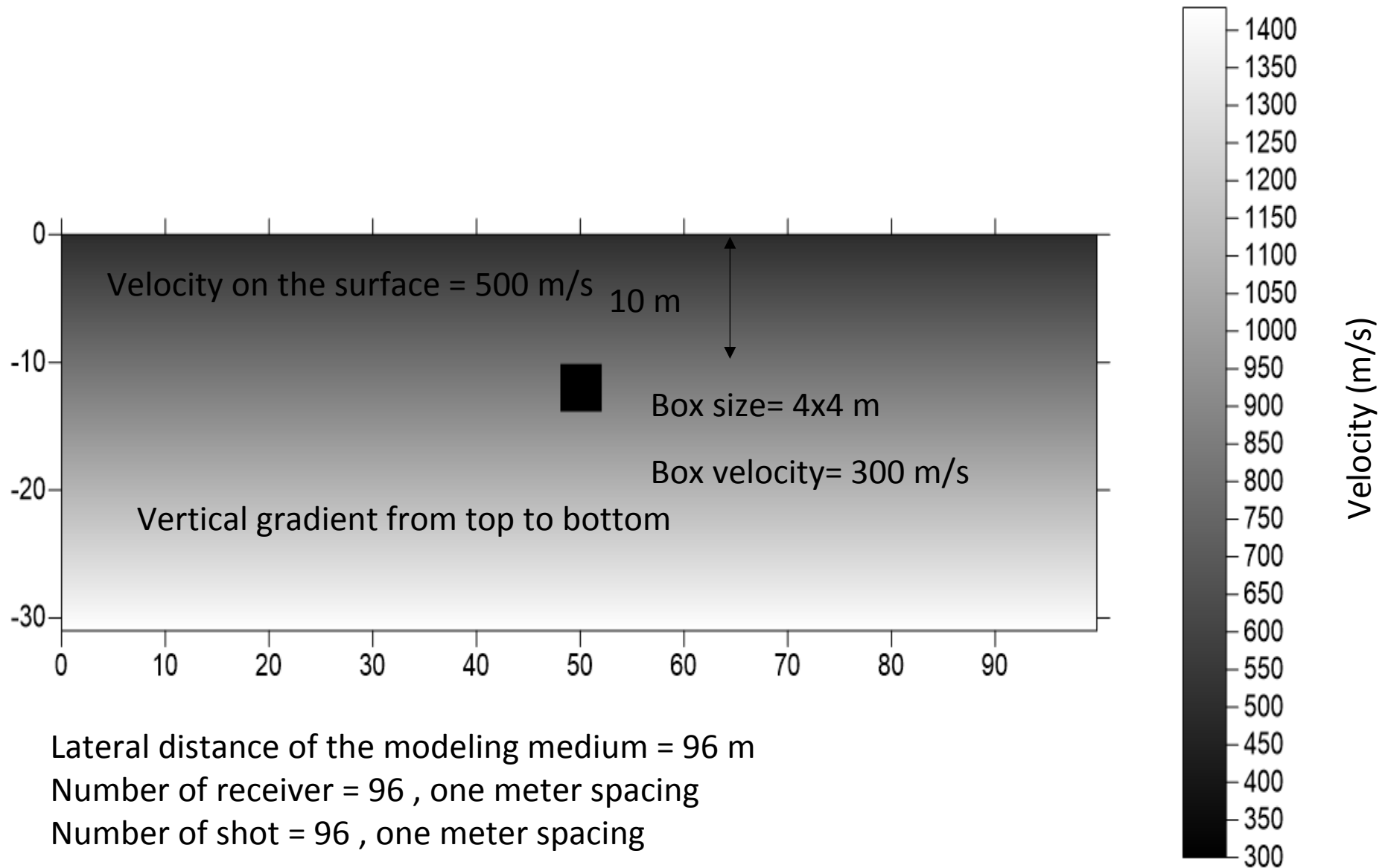


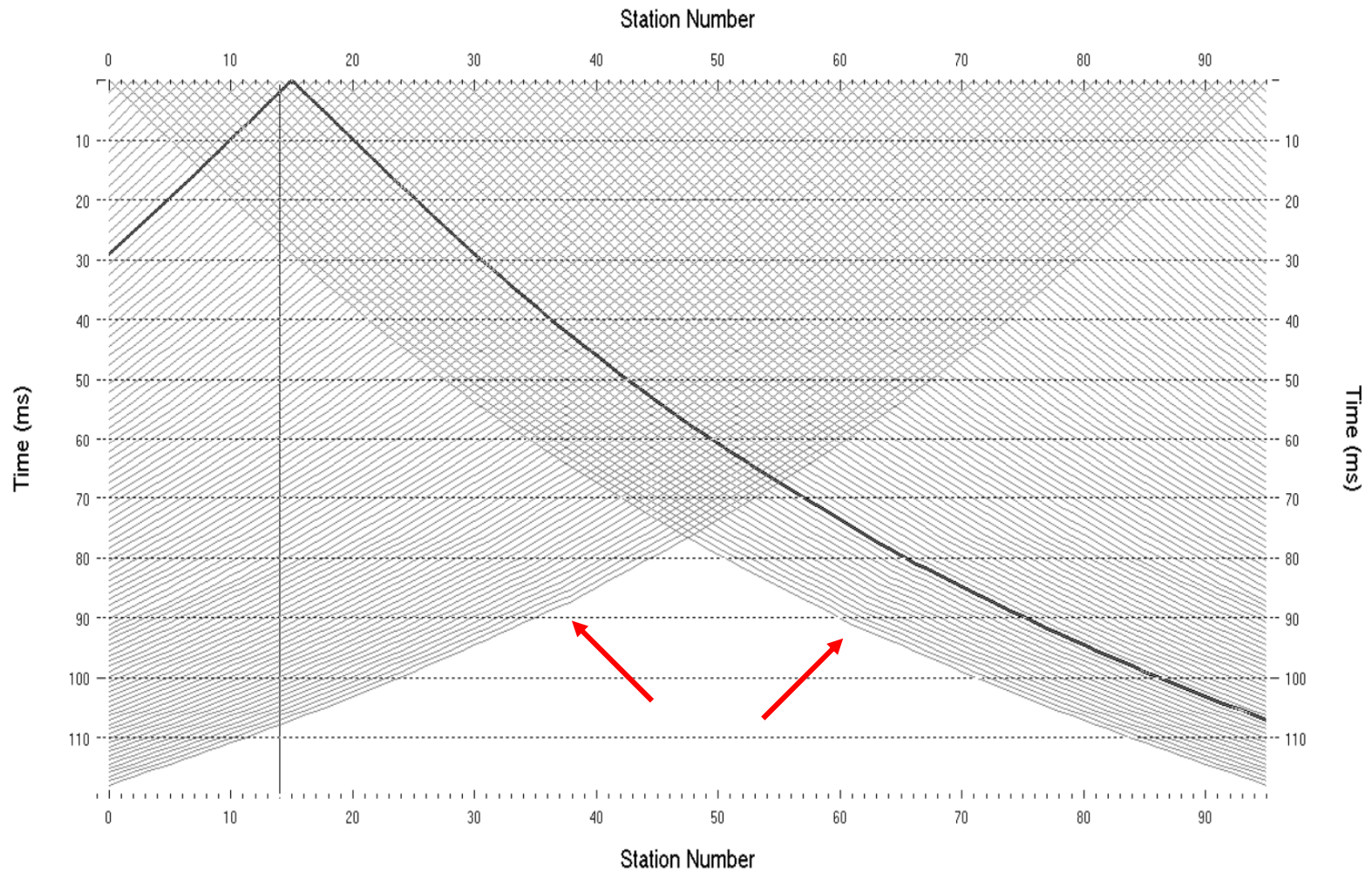
Tunnel detection using Frequency-Dependent Traveltime Tomography

