Filling in the white strip:
An evaluation of the use of phase-measuring bathymetric sidescan sonar for nearshore bathymetric and habitat mapping

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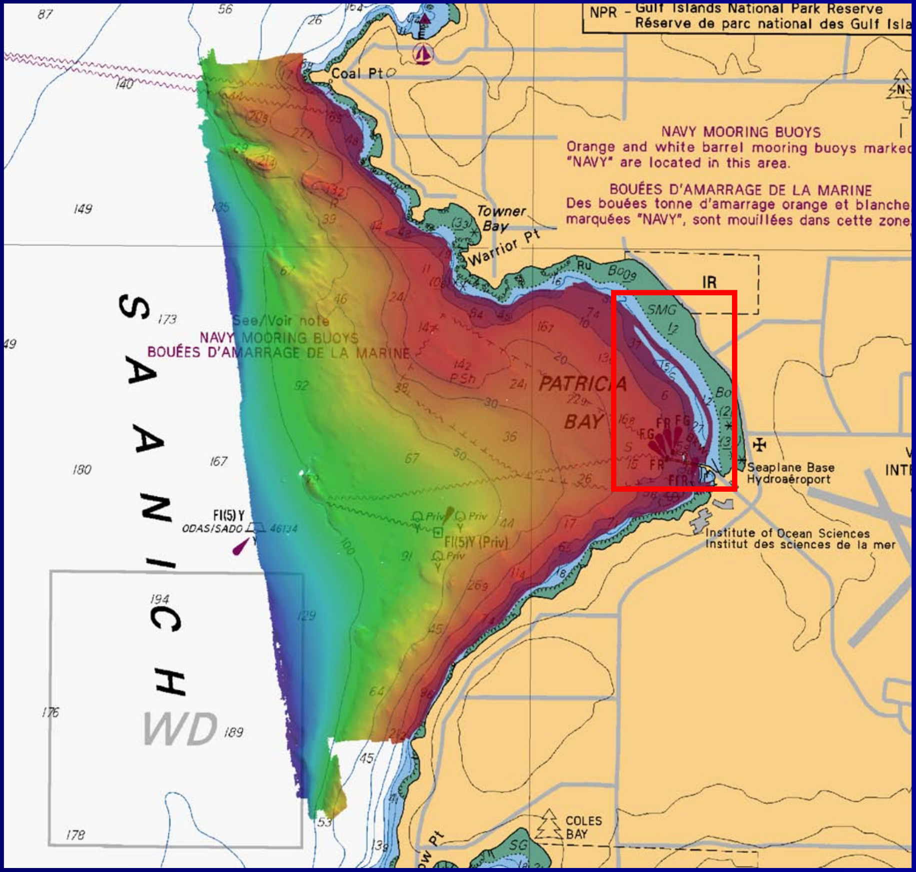
Overview

- Statement of the problem
- A possible solution
- A proposed test site
- Original Methodology (the plan)
- Actual methodology (a back-up plan)
- Results
- The way forward

The “white strip”



Shoal Seeker with C3D bow mount

CHS system specs

- Teledyne Benthos C3D phase-measuring bathymetric sidescan sonar
- Coda Octopus F185 motion sensor
- PPK (for primary antenna) – into HIPS
  - Inertial Explorer requires development;
  - POSPAC won't accept F-185 format.
- Hypack 2009a data logging
- CARIS HIPS 7.0 data processing includes refraction correction (but not re-ray-tracing)
- AML surface sound speed (not read in real time, manually entered in C3D software) and profiles

Patricia Bay at two tides

Workflow

- Collect and process point, line and area features by terrestrial positioning techniques at low tide in intertidal areas (ground truth)
- Use established hydrographic survey tools that meet or exceed IOS Order 1a in slightly deeper water areas (EM3002)
- Collect coincident bathymetric sidescan data (Hypack) for comparison and process using existing MB processing tools (CARIS HIPS)

Terrestrial ground truth at low tide

CCGS Otter Bay (EM3002)

Proposed methodology

- Comparison of EM3002 and C3D bathymetry
  - Depths over flat seafloor
  - Positions of pier pilings
- Comparison of depths on point and linear features (positioned by terrestrial PPK and DGPS)
- Comparison of area features delimited by terrestrial DGPS (and/or ortho-imagery) and C3D backscatter mosaic

- Answer the following:

Proposed research questions

- Can C3D acquire bathymetry to Order 1a position and depth uncertainty requirements?
  - Under what conditions?
  - Over what proportion of the swath?
- Can C3D reliably detect Order 1 or Special Order point targets?
  - Under what conditions?
  - Over what proportion of the swath?
- Can C3D backscatter identify habitat areas reliably?
- Can C3D backscatter be used to reliably locate small point targets (sawed-off piles) and linear features (pipelines)
- What are the operational limitations of the C3D for:
  - Navigational requirements?
  - Habitat mapping?

