

Low energy climate control in museums and galleries



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Human needs are different than objects needs



Museum buildings are often complicated structures

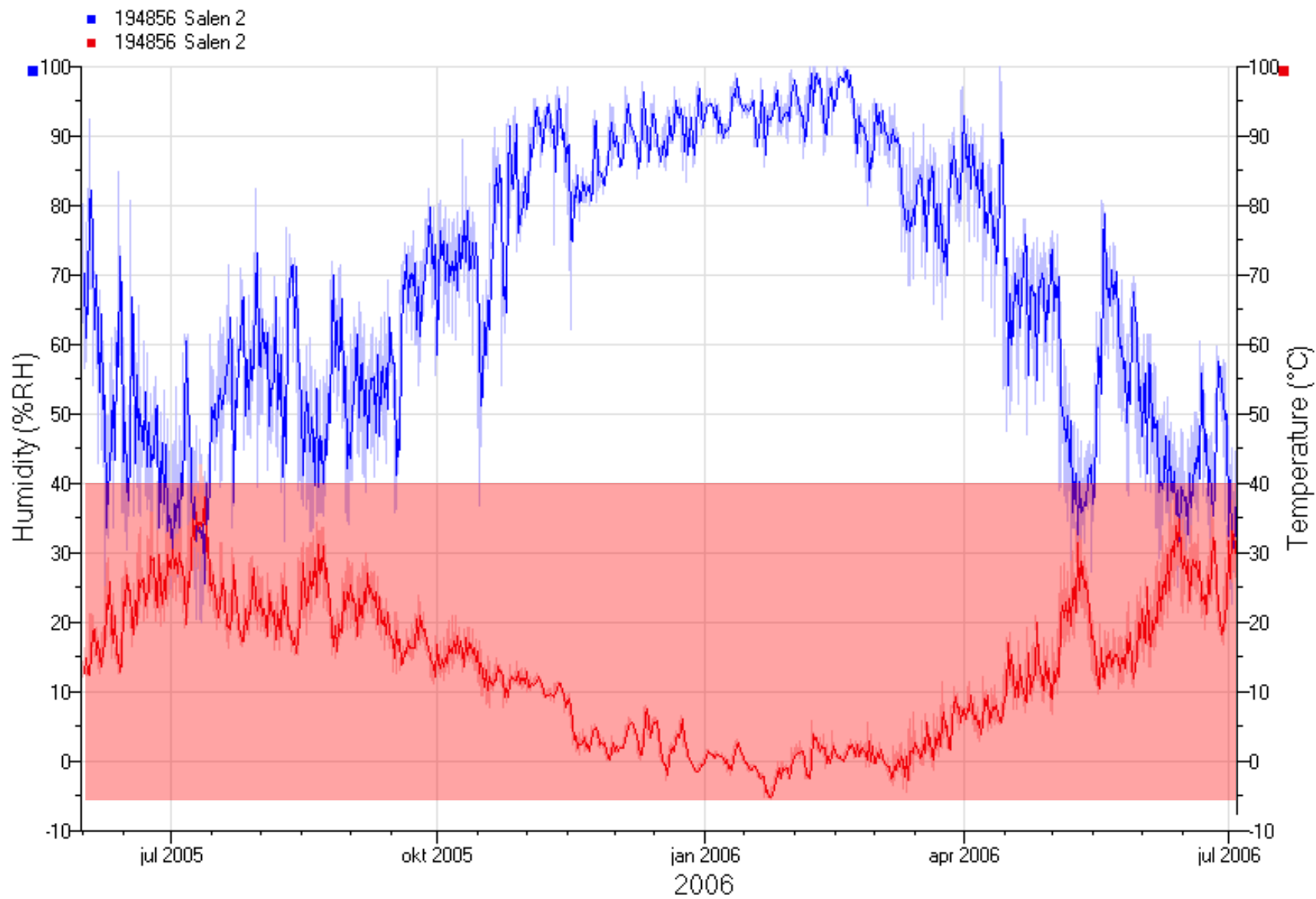


A submarine transformed into a museum



The interior is impermeable to water vapour

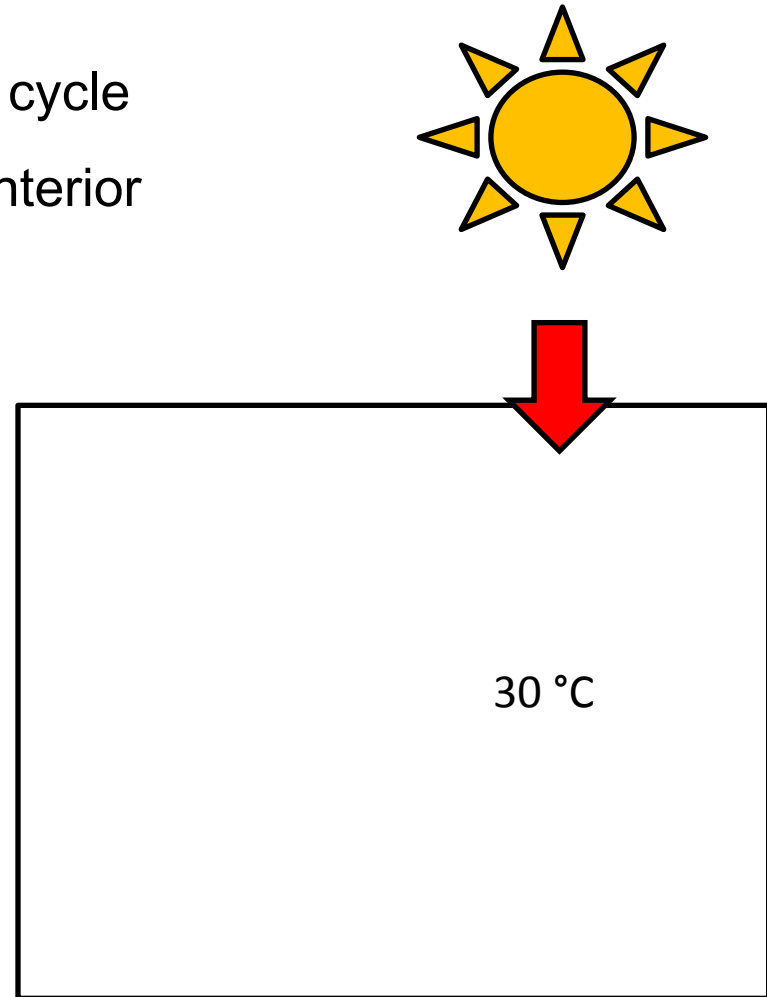




Temperature control

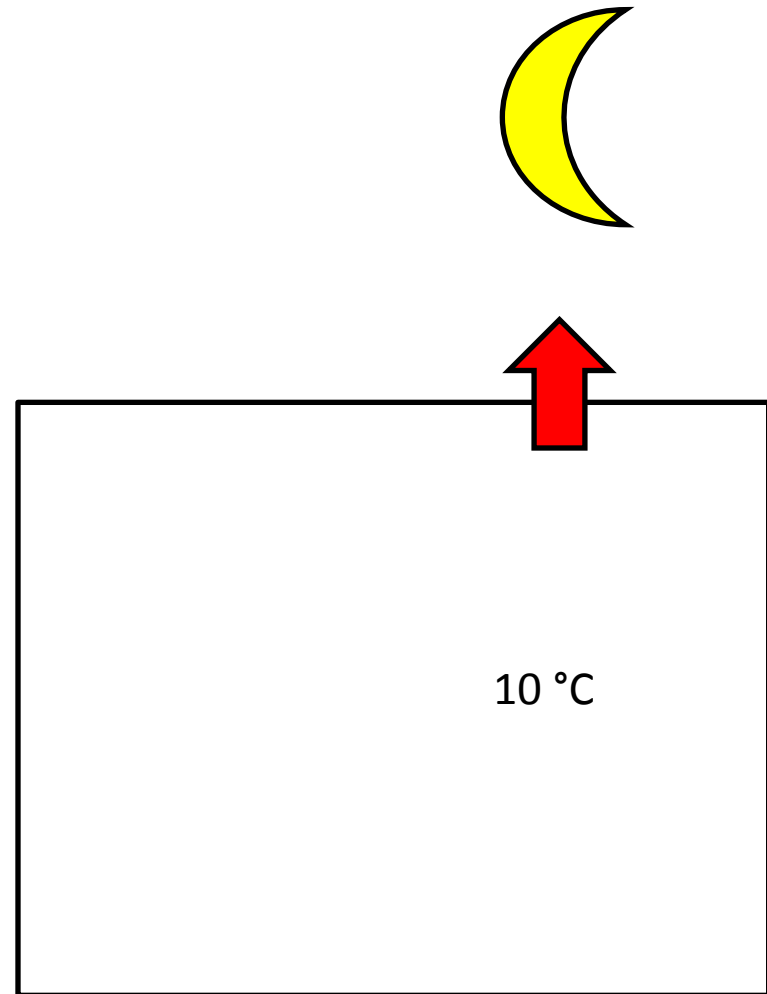
