

MULTI-LEVEL ANALYSIS OF LIGNIN DISTRIBUTION AND CELL GEOMETRY IN PICEA ABIES (L. KARST.) AS A BASIS TO EXPLAIN ANISOTROPIC SWELLING

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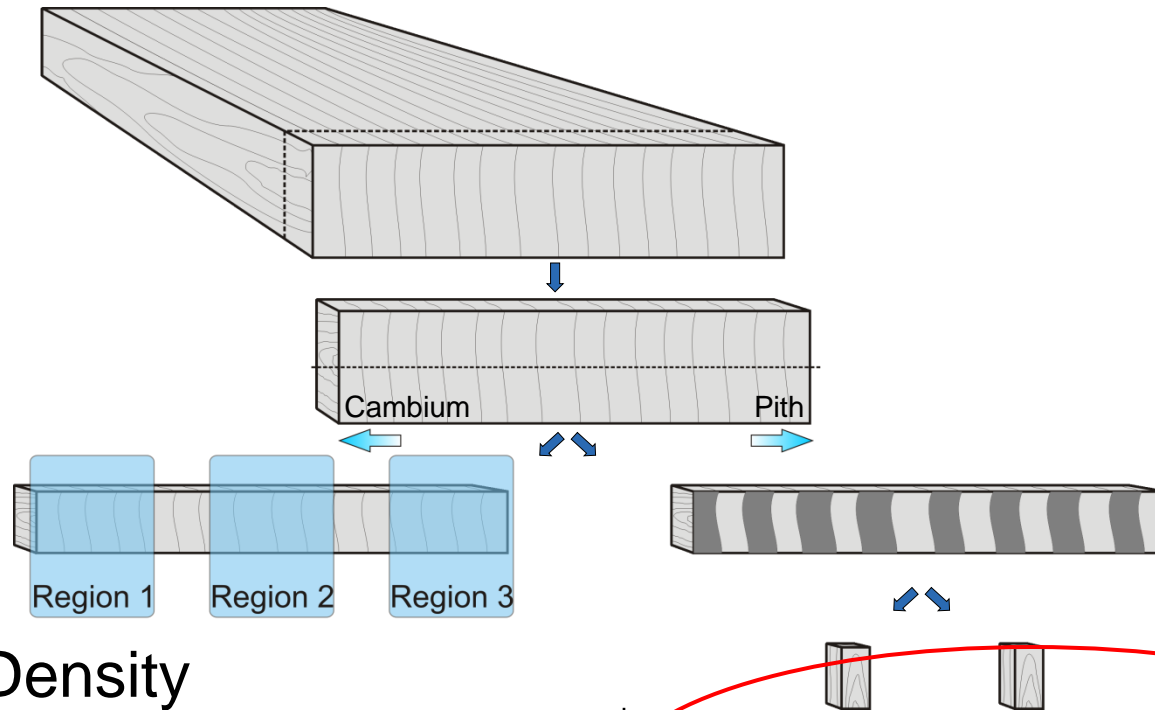
Outline

- Introduction
- Geometry measurements
- Lignin distribution
- Outlook
- Conclusions

Introduction

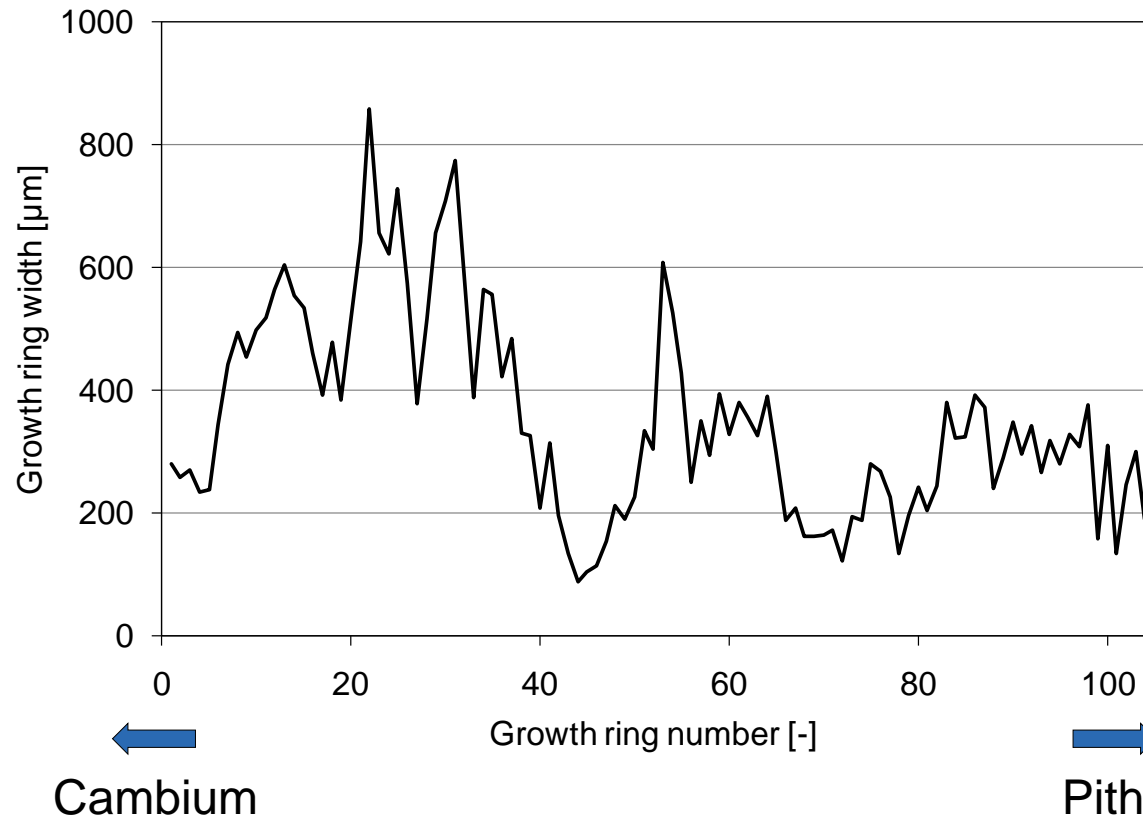
- Hierarchical assembly
- Cell features vary within growth ring(s) according to different functions of the tissue
- Need for research:
 - Consistent set of data according to:
 - Cell geometry distribution
 - Chemical description

Experimental Plan and Sample Preparation



- Density
- Microfibril angle
- Chemical composition
- Free swelling
- Geometry characterization
- Lignin distribution

Sample description



- Norway spruce (*Picea abies*)
- Origin: Switzerland
- Stereo microscope
- $n = 104$
- mean: $352.3 \mu\text{m}$

Geometry characterization

- RT-surface
- Field-Emission-Scanning-Electron-Microscope (FE-SEM)

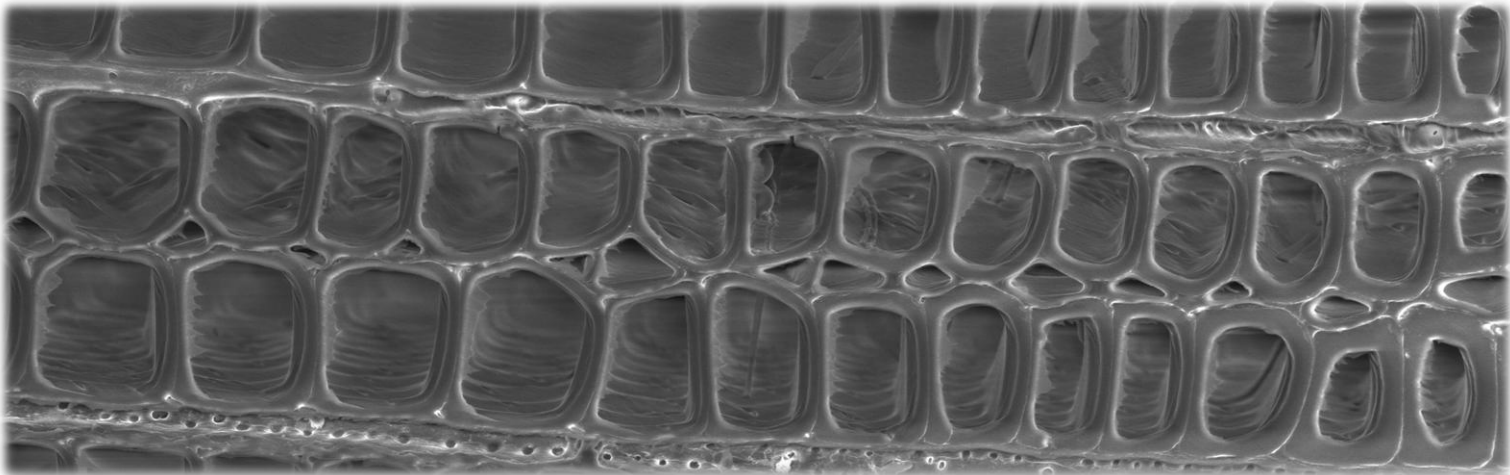
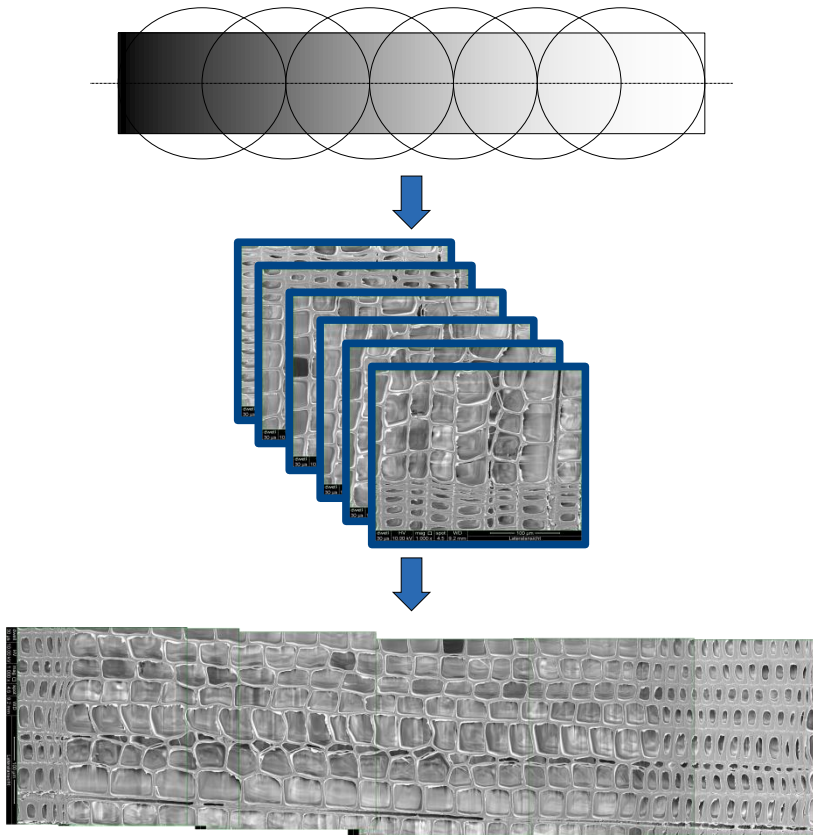


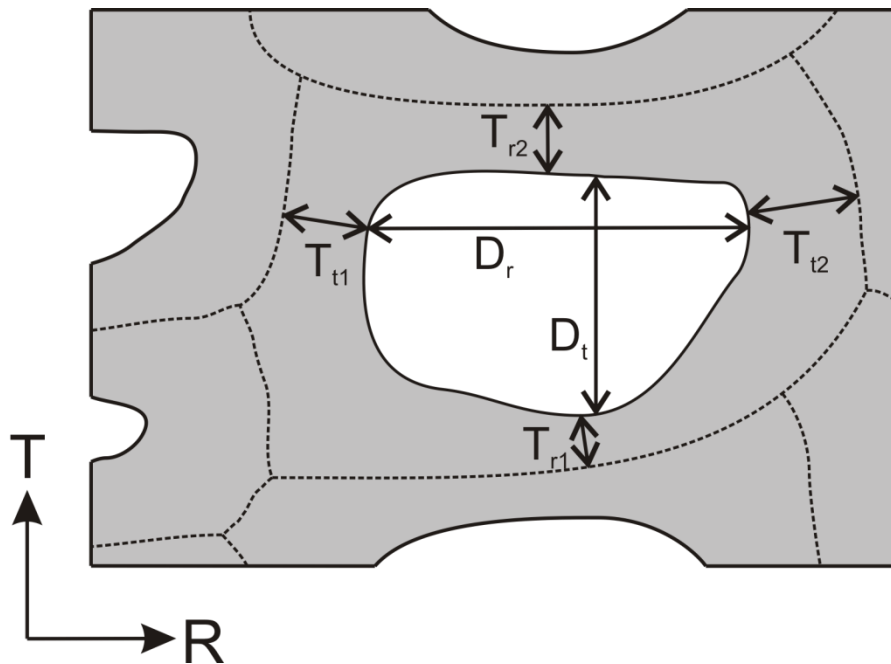
Image acquisition



Overlapping image acquisition
with equal magnification

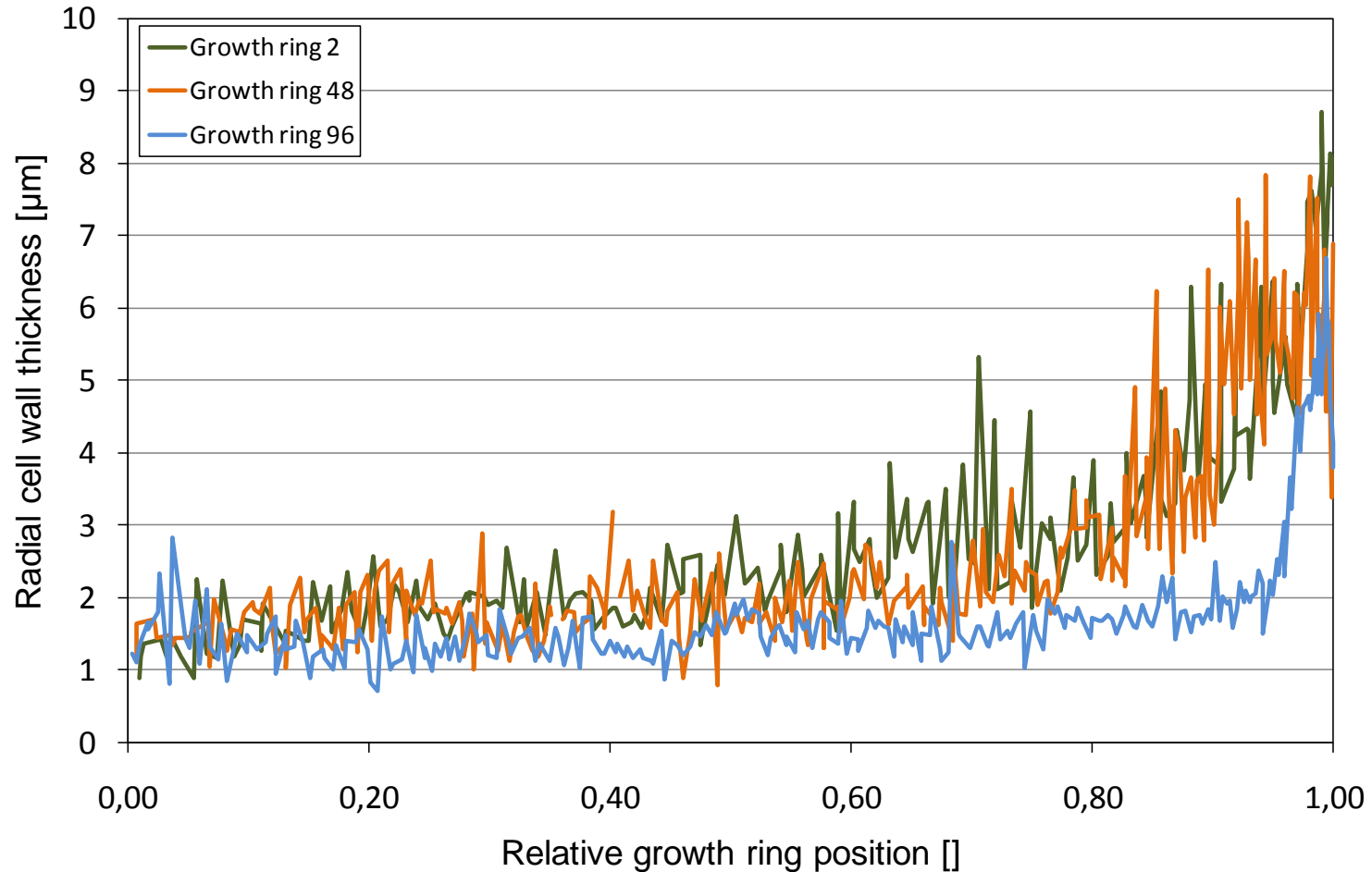
Reconstruction

Acquired geometry data

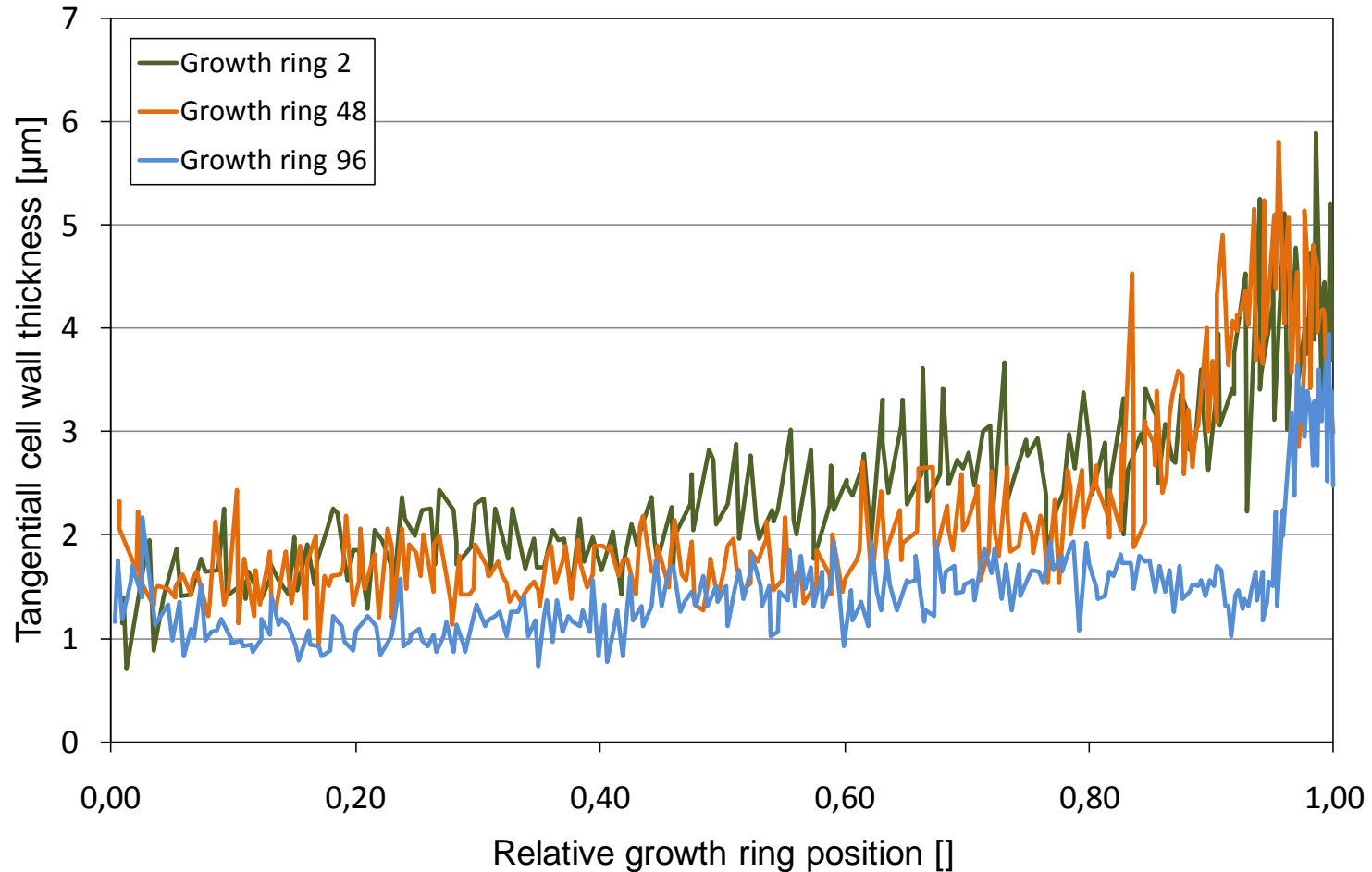


- Cell wall thicknesses
 - T_t radial direction
 - T_r tangential direction
- Lumen diameter
 - D_r radial direction
 - D_t tangential direction

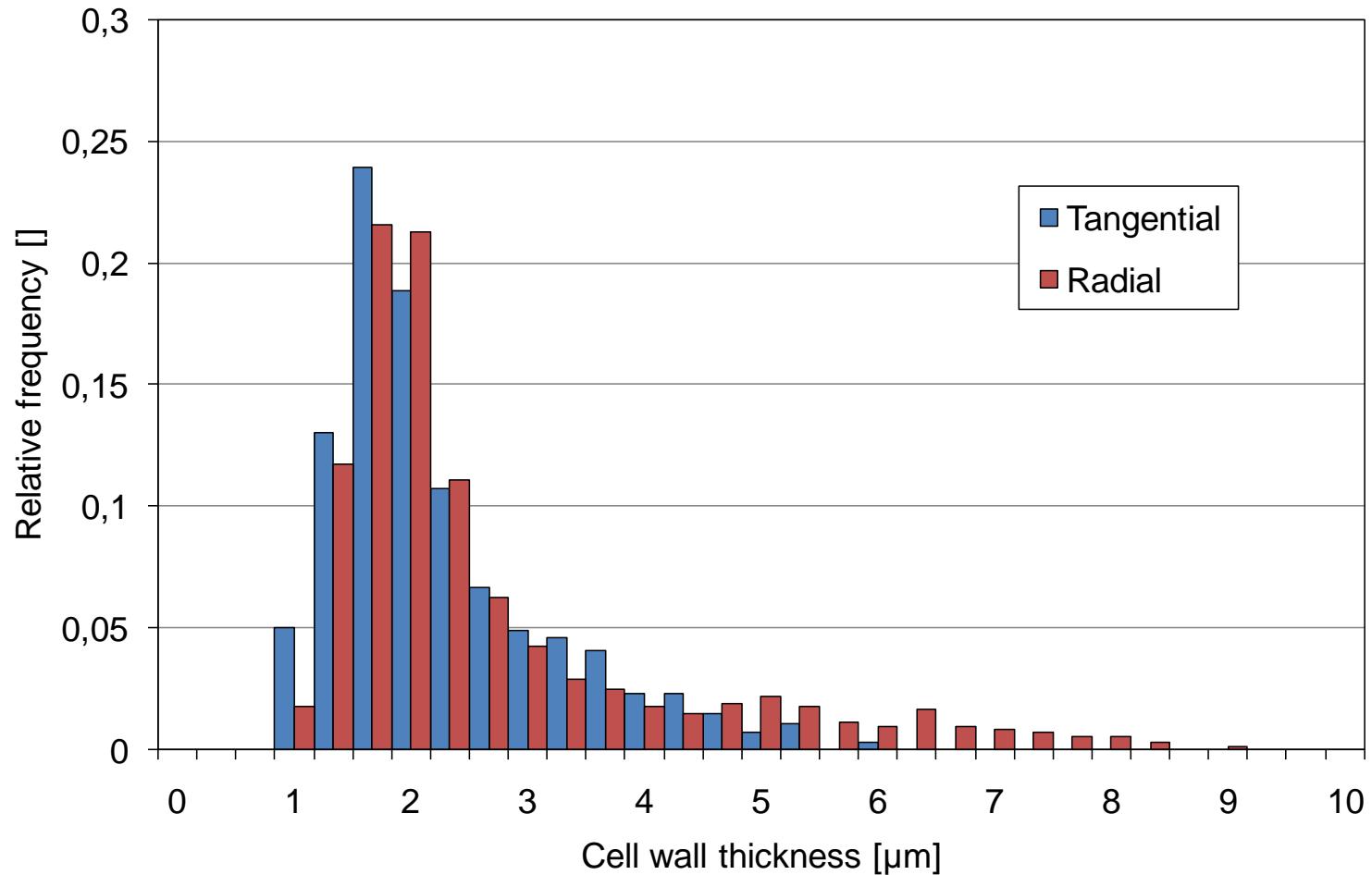
Radial cell wall thickness



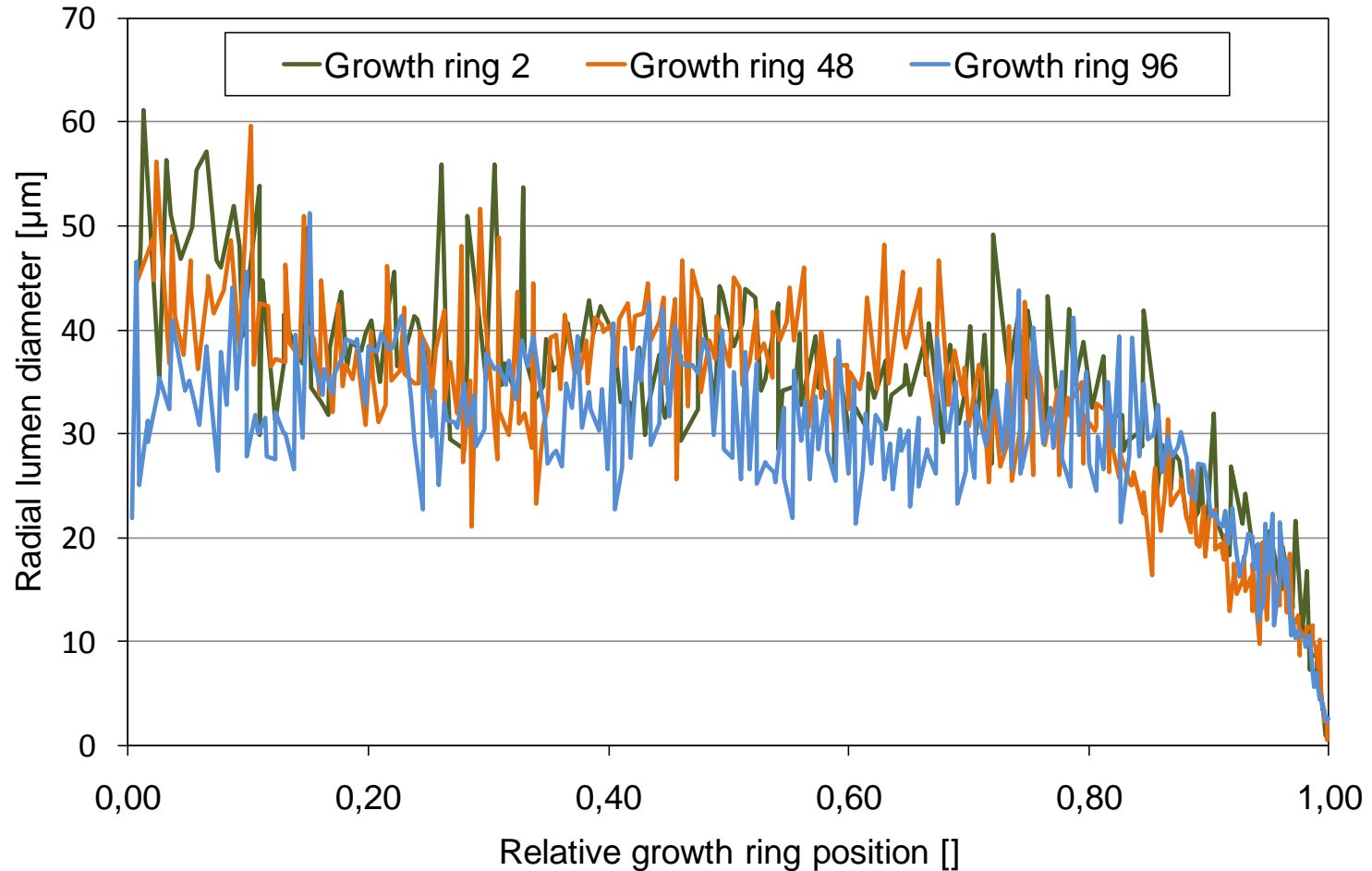
Tangential cell wall thickness



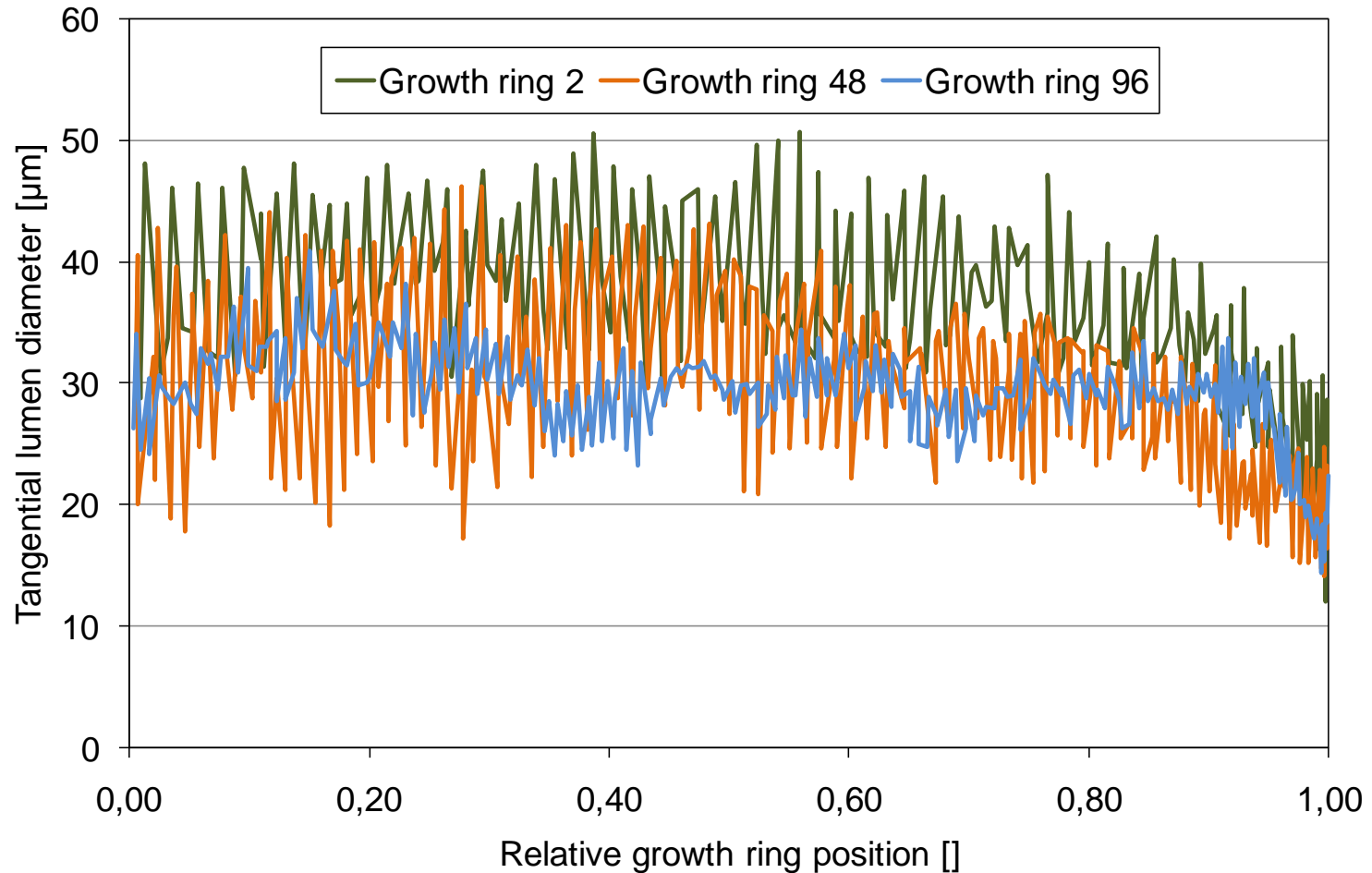
Cell wall thickness distribution



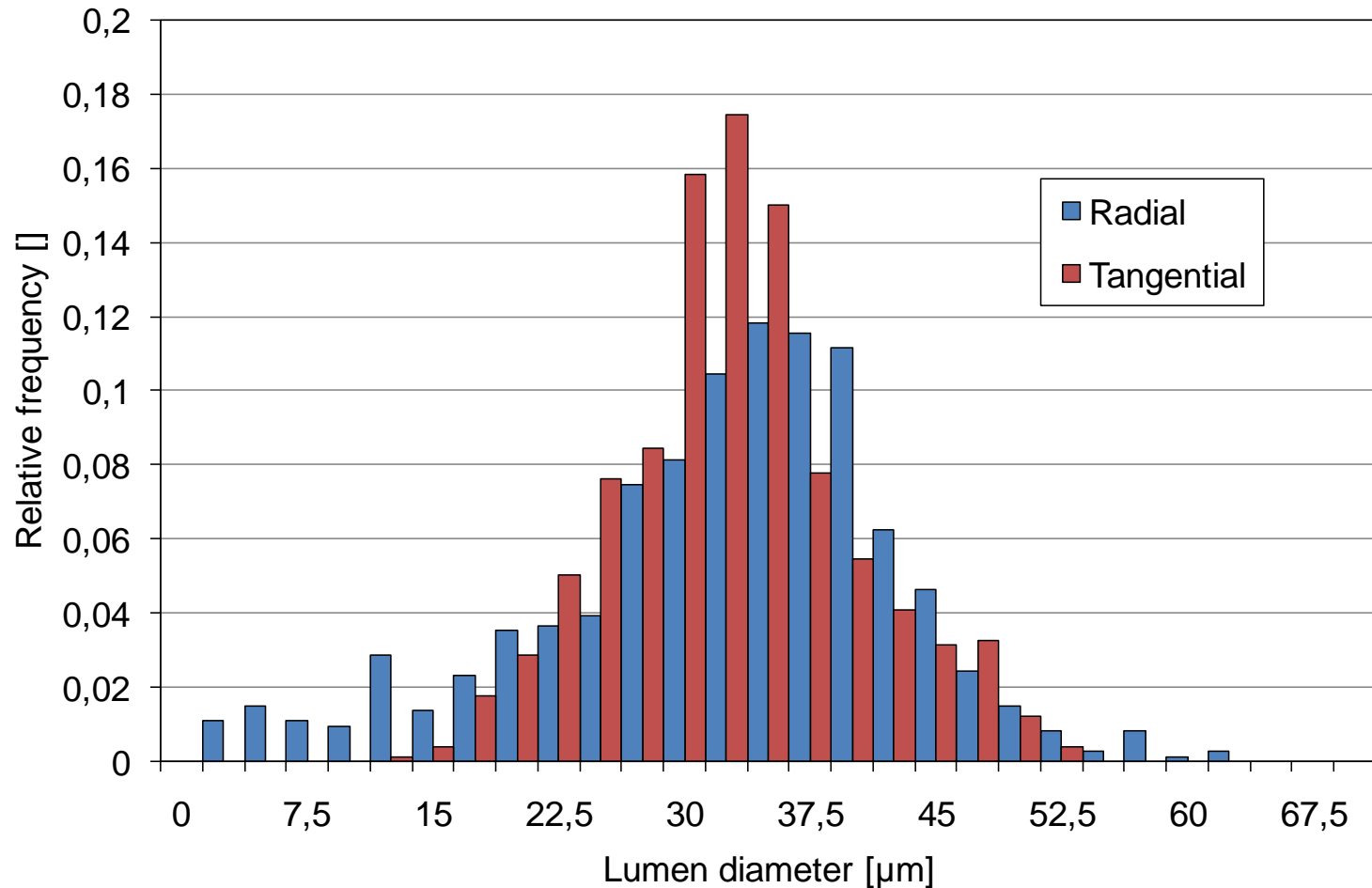
Radial lumen diameter



Tangential lumen diameter



Lumen diameter distribution

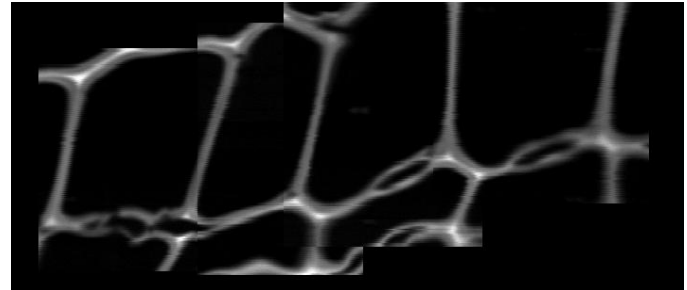


Lignin distribution

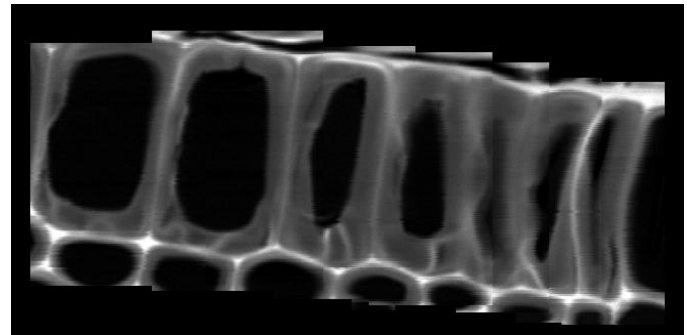
- UV-spectroscopy
 - Specific absorbance of softwood lignin: 280nm
 - Resolution: $0.25 \times 0.25 \mu\text{m}^2$
 - $1 \mu\text{m}$ RT sections

