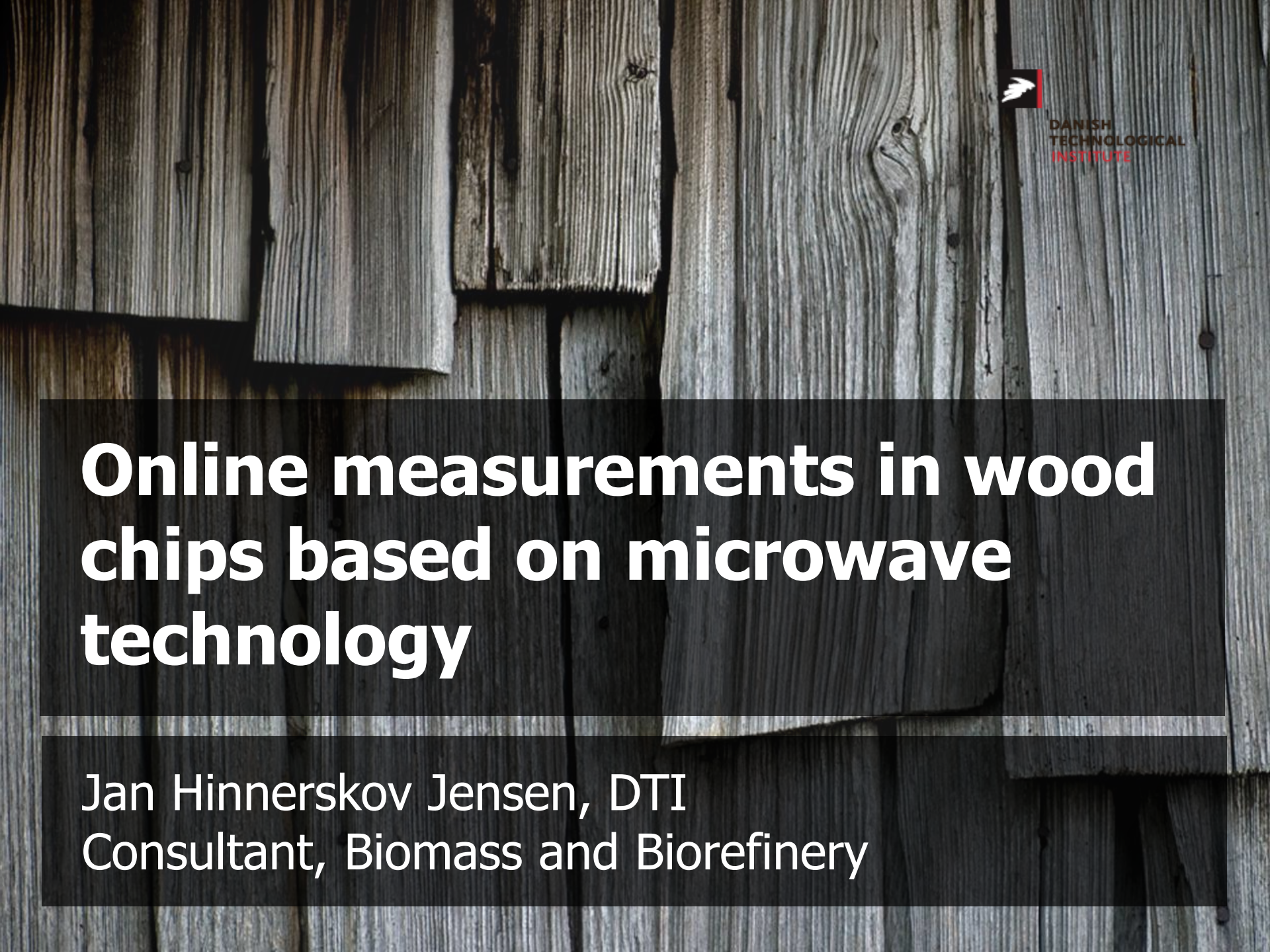

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Online measurements in wood chips based on microwave technology

