Sensorlink
Corrosion monitoring on welds

Subsea Controls Down Under 2018

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Sensorlink

ISO 9001:2008 certified
IECEx certified

Outline

- Sensorlink
- Motivations and applications for corrosion monitoring systems
- Monitoring versus manual UT inspection
- Pulse-echo ultrasonic measurements
- Monitoring on weld
- Installation configuration
- Results from installation
- Conclusions

Company Facts

- Established in 1997
- We were a spinoff from SINTEF *(one of Europe's largest R&D foundation)*
- Head office in Trondheim, Norway
- Sensorlink specializes in innovative solutions for pipeline integrity management based on ultrasound technology

Sensorlink value proposition:

We enhance our customers pipeline integrity management capability through:

- ✓ easy to install, non intrusive, high precision direct wall thickness monitoring
- ✓ resulting in reliable erosion and corrosion rate estimates

This knowledge is applied for:

- ✓ remaining service life estimates
- ✓ determining maintenance actions
- ✓ optimising chemical inhibition

Resulting in:

- ✓ reduced inspection/pigging cost
- ✓ reduced operational down time
- ✓ reduced risk for system failure and unplanned S/D

Motivations and applications – corrosion monitoring system

Reduced Opex:

- Reduce cost for inspection programs
- Optimise chemical injection program

Reduced HSE risks:

- Substitute for intrusive coupons and probes
- Reduce work in H2S area
- Difficult access area

Improved integrity management:

- Rapid detection of corrosion/erosion rates
- Monitor on welds and HAZ

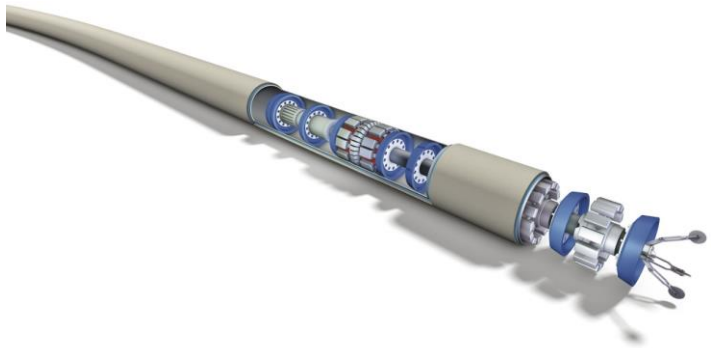
Inspection

Scanning

- Gives a picture of the situation now
- Labour and equipment intensive (man hours, scaffolding, vessel, ROV)
- Need to be repeated to give corrosion/erosion rate
- Repeatability not on the level of monitoring

Pigging

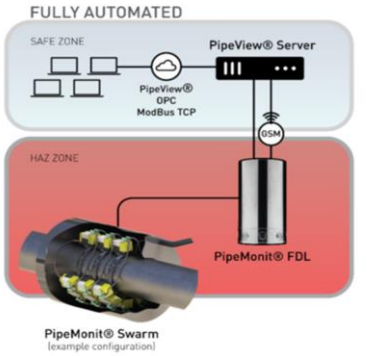
- Scan of pipe through it's length
- Gives a picture of the situation now
- Need pig launcher
- Have effect on the production(need's to be shut down)
- Need to be repeated to give corrosion/erosion development



Monitoring from Sensorlink

Permanent UT Monitoring:

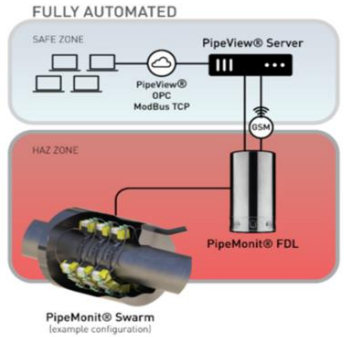
- **Used to monitor change in fixed locations**
- Real-time and online follow up of known defects
- Repeatability <0.1 mils/2.5 µm
- Rapid determination of erosion/corrosion rate
- Selective weld and HAZ corrosion



Permanent installation of sensors enables:

high *quality* wall thickness measurements:

- eliminate the multiple sources of error associated with manual inspection, such as
  - variability from one measurement to the next in time of measurement location
  - equipment used
  - operator expertise

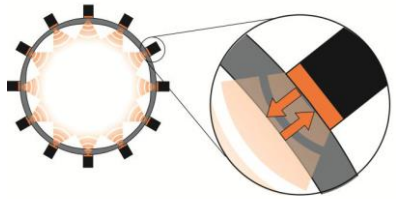


frequent wall thickness measurements :

- measurement frequency of the sensors can be programmed and corrosion/erosion rate can be determined quickly and accurately(within 2,5 um)

Monitoring using Single Element Pulse/Echo Transducers

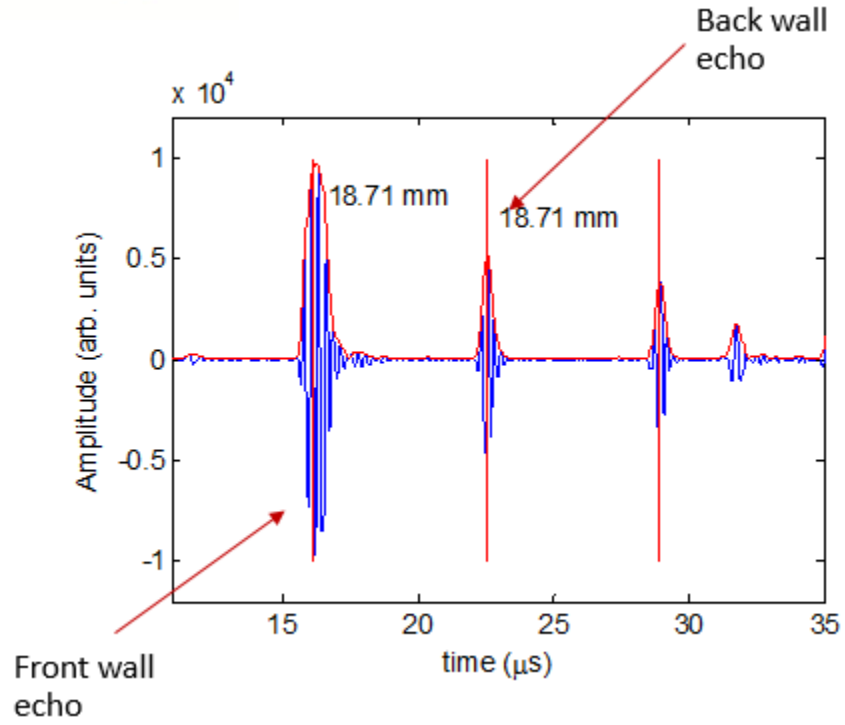
- Non-Intrusive
- Direct wall thickness measurement of pipe wall, weld, HAZ zone, elbow, t-piece
- Not sensitive to pipe wall thickness
- Works through solid coatings (FBE, 3LPP, PE, etc.)
- Possible to separate pipe wall front and back wall echo's when used on coating.
- Does not discriminate between erosion and corrosion
- Embedded temperature transducers enables temperature compensation
- Fixed sensors combined with advanced signal processing detects wall loss of less than .1 mills (2.5 micrometres)



