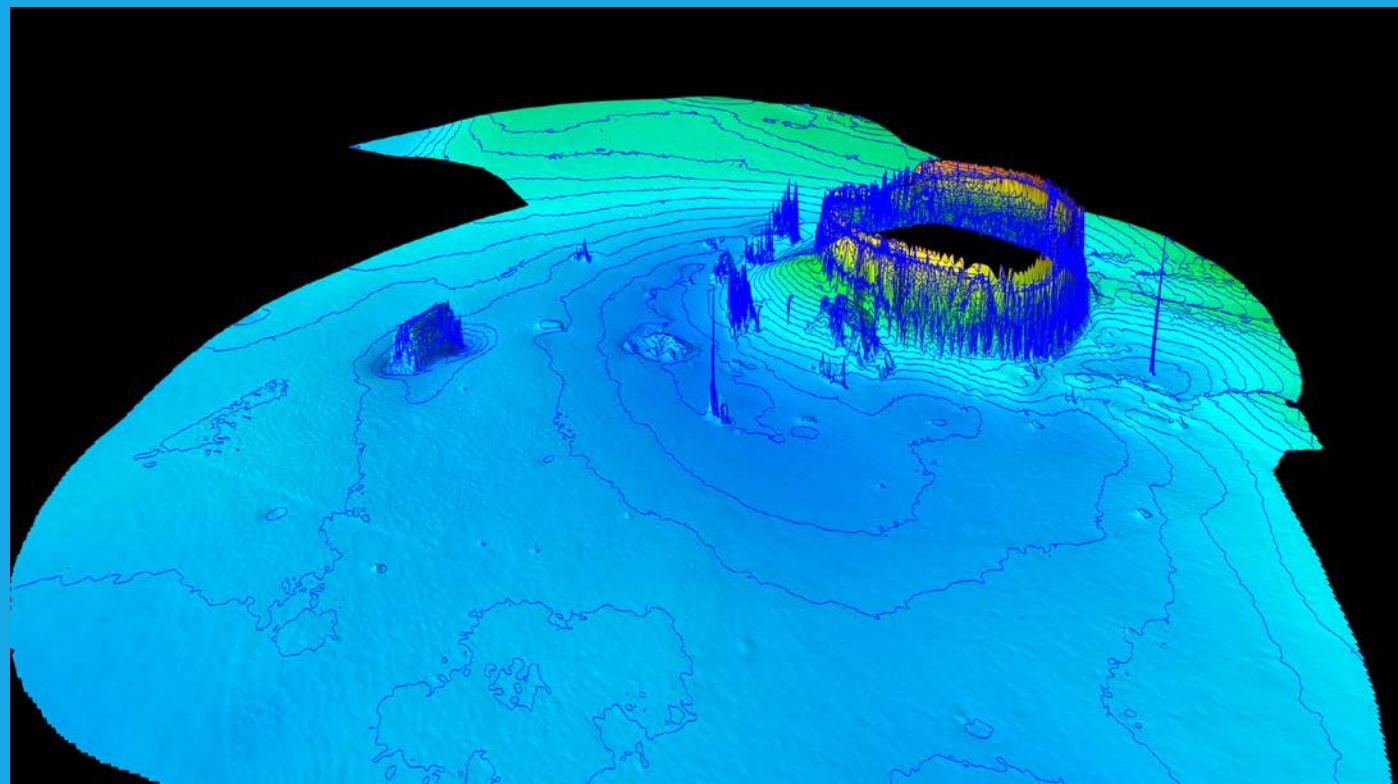
SONARWIZ 7

Seafloor Mapping: Easier, Faster, Smarter

One of the
Shallow water surveying obstacles
Calibrating your multibeam sonar



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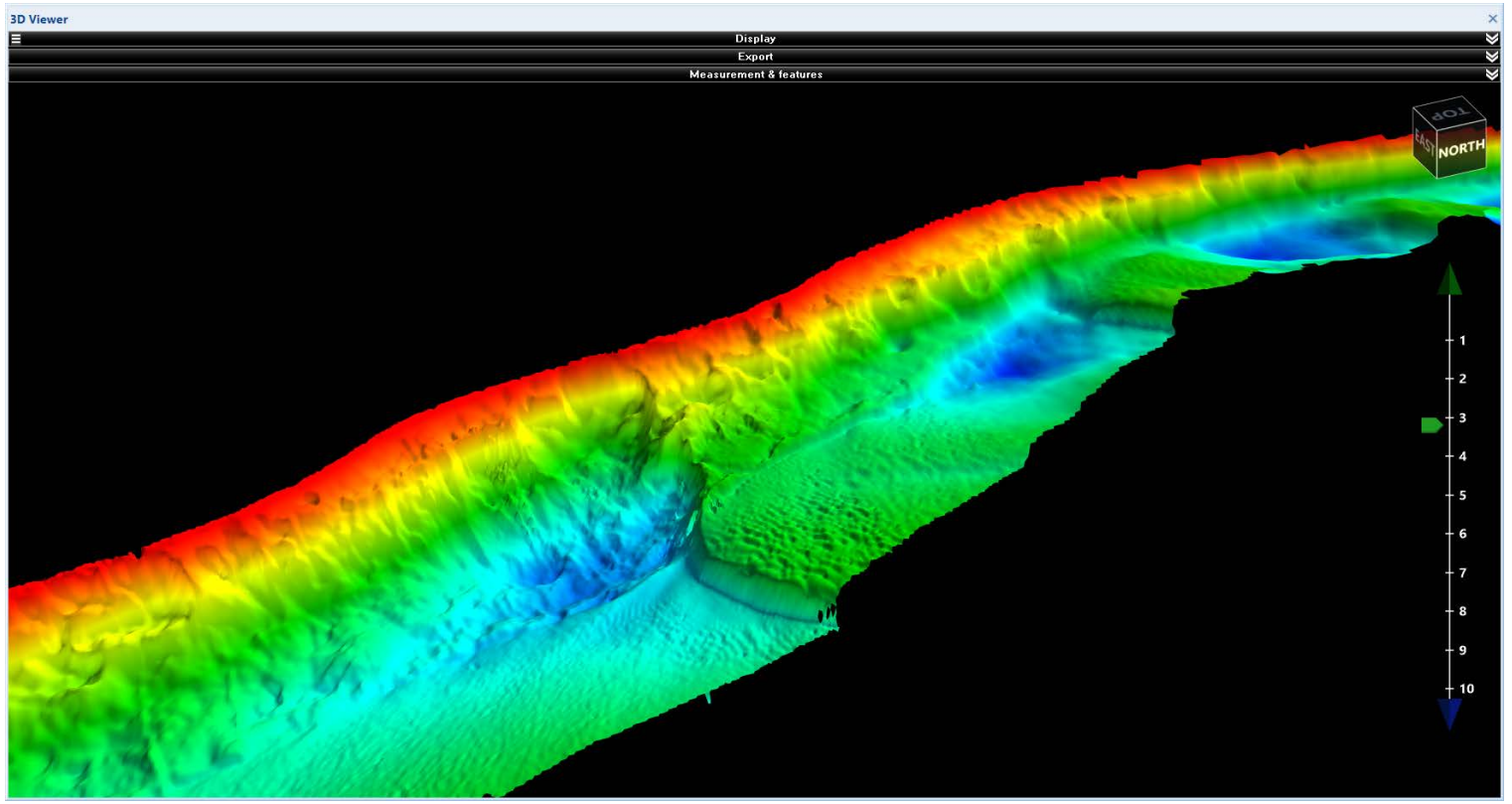
The difficulties of survey work

Among a few …

- Boat traffic
- Weather conditions
- Equipment failure
- Personnel issues
- **Shallow water**
- Currents and tides
- Access to the survey area restricted
- Low tree canopy restricted GPS coverage



Overcoming these challenges can get you data looking like this

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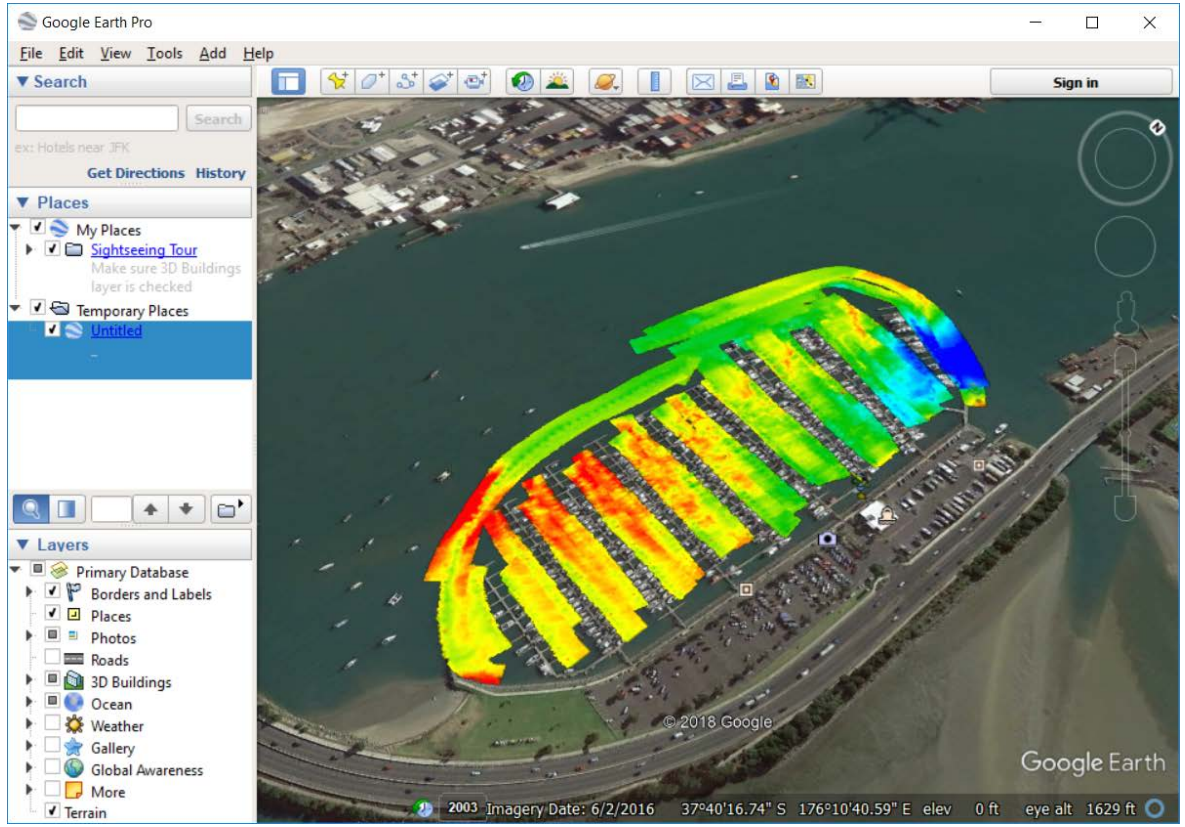
Shallow water survey - A marina in 3m of water

- Although the efficiency of multibeam sonar are limited in shallow water, surveys are still using this technology
- A survey at a marina was performed.
- Water depth ranged from 2 meters to a maximum of 5 meters

A patch test was done at the start of the survey work



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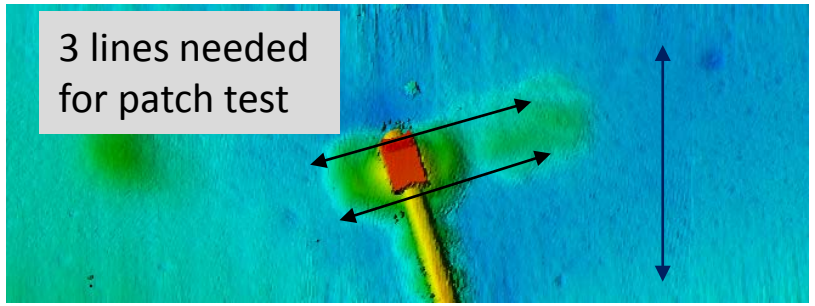
A Patch Test – calibrating your multibeam sonar

- Of the 4 tests needed – Roll, Pitch, Yaw, Latency, each have a specific seabed topography.
- Roll – flat area – Easy to do, and easy to find
- Pitch, Yaw and Latency – feature or slope.



