DEMONSTRATION OF 70 KW_{TH}-SCALE SOLAR CAVITY RECEIVER FOR GREEN HYDROGEN PRODUCTION THROUGH HIGH-TEMPERATURE ELECTROLYSIS

10.04.2025

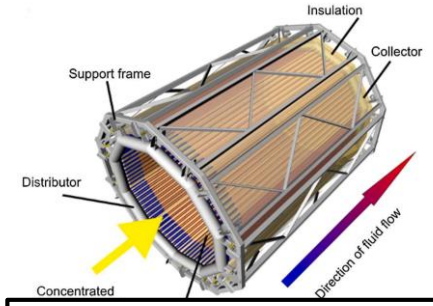
Yasuki Kadohiro, Timo Roeder, Kai Risthaus, Nathalie Monnerie, Christian Sattler

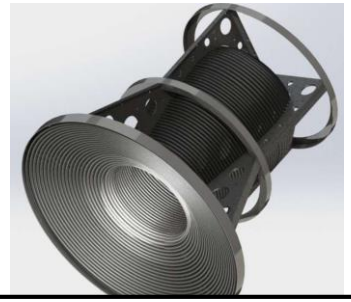
DLR – Institute of Future Fuels

Introduction

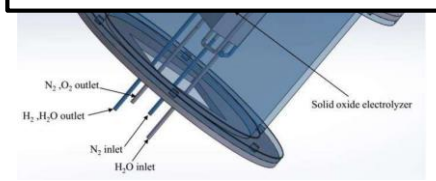
https://www.herzog-magazin.de/nachrichten/top-themen/solarer-treibstoff-made-in-juelich/

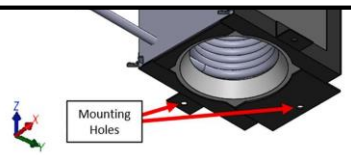
Coupling solar tower system with high-temperature electrolysis





- Simultaneous generation
- Experiment (> lab scale)
- High temperature (> 800 °C)

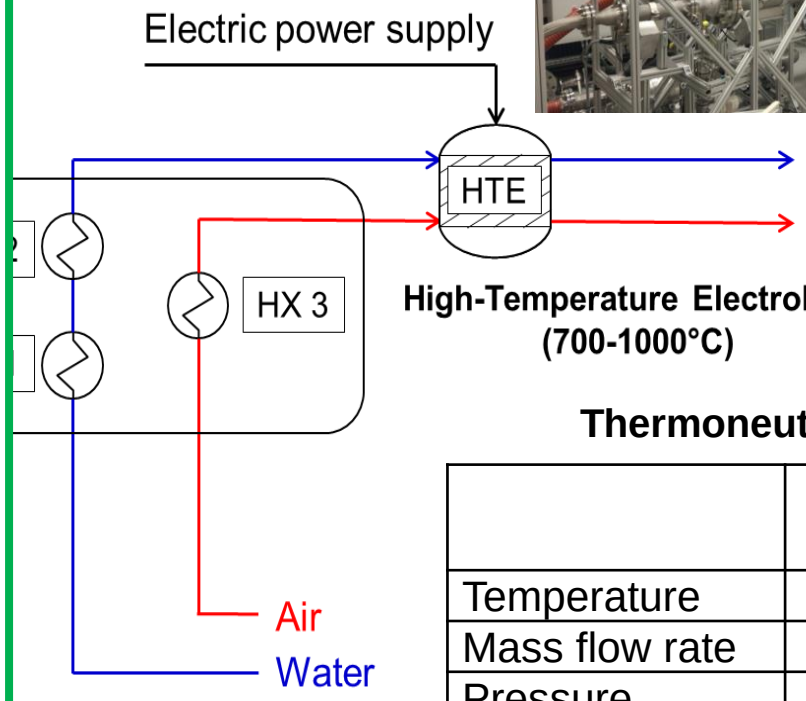




https://doi.org/10.1016/j.joule.2022.07.013

https://doi.org/10.1016/j.applthermaleng.2020.116427

Solar cavity receiver employing metal tubes to generate hot steam and air



High-Temperature Electrolysis (700-1000°C)

