Museum Microclimates

Kopenhagen 19 – 23 november 2007

Canvas paintings on cold walls: relative humidity differences near the stretcher.

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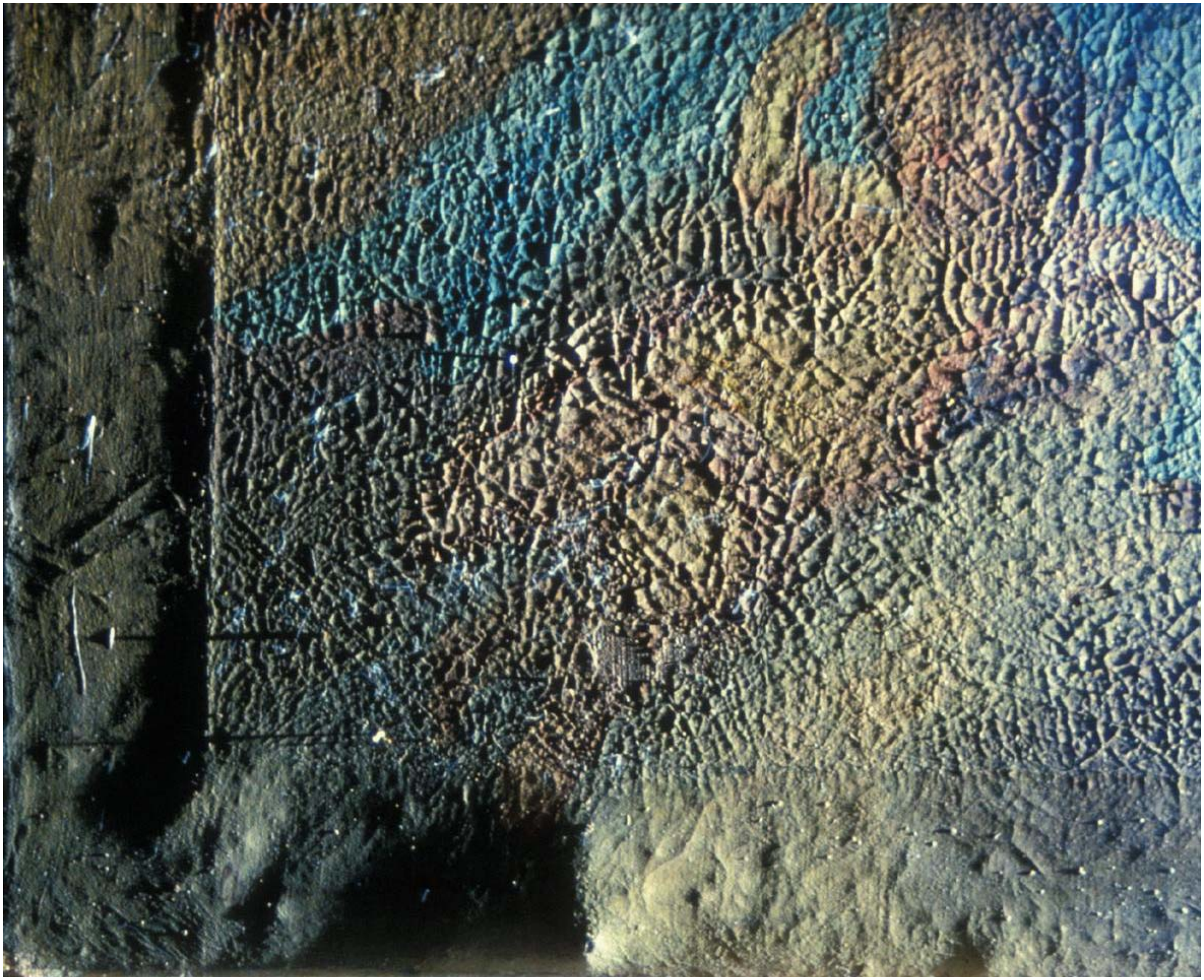

The ‘stretcher effect’ (photo: SRAL)

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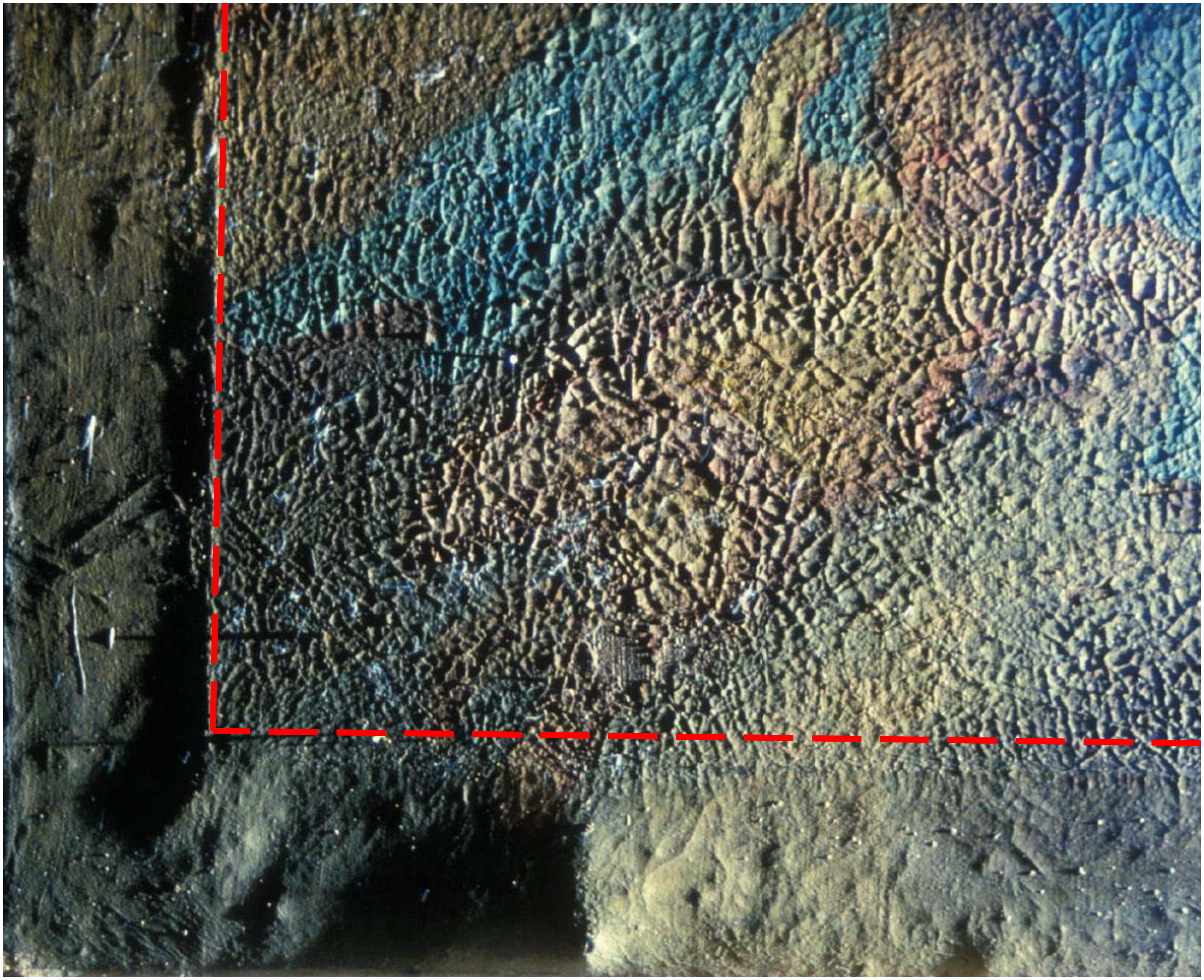
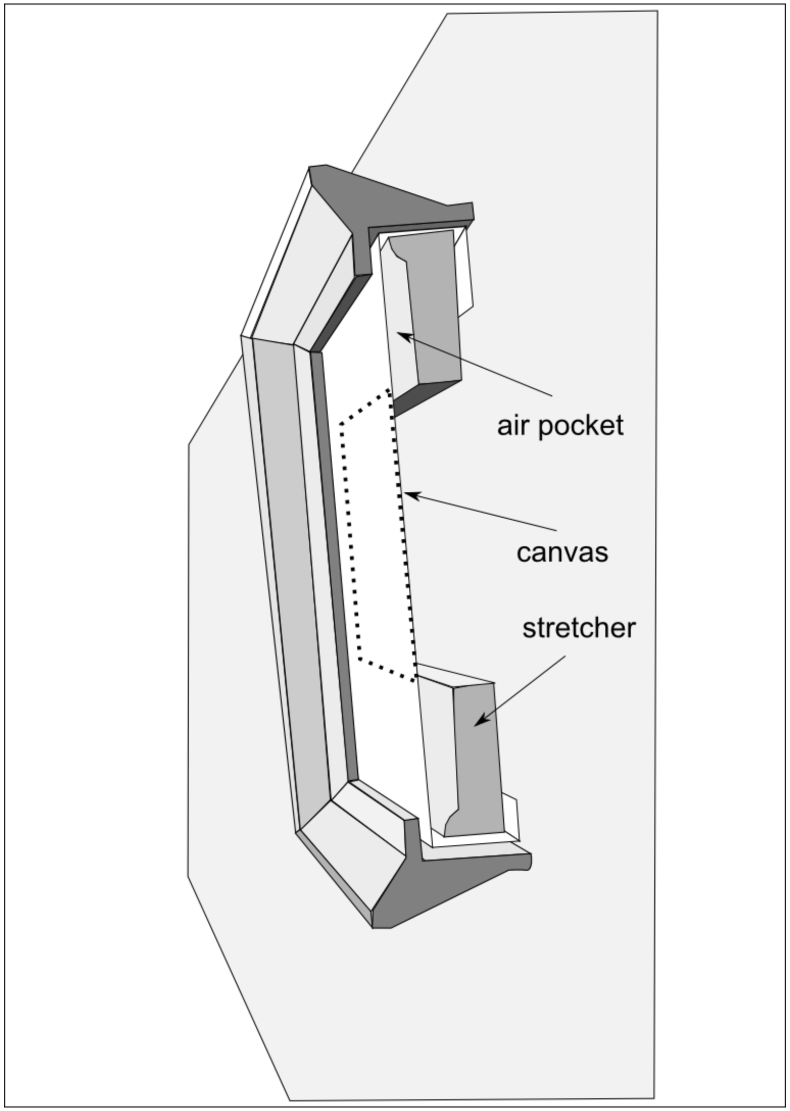


