Clean Sea – advanced and subsea resident robotics in support to oil&gas industry activities in deep and ultra-deepwater scenarios

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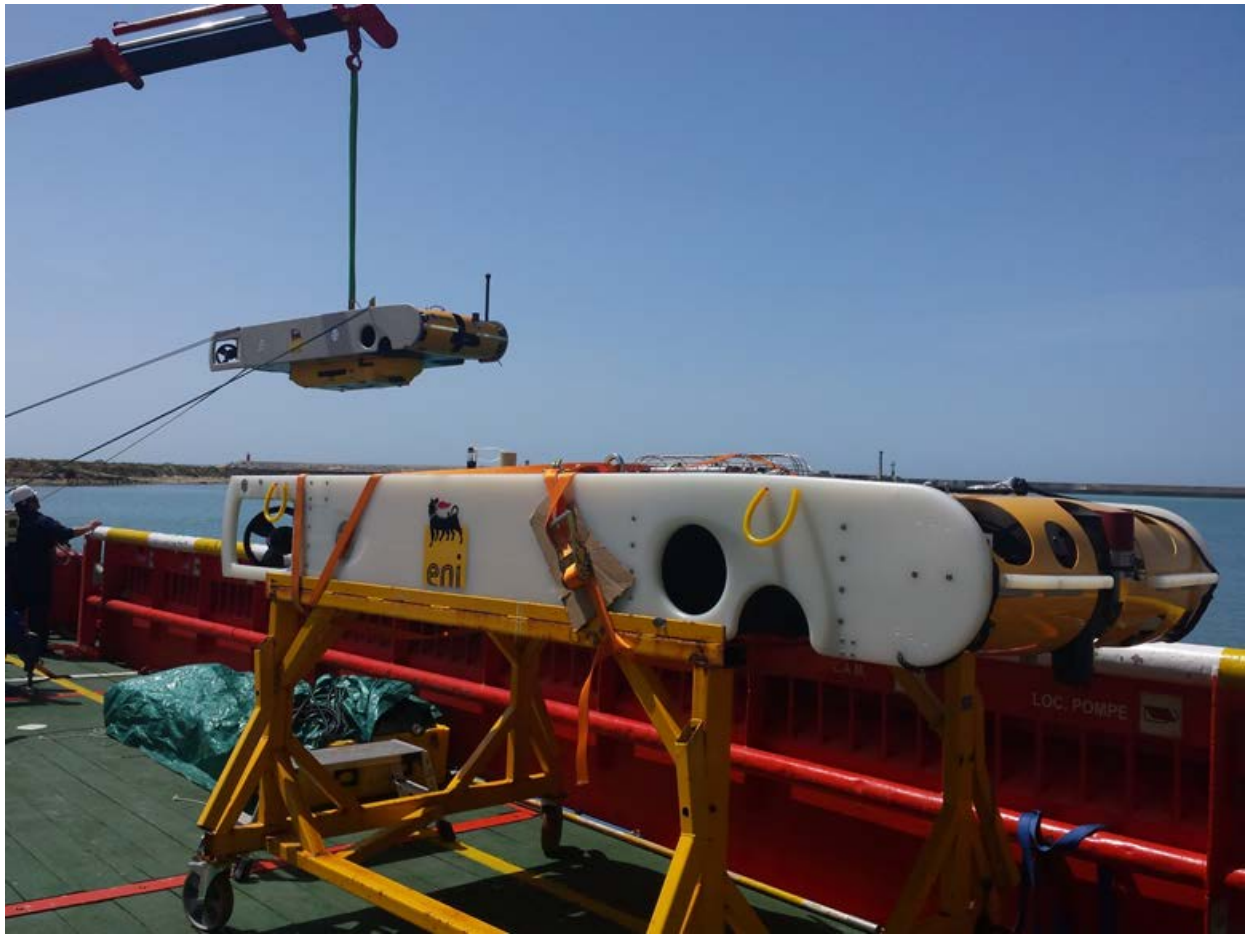
Clean Sea

- Eni underwater robot designed for environmental monitoring, survey and inspection tasks in oil&gas scenarios

- Original concept, characterised by
  - hybrid ROV/AUV architecture
  - interchangeable mission payload
  - capability to change mission strategy in real time
  - low-logistics requirements

- Two production units in service since end 2016
  - Clean Sea Mediterranean (1200 m)
  - Clean Sea Angola (3000 m)



Main drivers for unmanned operation

- Proactive approach in environmental and maintenance monitoring
- Cost reduction
- Challenging scenarios (e.g. deep water)
- Possibilities offered by advanced robotic technology

  ... *but present AUVs are mainly designed for seabed surveys*






Interchangeable pod concept

- Environmental monitoring

- Visual inspection and hydrocarbon leakage detection

- Water sampling

- Seabed acoustic inspection

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Capabilities

AVAILABLE

- Environmental monitoring ★
- Water sampling #1
- HC leakage detection and localisation ★
- Visual inspection ★
- Laser profiling #2
- Pipe tracking (magnetic)
- CP inspection (contactless/contact)
- Acoustic surveys (SSS, MBES, SBP) #4

