

Detection and spectral characterization of resin pockets in spruce by FT-NIR and near infrared hyperspectral imaging

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**2nd Workshop on application of NIR spectroscopy
for wood science and technology research**

NIR & WOOD – SOUNDS GOOD! #2

April 19-21, 2016
CNR-IVALSA, Via Biasi 75, 38010 San Michele all' Adige, Italy

SLOPE – Spectral characterization of wood defects of spruce, *Picea abies*



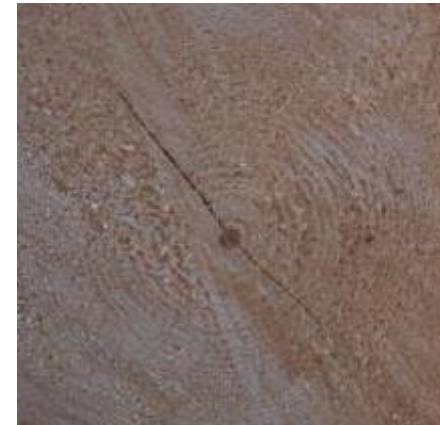
resin pockets



knots



shakes, checks, splits



eccentric pith + compression wood + rot



eccentric pith + rot + knot



**Measured with NIR
and hyperspectral imaging at
BOKU**

**and MicroNIR and
Hamamatsu at CNR**

SLOPE - model development



Lab (scientific basis,
calibration transfer)

Workflow

Calibration & field
transfer

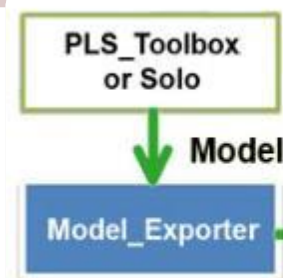
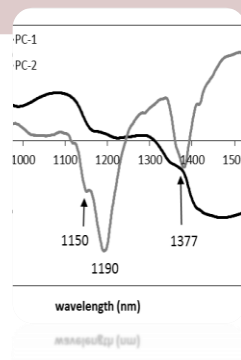
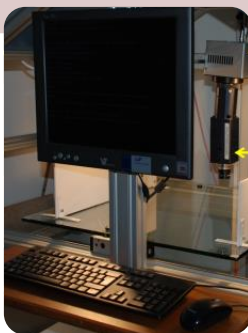
Collection of
training
samples with
different
deficits

Measurements
with NIR and HSI
Laboratory
equipment

Detection of
most significant
wavelength
regions for
deficits
First models, lab
equipment

Measurements with
NIR and HSI with
sensors that will be
on Processor Head
MicroNIR
Hamamatsu

Model development and export
with PLS model exporter
Models can be directly used for
data from scanning bar and the
Labview software installed on
Compactrio incl. preprocessing
and statistical methods
Models sensor arm equipment



SLOPE - Sensor wavelength range comparison



- Visible wavelength range ~ 390 - 700 nm
- Near IR wavelength range ~ 700 nm - 2500 μm

Visible & near infrared range (VNIR)