Sharp transition in the condition of the painting. Related to microclimate.

Can backing boards extend the stretcher effect on the whole canvas surface? (materials)

Understand the mechanism of formation of the stretcher effect == which microclimatic mechanism explains a SHARP difference?



Effects of wooden stretcher on microclimate:

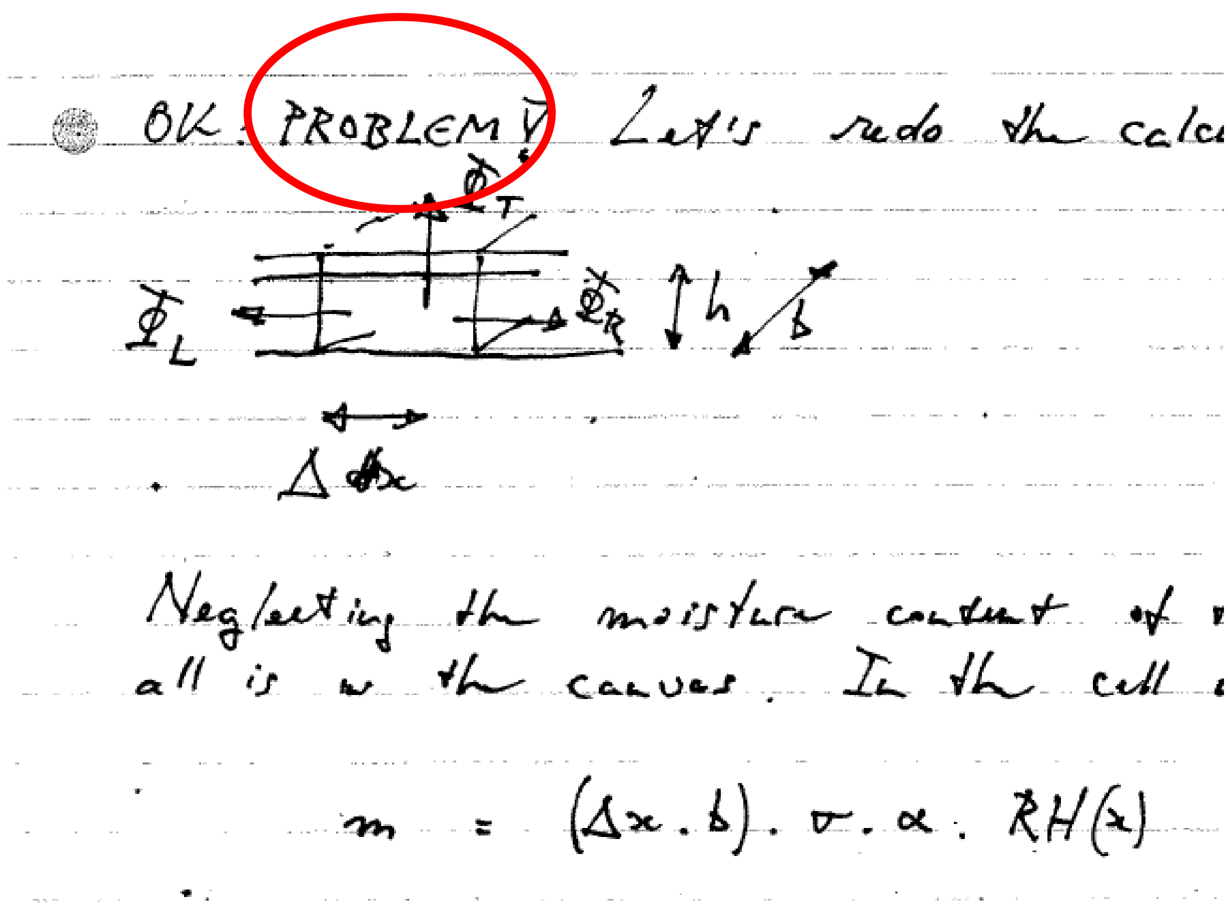
-Humidity buffering

-Thermal shielding

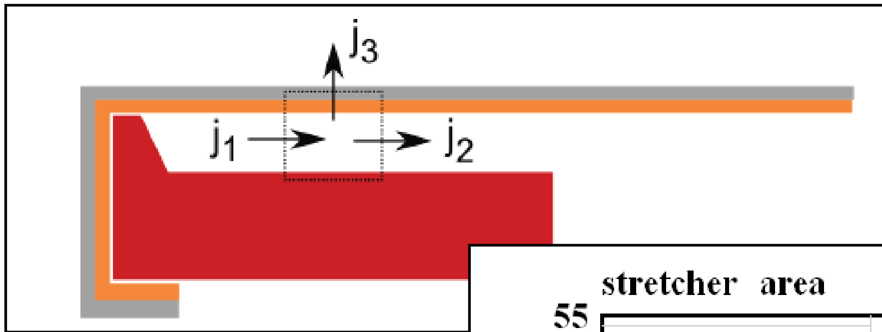
Humidity buffering

Wood releases moisture and counteracts RH fluctuations.

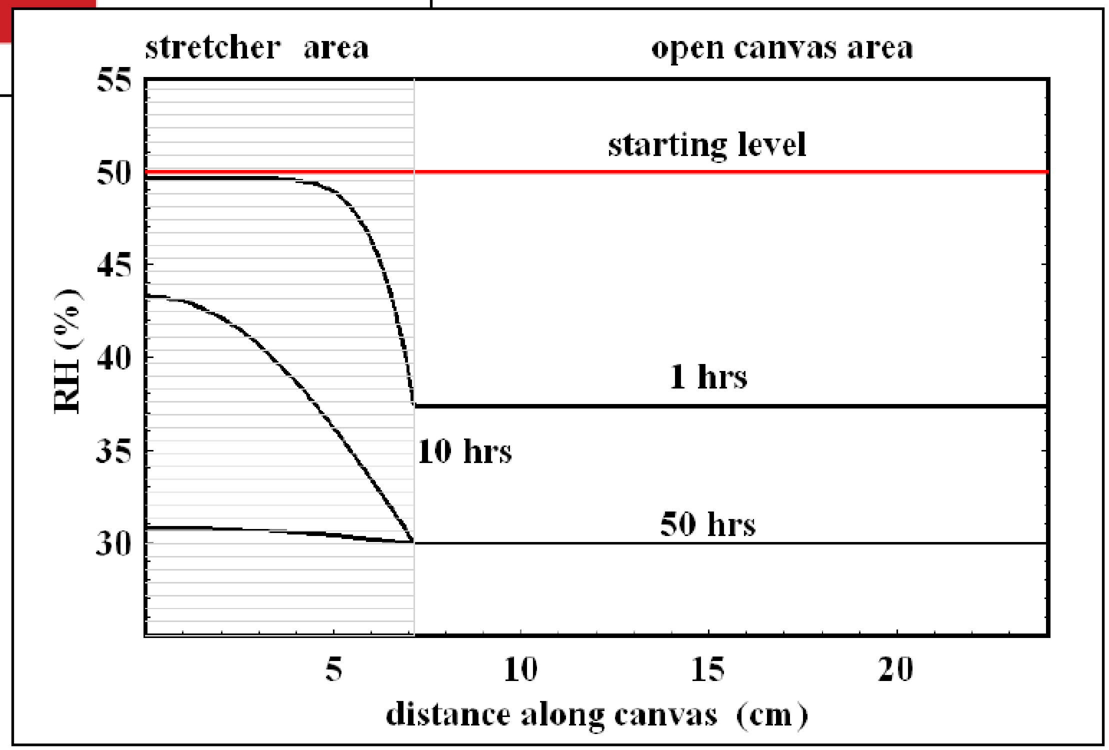
Does this produce a SHARP difference of RH => a sharp difference of moisture content in canvas?



