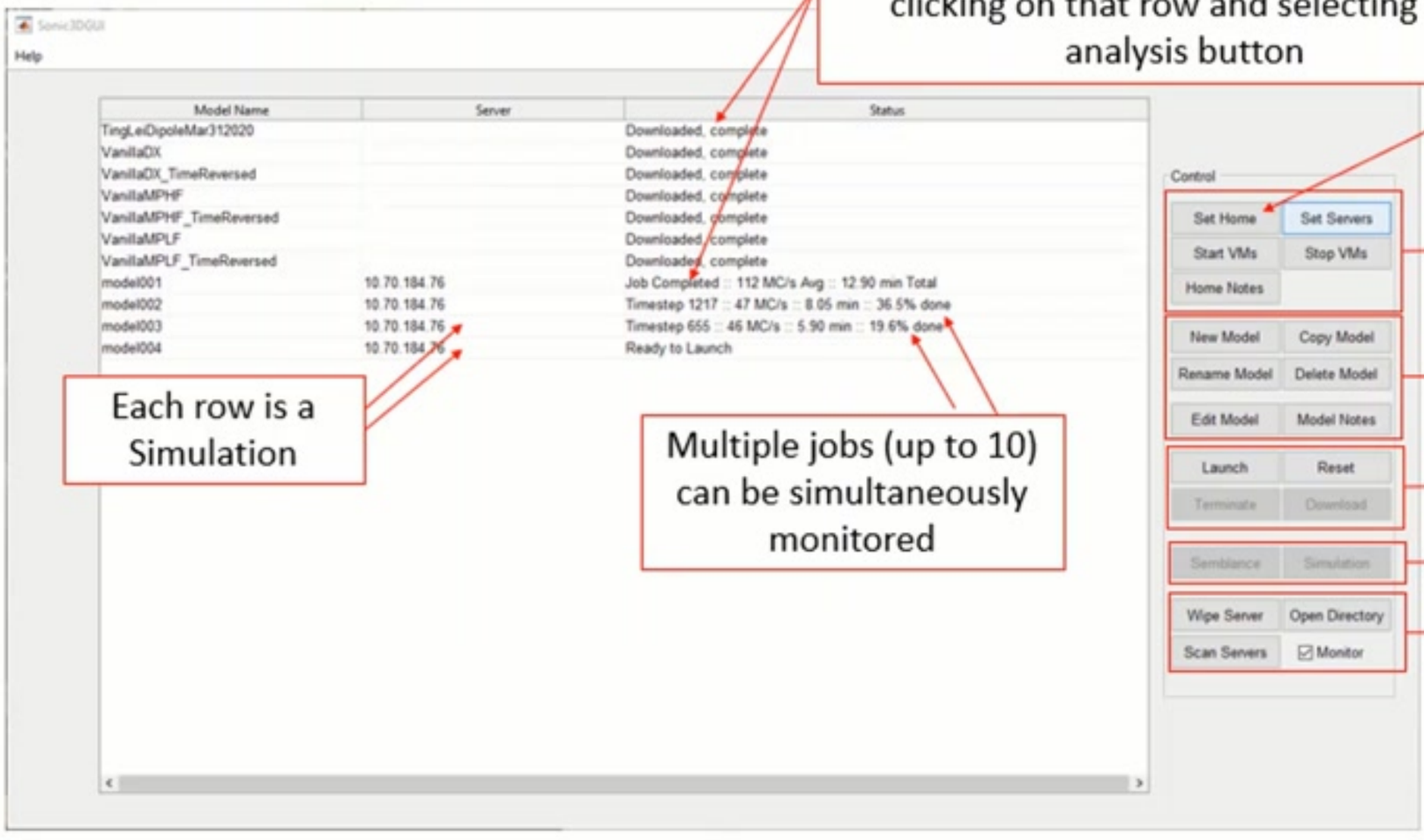
```
curl -X POST -H "Authorization: Bearer [TOKEN]" -d
"grant_type=client_credentials&client_id=[APPLICATION_ID]&client_secret=
[PASSWORD]&resource=https%3A%2F%2Fmanagement.azure.com%2F"
https://management.azure.com/subscriptions/[SUBSCRIPTION_ID]/resourceGro
ups/[RESOURCE_GROUP]/providers/Microsoft.Compute/virtualMachines/[VM_NAM
E]/deallocate?api-version=2019-07-01
```

© 2019 Chevron

Sonic3D: Main Window

All model data is stored in a database archive directory of your choosing using the “Set Home” button

Once a model is complete and downloaded, the Analysis tools can be used on it by clicking on that row and selecting the analysis button



Each row is a Simulation

Multiple jobs (up to 10) can be simultaneously monitored

Control Cloud Based Resources

Model Building

Job Control

Analysis

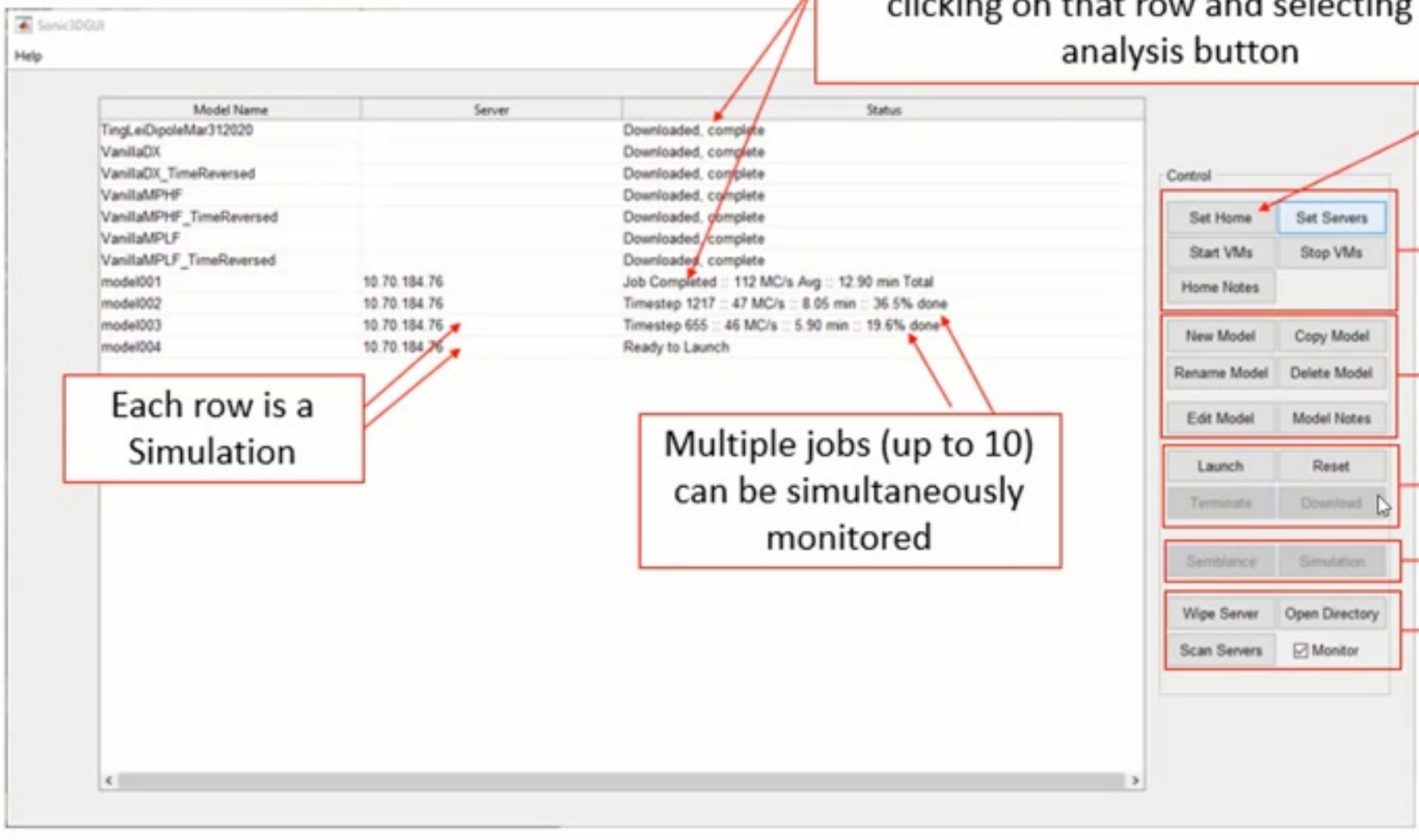
Utilities

© 2019 Chevron

Sonic3D: Main Window

All model data is stored in a database archive directory of your choosing using the “Set Home” button

Once a model is complete and downloaded, the Analysis tools can be used on it by clicking on that row and selecting the analysis button



Each row is a Simulation

Multiple jobs (up to 10) can be simultaneously monitored

Control Cloud Based Resources

Model Building

Job Control

Analysis

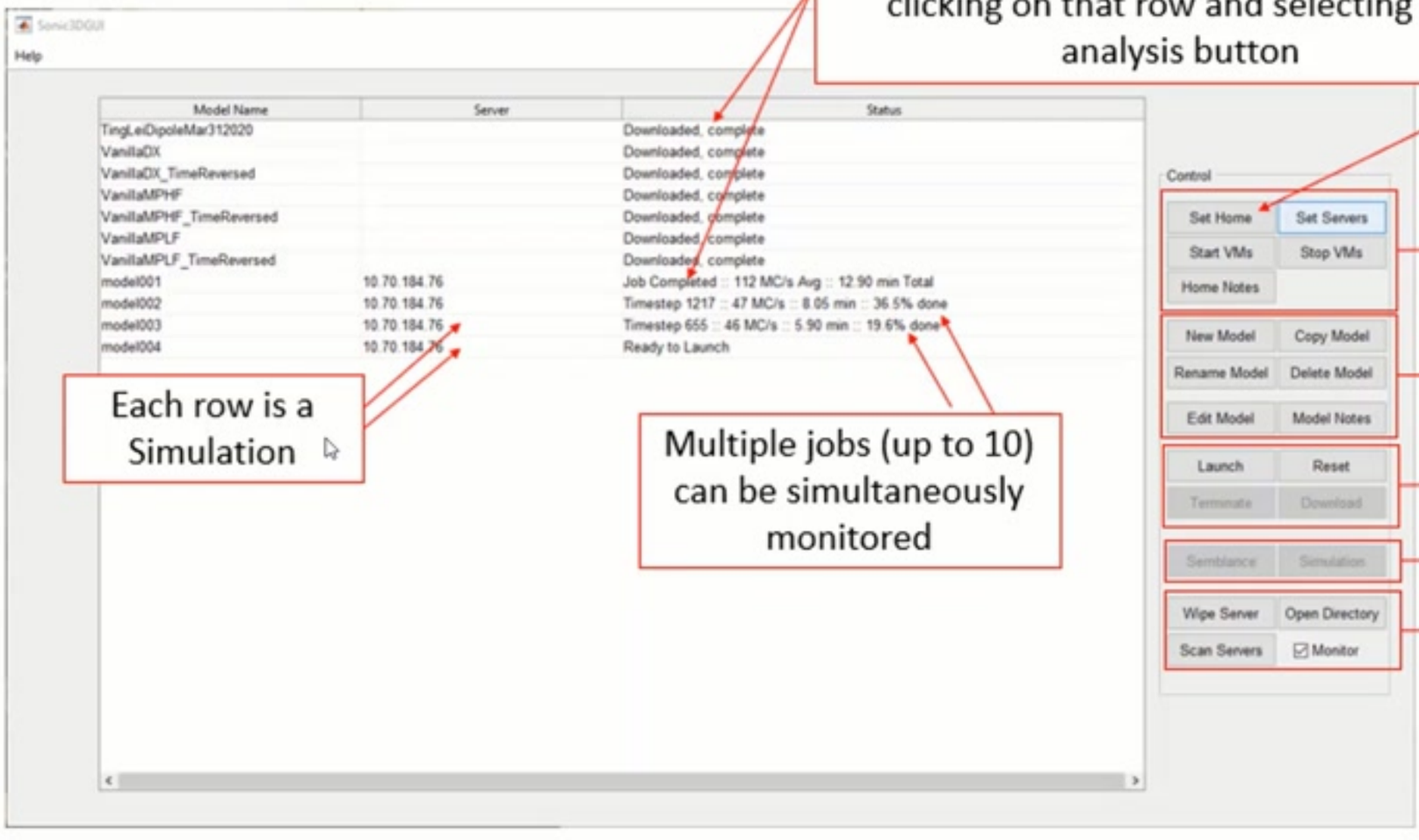
Utilities

© 2019 Chevron

Sonic3D: Main Window

All model data is stored in a database archive directory of your choosing using the “Set Home” button

Once a model is complete and downloaded, the Analysis tools can be used on it by clicking on that row and selecting the analysis button



Each row is a Simulation

Multiple jobs (up to 10) can be simultaneously monitored

Control Cloud Based Resources

Model Building

Job Control

Analysis

Utilities

© 2019 Chevron

Sonic3DGUI

Select modeling root directory

Walker, Kristoffer › source › repos › Sonic3DGUI ›

Search Sonic3DGUI

Organize | New folder

Quick access
- Documents
- Downloads
- Pictures
- Team Petrophysics Measurements
- KWLib
- Chevron
- kw
- KWDH
- Intermediate Petrophysics Seminar
- Intermediate Petrophysics Seminar
- geolog_etc_training
- ipps_kwdh
- Chevron
- AcousticData
- source
- rootfs
- ktwalker
- Bolshakov, Alexei - ClassMaterial
- examples
- QuickSonic

Name	Date modified	Type	Size
.git	7/15/2020 10:11 AM	File folder	
.vs	7/1/2020 8:58 AM	File folder	
bin	7/1/2020 12:29 PM	File folder	
doc	7/1/2020 12:29 PM	File folder	
examples	7/23/2020 8:23 AM	File folder	
examplesMathWorksConf	9/12/2020 11:15 AM	File folder	
installer	7/1/2020 8:58 AM	File folder	
src	8/18/2020 4:58 PM	File folder	
util	7/15/2020 10:05 AM	File folder	

Folder: examplesMathWorksConf

Select Folder | Cancel

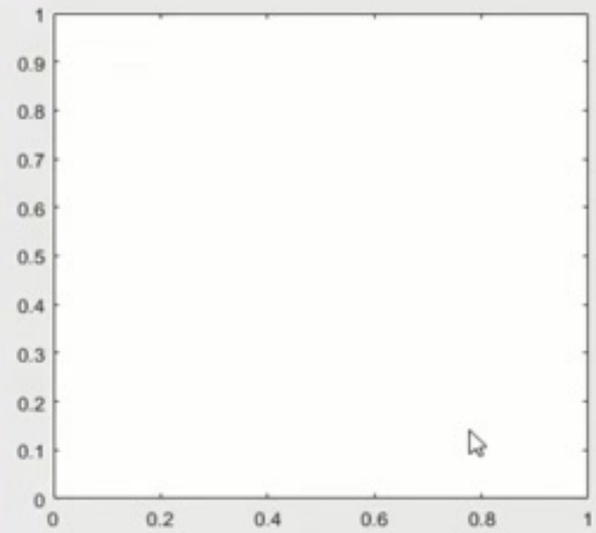
Set Servers
Stop VMs
Copy Model
Delete Model
Model Notes
Reset
Download
Simulation
Open Directory
Monitor

