



The TreeTrace Douglas database: quality assessment and traceability of Douglas fir

Fleur Longuetaud, Guillaume Pot, Frédéric Mothe, Alexis Barthelemy, Rémi Decelle, Florian Delconte, Xihe Ge, Grégoire Guillaume, Théo Mancini, Tojo Ravoajanahary, Jean-Claude Butaud, Robert Collet, Isabelle Debled-Rennesson, Bertrand Marcon, Phuc Ngo, Benjamin Roux, Joffrey Viguier



Context : TreeTrace project

ANR-FWF TreeTrace project:



Biometric fingerprints of trees: Log tracing from forest to sawmill and early estimation of wood quality



FH Salzburg Holztechnologie & Holzbau


Objectives :

- Traceability from the forest to the sawmill
- Evaluation of the quality of roundwood
- Evaluation of the quality of solid wood / strength grading of board

This presentation is only about data with a focus on Douglas fir



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DATA PAPER **Open Access**

Traceability and quality assessment of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) logs: the TreeTrace_Douglas database

Fleur Longuetaud^{1*}, Guillaume Pot², Frédéric Mothe¹, Alexis Barthelemy^{1,3}, Rémi Decelle^{1,3}, Florian Delconte^{1,3}, Xihe Ge², Grégoire Guillaume², Théo Mancini², Tojo Ravoajanahary⁴, Jean-Claude Butaud², Robert Collet², Isabelle Debled-Rennesson³, Bertrand Marcon², Phuc Ngo³, Benjamin Roux² and Joffrey Viguier²

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Traceability and quality assessment of Norway spruce (*Picea abies* (L.) H.Karst.) logs: the TreeTrace_spruce database

Fleur Longuetaud^{1*}, Rudolf Schraml^{2,3}, Frédéric Mothe¹, Tojo Ravoajanahary¹, Rémi Decelle^{1,4}, Thiéry Constant¹, Phuc Ngo⁴, Isabelle Debled-Rennesson⁴, Karl Entacher^{3,5}, Alexander Petutschnigg⁵, Franka Brüchert⁶ and Andreas Uhl²

Traceability from the forest to the sawmill

Why ? :

- guarantee the origin of wood
- fight against illegal logging

How ? :

- Images of cross-section of logs at different steps

Forest



Logyard



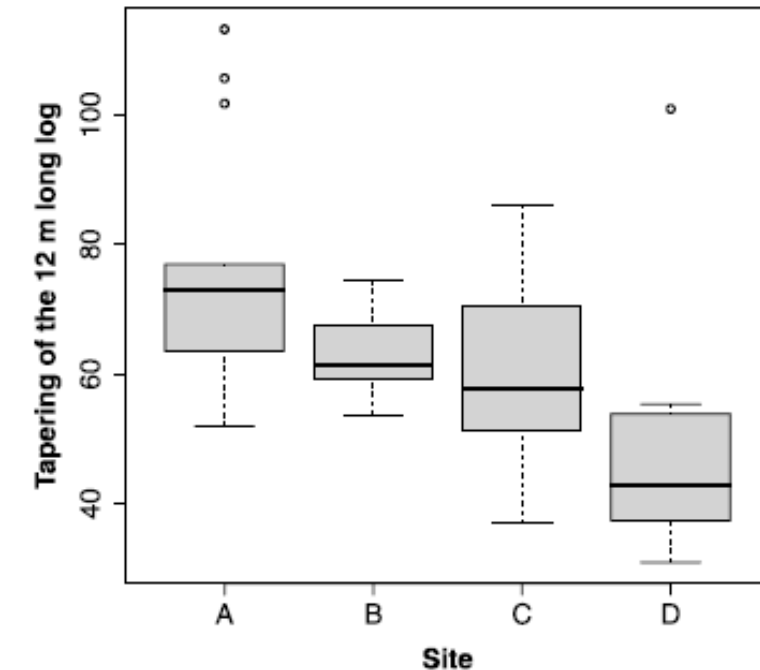
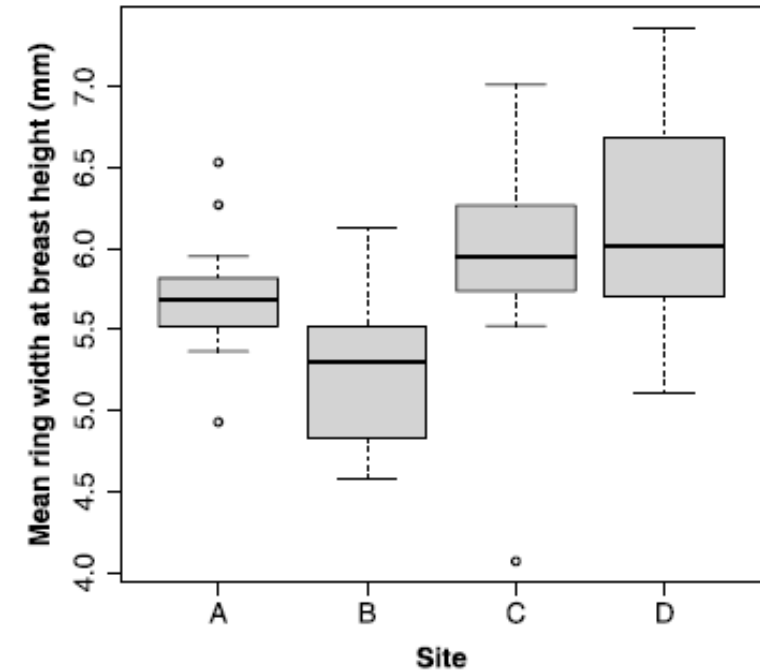
Sawmill



