This research is funded by the European Union
(EIC, Pathfinder Programme, G.A. 101046937)

Deep U-tube heat exchenger breakthrough: combaining laser and cryogenics gas for geothermal energy exploitation

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DeepU Project

Goals

- Developing new **laser drilling technology**
- Extracting energy from **deep (>4 km)** U-shaped closed-loop heat exchangers
- **Reducing the costs** of well drilling
- Making accessible **geothermal energy anywhere**

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

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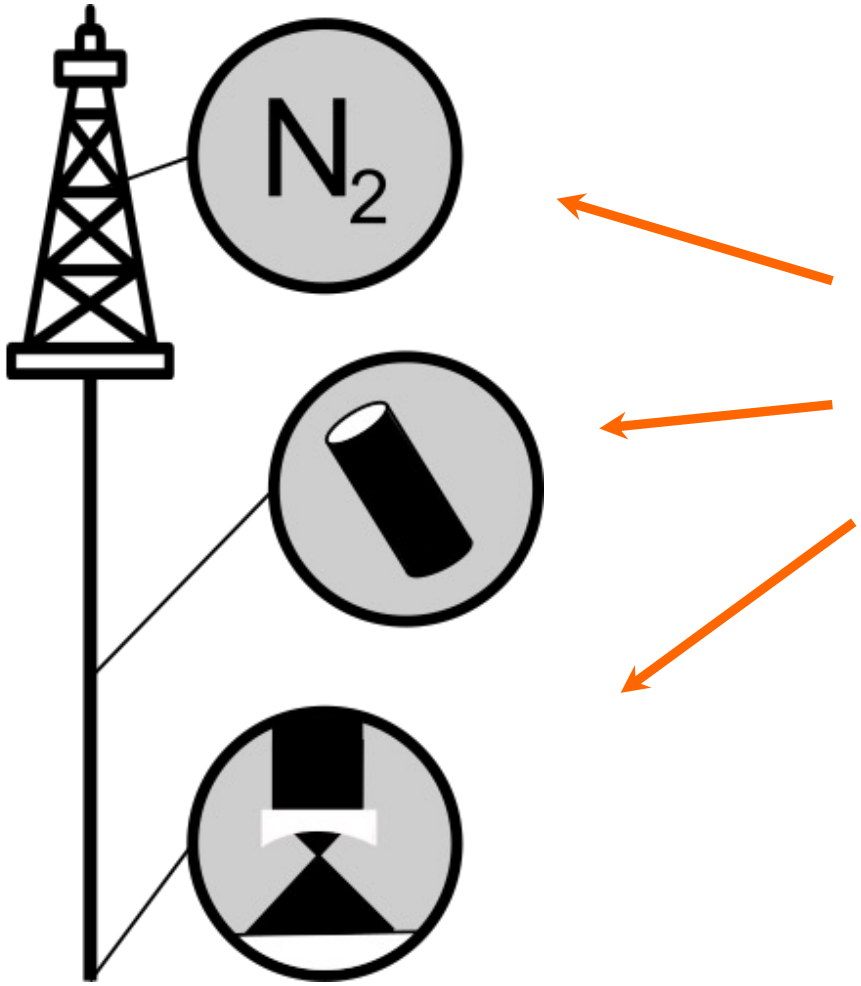
Workflow in DeepU Project



7 international teams work on different aspects of DeepU Project, such as:

- Gas flushing medium
- Scaled model of U-tube heat exchanger
- Petrophysical characterization of drilling process
- Standards and regulatory integration
- Exploitation planning and IPR management
- Communication
- Management

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Market analysis for a sustainable deployment

The project will analyze and assess:

- The **exploitation potential**
- The economics of the developed **drilling technology**
- The **legislative** aspects and **environmental**
- Health and safety (**EHS**) standards related to the proposed solution
- The **risks assessment** comparing DeepU technology to conventional deep drilling