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Setting the scene

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- Trade and import of bulk biofuels
  - Large quantities
  - Varying and partly unknown quality

- Moisture content used as:
  - Indirect parameter for energy content - settlement
  - Storage indicator – quality control

- Measurement of moisture
  - At the point of unloading or transfer
  - Harsh conditions

The past and present

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- Manual or mechanical sampling
- Analysis of moisture by drying at elevated temperatures

- Advantages
  - Established and accepted procedures
  - Standardised reference method for analysis of moisture
  - …..

- Disadvantages
  - Results are delayed several days
  - Average moisture content for a larger quantity
  - Man hours
  - Maintenance of equipment
  - …..

The future

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- On-line analysis at the point of delivery or transfer
- Advantages
  - Results in real time
  - Analysis of the total quantity – knowledge of variation
  - No sampling .....
- Disadvantages
  - No standardised reference method
  - Needs calibration and evaluation for traceability to reference method
- Challenge
  - How to establish and maintain a calibration function
  - Standards with reference values are not realistic

Field experience

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- On-line installations directly on moving conveyor belts
- Microwave for moisture determination
- Dual X-ray for moisture and ash determination
- Imported and domestic wood chips
- Imported wood pellets

Open questions

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Can on-line analysis equipment for moisture operate in the often harsh conditions without unacceptable downtime

Yes – several positive examples, but the supplier and the first user must put in efforts

Can it be calibrated to an acceptable uncertainty

It depends on the individual application

Supplier statements

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Accurate and long-term stable no need for frequent recalibration

The measuring range is from 1 to more than 70 % with a good accuracy of about 1 %

The measuring range is up to 100 % with an accuracy of 0.5 – 2 %

Typically you can measure within 0.1 – 0.3 % absolute from your reference method …… for homogenous products

Real data example

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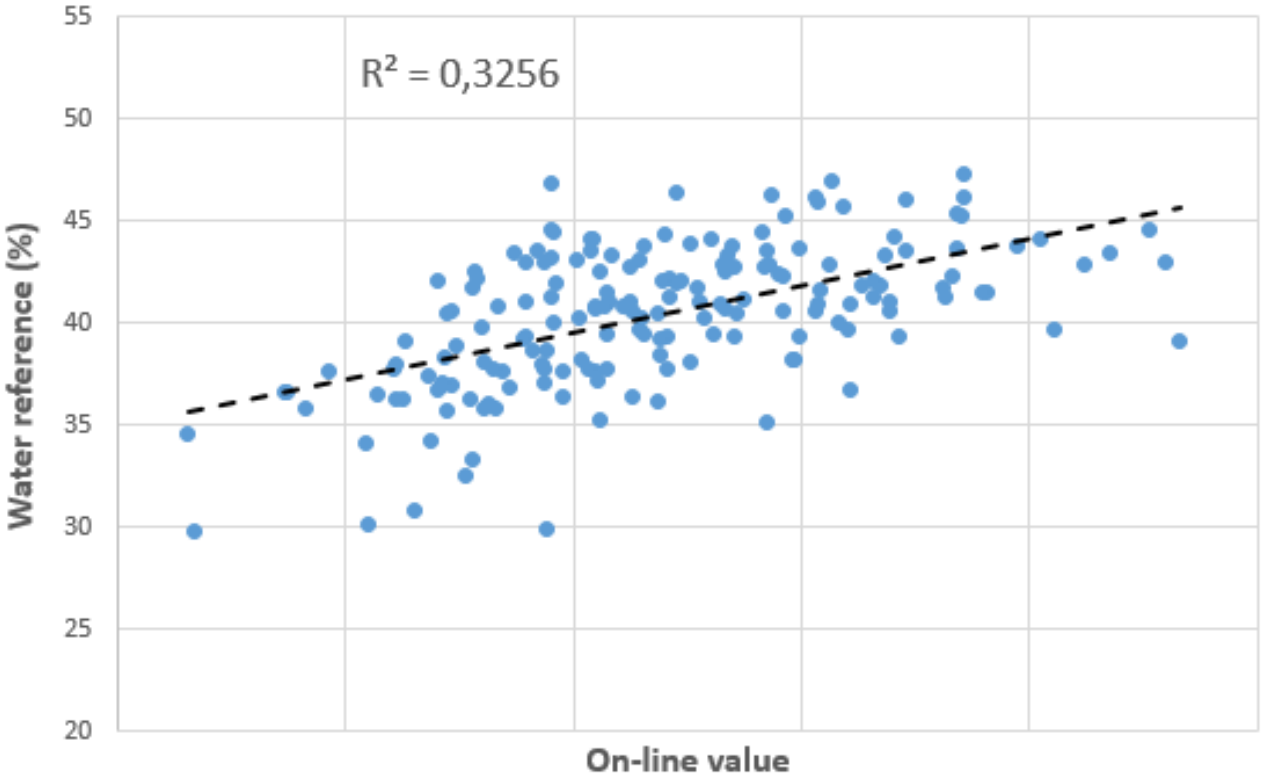

