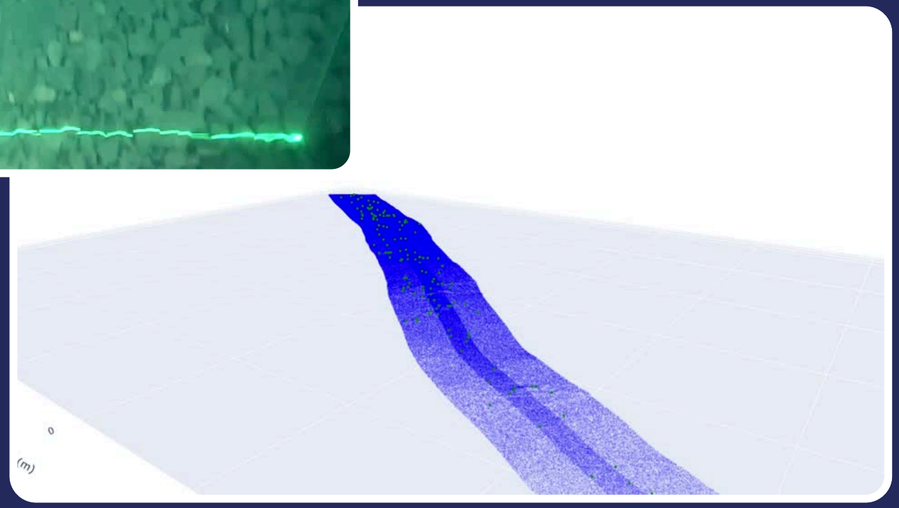
Subsea Operations Conference

Everything within Reach

Future Subsea Robotics



Sustainable access to ocean space.
Haugesund, August 2026

George Jones

The Vision

2030 targets

Advancing towards highly autonomous operations by 2030.

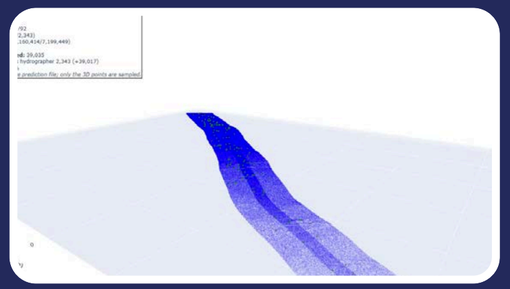
Enabled by Reach Remote & intelligent ROV.

Contents

Four proof of concept projects

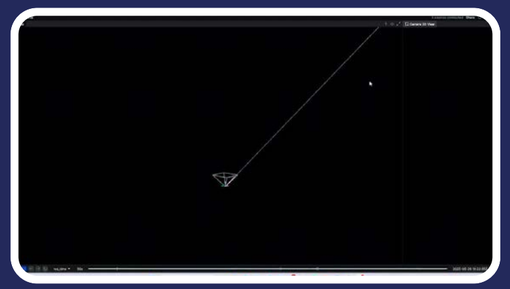
Asset Tracking

Automated Cleaning

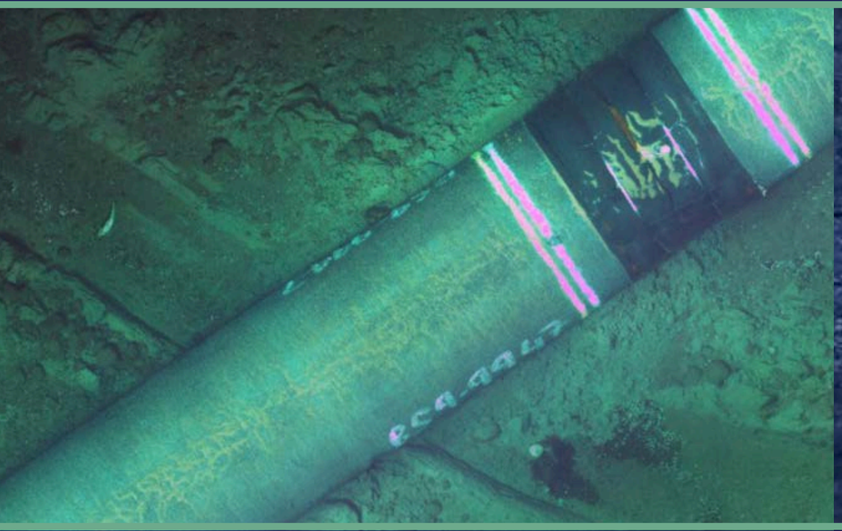


AI Supervision

Intelligent ROV



Pipeline Tracking



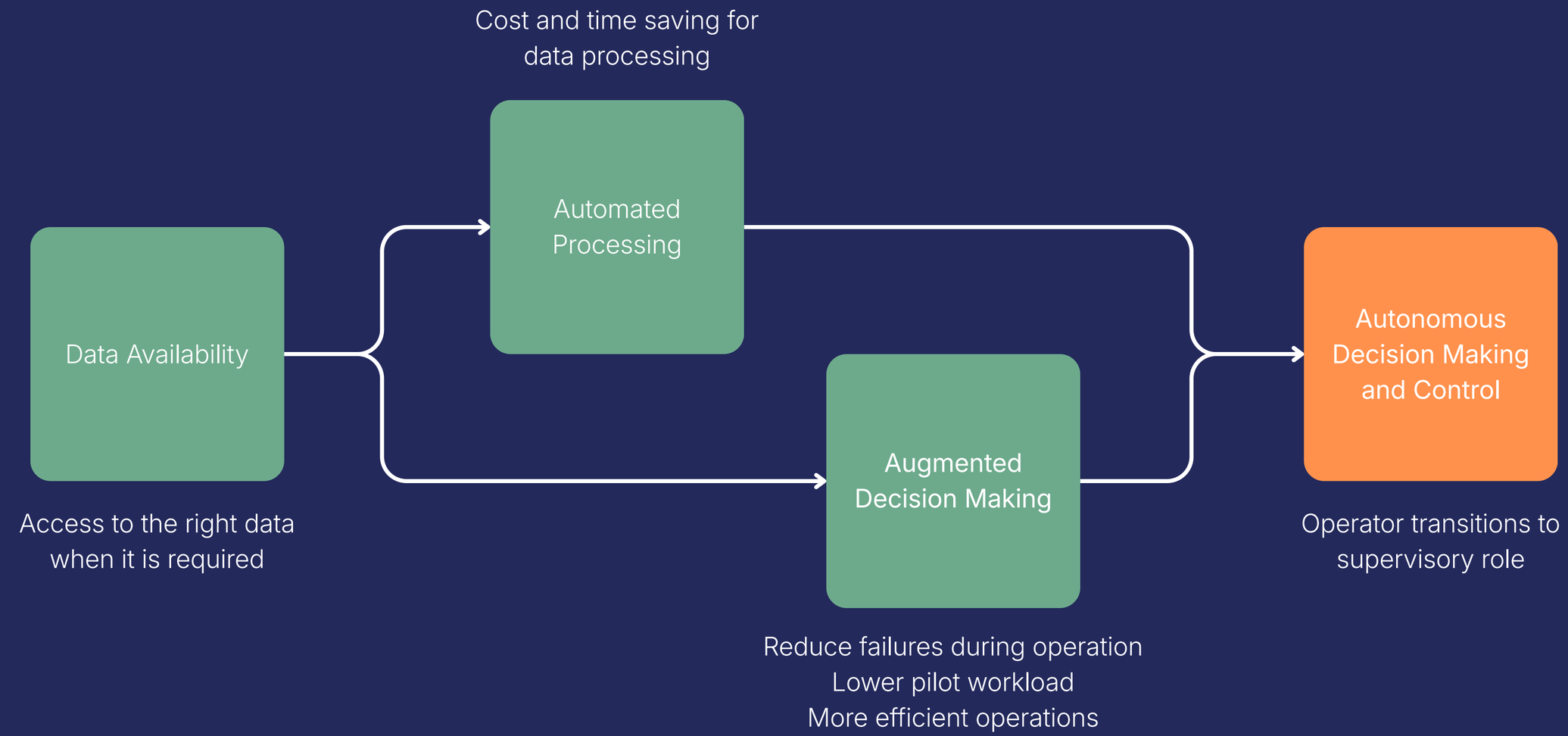
Aims & Objectives

- Track pipelines during surveys to:
  - Provide a safety failover for current autonomous operation.
  - A multi-modal approach to increasing probability of maintaining track of the pipeline.

- Augmenting the pilot view to make pipeline tracking easier, and more robust.

