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FACULTY OF BIOSCIENCE ENGINEERING

Wood quality parameters to assess potential of poplar and willow clones for short rotation coppice bioenergy plantations

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Vancouver, British Columbia, Canada

IUFRO

Instituut voor Natuur- en Bosonderzoek

inbo

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UGent WOODLAB

Collaboration INBO & UGent/Woodlab

Poplars and willows at INBO

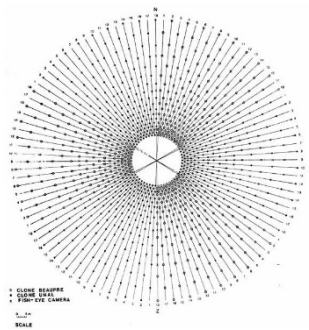
Link with 'Union Allumettière' – 'Swedish Match Group'

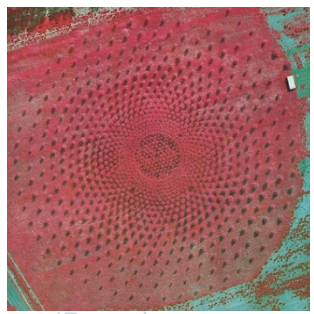
Geraardsbergen /Grammont

Poplar Institute 1948 ? Victor Steenackers

Poplars and willows at UGent/Woodlab

Center for study of Biomass 1982





IR areal

Collaboration INBO & UGent/Woodlab

Poplars and willows at INBO

Now integrated in “The Research Institute for Nature and Forest” (INBO), a scientific institute of the Flemish Government

Poplars and willows at UGent/Woodlab

Intensified interaction with poplar industry: Xylindus vzw

Long-lasting interaction with INBO both direct contract research and international cooperation, e.g. EU projects/networks

NovelTree

TREES 4 FUTURE

Pro Populus

MATERIALS versus BIOENERGY

Poplars and willows for bioenergy – specific clones and cultivation/harvesting

Multipurpose applications? Integrated wood transformation or specific production for bioenergy

MATERIALS and / or ENERGY

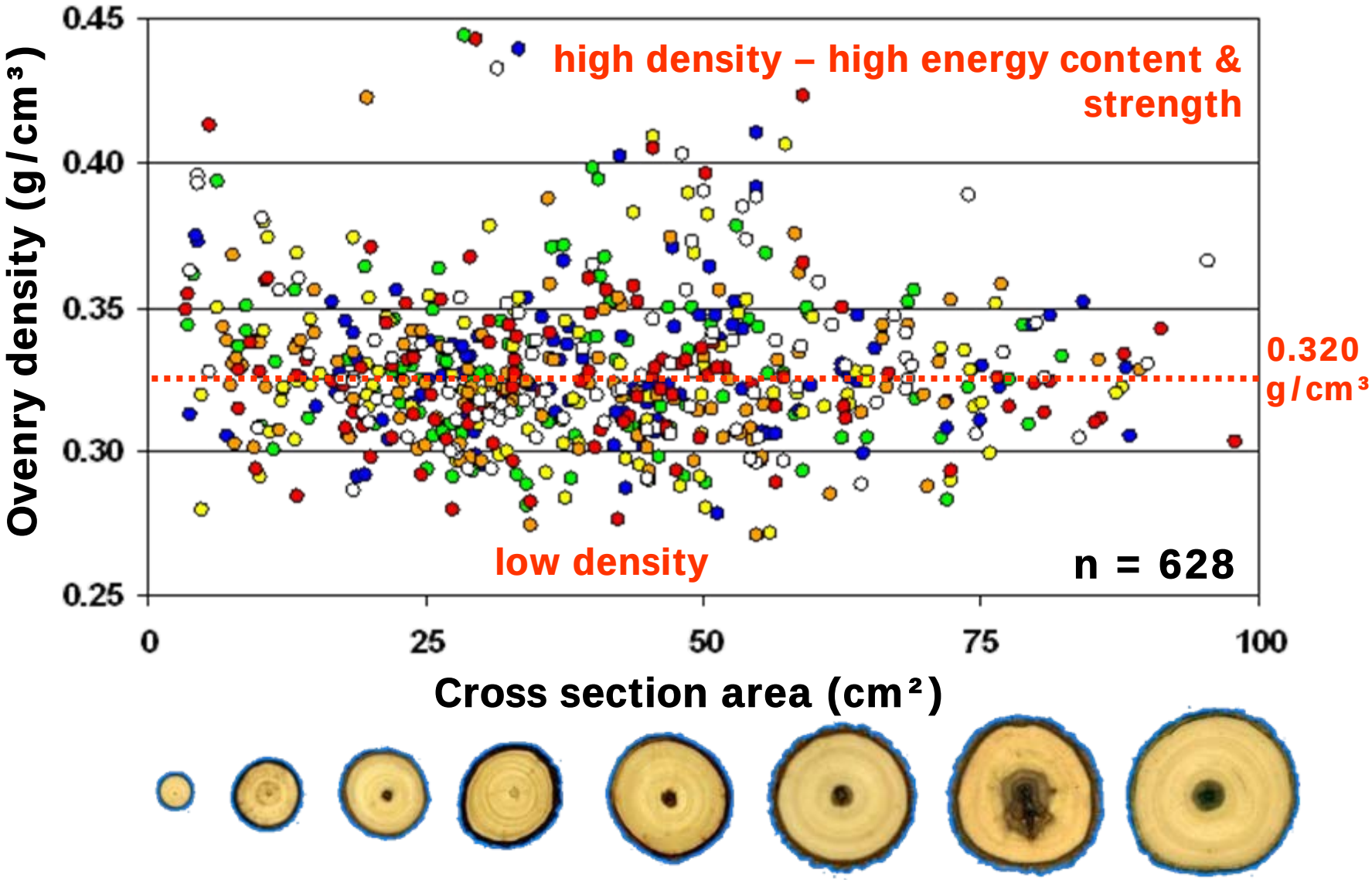
- Contradictions in selection and breeding?
- Cellulose or lignin... mechanical properties, pulp, bioenergy,...
- Bioenergy... via second generation biofuels & microbiology... Focus on carbohydrates... Lower lignin content?
- Bioenergy... direct combustion, pyrolysis,... Higher energy content... Higher lignin content?
- Can we combine or should we have specific, separate strategies?

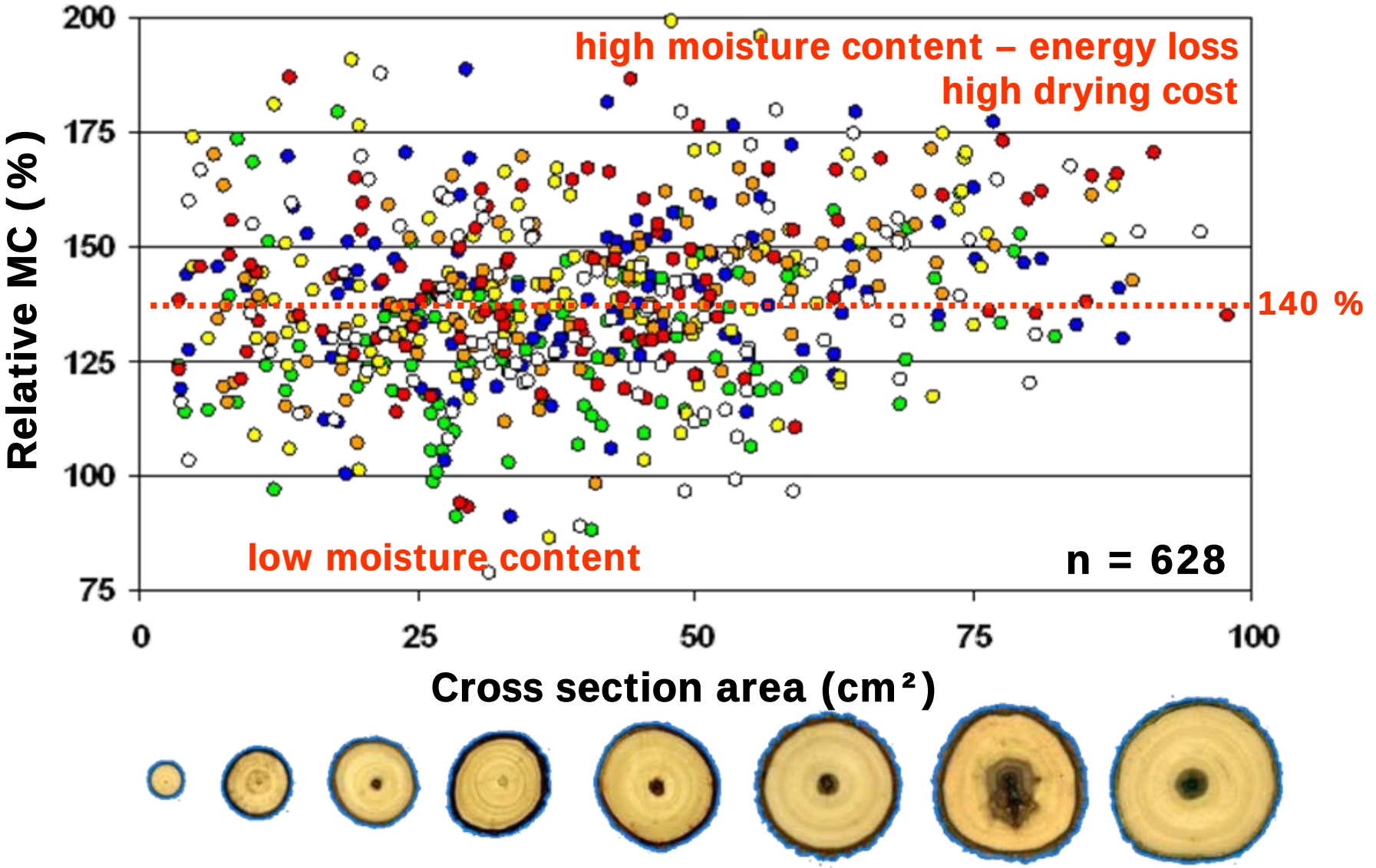
TOOLS to check WOOD QUALITY

HIGH THROUGHPUT SYSTEMS

- Micro CT scanner: structure, density
- Chemistry (cellulose, tension wood)
- Energy content, conversion potential

