REAL-TIME DRILLING OPTIMISATION

DRIVING DRILLING EXCELLENCE

SPE International
Western Australian Section

Drillinsight

Content

- Drilling Optimisation
- Real-time Drilling Optimisation – Concept
- Real-time Drilling Optimisation – Methodology
- Business Cases
- Conclusion

Drilling Optimisation

Specialised form of Risk Management achieved by;

- ✓ **Minimise the unplanned events**
- ✓ **Improvise the Drilling Efficiency**

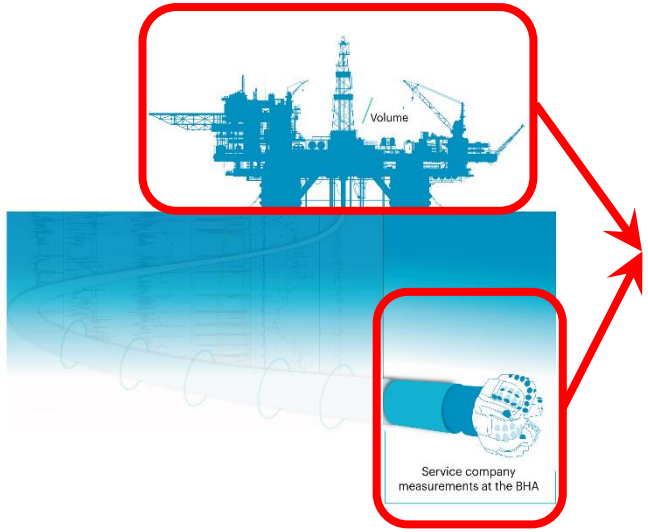
Why it is so important?

- / key technical challenges
  - Wells- Deviated, Extended Reach, Horizontal, Tight/ Depleted/ Narrow mud weight, HPHT wells
  - Operations- Deepwater, Ultra-deepwater
- / Cost objectives
- / Corporate goals

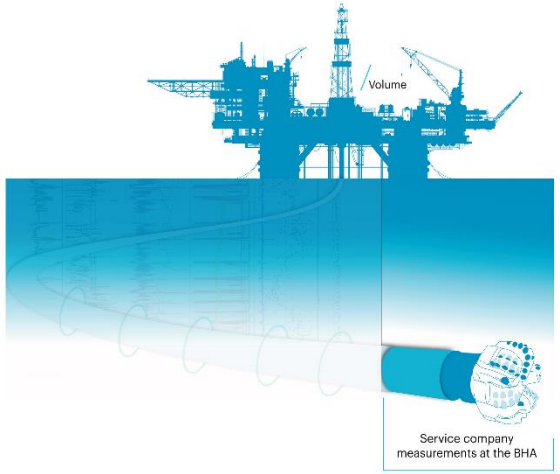
Scope for Drilling Optimisation

- ✓ Anticipate and Prevent issues leading to NPT
- ✓ Identify & Avoid ILT issues
- ✓ Maintain Wellbore Integrity
- ✓ Enhance Operational Safety
- ✓ Increase Drilling Efficiency

Traditional/Conventional Drilling Operation



- Data Aggregation
- Reacting and reviewing when incidents have taken place
- Performing cause analysis
- Need for continual re-calculation of static models



Reactive Drilling Optimisation

Real-time Drilling Optimisation (RTDO) - Concept

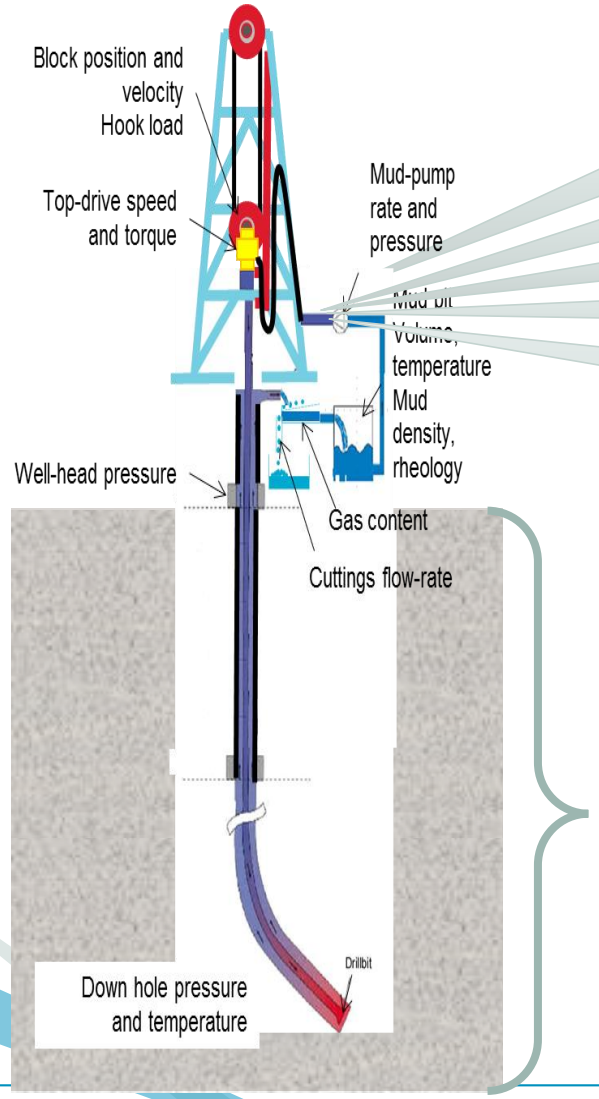
Essential Aspects of Drilling Optimisation

- Pre-planning in advance has limited impact as Drilling is a continual activity
- Need to incorporate Mechanical, Hydraulic, G&G and Thermal aspects
- What is not measured, can't be optimised
- Prototype - What-if, Look Ahead & Scenario-based Analysis

Key Aspects of RTDO

- State-of-the-art **Real-time Application**
- Advanced Transient Drilling Models - tightly coupled **Thermodynamic, Hydraulic & Mechanical (THM) Model**
- **Digital Twin of Wellbore** - Create dynamic, real-time picture of the entire wellbore