Roadmap to 2030 Autonomous Operations

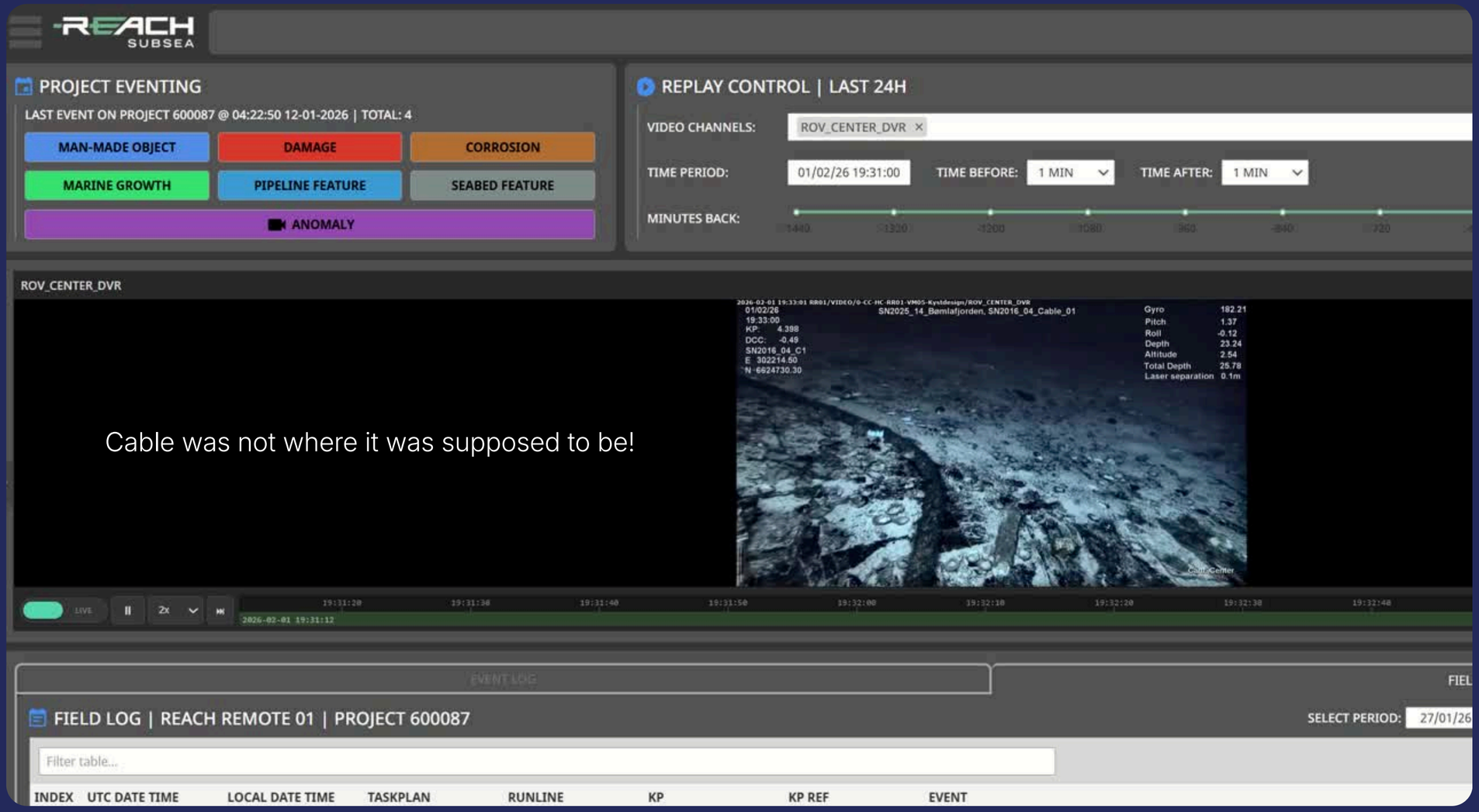
From data to actions



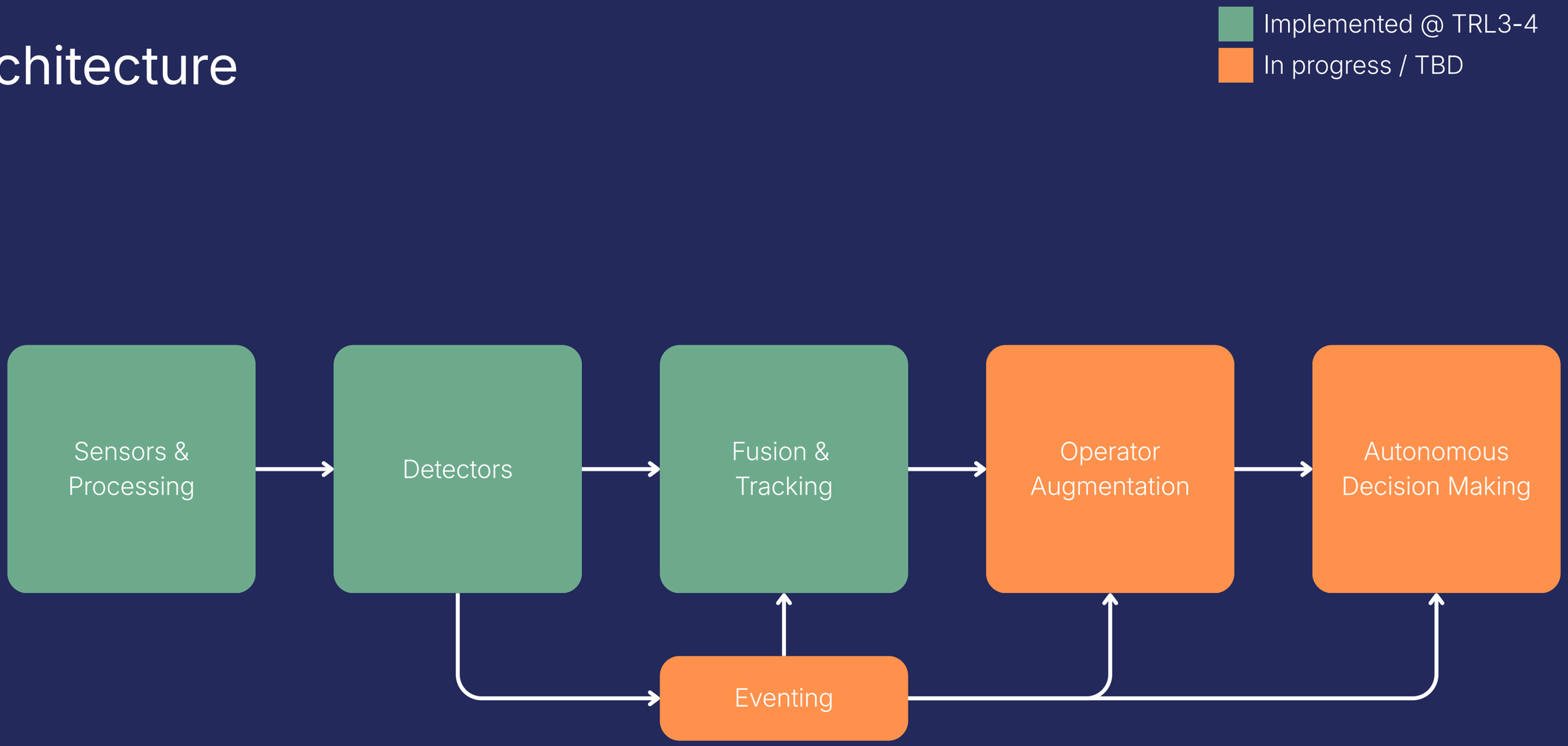
Pipe Video

Center Camera

The Challenge



Architecture



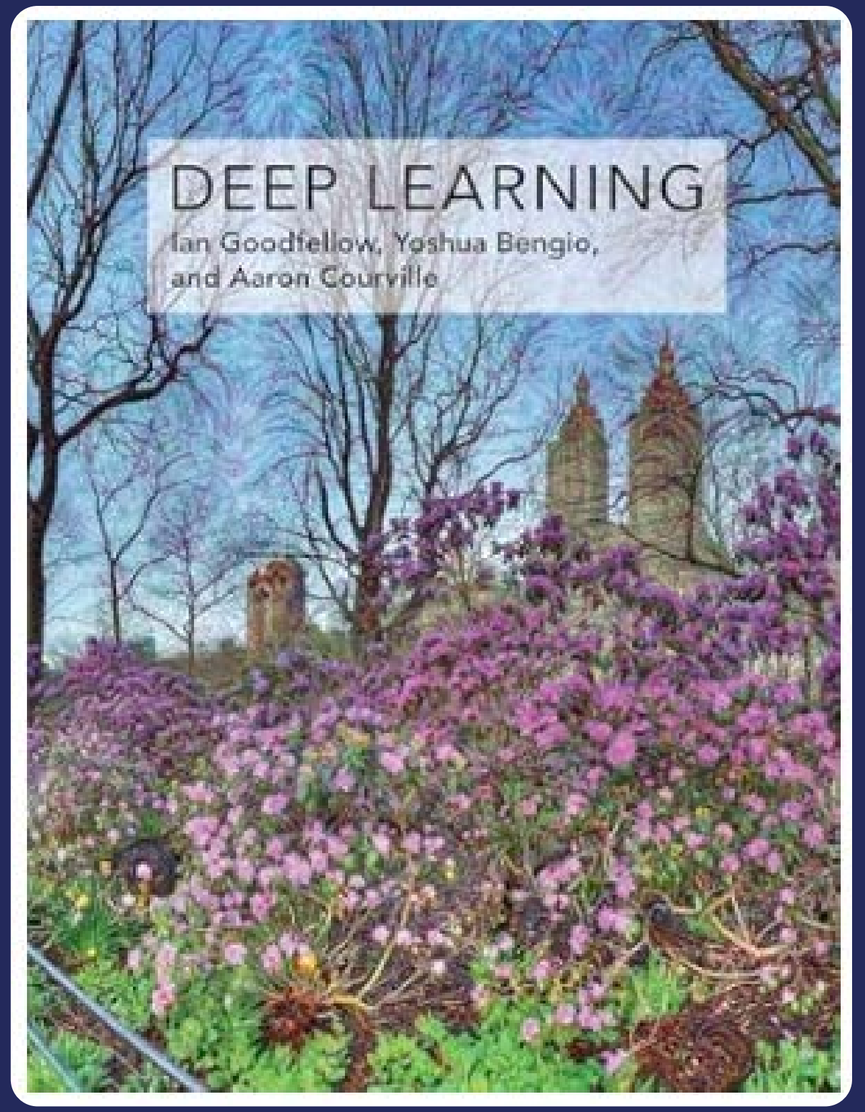
Laser Profiler

Laser Profiler

But there are two main challenges:

1. Requires a reference laser.
