This research is funded by the European Union
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WP2: Scaled model of a U-tube heat exchanger

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Fraunhofer IAPT

Overview

1. **Fraunhofer IAPT**
2. Tasks in the DeepU project
3. Experimental set-up
4. Processing results
5. Outlook

Fraunhofer-Gesellschaft

Leading Organization for Applied Research in Europe

- 76 Research Institutes and Institutions
- > 32.000 Employees
- > 3 Billion Euro research budget per year

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Fraunhofer IAPT and Hamburg University of Technology

Institution for Additive Manufacturing Technologies

- Located in Hamburg-Bergedorf
- Member of Fraunhofer since 2018
- Previously known as LZN Laser Zentrum Nord
- Expertise for all AM processes
- Part design and system development

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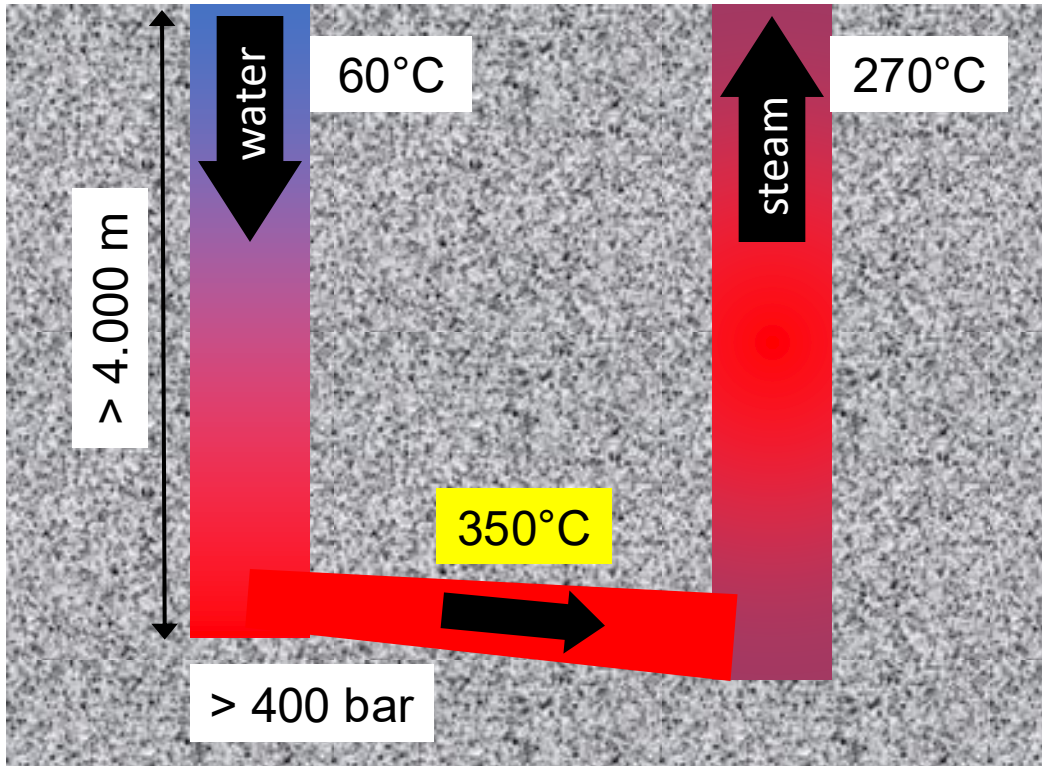
U-tube heat exchanger



Tasks in DeepU WP2:

2.1 Laser and gas processing head

2.2 Laboratory set-up for rock melting

2.3 Laboratory tests and modeling of laser and gas interaction with rocks

2.4 Temperature management for process adapting to different types of rock

Creating a lab scale model of a U-tube heat exchanger

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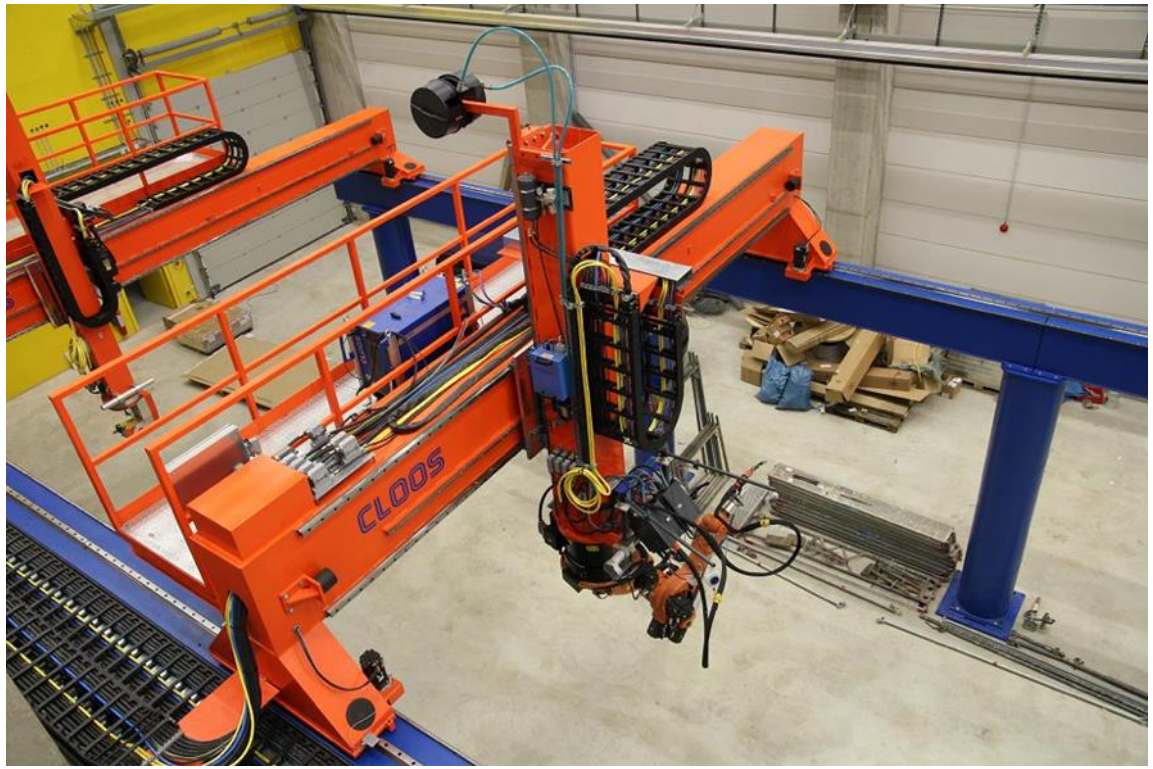
IAPT system technology



- Gantry system for the movement of the drill string
- 30 kW high power laser system

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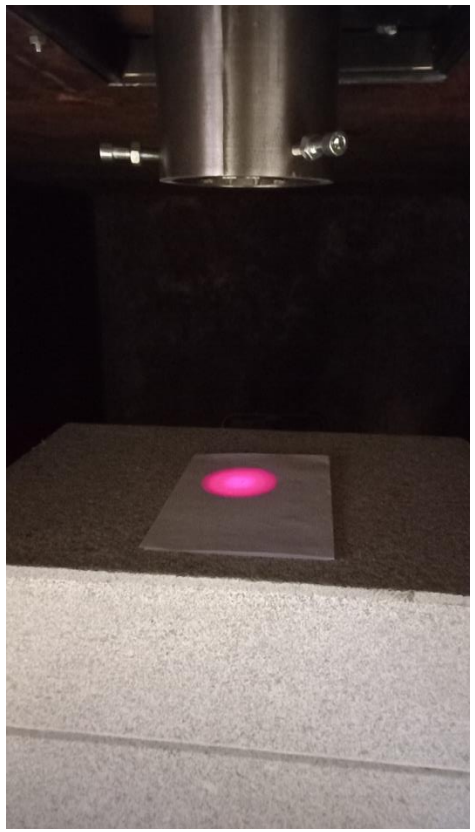
Press container