- we thank Dr. Parsa Bakhtiari Rad working at University of Mississippi, The National Center for Physical Acoustics (NCPA) for making available the following slides in Feb 2021
- the WET inversion (Wavepath Eikonal Traveltime inversion; Schuster 1993) was done with Rayfract[®] version 4.01 using our new Wavelength-Dependent Velocity Smoothing (Zelt and Chen, 2016)
- Golden Software Surfer was used to generate the model .GRD grid file
- synthetic traveltimes were modeled using Rayfract[®] version 4.01 with WDVS defaults : frequency preset to 200Hz
- both WDVS smoothing and WET smoothing were discarded after forward modeling during WET inversion for improved resolution
- WET inversion at 62.5Hz was done using our Minimal WET smoothing option, Uniform weighting with default WET smoothing settings

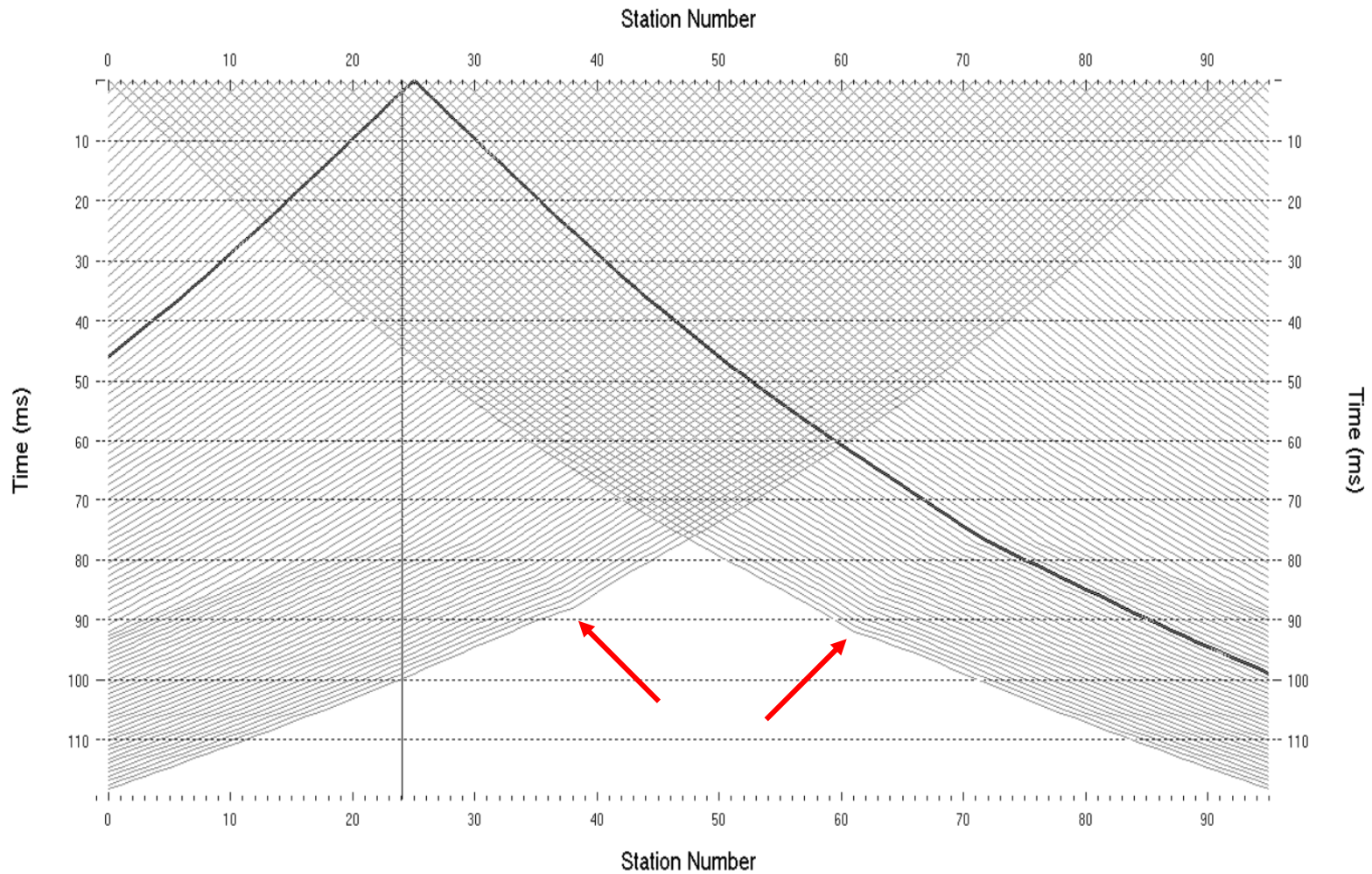
Test 1: 4x4 Low velocity box tomography



First arrival times calculated for 4x4 box **No WDVS**

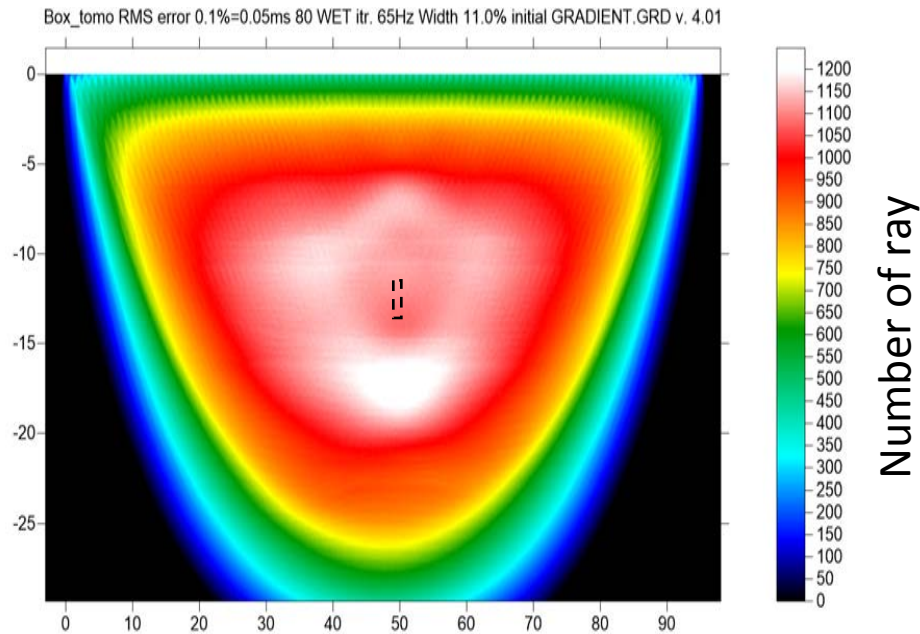


First arrival times calculated for 4x4 box with WDVS

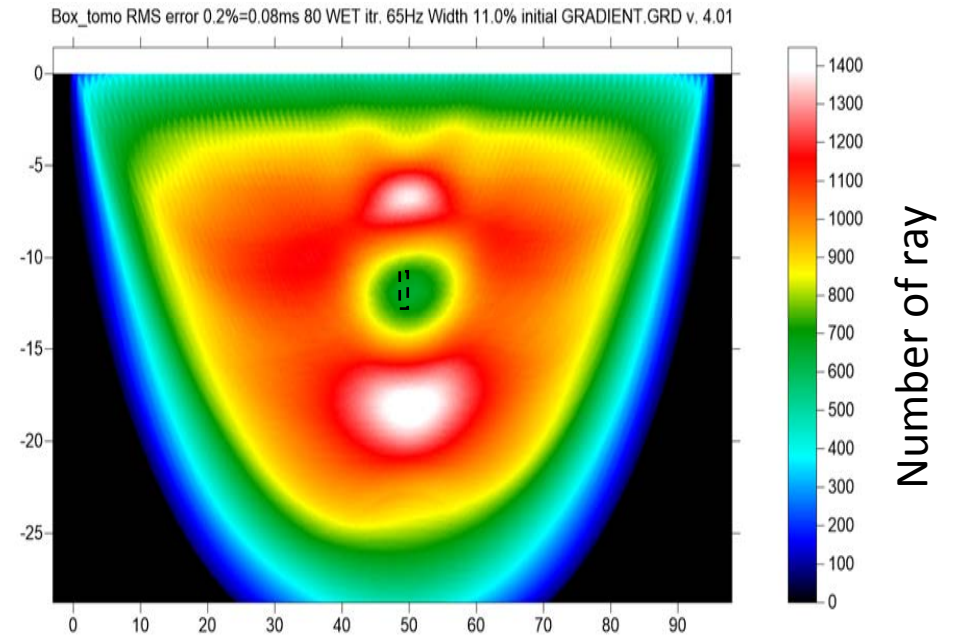


Ray coverage map for 4x4 box model :

