



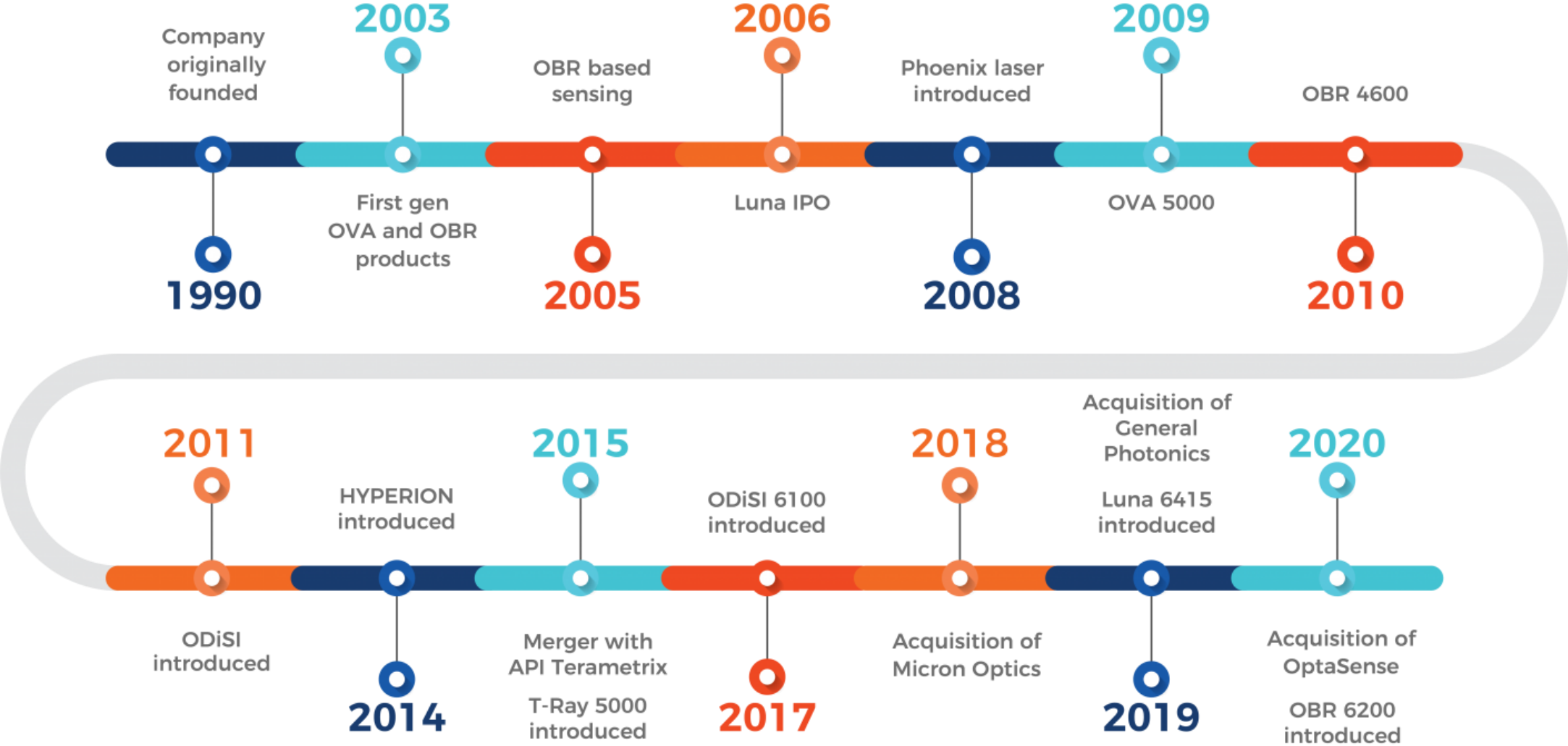
LUNA

# **EPIC Online Technology Meeting on Photonics Sensors for Safer and Intelligent Oil & Gas Producers**

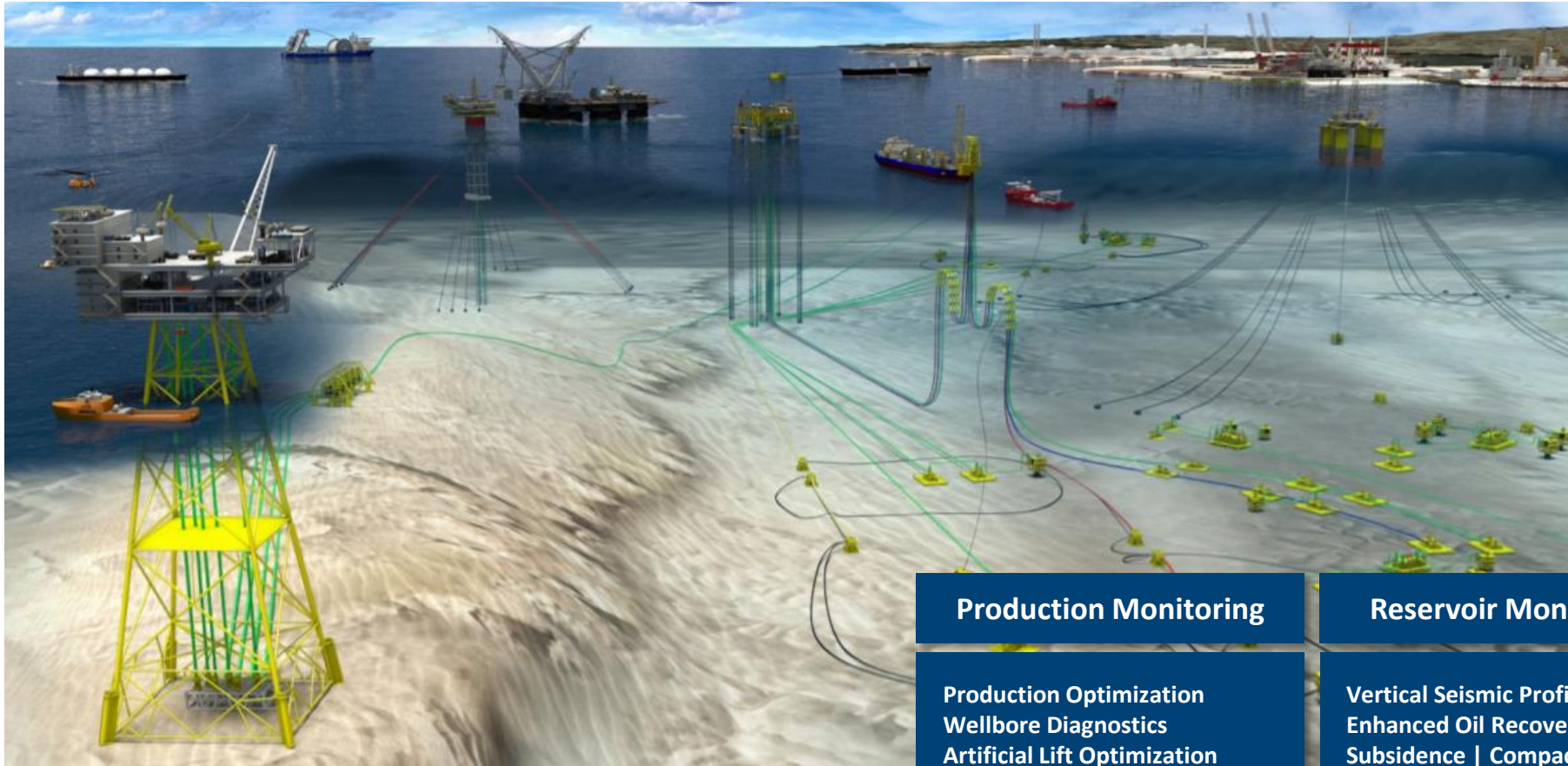
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# Overview



# Oil & Gas Sectors – Where does Luna play?



## Production Monitoring

Production Optimization  
Wellbore Diagnostics  
Artificial Lift Optimization  
Well Integrity | Leak  
GeoThermal Monitoring  
Subsea Umbilical | Flowline  
SAGD

## Reservoir Monitoring

Vertical Seismic Profiling  
Enhanced Oil Recovery  
Subsidence | Compaction  
CO2 Sequestration  
Induced Seismicity  
Microseismic Event Detection  
Ocean Bottom Node VSP