High scatter leads to a poor calibration

Calibration uncertainty contributors

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- Sampling of reference samples
- Analysis of reference samples
- "Sampling" of on-line samples
- The on-line analysis itself

Reference samples

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- Typical procedure prescribed by supplier
  - Reference samples are taken during operation with a running conveyor belt
  - Samples manual taken with a shovel from the top and middle part of the material
- To consider
  - Reference samples are taken as a total cross section of the material using the stop-belt method

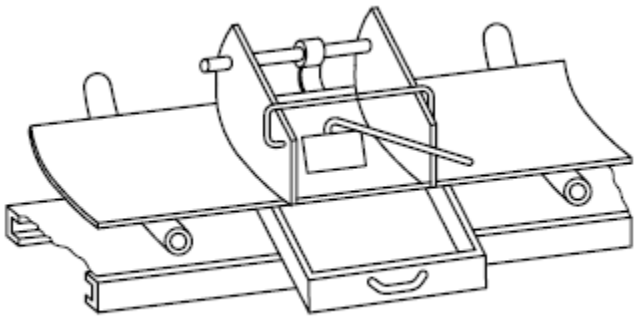

Figure 1 — Sampling frame

Analysis of reference samples

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- Reference samples are analysed according to current ISO standards for solid biofuels:
  - Analysis sample of minimum 300 g
  - Temperature of 105 ^{0}C until constant in mass – max 24 hours
  - The weight loss is expressed as moisture in %

- It is mentioned in the standard that the loss of volatile components will falsely contribute to the result

On-line ”samples”

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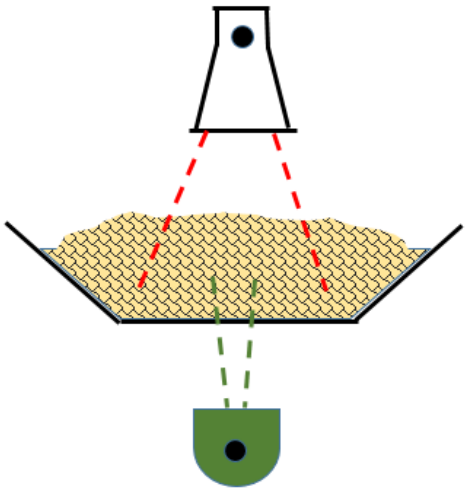
- On-line analysers measuring directly on the material on the conveyor belt has no preceding physical sampling
- Essential conditions related to sampling are nevertheless still an issue
  - A single sensor combining transmitter and receiver placed above the belt measuring reflection
  - A dual sensor system with a transmitter placed above the belt and a receiver placed under the belt
  - A secondary sensor for belt load



