Navigation & Positioning 2

Sponsored by **Exail**

South Gallery Room 7 & 8

Tuesday, 12th Mar

16:00 - 17:40

Surveying in Soft Mud Bed - Best Use the Multibeam Echosounder

Alex Evaristo da Silva

March 12, 2024

Oceanology International 2024

Alex Evaristo da Silva

Oceanographer

PhD Environmental Oceanography

Geophysics specialist at UMI SAN

UMI SAN Engineering and Hydrography, a Brazilian company, founded in 1999, specialized in integrated solutions in management of port works (as dredging), hydro-oceanographic, geotechnical and geophysical surveys, nautical signaling, environment, maritime operations and demolition.

UMI SAN is specialized in Special Order Hydrographic Surveys (S-44). Since **2015**, more than **180 surveys** used by the Brazilian Navy to update the nautical chart.

UMI 海 SAN
HIDROGRAFIA E ENGENHARIA

Hydrography at UMI SAN

- R2 SONIC 2024 and 2022
- Trimble APPLANIX I2NS Type II WaveMaster

R2Sonic I2NS Integrated Inertial Navigation System

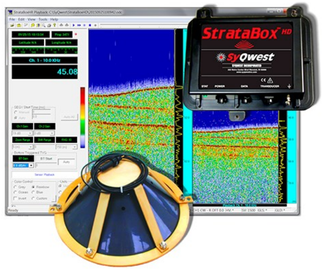
- LiDAR VLP-16 Puck Lite da Velodyne
- ODOM ECHOTRAC MKIII, CVM, CV100
- Teledyne ECHOTRAC E20
- 4125 Edge Tech Side Scan Sonar
- Applied Acoustic Systems (Boomer A301, CSP-D)
- Hydrographic software

CARIS HIPS and SIPS

HYPACK
a xylem brand

Qinsy.

BeamworX



SONARWIZ 7

CodaOctopus
Sound Underwater Intelligence

Hydrography at UMI SAN

- UMI SAN has its own vessels;
- Boats for hydroceanographic survey that includes workstation for analysis and data processing in real time, with high autonomy for long expeditions in open sea in boarding regime (24 hours);
- Moonpool;
- Autonomous Surface Vehicles (OCEANα SL40)
- Solar energy.

What means the Best Use of the Multibeam Echosounder?

R2 Sonic recommendations

Products Applications Case Studies Resources About Us Contact Us Tech Support Customer Portal

Home » Knowledge Hub » How to Best Use the Multibeam Echosounder Manual

How to Best Use the Multibeam Echosounder Manual

SONIC 2026/2024/2022

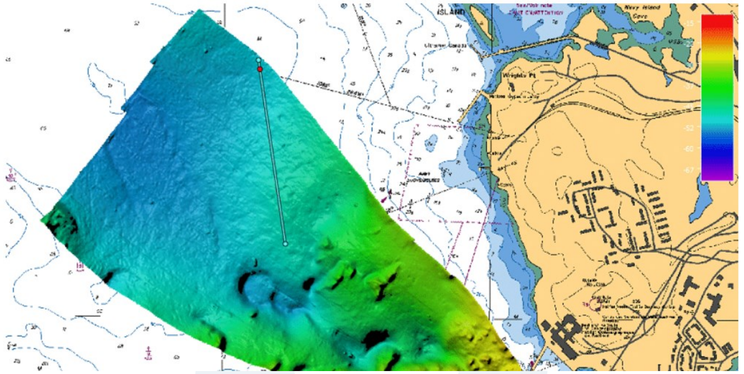
BROADBAND MULTIBEAM ECHOSOUNDERS

Introduction

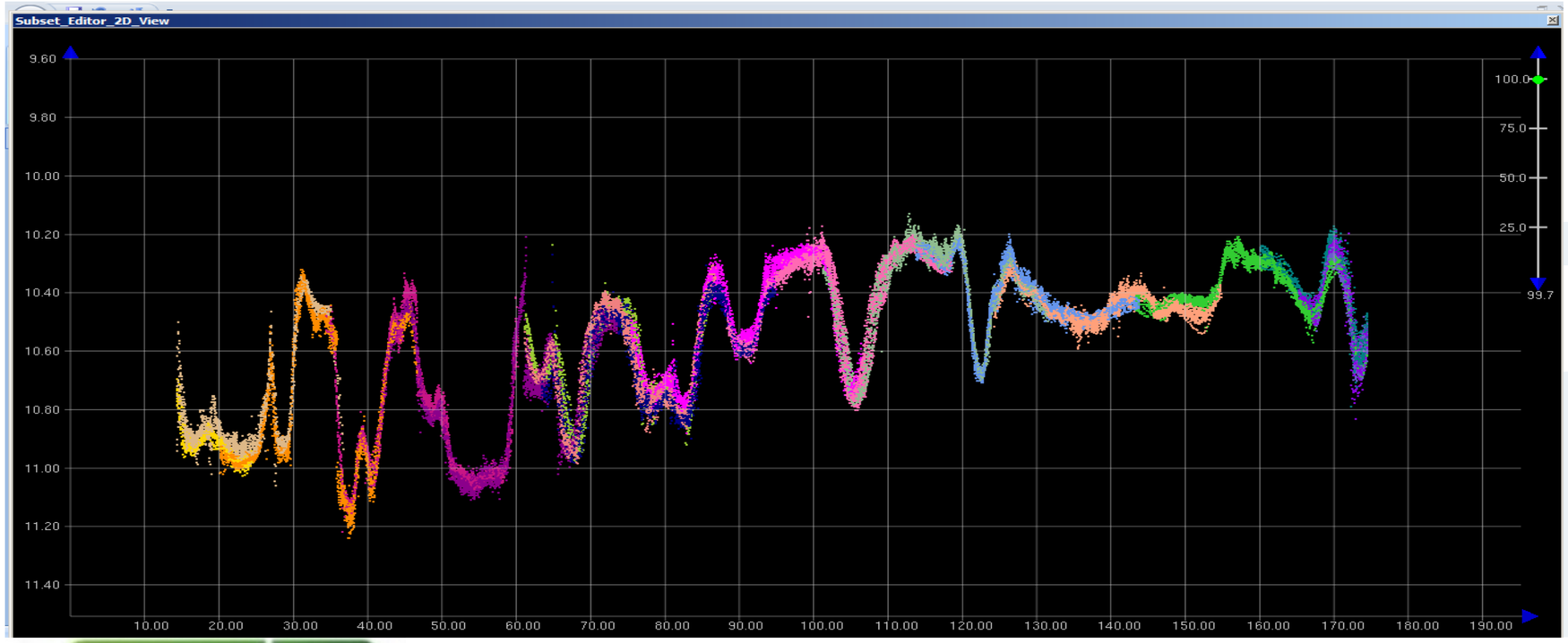
Products Applications Case Studies Resources About Us Contact Us Tech Support Customer Portal

Home » Knowledge Hub » Tips for surveying over soft & muddy bottoms

Tips for surveying over soft & muddy bottoms



What means the Best Use of the Multibeam Echosounder?



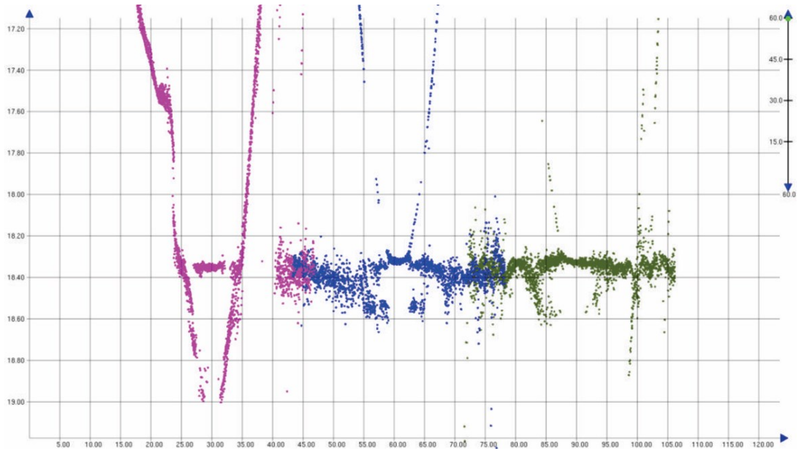
YES

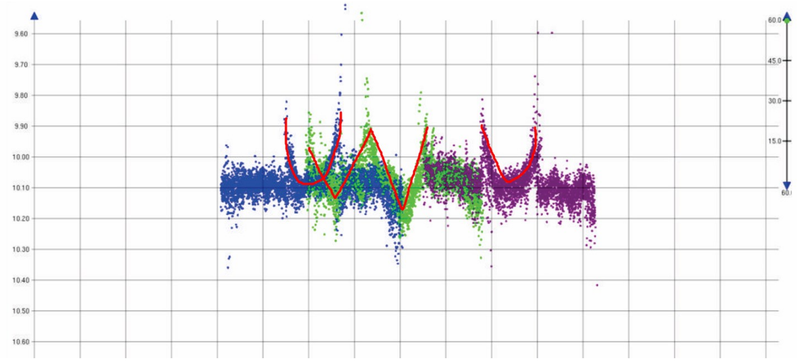
Good quality of Multibeam Hydrographic Survey
Can be used for updating nautical documents (Special Order)

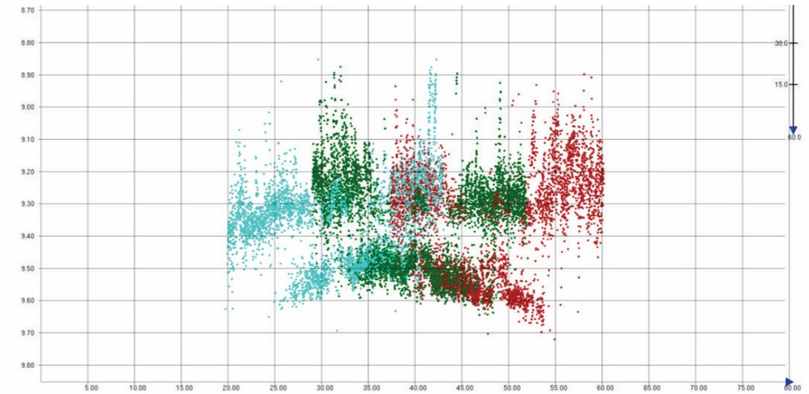
NORMAM 501 Brazilian Navy

What is the challenge of surveying over muddy?

