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Ministry of  
Industries, Mines and Energy,  
Republic of Namibia

4th  
Edition



**Namibia**

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18 - 20 August 2026 | Mercure Hotel, Windhoek, Namibia

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#NamibiaOGC26

# Maintaining Multiphase Flowmeter Data Quality in a Distributed Subsea Production System

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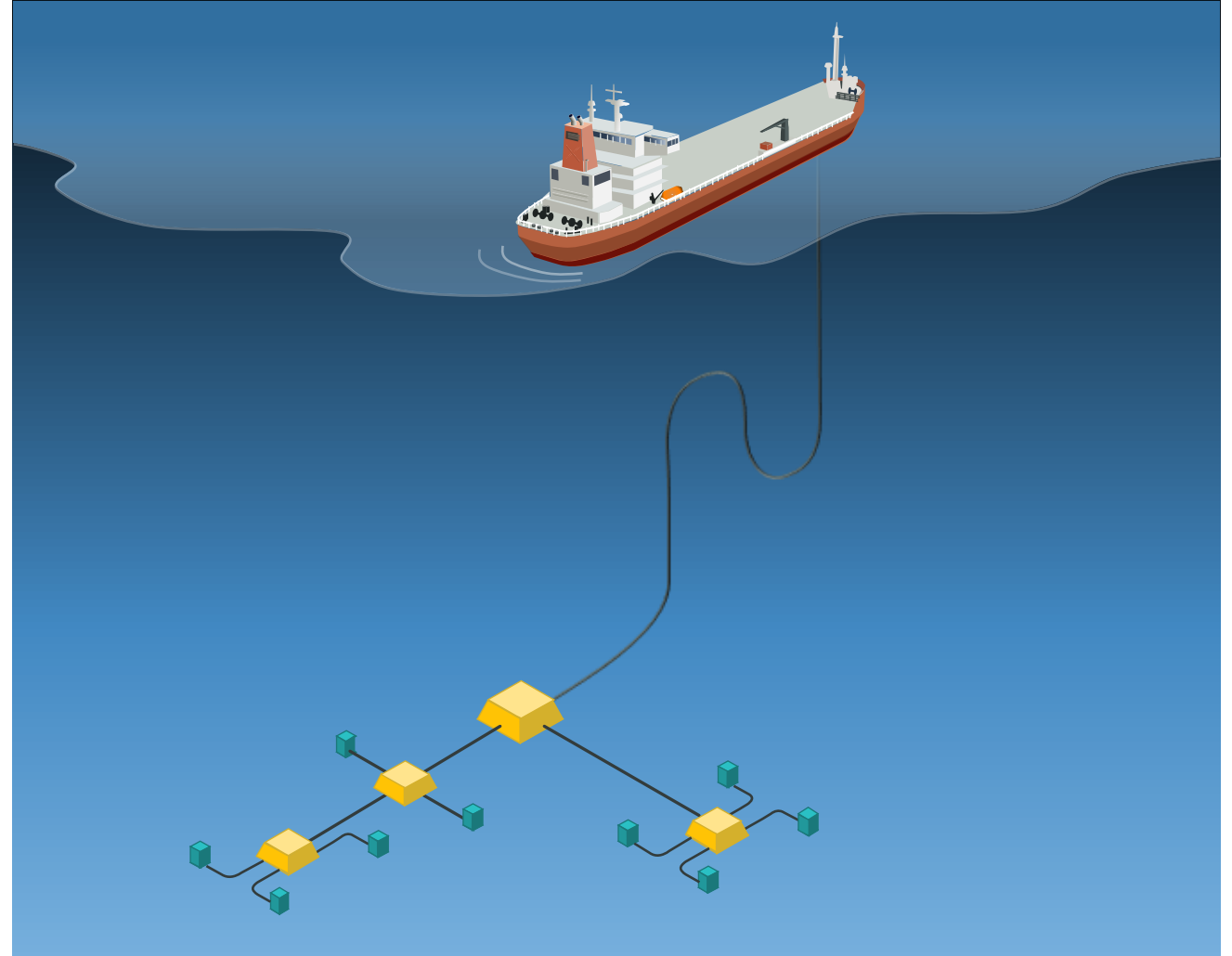
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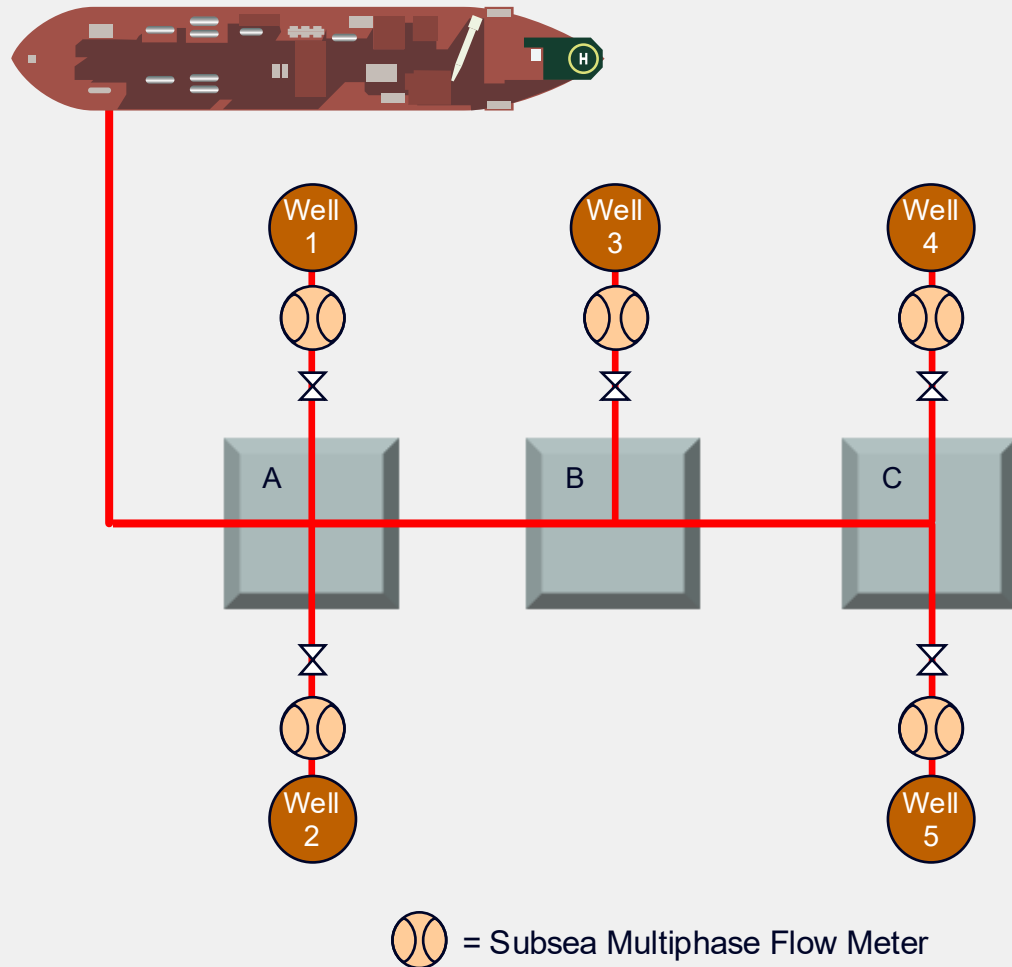


