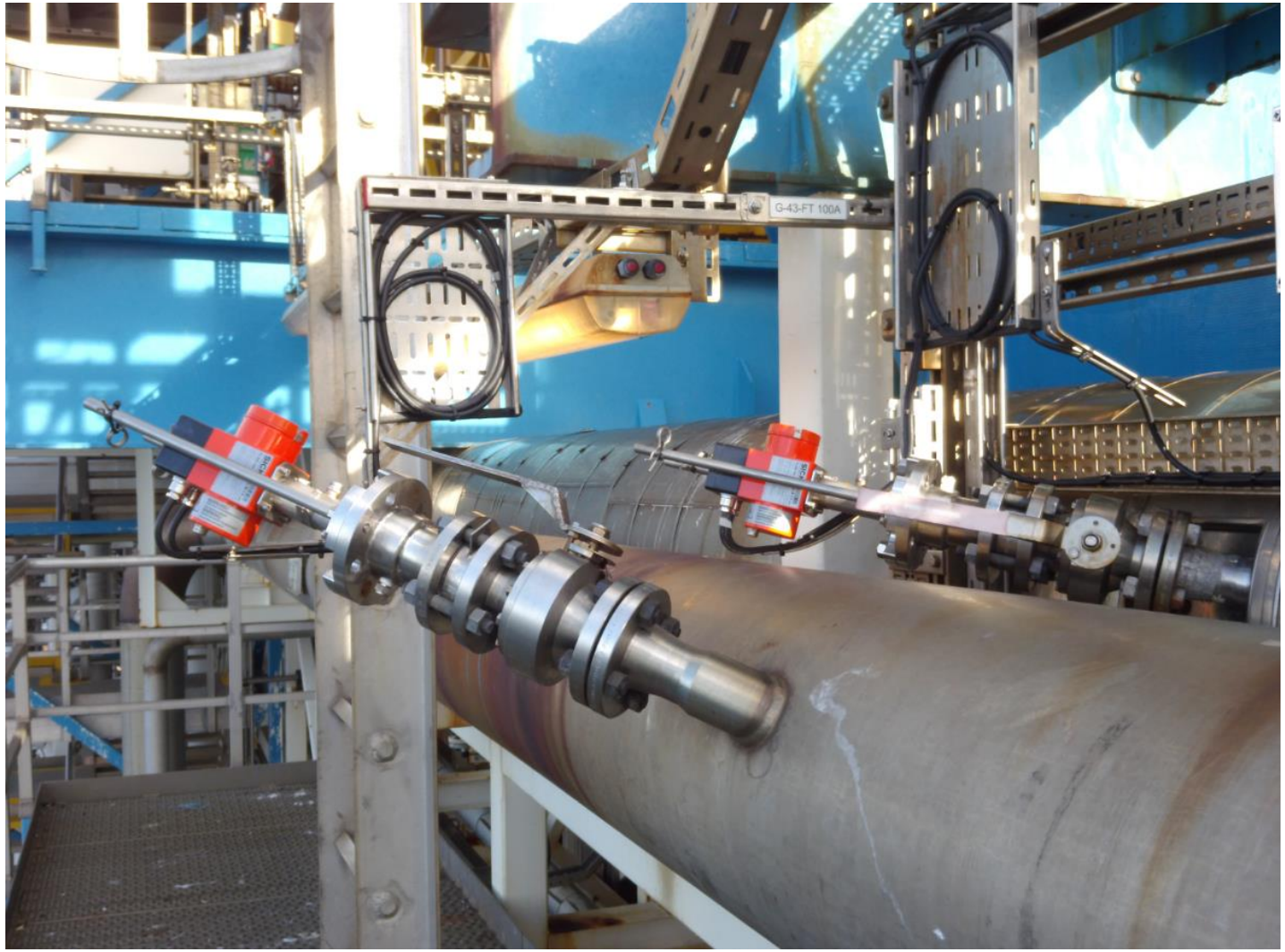
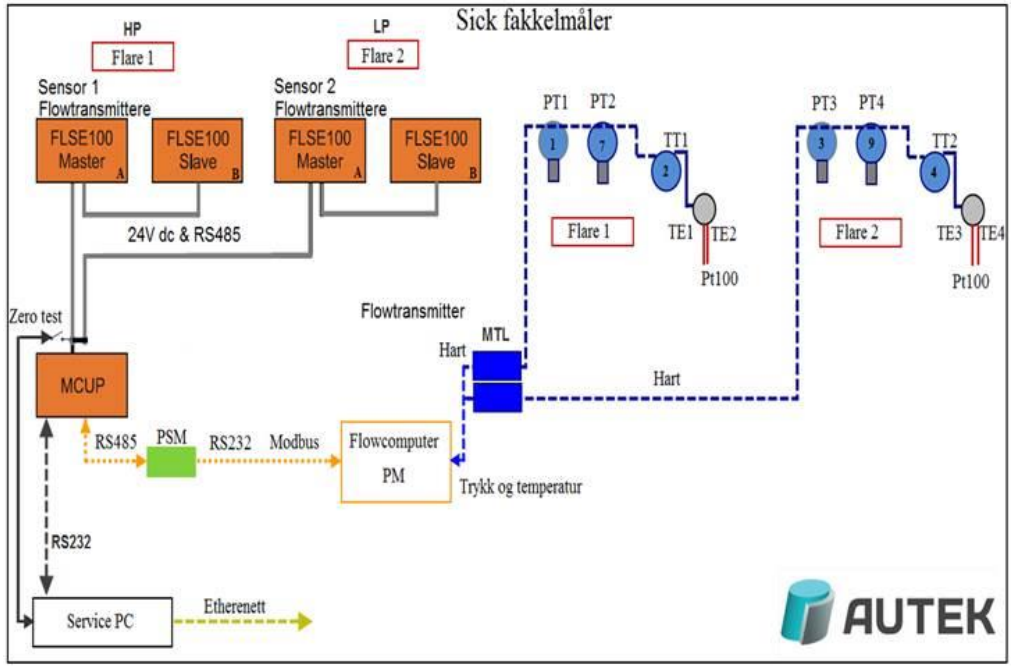
Flowsic 100, flare gas metering at high flow rates

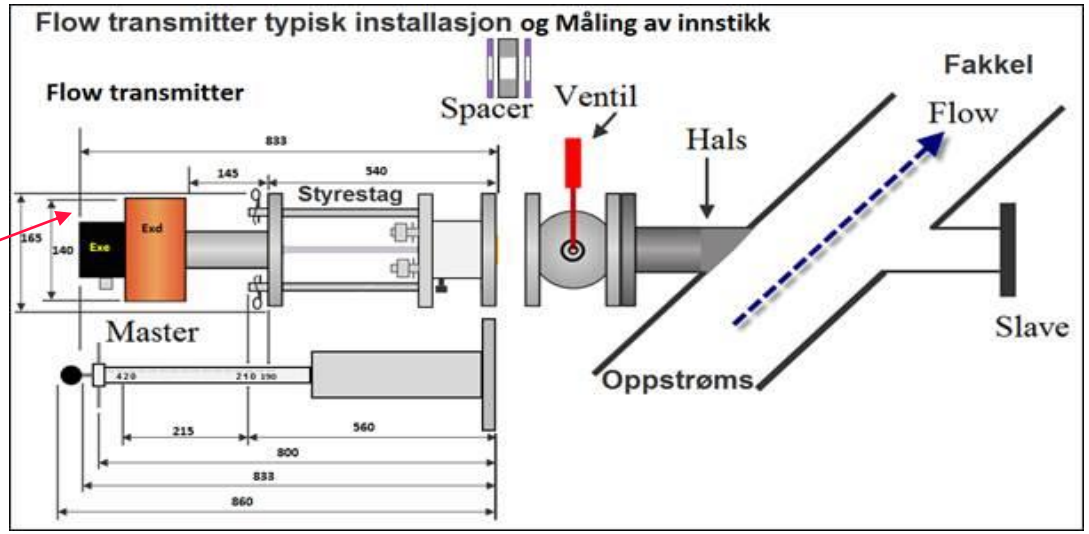


equinor

By:
Stian Nordnes Thunem

System set up Flowsic 100





All flowsic 100 transducers in DPN identically(ex Kvitebjørn, Troll B)

What can **theoretically** be measured with Flowsic100 ?