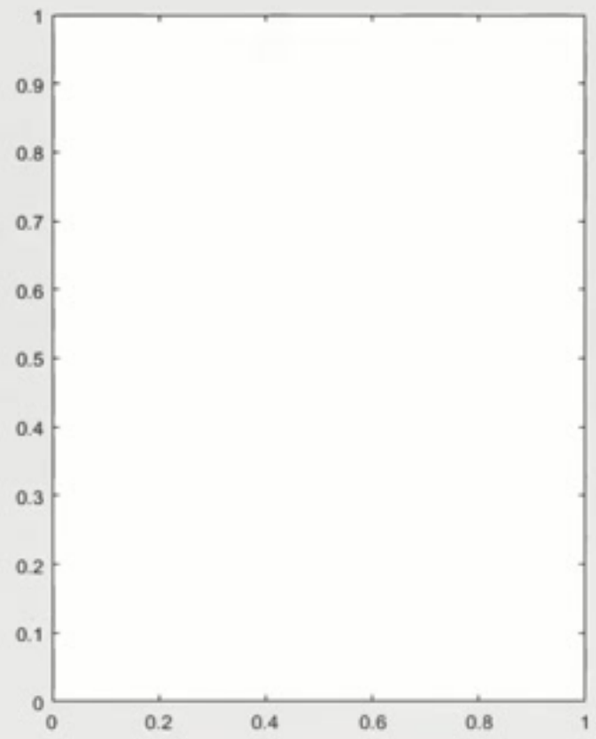
Sonic3DGUI

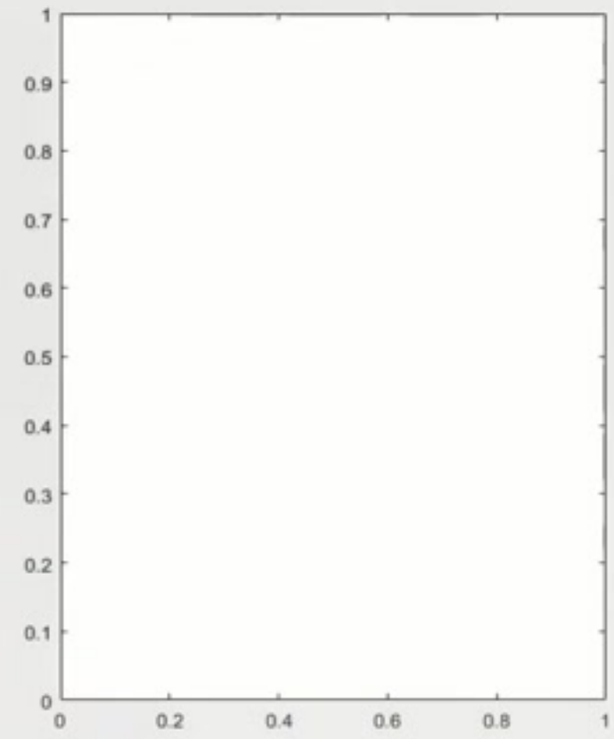
Help

ModelBuilderGUI

File Edit







XMin/m| -0.2 | XMax/m| 0.2 | dX[mm]| 5 | nX 96

YMin/m| -0.2 | YMax/m| 0.2 | dY/mm| 5 | nY 96

ZMin/m| 0 | ZMax/m| 5 | dZ/mm| 5 | nZ 1024

TMax/ms| 1 | dT/us| 0.5 | nT 2001

PML | FMax/kHz| 5 | UpdateGrid | Discretize

☐ Add Holes ☐ Grid ☐ Show Pixels

Sonic3DGUI

Help

ModelBuilderGUI

File Edit

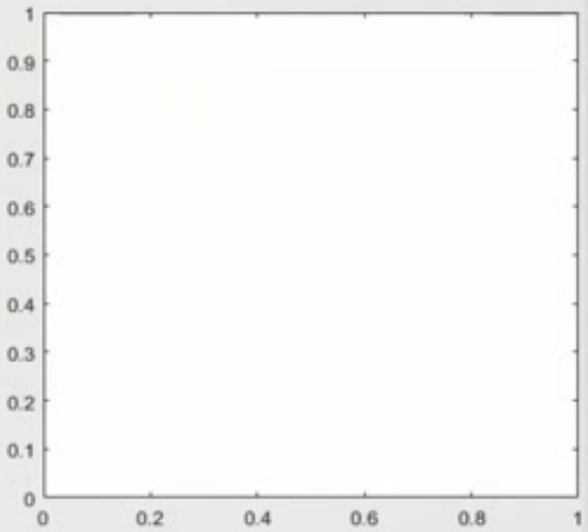
EditTubularsGUI

Tubular Info

n-Layer | QuickStart | Clear

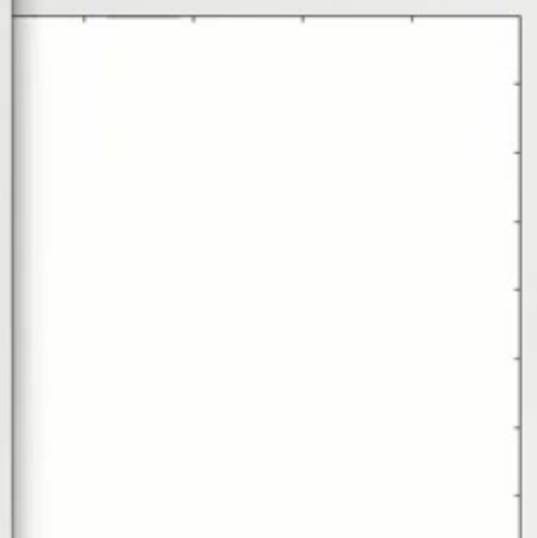
Layer	Src/Rec	2	3	4	5	6	7	8
Radius[m]								
Xc[m]								
Yc[m]								
Ecc								
rho[g/cc]								
Vp[km/s]								
Vs[km/s]								
Q								
EpsX								
EpsY								
GamX								
GamY								
DelX								
DelY								
Strike [deg]								
Dip [deg]								
Anisotropy	☐	☐	☐	☐	☐	☐	☐	☐

Update



XMin/ml	-0.2	XMax/ml	0.2	dX[mm]	5	nX	96
YMin/ml	-0.2	YMax/ml	0.2	dY/mm]	5	nY	96
ZMin/ml	0	ZMax/ml	5	dZ/mm]	5	nZ	1024
		TMax[ms]	1	dT[us]	0.5	nT	2001
PML		FMax[kHz]	5	UpdateGrid		Discretize	

☐ Add Holes ☐ Grid ☐ Show Pixels

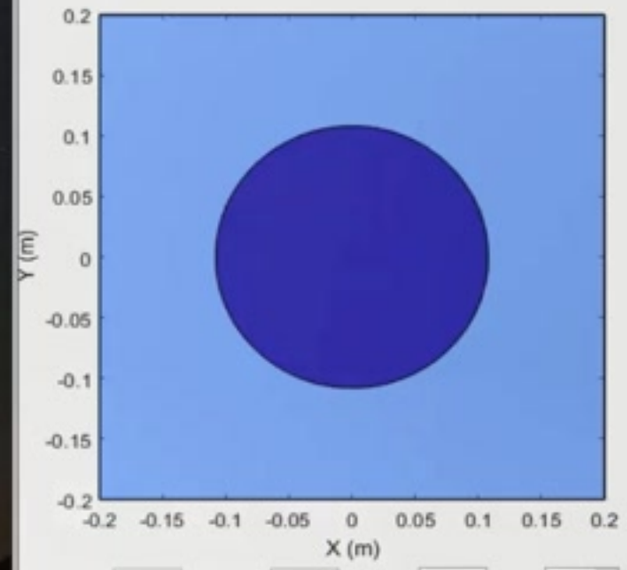


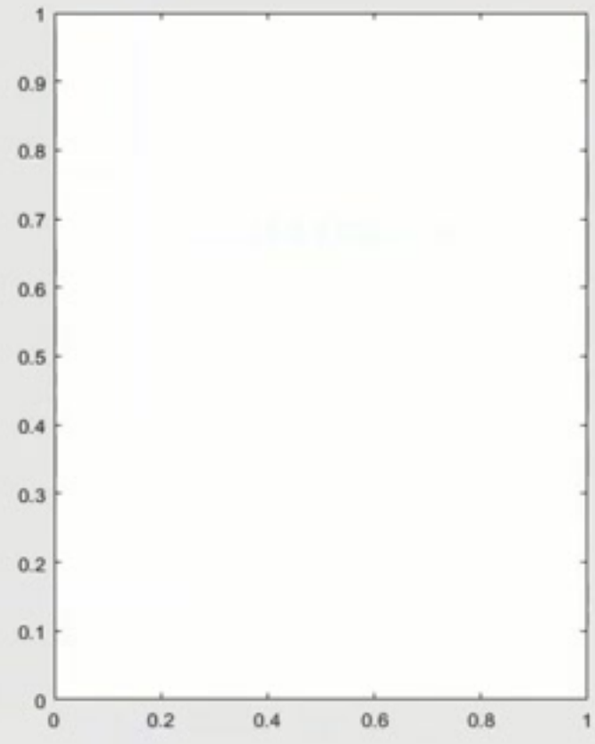
Sonic3DGUI

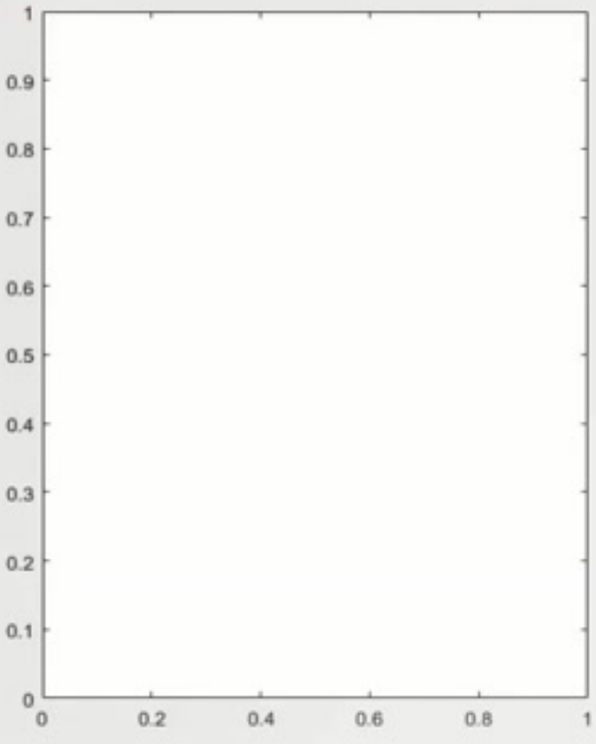
Help

ModelBuilderGUI

File Edit







XMin[m]	-0.2	XMax[m]	0.2	dX[mm]	5	nX	96
YMin[m]	-0.2	YMax[m]	0.2	dY[mm]	5	nY	96
ZMin[m]	0	ZMax[m]	5	dZ[mm]	5	nZ	1024
		TMax[ms]	1	dT[us]	0.5	nT	2001
PML		FMax[kHz]	5	UpdateGrid		Discretize	

☐ Add Holes ☐ Grid ☐ Show Pixels

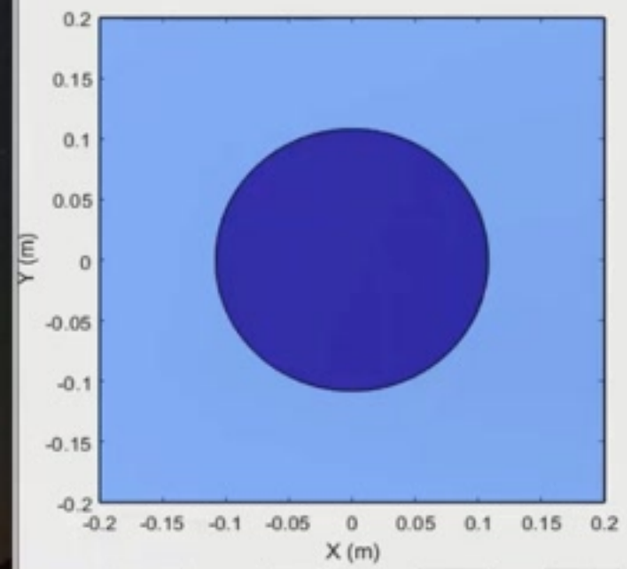
Update

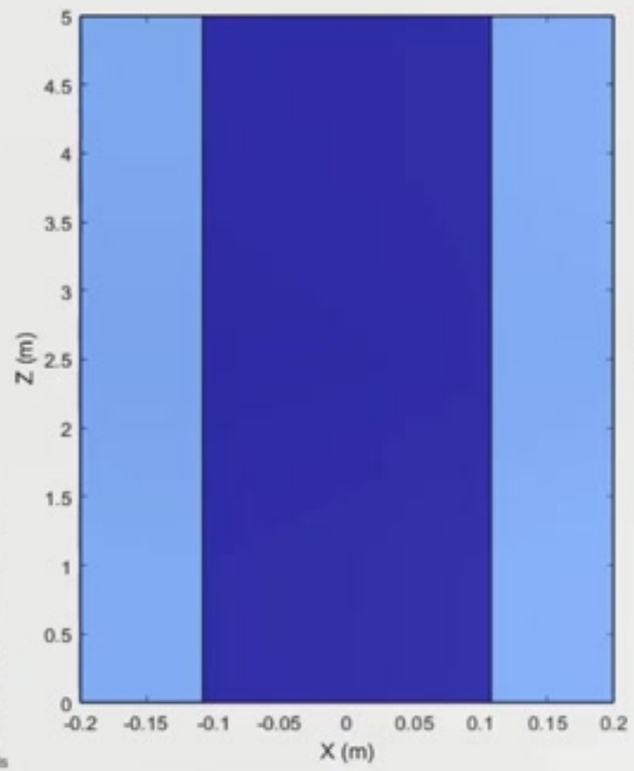
Sonic3DGUI

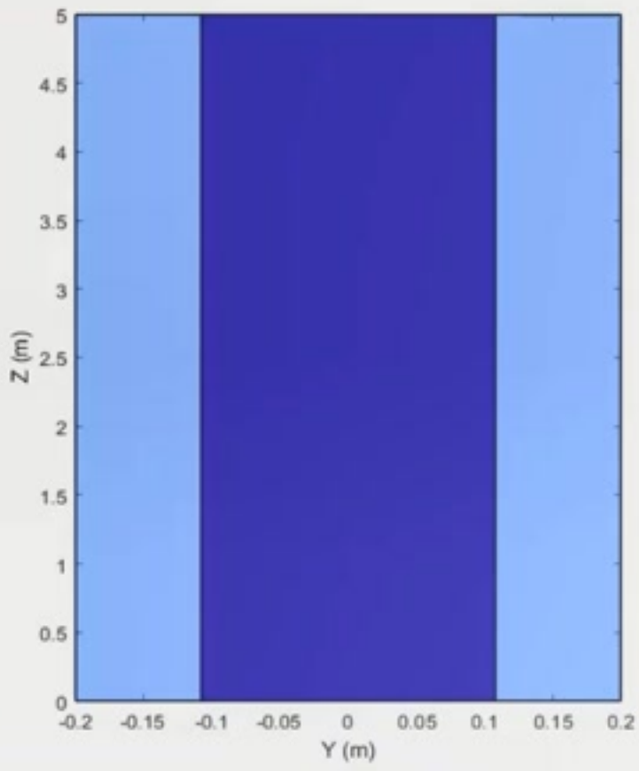
Help

ModelBuilderGUI

File Edit







XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120
		TMax[ms]	1	dT[us]	0.3	nT	2001
PML		FMax[kHz]	5	UpdateGrid		Discretize	

Add Holes Grid Show Pixels

Update

Sonic3DGUI

Help

ModelBuilderGUI

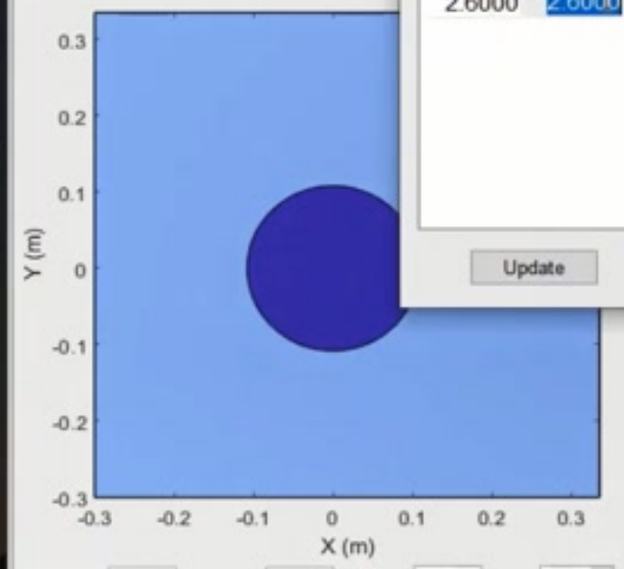
File Edit

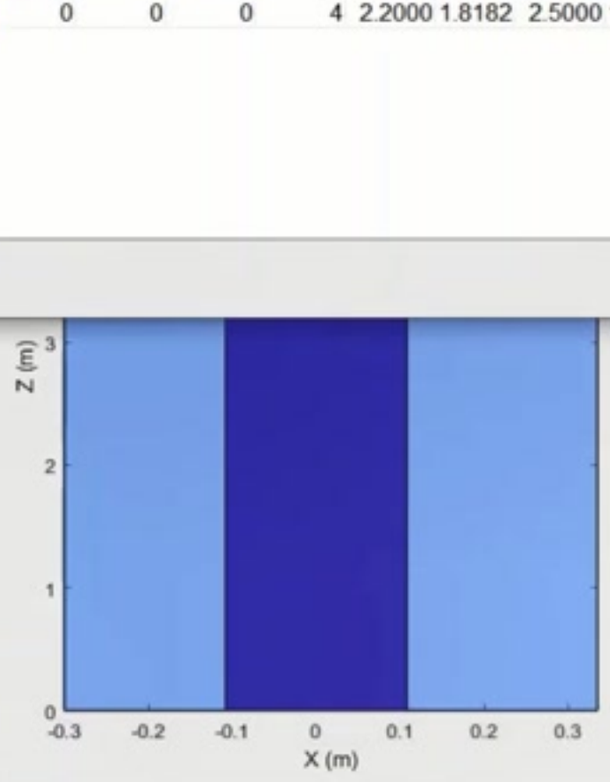
EditFormGUI

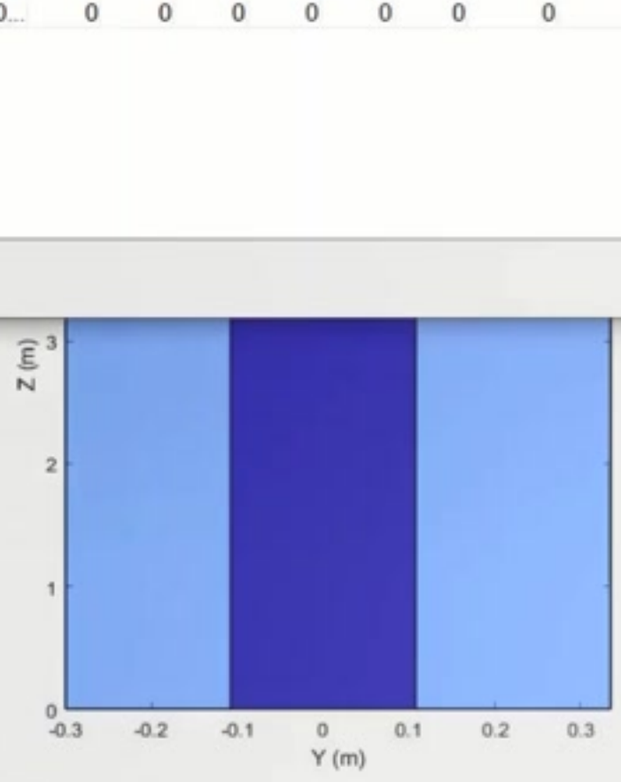
New Formation | Delete Formation | Copy From Tubular

zMax[m]	zMin[m]	Thk[m]	bStrk[deg]	bDp[deg]	vP[km/s]	vS[km/s]	VpVs	rho[g/cc]	q	epsX	epsY	gamX	gamY	delX	delY	aStrk[deg]	aDp[deg]
5.5950	2.7975	2.7975	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0
2.7975	2.6000	0.1975	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0
2.6000	2.6000	0	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0