DEMONSTRATED

- In-situ chemical analysis
  - Mass spectrometry #5
  - Trace metals #3

★ Standard payload

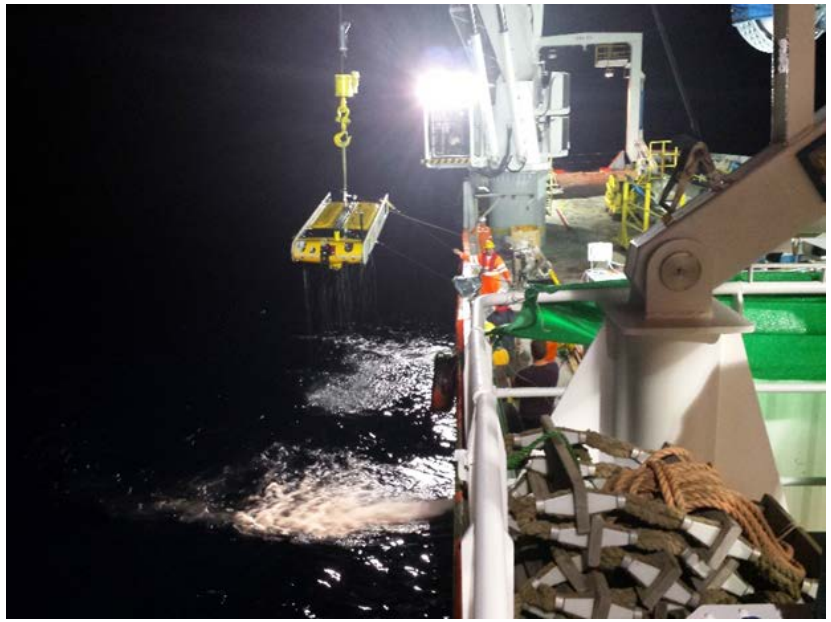
#x Dedicated e-pod

DEVELOPMENT ONGOING

- Bioacustics #7
- Magnetometry
- Sediment sampling (cores) #5
- Sediment removal and sampling #9
- Torque tool ★
- IMR #8
  - Manipulator (7F, electric)
  - Grabber (5F, electric)
  - Tools (UT, FMD, ACFM)
- 3D reconstruction #6
  - 3D imaging system (downward)
  - 3D imaging system (front)
  - Real time pipe tracking (laser)
  - 3D sonar

From R&D to operational life

- 2011-2013 Prototype development and test
- 2013-2015 Demonstration trials in real oil&gas scenarios (North Sea, Caspian Sea, Adriatic Sea, Sicily Channel)
- 2015 60 km pipeline inspected (Sicily Channel and Ionian Sea, up to 270 mwd)
- 2016 Environmental baseline survey (Mediterranean Sea, up to 1200 m water depth)
- 2016 Precision bathymetric survey over gas field (Adriatic Sea)
- 2016 Clean Sea Angola FAT
- 2017 Clean Sea Mediterranean FAT
- 2017 23 km seabed survey over a sealine corridor (Italy)
- 2017 365 km pipeline + 20 risers + target inspection (Italy, up to 270 mwd)
- *2018 305 km pipeline + 29 risers + target inspection (Italy)*



