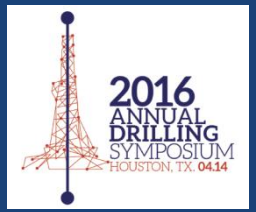


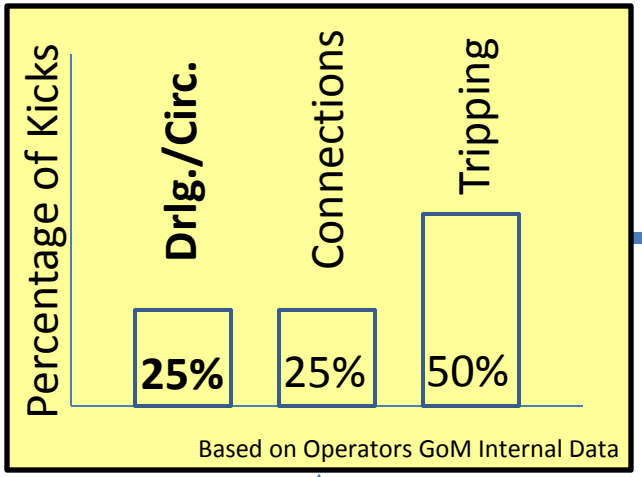
Next Generation Kick Detection during Connections: Influx Detection at Pumps Stop (IDAPS) Software

Brian Tarr, Shell

SPE International
Society of Petroleum Engineers

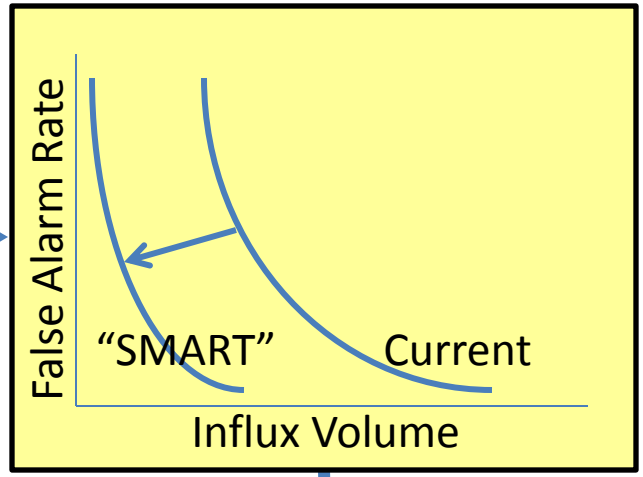
BACKGROUND

When Do Kicks Occur?



Fault Tree Analysis

Smart Kick Detection System



Focus of Current Rig Based Kick Alarm Systems:

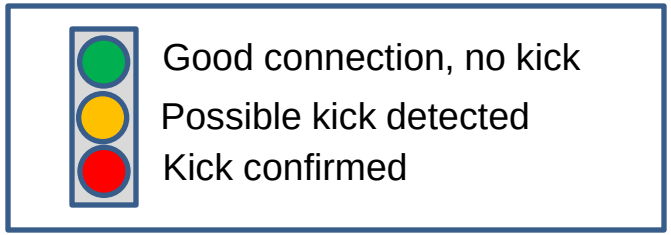
1. Drilling/Circulating

SMART Kick Alarms for:

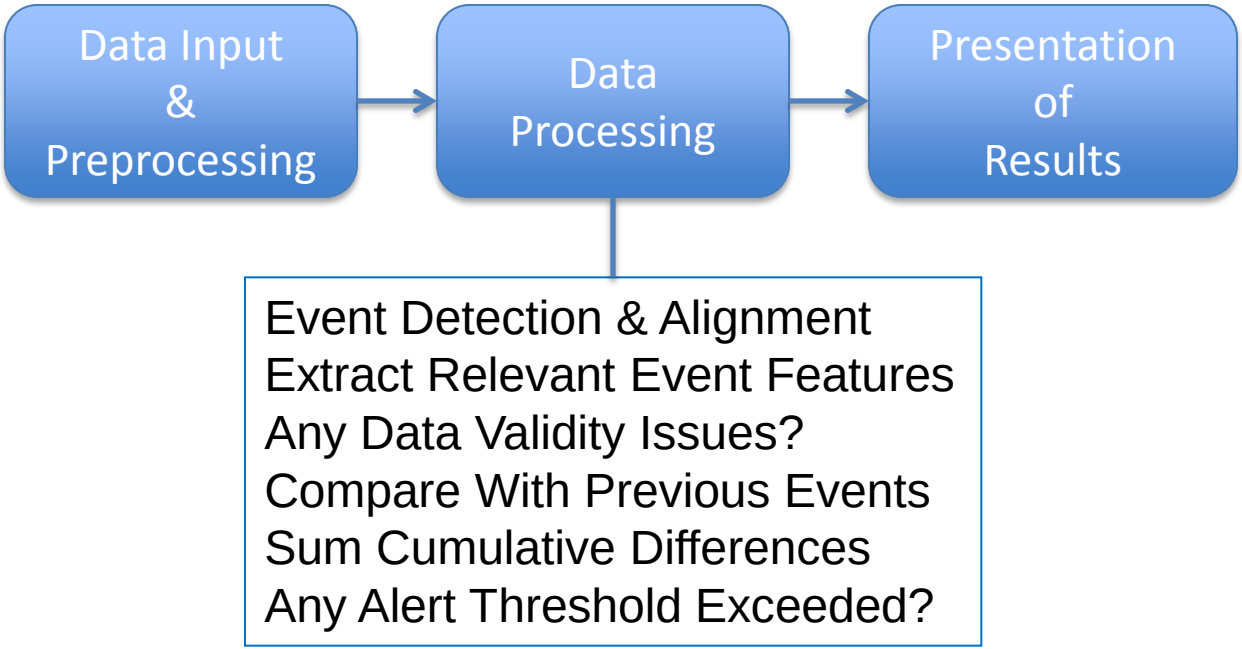
1. Drilling/Circulating
2. **Connections**
3. Tripping