Update







XMin/ml -0.3 | XMax/ml 0.335 | dX[mm] 5 | nX 128

YMin/ml -0.3 | YMax/ml 0.335 | dY/mm 5 | nY 128

ZMin/ml 0 | ZMax/ml 5.595 | dZ/mm 5 | nZ 1120

TMax/ms 4 | dT/us 0.3 | nT 13334

PML | FMax/kHz 5 | UpdateGrid | Discretize

Add Holes | Grid | Show Pixels

Sonic3DGUI

Help

ModelBuilderGUI

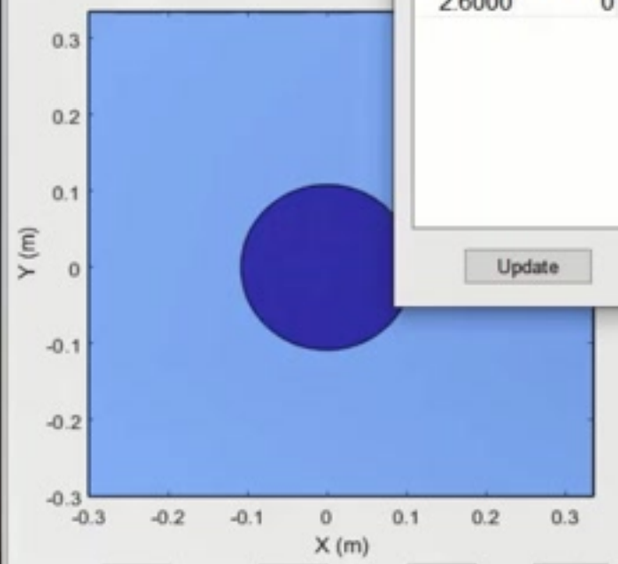
File Edit

EditFormGUI

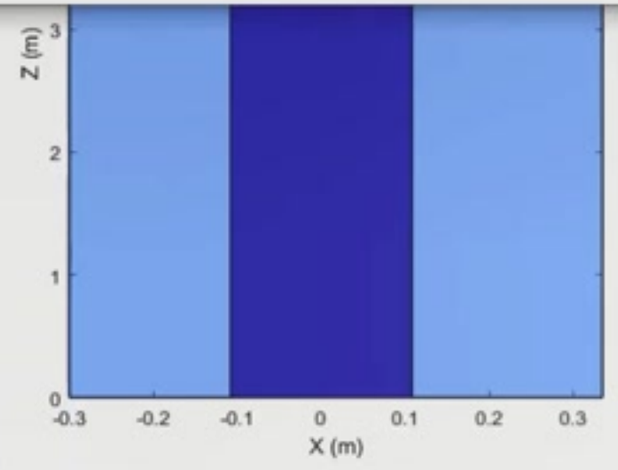
New Formation | Delete Formation | Copy From Tubular

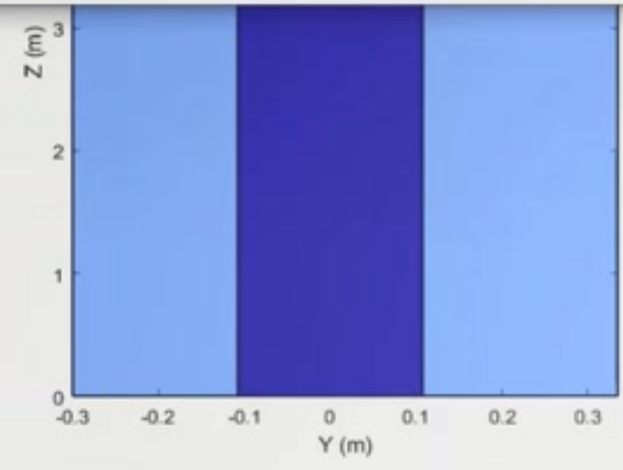
zMax[m]	zMin[m]	Thk[m]	bStrk[deg]	bDp[deg]	vP[km/s]	vS[km/s]	VpVs	rho[g/cc]	q	epsX	epsY	gamX	gamY	delX	delY	aStrk[deg]	aDp[deg]
5.5950	2.7975	2.7975	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0
2.7975	2.6000	0.1975	0	0	2	0.	0.9091	2.5000	10...	0	0	0	0	0	0	0	0
2.6000	0	2.6000	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0

Update



XMin/ml -0.3 XMax/ml 0.335 dX[mm] 5 nX 128
YMin/ml -0.3 YMax/ml 0.335 dY/mm] 5 nY 128
ZMin/ml 0 ZMax/ml 5.595 dZ/mm] 5 nZ 1120
TMax/ms] 4 dT/us] 0.3 nT 13334
PML
FMax/kHz] 5
UpdateGrid Discretize
Add Holes Grid Show Pixels





Update

Sonic3DGUI

Help

ModelBuilderGUI

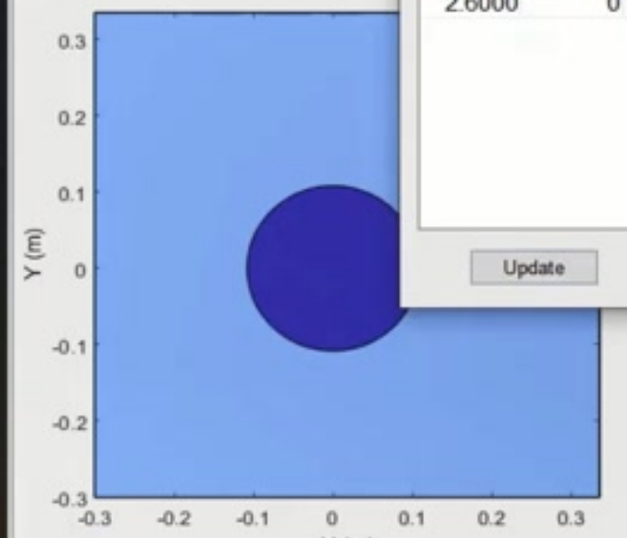
File Edit

EditFormGUI

New Formation | Delete Formation | Copy From Tubular

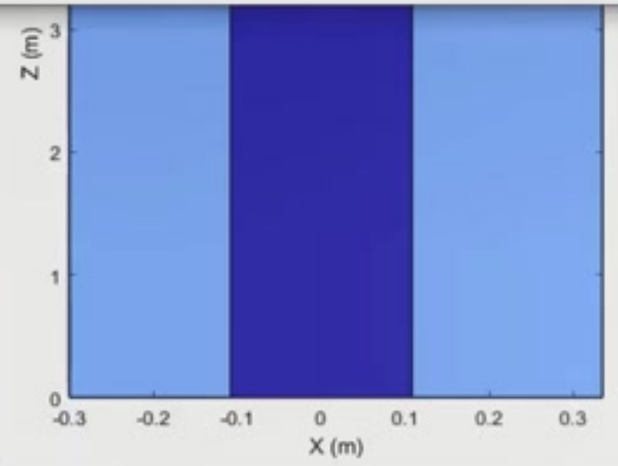
zMax[m]	zMin[m]	Thk[m]	bStrk[deg]	bDp[deg]	vP[km/s]	vS[km/s]	VpVs	rho[g/cc]	q	epsX	epsY	gamX	gamY	delX	delY	aStrk[deg]	aDp[deg]
5.5950	2.7975	2.7975	45	4	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0
2.7975	2.6000	0.1975	0	0	2	0.6000	3.3333	1.9000	10...	0	0	0	0	0	0	0	0
2.6000	0	2.6000	0	0	4	2.2000	1.8182	2.5000	10...	0	0	0	0	0	0	0	0

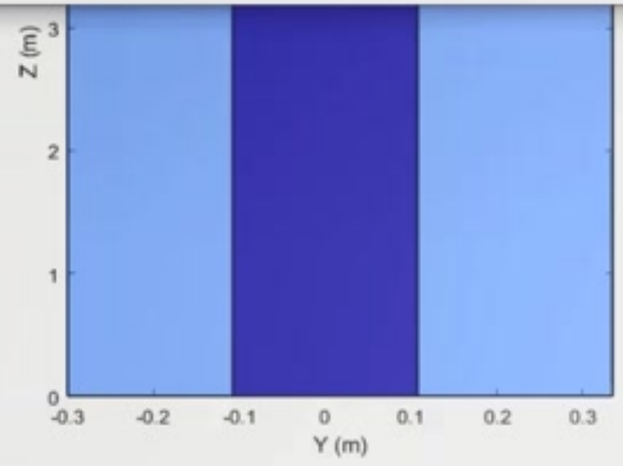
Update



XMin/m| -0.3 | XMax/m| 0.335 | dX[mm] | 5 | nX | 128
YMin/m| -0.3 | YMax/m| 0.335 | dY/mm| 5 | nY | 128
ZMin/m| 0 | ZMax/m| 5.595 | dZ/mm| 5 | nZ | 1120
TMax/ms| 4 | dT/us| 0.3 | nT | 13334
PML | FMax/kHz| 5 | UpdateGrid | Discretize

Add Holes | Grid | Show Pixels





Update

Sonic3DGUI

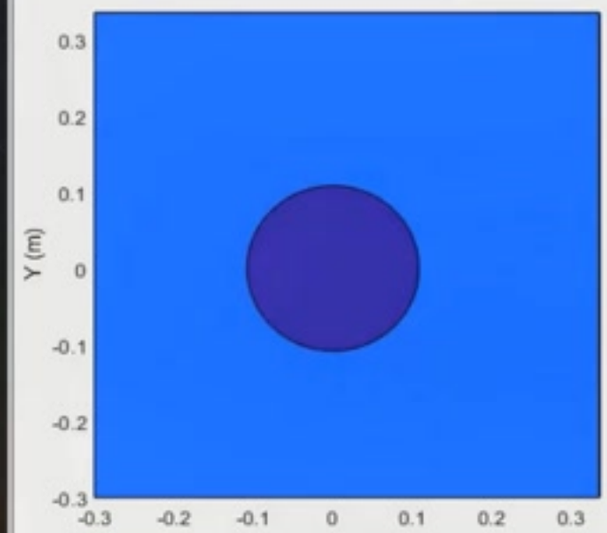
Help

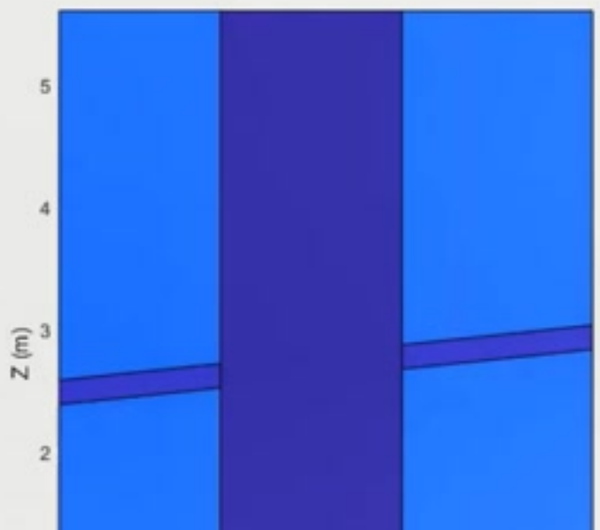
EditFormGUI

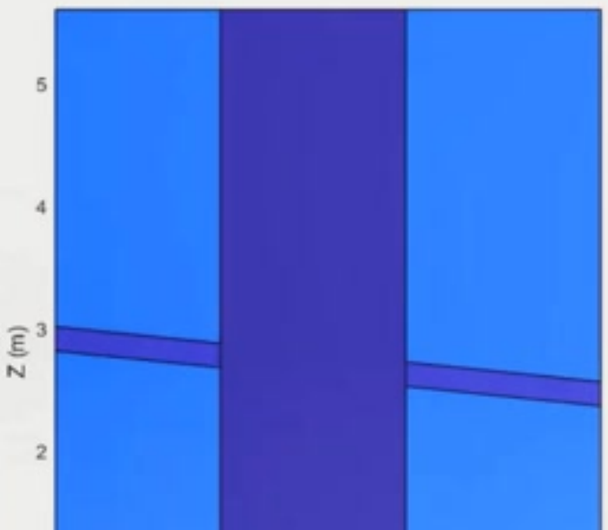
New Formation | Delete Formation | Copy From Tubular

ModelBuilderGUI

File Edit







XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128		
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128		
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120		
		TMax[ns]	4	dT[us]	0.3	nT	13334		
PML		FMax[kHz]	5	UpdateGrid		Discretize			

Add Holes | Grid | Show Pixels

Update

EditSourcesReceiversGUI

Tool Configuration

None

Source Array Builder

nRng | nAzi

dRng[m] | dAzi[deg]

rng0[m] | azi0[deg]

Monopole | r[m]

Add Source Array | zRef[m]

New Source Fnct

Delete Source Fnct

Plot Source Fnct

Receiver Array Builder

nRng | nAzi

dRng[m] | dAzi[deg]

rng0[m] | azi0[deg]

type | r[m]

zRef[m]

Time Reversal

Frequency Filter

FLow [kHz]

FHigh [kHz]

FilterOrder

Taper Win [ms]

TR Flip

Add Sou

Delete Receiver

Delete All

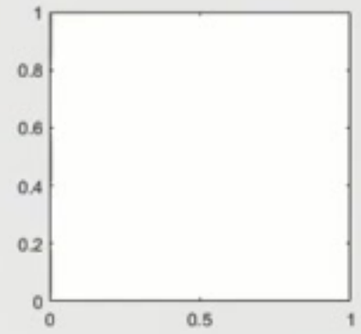
x [m]	y [m]	z [m]

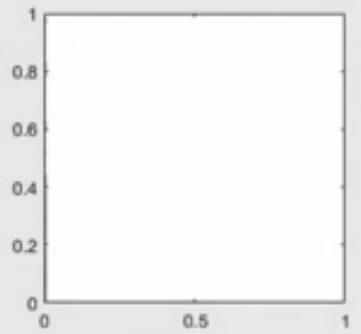
y [m]	z [m]	type (0-6)

EditSourceFunctionGUI

Function: Ricker | fC [kHz]: 5 | alpha: 0 | t0 [us]: 0

Auto Fit | Zoom | Grids | FileName: ricker5kHz | Save Source





Update

EditSourcesReceiversGUI

Tool Configuration

None

Source Array Builder

nRng | nAzi

dRng[m] | dAzi[deg]

rng0[m] | azi0[deg]

Monopole | r[m]

Add Source Array | zRef[m]

New Source Fnct

Delete Source Fnct

Plot Source Fnct

Receiver Array Builder

nRng | nAzi

dRng[m] | dAzi[deg]

rng0[m] | azi0[deg]

type | r[m]

zRef[m]

Time Reversal

Frequency Filter

FLow [kHz]

FHigh [kHz]

FilterOrder

Taper Win [ms]

TR Flip

Add Sou

Delete Receiver

Delete All

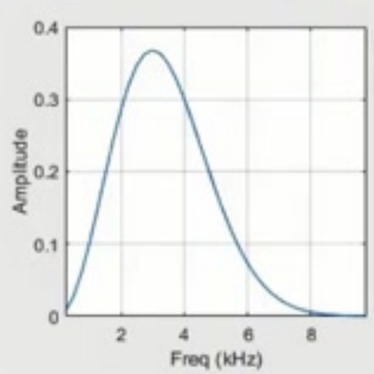
x [m]	y [m]	z [m]

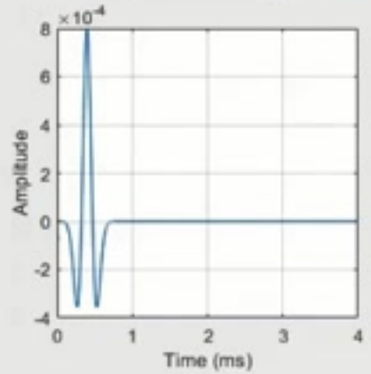
y [m]	z [m]	type (0-6)

EditSourceFunctionGUI

Function: Ricker | fC [kHz]: 3 | alpha: 0 | t0 [us]: 1600

Auto Fit | Zoom | Grids | FileName: ricker5kHz | Save Source





Update

EditSourcesReceiversGUI

Tool Configuration

None

- None
- XSI UMP
- XSI LMP
- XSI FMP
- XSI UFMP
- XSI DX
- XSI DY
- XAST FMP
- XAST DX
- XAST DY
- XBAT FMP
- BSAT Upper
- BSAT Lower
- SS UMP
- SS LMP
- SS FMP
- SS DX
- SS DY
- SonicScope4.75 MP
- SonicScope4.75 QP

New Source Fnct

Delete Source Fnct

Plot Source Fnct

ricker3kHz source

Update

Receiver Array Builder

nRng | nAzi

dRng[m] | dAz[deg]

rng0[m] | azi0[deg]

type | r[m]

Add Receiver Array | zRef[m]

Time Reversal

Frequency Filter

FLow [kHz]

FHigh [kHz]

FilterOrder

Taper Win [ms]

TR Flip

Add Source | Delete Source | Delete All

z [m]	amp	source

Add Receiver | Delete Receiver | Delete All

x [m]	y [m]	z [m]	type (0-6)

Update

EditSourcesReceiversGUI

Tool Configuration

XSI DX

Source Array Builder

nRng	1	nAzi	2
dRng[m]	0	dAzi[deg]	180
rng0[m]	0	azi0[deg]	0
Dipole		r[m]	0.0468
Add Source Array		zRef[m]	0.5

New Source Fnct

Delete Source Fnct

Plot Source Fnct

ricker3kHz.source

Update

Receiver Array Builder

nRng	13	nAzi	8
dRng[m]	0.1524	dAzi[deg]	45
rng0[m]	2.7432	azi0[deg]	0
type	0	r[m]	0.0468
Add Receiver Array		zRef[m]	0.5

Time Reversal

Frequency Filter

FLow [kHz]

FHigh [kHz]

FilterOrder

Taper Win [ms]