400 nm

FT NIR (lab) 800 – 2400 nm

Hyperspectral (lab)
900 – 1700 nm

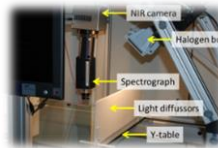
MicroNir (sensor)
900 – 1700 nm

Hamamatsu
C12666MA
340 – 780 nm

Hamamatsu
C11708MA
640 – 1050 nm

Range covered by sensors on processor head
340 – 1700 nm

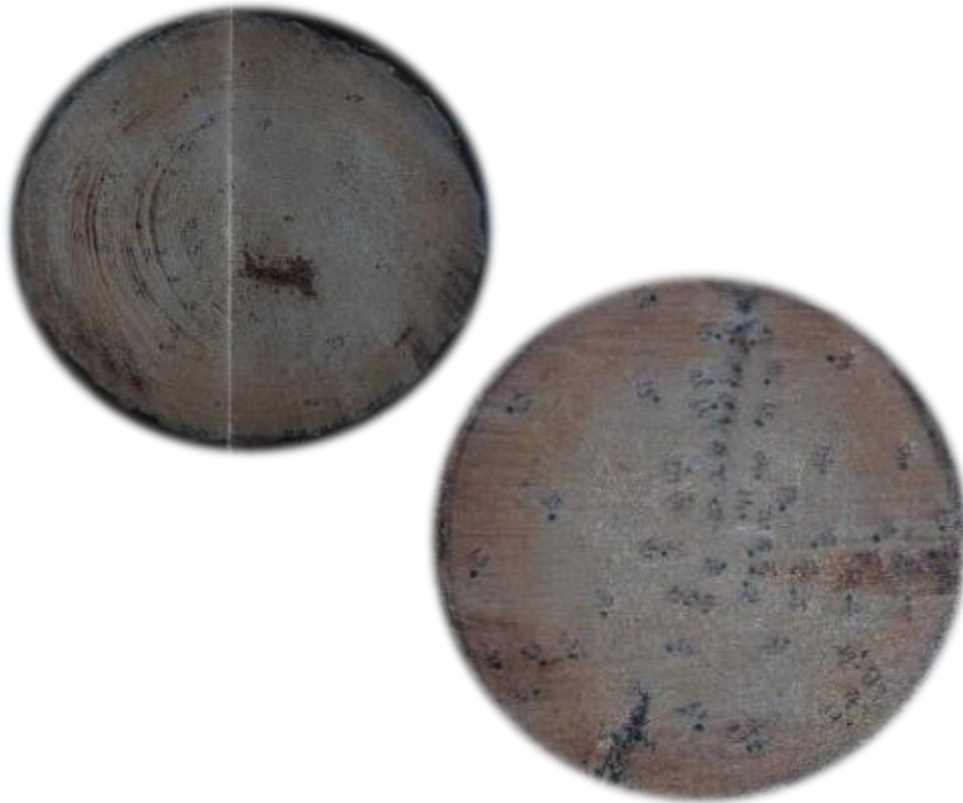
2500 nm



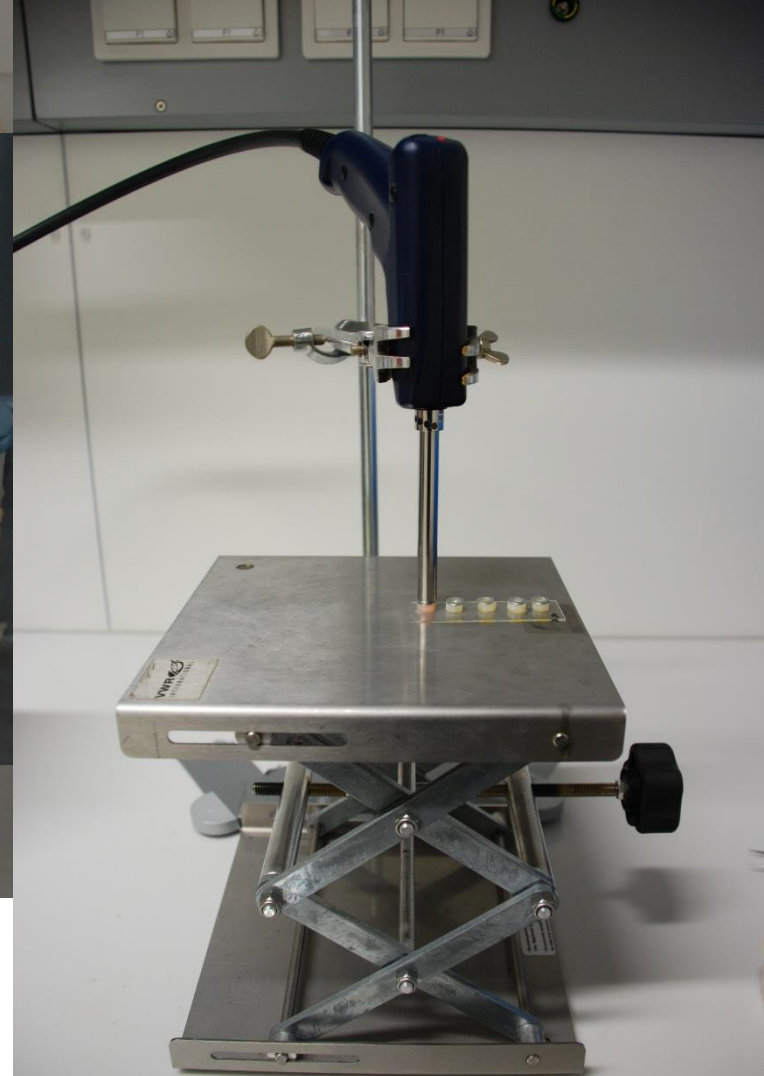
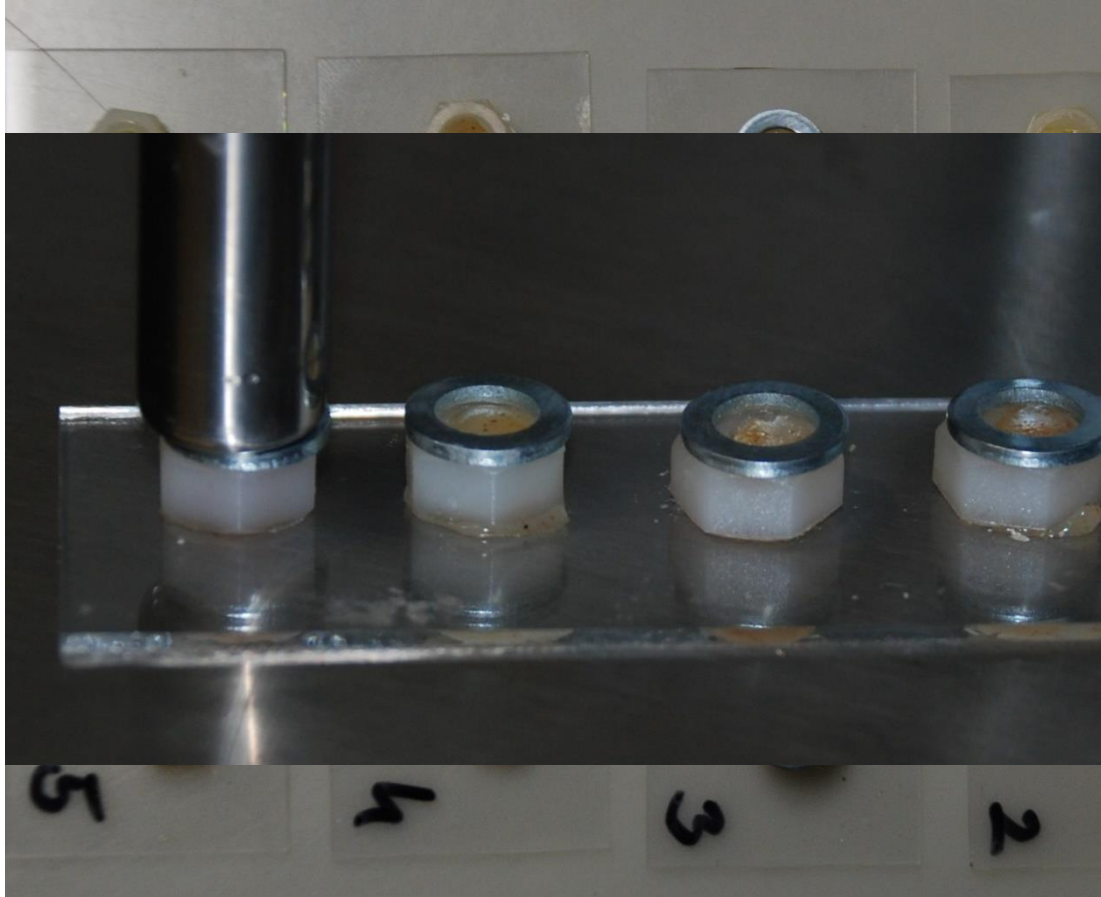
NIR-Spectroscopic measurements – BOKU – laboratory: wood discs



