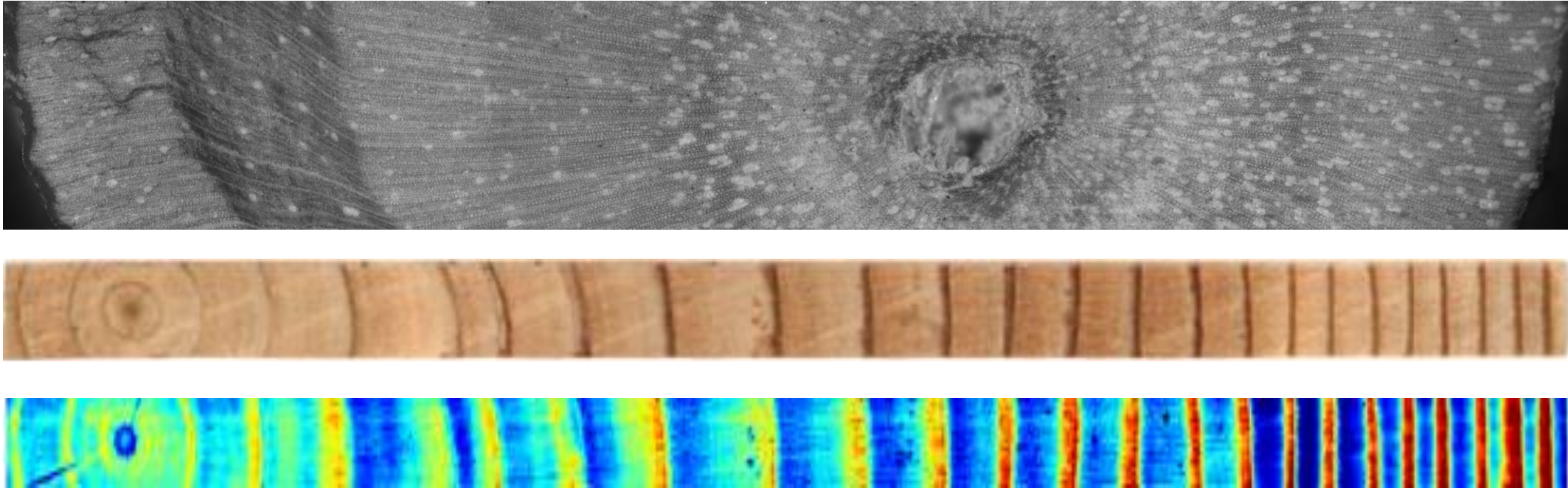


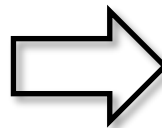
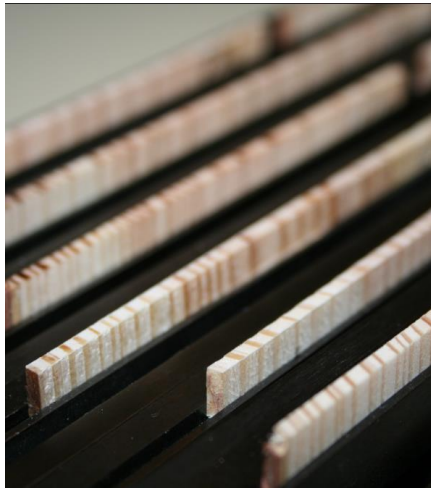
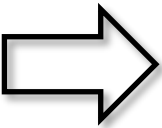
Developments in forest feedstock characterization



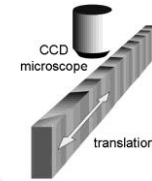
Gerhard Scheepers (gerhard.scheepers@ri.se)

Background

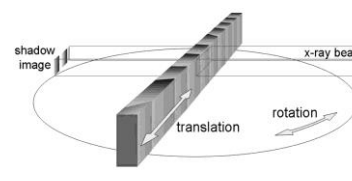
- Previously, we utilised SilviScan and NIR-imaging on multiple year ring samples
- Sampling is done from pith to bark, either from cross-cuts or cores
- Typically, we NIR-scan the SilviScan sample to predict chemistry



