SURGE – Workshop

09.-13.05.2016

Advances in Production Ecology and Dendroceoclogy

Field and Laboratory Methods of Dendroecology

Field and Laboratory Methods of Dendroecology

Field methods

- Stem analysis
- Increment core analysis
- Microcore analysis
- Dendrometer measurement.

Laboratory methods

- Anatomical analysis - macroscopic
  - microscopic
- Density analysis
- Hardness analysis
- Isotope analysis
- Chemical analysis

Research concept

- Hypotheses
- Research question

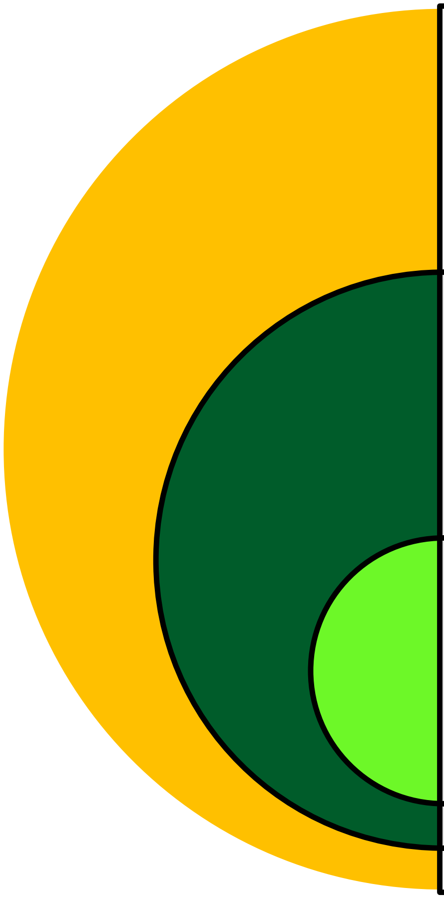
- Experimental or observational study?

- (Target) Population
- Sampling unit
- Sampling method, sampling design

- (Response) Parameter
- Measurement method
- Analysis method

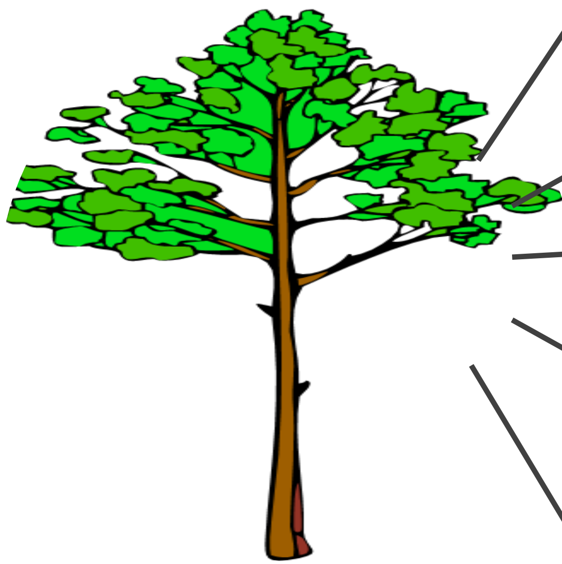
Parameter: e.g.
- tree-ring width,
- radial increment,
- height increment,
- volume increment,
- biomass increment,
- change in form factor

Field methods: Sampling



Site selection	• soil type • topography • aspect, …
Stand selection	• age distribution • species composition, …
Tree selection	• species • crown class • dbh-class, …

Field methods: Growth parameters



Tree-ring width
- Increment core

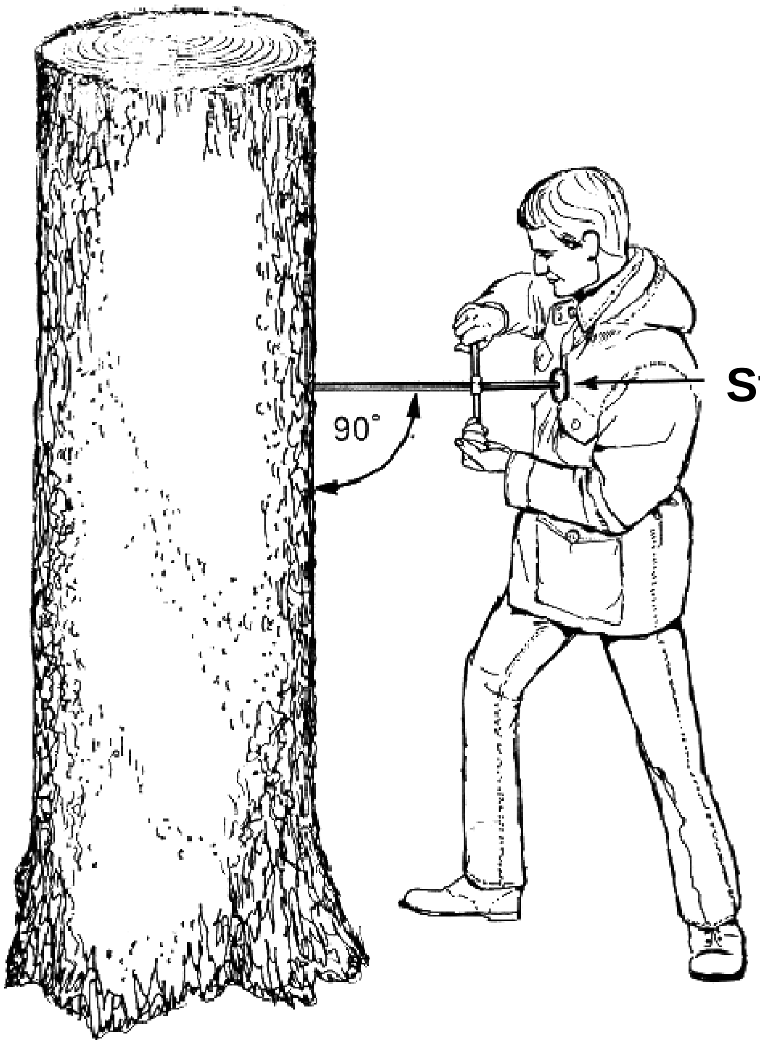
Radial growth
- Cross section

Height growth
- Stem analysis

Changes in form factor
- Stem analysis

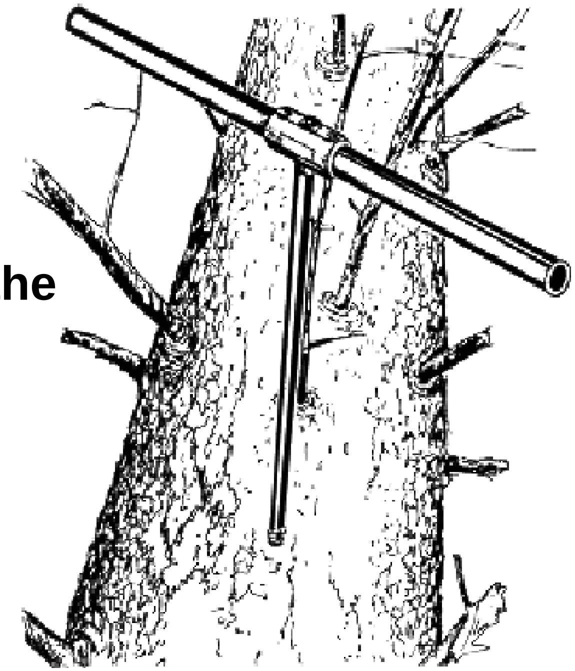
Volume growth
- Stem analysis

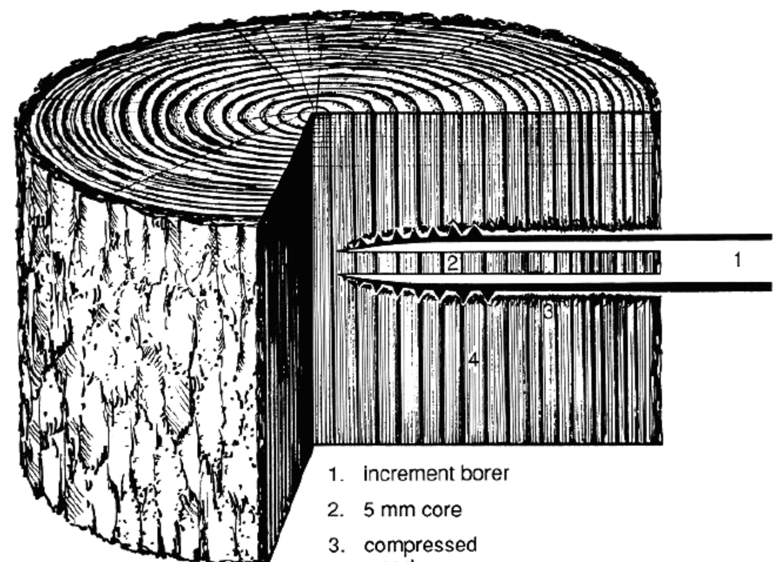
Application of increment borer



Starter-aid

Hitting the centre





1. increment borer
2. 5 mm core
3. compressed wood
4. vertical grain orientation

(Jozsa 1988)

Increment borer: Borer types

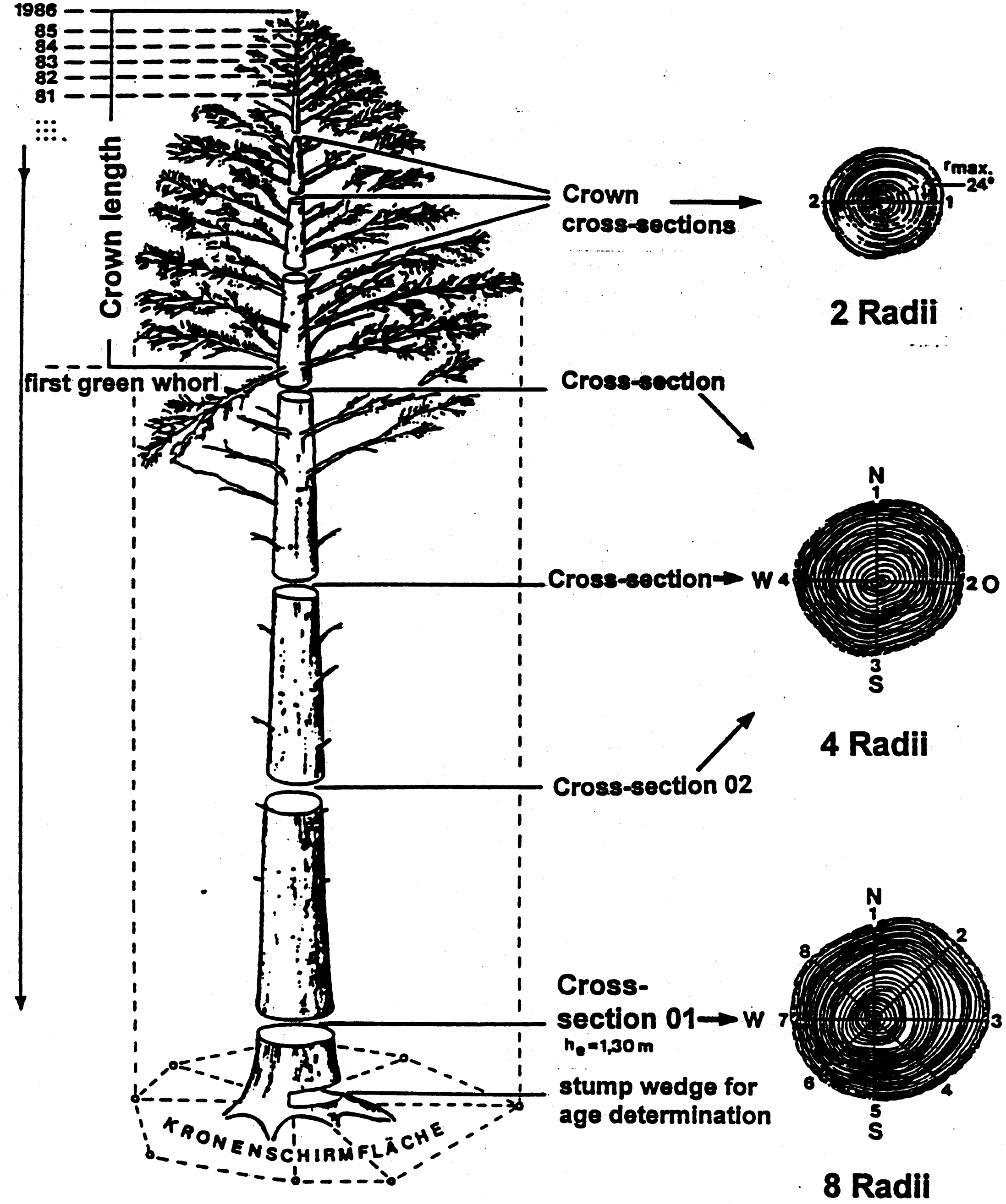
THREADINGS:

There are two different kinds of threading on our borers: 2- or 3-threading. The 2-threading is more suitable for hardwood, since it turns slower in the tree (*8 mm per turn*) and generates more strength when drilling. The 3-threading will be faster and easier when penetrating the tree (*12 mm per turn*).
A 3-threaded borer is 66% faster than a 2 threaded.

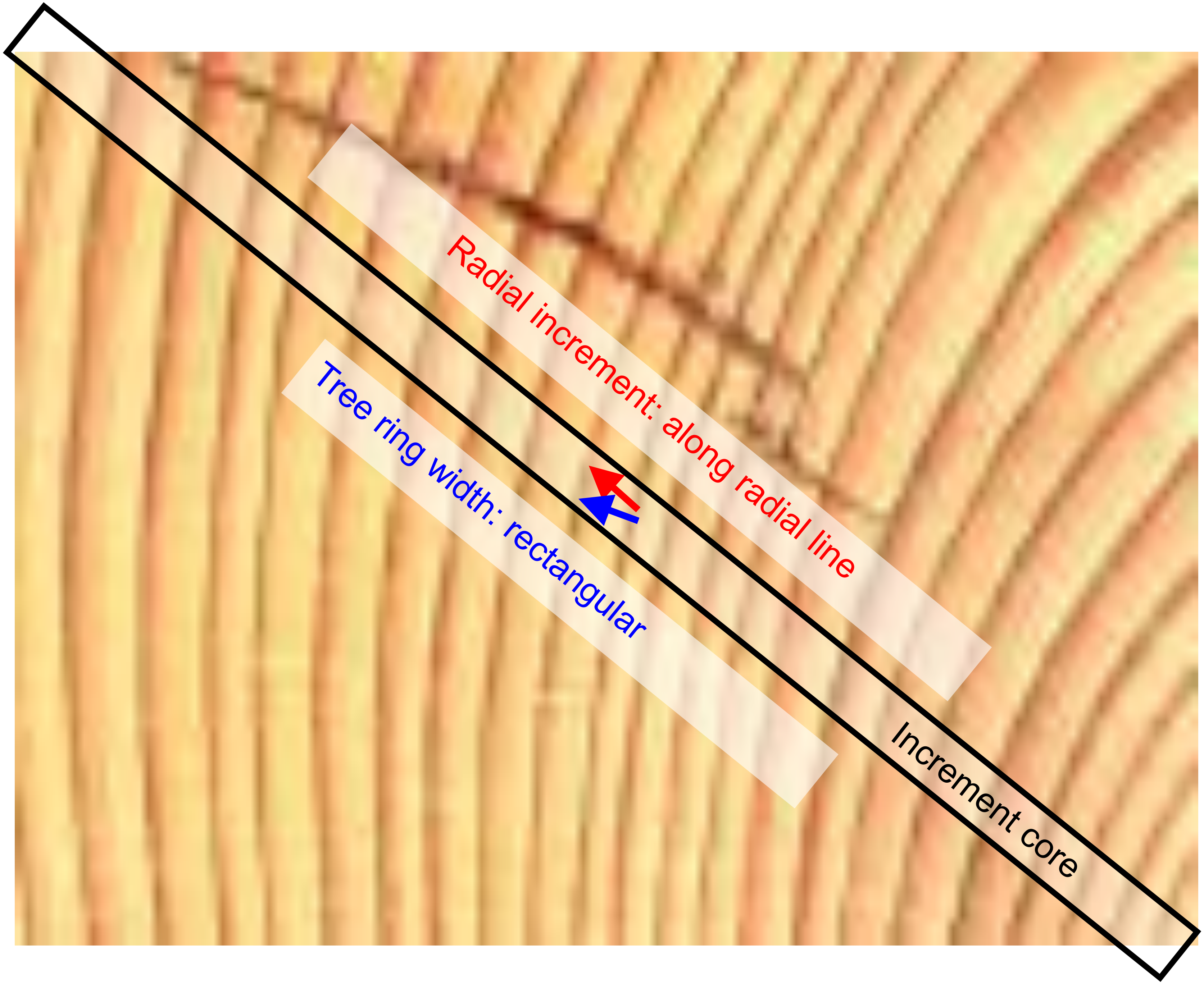
(Haglöf 2005)

Stem analysis

- Height analysis
- Analysis of cross-sections



(acc. to Gerecke, 1988)



Radial increment: along radial line
Tree ring width: rectangular
Increment core

Trephor - Tool for extracting microcores

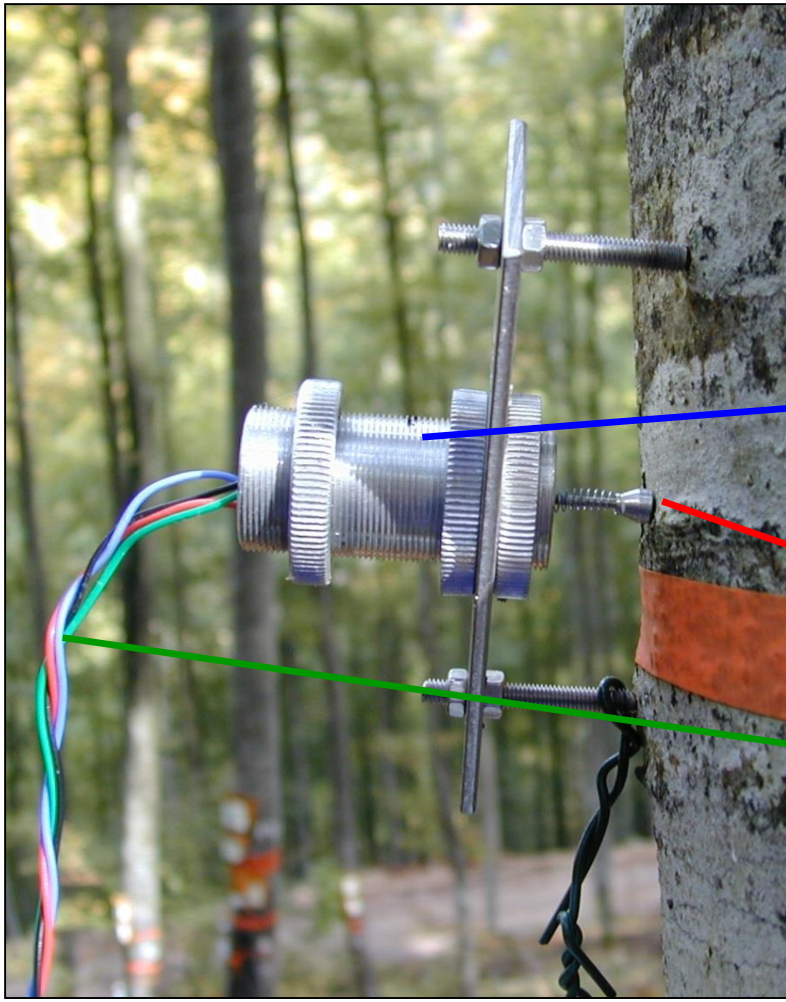
The tool driven in the trunk.

Use the “extracting needle” and push slightly the microcore on the top.

Trephor - Tool for extracting microcores

The microcore is ready to be kept in a storage container.

Point dendrometer (mounted on a beech stem)



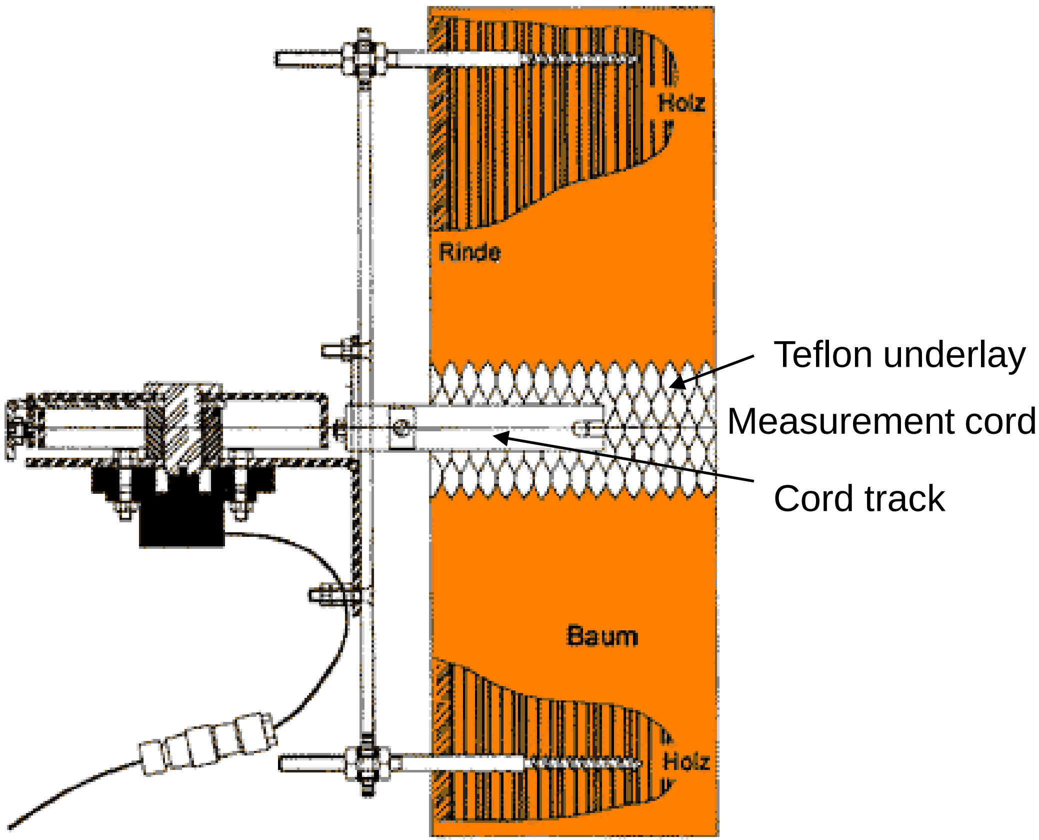
Stainless steel body with displacement transducer

