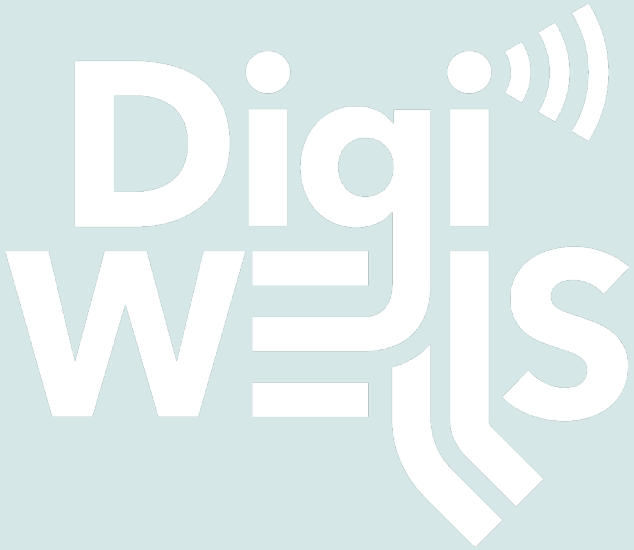
Annual Report 2025

DigiWells

Contents

DigiWells' Vision and Objectives	3
Message from the Board Chair	4
Message from the Director	5
About DigiWells / Partners	6
Automatic Well Engineering	7
DrillOpPlan - Automatic Drilling Operation Plan	10
DDBot:AI for Automatic Population of D-WIS Semantical Models	12
Dynamic Verification and Validation	15
DigiWells Annual Seminar	17
Spin-off Projects	20
DigiWells Innovation program	20
KSP Towards Autonomous Coiled Tubing Operations	23
Distributed Damping Subs - Verification Project	24
3D GIG: 3D Geological Interpretation for Geosteering of Wells	26
Status from UiS	27
From stavanger to Rio	31
Felix James Pacis Thesis Defence	33
Pauline Nüsse Thesis Defence	34
Center Management and Board of Directors	36
Postdocs / PhD students	37
Publications	42
Personnel	44
Statement of Accounts	45



DigiWells:
Digital Well Center for Value Creation, Competitiveness and Minimum Environmental Footprint

Vision

Unlock subsurface resources through improved drilling and well technology.

Main objective

DigiWells aims to develop new knowledge, methodologies, and innovative solutions to optimize the well delivery process with special attention to challenges and possibilities at the Norwegian Continental shelf.

Subobjectives

- Develop more efficient work processes for planning the well delivery process by new workflows that addresses the uncertainties in a systematic way
- Develop techniques for fast modelling of the drilling and formation evaluation processes to enable optimization and improved decisions
- Investigate and develop solutions for automation and autonomous well delivery process
- Investigate and develop new measurement techniques that will improve process control
- Investigate and develop innovative hardware concepts to improved drilling performance based on in- depth understanding of the drilling process
- Support standardization and interoperability
- Strengthen collaboration between academic and industrial players
- Ensure industrial relevance and generate new ideas by performing case studies in collaboration with end users

Center management and EPIC leaders, from left: Eric Cayeux, Benoit Daireaux, Helga Gjeraldstveit, Rodica Mihai, Sergey Alyaev and Erlend H. Vefring. Photo: Screen Story

You got to have faith

Dear reader,
A new Annual report from DigiWells is available for you to read. The report is full of information about the activities in DigiWells to date. The DigiWells focus is on developing digital technologies to improve the well construction process with the aim of increasing efficiency, reducing costs, and minimizing environmental impact. DigiWells is also a valuable supplier of digital well competence to the industry through several PhDs and Postdoctoral researchers.

Last year I shared the very good feedback we got on our half term review for the SFI Center from a panel of external industry experts.

When writing this we have just finalized a 2-week highly successful test at Ullrigg of the DWiS system. This system is developed by DigiWells in collaboration with Society of Petroleum Engineers (SPE) and the industry to develop a standardised interface for how we can interact with rig control systems so that the industry can implement autonomous drilling technology easily on existing rigs. This Ullrigg test was a part of the DigiWell Innovation Program that has been set up to mature the technology from the SFI further to reduce the gap towards industry implementation. This test was a major milestone, the next milestone being a planned test of the same system on Odfjells DeepSea Stavanger operated by Aker BP on the Yggdrasil later in the year.

It is also worth to mention the Automated Well Engineering field cases that also will be run this year on field data from Aker BP, ConocoPhillips and TotalEnergies. Here one will apply the new workflow from this Epic on field data and can assess the speed-up and increased quality of well planning using this new automated well planning workflow.

These tests show the role the sponsors and operators have, to make sure the good work done by the research institutes are relevant and can be implemented and used in the industry after the current SFI is ending.

The Norwegian Continental Shelf (NCS) is maturing after a wave of new projects have been executed the last few years. Everyone agrees that the future targets at NCS will typically be smaller and in more complex reservoirs, like HPHT and tight reservoirs or a combination of the two. Companies are looking at low-cost subsea tiebacks to existing infrastructure and extended reach drilling (ERD) of wells from existing drill centers to tap into small pools of hydrocarbons. This makes it difficult to maintain some of the key performance indicators, such as for an example cost/barrel since volume (barrels) are reducing and complexity (cost) is going up. One of the options the drilling and wells industry needs to investigate to keep costs down is automation of the existing rigs and drilling processes in an economical way. DWiS from DigiWell will help us achieve this.

Tron Golder Kristiansen. Photo: AkerBP

The heading is also this year from a famous song, this time from “Faith” a song by George Micheal (covered by among others Limp Bizkit…). It was suggested by Calvin Holt, Drilldocs (participating in the Ullrigg test last week). It follows nicely from last year’s song about prayers and faith. I guess this is what it is all about when developing new technology and testing it out in the real world.

Tron Golder Kristiansen, Board Chair

Message from the Center Director

The center has now been operational for just over five years.

Remarkable achievements have been made in 2025 thanks to the dedication and hard work of our clever scientists, PhD students, professors, and support team, as well as our close collaboration with industry partners. For 2025, we prioritized four main activities: “Automatic drilling engineering”, “Automatic drilling operational planning”, “Dynamic verification” and “DDBot – AI for automatic population of semantics”. Case studies were also performed. These activities were chosen in consultation with the end users, and they continue initiatives started in the center earlier. Now 4 PhD students have defended their thesis, and we are looking forward to coming defences.

Several spin-off projects have been initiated and started based on the activities in SFI DigiWells. The spin-off projects “3D Geological Interpretation for Geosteering of Wells” and “DISTINGUISH: Decision Support Using Neural Networks to Predict Geological Uncertainties When Geosteering” have been active since 2023. The verification projects “In-line PVT Measurements” and “Magnetic Damping Tool” are ongoing. The competence-building project “Towards Autonomous Coiled Tubing Operations” started in 2024 and is ongoing. The largest spin-off project is “DigiWells Innovation Program” which focuses on interoperability and autonomous drilling. Together, these projects complement the overall objectives of DigiWells and create significant synergies.

A crucial ongoing activity involves the center’s key personnel participating in international forums and committees, promoting interoperability and standardization. Center scientists collaborate with the cross-industry group D-WIS (Drilling and Wells Interoperability Standards). Several demonstrations with different industrial players have been performed in 2025 and beginning of 2026. A highlight was the demonstration of interoperability and autonomous drilling at Ullrigg early in February / March 2026.

The two-day annual DigiWells seminar was held in November for center partners and representatives from key external entities, including service companies, industry clusters, and public authorities. This annual seminar is vital for dissemination of knowledge and strengthening relationships with key stakeholders. The seminar also featured a panel debate and extensive interaction with participants.

Erlend H. Vefring. Photo: Rune Rolvsjord/NORCE

We eagerly anticipate an exciting 2026, filled with further advancements in research, development, innovation, support for industrialization, and collaboration.

Erlend H. Vefring, Centre Director, NORCE

About DigiWells

Digitalization, new sensors, interoperability, automation, autonomy, and improved work processes have the potential to enable a step change of the well delivery process.

The centre explores these possibilities by combining domain knowledge with fundamental research to accelerate the digital transformation of the well delivery process.

The centre aims to develop new work processes for planning drilling and well operations, new sensors, solutions for interoperability, solutions for automated and autonomous drilling, and decision support systems for geosteering. New solutions are planned to be demonstrated, often in spin-off projects, at the national research infrastructures OpenLab Drilling, Ullrigg and against field data from operators.

The centre supports collaboration between operators, service industry, public authorities, research institutions and academia in Norway and internationally. Results from the centre's activity enables innovation, business development, and value creation for Norwegian society. Moreover, in collaboration with universities, the centre will educate the next generation of specialists who will help implement the achieved research results.

Results from the research performed in DigiWells are disseminated to operators, service companies, public authorities, and academic partners to enable innovation and value creation.

Partners

AkerBP

ConocoPhillips

equinor

TotalEnergies

vår energi

Harbour Energy

PETROBRAS

ODFJELL DRILLING

Sekal

KONGSBERG

Universitetet i Stavanger

NTNU
Norwegian University of Science and Technology

UNIVERSITY OF BERGEN

The Research Council of Norway

NORCE

Automatic Well Engineering

We are moving from static, manually generated drilling programs to automatically generated, dynamic drilling programs. A first version of Automatic Well Engineering is now ready to be applied in use case in collaboration with the user partners.

Digitalization of the drilling process gives new opportunities. A novel framework for automatically generating drilling programs to support both automated and autonomous drilling is being developed. In well-construction, a plan and a strategy are essential for achieving the mission of drilling and completing the well as effectively and safely as possible.

The plan involves drilling and completing the well section by section, progressing one stand at a time until reaching the total depth (TD) of each section.

The strategy provides an adaptable framework to handle drilling challenges such as optimizing hole cleaning and managing drill-string vibrations to stay within an acceptable level. However, due to uncertainty about actual subsurface conditions and the operational risks inherent in drilling, adjustments often must be made to accommodate with scenarios that are different from those anticipated during the planning phase. Various tactics are employed to manage the complexity of well construction like for example adjusting the flow rates or rotational speed to control cuttings transport. Such real-time adjustments may have been investigated in advance and may stay within the margins set by a drilling strategy.

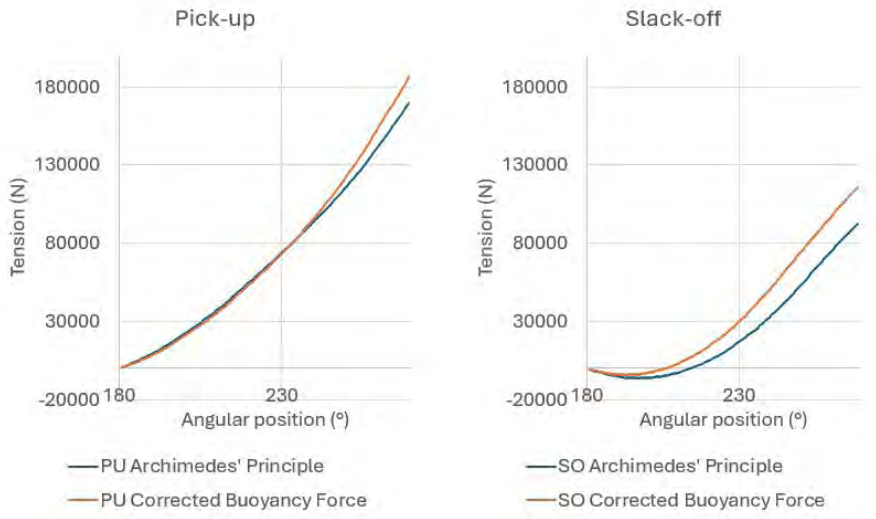


Fig 1: Archimedes' based versus Buoyancy Corrected show an observed effect of 10-20% difference in a 3°/30m 90° vertical curved section. Strongest effect in slack-off condition.