The back-up plan

- Acquire a test data set in San Diego using Fugro C3D system (working)
- Comparison of C3D bathymetry:
  - At cross-check lines
  - Against Reson 7125 reference surface

- Answer the following:

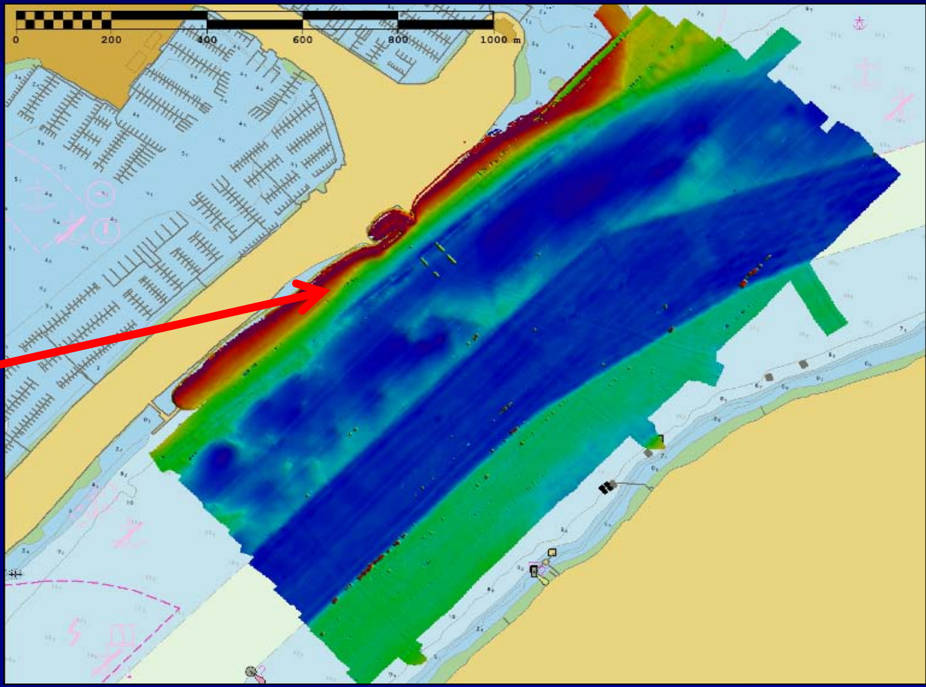
Modified research questions

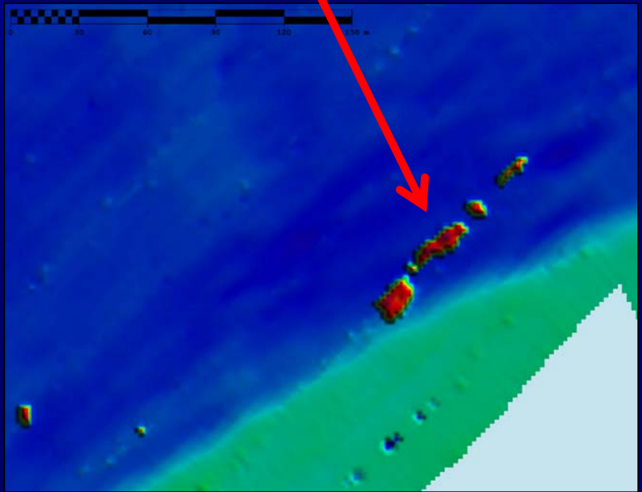
Can we develop an efficient and reliable methodology for C3D surveys?

- Efficiency:
  - Swath greater than 5 times water depth
  - Data processing time on the order of one-to-one with acquisition time
- Reliability:
  - Can C3D acquire bathymetry to Order 1a position and depth uncertainty requirements?
    - Under what conditions?
    - Over what proportion of the swath?
  - Can C3D reliably detect Order 1 or Special Order point targets?
    - Under what conditions?
    - Over what proportion of the swath?
  - Can C3D backscatter identify habitat areas reliably?
  - Can C3D backscatter be used to reliably locate small point targets (sawed-off piles) and linear features (pipelines)
  - What are the operational limitations of the C3D for:
    - Navigational requirements?
    - Habitat mapping?

