40th Biannual session of ICAR, Puerto Varas Chile, 24-28 Oct 2016

THE GLOBAL STANDARD FOR LIVESTOCK DATA

ICAR Chile 2016

Network. Guidelines. Certification.

OptiMIR: Use of MIR spectra to predict multiple cow status as advisory tools for dairy farms

Grelet.C[1], Gengler.N[2], Bastin.C[3], Vanlierde.A[1], Smith.S[4], Gelé.M[5], Soyeurt.H[2], Massart.X[6], Dardenne.P[1], **Dehareng.F**[1]

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[4] SRUC, Edinburgh, United Kingdom
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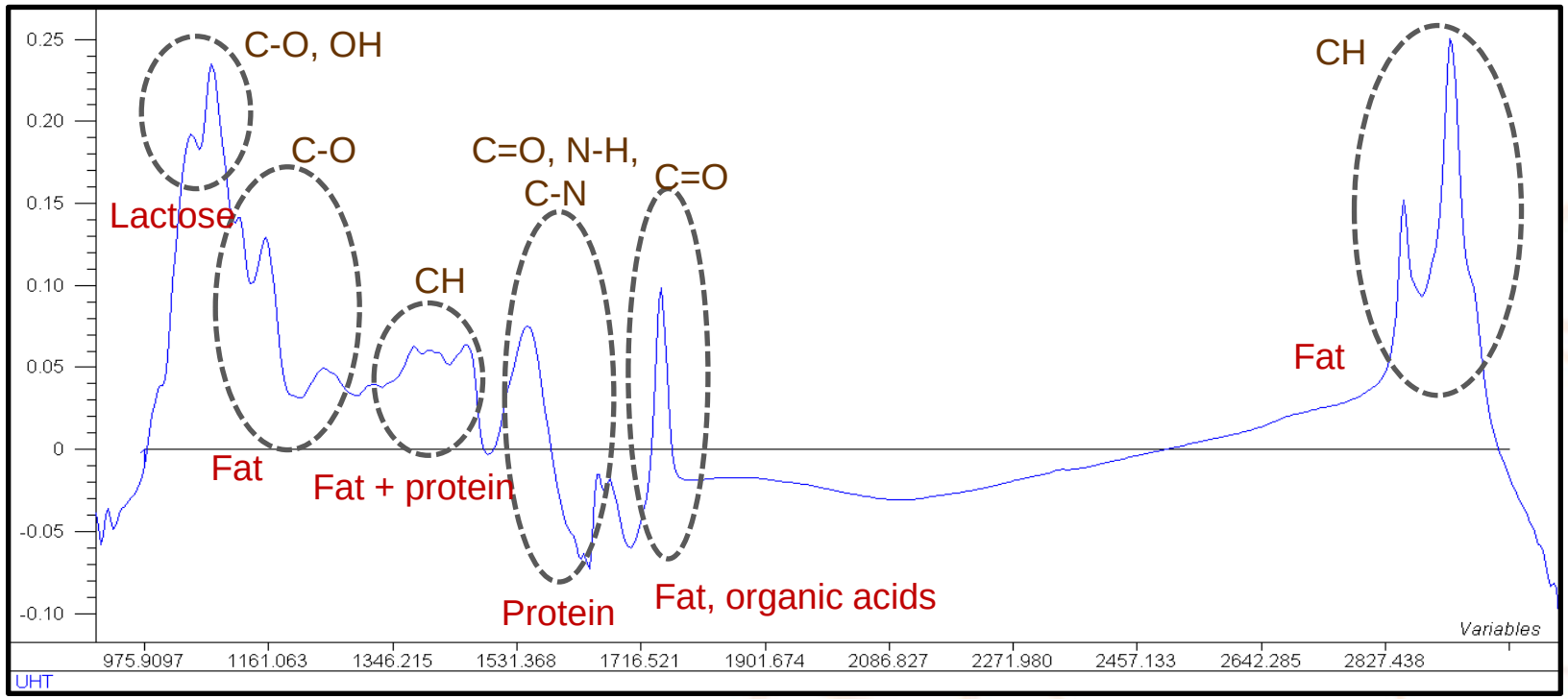
[6] EMR, Ciney, Belgium

