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” Applied FT-IR is a highly potential technology for uncovering new valuable herd management and breeding information”

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Fourier Transform Infrared (FT-IR) spectroscopy coupled with advanced chemometrics methods has proven a valuable tool for not only conventional milk parameters but also providing new information on fatty acids profiling and screening for ketosis and abnormal milk. These findings are promising for uncovering new herd management information for optimizing herd as well as individual cow performance for practical farm procedures and in breeding programs.

- *What can FTIR offer us today?*
- *What are the potential future parameters?*
- *What are the prerequisites for becoming successful?*
- *What are our challenges and opportunities in future?*
- *Conclusion*



What can FTIR offer us today?

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- Mid-Infrared (MIR) spectroscopy has been available since the 1970's as a rapid method for routine measurements of the main constituents in milk (fat, protein, carbohydrates)
- Fourier Transform Infrared (FT-IR) spectroscopy is the state-of-the-art method for acquiring MIR spectra analyzing:
 - Conventional parameters
 - fat, protein (true & crude), casein, lactose, solids, urea, citric acid, fatty acids, PH, freezing point depression
 - New parameters
 - Fatty acids
 - Ketosis screening (BHB and acetone)
 - Abnormal Milk Screening

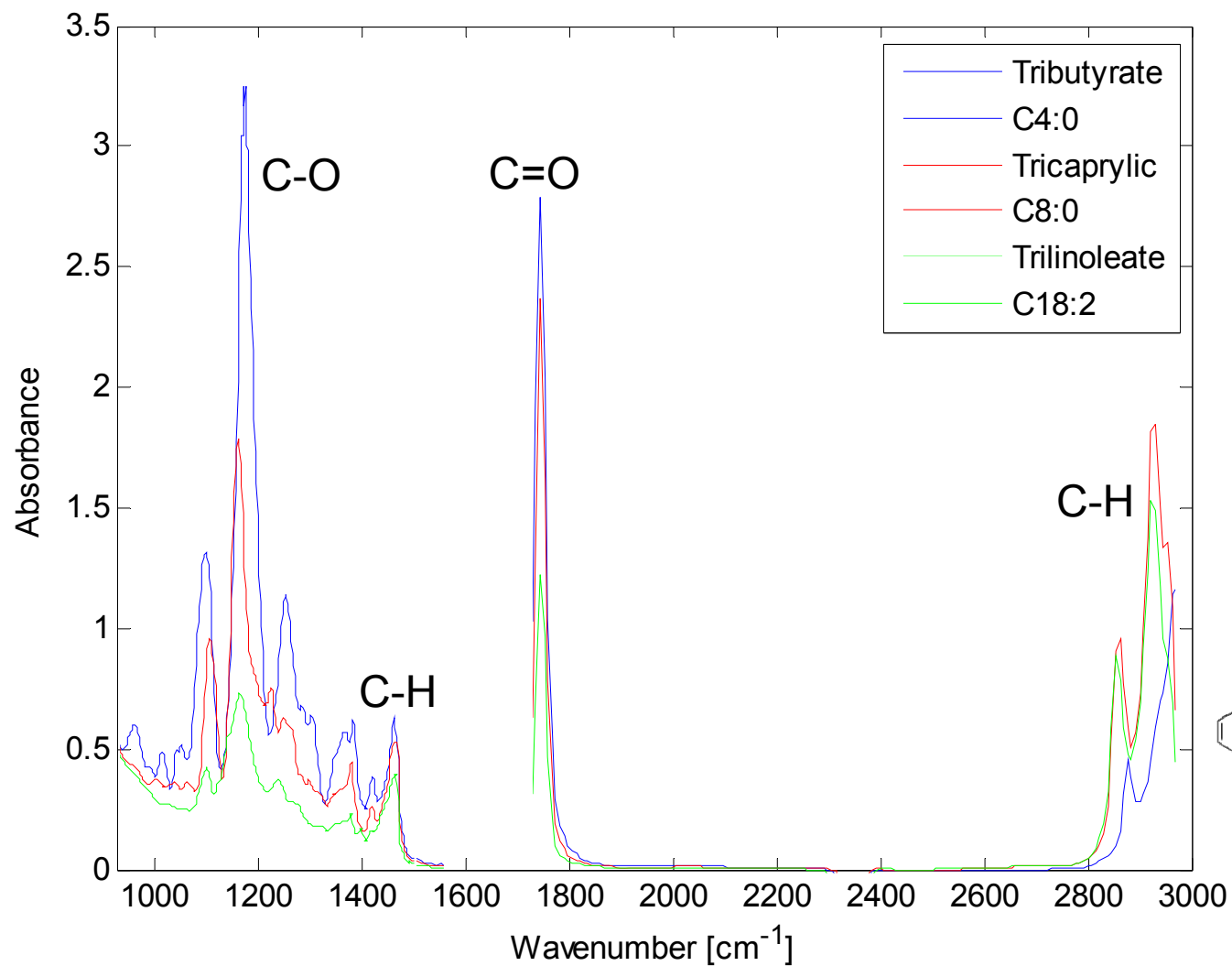
free



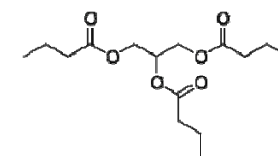
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FT-IR spectra of fat

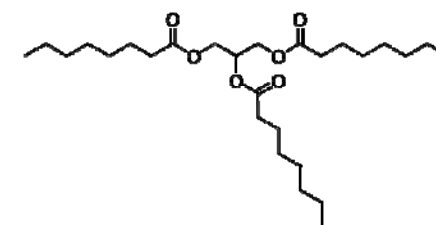
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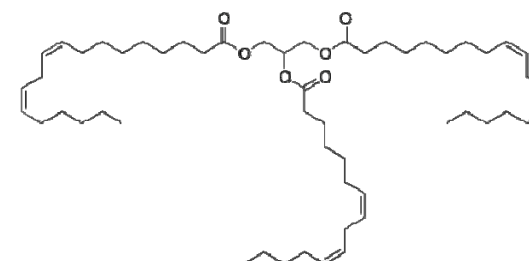
Tributyrate



Tricaprylic



Trilinoleate



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Fatty Acids calibrations - new release

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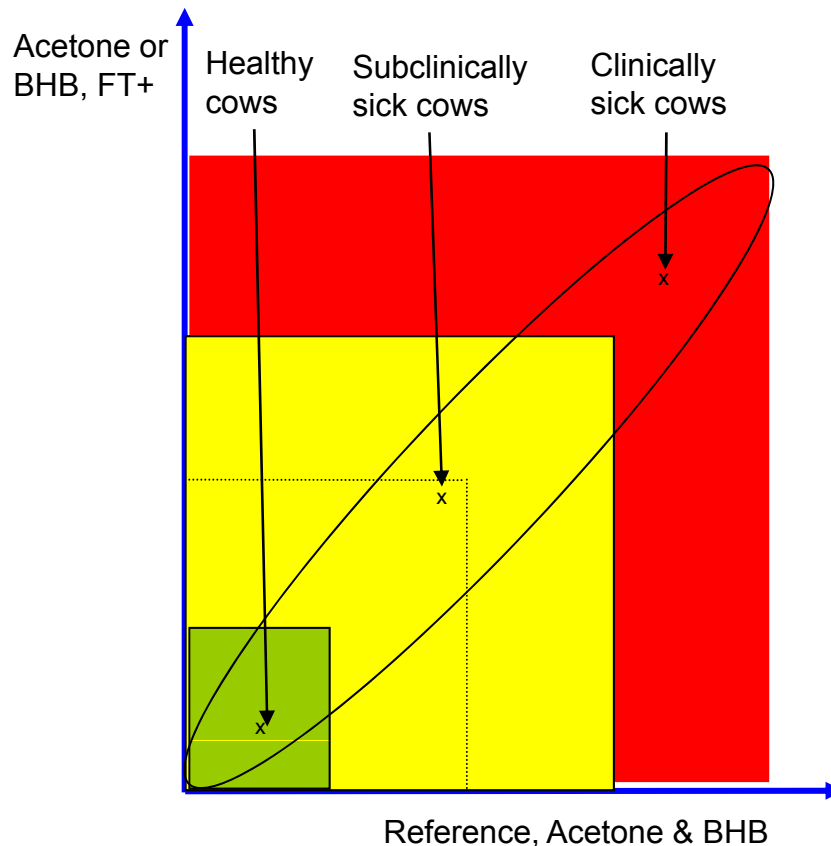
- Chain length
 - Short Chain Fatty Acids (SCFA): C4 + C6 + C8 + C10
 - Medium Chain Fatty Acids (MCFA): C12 + C14 + C16
 - Long Chain Fatty Acids (LCFA): C18
- Degree of unsaturation
 - Saturated Fatty Acids (SFA)
 - Mono Unsaturated Fatty Acids (MUFA)
 - Poly Unsaturated Fatty Acids (PUFA)
- Cis and trans double bonds
 - Trans Fatty Acids
- Major fatty acids
 - C14:0
 - C16:0
 - C18:0
 - C18:1 total



