



# Kuwait 4th Flow Measurement Technology Conference

3-5 December 2019  
Hilton Kuwait Resort



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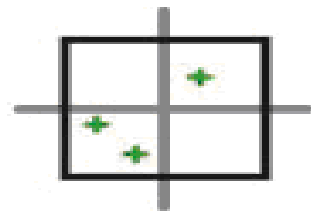


**MR. KIM LEWIS**

**DP Diagnostics**

# An Orifice Meter Verification System

Kim Lewis  
DP Diagnostics



**DP DIAGNOSTICS**

**MONITOR, VERIFY, AND TRUST YOUR DP METER**

# Introduction



- ⑩ Orifice meters are simple, relatively inexpensive, reliable and don't require calibration.
- ⑩ One orifice meter development is an automated validation tool (powered by a diagnostic suite).
- ⑩ A validation system is desirable for several reasons:
  - ⑩ verifies performance reducing exposure to error
  - ⑩ allows CBM instead of RSM
  - ⑩ avoids unnecessary exposure to danger
  - ⑩ makes technicians far more efficient

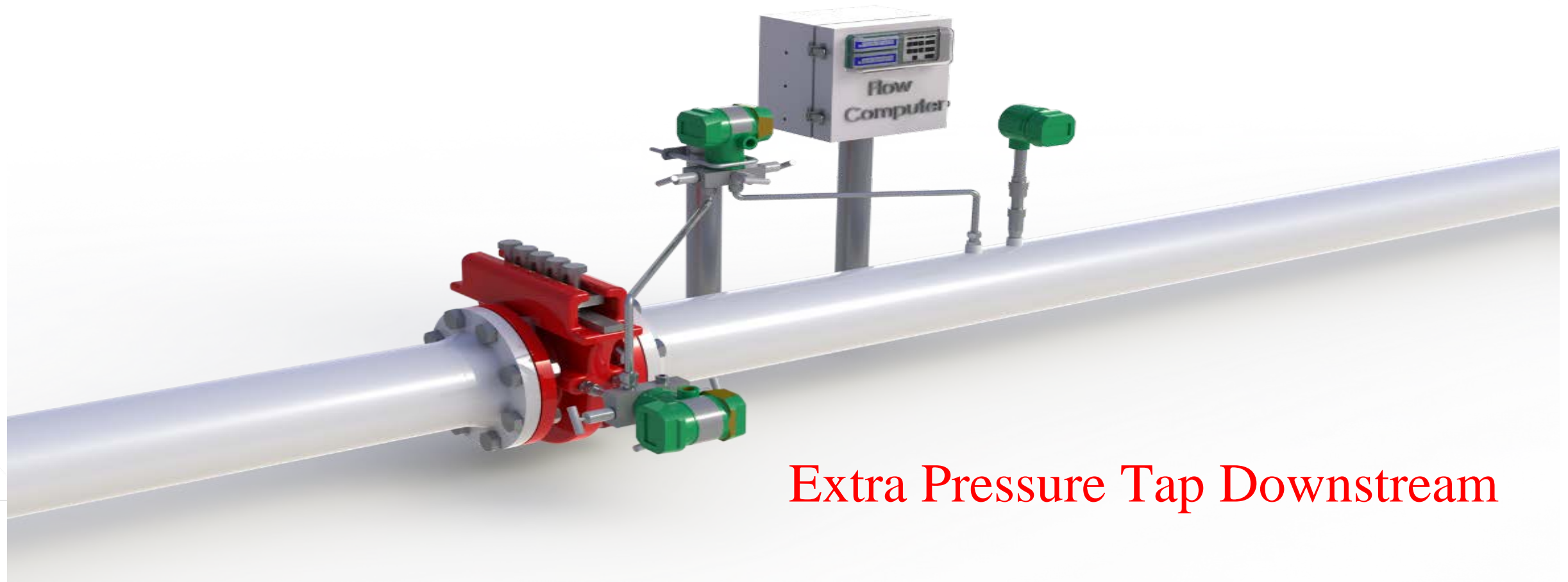
# Orifice Meter Correct Performance (API 14.3)



- ⑩ A verification system checks performance so as the meter's uncertainty statement is known to be true.

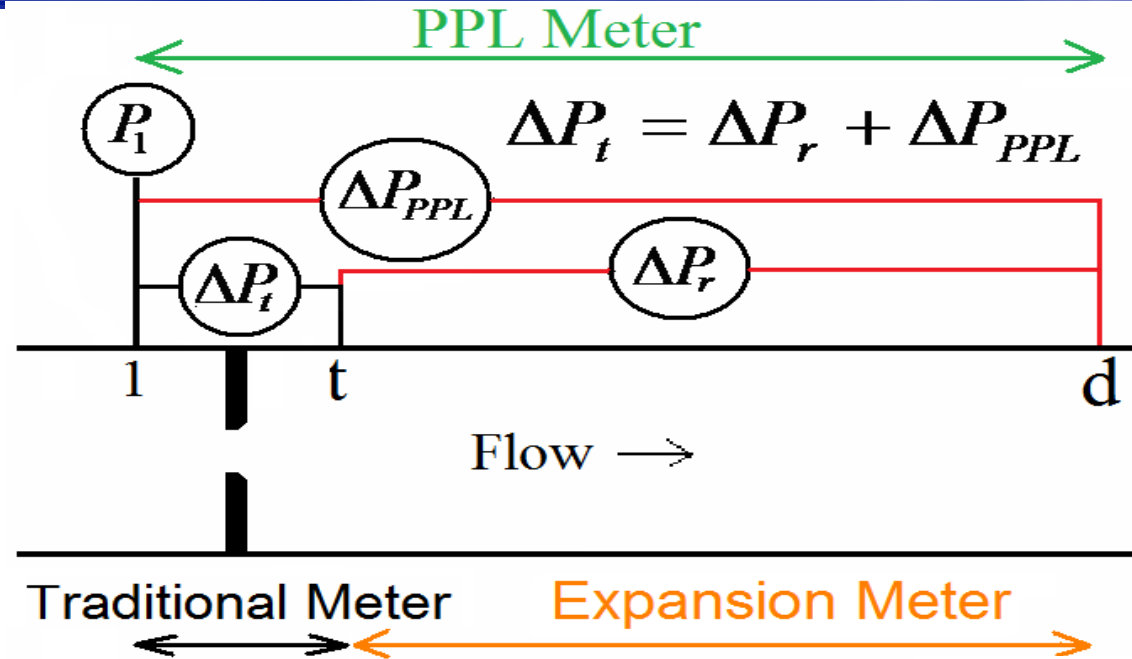
	Parameter	Uncert %	S	$(U95 \cdot S)^2$
Discharge Coefficient	Cd	0.44	1	0.1936
Expansibility	Y	0.03	1	0.0009
Orifice Diameter	d	0.05	2.13	0.0114
Inlet Diameter	D	0.25	-0.13	0.0011
Differential Pressure	DP	0.5	0.5	0.0625
Inlet Pressure	P	0.5	0.5	0.0625
Compressibility	Z	0.1	-0.5	0.0025
Temperature	T	0.25	-0.5	0.0156
Relative Density	RD	0.6	0.5	0.0900
			sum of squares:	0.4401
			% orifice meter uncertainty:	<b>0.663</b>