Fundamentally, the biggest issue to worry about is positioning (your GPS). However, this presentation will go a bit further into the analysis, and examine the relationship between swath size, positioning error and angular resolution determined by a Patch Test, and examine running these tests in a river.

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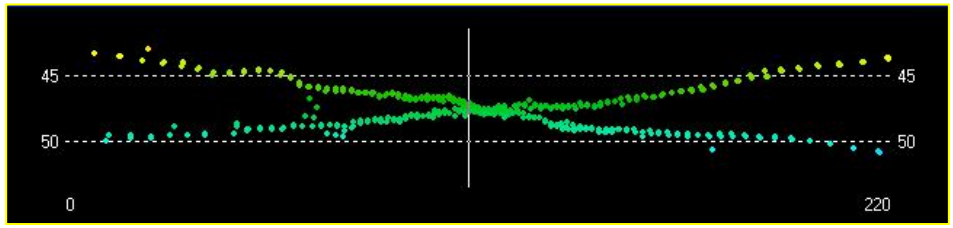
A Patch Test – calibrating your multibeam sonar

A few facts:

- A single beam sonar does not need a calibration done. It's a single point directly under the transducer
- Multibeam sonars need a calibration of the Sonar (to IMU) due to its swath coverage.

A Patch Test will resolve

- The Roll, Pitch and Yaw mounting angle. The measurement angle is from the multibeam to MRU and to the heading of the boat. Will lead to both depth and position errors



The results are impressive. Just 2 degree of roll will cause this type of error

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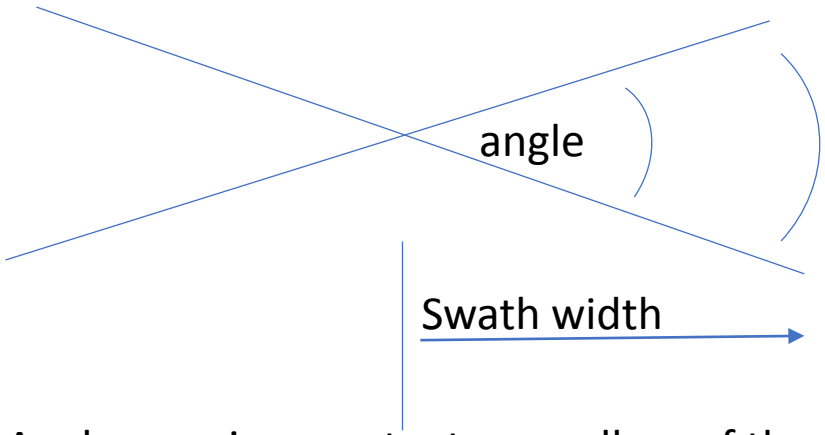
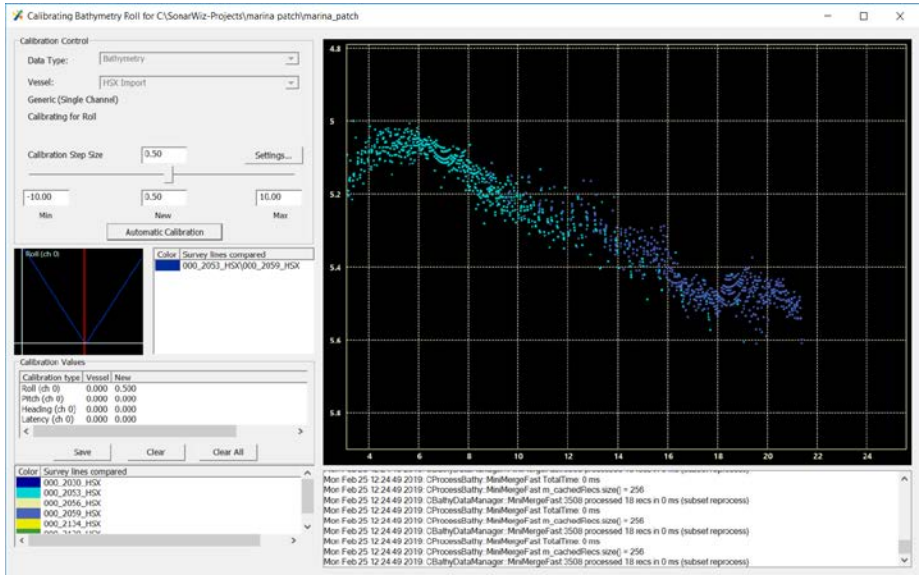
Roll, then Pitch, then Yaw….

- The roll test worked perfectly. Timing was fine, and a flat bottom produced a nice result
- The shallow water – small swath issue was not impacted, as the reciprocal lines used still had a swath of 10 meters of coverage



Angle remains constant, regardless of the swath size



Patch Test in Sonarwiz bathymetry

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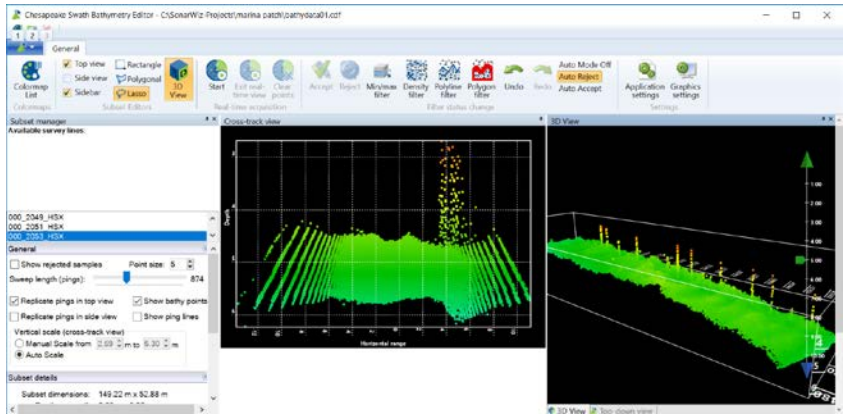
And then we come to the Pitch test…

The Pitch angle is determined with a feature of bottom slope.

Problems come with position, with the value you are looking for falls within the error of the positioning system

You'll need a very good positioning system and a very distinct feature

Bottom slopes will probably not work. A feature or defined sand waves will work best



A test for using pilings, with a diameters of 30 cm, the results were difficult to resolve

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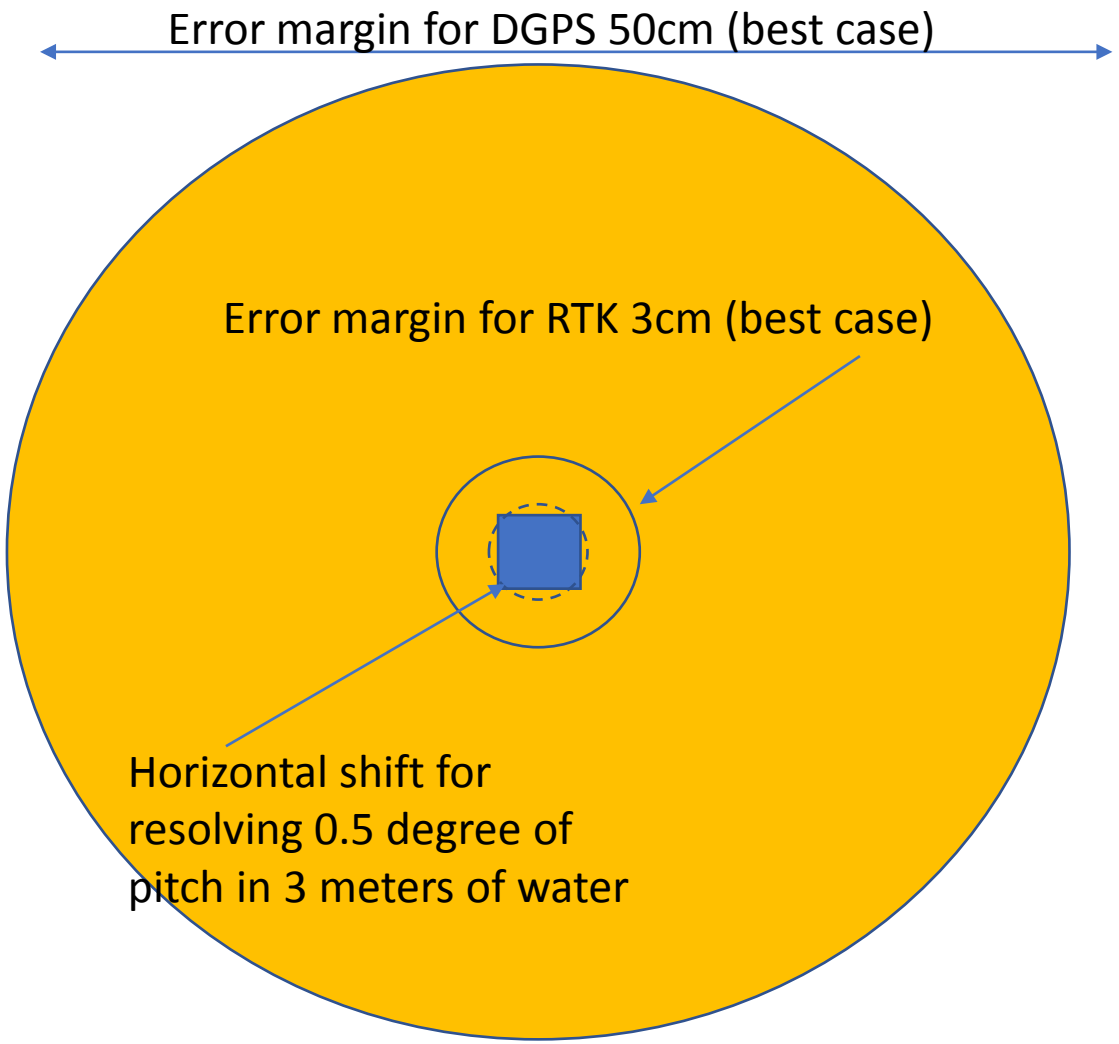
Position error

- Resolving Pitch to 0.5 degrees in 3 meters of water requires a position accuracy of 2.5cm

- Resolving Yaw to 0.5 degree in 3 meters of water requires a position accuracy of 3.9cm



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Pitch Test – a few numbers

Water depth	0.5 degree	1.0 degree	2 degree	3 degree	5 degree
2	1.7 cm	3.4 cm	6.9 cm	10.4 cm	17.4 cm
4	3.4 cm	6.9 cm	13.9 cm	20.9 cm	34.8 cm
6	5.2 cm	10.4cm	20.9cm	31.4 cm	52.2 cm
8	6.8 cm	13.9cm	27.9cm	41.9cm	70 cm
10	8.7 cm	17.4cm	34.9 cm	52.4 cm	87 cm

Water depth x Tangent (pitch angle) = **Bottom movement**

A decent GPS will resolve to 2 meter. DGPS will get 50 cm (best case), and RTK will get you to the sub decimeter value (5cm).