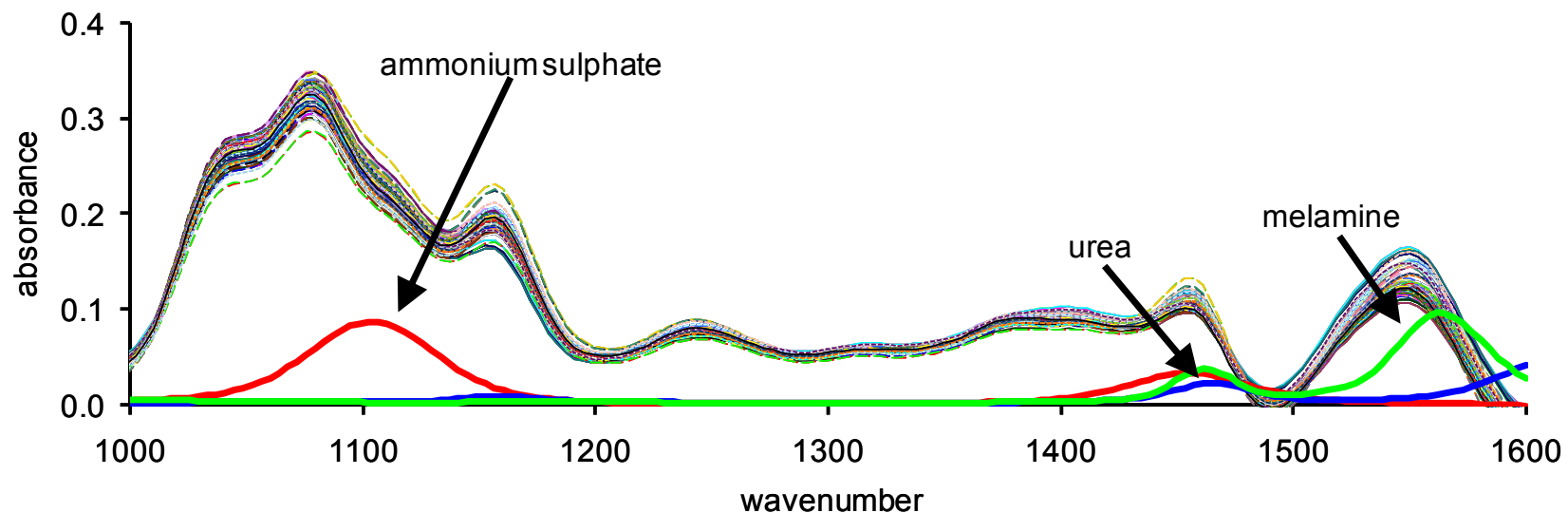
Based on samples from 4 countries and validated on samples from 5 countries
Ring trial including 7 laboratories for GC analysis.

