

# With dust all over – How to understand the challenge of sampling

DSK 2020

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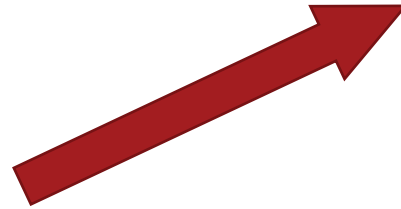




# Introduction in waste wood world



Waste wood:  
what is it?

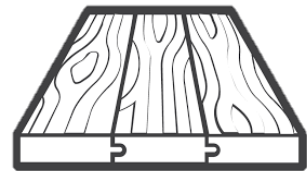


Promote reuse and recycle of the materials  
over the landfill

*Waste Framework Directive (2008/98/EC,  
European Parliament 2008)*



Increased demand for waste  
wood by the panel industry



The substitution of fossil fuels through the  
energy use of wood-based materials for  
mitigating GHG emissions

*EU sustainable development goal, points 7  
and 13*

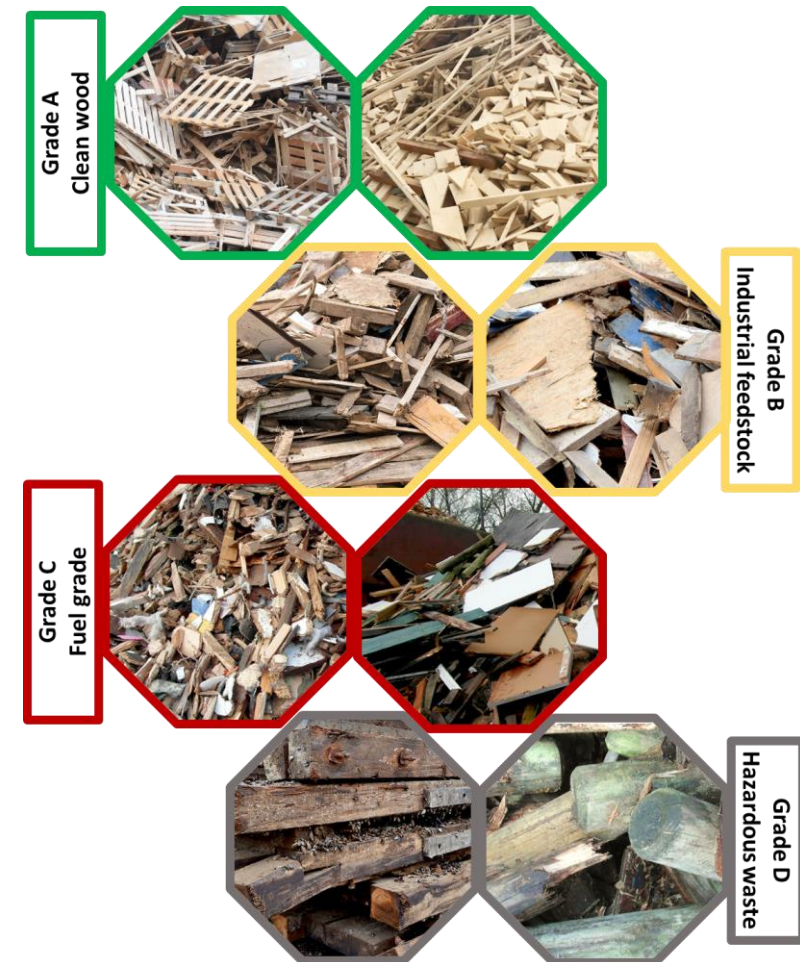
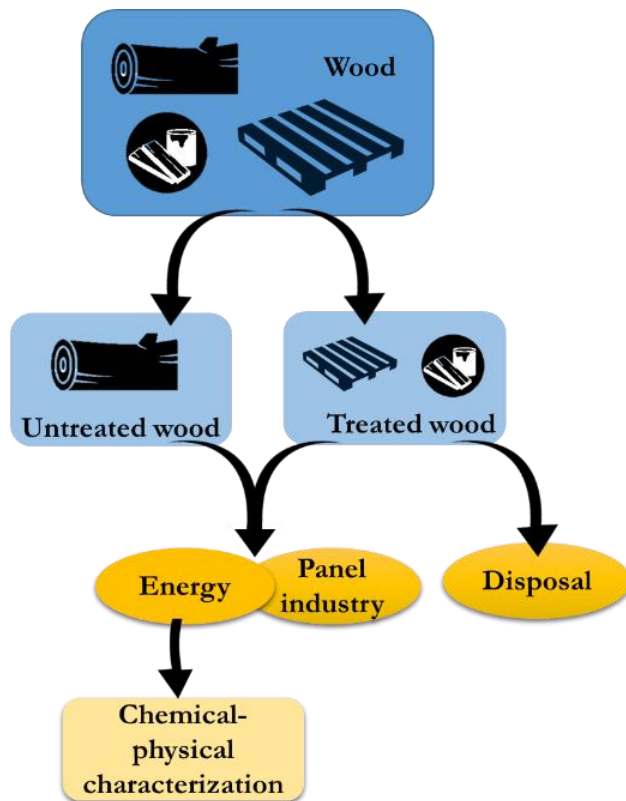


# Introduction in waste wood world



**WoodSpec (MSC-IF 838560)**

**WP1: Sampling study and collection phase**



# Sampling procedure (1)

EN-15442:2011 standard (CEN, 2011) with some modifications

## Some numbers:

- 2 days of sampling
- every hour deviation of WW material from the production stream in an external unloading tank
- 16 lots
- 24 increments of 10 L material for each lot



