Estimating Orifice Meter Flow Prediction Bias with Internal Diagnostics

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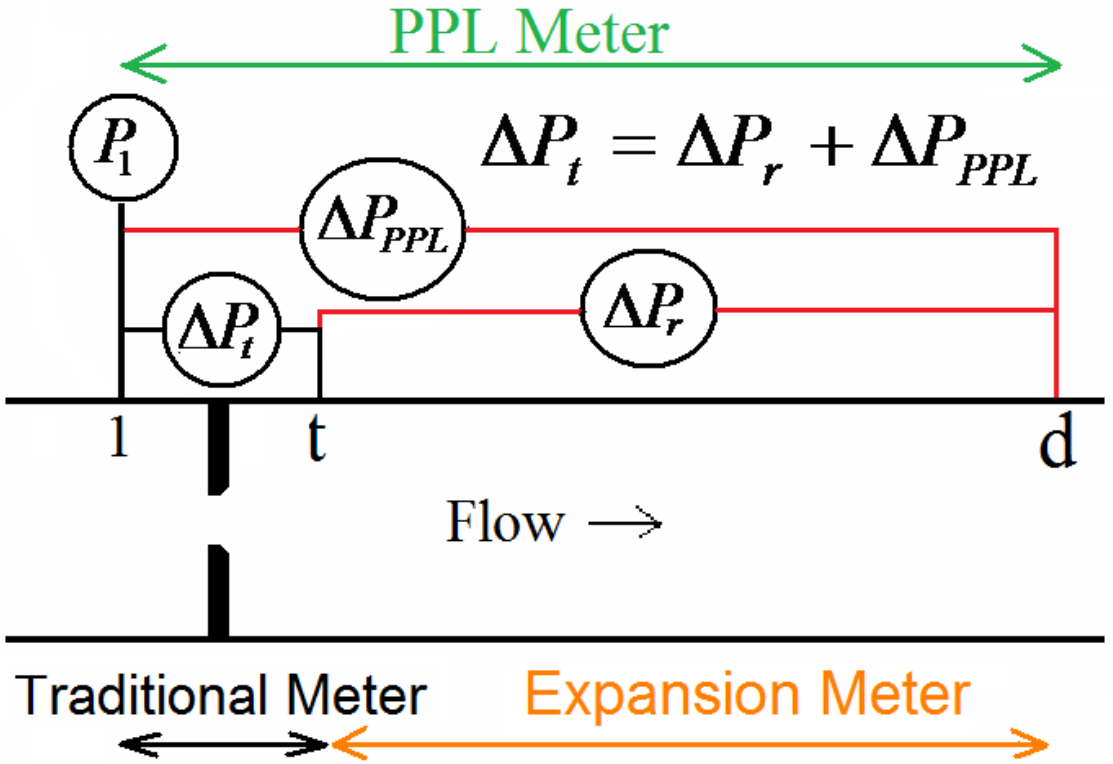
DP Diagnostics

DP DIAGNOSTICS

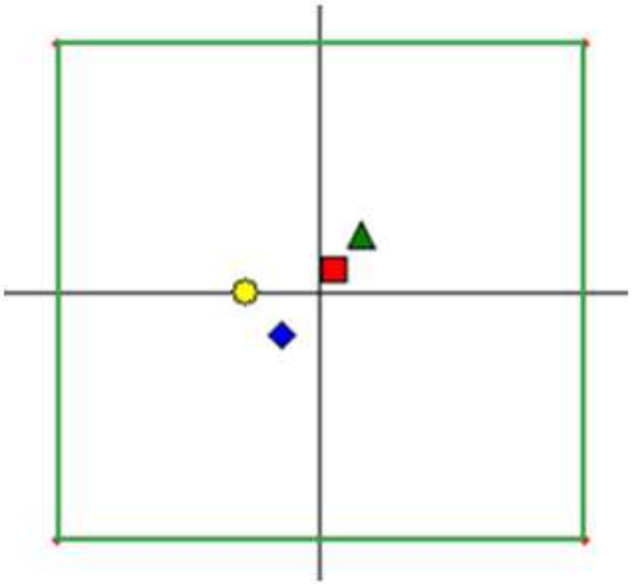
MONITOR, VERIFY, AND TRUST YOUR DP METER

