Fine milk compositional analysis by FTIR

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New Technology Development

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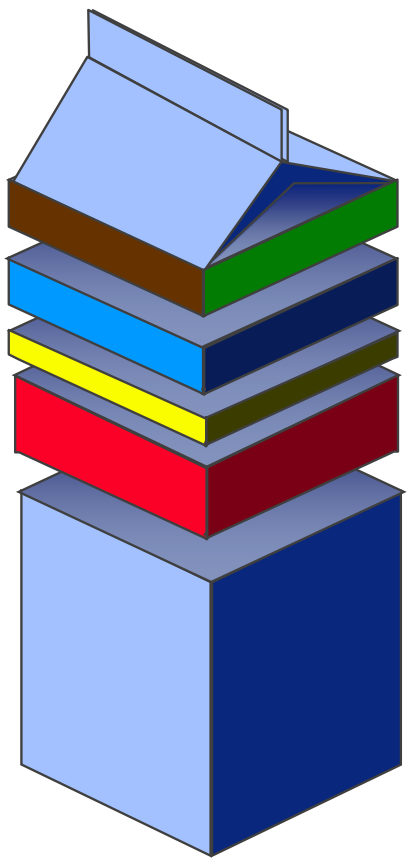
Bovine Milk Composition



Fat 4.7%

Protein 3.5%

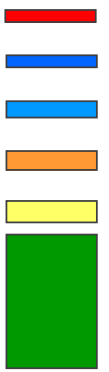
Minerals 0.8%

Lactose 4.5%

Fat-soluble vitamins

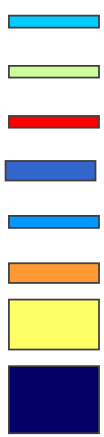
Water 86.5%

Water-soluble vitamins



Fat

- Free Fatty Acid
- Monoglyceride
- Sterol
- Diglyceride
- Phospholipid
- Triaglyceride
- Fat-soluble vitamins



Protein

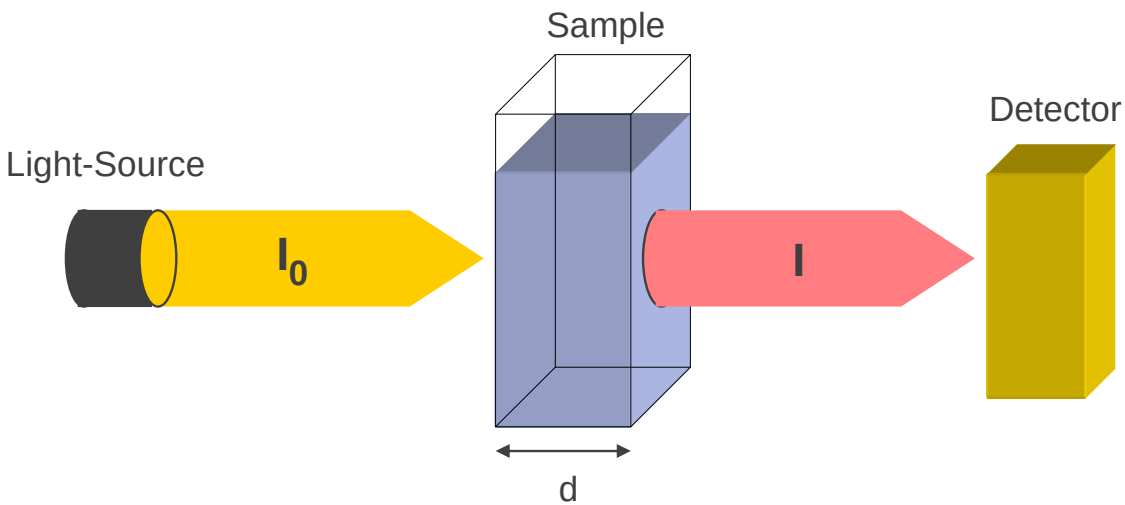
- Other, eg FBP, Lf
- Ig's, LPO, GFs
- Serum Albumin
- β - Lactoglobulin
- α - Lactalbumin
- κ - Casein
- β - Casein
- α - Casein

FTIR: Fourier transform infrared spectroscopy

FTIR is widely used for rapid compositional analysis of liquid dairy products.

- Centralised milk testing common globally.
- Allows rapid quantification for gross composition.
- Uses absorption of infrared frequency radiation.
- Fourier transform – mathematical function used for collecting data.

