Innovative analytical and automation solutions to extract the maximum value of every milk samples for optimal herds management

By Pierre Broutin
Managing, R&D Director/Western Europe
pbroutin@bentleyinstruments.eu
www.bentleyinstruments.eu

Introduction

EU milk production is shifting to a more sustainable model associated with the reduction of milk production over the coming years.

This shift will probably keep increasing market segmentation with consumers demand for high-quality, healthy and sustainable dairy products, especially for organic, low-fat, low-sugar, no allergens, probiotic and fortified dairy products. Cheese and whey are expected to benefit the most from this shift.

Sustainability is increasingly important to the dairy industry. Producers will need to adapt to reduce their carbon footprint and environmental impact, while maintaining their business profitability.

How to produce high quality dairy products while taking into account all new societal and environmental demands in terms of health, sustainability, animal welfare, carbon footprint, at a price accepted by consumers? What are the new milk components and functionalities of interest? Can milk composition and functionalities be optimized to meet markets new demand?

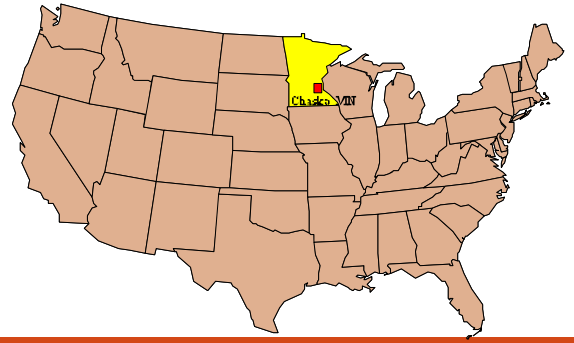
Reference methods are typically time consuming and quite expensive. New fast alternative, standardized and cost effective analytical methods are necessary to promote and monitor these new compositional and functional evolutions throughout the dairy chain.

FT-MIR technology is one of the obvious candidate being already used since 1990 on a large scale in the dairy industry and central milk testing laboratories for milk payment, dairy herd management and incoming milk and process monitoring.

Innovative Analytical & Automation Solutions for the Dairy Industry

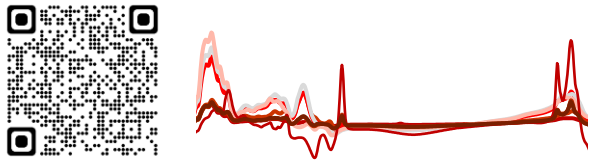
Bentley Instruments, Inc (USA)

- Company established in 1983 (near Minneapolis)
- Presents in > 60 countries
- > 110 employees
- 5 Subsidiaries in Europe + distribution network
- All our instruments IDF/ISO/ICAR certified
- Market: dairy industry exclusively



Solutions for the Dairy Plants for the rapid and highly accurate determination of milk chemical and hygienic composition

DairySpec FT
Milk/Dairy Products
Up to 64 chemical components
ICAR certified

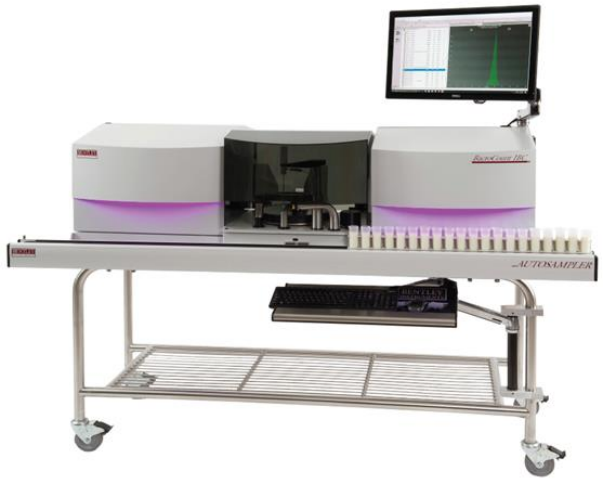


SomaCount FC
Somatic Cells
ICAR certified

New BactoCount IBCM3
Total bacteria/Somatic cells
ISO 16140 certified
By far, the fastest method on the market for total bacteria testing

