Robotic Characterisation of Pipelines in a High Energy, Near-Shore Marine Environment

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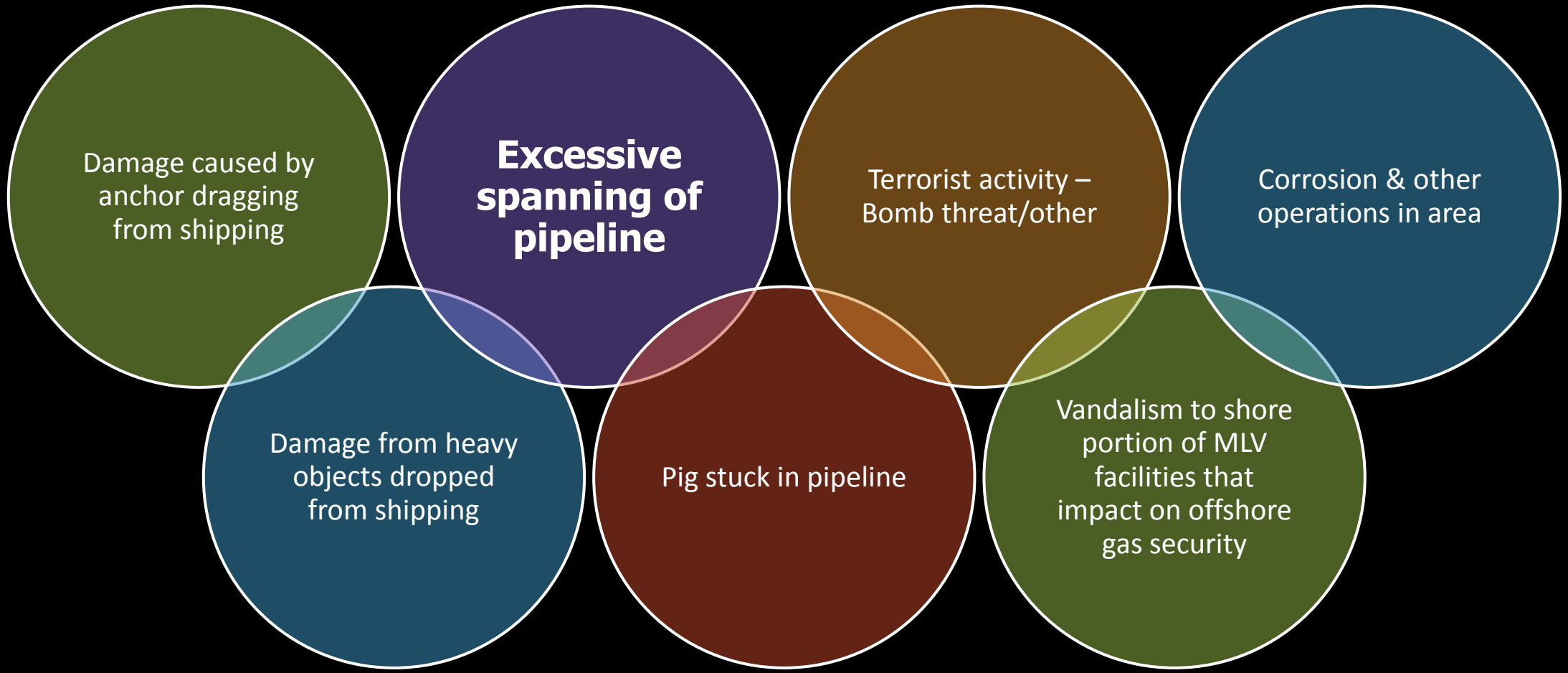
Presentation Overview

1. Introduction – Tasmanian Gas Pipeline
2. Methods – Robotic Characterisation
3. Results – Feature Detection & Environment Comparison
4. Discussion
5. Conclusions

ROV footage, Five Mile Bluff (2015)

Methodology



Regulated through the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA)

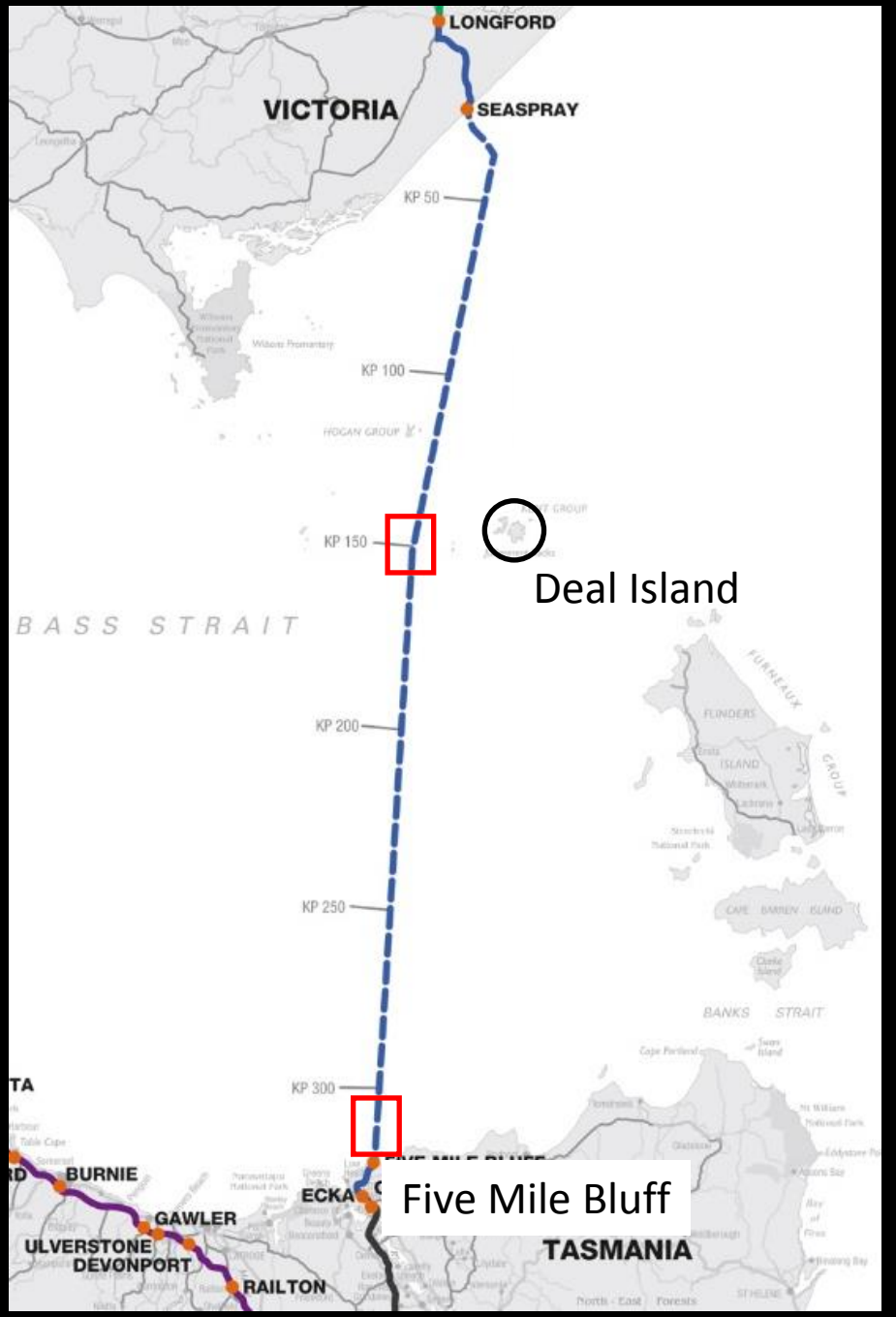
Asset Management

Grout Bag (2006)

- Millions are spent yearly on pipeline rectification through grout bags and concrete mattresses
- Tied closely to regions of high scour
- Marine growth is also an issue
- Need to identify areas of high risk