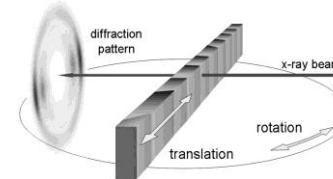
A: Image analysis



B: X-ray absorption

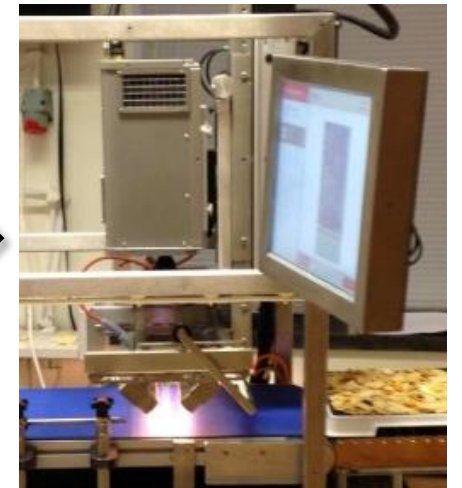
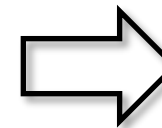


C: X-ray diffraction



Server

SilviScan



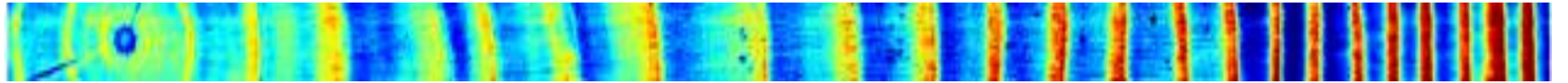
NIR

RI
SE

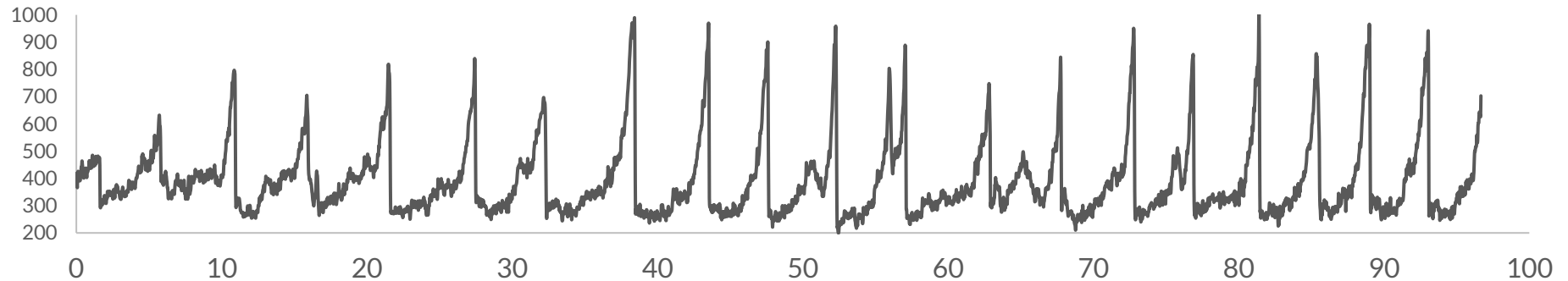
Background



Chemistry



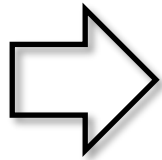
Physical properties



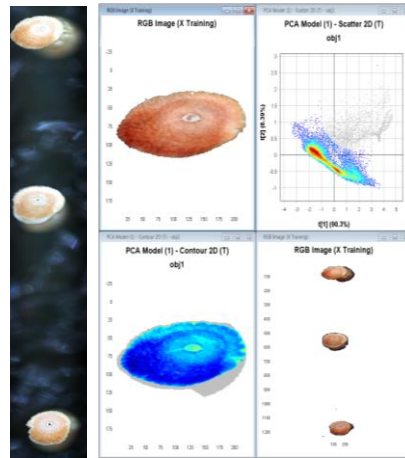
But, a lot of research is actually done on greenhouse samples!

Development: Analysing greenhouse samples

Growth and sampling
(3 month old Aspen tree cross-cuts. Some with induced tension wood.)