# Sampling procedure (2)



4 samples x each lot  
**64 samples**



lab analysis

# Lab analysis

Technical standard UNI 15443

Technical standard ISO 18122:2015



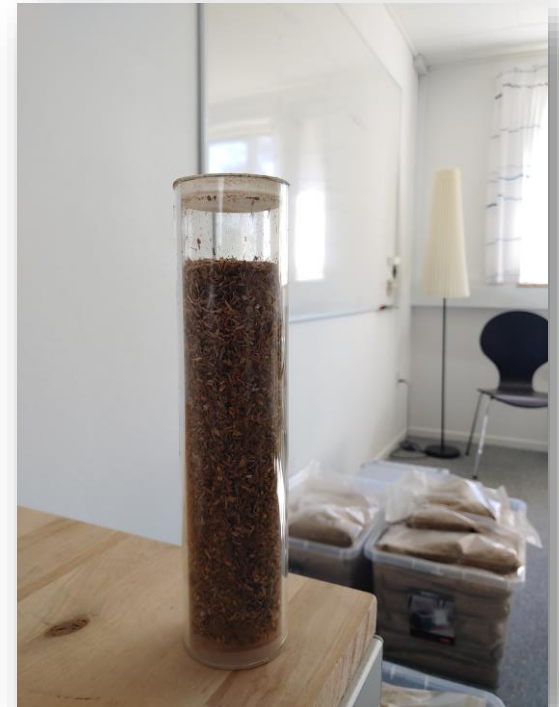
NIR analysis



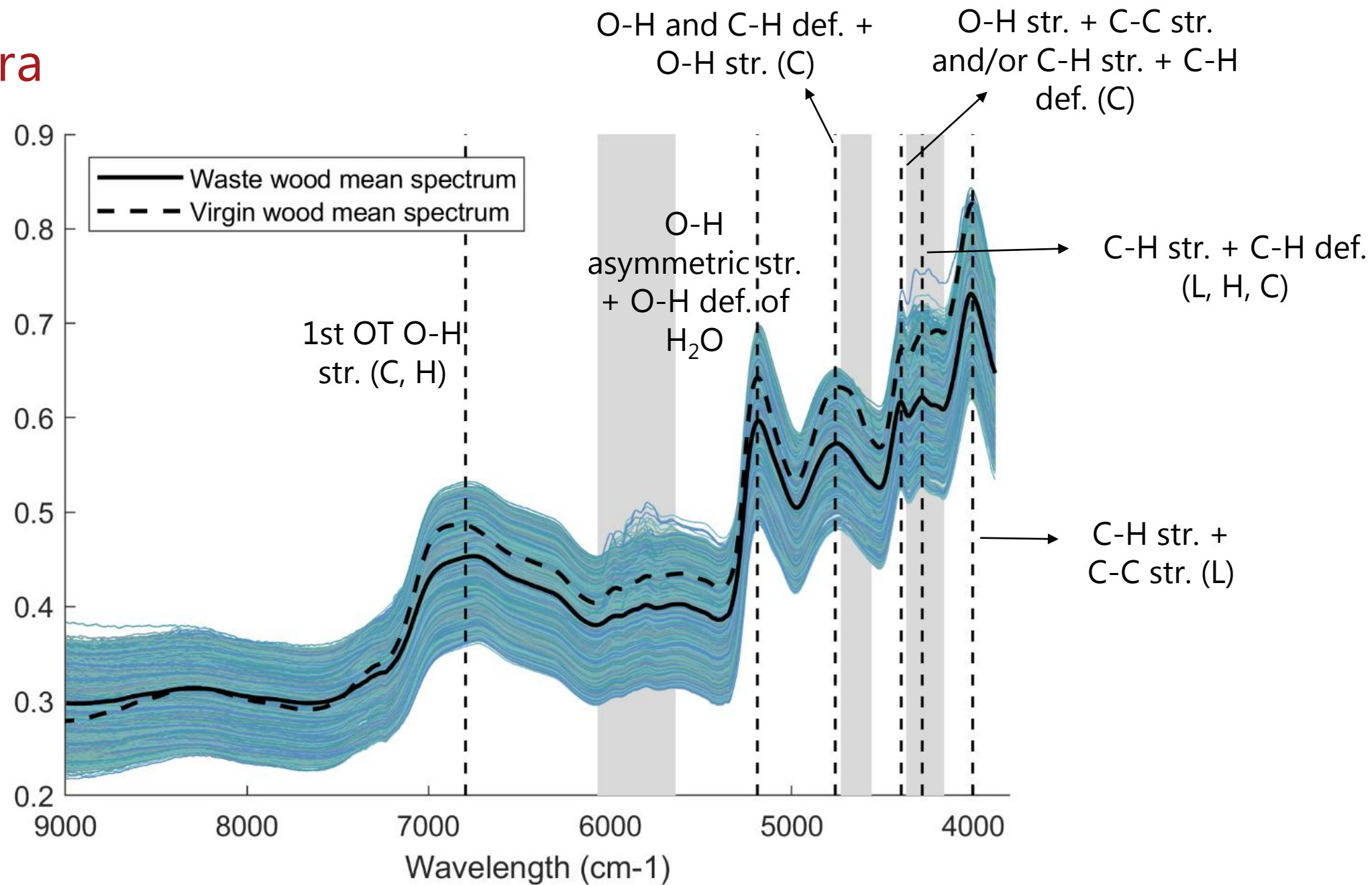
Videometer

# NIR analysis

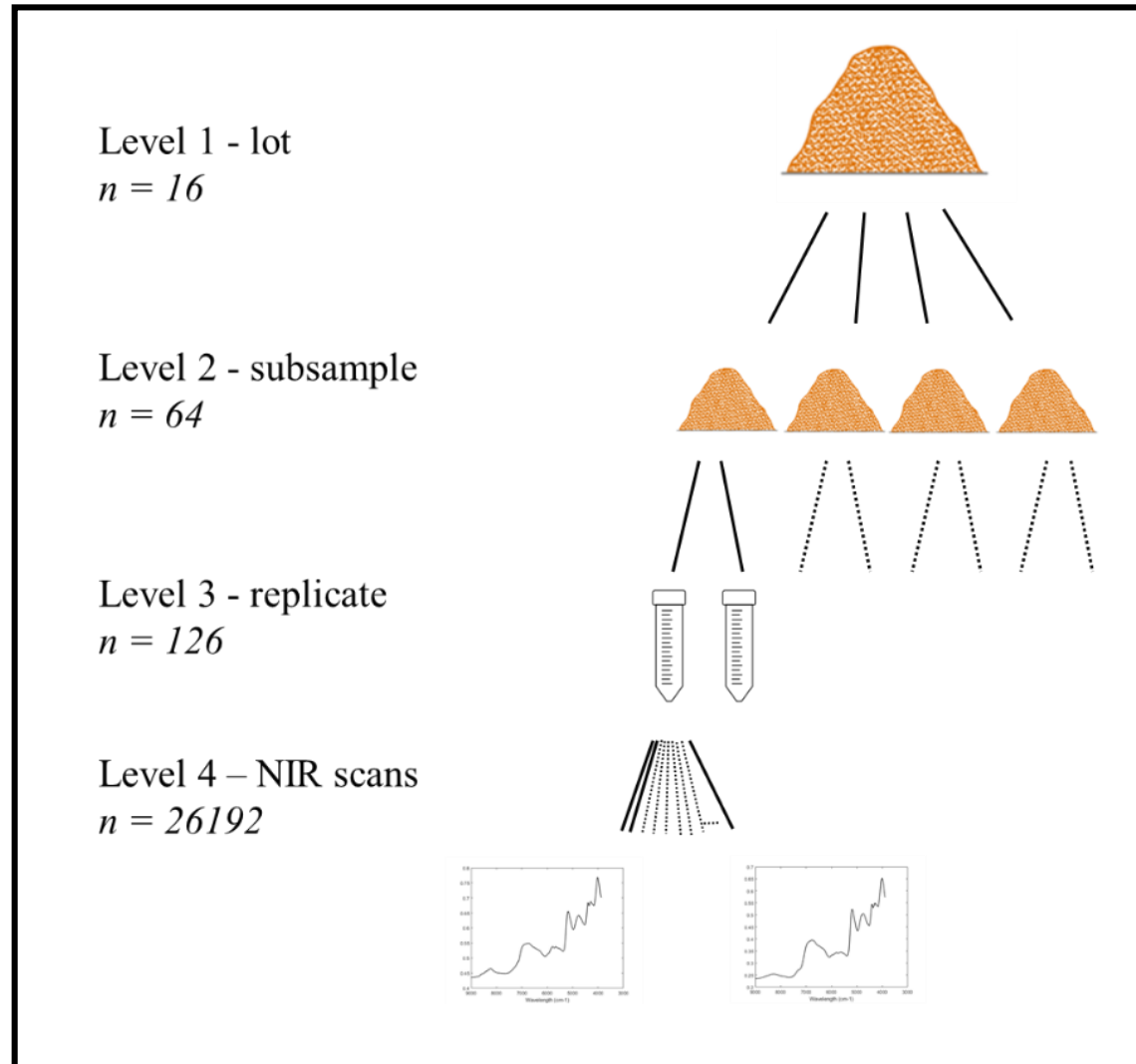
- Quant FT-NIR spectrophotometer (Q-Interline A/S, Tølløse, Denmark)
- The spiral sampler scans a total of 375 cm<sup>2</sup> surface (theory of sampling)
- Quartz halogen lamp as a light source and an InGaAs detector
- Range from 14,885 to 3,700 cm<sup>-1</sup>, a maximum of 210 scans per sample/tube and a spectral resolution of 8 cm<sup>-1</sup>



