Quality Control of Heat Treated Timber:

Classification of Thermally Treated Solid Wood Samples by Color Measurement and Near Infrared Spectroscopy (NIRS)

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Contents

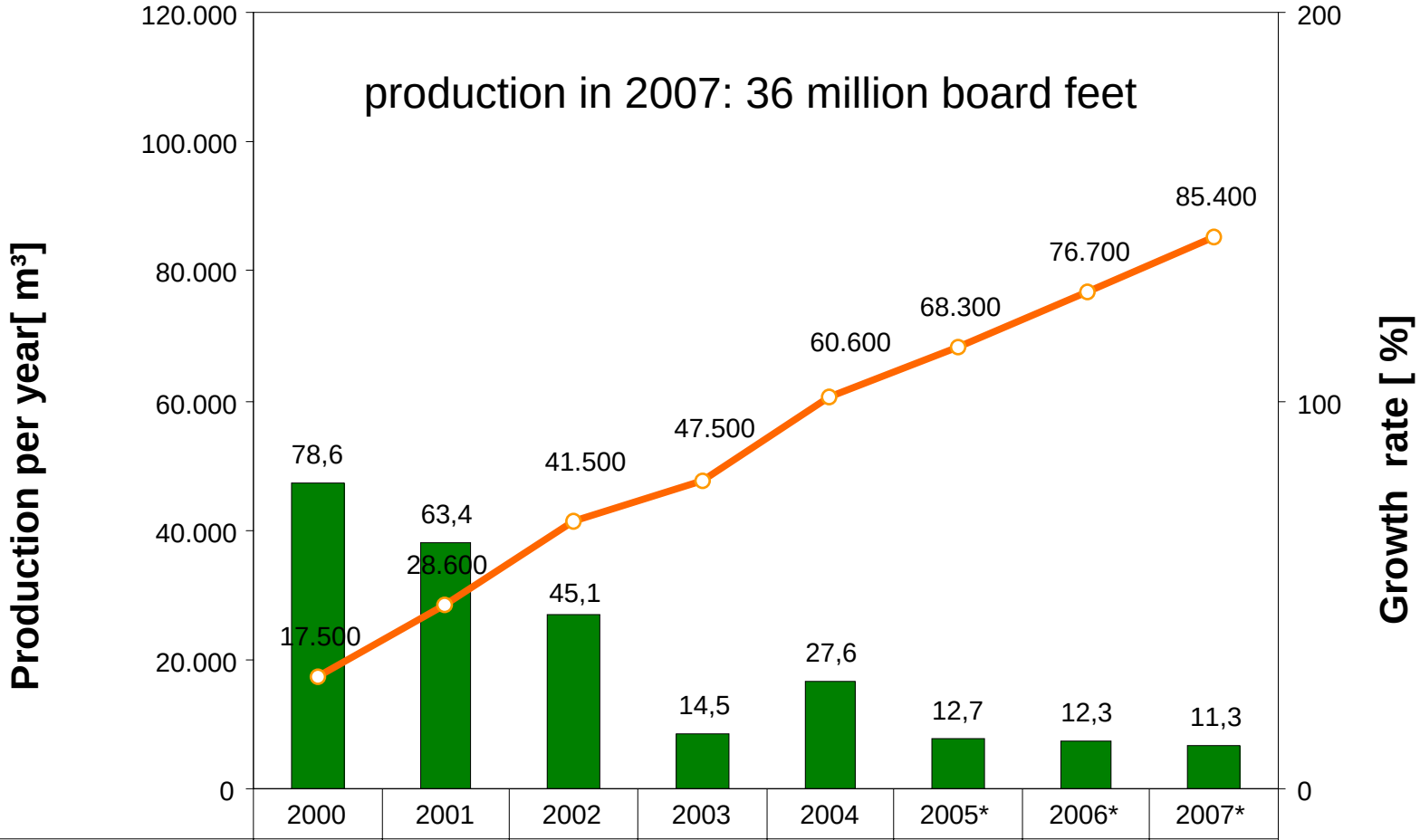
- wood modification by heat treatment
- properties and quality of heat treated lumber
- quality control – classification

  by color measurement

  by NIRS – near infrared spectroscopy
- future work:

  process control by color measurement and NIRS

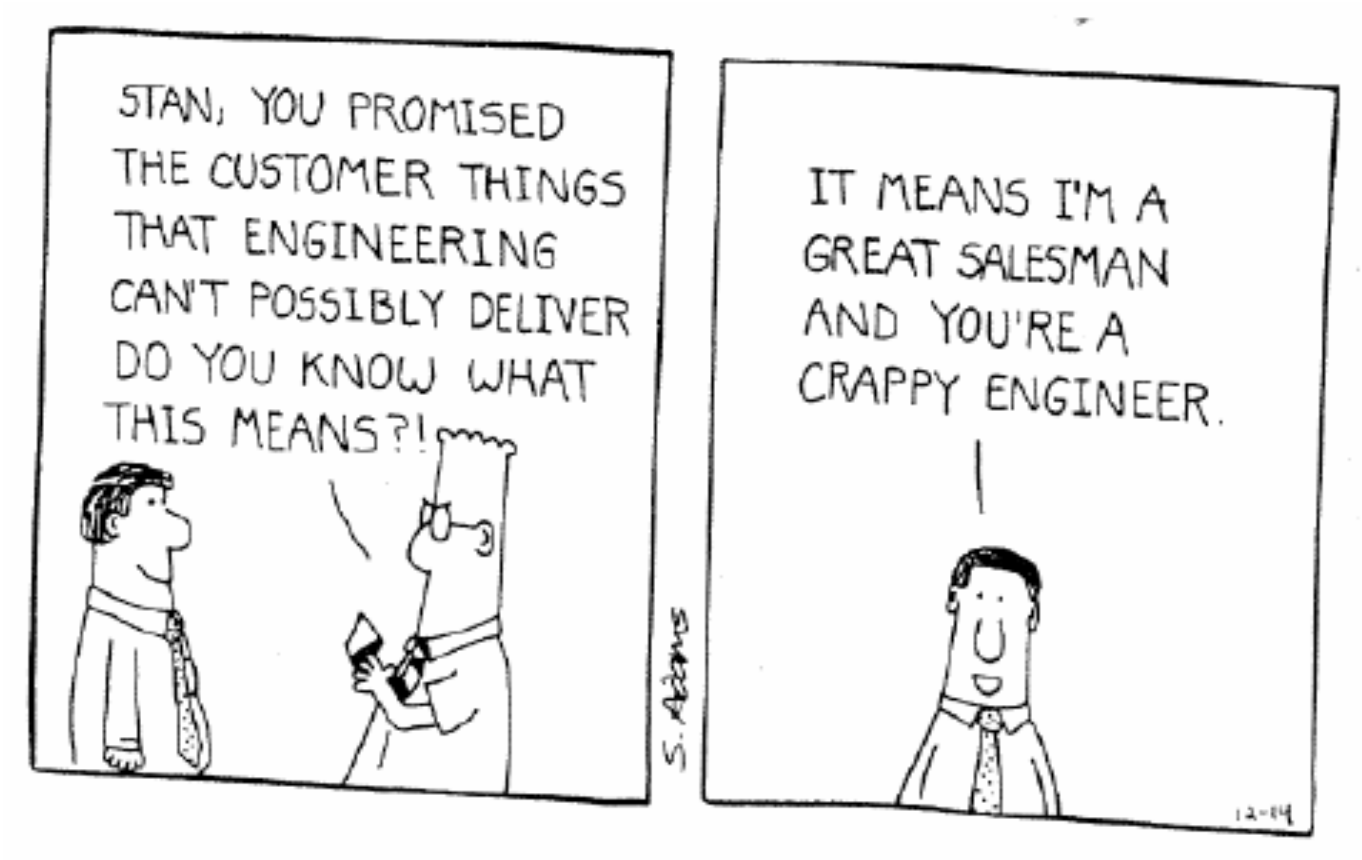
Market of thermally treated lumber in Europe



	2000	2001	2002	2003	2004	2005*	2006*	2007*
Growth rate in percent	78,6	63,4	45,1	14,5	27,6	12,7	12,3	11,3
Production in cubic meter	17.500	28.600	41.500	47.500	60.600	68.300	76.700	85.400

(Source: Huth 2006)

Objectives

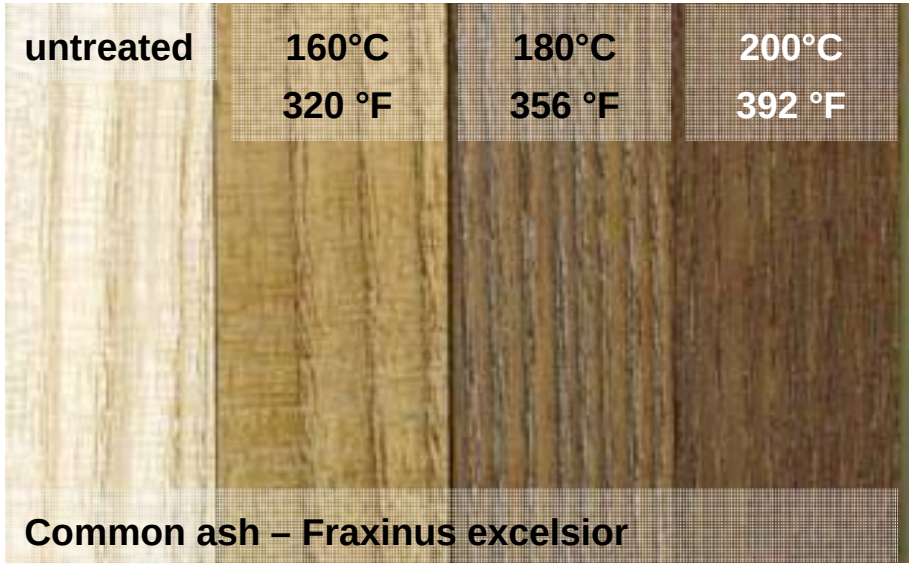


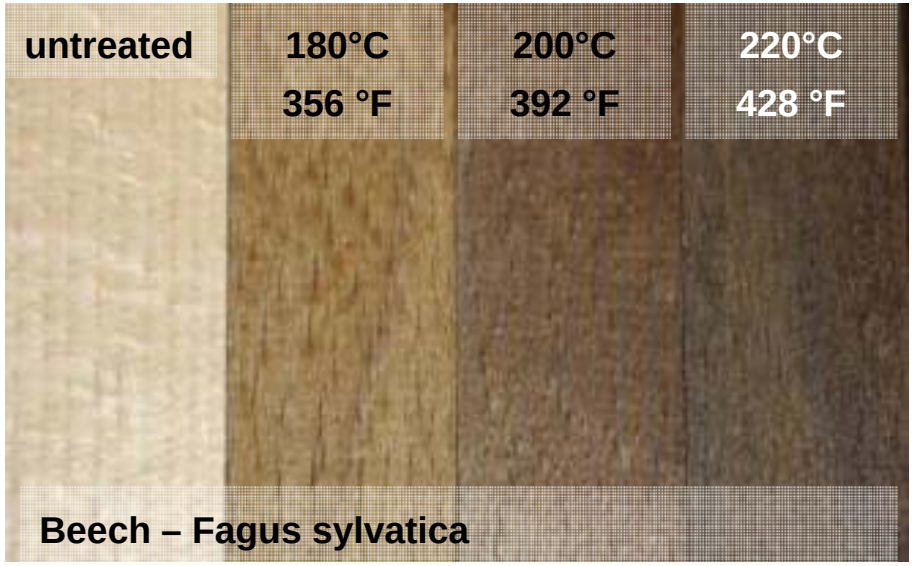
→ problems with quality control

(e.g. Quality Control Handbook (FTWA 2004),

Quality Control System (FTWA 2006), Gütezeichen TMT (2006))