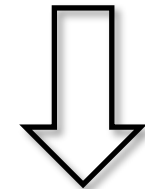
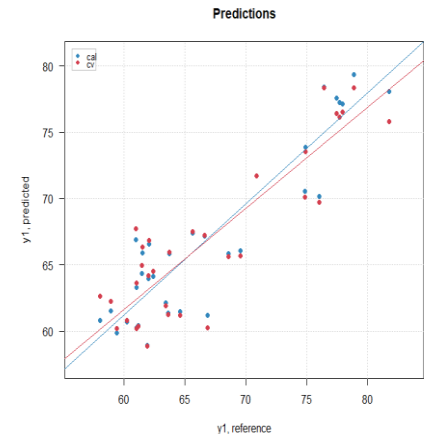
NIR-imaging



Chemical reference analysis
(Pyrolysis-GC/MS)



NIR prediction models
(chemical and physical characteristics)



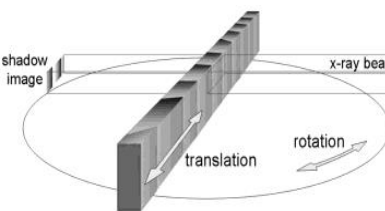
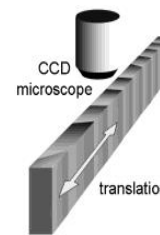
OUTPUT 1:
Images displaying
different physical and
chemical properties

**RI
SE**

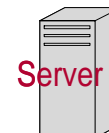
SilviScan

A: Image analysis

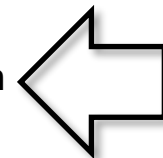
B: X-ray absorption



C: X-ray diffraction



OUTPUT 2:
Spreadsheets summarizing physical
characteristics in one dimension of a 2 mm
thick cut-out through the pith; and
corresponding microscopy image

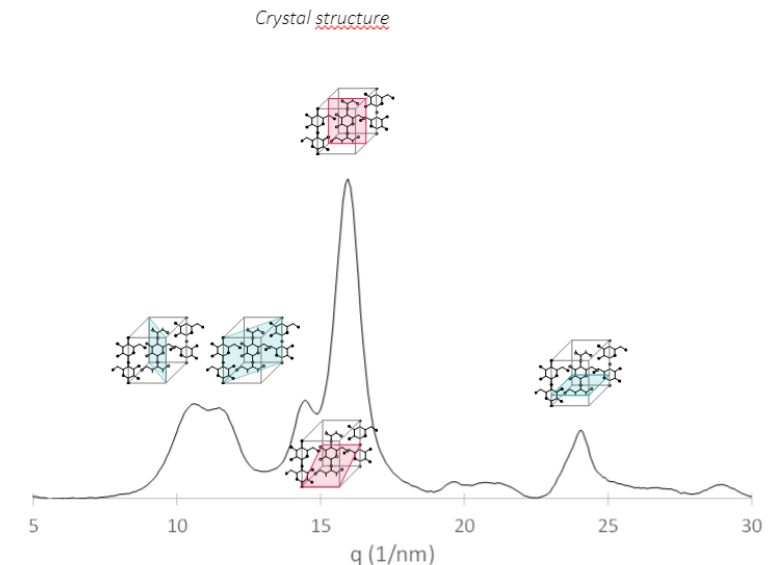
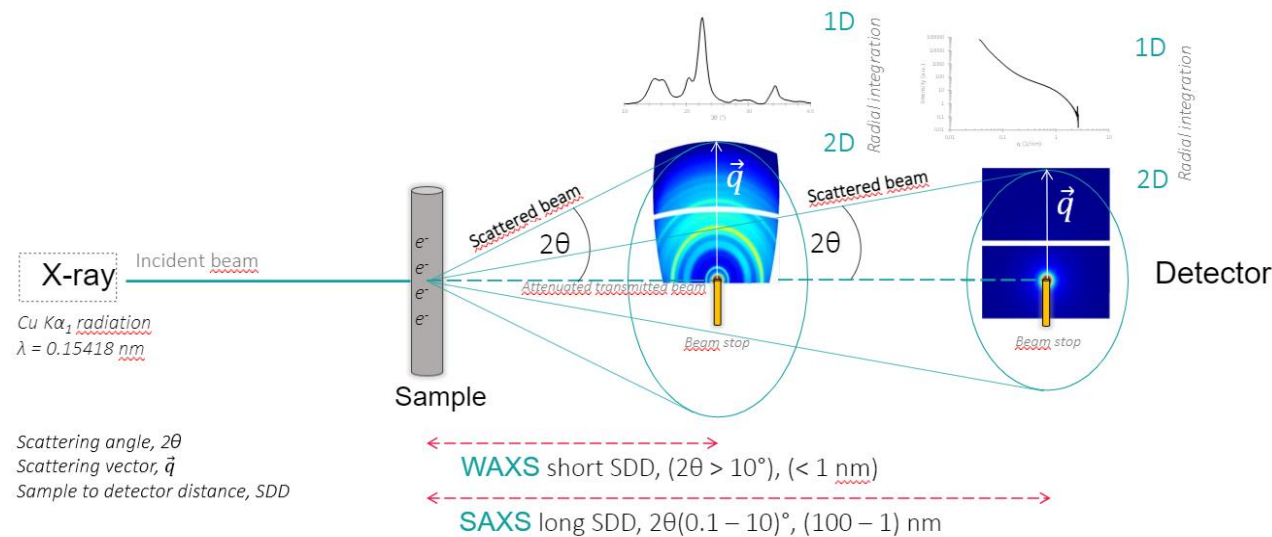


