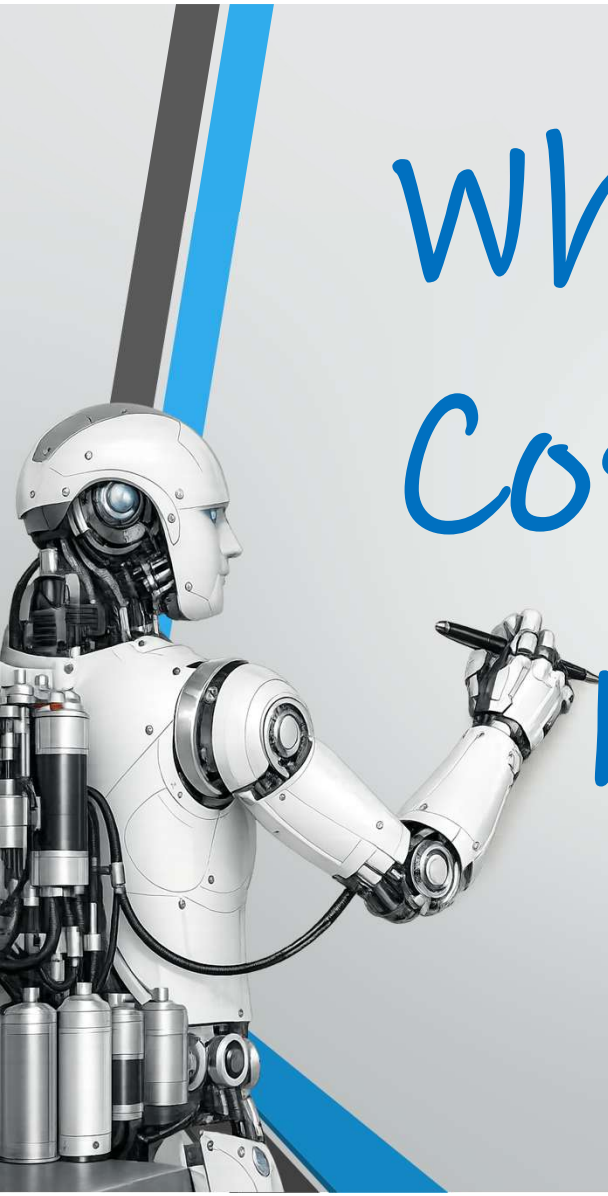
Developing a Continuous Monitoring Measurement System