The plan can be viewed as a hybrid arrangement of sequential steps (such as drilling sections) combined with recommended strategies and tactics. It enables an autonomous system to make informed decisions and generate dynamic plans to overcome challenges, when encountered, throughout the well construction process by utilizing the strategies that have been explored at the planning stage. The method is generative, as it automatically creates potential solutions.

Torque and drag

The last objective of the planning tool has been to establish a fast yet sufficiently accurate method for performing torque-and-drag calculations on the large number of candidate trajectories automatically generated by a generative well-planning workflow.

Normally, torque and drag are calculated by breaking the well into many tiny segments and performing thousands of calculations along the entire length. While accurate, this approach is too slow for large-scale screening. The method presented here solves this problem by using long steps: each major section of the well is calculated in one step instead of many. This reduces the number of calculations from hundreds or thousands to just a few per trajectory.

The work shows that some details that are often simplified actually matter. One example is buoyancy. Many models use Archimedes' principle, but this turns out to be incorrect for a continuous drill string. While this simplification does not affect straight or horizontal sections, it can change torque and drag predictions by 10–20% in curved vertical sections. Using the corrected buoyancy formulation significantly improves accuracy in these cases.

Another important finding is related to how the drill string contacts the wellbore in curved sections. In vertical curves, the string can move from the low side of the hole to the high side. If this change is ignored and the entire curve is treated the same way, large errors can occur. By splitting the curve at the point where this contact changes, the calculations remain accurate without adding extra computational cost.

For simple well geometries (vertical and horizontal), exact analytical formulas were developed. These show that traditional numerical methods need very small step sizes to be accurate—something that is often overlooked. For fully 3D well paths, exact formulas are not possible. Instead, a pseudo-analytical method that combines analytical investigation of special cases with data-driven, machine-learning-inspired techniques achieves a satisfactory accuracy of approximately 5% relative error when compared with numerical integration.

Overall, the approach dramatically reduces computational complexity—from hundreds of calculations per well to just a few dozen—while maintaining sufficient accuracy. Importantly, computation time depends on the number of well sections, not the total well length. By combining analytical physics with data-driven, machine-learning-inspired techniques, this framework enables fast, automated mechanical evaluation and represents a key step toward scalable, intelligent well planning.

The Automated Well Engineering Team. From left Gilles Perfrene, Eric Cayeux and Lucas Volpi. Photo: Screen Story

Gilles Perfrene. Photo: NORCE

Eric Cayeux. Photo SPE

Publications

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"Automatic calibration of systematic biases in directional drilling control for planar and non-planar curves", L. Saavedra Jerez, UiS, E. Cayeux, NORCE, D. Sui, UiS, Geoenergy Science and Engineering, Volume 246, March 2025, https://doi.org/10.1016/j.geoen.2024.213642

"Assisting Directional Drilling by Calculating a Safe Operating Envelope", L. Saavedra Jerez, UiS, E. Cayeux, NORCE, D. Sui, UiS, SPE Journal Oct 2024, https://doi.org/10.2118/217707-PA

"Approach Uses Multidisciplinary Constraints for Automatic Well-Path Generation", Chris Carpenter, Journal og Petroleum Technology, Sep 2024 https://doi.org/10.2118/0924-0097-JPT

"Facilitating Directional Drilling Work to Reach the Target Entry by Calculating a Safe Operating Envelope", L. Saavedra Jerez, UiS, E. Cayeux, NORCE, D. Sui, UiS, IADC/SPE International Drilling Conference and Exhibition, 5-7 March 2024, Galveston, USA https://doi.org/10.2118/217707-MS

"A New Paradigm for Automatic Well Path Generation Using Multidisciplinary Constraints", E. Cayeux; G. Pelfrene; R. Mihai; E. Dvergsnes; B. P. Tjøstheim; A. Baume; R. Khosravanian; T. G. Kristiansen, SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA, October 16–18, 2023, https://doi.org/10.2118/215021-MS

"Ensemble-Based Solution for Automating Drilling engineering: Application to Directional Surveying" by Eric Cayeux, Erik W. Dvergsnes, Liv A. Carlsen and Rodica Mihai, SPE/IADC International Drilling Conference, Galveston, Texas, USA, March 2022, https://doi.org/10.2118/208791-MS

Award

Best paper of the year (2024) "Modeling of the Dynamic Annular Flow of a Quemada Fluid with Axial and Rotational Pipe Movement", OMAE2024-127159, presented and published during the OMAE conference in Singapore, Jun 2024.

DrillOpPlan - Automatic Drilling Operation Plan

Several drilling programs are automatically evaluated in a probabilistic framework capturing uncertainty, performance and potential incidents using Monte Carlo simulations. The framework facilitates the selection of a drilling program and associated drilling operation plan.

Well design and drilling operation planning has for a long time suffered from siloed organizations and software systems. Although recent efforts attempt to streamline the process via digitalization, it is still challenging to achieve agile well planning and construction because of the difficulty of revising existing plans and programs based on operational observations or unexpected events.

In DigiWells we have now a first version of automatically generated drilling programs ready for use-cases. In this process, several well designs (drilling programs) and plans are automatically generated and evaluated. The evaluation enables an objective comparison between various design/plan candidates so that the planning crew can select the best options.

DrillOpPlan introduces a probabilistic framework to automatically evaluate the design/plan candidates capturing uncertainty, performance, and potential incidents using Monte Carlo simulations.

Framework and Methodology

A first stand-alone simulation framework is up and running. It uses a hybrid modelling strategy in which physics-based models are enhanced with machine-learning techniques and historical data. This combination is essential for managing uncertainty effectively while significantly reducing

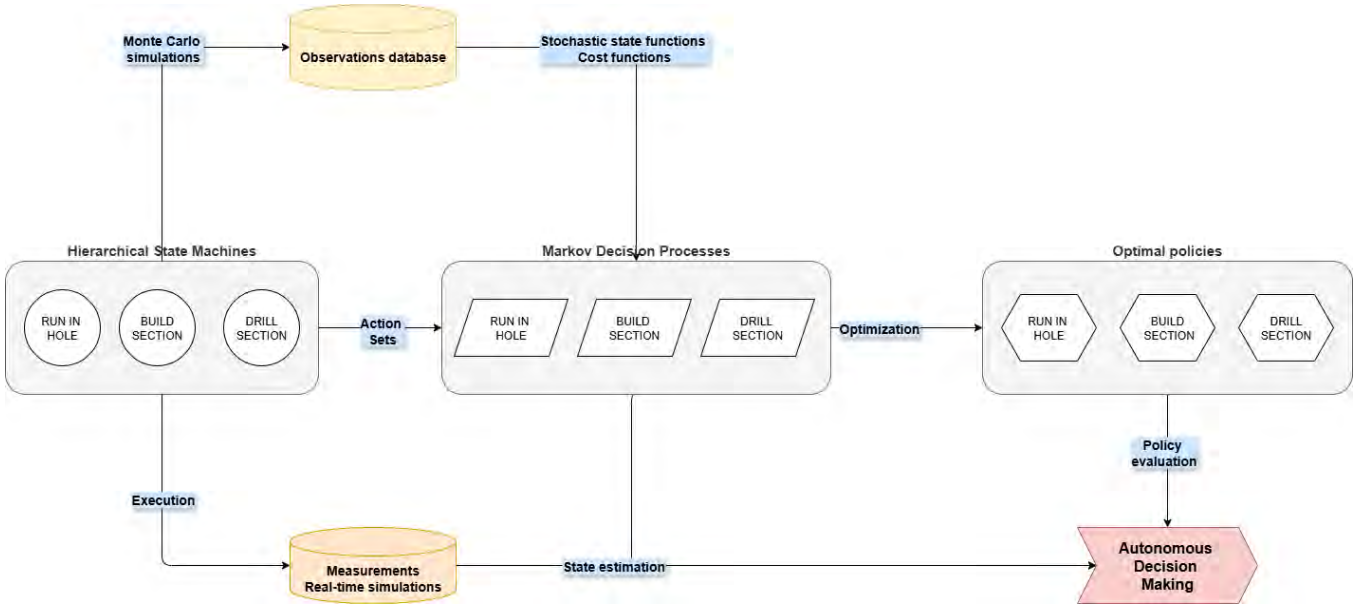

Fig 1: Workflow associated with the use of DrillOpPlan for training autonomous agents.

computational effort. The framework is designed to be flexible and generic, capable of hosting a wide range of numerical models and supporting seamless data exchange between them.

To better account for uncertainty and the operational impact of potential incidents, Monte-Carlo simulations are incorporated into the framework. The drilling process is represented through randomized sampling that reflects variations in geological conditions, operational parameters, and possible drilling incidents. Each simulation run produces a probability distribution of key performance metrics, enabling decisions to be made with a clear understanding of associated risks.

A continuous effort is ongoing to refine a generic and flexible operational plan for drilling activities. The performance of a drilling operation depends not only on the well design but also on how the operation is executed in real time. Flexibility to adjust strategies and policies is therefore essential. In this context, a strategy is defined as a mechanism that dynamically adapts the plan based on available observations. The framework incorporates automated agents that emulate decision-making during operations. To reflect the different layers of operational control, the system uses a hierarchical structure of nested Decision Agents, each overseeing a set of Mission Agents responsible for carrying out specific tasks.

The integration with Automatic Well Engineering together with enhanced user interaction will be done in 2026.

Ongoing and coming work

In addition to stand-alone risk analyses, the framework can be used as a training platform for autonomous operations. Key parameters of the optimized process can be estimated via intensive simulations: in this context it is of primary importance that the autonomous execution and pre-simulations use the same control strategy. A unified representation has therefore been designed that forms a link between those two phases of the well construction process. The representation is extensively based on Hierarchical State Machines, leading to a modular control environment that facilitates the optimization of individual components of the overall drilling strategy. The objective for 2026 is to actively use this feature of the DrillOpPlan platform for the training of autonomous operations planned for the end of the year.

In parallel, foundational modelling work is ongoing to allow for flexible modelling scenarios where the nature (hydraulic, mechanical, heat transfer, solid transport) and characteristics (static, dynamic, degrees of freedom) of the physical models can dynamically be adjusted to balance performance and accuracy depending on the simulation context. The objective for 2026 is to integrate the new modelling framework into DrillOpPlan and gradually replace the existing simulation engine.