No WDVS

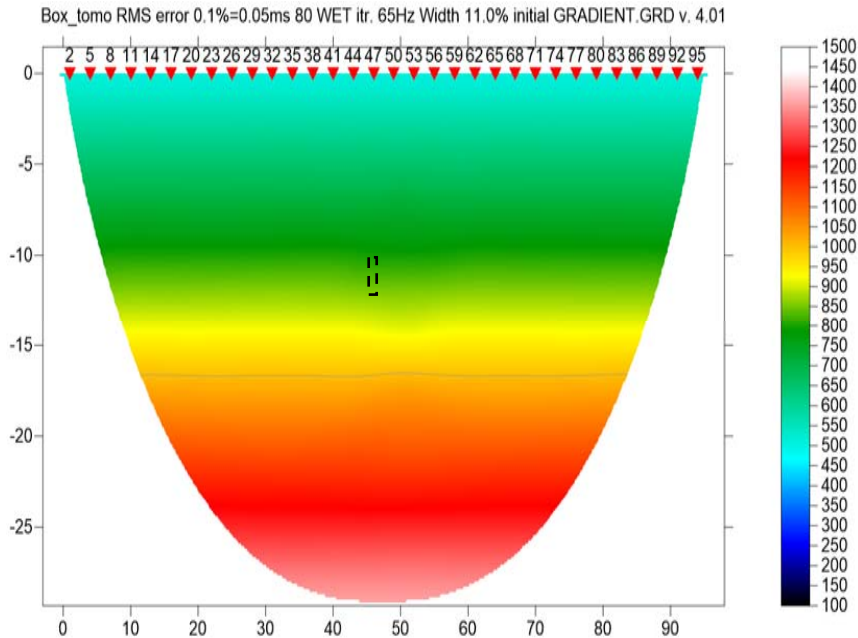


with WDVS

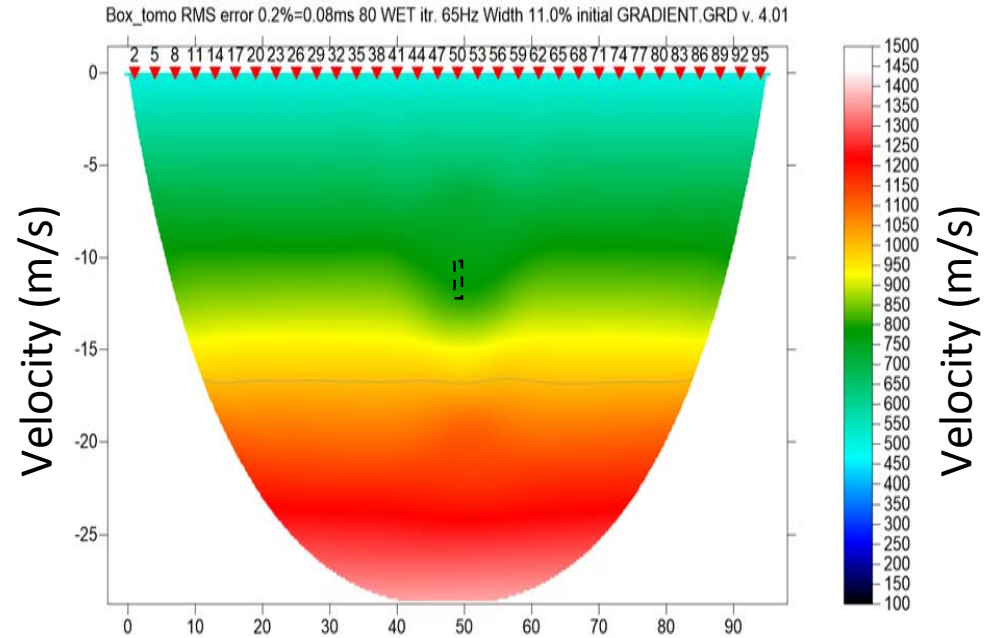


Velocity tomogram for 4x4 box model :