PERFORMANCE GOALS FOR IDAPS

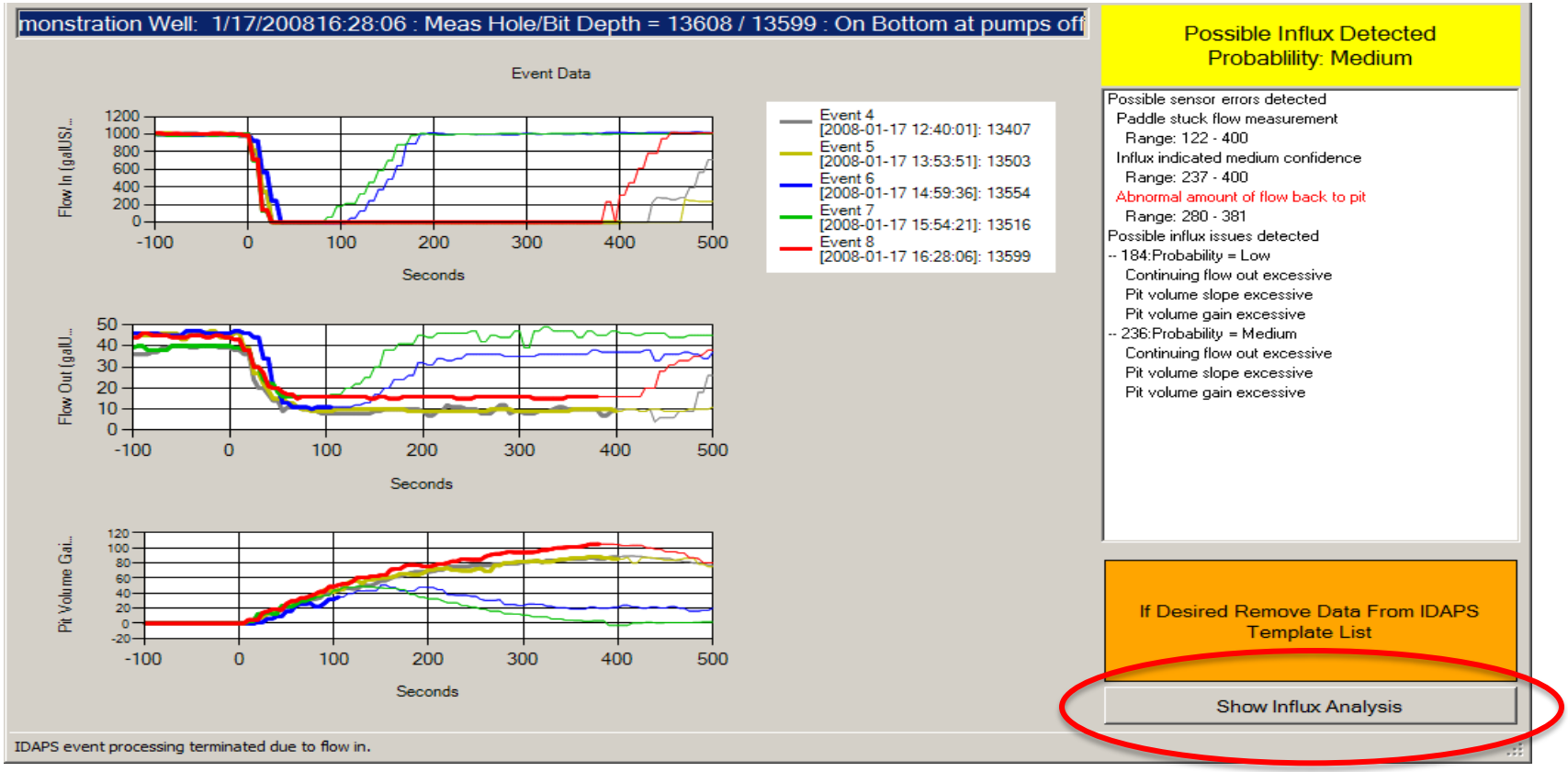
1. Kick probability of detection (PD): Required PD > 0.95, Target PD = 1
2. Kick false alarm rate (FAR): Required FAR < 1/100, Target FAR < 1/1,000
3. Time to detect (Td) a kick: Required Td < 240 sec, Target Td < 120 sec
4. Provide feedback if sensor data appears inconsistent
5. Adaptive to all well conditions
6. Use available surface sensor data
7. Simple to install and use