From left: Kevin Roy, Sonja Moi, Benoit Daireaux, Henrik Anfinsen and Prathik Rangayyan. Photo: Screen Story

Publications:

«A probabilistic Framework for the Risk-Based Evaluation of Drilling Plans", B. Daireaux, A Ambrus, S. Moi, E. Cayeux, NORCE, SPE/IADC International Drilling Conference and Exhibition, Stavanger, Norway, March 2025, doi: https://doi.org/10.2118/223781-MS

"From Planning to Execution: An Integrated Approach", B. Daireaux, OMAE 2026 (to appear).

DDBot:
AI for Automatic Population of D-WIS Semantical Models

D-WIS is the latest interoperability standard for the discovery and exchange of real-time drilling data. Its versatility is ensured by a complex semantic description of the metadata, which allows systems to communicate with one another. DDBot employs the latest generation of large language models and AI agents to help drilling engineers configure their systems for D-WIS, thereby accelerating the standard's adoption.

Since 2024, D-WIS was demonstrated interoperability between automated systems across companies and disciplines [1]. Still, broader adoption remains slow because semantic model configuration is labor-intensive and requires both drilling and software expertise. DDBot addresses this bottleneck by introducing AI-based support for mnemonic recognition, semantic mapping, consistency checking, and configuration generation. The goal is to simplify setup, improve robustness, and make D-WIS-based workflows easier to deploy in practice.

DDBot Epic builds artificial-intelligence solutions to accelerate the adoption of D-WIS by automating the generation of semantic models from drilling data and related documentation. During the initial stage, the research objective was to use WITSML mnemonics, commonly used for real-time signals, and combine them with other inputs to describe the signals' metadata in the D-WIS terminology. In 2025, the work demonstrated that AI-assisted semantic mapping can substantially improve efficiency and quality compared with manual workflows.

DDBot-team. From left: Liang Zhang, Benoit Daireaux and Sergey Alyaev. Photo: Screen Story

Framework and Methodology

DDBot developments were split into several use cases, each introducing specific requirements with increasing complexity. The use cases shift the balance between human and machine responsibilities in the D-WIS model generation, as shown in Figure 1.

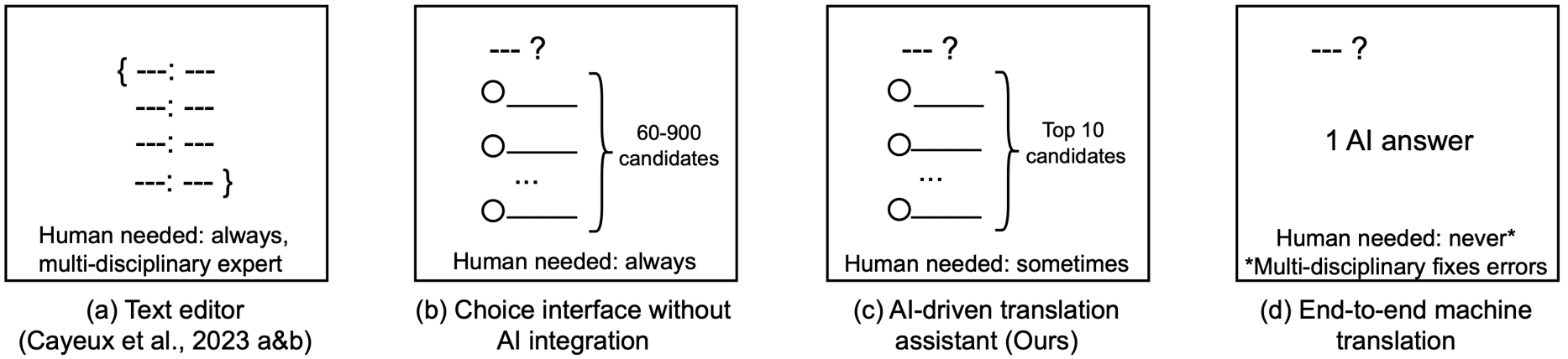

Fig 1. Human–machine tradeoff for translating into D-WIS: choice complexity spectrum [3,4,5].

DDBot-pure

The first stage of the work focused on DDBot-pure, a solution that generates a basic semantical model from WITSML mnemonics and a limited amount of accompanying data. The pure approach provides a baseline for evaluating the feasibility of automatically mapping operational data to D-WIS semantics. Results from 2025 showed that large-language-model-based recognition of signal types and units toward D-WIS gives over 80% accuracy. The work also identified that further gains depend on enriching the knowledge base and extending the system beyond pure mnemonic-based interpretation. A preprint describing this work has been submitted for peer review [2].

DDBot-chat

The second stage introduced DDBot-chat, a user-assisted workflow with a web-based interface. In this approach, the system automatically detects likely mnemonic interpretations using a probabilistic LLM-based method. It then presents these likely choices to a user, along with the system's judgment of the recognition quality. In this case, the user has to quality-assure the system's choice or choose from a list of human-readable options, rather than describing the meaning from scratch through the D-WIS ontology (see Figure 2). As a result, the interactive workflow improves quality, helps the user perform routine tasks efficiently, and reduces the learning curve.

This phase included the systematic testing of a large dataset of D-WIS signals with an emulated "oracle" user. An oracle user is a system that selects the correct answer if it is provided among the options. Our results indicate that the assisted workflow reduced errors to about 10% with 30-40% user interactions. Importantly, a user interaction within DDBot-chat had a 60-95% reduction in choice, highlighting the feasibility and effectiveness of the proposed choice pre-selection [3]. This systematic testing also revealed that the remaining 10% of errors, in many cases, stem from ambiguity in WITSML or the incompleteness of the D-WIS standard, and can provide thorough, actionable feedback for the standard development.

A live demonstration of the DDBot-chat web interface was presented at the DigiWells seminar 2025, and the system will be further tested following the expert feedback. In conclusion, the task simplification and time reduction in the initial testing of DDBot-chat indicate a clear benefit from combining AI support with interactive user guidance.

Ongoing and Coming Work

The next development step is DDBot-plus, which extends the approach from structured mnemonics toward additional natural-language documentation and, potentially, drawings. The 2026 objective is to develop a multimodal, user-assisted, explainable AI solution capable of supporting the generation of more complex interoperable semantical models for D-WIS. In parallel, the project plans to develop a modified AI agent that accumulates and reuses learned knowledge for semantical model generation. DDBot-plus shall improve the robustness of semantic model generation, reduce manual effort, and support more complete semantic models over time.

The expected added value is a faster, simpler setup of semantic models, accelerated adoption of advanced D-WIS-based automation, and improved framework usability through automatic identification of inconsistencies. The plan is to reach sufficient maturity to aid the field testing in DigiWells during 2026.

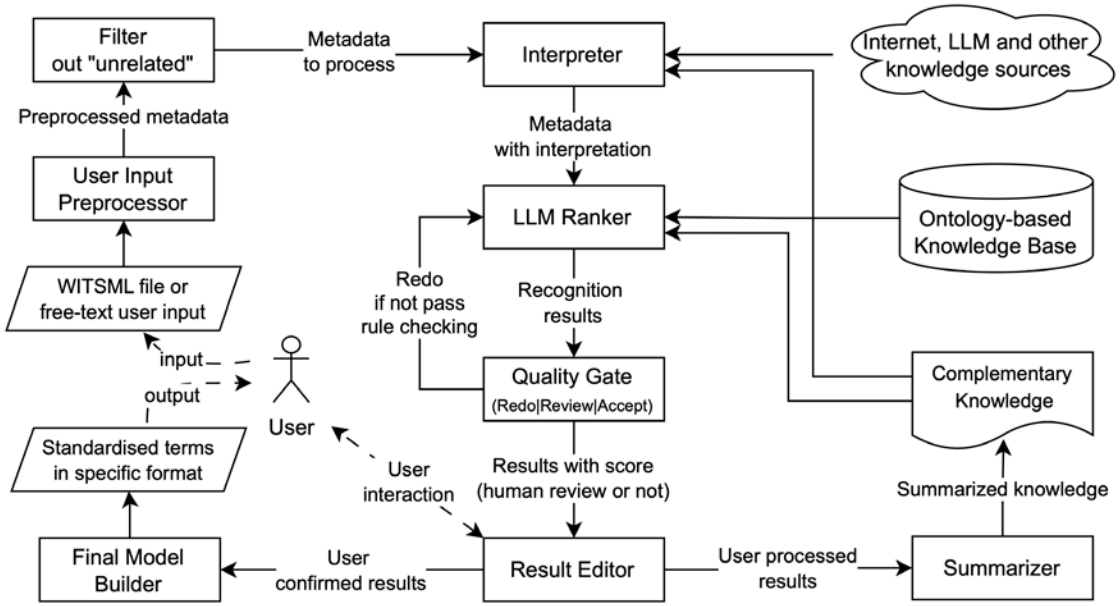

Fig 2. Overview of the human-in-the-loop architecture for the DDBot-chat system, including preprocessing, ranking, quality control, and knowledge integration [2].

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Dynamic Verification and Validation

How to evaluate the status of a complex drilling automation system continuously online? A framework facilitating online verification and validation in Complex Multi-Provider Drilling Automation Systems is proposed and investigated in this research activity.

Drilling automation has seen significant advancements, with multiple vendors contributing specialized functionalities. However, ensuring seamless integration and reliability among these distributed automation agents presents a major challenge.

Verification and validation (V&V) methods traditionally rely on pre-operational static checks, which fail to accommodate dynamic changes during operations. This method fails to account for dynamic changes that can occur during drilling, such as automation agents becoming unavailable, being replaced, or new functionalities being introduced. As a result, inconsistencies in data flow and system behavior may go undetected until they cause operational disruptions.

To address these challenges, a dynamic online V&V framework is designed to ensure that automated agents within a multi-provider system can collaborate effectively, detect inconsistencies, and respond to changing operational conditions without compromising safety or efficiency. (Fig 1)

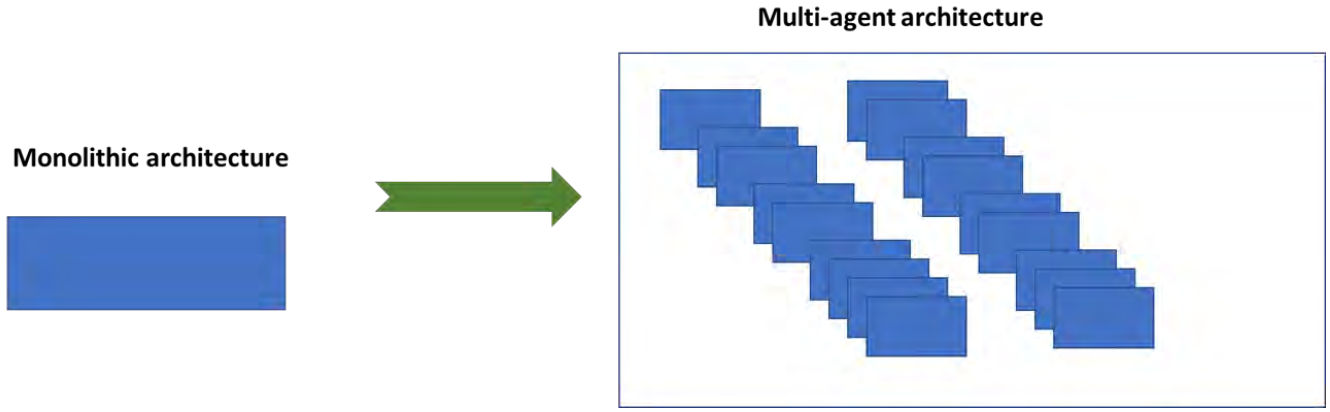

Fig.1: Change in architecture of the system from monolithic to distributed architecture

Key Elements Addressed in this Research Activity

During previous year, a generic framework to advance online verification and validation in complex drilling automation systems was introduced. This framework is aimed to set the basis for online consistency check in a multi-agent system approach where independent automation agents provide specialized functionalities. Continuous monitoring is aimed to detect potential inconsistencies in data or features provided by the automation agents involved.