Possible to optimise all?


high density – high energy content & strength
low density
n = 628
0.320 g/cm³
Ovenry density (g/cm³)
0.45
0.40
0.35
0.30
0.25
0
25
50
75
100
Cross section area (cm²)


high moisture content – energy loss
high drying cost
140 %
low moisture content
n = 628
Relative MC (%)
200
175
150
125
100
75
0
25
50
75
100
Cross section area (cm²)

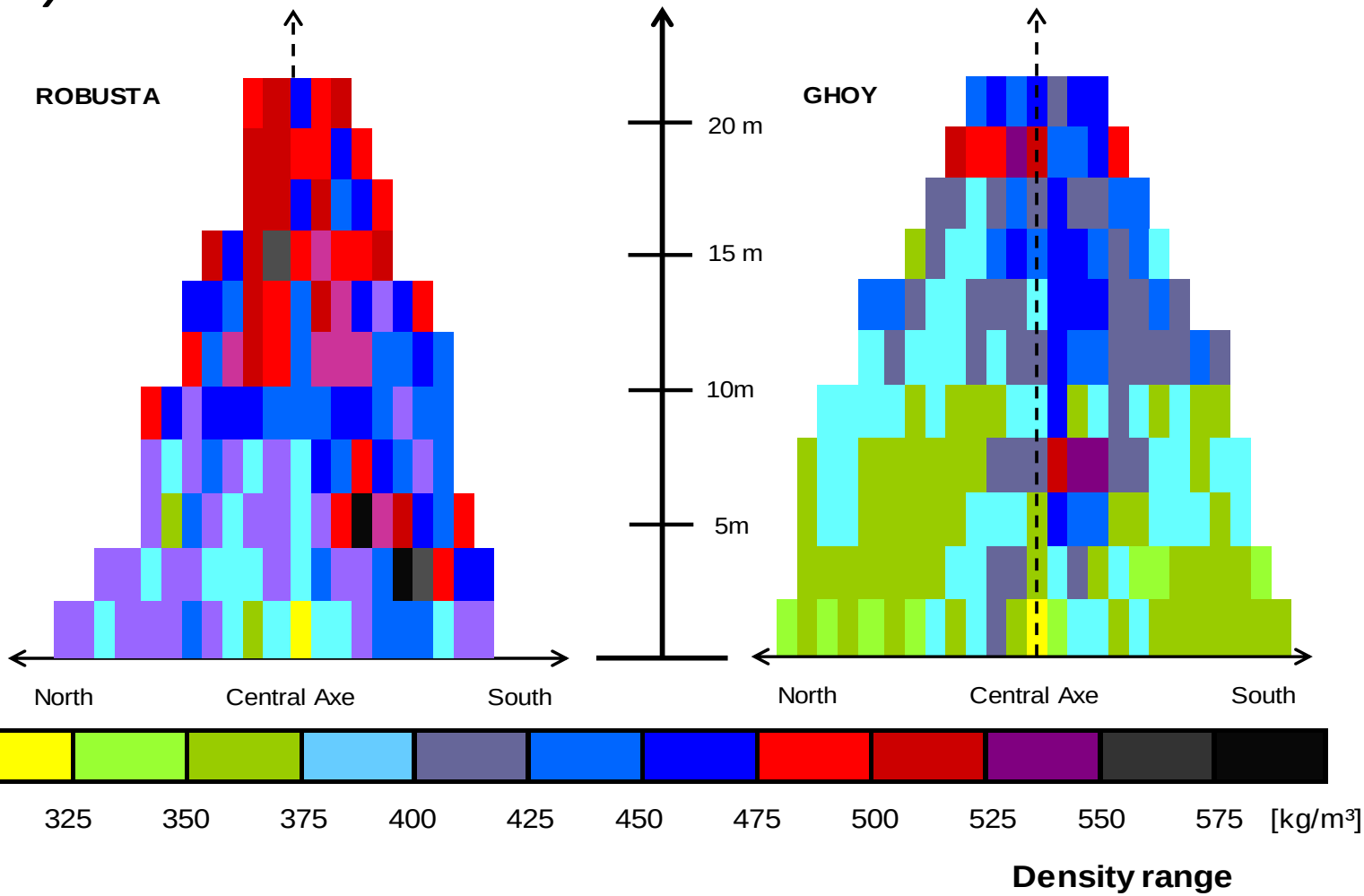
MEAN / AVERAGE - ENERGY WOOD QUALITY

Belgian * poplar clone	Density (kg/m³)	Green moisture content (%)	HHV of SRC (MJ/kg)	Bark,…
Muur	332	170	19.5	
Vesten	451	168	19.4	
Oudenberg	363	161	19.2	
Grimminge	452	137	19.5	
Bakan	420	156	19.4	
Skado	400	157	19.4	

* Introduced by INBO

Bomb calorimeter

Density


ROBUSTA
GHOY
20 m
15 m
10m
5m
North
Central Axe
South
North
Central Axe
South
325
350
375
400
425
450
475
500
525
550
575
[kg/m³]
Density range

High throughput phenotyping including variability, patterns,…
(1) structure – density
(2) lignin/(hemi-)cellulose

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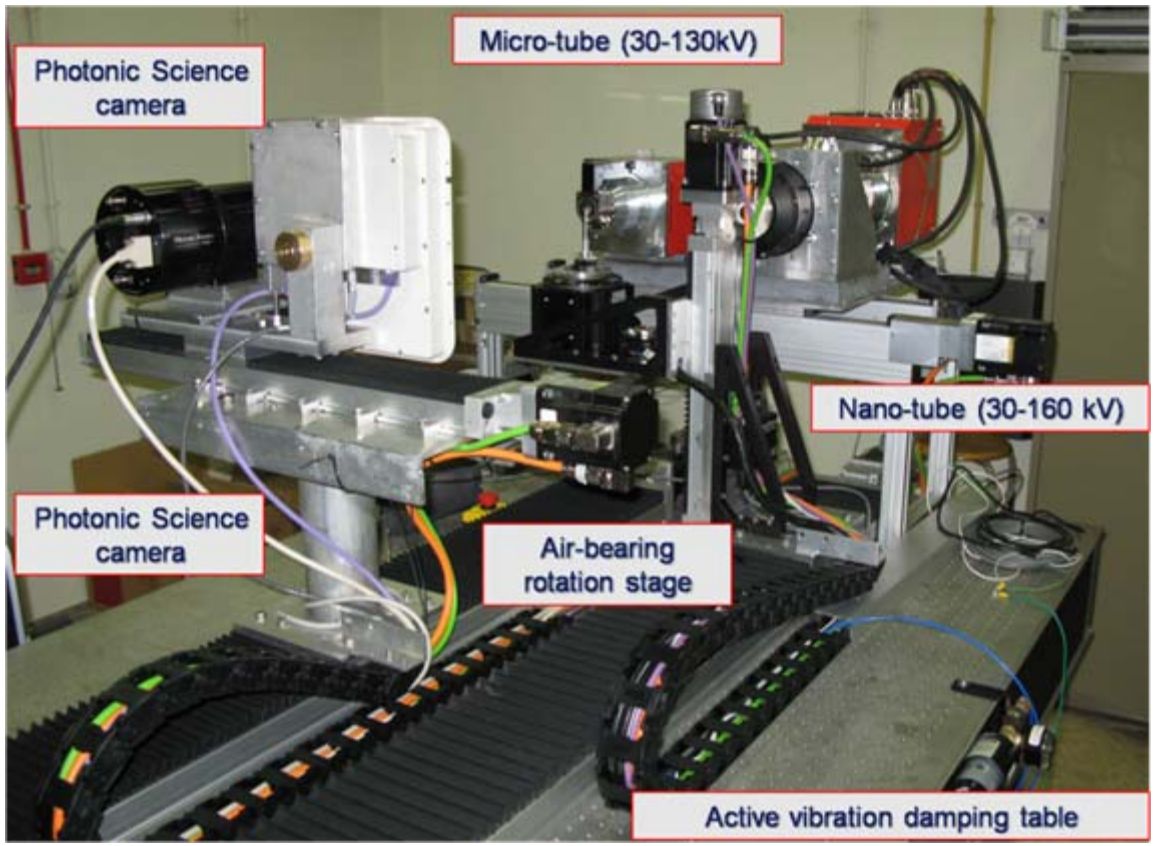
Analysis of microstructure & density

