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XACT Acoustic Telemetry Network

October 25, 2018

Applied acoustics. Different decisions. Reliable results.

A new acoustic telemetry system enables deepwater operators to manage pressures in real-time from drilling through completion installation

AADE Houston
Oct 24th 2018

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The need for downhole data

Uncertainty and lack of information about well conditions are some of the biggest risk associated with operations in complex wells.

Getting the right information at the right time, is essential for safe, successful, cost effective operations.

Real-time downhole data is currently limited to on bottom drilling time which on a deepwater rig can be less than 15% of total rig time.

Acoustic telemetry network

Sends data almost anytime drill or workstrings are in the well

FEATURES	ACOUSTIC TELEMETRY	FORMATION INDEPENDENT	FULLY THROUGH-BORE
	DISTRIBUTED REAL-TIME MEASUREMENTS	HIGHER DATA RATES THAN MP/EM	OPTIMIZED FOR BI-DIRECTIONAL
	FLUID INDEPENDENT/ WORKS WITH NO FLUID	EASY/RAPID TO DEPLOY AND DE-MOB	
	FLOW/PUMPING INDEPENDENT	DATA RATE IS NOT DEPTH LIMITED	

Exclusive enabling technology allows new approaches to well construction/completions

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Acoustic telemetry network

Same telemetry network across multiple applications

APPLICATIONS			
CEMENTING ☑	TCP GUN OPERATIONS ☑	INTERVAL ECD'S ☑	
FRAC AND GRAVEL PACK INSTALLATION ☑	DEPLETED AND FRACTURED RESERVOIRS ☑	MANAGED PRESSURE DRILLING/CEMENTING ☑	
LINER AND CASING RUNNING ☑	DOWNHOLE NEGATIVE TESTING ☑	DOWNHOLE MUD RHEOLOGY	
DRILLING ☑	DOWNHOLE FORMATION INTEGRITY TEST ☑	DATA BELOW CLOSED BOP'S ☑	
AIR DRILLING ☑	NO FLOW AND LOW FLOW OPERATIONS ☑	DATA DURING WELL CONTROL OPERATIONS	
TRIPPING ☑			
WELL TESTING (DST) ☑	LINER DRILLING	DOWNHOLE TOOL ACTIVATION	

☑ Denotes application where XACT has been utilized commercially.

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How it works

Making your drillstring smart with our easy to deploy network

EAR Wireless receiver at surface C1D1

On site Laptop

Onward transmission via WITS

Distributed measurement nodes
Acoustic repeaters spaced along string

Typical node separation in vertical +/- 5,000 FT

Acoustic Isolator below deepest tool

Typical node separation in lateral +/- 3,000 FT

FAST AND SIMPLE IMPLEMENTATION

- Place surface laptop in safe zone
- Attach wireless receiver at surface
- Pick-up deepest acoustic node with isolator as making-up BHA
- Pick-up subsequent nodes as needed during trip in hole/while drilling
- Network is bidirectional

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Downhole tools

Mechanical design optimized for drilling/completion applications

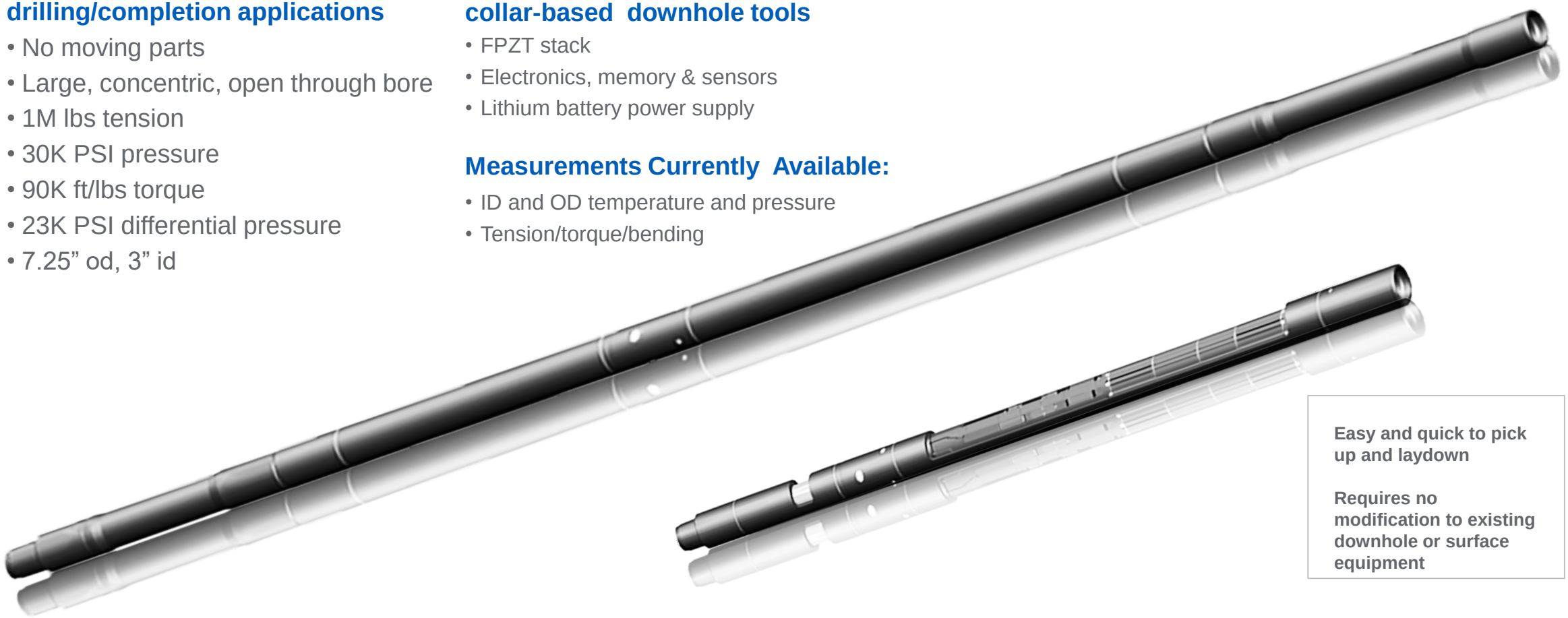
- No moving parts
- Large, concentric, open through bore
- 1M lbs tension
- 30K PSI pressure
- 90K ft/lbs torque
- 23K PSI differential pressure
- 7.25” od, 3” id

Acoustic technology is packaged in collar-based downhole tools

- FPZT stack
- Electronics, memory & sensors
- Lithium battery power supply

Measurements Currently Available:

- ID and OD temperature and pressure
- Tension/torque/bending



Easy and quick to pick up and laydown

Requires no modification to existing downhole or surface equipment

Deepwater TCP Operation

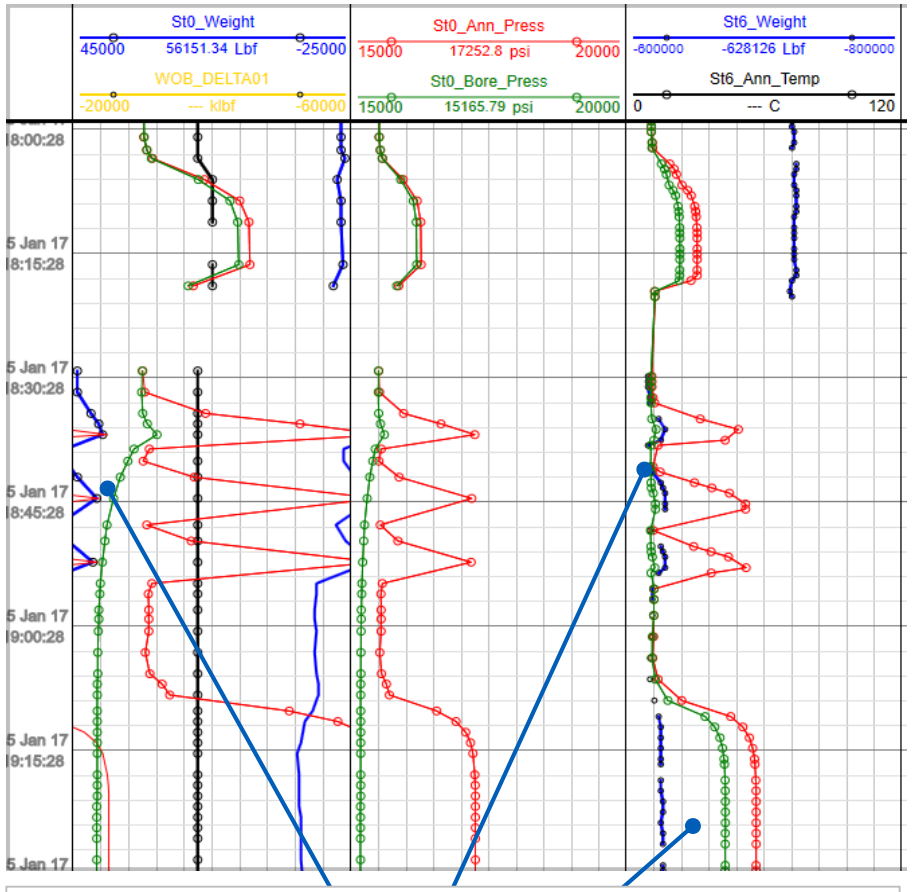
Objectives

- Gun firing verification
- Verification of IRDV positioning, in case of need to drop detonation bar
- Injectivity analysis

Benefits to Customer

- 6 hrs. from troubleshooting TCP valve position in next TCP run w/o XACT
- If troubleshooting is not successful in determining the position of the TCP valve then…
- Contingency of dropping detonating bar is not available
- ~54 hrs. of rig time:
- POOH, installing down/up of TCP manifold and iron, RIH again

With upcoming Surface Tool ability to fire guns remotely eliminates surface rig up and rig down of high pressure lines for safety and efficiency gains



Valve cycling through positions – Bore pressure drops when in blank position reading reservoir pressure (with hydrostatic offset)

Station 6 shows response above valve confirming circulate position
Downhole tensions show set down weight

Deepwater – MINIFRAC Analysis

Improve productivity

Objectives

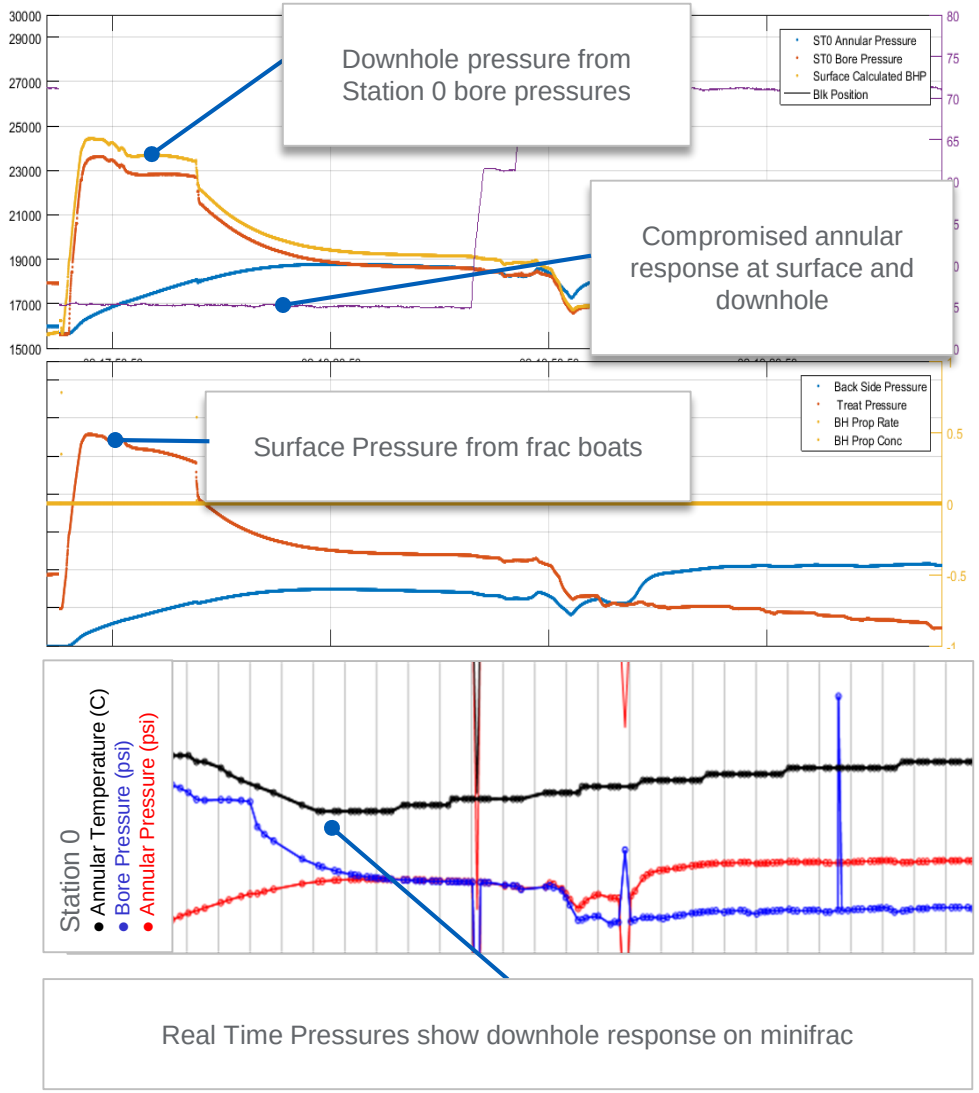
- Confirmation of frac model for optimum reservoir coverage
- Minimize skin, increase productivity index
- Increase time to intervention

Benefits to Customer

- Minimize Frac interference in massive reservoirs
- 10-20% increase in PI
- Increase in production 100-200 bpd (1000 psi drawdown assumption, low KH reservoir <20000md-ft. 1 yr cumulative production: $1.5-2.5M
- Reduced skin increased over time – increase time to intervention

Burst Telemetry

- Currently testing 1-3 second RT data resolution for
- Critical analysis such as Minifrac in downhole conditions