Sensor head

Cables to datalogger

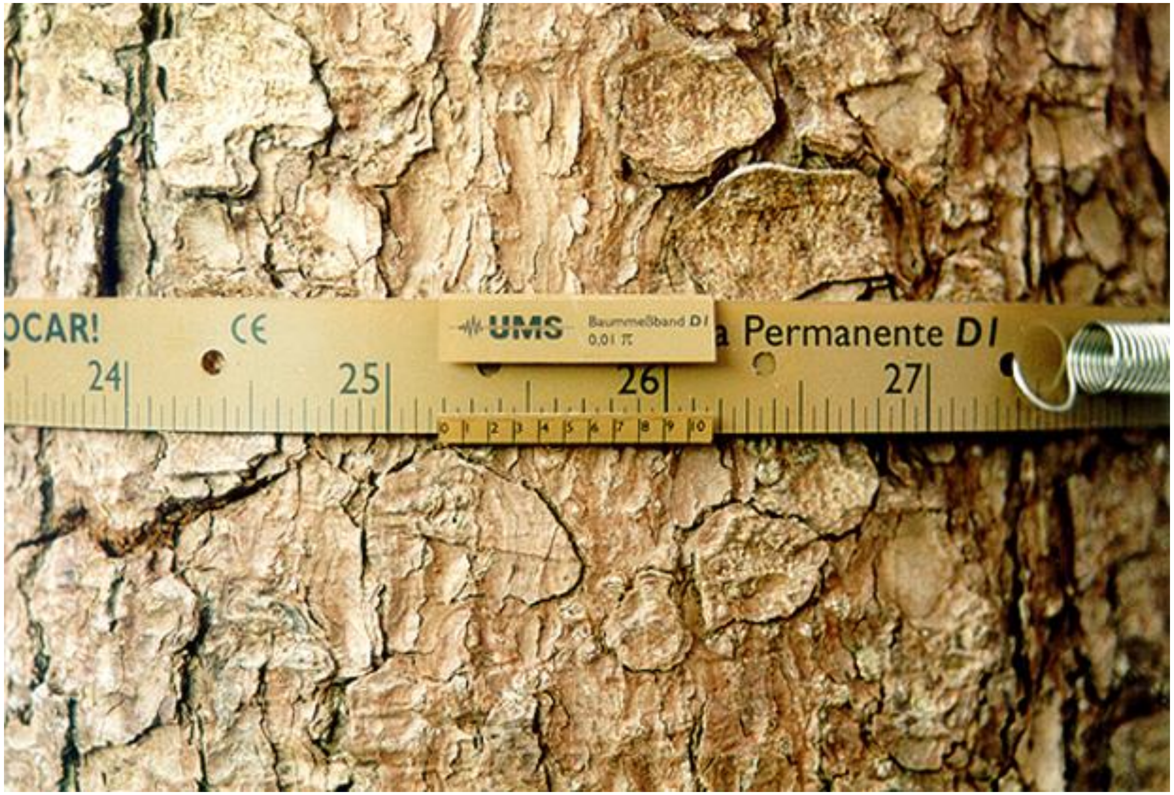
5 cm

Band dendrometer: Type UMS-Dial-Dendro



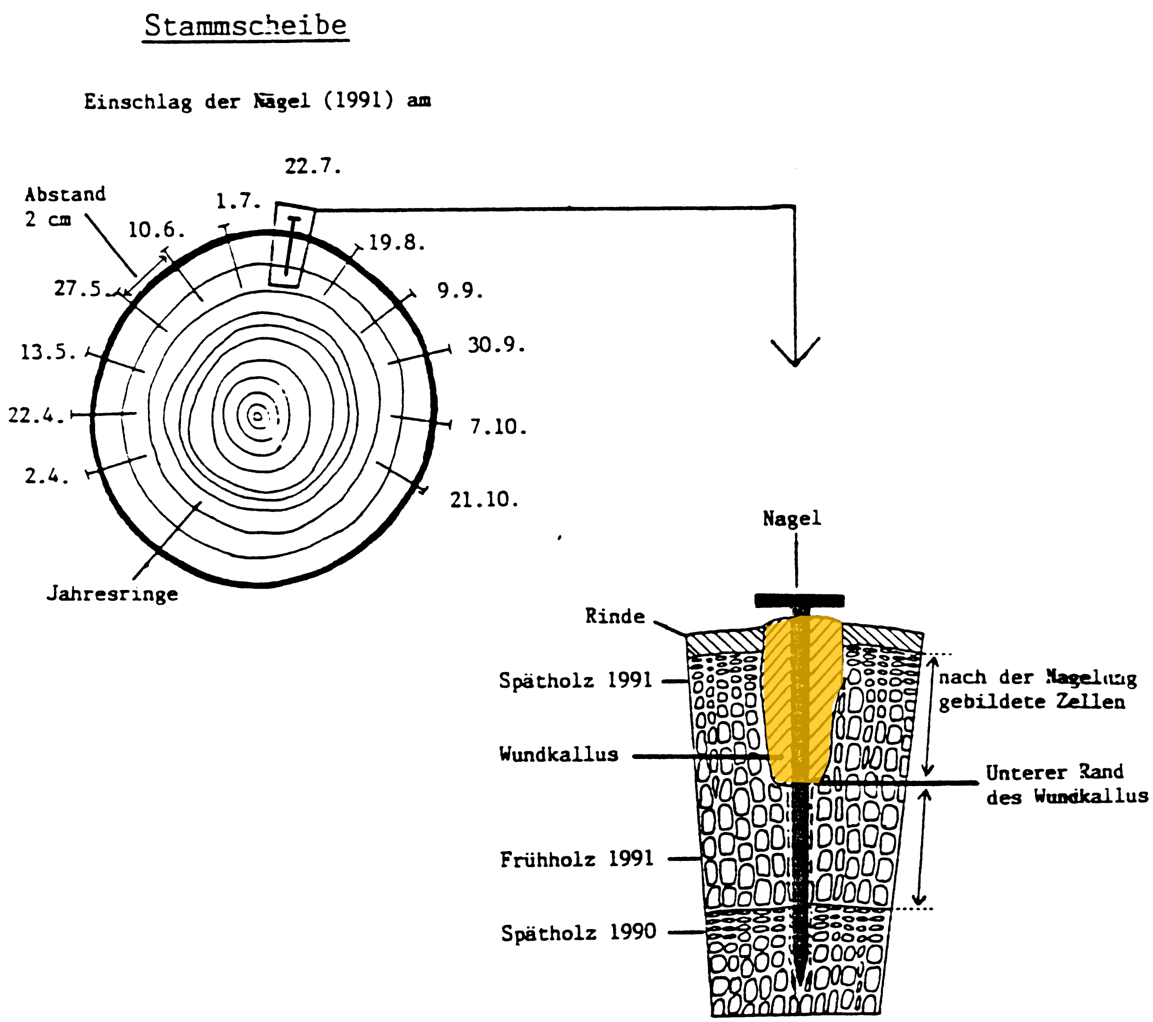
Permanent circumference band

- Weatherproofed material with small temperature expansion coefficient (*e.g.* Astralon)
- Scaling in Pi-units (0,05 Pi x cm)
- and Nonius for fine scaling (0,01 Pi x cm).



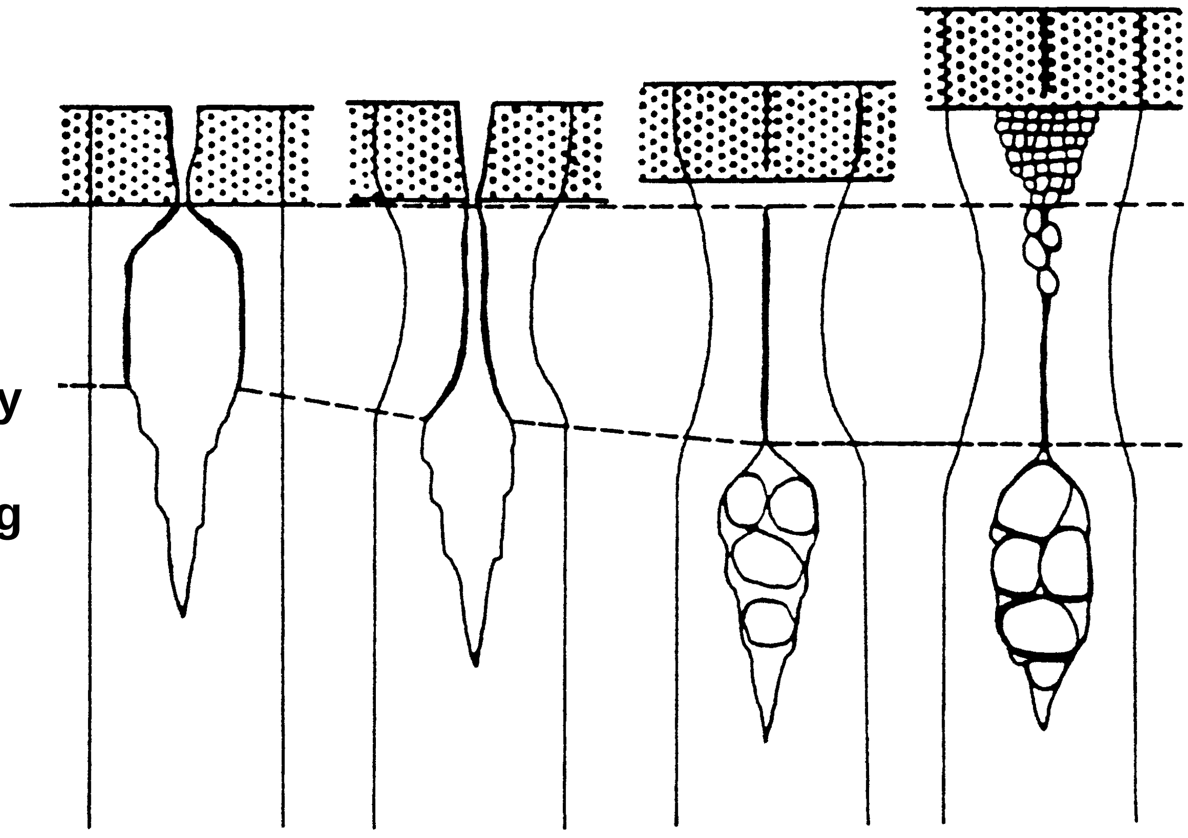
Cambial-marking:

Pinning-method



ABETZ, P.; E. KÜNSTLE und A. WOLFART 1993

Cambial-marking: Pinning-method



(Fink 1999)

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Tree-ring measurement system

Purpose: Image analysis based semi-automated measurement of annual radial increment on wood cross sections.

Output: Annual radial increment, grey value profiles, digital images with ca. 900 dpi resolution.