Solutions for the Central Milk Testing Laboratories

BactoCount: Rapid and highly accurate determination of milk hygienic composition



New BactoCount IBC 200 Multiplex
Total Bacteria/Somatic Cells
Up to 200 samples/hour
ISO 16140 Microval Certified
Cow/Sheep/Goat

Lloyd's Register

MICROVAL®
NEN

CERTIFICATE OF COMPLIANCE

LLOYD'S REGISTER QUALITY ASSURANCE

hereby declares that the certification assessment has demonstrated that

BactoCount IBC & IBCm

Manufactured and supplied by:
Bentley Instruments
4004 Peavey Road, Chaska
MN 55138 USA

has been validated and revealed to be at least equivalent to the reference methods as demonstrated by the validation study report. The summary of the validation report is available on the MicroVal website: www.microval.org

Reference methods:
1. EN-ISO 4833-1:2013 Microbiology of the food chain – Horizontal method for the enumeration of microorganisms – Part 1: Colony count at 30 degrees C by the pour plate technique.
2. EN-ISO 4833-2:2013 Microbiology of the food chain – Horizontal method for the enumeration of microorganisms – Part 2: Colony count at 30 degrees C by the surface plating technique.

Scope: raw cow's milk

The validation and certification has been performed in accordance with EN ISO 16140-2:2016, the EURL MMP document - Validation criteria of instrumental methods for enumeration of total flora in raw milk, version 2, 21 December 2011 and the MicroVal Rules and Certification Scheme version 8.

Certificate no.: 2013LR44

First approval date: 16 December 2014
Renewal date: 08 March 2019
Expiry date: 15 December 2022

ISSUED BY: Lloyd's Register Nederland B.V.
Rotterdam, The Netherlands

Certificate no.: 2013LR44 11-03-2019 Page 1 of 1

K.P. v.d. Mandelelaan 41a, 3062 MB Rotterdam, The Netherlands. Kvk nr.: 24247948
This approval is carried out in accordance with the LRQA assessment and certification procedures and monitored by LRQA

BactoCount IBC 50-150
Total Bacteria
ISO 16140 Microval Certified

Solutions for the Central Milk Testing Laboratories

Only Combi systems ICAR certified for cow, goat and sheep milk testing

CombiFTS 400/500/600

FTIR+FC (up to 64 components)

DairySpec Combi 100/200/300

FTIR+FC (up to 64 components)

IR spectra standardized in real time without any reagent

Bentley Combi FTS 600 & Ilas 3000 robot

Fully automated and standardized samples preparation for the highly accurate determination of **milk chemical and somatic cells composition**

Main characteristics :

- Up to 600 samples/hour (Combi FTS)
- Up to 64 chemical parameters analyzed simultaneously
- Spectra standardized* in real time (without reagents)
- Samples handling fully automated and standardized for optimal analytical performances

The samples are automatically:

- Identified(RFID, code-barres…)
- Heated to 40°C or Cooled at 4°C
- Inverted and uncapped
- Analyzed
- Replaced in their original position

*patented

Quantitative IR analysis

Fatty Acids origin profiling to feed dairy herds for optimal milk fat composition

Milk contains more than 400 individual fatty acids:
(over 100 publications over last decade)

De Novo/Short Chain Fatty Acids (18-30%)
C4:0, C6:0, C8:0, C10:0, C12:0, C14:0, C14:1

Preformed/Long Chain Fatty Acids (30-45%)
C18:0, C18:1, C18:2

Mixed/Medium Chain Fatty Acids
C16:0, C16:1

Traditional Fatty Acids
Saturated, Unsaturated, Mono & Polyunsaturated, Oleic (C18:1), Palmitic (C16:0) and Stearic (C18:0)

MOATE ET AL.

