

*“The World’s first autonomous inspection
of subsea pipelines”... ?*

16th September 2019

...OR REALLY...

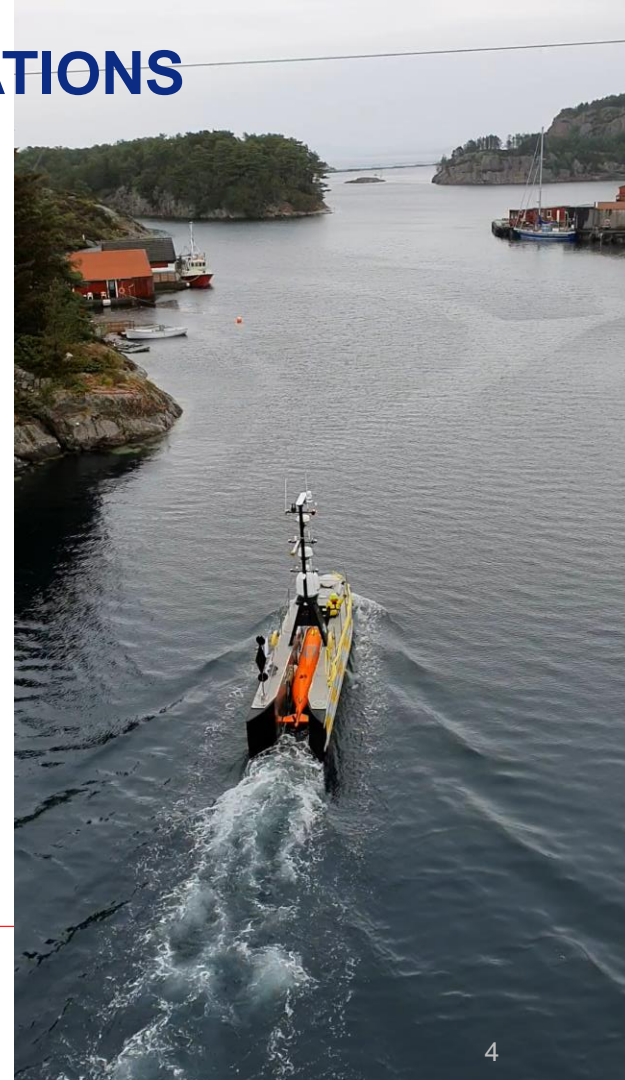
The first unmanned “over the horizon” pipeline inspection performed with an autonomous underwater vehicle (AUV) launched and recovered from a unmanned surface vessel (USV).

TODAYS NORMAL OPERATION WORLD WIDE



THE WAY TOWARDS UNMANNED OPERATIONS

- Swire Seabed have for the last 3 years worked with different approaches using AUV's for surveys and pipeline inspection
- The last 2 year heavily focusing doing unmanned operations
- Pilot projects for Equinor and other clients to prove concept
- Swire Seabed has performed pipeline inspection of 7 pipelines over the last year using this method. In total over 350 km operated from shore.



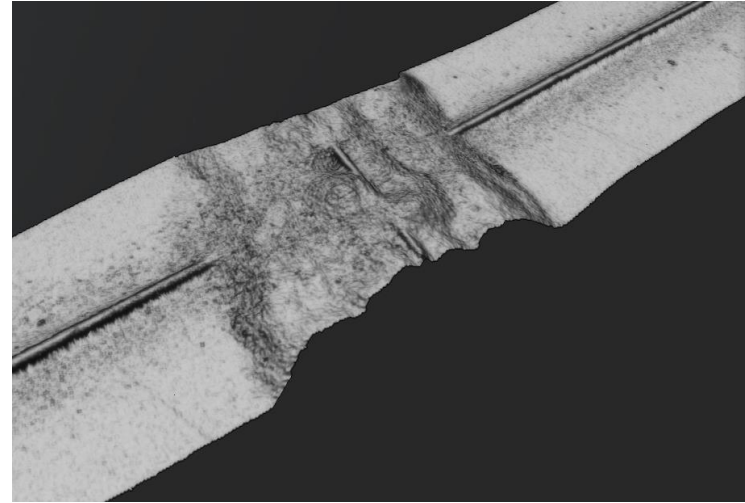
PILOT 1 OCTOBER-NOVEMBER 2018

Scope of work was to perform an Acoustic Pipeline Inspection of three pipelines from Kollsnes to Troll field.

