Funded by the European Union (G.A. 101046937)

NEWSLETTER #2

February 2024

Come to hear about DeepU

29-1 Feb.-March2024

GeoTHERM Expo 2024
Offenburg, Germany

14-19 April 2024

EGU General Assembly 2024
Vienna, Austria

Welcome to the second issue of the DeepU Project Newsletter!

The last period has seen important changes in the DeepU organisation and structure. First of all, in coordination. Eloisa Di Sipio, who led the Consortium till last summer, enthusiastically follows a new channel of work. We thank her for the wonderful job she did for us, and we wish her all the success she deserves. For this reason, I stepped in, changing my status from partner to Project Coordinator. Moreover, as anticipated in the previous issue, the DeepU Team has enlarged, and a new partner is on board; we are so pleased to announce it officially! This collaboration reshapes and deploys the structure of the DeepU Project, and we can't wait to share the details with you.

Our goal with this Newsletter remains to keep you engaged, informed, and inspired. Whether you are an expert industry professional or a curious enthusiast, there is something for everyone in this edition!

Get ready to read our latest updates, insightful analyses and a sneak peek into the future of DeepU geothermal drilling.

Happy reading!

Luc Pockelé, RED Srl, Padua (Italy)
DeepU Project Coordinator

Funded by the European Union (G.A. 101046937)

Key project figures

7 Partner organizations

4 Involved countries

36 Months duration starting on March 1, 2022

Key project actions

- Drilling technology design and development
- Validation at the lab scale
- Compliance with legal and environmental aspects
- Closed-loop scenario definition
- Cost-effectiveness assessment

A new important partner and an updated project structure for DeepU

Established in 1945, the Wrocław University of Science and Technology (WUST) has evolved into one of Poland's leading technical universities, boasting a legacy built on resilience and academic excellence. Rooted in the cryogenic traditions of two prominent Polish scientists, Karol Olszewski and Zygmunt Wróblewski, who first managed to liquefy the so-called "permanent gases" in Kraków in 1883, WUST has cultivated unparalleled expertise in cryogenic technology, notably WUST's work has led to Poland being the only country in Europe to liquefy helium.

Their prowess extends to the development, design, production supervision and commissioning of complex cryogenic distribution systems supplying liquid cryogens superconducting accelerators, free electron lasers, thermonuclear reactors and other Big Science machines. Notably, their exemplary cryogenic distribution system (**fig. 1**) currently provides superfluid helium to the European Spallation Source accelerator in Lund, Sweden.

Figure 1. *Cryogenic Distribution System designed by WUST, now under commissioning at ESS, Lund, Sweden.*

In the context of the DeepU project and its visionary breakthrough — merging laser technology and cryogenics for geothermal energy exploitation, WUST's participation is strategic and a major boost to the project.

The DeepU project originally envisaged the use of commercially available cryogenic transfer lines to be integrated into the drill string. However, the informative exchange with potential suppliers in the first half year of the project has shown that the provided technical solutions either offer insufficient thermal insulation or take up too much installation space within the drill string. In addition, the standard cryogenic gas lines are usually made of stainless steel, and their weight would be too high in deep drilling applications. This means that the new laser and gas drilling technology requires a new design of the cryogenic gas supply system. It is here that WUST steps in, to assess the minimal space requirements and technological feasibility of the cryogenic gas supply for the laser drilling system.

WUST has already commenced the analysis of potential novel solutions for gas supply down the bore and removal of the material drilled by the laser beam.

Focusing on this topic, the DeepU work program added a specific work package led by the WUST team and the DeepU Project structure is now in place.

WUST's objectives span a comprehensive list:

- determining the cryogenic gas flow needed to ensure melted rock adequate cooling and dispersed rock pneumatic transport to the surface;
- identifying the thermodynamic transition along the wellbore and the possible negative flow-related issues;
- investigating the thermal insulation concepts needed to guarantee the desired thermodynamic parameters at the drill outlet;
- assessing the mechanical and thermal requirements of the laser drill system elements, taking into account the thermal expansion compensation requirements of the material;
- assessing the laser drill cryogenic system risk analysis.