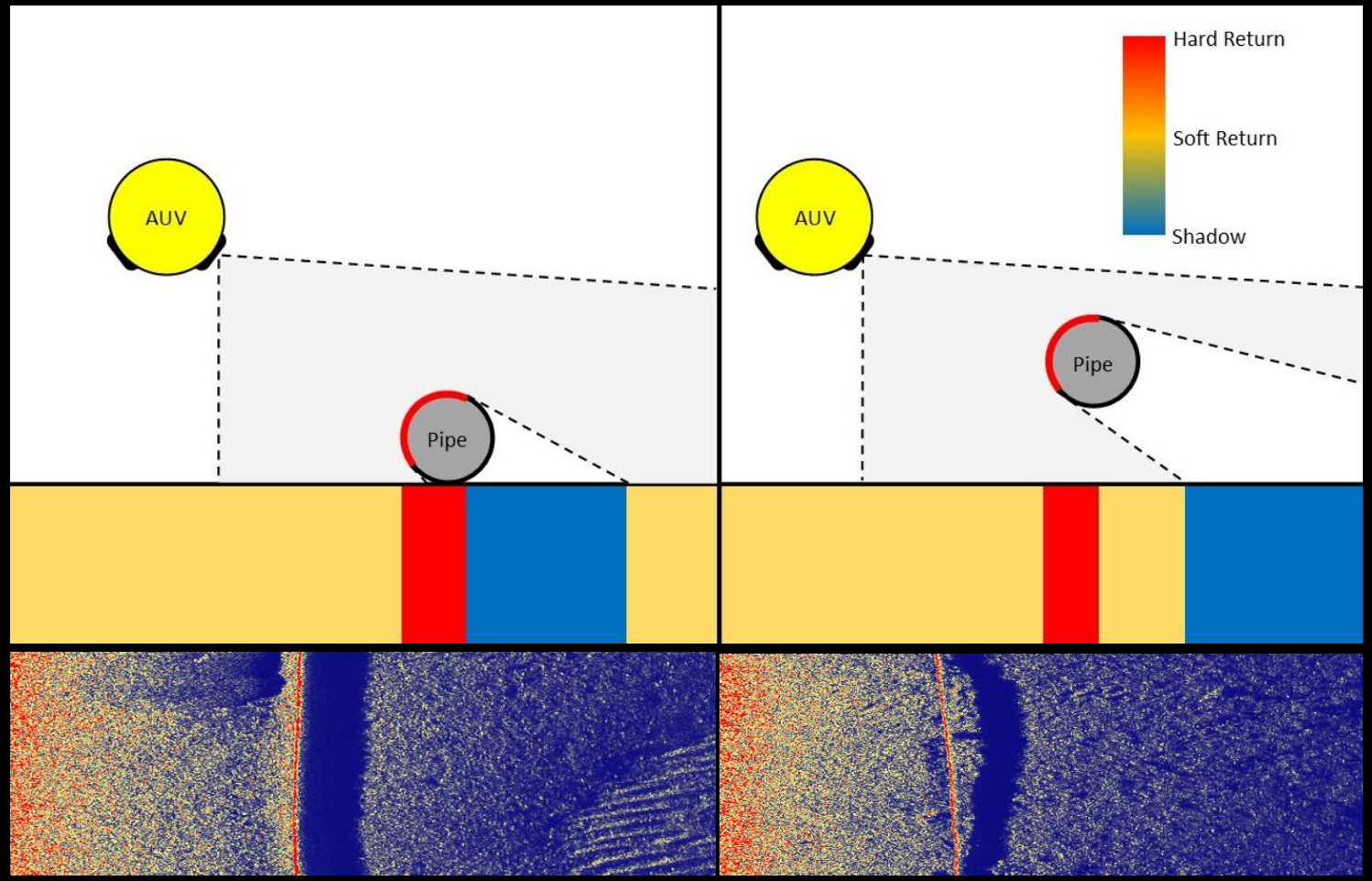
Tasmanian Gas Pipeline

- Liquefied Natural Gas (LNG)
- 320 km long
- OD 430-515 mm (excluding growth)
- Free span assessment
- Deal Island
  - Low Energy
  - 60-70 metres depth
- Five Mile Bluff
  - High Energy
  - 5-30 metres depth



http://www.tasmaniangaspipeline.com.au/offshore-map

Free Span Identification



No span, span example, Five Mile Bluff (2015)

- Acoustic shadow in contact with hard acoustic return
- Acoustic shadow separated from hard acoustic return
- Acoustic backscatter processed with Caris HIPS & SIPS

Why Autonomous Underwater Vehicles (AUVs)?

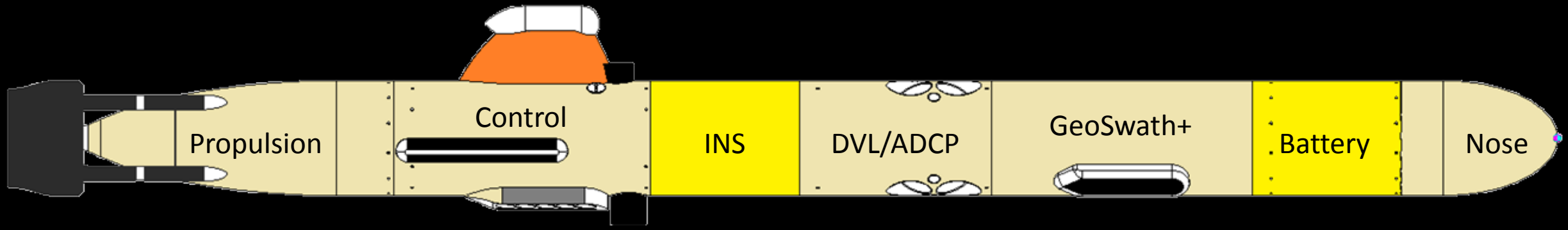
- Close Proximity
  - High resolution, regardless of water depth
- Constant Altitude
  - Maintain a shallow angle of 14° from horizontal
- Positional Accuracy
  - ≈0.1% distance covered (1 m/1 km)
- Decoupled from Surface Motions

Deal Island (2015)

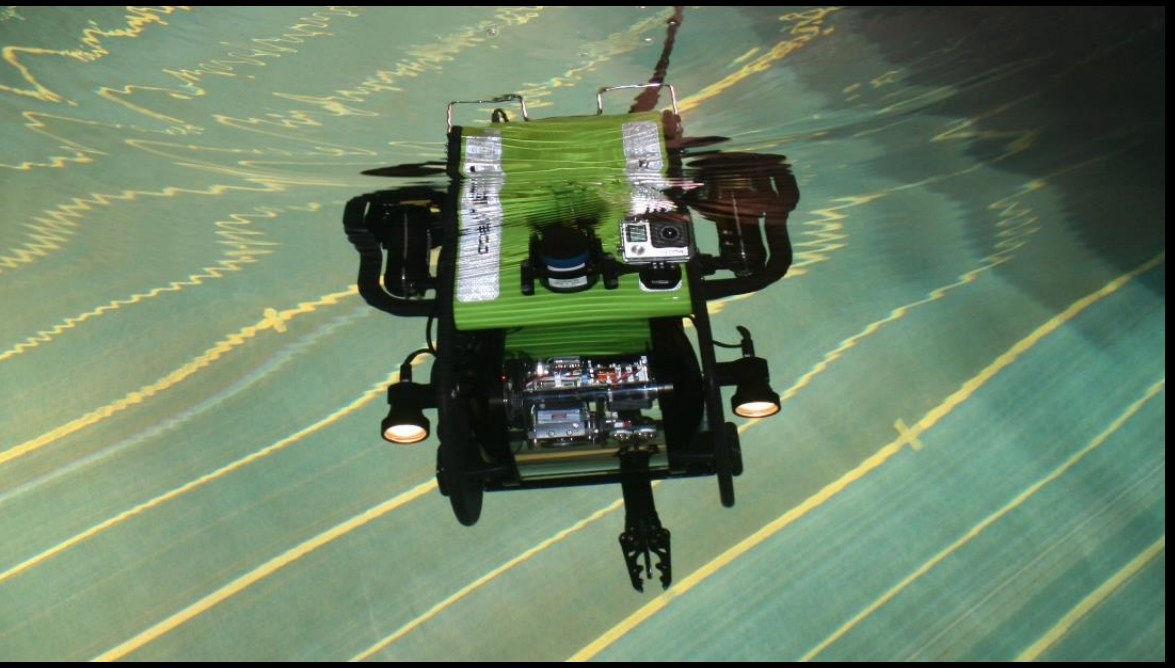
Gavia Scientific AUV Specifications

Length	2.5-3.0 m
Diameter	0.2 m
Depth Rating	500 m
Velocity	1.0-2.5 m/s
Range	20-30 km
Weight (in air)	80-90 kg

Inertial Navigation System (INS)	Kearfott T-24
Interferometric Sonar	Kongsberg 500 kHz GeoSwath+
Acoustic Doppler Current Profiler (ADCP)	Teledyne RDI 1200 kHz Workhorse
Side-scan Sonar	Imagenex 260/900 kHz
Optical Backscatter	WET Labs Ecopuck (470, 532, 650 nm)
Downwards Facing Camera	Scorpion 1.9 MP (3.75 FPS)