FLOWSIC100 EX/EX-RE

Measuring ranges		
	Gas velocity	0.03 ... + 120 m/s
Measuring span		4000 : 1
Nominal pipe size		
	1-path measurement:	8″ ... 72″ depending on gas composition
	2-path measurement:	12″ ... 72″ depending on gas composition
Ex-approvals		
	IECEx	Ex d IIC T4 optional: temperature class T6
	ATEX	II 2G Ex d IIC T4 II 2G Ex de IIC T4 optional: temperature class T6 II 3 G Ex nA IIC T4 Gc
	NEC/CEC (US/CA)	Cl I, div1 group B, C, D T4 Ex/AEx d IIB + H2 T4 optional: temperature class T6 Cl I, div2 group A, B, C, D T4 Ex/AEx nA IIC T4 optional: temperature class T6
	INMETRO	Ex d IIC T4 optional: temperature class T6
Enclosure rating		
	ATEX zone 1 with terminal box	IP65
	ATEX zone 1 without terminal box	IP65 / IP67
	Version for Ex zone 2	IP65
	NEC/CEC (US/CA)	Housing type 6, IP65/67, single seal
	INMETRO	IP65 / IP67
Dimensions (W x H x D)		Details, see dimensional drawings
Weight		≤ 14 kg

FLOWSIC100 Flare system

Measurands		Mass flow, volumetric flow at actual and standard conditions, molecular weight, gas volume and mass, gas velocity, gas temperature, speed of sound
Number of measuring paths		1, 2
Measurement principle		Ultrasonic transit time difference measurement
Measuring medium		Hydrocarbon mixture with or without H_2 content
Repeatability		0.2% at ≥ 10 m/s
Resolution		+ 0.001 m/s
Measurement uncertainty		
	Operational volume flow (1-path measurement):	± 1.5% to 5% of the measured value (in the range of 0.3 m/s to the upper range value) [1]
	Operational volume flow (1-path measurement):	± 0.5% of the measured value (in the range of 1 m/s to the upper range value) [1,2]
	Operational volume flow (2-path measurement):	± 1% to 3% of the measured value (in the range of 0.3 m/s to the upper range value) [1]
	Operational volume flow (2-path measurement):	± 0.5% of the measured value (in the range of 1 m/s to the upper range value) [1,2]
	Mass flow (1-path measurement):	± 2.5% to 5% of the measured value (in the range of 0.3 m/s to the upper range value) [1,2]
	Mass flow (2-path measurement):	± 2% to 4% of the measured value (in the range of 0.3 m/s to the upper range value) [1,2]
	Molecular weight:	≤ 2% of the measured value (in area 2 to 120 kg/kmol) [2]
		[1] For fully developed flow profiles [2] After throughput calibration [3] Hydrocarbon mixture with non-hydrocarbon content < 10%
Gas temperature		
	Standard:	–70 °C ... +180 °C
	High-temperature zone 1:	–70 °C ... +280 °C
	High-temperature zone 2:	–70 °C ... +260 °C
	Low temperature:	–196 °C ... +100 °C not for FLOWSIC100 EX/EX-RE zone 1 / class I, division 1
Operating pressure		–0.5 bar (g) to 16 bar (g) FLOWSIC100 EX-S 90°: –0.5 bar (g) to 19 bar (g)
Ambient temperature		
	Sensors, ignition group IIC T4:	–40 °C ... +70 °C
	Sensors, ignition group IIC T4:	–50 °C ... +70 °C optional
	Sensors, ignition group IIC T6:	–40 °C ... +55 °C
	Sensors, ignition group IIC T6:	–50 °C ... +55 °C optional
Storage temperature		–40 °C ... +70 °C –50 °C ... +70 °C optional

Flare gas metering Gullfaks A

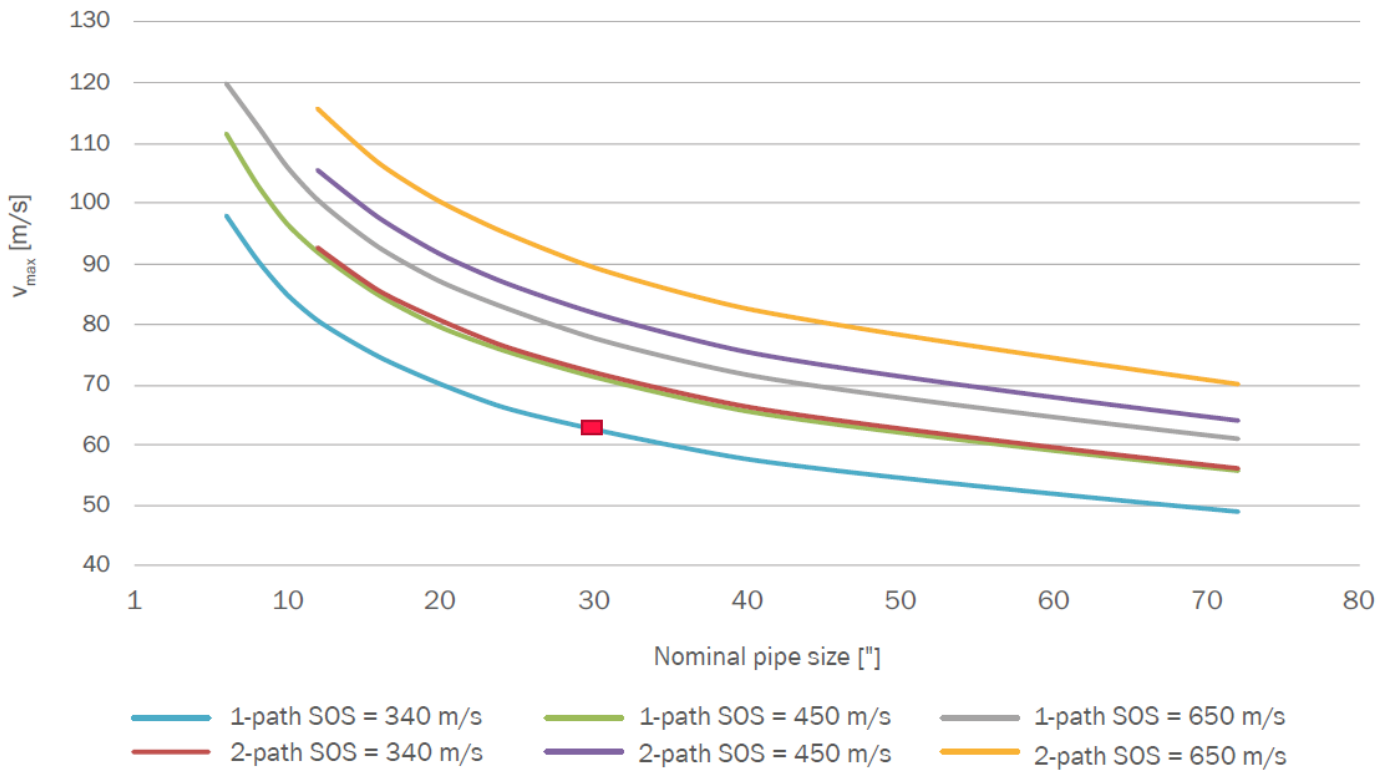
- Problems at high flow rates
- How does Fluenta FGM130 handle high flow rates on GFA ?
- How does Flowsic 100 handle high flow rates on GFA?