Principle of infrared spectroscopy

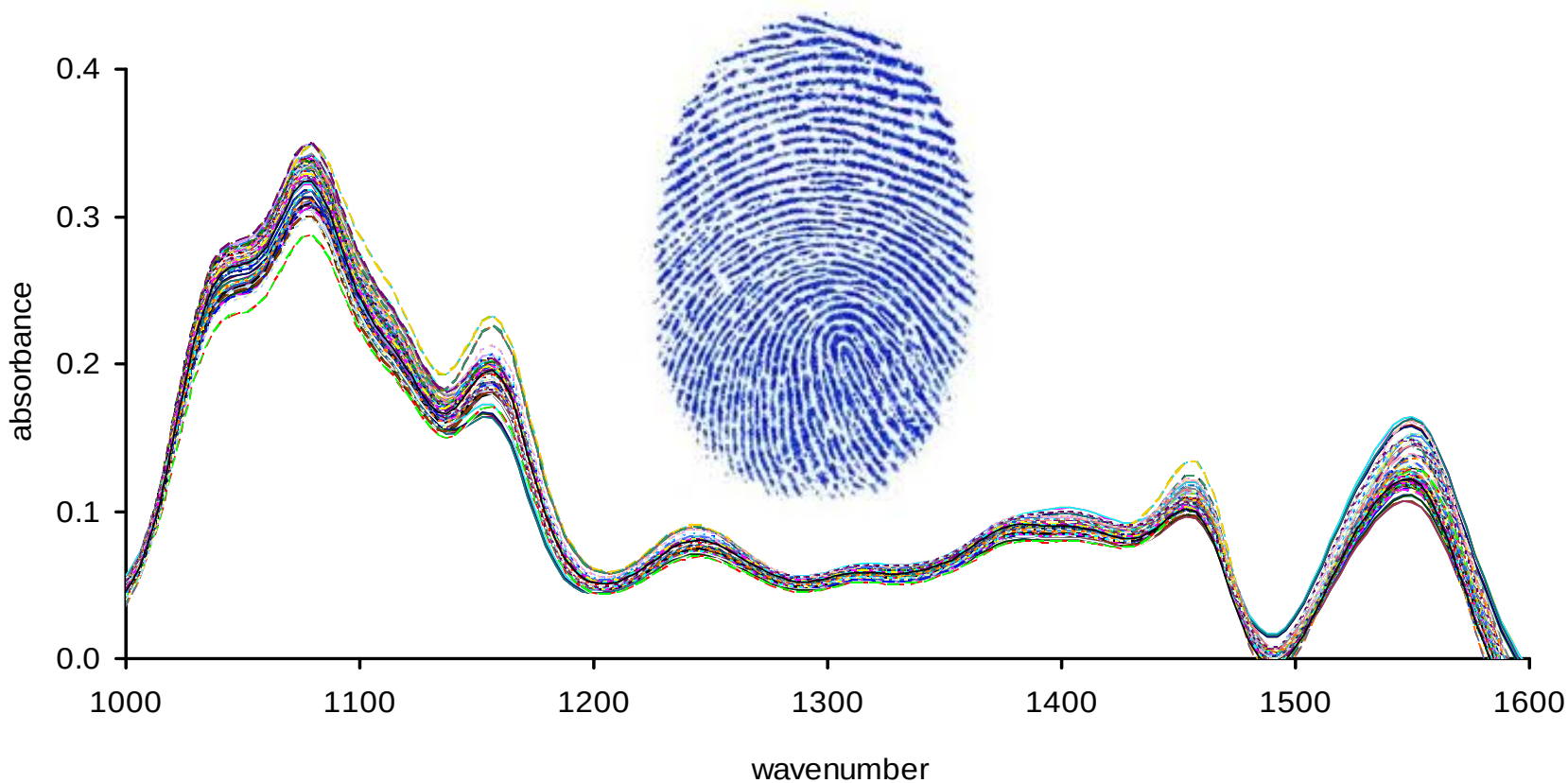


Beer's Law: Absorbance is proportional to concentration

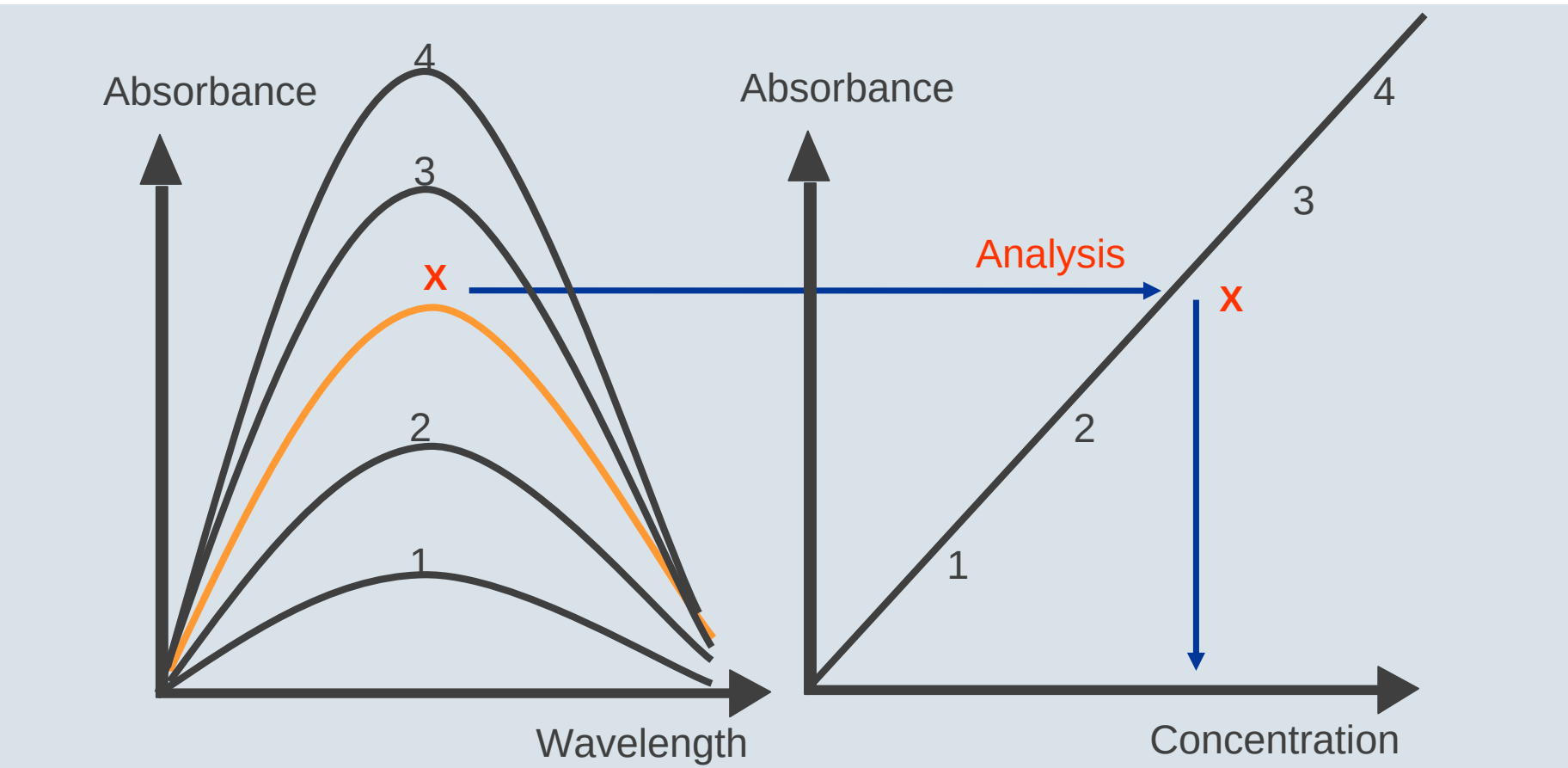
FTIR instrument platforms

- Traditional FTIR based instruments
  - Foss FT1, FT2, FT+
  - Bentley DairySpec
  - Delta Lactoscope
- Highly accurate (0.02% for fat and protein)
- Automated flow/cleaning system with temperature control and precise homogenisation for consistent sample presentation and high thru put.
- Lower costs systems coming to market.

