

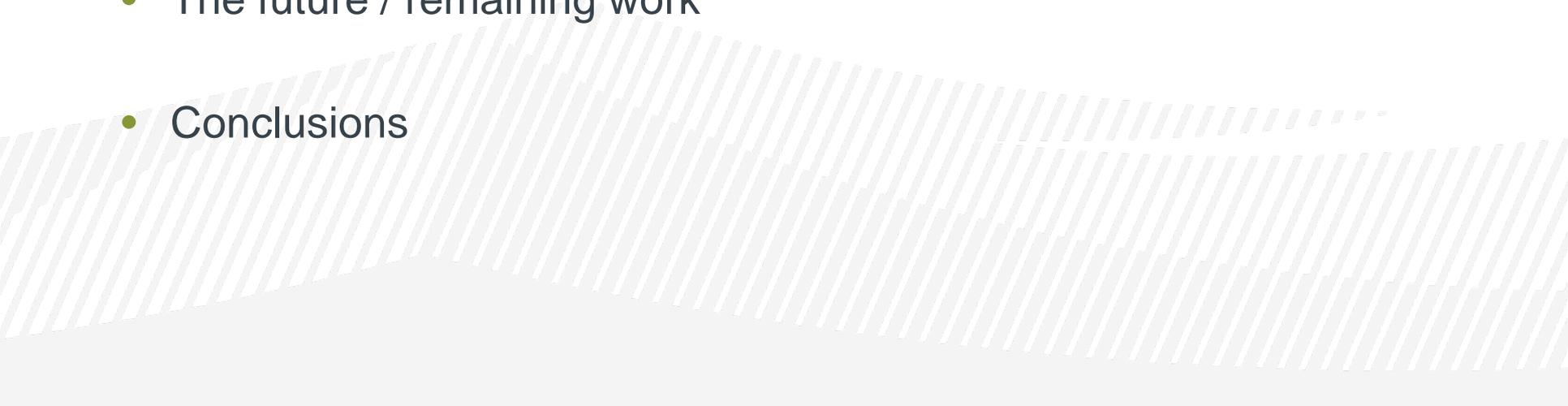


# Superior Survey ROV

NOSP – Stavanger 5<sup>th</sup> November 2015

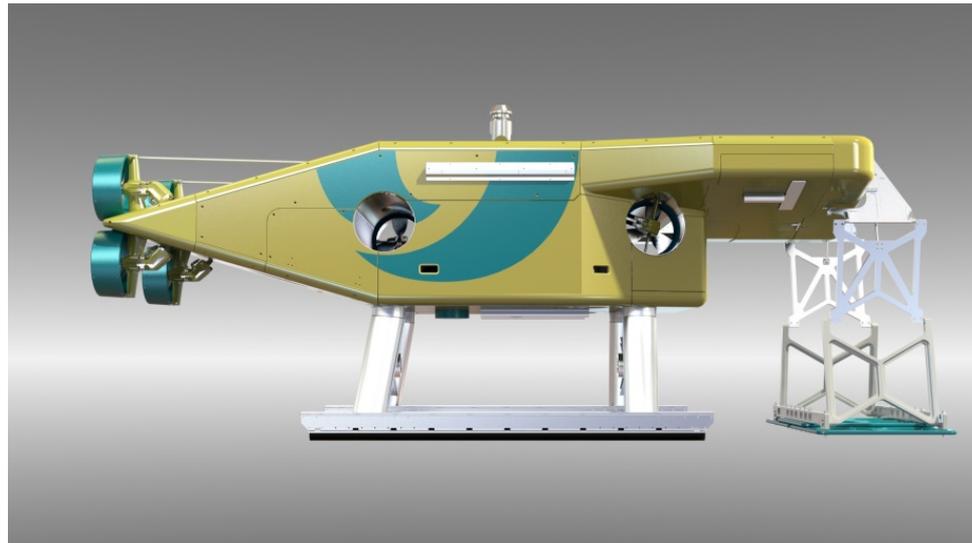
Tor Arne Paulsen

- Making a difference

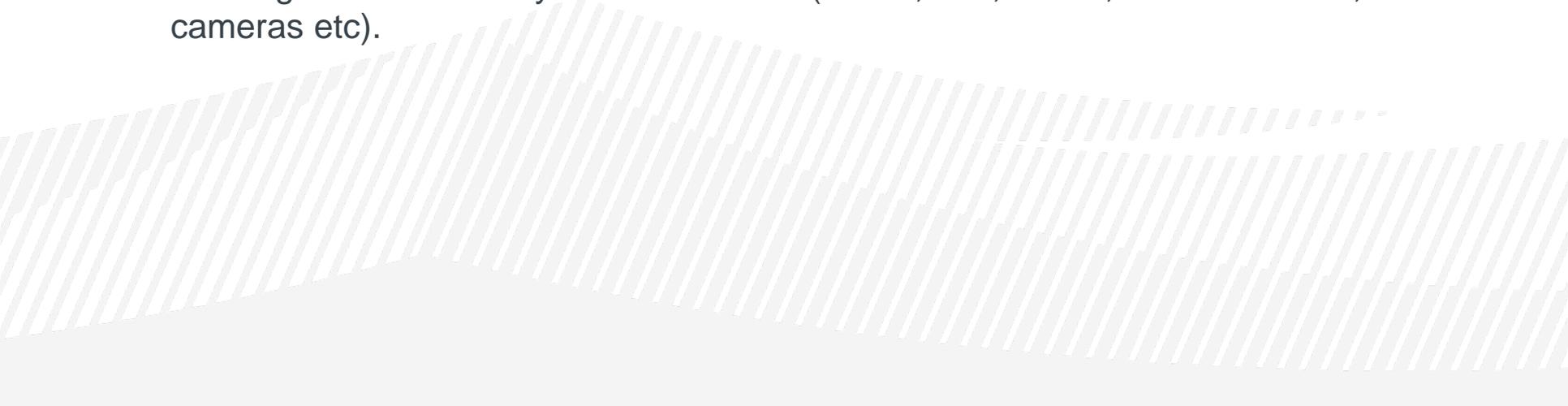
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- Background
    - Design
    - Evolution
  - The first projects
    - Calibration / Acceptance test
    - Visual pipeline inspection
    - Pipetracker survey
    - Acoustic survey
  - The future / remaining work
  - Conclusions
- 

## Background

- DeepOcean has had a survey ROV on the drawingboard for many years, and we have finally managed to realise it!
- Long internal design process (started in 2006!) – with many «interesting» shapes.
- Contract with Kystdesign signed April 2014, detailed engineering started 1st September 2014.
- Superior ROV was delivered to DeepOcean in June 2015 after a successful FAT.
- SAT performed in July 2015.