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Yaw test – a similar exercise to determine error

Water depth	0.5 degree	1.0 degree	2 degree	3 degree	5 degree
2	2.6 cm	5.2 cm	10.4 cm	15.7cm	26.2 cm
4	5.2cm	10.4 cm	20.8 cm	31.4 cm	52.4 cm
6	7.8 cm	15.6cm	31.2 cm	47.1 cm	78.7 cm
8	10.4 cm	20.8cm	41.6 cm	62.8 cm	1.04 m
10	13 cm	26.1cm	52.3 cm	78.6 cm	1.31m

(0.5 x Swath width) x Tangent (yaw) = Horizontal shift

Where swath width =3 x water depth (nominally)

Results in: horizonal shift = 1.5 x Water depth x tangent (yaw)

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To Test or Not

- We shouldn’t just ignore a patch test in shallow water. But we need to be aware of the limitations.

A few simple steps that might help:

- Always seek to do the Patch Test is the deepest water. Unlike a SV cast which needs to be done in the survey area, the Patch Test can be done anywhere, and stays the same unless you move the sensors
- Use a feature rather than a slope. Resolving the errors will be easier, and gradual slopes are not very effective
- Run multiple tests, in the event GPS outages or Satellite configurations degrade positions further

Patch Test - water depth more than 10 meters

Adding just a little more water will make a huge difference

Water depth	0.5 degree	1.0 degree	2 degree	3 degree	5 degree
2	1.7 cm	3.4 cm	6.9 cm	10.4 cm	17.4 cm
4	3.4 cm	6.9 cm	13.9 cm	20.9 cm	34.8 cm
6	5.2 cm	10.4cm	20.9cm	31.4 cm	52.2 cm
8	6.8 cm	13.9cm	27.9cm	41.9cm	70 cm
10	8.7 cm	17.4cm	34.9 cm	52.4 cm	87 cm

A test in 15 meters of water results in

Water depth	0.5 degree	1.0 degree	2 degree	3 degree	5 degree
15	12.8 cm	25.5 cm	51.0 cm	76.5 cm	1.27m

Somewhat easier with DGPS (it will work with RTK)

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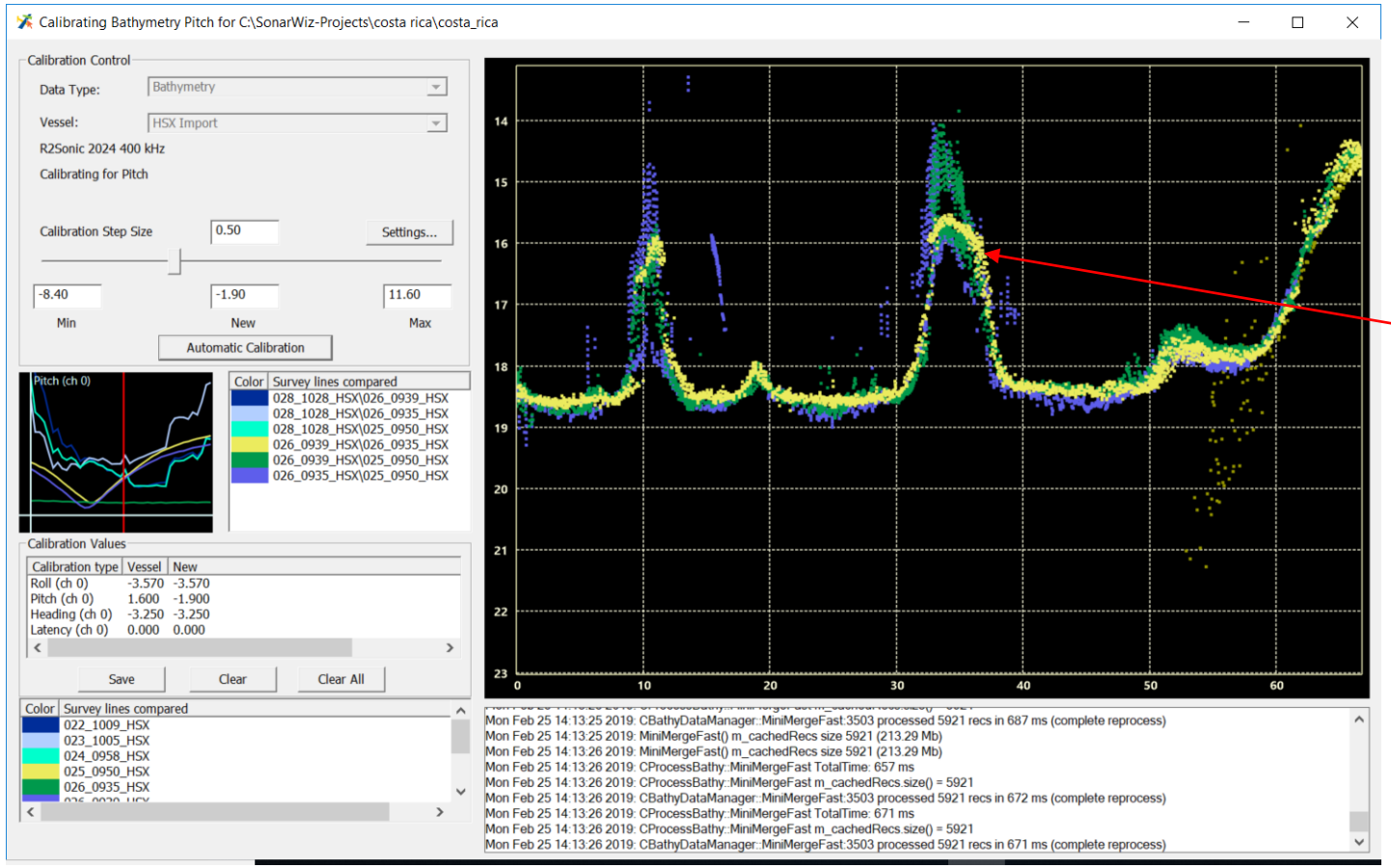
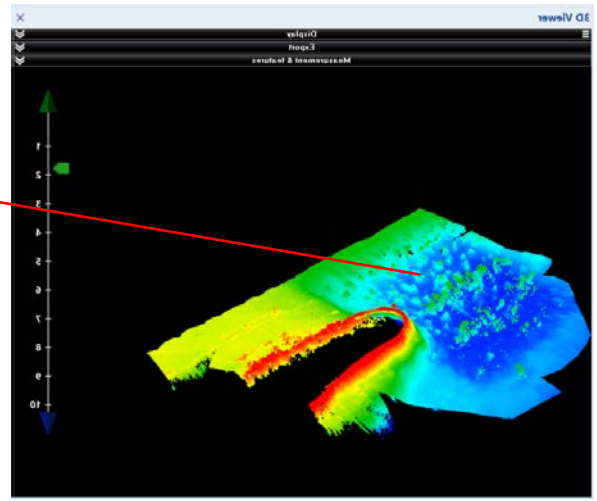
Patch Test over rocky area – 15 meters

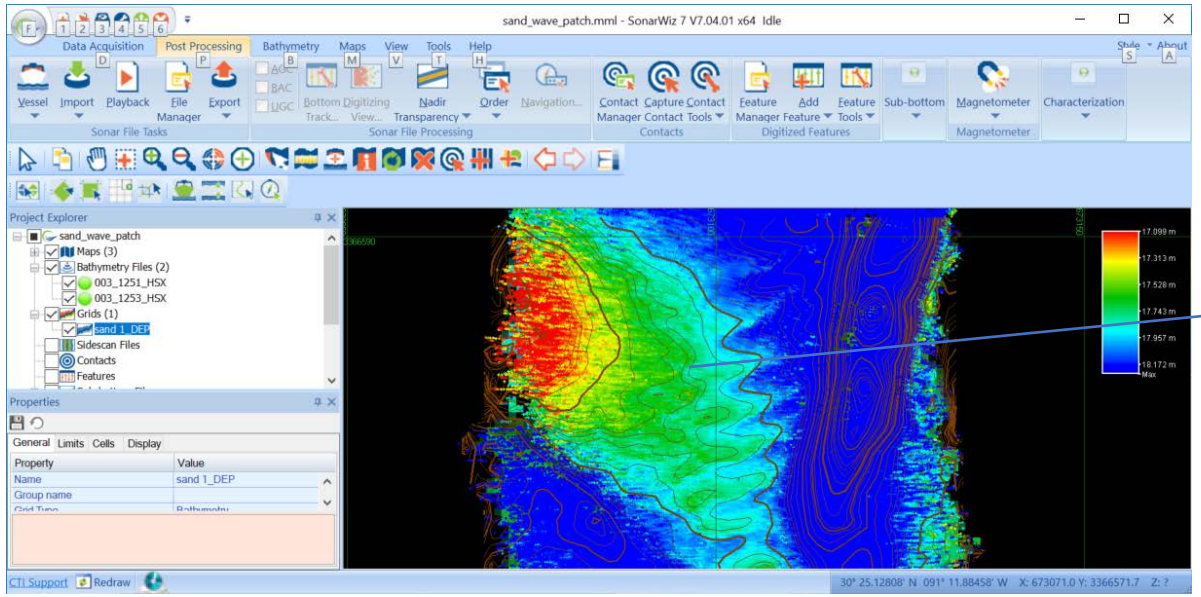
Rock features align perfectly, resolving angles to 0.1 degrees