## Solutions

Job Design & Planning  
Answer Products  
DxS Browser  
Reservoir Analysis  
Proteus Cable Portfolio  
Unit Sales & Installation  
Service Support  
Diagnostic Intervention Services

# Geothermal

## Completions Monitoring

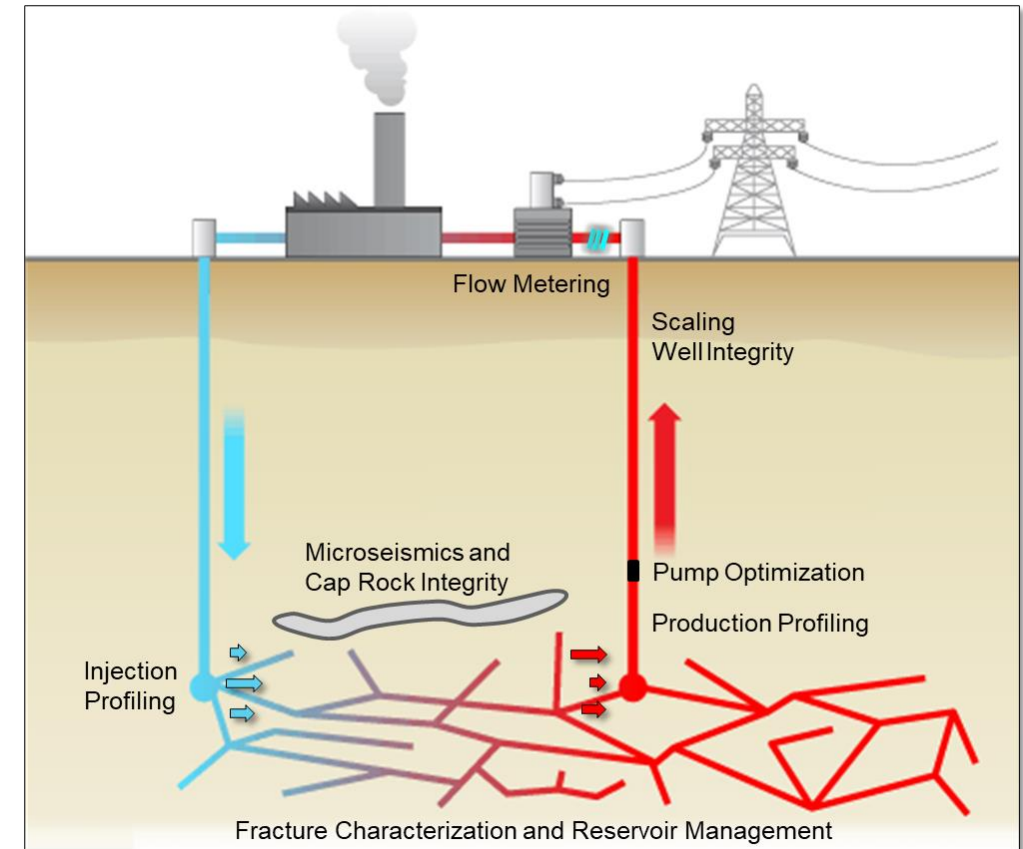
- Hydraulic Fracture Monitoring
- Crosswell Strain
- Microseismic Monitoring

## Production Monitoring

- Production and injection profiling distribution
- Well integrity for deformation and scaling deposits
- Gas production detection
- Flow metering at surface
- Pump optimization and integrity