Deepwater Multi-Zone Frac Pack Operations

Prevention of npt by full knowledge of downhole conditions

Objectives

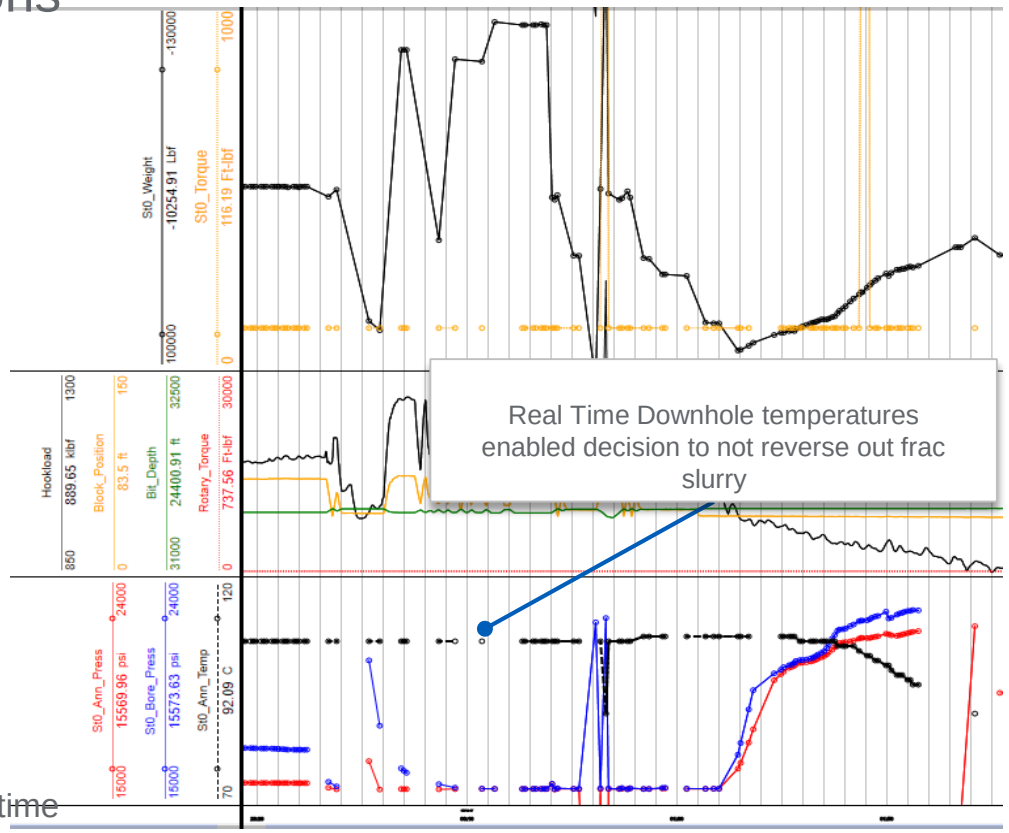
- Avoid wash pipe buckling
- Verify service tool positions
- Optimize frac operation

Service tool got stuck after spotting frac

- Got free after max pull-utilizing downhole data
- Pulled safely to maximum downhole without compromising assembly integrity
- Temp. measurements verified frac fluid condition avoiding reversing out/disposing fluid
- BH Pressures allowed frac to continue after high surface pressures were observed

Savings to Customer: 10-14 days of NPT

- Rig spread rate
- Coiled tubing unit for 4 days
- Reversing disposing of frac fluid + proppant and new batch of frac slurry + boat and rig time
- Total cost savings > $10M in 6 hours, three
- Separate incidents, 3 separate decisions



Real Time Downhole temperatures enabled decision to not reverse out frac slurry

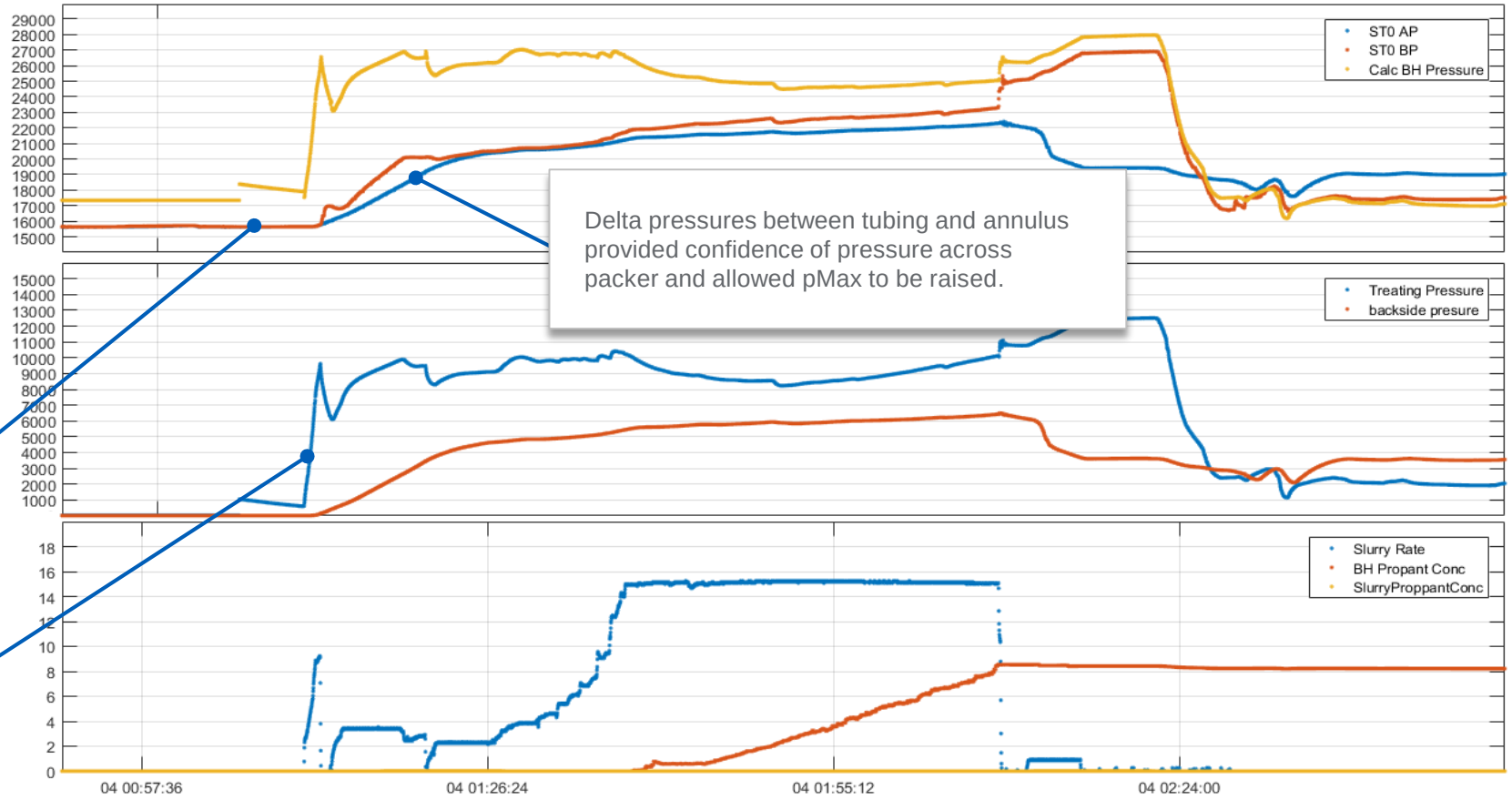
Real Time Pressures show high surface pressures not present downhole when getting frac treatment moving – confirming no downhole issues

Surface and Downhole Pressures varied Materially

Comparison of downhole pressures to surface treating and annular pressures at the start of the lower frac. Downhole pressures enabled rapid evaluation of the cause of the high surface treating pressures and allowed the frac to proceed with minimal trouble shooting time and avoid reversing the slurry out.