Real-time Drilling Optimisation - Methodology



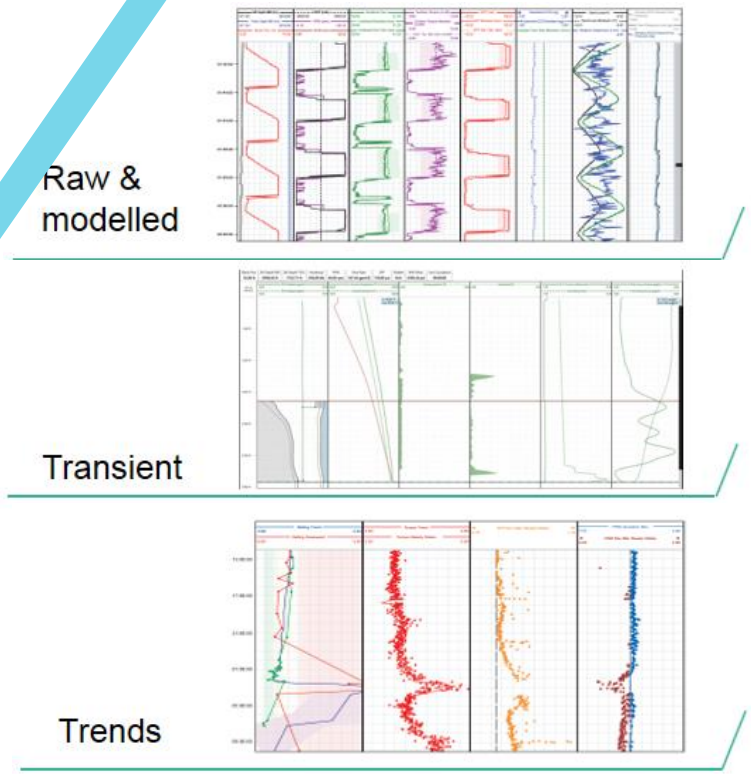
Real-time Data

- Sensor data
- LWD/MWD
- PWD
- Mudlogging
- Sample data

Configuration Data

- Well Profile
- Casing Design
- BHA Design
- Pore Pressure
- Fracture Pressure

RT Data Drive & Govern the model in Real-time



Compare RT data with modelled Output

Develop Transient Plots for Wellbore Condition

Plot the deviation when RT data deviate from Modelled O/P

Software HMI

WITSML export

Notifications

Western Australian Section

Real-time Drilling Optimisation - Methodology

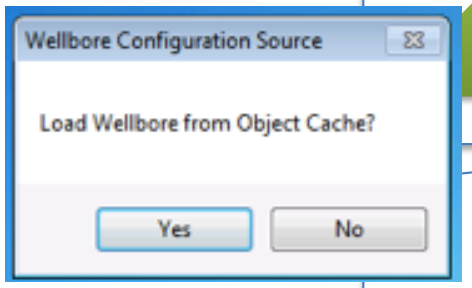
Real-time monitoring of operations with RTDO

Monitor with RT models using RT signals as input

Detect deviations between modeled output and rig sensors

Report and discuss abnormal trends with drilling team

Implement changes if required



One-click transfer of current downhole conditions from Real-time into Offline simulation tool

Apply models in calibrated offline simulations

Import current downhole situation and calibrated configuration into simulation tool

Simulate current situation and the expected outcome of possible solutions

Run what-if scenarios

Test ideas before implementation

Run look-ahead simulations with current or alternative drilling / tripping parameters

Model expected performance

Run transient hole-cleaning simulations

Optimize tripping speeds

Apply gel breaking before speed increase

Model downhole temperature evolution while tripping

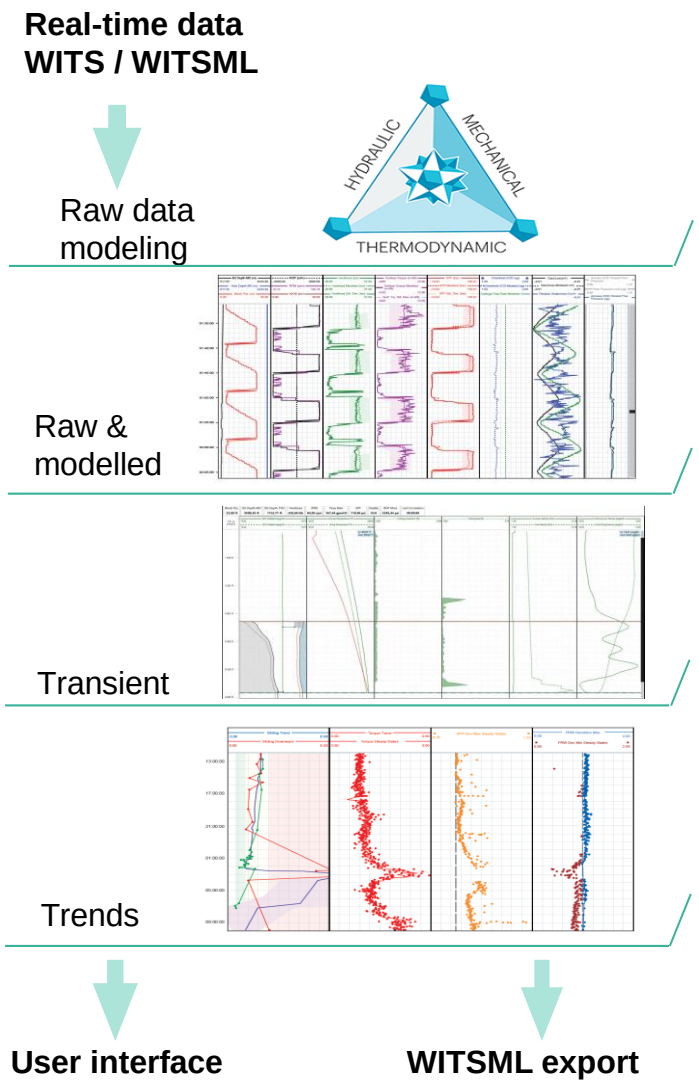
(examples)

Make informed decisions

Optimize operations

Observe results versus expected outcome

Real-time Drilling Optimisation - Methodology



Monitoring and trend analysis with real-time dynamic models

/ Delivers real-time transient simulations of:
- Cuttings transport, bed generation & erosion
- Downhole ECD, surge and swab along entire wellbore
- Automated drilling / tripping roadmaps

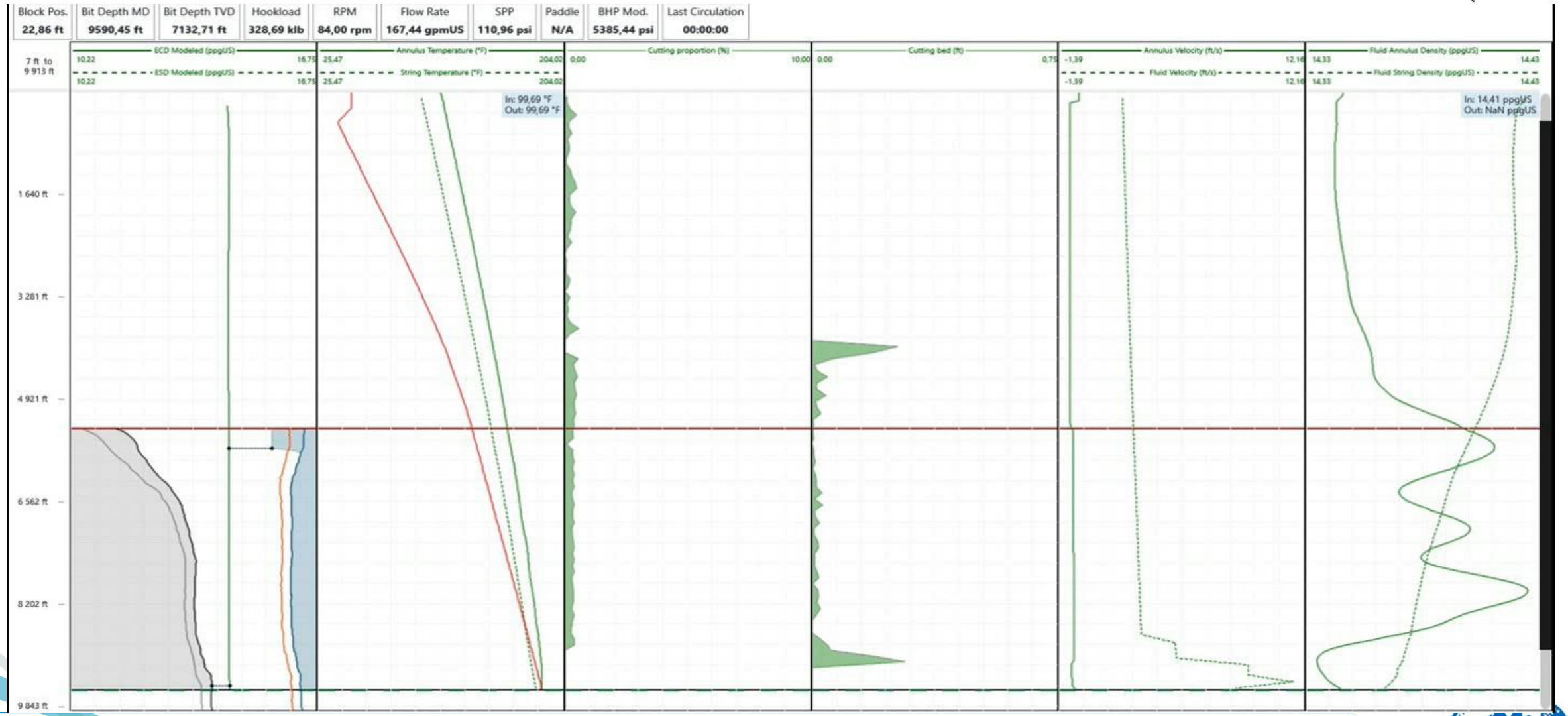
/ What-if analysis:
- Validate the decided action on the current state of operation before it get implemented
- Leads to eliminating ILT
- Optimise Operation

