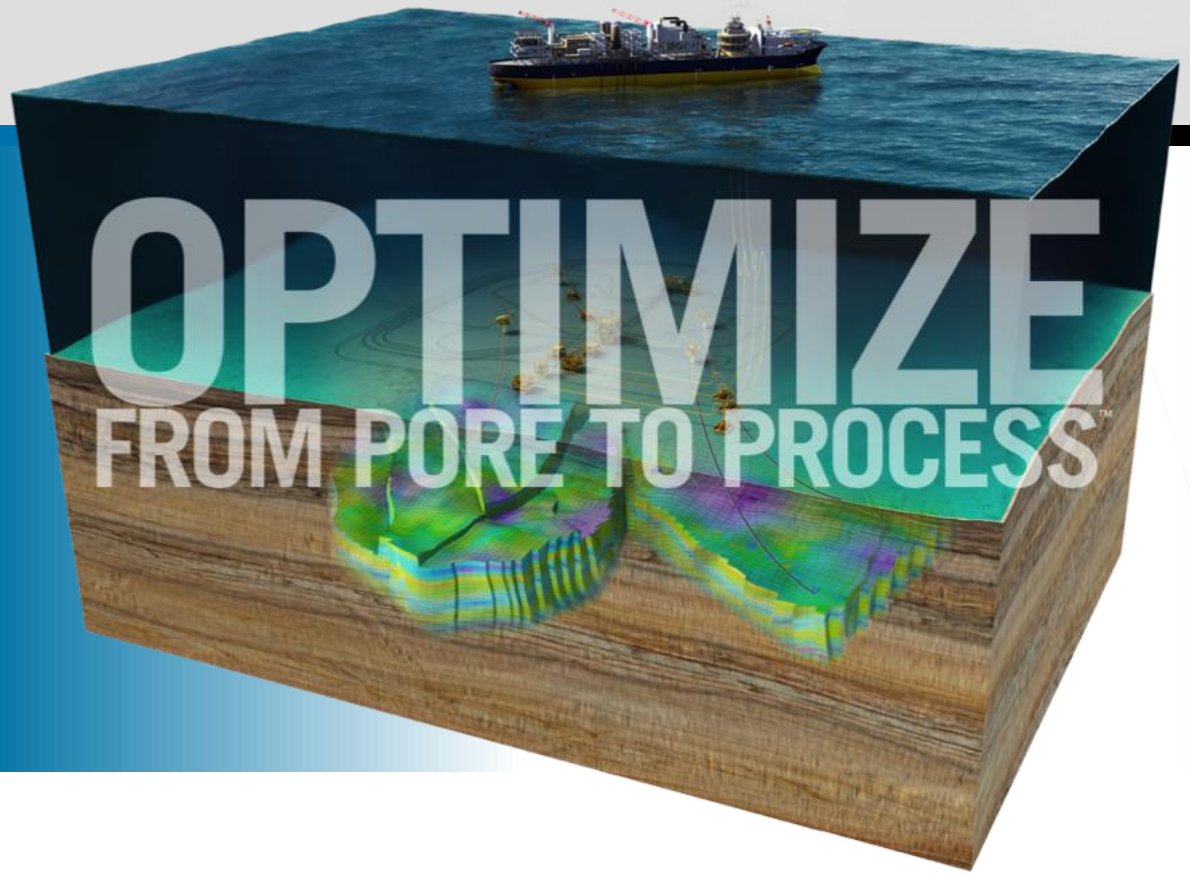
NFOGM Temadag, 10. Mars 2016

Radisson Blu Atlantic Hotel, Stavanger



OneSubsea
A Cameron & Schlumberger Company

Challenges of comparing MPFM's measurements with Separator's measurements

by

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Company: OneSubsea

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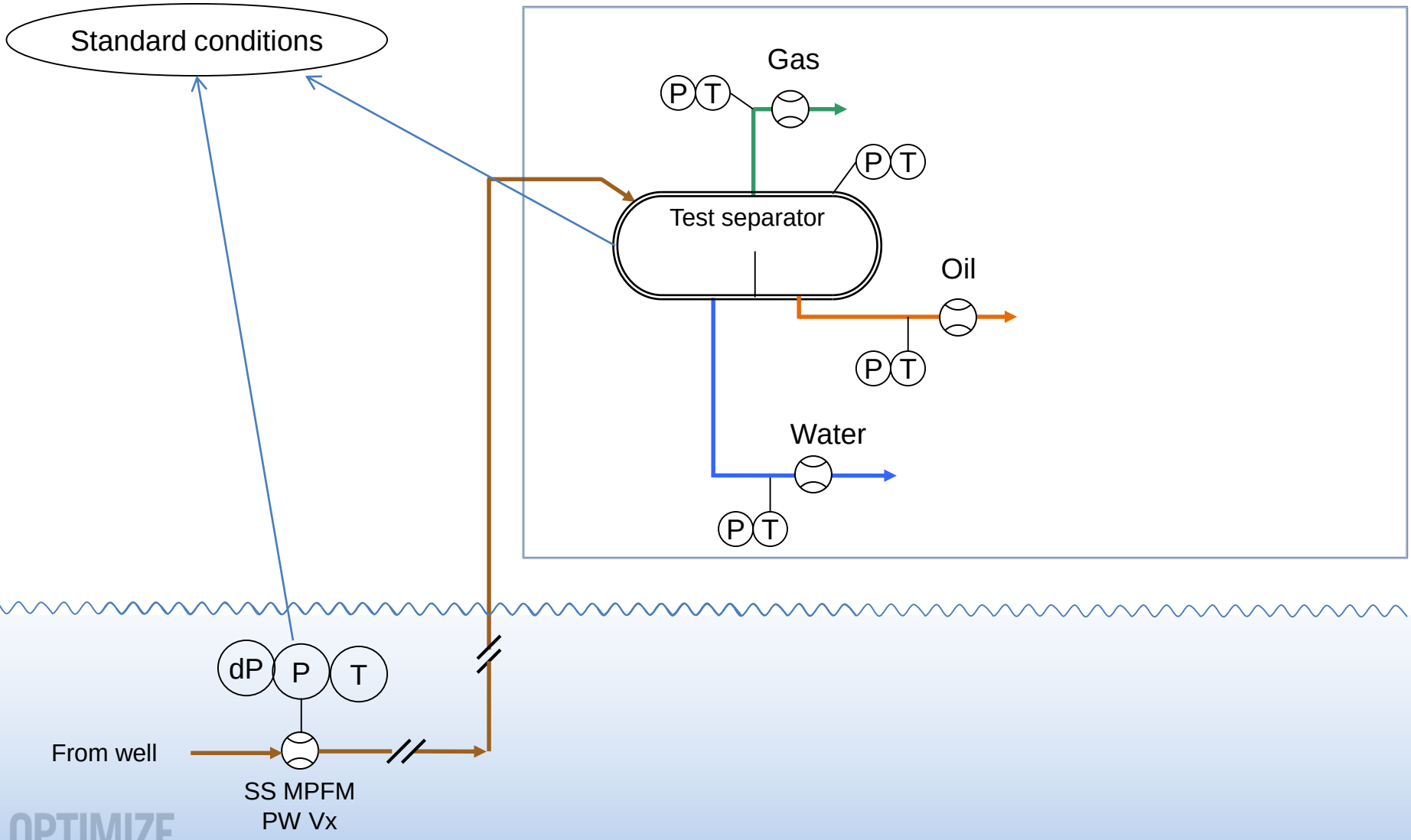
Content

Introduction

Example of test setup



Introduction