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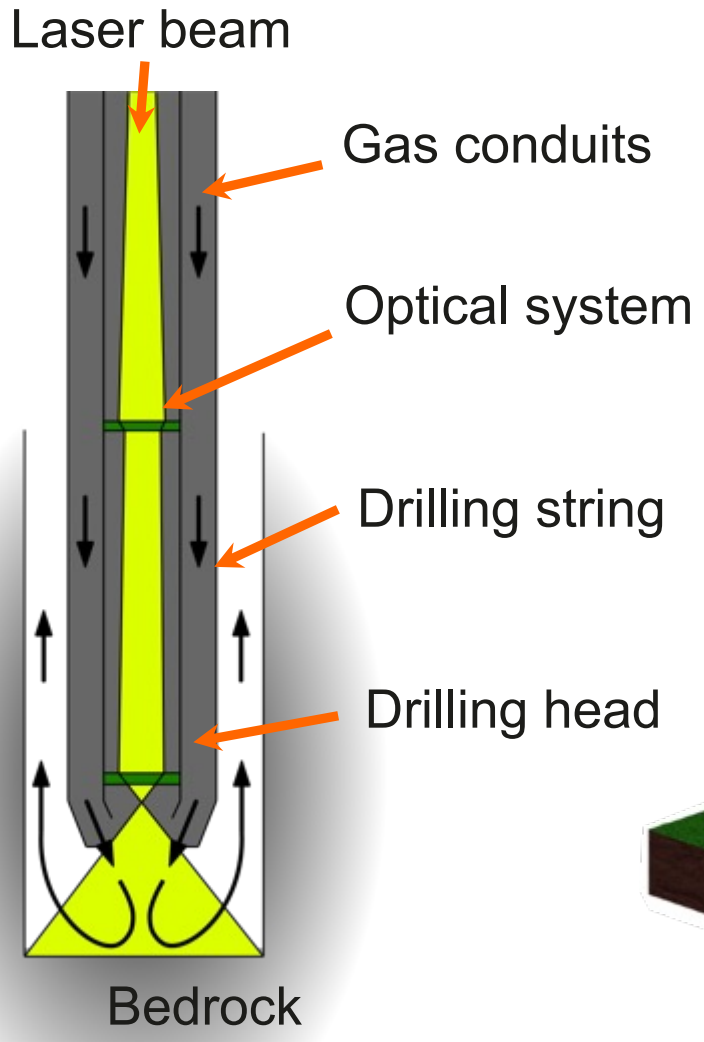
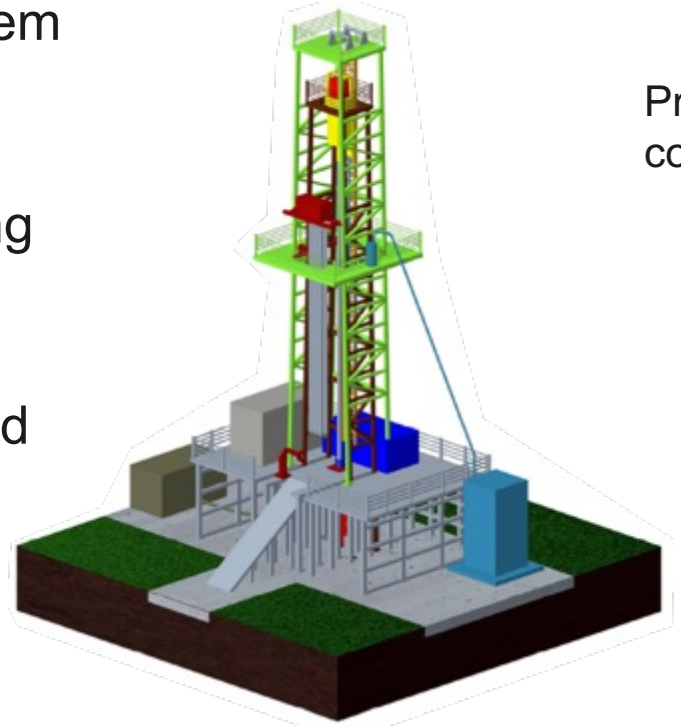
Cryogenic gas supported laser drilling technology



3D designed of the Drilling Tower



Few 3D solutions of the drilling strings

Prototype has been constructed!