Little thermal stability on daily cycle

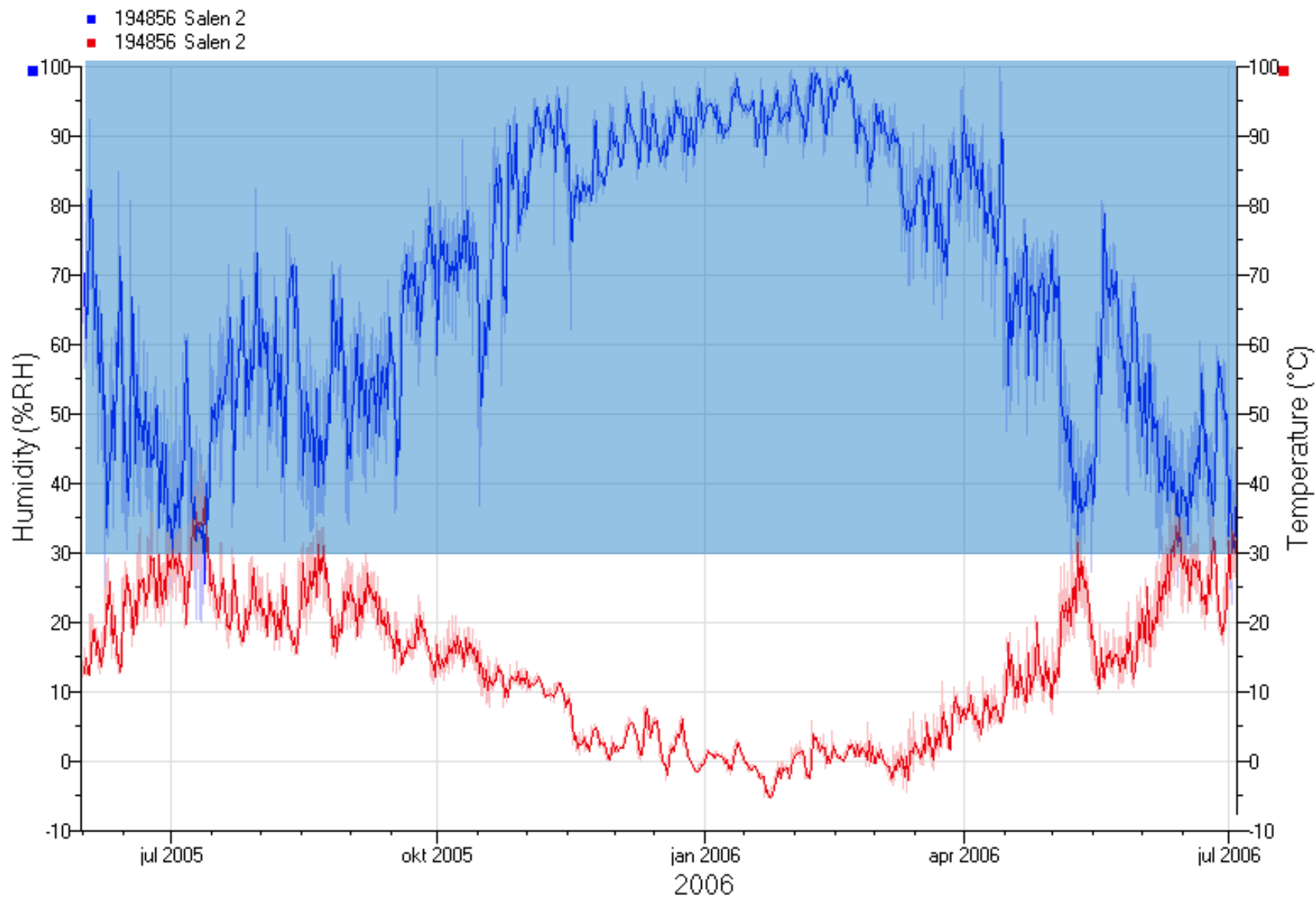
Heat radiation warms up the interior during the day



Temperature control

... and cool it during night

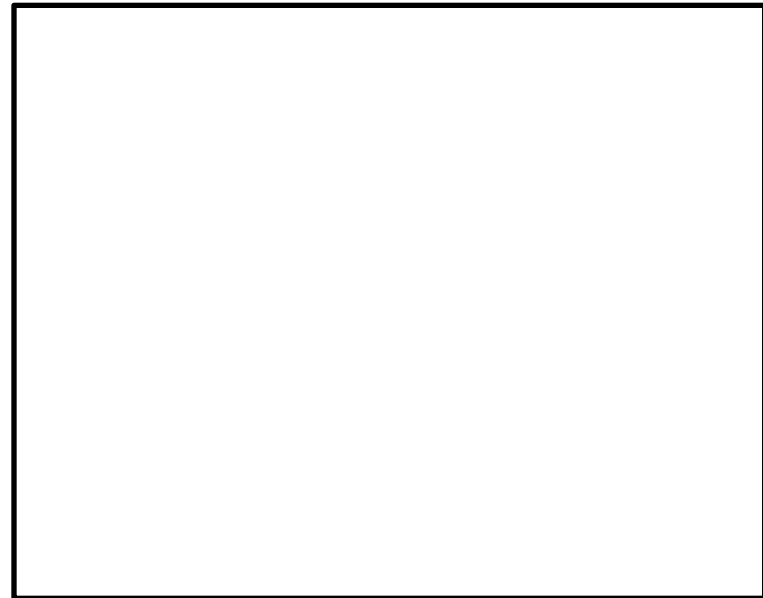
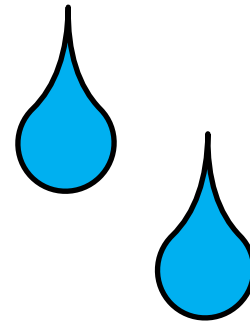




Humidity control

The structure is water tight

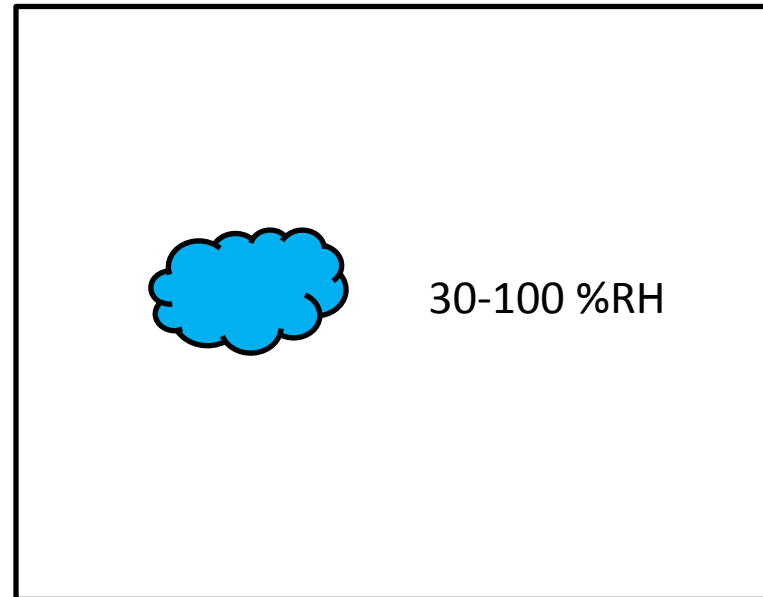
The surface is impermeable to water vapour