n; HX 2: Superheating Steam; HX 3: Heating Air

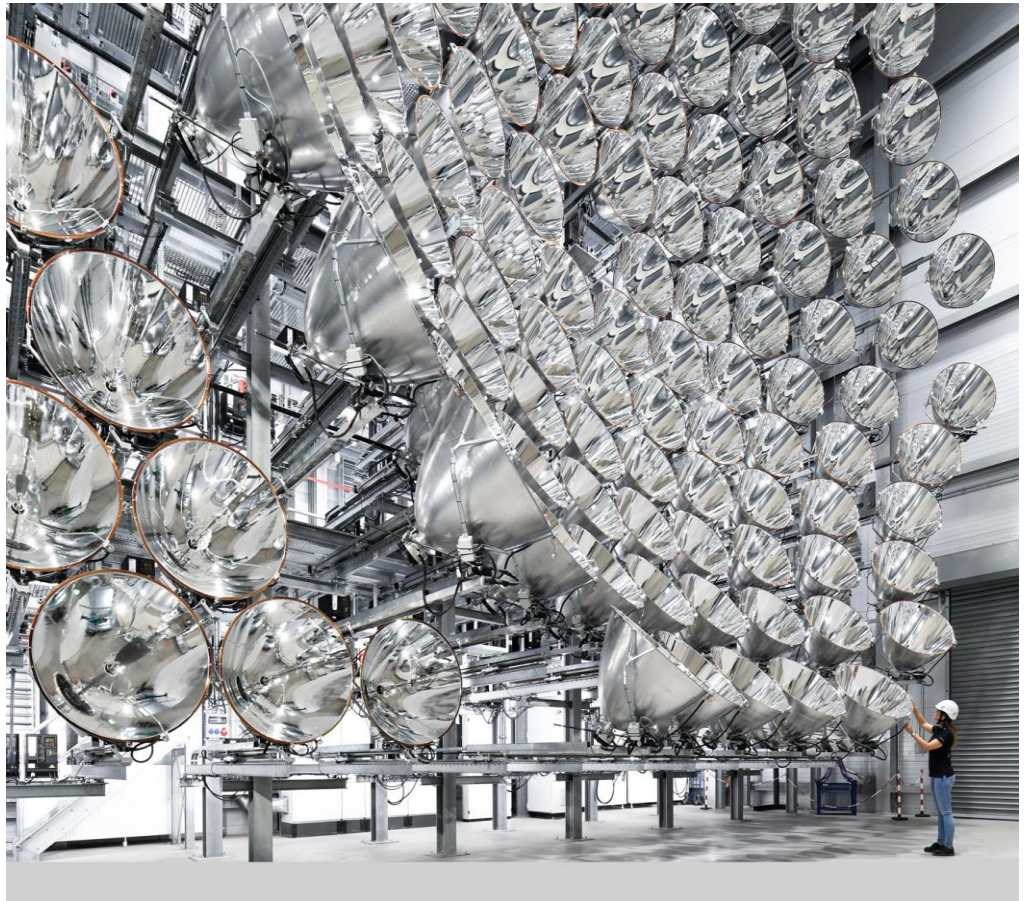
Thermoneutral Operation at 50 kW_{el}

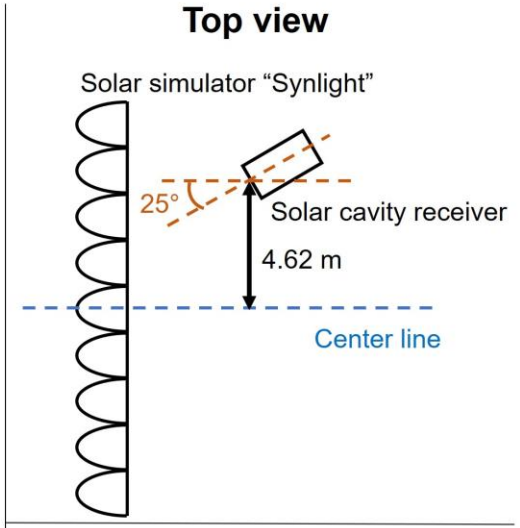
	Steam Flow (Cathode)	Sweep Gas Flow (Anode)
Temperature	820°C	850°C
Mass flow rate	20 kg/hr	80 kg/hr
Pressure	1 atm	1 atm

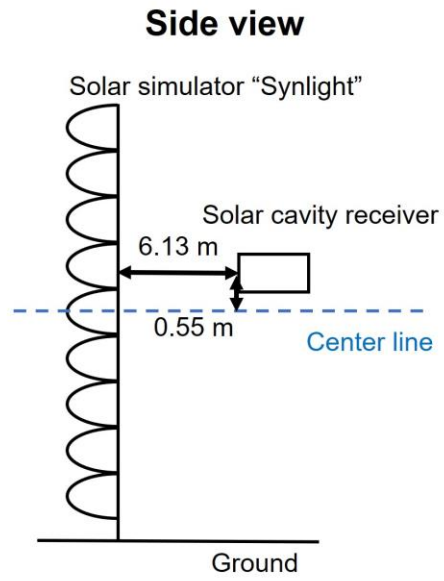
Methodology (experimental)

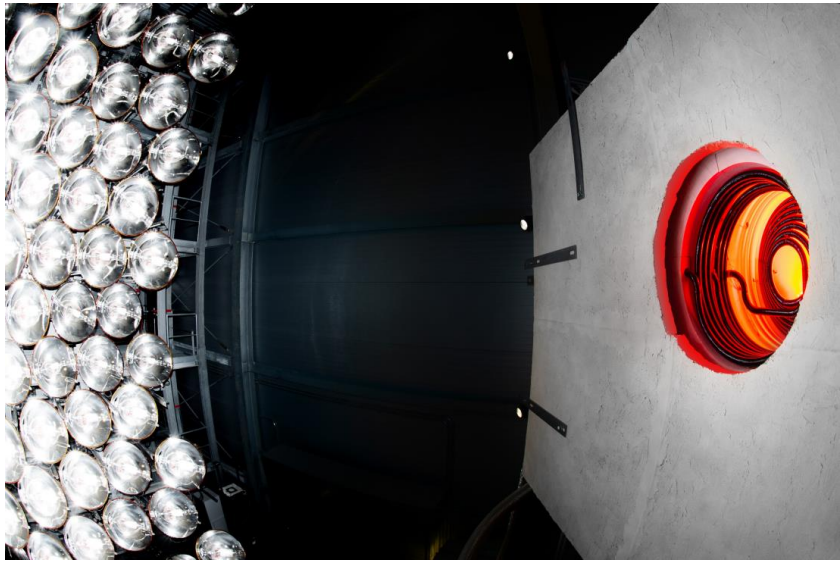
Heat flux supply from Synlight

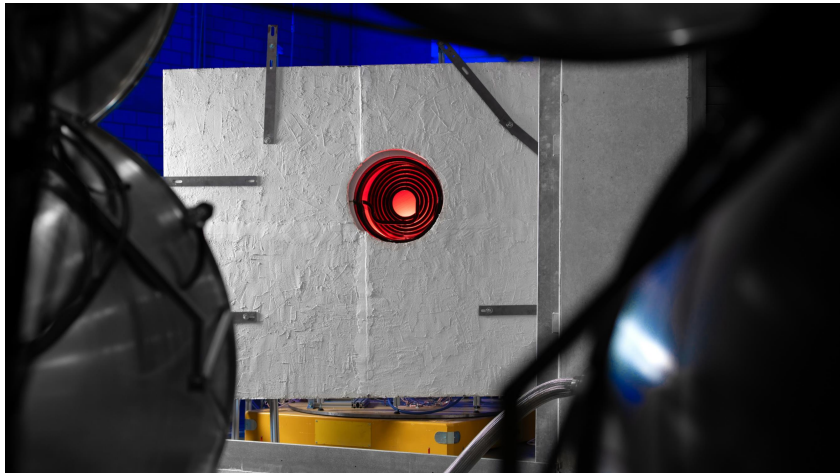
29 lamps (75.5 kW_{rad}) used in the experiment