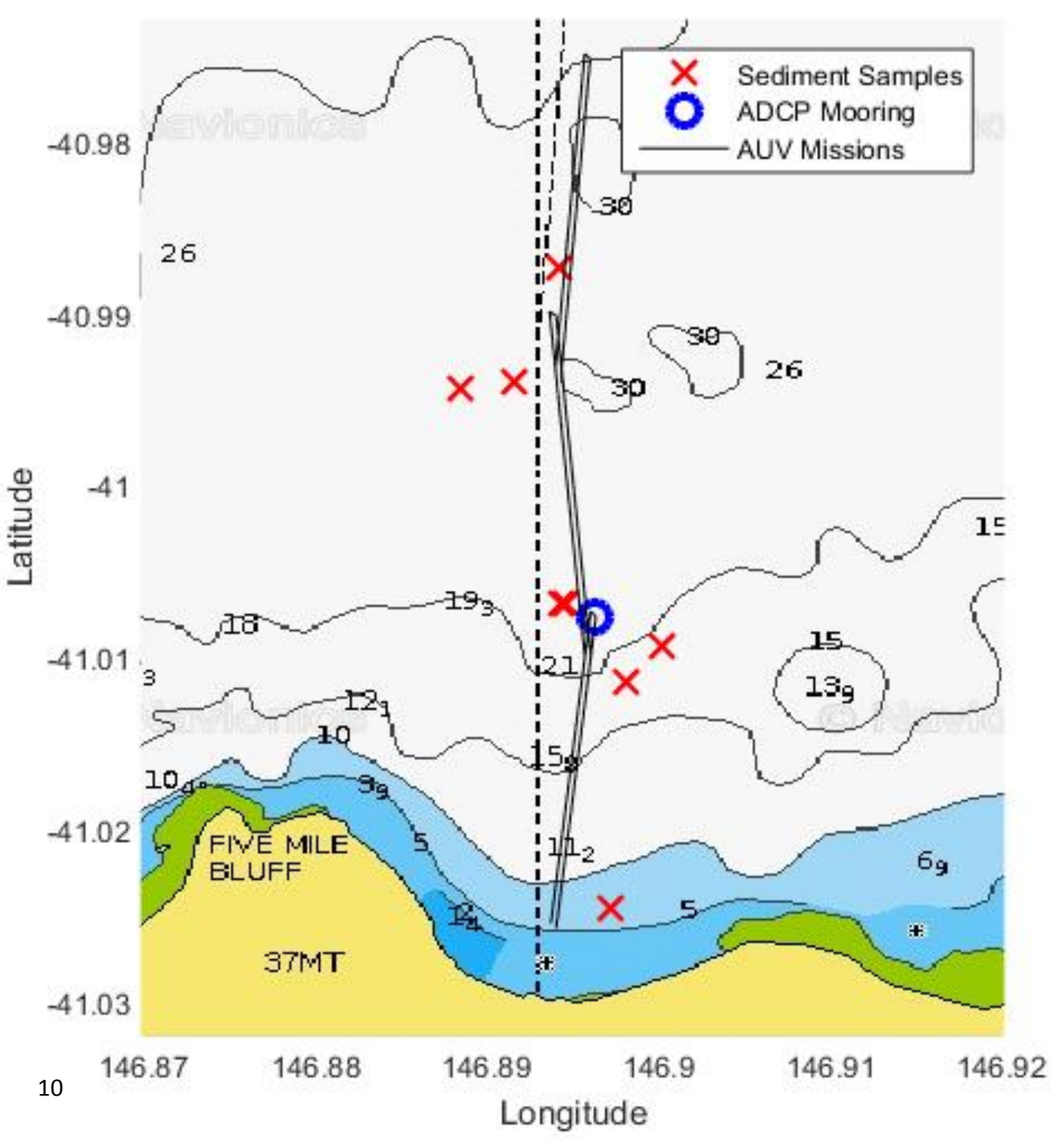
Remotely Operated Vehicle (ROV)



- SeaBotix LBV300 Observation Class ROV
  - 300 metre depth rating
  - Ultra Short Base-Line positioning
  - On-board mono & colour camera
  - Attached GoPro
- Validate detection method
- Validate span height approximation

Five Mile Bluff

- June 2014, May 2015
- Horizontal Directional Drill (HDD) exit to 5 km offshore
- Depth
  - 5-30 metres
- Mission length
  - 4.3-4.8 km
  - 45-50 minutes



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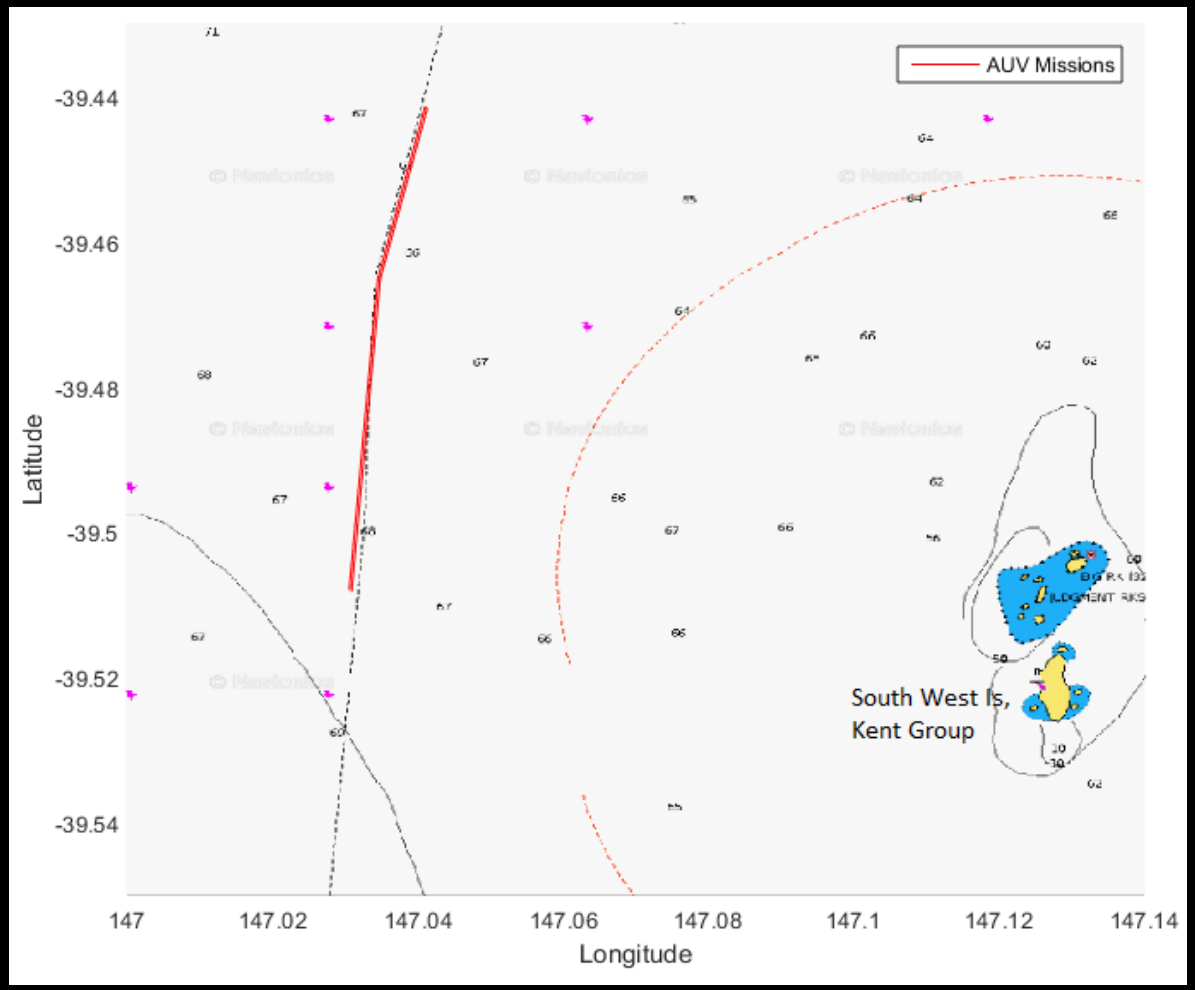
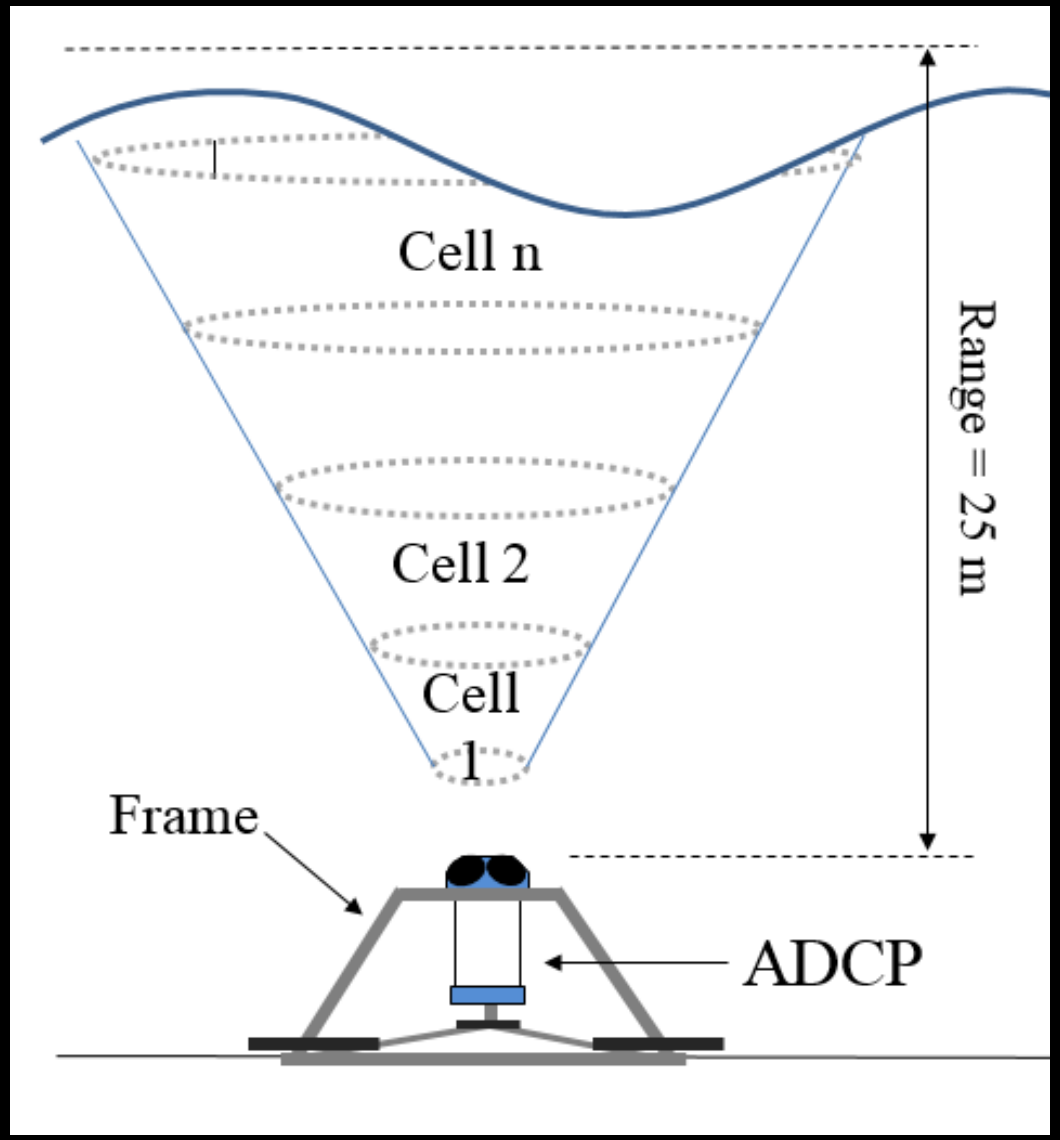
Deal Island