+ data that can be used for traceability from logs to boards

Sampling and data on long logs

- ❑ Specie : Douglas fir
 - ❑ 4 harvesting sites (A, B, C and D)
 - ❑ 52 trees => 52 long logs of 12.5m (13 trees per harvesting site)
 - ❑ Representative of what is usually processed at the sawmill
-
- ❑ For each long logs :
 - ❑ Estimated number of rings at height 1.3m
 - ❑ Diameter measured on the logyard at height 1.3m
 - ❑ Slenderness
 - ❑ Estimated air dry density at height 1.3m

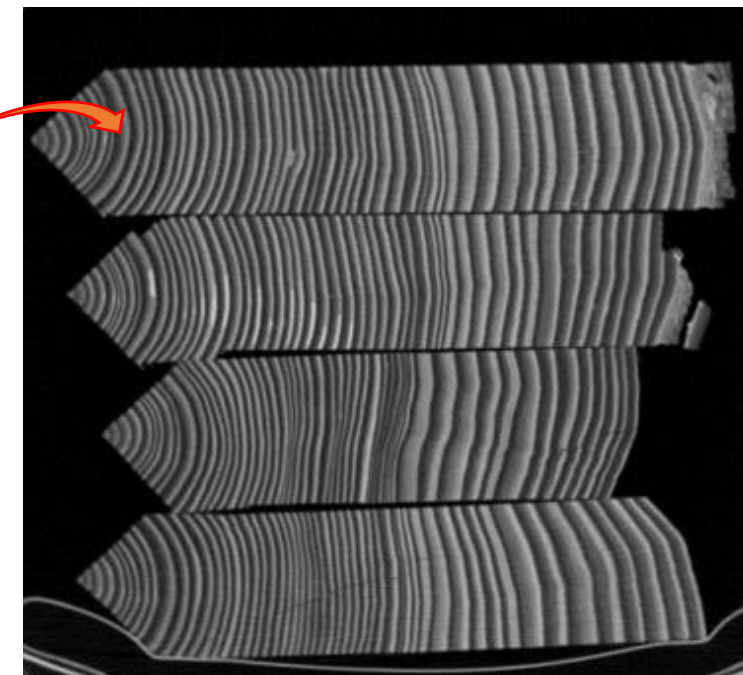


Sampling and data on discs

- On each 12 m long logs (out of the 52 total logs)
 - 208 disks and 156 short logs



- For each discs :
 - Estimated height of the disc in the tree
 - Mean air dry density
 - Total number of annual growth rings in the disc
 - Arithmetic mean of disc ring widths
 - + Pictures
 - + CT-Scan and pictures of 4 strips per disc



About the pictures and some examples on the use of these data

- ❑ Automatic detection of the pith :



