KUWAIT 3RD FLOW MEASUREMENT TECHNOLOGY CONFERENCE

19 - 21 NOVEMBER 2017

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ULTRASONIC METERS AND MEASUREMENT ACCURACY IN LEAK DETECTION

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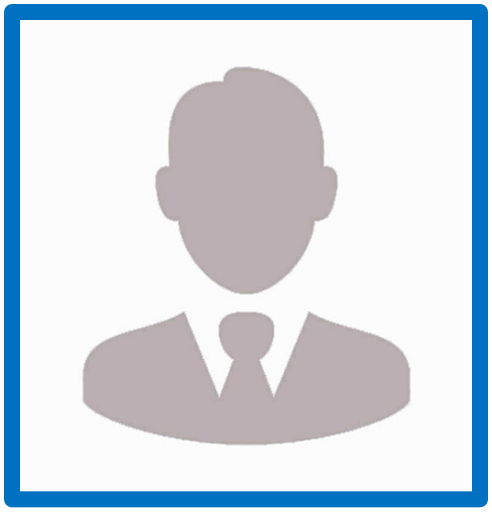

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KUWAIT FLOW MEASUREMENT TECHNOLOGY CONFERENCE 2017

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DISCUSSION TOPICS

- Recognizes the importance of **accuracy within the metering equipment utilized**

- Illustrates the abilities of **liquid ultrasonic meter (USM) diagnostics**
  - improve current leak detection real time transient models (RTTM)
  - Improve pipeline operational procedures

- Addresses benefits of the meter's capabilities and the importance of **diagnosing other pipeline issues** and uncertainties outside of measurement errors

REGULATIONS

- The American Petroleum Institute (API) provides detailed performance and selection criteria, as well as identifying general suggestions for operating leak detection systems

  - **API 1130**: Computational Pipeline Monitoring (CPM) for Liquids
  - **API 1149**: Pipeline Variable Uncertainties and Their Effects on Leak Detectability, using computational methods based upon physical hydraulic state measurements

- Recommendations on the design, implementation, testing, and operation of **internal CPM systems** that use an algorithmic approach to detect hydraulic anomalies in pipeline operating systems

- Consider the importance of performance metrics such as sensitivity, accuracy, robustness, and reliability of the system to identify potential leaks

API 1130 FIELD INSTRUMENTATION

- The quality of instrument data can affect the CPM system. Instruments should be selected considering the required **measurement accuracy**

- Ranges and specifications should be carefully matched to pipeline operating design, pressure, flow, temperature, density, viscosity

- Flow measurement technologies, the effect of viscosity, Reynolds number ranges on accuracy and performance under line shutdown conditions.

- Pressure drop and maintenance are important considerations

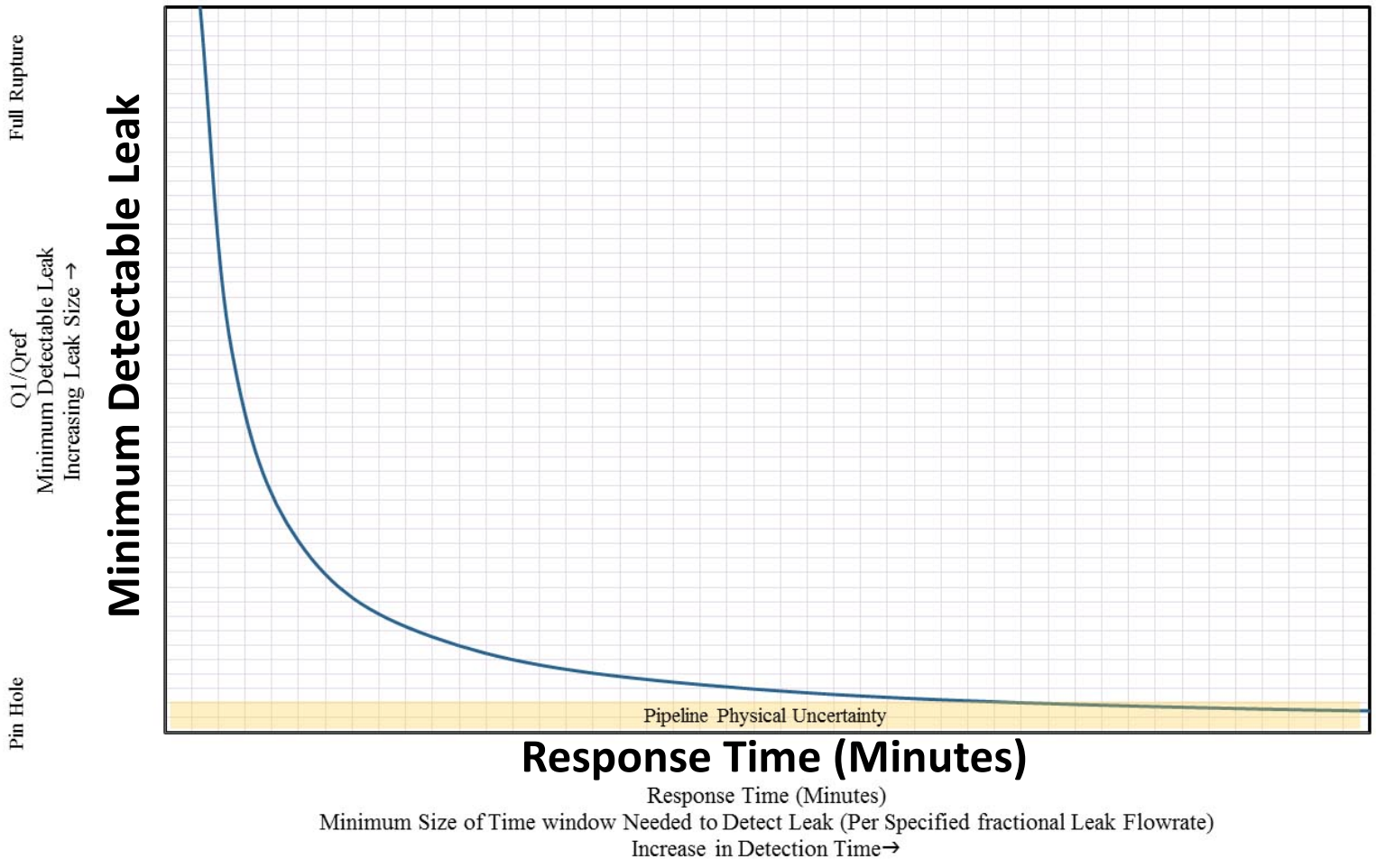
- Calibration and re-calibration of large meters: Return to the factory or by independent flow lab.

