Machine Vision based Data Acquisition, Processing & Automation for Subsea Inspection & Detection

1st Nov 2017

SUT Presentation: The Leading Edge of Value Based Subsea Inspection

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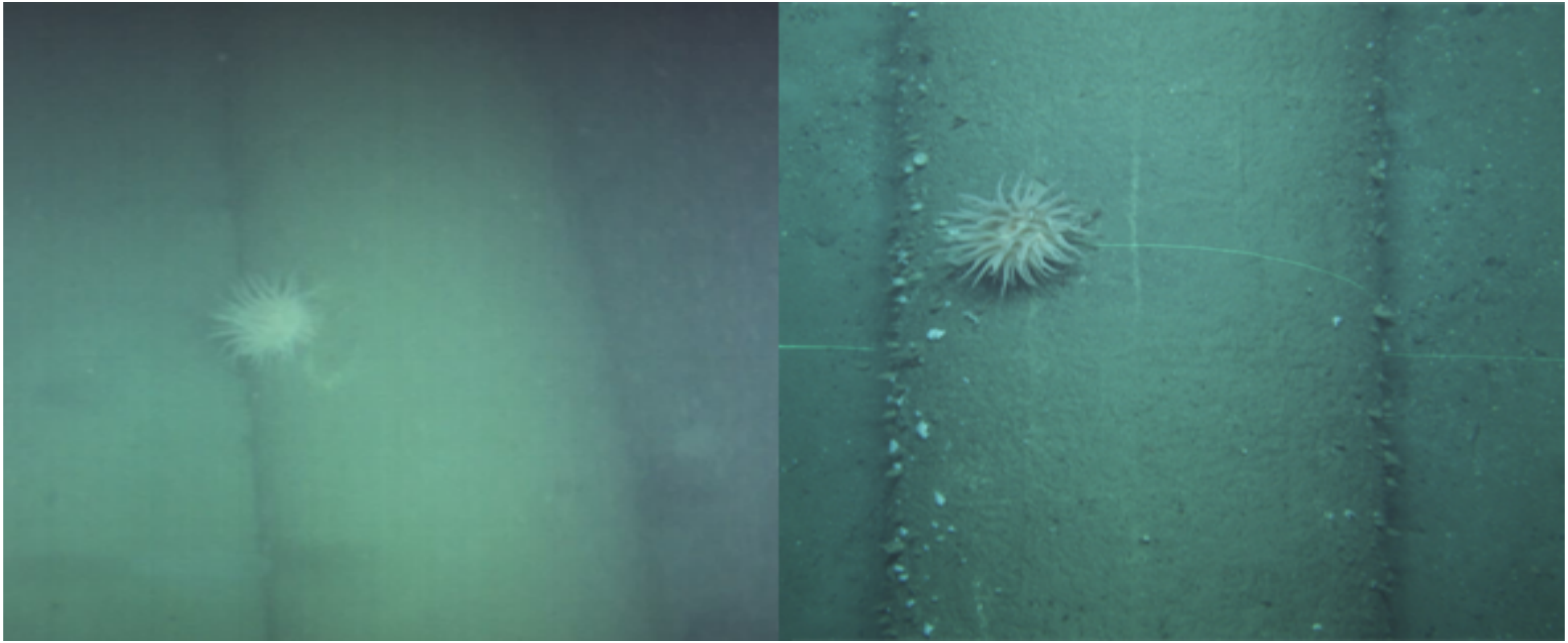
Introduction

- Cathx Ocean Founded in 2009
- To deliver subsea Machine Vision automation subsea
- What we do
  - Hardware: Image acquisition with measurement
    - "if you've gone to the trouble of going there, you may as well collect the best data you can"
  - Software : Machine Vision systems
    - "By collecting the best data you can, it is possible to automate the analysis of that data"

To deliver efficiency

- Reduce Vessel cost
  - Speed or ROV or AUV (pipeline)
  - Time to acquire data (Infield)
- Increased Autonomy
  - AUV operations
  - Shore launch AUV
  - Resident AUV
- Automation
  - Automated processing
  - Auto eventing and measurement
  - Automated vehicle operations

Data quality



ROV visual inspection

- ROV systems for pipeline -historically at 0.5 Knots
- Driver - good quality video.
- Moving at higher speed introduced problems
  - Motion Blur: Moving at speed higher than 0.5 knots
  - Range : usually < 3m
  - Area of lighting: Low power sources, long exposure times.
  - Image quality: Poor sensitivity, poorimage quality forced video rather than stills.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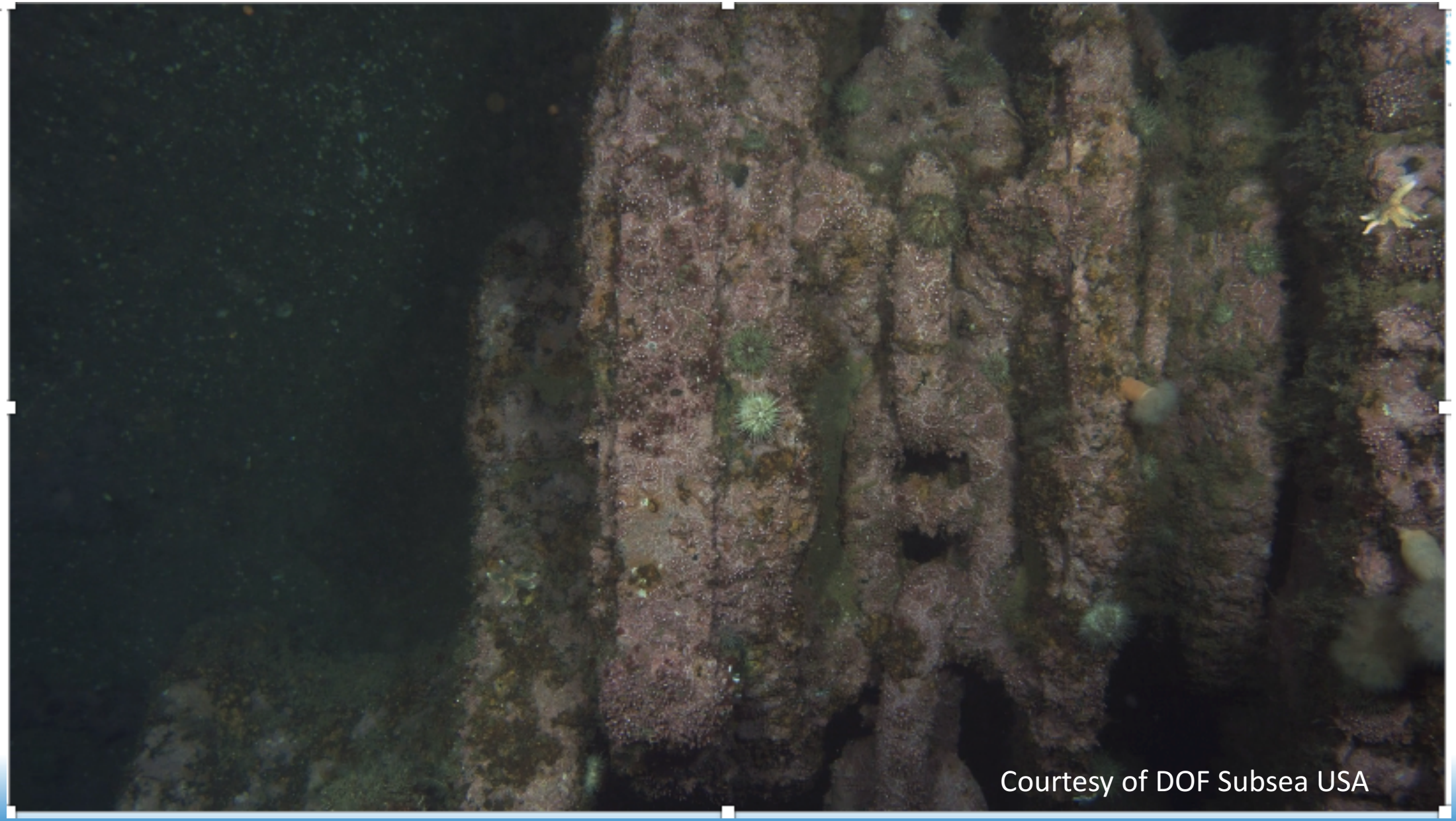
Stills (or sync'd video)



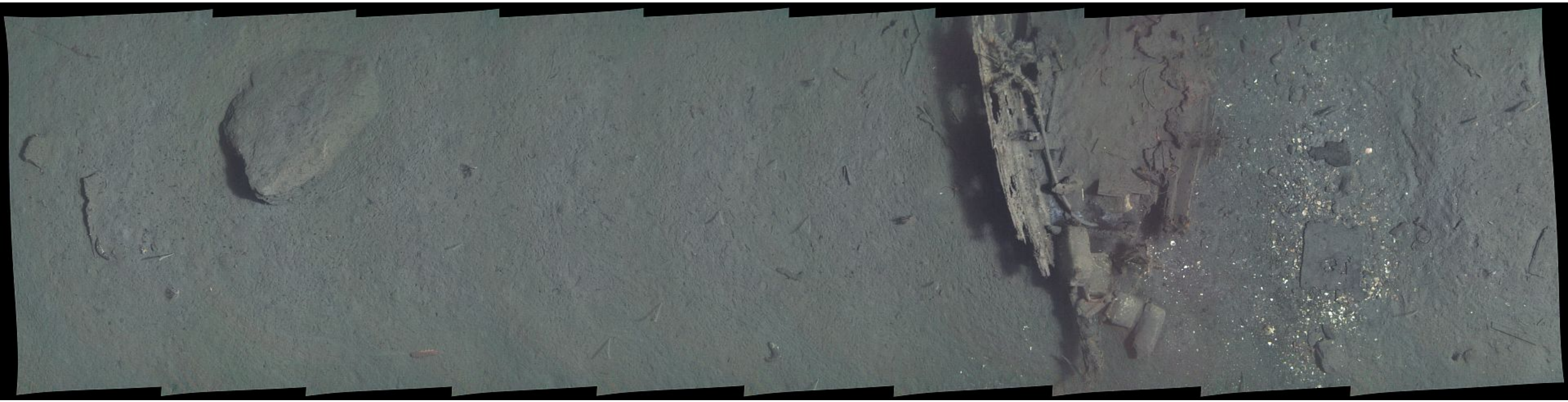
High speed pipeline survey: Image Quality