Data set for 208 discs :

- Picture
- Ground truth for pith location

Decelle et al. (2019) A new algorithm to automatically detect the pith on rough log–end images. *21st International Nondestructive Testing and Evaluation (NDTE) of Wood Symposium*

- ❑ Working on segmentation of cross section and/or heartwood/sapwood :



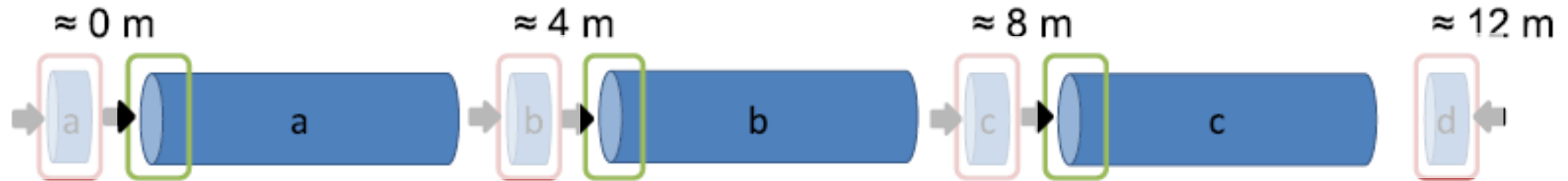
Decelle et al. (2019). Neural Networks for Cross–Section Segmentation in Raw Images of Log Ends. *Fourth IEEE International Conference on Image Processing, Applications and Systems (IPAS 2020)*

Data set for 208 discs :

- Cross-section
- Heartwood/sapwood limits

Some details on the sampling

- On each 12 m long logs out of the 52 total long logs
 - 208 disks and 156 short logs



- For each short logs :
 - Estimated height of the bottom log end in the tree
 - Log length measured on the logyard (after disc cutting)
 - Natural frequency using Fakopp Log Grader for Android (Divos 2014).
 - Pictures of both large and small ends

346 boards were collected from 32 short logs (4 sites × 4 trees × 2 logs per tree, logs #a and #c),