Table 2. The proportions of 26 individual fatty acids (mg/g) in the total milk fatty acids from milks described in 28 publications

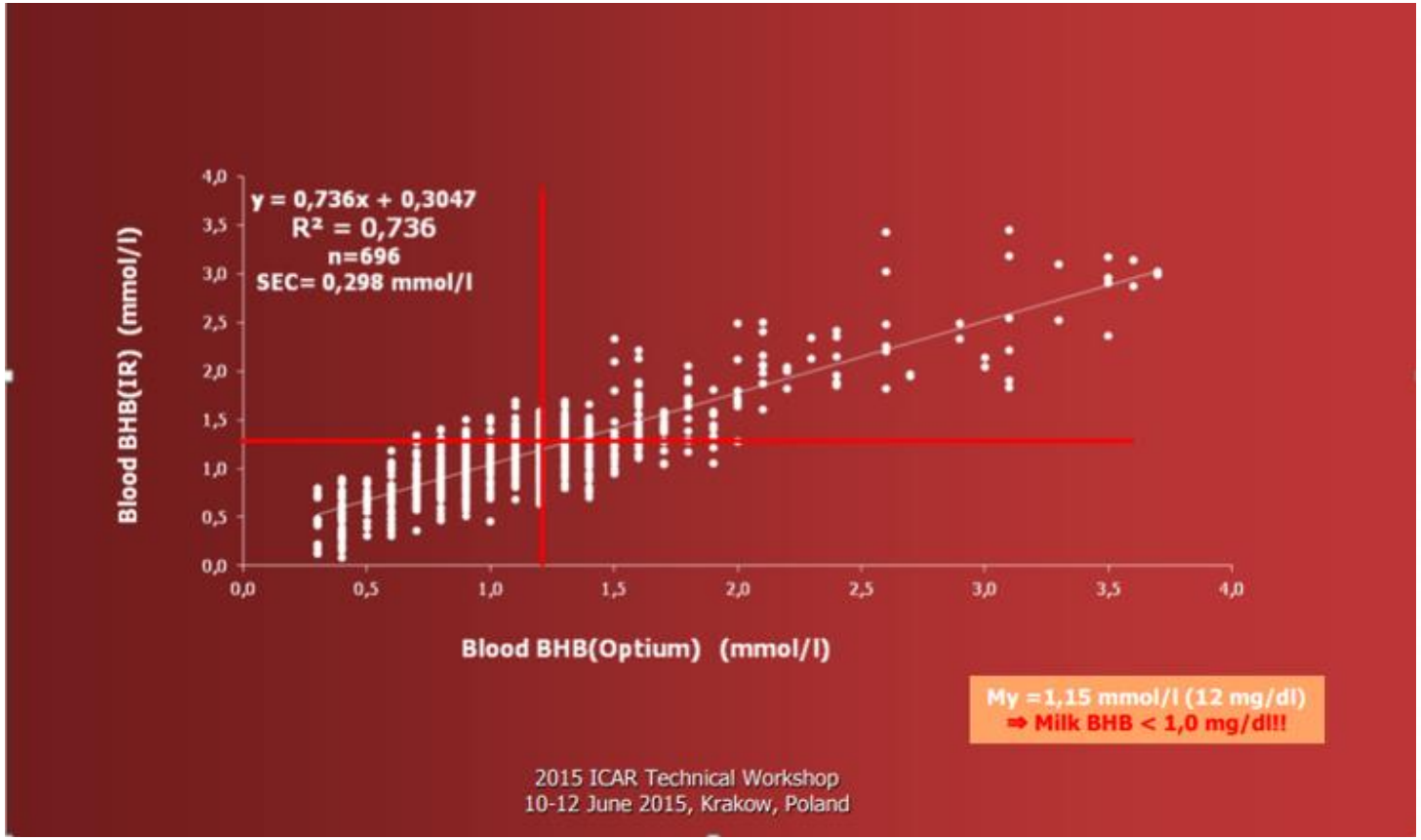
Fatty acid[1]	n[2]	Mean ± SD	Median	Minimum	Maximum
4:0	95	31.3 ± 6.8	29.9	18.4	49.2
6:0	111	19.4 ± 5.2	19.2	6.3	32.3
8:0	111	11.7 ± 3.5	12.0	4.8	20.9
10:0	111	24.8 ± 7.3	25.0	10.3	39.4
12:0	111	29.9 ± 8.5	29.0	15.0	52.2
14:0	111	103.8 ± 17.1	101.7	63.3	135.0
14:1c9	101	10.8 ± 3.6	10.9	3.5	21.3
15:0	88	10.5 ± 3.3	10.2	4	22.6
16:0	120	285.1 ± 49.8	281.5	147.1	462.1
16:1c9	109	17.3 ± 6.3	17.3	4	36.5
C_{17}	78	7.3 ± 3.5	5.9	3.3	16.7
18:0	120	105.1 ± 35.9	99.7	30.6	268.7
18:1*t*6–8	33	4.6 ± 2.1	4.9	1.2	9.6
18:1*t*9	37	4.4 ± 2.0	4.4	1.4	11.4
18:1*t*10	30	13.1 ± 15.2	8.1	0.3	64.7
18:1*t*11	90	33.3 ± 21.8	32.6	5.8	99.5
18:1*t*12	19	6.5 ± 3.6	6.3	0.9	12.7
18:1c9	120	205.0 ± 53.5	199.6	70.3	371.4
18:2c9,*c*12	120	31.3 ± 21.1	26.6	5.1	133.0
18:2c9,*t*11	76	10.2 ± 6.0	8.4	2.8	24.5
18:2*t*10,*c*12	35	0.4 ± 0.3	.3	0	1.4
18:2c11,*t*13	6	0.4 ± 0.3	0.3	0.2	0.9
OCLA	25	1.5 ± 1.4	1.1	0	4.2
18:3	114	5.9 ± 3.6	4.9	0.2	19.0
20:0	30	1.5 ± 0.6	1.5	0.4	3.0
20:5	39	1.0 ± 1.1	0.5	0	4.8
22:6	31	0.7 ± 0.7	0.4	0	2.6
Others	120	75.1 ± 56.2	76.4	0	237.3
Total CLA	82	10.3 ± 6.6	8.3	3	28.4
Total 18:1 *trans*	94	42.5 ± 26.3	39.5	8.6	145.1
Total de novo	120	232.6 ± 42.4	237.9	136.6	300.6
Total C_{16}	120	300.9 ± 52.7	303.0	154.2	462.1
Total preformed	120	466.5 ± 75.8	477.4	315.6	641.3