- 14 out of 25 samples wood discs were measured using a FT-NIR with a fibre optic probe at BOKU



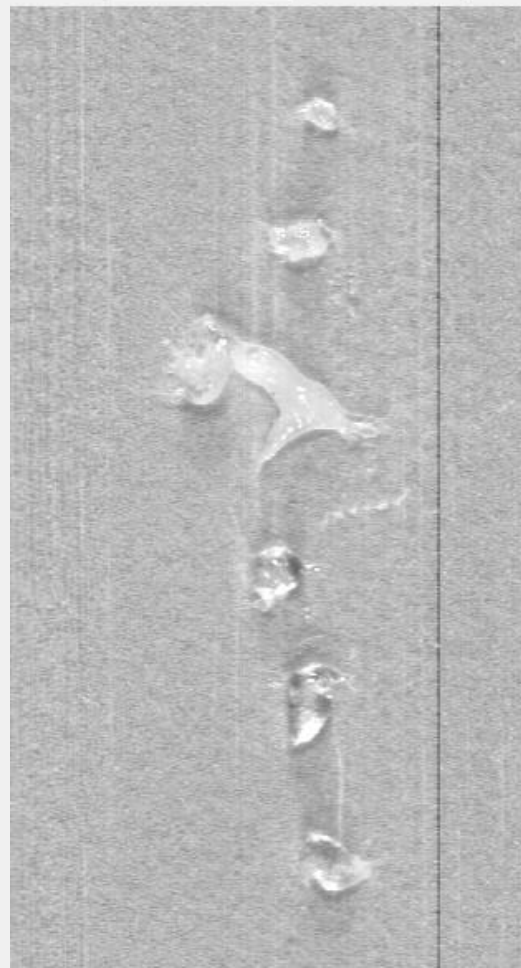
NIR-Spectroscopic measurements – BOKU – laboratory: **pure resin**



Hyperspectral measurements – BOKU – laboratory: pure resin



Hypercube: D:\Dropbox\SLOPE cooperation folder BOKU\H-...	<input type="radio"/> Single	Gray/R: 962.30	Hypercube: D:\Dropbox\SLOPE cooperation folder BOKU\H-...	<input checked="" type="radio"/> Single	Gray/R: 945.56
Description: Argos output: relative [22.06.2015 15:27:51]	<input checked="" type="radio"/> Scroll by, ms 50 Stop	G: 1290.51	Description: Argos output: relative [22.06.2015 15:19:51]	<input type="radio"/> Scroll by, ms 50 Stop	G: 1290.51
X * Y * B: 319 * 1164 * 207	<input type="radio"/> Pseudo RGB	B: 1635.47	X * Y * B: 319 * 582 * 207	<input type="radio"/> Pseudo RGB	B: 1635.47
X * Y size: 54.868mm * 200.208m	<input type="radio"/> Linear Combination		X * Y size: 54.868mm * 100.104m	<input type="radio"/> Linear Combination	
View enlarge: 1	Save XY section as PNG	Save XY section as Data	View enlarge: 1	Save XY section as PNG	Save XY section as Data



Hyperspectral measurements – BOKU

– laboratory: wood discs with resin



Hypercube: D:\Dropbox\SLOPE cooperation folder BOKU\H ...