# NIR spectra



# Nested analysis of variance



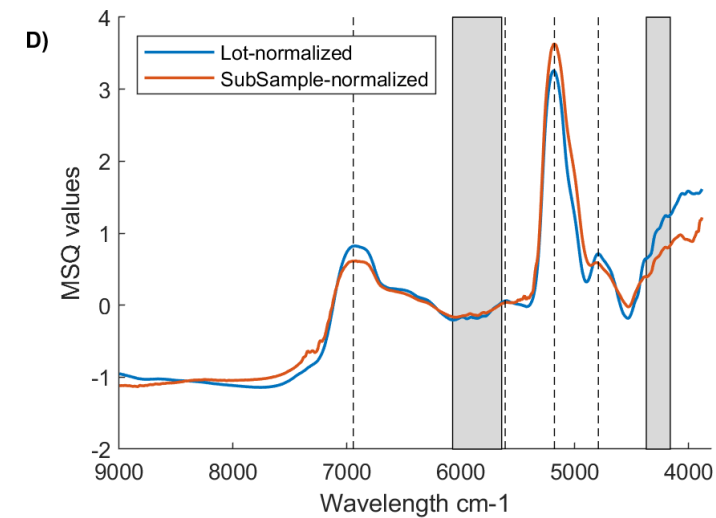
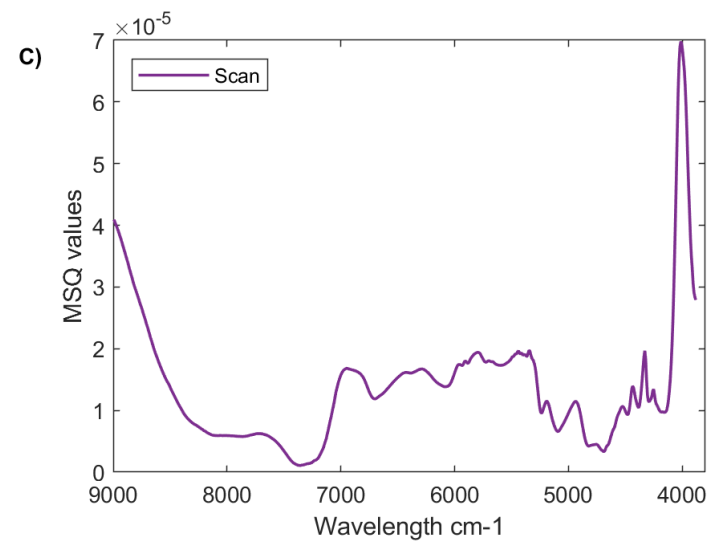
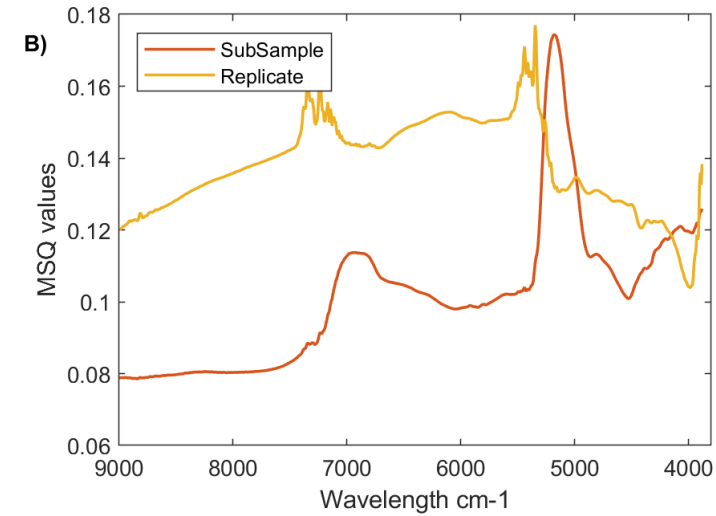
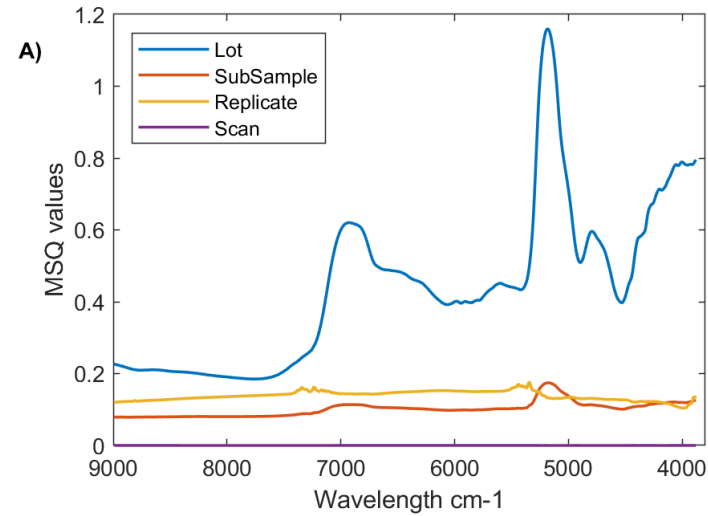
Multi-stage approach of the sampling procedure