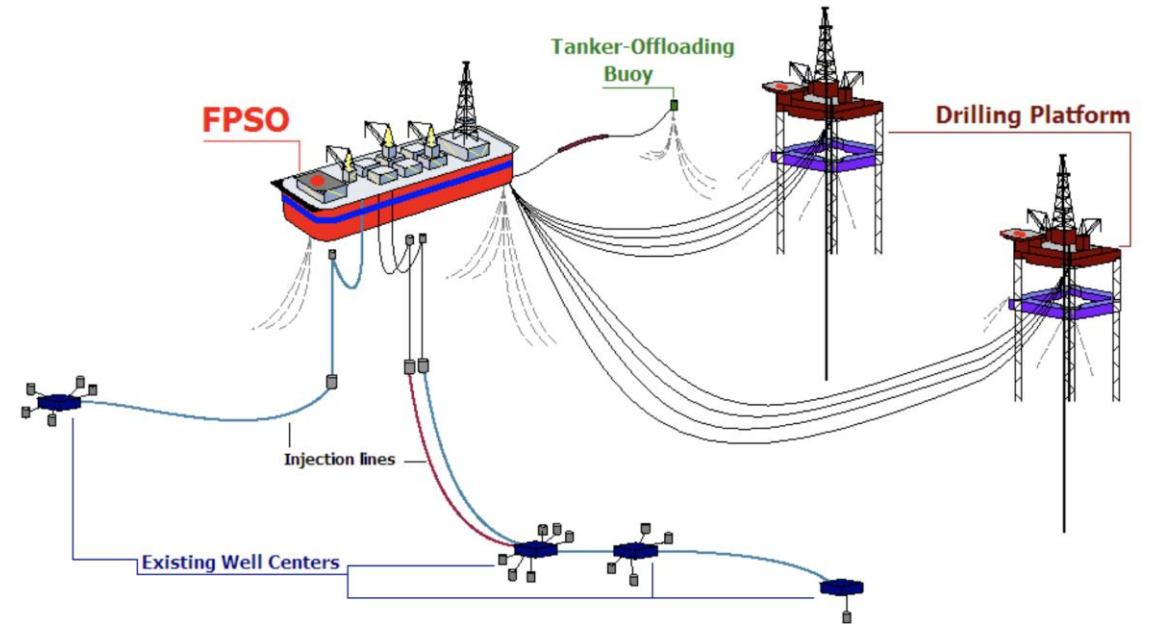
## Reservoir Monitoring

- High resolution seismic imaging | Cap rock integrity
- Heat flow and fluid communication mapping
- Fracture characterization
- Microseismic event detection