X ray Tomography - NanoWood

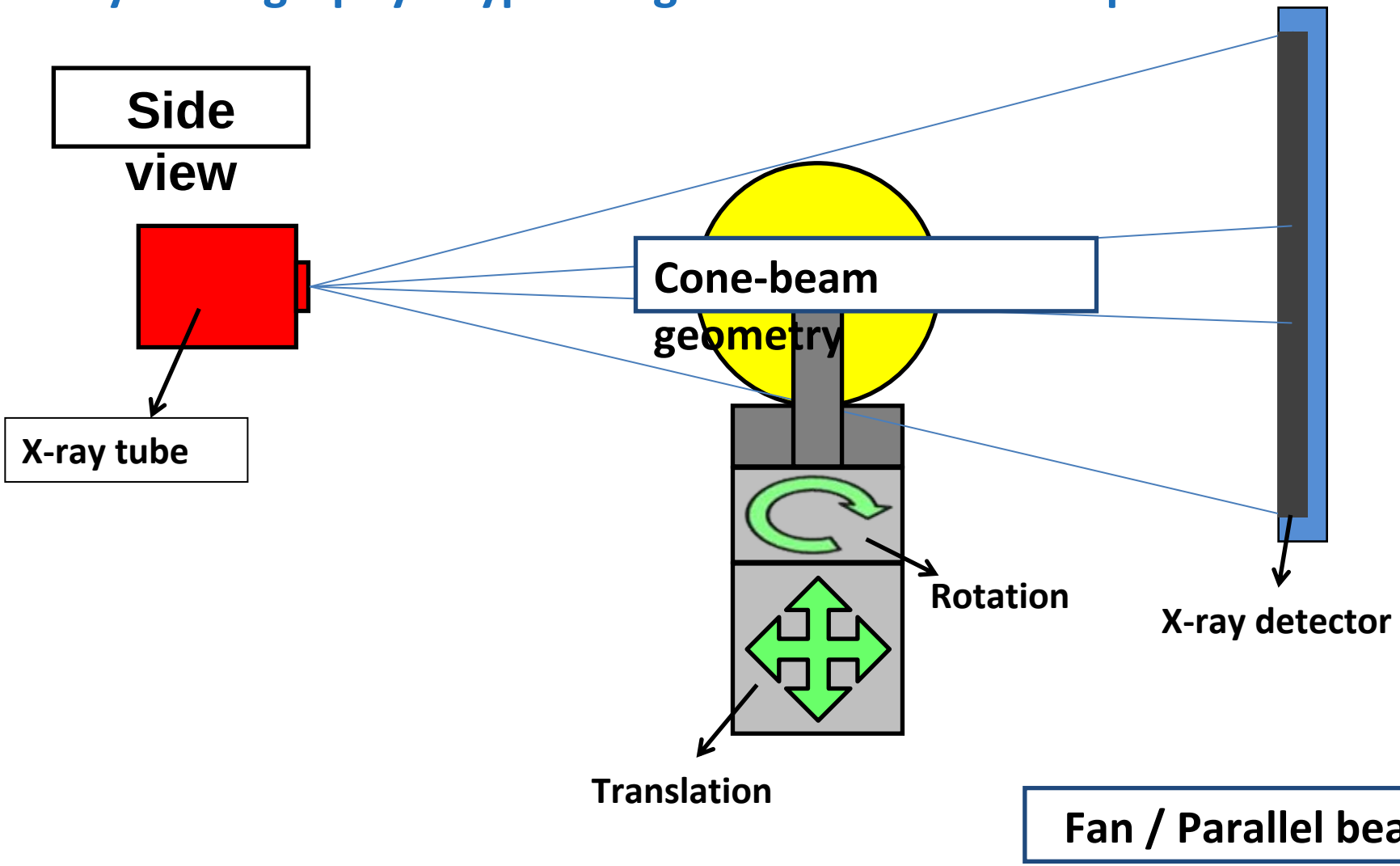
EU Projets Noveltree & Trees4future



NovelTree

TREES 4 FUTURE

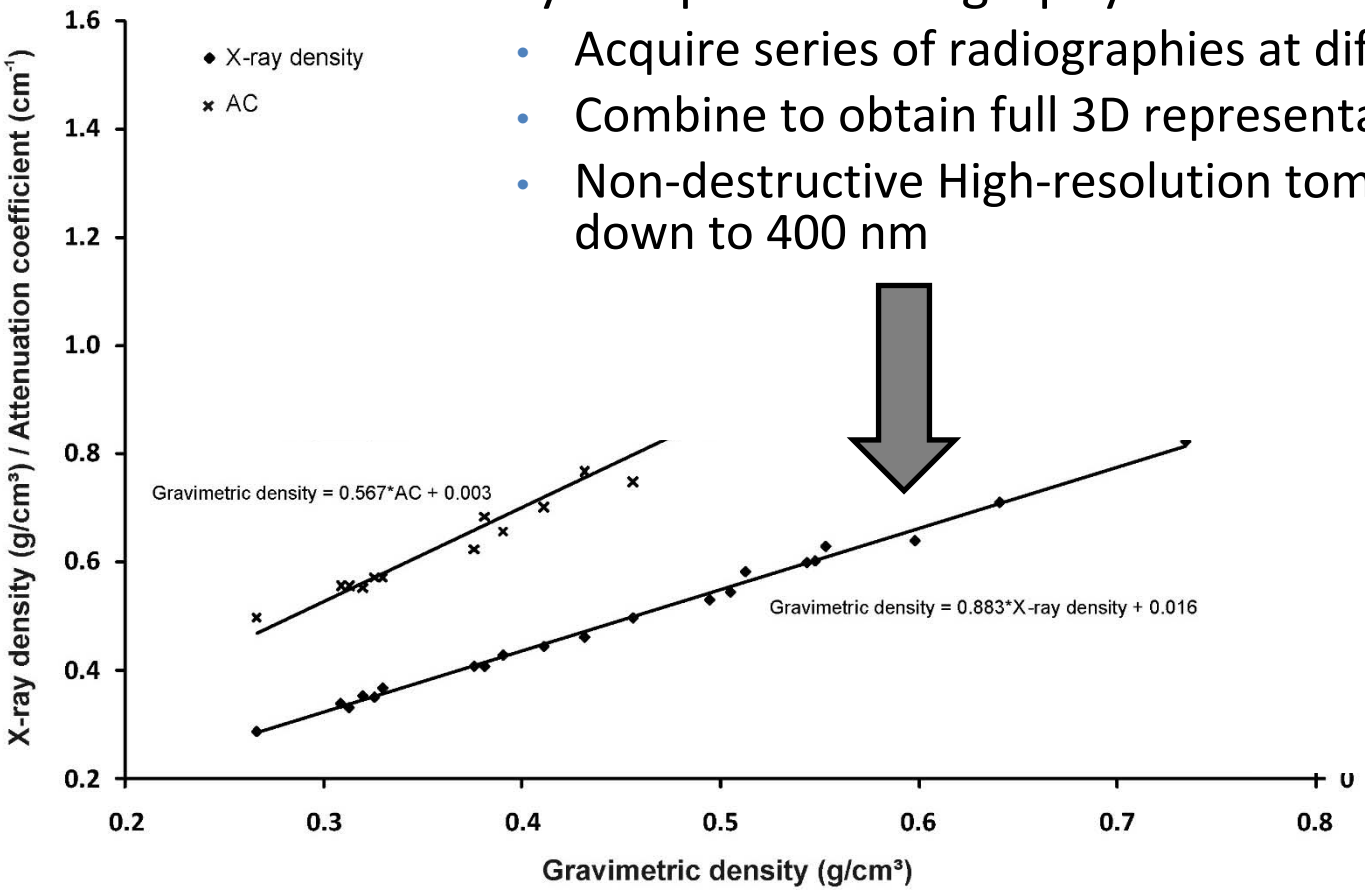
X ray Tomography - Typical high resolution CT setup