Wood (lumber) modification by heat treatment

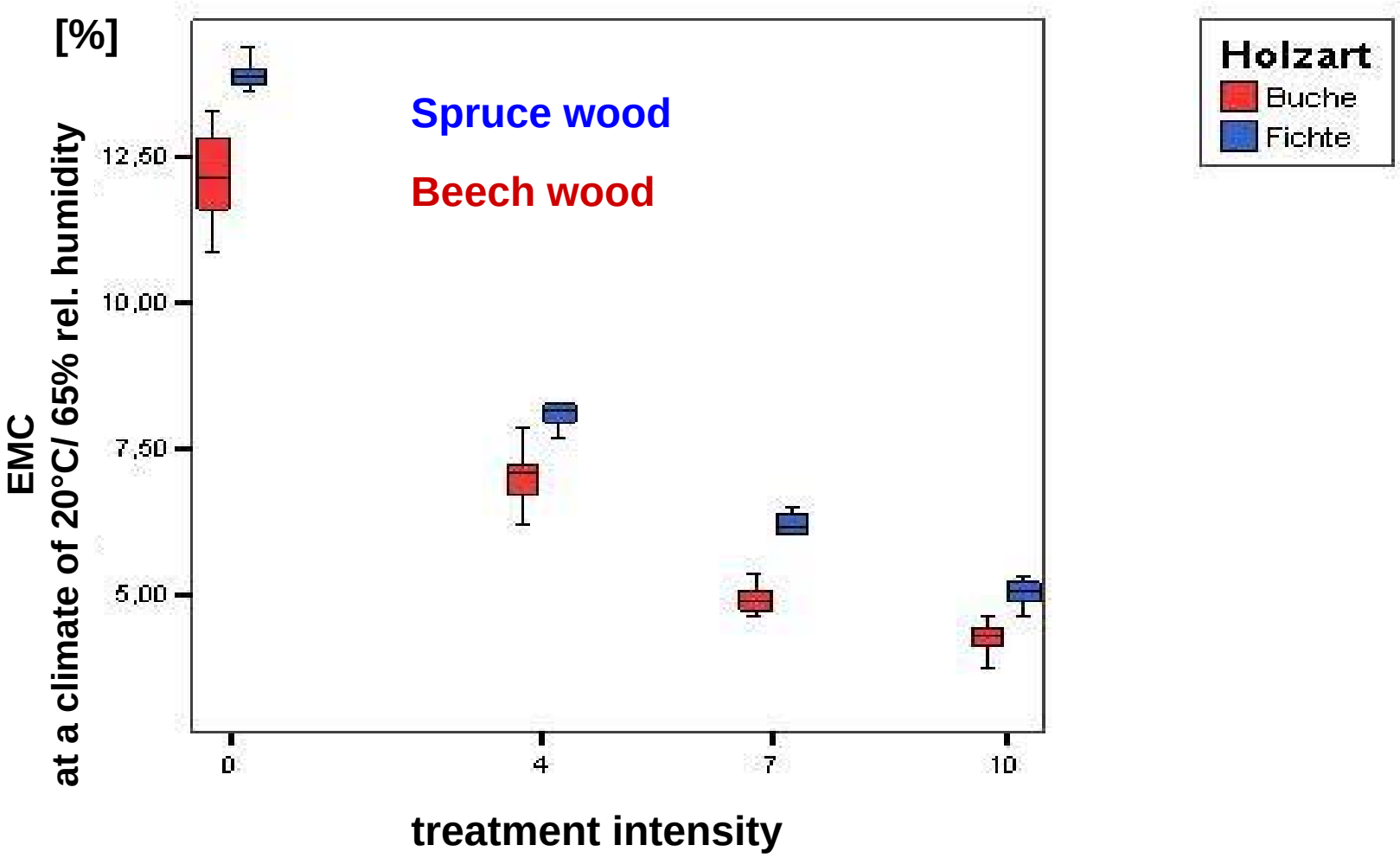




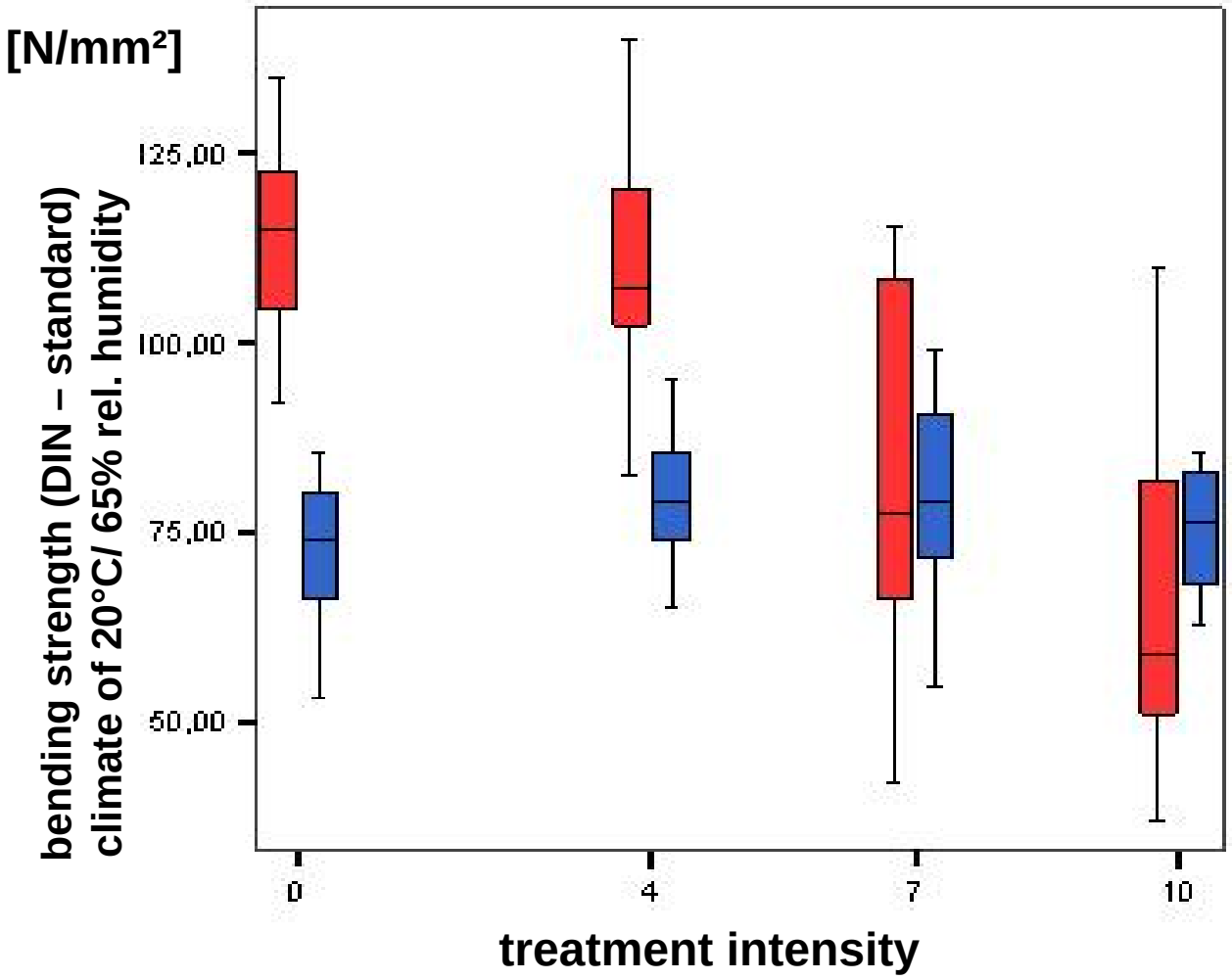
Modification of wood properties by thermally treatment without any active agents.

- ☺ natural durability
- ☺ dimensional stability
- ☺ EMC – equilibrium moisture content