Performed the inspection according to Equinor's specifications for Acoustic Pipeline Inspection.

All operation without use of an ROV vessel.

Tested the technology readiness for operation.



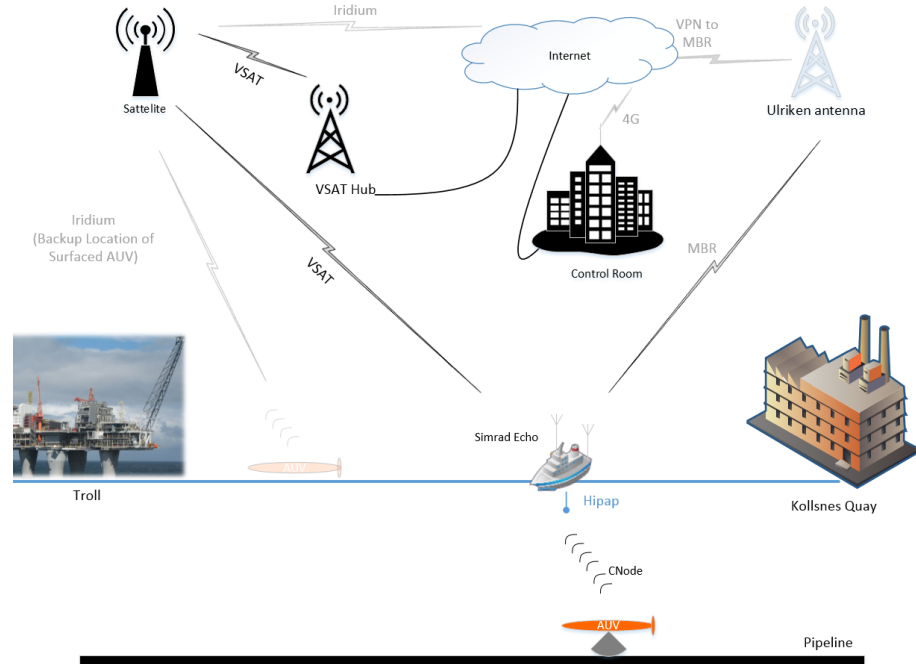
PILOT 1 - COMMAND AND CONTROL CENTRE

- Main operation room for remote operations at Swire Seabed. Can be set up in other locations.
- During pilot 1, the operation was controlled from the operations centre in Bergen.
- Live update of mission and change of AUV route was successfully performed from the shore side operation room.



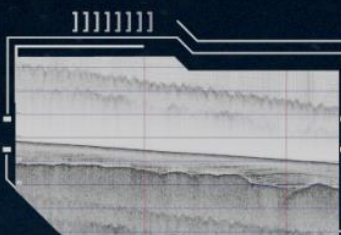
PILOT 1 - COMMUNICATION INFRASTRUCTURE

- Bergen Office to/from USV: 4G, MBR and Inmarsat. Iridium modem as backup.
- Bergen Office to/from AUV: 4G, MBR and Inmarsat routed through USV.
- USV-AUV: Acoustic, UHF, WiFi, and Iridium.
- Individually powered Iridium emergency beacon on both AUV and USV.

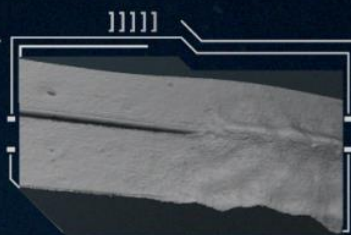




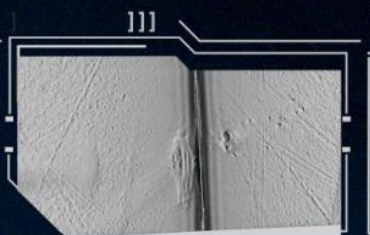
CATHX CAMERA



SUB BOTTOM PROFILER



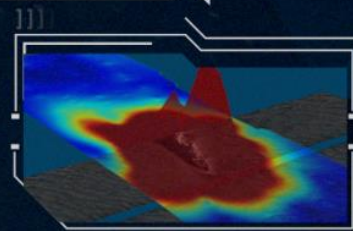
MULTIBEAM EM2040



HISAS



LASER



MAGNOMETER



PILOT 1 - «USV» USED

Due to the Sea-Kit USV needed to be transported to Shell Ocean Xprice in Greece we had to use Simrad Echo for Pilot

Communication between control room and Simrad Echo was performed in the same fashion as planned for the USV.