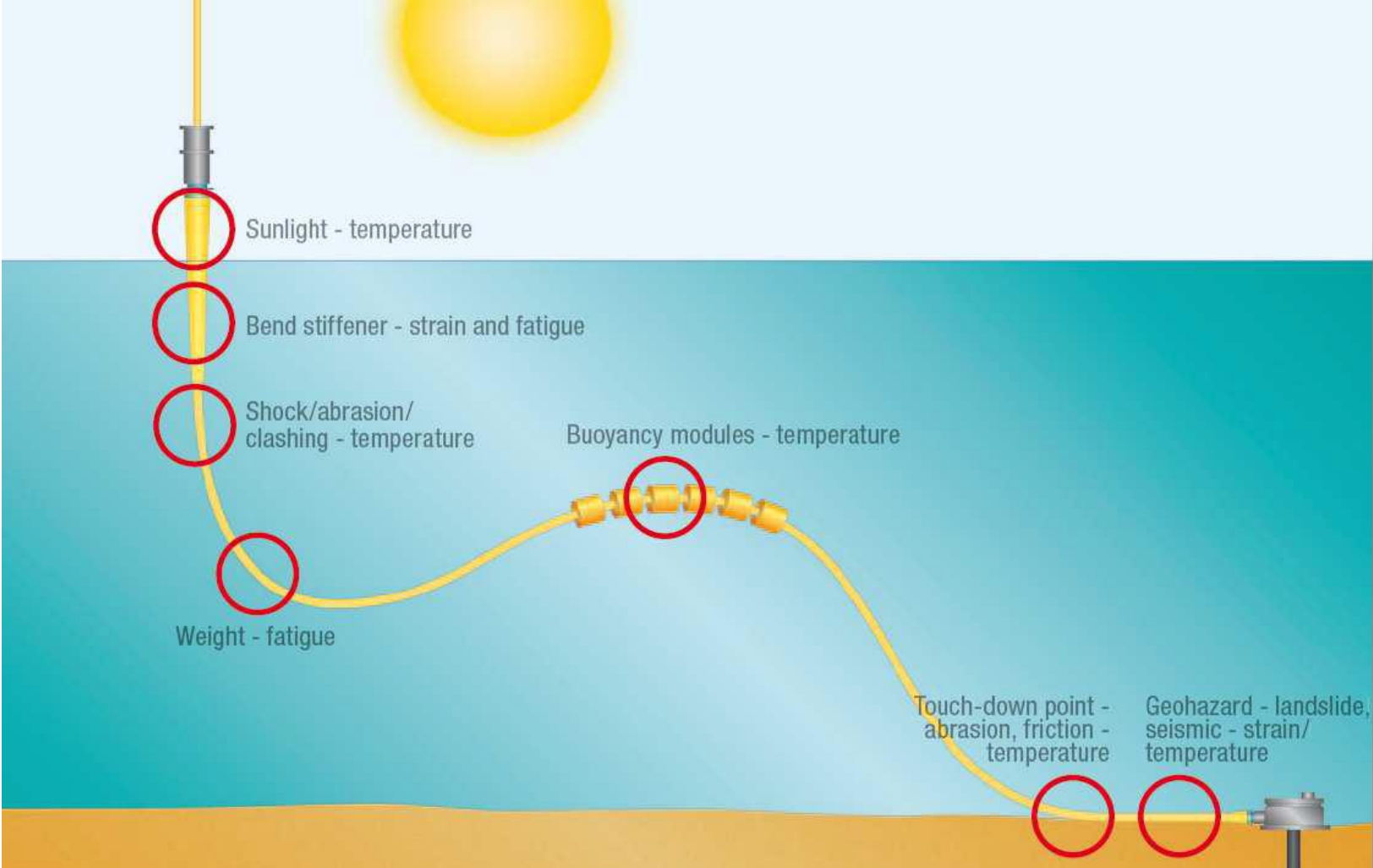
# FPSO/FSO Example

- FPSO (Floating Production Storage and Offloading)
- FSO (Floating Storage and Offloading)





# Oil & Gas Riser Flowline Effects



# Flexible Riser Construction

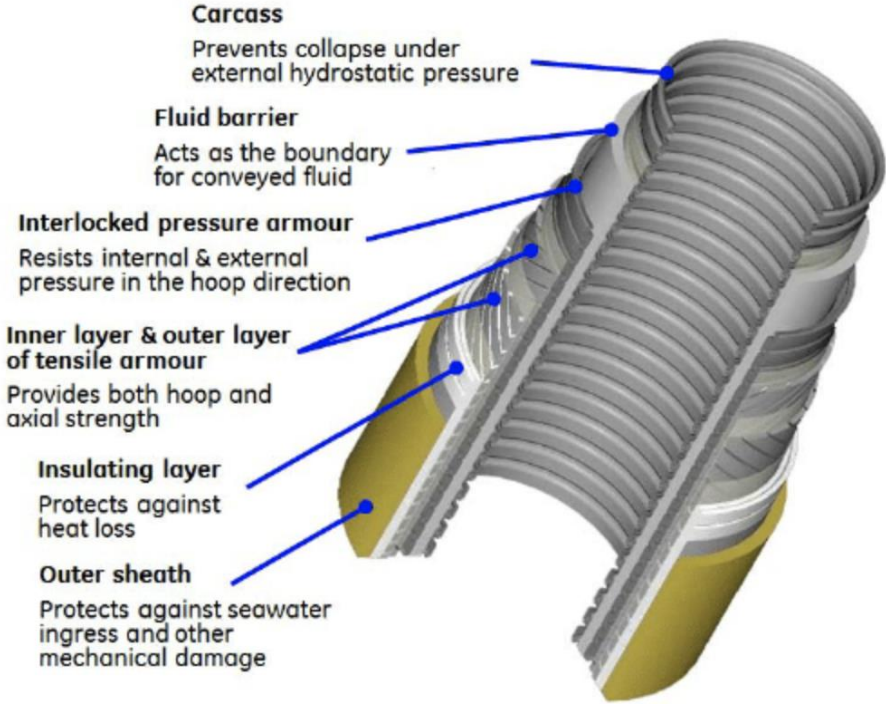


TABLE 1: Layers' functions.