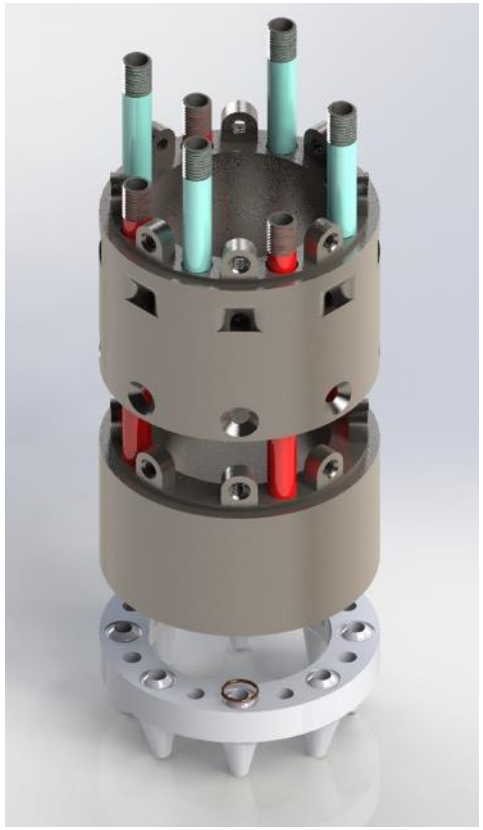
- Original functional purpose is waste paper collection
- Safety housing for the process
- Possibility of embedding the rocks in pressed sand
- Some conversion work was necessary
- Opening in the roof for laser beam and drill string
- Closable windows for process observation on both sides

Laser processing optics



- Linear laser optical system
- Mounted at one robot of the gantry system
- The drill pipe can be inserted into the press container by the robot
- Gas feeding up to 30 bar pressure possible
- Rock material inside the container
- Guide laser spot on the rock surface

Processing head



- Using IAPT expertise
- 3D printed processing head made of titanium with integrated gas channels
- 76 mm outer diameter
- 3 components: nozzle ring, feeding part for hot gas, feeding part for cold gas
- 50 mm inner space for the laser beam
- Diffusing lens at the botom of the drill head to enlarge the laser spot diameter

Temperature management

- 40 kW inductive heating system installed for tempering the gas
- System consists of induction coil, power source and resonant circuit generator
- 3 parallel gas lines are routed through the inductor to the drill pipe
- Temperature measurement by thermocouples (300°C reached)
- Extension of the heating section is possible (meander gas line)

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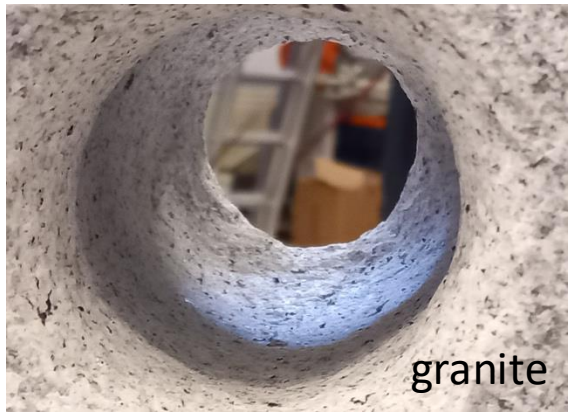
Processing rocks

- Types of rock: granite, sandstone and limestone
- Stacked blocks of 500*350*150 mm
- 250 mm working distance between the drill string and the bottom of the borehole
- Gas jets comming out of the nozzels are fokussed on the working point
- Gas necessary to blow the melted rock particles out of the borehole

Process results



- Laser and gas process successful on granite and sandstone
- Rocks completely penetrated by the laser beam (∅ 80-90 mm)
- Speed of up to 20 meters per hour
- Clean symmetric boreholes with a quite smooth surface inside
- Limestone: rock melted, but not blown out by the gas