All data traffic routed from control room, through vessels HiPAP system to the AUV.

Mission changes sent from control room to AUV through vessel HiPAP system. Data snippets received back to office

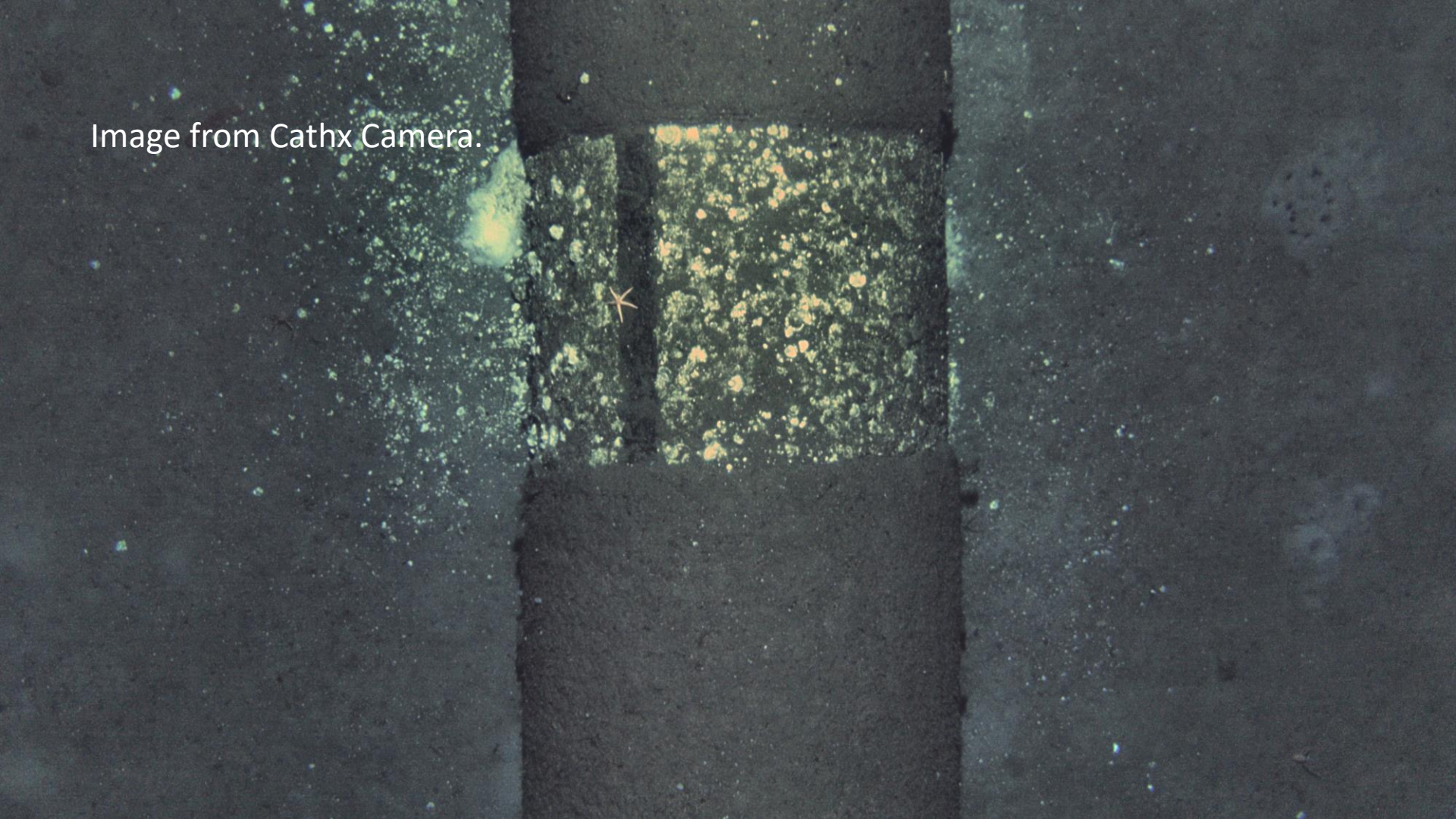
Vessel operation and Launch and recovery of AUV executed by personnel onboard.



