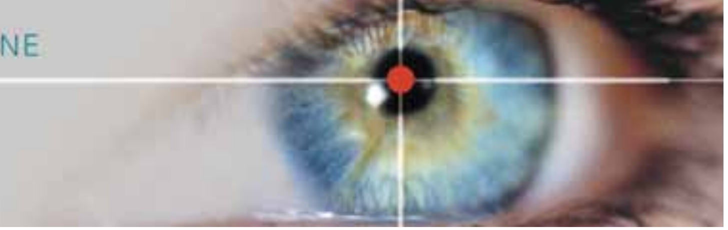
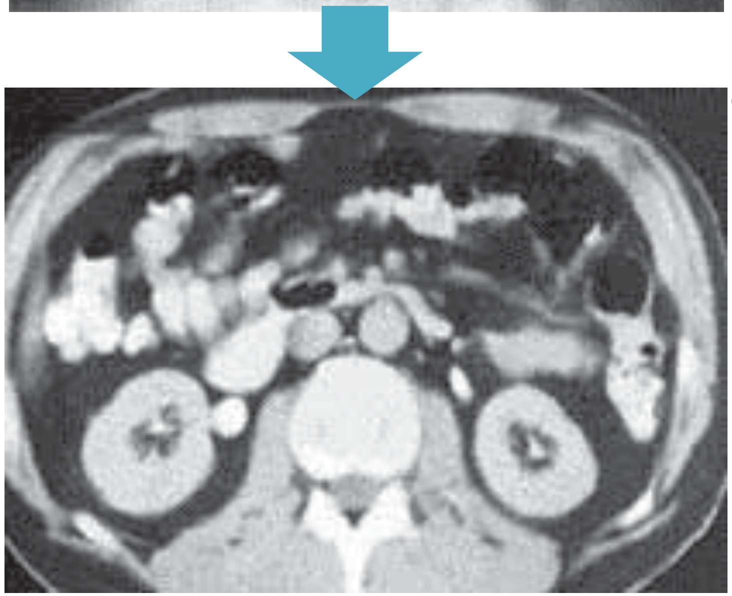


HIGH-SPEED COMPUTED TOMOGRAPHY

P A S S I O N – I N N O V A T I O N - D E D I C A T I O N

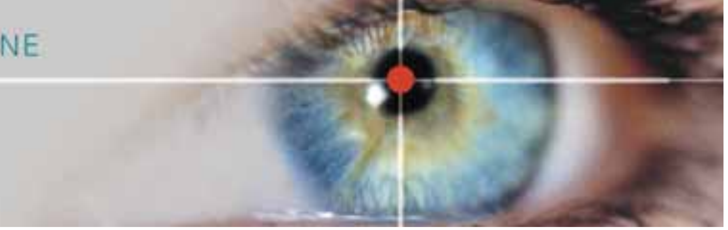
Radiography vs. Computed Tomography

Radiography returns a two-dimensional view of an object



CT can “see” the third dimension of the object

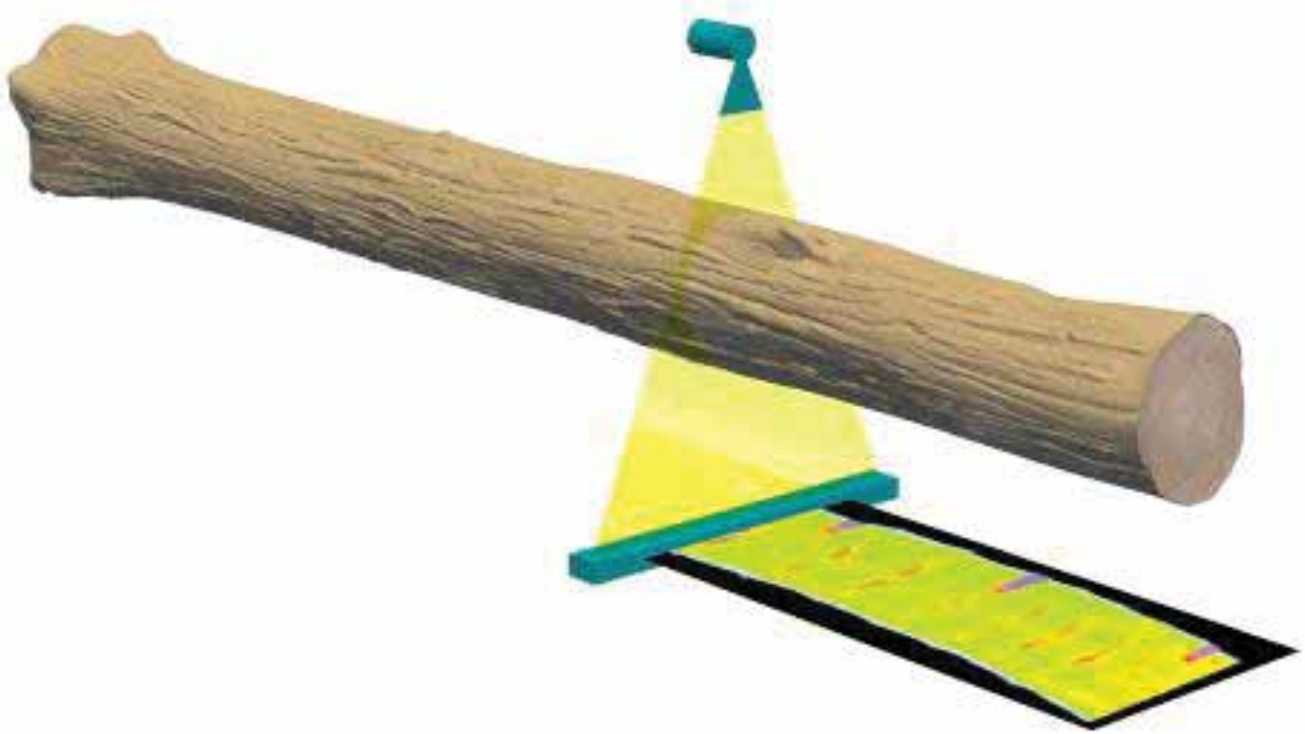
	ADDING VALUE TO THE TIMBER-LOG PROCESSING CHAIN
LOGEYE	MULTIPLE LOG RADIOGRAPHY
CT.LOG	COMPUTED TOMOGRAPHY FOR LOGS



LOGEYE

MULTI-VIEW APPROACH WITH MULTIPLE X-RAY LEVELS

X-RAY TECHNOLOGY



FOR OVER 33 YEARS, MICROTEC DEVELOPS SYSTEMS FOR THE RECOGNITION OF WOOD CHARACTERISTICS AND FOR INCREASING VALUE OF BOTH, MANUFACTURING PROCESS AND THE FINAL PRODUCTS. IN THE PAST 15 YEARS THE X-RAY TECHNOLOGY FOR TIMBER-LOGS AND SAWN-WOOD HAS BEEN A MILESTONE IN THE WOOD PROCESSING INDUSTRY.

1995: X-RAY SCANNER FOR SAWN-WOOD (***GOLDENEYE***)

2000: X-RAY SCANNER FOR LOGS (***LOGEYE***)

LOGEYE

THE MULTI-VIEW APPROACH

- BY USING MULTIPLE X-RAY SOURCES THE MULTI-VIEW SYSTEM IS ABLE TO DETECT INTERNAL STRUCTURES OF LOGS

- THE DISCRETE TOMOGRAPHY ALGORITHM IS CAPABLE OF RECONSTRUCTING A SIMPLIFIED MODEL OF THE LOG FOR THE DETECTION OF GENERAL CHARACTERISTIC SUCH AS KNOTTINESS, INTERNODE DISTANCE, KNOTTY-CORE DIMENSIONS, DENSITY, ….

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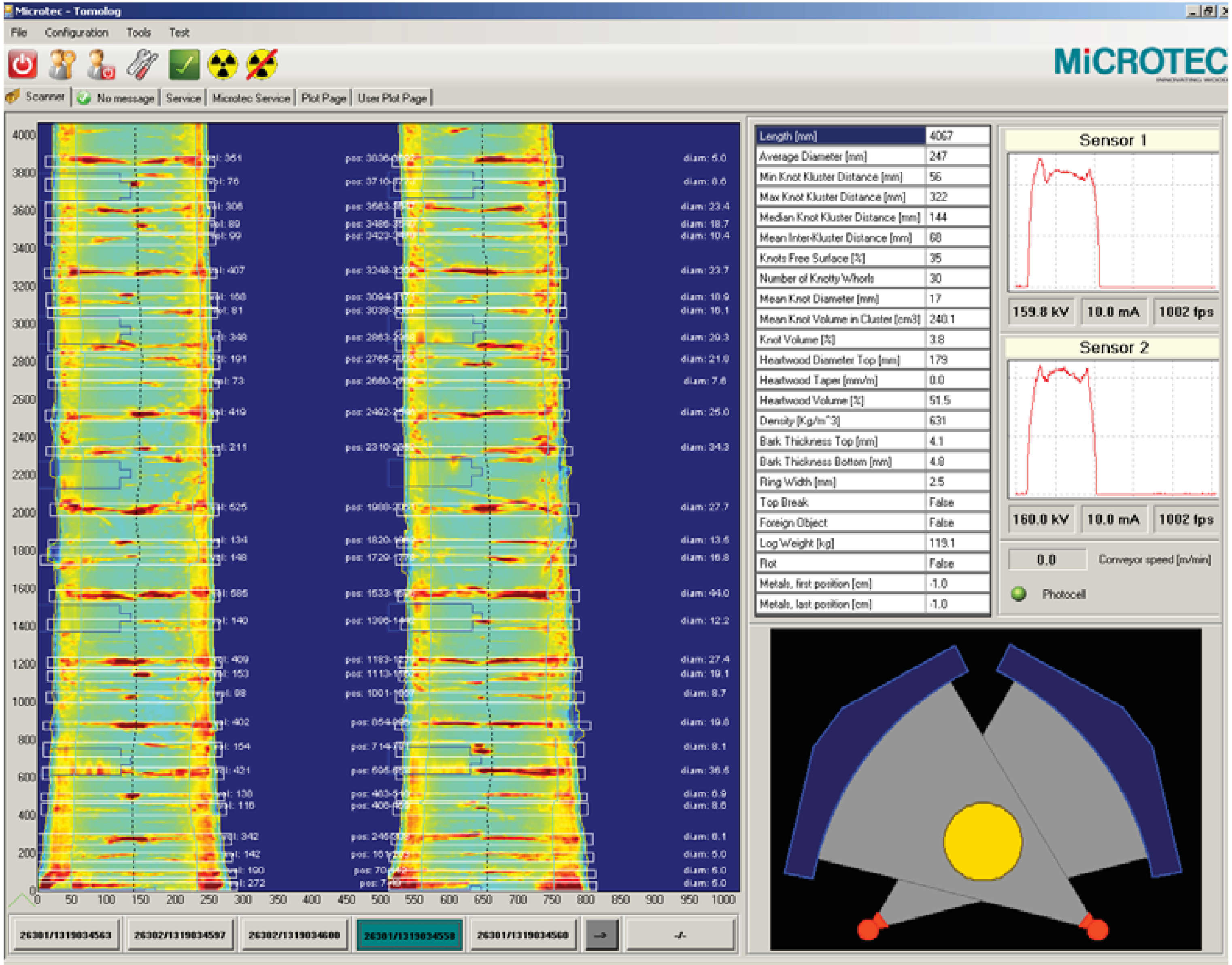
MiCROTEC
INNOVATING WOOD

LOGEYE



Length [mm]	4067
Average Diameter [mm]	247
Min Knot Kluster Distance [mm]	56
Max Knot Kluster Distance [mm]	322
Median Knot Kluster Distance [mm]	144
Mean Inter-Kluster Distance [mm]	68
Knots Free Surface [%]	35
Number of Knotty Whorls	30
Mean Knot Diameter [mm]	17
Mean Knot Volume in Cluster [cm3]	240.1
Knot Volume [%]	3.8
Heartwood Diameter Top [mm]	179
Heartwood Taper [mm/m]	0.0
Heartwood Volume [%]	51.5
Density [Kg/m^3]	631
Bark Thickness Top [mm]	4.1
Bark Thickness Bottom [mm]	4.8
Ring Width [mm]	2.5
Top Break	False
Foreign Object	False
Log Weight [kg]	119.1
Rot	False
Metals, first position [cm]	-1.0
Metals, last position [cm]	-1.0

LOGEYE


ViSCAN
LOGEYE
MICROTEC TOMOLOG
COLOR SCANNING
3D SCANNING
X-RAY SCANNING
iDENTIKIT LOGEYE
Scales, and provides in-depth stem and log description
Determines volume under and over bark
Recognizes size and position of knots, shakes, cracks, ...
Sorts stems and logs according to stiffness and MOE
Enables optimum clearwood recovery
Increases throughput and products with higher value
Calculates cutting pattern with the highest yield, quality and value
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MiCROTEC INNOVATING WOOD
LOGEYE

LOGEYE

SCA Tunadal/Sweden

TOMOLOG: X-RAY SCANNING FOR DETERMINING INTERNAL WOOD CHARACTERISTICS

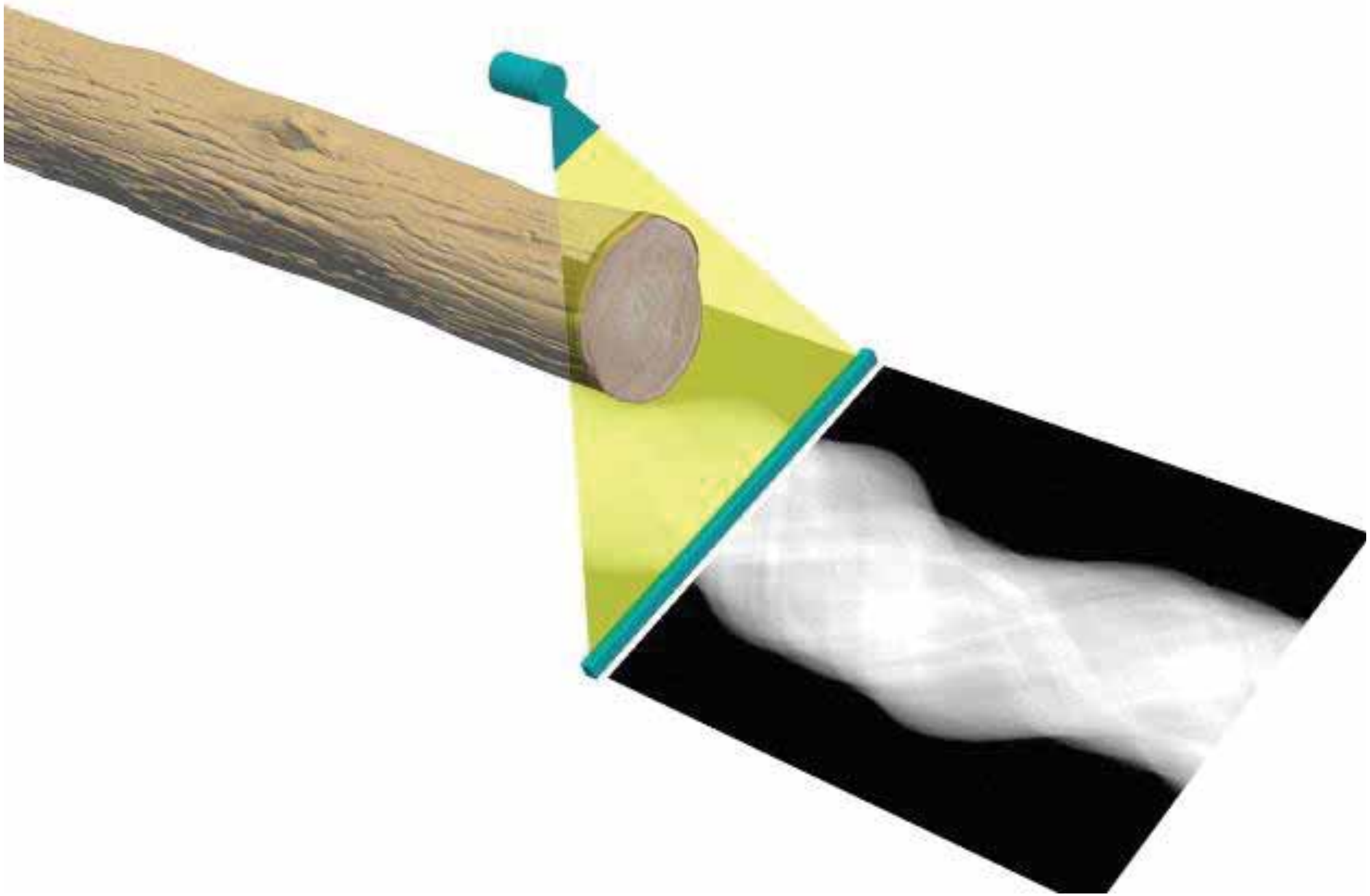
SCREENLOG-PLUS: COLOR SCANNING AND LASER TRIANGULATION FOR 3D RECONSTRUCTION

Computed Tomography

CT.LOG

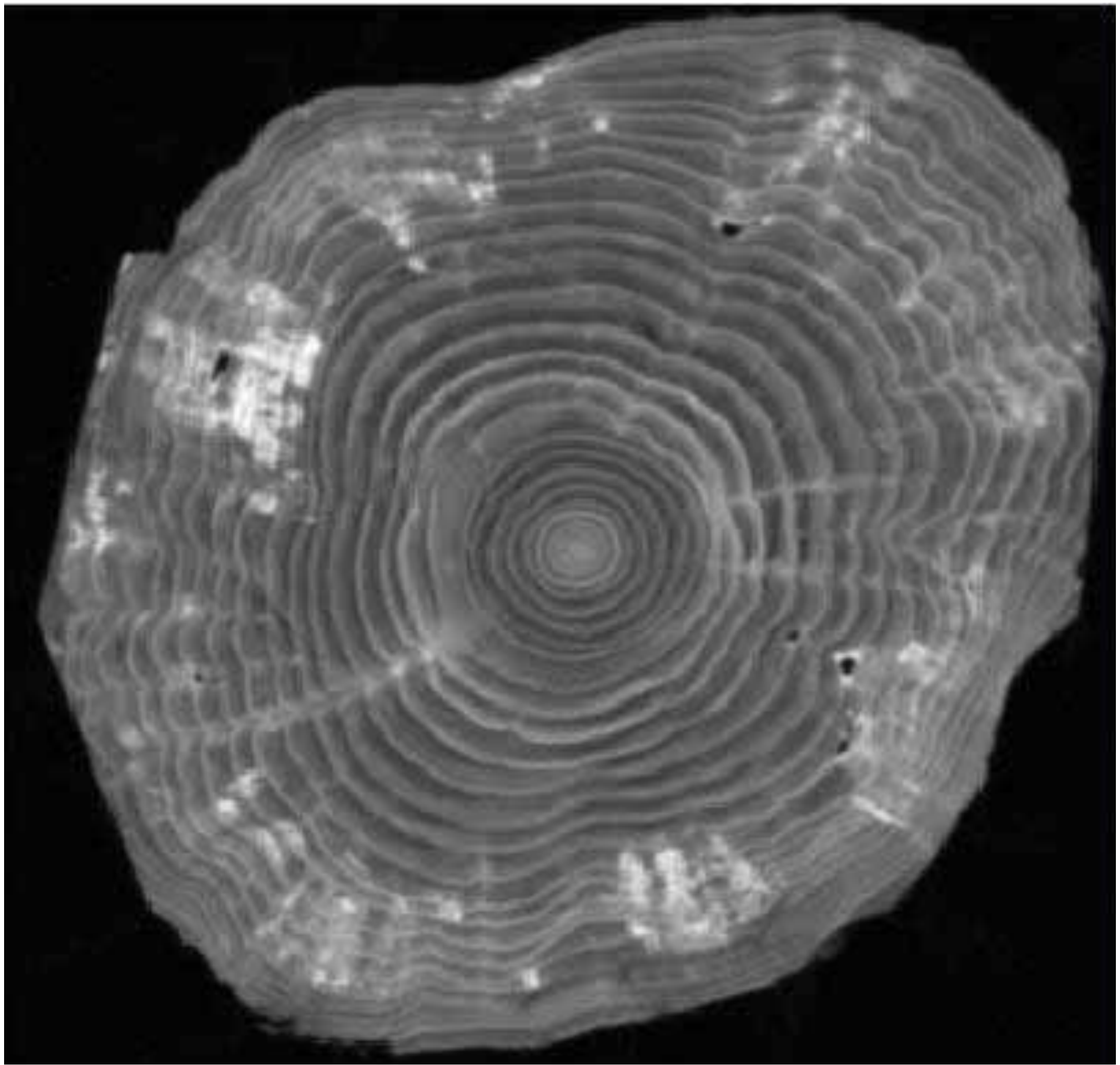
Industrial High-Speed CT-Technology for the Ultimate Added Value of Logs

COMPUTED TOMOGRAPHY – THE TECHNOLOGY

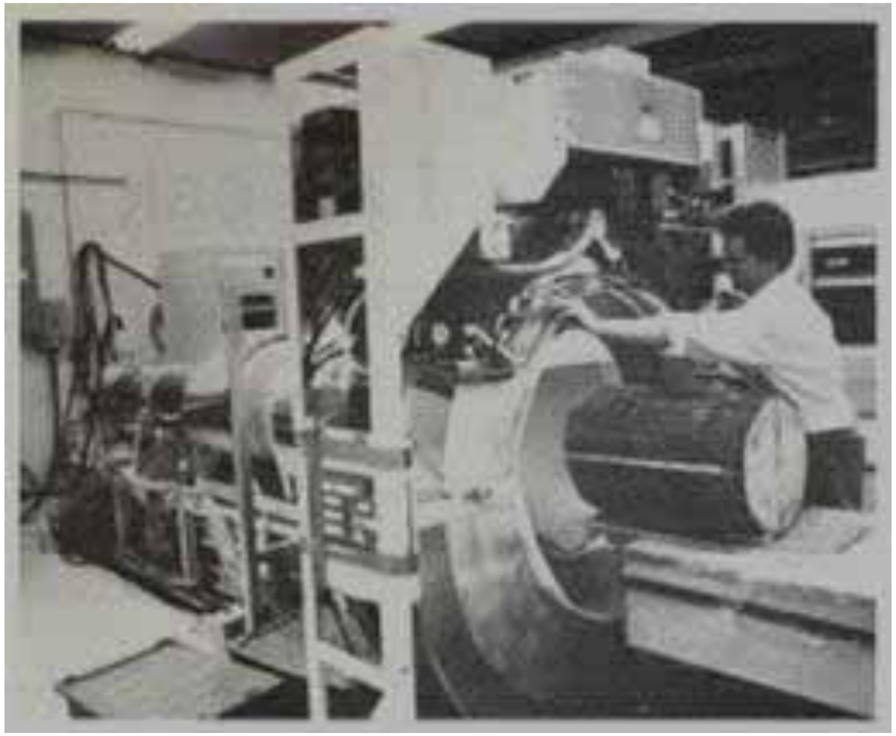


COMPUTED TOMOGRAPHY

RECONSTRUCTION OF THE AXIAL IMAGE AFTER THE TOMOGRAPHIC INVERSION (RADON TRANSFORM) OF THE SINOGRAM



COMPUTED TOMOGRAPHY – FIRST TRIALS



FIRST LOG IN A CT SCANNER :
IMATRON (CALIFORNIA) 1986

FIRST FULL LOG SCANNED:
LOUSIANA STATE UNIVERSITY 1994

CT.LOG

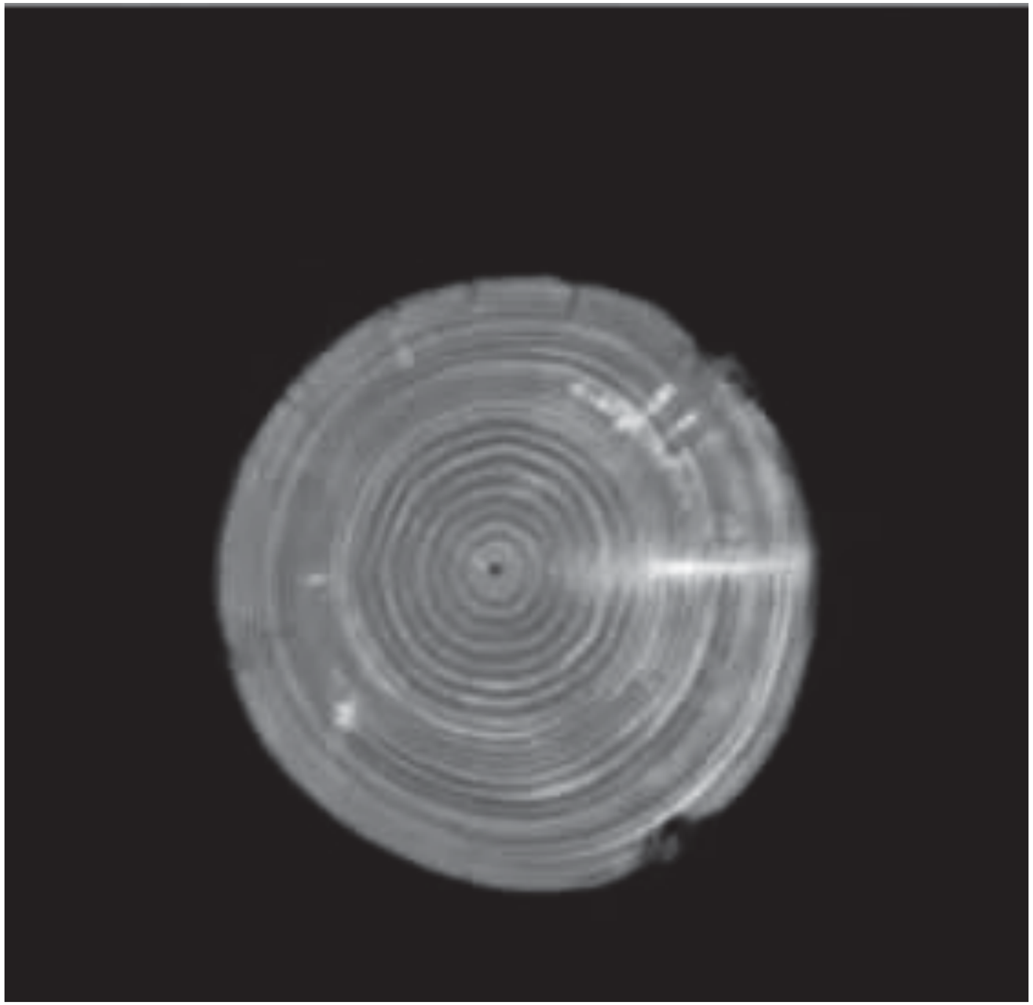
Cone Beam CAT-scanner at the Wood Research Center of Freiburg Germany (FVA)

Operations were started October 2007.