/ Look-ahead:
- Perform actions in futuristic horizon to see what will happen if continue current state of operation
- Ensure reduction in operational and/or technical NPT
- Make informed decisions

Supports proactive drilling decisions

Real-time Drilling Optimisation – Transient simulation

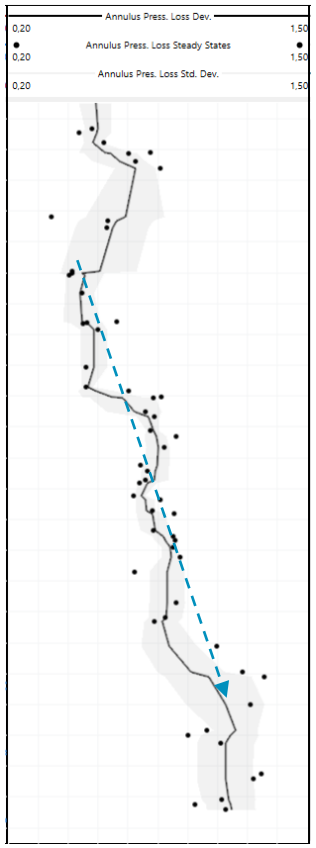
Cutting Transport & Transient ECD



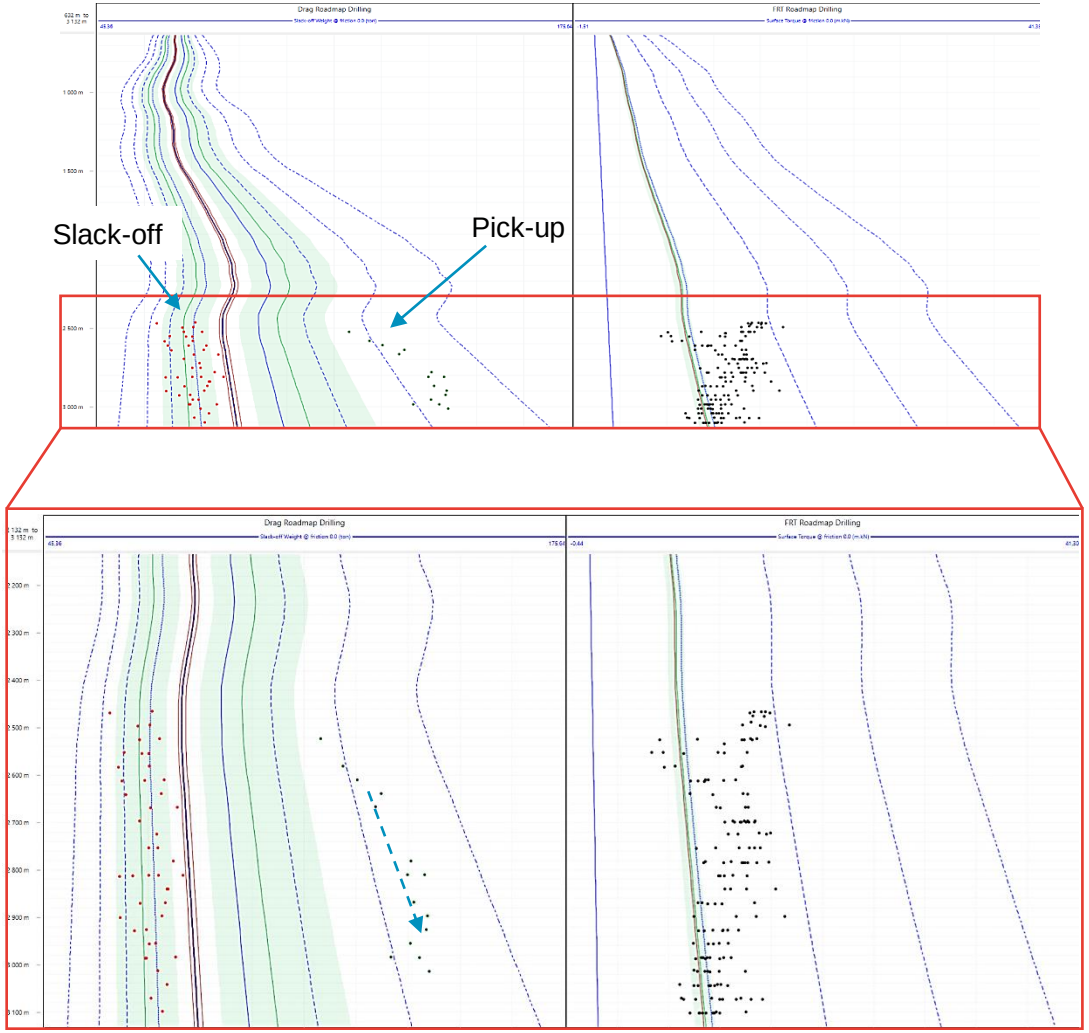
Real-time Drilling Optimisation – Look Ahead

Dynamic Roadmaps

- ✓ The system automatically detects pick-up, slack-off, FRW and FRT during steady conditions for roadmapping
- ✓ Considers current conditions, mud properties and updated trajectory
- ✓ The roadmaps preserve history and visualize trends
  - ❑ Drilling roadmaps
    - Hookload, torque, FRW
  - ❑ Tripping roadmaps