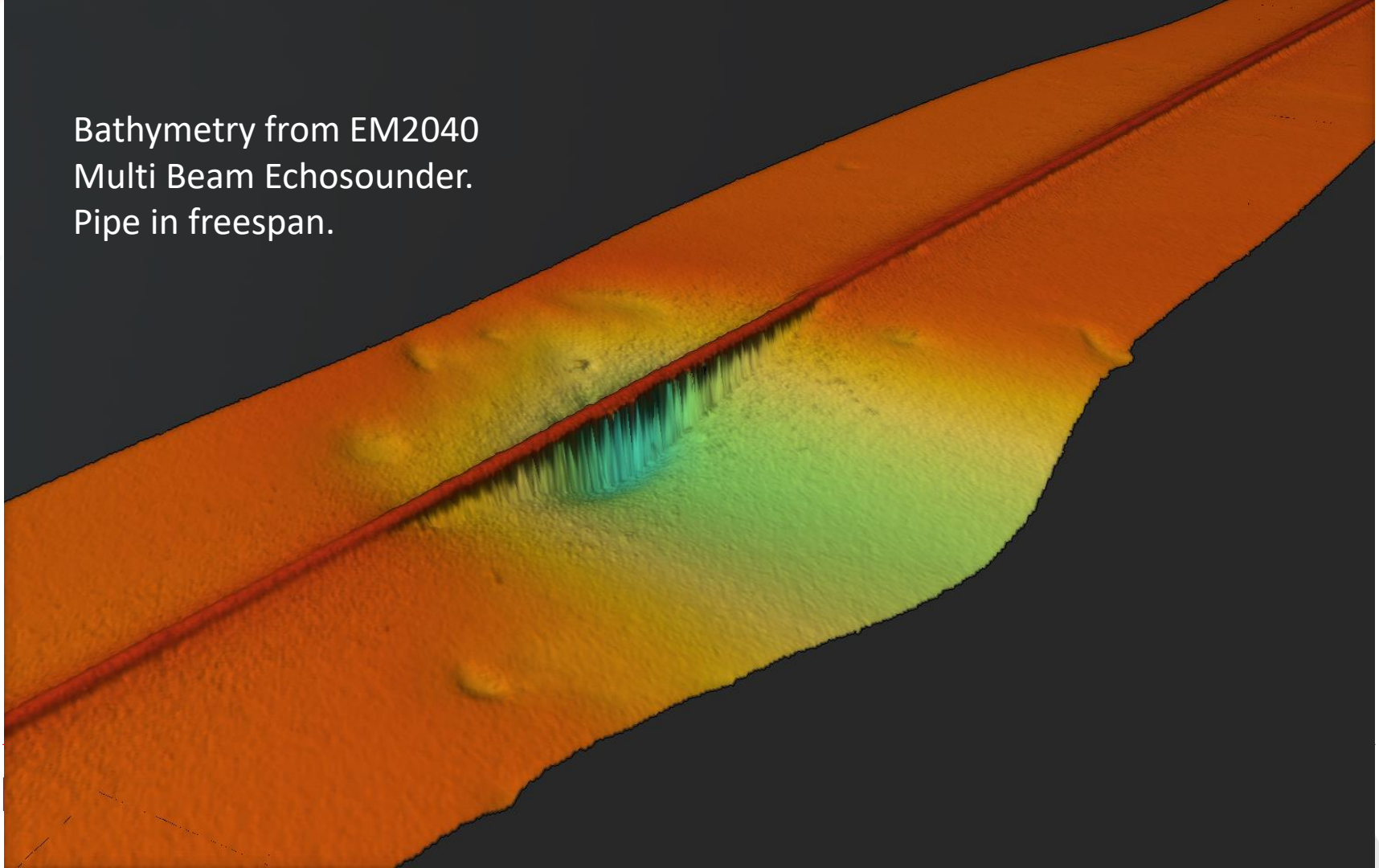
PILOT 1, RESULTS

- 3 x Pipelines covered from Kollsens to Troll. Approx 180km in total.
- Total fuel consumption during operations ~2,4m³
- 2 Dives performed, Dive #1: 21hrs, Dive #2: 24hrs
- Dives were pre-planned, and monitored from the Swire Seabed Office (Control Centre).
- Update of mission plans from control room executed successfully during operations.
- No intervention from vessel required (Except from L&R)
- Data quality is good, consistent and we are able to fulfill requirements in specification.

Image from Cathx Camera.