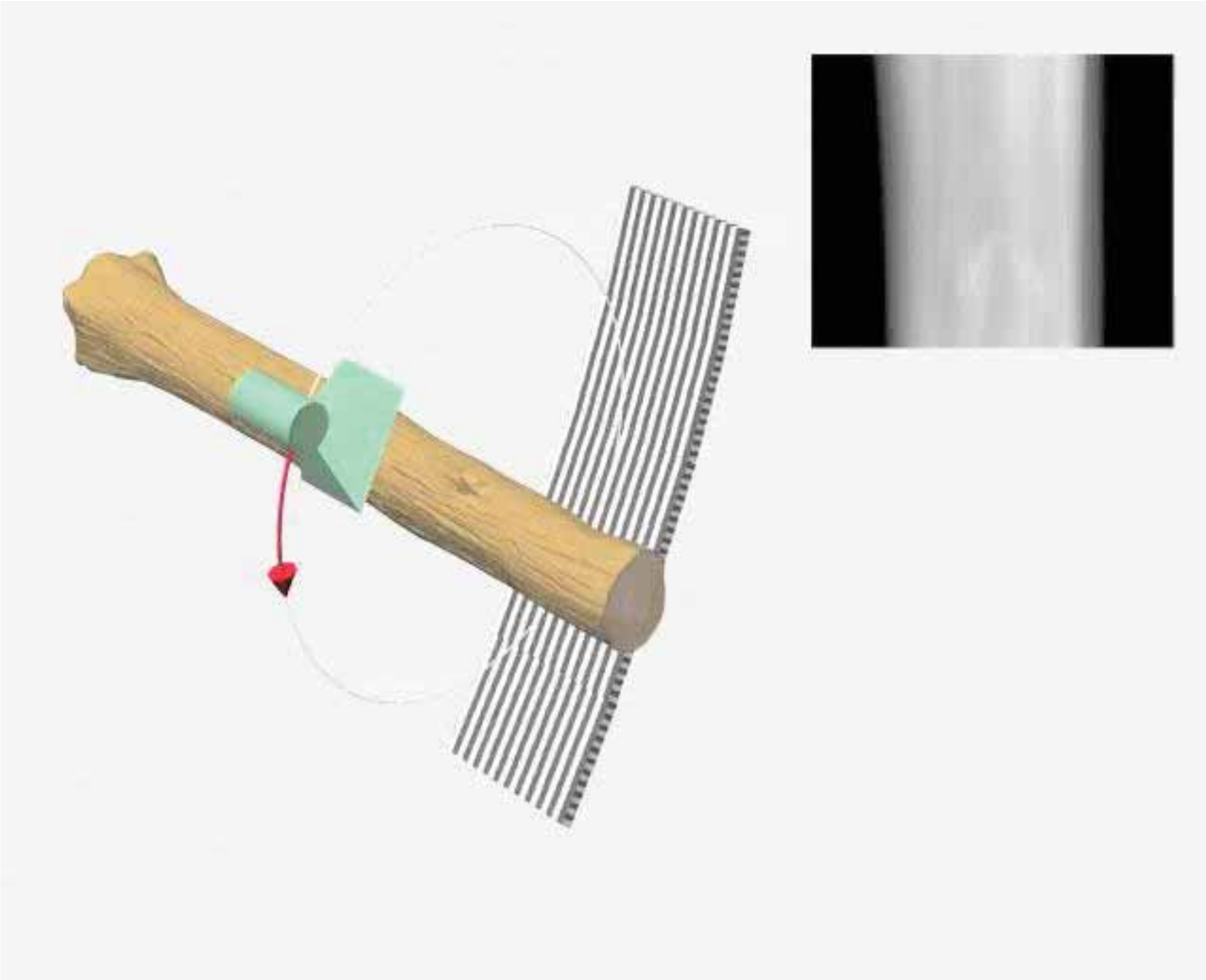
The Machine is used for developing and validating the Algorithms for the ***LOGEYE*** by delivering the reference and simulating different projections for an optimal choice of number and angular distance of the Multi-view projections

CT.LOG

First full Scan



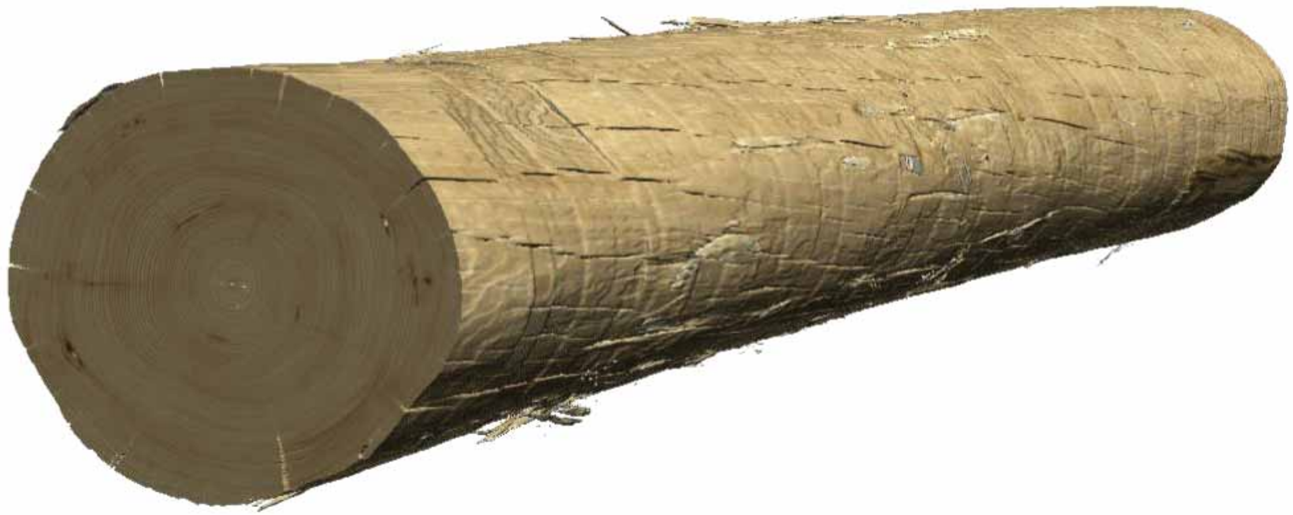
Large Cone Beam Computed Tomography



Large Cone Beam Computed Tomography

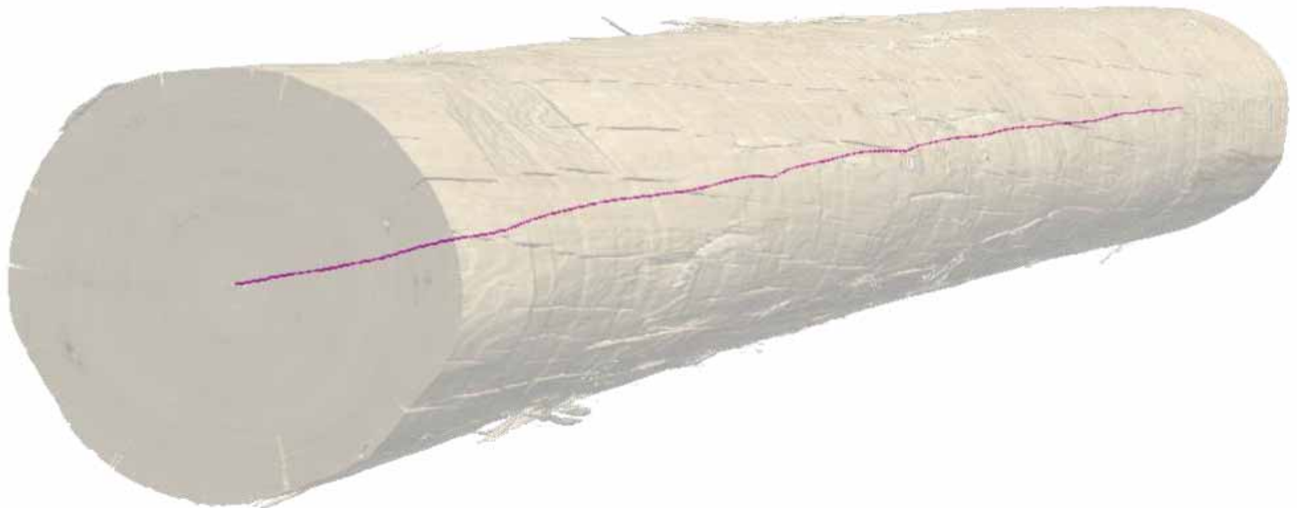
Wood property extraction with CT.LOG:

CT.LOG: one scanner for the internal inspection of multiple wood properties of each log during production



Pith

Wood property extraction with CT.LOG:



Pith

Sound Knots

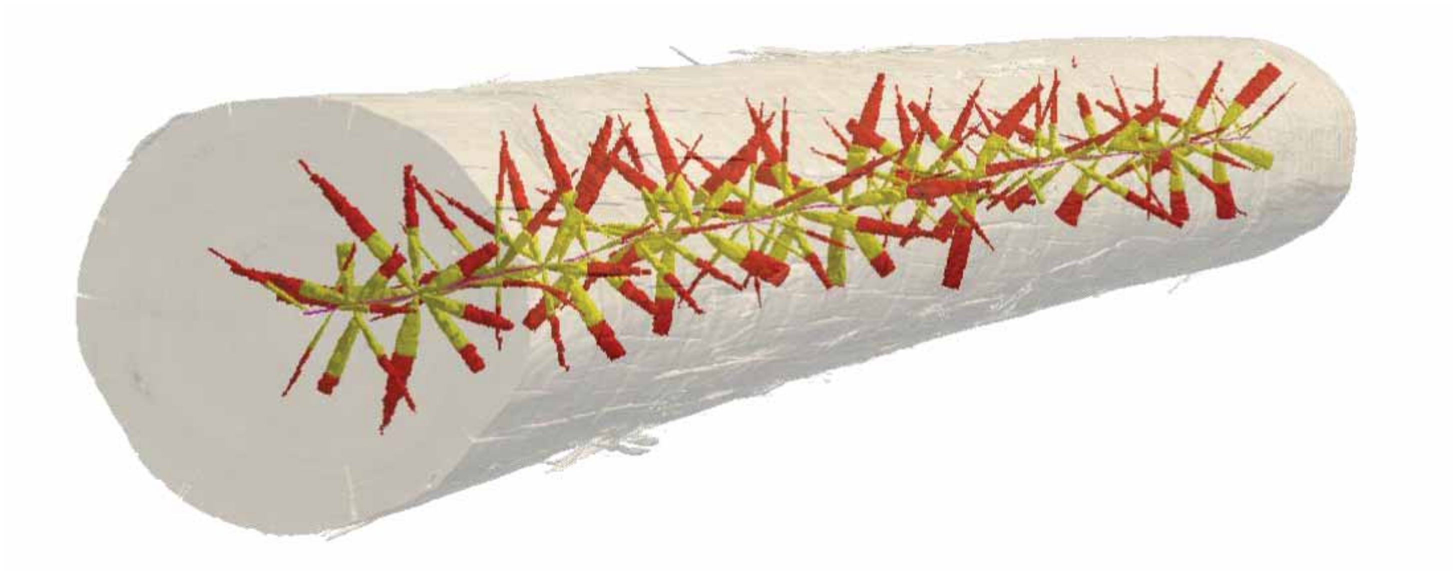
Wood property extraction with CT.LOG:

Pith

Sound Knots

Dead Knots

Wood property extraction with CT.LOG:



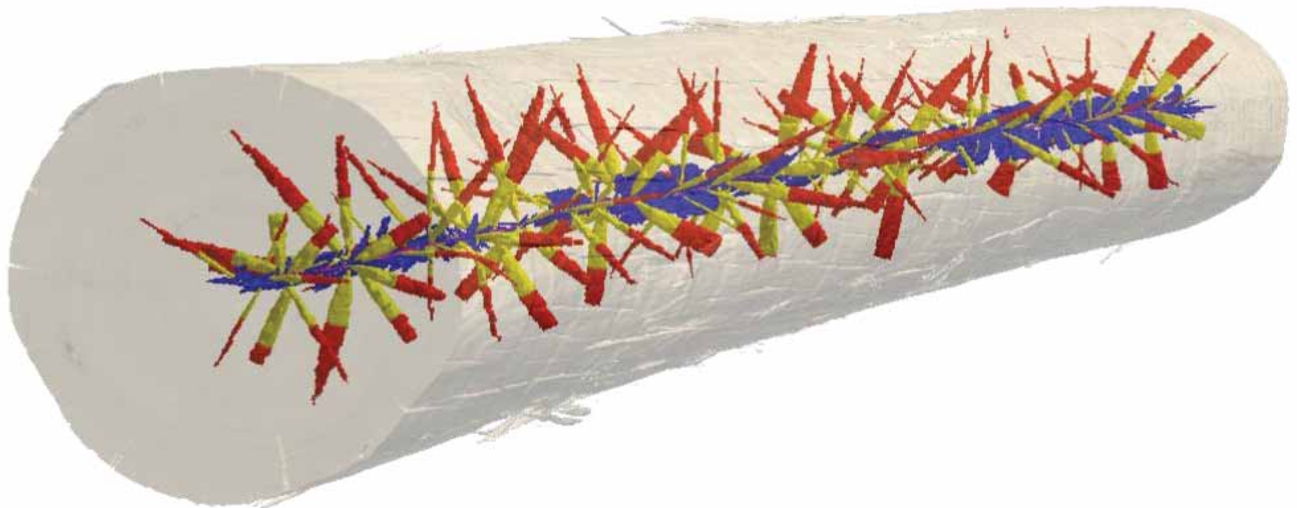
Pith

Sound Knots

Dead Knots

Splits

Wood property extraction with CT.LOG:



Pith

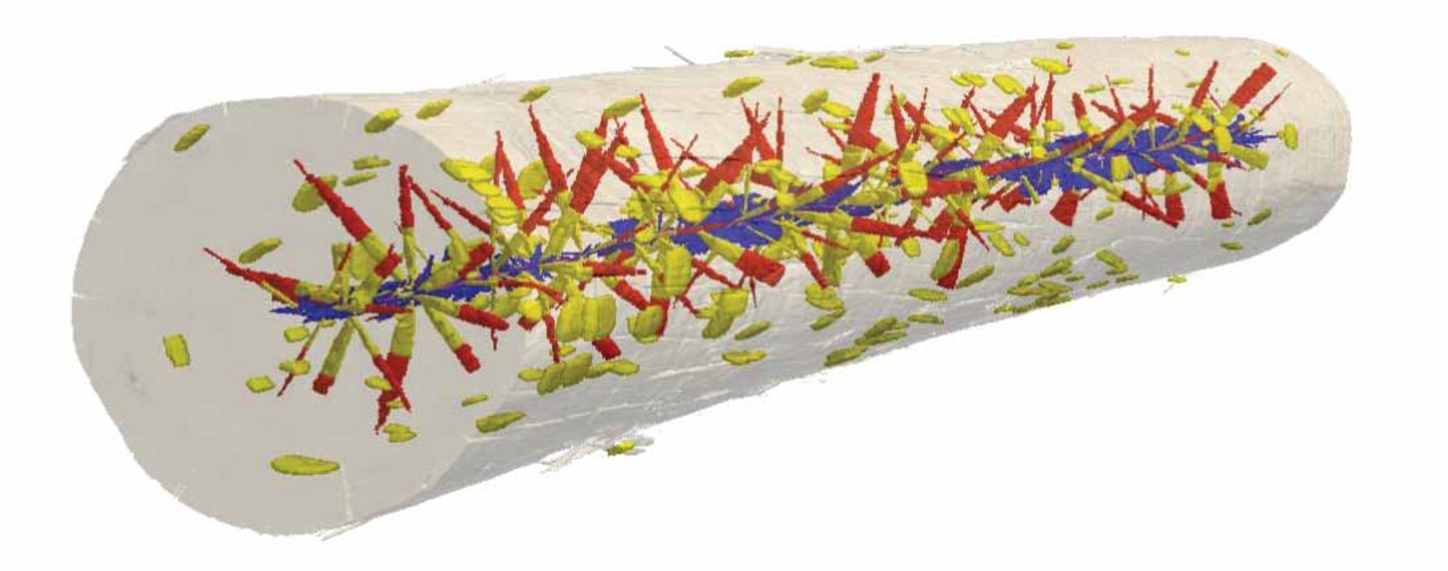
Sound Knots

Dead Knots

Splits

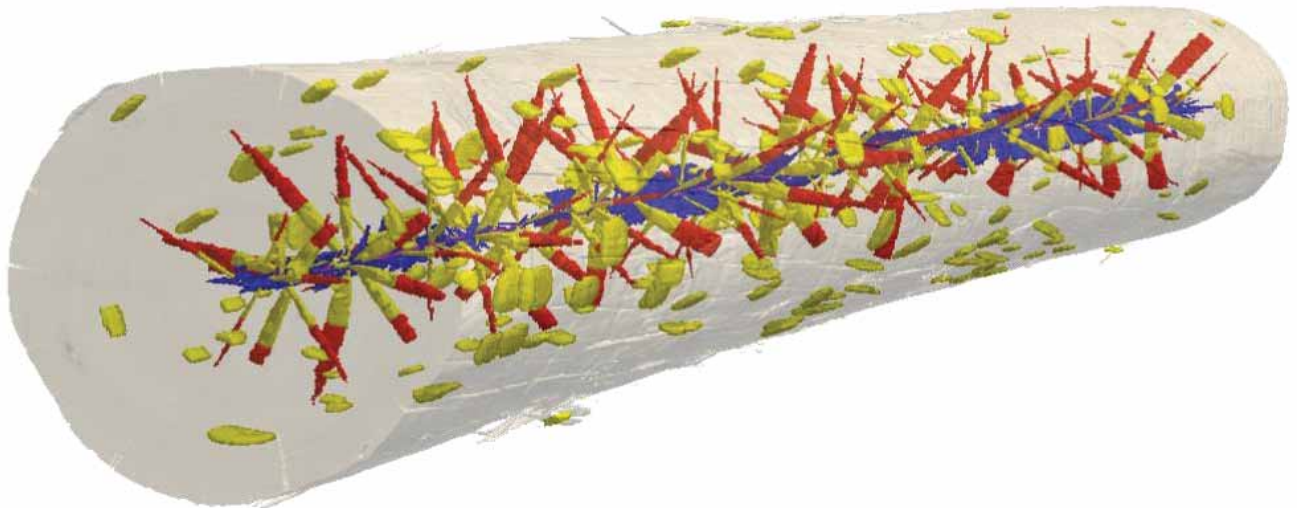
Resin Pockets

Wood property extraction with CT.LOG:



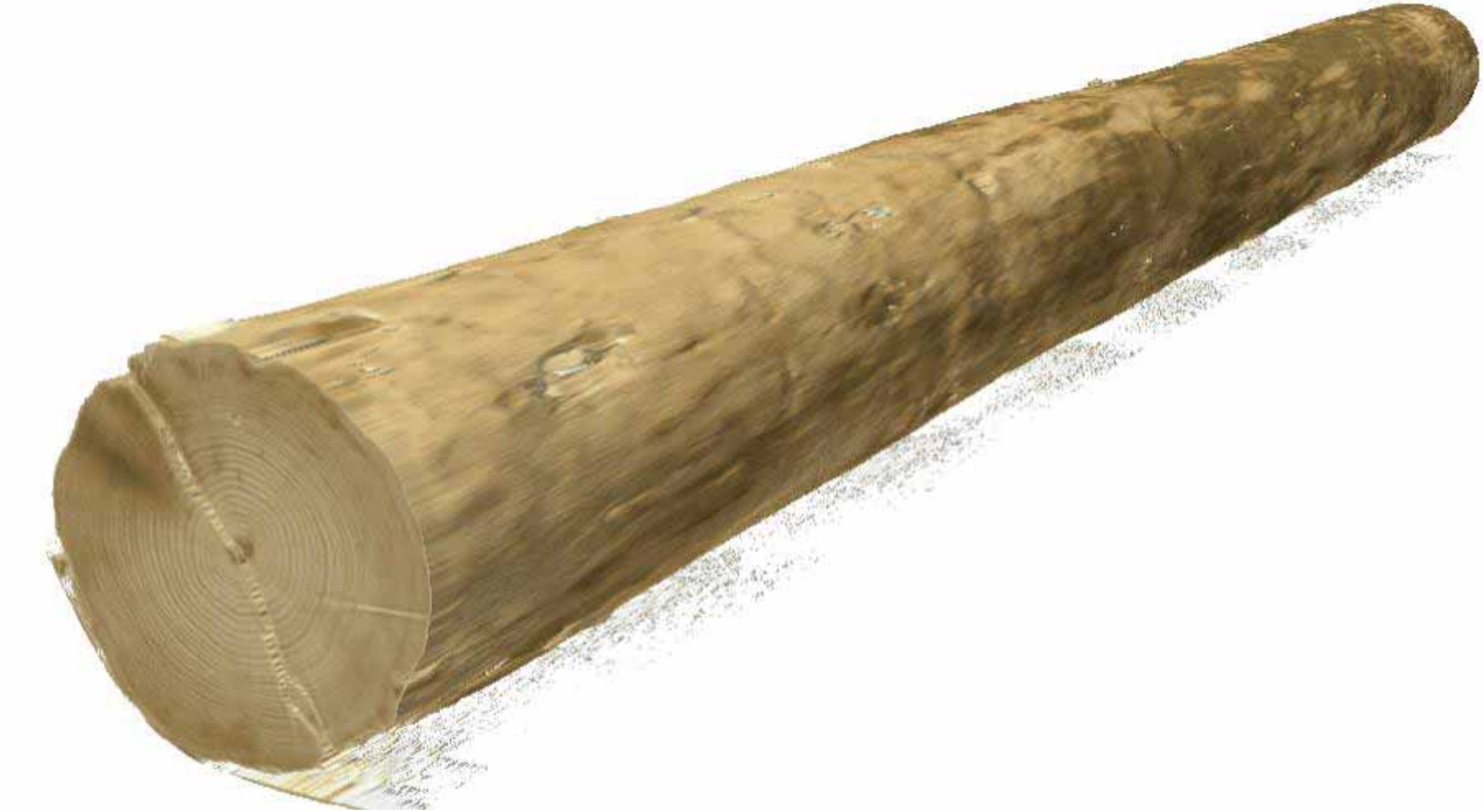
Wood property extraction with CT.LOG:

- Pith
- Sound Knots
- Dead Knots
- Splits
- Resin Pockets
- Rotten parts
- Slope of grain
- Heartwood
- Metals
- Green density
- Annual ring spacing
- Compression wood
- Bark enclosures
- Specie recognition
- Under bark shape



CT.LOG Virtual Sawing

CT data can be used to analyze and evaluate different production strategies for each log

