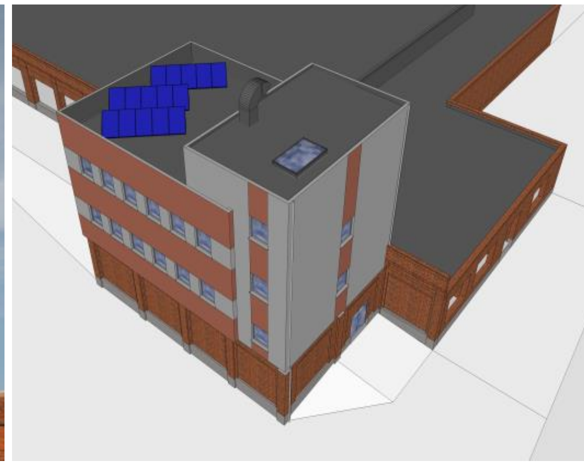
LECTURE ROOMS AT KAHO



Institute/organisation:

KAHO-Sint-Lieven / KU Leuven

Contact person:

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Exact location:

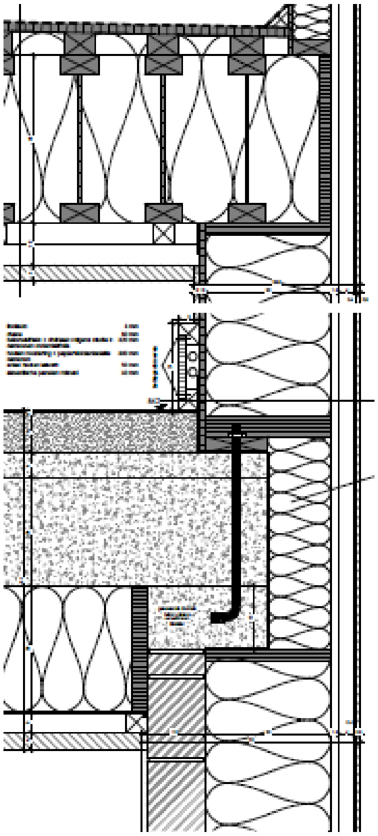
Gent, Belgium
51.06005 (N), 3.70927 (E)
(decimal Lat./Long.)

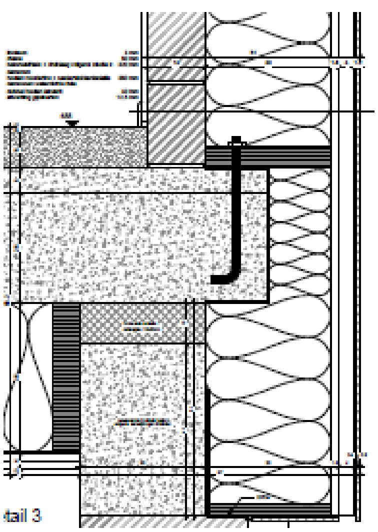
General description

Major aim of the test facility

The building has three combined functions:

- **Part of the campus facilities** of the Technology-campus Gent, KAHO Sint-Lieven, KU Leuven, with two lecture rooms for 80 students each. This new facility has a much higher comfort and performance level than the other lecture-rooms of the campus and can serve as "good example" for the students of the Civil Engineering department. The students can experience the difference in indoor air quality, thermal comfort and monitored energy performance between this new facility and the existing, older campus facilities.