# The Orifice Meter 'Prognosis' Methodology

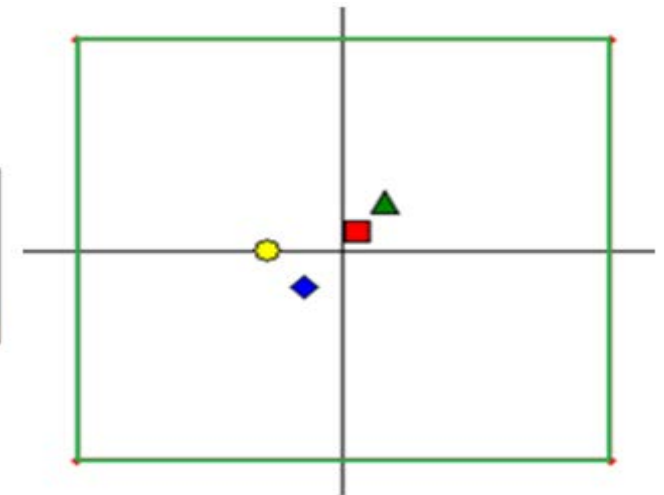
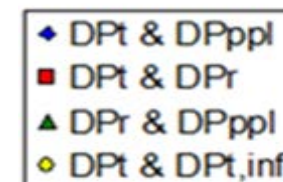


Extra Pressure Tap Downstream

# The Orifice Meter 'Prognosis' Methodology

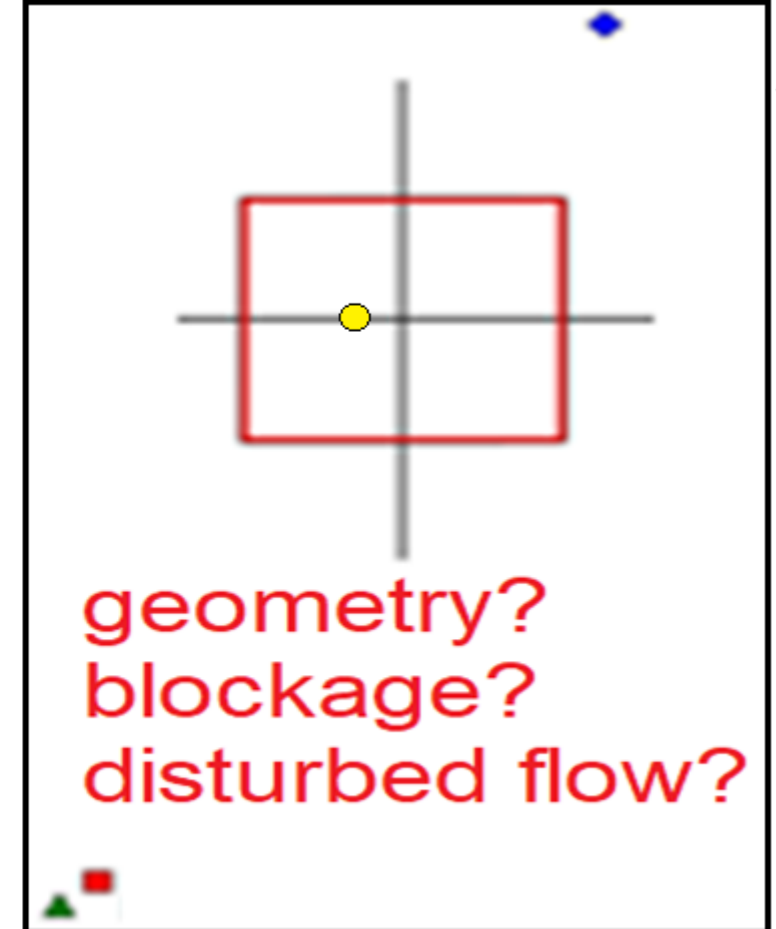
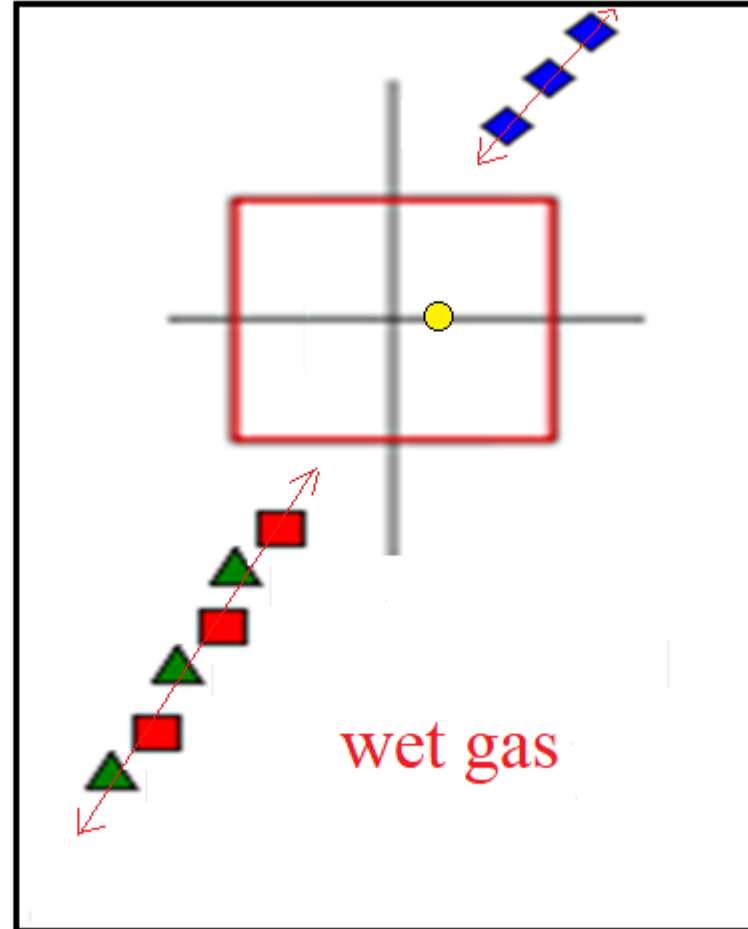
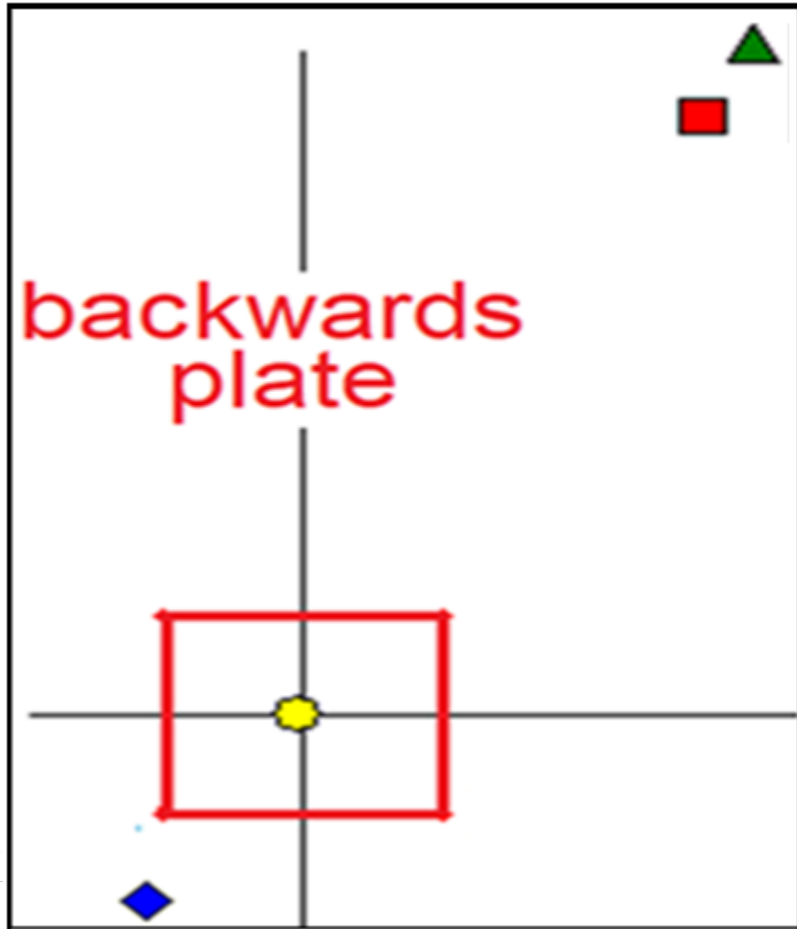


