RIEGL VQ-880-G:

Improved Bathymetric Tools Developed through Collaborative Efforts

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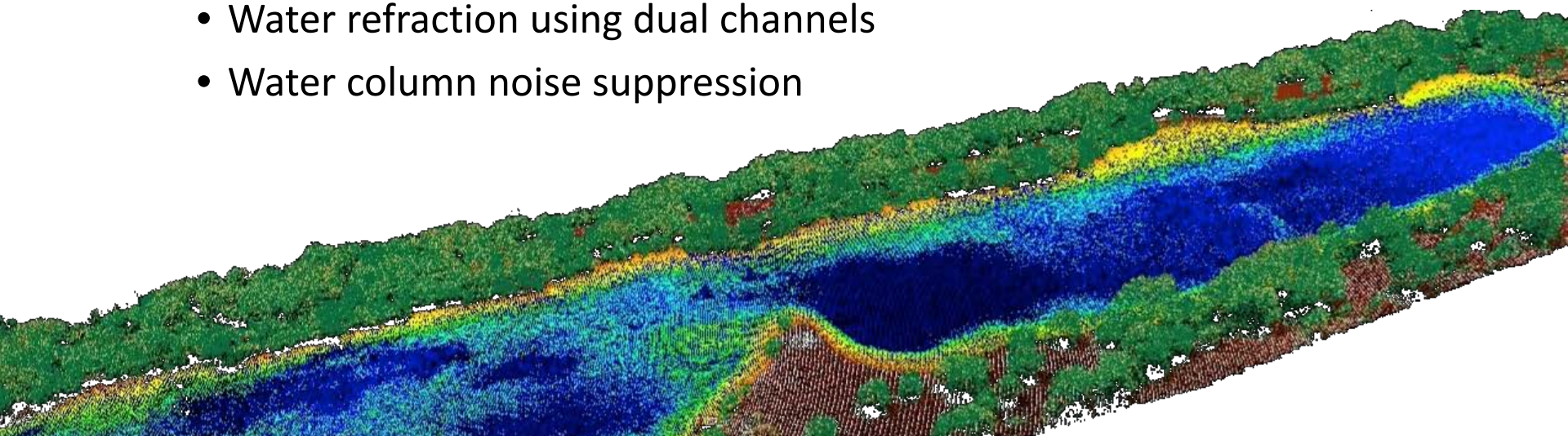
NOAA RSD, Dr. Wayne Wright & *RIEGL* LMS: Development Collaboration with NOAA's VQ-880-G

- Improvements over original VQ-820-G
- Scope of work
- Improvements to acquisition
  - RiACQUIRE
- Water refraction using dual channels
- Water column noise suppression

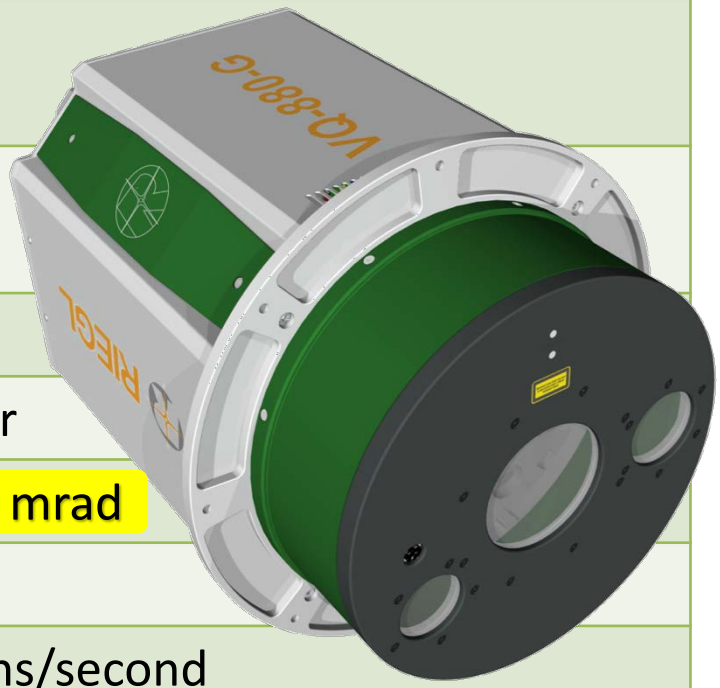


The philosophy of *RIEGL* topo-bathymetric laser scanners

- Excellently suited for combined hydrographic and topographic airborne surveying
- High-accuracy ranging based on **echo digitization** and **online waveform processing** with multiple target capability
- Concurrent **waveform data output**
- **High spatial resolution** due to narrow laser beam, high pulse repetition rate, and high scanning speed
- Compact, rugged, and lightweight configuration, compatible with standard airborne platforms
- Seamless integration with other *RIEGL* ALS Systems and software packages

VQ-880-G Key Specifications

wavelength	532 nm (visible green light)
measurement range *topography*	2500 m at ρ ≥ 20% 3600 m at ρ ≥ 60%
measurement range *hydrography*	Greater than 1.5 Secchi depth
ranging accuracy	25 mm
Scanner field of view	40°, 20° from Nadir
Laser beam divergence	selectable, 0.7-2.0 mrad
measurement rate	up to 550 kHz
scan speed	up to 80 revolutions/second
laser safety	Laser Class 3B
Multiple-Time-Around processing	Yes

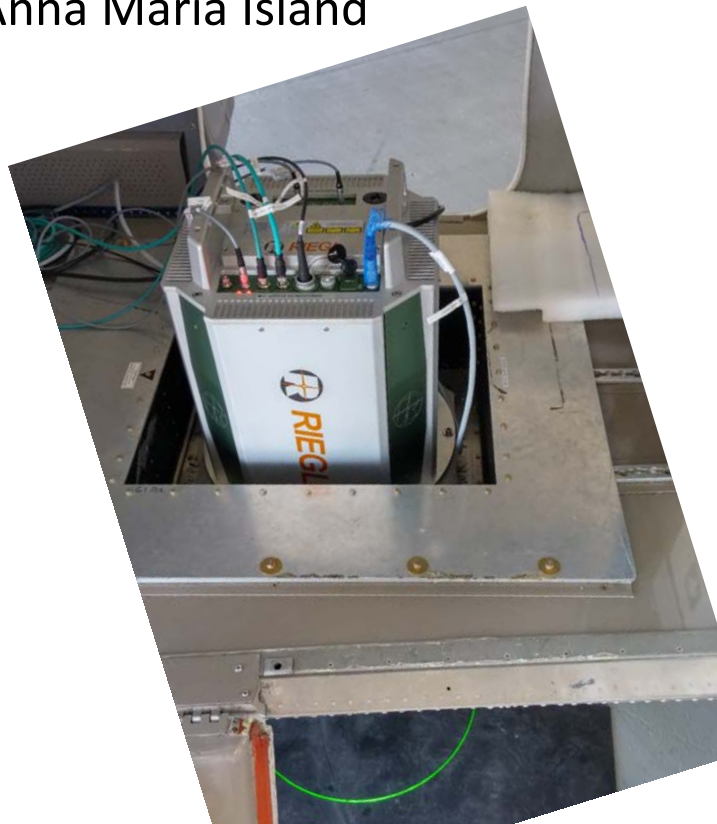


VQ-880-G Key Specifications

wavelength	**1064 nm (IR)**	
measurement range topography	900 m at ρ ≥ 20% 1500 m at ρ ≥ 60%	@ 145 kHz Laser PRR
ranging accuracy	25 mm	
Scanner field of view	40°	
Laser beam divergence	0.2 mrad	
measurement rate	up to 177 kHz @ 550 kHz laser PRR	
scan speed	up to 200 revolutions/second	
laser safety	Laser Class 3B	
Multiple-Time-Around processing	Yes	

Scope of Work

- NOAA acceptance tests of the VQ-880-G over Florida coastal sites
  - Tampa Bay Area – Ft Desoto, Egmont Key, Anna Maria Island
  - Florida Keys – Marathon Key
  - Ft Lauderdale – Bathymetric Site offshore



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  - Tampa Bay Area – Ft Desoto, Egmont Key, Anna Maria Island
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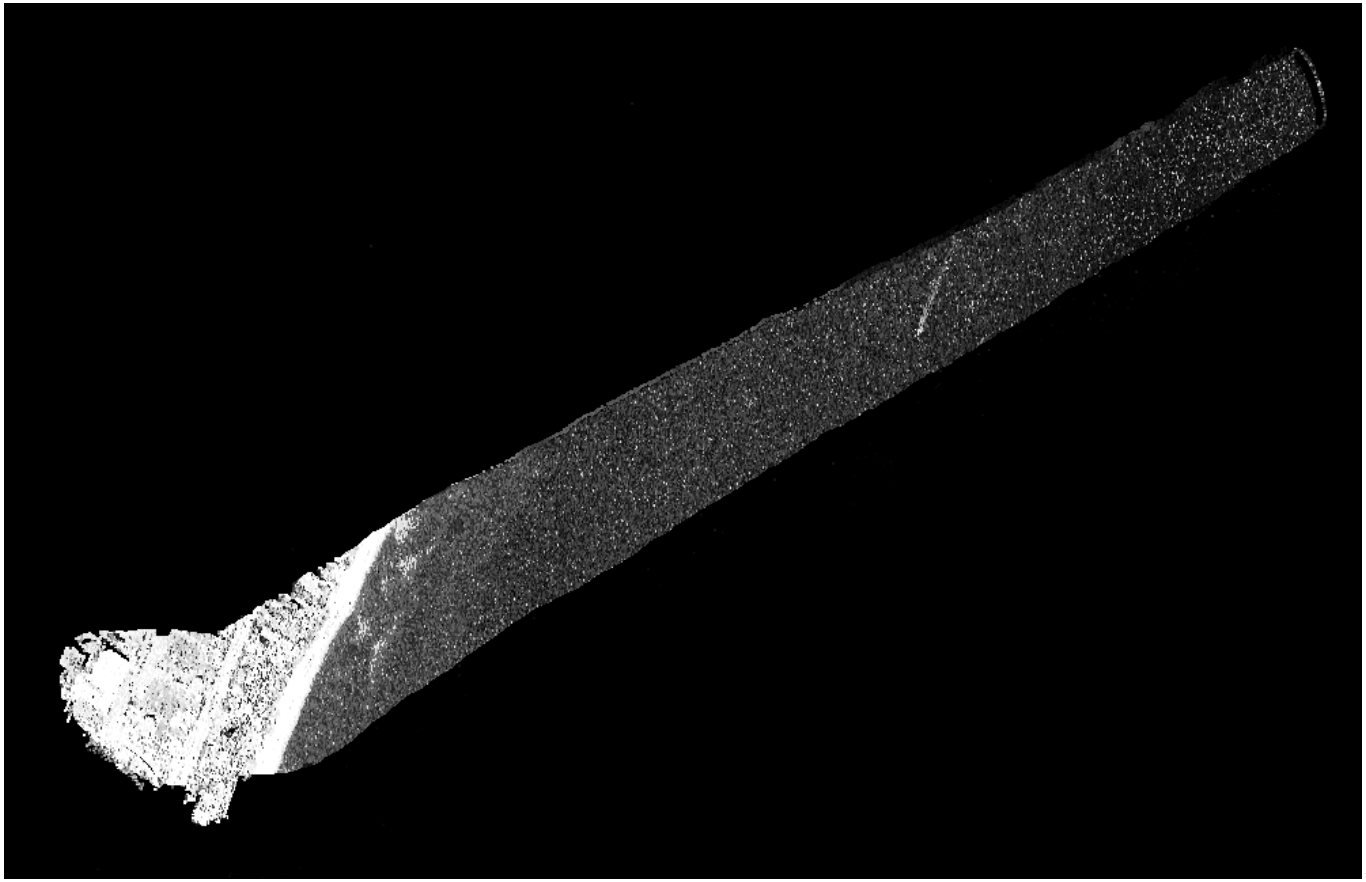
- NOAA operations requests for data acquisition.
  - Lessons learned and requests from previous VQ-820-G
  - Realtime penetration performance analysis
- Dr Wayne Wright
  - Characterization and implementation of features within the software
  - Visit to Austria to meet with Bathymetric team

Acquisition Improvements

- MonLas
  - Realtime generation of LAS files for quick look capabilities



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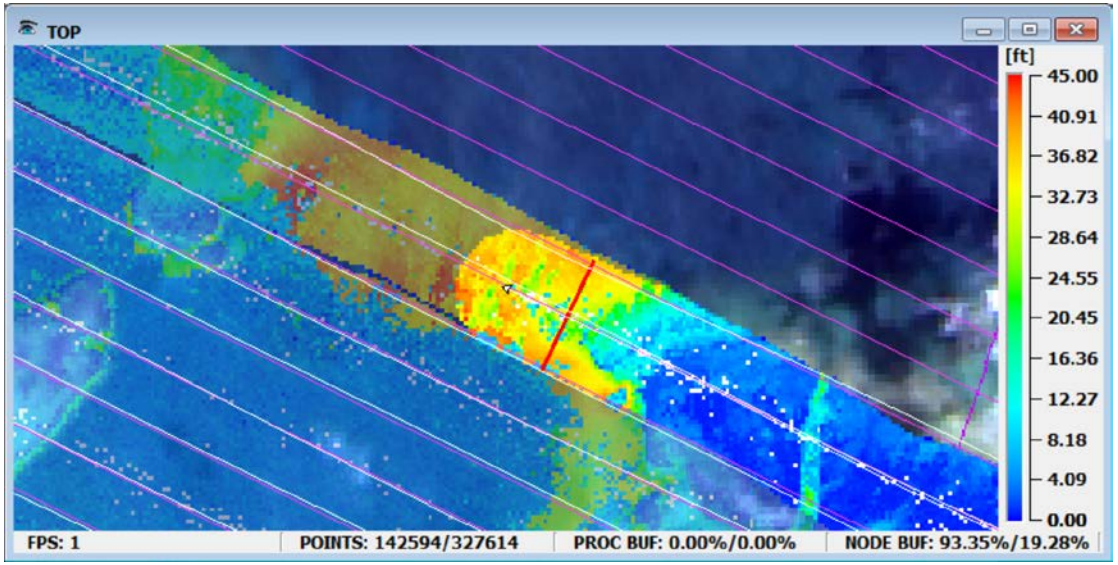
- Top View
  - 2D view overlooking project
  - Height color scale representing penetration performance as a difference from the water surface first return