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X*Y*B: 319 * 164 * 202 Min,max 0 1

X*Y size 388.861mm * 199.916 View enlarge: 1

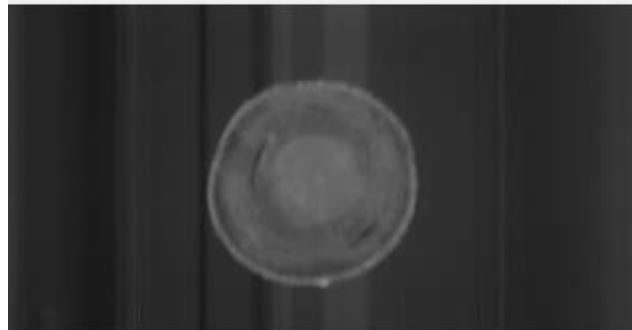
☐ Single ☒ Scroll by, ms 50 Stop ☐ Pseudo RGB ☐ Linear Combination

Gray/R: 1555.09 ▾ 1.0

G: 1290.51 ▾ -1.0

B: 1628.78 ▾ 0

Save XY section as PNG Save XY section as Data



Hypercube: D:\Dropbox\SLOPE cooperation folder BOKU\H ...

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X*Y*B: 319 * 205 * 202 Min,max 0 1

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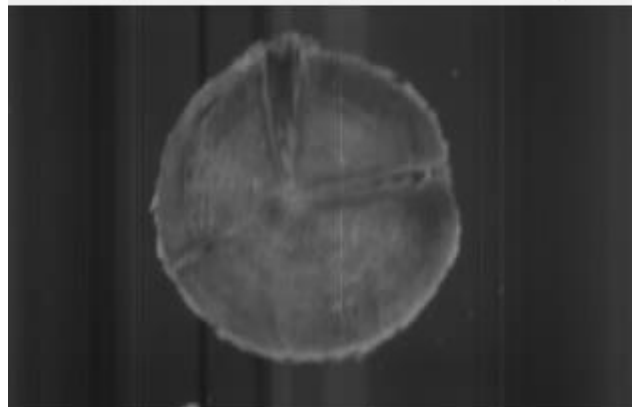
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Gray/R: 1578.54 ▾ 1.0

G: 1290.51 ▾ -1.0

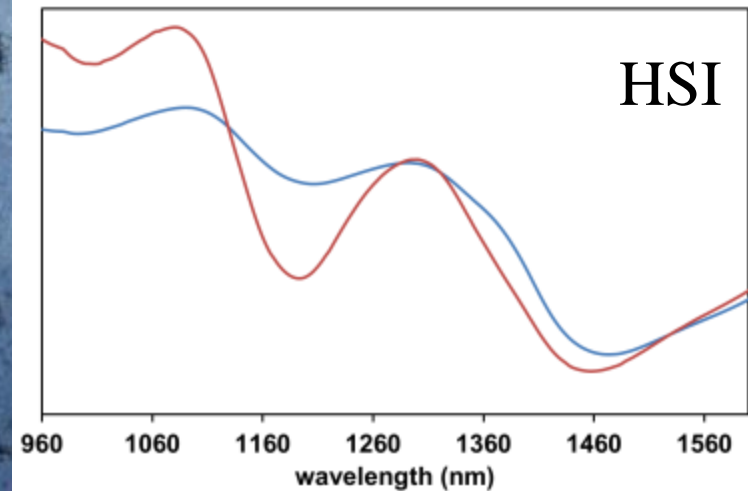
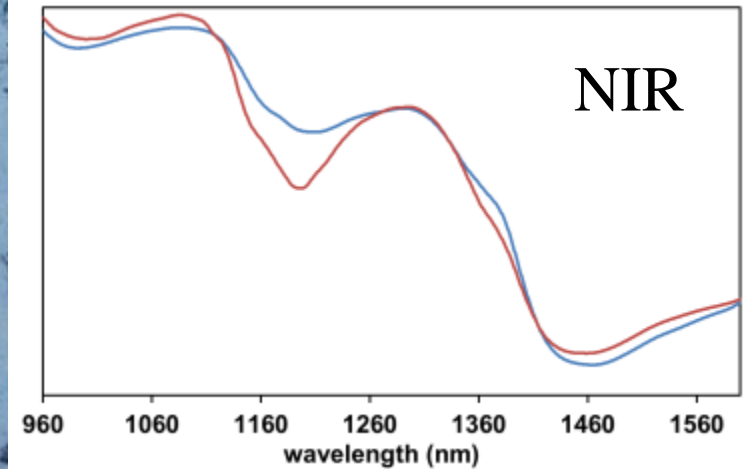
B: 1628.78 ▾ 0

