

AUV Pipeline Inspection (PI) Development Project Close out and way forward

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AGENDA

- ❖ Introduction
- ❖ AUV PI Development Objectives
- ❖ Development Time Line
- ❖ Technology Evolution
- ❖ Key Technologies Development
- ❖ AUV PI Key Achievements
- ❖ Conclusion / Way Forward



Introduction

- A 2 years R&D industrial collaboration project to respond to the needs to both reduce the cost of the subsea pipeline inspection and to increase its frequency in a context of ageing facilities
- Total and Chevron common specification was used to select Oceaneering Survey Services through an RFI& RFQ



AUV PI development objectives

- To reduce significantly the cost of the pipeline survey/inspection by achieving pipeline detection and tracking at low altitude and increase the frequency of the AUV PI
- Application: To replace the conventional pipeline inspection campaign by ROV or the Deep Tow (ROTV) acquisition for long distance Pipeline inspection
- Pipeline integrity = free span detection, pipe displacement (lateral or upheaval buckling), crossings, pipe walking, anodes status, CP measurement, coating damages, pipeline marks



Development Time Line



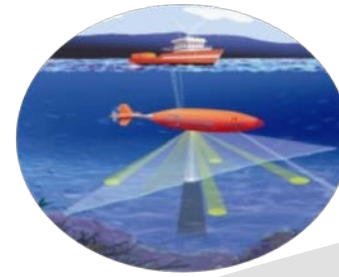
PHASE I : 2014 – 2015

- Collection of Data From Pipelines
- Demonstrate Basic Reacquisition of Lost/Buried P/L.
- Logging of All Sensor Data.
- Demonstrate Navigation Constraints, Endurance, And Speed



PHASE II : 2015-2016

- P/L Tracking With MBES – LASER
- Recognize P/L Crossings
- Recognition of Some Subsea Features
- Track Buried P/L



PHASE III : 2016-2017

- Flying at Slower Speeds /Lower Altitude
- Correction Of Navigation Error Based on Subsea Features
- Obstacle Avoidance Behaviors
- Demonstrate Full P/L Inspection
- Invite Inspection Managers From Affiliates to Witness The Field Demonstration

Ready for Affiliates
Deployment
2017

A TOTAL , CHEVRON & OCEANEERING R&D COLLABORATION PROJECT



Technology Evolution

ROV

Altitude <1m above pipeline

speed (<.5 knot)
100 Km of Pipe Takes ~ 5 Days

Need Min. DP/II Vessel

Visual Navigation

Post Processing of Data

CP Survey

Manual Obstacle Avoidance

AUV today

Altitude ~6 m above pipeline

speed (<= 4 knot)
100 Km of Pipe Takes ~ 15h

No Need for DP Vessel

Navigate using As Built Data

Post Processing of Data

No CP (Technology Gap)

No Obstacle Avoidance Sonar

Innovative Inspection AUV

Altitude ~2,5 m above pipeline

speed (<= 4 knot)
100 Km of Pipe Takes ~ 15 h

No Need for DP Vessel

Navigate using Auto-Tracking

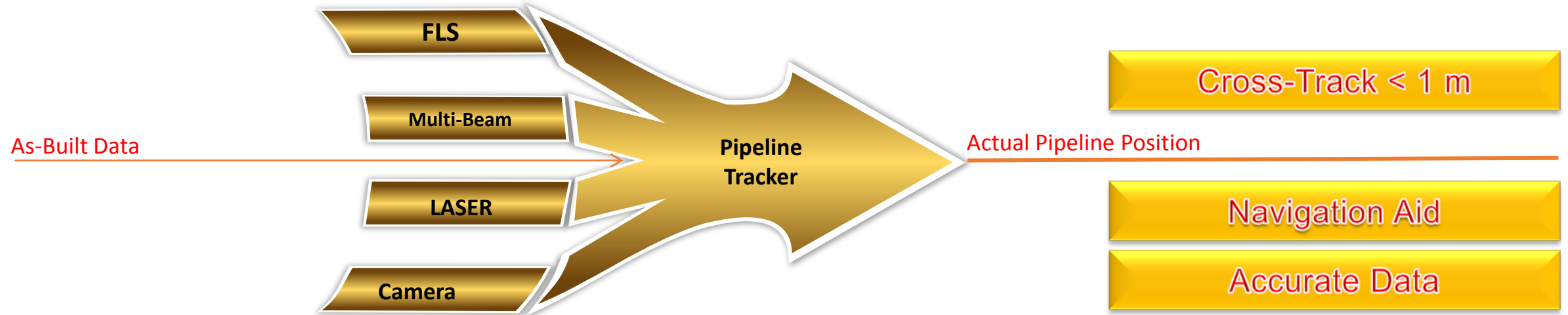
Real-time Data Processing
Pipe defects – Features