API 1149

- Investigates Software-based Leak Detection Systems (LDS)
- Outlines the **importance of instrumentation** and measurement to CPM performance
- Enable users to **determine the achievable level of leak detection** for a specified pipeline with a specified set of instrumentation and SCADA System.

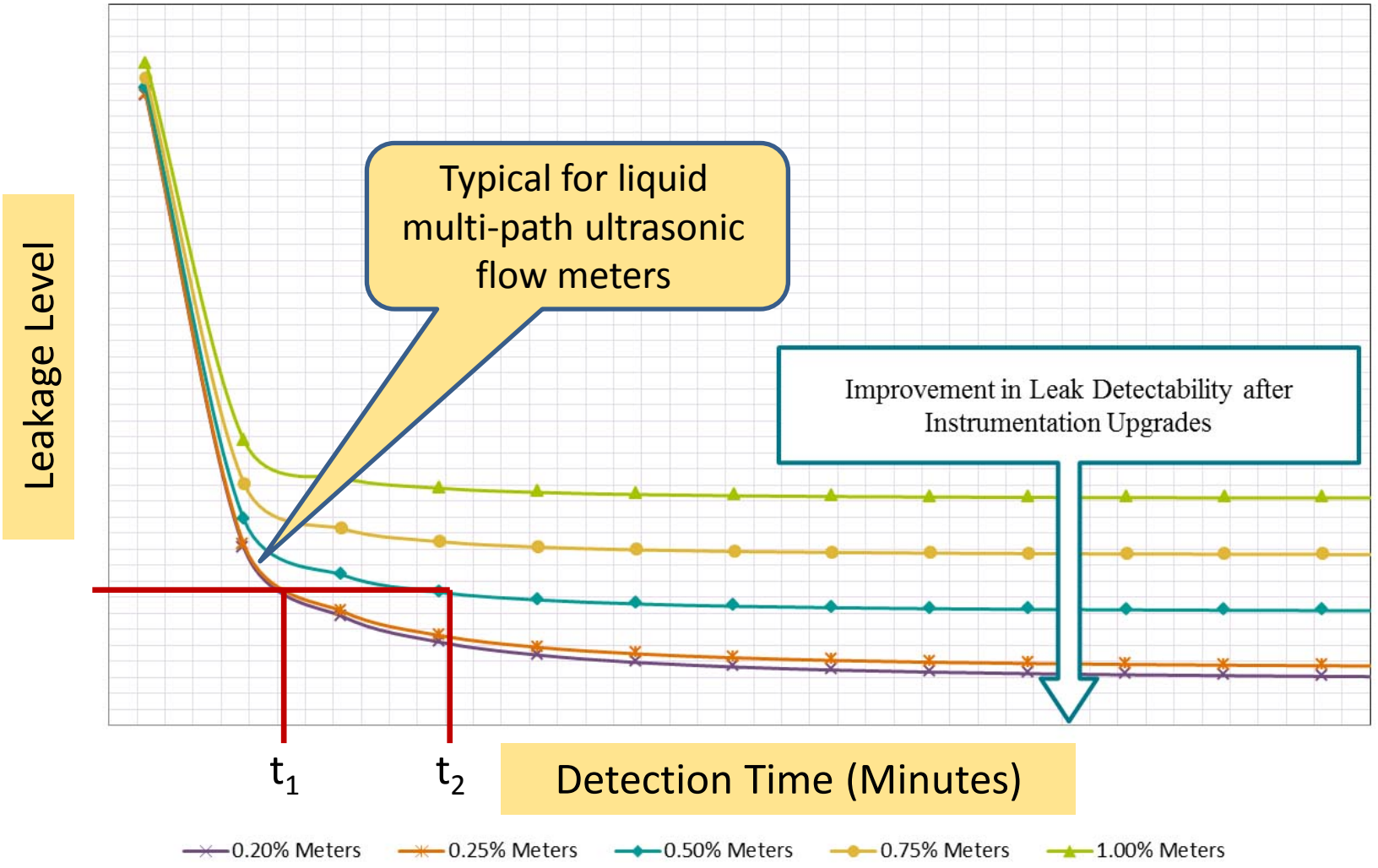
Pros	Cons
Can perform programmatically	Highly Theoretical
System Independent	Valid for Stead State Conditions Only
Capable of predicting future detectability for instrumentation improvements (improving the diagnostic capabilities within the meter)	Does not reflect state estimation
	Valid for mass balance systems