# Benefits of using multiphase flow meters in a subsea production system

- ↳ Avoid expensive test manifolds and test lines.
- ↳ No need for test separator.
- ↳ Continuous production monitoring of every well.
- ↳ Immediate detection of water or gas break-through.
- ↳ Provides flow assurance insights.
- ↳ Very efficient for gas lift optimization.
- ↳ Optimized reservoir management.



# The challenge with MPFMs in a distributed SPS



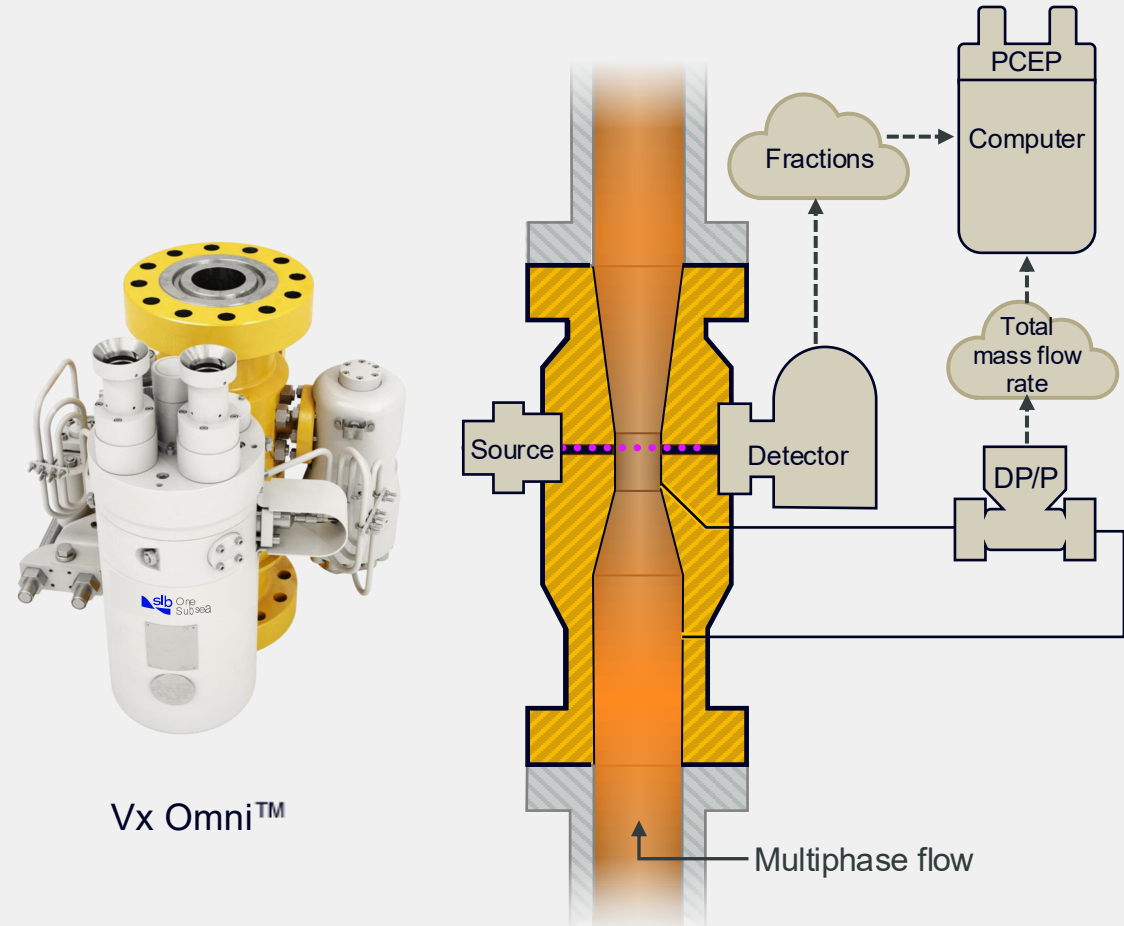
- ↳ A typical subsea production system with multiphase flow meters on each well.
- ↳ It is not possible to verify the performance of the individual subsea meters with a topside reference meter.
- ↳ How can we check the quality of the flow measurements of the subsea meters?

# The Vx technology for multiphase measurements

- ↳ Phase fractions measured by dual energy gamma.
- ↳ Total mass flow rate by a classic venturi meter.
- ↳ Simple principle with clear physical basis.
- ↳ All measurements made at same point.