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  - Cross section view
  - Shows all three scan lines (fore and aft green channel and IR channel)
  - 1 Hz frequency refresh where all three scans are drawn on top of eachother

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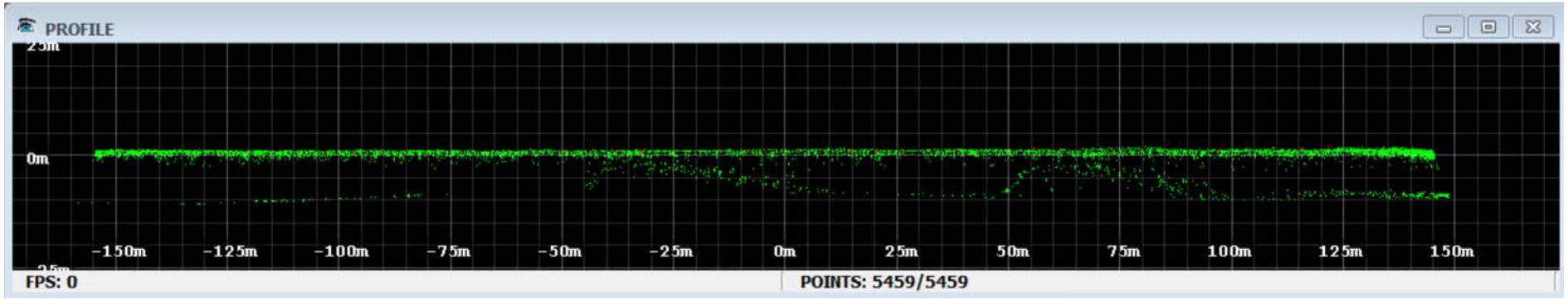
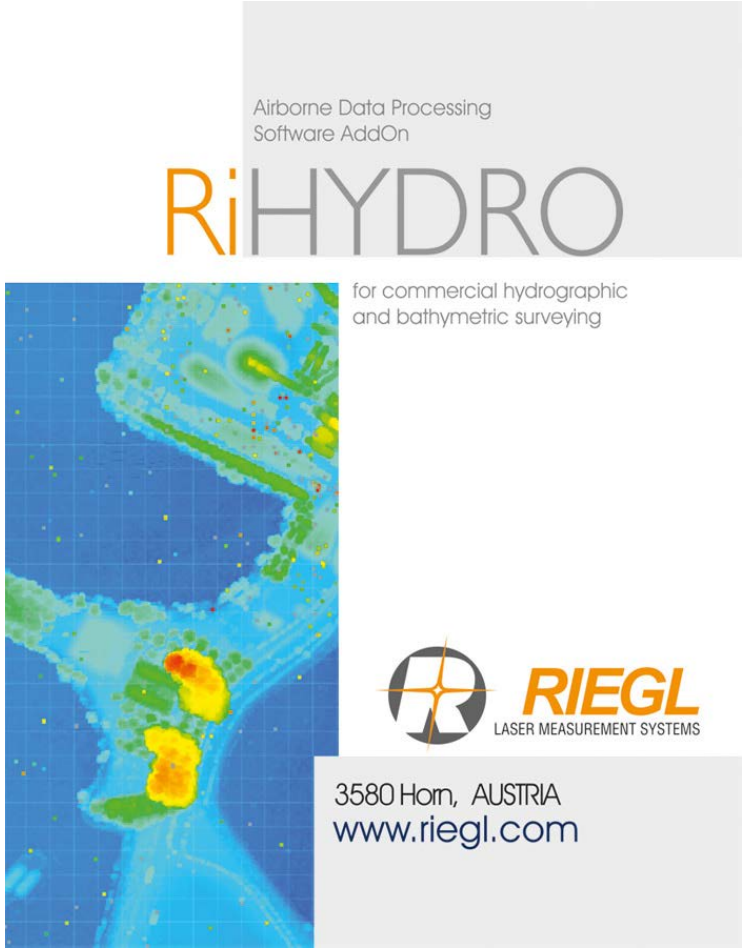
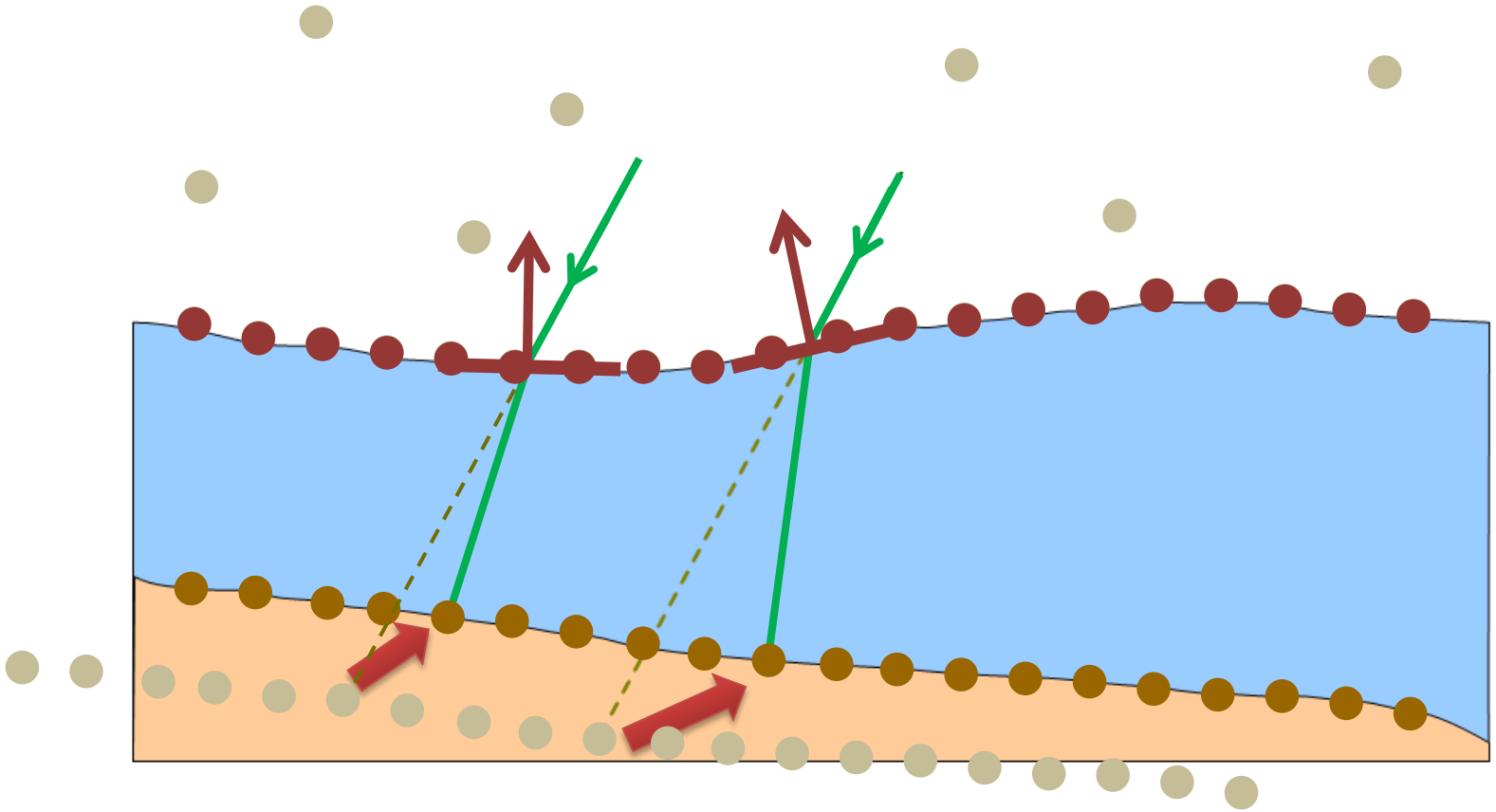


RIEGL Software RiHYDRO (RiPROCESS Add-on)

- Point cloud classification
- Water surface modeling
- Refraction correction





Classification of water surface points

- fully automatic approach
- each record (flight strip) is processed independently
- makes use of reference ellipsoid to overcome areas with insufficient or missing water surface echoes

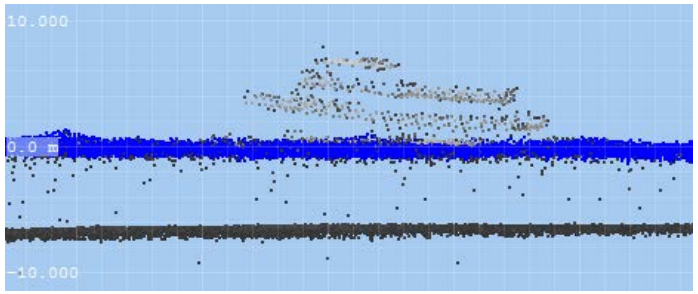
Precondition:

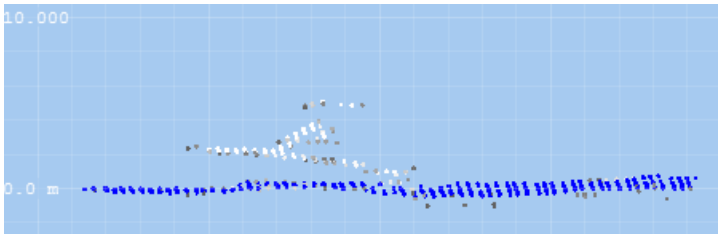
- flight strip must be already geo-referenced with sufficient quality

Alternative/post-processing: manual classification tool (RiPROCESS)

Classification of water surface points

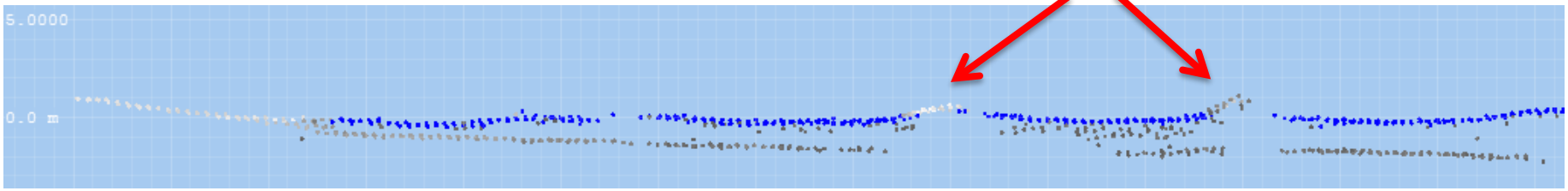
Ships/boats:



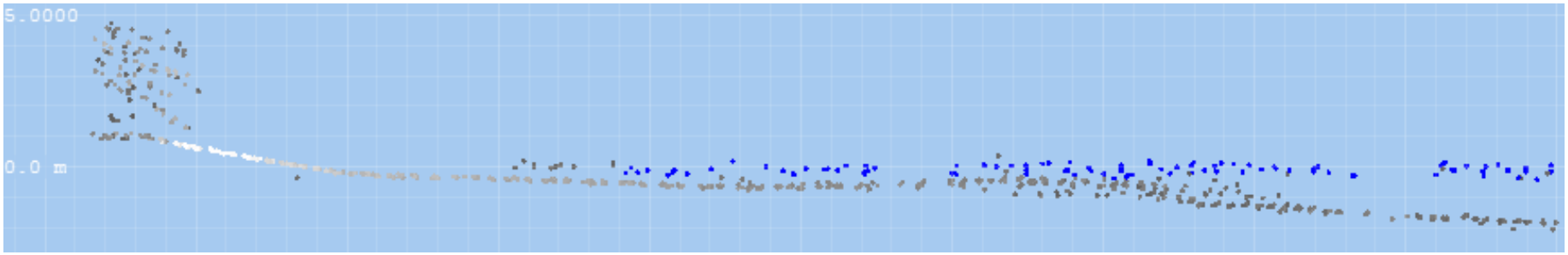


Typical profiles crossing coast line:

high waves & white caps



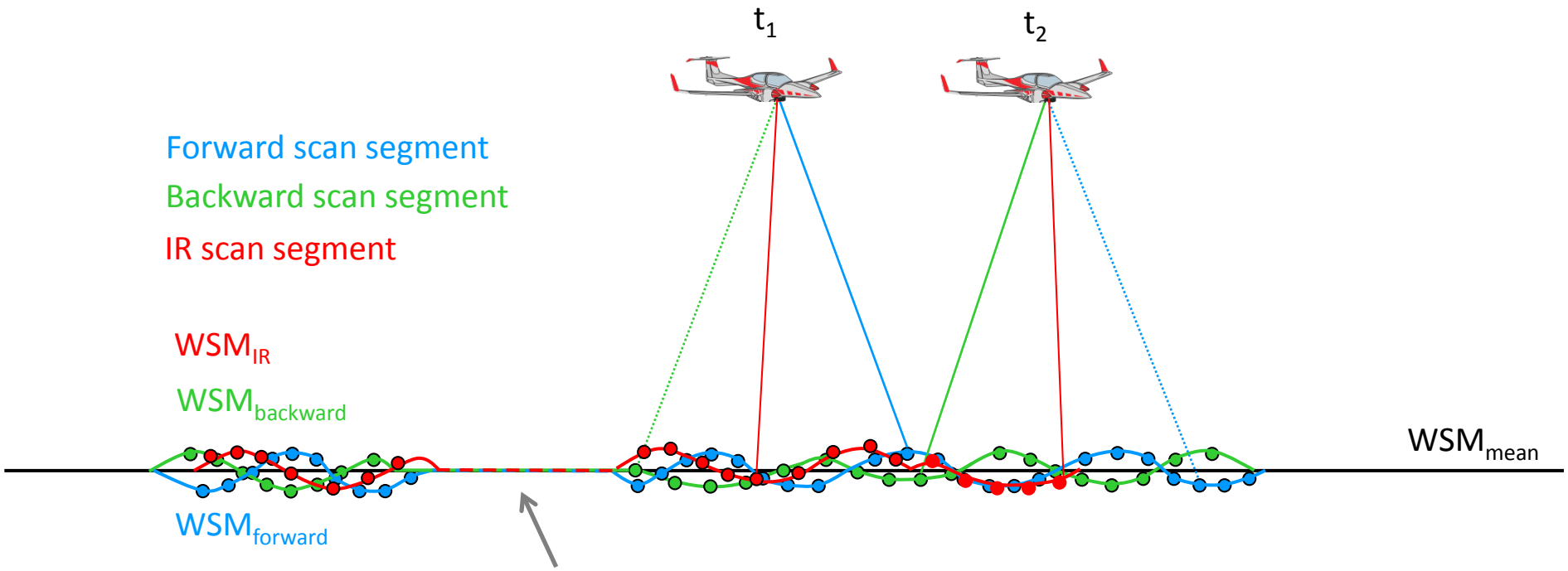
Excellent shallow-water performance:



VQ-880-G Specific Water Surface Model

VQ-880-G record:

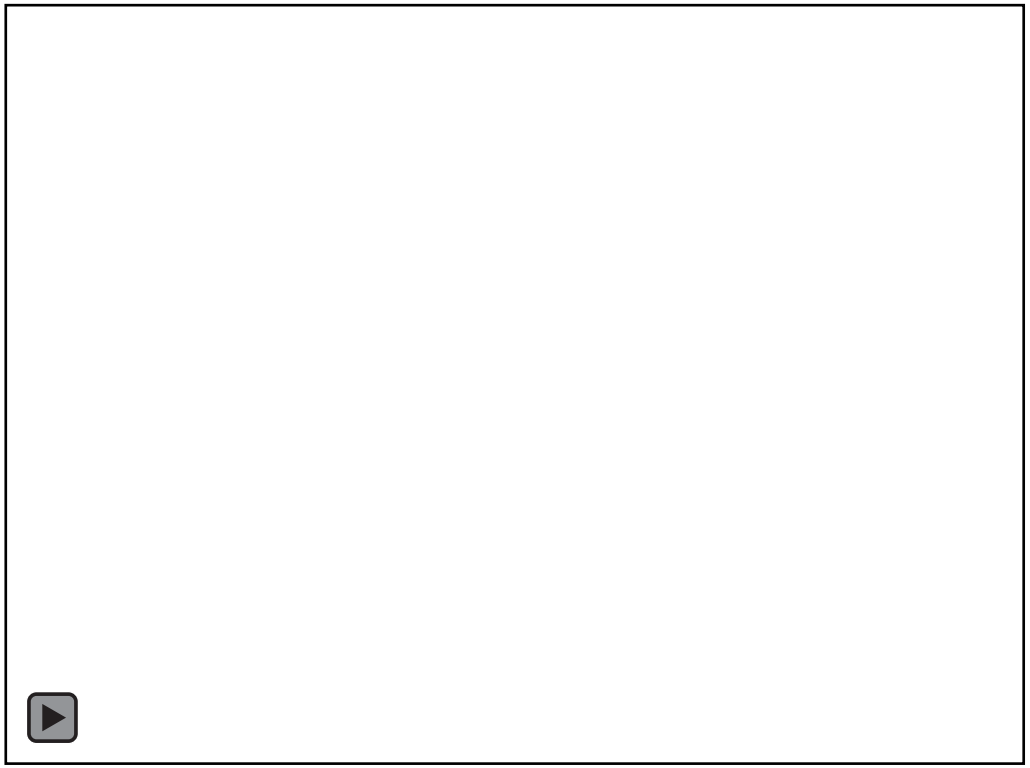
3 resulting water surface models – one for each scan segment and one for IR

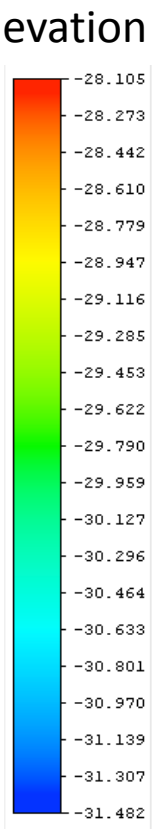


WSM_{mean}: fallback model supplementing WSM in areas lacking water surface points, respectively

Generation of WSM – Results

WSM in case of high waves:

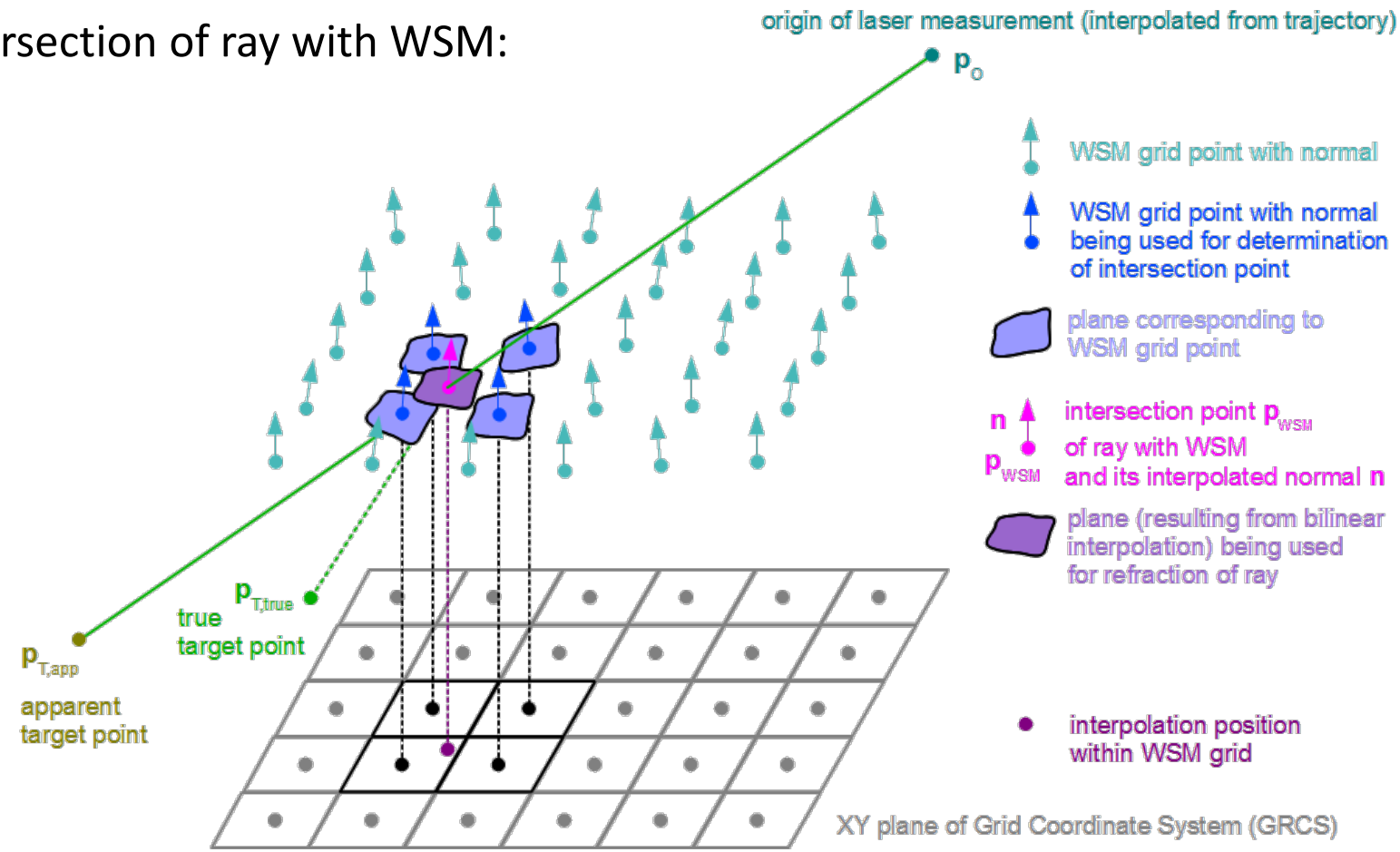




WSM (displayed as normal vector field) and water surface points (z-color-coded)

Refraction correction

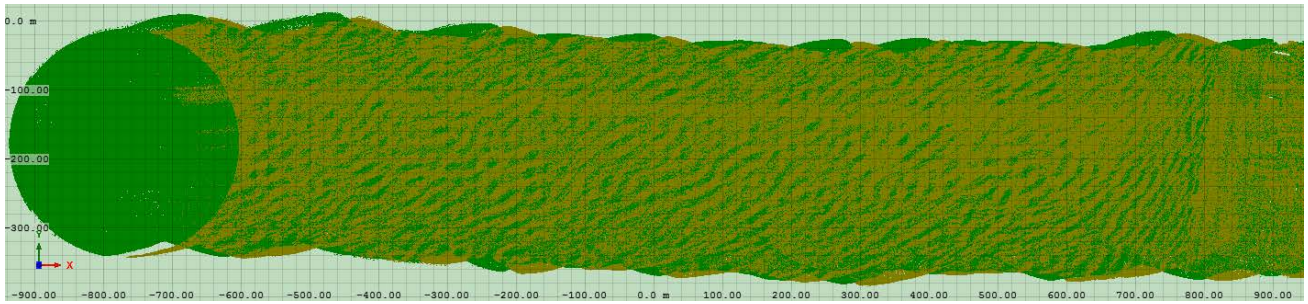
Intersection of ray with WSM:



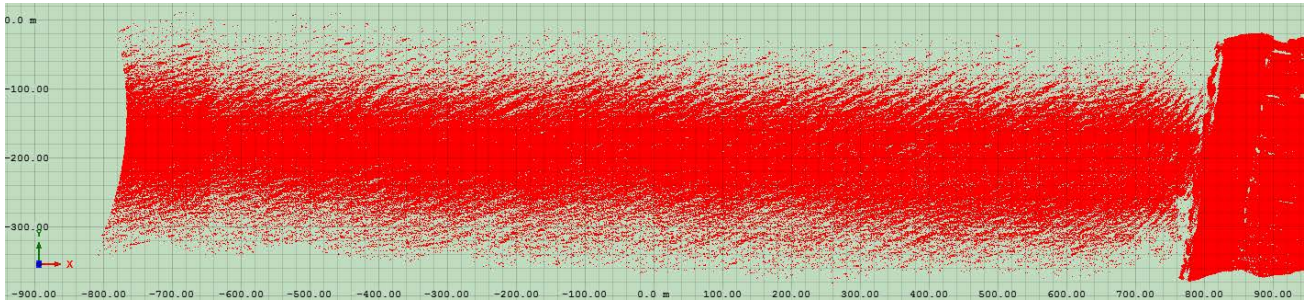
Refraction correction – Dual Channelc

Flight Direction

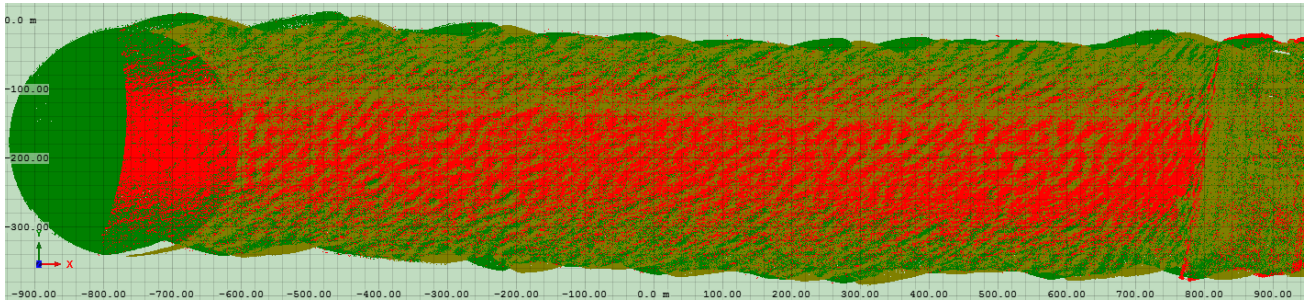
Green (fore & aft scan segments):



