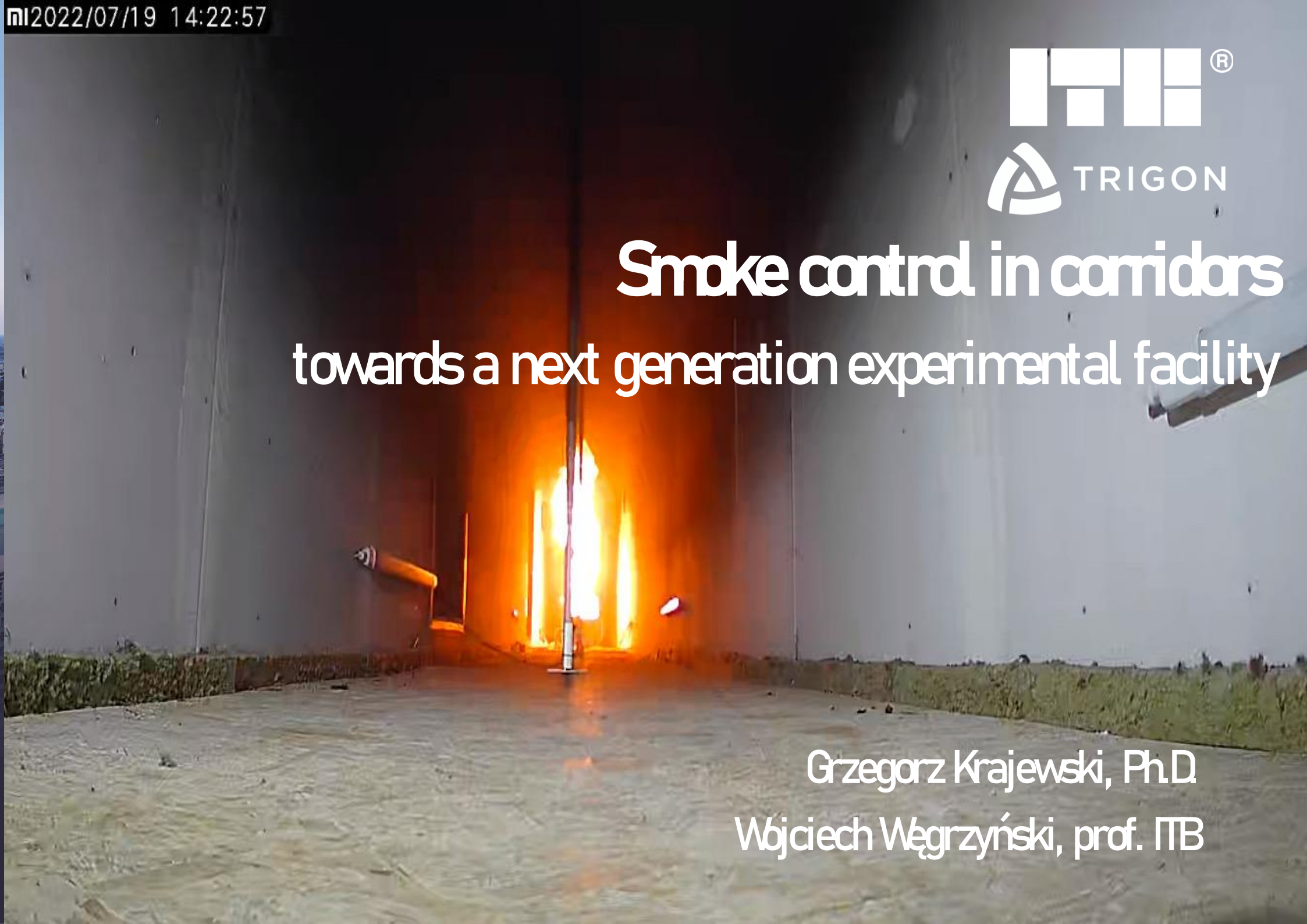


Smoke control in corridors

towards a next generation experimental facility

Grzegorz Krajewski, Ph.D.

Wojciech Węgrzyński, prof. ITB

Why?

Lack of current knowledge based on full-scale experiments in relation to currently used technical solutions.

A number of questions that we currently do not know the answer to ...

Why do we design a fire ventilation system in the corridor?

What parameters of a fire in rooms should be assumed?

What are the evaluation criteria? What should be the main focus of the systems?

What is the effect of smoke control systems on vertical escape routes?

What impact will the parameters of the external environment have?

And many many others.....

Full scale experimental facility

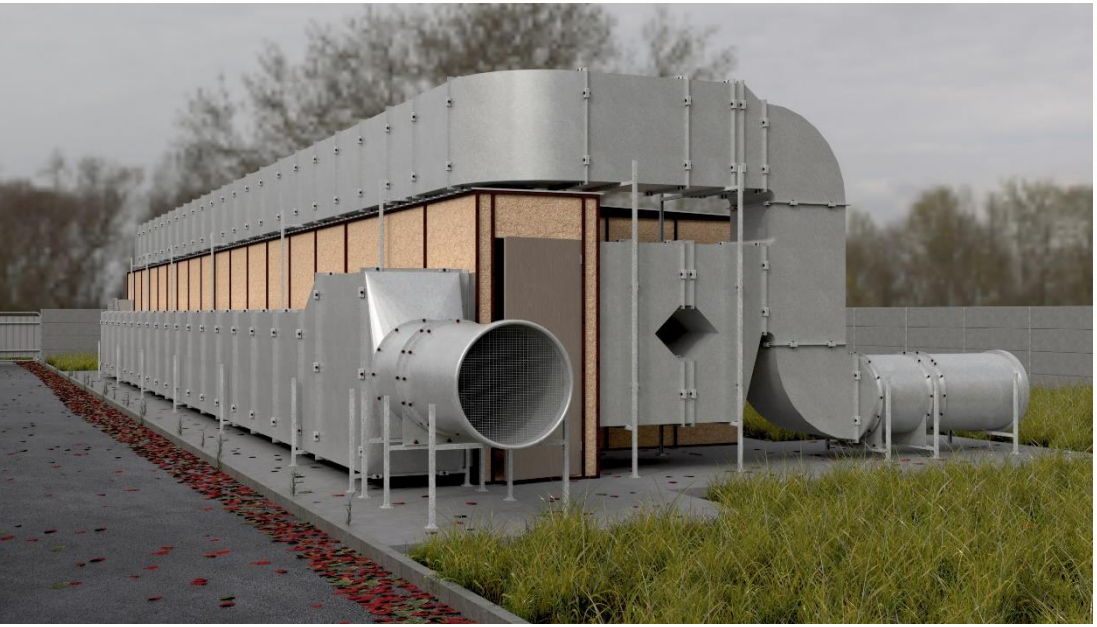
Corridor dimensions:

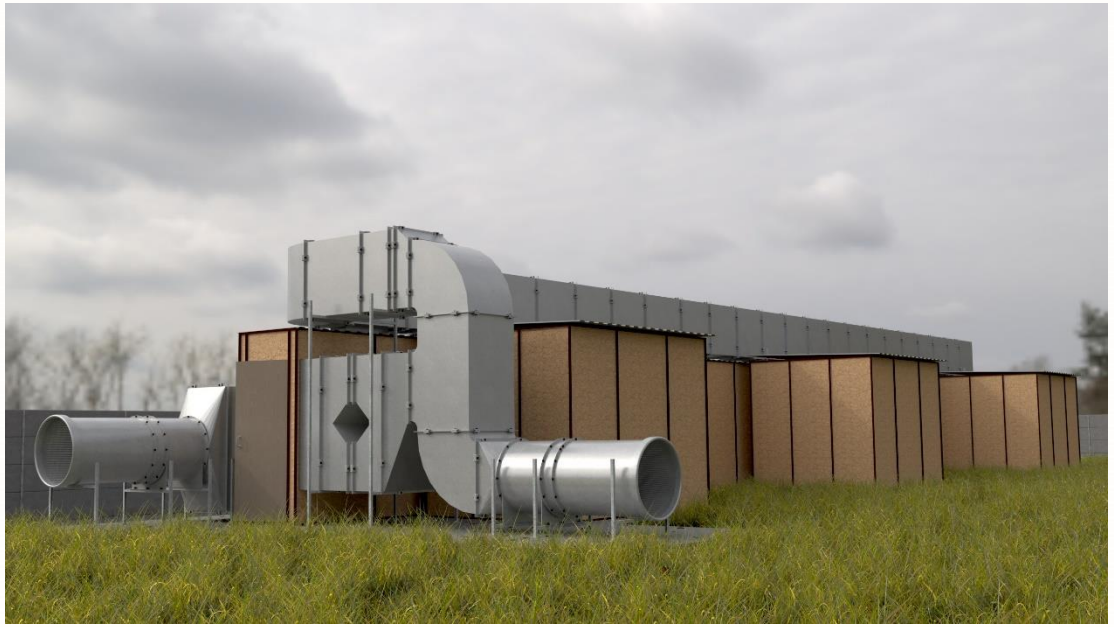
Length: 30 m + 2 m fire vestibule (under construction)

Total height: 3 m

Width: 1.4 m

Three rooms with dimensions of 3x4x3 m





Full scale experimental facility – materials

The structure of the corridor and rooms: steel profiles

Corridor casing: OSB 15÷22 mm + 2 layers of 2x12 mm drywall (gypsum board)

Room housing: OSB 15÷22 mm, mineral wool 50 mm, 2 layers of 2x12 mm gypsum board

Full scale experimental facility – materials

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Room casing: OSB 15÷22 mm, mineral wool 50 mm, 2 layers of 2x12 mm gypsum board

Additionally, thermocouples were placed under the last layer to control the temperature and wear of the first layers

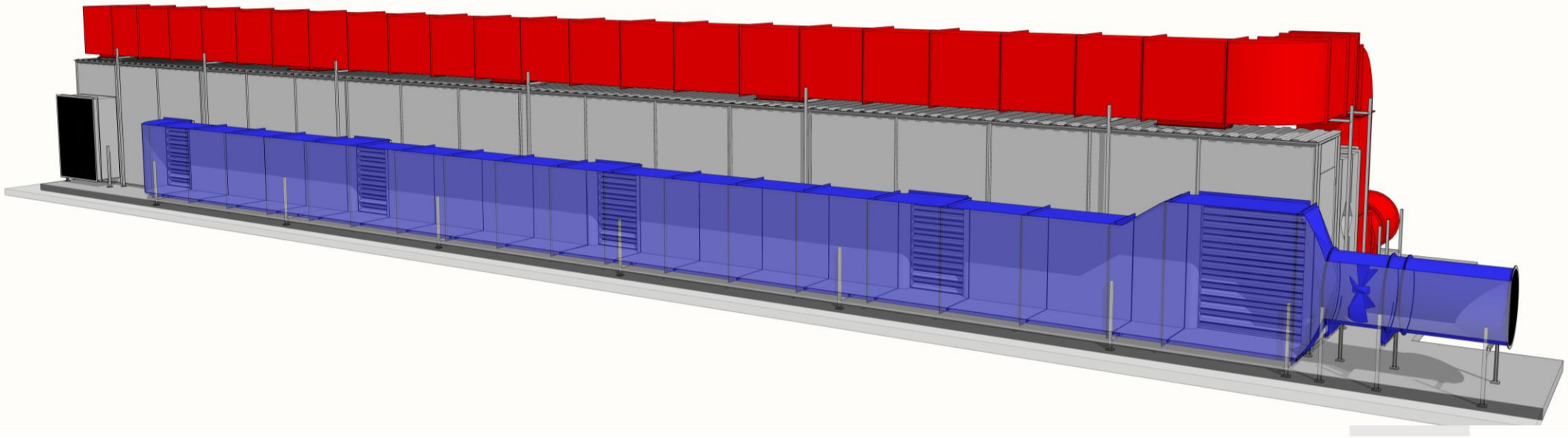
Fire ventilation system

In the experimental corridor, a smoke control system was designed and made so that it was possible to conduct tests in the widest possible range of combinations in terms of the location and type of exhaust and supply installations.