## Essential inputs:

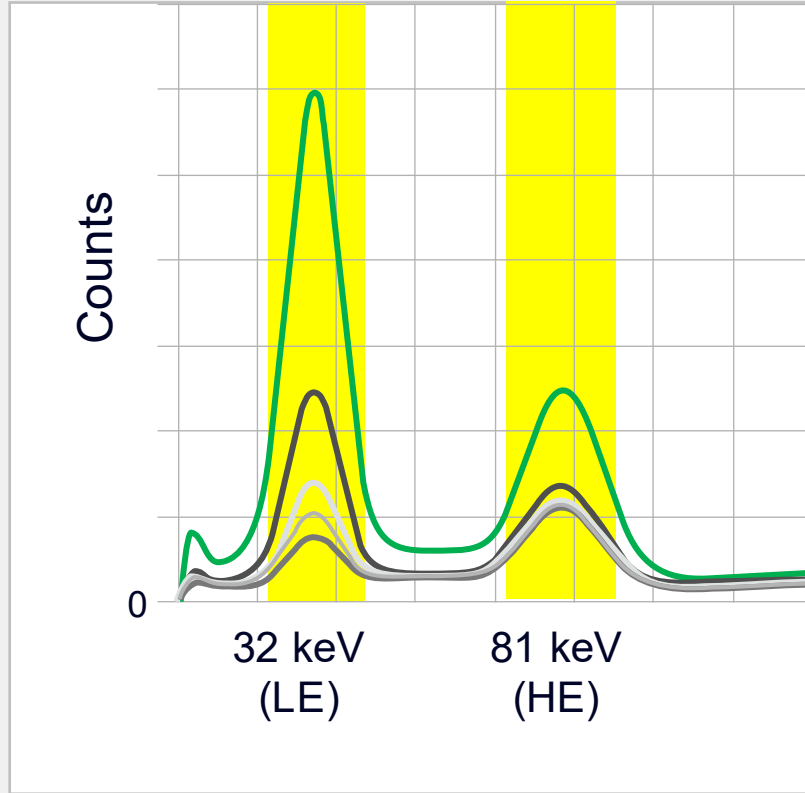
- ↳ Fluid properties oil, water, gas:
  - ↳ Density =  $f(P,T)$
  - ↳ Mass attenuation coefficients



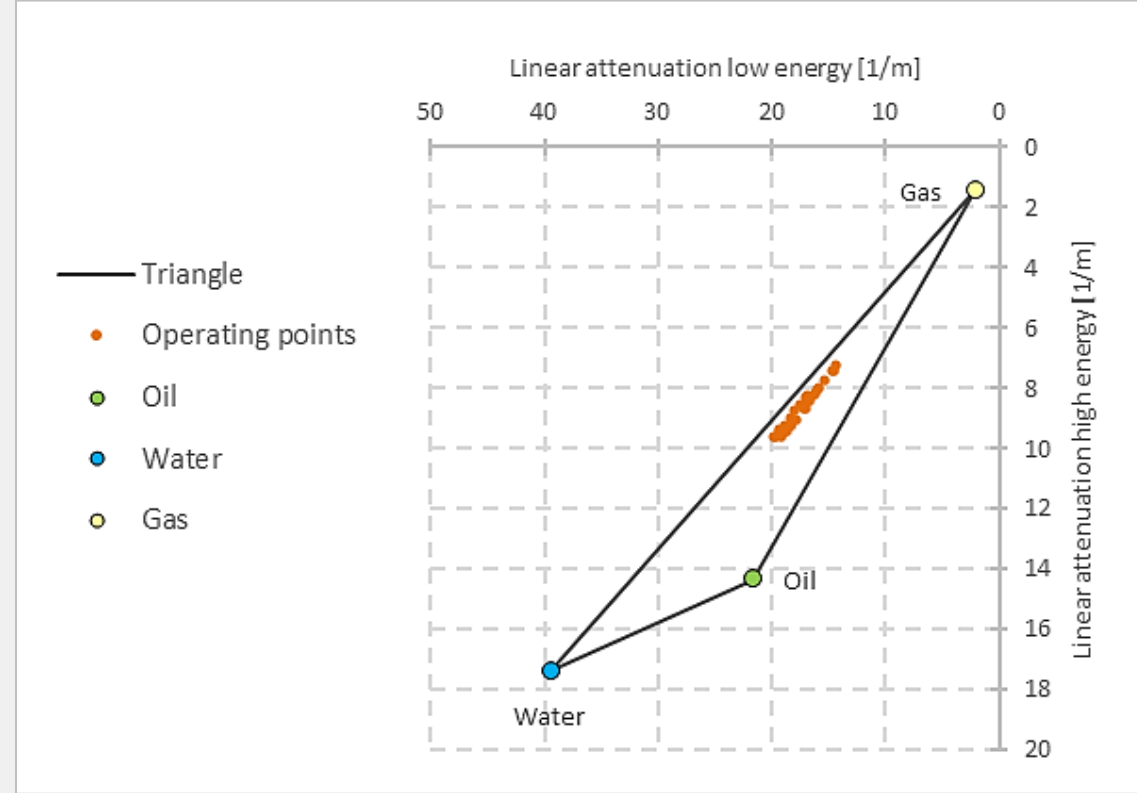
Vx Omni™

*Vx technology™ = combination of a dual energy fraction meter and a venturi meter used for multiphase flow measurements.*

# The Dual Energy Gamma Fraction Meter



The gamma spectrum with two characteristic peaks.