Global non-destructive data on the 346 boards

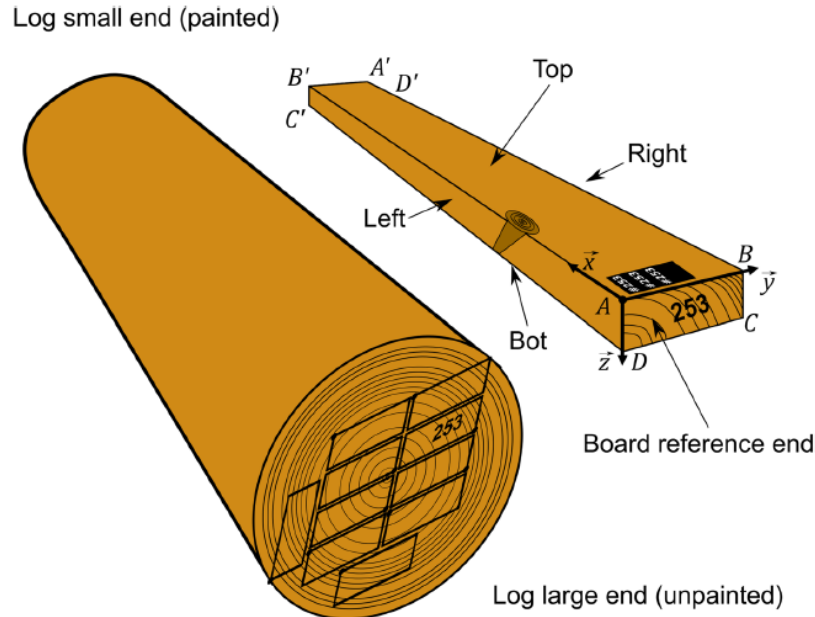
- ☐ Pictures of both board's end



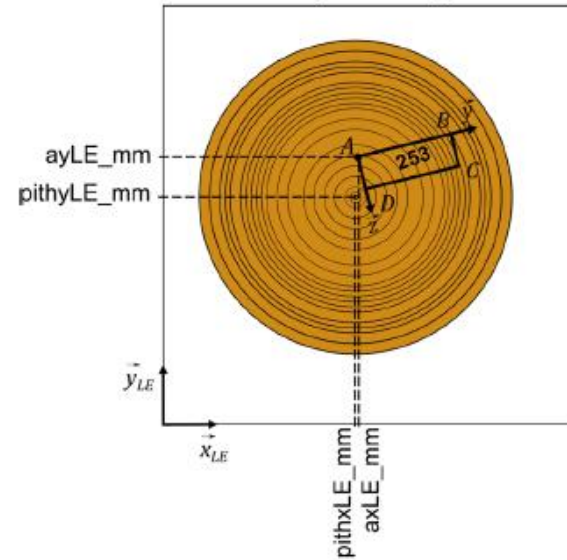
- ☐ Identification number of the log from which the board was sawn
- ☐ Location of boards relatively to the pith
- ☐ Board dimension and mass
- ☐ Dynamic MOE using vibratory machine



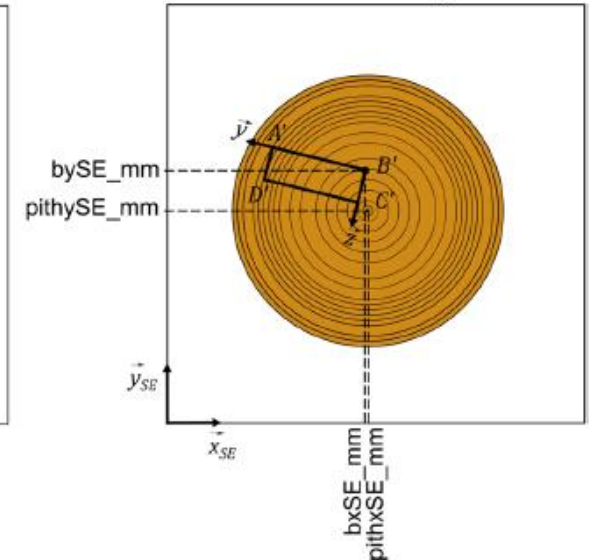
Final dimension after drying/planing :
45x145x4000 mm