- Quality degradation of multibeam data (mismatching)
- Spikes (spurious depth) causing gaps on surface
- “W” or “V”-shaped feature
- Double bottom







Acquisition Parameters Test

- **> 150 tests** performed between 2020 and 2023 along 14 different ports in Brazil
- Multibeam sonar 2022 or 2024 R2 Sonic model
- Visual analysis of mud
- Multibeam parameters:
  - ❑ **Frequency (kHz)**
  - ❑ **Pulse width (µsec)**
  - ❑ **Power (dB)**
  - ❑ **Gain (dB)**
  - ❑ Absorption (dB/km)
  - ❑ Spreading (dB)
- Non-systematic tests

Study Area

Acquisition Parameters Test

Multibeam Parameters					
Frequency (kHz)	**Pulse width (µsec)**	**Power (dB)**	**Gain (dB)**	**Absorption (dB/km)**	**Spreading (dB)**
200 - 400	30 -140	190 - 218	5 - 20	80 - 140	20 - 50

Multibeam Parameters						
Classification	**Frequency (kHz)**	**Pulse width (µsec)**	**Power (dB)**	**Gain (dB)**	**Absorption (dB/km)**	**Spreading (dB)**
low	<250	>65	<200	<7	<100	<25
medium	250 - 350	65-100	200 - 210	7 - 14	100 - 125	25 - 35
high	>350	>100	>210	>14	>125	>35

Good News

- There is a set of parameters to obtain good quality of multibeam data (Special Order)

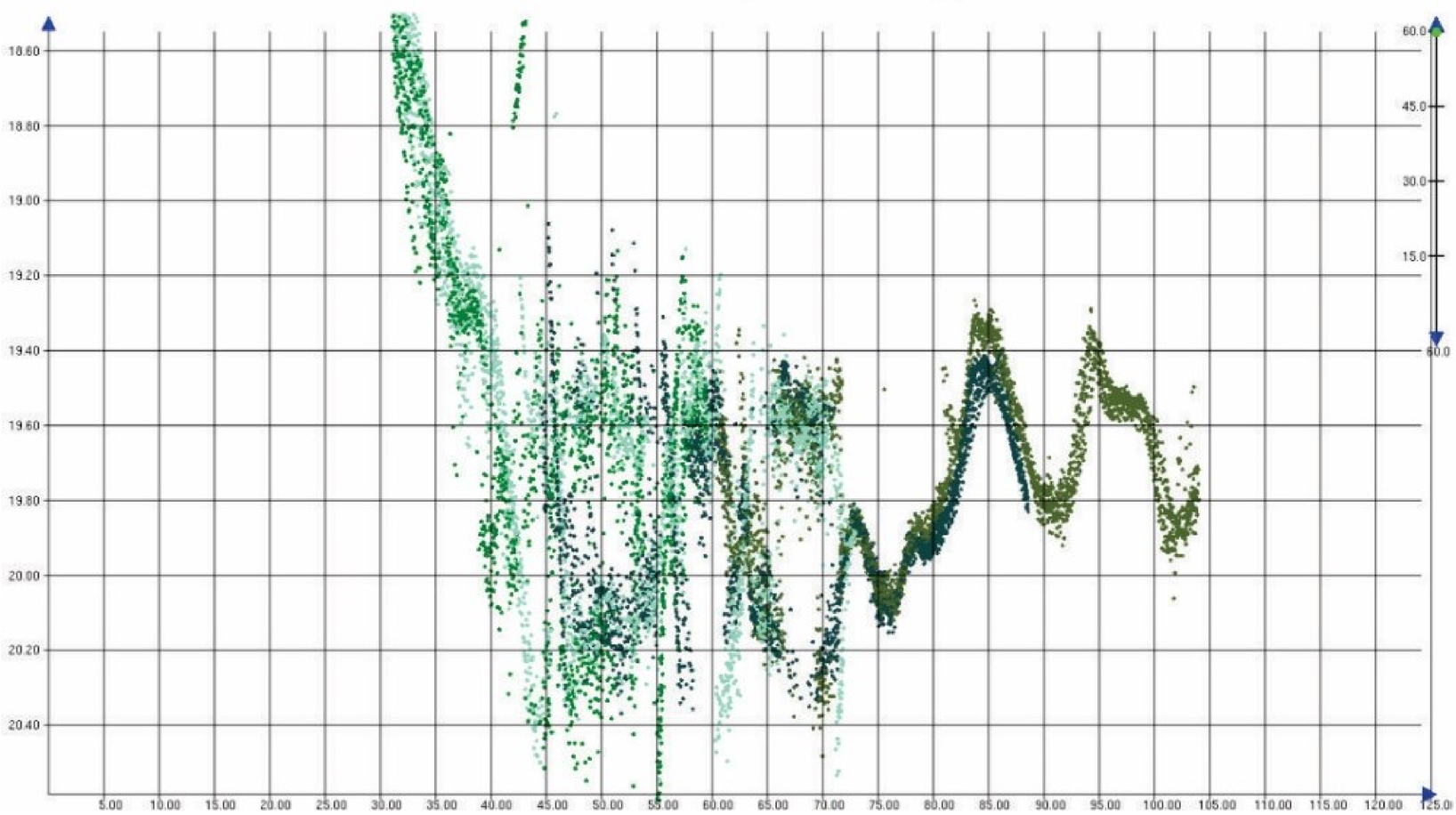
Bad News

- The results show that there is not always the same response

Main Relationship

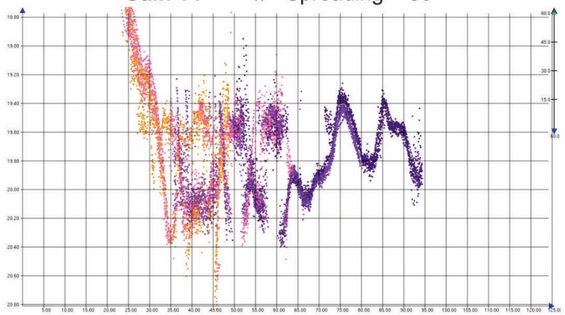
- ✓ Low Pulse Width, changing the Frequency, does not affect the matching between lines;
- ✓ High Frequency produces better line matching;
- ✓ Low Frequency and variable pulse width produce double bottom;
- ✓ Low Power, Absorption and Spreading generate a “W”-shaped feature;
- ✓ High Pulse width generates a “W”-shaped feature;
- ✓ High Power reduces the influence of absorption and spreading.

Test 1
The Problem



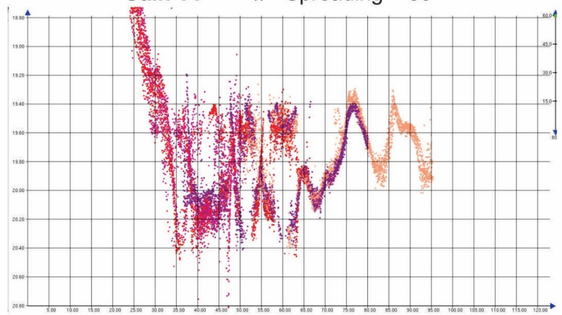
Config T1

Freq.= 250 // **Pulse = 90**
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



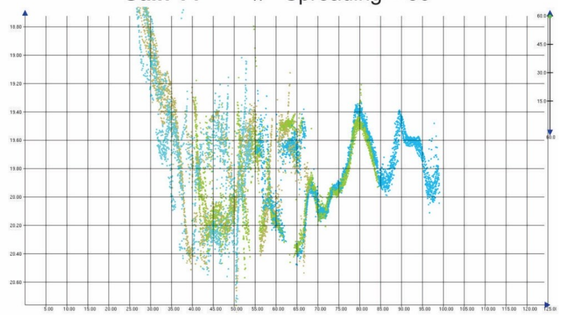
Config T2

Freq.= 250 // **Pulse = 120**
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



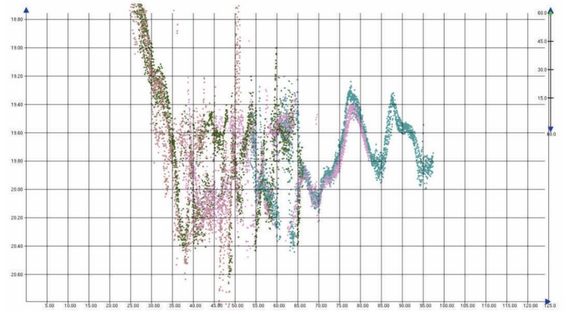
Config T3

Freq.= 250 // **Pulse = 60**
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



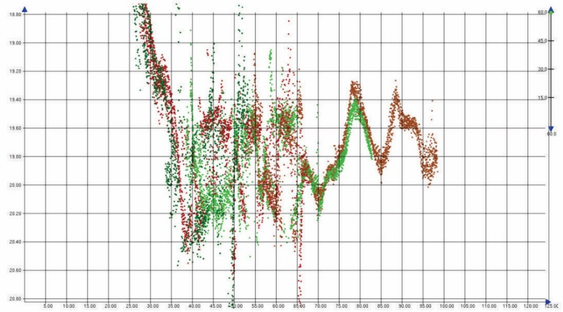
Config T4

Freq.= 250 // **Pulse = 90**
Power = 218 // Absorption = 110
Gain 14 // Spreading = 30



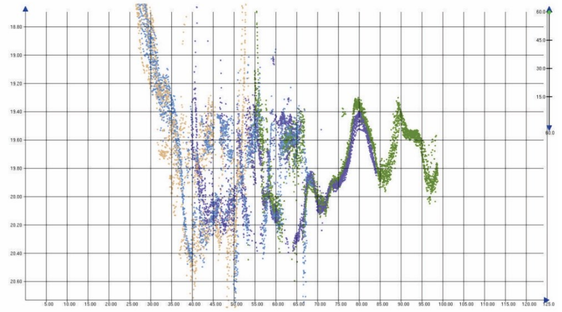
Config T5

Freq.= 250 // **Pulse = 120**
Power = 218 // Absorption = 110
Gain 14 // Spreading = 30



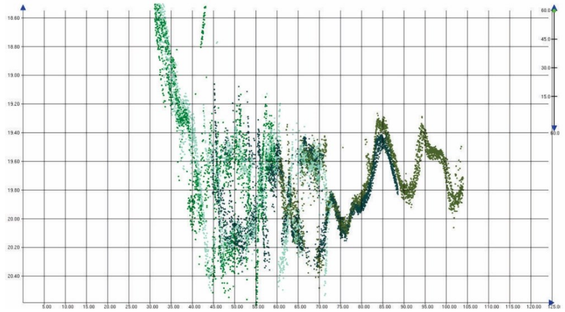
Config T6

Freq.= 250 // **Pulse = 60**
Power = 218 // Absorption = 110
Gain 14 // Spreading = 30



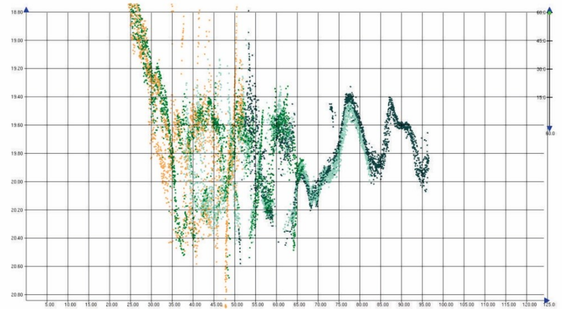
Config T7

Freq.= 250 // **Pulse = 90**
Power = 218 // Absorption = 110
Gain 7 // Spreading = 30



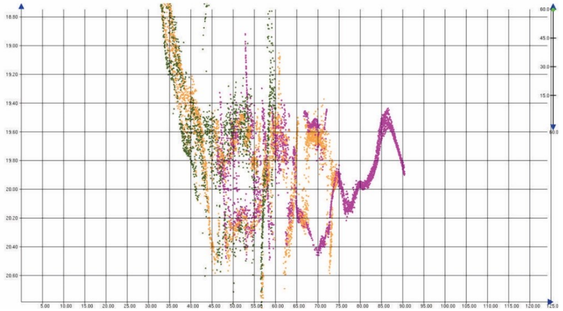
Config T8

Freq.= 250 // **Pulse = 120**
Power = 218 // Absorption = 110
Gain 7 // Spreading = 30