TR Flip

Add Source | Delete Source | Delete All

x [m]	y [m]	z [m]	amp	source
0.0469	0	0.5000	1	ricker3kHz.source
-0.0469	0	0.5000	-1	ricker3kHz.source

Add Receiver | Delete Receiver | Delete All

x [m]	y [m]	z [m]	type (0-6)
0.0469	0	3.2432	0
0.0469	0	3.3956	0
0.0469	0	3.5480	0
0.0469	0	3.7004	0
0.0469	0	3.8528	0
0.0469	0	4.0052	0
0.0469	0	4.1576	0
0.0469	0	4.3100	0
0.0469	0	4.4624	0
0.0469	0	4.6148	0
0.0469	0	4.7672	0
0.0469	0	4.9196	0
0.0469	0	5.0720	0
0.0331	0.0331	3.2432	0
0.0331	0.0331	3.3956	0
0.0331	0.0331	3.5480	0
0.0331	0.0331	3.7004	0
0.0331	0.0331	3.8528	0
0.0331	0.0331	4.0052	0
0.0331	0.0331	4.1576	0
0.0331	0.0331	4.3100	0
0.0331	0.0331	4.4624	0

Update

EditSourcesReceiversGUI

Tool Configuration

XSI DX

New Source Fnct

ricker3kHz source

Receiver Array Builder

nRng 13 nAzi 8

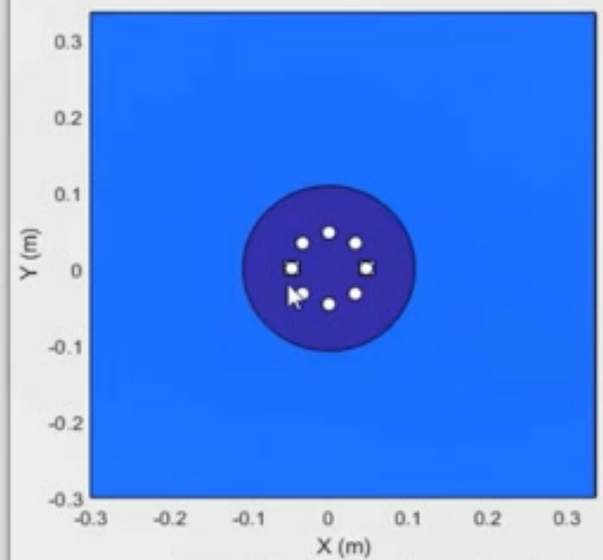
Time Reversal

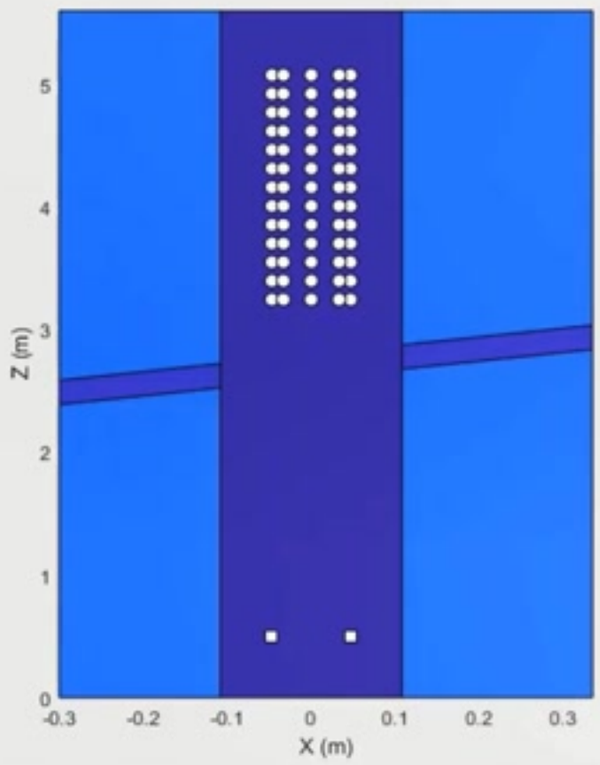
Frequency Filter

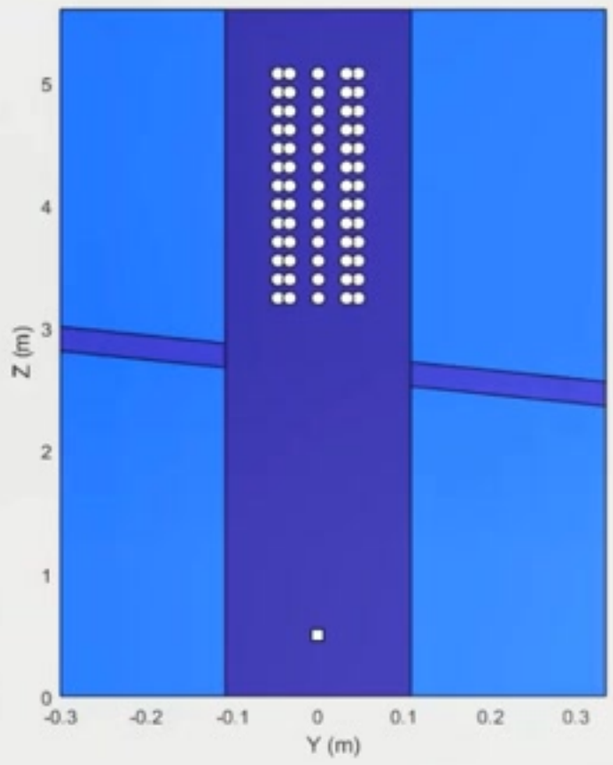
FLow [kHz]

ModelBuilderGUI

File Edit







XMin[m] -0.3 XMax[m] 0.335 dX[mm] 5 nX 128

YMin[m] -0.3 YMax[m] 0.335 dY[mm] 5 nY 128

ZMin[m] 0 ZMax[m] 5.595 dZ[mm] 5 nZ 1120

TMax[ms] 4 dT[us] 0.3 nT 13334

PML

FMax[kHz] 9

UpdateGrid Discretize

Add Holes Grid Show Pixels

Update

EditSlicesGUI

Time Inc:

Update

1x

1x
2x
4x
8x
16x
32x
64x
128x
256x
512x
1024x

New X Slice | Delete | w Y Slice | Delete Y Slice | New Z Slice | Delete Z Slice

x [m]	typ	y [m]	type

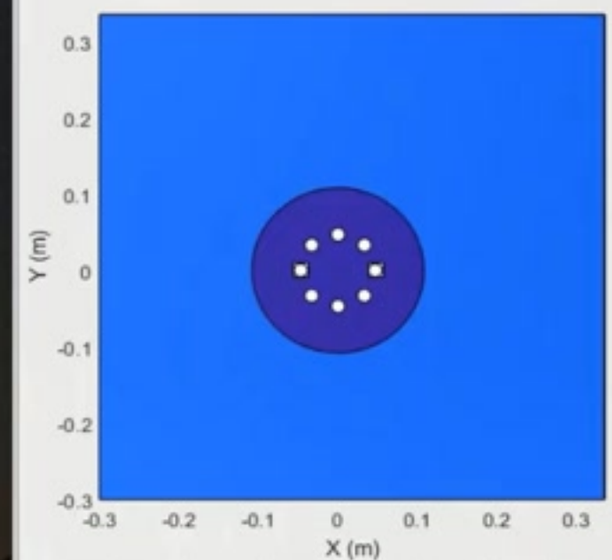
z [m]	type

Sonic3DGUI

Help

ModelBuilderGUI

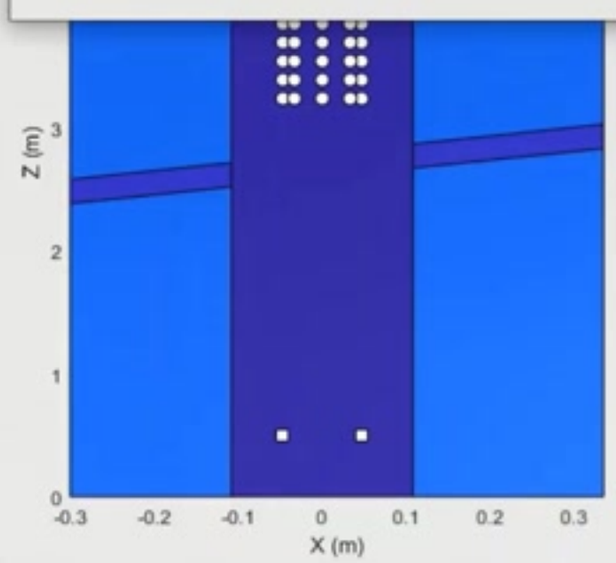
File Edit

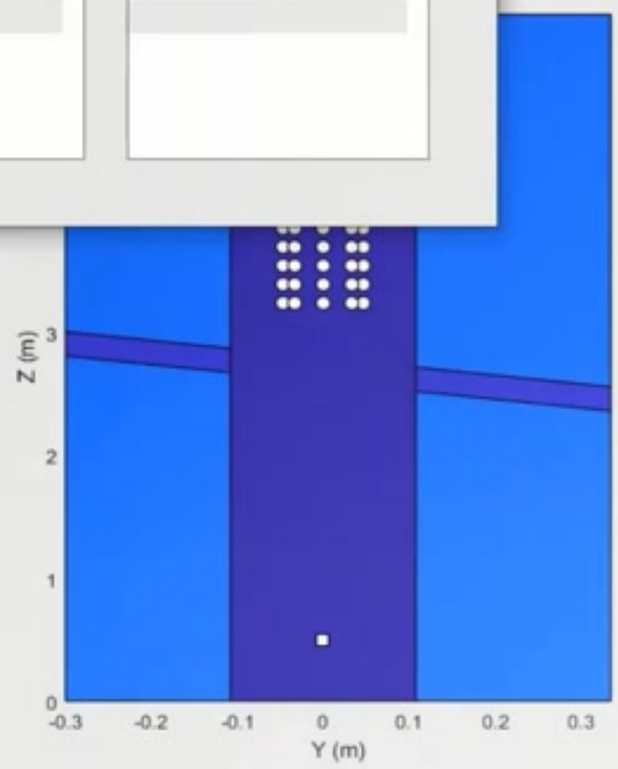


XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120
		TMax[ns]	4	dT[us]	0.3	nT	13334
PML		FMax[kHz]	9				

UpdateGrid | Discretize

Add Holes | Grid | Show Pixels





Update

EditSlicesGUI

Time Inc: 9.6 us

Update

32x

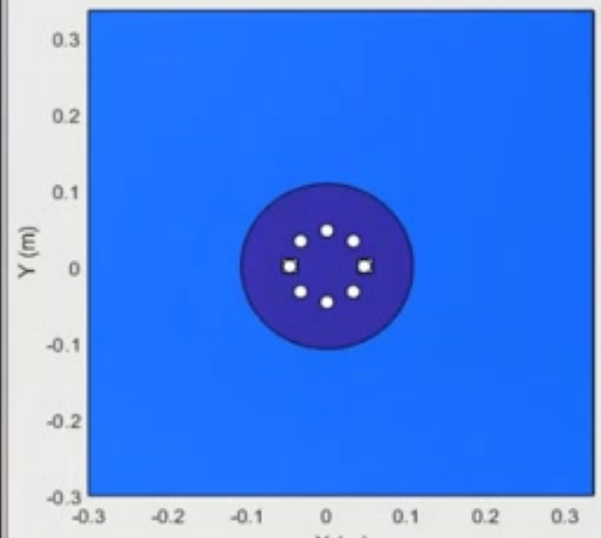
New X Slice | Delete X Slice | New Y Slice | Delete Y Slice | New Z Slice | Delete Z Slice

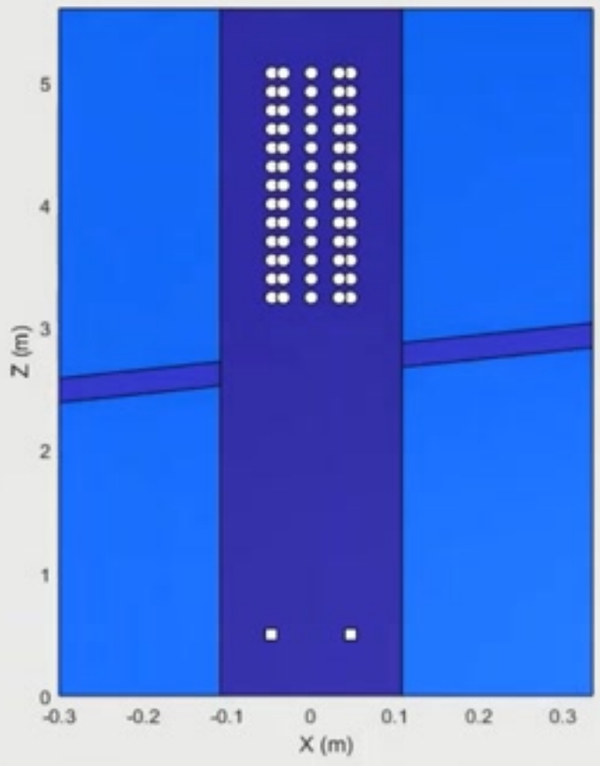
Sonic3DGUI

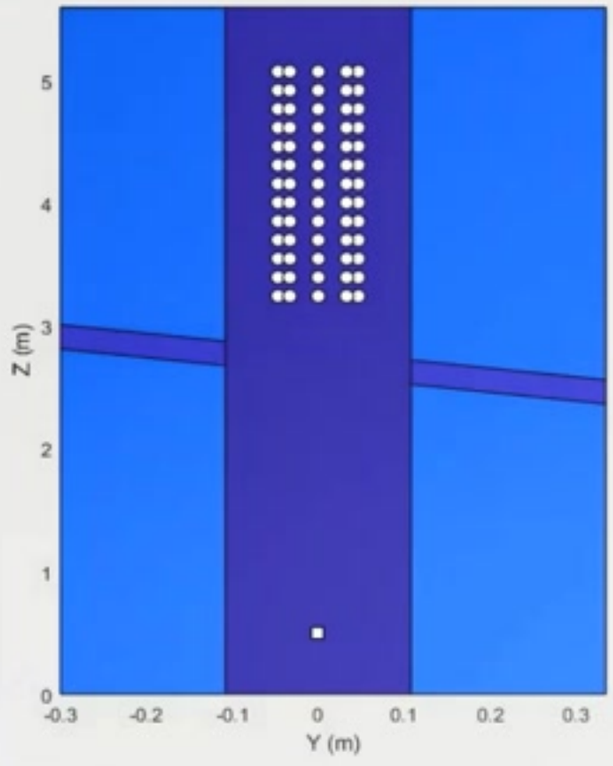
Help

ModelBuilderGUI

File Edit







XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120
		TMax[ms]	4	dT[us]	0.3	nT	13334
PML		FMax[kHz]	9	UpdateGrid		Discretize	

Add Holes | Grid | Show Pixels

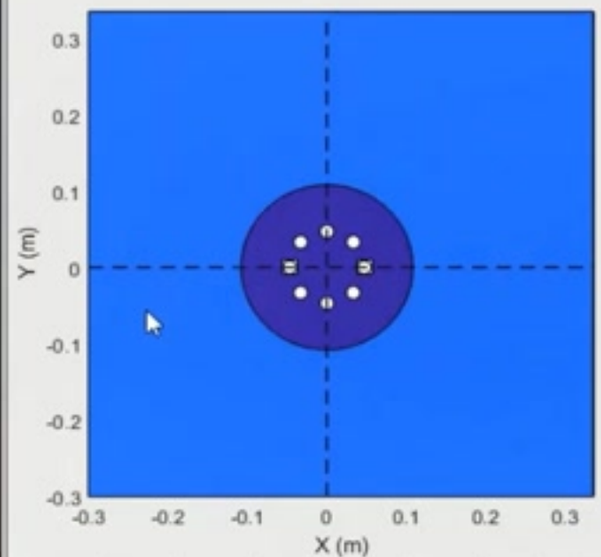
Update

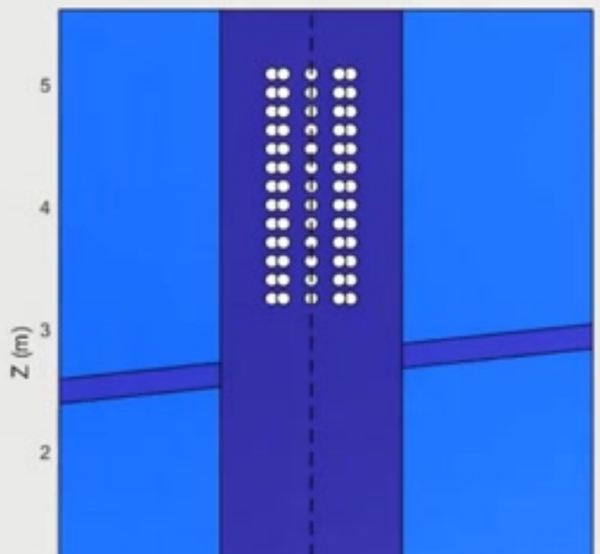
Sonic3DGUI

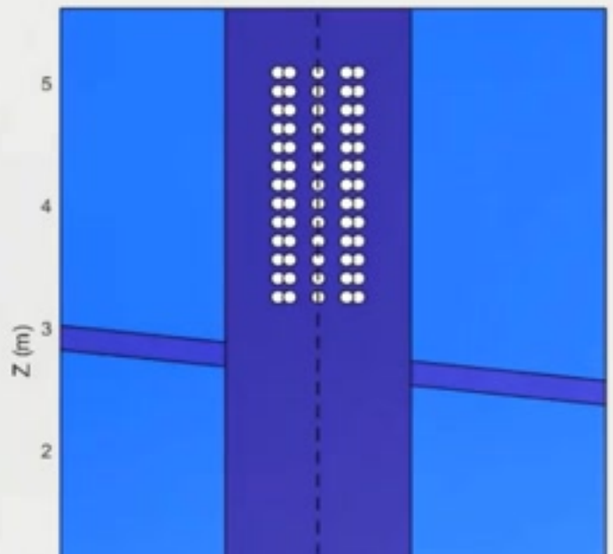
Help

ModelBuilderGUI

File Edit







XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128				
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128				
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120				
		TMax[ms]	4	dT[us]	0.3	nT	13334				
PML		FMax[kHz]	9	UpdateGrid		Discretize					