Spectroscopy – FTIR spectra of liquid milk

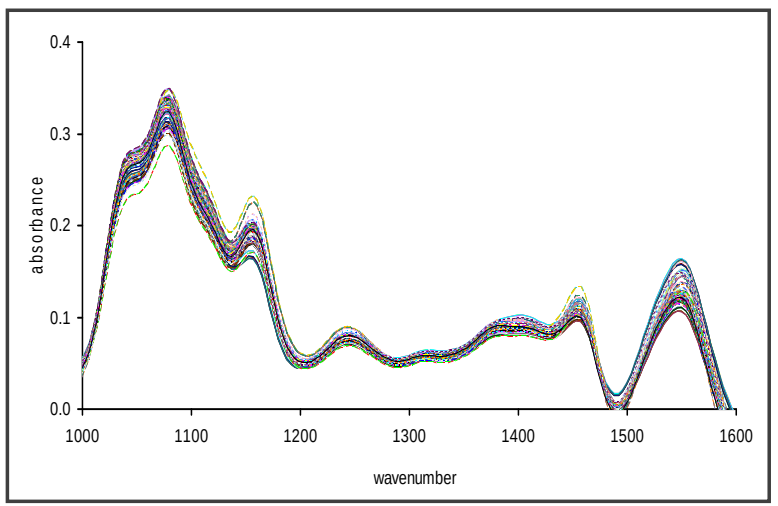


Traditional calibration - quantitative analysis; regression



Historic measurement of components in milk

- 1980-90s: Traditional quantitative calibration are for gross composition.
  - Fat, protein, lactose, total solids, solids not fat.
- 2000: Major fractions of fat and protein.
  - Casein, saturated and unsaturated fatty acids.
- 2008 onwards – adulterants.
- 2012 onwards: Individual fatty acids and proteins and adulterants at concentrations 100-1000ppm.