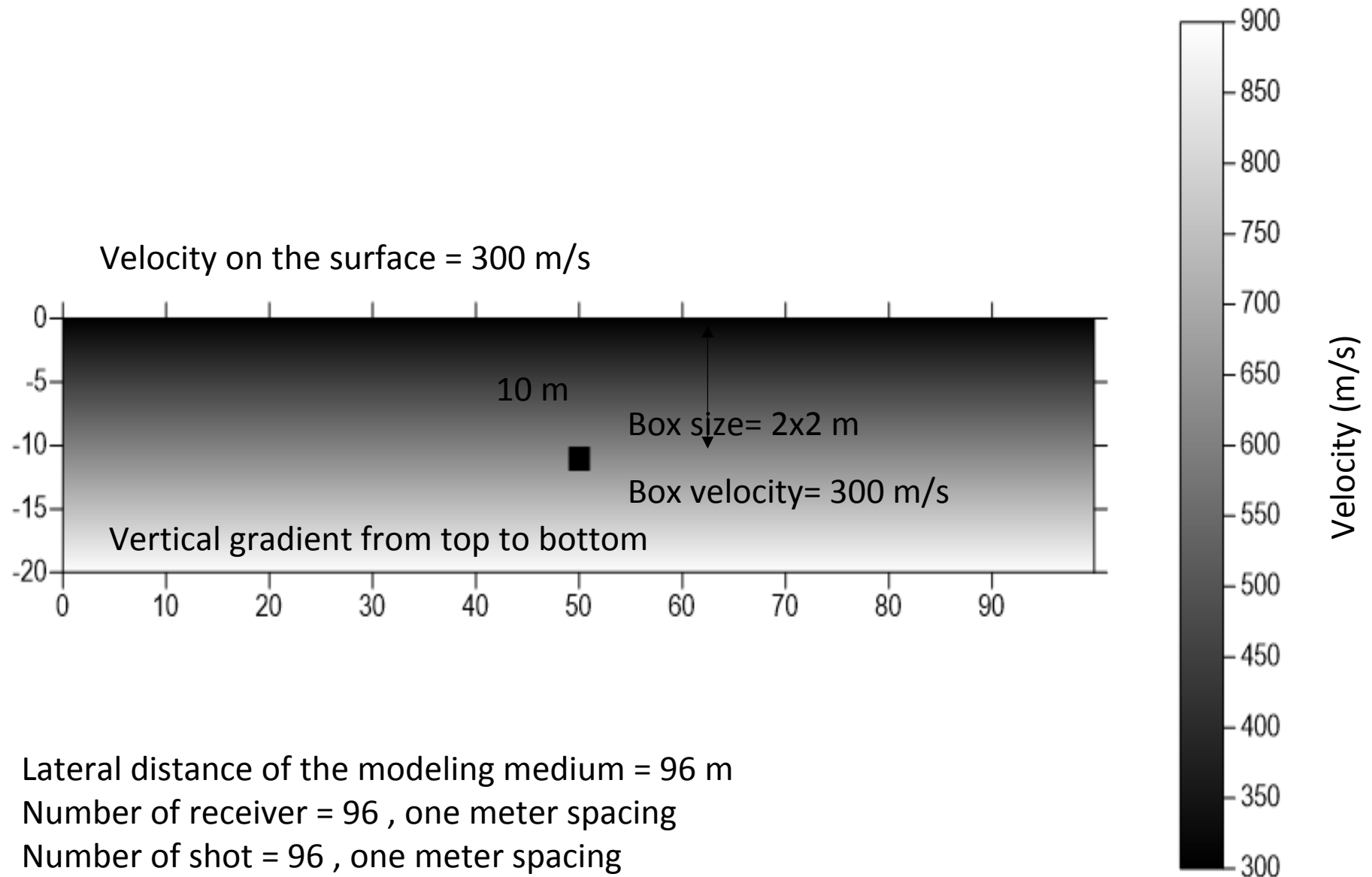
No WDVS



with WDVS

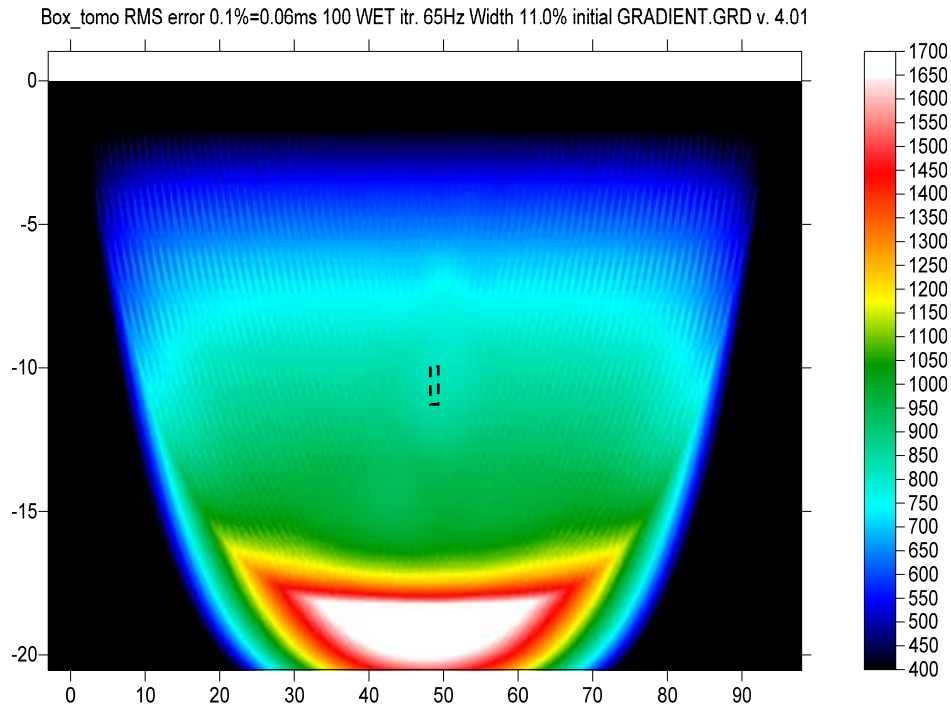


Test 2: 2x2 Low velocity box tomography

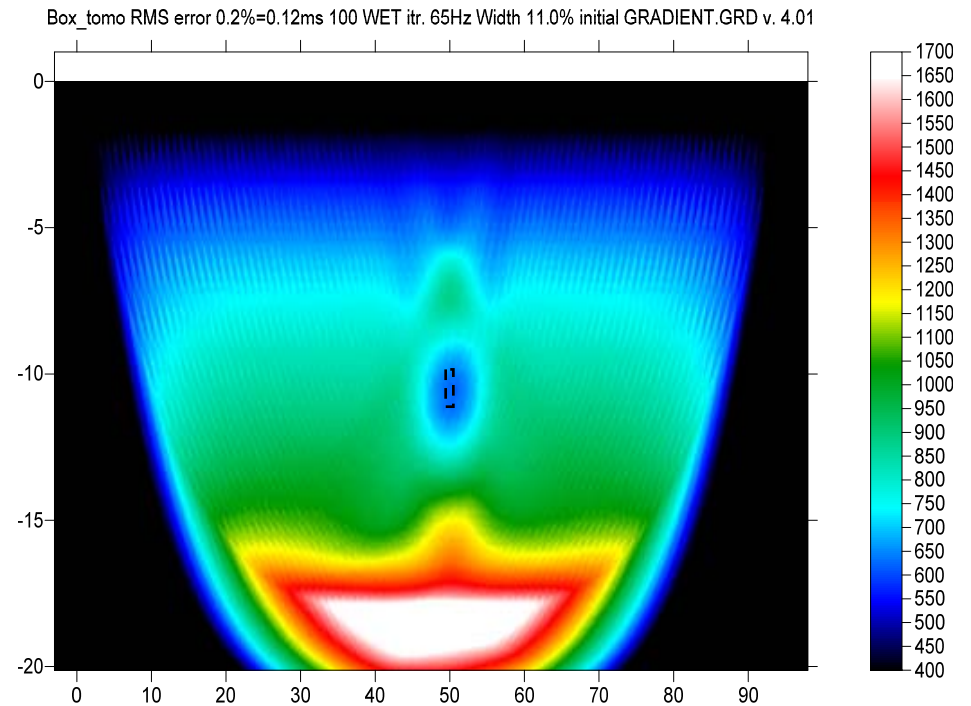


Ray coverage map for 2x2 box model :