## Main Design Requirements

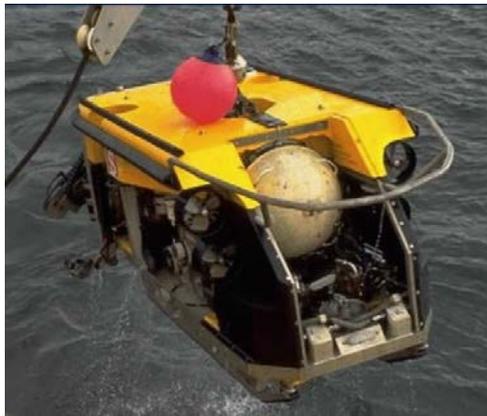
- Large, stable vehicle with optimal placement of sensors for acoustically silent environment.
  - Reliable construction, capable of 24/7 operations all year around in the North Sea.
  - Acoustic survey speed of 4 knots at 400m.
  - Autotrack, plus autoheading, autoaltitude, autodepth, etc.
  - Capability of performing «traditional» visual inspections with 3 cameras close to the pipeline, with the ability to carry a TSS pipetracker.
  - Latest generation survey instrumentation (MBEs, INS, lasers, video-cameras, still-cameras etc).
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# “Survey” ROV Evolution

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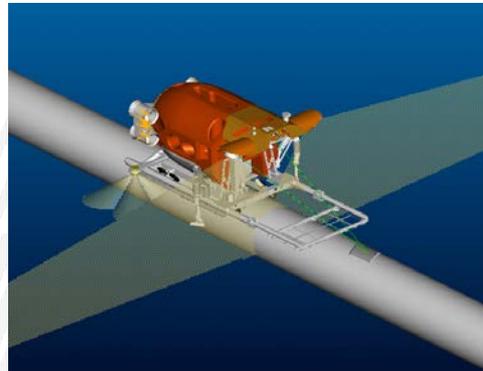


Scorpio - 1980



Solo 1 - 1984

HiROV – 1998-2000

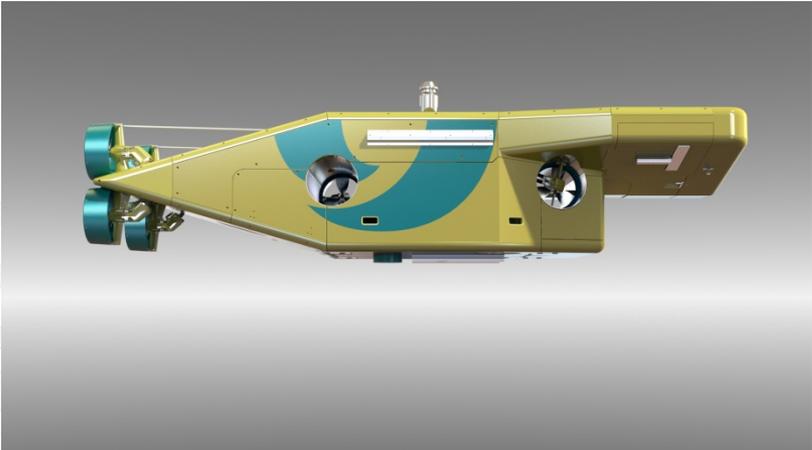
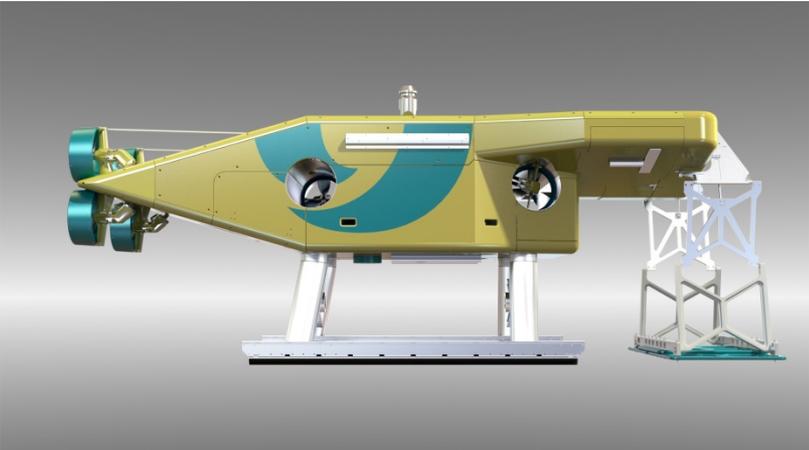


Solo 2 - 2001



And now!