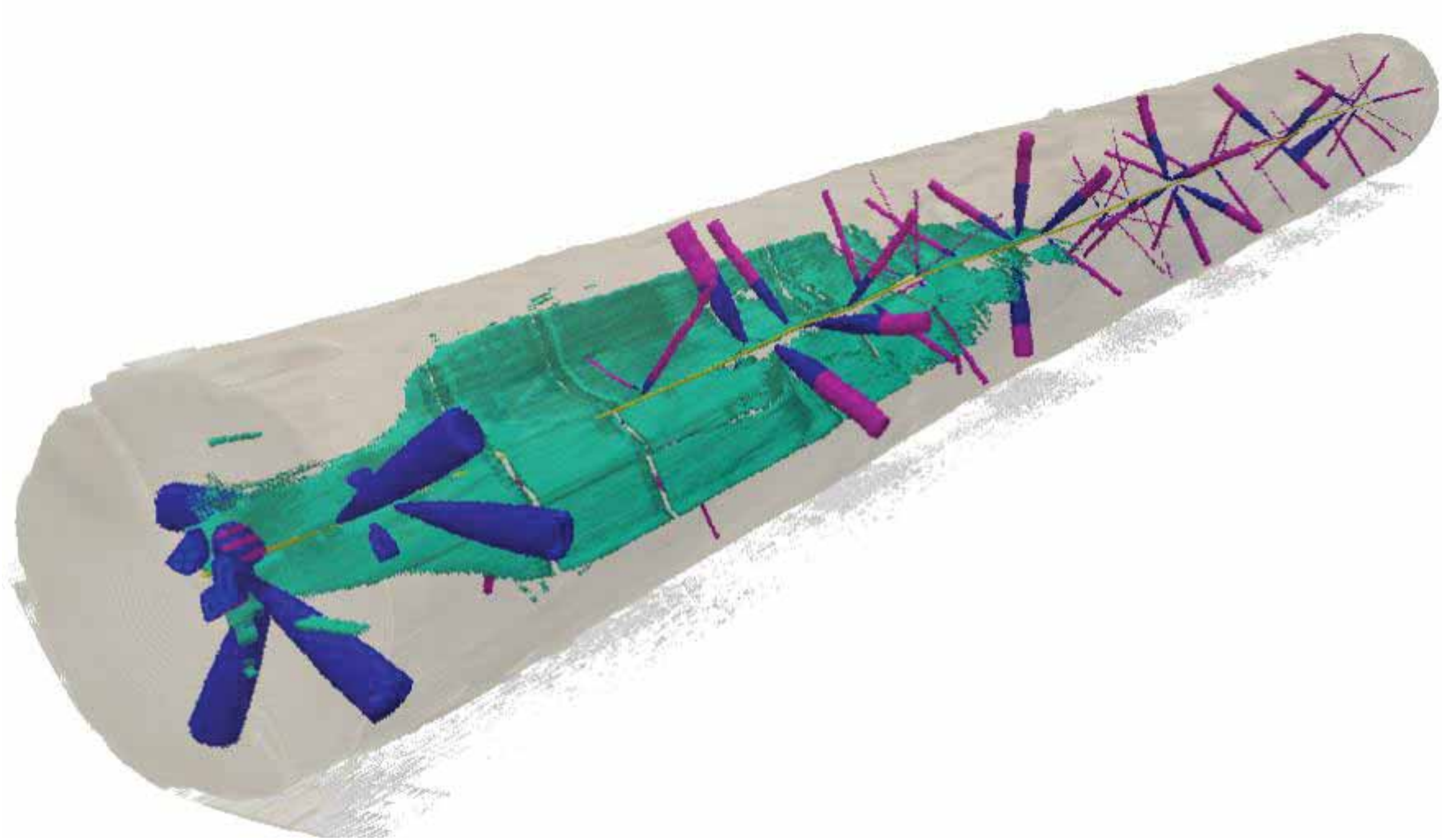


CT.LOG Virtual Sawing

All possible cutting pattern can be simulated

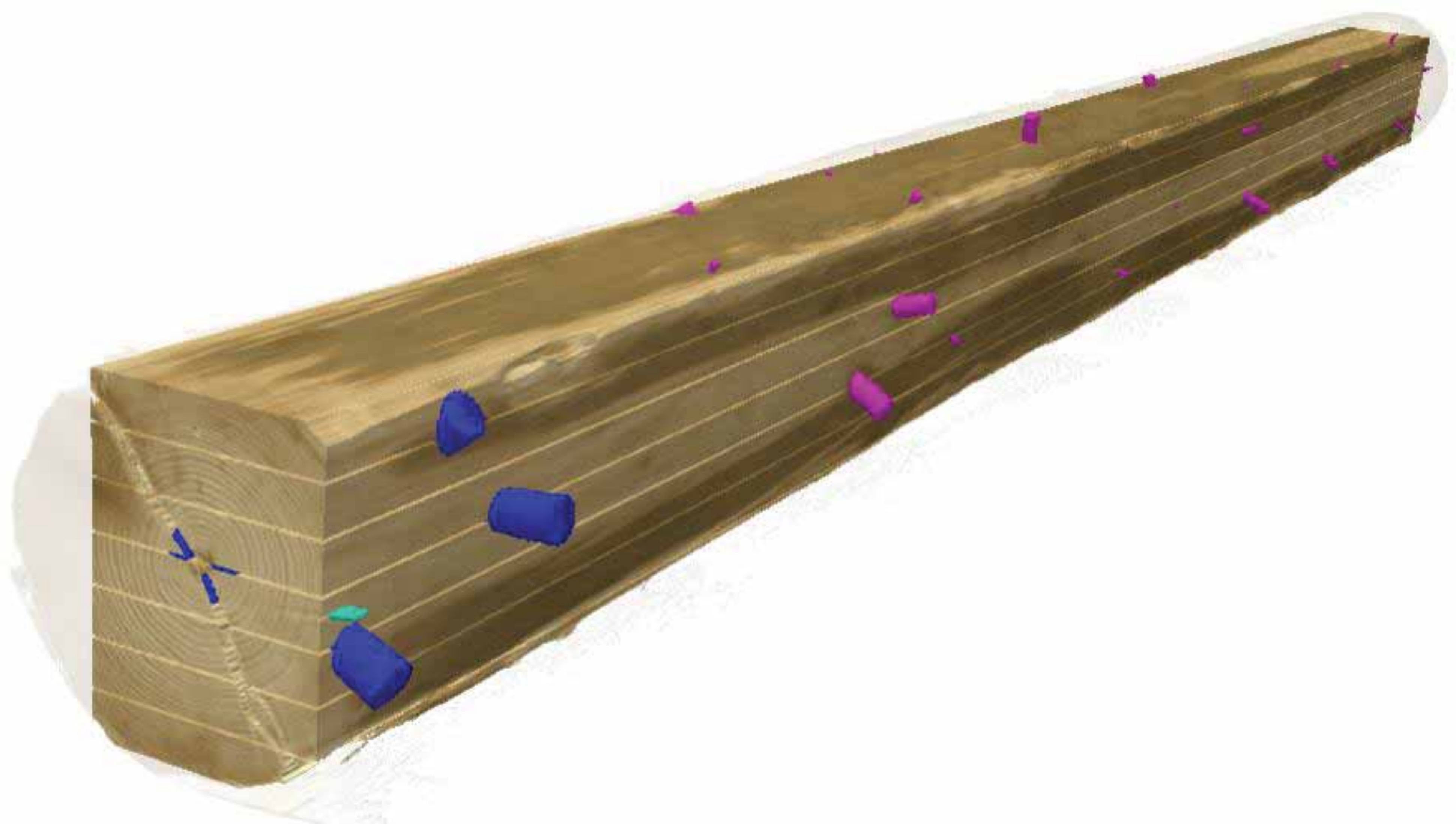
CT.LOG Virtual Sawing

Wood properties detected



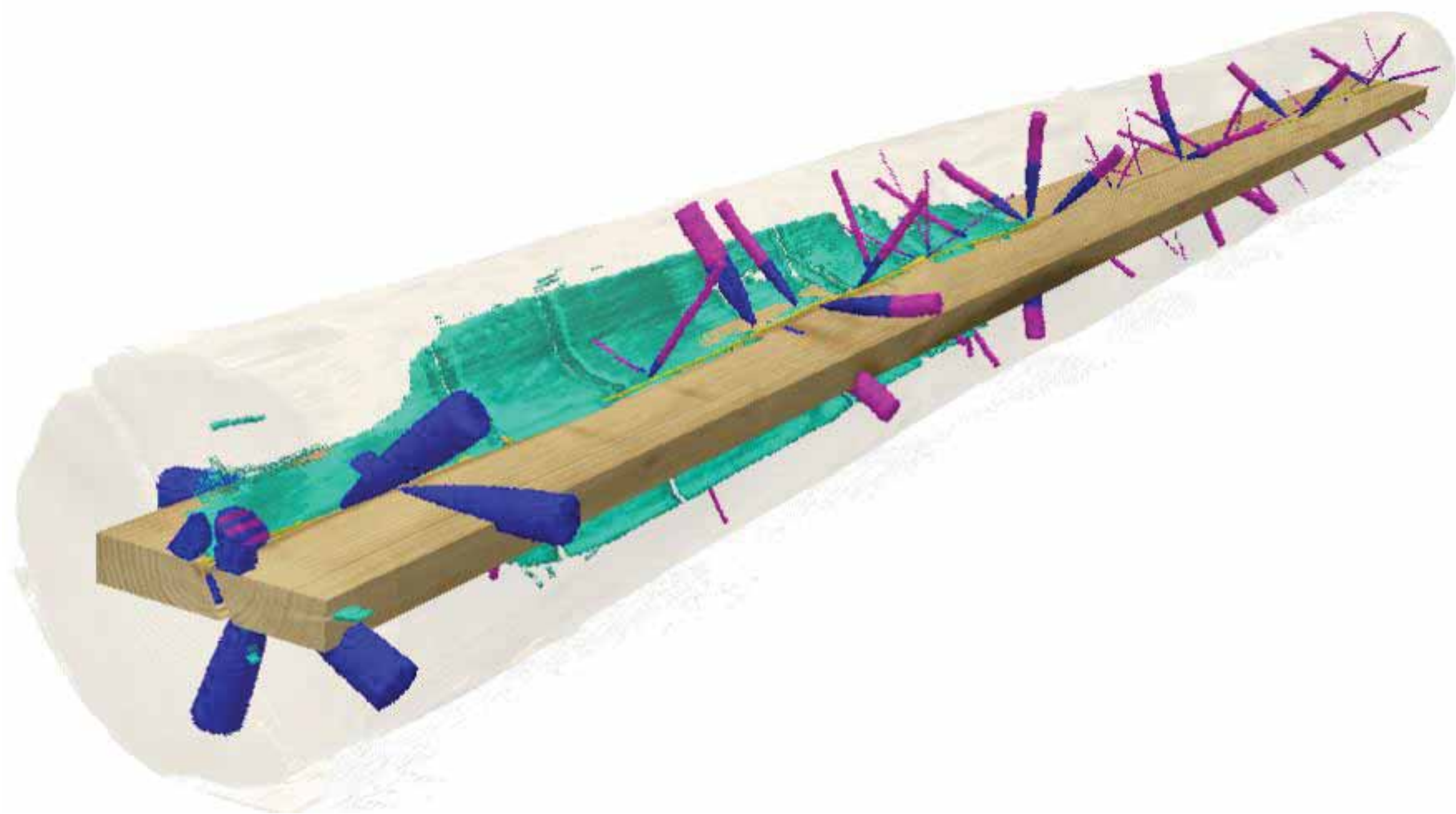
CT.LOG Virtual Sawing

Virtual boards and wood properties intersected



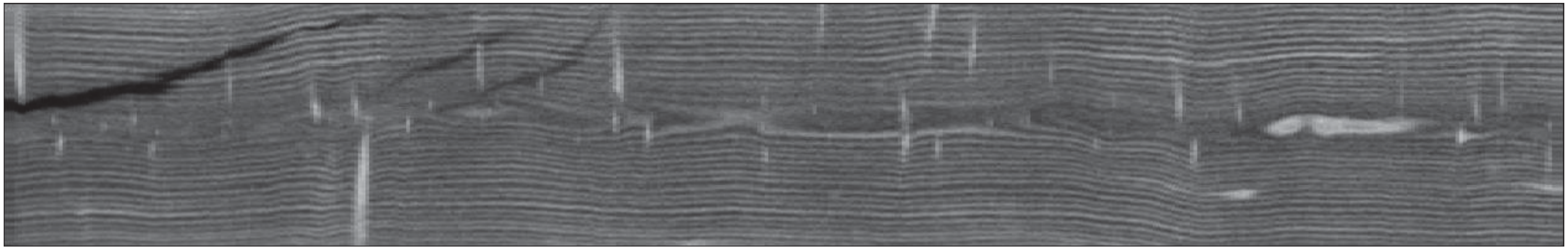
CT.LOG Virtual Sawing

Each board analyzed



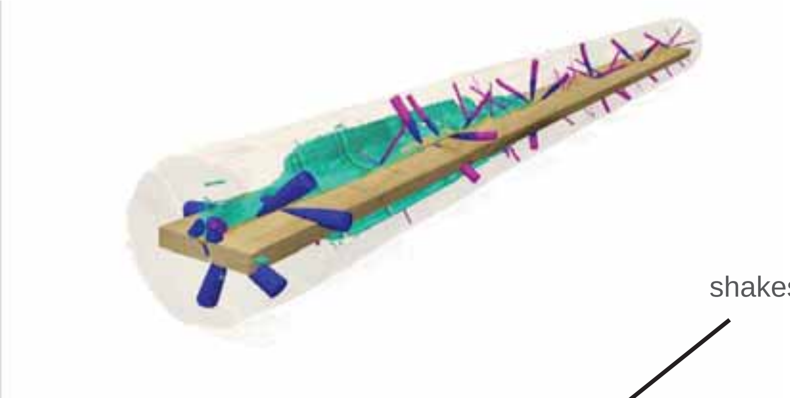
CT.LOG Virtual Sawing

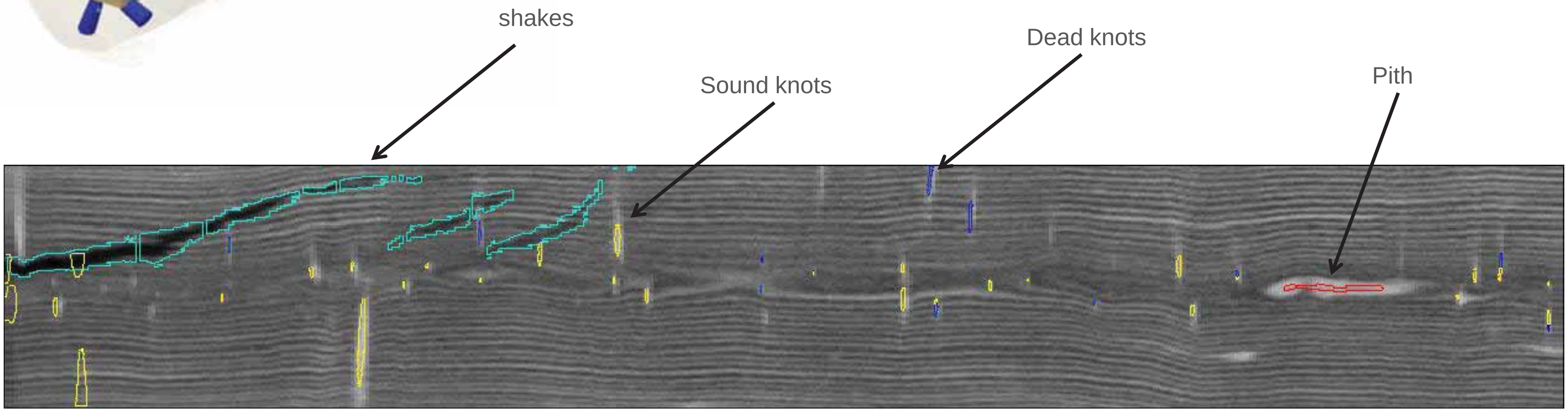
Density image of a virtual board



CT.LOG Virtual Sawing

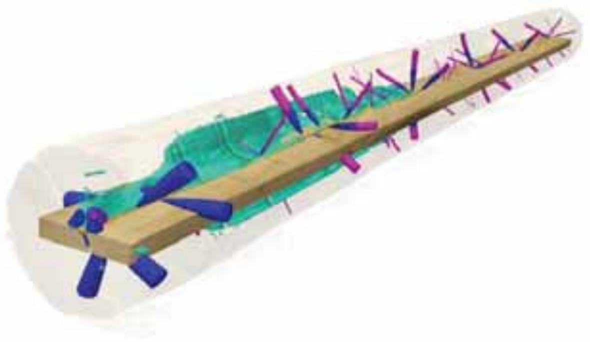
Intersection of wood properties with a virtual board

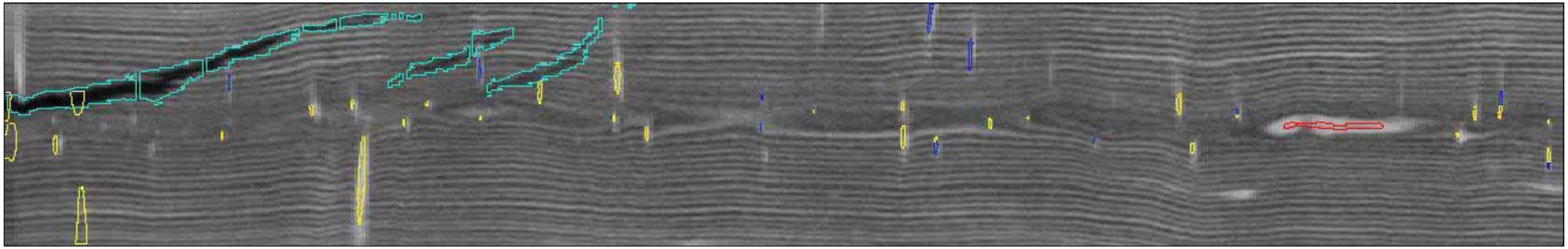




CT.LOG Virtual Sawing

Comparison with the real sawn board





CT.LOG

Customer Installations

CT.LOG Installation in North-America

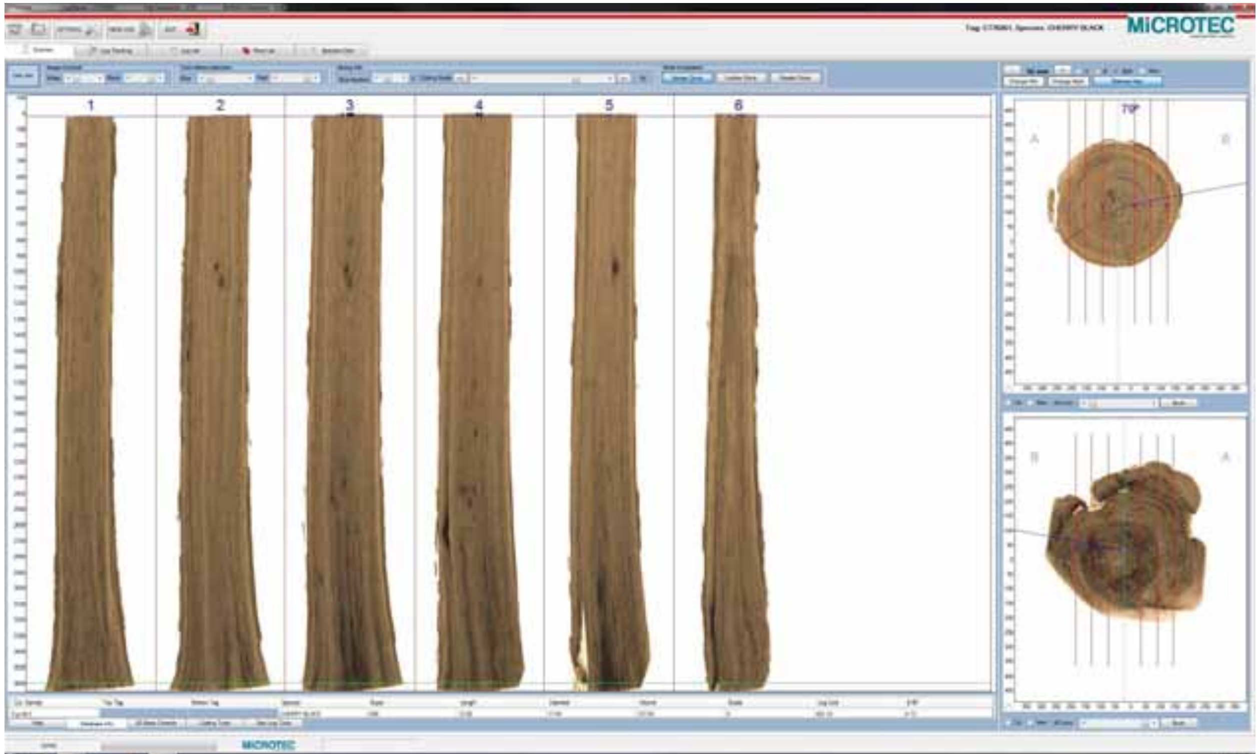
Installation: July 2012
Conveying speed: 3 m/min
Wood species: Cherry, walnut, maple, oak

CT.LOG Installation in North-America

Application:

- Full digital log description including internal wood characteristics
- Automated quality and value determination with operator confirmation
- Manual grading and sorting based on quality, value and optimised cutting-pattern
- Manual cutting-pattern and break-down optimization based on internal quality
- Log-front marking for correct saw-infeed

CT.LOG Installation in North-America



Recognition of:

- Knots
- Insects holes
- Internal cracks
- Rot presence
- Bark inclusions
- Grain patterns
- Visual defects
- Pith identification
- Foreign body detection

CT.LOG Installation at Arauco in Chile

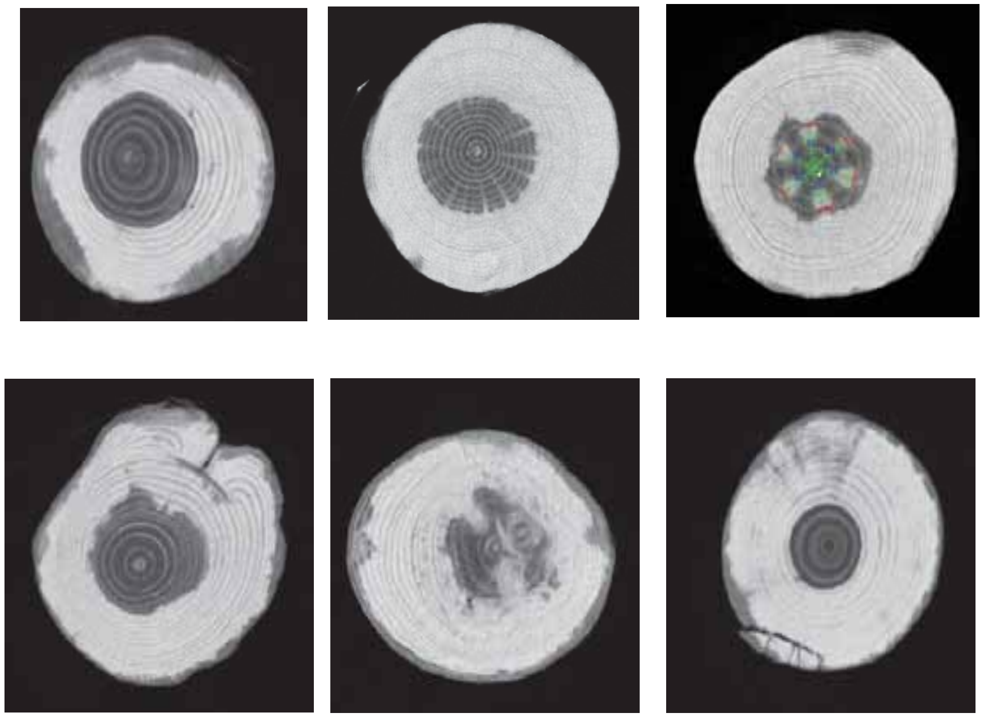
Installation:	September 2012
Conveying speed:	60 m/min
Wood species:	Radiata Pine

CT.LOG Installation at Arauco in Chile

Application:

- Full digital log description including internal wood characteristics
- Real-time grading and sorting based on quality, value and optimised cutting-pattern
- Real-time cutting-pattern and break-down optimization based on internal quality

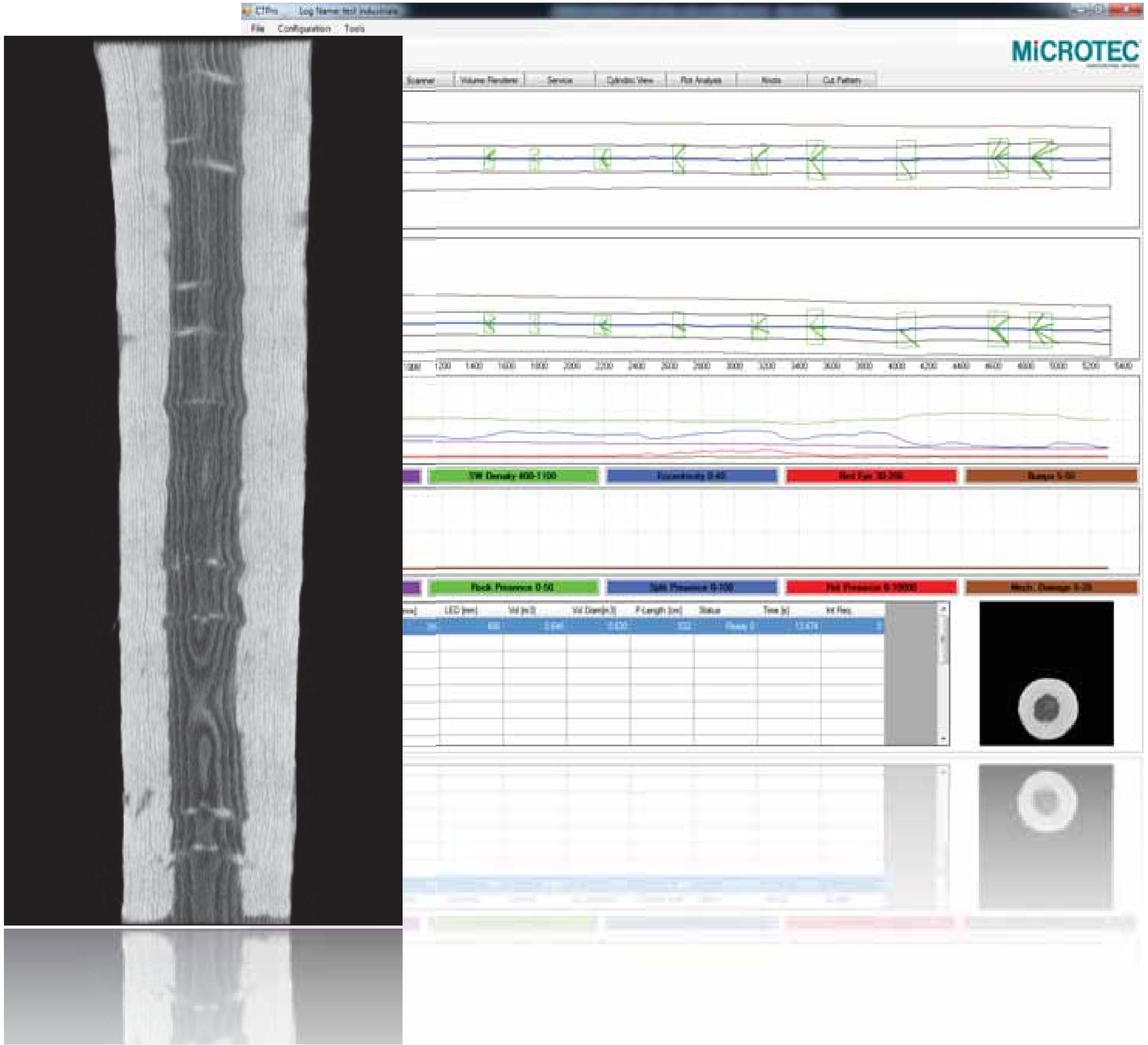
CT.LOG Installation at Arauco in Chile



Recognition of:

- Knotty whorls position
- Pruned length
- Knotty core diameter
- Knot diameter evaluation
- Bird-eye presence
- Sapwood/Heartwood density
- Internal pith position, eccentricity
- Low density rot identification
- External and internal cracks
- Foreign body detection

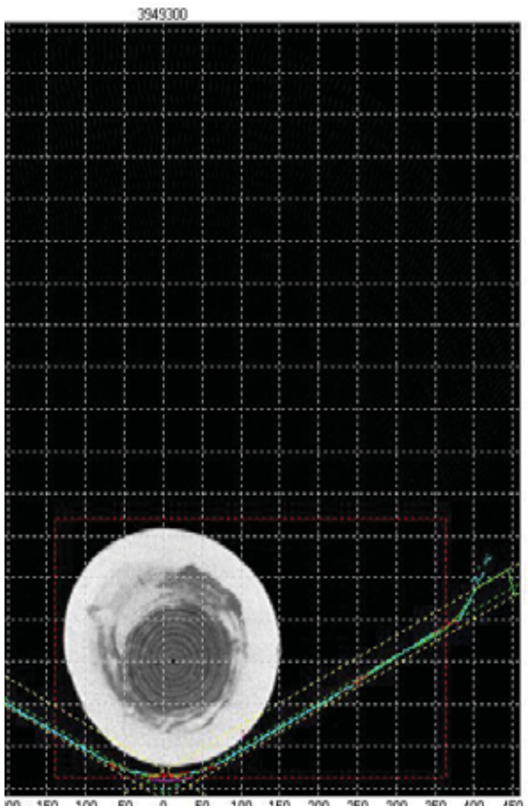
CT.LOG Installation at Arauco in Chile

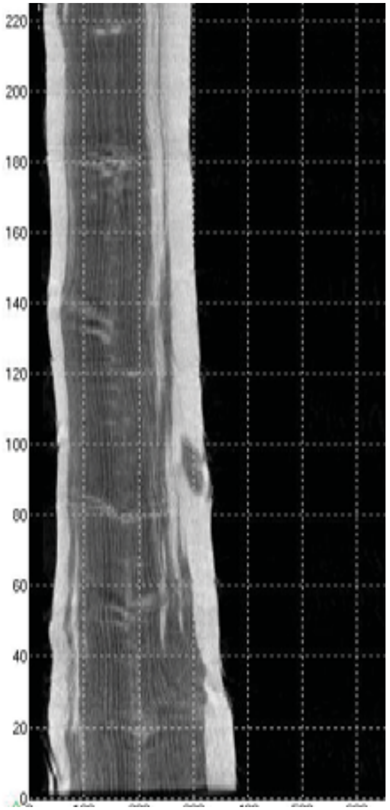


CT.LOG Installation at Siat-Braun in France

Installation: December 2012
Conveying speed: 120 m/min
Wood species: Spruce, fir, pine

CT.LOG Installation at Siat-Braun in France





Application:

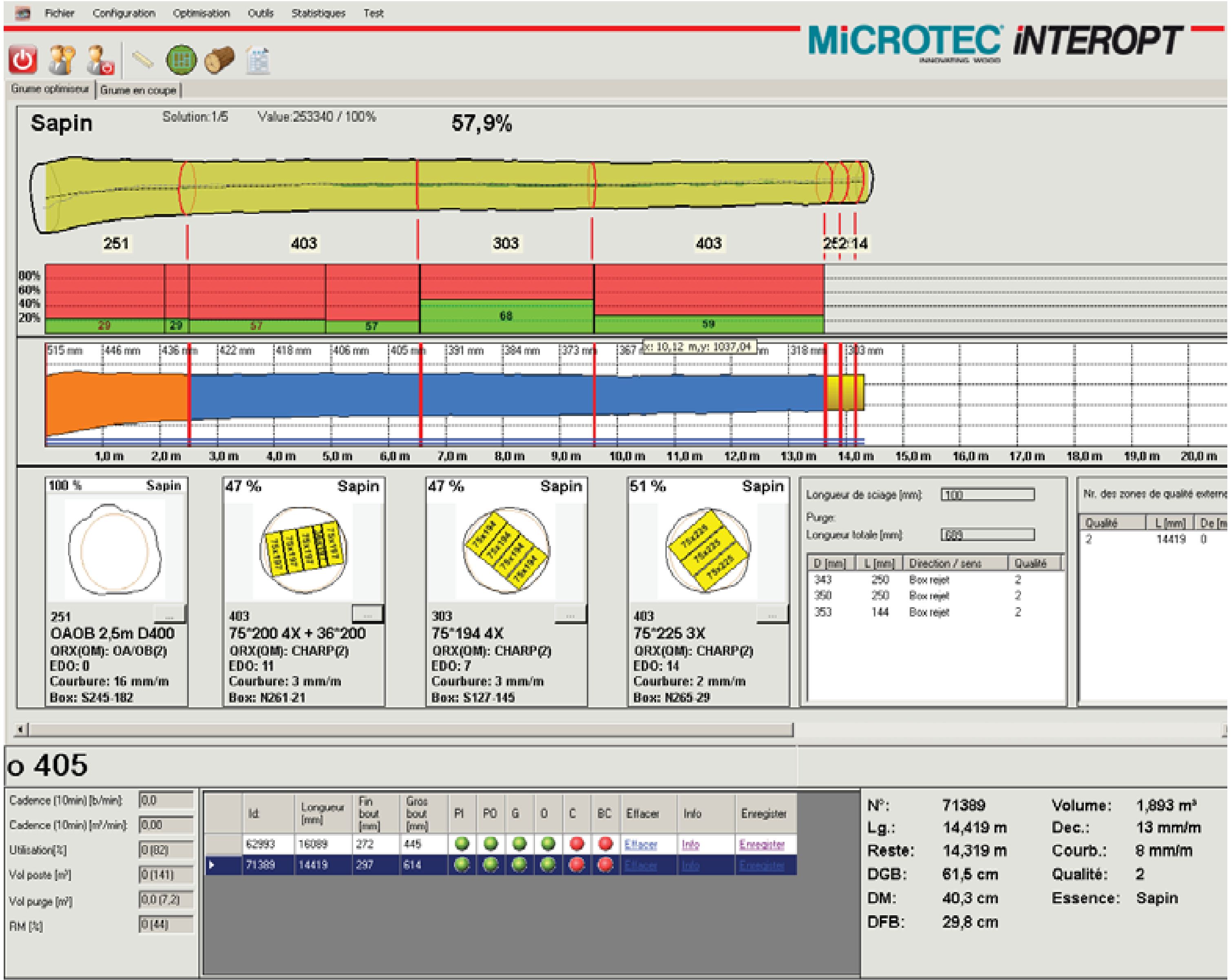
- Full digital stem description including internal wood characteristics for stems up to 25 m
- Real-time grading and sorting based on quality, value and cutting-pattern of logs
- Real-time bucking optimization for stems up to 25 m based on internal quality

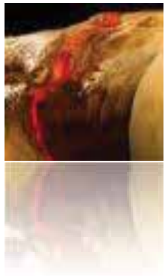
CT.LOG Installation at Siat-Braun in France

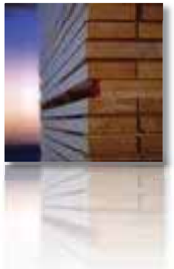
Recognition of:

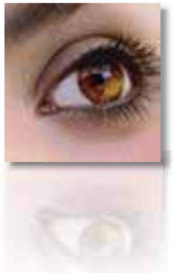
- Species recognition
- Single knot identification and measure
- Whorls characterization
- Sapwood/Heartwood detection
- Internal pith position, eccentricity
- Density and weight measurement
- Ring width distribution
- Grain shape evaluation
- Resin pockets presence evaluation
- Rotten log identification
- External and internal cracks
- Spiral grain
- Foreign body detection

CT.LOG Installation at Siat-Braun in France





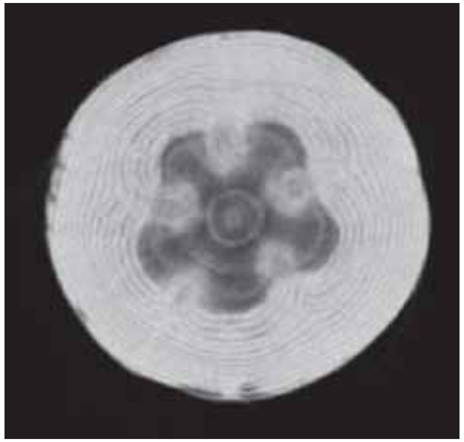


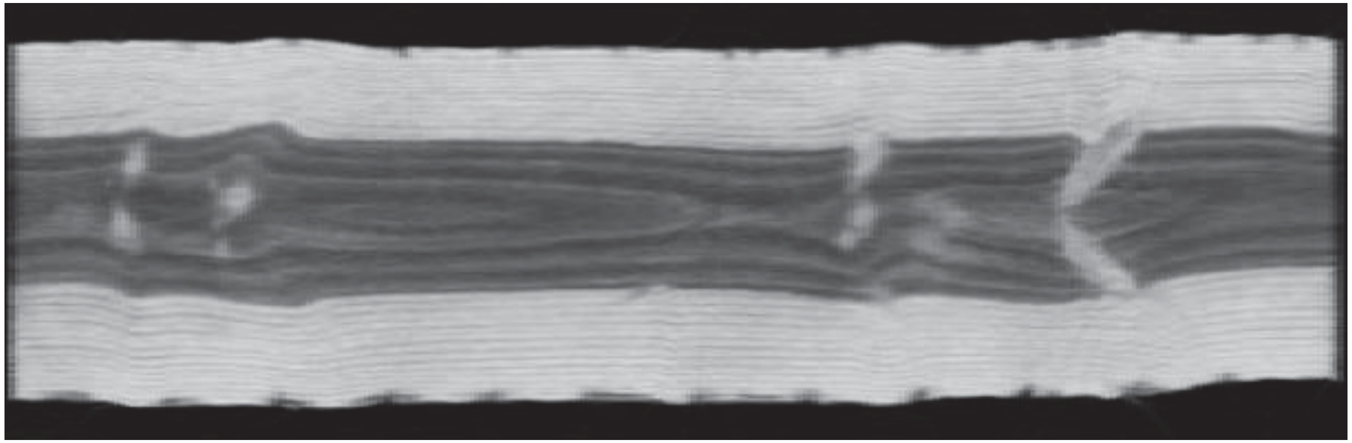


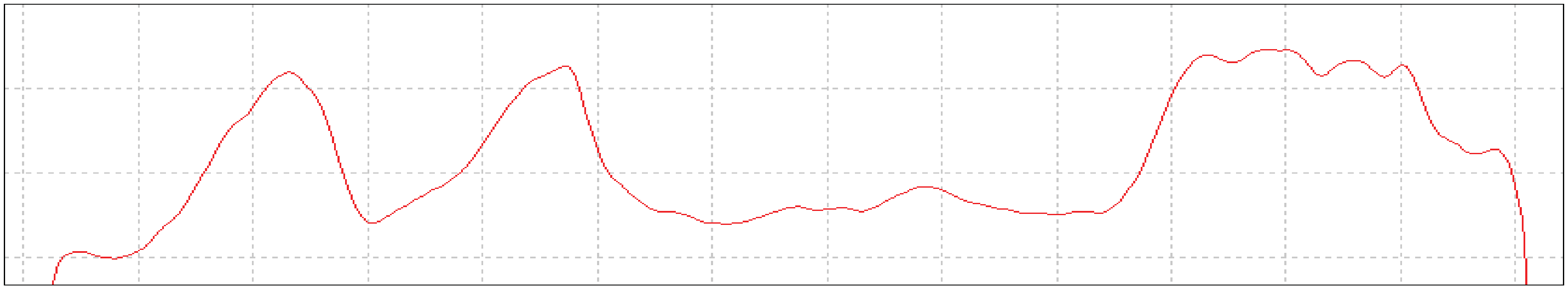
CT.LOG

FINGERPRINT ID

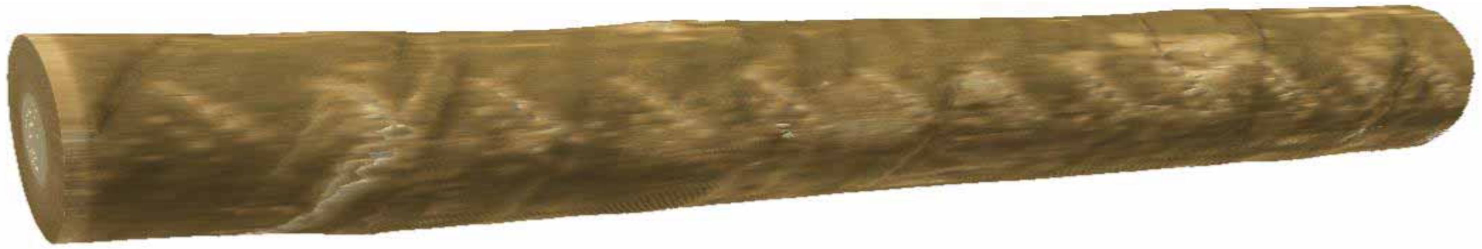
Extraction of a finger print profile for each log using CT data