Components:
- Base frame
- Pneumatic clamping and support system
- Measuring slide (diameter of discs max. 100 cm)
- Digital USB camera 1280 * 1024 pixels
- Software modules: “*Foto*“ and “*Woodscan*”
- “*Foto*” provides the array of images of one radius or one diameter with 2 radii in a special format (.rad)
- For “*Woodscan*” see separate poster

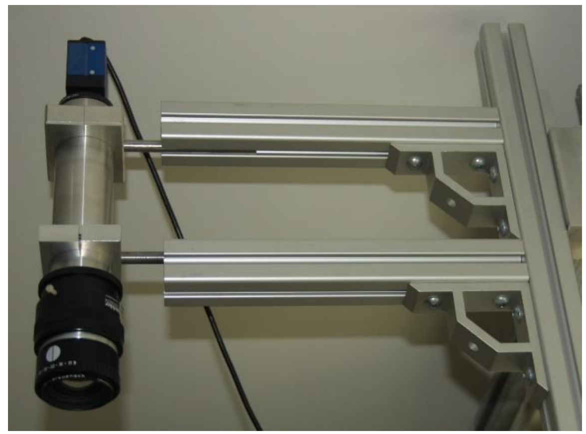


Fig. 1: Digital USB camera.

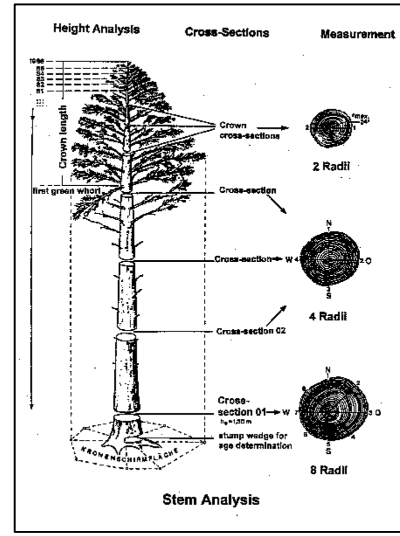


Fig. 2: Schematic diagram of stem analysis.

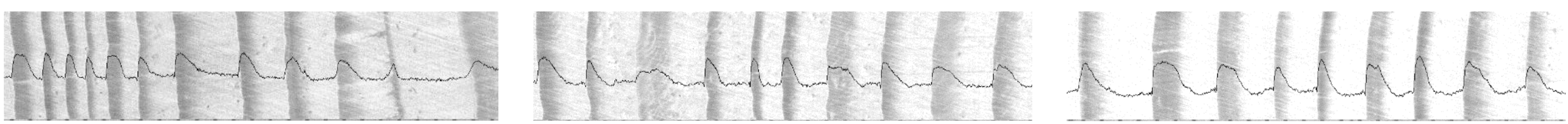


Fig. 3: Picture detail of Norway spruce cross sections with grey value profiles (black).

Specifications: Max. length of measurement range: 100 cm, width: 4-15 cm, resolution: 36 pixel/mm, 256 grey values.
Options: Measurement of tree cross sections and increment cores.

Digitalpositiometer System Johann

Purpose: Measuring tree-ring width or annual radial growth.

Output: Tree-ring width resp. annual radial growth series.

Components:
- Measuring system after Johan
- Measuring resolution: 5 µm
- Johann “small“: measurement of tree-ring width and annual radial growth
- Johann big: measurement of annual radial growth

Fig. 1: Measurement and comparison.

Fig. 2: Johann “small“.

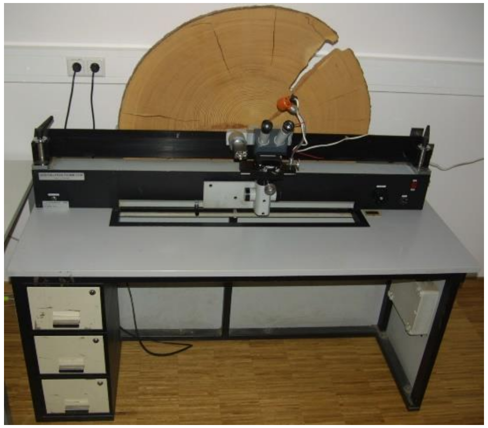


Fig. 3: Johann “big”.

Software module “*Woodscan*”

Purpose:

Automatic recognition of tree rings and determination of tree-ring width or annual radial growth.

Output:

Tree-ring width resp. annual radial growth.

Options:

- Dating of tree-rings
- Correction of the measurements (when required)
- Determination of tree-ring width or radial growth
- Convert the format of the image from .rad in .tga or .bmp
- Visualising wood density profiles

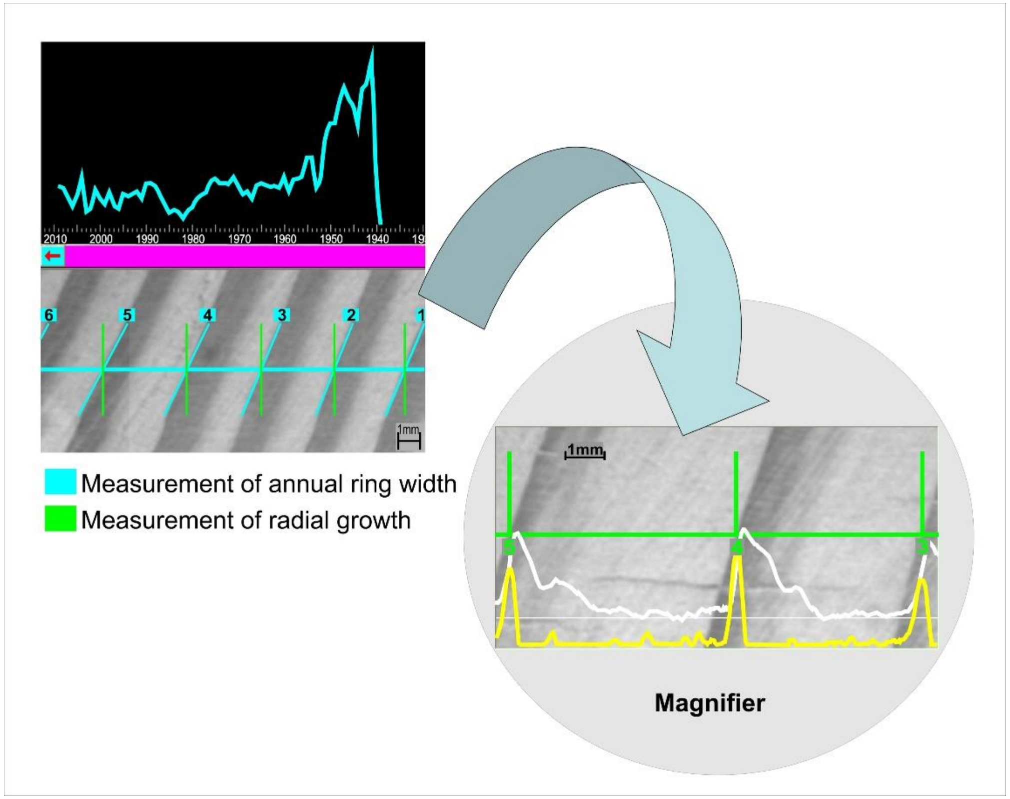


Fig. 1: Determination of tree-ring width and annual radial growth and the function of the magnifying glass.

Ultra-precision milling machine

Purpose: Preparation of wood samples for high-resolution image analysis and HF-densitometry.

Output: Sample surfaces with low roughness (deviations < 1µm) and very low sub-surface damage regions.

Main components: Base table, diamond flycutter equipped with air bearings, rotating single-point diamond tool, dust extraction system.

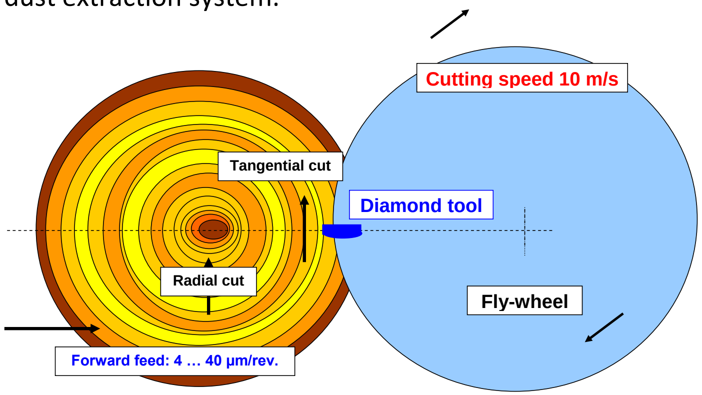


Fig. 1: Schematic diagram of the single-point diamond flycutter.

Specifications: Cutting and processing time depends on sample size, linear motion feed rate, and flycutter speed.

Options: Various diamond tools with different edge microgeometry to ensure high-quality preparation and long tool-life.

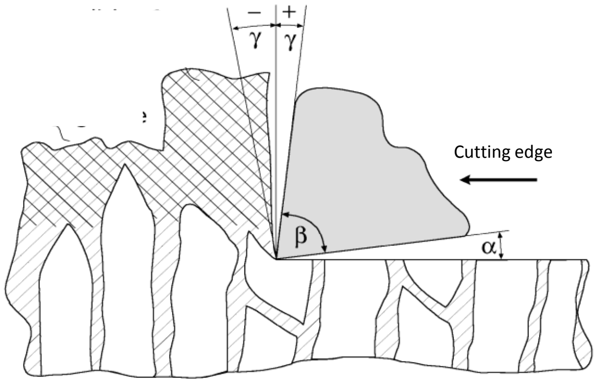


Fig. 2: Details of the cutting edge micro-geometry of the diamond tool and angle to the direction of the fibres.