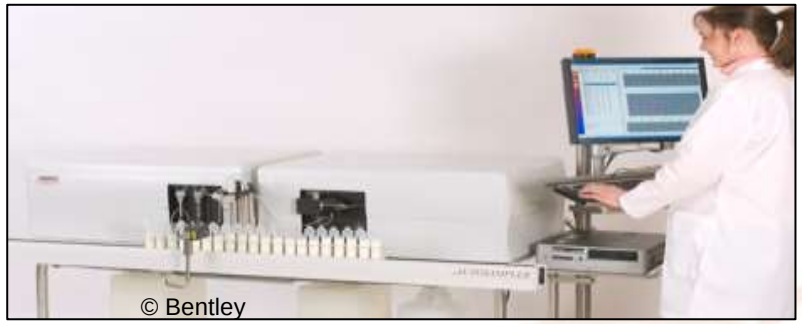
MIR technology

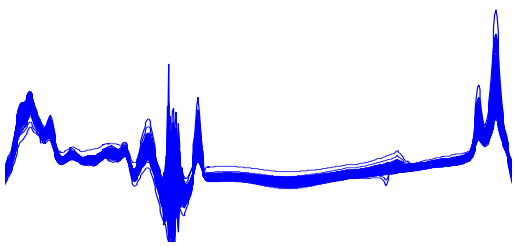


- **Position** of the peaks → **Qualitative** analysis
- **Intensity** of the peaks → **Quantitative** analysis

Classical use of MIR spectra

Milk control





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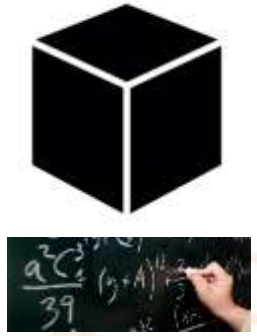


Composition

Fat

Proteins

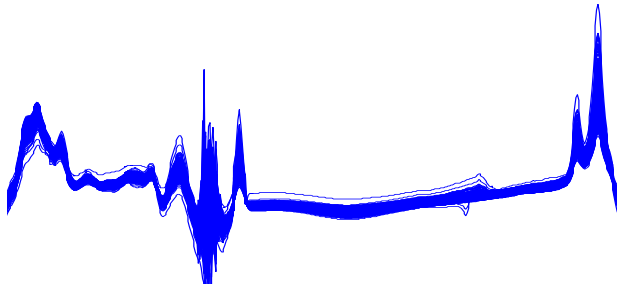
Urea

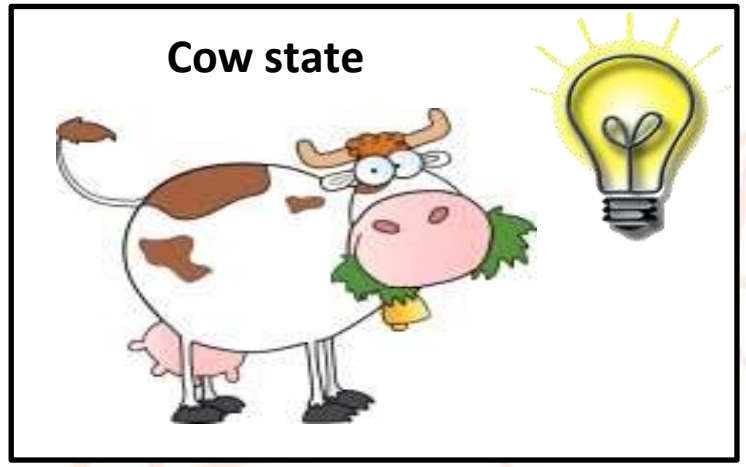
Lactose

...

Innovative view of OptiMIR

MIR spectra



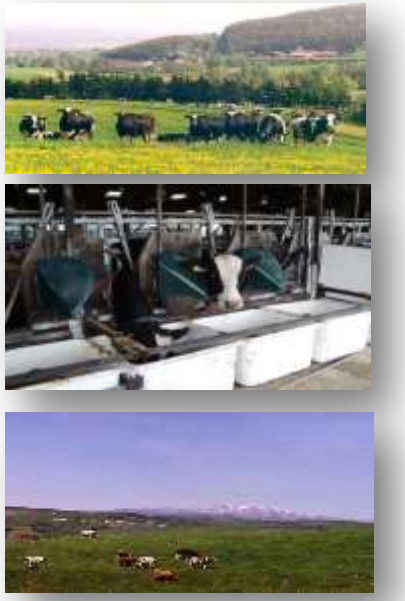


Prediction tools fast, cheap, via milk control organisations

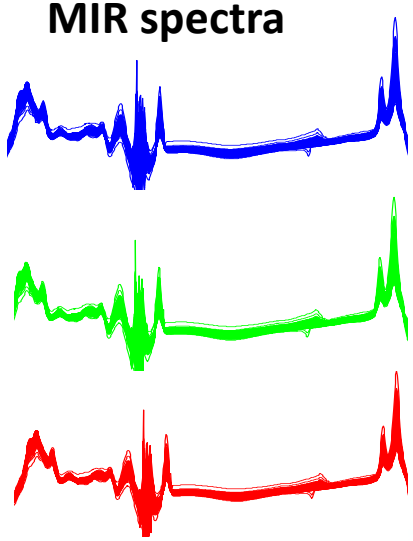
Information on :

- **feeding** (acidosis, ketosis, energy balance…)
- **health** (mastitis…)
- **environmental impact** (methane…)
- **fertility** (pregnancy…)