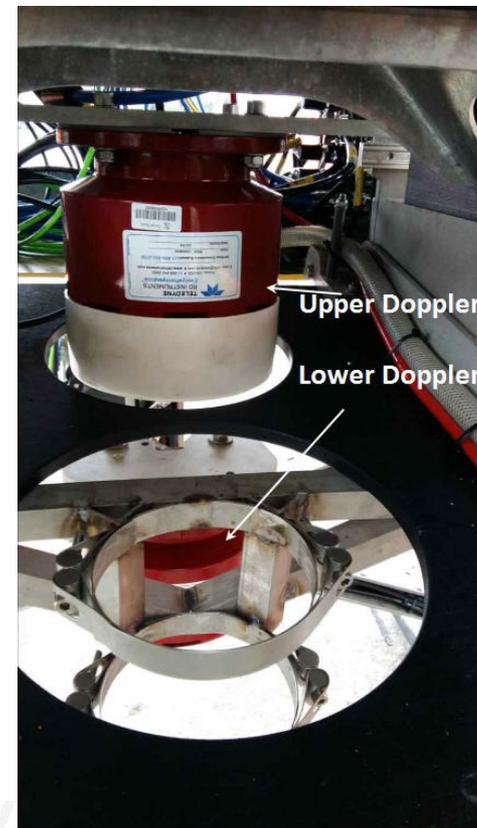
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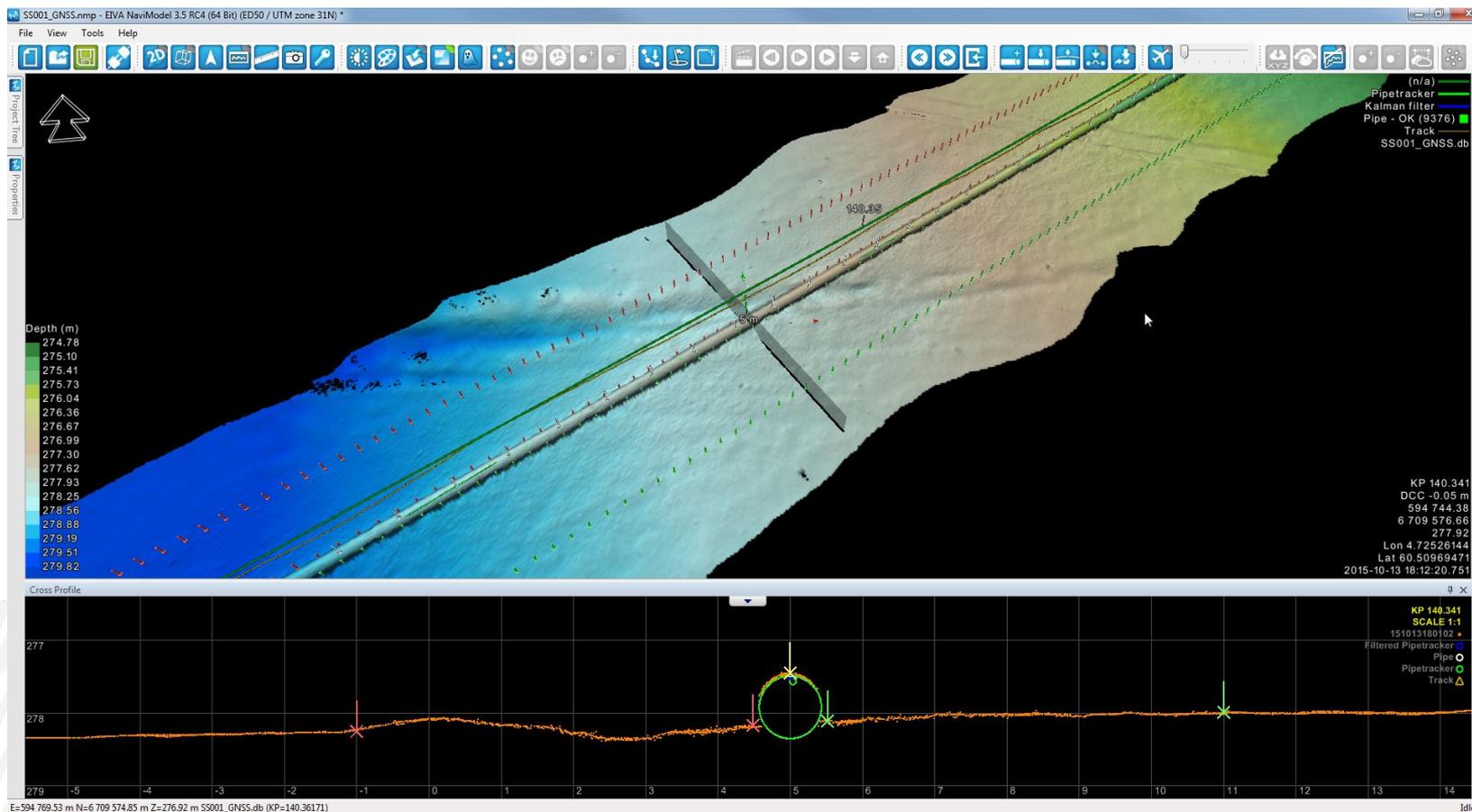
- The Superior was mobilised on the back deck of Volstad Surveyor and calibrated in Haugesund for the Statoil Frame Agreement.
- Three types of jobs were performed by the Superior:
  - Visual pipeline inspection
  - (Visual) Pipetracker survey
  - Acoustic Deep Water survey
    - Plus a short acoustic survey test



- Full set of ROV dimcon, calibrations and acceptance test performed in and near Haugesund
- 2 INS'es (Kongsberg HAIN and IXBlue ROVINS) combined with 2 dopplers meant a minimum of 2 ROV doppler calibrations!
- During the acceptance test it became evident that HD video was required for video eventing. Recording this format to MPEG2 was not the optimal solution, and did give us some issues. (Statoil's latest revision of TR2234 opens for recording of H264.)

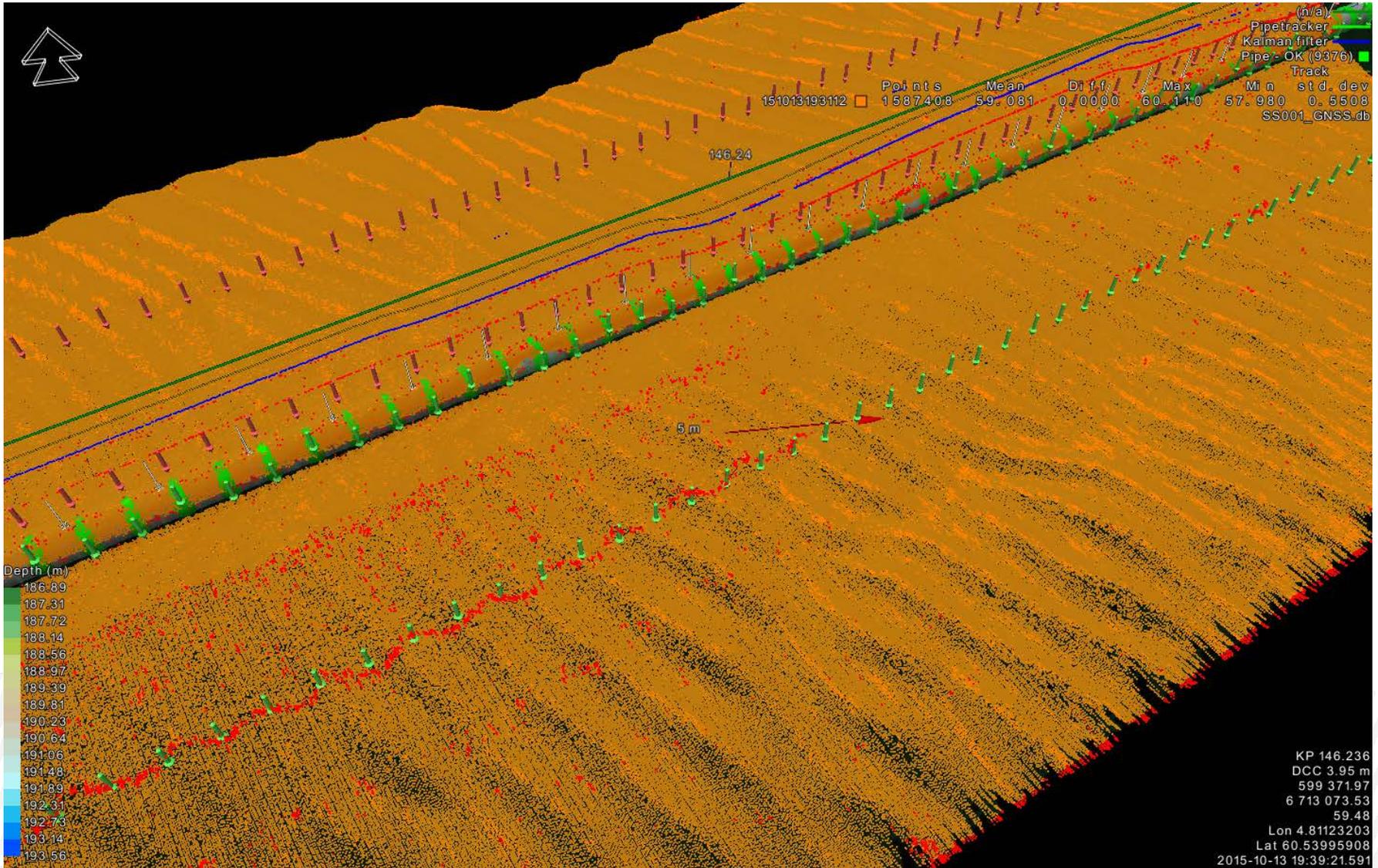


- Visual Pipeline Inspection was performed with an average survey speed of 1.5m/s (~3 kn) over a distance of 44km. SSS and MBE data were of high quality, with limited data cleaning required. The achieved DTM grid cell size was of 0.1m x 0.1m.



