



# Recent Advances in Riser Monitoring Systems

Shreenaath Natarajan  
2H Offshore

# Riser and Conductor VIV



## Why Monitor Risers

- Risers are **fatigue critical** structures
- **Complex interfaces** at the vessel and the seabed
- Multiple **assumptions** involved in **design data** and methodologies
- Riser **failure** is totally **unacceptable**



SCR Trench



Parted Drilling Riser

*Courtesy: SPE 2005*

# Riser Monitoring System Design

- Monitoring Purpose
  - Environment / Vessel motion induced riser response
  - Riser/soil interaction
  - Specific component performance
  - Capture uncertainties in extreme event response
  - Fatigue concern
- Suitable instrumentation
- Data processing requirements
- Data communication requirements
  - Real time / quasi-real time / log & retrieve
- Cost
- Installation
  - Retrofit / Pre-installation / during riser installation

# Recent Achievements

- Cost-effective subsea strain sensor
- Acoustic data transmission
- Subsea microphone based flexible armour wire monitoring



# Strain Measurement

## **INTEGRI**stick™ Features



- Conventional electrical foil strain gauges in pressure balanced cylindrical tube
- Bending strains along 2 planes
- 3 micro-strain accuracy



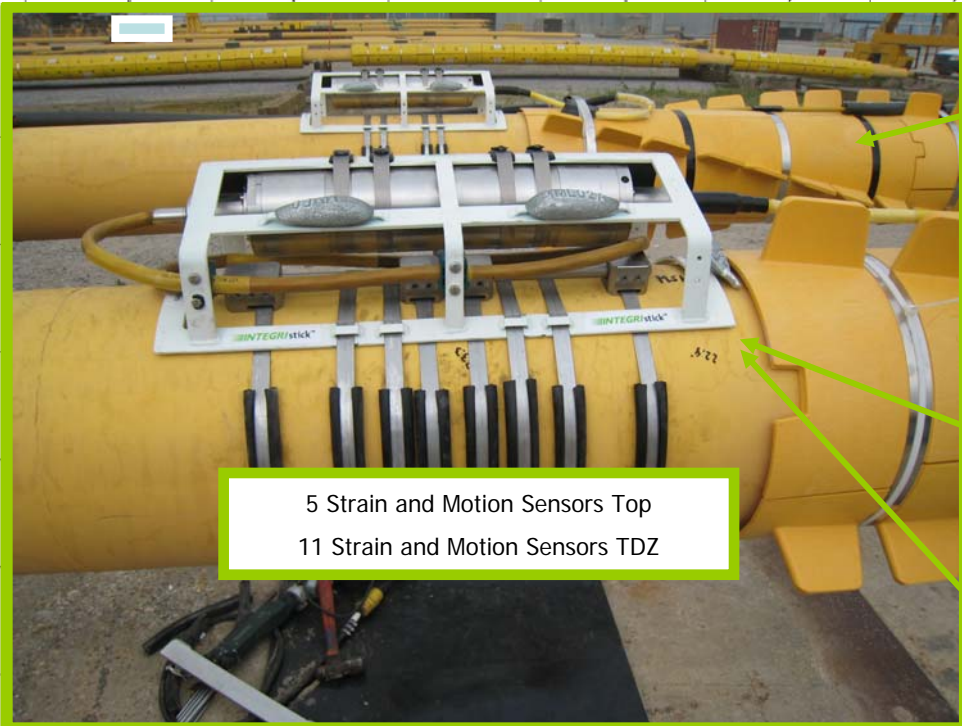
# Strain Measurement

## **INTEGRISTICK™** Benefits

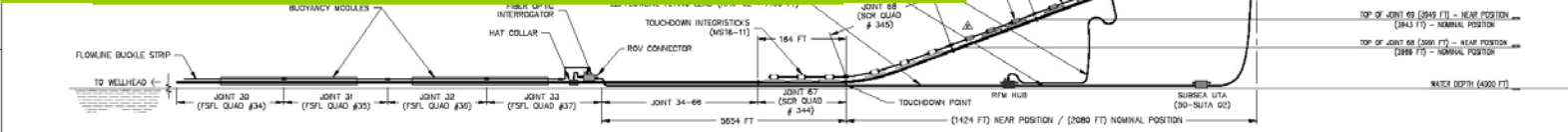
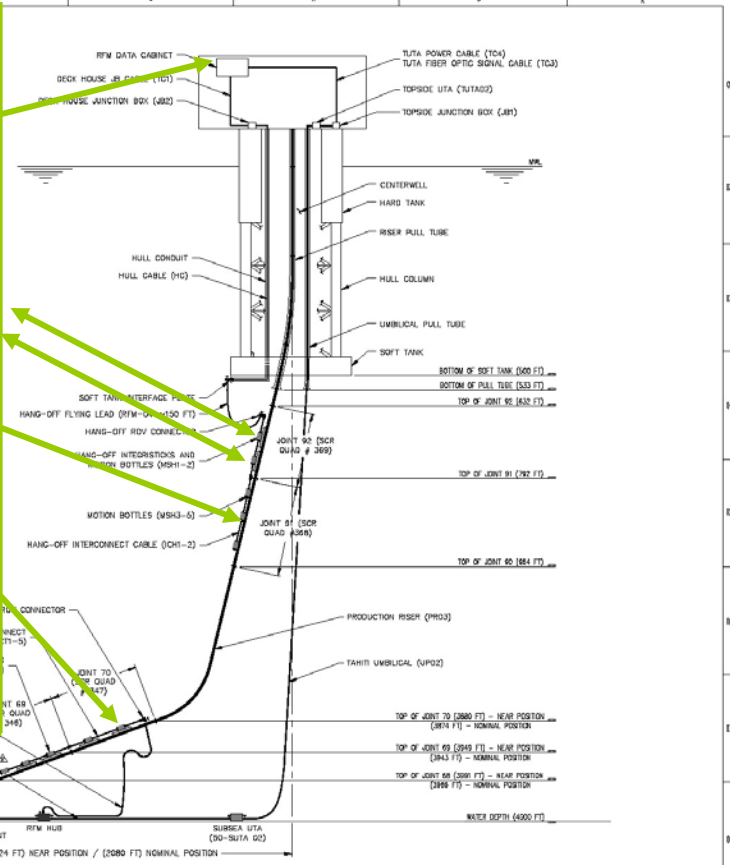


- 3000m depth rating
  - Conventional electrical foil strain gauges are restricted to above surface / near surface
- High resolution suitable to capture small strains causing riser fatigue
- Extremely low power consumption
- Suitable for both standalone and real-time applications
- Cheapest strain gauge option for subsea application

# GoM Tahiti SCR Real Time Monitoring System



5 Strain and Motion Sensors Top  
11 Strain and Motion Sensors TDZ



				300 BARREL PROTECT LANE SURF 016 NUMBER: 26 73276 TEL: (510) 282 250 2501 FAX: (510) 282 250 2599		300 BARREL PROTECTION 		SPEC IN ACCORDANCE WITH ASME 1943M 1994		CAD DATA 15 METER	
REFERENCE DRAWINGS AND NOTES 1. REMOVE ALL SHARP CORNERS & BURRS 2. 1/8" DIA OR DIMETER IF 3/32" DIA IS PERMITTED IN CORNER OF BEND HELIX ACCESS & STOPS				REFERENCE PART NAME RISER & FLOWLINE MONITORING SYSTEM GR		NEXT ASSEMBLY		CAD SYSTEM 2D DRAWINGS		SHEET 1/1	
SURFACE FINISH SYMBOLS: 1/16 TURNING, 3/32 MILLING				PART NUMBER 32514-1054-0001-2		SCALE AS NOT SCALE		SHEET 1/1		A3	