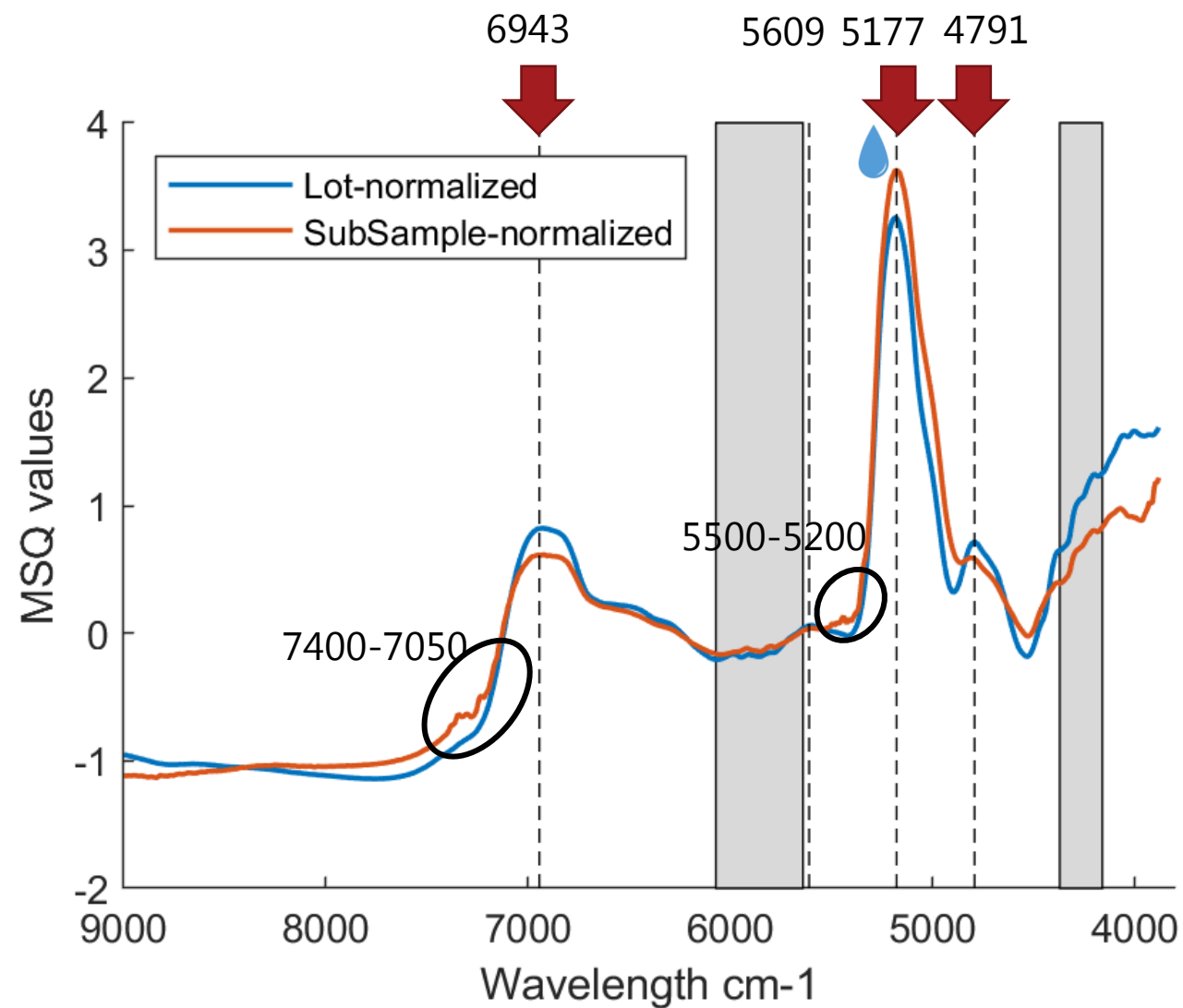
Nested analysis of variance (ANOVA) for investigating the statistical differences between:

- the different **lots** (level 1);
- the **subsamples** within each lot (level 2);
- the two **replicates** within each subsamples (level 3)
- the **scans** within each subsample replicate (level 4).