Downhole tubing pressure (red) shows much lower pressures, indicating the frictional pressure is along the drill pipe not at the downhole tools

Surface treating pressure high due to stationary slurry. The annular pressure response was slow, which had also been seen in the minifrac and did not give a good indication of downhole conditions



Delta pressures between tubing and annulus provided confidence of pressure across packer and allowed pMax to be raised.

Fluid loss control

Fluid loss control after perforating and stimulation

Objectives

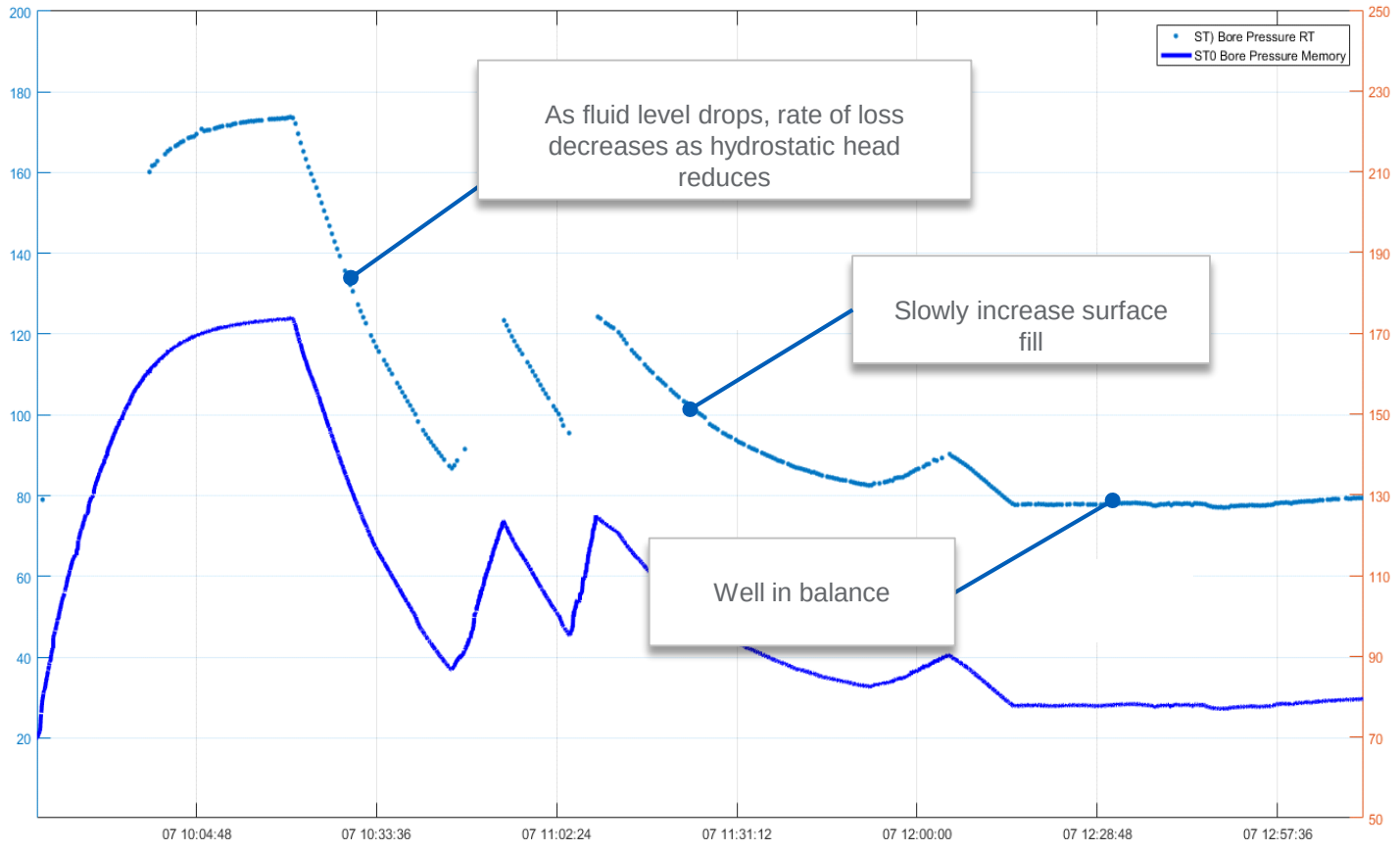
- Continuous validation of fluid barrier to avoid changing completion program
- Minimize fluid losses and avoid FLC pill
- Minimize formation damage

Top of fluid monitored continuously

- Approved by BSEE
- Optimum overbalance
- In-situ injectivity test to compare skin evolution after frac/stimulation treatment

Benefits to Customer

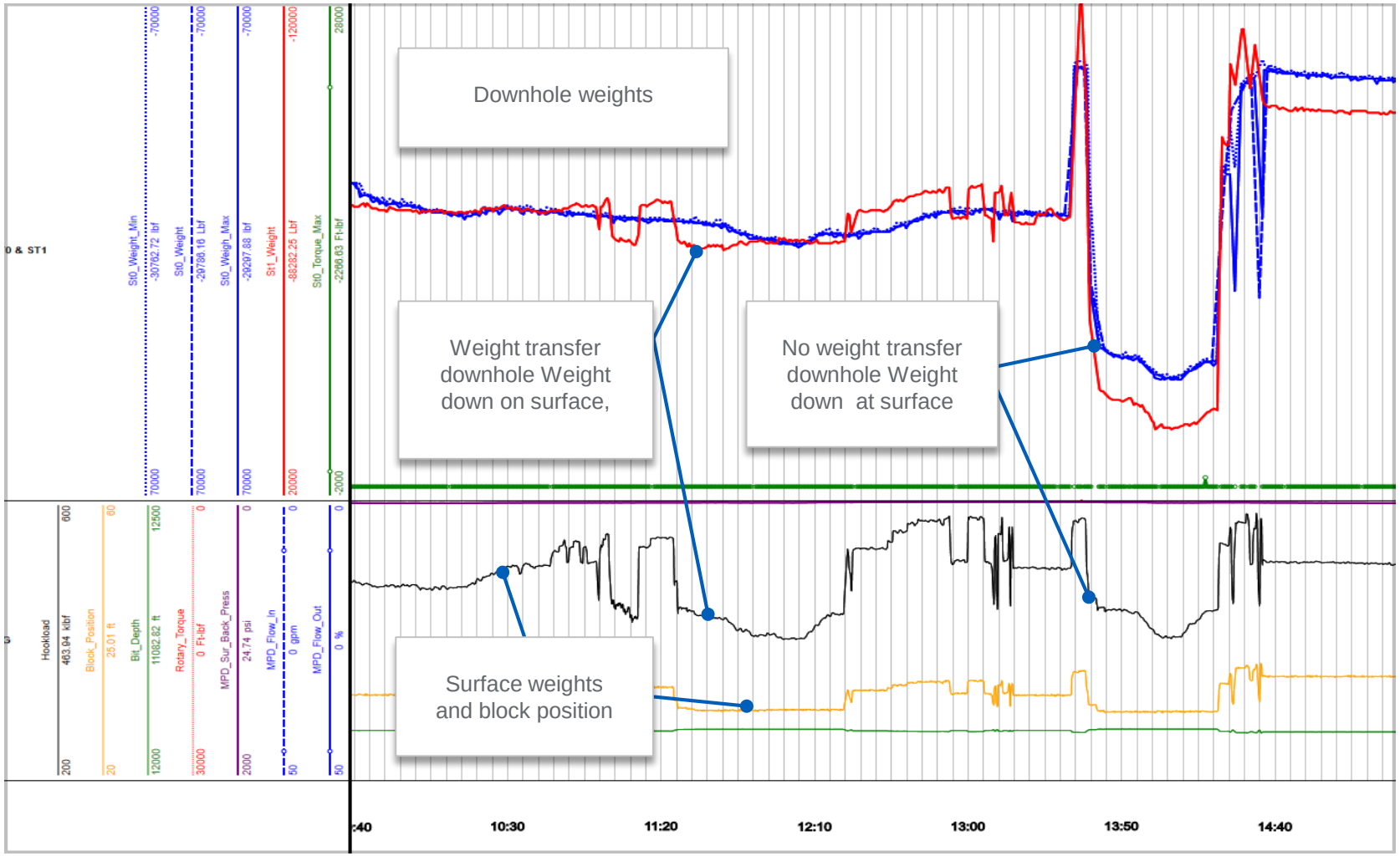
- Saved ~300 bbls of fluid lost in formation (average)
- Minimized formation damage
- Increase safety of operations by continuous pressure monitoring