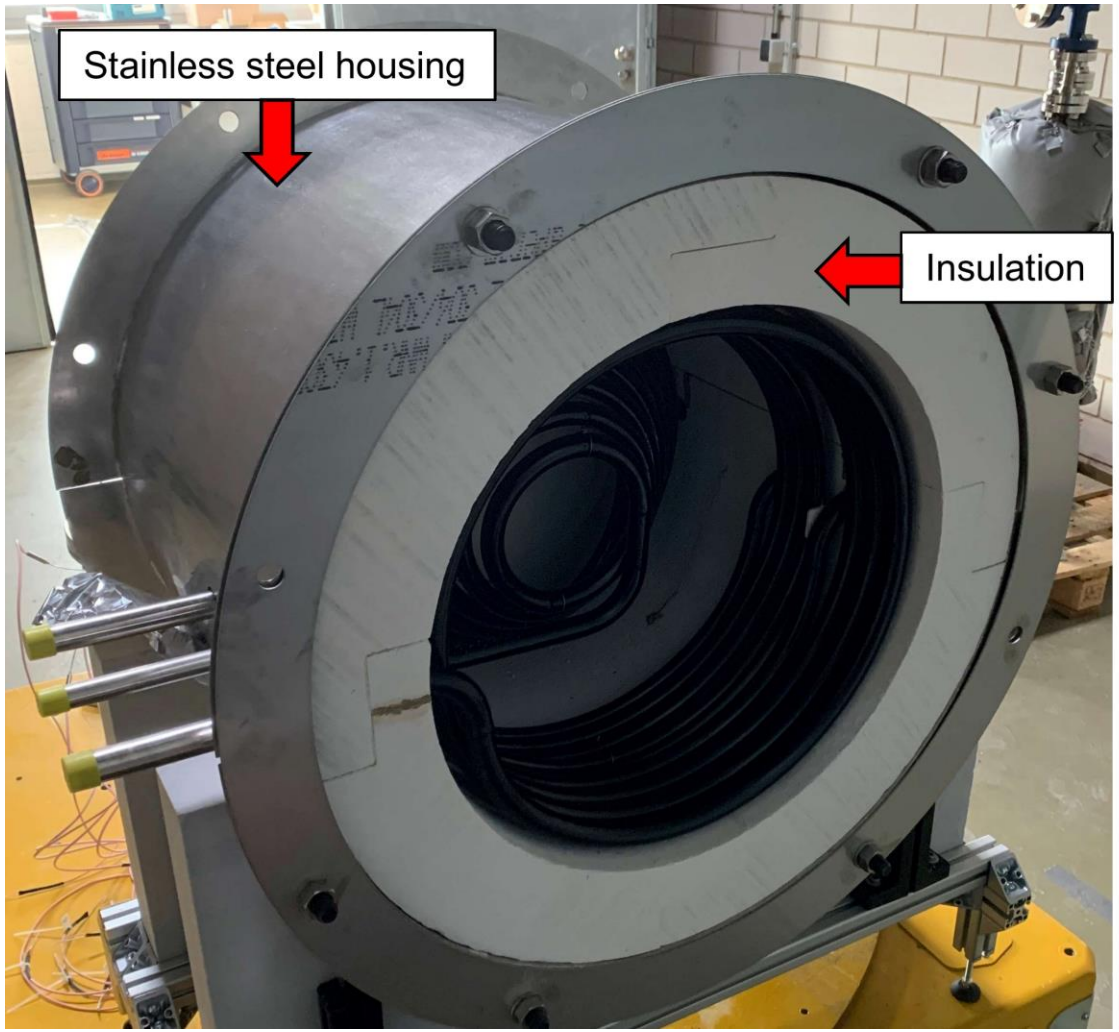


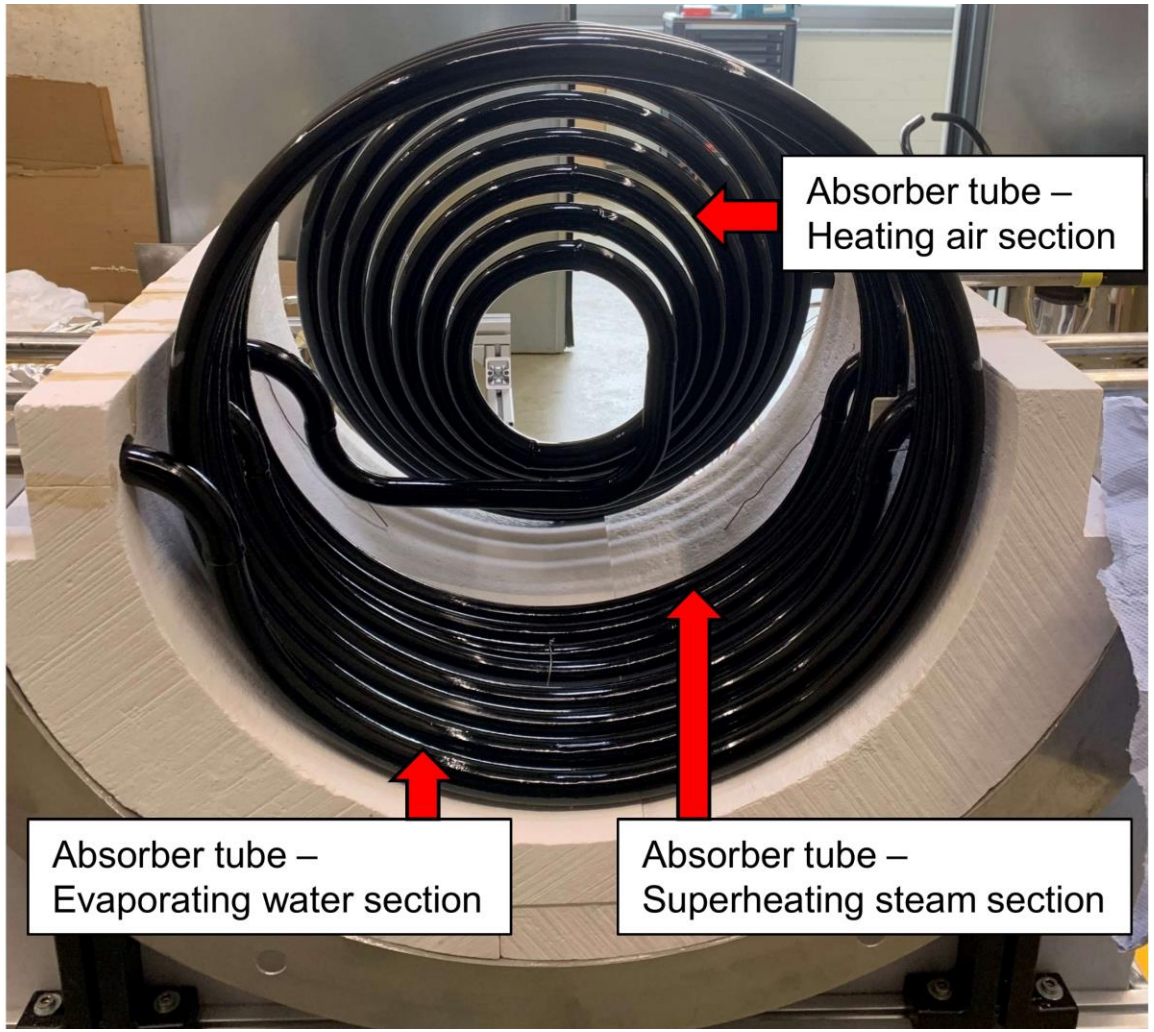




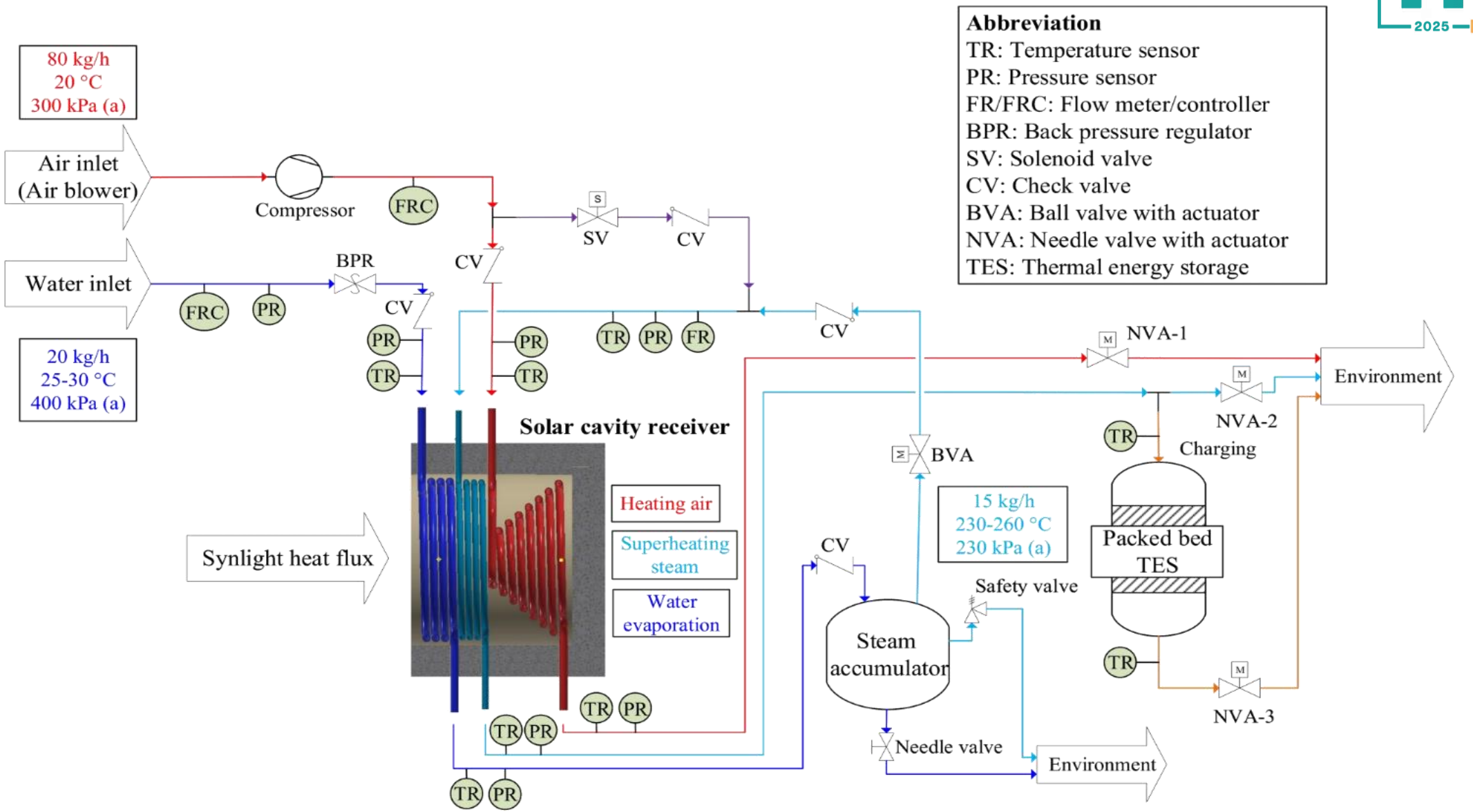
Solar cavity receiver design

- **Cavity inner diameter**: 0.545 m
- **Cavity outer diameter**: 0.745 m
- **Cavity length**: 0.574 m