The framework is a graph-based approach, where interconnected automation agents exchange critical information. This structure enables the detection of inconsistencies that might occur, such as due to missing information and data, communication delays, or unexpected changes in dependencies. Each agent sends periodic heartbeat signals, which indicate its availability and functionality status. If an agent stops sending these signals or fails to provide the expected data, the system can flag potential issues before they escalate into operational failures.

Further, several use cases have been considered. Each analysis considered elements such as:

- Assuming multiple advisors delivering functionalities for complementary contextual situations
- V&V functions in the shared backbone architecture
- Verified properties
- Degree of decentralization
- Relevant formal verification methods
- Automated procedures for the analysis if proper parameterization
- Identification of minimum threshold for a requirement to be satisfied
- Neural-symbolic components

Let's assume an example where multiple automation agents are delivering functionalities for complementary contextual situations, such as illustrated in Figure 1. The automation agents have multiple goals, and possible conflictual decisions might be provided to the rest of the system. At the same time, assuming different estimation and data for the basis of the calculations performed by these automation agents, inconsistencies may arise. These represent some of the situations that are desired to be capture with the methods and frameworks provided in this epic.

Future Work

Relevant use cases to implement the framework have been investigated and the aim is to further explore this direction in coming activities. Current directions considered for the use cases include methods to enable self-evaluation for dynamic verification and validation and methods to automatically assess stability of a multi-agent drilling automation system. It is a priori assumed that some of the drilling automation systems involved may be using different AI methods. Relevant aspects such as training constraints and limitations, extrapolation capabilities are investigated in this work.

Summary

By investigating an online V&V framework and associated methods, it is aimed to significantly enhance the reliability, stability, and efficiency of multi-provider automation systems. This approach facilitates real-time monitoring, automatic detection of inconsistencies, and seamless adaptability to evolving drilling conditions. The framework for multi-agent drilling automation systems can potentially also be of use in dealing with aspects related to cybersecurity threats and assist the human operator by generating a warning when inconsistencies are detected. The aim is also to provide a list of possible causes for these inconsistencies in order to help the human operator assess the situation. A technical perspective to human oversight when complex drilling automation systems are in used was investigated in the activities in this epic. A generic approach was introduced, focusing on aspects related to AI methods and five scenarios were investigated. A generic framework to manage safe transition to manual control in complex AI systems for autonomous decision-making was introduced.

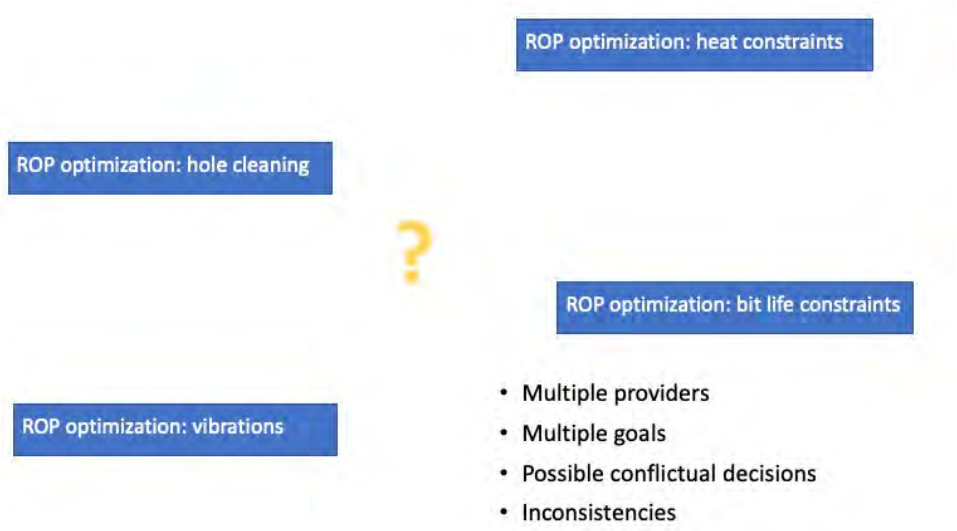

Fig 2: Example with several optimization agents focusing on different aspects of drilling operation

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DigiWells Annual Seminar

Around 70 participants gathered for DigiWells Annual seminar, where industry, authorities and researchers shared experiences from operations, their insight on digitalisation, automation and autonomous well construction.

Gunnar Lille, who leads Energi2050, set the stage by outlining its focus, building on the work of OG21 and Energi 2021. His introduction was followed by engaging presentations from the operators, sharing experiences and strategies for the way forward.

One of the highlights of the seminar, was a panel debate about “Collaboration strategies for challenging barrels”. The background for the topic is challenges on the NCS related to recoverable reserves per well are declining; reservoirs are becoming more complex, and costs are increasing.

- Having a clear thread from planning to execution, real-time updates of geomodels, and more robust execution will be important, said Thor Løvoll, Vår Energi.

Equinor pointed out another essential factor.
– An important step to improve efficiency is by leveraging from historical data, both before and during well construction, said Praveen Jain, leader of drill and well technology at Equinor.

At DigiWells, we focus on interoperability and standardization, leveraging a microservice framework to facilitate adoption across the industry. As Eric Cayeux put it:

– We are trying to make life simpler for you.

– DigiWells contributes to collaboration and value creation, and we are helping the industry move the technology front, finished Tron Golder Kristiansen, board chair of DigiWells and Chief Engineer Drilling and Wells, Aker BP.

From the left: Morten Welmer, Praveen Jain, Thor Løvoll, and Tron Golder Kristiansen. Photo: Screen Story

Engaged audience
Researchers, postdocs, and PhD candidates presented the latest developments from ongoing work at DigiWells, covering the full spectrum from planning and geosteering to interoperability/DWIS demonstrations, innovative concepts, and how it all integrates from planning through execution. Furthermore, plans were outlined for demonstrating autonomous drilling together with the DWIS framework in OpenLab, at Ullrigg, and if successful offshore on DeepSea Stavanger.

Top:Chief Scientist Benoit Daireaux presenting: From Planning to Execution - How it all fits together. Bottom: Aina Berg. Photos: Screen Story

Top and bottom: Fruitful discussions during the breaks Photos: Screen Story

Spin-off Projects

Knut Bjørkevoll og Jan Einar Gravdal. Photo: Screen Story

DigiWells Innovation program

In 2025, the DigiWells Innovation Program focused on advancing and demonstrating the DWIS interoperability framework, integrating autonomous drilling with DWIS, and developing explainability features that clarify the decisions made by autonomous systems.

Implementing interoperability for drilling automation
Multiple demonstrations have confirmed that the DWIS interoperability framework is fully functional. It enables seamless data exchange and supports drilling automation directly at the rig site. The D-WIS infrastructure allows different vendors' systems to automatically discover and share information in real time. This capability accelerates deployment of automated solutions, making it possible to install them on any rig without custom integration — realizing the vision of "develop once, deploy anywhere."

How it works
A standardized semantic description of exchanged data ensures that information is consistently structured and machineinterpretable, enabling systems to understand and use the data without manual intervention. With this foundation, available information can be automatically discovered and exploited, removing the need for manual configuration and allowing systems to adapt dynamically. Incorporating uncertainty descriptions throughout the data exchange process makes it possible to estimate confidence levels, while leveraging multiple information sources—through sensorfusion techniques—helps reduce overall uncertainty.

To further improve performance, eventbased propagation of information to minimizes latency by transmitting updates only when relevant changes occur. Exchanging lookup tables that describe system behaviour, rather than simple scalar values, promotes timeindependent data exchange and supports more robust decisionmaking.

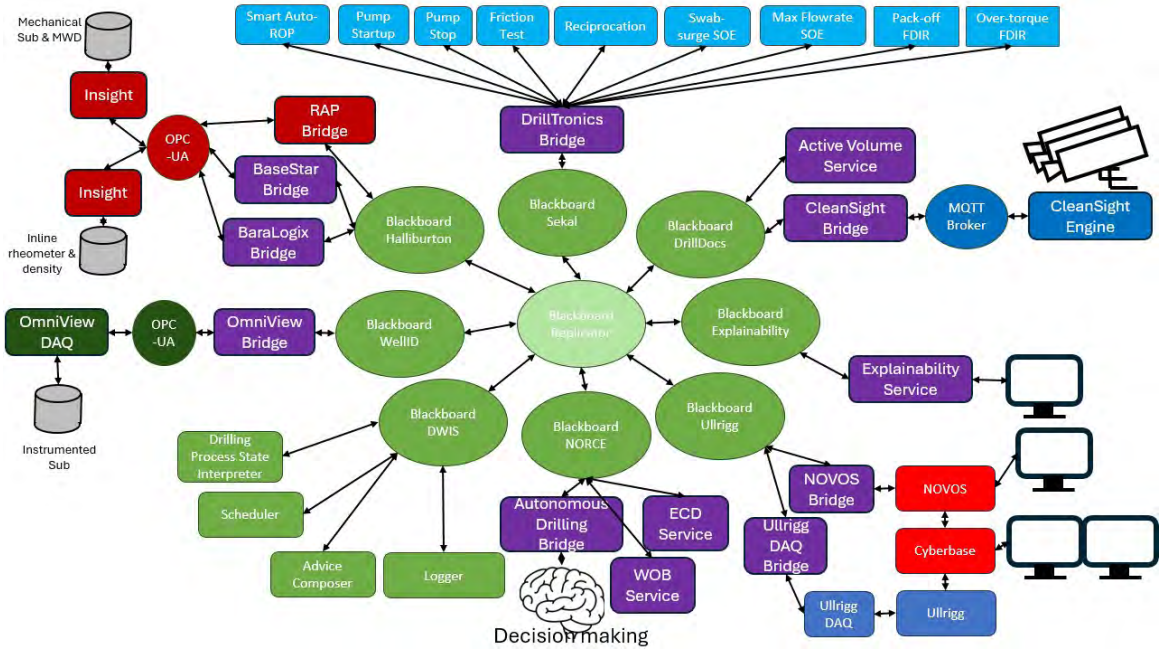

Figure: An overview of the system set-up with autonomous drilling and seamless communication between the different players.