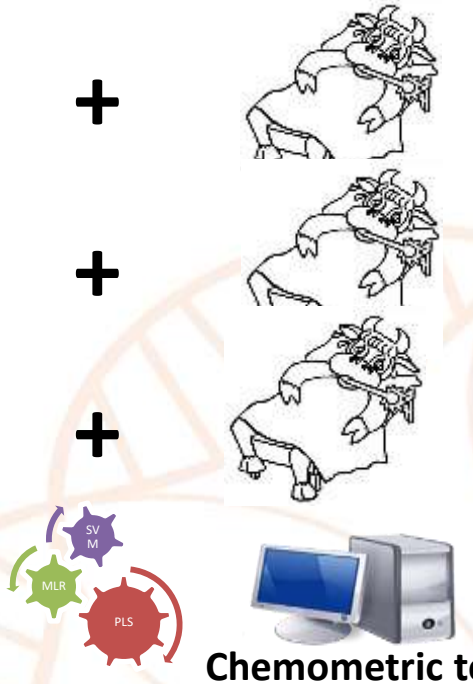
Development of new tools



MIR spectra



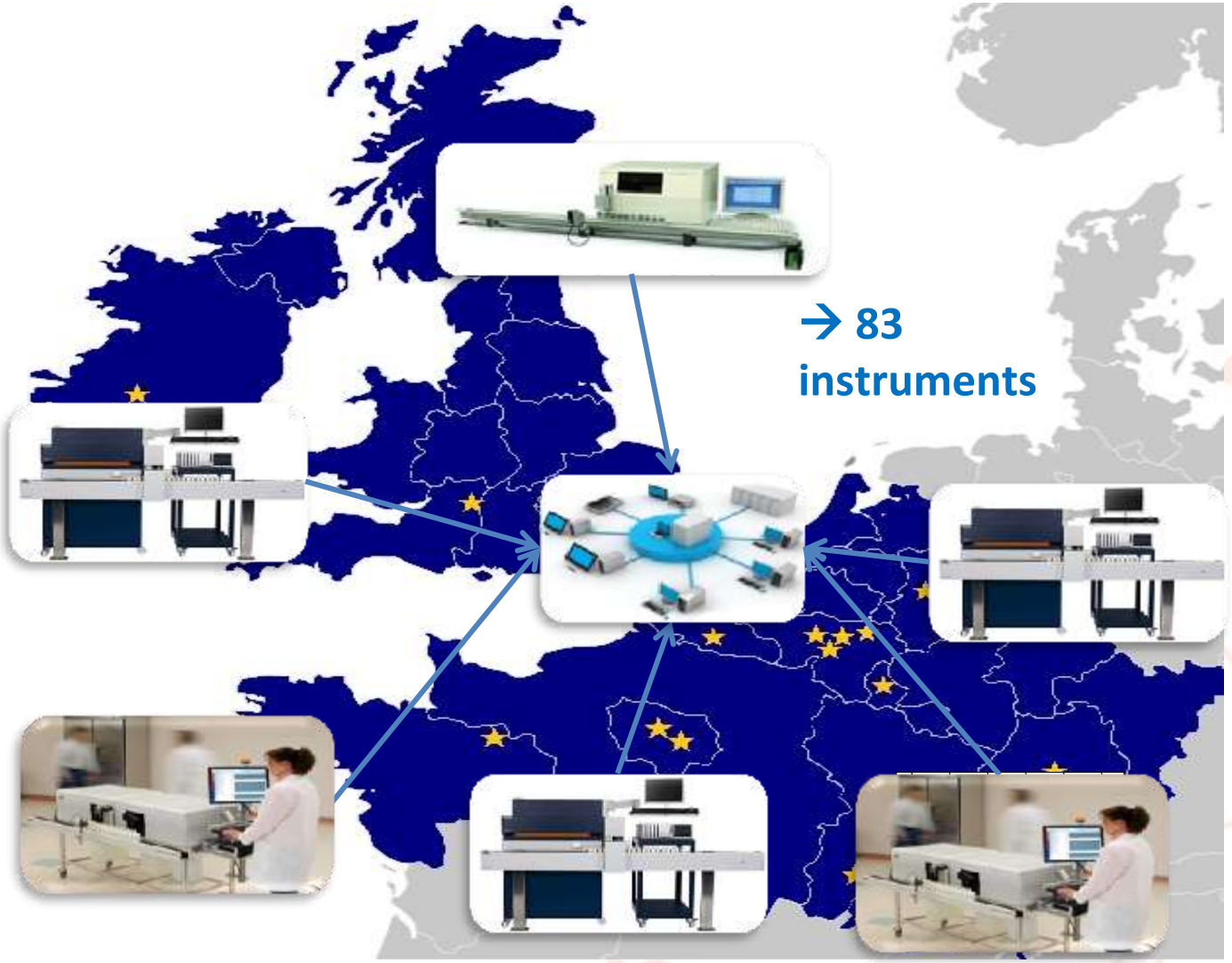
Reference analysis



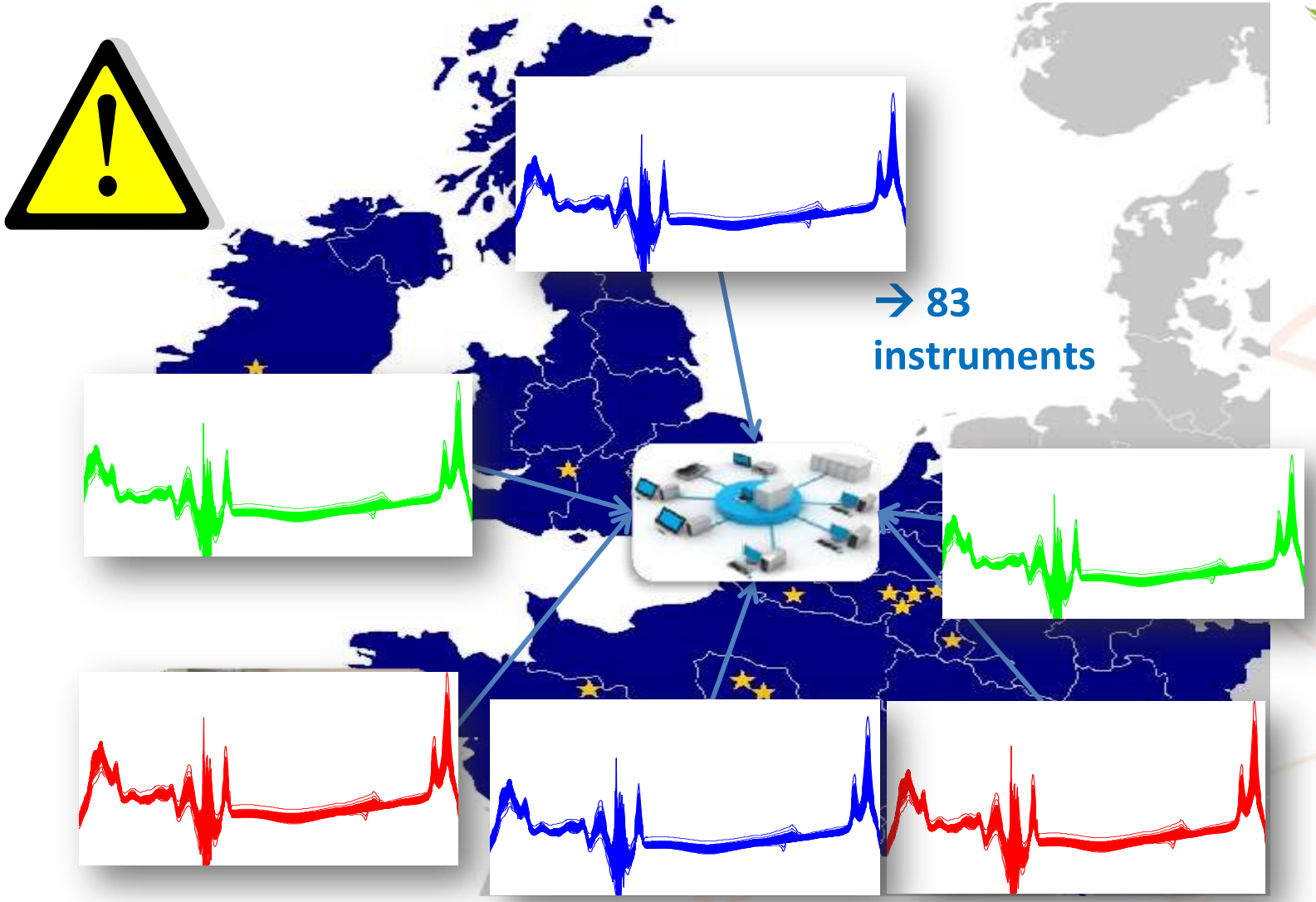
Chemometric tools

Model predicting reference analysis from MIR spectra

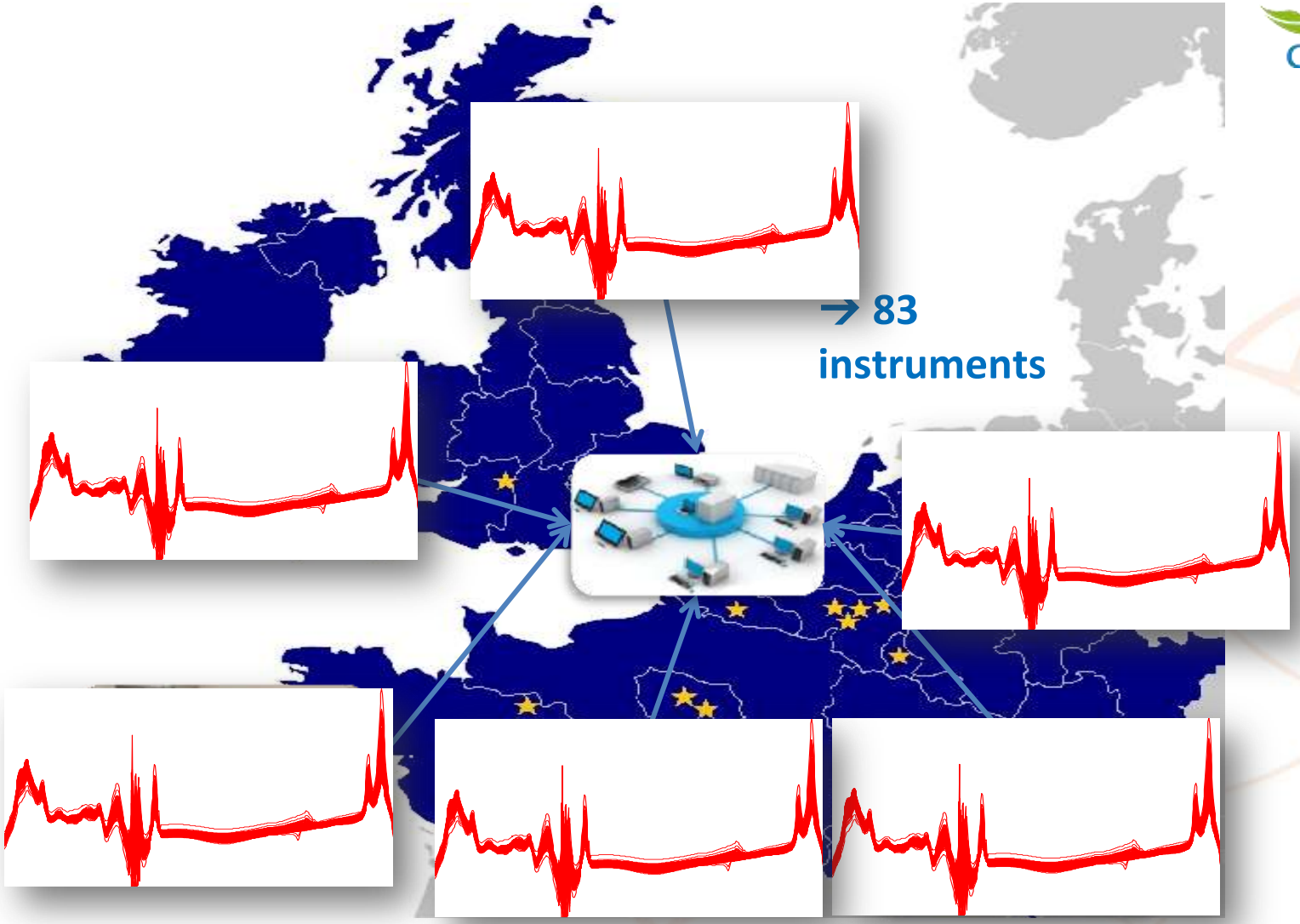