Add Holes Grid Show Pixels

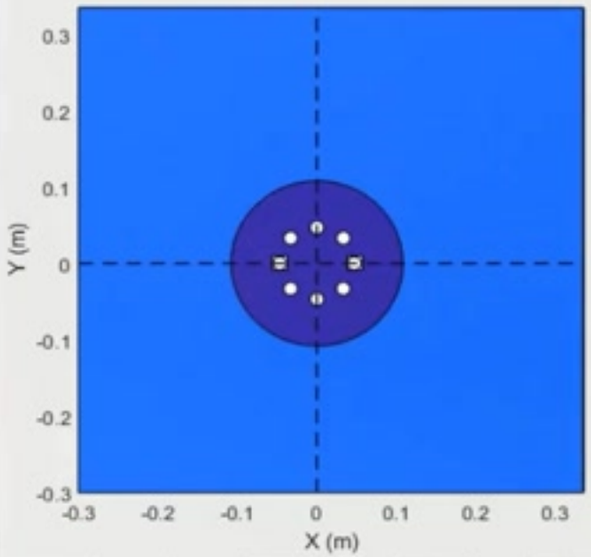
Update

Sonic3DGUI

Help

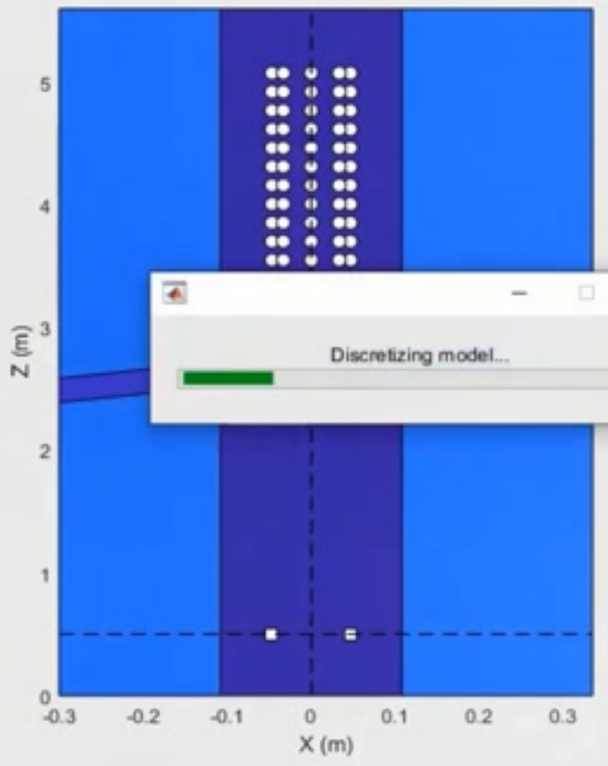
ModelBuilderGUI

File Edit

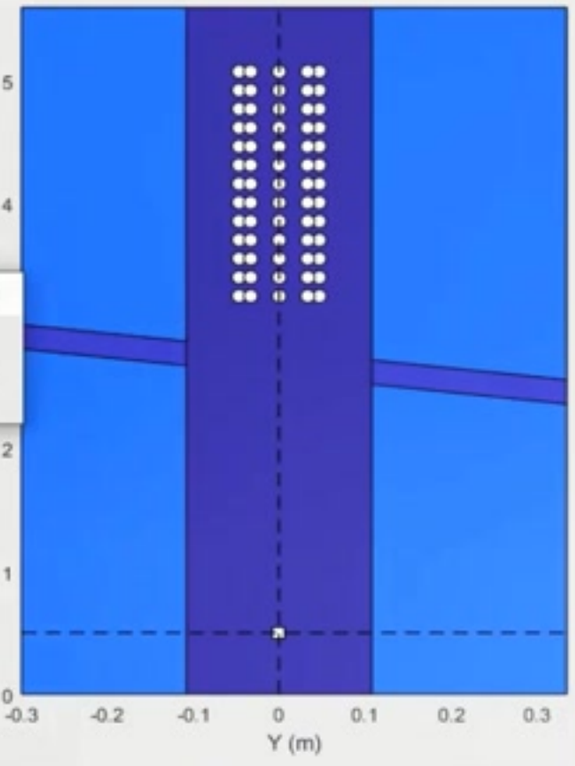


XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120
		TMax[ns]	4	dT[us]	0.3	nT	13334
PML		FMax[kHz]	9	UpdateGrid		Discretize	

Add Holes Grid Show Pixels



Discretizing model...



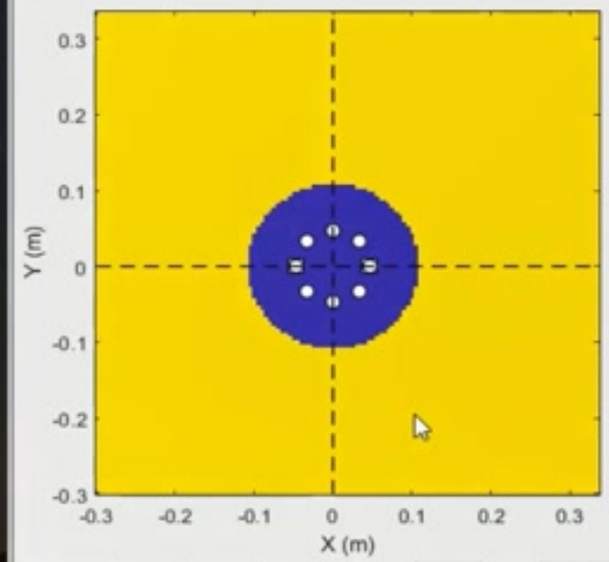
Update

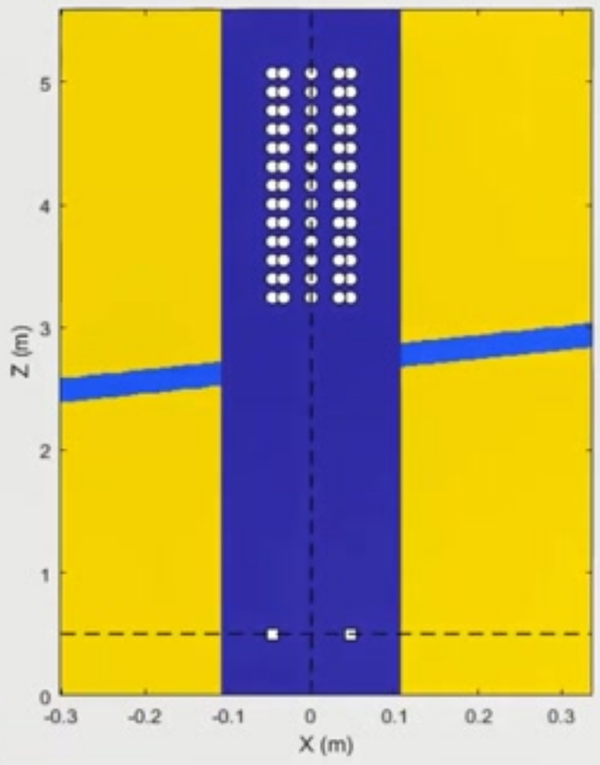
Sonic3DGUI

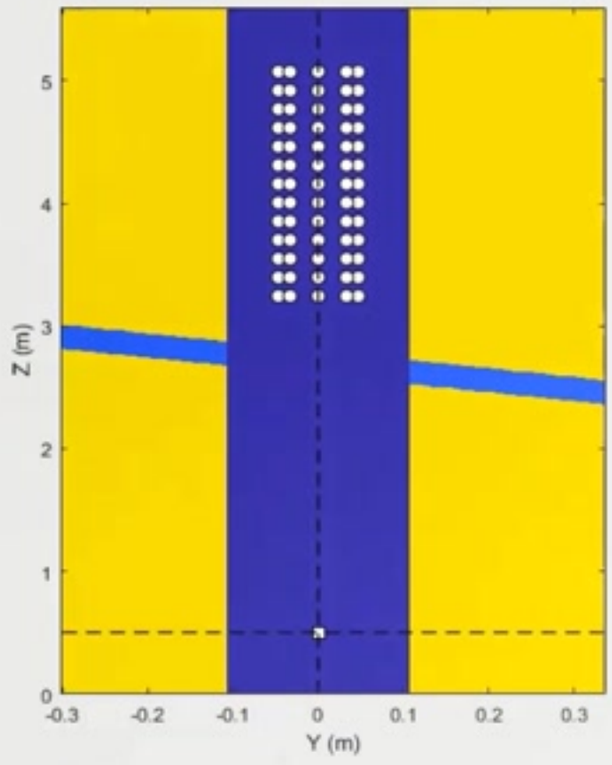
Help

ModelBuilderGUI

File Edit







XMin[m]	-0.3	XMax[m]	0.335	dX[mm]	5	nX	128		
YMin[m]	-0.3	YMax[m]	0.335	dY[mm]	5	nY	128		
ZMin[m]	0	ZMax[m]	5.595	dZ[mm]	5	nZ	1120		
		TMax[ms]	4	dT[us]	0.3	nT	13334		
PML		FMax[kHz]	9	UpdateGrid		Discretize			

Add Holes Grid Show Pixels

Update

Sonic3DGUI

Help

Model Name	Server	Status
model001		Ready to Launch

Control

Set Home | Set Servers

Start VMs | Stop VMs

Home Notes

New Model | Copy Model

Rename Model | Delete Model

Edit Model | Model Notes

Launch | Reset

Terminate | Download

Semblance | Simulation

Wipe Server | Open Directory

Scan Servers | ☐ Monitor

Sonic3DGUI

Help

Model Name	Status
model001	y to Launch

Select Server

Choose server

Ok

Control

Set Home | Set Servers

Start VMs | Stop VMs

Home Notes

New Model | Copy Model

Rename Model | Delete Model

Edit Model | Model Notes

Launch | Reset

Terminate | Download

Semblance | Simulation

Wipe Server | Open Directory

Scan Servers | Monitor

Sonic3DGUI

Help

Model Name	Server	Status
model001	10.70.176.19	Ready to Launch

Launching job. Please be patient...

Control

Set Home | Set Servers

Start VMs | Stop VMs

Home Notes

New Model | Copy Model

Rename Model | Delete Model

Edit Model | Model Notes

Launch | Reset

Terminate | Download

Semblance | Simulation

Wipe Server | Open Directory

Scan Servers | Monitor

Sonic3DGUI

Help

Model Name	Server	Status
model001	10.70.176.19	Working...

Control

Set Home | Set Servers

Start VMs | Stop VMs

Home Notes

New Model | Copy Model

Rename Model | Delete Model

Edit Model | Model Notes

Launch | Reset

Terminate | Download

Semblance | Simulation

Wipe Server | Open Directory

Scan Servers | ☐ Monitor

ReceiverSelectorGUI

Select All | Unselect All | Update

	x [m]	y [m]	z [m]	type (0-6)
☑	0.0469	0	3.2432	0
☑	0.0469	0	3.3956	0
☑	0.0469	0	3.5480	0
☑	0.0469	0	3.7004	0
☑	0.0469	0	3.8528	0
☑	0.0469	0	4.0052	0
☑	0.0469	0	4.1576	0
☑	0.0469	0	4.3100	0
☑	0.0469	0	4.4624	0
☑	0.0469	0	4.6148	0
☑	0.0469	0	4.7672	0
☑	0.0469	0	4.9196	0
☑	0.0469	0	5.0720	0
☑	0.0331	0.0331	3.2432	0
☑	0.0331	0.0331	3.3956	0
☑	0.0331	0.0331	3.5480	0
☑	0.0331	0.0331	3.7004	0
☑	0.0331	0.0331	3.8528	0
☑	0.0331	0.0331	4.0052	0
☑	0.0331	0.0331	4.1576	0

	Server	Status
		Downloaded, complete

Control

Set Home | Set Servers
Start VMs | Stop VMs
Home Notes

New Model | Copy Model
Rename Model | Delete Model

Edit Model | Model Notes

Launch | Reset
Terminate | Download

Semblance | Simulation

Wipe Server | Open Directory
Scan Servers | ☑ Monitor

SimulationGUI

File

Slice Selector XY: z = 0.500 m...

Slice Selector XZ: y = 0.000 m...

Slice Selector YZ: x = 0.000 m...

Y (m)

X (m)

Z (m)

X (m)

Z (m)

Y (m)

$\times 10^{-6}$

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC

2 FPS

Make Movie

Image

Time [ms] 0.0096

Display Gain 1.5

Set Servers

Stop VMs

Copy Model

Delete Model

Model Notes

Reset

Download

Simulation

Open Directory

Monitor

ReceiverSelectorGUI

Select All | Unselect All | Update

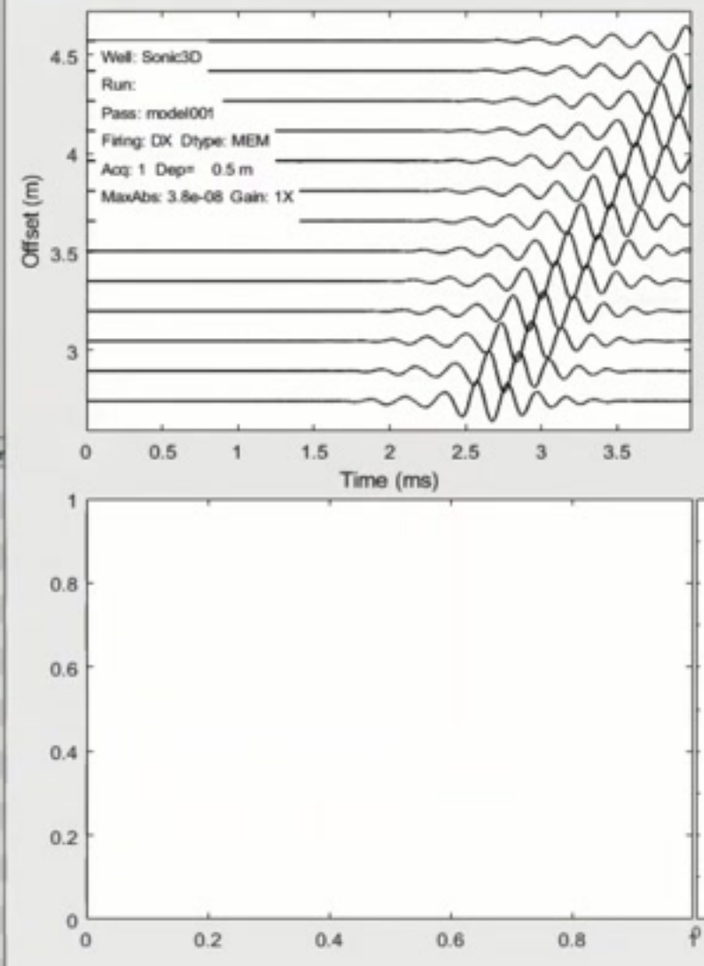
x [m]	y [m]	z [m]
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	

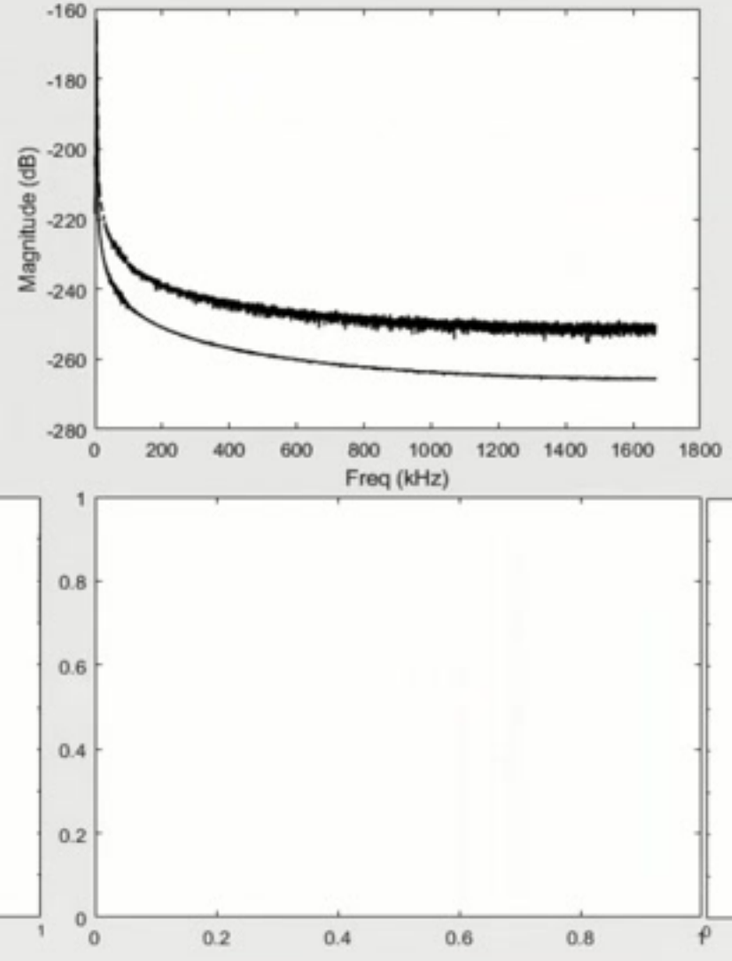
Slice Selector XZ: x = 0.000 m

Slice Selector YZ: x = 0.000 m

SemblanceGUI

File Help





Firing Type: Dipole | Dipo... | Compl... | iDe 1

Waveform Filtering: No Filter | Min Phase | FFiltMin[kHz] 0.5 | FFiltMax[kHz] 25 | Noise[dB] -80 | NTaps -67