Additionally, passing grouped data as transactions ensures consistency, enables validation checks, and keeps the ADCS (Automated Drilling Control Systems) in control of the overall process.

Demonstrations
The developed reference implementation has been tested in more and more complex situations. It has been verified that the DWIS architecture can adapt to multiple ADCS systems and checked that various advisory systems can seamlessly adapt to different ADCS configurations.

You can explore demonstrations and watch a recording of the DWIS workshop hosted by Aker BP during the SPE Drilling Conference in Stavanger 2025 at: https://digiwells.no/standarization

Full-Scale Demonstration at Ullrigg
In February/March 2026, we successfully carried out demonstration of autonomous drilling combined with DWIS interoperability and a preliminary explanation interface for the driller. The demonstrations were conducted using both OpenLab and Ullrigg at NORCE in Stavanger.

Further development will focus on enhancing the system's ability to explain the reasoning behind its autonomous decisions. A video of the demonstration will soon be available on https://digiwells.no/standarization

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"A Framework to Capture the Relationships in Drilling Data and the Propagation of Uncertainty" presented at the SPE/IADC Drilling Conference in Galveston, TX, USA, March 2022, https://doi.org/10.2118/208754-MS

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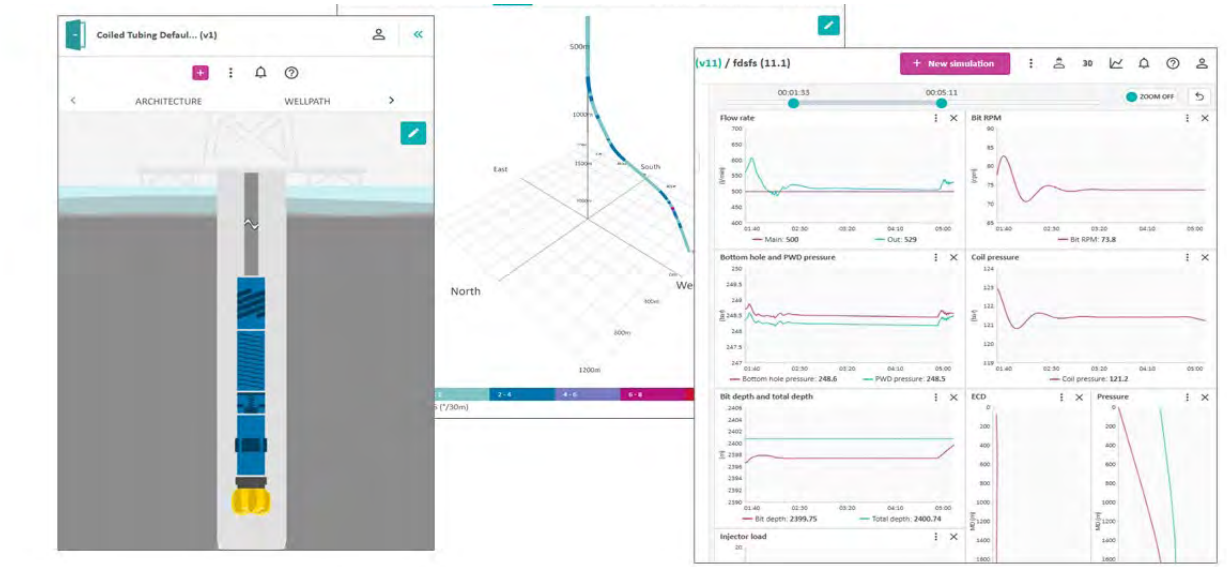
Erlend H. Vefring. Photo: Screen Story

KSP Towards Autonomous Coiled Tubing Operations

This research project (2025–2028) develops an automated workflow and enabling technology for future autonomous coiled tubing (CT) operations, with emphasis on conveyance, drilling and milling. CT operations are performed in a complex and often sparsely instrumented environment, where hydraulics, mechanics and temperature are strongly coupled, and where feedback and control of key downhole processes, such as motor performance and bit rock/metal interaction are limited. This makes early warning and mitigation of events such as buckling, packoff and bit stall-out challenging.

The project's core concept is that autonomy requires contextual understanding: accurate internal state estimation, predictive capabilities, and evaluation of alternatives in real time. Since most downhole states cannot be measured directly, the project develops a high-fidelity, transient, physics-based digital twin that can infer key states (e.g., tension, pressure, temperature, and multiphase fractions) and monitor critical operational boundaries (e.g., buckling, stall-out, overpull and pack-off). This forms the basis for automated decision-support functions and, in the longer term, autonomous CT workflows.

The modelling approach includes transient multiphase hydraulics and dynamic temperature in the tubing (coil + well), annulus and near-well formation, a transient soft-string torque-and-drag model with support for non-Newtonian fluids, and event submodels and transitions (stall-out, buckling and packoff). A key requirement is faster-than-real-time performance, enabled by flexible simulation modes and modular tool/topside submodels. The first version of the simulation model is implemented and tested through the OpenLab Drilling simulation environment and will later be released as a dedicated OpenLab Coiled Tubing simulator to accelerate verification, dissemination, and TRL progression. A PhD student has been hired at the University of Stavanger, starting January 2026.



Next steps focus on broader verification (Ullrigg and field data), model improvements, OpenLab integration and testing, development of soft sensors and calibration triggers, and selection of a main demonstration case (e.g., stall-out mitigation). In 2027–2028 the work will emphasize autonomy architecture, a prototype for autonomous CT control, and full system integration and testing in OpenLab.

Project partners:

Academic: NORCE, University of Stavanger, TU Clausthal; Industry; AkerBP, ConocoPhillips, Equinor, Harbour Energy, TotalEnergies

Project webpage: https://www.norceresearch.no/en/projects/towards-autonomous-coiled-tubing-operations

Project leader: Jan Einar Gravdal

Distributed Damping Subs – Verification project

The concept aims to eliminate torsional vibrations and reduce energy consumption by integrating a series of non-rotating damping subs clamped on along the drill string.

Drilling of complex well trajectories is often hindered by downhole drill string vibrations and stick-slip. These can lead to drill bit and downhole tool damage, tool-joint and drill string wear possibly leading to a twist-off, or formation damage. Traditional surfacebased mitigation systems often fail to suppress drillstringrelated stickslip or higher torsional modes, especially in extendedreach drilling.

The new patented concept introduces a series of nonrotating damping subs that can be clamped on along the drill string to eliminate torsional vibrations and improve weight transfer. Each damping sub uses a magnetic braking system that dissipates vibrational energy through eddy currents. The subs also feature an innovative rollingpad design that reduces friction along the drill string and decouples axial movement from torsional movement. The technology has potential to provide more efficient operations, with reduced energy consumption and reduced emissions.

Numerical modelling has confirmed the effectiveness of DDS, showing that it eliminates stickslip in highly deviated wells, suppresses higher torsional modes, and reduces topdrive torque by around 40 percent, outperforming conventional surfacebased mitigation systems.

The concept is based on a patented invention developed by Eric Cayeux. In DigiWells' Vibration Damping we have done research including experimental set-up related to the DDS. Furthermore, simulations showing the advantage with coordinated control of the subs which is not part of this project. In the verification project, the goal is to develop and design DDS from concept to a full-scale field-ready prototype.

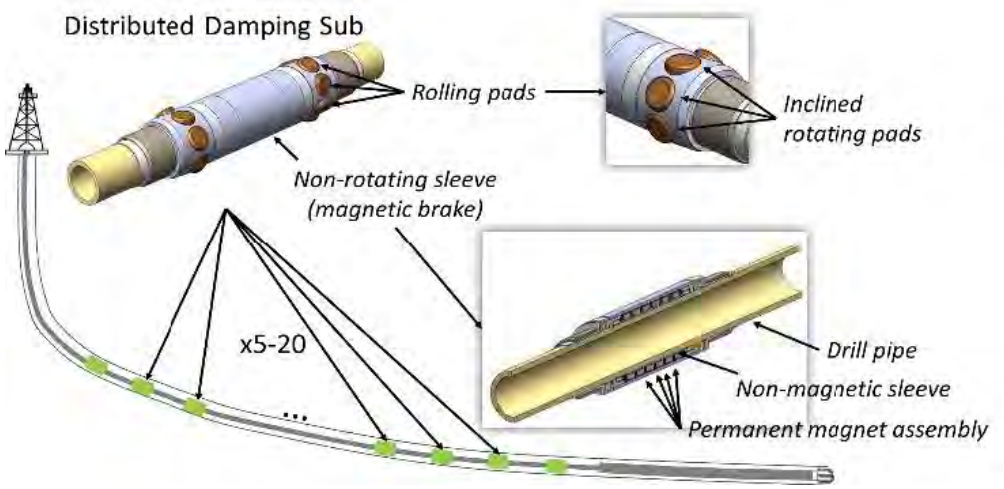
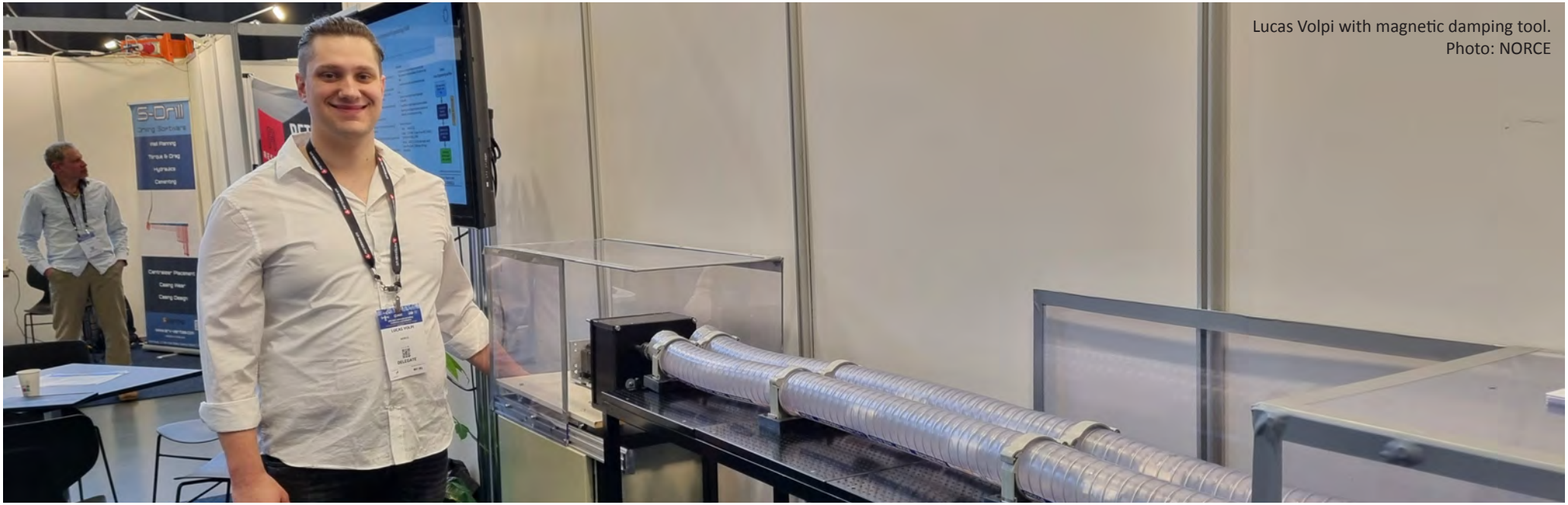


Figure: The solution aims to eliminate torsional vibrations and improve weight transfer by integrating a series of non-rotating damping subs distributed along the drill string. Each sub features a magnetic braking system that dissipates vibrational energy as eddy currents.