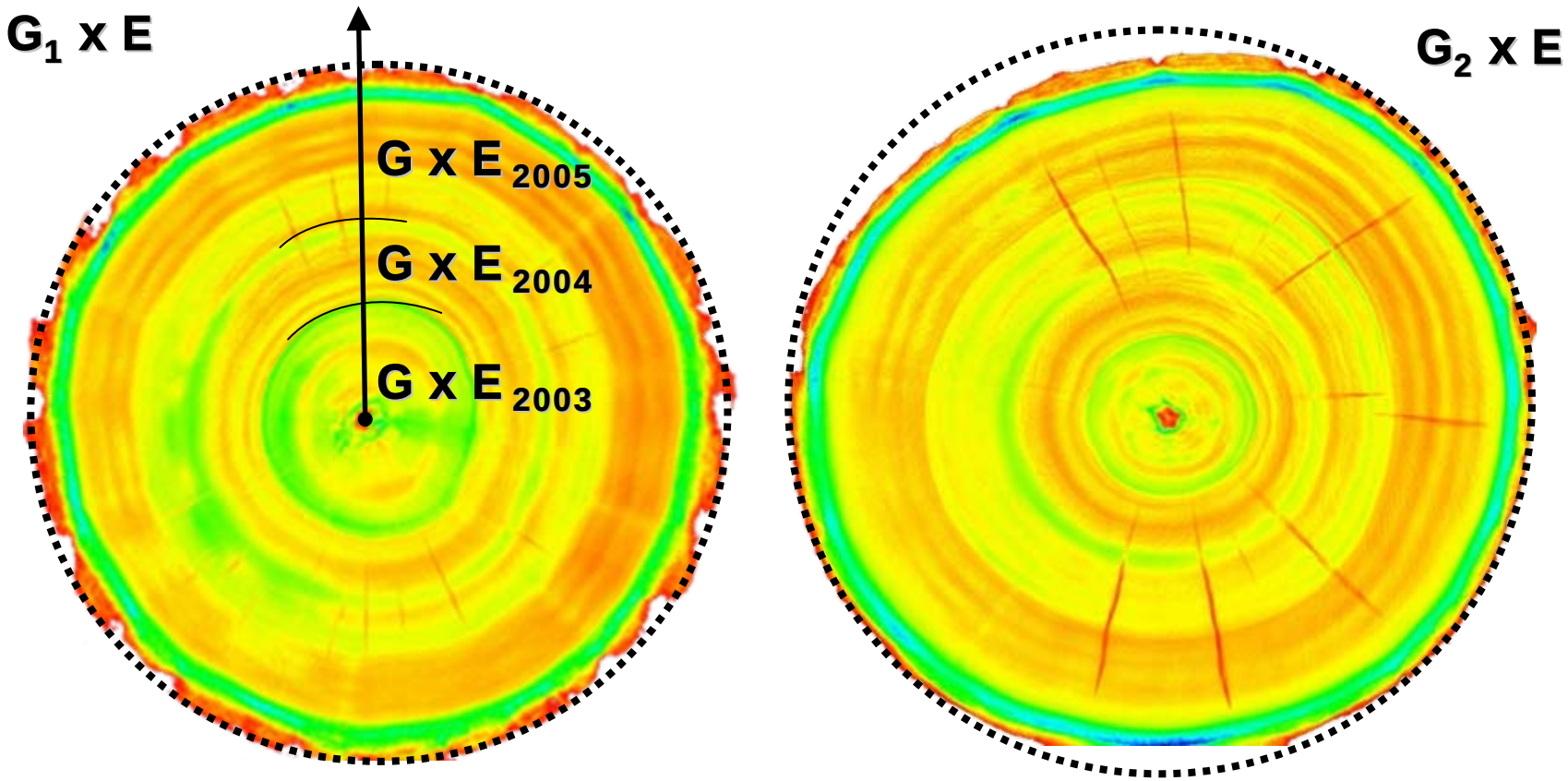
Linking with (micro)density

X-ray computed tomography:

- Acquire series of radiographies at different angles
- Combine to obtain full 3D representation
- Non-destructive High-resolution tomography: down to 400 nm



De Ridder et al. (2011). Annals of Botany

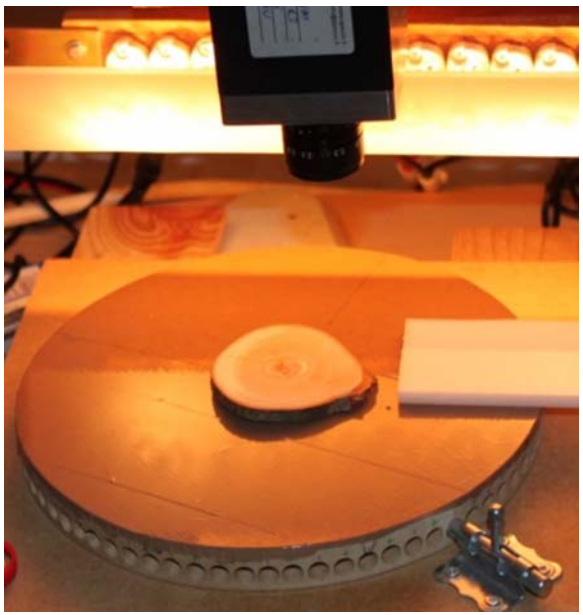


Macro-density ignores & integrates G x E interactions at smaller time-scales

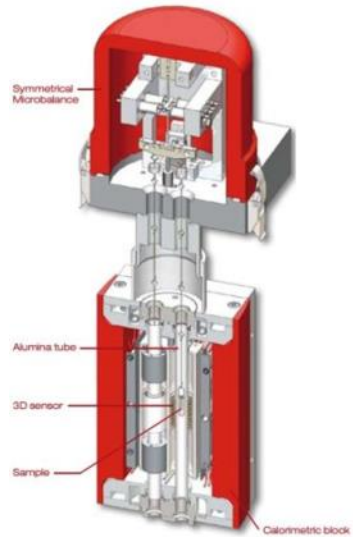
Calorimetric properties - macrochemicals

EU Projets Noveltree & Trees4future

Short-Wave InfraRed (SWIR)