2026

CEESI Gas Ultrasonic Meter Use's Conference

Exploring the Benefits of a Self Monitoring Diagnostic Measurement System

by Randy Miller

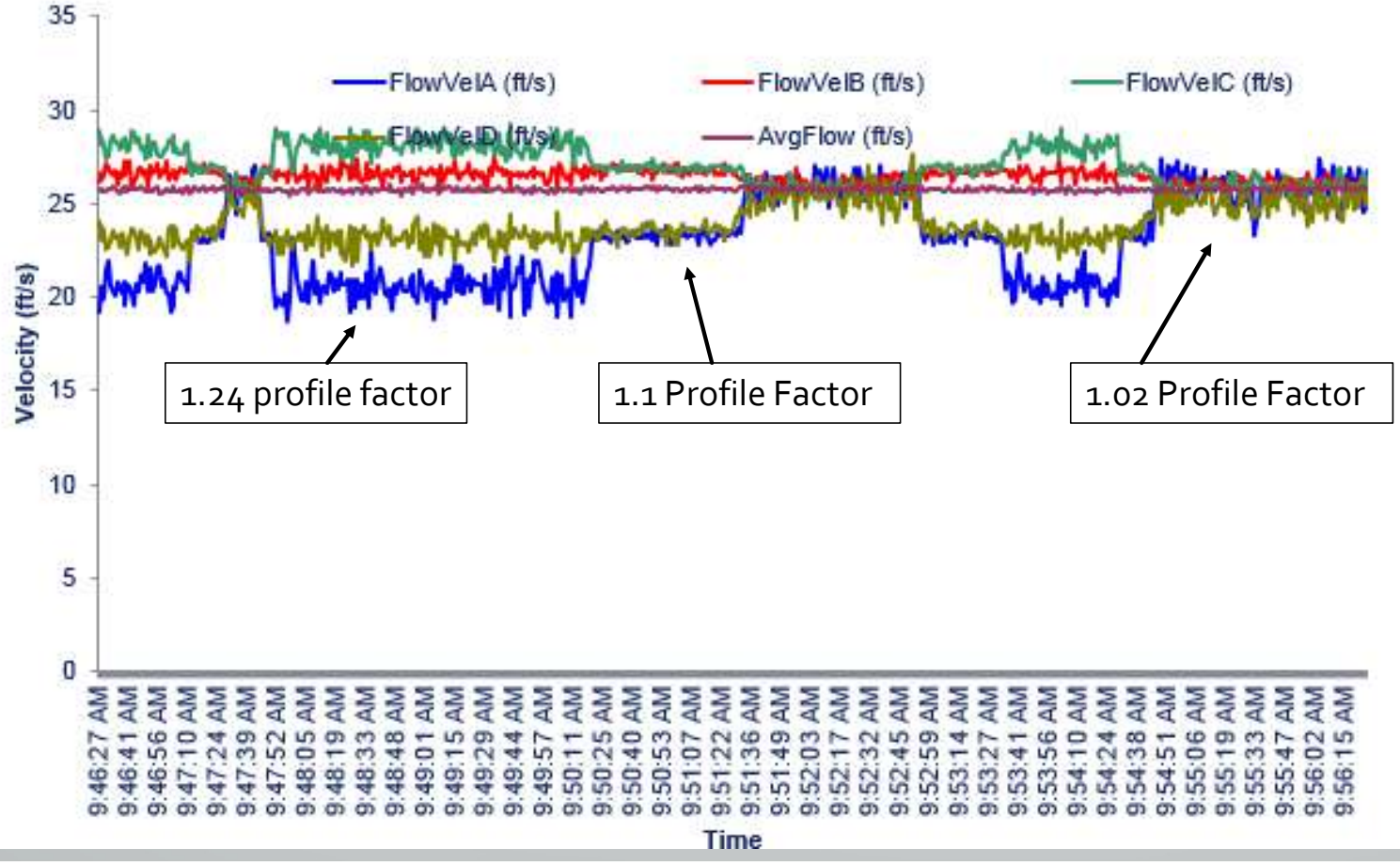


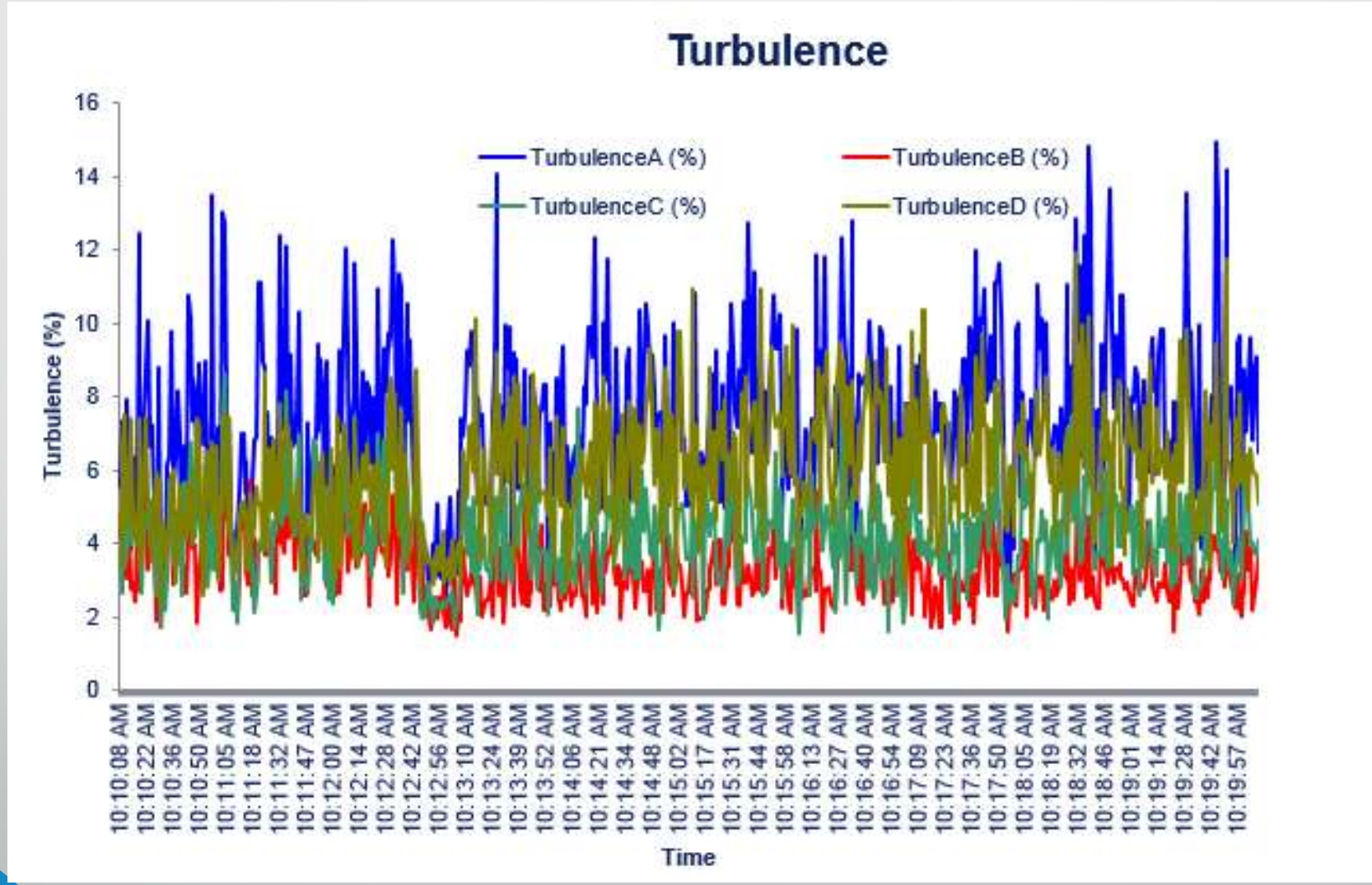
What is the Cost of Doing Nothing?

Configuration Change

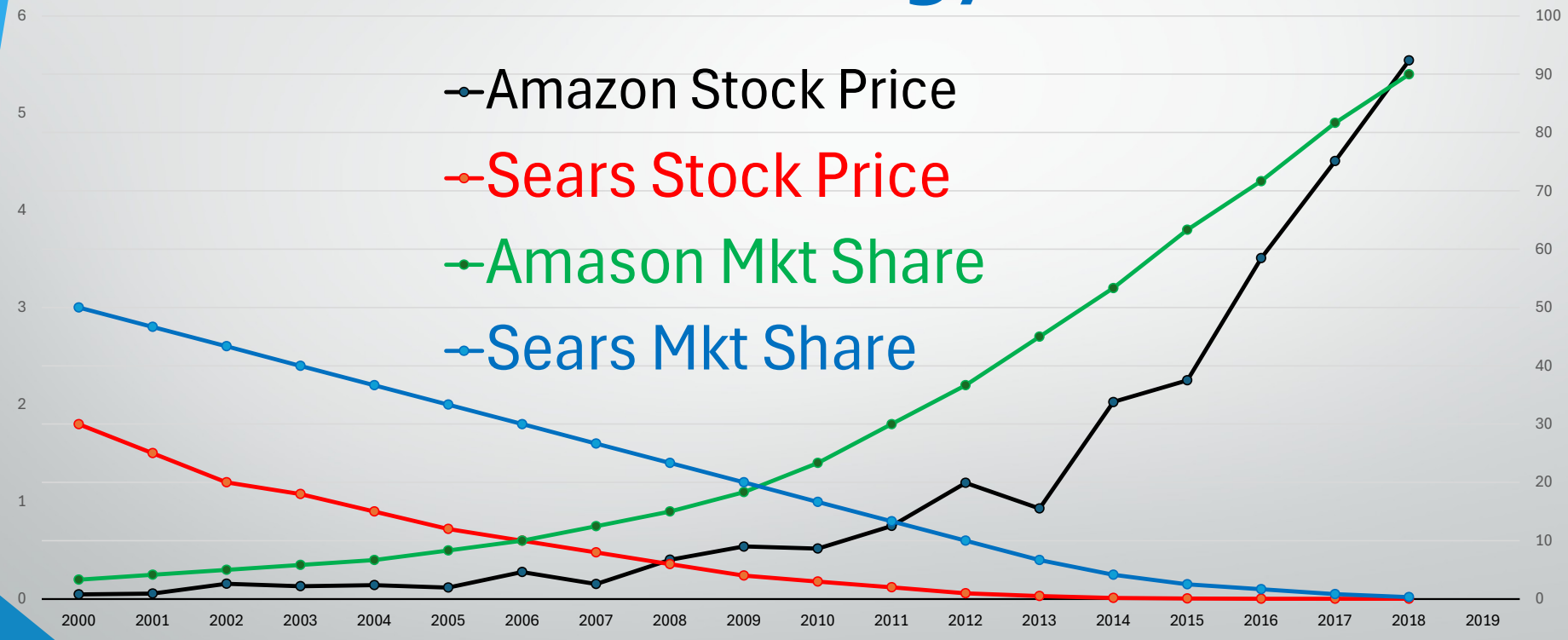
- 0.00009 Correct A2 value
- 8EA5 Correct CRC / Checksum
- 0.00088 Value A2 was changed to
- 8E5E CRC / Checksum with incorrect A2
- 6% Error at 80 fps velocity
- 730 Number of days the value was incorrect
- **$14,000,000** **Cost of the measurement error**