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- Ketosis is a metabolic disease causing big losses in some herds
- Acetone and beta hydroxy butyrate in milk is a good indicator about ketosis in the herd
- Based on extensive testing in 2 regions and incorporation data from several countries a screening tool is now available
- BUT we are at the limit of what is feasible with FTIR!
 - The calibration is semi quantitative
 - Instrument performance must be good
 - Advisory service on how to use results must be in place



- Adulterants have unique fingerprints very different from milk spectra



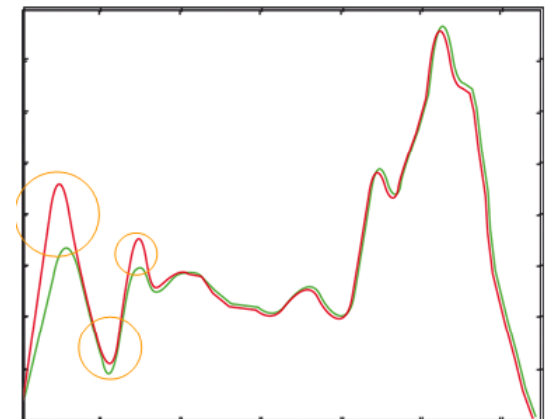
- Adulterants are usually present in very low concentrations
- Levels are highest close to the adulteration source, i.e. before milk processing

Abnormal Spectrum Screening is:

- A new screening tool for routine analysis in raw milk testing
- FTIR spectra from natural raw milk samples is a unique finger print
- Develop your own screening for abnormal properties of your milk samples

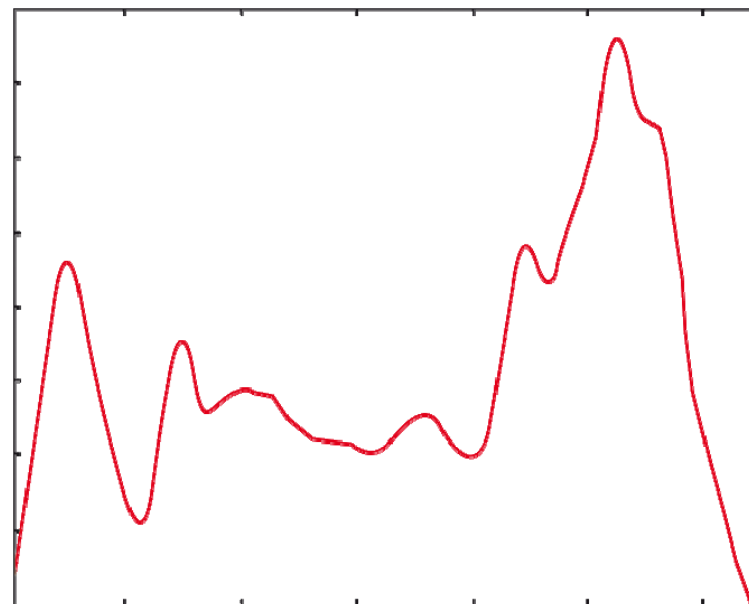
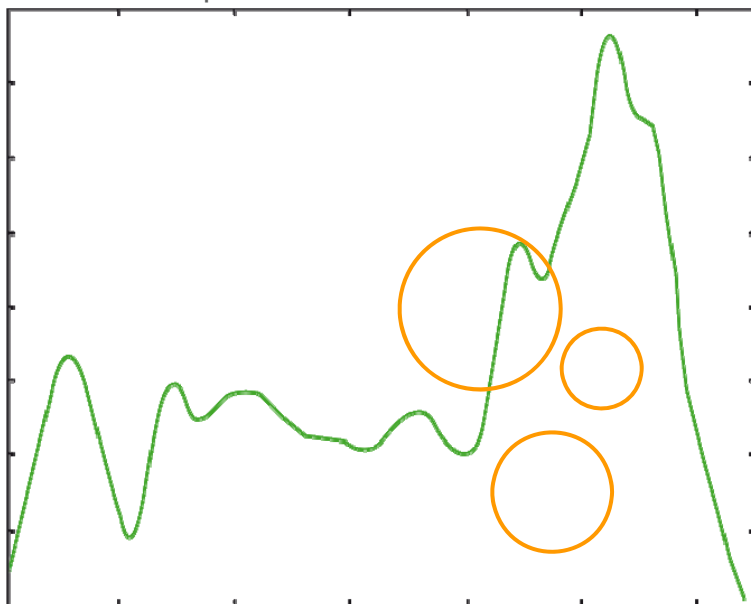
Examples of what can be screened for:

- Cleaning agents
- Different types of milk (cow, sheep, buffalo)
- Protein adulterants
- Fat adulterants
- Others? This application allows you to create an unlimited number of screening models



- FTIR spectra from natural raw milk samples is a unique finger print of normal milk

Raw milk sample



- Many research projects are actively researching new parameters from FT-IR:
 - CRA-W, Agramir, Phénofinlait, OptiMIR, Robust Milk, University Padova and many more
 - FOSS are involved in some of above projects and in several other projects with key customers
- Numerous publications are available
- Some of the new potential parameters are
 - Milk coagulation properties
 - Titratable acidity
 - PH
 - Protein composition
 - But there are many more!



What are the prerequisites
for becoming
successful?

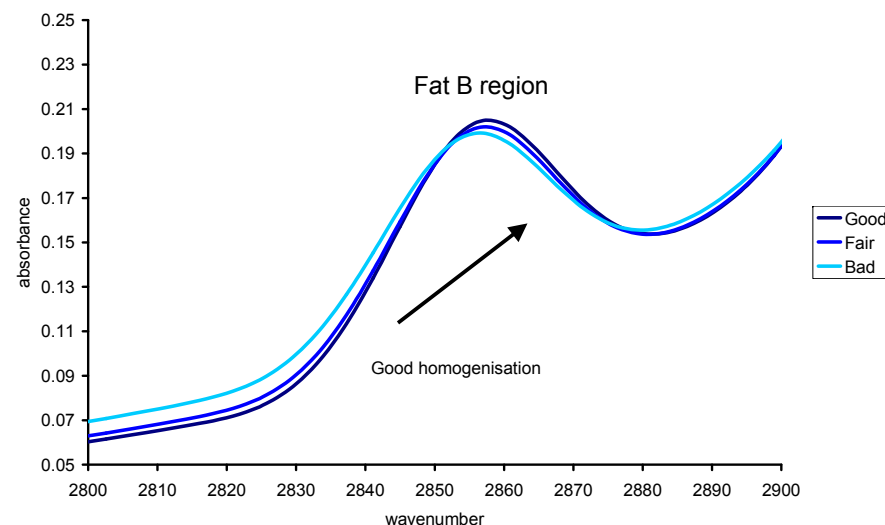
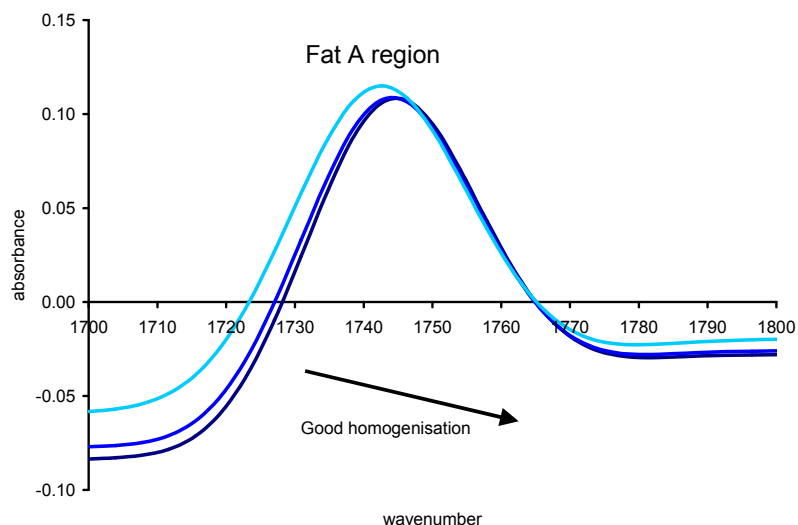
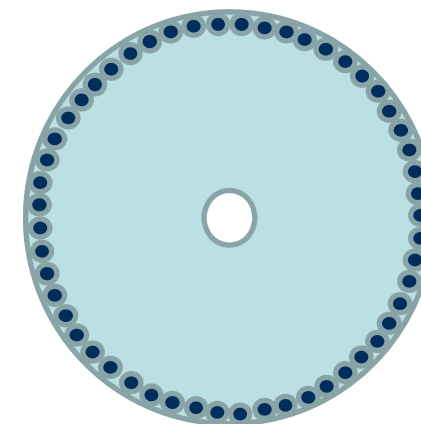