2. Rocks *(or other non-planar objects)* can cause detections.

But what about...



But what about Deep Learning

- First we utilised open source datasets
  - MarinaPipe
  - SubPipeMini

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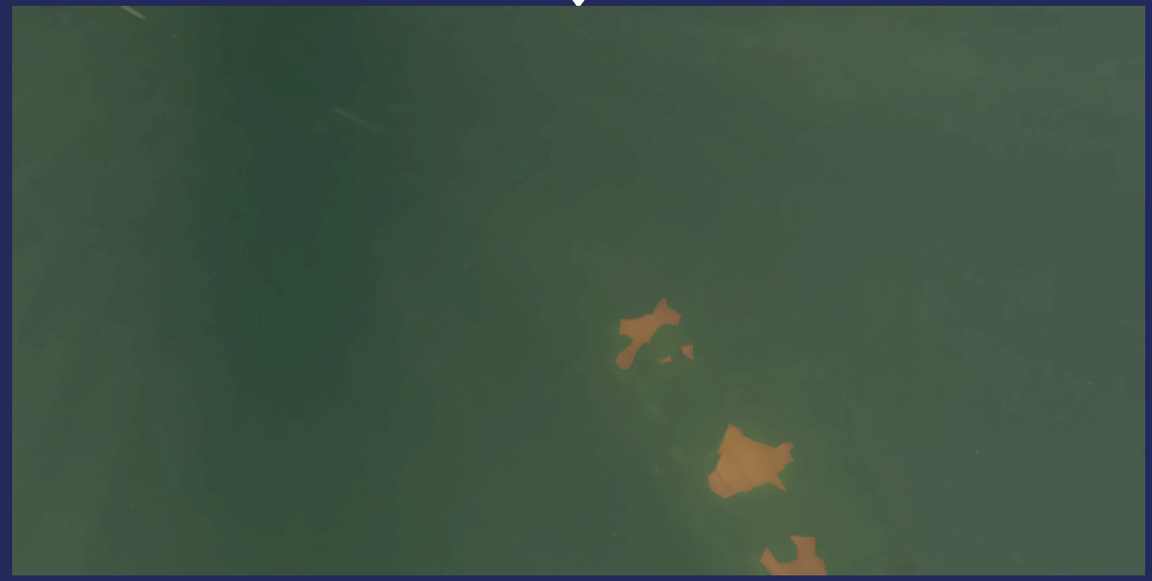
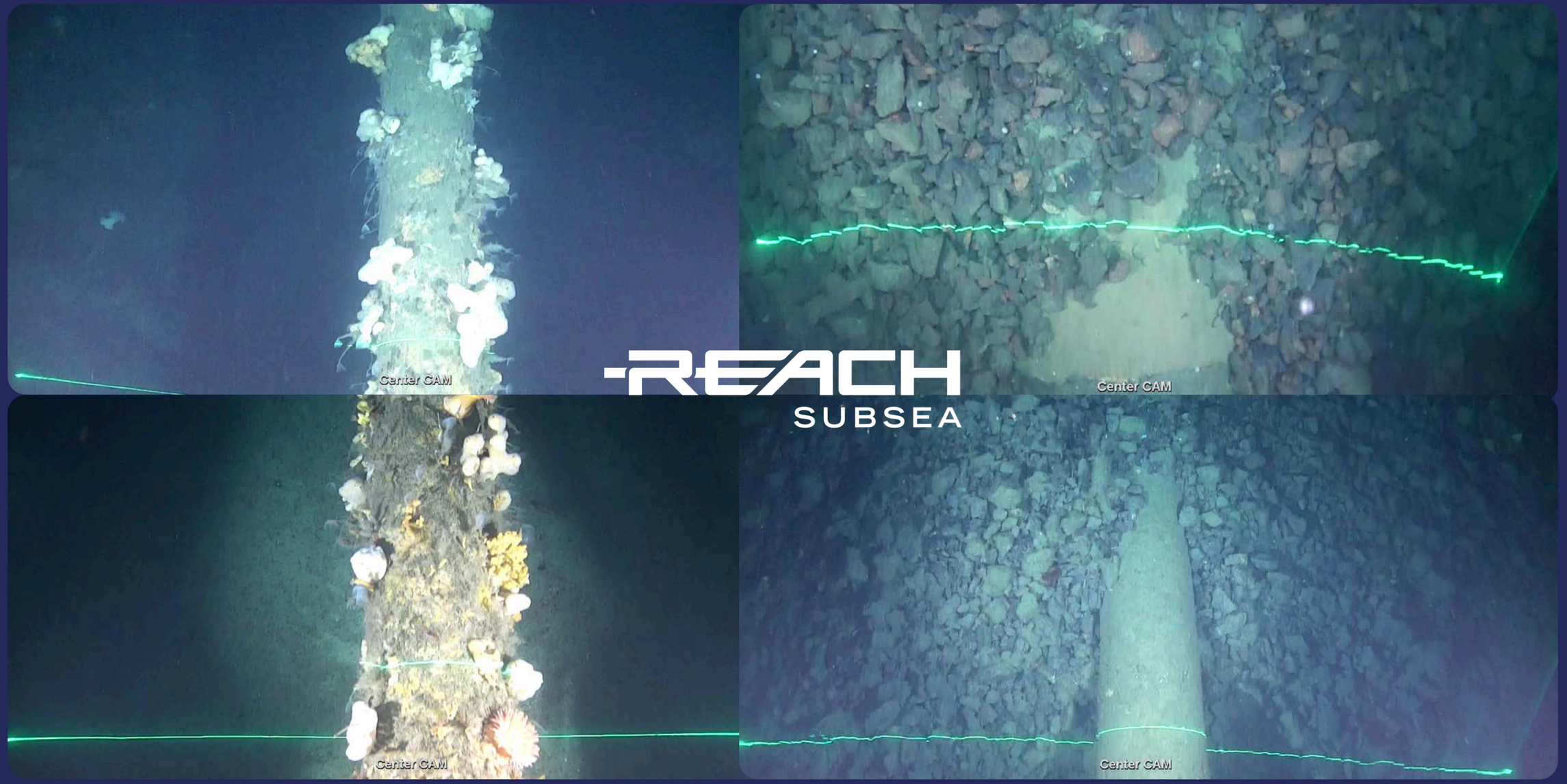