CP Survey (Under Development)

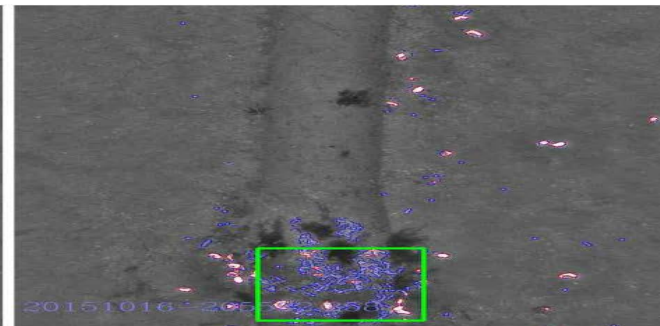
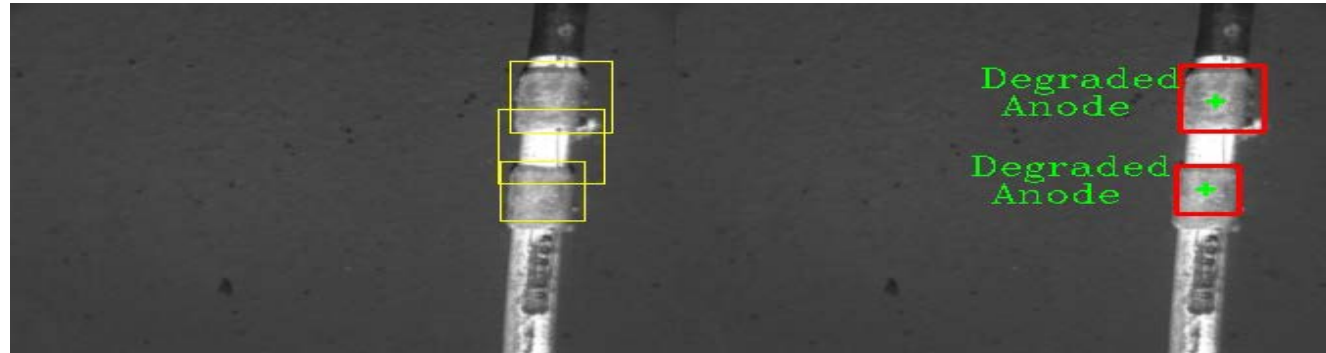
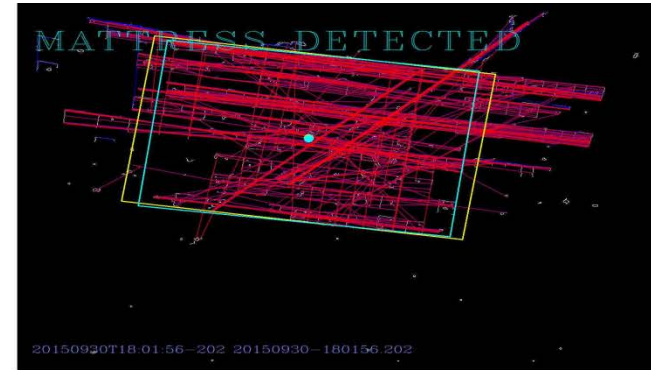
Automatic Obstacle Avoidance Sonar