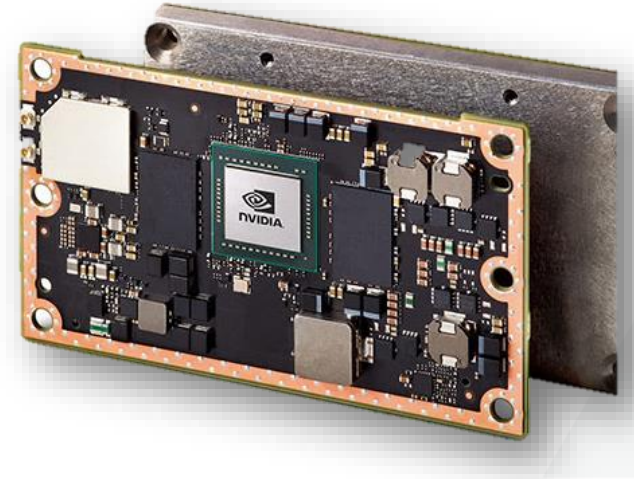


Bathymetry from EM2040
Multi Beam Echosounder.
Pipe in freespan.



SUBSEA PROCESSING

- **Main objective to detect missing data during dive and report back to AUV Operating System to perform rerun.**
- **This enables live data quality control and response to detected events.**
- Installed two high speed processor card in AUV
- Hardware and software for real time processing and machine learning.
- Interfaces for camera, sonar, motion etc.
- **Future real-time reporting and adaptive mission control**



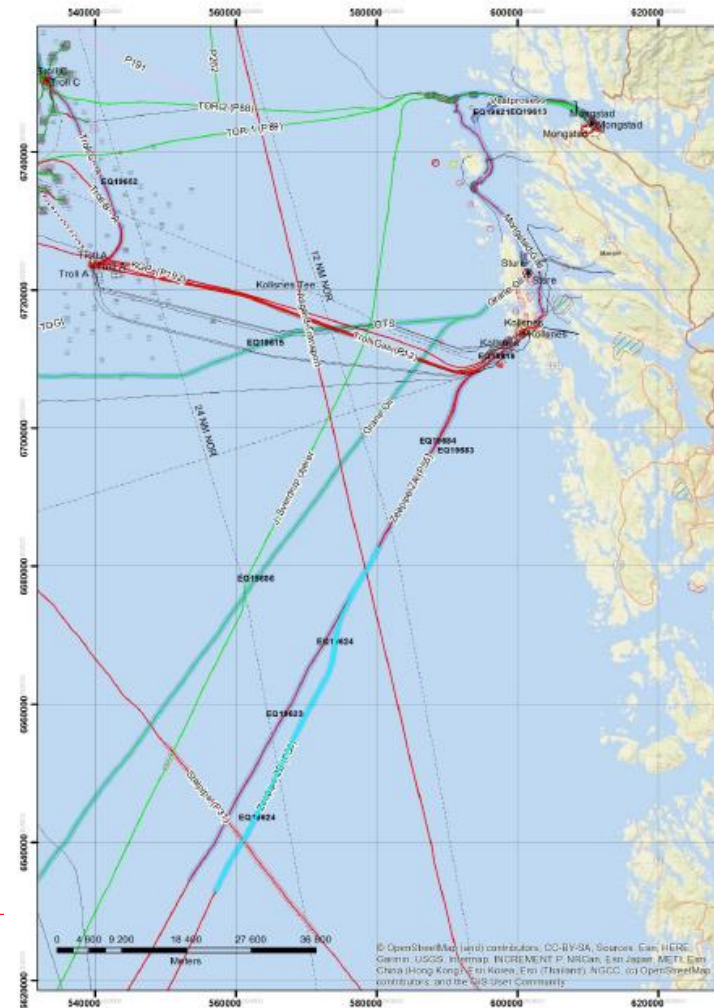
PILOT 2 JULY 2019

- 6 days offshore utilising Kongsberg Maritime's Hugin AUV (Autonomous Underwater Vehicle) with the SeaKit Maxlimer Unmanned Surface Vessel (USV) acting as the host vessel for surface positioning and communications onshore.
- Controlled from onshore including launch and recovery of the AUV, command and control of the USV/AUV and monitoring of the acquisition of pipeline inspection data.
- Four pipelines where inspected, a total of 175 km over 2 dives
- 55km offshore «over horizon operation»