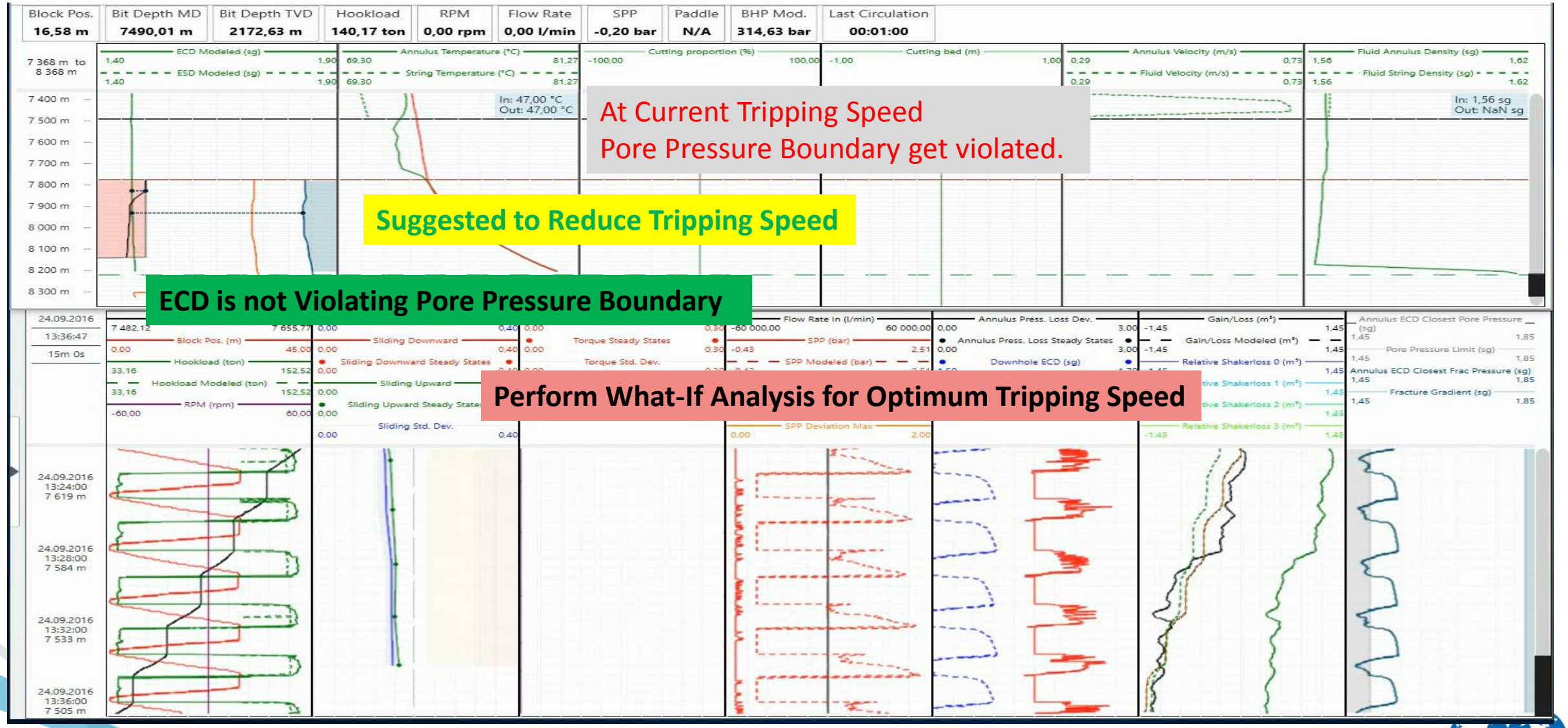
Increasing annulus pressure loss deviation



The auto-generated roadmap shows increasing upward drag while drilling

Real-time Drilling Optimisation – 'What-if' Analysis

Tripping Operation - Pulling out of hole



Real-time Drilling Optimisation

Proactive Drilling Decision

Assess

- Drilling Performance
- Borehole Conditions
- Risks
- Interaction between Surface equipment, drill pipe & Wellbore
- Opportunity for Operational Anomalies, Optimisation

Anticipate & Avoid

- Poor hole Cleaning
- Stuck Pipe
- Pack Off
- Lost Circulations, Gains
- Underground Blowout
- Swab and Surge
- Torque and Drag
- Formation Damage
- Borehole Instability

Results/Outcome

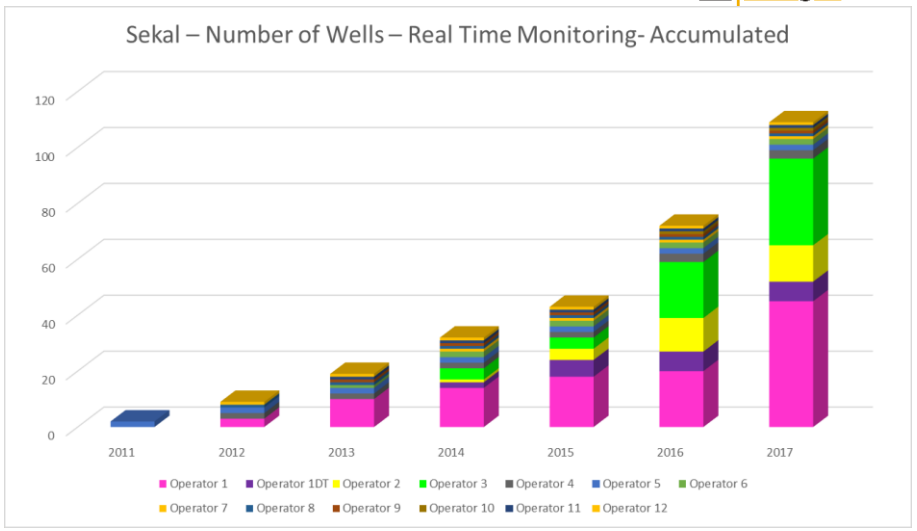
- Improved Drilling Efficiency
- Reduction in NPT, ILT
- Enhanced Safety
- Simplify Real-time Analysis
- Effective Cost Savings
- Optimum Drilling Performance
- Proactive Drilling Decisions

Real-time Drilling Optimisation – Reduce NPT

Technical Sidetracks:

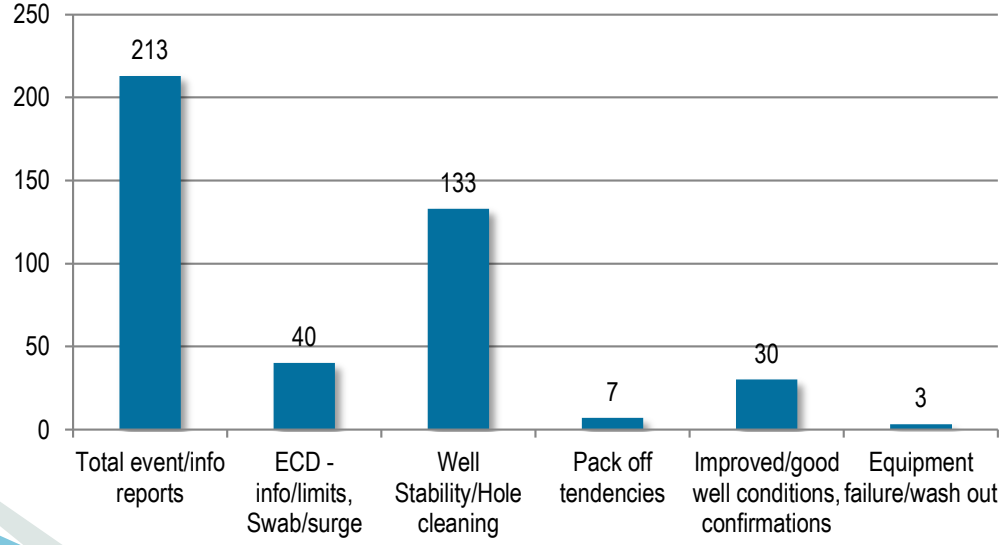
Norway, reported to NPD 2013 – 2016:

- 176 sidetracks on 558 development wells (31.5%)



Statoil

- ✓ 1000+ days real-time monitoring of drilling operations
- ✓ Improved downhole awareness reduced escalating wellbore problems



Operator data 2013 – 2015:

- 90 sidetracks on 280 wells (32%)
- Study of sidetracks: main reason - POOH
- Cost of sidetracks: > **USD 220Mn / year**

Data from Wells with RTDO software:

- Only 7 sidetracks in 116 wells: **6.03%**
- Statistically, 29 technical sidetracks were avoided

Cost saving potential for Operator:

- Sidetrack reduction of more than 80%
- Operator data above: Potential yearly savings: **>USD 175Mn.**

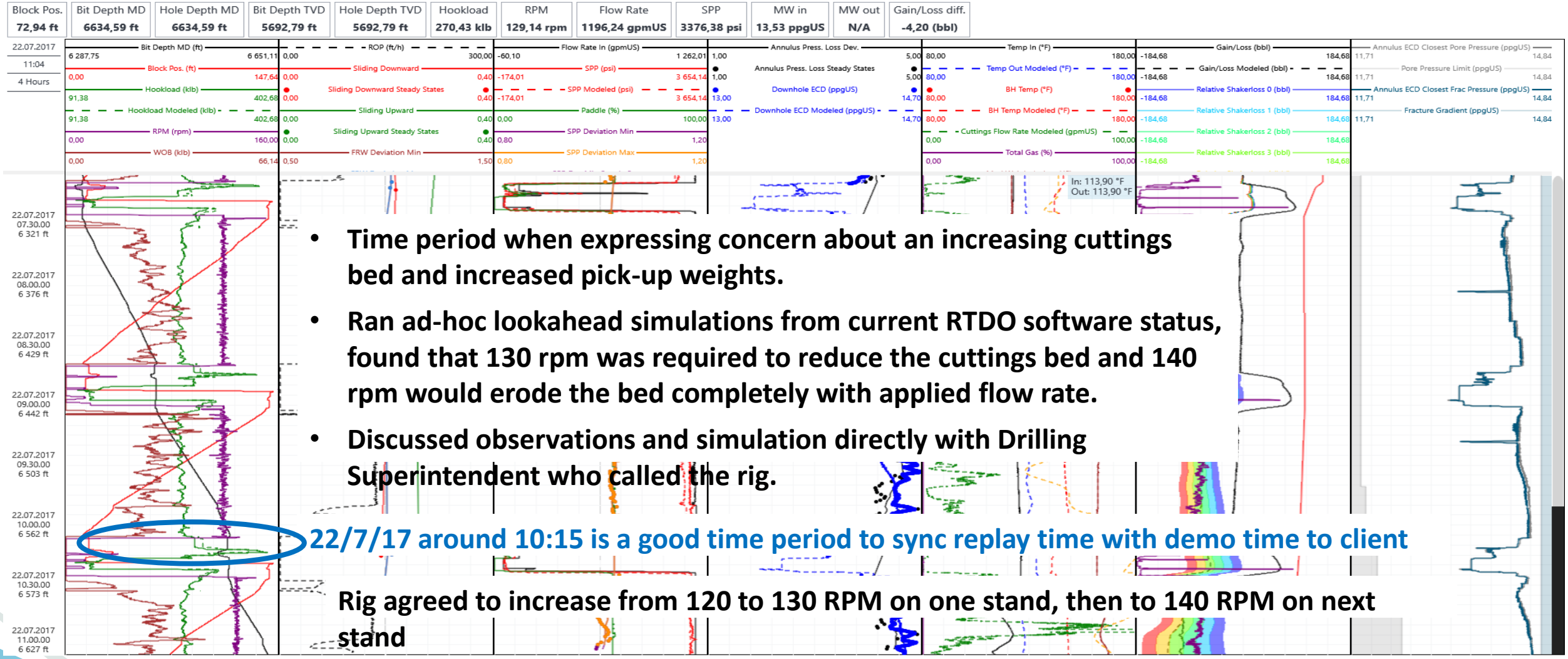
Real-time Drilling Optimisation – Efficient Drilling

MAERSK OIL

- Pre- and Lookahead simulations optimised drilling operations, significantly reduced NPT
- No drilling and liner run problems due to THM driven RTDO software' forecasting and trend analysis

- 9 + 2 wells drilling program
- First well AFE 110 days, completed in 125 days
  - Wellbore instability issues – No simulations were performed
- Well 2 reduced time from 110 days to 61 days (P10)
  - Simulation support to optimize;
    - hole cleaning
    - pump start-up
    - Liner/casing running speeds
  - RT Monitoring, Forecasting and Trend Analysis
    - No technical side-tracks during the campaign
    - Last two wells monitored by Maersk
- Following wells completed ahead of AFE