Courtesy of MMT Sweden

MMT Image Mosaic

- High Speed Stills (5 knots at 5m working distance)
  - UHD resolution stills up to 5 per second or HD stills up to 30 per second
  - Short exposure strobe lighting to allow working distance 5m and greater
  - Typically acheives 0.8mm to 1.5mm pixel resolution

AUV Mosaic



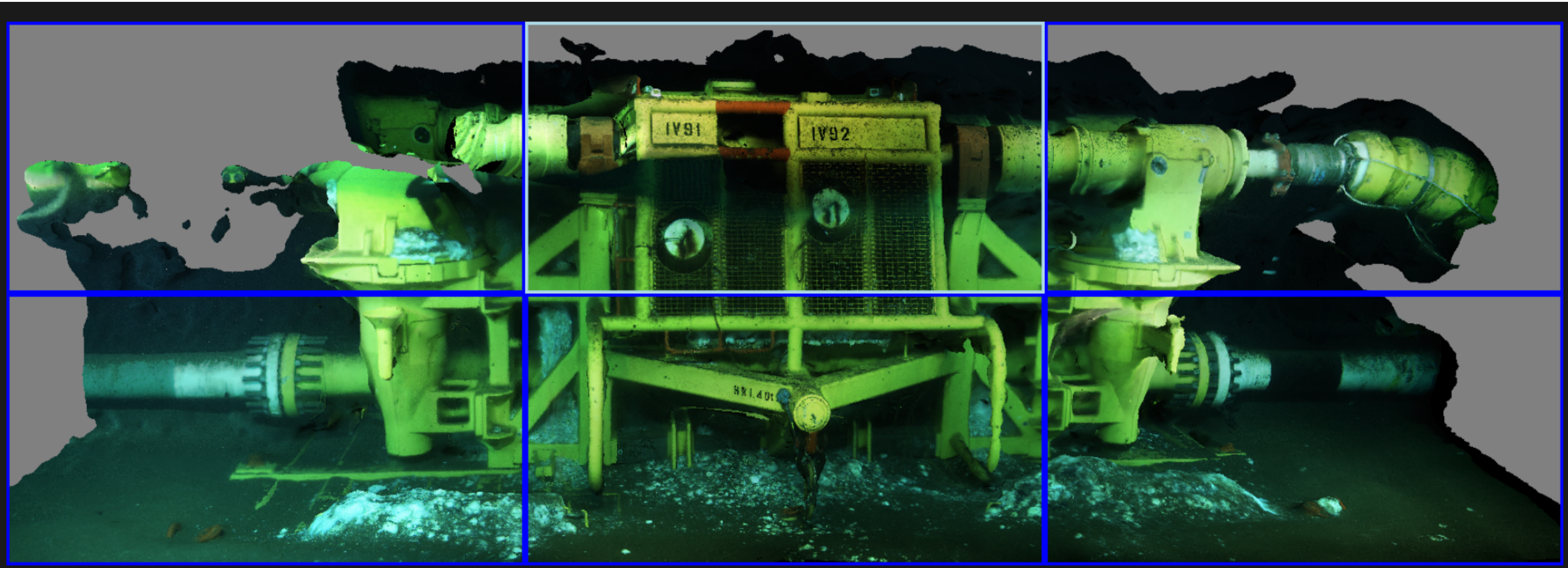
- Mosaic tool
  - Allows uniform high resolution 2D mosaics
  - With Mosaic compression off camera
  - Data volume control

High Resolution Imagery

3D Photo Models

Courtesy of Black Sea M.A.P. & MMT Sweden

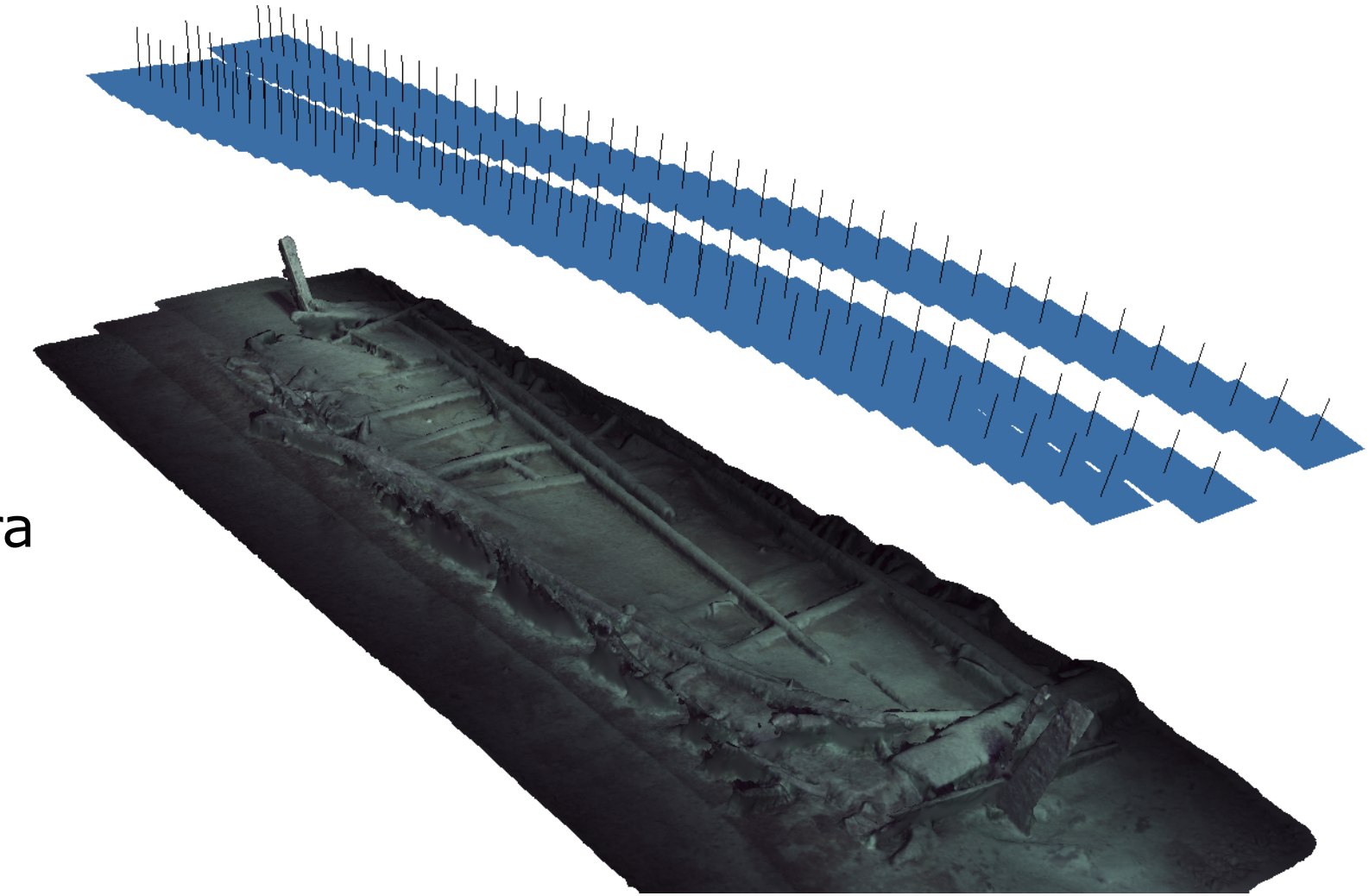
Infield Structures - Stills



Back to InlineTee

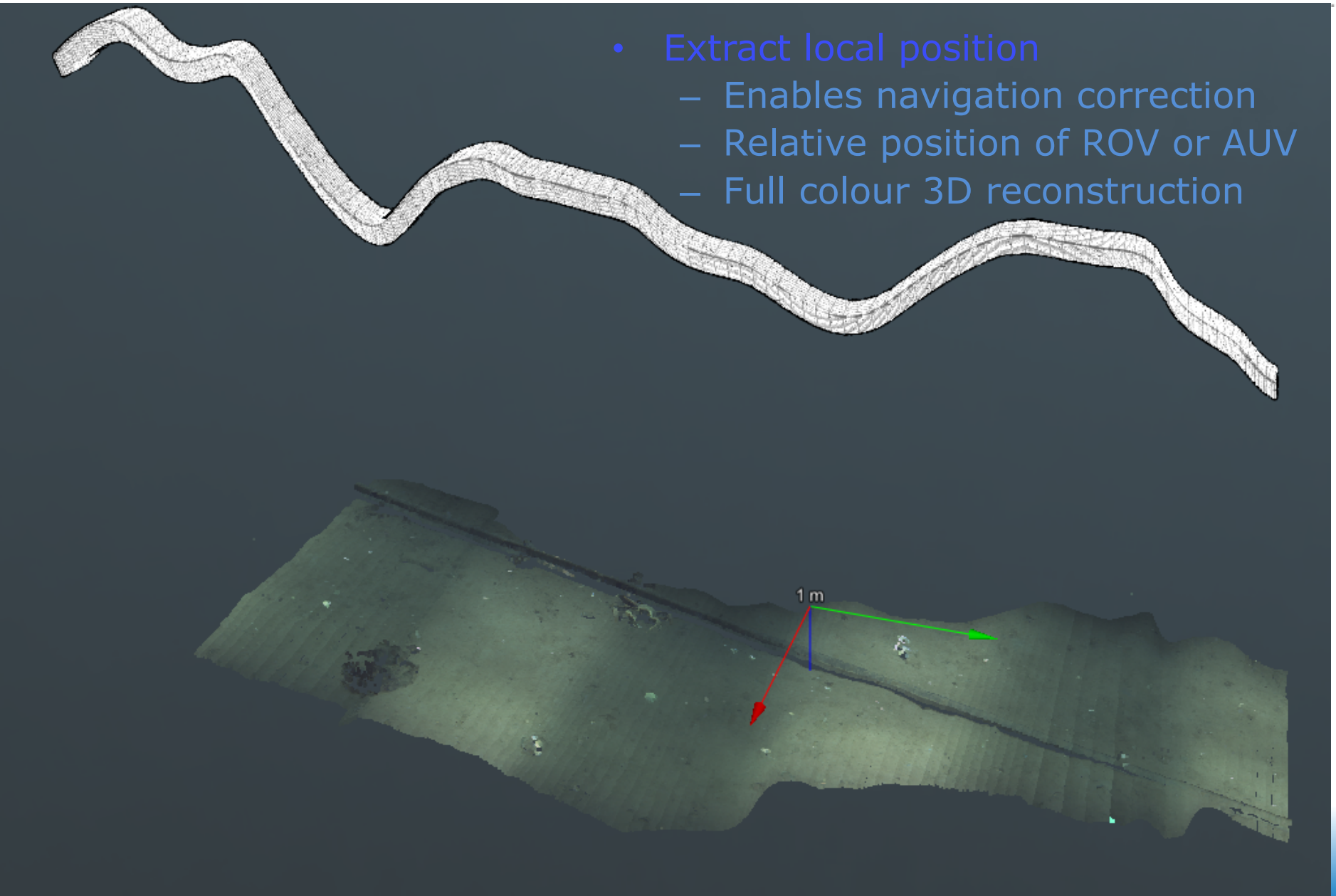
Local position from Images

- First step in Photogrammetry
  - Fast
  - Provides relative position of ROV camera



