



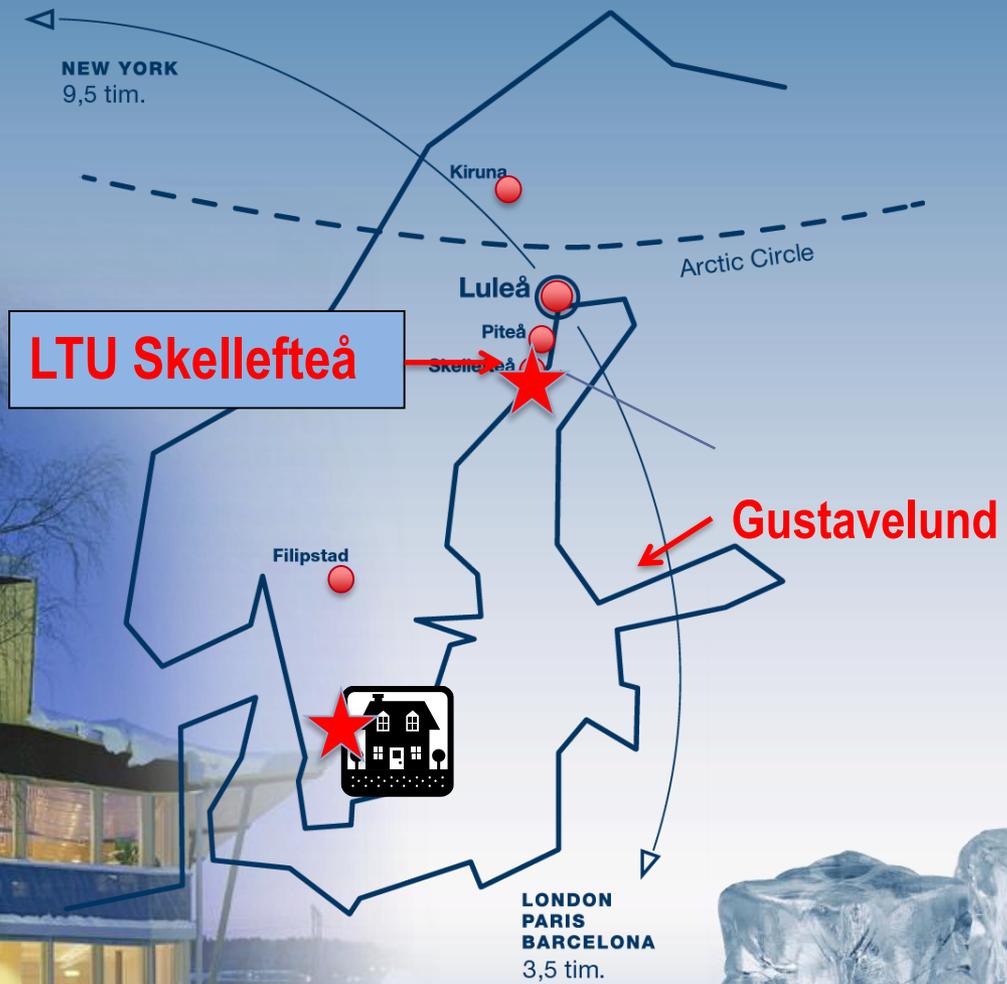
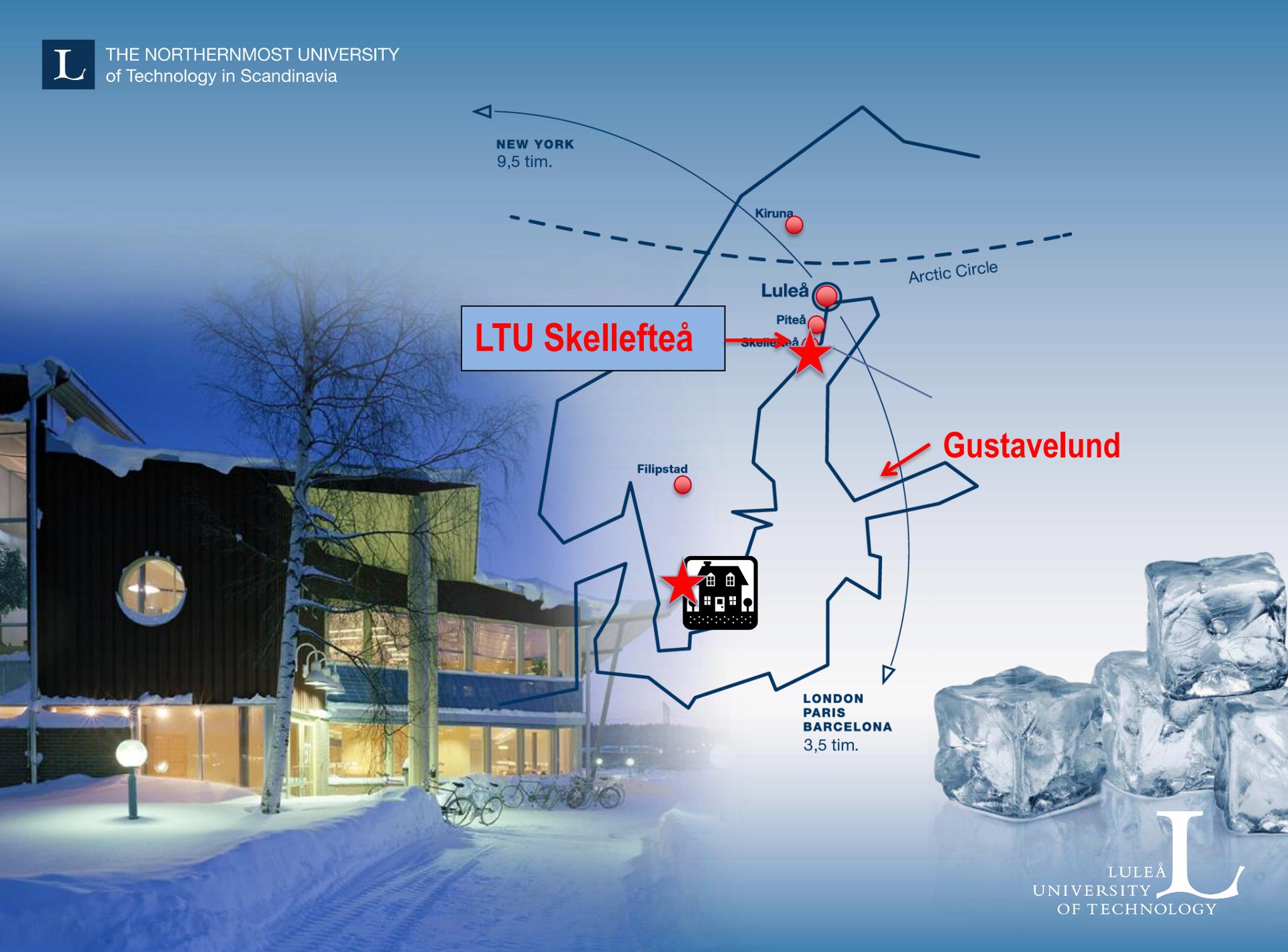
***Luleå University of  
Technology, Sweden***