- February 2015
- 7km section due west of Deal Island
- Depth
  - 67-72 metres
- Mission length
  - 5.6-9.8 km
  - 4.7 2.5

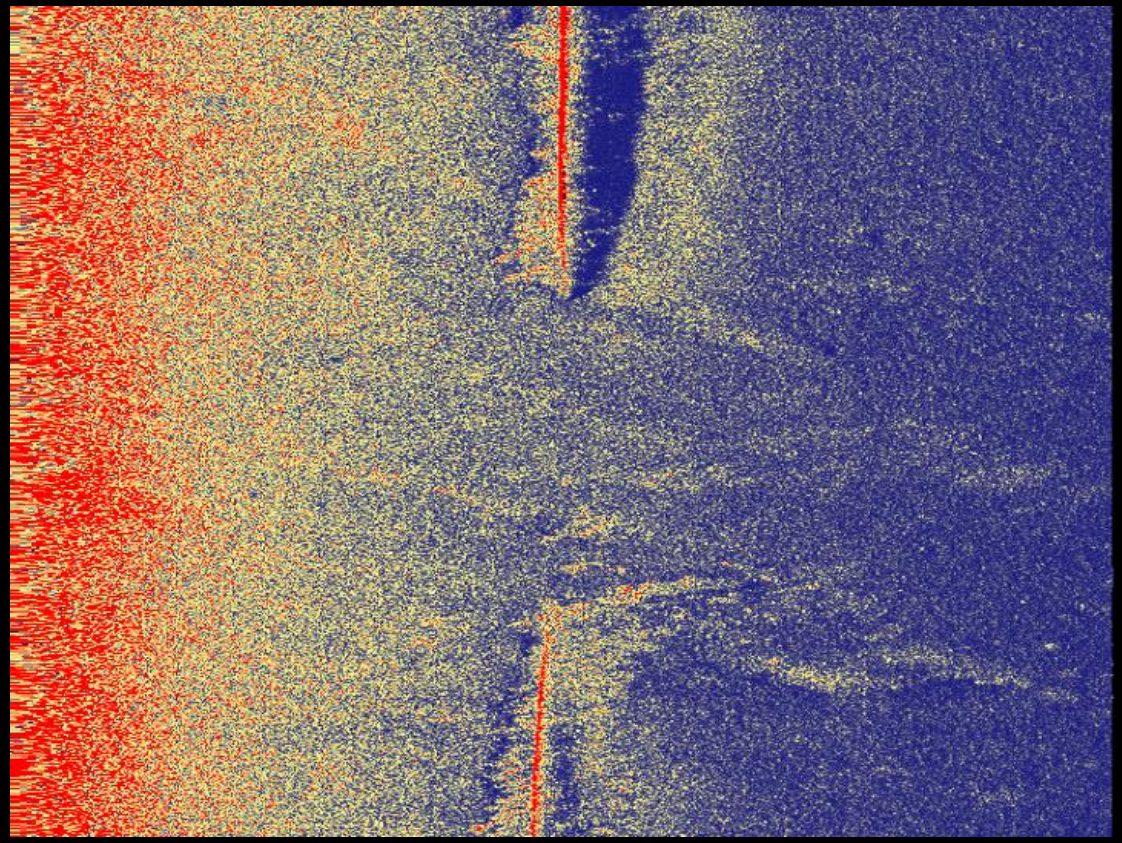
Current Profiling

- Stationary ADCP (RDI Workhorse V50 500 kHz)
  - Ping every 5 seconds (0.2 Hz)
  - Averaged over 5 minute intervals