IR:



Green & IR:



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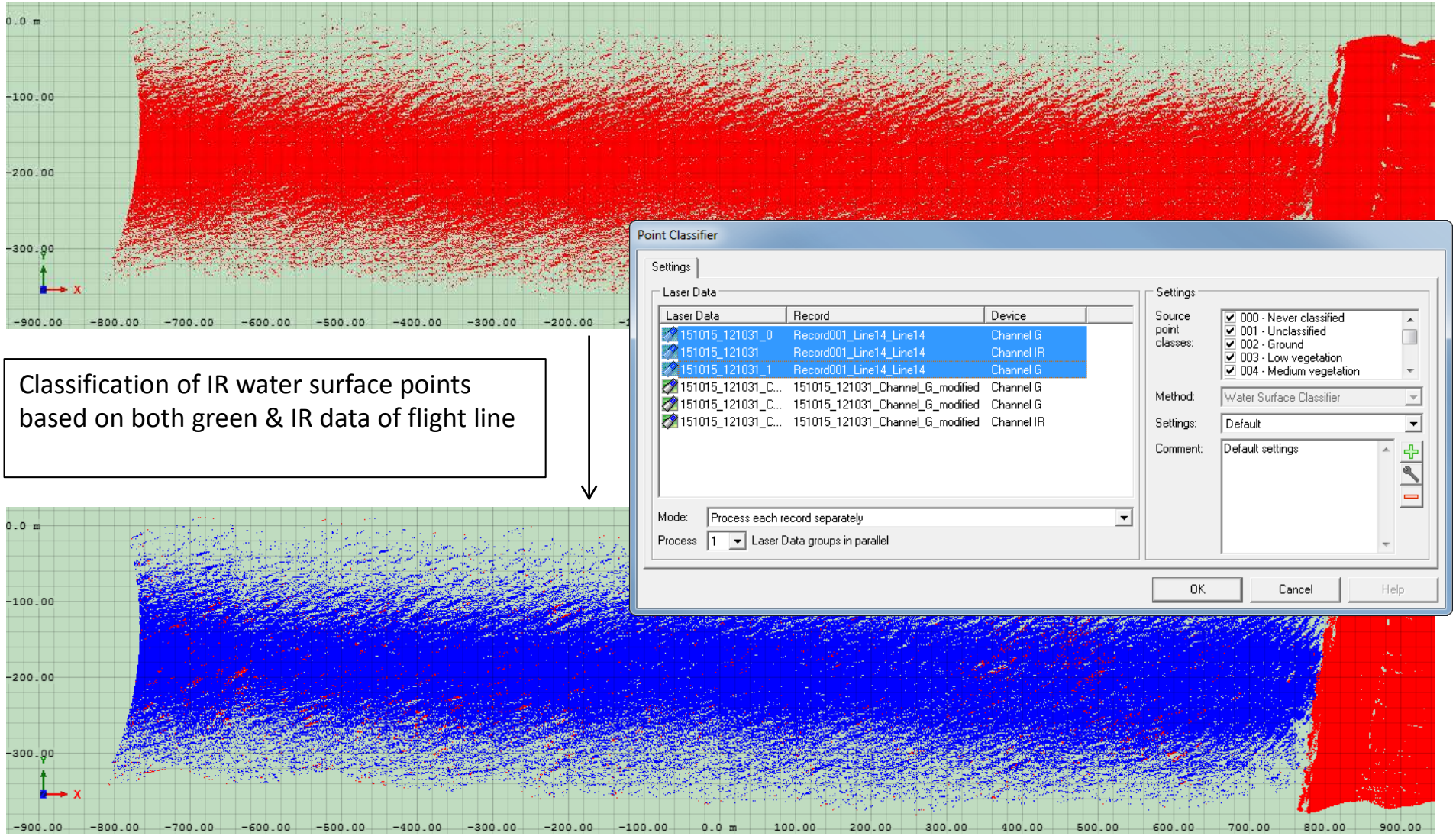
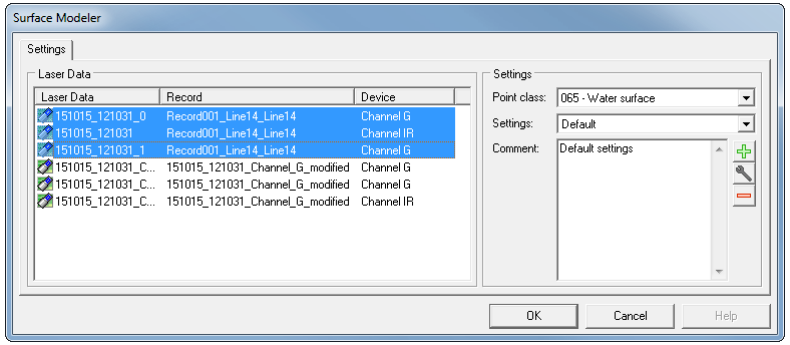


Classification of IR water surface points based on both green & IR data of flight line

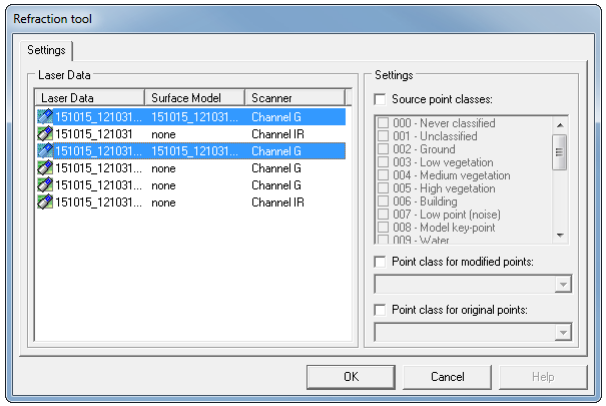
Classified IR water surface points

Generation of Water Surface Model



Water surface model (smoothed)

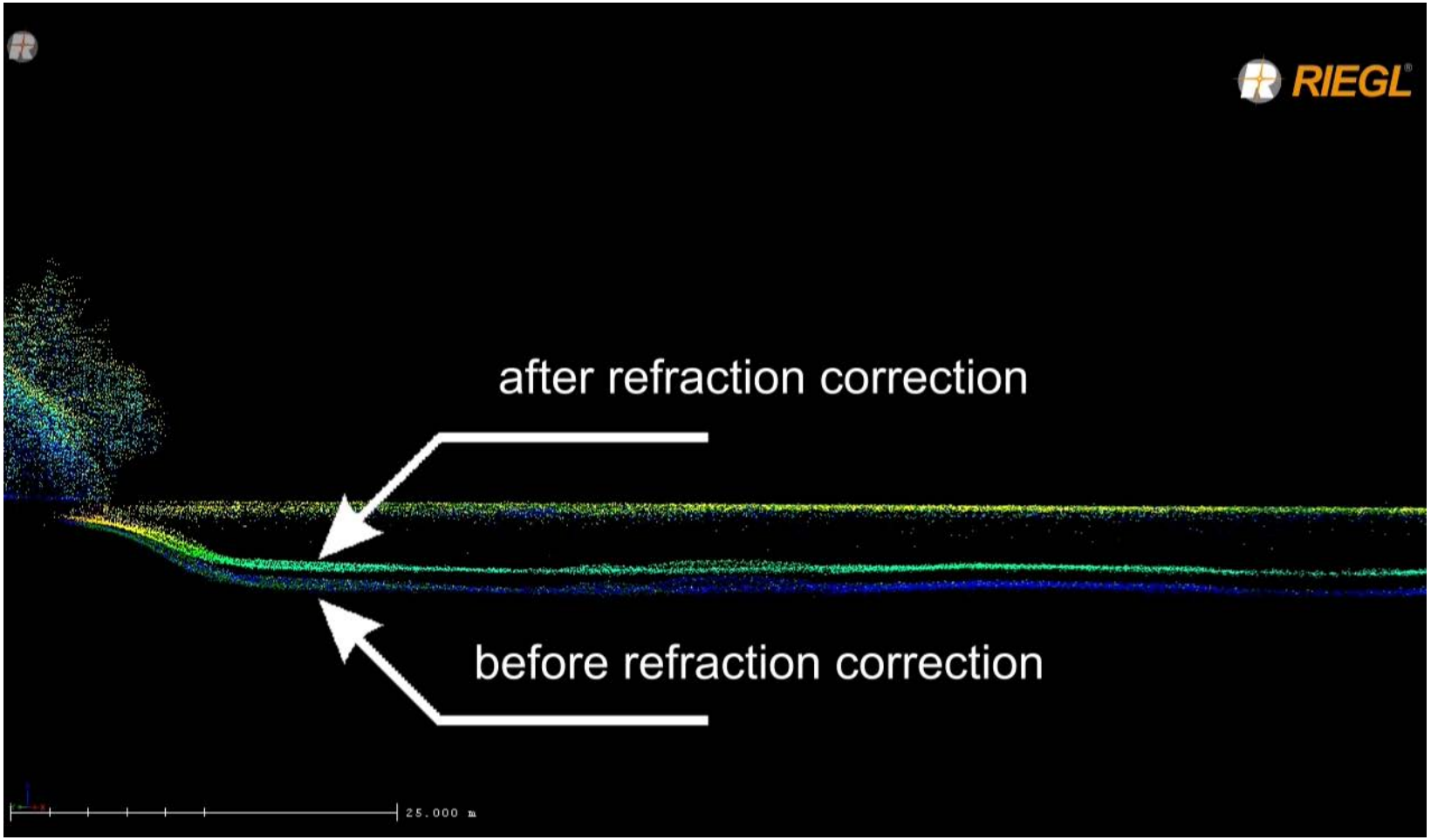
Refraction correction



Refraction-corrected forward scan

Refraction-corrected aft scan

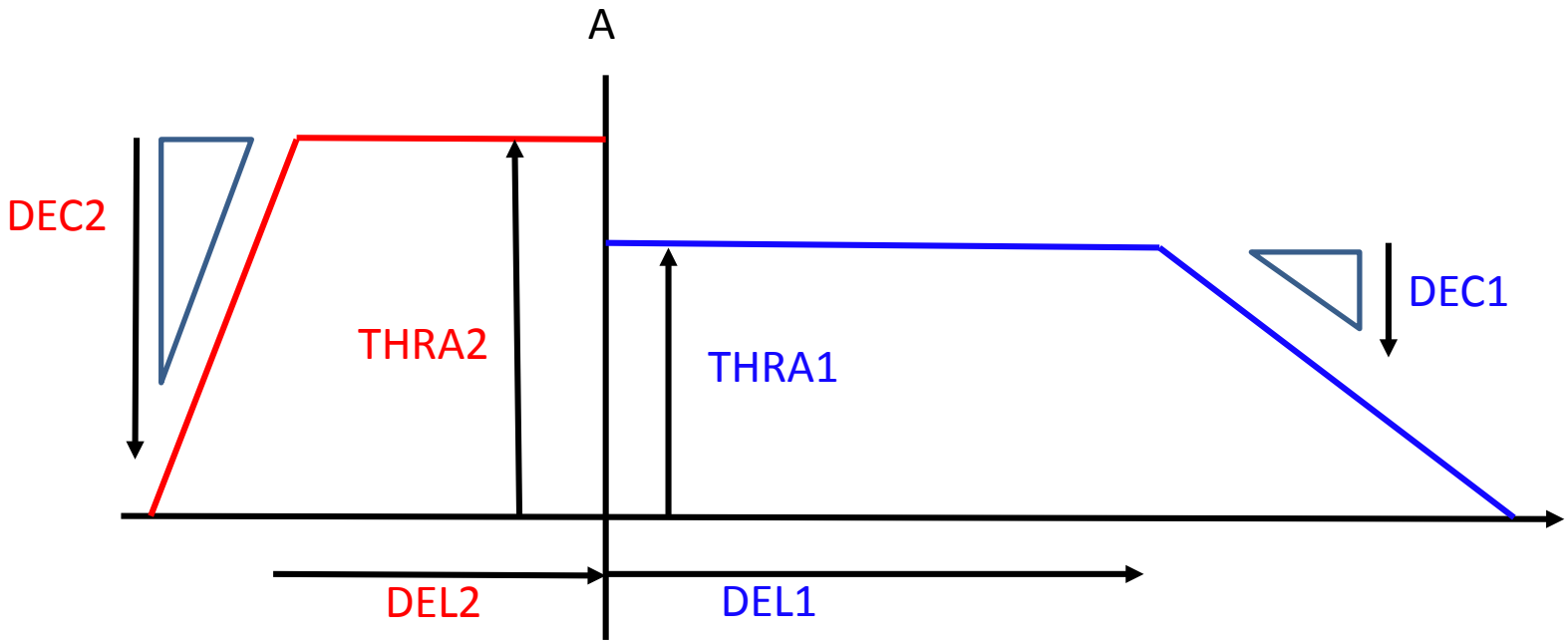
Refraction correction – Results



Noise Suppression – Water Column

- Noise suppression discussed and developed in conjunction with Dr. Wayne Wright (NOAA) and Dr. Martin Pfennigbauer (*RIEGL* LMS)
- Trigger Table
  - Built in *RIEGL* hardware functionality for noise suppression.
  - Implemented during raw data extraction
    - SDCImport
  - Thresholding scheme used to determine validity of next or previous return based off
    - Threshold of return
    - Delay before or after return
    - Decay in intensity after threshold delay

