

# Sensor Accuracy & Validation

Absmart Density, % Water & % Oil

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# Sensor Accuracy Validation

## Mud Density & Oil/Water Sensor

### Mud Density Sensor:

- Differential pressure Density in the mud pits
- Has an error margin of **+/- 0.115** ppg

### SiCon - Oil/Water Sensor:

- Capacitance measurement of % Oil & % Water in the mud pits
- Has an error margin of **+/- 3.0 %** on Oil & **+/- 2.5%** on Water

# Sensor Accuracy – Reference Data

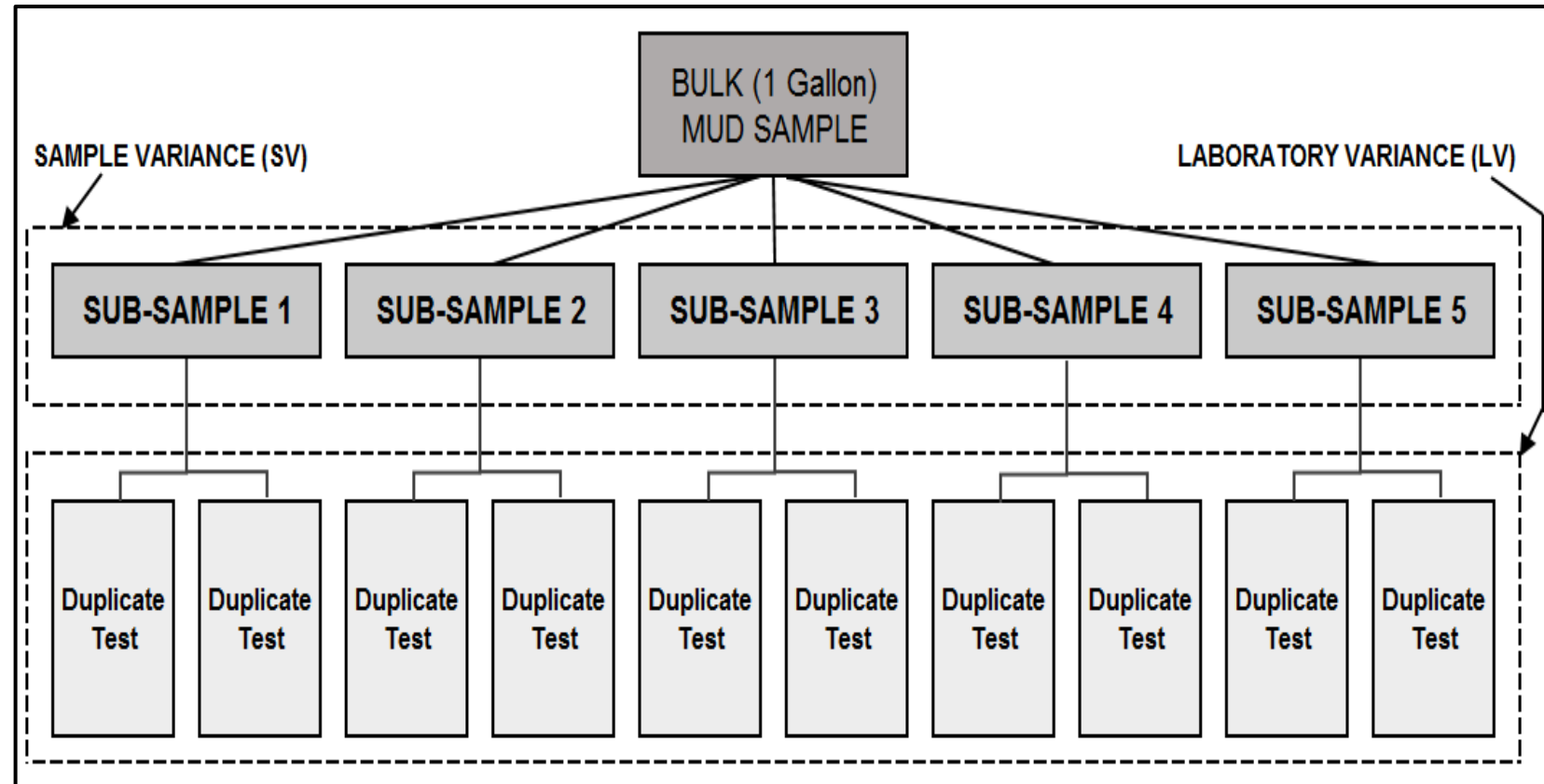
## TEV (Total Existing Variance) Analysis