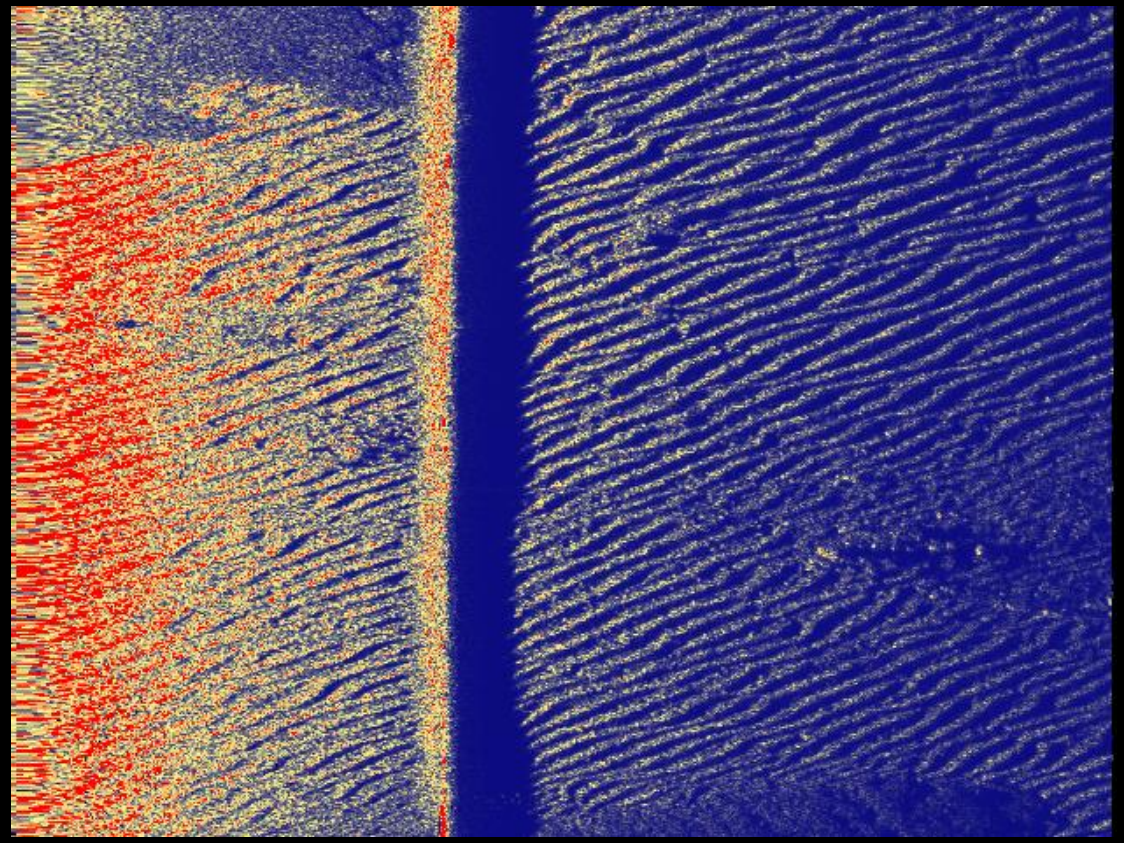


Acoustic Backscatter Results

Full burial



Partial burial



Hard Acoustic Return
Soft Acoustic Return
Acoustic Shadow

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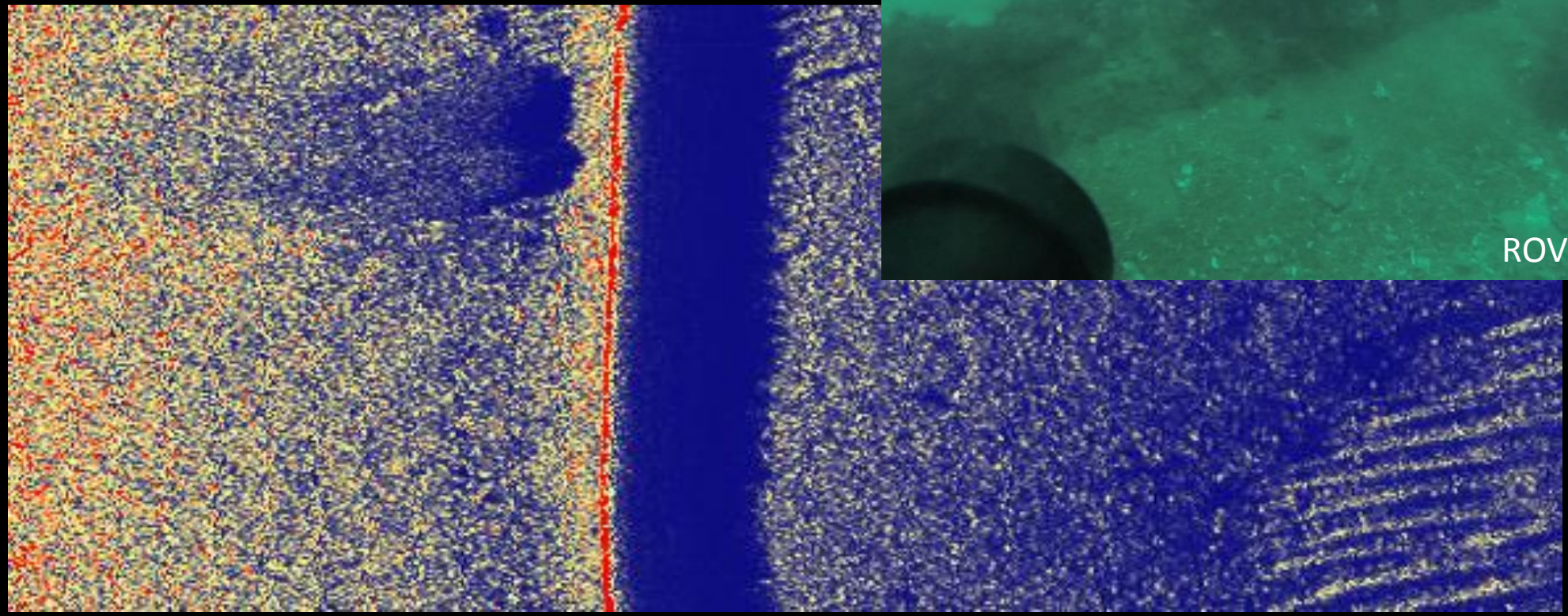
No span



Hard Acoustic Return
Soft Acoustic Return
Acoustic Shadow

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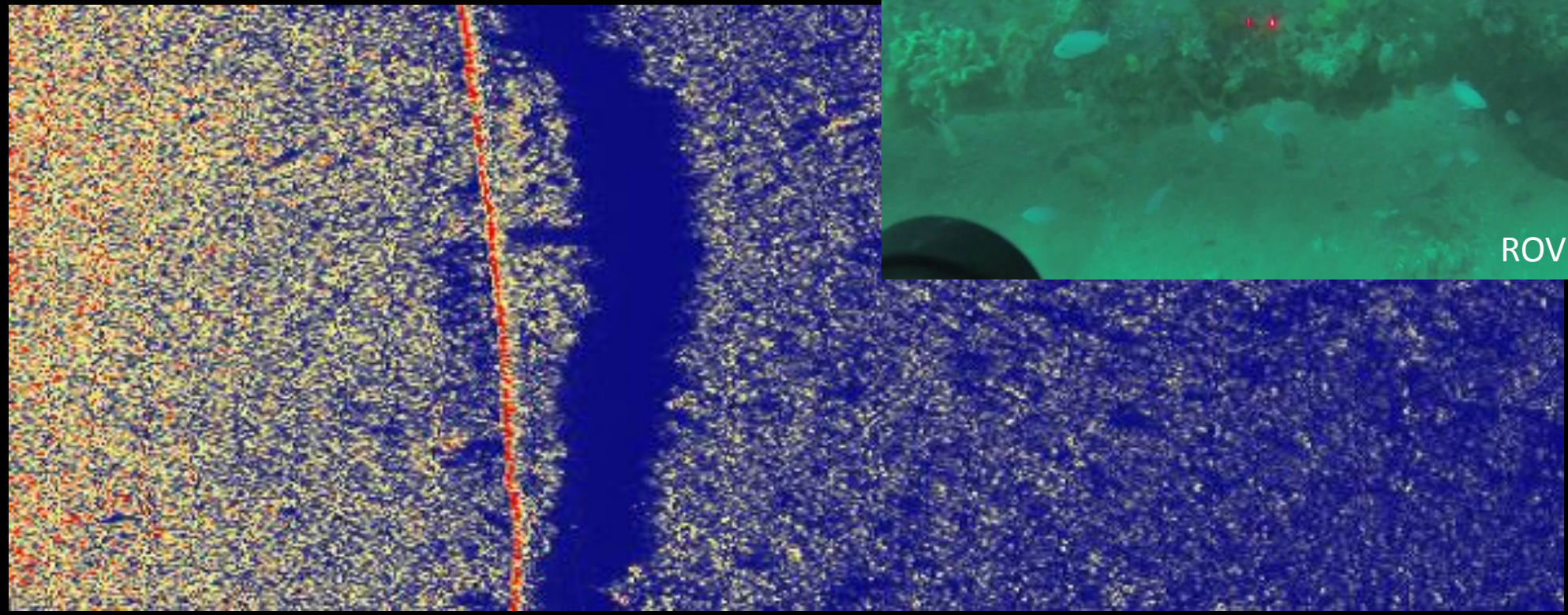
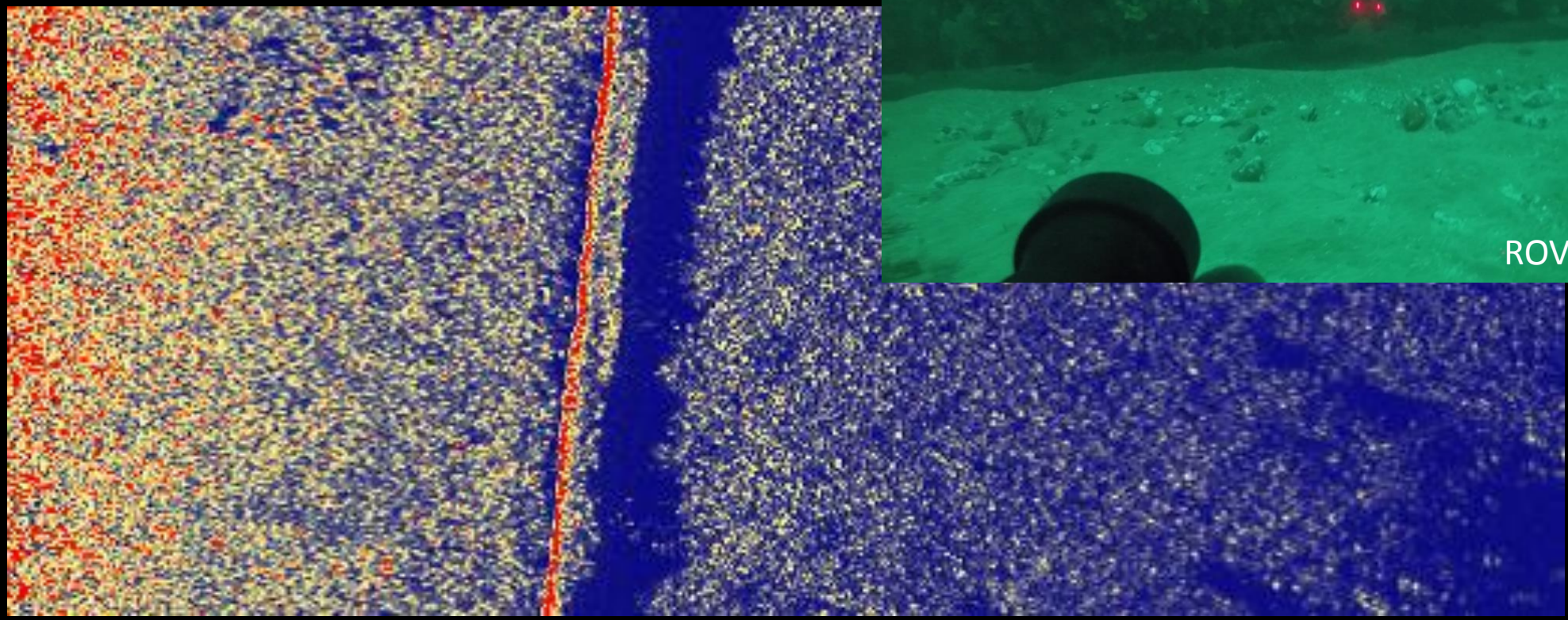
High Spans



