



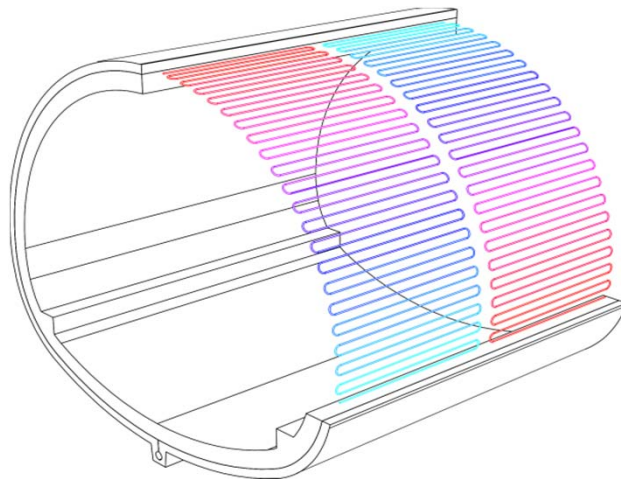
Universität Stuttgart
Germany



International Symposium on Energy Geotechnics

Universitat Politècnica de Catalunya (UPC)

Barcelona, Spain. June 2nd to 4th 2015



Tunnel Geothermics – International experiences on regenerative energy concepts in tunnel projects