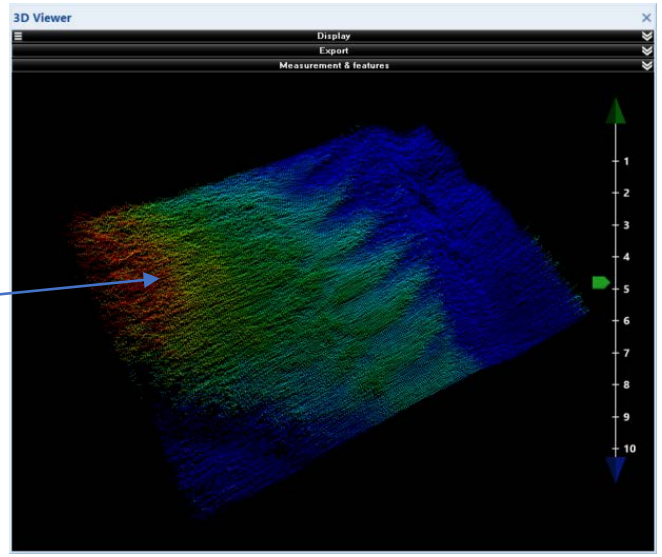




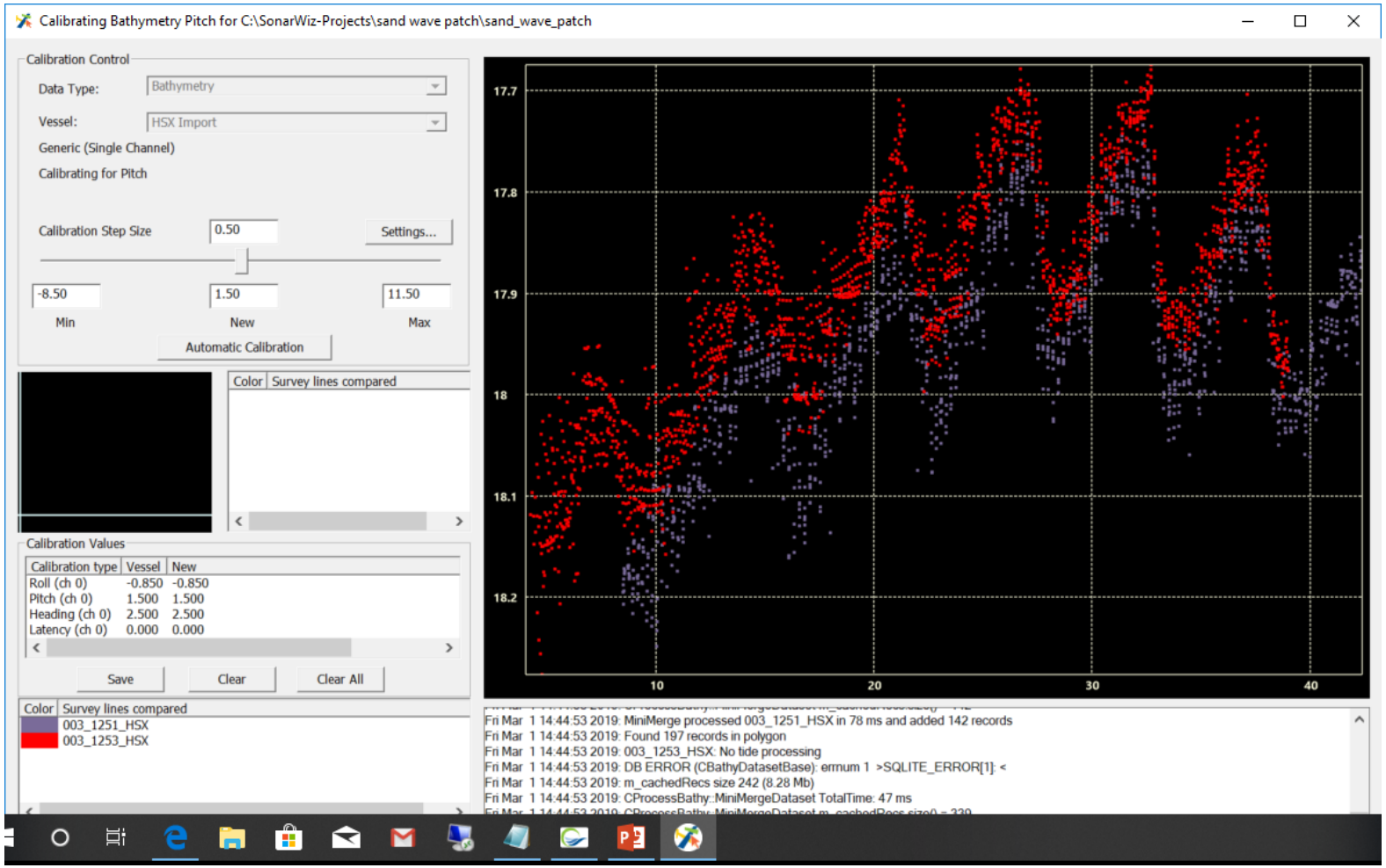
When we have enough water… Survey obstacle 2 - Sand Wave Analysis

Sand waves are often be found on the seafloor. In some cases, they will make a good case for a Pitch Test. Yet, we can't always depend on the test results. Often, these ripples look the same (magnitude and frequency)





Sand Wave Analysis



Sand ripples almost in alignment.

Let’s run a Pitch Test to get it perfect

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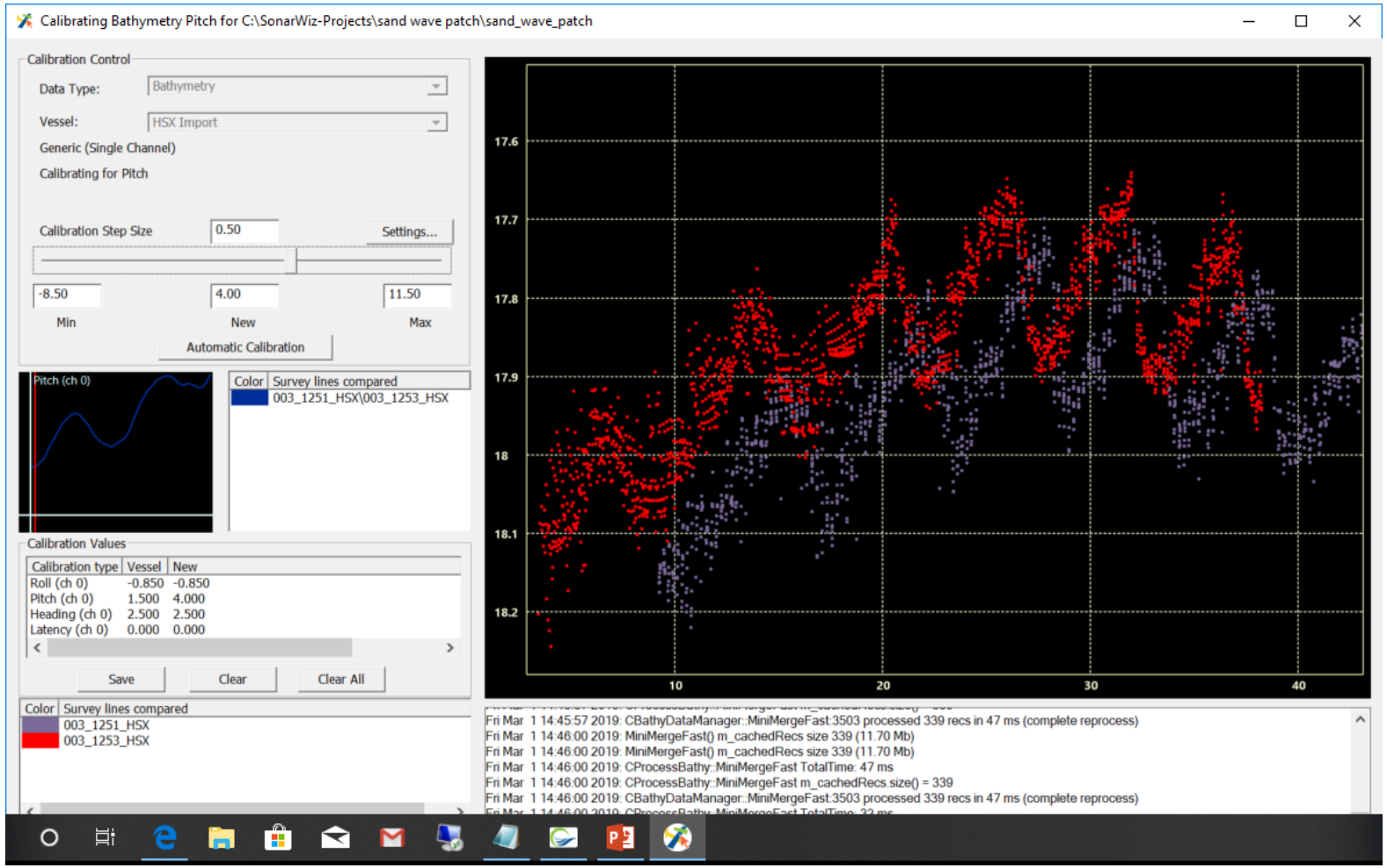
Sand Wave Analysis



Pitch of 4 degrees, shift the sand waves almost half a wavelength

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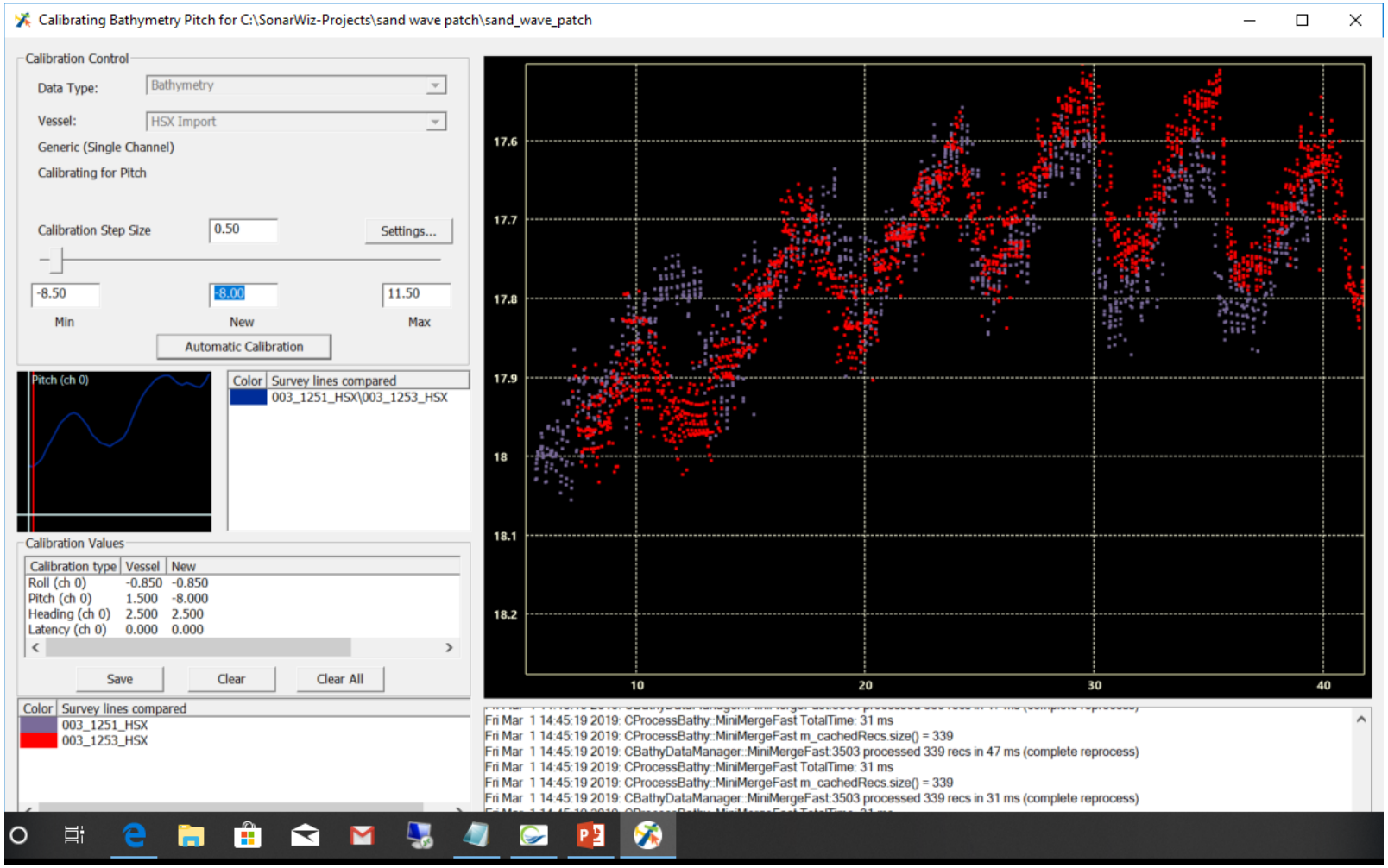
Sand Wave Analysis



Pitch of 8 degrees, shift the sand waves almost a full wavelength

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Sand Wave Analysis

- Do we really believe the answer is 8 degrees.

  It’s very unlikely that is the correct answer.

When using sand waves as a source for a bottom feature, you should run the survey lines at some angle other than perpendicular to the sand waves.

You still will run reciprocal lines, but you’ll have a better chance to distinguish the changes from each set of sand waves.

Where did the images and data come from?

- Chesapeake Technology started in the late 1990's, primarily for handling sidescan data.
- In the first decade of business, work was concentrated on sidescan, sub bottom and utilities for hydrographic and geophysical work.
- Since 2010, a push was made to expand our product line into bathymetry – multibeam, single beam, lidar.
- The company is based in Mountain View, CA, with 12 employees. The East coast office was opened in 2019.

