Solid-State Gyro Technology Allows Safe and Reliable Real-time Remote Operations
(Based on SPE-205870-MS)

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Content

• Background on gyro technology
• Tool verification process
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Gyro Sensors - Background

Post-drilling surveys
- The gyro is not part of the BHA
- Wireline
- Memory (drop or slickline)

“Real-time” drilling surveys
- The gyro survey tool is part of the BHA
- Closer to the bit
- Independent survey data
- Uncertainty reduction
Gyro Sensors

Dry Tuned Gyroscope (DTG)

- Very low noise
- Fragile (8G’s rms Vibration)
- Very complex (~16ft tool)
- High power consumption
- Spin-up time required (~30 sec)

Solid State Gyroscope

- Low noise
- Robust (20G’s rms Vibration)
- Simple (~3ft tool)
- Very low power consumption
- No spin-up time
Tool Verification Process

1. Job Callout, planning and preparation
2. Pre-job activities - base
3. Pre-job activities - wellsite
4. Job execution
5. Post-job activities - wellsite
6. Post-job activities - base
7. Equipment Return, maintenance & Certification

Tool Verification Process
### Tool Verification Process

#### Activity | DTG | Solid-state
--- | --- | ---
1. Job Callout, Planning & Preparation | 3 hrs | 3 hrs
2. Pre-job Activities - Base | 11.5 hrs | 9 hrs
3. Pre-job Activities Well site | 15 hrs | 3 hrs
4. Job Execution – survey time | 2m20sec - 3min35sec | 2min
5. Post-job Activities – Well Site | 7 hrs | 1 hrs
6. Post-job Activities – Base | 13 hrs | 10 hrs
7. Equipment Maintenance / Recertification | 10 hrs | 3 hrs
## Uncrewed Operations

<table>
<thead>
<tr>
<th>DTG Technology</th>
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<tbody>
<tr>
<td>2 SS* at Well Site</td>
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<tr>
<td>Tools loaded in the collar at the Well Site</td>
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<tr>
<td>Pre-job well site checks completed by SS</td>
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<tr>
<td>Job execution completed by SS at well site</td>
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</tbody>
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*SS* refers to solid-state sensors or similar technology used in uncrewed operations to monitor and execute tasks remotely. The diagram illustrates the sequence of operations, starting with technology deployment and ending with job execution. Each step is represented by an arrow, indicating the flow of activities from one phase to the next.
Survey Automation

Auto-decode of survey data means no intervention required from RMC and minimal training required for 3rd party monitoring.
Survey Automation - Troubleshooting

Interrogation of additional data in the WITSML feed allows basic troubleshooting and recommended actions to be generated when surveys fail QC.
Case Study I

- Jack-up - 16” hole section
- Phase II uncrewed operations.
- North Sea – Norwegian sector
- Expected magnetic interference from 550 to 850 mts.
- Inclination: 5 to 27 deg.

Benefits of the solid-state GWD:
- Seamless drilling in area of magnetic interference
- Rig-time saving of 30 minutes
- Independent validation of MWD data
Case Study II

- Jack-up – 12.25” hole section
- Phase II uncrewed operations.
- North Sea – UK sector
- No expected magnetic interference
- Inclination: 68 to 71 deg.

Benefits of the solid-state GWD:
- MWD & Solid state GWD surveys over 18,000 ft section combined to produce reduced EOU making hitting geological target achievable.
Uncrewed Operations – Environmental Benefits Summary

Remote Operations
- Engineer not travelling Offshore
- Ease POB constraints & costs
- Reduce helicopter requirements
- HSE

Reduced Rig Operational impact
- Reduced Crane Operations
- Reduced Footprint On Rig
- Reduced BHA handling
- Testing /verification onshore

Engineer Travel
- Remote Operations reducing domestic & International travel

Lower Power Consumption
- Reduced Battery Consumption
- Reduced Environmental Impact
- Enabling Remote Operations

Reduced / Lighter Shipments
- Smaller shipping boxes
- Loaded out in collar no container
- Shortened collar required

Fewer Shipments
- Maintenance frequency reduced
- Calibration frequency reduced
Conclusion

• Solid state technology contains a number of benefits over spinning mass gyros to enable remote monitoring
  • Lower power consumption
  • Increased shock tolerance
  • No shift in calibration
  • No requirement for real time or post run correction
  • Simplified testing and QC

• High levels of automation are achievable allowing tools to be run by 3rd parties with minimum training requirements.
Acknowledgements

• Thanks to co-authors Adrian Ledroz (Gyrodata) and Navin Maraj (Halliburton).