Why comparing measurements?

- Evaluate and validate measurements
- Determine the reliability of equipment
- Validate consistency in fluid properties

Challenges in comparing measurements

- Difference in measurement principles
- Different operating conditions
- Different fluid property model

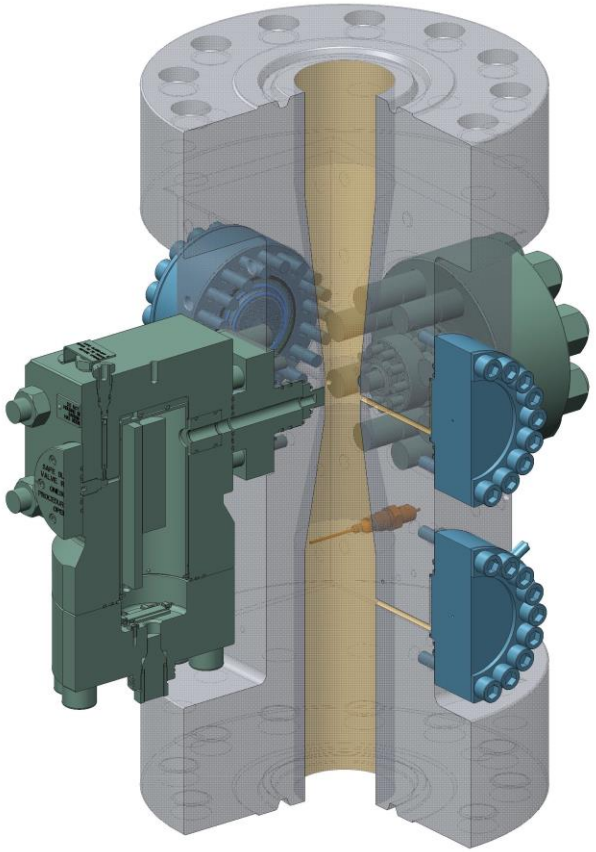
Potentially there can be large discrepancies between measurements

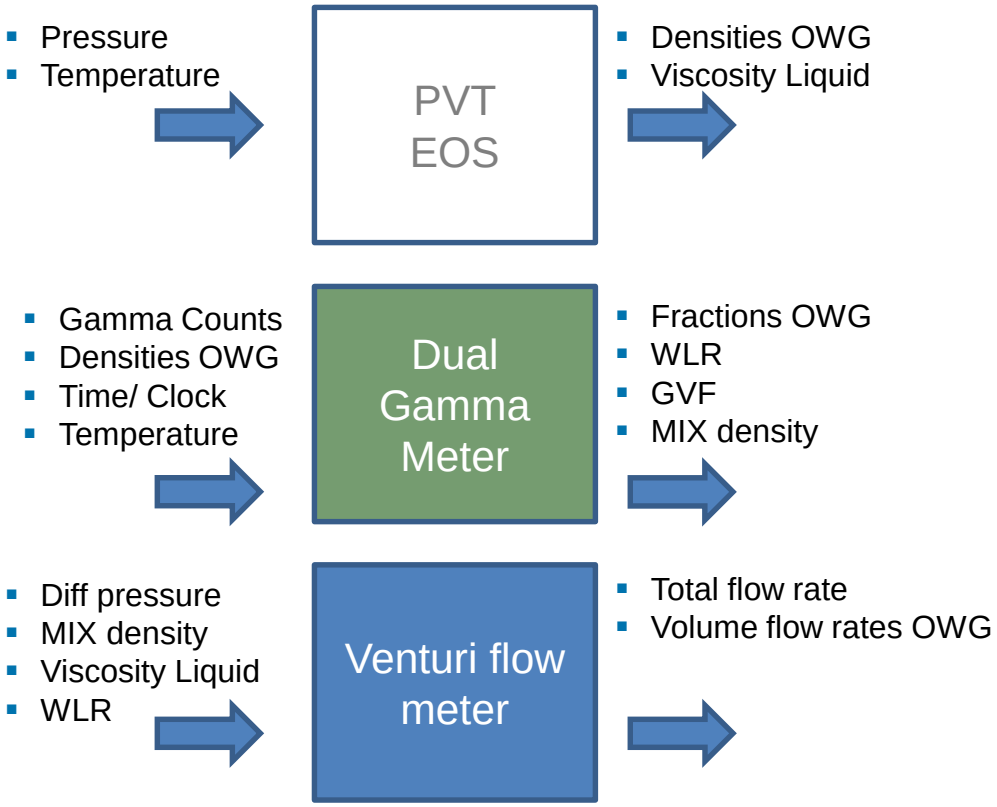
- Causes have to be identified and corrected.