Types of fire ventilation combination (1)

- Transversal ventilation system

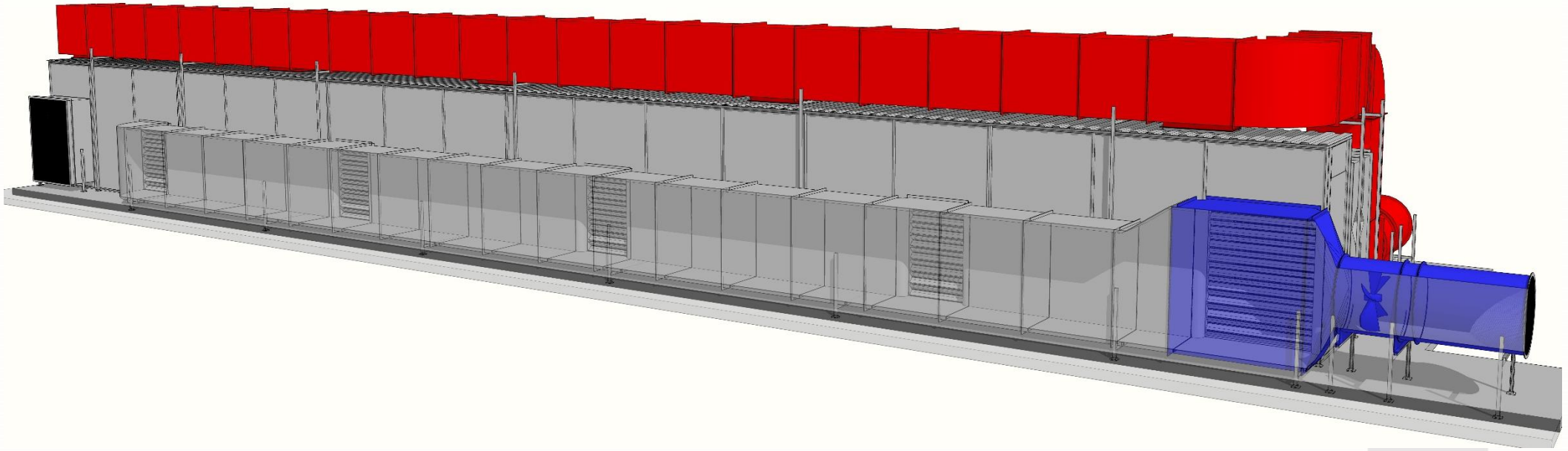
Inlet vents located at the bottom along of corridor, outlet grills located at the top of the corridor in the celling.



Types of fire ventilation combination (2)

- Transversal ventilation system

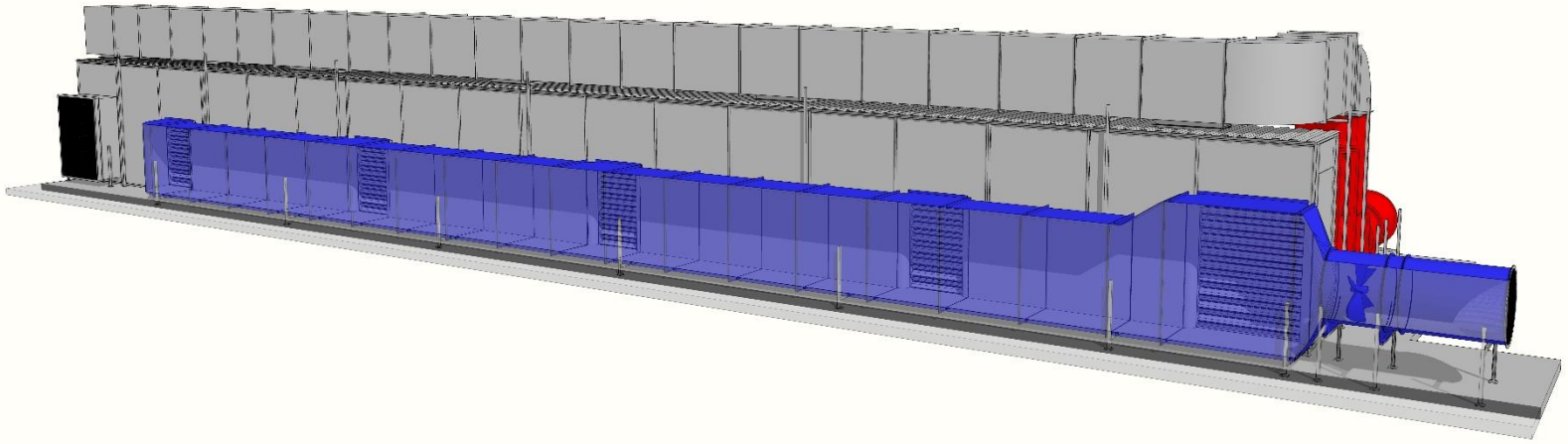
Inlet vents located at end of corridor, outlet grills located at the top of the corridor in the celling.

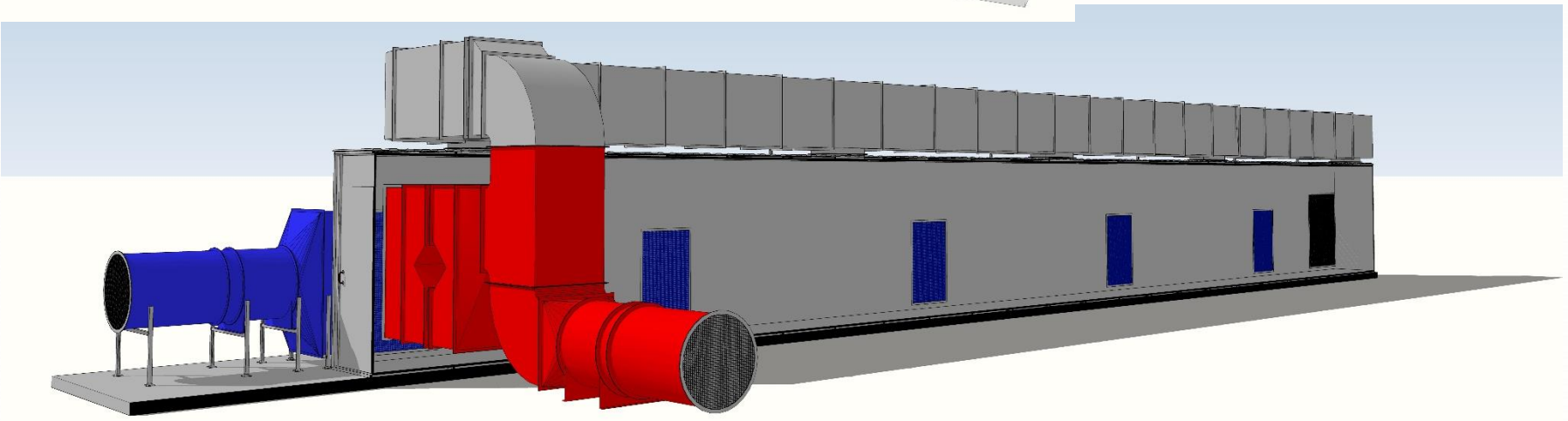


Types of fire ventilation combination (3)

- Semi transversal ventilation system

Inlet vents located at end of corridor, outlet grills located at the top of the corridor in the celling.