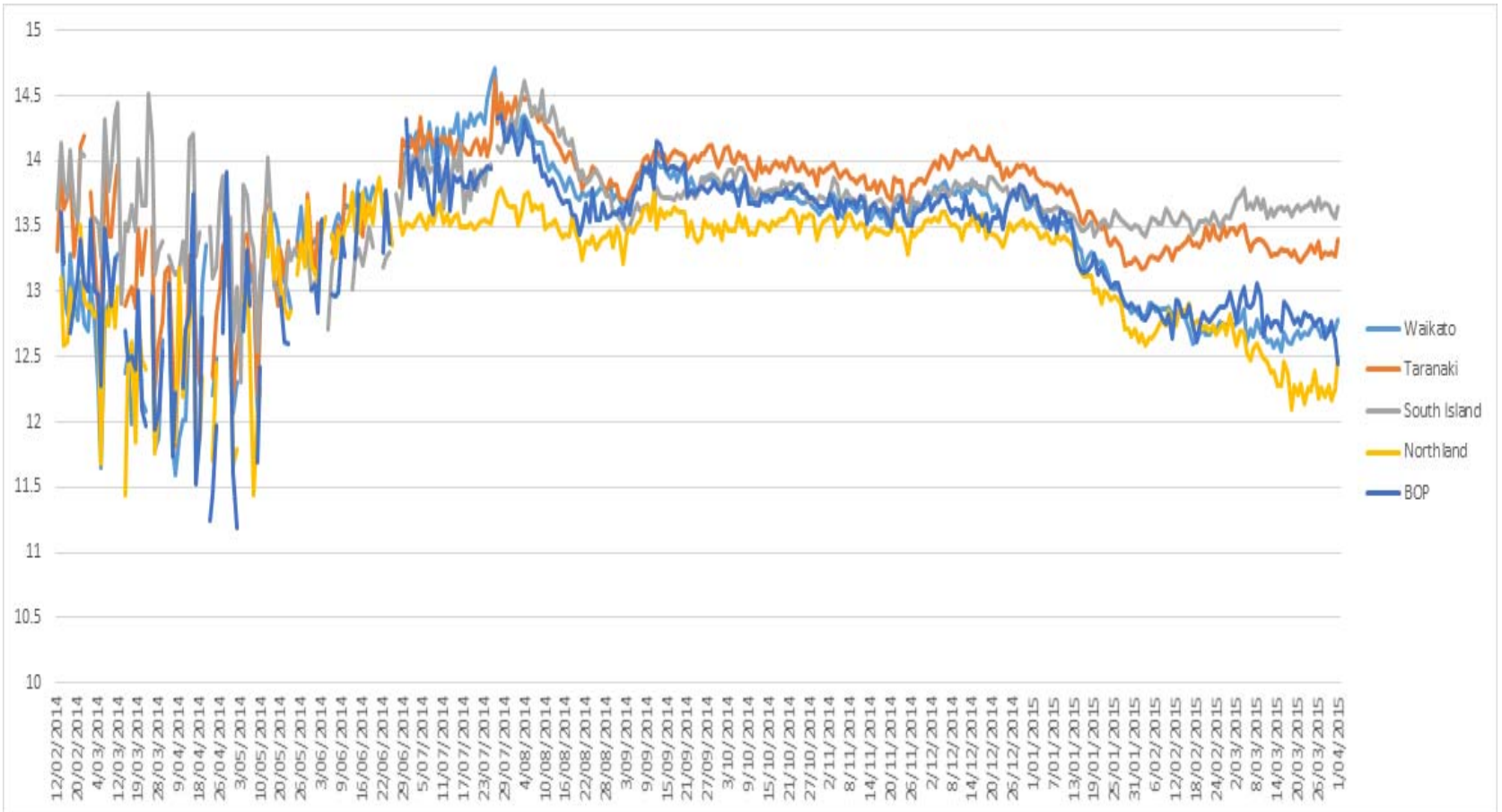
2015-2017 publications FTIR/milk composition

- Estimation of genetic parameters by FTIR – energy balance.
- Detection of whey in milk/whey quality.
- Within milking variation of milk composition and fatty acid profile.
- Estimation of genetic and cross breeding parameters of fatty acid concentrations in milk fat.
- Screening methods for detection of five adulterants by FTIR.
- Impact of feed on milk composition.
- Estimation of oestrous cycles from milk compositional changes.

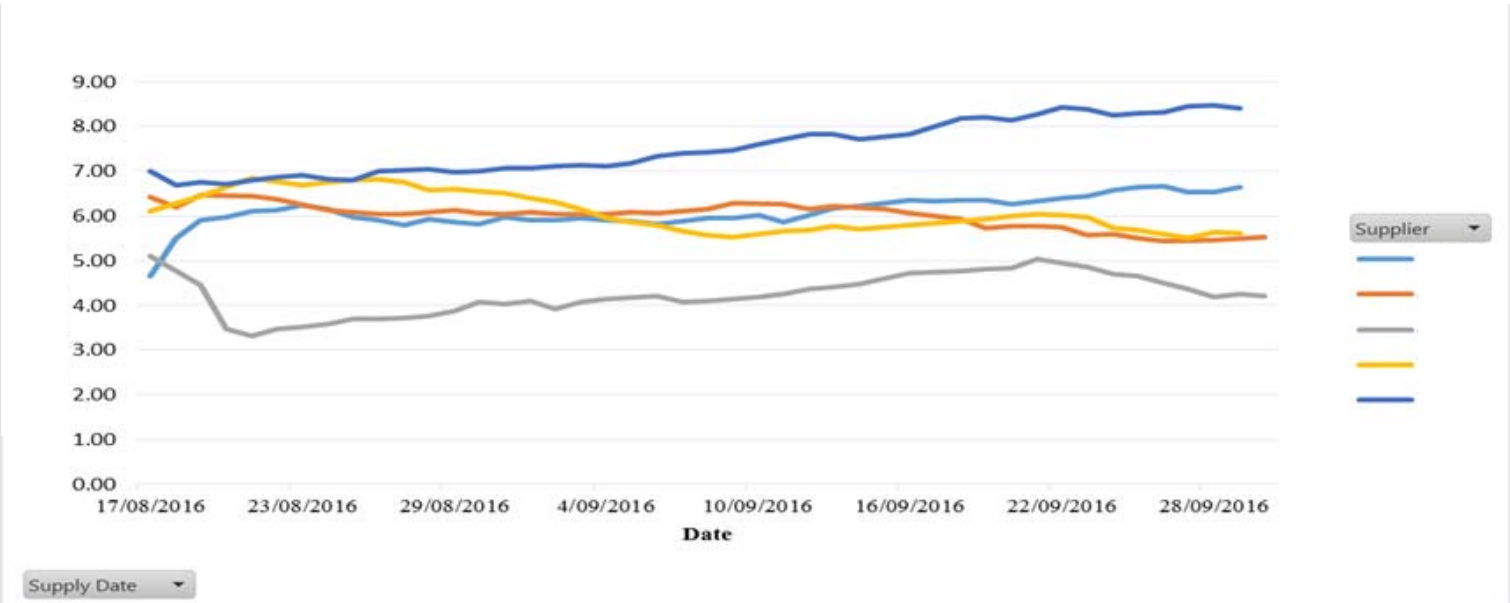
Centralised milk testing by FTIR: Opportunities