Let´s have a look at Gullfaks A

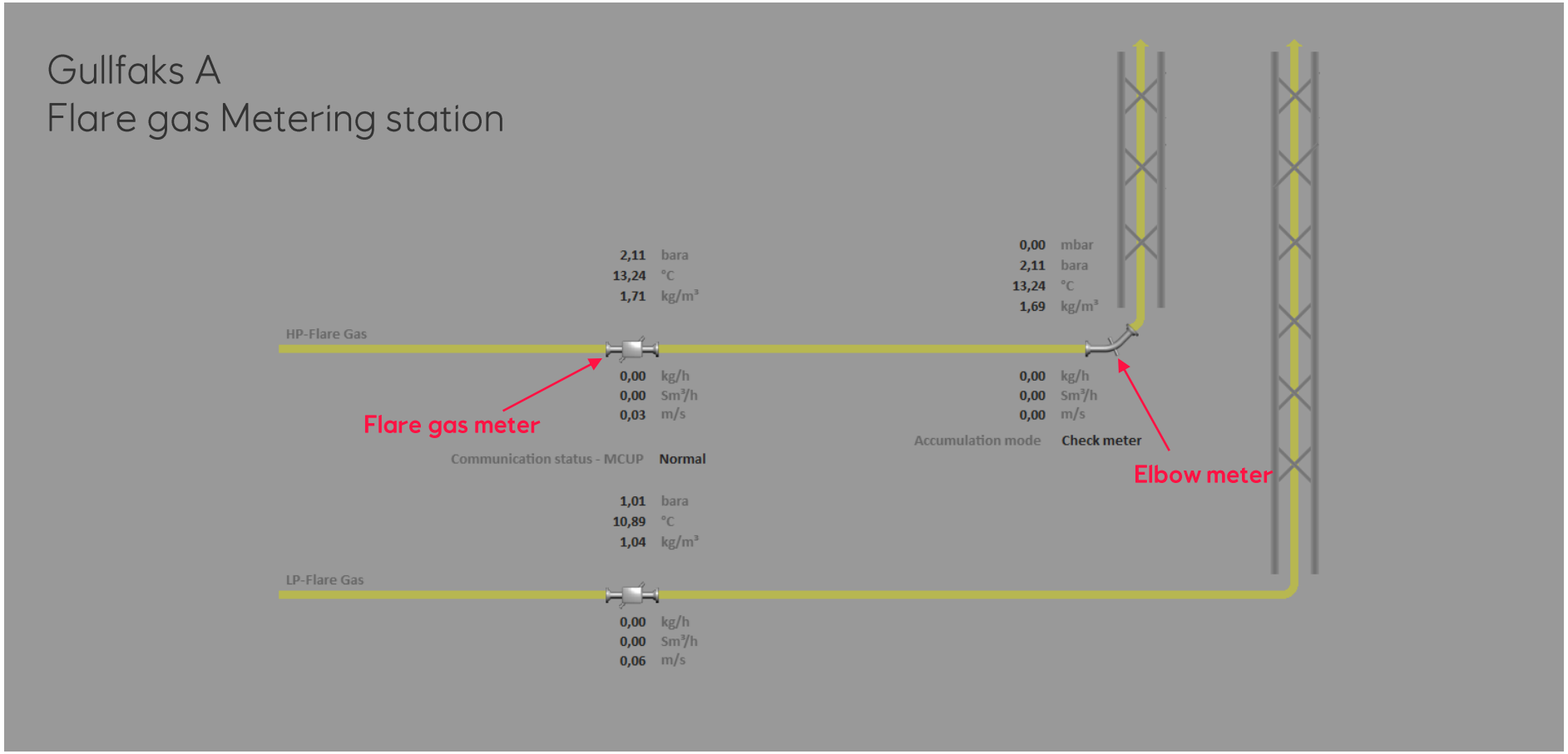
What can be measured with Flowsic100 on GFA?

APPLICATION RANGES

V_{max} of 1-path and 2-path solutions dependent on Speed of Sound (SOS)



Flare gas metering at Gullfaks A



Flare gas metering at Gullfaks A

History:

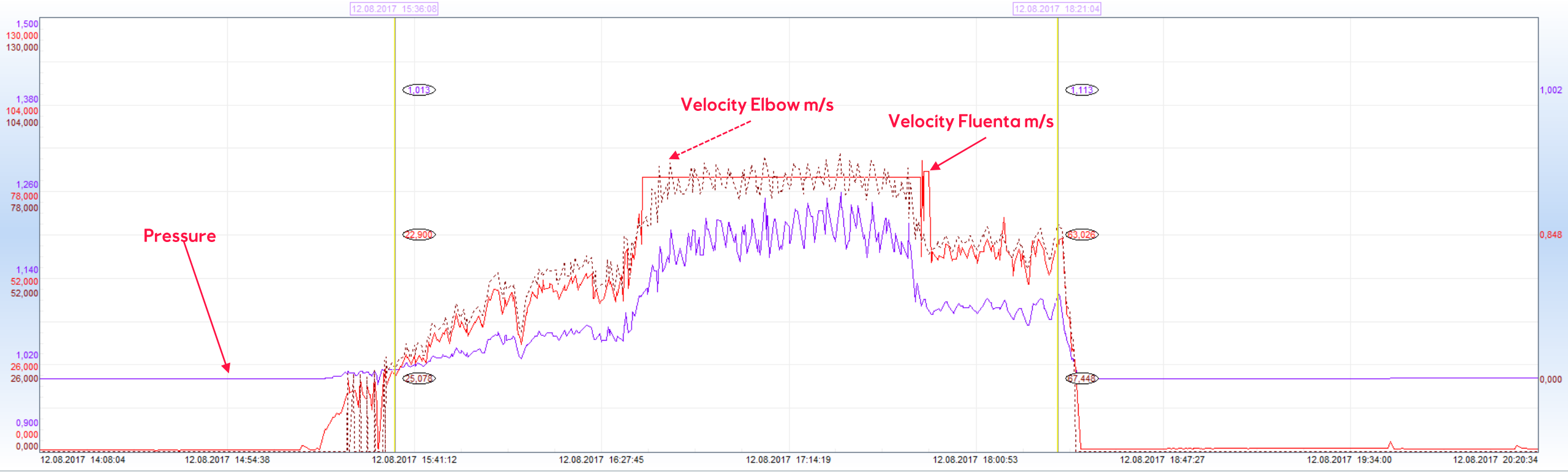
- Fluenta FGM 130 in operation until 20.01.2018
- Flowsic 100 in operation from 01.02.2018

- Challenge HP flare:

Measure higher flow rates above approximately 60-70 m/s

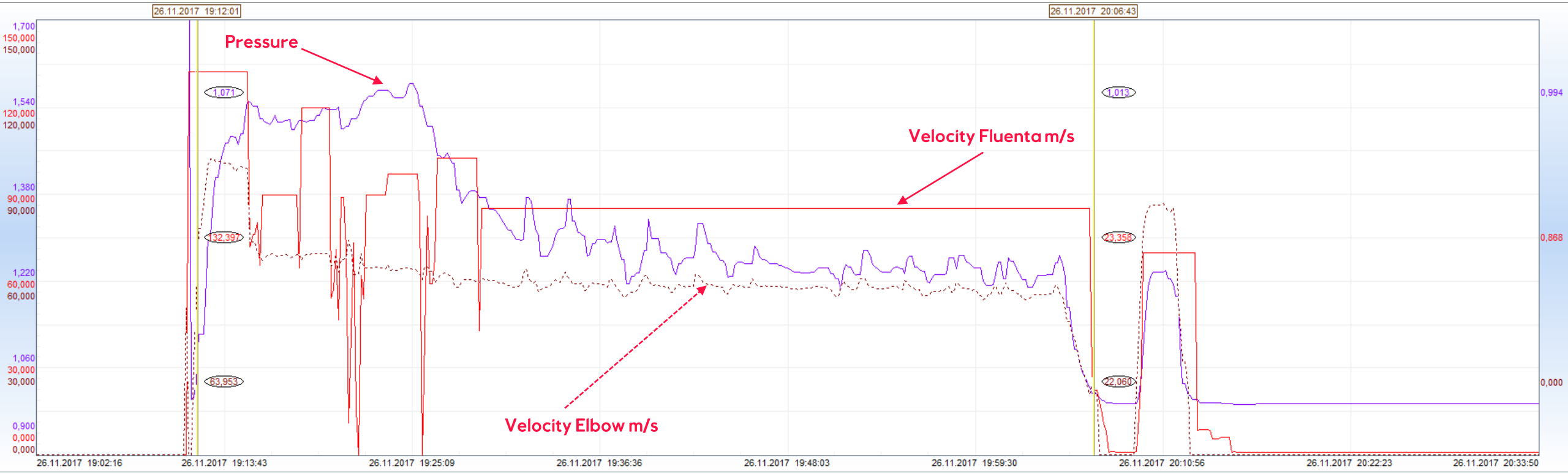
Fluenta HP flare gas meter 12th August 2017

- Fluenta FGM 130 falls out and holds last reliable measurement
- 2 h 45 min hours flare. Deviation Elbow/Fluenta -1,29%, unit Sm3 (Fluenta lowest)



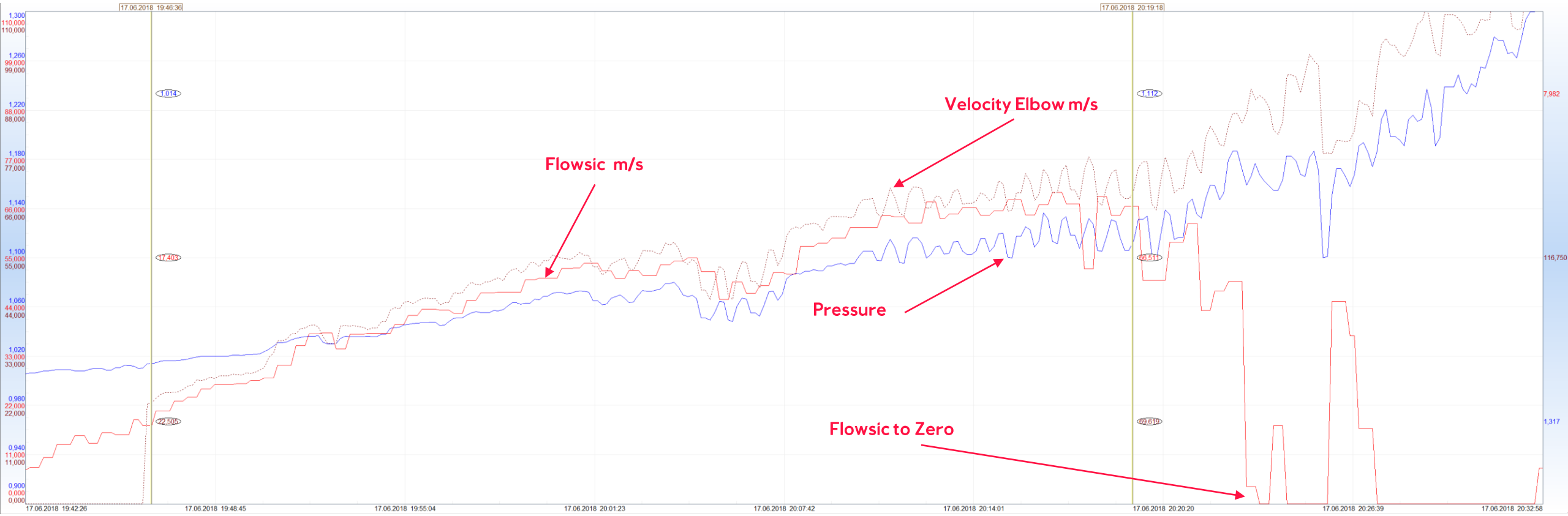
Fluenta HP flaregas meter 26th November 2017

- Fluenta FGM 130 falls out and holds last reliable measurement
- 55 min flare. Deviation Elbow/Fluenta 42,8%, unit Sm3 (Fluenta highest)



Sick flare gas meter 17th June 2019

- Flowsic 100 after installation
- Sick philosophy: Meter goes to zero when ultrasonic pulses are not detected.



How to correct for loss of ultrasonic signal?

- Flowsic 100 falls out at approx 60-70 m/s
- Correction done with:
- $Q_{line}=C^*\sqrt{\Delta P}$ (m3/h)

  Where:

  Q_{line} =Volum flow rate (m3/h)

  C=Constant

Δ P=Pressure difference inside pipe to atmospheric

The constant C is found when the flare gas meter works in ultrasonic modus

Flowsic 100 versus FGM 130 in ultrasonic modus

When loss of ultrasonic signal:

FGM 130: Holds last approved signal

Flowsic 100: Signal goes to zero

Tip: When flaring. Always compare pressure curve with flow rate. Curves shall have the same shape

Equinor contacts Autek and ask for possible improvements for measuring high flow rates

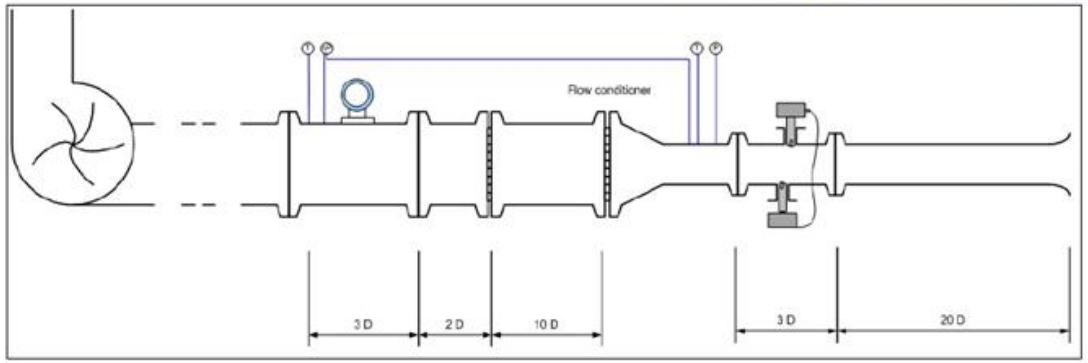
Update software in Flowsic 100 to be able to measure higher flow rates