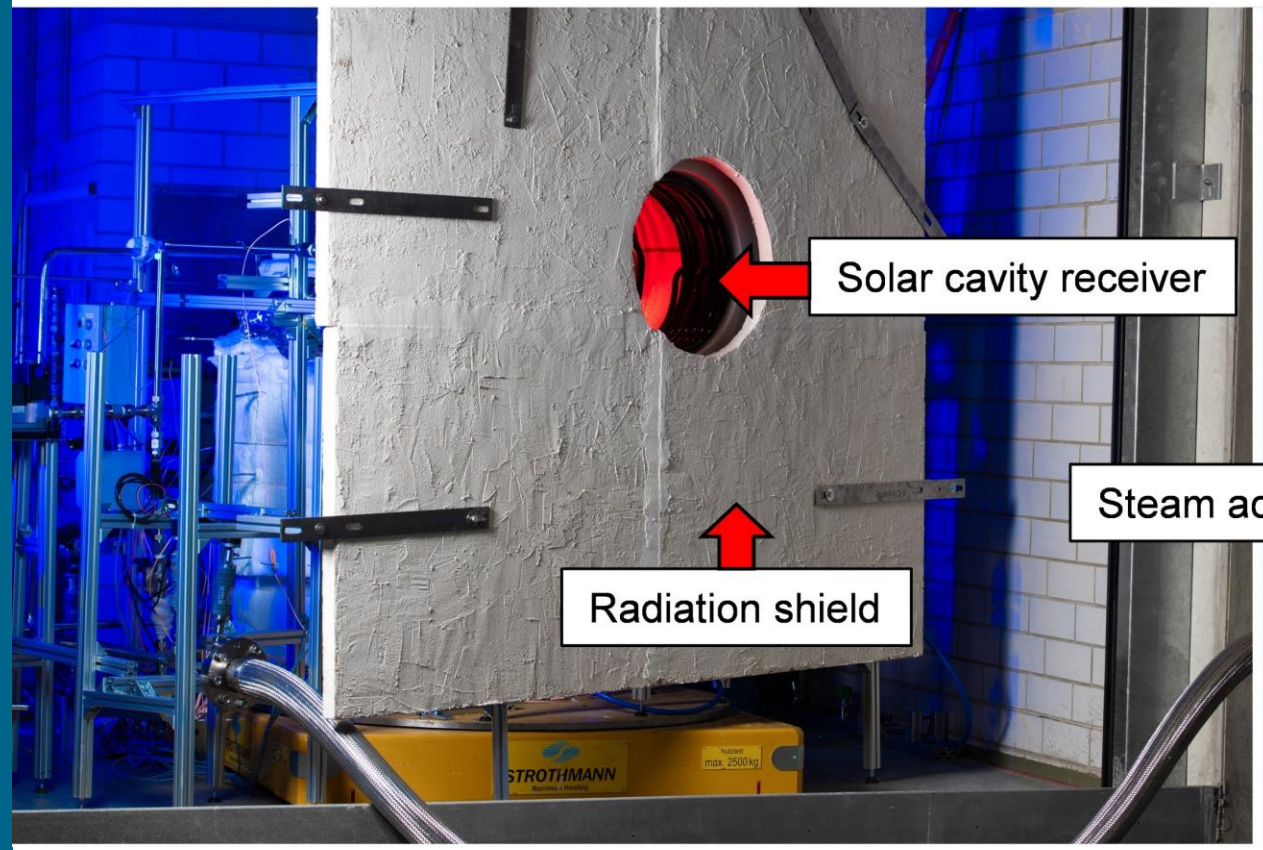
PID of the experiment



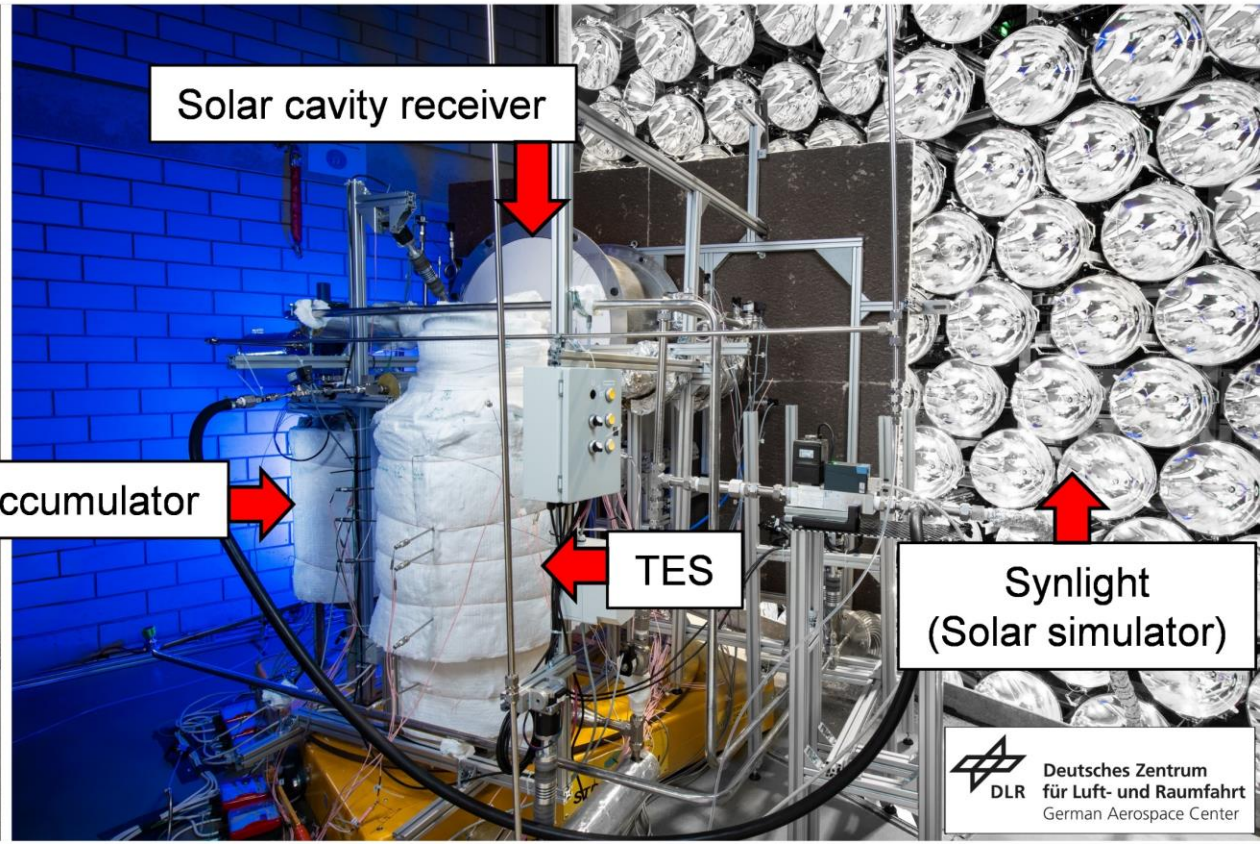
Experimental setup

*TES: Thermal energy storage