- 1 DP Integrity Check
- 3 Flow Rate Comparisons
- 3 Read vs. Baseline DP Ratios
- Turbulence Diagnostics



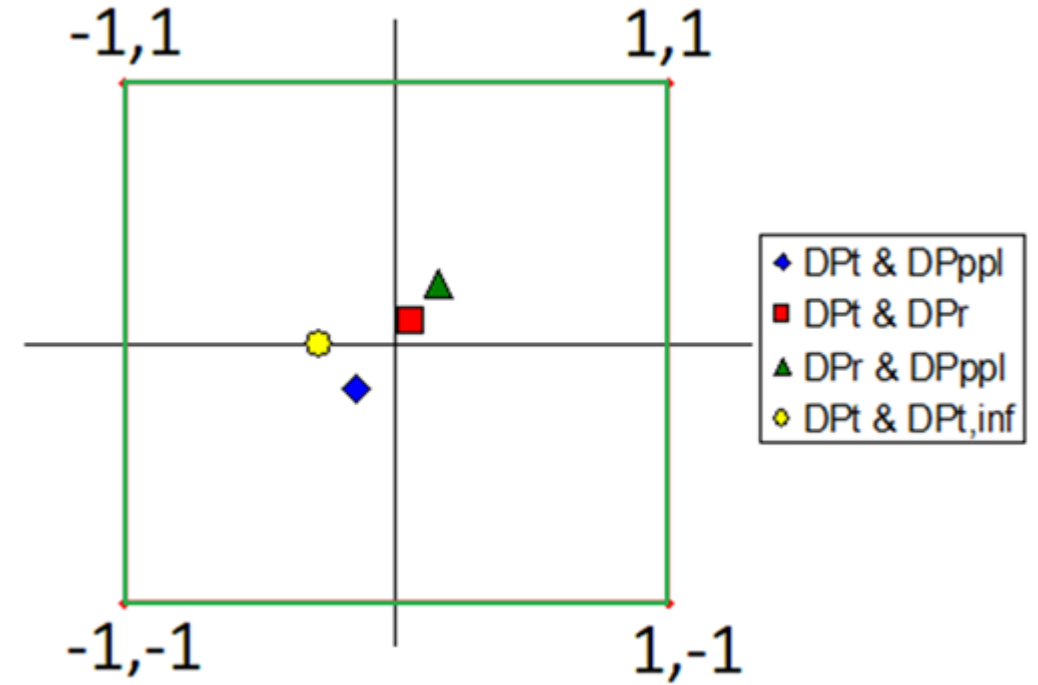


# Pattern Recognition

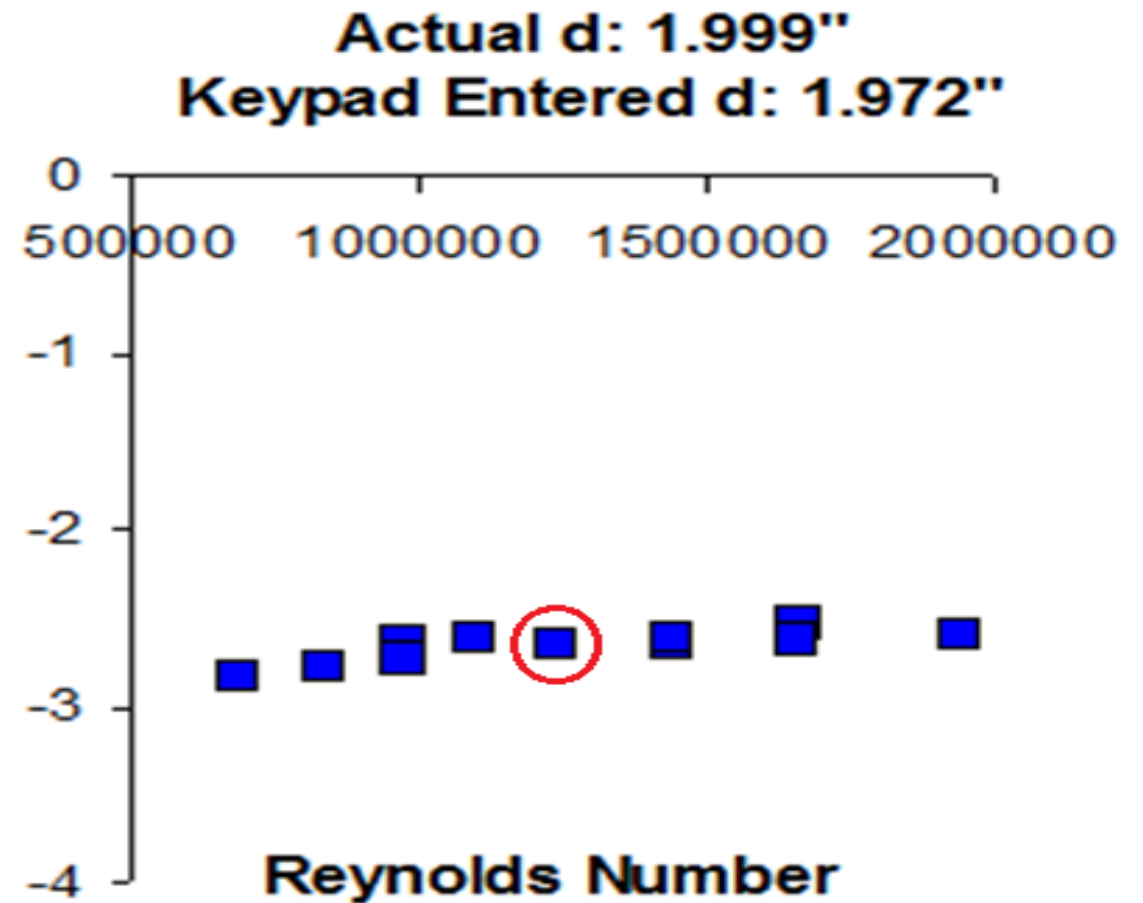
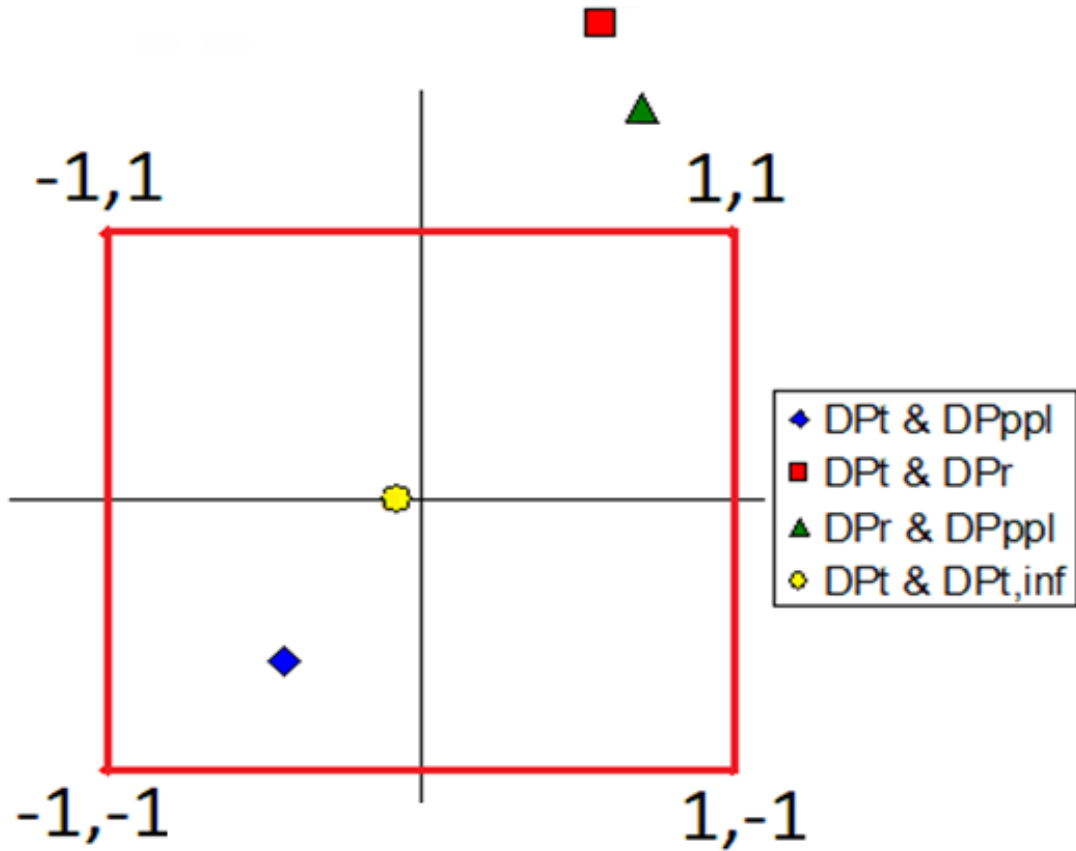