***Wood Science and  
Engineering***

**Dick Sandberg**  
*Chaired professor and  
head of wood division*

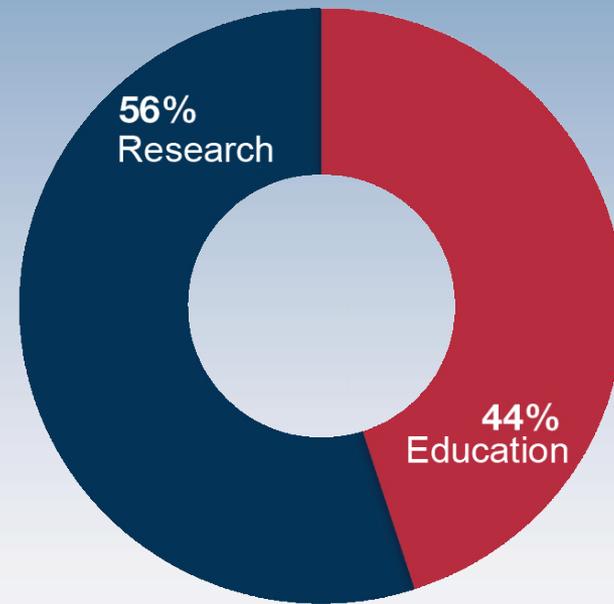
**Great ideas grow  
better below zero!**





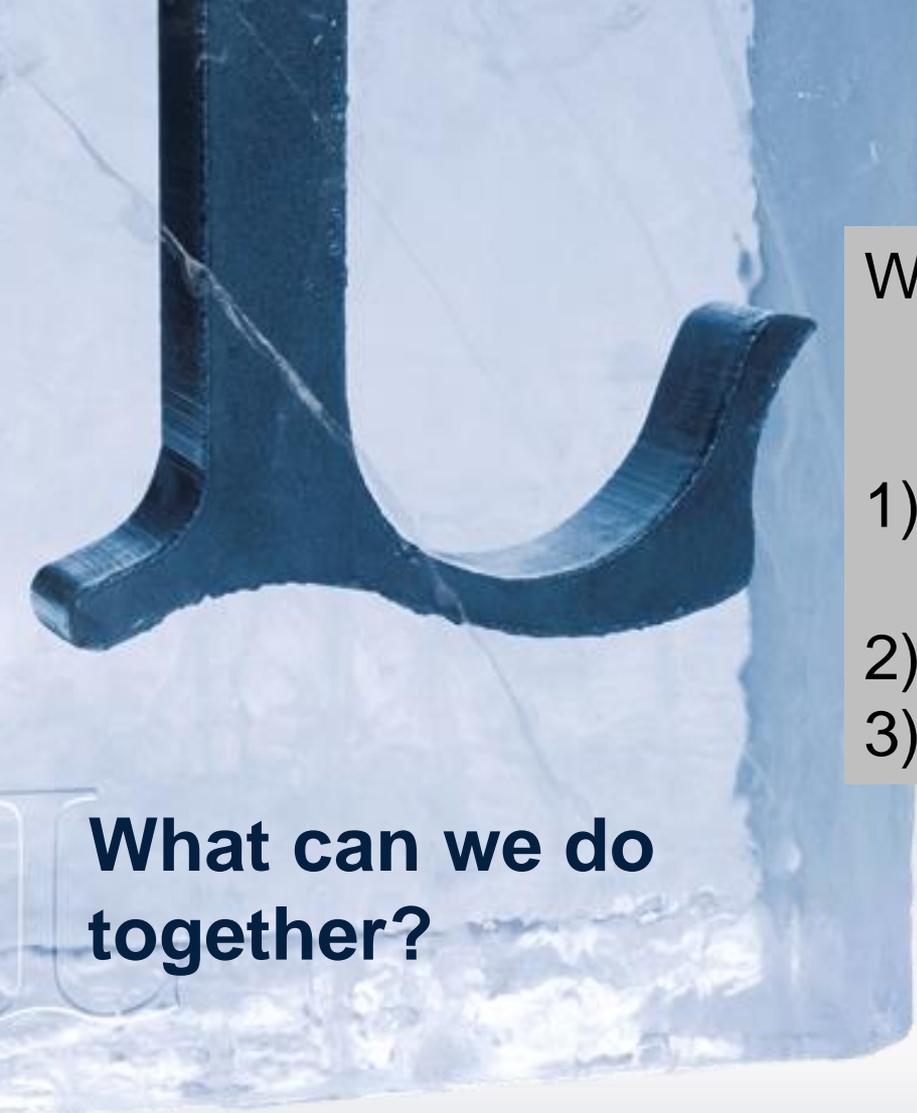
# Luleå University of Technology

- Founded 1971
- Turnover Euro 0.16 billion
  
- 15,000 students
- 1,800 employees
  - 236 professors
  - 811 teachers & researchers
  - 327 PhD students