Humidity buffering

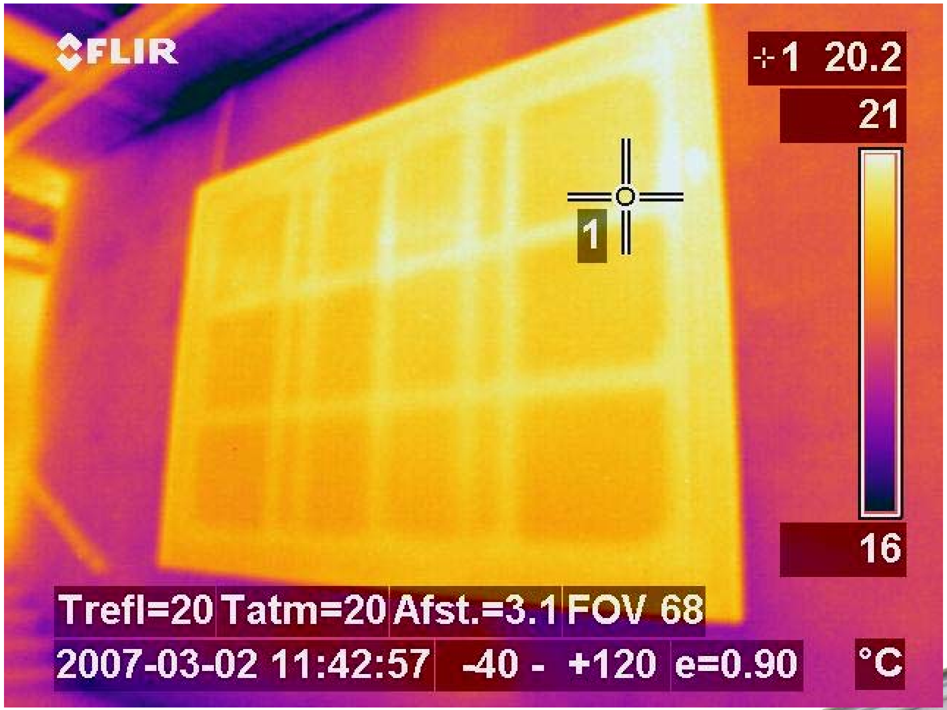


- painting hanging away from the wall.
- RH in room from 50% to 30%



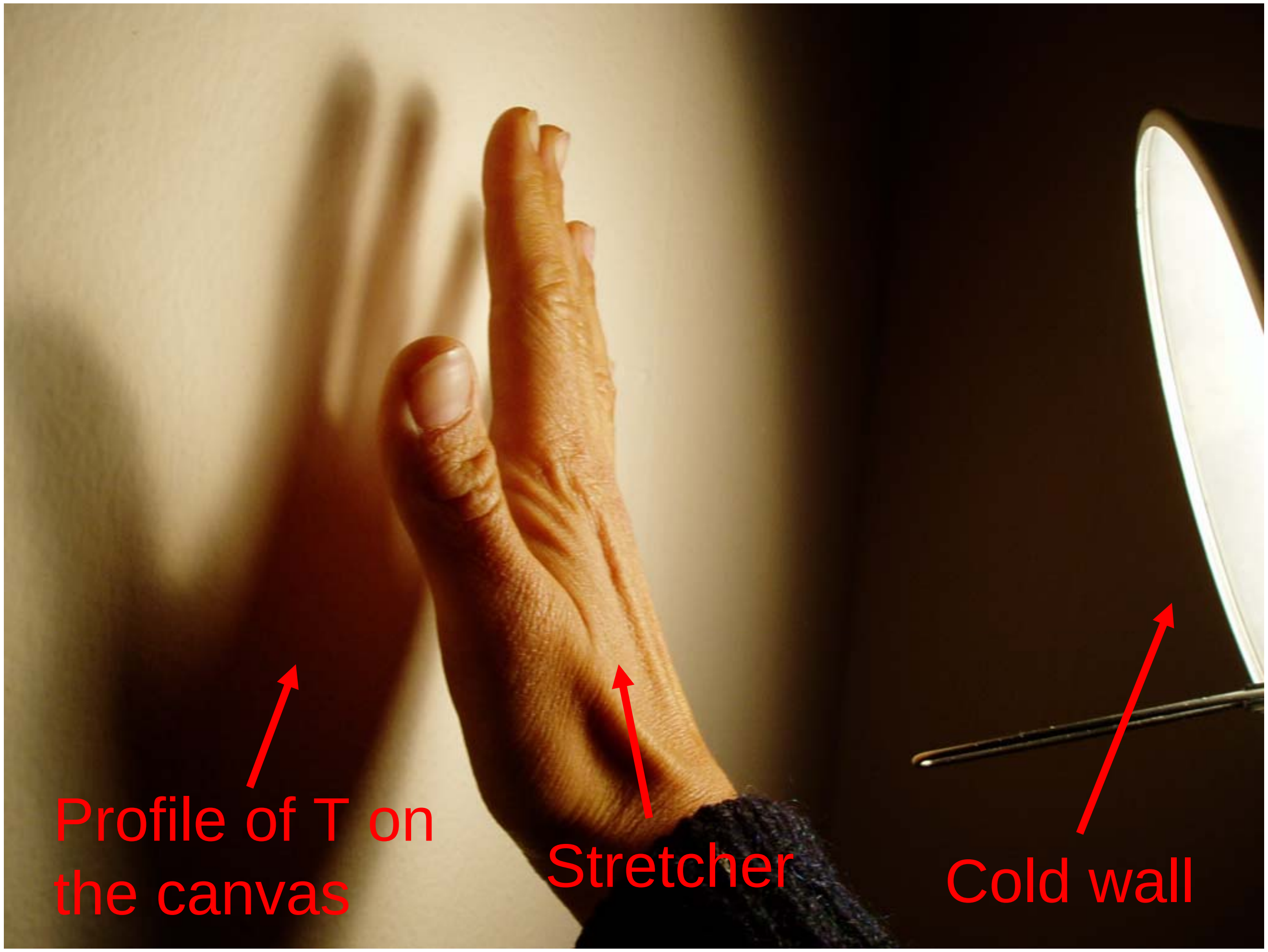
The profile of RH is smooth and short-lived =>
humidity buffering mechanism can not explain the stretcher effect

Thermal shielding



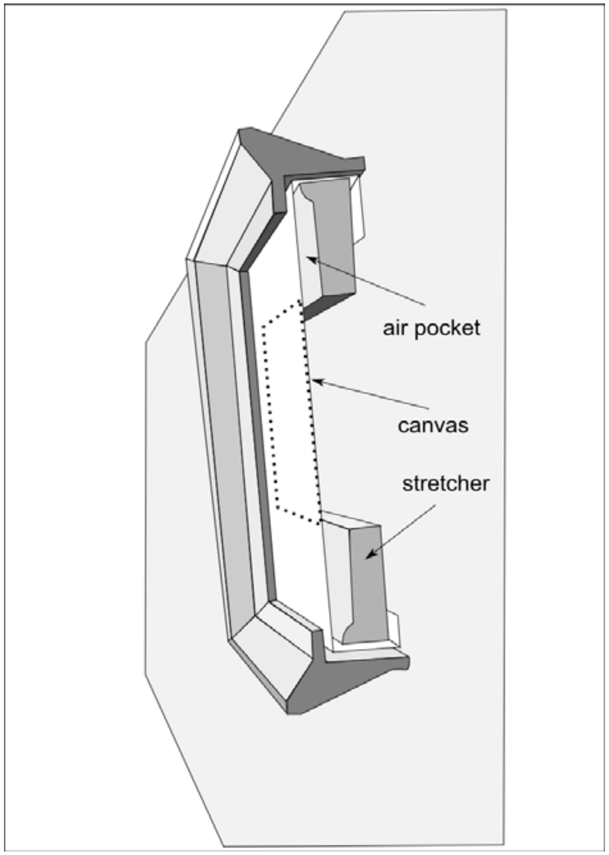
Distribution of temperature on a painting hanging against the wall

Thermal shielding = shadow



Profile of T on canvas => profile of RH (csat depends on T) => profile of moisture content