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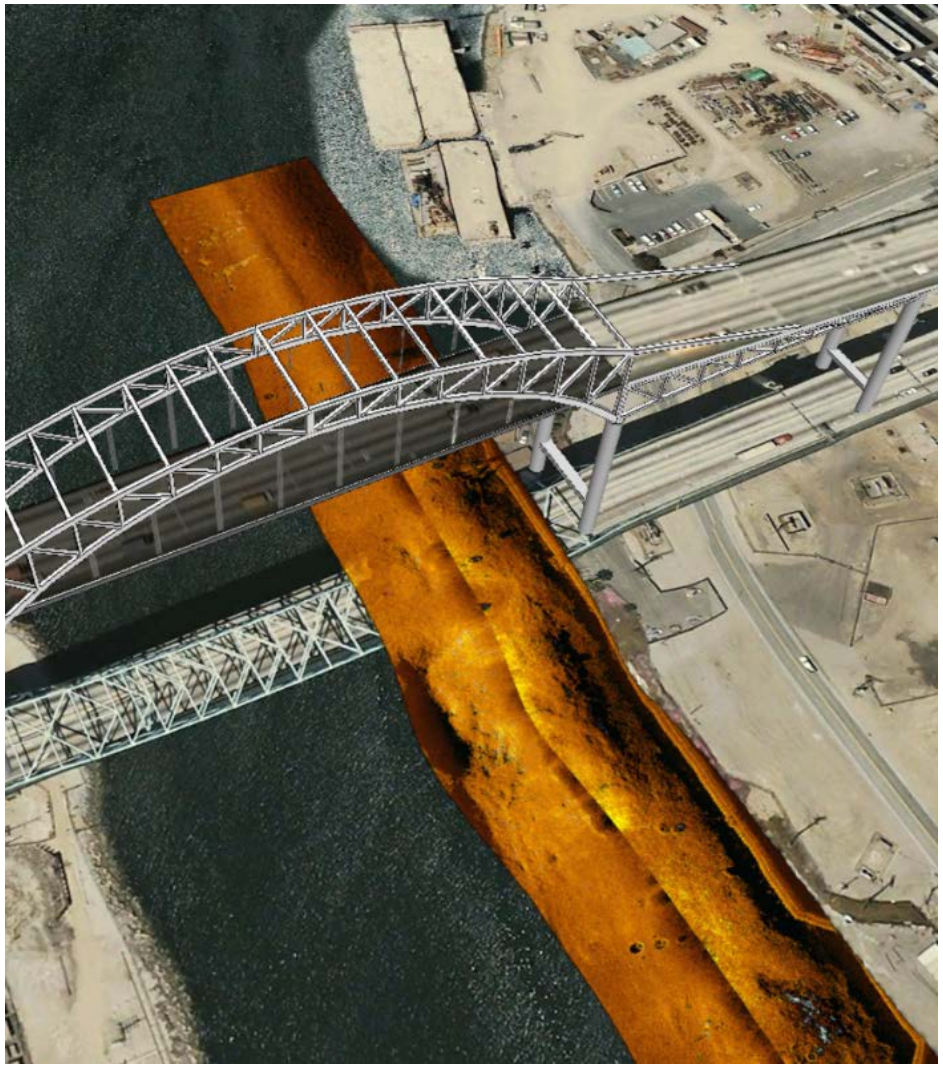
Combining data sets – provides a better overview of where the data has been collected



Sonarwiz software will mosaic sidescan and backscatter data, and when used with the multibeam sonar, can create a full data set for analysis

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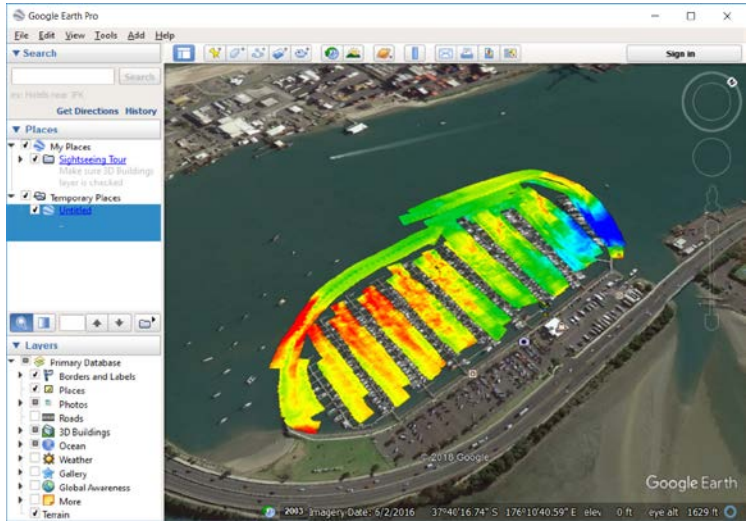
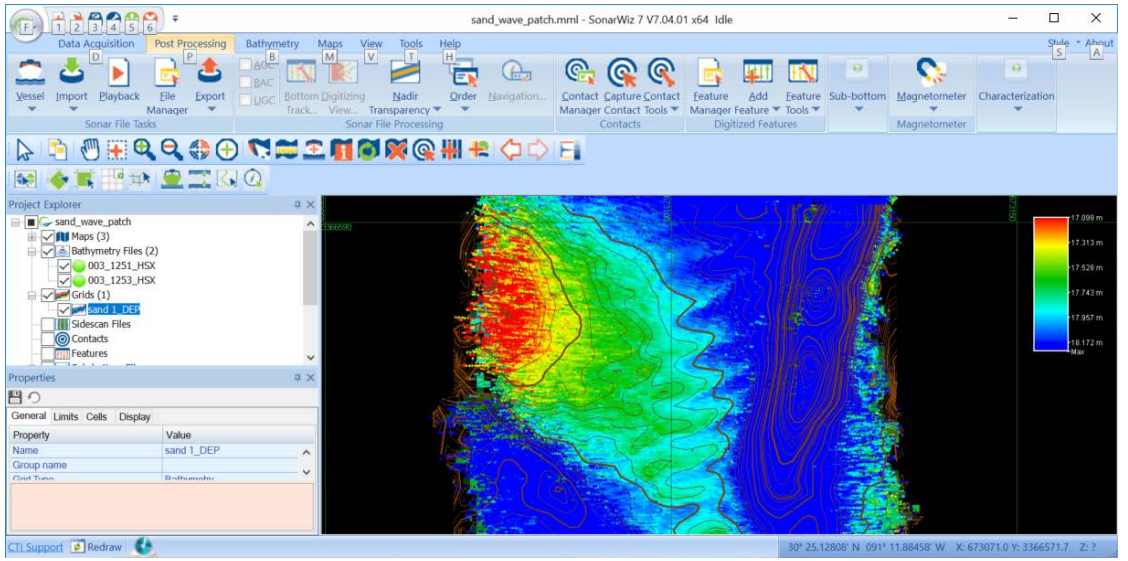
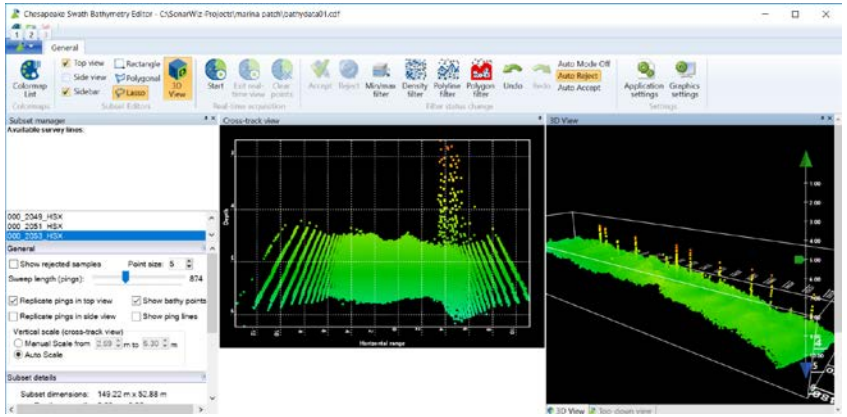
Various way to handle Multibeam Data in SonarWiz



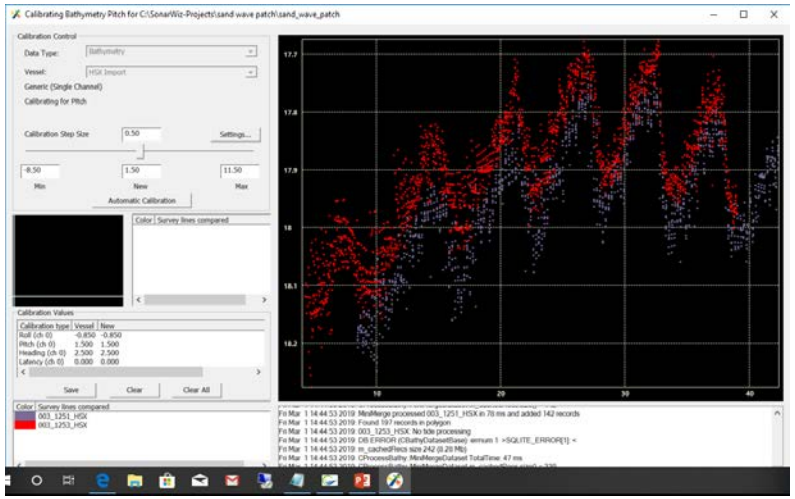
Bathymetry display over background file (Bay of Plenty, NZ)