E=594 769.53 m N=6 709 574.85 m Z=276.92 m SS001\_GNSS.db (KP=140.36171)

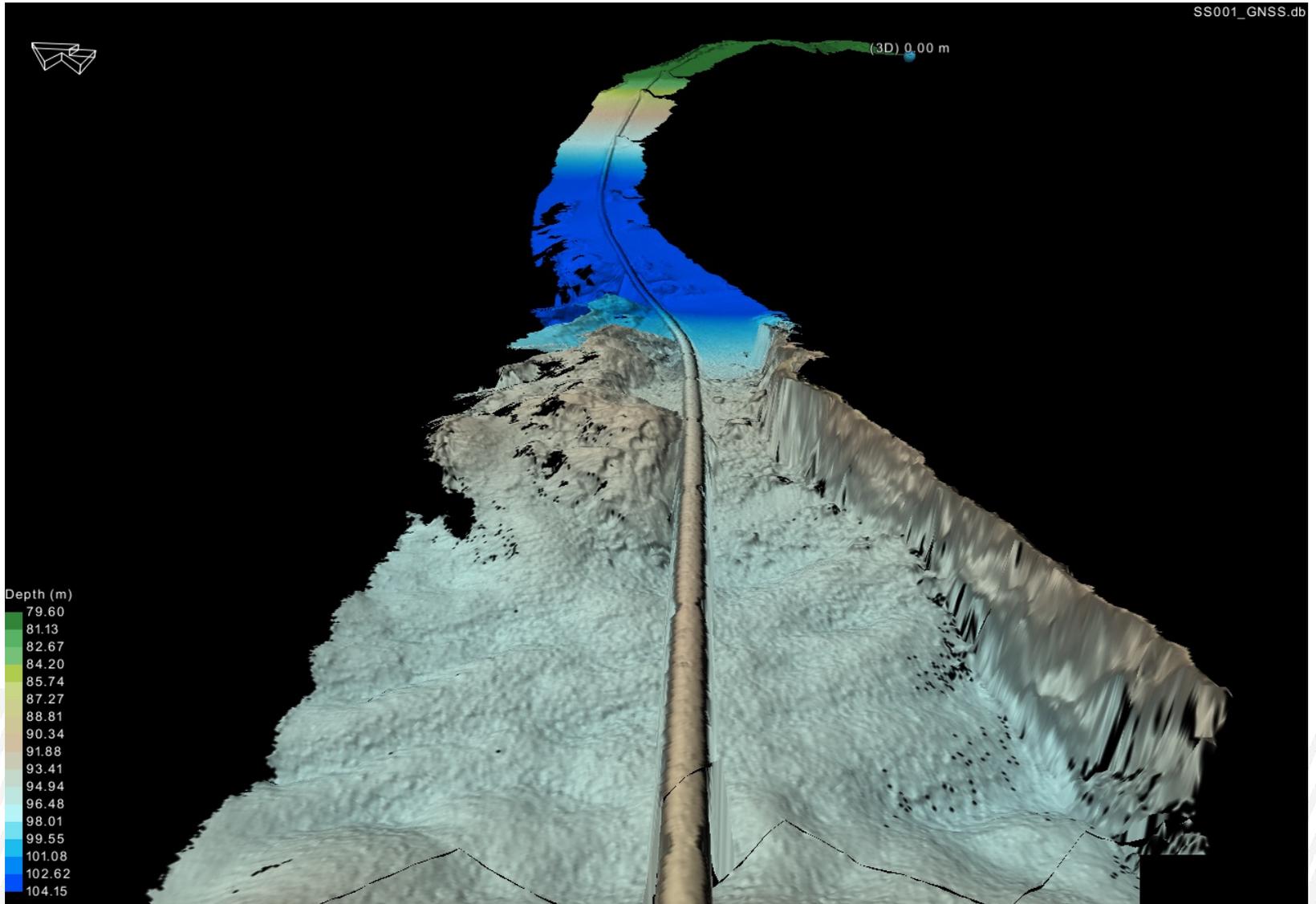
Idle



# Visual Pipeline Inspection

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The screenshot displays the VisualReview V10.1.7 software interface. The title bar shows the project path: "VisualReview V10.1.7 [Layout File: C:\ProgramData\VisualSoft\VisualWorks\default.vedx] [Project: VOS\_ST15625V-Kvitebjorn-Gas-P192-TN-External-PI]". The menu bar includes "Layout", "Import", "Options", and "Help". The ribbon contains various tool groups: "Open Layout", "Save", "Save As", "Default", "DVR1", "DVR2", "DVR3", "Camera 4", "Projects", "Survey Data", "Events", "QC", "Side View", "Plan View", "Cross Profile", "3D Cross-Profile", "Components", "3D Viewer", "Pipeshet", "Search", "Time Display", and "More Views". The main workspace is divided into three vertical panels, each showing a 3D perspective view of a pipeline. The left panel is labeled "PORT", the middle "SUPERSONIC CENTRE", and the right "STARBOARD". Each panel shows a timestamp of "14/10/2015 05:41:31" and a DCC value of "0.16". A large digital clock in the top right corner displays "05:41:31". Below the 3D views is a data table with columns: "Raw Survey", "Processed Survey", "X-Profiles", "DVR Log", "ASFIIndex", "Date", "Time", "Easting", "Northing", "KP", "Gyro", "Depth", "Pitch", "Roll", "Runline", "D...", "Altitude", "SurveyID", and "DiveTask". The "DiveTask" column contains multiple entries of "Superior Acceptanc". To the right of the table is an "Events" panel. The bottom status bar shows "OFFLINE MODE" and various coordinates: "Dx: 0.000000", "Dy: 0.000000", "Range: 0.000000", "Project History", "KP: 0.000000", "DCC: 0.000000", "X: -64.161458", "Y: 2.381250". The Windows taskbar at the bottom shows several open applications: "Microsoft Outlook...", "Windows Media Pla...", "Mike Oldfield", "Pictures", "Downloads", "ShareFile - Where C...", "Mp3tag v2.70 - L...", "Programs and Feat...", "Microsoft Lync", and "VisualReview V10.1...". The system clock shows "09:08".



- During the visual survey Ecotone's hyperspectral camera was mounted on the ROV.
- They are still working on UHI classifications, but below are some preliminary results.