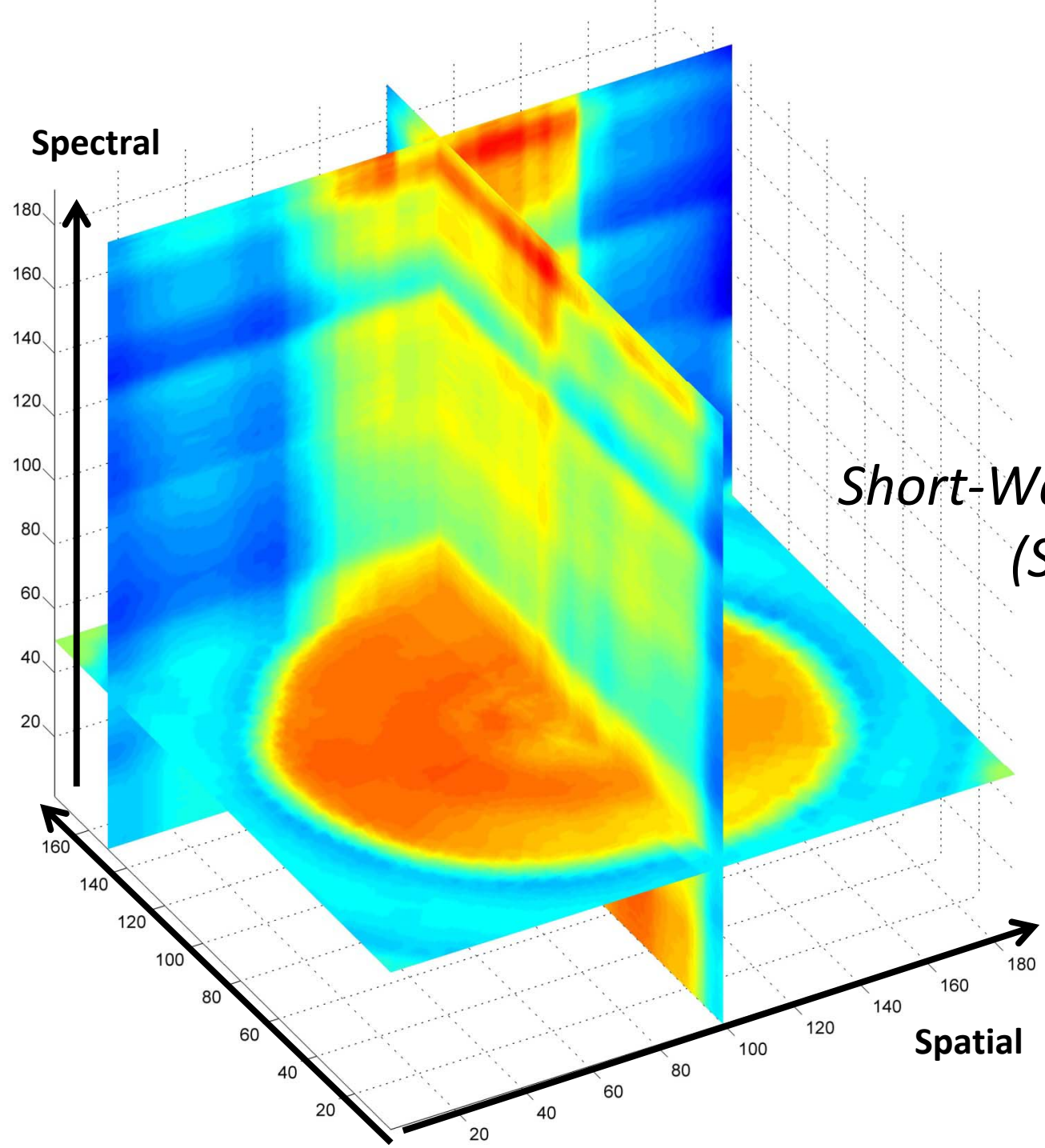


Coupled DSC-TGA

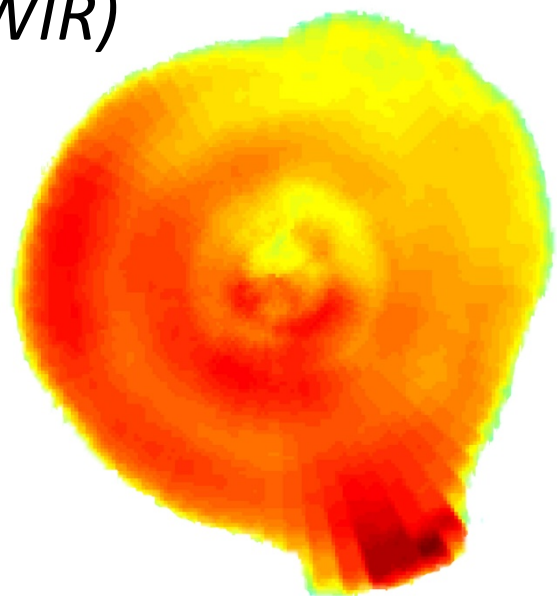


NovelTree

TREES 4 FUTURE



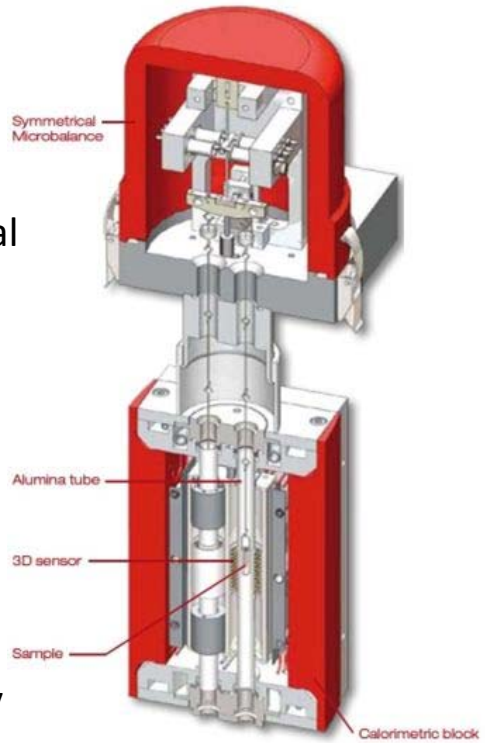
Short-Wave InfraRed (SWIR)