Sick is testing a new technology called Active sound correlation, ASC (Also called Heavy noise algorithm)

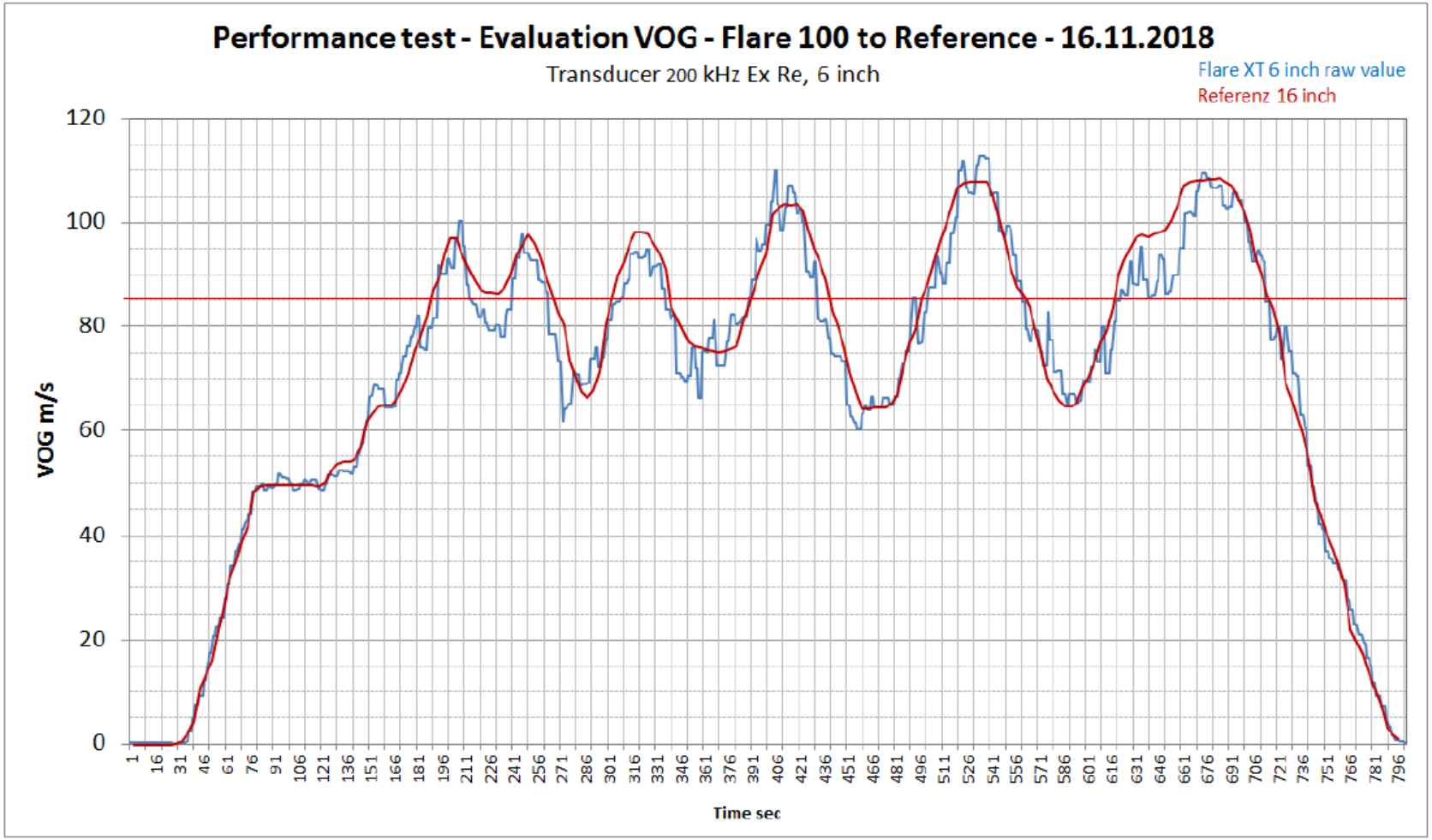
- What is new?
- When ultrasonic signal is not strong enough to be picked up, new algorithm is activated
- Transducers start to listen for noise in the flare pipe
- There is a correlation between noise in the pipe and velocity of gas

Test of noise algorithm in test loop

Type:	FLOWSIC 100 Ex Re
Transducer:	200 kHz
Number of paths:	1
Nominal pipe size:	6"
Path angle:	77.5°
Path length:	0.152 m
Internal diameter:	0.146 m
Calibrated:	Yes



Test of heavy noise algorithm in test loop



Update software of Flowsic 100 to be able to measure higher flow rates

Gullfaks A upgraded software to include ASC algorithm in flowsic 100 meter.

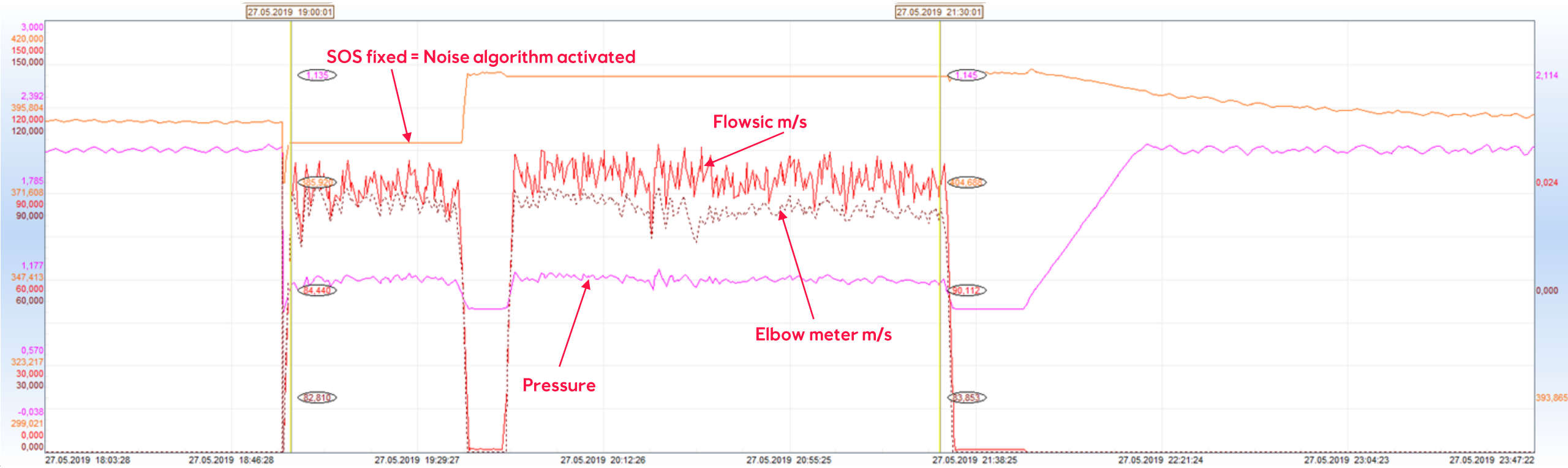
- New software implemented 24 March 2019
- Found a fault in the algorithm the first time when flaring

m/s/db was not for the specific sensor that was installed on GFA

The fault was corrected

Sick flare gas meter 27th May 2019

- Heavy noise algorithm activated
- 2 h 30 min flare. Deviation Elbow/Flowsic 10,83%, unit Sm3 (flowsic 100 highest)