Noise Suppression – Water Column



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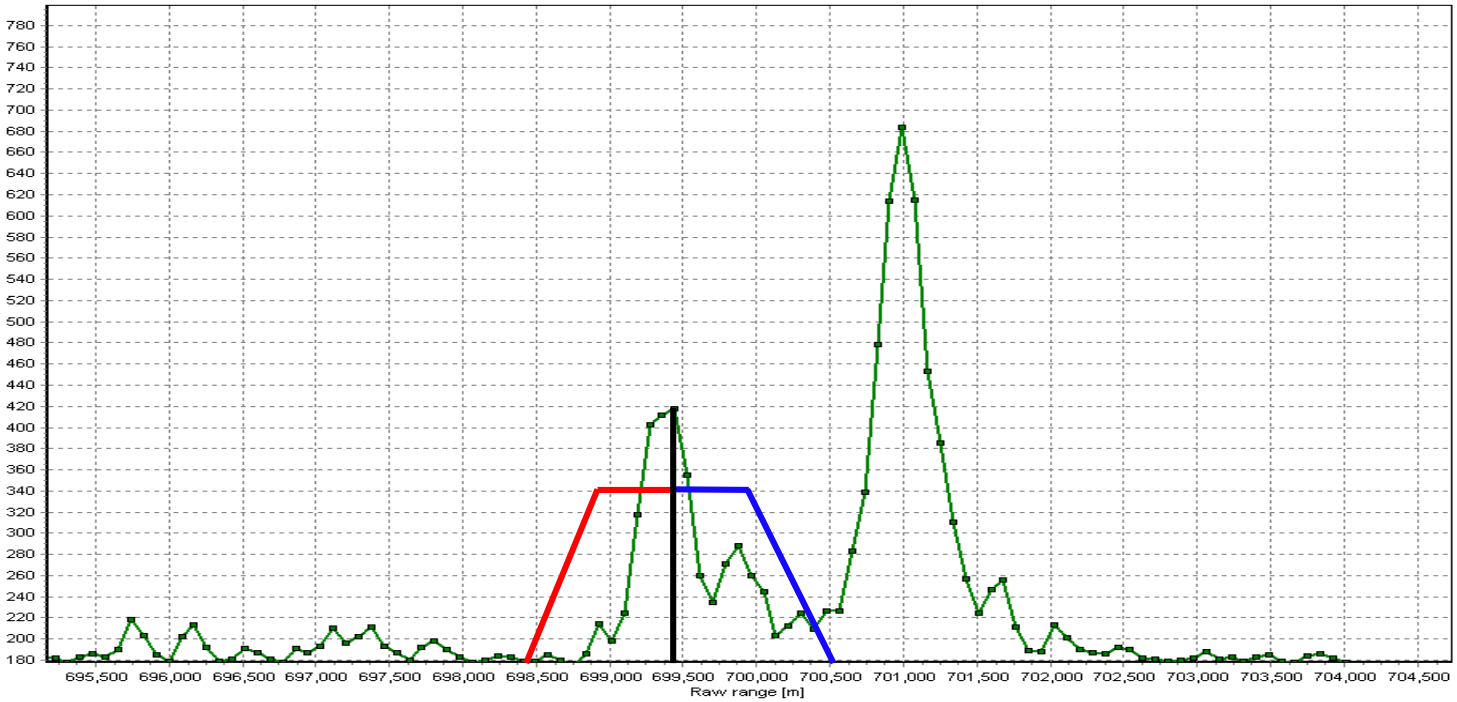
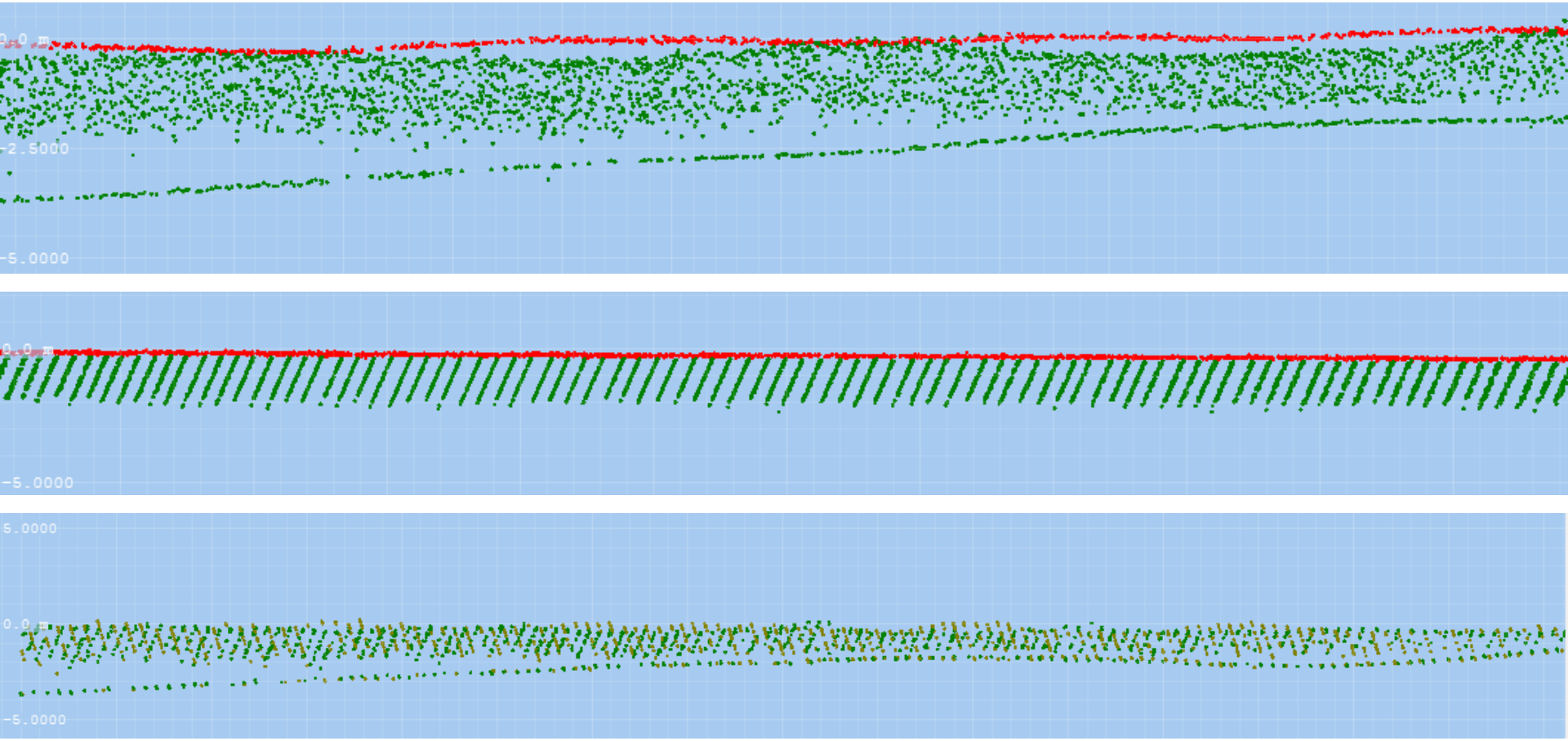


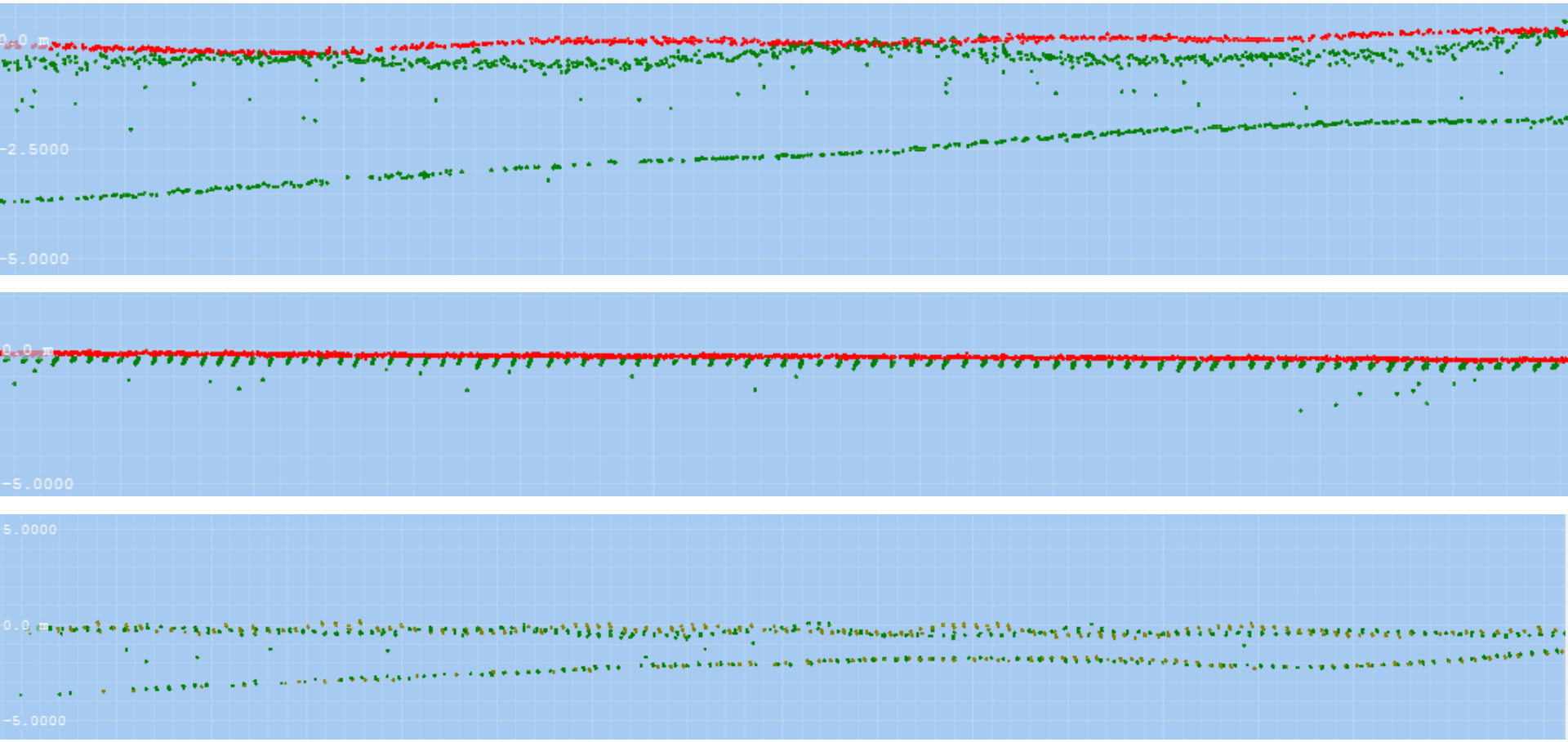
Noise Suppression – Water Column

RAW Point Cloud



Noise Suppression – Water Column

Tuned trigger table for area



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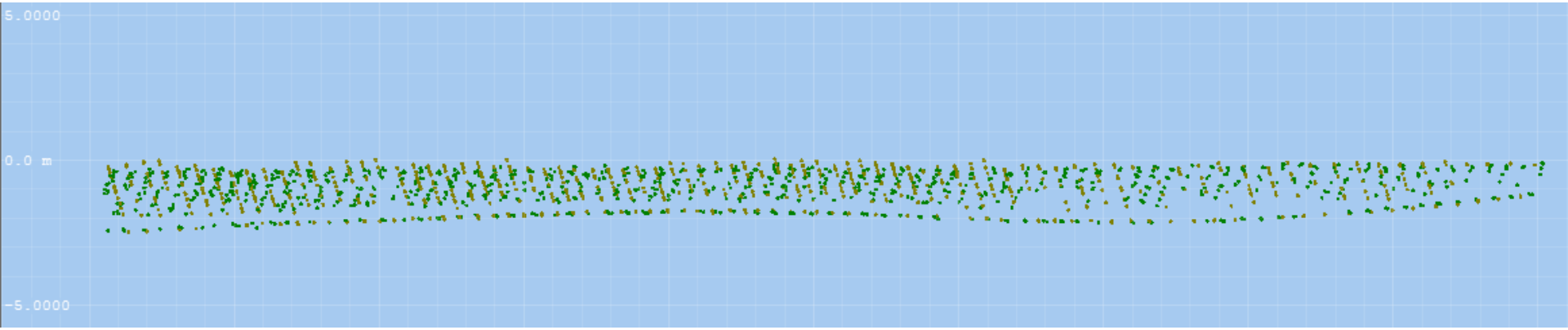