# Why wood?





# Wood Science at LTU

*in Skellefteå*

1) Wood Science and Engineering

*in Luleå*

2) Timber Structures

3) Wood and bio-nano composites

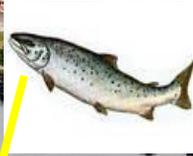
**What can we do  
together?**





THE NORTHERNMOST UNIVERSITY  
of Technology in Scandinavia

# SKELLEFTEÅ

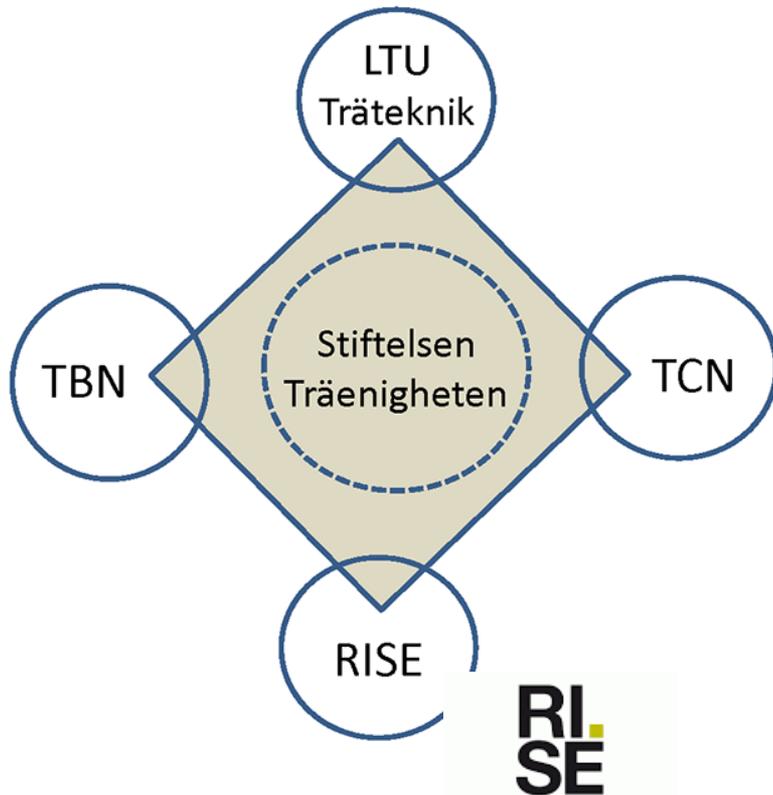


**LTU  
Wood**

**RI  
SE**



# Wood Industry Tradition in Skellefteå



- LTU Wood Sci. & Engineering
  - Material
  - Processes
  - Wood mechanics/construktion
- Wood Industry North (TBN)
  - Joinery enterprises in N. Sweden
- RISE
  - Bio-science and wood material
  - Built environment
- Wood Centre North, TCN
  - Forest owner, sawmills and timber construction enterprises

Focus: North and middle Sweden

# Wood Science and Engineering

Education

Research

Engineering

Test Centre

## ***Wood Science & Engineering***

- 4 Professors (+ 4 prof. em.)
- 1 Adjunct professor
- 10 senior researchers
- 1 Centre leader TCN
- 14 Doctoral students

**30 active in R&E**

## ***Timber Structures***

- 1 Professors
- 4 senior researchers
- 7 Doctoral students

**12 active in in R&E**

## ***Wood and bio-nano composites***

- 1 Professors
- 5 senior researchers
- 8 Doctoral students

**14 active in in R&E**

+ Research engineers & adm staff

**12 pers. at RISE Skellefteå**



# Wood Science and Engineering

Education

Research

Engineering

Test Centre



- 1) Bachelor Wood Technology, 3 years
  - 2) Master Wood Technology, 2 years  
✓ *Mozambique*
  - 3) Doctoral studies, 4 years
- } M Sc

DOCTORAL THESIS



DOCTORAL THESIS



LICENTIATE THESIS



DOCTORAL THESIS



The Value of Wood  
Production Strategies in the Forestry-Wood  
Chain Using X-ray Scanning and  
Computer Simulation



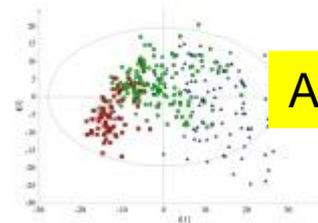
Magnus Fredriksson

Wood Fingerprints  
- Recognition of sawn wood products



Tobias Pahlberg

Efficient Utilization of Sawlogs  
Using Scanning Techniques and  
Computer Modelling



Anders Berglund

Machining Properties of Wood:  
Tool Wear, Cutting Force and Tensioning of Blades

Luís Cristóvão

All thesis you find at [www](http://www)



# Colours of the Skellefteå ice hockey team



# Wood Science and Engineering

Education

Research

Engineering

Test Centre



## Wood in use

- Wood Material
  - **Durability**
  - Impregnation
  - **Chem. modification**
  - **Thermal treatment**
  - **Wood water relations**
  - Timber properties
  - Board materials
  - Composites
  - Bio insulation