Large End image



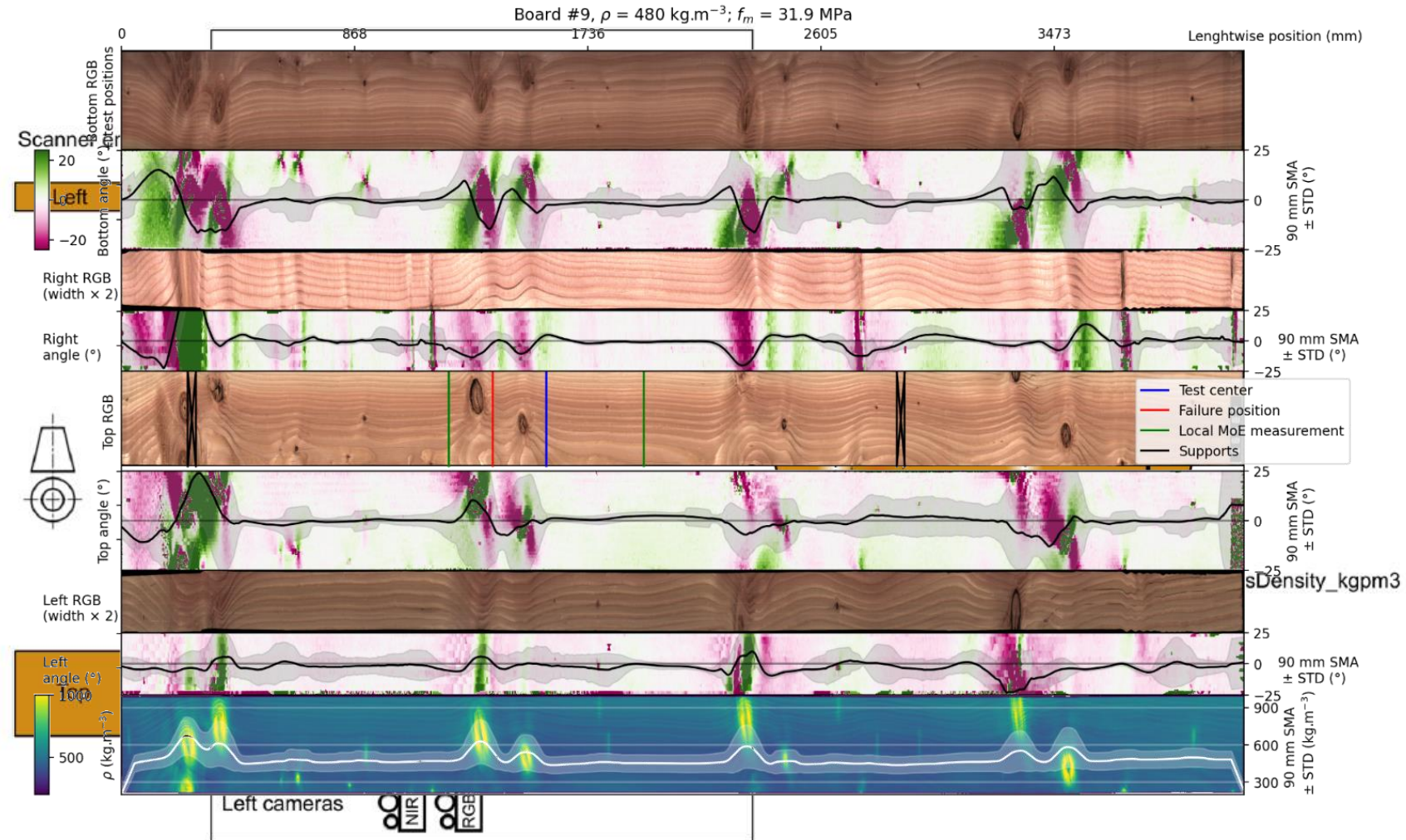
Small End image



Local non-destructive data on the 346 boards

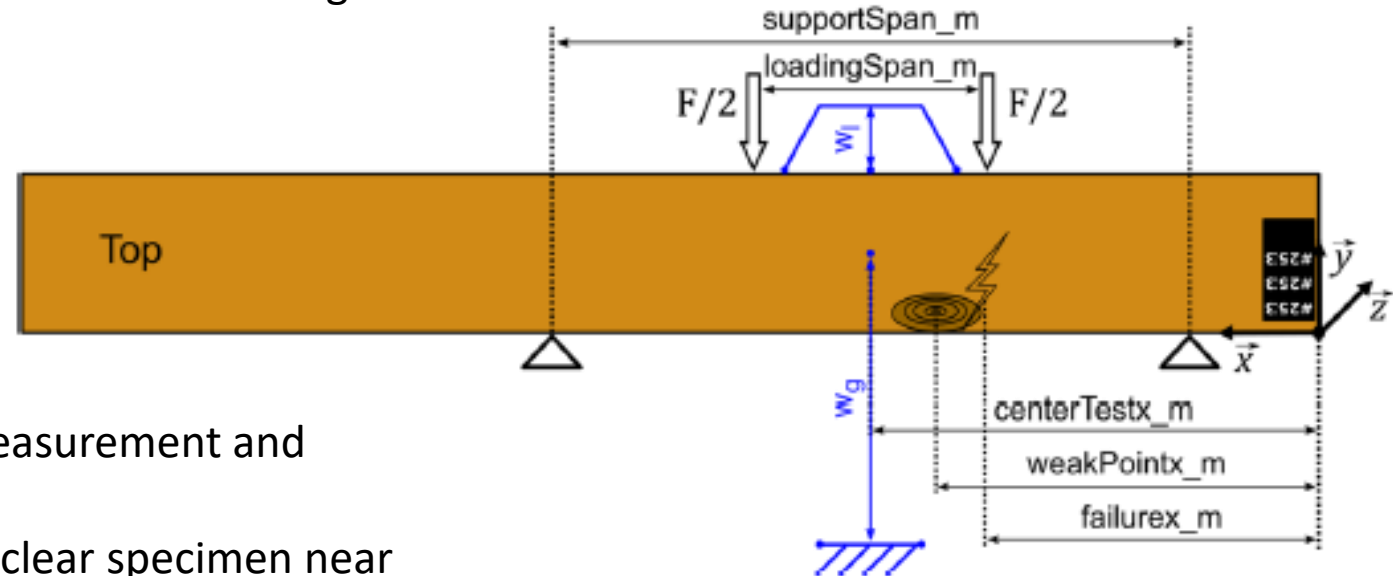
Lengthwise resolution : 1 mm

- Data using an industrial scanner
 - Gray level images of 4 faces
 - Transverse resolution : 0.25 and 0.125 mm
 - Local grain angle data using tracheid effect of 4 faces
 - Measurement coordinates
 - Angle + length of major and minor axis
 - Transverse resolution : 4 mm
 - RGB images of 4 faces
 - Transverse resolution : 0.25 and 0.1 mm
 - Local density using X-Rays
 - 2D map of the averaged density through the thickness
 - Given in kg/m³
 - Transverse resolution : 0.3 mm



Destructive data on the 346 boards

- ❑ 4-point bending test according to EN 408 and EN 384