OptiMir network



OptiMir network



Spectral standardisation



Grelet et al. 2015 J. Dairy Sci. 98: 2150-60

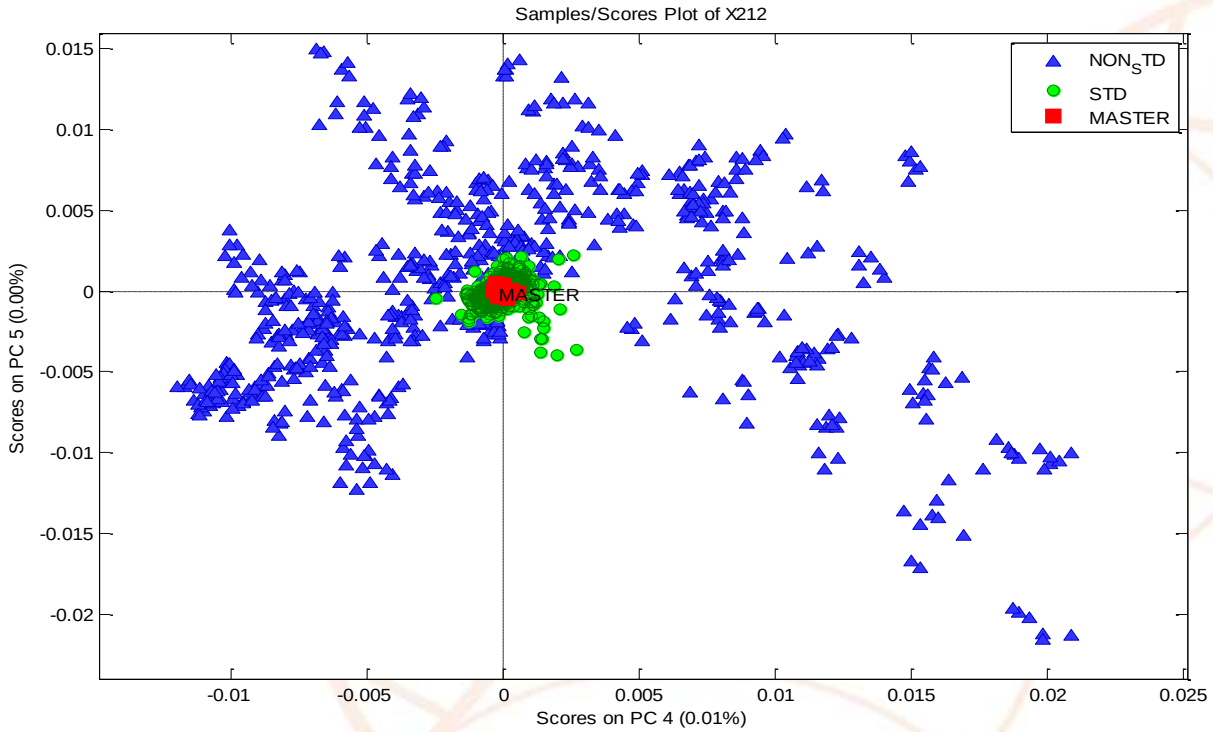
Impact of standardisation

-Harmonize the spectral format

-Allow merging of data

-Creation of common models

Models can be used on all instruments