1. Standardized instruments for uniform spectra
 - Standardization (intensity and wavelength)
 - Zero setting and pilot samples
 - Homogenization index within certain limits
 - Preventive maintenance of the instruments according to our recommendations
2. Powerful database with full spectra
3. Robust calibrations
 - Variation in calibration samples
 - Race, feeding, season, region, sample range and number of samples
 - Temperature, homogenizer, critical instrument settings
 - Good reference results
 - The more sensitive the parameter the more important the sample selection becomes, both for the calibration and for the validation
 - In this way calibrations can be made which are stable worldwide!

Improved robustness comes with variation in samples used for the calibration...

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- FTIR corresponds to using more than 100 filters!
 - With spectrum calibration we do not only look at Fat A and Fat B when analyzing for total fat!
 - All relevant ranges in the spectrum can be used for determination of any parameter
- FTIR allows stabilisation of the calibrations, for instance:
 - Sample temperature can be compensated for
 - Homogeniser efficiency can be compensated for!



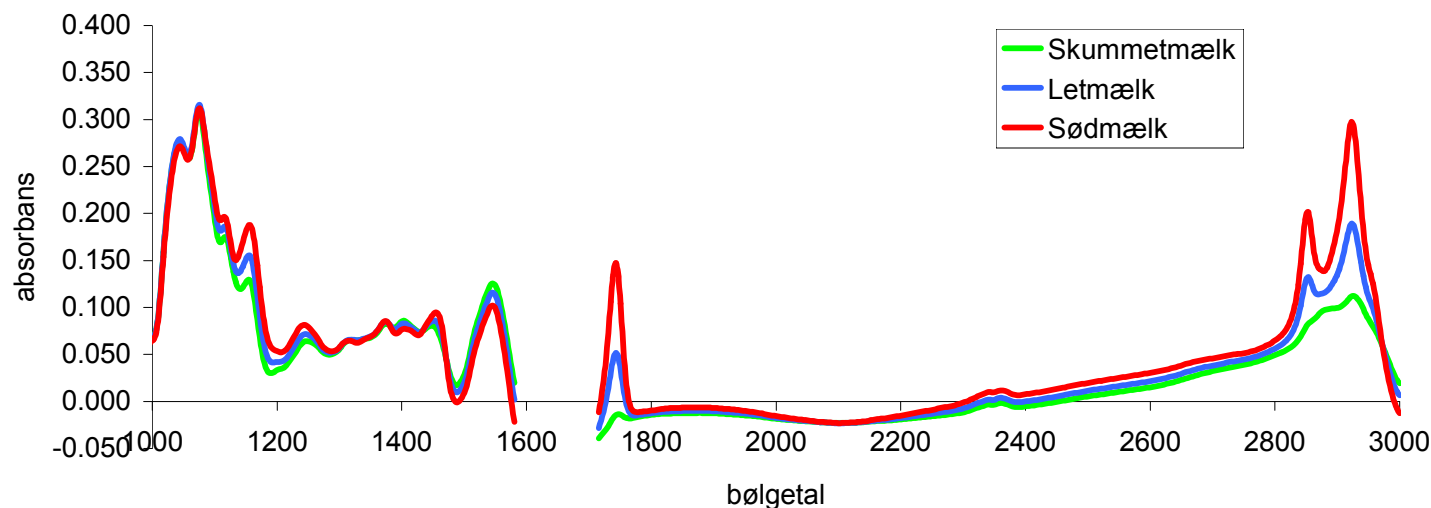
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So, it is important to have relevant sample variation built into the calibration!