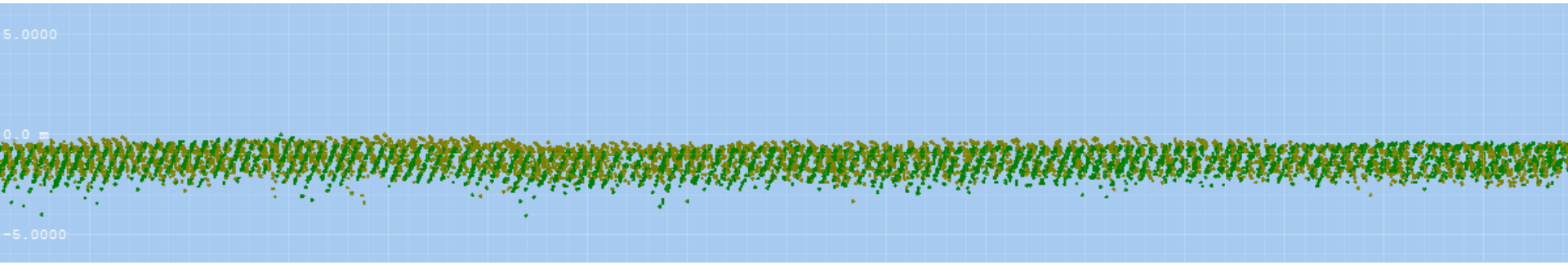

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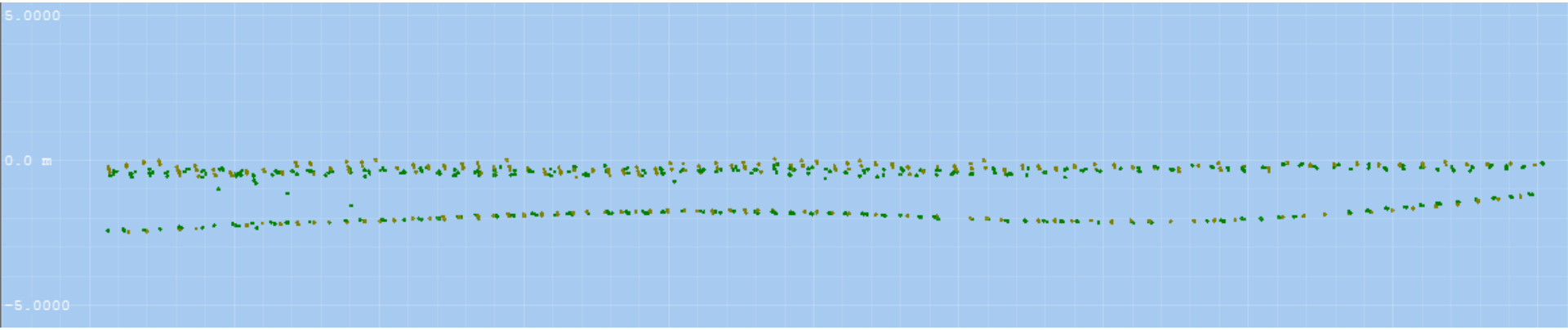

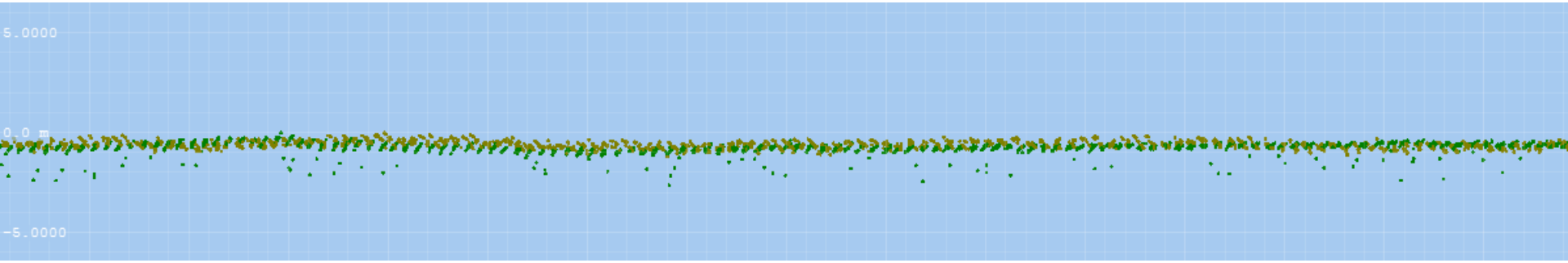

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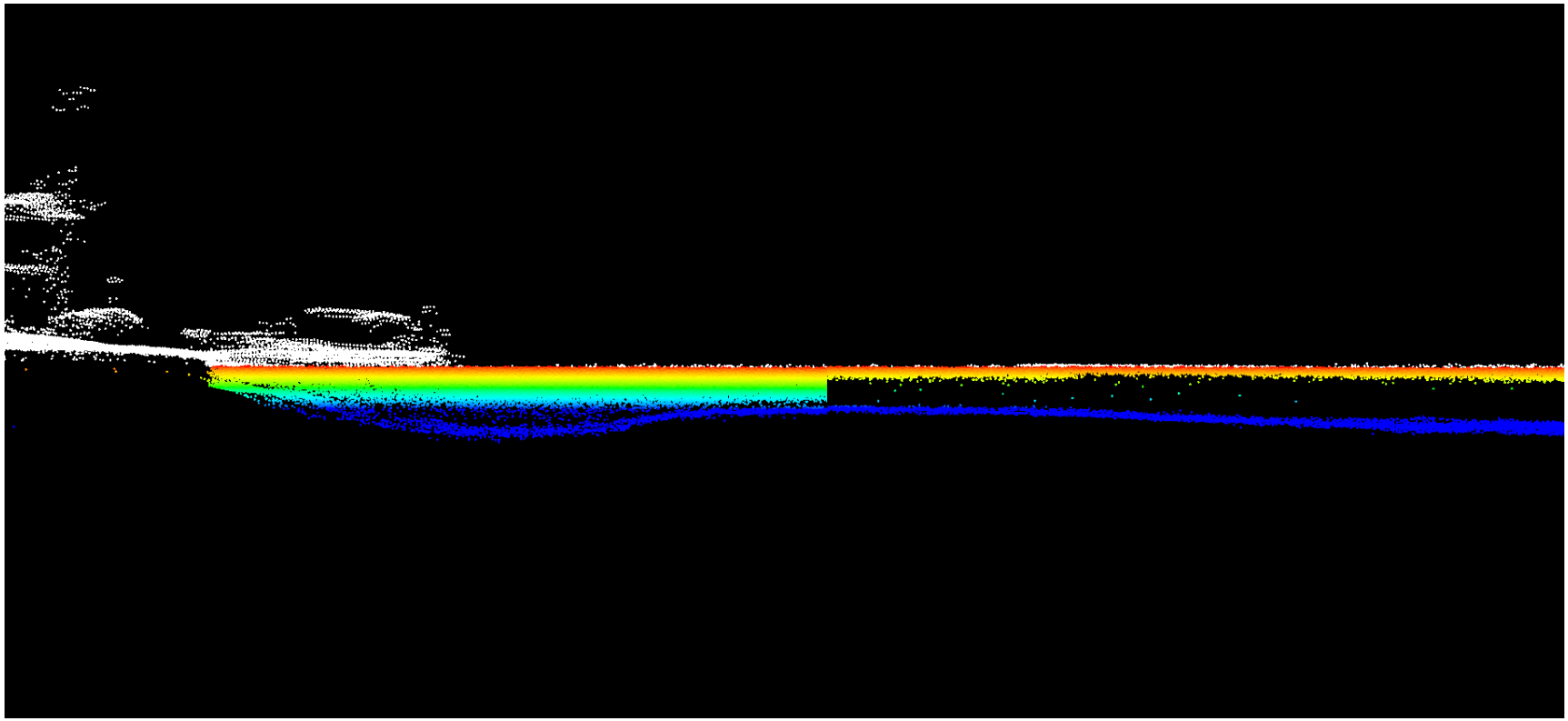

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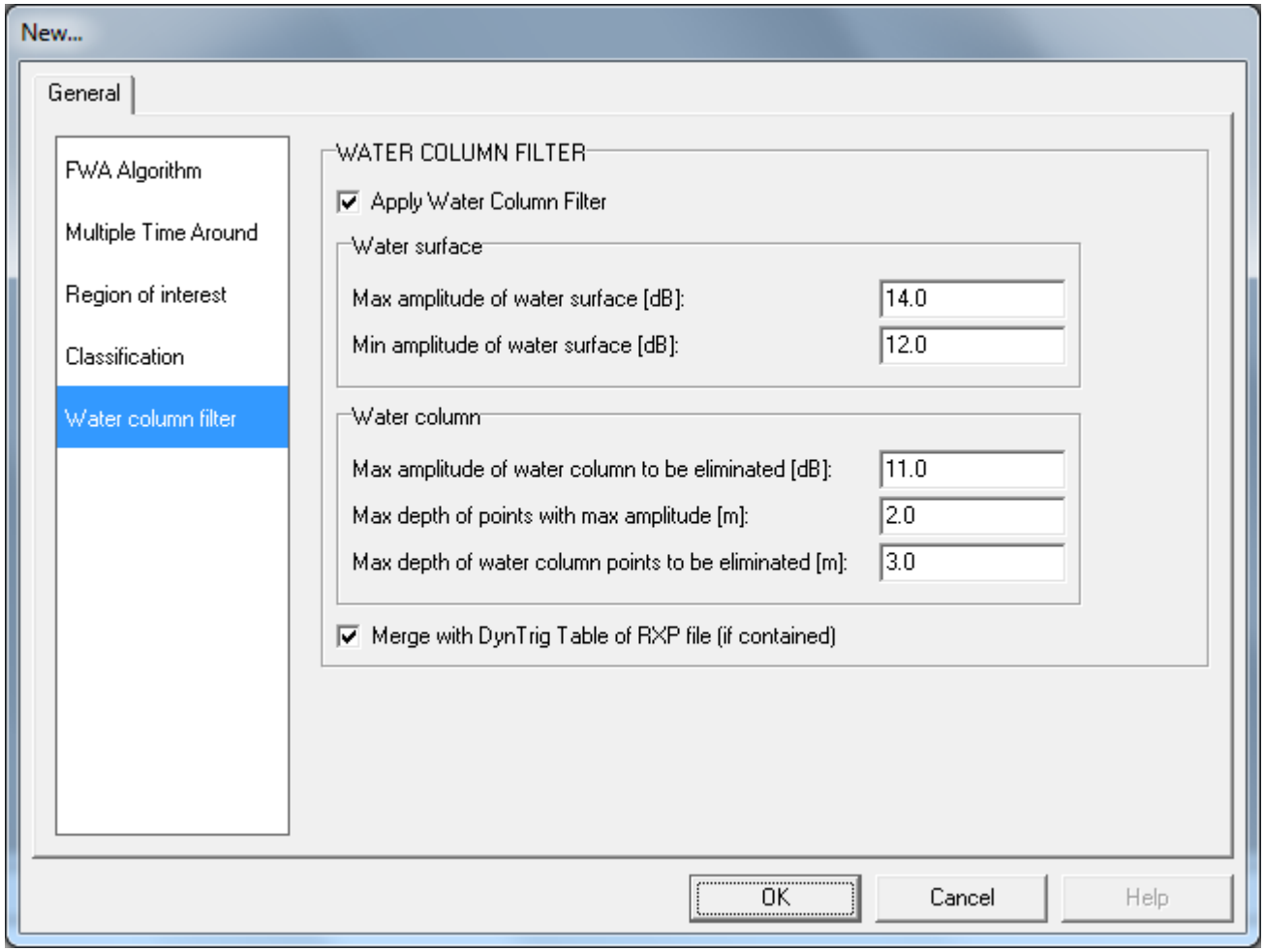
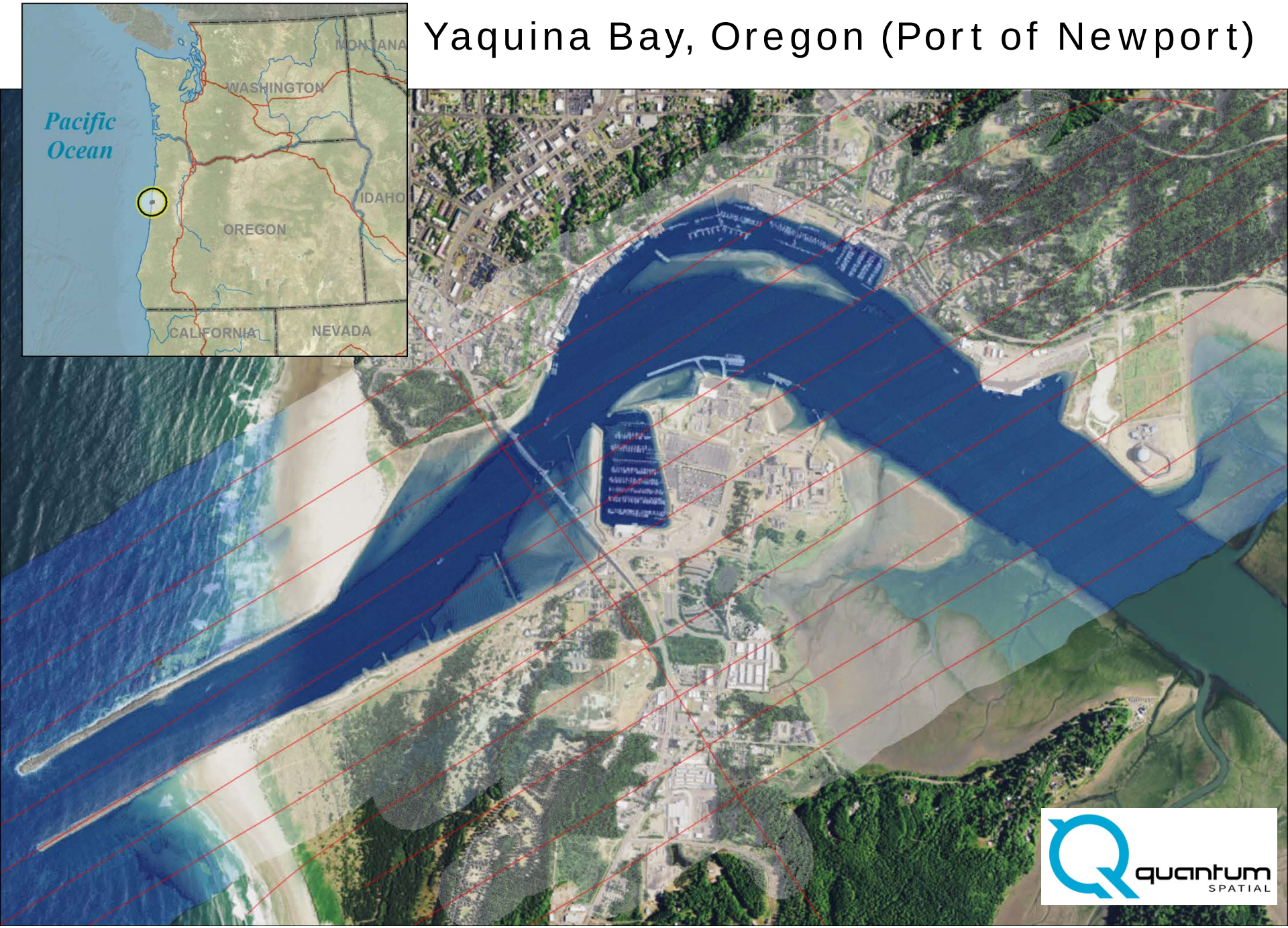