Dipl.-Ing. Patrik Buhmann

Institute of Geotechnical Engineering, University of Stuttgart - IGS

Univ.-Prof. Dr.-Ing. habil. Christian Moormann

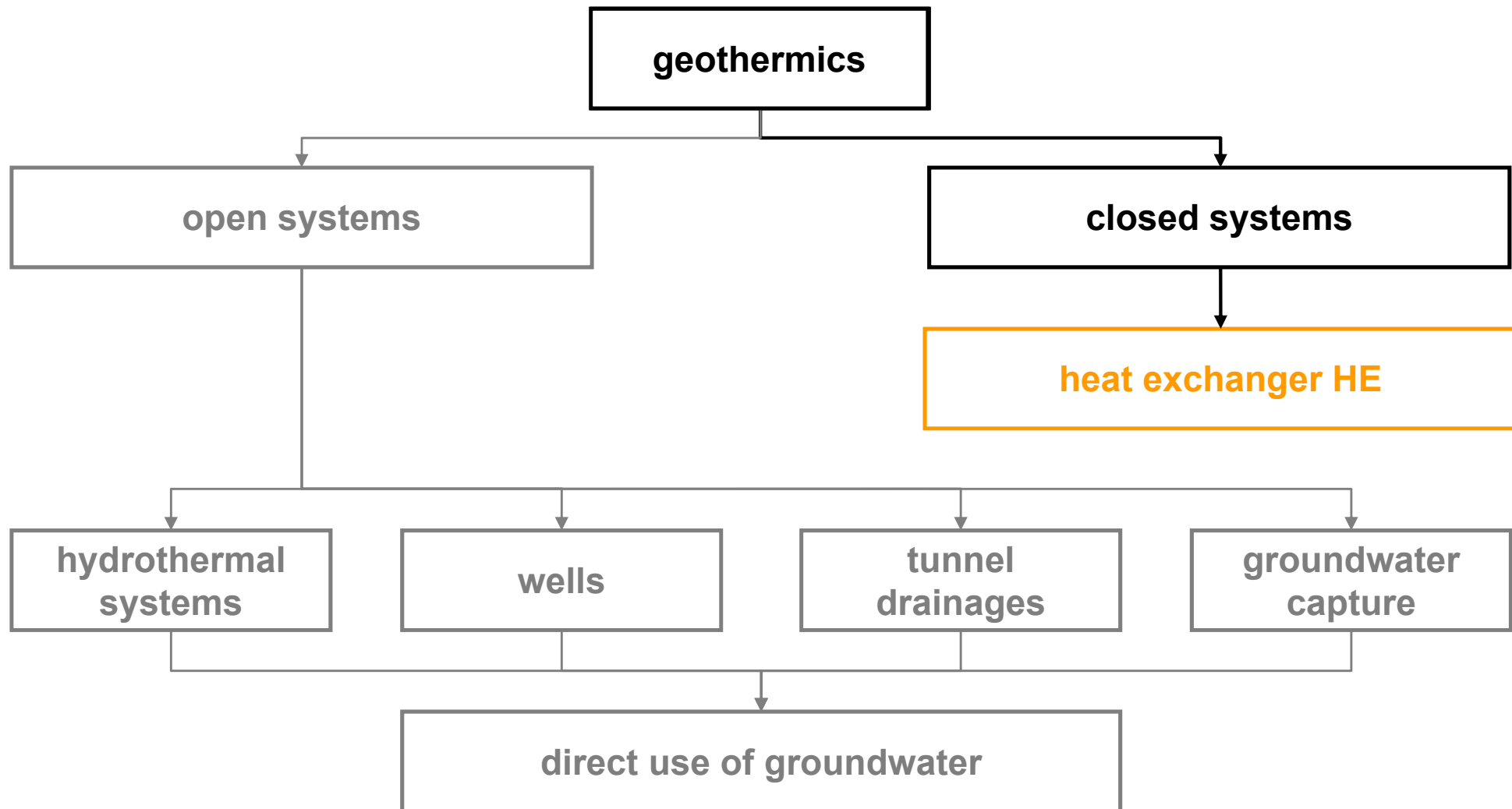
Dr.-Ing. Norbert Pralle

Dipl.-Ing. Wolf Friedemann

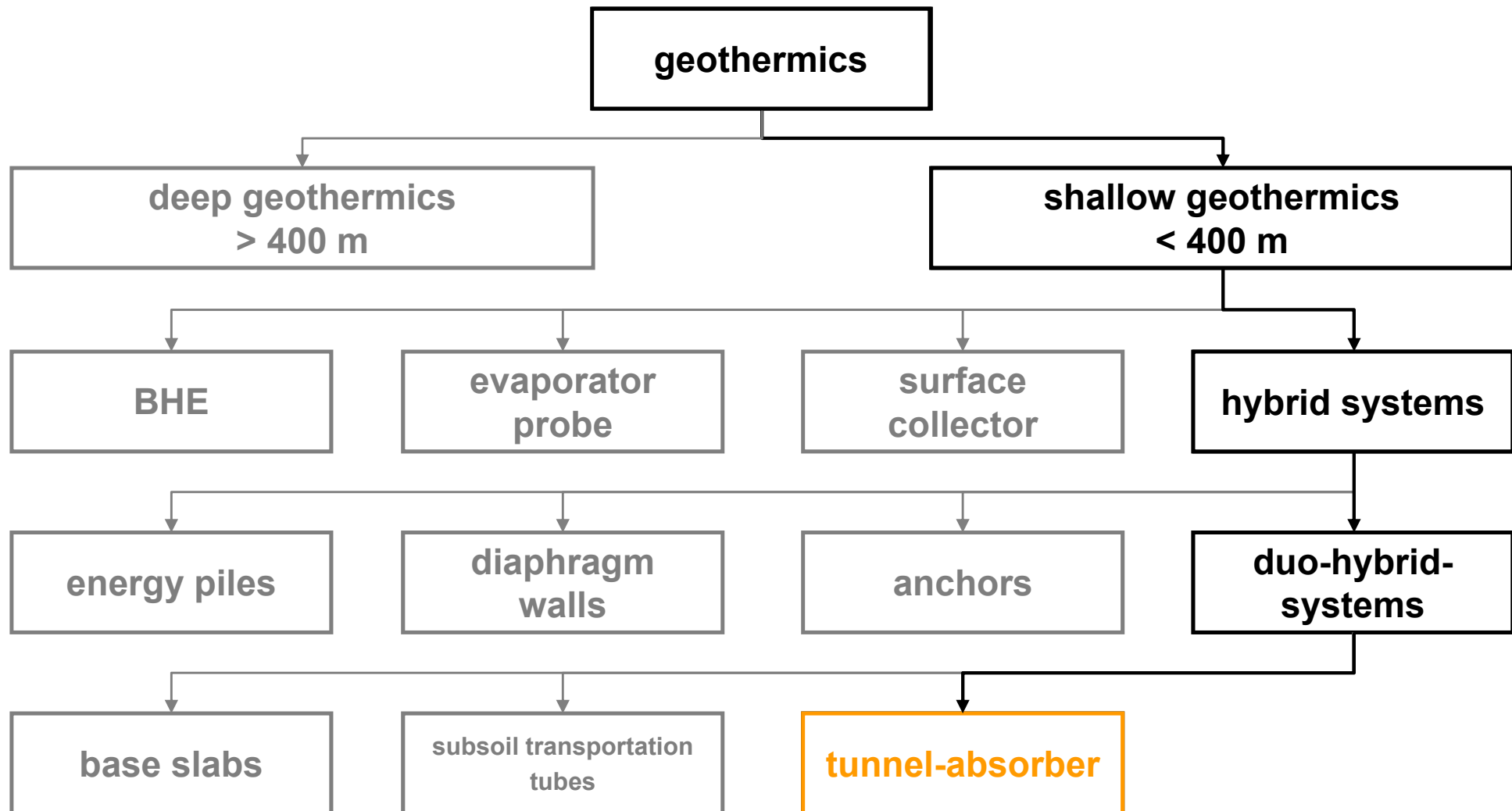
Overview

- **Introduction**
- **Test Plants**
- **Measuring results**
- **Conclusions and outlook**

