

LAB ACTIVITY #2

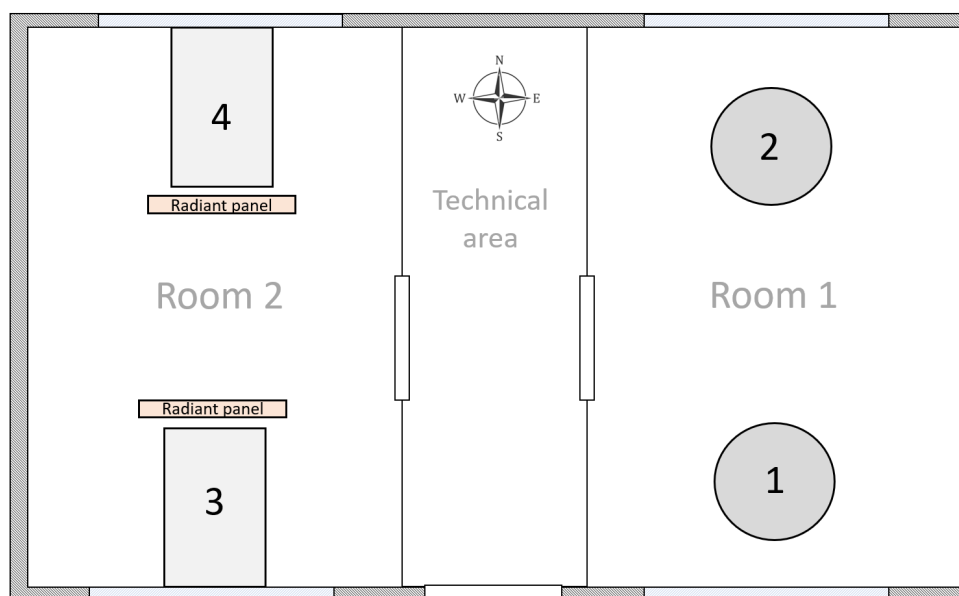
Building interfaces: effect on the heat and thermal comfort

Overview: During the lab activity, you will move with your group between different locations and perform 15-minute-long measurements at the following spots:

1. Inside the CELLS, by the South window, no local radiant panel
2. Inside the CELLS, by the North window, no local radiant panel
3. Inside the CELLS, by the South window, next to the local radiant panel
4. Inside the CELLS, by the North window, next to the local radiant panel
5. Inside an atrium of the nearby building with a glazed roof
6. Outdoors (2 times)

No.	Timing	Location	Window	Local panel
1		CELLS, Room 1	South	No
2		CELLS, Room 1	North	No
3		CELLS, Room 2	South	Yes
4		CELLS, Room 2	North	Yes
5		Atrium	--	--
6a		Outdoors	--	--
6b		Outdoors	--	--

The interior plan of the CELLS is provided in the following figure:



Surveys: You should complete a comfort survey provided at each location, after 15 minutes of exposure.

Preparations: Prior to the measurements, you should estimate your group's average clothing insulation (*clo* value) and metabolic rate (in *met*).

Measurements:

1. Environmental measurements using the CUBE sensors:

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- MRT (*C)
 - LONGWAVE RADIANCE (*C)
 - SHORTWAVE RADIANCE (*C)
 - AIR TEMP (*C)
 - HUMIDITY (%)
 - AIR SPEED (m/s)
 - STANDARD EFFECTIVE TEMP (*C)
 - OPERATIVE TEMP (*C)
 - WETBULB GLOBE TEMP (*C)
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- UP LW RADIANT TEMP (*C)
 - NORTH LW RADIANT TEMP (*C)
 - EAST LW RADIANT TEMP (*C)
 - SOUTH LW RADIANT TEMP (*C)
 - WEST LW RADIANT TEMP (*C)
 - DOWN LW RADIANT TEMP (*C)
-
- UP SW RADIANCE (W/m²/sr)
 - NORTH SW RADIANCE (W/m²/sr)
 - EAST SW RADIANCE (W/m²/sr)
 - SOUTH SW RADIANCE (W/m²/sr)
 - WEST SW RADIANCE (W/m²/sr)
 - DOWN SW RADIANCE (W/m²/sr)
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2. Environmental measurements (in the middle of the room):

- Air temperature (*C)
- Globe temperature (*C)
- Air speed (m/s)

3. Visual data collected at each location:

- a) Regular (RGB) images of the surroundings
- b) Infrared (IR) images of the surroundings, and pictures of yourselves at selected location (to extract clothing surface temperatures)

4. **Solar exposure:** global, diffuse, and total irradiance measured on the roof of the CELLS using [SPN1 Sunshine Pyranometer](#) (data will be provided after the lab)

5. **Building envelope measurements:** temperatures of the indoor surfaces of the CELLS - walls, windows, radiant ceiling (data will be provided after the lab)

Task: Using the data collected, address the listed tasks with your group and discuss the results. Address each task in detail in your group report; the report's evaluation will be based on the extent of the answers and the proper support of arguments with the data.

Task 1: Radiant heat transfer

- 1.1. **Radiation coming from the Sun:** Compare the global, direct, and diffuse irradiance measured using the outdoor pyranometer and discuss their differences.
- 1.2. **Difference between directional longwave and shortwave radiation measured at all locations.** Using the data from the CUBE sensor, compare the magnitude of the measured values and explain the differences with respect to the surrounding heat sources (differentiate between opaque and transparent building elements, thermally activated and passive surfaces).
 - Support your answers by amending the IR images from the surroundings
 - Compare the shortwave radiation incident through the glass with the outdoor direct irradiance

Task 2: Thermal comfort and heat transfer

- 2.1. **Radiant vs. convective heat transfer from the body (for selected locations where you have the IR images of the body):**
 - Calculate radiant and convective heat transfer between certain body parts and the environment. Select the body parts to analyze and explain your selection criteria.
 - Compare their magnitude across locations and persons. Discuss building elements that affect the heat transfer and their properties.
- 2.2. **Local (dis)comfort:** Compare your local comfort votes with the magnitude of the radiant heat transfer from your body (calculated in task 2.1), and discuss the results.
- 2.3. **Overall comfort:**
 - Compare PMV values given by the CUBE sensor with your actual comfort votes
 - Compare the SET (standard effective temperature) given by the CUBE sensor with your actual comfort votes, and discuss the results
- 2.4. **Effect of the shortwave radiation on human comfort:**
 - Can the PMV method be applied when solar radiation is present?
 - Develop a framework to consider the shortwave radiation from the Sun in human energy balance

Task 3: Performance of the glazing

- 3.1. **Thermal efficiency of the window:** Estimate the *solar heat gain coefficient* (g-value) of the window and discuss the thermal performance of the window in the CELLS facility.