But what about Deep Learning

- First we utilised open source datasets:
  - MarinaPipe
  - SubPipeMini

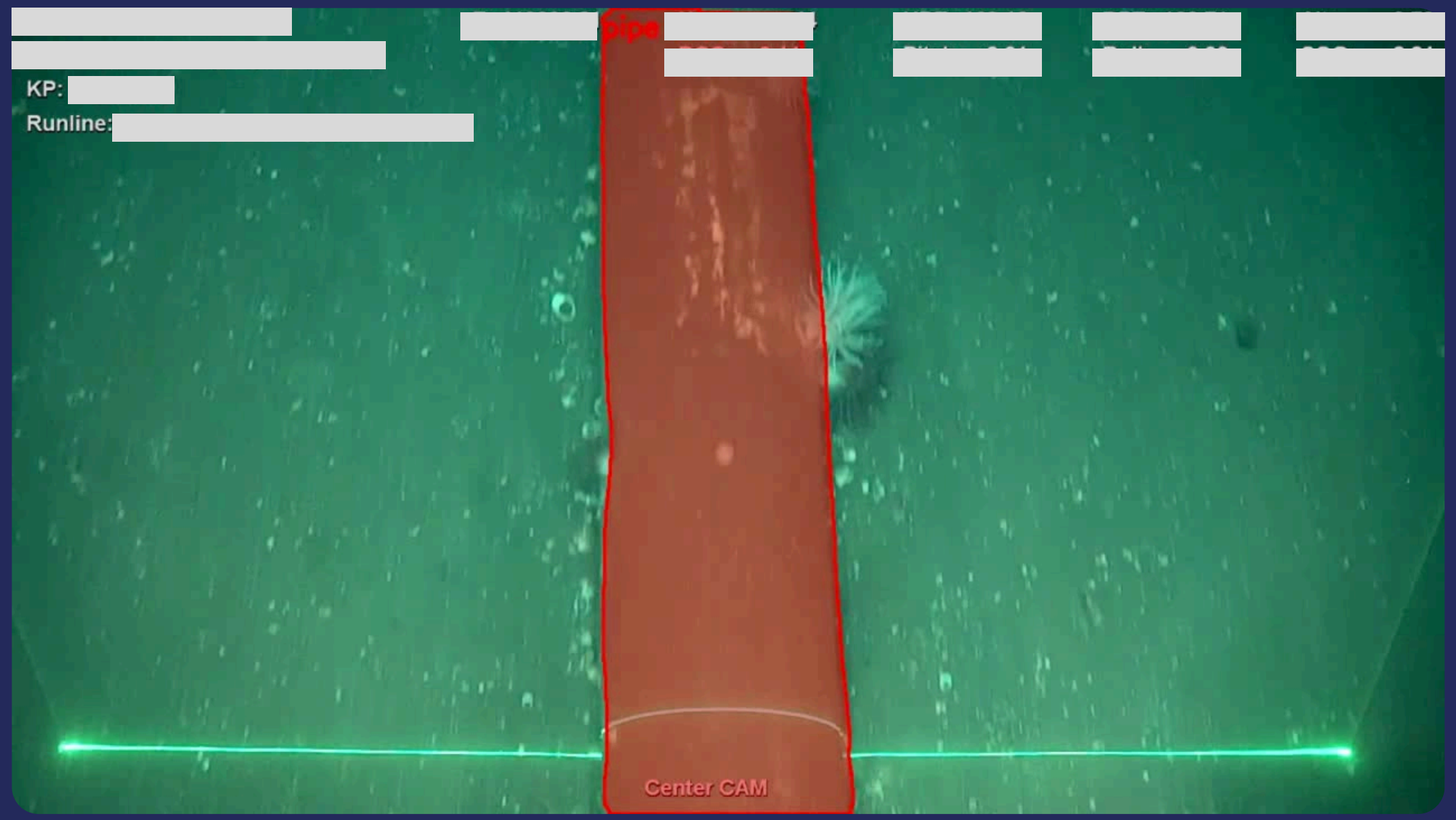
- But it had issues:
  - A lot of the images had no pipe in them.
  - Licensing considerations.
  - Camera qualility.
  - Not really representative of what we wanted to use it on.

So we labelled some of our own...