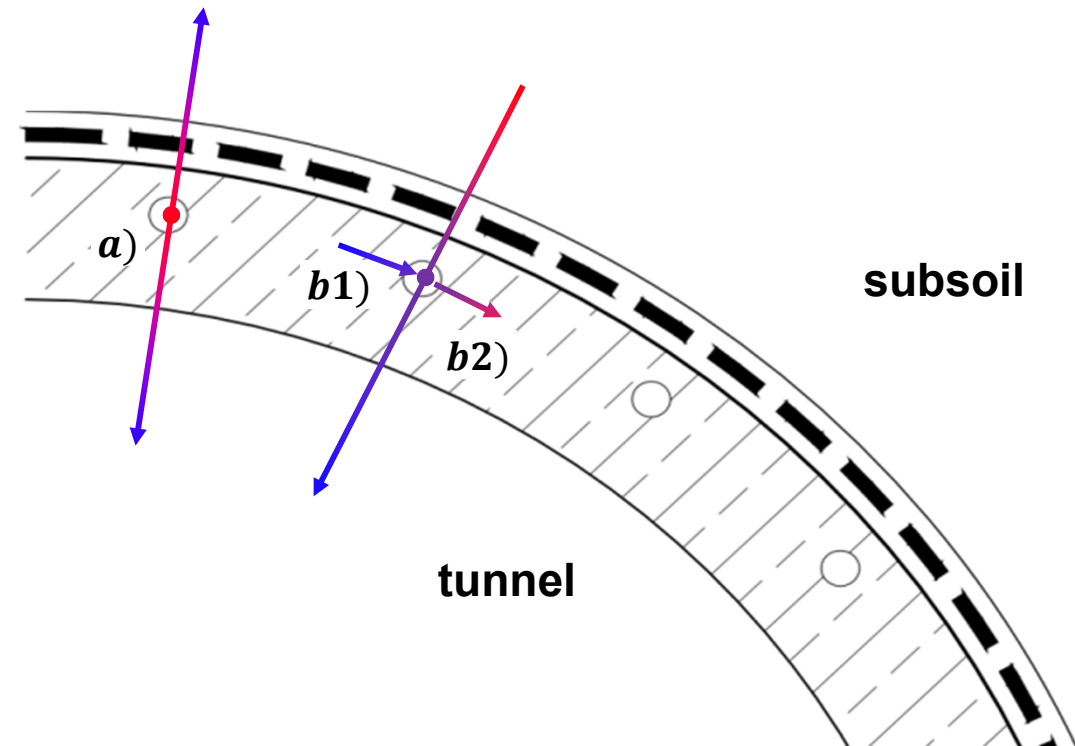
Introduction to tunnel geothermics



Introduction to tunnel geothermics



Basic sketch



a) $\dot{Q}_{tot} = \dot{Q}_{HE-GEO} + \dot{Q}_{HE-TC}$ → tunnelgeothermal plant (cooling mode)

b1) $\dot{Q}_{tot} = \dot{Q}_{GEO-TC} - \dot{Q}_{HE}$ → geothermal plant (heating mode)

b2) $\dot{Q}_{tot} = \dot{Q}_{GEO-TC} + \dot{Q}_{HE}$ → tunnelthermal plant (cooling mode)