Principles of operation - Vx

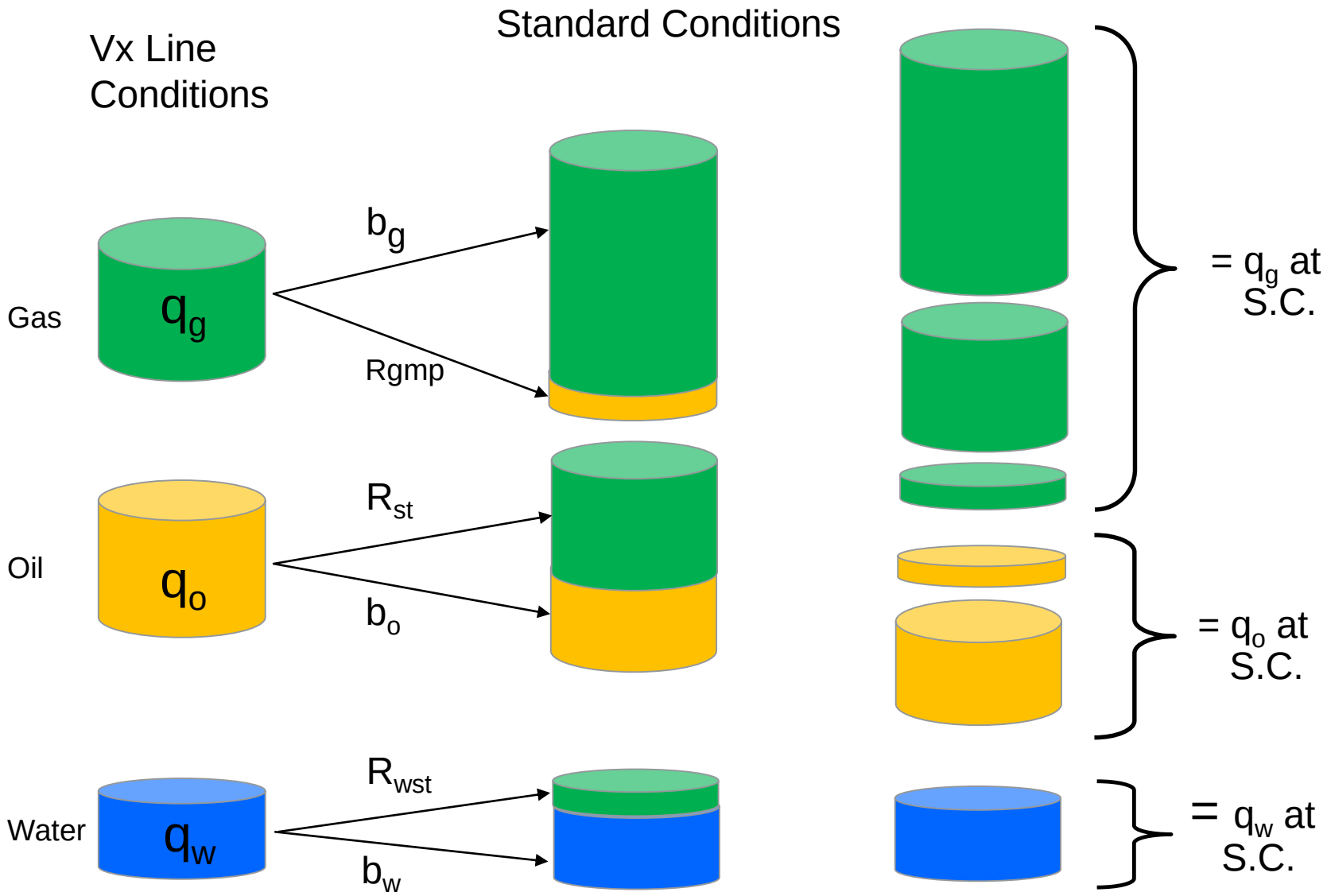
Vx is utilizing two measurement principals

- **Venturi mass / volume flow**
- **Dual gamma fraction meter**
- Supporting calculations PVT EOS – configured in a configuration file





Principles of operation - Vx



Principles of operation - Separator

The separator relies on:

- Separator size
- Difference in phases densities
- Immiscibility of components (oil and water)
- Difference in phases viscosity (oil and water)

Sources of error in measurements

Vx sources of error

- **Incorrect PVT data**
- **Solid deposits**
- MPFM not sized for the producing conditions