Humidity control

Water vapour flow is little

Air Exchange Rate AER $\sim 0 \text{ h}^{-1}$

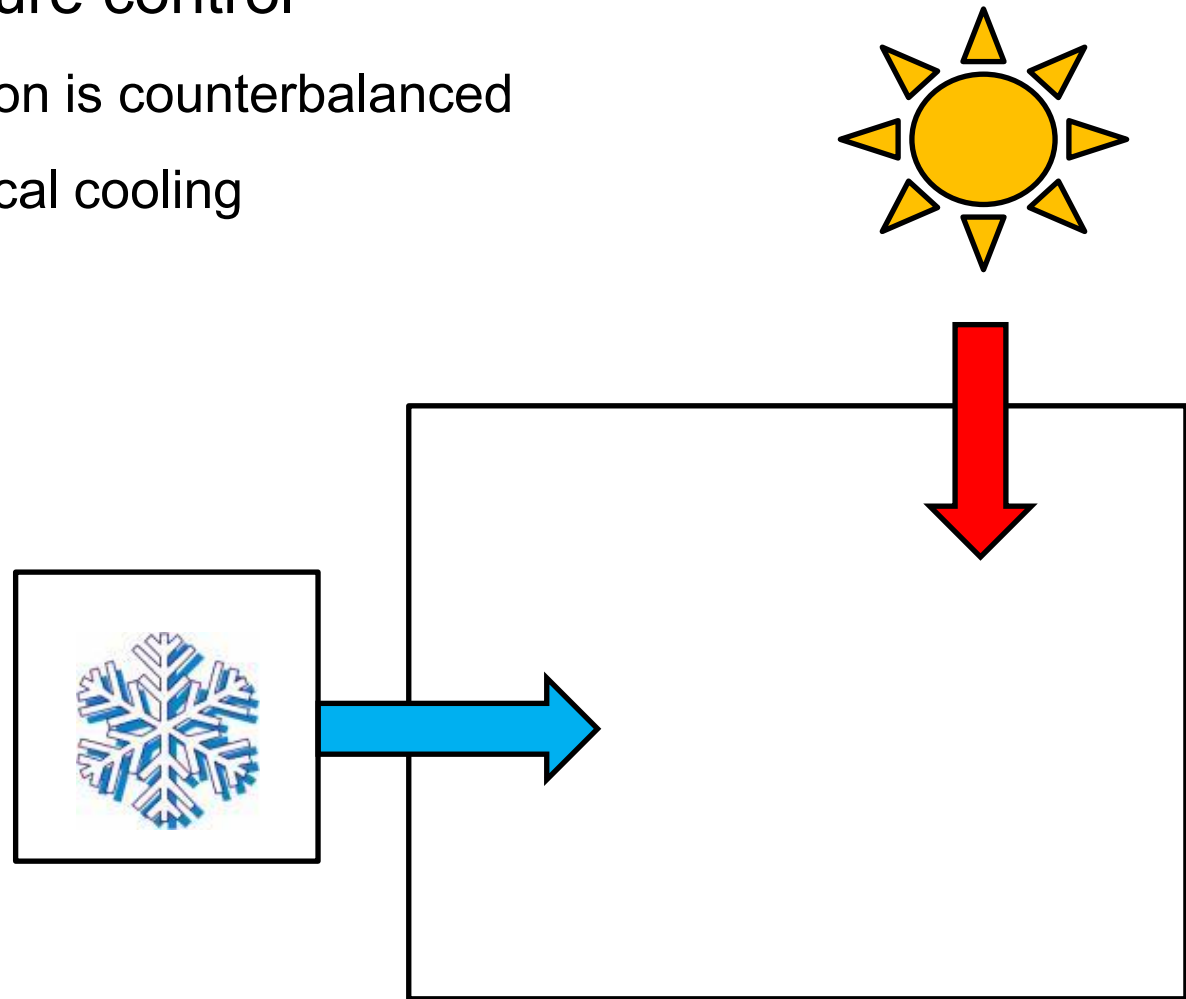


Imperial War Museum, Manchester, UK



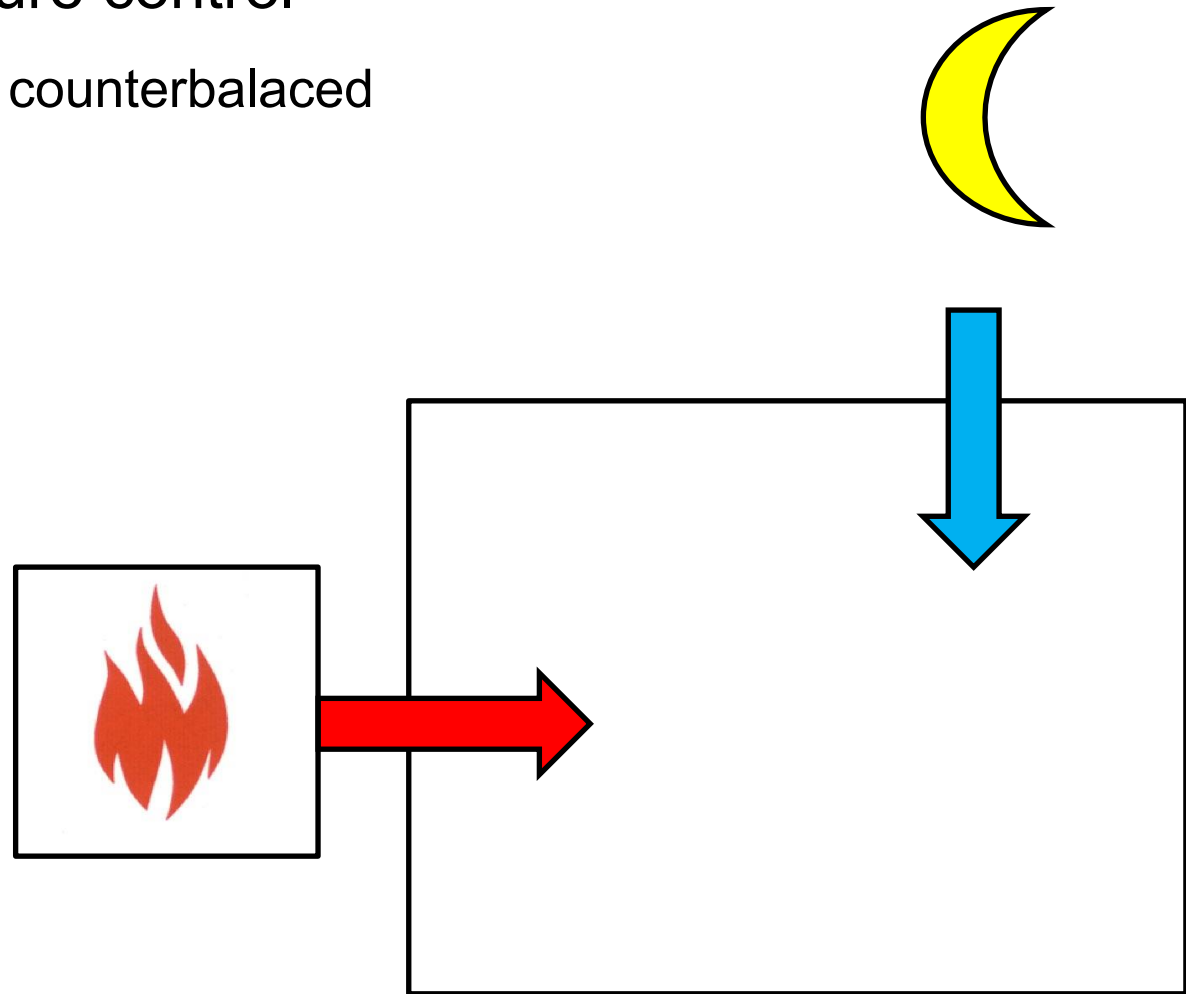
Temperature control

Heat radiation is counterbalanced
by mechanical cooling



Temperature control

Heat loss is counterbalanced
by heating



Temporary exhibition of iron age warship

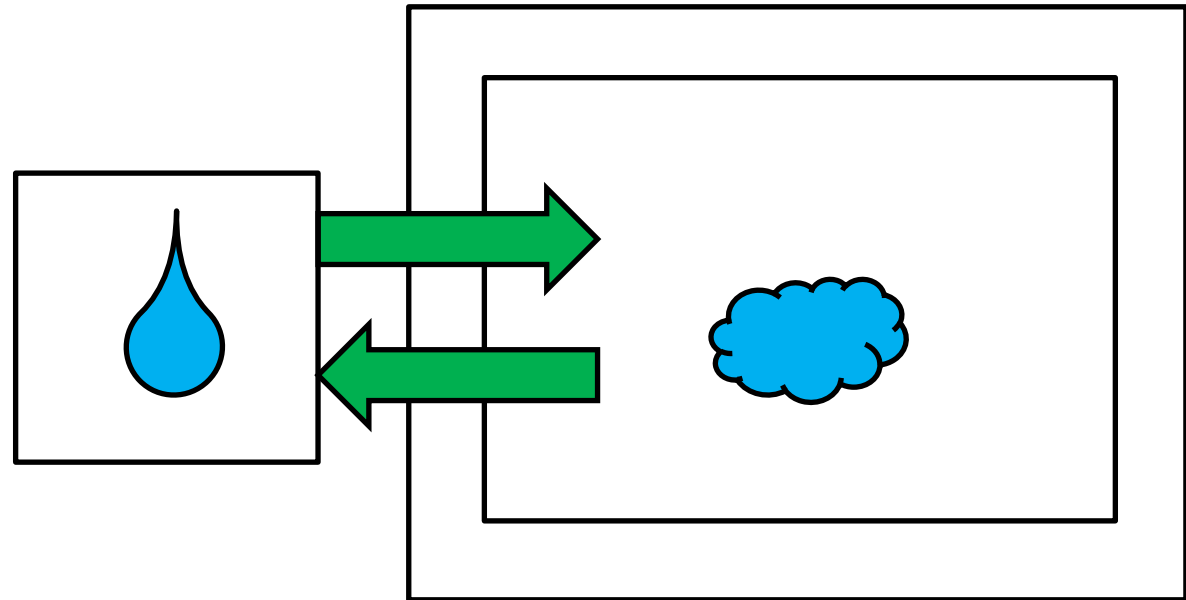