Grelet et al. 2015 J. Dairy Sci. 98: 2150-60

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OptiMIR models

Grelet.C, Gengler.N, Bastin.C, Vanlierde.A, Smith.S, Gelé.M, Soyeurt.H, Massart.X, Dardenne.P, Dehareng.F

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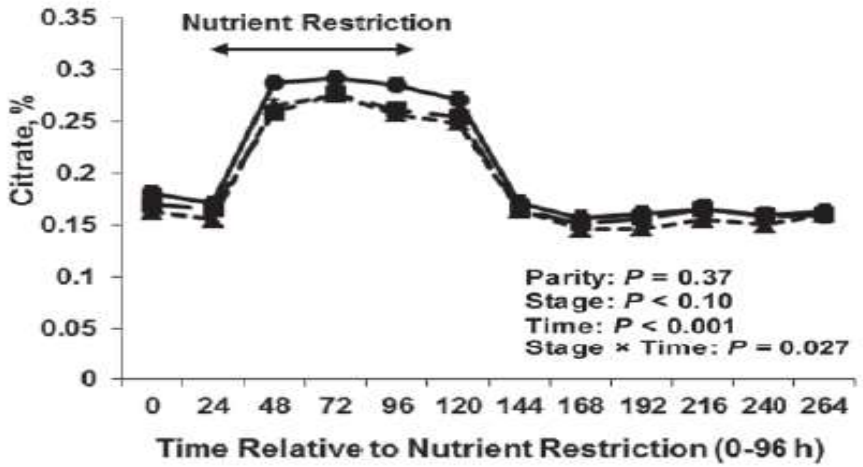