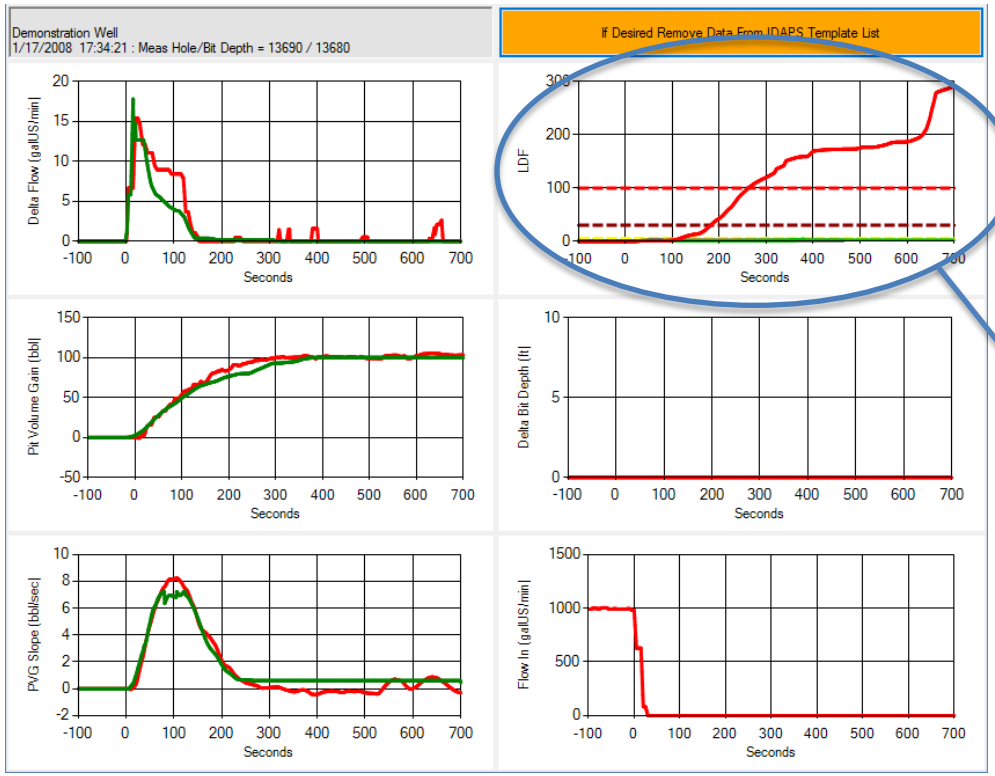


IDAPS FUNCTIONAL DESIGN



IDAPS PUMPS-OFF EVENT COMPARISON DISPLAY





IDAPS EVENT ANALYSIS DISPLAY

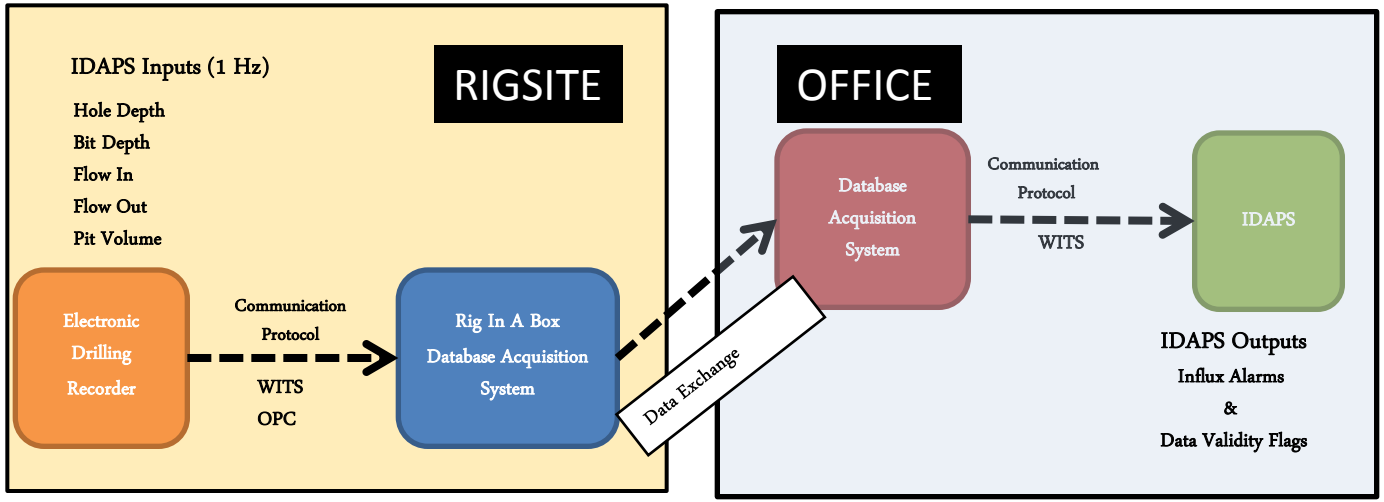
Current pumps-off event

Comparison Signature (derived from prior events)

Likelihood Derived Factor (LDF)
= **A (V1 x V2 x V3 x V4) + B x V1 + C x V2 + D x V4**

V1 to V4 = Cumulative sum Variables
A to D = Constants

IDAPS DATA FLOW DIAGRAM



IDAPS Validation Using Historical Data Set

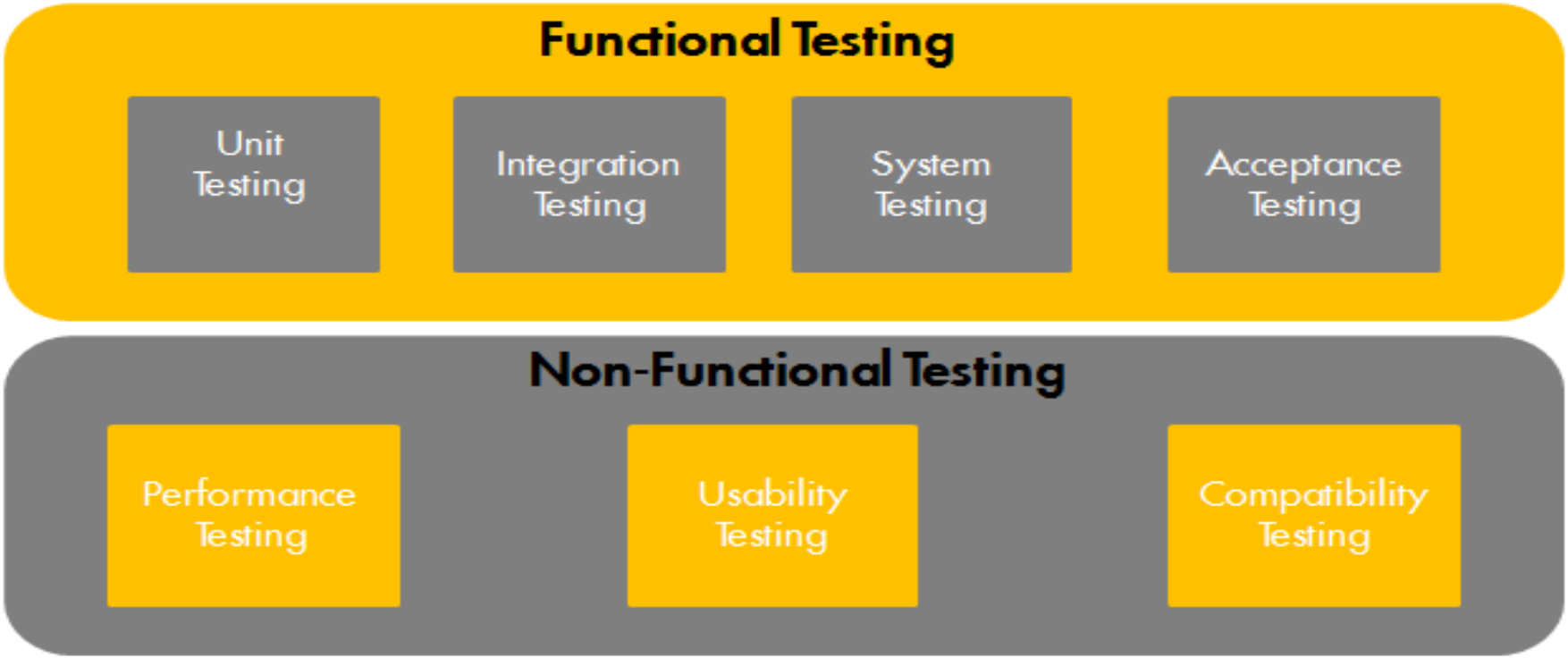
Filename	Event Number	Comments	Estimated Influx Volume [bbl]
Well1	**16**	**Verified Influx**	**15**
Well2	25	Suspected Influx	10
Well3	**29**	**Verified Influx**	**22**
Well4	**12**	**Verified Influx**	**8.5**
Well5	**30**	**Verified Influx**	**14**
Well6	17	Suspected Influx	10
Well7	12	Possible Influx	16
Well8	17	Possible Influx	N/A
Well9	8	Possible Influx	35
Well10	18	Suspected Influx	17
Well11	12	Suspected Influx	20