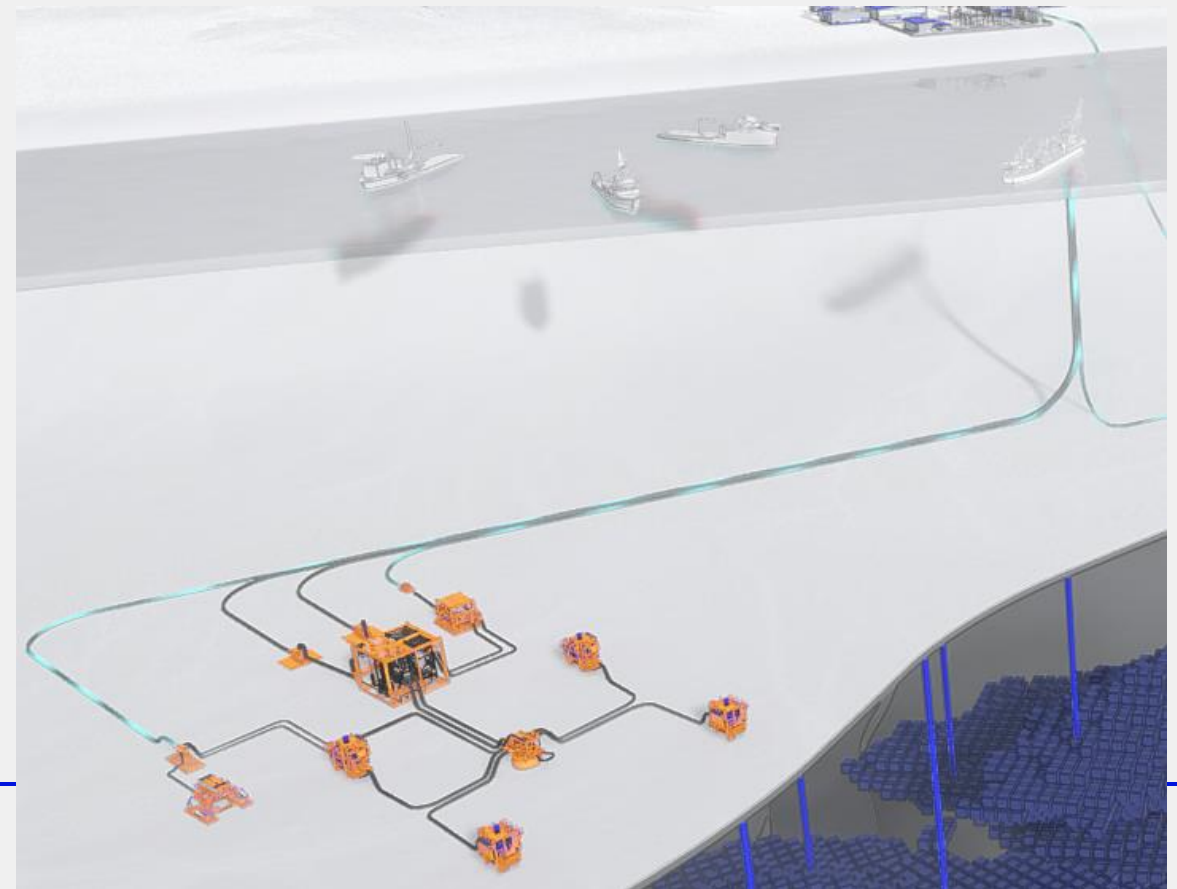


The "solution triangle". A graphic presentation of the nuclear attenuation in a mixture of oil, water and gas.

# Maintaining measurement data quality in a distributed SPS

More than 1200 Vx subsea multiphase flowmeters have been delivered.  
Approximately 350 of them to projects in West Africa.

The following examples shows how data quality is maintained without a reference flow meter and they are selected from work that has been done by the OneSubsea operations support team.



# Subsea Live™

Integration of real-time data from the field, OEM expertise & experience, and physics-based models to provide insights and support to operators.



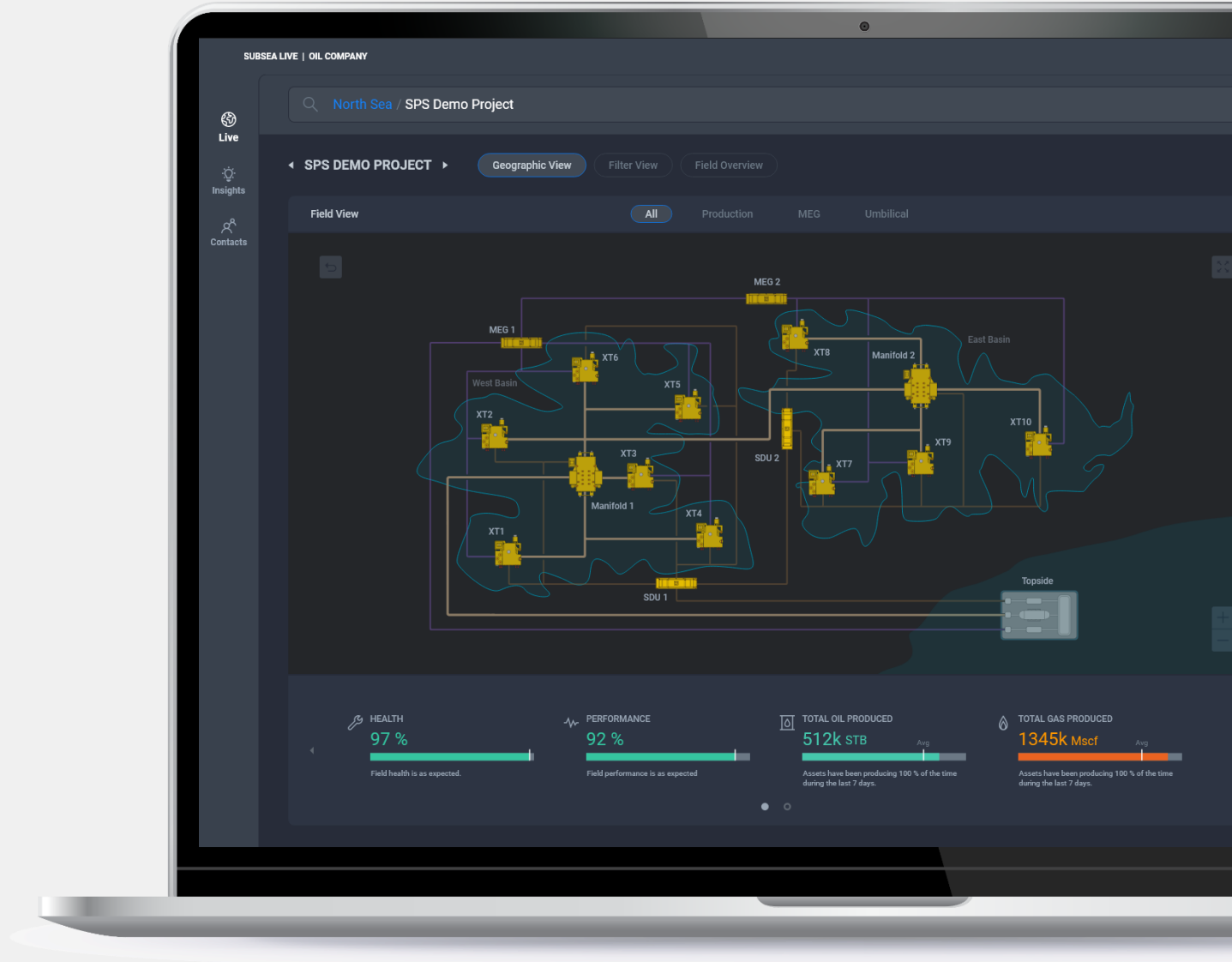
Health insights:  
Understanding the health and hardware condition of the equipment.