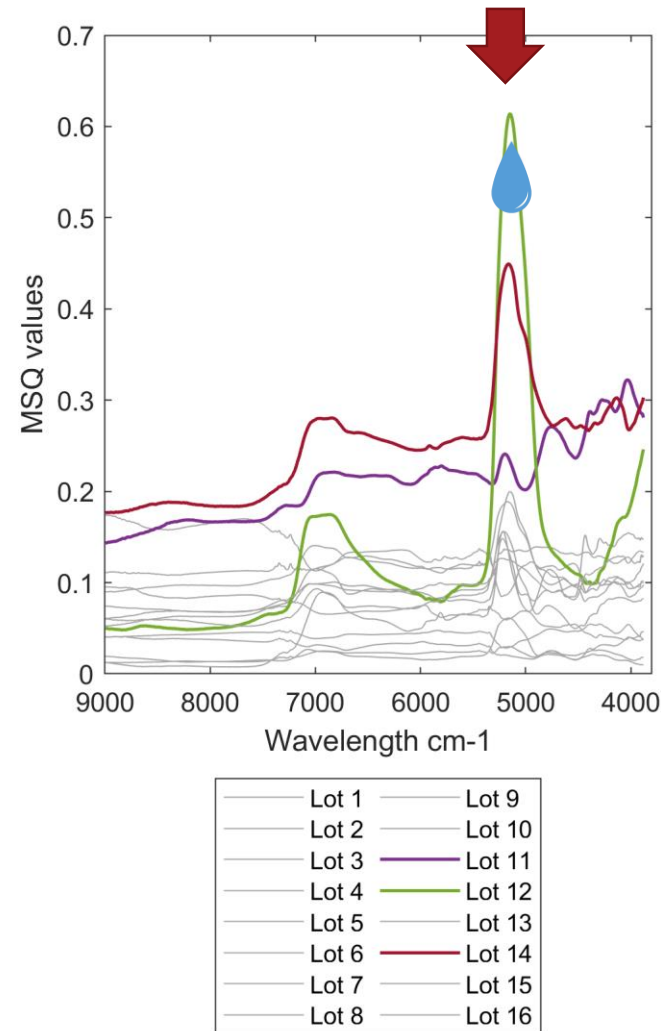
# Nested analysis of variance



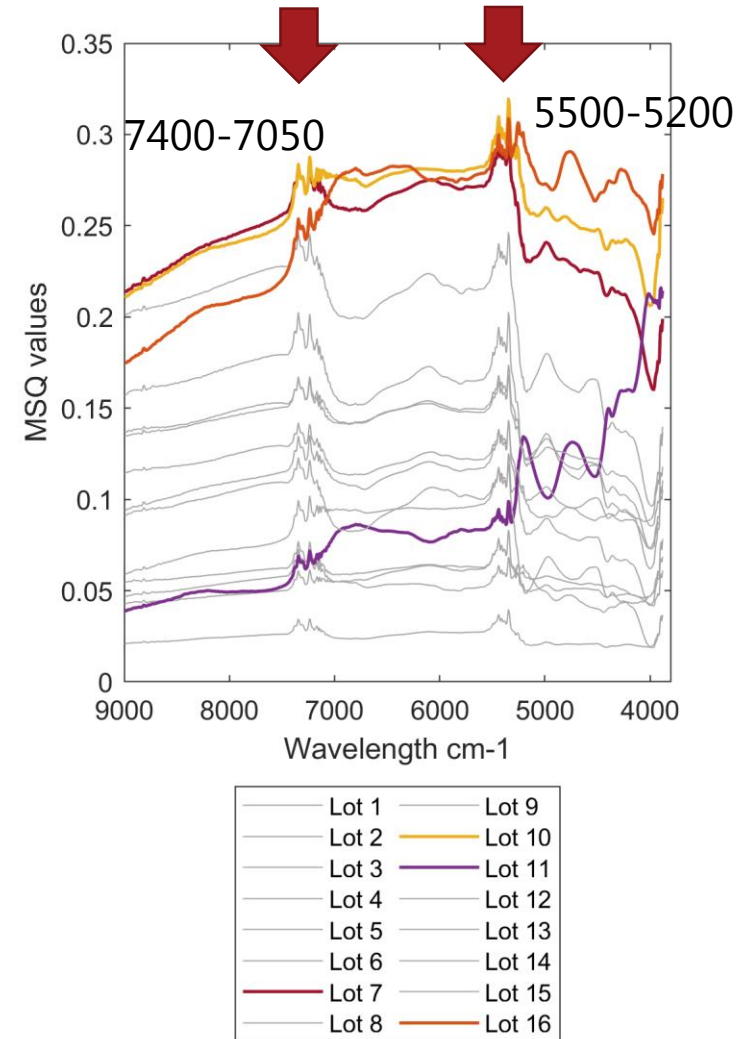
# Nested analysis of variance



# Nested analysis of variance

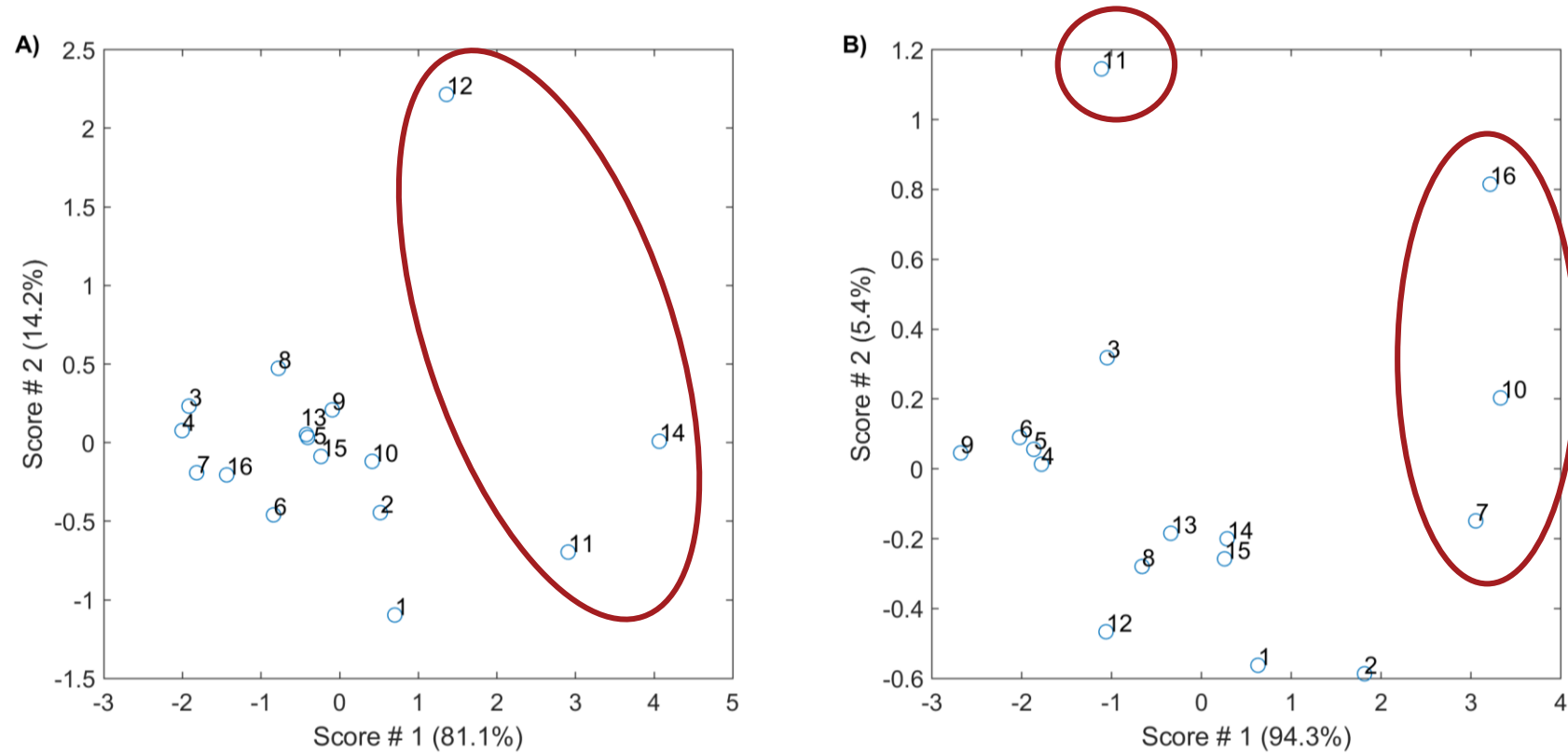


Variability within subsample level



Variability within replicate level

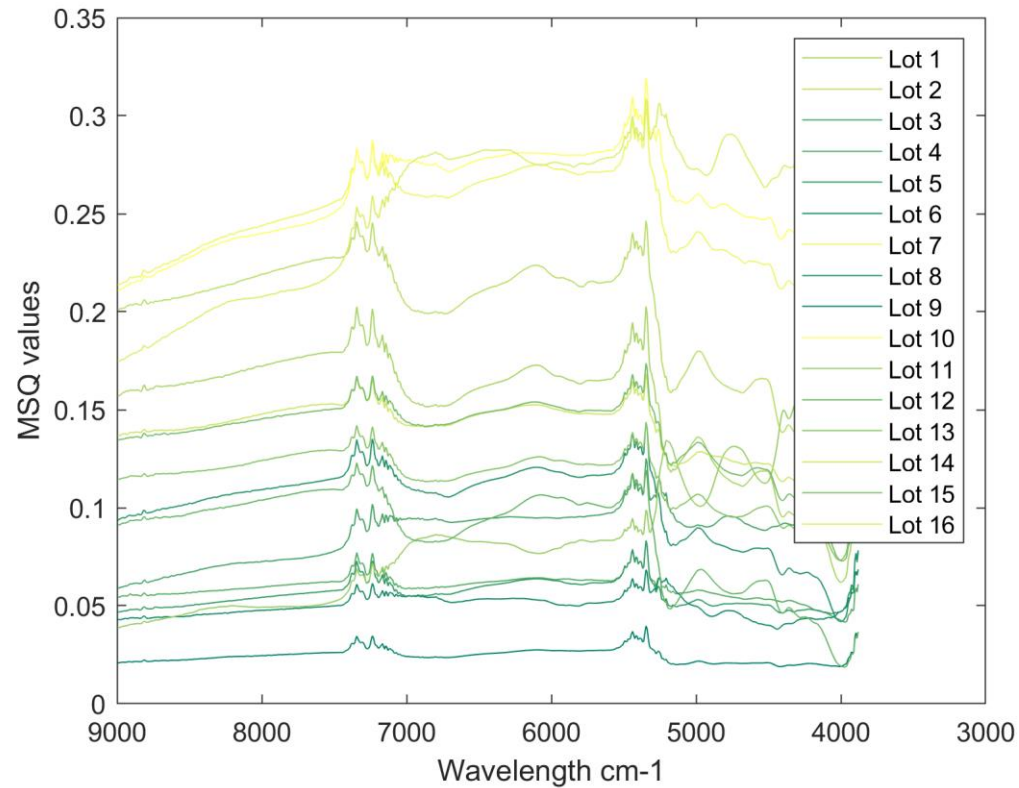
# PCA on the nested analysis of variance