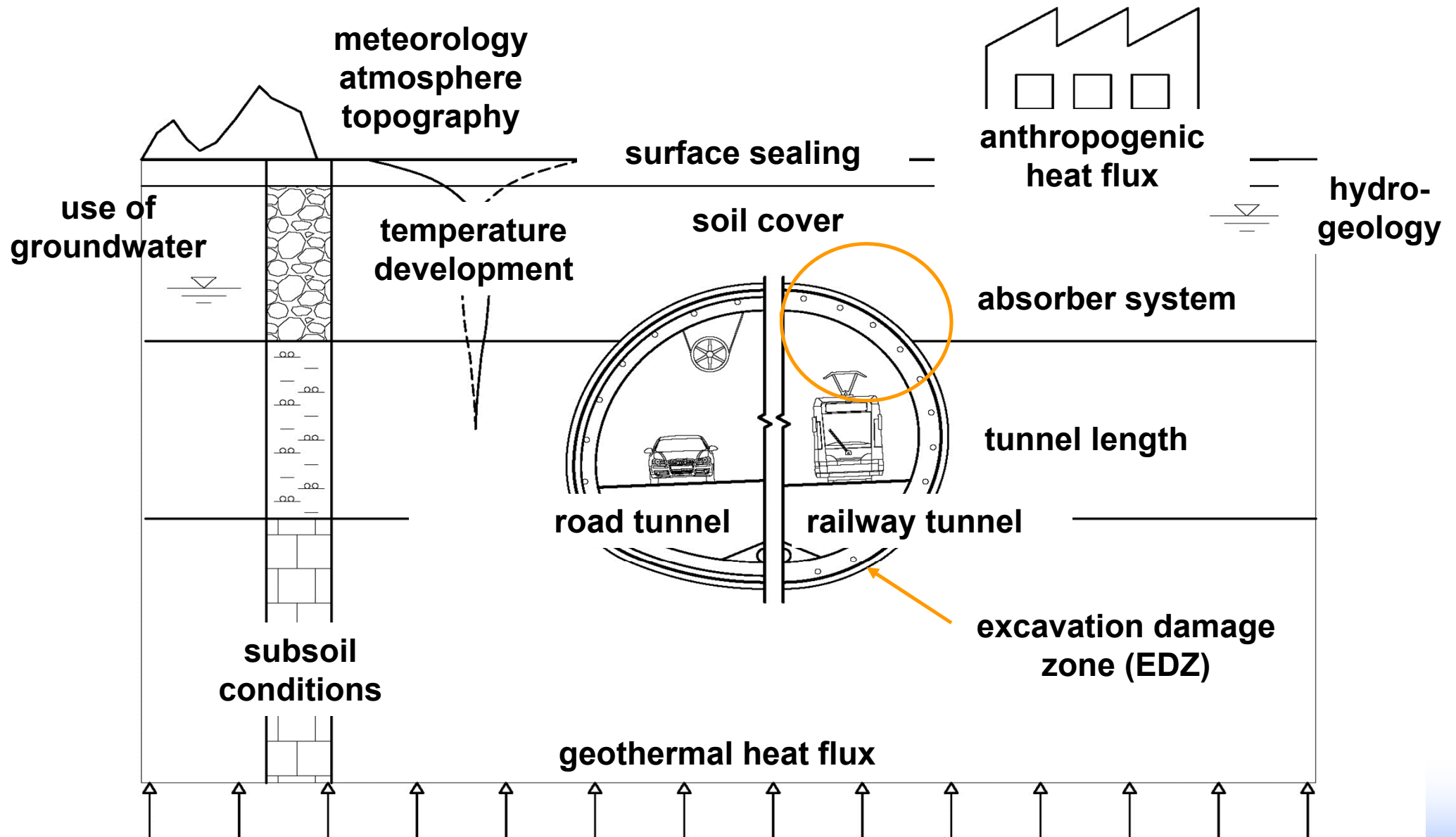
HE = heat exchanger

TC = tunnel climate

GEO = heat flux from subsoil

→ Duo-Hybrid-System

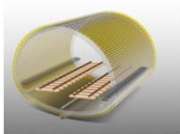
External actions / interactions



Overview test plants

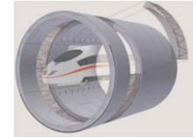


General data



Stuttgart

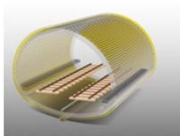
- double tracked 380 m metro tunnel
- excavated section 72 m²
- mined tunnel with inner and outer shotcrete lining
- 800 m absorber pipes Ø 25 mm
- 360 m² geothermal activated area
- 2 x 10 m geothermal activated section



Jenbach

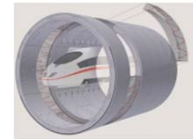
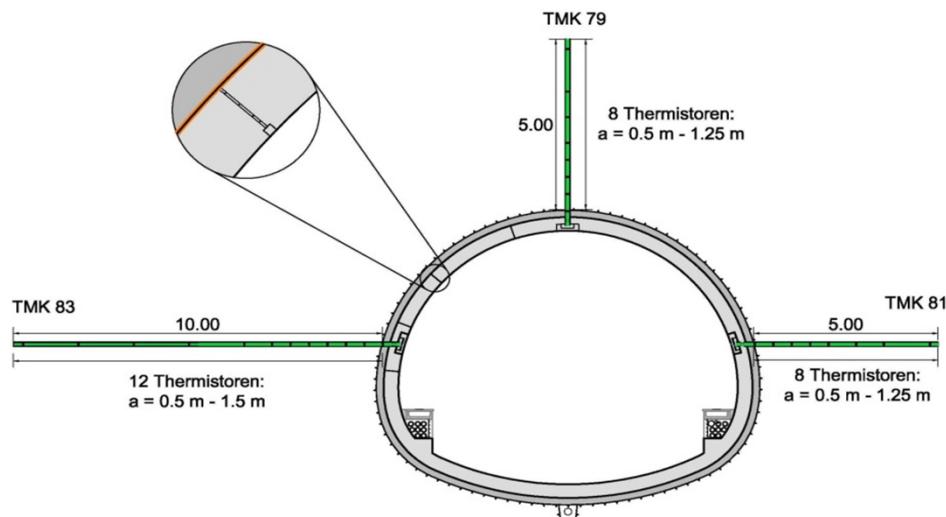
- double tracked 3470 m railway tunnel
- excavated section 134 m²
- mechanical tunnel drive with tubing support
- 4700 m absorber pipes Ø 25 mm
- 2200 m² geothermal activated area
- 54 m geothermal activated section

Monitoring setup



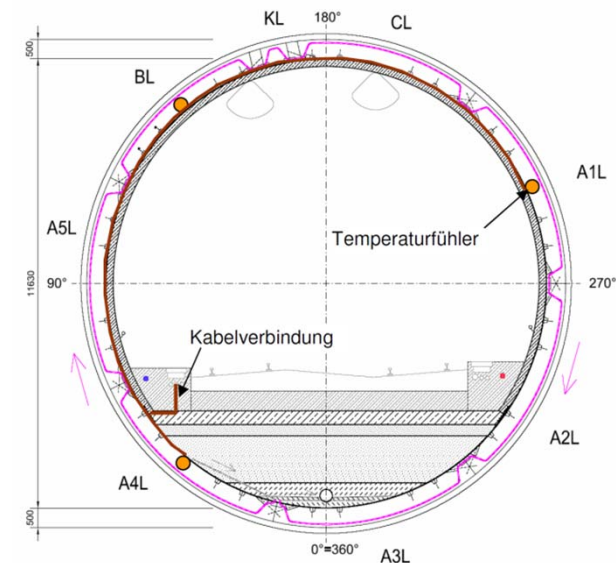
Stuttgart

- 6 measuring probes logging the subsoil temperature
- 8 measurement cross sections logging the lining temperature
- 8 measuring devices logging the tunnel air temperature