Performance insights:  
Understanding the performance and measurement accuracy of the equipment.



Operational insights:  
Understanding flow assurance risks.



# Subsea Live for MPFM



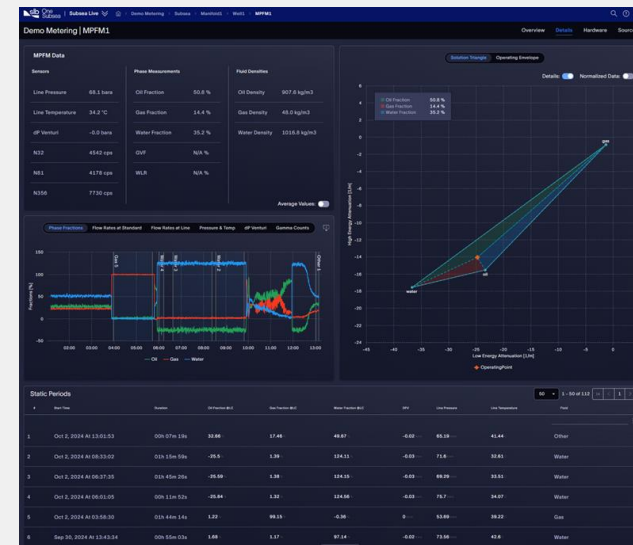
**Access** to live measurement performance evaluations in a **collaborative space**, and immediate notifications of concerns



Ensure that the data is clean and reliable, such that support related to flow assurance challenges can be offered with precision



Access to **OneSubsea meter expertise**, and advanced data interpretation models such as sand detection, scale detection, and the compensation of these.



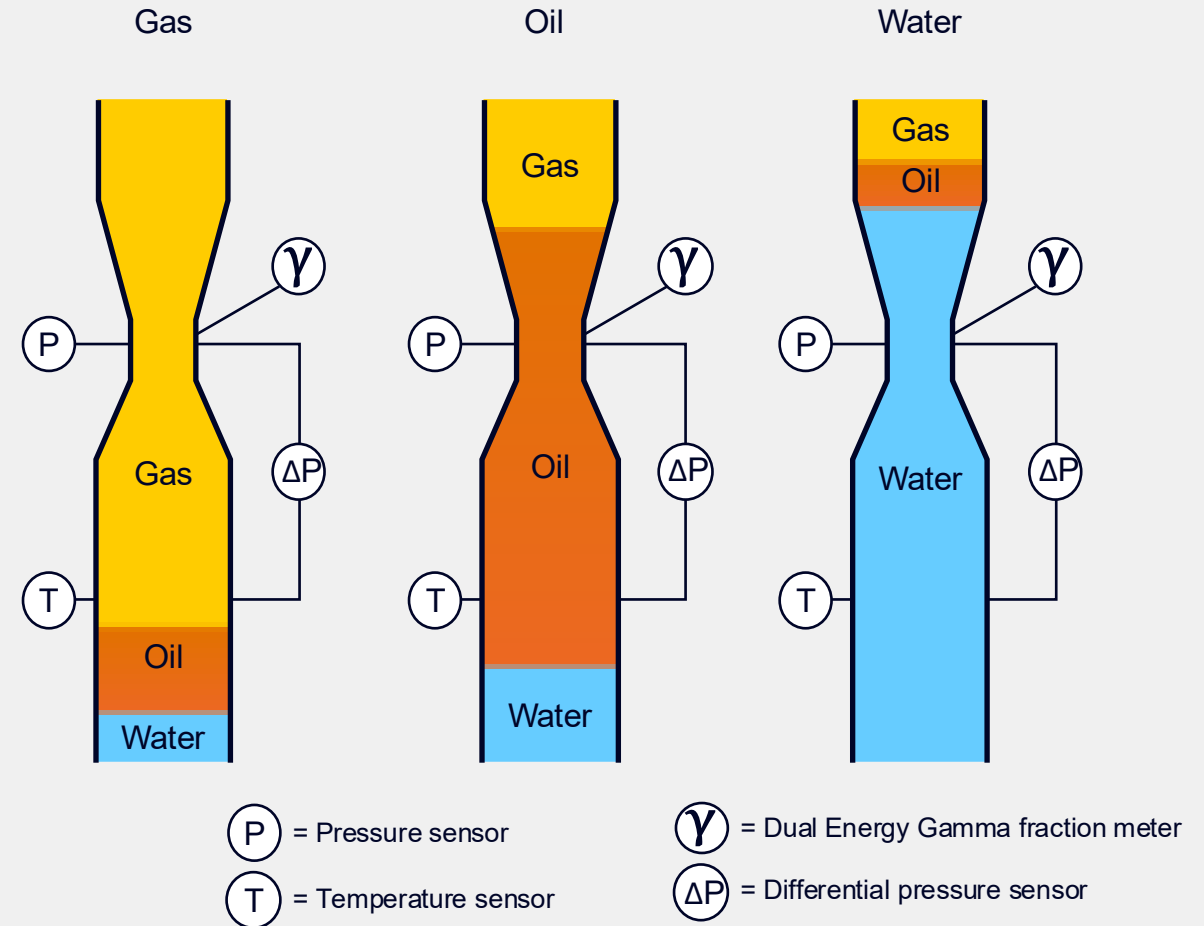
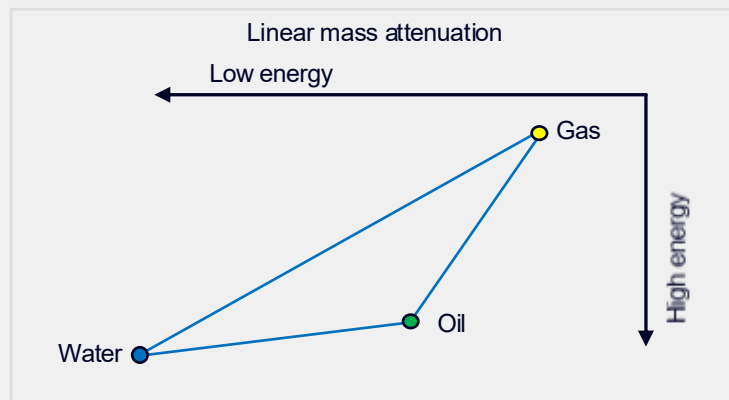
## Example 1: Single-phase fluid trapped in the measurement section during a well shut-in

Experience has shown that most oil and gas wells experience planned, or unplanned shut-downs relatively frequently (several times per year).