Designed and 3D printed drilling head

Fully operational and tested!

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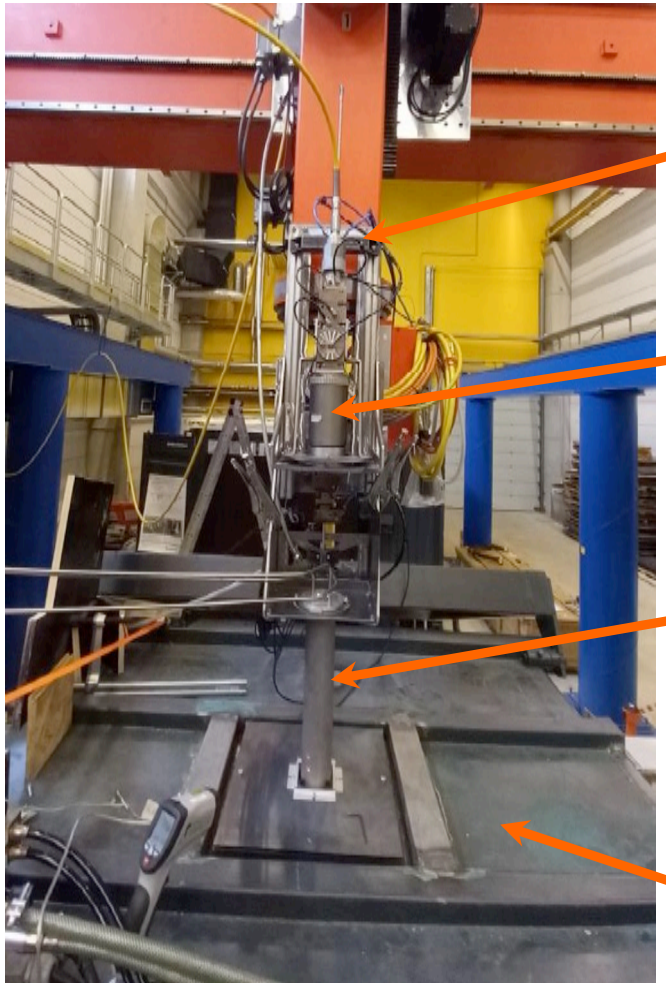
Laser drilling laboratory tests