No WDVS

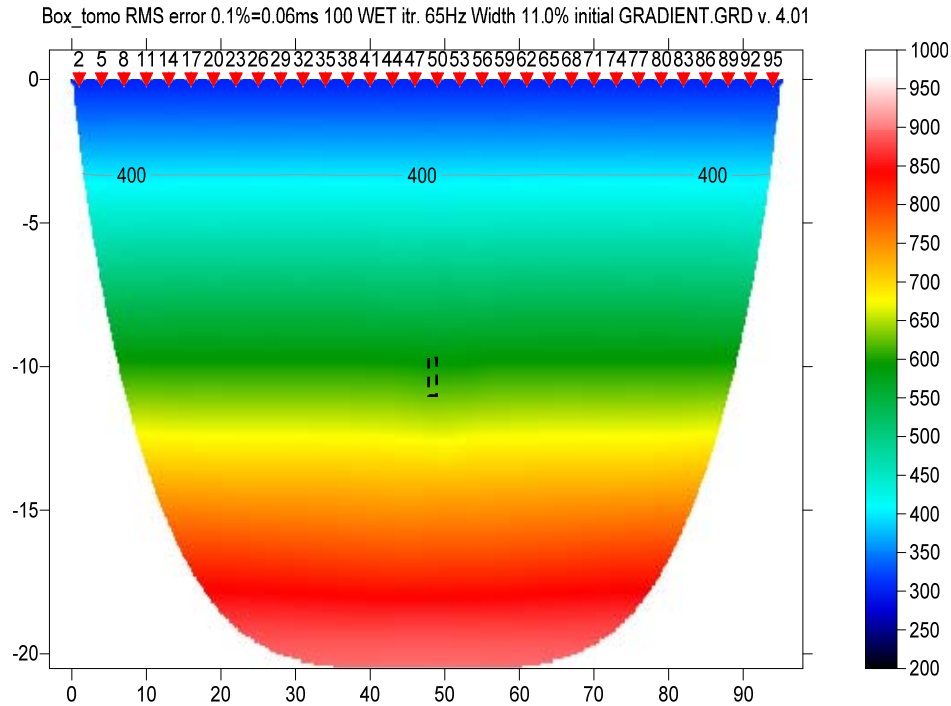


with WDVS

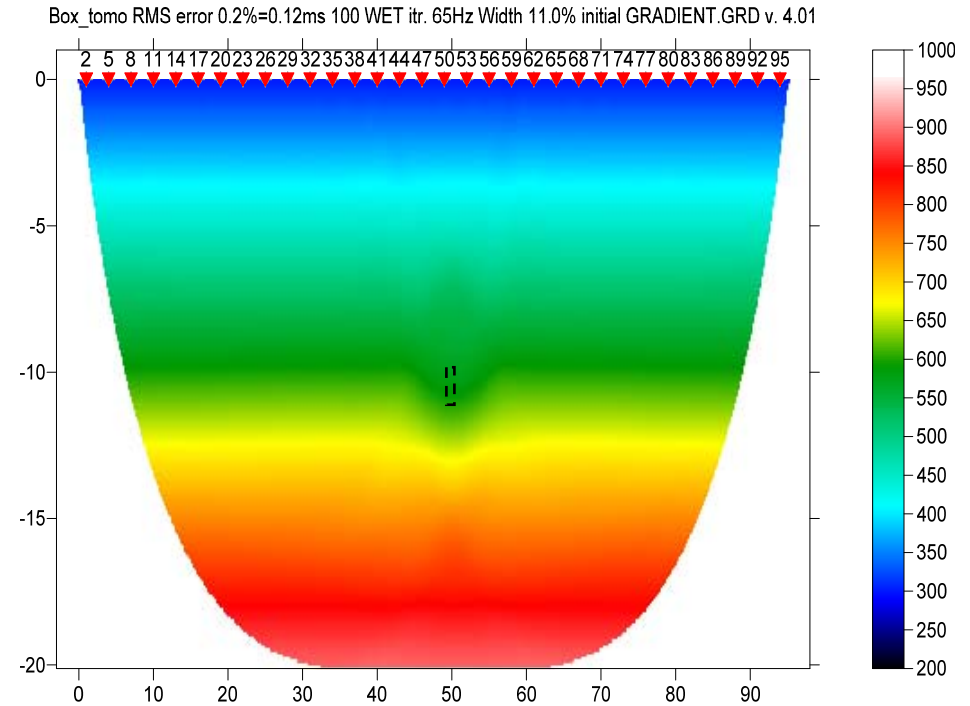


Velocity tomogram for 2x2 box model :