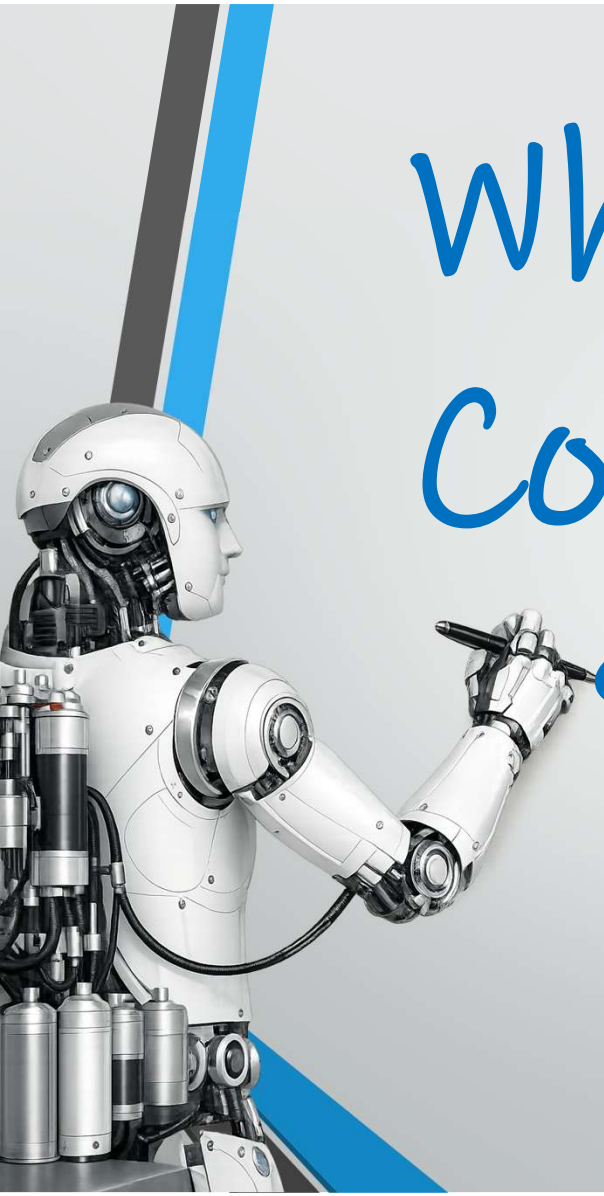
Erratic Velocity Profile




Turbulence
TurbulenceA (%)
TurbulenceB (%)
TurbulenceC (%)
TurbulenceD (%)
Turbulence (%)
0
2
4
6
8
10
12
14
16
10:10:08 AM
10:10:22 AM
10:10:36 AM
10:10:50 AM
10:11:05 AM
10:11:18 AM
10:11:32 AM
10:11:47 AM
10:12:00 AM
10:12:14 AM
10:12:28 AM
10:12:42 AM
10:12:56 AM
10:13:10 AM
10:13:24 AM
10:13:39 AM
10:13:52 AM
10:14:06 AM
10:14:21 AM
10:14:34 AM
10:14:48 AM
10:15:02 AM
10:15:17 AM
10:15:31 AM
10:15:44 AM
10:15:58 AM
10:16:13 AM
10:16:27 AM
10:16:40 AM
10:16:54 AM
10:17:09 AM
10:17:23 AM
10:17:36 AM
10:17:50 AM
10:18:05 AM
10:18:19 AM
10:18:32 AM
10:18:46 AM
10:19:01 AM
10:19:14 AM
10:19:28 AM
10:19:42 AM
10:19:57 AM
Time

Cost of Not Keeping up with Technology!

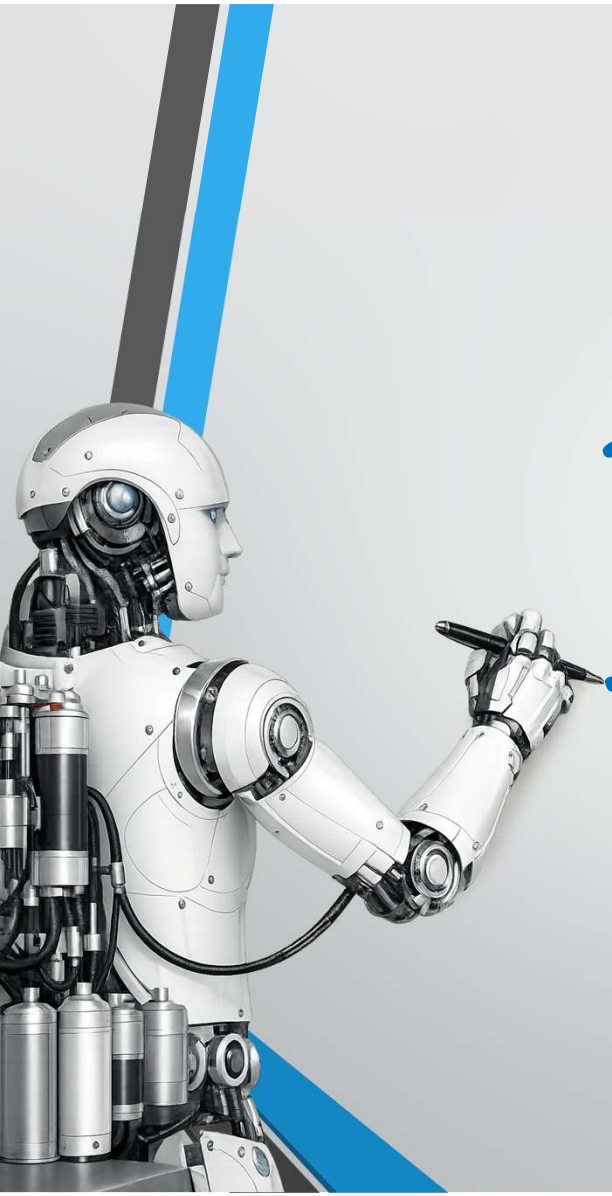




What are the Costs of Doing Something?

Costs of a Measurement Diagnostic System

- Capital Investment for hardware and software development
- O&M Expenses for system updates, maintenance or on-going expenses for 3rd party system
- Possible Staff Reductions due to fewer employees needed
- Increased Employee Technical Requirements / A higher skilled workforce



What are the Benefits of Doing Something?

Data Quantity

- Diagnostic systems can store the normal conditions for limitless numbers of meters as well as all the secondary measurement devices associated with the meters.