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- You can only correct for what you can measure!
 - Big variation (range) in calibration samples ensures robust calibrations
 - FTIR allows correction for:
 - Varying concentration of components analyzed for
 - Other factors that varies in the milk from sample to sample

As long as it is built into the calibration!!



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And this becomes even more important with the minor components....

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- The presence of minor components, such as urea or acetone, only adds minor perturbations to the FT-IR spectrum
- Hence, it is impossible to assign major optical filters for their determination
- The full spectrum nature of FT-IR and standardization gives us more information for the detection of such components – and chemometrics allows us to extract this information
- Components that can only be determined with good accuracy by use of FT-IR spectroscopy and standardisation include
 - Urea
 - Acetone
 - Fat properties, such as FFA, SFA, UFA, MUFA, PUFA

t1

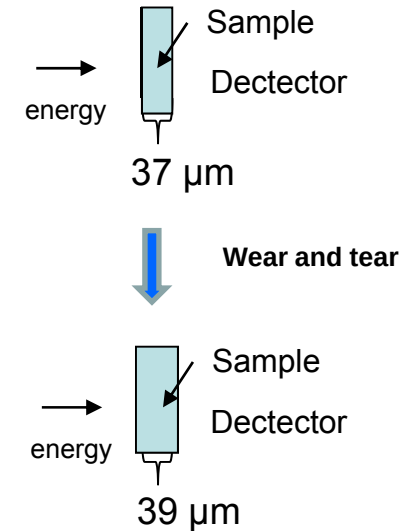
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What does standardisation do?

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All CaF₂ cuvette path length will change over time due to:

- a) Dissolution of cuvette due to rinse solution and the samples
- b) A film can be building up inside.



you do not standardize then the changing pathlength over time will cause the energy to pass through more/less sample than before.

This results in wrong results!

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Diapositive 16

t1 toa; 23/08/2010

t2 toa; 23/08/2010

- Global calibrations can be made
 - Regional variation can be built in
 - Seasonal variation can be built in
 - Different races and species can be built in
- Calibrations can be transferred from one instrument to another
 - No initial work in the labs when introducing a new MilkoScan
 - More resources can be invested in each calibration
- Benefits to the labs:
 - Instruments delivered with plug and play calibrations
 - Stability over time of calibrations
 - Considerable time and money saved on calibration procedures



- We have already covered measurements where an easy "copy-and-paste" of a reference method to FT-IR is possible
 - It now becomes more challenging – but not impossible to develop new parameters based on what FT-IR is capable of
 - Sometimes the uncertainty of the reference method is the problem
- Accuracy is not necessarily everything
 - Classification only requires good accuracy close to the classification limit
 - Semi-quantitative models are possible for low concentration constituents
- Combine FT-IR with other analytical info

Learning from Herd Navigator

- Combine with other relevant herd management information?
- Looking at trends by following the individual cow?





FT-IR still has a lot of potential!

We just have to learn to use it in a slightly different way

Thank You!