FULL PRESSURE MANAGEMENT FOR ALL WELL OPERATIONS

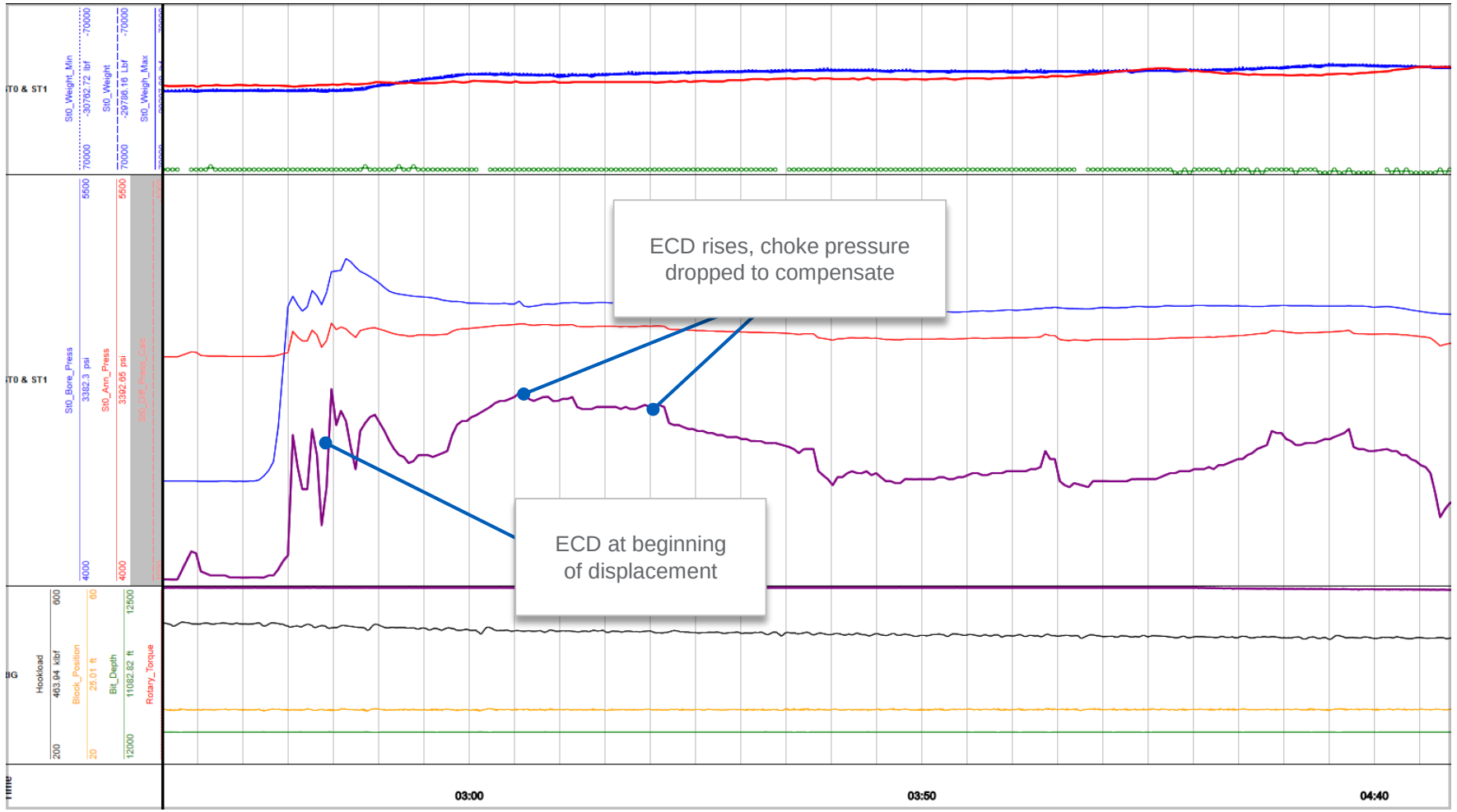
Weight Transfer is not always what you think?

Understanding the weight transfer downhole allowed the operator to fully understand the problem and rapidly react and proceed with the operational plan



Real-time Management of Displacement in Tight Margin Well

Understanding the Equivalent mud weight downhole allowed the operator to safely remain within the tight mud window whilst maximizing the displacement rate and improving the efficiency of the operation.