Save XY section as PNG Save XY section as Data



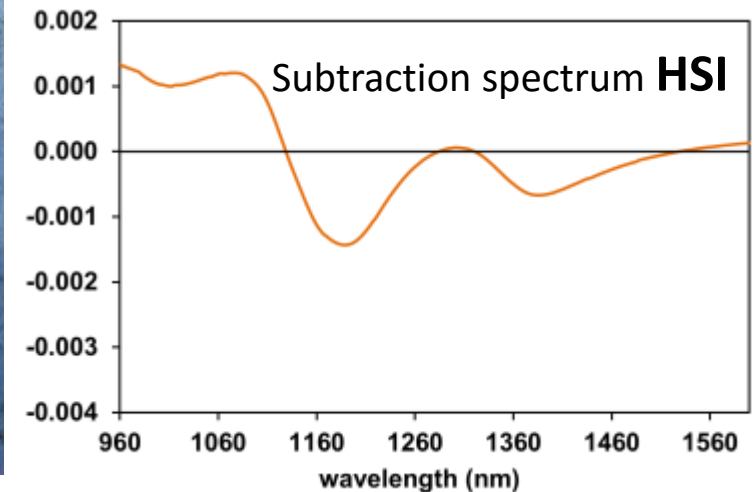
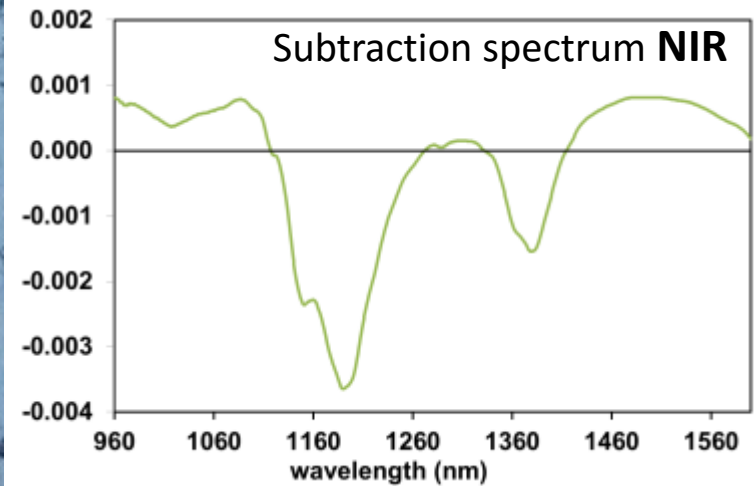
SLOPE - First results resin pockets

NIR vs. HSI (NIR)