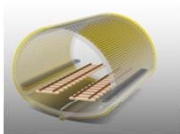


Jenbach

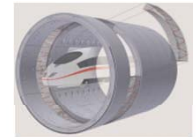
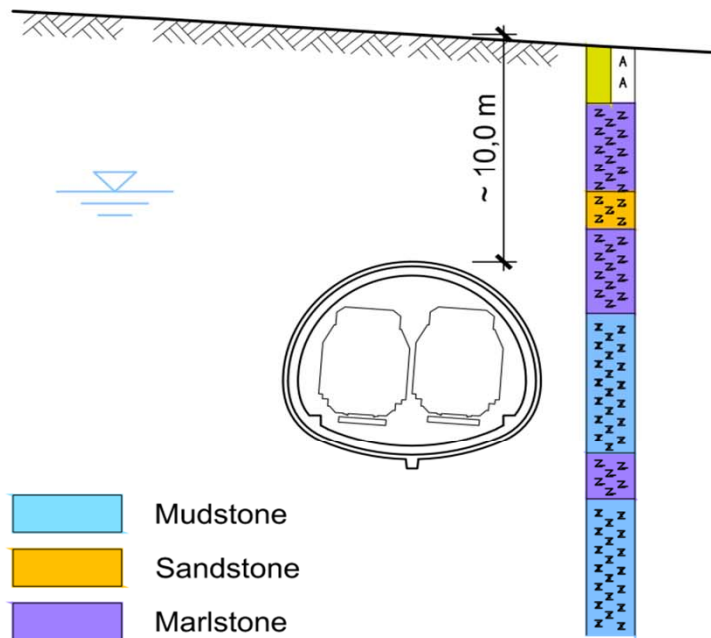
- 8 measuring devices logging the tunnel lining temperature
- 2 measuring devices logging the tunnel air temperature