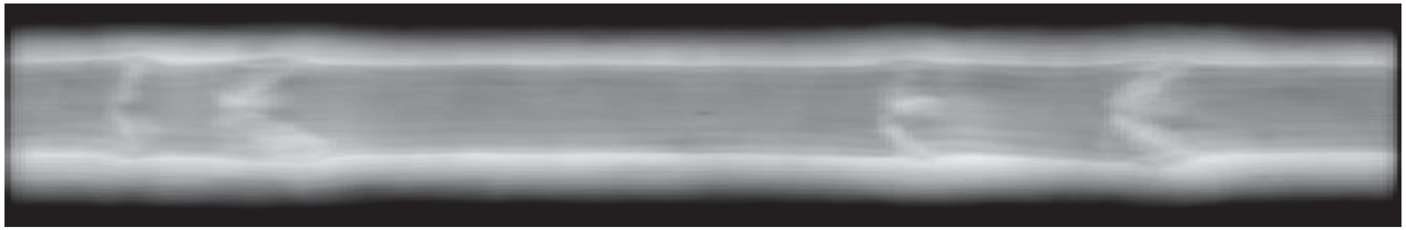


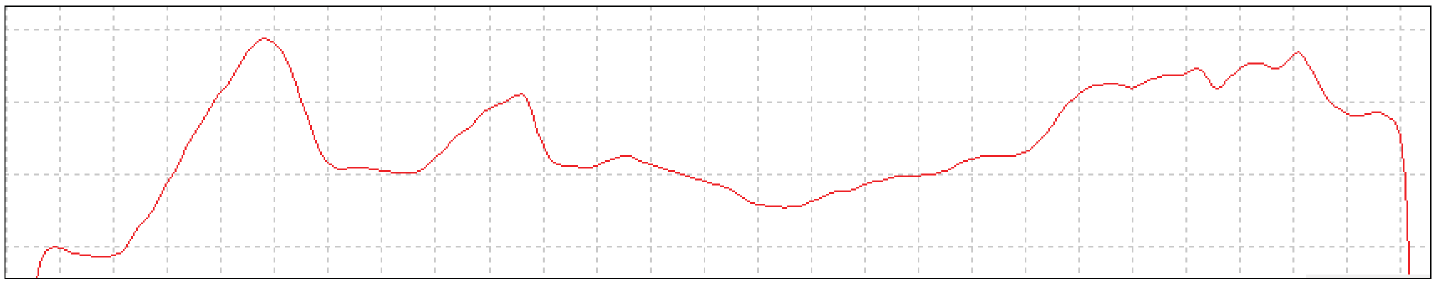




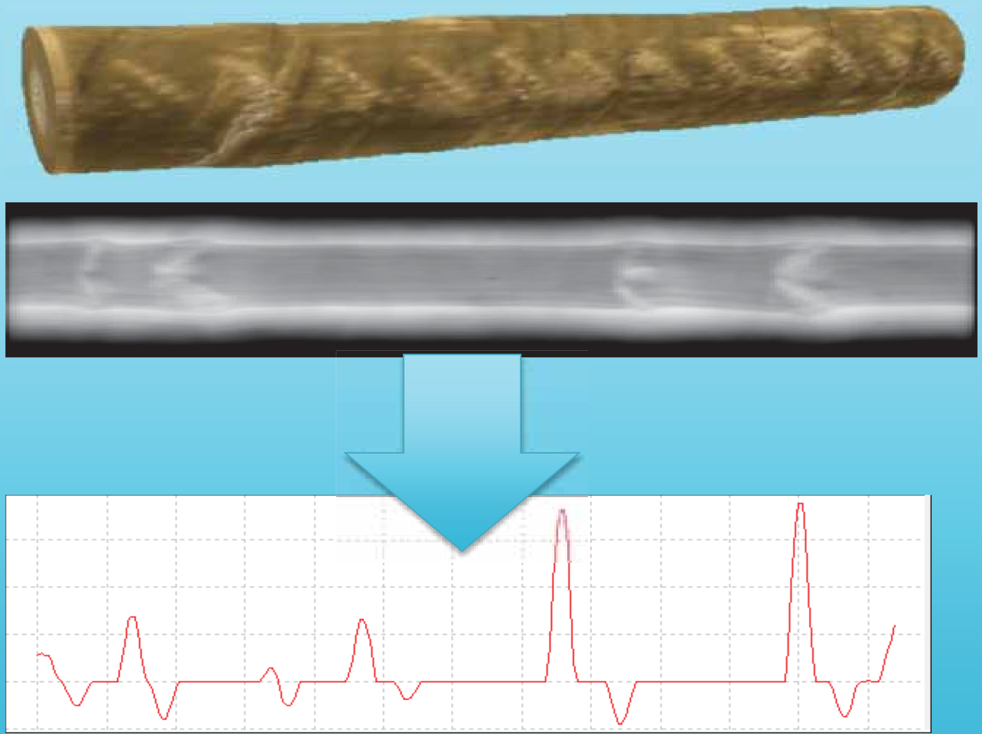
EXTRACTION OF A FINGER PRINT PROFILE FOR EACH LOG COMBINING TOMOLOG AND DISHAPE INFORMATION