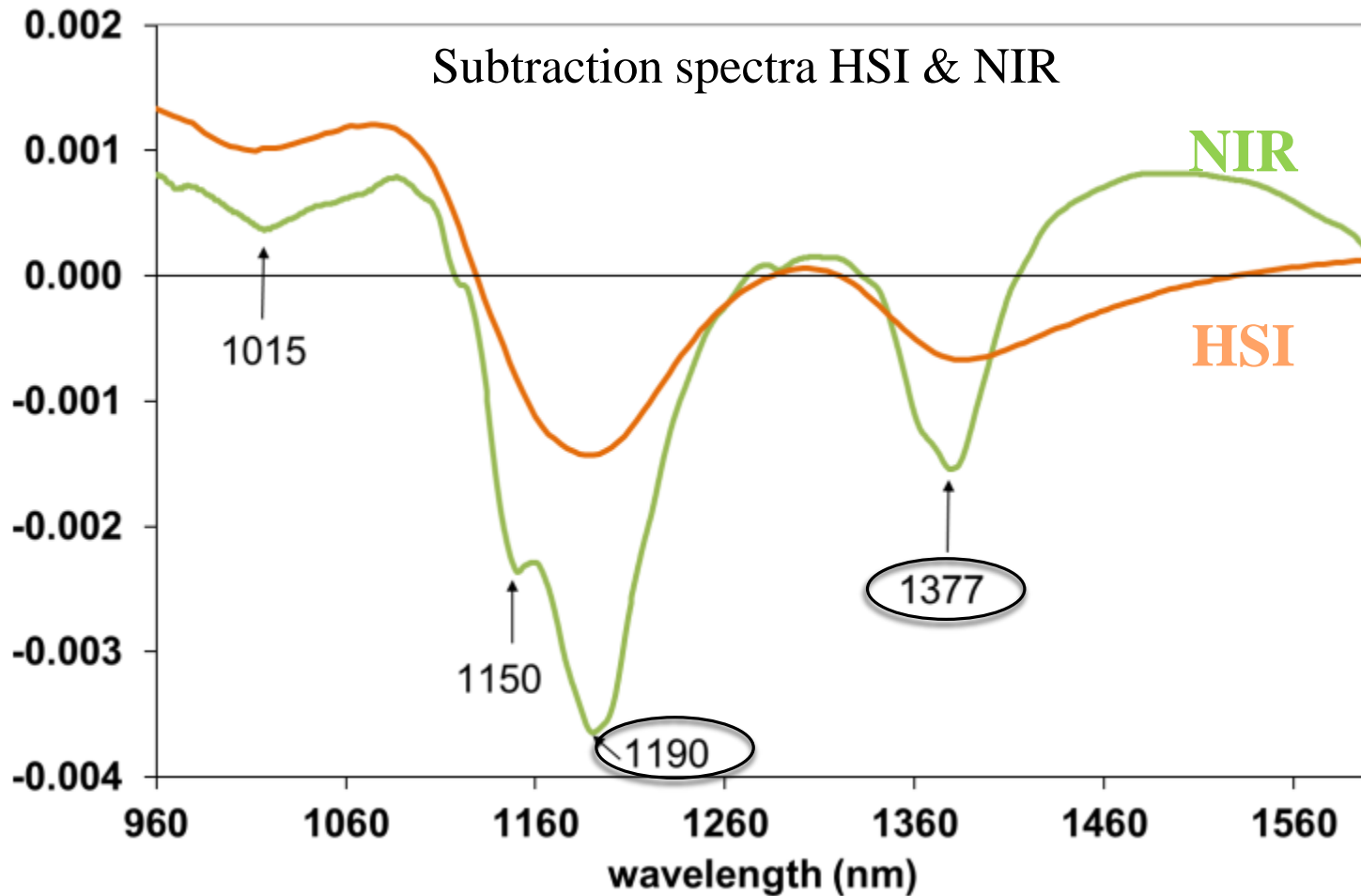
SLOPE – First results resin pockets

NIR vs. HSI (NIR)

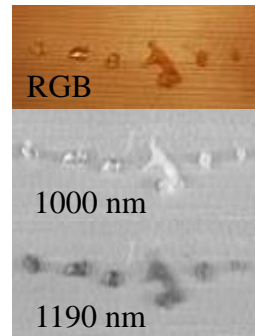


SLOPE – First results resin pockets

NIR vs. HSI (NIR)



HSI of resin

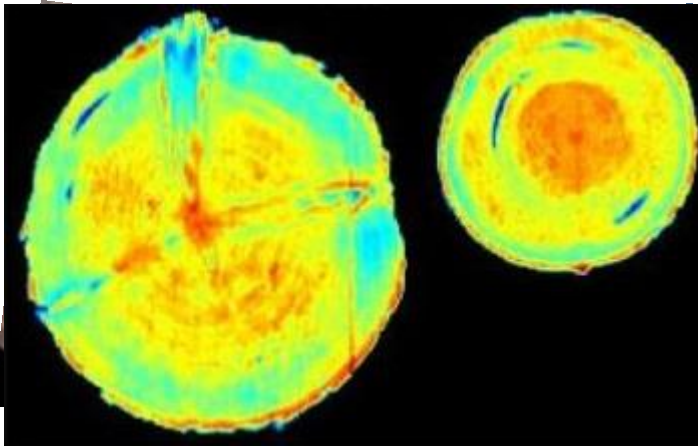


SLOPE – Results for resin pockets

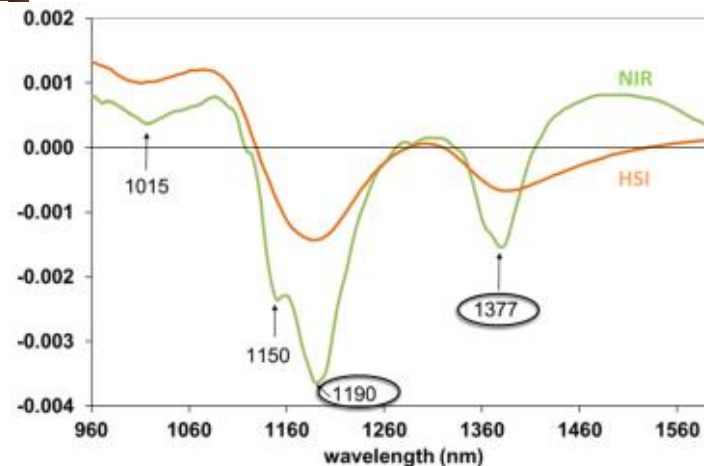
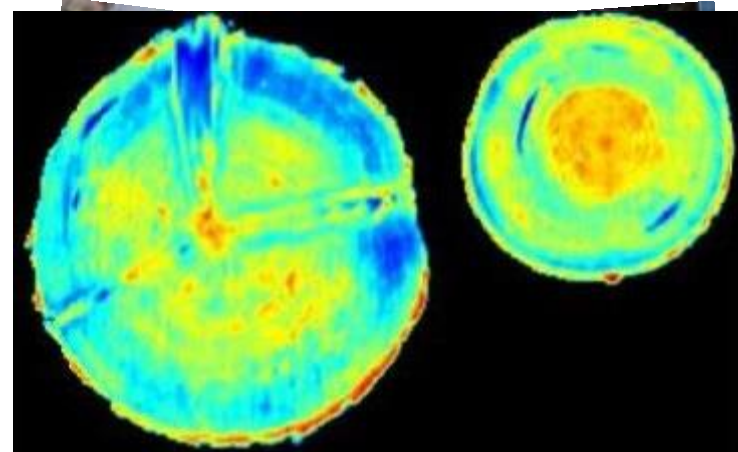
Intensity slabs