LEAK DETECTION POTENTIAL CURVE

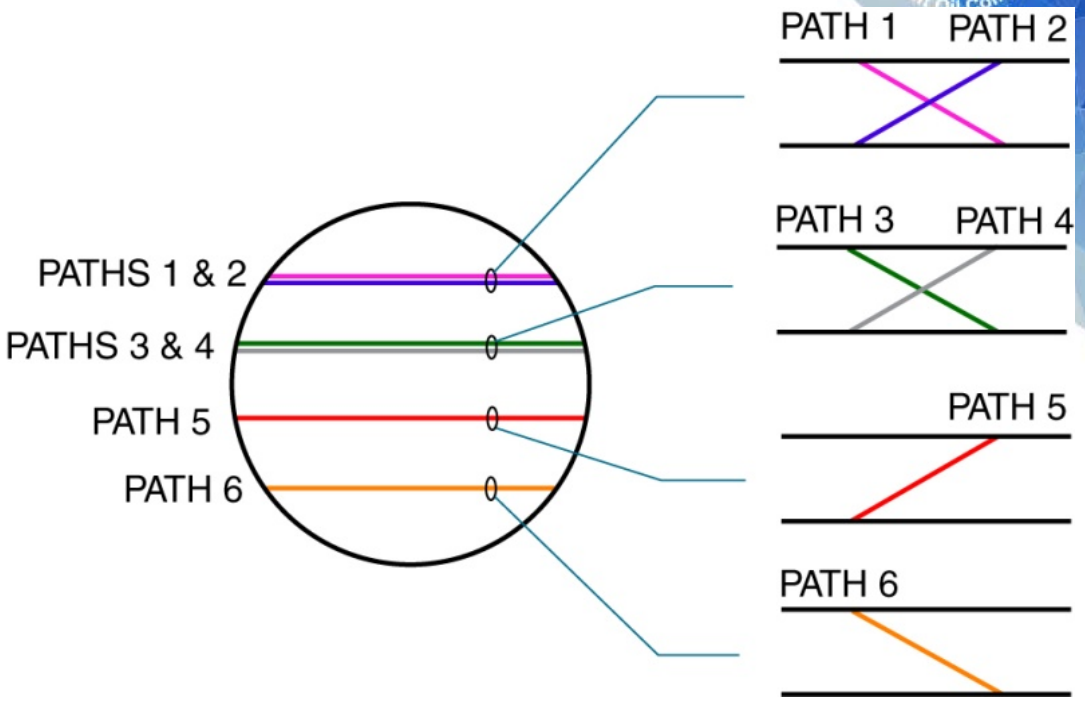


Response Time (Minutes)
Minimum Size of Time window Needed to Detect Leak (Per Specified fractional Leak Flowrate)
Increase in Detection Time→

INFLUENCE OF METER QUALITY



ULTRASONIC METER DIAGNOSTICS



- Ultrasonic meters are **robust**, **reliable**, and have the ability to provide **custody transfer accuracy** over varied application ranges.

ULTRASONIC METER DIAGNOSTICS

Alarm
sts = 2048

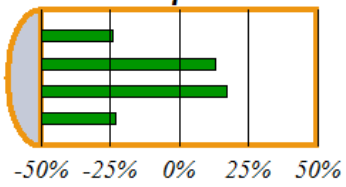
Measured values
Smith Meter Ultra 6

FMC Technologies
FMC Measurement Solutions

Current values

Flow rate	**614.109 m3/h**	Used T	15.00 °C	Profile Flatness	67.1 %
Flow velocity	5.4308 m/s	Used P	15.0 barg	Profile Symetry	-3.5 %
VOS	1151.50 m/s	Vol. Forward	15 m3	Swirl	-1.0 %
Log count	864 -	Vol. Reverse	0 m3	Crossflow	1.0 %

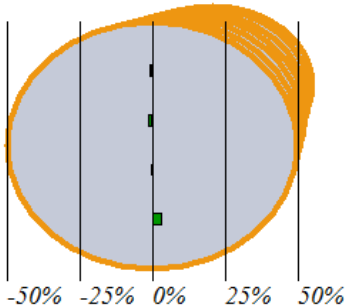
Axial flow profile



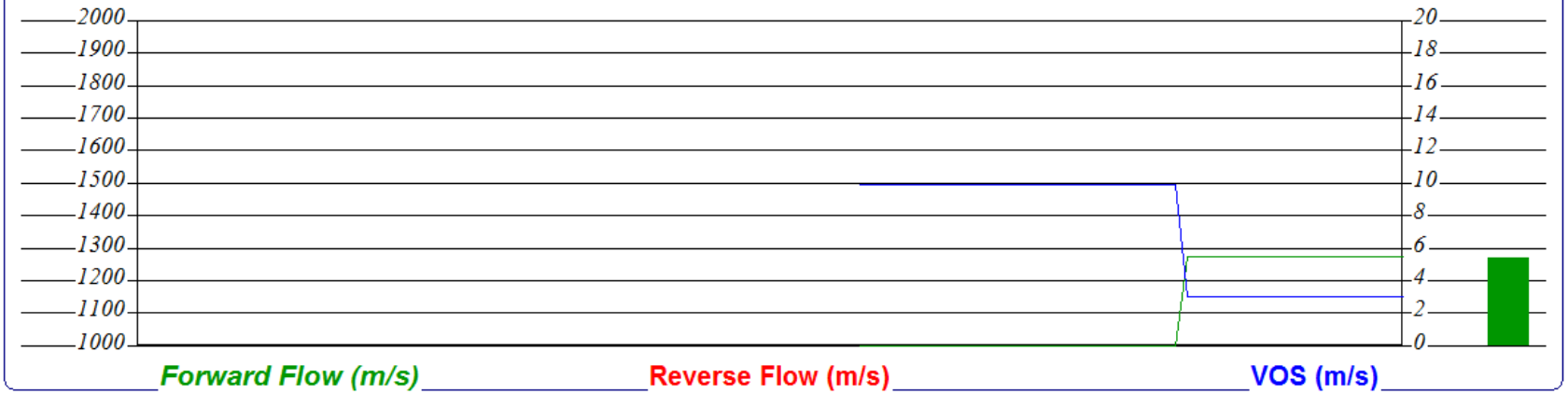
Current path values

Path	Flow velocity m/s	VOS m/s	Turbulence %	S/N Raw dB	S/N Used dB	Signals %		Gain -	
1	4.1200	1151.00	0.0	28	52	99	99	1000	1000
2	4.2000	1152.00	0.0	28	52	99	99	1000	1000
3	6.0600	1153.00	0.0	28	52	99	99	1000	1000
4	6.3000	1152.00	0.0	28	52	99	99	1000	1000
5	6.4000	1151.00	0.0	28	52	99	99	1000	1000
6	4.0200	1150.00	0.0	28	52	99	99	1000	1000