LIMITS UNLESS OTHERWISE STATED TO EN 22560-1											
MATERIAL				DIMENSIONS (TO CENTER UNLESS OTHERWISE STATED)				TOLERANCES (TO CENTER UNLESS OTHERWISE STATED)			
GROUP	ITEM	UNIT	VALUE	GROUP	ITEM	UNIT	VALUE	GROUP	ITEM	UNIT	VALUE
1	GROUP	mm	0.254	1	GROUP	mm	0.254	1	GROUP	mm	0.254
2	GROUP	mm	0.127	2	GROUP	mm	0.127	2	GROUP	mm	0.127
3	GROUP	mm	0.076	3	GROUP	mm	0.076	3	GROUP	mm	0.076
4	GROUP	mm	0.051	4	GROUP	mm	0.051	4	GROUP	mm	0.051
5	GROUP	mm	0.025	5	GROUP	mm	0.025	5	GROUP	mm	0.025
6	GROUP	mm	0.013	6	GROUP	mm	0.013	6	GROUP	mm	0.013
7	GROUP	mm	0.008	7	GROUP	mm	0.008	7	GROUP	mm	0.008
8	GROUP	mm	0.005	8	GROUP	mm	0.005	8	GROUP	mm	0.005
9	GROUP	mm	0.003	9	GROUP	mm	0.003	9	GROUP	mm	0.003
10	GROUP	mm	0.002	10	GROUP	mm	0.002	10	GROUP	mm	0.002
11	GROUP	mm	0.001	11	GROUP	mm	0.001	11	GROUP	mm	0.001

# Acoustic Logging

## **INTEGRIPod™ - AM** Features

- Acoustic transponder and sensors powered by self-contained battery unit
- Acoustic receiver on deck
- Software to process and display on-board
- Low power and high precision accelerometer/inclinometer arrangement
- Electronics adaptable for any type of measurements



# Acoustic Logging

## **INTEGRIPod™ - AM** Benefits

- Acoustic link enables data communication near quasi-real time
- Reduces complex cabling and risk of damaging the cables
- Low power electronics minimizes power consumption
- Acoustic link enables data logger switching on/off as required, maximizing the battery life
- Provides easy retrofit options using ROV/diver
- Off the shelve monitoring product