Config T9

Freq.= 250 // **Pulse = 60**
Power = 218 // Absorption = 110
Gain 7 // Spreading = 30



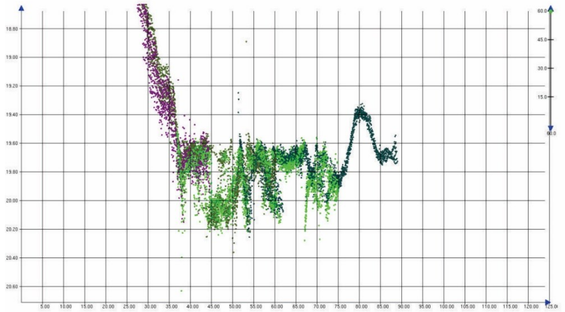
Test 1

Frequency 250 kHz

Pulse Width Energy

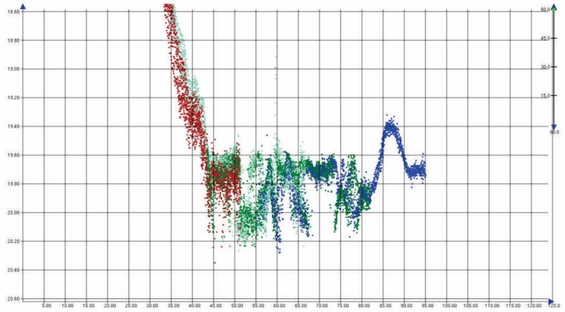
Config A

Freq.= 300 // Pulse = 90
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



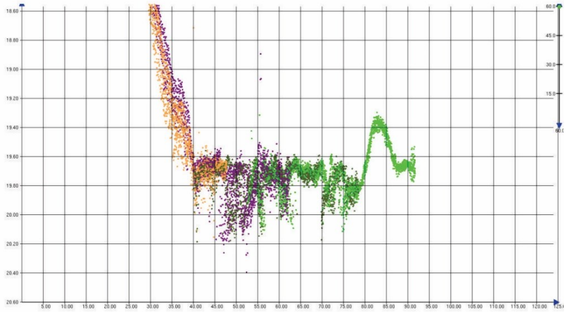
Config B

Freq.= 300 // Pulse = 120
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



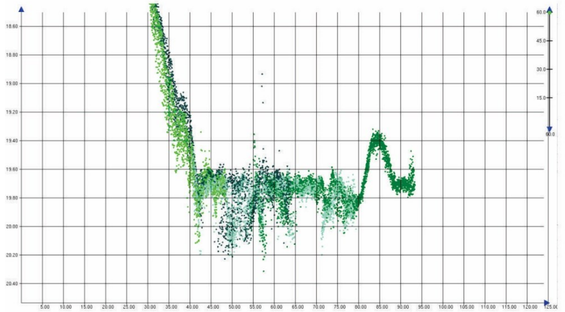
Config C

Freq.= 350 // Pulse = 90
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



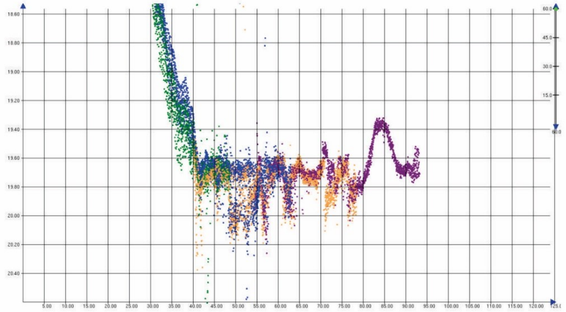
Config D

Freq.= 350 // Pulse = 120
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



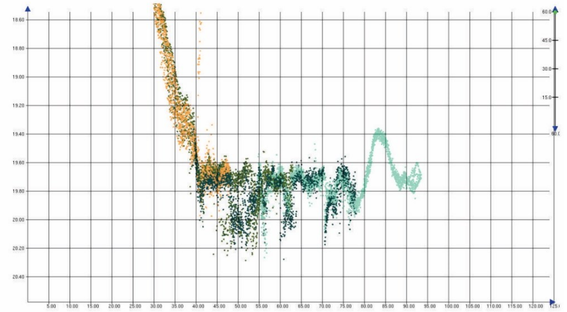
Config E

Freq.= 350 // Pulse = 90
Power = 203 // Absorption = 110
Gain 7 // Spreading = 30



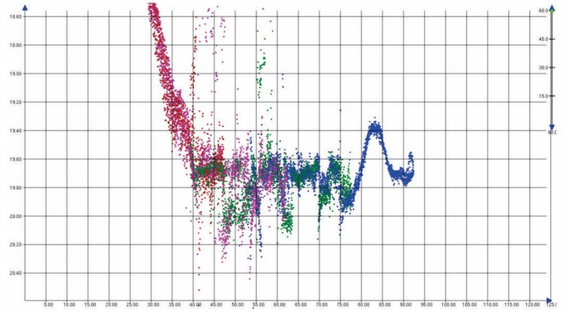
Config F

Freq.= 350 // Pulse = 90
Power = 203 // Absorption = 110
Gain 20 // Spreading = 30



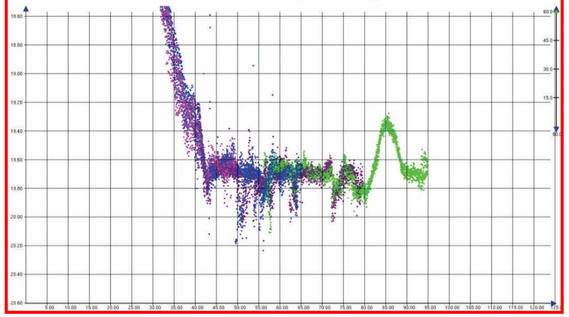
Config G

Freq.= 350 // Pulse = 90
Power = 218 // Absorption = 110
Gain 20 // Spreading = 30



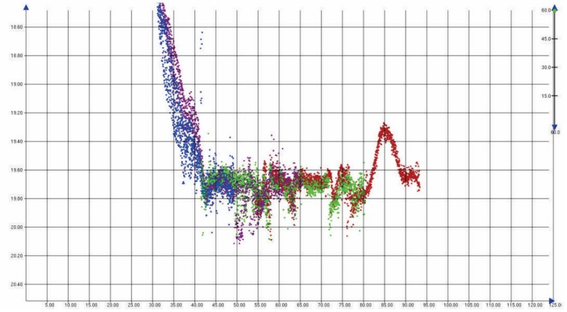
Config H

Freq.= 400 // Pulse = 90
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



Config I

Freq.= 400 // Pulse = 120
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30