On-line analysis

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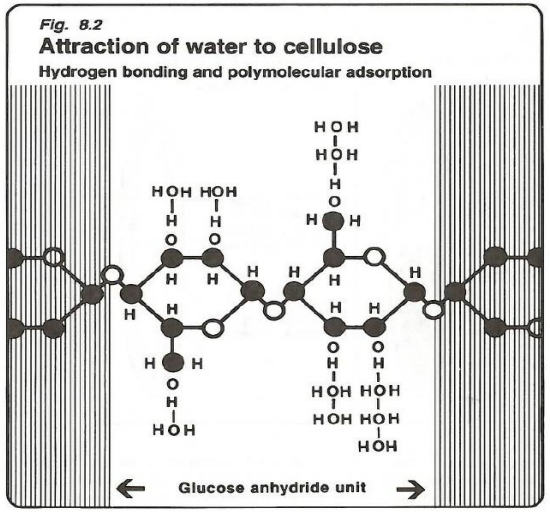
- Microwaves set free water molecules into rotation
- The binding of water molecules to the solid matter matters
  - Surface
  - Capillary
  - Hydrogen bonding
  - .....



- Ice and crystal water cannot be measured
- Different response for different sample matrices

Reduced uncertainty

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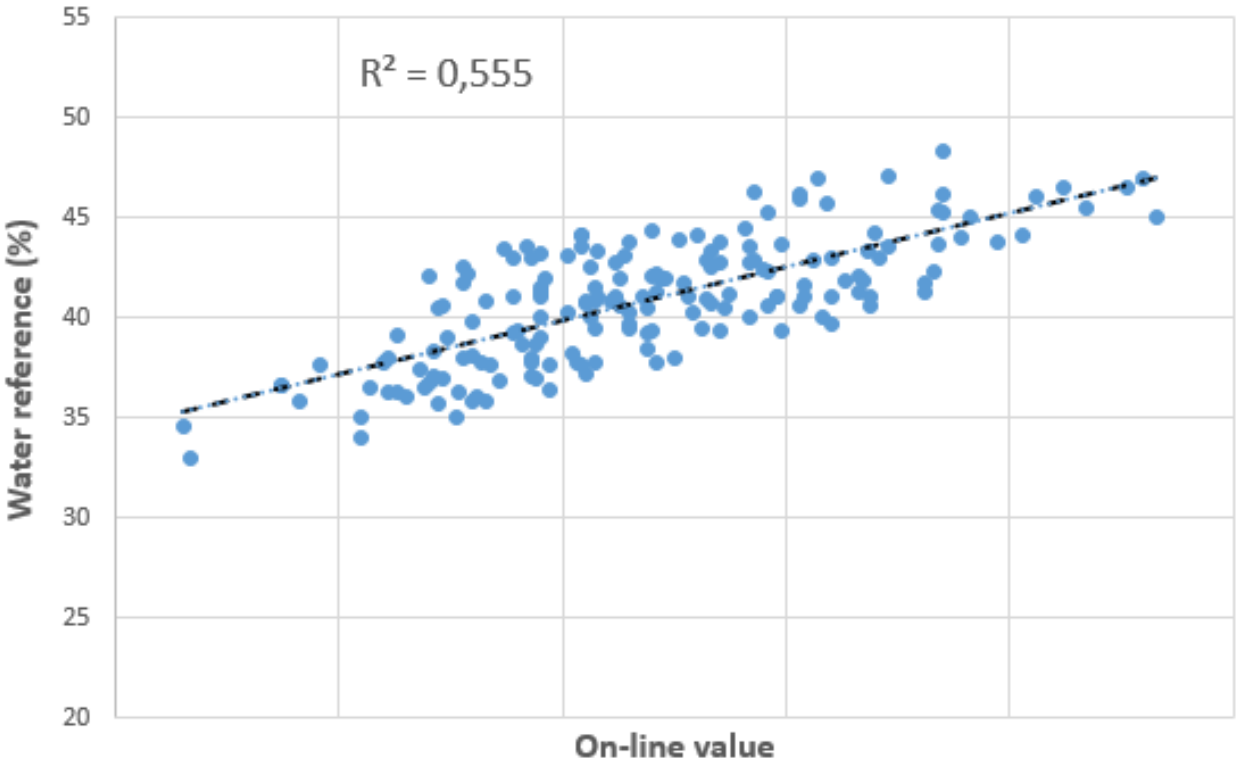
Reduced uncertainty contributions will lead to a lower scatter