Negative energy balance – milk biomarker

Bjerre-Harpoth (2012) : Induced nutrient restriction



« …greatest increase (58%) during restriction for all cows »

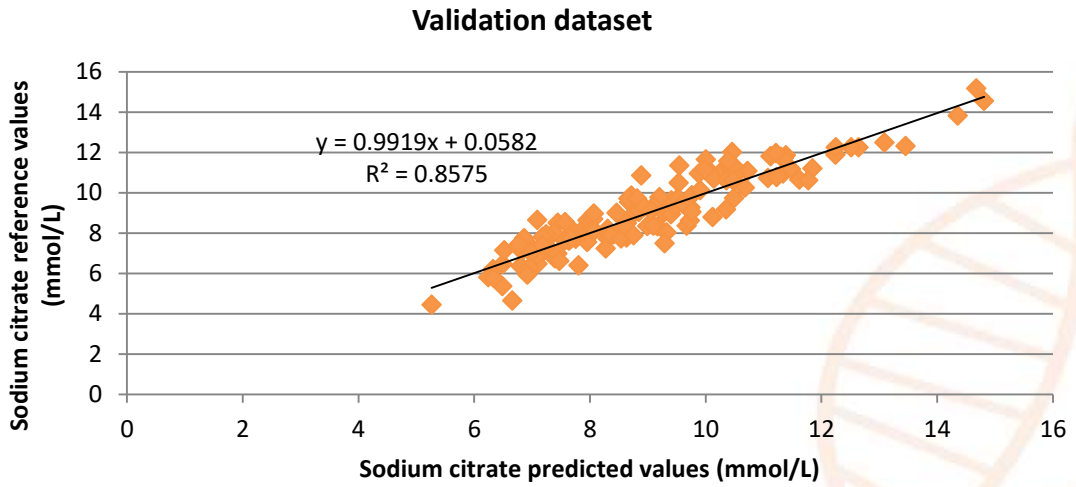
« …promising <u>early</u> indicator of physiological imbalance »