Contour overlay in the main view



Editing multibeam data



Patch Test calibration

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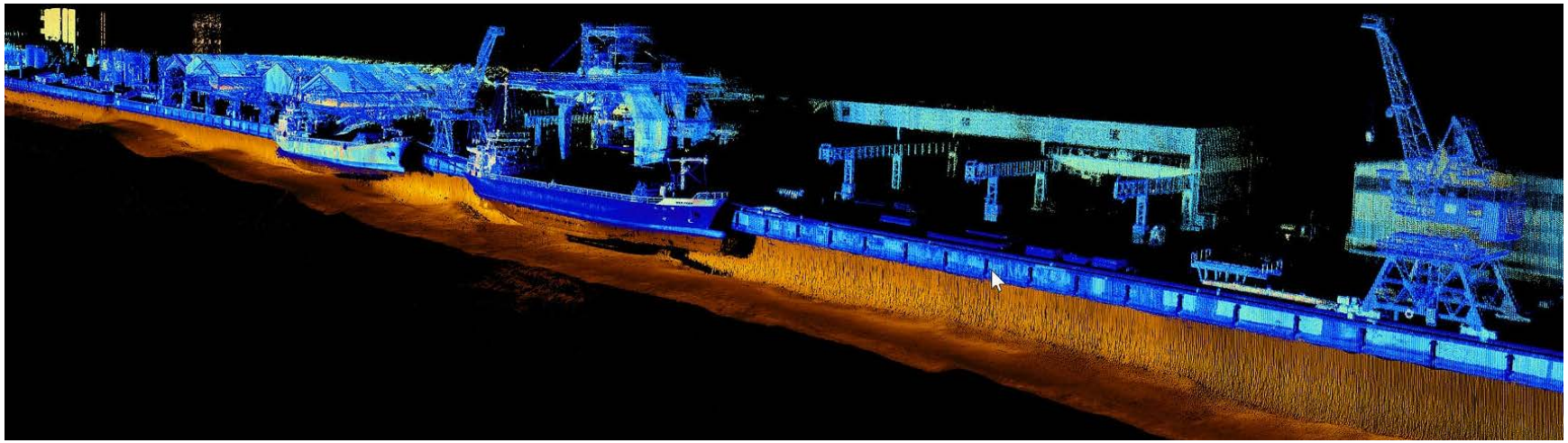
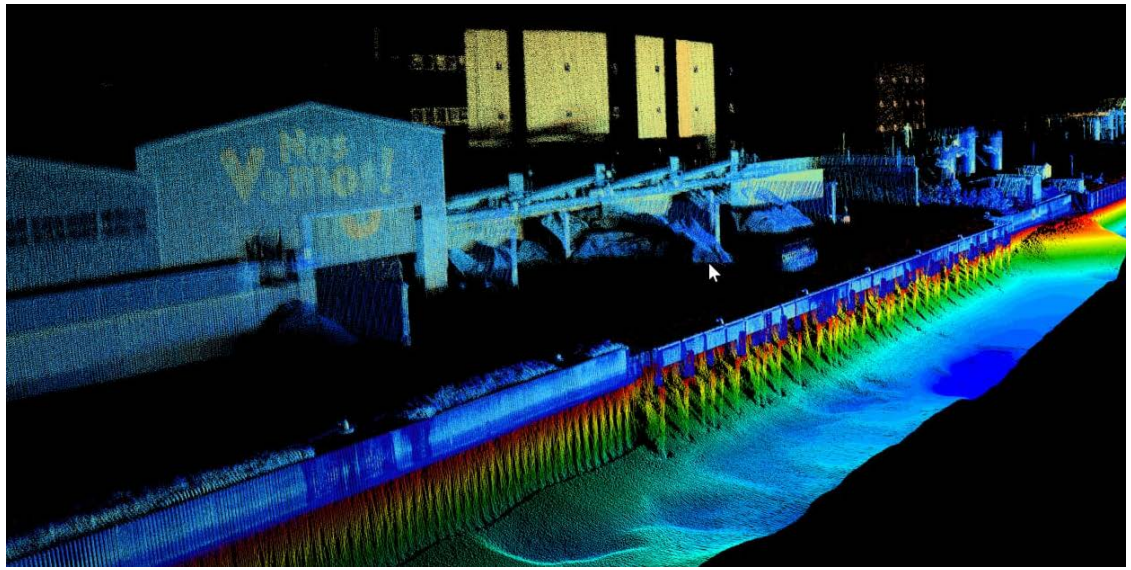
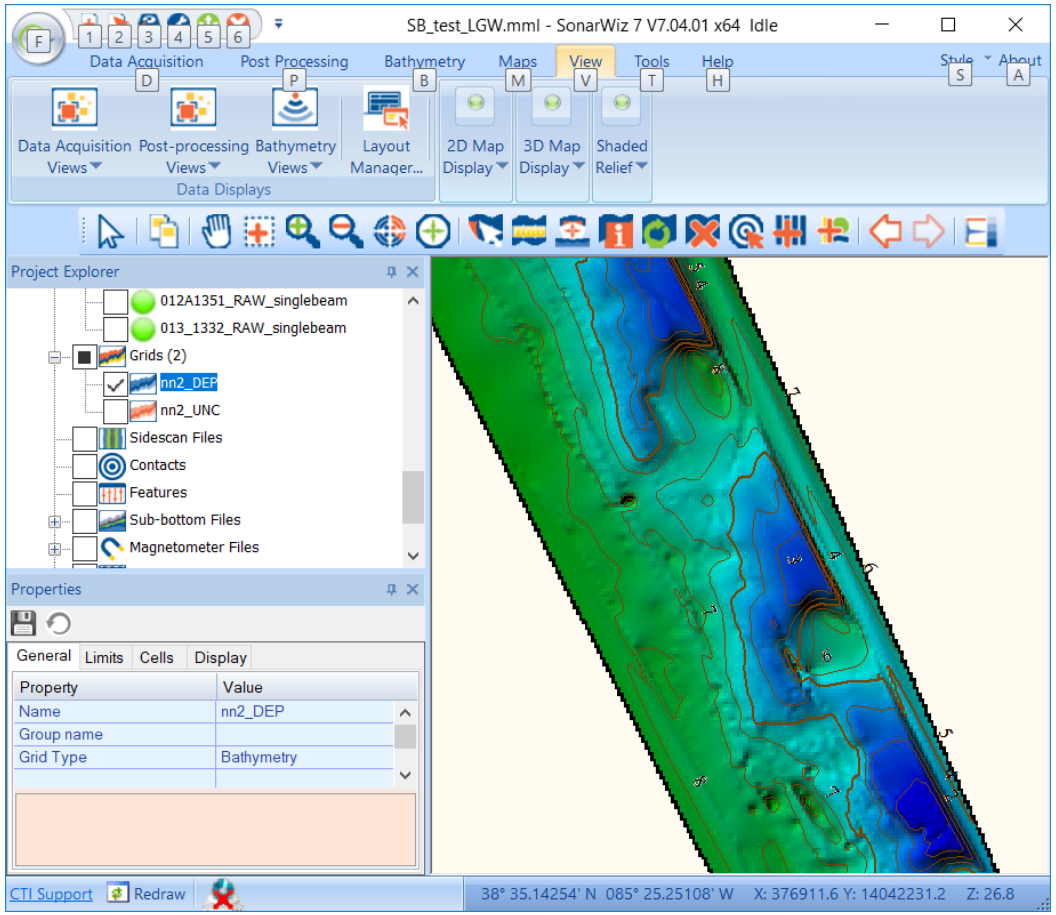
Adding Lidar to your survey data

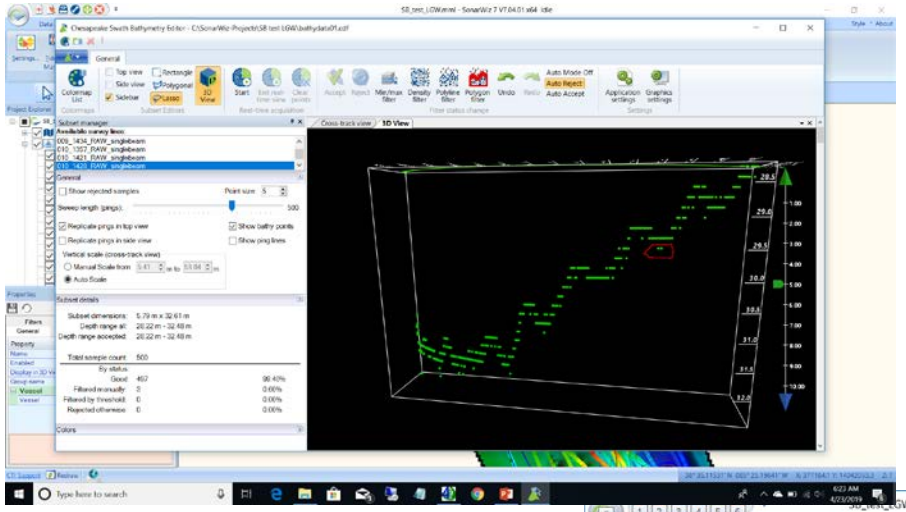




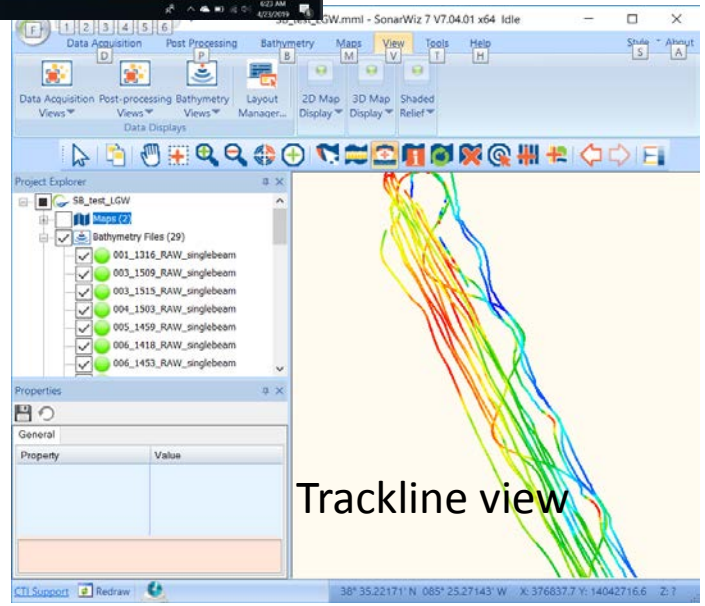
Combined data set with multibeam and lidar