Lucas Volpi with magnetic damping tool.
Photo: NORCE

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3D GIG: 3D Geological Interpretation for Geosteering of Wells

This project focuses on developing an automated workflow for 3D geological interpretation to support geosteering. The objective is to link a global-scale 3D geomodel with high-resolution electrical resistivity images around the well trajectory. These images are generated using: (1) a 3D stochastic multi-resolution inversion of ultra-deep azimuthal resistivity (UDAR) and electromagnetic measurements, and (2) deep learning models predicting resistivity patterns based on collected data. As new measurements are acquired, the resistivity image is updated to refine the global geomodel in real time. This process improves geological structure identification, enhances well placement strategies, and reduces drilling risks. The project integrates uncertainty quantification to improve decision-making.

Key developments are divided into four work packages: WP1) Automated generation of the most probable 3D geomodel using pre-drill information and seismic data, WP2) Multi-fidelity inversion strategies that improve efficiency by reducing input data volume and sparsity, WP3) Automated linkage between geomodel and inversion grids for improved data integration, and WP4) Deep Neural Networks (DNN), combining RNNs and CNNs, to estimate formation structures near the wellbore.

Project Partners

Academic: University of Stavanger, University of Texas at Austin. Industry: Equinor, AkerBP, Vår Energi, ConocoPhillips, Harbor Energy, TotalEnergies

Project Leader: Nazanin Jahani

From left: Kristian Fossum, Nazanin Jahani and Sergey Alyaev. Photo: Screen Story

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Status from UiS

The DigiWells Project at the University of Stavanger (UiS) has three PhD students, Åsmund Aamodt Resell, Prathik Prasad Mandyam Rangayyan and Michal Chudoba. Åsmund is developing a numerical framework for accurate and fast computation of stresses and displacements along the drill string in realistic, curved and potentially irregular wellbore geometries. He is supervised by assoc. prof. Hans Joakim Skadsem and prof. Knut Erik Teigen Giljarhus at UiS, and by senior researcher Rodica Mihai at NORCE. Åsmund is also collaborating with prof. Thiago G. Ritto at the Federal University of Rio de Janeiro (UFRJ) in Brazil.

Åsmund Resell

Professor Hans Joakim Skadsem

Åsmund's research

My research is mainly focused on developing a highly efficient 3-dimensional finite element model of drill strings for approximately real-time simulation of drilling dynamics in complex extended-reach wells. Whereas previous research has mainly dealt with drill string vibration modelling in vertical and near-vertical wells, the current modelling effort aims to target realistic and fully 3-dimensional ERD wells with arbitrary curved sections. Moreover, the modelling framework also accounts for potentially irregular wellbore geometry along the open-hole section, and allows in-depth analysis of the interaction between the wellbore wall with the BHA and the rest of the drill string. A goal of the project is to better understand the link between wellbore geometry and drill string vibrations, and in the future also to explore how drill string impacts with the wellbore can result in deformation and damage to the wellbore wall itself. The introduction of wellbore irregularities into my numerical framework was one of the key outcomes from my 6-month stay with prof. Ritto at UFRJ in 2025, and we have since used the computational approach to study both running and centralization of casings in ERD wells, as well as fully transient drill string dynamics for drilling applications.

Research focus

The PhD project focuses on the development of a general 3-dimensional finite element formulation for a drill string in a curved, extended-reach wellbore. The computational advantage is realized in part by exploiting the fact that the instantaneous displacements of the drill string is confined within the wellbore, which enables key approximations in the drill string model. The finite element formulation includes interaction between drill string and wellbore, fluid-structure interactions as well as a PDC bit-rock interaction model.

Project goals

- Formulation and numerical implementation of a 3-dimensional finite element model for drill string dynamics
- Accurate and real-time simulation capabilities for realistic ERD wells
- Representation of realistic irregular wellbore geometries and their interaction with the drill string

Collaborations and industry interaction
Åsmund's workplace is at the Department of Energy and Petroleum Engineering at UiS, and at NORCE in Stavanger. Åsmund is actively engaging with industry partners through SFI DigiWells, in particularly on the topics of downhole imaging of irregular wellbore geometries, and assessment of drill string impacts on the mechanical stability of the wellbore wall along open-hole sections. This interaction provides valuable insights and practical applications, enhancing the relevance and impact of his research.

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Prathik Prasad Mandyam Rangayyan

Professor Dan Sui, photo: UiS

Overview
Prathik Prasad Mandyam Rangayyan is developing intelligent automation methods for drilling optimization. His research focuses on applying reinforcement learning and advanced simulation environments to improve decision-making during drilling operations. Prathik is supervised by Professor Dan Sui at the Department of Energy and Petroleum Engineering at UiS, with co-supervision from Senior Researcher Sergey Alyaev and Chief Scientist Benoit Daireaux at NORCE. His PhD project runs from May 2025 to May 2028.

Prathik's Research
The goal of this research is to enable autonomous or semi-autonomous optimization of drilling parameters, reducing the dependence on purely manual decision-making. Reinforcement learning provides a powerful framework where algorithms learn from trial-and-error interactions with a simulated environment, gradually improving operational strategies based on performance feedback.

Within the DigiWells project, Prathik's work contributes to the broader vision of AI-driven drilling automation. By combining advanced simulation models with machine learning techniques, the research aims to create systems capable of anticipating operational risks and optimizing drilling performance before problems occur. This approach supports safer and more efficient drilling operations by transforming large volumes of real-time data into actionable operational decisions.

Research Focus
The PhD project focuses on developing reinforcement learning frameworks and simulation environments for automated drilling optimization. The research integrates physical drilling models with machine learning algorithms to create intelligent agents capable of learning optimal operational strategies.

Key methodological components include:

- Reinforcement learning algorithms for sequential decision-making in drilling operations
- Simulation-based training environments that represent realistic drilling dynamics
- Integration of physics-based drilling models with AI learning frameworks
- Evaluation of learned policies for improving drilling efficiency and reducing operational risks
- Through this approach, the project explores how autonomous decision-making systems can support drilling engineers by continuously analyzing operational data and recommending optimized drilling parameters.

Project Goals

- Develop Reinforcement Learning Algorithms
  Design and implement machine learning algorithms capable of learning optimal drilling strategies from simulation environments.

- Test High-Fidelity Simulation Environments
  Use developed algorithms on realistic drilling simulators that accurately represent the dynamic interactions between drilling parameters, wellbore conditions, and equipment behavior.

- Optimize Drilling Operations
  Use trained AI agents to identify parameter combinations that improve drilling performance metrics such as rate of penetration, stability, downhole pressure and operational safety.

- Enable Intelligent Decision Support
  Provide AI-based recommendations that assist drilling engineers in making informed decisions during real-time operations.

Collaborations and Industry Interaction

His work involves collaboration with researchers from NORCE, where expertise in drilling simulation and modeling contributes to the development of advanced training environments for reinforcement learning algorithms. This collaboration ensures that the research maintains strong relevance to real-world drilling challenges. Through these partnerships, the project benefits from access to industry datasets, simulation platforms, and operational expertise, enabling the development and validation of AI-driven drilling optimization methods.

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Michal Chudoba. Photo: NORCE

Professor Tomasz Wiktorski. Photo: UiS

Overview
Michal Chudoba works on AI methods that help language models use technical knowledge bases and domain ontologies. His work focuses on reducing manual effort when a model must navigate complex, non-standard ontology structures. He is supervised at UiS by prof. Tomasz Wiktorski and dr. Petra Galuscakova, and at NORCE by dr. Sergey Alyaev.

Research focus
Michal's work centers on agentic workflows for ontology-based tasks. A main direction is to replace rigid retrieval pipelines with a tool-based approach: the model is given examples and access to a controlled execution environment (for example, a Python sandbox). The model then creates its own queries and helper code to access and process the data. This approach is designed to be more flexible when ontology structures, relationships, or naming conventions change.

A second direction is reliability and transparency. Michal has explored ways to detect when a model is overconfident or likely to fail on out-of-distribution cases. He has also tested explainability methods that attribute which parts of the input drive the model's output.

Project goals
- Deliver a working agent workflow that can load, browse, and query an ontology using examples and tool access, with minimal manual retrieval engineering.
- Demonstrate reduced maintenance effort when ontology structures or conventions change, compared to solutions that depend on fixed retrieval logic.
- Show stable performance across different ontology formats, including cases that do not follow standard RDF assumptions.
- Improve trust in the approach by adding reliability signals and practical explainability methods, and by supporting user quality control through ranked alternatives, consistency checks, and interactive review.

Collaborations and industry interaction
The work is being carried out in close collaboration with academic supervisors and research partners, with a clear focus on delivering concrete technical outcomes. This includes jointly defining target use cases, validating architectural choices, and iterating on implemented solutions based on technical review. Michal is one of the main contributors to the DDBot project, this collaboration has led to working prototypes such as DDBot-chat, systematic testing with emulated user feedback, and a live demonstration at the DigiWells seminar 2025. The work has also produced actionable feedback on ambiguity in WITSML and gaps in the D-WIS standard, which is relevant for further standard development and field testing.

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From Stavanger to Rio

During a six-month stay in Rio de Janeiro, PhD candidate Åsmund Aamodt Resell stepped outside both his scientific and personal comfort zone.

At the Federal University of Rio de Janeiro, Resell worked on his PhD on drill string vibration.

— I particularly work on the complex dynamics that arise in irregular wellbores. In Rio, I met a larger professional environment working on very relevant issues, says Åsmund Aamodt Resell.

— At the University, they were especially strong in bit–rock modelling, and they helped develop my work a great deal. We complemented each other well — there were areas where they had extremely useful expertise, and areas where I could contribute knowledge from my own work back home, explains Resell.

During his stay, Resell had a close collaboration with Professor Thiago Ritto.

— Ritto had developed a method to generate random irregular wellbore geometries. We then combined the geometry from his method with my drill string model to study the effects on the drilling dynamics. We expect to publish an article on this very soon.

Overcoming language barriers

— Most communication at the University was in Portuguese, and I spent a lot of my free time at the language school taking classes, says Resell.

The language school also arranged social activities, and Rosell's language skills quickly developed.

— Overall, the stay was a very efficient way to learn the language. Towards the end of my stay, I could follow discussions in joint meetings in Portuguese.

Åsmund Aamodt. Photo: Private

The Brazilian life
Outside the university and language classes, Resell explored Rio's mountains and islands and spent much of his spare time surfing.