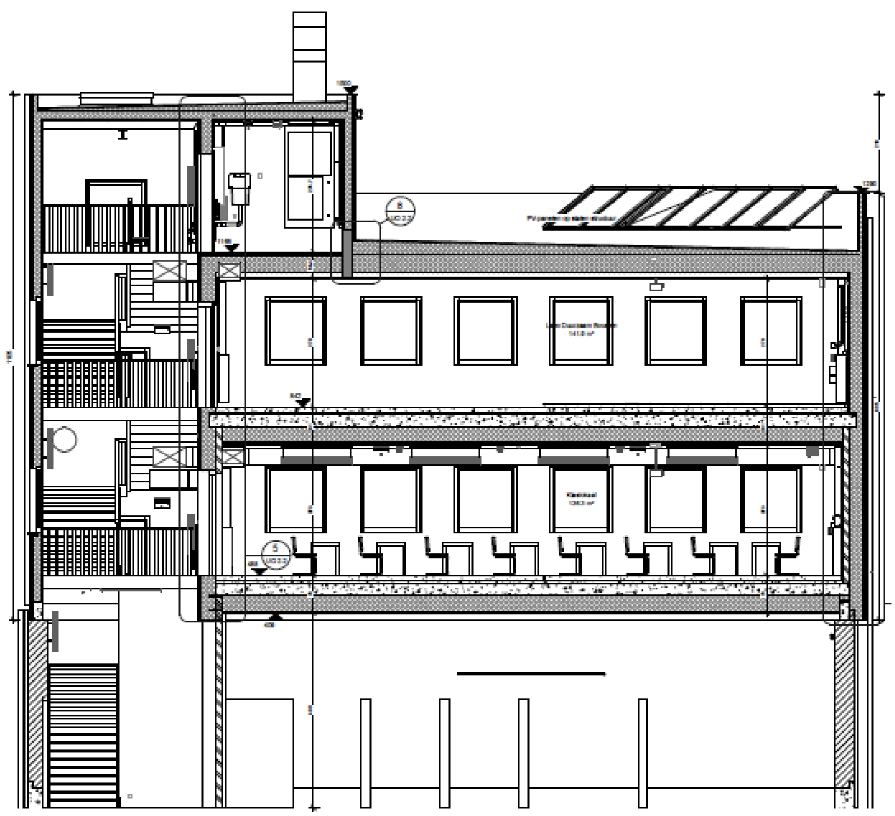


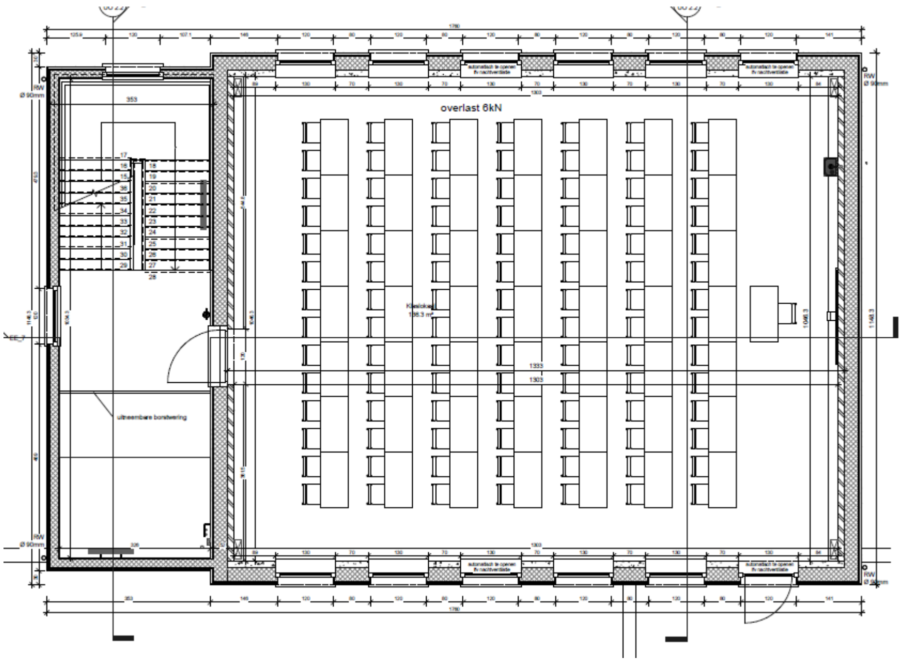


- **Showcase** for innovative HVAC, BMS and monitoring technology for engineering students, complemented by a “virtual building” (BIM) and the use of LCA for the choice of materials with a low environmental impact and a limited carbon footprint. It will be complemented with a exposition space, showing the used construction materials, and a Lab with different elements of the BMS and monitoring-system, that can be used by students for experiments and thesis projects, on the ground floor.
- **Test facility** with an integrated, open and modular system for monitoring and control of the building and with a free choice between “real use” and “test conditions”. The test facility will be gradually extended and refined, depending on the different research projects and obtained financial support.