Future Work

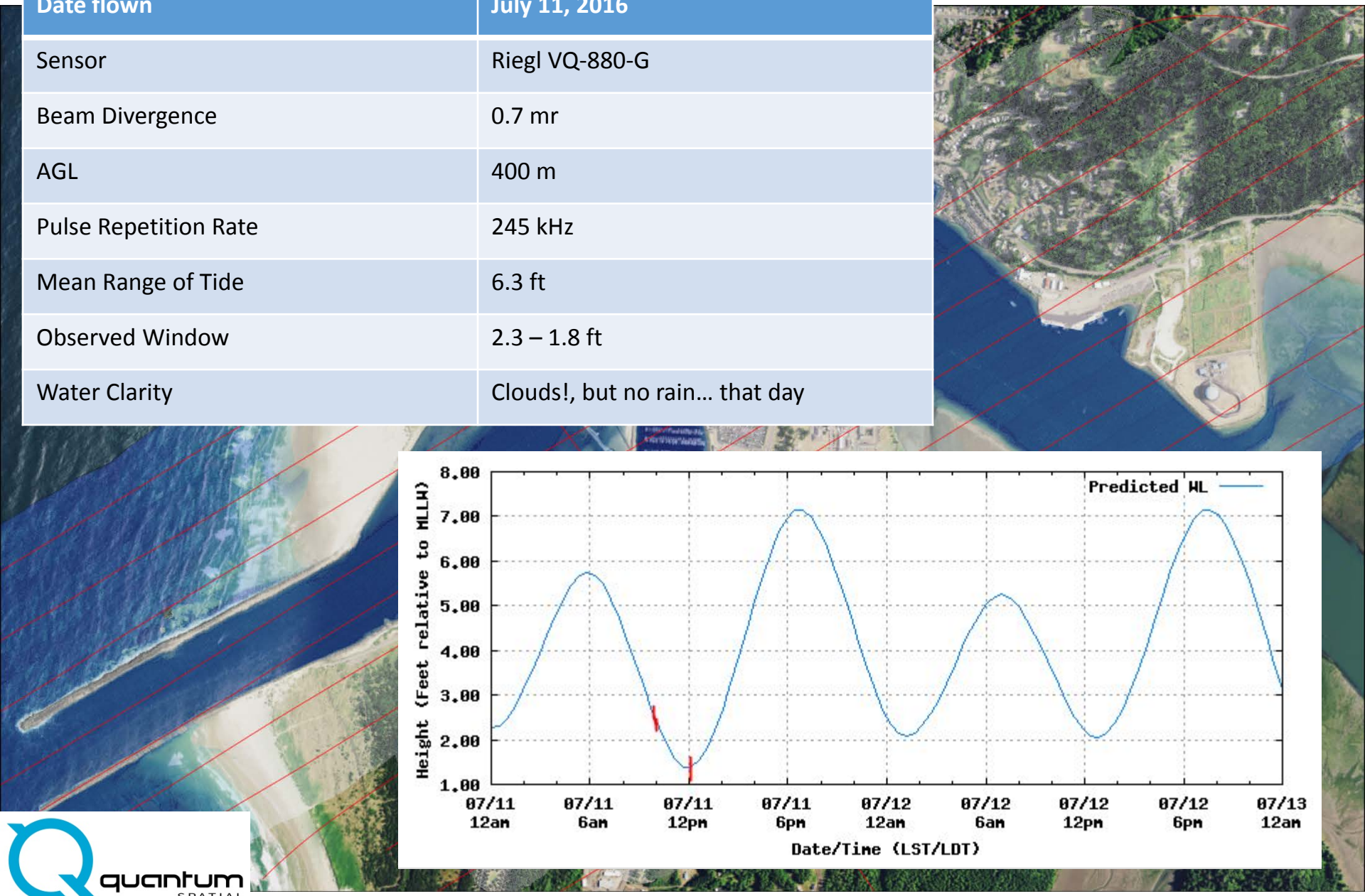
- Implementation of water column noise attenuation in Extraction Parameters
- GUI created with specific trigger table for type of water being surveyed
  - Specific water condition tables created by expert user where operator only uses drop down menu
- Ability to choose every nth waveform to store

Yaquina Bay, Oregon (Port of Newport)



Yaquina Bay, Oregon (Port of Newport)

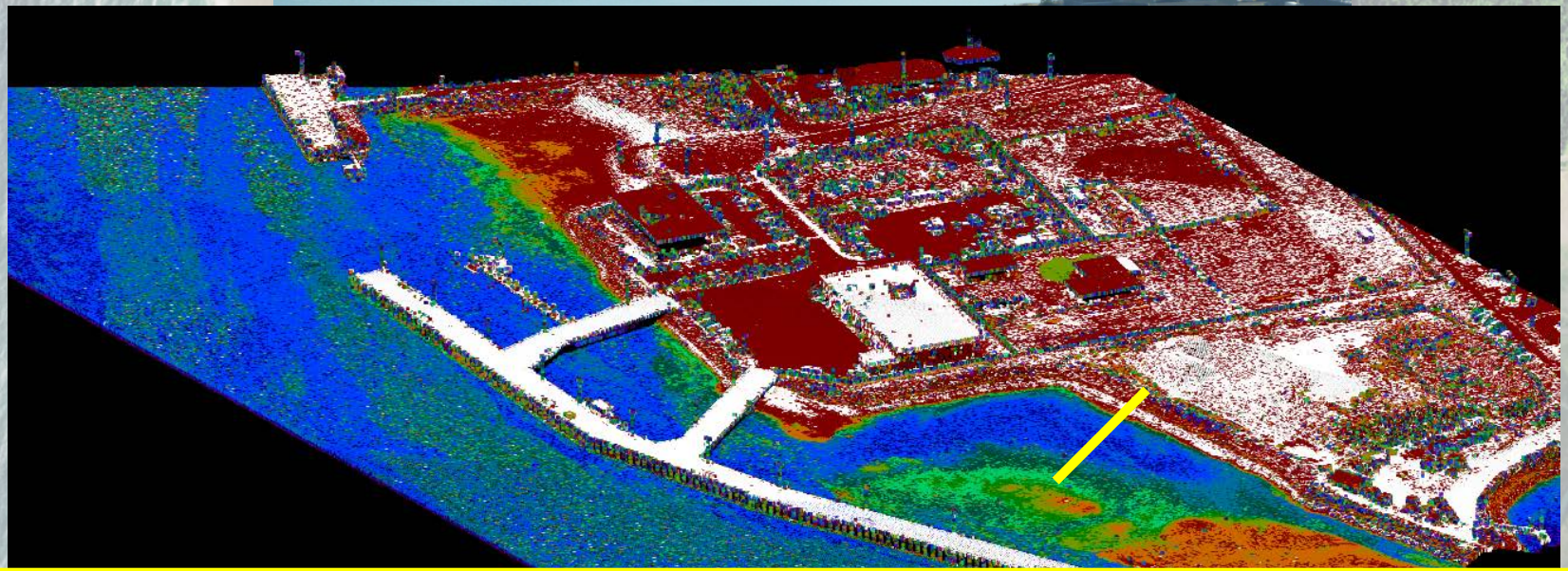
Date flown	July 11, 2016
Sensor	Riegl VQ-880-G
Beam Divergence	0.7 mr
AGL	400 m
Pulse Repetition Rate	245 kHz
Mean Range of Tide	6.3 ft
Observed Window	2.3 – 1.8 ft
Water Clarity	Clouds!, but no rain… that day