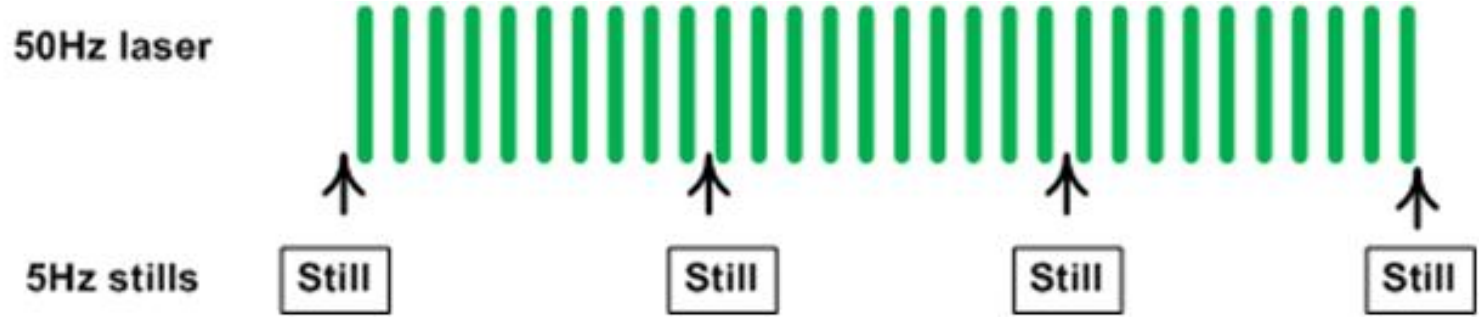
Local position from Images

- Extract local position
  - Enables navigation correction
  - Relative position of ROV or AUV
  - Full colour 3D reconstruction



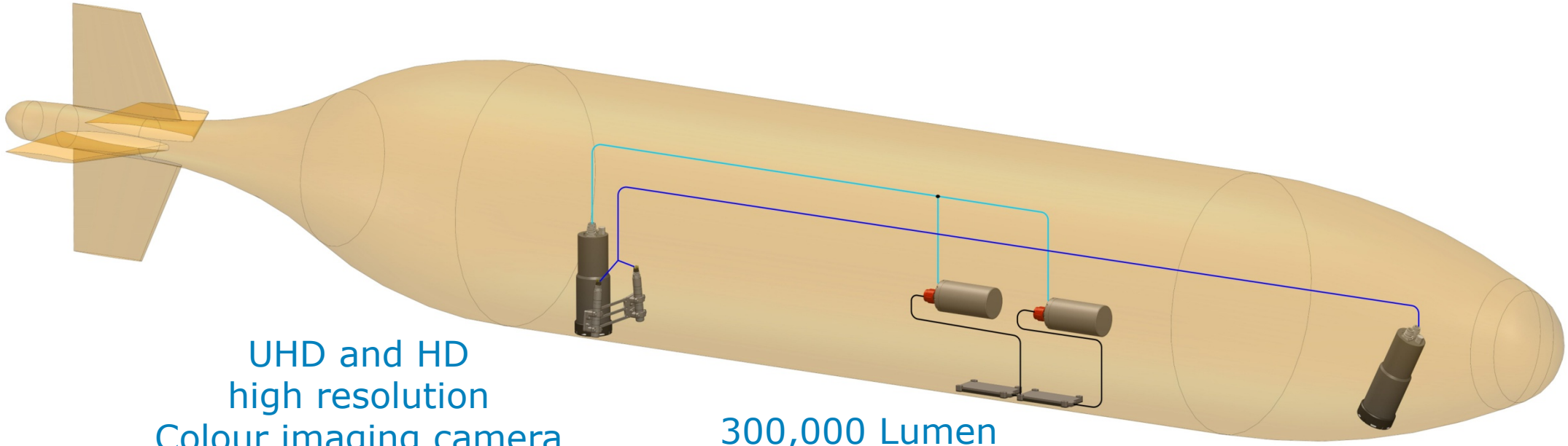
Co Registered Data – Images and laser

Multiple data at a single location



- System Architecture for AUV and ROV systems
  - Strobe Lighting and interleaved laser allows operation to 5 knots
  - Precision Time stamp on all Laser and Image data
  - Nav data and other sensor inputs stored in EXIF (through camera inputs)
  - Up to 50 laser Lines per second
  - UHD and HD images
  - Designed for full automation of data processing (coming up)

AUV Dual Mode configuration



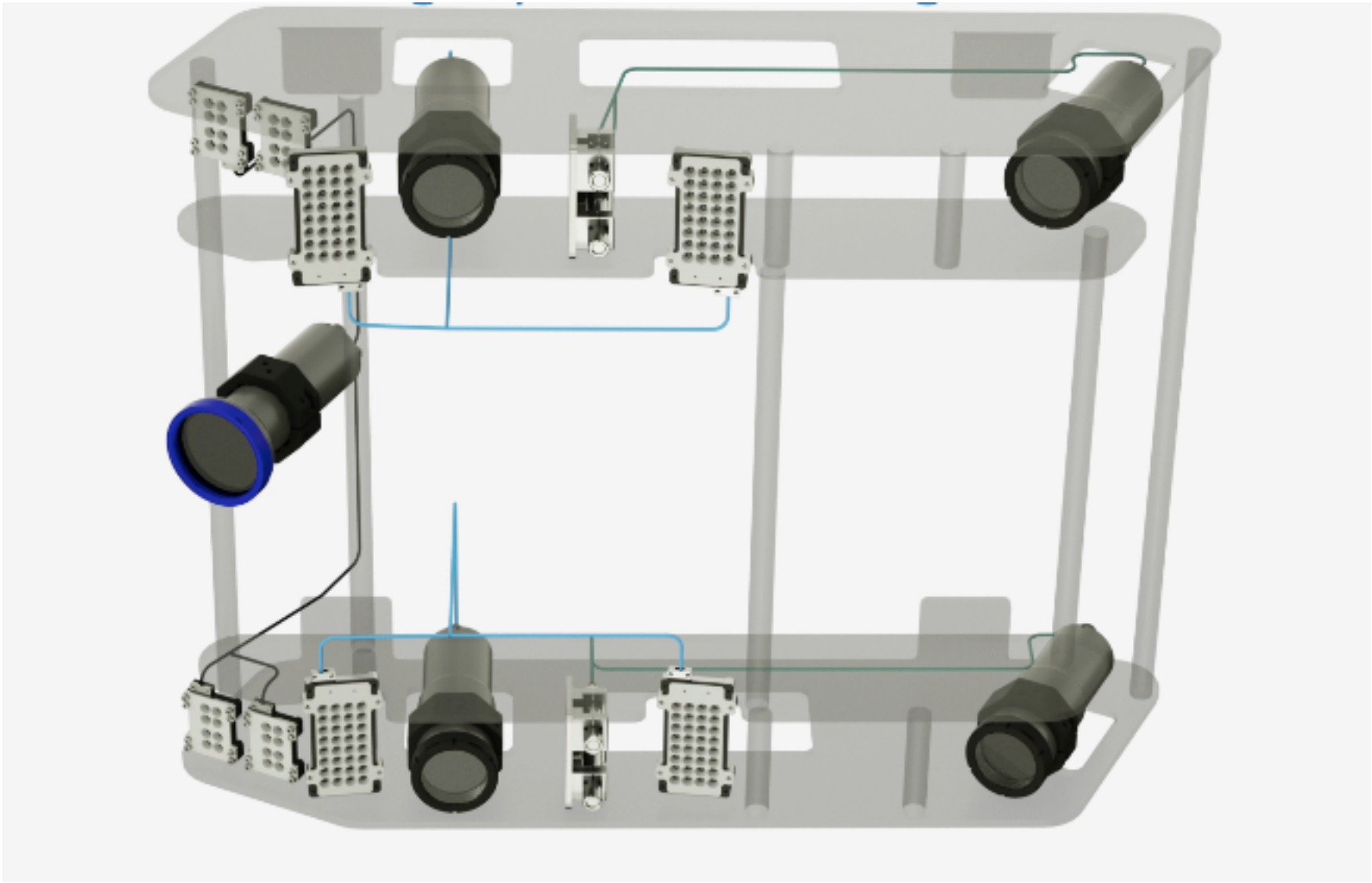
UHD and HD
high resolution
Colour imaging camera

300,000 Lumen
lighting strobes

100,000 points
per second laser point cloud

- AUV
  - UHD stills at 7 FPS or HD stills up to 30 FPS
  - 300,000 lumens of light – allows > 4 knots
  - Laser and lighting synchronised to sub ms
  - Spatially and temporally co-registered

Work Class and High speed ROV configuration (Dual swath)



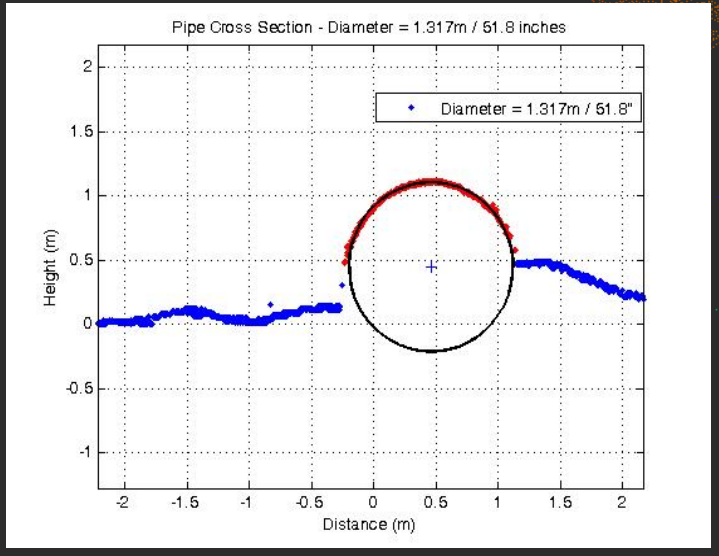
Pipeline inspection (laser)