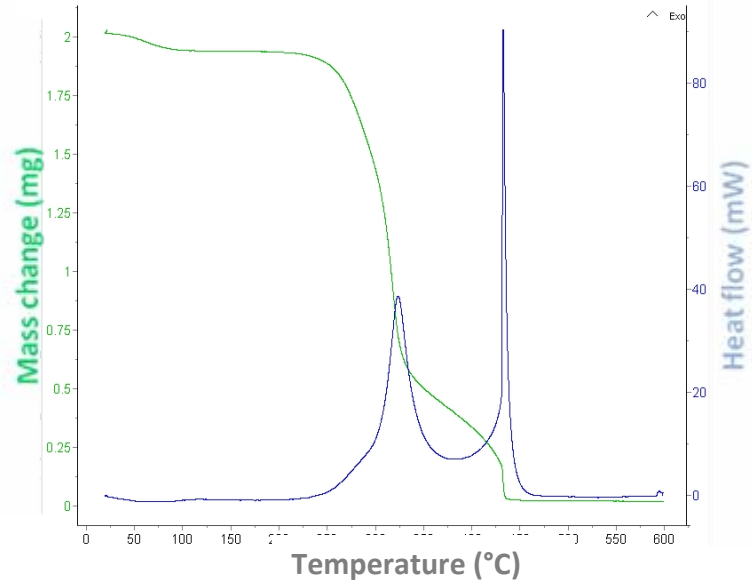


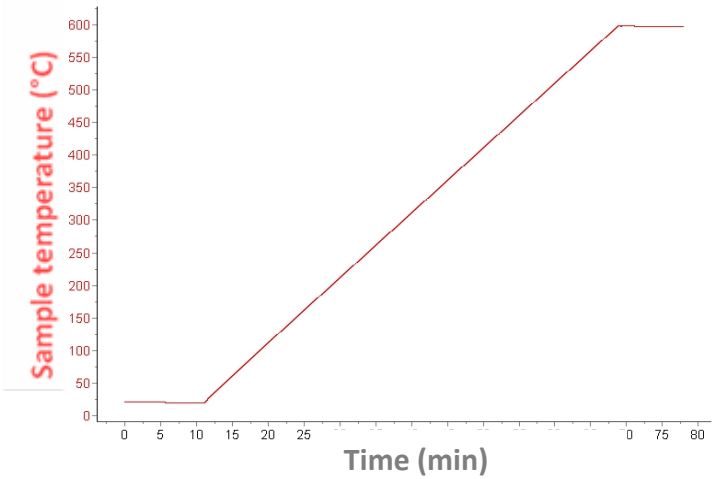
Coupled DSC-TGA

TGA
Thermo
Gravimetrical
Analysis

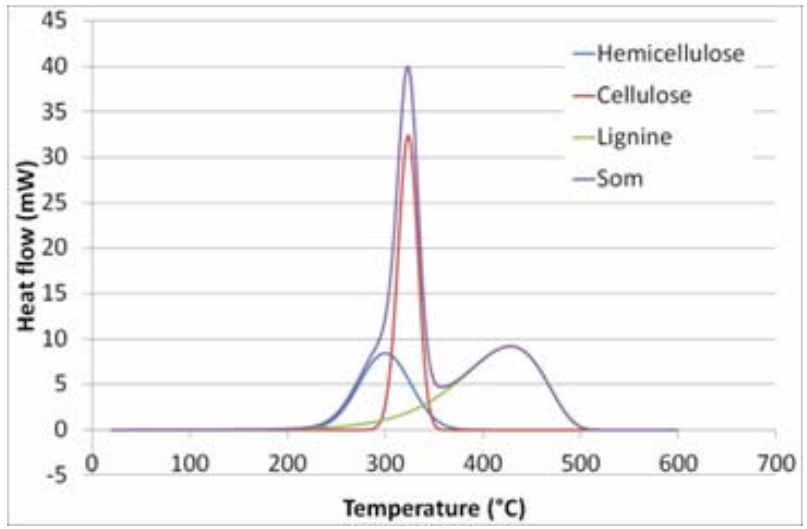
DSC
Differential
Scanning
Calorimetry

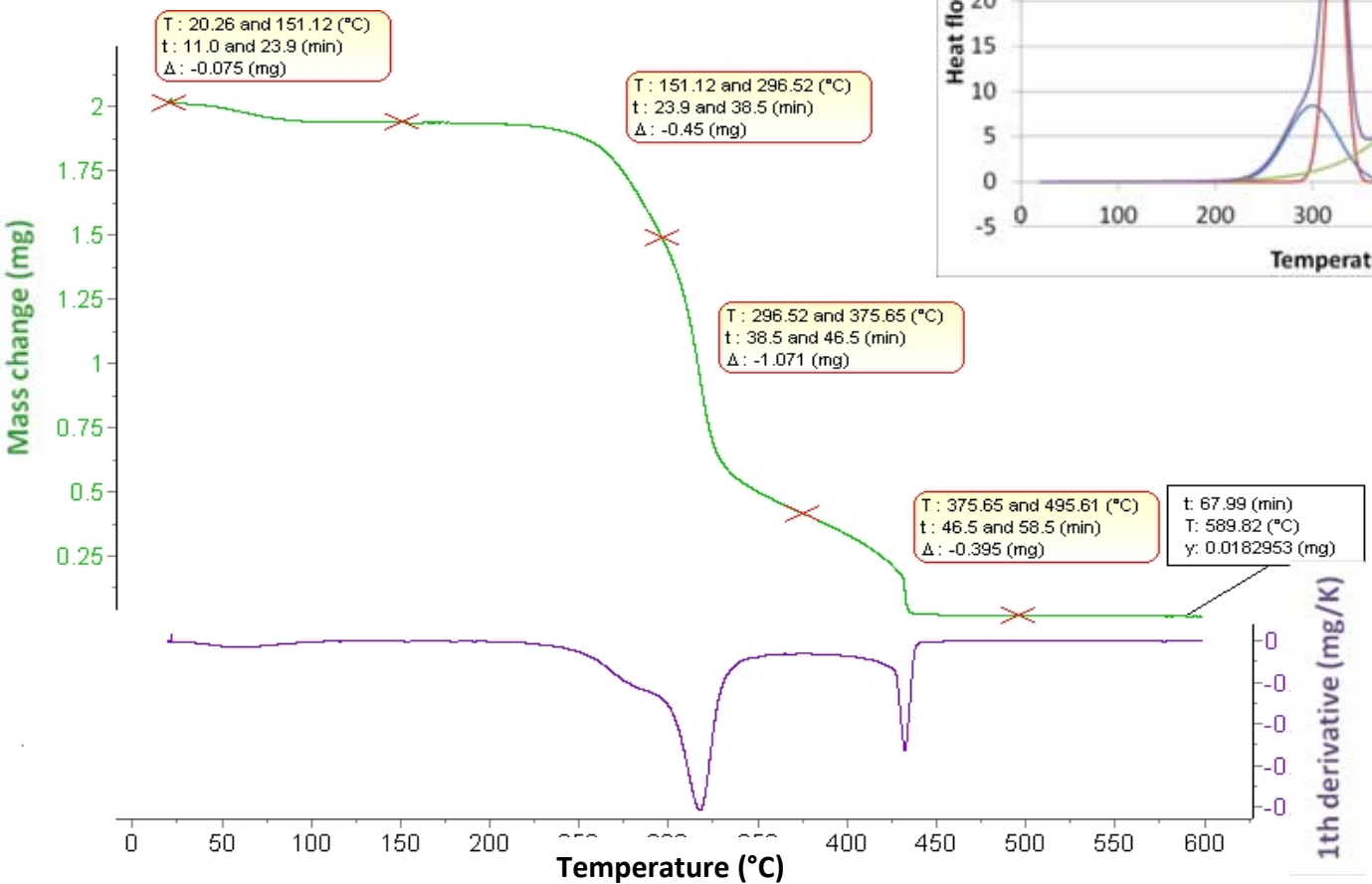




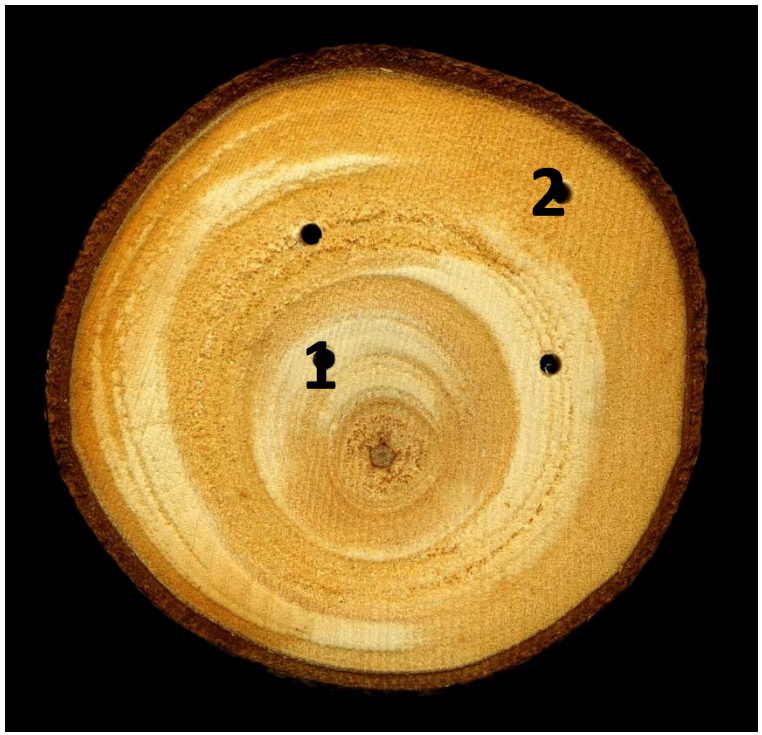


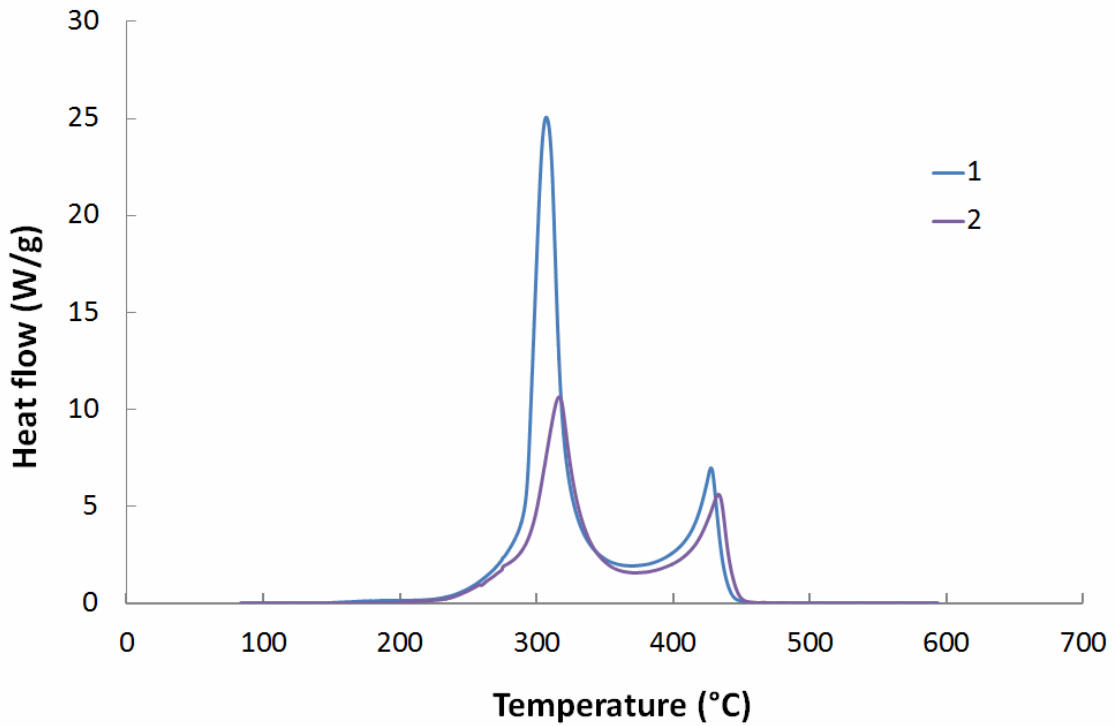
Deconvolution - macrochemicals





Calibration of SWIR





Combined microdensitometry - macrochemicals

EU Projets Noveltree & Trees4future

Case study using different poplar clones

Disc material

Origin:

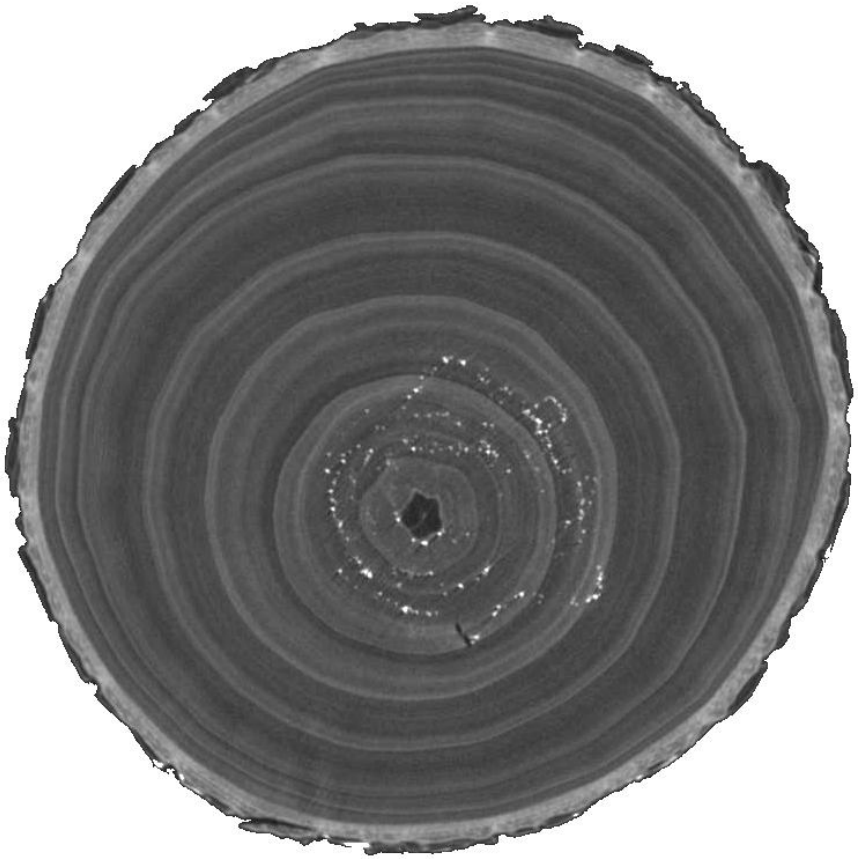
INRA (Institut National de la Recherche Agronomique)