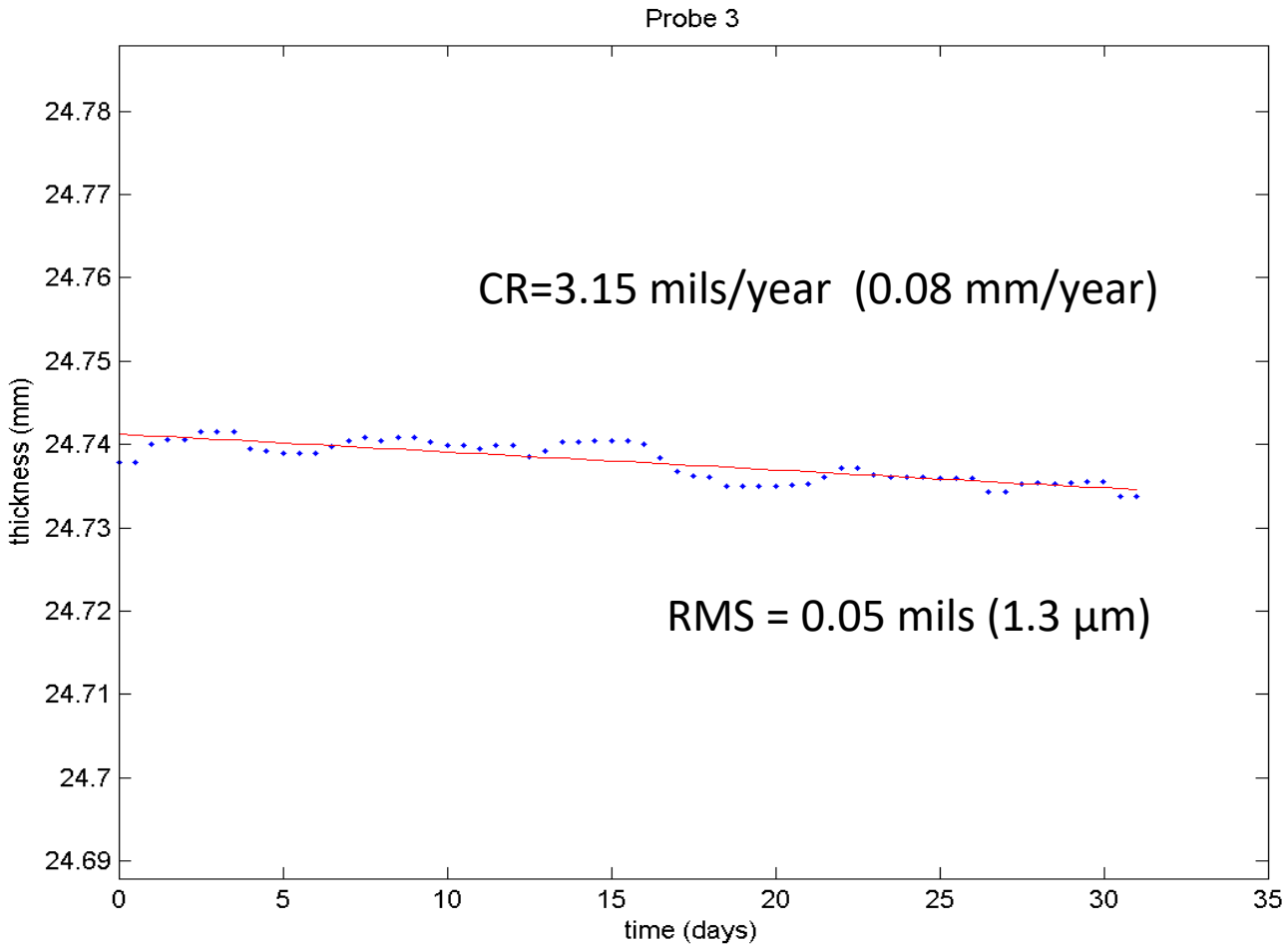
Pulse-echo:

$$d = \frac{t \cdot c}{2}$$

c – speed of sound in steel
t – *time*
d – *wall thickness*

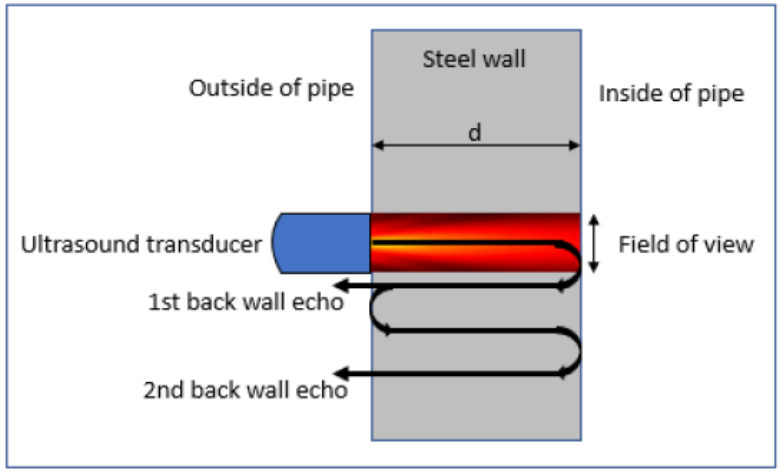


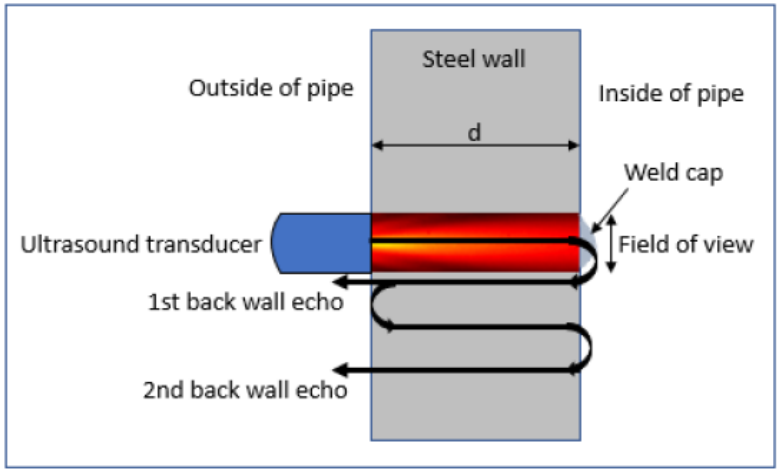
Typical wall thickness graph

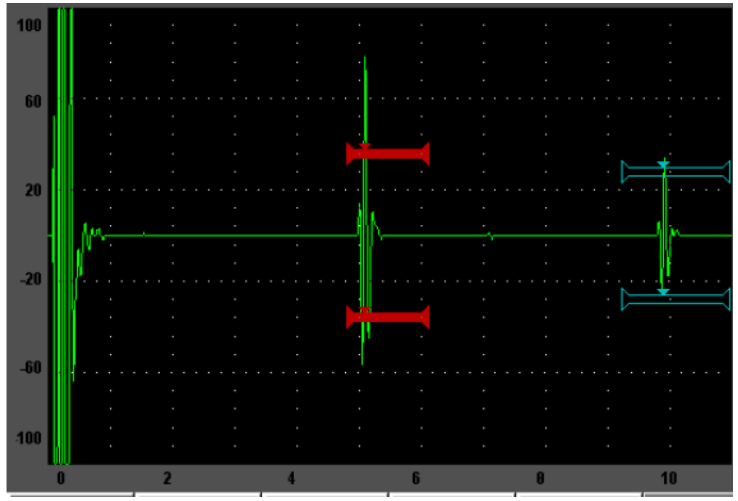


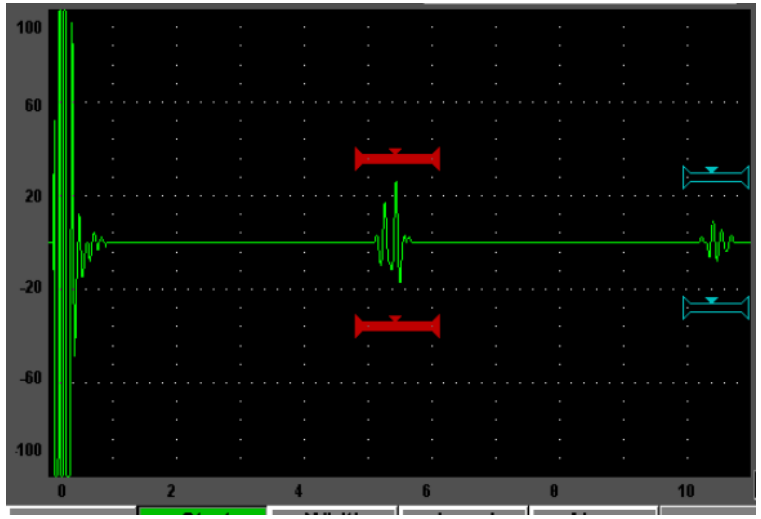
Monitoring on weld

Monitoring on weld

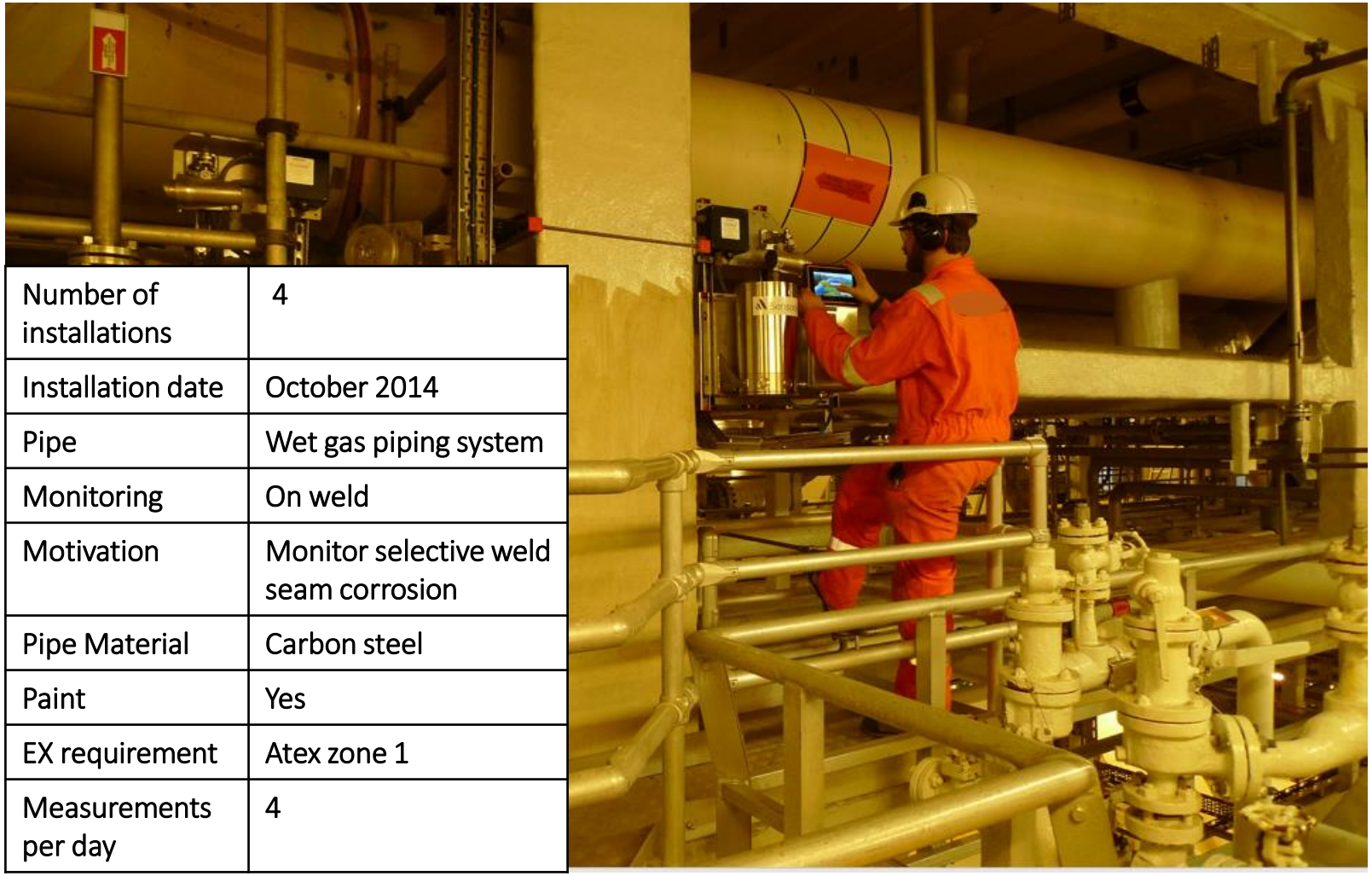








Installation configuration

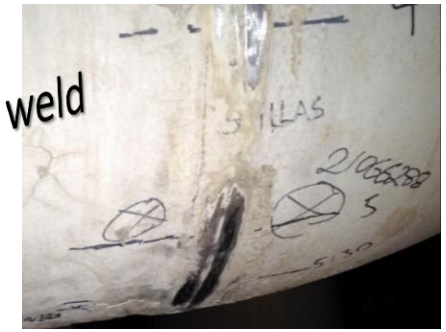


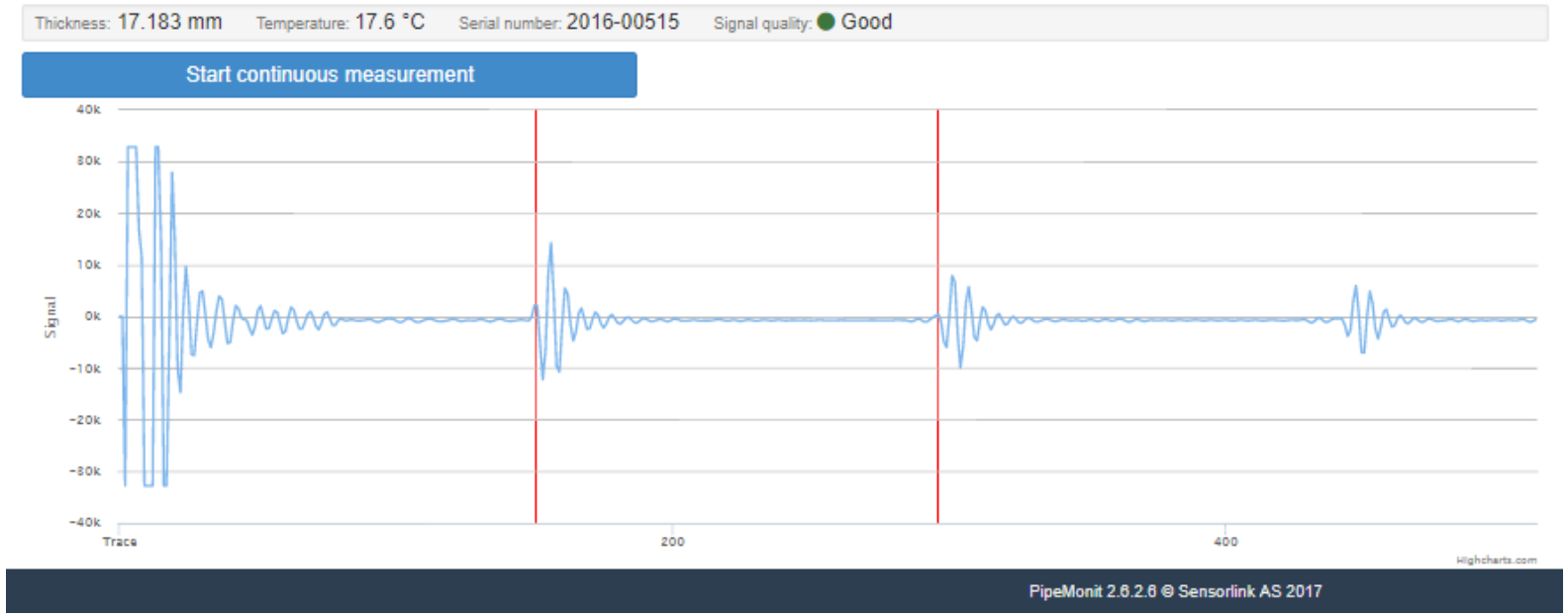
Number of installations	4
Installation date	October 2014