Abnormal Condition Identification

- Consistent abnormal condition identification regardless of a technician's knowledge, experience or expertise

Continuous Data Analysis

- Constant data analysis vs. the industry standard monthly, two-minute log

Simplicity

- Universal look and feel to meter software and diagnostics regardless of manufacture

Efficiency

- Condition Based Maintenance
- Searching for System Imbalances

Spreading Out Risk

- Measurement Diagnostic System can provide easy data access to a variety of employees


Getting
Started

Phase One

- We began by polling this one Instromet meter with the measurement RTU for path velocities and used the RTU to calculate the profile factor
- The data was sent to the SCADA system which also generated alarms

Phase Two

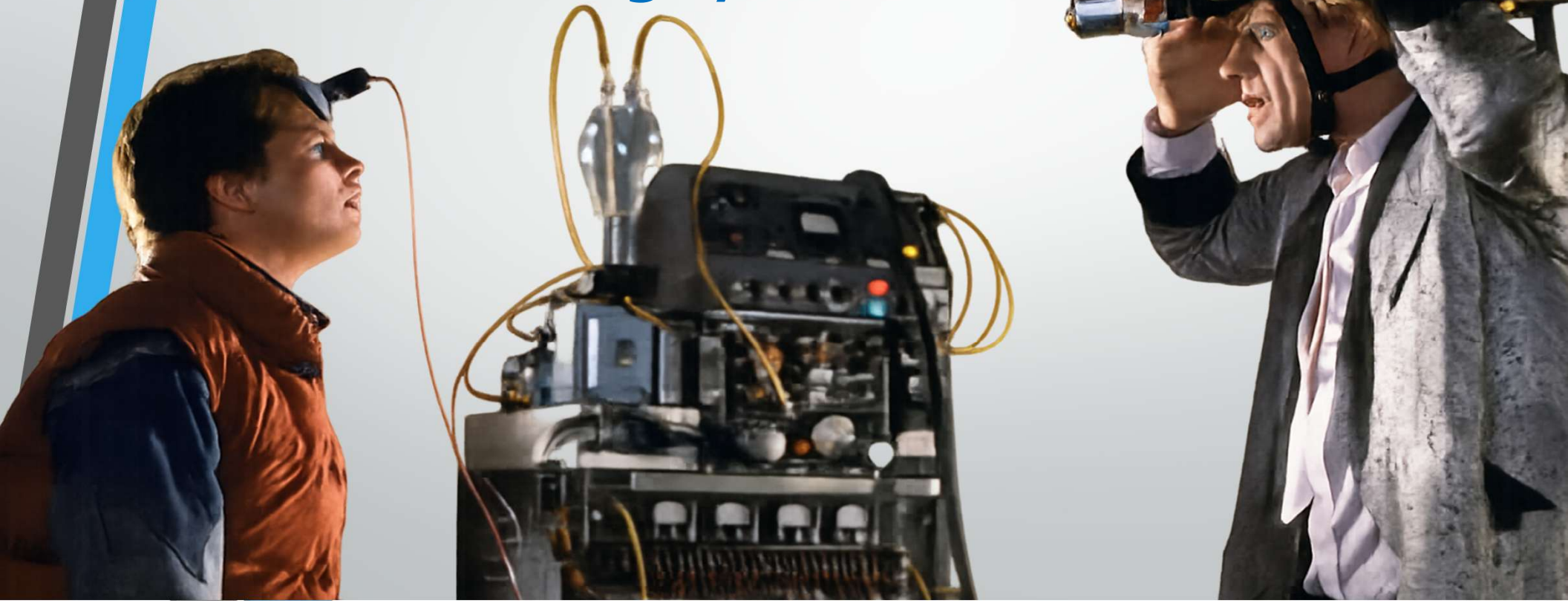
- Still polling Instromet meters only, but added polling for speed of sound, swirl, path gains, gain limits and performance
- All polling and calculations continued to be performed in the measurement RTU and was expanded to poll up to 4 meters
- All data continued to be sent to our SCADA system to provide alarms and warnings

Phase Three

- Diagnostics for Daniel and SICK meters
- Polling for Symmetry, SNR and alarms for frequency validation and main to check meter comparison
- Application was expanded to poll up to 4 bidirectional meters
- All polling and calculations continued to be performed in the measurement RTU
- All data continued to be sent to our SCADA system to provide alarms and warnings

Phase Four

Solving problems with the existing system



Phase Four

- **To address these issues in 2015 we developed our Advanced Diagnostic Monitoring System (ADMS)**
  - Utilized a separate RTU for field polling, diagnostics, alarms
  - Utilized our newly developed Measurement Dashboard to store and display our diagnostic data as well as provide notifications to the responsible parties

Phase Four Additions

- Expanded to handle up to 8 bidirectional meters and their secondary measurement equipment
- Provided for linearization of Profile factor and Symmetry factor baselines allowing for tightened alarm bands
- Widened alarm bands for Profile and Symmetry alarms at velocities below 5 fps

Phase Four Additions

- Developed Auto Learning function to better define normal conditions and recommend alarm settings.
- Added reference pressure and temperature transmitters
- Added diagnostics for Coriolis meters Orifice meters and gas chromatographs