Simple, but effective - Single Beam data



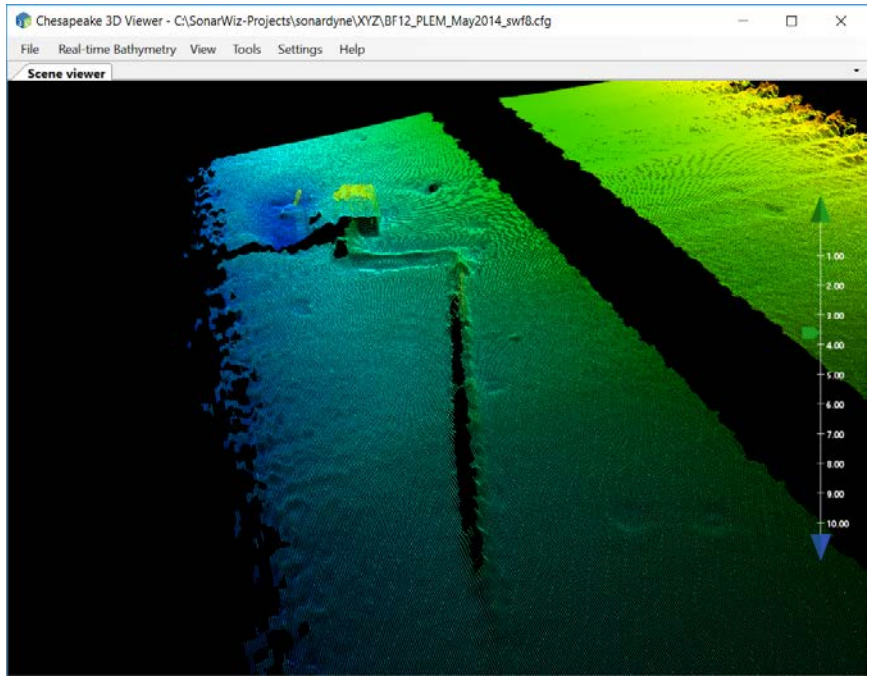


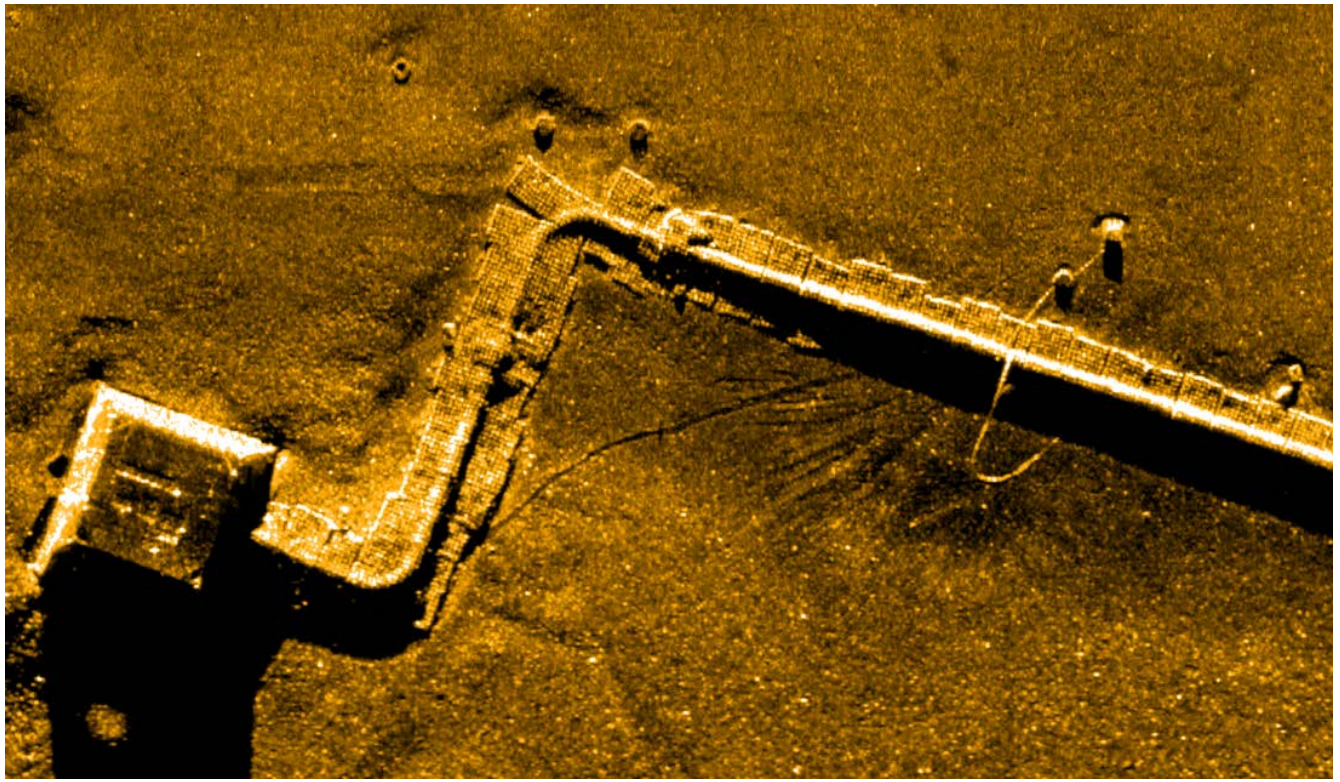
Editing Single Beam Data



High Resolution imagery of a pipe

SAS sonar, producing bathy and sidescan data





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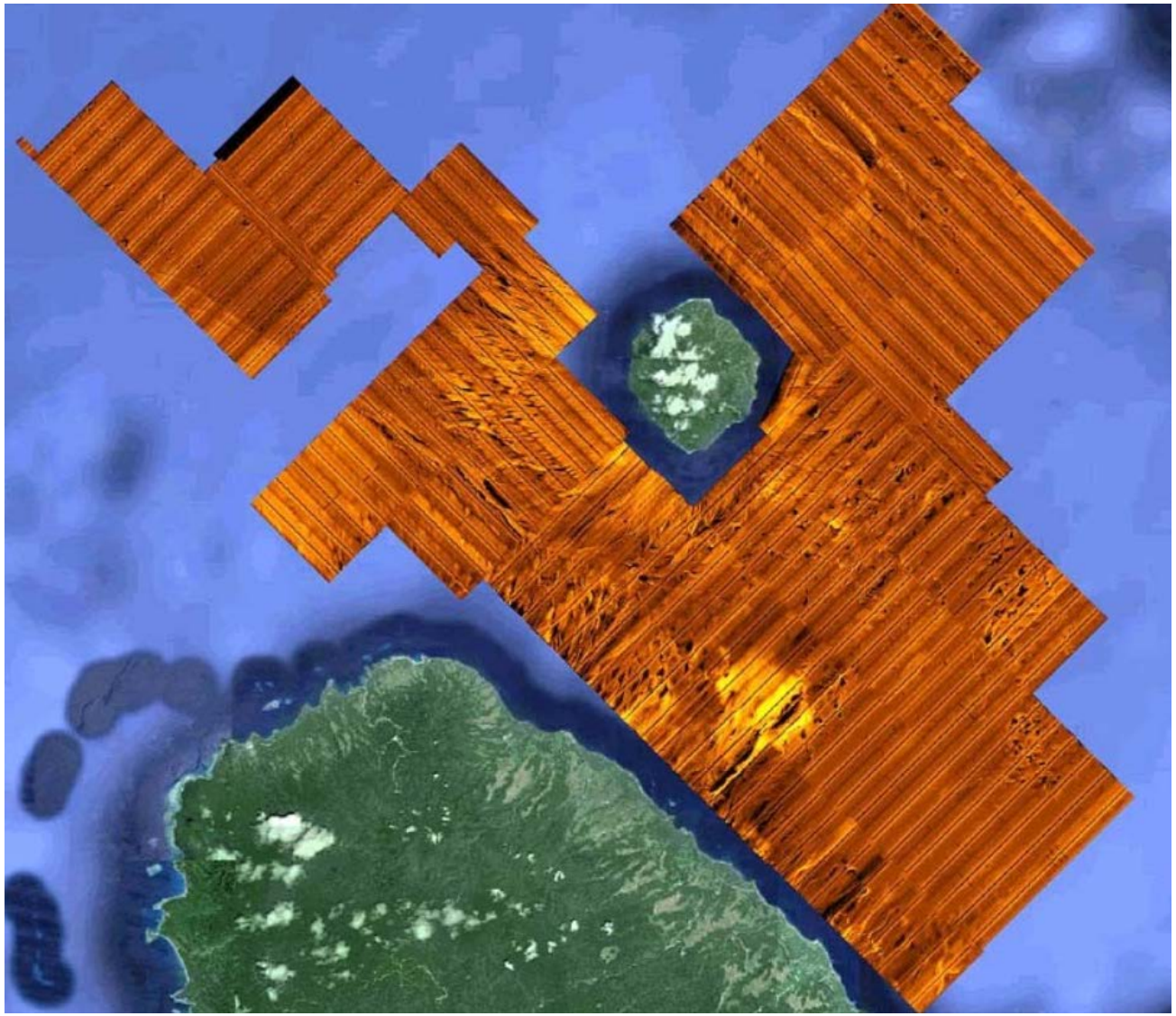
Sidescan Mosaic



With multiple tools in Sonarwiz, creating a full survey mosaic is easy to do.

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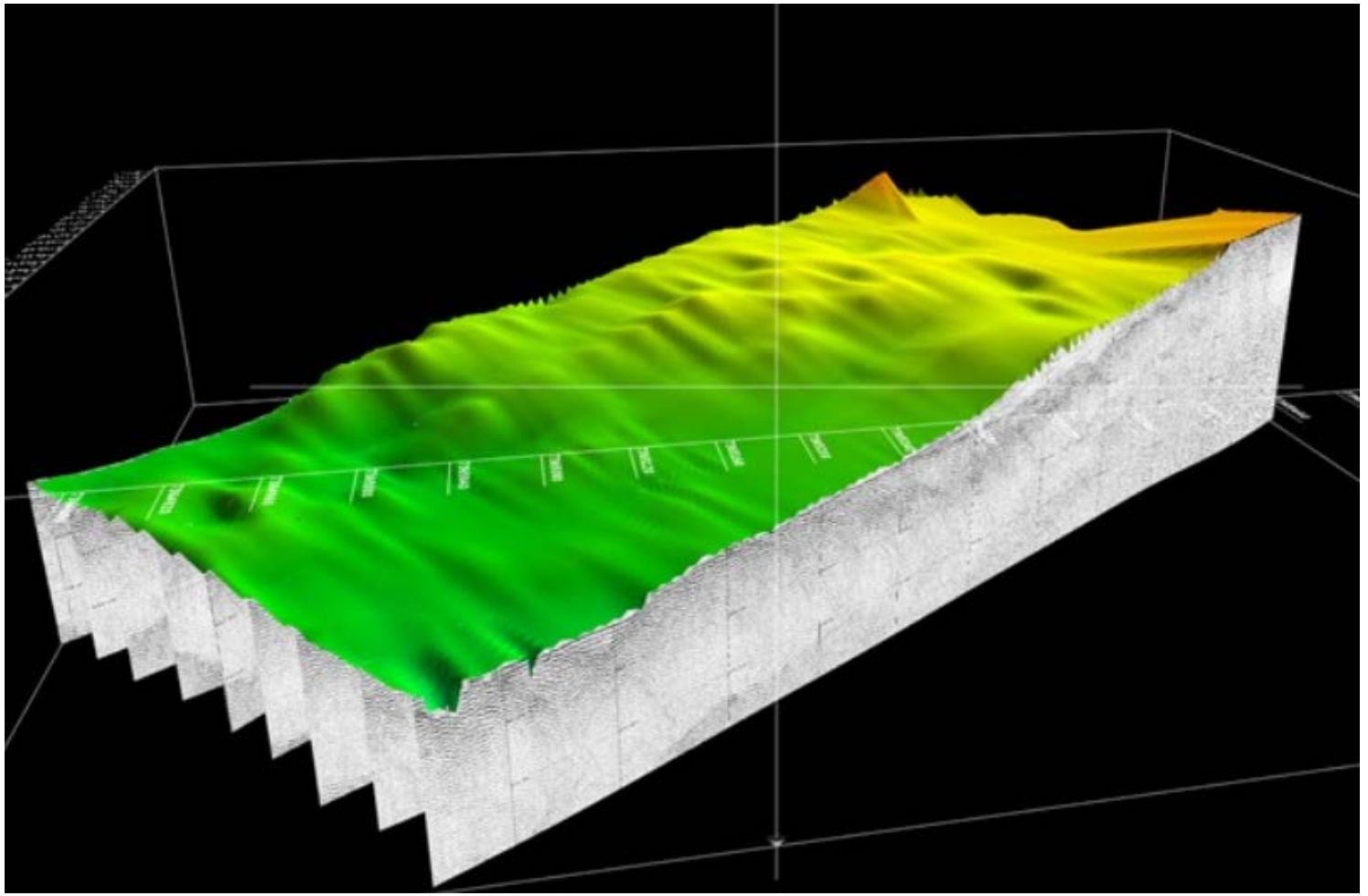
Bathymetry over sub bottom