The balloon is held up by pressurized air

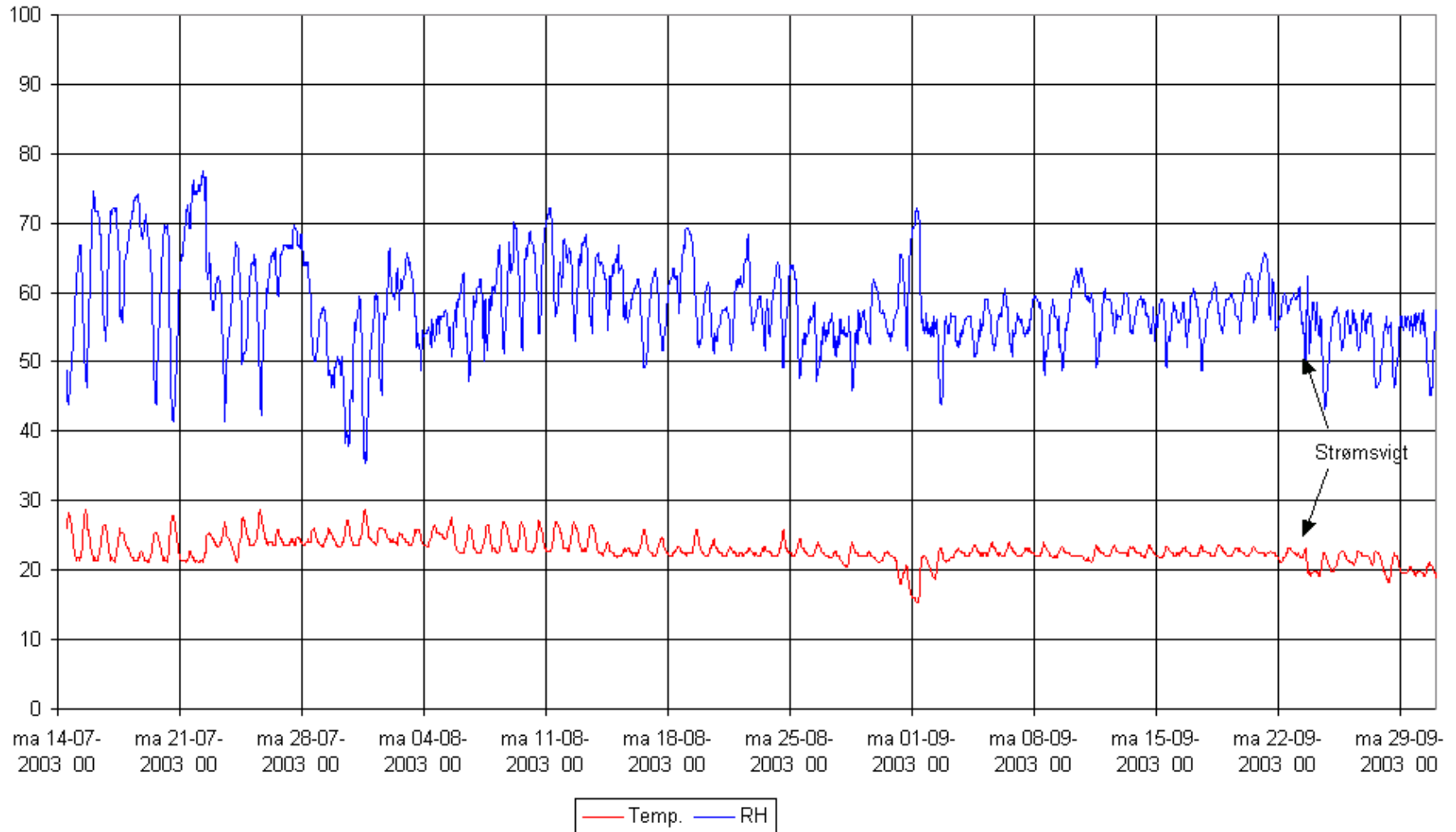


Humidity control

The RH was controlled by
humidification /dehumidification



Large RH fluctuations due to temperature variation



The ballon collapsed during a power failure



Museum of Rudolf Tegner – a solid concrete building



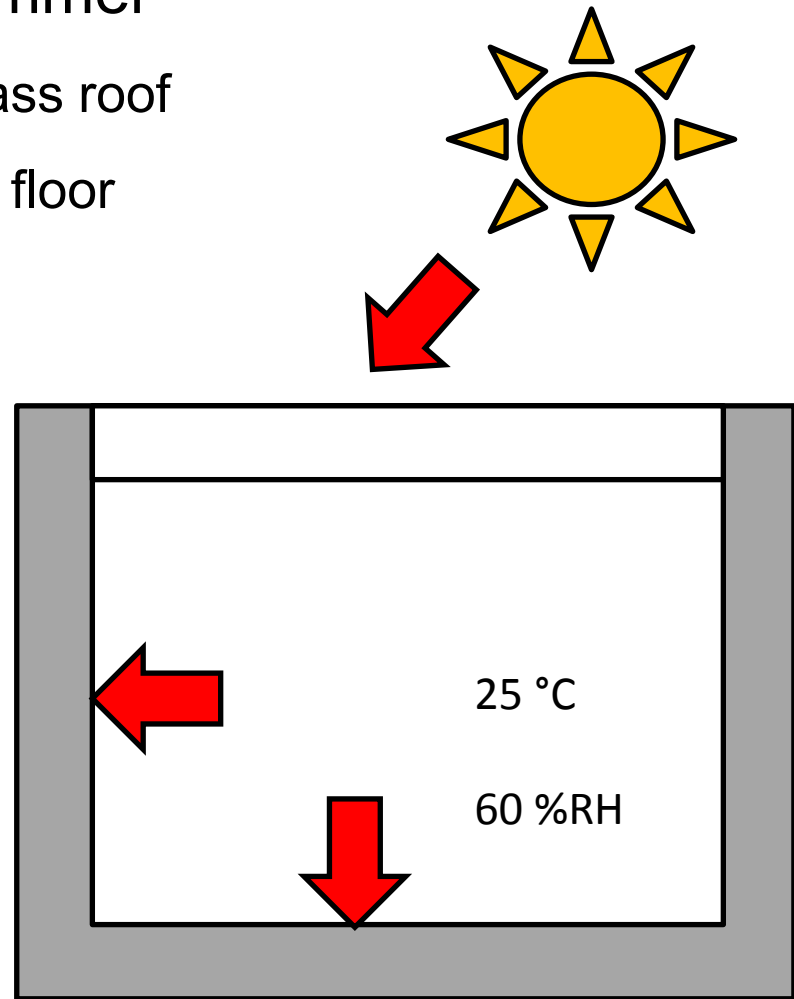
The building has no climate control and only natural light