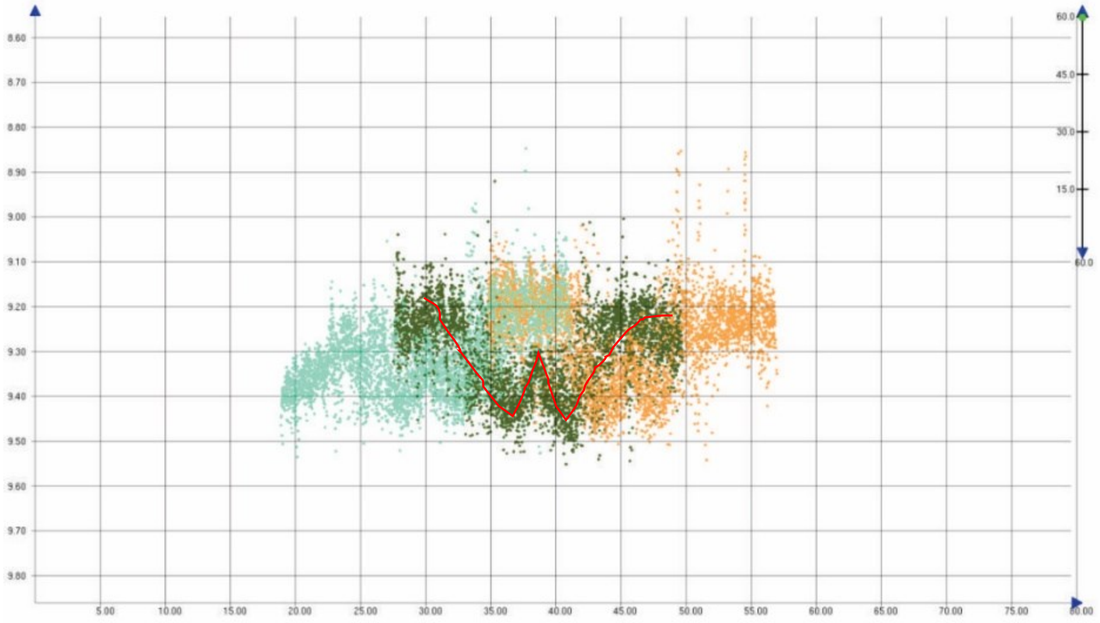


Test 1

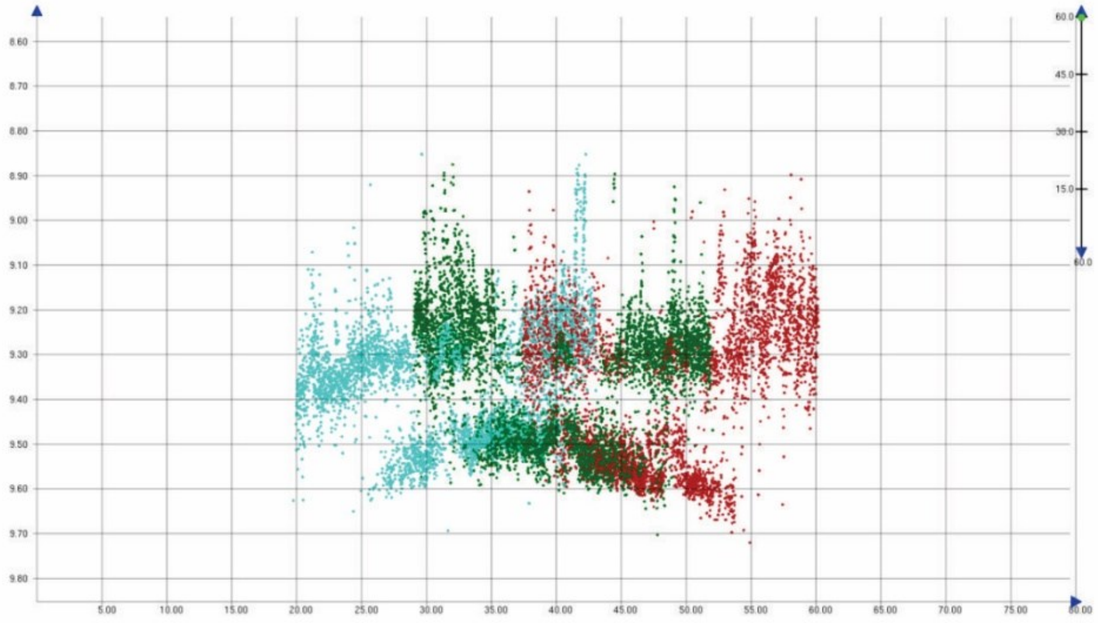
High Frequency

Freq.= 400 // Pulse = 90
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30

Test 2
The Problem



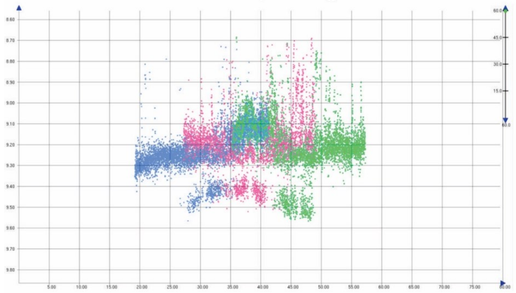
W-shaped feature



double bottom

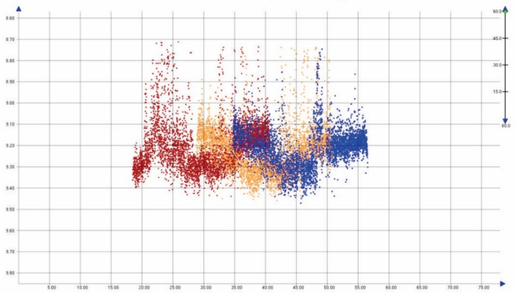
Config T1

Freq.= 350 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



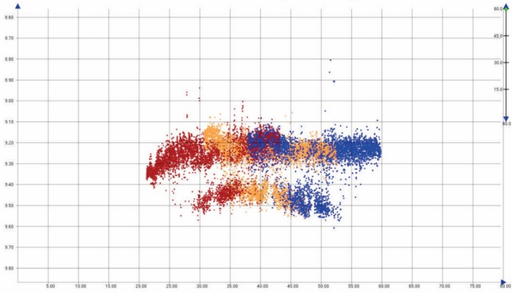
Config T2

Freq.= 350 // Pulse = 120
Power = 209 // Absorpion = 90
Gain 07 // Spreading = 35



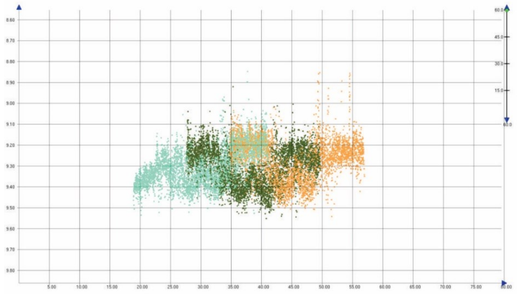
Config T3

Freq.= 300 // Pulse = 60
Power = 209 // Absorption = 90
Gain 07 // Spreading = 35



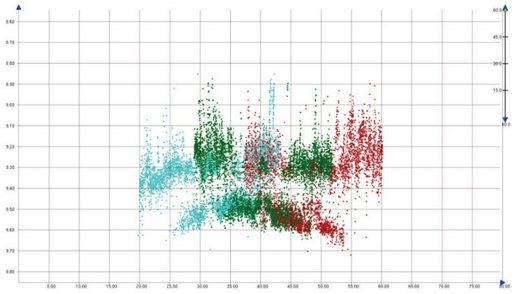
Config T4

Freq.= 300 // Pulse = 120
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



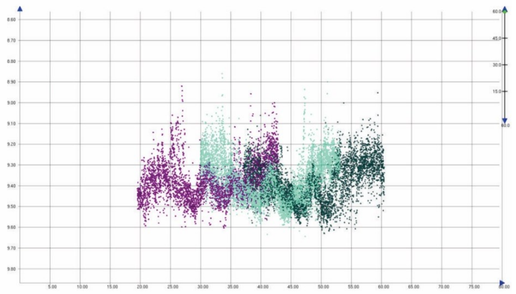
Config T5

Freq.= 250 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



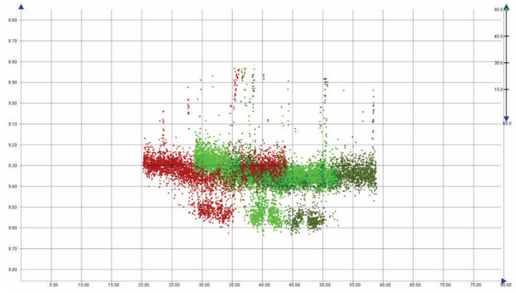
Config T6

Freq.= 250 // Pulse = 120
Power = 202 // Absorpion = 90
Gain 07 // Spreading = 35



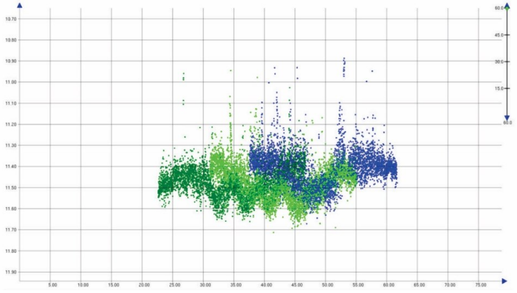
Config T7

Freq.= 400 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



Config T8

Freq.= 400 // Pulse = 120
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35

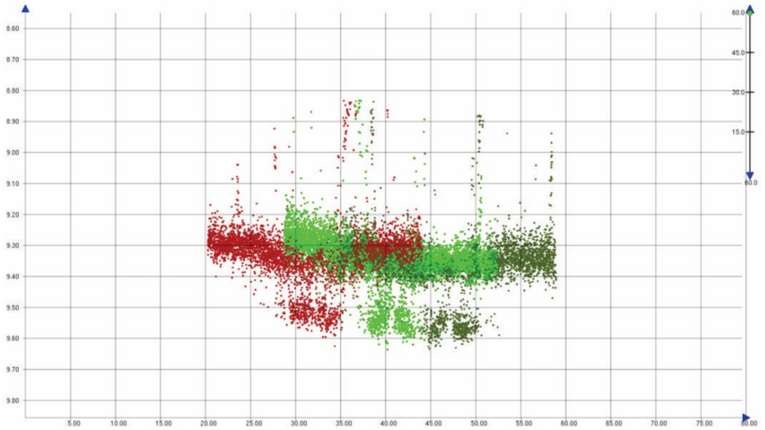


Test 2 A

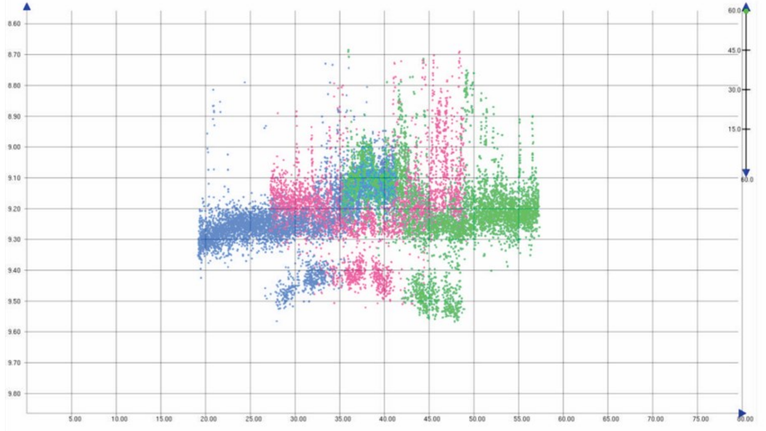
Pulse Width and Double Bottom

Multibeam Parameters					
Frequency (kHz)	**Pulse width (µsec)**	**Power (dB)**	**Gain (dB)**	**Absorption (dB/km)**	**Spreading (dB)**
250 300 350 400	**60 (low) 120 (high)**	202 (medium)	7 (low)	90 (low)	35 (medium)

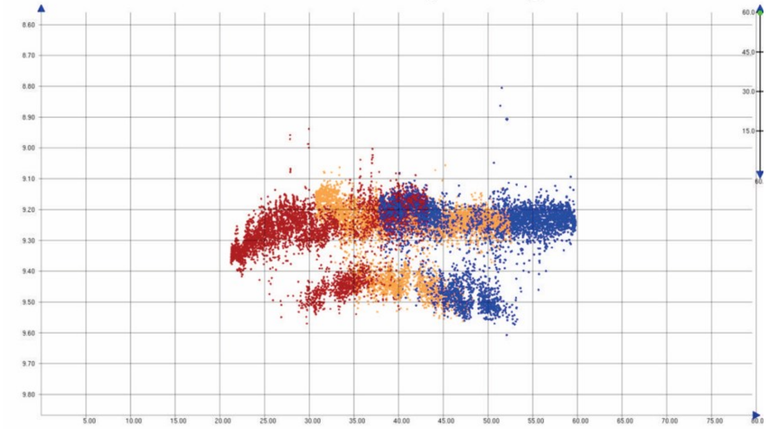
Freq.= 400 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



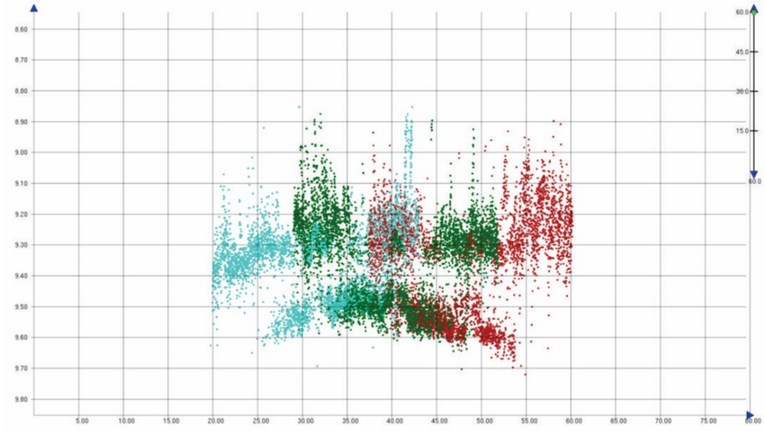
Freq.= 350 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



Freq.= 300 // Pulse = 60
Power = 209 // Absorption = 90
Gain 07 // Spreading = 35



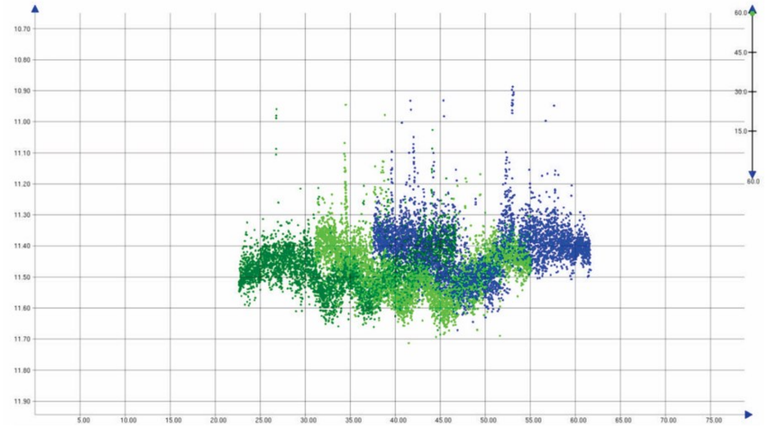
Freq.= 250 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