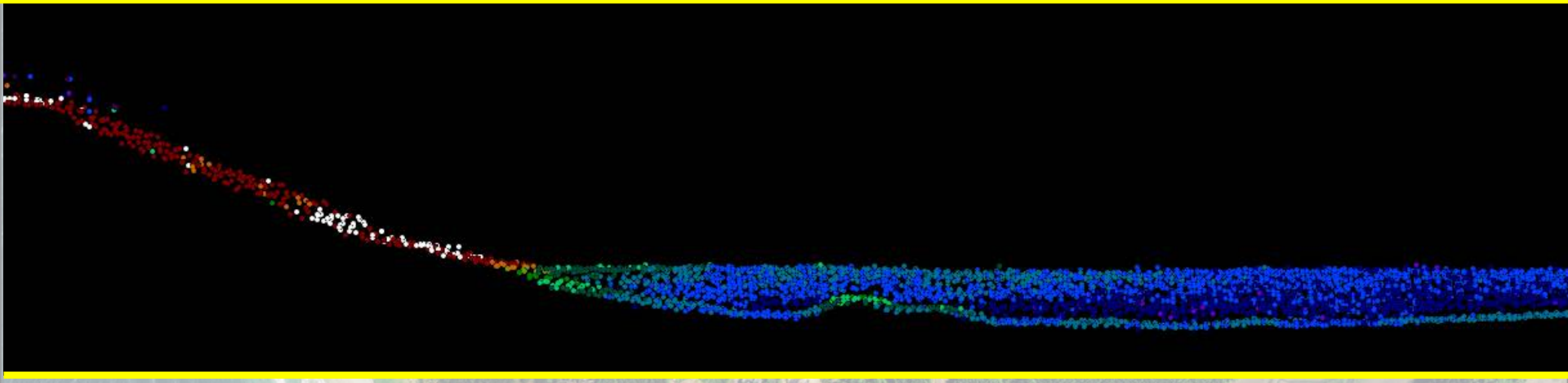


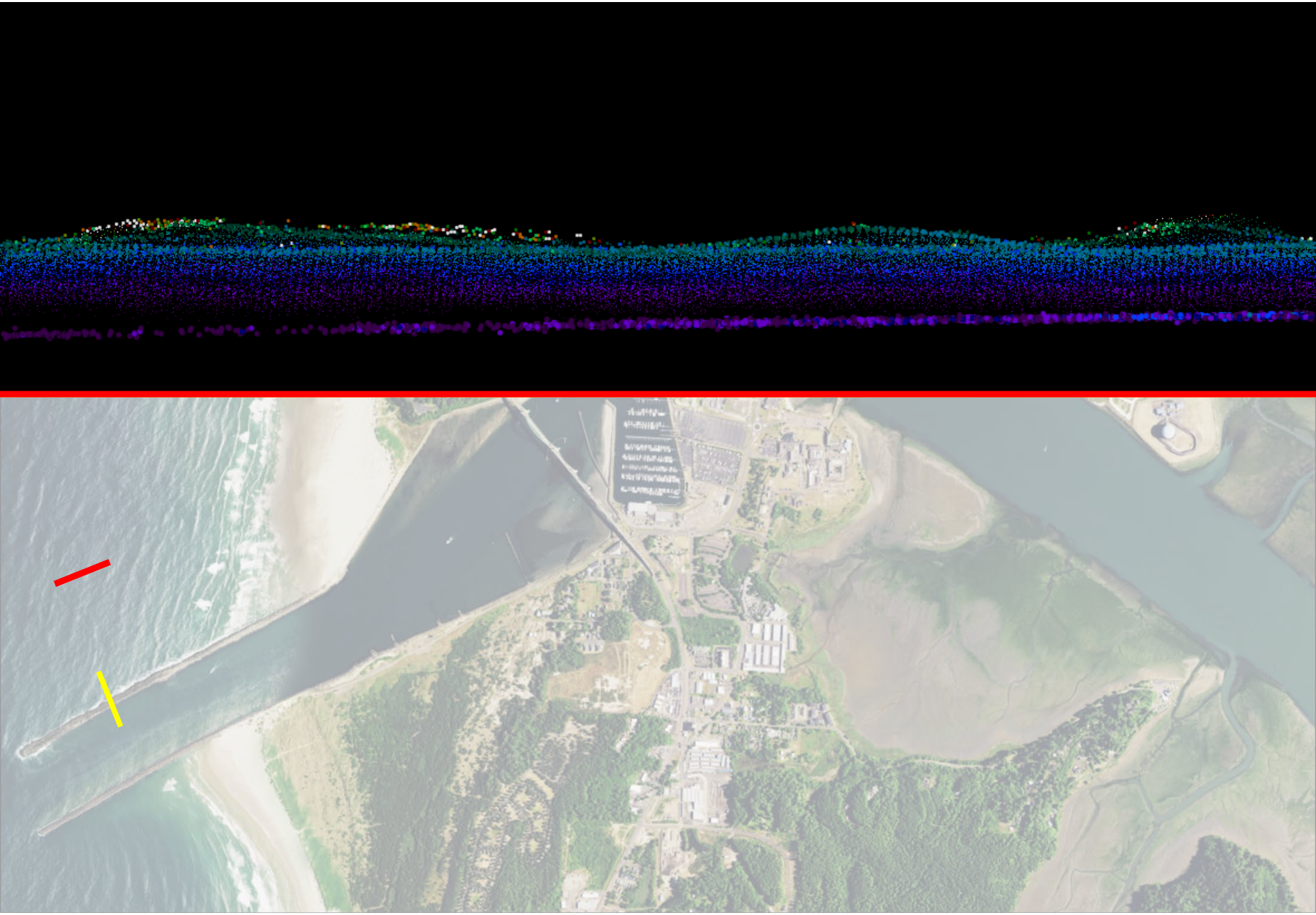
quantum SPATIAL

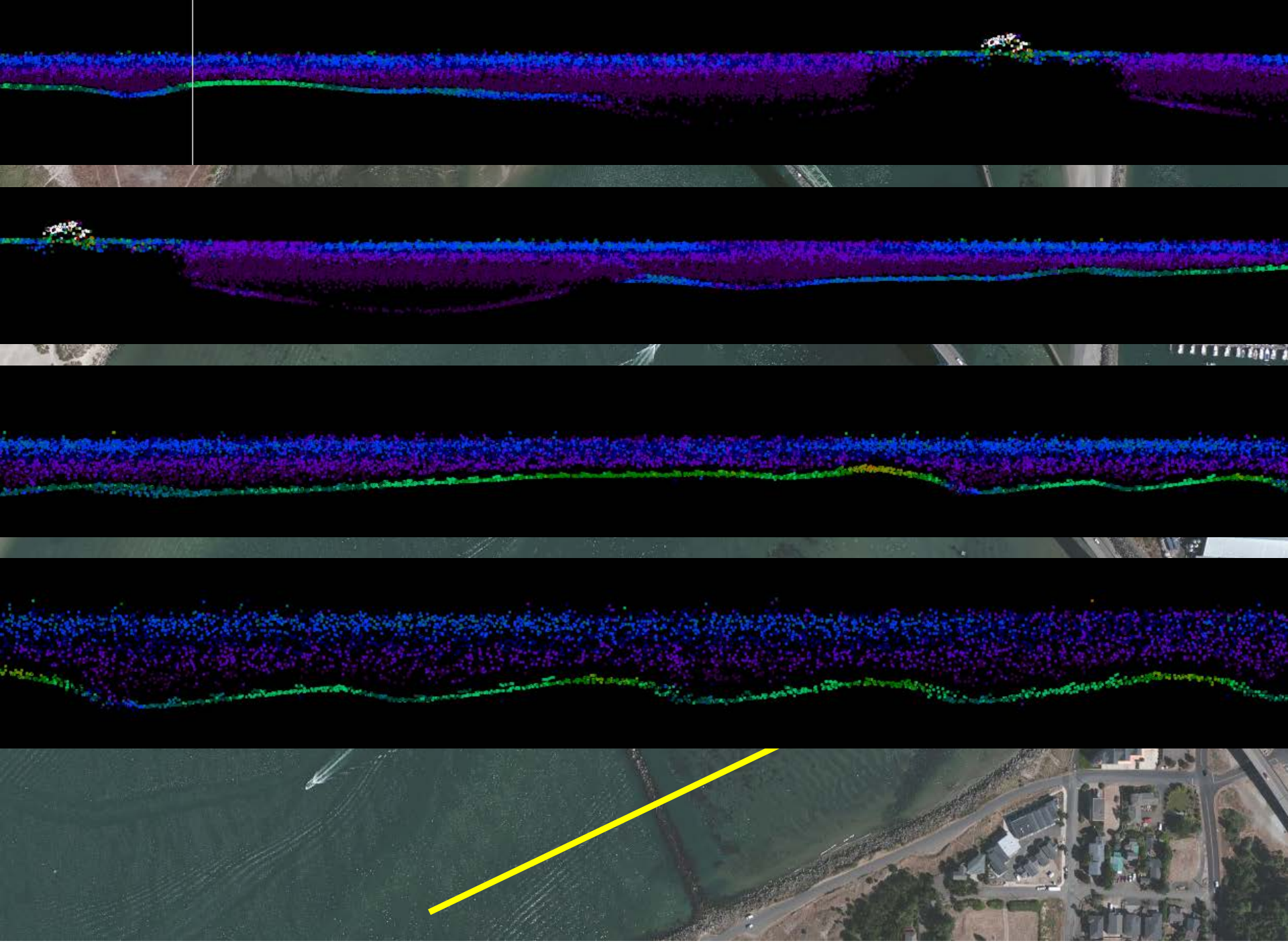
Hard at work!

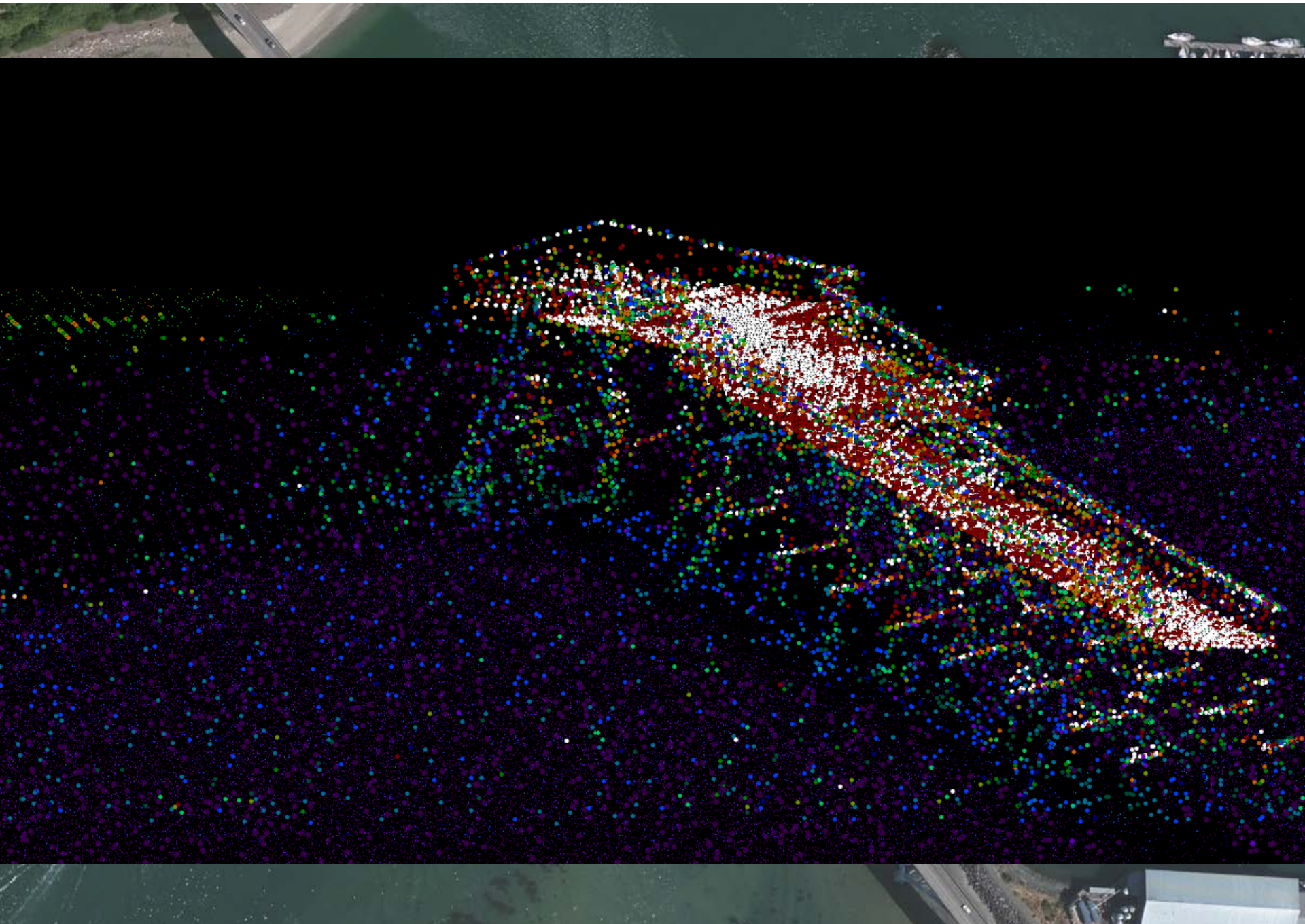
NOAA Marine Operations Center

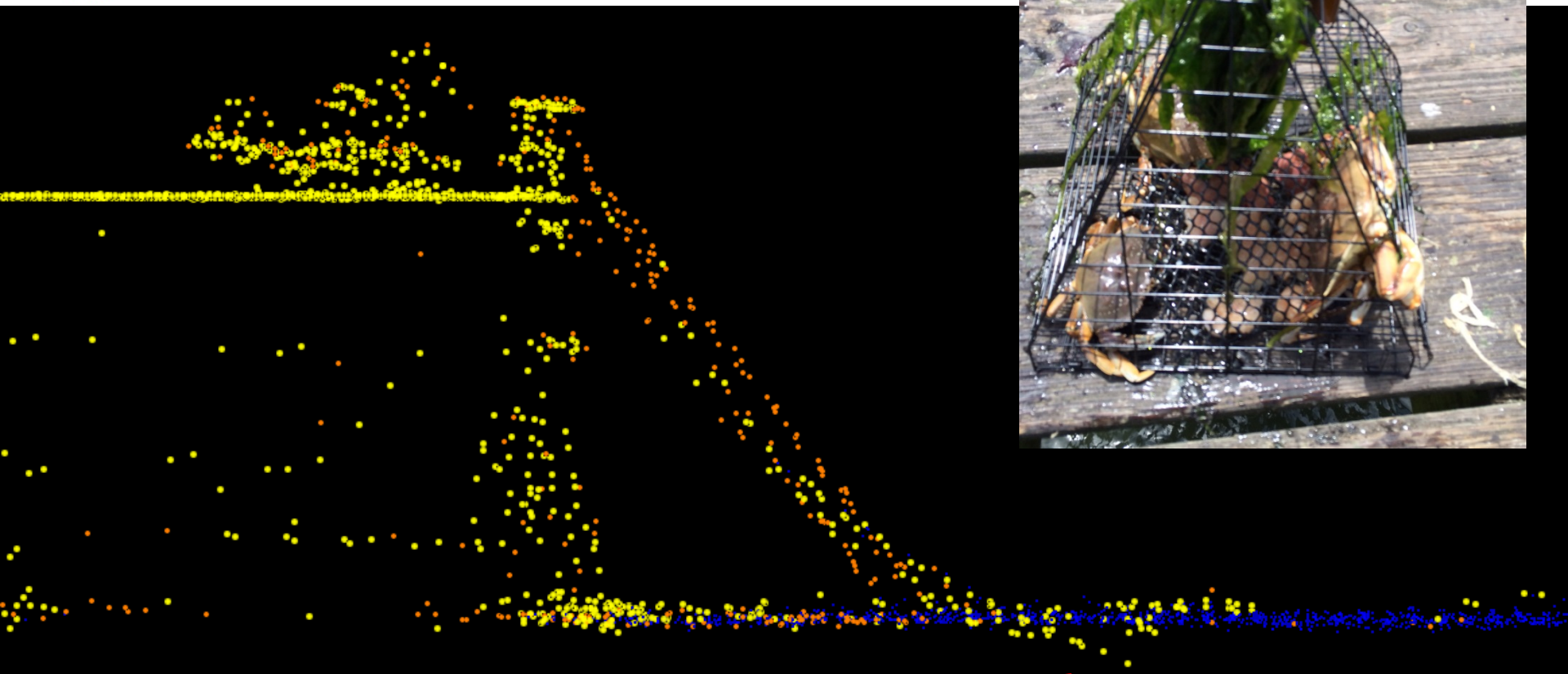




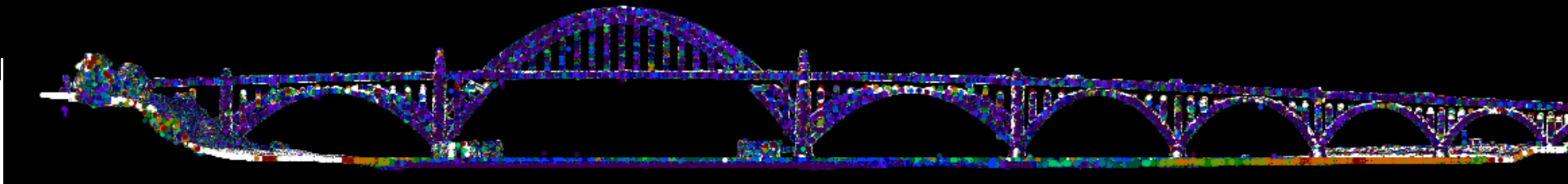








Crab line?



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