 - ❑ Calculation of MOE (local and global) and MOR
 - ❑ Board tested with the assumed bigger defect between the loading head
 - ❑ Position of the board during the test
 - ❑ Location of failure point
- ❑ Moisture content measurement
 - ❑ Two using hygrometer during dynamic MOE measurement and bending tests
 - ❑ One using double weighing method with small clear specimen near the failure zone (EN 13183)
- ❑ Density measurement
 - ❑ Same clear wood specimen used for moisture content measurement



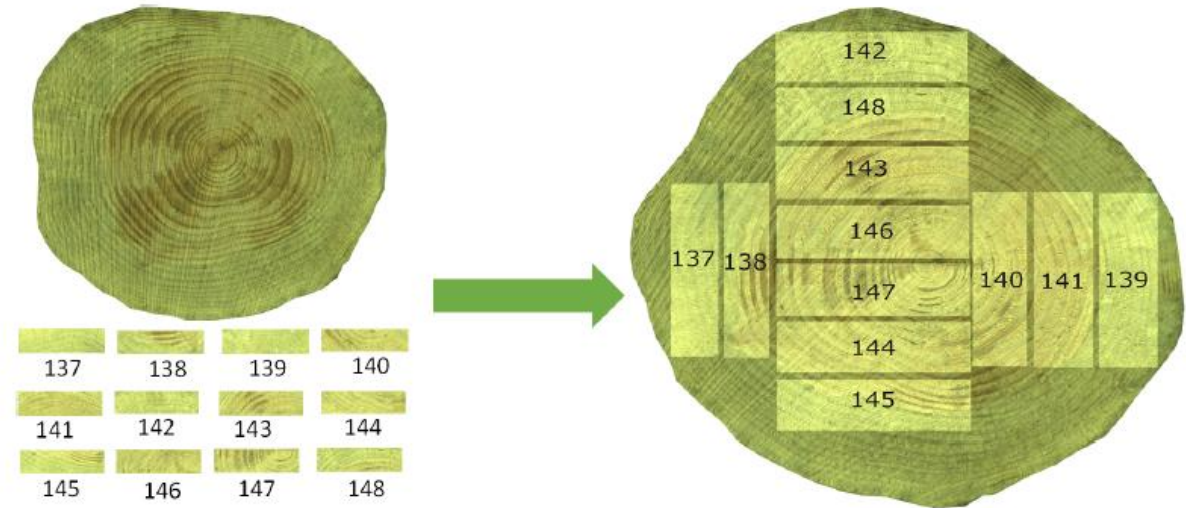
Summary on boards :

- Traceability : radial and longitudinal position of boards
- Dynamic MOE
- Scanning : local data on density and grain angle + images
- Destructive tests : mechanical properties