- 😐 color
- 😐 maschining
- ☹ strength properties

EMC – equilibrium moisture content



Bending strength [N/mm²]



Beech wood

Spruce wood

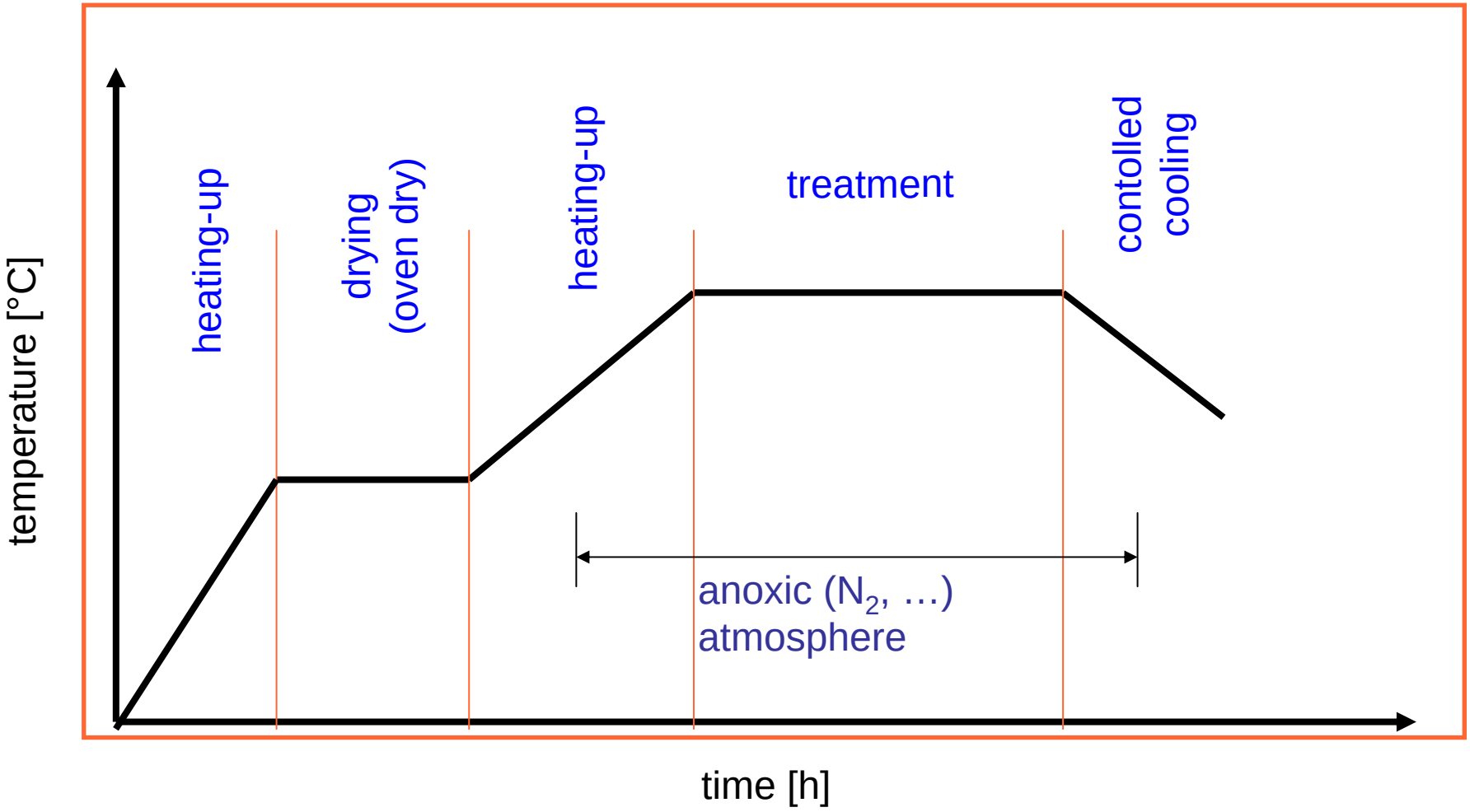
Applications of heat treated lumber

Treatment conditions – parameters

results influenced by:

- ✓ species
- ✓ dimensions
- ✓ moisture content
- ✓ origin (region)

Heat treatment:
the austrian process (Mühlböck)



Treatment conditions – process control

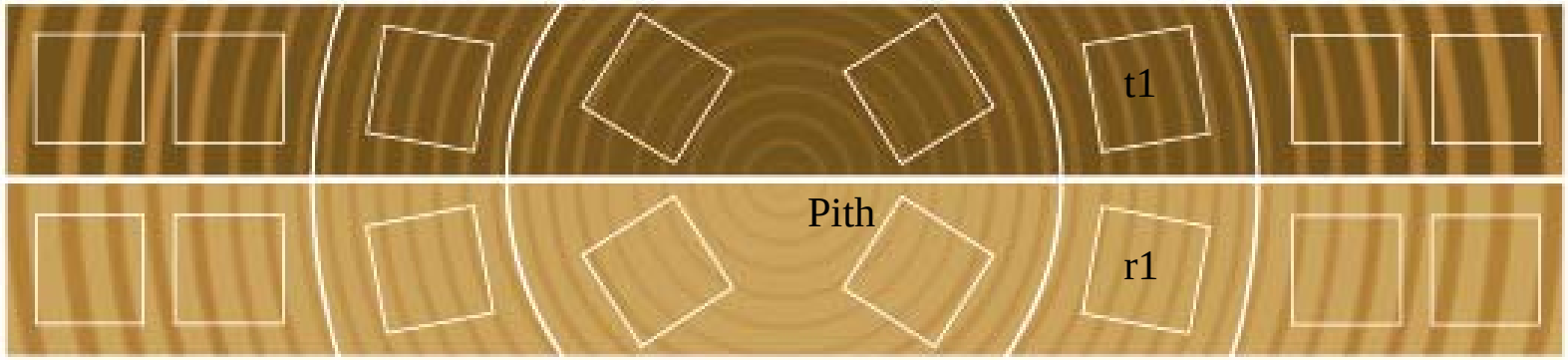
- ✓ temperature
- ✓ time
- ✓ experience

Testing material - sampling

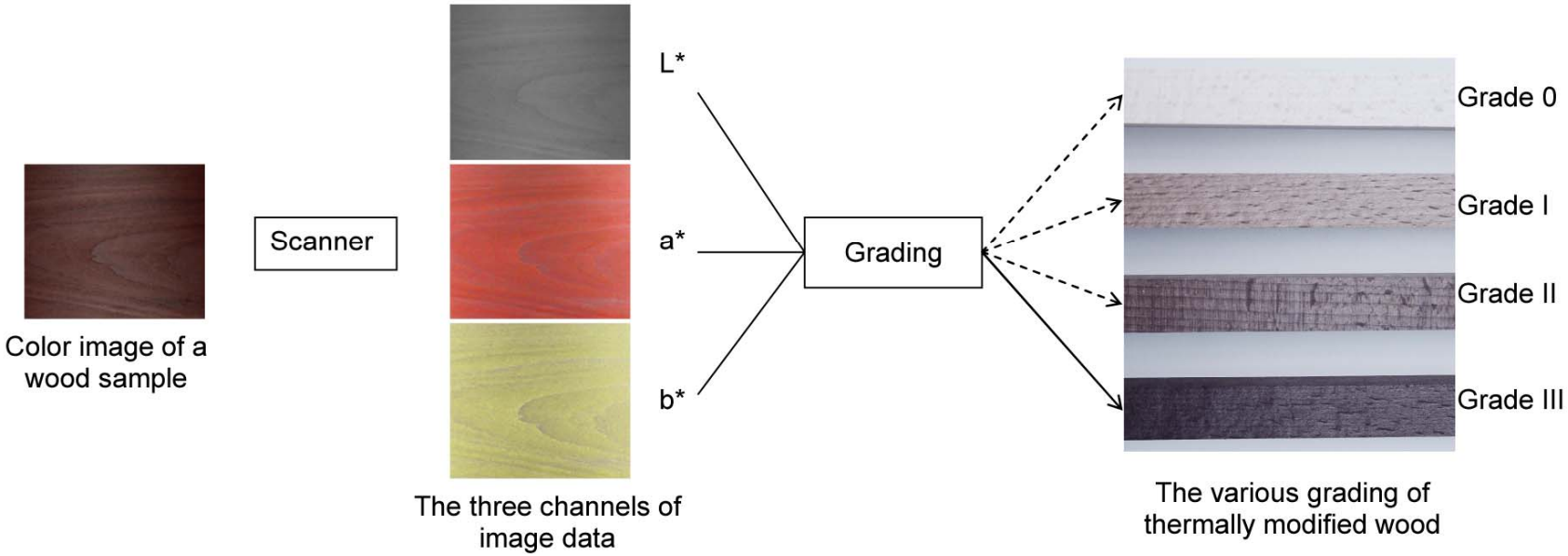