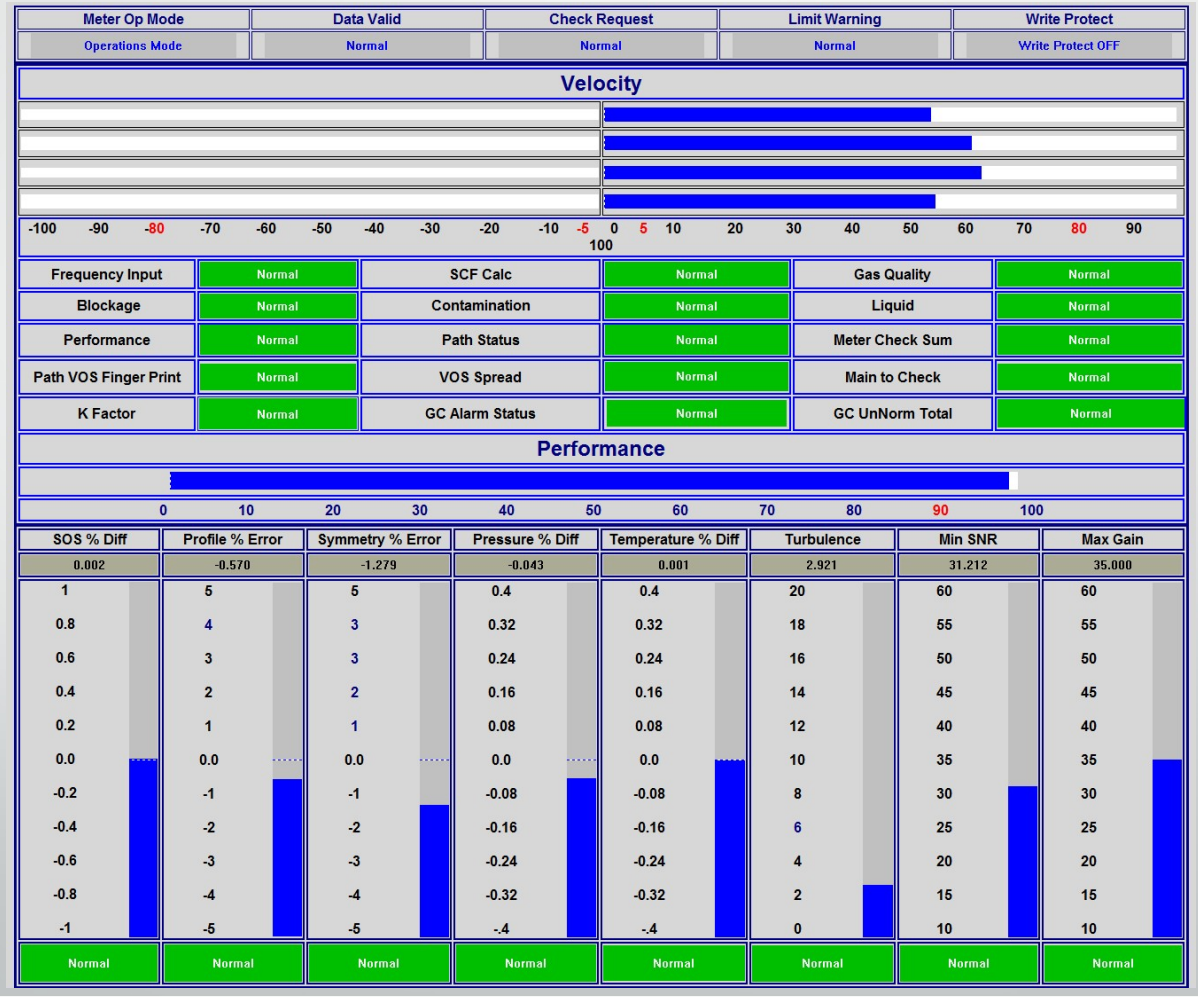
ADMS Field RTU Historical Data

- All polled data put into hourly archives with Min, Max and Averaged values and associated alarm statuses stored for 35 days
- All alarms are automatically cleared at the top of every hour to create individual hourly records
- Developed Excel spreadsheets for importing data to create monthly reports and graphs

ADMS Dashboard Historical Data

- Measurement Dashboard gathers data from ADMS field computer 1 to 2 times per hour
- Min Max and average data as well as alarm statuses stored in Measurement Dashboard for the life of the meter.
- Developed Excel spreadsheets for importing data to create extended data reports and graphs

ADMS Ultrasonic Meter Diagnostics Overview

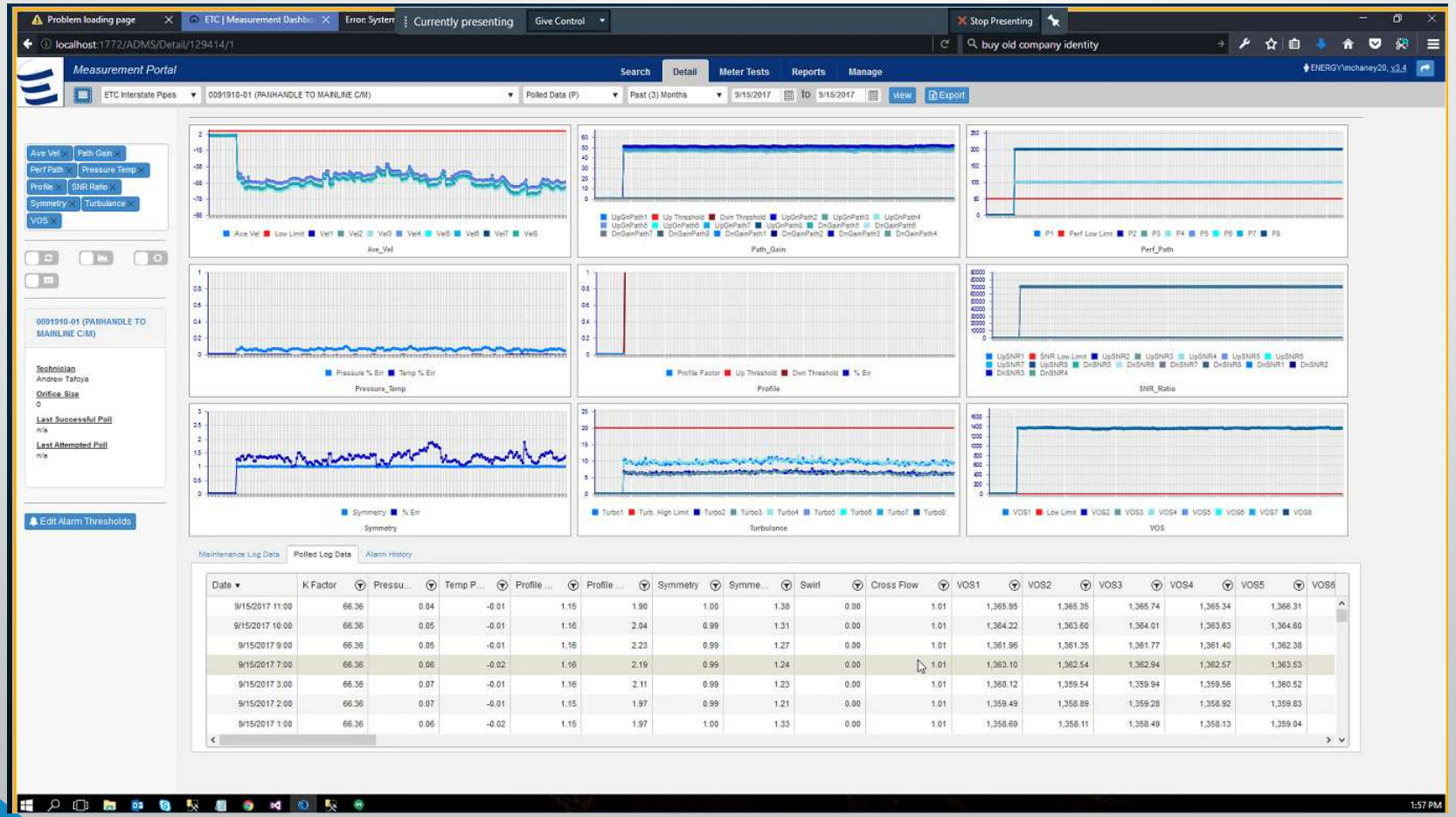


ADMS Individual Alarm Setup / Detail

Configuration		Status Detail	
Baseline	1.095	Alarm Input	0.047
Max % Error	4.000	Profile Factor Live	1.096
Max Alarm Duration	120.000	Profile Factor Baseline	1.095
Max Alarm Event Count	20	Differance from Baseline	0.001
Alarm Latch	Latched	Meter Velocity	26.316
Use Linearized Baseline	YES	Alarm Duration	0.000
Low Velocity Max % Error	5.600	Alarm Event Count	0
		Alarm Status	Normal

