

EXPERIMENTAL DETERMINATION OF CONVECTIVE HEAT FLUX TO A PMMA SURFACE

Anna Tscherniewski, Alexander Belt, Lukas Arnold

Jülich Supercomputing Centre, Forschungszentrum Jülich, Jülich, Germany

Experimental studies of thermal plume-wall interaction in small scale compartment for FDS validation

Experimental setup:

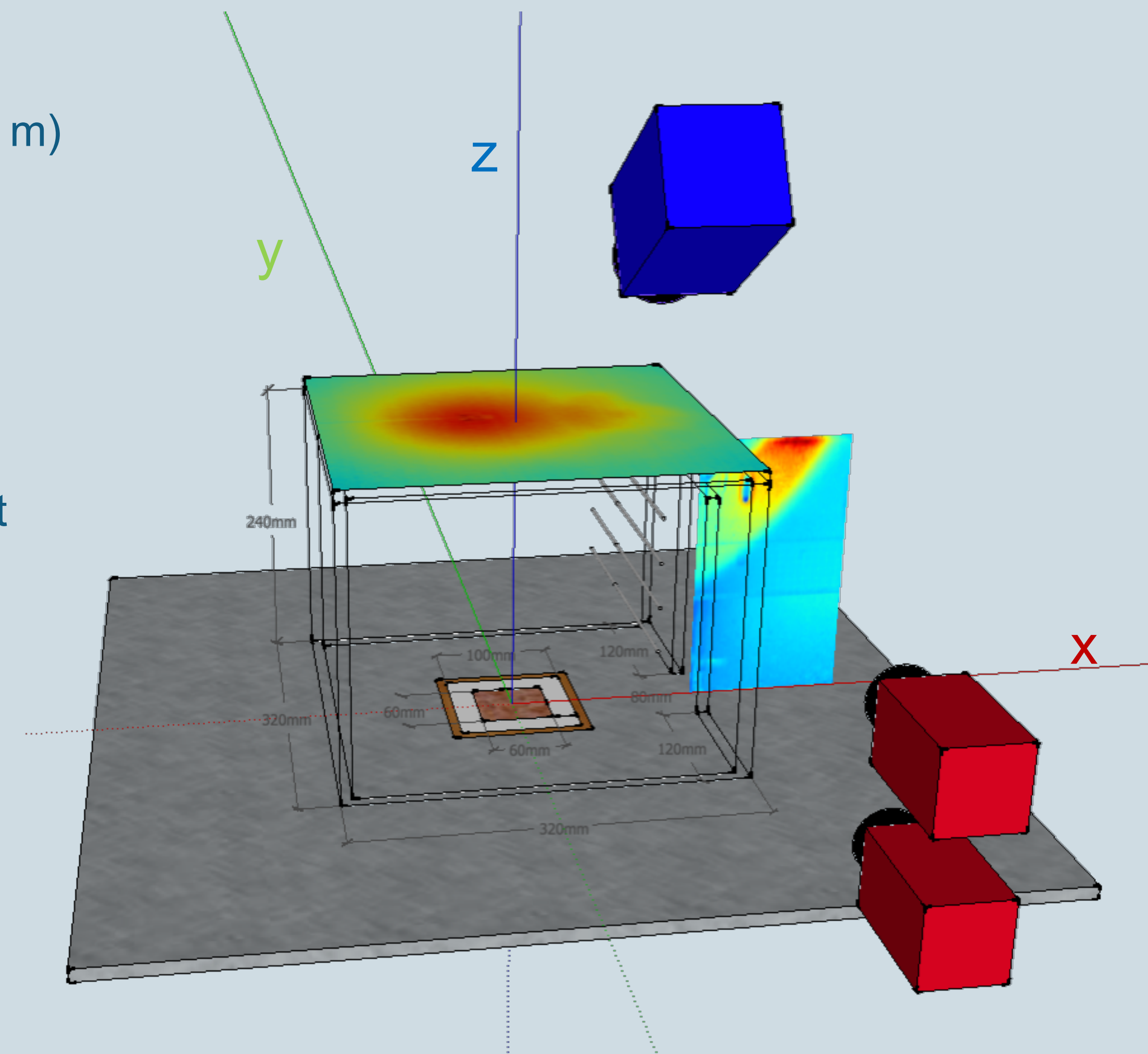
- Plexiglas (PMMA) compartment (0.32 m x 0.32 m x 0.25 m) with a door opening (0.08 m x 0.20 m)
- Heat source is an electrically operated copper block

Previous studies:

- Significant deviation in the flow rates through the doorway between experimental data (Particle Image Velocimetry, PIV) and solution of FDS model [1]
- Plausibility check of the experimental data was done by means of an independent measurement technique (Laser Doppler Velocimetry, LDV) [2]
- Possible causes:
 - Boundary conditions - heat transfer through the PMMA, heating source
 - Modelling errors

Current studies:

- Determination of the wall temperatures of the compartment, especially of the ceiling
- Examination of the flow field through the doorway

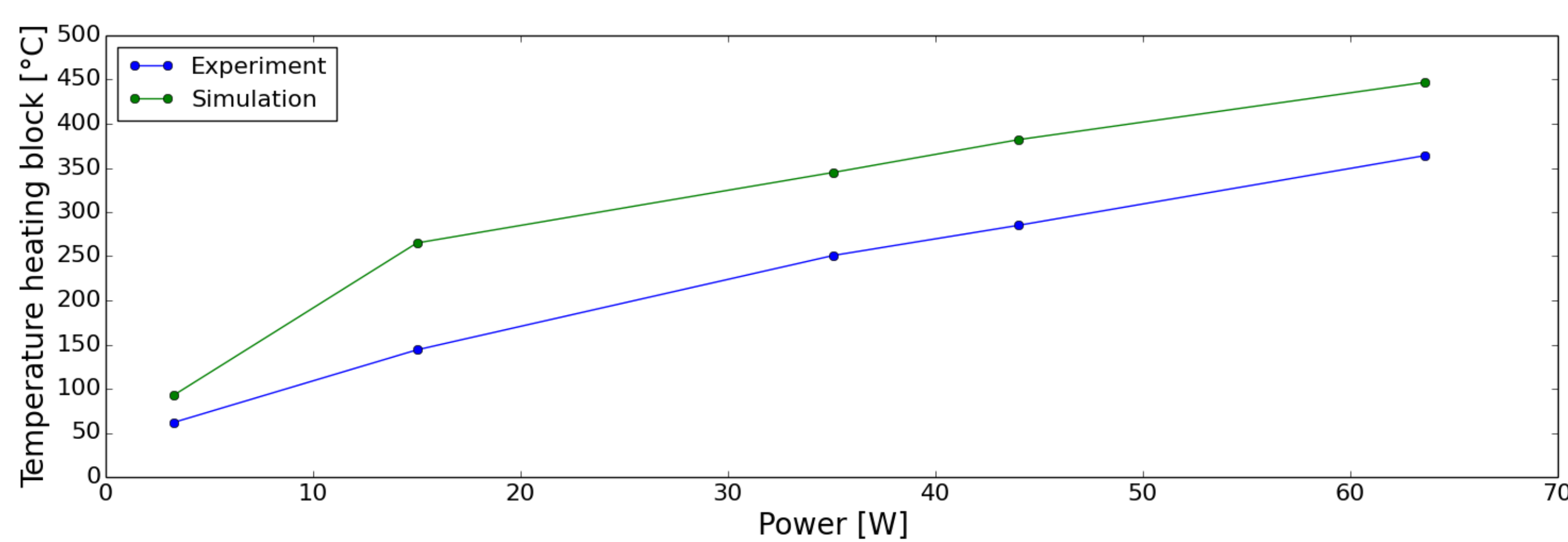


Measurement

- Surface temperatures are measured by a thermal imaging camera and thermocouples
- Different power levels of the heating block are investigated
- The flow field through the doorway is measured by a PIV-system