All 4 Verified Kicks Detected
PD = 1.0

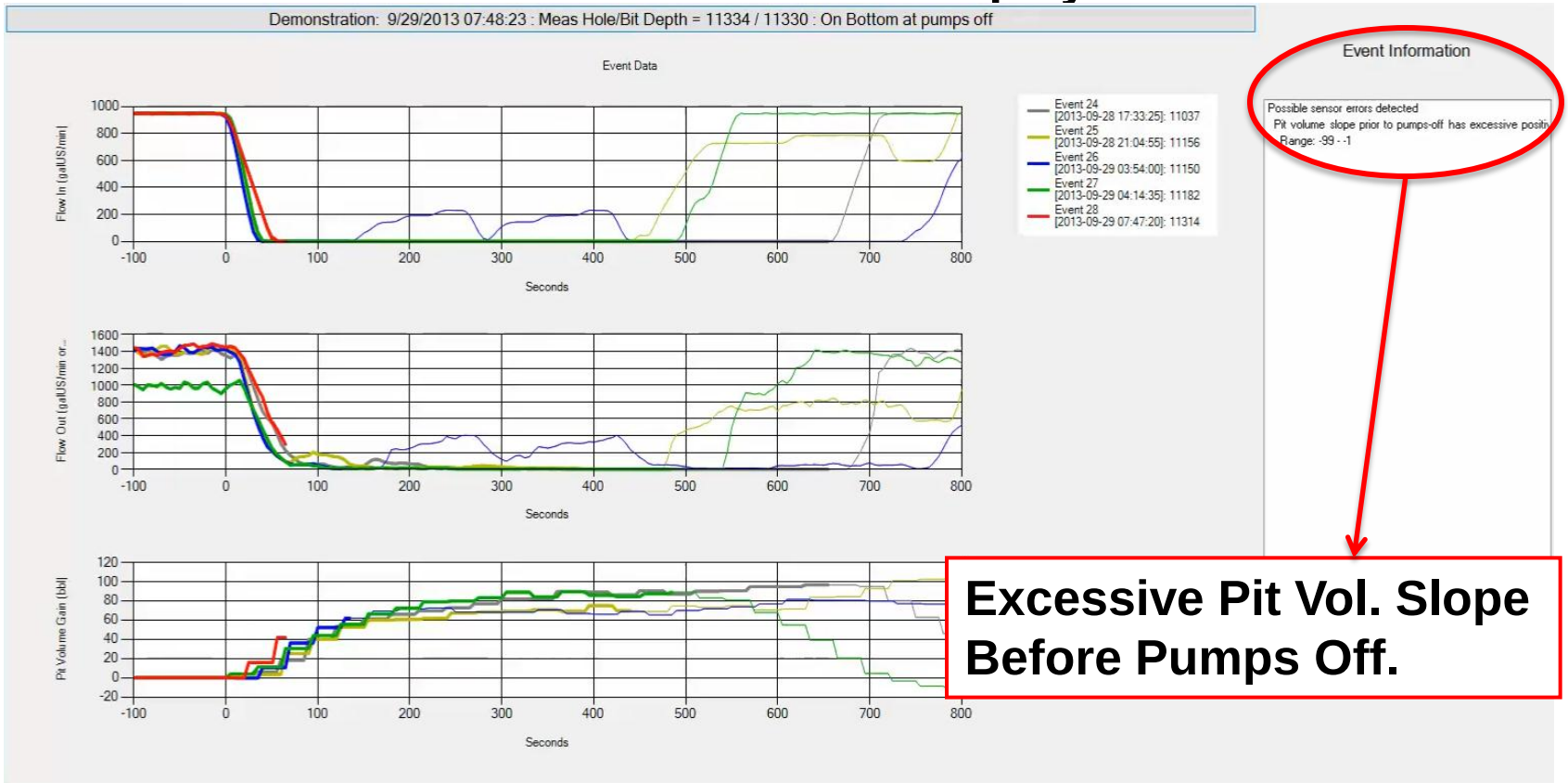
Only 7 IDAPS False Alarms in 1362 connections
FAR = 1 per 195 Connections