Exemplaric reconstructions

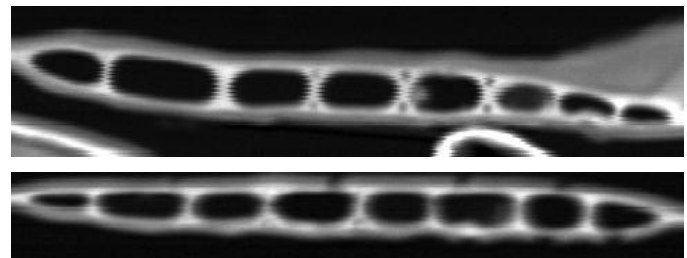
Earlywood



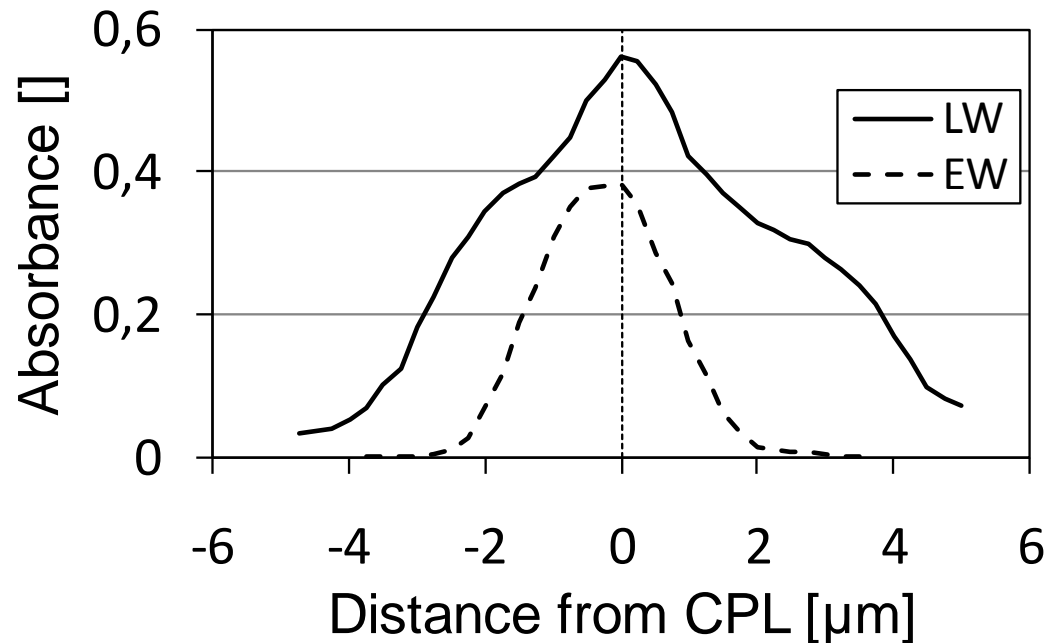
Latewood



Wood rays



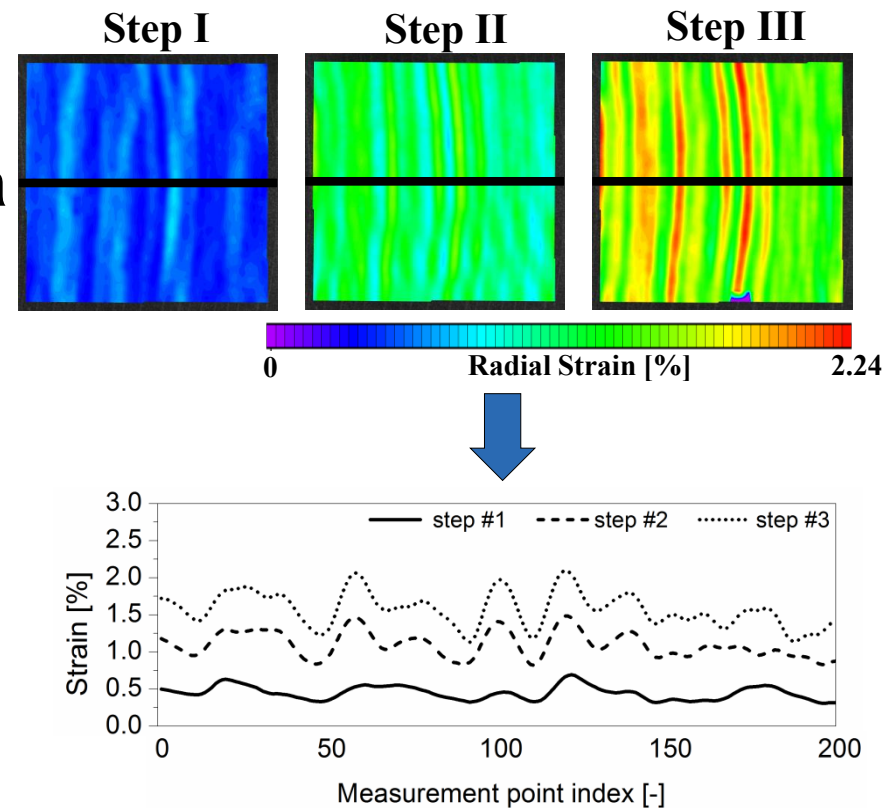
Differences in Lignin content



- Different lignin content within EW and LW cell walls clearly visible

Outlook

- Application of DIC
- Extraction of deformation data
- Quantitative evaluation



Quantitative Correlation

- Local density
- Local cell geometry
- Local microfibril angle



- Local strain

Conclusions

- A method is presented to create a consistent set of data as a basis for the explanation of the anisotropic behavior of wood towards changes in its moisture content

A blue-tinted photograph of a large building with a prominent dome, likely a historical or institutional structure, set against a landscape with mountains in the background.

Thank you for your attention!