- Collection of thousands milk FTIR spectra/day.
- Networking software allows rapid collation of information.
- FTIR instruments can give outputs from multiple complex calibrations simultaneously.

Specific parameter in raw milk assessed by FTIR
3.6 million Fonterra samples 2014/5



Details on milk composition at farm level daily

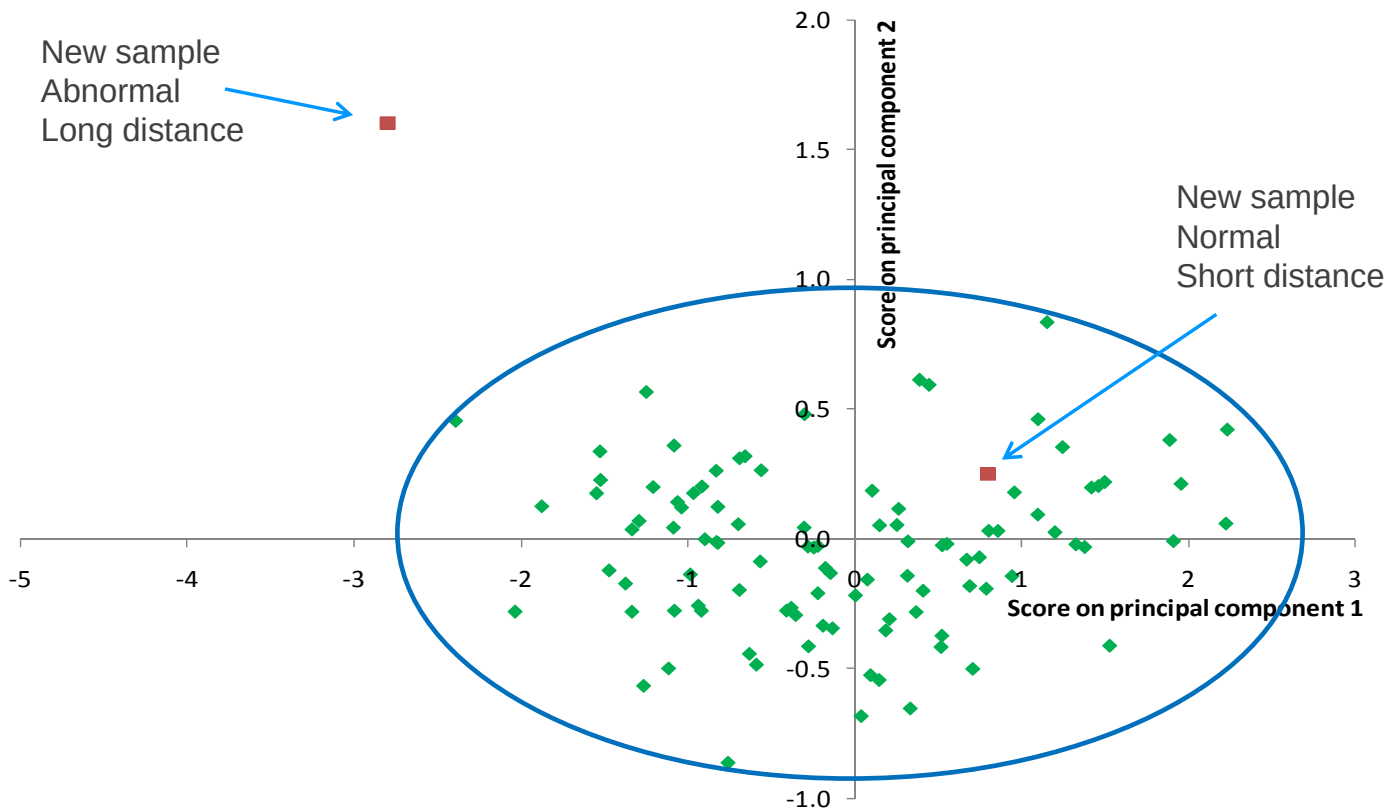


Rapid fine milk composition analysis by FTIR

- Not as accurate as “traditional” calibrations.
- Useful for trending but must understand fitness for purpose.
- Still require careful calibration and validation.
- Quantitative vs. qualitative approaches.