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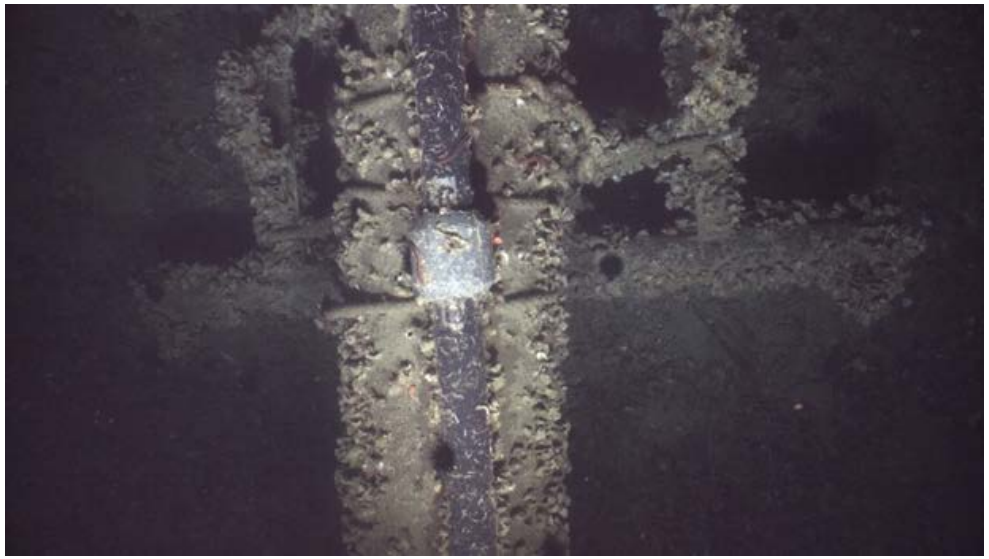
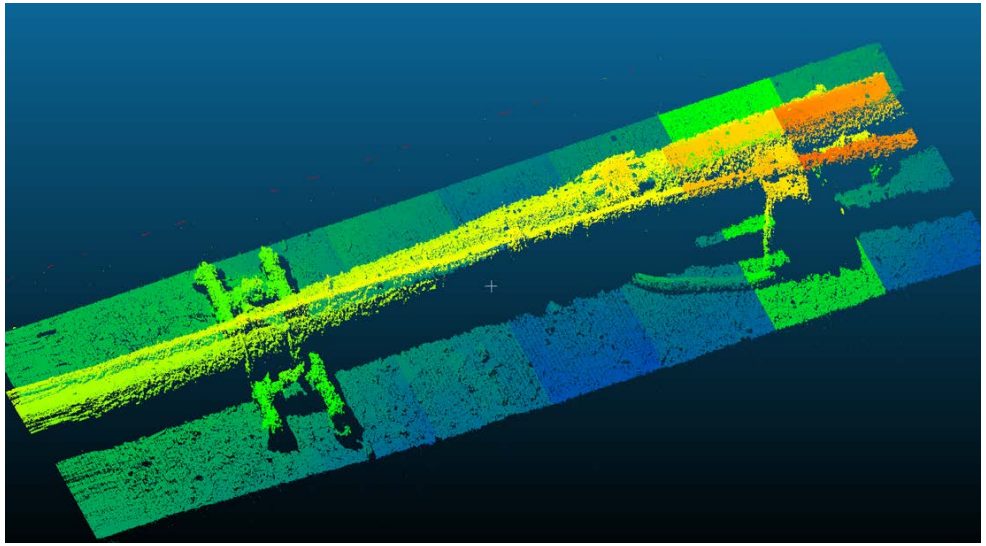
Video inspection