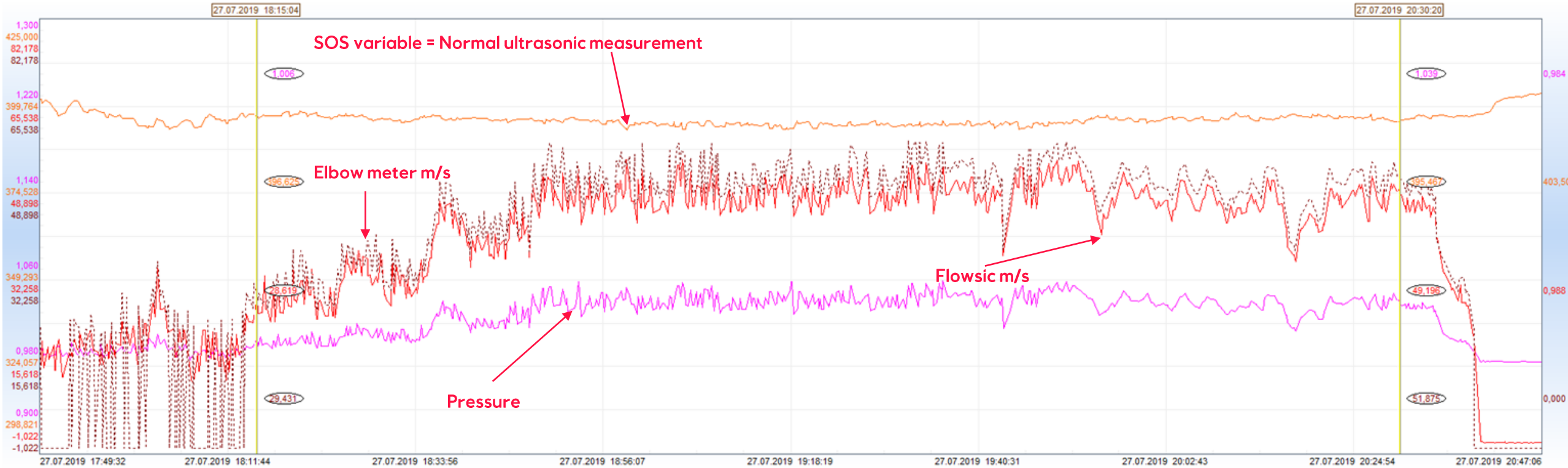


Adjustments in flowsic 100 algorithm

- Adjustments in the noise algorithm performed 11 July 2019
- Sick has not used the elbow meter data for adjustment of heavy noise algorithm

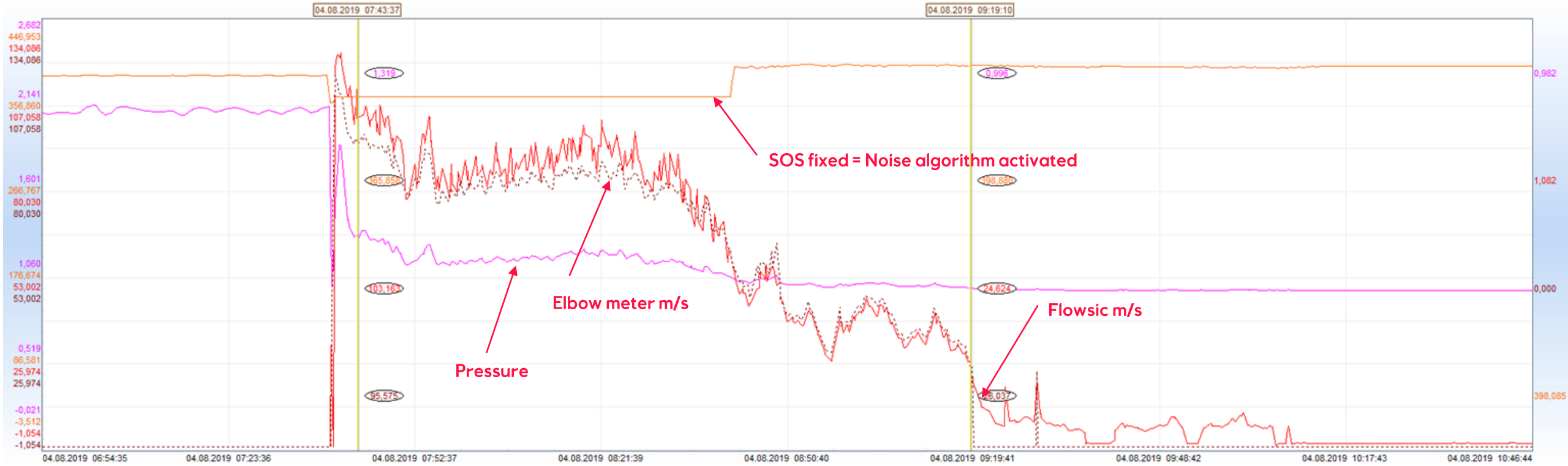
Sick flare gas meter 27th July 2019

- Only ultrasonic measurement during flare period
- 2 h 15 min flare. Deviation Elbow/Flowsic -6,42%, unit Sm3 (Elbow highest)



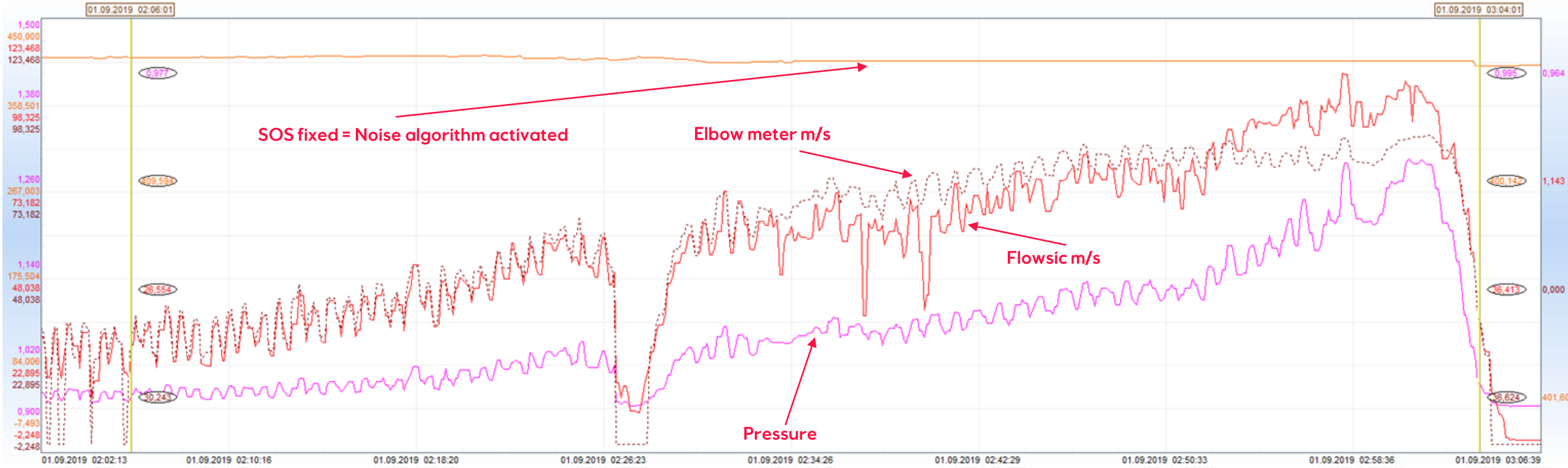
Sick flare gas meter 04th August 2019

- Heavy noise algorithm activated
- 1 h 36 min flare. Deviation Elbow/Flowsic 4,33%, unit Sm3 (Flowsic 100 highest)