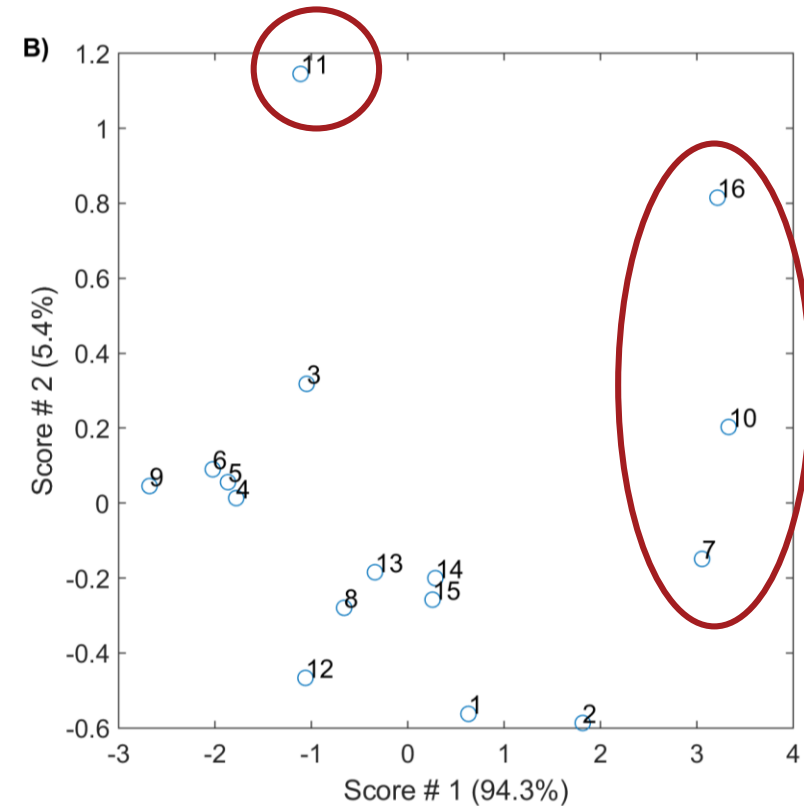
Variability within subsample level

Variability within replicate level

# PCA on the nested analysis of variance

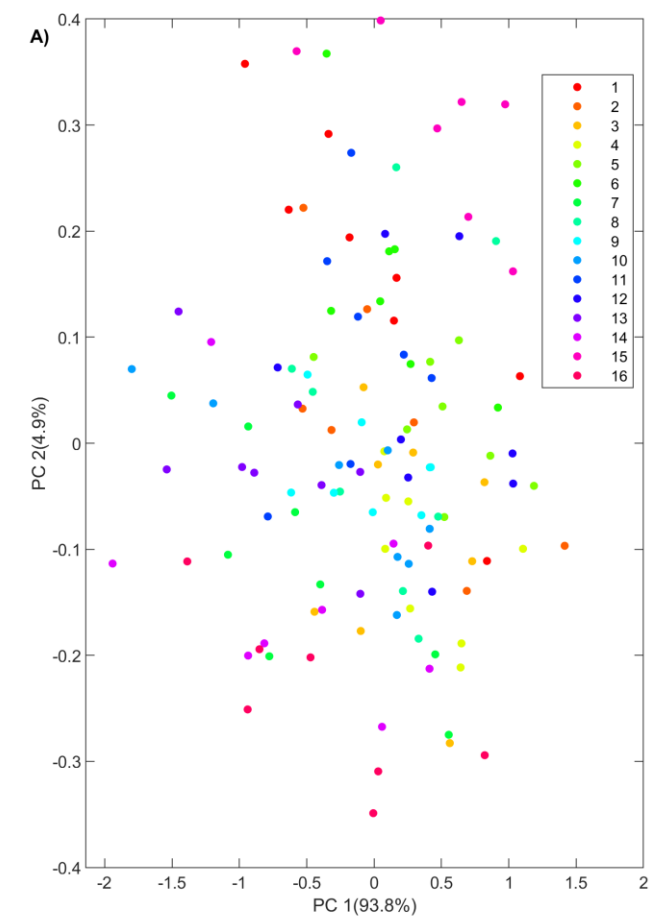
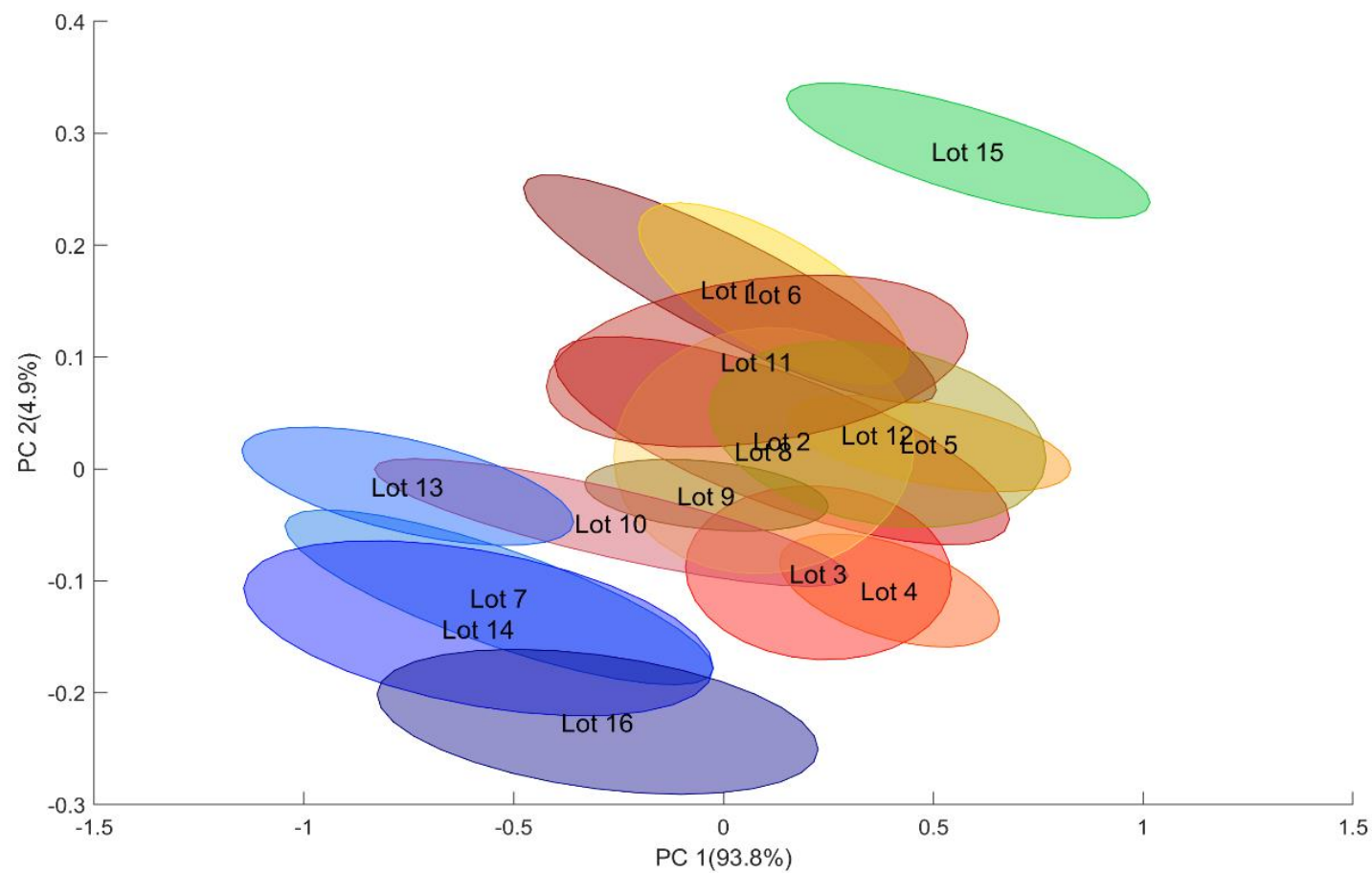