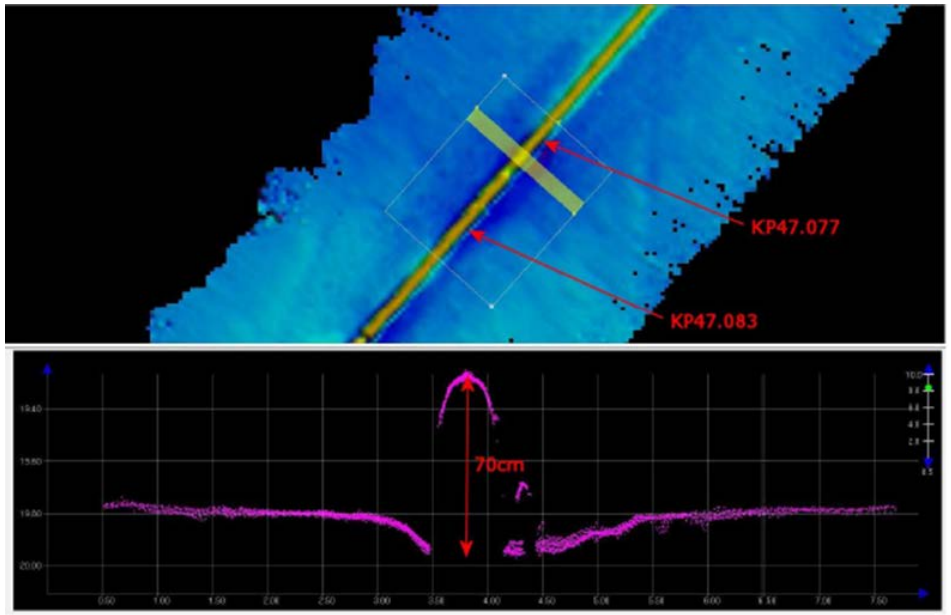


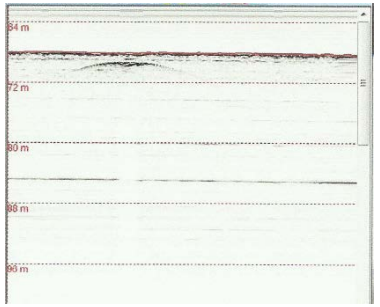


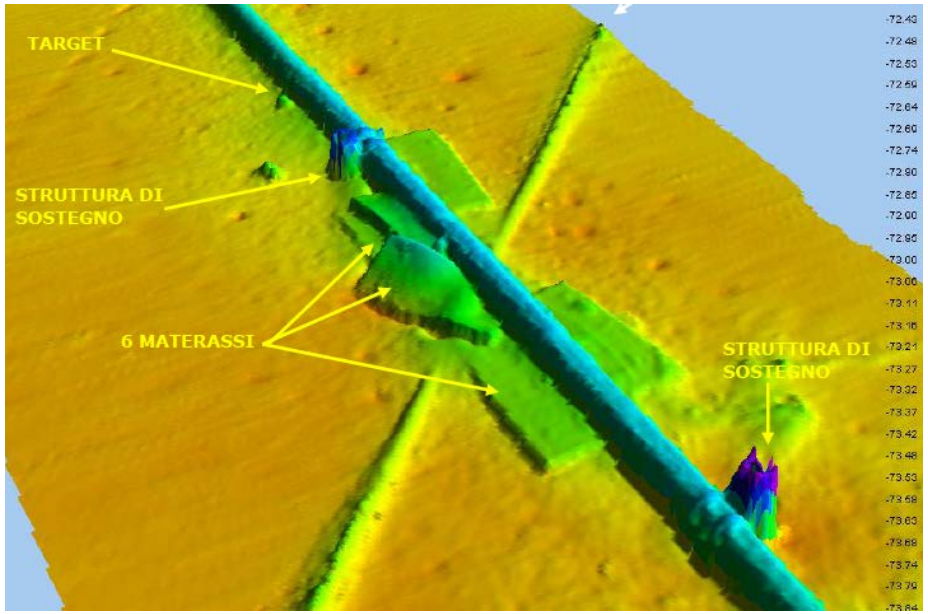
- 3D video reconstruction
- 3D laser reconstruction
- mm resolution @ 3 m altitude and 0.5 m/s

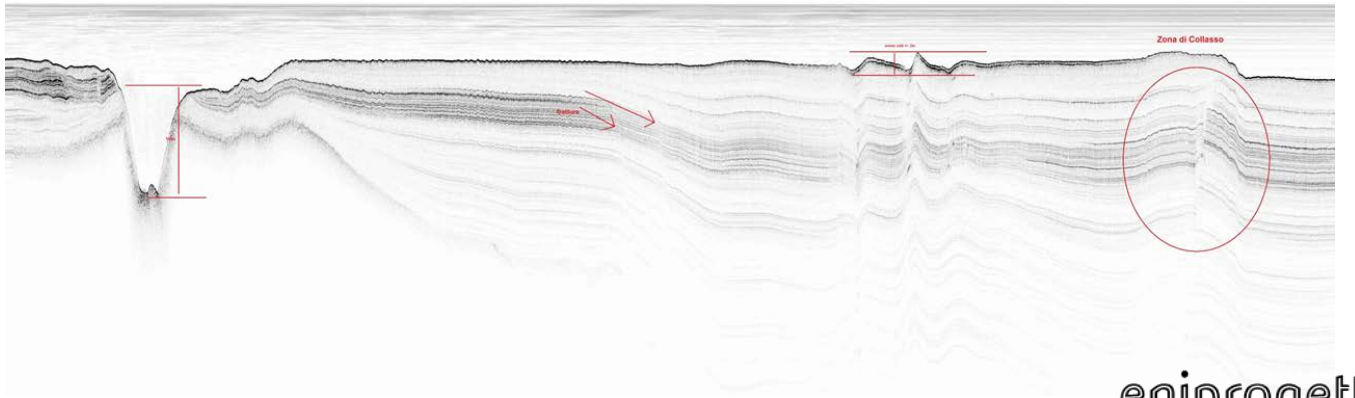
Acoustic inspection

- MBES, SSS, SBP synchronized and acquired simultaneously
- Integration with best available processing and visualisation softwares (QINSy, Fledermaus, Qimera)