Pipe	Wet gas piping system
Monitoring	On weld
Motivation	Monitor selective weld seam corrosion
Pipe Material	Carbon steel
Paint	Yes
EX requirement	Atex zone 1
Measurements per day	4

Installation configuration

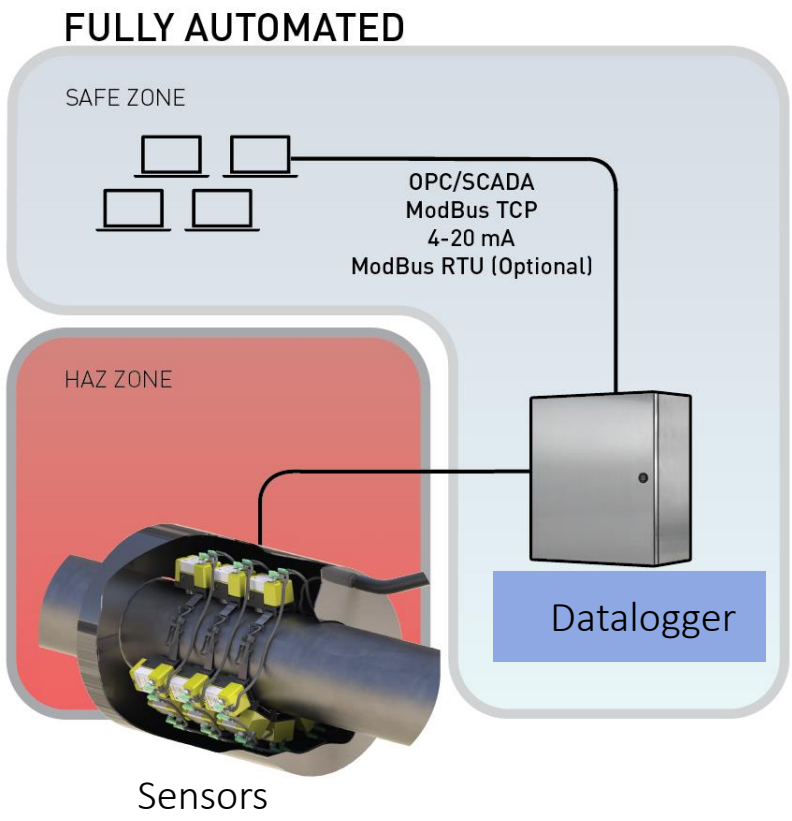
Instr ID	Pipe ID	Wall Thickness (Approximately)	Location	Pipe material	Pipe temperature
1	24"	19-22 mm	on weld	Carbon steel	~50 degC
2	30"	21-22 mm	on weld	Carbon steel	~20 degC
3	36"	21-26 mm	on weld	Carbon steel	~20 degC
4	36"	22-26 mm	on weld	Carbon steel	~20 degC