<u>Citrate</u> in milk as early indicator of physiological imbalance

Negative energy balance – milk biomarker

- **Statistics for citrate model (PLS)**

Item	N	No. of LV	No. of Outliers	Min	Max	Mean	SD	RMSE	R^2	RPD
Sodium citrate (mmol/L)										
Cross-validation	380	9	2	3.88	16.12	9.03	2.26	0.7	0.9	3.21
Validation	126	-	-	4.44	15.16	9.08	2.03	0.76	0.86	2.96



Allows screening, quantitative information

Negative energy balance – direct phenotype

SRUC

Data :

- 526,509 daily records
- 962 cows were available from
- France and the UK

Data treatment

- Spectra standardized
- Smoothed data (S.Denholm 2015)
- PLS regression

OptiWIR

Innovate UK
Technology Strategy Board

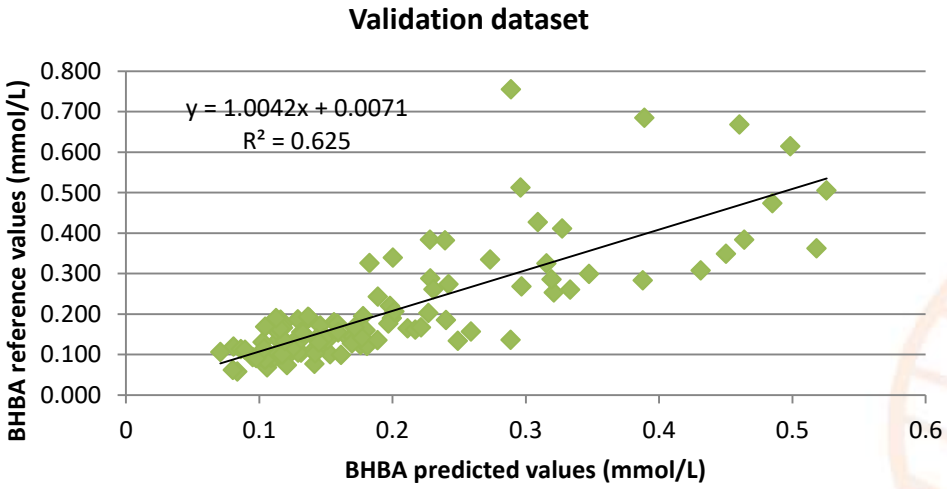
	R^2cv	R^2cv
Energy Balance (MJ/d)	0.20	0.58
Energy Content (MJ/d)	0.22	0.24
Energy Intake (MJ/d)	0.32	0.48
	S.Smith, 2015	S.Smith, 2016, personal communication

Ketosis – milk biomarkers

BHB and Acetone in milk known as biomarkers (Enjalbert et al., 2001)

- **Statistics for milk BHB model (PLS)**

Item	N	No. of LV	No. of Outliers	Min	Max	Mean	SD	RMSE	R^2	RPD
BHB (mmol/L)										
Cross-validation	325	8	7	0.045	1.596	0.235	0.193	0.109	0.71	1.77
Validation	108	-	-	0.058	0.755	0.204	0.136	0.083	0.63	2.36



	Low BHB content (<0.200mmol/l)	High BHB content (>0.200mmol/l)	Global good classification
Validation	n=77	n=32	
Predicted low	90.90%	9.40%	90.80%
Predicted high	9.10%	90.60%	

Allows discriminate high or low levels

Ketosis – Direct phenotype

4 farms in France and Germany
1124 collected phenotypes on 214 cows

Prediction of the level of ketosis risk

- **High risk: blood BHB>1.2 mmol/L or NEFA>0.8**

versus

- **Low risk**

Results on cross validation (n=566)

Sensitivity = 84,5 %

Specificity = 84,2 %

		Prediction	
		Negative	Positive
Observation	Low risk	234	44
	High risk	43	235

M.Gelé, 2015

Other models

- Fatty acids profile (32 FA and groups of FA)
  - 1827 milk samples
  - 6 countries
  - 17 breeds

Soyeurt et al. 2011 J. Dairy Sci. 94: 1657-67
& Bastin et al. 2011 J Dairy Sci. 94: 4152-63

- Minerals in milk
  - 1181 samples
  - 4 countries

Soyeurt et al. 2009 J. Dairy Sci. 92: 2444–54
& Soyeurt et al. 2012 EAAP 63rd Annual meeting, 17

- Methane
  - SF6 and respiratory chambers
  - 7 countries

Vanlierde et al. 2015 J. Dairy Sci. 98 : 5740-47
& Vanrobays et al. 2016 J. Dairy Sci. 99 : 7247-60

cra-w

Use on field

Grelet.C, Gengler.N, Bastin.C, Vanlierde.A, Smith.S, Gelé.M, Soyeurt.H, Massart.X, Dardenne.P, Dehareng.F