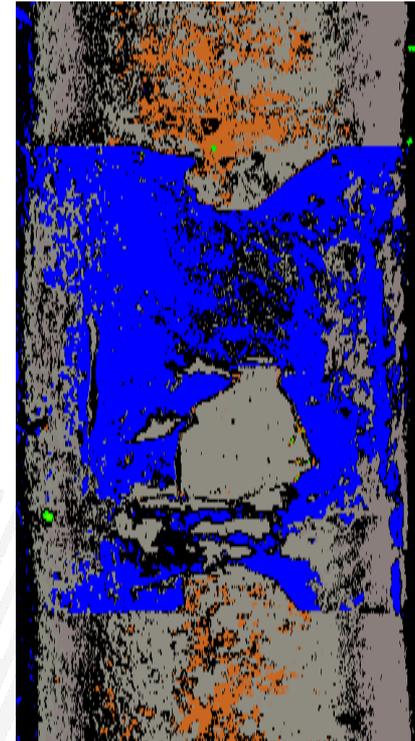
Video



RGB visualisation



UHI Classification



# (Visual) Pipetracker As-Built Survey

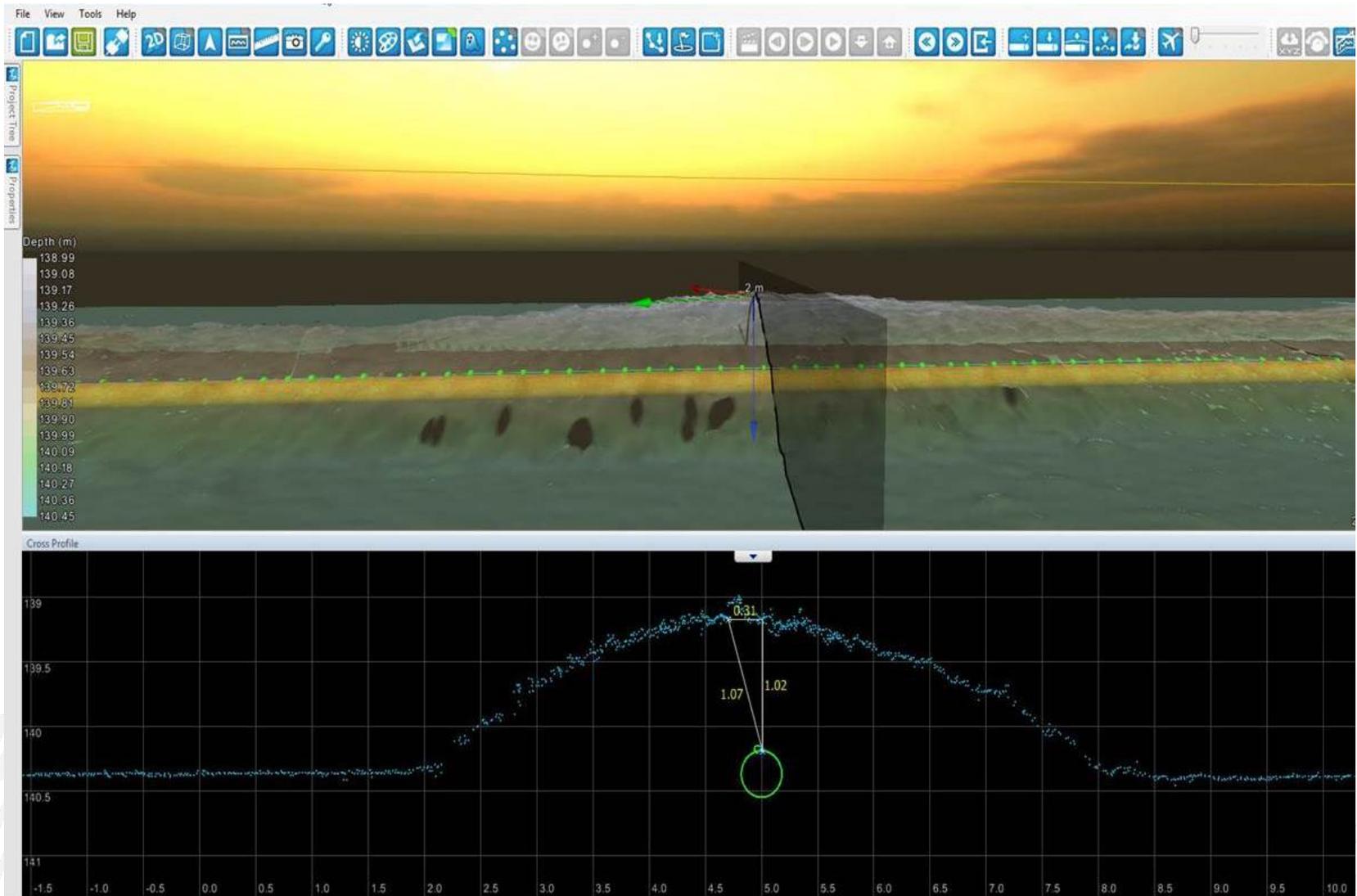
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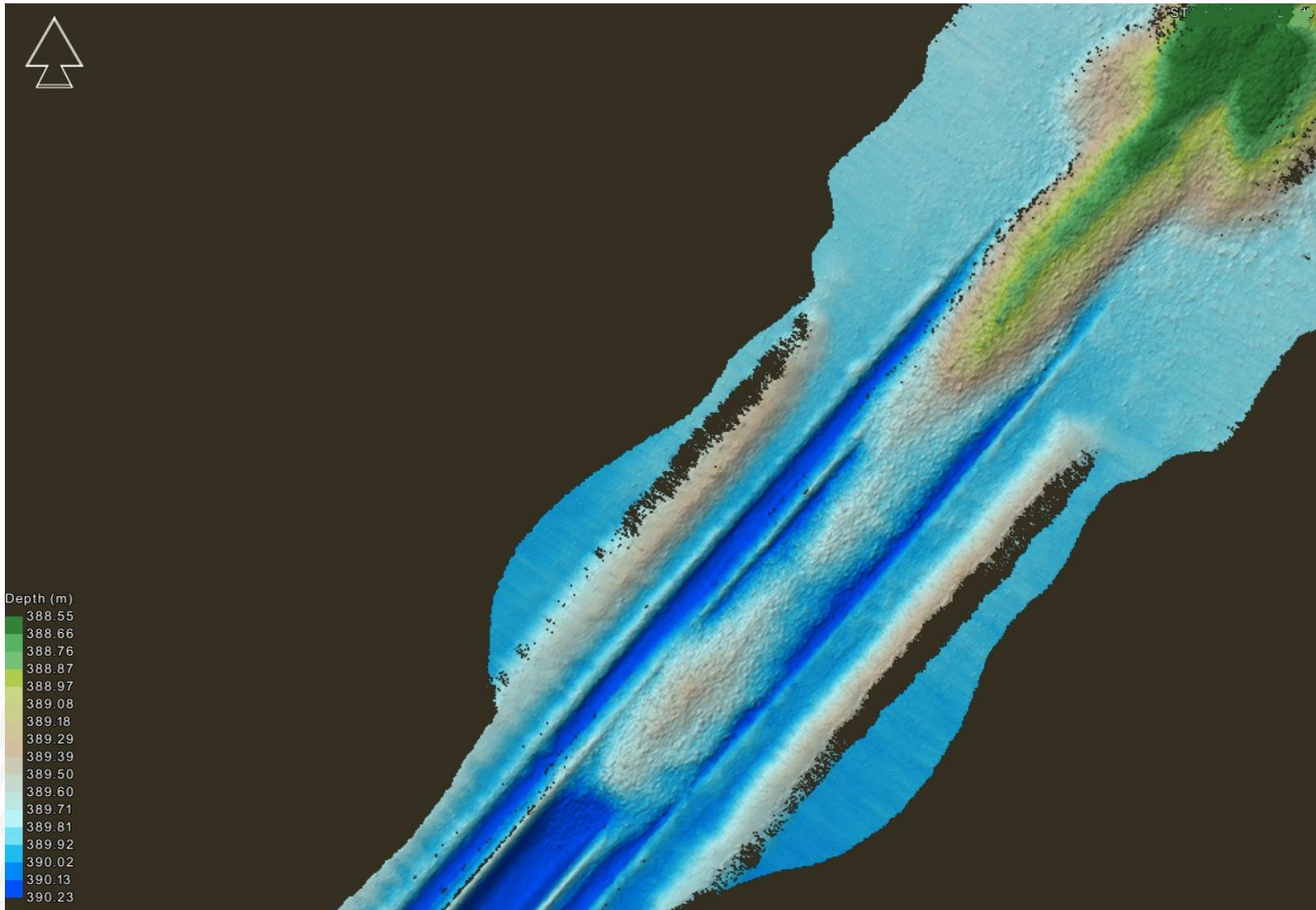
- A (Visual) Pipetracker As-Built survey was done on a 106 km long 12" pipeline.
- Most of the pipeline is trenched and backfilled, in some places as deep as 1.5 m.
- The trench made it difficult to locate the pipetracker close to the pipeline
- The design of the pipetracker mounting frame proved to be functional and in no conflict with the simultaneous recording of MBE data (we typically see continuous stripes in the DTM due to pipetracker beams shadowing the MBE data).
- The design appeared to be somewhat wiggly; however during survey it was stable.
- Except when running into a gravel heap!