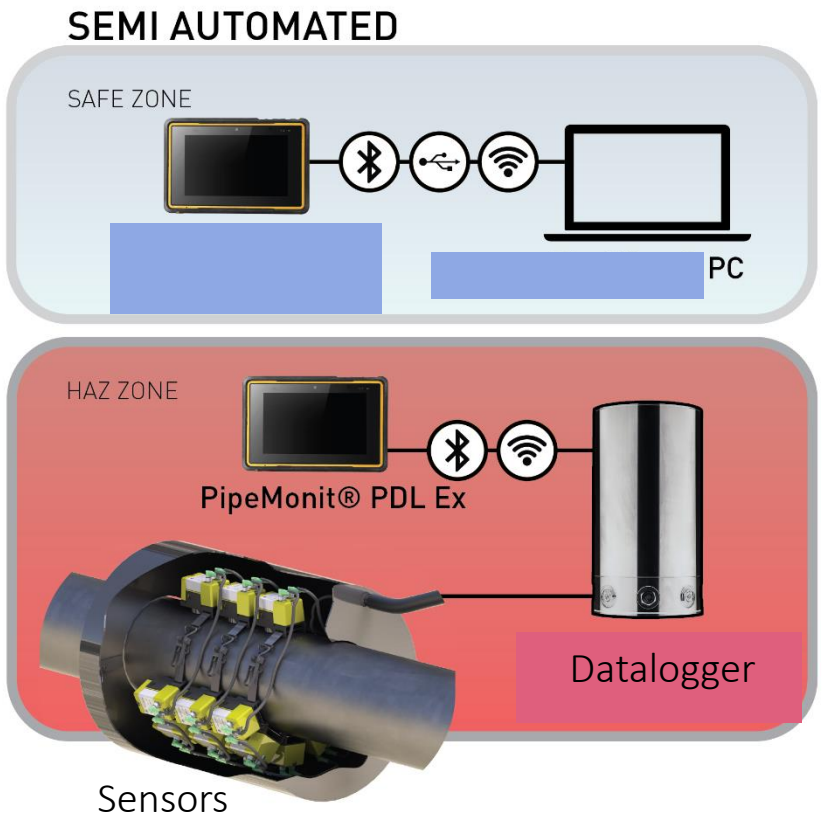
Preparing the weld



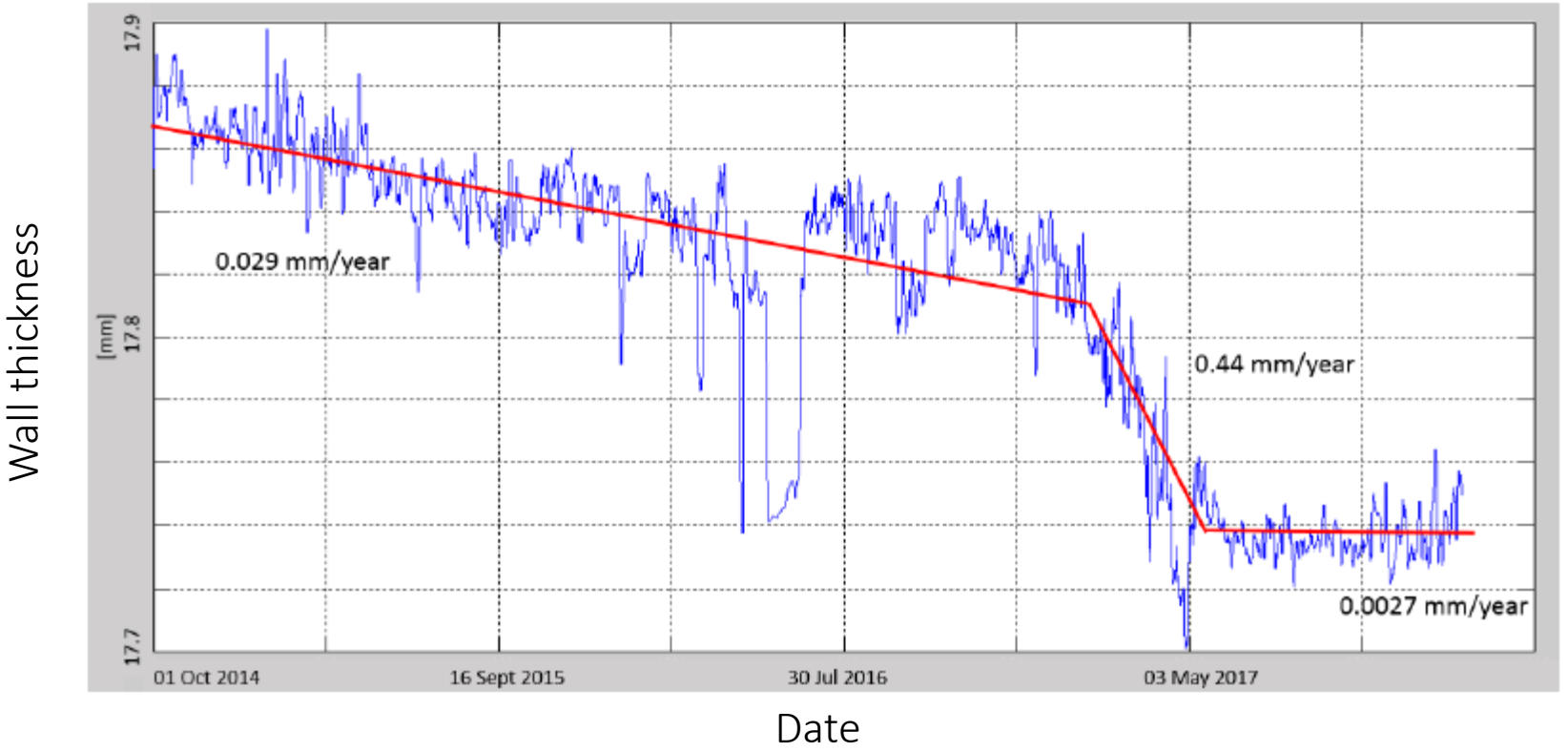


Sensor interfaces

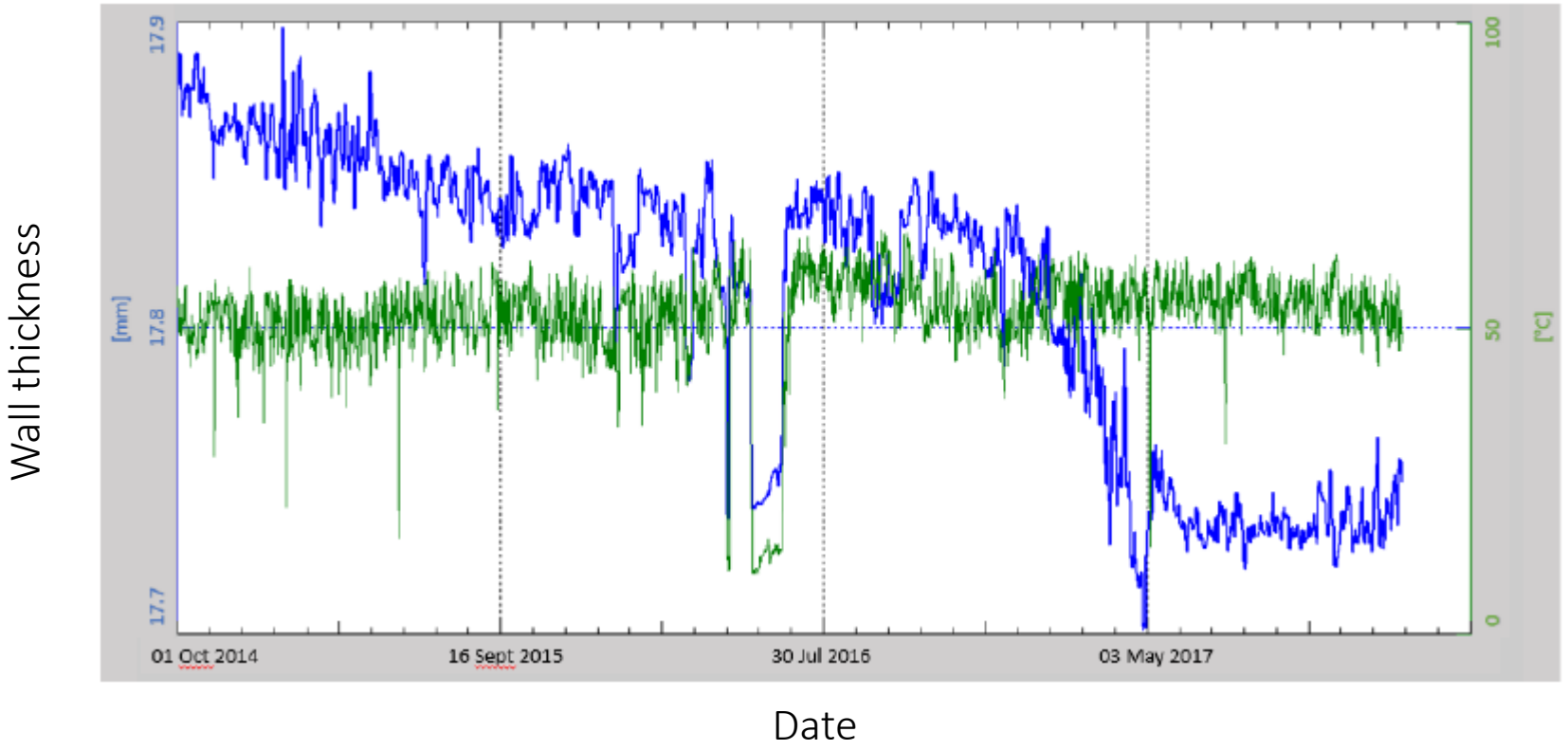




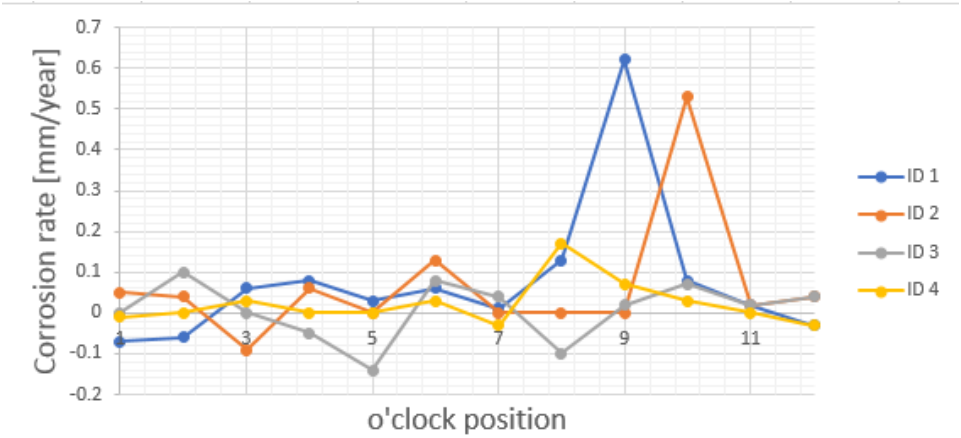