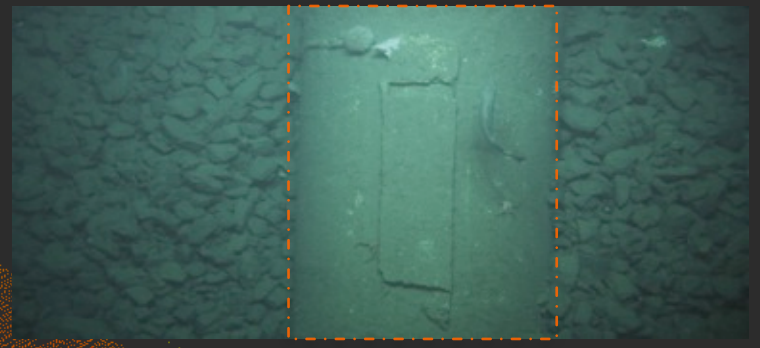
Laser Measurement

Speed: 4 knots

7.4 km/h

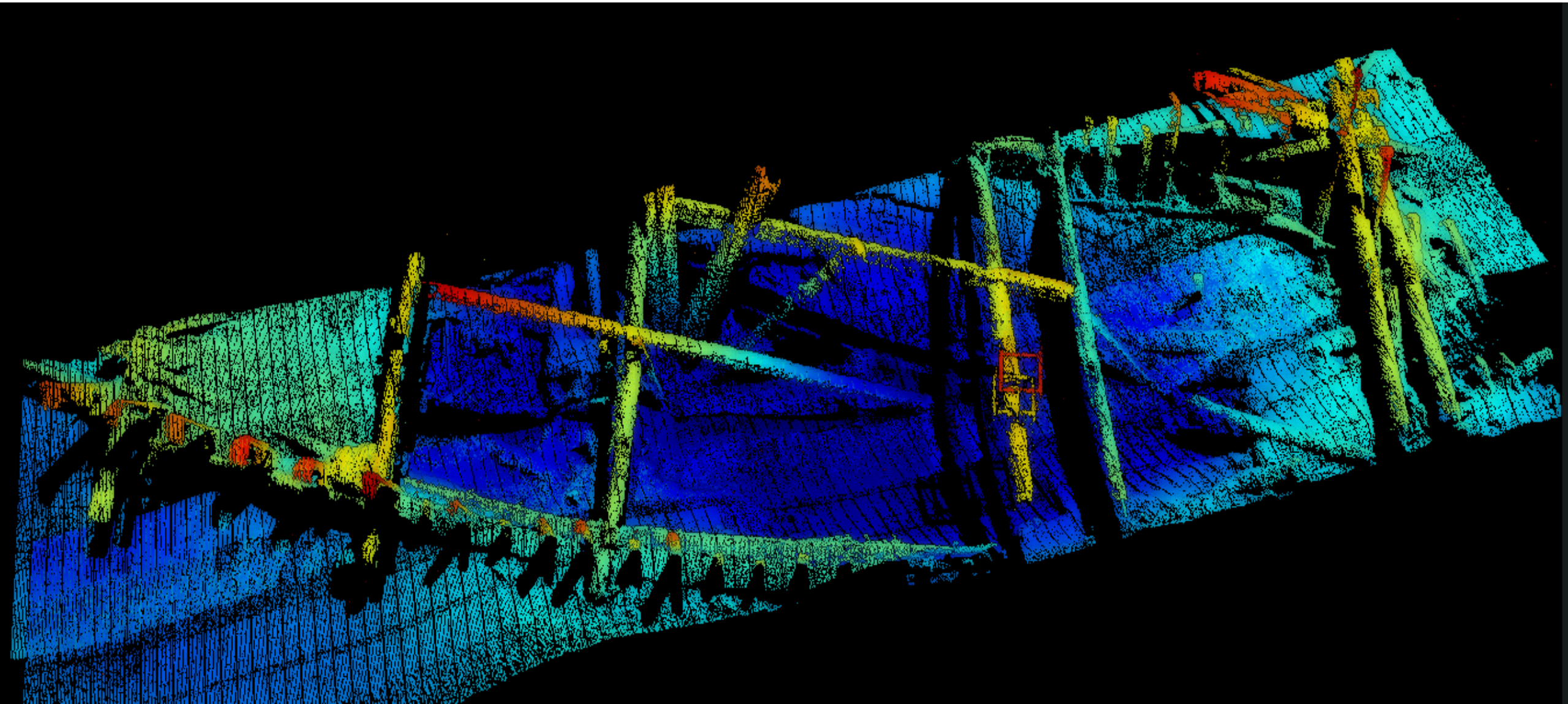
5 m altitude



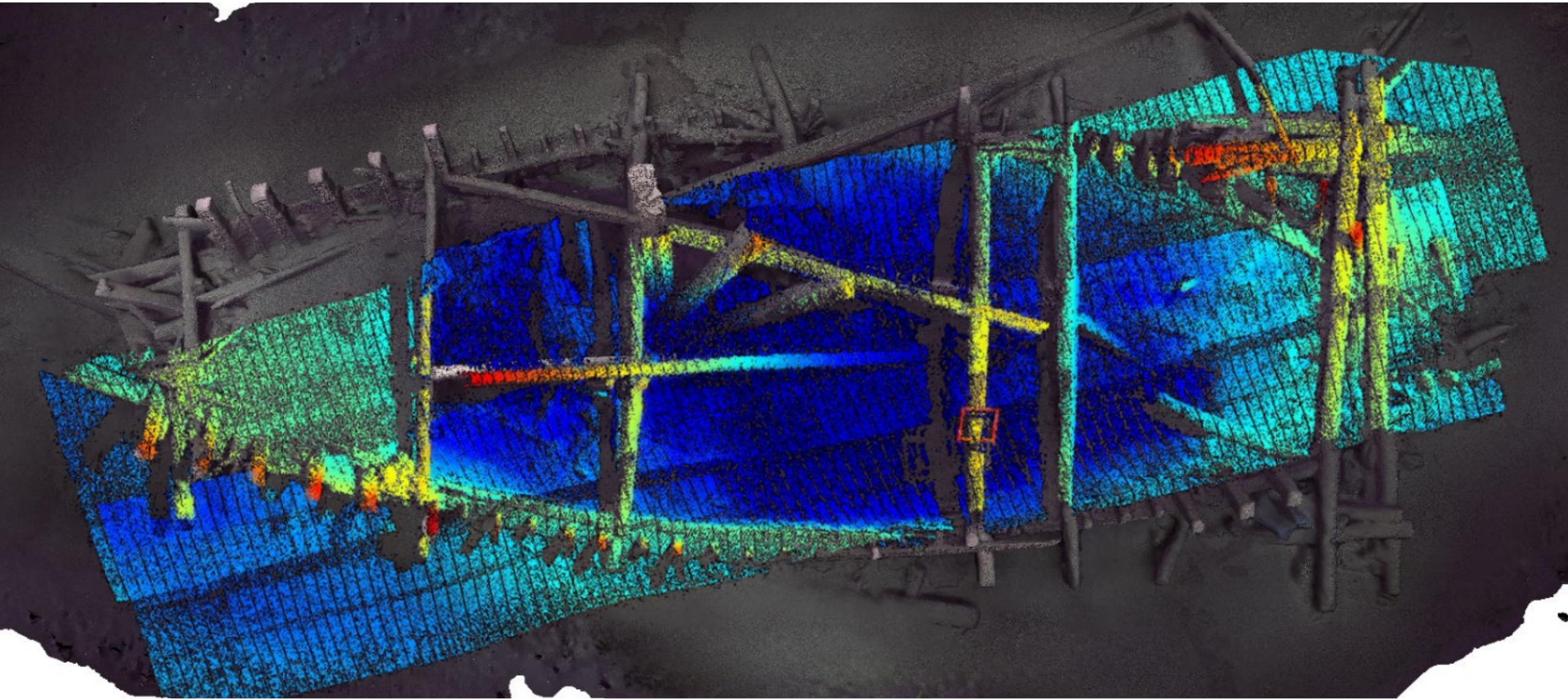


2.5

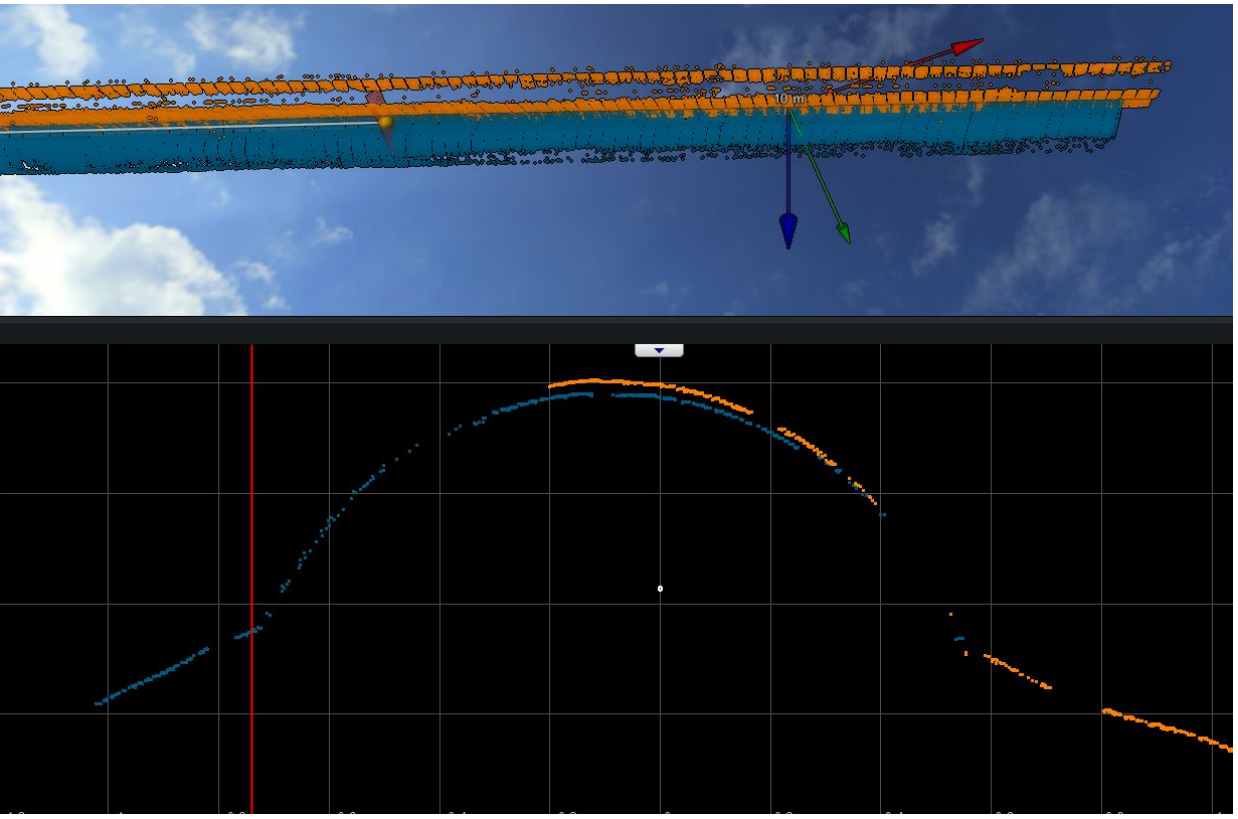
Laser 3D Models

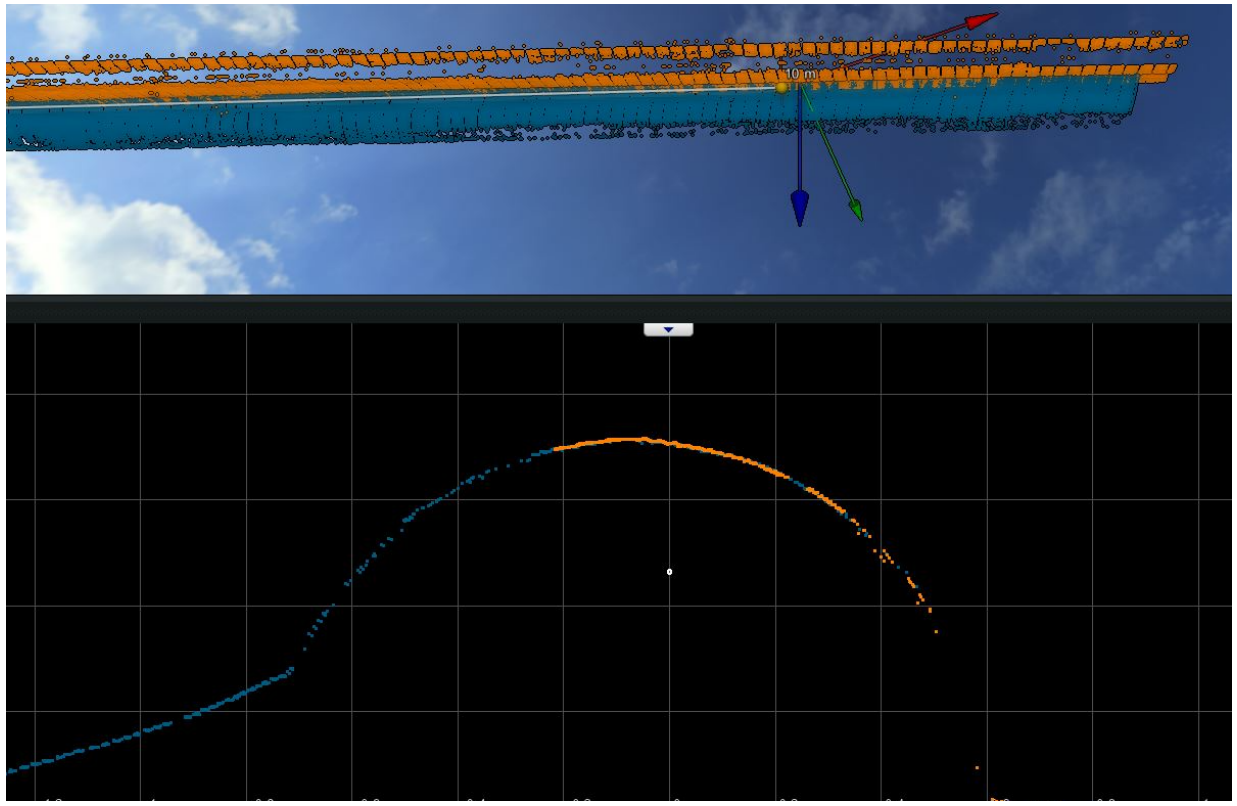