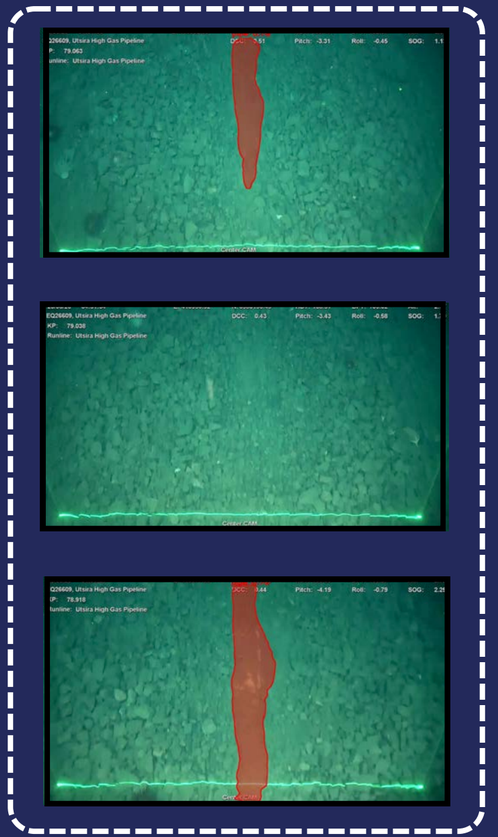

Center CAM
Center CAM
Center CAM
Center CAM

Computer Vision - Pipe Segmentation

Pipe in full view

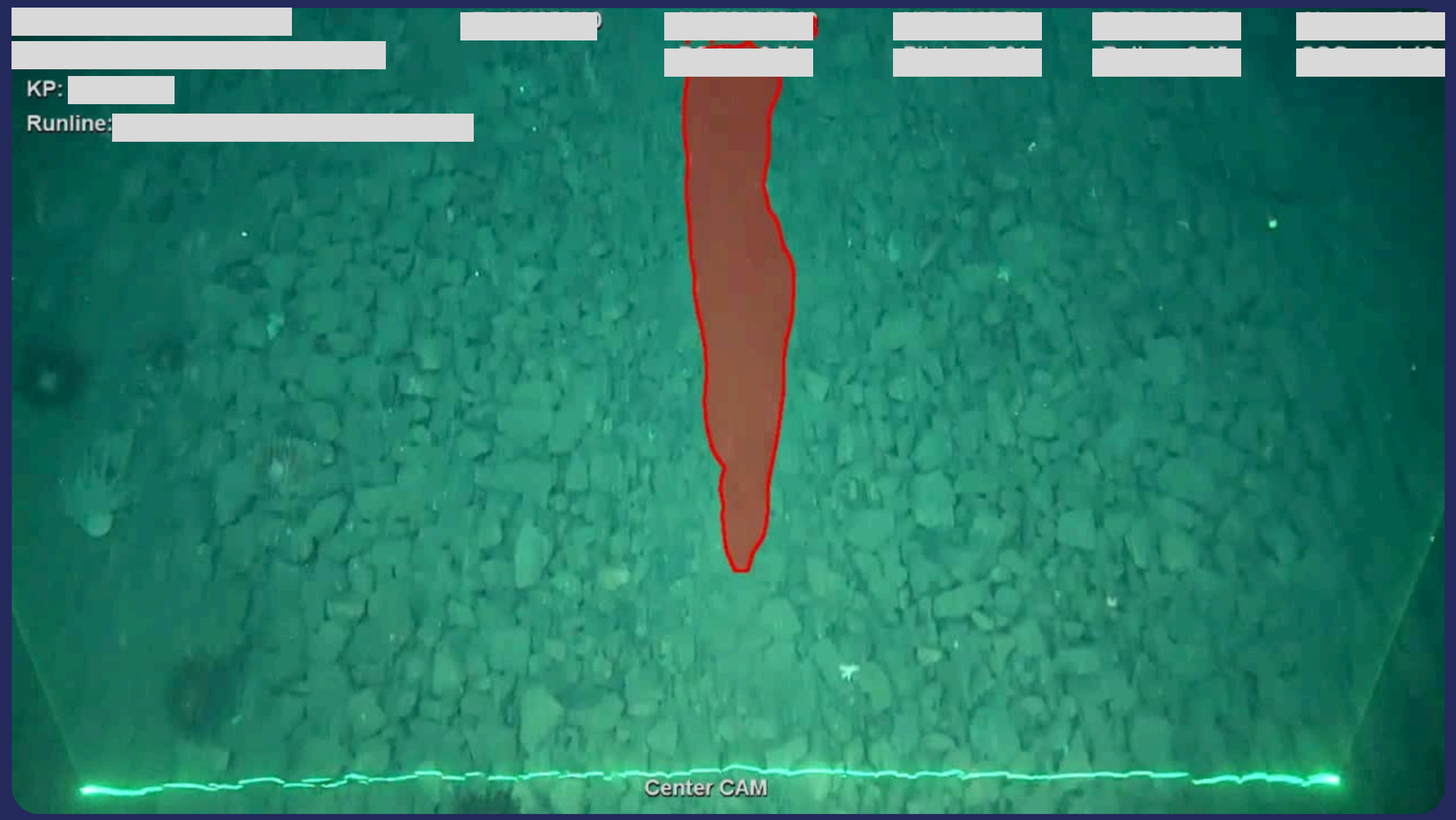


Click to enlarge

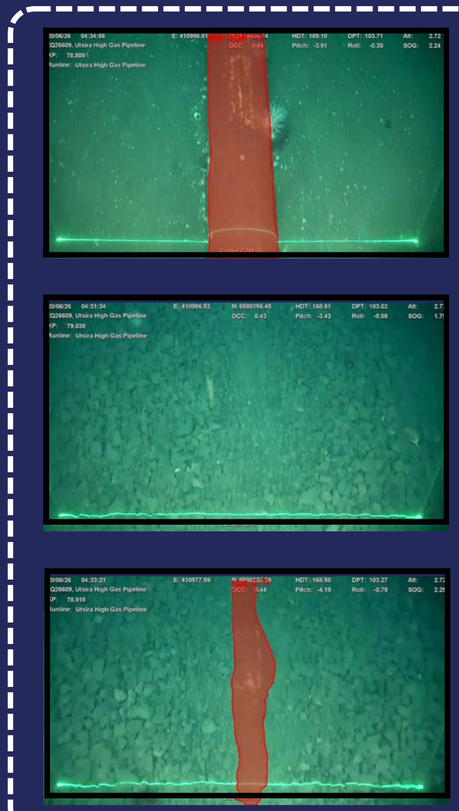


Computer Vision - Pipe Segmentation

Pipe entering gravel dump



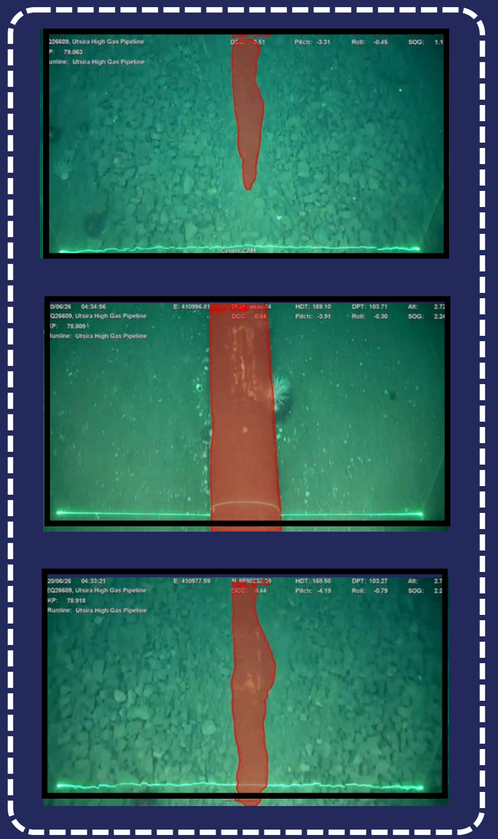
Click to enlarge



Computer Vision - Pipe Segmentation

Small pipe segments showing through gravel dump

Click to enlarge



Computer Vision - Re-ran on cable example

CV applied blindly to video of losing track of cable

Target Hardware Deployment with Tracker in Realtime

Jetson Thor

Summary

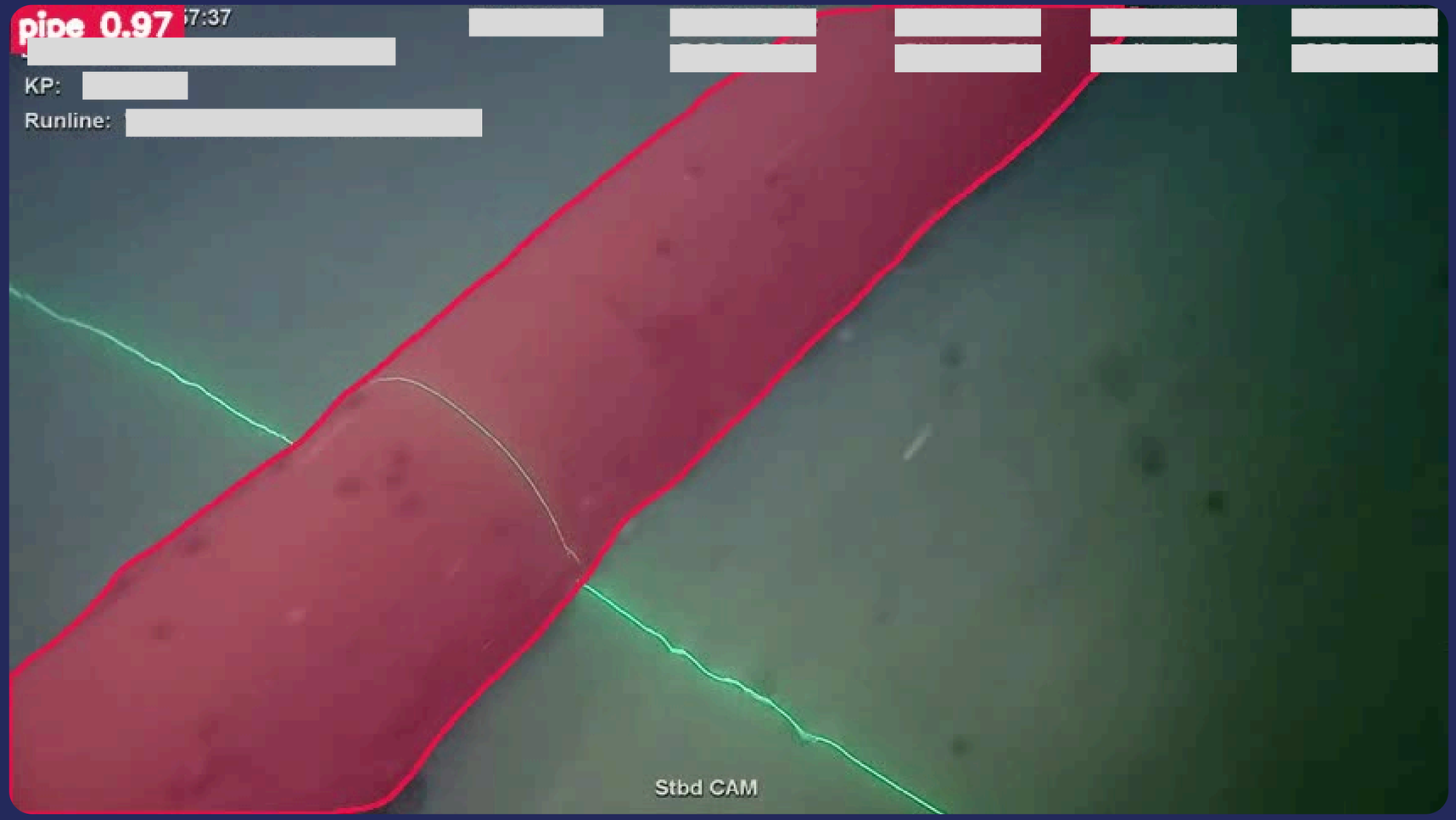
How it performed

- Tracks pipe well.
- Identifies and maintains track of pipe in difficult situations.
- Can run in realtime on edge hardware.