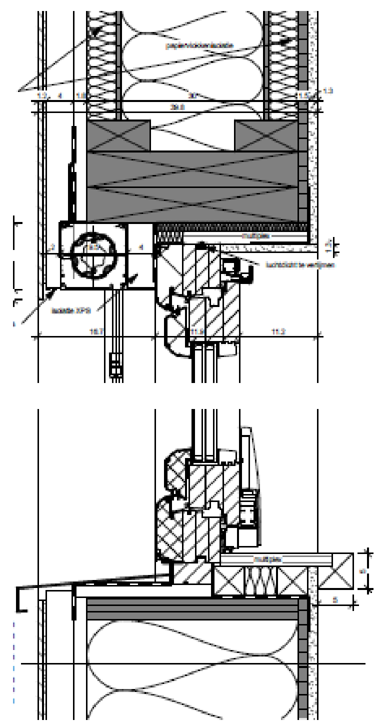
Overall lay-out

The building was designed according to the Passive-House standard, with two lecture rooms for 80 students each. The geometry of the building was kept “simple” to facilitate the creation of different simulation models and to limit the complexity of the monitoring system. On the other hand the building was equipped with a high performance AHU (heating and cooling), a wood pellet boiler, motor-controlled exterior sun-shading and windows and high performance lighting with daylight control (DALI), to be able to test the interaction of these different technologies and to measure their impact on comfort and energy performance of the building.





The new facility consists of two levels, constructed on top of an existing building (ground-floor only). Air-tightness of the two classrooms was tested and fulfils the requirements of the Passive House standard. Access to the classrooms as well as to the technical room and further to the flat roof is provided by a staircase, which forms a thermally separated volume. This results in a layout with two identical, box-shaped volumes with different thermal mass (one with a timber-frame structure, one with brick-walls). These two volumes are separated with thermal insulation in-between the two and towards the staircase and the technical room.



Inside boundary conditions

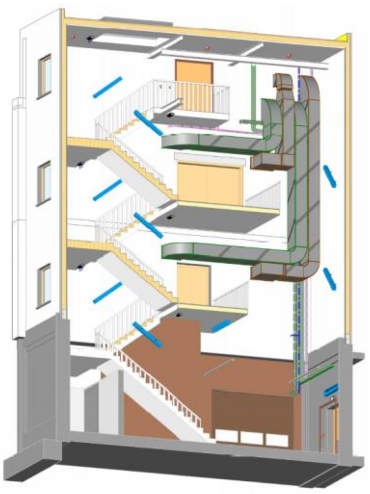
In normal operation, indoor conditions are kept in a comfortable range (about 20ºC in winter and a maximum of 25ºC in summer) with the AHU (heating and cooling) and if desired with night-ventilation (automatically operated windows with mechanical extraction (if needed). The exact operating schedule has still to be determined and could be adapted to the needs of research projects.

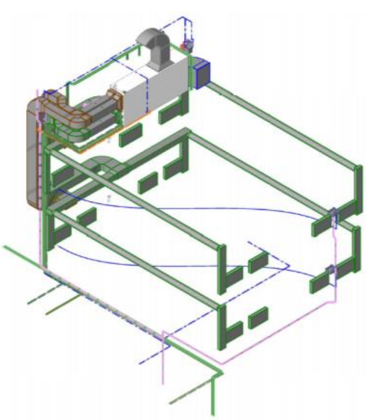
For test purposes dynamic inside BC’s can be imposed. Only one of the two rooms has to be available for teaching purposes, the choice which of the two is in “normal use” is up to the research team. The other one might be occupied for longer periods for tests without users, or use can be switched between the two for comparison purposes.

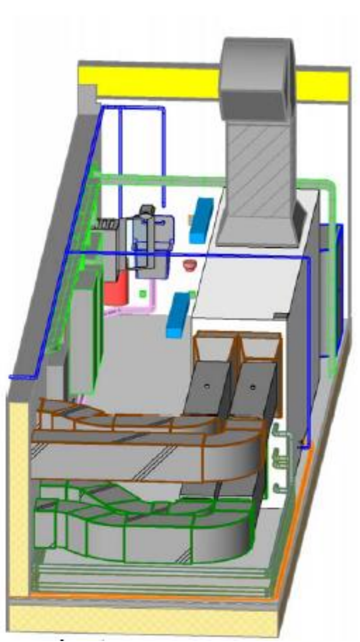
Outside boundary conditions

Natural climate, monitored with weather-station on top of the building: global irradiation, temperature, humidity, wind speed and direction, precipitations.