# MOORASSURE™

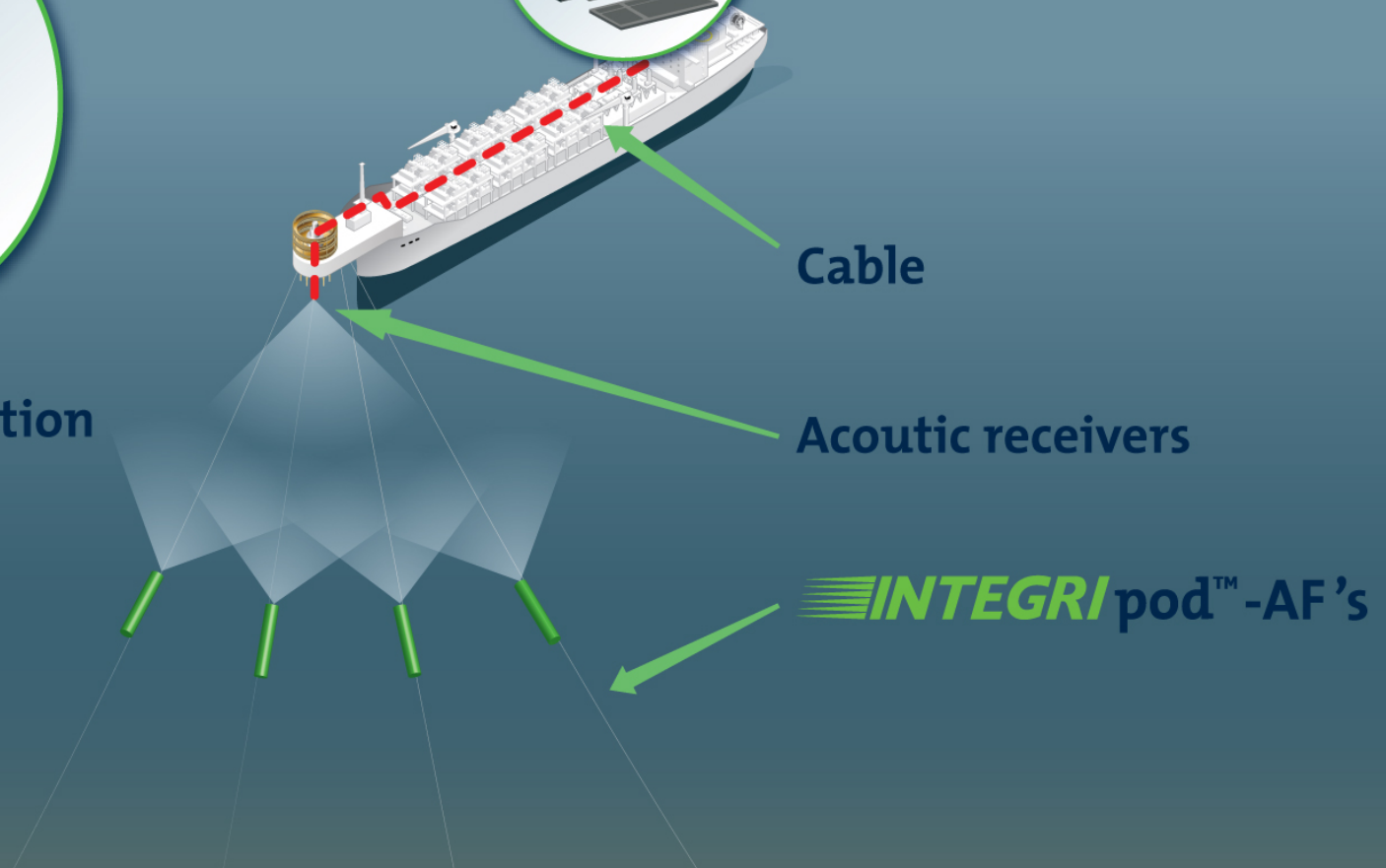
## Mooring Line Monitoring System



Sample configuration



Topside data acquisition package



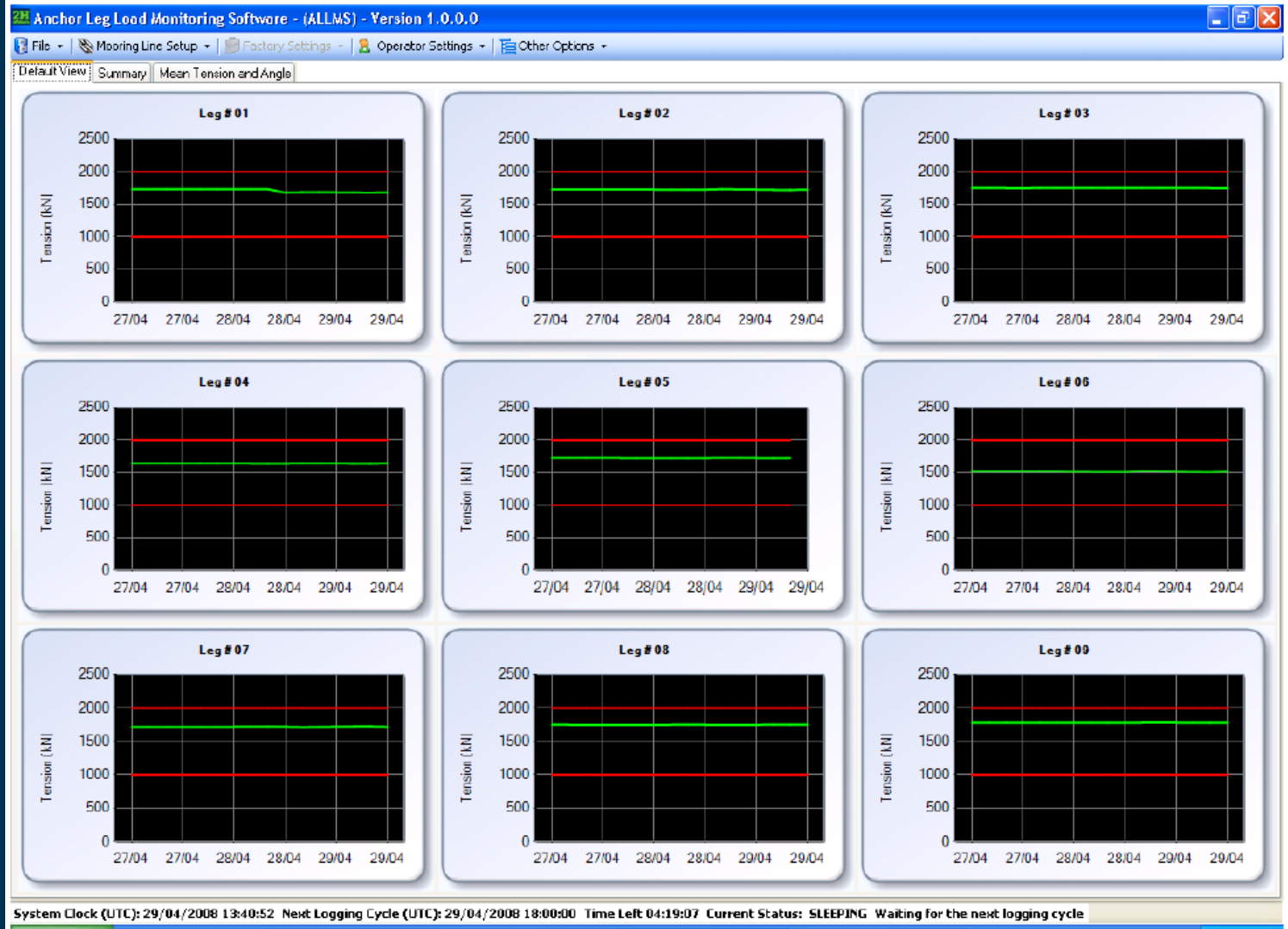
Cable

Acoustic receivers

**INTEGRI** pod™ -AF's



# Shell BC-10 Mooring Line Monitoring System





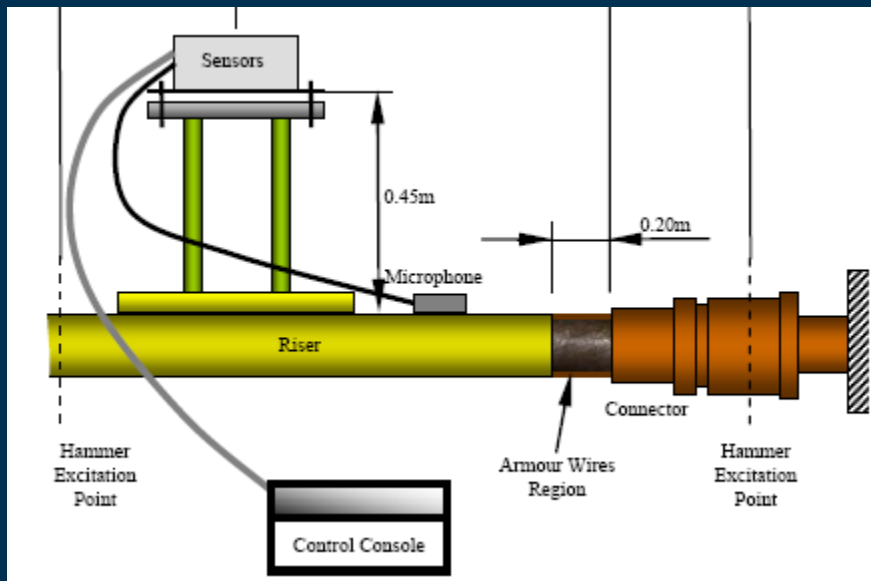