# (Visual) Pipetracker As-Built Survey

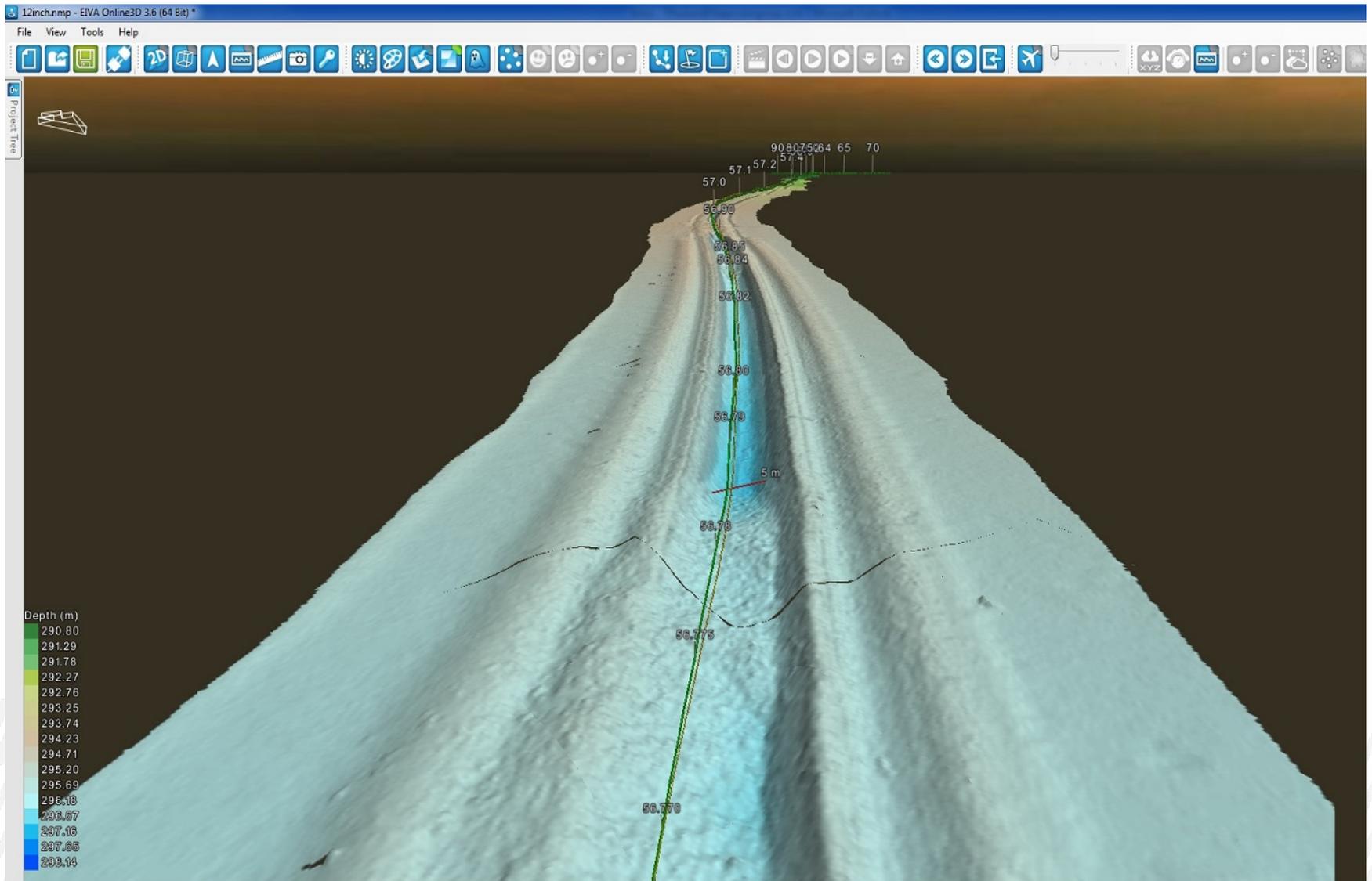
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# (Visual) Pipetracker As-Built Survey