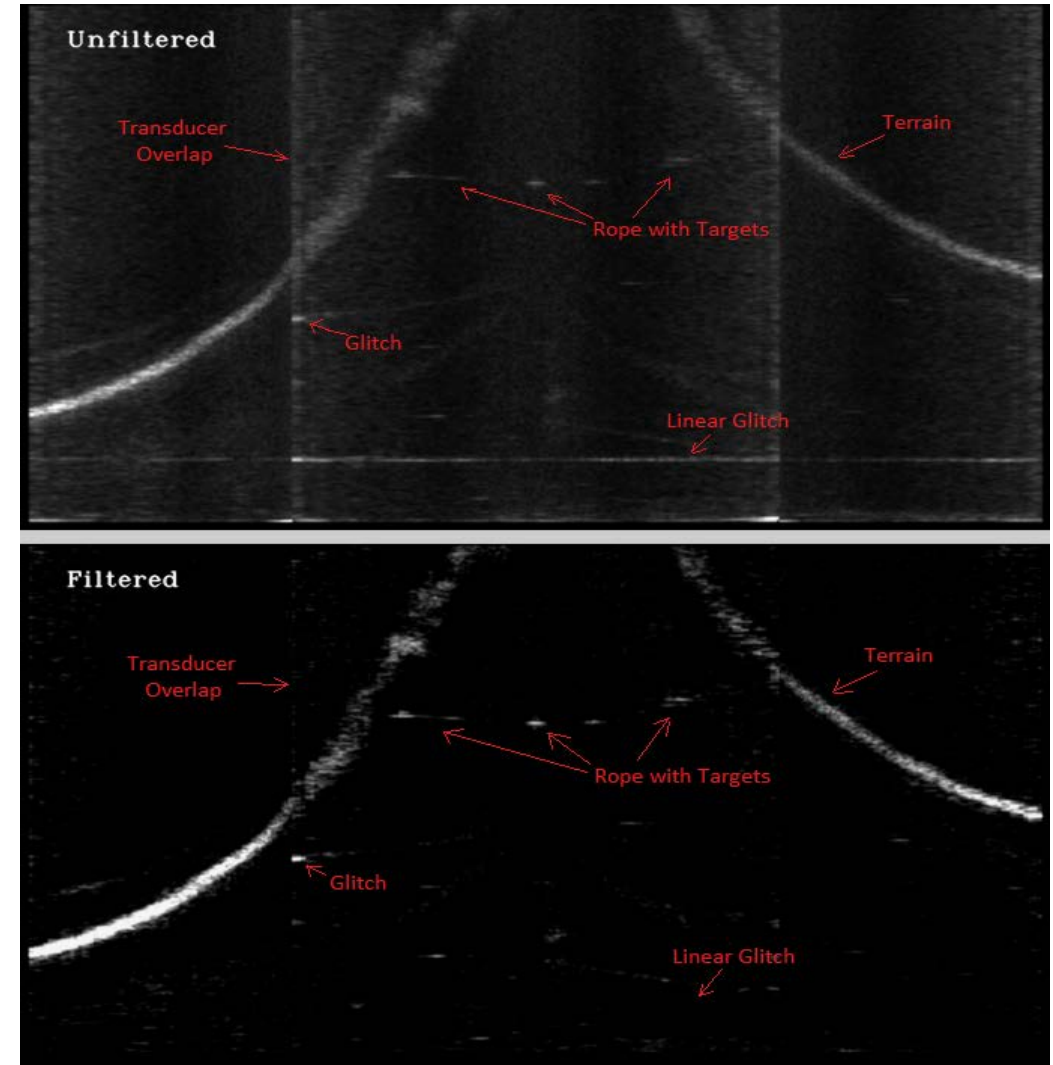
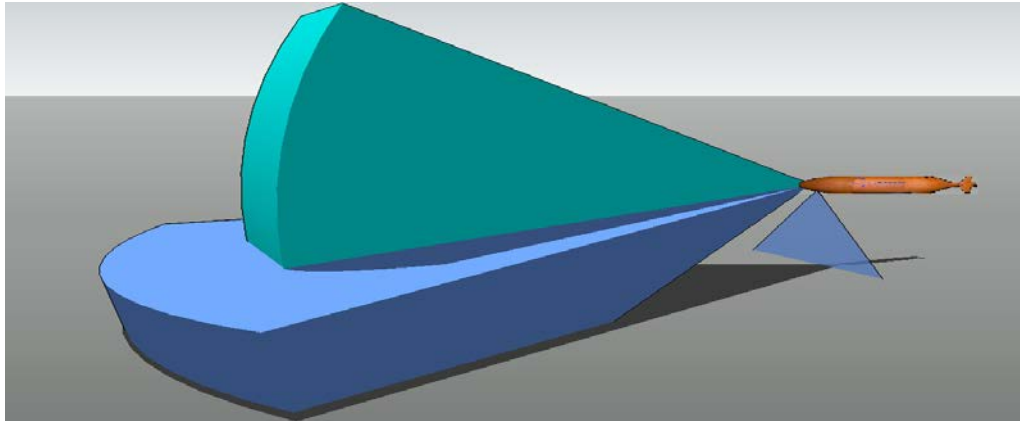
Key Technologies Development - Pipeline Auto-Tracking