# Flexible Riser Monitoring Features

- 1D Axial acceleration sensor
- 2D Angle rate and inclination sensors
- Microphone



# Laboratory Tests

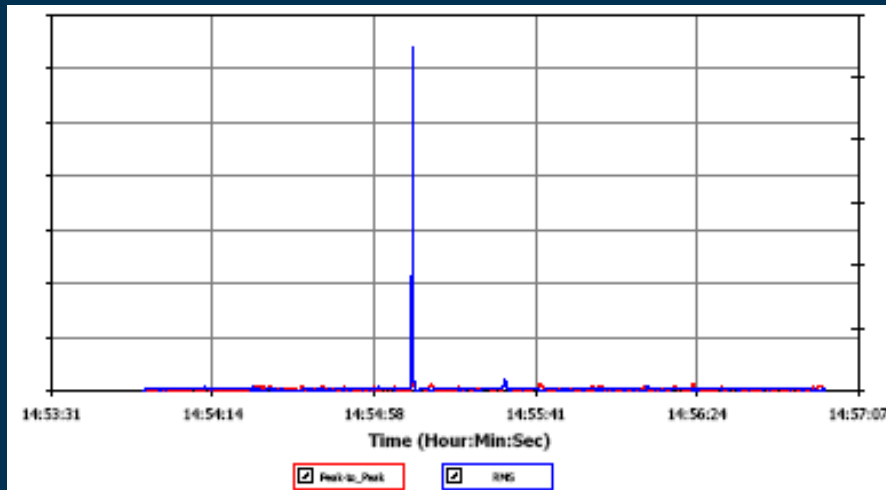
- Flexible riser on a test rig to maintain static tension and apply dynamic tension cycles
- Armour wires cut initiated using hand held tools



