

Laser Doppler Vibrometry

LDV

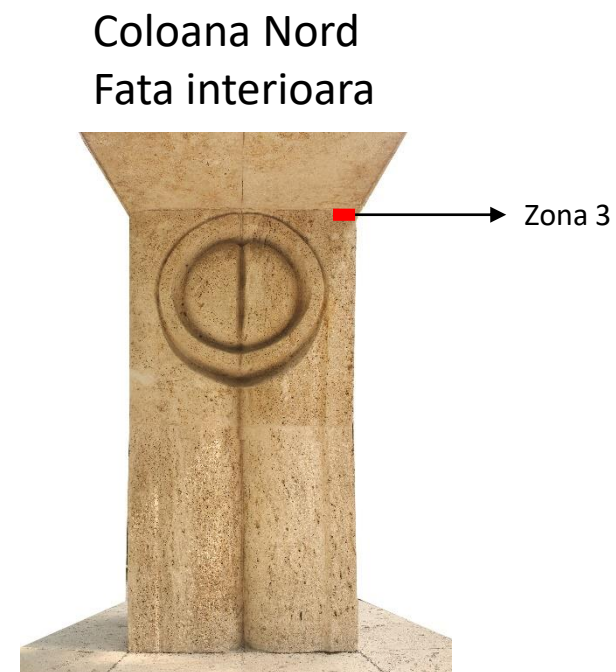
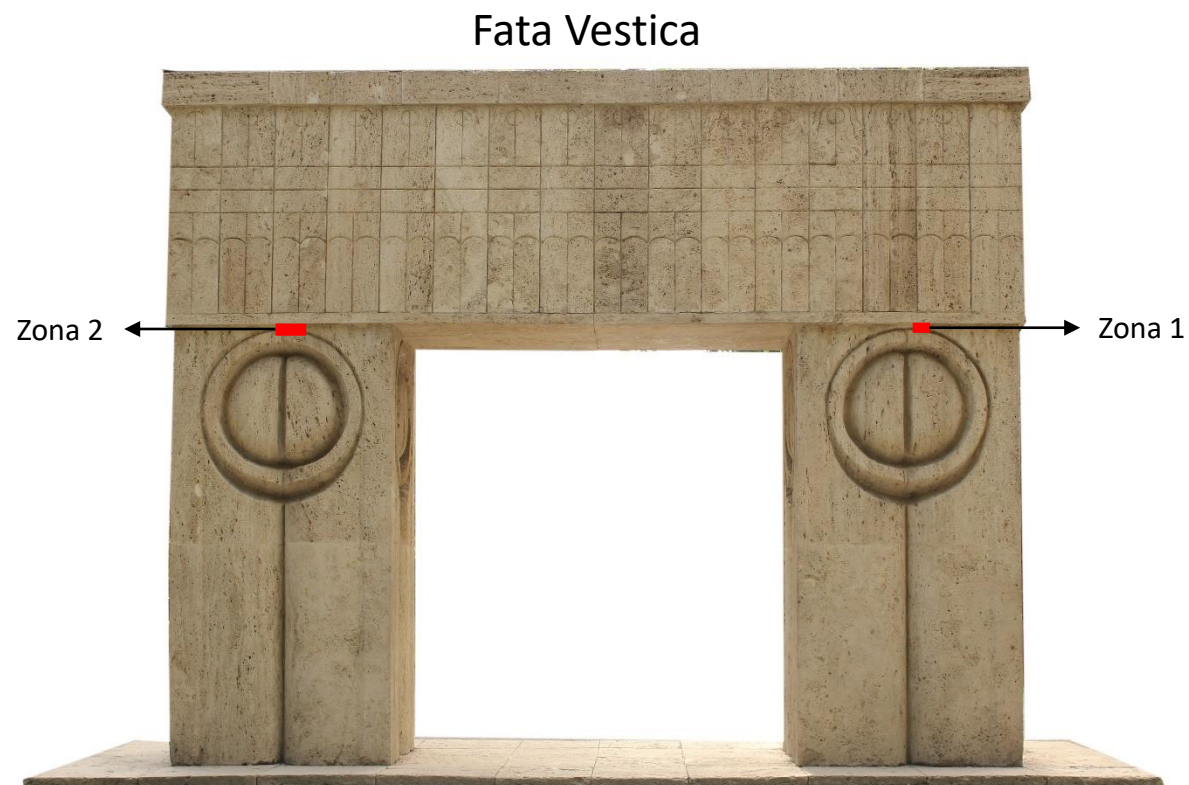
Poarta Sarutului, Tg. Jiu
Campanie Iulie 2016

Vibrometria Doppler cu laser este o metodă non-invazivă, non-contact folosită pentru identificarea defectelor ascunse, precum desprinderi, lacune, crăpături, fisuri etc. ale obiectelor de artă. Un spot laser este proiectat pe suprafața obiectului studiat, care este excitată folosind senzori piezoelectrice sau alți excitatori acustici, în funcție de dimensiunea obiectului investigat. Nivelurile vibrațiilor induse sunt foarte mici, comparabil cu cele găsite în mod normal în biserici și muzee și mult mai scăzute decât cele induse de ciocănitul unui restaurator.

Suprafața este eșantionată prin puncte, iar în funcție de rezoluția dorită sau suprafața de studiat, o înregistrare poate consta din zeci până la mii de puncte. O suprafață uniformă și fără defecte rezultă din vibrații asemănătoare ale punctelor înregistrare. Acolo unde este un defect, vibrația punctului, sau punctelor, în funcție de mărimea defectului, este diferită de punctele limitrofe, fie în amplitudine, fie în frecvență, și astfel sunt identificate defectele. De exemplu în cazul unei fresce zonele în care pictura este desprinsă de pe perete substratul va vibra mai mult decât cele lipite, deci fasciculul laser va măsura pe aceste domenii valori de viteză mai mari, care vor fi individualizate în mod clar prin hărțile de culoare.



Zone investigate



Verificarea stabilitatii mortarelor s-a facut intr-un numar limitat de puncte, alese pentru ca prezentau crapaturi nu foarte accentuate. Puntele in care mortarele prezinta stabilitate buna se vor verifica periodic pentru a sesiza riscul desprinderi in faza incipienta. Punctele cu stabilitate relative buna se vor reverifica in primul rand.

Parametrii generali scanare:

Hardware	
Scanning Head :	PSV-I-400 LR (OFV-505)
Firmware version:	1.20
Junction Box:	PSV-E-401-H4
Firmware Version:	2.0
Acquisition Board:	National Instruments PCI-4462
Channels Count:	4
Highest Sample Frequency:	204.8 kHz
Function Generator	
Channels Count:	4

General	
Acquisition Mode:	FFT
Averaging:	Magnitude
Averaging count:	3
Remeasure Automatically:	
Active	
AutoRange:	Active
PCA (MIMO):	Not active
Cosine correction X:	Active
Cosine correction Y:	Active

Channel Vibrometer (connected to Vibrometer 1)	
Direction:	+Z
Range:	10 V
Coupling:	DC
Impedance:	1 MOhm
Differential Input:	Off
Quantity:	Velocity
Calibration factor:	1 (m/s)/V
Signal Delay:	1.04e-6 s
Filter Type:	High Pass
Quality:	Middle
Cutoff Frequency 1:	200 Hz
Int/Diff Quantity:	Velocity
Window:	Rectangle
Signal Enhancement:	Active

Vibrometer 1	
Controller:	OFV-5000
Firmware version:	2.11
Tracking filter:	Fast
Velocity output	
Range:	VD-03 1000 mm/s/V
Low pass filter:	Off
High pass filter:	100 Hz

Sampling	
FFT Lines:	200
Sample frequency:	4 kHz
Sample time:	128 ms
Resolution:	7.8125 Hz

Trigger	
Source:	Internal
Edge:	Positive slope
Pretrigger:	20 %
Phase from reference:	Off

Frequency	
Bandwidth:	1.5625 kHz
Bandwidth from:	7.8125 Hz
Bandwidth to:	1.5625 kHz

Signal Enhancement	
Speckle Tracking:	Active
Mode:	Best

Funcții generator folosite:

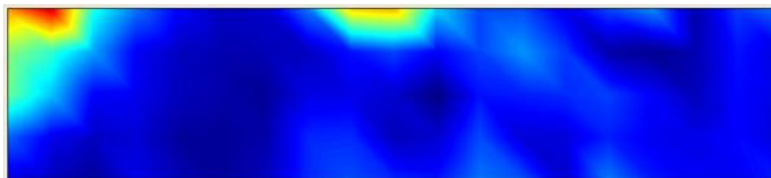
-Burst Chirp, Burst Random, Periodic Chirp, Pseudo Random, Ramp, Sine, Square, Sweep, Triangle

Zona 1:

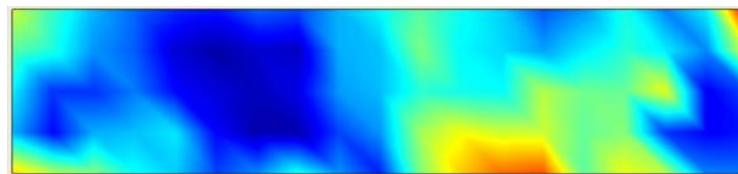


Comparatie rezultate zona 1 pentru diferite functii folosite

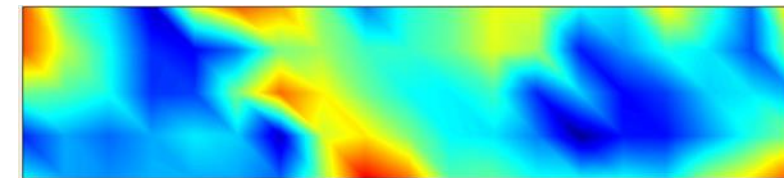
Burst Chirp 5 V



Burst Random



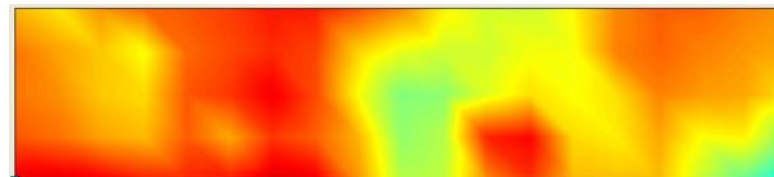
Sine



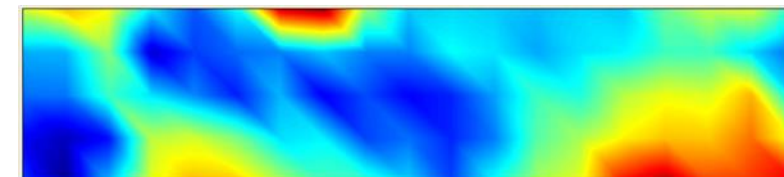
Burst Chirp 5 V



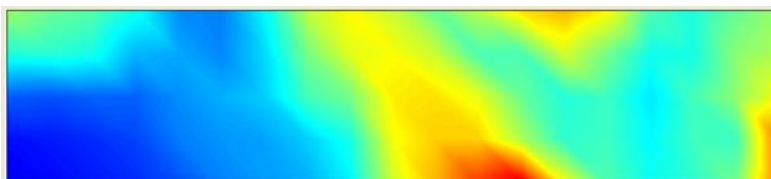
Periodic Chirp



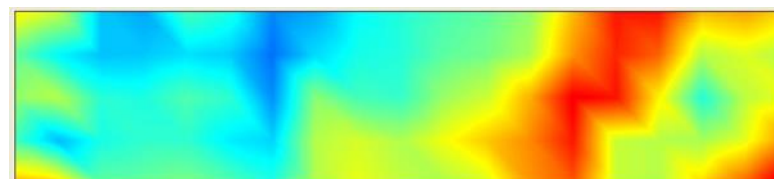
Square



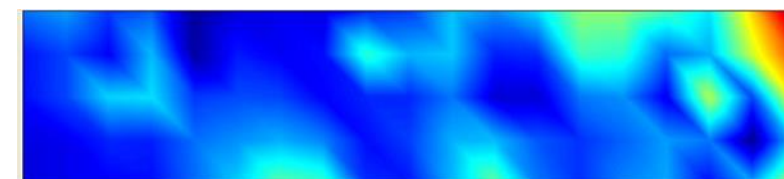
Burst Chirp 7,5 V



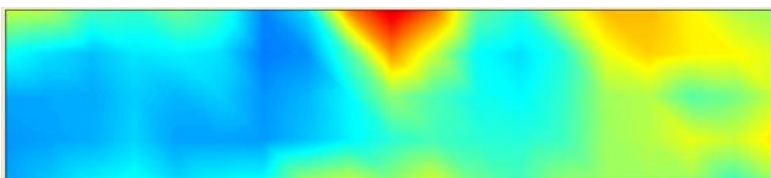
Pseudo Random



Sweep



Burst Chirp 10 V



Ramp



Triangle



Zona 2:



Comparatie rezultate zona 2 pentru diferite functii folosite

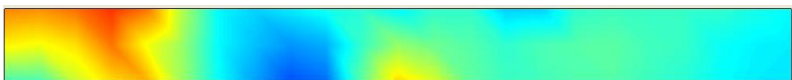
Burst Chirp



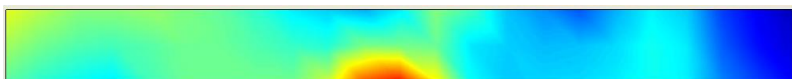
Burst Random



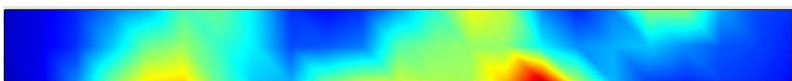
Periodic Chirp



Pseudo Random



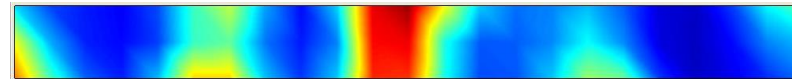
Ramp



Triangle



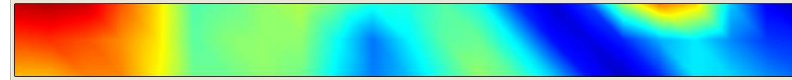
Sine



Sine, 5kHz



Sine, 7,5 V



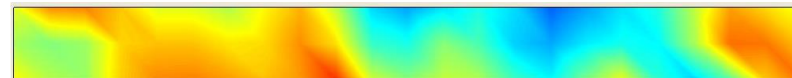
Sine, 10 V



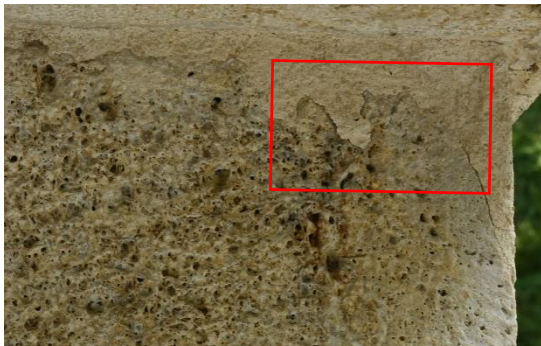
Square



Sweep

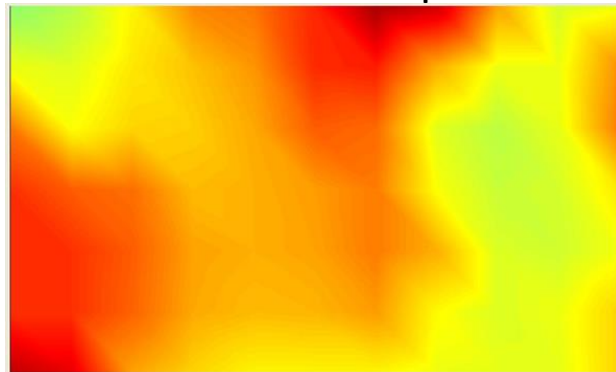


Zona 3:

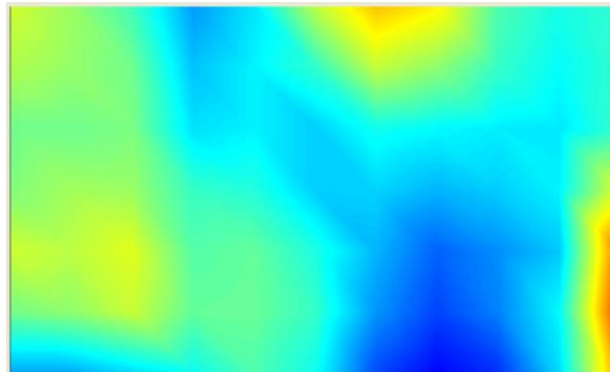


Comparatie rezultate zona 3
pentru diferite functii folosite

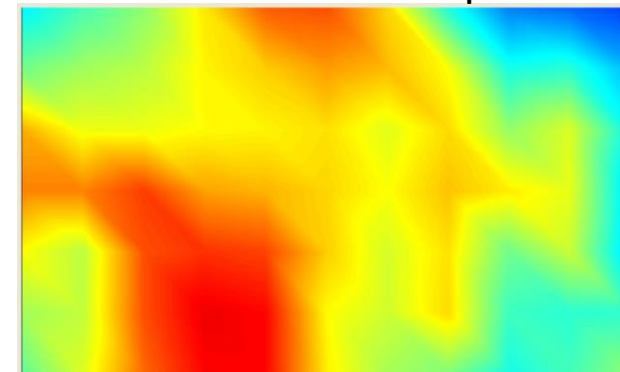
Burst Chirp



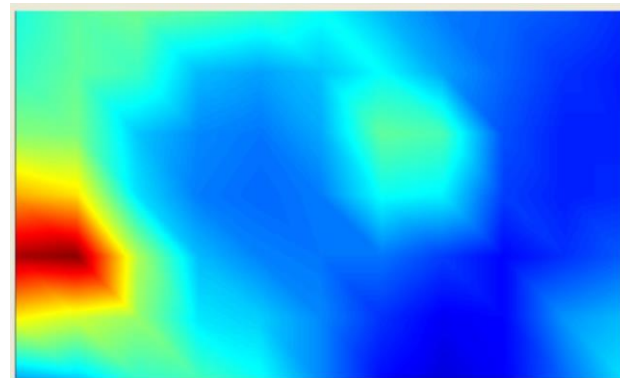
Burst Random



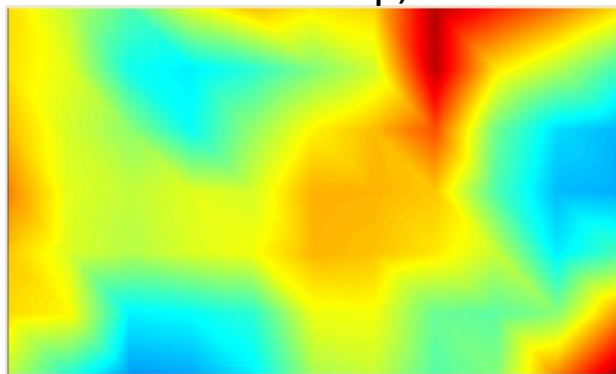
Periodic Chirp



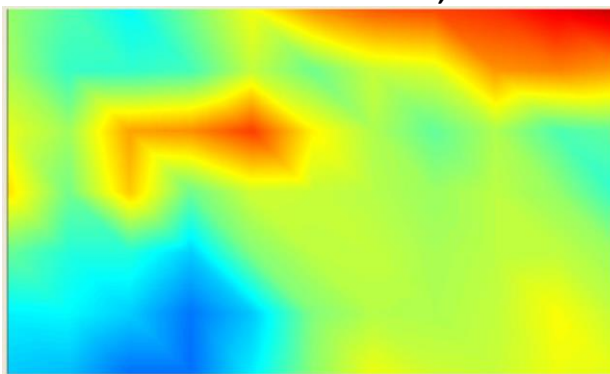
Pseudo Random



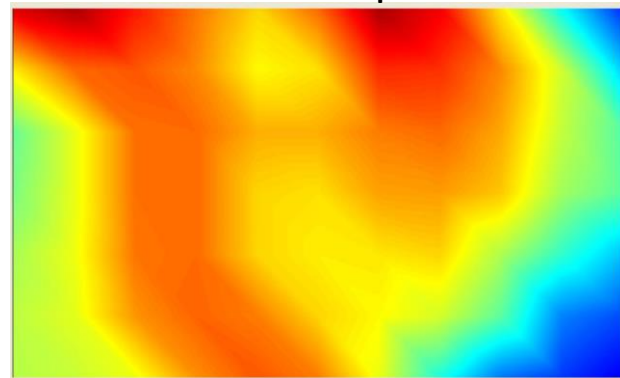
Burst Chirp, 10 V



Burst Random, 10V



Sweep



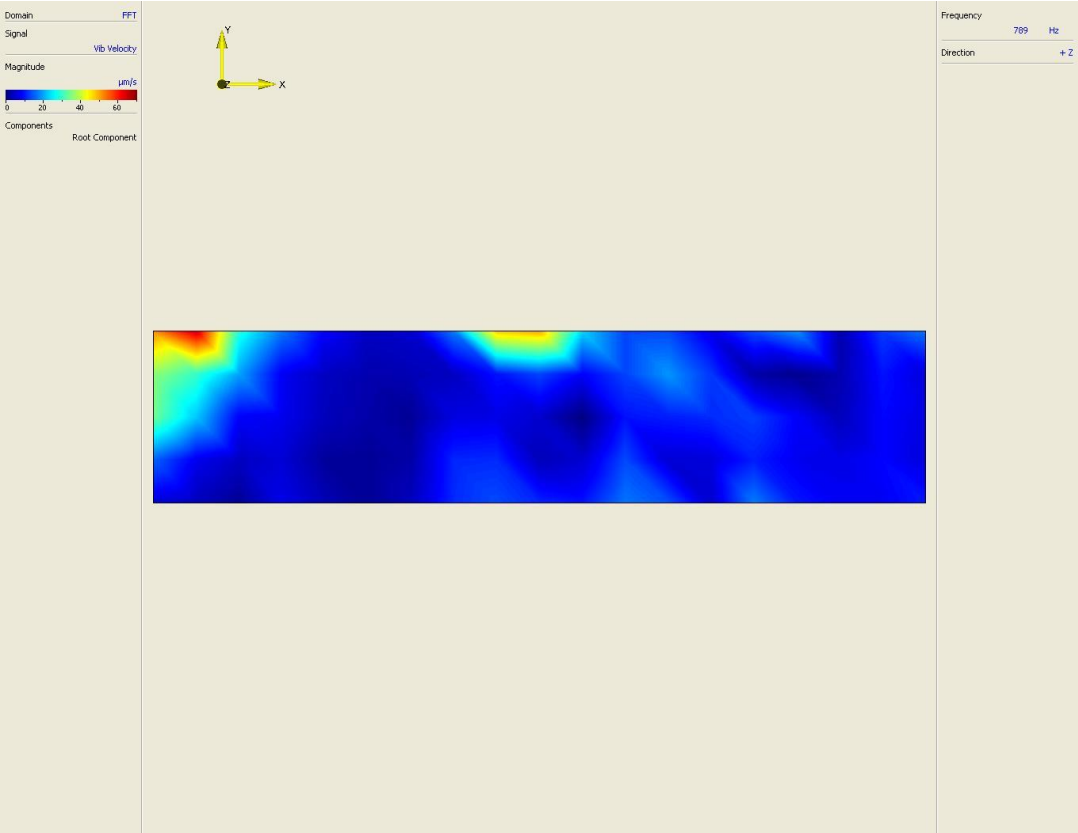
Zona 1:

Puncte scanare : 95

Burst Chirp 5 V- prima incercare

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 5 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