Model to calculate the thermally induced RH difference along the canvas

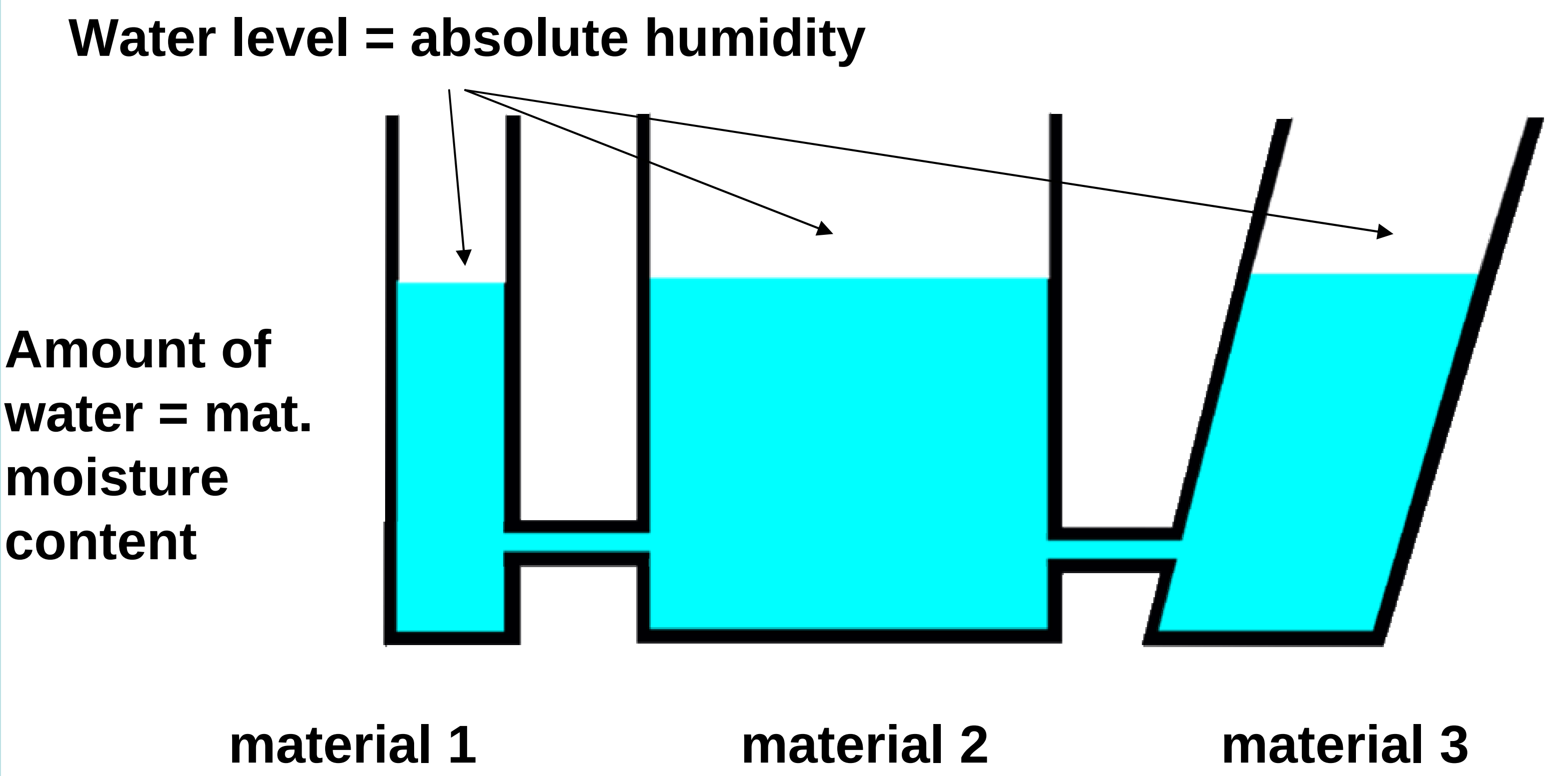


Simplifying assumptions:

- Closed system painting - stretcher - wall (total moisture is constant)
- Absorbent materials (sections) with constant T
- Absolute humidity homogeneous in open volume

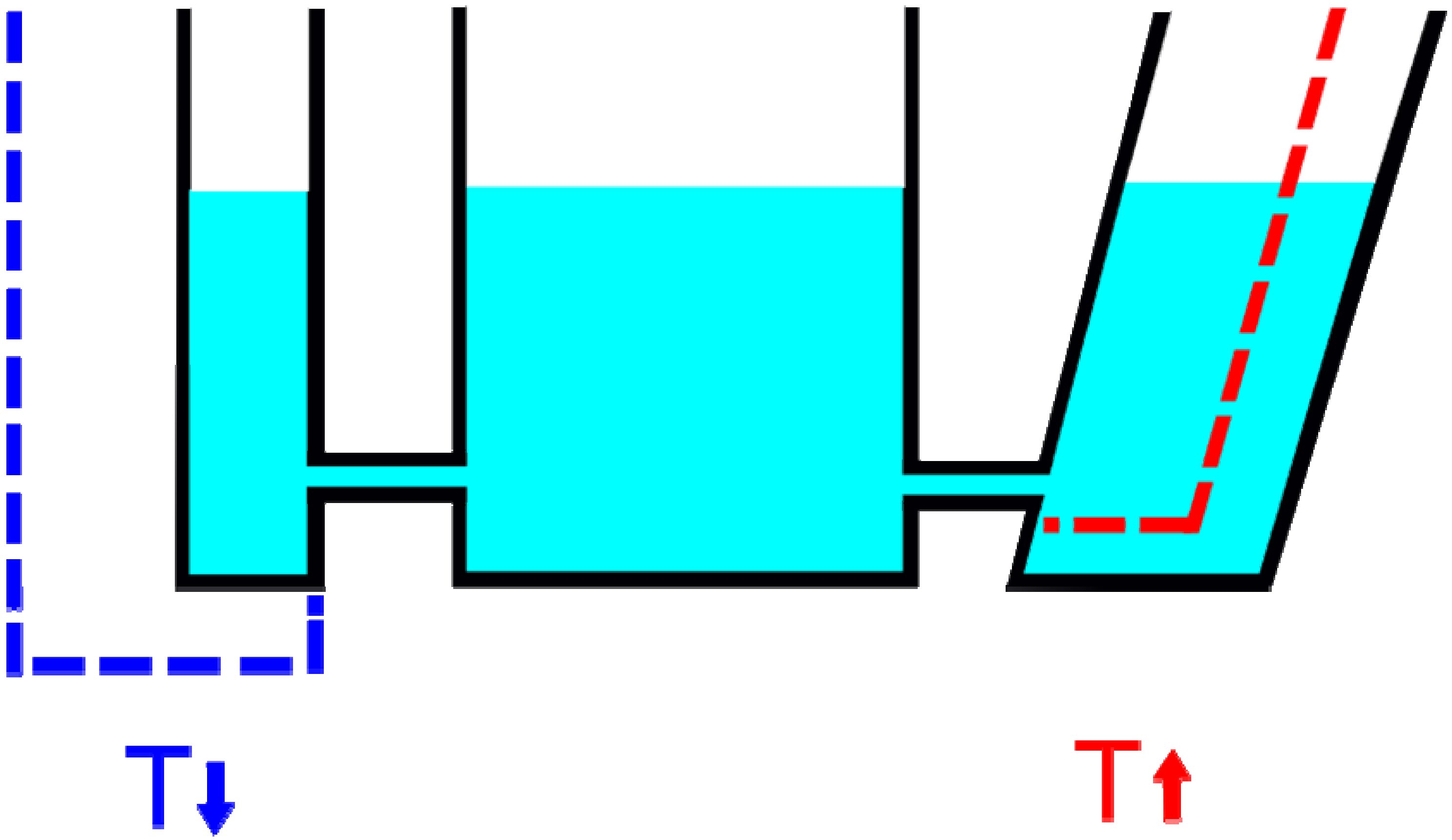
How does the moisture distribute among the absorbent materials in the system if there is a temperature difference? Analogy: communicating vessels