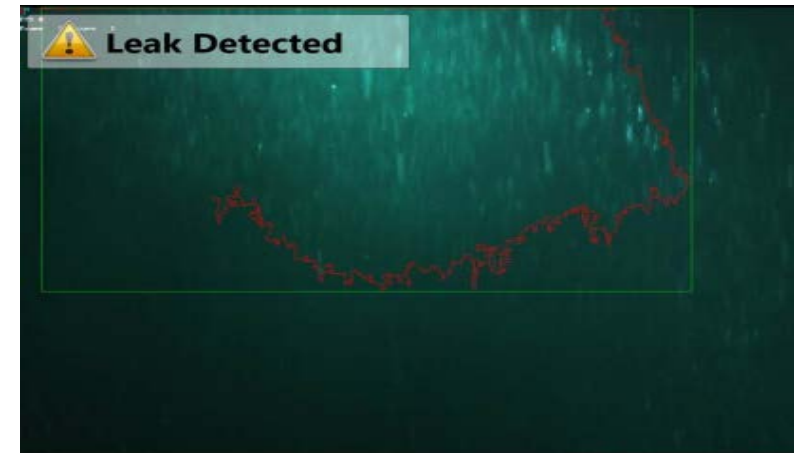
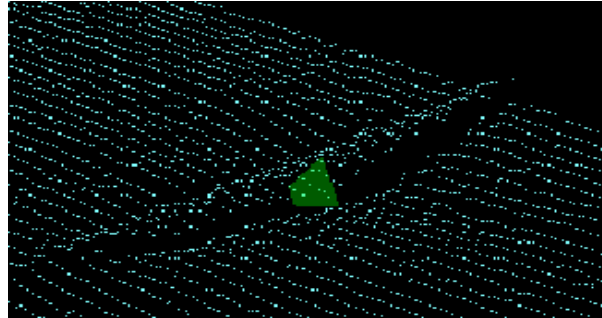
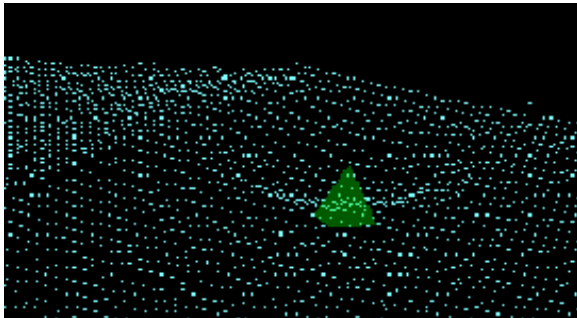
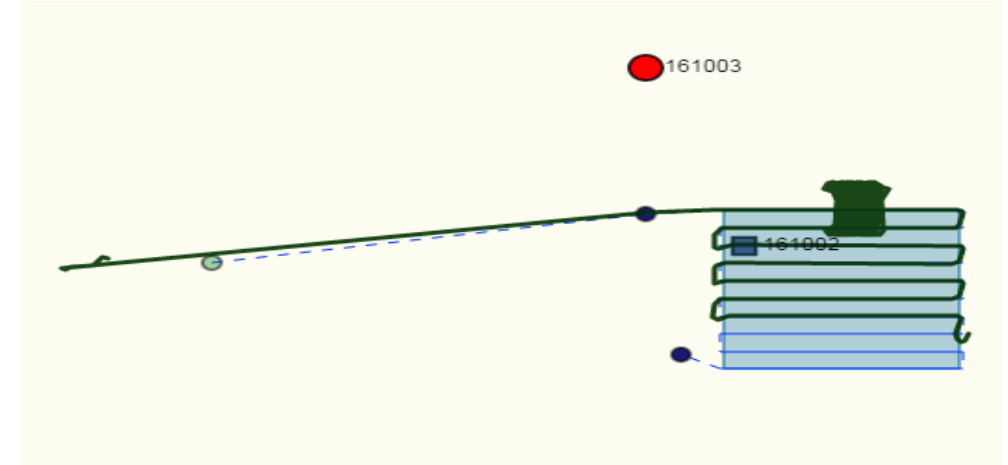
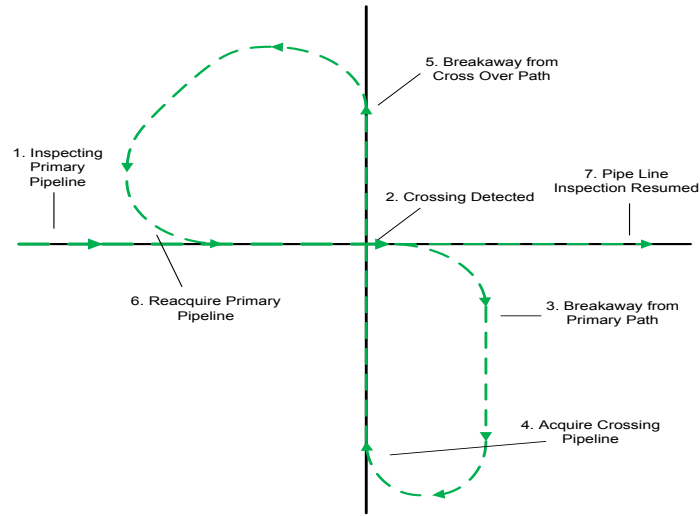
Key Technologies Development - Auto-Detection of Pipeline Features