Testing material – „twin samples“

treated

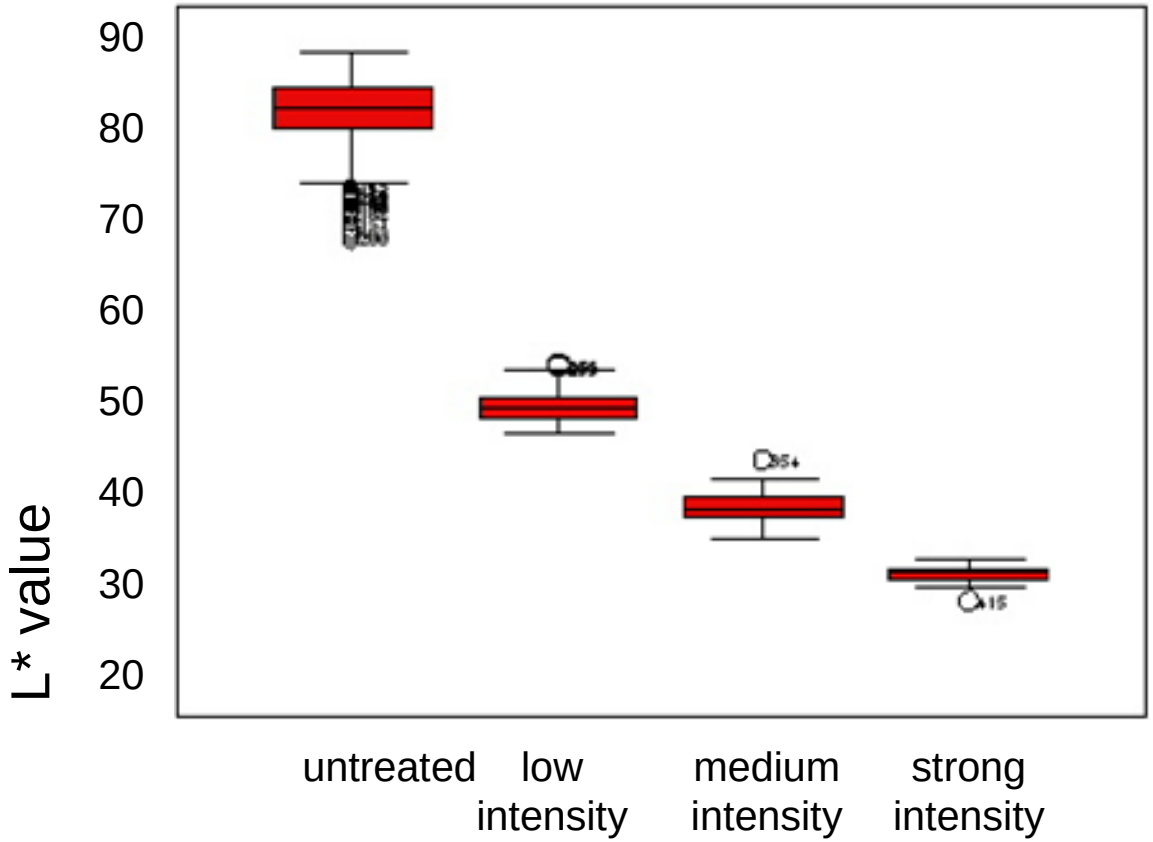
untreated



Classification by color measurement



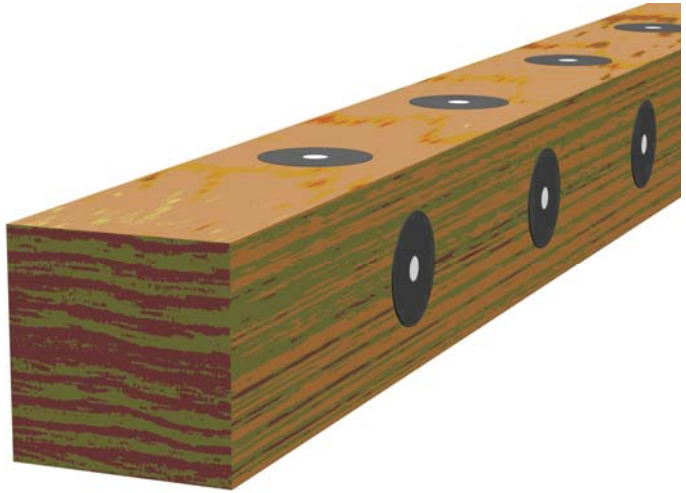
Results for beech wood

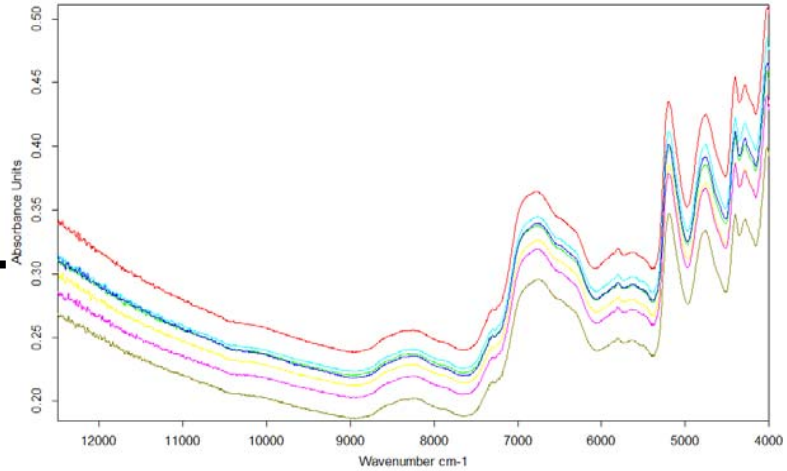


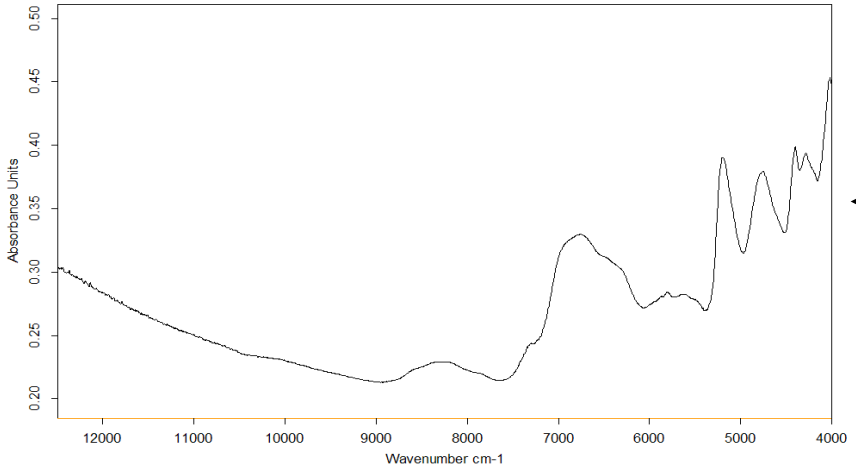
Results are published in the Forest Products Journal:

Schnabel T., Zimmer B., Petutschnigg A.J., Schönberger S. (2007): „An Approach to Classify Thermally Modified Hardwoods by Color.", in: Forest Products Journal, Volume 57, Issue 9, S 105 – 110, 09/2007

NIRS on samples for bending strength (DIN 52186)







NIRS - advantages

- ✓ nondestructive
- ✓ costefficient
- ✓ easy sample preparation
- ✓ fast measurement
- ✓ taking chemical composition into account

Multivariate data analysis

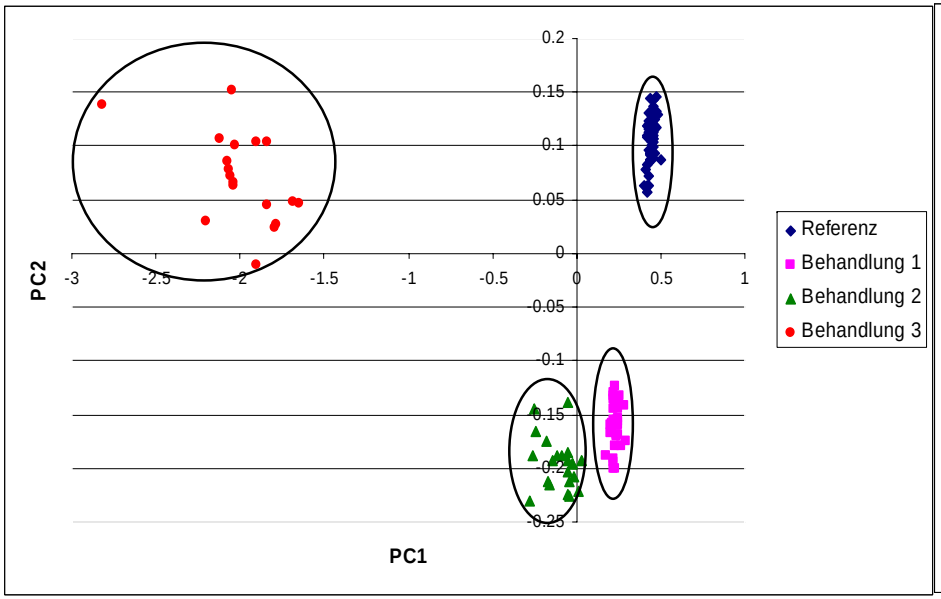
- Principal Component Analysis –PCA
- regression analysis by PLSR

  (Partial Least Squares Regression)
- classification by SIMCA

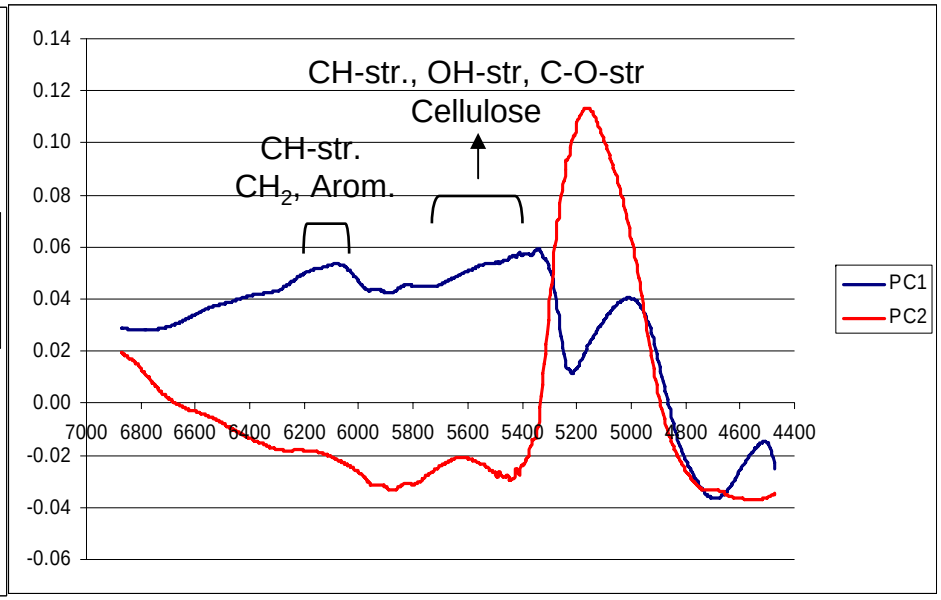
  (Soft Independent Modelling of Class Analogy)

Principal Component Analysis – beechwood, radial

Scoreplot



Loadingplot



SIMCA –
classification for beech wood (radial, tangential)