Separator sources of error

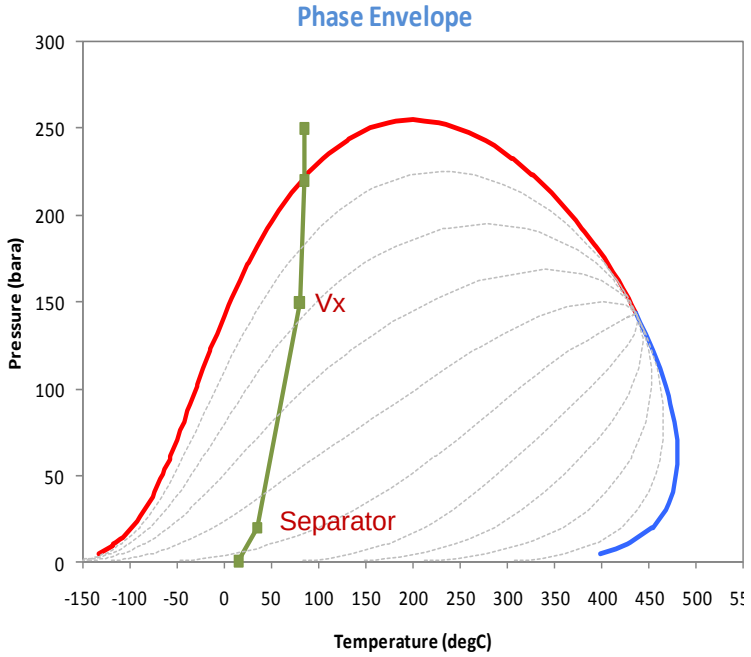
- **Incorrect PVT data in the instruments**
- **Incorrect calibration (separator)**
- Under/oversized for the producing conditions
- Instrument malfunctioning

Sources of error in measurements

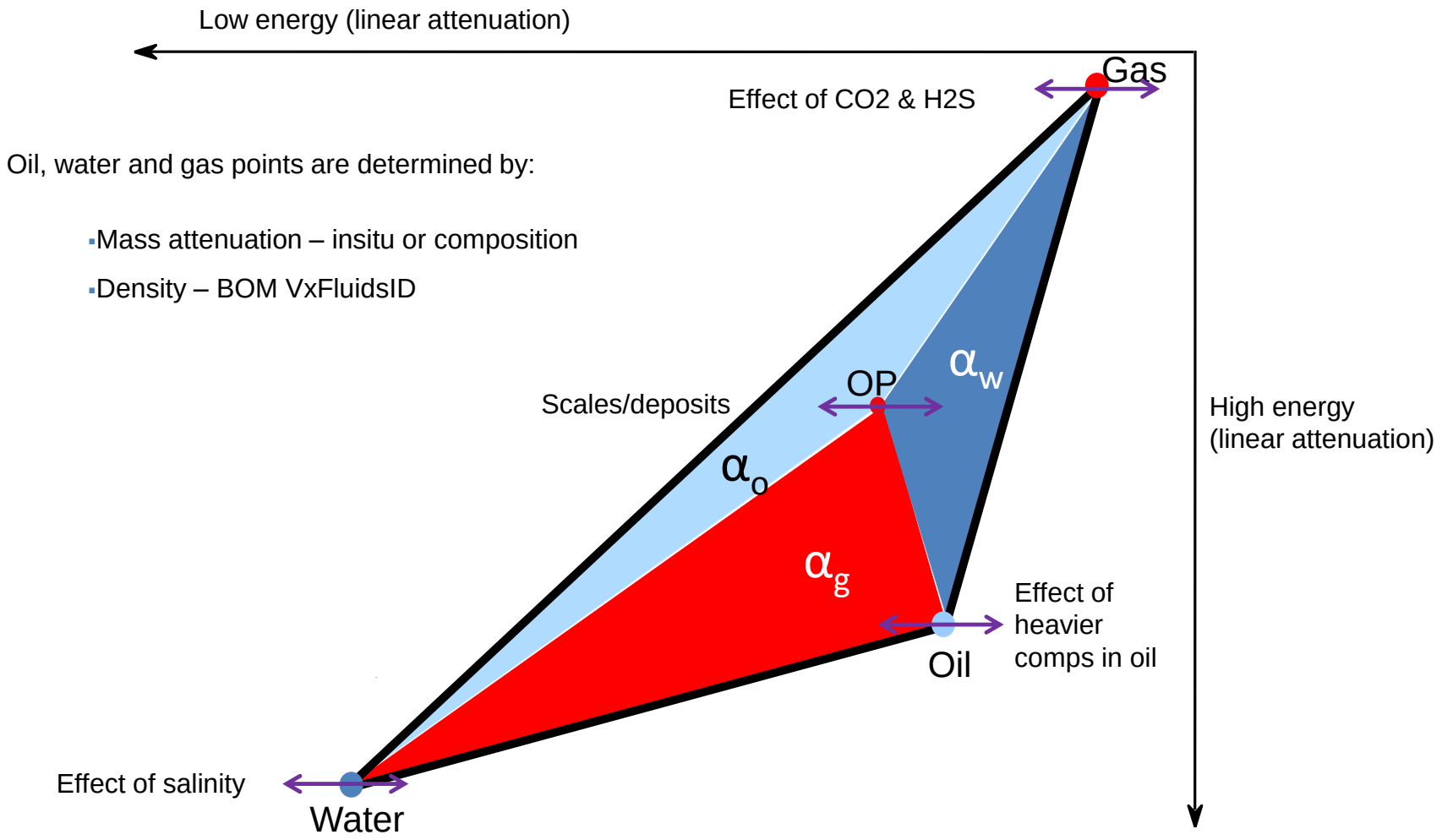
Incorrect PVT data in MPFM and/or in separator instruments

PVT is quite important in the quality of measurement and it is important that the following parameters are correct and consistent in both instruments.

- Densities of oil, water and gas
- Mass attenuation coefficients
- Viscosities of oil and water
- Hydrocarbon composition
- Water salinity
- Non hydrocarbon components in oil

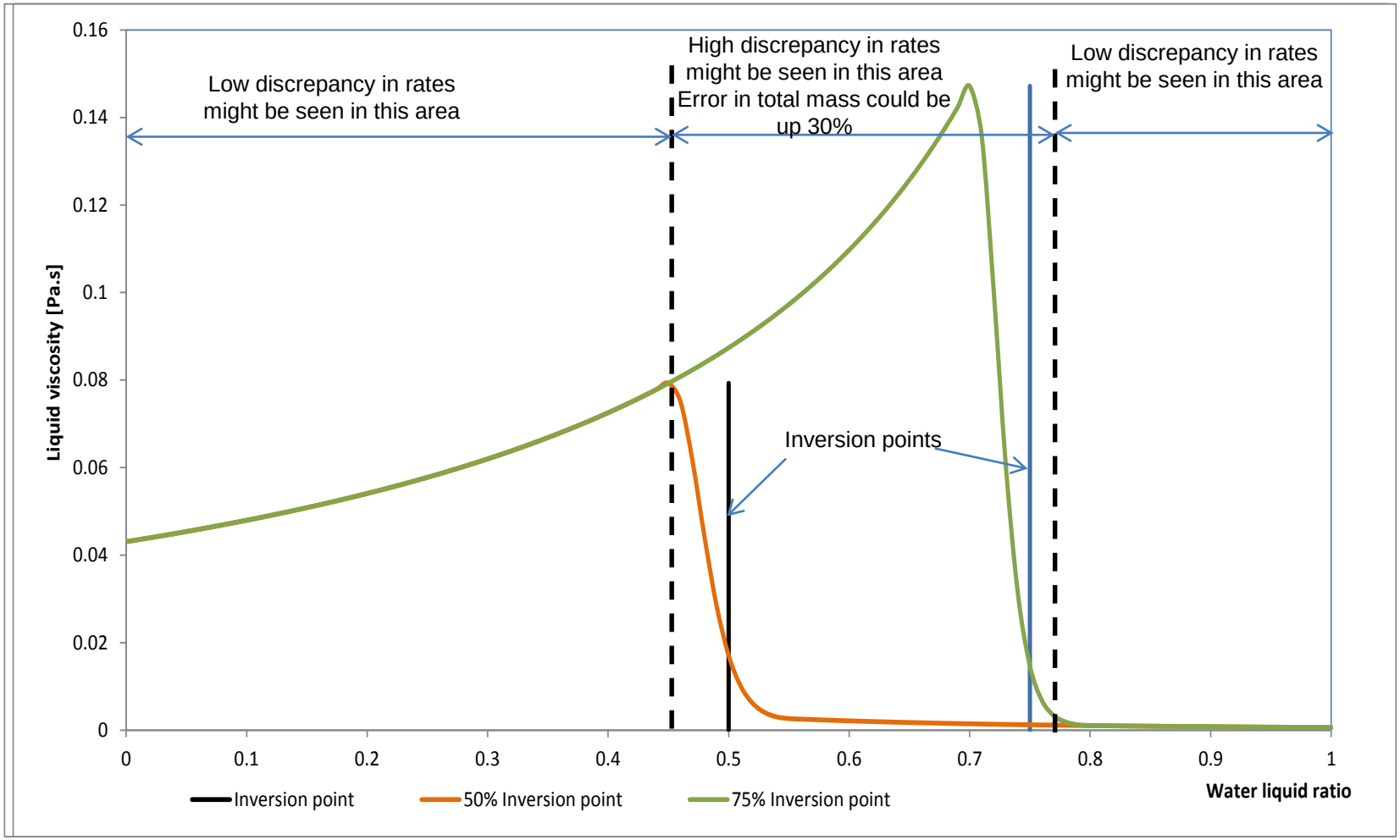


Effect of incorrect PVT and/or deposit



Sources of error in measurements

One other challenge is getting accurate liquid/emulsion viscosity model. Liquid viscosity will affect the GVF and may also affect the total mass flow