Introduction

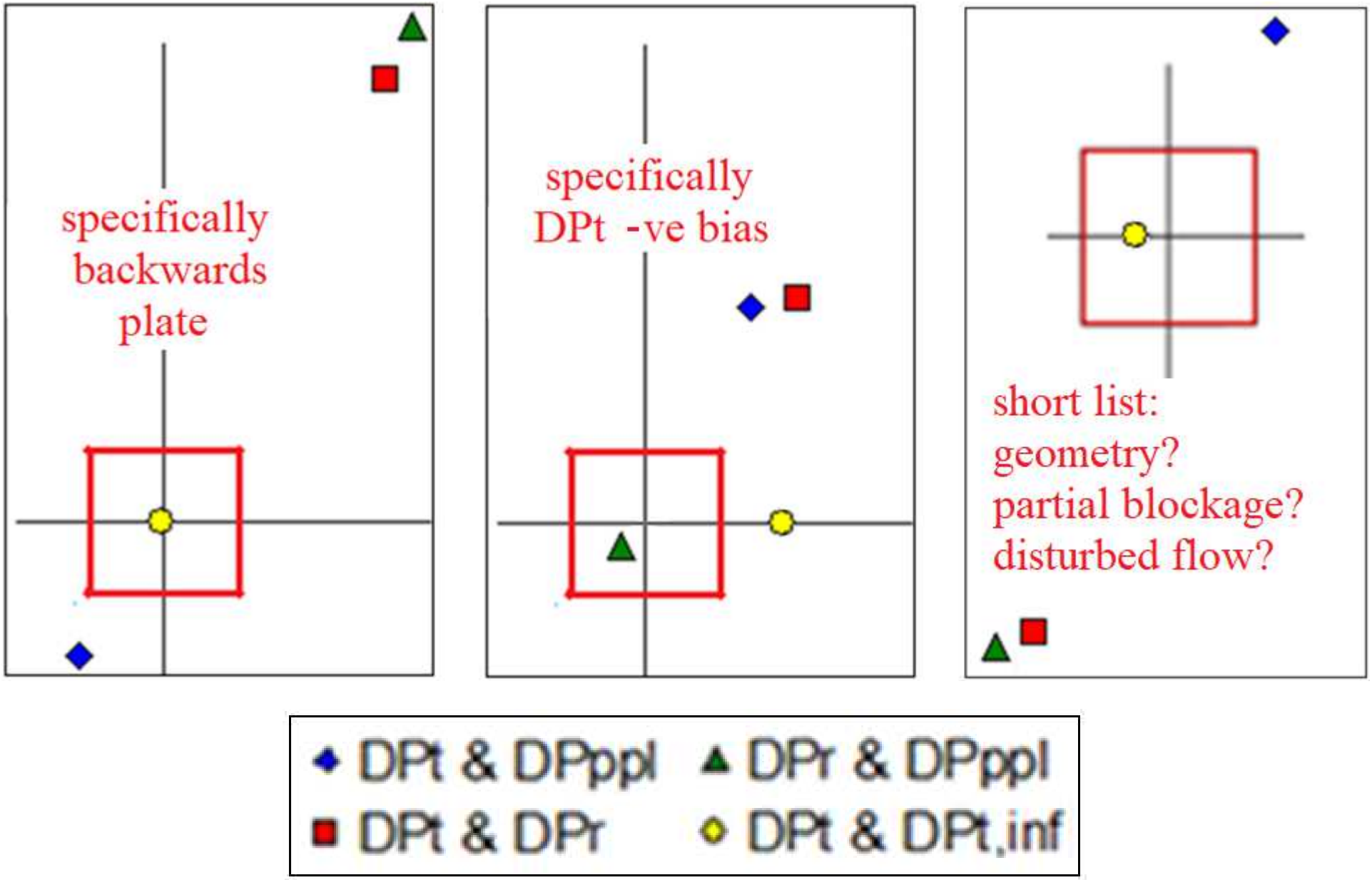
- Industry is used to flow meter diagnostic systems.
- State of the art isn't 'can you tell if *something is* wrong?', but 'can you identify *what* is wrong?'
- But as yet there is little development on also predicting the associated flow prediction bias.
- Why? That would obviously be useful.
- Achievable? Too complicated? A fools errand?
- Let's look at orifice meter diagnostics…



- 1 DP Integrity Check
- 3 Flow Rate Comparisons
- 3 DP Ratios
- 1 Parameter turbulence



Diagnostic Pattern Recognition



Can You Also Predict the Associated Flow Bias?

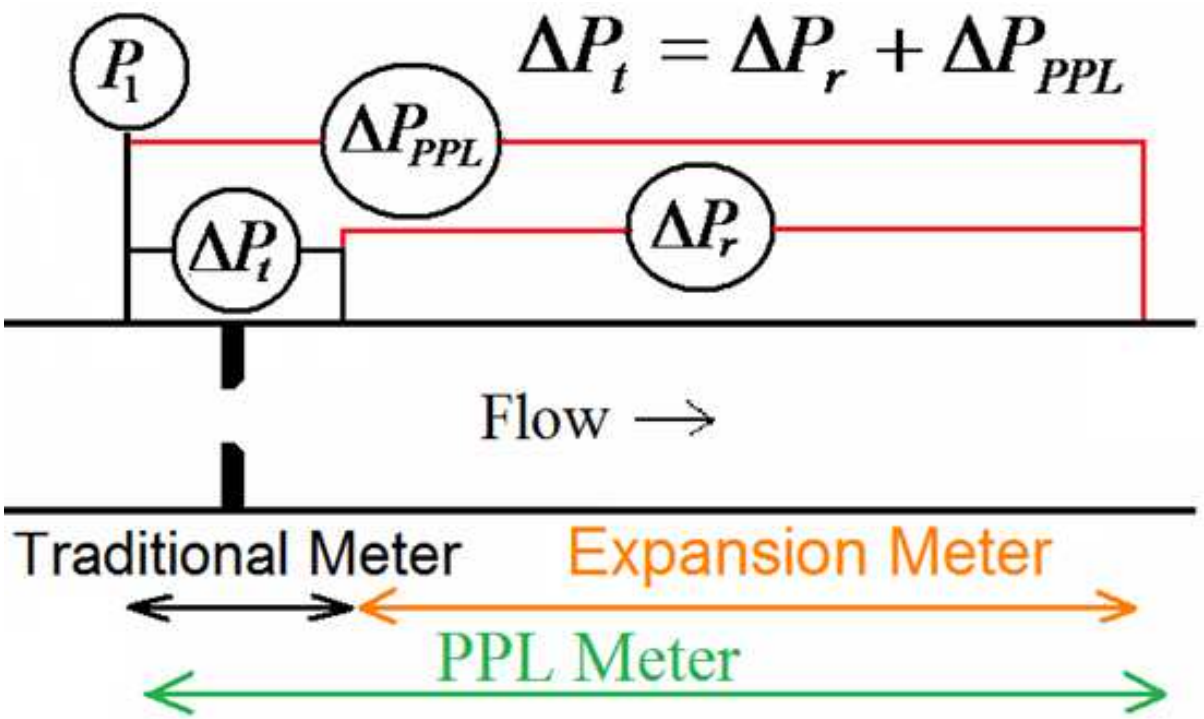
- In many malfunction cases: **YES**.