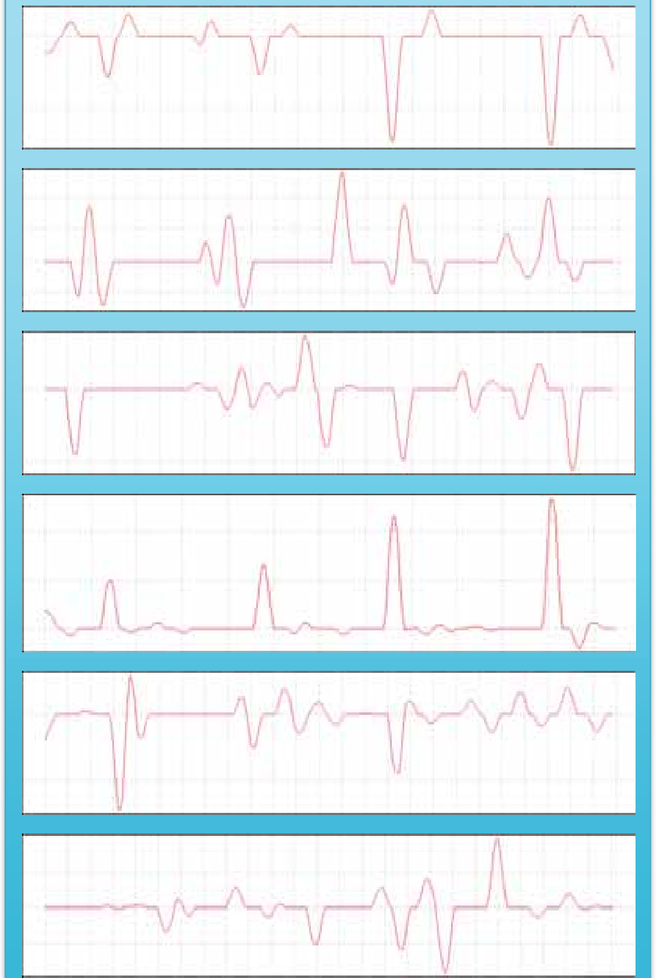


MATCHING OF THE FINGER PRINTS TO IDENTIFY THE CORRECT LOG

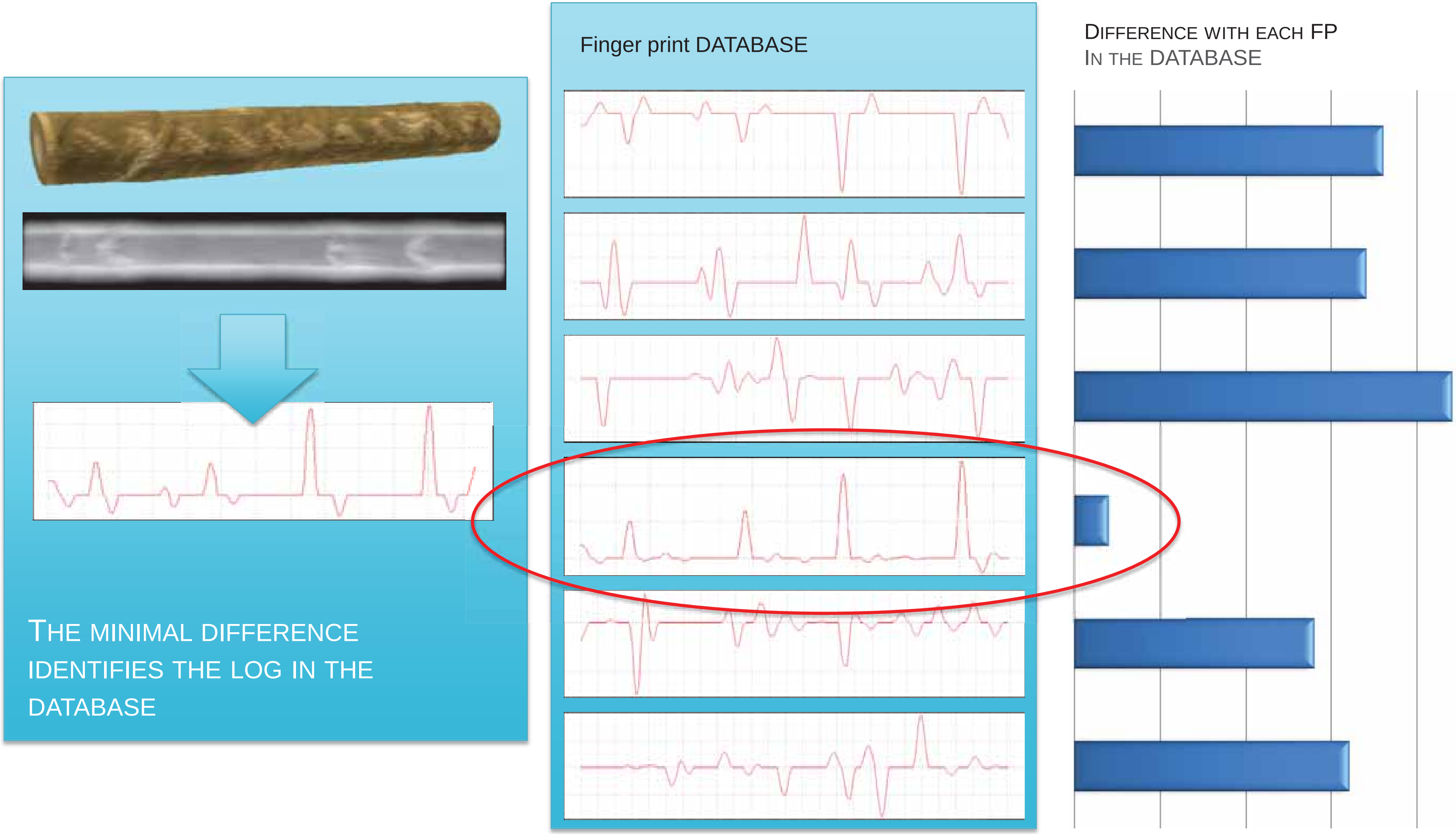


THE FINGER PRINT IS COMPARED WITH EACH COMPATIBLE LOG IN THE DATABASE

FINGER PRINT DATABASE

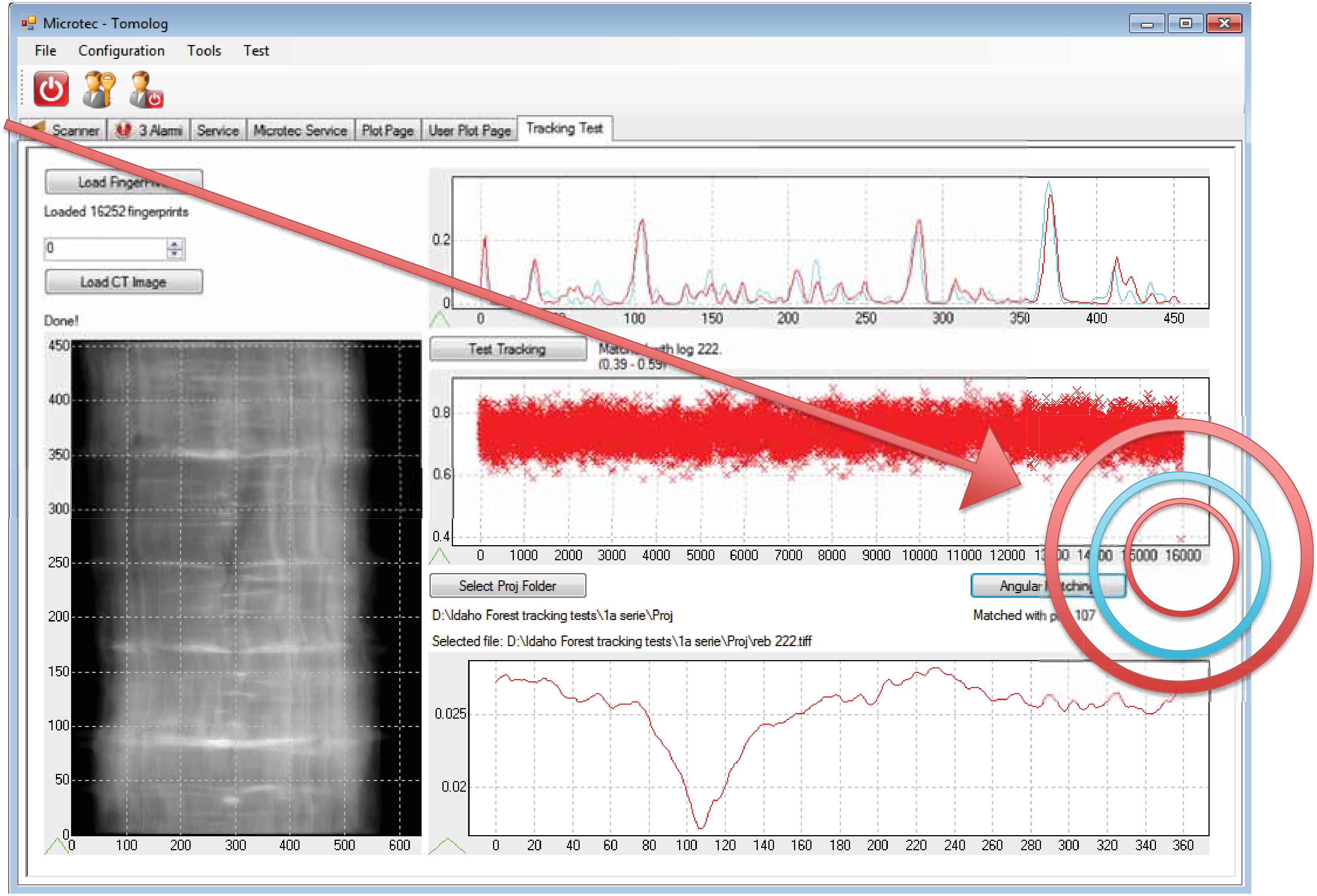


MATCHING OF THE FINGER PRINTS TO IDENTIFY THE CORRECT LOG



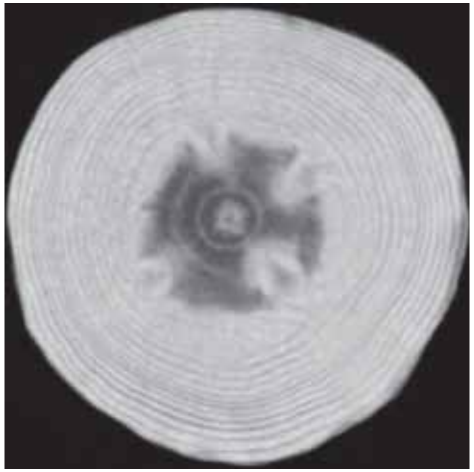
Matching Process

Matching of 16.000 logs

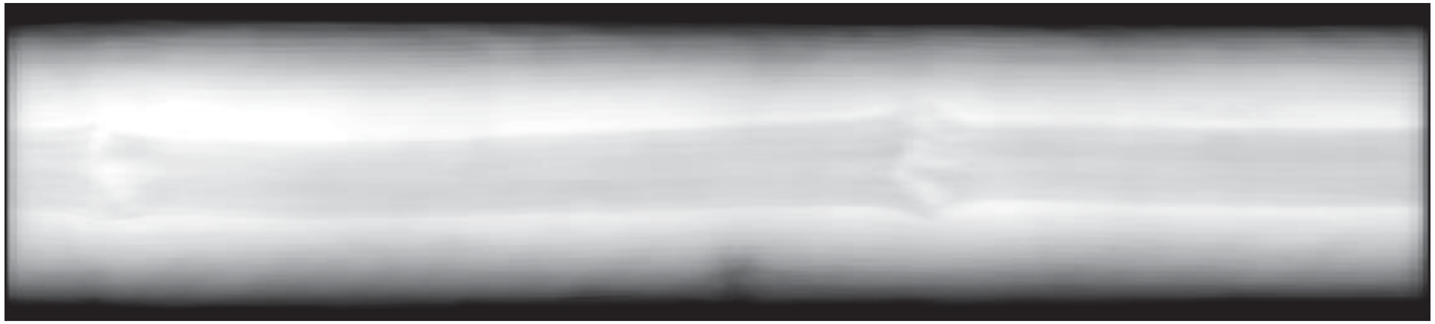


ROTATION RECOVERY: SIMULATION OF ***DiSHAPE*** AND ***TOMOLOG*** AT DIFFERENT ANGLES USING ***CT.LOG*** DATA PROJECTION

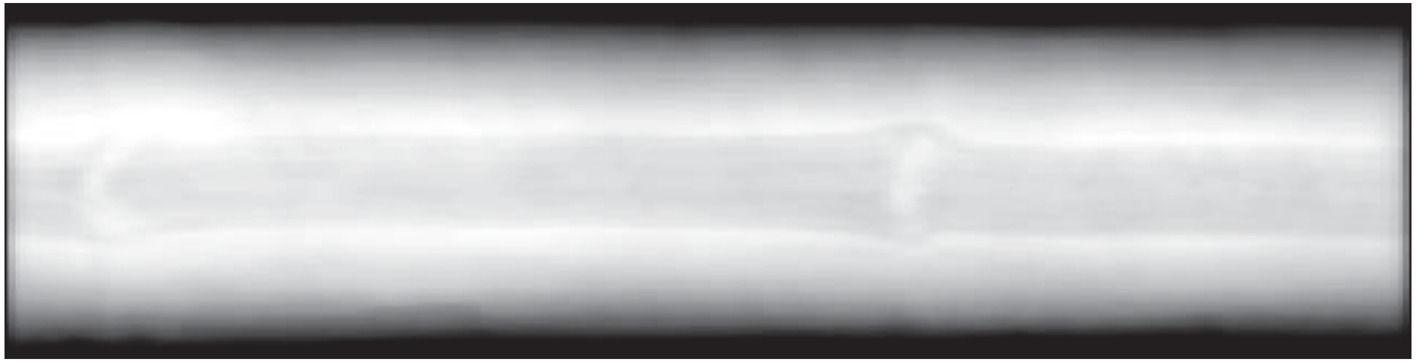
ANGLE = 0°

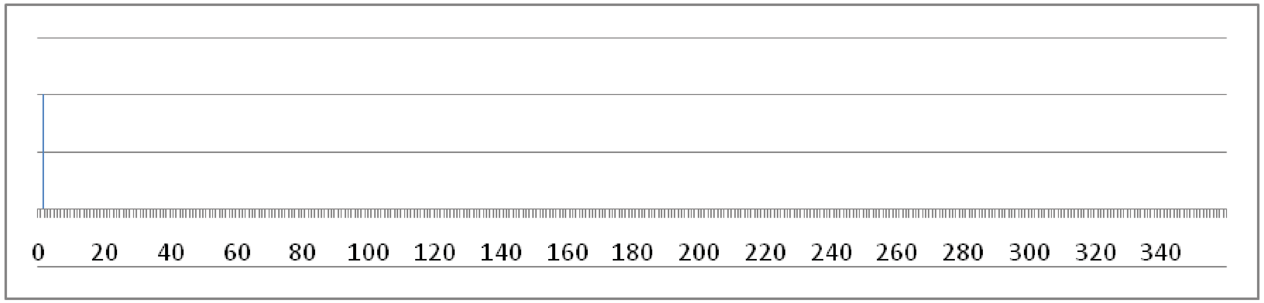


TOMOLOG PROJECTION



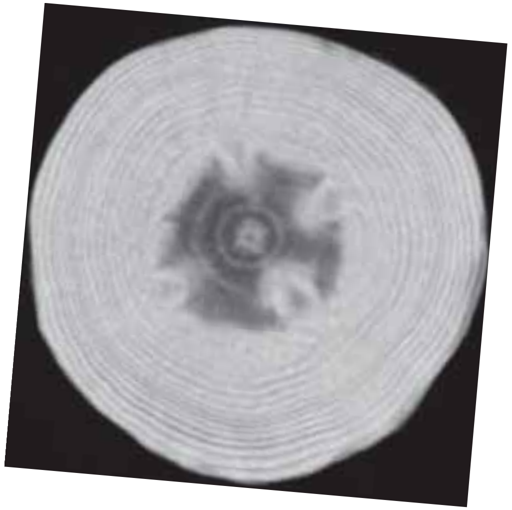
SIMULATED ***TOMOLOG*** PROJECTION BASED ON CT AND ROTATION



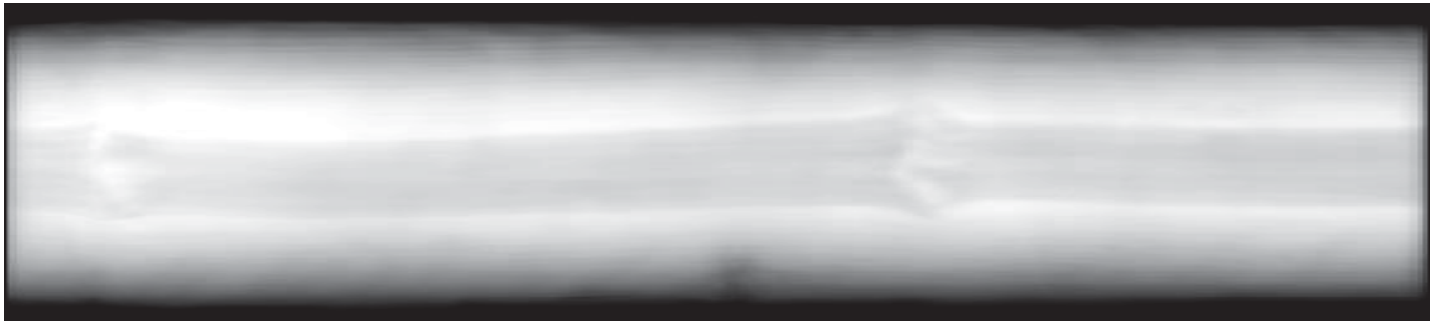


MATCHING OF *TOMOLOG* PROJECTION

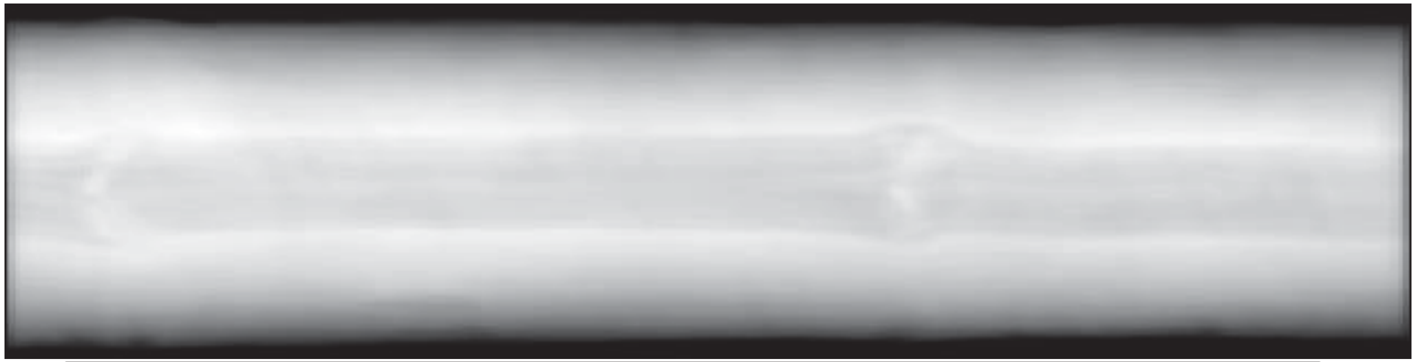
ANGLE = 5°

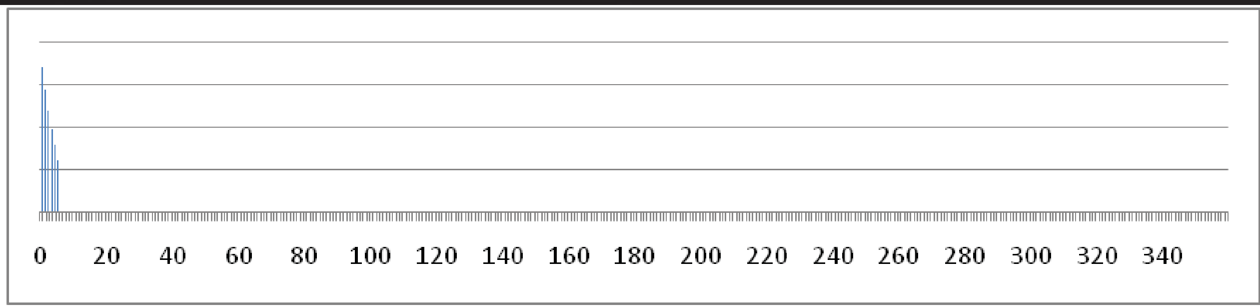


TOMOLOG PROJECTION



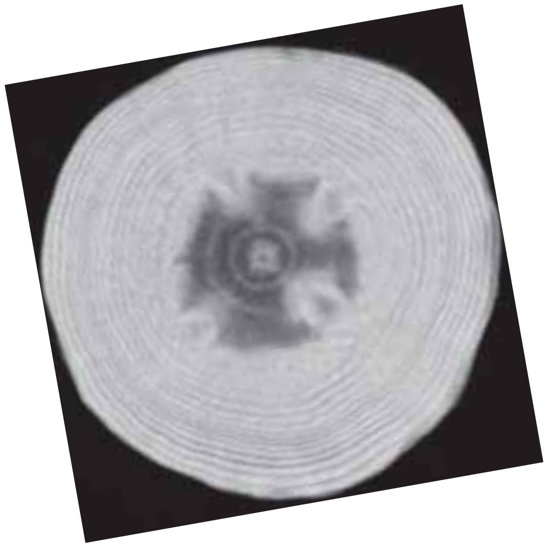
SIMULATED ***TOMOLOG*** PROJECTION BASED ON CT AND ROTATION



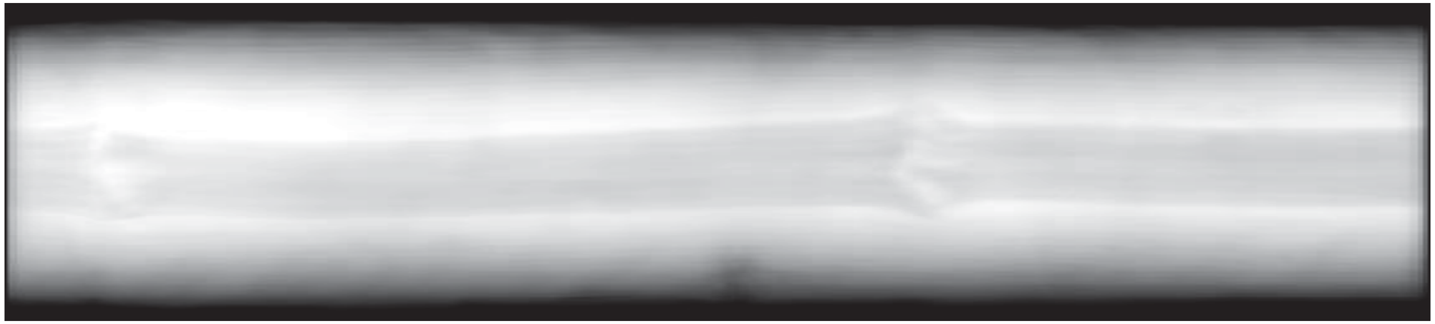


MATCHING OF ***TOMOLOG*** PROJECTION

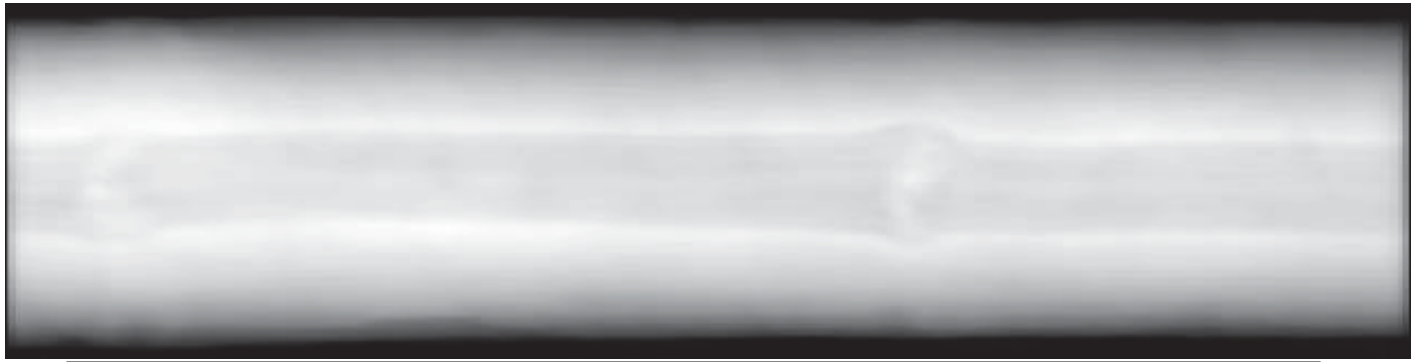
ANGLE = 350°

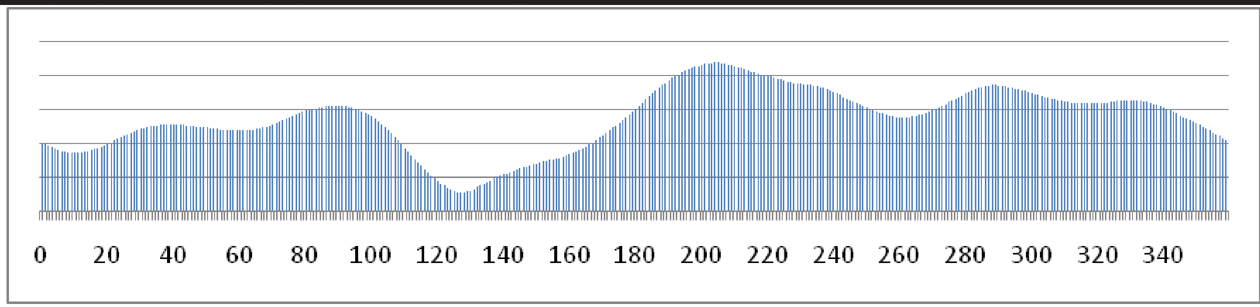


TOMOLOG PROJECTION



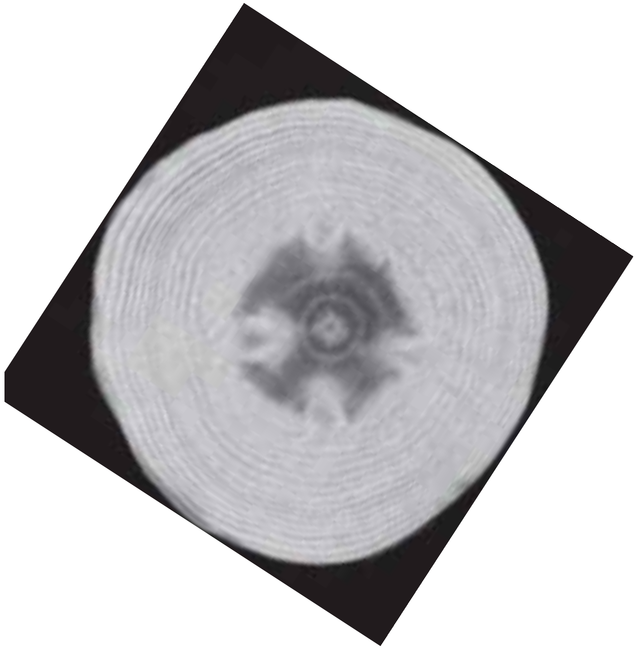
SIMULATED ***TOMOLOG*** PROJECTION BASED ON CT AND ROTATION



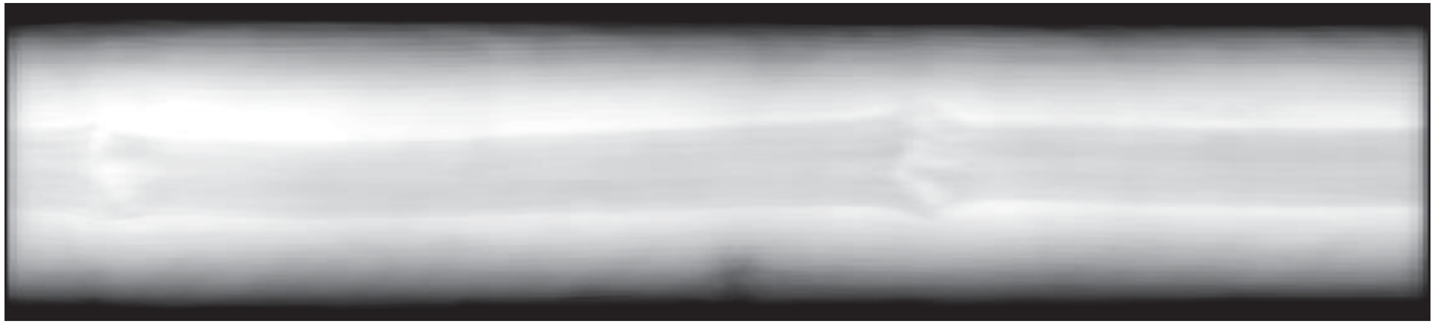


BEST ANGLE MATCHED

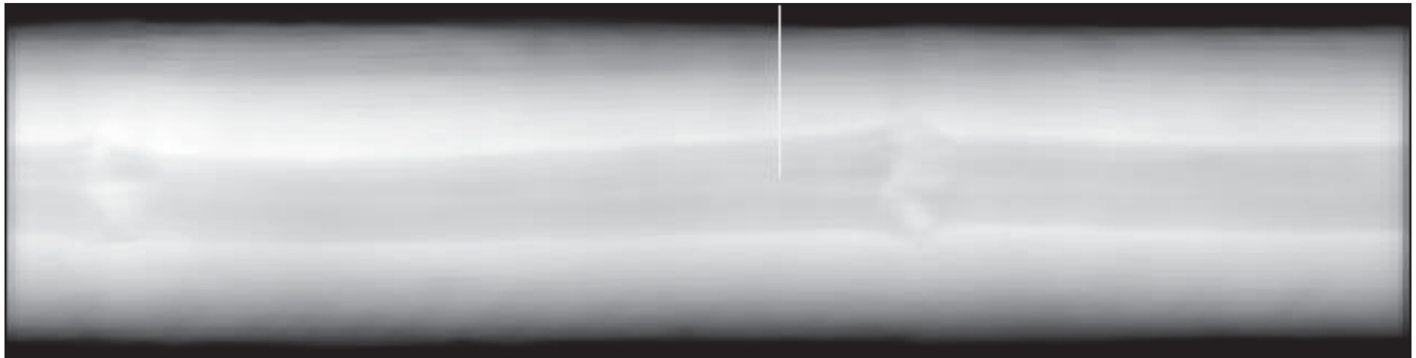
ANGLE = 123°

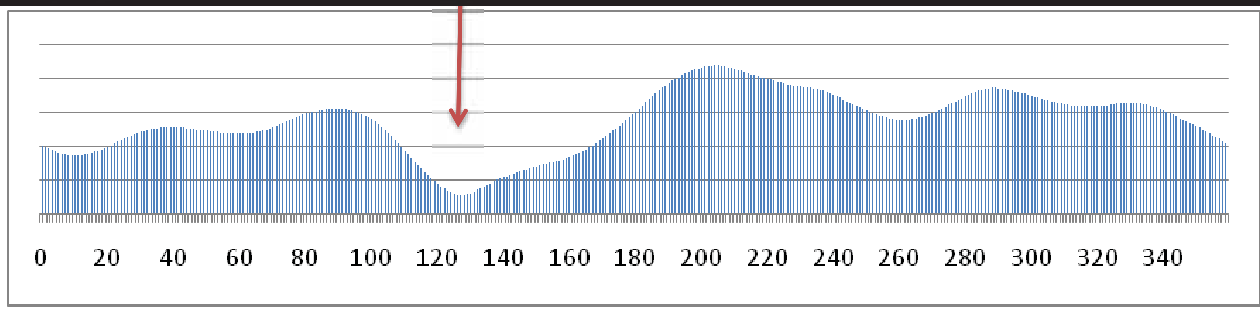


TOMOLOG PROJECTION

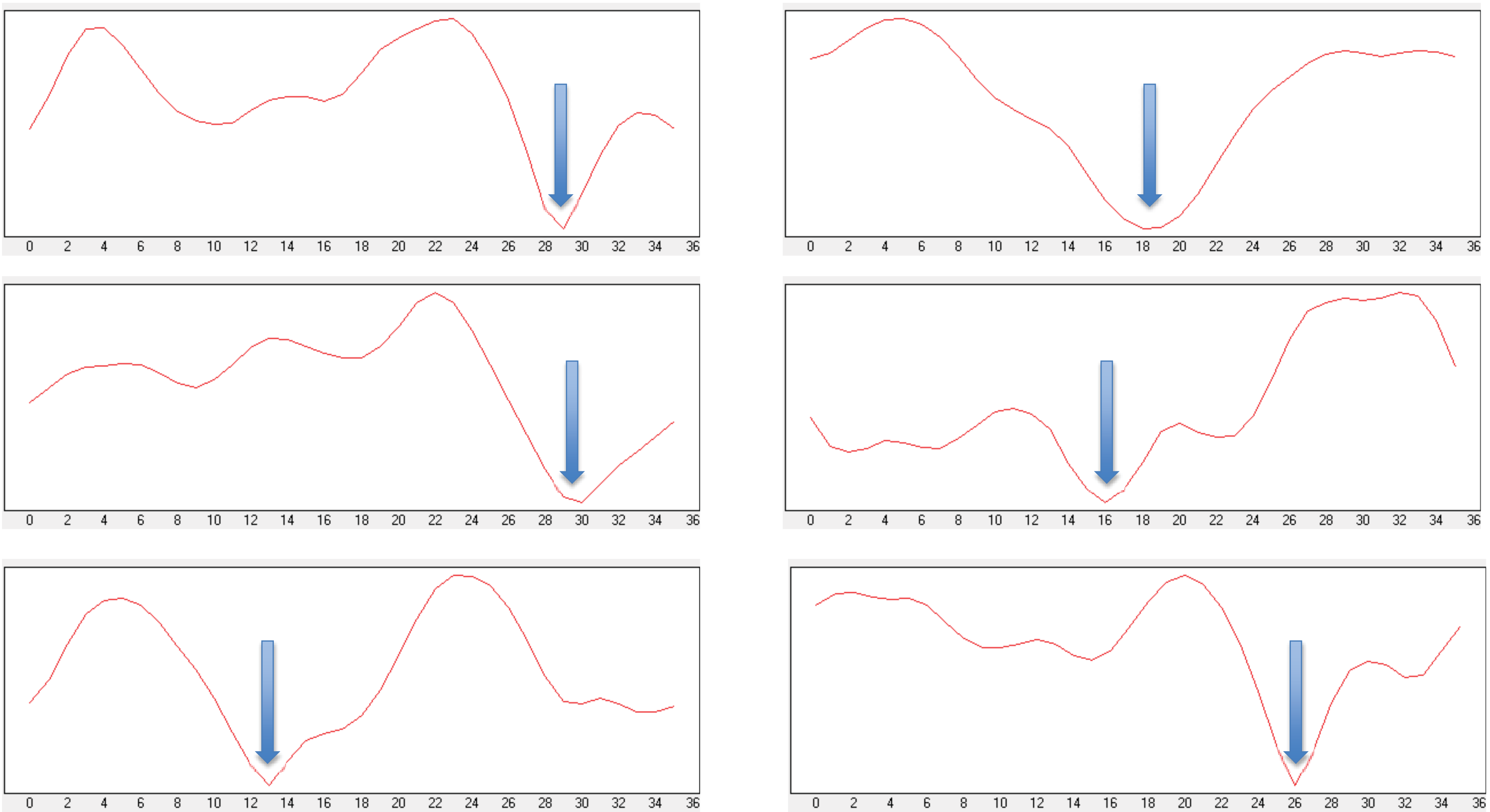


SIMULATED *TOMOLOG* PROJECTION BASED ON CT AND ROTATION





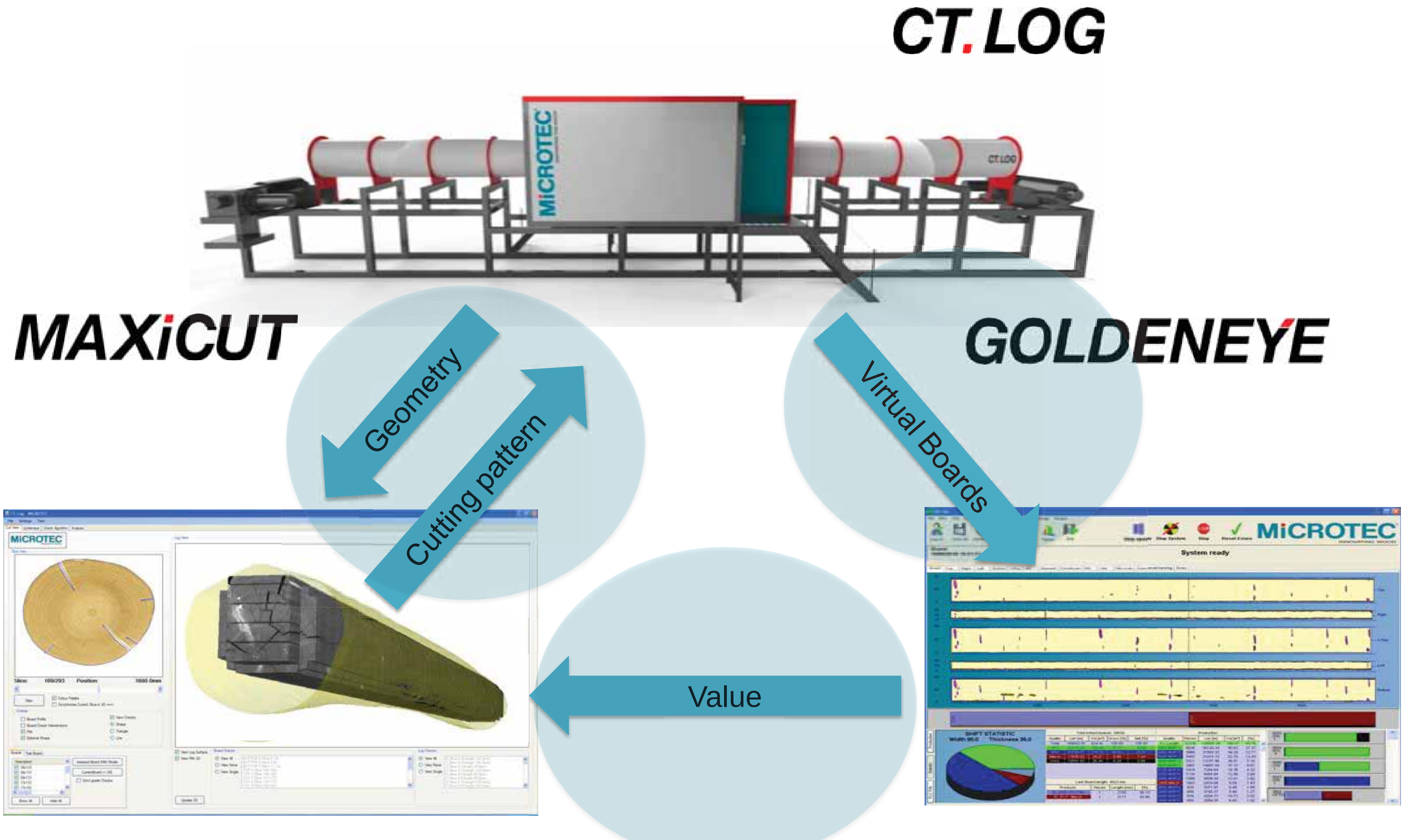
EXAMPLES OF ANGULAR MATCHING OBTAINED FROM SOME LOGS. THE MINIMUM CORRESPONDS TO THE ANGLE IN THE ORIGINAL CT DATA.

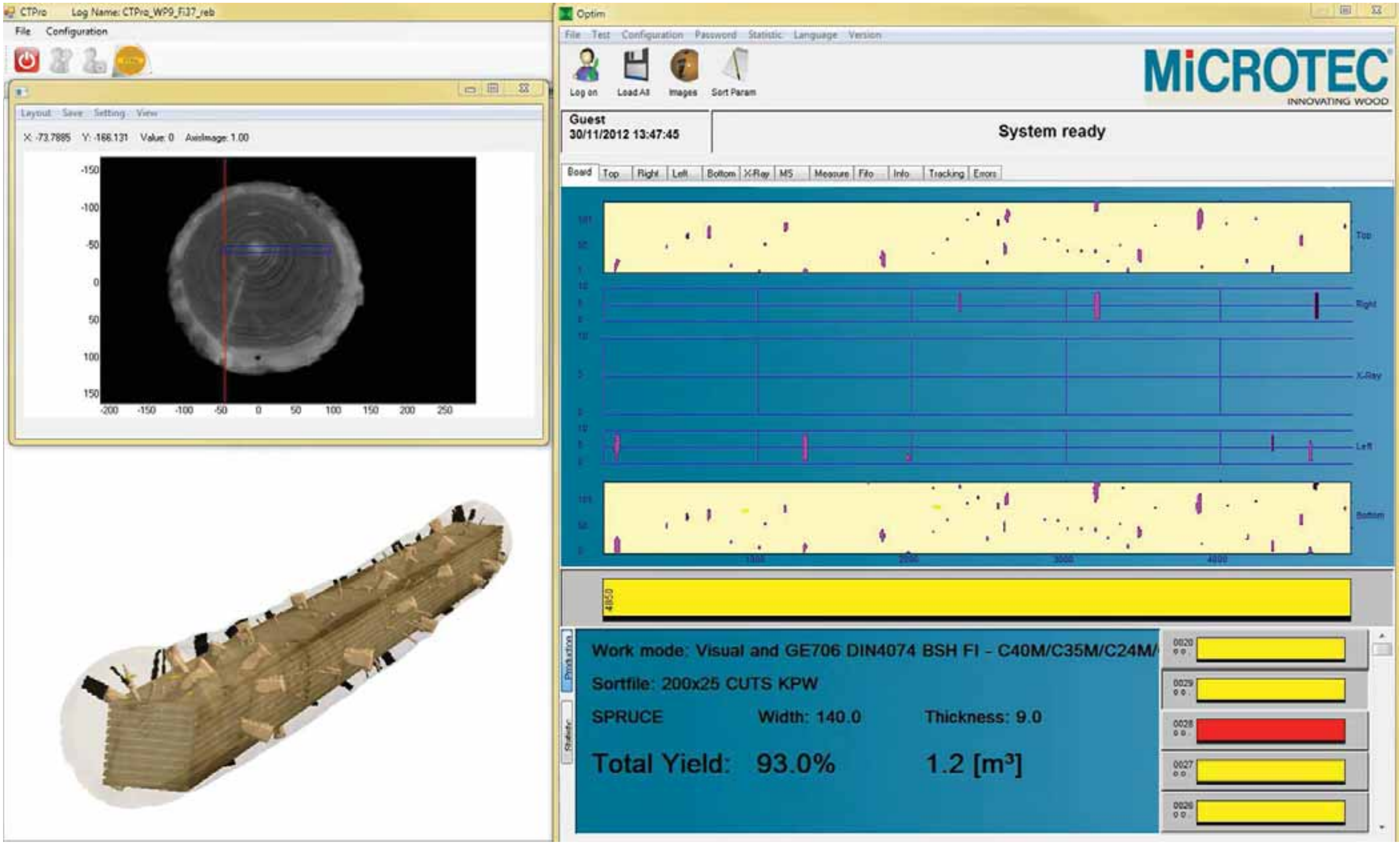


CT.LOG

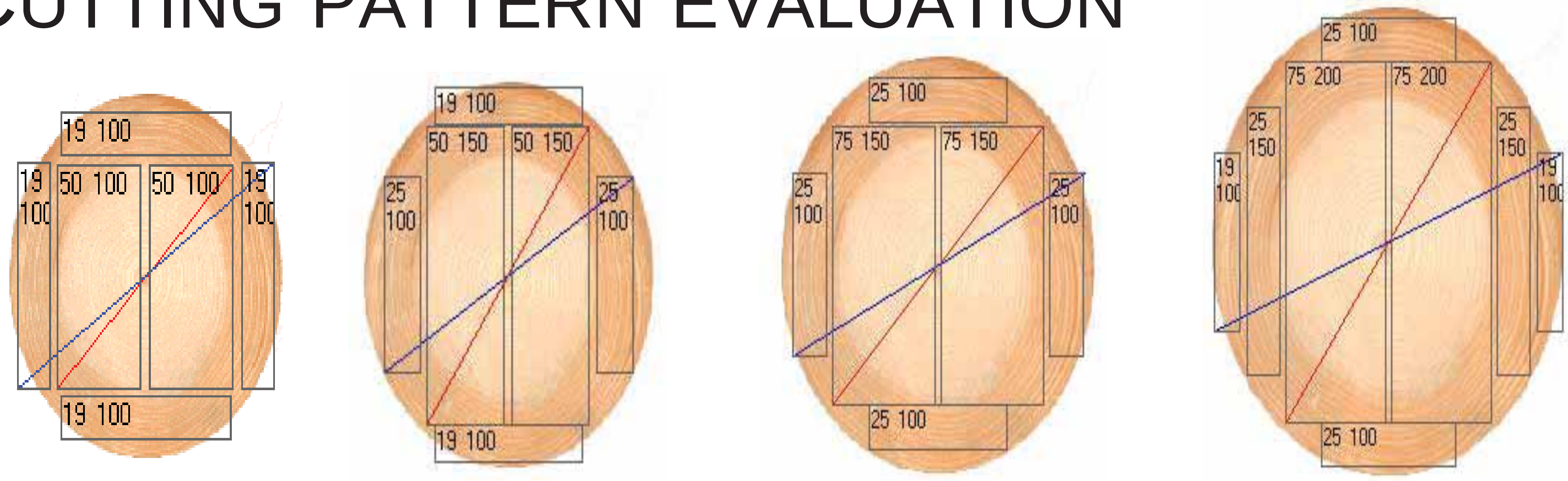
Closing the loop
Virtual Sawmill

10A. INTEGRATION BETWEEN BREAKDOWN MACHINERY SOFTWARE AND CT.LOG



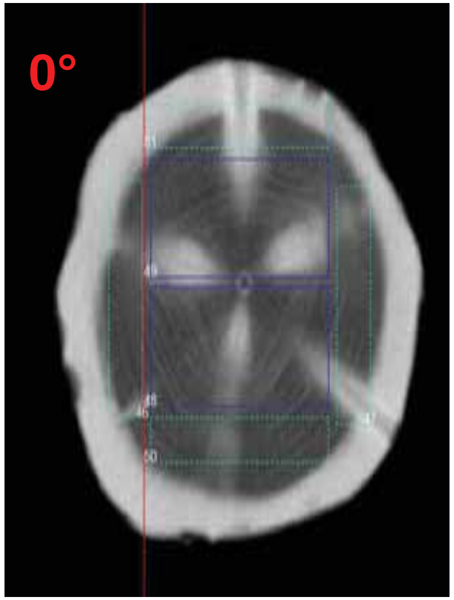

CTPro Log Name: CTPro_WP9_Fi37_reb
File Configuration
Layout Save Setting View
X: -73.7885 Y: -166.131 Value: 0 AxisImage: 1.00
Optim
File Test Configuration Password Statistic Language Version
Log on Load All Images Sort Param
MiCROTEC
INNOVATING WOOD
Guest
30/11/2012 13:47:45
System ready
Board Top Right Left Bottom X-Ray MS Measure Fifo Info Tracking Errors
Work mode: Visual and GE706 DIN4074 BSH FI - C40M/C35M/C24M/
Sortfile: 200x25 CUTS KPW
SPRUCE Width: 140.0 Thickness: 9.0
Total Yield: 93.0% 1.2 [m³]

CUTTING PATTERN EVALUATION



- Based on the diameter, the appropriate cutting pattern is selected
- Each cutting pattern is evaluated for each angle (step of 2°)
- The optimal rotation is selected in order to obtain the maximal price from boards
- Each board is classified and priced based on the defects on the 4 surfaces: sound knots, dead knots, wane, splits, resin pockets.