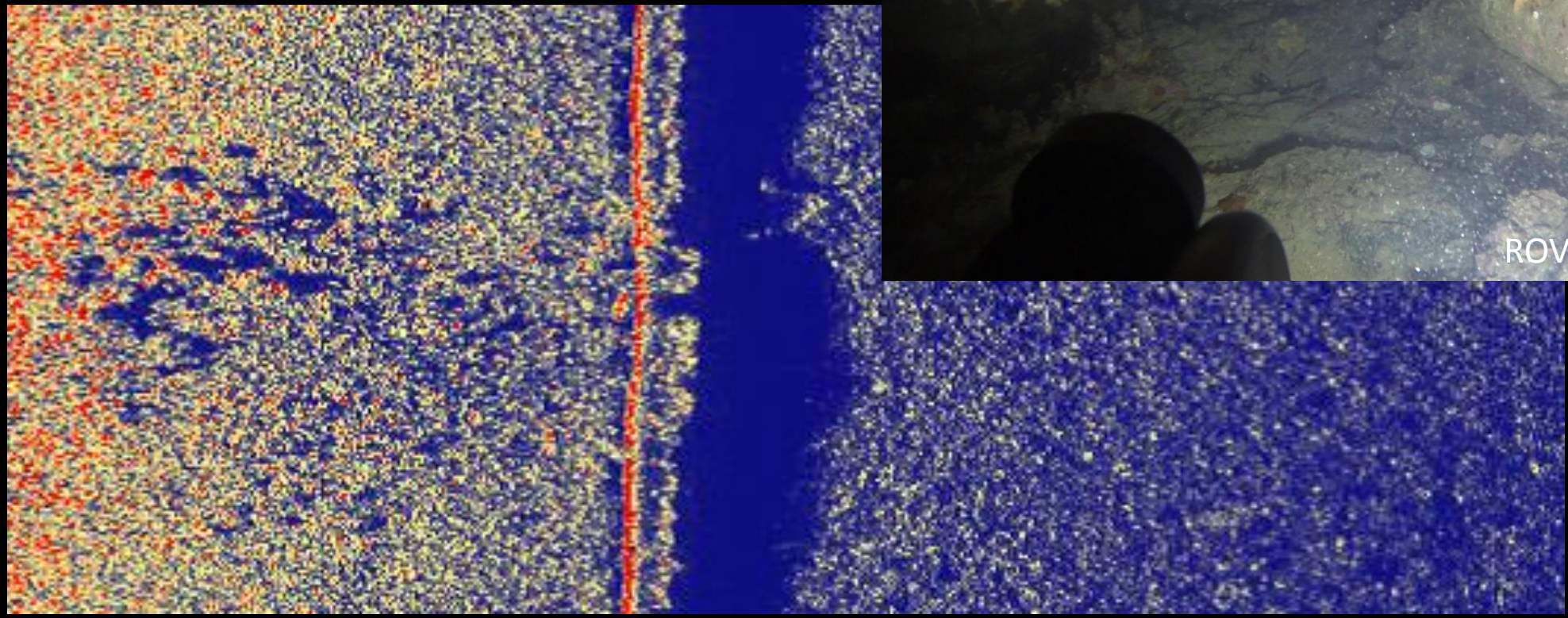
Hard Acoustic Return
Soft Acoustic Return
Acoustic Shadow

Low Spans



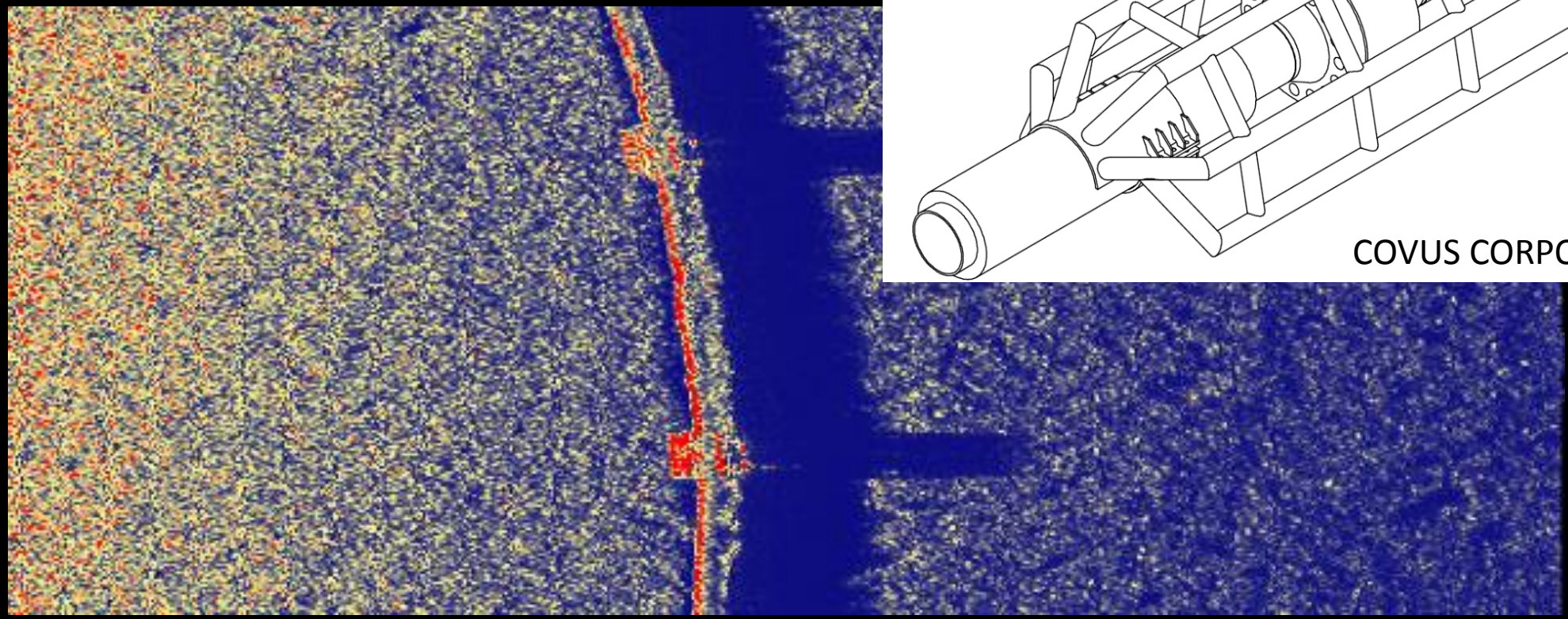
Hard Acoustic Return
Soft Acoustic Return
Acoustic Shadow