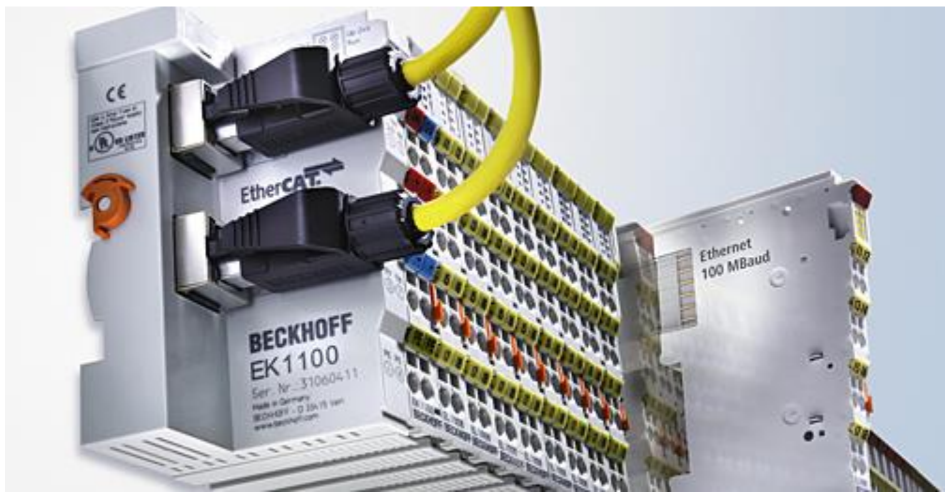
Special limitations / possibilities







The sensors and all the equipment of the building (AHU, shading, windows, lighting, …) is connected to an open, modular Building Management System (BMS). The system consists of two industrial PCs and distributed bus couplers with I/O modules. The bus couplers are connected through Ethernet-cable to the IPC using the EtherCAT-protocol for efficient and fast data transfer (see also www.beckhoff.com). A large choice of I/O-modules (EtherCAT terminals) is available and can be stacked on to the bus-couplers. This provides a very flexible system for the direct connection of sensors and actuators, that can easily modified or extended, depending on the needs of different research projects.



The system is controlled from one or several Soft-PLCs (Beckhoff TwinCAT3 running on one of the IPCs).

A second IPC can interact with the BMS and provide for example input from real-time simulation, weather prediction or data-analysis for predictive control or fault-detection algorithms. On this second IPC a database-server is running, that stores the information from all data-points connected to the I/O-modules of the first IPC.

Through dedicated EtherCAT terminals and software libraries connections can be made using open standard fieldbus protocols.

In this test facility, BACNet will be used for the connection to the AHU, giving access to most of the internal sensors and actuators of the unit.

Lighting will be controlled through DALI, solar shading through KNX. The calorimeters between wood-pellet boiler and heat exchanger of the AHU will be connected through M-bus.

This will allow gaining experience with the most commonly used open standard fieldbus systems, while keeping all the data in one system and hiding the complexity of different hardware and communication protocols. The user can get data in real-time from an internal temperature sensor in the AHU in the same way as from another sensor located in a room or outside the building.

A full as-Built BIM (AutoDesk REVIT and IFC models) will be available and will serve as context for simulated and measured data.

Data analysis

Typical equipment within test building

As stated earlier, sensors can be added as needed to the system. For the time being a monitoring system was designed, that captures all relevant energy-flows and occupancy of the building.

Four Venturi's with differential pressure sensors are integrated in the duct-system, providing accurate data for the air-flow towards and from the two classrooms separately. Also temperature and humidity at different locations in the air-ducts is measured.

Calorimeters are installed between boiler and heat exchanger of AHU.

In the classrooms temperature, humidity and CO_2 is measured.

Electricity consumption is measured for each circuit (e.g. AHU, lighting class-room 1, plug loads class-room 2, …). For lighting additional detail is available through DALI (e.g. dimming % per fixture).

Accuracy and logging resolution

As-built specifications will be soon available.

Analysis of the data

Using R and CTSM (to be confirmed…).

Examples of previous studies

New test facility: will start operation later this year (some delay due to construction delays).

MAINTENANCE / COLLABORATION

Personal involved

Still to be extended/confirmed, first steps accomplished:

- Financial support for a PhD student obtained
- Limited support from technicians / research staff already available, to be extended with additional funding.

International collaboration

Through KU Leuven Building Physics network.

Link with other devices

Research will be performed in close collaboration with Building Physics Lab, KU Leuven. Other collaborations still to be confirmed.

RELEVANT LITERATURE

General literature about the test facility:

Not yet published.

Literature on previous measuring campaigns:

New test facility.

ACKNOWLEDGEMENTS

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