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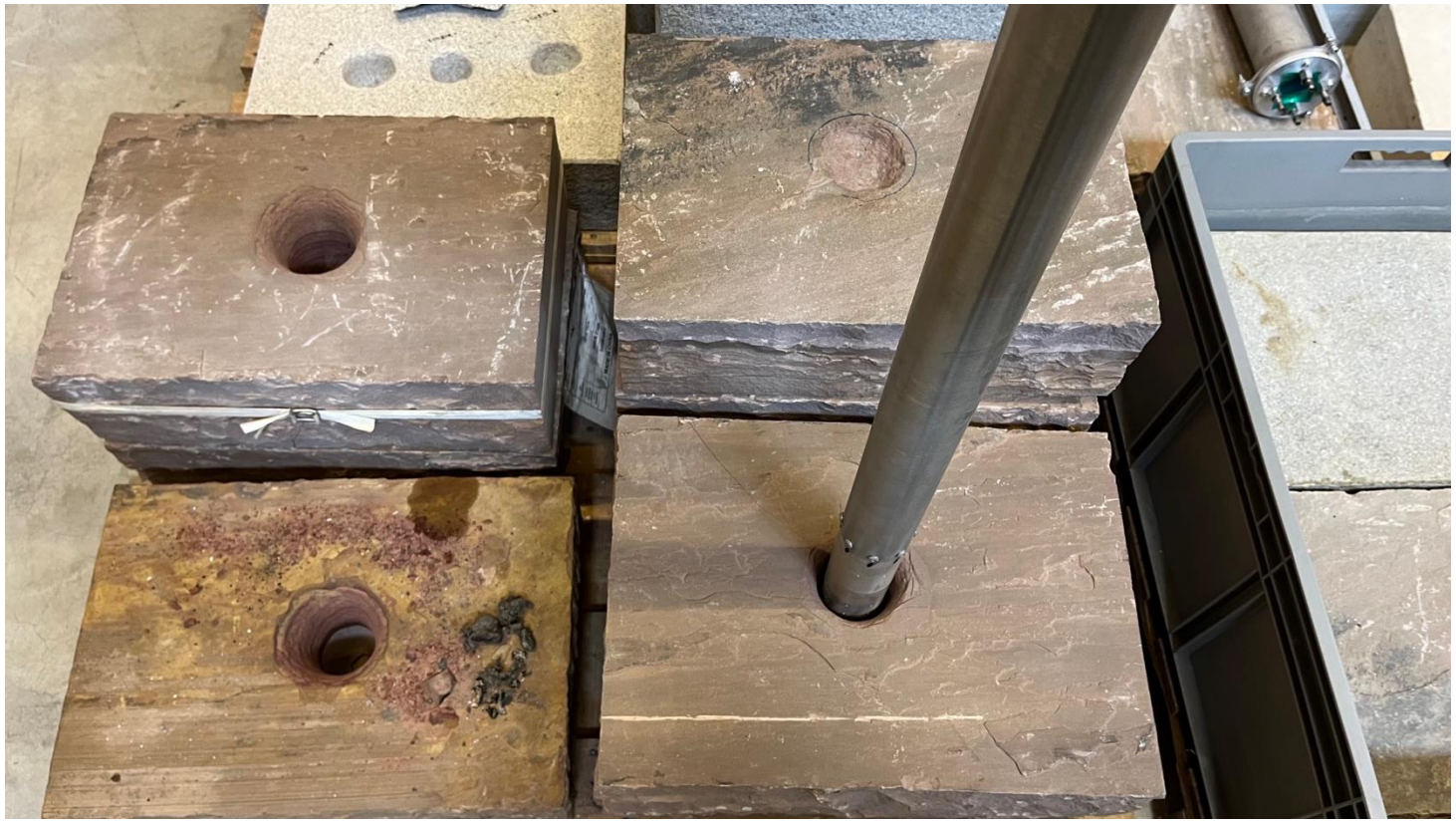
What's next?



- Horizontal drilling
- Processing other types of rock
- Increasing laser power
- Outdoor experiments under real conditions

Thanks for attention!

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