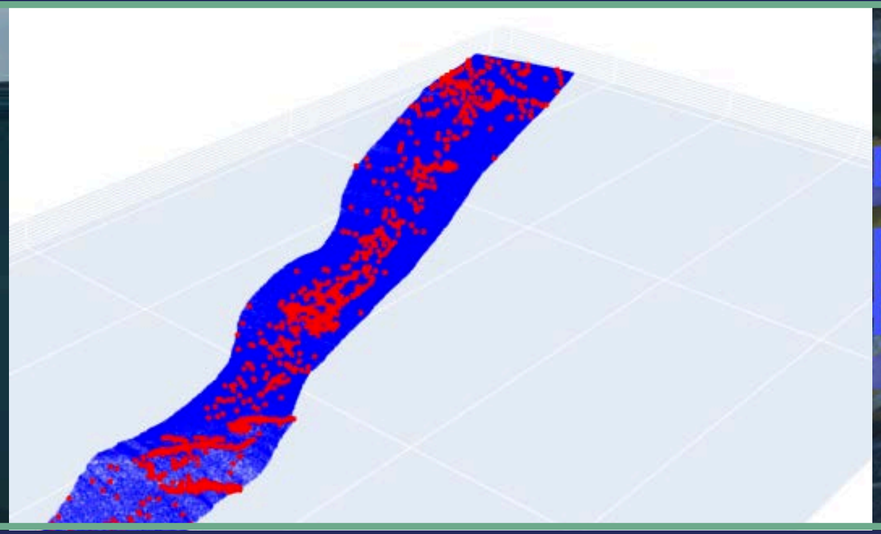
What next?

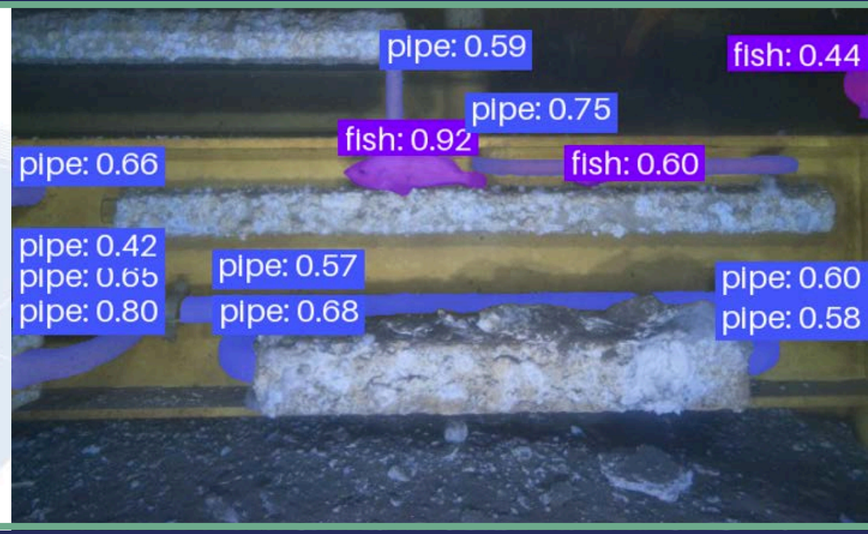
- Work with ROV pilots to understand how to best present this information to them.
- Sonar detector.
- Sensor fusion (ready for multi-modal)
- **Automatic eventing...**

Automatic Eventing / Feature Extraction

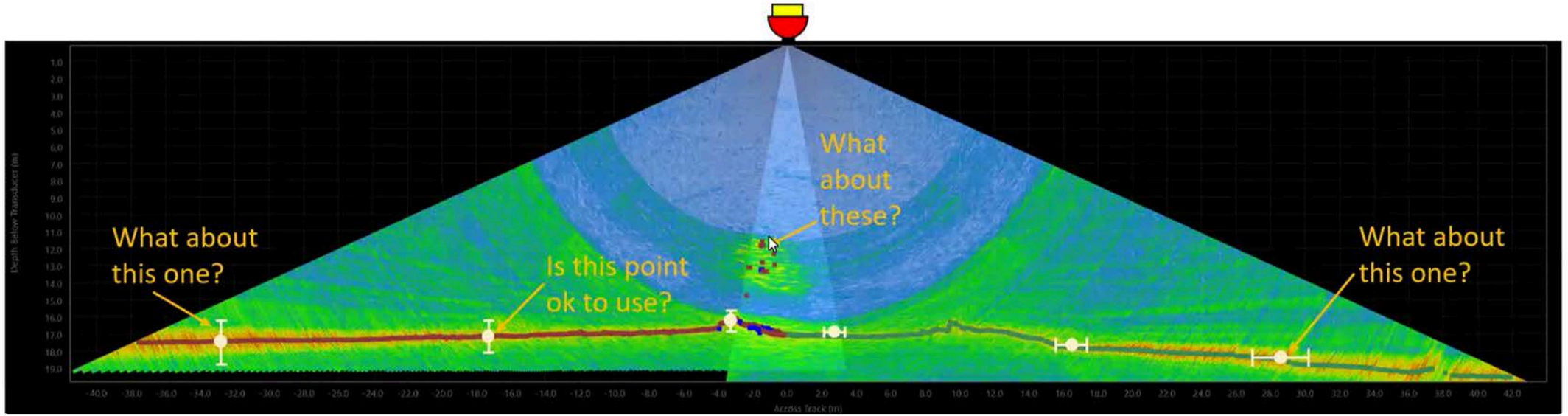


Machine learning for MBES cleaning



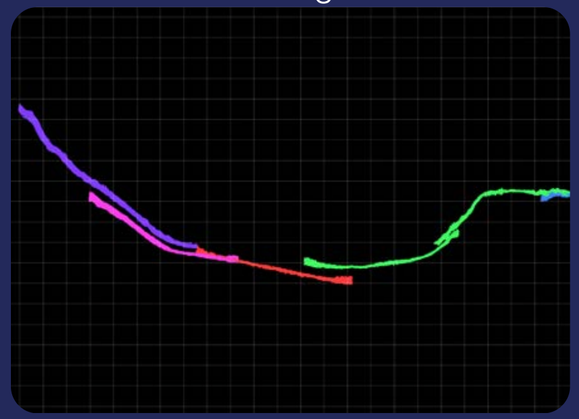


What is going on?