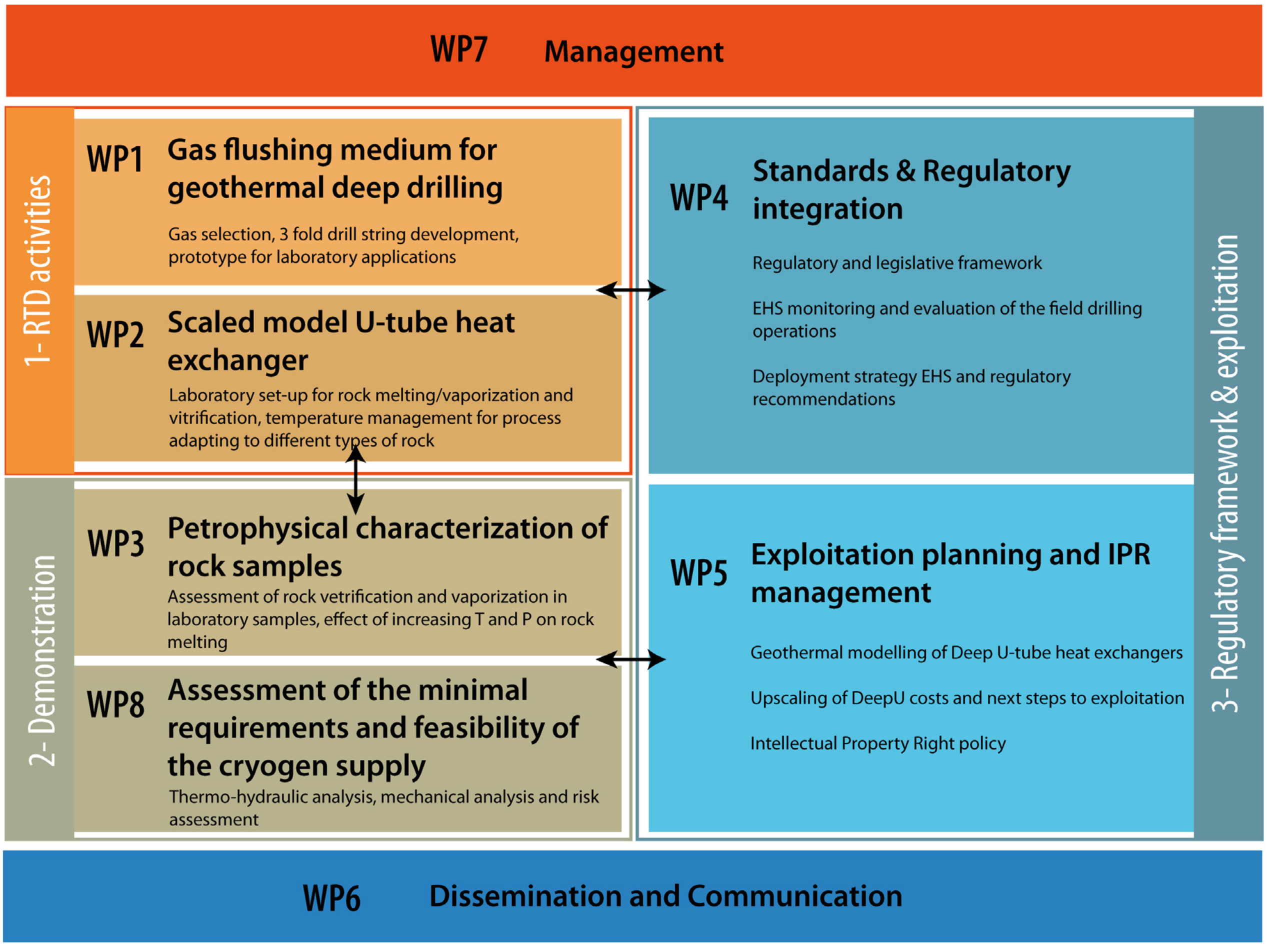
Prof. Chorowski, our WUST team leader, highlights that *"The project is a real challenge. To combine cryogenics with drilling is a new concept and requires an innovative approach. The WUST team is young and very motivated. If the task is feasible, we will do it."* This determined perspective underscores the team's motivation and determination to pioneer this innovative concept.