Step 0: materials at same temperature



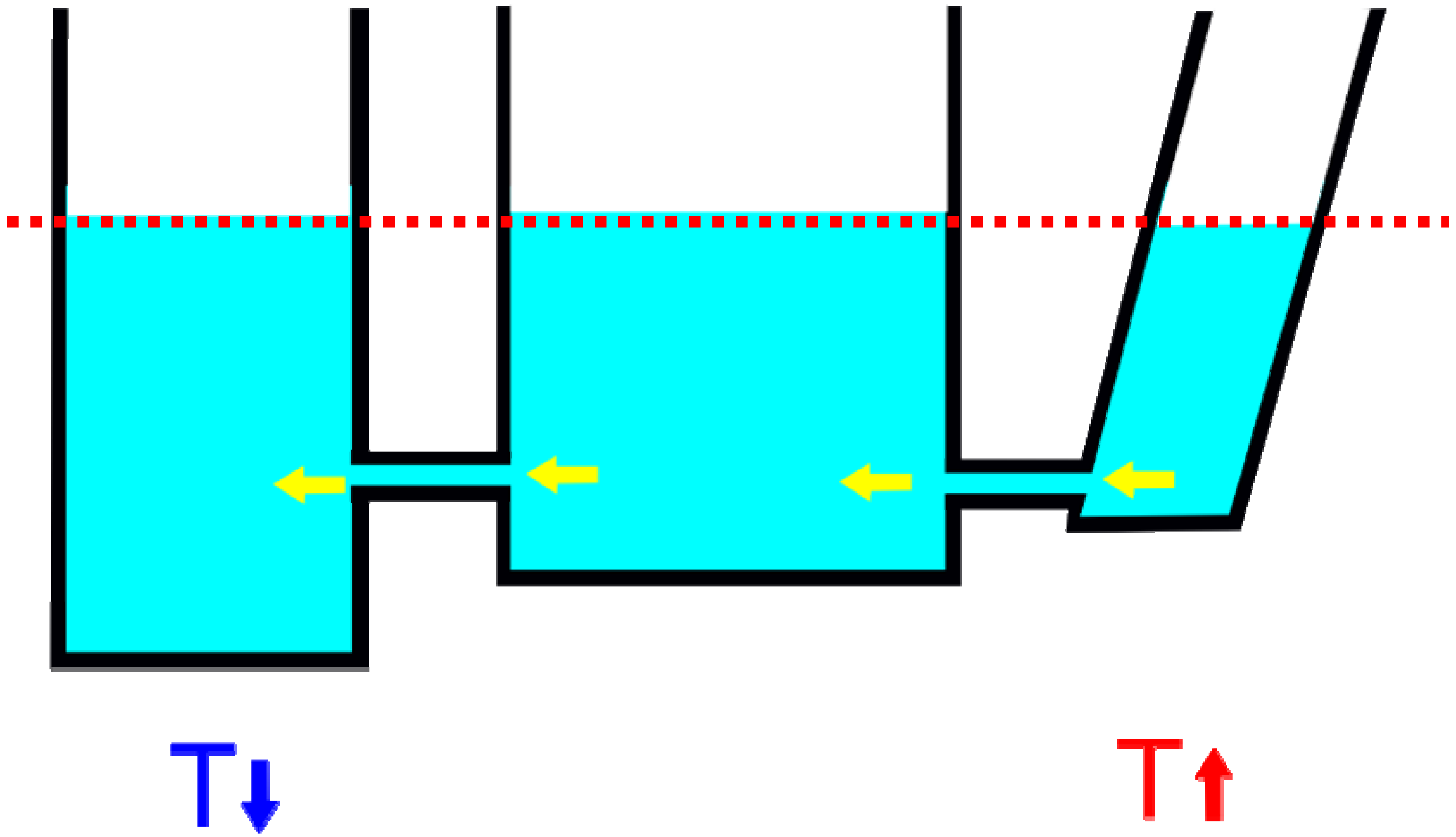
Step 1: material 1 is cooled, material 2 is heated

Water level = absolute humidity   Amount of water = mat. moisture content



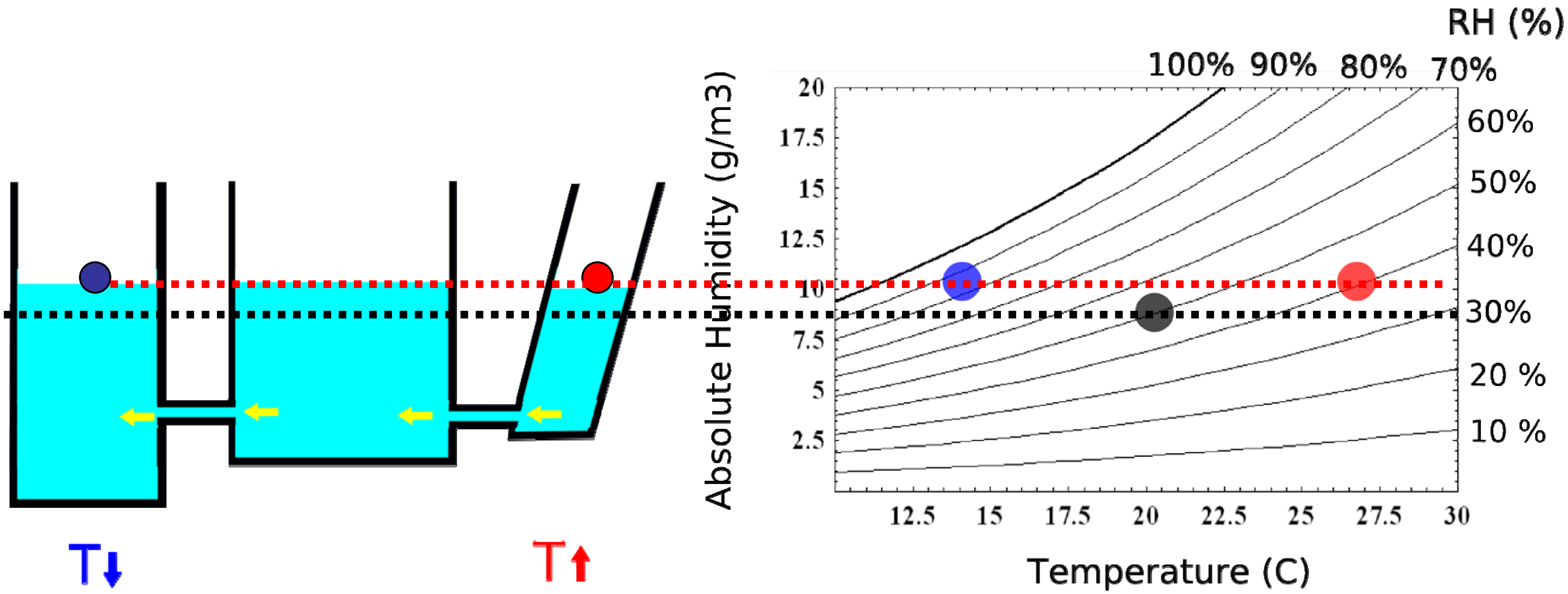
- Cold materials attract moisture and increase their moisture content
- Warm materials give off moisture and decrease their moisture content

Water level = absolute humidity Amount of water = mat. moisture content



- Moisture flows from warm to cold materials.

- A new global level of absolute humidity is reached



New level of absolute humidity + local different temperatures ➡

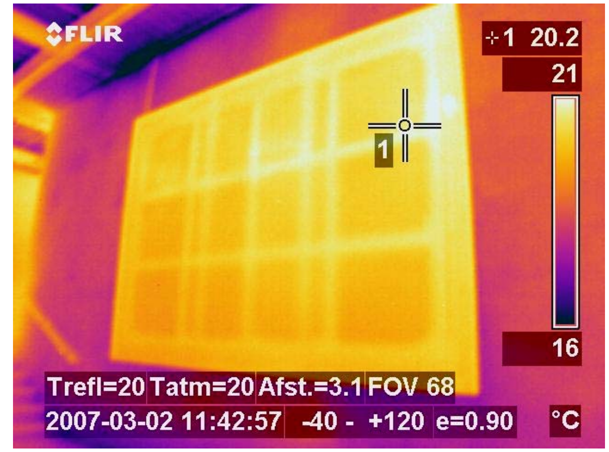
Local different relative humidities

NB: if not absorbent materials=> absolute humidity constant

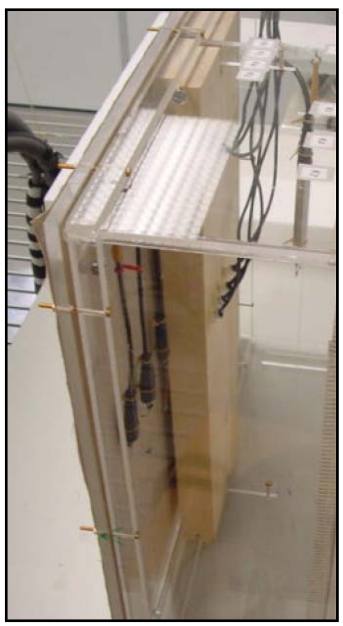
Temperature distribution in the system → Model → RH profile