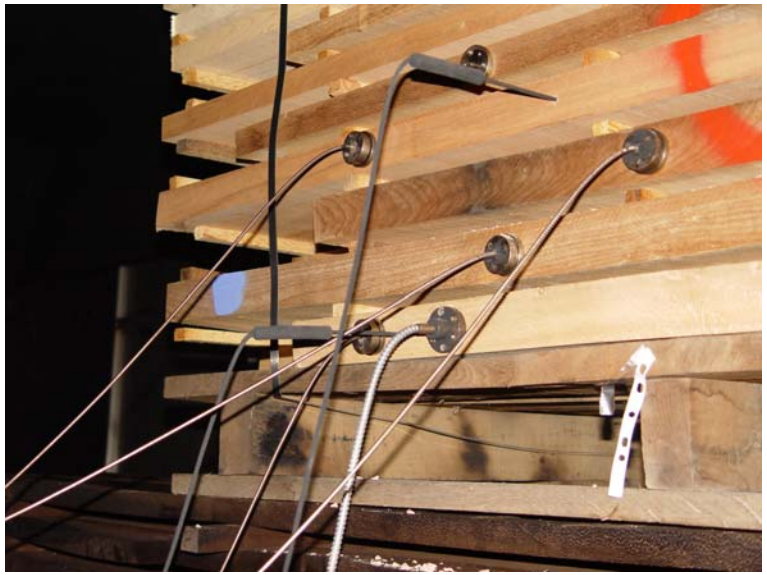
	Beh.2	Beh.3	Beh.1	Referenz
1-29-1-2-3-6-	*			
1-31-1-2-2-2-	*			
1-33-1-2-2-4-	*			
1-35-1-2-1-1				
1-37-1-2-2-3-	*			
1-39-1-2-2-1-	*			
1-59-3-3-3-3-		*		
1-61-2-3-3-12-		*		
1-63-1-3-3-8-		*		
1-65-2-3-1-1-		*		
1-67-2-3-3-4-		*		
1-73-1-3-3-4-				*
1-11-1-1-3-8-			*	
1-11-2-1-3-5-			*	
1-13-1-1-3-2-			*	
1-3-1-1-2-2-			*	
1-3-1-1-3-1-			*	
1-3-1-1-3-8-			*	
1-3-2-1-2-1-			*	
1-7-2-1-3-4-			*	
1-11-2-0-3-5-				*
1-13-1-0-2-4-				*
1-29-1-0-3-6-				*
1-3-1-0-3-1-				*
1-31-2-0-3-3-				*
1-39-1-0-3-2-				*
1-63-1-0-3-9-				
1-69-2-0-2-3-				*

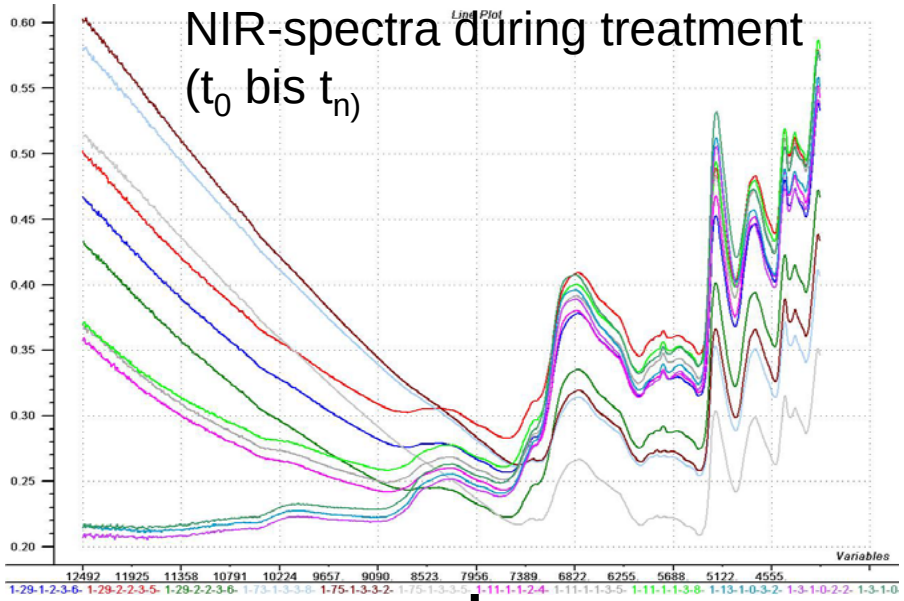
Signifikanz: 5%

	Beh.2	Beh.3	Beh.1	Referenz
1-29-1-2-3-6-	*			
1-31-1-2-2-2-	*			
1-33-1-2-2-4-	*			
1-35-1-2-1-1-		*		
1-37-1-2-2-3-	*			
1-39-1-2-2-1-	*			
1-59-3-3-3-3-		*		
1-61-2-3-3-12-		*		
1-63-1-3-3-8-		*		
1-65-2-3-1-1-		*		
1-67-2-3-3-4-		*		
1-73-3-3-3-3-				*
1-11-1-1-3-8-			*	
1-11-2-1-3-5-			*	
1-13-1-1-3-2-			*	
1-3-1-1-2-2-			*	
1-3-1-1-3-1-				
1-3-1-1-3-8-			*	
1-3-2-1-2-1-			*	
1-7-2-1-3-4-			*	
1-11-2-0-3-5-				
1-13-1-0-2-4-				*
1-29-1-0-3-6-				*
1-3-1-0-3-1-				
1-31-2-0-3-3-				*
1-39-1-0-3-2-				*
1-63-1-0-3-9-				*
1-69-2-0-2-3-				*

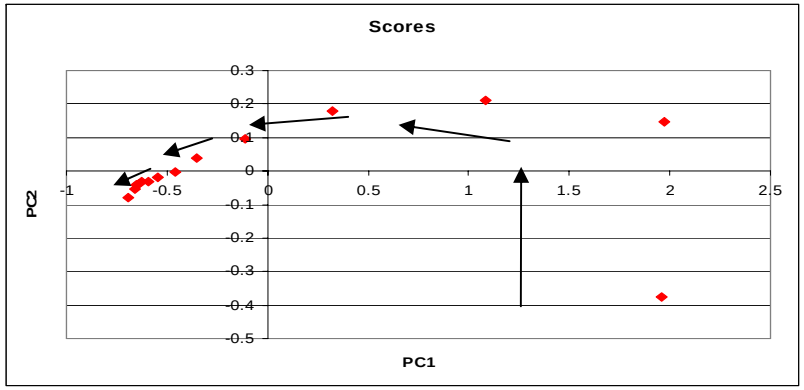
Signifikanz: 5%

Future work: aim is process control





data analysis using spectra like a „fingerprint“



Control the process online and stop if the desired treatment intensity and quality is reached.

Thank you for attention!

Acknowledgement:

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