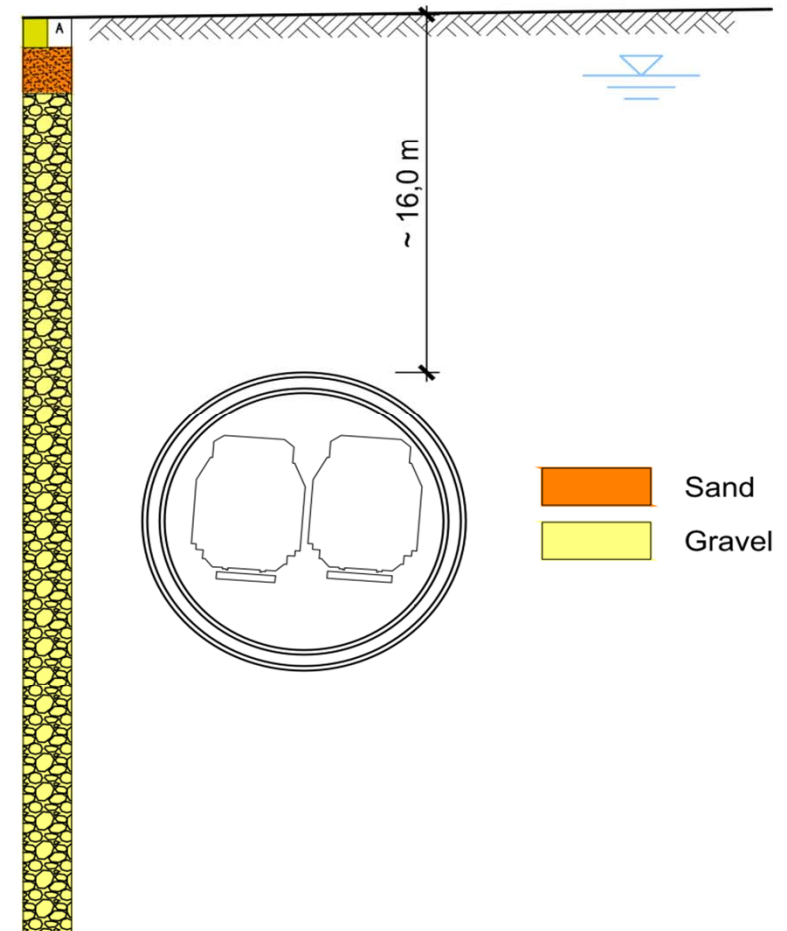
Hydrogeological conditions



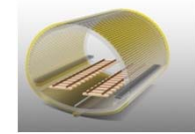
Stuttgart



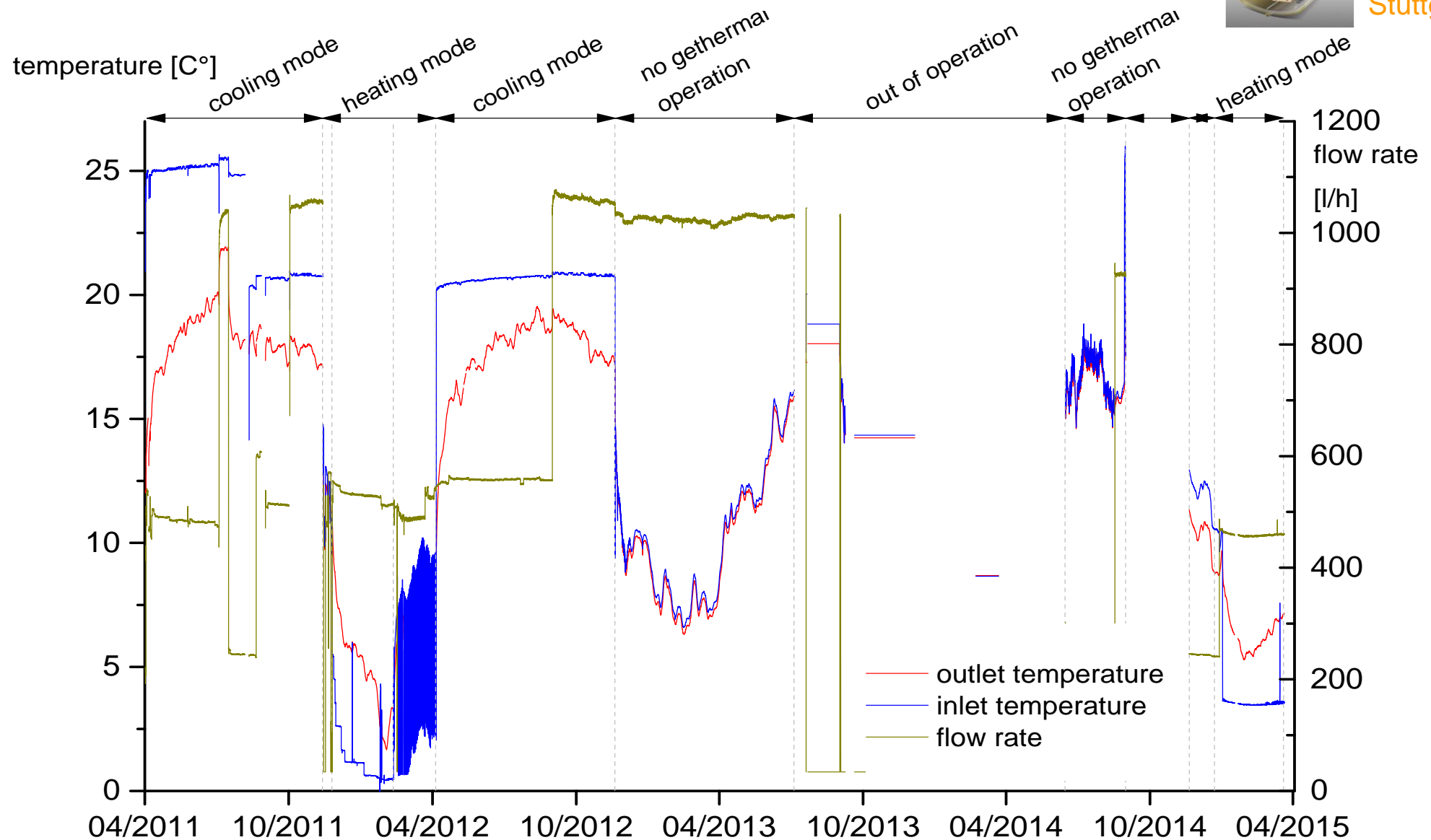
Jenbach



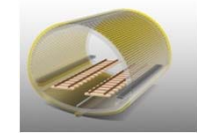
Overview of operation



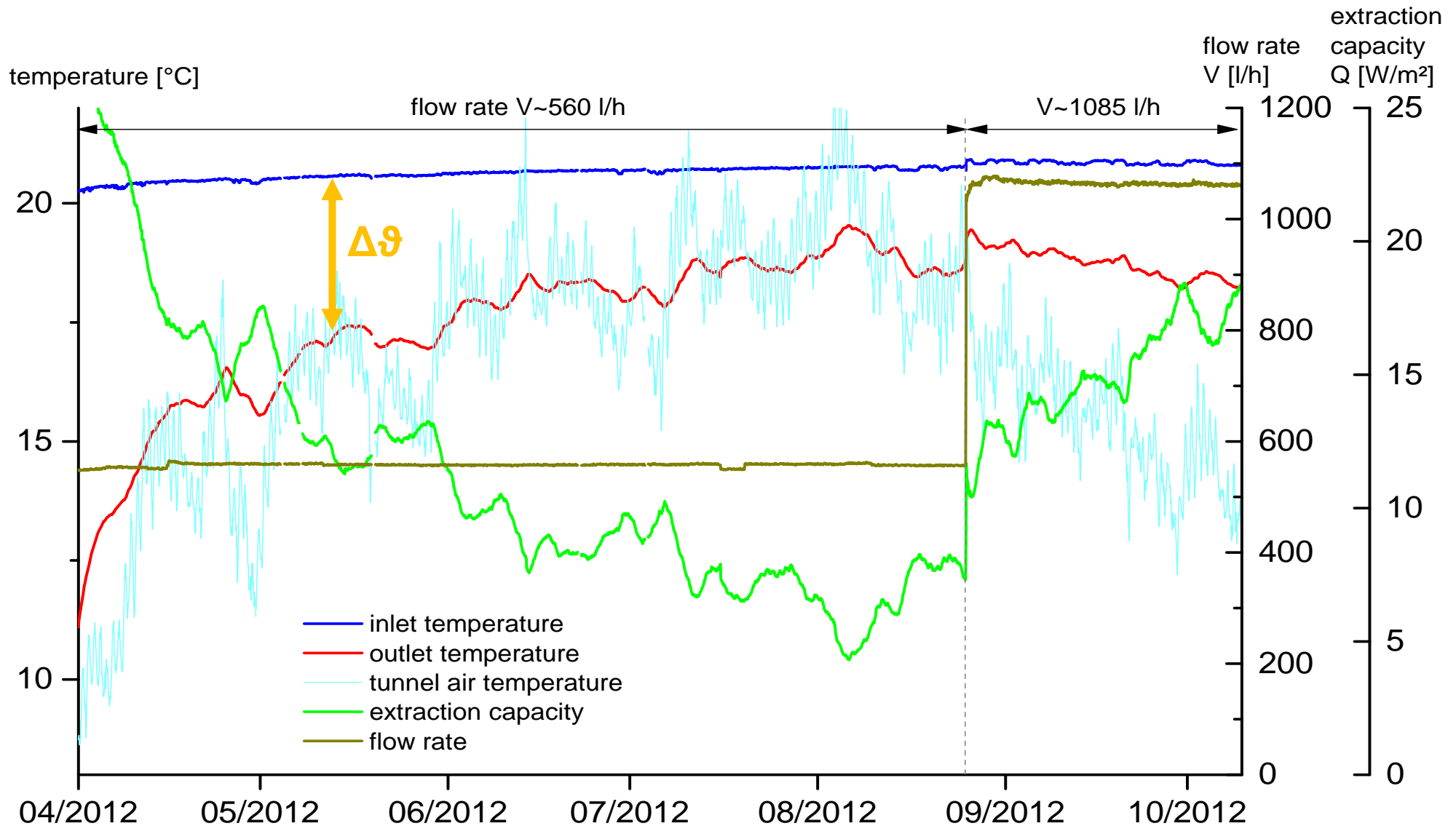
Stuttgart



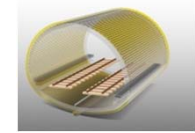
Cooling mode 2012