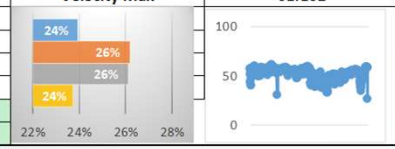
Auto Learn Minimum Baseline Setting			
Start Run 1 Auto Learn Tests	Push to Start Test	Test Duration / Days	30.000
Start This Test Only	Push to Start Test		
Test Time Remaining / Days	0.00	Test Result Status	Valid Test
			Test Complete
Max Input Value	1.098	Min Input Value	1.090
Average Input Value	1.094	Standard Deviation	0.002
Suggested Max % Error	3.726	Time Stamp for Last Completed Test	06/12/2017 18:25:17

ADMS Measurement Dashboard Overview Display

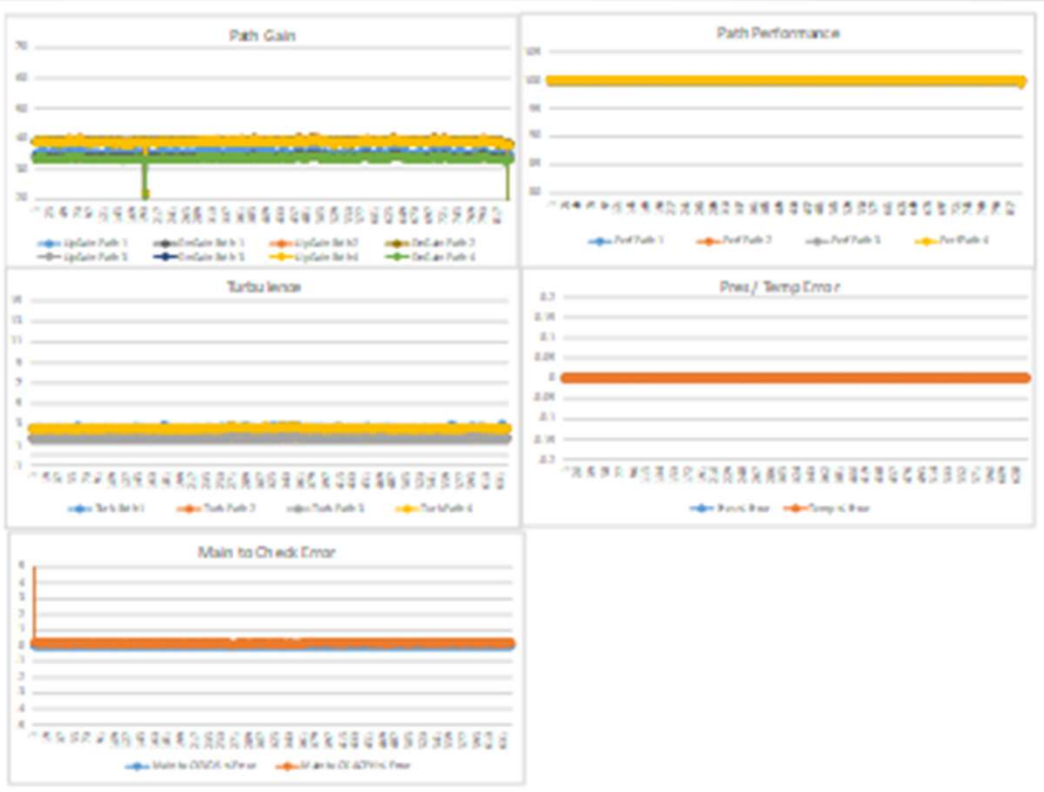


ADMS Diagnostic Report

	Advanced Diagnostic Archive Meter Test Report		Setup Menu	Save Report	***GC Alarm Status***		Print Report
Meter Name	Default Meter Name	**Meter Number**	Default Meter Number	D/A 2 Low	D/A 1 High	D/A 1 Low	A/D 2 High
Date Range	11/11/2020	12/16/2020	10:00:00 AM	Normal	Normal	Normal	Normal
Flow and Velocity Data				RF Deviation	Power Fail	Checksum	Alalyzer Fail
Profile Factor	1.097	**Symmetry**	1.006	Normal	Normal	Normal	Normal
Pct Error	0.000	**Pct Error**	0.447	A/D 2 Low	A/D 1 High	A/D 1 Low	D/A 2 High
Status	Normal	Status	Normal	Normal	Normal	Normal	Normal
Contamination Status		Normal		D/A 3 High	D/A 3 Low	PreAmp Fail	PreAmp Adjust
MACFH Avg	115.363	**Velocity Avg**	52.038	Normal	Normal	Normal	Normal
Velocity Min	26.297	**Velocity Max**	61.102	***ADMS GC Alarms***			
Path 1 Velocity	47.566			RF Order	RF Dev C1	RF Dev C2	RF Dev C3
Path 2 Velocity	51.984			Normal	Normal	Normal	Normal
Path 3 Velocity	51.849			RF Dev IC4	RF Dev NC4	RF Dev IC5	RF Dev NC5
Path 4 Velocity	47.130			Normal	Normal	Normal	Normal
Min Velocity Status	Normal			RF Dev NeoC5	RF Dev C6	RF Dev C7	RF Dev C8
Max Velocity Status	Normal			Normal	Normal	Normal	Normal
VOS Data				RF Dev C9	RF Dev CO2	RF Dev N2	Warning Status %
VOS % Error	-0.031	**Main to CK VOS % Err**	0.601	Normal	Normal	Normal	0.000%
Main to Calc Status	Normal	**Main to CK Status**	Warning	***Station Press Temp SOS Vel Comparison Alarms***			
Path 1 VOS	1423.781	**Path 2 VOS**	1423.608	Sta Mtrs Temp Spread	Sta Mtrs Pres Spread	Sta Mtrs SOS Spread	Sta Mtrs Vel Spread
Path 3 VOS	1423.661	**Path 4 VOS**	1423.579	Station Warning	Station Warning	Station Warning	Station Warning
Presure and Temperature Verification				Normal	Normal	Normal	Normal
Pressure Verification	0.000	**Temp Verification**	0.000	***Monthly Accumulated ADMS Warning Status***			
Status	Normal	**Status**	Normal	Calculation	Static Press	Ftemp	GC
Path Performance Data				Normal	Normal	Normal	Warning
Path 1	99.999	**Path 2**	99.830	VOS Spread	VOS	Freq	4+1
Status	Normal	**Status**	Normal	Normal	Warning	Normal	Warning
Path 3	99.820	**Path 4**	99.999	SNR	Path Status	Gain	Performance
Status	Normal	**Status**	Normal	Normal	Warning	Normal	Normal
Path Gain Data				Symm	Profile	CPU Restart	Liquid
Path 1	34.599	**Path 2**	39.115	Normal	Normal	Warning	Normal
Status	Normal	**Status**	Normal	Blockage	Contamination	Xflow	Turbulance
Path 3	38.974	**Path 4**	33.998	Normal	Normal	Normal	Normal
Status	Normal	**Status**	Normal	Swirl	Write Protect	Limit Warning	Check Request
Signal to Noise Ratio Data				Normal	Normal	Normal	Normal
Path 1	35.784	**Path 2**	33.542	Data Valid	Meter Mode	Check Sum	Zero Flow
Status	Normal	**Status A**	Normal	Normal	Normal	Normal	Normal
Path 3	33.528	**Path 4**	33.554	PF+ Symm	Path Finger Print	Min Velocity	Max Velocity
Status	Normal	**Status**	Normal	Normal	Normal	Normal	Normal
Path Turbuluance Data				Show Raw Data	Hide Raw Data		Warning Status %
Path 1	2.630	Path 2	1.704				0.598%
Status	Normal	Status	Normal				
Path 3	1.671	Path 4	2.594				
Status	Normal	Status	Normal				