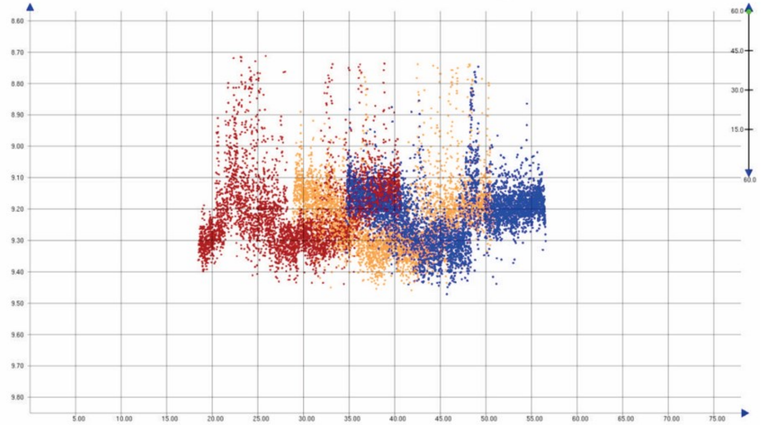
Test 2 A

- ✓ Low Pulse Width produces double bottom
- ✓ At Lower Frequencies the double bottom is clearer

Freq.= 400 // Pulse = 120
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



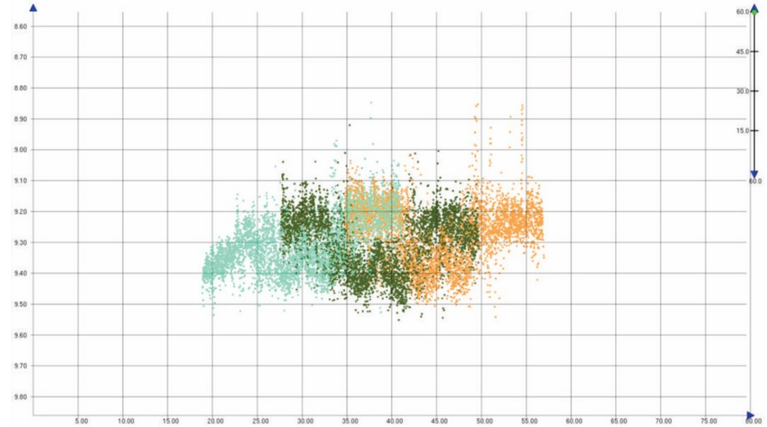
Freq.= 350 // Pulse = 120
Power = 209 // Absortpion = 90
Gain 07 // Spreading = 35



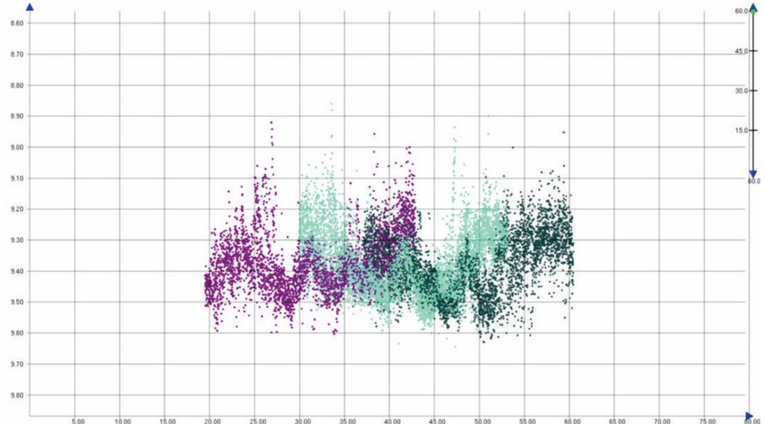
Test 2 A

- ✓ High Pulse solves double bottom
- ✓ High Pulse generates “W”-feature
- ✓ High Pulse, Lower Frequencies the “W”-shaped is clearer

Freq.= 300 // Pulse = 120
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35

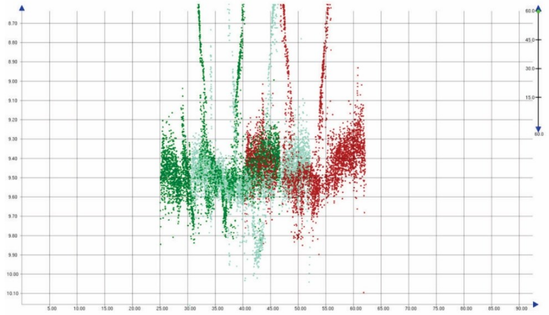


Freq.= 250 // Pulse = 120
Power = 202 // Absortpion = 90
Gain 07 // Spreading = 35



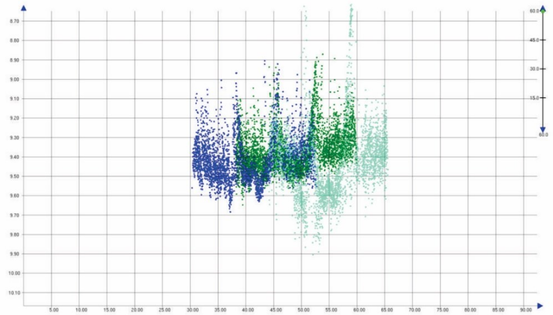
Config A

Freq.= 200 // Pulse = 70
Power = 190 // Absorption = 90
Gain 07 // Spreading = 35



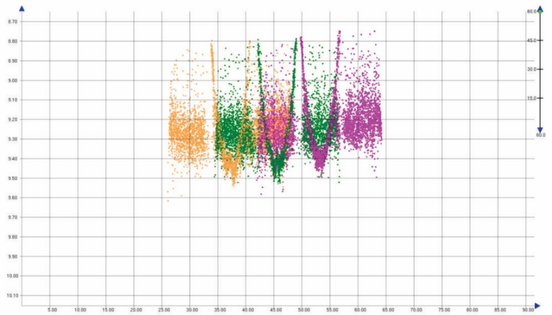
Config B

Freq.= 200 // Pulse = 140
Power = 190 // Absorption = 90
Gain 07 // Spreading = 35



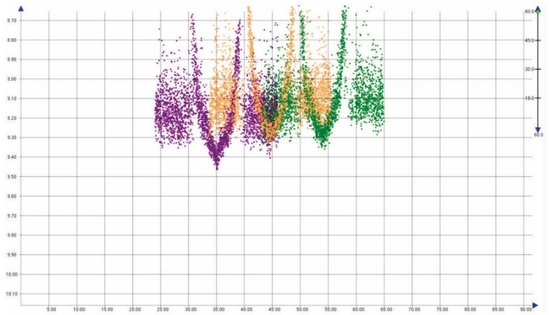
Config C

Freq.= 400 // Pulse = 70
Power = 190 // Absorption = 90
Gain 07 // Spreading = 35



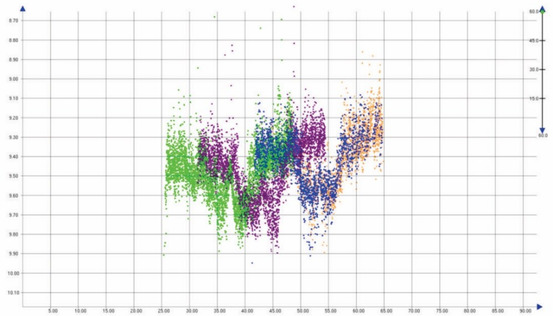
Config D

Freq.= 400 // Pulse = 140
Power = 190 // Absorption = 90
Gain 07 // Spreading = 35



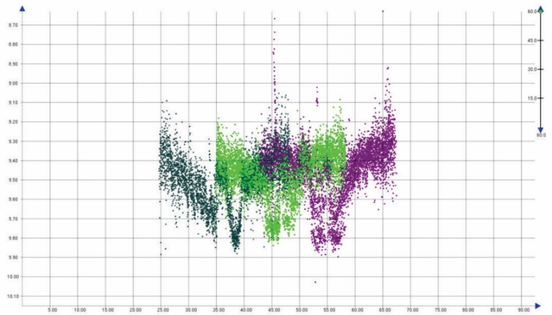
Config E

Freq.= 200 // Pulse = 140
Power = 190 // Absorption = 90
Gain 14 // Spreading = 35



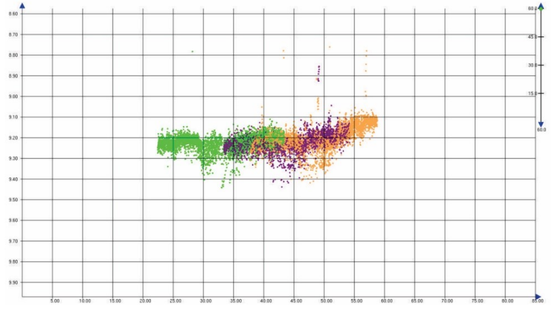
Config F

Freq.= 200 // Pulse = 70
Power = 190 // Absorption = 90
Gain 14 // Spreading = 35



Config G

Freq.= 350 // Pulse = 45
Power = 212 // Absorption = 90
Gain 07 // Spreading = 35



Freq.= 350 // Pulse = 45
Power = 212 // Absorption = 90
Gain 07 // Spreading = 35

Test 2 B

Frequency
Pulse Width

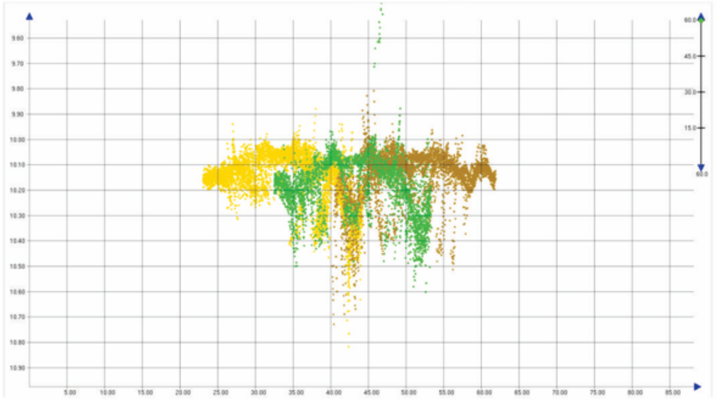
Low Power

- ✓ Low Power generates “V” and “W”-features
- ✓ Low Frequency → “W”-features
- ✓ High Frequency → “V”-features
- ✓ Better results with High Power and High Frequency
- ✓ High Gain solves systematic spikes