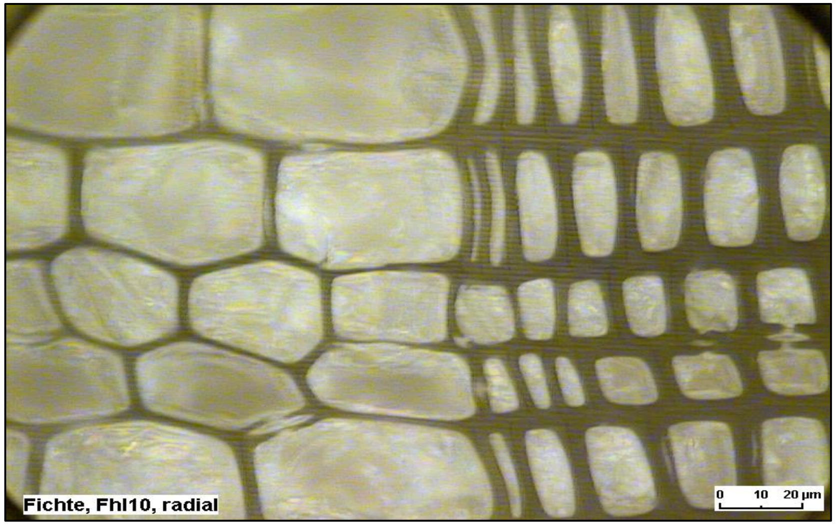
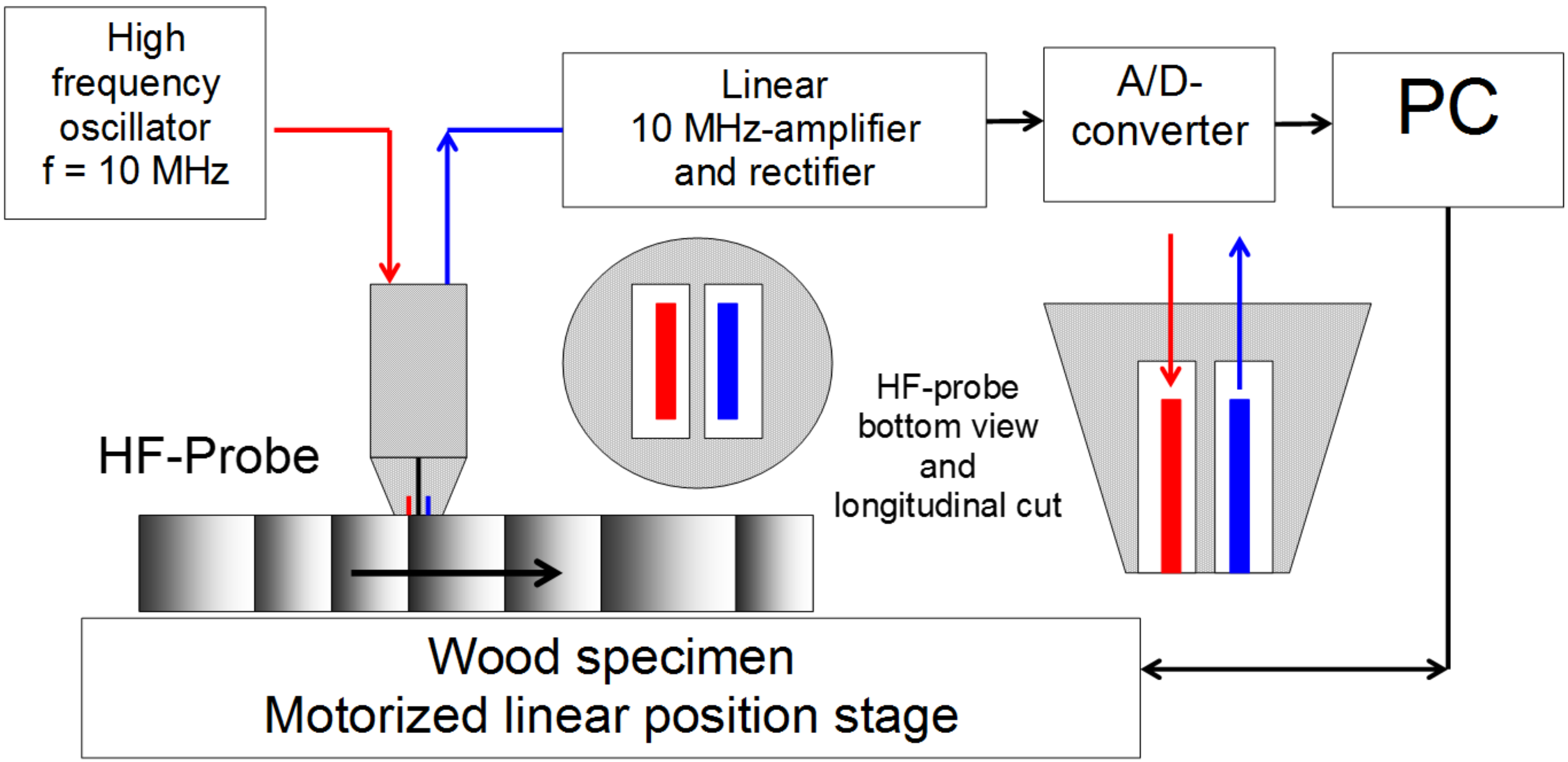


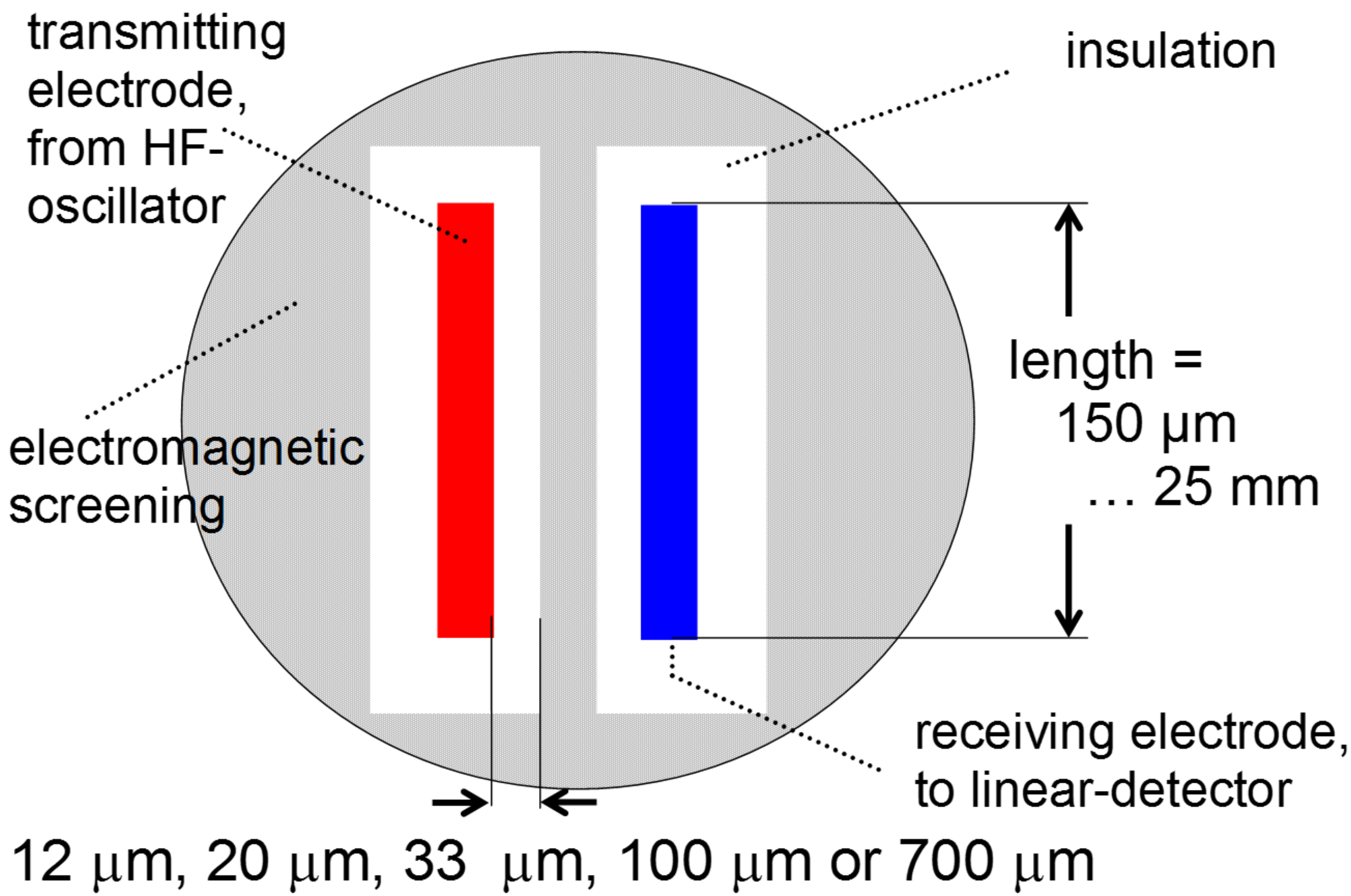
Fig. 3.: Detail of an ultra-precisely cut spruce cross section in the area of a growth ring boundary.

Principle of High-Frequency Densitometry



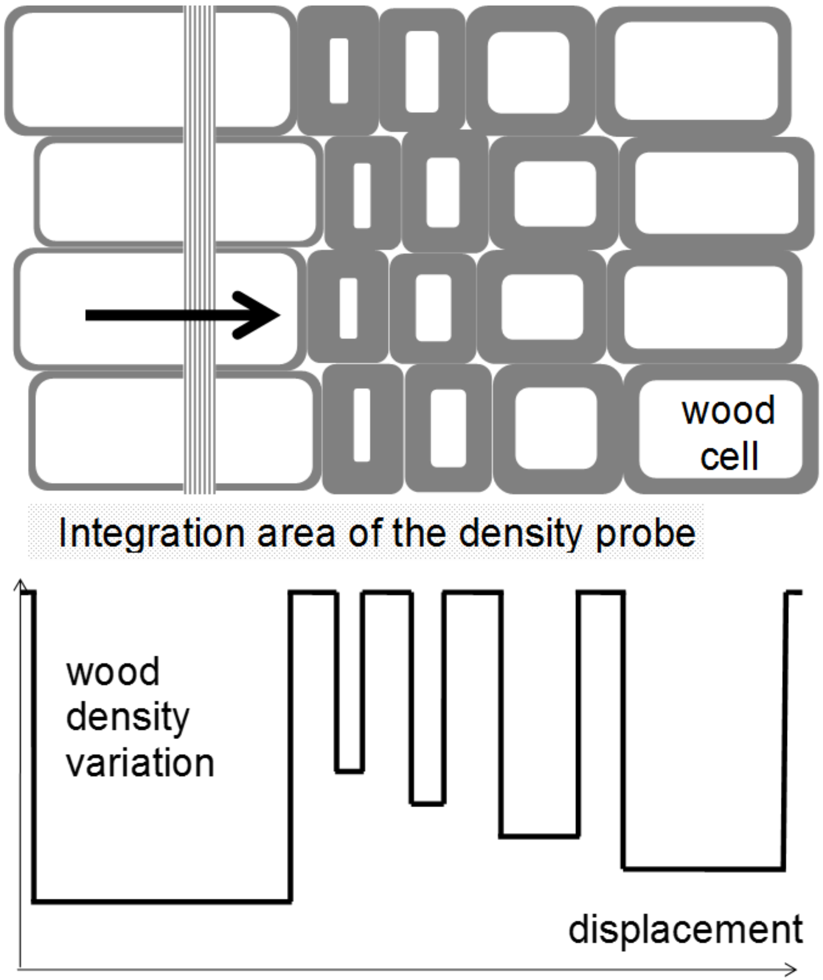
(Schinker, unpublished)