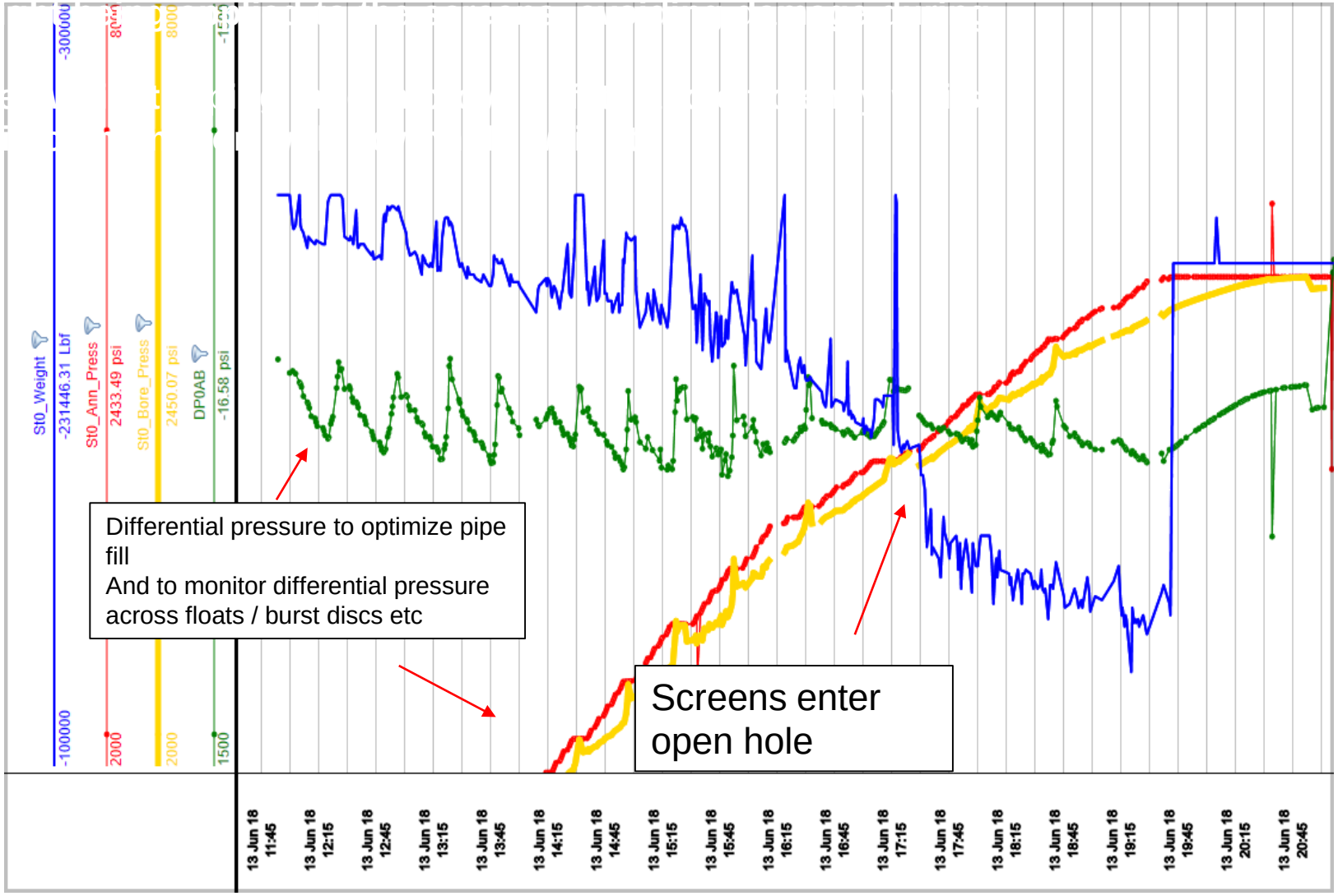
Screen Running-Tripping In

Ability to monitor the weight being applied to the screens, avoiding damage during installation

Swab and Surge Pressures while tripping in to improve safety and efficiency

Differential pressures used to optimize pipe fill and to monitor across floats and burst disks

Maximizing trip in speed by improving safety and efficiency of tripping whilst avoiding costly NPT and productivity impairment due to damaged screen



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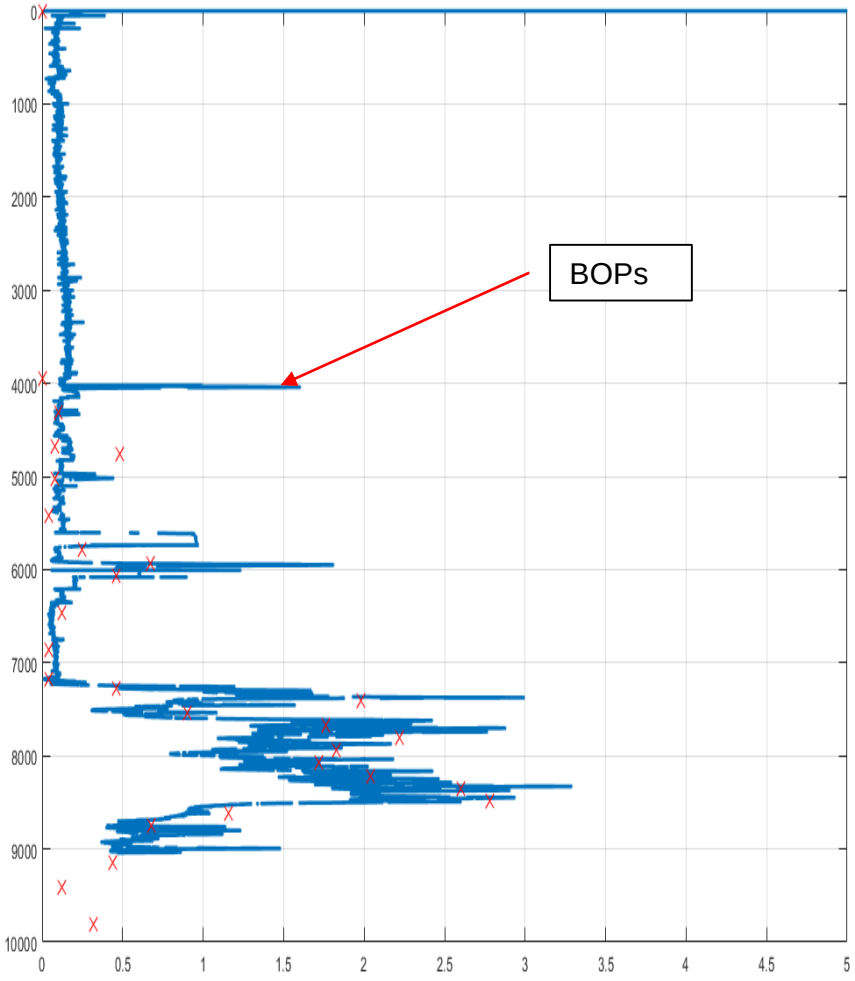
Screen Running-Micro Dogleg Analysis