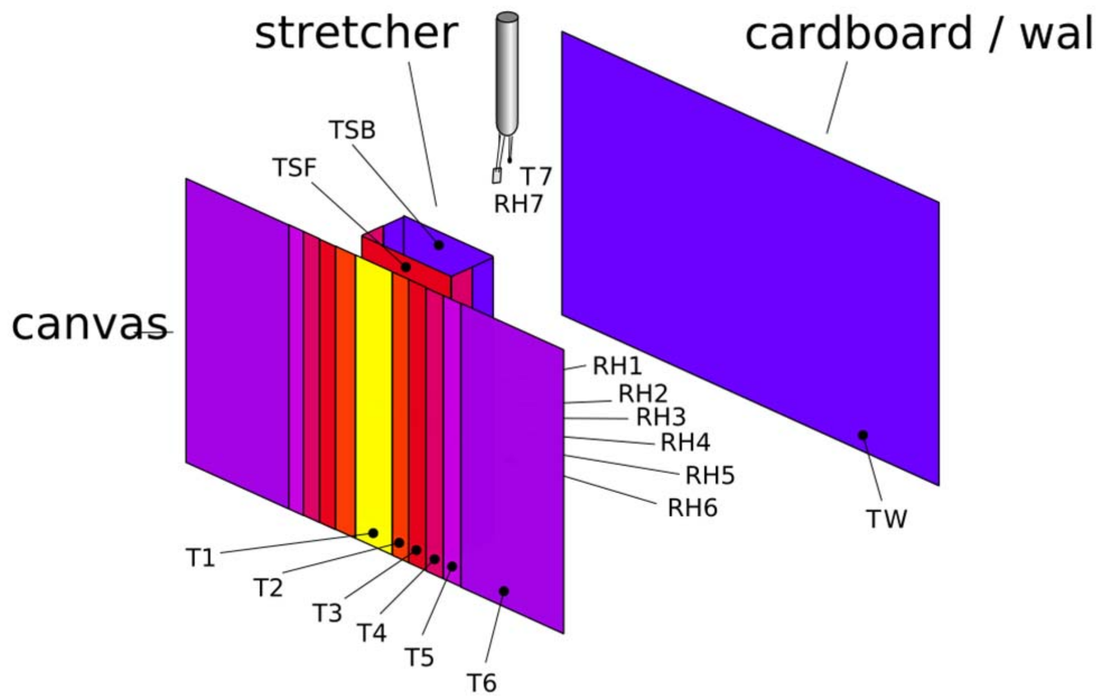
Experiments

Real system:



Symplified system:





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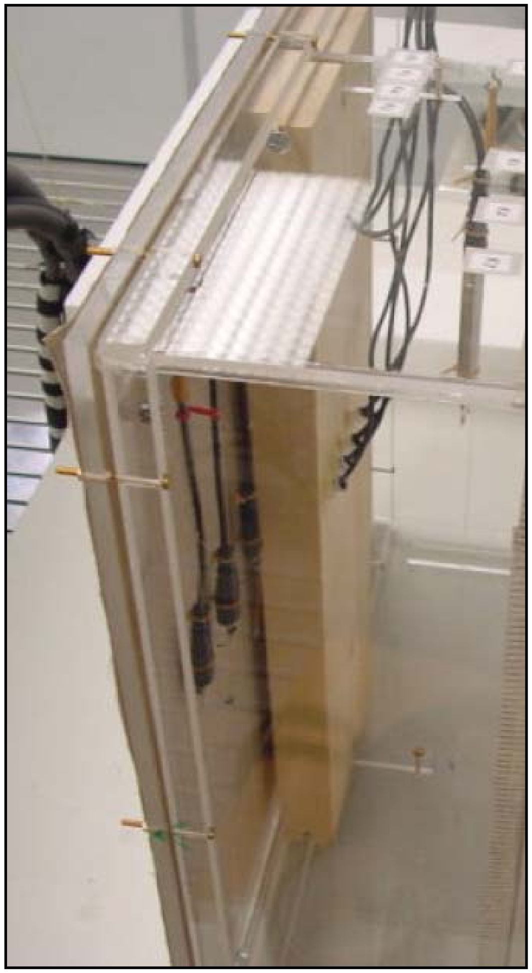
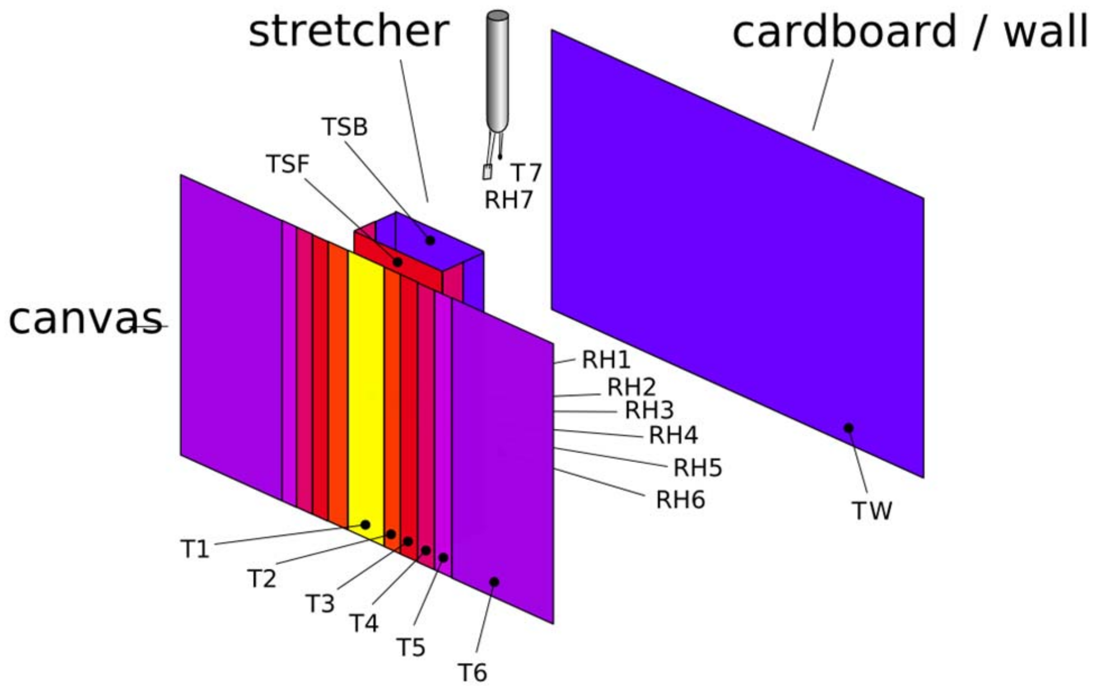
Symplified system:





- Mock-up painting with central wooden stretcher bar, canvas, acrylic frame, hanging to a gypsum wall (T control) placed in a climatic room.
- Absorbent materials: canvas (6 different T), stretcher bar (2T), wall.
- Measurement: surface T (canvas, stretcher bar, wall), air RH (canvas, stretcher wall).

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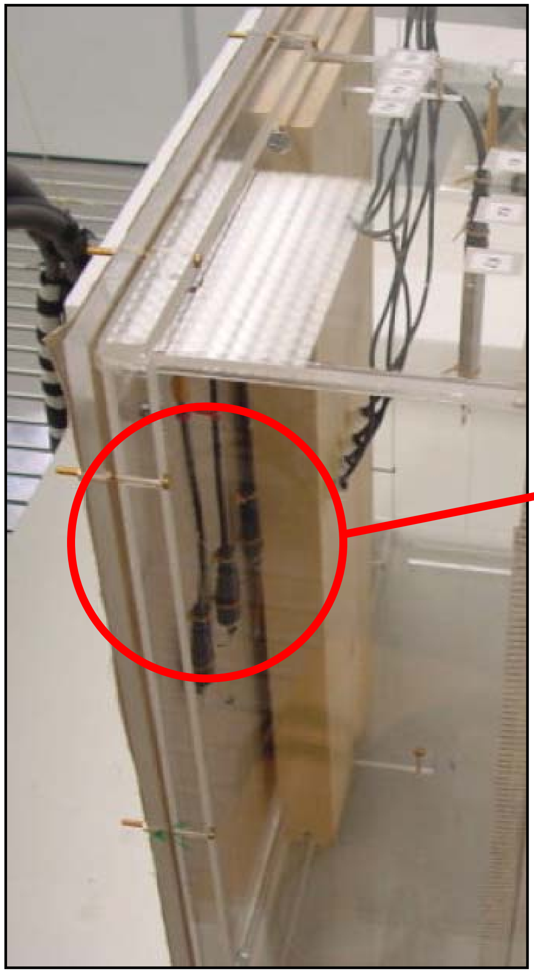