1. Use pattern recognition to identify the specific malfunction.
2. Select an **objective diagnostic** check to quantify the physical magnitude of that malfunction.
3. Apply this quantified magnitude to a known maths relationship between the malfunction's magnitude & flow bias.

An '***objective***' diagnostic check!?

The Nature of Diagnostic Tests

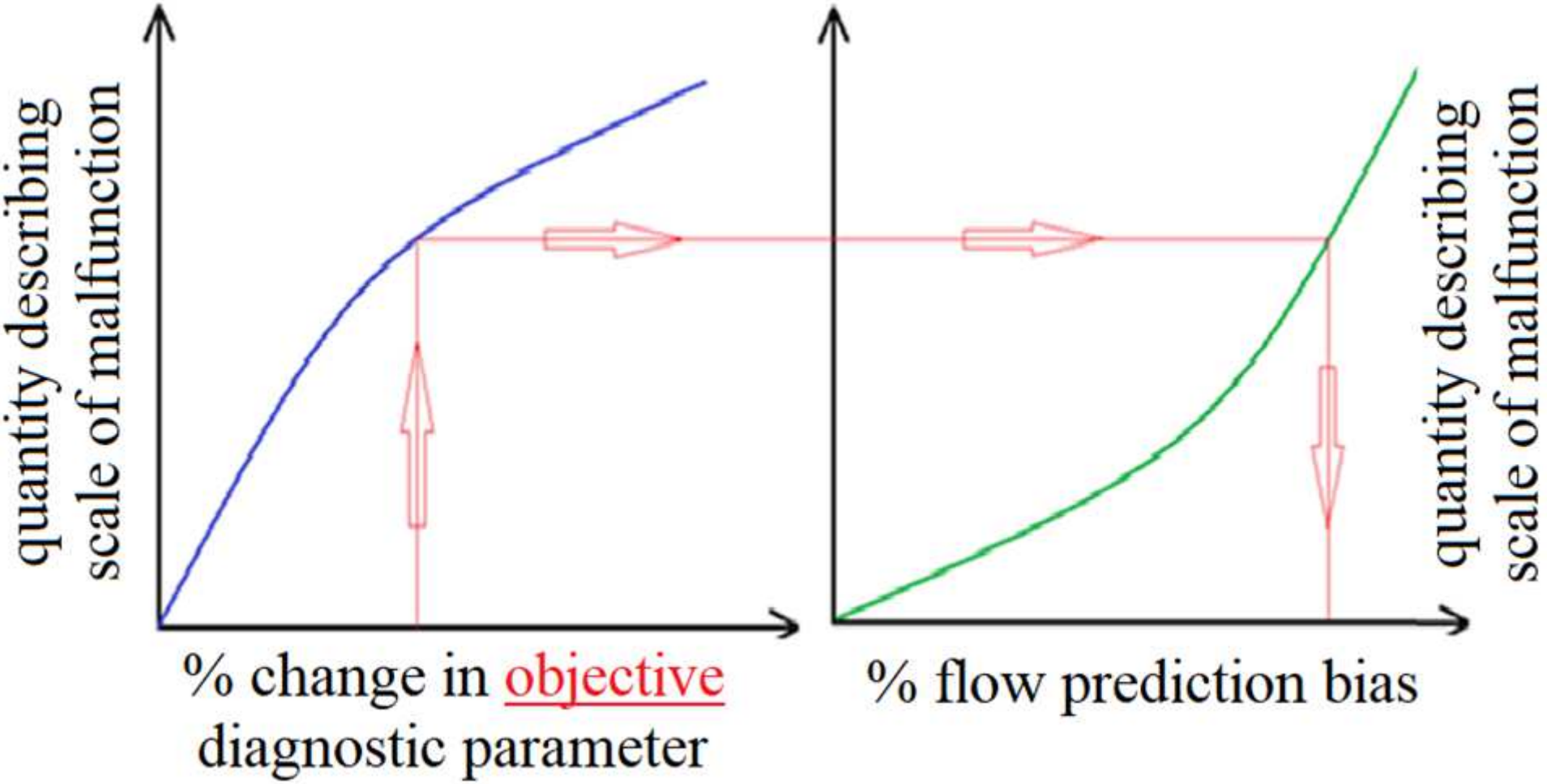
- *To learn more from diagnostic suites we first need to learn more about diagnostic suites.*
- There are two distinct types of diagnostic tests:
  - *Objective* diagnostic: from comparison with physical law, fixed baseline, produce a *quantitative result*.
  - *Subjective* diagnostic: **not** from physical law, but experience / opinion / rule of thumb, no fixed baseline thereby producing a *qualitative result*.
- *Only* objective diagnostics can ***quantify*** malfunction magnitudes and flow prediction biases.