Time to “confirmed” alarm ranged from 84 to 263 seconds

IDAPS TESTING



EXAMPLE Connection Event Display Evolution



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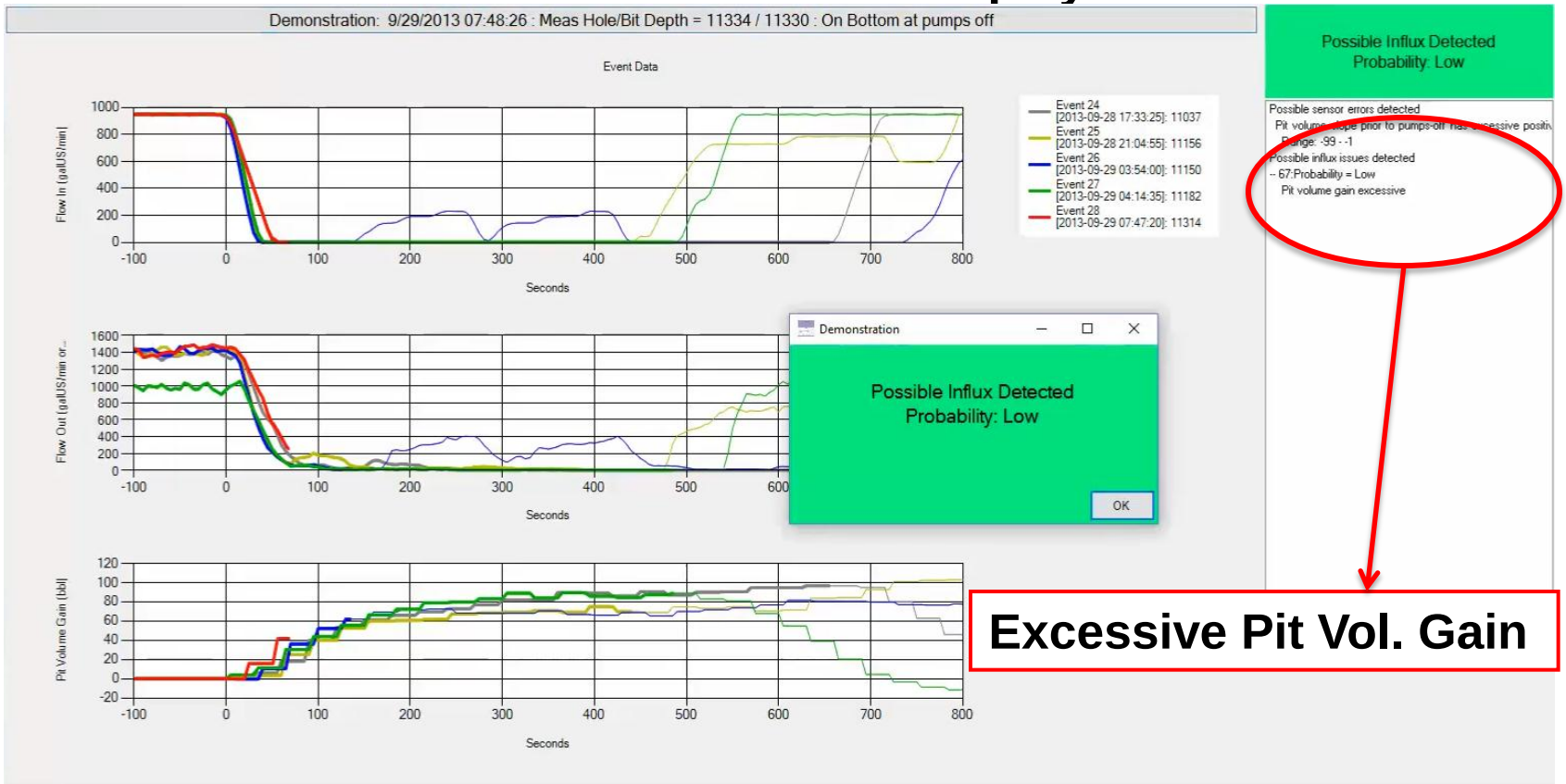

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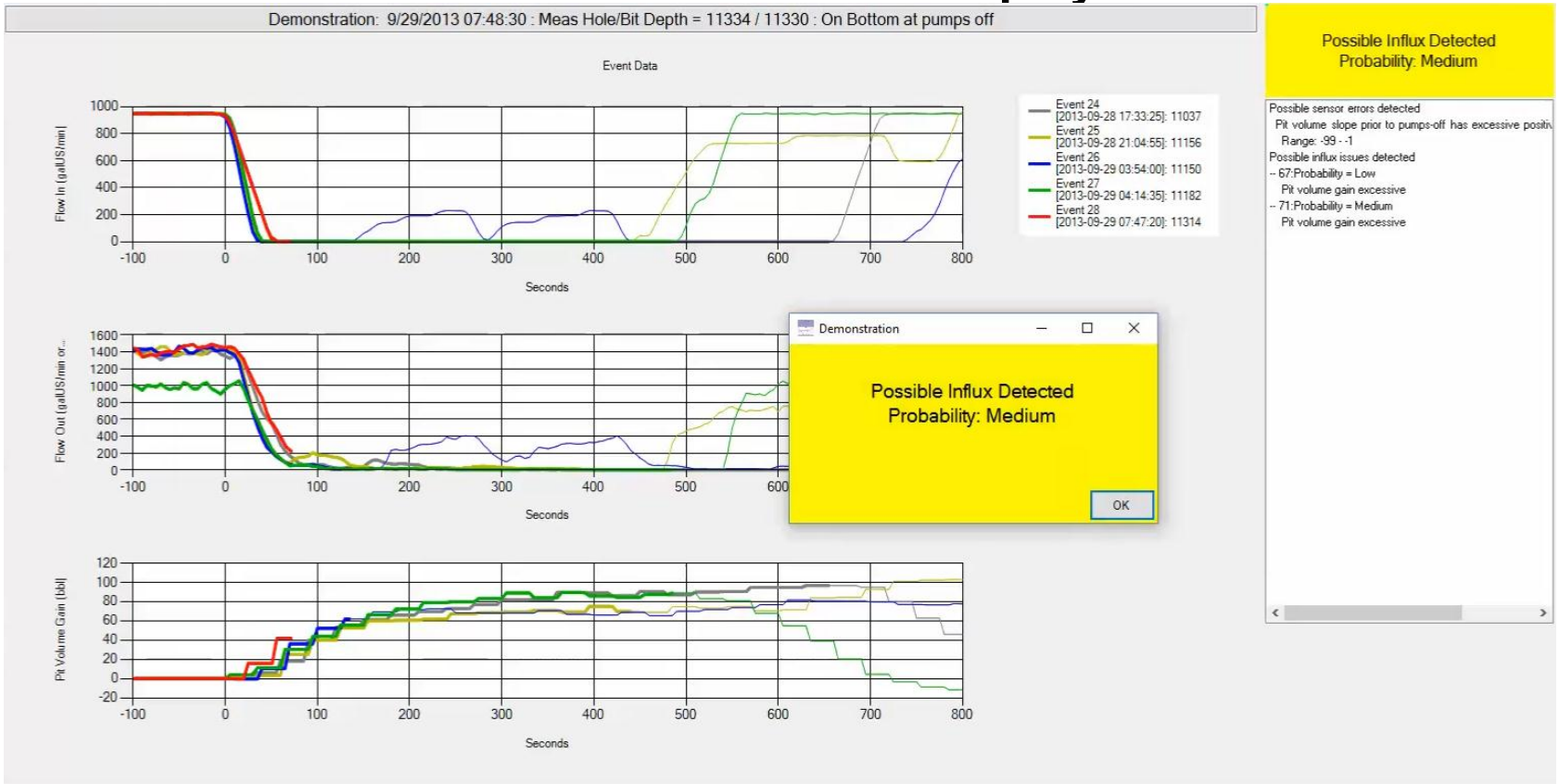