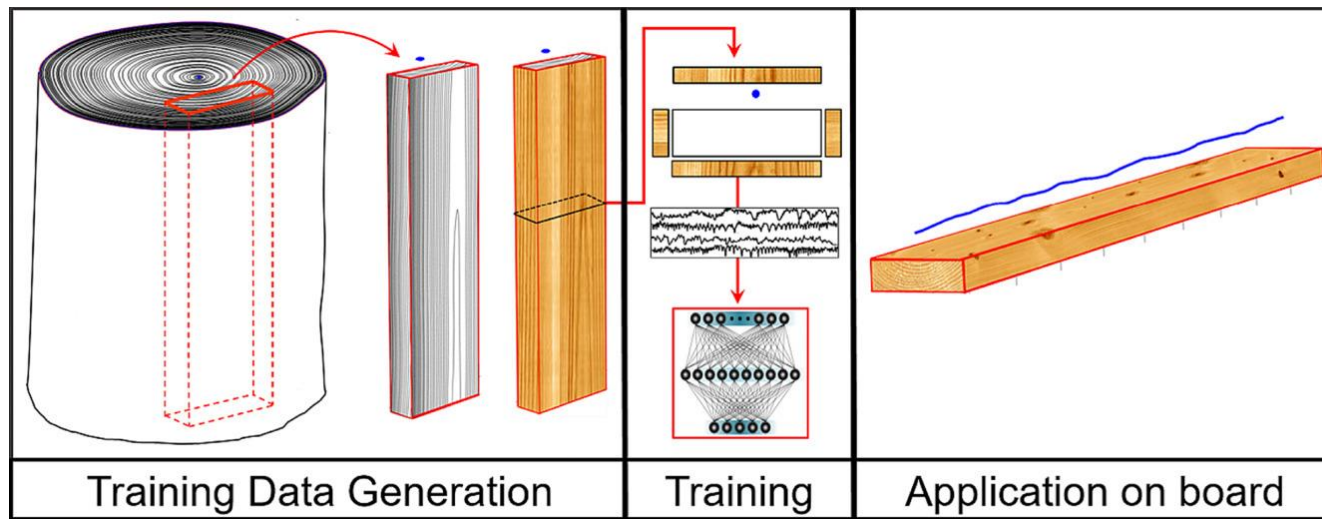
Example of application

Traceability

Doing what we did automatically !



Li et al. , 2022. An image processing method to recognize position of sawn boards within the log. Wood science and technology