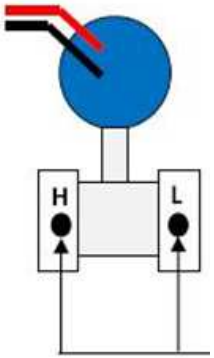
Diagnostic Check	Diagnostic Type
1st Mass Flow Comparison (x_1)	objective
2nd Mass Flow Comparison (x_2)	objective
3rd Mass Flow Comparison (x_3)	objective
PLR Shift (y_1)	objective
PRR Shift (y_2)	objective
RPR Shift (y_3)	objective
DP Integrity Check(x_4)	objective
DP & Parameter Std. Dev.	subjective

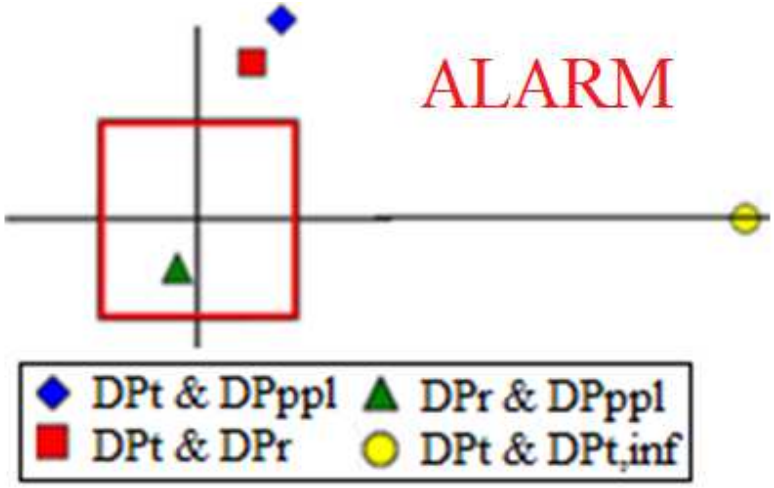
The Method…

Once the diagnostic pattern identifies a specific malfunction, and an objective check is selected:



Example 1: DP Reading Bias

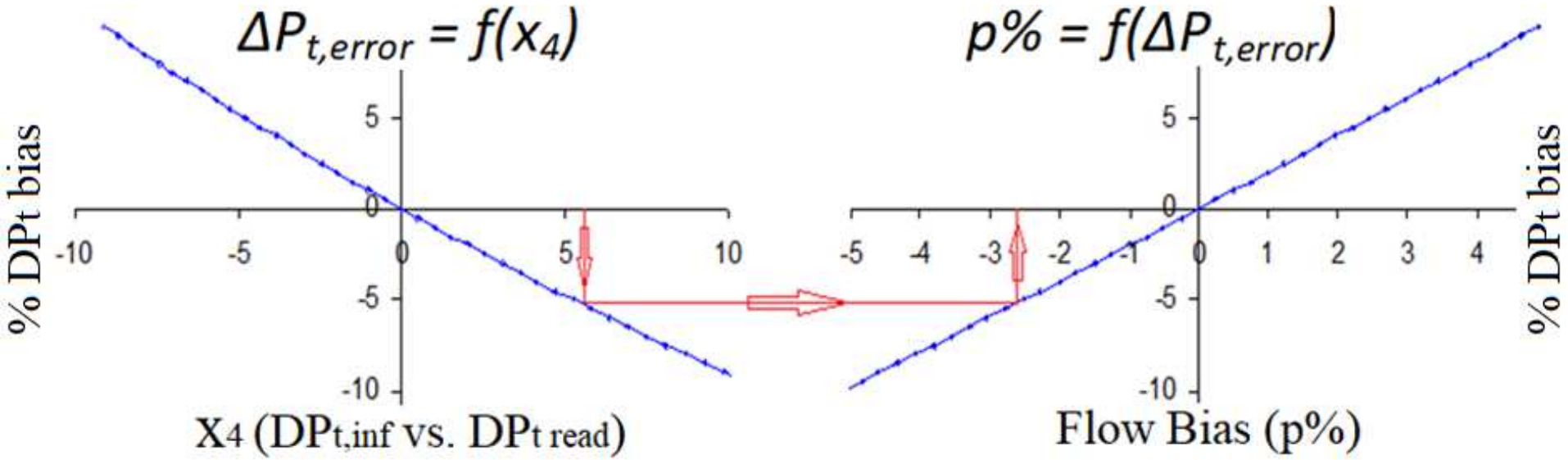




1. Pattern : -ve DP_t error
2. Objective diagnostic x_4:
3. Magnitude:

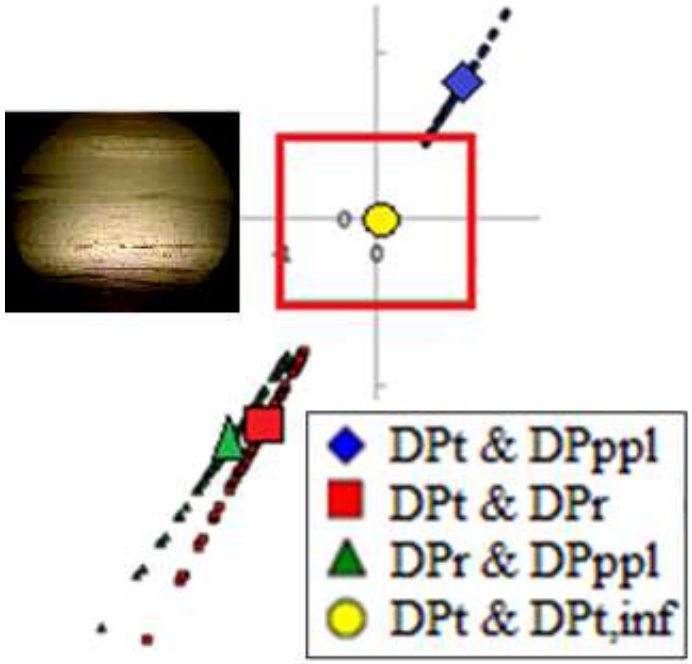
$$\Delta DP_{t,error} = \Delta DP_{t,read} - (DP_r + DP_{PPL})$$