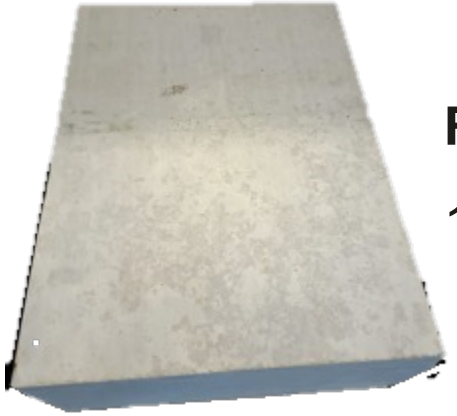


Robotic arm

Optical system

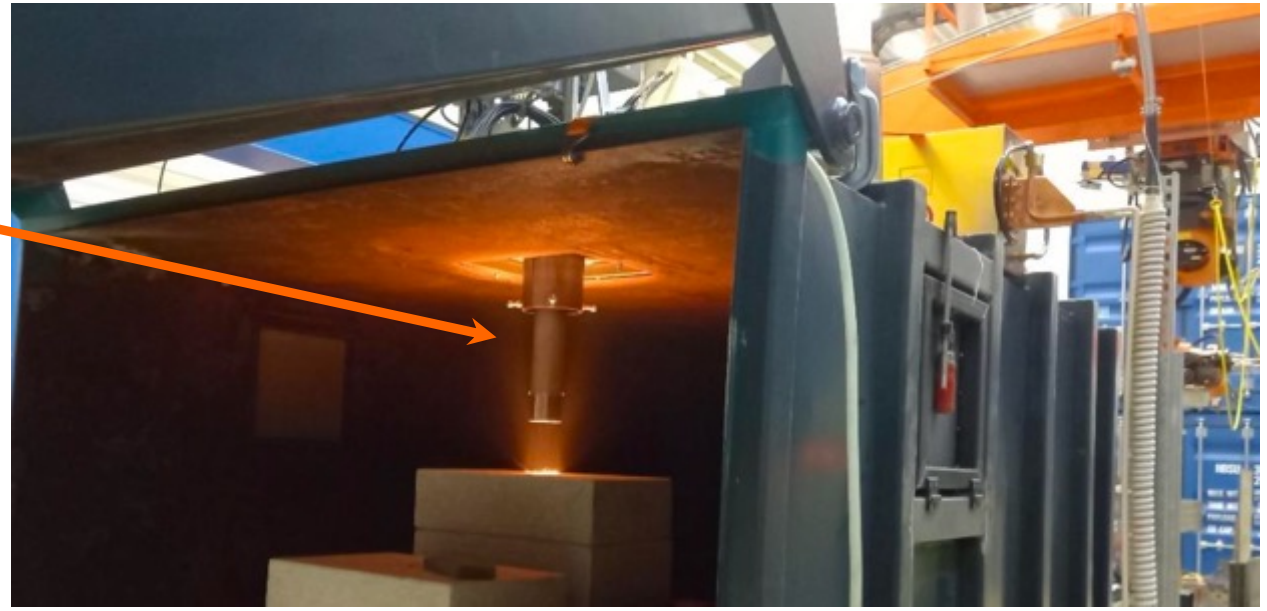
Drilling string

Steel container



Rock slabs

150 mm x 300 mm x 500 mm



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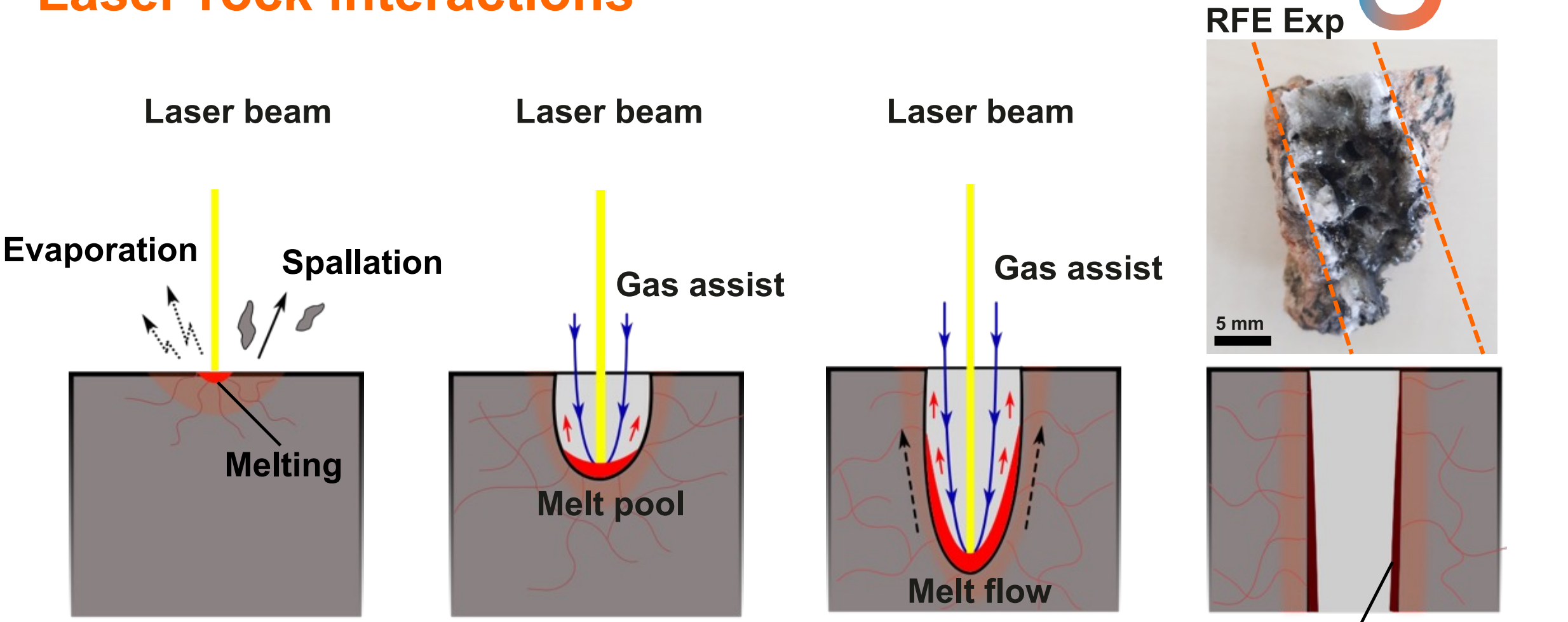
Laser-rock interactions