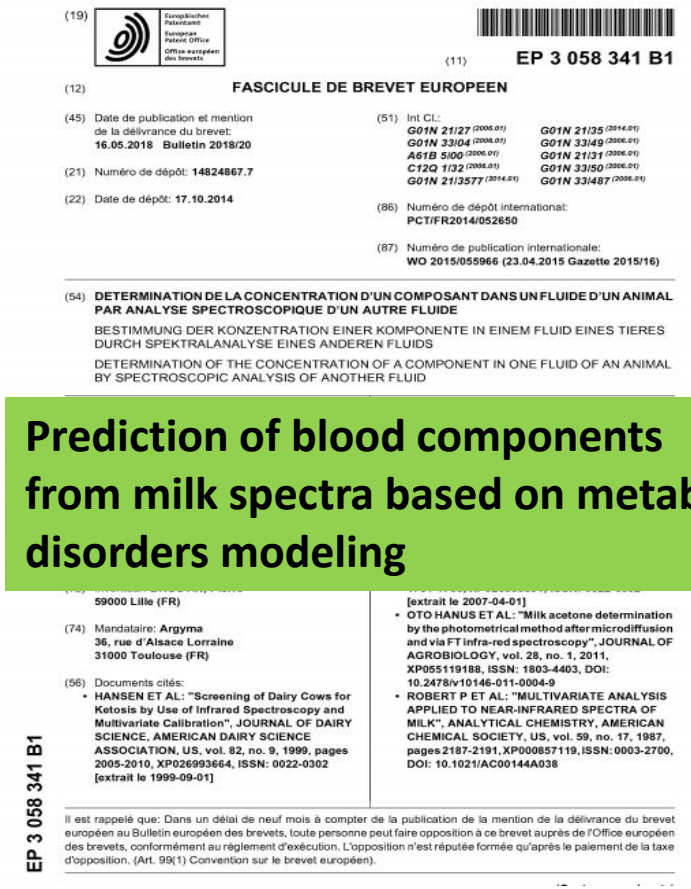
[1]*c* = *cis*; *t* = *trans*; OCLA = other conjugated linoleic acids; CLA = conjugated linoleic acid; total 18:1 *trans* = sum of 18:1*t*6–8, 18:1*t*9, 18:1*t*10, 18:1*t*11, and 18:1*t*12 isomers; total de novo = sum of 4:0 to 15:0 fatty acids; total C_{16} = sum of 16:0 and 16:1; total preformed = sum of all milk fatty acids with more than 17 carbon atoms.