Processing approach (1)

- An iterative processing approach is used to reduce manual editing.
- A CUBE surface is built from down sampled data
- Obvious fliers are manually removed





Relative data volumes for this area:

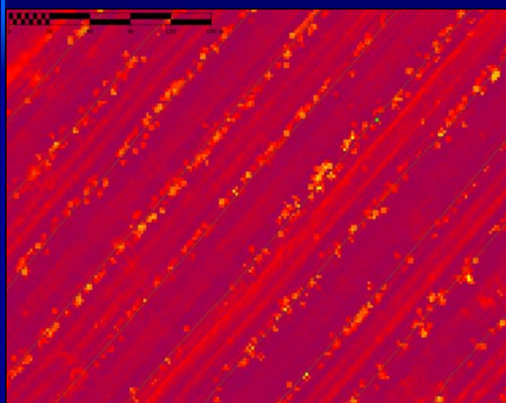
8101: 0.9 GB
7101: 1.8 GB
7125: 12.5 GB
C3D: 25.6 GB

Processing approach (2)

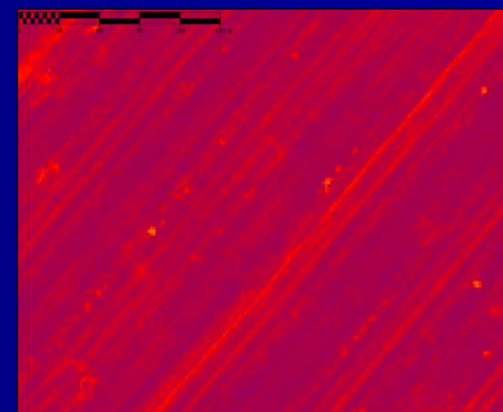
A 1-sigma surface filter is applied to edited soundings