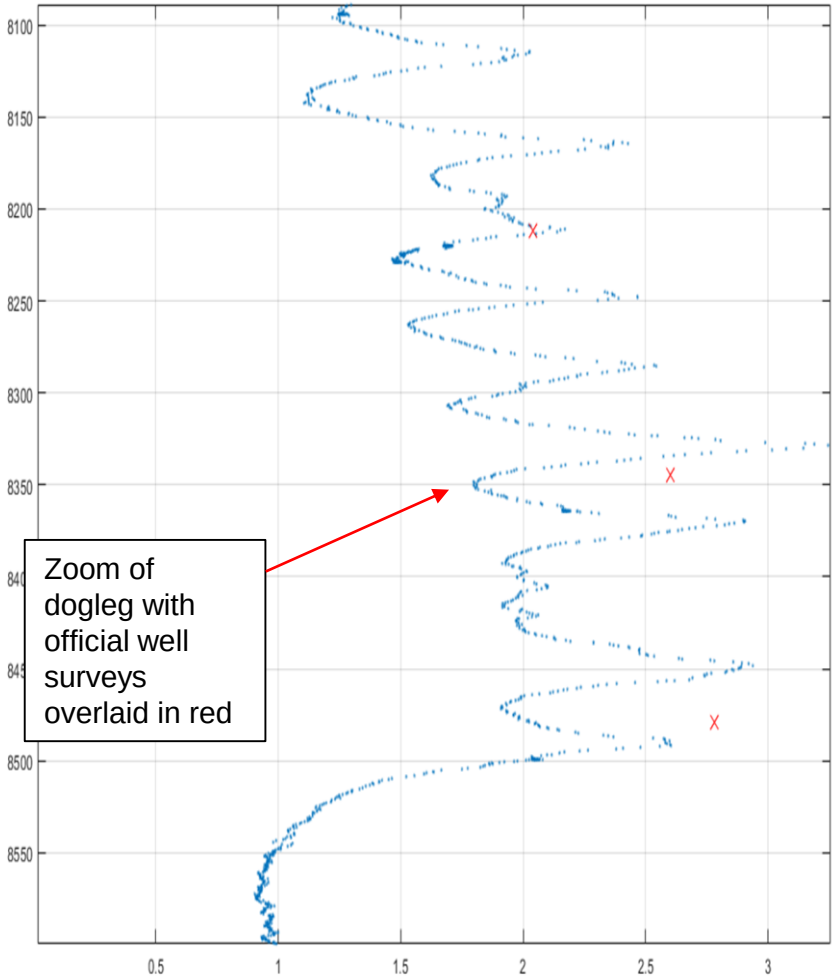
Bending moment converted to a dog leg for a continuous measurement throughout the well

Zoom in shows cyclical nature of the dog leg probably due to the rotary steerable moving from active biasing to non active biasing

Normal survey intervals smooth out the variations in dogleg

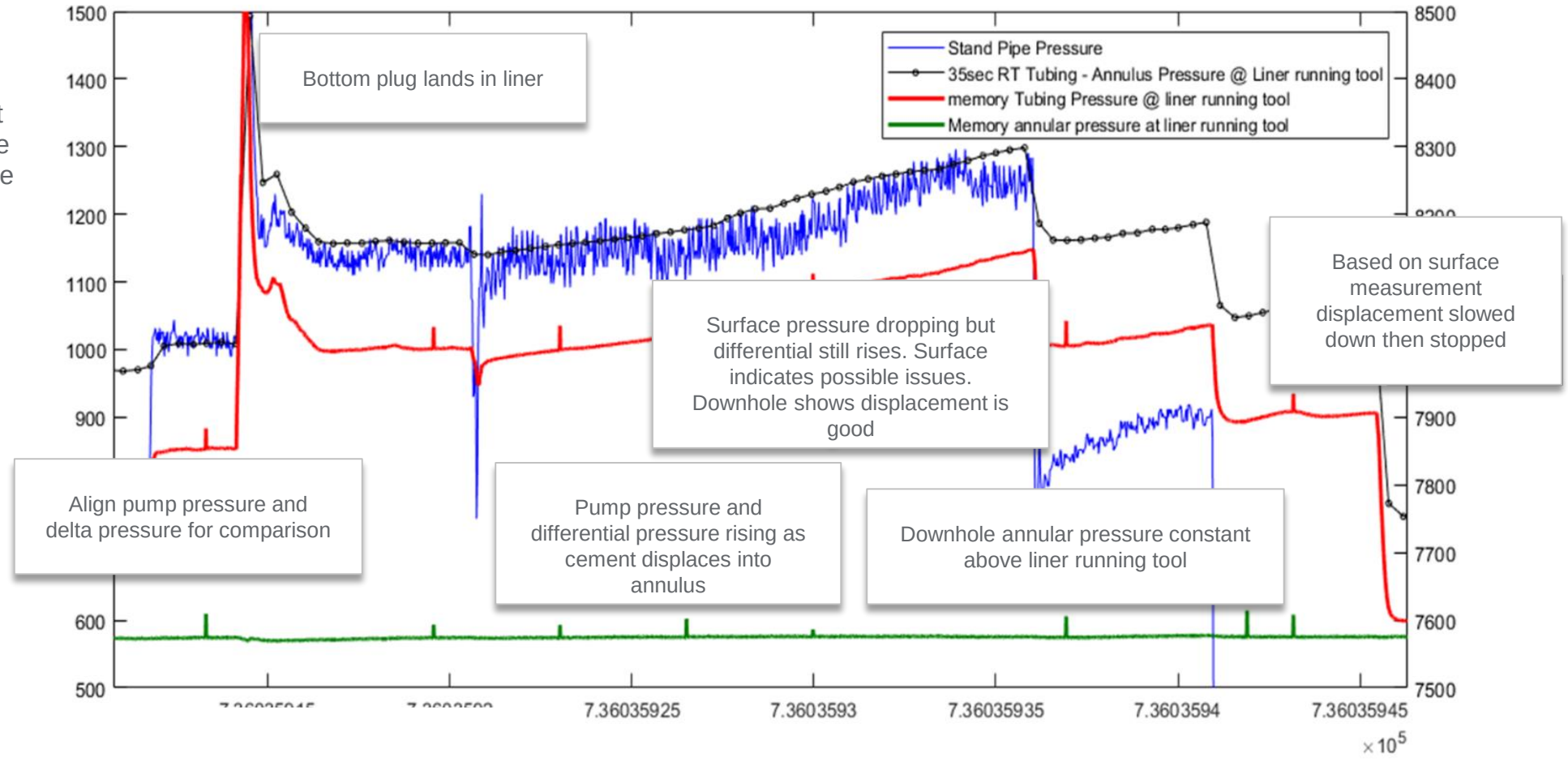
Torque and drag models are affected and can effect casing/liner and screen running operations in complex wells





Data while Cementing and Installing Liners

Data while cementing looking at rise pressures downhole. The ability to rotate liners downhole whilst cementing utilizing downhole weight and torque to Improve cement coverage for well integrity and zonal isolation. The possibility to revitalize liner drilling in problematical zones, depleted reservoirs and total loss zones