## Wood in processing

- Wood ind. processes
  - Raw material...
  - **Sawmilling, drying...**
  - Planing, machining....
  - Joinery processes....
  - **Scanning**
  - Process modelling
  - Sensors
  - **E-shopping**
  - **Digitalization**

## Wood in built environment

- Timber Engineering
  - **Multi-storey buildings in wood**
  - **Wooden bridges**
  - **Timber engineering**  
*Stability, strength, stiffness*
  - **CLT**
  - **Modelling/simulation**

Forestry

Pulp & Paper

Panels

Saw milling

Components

Packaging

Joinery

Furniture

Timber housing

Energy production from waste in the forestry based sector

# Wood in use

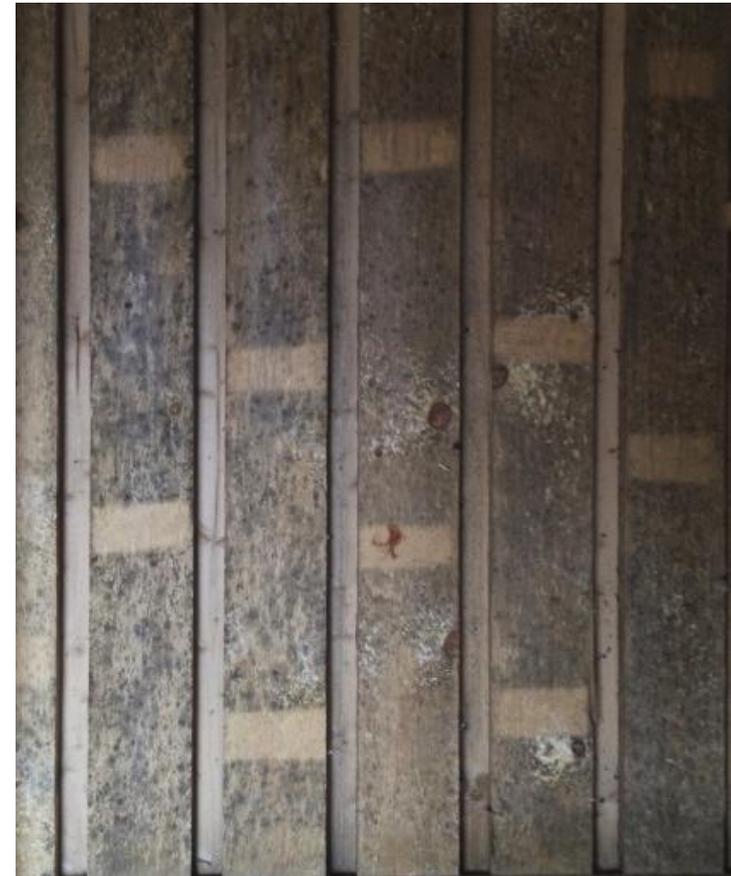


# Problem?

## Mould growth on outdoor sapwood boards



Links to the drying process

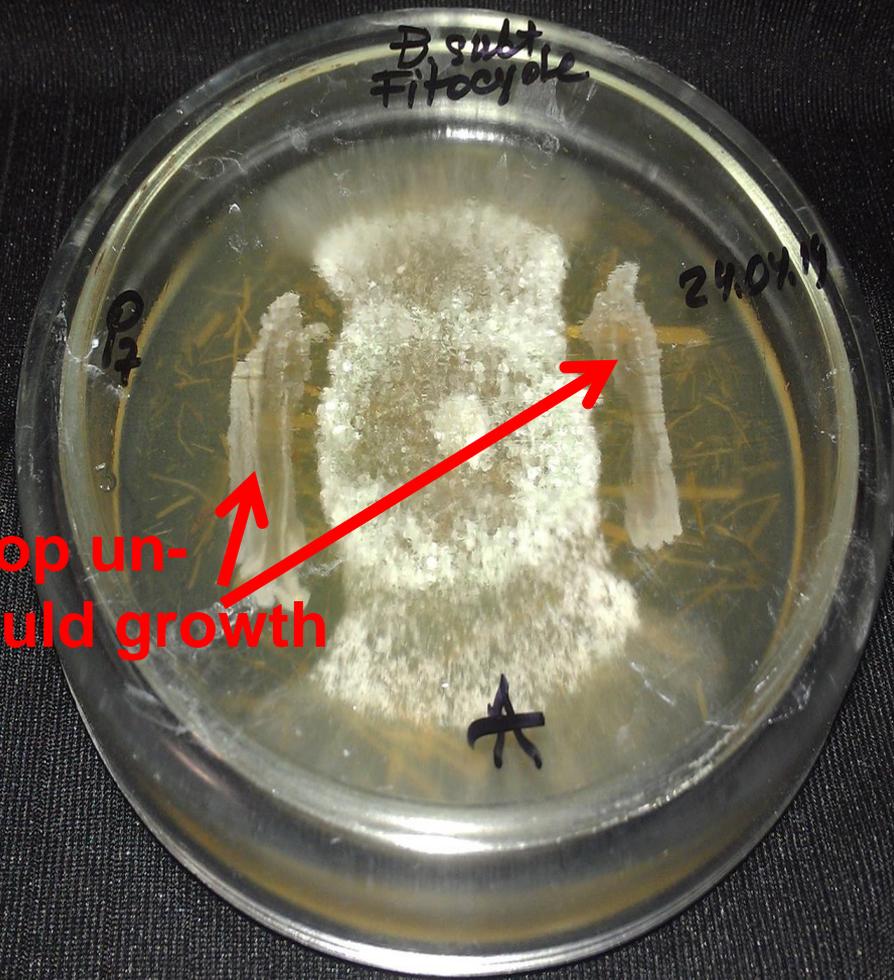


- Increased use of wood for outdoor applications
- Less harmful chemicals/alternatives
- Life cycle cost