Test 3 and Test 4
Similarities and differences responses in different locations

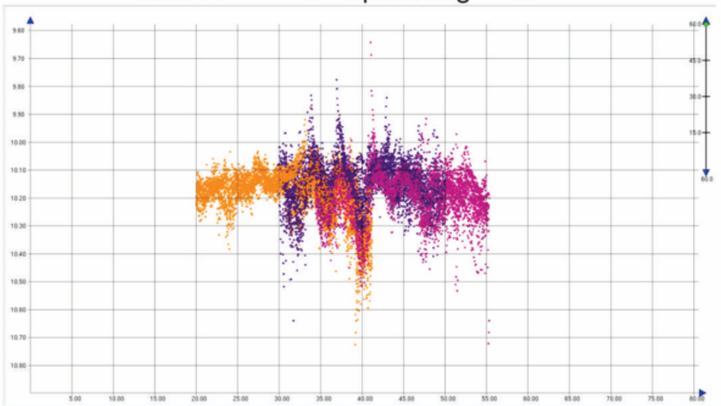
Config T1

Freq.= 250 // Pulse = 30
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



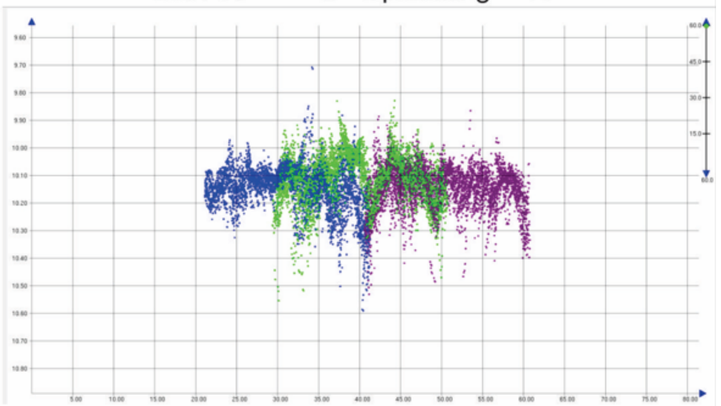
Config T2

Freq.= 250 // Pulse = 85
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



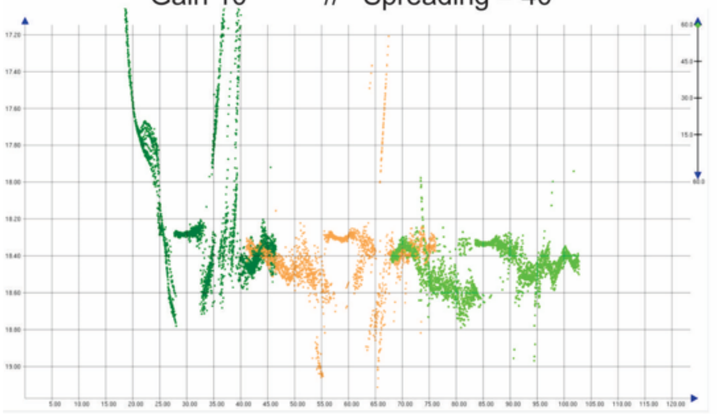
Config T3

Freq.= 250 // Pulse = 130
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



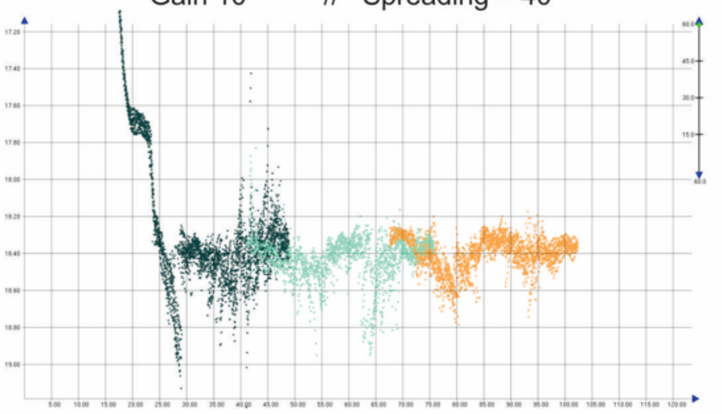
Config T1

Freq.= 250 // Pulse = 30
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



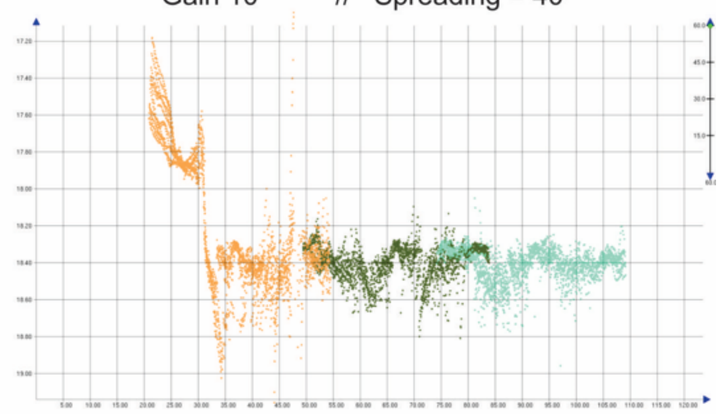
Config T2

Freq.= 250 // Pulse = 85
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



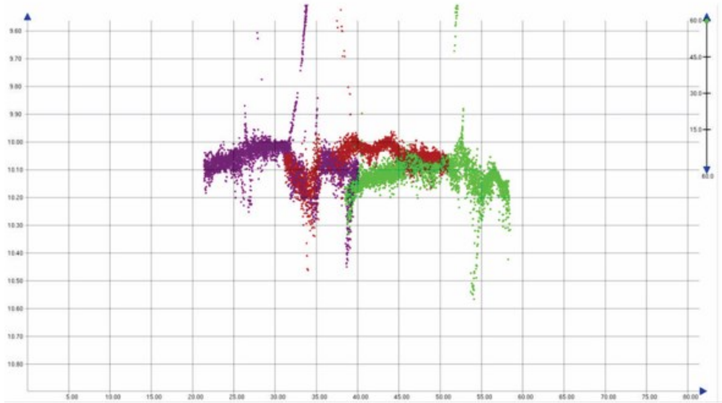
Config T3

Freq.= 250 // Pulse = 130
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40

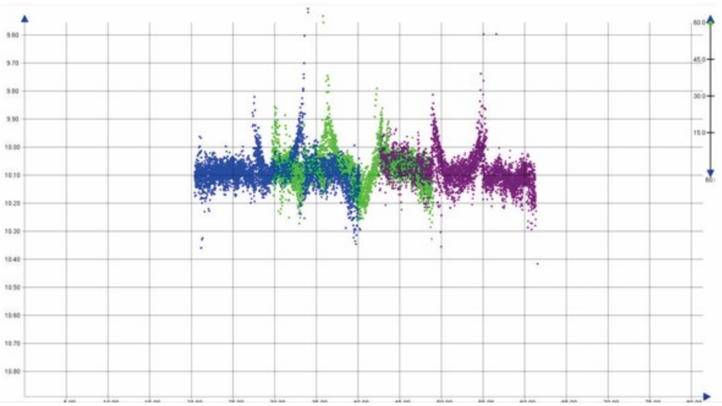


Test 3 and Test 4
Similarities and differences responses in different locations

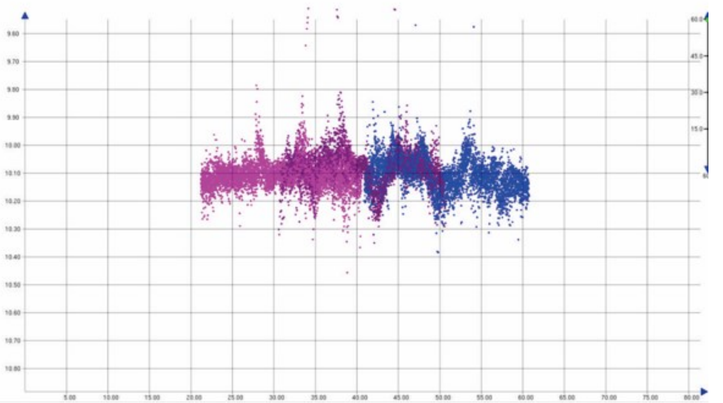
Config T7
Freq.= 350 // Pulse = 30
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



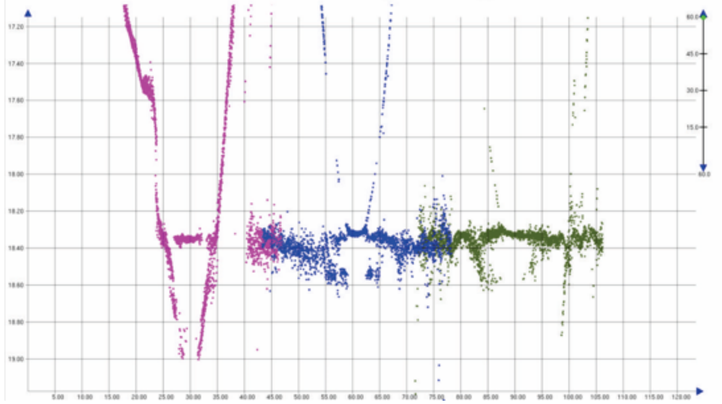
Config T8
Freq.= 350 // Pulse = 85
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



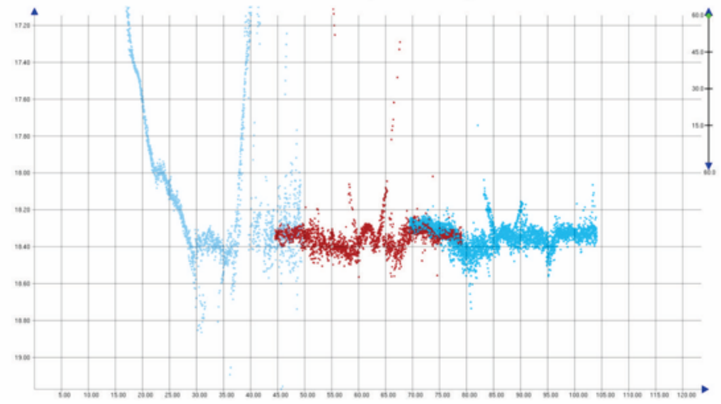
Config T9
Freq.= 350 // Pulse = 130
Power = 209 // Absortion = 110
Gain 10 // Spreading = 40



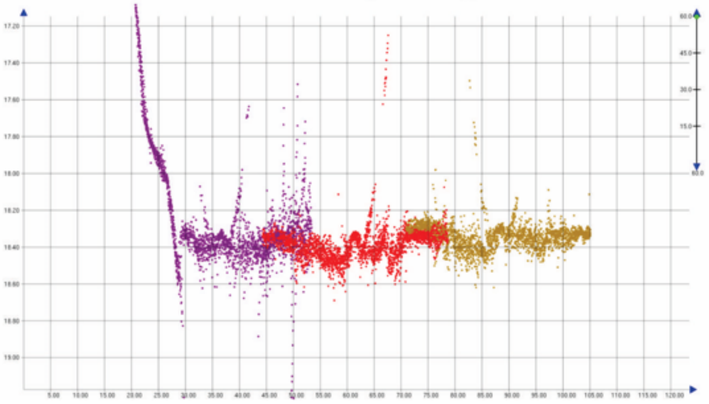
Config T7
Freq.= 350 // Pulse = 30
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



Config T8
Freq.= 350 // Pulse = 85
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40

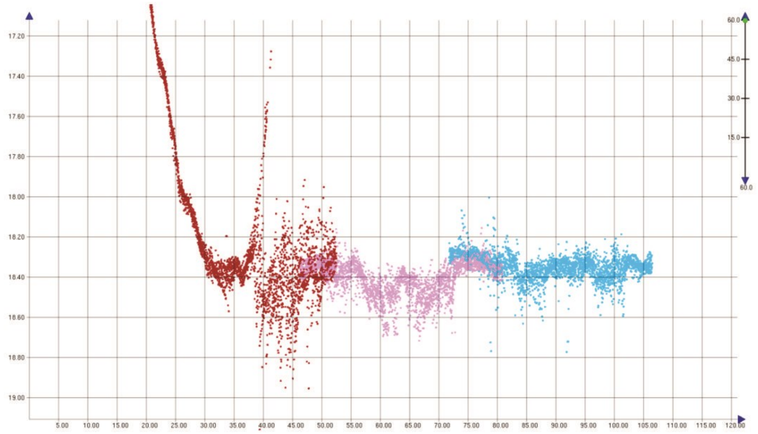


Config T9
Freq.= 350 // Pulse = 130
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