1190 nm



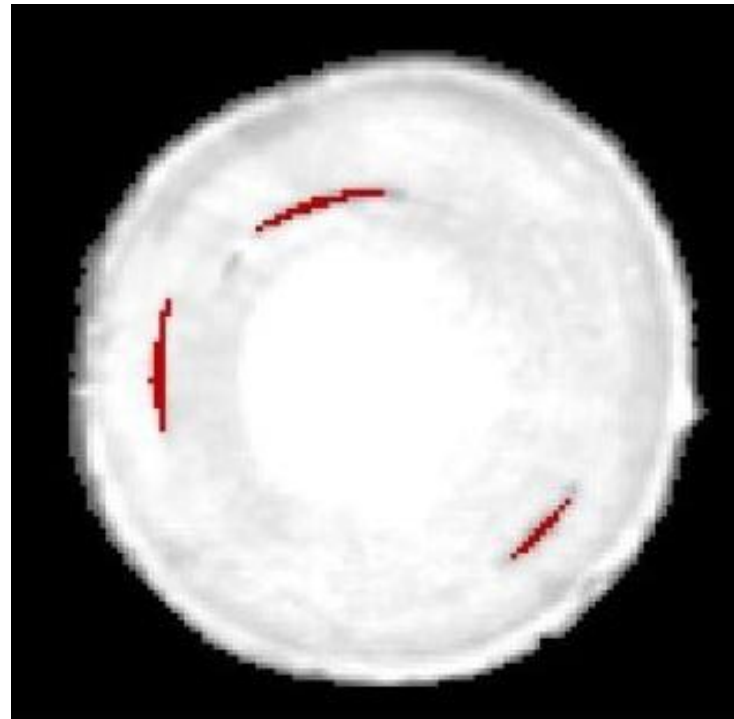
1377 nm



SLOPE – Results resin pockets Training & Classification



Training sample - PLS-DA supervised classification



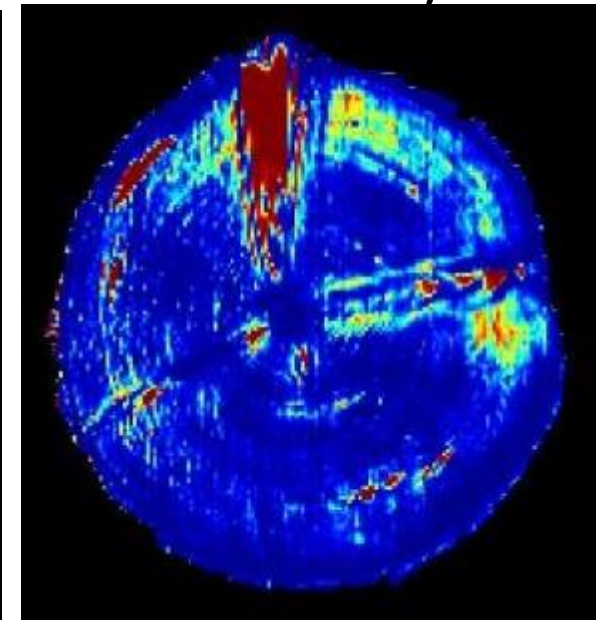
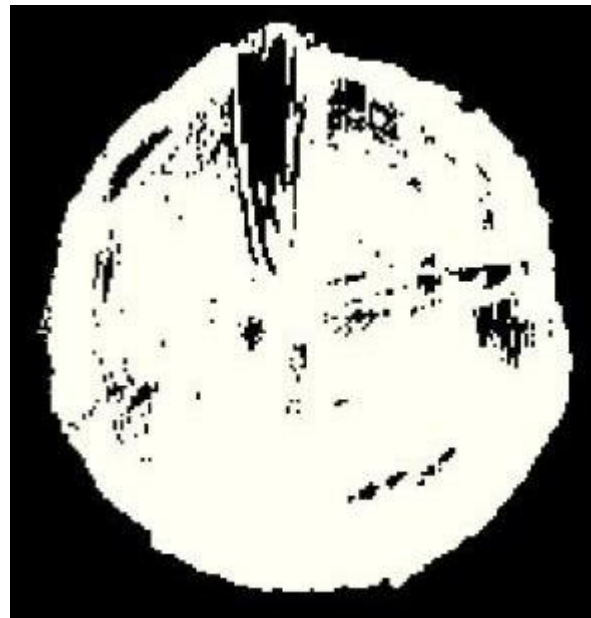
SLOPE – Results resin pockets Training & Classification