Orléans – France

Responsible: Catherine BASTIEN

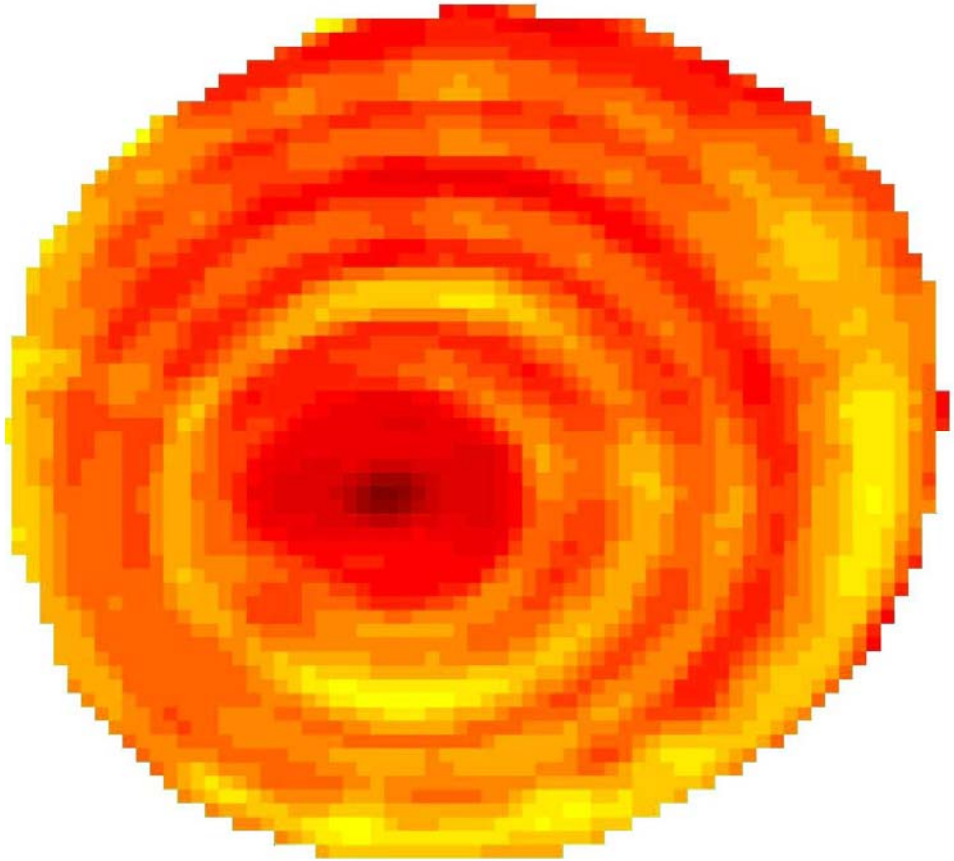
Microdensitometry

Nanowood CT scanner



Macrochemical

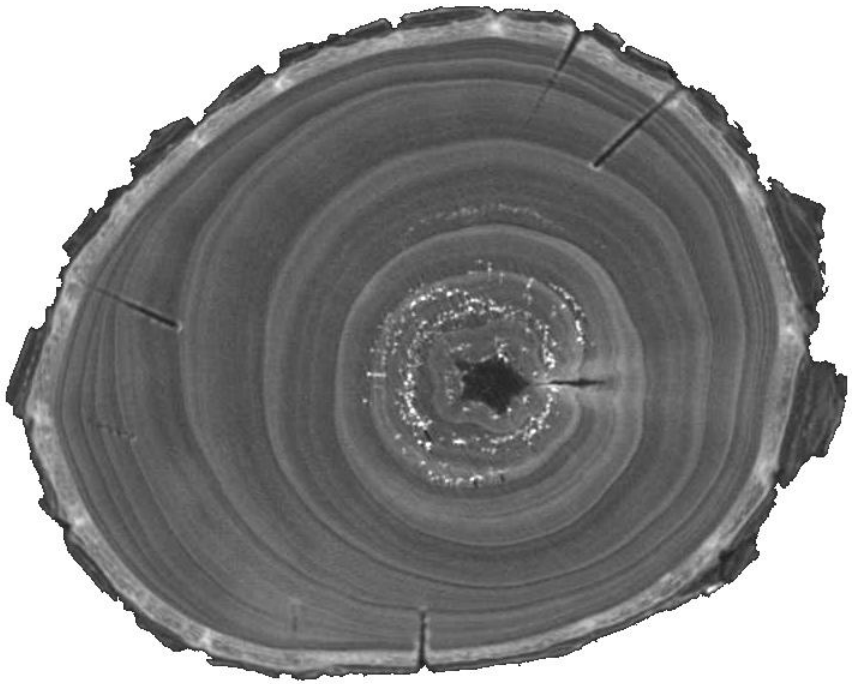
NIRS & DSC-TGA



Specimen 1: ringshaped tension wood (one side)