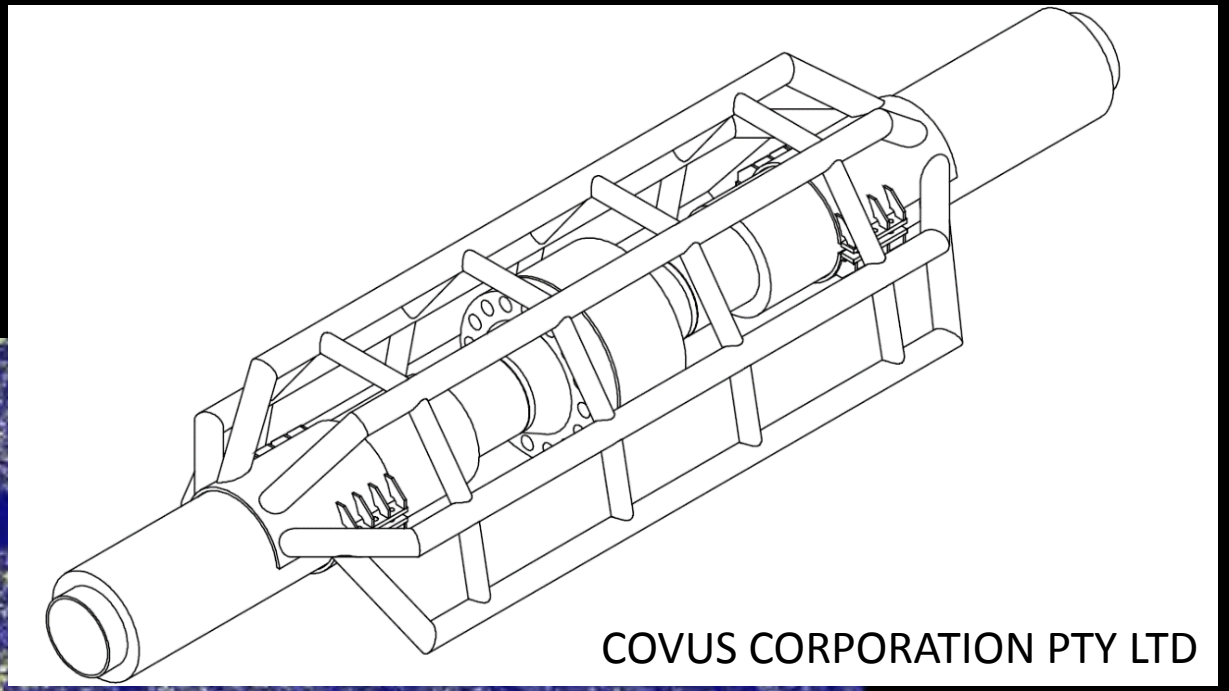
Grout Bag



Hard Acoustic Return
Soft Acoustic Return
Acoustic Shadow

Flange





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Hard Acoustic Return

Soft Acoustic Return

Acoustic Shadow

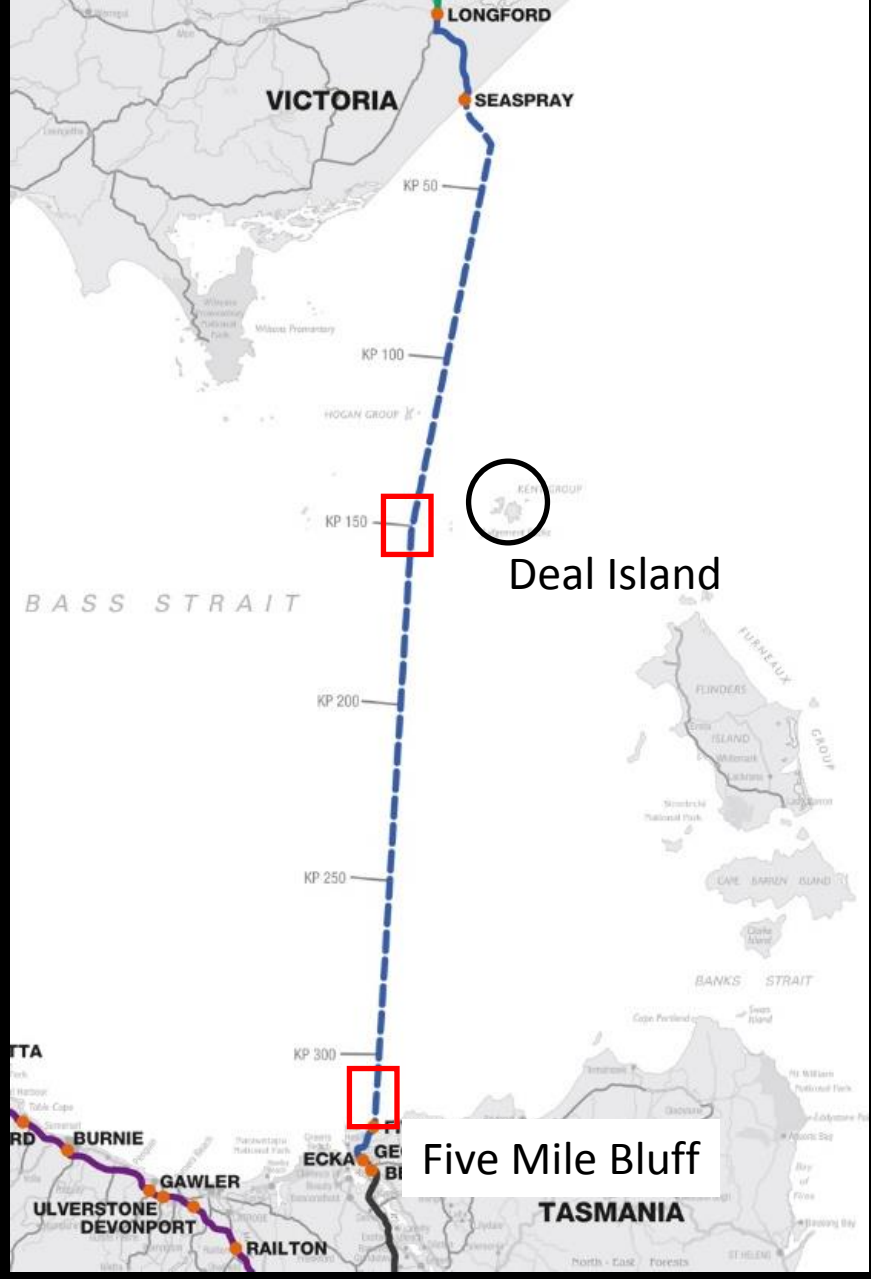
High Energy Vs Low Energy

Low Energy Environment - Deal Island (2015)

- 60-70 meters depth
- 15 spans per kilometre average

High Energy Environment - Five Mile Bluff (2015)

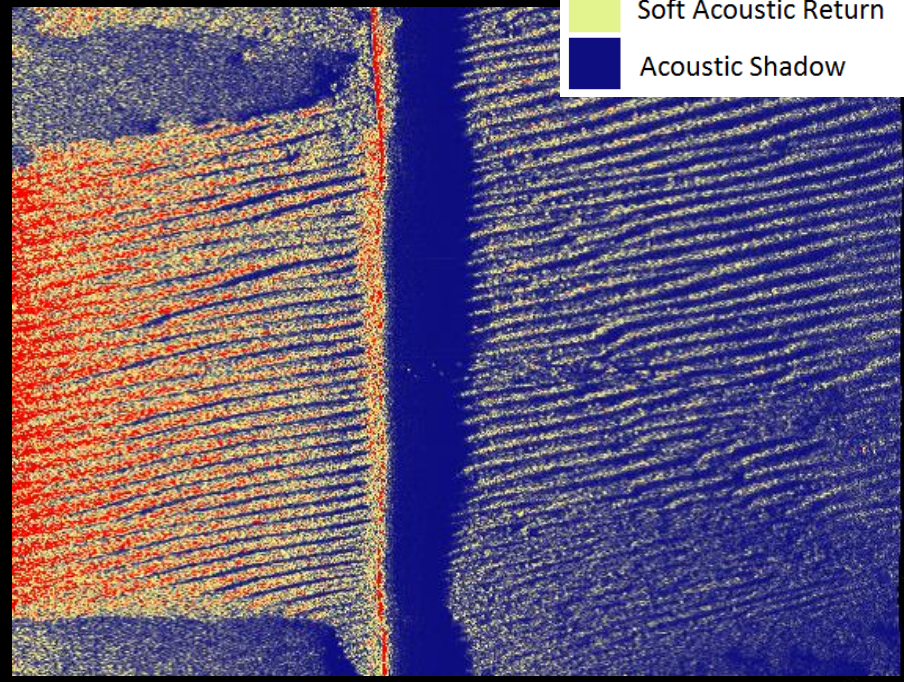
- 5-30 meters depth
- 30 spans per kilometre average
- Wave action