Test sample – PLS-DA supervised classification

Class Pred.
Membership

Class Pred.
Probability



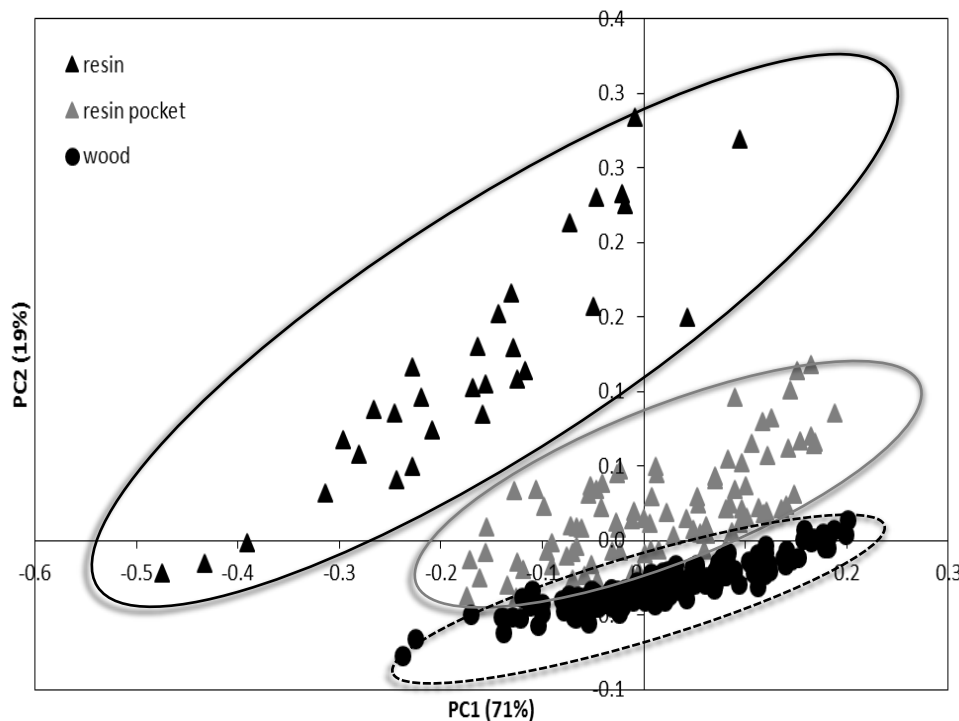
SLOPE – Results resin pockets

Scientific publication *in prep.*

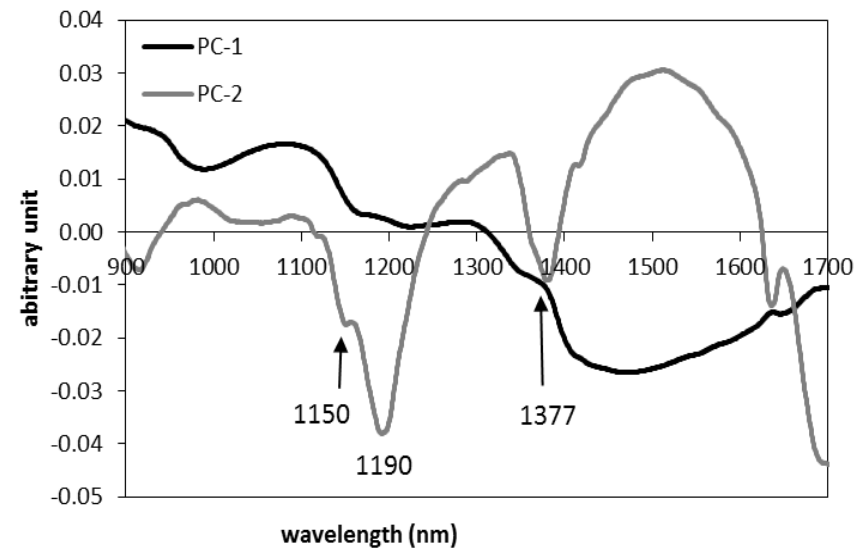


Principal component analysis for wood and resin (resin pockets)

Scores



Loadings



Zitek, Böhm et al., in prep, Assessing resin pockets on freshly cut wood logs of spruce by NIR and hyperspectral imaging, *European Journal of Wood and Wood Products*



Thank you for your interest!

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