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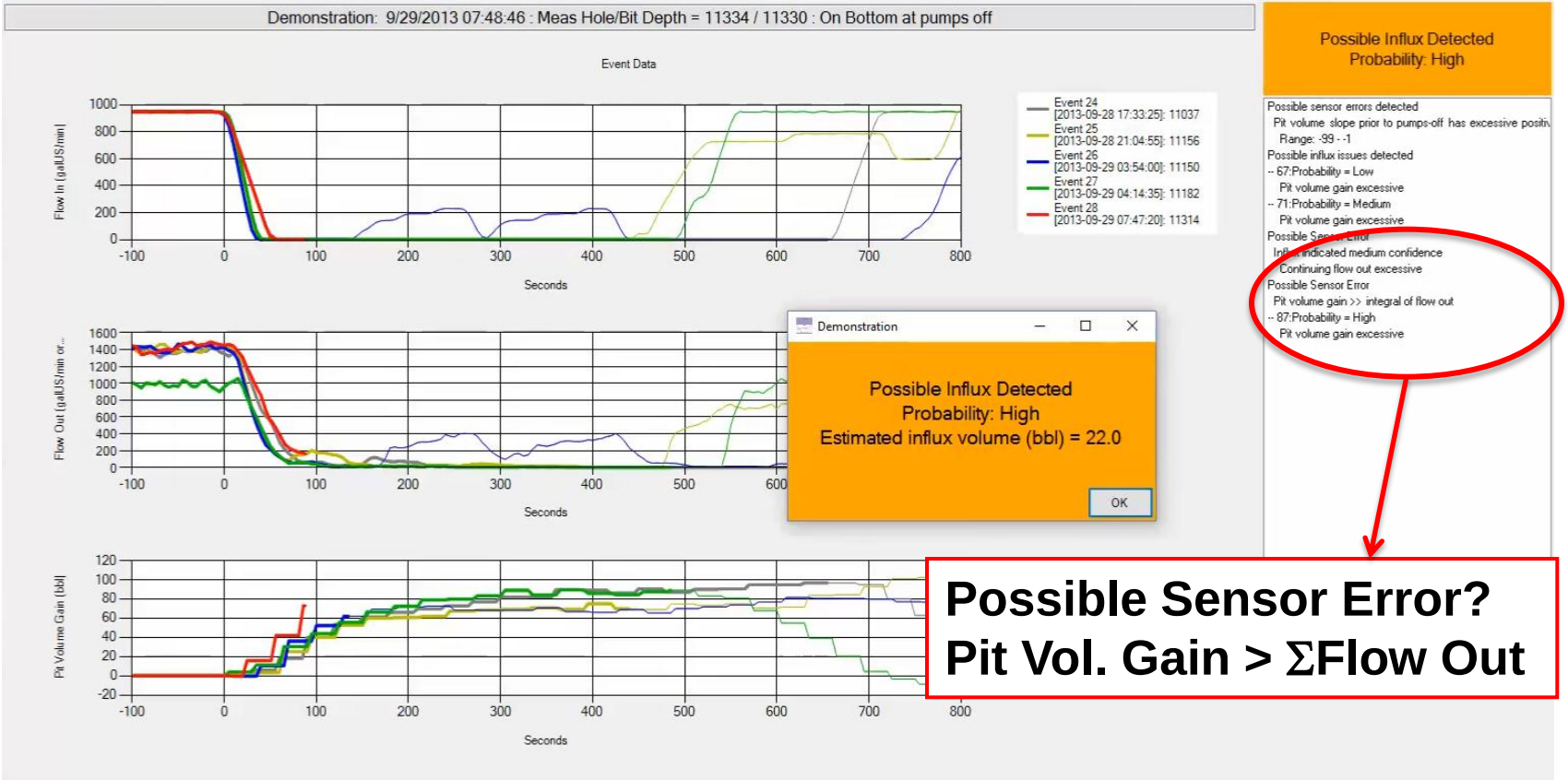