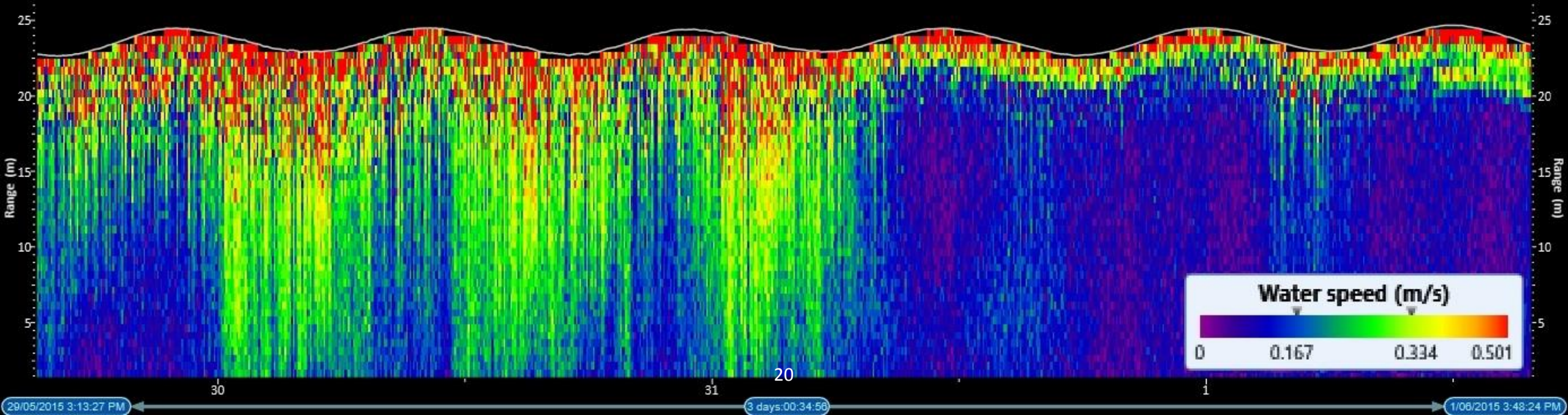


http://www.tasmaniangaspipeline.com.au/offshore-map

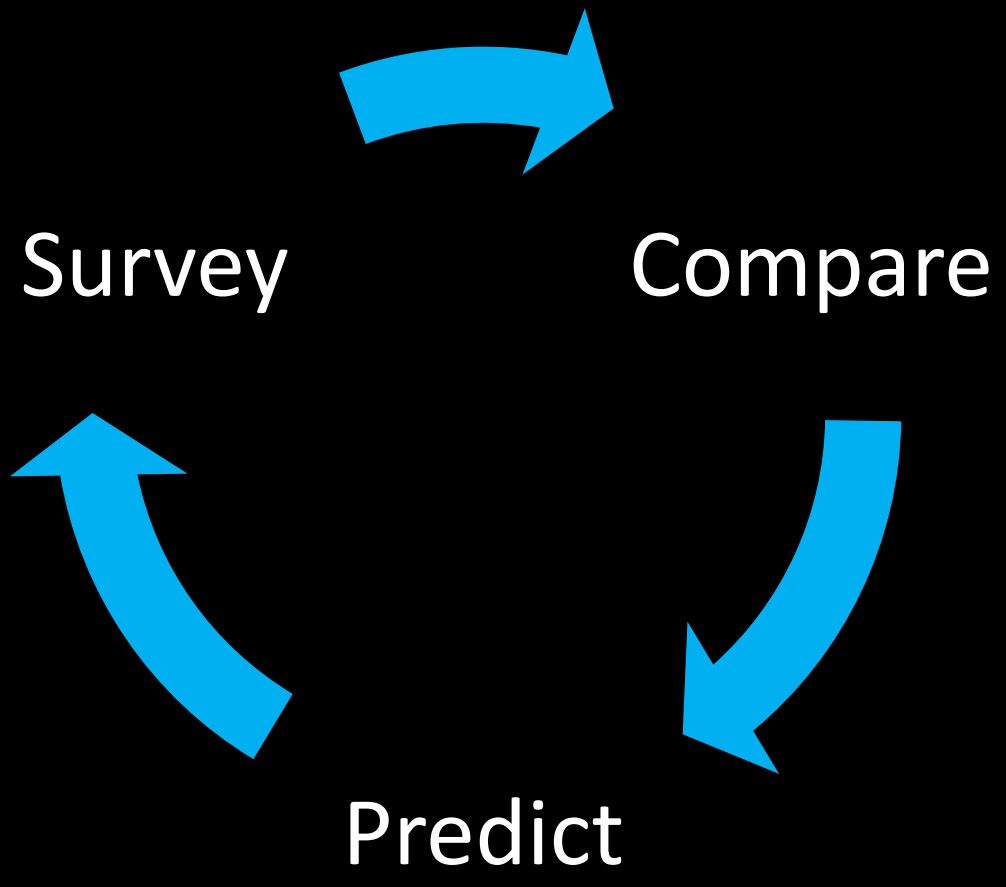
High Energy in shallow water

- Five Mile Bluff
  - 2014 – Averaged 26 spans per kilometre
  - 2015 – Averaged 30 spans per kilometre
- Indicated by sand ripples
- Current Profile





Discussion



- AUV Pipeline Survey
  - Collection time
  - Data processing time
  - Deployment logistics
  - Additional data collection
- Periodic Survey
  - Repeat surveys to understand pipeline scour
  - Identify high energy and low energy areas
  - Reduce number of surveys based on scour knowledge and prediction

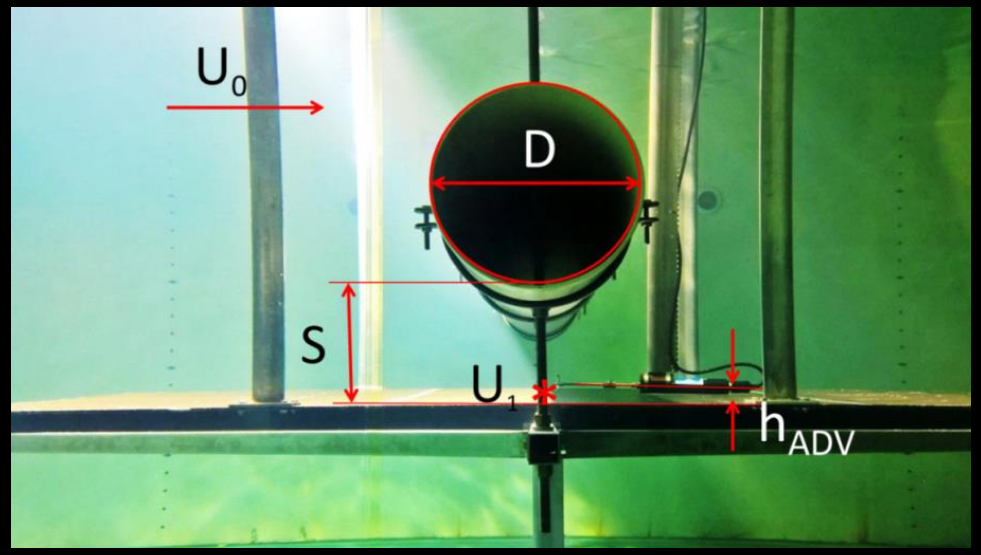
Conclusions

- AUVs pipeline surveys
  - Geo-referencing free span length and height down to 100mm
  - Geo-reference grout bag and flanges
- ROV Validation
  - Method
  - Feature recognition
  - Span heights
- Repeat Surveys
  - Direct Comparison
  - Develop pipeline scour knowledge
  - Feed knowledge into predictions to reduce survey intervals

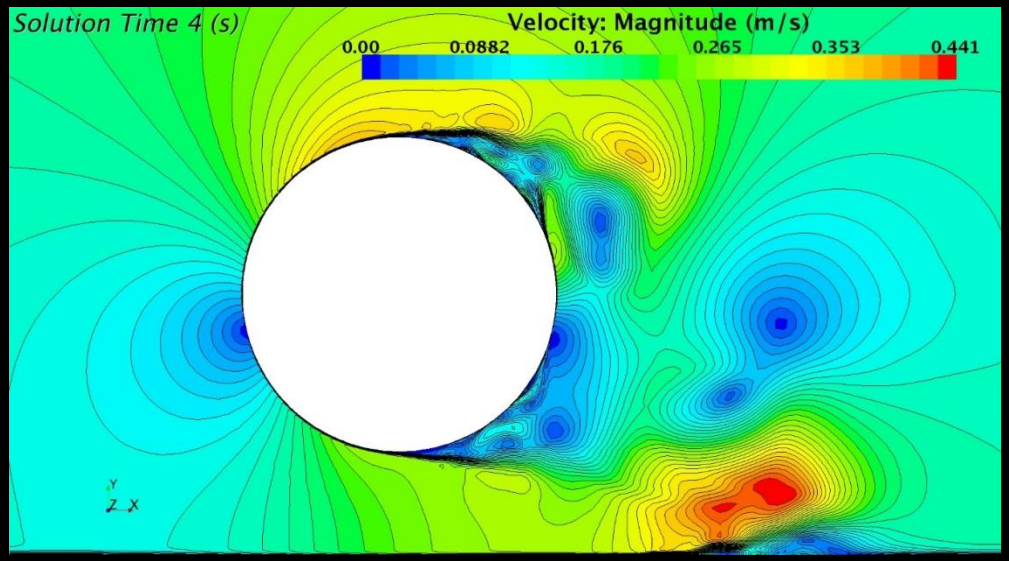

Five Mile Bluff (2014)

Ongoing Research

- Circulation Water Channel testing
- Computational Fluid Dynamics (CFD)
- Sediment Sampling



McInerney (2015)



Lee (2015)

Acknowledgments

Tasmanian Gas Pipeline

ADETRA Pty Ltd
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DST GROUP

East Cove, Deal Island (2015)

Questions

AUV GoPro footage, Five Mile Bluff (2015)

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