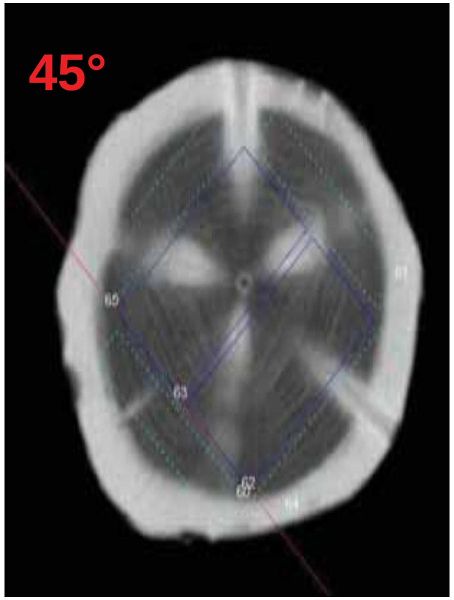
• Virtual sawmill approach: the cutting pattern is rotated and each single board is priced



Prices:

Board id: 3837 : 7 : PL / VL :
Board id: 3838 : 7 : PL / VL :
Board id: 3839 : 15 : PL / VL :
Board id: 3840 : 18 : PL / VL :
Board id: 3841 : 7 : VI :
Board id: 3842 : 1 : Chip :

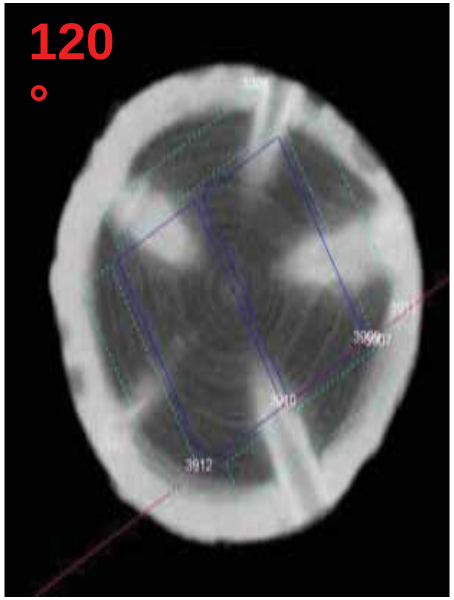
Total price: 55€



Prices:

Board id: 20 : 1 : Chip :
Board id: 21 : 7 : VI :
Board id: 22 : 1 : Chip :
Board id: 23 : 18 : PL / VL :
Board id: 24 : 7 : VI :
Board id: 25 : 7 : VI :

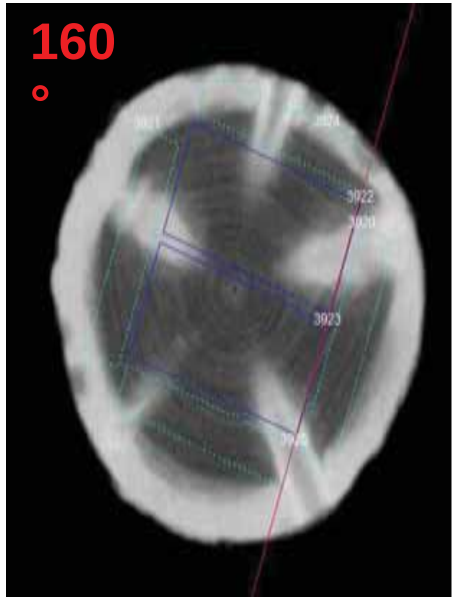
Total price: 41€



Prices:

Board id: 3907 : 7 : VI :
Board id: 3908 : 7 : VI :
Board id: 3909 : 18 : PL / VL :
Board id: 3910 : 18 : PL / VL :
Board id: 3911 : 1 : Chip :
Board id: 3912 : 7 : VI :

Total price: 58€

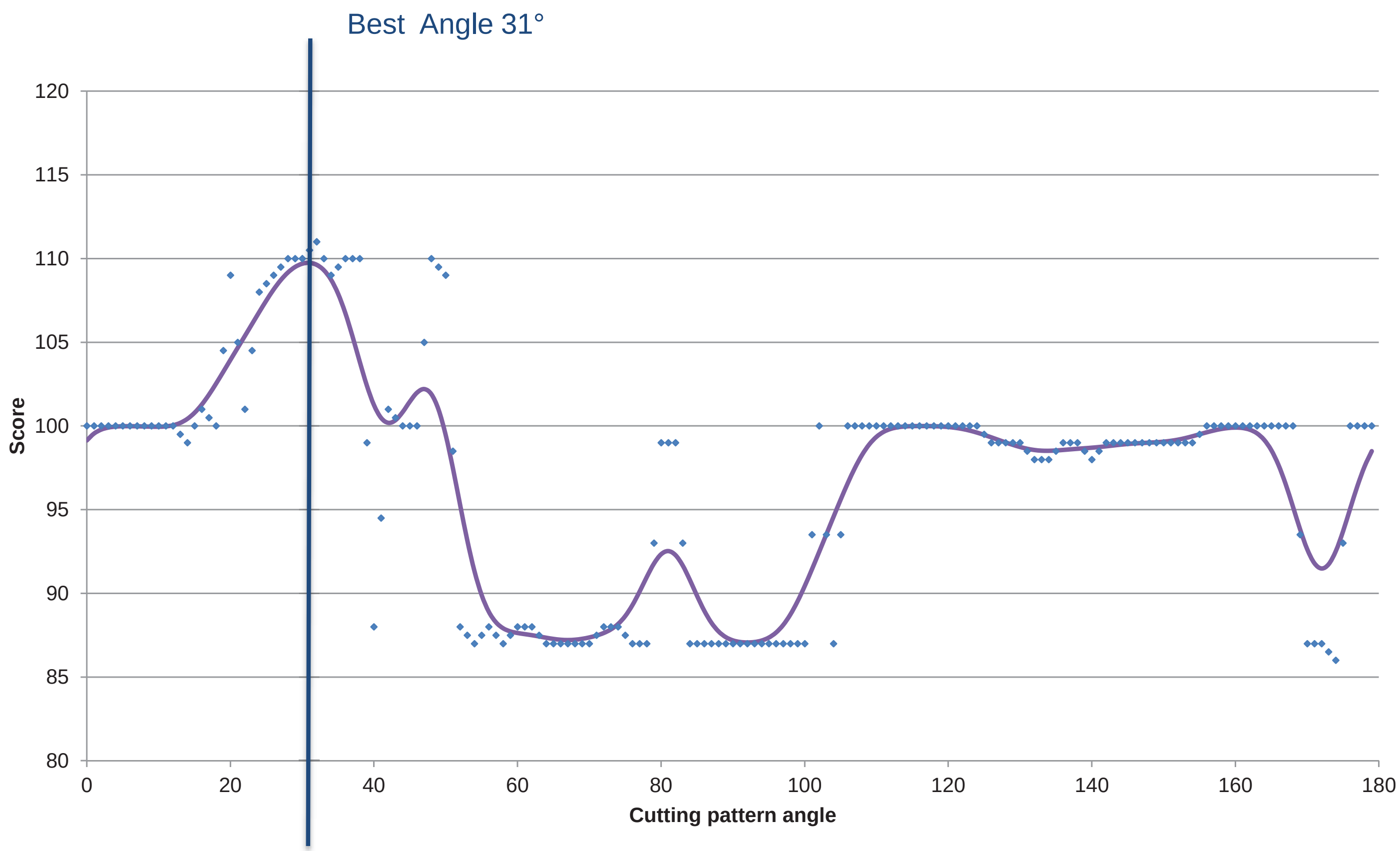


Prices:

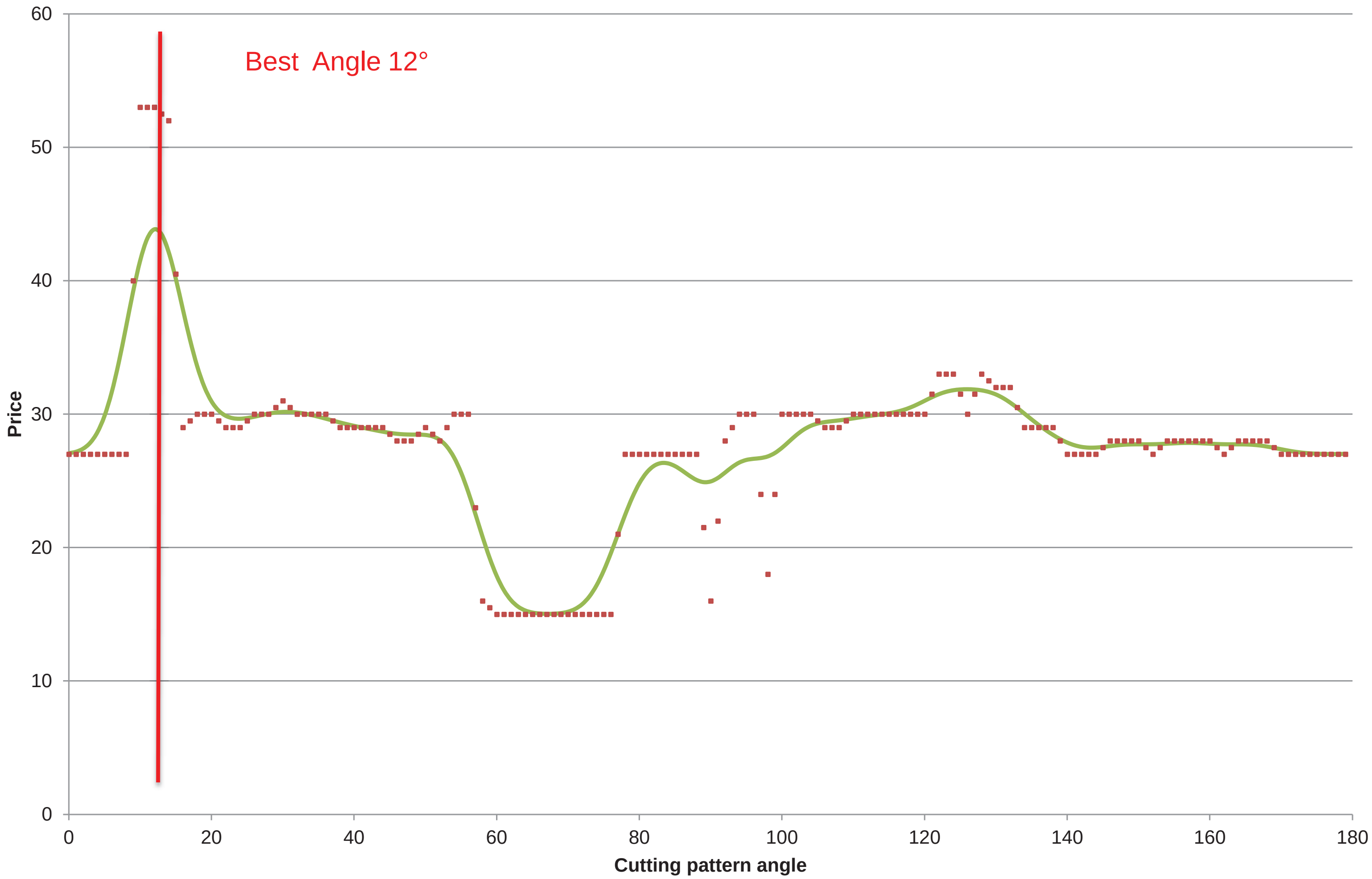
Board id: 3920 : 7 : VI :
Board id: 3921 : 7 : VI :
Board id: 3922 : 18 : PL / VL :
Board id: 3923 : 18 : PL / VL :
Board id: 3924 : 1 : Chip :
Board id: 3925 : 1 : Chip :

Total price: 52€

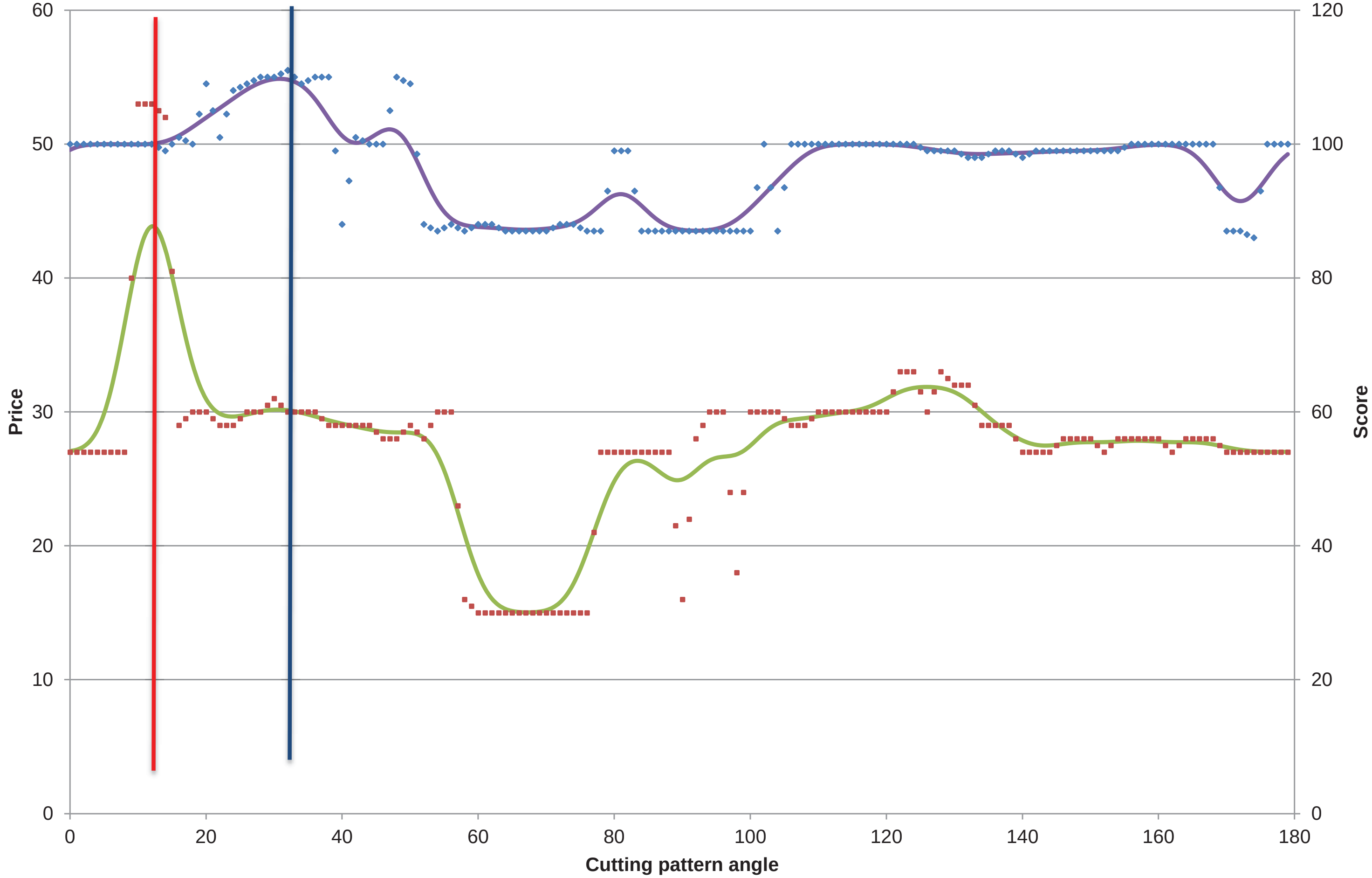
- Rotation optimization based only on external shape
- Assuming board without knots or other internal defects
- Filtered to consider mechanical positioning errors



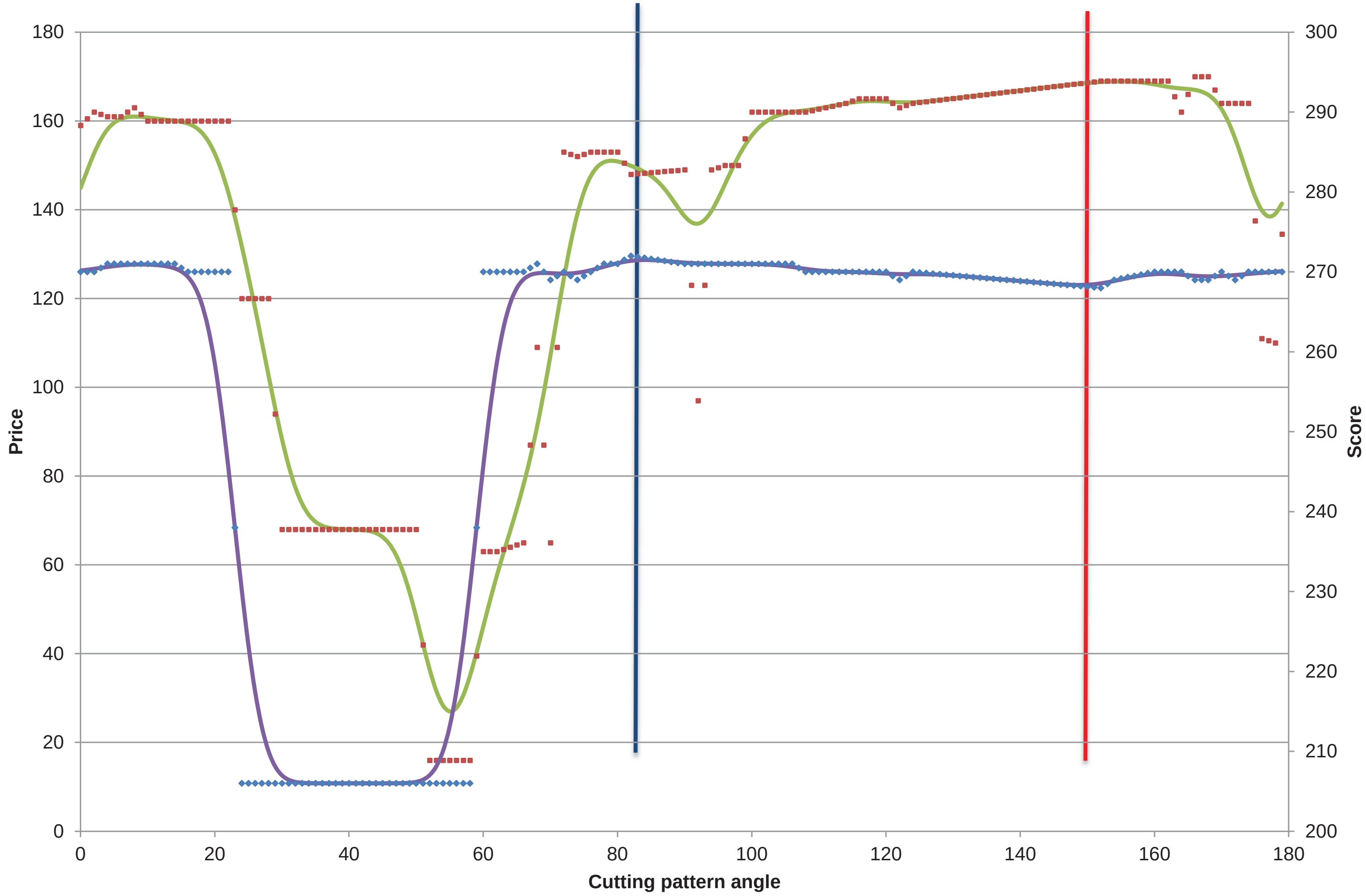
- Rotation optimization using internal knot evaluation (CT)
- **Estimation of the real price of each board in the cutting pattern**
- Filtered to consider mechanical positioning errors.



- Optimal angle based on external shape doesn't coincide with the optimal angle for price.
- Using CT optimisation the price of the boards increases from 30,2€ to 43,8€



- Optimal angle based on shape: 84°. Price 148.8 €
- Optimal angle based on CT: 155°. Price 168.9 €



CT.LOG

Closing the loop

Virtual Peeling

Virtual Peeling

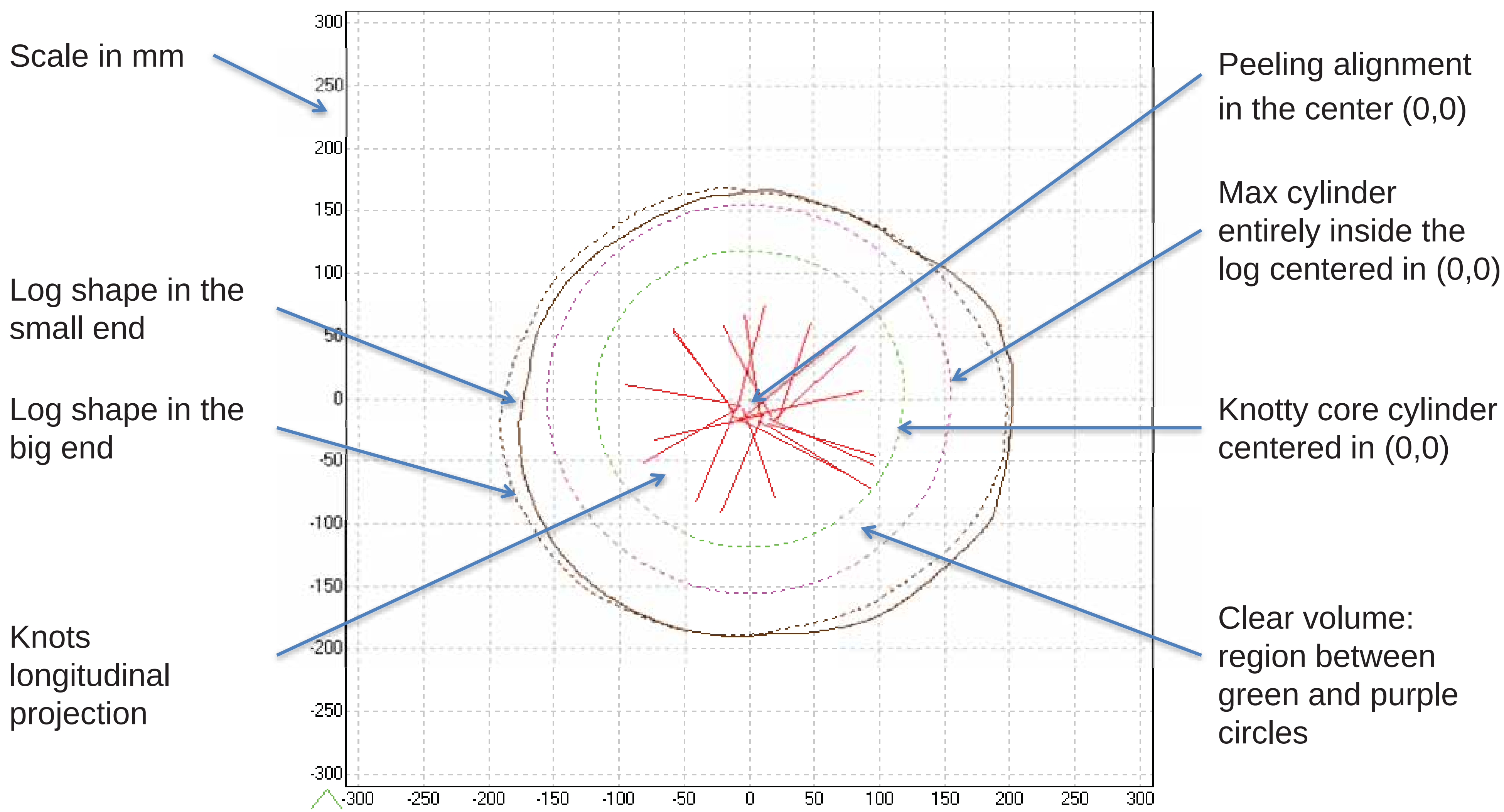
TEST DESCRIPTION

Logs used: 50 pruned radiata pine from Arauco scanned with with the CT.LOG

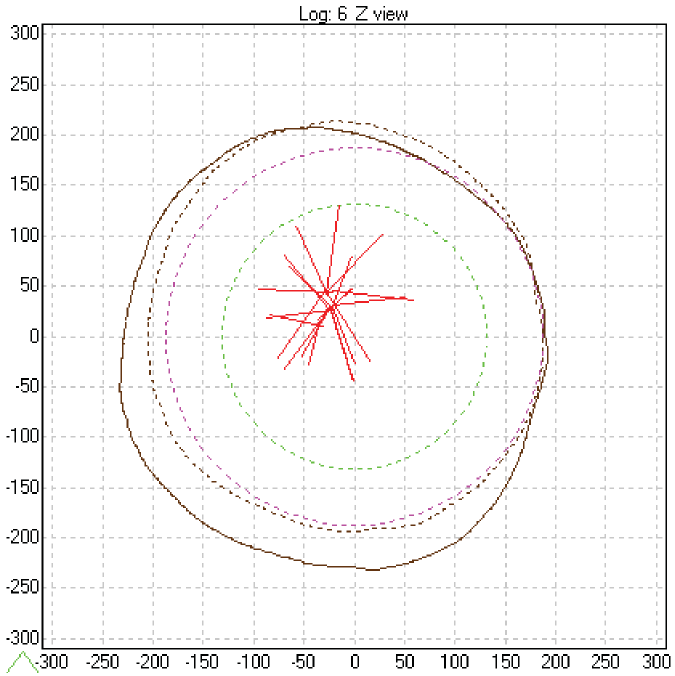
Evaluation of the clear volume obtained with 2 different alignment methods:

1. Alignment based on the maximal cylinder contained in the log (using external shape)
2. Alignment based on the maximization of the clear volume in function of the effective knots position (using CT data)

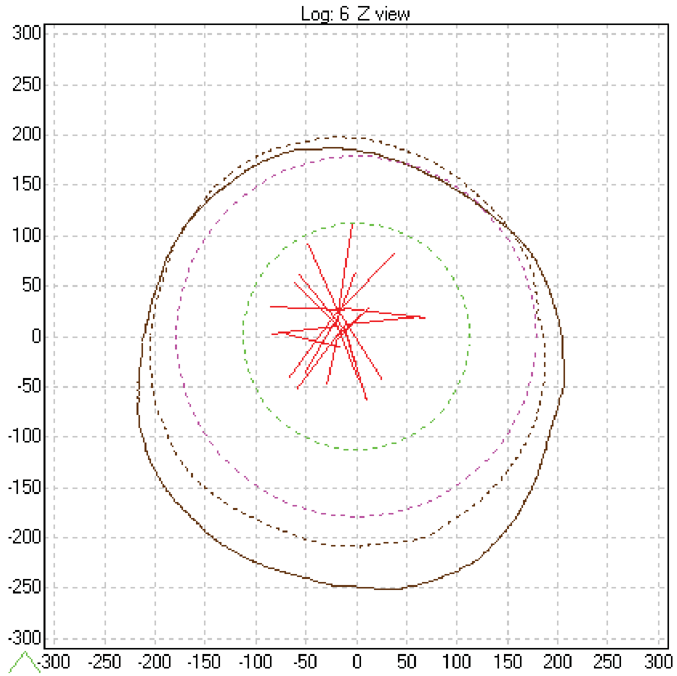
CONVENTIONS FOR THE LONGITUDINAL VIEW IMAGES



Peeling comparison on log 6



OPTIMIZED WITH EXTERNAL SHAPE

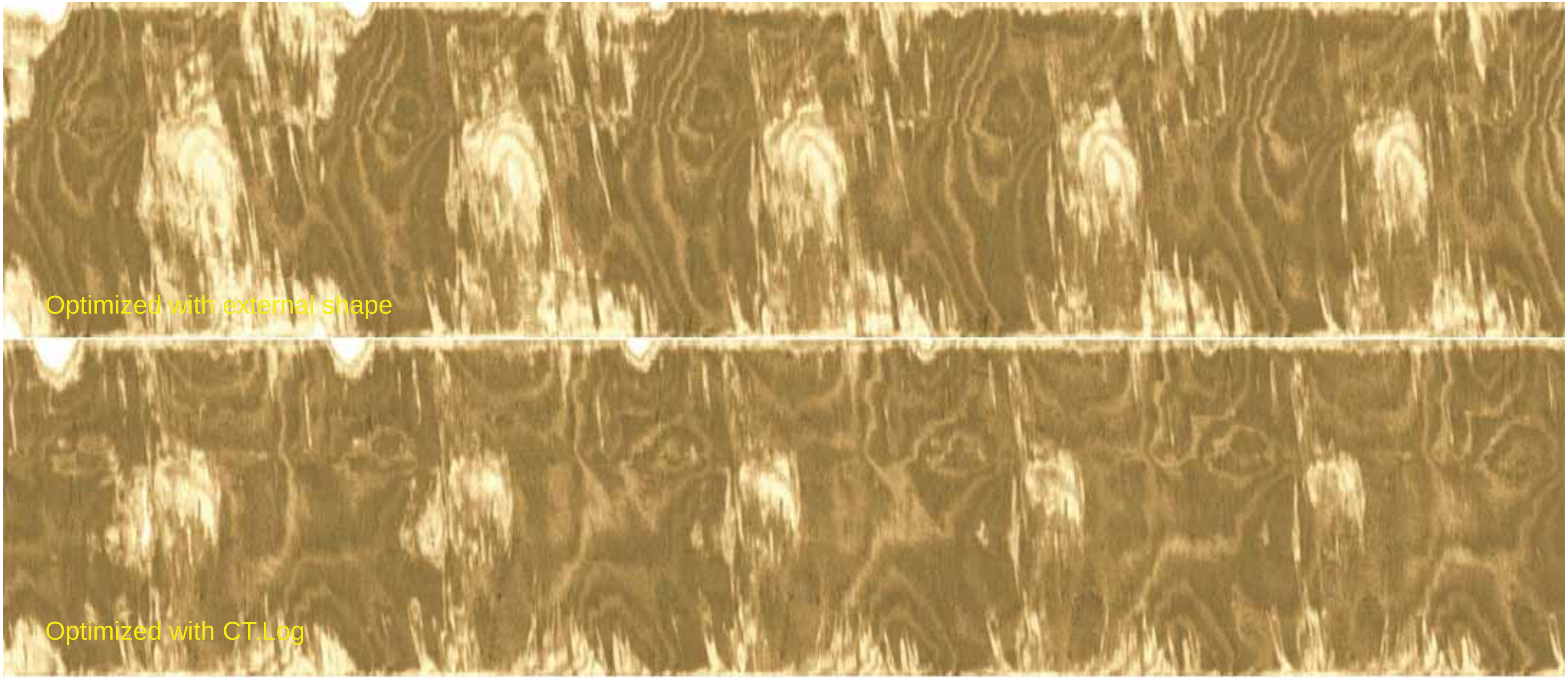


OPTIMIZED WITH CT.LOG

N log	sed	led	length	DJAS	JAS		perfect diam	kcd	vol clean	Yield	increment with CT
6	396	450	2170	38	0.313	OPTIMIZED WITH SHAPE	378	263	0.126	40%	11.1%
						OPTIMIZED WITH CT	364	225	0.139	45%	