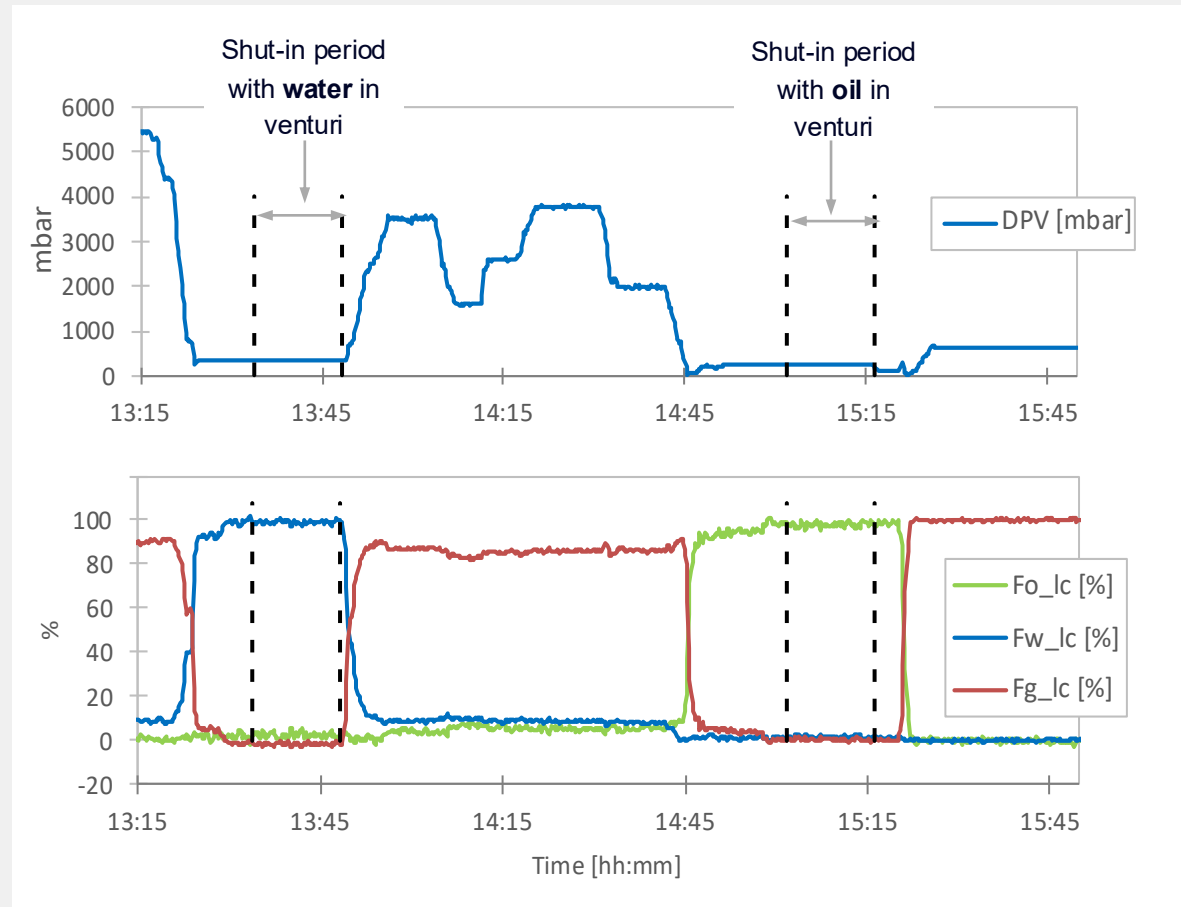
In these cases, either gas, oil or water are trapped in the measurement section.

These events can be used to verify that the input parameters to the meter are valid by measuring the attenuation.

The analysis does not have to be done in real time, when the shut-down occurs. It can be done by capturing events that happened in the past.