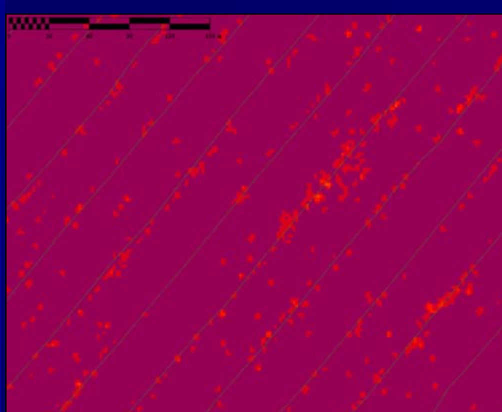
Before Surface Filter

After Surface Filter



Standard Deviation



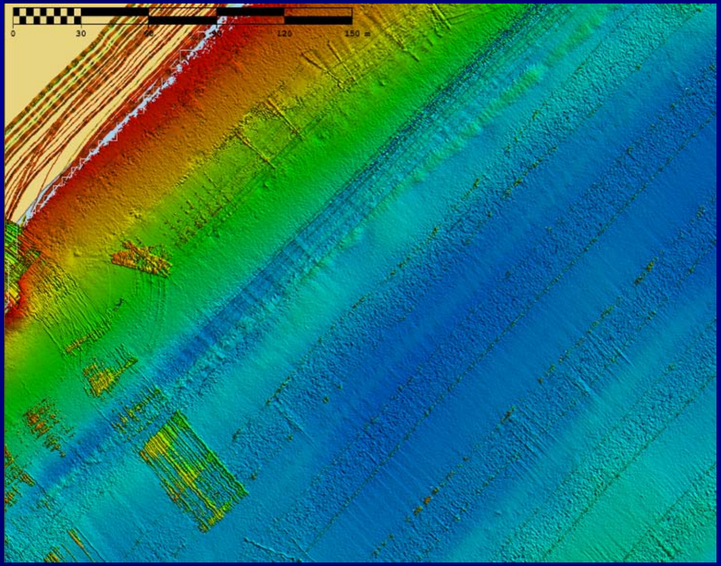


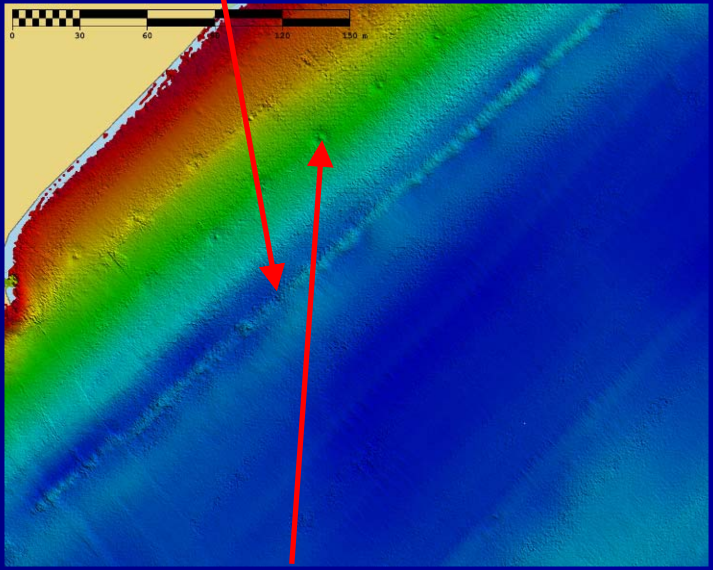
Hypothesis Count

Processing approach (3)

- Next, the full resolution data set is imported and cleaned using the surface filter and the low resolution surface