ADMS Data Graphs



Phase 5

- Replace the ADMS field device due to that hardware becoming obsolete
- Utilize an analytics and industrial AI platform software to replace use of the Measurement Dashboard.

Problem Identification Examples

Intermittent Failures

- Intermittent missing pulses


Blocked Flow Conditioners

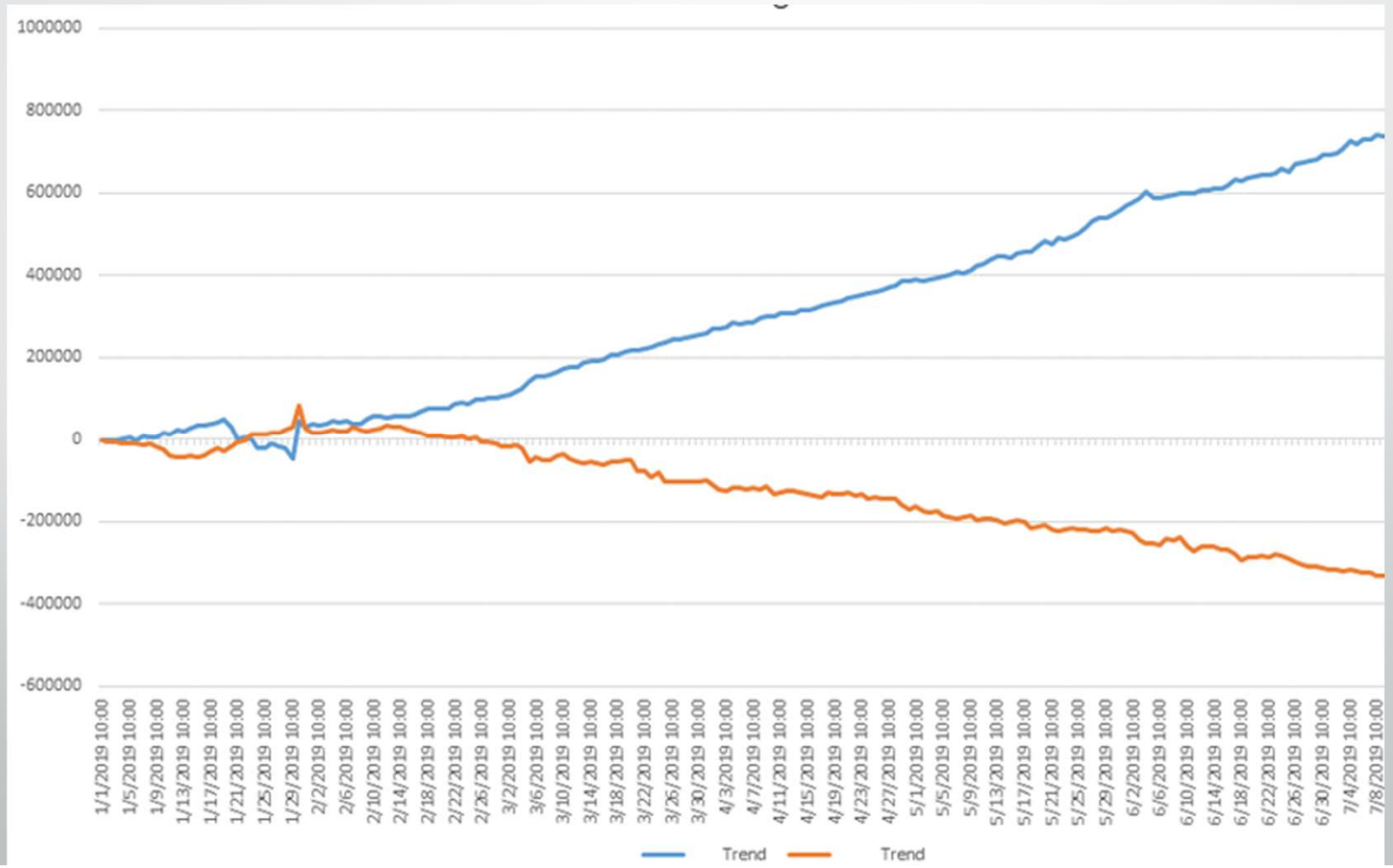
Dirty Meters!

- Dirty Meters are the number one measurement error causing issue we found.
- Yet are one of the more difficult issues to detect.