Based on Li et al. 2015

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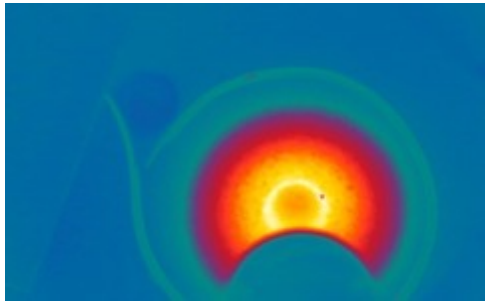
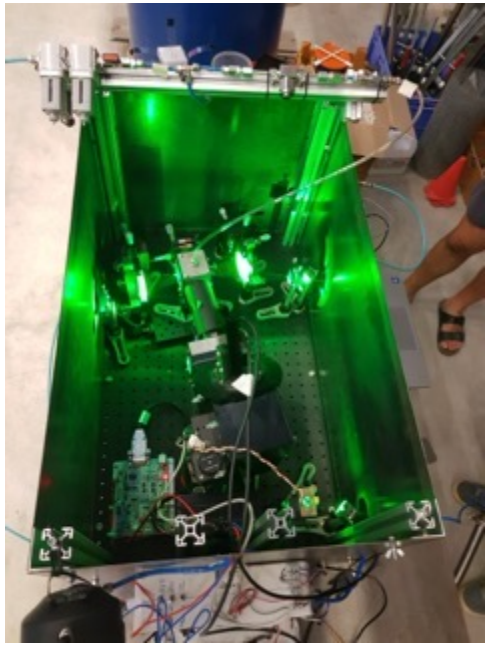
Experimental setup

- Fixed position of robotic arm (working distance)
- Drill with and without assistance of room temperature N_2 flux
- New drilling head
- Fixed laser power 30 kW
- Selected lithologies: granite, sandstone, limestone

- Video documentation
- IR video documentation (thermocamera)
- Gas spectrometry





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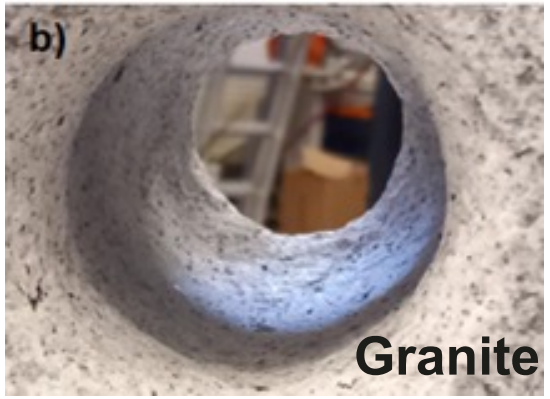
Results