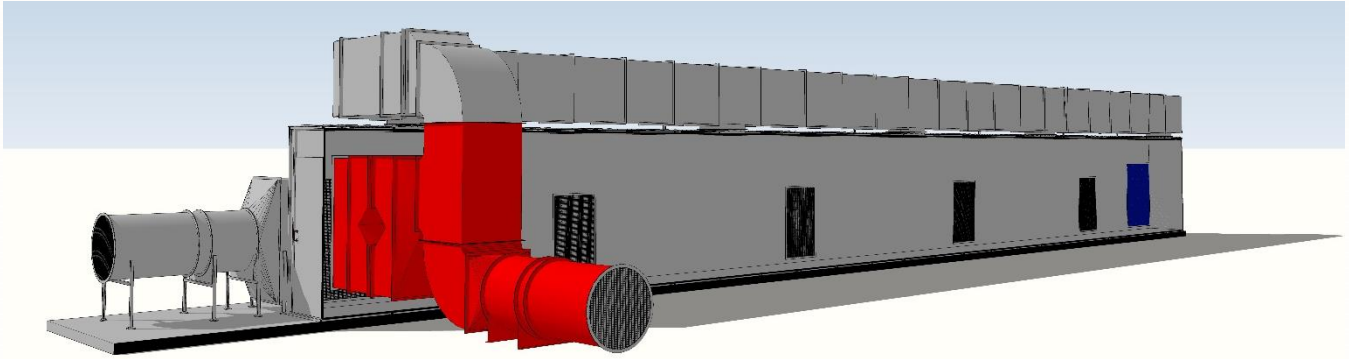


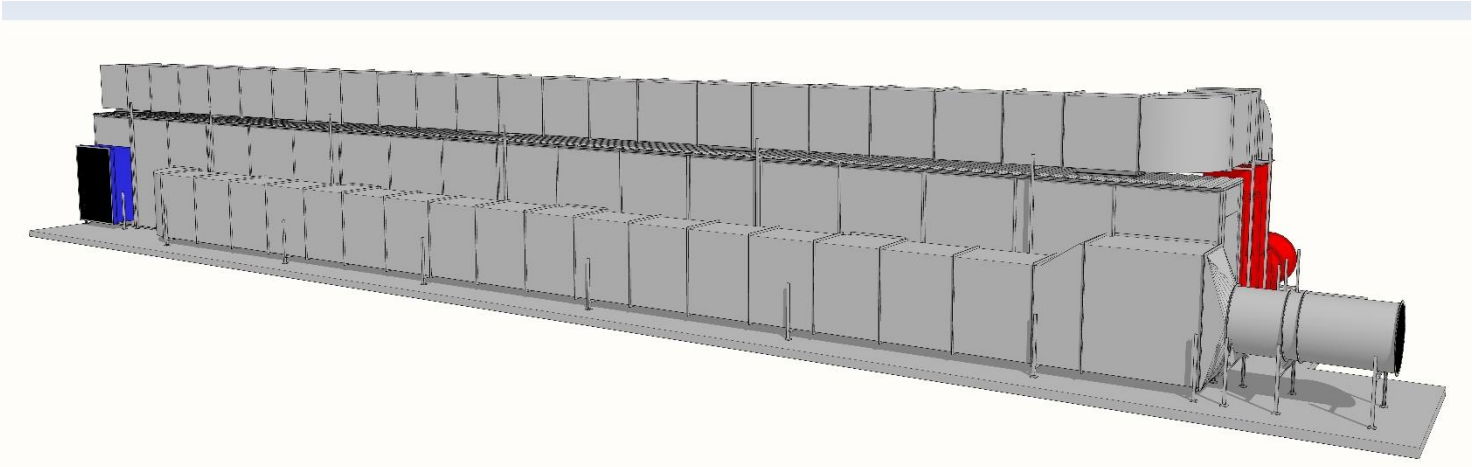


Types of fire ventilation combination (4)