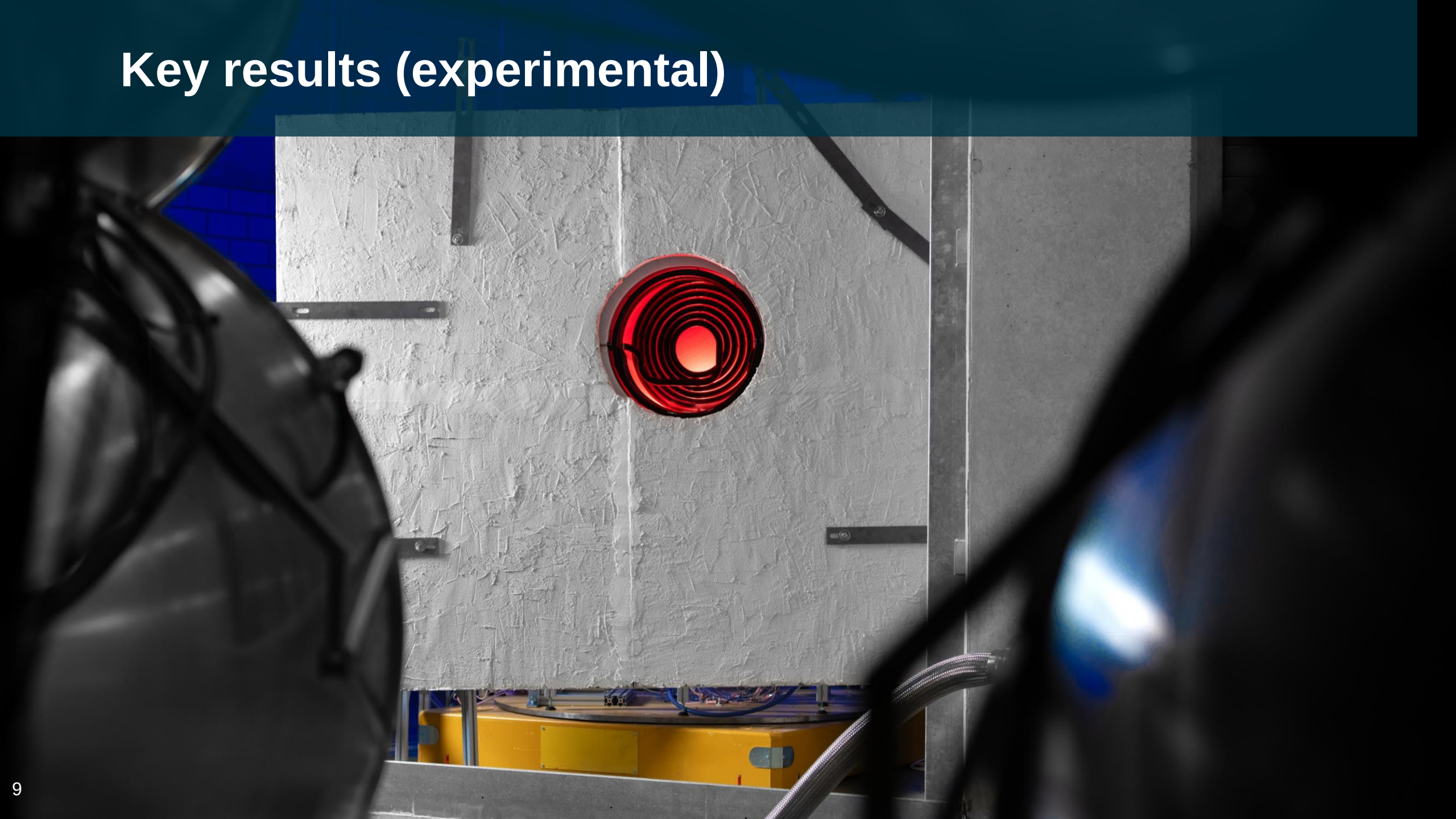
Front view



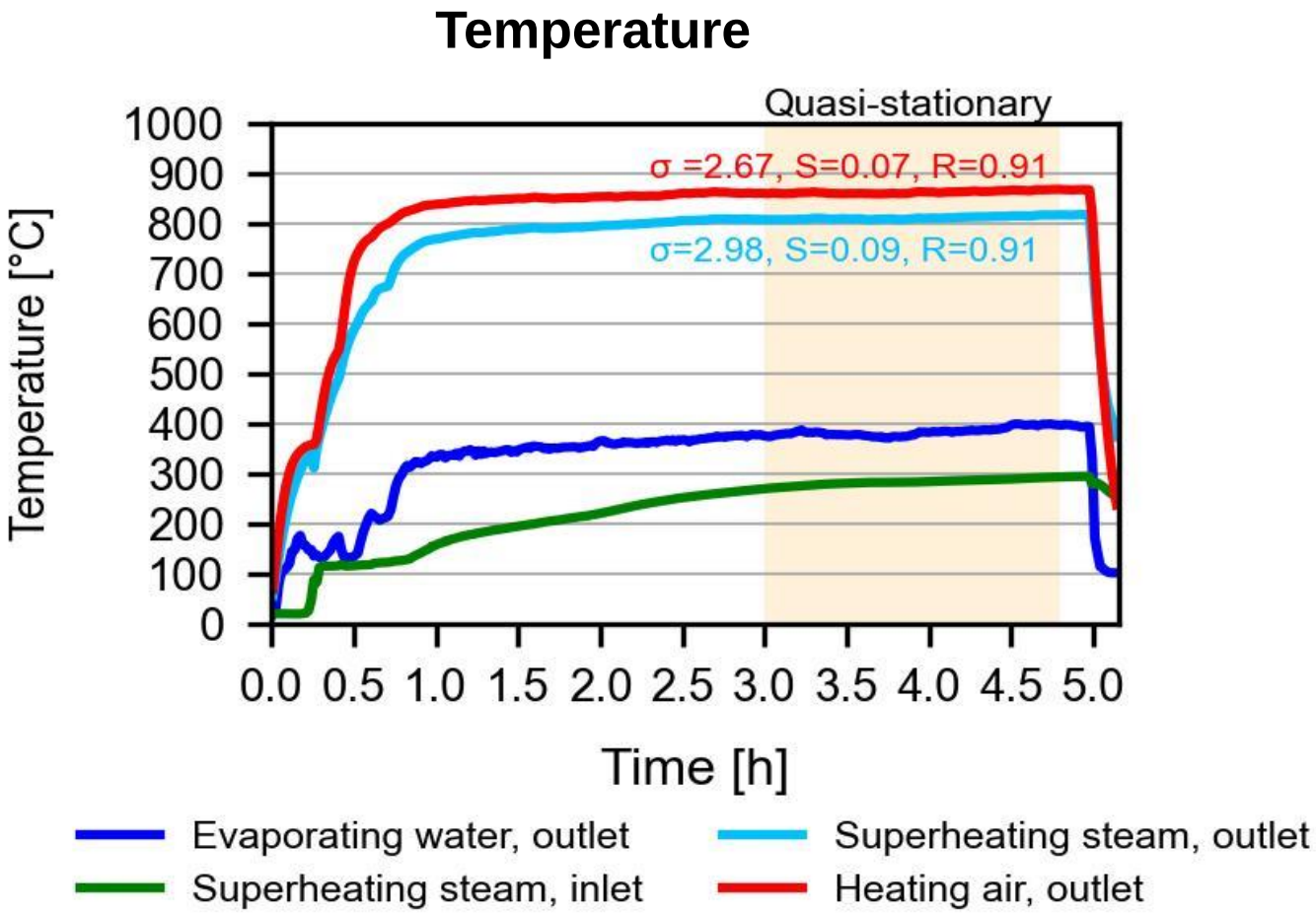
Rear view

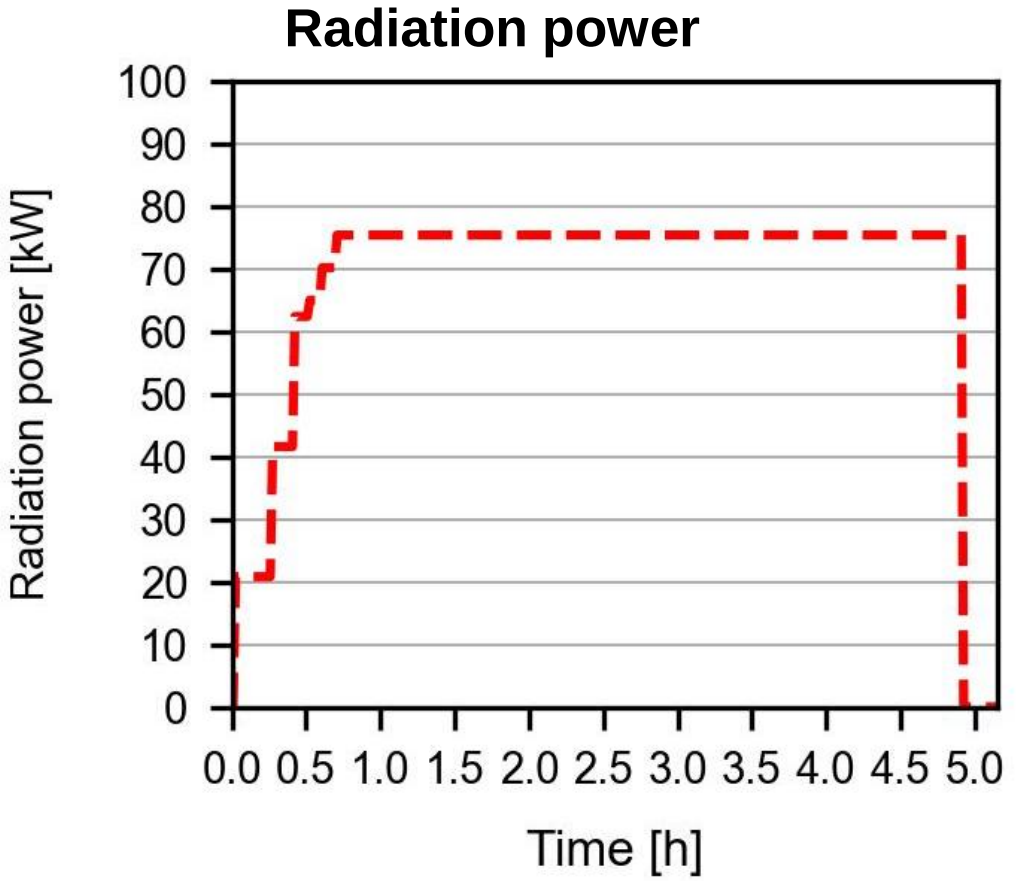


Key results (experimental)