[2]n = total number of dietary treatments contributing to each mean.

New biomarkers for ketosis detection

Blood BHB*(from milk spectrum)





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(54) DETERMINATION DE LA CONCENTRATION D'UN COMPOSANT DANS UN FLUIDE D'UN ANIMAL PAR ANALYSE SPECTROSCOPIQUE D'UN AUTRE FLUIDE

BESTIMMUNG DER KONZENTRATION EINER KOMPONENTE IN EINEM FLUID EINES TIERES DURCH SPEKTRALANALYSE EINES ANDEREN FLUIDS

DETERMINATION OF THE CONCENTRATION OF A COMPONENT IN ONE FLUID OF AN ANIMAL BY SPECTROSCOPIC ANALYSIS OF ANOTHER FLUID

59000 Lille (FR)

(74) Mandataire: Argyma
36, rue d'Alsace Lorraine
31000 Toulouse (FR)

(56) Documents cités:
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- OTO HANUS ET AL: "Milk acetone determination by the photometrical method after microdiffusion and via FT infra-red spectroscopy", JOURNAL OF AGROBIOLOGY, vol. 28, no. 1, 2011, XP055119188, ISSN: 1803-4403, DOI: 10.2478/v10146-011-0004-9 [extrait le 2007-04-01]
- ROBERT P ET AL: "MULTIVARIATE ANALYSIS APPLIED TO NEAR-INFRARED SPECTRA OF MILK", ANALYTICAL CHEMISTRY, AMERICAN CHEMICAL SOCIETY, US, vol. 59, no. 17, 1987, pages 2187-2191, XP000857119, ISSN: 0003-2700, DOI: 10.1021/AC00144A038

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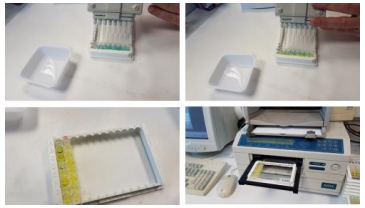
Prediction of blood components from milk spectra based on metabolic disorders modeling

Milk Amyloid A (MAA): a potent biomarker for early mastitis diagnosis and milk quality monitoring

Natural Clinical Mastitis		
Sensitivity	Specificity	Reference
93.0%	100%	Eckersall et al. 2001

Natural Subclinical Mastitis		
Sensitivity	Specificity	Reference
90.6%	98.3%	Safi et al. 2009
92.3%	92.1%	Shirazi-Beheshtiha et al. 2012



MAA is the only Acute Phase Protein produced directly by the epithelium of the udder in response to bacterial infection in the udder and as such is an immediate and direct marker of infection

Exclusive worldwide distributor

Tridelta Development Limited

Bioteck lait

Bentley Combi FTS

New potential developments: Milk-based Genetic analysis & selection

Sequence-based genome-wide association study of milk mid-infrared wavenumbers in dairy cattle

Kathryn Tiplady

T. Lopdell[1], E. Reynolds[2], R. Sherlock[1], M. Keehan[1], T. Johnson[1], J. Pryce[3,4], H. Blair[2], S. Davis[1], M. Littlejohn[1,2], D. Garrick[2], R. Spelman[1] and B. Harris[1]

[1]Livestock Improvement Corporation, Hamilton, NZ
[2]Massey University, AL Rae Centre, Hamilton, NZ
[3]Agriculture Victoria, AgriBio, VIC, Australia
[4]La Trobe University, VIC, Australia

MASSEY UNIVERSITY TE KUNENGA KI PŪREHUROA UNIVERSITY OF NEW ZEALAND

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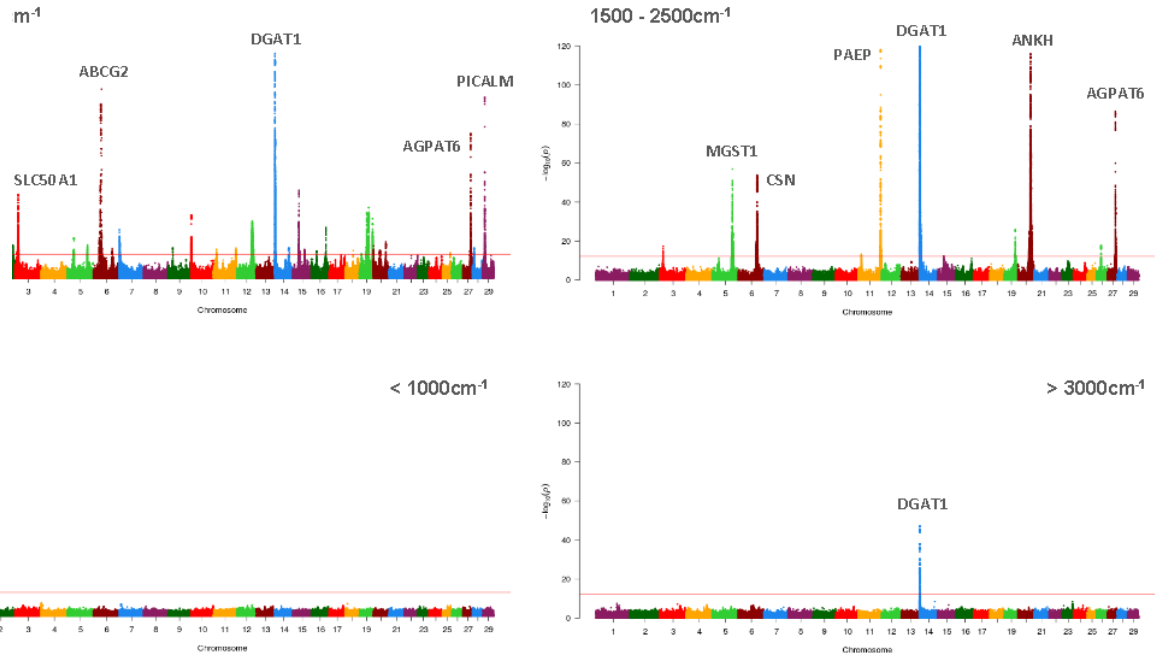


Bonferroni-threshold: $0.01/17.7m/895=6.3 \times 10^{-13}$.

Significant associations conserved across multiple wavenumbers: DGAT1 significant for over 750 wavenumbers!

Development of new IR milk phenotypes necessary to keep improving dairy herds management and sustainability

- **Feeding optimization:** fatty acids profile, urea, protein…
- **Early mastitis detection:** SCC, Milk Amyloid A, lactoferrin, citrate …
- **Early Ketosis detection:** Blood BHB*, ketone bodies, citrate, fatty acids profile …
- **Breeding/Genetic selection:** Standardized IR spectra*, fat & protein profiling, urea, ketone bodies…
- **Environmental impact mitigation:** nitrogen, methane emission (from fatty acids profile), phosphorus….

*patented

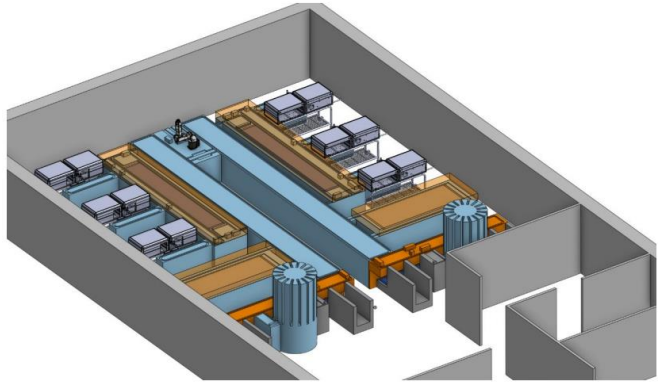
A new holistic approach for the optimum valorization of every milk samples

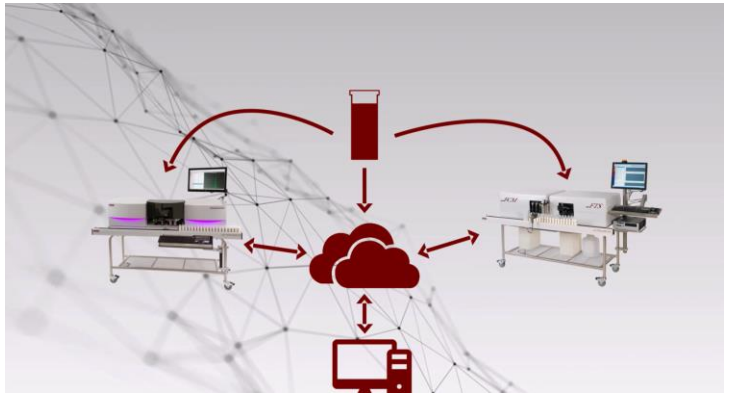
Why?

- **Streamline mass & multiplex testing at the sample level** to reduce operation costs while extracting the maximum value of every samples of interest by intelligently combining multiple analytical methods

- **Standardize milk samples preparation** and handling before testing, a critical step to secure analytical methods standardization and performances for worldwide results equivalence

- **Increase laboratory throughput** with potential speed up to 600 samples/hour and deal more efficiently with peaks in samples distribution with samples automatically dispatched to open analyzers

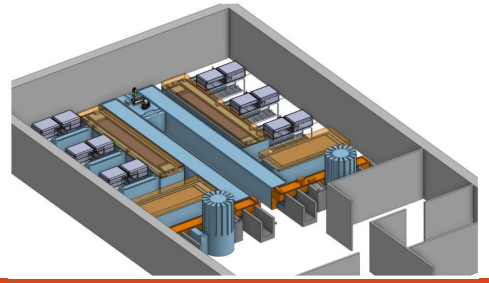




Innovative analytical and automation solutions to extract the maximum value of every milk samples for optimal herds management

Conclusion

The development of a holistic model combining latest high throughput standardized methods in combination with complete laboratory automation makes it possible to streamline mass & multiplex testing at the sample level for the benefit of the dairy industry.



Thank you for your attention!

Looking forward to meeting you on our stand

pbroutin@bentleyinstruments.eu

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