- Longitudinal ventilation system

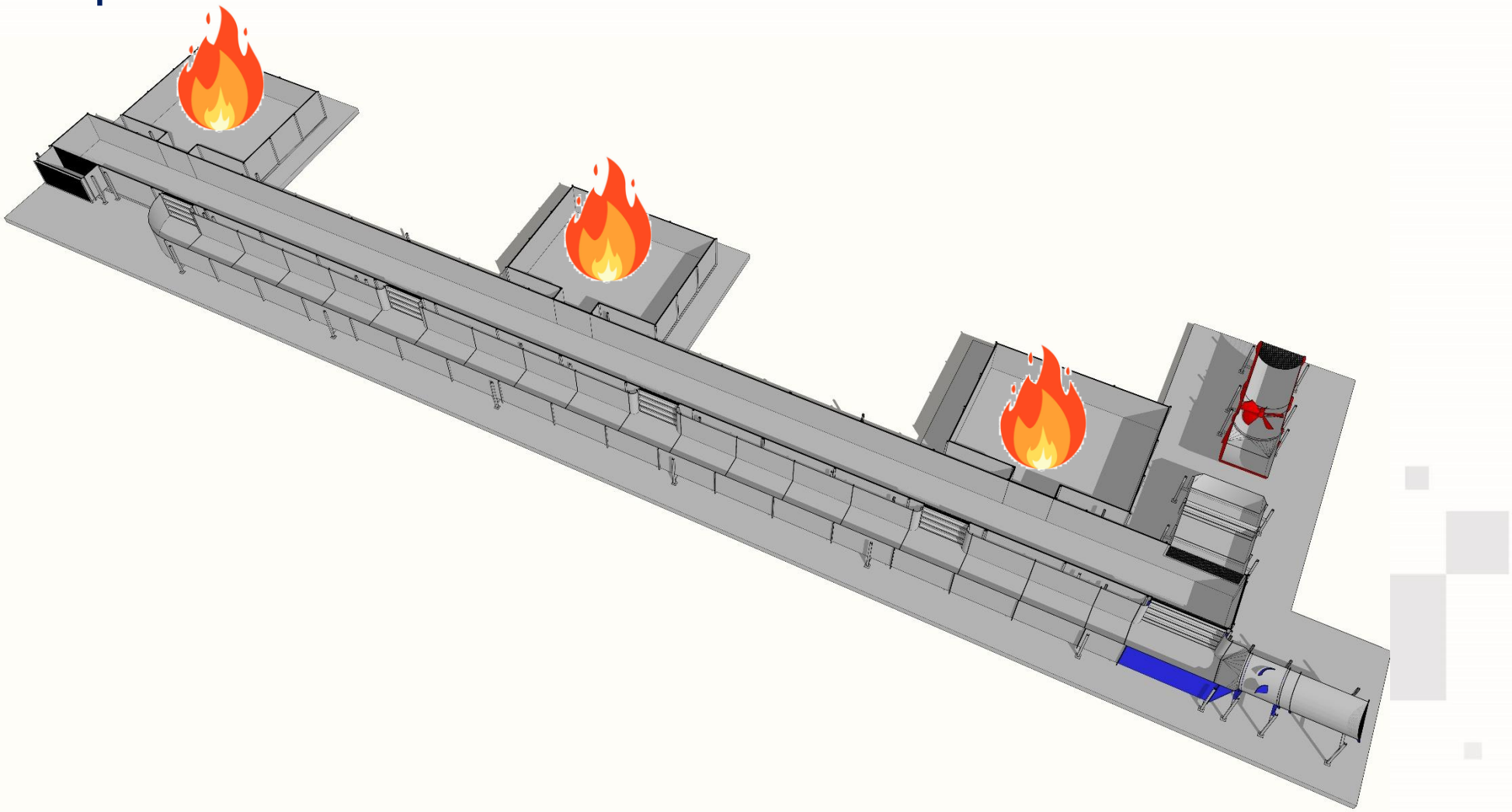
Natural inlet vent located at the end of corridor, outlet vent located at the oposite side of the corridor





Fire location

Possibility of any fire location in one of the three rooms adjacent to the corridor and in the corridor space.



Fire HRR

Four mass gas flow regulators (0–500 l / min) provide the possibility to freely set the fire power and define the rise curve. The system is computerized and follows any designed curve.

Fire HRR

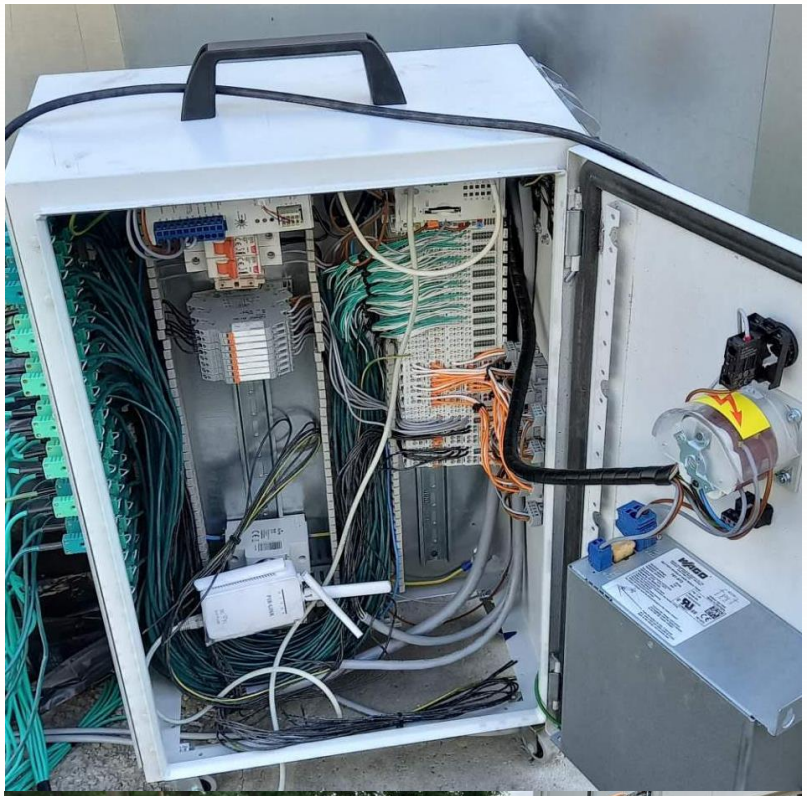
For the purposes of the research, four gas burners with dimensions of 0.5 x 0.5 m each were designed and manufactured. Four mass flow regulators allow for any regulation of the generated heat stream

Instrumentation

Currently, 5 tripods with 8 thermocouples each have been located in the space of the station. Tripods are placed every 5 m. Additionally, in the under-boot space there are 3 velocity converters (up to 350 ° C and 20 m/s).

Integrated measurement and control system

- control and fire dampers
- control of the efficiency of supply and exhaust fans
- control of mass flow regulators to define the current HRR of the fire
- control of the supply pump for the extinguishing hose and the sprinkler system
- continuous recording of environmental parameters in accordance with the assumed configuration
  a. temperature
  b. velocity
  c. pressure difference
  d. intensity of thermal radiation flux
  e. device status monitoring
  f. full synchronization of the recorded data



Fire ventilation fans

The system has two fans with a maximum capacity of about 40,000 m³/h each. The use of frequency converters allows for smooth control of the supply and exhaust fan.