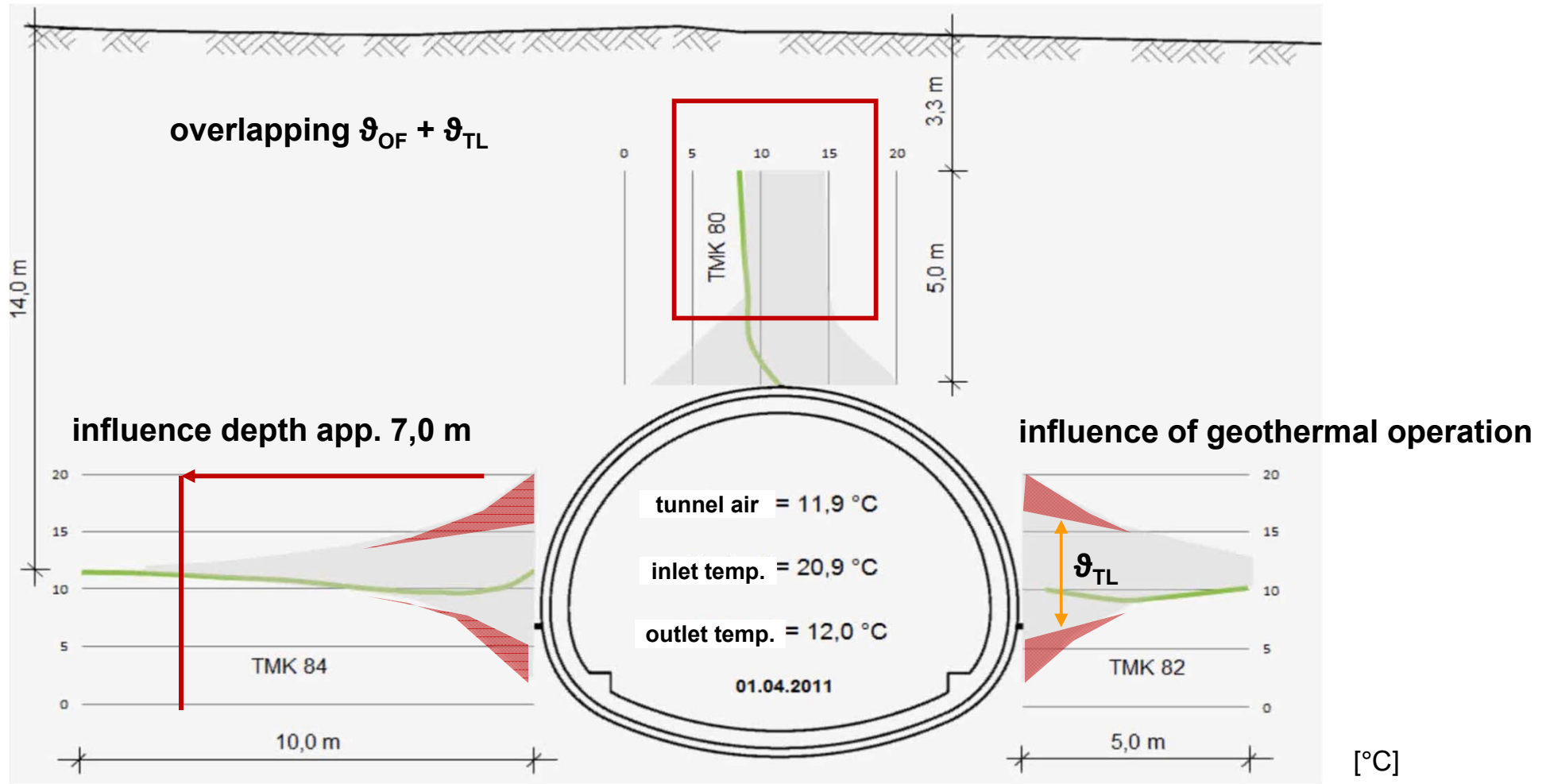
Stuttgart



Subsoil temperature development



Stuttgart



Conclusions and outlook

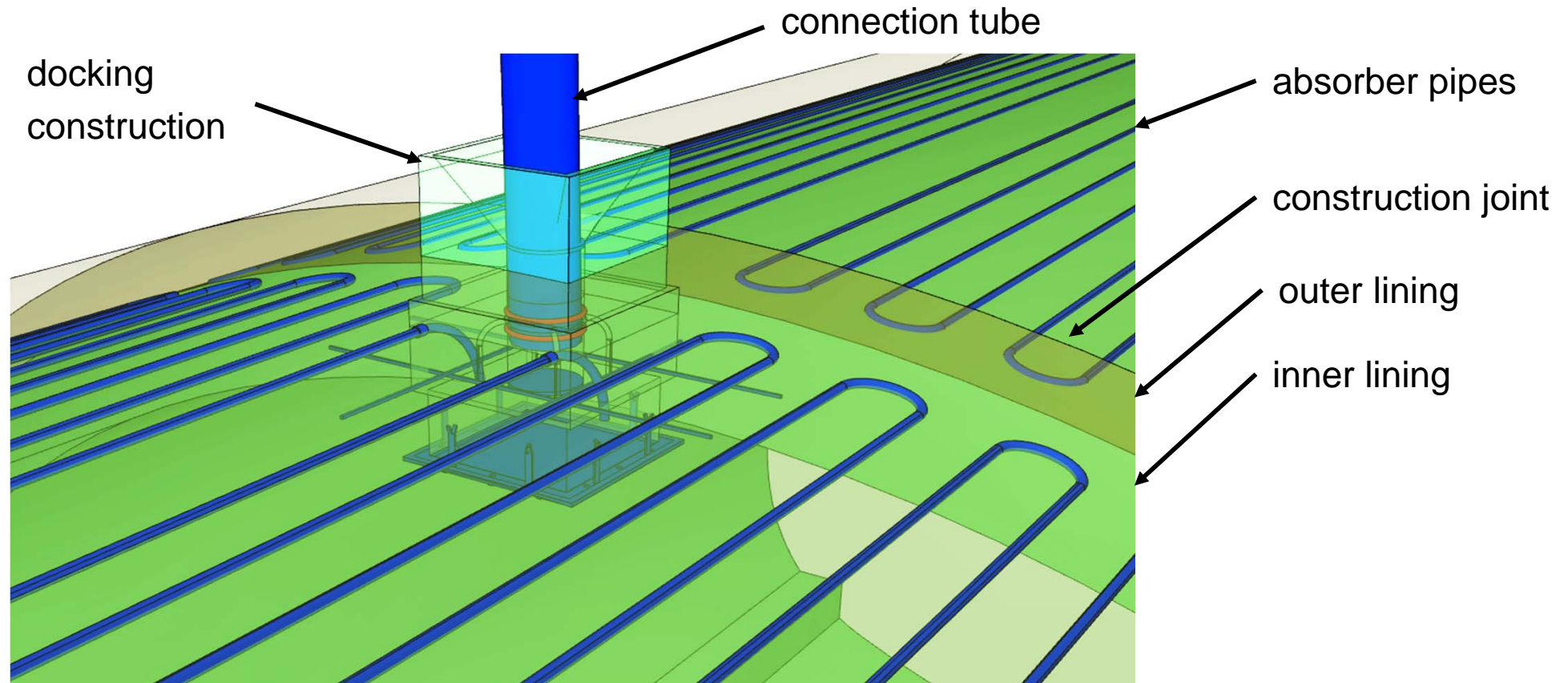
Conclusions

- heat extraction rate of Stuttgart is highly influenced by the tunnel air
- extractions rates up to 50 W/m² and more are achievable
- development of simulation tools
- development of design and operation recommendations

Outlook

- knowledge transfer to other subsoil constructions
- investigations on the seasonal heat storage capability
- development of the interface point between the building and the subsoil equipment

Construction of interface point



Thank you for your attention!

Funded by:



Bundesministerium
für Wirtschaft
und Energie



Cooperation:

