The use of NIR spectroscopy as a quality marker of hydrothermally treated wood

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1. INTRODUCTION - HYDROTHERMAL TREATMENT (HTT)

- **ADVANTAGES OF HTT**
- **DISADVANTAGES OF HTT**

- balance colour differences
- improve dimensional stability
- improve decay resistance and durability of wood
- useful tool in wood densification

1. INTRODUCTION - HYDROTHERMAL TREATMENT (HTT)

- ADVANTAGES OF HTT
- **DISADVANTAGES OF HTT**

  - darkening
  - degradation of mechanical properties

1. INTRODUCTION - HYDROTHERMAL TREATMENT (HTT)

Parameters of HTT affecting properties

- Medium (steam saturation, vacuum, others?)
- Temperature
- Duration
- Moisture content of wood
- Other?

Properties affected

- Chemical composition, chemical properties
- Aesthetic properties (Color, ….)
- Mechanical properties (Hardness, Elastic recovery ….)
- etc

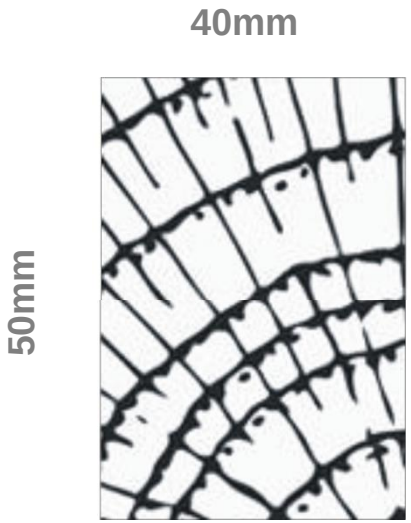
2. AIM

- **Attain relationships between HTT parameters and properties of wood**

- **Tools for on-site control/proof of modification degree**

3. MATERIALS AND METHODS

SPECIMEN PREPARATION



European Beech

(Fagus sylvatica L.)

- sapwood
- no defects
- not kiln dried

Thickness=22mm

3. MATERIALS AND METHODS

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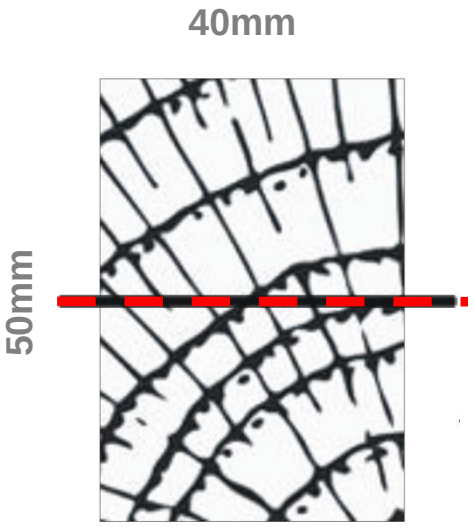

Specimens cut in pairs (Hansson and Antti, 2006) to facilitate comparison between the treated and non treated ones

3. MATERIALS AND METHODS

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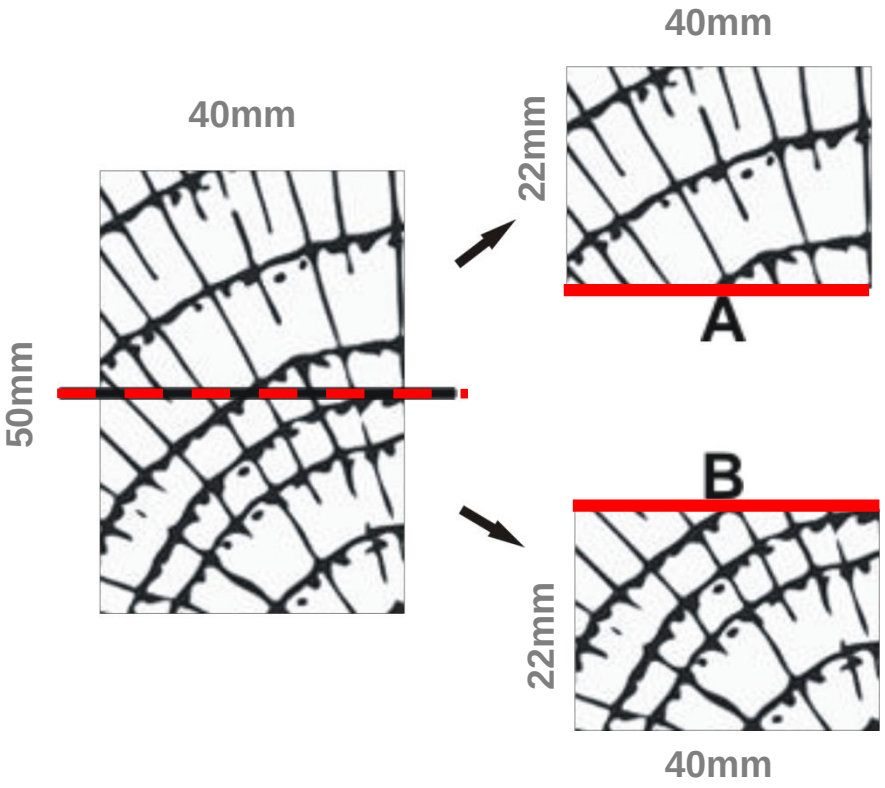

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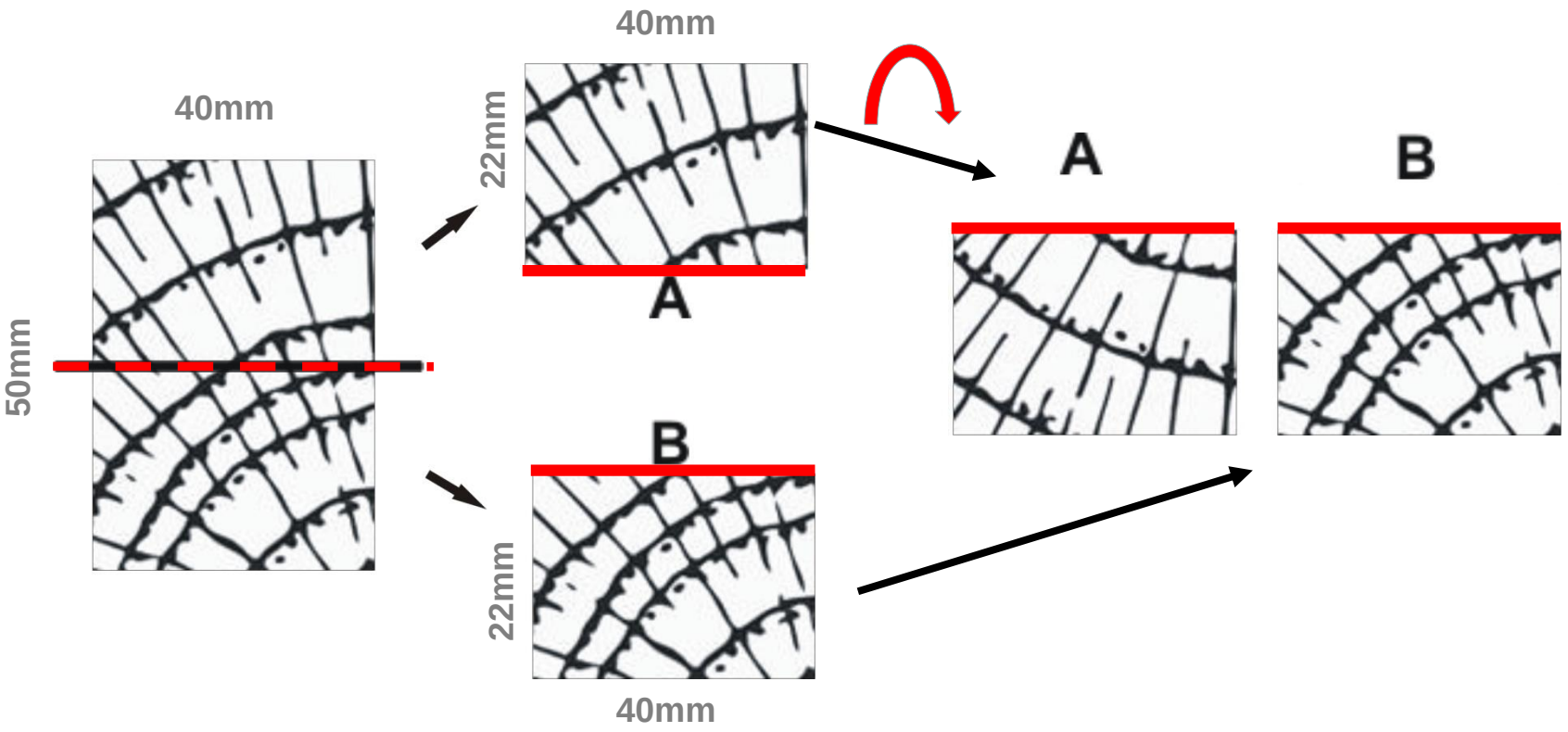

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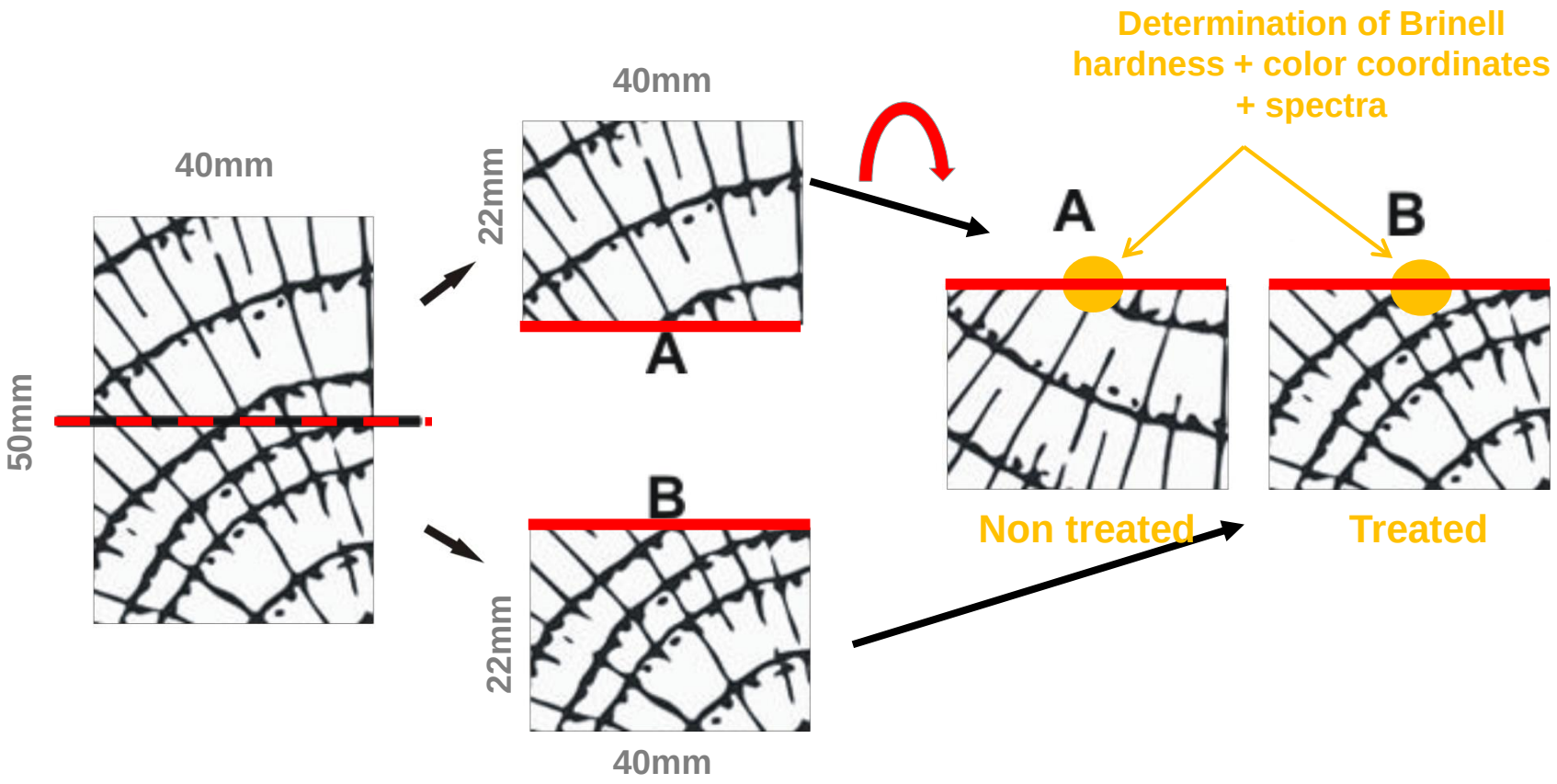

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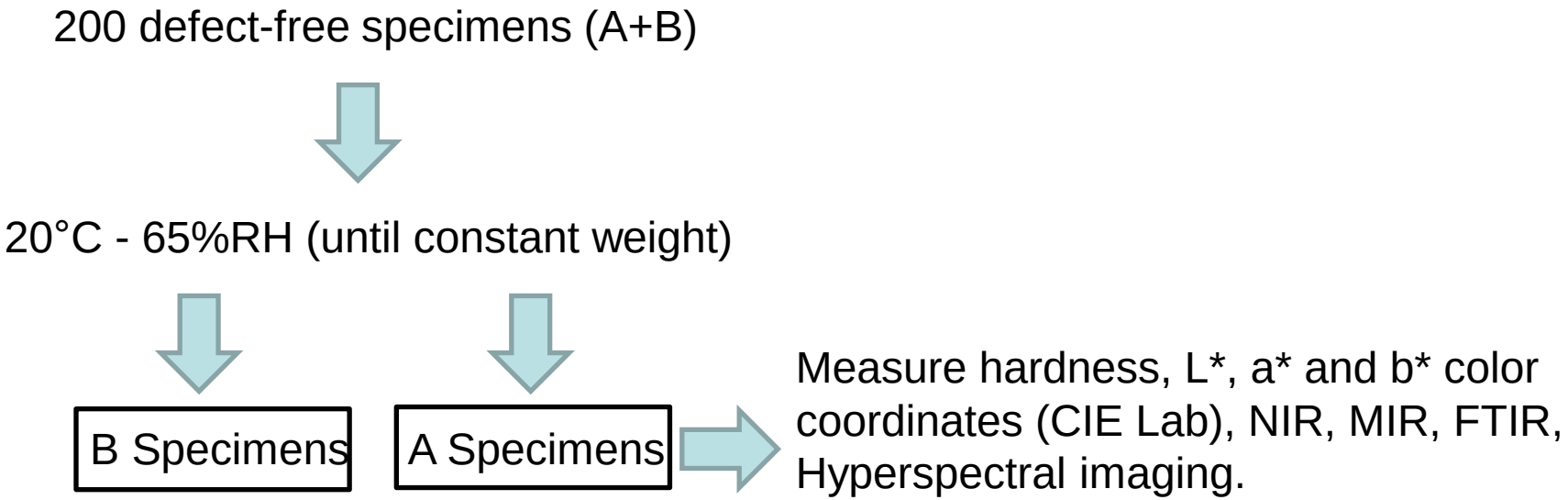

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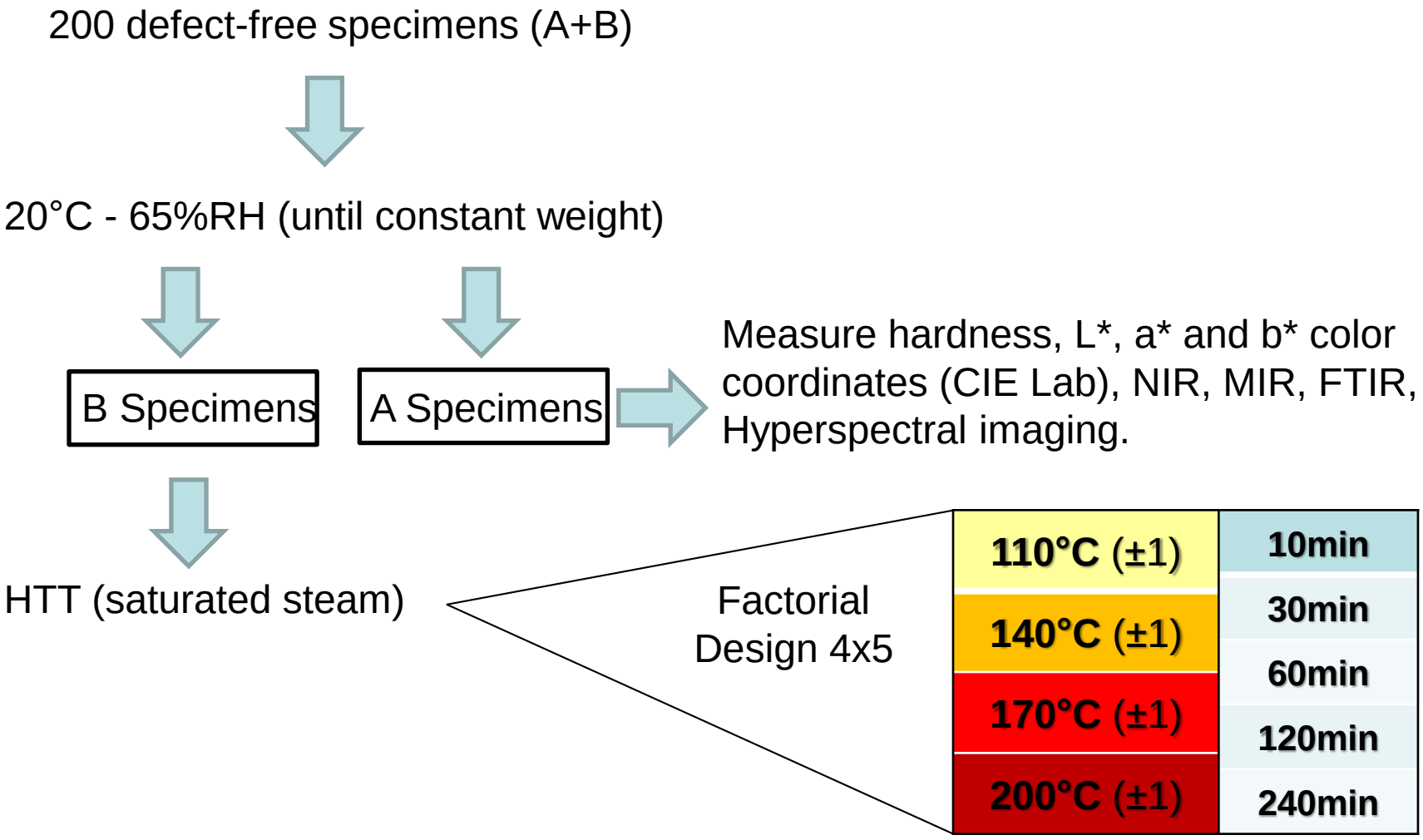

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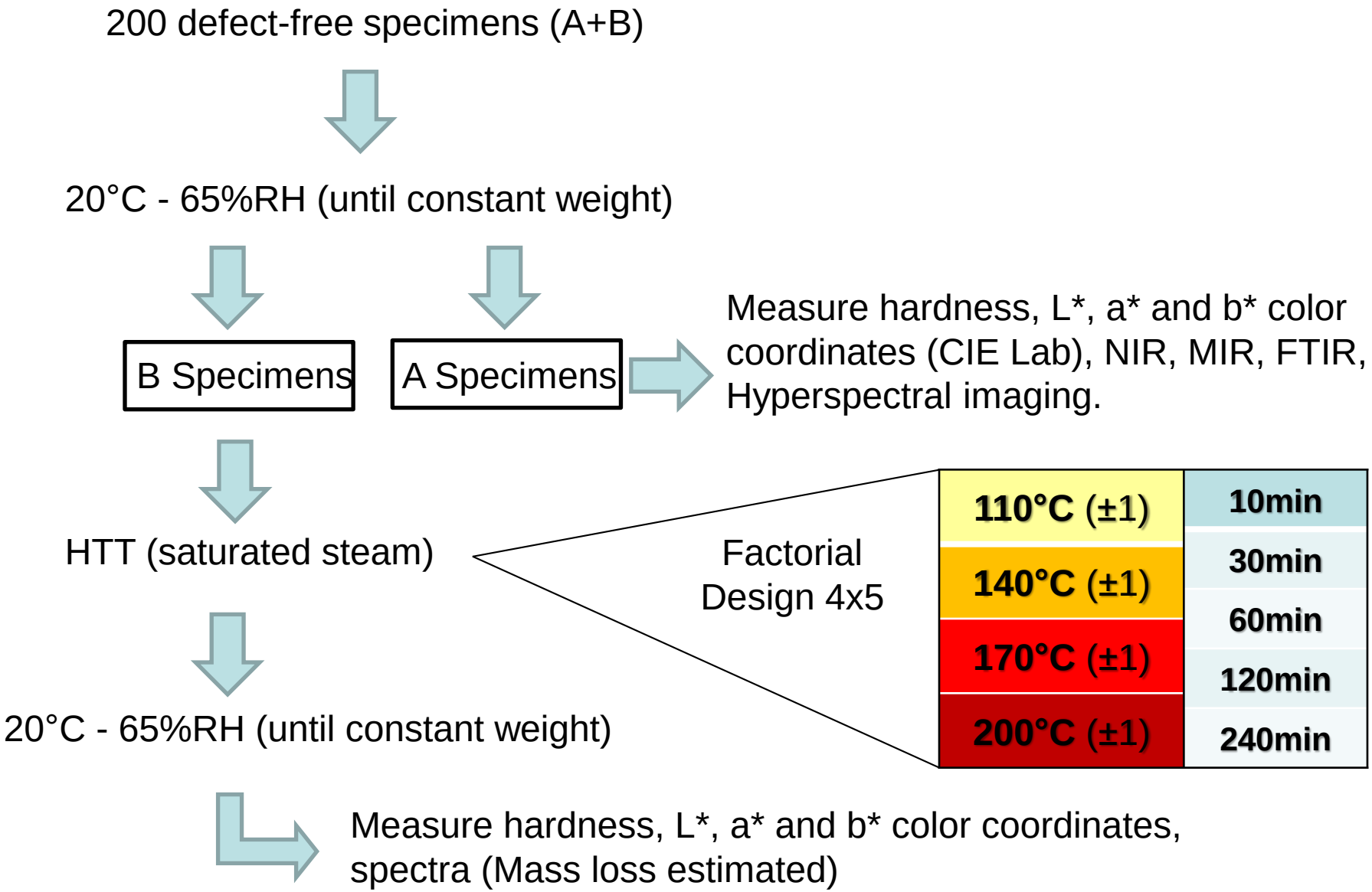

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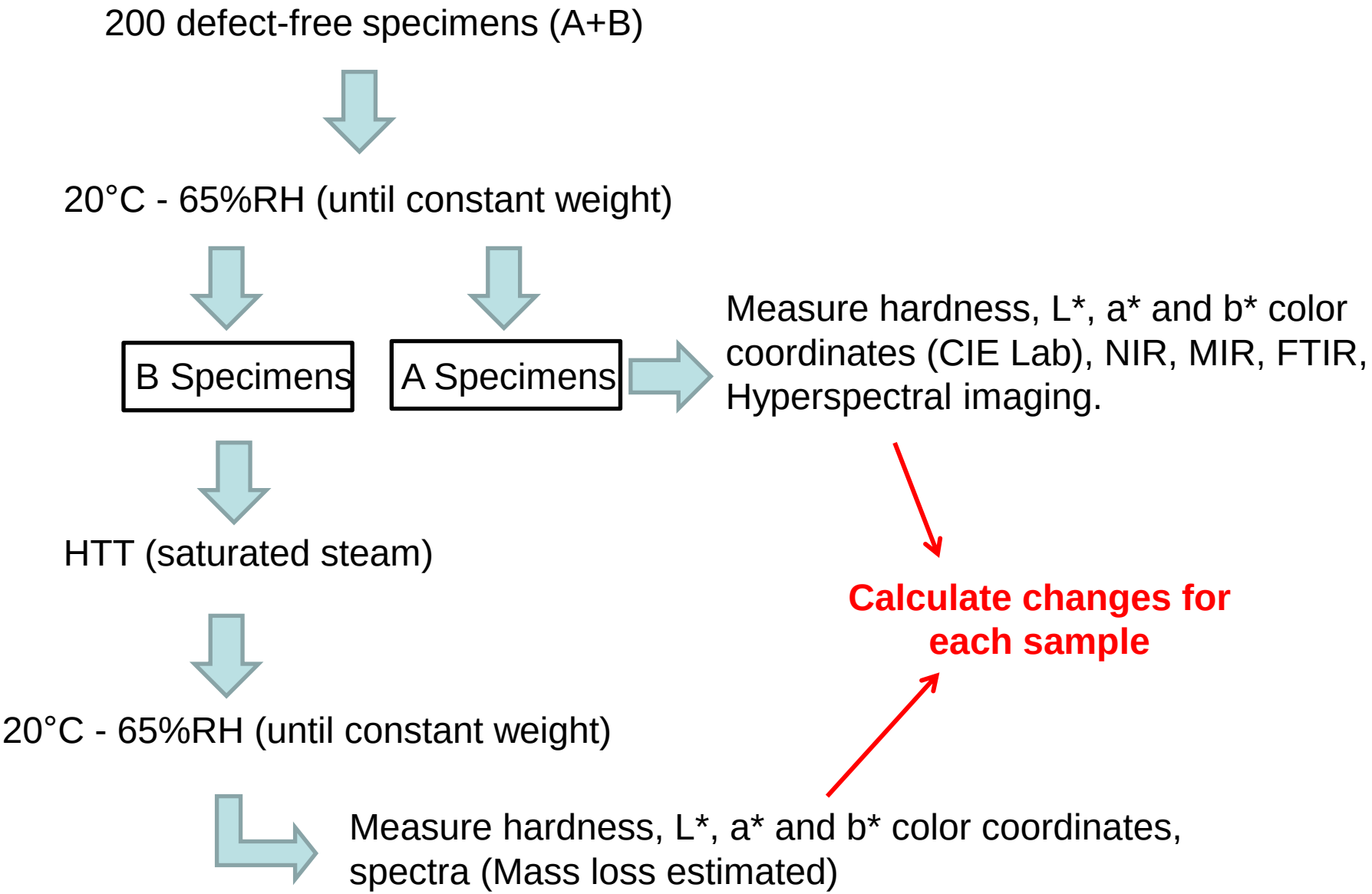
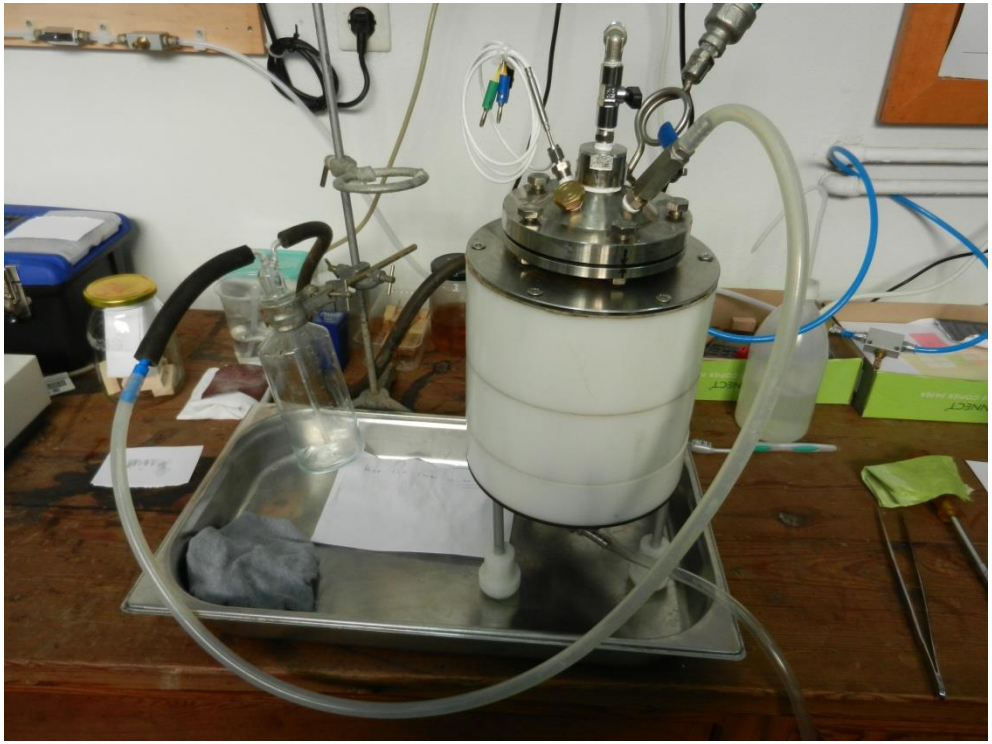


3. MATERIALS AND METHODS

1,2l Lab Reactor (SS)

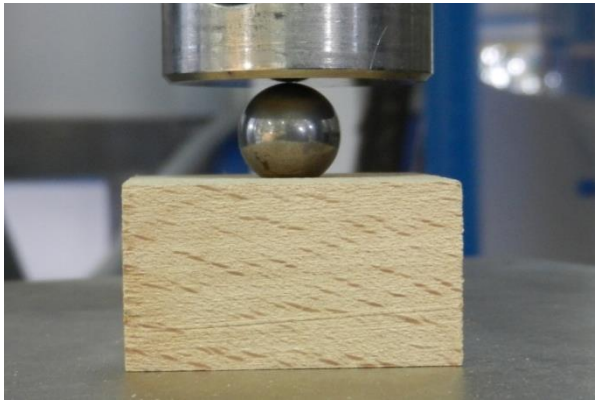
- thermal/hydrothermal treatments at temperatures up to 225°C (deviation<1°C)
- vacuum treatments up to 120mbar (abs)
- pressure treatments up to 25bar
- equipped with THM treatment component



3. MATERIALS AND METHODS

Surface colour (L*, a* ,b* and ΔE*)

BYK Gardner tristimulus colourimeter
- 45/0 measuring geometry,
- measuring area: 20 mm (diameter)
- D65 illuminant
- 10° standard observer

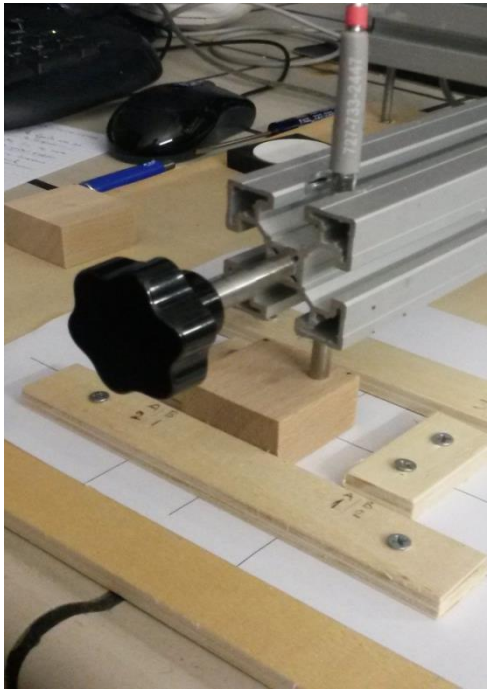


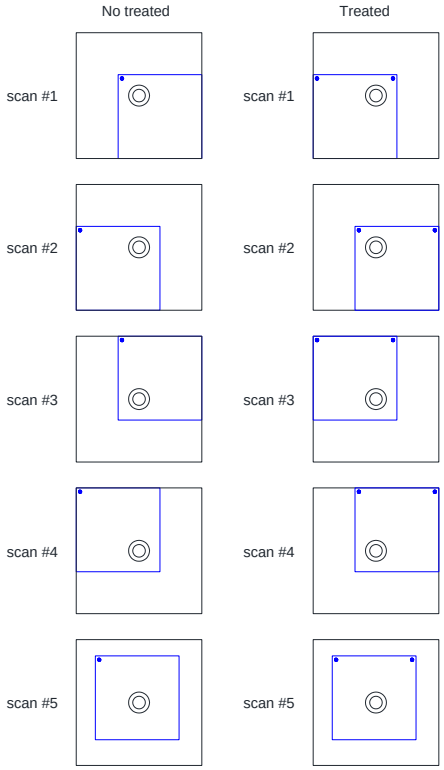
Brinell hardness - indentation depth

- EN1534:2000
- Niemz and Stübi (2000)

Zwick 2020 Universal Testing Machine.

3. MATERIALS AND METHODS

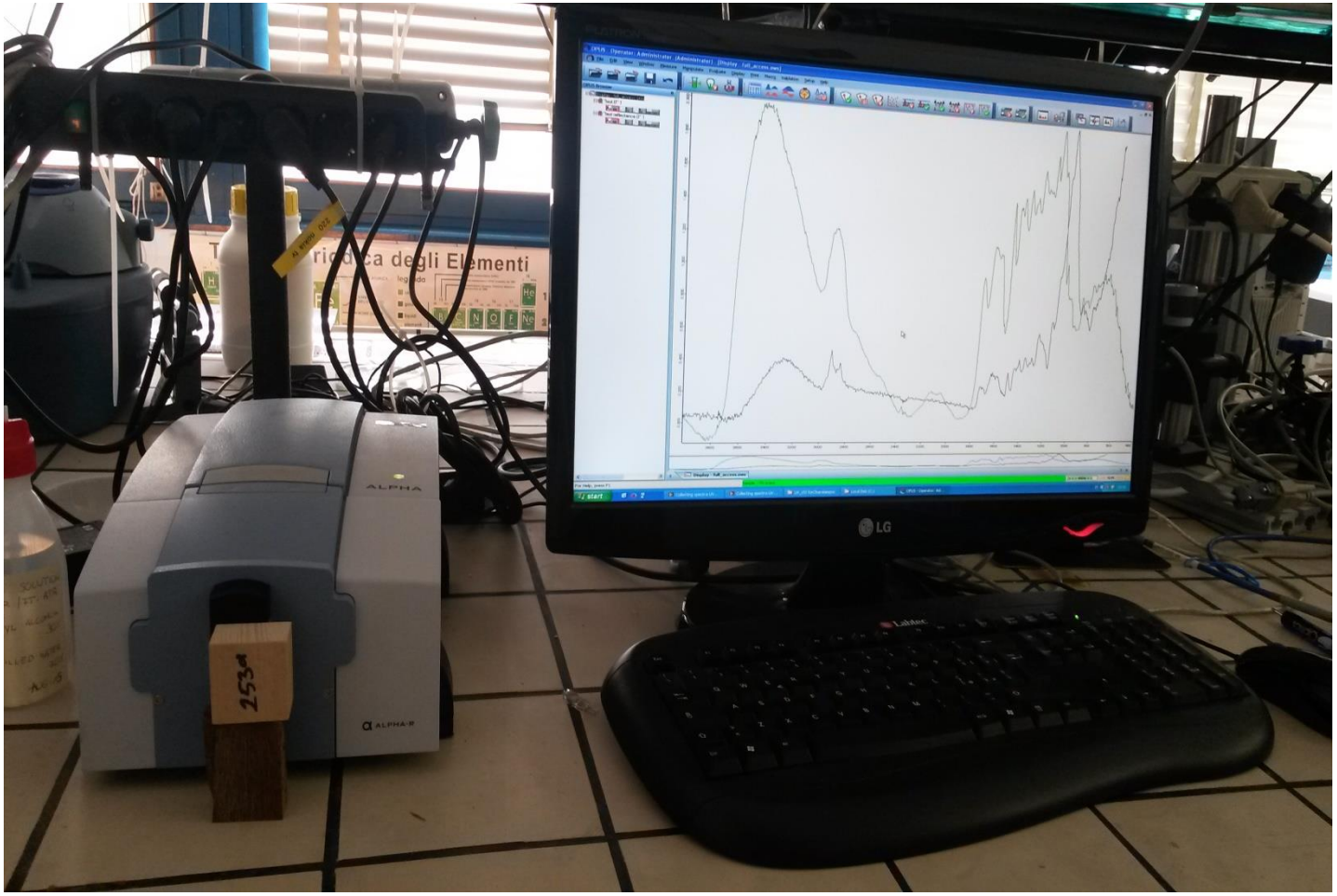




Sample holder and measurement scheme for the acquisition of the spectra

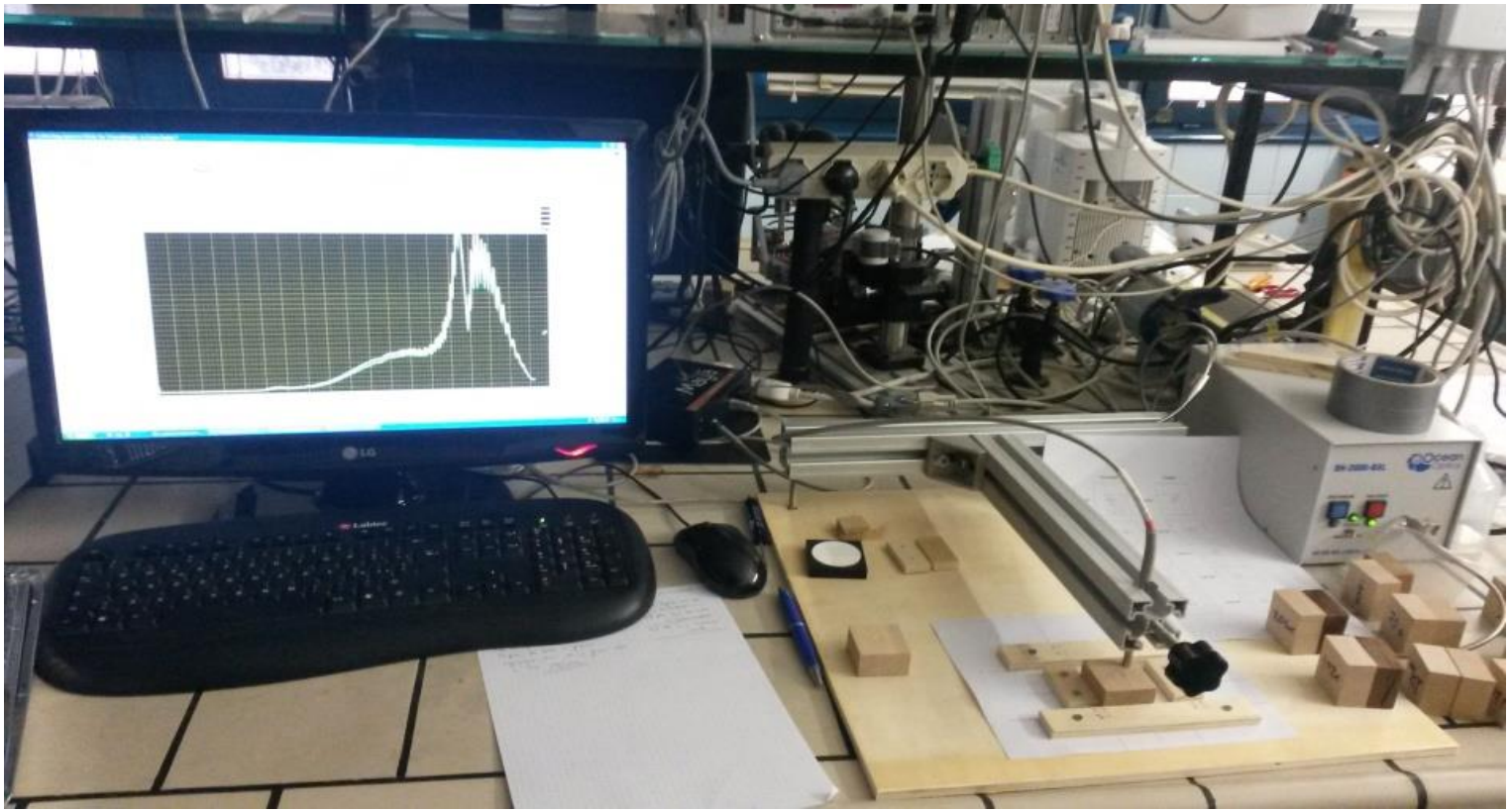
Modified probe for the acquisition of UV-VIS spectra acquisition using integration sphere

3. MATERIALS AND METHODS



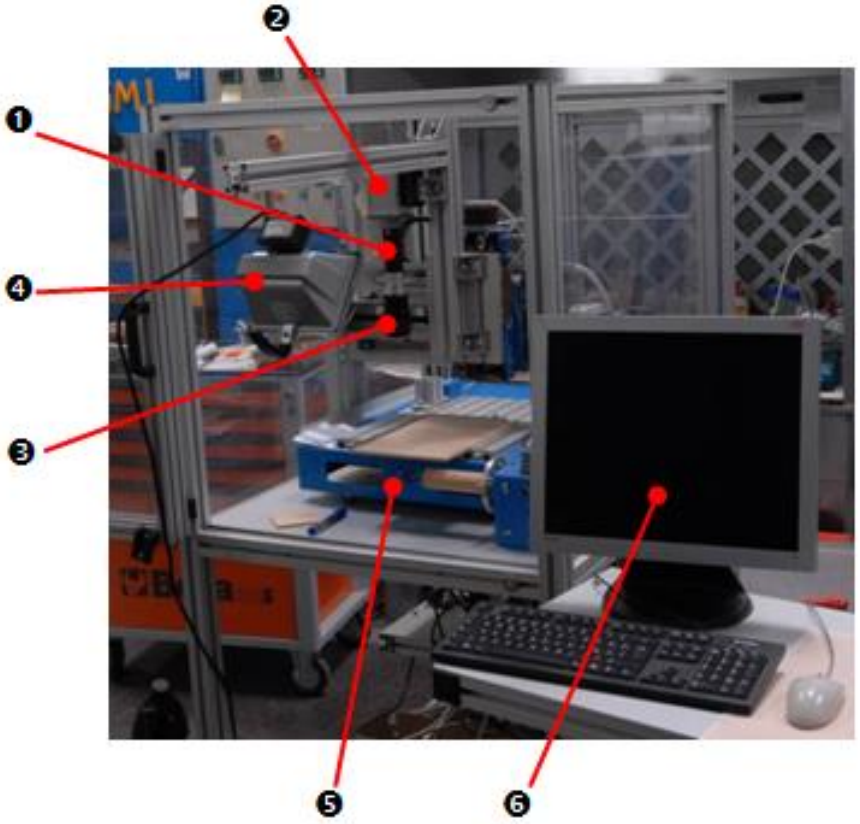
FT_MIR spectra acquisition

3. MATERIALS AND METHODS

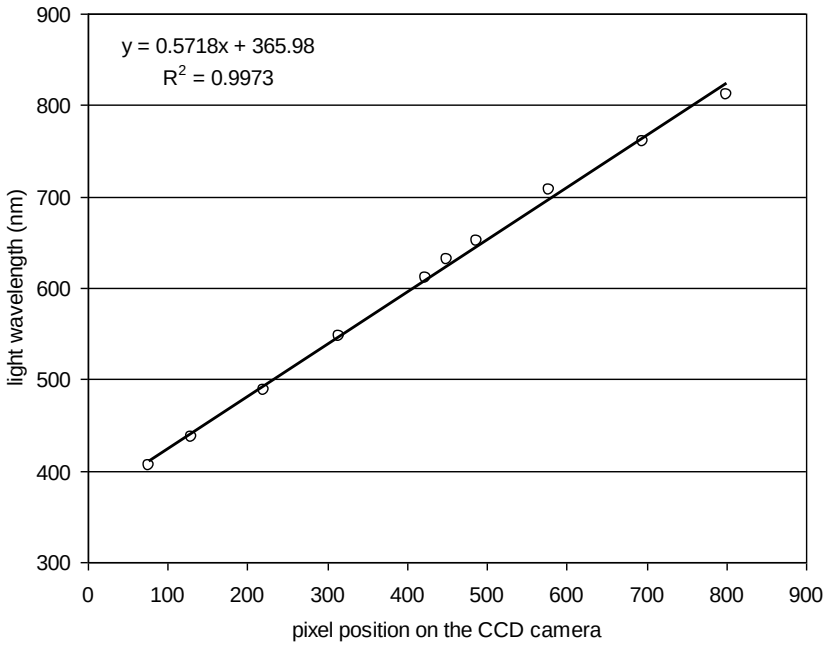


UV VIS spectra acquisition using a fiber optic probe

3. MATERIALS AND METHODS



Experimental set-up for hyperspectral imaging of wood samples, developed at CNR-IVALSA



Hyperspectral imaging wavelength calibration

3. MATERIALS AND METHODS

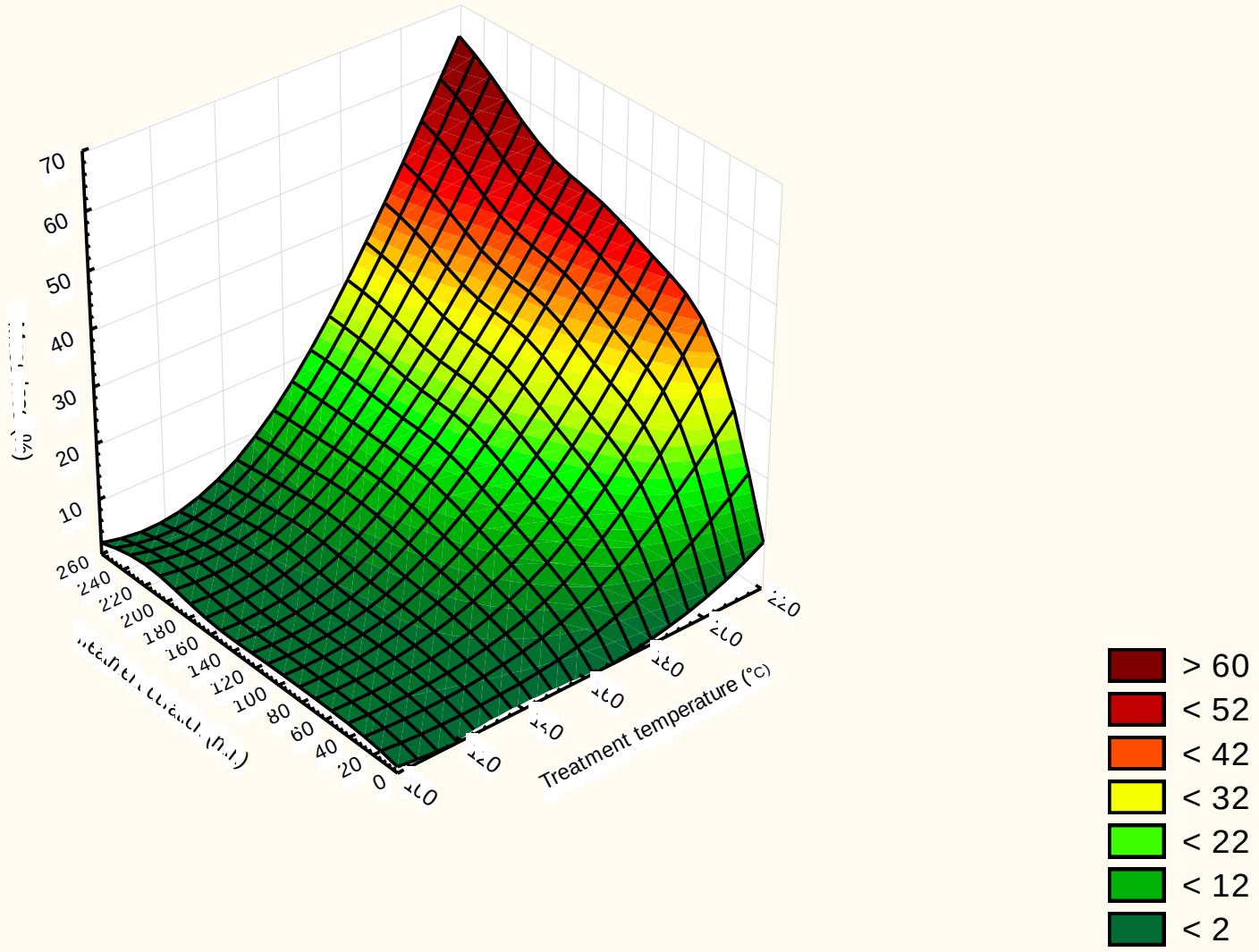
Preprocessing
extended multiplicative scatter correction
1st derivative

Chemometrics
Principal Components Analysis,
Partial Least Squares,
2D spectral correlation
Multiple Linear Regression

4. RESULTS – Wood properties

3D Surface Plot of Mass loss (%) against Treatment temperature (°C) and Treatment duration (min)

Mass loss (%) = Distance Weighted Least Squares



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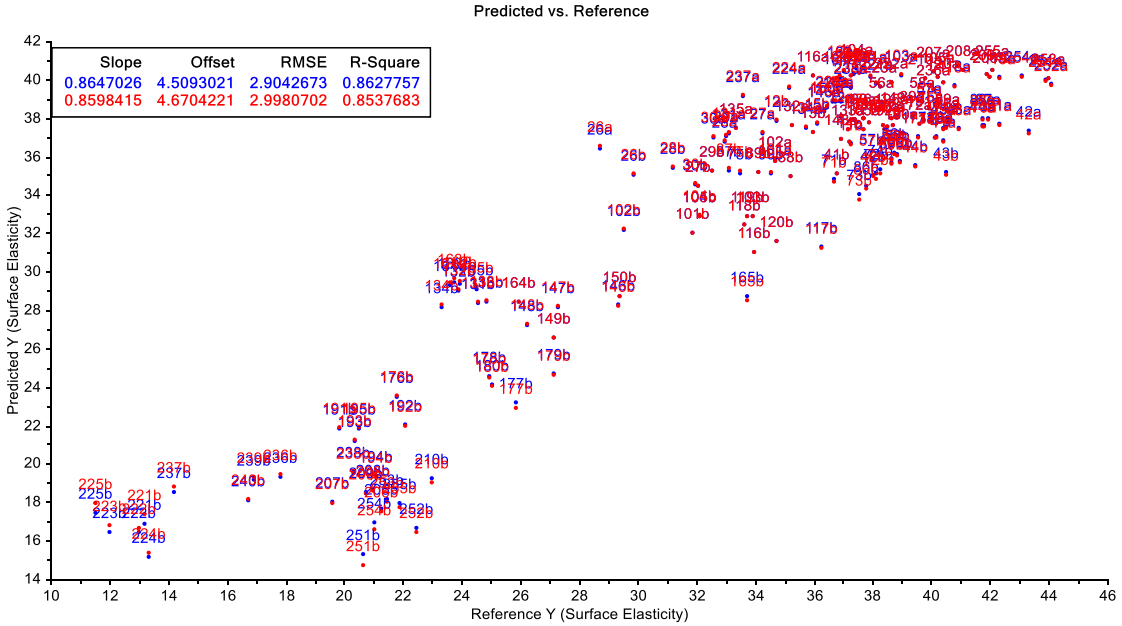
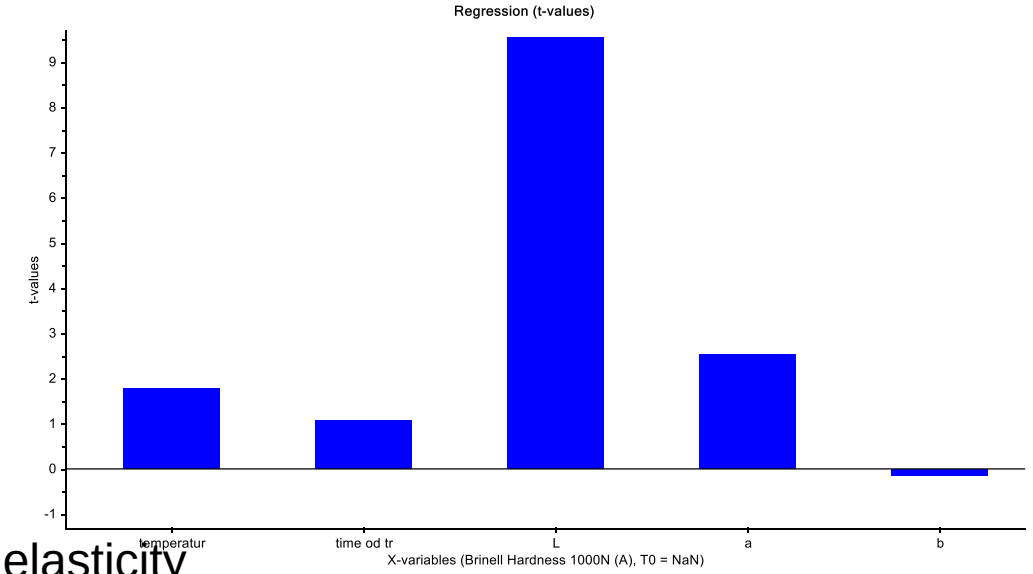
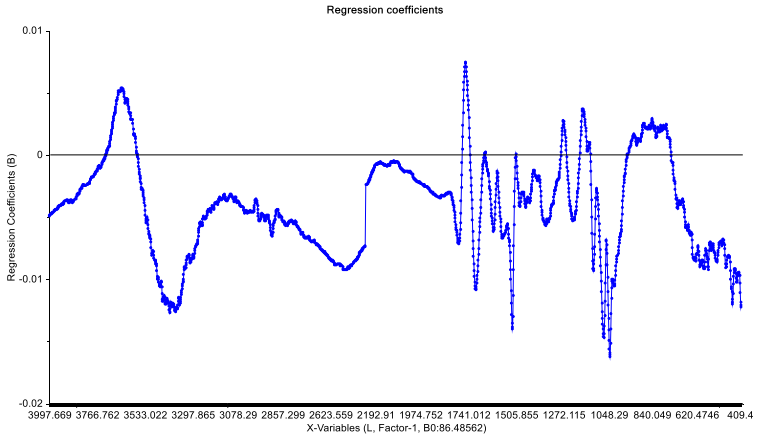
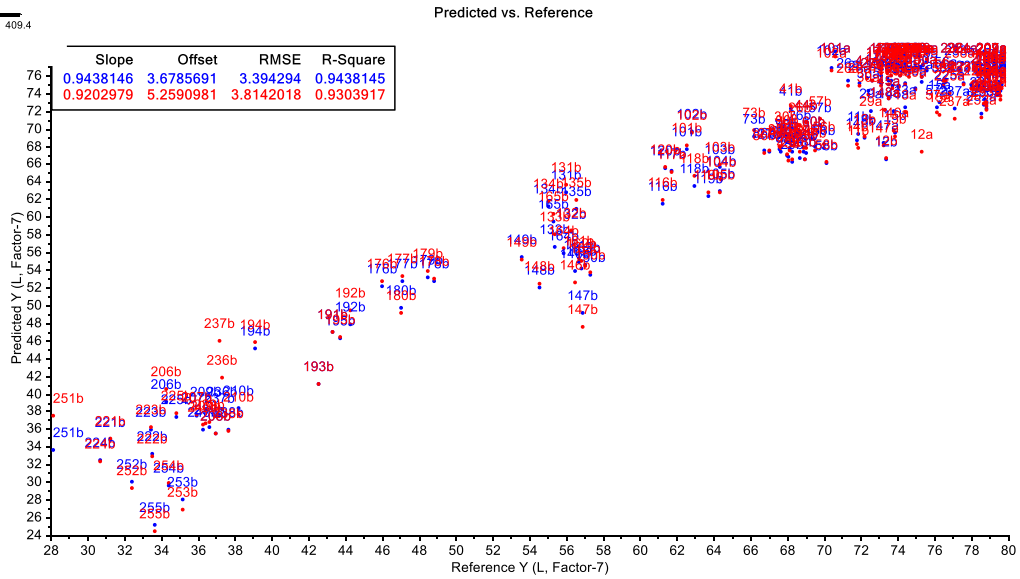




Prediction of surface elasticity

4. RESULTS – Wood properties





prediction of CIE L on the base of MIR spectra (EMSC + 1st derivative)

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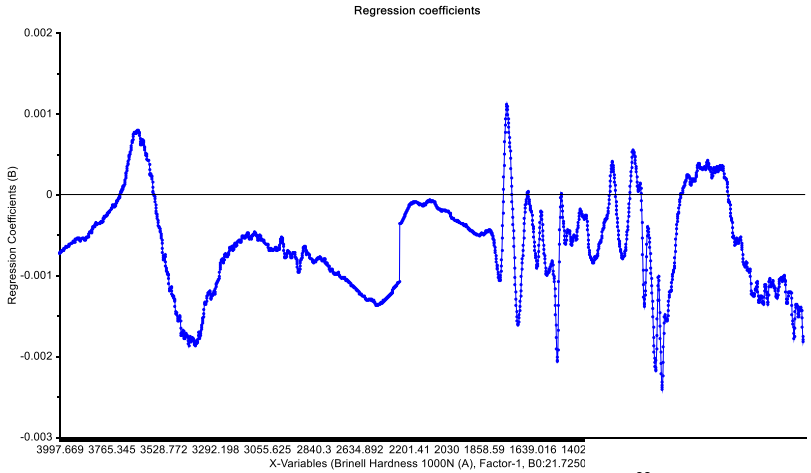
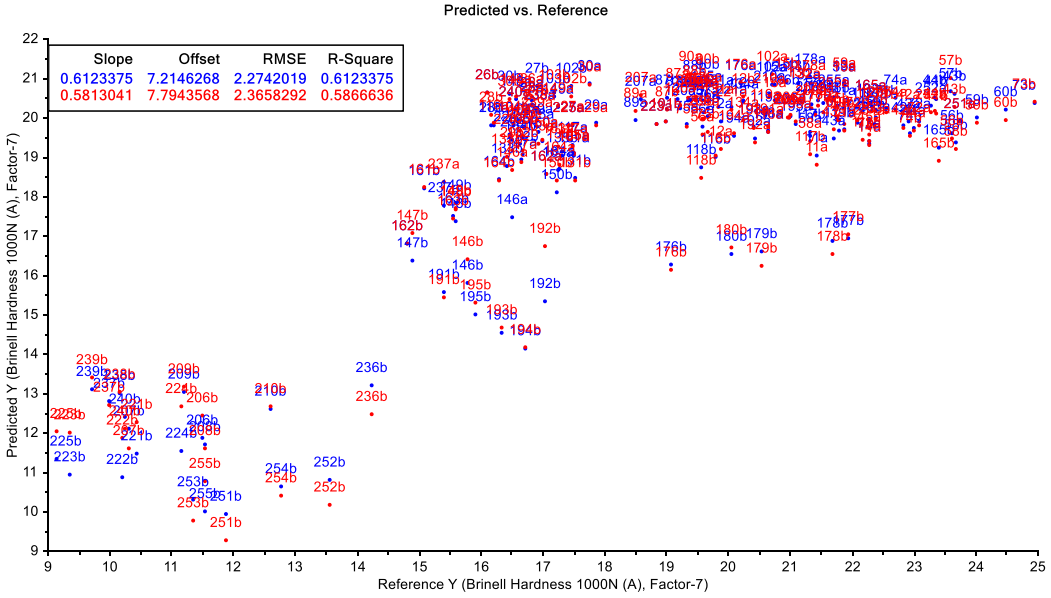
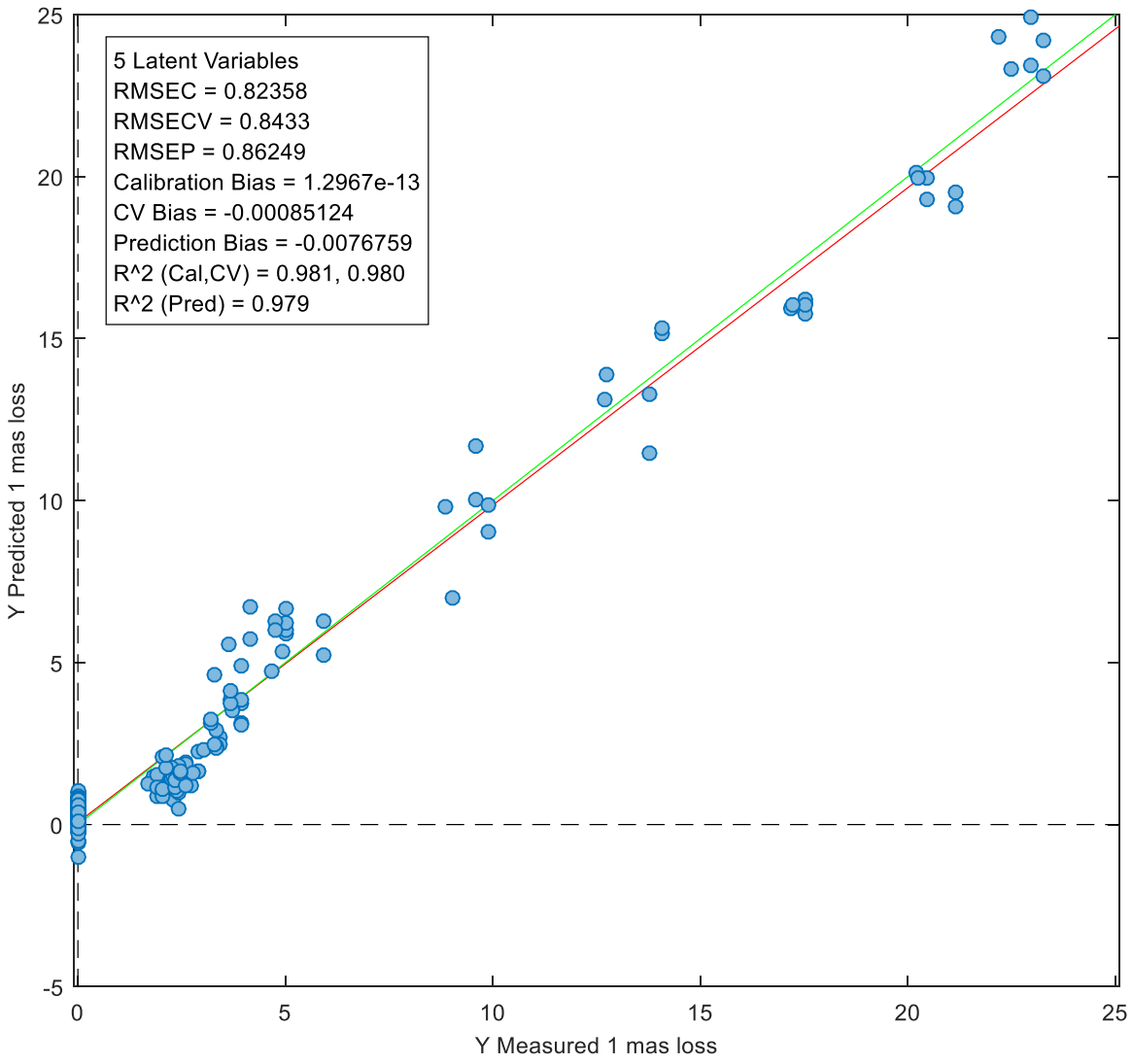




: Prediction of hardness by means of PLS-R of MIR data, EMSC+1st derivative

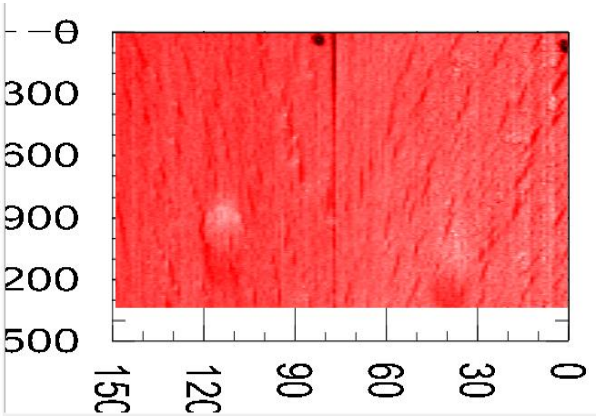
4. RESULTS – Wood properties



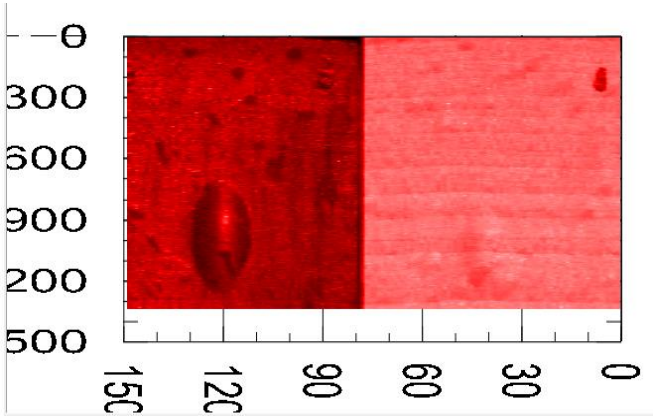
Prediction of mass loss by means of NIR spectra

4. RESULTS – Wood properties

Hyperspectral imaging



Mildly treated sample



Intensively treated sample

5. CONCLUSIONS

- Estimation of thermal modification degree of wood non-destructively can be possible
- Estimation of properties of HT wood could be possible
- Data still needs to be processed, work is underway
- Improve methodology (experimental/analysis) to reduce errors of estimation


THANK YOU !