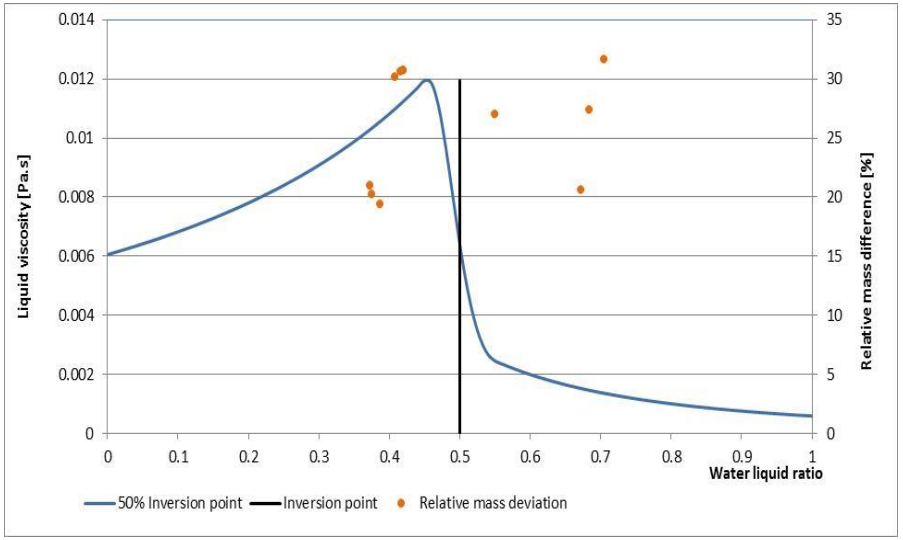


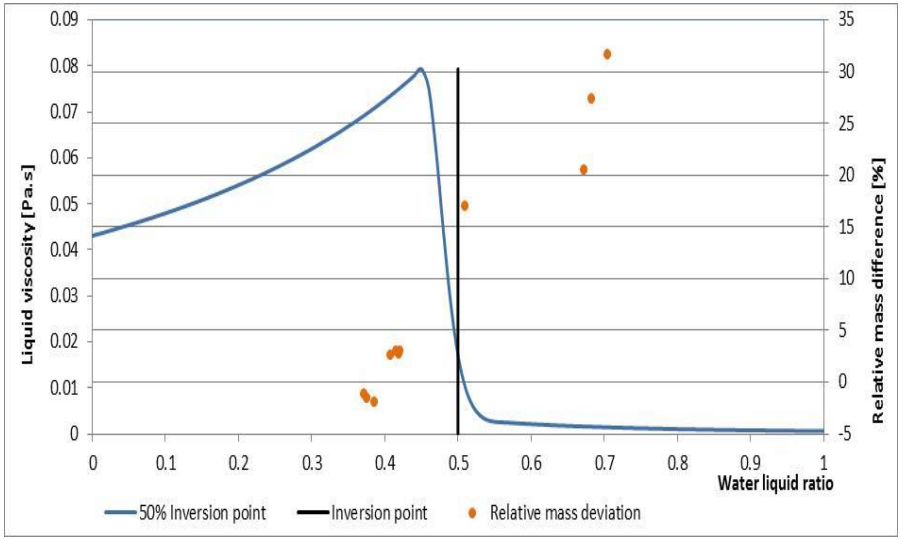
Sources of error in measurements

Field experience with incorrect oil viscosity

Oil viscosity [Pas] @ 30 bara and 32 degC
Before update = 0.027 Pa.s
After update = 0.340 Pa.s

	Before update		After update	
		rel dev		rel dev
m_lc[kg/s]	6.0	30.6%	4.6	1.0%
qo_sc[Sm3/h]	11.2	44.6%	7.8	-0.3%
qw_sc[Sm3/h]	8.2	63.3%	5.7	12.5%
qg_sc[Sm3/h]	3914	-23.4%	5213	2.0%
Liq.Visc [Pas]	0.027		0.340	





Challenges when MPFM is topside

With topdside MPFMs, the challenges are fewer and are easy to overcome because:

- Often short slow distance between the MPFM and the separator
- Little difference between operating conditions (P & T)
- Sampling is feasible, thus PVT data can easily be verified
- Offshore maintenance is feasible

Challenges when MPFM is subsea

With subsea MPFMs, the challenges require careful evaluation due to:

- Often long tie-backs
- Often large difference in operating conditions between the MPFM and the separator
- Sampling is more complicated – PVT data cannot be easily verified
- Deposit might not be detected

Separator challenges

- Incorrect separator sizing with respect to process conditions
- Separation efficiency

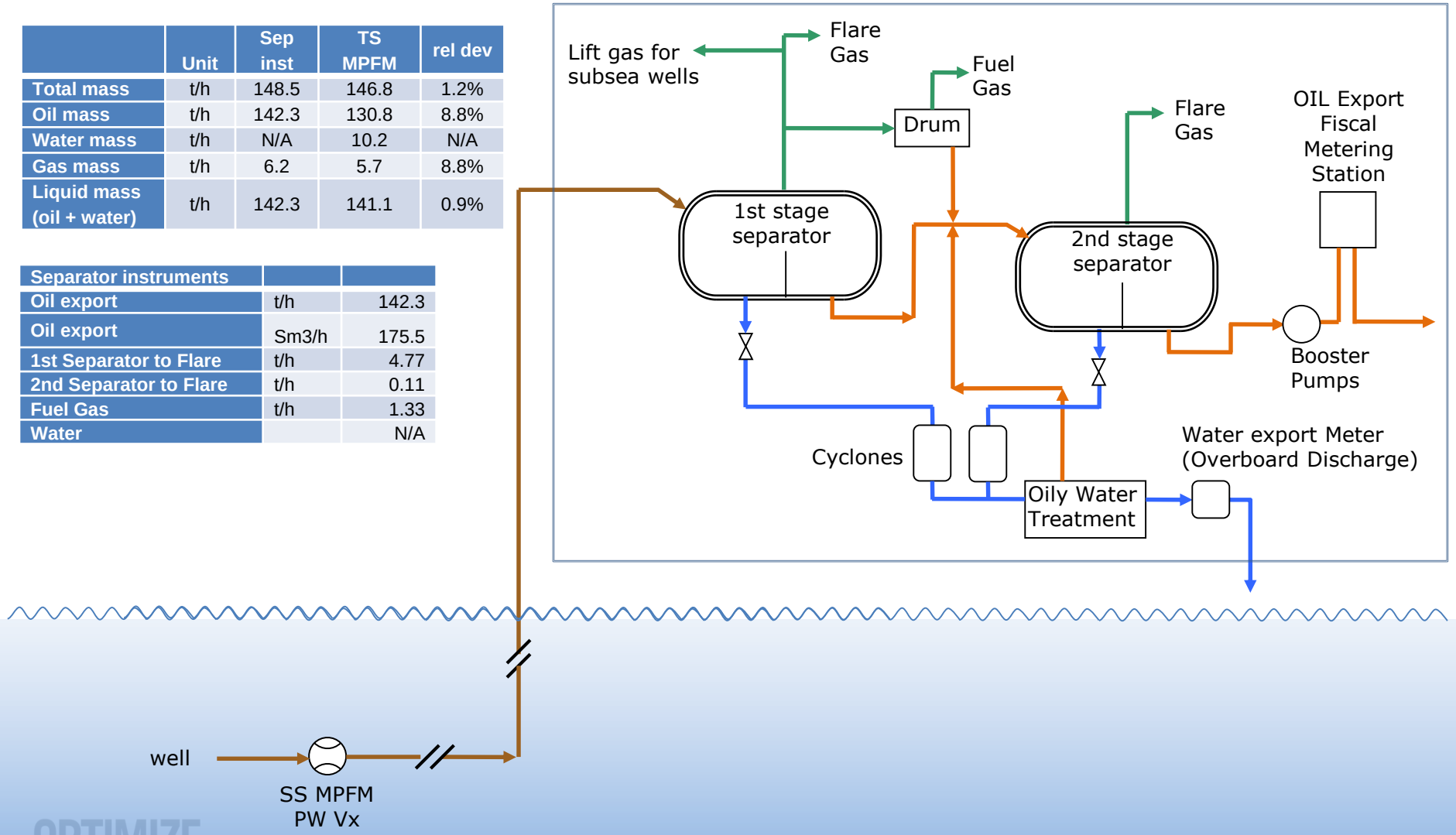
  carry over, carry under, water in oil
- Only few tests possible per day
- Foaming, emulsions, clean-up
- Flow meter size
- Calibration of secondary instrumentation