The team's approach, driven by this ambitious goal, is multidisciplinary and forward-thinking. Key members, including DSc Zbigniew Rogala leading the modelling task, Dr Katarzyna Strzelecka, Dr Michał Stanclik heading the design task, alongside Dr Agnieszka Piotrowska, Dr Wojciech Gizicki, Dr Tomasz Banaszkiewicz, and Jakub Kielar, exemplify this diverse expertise.

Fuelled by the passion and enthusiasm of its young team, WUST aims to achieve the fusion of cryogenics and drilling, driving innovation and setting new benchmarks in the field.

The DeepU Project structure modified to embed the new contribution provided by WUST.

Funded by the European Union (G.A. 101046937)



The reorganized WPs structure

DeepU storyline

While we take pride in this new collaboration, it is equally essential to highlight the ongoing Research and Technological Development (RTD) activities and our successful communication initiatives.

In these recent months, our DeepU team has been immersed in a flurry of activity, marked by meticulous petrophysical analyses, strategic planning, and the exploration of diverse materials and designs. Our commitment has extended beyond borders, with active participation and impactful communication at both European and global levels. Notably, our presence at the World Geothermal Congress in Beijing allowed us to showcase our advancements and engage with experts on an international stage.

We also presented DeepU at key events in Italy, including Geofluid in Piacenza, Energy Trends 2023 in Rome, The Geoscience Paradigm: resources, risk and future perspectives in Potenza and ETIP Geothermal Annual Conference in Pisa. These experiences facilitate knowledge exchange and strengthen our collaborative networks within the global geothermal community.

The endeavours of the **IAPT** and **Prevent** partners align with our implementation objectives and also serve as the bedrock for the next phases of the project. Currently, our laboratory demonstration partners, **University of Padua**, **CNR-IGG** and **WUST**, and regulatory and framework exploitation collaborators, **Geoserv** and **RED**, are now transitioning into a crucial concentration phase, symbolising a pivotal point in our project.

DeepU
Funded by the European Union
(G.A. 101046937)

DeepU's
First 23 months

PRESS RELEASE
Learn more about the project at www.deepu.eu

01

MEETINGS
We coordinated actions and discussed technical details in four virtual or physical meetings

04

LANGUAGES
Our leaflet already speaks in three languages: English, German, Italian and the Polish version is in production

PARTCIPATED EVENTS
DeepU Concepts have been circulated and presented in eight events

08

DELIVERABLES
Seven of these reports are entirely public, and three have a publishable summary. Look for them on our website

https://www.deepu.eu/index.php/project-outputs/

10

Let us recap what we are doing, with a novel graphic summarising the concept.

The core concept of DeepU (Deep U-tube heat exchanger) is the novel drilling technology, which is poised to revolutionise the boundaries of geothermal development and use.

We are working to create a deep (>4 km) closed-loop connection in the shape of a U-tube exchanger by developing a fast and effective laser drilling technology and increasing the accessibility of deep geothermal resources for low-carbon heating and possible power generation.

The drill-head prototype has been realised, combining the laser system with a novel drill strings design that can sustain the coupled action of laser and cryogenic gas (**fig. 2**). This image encapsulates a glimpse into the future of geothermal drilling: the laser, with the power to cut through the toughest materials, is enhanced by the cryogenic gas, strategically optimising the drilling process.