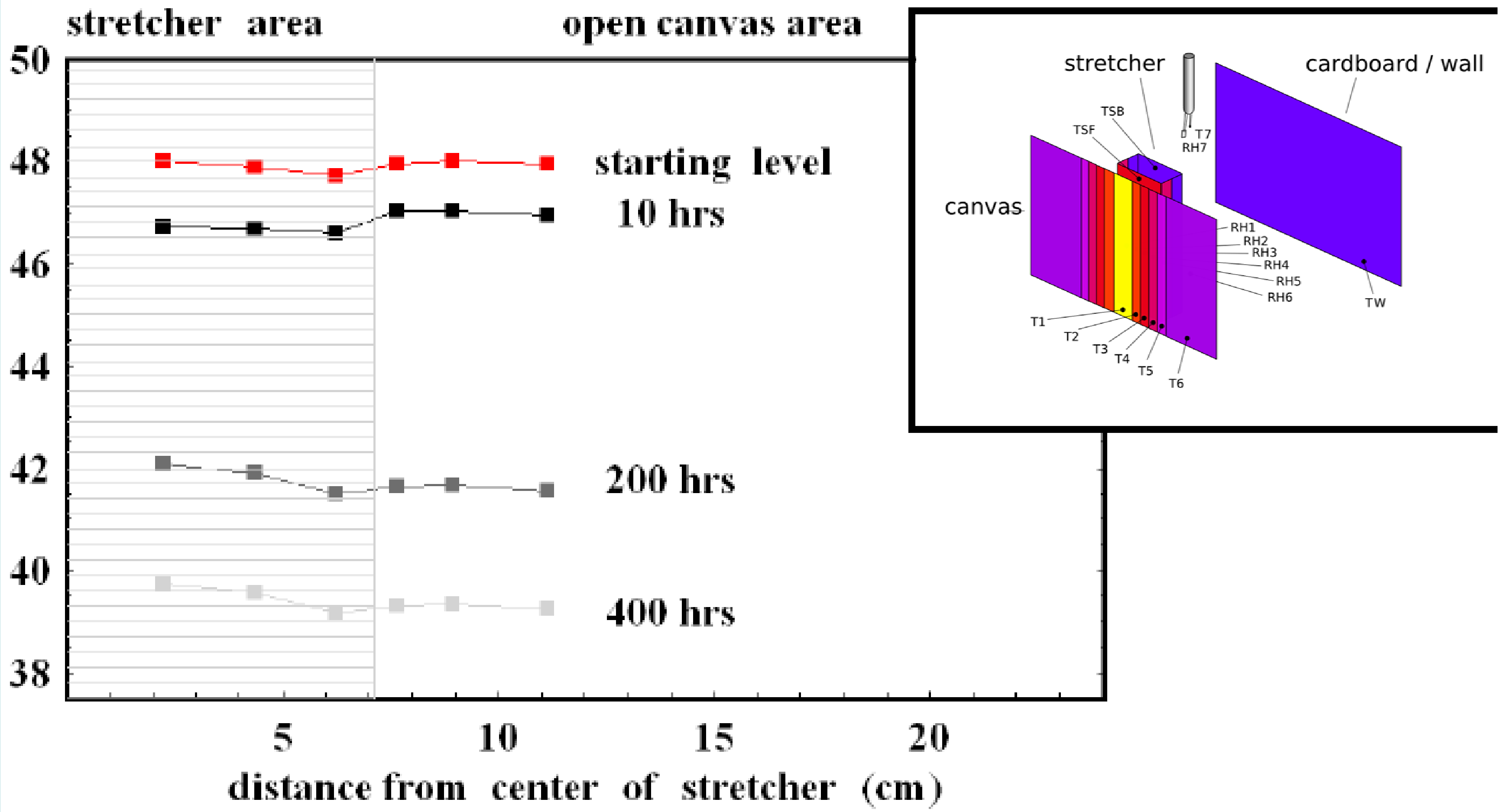
Measurement of RH and T along the canvas with sensor array

Experiments

- Dry room
  - T constant, RH in room from 50% to 30%
- Cold wall
  - RH in room constant
  - T wall from 20 C to 14 C
  - Inert materials (covered with foil)
  - Absorbent materials