Wellbore Stability– Look Ahead Analysis



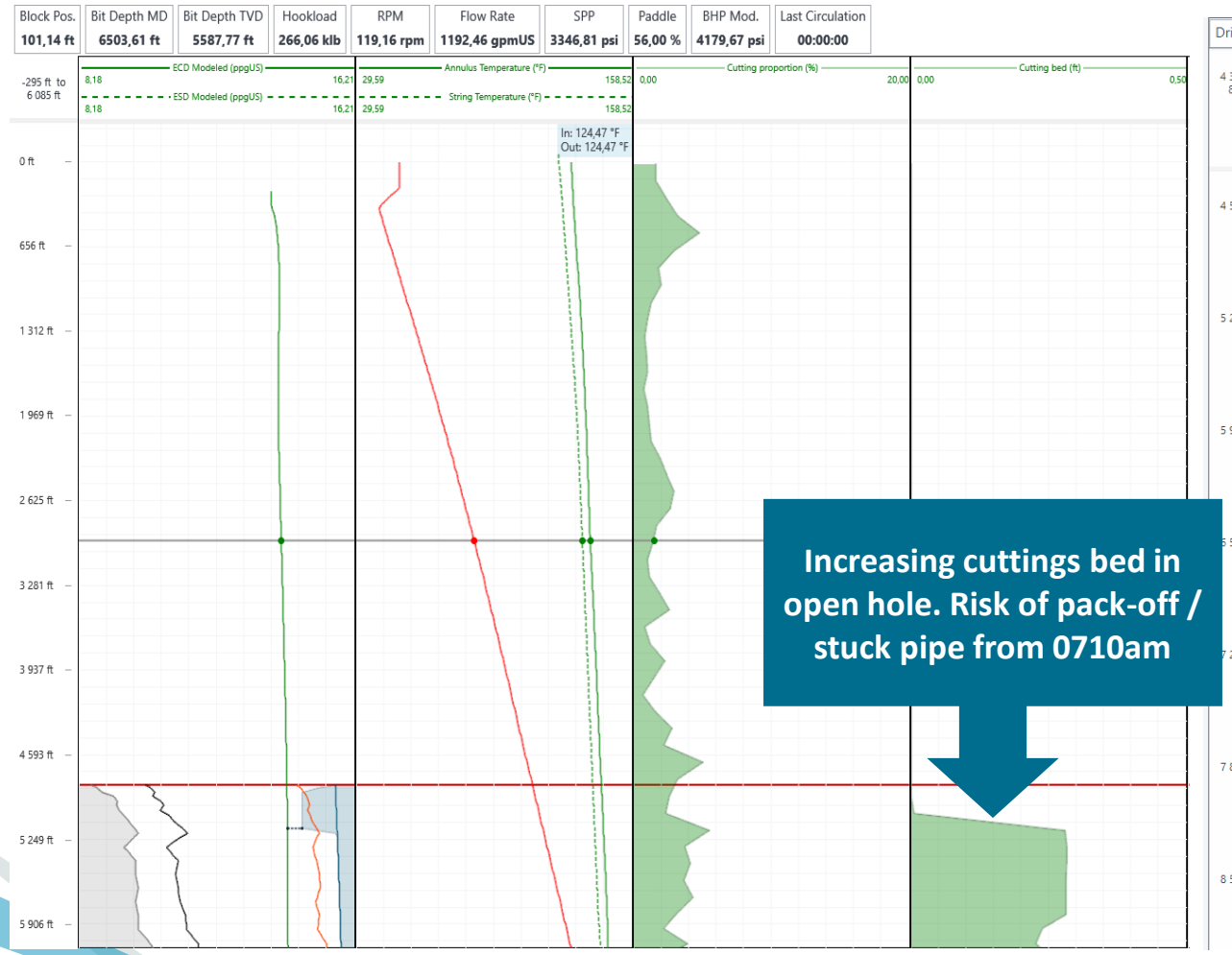
- **Time period when expressing concern about an increasing cuttings bed and increased pick-up weights.**
- **Ran ad-hoc lookahead simulations from current RTDO software status, found that 130 rpm was required to reduce the cuttings bed and 140 rpm would erode the bed completely with applied flow rate.**
- **Discussed observations and simulation directly with Drilling Superintendent who called the rig.**

22/7/17 around 10:15 is a good time period to sync replay time with demo time to client

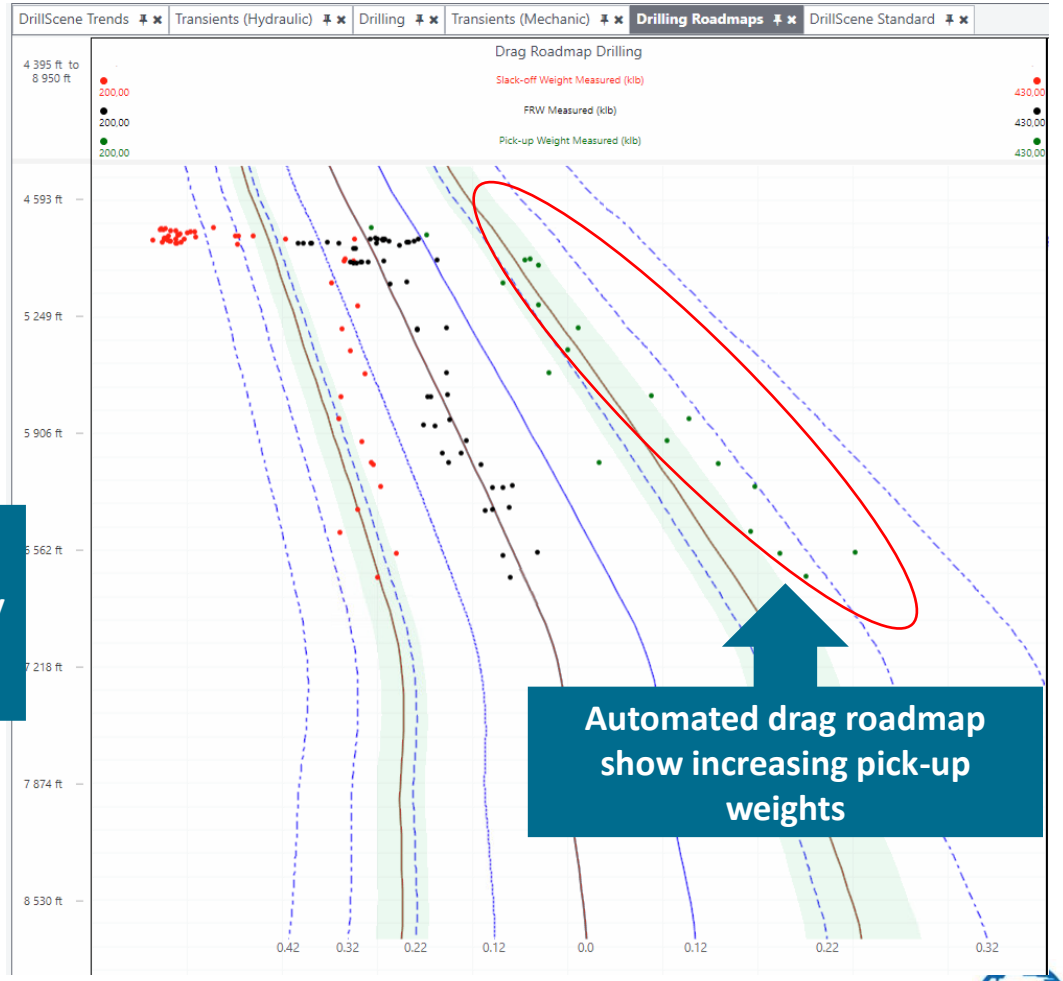
Rig agreed to increase from 120 to 130 RPM on one stand, then to 140 RPM on next stand

Wellbore Stability– Look Ahead Analysis

Automated drag roadmap confirms cuttings bed. Ad-hoc simulations run for clean-up strategy.