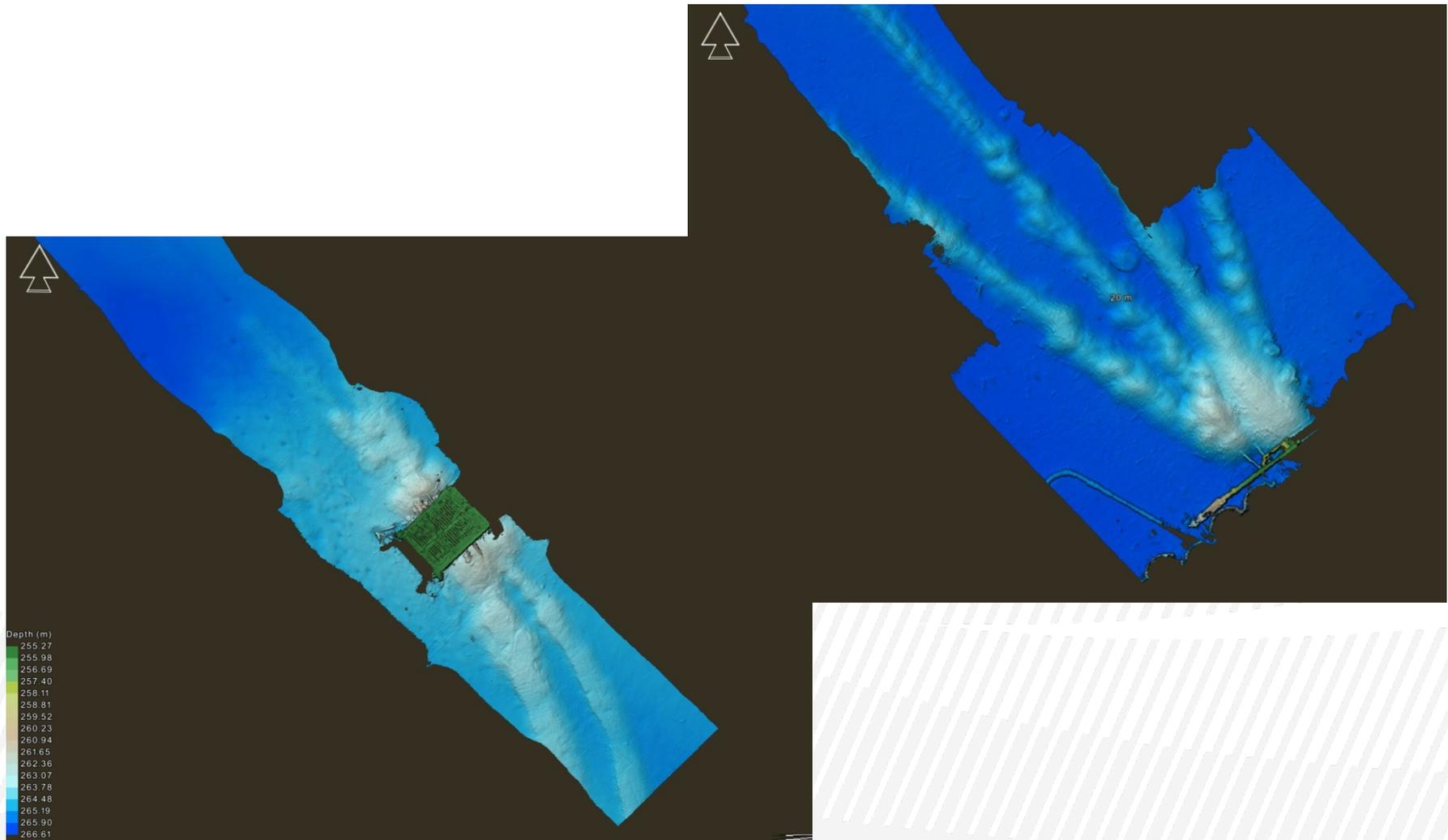
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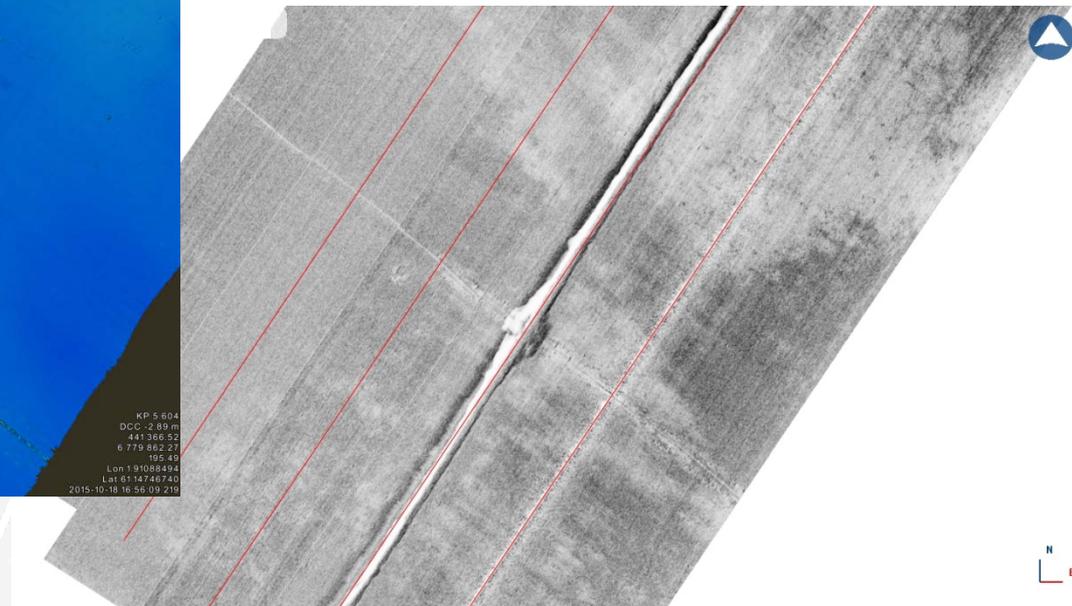
# Acoustic Pipeline Inspection

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- Acoustic survey of infield lines with the skid off.
- Finished off with some high speed acoustic tests / survey