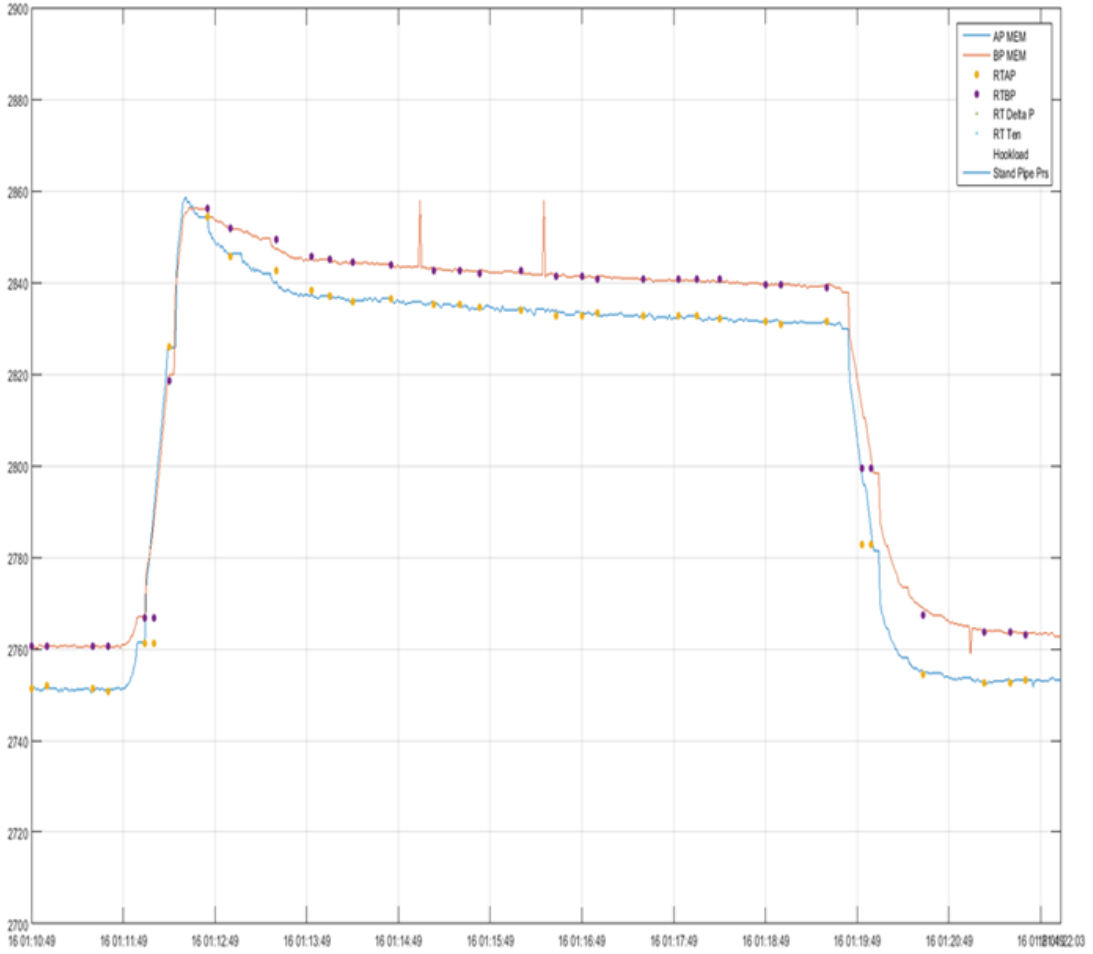
Riserless Formation Integrity Test

Objectives

- Real-time data supplied in riserless operation, either side of openhole packer.
- FIT pushed to the limit.
- Full through bore allowed activation of flow control valves using bars and balls
- Allowed wireline logging through the tools
- Allowed for the potential to cement in the same run as necessary
- BSEE Approved

Value and Efficiency Gains

- Attaching drilling riser and deepwater BOP to do a conventional test was uneconomic
- Identified packer inflating prematurely, ability to troubleshoot downhole devices due to distributed measurements
- 4-6 weeks of efficiency gains by going riserless plus cost of procuring drilling riser and BOP
- Slot has been recovered

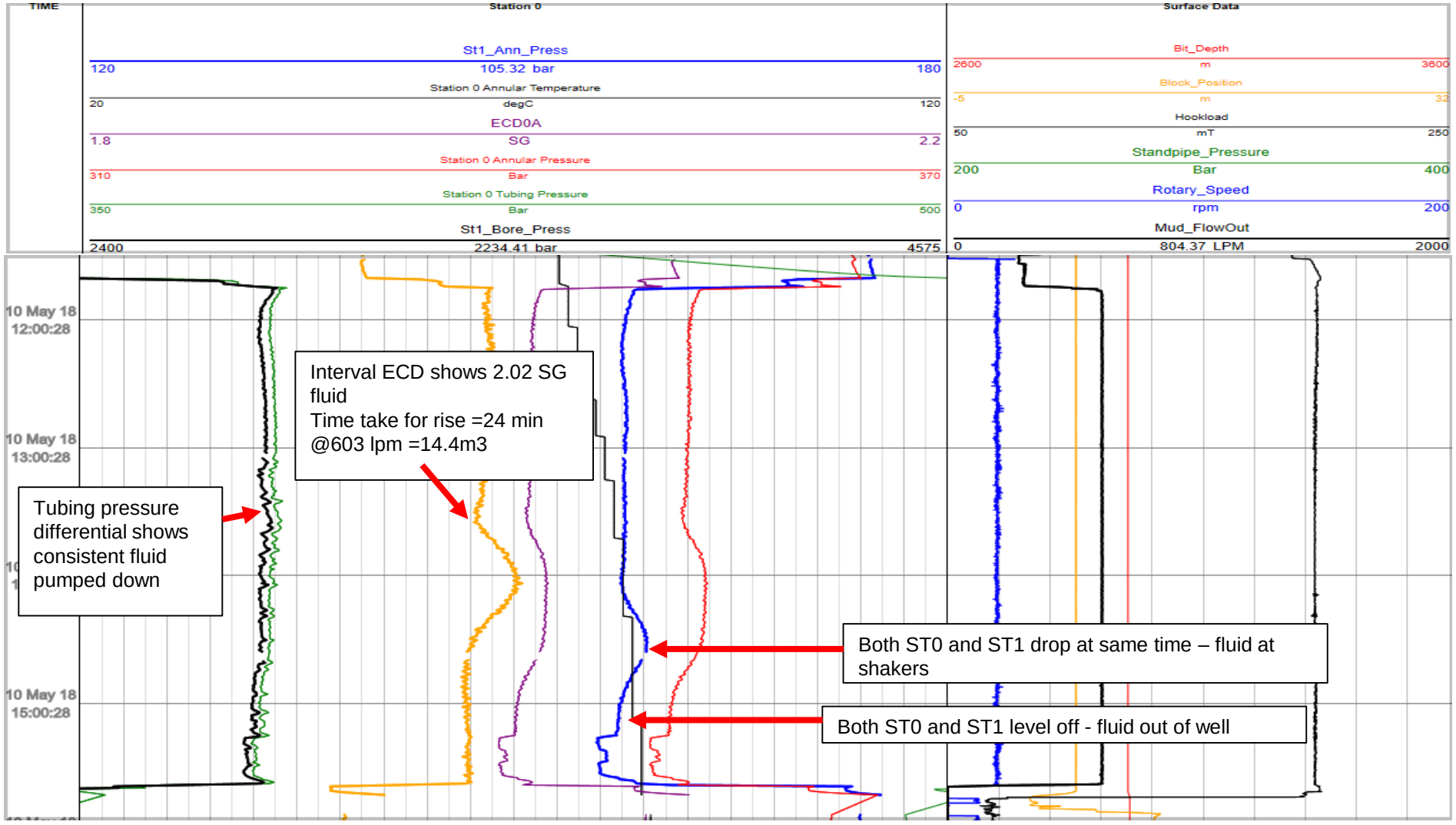


Drilling Under MPD Conditions Different Mud Densities

Interval ECD shows conditions along the well bore

Calculate volume and density of slugs of fluid moving up the annulus

If the mud is not consistent a static FIT based on surface measurements may be skewed.



Conclusions

Real-time data now available during operations where downhole data was never available before

Downhole data conclusively shows that what you are reading on surface is very often materially different from what is actually happening downhole

This technology has been field proven in the deepwater and in complex wells

The technology has been proven right across well construction from Drilling through Completion Installation

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