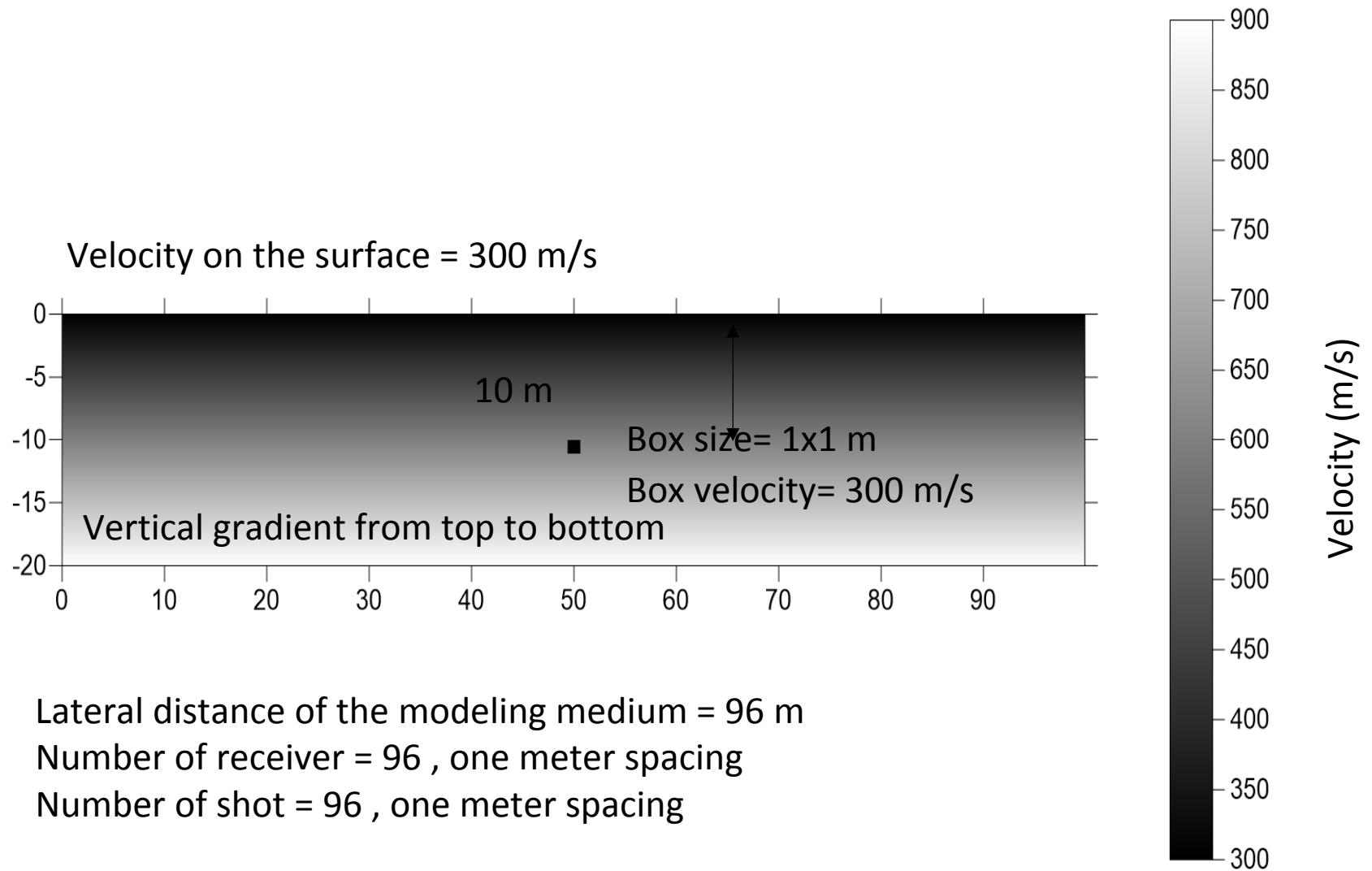
No WDVS



with WDVS

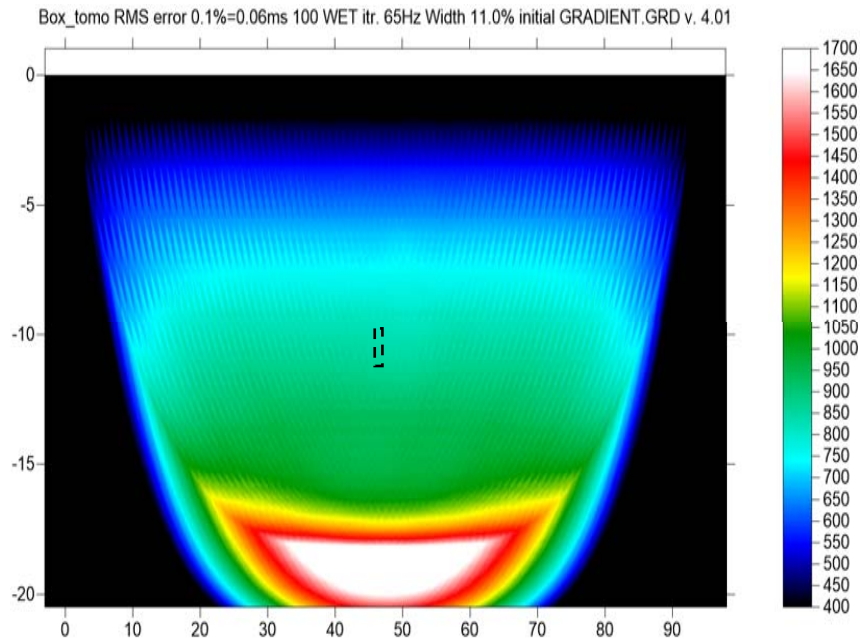


Test 3: 1x1 Low velocity box tomography

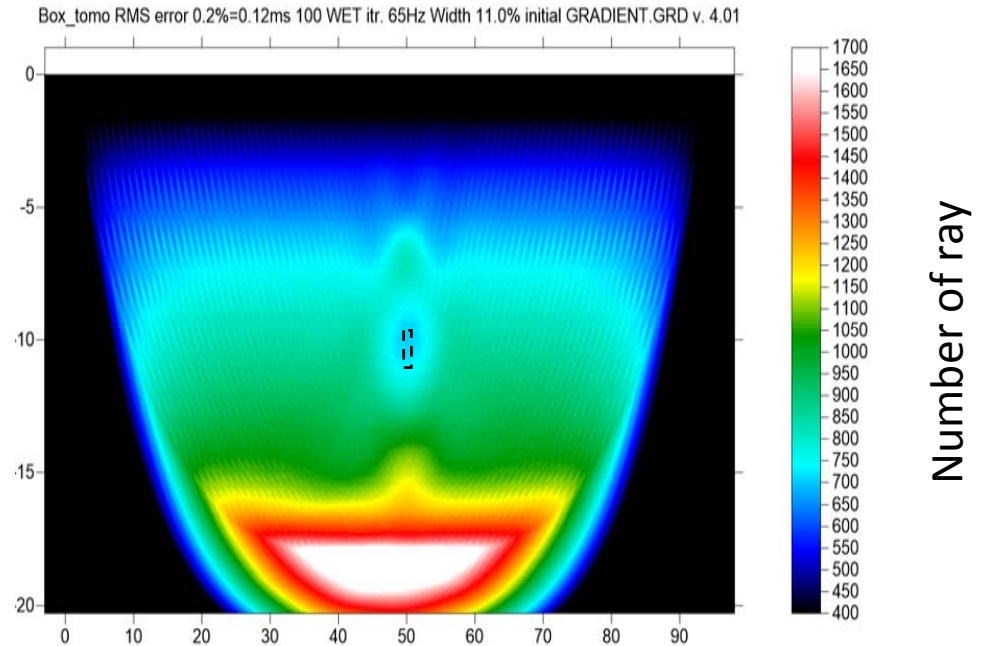


Ray coverage map for 1x1 box model :