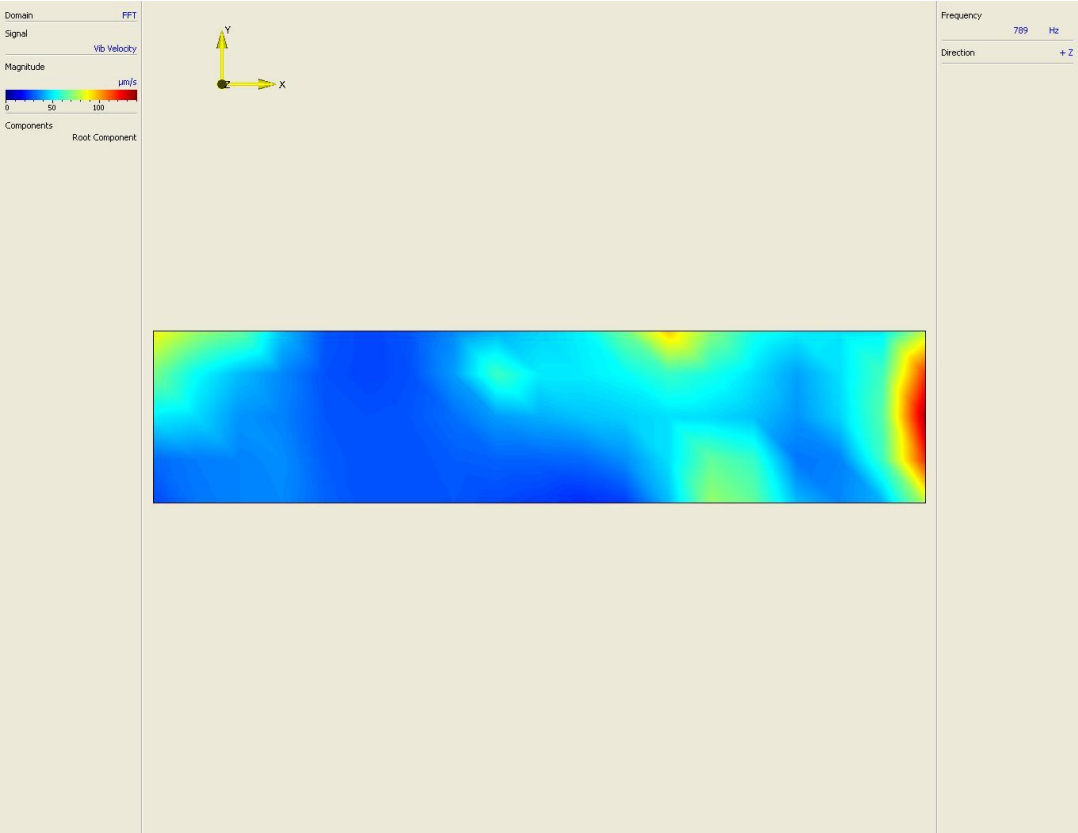
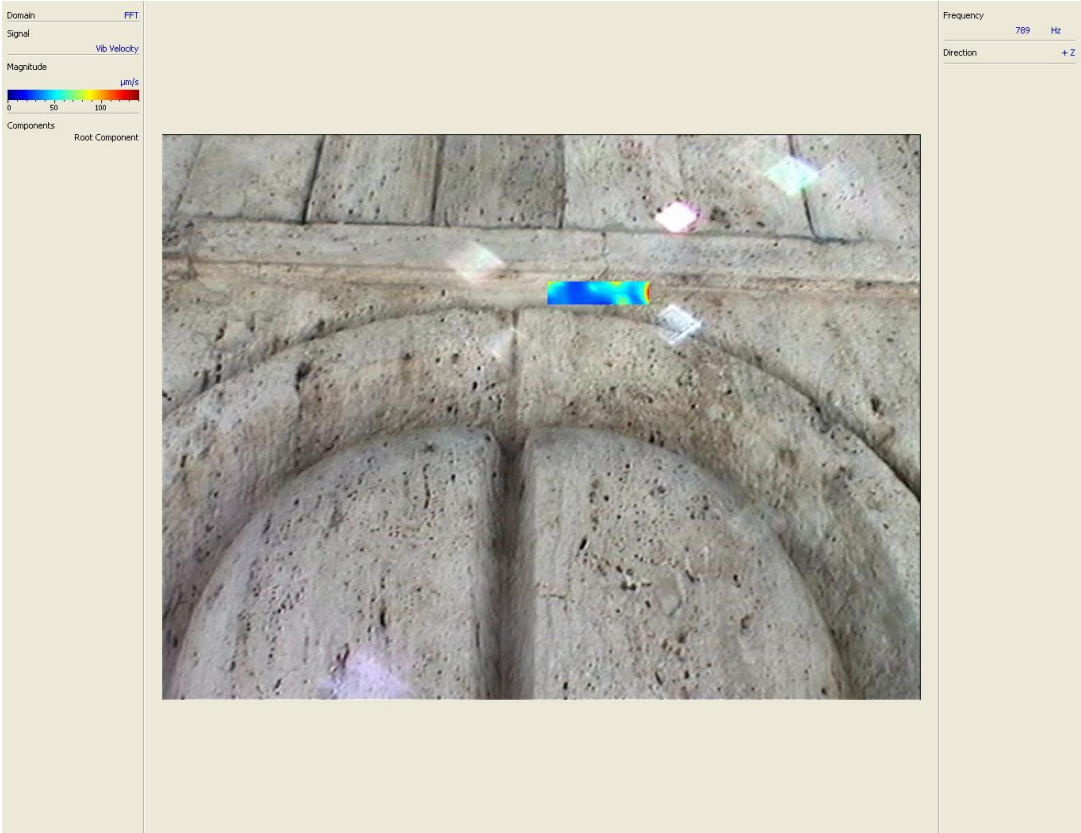
Zona 1:

Puncte scanare : 95

Burst Chirp 5 V- a doua incercare

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 5 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



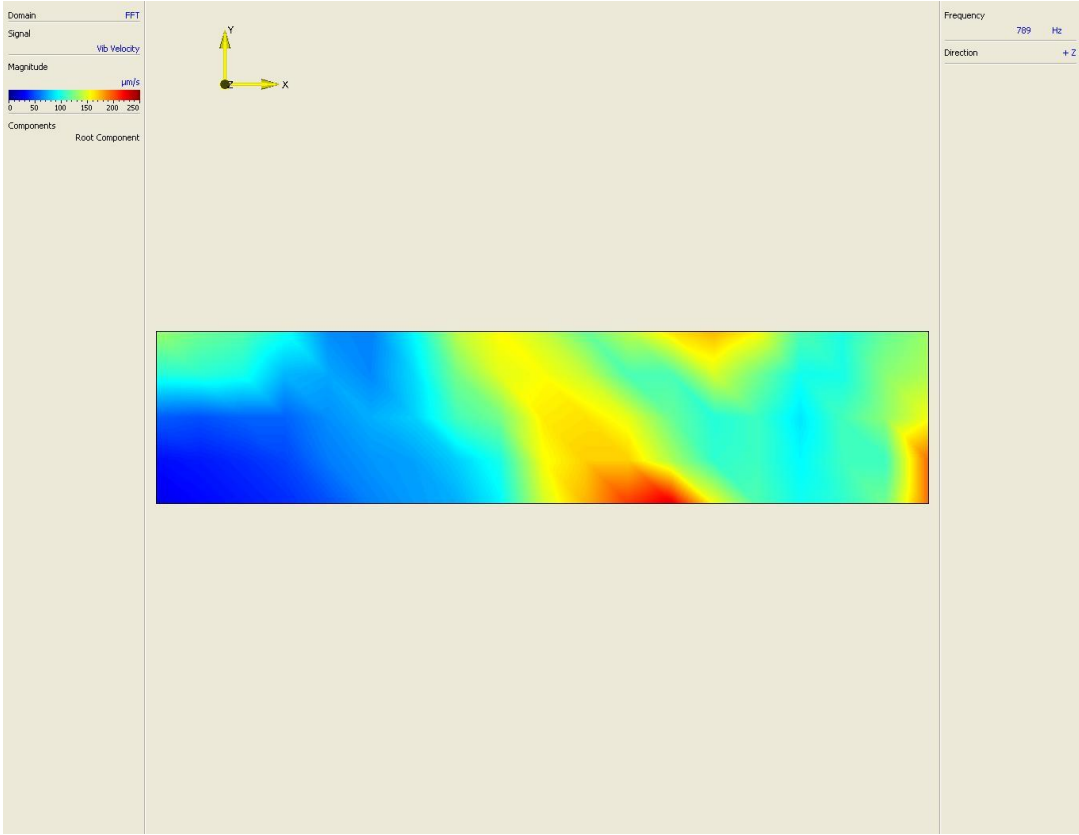
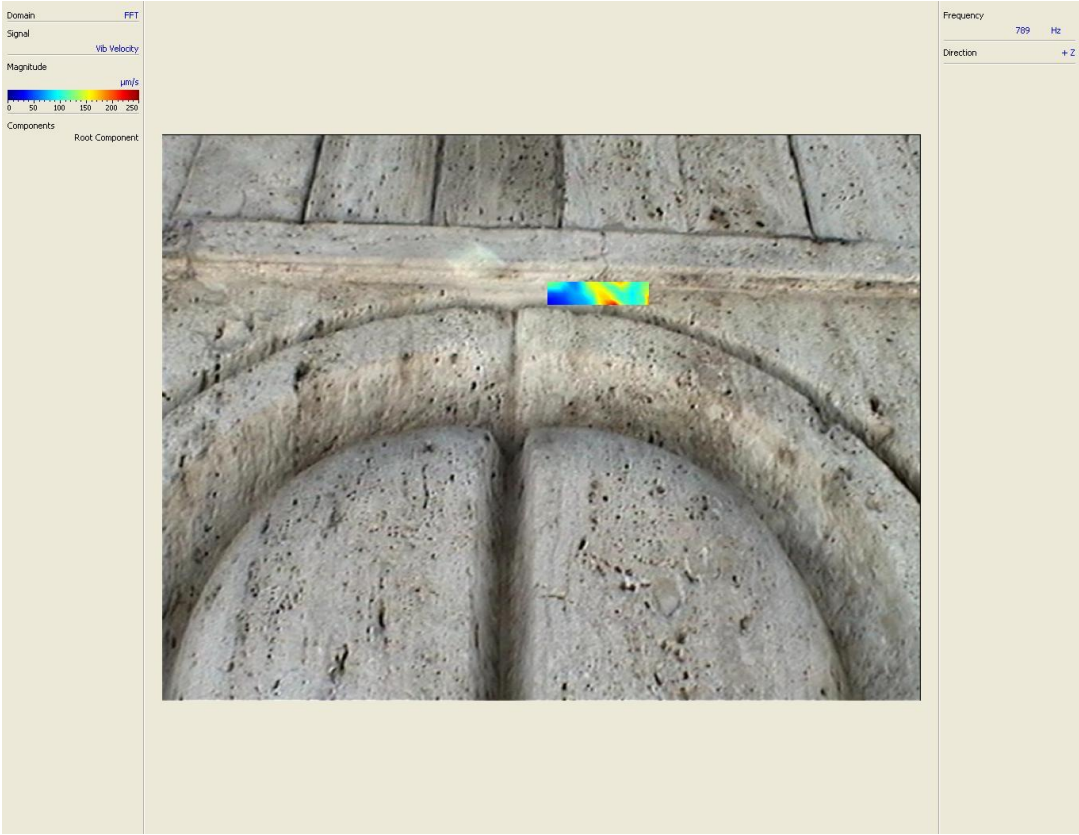
Zona 1:

Puncte scanare : 95

Burst Chirp 7,5 V

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 7.5 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



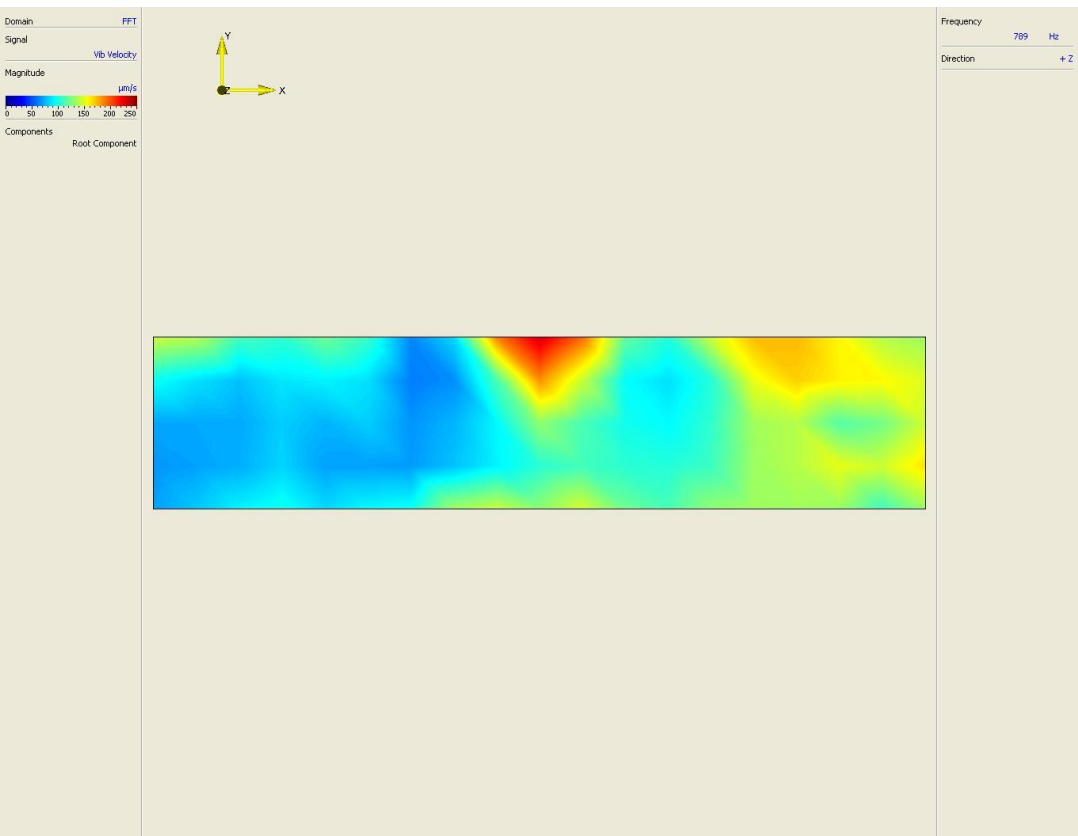
Zona 1:

Puncte scanare : 95

Burst Chirp 10 V

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 10 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



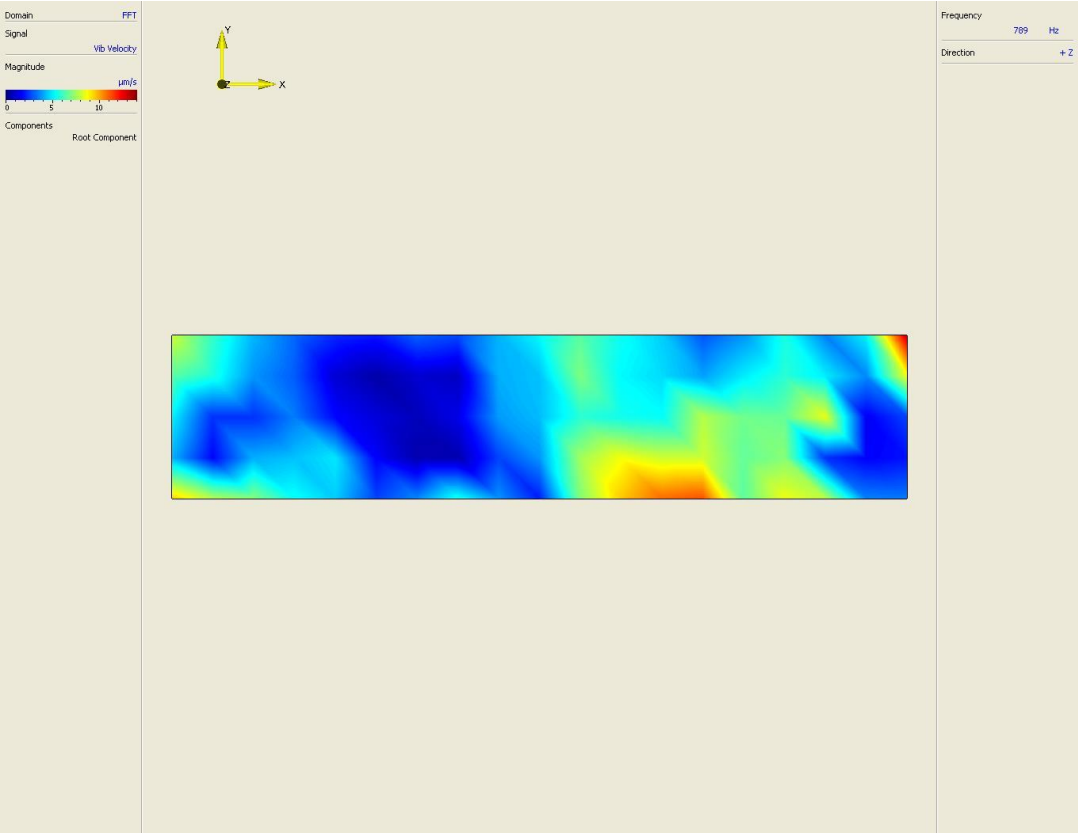
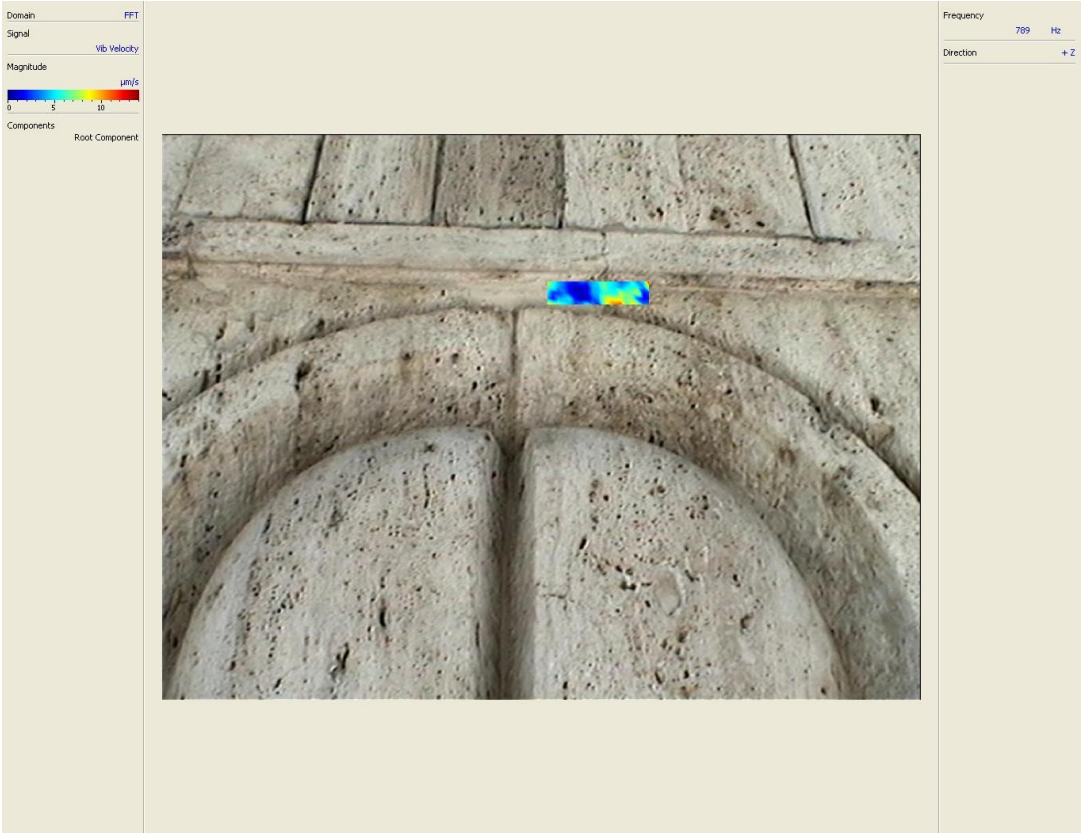
Zona 1:

Puncte scanare : 95

Burst Random

Generator Functie

Type: NI 671x
Signal: Burst Random
Amplitude: 5 V
Offset: 0 V
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



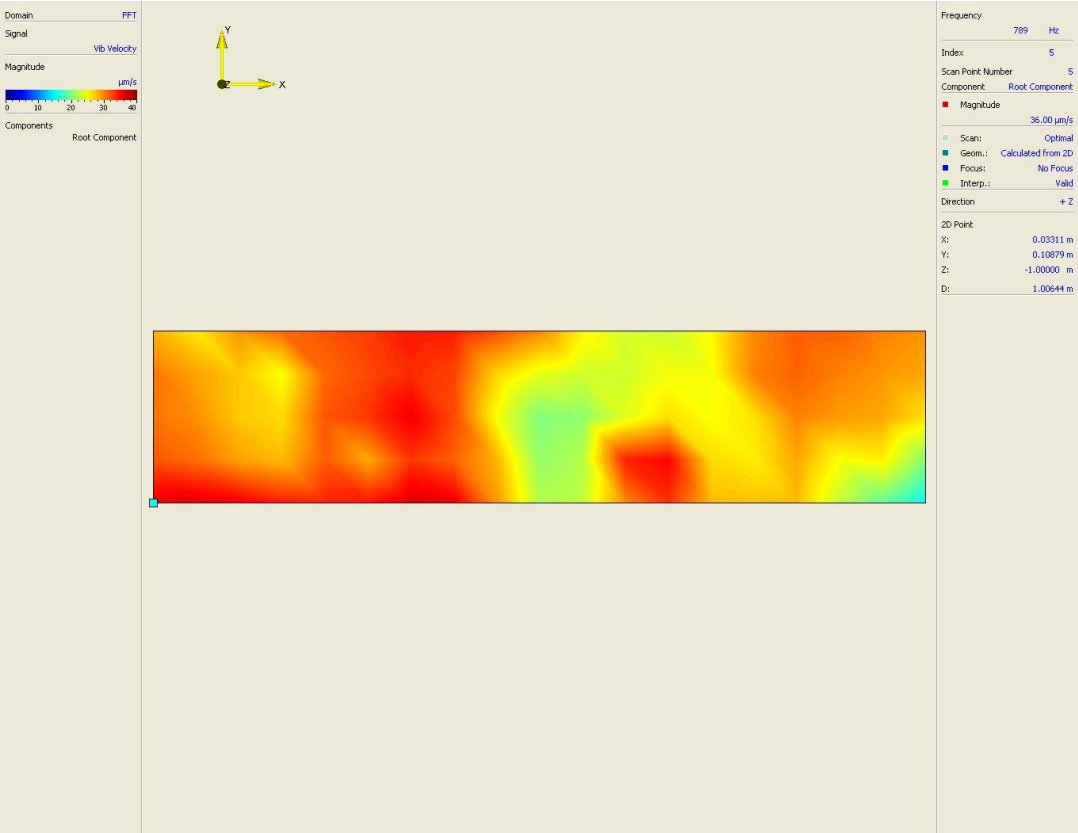
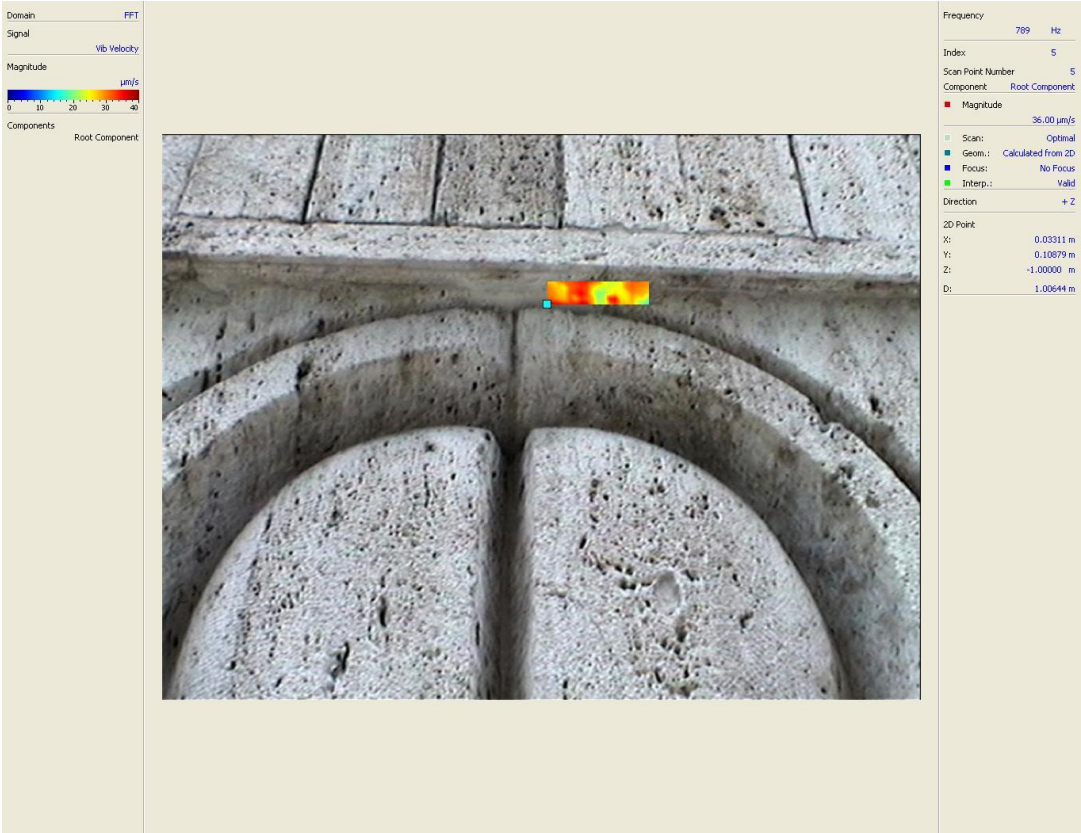
Zona 1:

Puncte scanare : 95

Periodic Chirp

Generator Functie

Type: NI 671x
Signal: Periodic Chirp
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



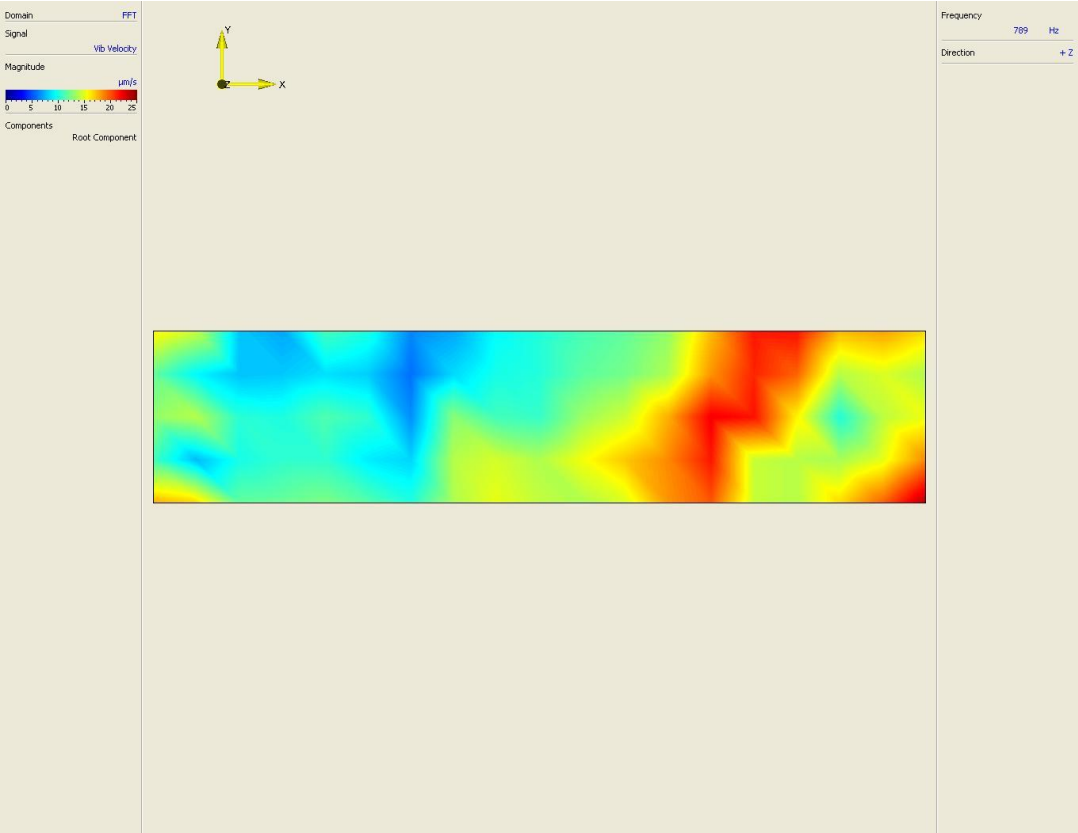
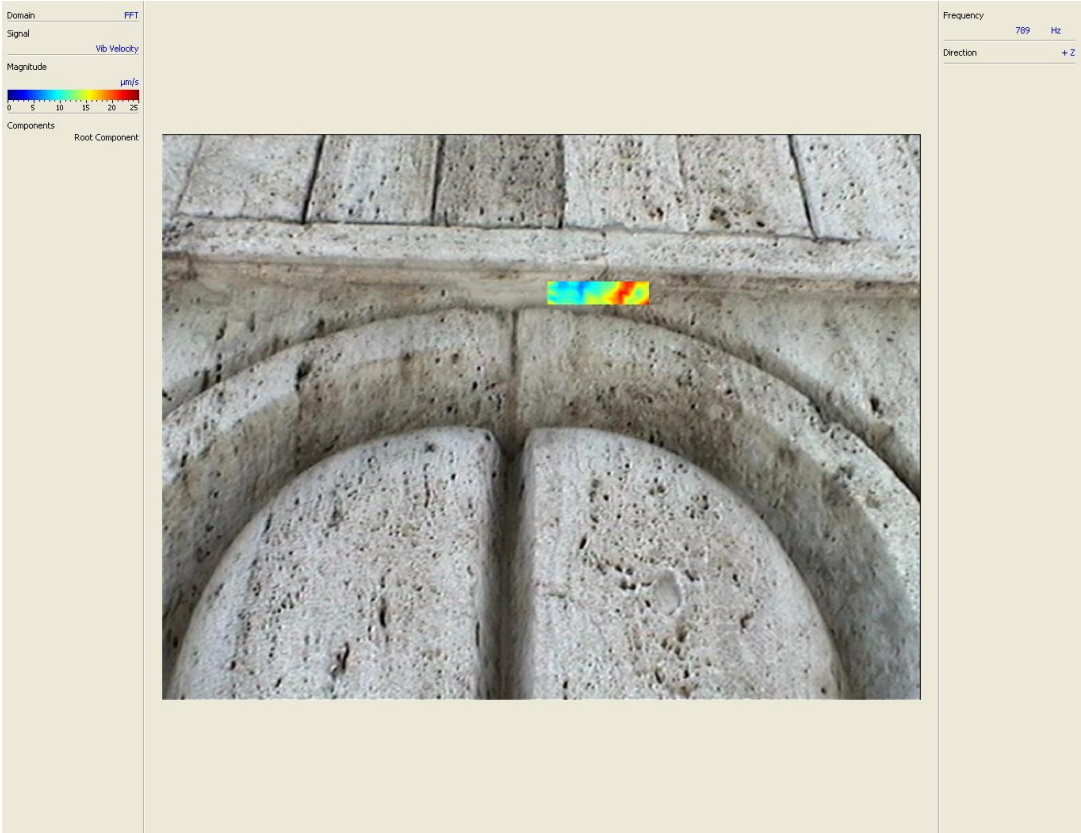
Zona 1:

Puncte scanare : 95

Pseudo Random

Generator Functie

Type: NI 671x
Signal: Pseudo Random
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



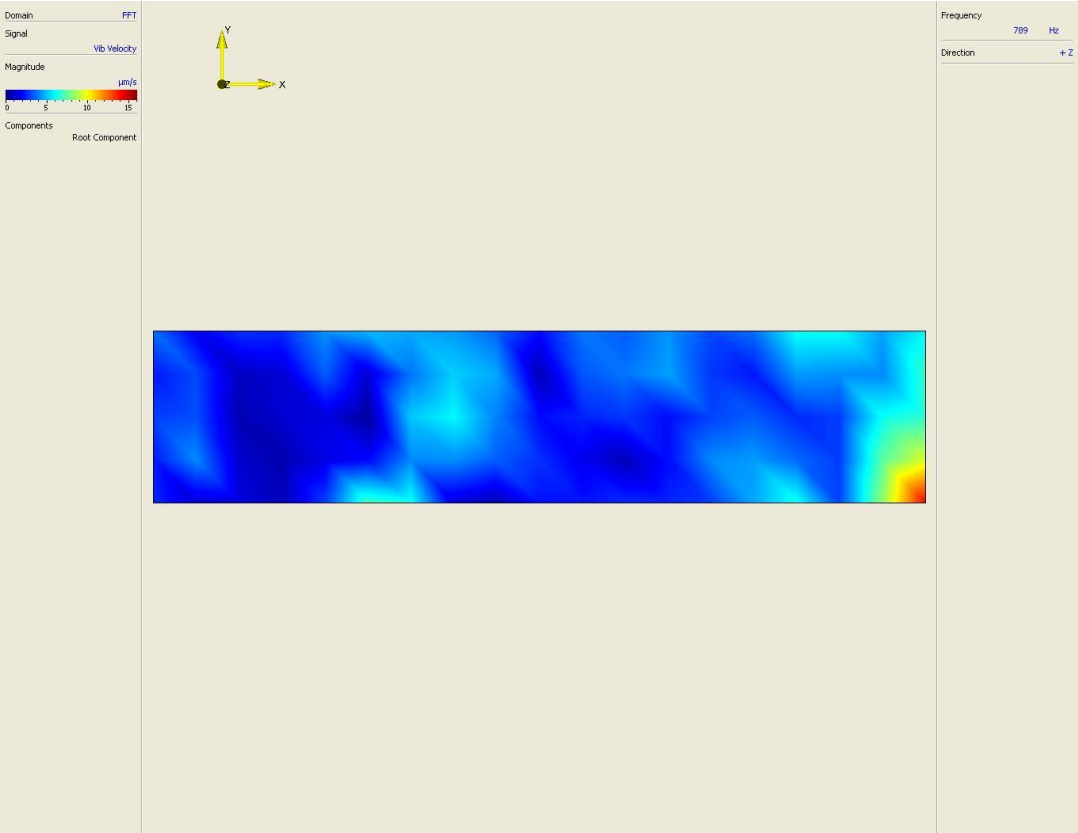
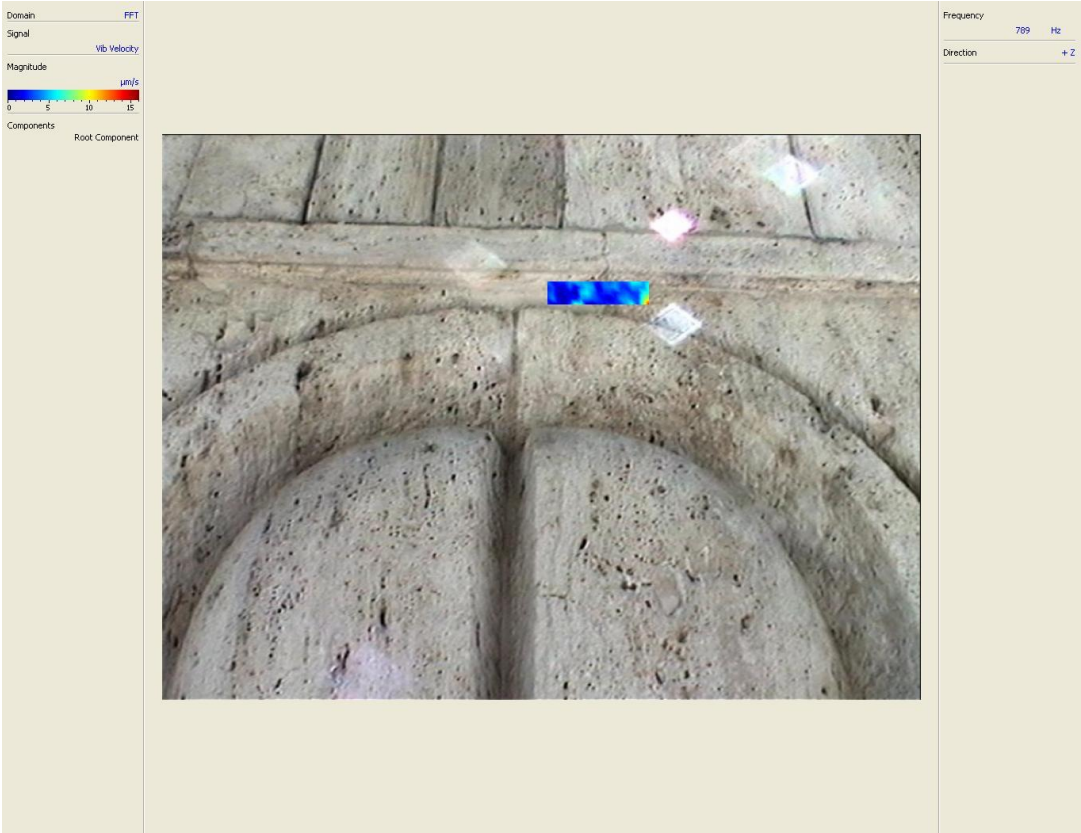
Zona 1:

Puncte scanare : 95

Ramp

Generator Functie

Type: NI 671x
Signal: Ramp
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



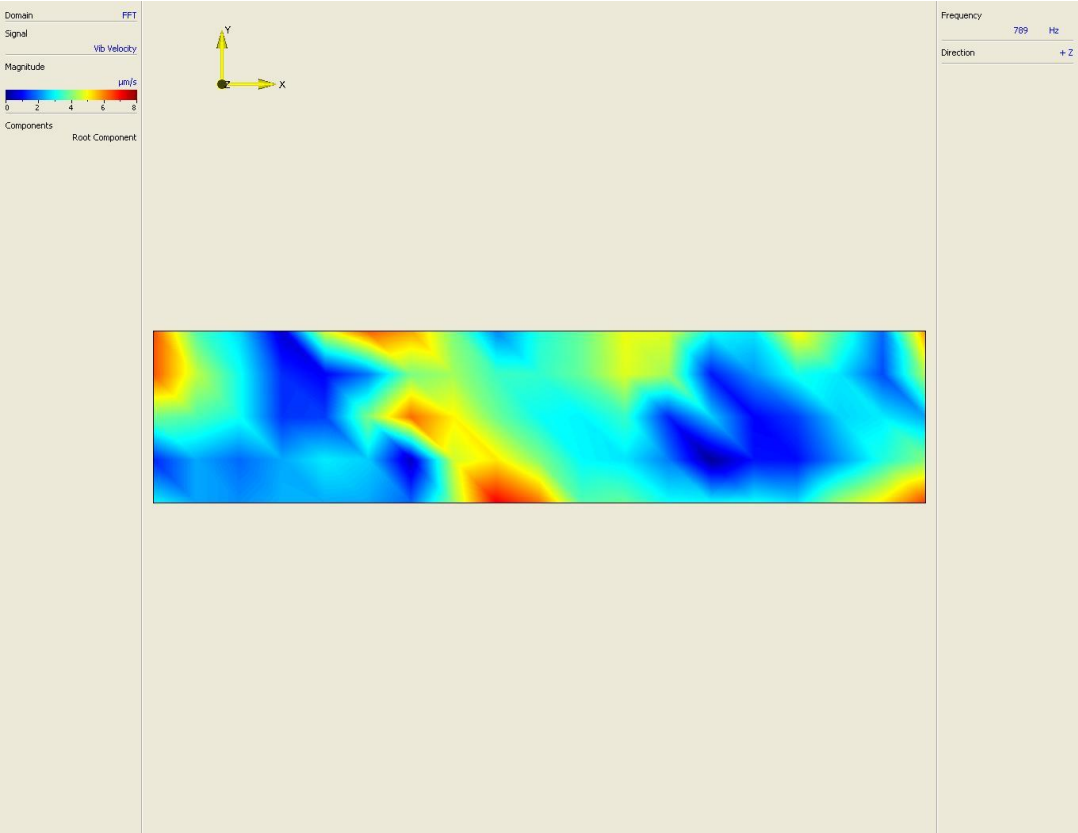
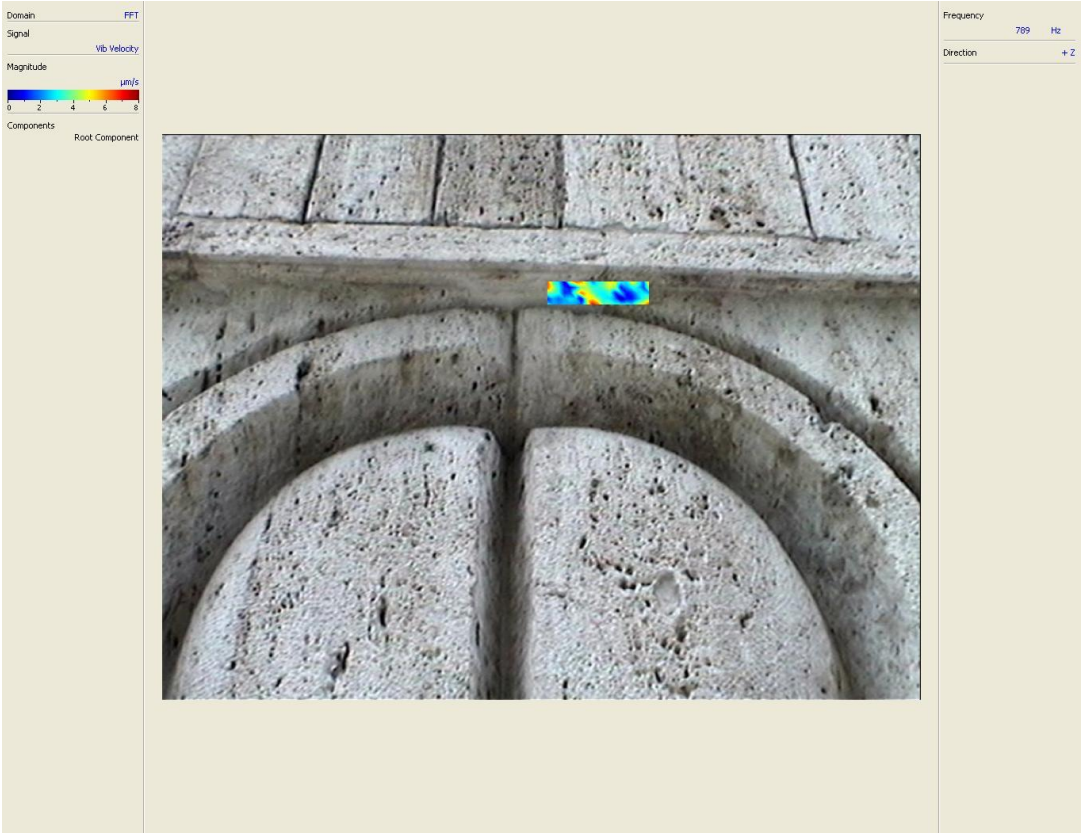
Zona 1:

Puncte scanare : 95

Sine

Generator Functie

Type: NI 671x
Signal: Sine
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



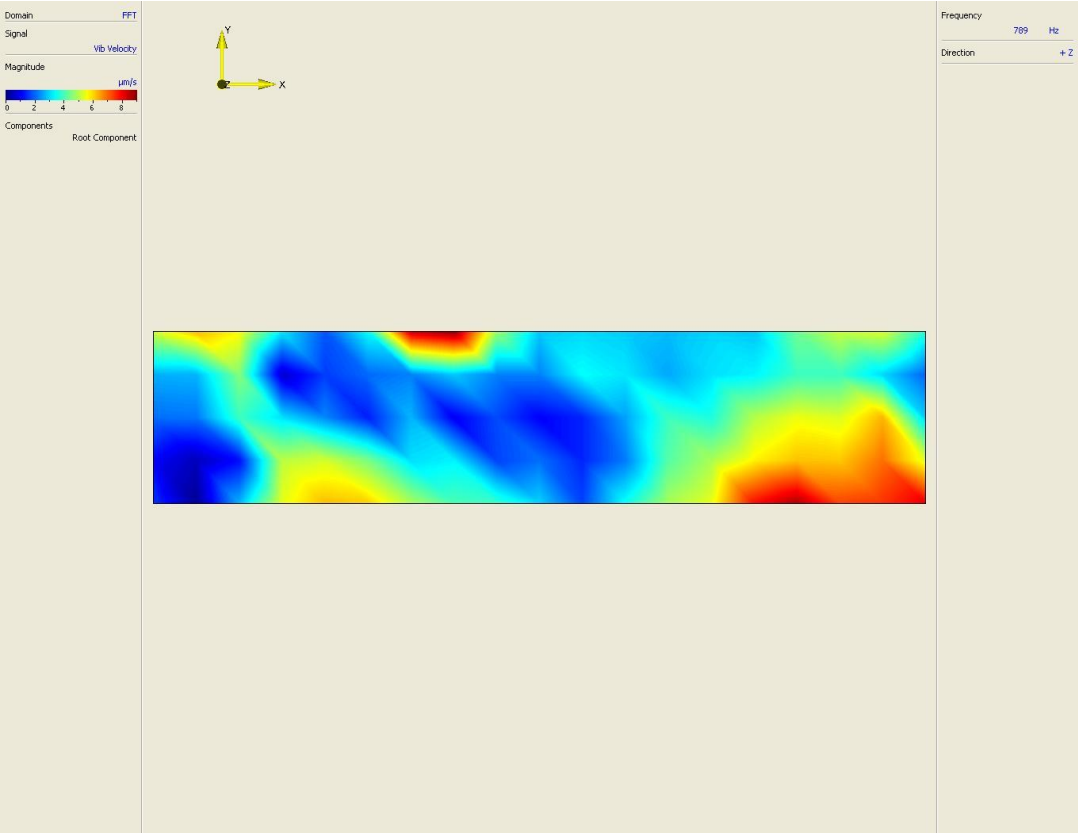
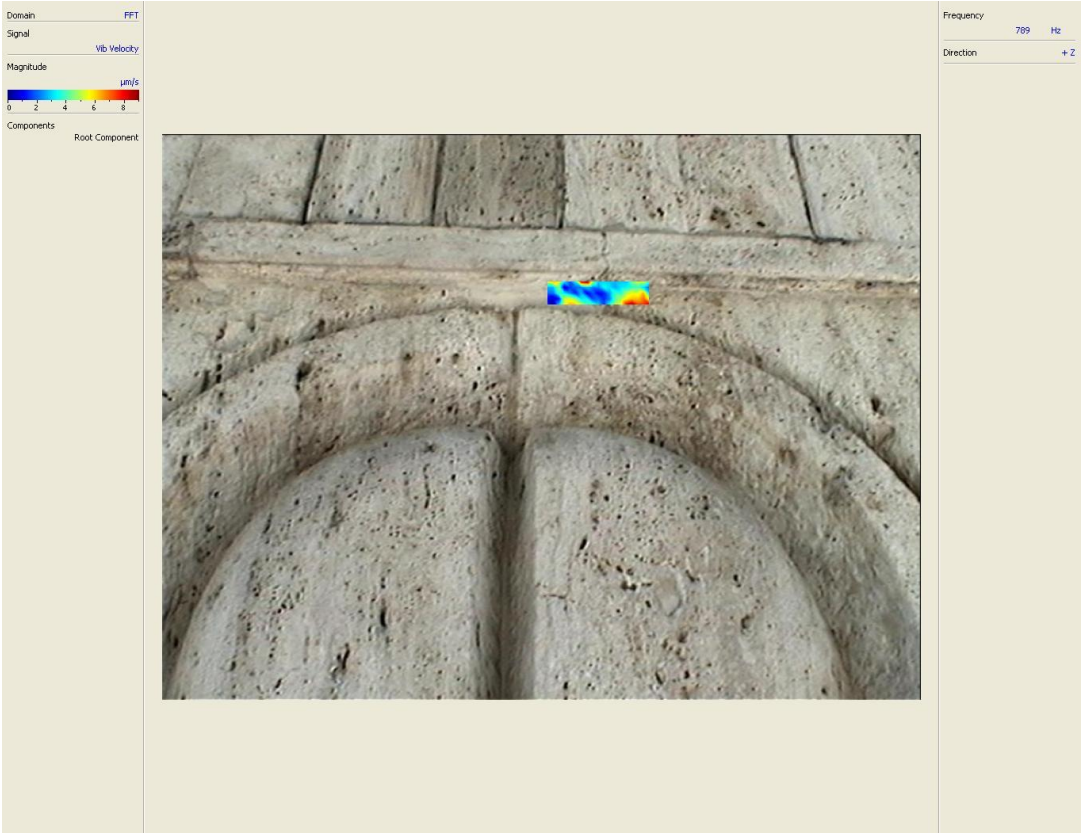
Zona 1:

Puncte scanare : 95

Square

Generator Functie

Type: NI 671x
Signal: Square
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



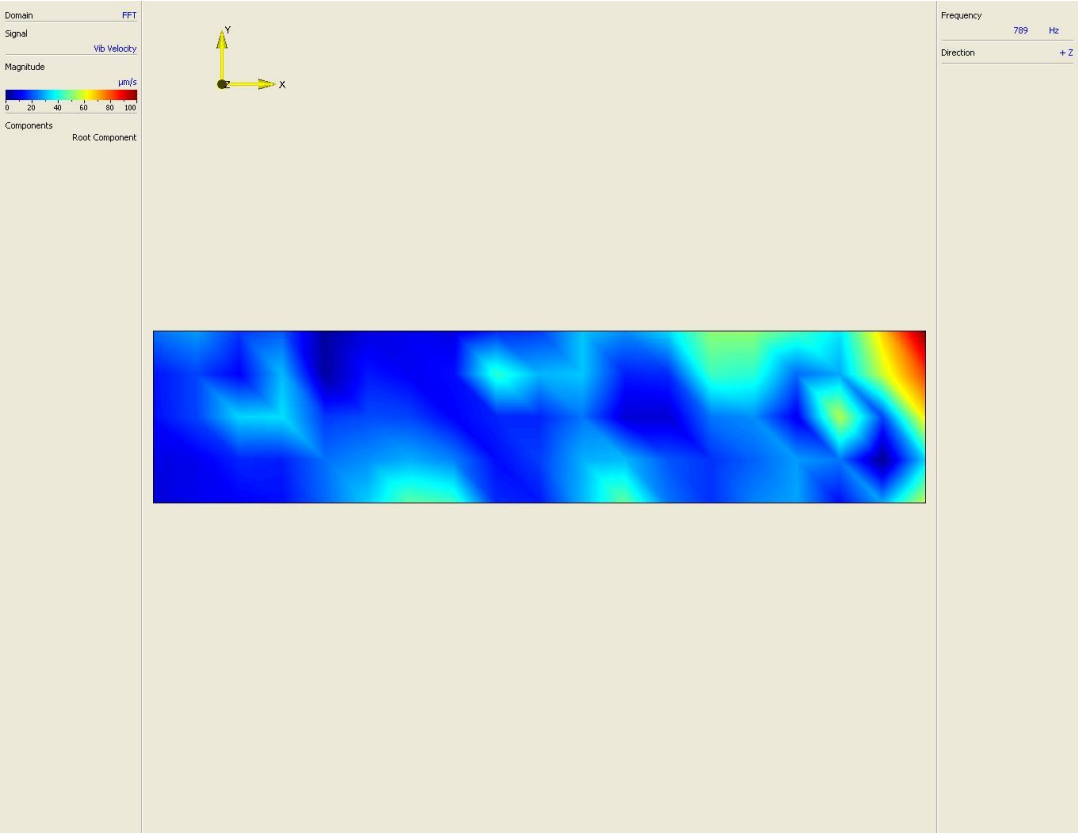
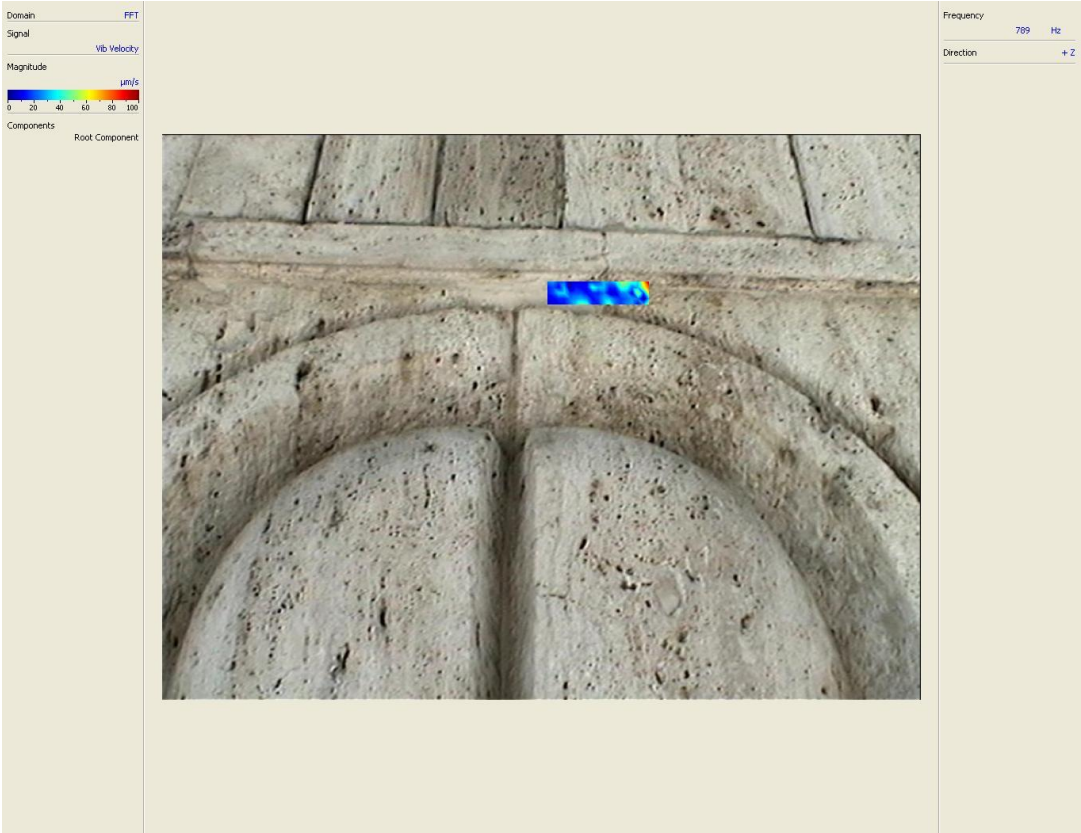
Zona 1:

Puncte scanare : 95

Sweep

Generator Functie

Type: NI 671x
Signal: Sweep
Amplitude: 5 V
Offset: 0 V
Sweep type: Linear
Start frequency: 100 Hz
End frequency: 700 Hz
Sweep time: 300 ms
Multiple Channels: Off



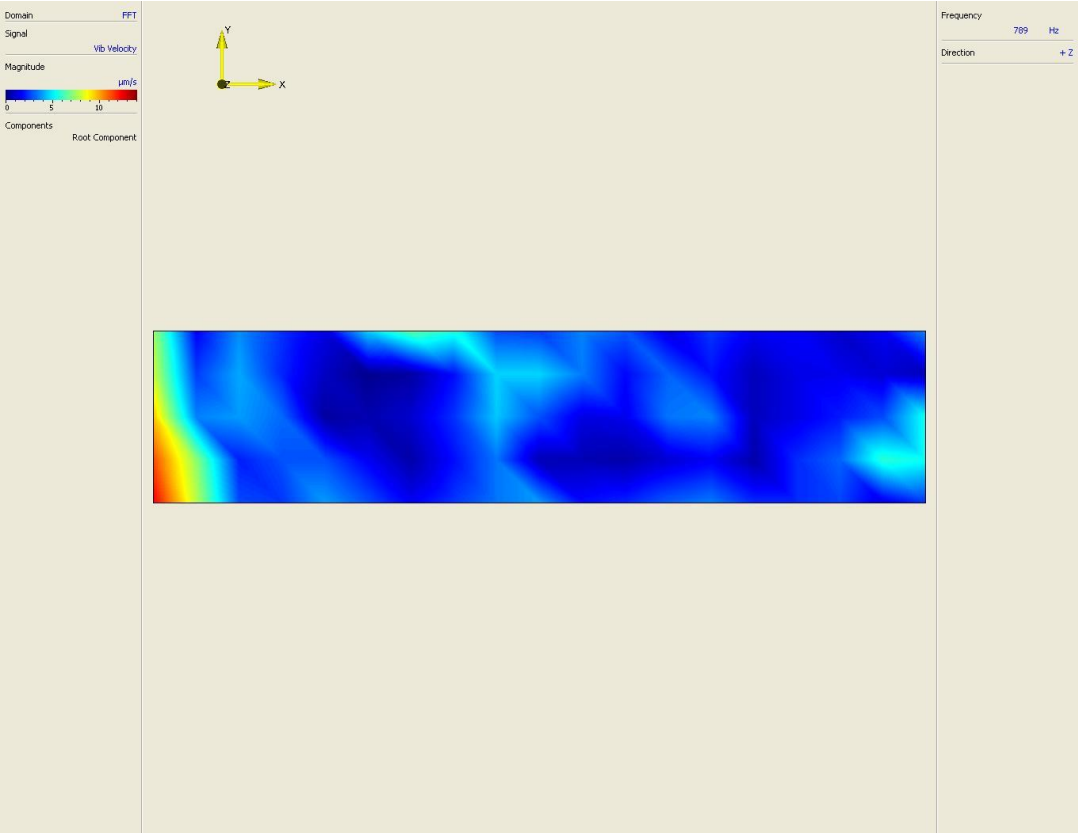
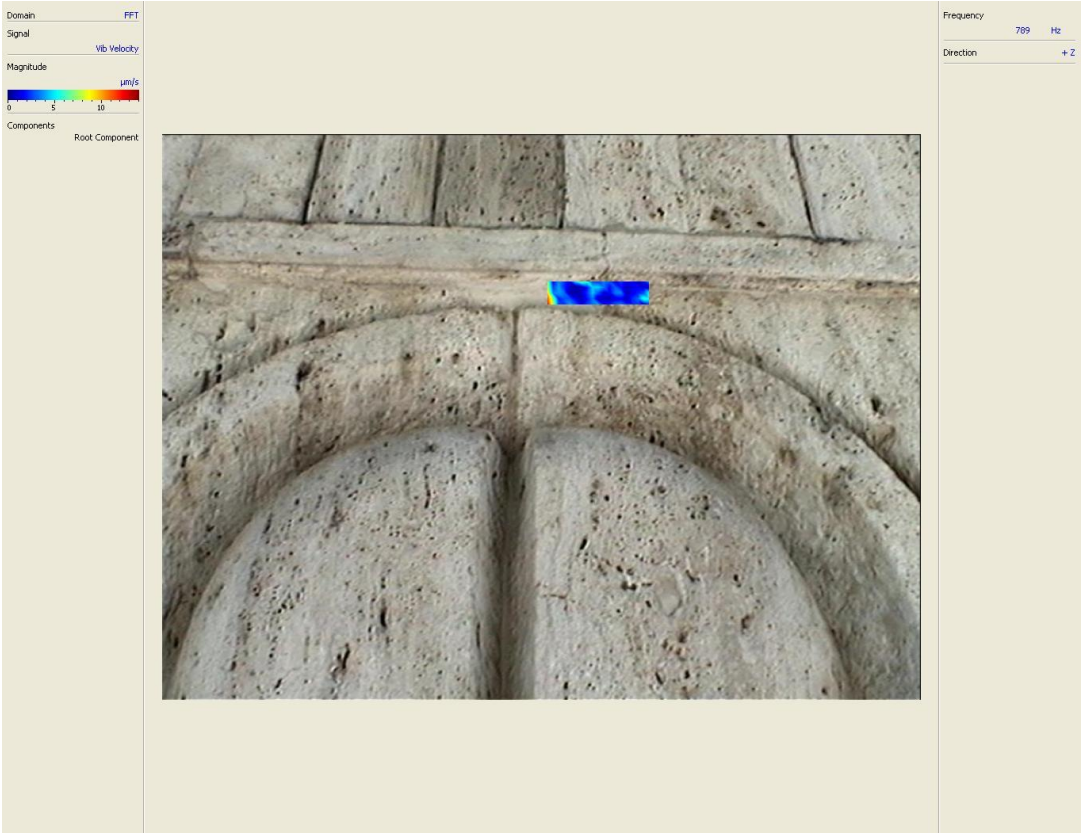
Zona 1:

Puncte scanare : 95

Triangle

Generator Functie

Type: NI 671x
Signal: Triangle
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



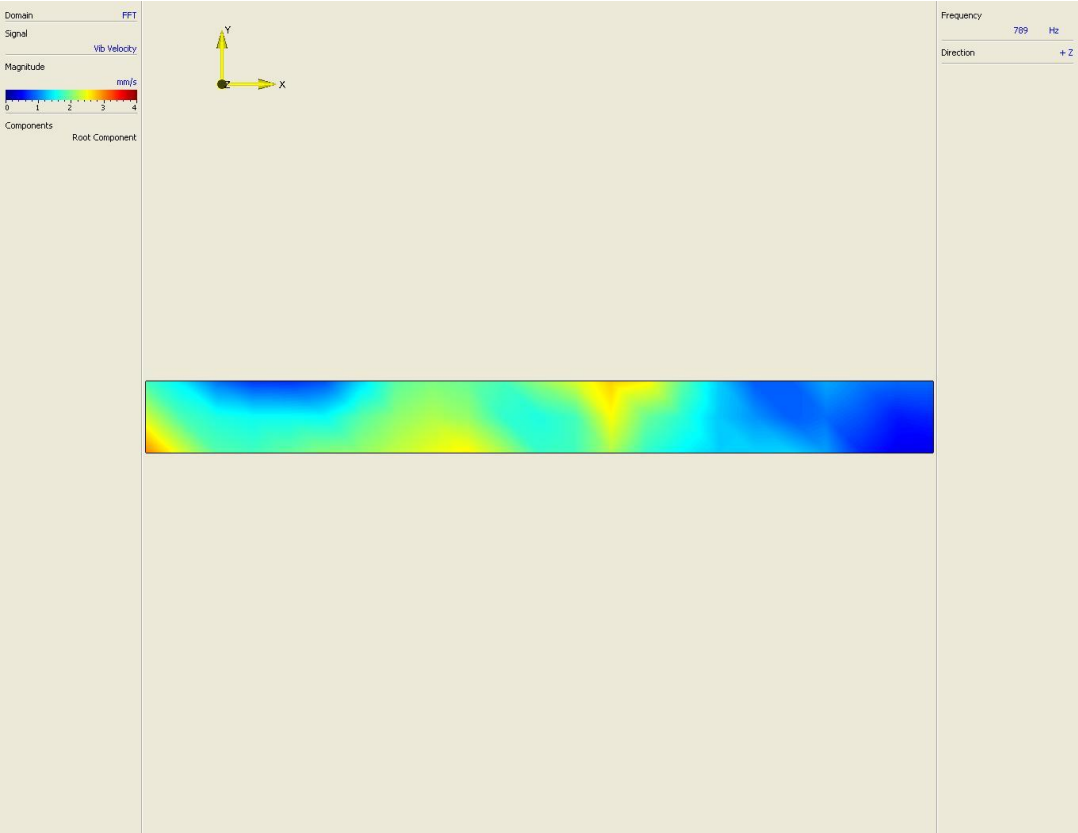
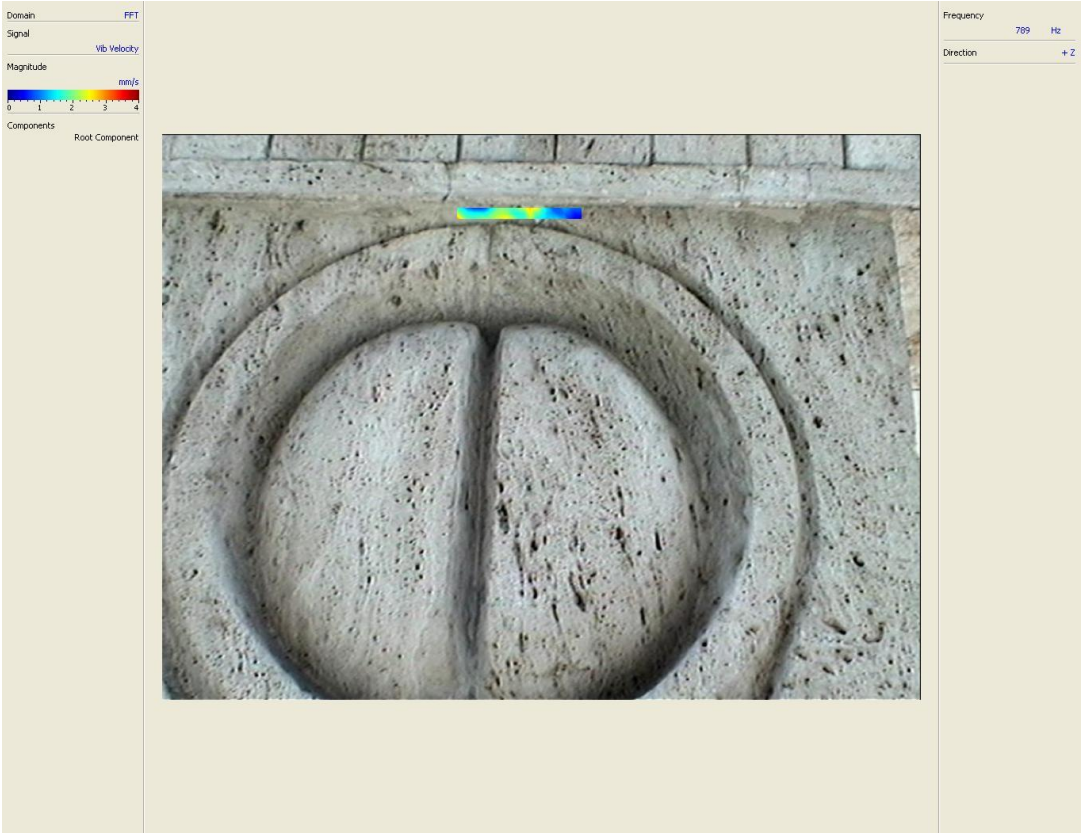
Zona 2:

Puncte scanare : 69

Burst Chirp

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 5 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



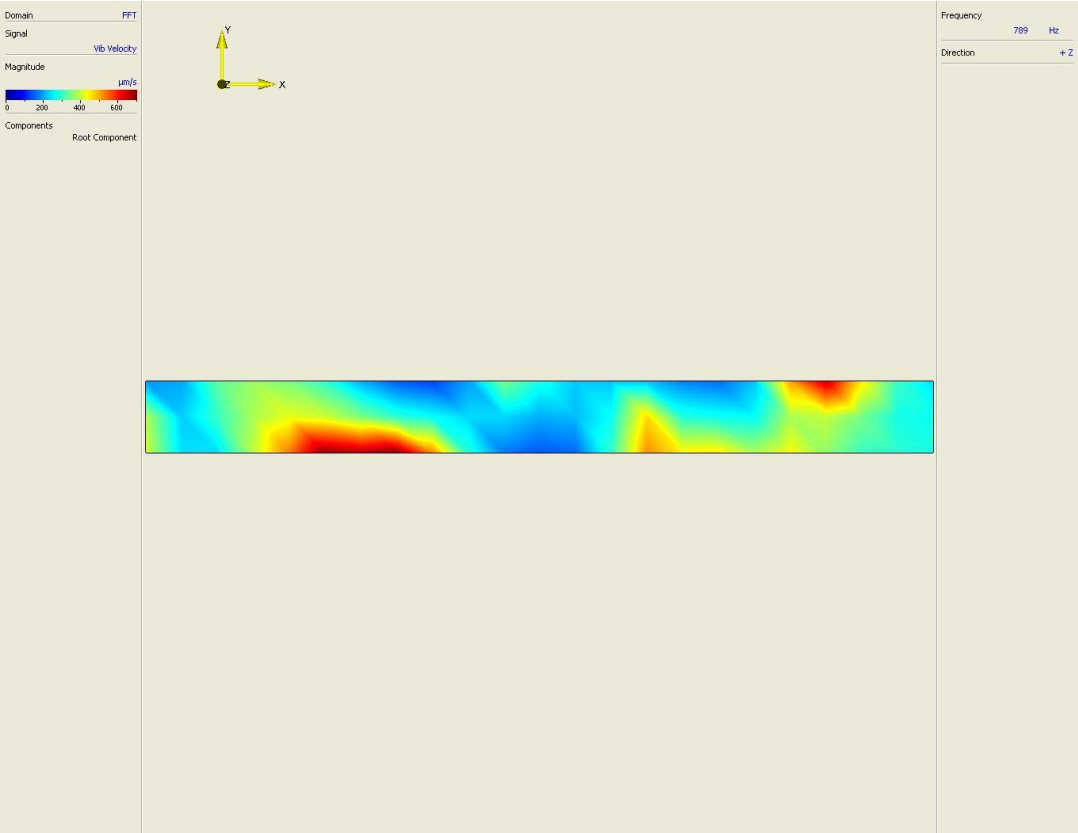
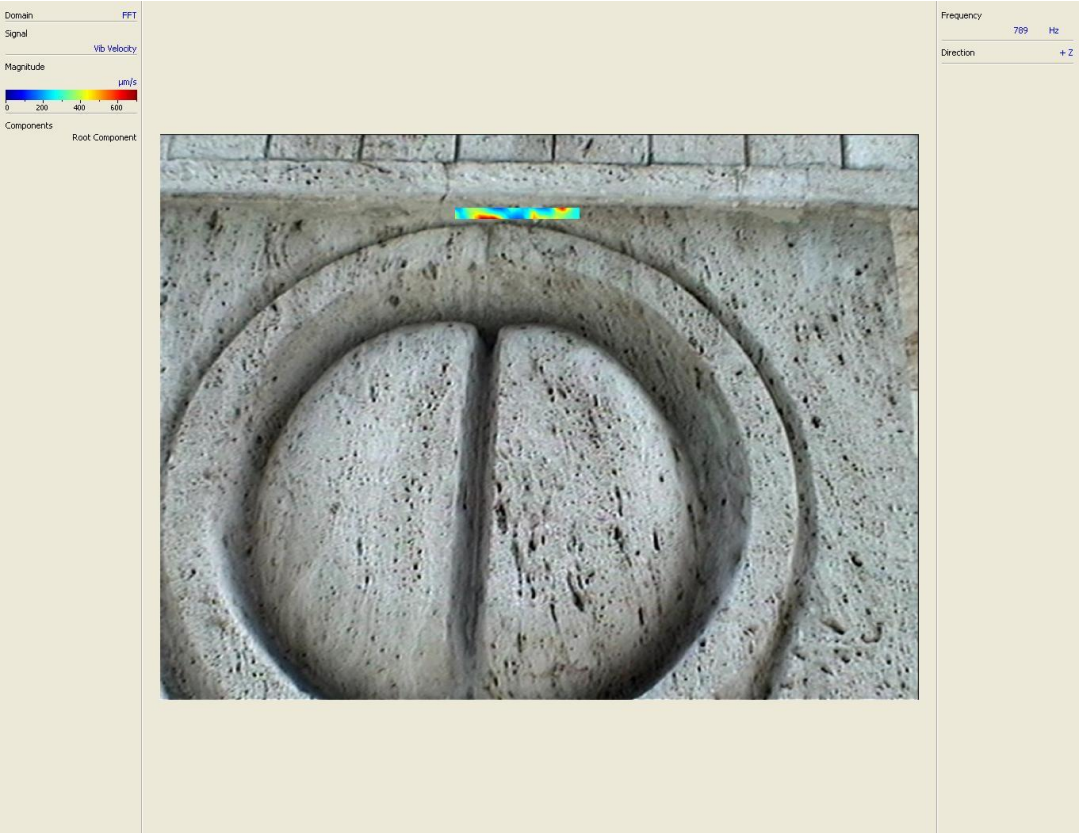
Zona 2:

Punte scanare : 69

Burst Random

Generator Functie

Type: NI 671x
Signal: Burst
Random
Amplitude: 5 V
Offset: 0 V
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



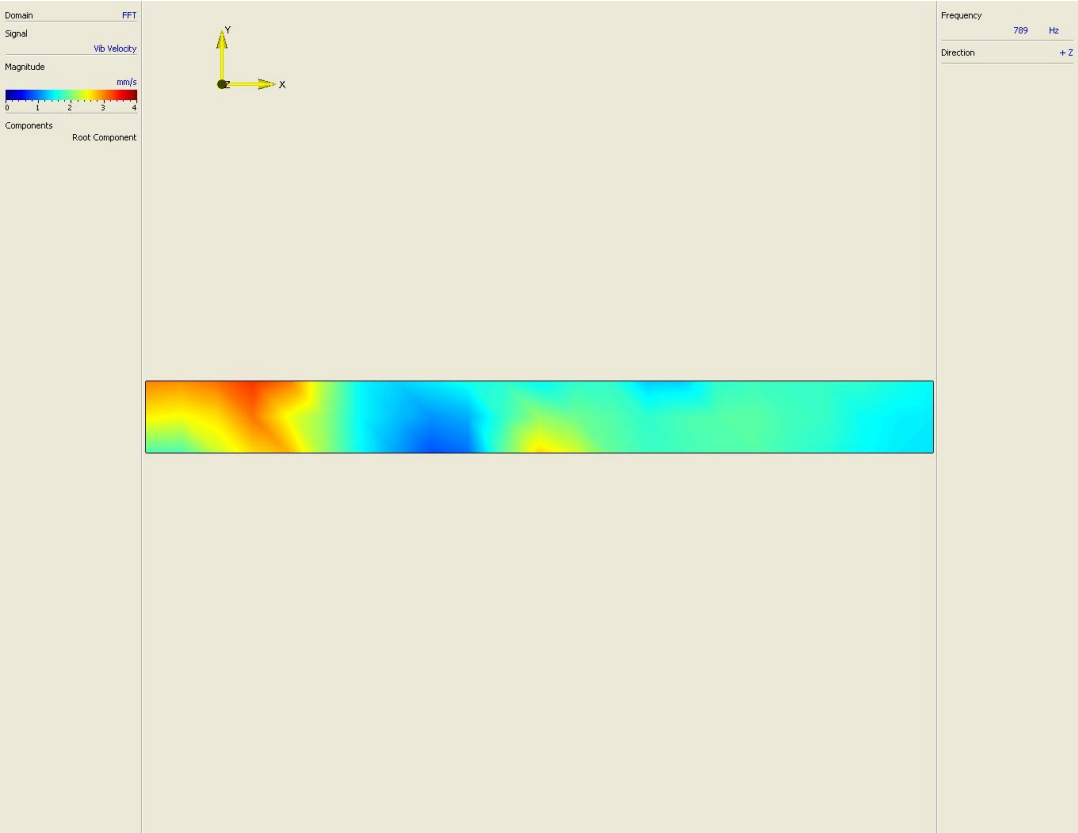
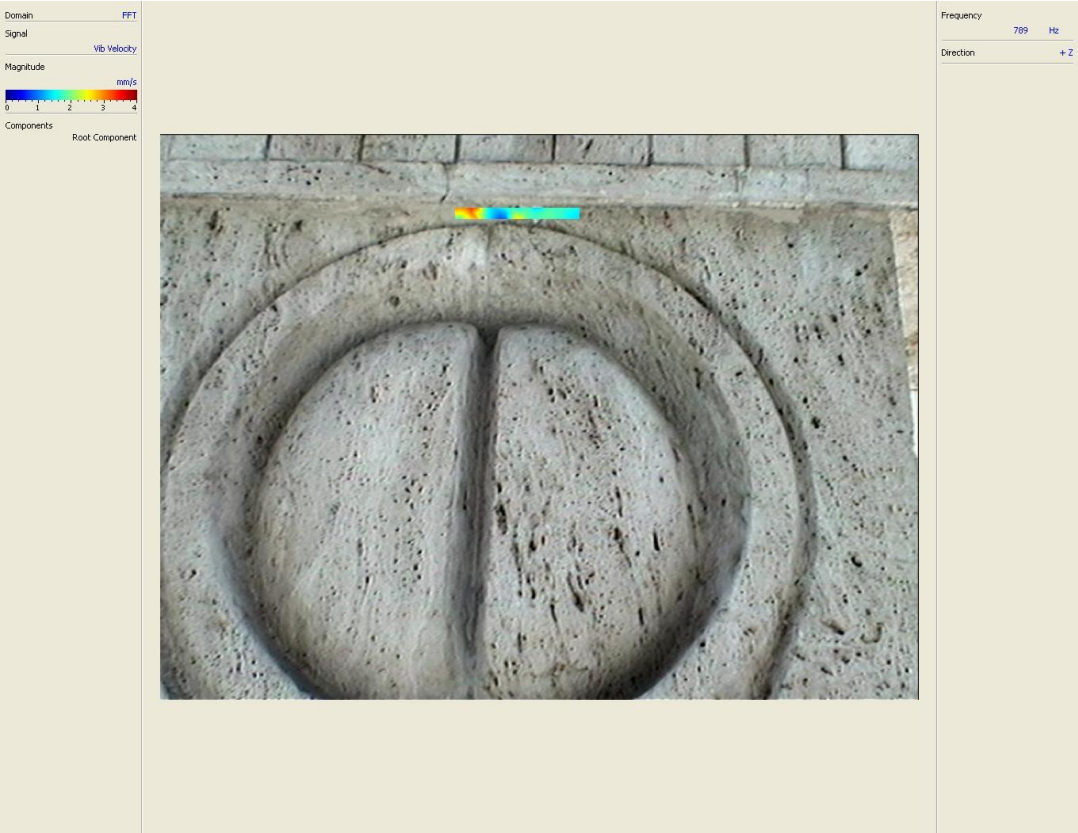
Zona 2:

Puncte scanare : 69

Periodic Chirp

Generator Functie

Type: NI 671x
Signal: Periodic Chirp
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



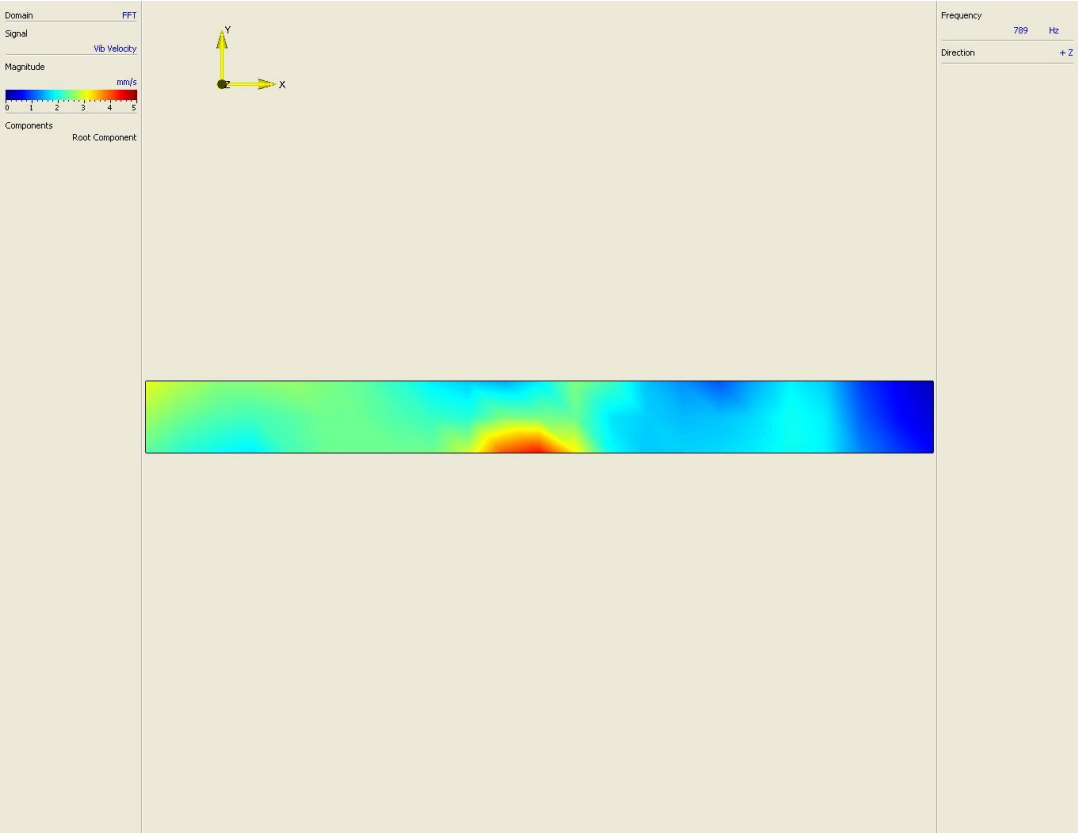
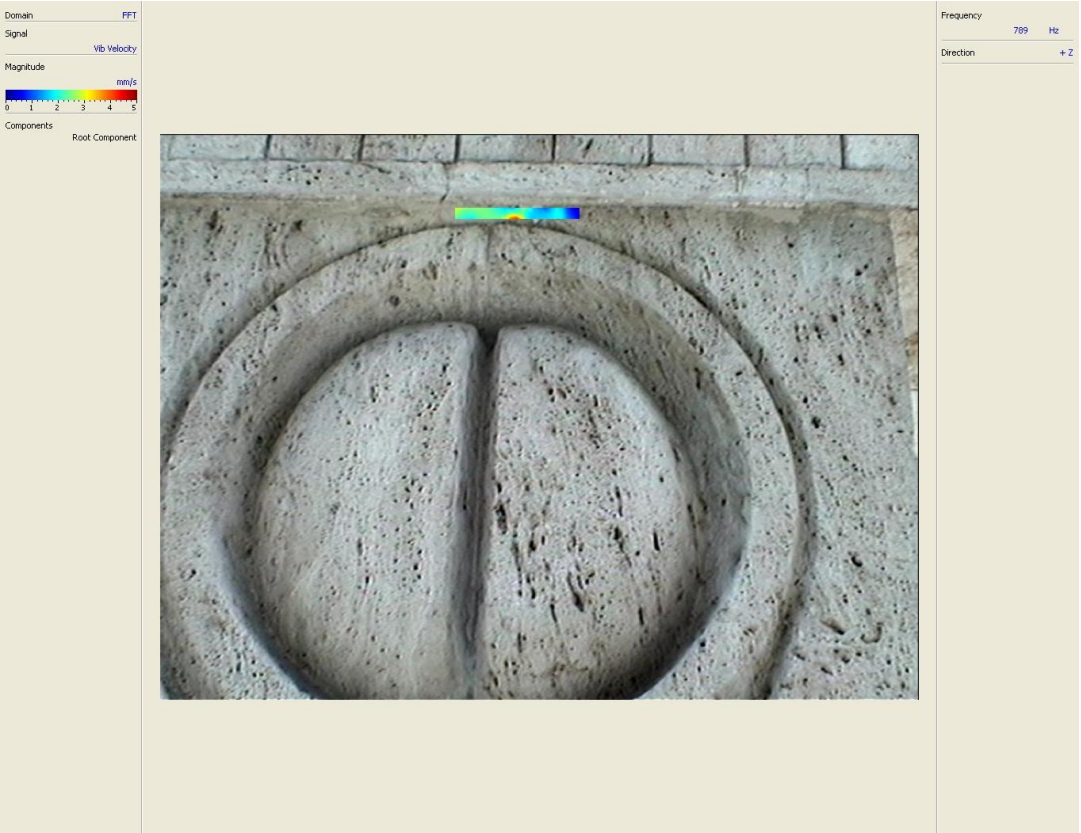
Zona 2:

Puncte scanare : 69

Pseudo Random

Generator Functie

Type: NI 671x
Signal: Pseudo Random
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



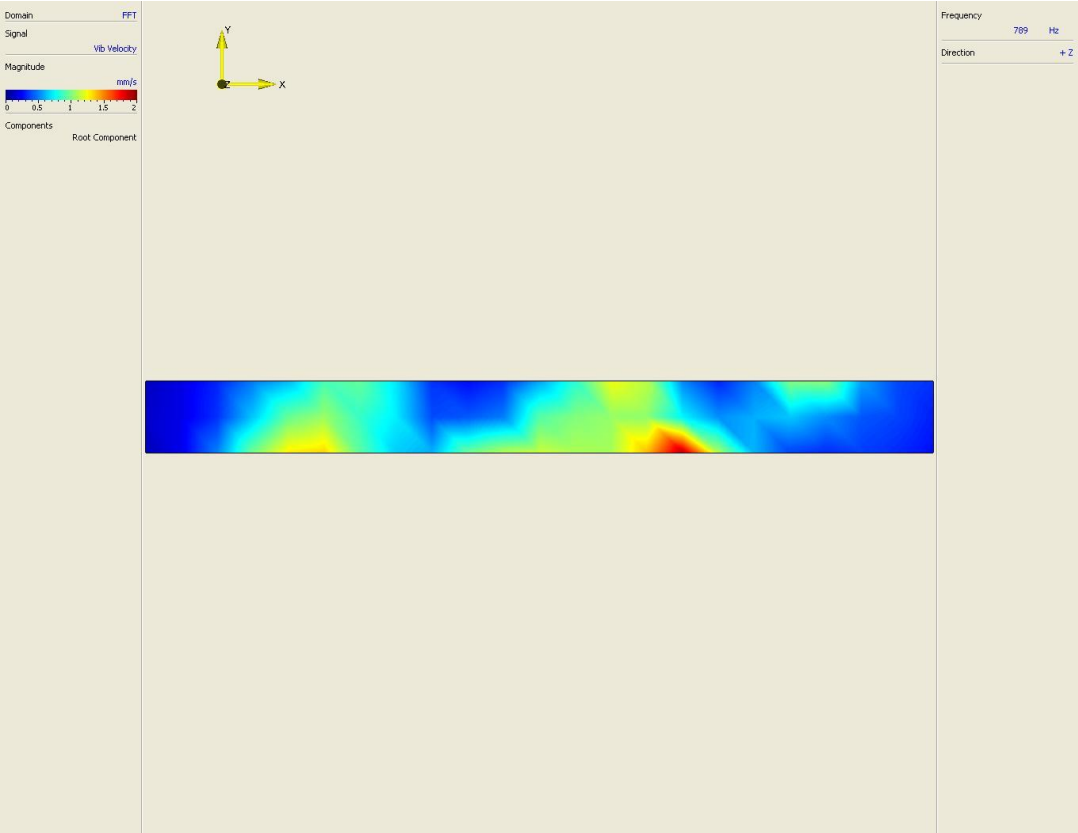
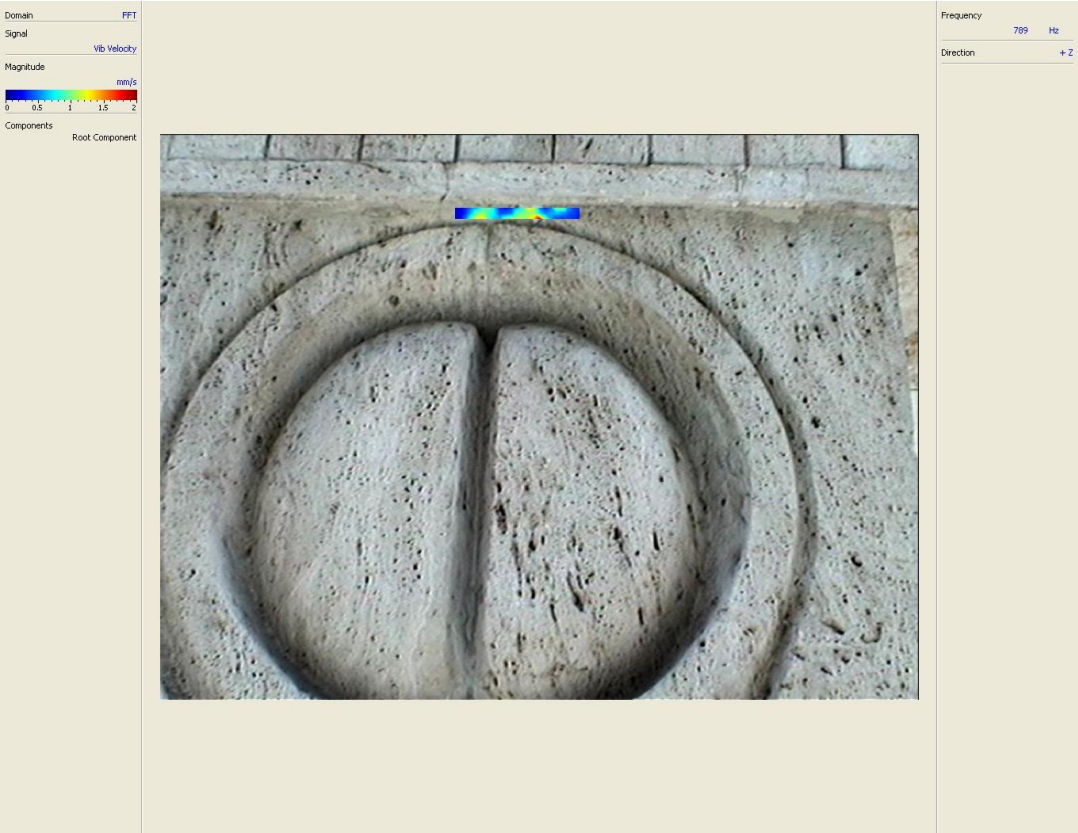
Zona 2:

Puncte scanare : 69

Ramp

Generator Functie

Type: NI 671x
Signal: Ramp
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



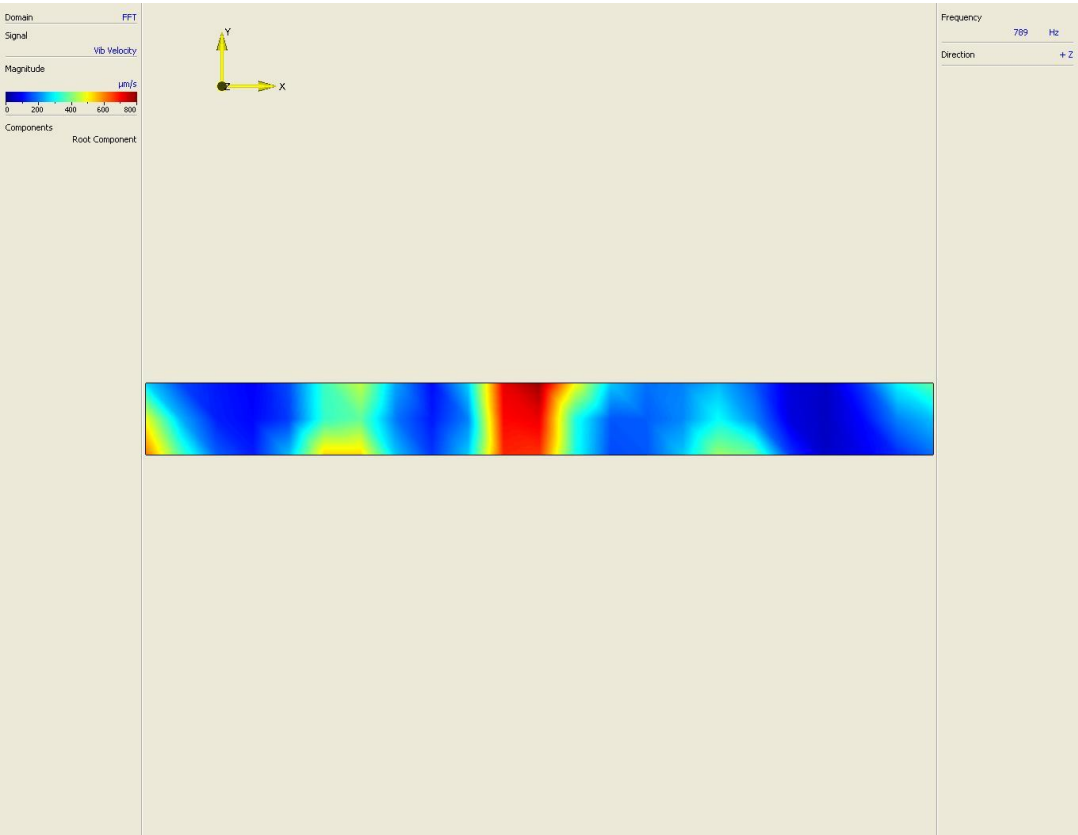
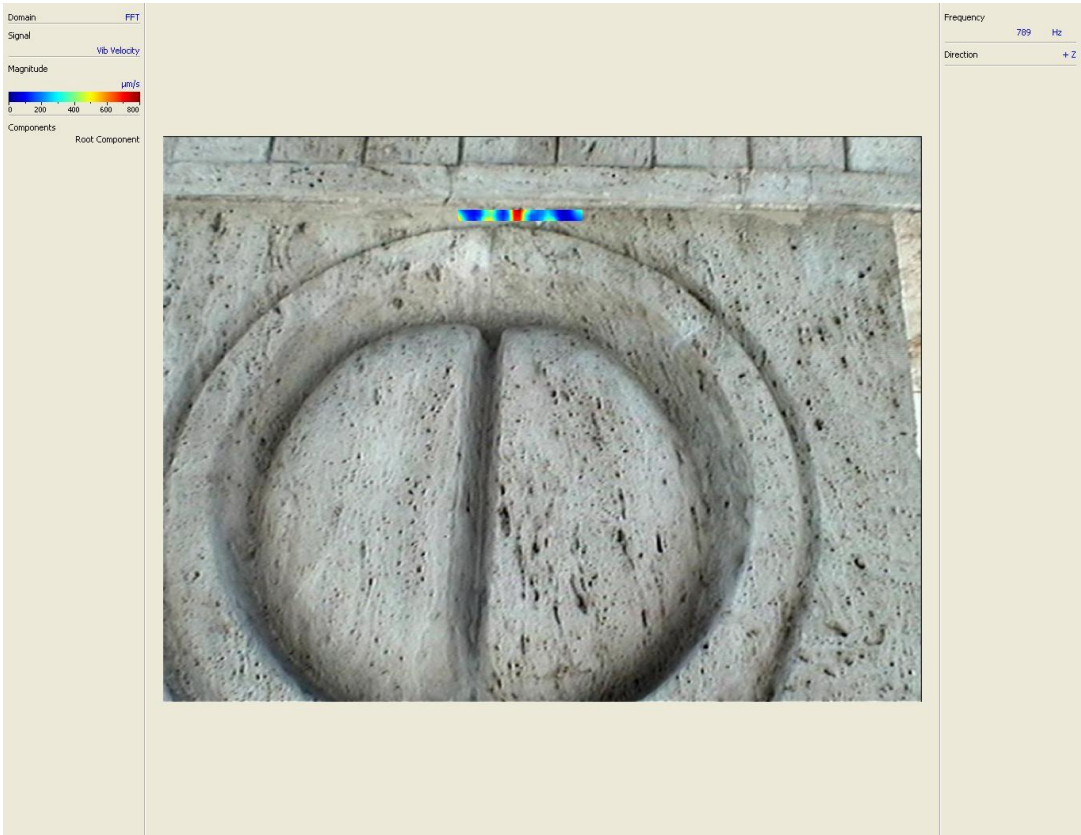
Zona 2:

Puncte scanare : 69

Sine

Generator Functie

Type: NI 671x
Signal: Sine
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



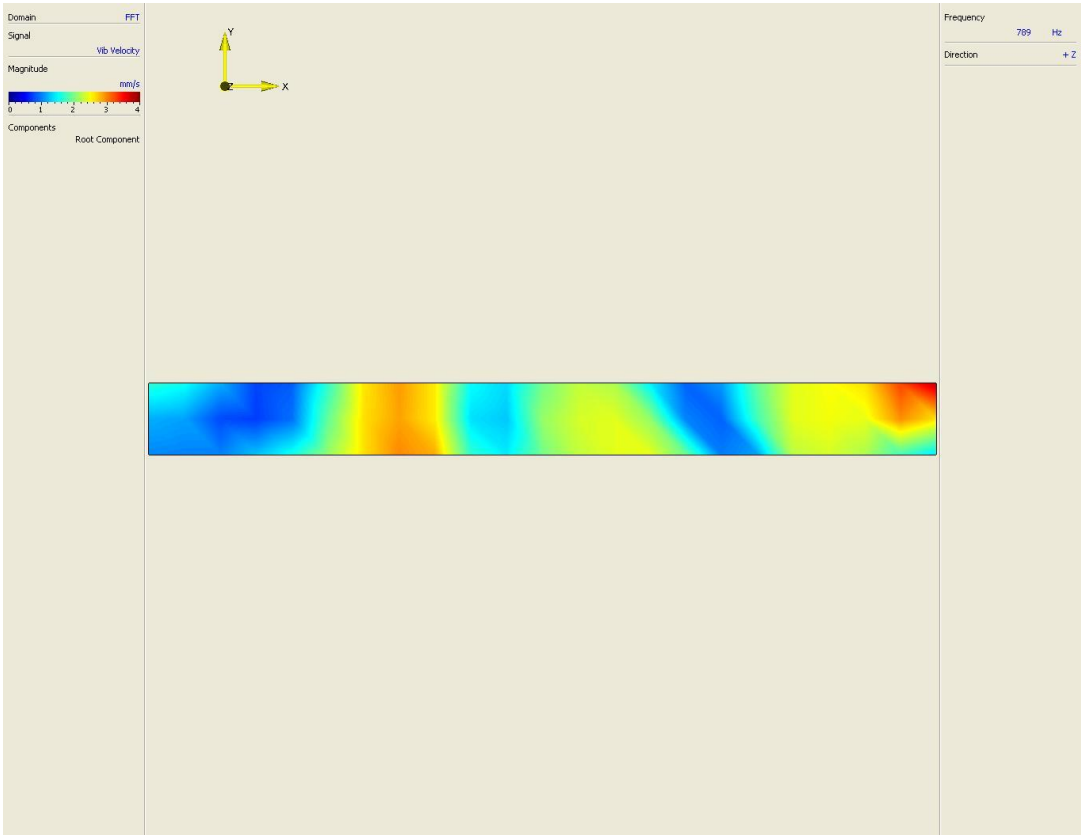
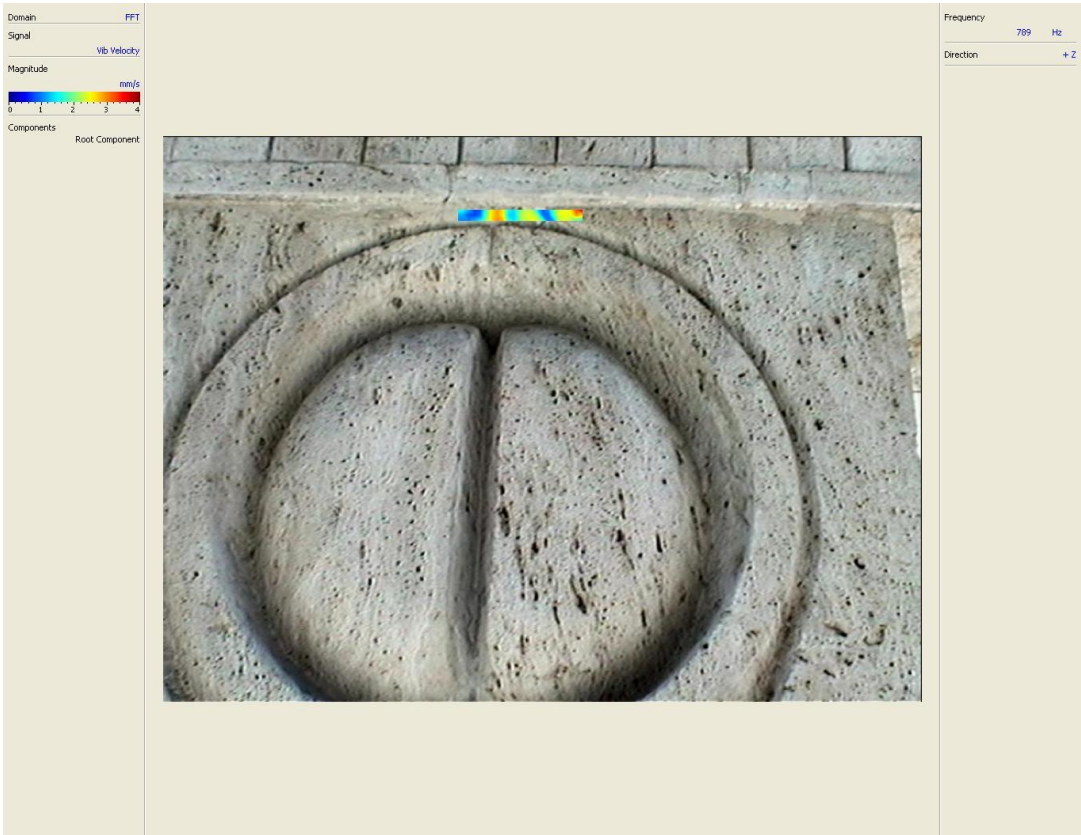
Zona 2:

Puncte scanare : 69

Sine, 5kHz

Generator Functie

Type: NI 671x
Signal: Sine
Frequency: 5 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



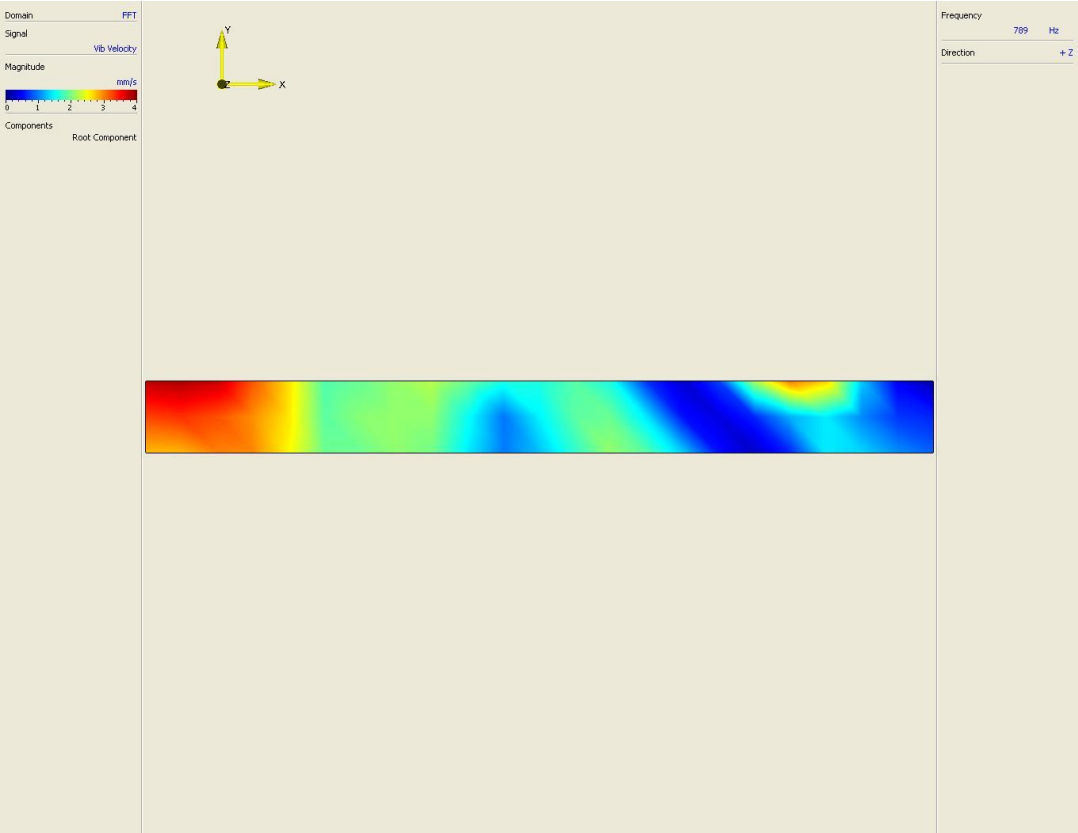
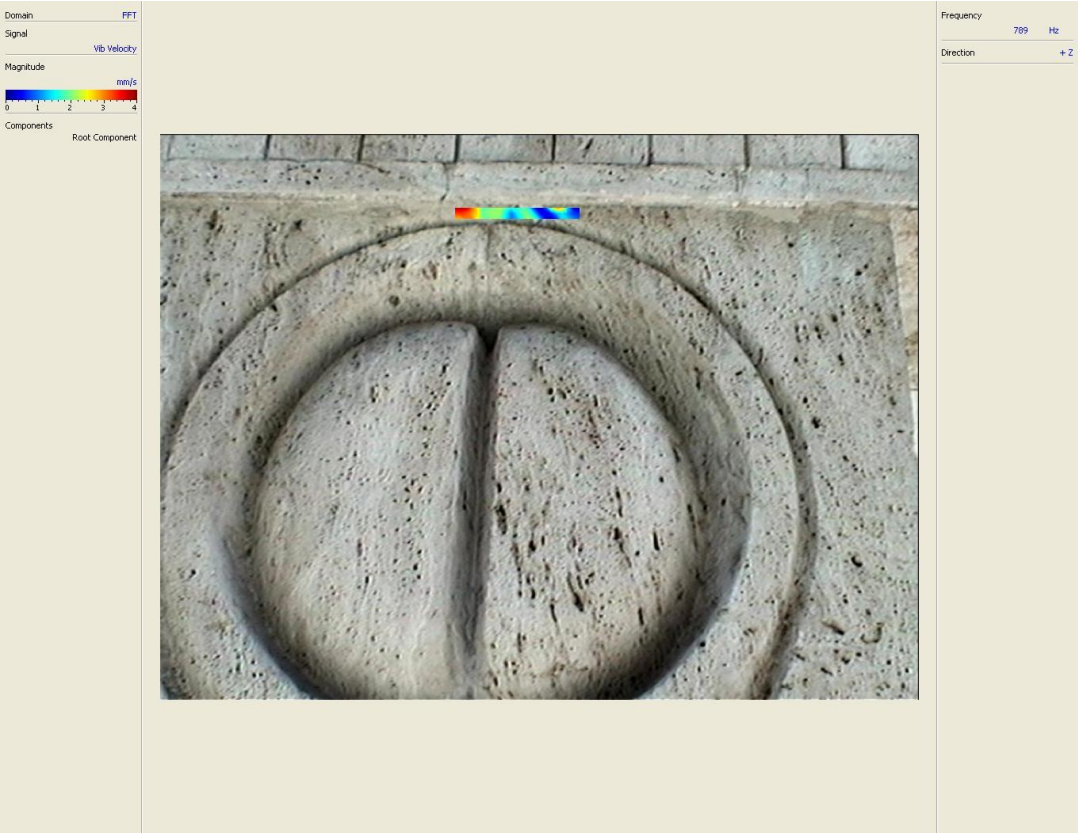
Zona 2:

Puncte scanare : 69

Sine, 7,5 V

Generator Functie

Type: NI 671x
Signal: Sine
Frequency: 10 kHz
Amplitude: 7.5 V
Offset: 0 V
Multiple Channels: Off



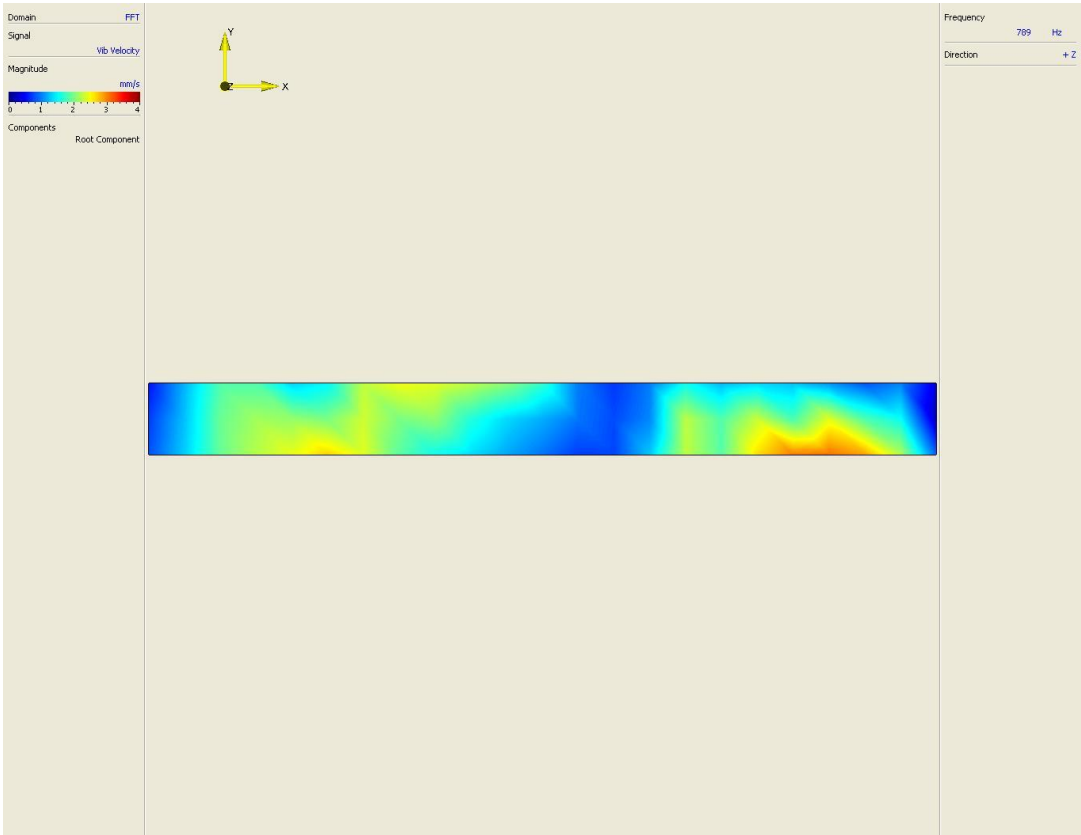
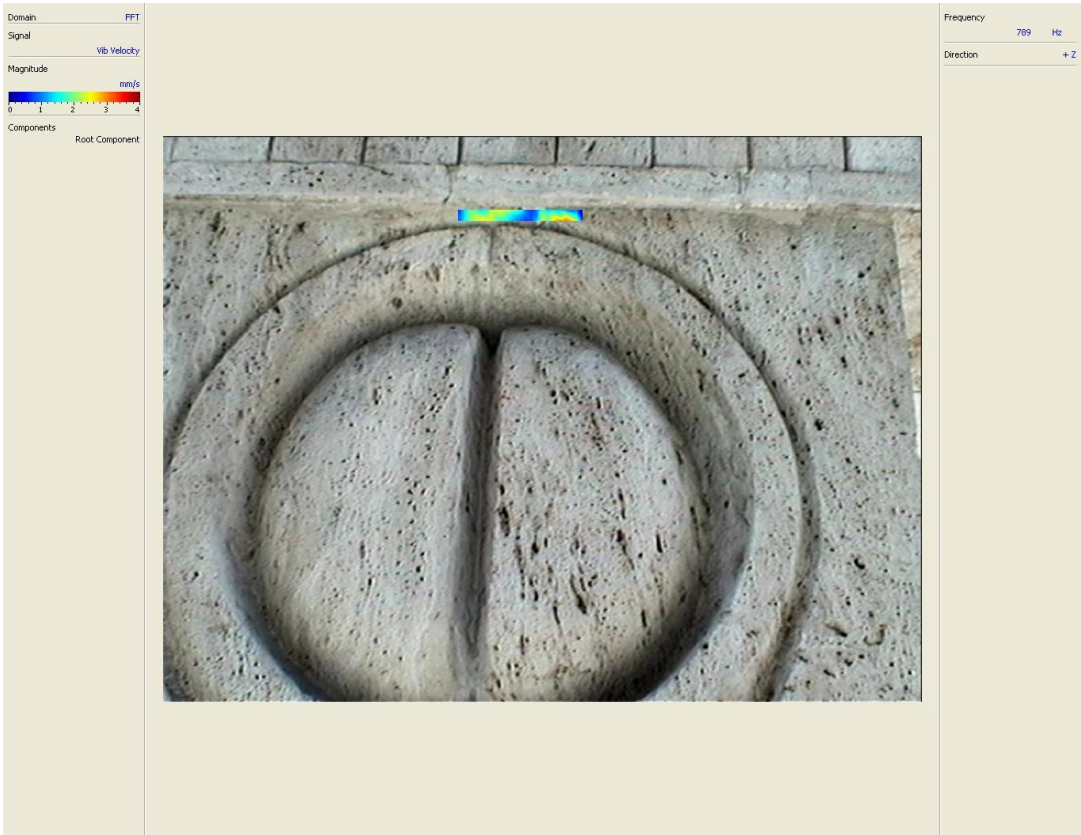
Zona 2:

Puncte scanare : 69

Sine, 10 V

Generator Functie

Type: NI 671x
Signal: Sine
Frequency: 10 kHz
Amplitude: 10 V
Offset: 0 V
Multiple Channels: Off



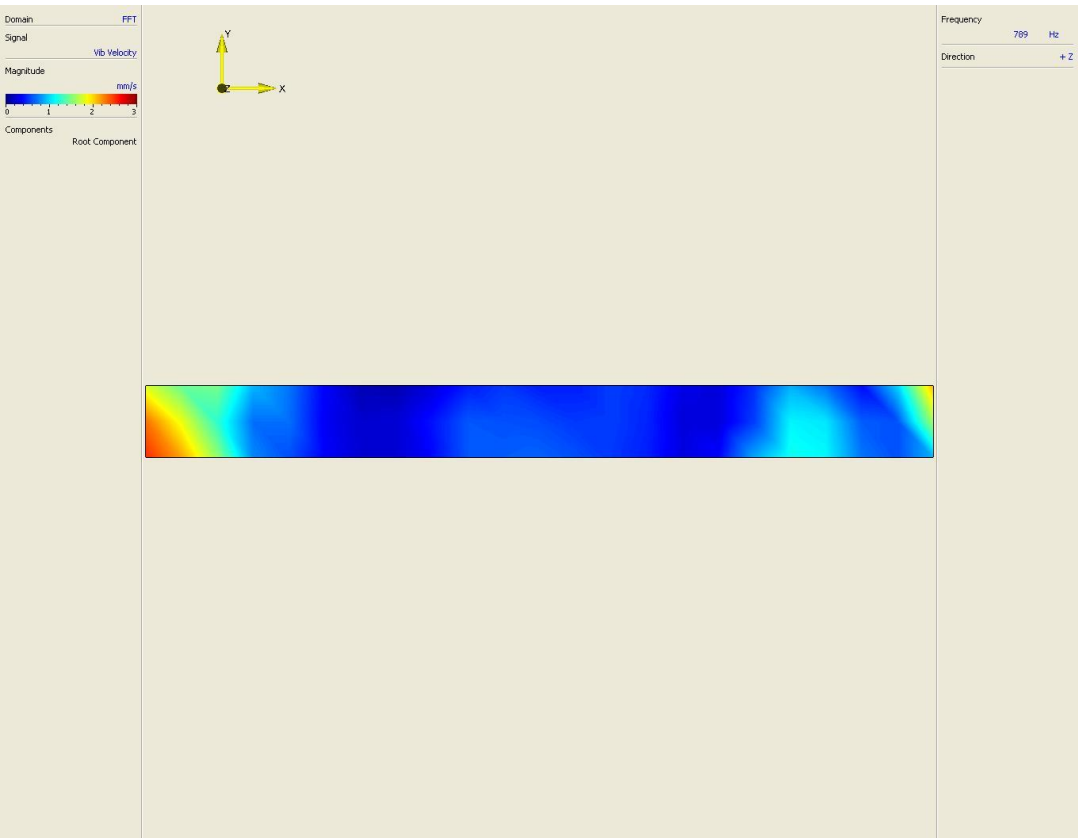
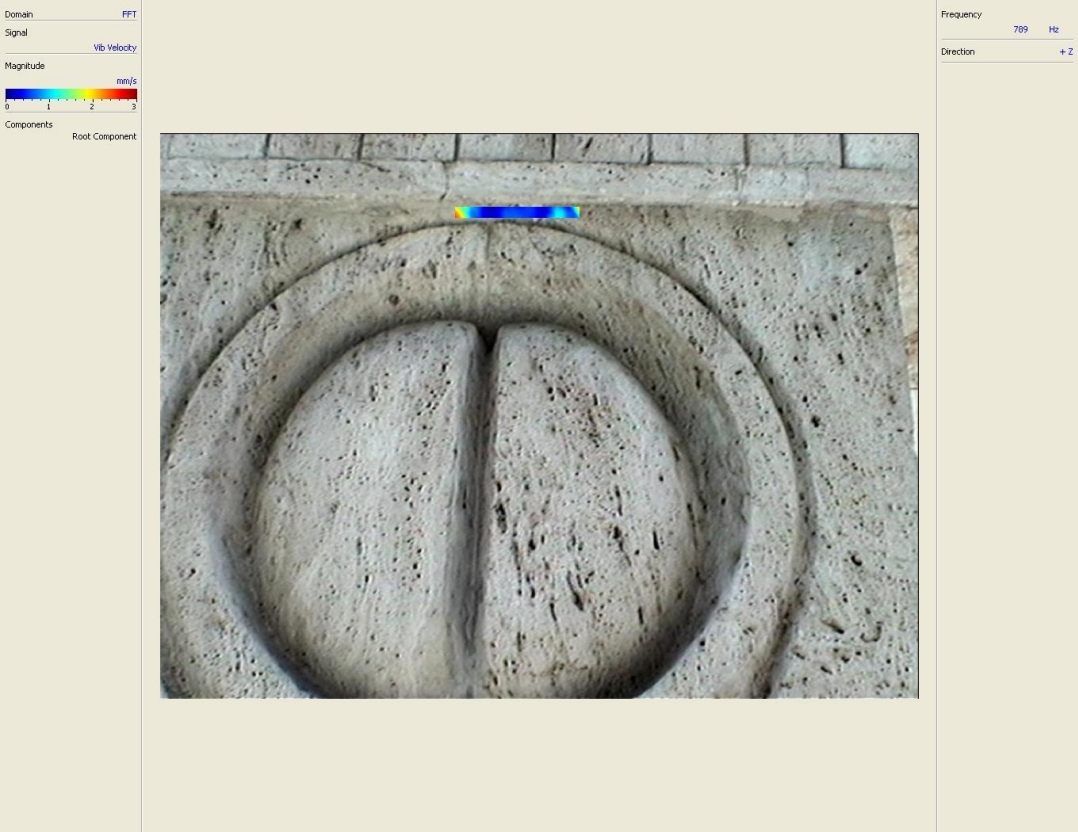
Zona 2:

Punte scanare : 69

Square

Generator Functie

Type: NI 671x
Signal: Square
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



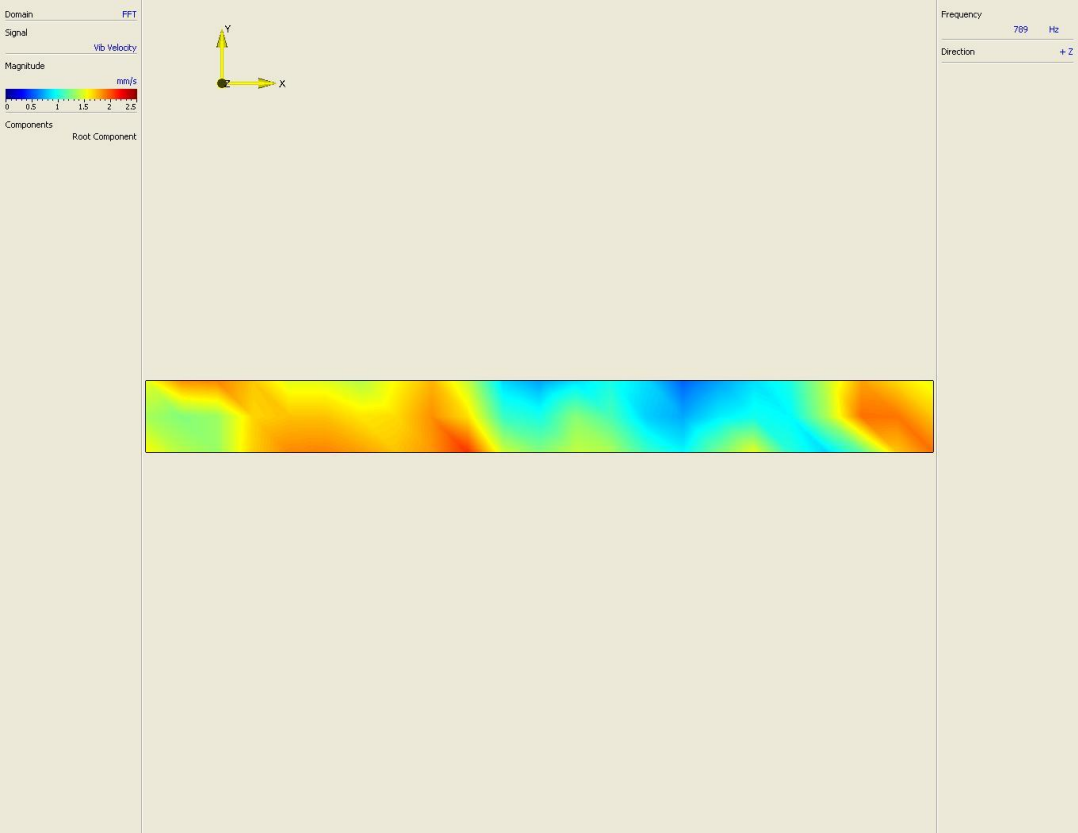
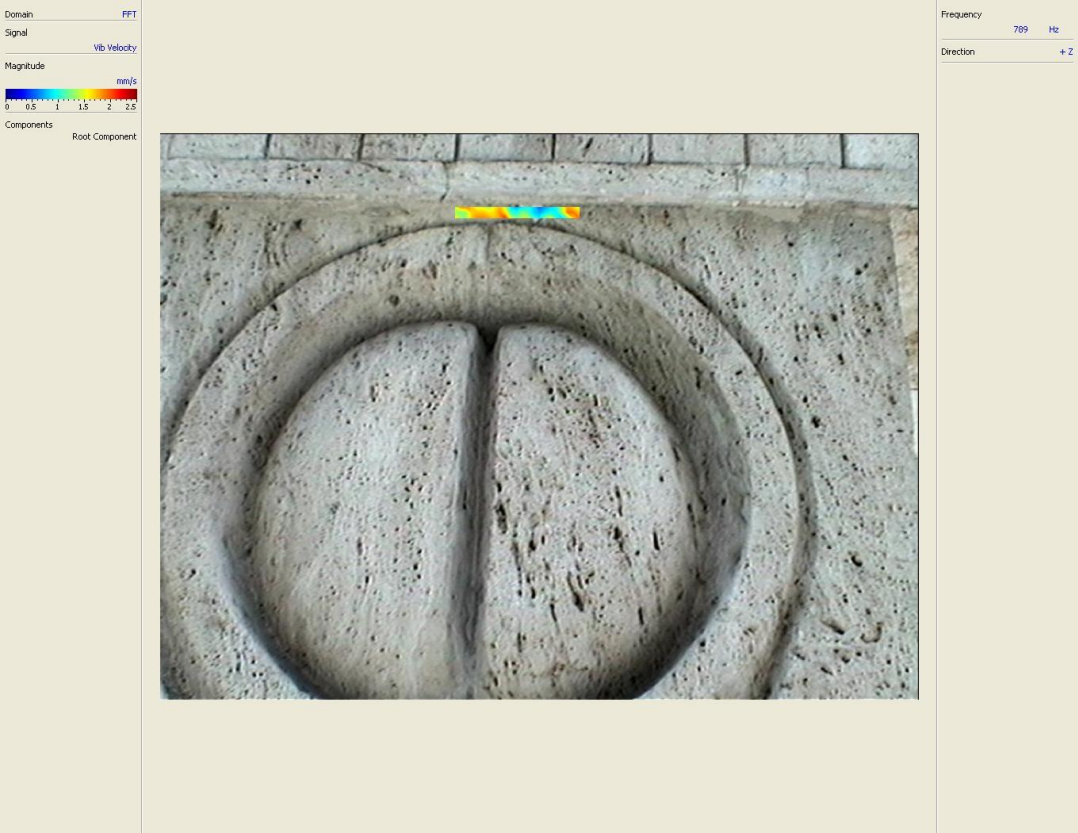
Zona 2:

Punte scanare : 69

Sweep

Generator Functie

Type: NI 671x
Signal: Sweep
Amplitude: 5 V
Offset: 0 V
Sweep type: Linear
Start frequency: 100 Hz
End frequency: 700 Hz
Sweep time: 300 ms
Multiple Channels: Off



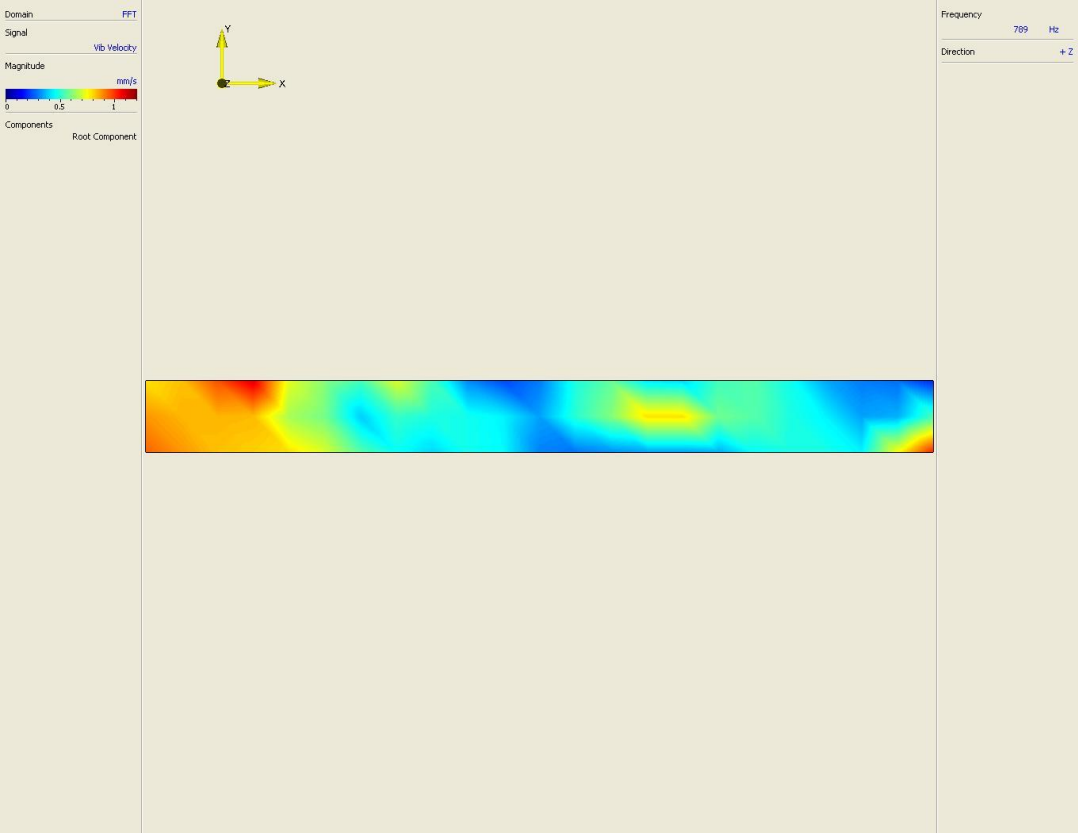
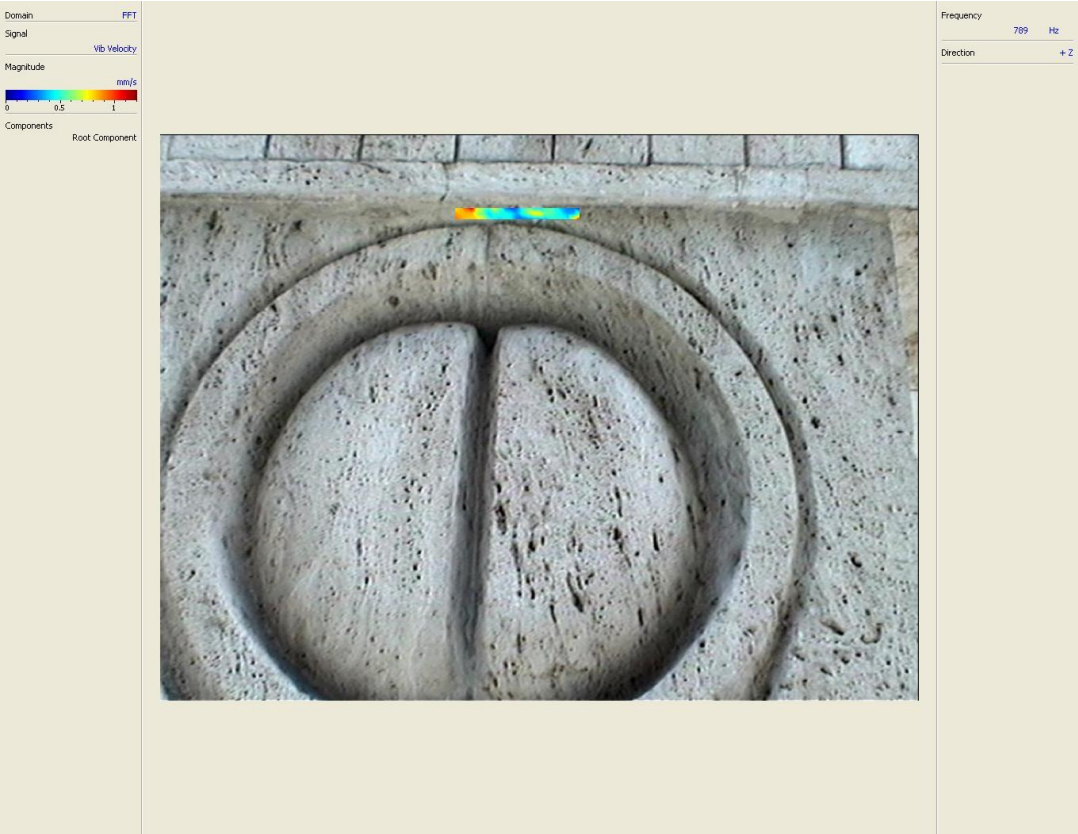
Zona 2:

Puncte scanare : 69

Triangle

Generator Functie

Type: NI 671x
Signal: Triangle
Frequency: 10 kHz
Amplitude: 5 V
Offset: 0 V
Multiple Channels: Off



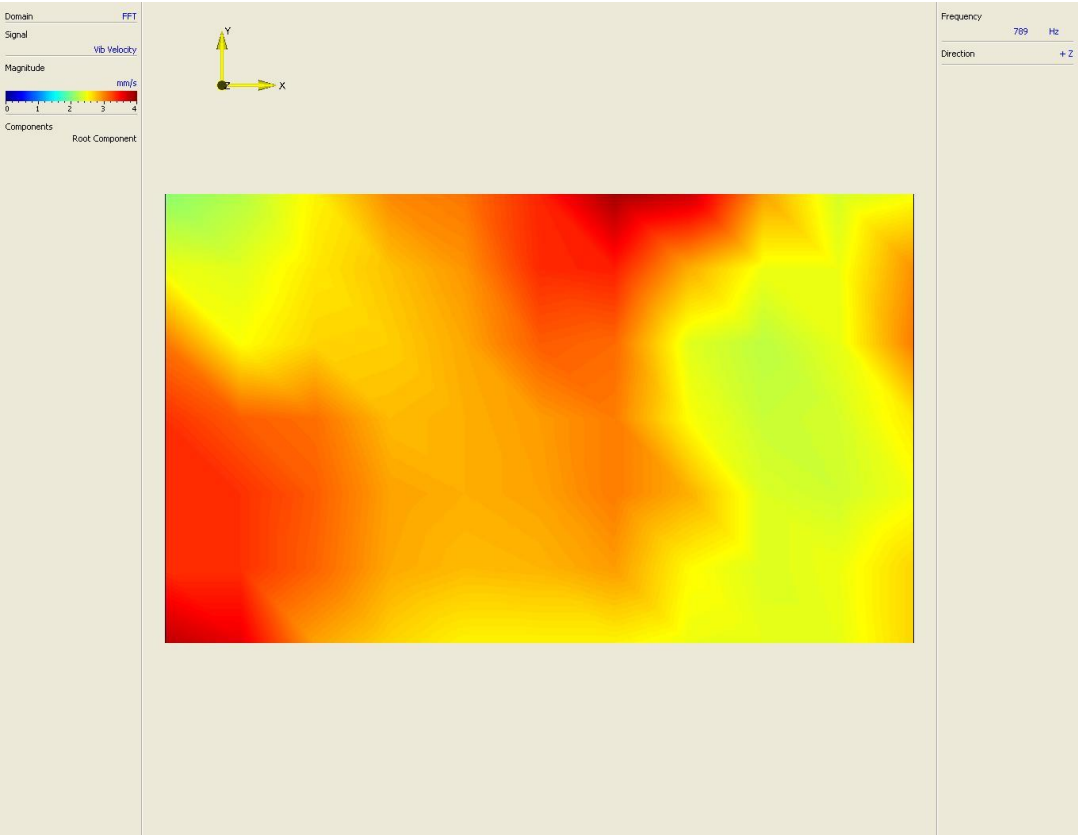
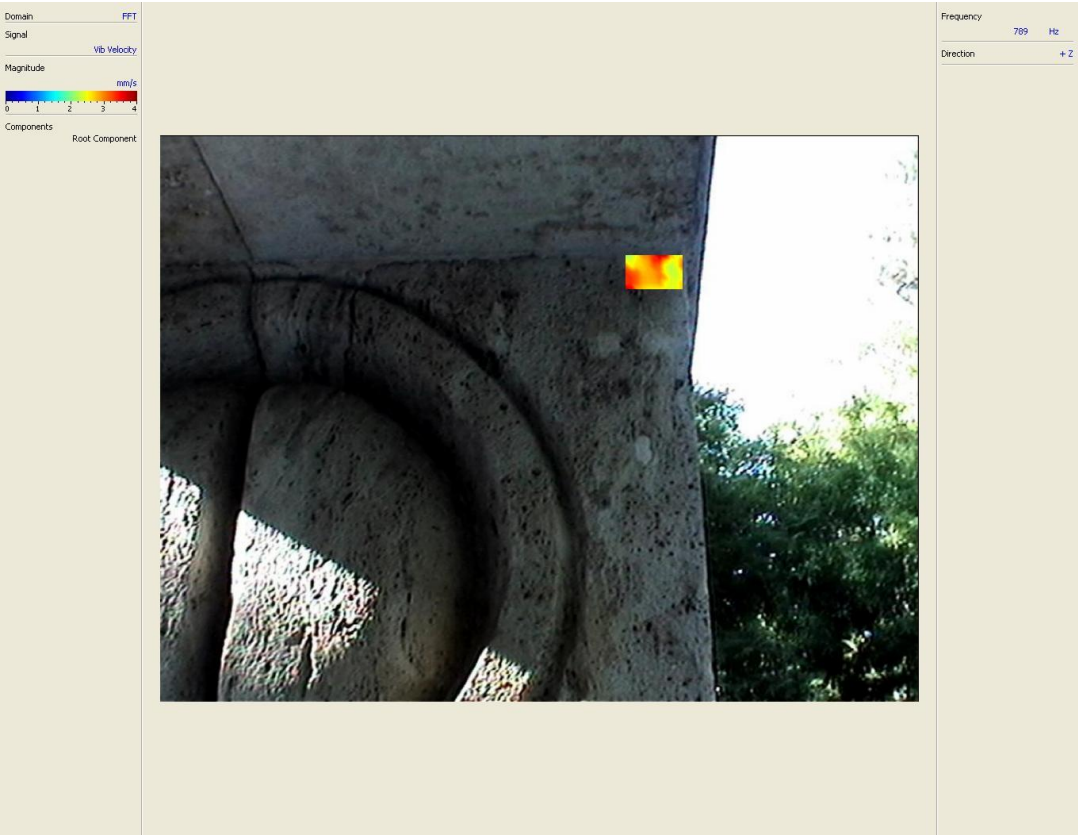
Zona 3:

Puncte scanare : 77

Burst Chirp

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 5 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



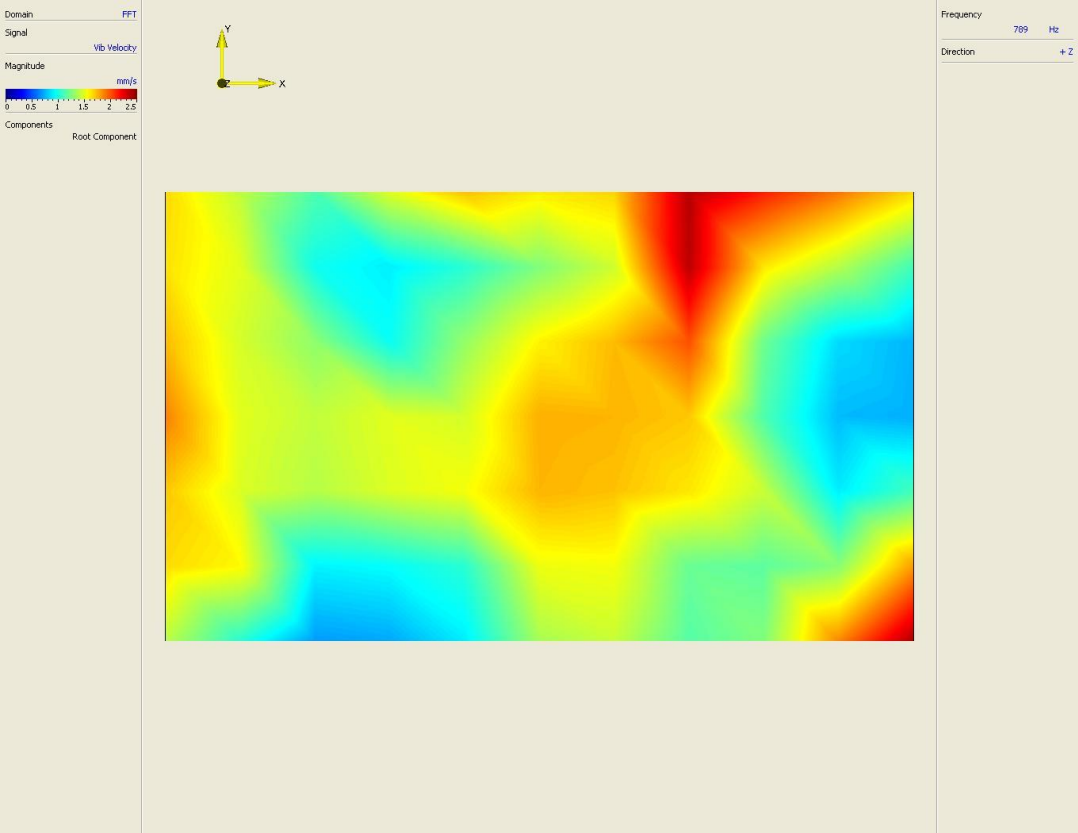
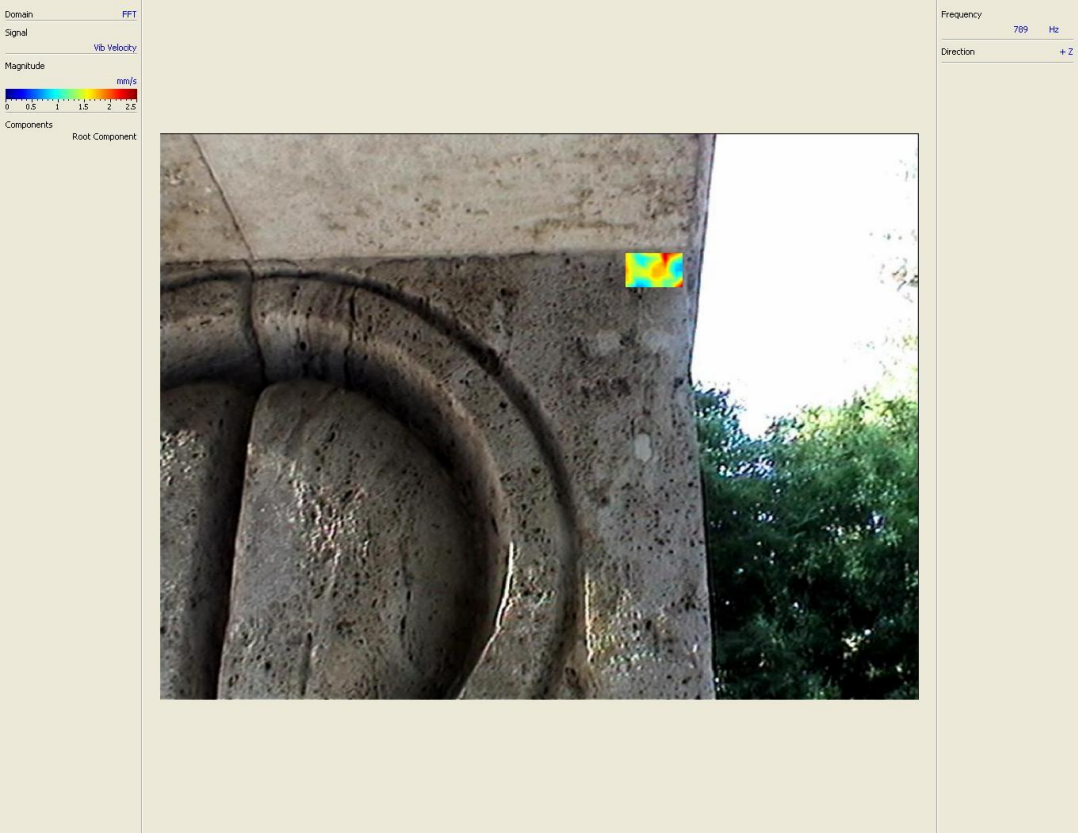
Zona 3:

Puncte scanare : 77

Burst Chirp, 10 V

Generator Functie

Type: NI 671x
Signal: Burst Chirp
Amplitude: 10 V
Offset: 0 V
Start frequency: 100 Hz
End frequency: 700 Hz
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



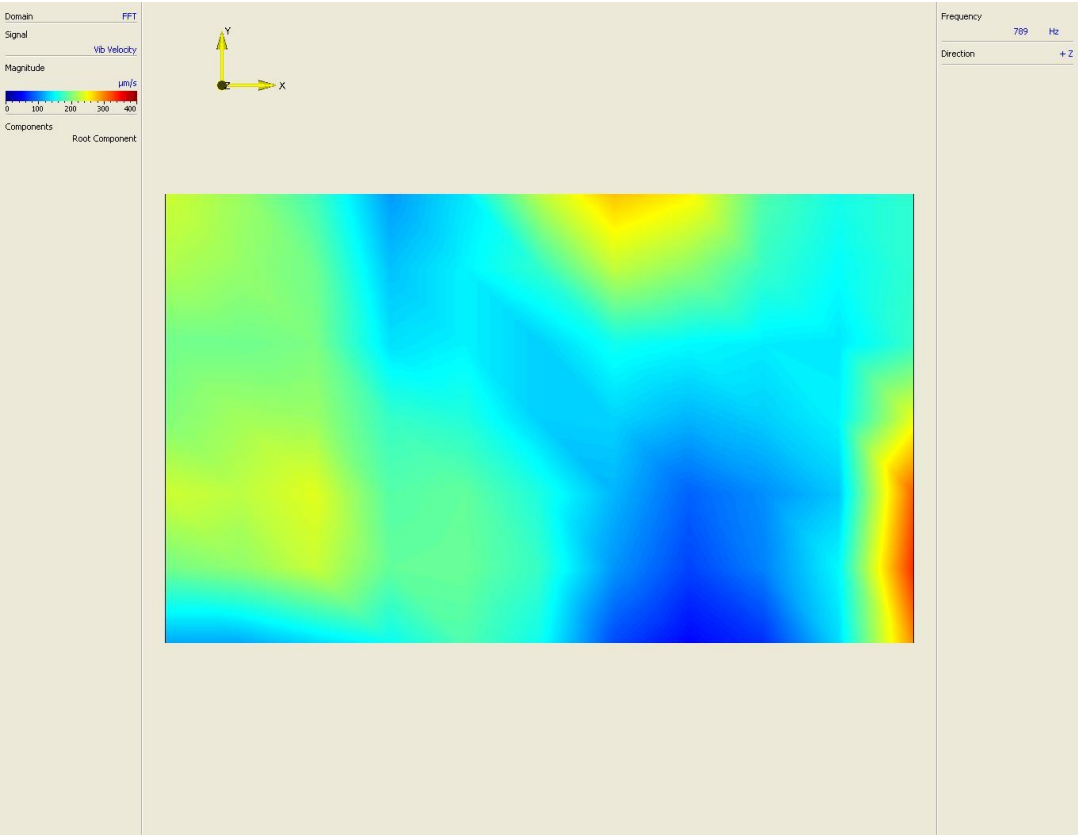
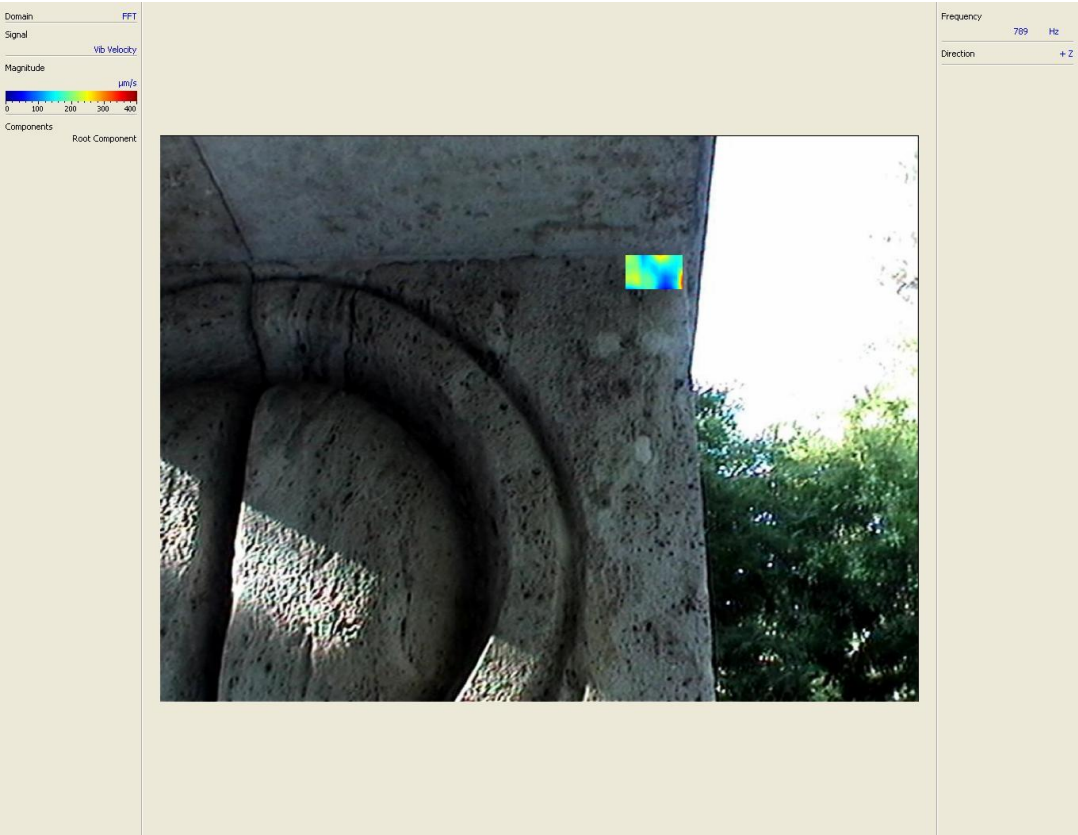
Zona 3:

Puncte scanare : 77

Burst Random

Generator Functie

Type: NI 671x
Signal: Burst Random
Amplitude: 5 V
Offset: 0 V
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



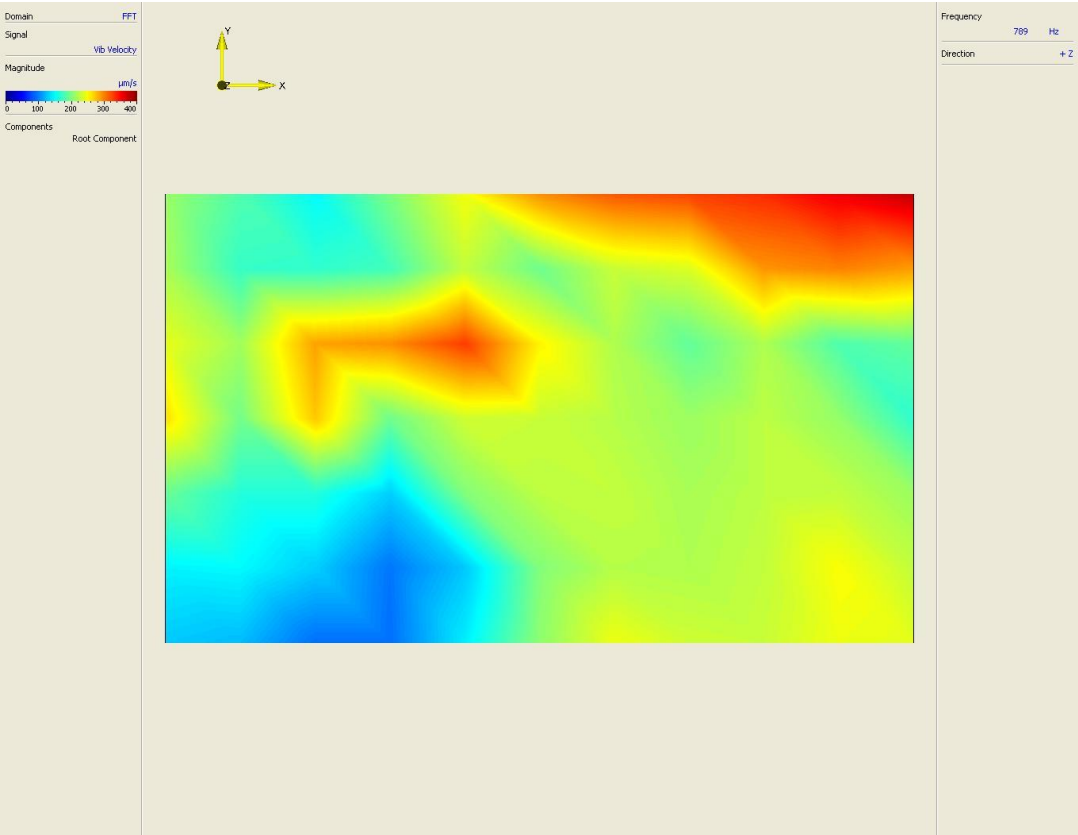
Zona 3:

Puncte scanare : 77

Burst Random, 10V

Generator Functie

Type: NI 671x
Signal: Burst Random
Amplitude: 10 V
Offset: 0 V
Burst start: 50 %
Burst length: 90 %
Multiple Channels: Off



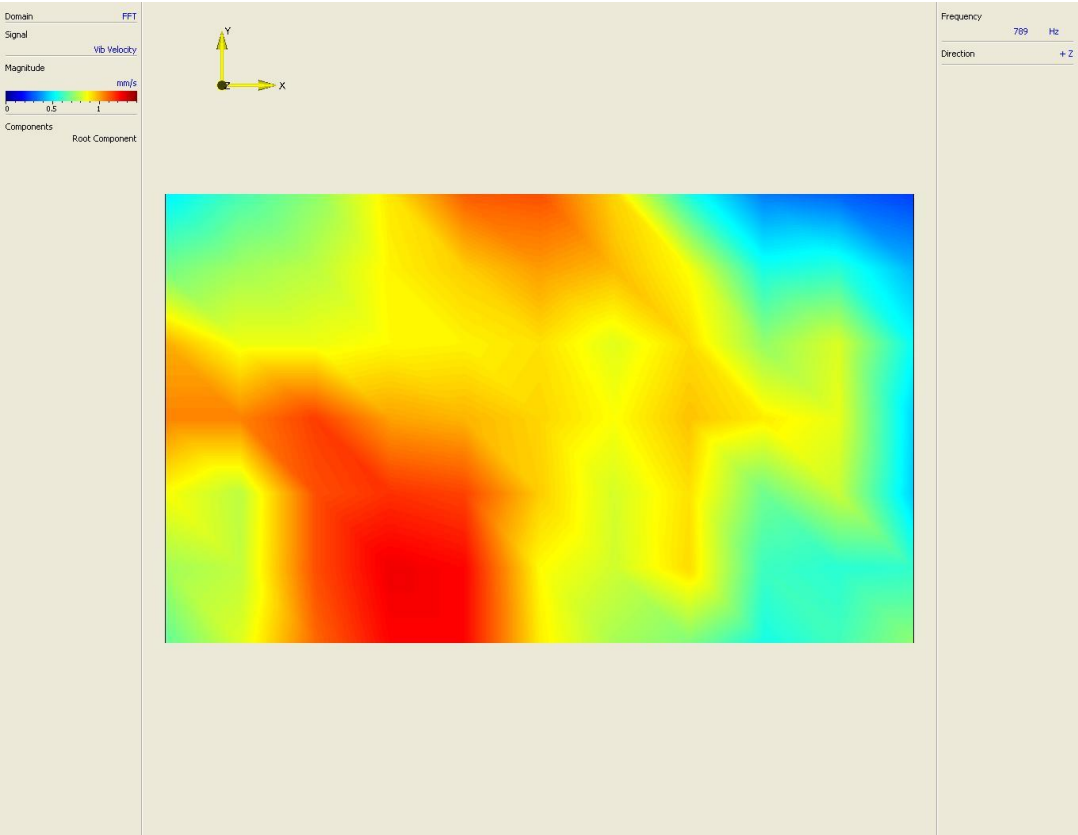
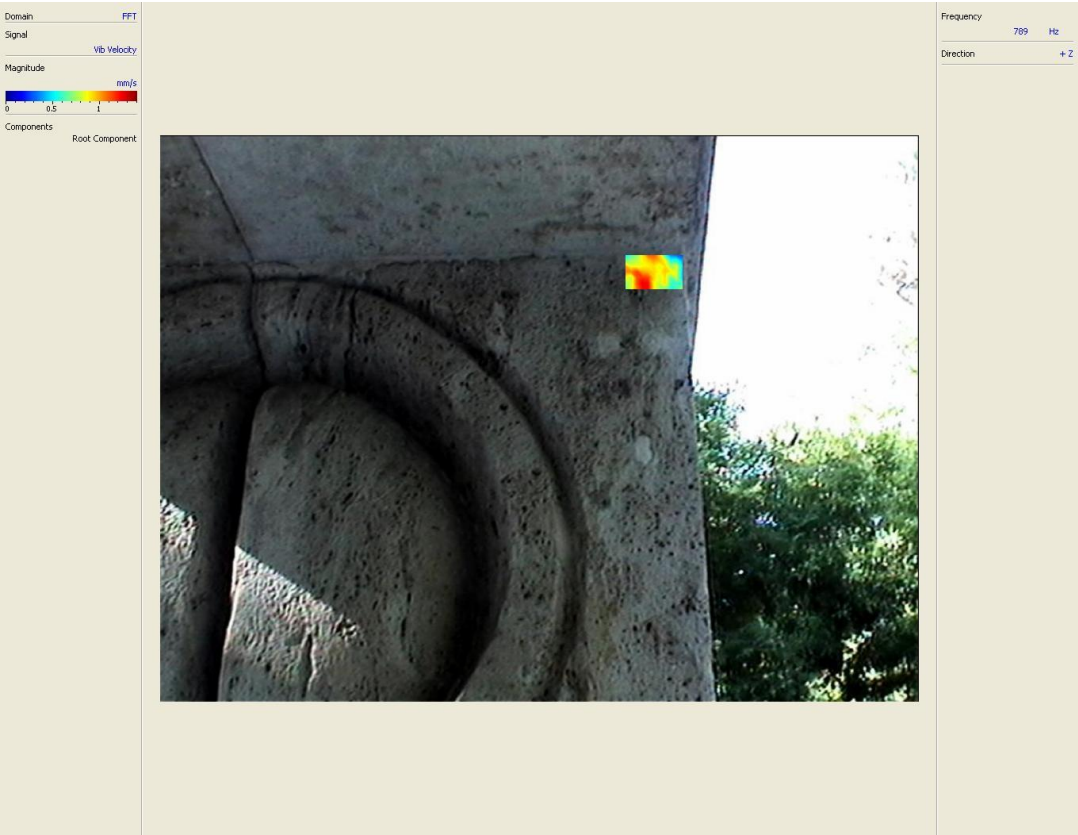
Zona 3:

Puncte scanare : 77

Periodic Chirp

Generator Functie

Type: NI 671x
Signal: Periodic Chirp
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



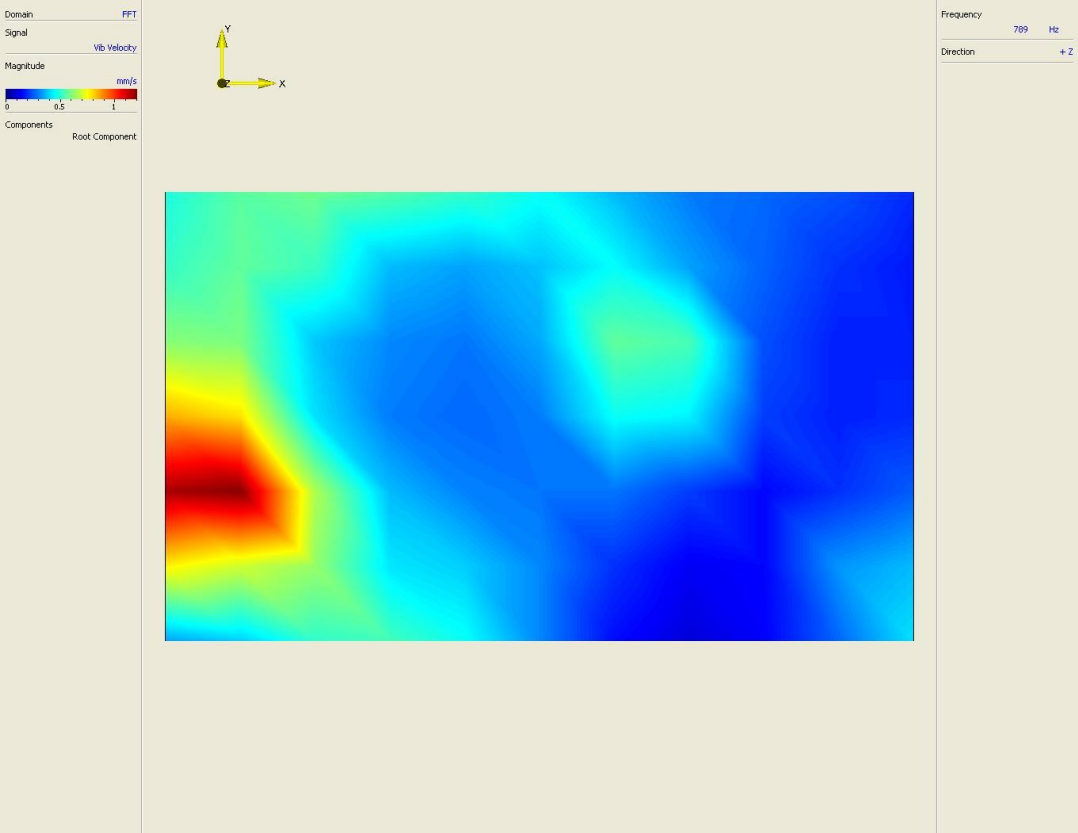
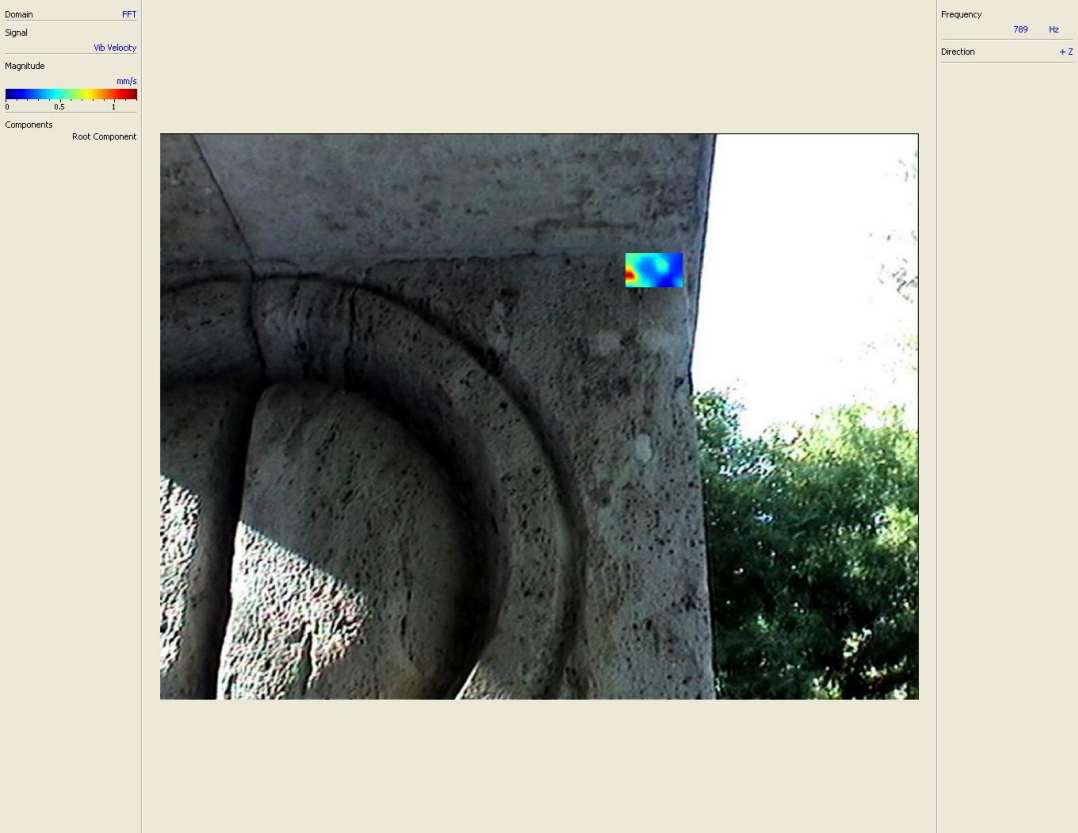
Zona 3:

Puncte scanare : 77

Pseudo Random

Generator Functie

Type: NI 671x
Signal: Pseudo Random
Amplitude: 5 V
Offset: 0 V
Amplitude correction: None
Multiple Channels: Off



Zona 3:

Puncte scanare : 77

Sweep

Generator Functie

Type: NI 671x
Signal: Sweep
Amplitude: 5 V
Offset: 0 V
Sweep type: Linear
Start frequency: 100 Hz
End frequency: 700 Hz
Sweep time: 300 ms
Multiple Channels: Off