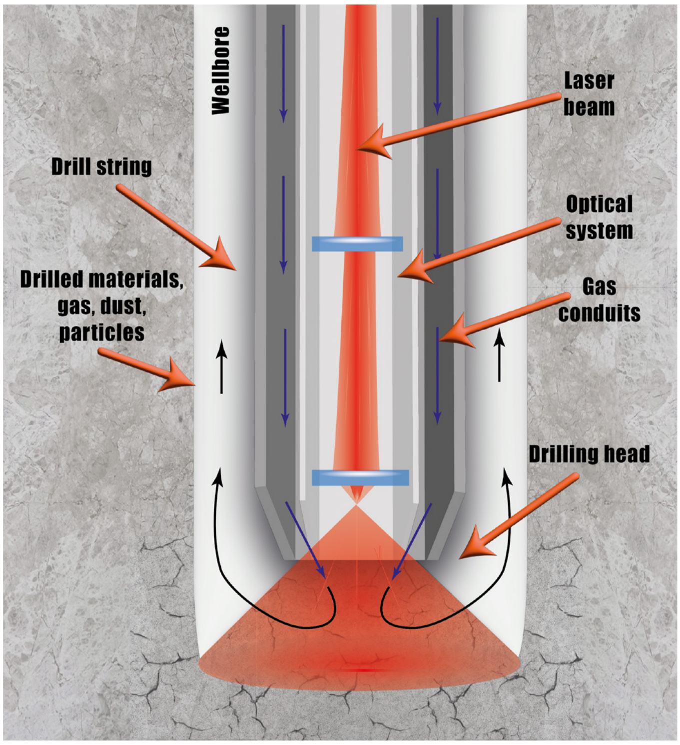


Figure 2. *Drill head designed by the DeepU project*

The research team in Hamburg at Fraunhofer IAPT during experimental activities

Unravelling the secrets of DeepU

How does laser-cryogenic gas drilling take place?

At the heart of the drilling emerges a powerful laser beam, which heats up the surface of the drilling target. The fine particles of the rock begin to yield to the overwhelming heat, initiating the spallation journey supplemented by melting and evaporation. The rock undergoes extreme temperatures that generate stress forces affecting the rock. As the laser's influence persists, layer by layer, portions of the rock are broken out in a violent process of spallation. The strain energy accumulated on the surface is released, and the surface portion of the rock is removed. That allows to progressively heat subsequent portions of rock and sustain the drilling process. With a current laser setup, spallation is the most efficient process for rock penetration, while melting and evaporation are the secondary processes. The spallation is supported by the flow of N2 that efficiently removes spalled particles. The fine particles of drilled rocks are ejected to the surface in the gas stream via the borehole annulus.

The laser's influence has penetrated the rock and left its indelible mark.

Our expert team monitors the process with unwavering attention using an optical camera and a thermo-camera, investigating the borehole to unravel the secrets of the drilling process as it progresses.

The meticulous optimisation of laser parameters and experimental setups, coupled with microscopic examinations of drilled rocks, has revealed macro- and micro-scale phenomena that contribute to the successful development of this innovative drilling method. DeepU study not only delves into the geothermal potential of rocks but also paves the way for the sustainable exploitation of geothermal energy from depths below 4 km.

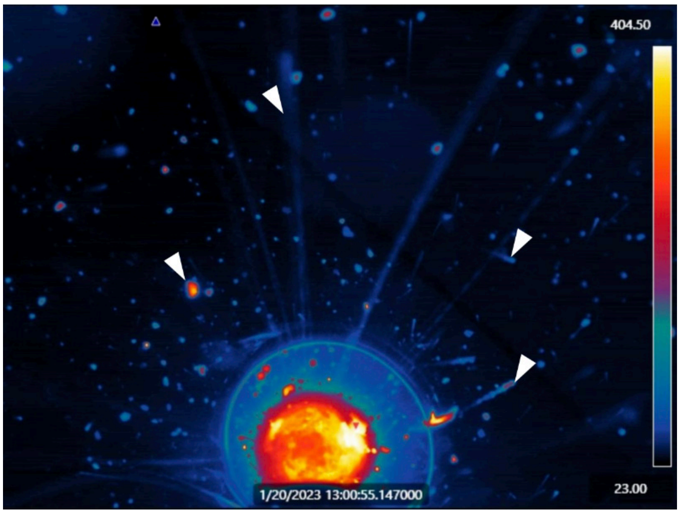


Figure 3. *Thermal image of laser-drilled wet sandstone. High temperature region represents laser beam spot size (5cmØ) i.e., borehole. White arrows show spalled particles. Temperature scale is expressed in °C.*

DeepU seen from a Legislative and Regulatory perspective

Let's delve into the intricate landscape of legislative and regulatory frameworks in Europe as they pertain to DeepU drilling technology.