- ◆ DPt & DPppl
- ▲ DPr & DPppl
- DPt & DPr
- DPt & DPt,inf

# 4", 0.5 $\beta$ Paddle Plate Orifice Meter Test

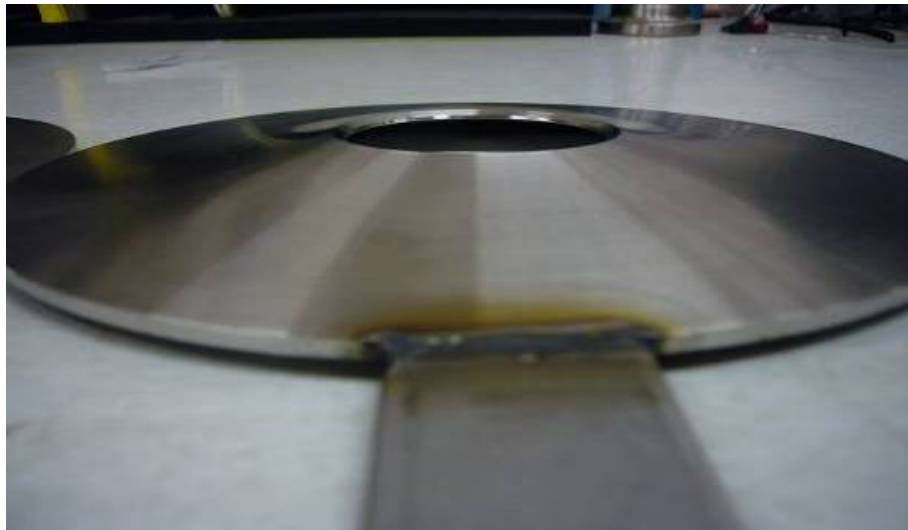


# 4", 0.5 $\beta$ Meter with Orifice Bore Keypad Entry Error

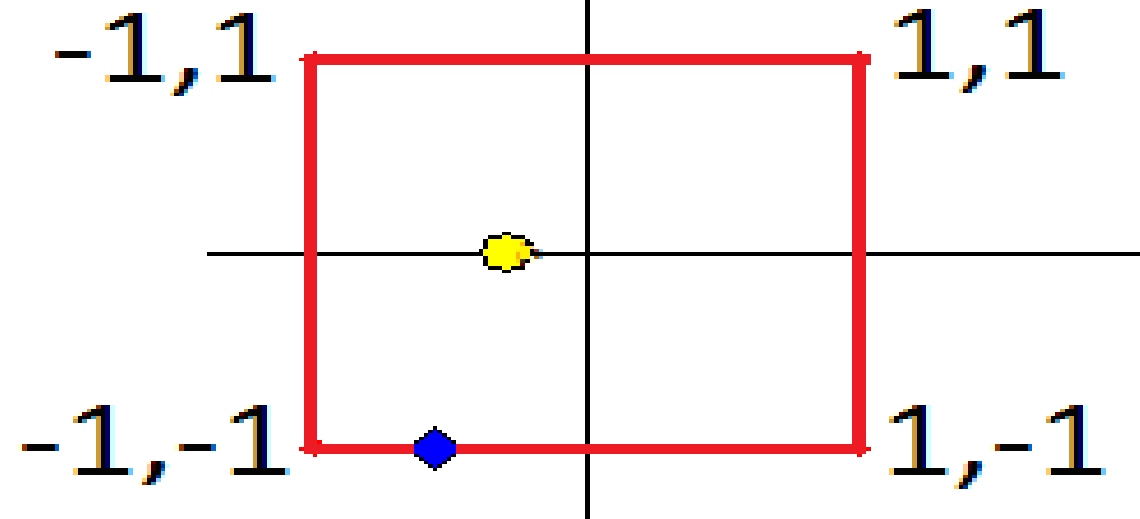
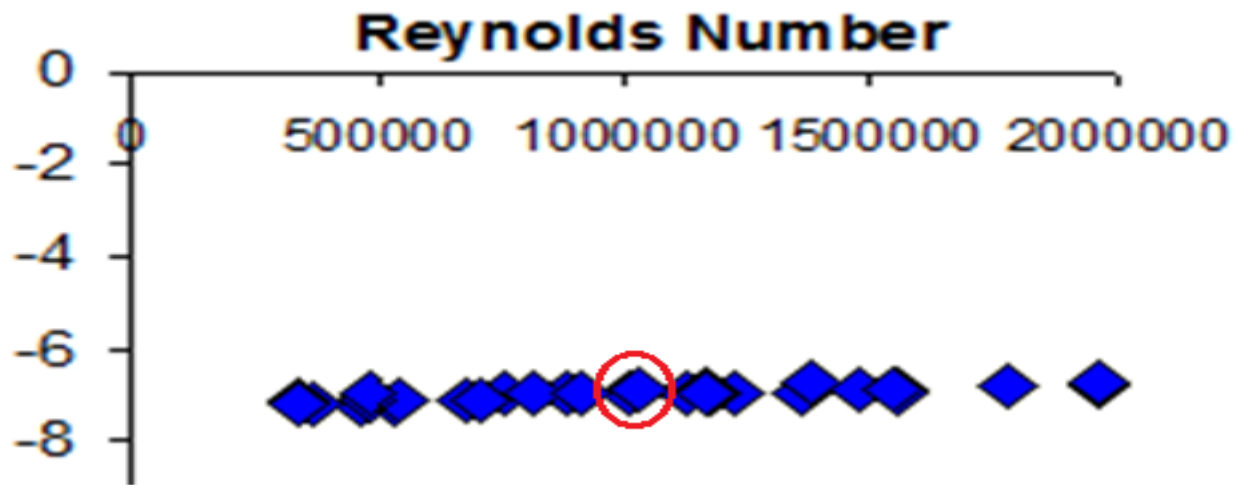