Separator challenges

Field example of incorrectly setup separator

	Unit	Sep inst	TS MPFM	rel dev
Total mass	t/h	148.5	146.8	1.2%
Oil mass	t/h	142.3	130.8	8.8%
Water mass	t/h	N/A	10.2	N/A
Gas mass	t/h	6.2	5.7	8.8%
Liquid mass (oil + water)	t/h	142.3	141.1	0.9%

Separator instruments		
Oil export	t/h	142.3
Oil export	Sm3/h	175.5
1st Separator to Flare	t/h	4.77
2nd Separator to Flare	t/h	0.11
Fuel Gas	t/h	1.33
Water		N/A



Error and causes

- Comparison of total mass at line conditions versus comparison of individual flow rates at standard conditions may reveal the source of error.

- Low total mass error, but high errors at standard conditions
  - Oil shrinkage, gas expansion, direct flash/multi stage flash for both instruments

- High error in total mass
  - will require checking both systems and PVT data
  - Is the PVT model suitable for the operating conditions?
  - Is the test separator instruments calibrated?

- If the difference in total mass is within specification and there is a bias in gas and liquid rates, this may be sign of:
  - Deposit within the MPFM or low separation efficiency of the separator
  - Incorrect liquid viscosity
  - Incorrect PVT data

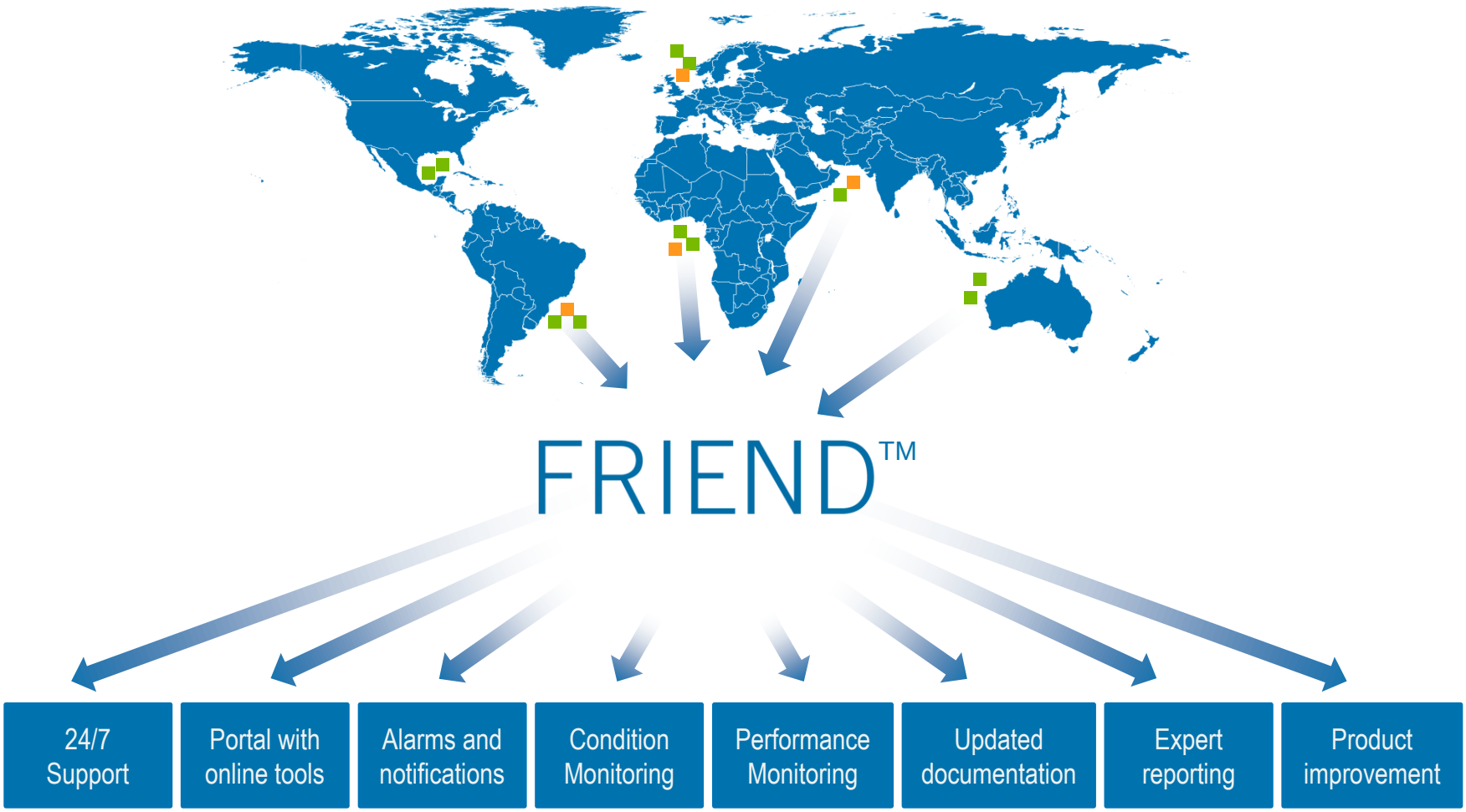
Error and causes

- If the total mass is within specification and gas rates are okay but a bias exists in oil and water rates,
  - This could be an indication of incorrect oil and /or water PVT data
  - It could be a sign of scale and other deposits

Things to do before test

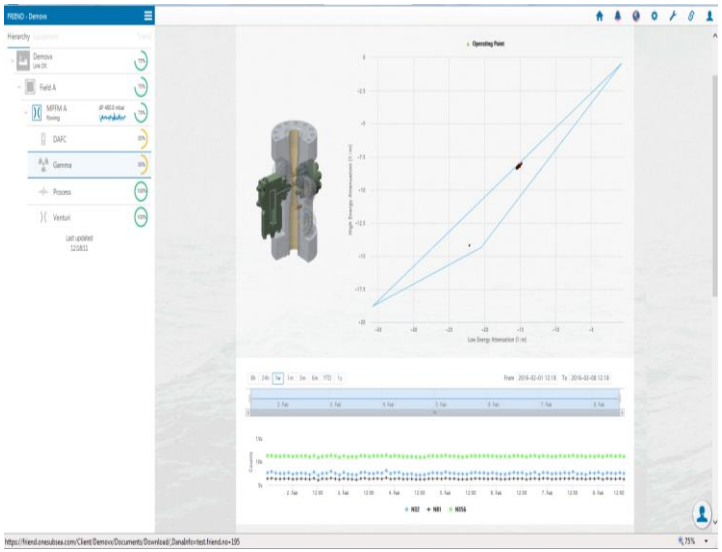
- Long enough flowing time prior to test is should be allowed to flush out all fluids from other wells through the separator