Variability within subsample level

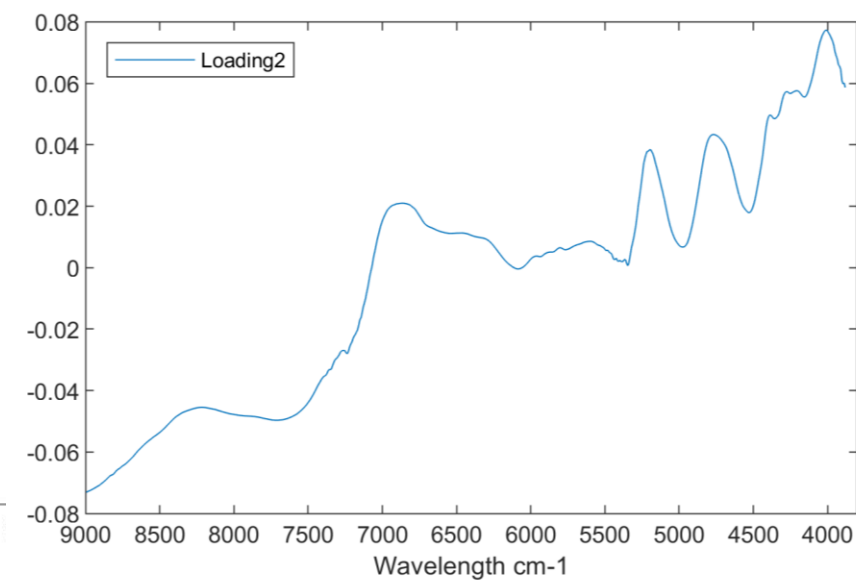
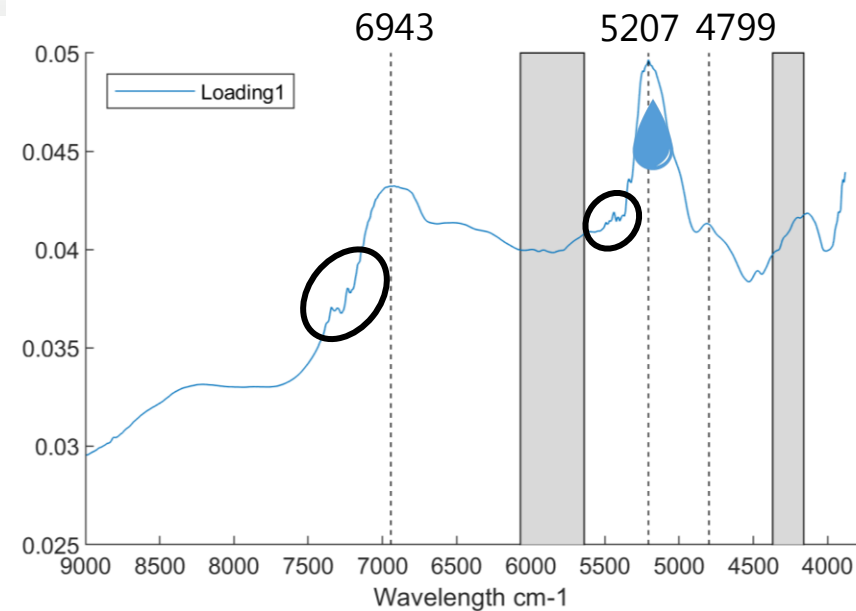
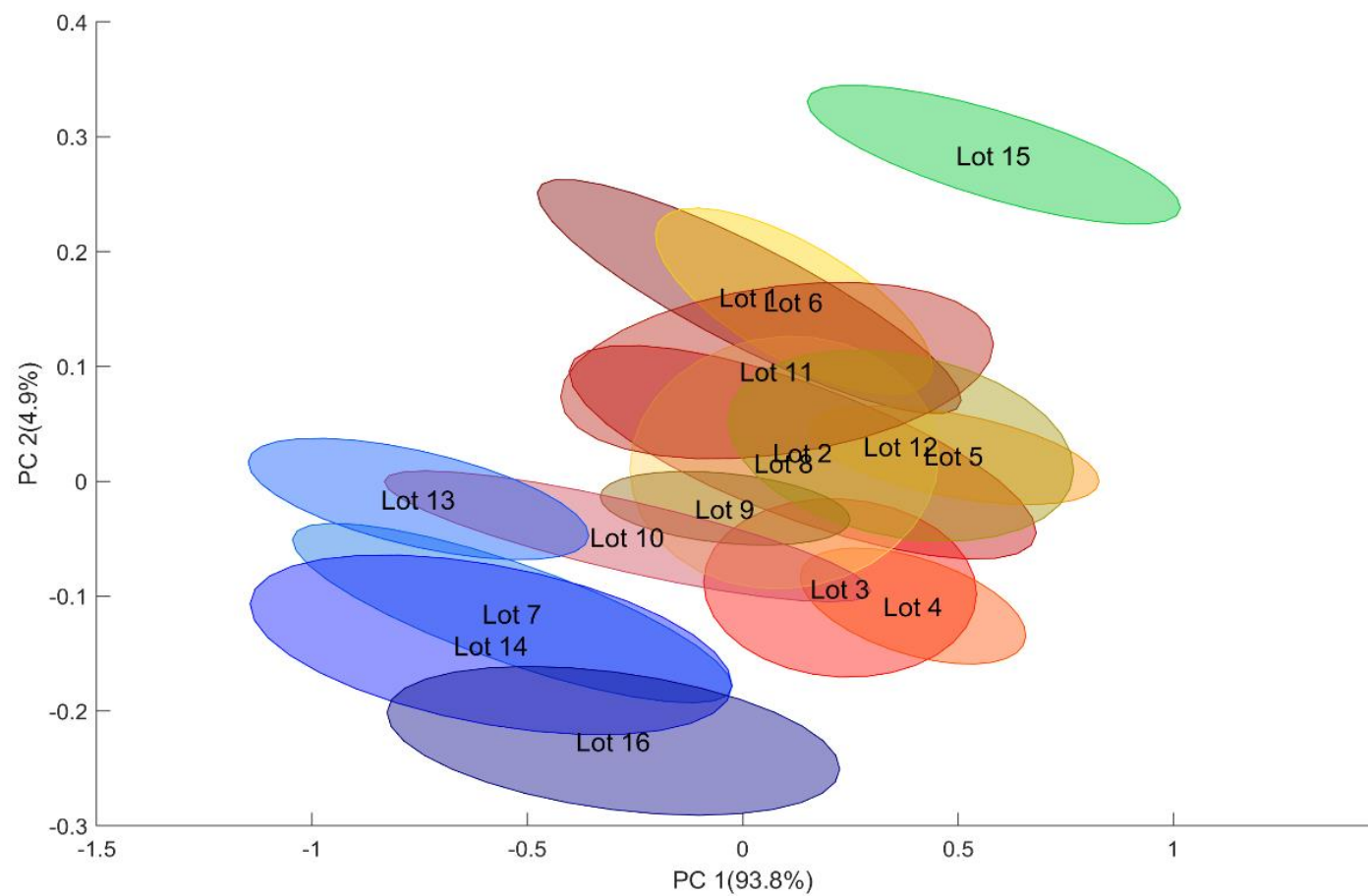