### TEV Analysis:

- Is a statistical analysis tool we use to validate the **Reference Data**
- The TEV test results provides the true accuracy of the lab instruments

### Procedure:

- Take a larger sample of mud, divide that sample into 5 equal sub-samples. Then divide each sub-sample into 2 test samples





# Sensor Accuracy – Mud Density

## TEV Mud Balance

- TEV analysis was conducted using a conventional pressurized mud balance

### Results:

- Standard error margin on a typical mud balance is +/- 0.178 ppg
- What this means is that 95 out of 100 samples of mud measured using a mud balance will fall within +/- .178 ppg of the median

<b>TEV Worksheet: Mud Density Primary Lab Method</b>								
<b>Customer Inputs (all other cells locked)</b>								
<b>Parameter Being Tested:</b>			<b>DENSITY (ppg)</b>					
<b>Lab Equipment Mfg and Model:</b>			<b>PRESSURIZED MUD BALANCE</b>					
Sample ID	Duplicate Test A	Duplicate Test B	"A" - "B"	(A-B)^2	Avg(A,B)	Median of Avg's	Avg-Median	Diff^2
Sub-Sample 1	10.25	10.15	0.1	0.0100	10.2	10.225	-0.025	0.000625
Sub-Sample 2	10.25	10.30	-0.05	0.0025	10.275		0.05	0.0025
Sub-Sample 3	10.30	10.35	-0.05	0.0025	10.325		0.1	0.01
Sub-Sample 4	10.25	10.20	0.05	0.0025	10.225		0	0
Sub-Sample 5	10.20	10.25	-0.05	0.0025	10.225		0	0
				Lab Variation: Sqrt(sum((A-B)^2/4)	0.0707	Sampling Variation: Sqrt(sum(Diff^2/4)		0.057282
<b>95% Confidence - Total Error Band</b>								<b>+/- 0.178</b>