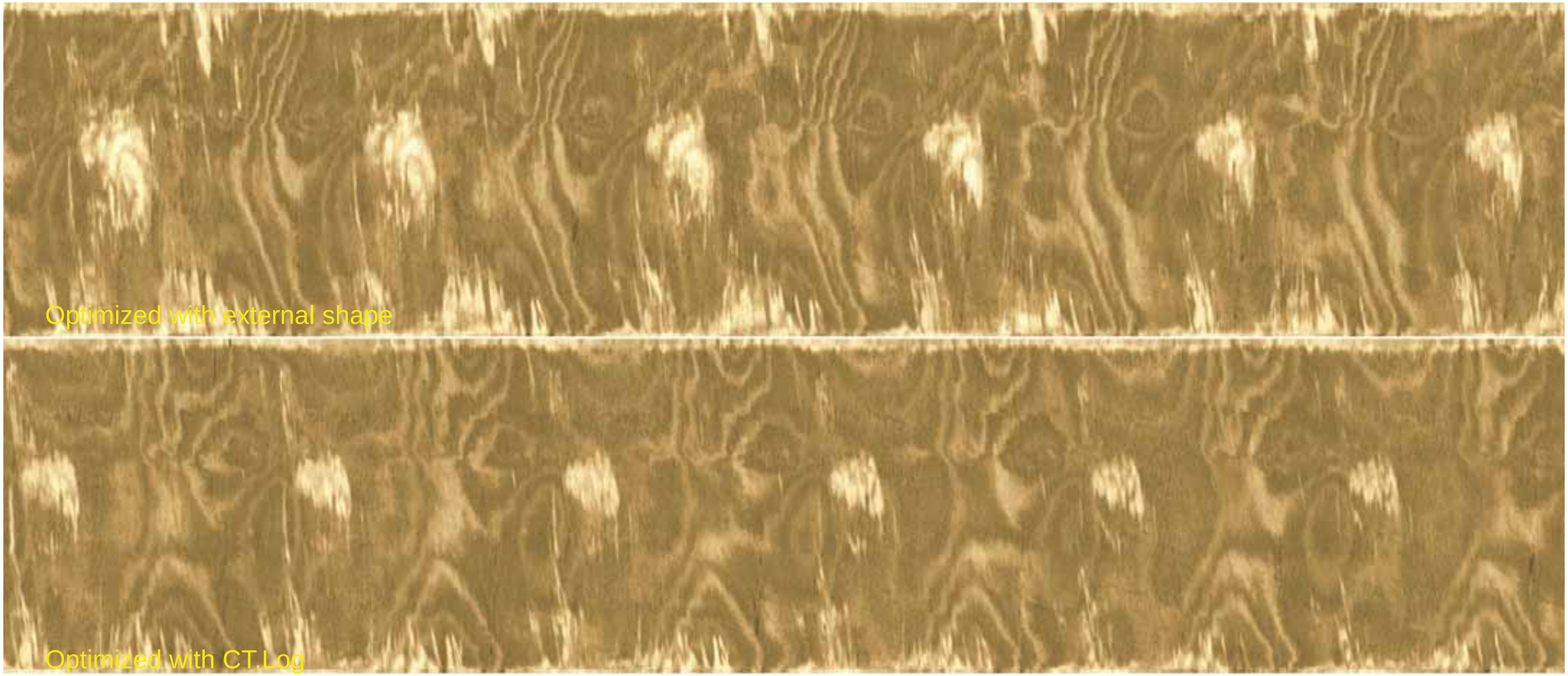
Log 6 / 1

Peeling comparison between optimization based on external shape and CT.LOG



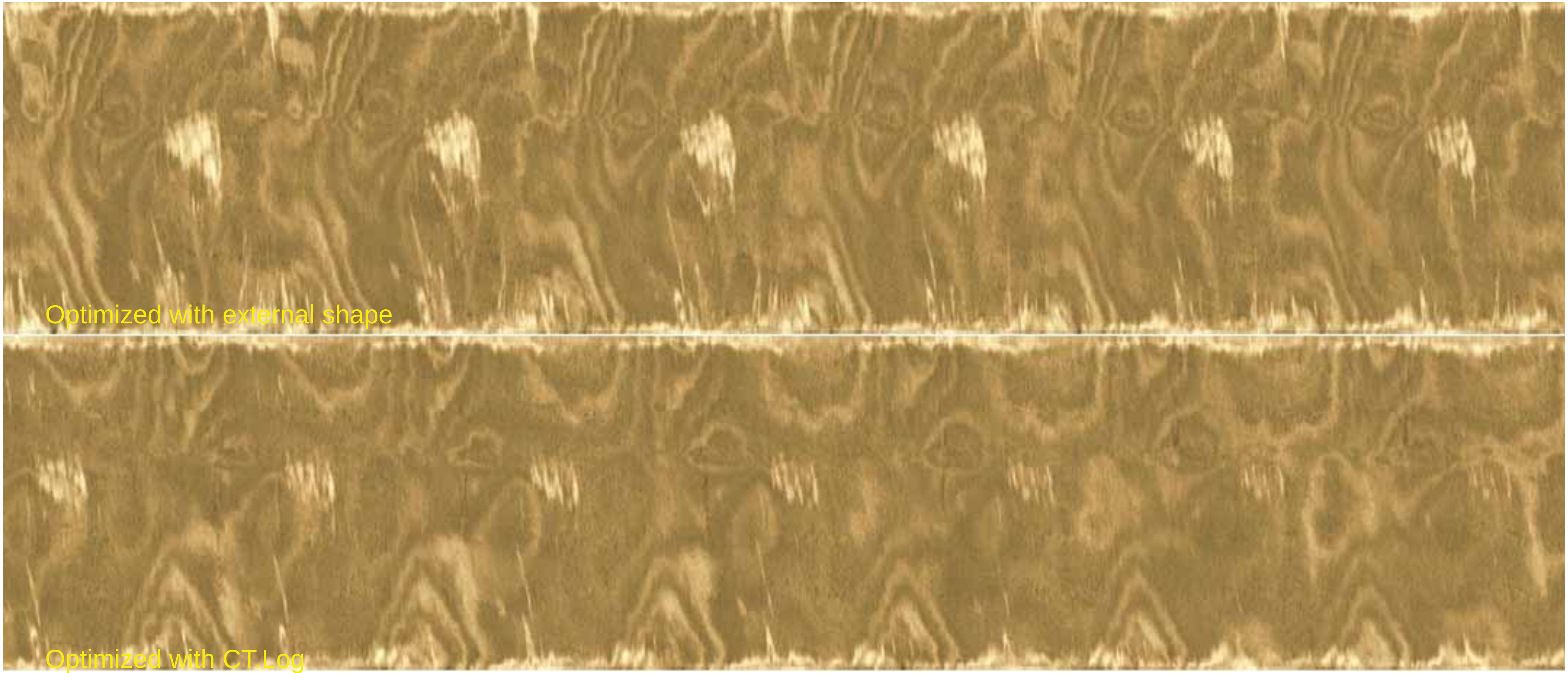
Log 6 / 2

Peeling comparison between optimization based on external shape and CT.LOG



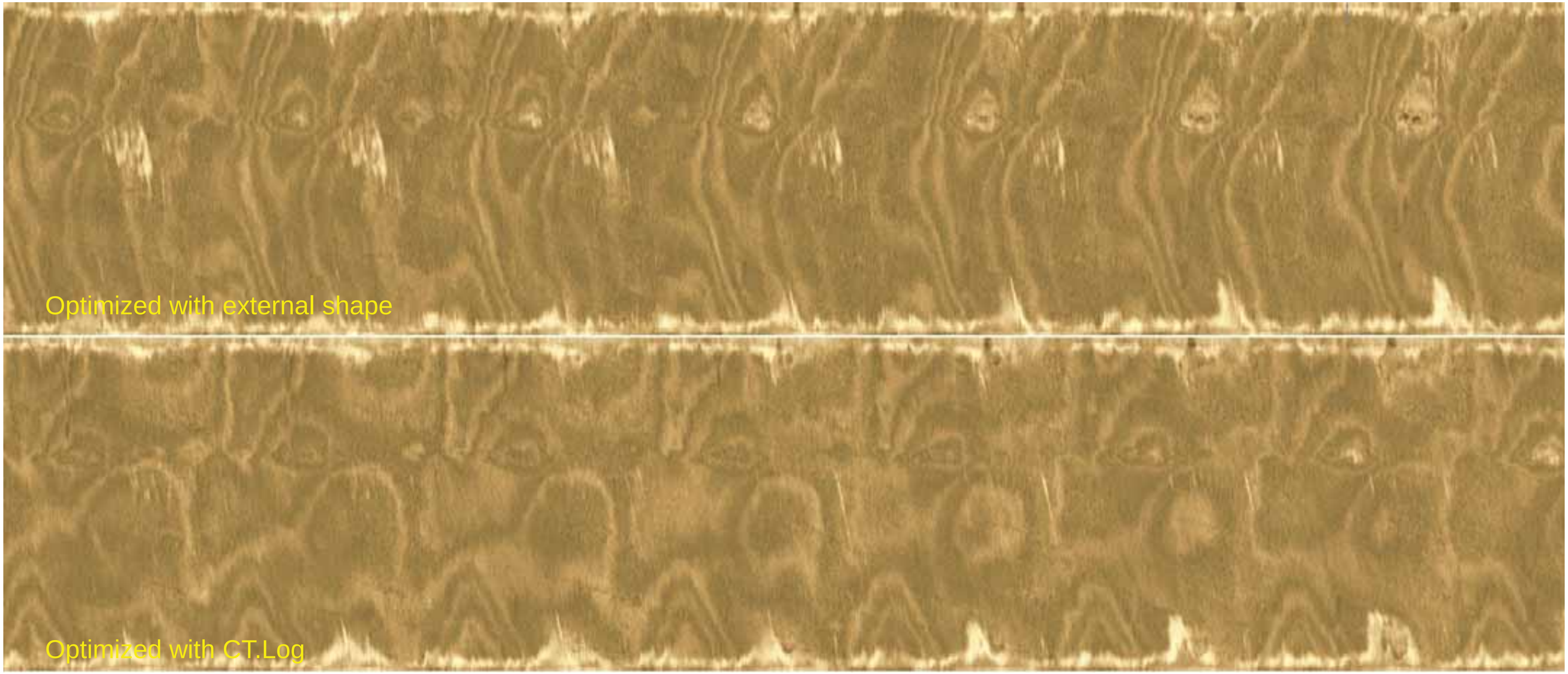
Log 6 / 3

Peeling comparison between optimization based on external shape and CT.LOG



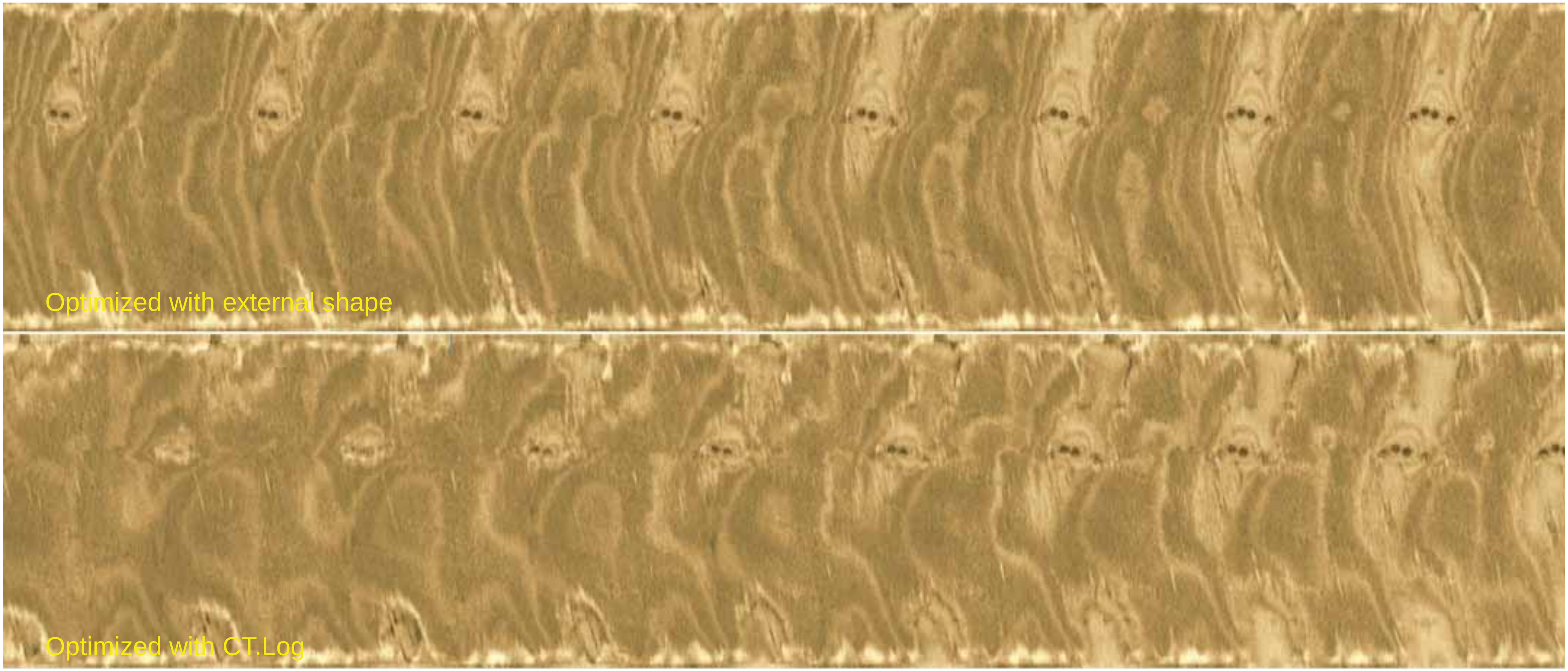
Log 6 / 4

Peeling comparison between optimization based on external shape and CT.LOG



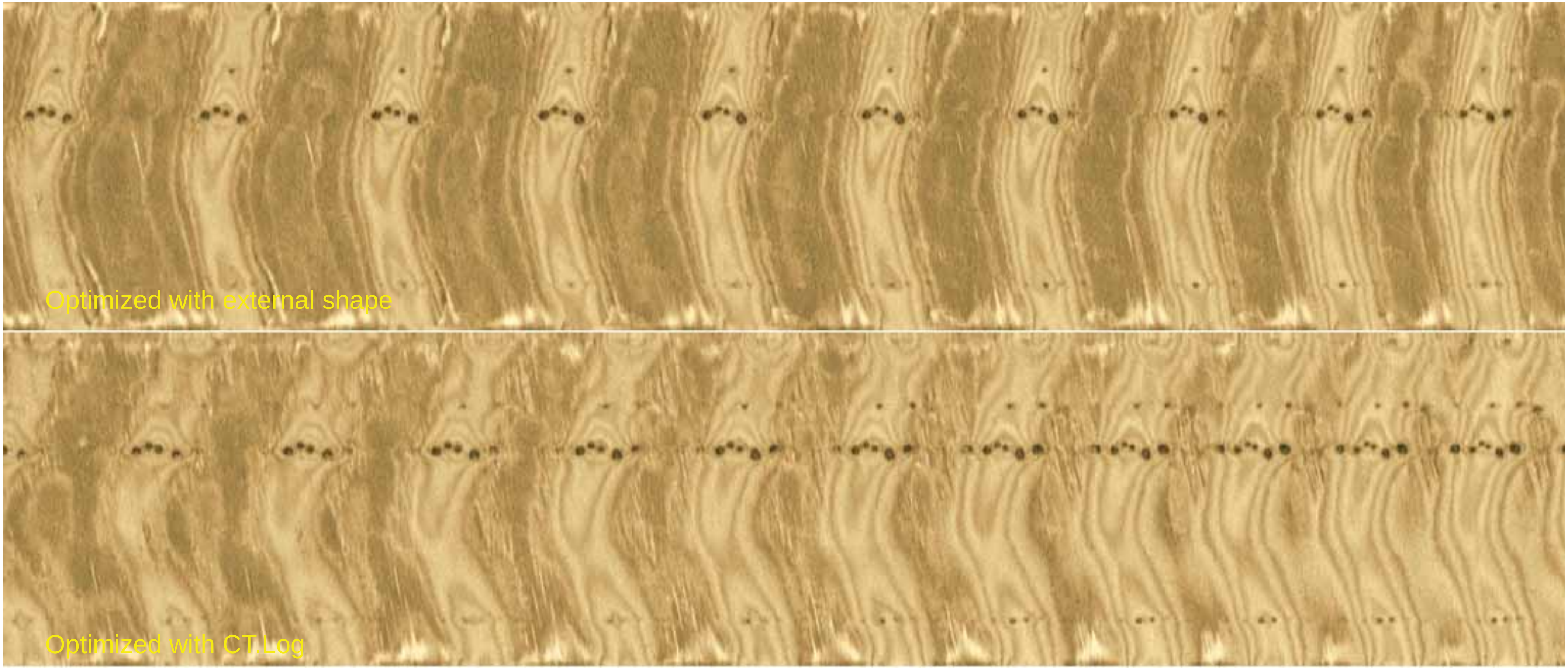
Log 6 / 5

Peeling comparison between optimization based on external shape and CT.LOG

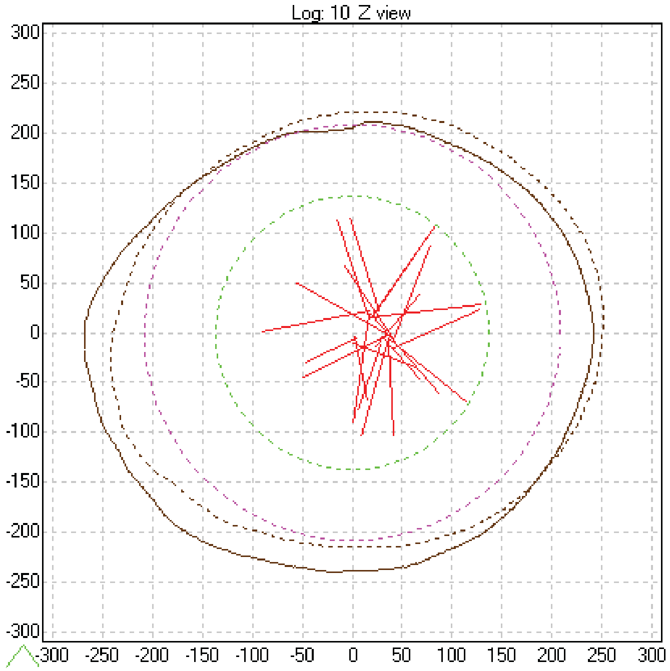


Log 6 / 6

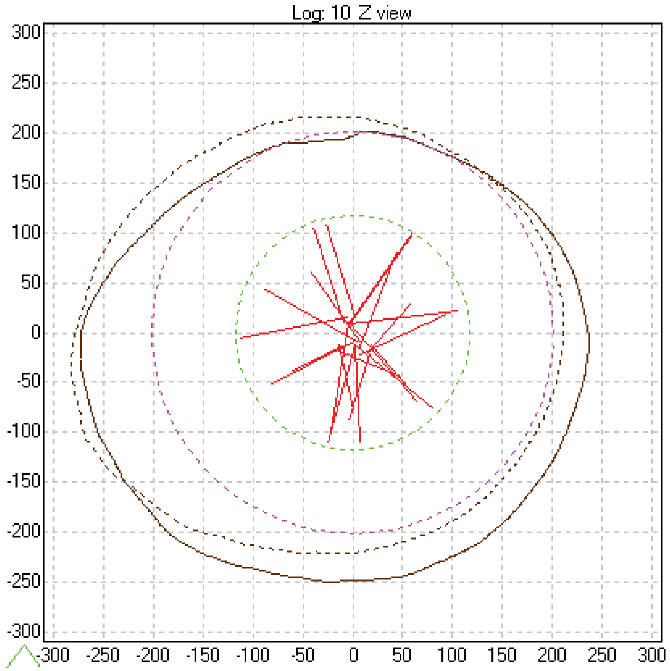
Peeling comparison between optimization based on external shape and CT.LOG



Peeling comparison on log 10



OPTIMIZED WITH EXTERNAL SHAPE



OPTIMIZED WITH CT.LOG

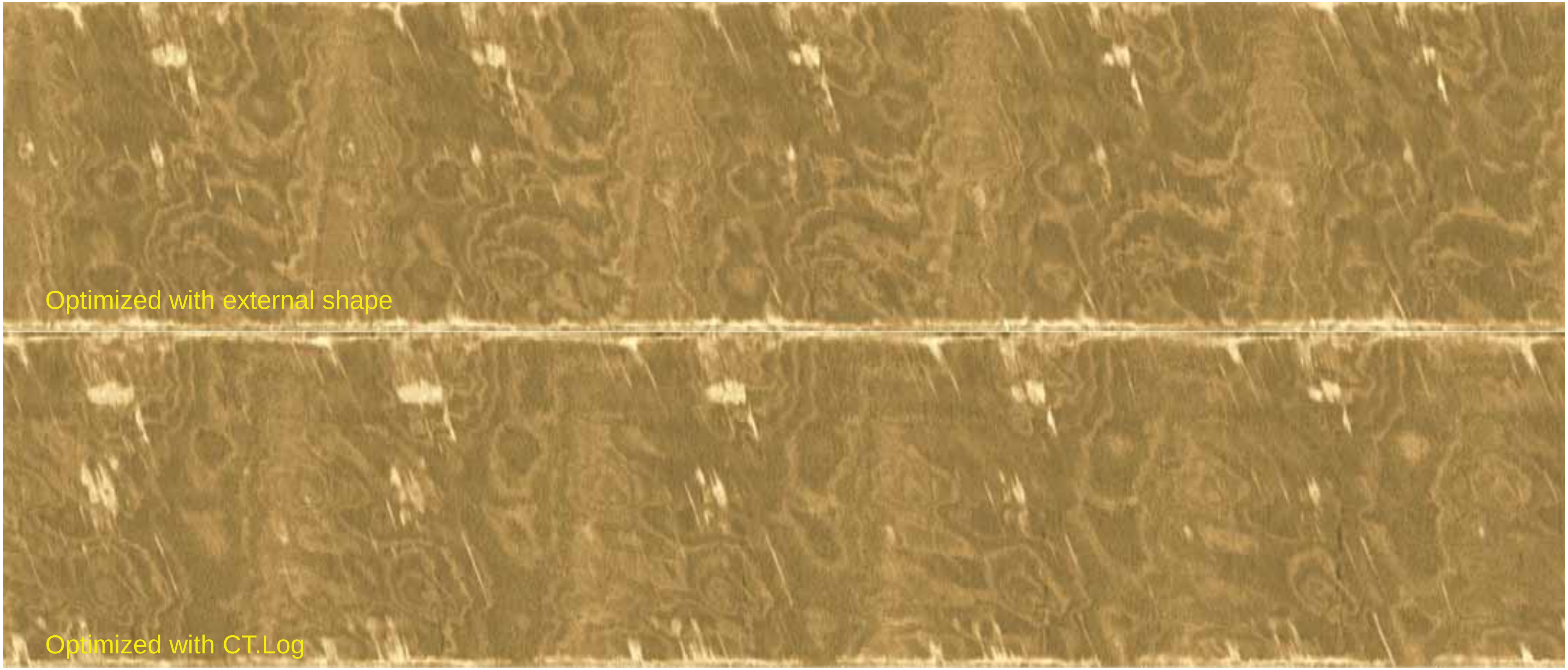
N log	sed	led	length	DJAS	JAS		perfect diam	kcd	vol clean	Yield	increment with CT
10	440	516	2190	44	0.424	OPTIMIZED WITH SHAPE	418	274	0.171	40%	9.2%
						OPTIMIZED WITH CT	405	235	0.187	44%	