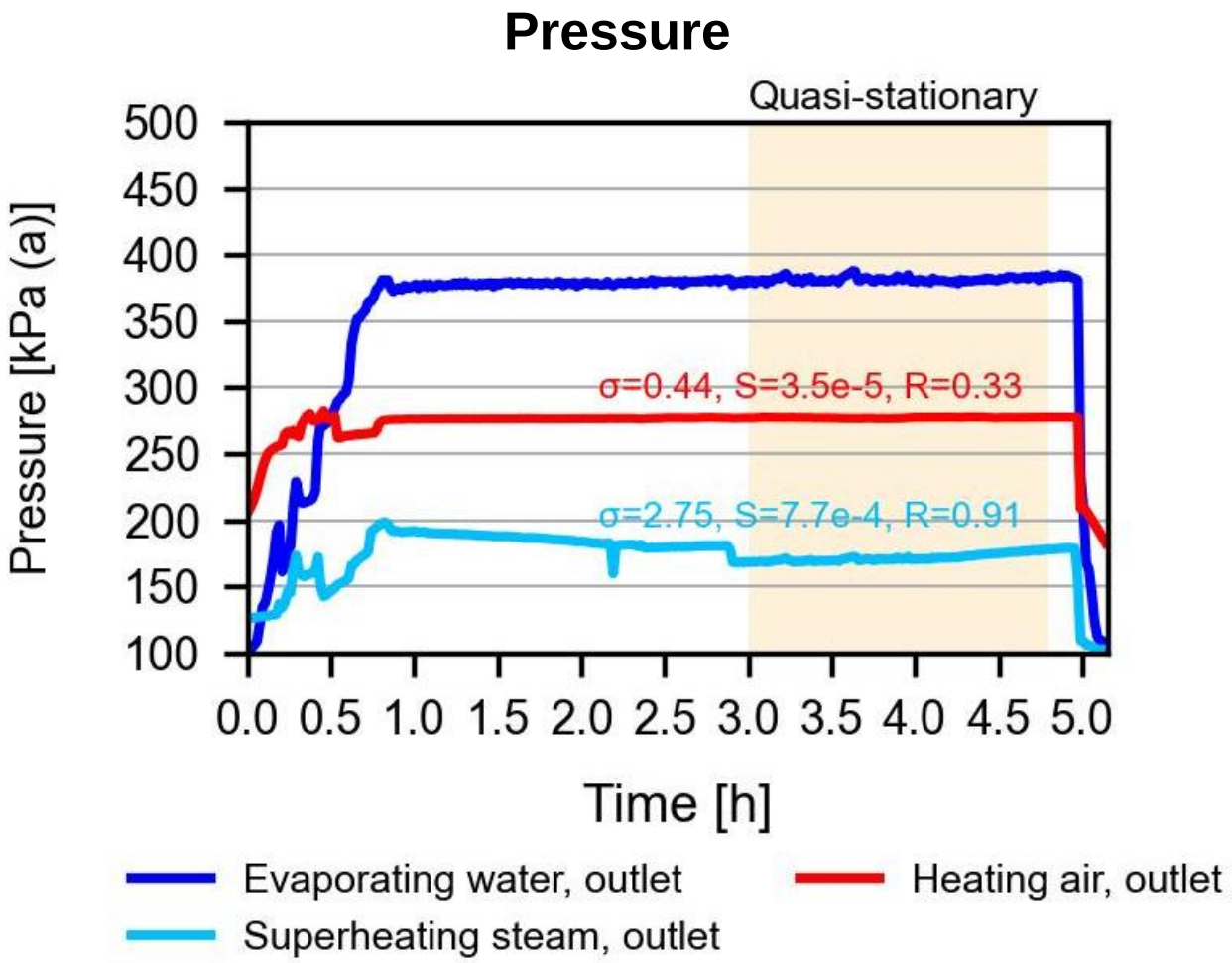
Key results – Experiment

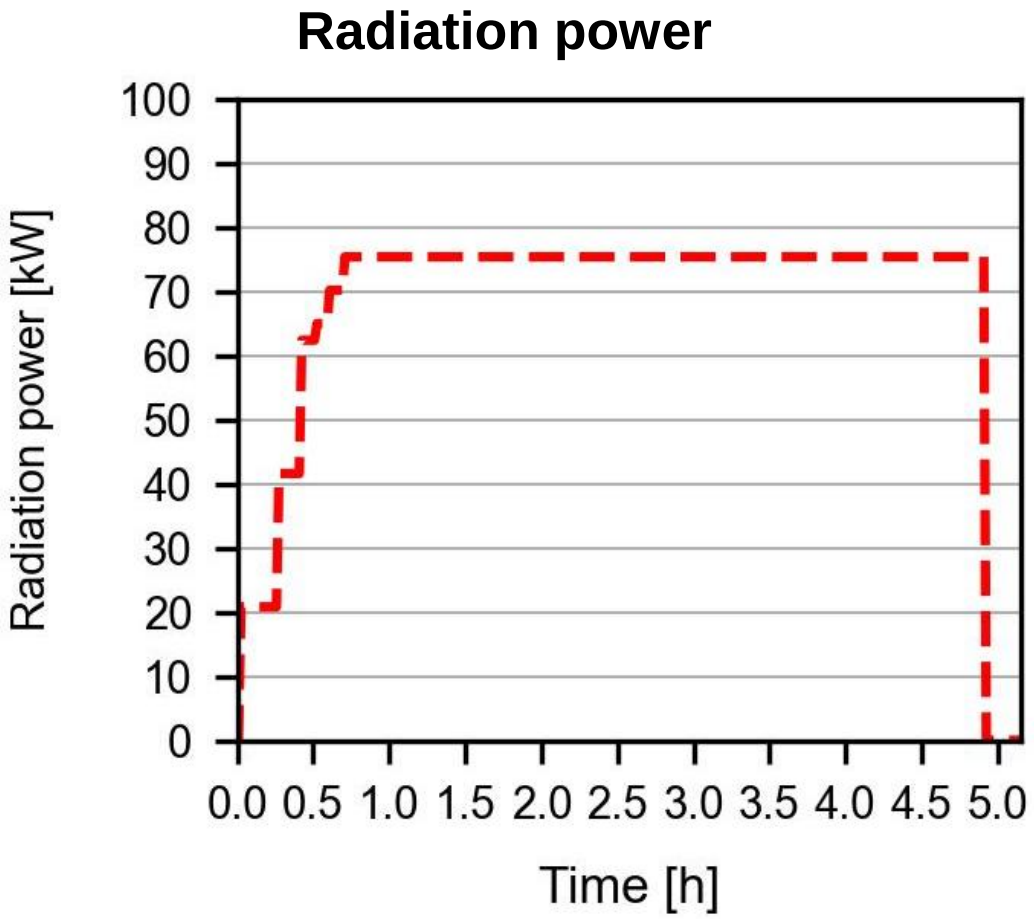




- High-temperature steam (811 °C) and air (863 °C) was continuously produced
- Inlet temperature of superheating steam section (steam from the accumulator) had slow response

Key results – Experiment

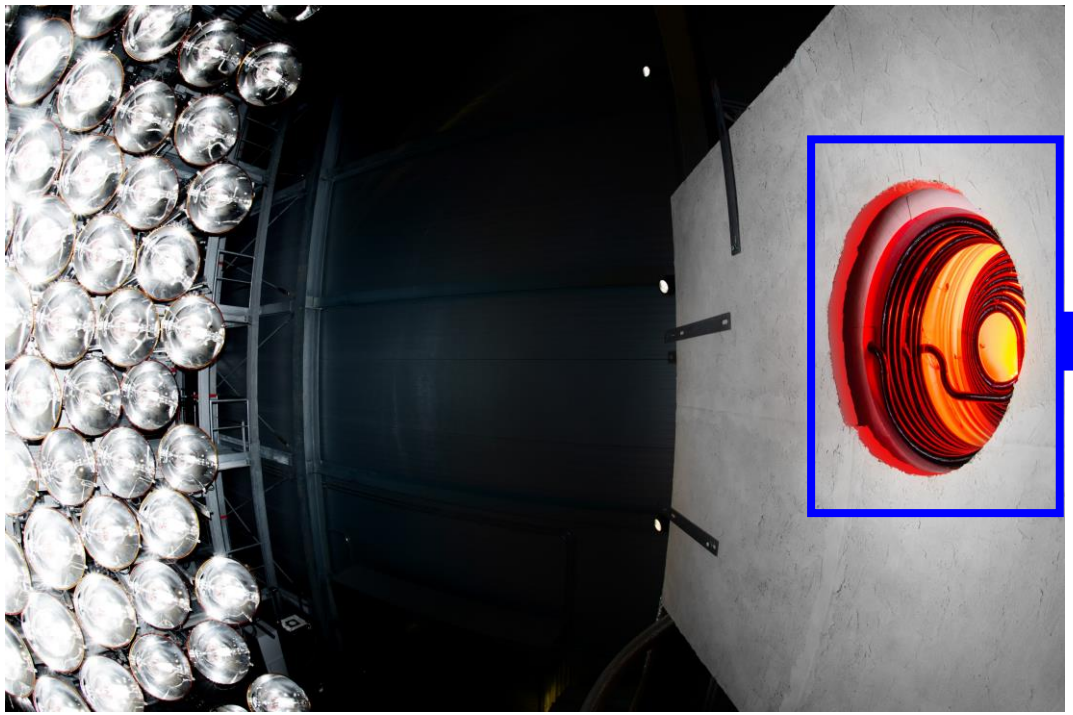




- Evaporating water and superheating steam sections had more fluctuation compared to heating air section

Summary and outlook

Summary and outlook