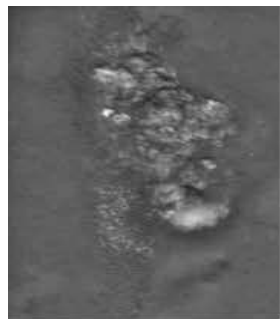
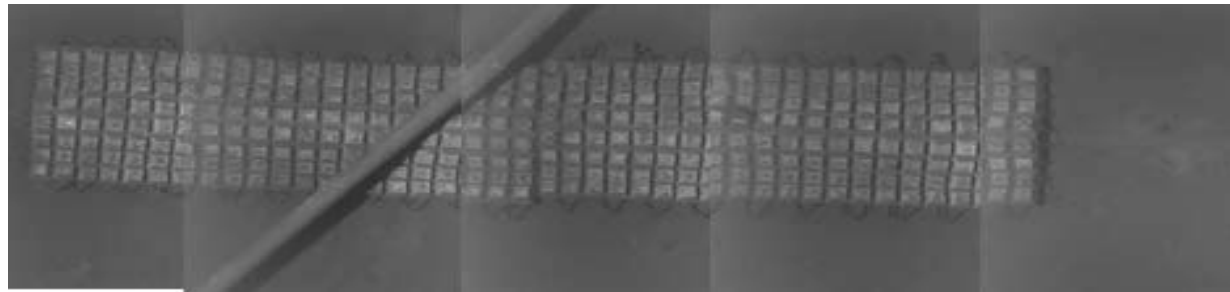
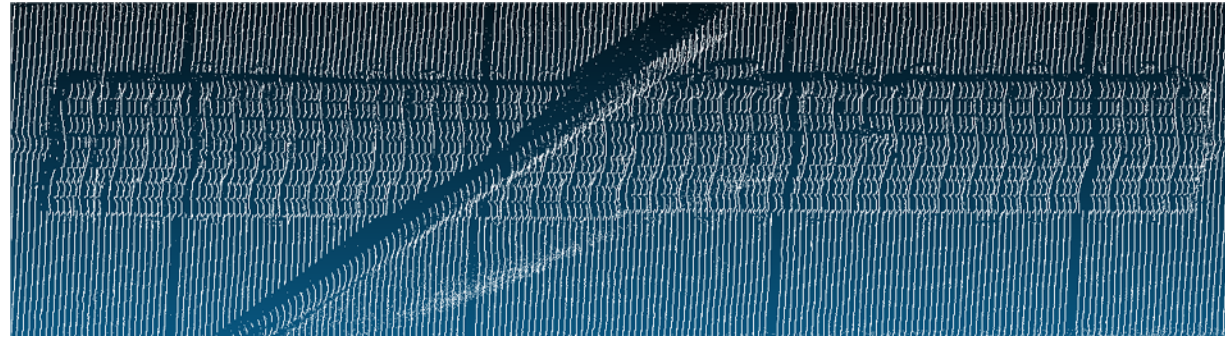
Key Technologies Development - Obstacle Avoidance