The record-cold winter in Rio de Janeiro was not a hindrance.

— They told me it was the coldest winter in Rio in 20 years. But it was the equivalent of a Norwegian summer, and much more comfortable for a Norwegian than the average Brazilian summer, explains Resell.

While some worry that Rio is not the safest place to visit, Resell found it manageable — with some planning.

— You adapt quickly and learn which areas are safe and which are best to stay away from, he says.

Resell highlights the benefits of travelling and staying by himself, far away from his homeland.

— Going alone really pushed me out of my comfort zone and forced me to be more extroverted than I normally am. I would recommend a stay like this to anyone, concludes Resell.

Resell studies vibration behaviour in drill strings. His interest began after completing his mechanical engineering degree at NTNU and spending a year in industry.

Åsmund expects to complete his PhD next autumn.

Åsmund with the research group and Professor Ritto. Photos: private

Felix James Pacis Defends Thesis on Applied Transfer Learning in Drilling Engineering

On Monday, April 7, Felix James Pacis defended a thesis with the title Applied Transfer Learning in Drilling Engineering at the University of Stavanger (UiS). He is the second PhD alumni from DigiWells.

Some quotes from the committee report:

At the defense Felix "offered a comprehensive and well-structured overview of the motivation behind his research, clearly articulating the research problems, objectives, and key findings."

"…the original contributions of this research include the well-executed and relatively novel application of transfer learning to a regression task specifically, predicting the rate of penetration from drilling parameters. Additionally, the thesis presents a documented exploration of the retrieval-augmented generation pattern for artificial intelligence systems in the drilling domain, further contributing to the field's innovation. Another significant contribution is the author's commitment to open science, demonstrated through the development and sharing of code and data in an open-source AI system that effectively showcases the research in a novel and practical way."

"The committee was pleased with his ability to answer questions and respond thoughtfully to the comments and critiques raised by the opponents" throughout the presentation and the oral defense.

This is the second successful PhD defense from SFI DigiWell. Only 12 left!

The picture with the PhD supervisors and the committee after the defense, from left to right: Committee: Dr. Matt Hall (Equinor) Prof. Artur Klepaczko (Lodz University of Technology) and Dr. Mina Farmanbar (UiS); Dr Felix Pacis (DigiWells); Supervisors: Prof. Tomasz Wiktorski (UiS) and Dr. Sergey Alyaev (NORCE); Dr. Tom Ryen (UiS). Credit: Ståle Freyer/UiS.

Reference

Pacis F.J. "Applied Transfer Learning in Drilling Engineering" PhD Thesis, University of Stavnger. URI: https://uis.brage.unit.no/uis-xmlui/handle/11250/3185007

Pauline Nüsse defends Thesis on Control of Distributed Damping Subs for Torsional Vibration Mitigation in Drilling

Some quotes from the committee report from Pauline's defense May 13th 2025:
"…gave a good representation of the content of the thesis. It was clear and well structured."

"The research is empirical, addressing a significant and timely industrial challenge in the mitigation of torsional vibrations in drilling through active control strategies. The candidate proposes innovative solutions including an active sleeve control, an anti slip logic, and a combined control approach integrating both downhole and surface based mitigation systems. These contributions are original and represent a state of the art advancement in the field. The thesis demonstrates academic independence, methodological rigor, and relevance to real world applications."

"Supported by publications in reputable peer reviewed venues, the work reflects strong research capability and delivers a coherent and comprehensive contribution to the field. It meets and exceeds the expectations for a PhD level dissertation in both quality and originality."

Dr. Pauline Nüsse (DigiWells) with representatives from the committee and the PhD supervisors, from left to right: Committee: Prof. Børge Rokseth (NTNU); Supervisors: Prof. Ole Morten Aamo (NTNU) and Dr. Adrian Ambrus (NORCE)

Publications

Nüsse, P. M., Ambrus, A., Aarsnes, U. J. F., Aamo, O. M., "Evaluationof distributed damping subs with active control for stick–slip reduction in drilling". In: Geoenergy Science and Engineering 231 (2023), p. 212255. doi:https://doi.org/10.1016/j.geoen.2023.212255

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Nüsse, P. M., Ambrus, A., Aamo, O. M., "Active Control of Distributed Subs With Anti-Slip Logic for Torsional Vibration Damping in Drilling". In: vol. 8: Offshore Geotechnics; Petroleum Technology. International Conference on Offshore Mechanics and Arctic Engineering. June 2024, V008T11A003. url: https://doi.org/10.1115/OMAE2024-123992

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Thesis:
Nüsse P.M Control of Distributed Damping Subs for Torsional Vibration Mitigation in Drilling PhD Thesis, NTNU. URI: https://hdl.handle.net/11250/3191968

From left: Morten Welmer, Praveen Jain and Thor Løvoll. Photo: Screen Story

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SFI Director

WP7 - Project management

Helga Gjeraldstveit

SFI Assistant Director

WP6 - Studies and analysis

Sergey Alyaev

WP-leader

WP2 - Predictive modelling

Eric Cayeux

WP-leader

WP3 - Smart sensing

WP4 - Interop-erability and user-system interaction

Benoit Daireaux

WP-leader

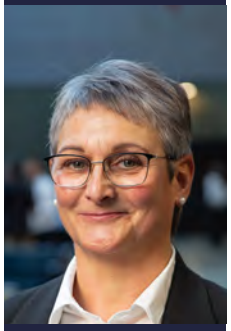
WP1 - Agile well construction workflow

Rodica G. Mihai

WP-leader

WP5 - Drilling automation and autonomy

Mette Stokseth Myhre



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Norwegian University of Science and Technology (NTNU)

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NORCE AS

Halil Øzarpa (Observer)
Research Council of Norway

Postdocs

Liang Zhang

Post Doc.: DDBot – AI for automatic population of semantics

Affiliation:	**Energy and Technology, NORCE**
Supervisor:	**Benoît Daireaux, Sergey Alyaev**
Associated Epic:	**WP4 - Interoperability and user-system interaction**
Period:	**06.2024 - 07.2027 as Post. Doc**

Photo: ScreenStory

Liang Zhang received the Ph.D. degree in Engineering from the Dept. of Mechanical and Industrial Engineering at NTNU Trondheim in 2024. He also holds the M.Sc. degree in Naval Architecture and Ocean Engineering.

Liang works on a Drilling Data Bot (DDBot) leveraging LLM to automatically convert mnemonics-based metadata of drilling signals into semantic models based on predefined DDHub terms. These models can be integrated into various digital platforms including DDHub, to enable effortless exchange of drilling signals.

Liang presented a simple version DDBot in DigiWells seminar 2024 and published a paper “Cloud-Free Question Answering from Internal Knowledge Bases: Building an AI for Drilling Applications”. He is currently developing “DDBot-chat”, importing user interactions to assist the modeling. A future “DDBot+” is envisioned for more capable modeling by incorporating natural-language documents.

Pauline Nüsse

Thesis title: Optimizing the placement of distributed damping subs

Affiliation:	**NTNU**
Supervisor:	**Ole Morten Aamo**
Co-supervisor:	**Rodica Mihai**
Associated Epic:	**Distributed Drilling Control**
Period:	**06.2025 - 12.2026 as Post. Doc**

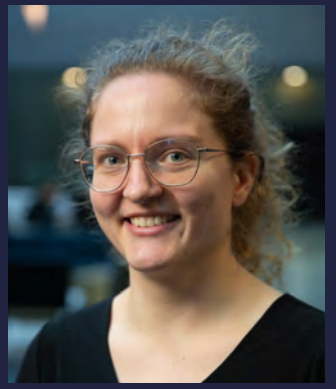

Photo: ScreenStory

I received both my B. Sc. and M.Sc. in Computer Science in Engineering from the University of Augsburg, Germany. In 2025, I finished my PhD in Engineering Cybernetics at NTNU as part of DigiWells. My thesis was on active control of damping subs for vibration mitigation in drilling.

Now as a Postdoc, I continue with the work on distributed damping subs. The focus is shifted from the controller within the subs to the placement of those subs along the drill string. The idea is to find an optimal positioning of the sleeves for drilling a certain section. Here, among others, the number of sleeves, as well as their placement or damping coefficient could be varied. To reduce the complexity of the optimization problem in the beginning, it is simplified into smaller cases, e.g. finding the optimal positioning of a fixed number of passive sleeves.

As a side project I also work on finishing up the work of the Postdoc before me, Nils. Here, the idea is to diagnose washouts from topside measurements only.

PhD students

Marios Gkionis

PhD topic: Physics-Informed Multi-task Learning, applications to Fault Detection and Diagnosis

Affiliation:	**NTNU, Department of Engineering Cybernetics**
Supervisor:	**Ole Morten Aamo**
Co-Supervisors:	**Bjarne Andre Grimstad, Ulf Jacob Flø Aarsnes**
Associated Epic:	**Distributed Drilling Control**
Period:	**2022 - 2025**

Photo: Rune Rolvsjord, NORCE

Thesis title: Multitask Learning for Fault Detection and Diagnosis in Drilling

I am educated in Mechanical Engineering (received my Integrated Master's degree with honors from the Aristotle University of Thessaloniki, Greece in 2020). I hold experience in dynamics simulations and NMPC control.

The goal of the PhD project is to develop Real-Time Fault Diagnosis and Detection algorithms for Drilling by leveraging Multitask Learning. We generate training data through simulations of the dynamics during drilling and train a Multitask Neural Network using only topside measurements, since a distributed array of measurements is not typically expected to be available in practice. We assess the robustness of the trained Neural Network on different types of noise and disturbances, such as meaningful model noise, wherein certain fluid and geometric parameters are perturbed in the simulation to emulate error sources that stem from unmodelled dynamics.

"Fault Diagnosis for Drilling using a Multitask Physics-Informed Neural Network", M. Gkionis, N.C.AA. Wilhelmsen, O.M. Aamo, NTNU, published in IFAC-PapersOnLine, Volume 59, Issue 6, 2025. DOI: https://doi.org/10.1016/j.ifacol.2025.07.189

"Real-Time Fault Detection and Diagnosis for Oil Well Drilling using a Multitask Neural Network", M. Gkionis, NTNU; O.M. Aamo, NTNU; U.J Aarsnes; NORCE, The 22nd International Conference on Informatics in Control, Automation and Robotics (ICINCO 2025). https://hdl.handle.net/11250/3287896

Åsmund Aamodt Resell

PhD topic: Annular fluid flow coupled with drill string vibration

Affiliation:	**University of Stavanger**
Supervisor:	**Hans Joakim Skadsem**
Co-Supervisors:	**Rodica G. Mihai, Knut Erik Teigen Giljarhus**
Period:	**2023 - 2026**

Photo: ScreenStory

I received my master's degree in mechanical engineering from NTNU in Trondheim. My specialization is in structural mechanics and fluid dynamics, with a strong focus on numerical modeling and computational analysis.