Results

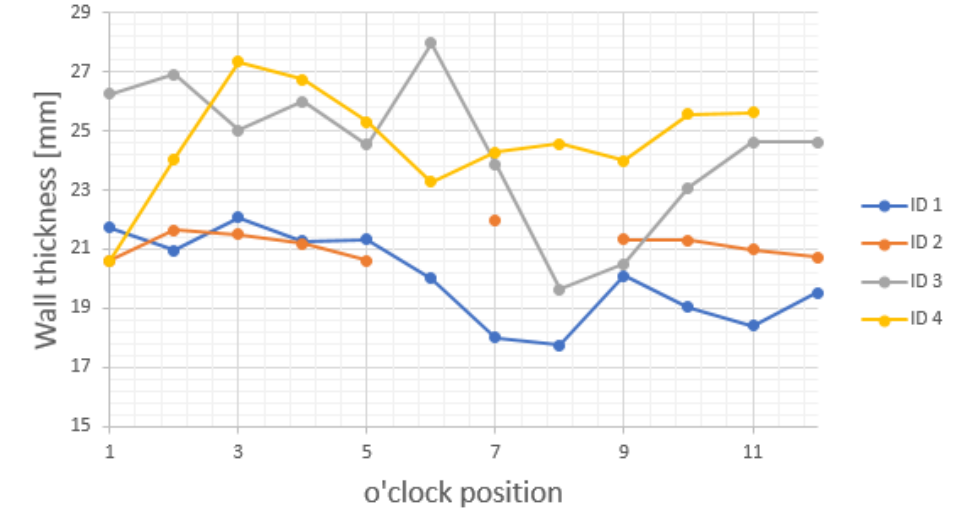

Wall thickness
17.9
[mm]
17.8
17.7
0.029 mm/year
0.44 mm/year
0.0027 mm/year
01 Oct 2014
16 Sept 2015
30 Jul 2016
03 May 2017
Date