As we navigate the new state-of-the-art drilling technologies of DeepU, understanding and aligning with regulatory expectations becomes paramount.

Our ongoing commitment to environmental, health, and safety (EHS) standards remains a keystone in paving the way for the successful integration and commercialisation of DeepU technology. GeoServ, at the forefront of this regulatory exploration, has meticulously examined the legislative landscape and licensing systems for geothermal projects.

Based on this, Geoserv has looked at how the laser and cryogenic gas will operate in a real drilling operation, which includes surface equipment and the downhole environment. There are many novel aspects to consider to guarantee that the system will succeed commercially and meet all health, safety and environmental requirements. Using conventional oil and gas and deep geothermal technologies as a benchmark, a report was compiled on the risks that may arise with the laser/cryogenic gas technology and its corresponding mitigation strategy. Not least, the concerns around the high temperatures generated downhole and how lithologies encountered will behave. The work undertaken by UniPD and Fraunhofer is essential in gaining a better understanding of these particular aspects.

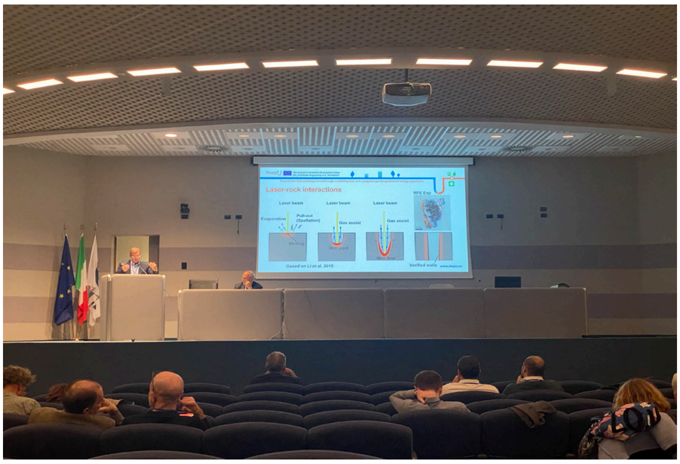
Complementing this, a Failure Mode and Effects Analysis (FMEA) was carried out, whereby each process was analysed as to how and when it may fail, and the effect such failures would have on the overall drilling/operational process. The FMEA also ranks the risks and combines a step-by-step understanding of how risks can be detected, minimised and accounted for. This is a powerful tool in any process-driven operation.

Looking ahead, future work includes the development of a technology roadmap and a fully integrated Environment, Health and Safety (EHS) plan. This plan is designed not only to meet but exceed current legislation and protocols, ensuring that DeepU remains at the forefront of technological innovation while upholding the highest standards of EHS.

Event Snapshots

World Geothermal Congress 2023, Beijing (China)

Energy trends 2023, Rome (Italy)



ETIP Geothermal Annual Conference, 2023, Pisa (Italy)

Let's come to hear about DeepU in these upcoming events:

1. **GeoTHERM Expo & Congress 2024** - Offenburg, Germany
    - **Date**: February 29 - March 1, 2024
2. **EGU General Assembly 2024** - Vienna, Austria
    - **Date**: April 14-19, 2024

We look forward to meeting you there!

DeepU is online

Follow us and stay up to date!

Contact us:
info@deepu.eu

This research is funded by the European Union (G.A. 101046937). However, the views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union or EISMEA.
Neither the European Union nor the granting authority can be held responsible for them.