Photogrammetry with laser based measurement



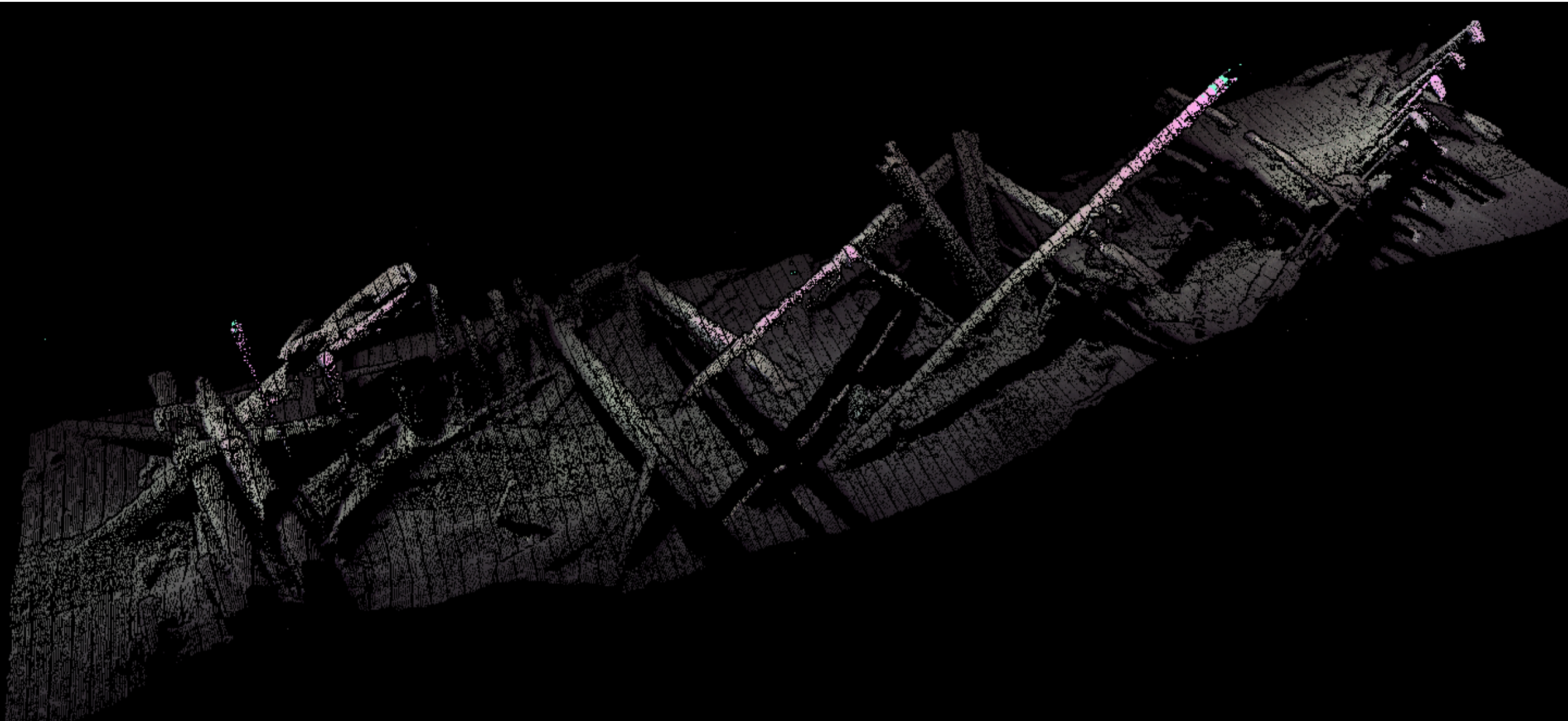
Co Registered Data – Cross calibration



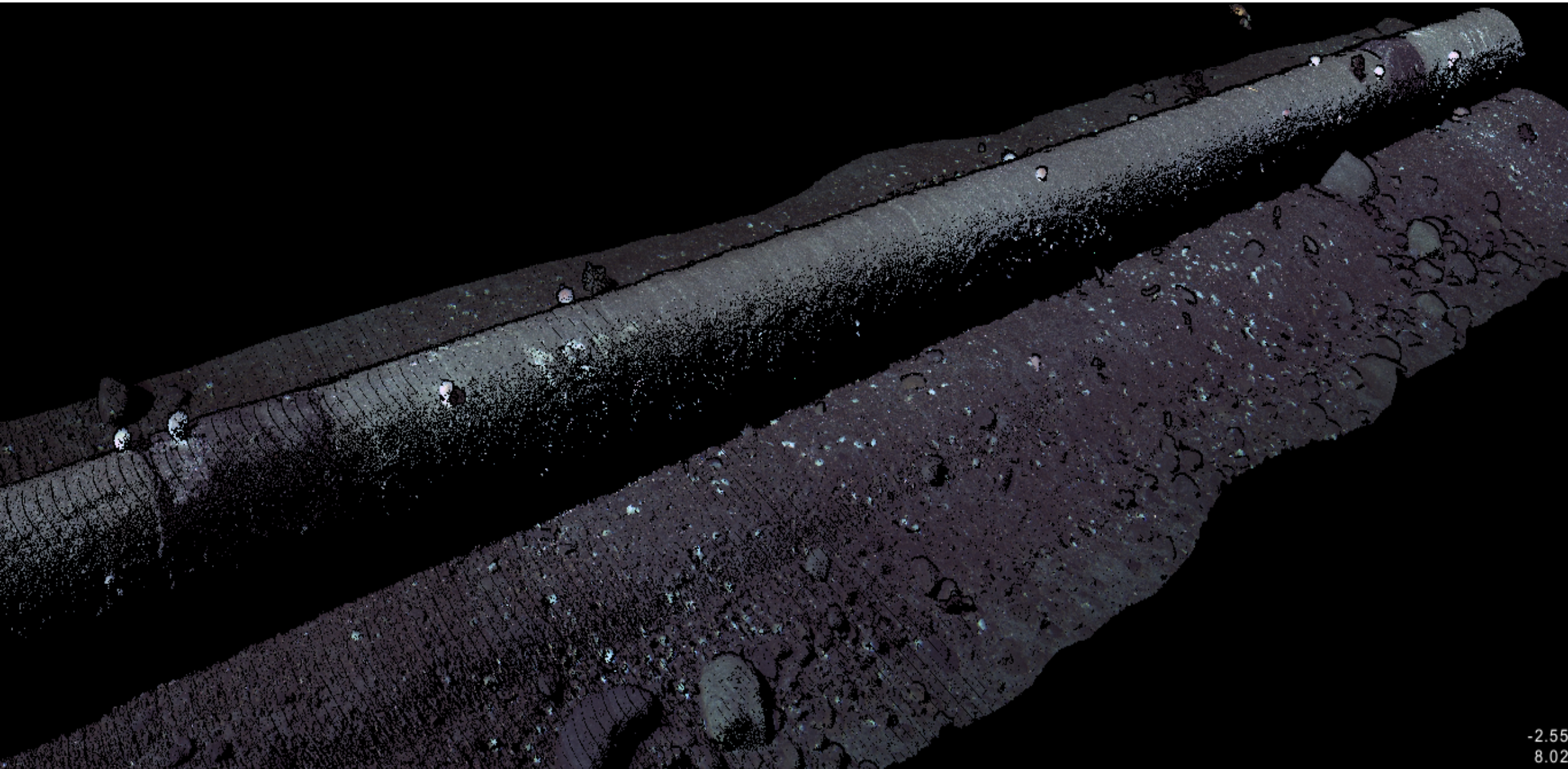


- Two cameras imaging the same scene
  - Allows post acquisition calibration for environmental factors
  - For AUV or ROV
  - Example shows port and starboard