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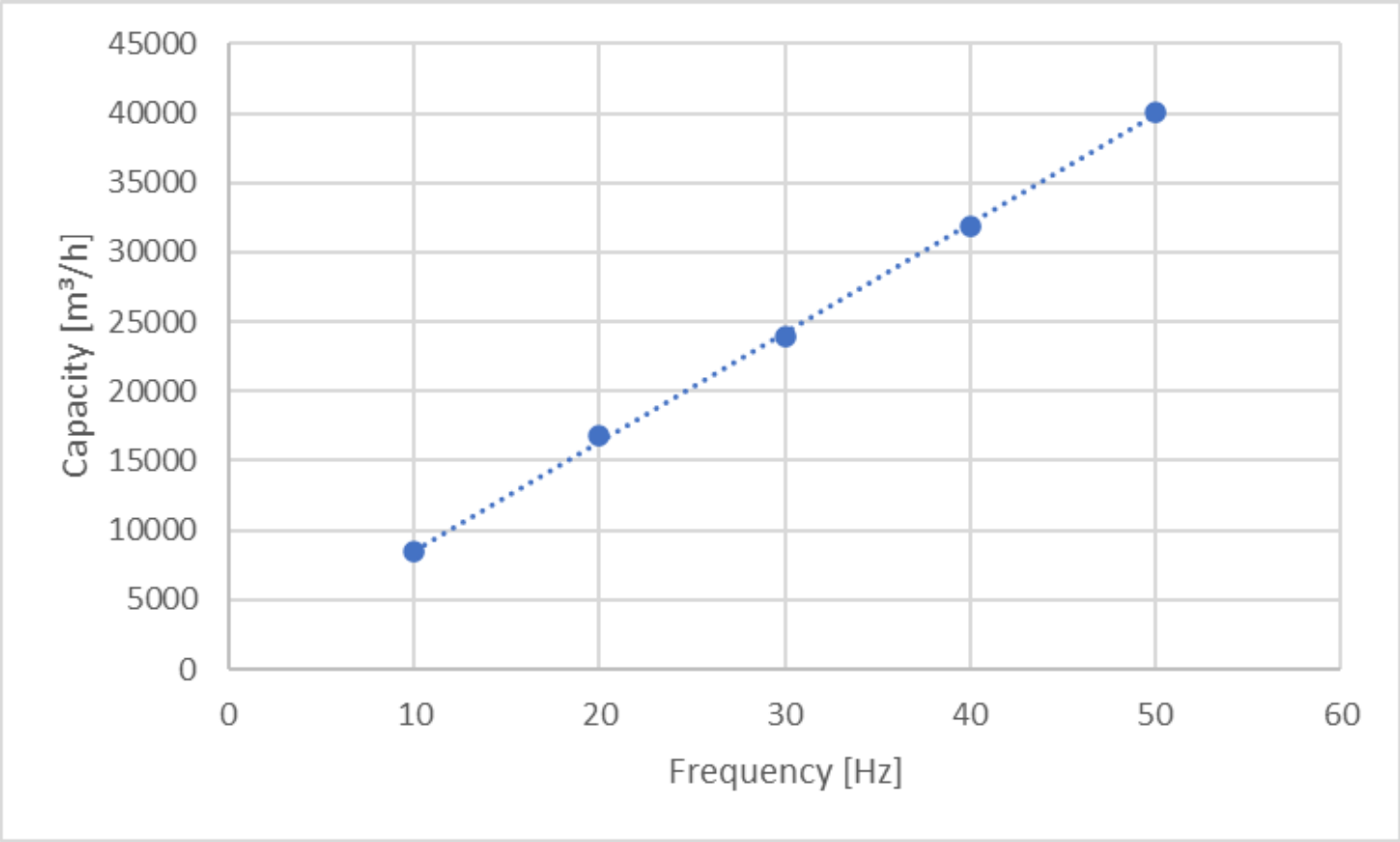
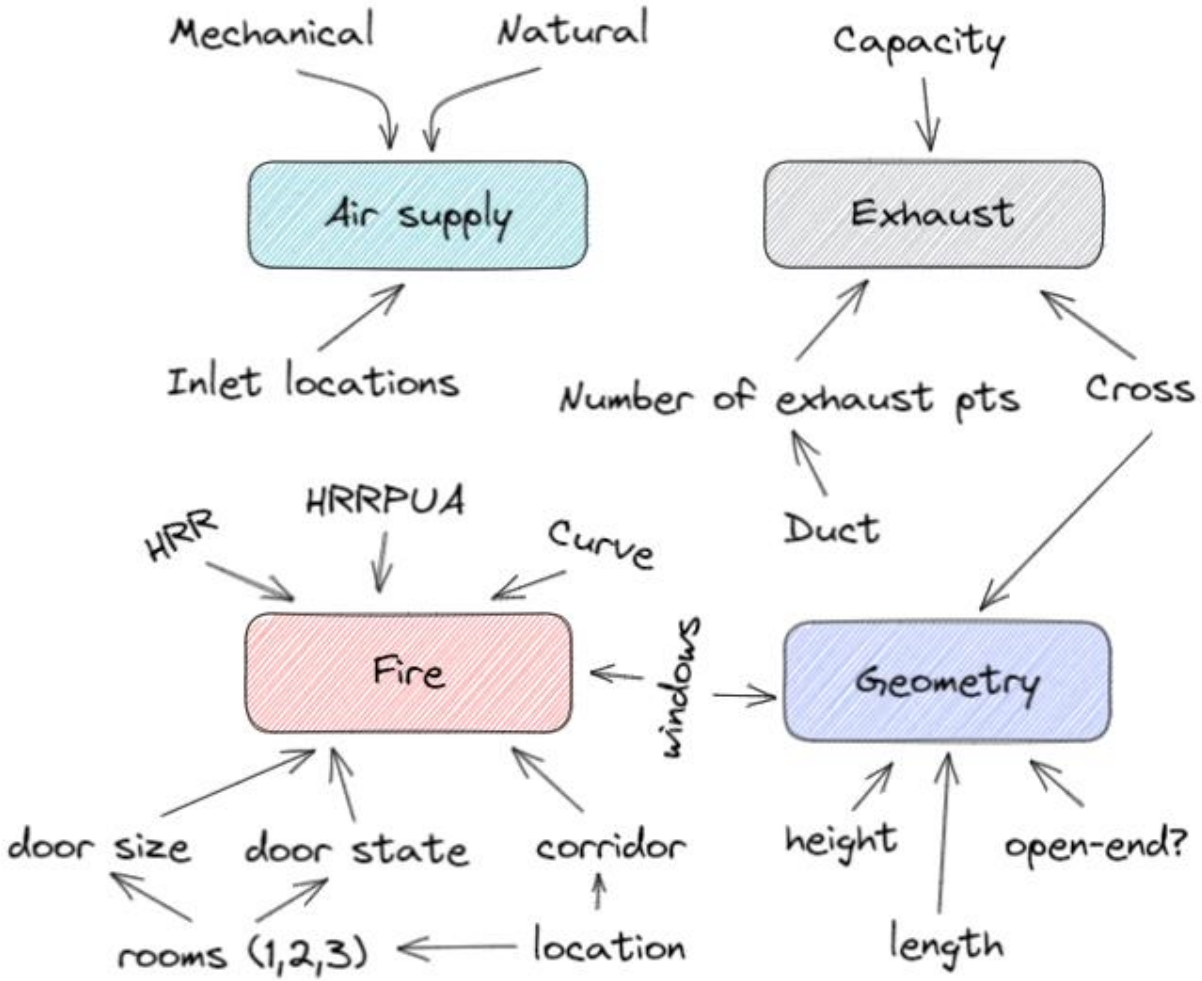