# Sensor Accuracy – Mud Density

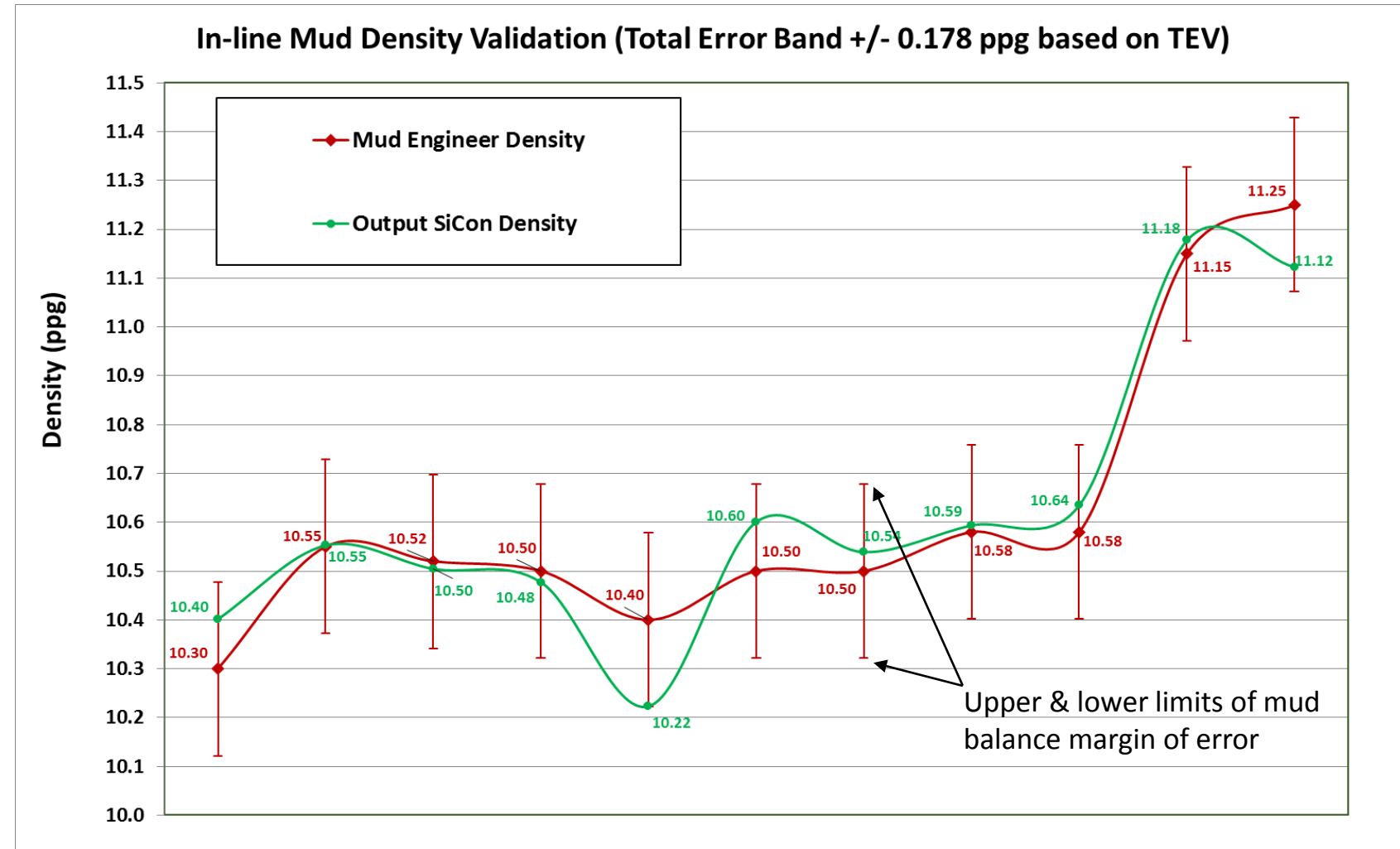
## Field Validation



- Mud Engineer used a pressurized mud balance to collect mud density measurements