NIR for classification of fungi

**Fungi to stop unwanted mould growth**



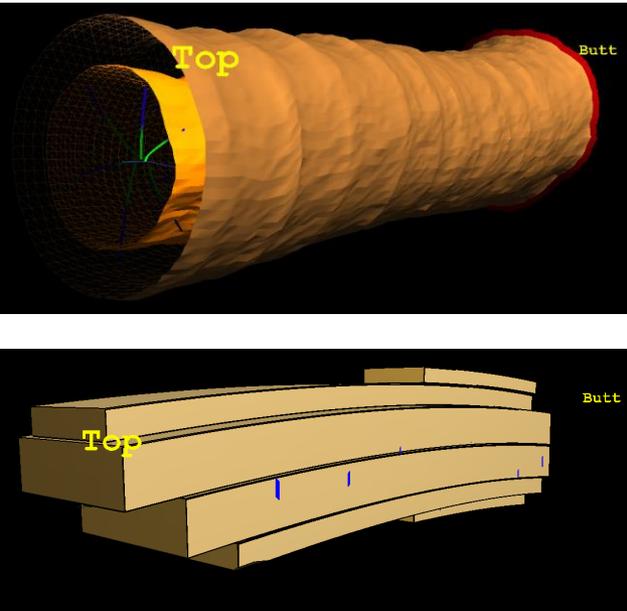
# Preference study



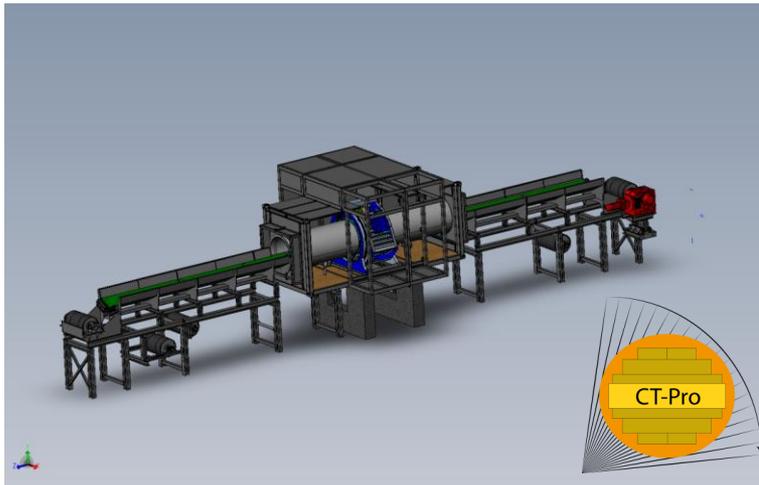
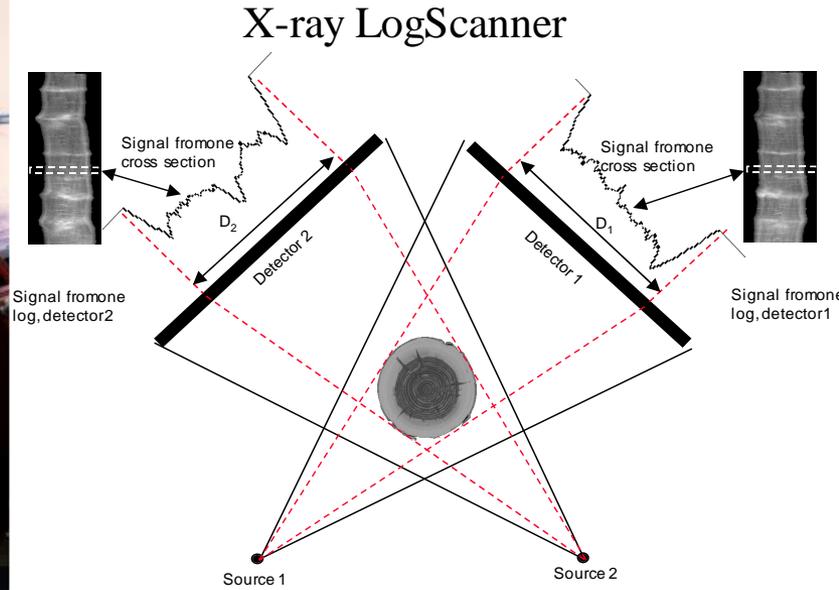
# Wood in processing



# Lab CT Scanner



# Industrial X-ray LogScanner



- Industrial high-speed CT scanner prototype
- Scanning logs at 2 m/s
- First industrial implementation of Katsevich's reconstruction algorithms

# Microtec industrial CT scanner

(The first instalation in Sweden during 2017)

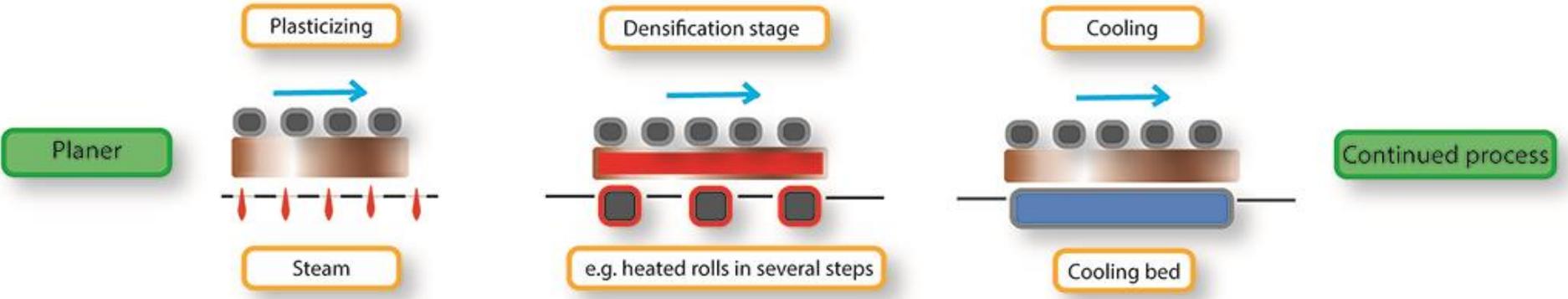


Figure 1. The first installation of a high-speed CT scanner for logs.