-2.6% bias > -\$28.5K / quarter

# 4", 0.5 $\beta$ Orifice Meter Buckled Plate

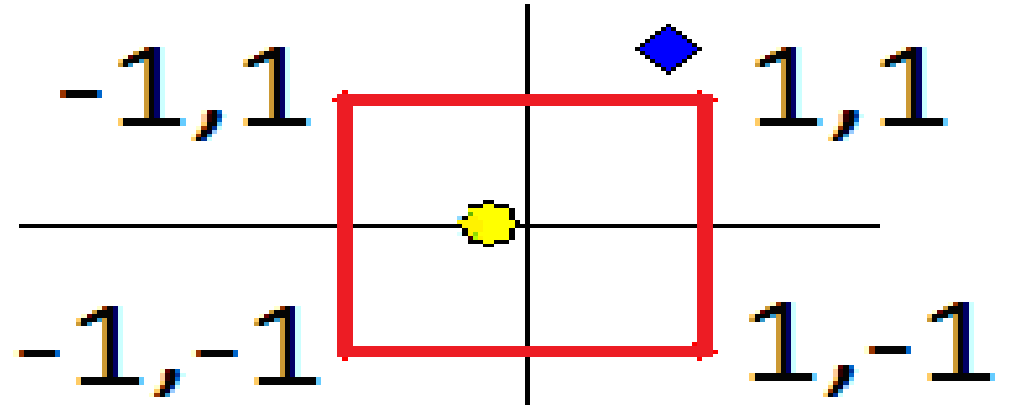
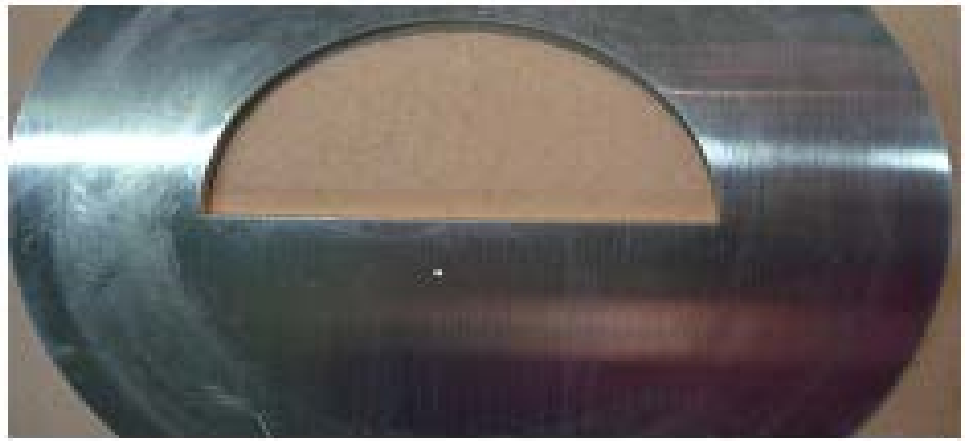


- ◆ DPt & DPppl
- DPt & DPr
- ▲ DPr & DPppl
- DPt & DPt,inf

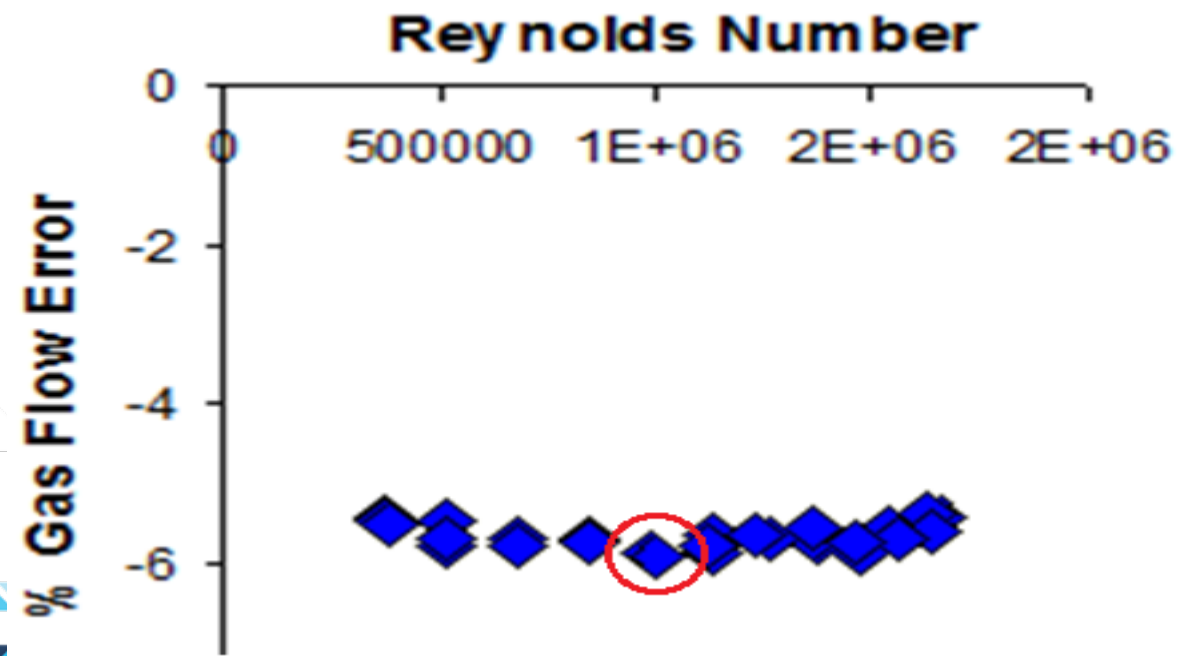


-7% bias > -\$57K / quarter

# Disturbed Flow: 4", 0.5β Meter (HMOP at 2D upstream)

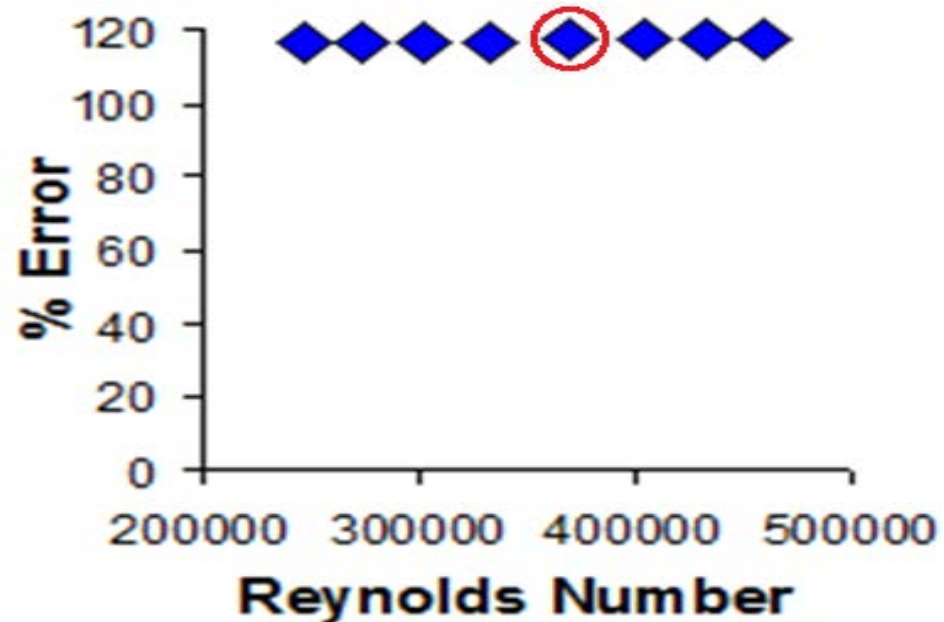
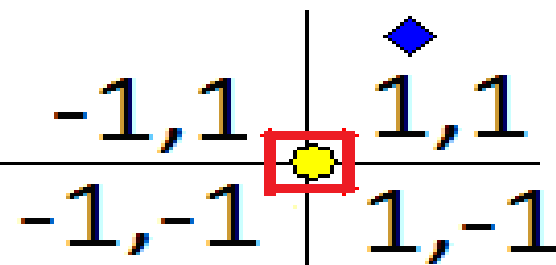