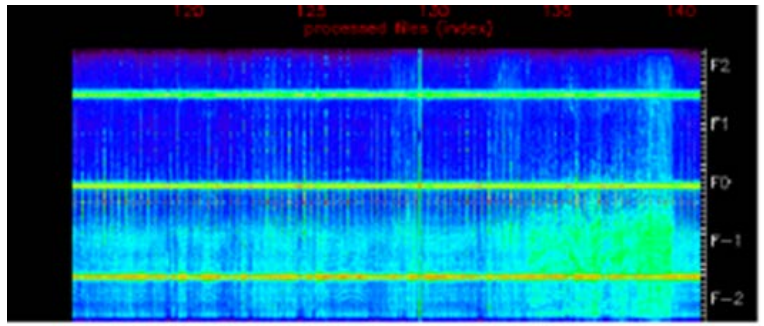


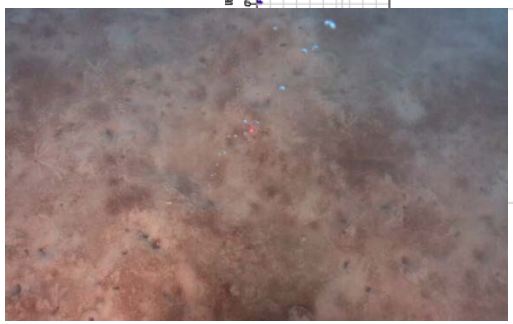


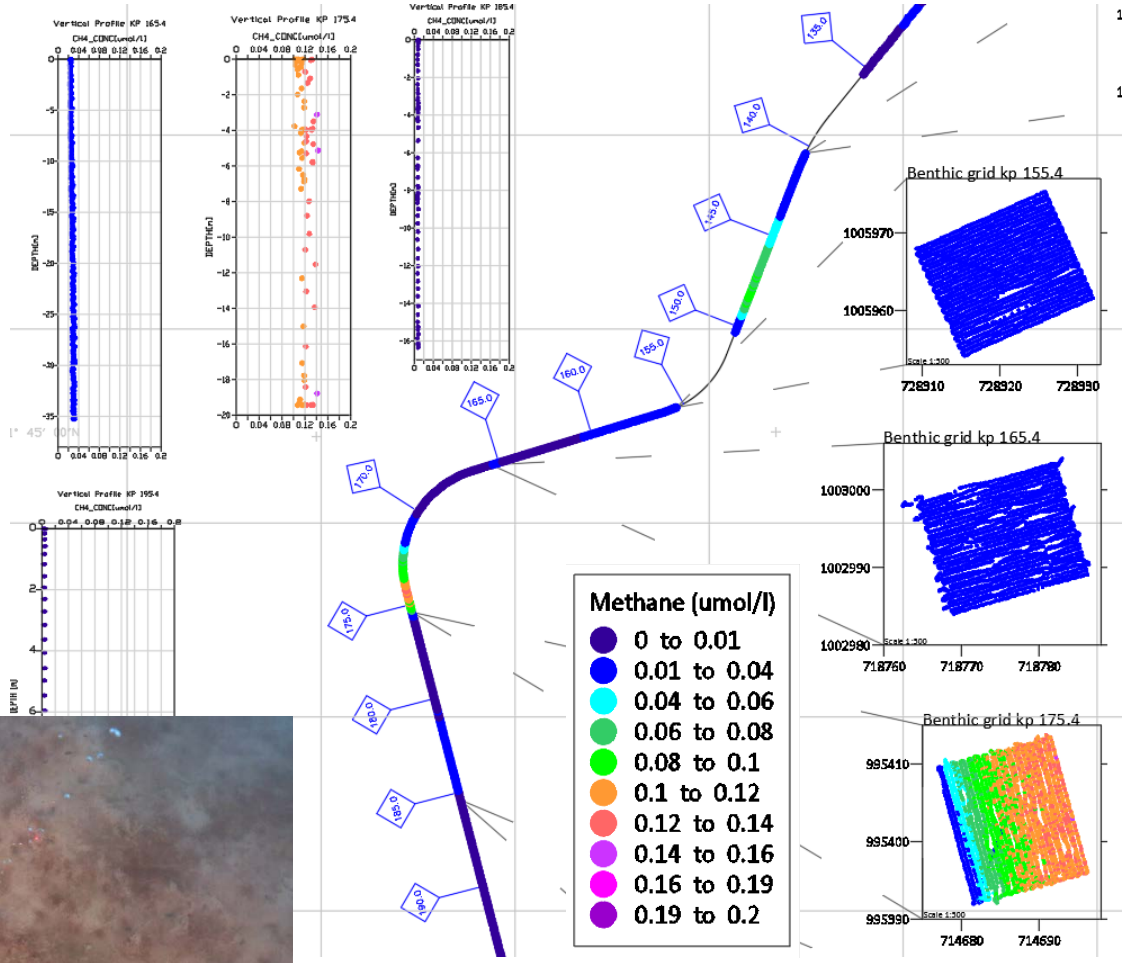


Hydrocarbon leakage detection and characterisation

- Multiple hydrocarbon detection techniques operated in parallel
  - Passive acoustics
  - Optical camera (visual range, UV)
  - Fluorescence
  - Gas sniffer (semiconductor, laser)
- "reactive behaviour" capability implemented for automatic localisation of anomaly source