Layer	Function
Carcass	Prevent collapse
Internal pressure sheath	Internal fluid integrity
Interlocked pressure armour	Hoop stress resistance
Back-up pressure armour	Hoop stress resistance
Antiwear layer	Reduce friction between layers
Inner layer of tensile armour	Crosswound armor wires used for tensile stress resistance balanced with outer layer
Antiwear layer	Reduce friction between layers
Outer layer of tensile armour	Crosswound armor wires used for tensile stress resistance balanced with inner layer
Outer sheath	External fluid integrity

# Flexible Risers – Main Failure Modes

No.	Failure mode	Description
1	Collapse	Collapse of carcass and/or pressure armor due to excessive tension, excessive external pressure or installation overloads
2	Burst	Rupture of tensile or pressure armors due to excess internal pressure
3	Tensile failure	Rupture of tensile armors due to excess tension
4	Compressive failure	Birdcaging of tensile armor wires
5	Overbending	Rupture or crack of external or internal sheaths
6	Torsional failure	Failure of tensile armor wires
7	Fatigue failure	Tensile armor wire fatigue
8	Erosion	Of internal carcass
9	Corrosion	Of internal carcass or tensile/pressure armor exposed to seawater or diffused product





# Riser Monitoring System

## ***Direct fiber optic monitoring of the wires in armor layers of flexible risers using FBG strain sensors***

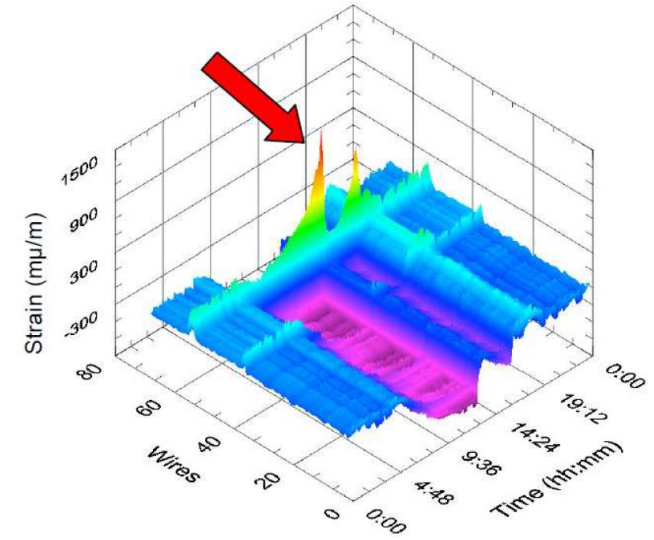
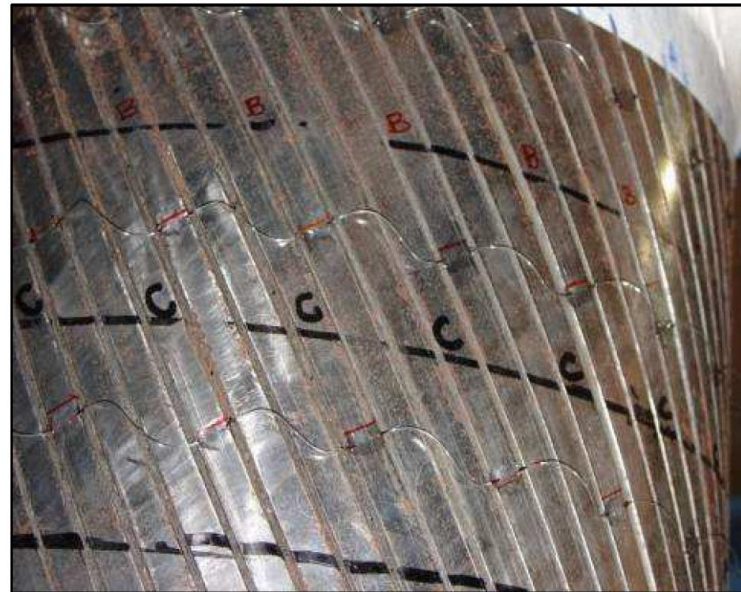
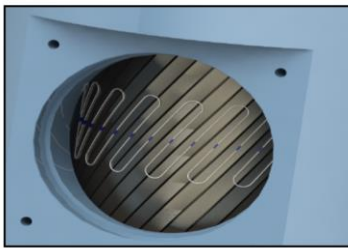


- *All wires in the external armor are instrumented*
- *Monitor progressive damage (sequential wire ruptures) as well as accumulated fatigue*
- *Rupture brings tension from the operational tension to zero.*

Fiber Optic Connection



Fiber Optic Sensors





# Installation example



# Questions?

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Thank you