Development: SAXS/WAXS analysis

Equipment acquired ca. 2018
Small Angle X-ray Scattering (SAXS)
Wide Angle X-ray Scattering (WAXS)

Microfibril angle
Crystallinity and crystallite dimensions

Sample types:
Nanocellulose films
Wood
Solutions



Development: 5 mm increment cores

- Normally, 10 mm increment cores, but small diameter trees get damaged
- 5 mm cores makes it possible to take samples from trees as young as ca. 10 years



Development: Applying deep learning to identify features

- Application of deep learning models on SilviScan microscopy images
- Resin canals in softwood
- Vessels in hardwood

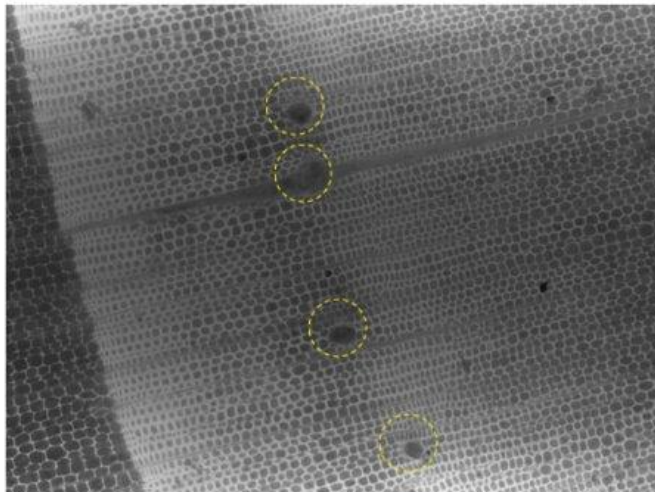
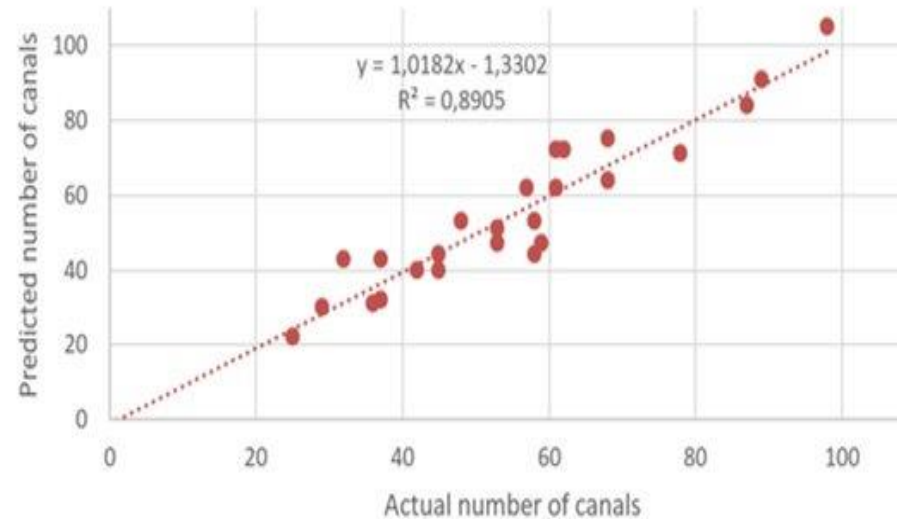


Figure 1: Microscopy image from the SilviScan CellScanner microscope with a resolution of 1,3 μm . The yellow circles show the four resin canals present in this image.



- But, another development:
 - RISE invested in another NIR-camera for industrial scale trials
 - Online characterization of feedstock in larger scale processes
 - A possibility for Bio4Energy strategic joint collaboration in pilot scale processes?