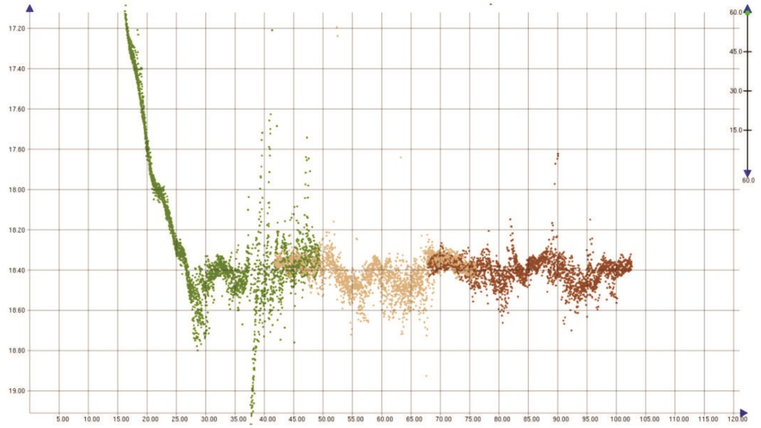
Config A

Freq.= 300 // Pulse = 130
Power = 215 // Absorption = 125
Gain 16 // Spreading = 50



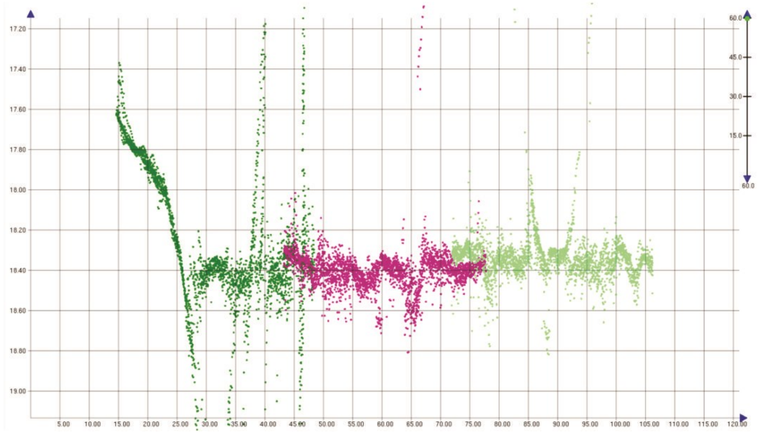
Config B

Freq.= 300 // Pulse = 130
Power = 215 // Absorption = 80
Gain 16 // Spreading = 25



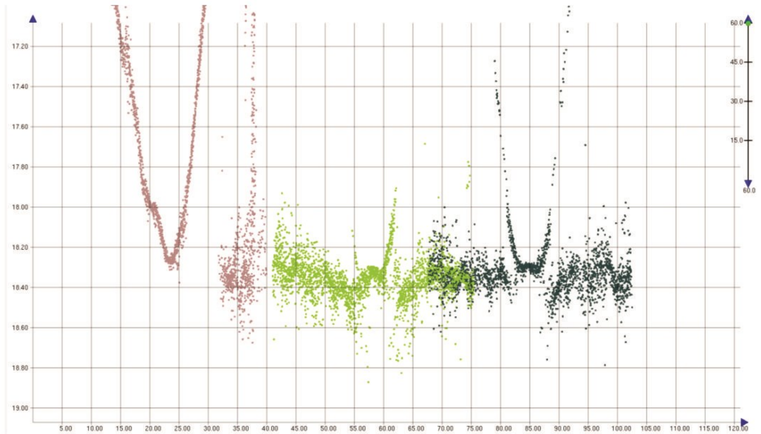
Config C

Freq.= 300 // Pulse = 130
Power = 203 // Absorption = 125
Gain 5 // Spreading = 50



Config D

Freq.= 300 // Pulse = 130
Power = 203 // Absorption = 80
Gain 5 // Spreading = 25



Test 5

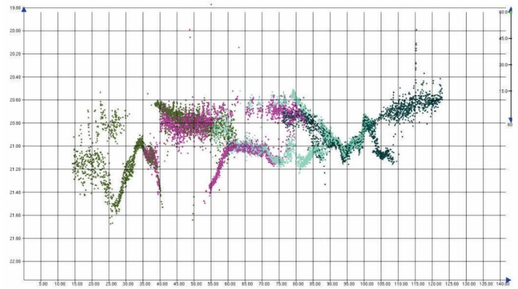
Energy

Transmission Losses

- ✓ High power → smaller gaps and spikes
- ✓ Absorption and spreading interfere if Power is Low

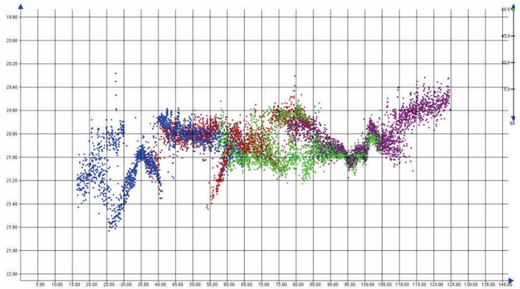
Config T1

Freq.= 350 // Pulse = 50
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30



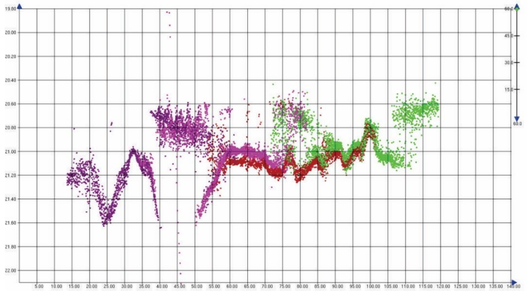
Config T2

Freq.= 350 // Pulse = 135
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30



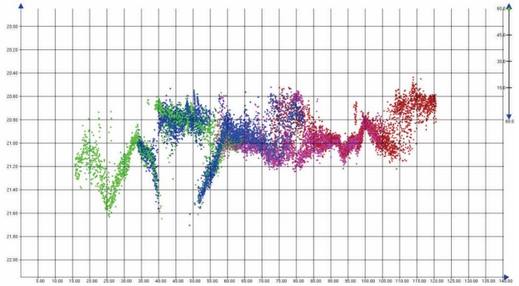
Config T3

Freq.= 300 // Pulse = 50
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30



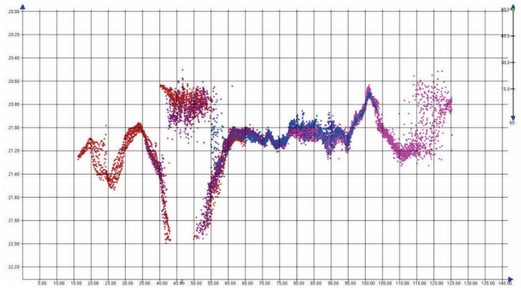
Config T4

Freq.= 300 // Pulse = 135
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30



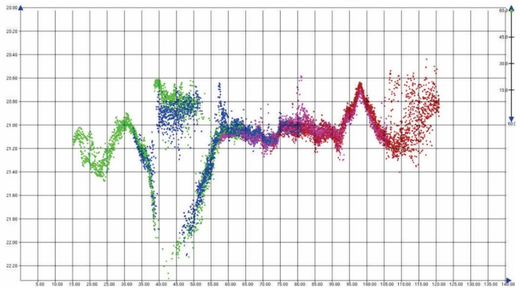
Config T5

Freq.= 220 // Pulse = 50
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30



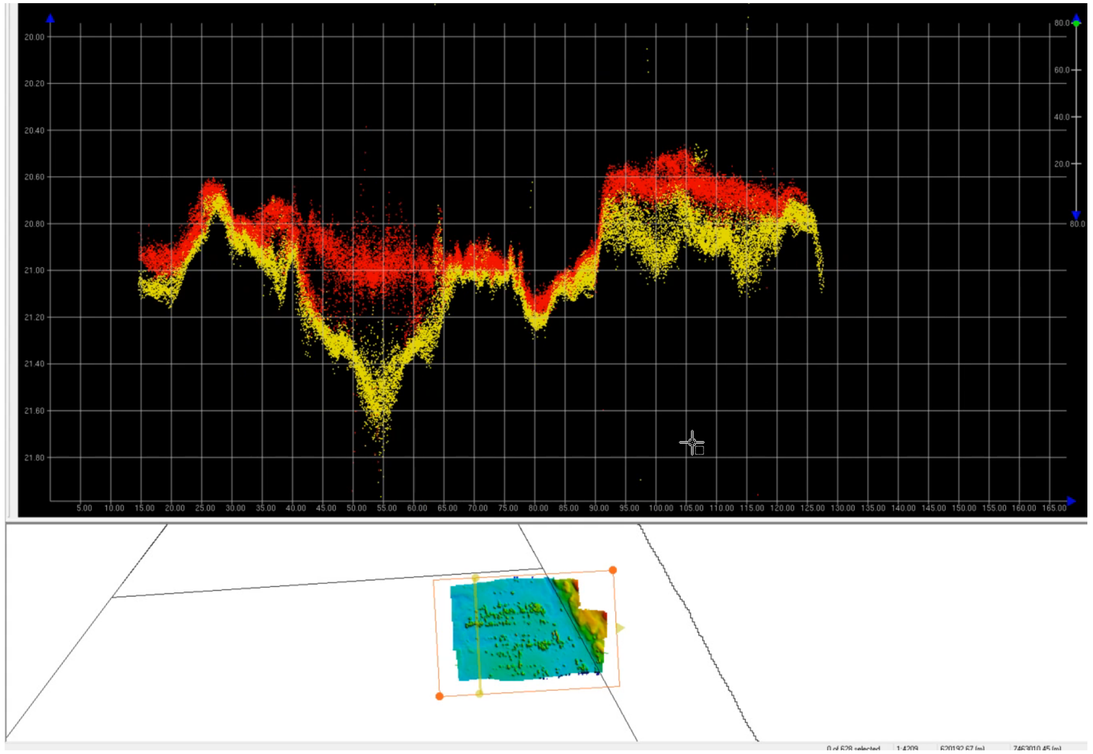
Config T6

Freq.= 220 // Pulse = 135
Power = 203 // Absorption = 80
Gain 6 // Spreading = 30

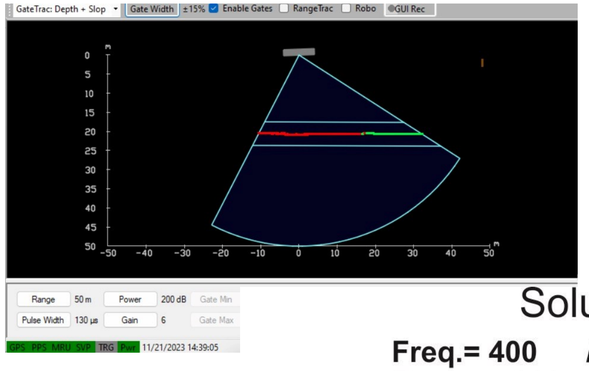


What to do When Nothing Seems to Work?