Experiments and Simulations

- Heating block temperatures measured by a thermocouple



- The heating block temperatures in the simulations are higher than in the experiments $T_{HB,exp} < T_{HB,sim}$
- Investigation of the influence of the PMMA on the heating block with respect to reflection and absorption of the radiation (transmission=0)
- Detailed investigation of the heat loss of the heating block

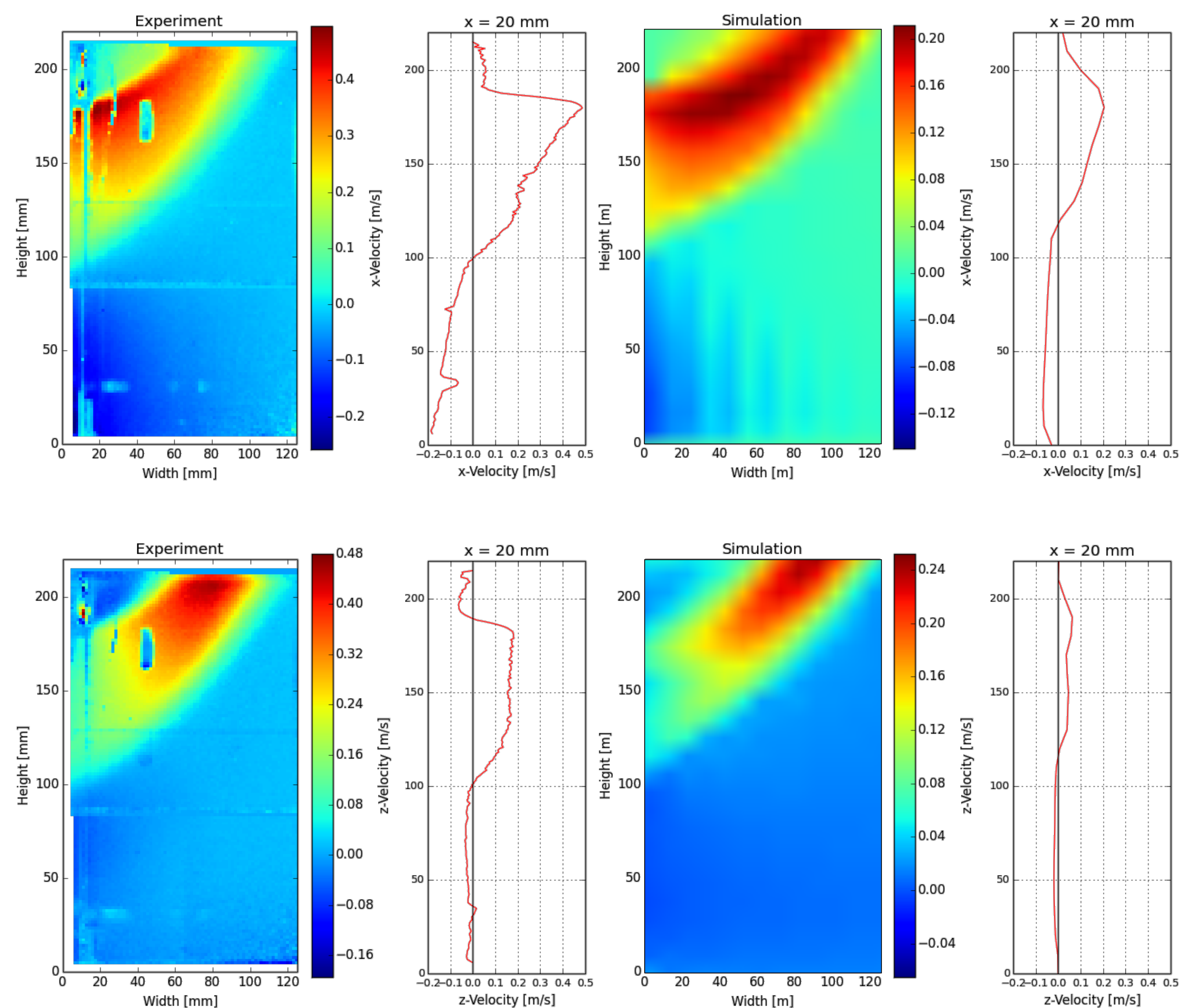
- Averaged ceiling temperature integrated over the surface