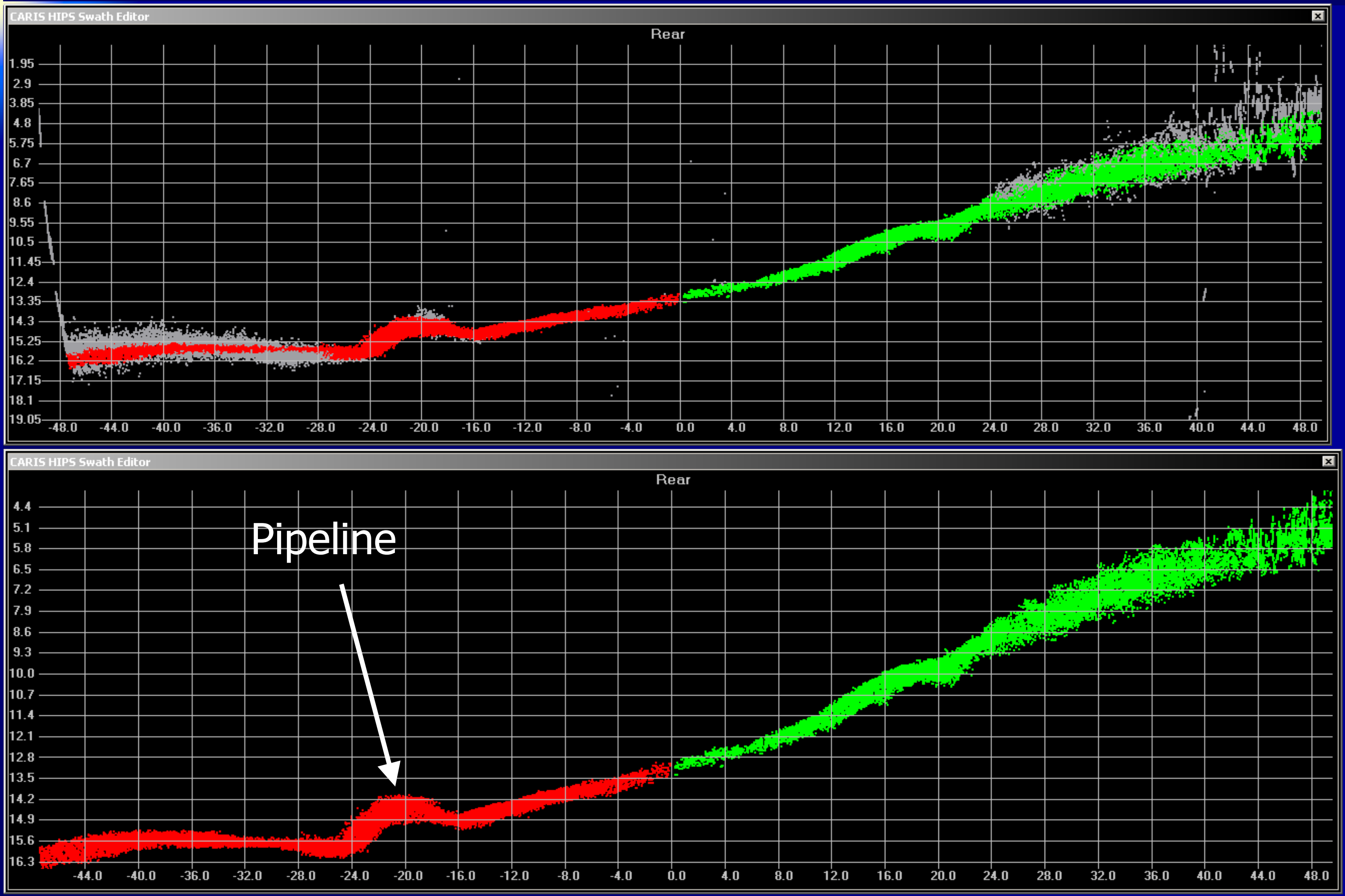
Pipeline





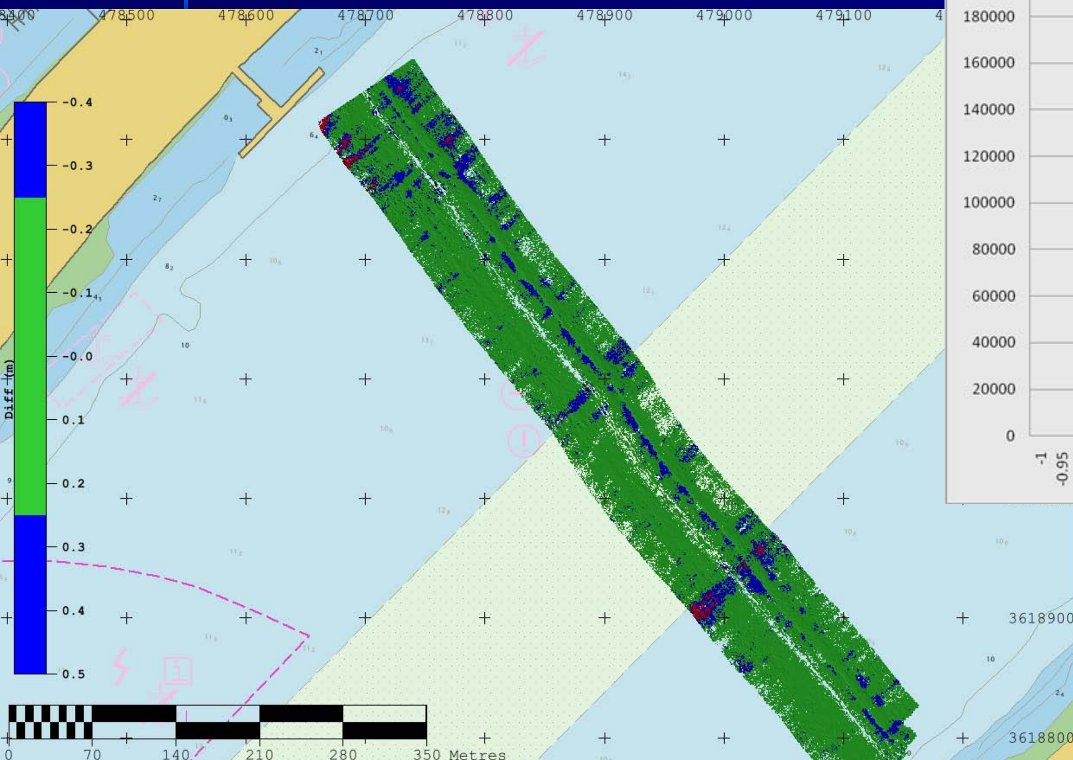
Anchor blocks

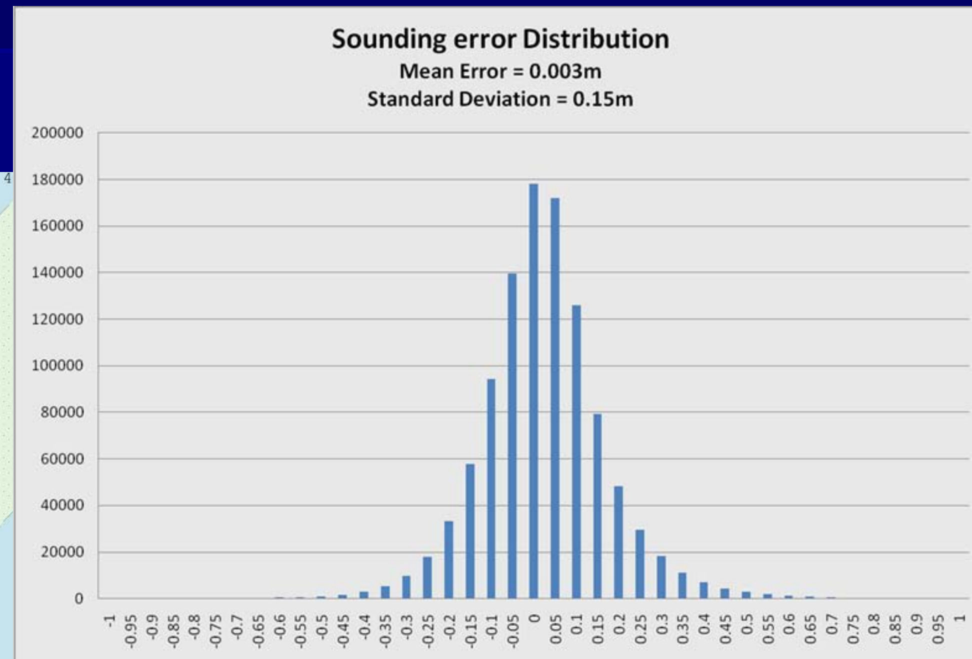