Transversal flow



Velocity / VOS history



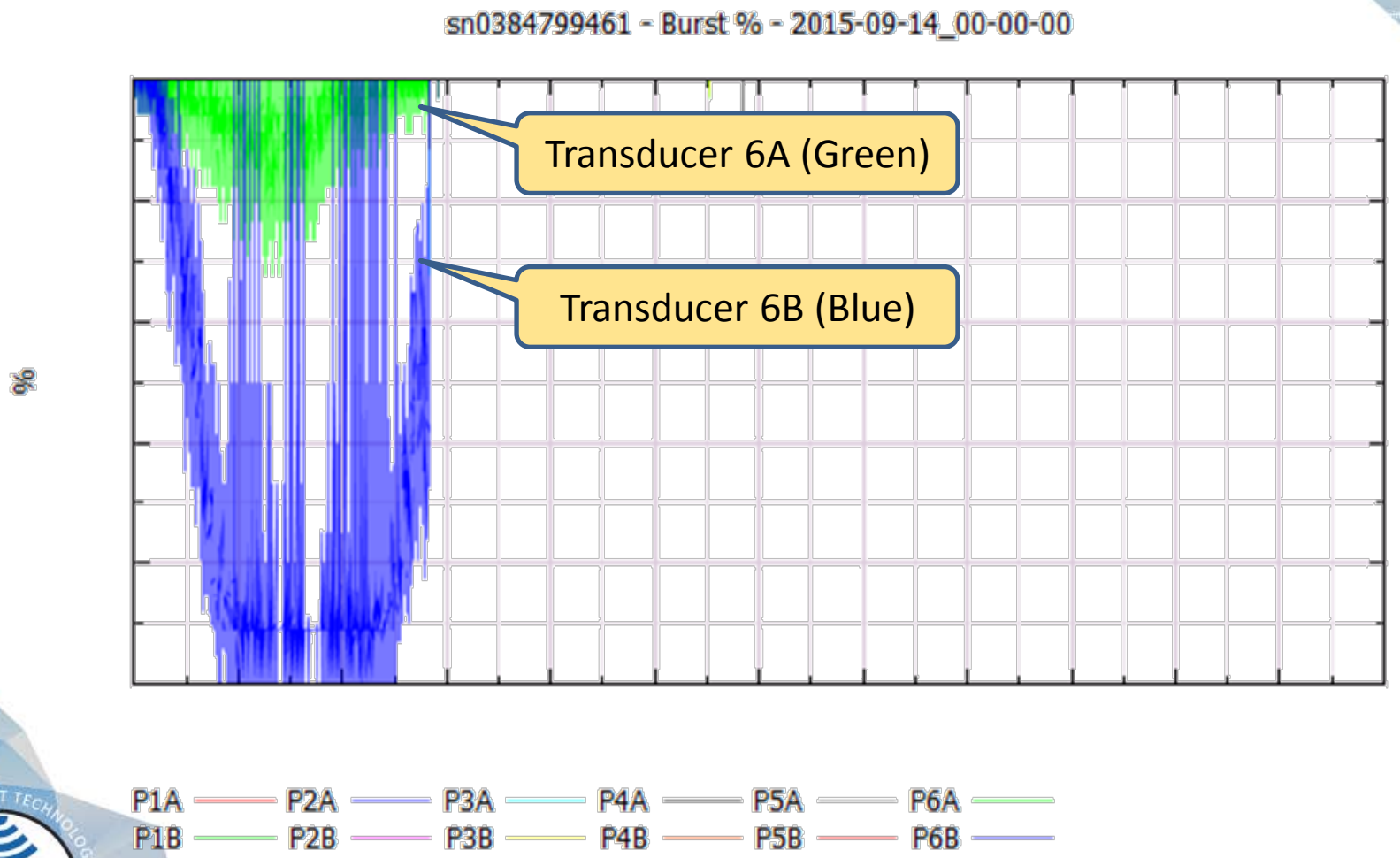
STRATIFICATION

- A stratified fluid is a fluid with **density variations in the vertical direction**, typically seen during pipe shutdowns and startups

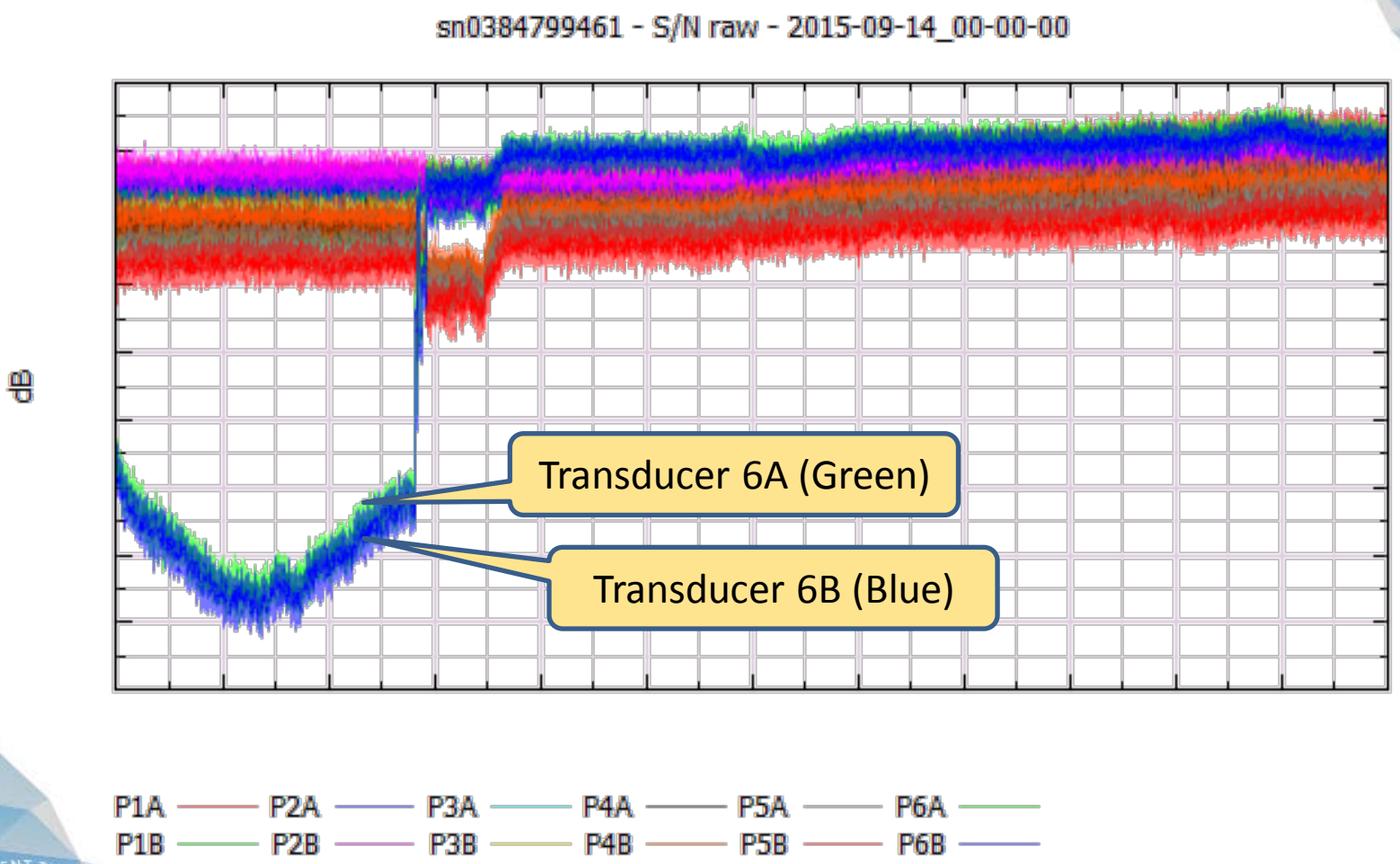
- Diagnostics provide the ability to witness that the fluid within the pipe is differentiated by decreasing densities with height