- The separator level(s) should be kept constant during test
- Allow long enough test period (typically 12 to 24 hours) to minimize errors due to flow variations
- Separator maintenance and inspection
  - Instrument calibration
  - Removal of solids and other residues
- MPFM maintenance and inspection
  - Check transmitters at static conditions
  - Check for deposits

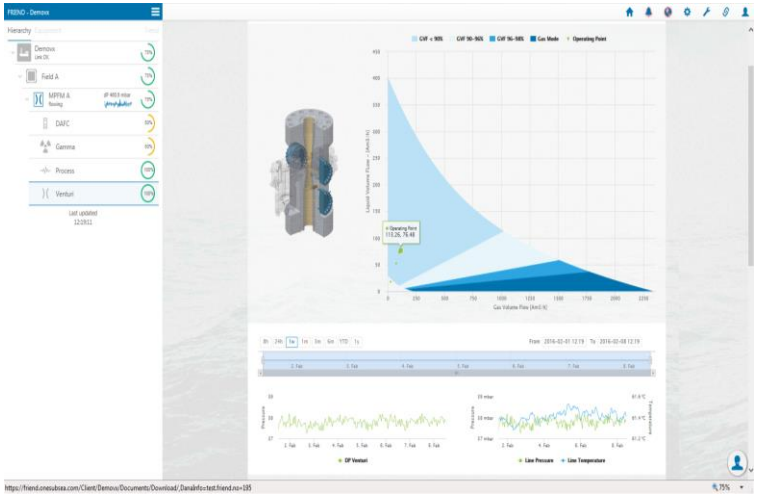
OneSubsea system for monitoring



Typical Vx monitoring in FRIEND

- Differential Pressure – Total mass flow
- Pressure – PVT
- Temperature – PVT
- Nuclear Count Rates – deposits & PVT
- Gamma Detector Performance
- Data Acquisition Flow Computer (DAFC)
- Validating PVT data, events in the process can provide information about e.g. oil, water or gas density





Summary

- Comparing Vx's measurements with Separator's measurements is challenging due to their difference in approach, operating conditions and fluid property model
- Maintaining equipment and configuration will minimize challenges
- Comparison is important and should be considered as a process of detecting deviations and causes.
- Never update the MPFM based on an isolated test period. It is best practice for the MPFM to follow the dynamics of production.
- A correctly configured Vx is as good as well maintained test separator
- For the past 25 years, the MPFM technology has greatly improved and this is thanks to the collaboration between the various stakeholders
- Continued improvement of measurements is possible in this domain if such collaboration is maintained

Thanks for your attention

Questions?