Log 10/ 1

Peeling comparison between optimization based on external shape and CT.LOG

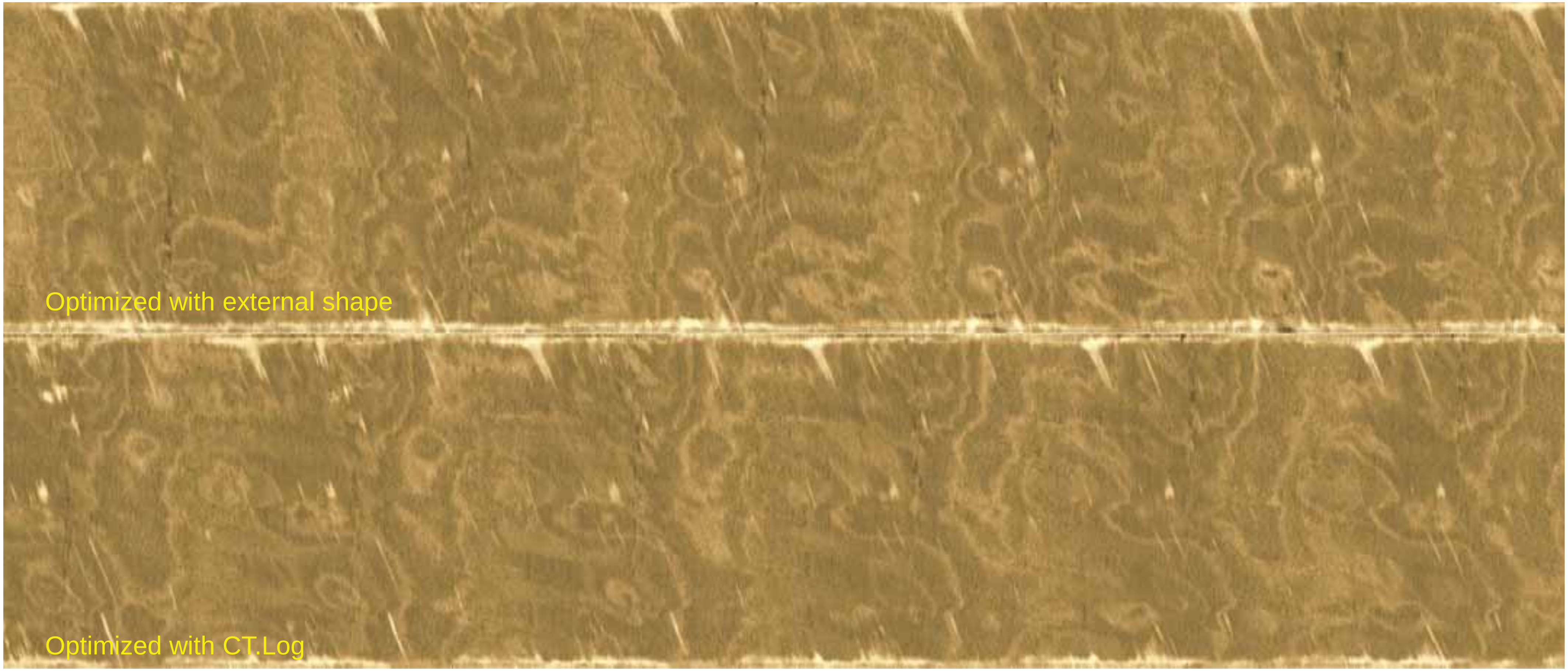
Log 10/ 2

Peeling comparison between optimization based on external shape and CT.LOG



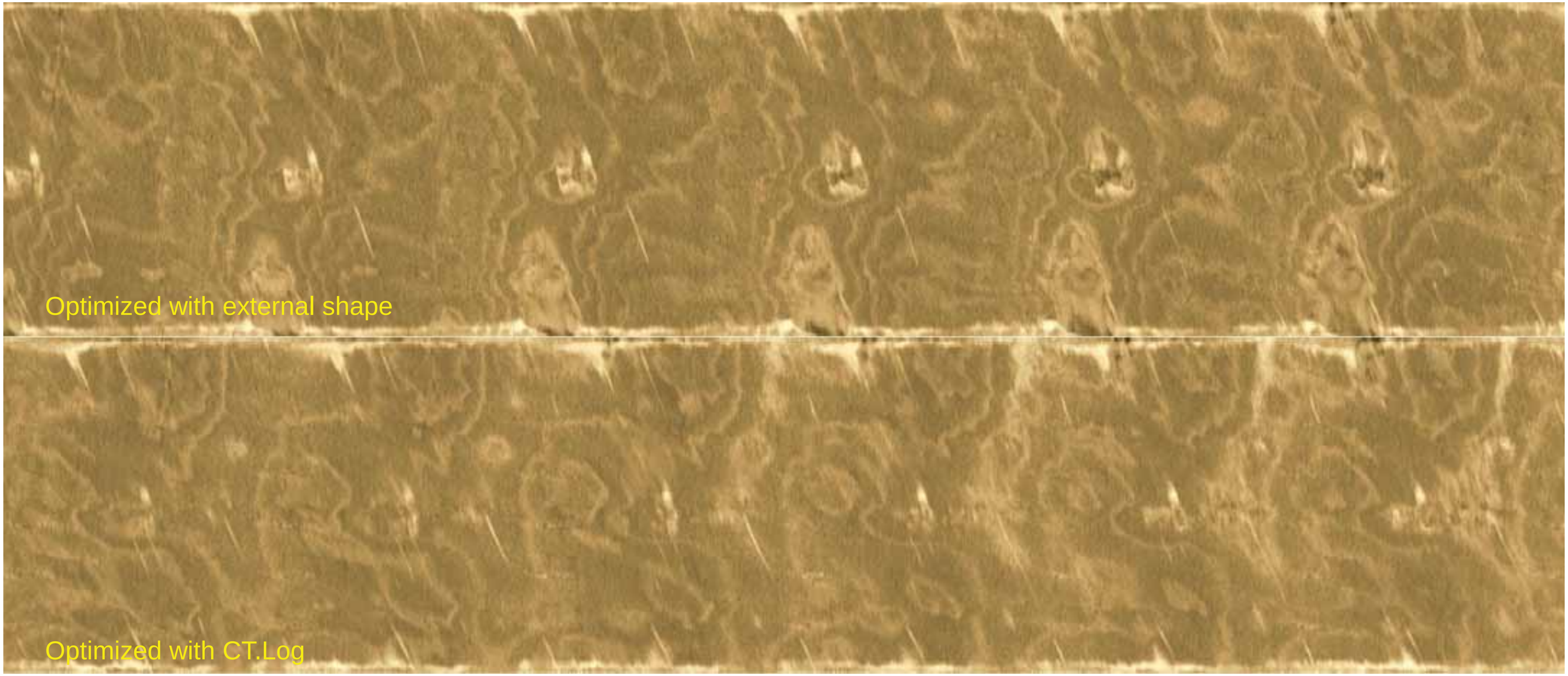
Log 10/ 3

Peeling comparison between optimization based on external shape and CT.LOG



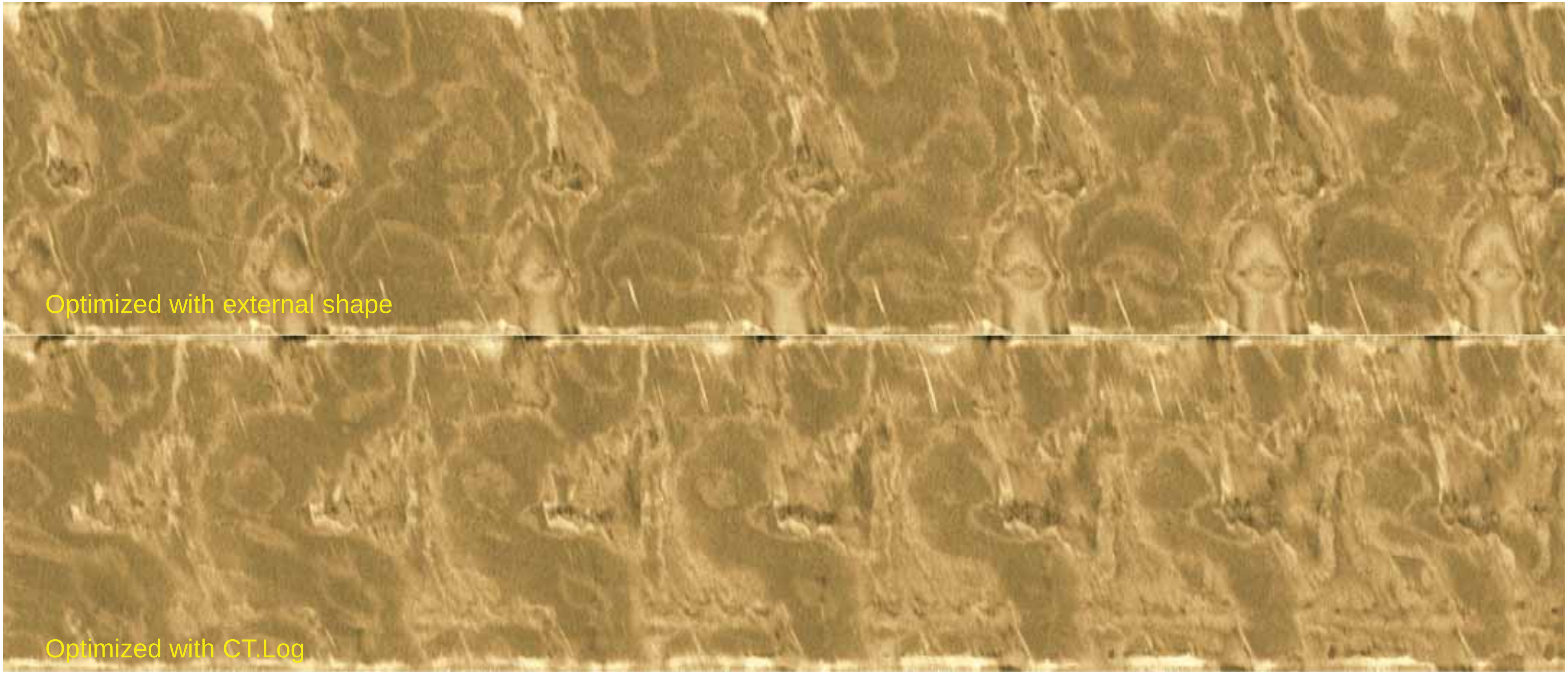
Log 10/ 4

Peeling comparison between optimization based on external shape and CT.LOG



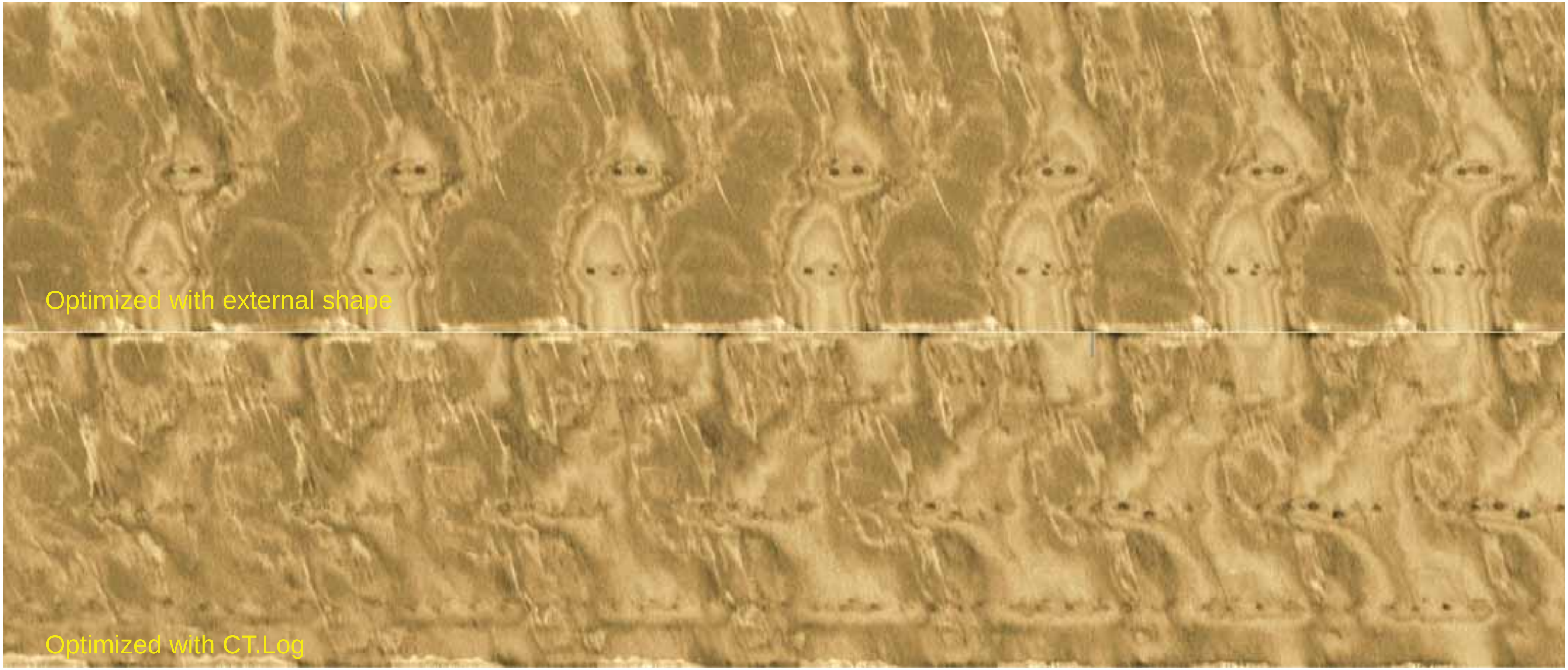
Log 10/ 5

Peeling comparison between optimization based on external shape and CT.LOG



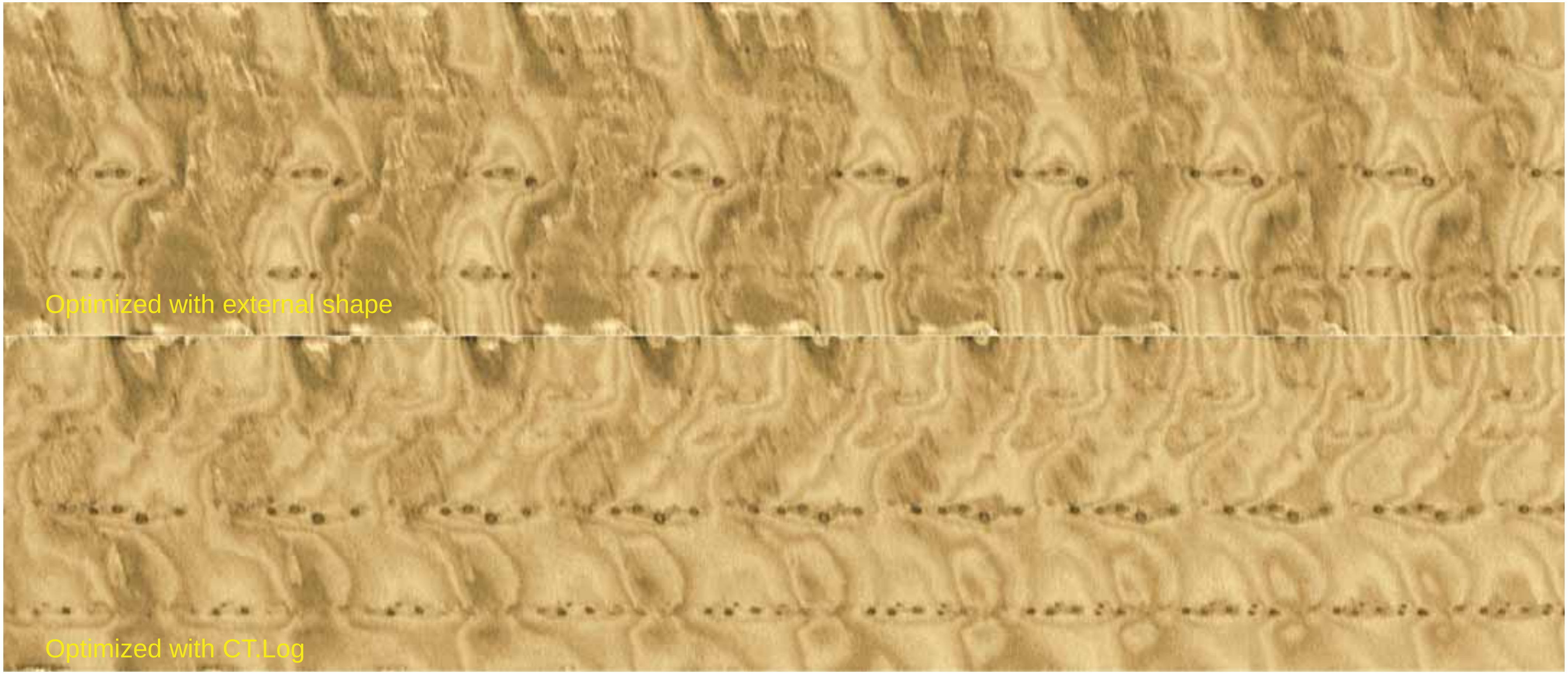
Log 10/ 6

Peeling comparison between optimization based on external shape and CT.LOG



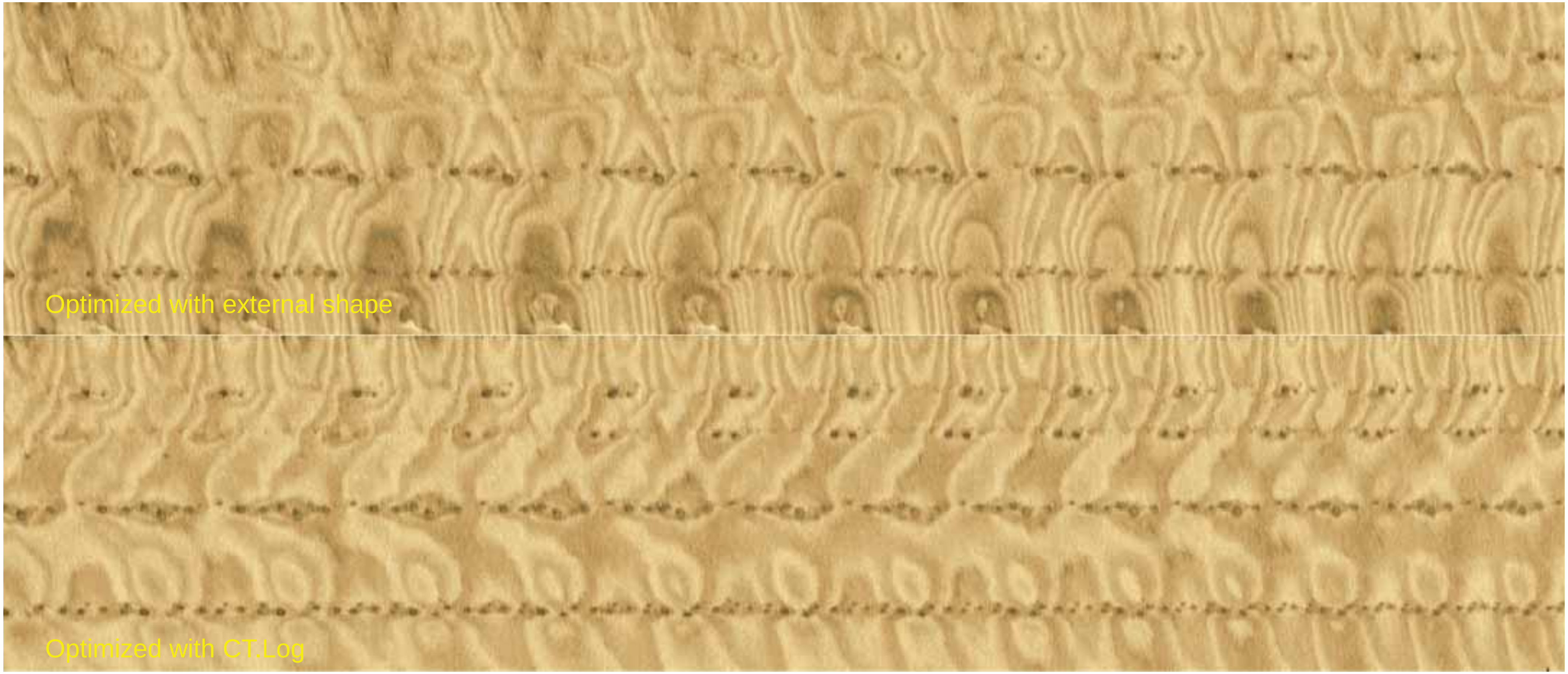
Log 10/ 7

Peeling comparison between optimization based on external shape and CT.LOG

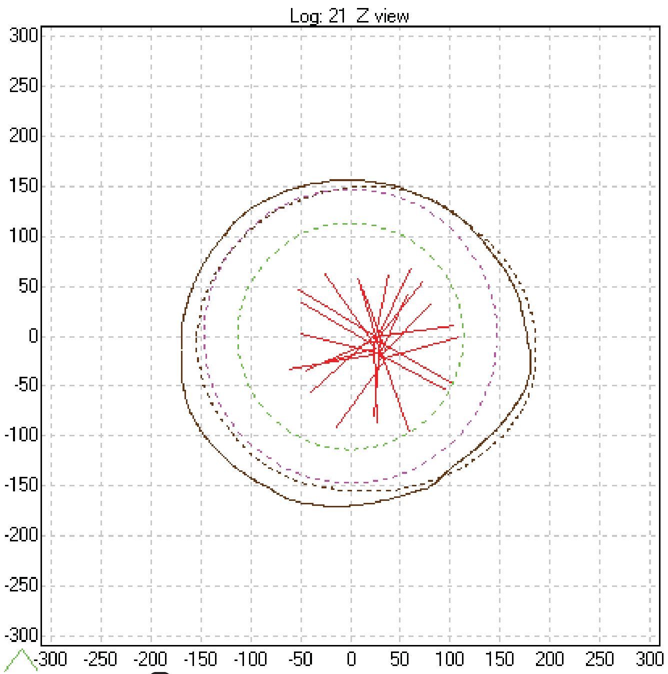


Log 10/ 8

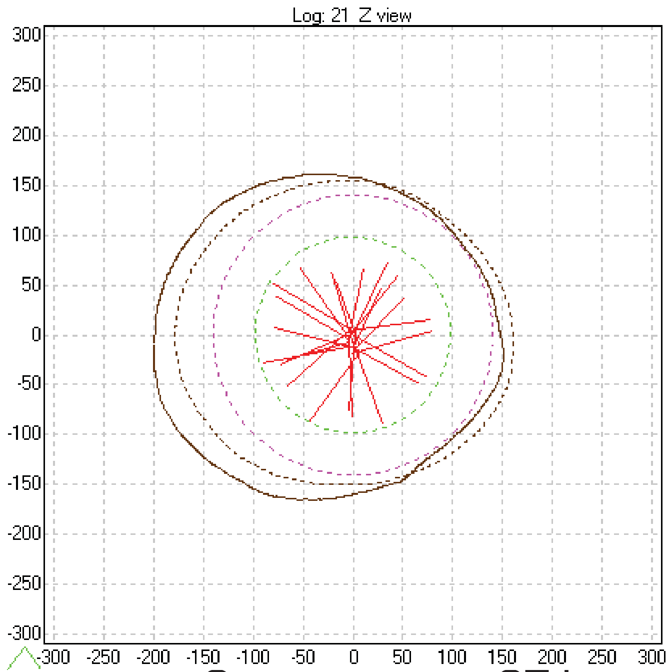
Peeling comparison between optimization based on external shape and CT.LOG



Peeling comparison on log 21



OPTIMIZED WITH EXTERNAL SHAPE

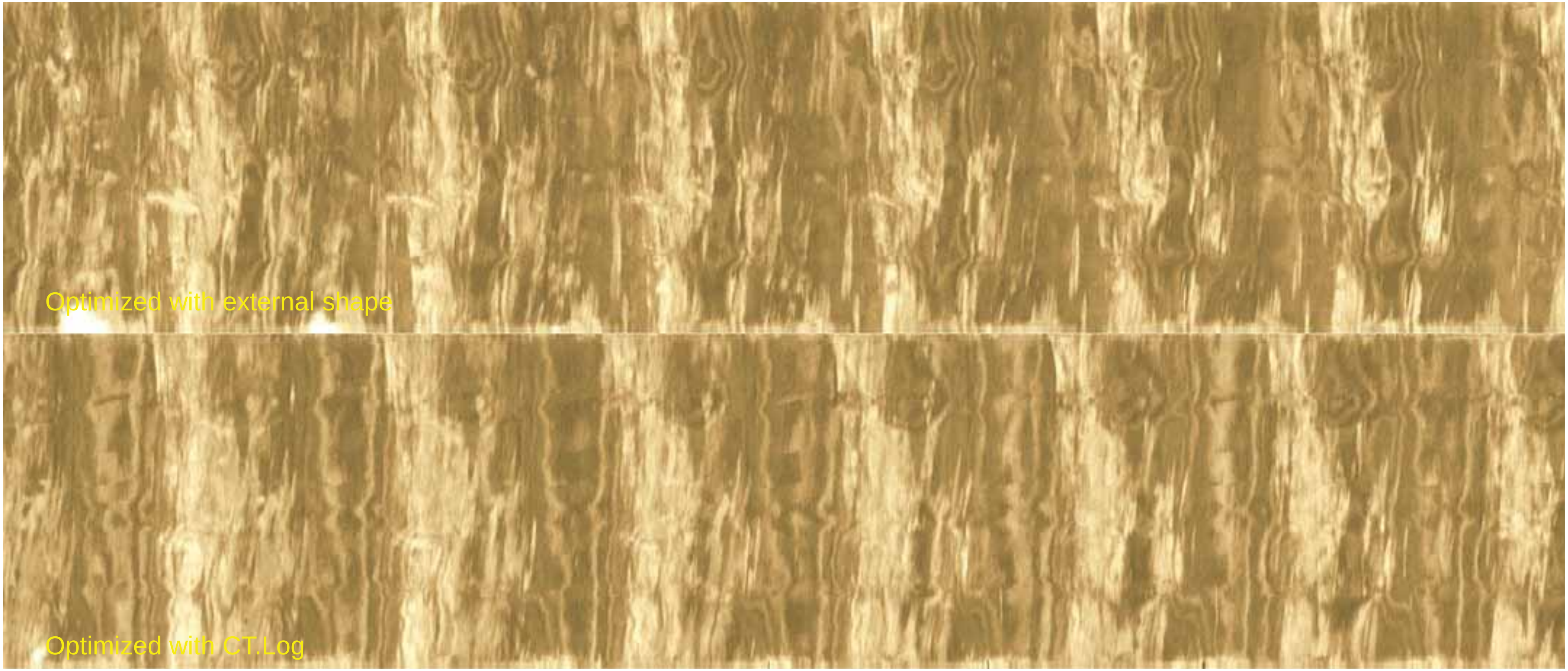


OPTIMIZED WITH CT.LOG

N log	sed	led	length	DJAS	JAS		perfect diam	kcd	vol clean	Yield	increment with CT
21	307	353	2190	30	0.197	OPTIMIZED WITH SHAPE	298	227	0.064	33%	24.6%
						OPTIMIZED WITH CT	288	191	0.080	41%	

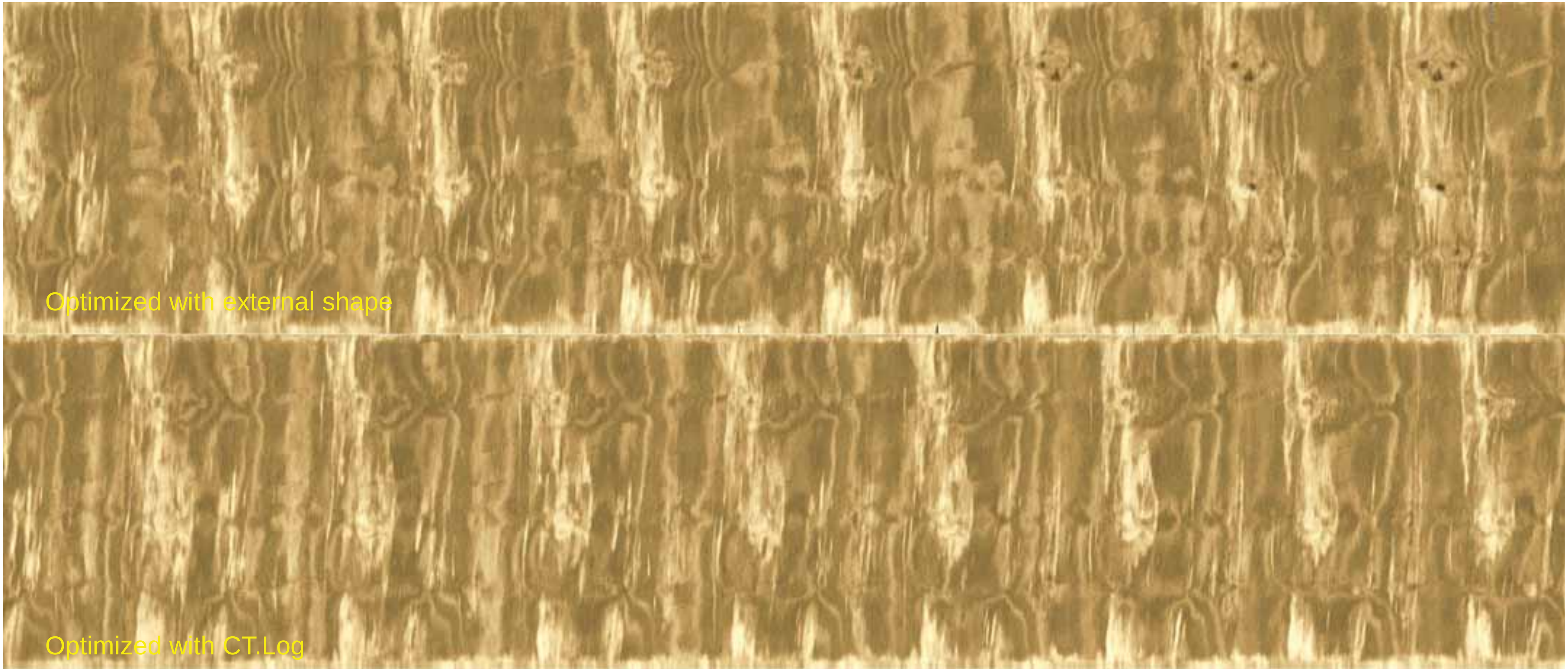
Log 21/ 1

Peeling comparison between optimization based on external shape and CT.LOG



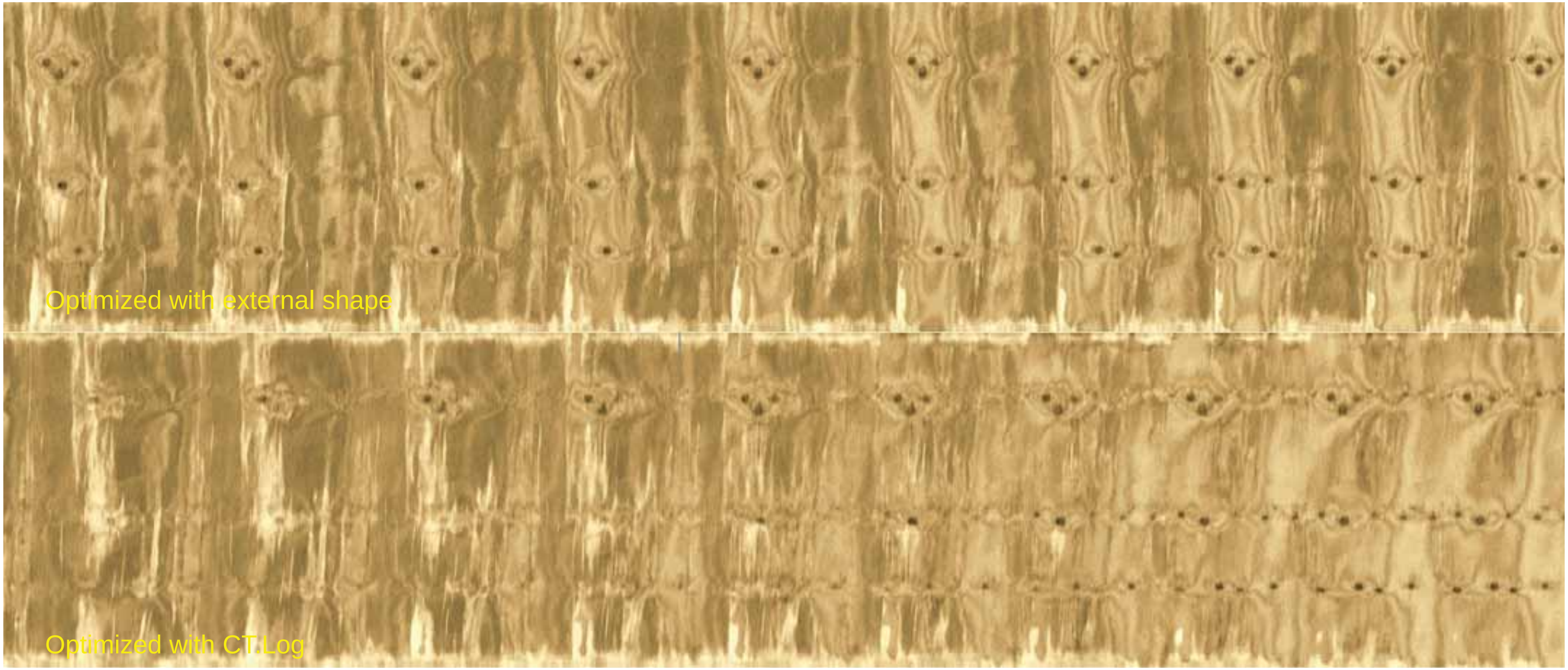
Log 21/ 2

Peeling comparison between optimization based on external shape and CT.LOG



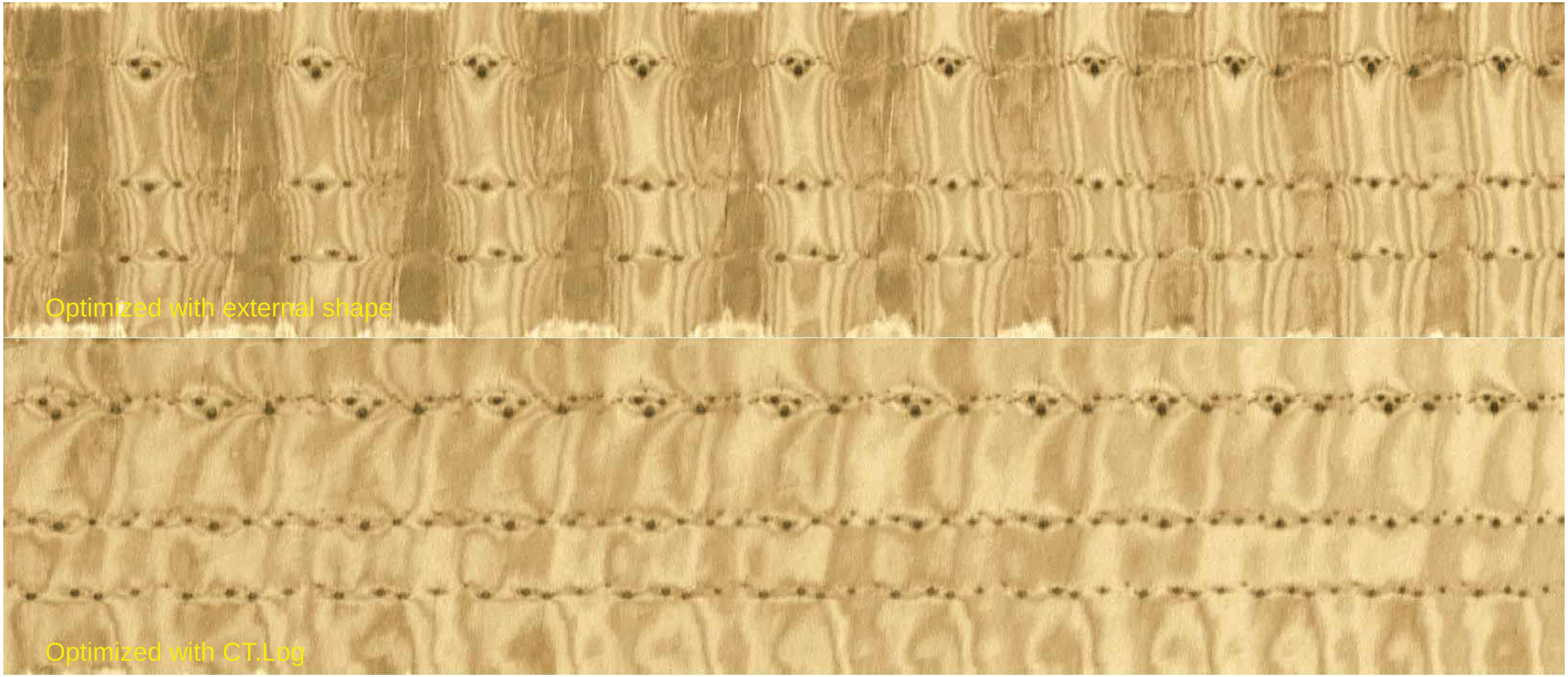
Log 21/ 3

Peeling comparison between optimization based on external shape and CT.LOG



Log 21/ 4

Peeling comparison between optimization based on external shape and CT.LOG



GLOBAL RESULTS ON ALL LOGS

Alignment method	Total clear volume (m^3)	Expected increment with CT.LOG
Optimization with shape	7.38	+7.1%
Optimization with CT.LOG	7.90	

Thank you!

Federico.giudiceandrea@microtec.eu