Semblance

TSembMax[ms]	4	Array	1:13 - 1.8288 m
TSembMin[ms]	0		
NSmoothWin[ms]	0.3	Time Method	DPTS-I
FSembMax[kHz]	10		
FSembMin[kHz]	0.5	Freq Method	DPFS
NSmoothWin[kHz]	0.3		
NPadFactor	2		
SSembMax[usp/f]	350		
SSembMin[usp/f]	40	Compute Semblance	
dS[usp/f]	2		

Display

T[ms]	0	3.99	Display Gain	1
O[ft]	2.5908	4.7244		
F[kHz]	0.5	10	RSlow[usp/f]	0
A[dB]	-100	20	AGC[ms]	0
S[usp/f]	40	350	Legend / Grids / Zoom / Hold	
CohMin	0.2			
AMin[dB]	-20		Disp Curve Pts	k-
			Disp Curve Pts	ko

Phase | ShowDispPts | SaveDispPts

Clear Disp | Pick Disp

ReceiverSelectorGUI

Select All | Unselect All | Update

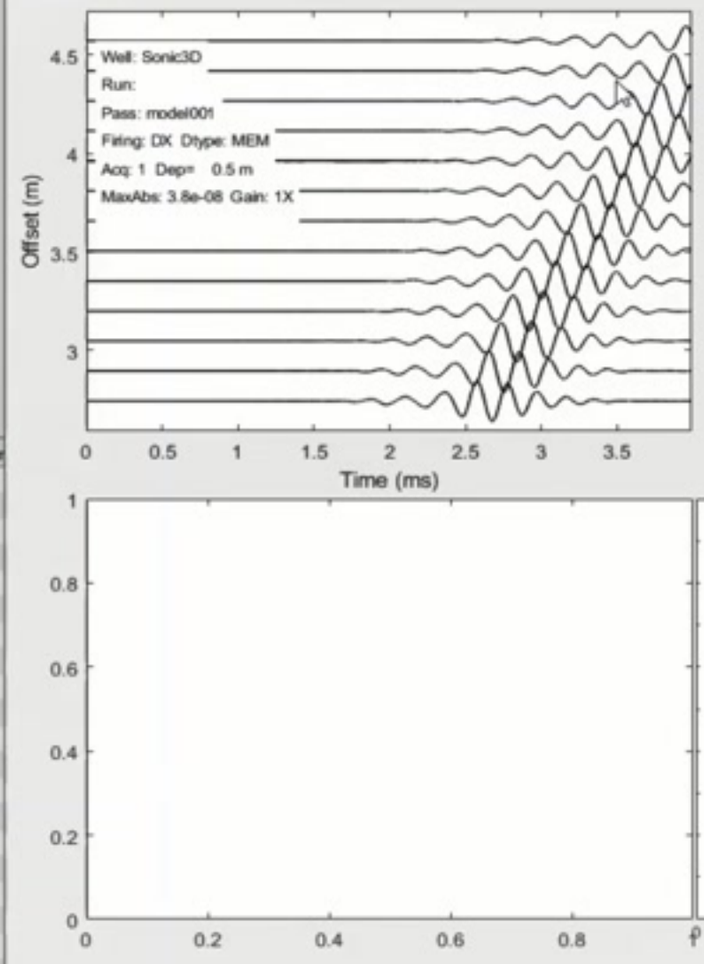
x [m]	y [m]	z [m]
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0469	0	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	
0.0331	0.0331	

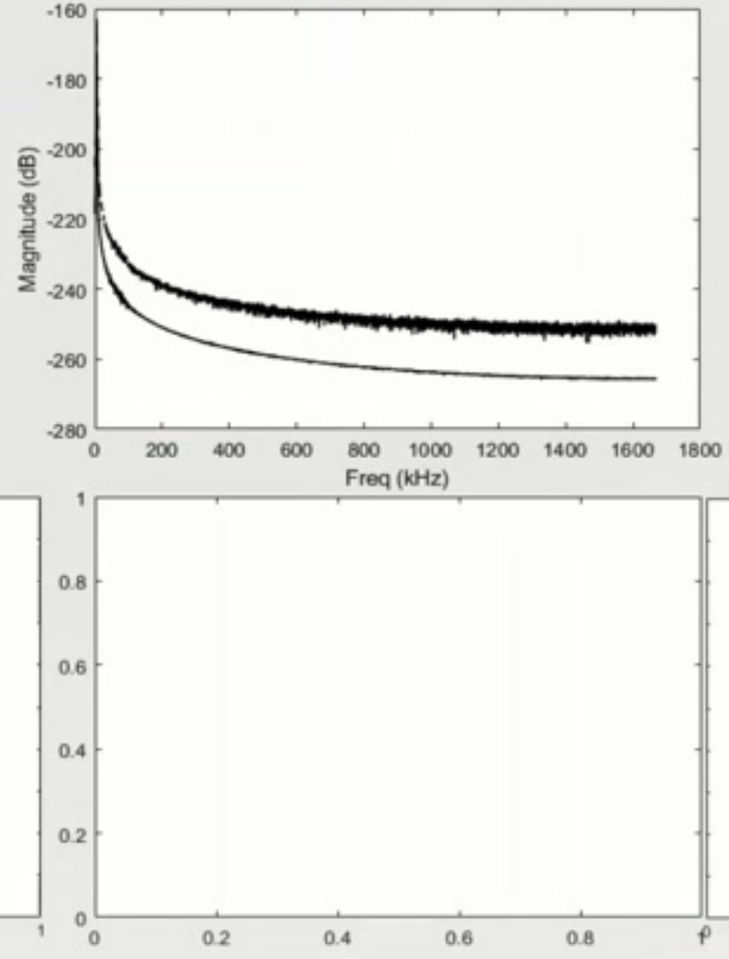
Slice Selector XZ: x = 0.000 m

Slice Selector YZ: x = 0.000 m

SemblanceGUI

File Help





Firing Type: Dipole | Decon | Compl | iDe 1

Waveform Filtering: No Filter | Min Phase | FFiltMin[kHz] 0.5 | FFiltMax[kHz] 25 | Noise[dB] -80 | NTaps -67

Semblance

TSembMax[ms]	4	Array	1:13 - 1.8288 m
TSembMin[ms]	0		
NSmoothWin[ms]	0.3	Time Method	DPTS-I
FSembMax[kHz]	10		
FSembMin[kHz]	0.5	Freq Method	DPFS
NSmoothWin[kHz]	0.3		
NPadFactor	2		
SSembMax[uspf]	350		
SSembMin[uspf]	40		Compute Semblance
dS[uspf]	2		

Display

T[ms]	0	3.99	Display Gain	1
O[ft]	2.5908	4.7244		
F[kHz]	0.5	10	RSlow[uspf]	0
A[dB]	-100	20	AGC[ms]	0
S[uspf]	40	350	Legend / Grids / Zoom / Hold	
CohMin	0.2			
AMin[dB]	-20		Disp Curve Pts	k-
			Disp Curve Pts	ko
Phase			ShowDispPts / SaveDispPts	

Clear Disp | Pick Disp

SimulationGUI

File

Slice Selector XY: z = 0.500 m

Slice Selector XZ: y = 0.000 m

Slice Selector YZ: x = 0.000 m

Y (m)

X (

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC

2 FPS

Make Movie

0.0469	0
0.0331	0.0331
0.0331	0.0331
0.0331	0.0331
0.0331	0.0331
0.0331	0.0331
0.0331	0.0331
0.0331	0.0331

SemblanceGUI

File Help

Well: Sonic3D
Run:
Pass: model001
Fltng: DX Dtype: MEM
Acq: 1 Dep= 0.5 m
MaxAbs: 3.8e-08 Gain: 1X

Offset (m)

Time (ms)

Magnitude (dB)

Freq (kHz)

Firing Type

Dipole

Dipo...

Compl...

iDe 1

Waveform Filtering

No Filter FFiltMin[kHz] 0.5

Min Phase FFiltMax[kHz] 25

Noise[dB] -80 NTaps -67

Semblance

TSembMax[ms]	4
TSembMin[ms]	0
NSmoothWin[ms]	0.3
FSembMax[kHz]	10
FSembMin[kHz]	0.5
NSmoothWin[kHz]	0.3
NPadFactor	2
SSembMax[usp/f]	350
SSembMin[usp/f]	40
dS[usp/f]	2

Array: 1:13 - 1.8288 m

Time Method: DPTS-I

Freq Method: DPFS

Compute Semblance

Display

T[ms]	0	3.99
O[ft]	2.5908	4.7244
F[kHz]	0.5	10
A[dB]	-100	20
S[usp/f]	40	350
CohMin	0.2	
AMin[dB]	-20	

Display Gain 1

RSlow[usp/f] 0

AGC[ms] 0

Legend Grids

Zoom Hold

Disp Curve Pts k-

Disp Curve Pts ko

Phase

ShowDispPts

SaveDispPts

Clear Disp Pick Disp

SimulationGUI

File

Slice Selector XY: z = 0.500 m...

Slice Selector XZ: y = 0.000 m...

Slice Selector YZ: x = 0.000 m...

Y (m)

X (m)

Z (m)

X (m)

Z (m)

Y (m)

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC
- FPS: 2

Make Movie

Image

Time [ms]: 0.0096

Display Gain: 2.7

Waveform Filtering

- No Filter
- Min Phase
- FFiltMin[kHz]: 0.5
- FFiltMax[kHz]: 25
- Noise[dB]: -80
- NTaps: -67

Array: 1:13 - 1.8288 m

Time Method: DPTS-I

Freq Method: DPFS

Compute Semblance

Display Gain: 1

RSlow[uspf]: 0

AGC[ms]: 0

Legend
Grids
Zoom
Hold

Disp Curve Pts: k-

Disp Curve Pts: ko

Phase

ShowDispPts
SaveDispPts

Clear Disp

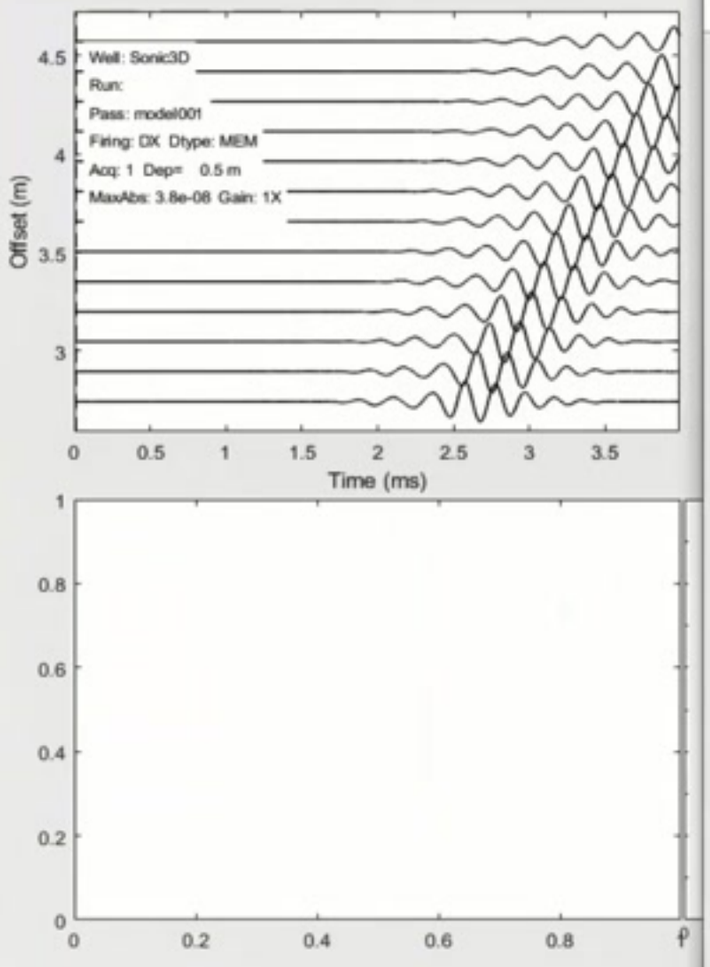
Pick Disp

ReceiverSelectorGUI

Select All | Unselect All | Update

SemblanceGUI

File Help

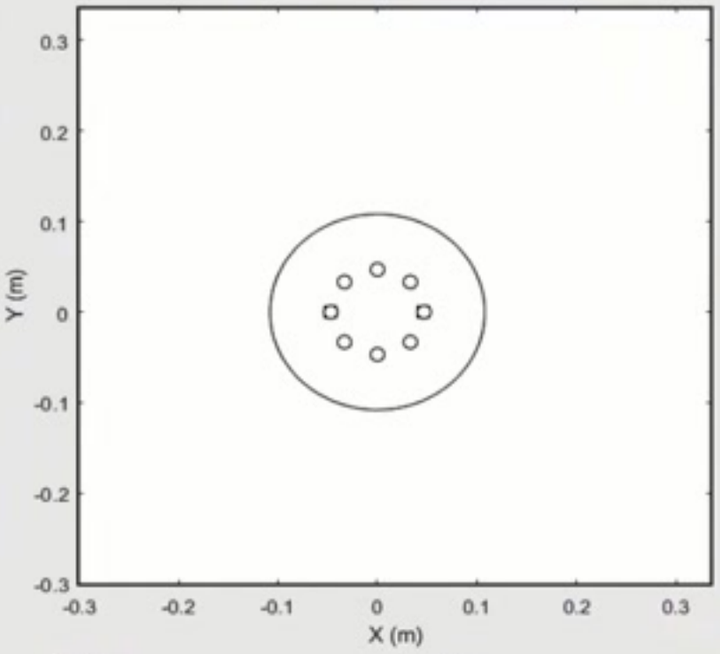


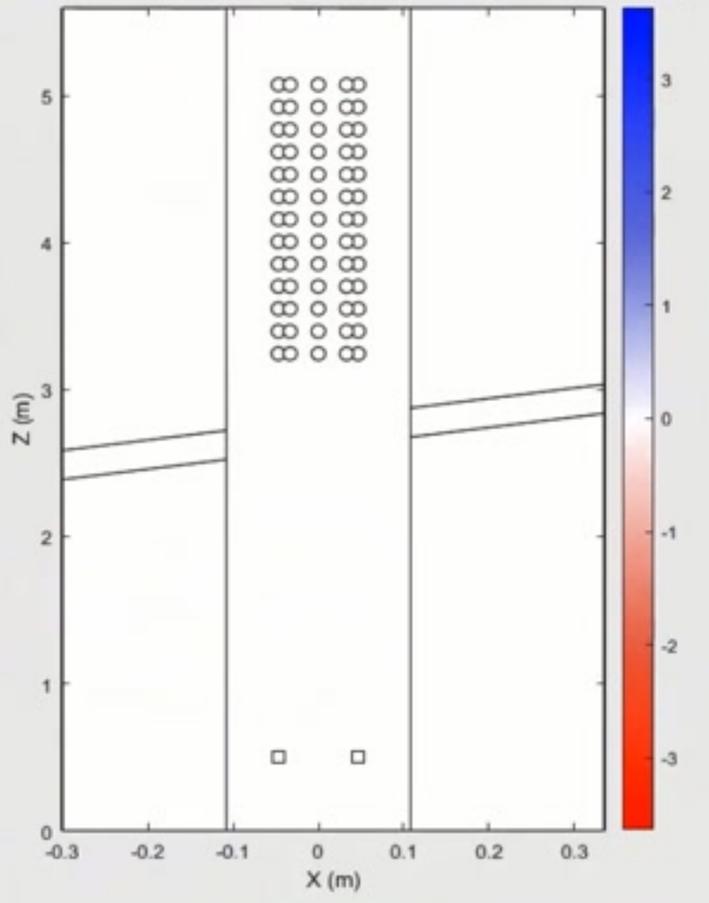
SimulationGUI

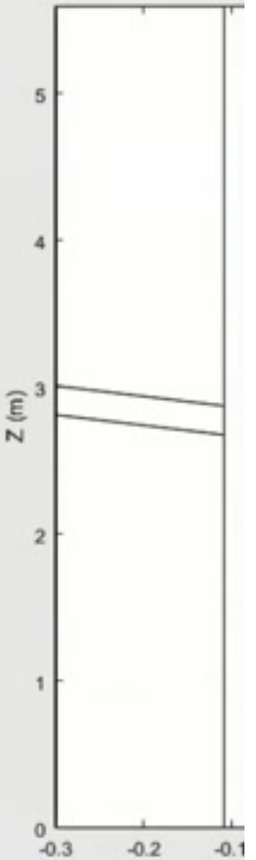
File

Slice Selector XY: z = 0.500 m, pr

Slice Selector XZ: y = 0.000 m, pr







View

- [x] Receivers
- [x] Sources
- [x] Model Edges
- [ ] Slice Lines
- [ ] Auto Advance
- [x] Time Line
- [ ] Pixels
- [ ] Zoom
- [ ] AGC