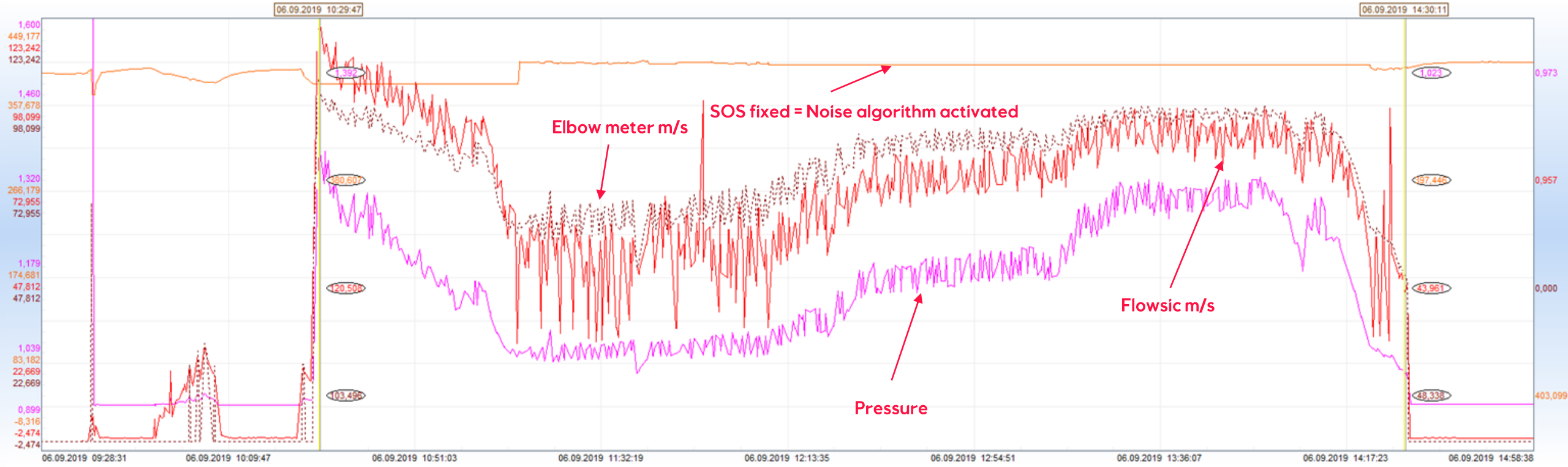
Sick flare gas meter 01th September 2019

- Heavy noise algorithm activated
- 58 min flare. Deviation Elbow/Flowsic -1,46%, unit Sm3 (Elbow highest)



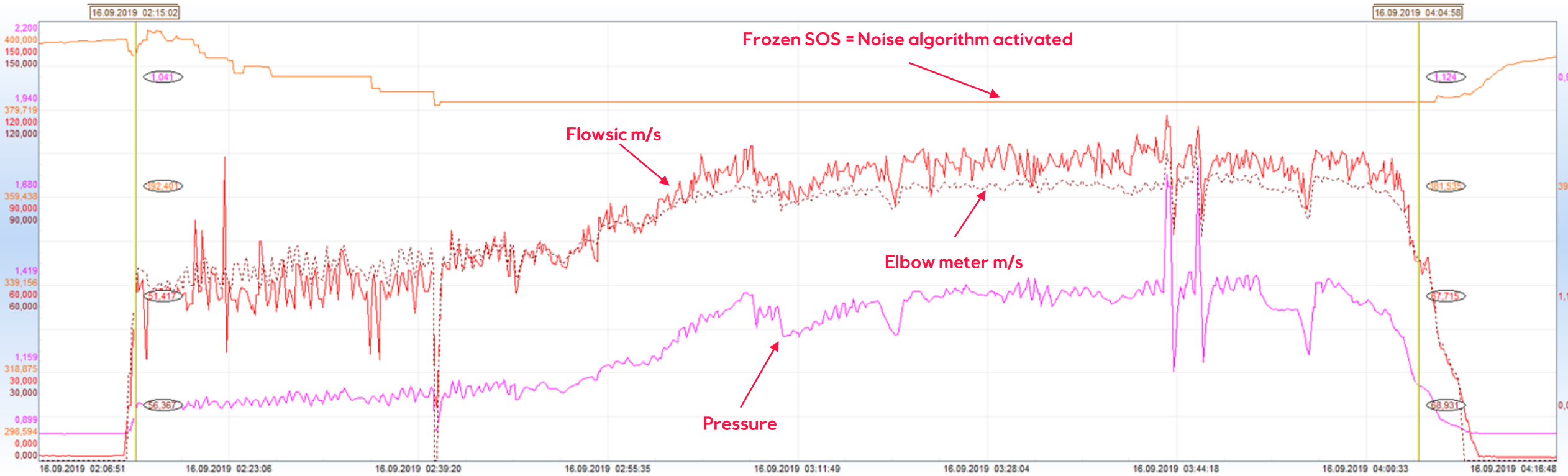
Sick flare gas meter 06th September 2019

- Heavy noise algorithm activated
- 4 h flare. Deviation Elbow/Flowsic -6,34%, unit Sm3 (Elbow highest)



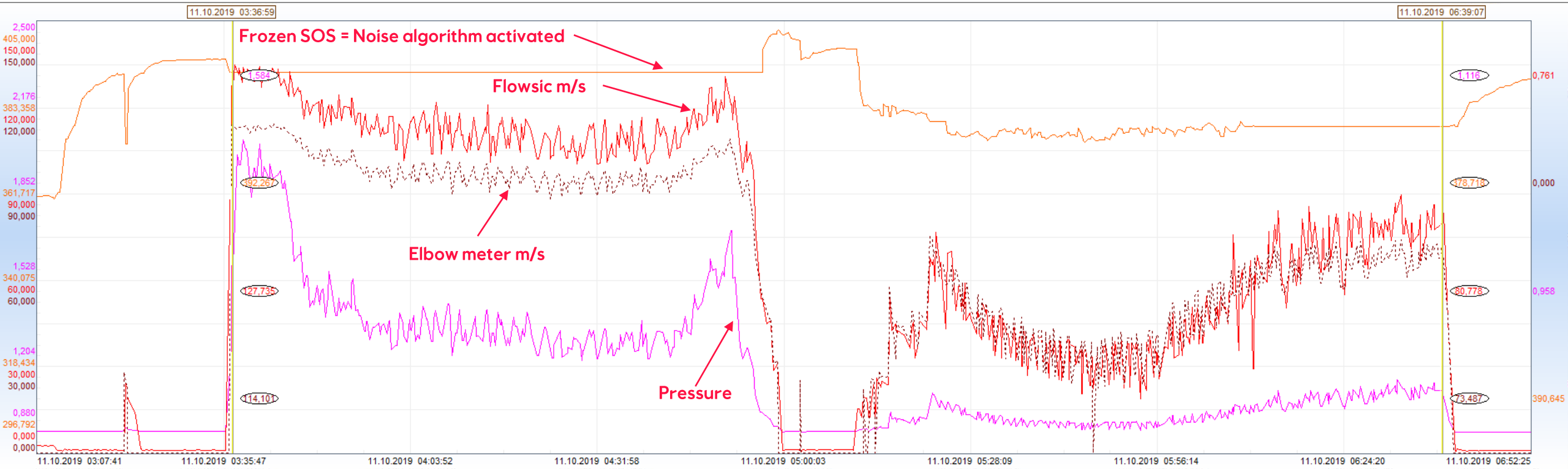
Sick flare gas meter 16th September 2019