Variability within replicate level

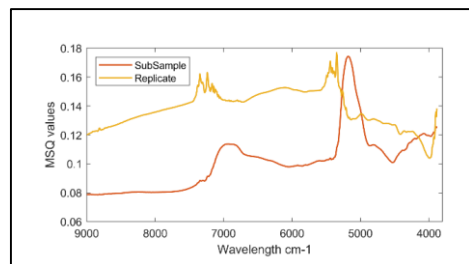
# PCA on spectral data



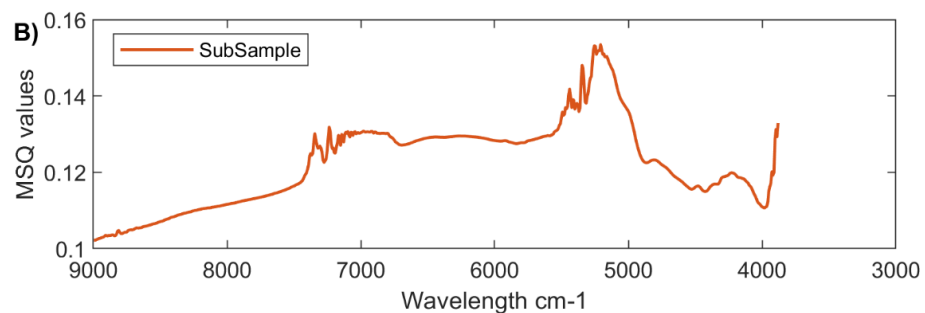
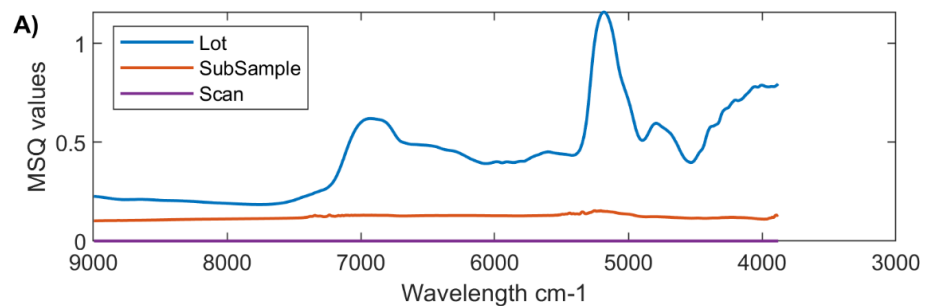
# PCA on spectral data



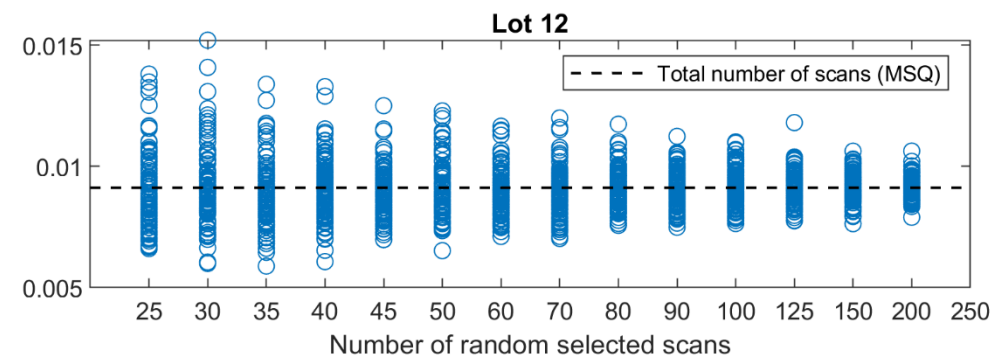
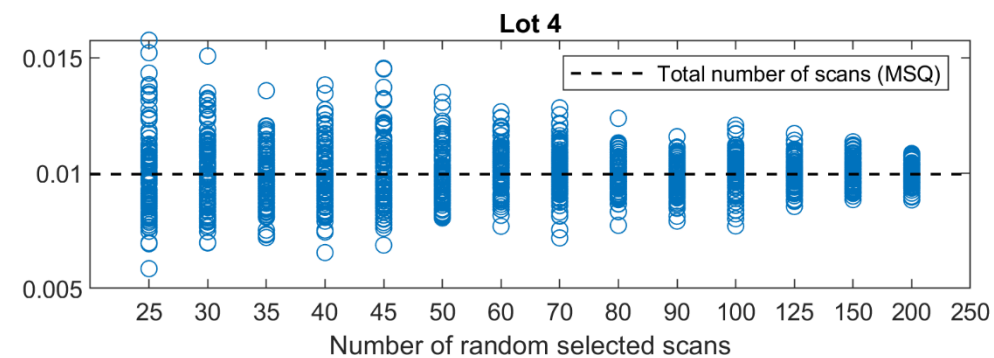
# Investigation on sampling procedure



Replicate level



Scan level



# Conclusions

- **Highest** variability at the lot level and **lowest** at the scan level.
- The **MSQ values at subsample and lot levels** have a similar trend indicating that the variability is affected by the same wavenumbers.
- PCA turned out to be a valid tool for getting a **quick overview of how the variability changes between the different lots** confirming the results of nested analysis of variance.
- The outcomes of this study provide preliminary indications about the **sampling procedure** to carry out in terms of frequency of sampling and number of replicates and scans to perform in order to collect representative samples and describe the variability in the waste wood materials.
- The **knowledge of waste wood variability and composition** is a key-point for enhancing the sorting and related best-reuse of the material with related positive effects in terms of economic, health and environmental issues and NIRS represents a valid technique for getting this information in a rapid way.

# Acknowledgments

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**Thank you!!**