4. Flow bias: $p\% = f(\Delta DP_{t,error})$

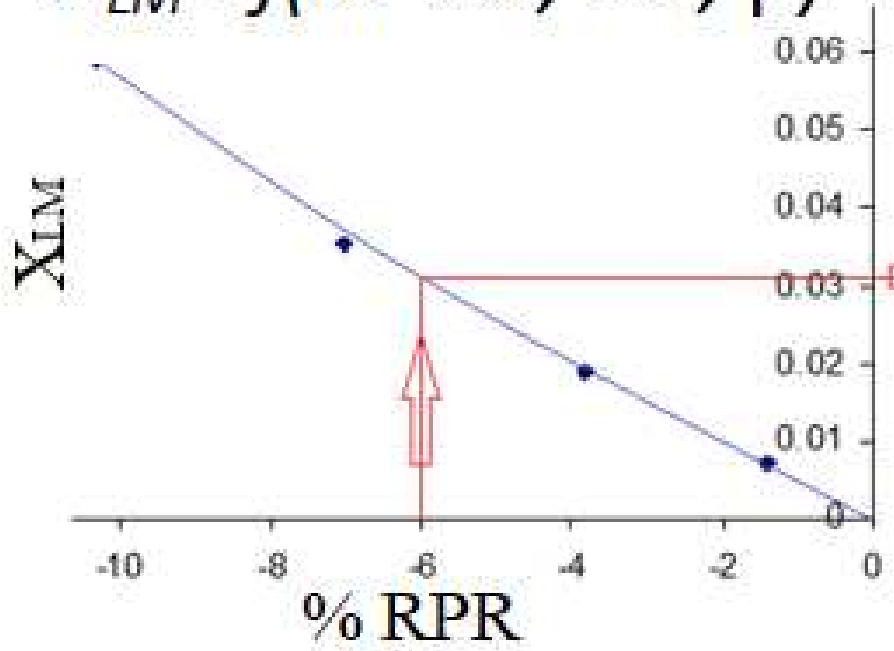


Example 2: Wet Gas Flow

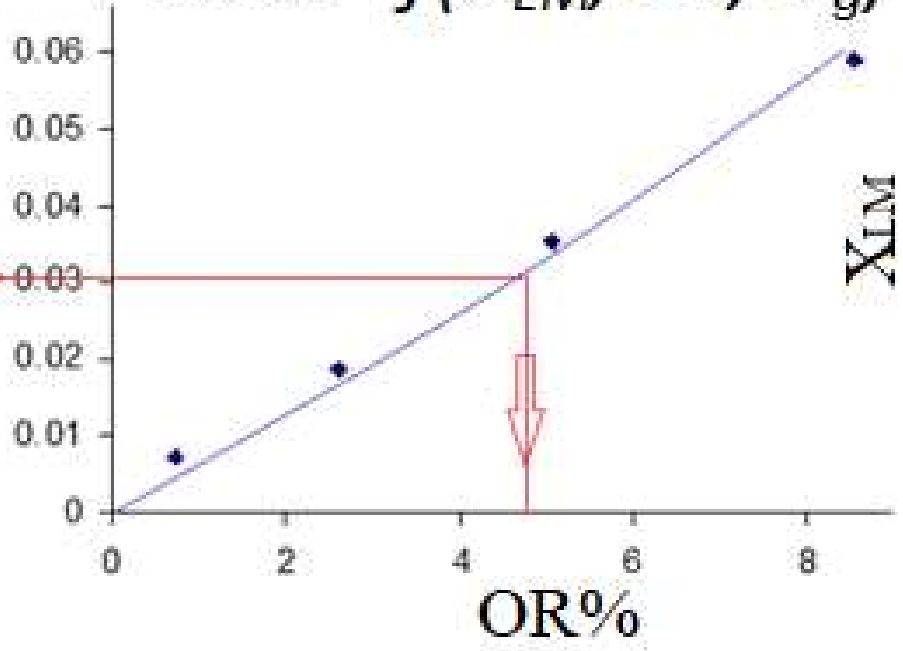
1. Pattern : Wet Gas
2. Objective diagnostic RPR (y_3):
3. Magnitude: $X_{LM} = f(RPR, DR, \beta)$
4. Flow Bias: $OR\% = f(X_{LM}, DR, Fr_g)$