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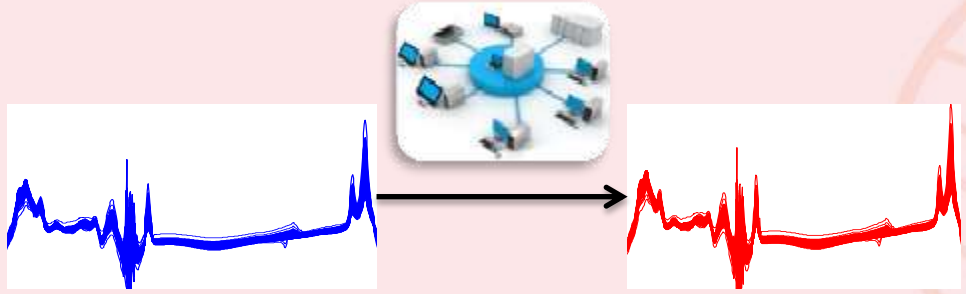
Use of new tools on field

Standardization



New models

New phenotypes

NEB

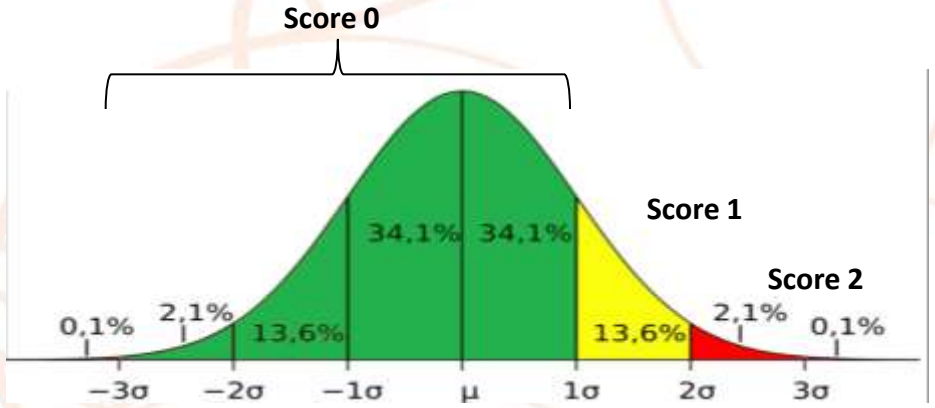
Ketosis risk

Methane…

Ketosis tool developed by AWE (BE)

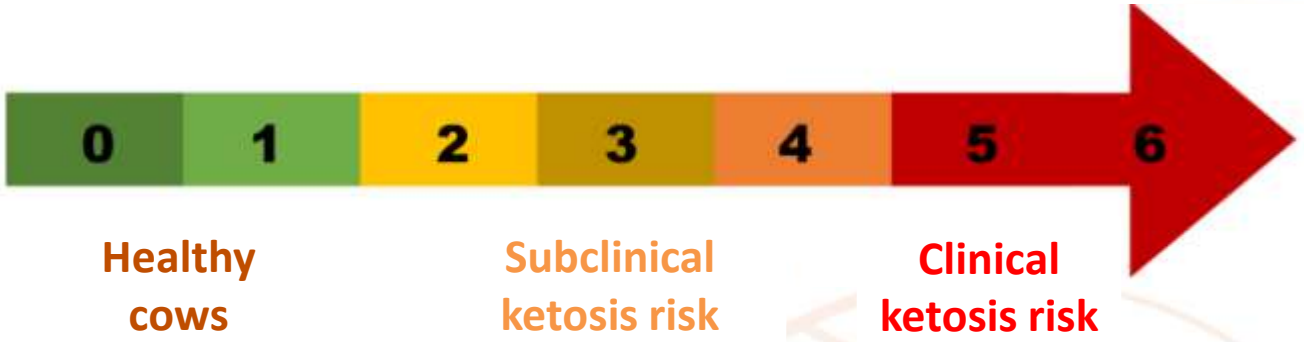
- Walloon breeding association (AWE) tool using models developed in Optimir project
- Global Ketosis index tool: Combination of BHB, acetone predictions and fat/protein ratio
- Relative approach for each biomarker: Cow value compared to population values at same DIM

Score 0,1 or 2 for each component



Ketosis tool developed by AWE (BE)

- Global score from 0 to 6 as a global indication for ketosis status



- Currently in test in 75 farms
- Good feedback from cattle breeders

Conclusion

✓ Creation of Standardization procedure

- Network of 83 MIR instruments currently standardized in routine
- Creation of common spectral data base
- Possible to use all existing and future models on all instruments

✓ Creation of new models
e.g.

- Prediction of Negative energy balance
- Prediction of ketosis risk

✓ Upgrade of existing models : Methane, fatty acids, minerals, …

✓ Creation of EMR (European Milk Recording)

Thank to all our partners

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