SWIRE SEABED

Reaching further



PILOT 2 - USV USED

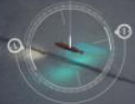
Multipurpose platform Sea-Kit

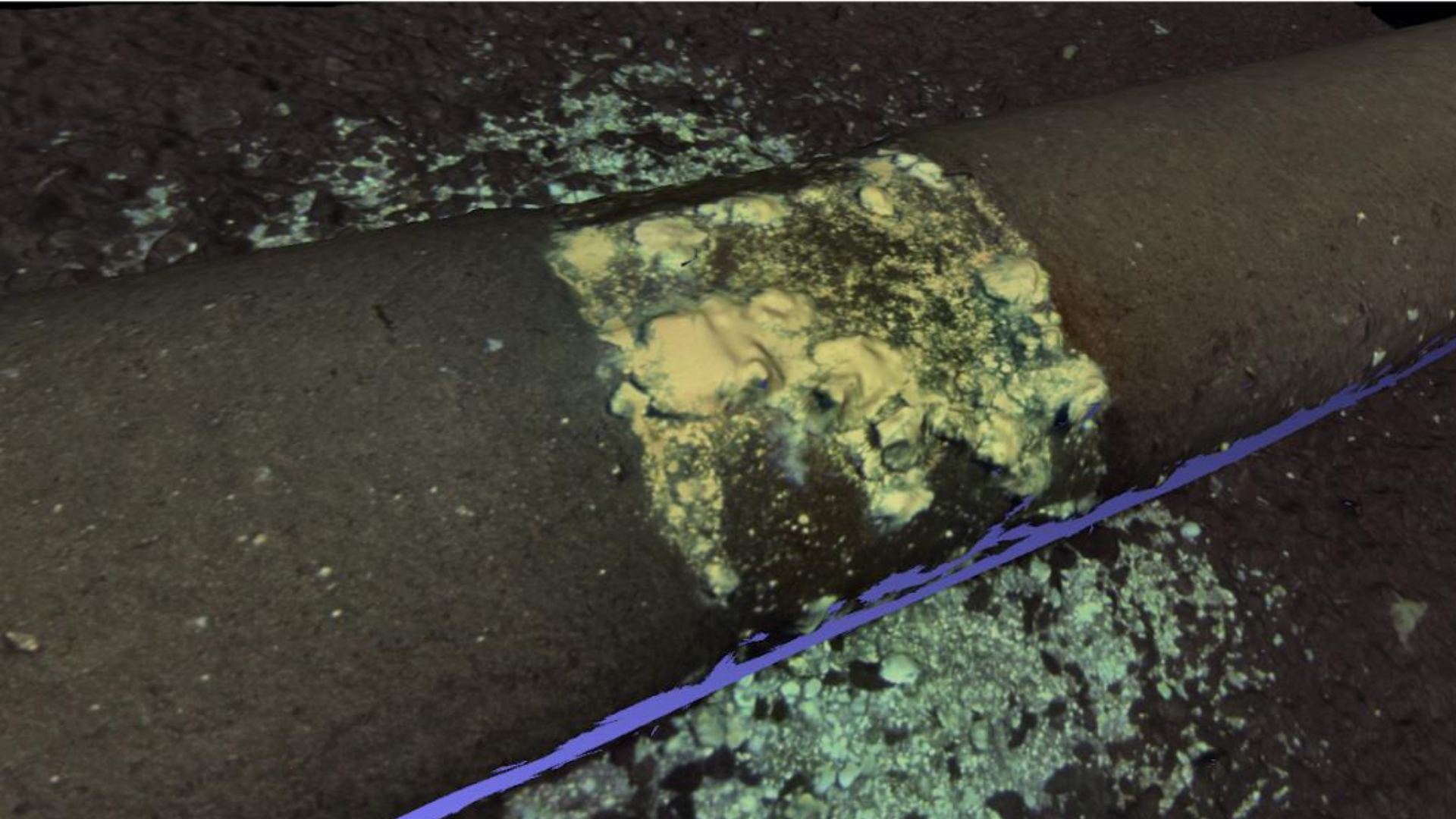
- Hydrography
- AUV launch and recovery
- Configured to carry an AUV
- Autonomous waypoint following, AUV following and control of onboard equipment.
- Length 12 m
- Endurance 200 hours
- Energy: Diesel engine
- Maximum speed 10 knots

Navigation, Communication & Collision Avoidance:

- HiPAP 502P or 352P
- Seapath 136 and MRU5+
- AIS 300
- Radar, Camera & LIDAR
- Marine Broad Band Radio
- Iridium and 4G







SAME MISSION, OLD VS NEW

Old solution. 66
people onboard

New solution.
Unmanned and
95% less fuel
consumption



SWIRE SEABED

Reaching further