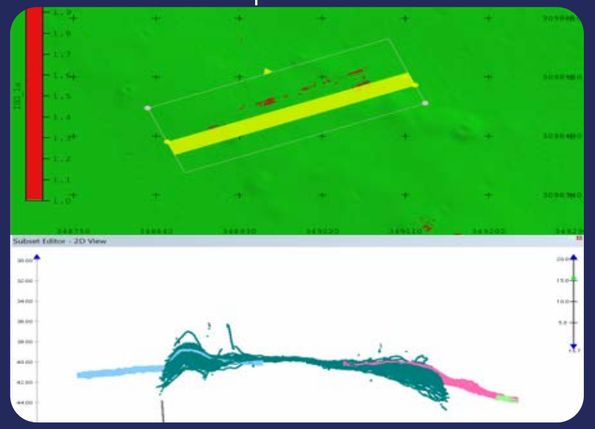
Sources of uncertainty

Tide misalignment

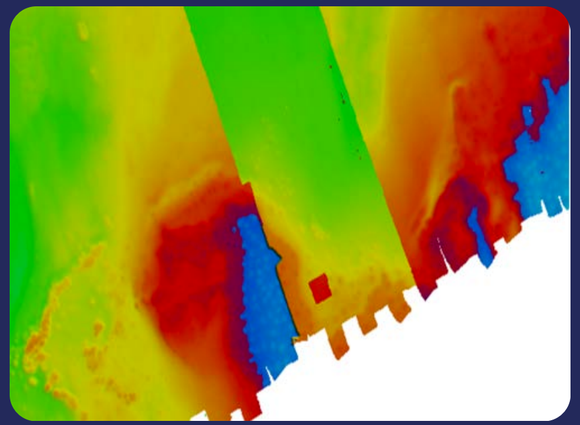


Bad weather

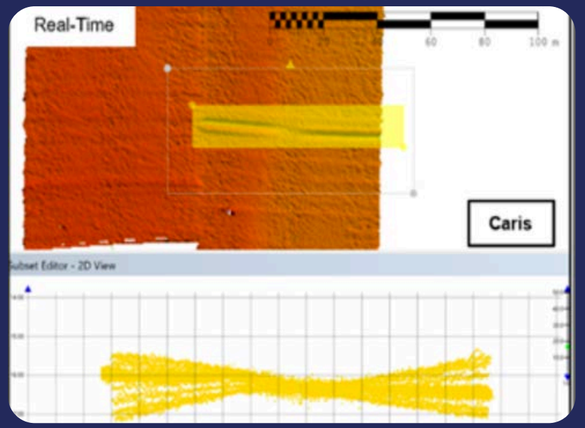
Swath open too much



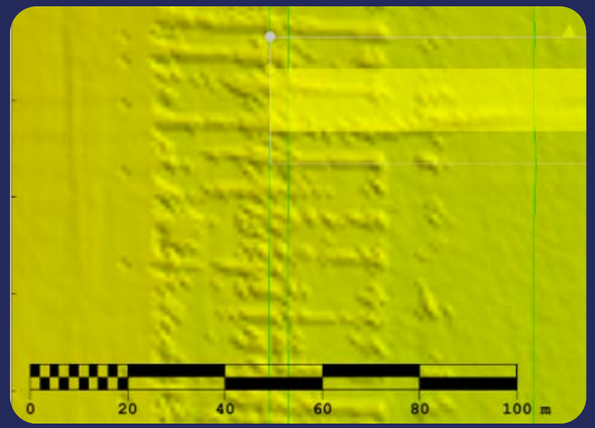
GPS Loss



Motion Artifact

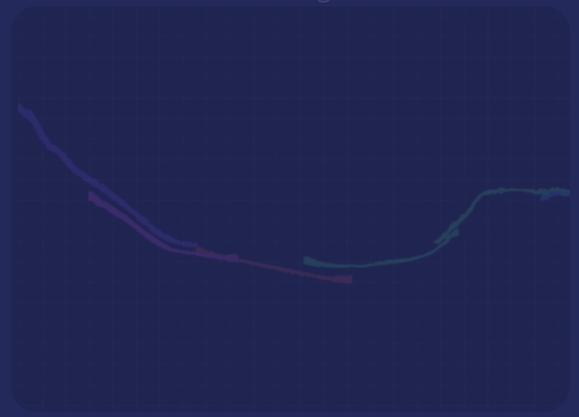


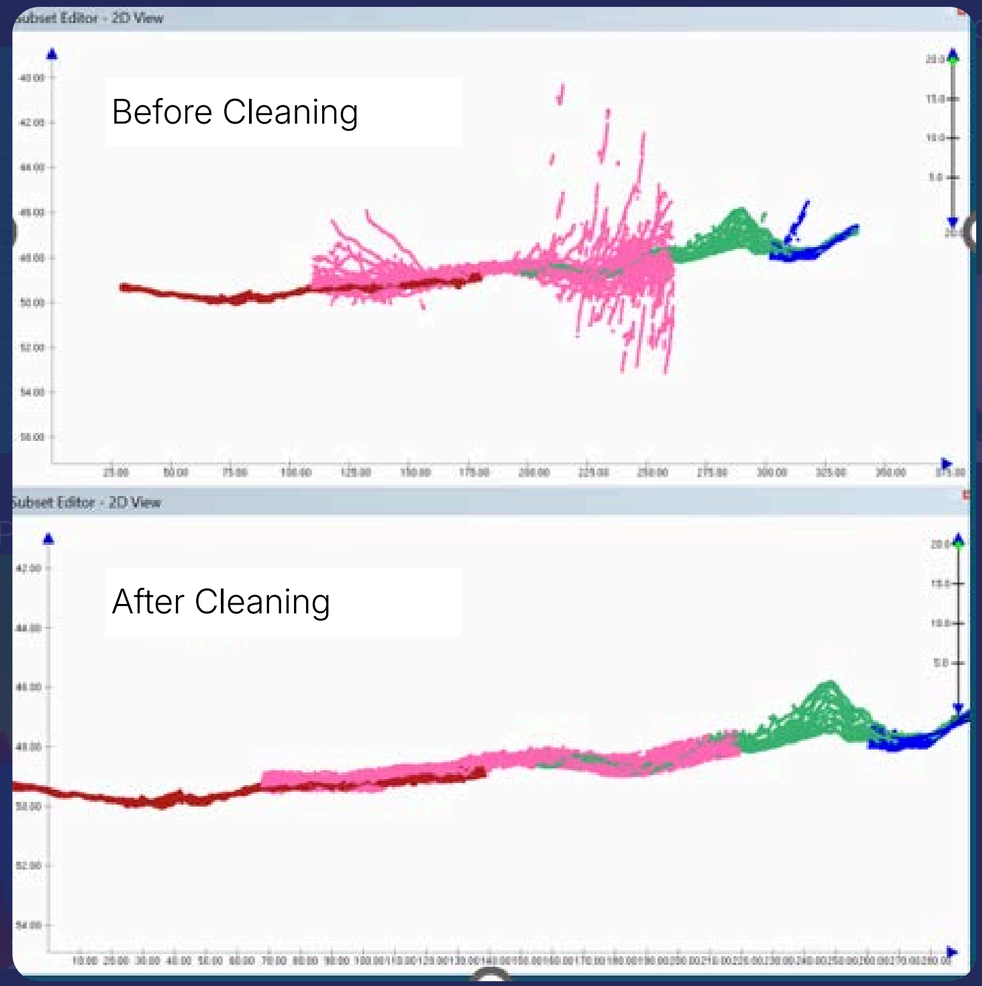
Poor GPS



Sources of uncertainty

Tide misalignment





Poor GPS

The Challenge

1:4

Collection : Processing

For every 15 minutes spent collecting data, 1 hour must be expended processing.

~€15k

per day currently spent

24 + 8 data processors across reach operating at ~€60p/h.

32 * 8 hrs/day * €60 = $15,360 /day.

1200hrs

backlog of data

Significant backlog of data waiting to be processed.

1200 hrs processing time.

CLEANBYMACHINE

The (Proposed) Solution

What?

- A software tool to clean multibeam bathymetry using machine learning techniques, specifically gradient boosted trees (XGBoost).
- Uses Reach data assets (archived data) for training
- Training data is all hand-cleaned, formally approved multibeam recordings.
- One model per sonar type.
- During model training, feature combinations which indicate ‘noise’ are learned.

Why?

- Reduce manual data processing step by **X**%
- Increased consistency, repeatability and predictability compared to human operators.
- Time (and therefore) capital savings
  - at 60% reduction (assuming numbers from previous slide) - $15,000 per day saving.
  - at 80% reduction - $20,800 per day saving.

Training, testing and unseen survey data

Training

728

Survey files

Across several surveys & several vessels.