### Field Results:

- The average margin of error for the sensor was calculated at .115 ppg



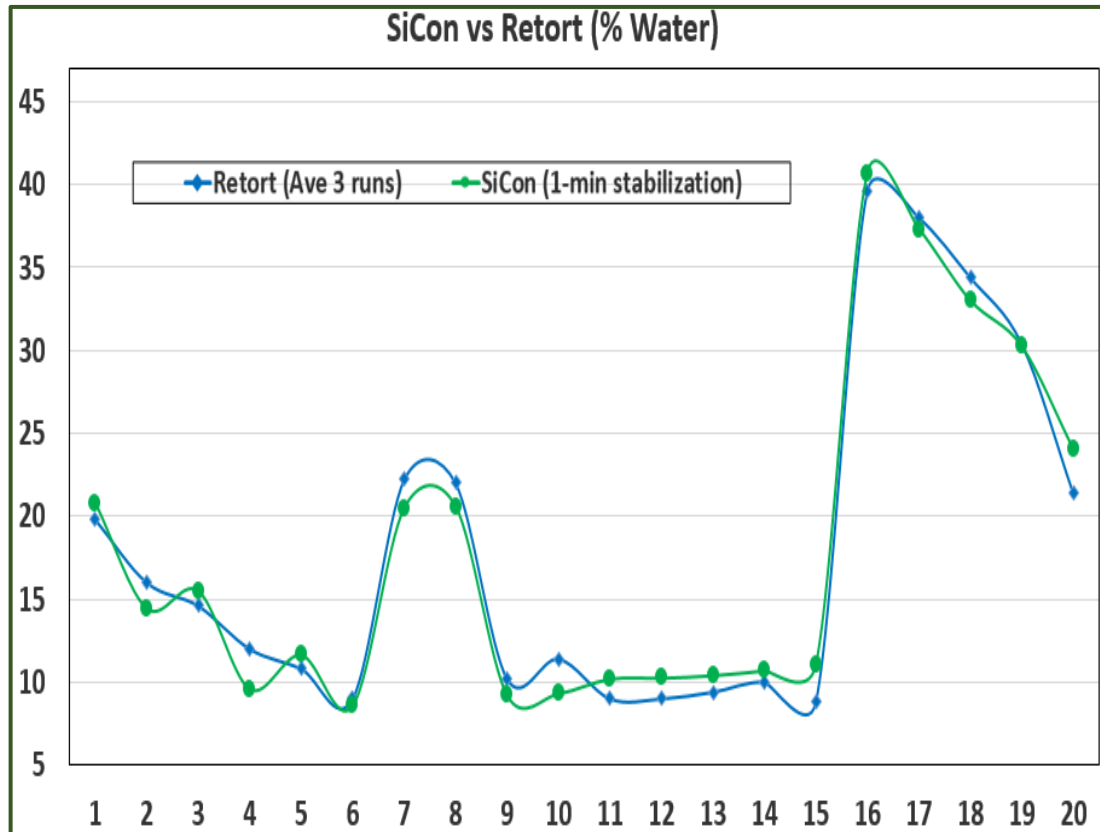


# Sensor Accuracy – SiCon

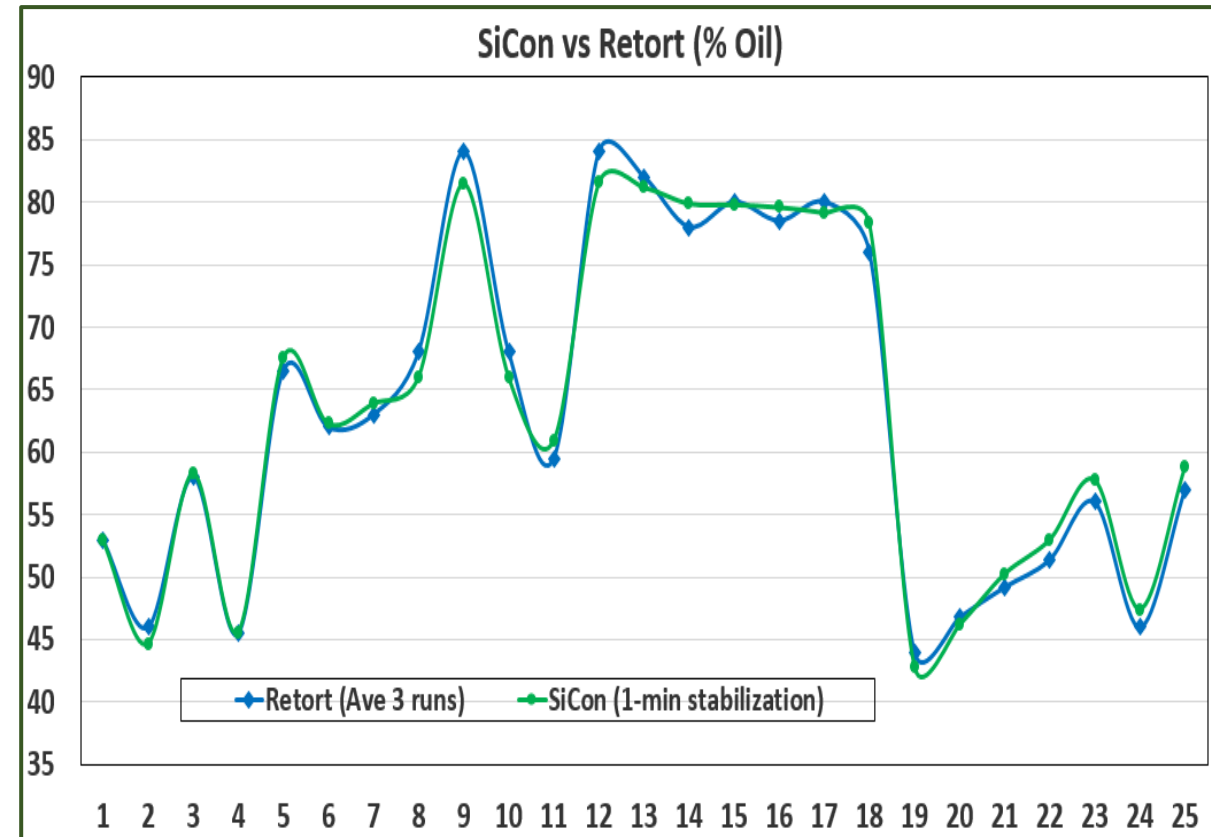
## Lab Validation

Oil/Water cut sensor has been thoroughly tested on a dynamic flow loop, verified by 60+ retorts. Results yielded a very good correlation to the lab data, approximately 3% error average.

### % Water Data Verification



### % Oil Data Verification





# Sensor Accuracy – Retort % Oil

## TEV Analysis

- 50 ml retort was used to determine reference data accuracy
- There are several contributing factors to standard error of a retort:
  - Cleanliness (residual cake)
  - Glassware choice (TD vs TC)
  - Reading the meniscus
  - O-ring damage