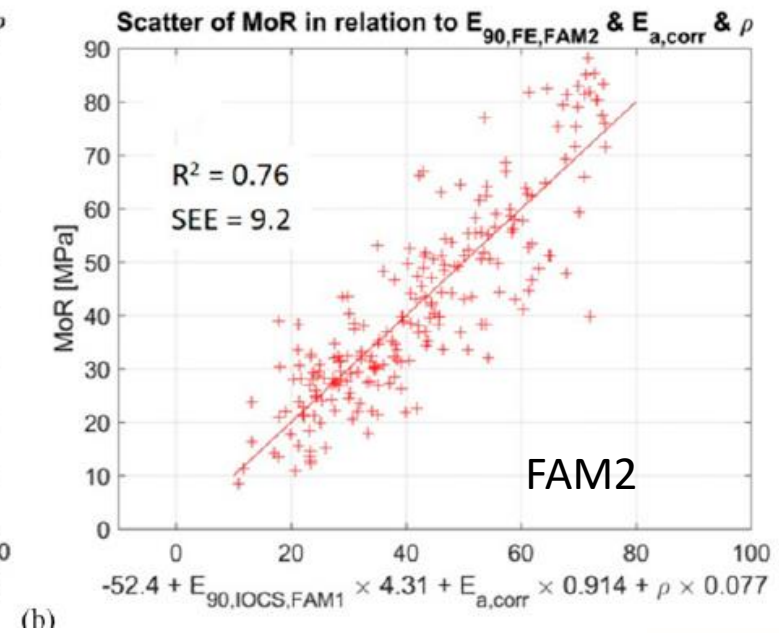
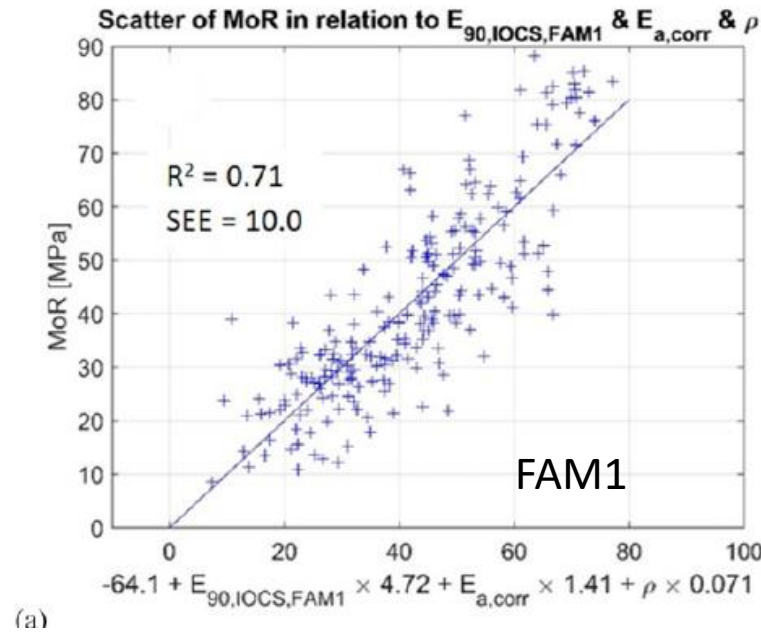
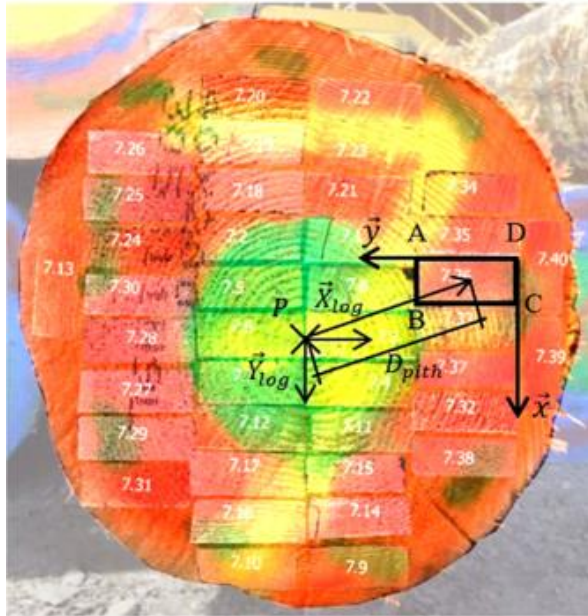
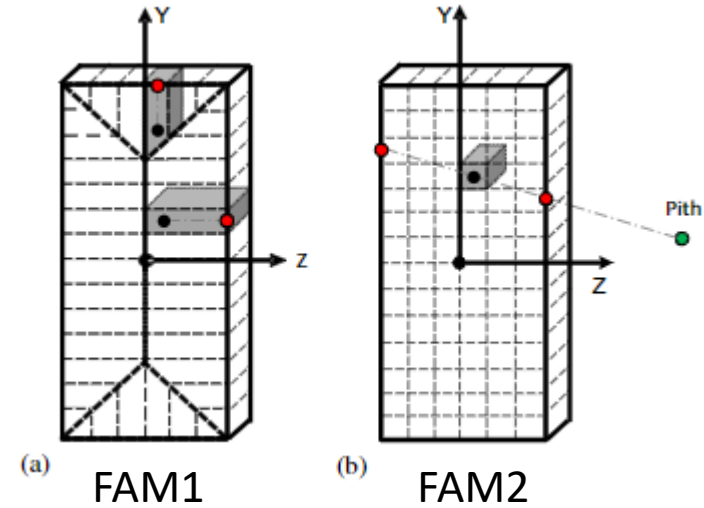
Providing ground truth for other species / approach

Habite et al. (2022). Determination of pith location along Norway spruce timber boards using one dimensional convolutional neural networks trained on virtual timber boards. *Construction and Building Materials*

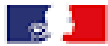
Example of application

Strength grading

Olsson et al. (2022). PERFORMANCE OF TIMBER BOARD MODELS FOR PREDICTION OF LOCAL BENDING STIFFNESS AND STRENGTH—WITH APPLICATION ON DOUGLAS FIR SAWN TIMBER. *Wood and Fiber Science*, 54(4).



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Joffrey Viguière²

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Future work : Data paper on 900 boards of oak

- Scanning (X-Rays, images, grain angle)
- Tensile tests
- Traceability

**Thank you for your
attention**



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