- ◆ DPt & DPppl
- DPt & DPr
- ▲ DPr & DPppl
- ★ DPt & DPt,inf



-5.8% > -\$47K / quarter

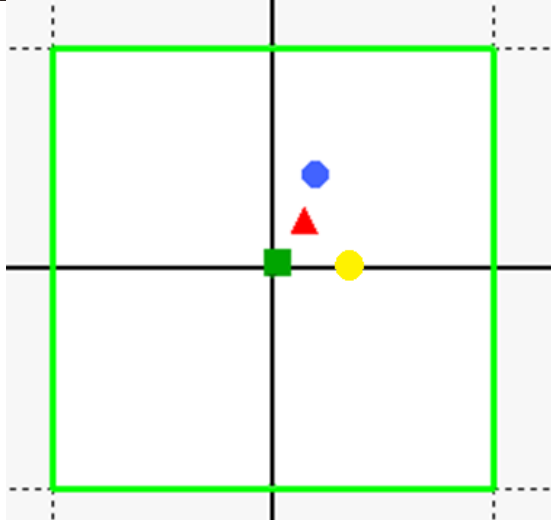
# 4", 0.4 $\beta$ Orifice Meter with Trapped Debris



- ◆ D<sub>Pt</sub> & D<sub>Pppl</sub>
- D<sub>Pt</sub> & D<sub>Pr</sub>
- ▲ D<sub>Pr</sub> & D<sub>Pppl</sub>
- ◆ D<sub>Pt</sub> & D<sub>Pt,inf</sub>