Combining gridded bathymetry draped on top of sub bottom profiles

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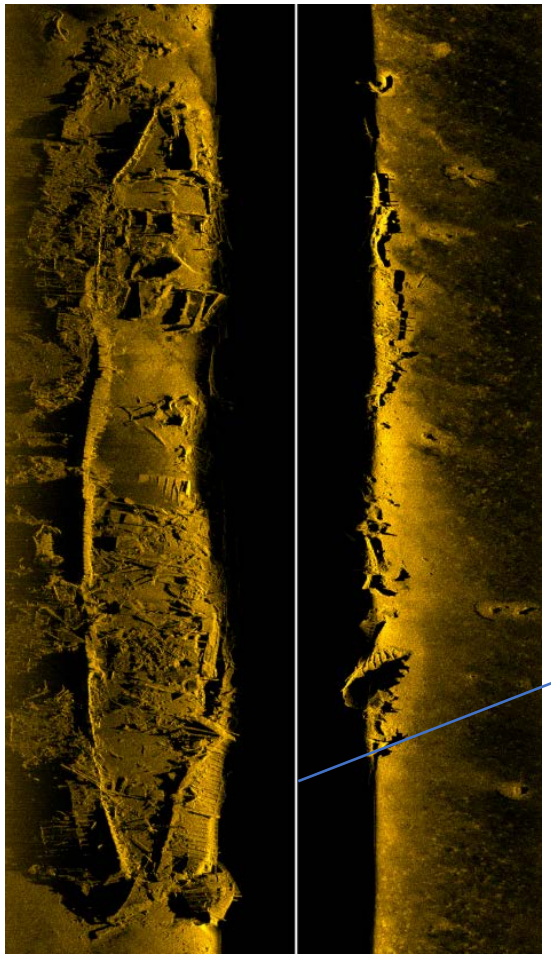
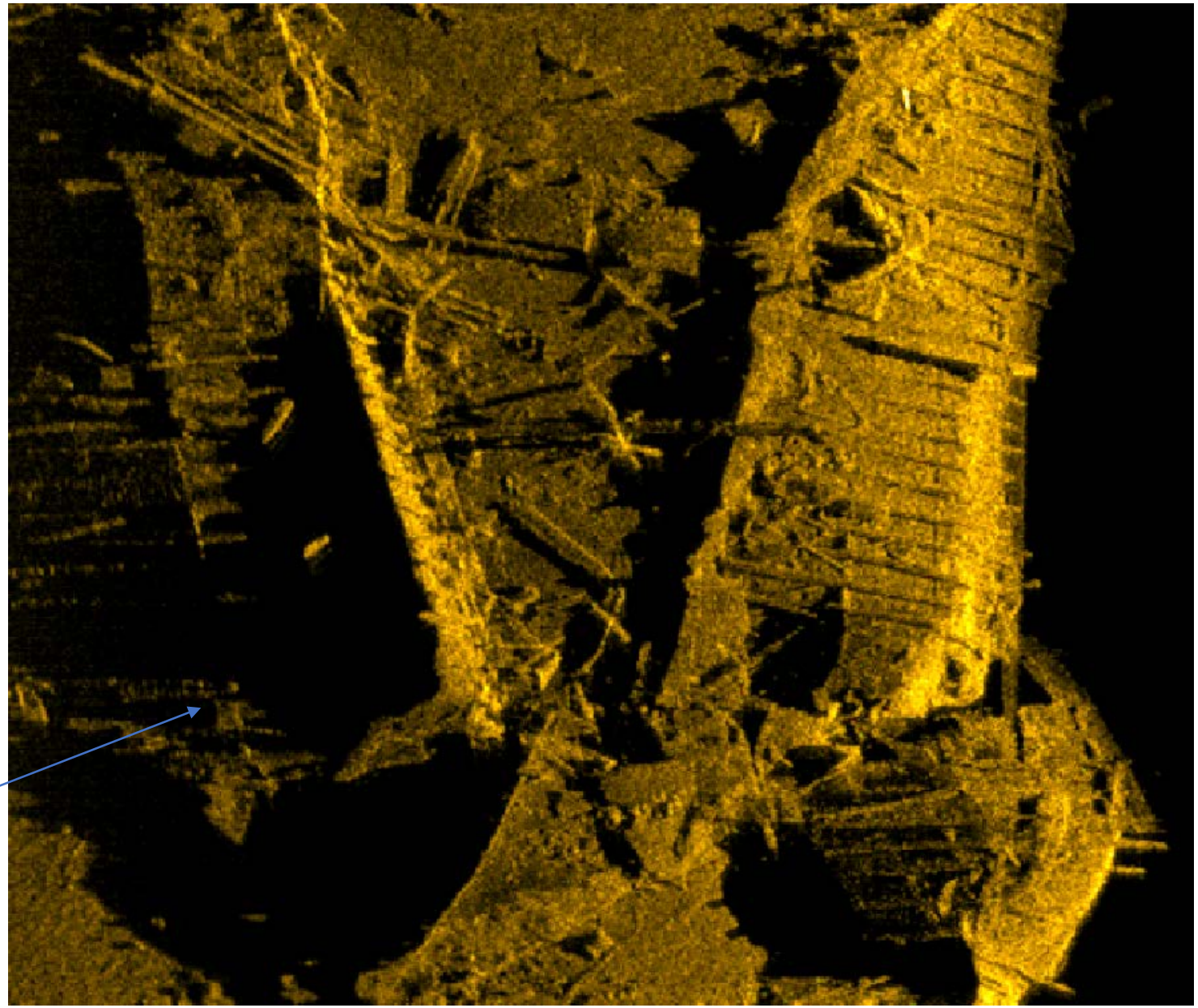
An imaged shipwreck, details with sidescan imagery





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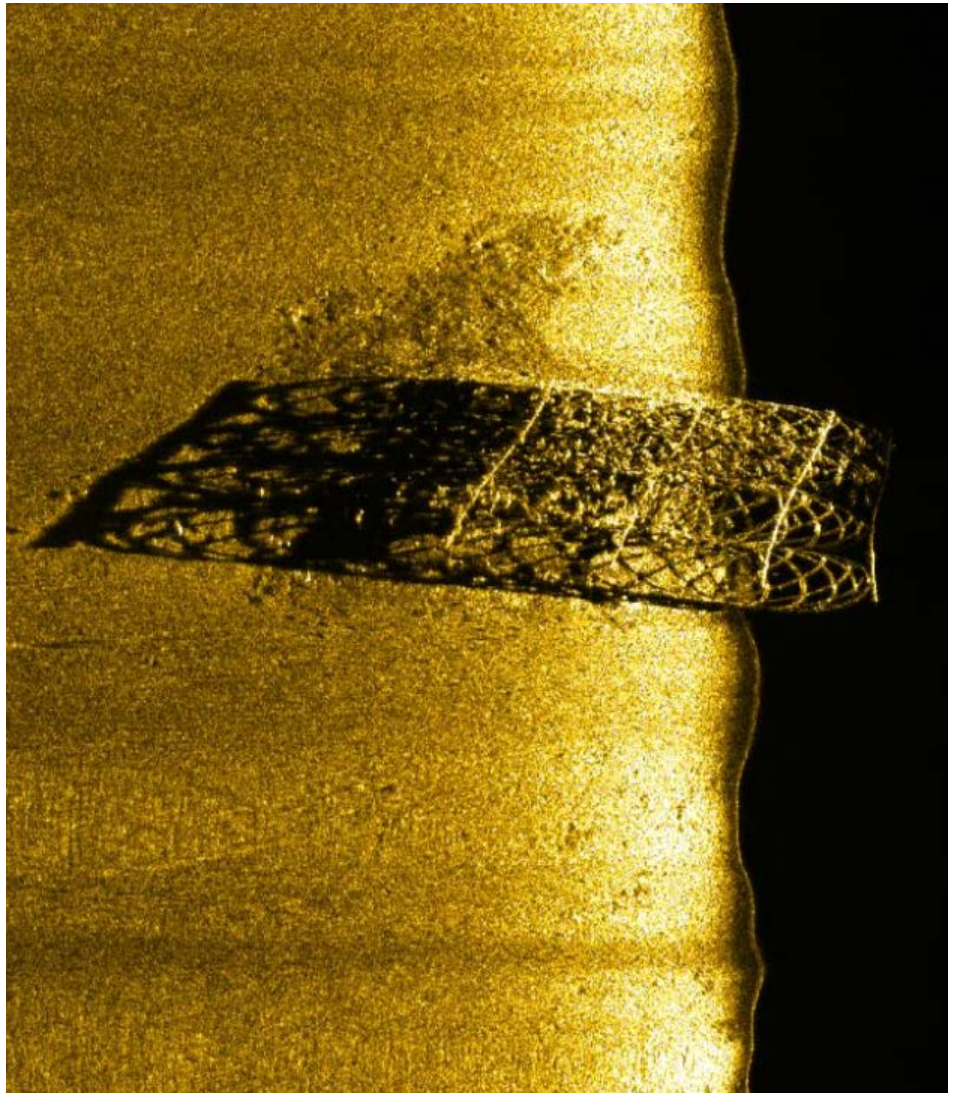
What lies beneath….



Part of a oil platform structure

Bridge footing (Jacksonville, FL)

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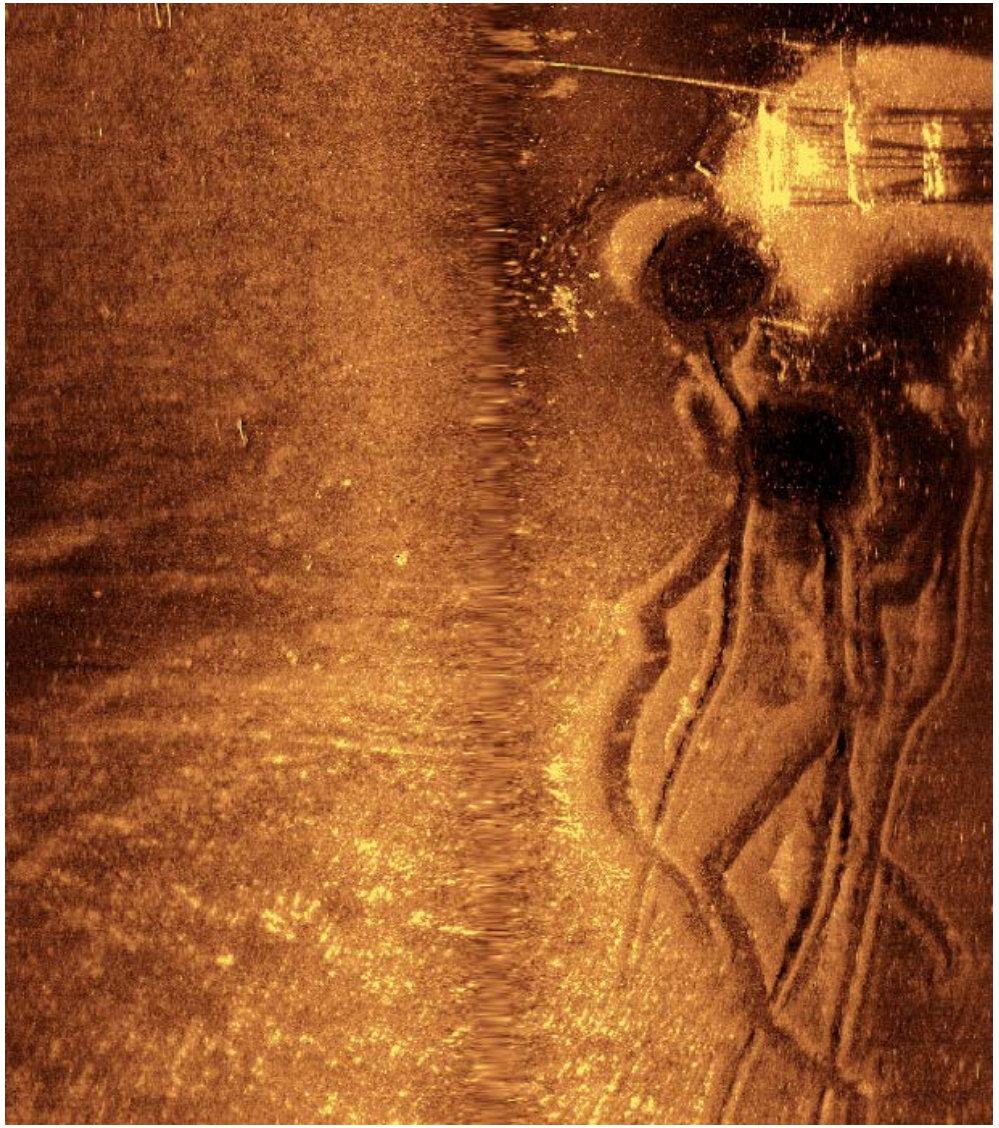
Careful out there… Someone is watching us….



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Thank you