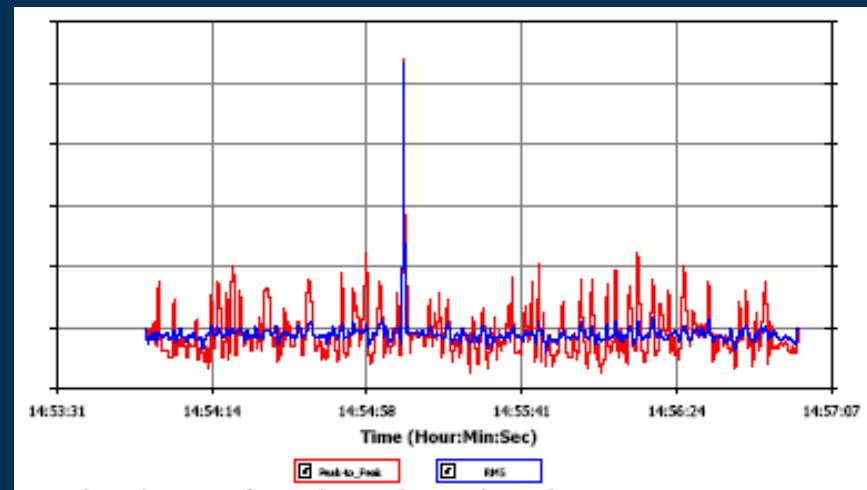
# Laboratory Test Results

- All 30 wire break tests are recorded by the instrumentation package

**Acceleration**



**Microphone**

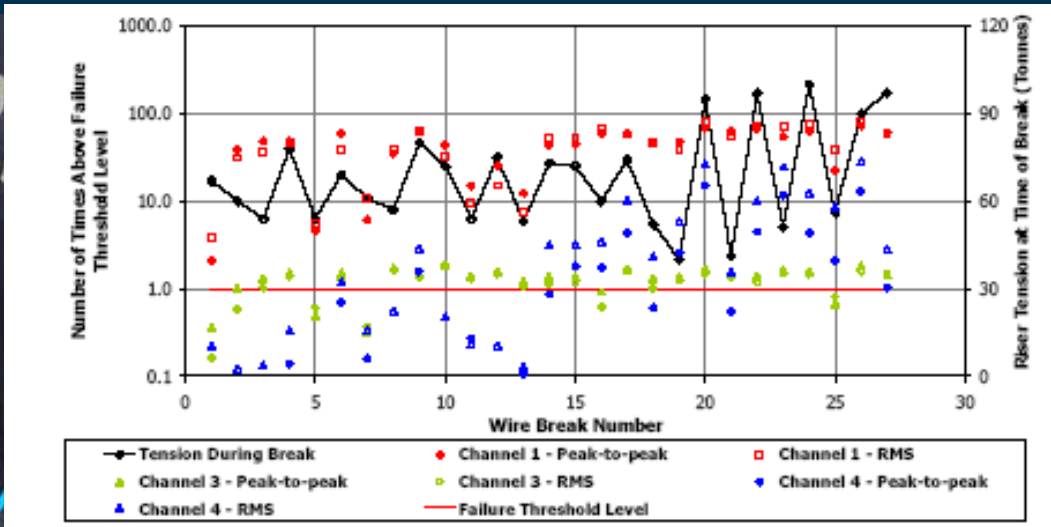


# Offshore Tests

- Installed near the bend stiffener to measure the background offshore noise detected
- Armour wire break noise is clearly distinguishable compared to:
  - Background noise
  - Impact due to dropped objects or collision