Cross-section pre and post CUBE filter



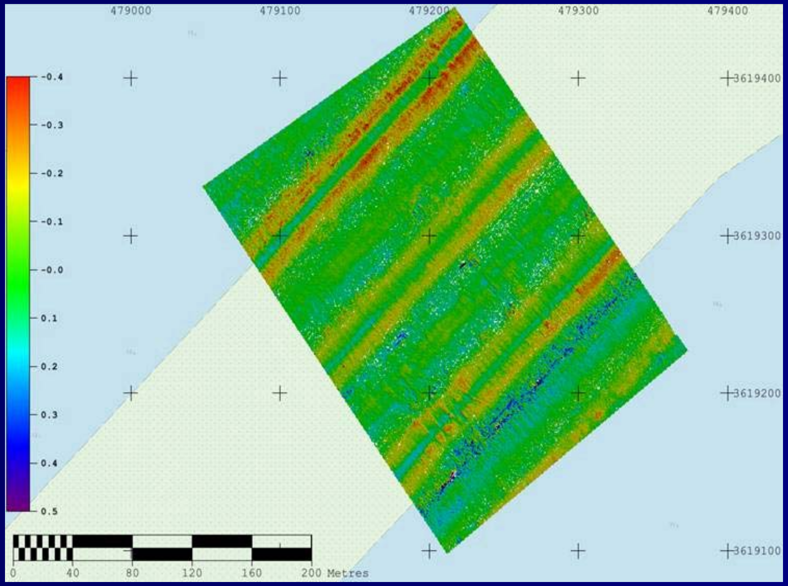
Results

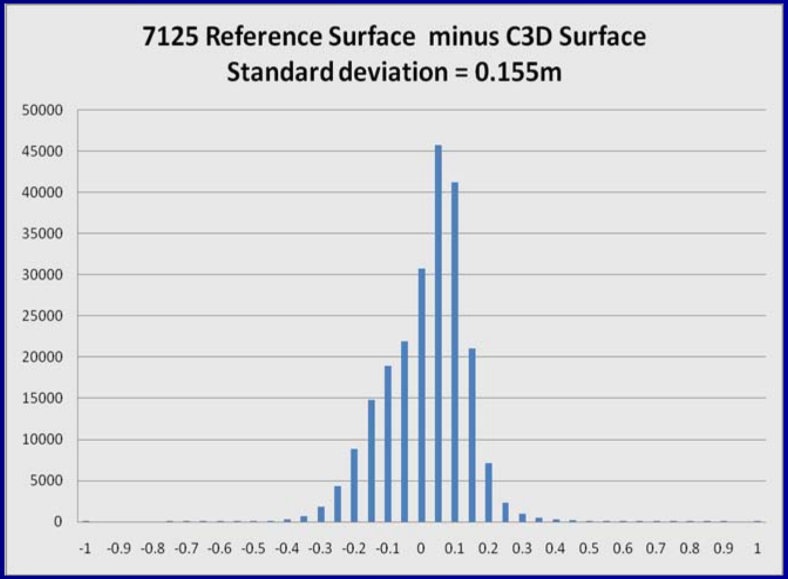
Tie Line comparison:



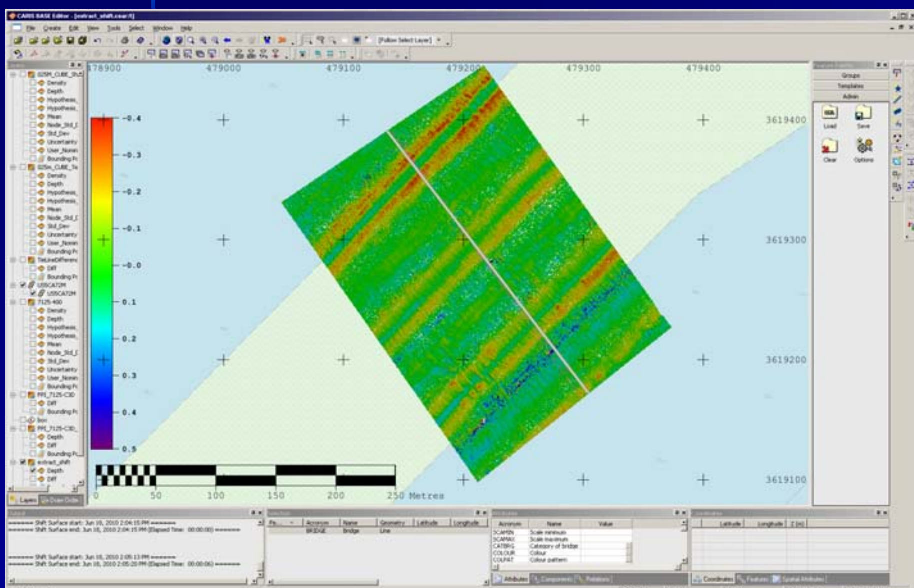


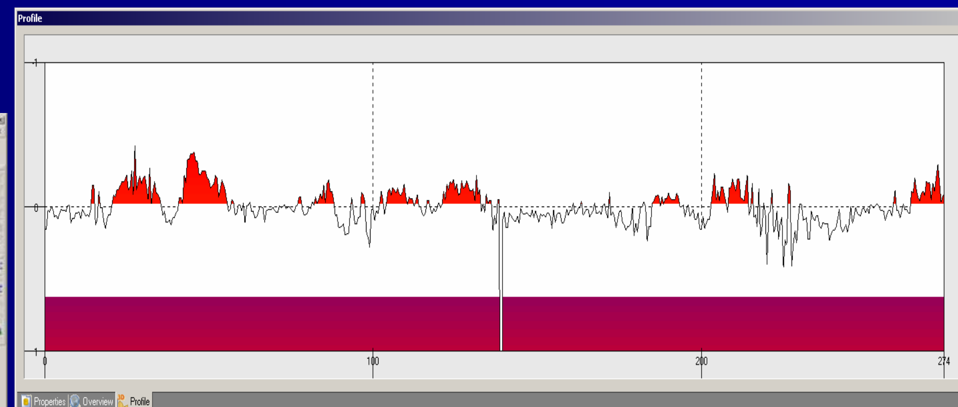
7125 reference surface

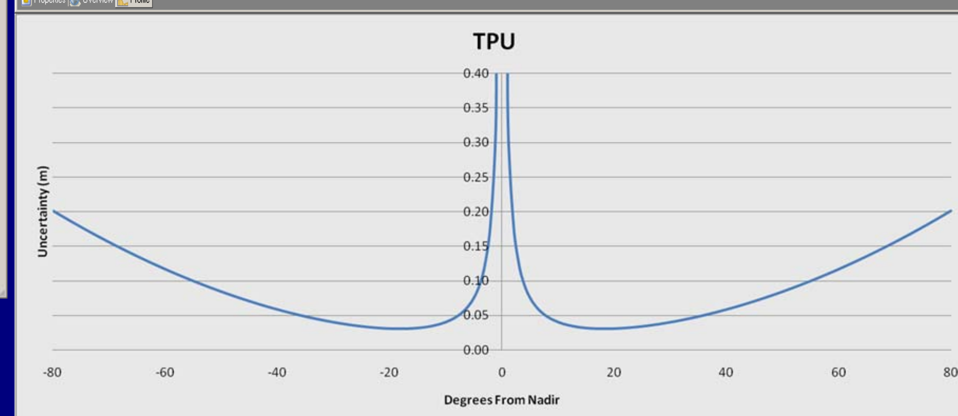




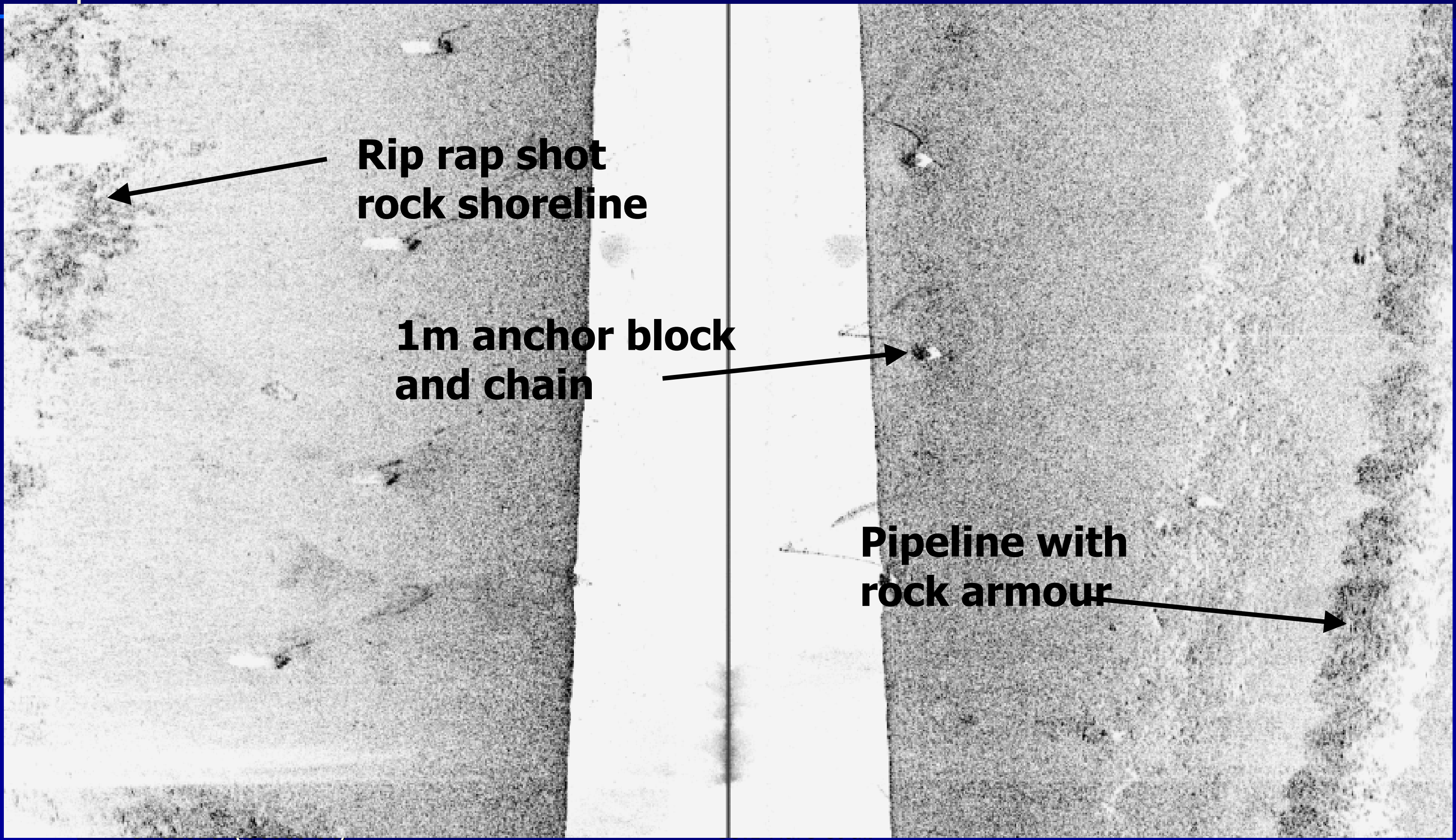
C3D difference cross-section







Sidescan waterfall



Conclusions

- Reliability:
  - Can we say meets Order 1a TPU-H? Using POSPAC - yes
  - TPU-V <= 30 cm (95%) – yes (Order 1, not Special)
  - Target detection – 1 m anchor blocks – yes (Special)
  - Can different seabed types be reliably identified? Yes
- Efficiency:
  - Does it achieve 5 times depth swath while meeting above specs? 5 times in deeper; more than 5 times in shallower
  - What is DA:DP ~ 1:1

Next steps - 2010

- Get CHS C3D system working
- Improved documentation for both acquisition and processing. This documentation will be more of a user guide than a system manual.
- Acquisition and processing flows will be defined.
- System timing will be improved through the use of an NTP server.
- An additional serial port will be added to the C3D transceiver to improve timing of ancillary sensors.
- Implementation of an autogain

Next steps – longer term

- Planned improvements in 2011 are:
  - Improved bottom following algorithm
  - Development of dynamic uncertainty values.

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Thank-you
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