- Through evaluation of the various chordal paths, the density shift can be identified and acknowledged as a process condition rather than pipeline uncertainty

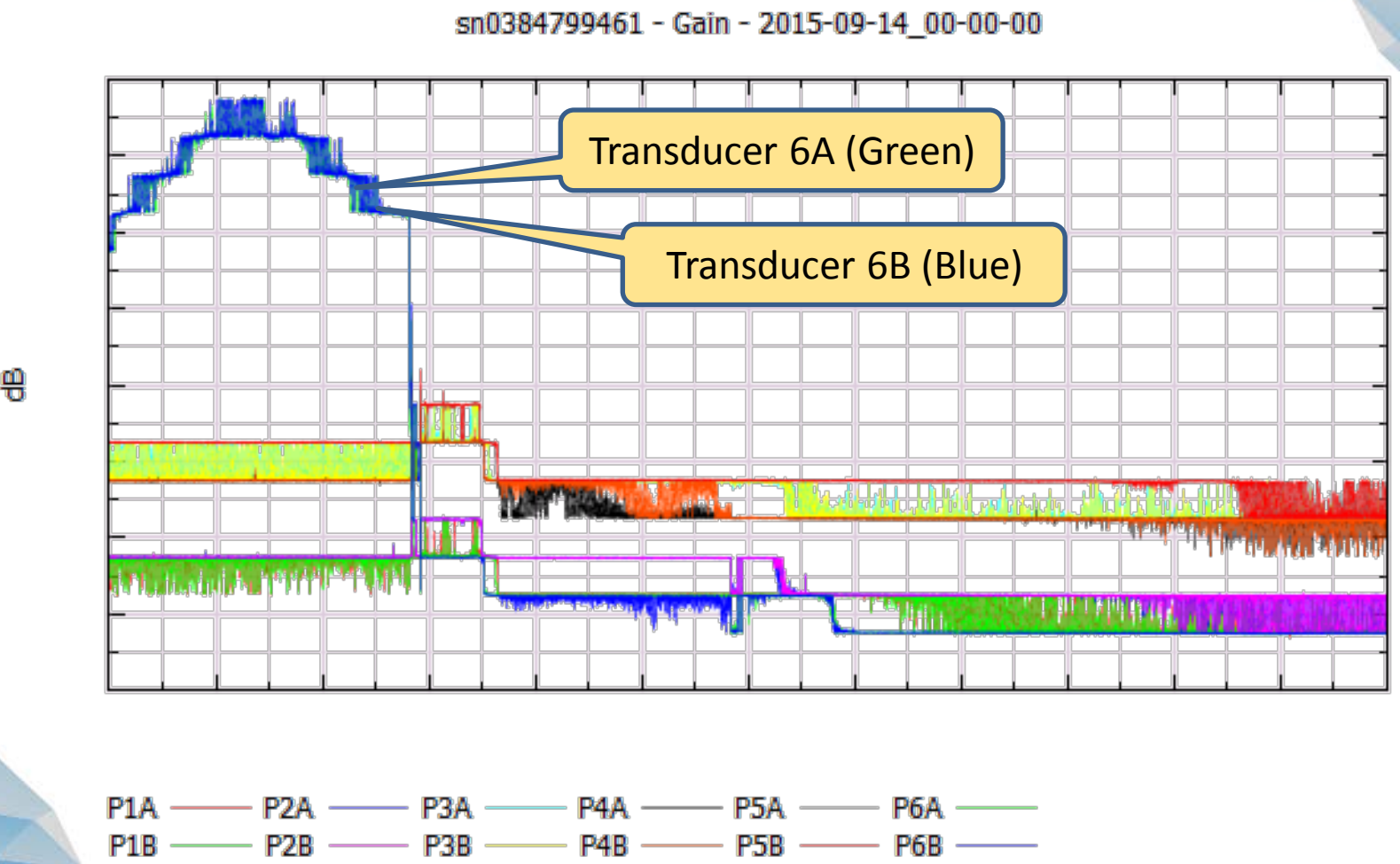
STRATIFICATION – SIGNAL %



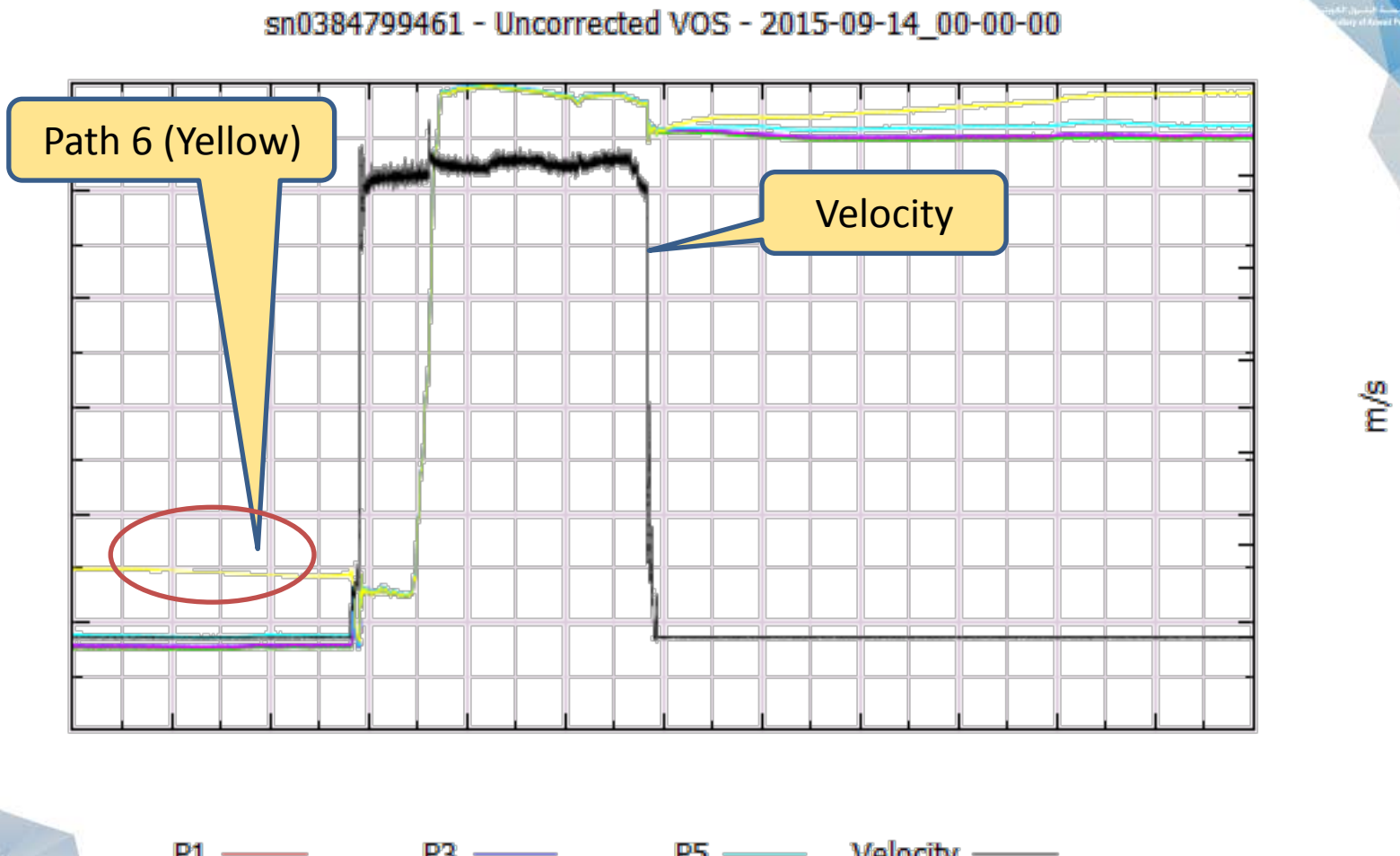
STRATIFICATION – S/N RAW