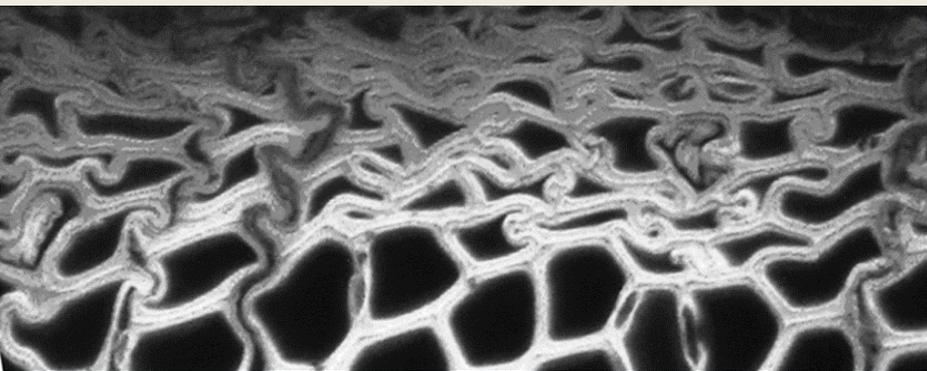
Figure 2. Left: Log with automatically detected features; sound knots (yellow), dead knots (red), splits (blue) and resin pockets (yellow). Right: Virtual break-down of log into boards.

# Densification process



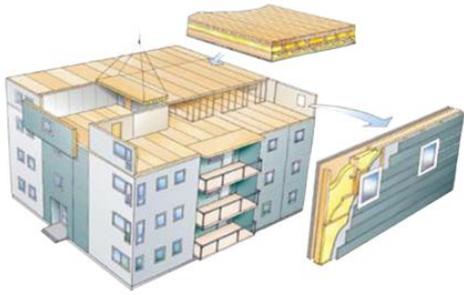
Surface densification

80 m/min



# Wood in Built Environment



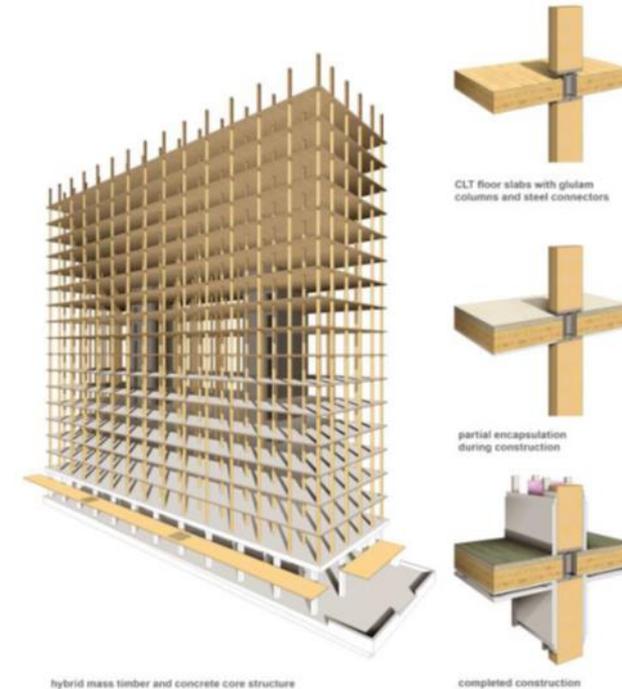
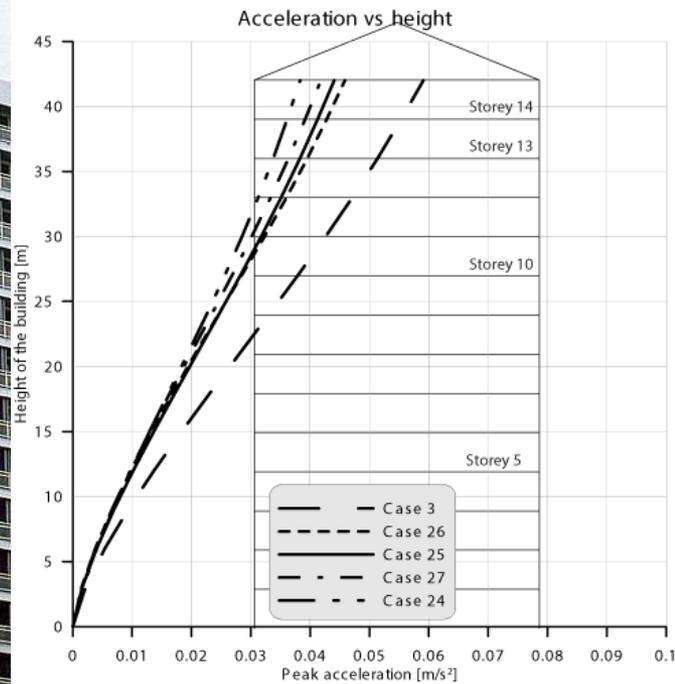