  - Air bubbles

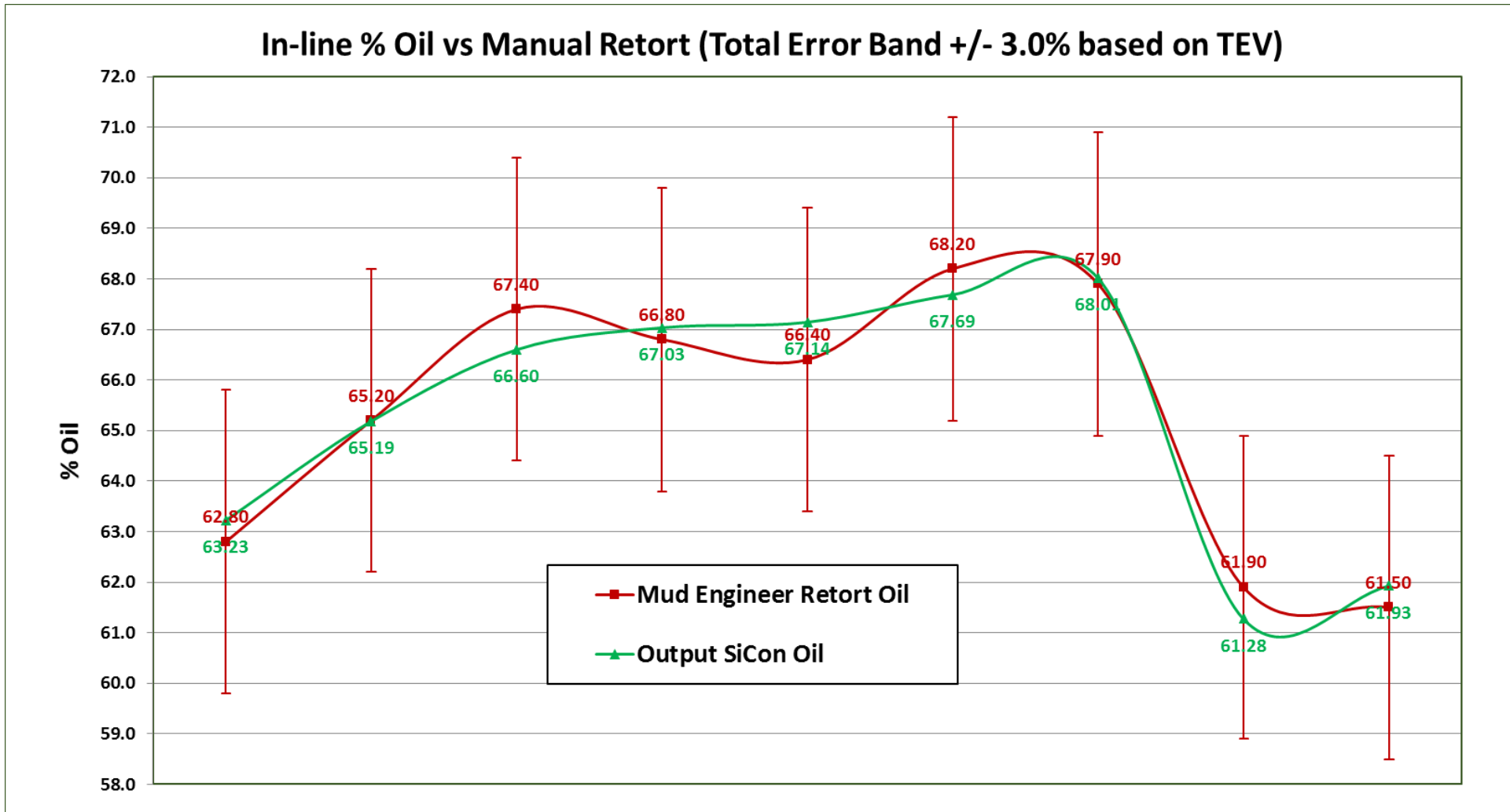
TEV Worksheet: Retort % Oil Primary Lab Method								
Customer Inputs (all other cells locked)								
Product Being Tested:				% OIL				
Lab Equipment Mfg and Model:				RETORT				
Sample ID	Duplicate Test A	Duplicate Test B	"A" - "B"	(A-B)^2	Avg(A,B)	Median of Avg's	Avg-Median	Diff^2
Sub-Sample 1	62.80	63.50	-0.7	0.4900	63.15	64.25	-1.1	1.21
Sub-Sample 2	63.50	65.00	-1.5	2.2500	64.25	64.25	0	0
Sub-Sample 3	62.50	64.40	-1.9	3.6100	63.45	64.25	-0.8	0.64
Sub-Sample 4	64.00	65.00	-1	1.0000	64.5	64.25	0.25	0.0625
Sub-Sample 5	63.90	64.60	-0.7	0.4900	64.25	64.25	0	0
Lab Variation: Sqrt(sum((A-B)^2/4)				1.4000		Sampling Variation: Sqrt(sum(Diff^2/4)		0.691466
95% Confidence Total Error Band							<b>+/- 3.060</b>	