Reconstruction of Structures without Nav

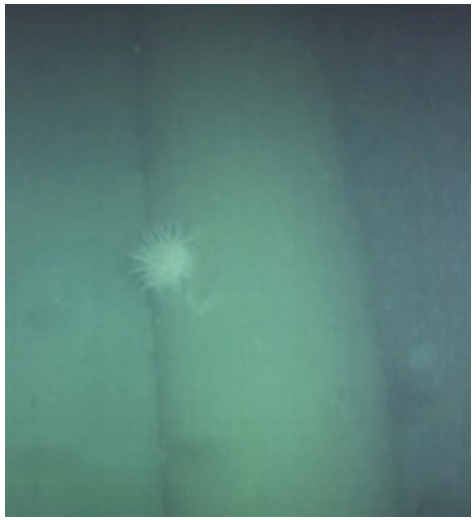


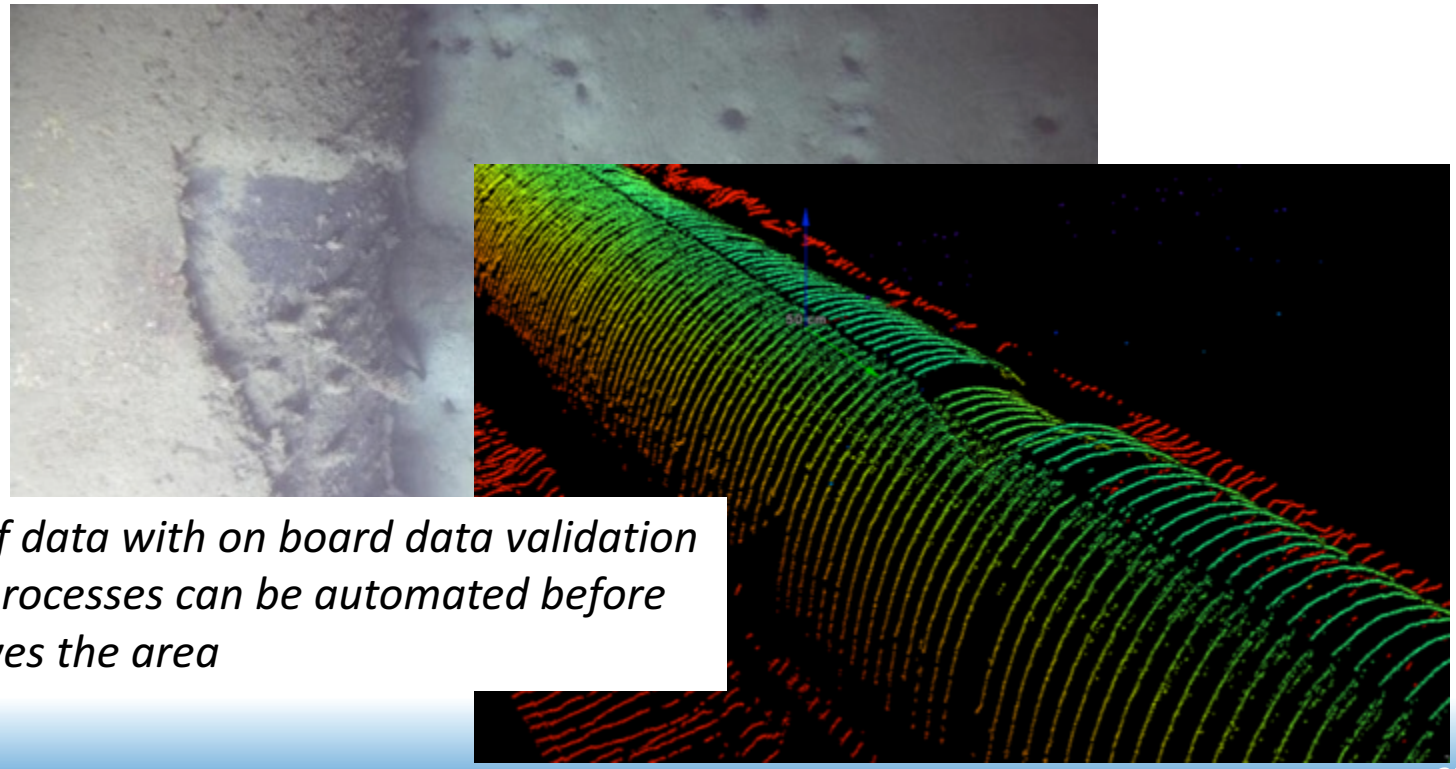
Reconstruction of pipeline sections without nav



Automation – Machine Vision (& Learning!)

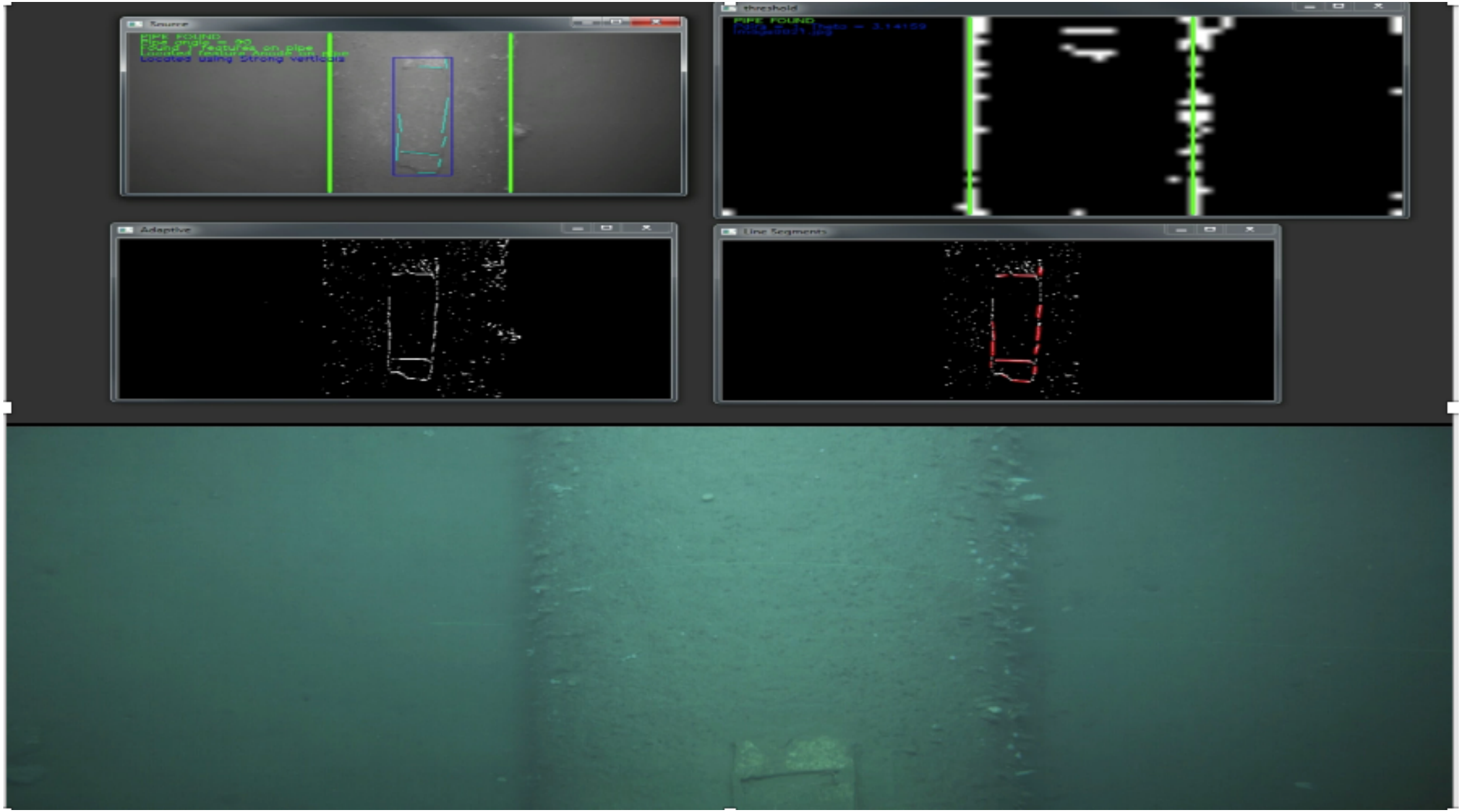
- An AUV in commercial operation can collect 300GB of data per day
- Dual source data acquisition is the basis for robust automation
  - Automation must be reliable and trusted
  - To achieve 100% automation requires real time data integrity checks
  - This requires 3D laser data Plus co-registered image data





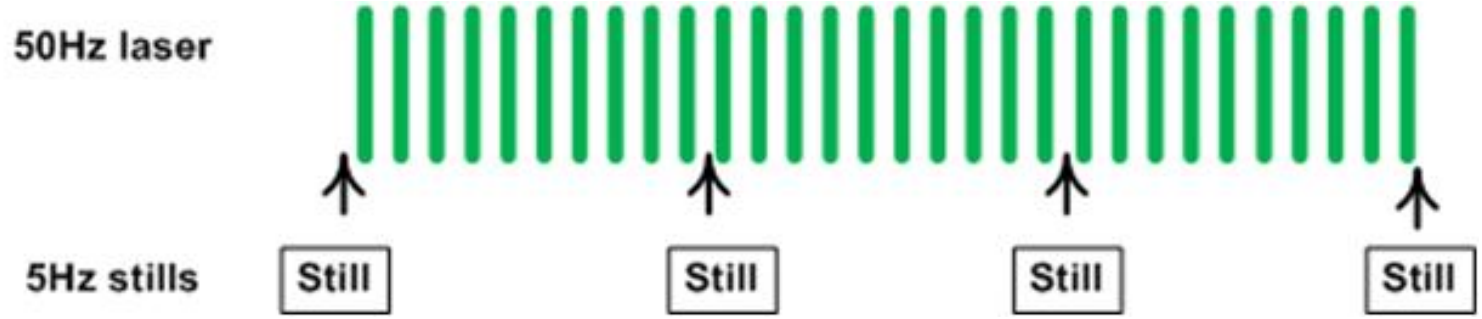
Two sources of data with on board data validation ensures post processes can be automated before the vessel leaves the area