Temperature control summer

Solar heating through the glass roof

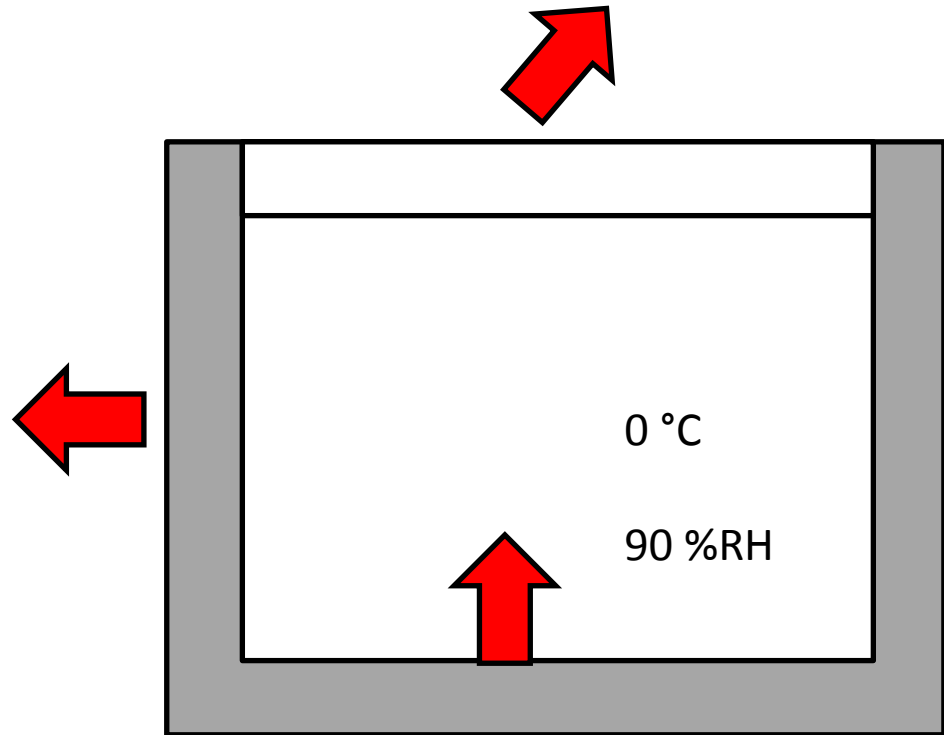
Heat absorption in walls and floor



Temperature control winter

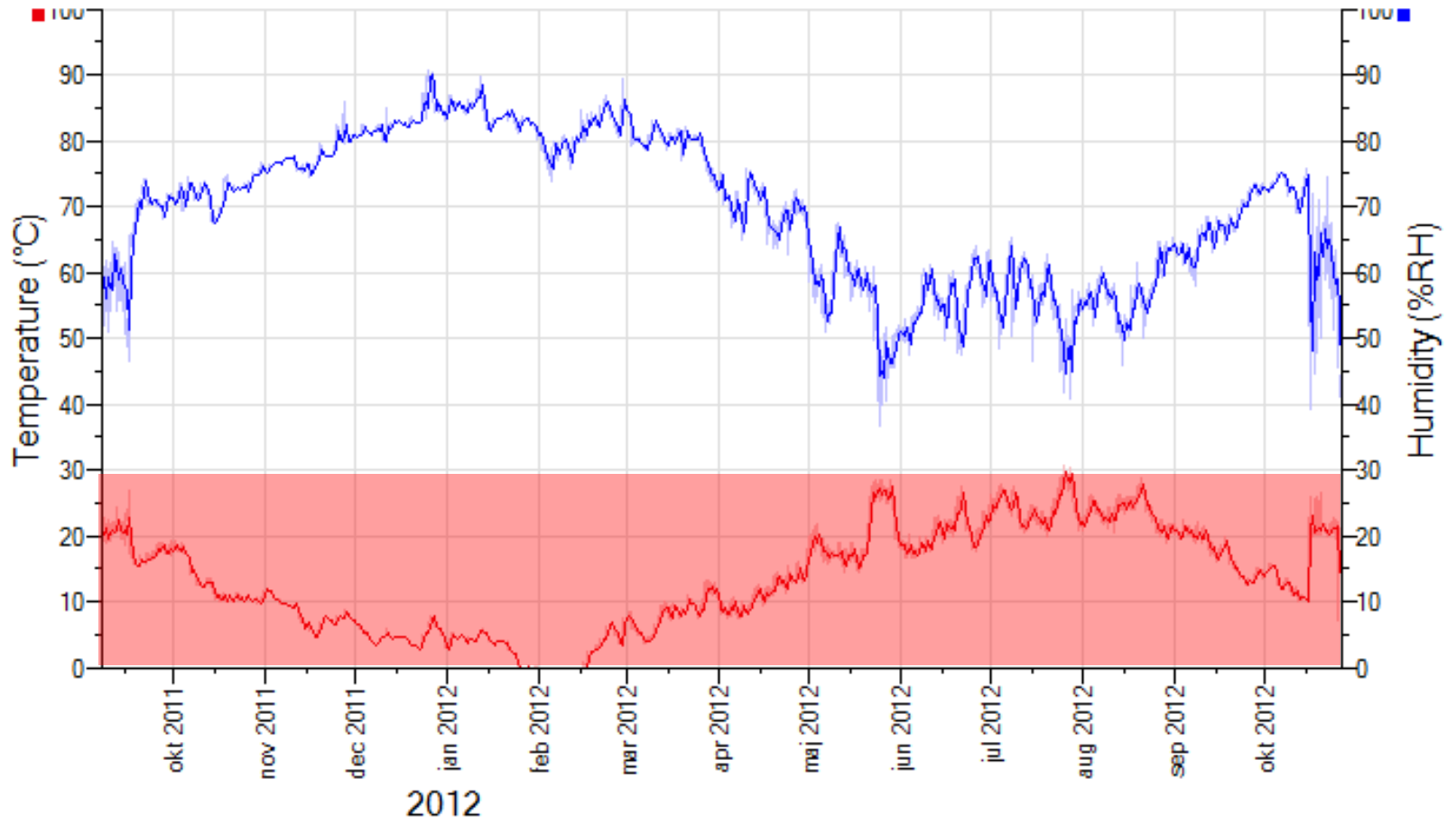
Heat loss through roof and walls

Heat gain from ground



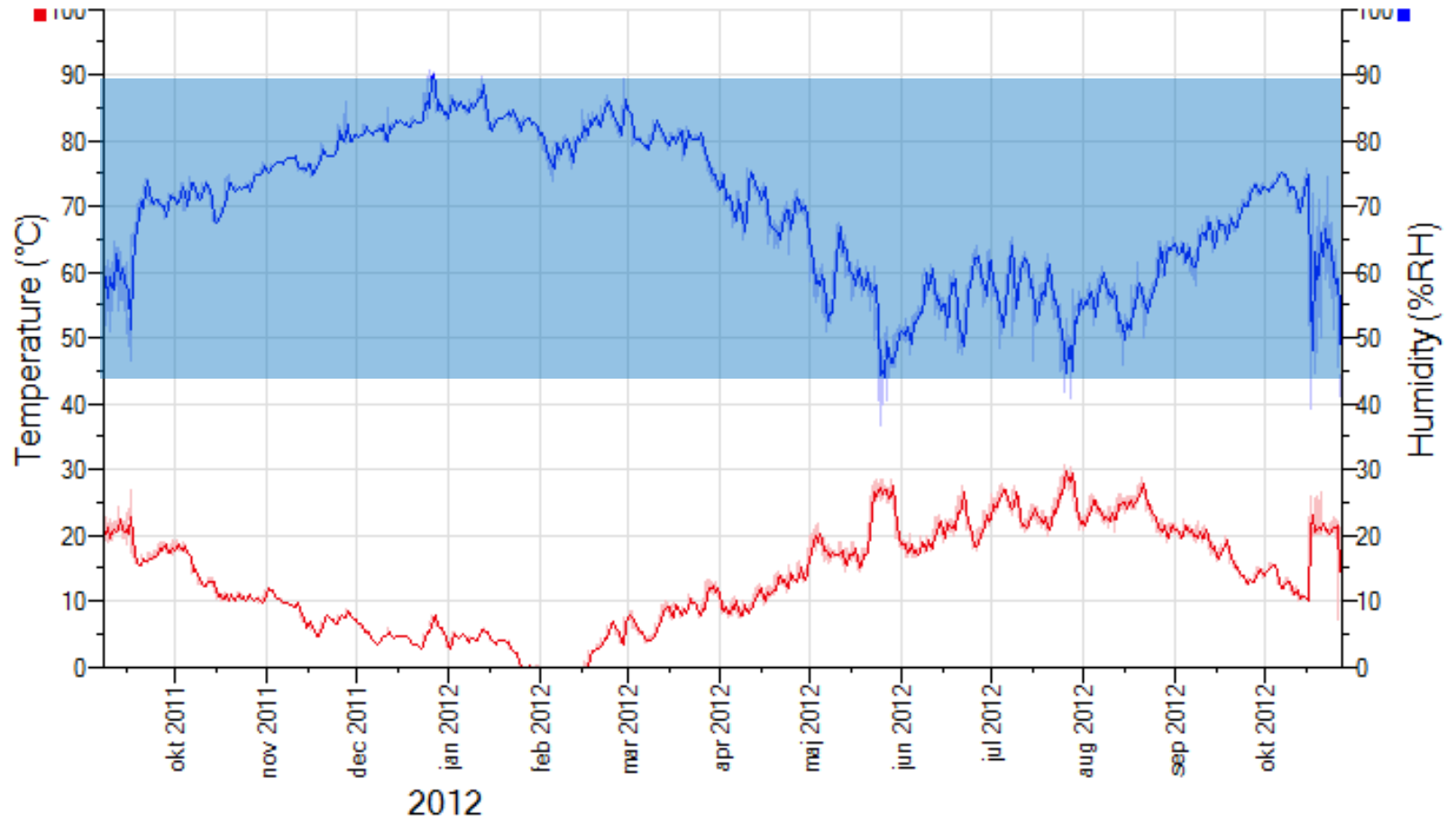
Tegners Museum

- 619070 Temperature Tegners Museum
- 619070 Humidity Tegners Museum



Tegners Museum

- 619070 Temperature Tegners Museum
- 619070 Humidity Tegners Museum



The “stone house” for a collection of minerals



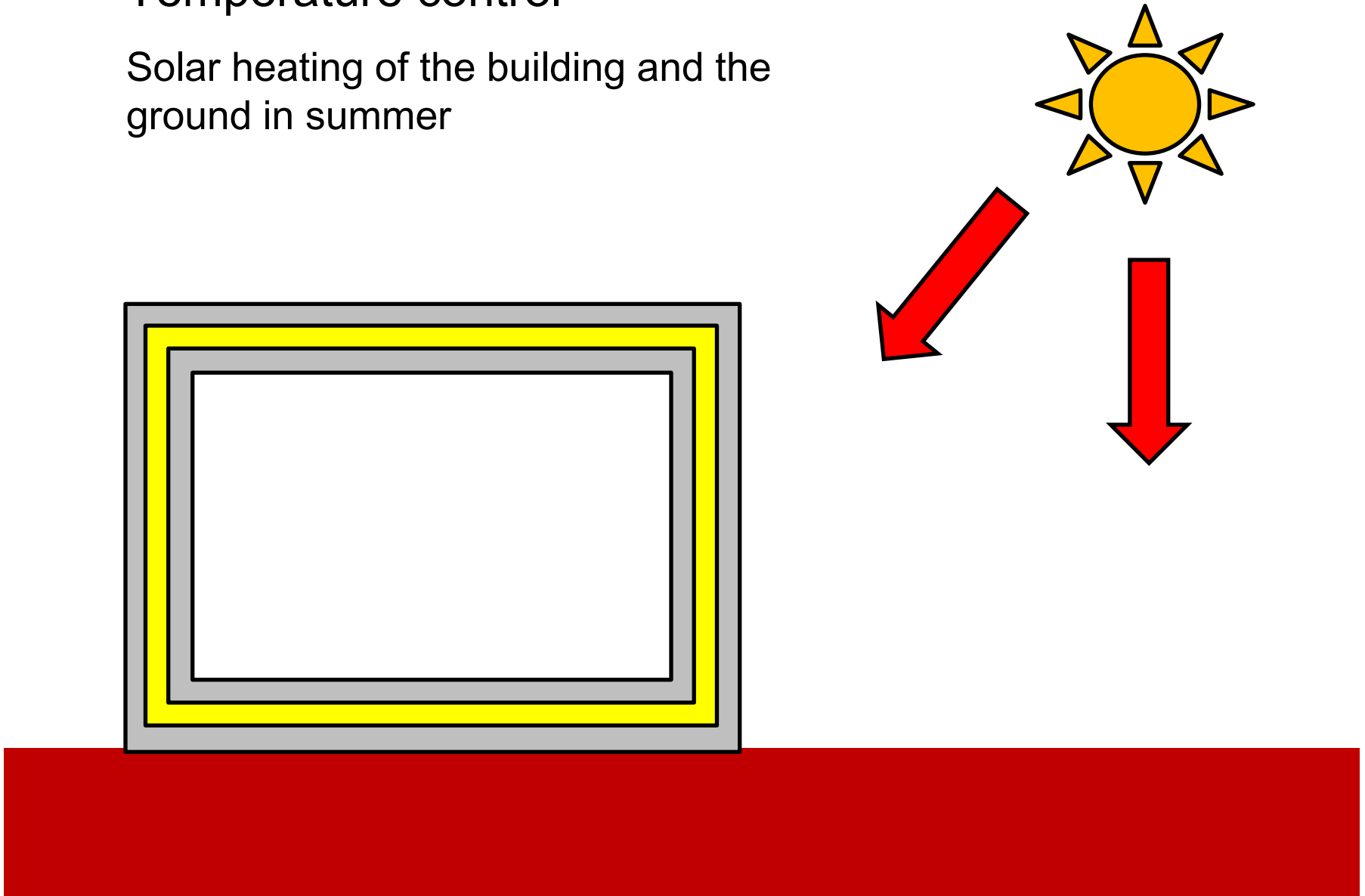
The gallery has

- a heavy structure to give thermal stability and thermal insulation to reduce heat loss
- a ground heat pump with floor heating for moderate winter heating
- tall space to reduce need for ventilation
- small windows to reduce solar heating but allow natural lighting