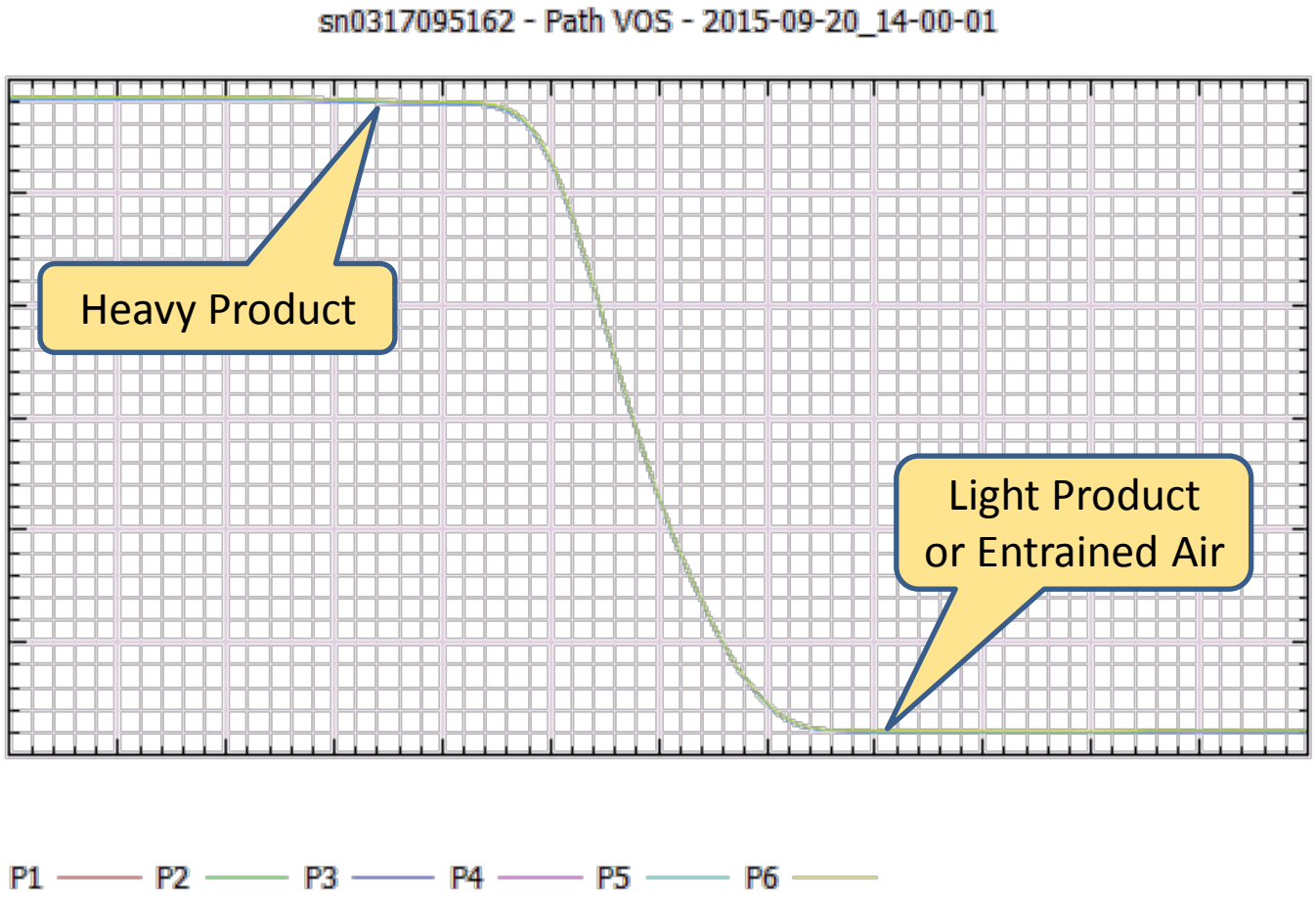
STRATIFICATION – GAIN



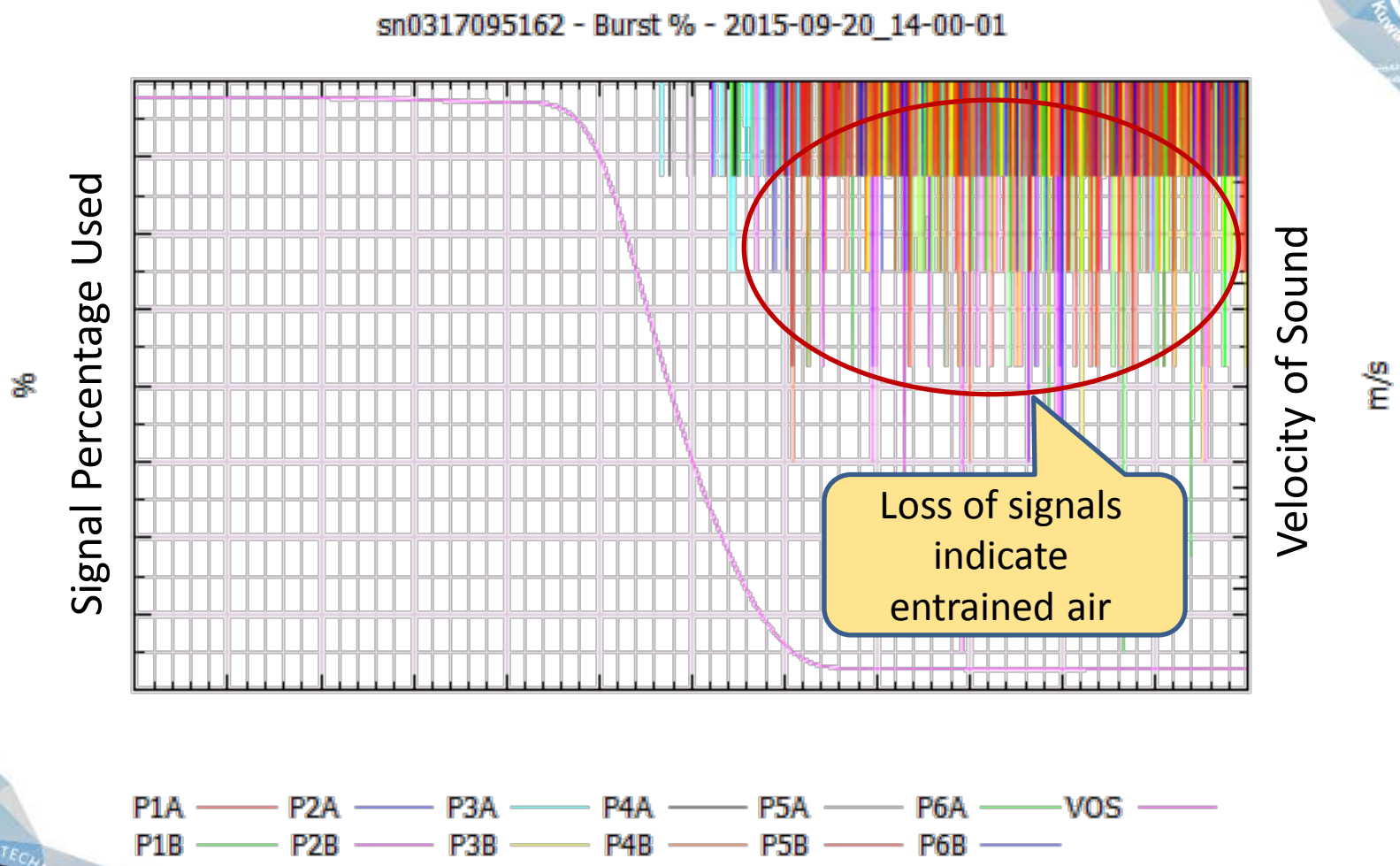
STRATIFICATION – VOS (VELOCITY OF SOUND)