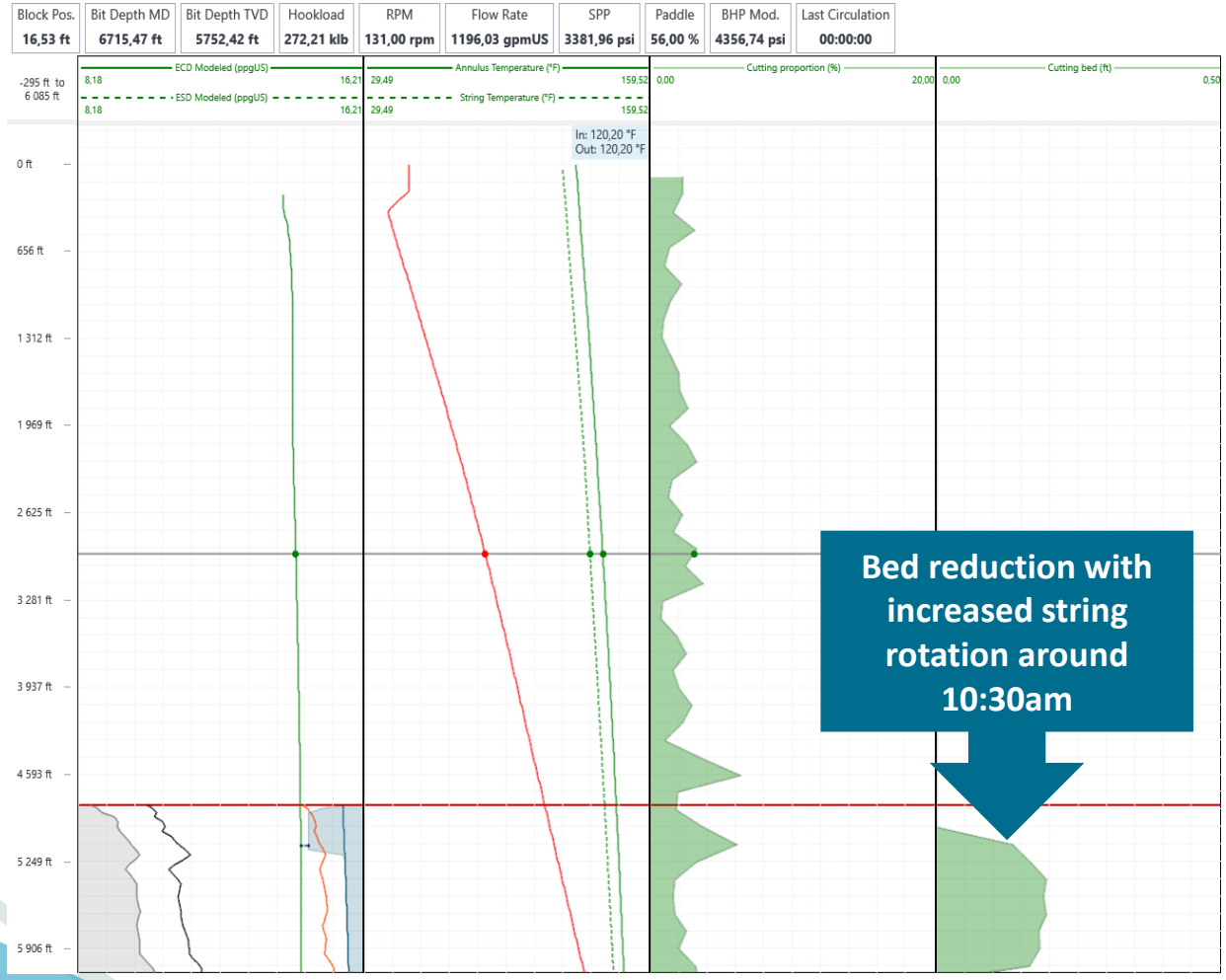
Increasing cuttings bed in open hole. Risk of pack-off / stuck pipe from 0710am