Variables

Thanks to the flexibility of the research infrastructure for parametric research, we can take into account a number of variables during the research.



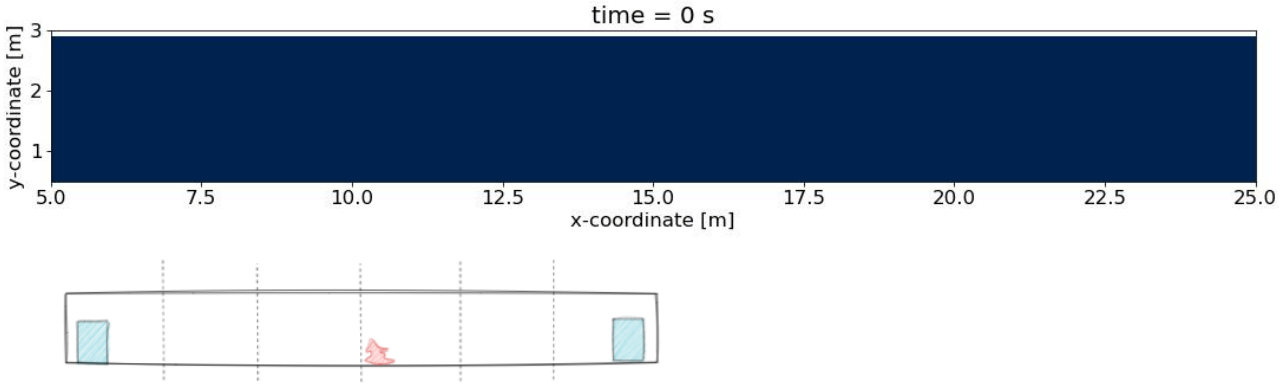
Performed tests

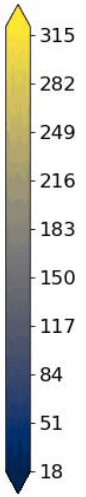
13 experiments have been carried out, taking into account:

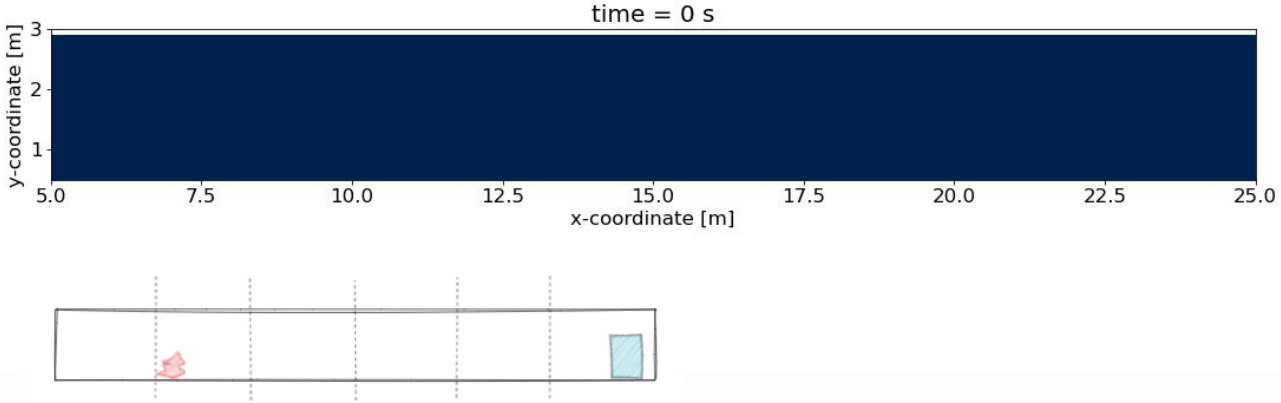
- different fire HRR,
- constant over time and variable from 50 kW to 500 kW
- two burner locations (end and center)
- two combinations of the number of burners (one or two)
- variable system capacity (0–40,000 m³/h) for different fire powers (100kW-400kW)

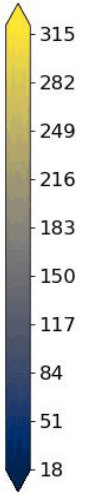
Test results

A detailed description of the obtained results and comparisons with CFD analyzes can be found in the Smoke Control In Corridors A Multiparametric Experimental Study And Its CFD Digital Twin presentation, dr Wojciech Węgrzński, prof. ITB, Dr. Grzegorz Krajewski