Image Based Machine Vision



Dual mode: Laser and images

Co-registered Image and Laser data



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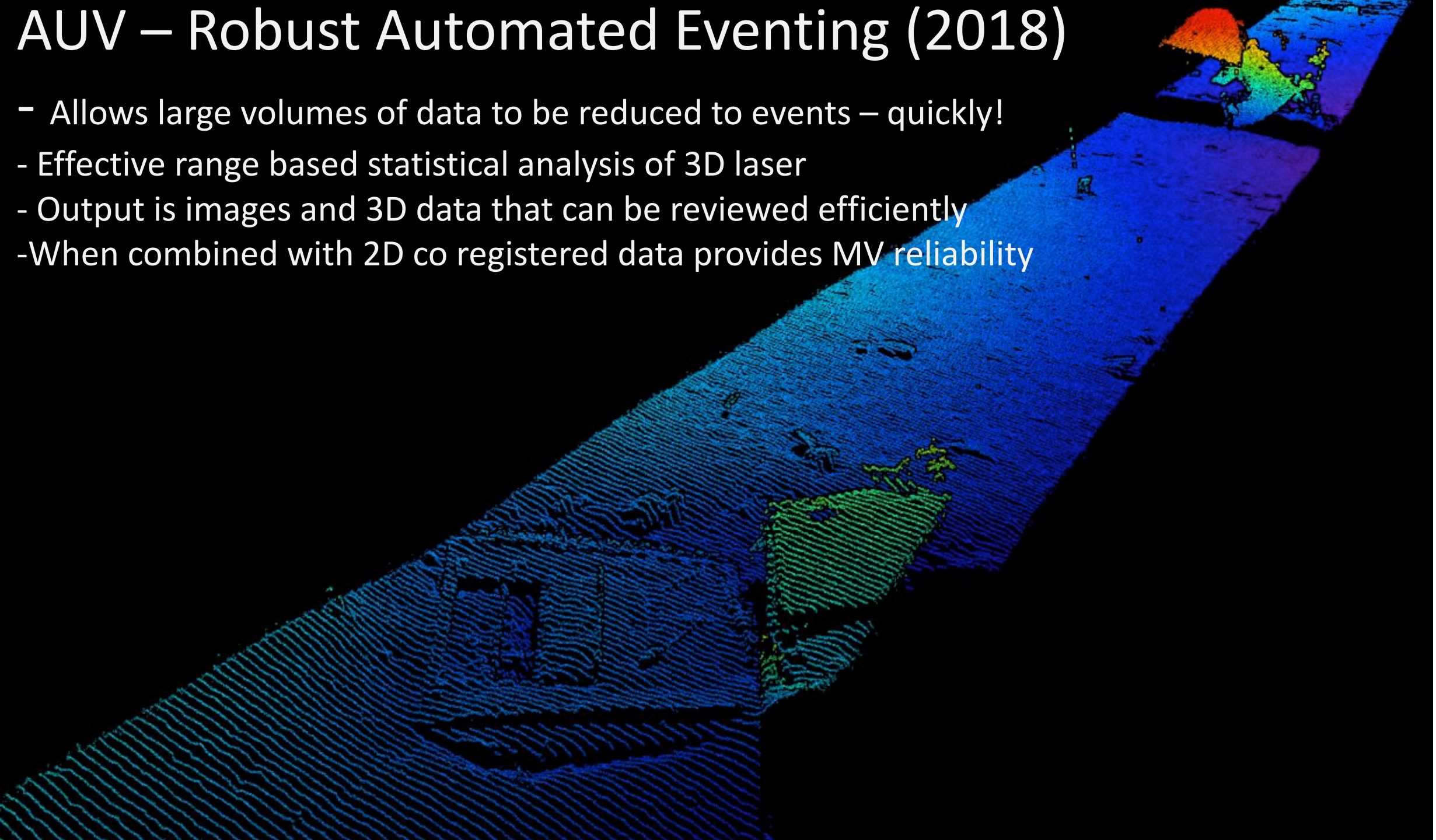
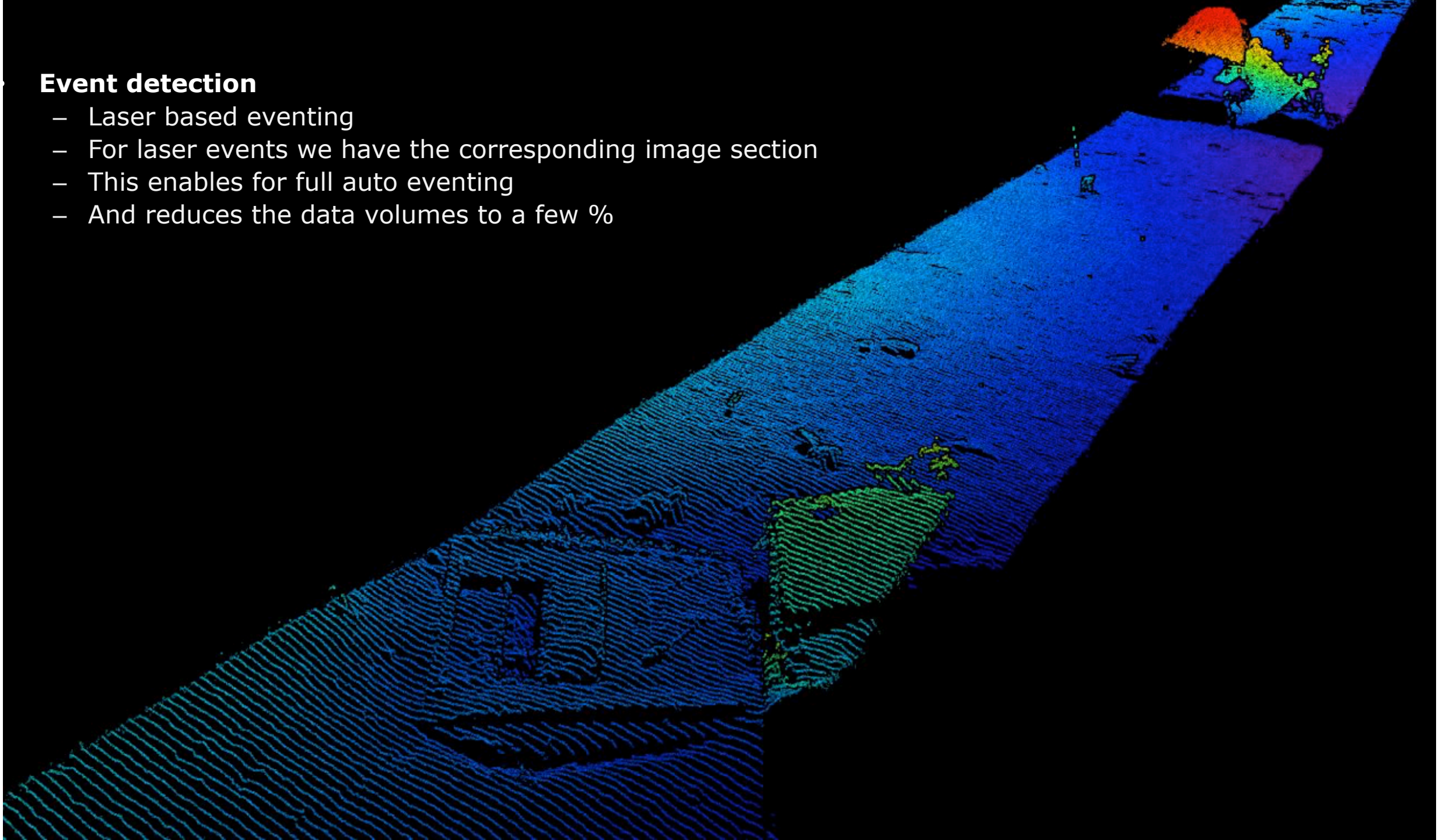
AUV – Robust Automated Eventing (2018)

- Allows large volumes of data to be reduced to events – quickly!
- Effective range based statistical analysis of 3D laser
- Output is images and 3D data that can be reviewed efficiently
-When combined with 2D co registered data provides MV reliability