Results


Wall thickness
17.9
17.8
17.7
[mm]
100
50
0
[°C]
01 Oct 2014
16 Sept 2015
30 Jul 2016
03 May 2017
Date

Results


Corrosion rate [mm/year]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
1
3
5
7
9
11
o'clock position
ID 1
ID 2
ID 3
ID 4


Wall thickness [mm]
29
27
25
23
21
19
17
15
1
3
5
7
9
11
o'clock position
ID 1
ID 2
ID 3
ID 4

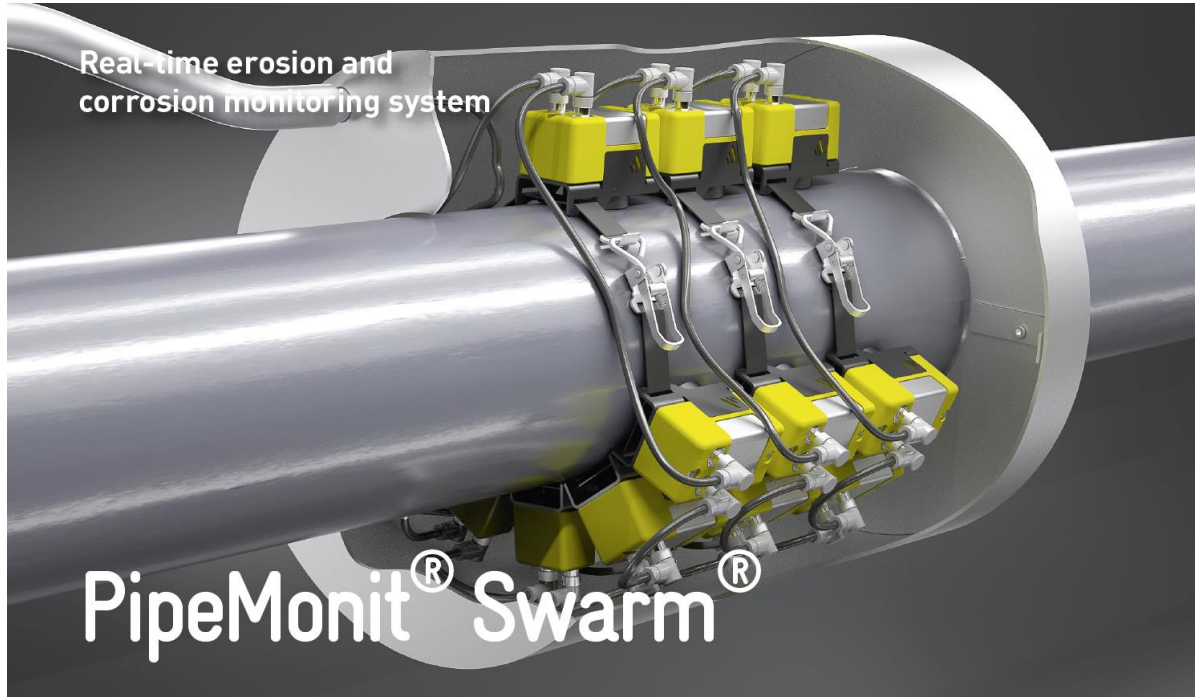
Conclusions

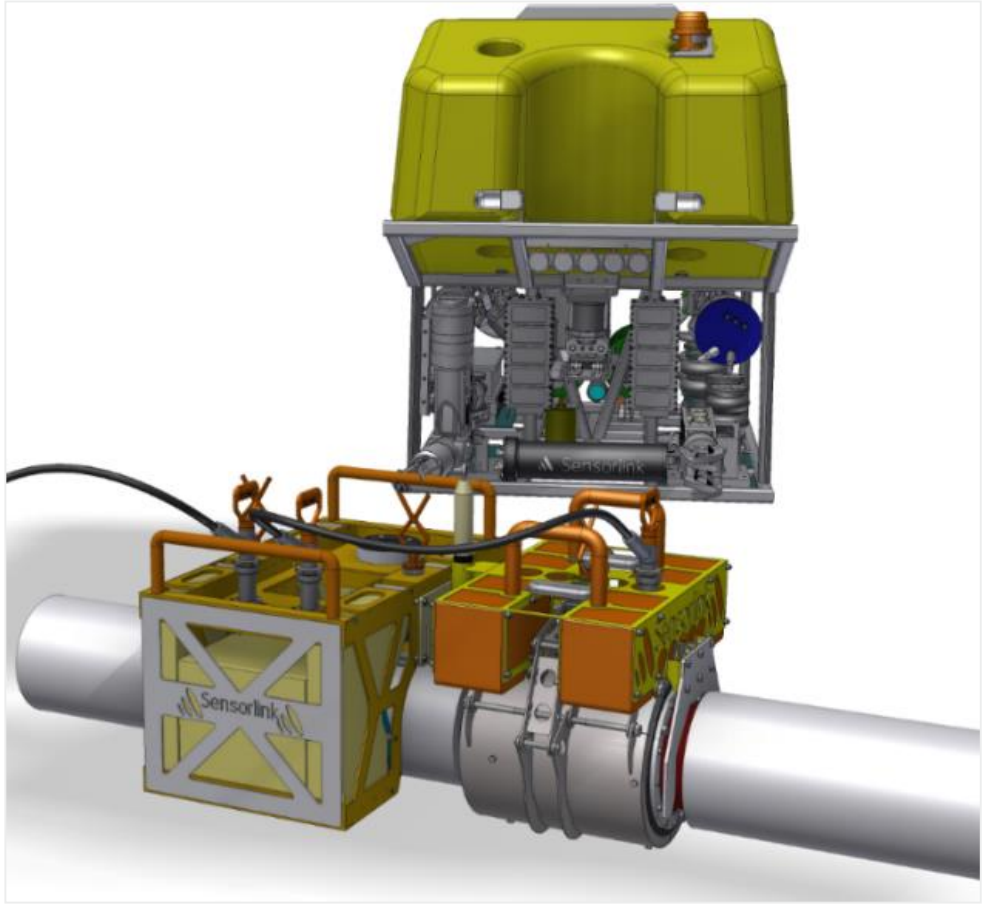
- Corrosion monitoring demonstrated on weld
- Corrosion monitoring system demonstrated that corrosion was low after inhibitor system was set in place
- Measurements from corrosion monitoring systems are important input to the corrosion management program