$$T_c = \frac{1}{i} * \sum_{i=1}^n T_i$$

	30 Volt	60 Volt	90 Volt	100 Volt	120 Volt
Ceiling Temperature Experiment $T_{C,exp}$ [°C]	24.10	26.16	28.97	30.97	33.61
Ceiling Temperature Simulation $T_{C,sim}$ [°C]	20.2	20.4	20.7	20.9	21.2

- The heat transfer through the Plexiglas in the simulations are much lower than in the experiments $T_{HB,exp} < T_{HB,sim}$ $T_{C,exp} > T_{C,sim}$
- Check the modelling

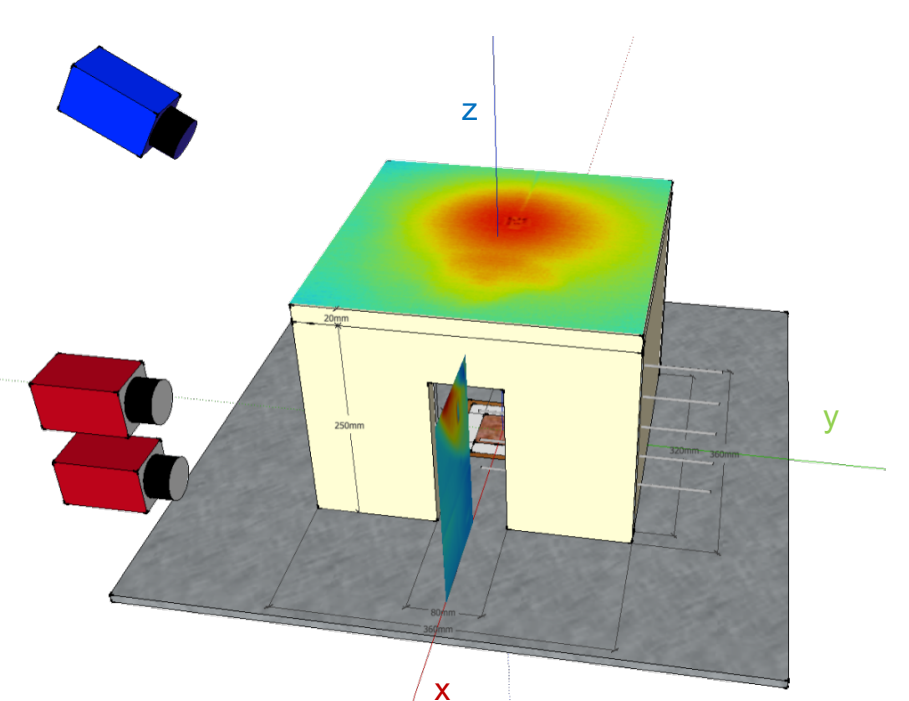
- Velocity of the flow field through the doorway (Power = 100V)



- Lower velocity of the flow field in the simulations than in the experiments

Next Steps

- Further improvement of the boundary conditions of the experiments and the simulations e.g. by isolating the enclosure walls
- Investigation of the heat loss of the heating block and improvement of its modelling



References

- [1] Meunders, A., A study on buoyancy-driven flows: Using particle image velocimetry for validating the Fire Dynamics Simulator, IAS Series Volume 31
- [2] Belt, A., Temperature and laser Doppler velocimetry measurements of a spill plume in a small scale experiment with an electrical heat source