2 FPS

Make Movie

Image

Time [ms] 0.0096

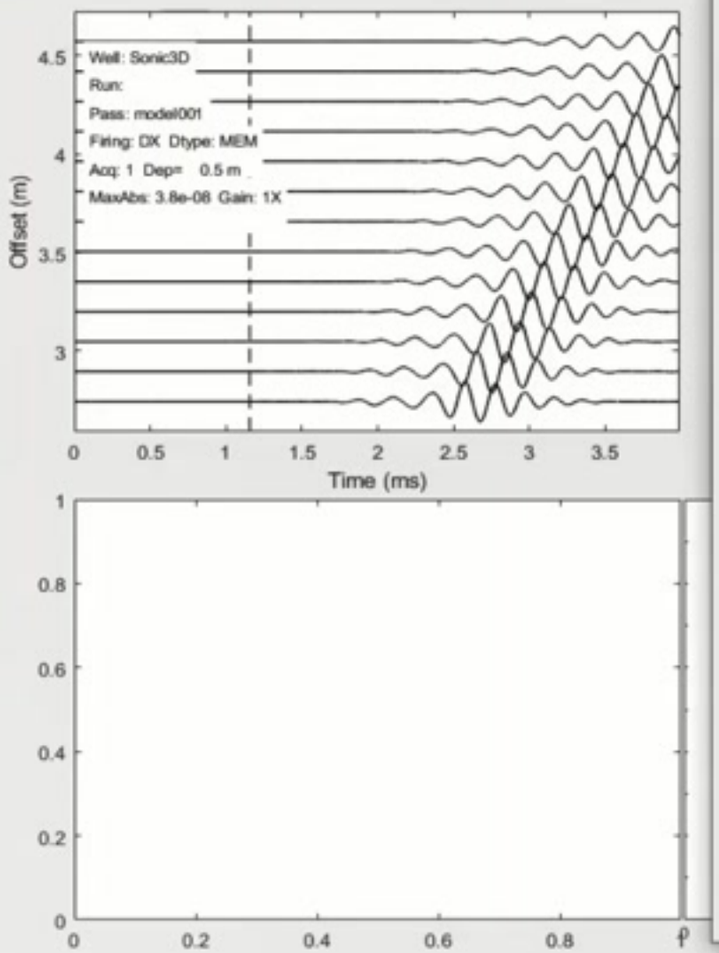
Display Gain 2.1

ReceiverSelectorGUI

Select All | Unselect All | Update

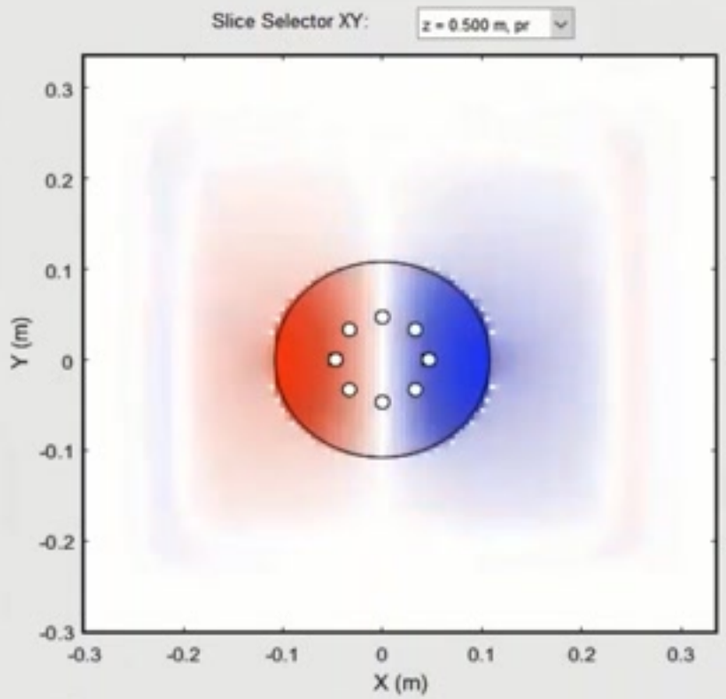
SemblanceGUI

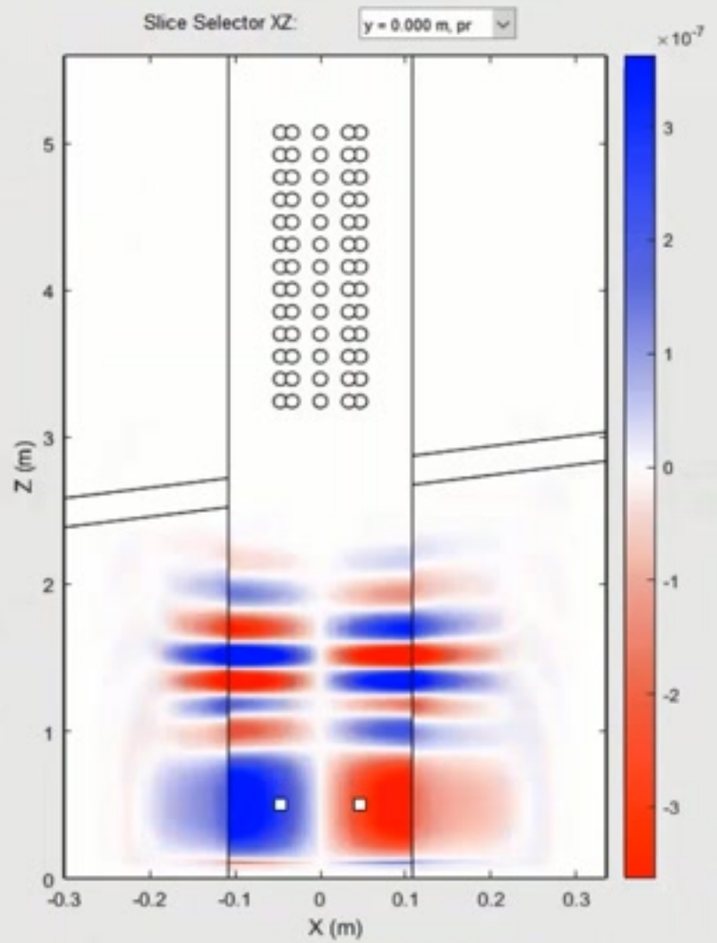
File Help

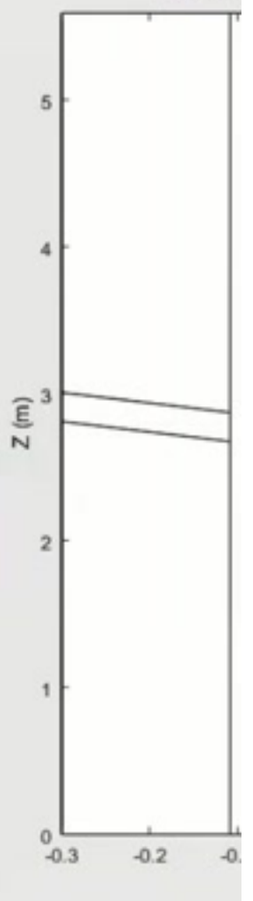


SimulationGUI

File







View

- [x] Receivers
- [x] Sources
- [x] Model Edges
- [ ] Slice Lines
- [ ] Auto Advance
- [x] Time Line
- [ ] Pixels
- [ ] Zoom
- [ ] AGC