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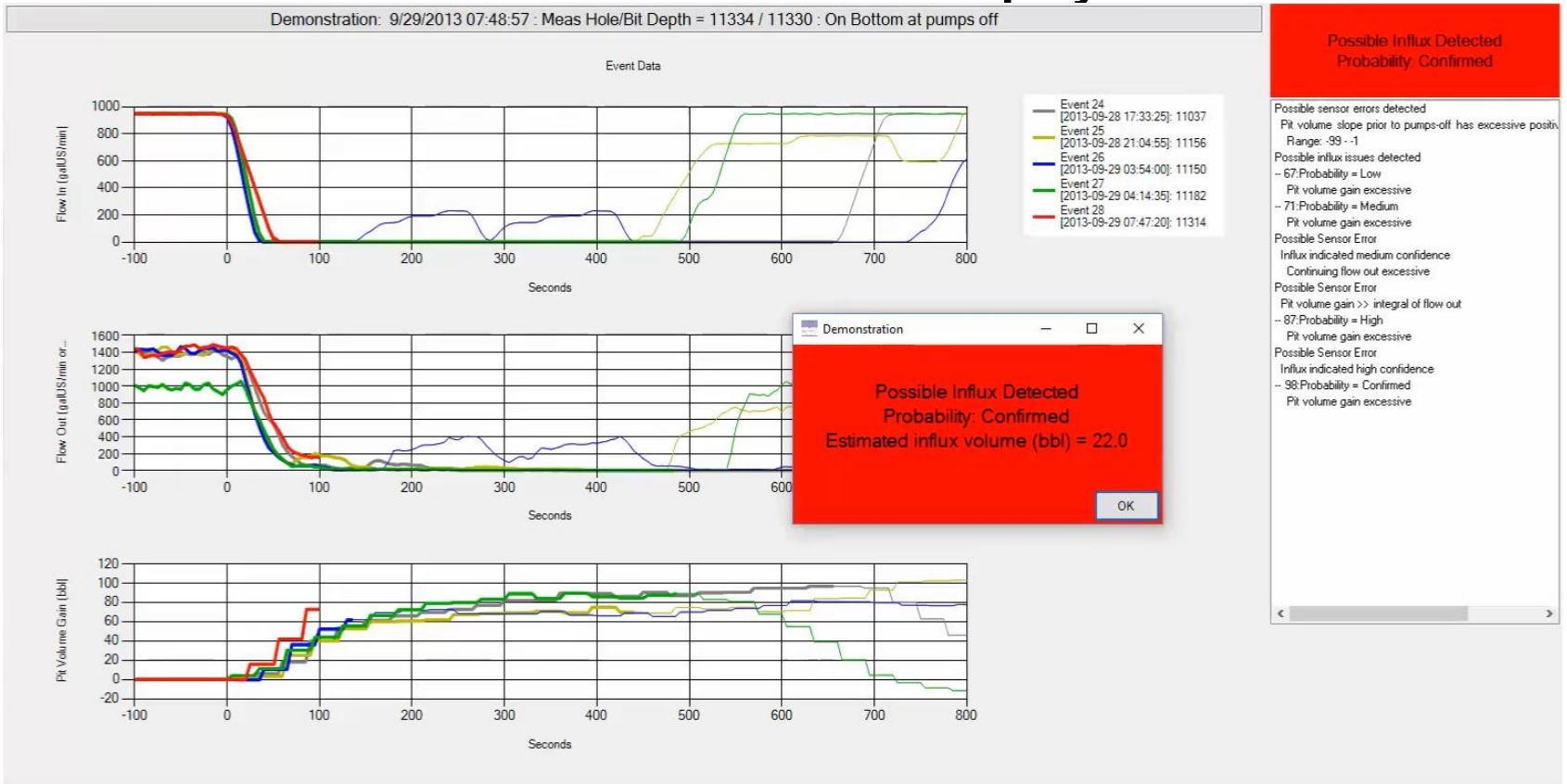
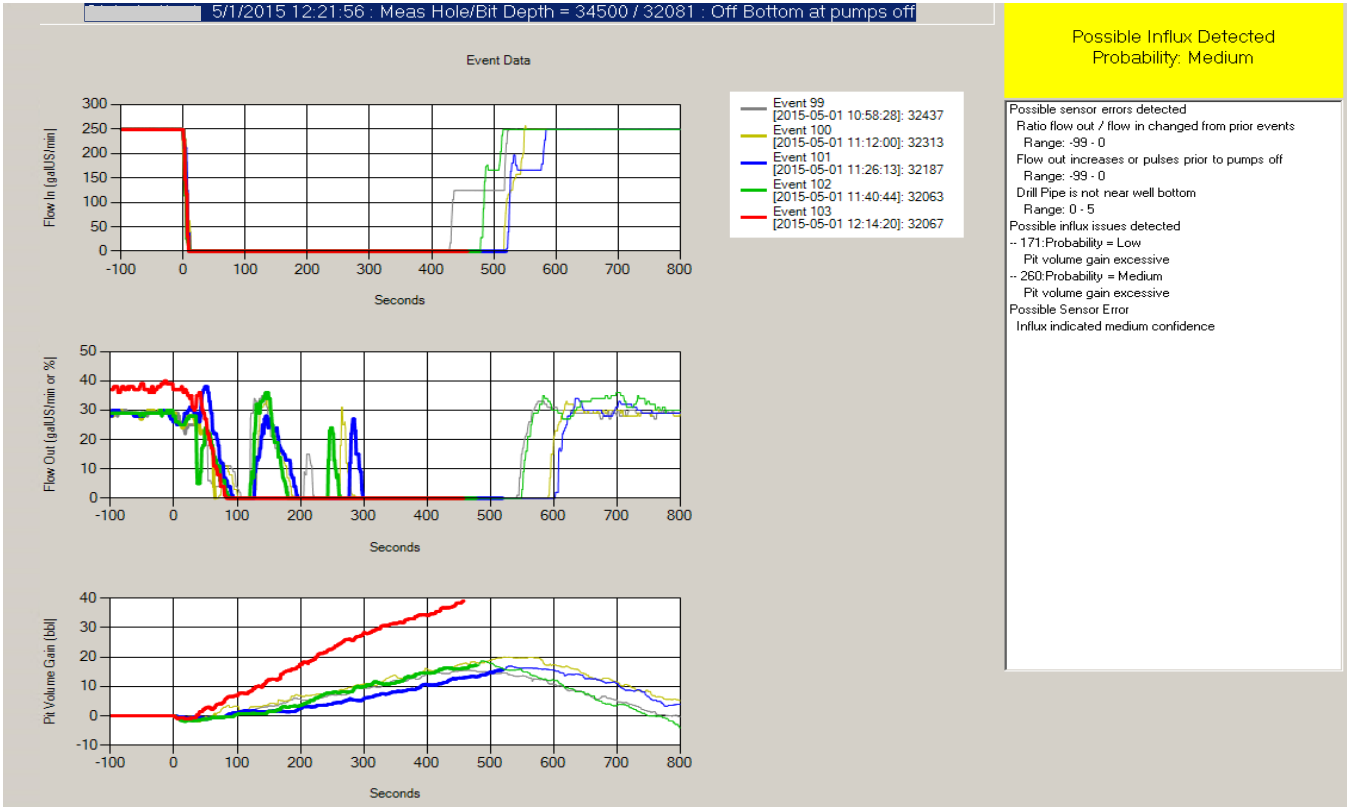