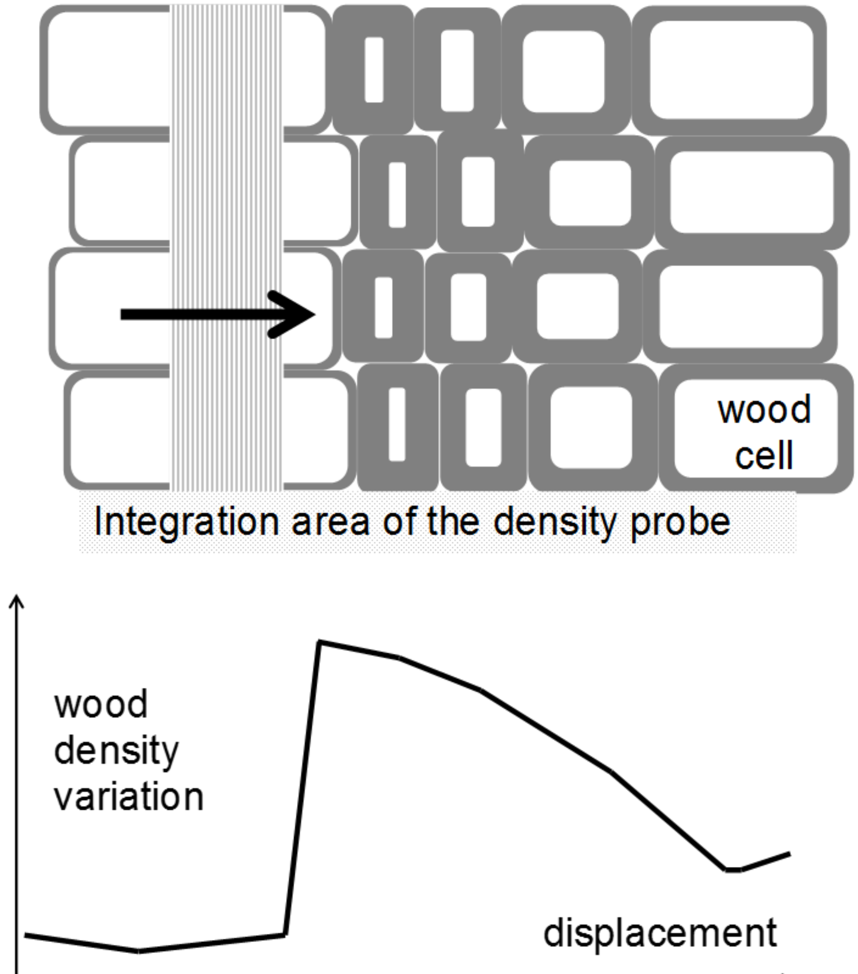
Footprint of a dielectric density probe



(Schinker, unpublished)

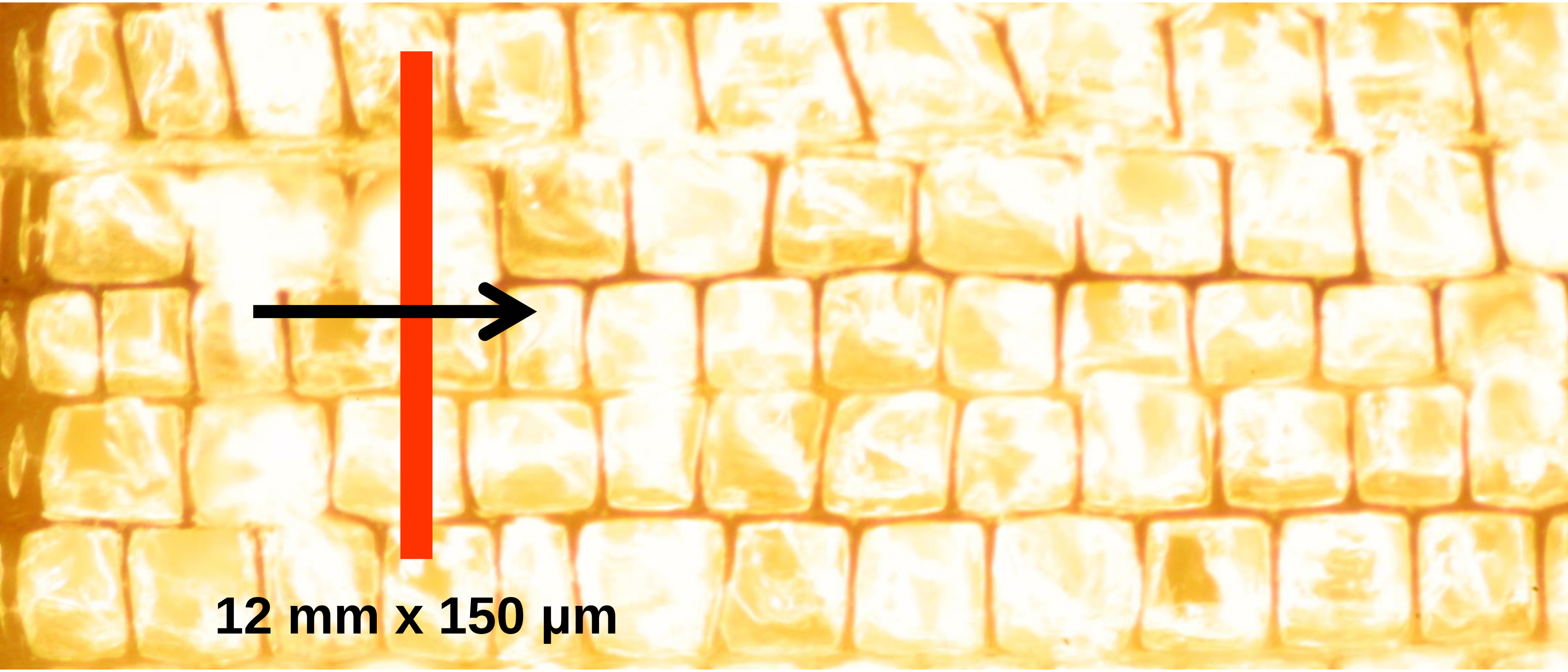
Integration area size of HF-density probe





(Schinker, unpublished)

Micrograph of a diamond machined Norway spruce

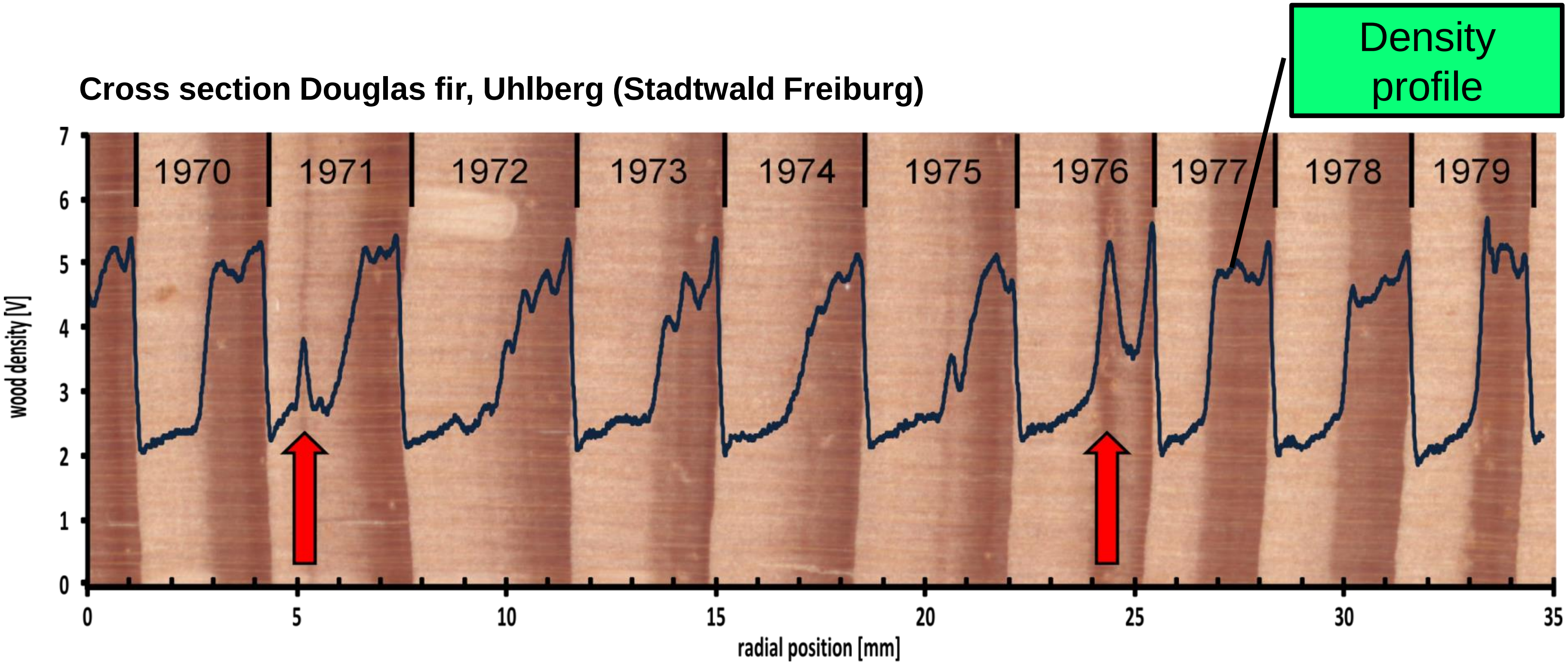


The red bar is indicating the 12 mm x 150 µm large integration area of the HF-probe.

(Schinker, unpublished)

Drought stress tolerance of different Douglas fir (*Pseudotsuga menziesii*) provenances

Cross section Douglas fir, Uhlberg (Stadtwald Freiburg)



Intra-annual density variation

1971: drought in May

1976: Drought in June

(Bender in prep.)

Microscope for cell structure measurements

Purpose: Analysis of cell parameters.

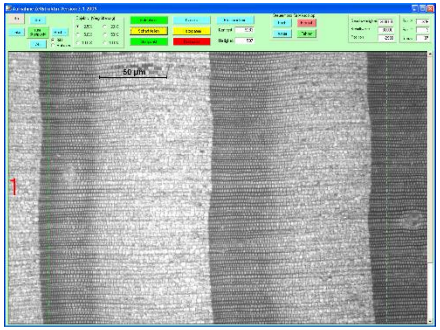
Output: Images of cell structure.

Components:

- Zeiss Microscope with diverse lenses (2,5 10 20 50 100 fold)
- USB-camera 1280 * 1024 pixels, 256 grey values

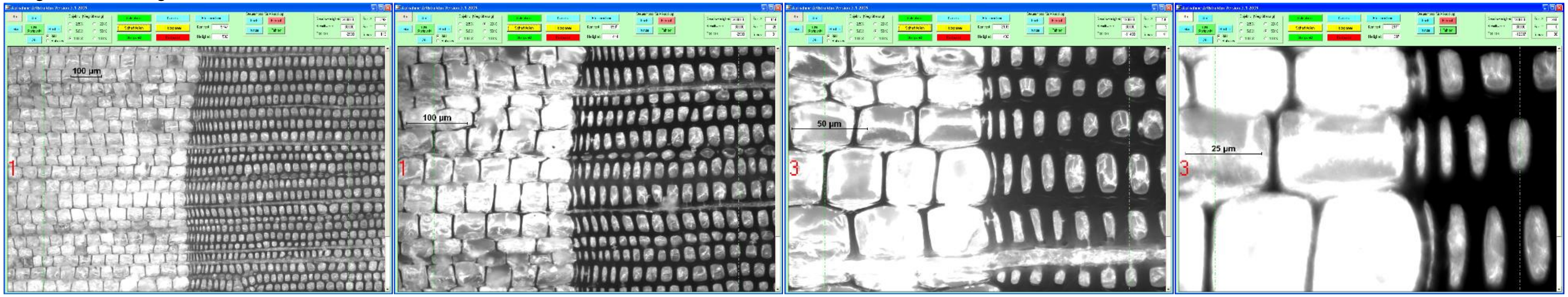
Options:

- Program *Mikroskop*:
  » automatical focussing
  » photographing of single images or image series
  » individual photos are merged in digitized image arrays



2,5x

Fig. 1: Result of maginification with different lenses.