# Example Timber Engineering

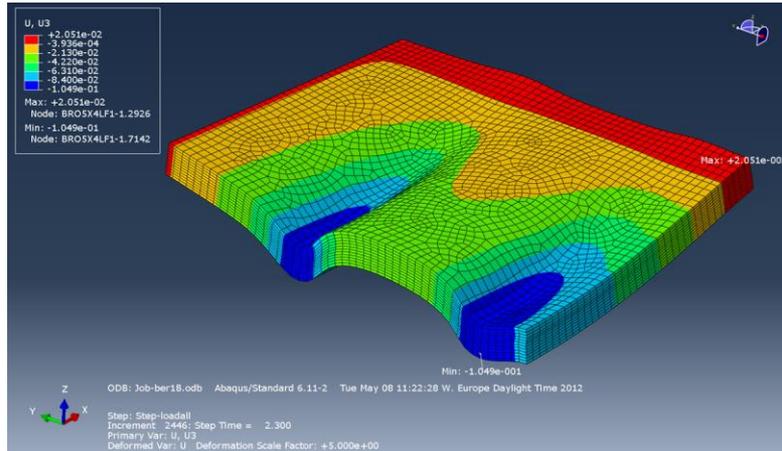
## Robustness

## Dynamics

## New construction systems



# Simulations and tests of timber bridges



# Wood Science and Engineering

Education

Research

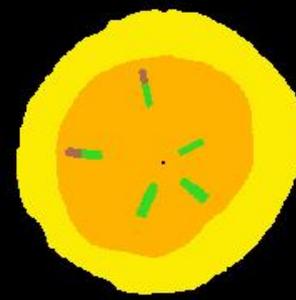
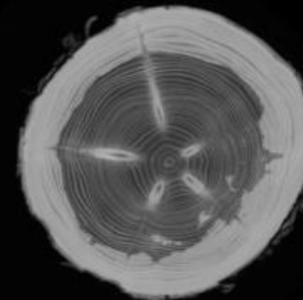
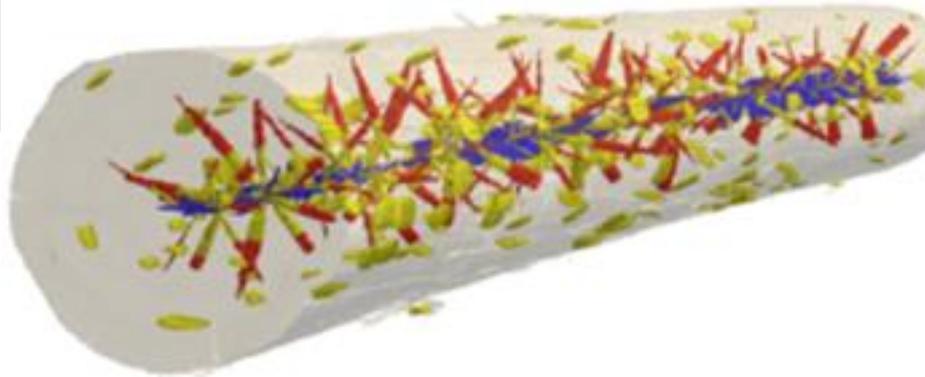
Engineering