PRODUCT TRANSITION – VOS

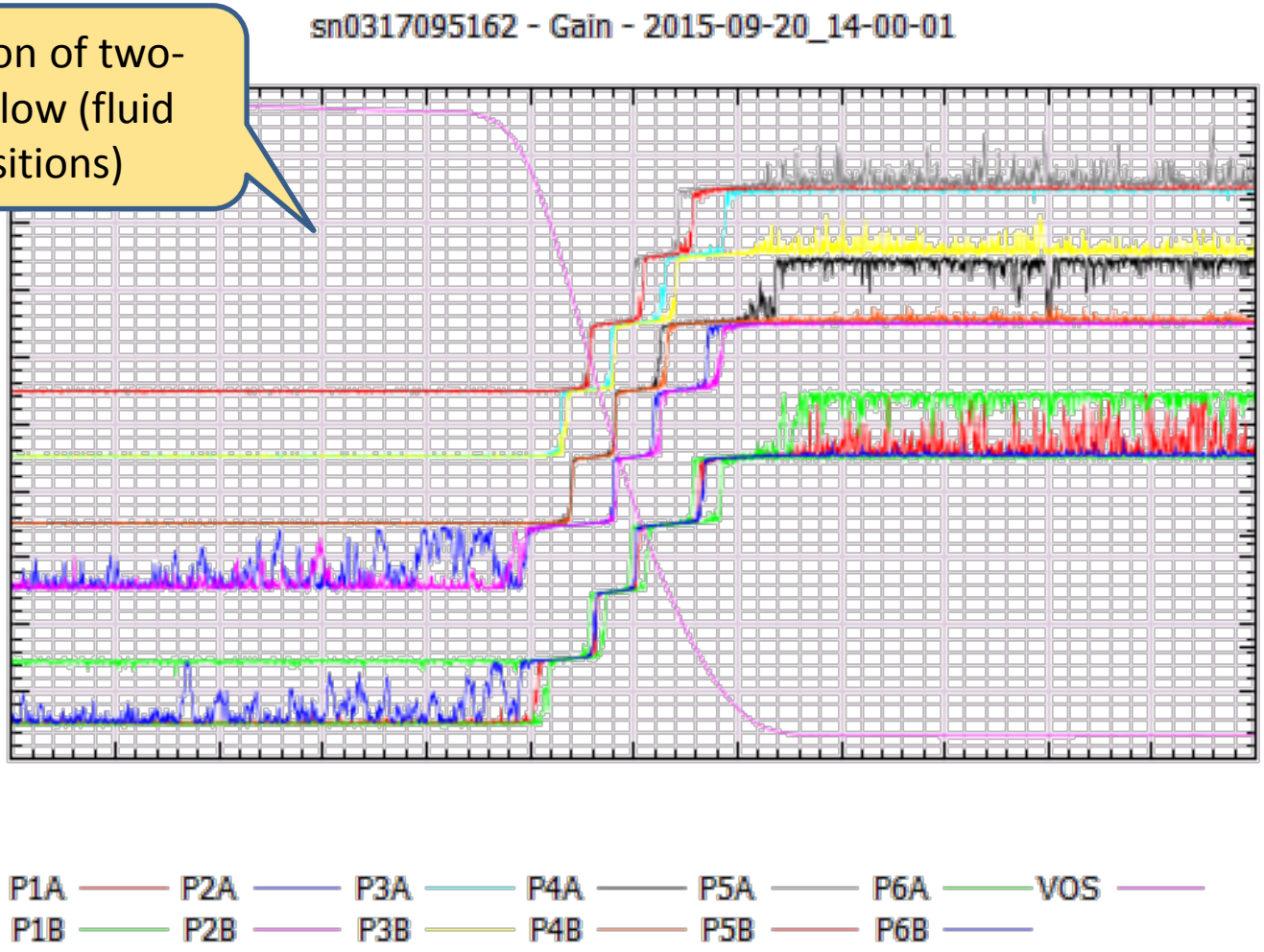


TWO-PHASE FLOW – SIGNAL %



TWO-PHASE FLOW – GAIN

Indication of two-phase flow (fluid transitions)



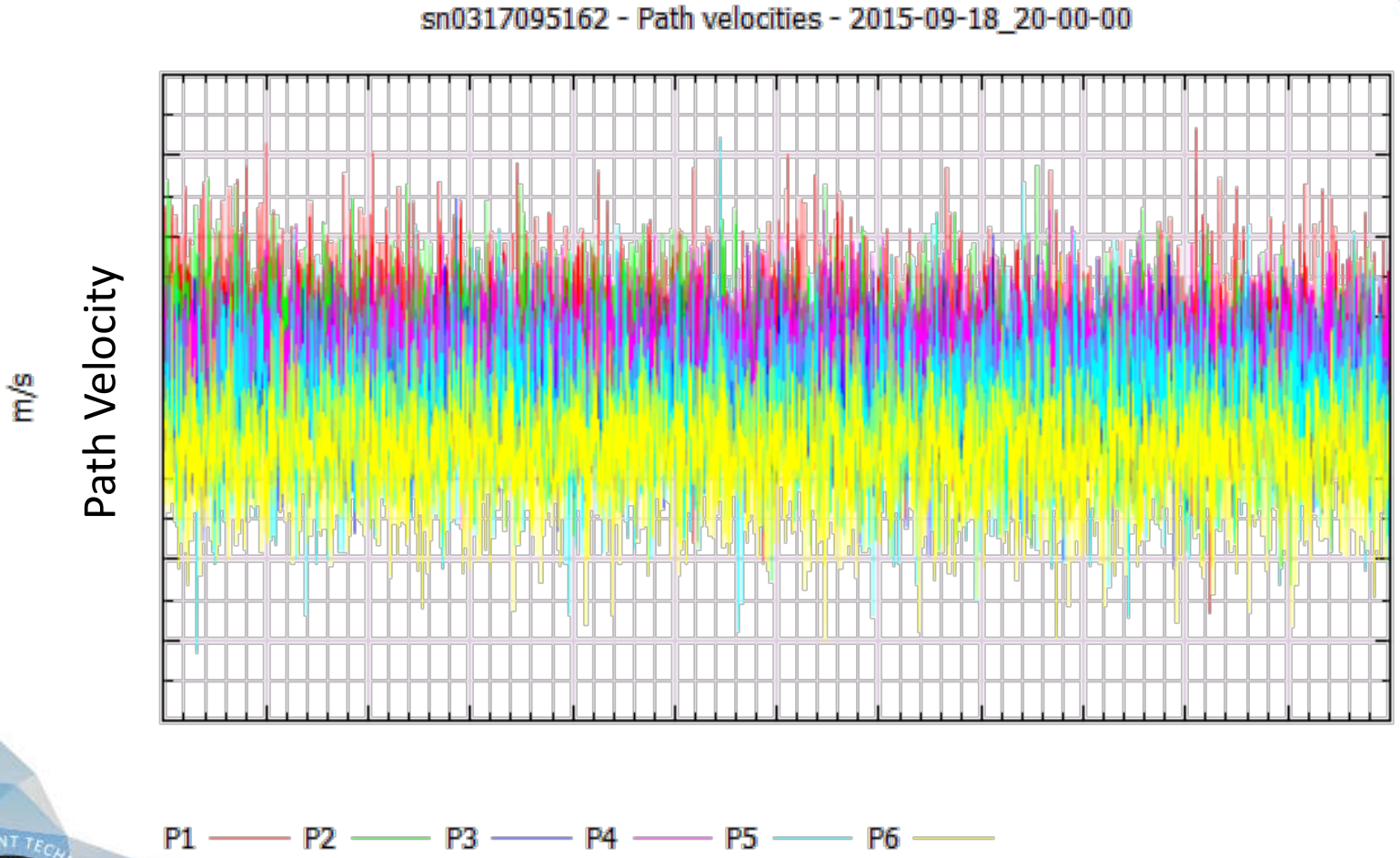
ZERO FLOW MEASUREMENT

- During line shutdown conditions it is critical that LDS are capable of identifying potential leaks

- When pipelines remain at zero-flow conditions for extended periods of time, ultrasonic meter diagnostics are **reliable to determine small changes** and address potential concerns with the pipeline process and fluid characteristics

- Instruments with limited turndown ratios utilized during the zero-flow conditions will reduce the reliability and effectiveness of the LDS during static-flow conditions

ZERO FLOW MEASUREMENT– VELOCITY



CONCLUSIONS

- **Metering accuracy directly correlates to the overall pipeline uncertainty** and is important in ensuring that the diagnostic capabilities are available for pipeline use

- Through the evaluation of real-time data collected from installed liquid custody transfer grade ultrasonic meters used in pipeline leak detection, **the benefits of utilizing ultrasonic diagnostics in various pipeline process and fluid properties is apparent**

- **Optimal Leak Detection System** (LDS) solution can be achieved **when utilizing Ultrasonic meters** to diagnose pipelines and provide insight to process and fluid conditions the

Thanks for Attention