$X_{LM} = f(RPR\%, DR, \beta)$

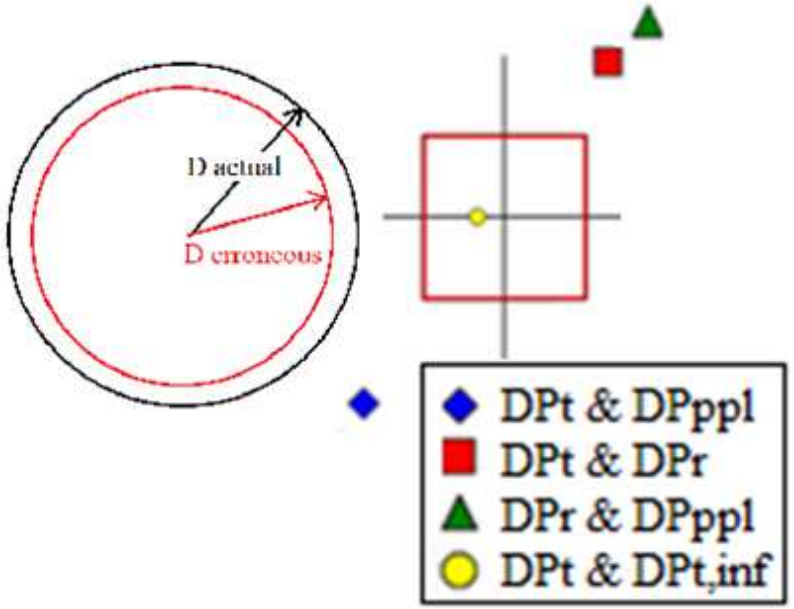


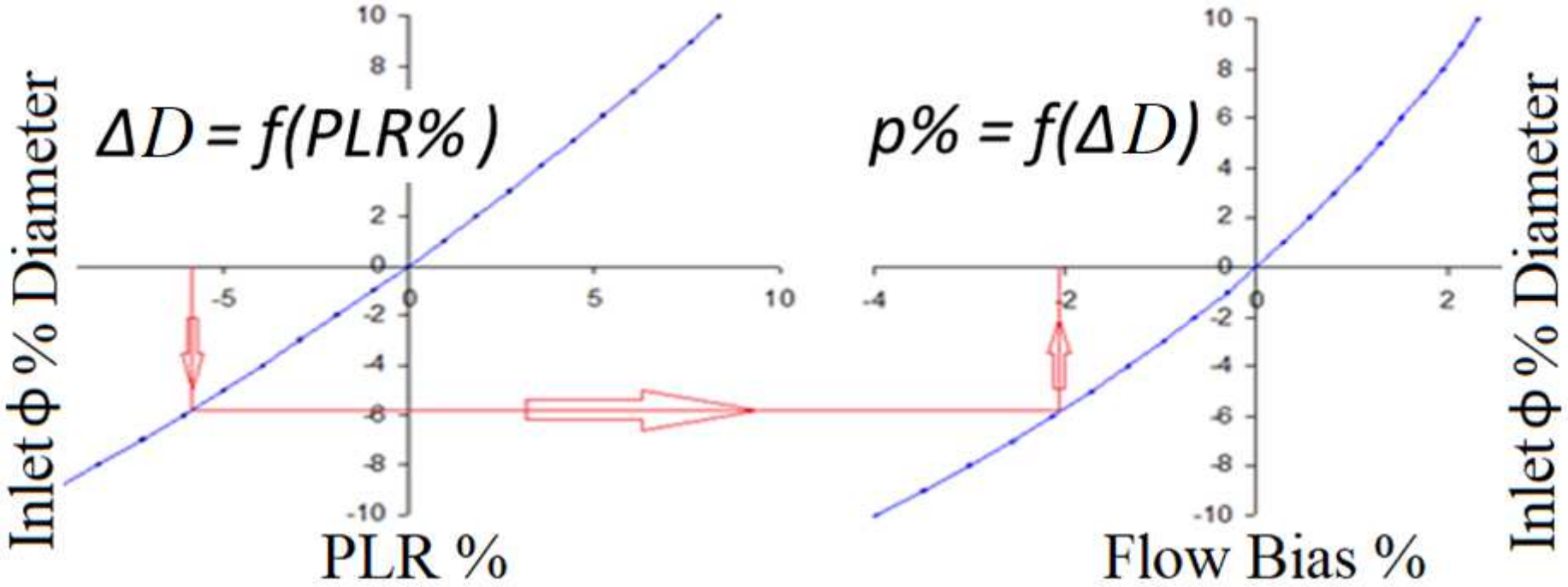
$OR\% = f(X_{LM}, DR, Fr_g)$



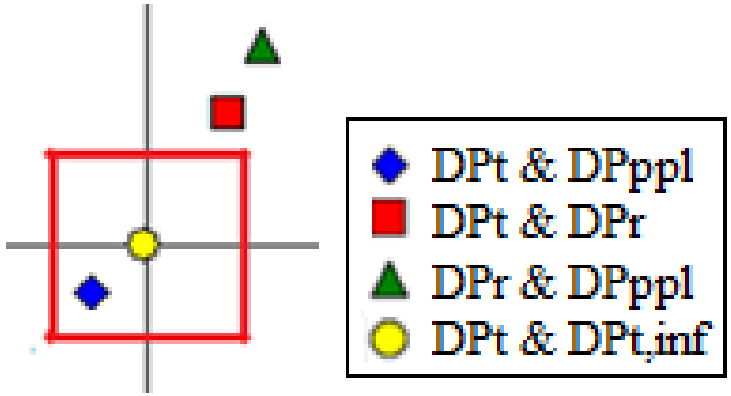
Ex 3: Incorrect Geometry

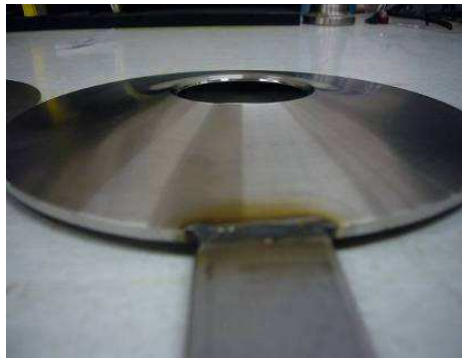
1. Pattern: *includes* 'low inlet diameter keypad entry'.
2. Objective diagnostic PLR(y_1):
3. Magnitude: $\Delta D = f(\Delta\beta) = f(PLR\%)$
4. Calculate: $p\% = f(\Delta D)$

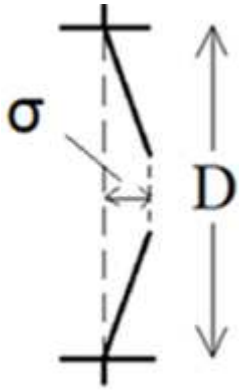




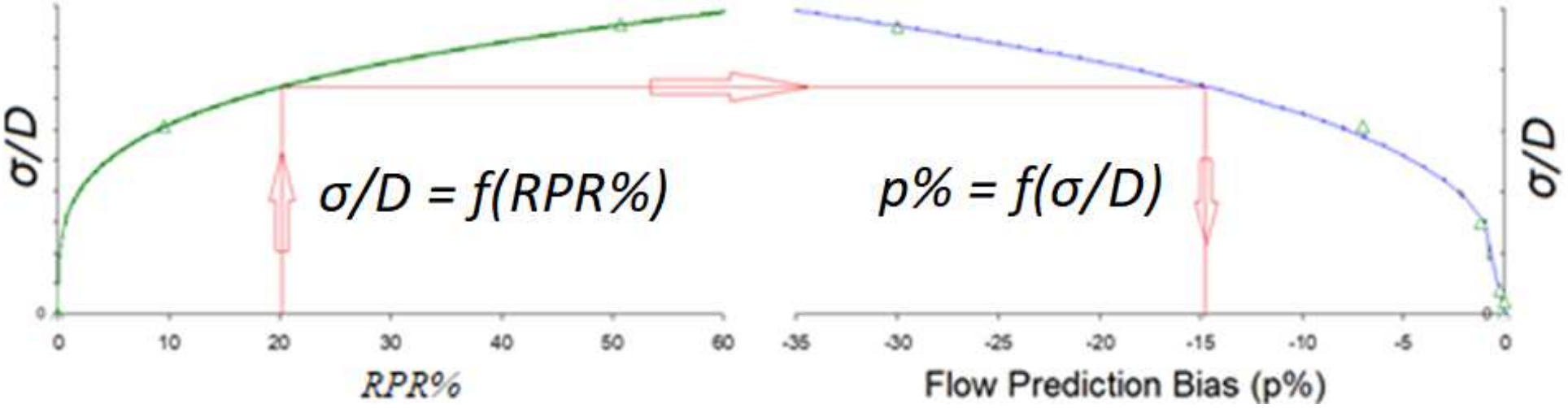
Ex 4: Buckled Plate







1. Pattern: *includes* 'buckled'
2. Objective diagnostic RPR(y_3):
3. Magnitude: $\sigma/D = f(RPR\%)$
4. Calculate $p\% = f(\sigma/D, \beta)$