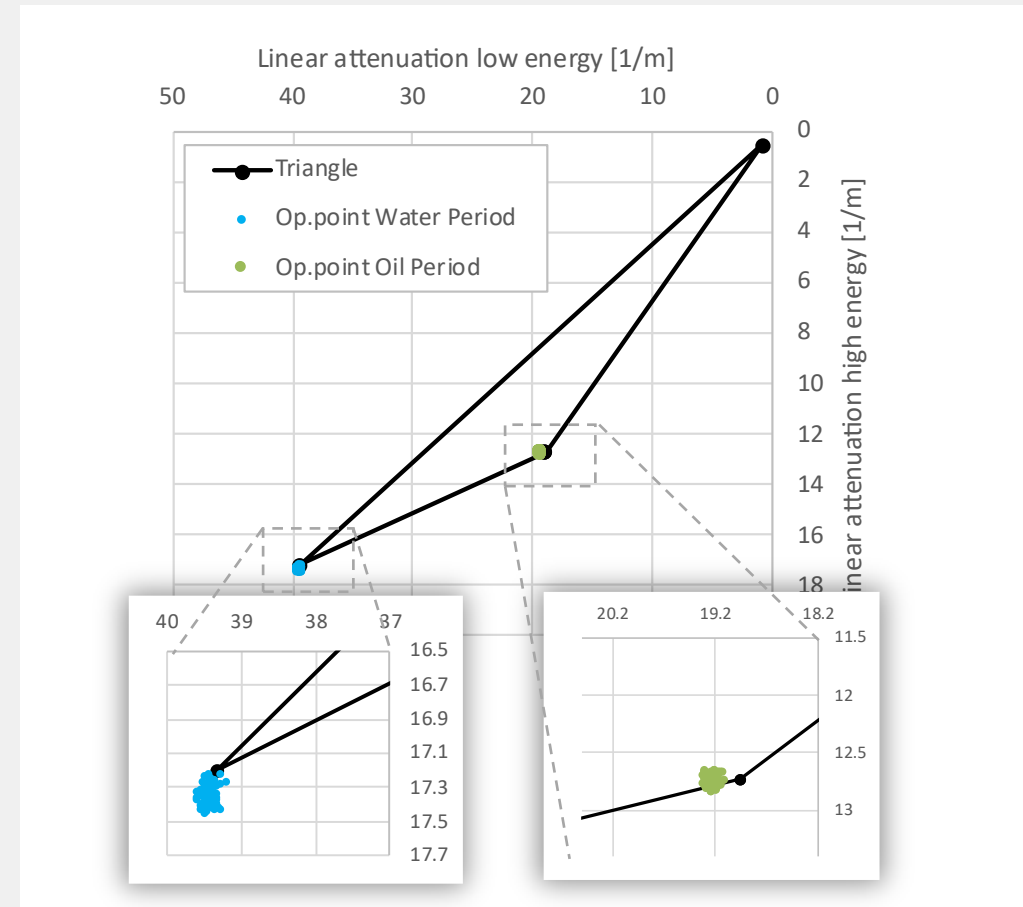


# Oil and water measurements during shut-in

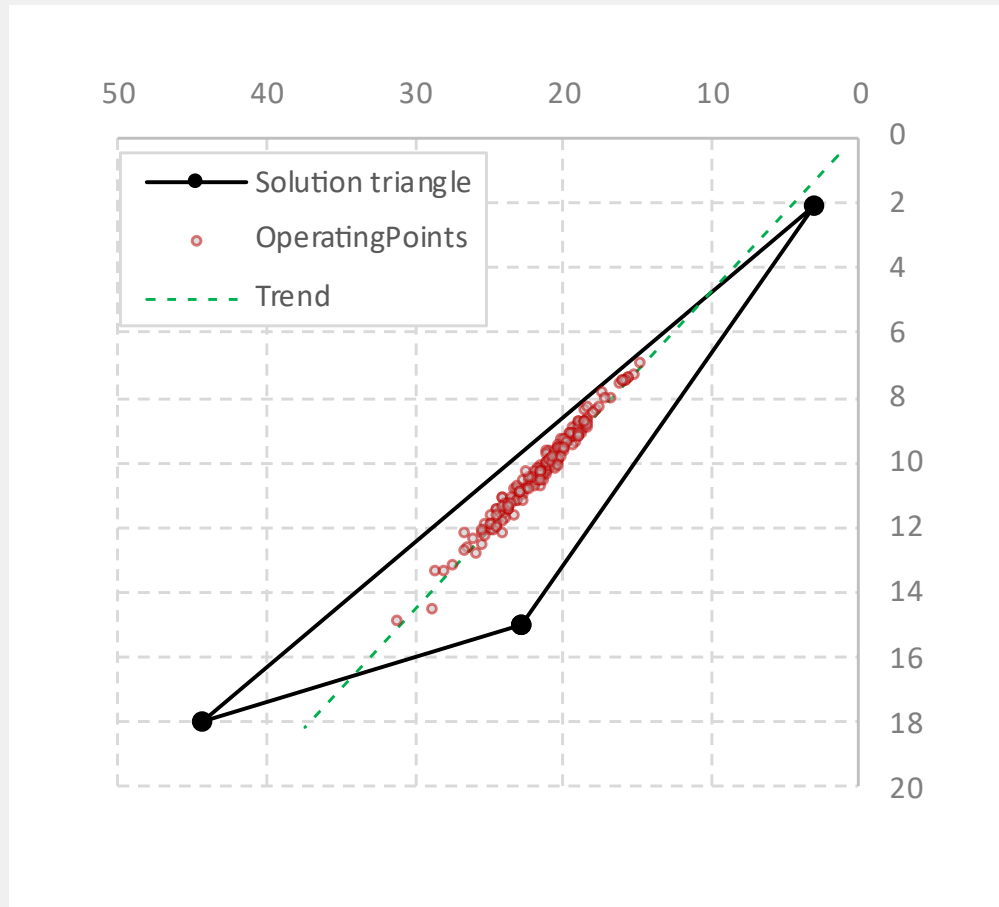


$Fo_{lc}$  = Oil fraction at line conditions  
 $Fw_{lc}$  = Water fraction at line conditions

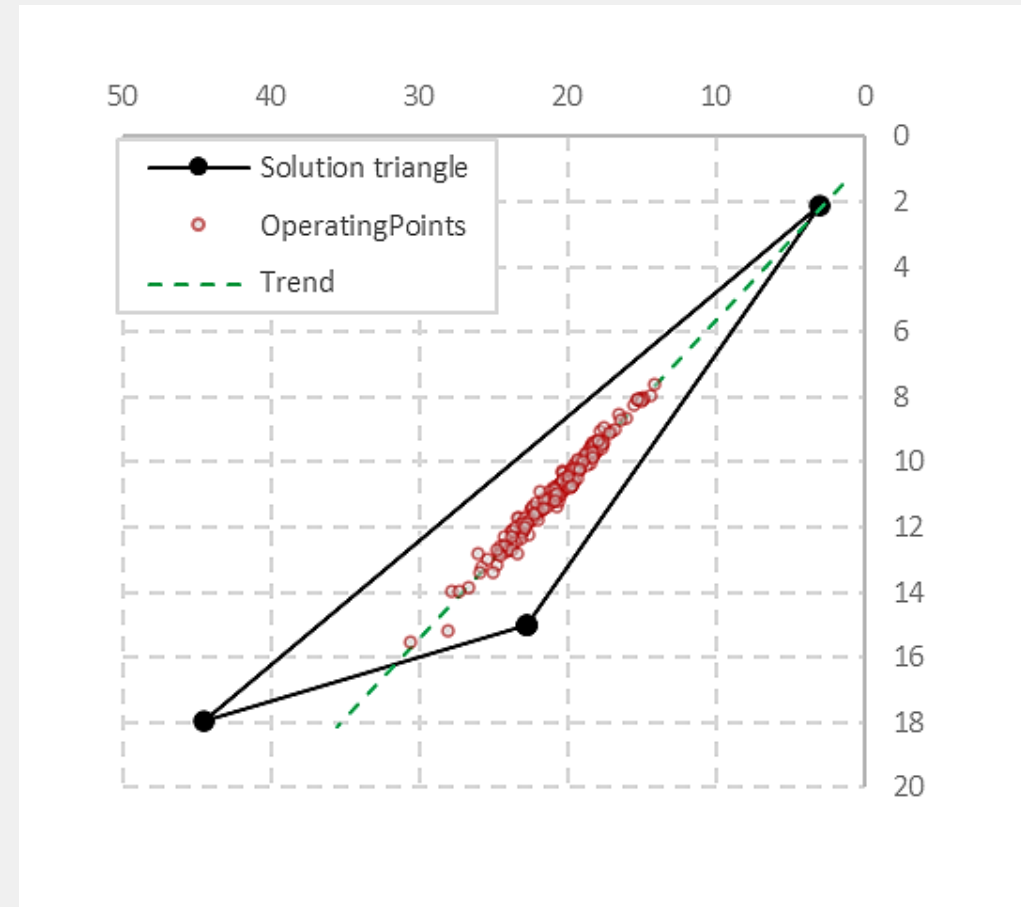
$Fg_{lc}$  = Gas fraction at line conditions  
 DPV = Venturi differential pressure