This project aims to improve our understanding of fluid dynamics within the annular space outside the drill string and to strengthen our knowledge of the coupling between drill string vibrations and fluid flow. The work investigates how the fluid forces acting on the drill string is affected by varying flow regimes in the annulus, which again can be affected by the rotation and eccentricity of the drill string itself. The work of the thesis also investigates how the coupled effects can be captured in real-time models suitable for use in operational settings. The research work uses various numerical and machine learning methods such as computational fluid dynamics, finite element analysis and genetic programming.

Resell, Å. A., Giljarhus, K. E. T., and Skadsem, H. J. (December 9, 2024). "Entrance Lengths for Fully Developed Laminar Flow in Eccentric Annulus." ASME. J. Fluids Eng. May 2025; 147(5): 051302. https://doi.org/10.1115/1.4067129

Prathik Prasad

Thesis title: Reinforcement Learning and Simulation for Automated Drilling Optimization

Affiliation: University of Stavanger
Supervisor: Dr. Dan Sui
Co-Supervisors: Benoit Daireaux, Sergey Alyaev
Associated Epic: AI Powered Drilling Systems
Period: 2025 - 2028

Photo: ScreenStory

My oil and gas engineering background led me to an unexpected passion discovered during my first drilling course in undergrad. I'm fascinated by the complex coordination of drilling operations – watching these systems work together perfectly shows engineering at its best

My research aims to develop an autonomous agent for drilling operations by leveraging extensive simulations performed during well-planning alongside field data. The objective is to create an intelligent decision support system capable of operating under uncertainty, effectively bridging the gap between simulation-based planning and real-time operational activities.

I plan to achieve this through developing a reinforcement learning (RL)-powered system that learns optimal policies for autonomous drilling operations. These policies will be designed to reflect the complex, hierarchical nature of drilling workflows, enabling the system to make decisions that align with established processes.

The methodology involves designing decision problems that mirror real-world drilling scenarios, creating comprehensive training environments using multi-system simulations, and implementing uncertainty management protocols for data and operational variability. Through iterative policy optimization from simulation-generated data, this integrated approach ensures effective transition from simulated environments to field applications.

Michal Chudoba

Thesis title: AI-Driven Data Analysis in Drilling Operations

Affiliation: University of Stavanger
Supervisor: Dr. Tomasz Wiktorski
Co-Supervisors: Dr. Petra Galuscakova, Dr. Sergey Alyaev
Period: 2025 - 2028

Photo: Private

I am a computer scientist graduated from Charles University in Prague, where I focused on machine learning and LLMs.

I have spent a year in the private sector, working on recommender systems and data analysis.

Thesis Objectives
The goal of my thesis is to explore advanced AI techniques, powered by large language models, to enhance the data analysis of drilling operations.

The focus is to leverage large amounts of heterogeneous data, such as drilling reports, sensor data, and geological information, to improve decision-making processes in drilling operations.

The primary way to achieve this objective is to leverage the capabilities of large language models to extract insights from semi-structured data such as logs to detect anomalies, predict failures and find causality sequences.

During the research, data annotation will be performed to create a dataset for in-context learning, fine-tuning and evaluation of the models.

Håkon Per Gulestø Stavang

PhD topic: Real-Time Joint Inversion of Borehole EM and Acoustic Data

Affiliation:	**University of Bergen**
Supervisor:	**Morten Jakobsen**
Co-Supervisors:	**Nazanin Jahani, Koen van Dongen, Ketil Hokstad**
Associated Epic:	**Accurate real-time geophysical data imaging while drilling**
Period:	**2025 - 2029**

Photo: Private

I graduated from UiB's master program for theoretical physics. My research interests lie in efficient numerical modeling of physical systems. My thesis was in developing accurate approximation schemes for high energy atoms.

The objective of my thesis is to develop a real-time algorithm that jointly inverts borehole EM and Acoustic data for fast and accurate imaging of the surrounding geology. This will be achieved by first developing separate single inversion algorithms for borehole EM and acoustic data that are fast and reliable, then combining them into a joint inversion workflow. The main feature of the joint inversion will be cross-gradient and rock-physics constraints that will improve convergence and accuracy. Applications of machine learning, such as picking the parameterization effectively and for building low rank approximations are also considered for the project.

Social gathering for PhD-candidates. Photo: NORCE

Publications 2025

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Durra Handri Saputera, Morten Jakobsen, Koen W.A. van Dongen, Nazanin Jahani Sequential multi-dimensional parameter inversion of induction logging data, Geophysical Prospecting, volume 73, Issue 4, page 1315-1332, ISSN: 1365-2478. UiB, Technische Universiteit Delft, NORCE

Eric Cayeux Borehole Trajectory Modeling using Circular Arcs, Constant Curvature and Toolface, and Sections with Constant Build-up and Turn Rates, International Conference on Offshore Mechanics and Arctic Engineering (OMAE), Volume 6: Offshore Geotechnics; Petroleum Technology, NORCE

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Nazanin Jahani, C. Torres-Verdin, W. Saputra,E. Romsaas Fjeldberg Adaptive Multidimensional and Multiresolution Inversion of Borehole Ultra-Deep Azimuthal Resistivity Measurements for 3D Imaging and Geosteering | Earthdoc, EAGE Conference and Exhibition, Volume 2025, page 1-5, NORCE, University of Texas at Austin, Aker BP ASA

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Society of Petroleum Engineers Society of Petroleum Engineers, Felix J. Pacis, Sergey Alyaev, Gilles Pelfrene, Thomas Wiktorski Zero-Shot Learning With Large Language Models Enhances Drilling-Information Retrieval, Journal of Petroleum Technology, ISSN: 1944-978X, SPE, UiS, NORCE

Yasaman Cheraghi, Sergey Alyaev, Reidar Brumer Bratvold, Aojie Hong, Igor Kuvaev, Stephen Clark, Andrei Zhuravlev Analyzing expert decision-making in geosteering: Statistical insights from a large-scale controlled experiment, Applied Computing and Geosciences, Volume 26, Article 100237, ISSN: 2590-1974, UiS, NORCE, ROGII Inc

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Eric Cayeux, Rodica Georgeta Mihai, Rune Herikstad, Karl Kristian Olsen, Kamil Antosz, Minh Pham, Code Generation of Automatic Drilling Control System Functions with Embedded Verification and Validation Functionalities, SPE/IADC International Drilling Conference and Exhibition, March 4–6, 2025, ISBN: 978-1-959025-64-1, NORCE, BTWN, Halliburton, Aker BP ASA

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Hibat Errahmen Djecta, Sergey Alyaev, Kristian Fossum, Reidar Brumer Bratvold, Ressi Bonti Muhammad, Apoorv Srivastava, Uncertainty-Aware Well Placement: Simulator-Verified Dual-Network Reinforcement Learning Approach Meets Particle Filters, Computational Science : ICCS 2025 Workshops : 25th International Conference, Singapore, Singapore, July 7–9, 2025, Proceedings, Part I, ISBN: 978-3-031-97554-7, 978-3-031-97553-0, NORCE, UiS, Stanford University

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Felix James Cardano Pacis, Tomasz Wiktorski, Sergey Alyaev, Applied Transfer Learning in Drilling Engineering, Universitetet i Stavanger, ISBN: 978-82-8439-351-3, UiS, NORCE

Pauline Marie Nüsse, Ole Morten Aamo, Adrian Ambrus, Control of Distributed Damping Subs for Torsional Vibration Mitigation in Drilling, Norges teknisk-naturvitenskapelige universitet, ISBN: 978-82-326-8983-5, NTNU, NORCE

Ressi Bonti Muhammad, Reidar Brumer Bratvold, Sergey Alyaev, A Probabilistic Reinforcement Learning Framework for Optimized Decision-Making in Geosteering, Universitetet i Stavanger, ISBN: 978-82-8439-328-5, UiS, NORCE

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Sergey Alyaev, Real-Time Geological Inversion for Decision-Making and Stratigraphic Inversion Exercise, Geilo Winter School, 19.01.2025 – 24.01.2025, NORCE

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Personnel

Key researchers	Institution	Research area
Eric Cayeux	NORCE	Drilling
Sergey Alyaev	NORCE	Geostreering
Rodica Mihai	NORCE	Drilling
Adrian Ambrus	NORCE	Drilling
Erik Wolden Dvergsnes	NORCE	Drilling
Gilles Pelfrene	NORCE	Drilling
Knut Steinar Bjørkevoll	NORCE	Drilling
Benoit Daireaux	NORCE	Drilling
Lucas Volpi	NORCE	Drilling
Sonja Moi	NORCE	Drilling
Nazanin Jahani	NORCE	Geosteering
Ulf Jakob Aarsnes	NORCE	Drilling
Kevin Roy	NORCE	Drilling
Jan Einar Gravdal	NORCE	Drilling
Henrik Anfinsen	NORCE	Drilling
Morten Jacobsen	UiB	Formation physics
Reidar Bratvold	UiS	Decision Analysis
Dan Sui	UiS	Drilling
Hans Joakim Skadsem	UIS	Fluid Mechanics
Tomasz Wiktorski	UiS	Computer science and Data science
Petra Galuscakova	UiS	Computer science and Data science
Ole Morten Aamo	NTNU	Cybernetics

Postdoctoral researchers with financial support from the centre budget

Name	*Nationality*	*Period*	*Sex M/F*	*Topic*
Liang Zhang	Chinese	2024-2026	M	DDBot - AI for automatic population of semantics
Pauline Nüsse	German	2025-2027	F	Optimizing the placement of distributed damping subs

PhD students with financial support form the Centre budget

Name	*Nationality*	*Period*	*Sex M/F*	*Topic*
Pauline Nüsse	German	2021-2024	F	Automatic control of vibration-damping sleeves for drill strings
Durra Handri Saputera	Indonesian	2022-2025	M	Efficient integral equation methods. For modelling and inversion of electromagnetic induction data: Focus on the use of different scattering approximations
Prathik Presad Rangayyan	Indian	2025-2028	M	Reinforcement Learning and Simulation of Automated Drilling Operation

PhD students working on projects in the centre with financial support form other sources

Name	*Funding*	*Nationality*	*Period*	*Sex M/F*	*Topic*
Marios Gkionis	NTNU	Greek	2022-2025	M	Extremum seeking control using ideas from reinforcement learning
Åsmund Aamodt Resell	UIS	Norwegian	2023-2026	M	Computational fluid dynamics and drill string mechanics
Michal Chudoba	UiS	Czeck	2025-2028	M	AI-driven Data Analysis in Drilling Operations

Statement of accounts

(All figures in 1000 NOK)

Funding			
	Amount	**In-kind**	**Sum**
The Research Council	11,161		11,161
The Host Institution (NORCE Energy)		1,000	1,000
Research Partners			
Universitetet i Bergen, UiB		-	-
Universitetet i Stavanger, UiS		2,464	2,464
Norges teknisk-naturvitenskapelige universitet, NTNU		730	730
Enterprise partners			
Operators	9,339	1,409	10,748
Vendors		148	148
Public Partners			
Sum	**20,500**	**5,751**	**26,251**
Costs			-
The Host Institution (NORCE Energy)	18,279		18,279
Research Partners	3,221	3,194	6,415
Enterprise partners		1,557	1,557
Sum			**26,251**

Photo: NORCE

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