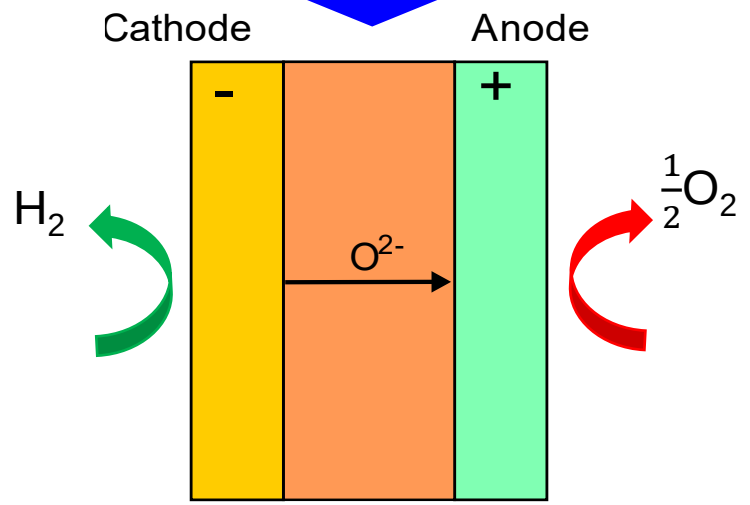


Air

T_{out}: 863 °C
(σ: 2.98 °C, 2.75 kPa, 0.169 kg/h)

Steam

T_{out}: 811 °C
(σ: 2.67 °C, 2.44 kPa, 0.177 kg/h)



- **Virtual coupling with 50 kW_{el} scale**
- **Physical coupling with 5 kW_{el} scale**
- **Syngas (CO and H_2) production**
- **Further optimization and model refinement**

Thank you for your Attention!

M.Eng. **Yasuki Kadohiro** | Research Engineer
Telephone 49 2203 601 1104 | Yasuki.Kadohiro@dlr.de
www.DLR.de/FF | www.DLR.de/FF/Project-SOL