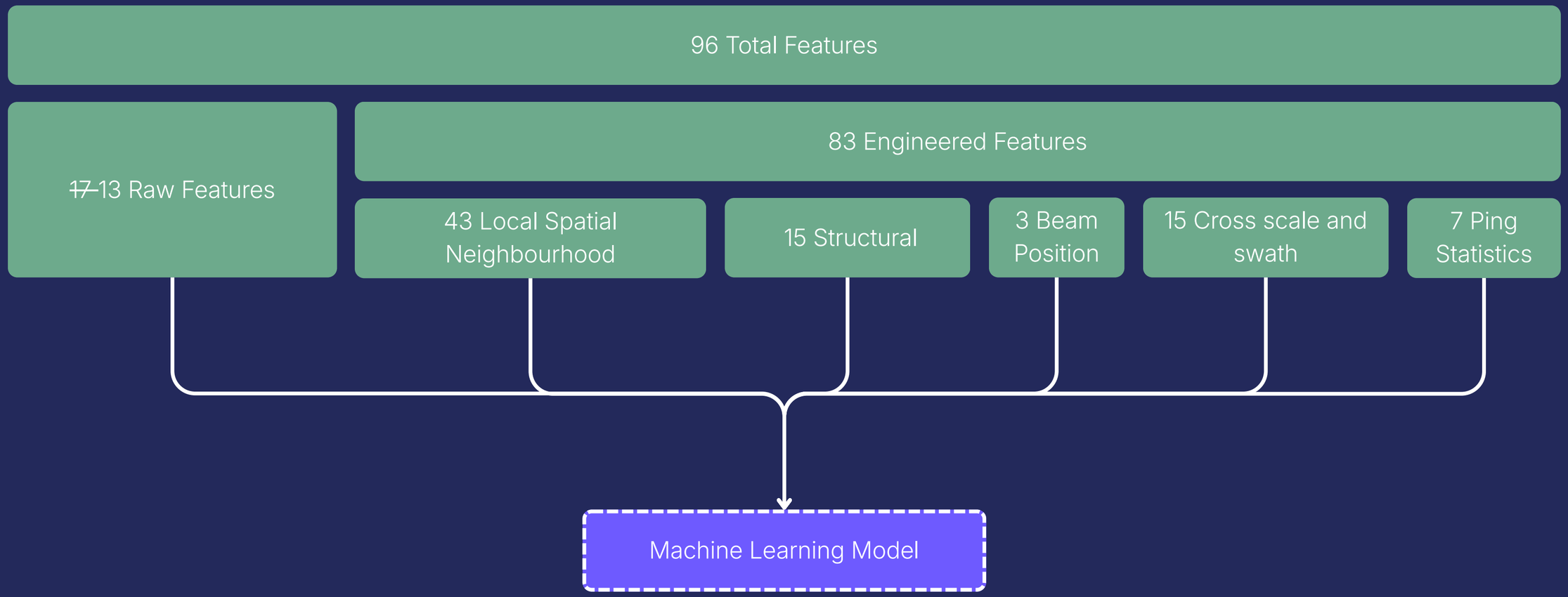
Unseen

20

Unseen survey files

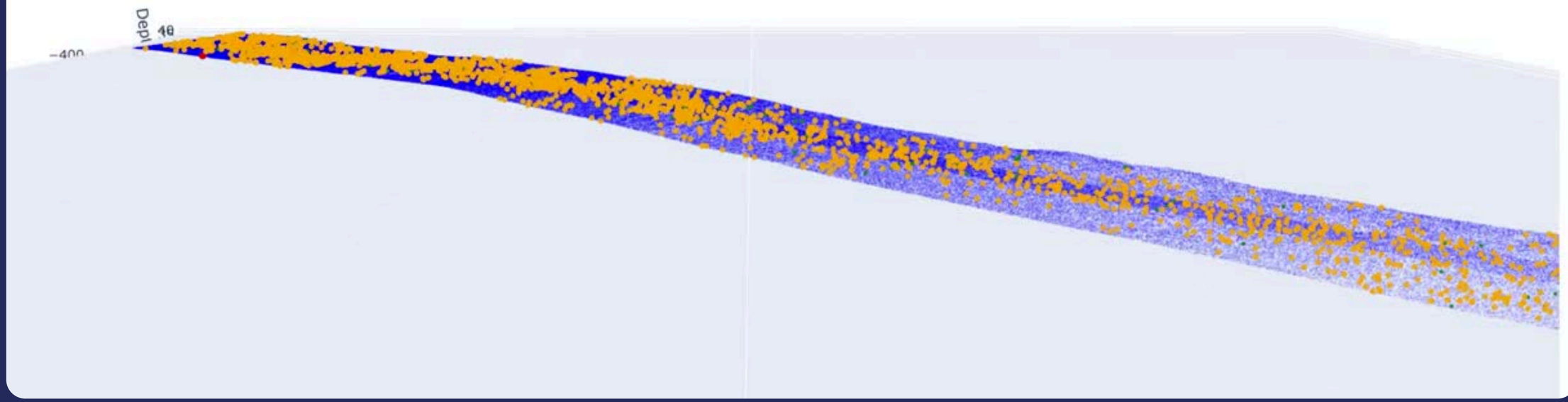
Ringfenced from training to assess blind transferrability.

Features Summary - 96 total



Results (run 26)

Threshold: 0.50
Full-file rows: 7,201,792
Valid labelled rows: 7,201,792
Noise found: 99.1% (2,322/2,343)
Good data kept: 99.41% (7,156,715/7,199,449)
Noise missed: 21
Good data wrongly removed: 42,734
Cleaner rejected: 45,056 vs hydrographer 2,343 (+42,713)
Overall agreement: 99.41%
Summary covers the complete prediction file; only the 3D points are sampled.



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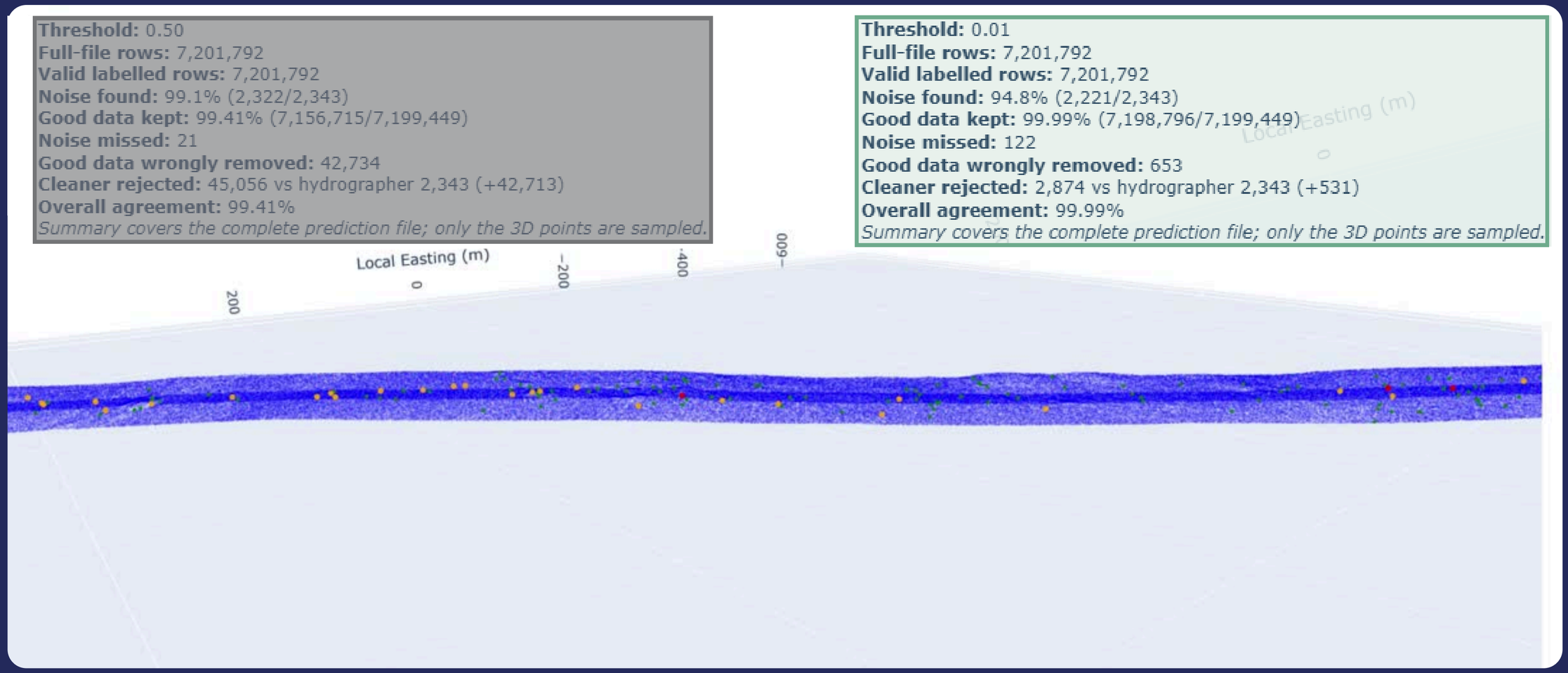
Good data kept: 99.41% (7,156,715/7,199,449)
Noise missed: 21
Good data wrongly removed: 42,734
Cleaner rejected: 45,056 vs hydrographer 2,343 (+42,713)
Overall agreement: 99.41%
Summary covers the complete prediction file; only the 3D points are sampled.

Threshold: 0.01
Full-file rows: 7,201,792
Valid labelled rows: 7,201,792
Noise found: 94.8% (2,221/2,343)
Good data kept: 99.99% (7,198,796/7,199,449)
Noise missed: 122
Good data wrongly removed: 653
Cleaner rejected: 2,874 vs hydrographer 2,343 (+531)
Overall agreement: 99.99%
Summary covers the complete prediction file; only the 3D points are sampled.



Results - mapped back to the challenge

1 : 1.2
Collection : Processing

With a 70% reduction in workload, the ratio of collection to processing is much closer to 1:1.

~€11k
per day saved

70% reduction in time spent processing results in ~€11k savings per day.

360hrs
backlog of data

Should take 360 hours to process, as opposed to 1200 hrs.

Machine learning for PPE Detection

- Trained on open source dataset
- Capable of detecting
  - Person
  - Ear
  - Ear-muffs
  - Face
  - Face-guard
  - Face-mask
  - Foot
  - Tool
  - Glasses
  - Gloves
  - Helmet
  - Hands
  - Head
  - Medical-suit
  - Shoes
  - Safety-suit
  - Safety-vest

REACH SUBSEA

Everything within Reach

Presenter: george.jones@reachsubsea.com

Future Subsea Robotics

Link to Slides

Reach - LinkedIn

George - LinkedIn

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