No WDVS

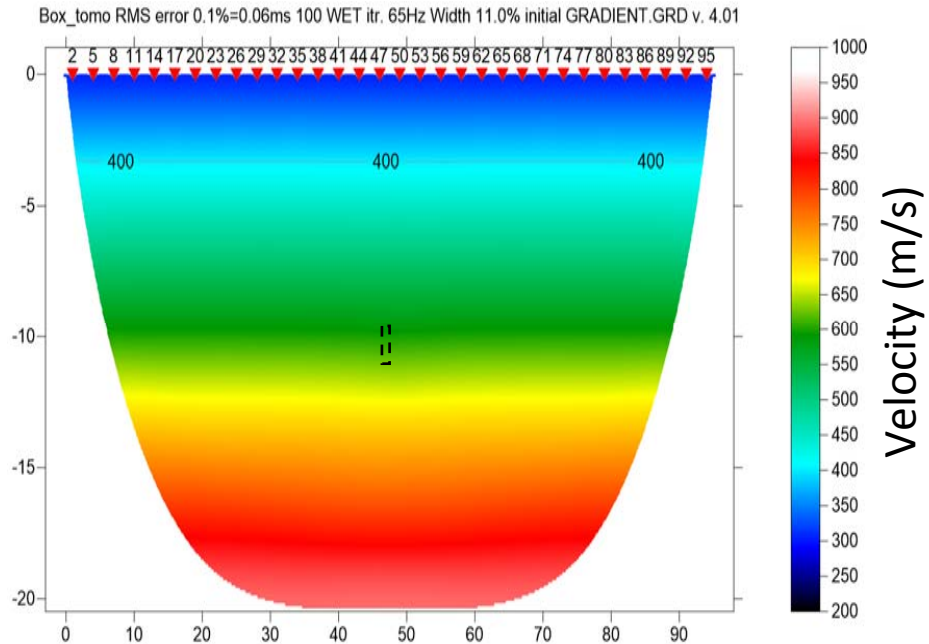


with WDVS

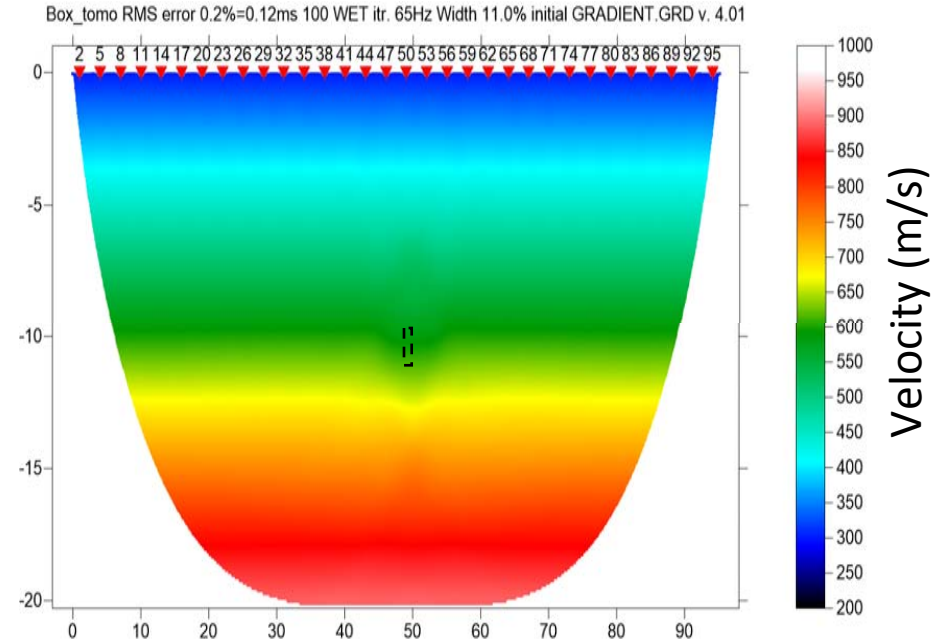


Velocity tomogram for 1x1 box model :

No WDVS



with WDVS



WDVS parameters used for box tomography:

Edit WET Wavepath Eikonal Traveltime Tomography Parameters

Specify initial velocity model
 C:\RAY32\LINE15_BOX_TOMO\GRADTOMO\GRADIENT.GRD

Stop WET inversion after
Number of WET tomography iterations : iterations
☐ or RMS error gets below percent
☐ or RMS error does not improve for n = iterations
☐ or WET inversion runs longer than minutes

WET regularization settings
Wavepath frequency : Hz
Ricker differentiation [-1:Gaussian,-2:Cosine] times
Wavepath width [percent of one period] : percent
Wavepath envelope width [% of period] : percent
Min. velocity Max. velocity m/sec.
Width of Gaussian for one period [sigma] : sigma

Gradient search method
☒ Steepest Descent ☐ Conjugate Gradient

Conjugate Gradient Parameters
CG iterations Line Search iters.
Tolerance Line Search tol.
Initial step ☐ Steepest Descent step

Edit WDVS (Zelt & Chen 2016)

Edit parameters for wavelength-dependent velocity smoothing
☒ use WDVS for forward modeling of traveltimes
WDVS frequency [Hz]
Angle [Degree]
Regard nth [node]

Parameters for Cosine-Squared weighting function
a : Cosine argument [power]
b : Cosine-Squared power [power]

Modify WET smoothing mode : discard after forward modeling
☒ discard WET smoothing after forward modeling

*Unchecked the boxes for non-WDVS case

WET parameters used for box tomography:

Edit WET Wavepath Eikonal Traveltime Tomography Parameters

Specify initial velocity model

SelectC:\RAY32\BOX_TOMO\GRADTOMO\GRADIENT.GRD

Stop WET inversion after

Number of WET tomography iterations :20iterations

☐ or RMS error gets below2.0percent

☐ or RMS error does not improve for n =20iterations

☐ or WET inversion runs longer than100minutes

WET regularization settings

Wavepath frequency :50HzIterate

Ricker differentiation [-1:Gaussian,-2:Cosine]-1times

Wavepath width [percent of one period]:11.0percentIterate

Wavepath envelope width [% of period]:0.0percent

Min. velocity10Max. velocity6000m/sec.

Width of Gaussian for one period [sigma]:3.0sigma

Gradient search method

☒ Steepest Descent☐ Conjugate Gradient

Conjugate Gradient Parameters

CG iterations10Line Search iters.2

Tolerance0.001Line Search tol.0.0010

Initial step0.10☐ Steepest Descent step

Edit velocity smoothing

Edit grid file generation

Start tomography processing

Reset

Cancel

Edit WET Tomography Velocity Smoothing Parameters

Determination of smoothing filter dimensions

☐ Full smoothing after each tomography iteration

☒ Minimal smoothing after each tomography iteration

☐ Manual specification of smoothing filter, see below

Smoothing filter dimensions

Half smoothing filter width :4columns

Half smoothing filter height :1grid rows

Suppress artefacts below steep topography

☒ Adapt shape of filter. Uncheck for better resolution.

Maximum relative velocity update after each iteration

Maximum velocity update :25.00percent

Smooth after each nth iteration only

Smooth nth iteration : n =1iterations

Smoothing filter weighting

☐ Gaussian☒ Uniform☐ No smoothing

Used width of Gaussian1.0sigma

Uniform central row weight1.0[1..100]

Smooth velocity update before updating tomogram

☒ Smooth update☐ Smooth nth☒ Smooth last

Damping of tomogram with previous iteration tomogram

Damping0.000☐ Damp before smoothing

Accept parameters

Reset parameters