- Description of petro-thermo-mechanical phenomena; **spallation, melting, evaporation**
- **Formation of the glass** at the bottom of the borehole
- **Successful drills** of selected lithologies
- Diameter of the boreholes up to **18 cm**
- ROP up to **20 m/h**



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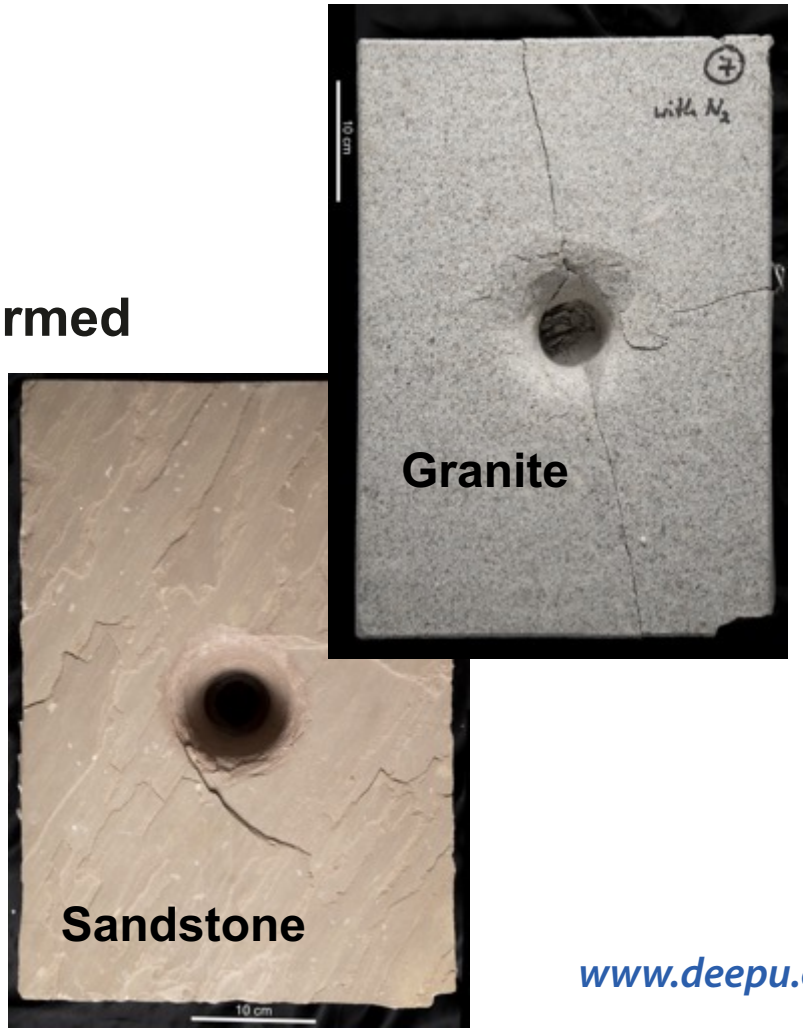
Conclusions

- **3D Design of drill tower** has been prepared
- Prototype of **drill string is ready** for the tests
- **Drill head** was manufactured and tested
- First experimental laser drills supported by N_2 gas **were performed**
- Constant rate of penetration (ROP) **up to 20m**
- All **3 lithologies has been drilled** successfully
- The health and safety standards are assessed
- The legislative and environmental aspects are assessed



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Future developments

- Construction of drilling tower
- First tests of manufactured drill strings
- Drilling tests with assistance of cryogenic N_2 flux
- Testing drills on different lithologies, such as claystone
- Understanding and modeling petro-physico-mechanical phenomena
- Optimizing laser parameters
- Increasing laser power

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Thank You for Your Attention!

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