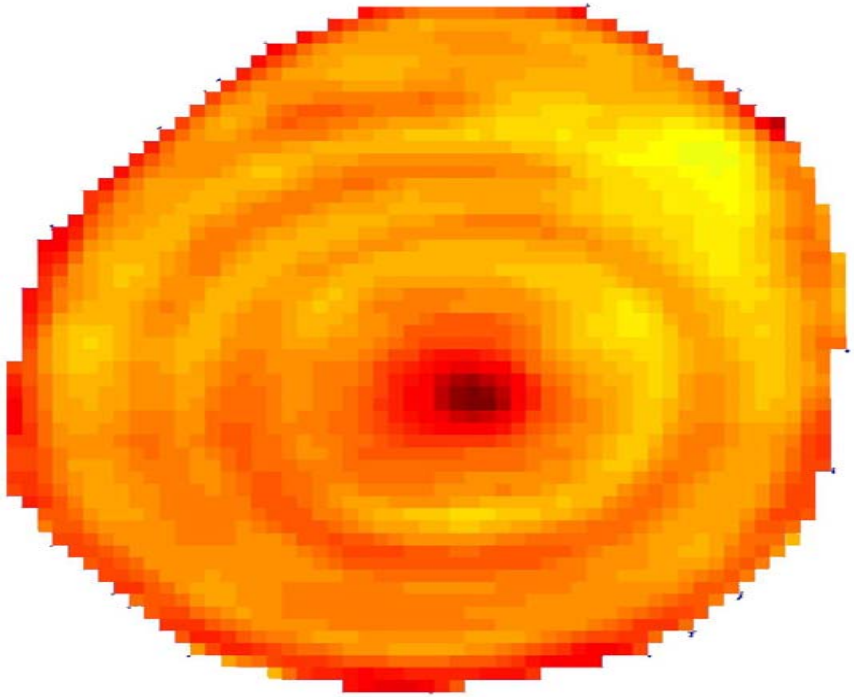
Microdensitometry

Nanowood CT scanner



Macrochemical

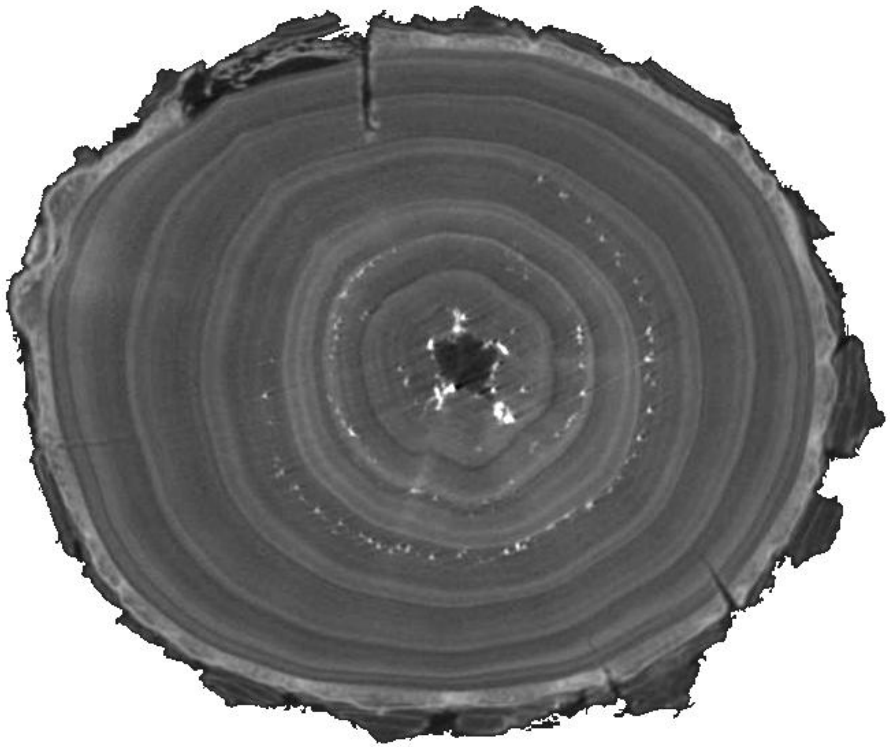
NIRS & DSC-TGA



Specimen 2: semi-uniform

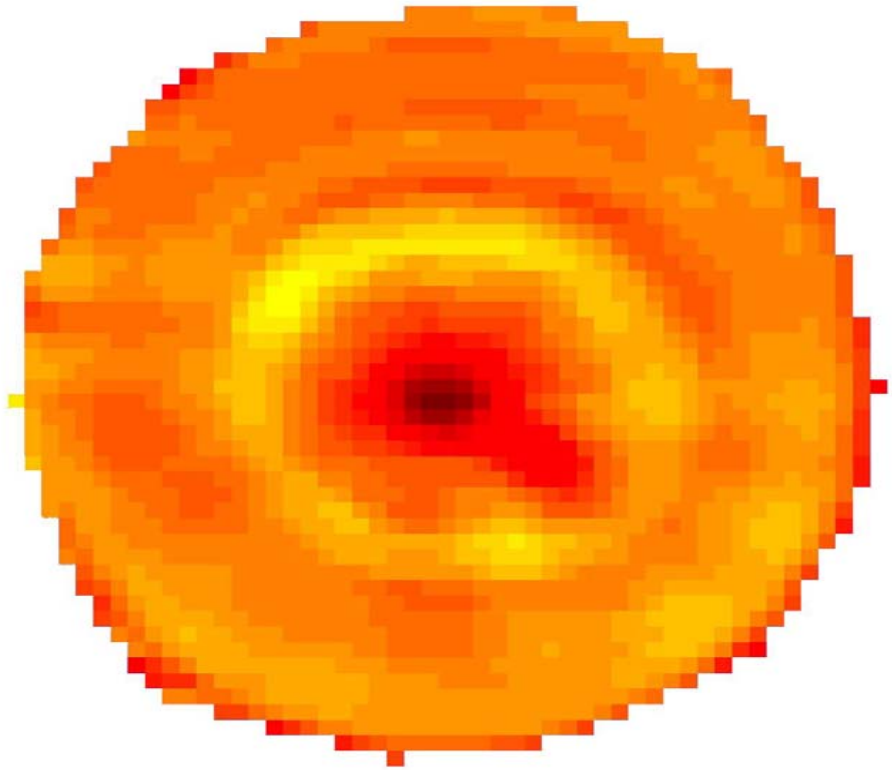
Microdensitometry

Nanowood CT scanner



Macrochemical

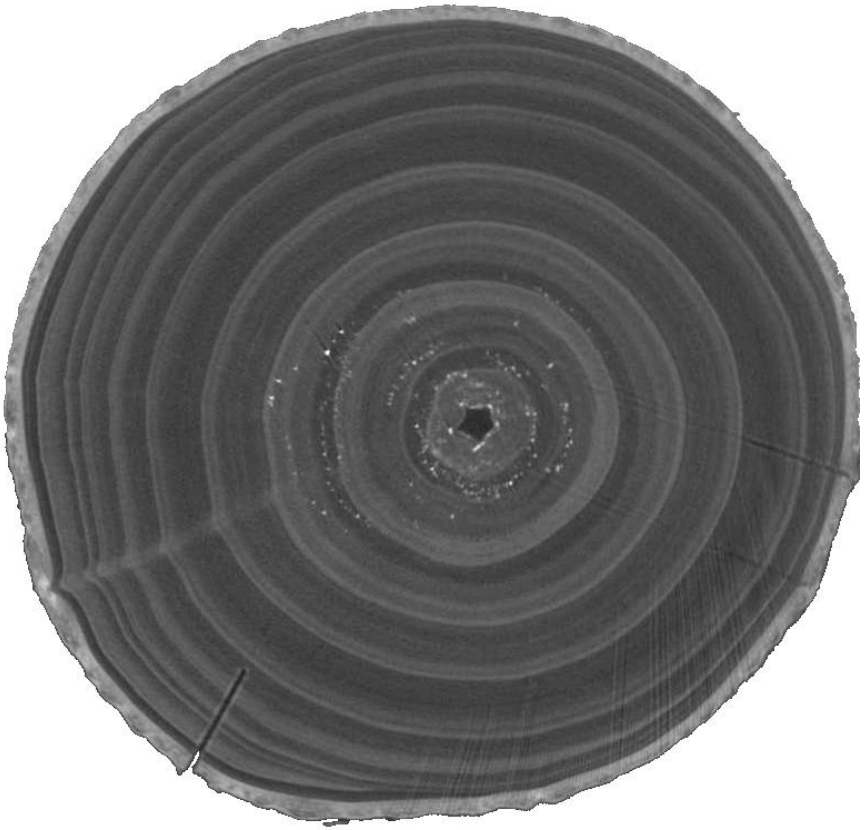
NIRS & DSC-TGA



Specimen 3: shift early juvenile - juvenile – mature wood

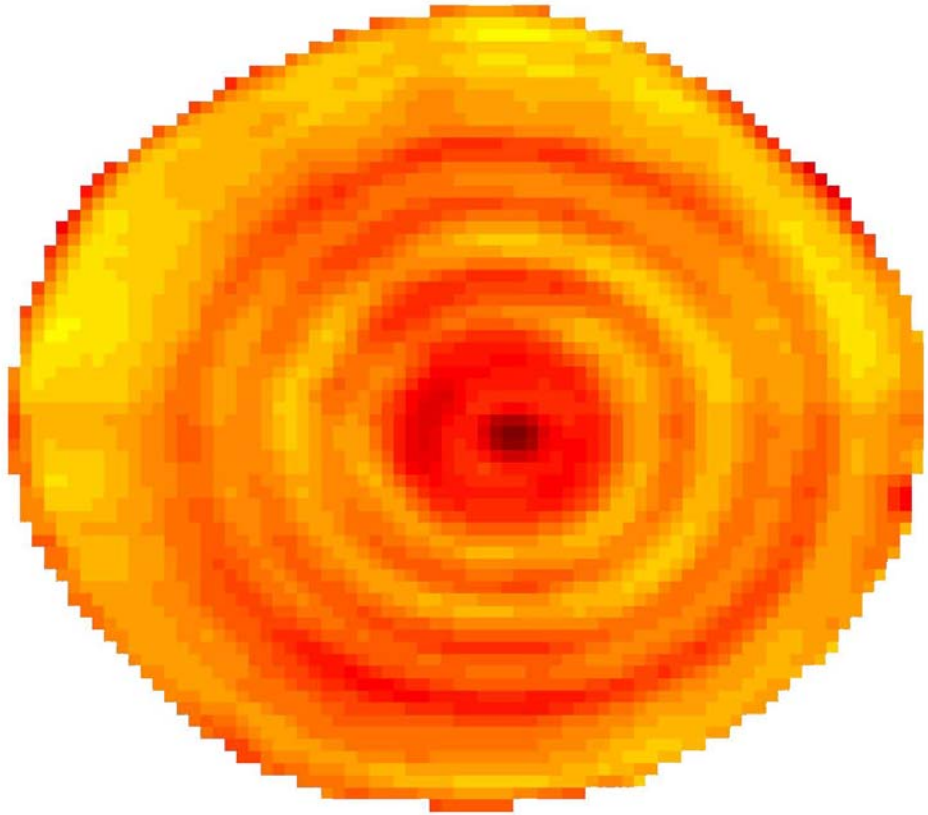
Microdensitometry

Nanowood CT scanner



Macrochemical

NIRS & DSC-TGA



Specimen 4: earlywood – latewood pattern / low orientation

3 complementary techniques

- DSC-TGA: energy / approx. chemical composition
- Hyperspectral NIR imaging: via PLS any property
  -> energy & chemical composition
- X-ray tomography: density, porosity, dimensions, moisture content, microstructure

⟶ **Fast characterization of woody biomass linked to spatial patterns**

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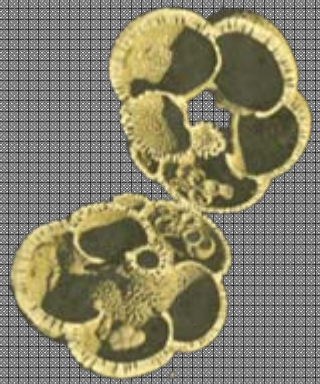

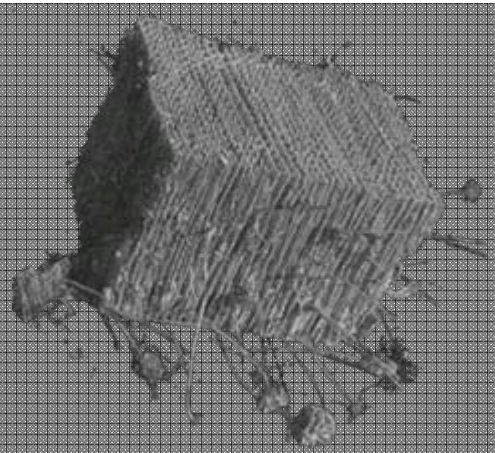

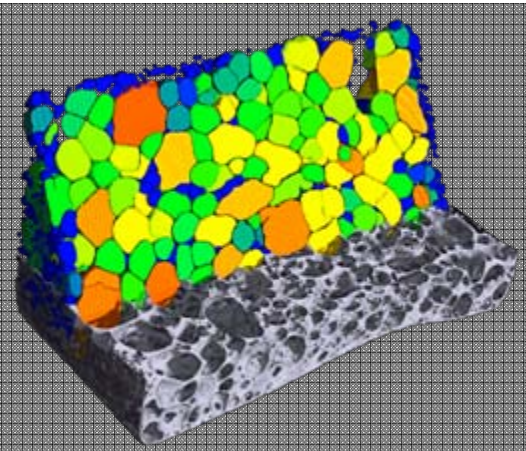

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www.woodlab.be

www.ugct.ugent.be

www.inCT.be (spin-off)

www.xre.be (spin-off)

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X-ray tomography and coupled DSC-TGA

EU project for funded research access – **Trees4Future** project
http://www.trees4future.eu/transnational-accesses.html