DigiFlis - a BioInnovation PiiA project

online characterization of feedstock

- RISE
- Smurfit Kappa
- PulpEye (ScanChip)
- Prediktera (NIR)

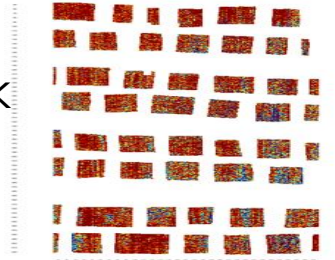
Continuous online measurement



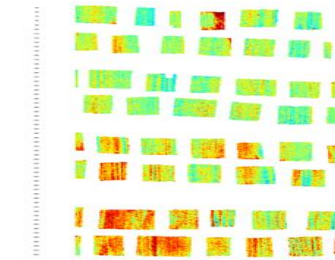
Wood chips



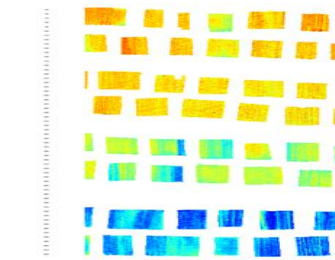
Spruce/Pine/Bark
classification



Density



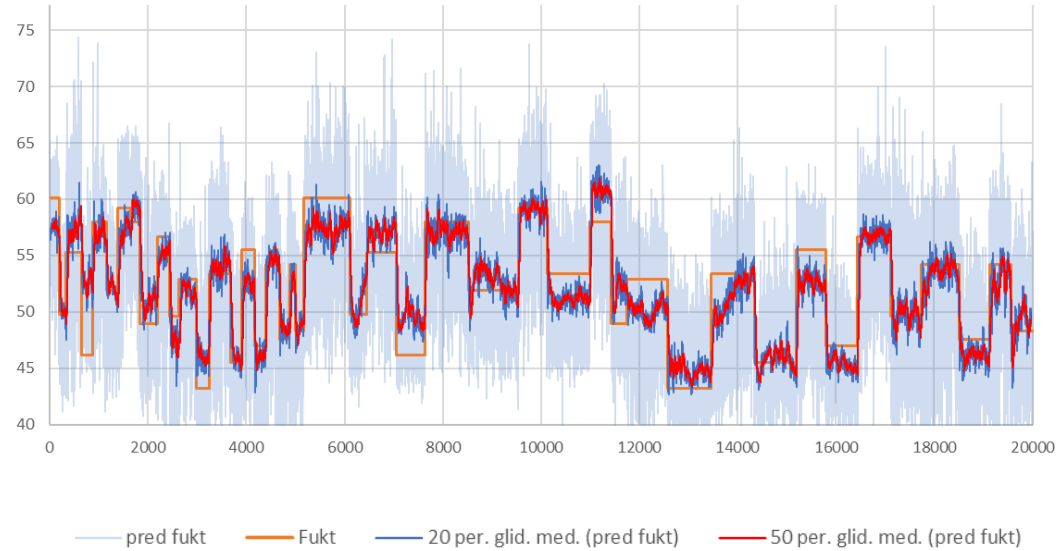
Moisture



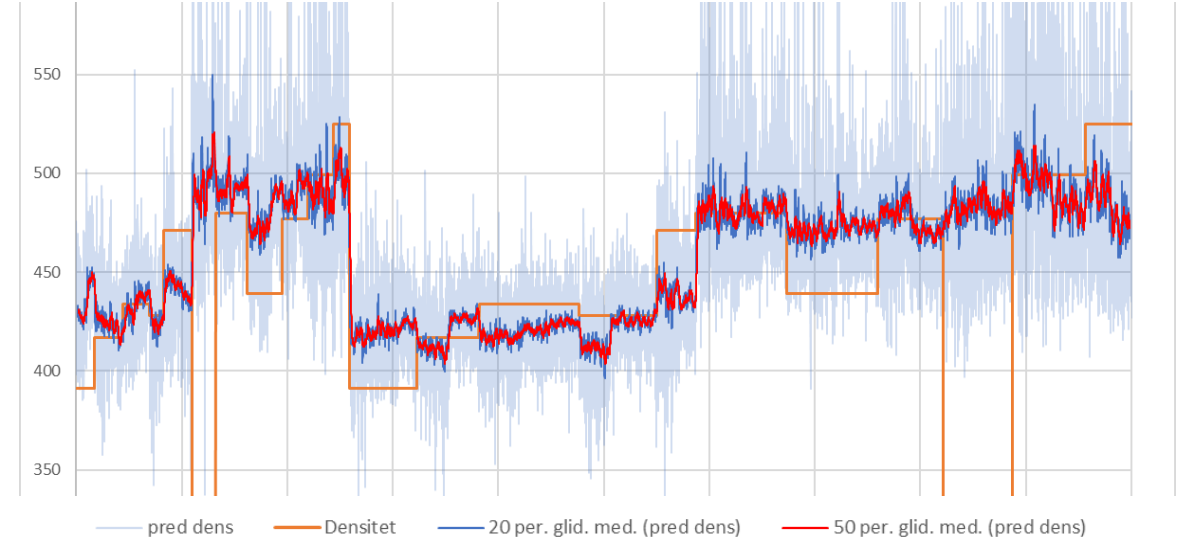
Cellulose, Lignin, etc.?

NIR-measurement vs. laboratory

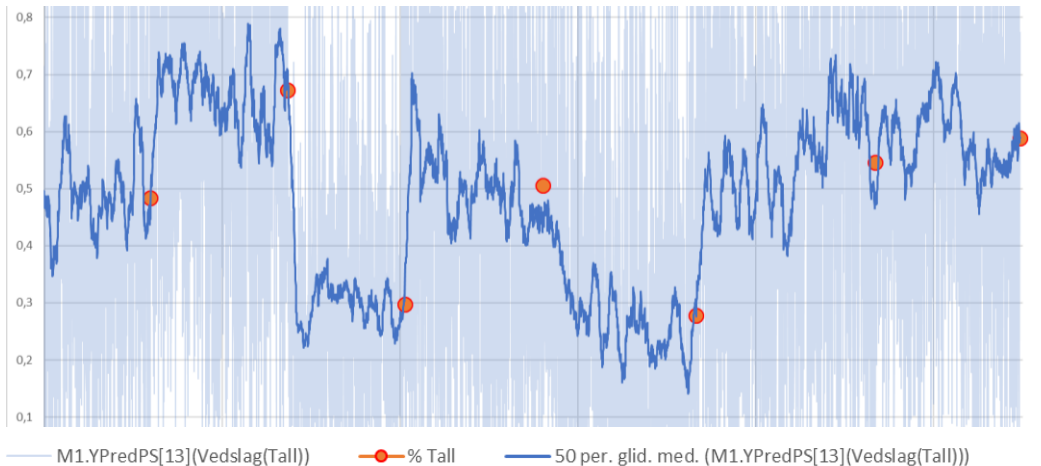
Moisture



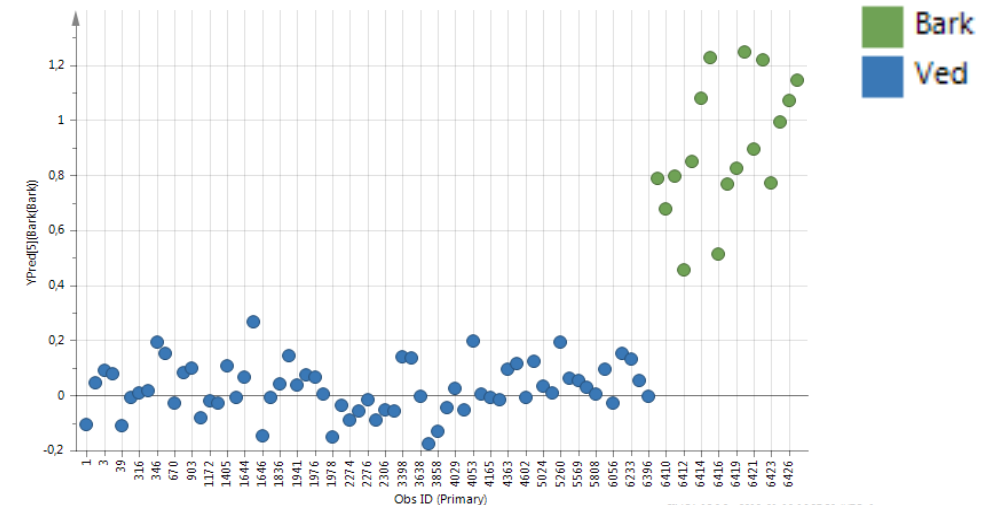
Density



Pine fraction



Wood/Bark classification



Thank you!



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gerhard.scheepers@ri.se