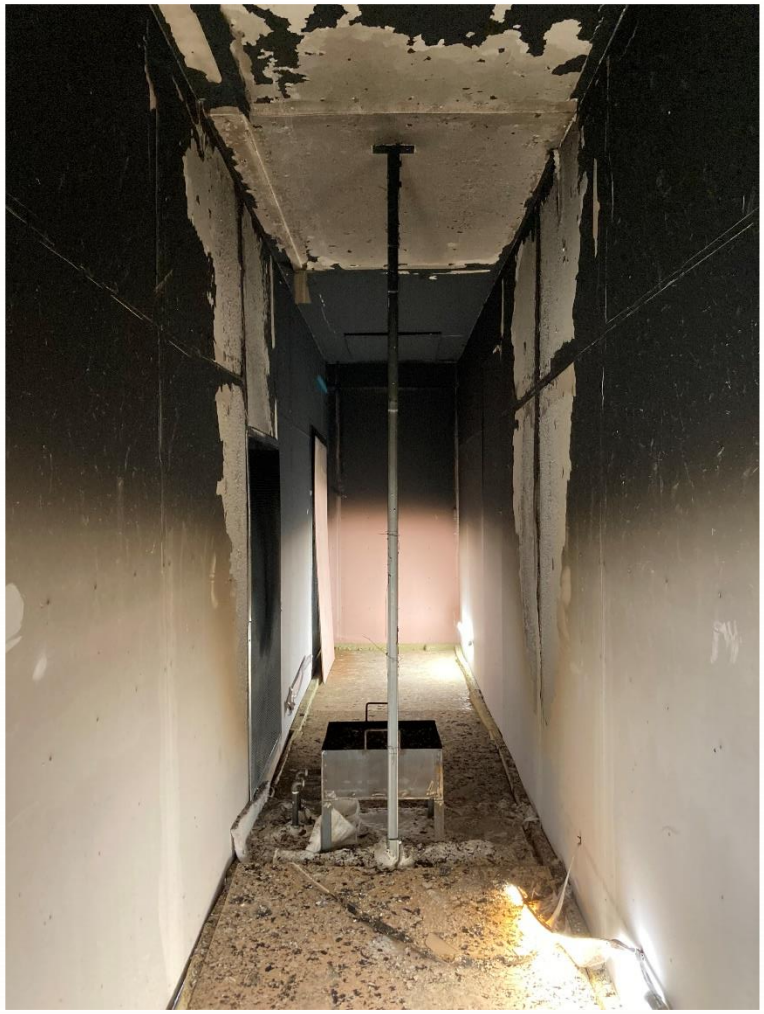


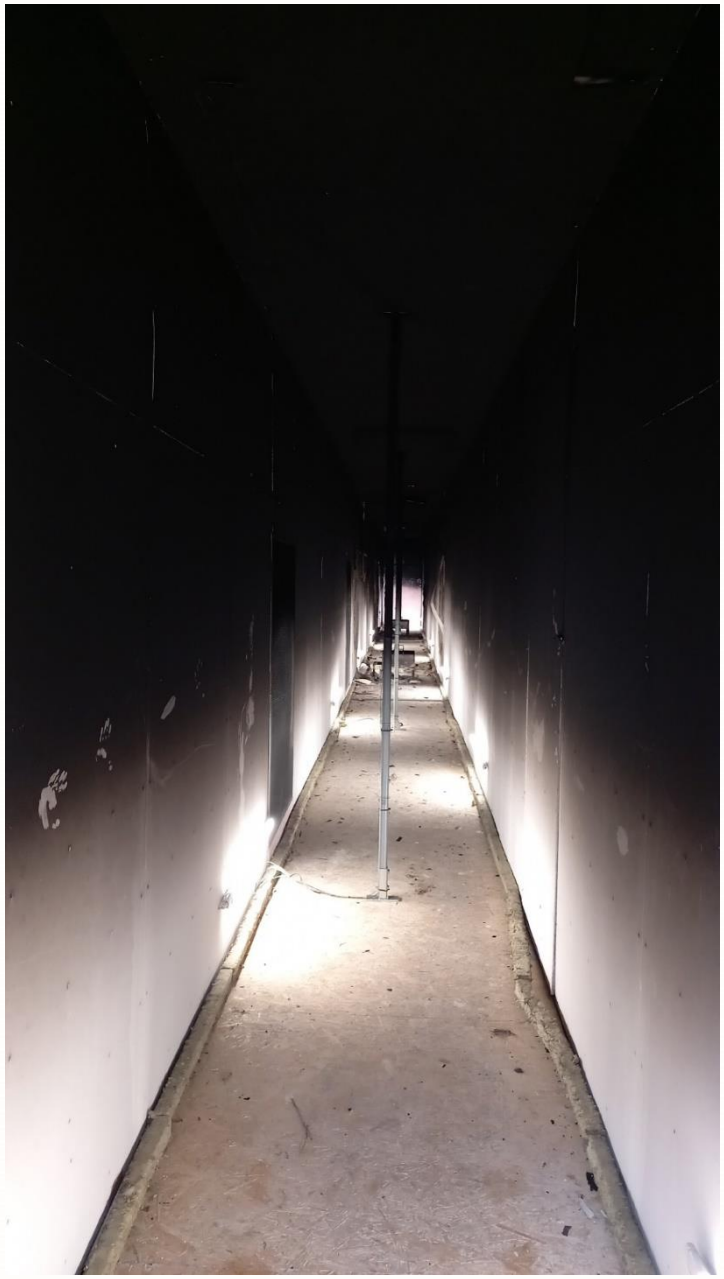






After tests...





Next steps

In the short (and a little later) future we plan to:

- increasing the number of thermocouples from 60 to 120
- increase the number of measuring points at the floor and ceiling level of the corridor
- adding two thermocouple trees at the ends of the corridor
- carrying out tests with a functioning ventilation system for different fire HRR and different capacities of the exhaust and supply fan
- perform the tests taking into account the operation of the sprinkler and fog systems
- take into account the interaction of the fire ventilation system with the pressure differential system
- verify the operation of fire ventilation systems under the action of side wind

Next steps

- determine the working conditions of a firefighter under fire conditions, taking into account the operation of the fire ventilation system, sprinkler system and during the rescue and firefighting operation using an external fan
- relocation of the fire source from the corridor to the rooms
- carrying out numerical CFD analyzes to validate the numerical model and the fire source model in FDS and ANSYS Fluent
- assessment of environmental conditions during a fire, taking into account the previously discussed variables
- use of full-scale research data in AI analyzes

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Thank You

Dr. Grzegorz Krajewski.
g.krajewski@itb.pl
@GrzegorzITB

Dr. Wojciech Węgrzyński, prof. ITB
w.wegrzynski@itb.pl
@WojciechITB