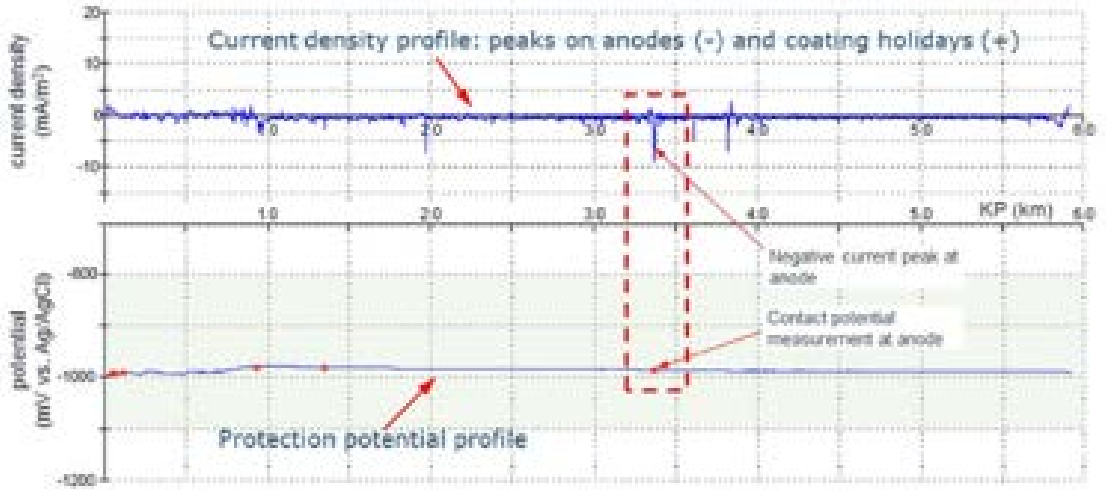


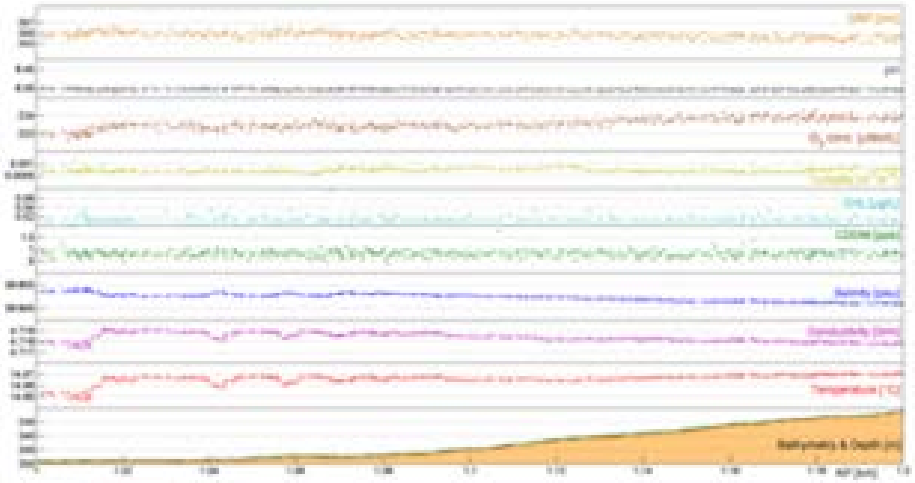




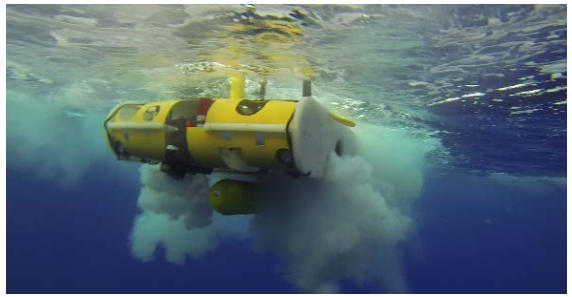
Cathodic protection and environmental characterisation

- Continuous, non-contact potential and current density measurements over the line
- Contact measurements over selected points (e.g. anodes, flanges)
- Environmental characterisation always made, whichever mission task is selected





From Clean Sea to Clean Sea EVO1

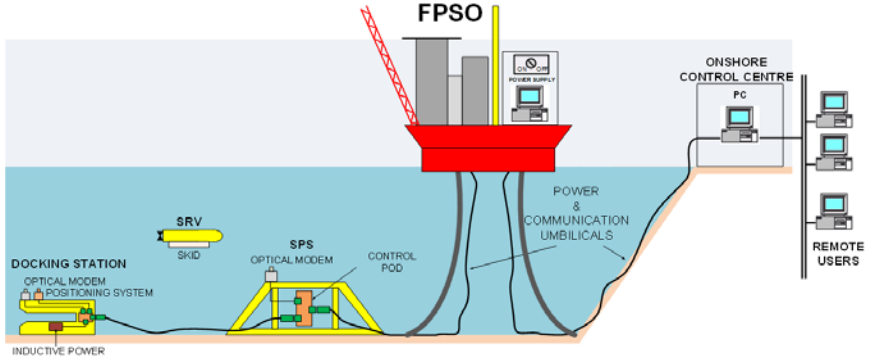


- Multidisciplinary, routinary tasks (environmental monitoring, oil spill detection and general visual inspection)
- Operable by ship of opportunity, SSV, platform
- Cost effective
- Operable as AUV or ROV (for tasks requiring operator supervision)

DEMONSTRATED

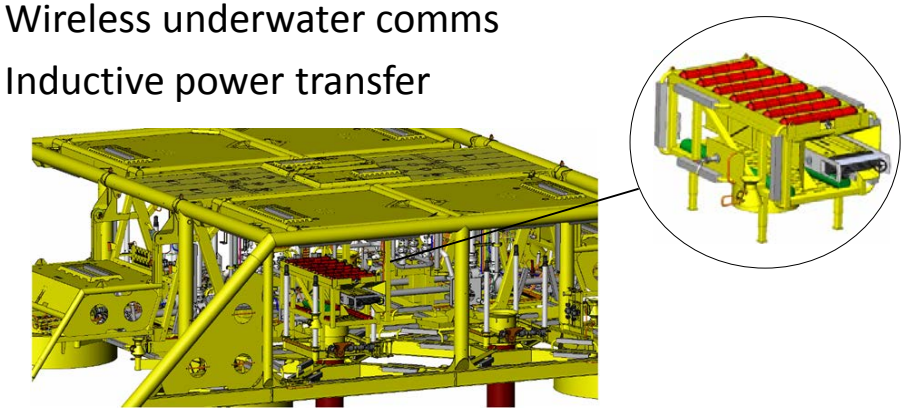
ENABLING TECHNOLOGIES
FOR A RESIDENT IMR AUV