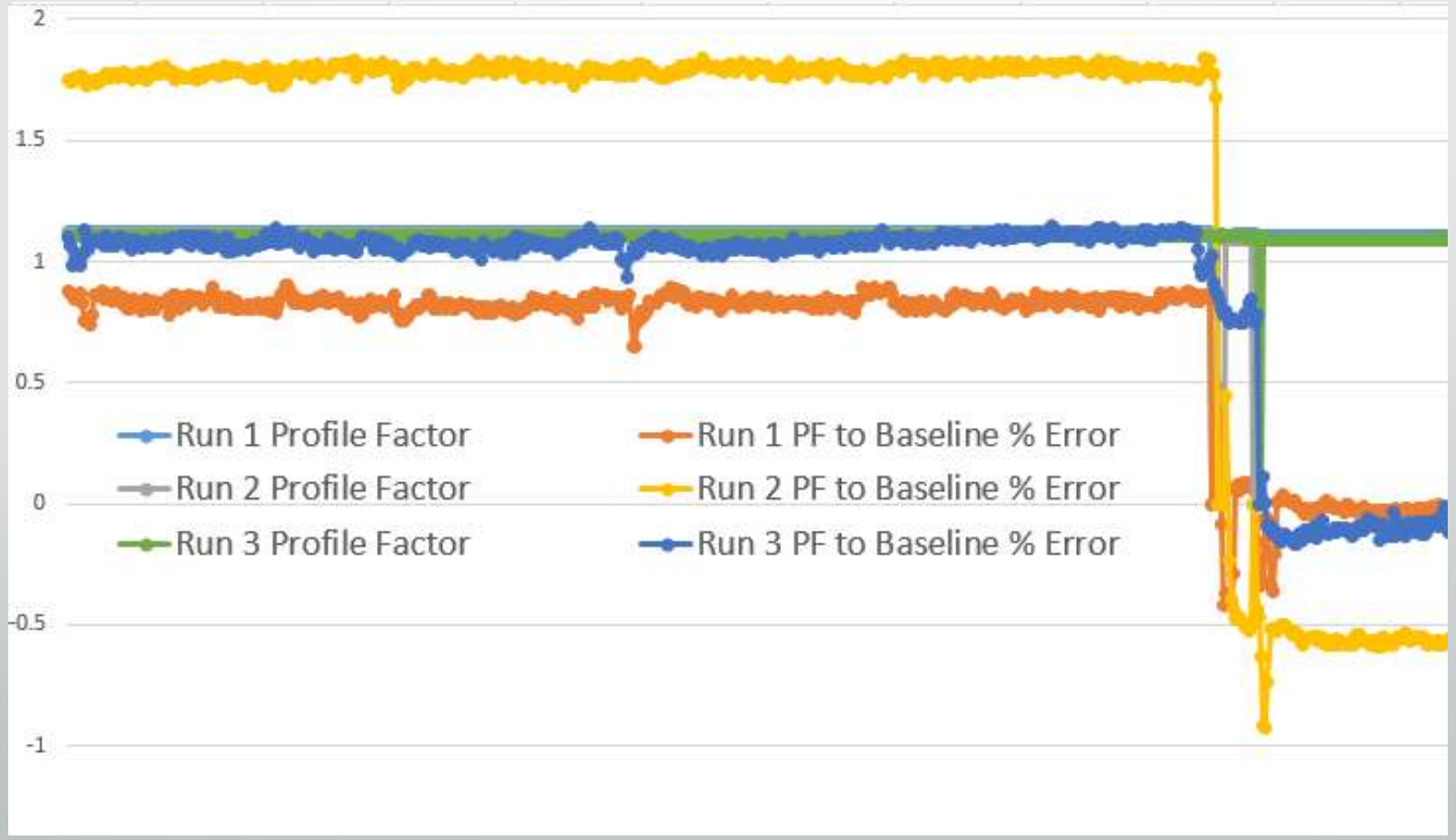
Meter Contamination Detection Obstacles

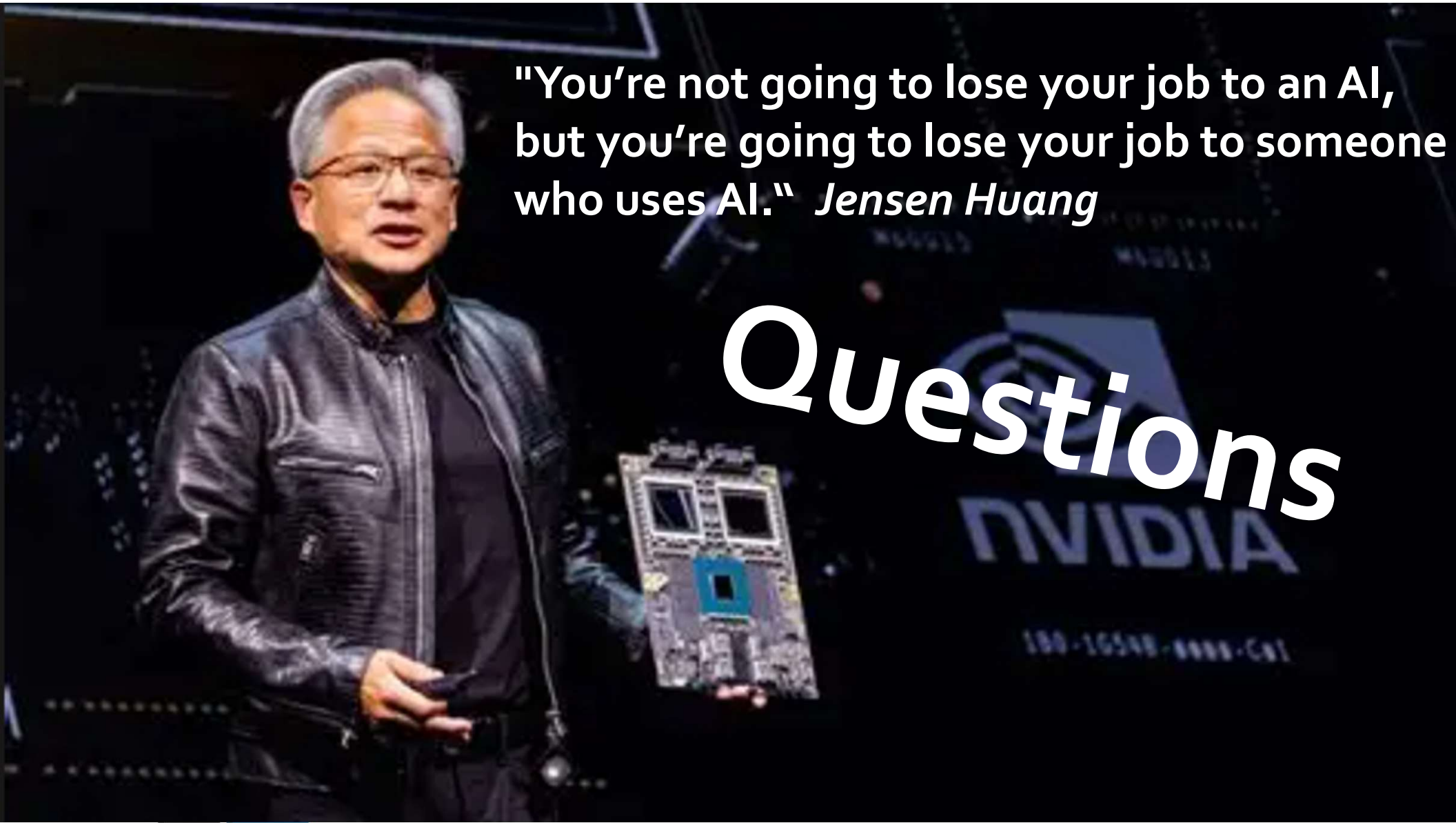
- Meter wall buildup typically occurs slowly over time
- Creates minimal shift in diagnostics
- Measurement shift created by contamination build up is different for different meter sizes and path configurations

Pipeline Imbalance



Meter Profile Factor Shift




"You're not going to lose your job to an AI, but you're going to lose your job to someone who uses AI." *Jensen Huang*
Questions
NVIDIA