Test Centre



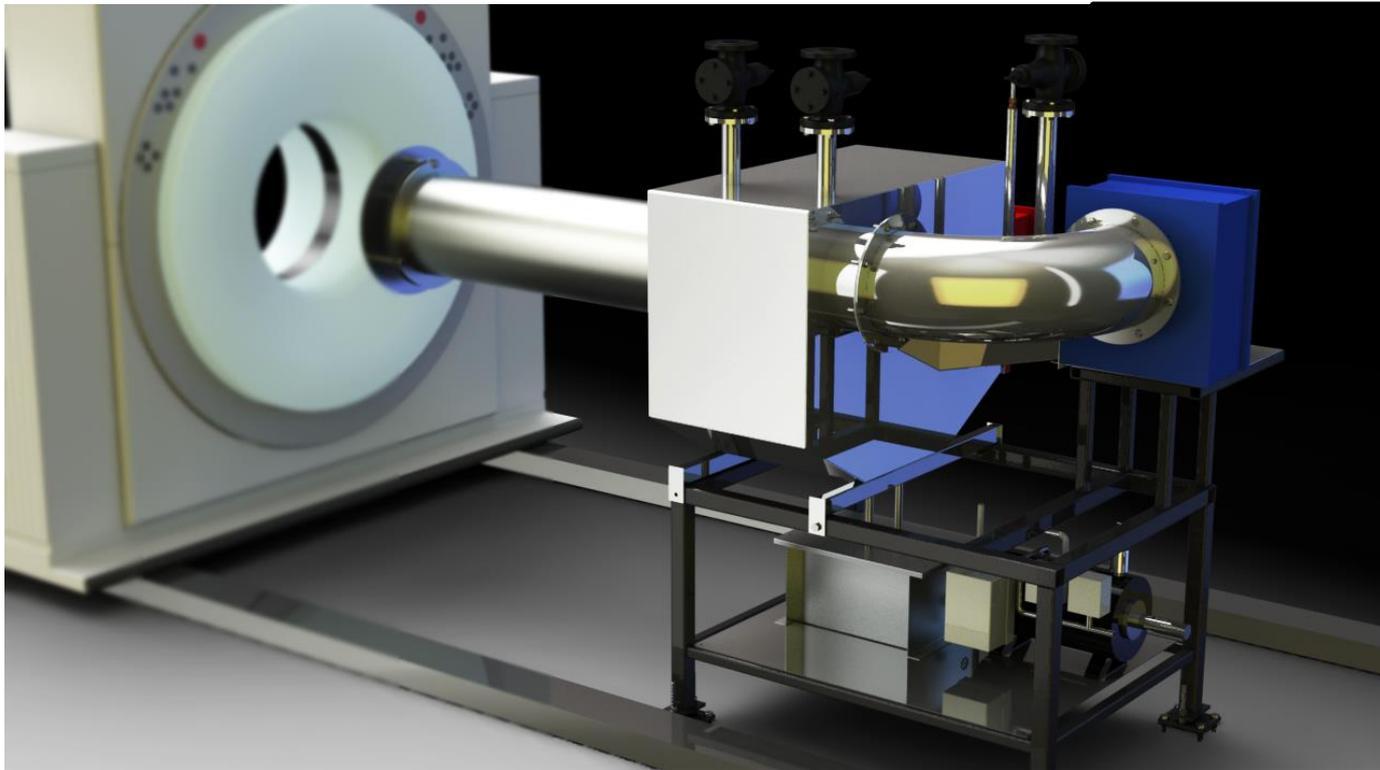
## Test and laboratory functions

- Chemistry & material labb.
- Microscopy
- Impregnation
- Scanner, Visualisation – Vibe
- Wood welding
- CT scanning



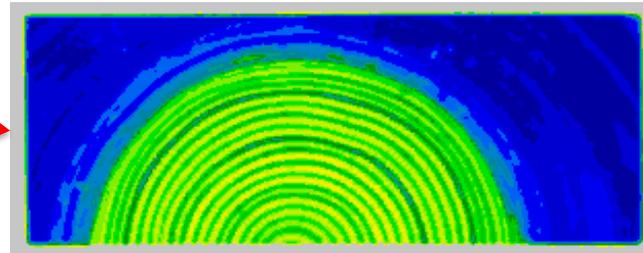
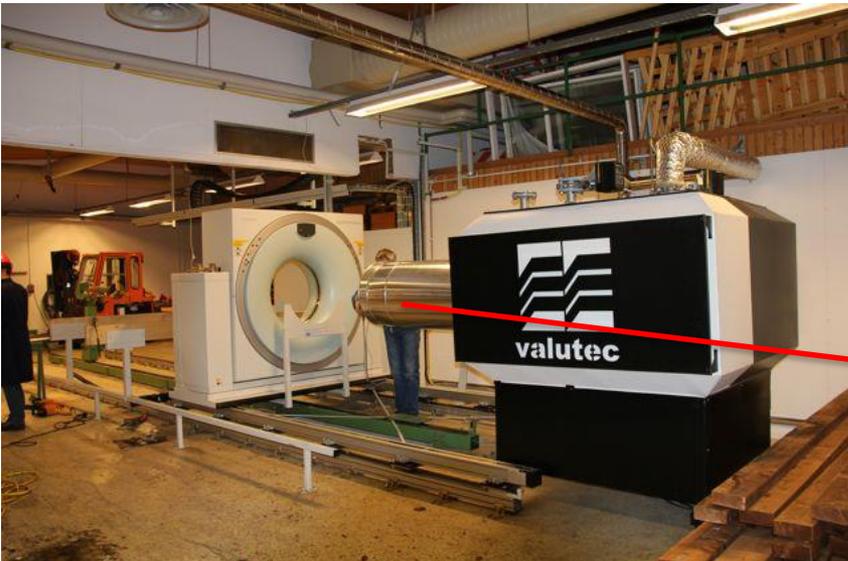
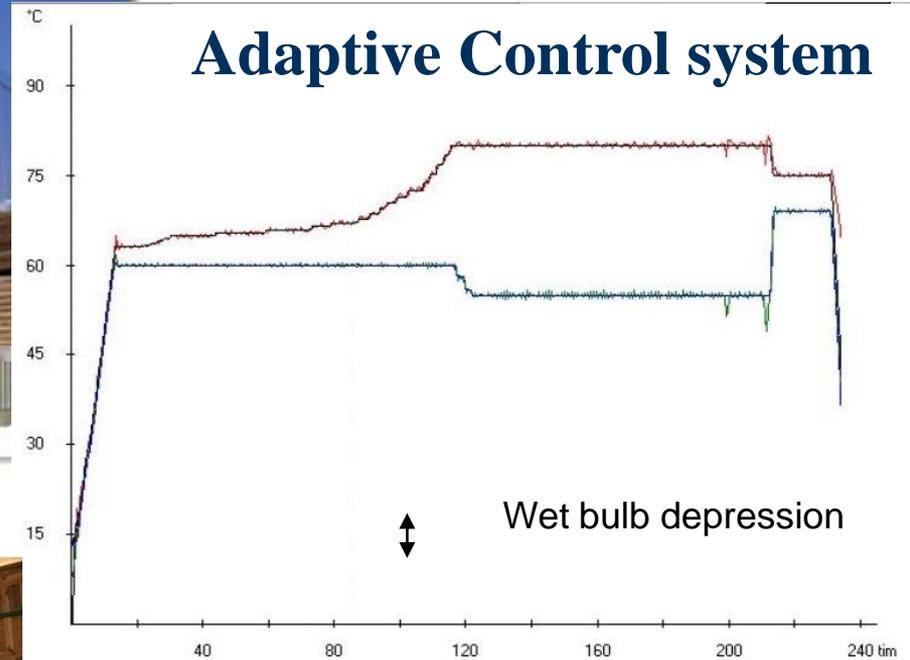
# Climate/drying chamber - CT scanner

Max 230 °C in superheated steam at 1 atm.



# Wood drying: Process improvement

Steam heating and conditioning





**Thank you for your kind  
attention!**