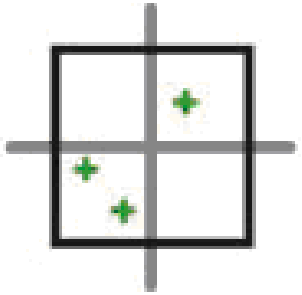


Conclusions

- It's possible to develop flow meter diagnostics to:
  - See a problem exists
  - Identify or short list many specific problems
  - Use *objective* diagnostic results to quantify that specific problem, and from there
  - Predict the associated flow prediction bias.
- The DP meter method won't work for ***all*** problems ***all*** of the time, but it works for ***most*** common problems ***most*** of the time.
- Such an orifice, Venturi and cone meter system is in advanced development.

Thank You

Questions?



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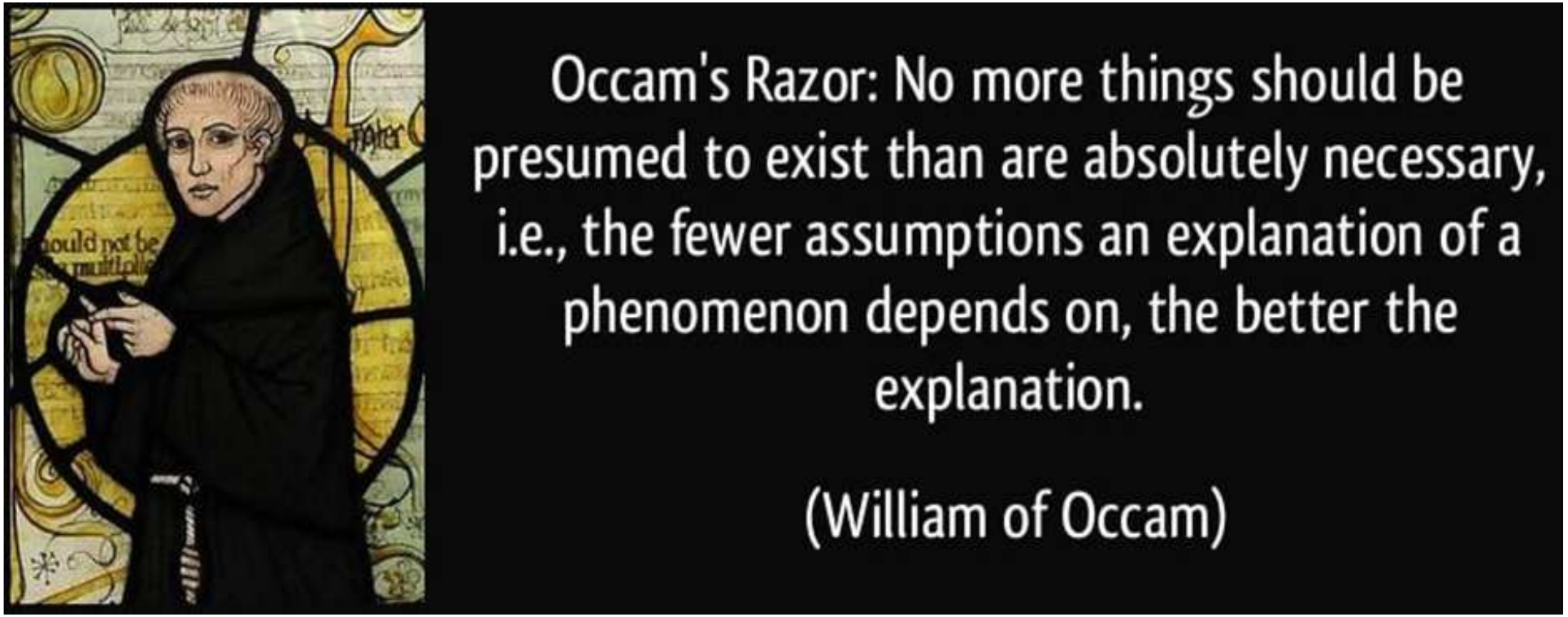
How Do You Know the Problem Isn't a Combination of Multiple Malfunctions!?

- You don't. Get over it. Most times it's single source.



A Final Word on Flow Meter Diagnostics

- Flow prediction: very high standard, usually '2σ', say '*beyond reasonable doubt*'.

- Diagnostics: best effort, '*balance of probabilities*', say '*the preponderance of evidence*', i.e. choosing the possibility that is more probable than the other.

- Diagnostic systems are not perfect. *But a technology does not need to work perfectly all of the time to be of practical use most of the time*.

Can:

- DP transmitter issues (saturated, drift, bad cal)
- Blocked impulse line
- Backwards plate
- Worn edge
- Buckled plate
- Wrong geometry (Inlet & orifice bore)
- Wet gas

Cannnot yet:

- Disturbed flow
- Contamination
- Partially blocked orifice