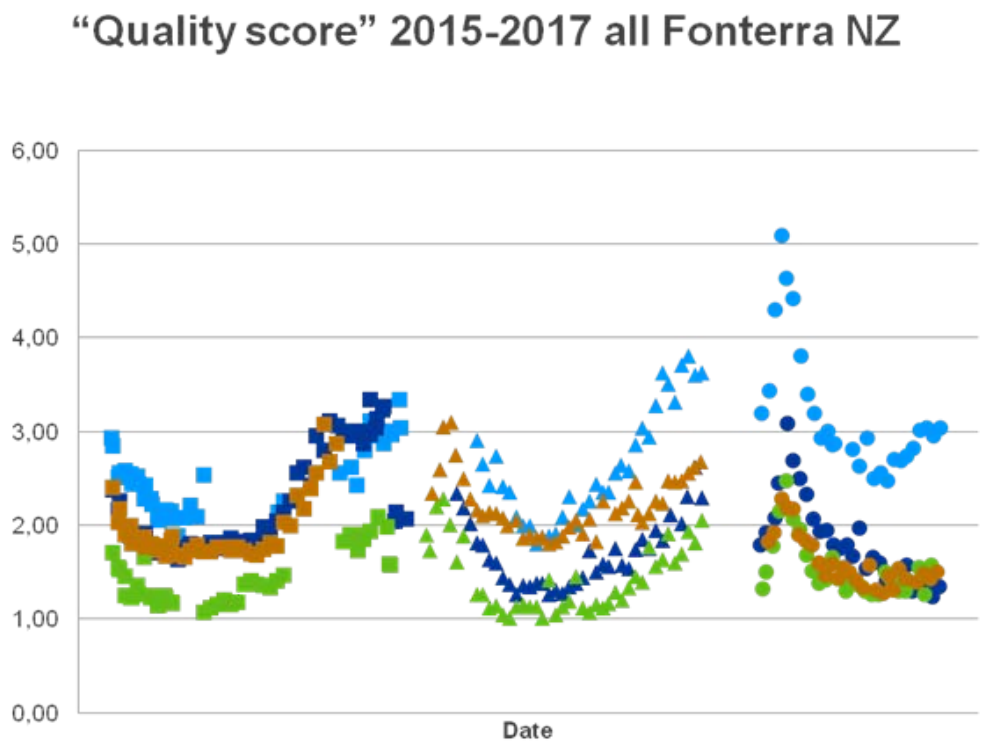
What are non-targeted methods?

Non-targeted evaluation of spectra



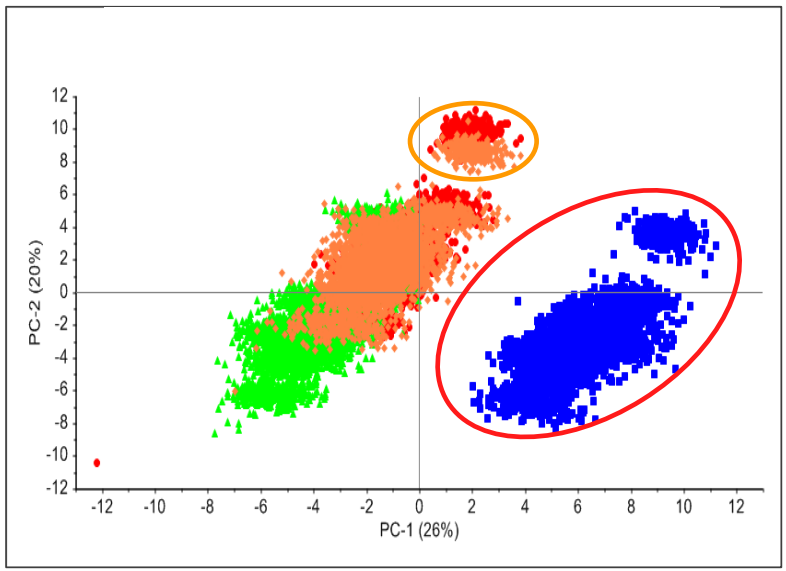
Milk “quality” by FTIR

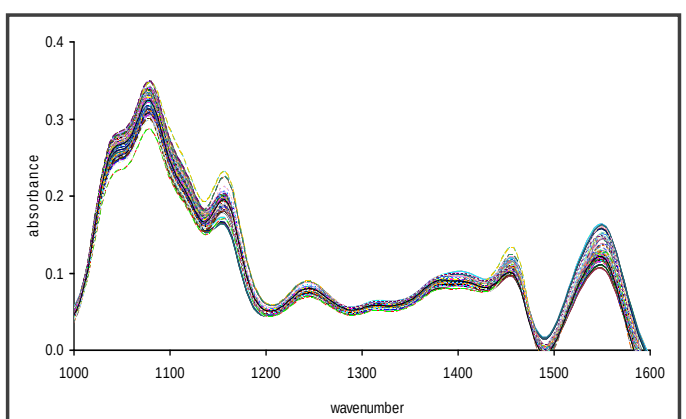
- Expand the range of compositional information available.
- Extend milk fingerprinting through the use of complimentary data sets.



Non-targeted methods - process

- Gather database – “fingerprints”
- Do statistics.
- Measure new sample and make a decision.