EXAMPLE INTERVENTION #1

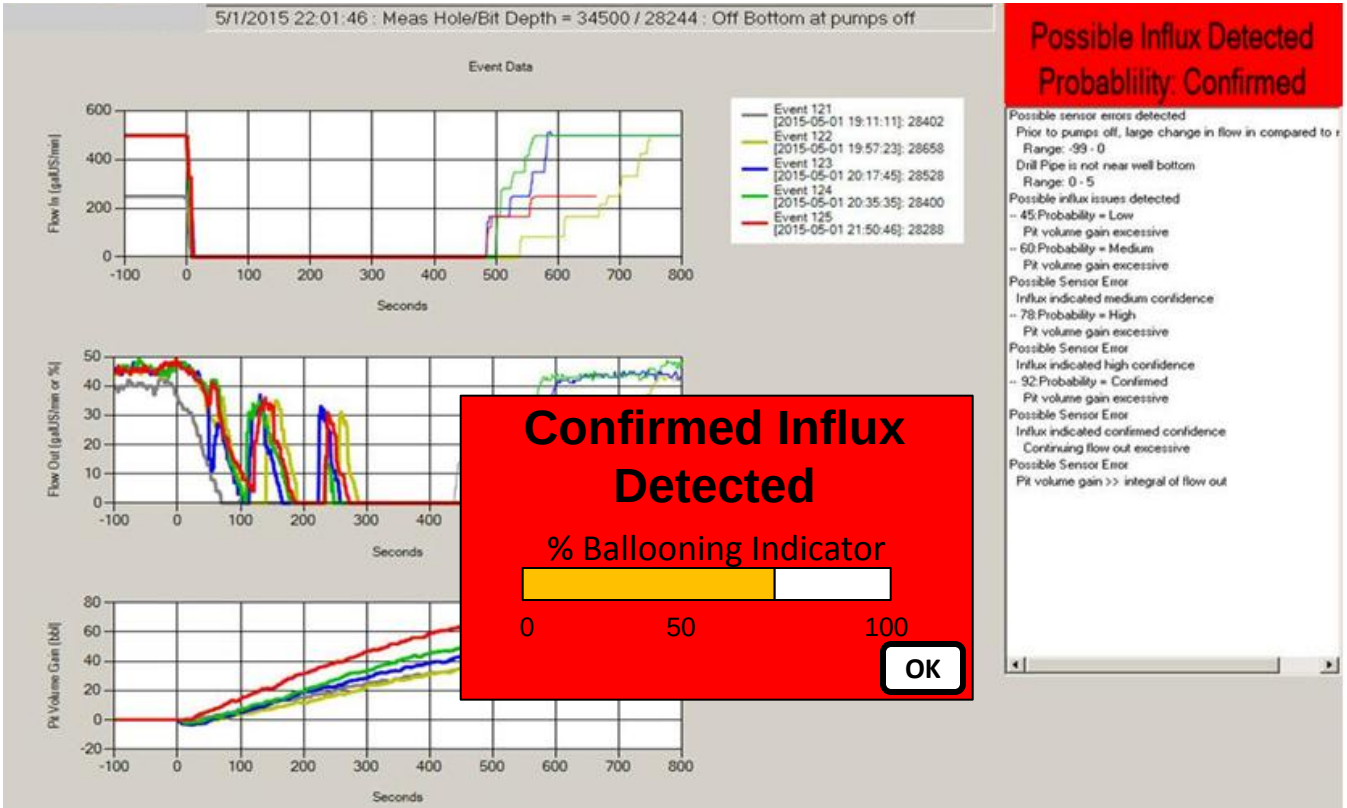


Operation:
Pumping out of the hole.

Action:
RTOC Engineer Notified the Rig.

No indication of flow during remainder of trip out.

EXAMPLE INTERVENTION #2



Operation:
Reaming tight spot.

Action:
RTOC Engineer Notified the Rig.

Flow checked well (no flow).

Ballooning?

CONCLUSIONS

1. By using advanced machine learning and optimal trend detection processing IDAPS achieved:
    - Probability of detection (PD) of 1.0 (no kicks missed)
    - False alarm rate (FAR) of 1/195 connections
    - Confirmed kick alarm in as little as 84 seconds

2. Overlay plots of recent pumps-off event flow and pit volume data are being used by the operators RTOC engineers to validate anomalous connection signatures identified by IDAPS.

3. IDAPS possible influx alerts and confirmed influx alarms are now taken seriously by the operators rig teams.

4. New Formation Breathing/Ballooing Discriminator now being tested.

THANK YOU

QUESTIONS & COMMENTS

Paper Reference For More Information: **IADC/SPE-178821**

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Brian Tarr, Doug Ladendorf & Diego Sanchez Shell International E&P Inc., Martin Milner CoVar Applied Technologies Inc.