What to do When Nothing Seems to Work?

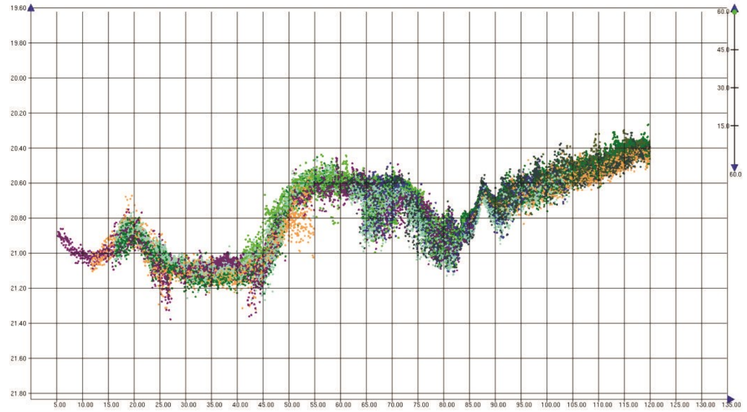


200 kHz x 400 kHz

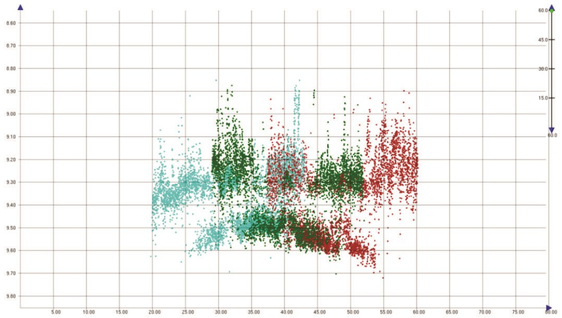


Solution

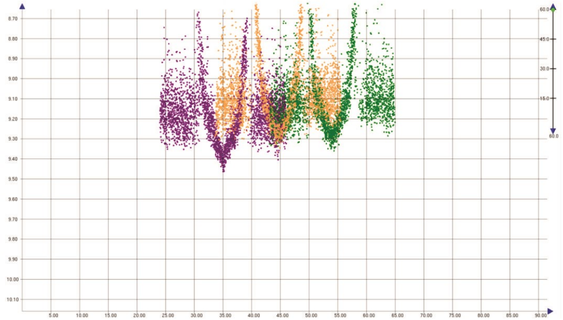
Freq.= 400 // Pulse = 130
Power = 200 // Absorption = 80
Gain 6 // Spreading = 30
Swath Rotation 15º Coverage 85º



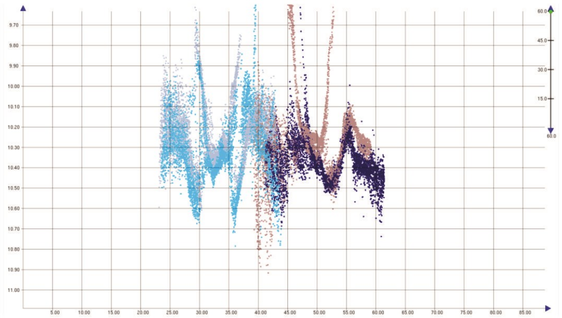
Freq.= 250 // Pulse = 60
Power = 202 // Absorption = 90
Gain 07 // Spreading = 35



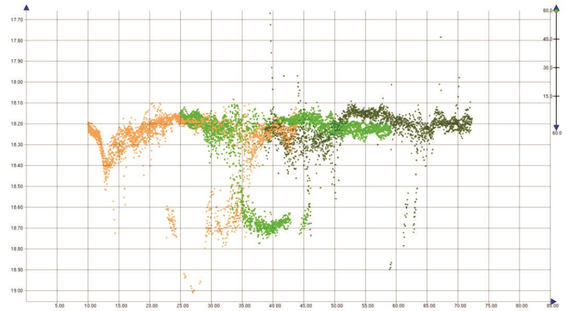
Freq.= 400 // Pulse = 140
Power = 190 // Absorption = 90
Gain 07 // Spreading = 35



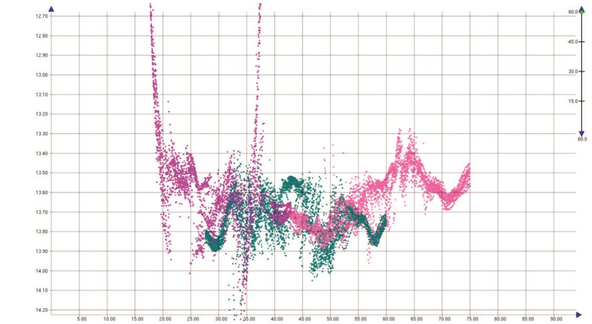
Freq.= 250 // Pulse = 105
Power = 203 // Absorption = 80
Gain 05 // Spreading = 25



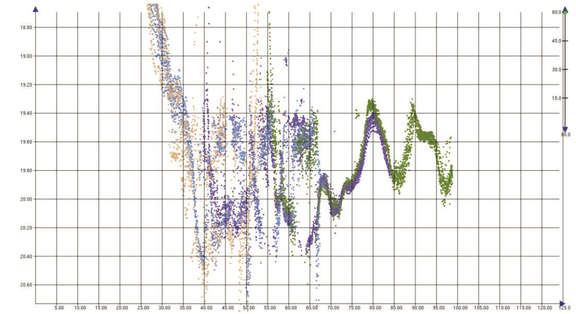
Freq.= 250 // Pulse = 45
Power = 206 // Absorption = 110
Gain 13 // Spreading = 40



Freq.= 200 // Pulse = 100
Power = 206 // Absorption = 80
Gain 10 // Spreading = 25



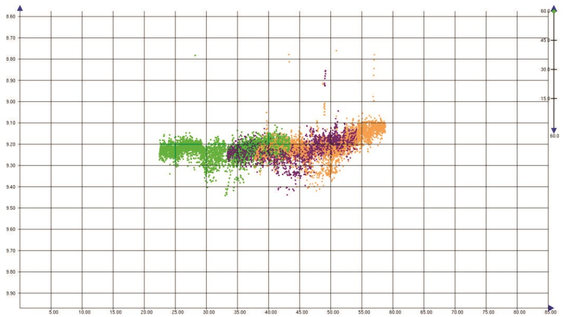
Freq.= 250 // Pulse = 60
Power = 218 // Absorption = 110
Gain 14 // Spreading = 30



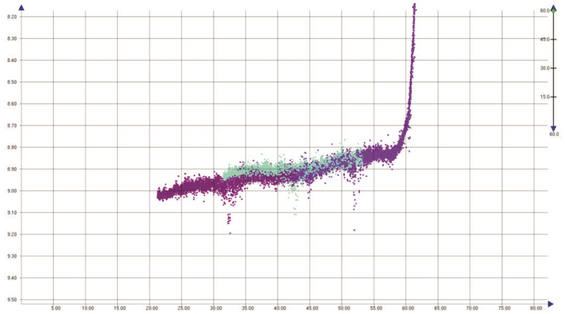
Worst Parameters

- ✓ LOW FREQUENCY
- ✓ HIGH PULSE WIDTH (sometimes low pulse)
- ✓ LOW POWER
- ✓ LOW ABSORPTION AND SPREADING

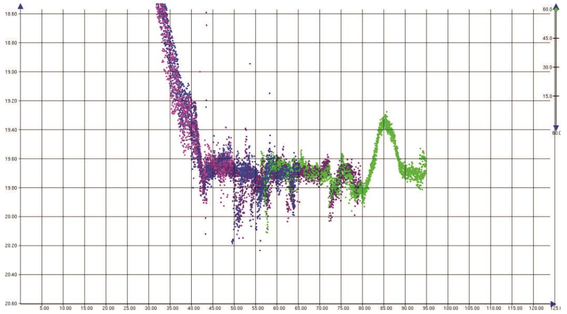
Freq.= 350 // Pulse = 45
Power = 212 // Absorption = 90
Gain 07 // Spreading = 35



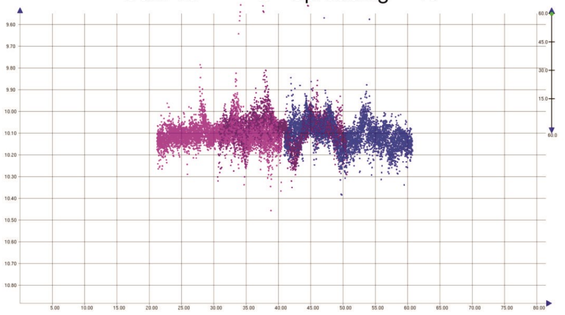
Freq.= 350 // Pulse = 60
Power = 202 // Absorption = 100
Gain 07 // Spreading = 45



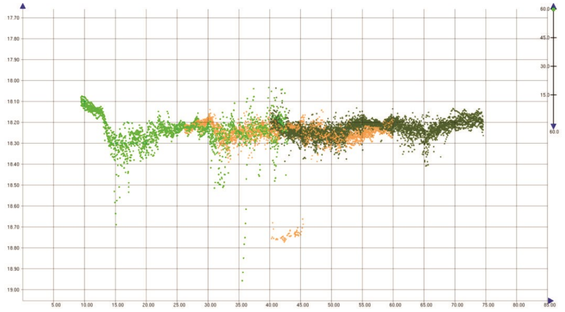
Freq.= 400 // Pulse = 90
Power = 203 // Absorption = 110
Gain 14 // Spreading = 30



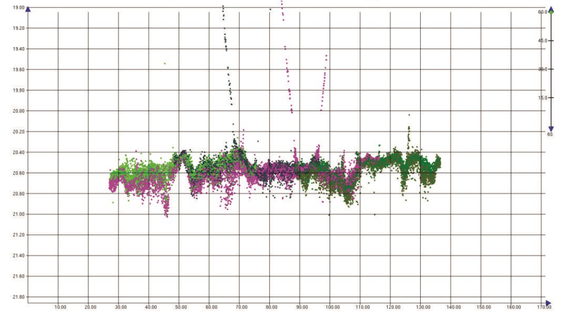
Freq.= 350 // Pulse = 130
Power = 209 // Absorption = 110
Gain 10 // Spreading = 40



Freq.= 300 // Pulse = 45
Power = 206 // Absorption = 110
Gain 13 // Spreading = 40



Freq.= 300 // Pulse = 120
Power = 202 // Absorption = 130
Gain 11 // Spreading = 20



Best Parameters

- ✓ HIGH FREQUENCY
- ✓ LOW AND MEDIUM PULSE WIDTH
- ✓ MEDIUM POWER
- ✓ ABSORPTION AND SPREADING LITTLE INTERFERENCE

What’s next?

- Compare quality with statistics results (std. dev; uncertainty);
- Publication;
- Systematic tests and soft mud study.

“There is still a lot left to be done.”
Captain Airton

Thanks a milion!

Alex Evaristo da Silva
+55 27 98192-4142
alex.silva@umi.com.br

oceanology international

UMI 海 SAN
HIDROGRAFIA E ENGENHARIA