Current product line

PipeMonit® Swarm®
Topside/onshore wall thickness monitoring

World wide distribution agreement with Cosasco





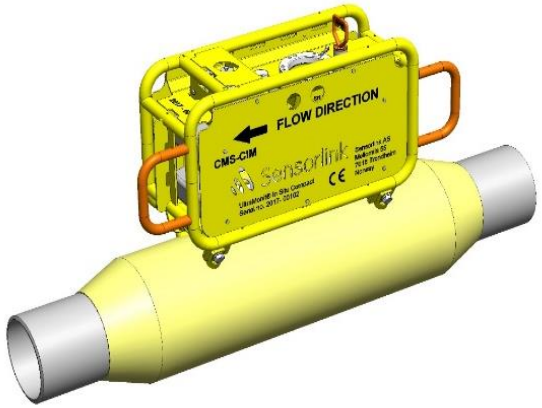
UltraMonit® SEC

Subsea Erosion Corrosion monitoring

UltraMonit® SEC subsea instruments for pipelines

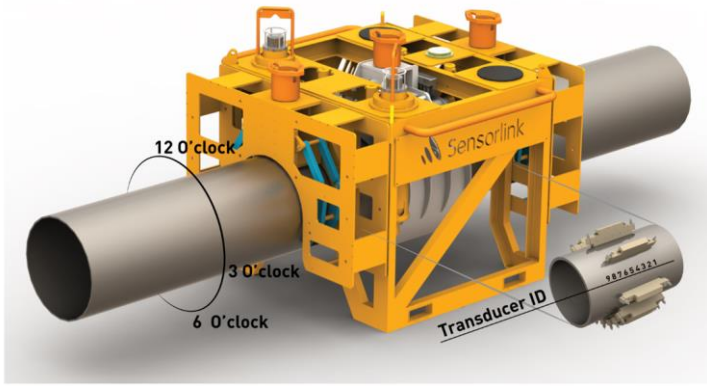
Fixed installations/new pielines(InSitu):

- Preinstalled sensor arrays
- 30 year life time
- Sensors installed inside insulation
- Can be installed to monitor a weld



Retrofittable installations:

- Installed on existing subsea pipelines without production interference
- Fully ROV or diver installable, removable and movable
- 15 years lifetime



UltraMonit® SEC Erosion Monitoring

Concept:

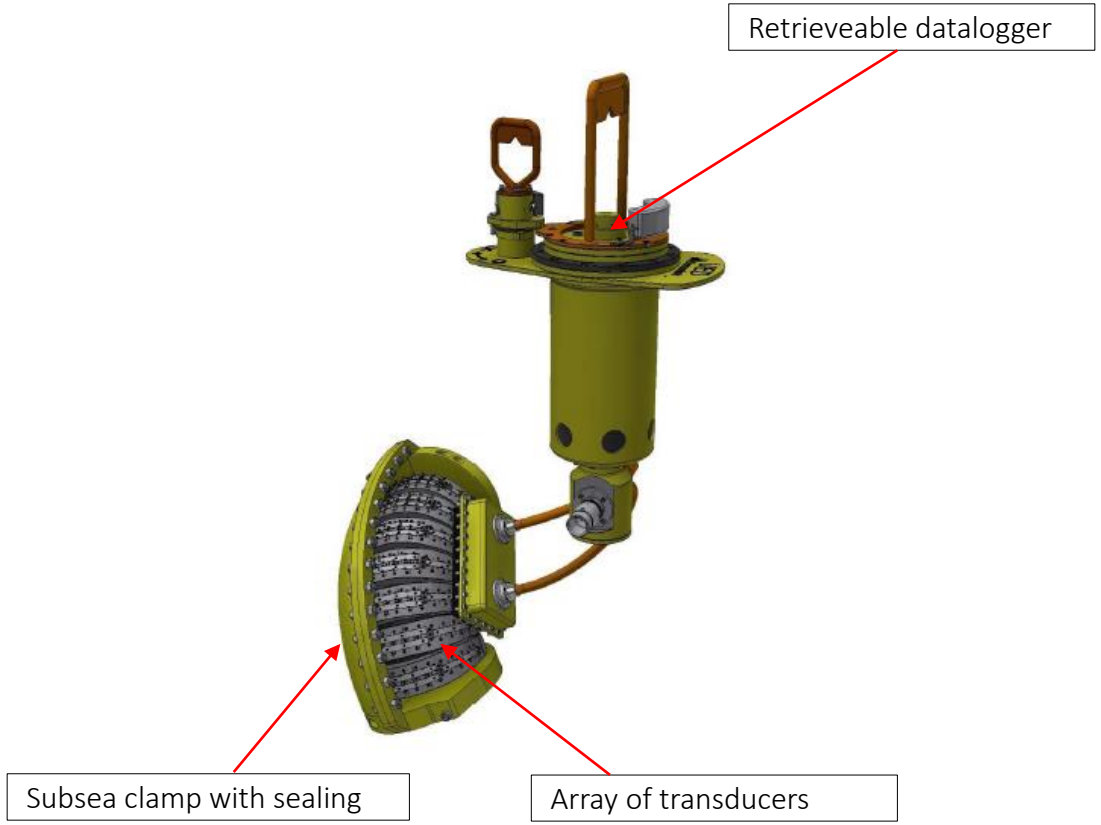
Array of Ultrasound transducers

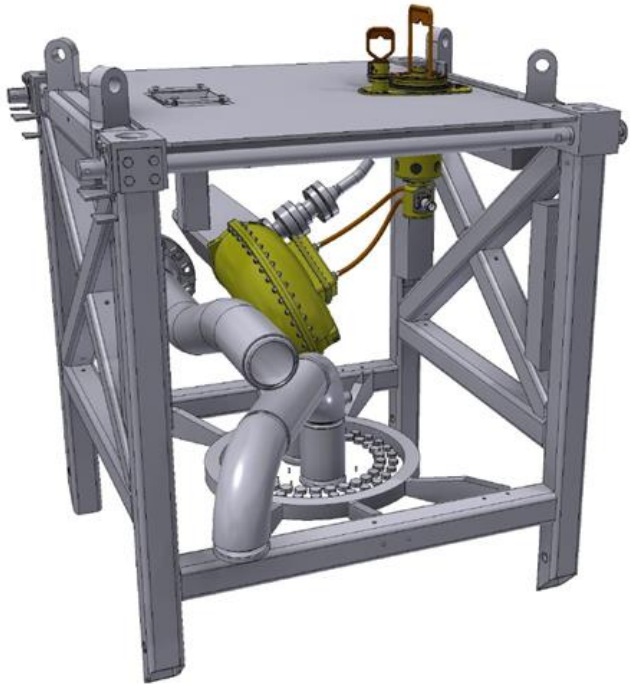
Subsea clamp with sealing

Pressure compensated

Retrieveable datalogger

Self contained unit with batteries or connected to subsea control system





With Sensorlink up and above!