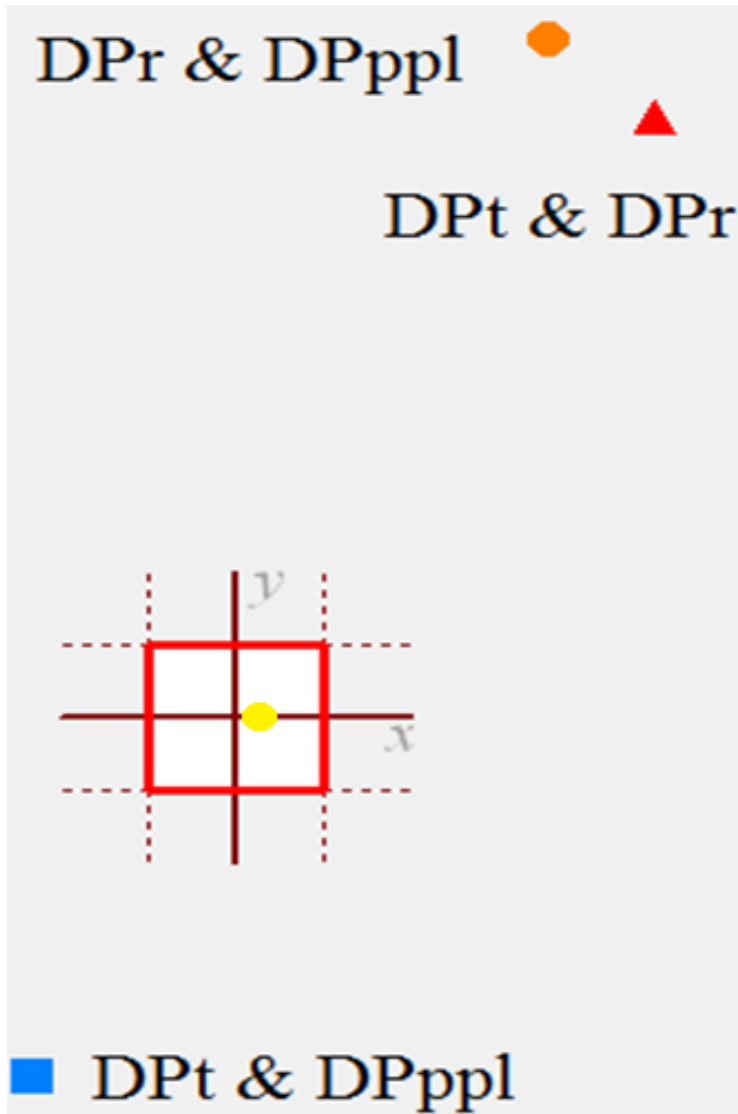
+118% > +\$1e6 / quarter

# Central Area Transmission System, UK



Pipe ID 13.738", 0.596  $\beta$   
201.5 MMSCFD  $\approx$  \$518K/day

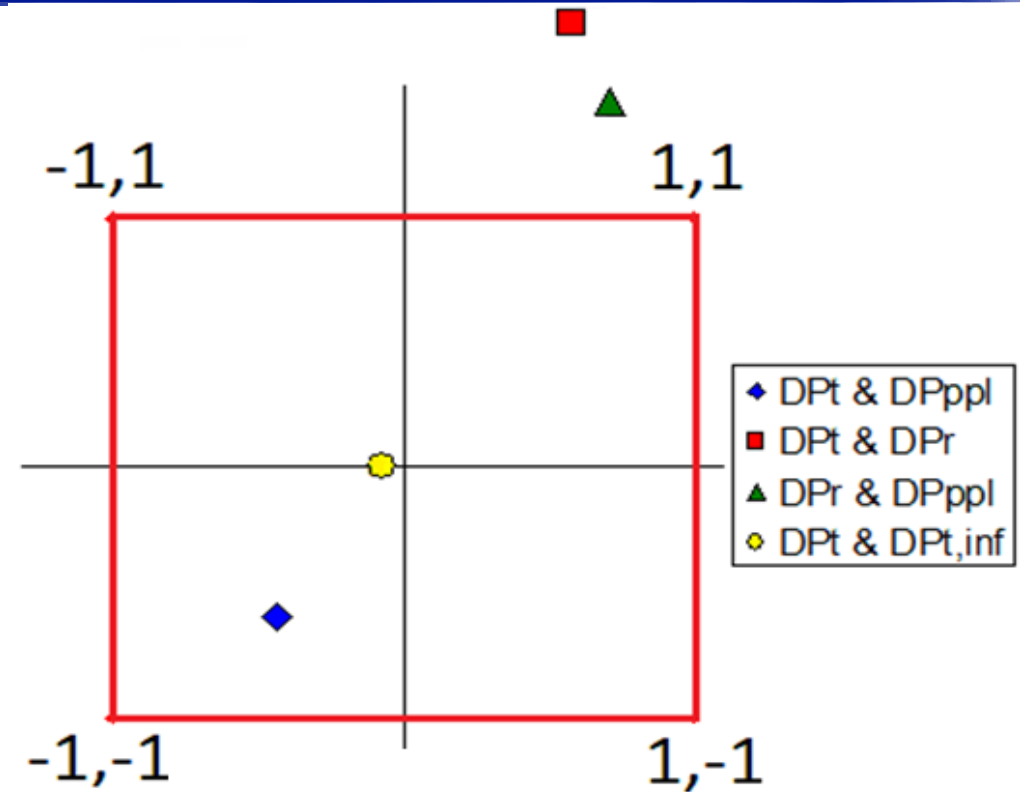
# CATS Reversed Orifice Plate Test



-15% > -\\$77K/day  
or > -\\$6.9 million / quarter

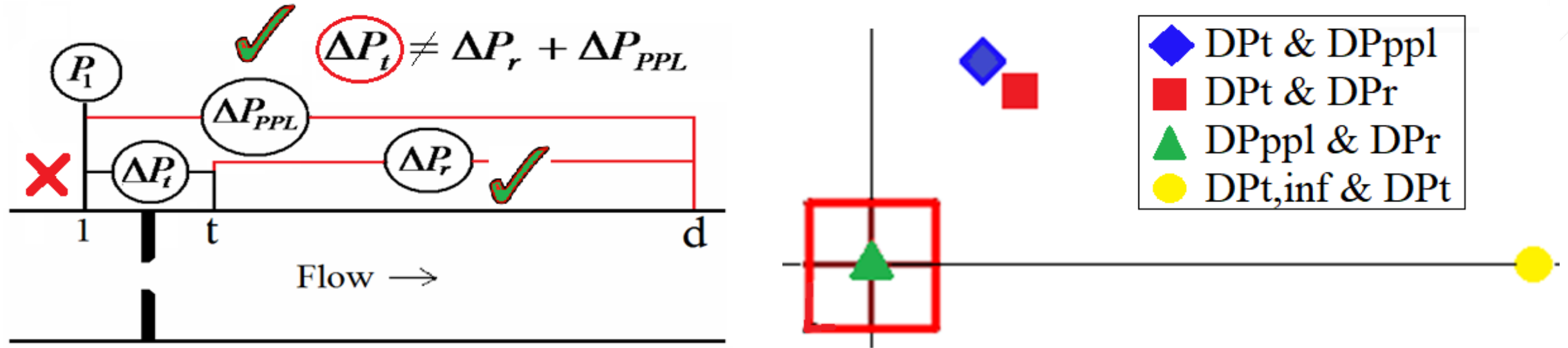


# CATS - Worn Orifice Edge Test



⑩ Plate deliberately worn, -2% error induced  
-2% > -\$910K / quarter

# CATS - Saturated DP Transmitter Test

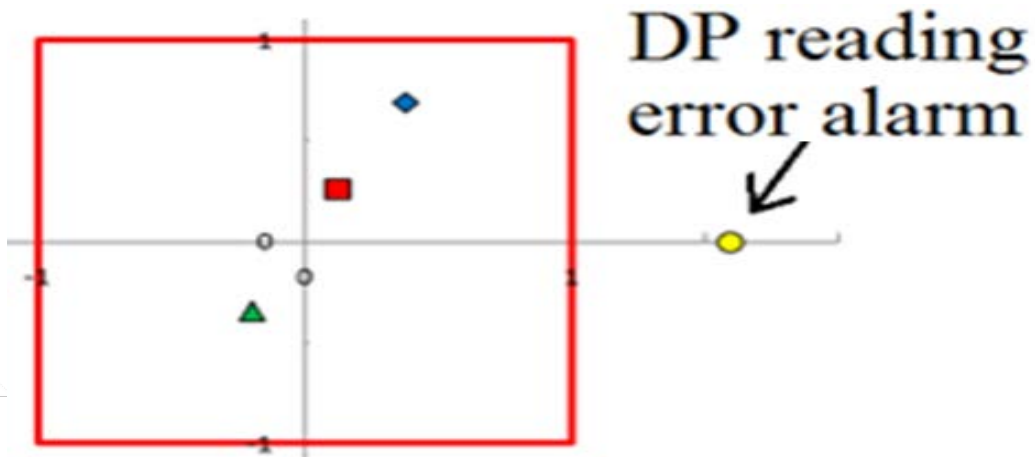


Tradition DP transmitter Spanned **15.0**kPa

$DP_t = 17.5$  kPa,  $DP_r = 6.2$  kPa,  $DP_{PPL} = 11.3$  kPa

-8% flowrate bias, > \$3.5 million

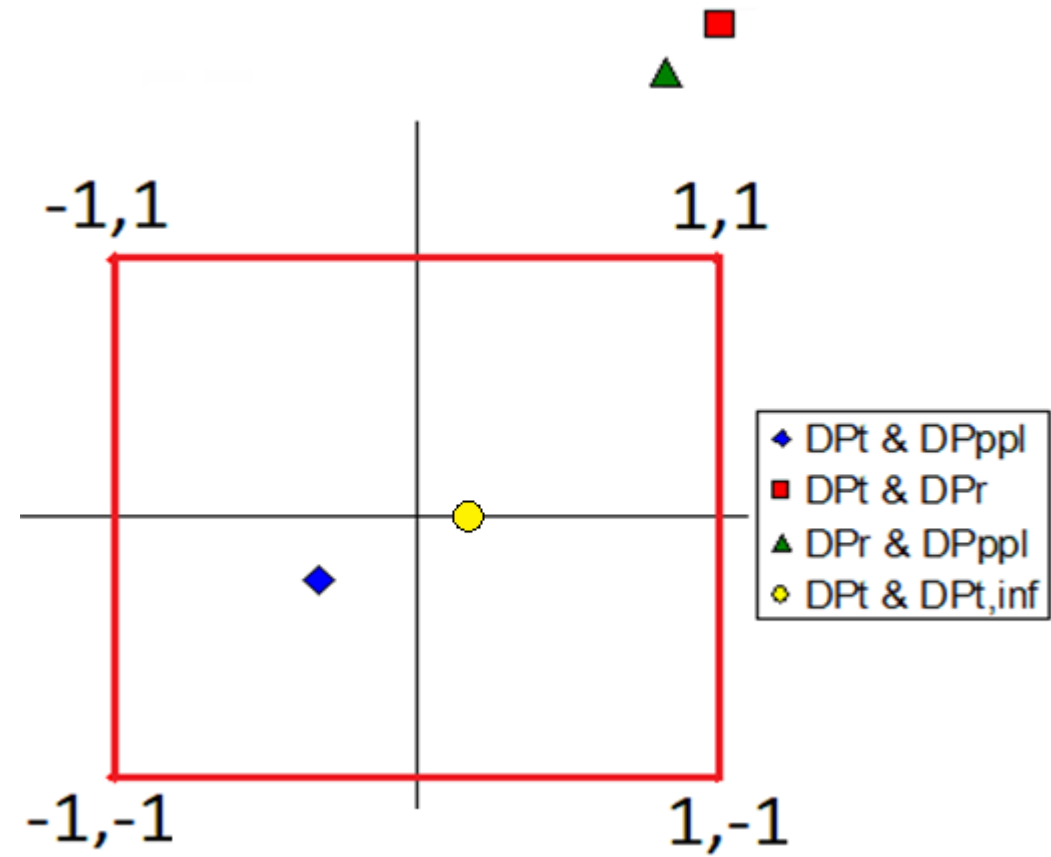
# Field Ex 1: 12" Sales Orifice Meter to Power Station