2 FPS

Make Movie

Image

Time [ms] 1.2717

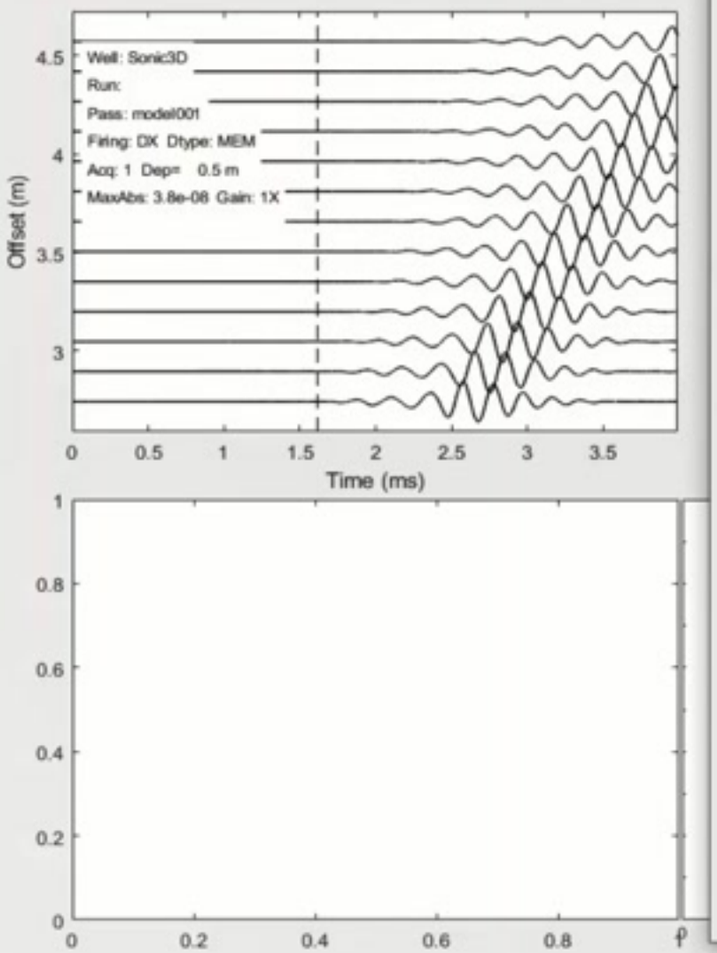
Display Gain 2.1

ReceiverSelectorGUI

Select All | Unselect All | Update

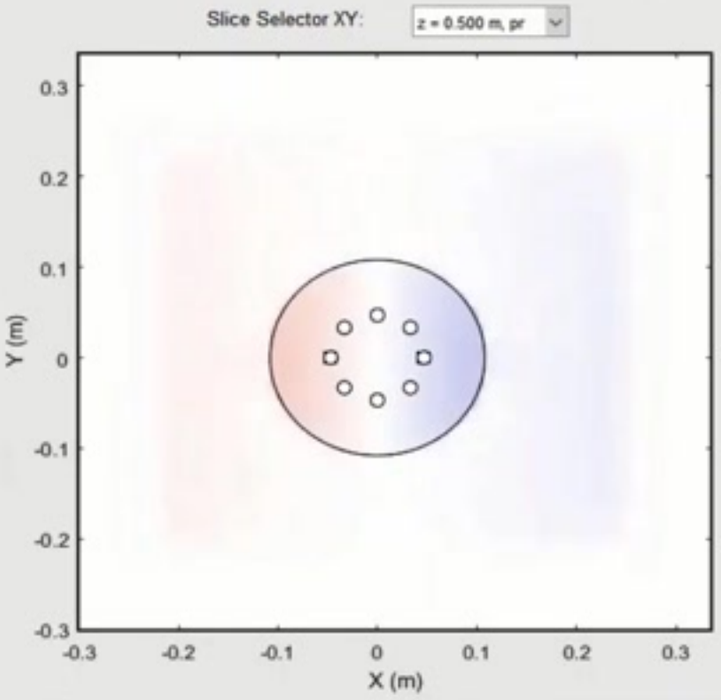
SemblanceGUI

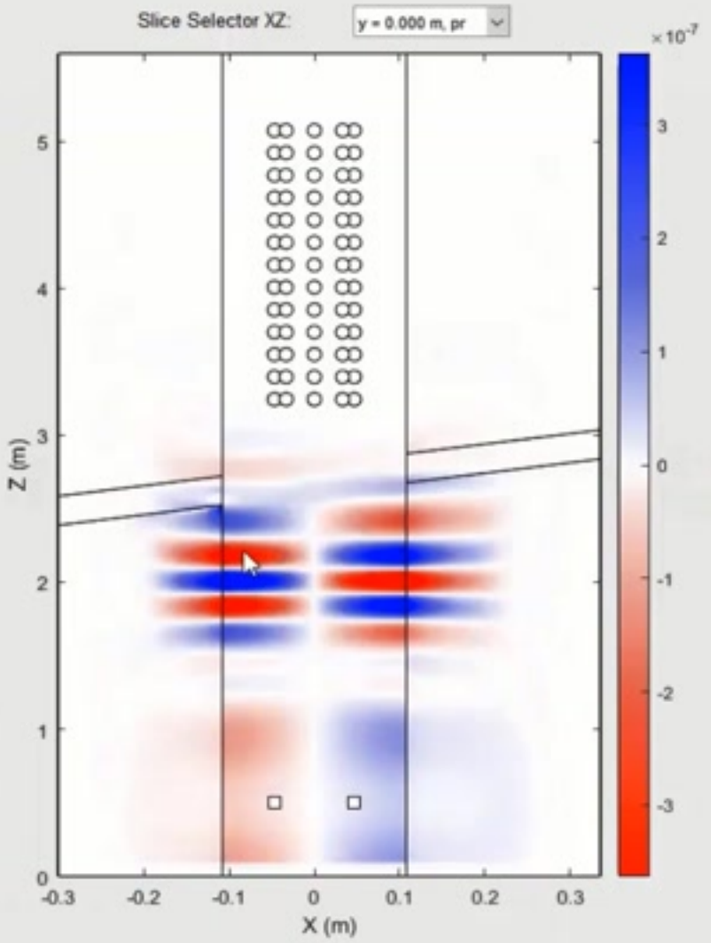
File Help



SimulationGUI

File





Slice Selec

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC
- 2 FPS

Make Movie

Image

Time [ms] 1.6159

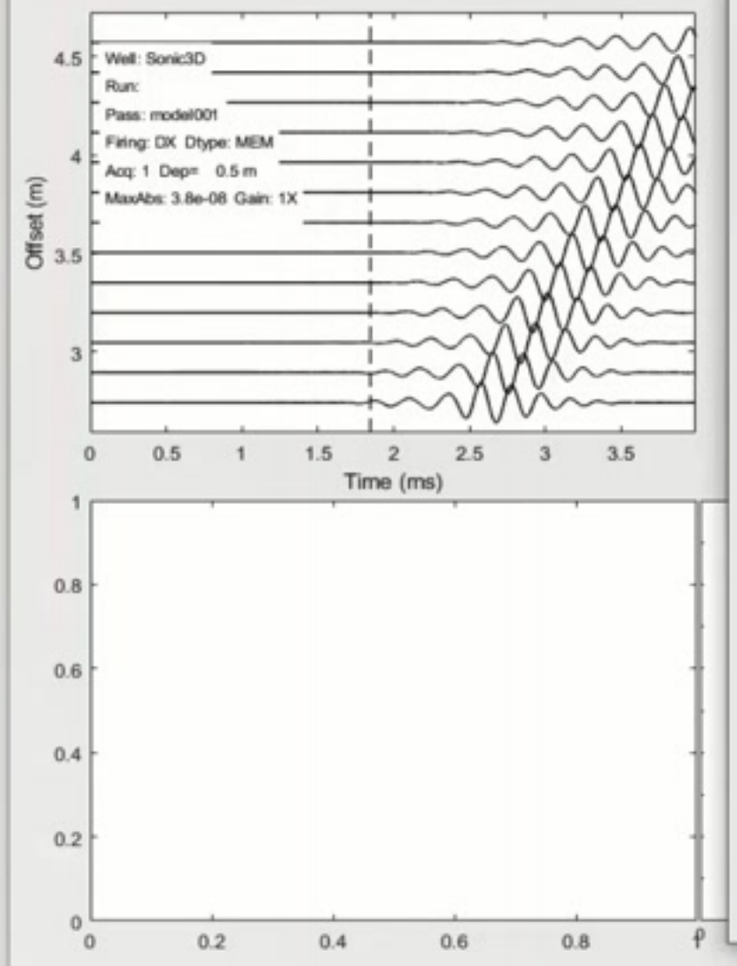
Display Gain 2.1

ReceiverSelectorGUI

Select All | Unselect All | Update

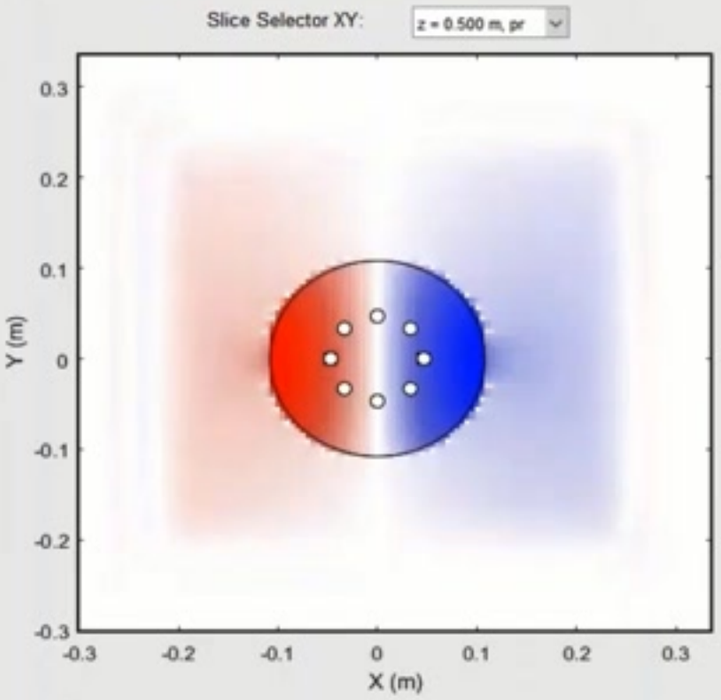
SemblanceGUI

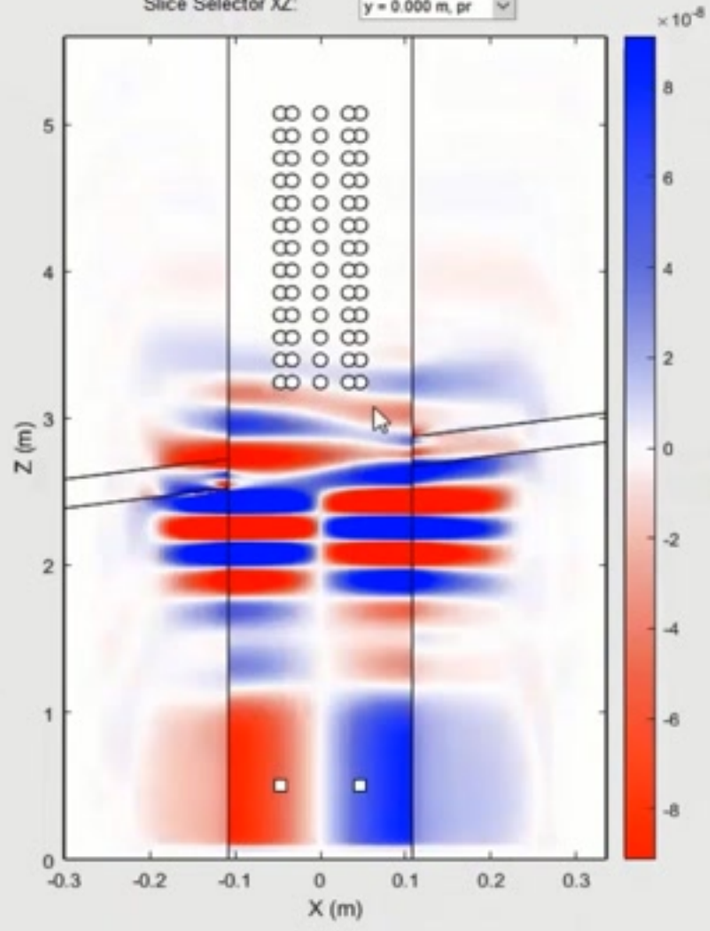
File Help

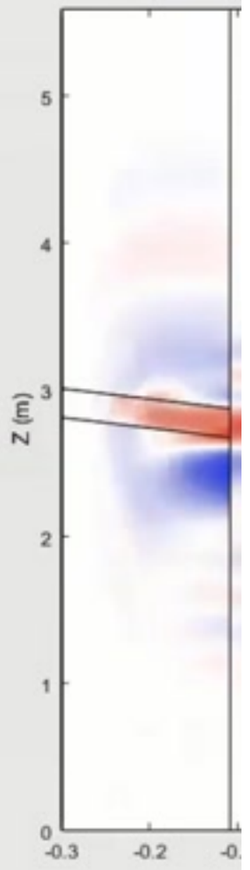


SimulationGUI

File







View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC
- 2 FPS
- Make Movie

Image

Time [ms] 1.8454

Display Gain 2.7

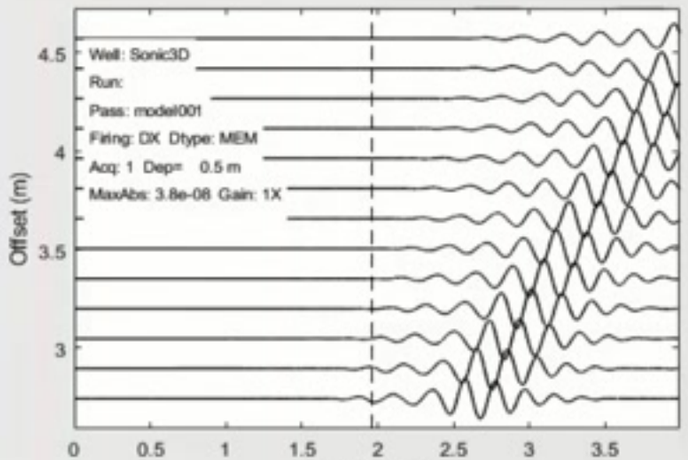
ReceiverSelectorGUI

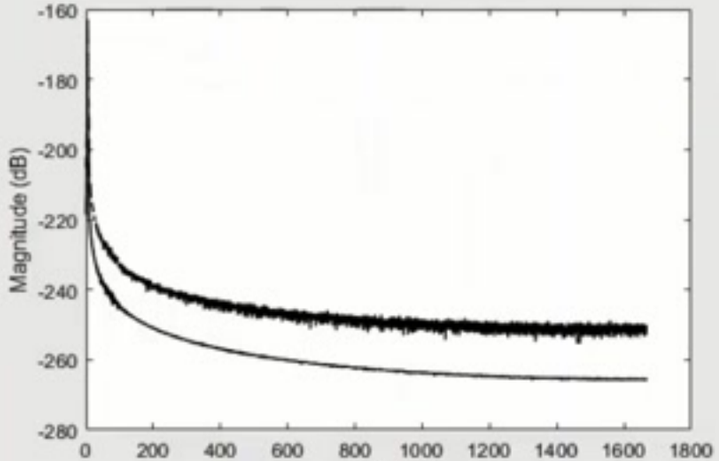
Select All | Unselect All | Update

SimulationGUI

SemblanceGUI

File Help

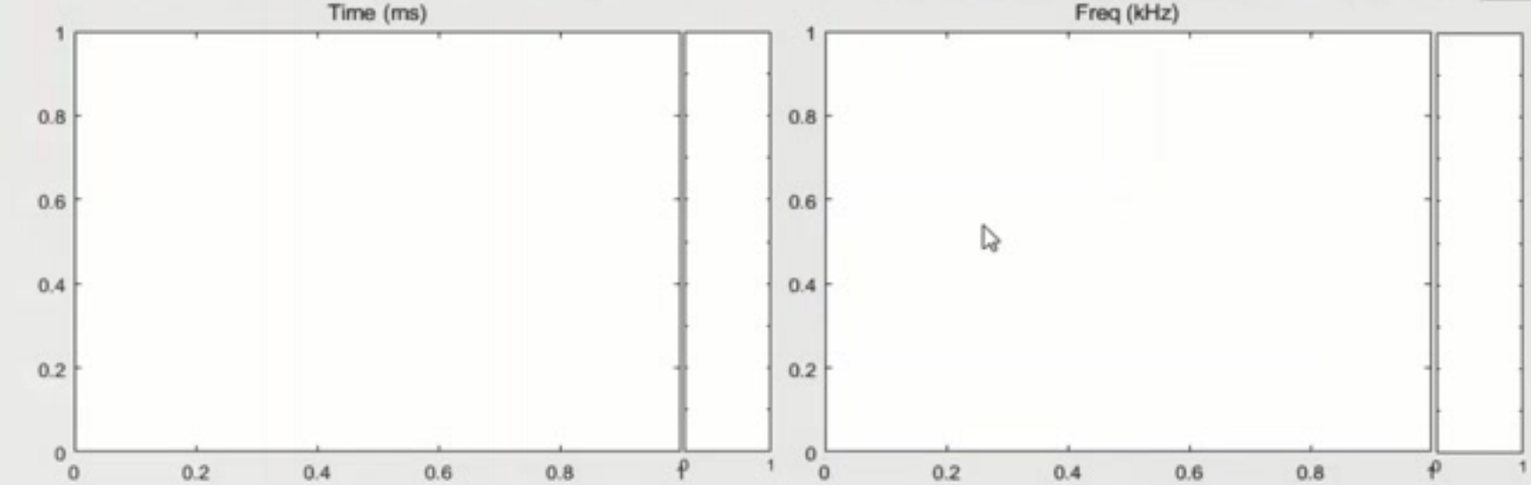




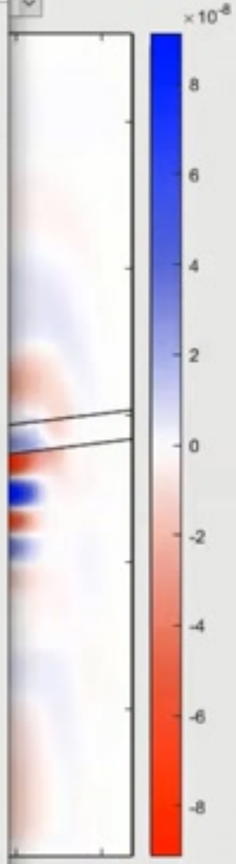
Firing Type: Dipole; Deco.; Compl.; iDe 1

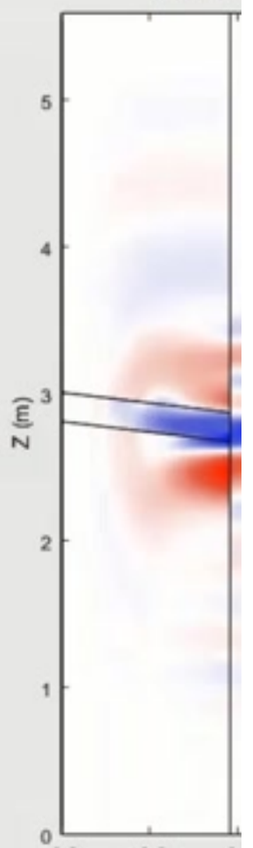
Waveform Filtering: No Filter; Min Phase; FFiltMin[kHz] 0.5; FFiltMax[kHz] 25; Noise[dB] -80; NTaps 67

Semblance: TSembMax[ms] 4; TSembMin[ms] 0; NSmoothWin[ms] 0.3; FSembMax[kHz] 10; FSembMin[kHz] 0.5; NSmoothWin[kHz] 0.3; NPadFactor 2; SSembMax[uspf] 350; SSembMin[uspf] 40; dS[uspf] 2; Array 1:13 - 1.8288 m; Time Method DPTS-I; Freq Method DPFS; Compute Semblance



Display: T[ms] 0 3.99; O[ft] 2.5908 4.7244; Display Gain 1; F[kHz] 0.5 10; A[dB] -100 20; RSlow[uspf] 0; AGC[ms] 0; S[uspf] 40 350; Legend; Grids; Zoom; Hold; CohMin 0.2; AMin[dB] -20; Disp Curve Pts k-; Disp Curve Pts ko; Phase; ShowDispPts; SaveDispPts; Clear Disp; Pick Disp





ReceiverSelectorGUI

Select All | Unselect All | Update

SemblanceGUI

File Help

Well: Sonic3D
Run:
Pass: model001
Firing: DX Dtype: MEM
Acq: 1 Dep= 0.5 m
MaxAbs: 1.7e-07 Gain: 1X

Offset (m)

Time (ms)

Slowness (uspf)

Time (ms)

SimulationGUI

File

Slice Selector XY: z = 0.500 m, pr

Y (m)

X (m)

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC

2 FPS

Make Movie

Image

Time [ms] 1.9602

Display Gain 2.7

Slice Selector XZ: y = 0.000 m, pr

Z (m)

X (m)

Slice Selec

Z (m)

Coh

Freq (kHz)

Coh

ReceiverSelectorGUI

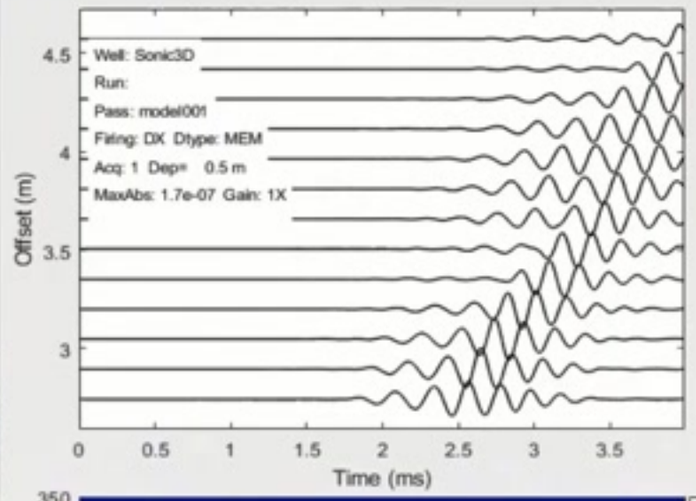
Select All | Unselect All | Update

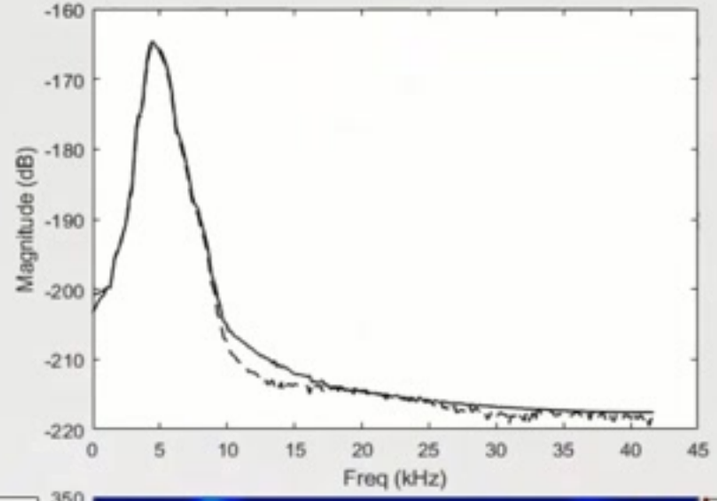
SimulationGUI

File

SemblanceGUI

File Help





Firing Type: Dipole; Deco...; Compl...; fDe 40.0

Waveform Filtering: No Filter; Min Phase; FFiltMin[kHz] 0.5; FFiltMax[kHz] 25; Noise[dB] -80; NTaps -67

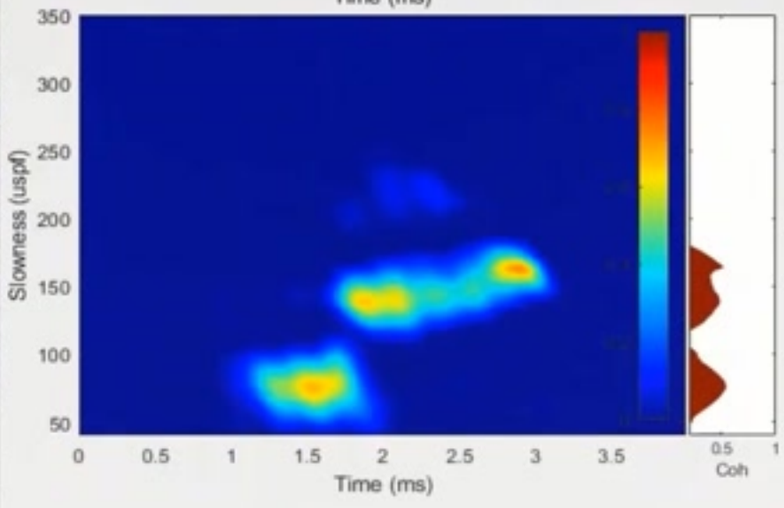
Semblance: TSembMax[ms] 4; TSembMin[ms] 0; NSmoothWin[ms] 0.3; FSembMax[kHz] 10; FSembMin[kHz] 0.5; NSmoothWin[kHz] 0.3; NPadFactor 2; SSembMax[uspf] 350; SSembMin[uspf] 40; dS[uspf] 2

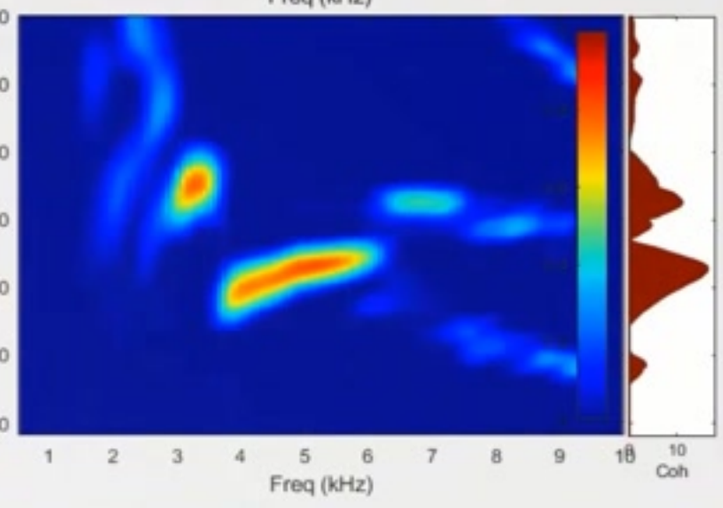
Array: 1:13 - 1.8288 m

Time Method: DPTS-I

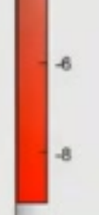
Freq Method: DPFS

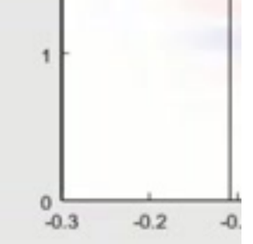
Compute Semblance





Display: T[ms] 0 3.99; O[ft] 2.5908 4.7244; Display Gain 1; F[kHz] 0.5 10; A[dB] -100 20; RSlow[uspf] 0; AGC[ms] 0; S[uspf] 40 350; CohMin 0.2; AMin[dB] -20; Legend; Grids; Zoom; Hold; Disp Curve Pts k-; Disp Curve Pts ko; Phase; ShowDispPts; SaveDispPts; Clear Disp; Pick Disp





ReceiverSelectorGUI

Select All | Unselect All | Update

SemblanceGUI

File Help

Well: Sonic3D
Run:
Pass: model001
Firing: DX Dtype: MEM
Acq: 1 Dep= 0.5 m
MaxAbs: 1.7e-07 Gain: 1X

Offset (m)

Time (ms)

Slowness (usp/f)

Time (ms)

Magnitude (dB)

Coh

Freq (kHz)

Coh

SimulationGUI

File

Slice Selector XY: z = 0.500 m, pr

Y (m)

X (m)

Slice Selector XZ: y = 0.000 m, pr

Z (m)

X (m)

Slice

Z (m)

View

- Receivers
- Sources
- Model Edges
- Slice Lines
- Auto Advance
- Time Line
- Pixels
- Zoom
- AGC
- 2 FPS

Make Movie

Image

Time [ms] 2.3044

Display Gain 2.7

Clear Disp | Pick Disp

ReceiverSelectorGUI

Select

SimulationGUI

File

Slice Selector XY: z = 0.500 m, pr

Slice Selector XZ: y = 0.000 m, pr

Slice Selector YZ: x = 0.000 m, pr

SemblanceGUI

File Help

Well: So

Run:

Pass: m

Firing: D

Acq: 1

MaxAbs:

Offset (m)

Y (m)

X (m)

Z (m)

Slowness (uspf)

Time (ms)

Freq (kHz)

Coh

View

Receivers

Sources

Model Edges

Slice Lines

Auto Advance

FPS

Make Movie

Time Line

Pixels

Zoom

AGC

Image

Time [ms]

2.5339

Display Gain

2.7

SaveDispPts

Clear Disp

Pick Disp

MATLAB Specific Development Notes

- Sonic3D GUI developed with GUIDE
- GUIDE being replaced by App Designer
- Both are feature rich
- Both are easy to use and expand upon, but I've found App Designer to be much easier to use
- App Designer's responsiveness is faster than GUIDE's
- App Designer has buttons to:
  - Convert to a stand-alone *.exe
  - Deploy the GUI to a VM as a "Web App"
- Pluses of using App Designer grossly outweigh those for GUIDE

© 2019 Chevron

Chevron