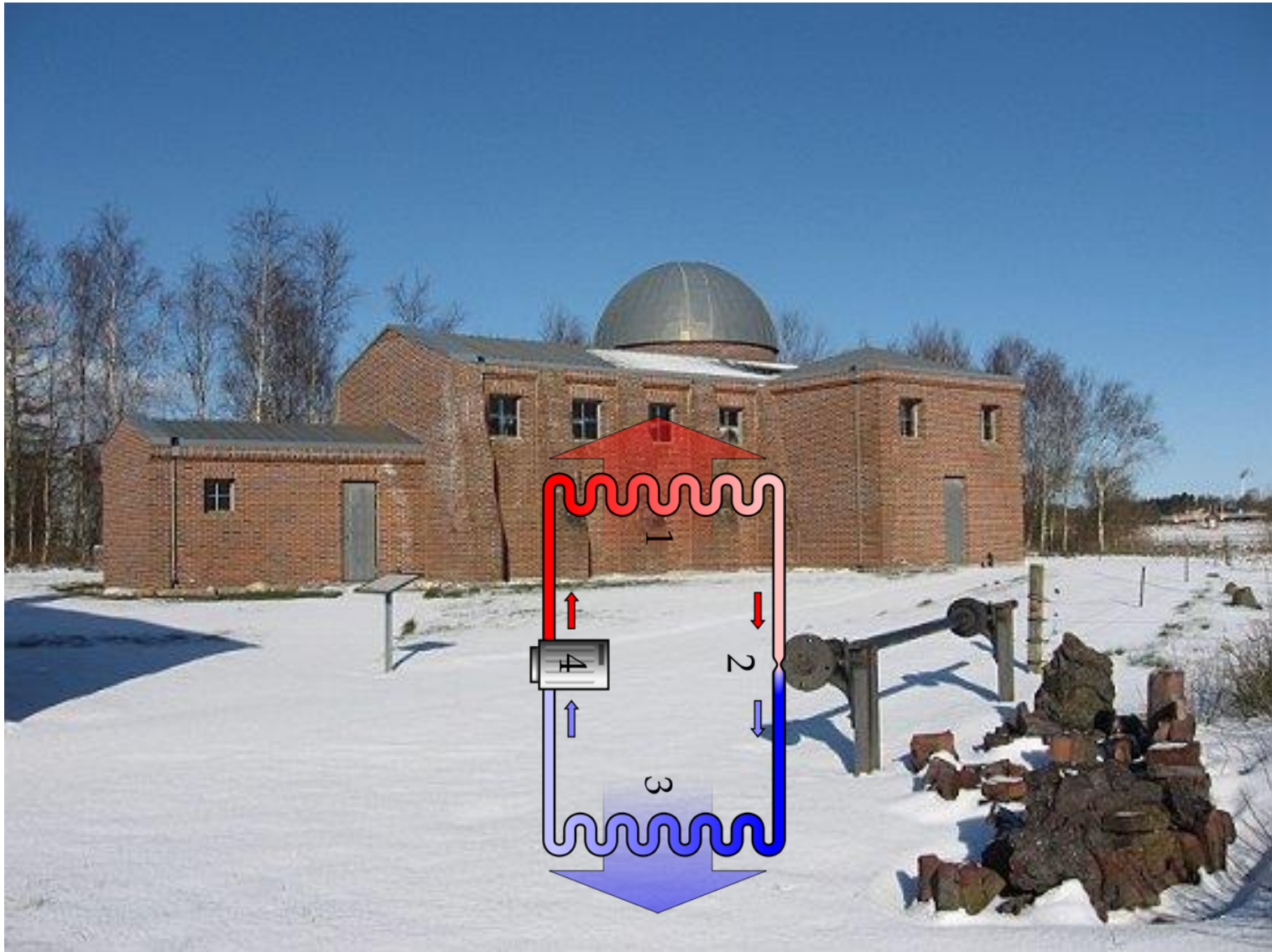


Temperature control

Solar heating of the building and the ground in summer



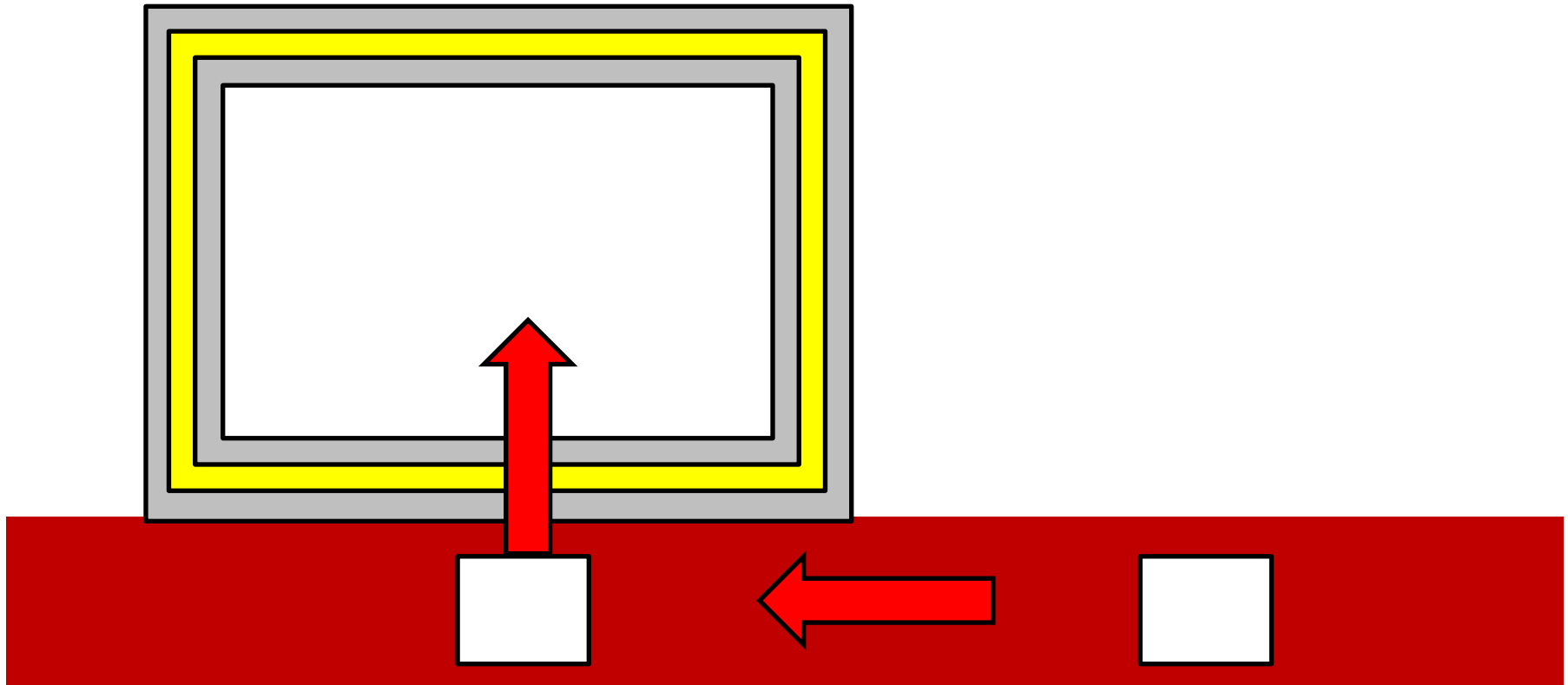
Ground heat pump with floor heating



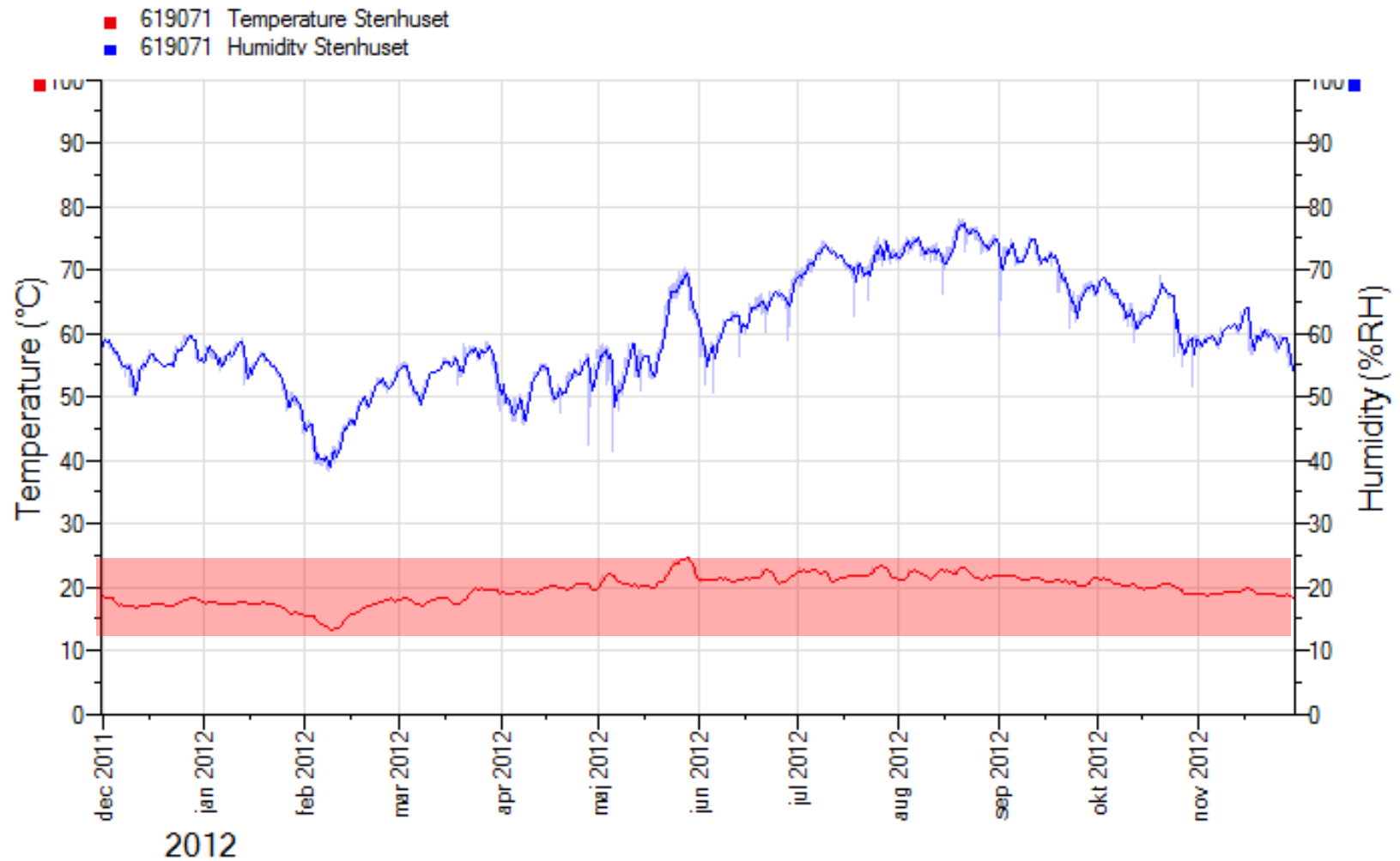
Temperature control

Floor heating with ground heat pump in winter

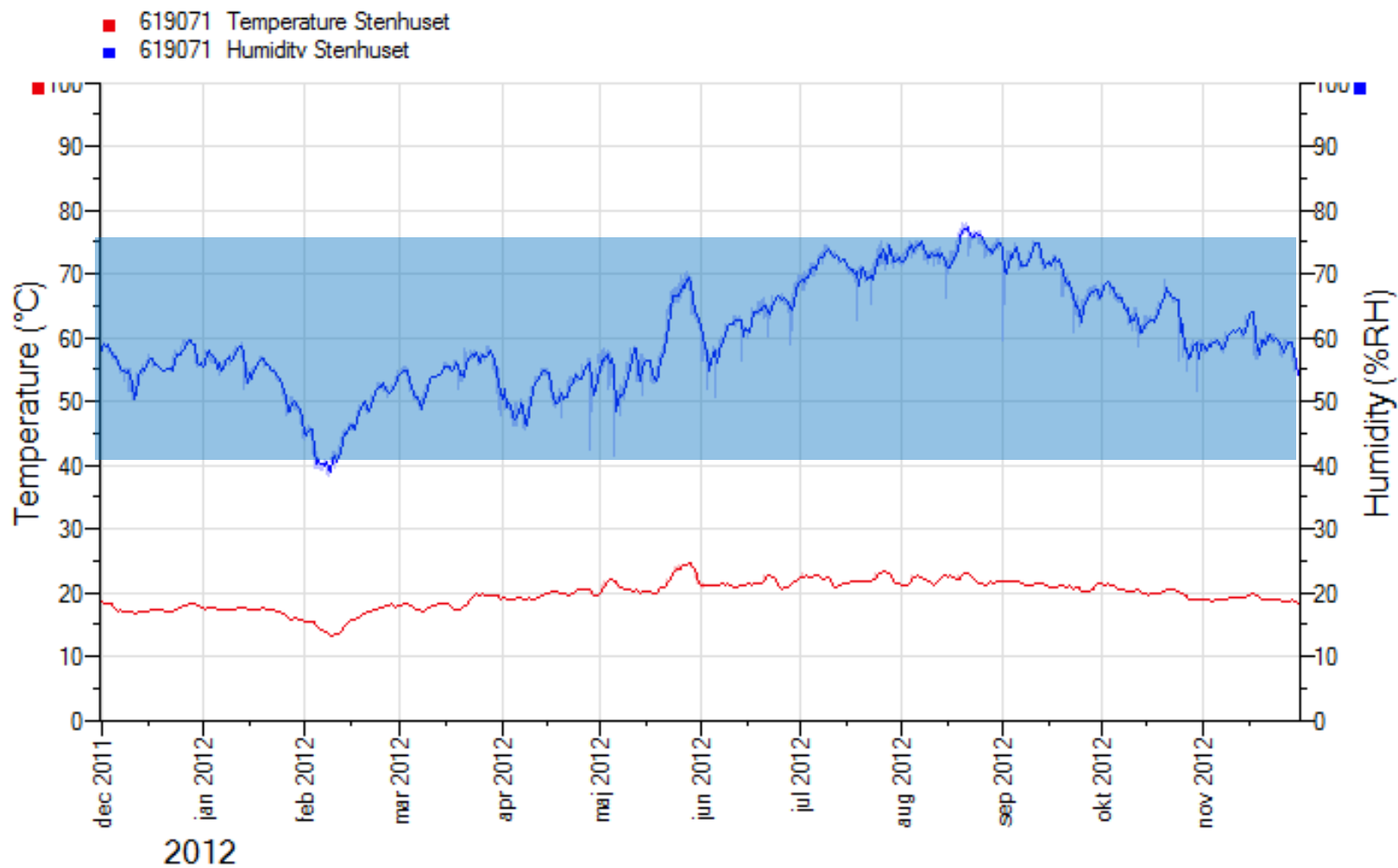
Thermal insulation to reduce heat loss



Temperature 13 – 25 °C = conservation heating