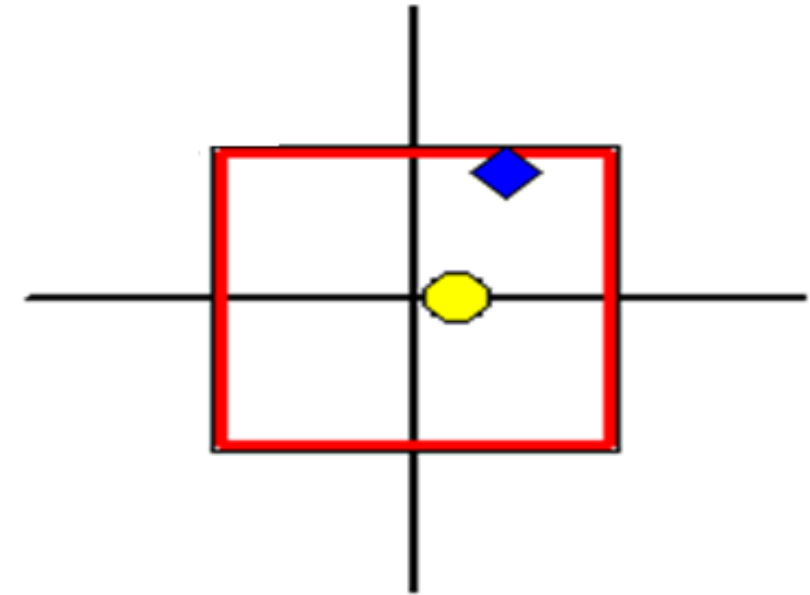
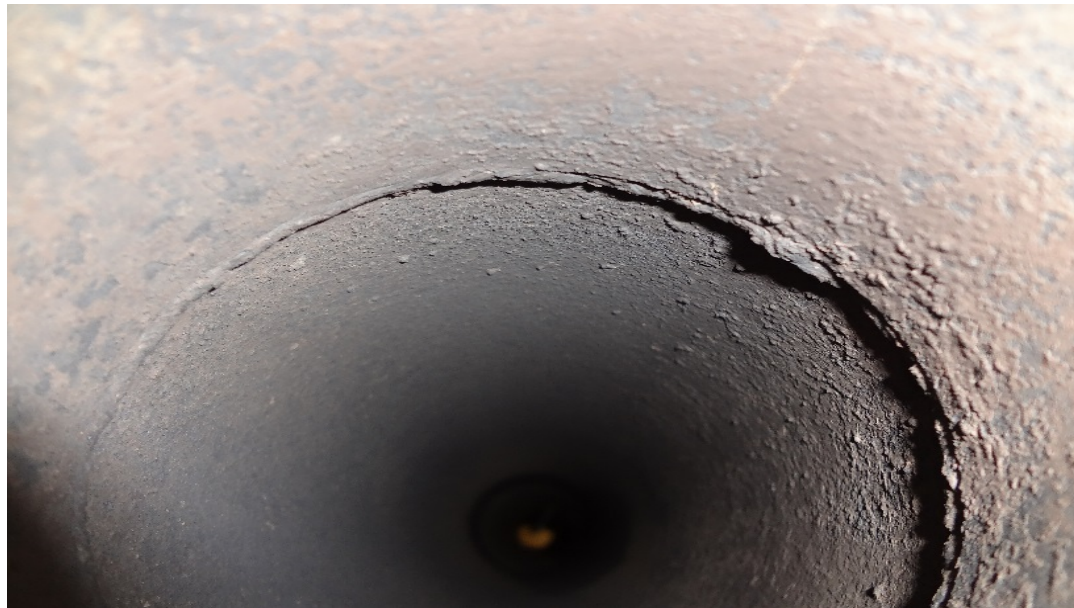
- ⑩ DP transmitter wiring problem:
  - +1.6% DP bias
  - +0.8% flow bias.

- ⑩ Problem found by diagnostics during commissioning.

# Field Example 2: Meter with Contamination



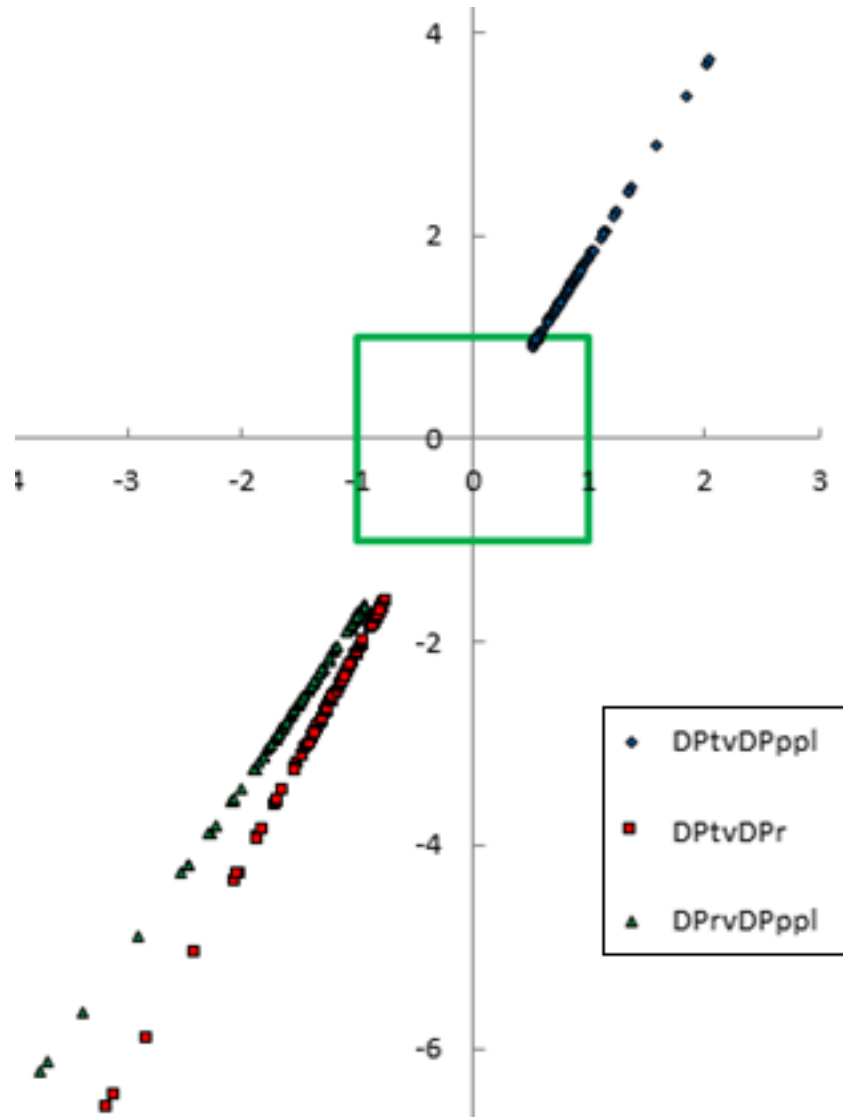
# Field Example 3: Meter with Wrong $\Phi$ & Contamination



- ◆ DPt & DPppl
- DPt & DPr
- ▲ DPr & DPppl
- DPt & DPt,inf

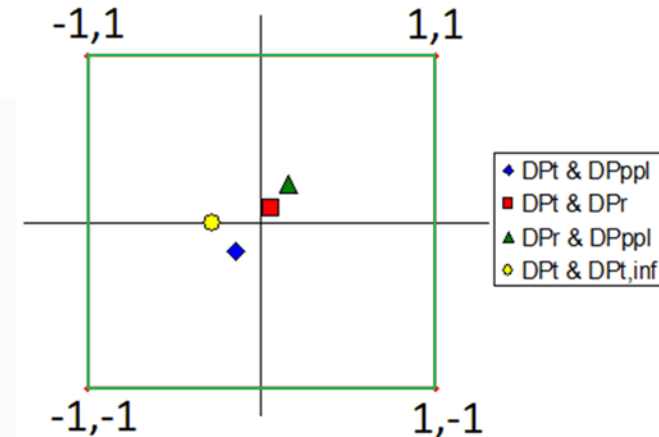
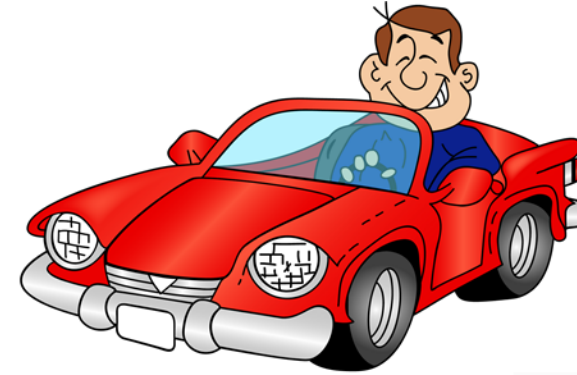


# Field Ex 4: 12" Orifice Meter North Sea Platform



⑩ Wet gas flow identified and liquid loading monitored.

# Do you want to be a Meter Mechanic or Operator?



# Conclusions



- ⑩ Orifice meters have a comprehensive validation tool (Prognosis™).
  - ⑩ Prognosis assures: correct meter operation,
    - ⑩ reduces exposure to mismeasurement,
    - ⑩ facilitates CBM,
      - ⑩ increase technician productivity, and
      - ⑩ reduces needless technician exposure to danger
- ⑩ Latest developments:
  - ⑩ automated prediction of associated flow bias magnitude
  - ⑩ reduces correct operating meters uncertainty





**THANK YOU**