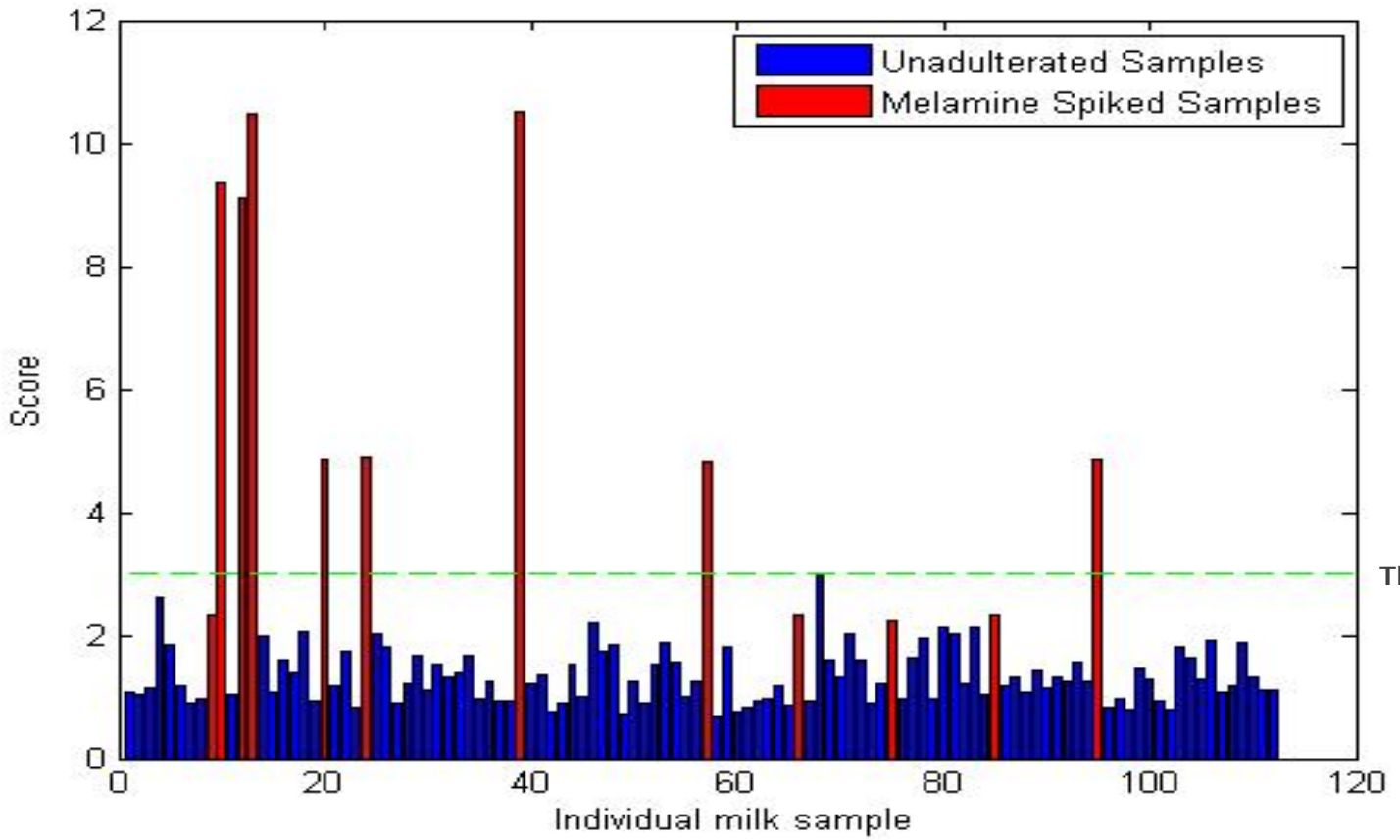




The use of targeted and non-targeted calibration models

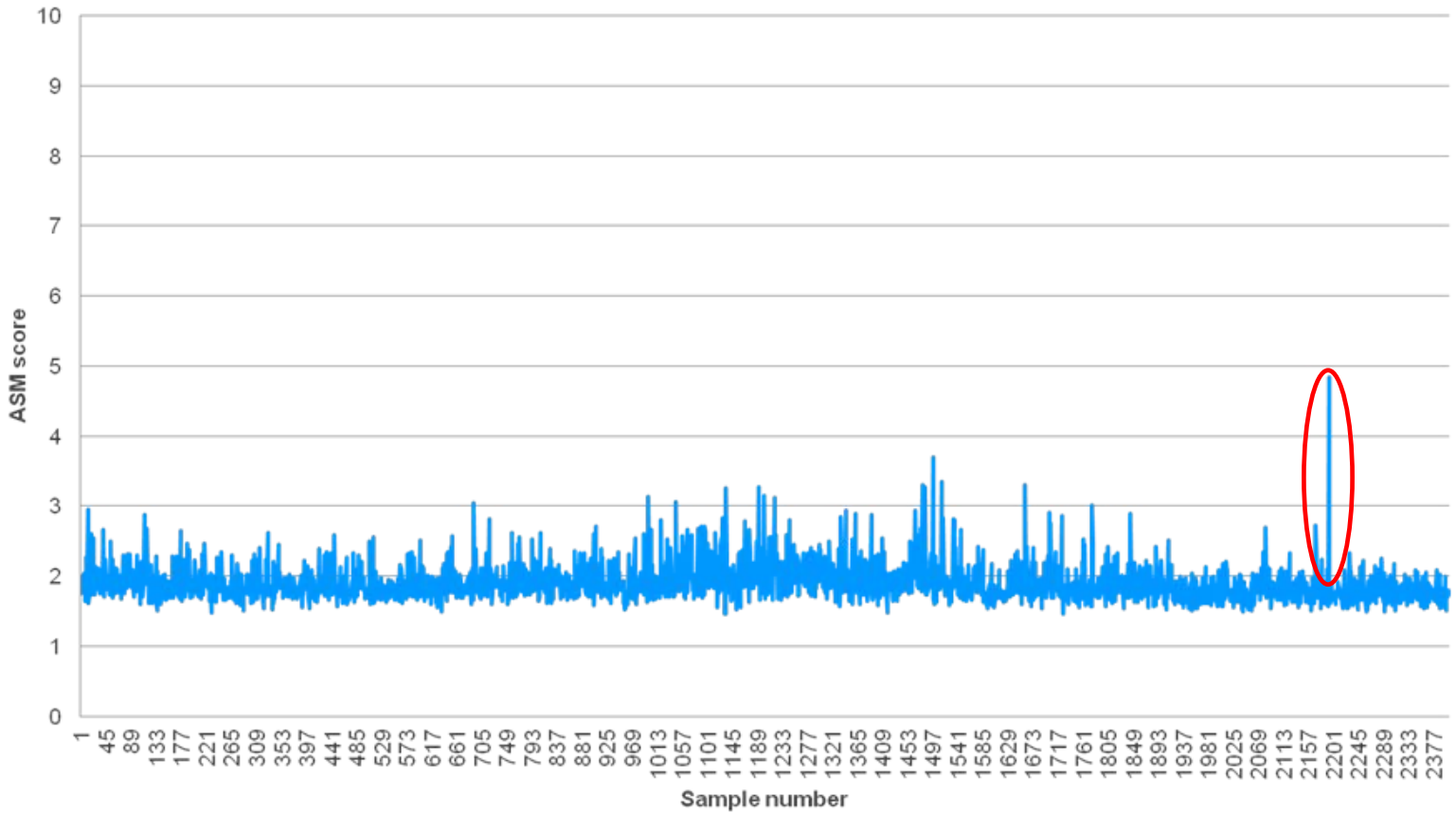
- Melamine crisis (2008) liquid milk deliberately adulterated for economic gain.
- Resulted in development of targeted and untargeted FTIR models for detecting milk adulteration at economic levels.
- Use of much more FTIR spectral information.

Results –non-targeted analysis of liquid milk by FTIR



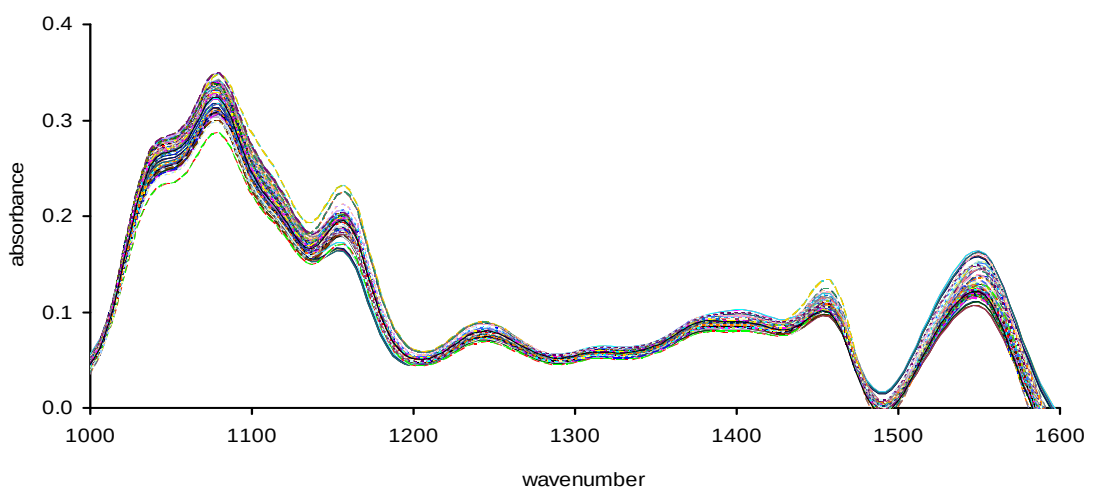
Threshold

Fingerprint FTIR analysis of NZ milk



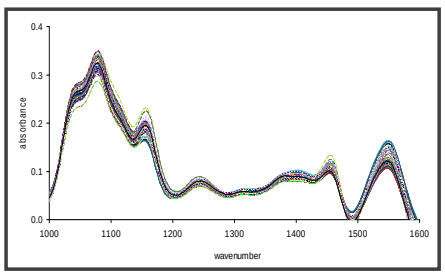
Challenges of FTIR for detailed milk composition

- How accurate can the measurement be?
- What is actually being measured?
- Will the calibration remain reliable over time and how to check it?
- Can different FTIR instruments give the same performance over time?



Vision of the future

- Wide range of FTIR systems with accuracy dependent upon value chain in specific location.
  - Targeted and non-targeted models using full FTIR spectral region.
  - Systems networked and data integrated and accessible.
  - Cost vs. accuracy understood.
  - Calibration models used for range of quality parameters.
  - Validation appropriate for application.



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