10x

20 x

50x

100x

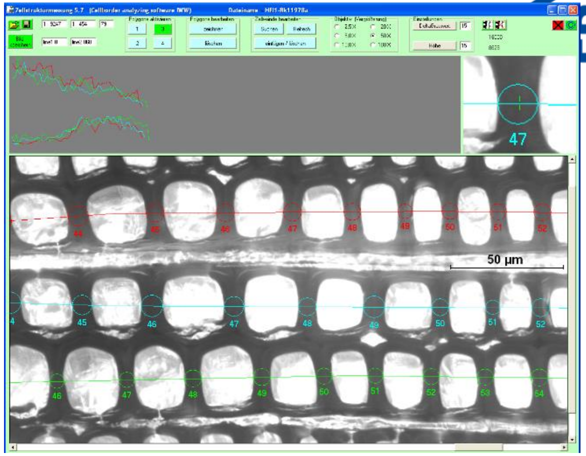
Computer-assisted analysis of digitized images

Purpose: Efficient measurement of cell structures on wood samples.

Output: Time series of various cell parameters (tracheid diameter, number of tracheids, cell wall thickness, vessel area, diameter of vessel volume, etc).

Main components:
- Software packages adapted to individual cell characteristics
- Black-and-white video camera connected to a reflected-light microscope

Specification: Software selects and reassembles digitized image arrays of complete radii. Cell parameters are identified and marked automatically on the basis of differences in grey values and of pattern recognition.



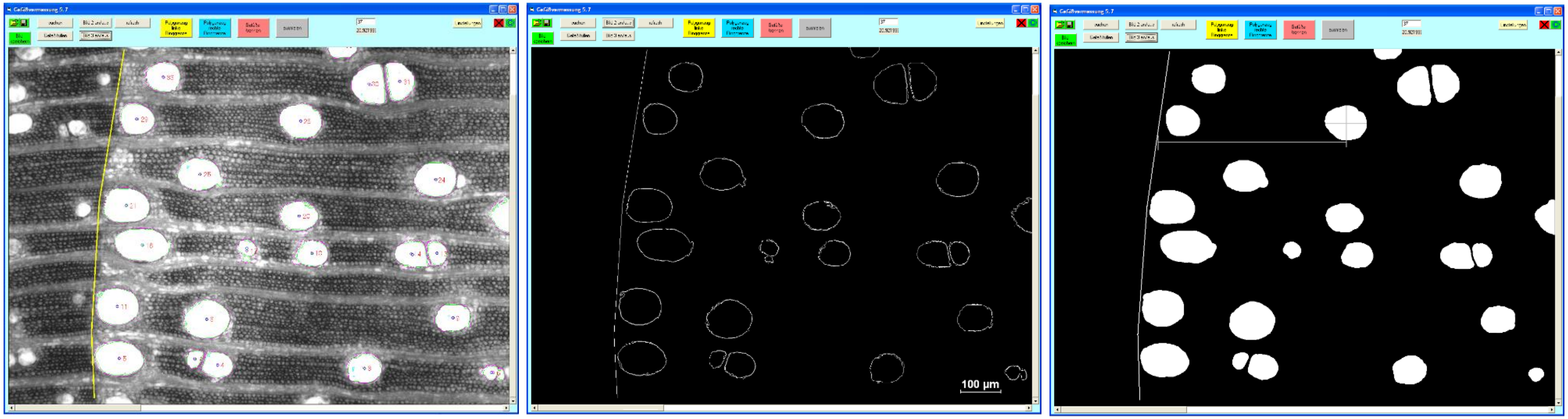


Fig. 1: Details of the digitized image analysis based on grey value differences.

Hyperspectral image analysis

Purpose: Analysis of the reflectance properties of wood surfaces for the detection and classification of wood tissues such as c in reflected light.

Output: Four-dimensional hyperspectral image data set with optical spectrun components at visible light and near infrared of an p

Main components:
- Imaging spectograph (ImSpector V10, Canon objective and Teli camera)
- Halogen lamp (150 W, 21 V EKE) with fibre line and white standard
- PC and Software modules (SpectralScanner & ENVI/IDL)

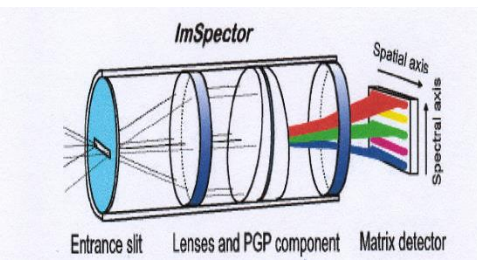
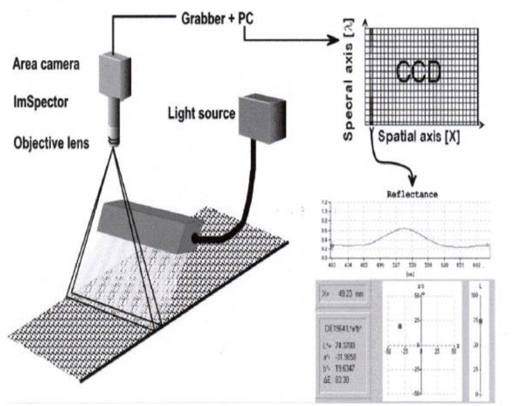


Fig.1: Schematic of the ImSpector imaging spectograph showing also the simultaneous spatial (line) and spectral mapping with an area detector.



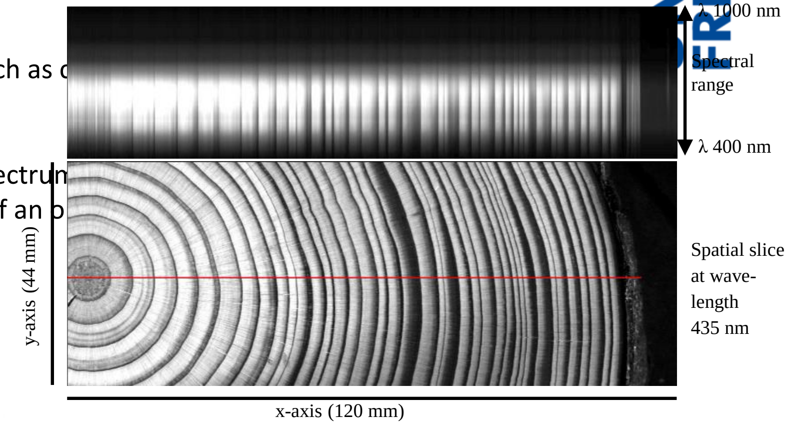


Fig. 2: Spectral slice at y_{278}-sample line (red).

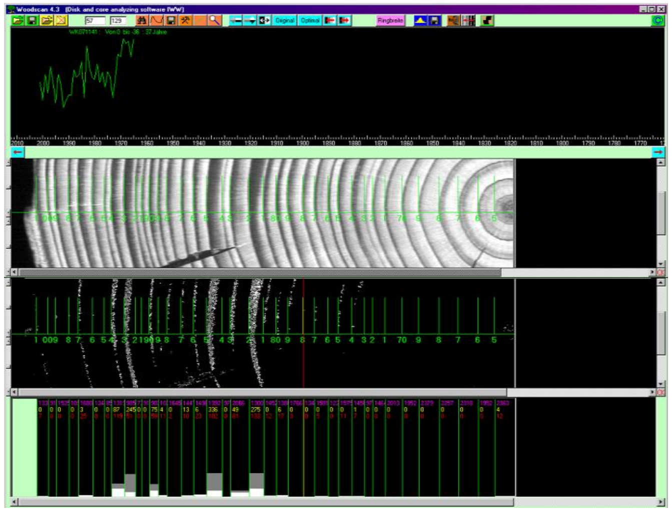


Fig. 3: Cross linking of the pixel classification to the tree-ring sequence.

Specification: Light intensity at wavelengths 400-1000 nm in 5 nm resolution (121 bands); spatial location (x,y-position) in resolution 0.1 - 0.079 mm.

Options: The chronological pattern of the formation of compression wood is recorded by cross linking the pixel classification to the tree ring sequence.

Identification of compression wood

RGB-Image of a *Picea abies* test radius

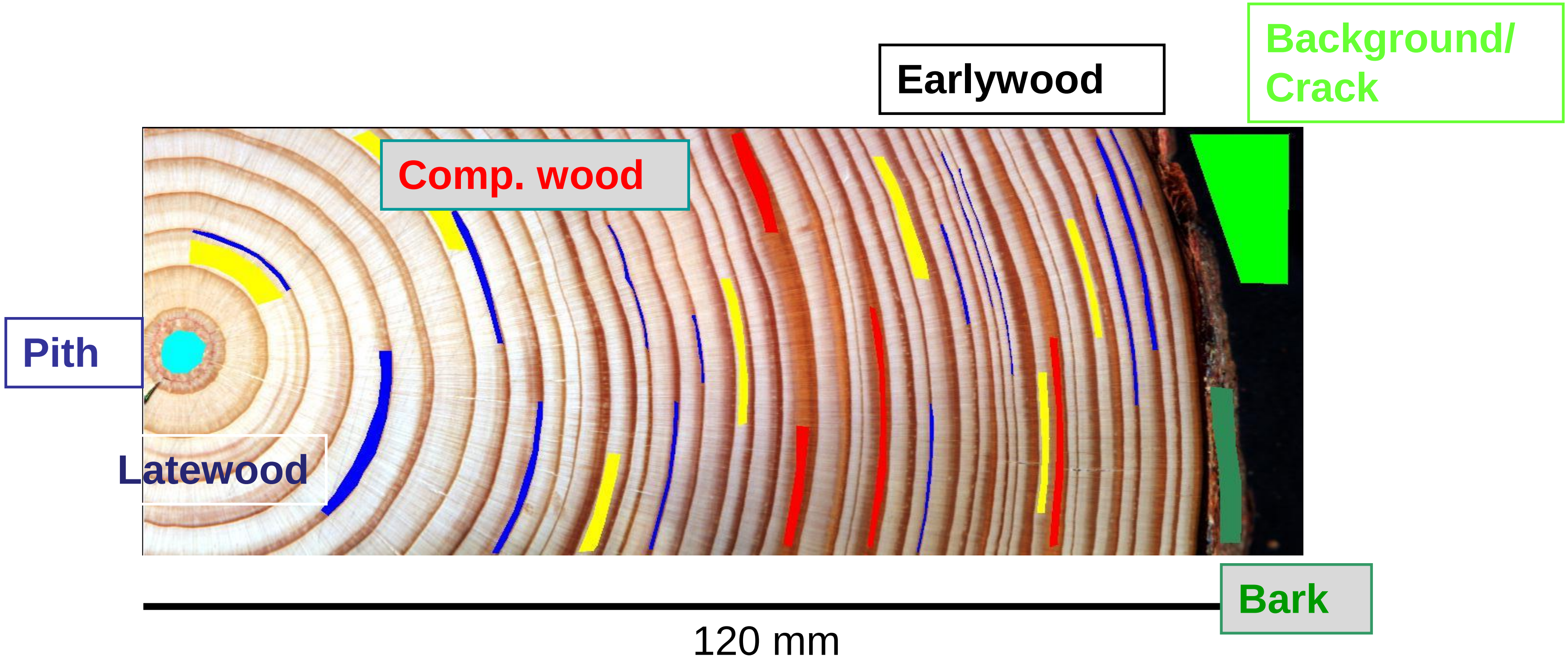
Hyperspectral scanner, spatial resolution: 0.1 x 0.1 mm²/pixel
R = 700 nm, G = 545 nm and B = 435 nm.