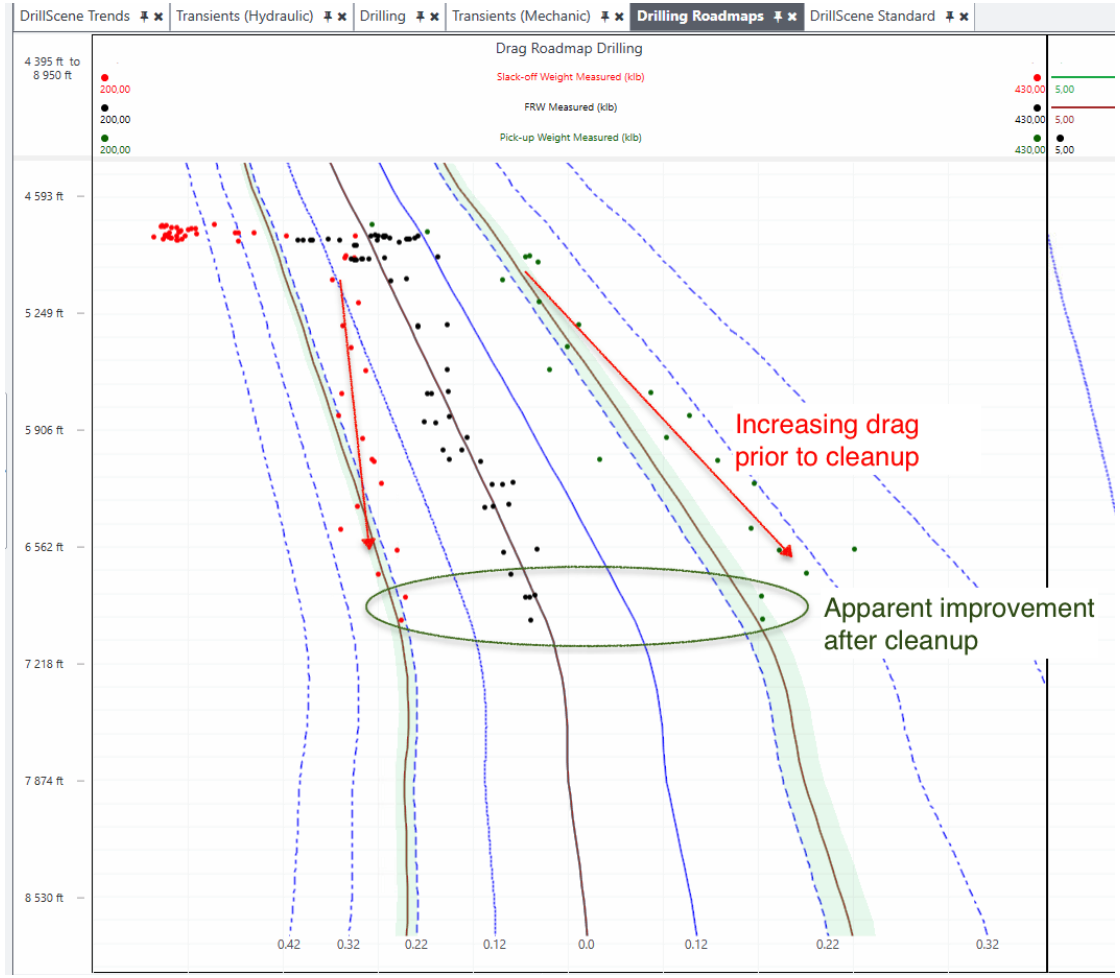


Automated drag roadmap show increasing pick-up weights

Wellbore Stability– Look Ahead Analysis

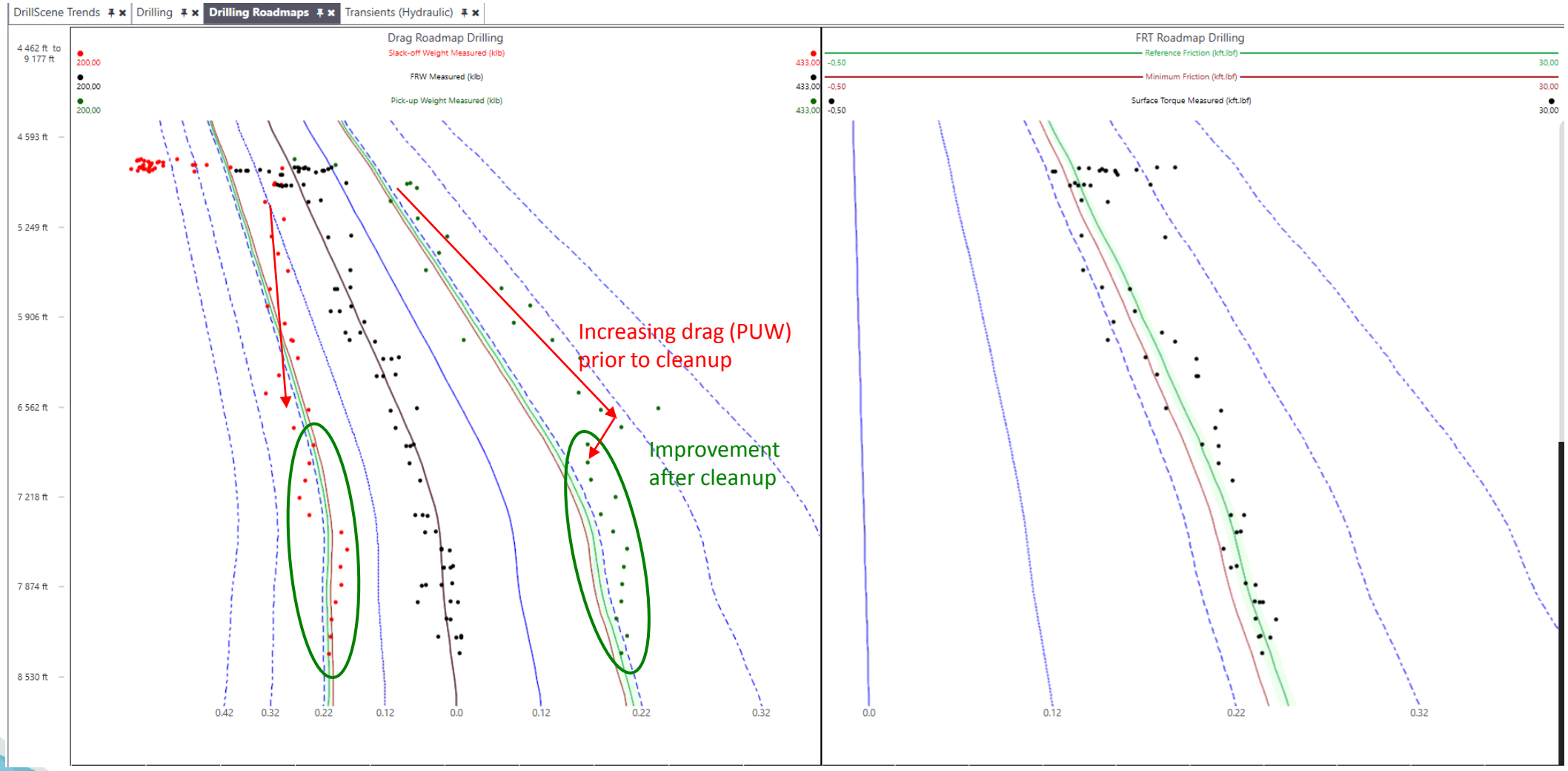
Immediate improvement after clean-up



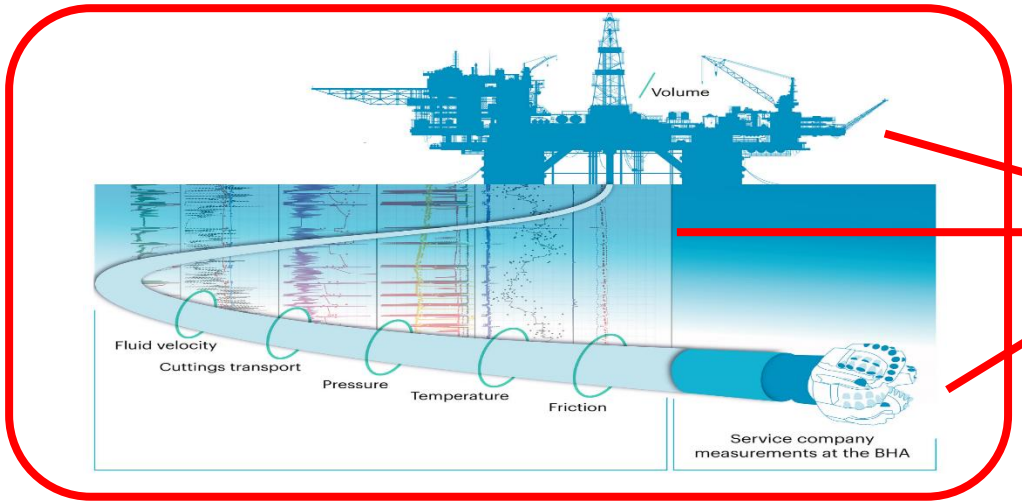


Wellbore Stability– Look Ahead Analysis

Continued drilling to TD with 130 rpm



Real-time Drilling Optimisation – Conclusion



Drilling Operation
With **Real-time Drilling Optimisation Solution**

- High fidelity Physics based approach – to better understand the entire wellbore
- Real-time Dynamic model - to better understand changing conditions
- Simply real-time monitoring – accelerate Decision making
- Notify early symptoms of issues - Revealing the symptoms of non productive time
- Optimisation opportunities - Identifying performance improvements to drive drilling efficiency

Thank You….

Question / Answer

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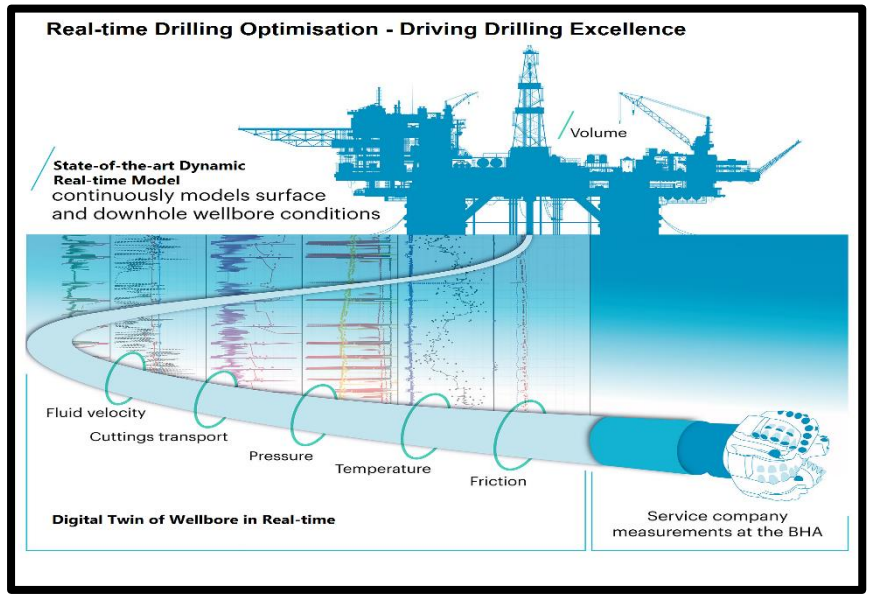

Established 2011

20 years technology development by IRIS

Funded by operators; Statoil, Chevron, ENI, and BP together with the Norwegian Research council

IP Owner

Statoil

aramco energy ventures

IRIS International Research Institute of Stavanger

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