## Example 2: Verification of gas point in dynamic conditions



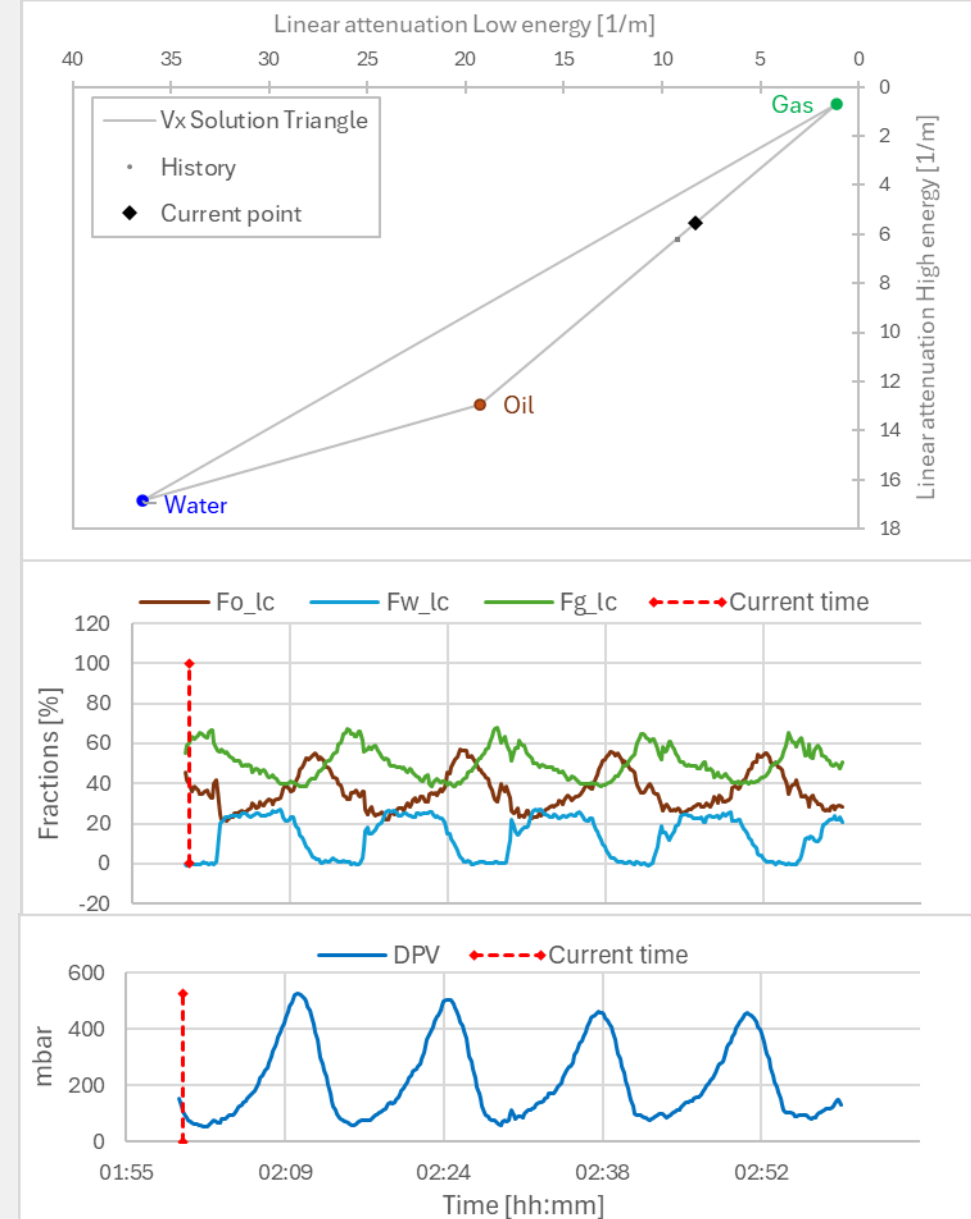
The diagram shows a slugging well. Water-Liquid-Ratio (WLR) is relatively stable, and Gas Volume Fraction (GVF) is varying. The trend line should be pointing at the gas point, but it is not.



The gas point is updated, and the operating points fall in place in the triangle.

# Example 3: Dynamic data analysis verifying fraction measurements

- ↳ May contain useful information about correctness of the phase fraction measurements.
- ↳ Example shown here shows high variations between the phases.
  - ↳ Chart 1: Attenuation diagram, solution triangle
  - ↳ Chart 2: Phase fractions/hold-ups
  - ↳ Chart 3: Venturi differential pressure (DPV)
- ↳ The water fraction regularly ends at the same minimum level: zero, not above, not below
- ↳ → suggests correct oil-gas line in triangle.



# Summary

- ↳ It can be challenging in many cases to verify performance of a subsea meter in a distributed SPS.
- ↳ Based on many years of operational experience, OneSubsea have developed various methods to check the quality of the measurements without the need for a reference meter.
- ↳ These methods take advantage of events in the production flow, and use built in Vx technology features to verify that the subsea meters are correctly configured.