What this means is that 95 out of 100 samples should fall to within +/- 3% of the median



# Sensor Accuracy – SiCon % Oil Field Data

## Field Validation







# Sensor Accuracy – TEV Retort % Water

## TEV Analysis

- When burning retorts, outliers can result from multiple areas along the process.
- For example:
  - Condenser leak
  - Entrained bubbles
  - Inadequate cook time
  - Retort cell not completely clean
- In the field we rarely run duplicate retorts if suspicious of an outlier.

TEV Worksheet: Retort % Water Primary Lab Method								
Customer Inputs (all other cells locked)								
Product Being Tested:				% WATER				
Lab Equipment Mfg and Model:				RETORT				
Sample ID	Duplicate Test A	Duplicate Test B	"A" - "B"	(A-B)^2	Avg(A,B)	Median of Avg's	Avg-Median	Diff^2
Sub-Sample 1	17.00	17.90	-0.9	0.8100	17.45	17.3	0.15	0.0225
Sub-Sample 2	15.90	17.00	-1.1	1.2100	16.45		-0.85	0.7225
Sub-Sample 3	16.70	17.90	-1.2	1.4400	17.3		0	0
Sub-Sample 4	16.50	17.10	-0.6	0.3600	16.8		-0.5	0.25
Sub-Sample 5	16.70	18.00	-1.3	1.6900	17.35		0.05	0.0025
				Lab Variation: Sqrt(sum((A-B)^2/4)	1.173669	Sampling Variation: Sqrt(sum(Diff^2/4)		0.499375
95% Confidence Total Error Band							+/- 2.50	



# Sensor Accuracy – SiCon % Water Field Data

## Field Validation