120 mm

(Duncker 2006)

Identification of compression wood

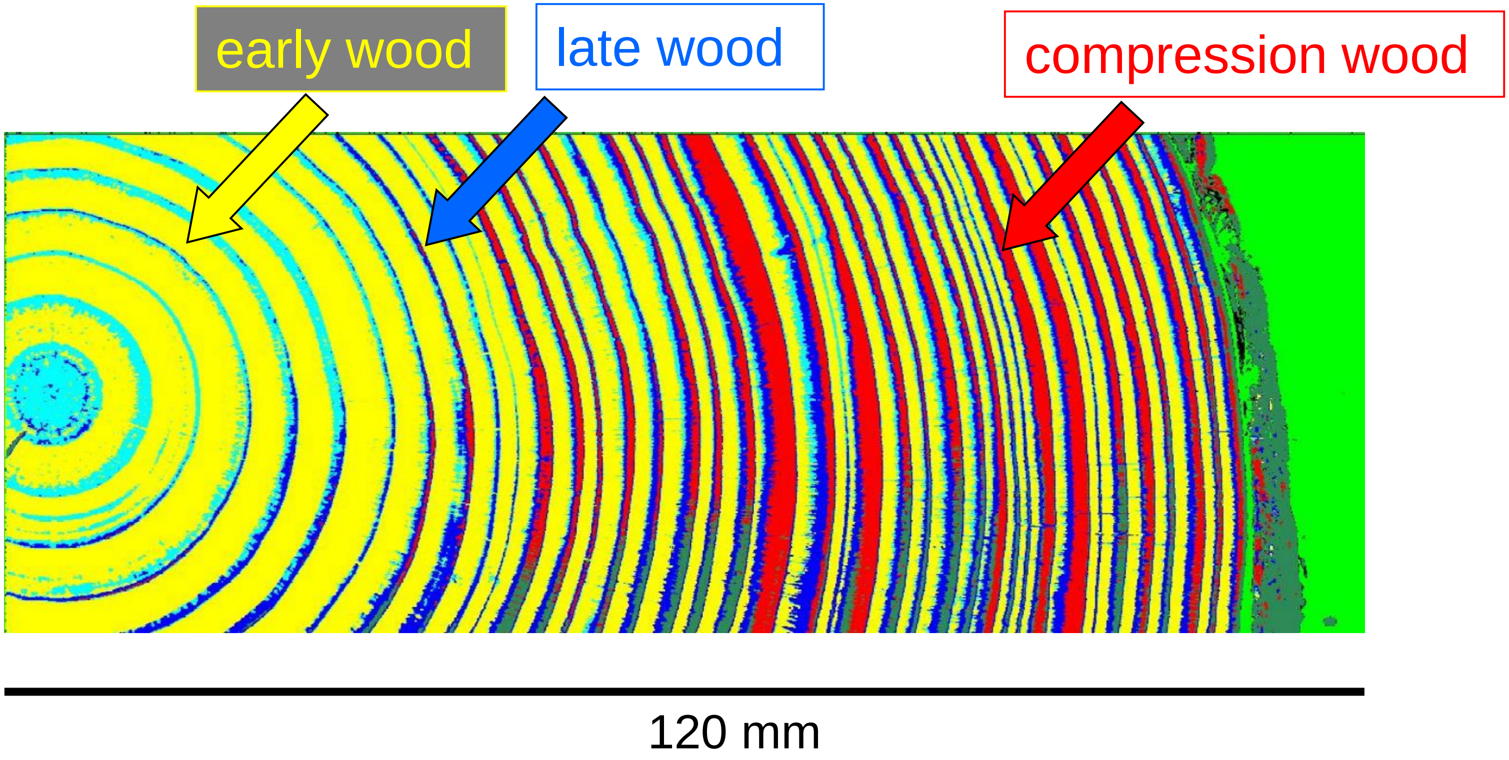
Image including defined ROI's from areas with known cell types (identified by light microscope).



(Duncker 2006)

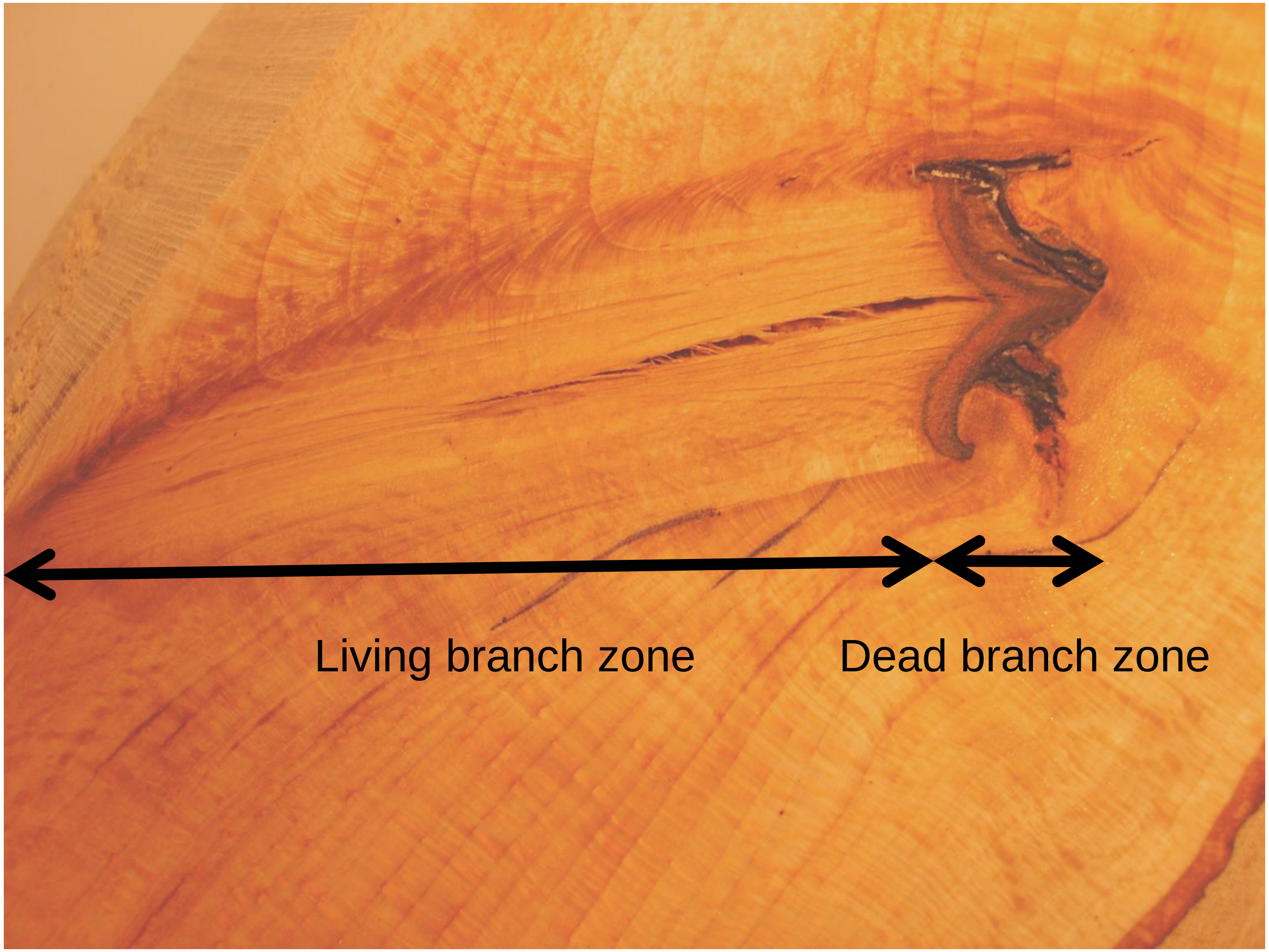
Identification of compression wood

Result of the classification with the *Spectral Angle Mapper*:



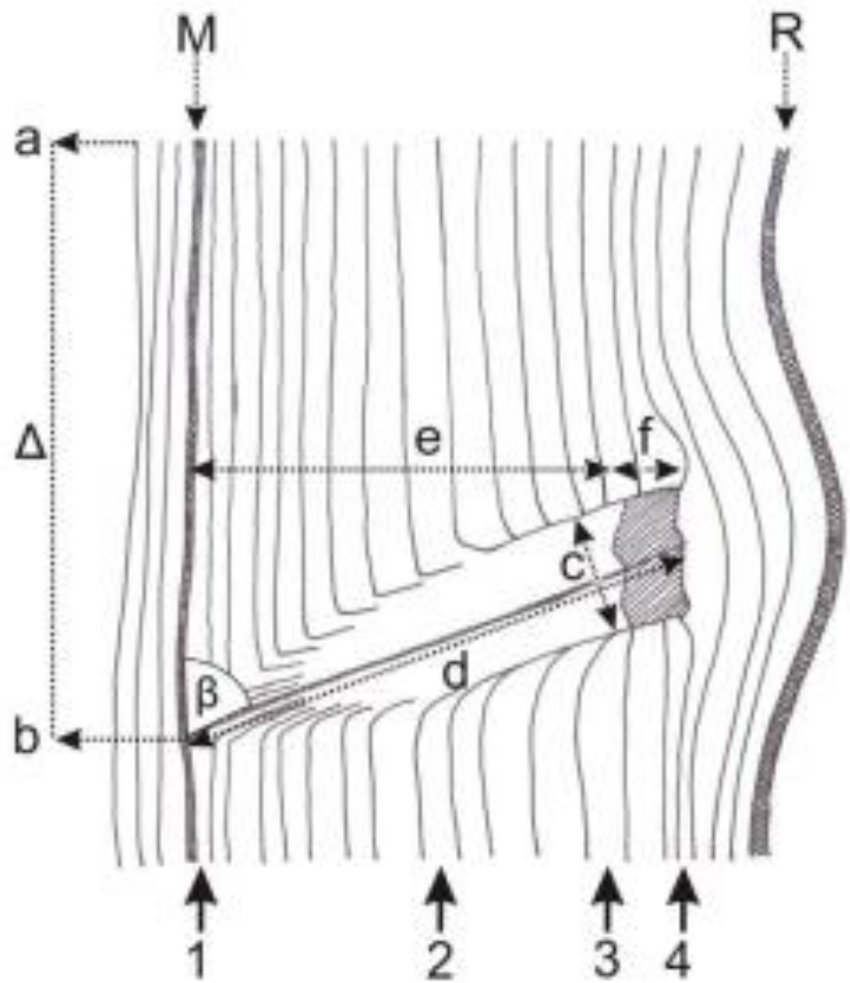
(Duncker 2006)

Branch characteristics (*Fagus sylvatica*)



(Schuler 2009)

Radius of wooden core with branches



e+f= Radius of core with branches

(Schuler 2011)