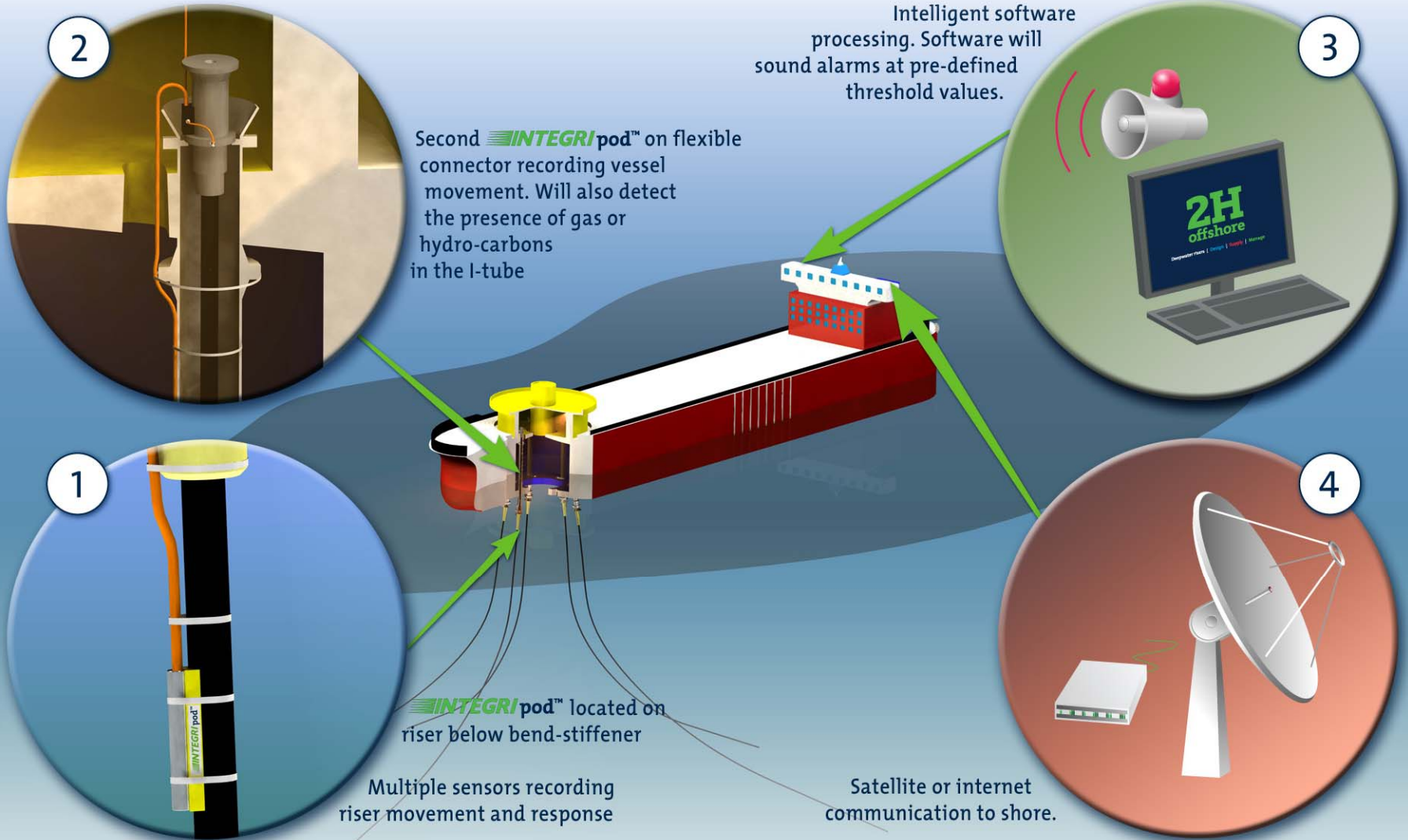


Sensors Location



# FLEX ASSURE™

## Flexible riser monitoring system



## Conclusions

- **INTEGRISTICK™**
  - Low power and more reliable electronics
  - High resolution
  - Cost effective
- **INTEGRIPOD™ - AM**
  - Acoustic transmission reducing complex cabling
  - Reduced risk of cable failure compared to a hardwired system
  - Instrumentation is away from critical path of installation
  - Field proven technology
- **FLEXASSURE™**
  - Novel concept turned in to a reality
  - Capture flexible riser response near critical riser-vessel interface
  - Early identification of armour wire rupture