Results ‘dry room’ experiment

T constant, RH in room from 50% to 30%

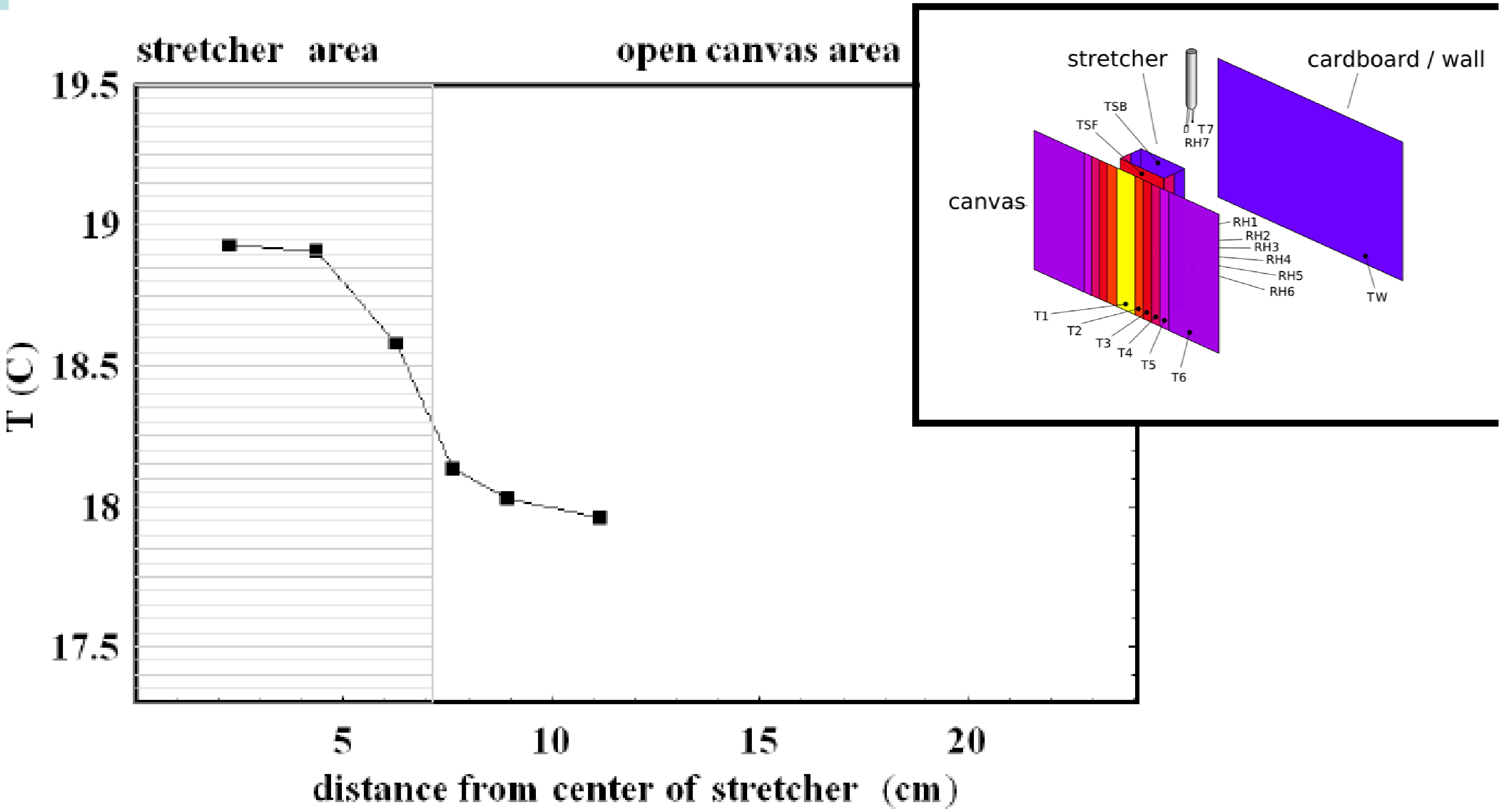


Flat RH profiles

Results ‘cold wall’ experiment

RH in room constant, T wall from 20 C to 14 C

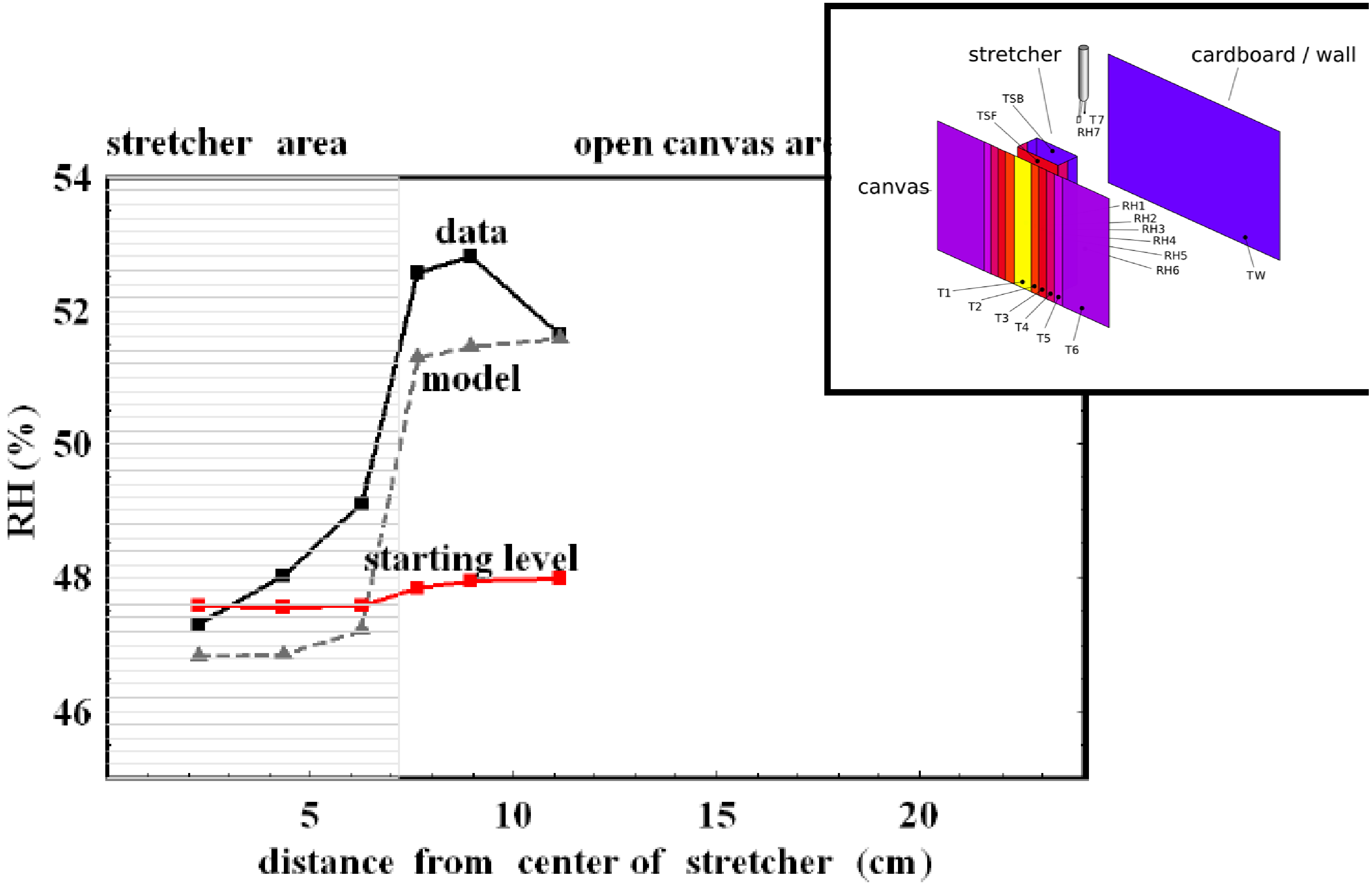
Temperature profile along canvas



Results ‘cold wall’ experiment, inert materials

RH in room constant, T wall from 20 C to 14 C

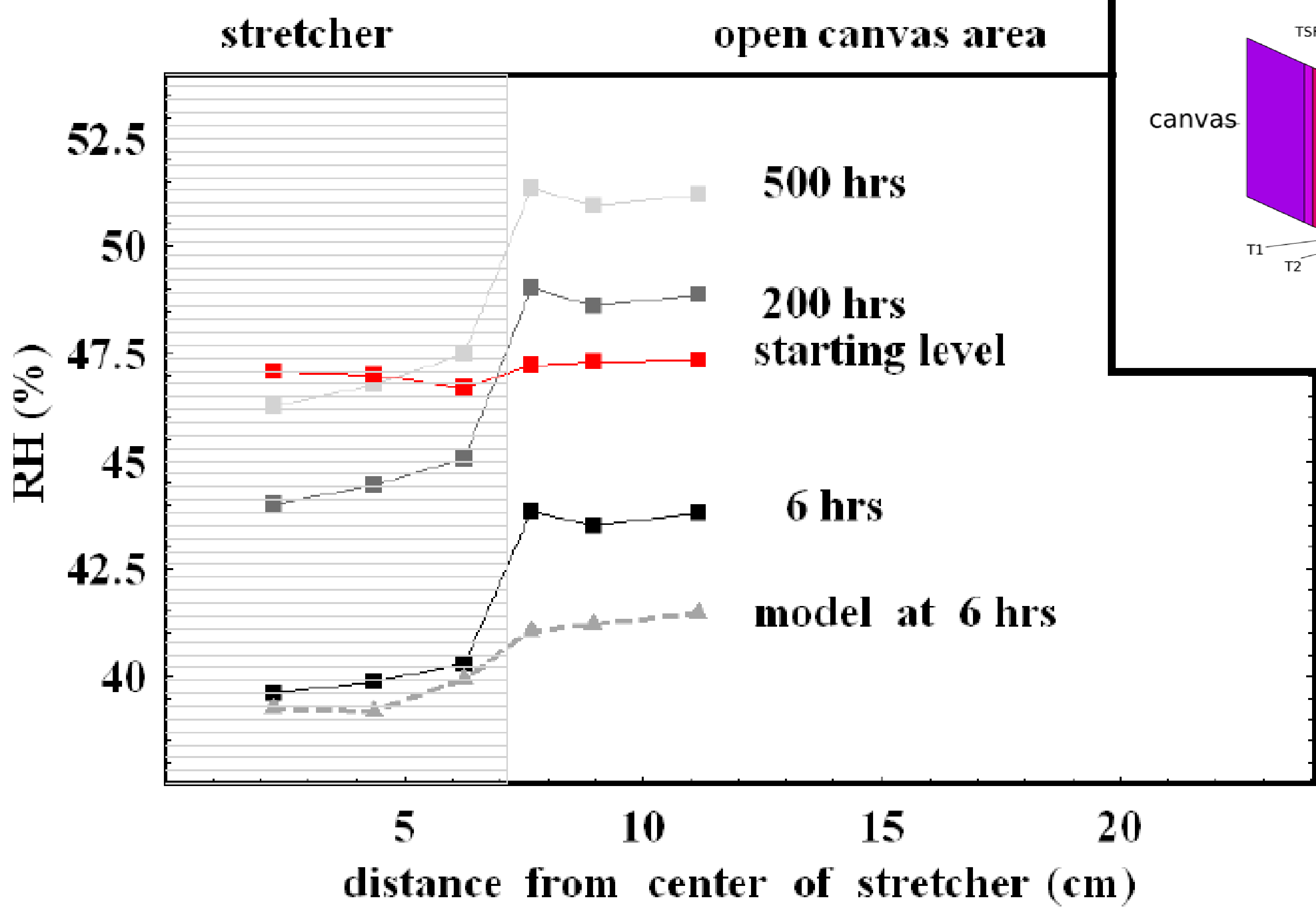
RH profile along canvas

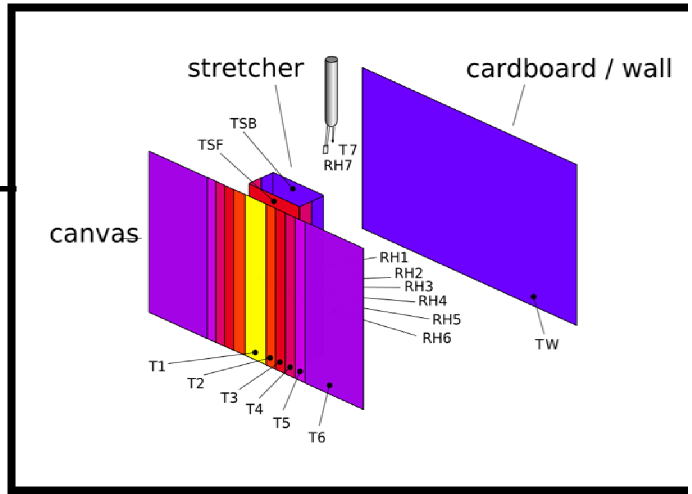


Results ‘cold wall’ experiment, absorbent materials

RH in room constant, T wall from 20 C to 14 C

RH profile along canvas





Conclusions

- Humidity buffering does not produce sharp RH differences → no stretcher effect

-Thermal gradients produce sharp RH differences → stretcher effect

- Model works well, can be used to predict RH differences in closed spaces (boxes, showcases, paintings with backing boards, etc) with T differences.

Implications for backing board protected paintings

-Moisture accumulates in cold absorbent materials

-If backing boards are in direct thermal contact with a "cold" wall, they may accumulate moisture and release it when the climate change → danger of high RH and condensation → avoid thermal gradients when using backing boards (hang paintings away from wall)

- The stretcher effect can be avoided by avoiding thermal gradients