- Extend capabilities to contact inspection and light intervention tasks
- New IMR tools



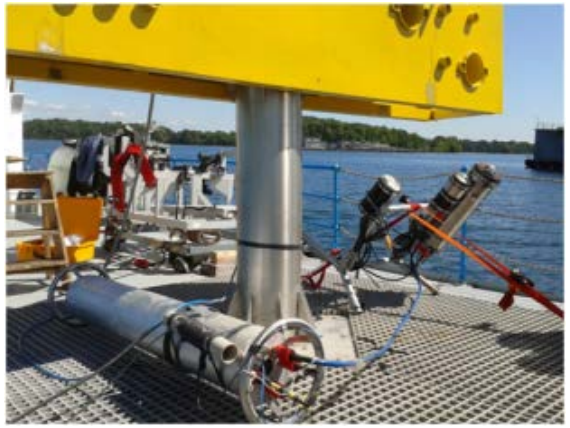
ONGOING

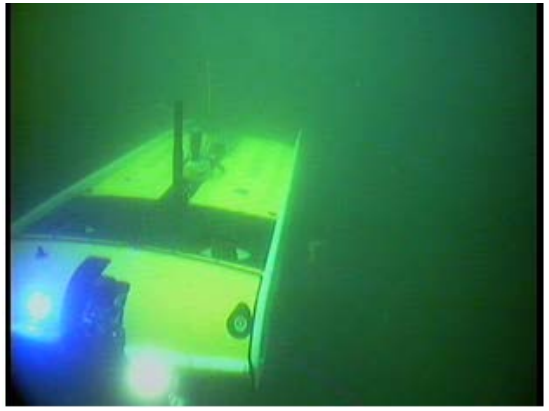
- Subsea Docking Station
- Wireless underwater comms
- Inductive power transfer



AKER-SAAB-TECNOMARE study for Goliat SPS (2014)