- Heavy noise algorithm activated
- 2 hours flare. Deviation Elbow/Flowsic 4,05%, unit Sm3 (Flowsic 100 highest)



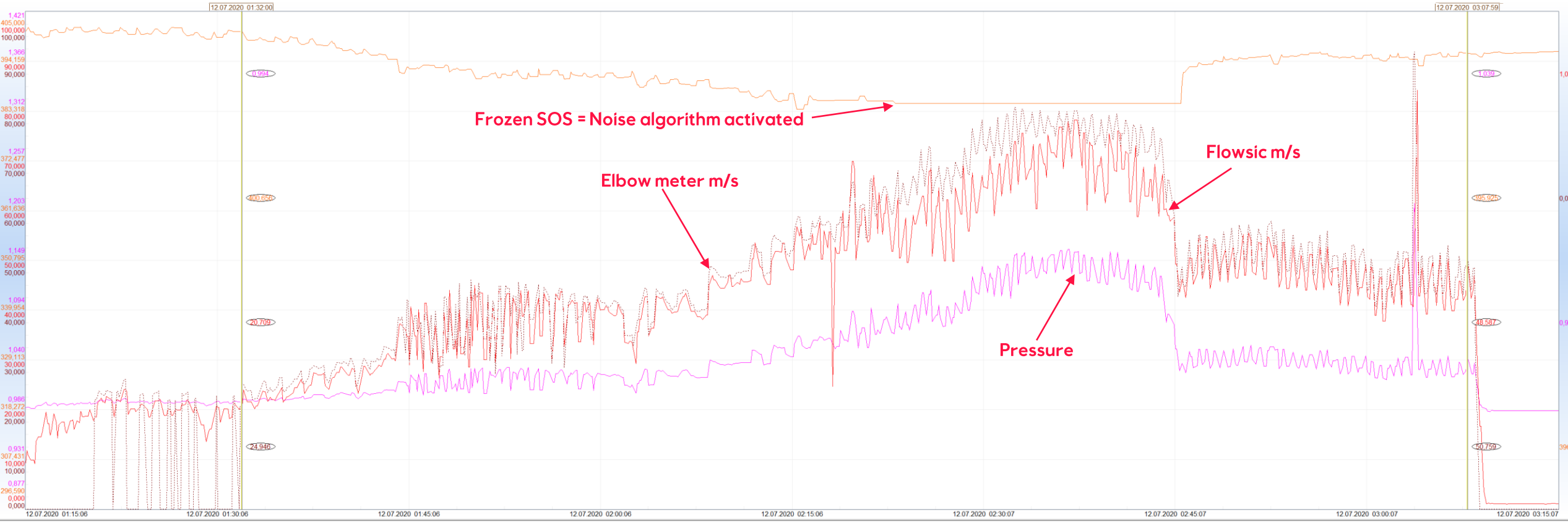
Sick flare gas meter 11th October 2019

- Heavy noise algorithm activated
- 3 hours flare. Deviation Elbow/Flowsic 11,6%, unit Sm3 (Flowsic 100 highest)



Sick flare gas meter 12th July 2020

- Heavy noise algorithm activated
- 1 h 36 min flare. Deviation Elbow/Flowsic 6,7%, unit Sm3 (Elbow highest)



Uncertainties calculated by Norce

Sick ultrasonic modus:

Sm3: 6,78% (95% Confidence interval)

Mass: 7,23% (95% Confidence interval)

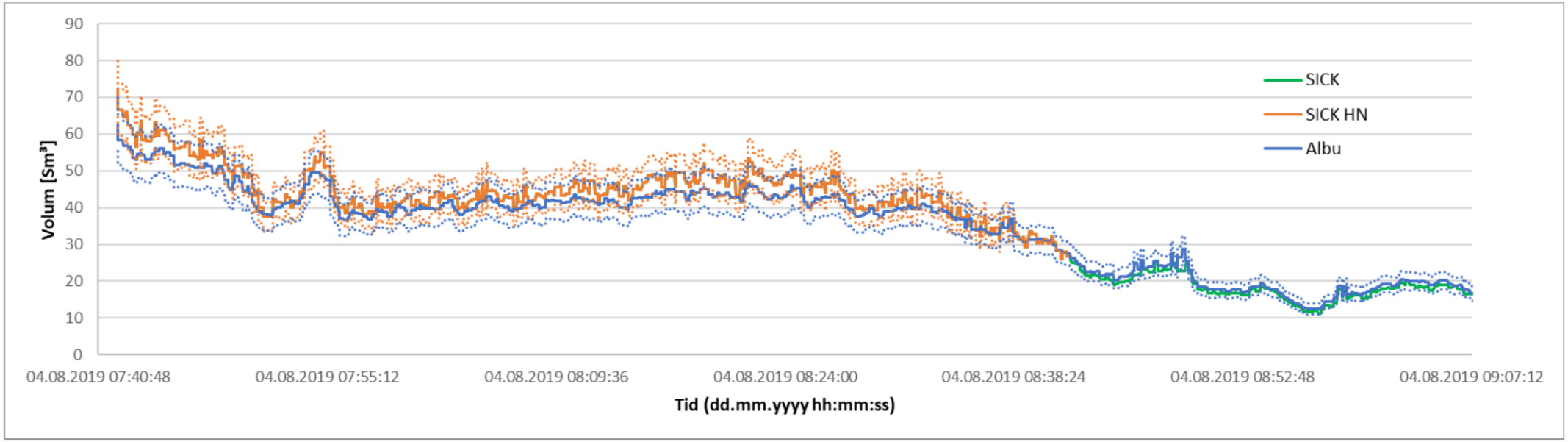
Sick ASC modus GFA:

Sm3: 10,5% (95% Confidence interval) for speed 70-91 m/s

Elbow meter GFA:

Mass: 11,8% (95% Confidence interval)

Example 4 August, uncertainty from Norce report



Figur 3 Eksempel for fakling 4. August 2019 der Heavy noise algoritmen er benyttet i første del av perioden (oransje heltrukken linje, usikkerhet tilsvarende 10 % markert med oransje stiplete linjer). Sammenliknet med volumstrømningsrate målt med albuemåler (blå heltrukken linje, usikkerhet tilsvarende 11,8 % markert med blå stiplete linjer). Ordinære målinger med ultralydsmålingen i slutten av perioden er vist i grønt.

ASC algorithm representativity

- The tests on Gullfaks A is not enough
  - How will different diameters on flare pipe impact?
  - Impact of upstream and downstream lengths?
  - Impact of molecular weight?

- More testing is required
- Sick is planning 3-part testing in Q4 2020

Equinor will implement the algorithm on platforms with similar problem as GFA.

Measurements with ASC has to be handled as loss of measurement and conservative amount must be added.

Goal:ASC to be approved technology for measuring high flow rates in the future

Thanks for your attention

Flowsic 100, flare gas metering at high flow rates

Stian Nordnes Thunem