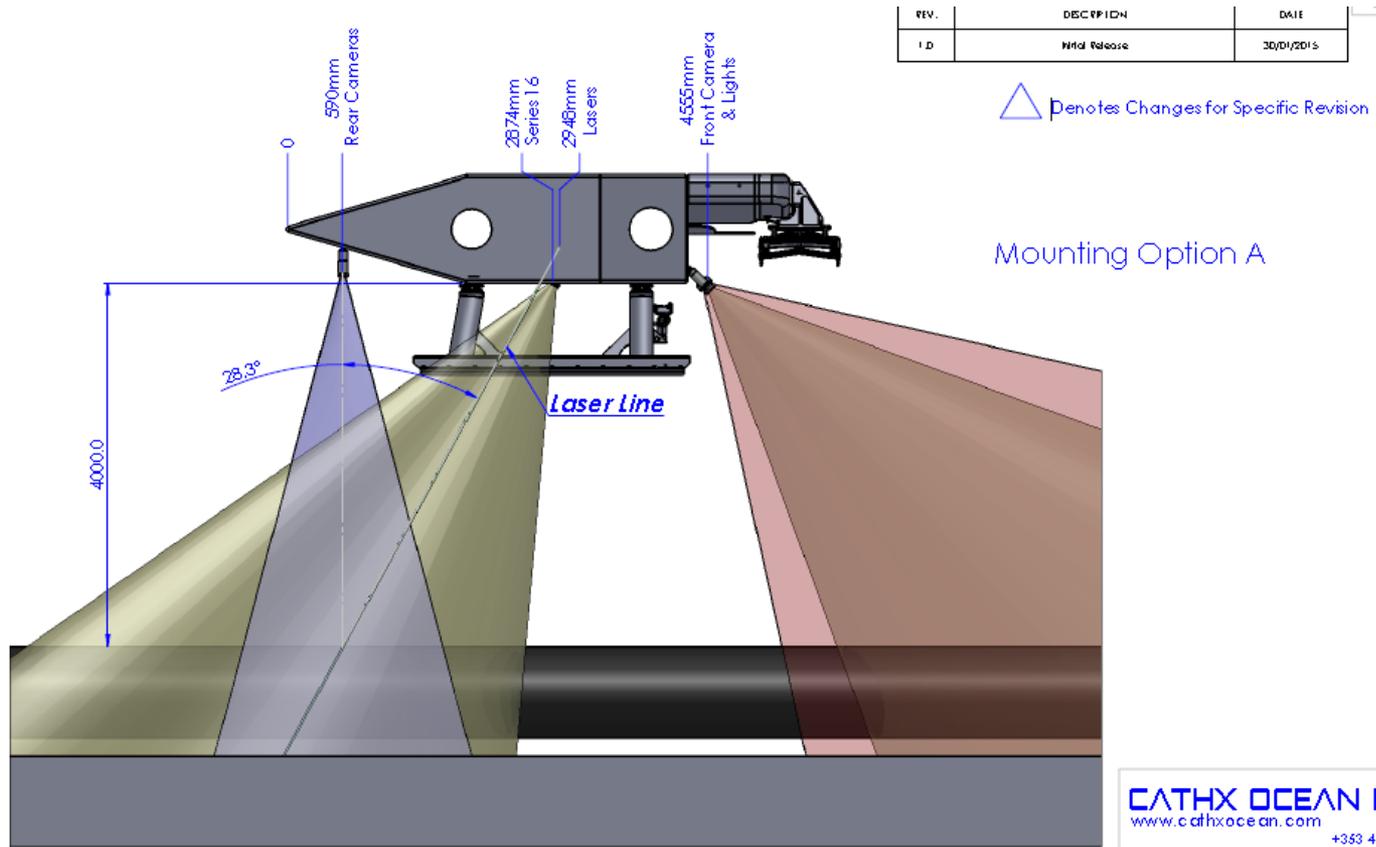
- **Site survey**
- 4 parallel lines – 15m altitude – pipeline crossing
- Average speed of 2 m/s, with a max speed of 3 m/s
- Flat seabed – still very few artefacts in the MBE data. Pipeline position for the crossing pipe is matching very well between the different lines
- Sidescan data shows very good positional correlation with MBE data.





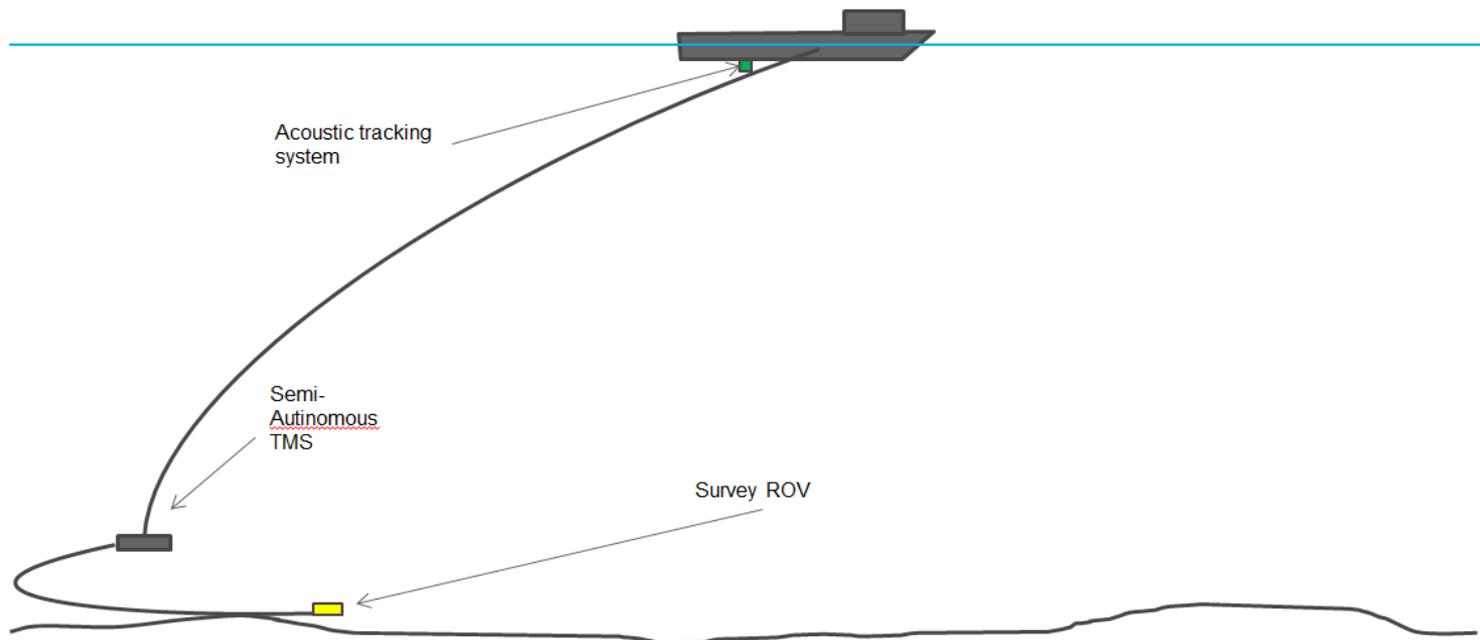
# To be done

- New launch and recovery system with running latch
- Integrating LARS & ROV inside vessel
- Integration of CATHX Ocean High definition laser profiler and stills camera system



- Semi-autonomous TMS system with hydrodynamic shape and depressor features and constant tension on tether are new additions to concept.

## Proposed high speed Survey ROV concept



- All types of surveys were performed at a significantly higher survey speed than we normally do.
- Autotrack is an absolute requirement at high speed (also during pipeline surveys).
- Calibrations, including time synch are critical, as the higher speed is much more unforgiving!
- HD video required: 1920 x 1080p x 30fps, or possibly 60fps
- In general the data quality is very good, so processing is faster, but still needs to be reported.
- The vessel is critical for being able to maintain a high speed.
- Launch and recovery more affected by weather, new systems being developed.
- One week SAT and testing – then straight on job!
- Fast ROV surveys have been done before as well, but what about the data quality and expectations?





**THINK**

**INVENT**

**SOLVE**

High ambitions – Deep knowledge

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