Hidden correlations

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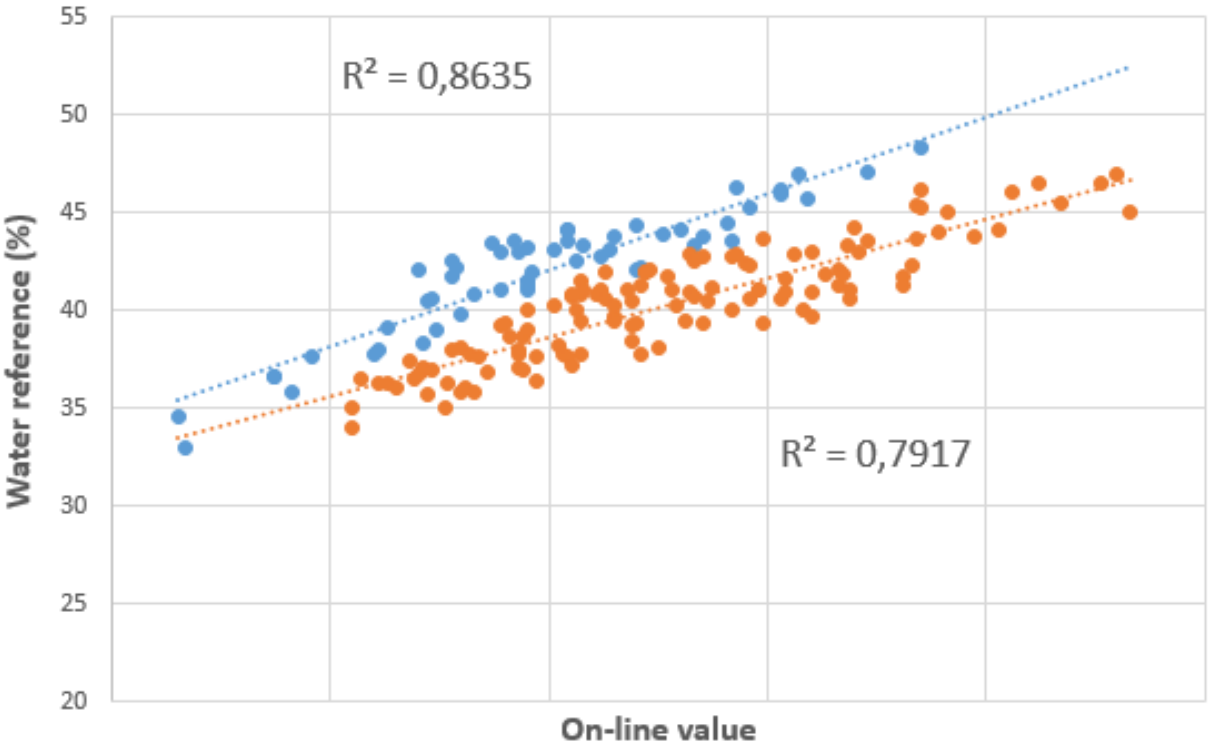
Be open for the existence of more calibration functions



Summary

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- On-line analysis of water in solid biofuels has a big potential
- More examples from industry show that on-line equipment can operate in harsh conditions
- Calibration of moisture in bulk biofuels is not that easy and efforts must be put in establishing and maintenance of calibration
- The suppliers need to be more open and realistic
- And so does the users

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Thanks for listening!

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