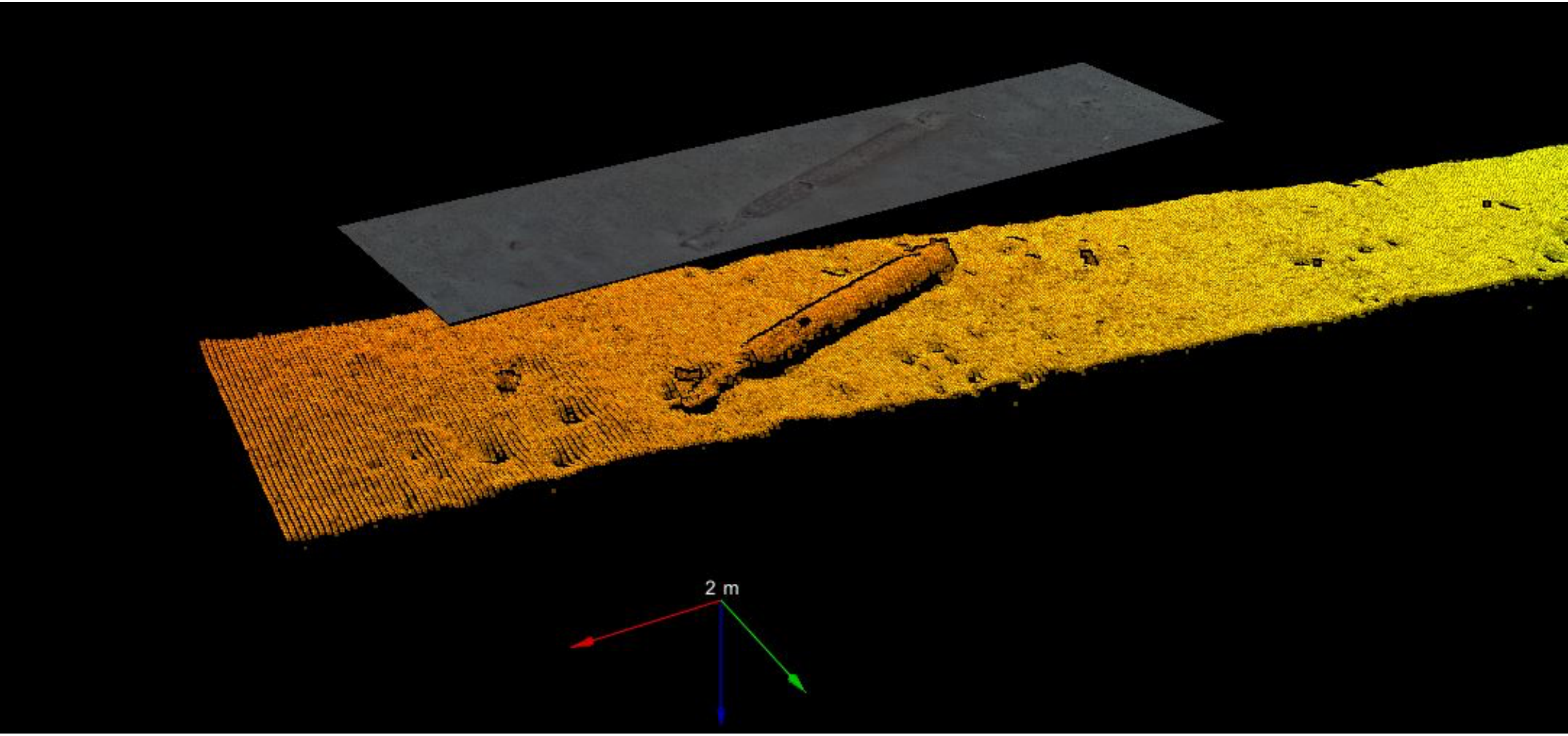


Event detection

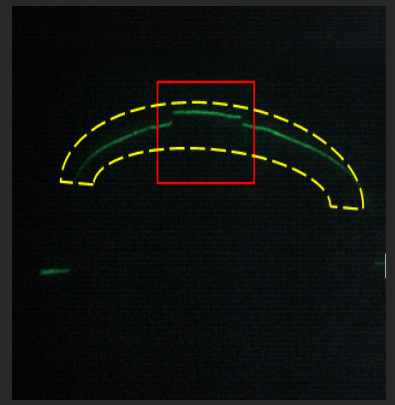
- Laser based eventing
- For laser events we have the corresponding image section
- This enables for full auto eventing
- And reduces the data volumes to a few %

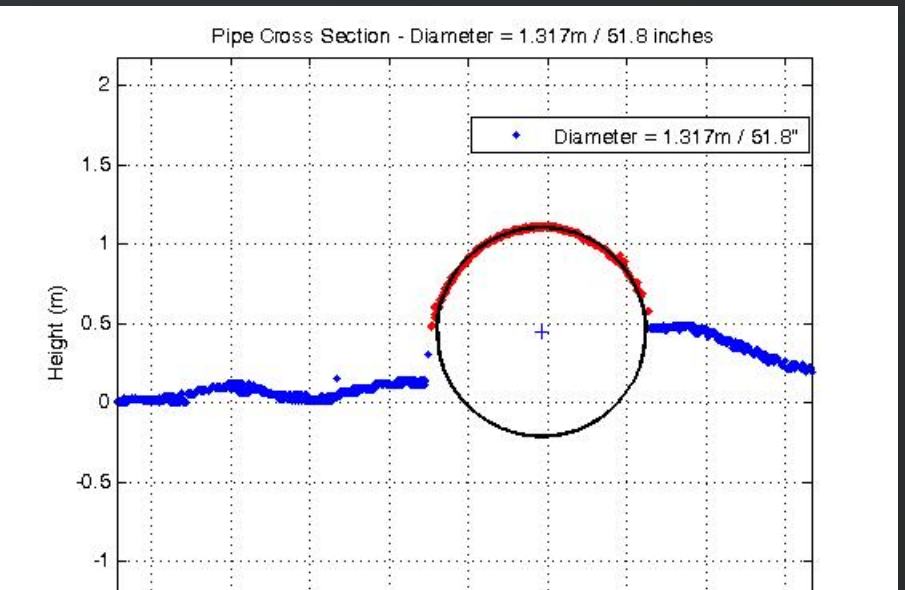


Spatial registration of laser and images

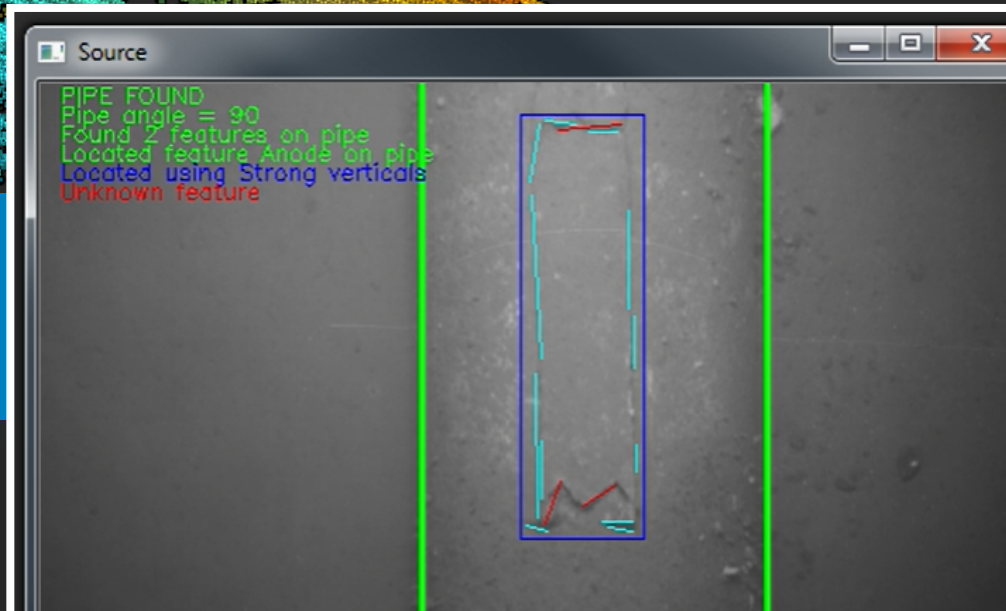


- 3D machine vision
  - Cross sectional geometric analysis
  - Freespans and Circularity
  - Testing OOS Q1 2018

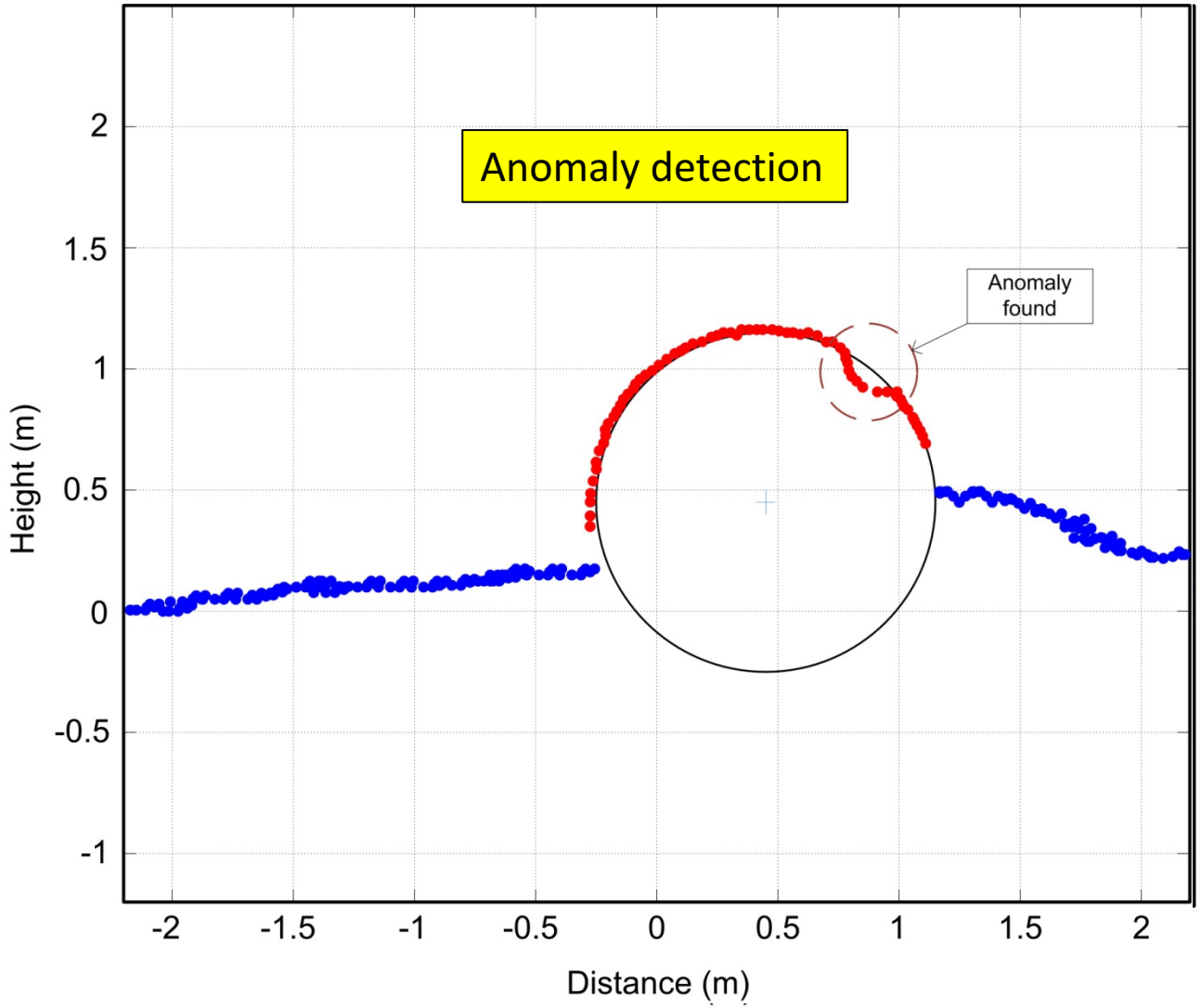




Pipeline Cross Section



3D Measurement Tools (2018)



Thank You!

For more information please contact :

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