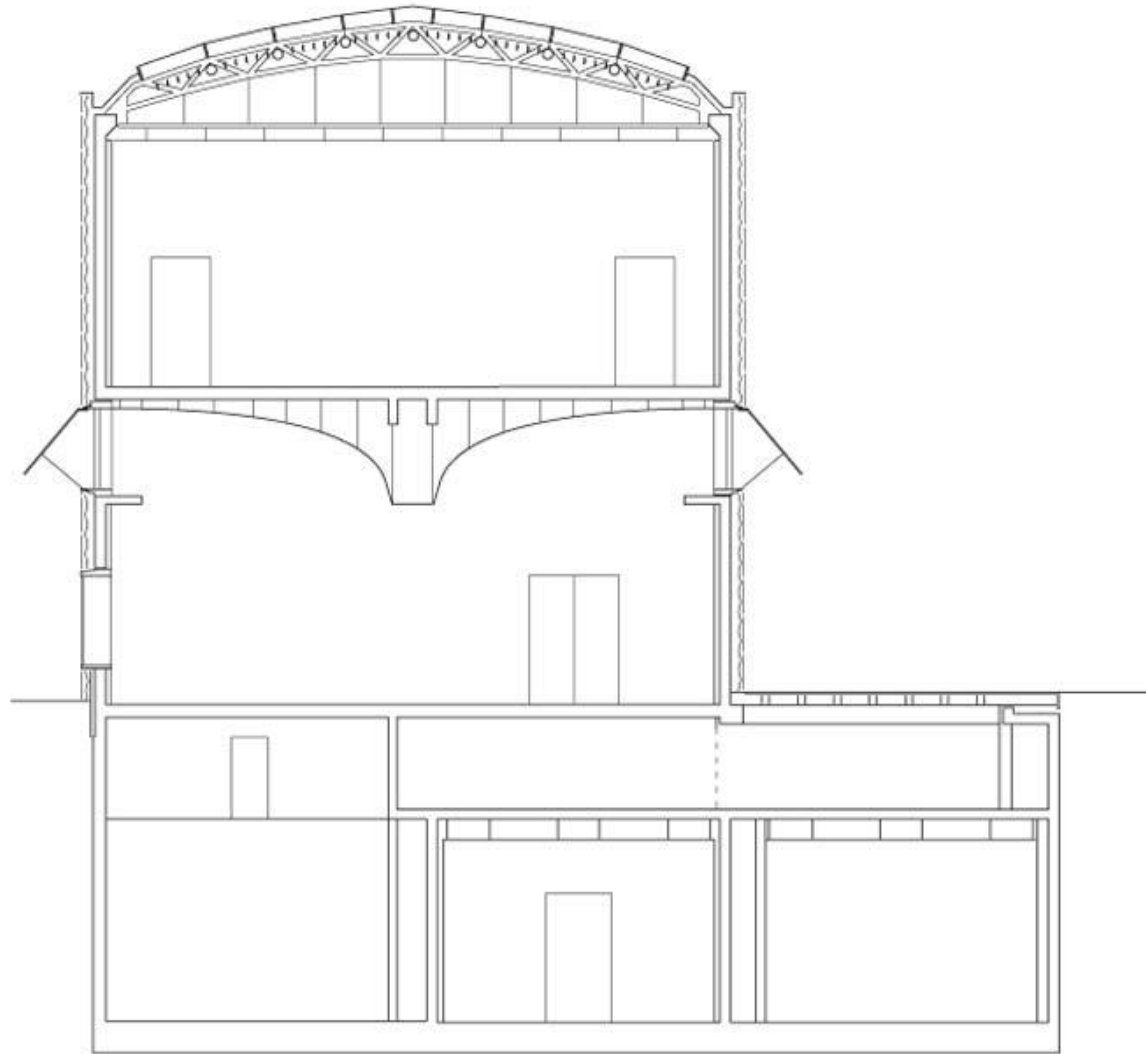
Relative humidity 40 – 75 % RH



Brandhorst Museum, München



Concrete structure with insulation and tile cladding



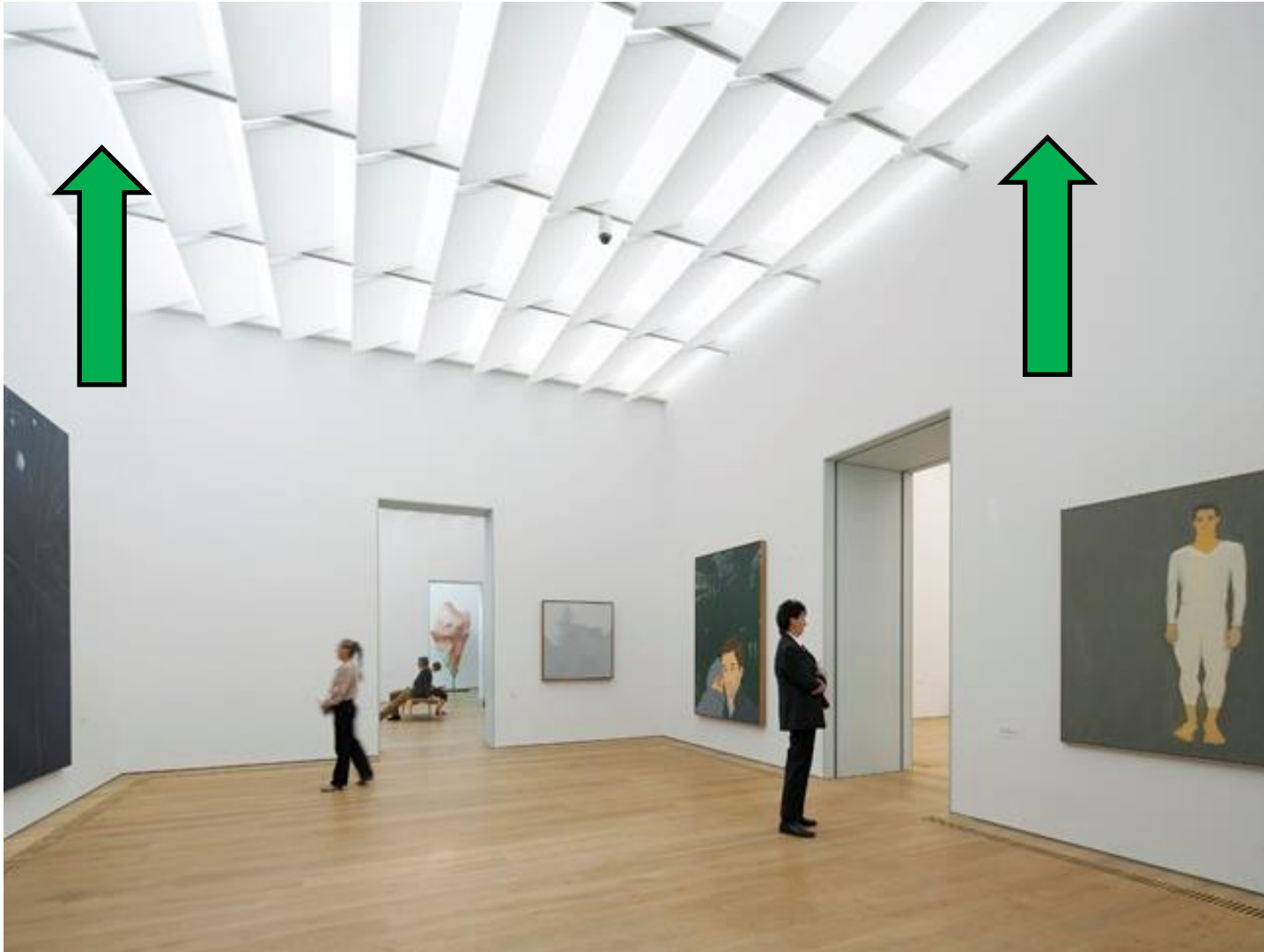
Heating (and cooling) in floor and walls



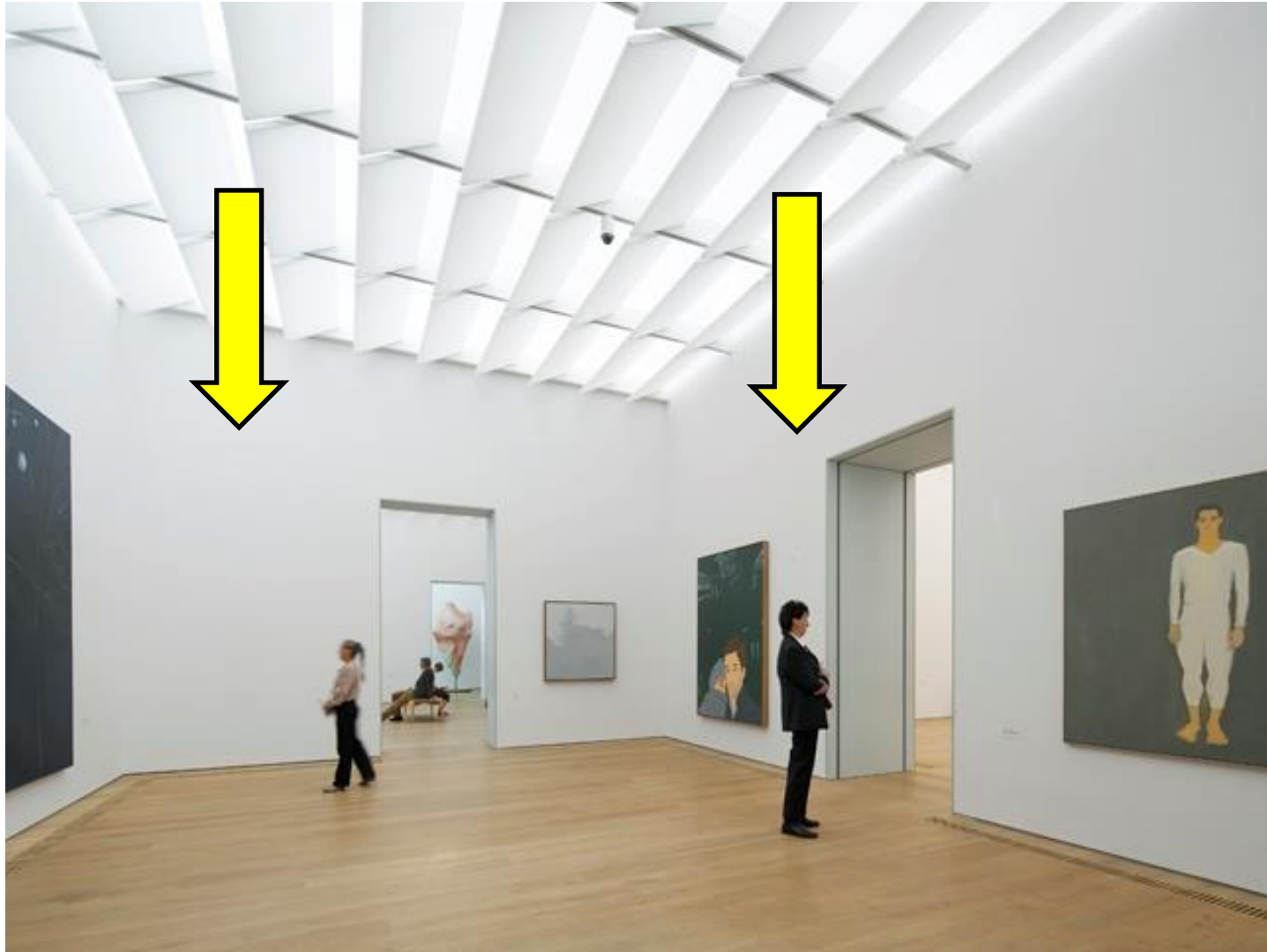
Humidity control independent of temperature



Ventilation controlled by CO2 level



Natural light through ceiling + LED



Conclusion

Heavy structure to moderate daily temperature variation imposed by people and lighting

Radiant heating (and cooling) in floor or walls.

Separate temperature control and humidity control

Reduce need for humidity control by adjusting temperature setpoint to seasonal variation

If possible use air tight display cases with humidity buffer.

Tall spaces for reduced ventilation need.

Natural lighting combined with LED