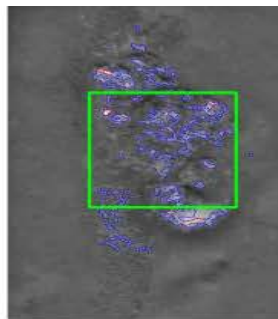
Key Technologies Development - Smart behaviour



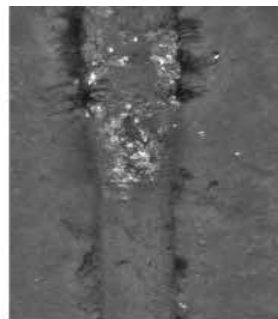
Key Technologies Development - Pipeline Feature Based Navigation



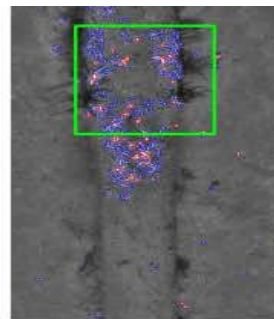
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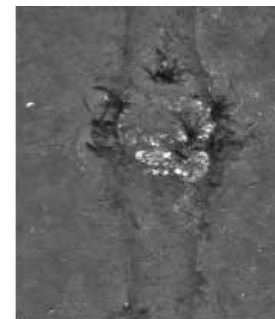
(a2)



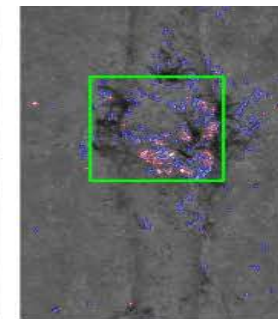
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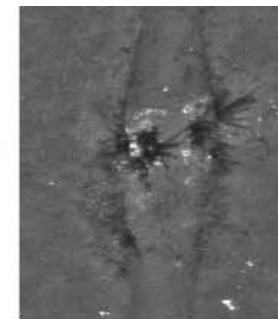
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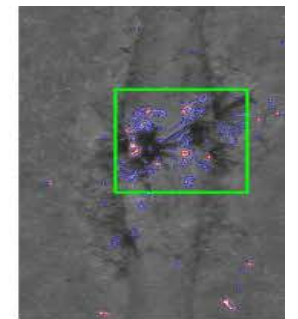
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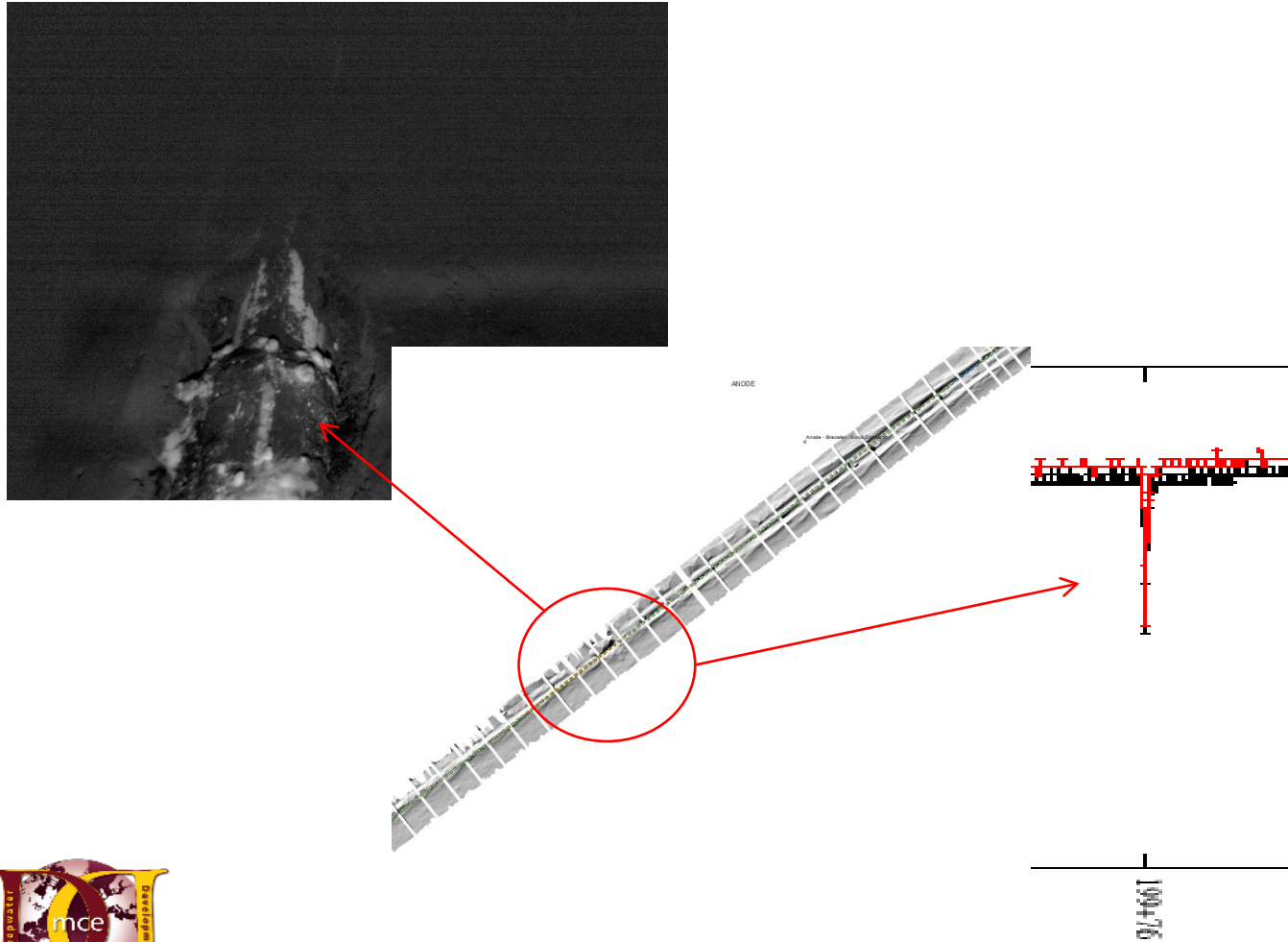
(d1)



(d2)

Key Technologies Development - Cathodic Protection Measurements

- Proof Of Concept (POC) tested in Field Conditions:



AUV PI - Key Achievements

- **Pipeline Auto-Tracking**

- ✓ Capability to maintain the vehicle at low altitude with a cross track +/-1m

- **Auto-Detection of pipeline features**

- ✓ Real-time detection of mattresses, Anodes, free spans

- **Obstacle Avoidance**

- ✓ The AUV detected obstacles using the Forward Looking Sonar and avoided simulated obstacles

- **Smart Behaviour**

- ✓ AUV route modification while passing through pre-programmed features (crossing, free-spans)

- **CP measurement**

- ✓ Demonstration of the Proof of Concept during a field trial by measuring some potential difference while the AUV was flying above the pipeline using the pipeline auto-tracking



Conclusions and way forward

- AUV PI system fully industrial Q3 2017
- Cost divided by 3 in average for subsea pipeline inspection
- AUV for PI is a **major milestone** in our way to full subsea robotics deployment:



Today:

- Inspection AUV and workclass ROV

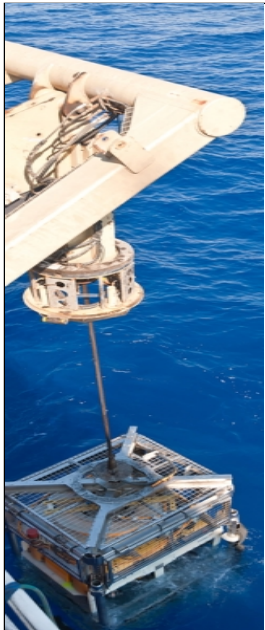
2020:

- Inspection AUV
- workclass AUV/USV deployed ROV
- Embedded robotics in Subsea Production systems



END OF THE PRESENTATION

QUESTIONS ?



A Mission Pipelines Inspection

- Surface defects on equipment
- Movement of equipment
- Free-spans
- Cathodic protection measurements
- Today, done with ROV

A Technology Autonomous Underwater Vehicle (AUV)

- Launch and Recovery
- Propulsion and Power
- Collect and Store Data
- Avoid Obstacles



Goal of our innovation :

Develop AUV to meet pipeline inspection specification for global pipeline inspection services