Clean Sea EVO1 enabling technologies



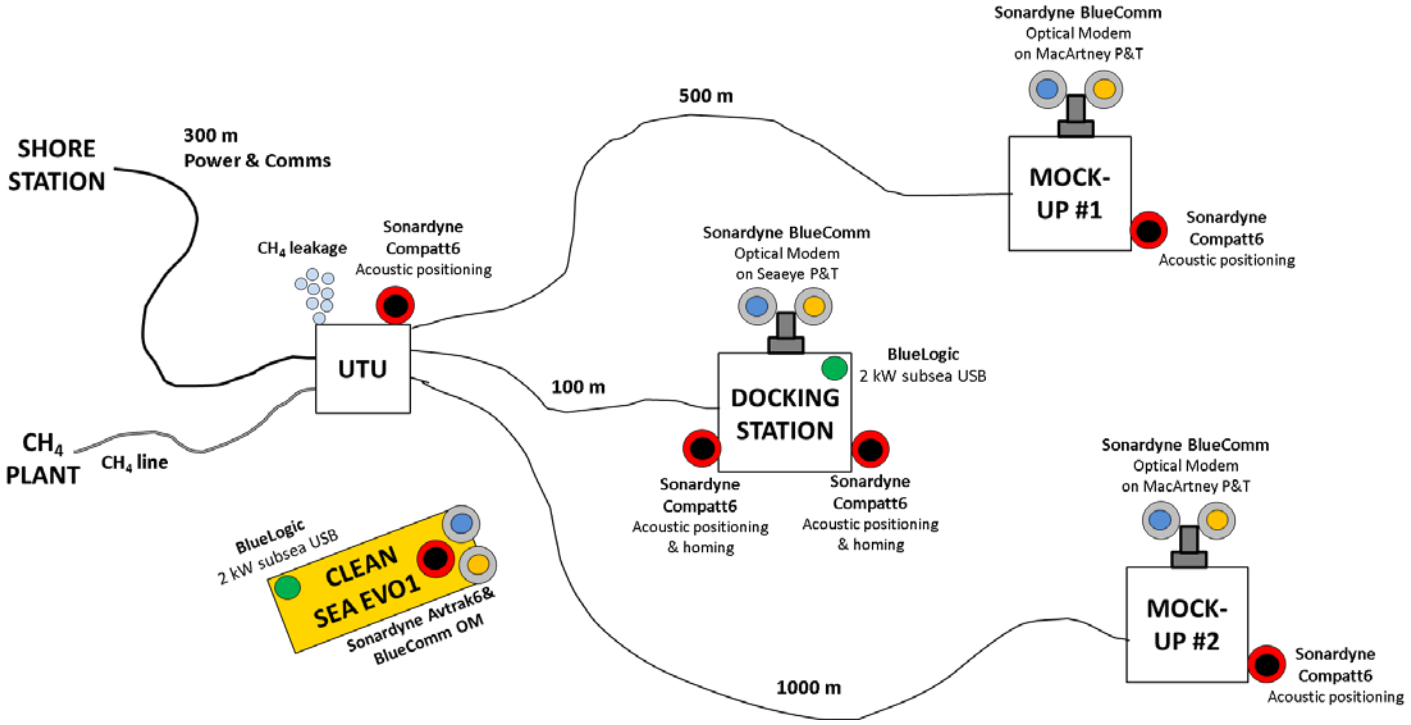


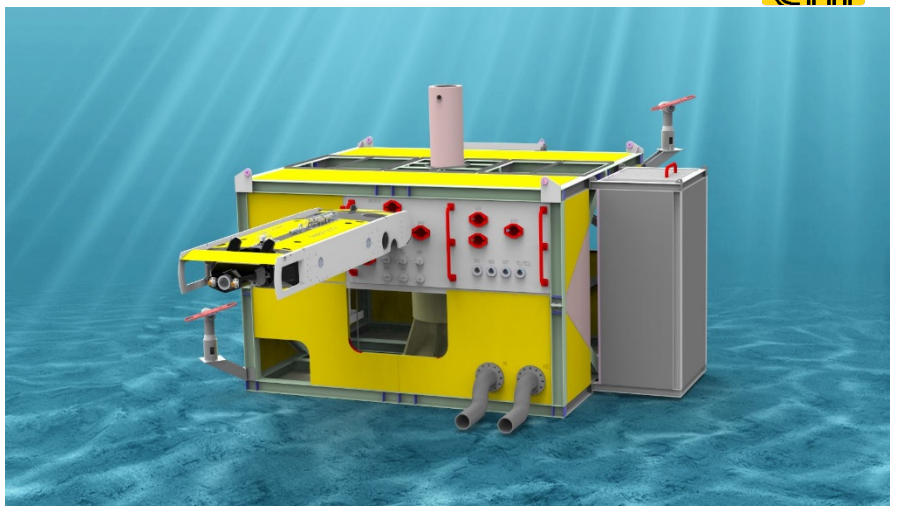
- Clean Sea demo test (lake and offshore Hammerfest), 2013
- SPS panel inspection simulated, with vehicle wireless controlled via optical modem (up to 6 Mbit/s @ 100 m)

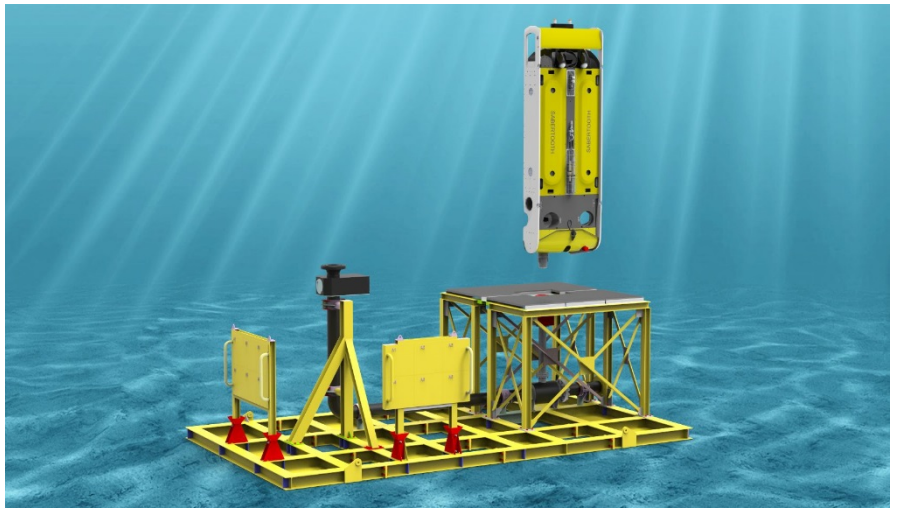
SAAB Sabertooth demo, OneSubsea Technology Symposium (October 2016, NASA Neutral Buoyancy Laboratory)

Clean Sea EVO1 demonstration tests

- Test infrastructure simulating significant features of SPS (Wellhead, PLET, pipelines)
- Demonstration test shall include continuous long-term (6 months) operation







Conclusions – Clean Sea benefits

- More data, better data → increase situation awareness in the field, lower risk
- Faster response time → early warning of anomalous situations
- Simpler logistics at sea required → cost effectiveness
- Less vessel time and personnel involved in field operations → improve HSE
- Possibility to operate in areas with restricted access → challenging scenarios, sensitive areas
- Proactive approach in maintenance and environmental monitoring → comply with evolving legislation, use of BAT (Best Available Technologies)

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Thank You

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