Individual methane prediction from milk MIR spectra, across multiple breeds, lactation stages, partities and country-specific dairy farming systems

A. Vanlierde, N. Gengler, H. Soyeurt, C. Martin, E. Lewis, F. Grandl, M. Kreuzer, B. Kuhla, P. Lund, C. Ferris, C. Bertozzi, F. Dehareng

Speaker: ***Frédéric Dehareng***

Walloon Agricultural
Research Centre

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Context : Methane produced by ruminants

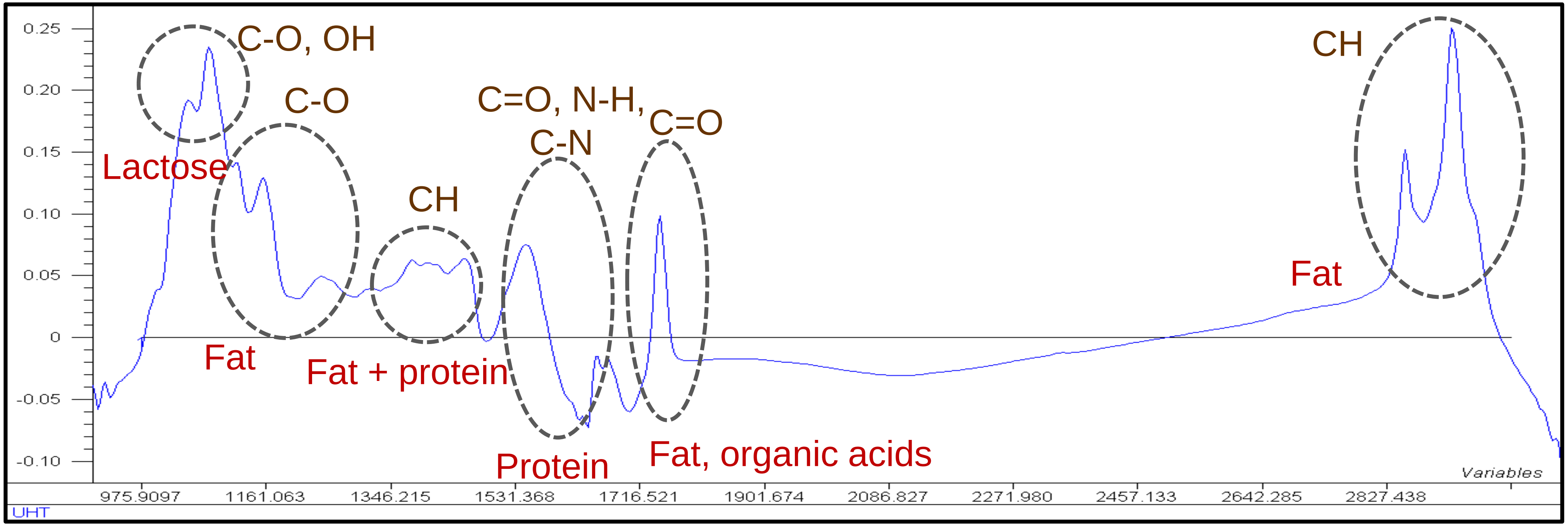
Greenhouse gas + loss of gross energy intake (6 to 12%)

Sources of mitigation of CH_4 emissions :
- genetics
- diet
- management

Development of a technique that allows large scale studies

FT-IR used in Milk Recording Organisation ?

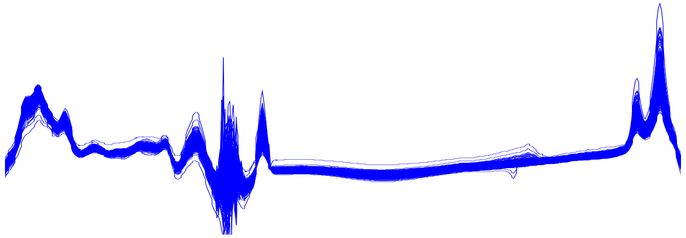
Potential use of Mid infrared spectra of the milk ?

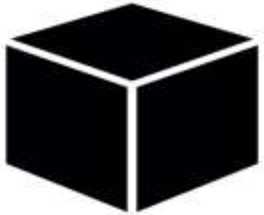


- **Position of the peaks → Qualitative analysis**
- **Intensity of the peaks → Quantitative analysis**

Potential use of Mid infrared spectra of the milk ?

Milk control





Classical use of MIR spectra

Composition

Fat

Proteins

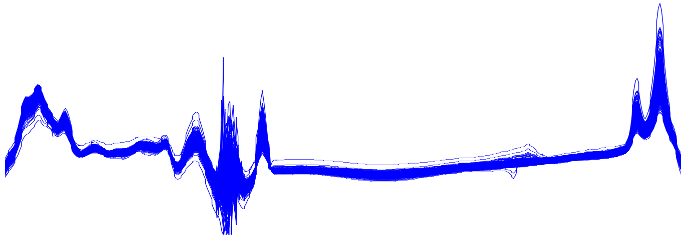
Urea

Lactose

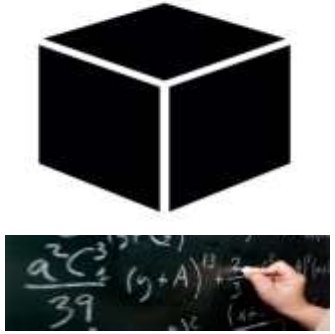
…

Potential use of Mid infrared spectra of the milk ?

Milk control



+



Indirect trait

ERUCTED METHANE ?

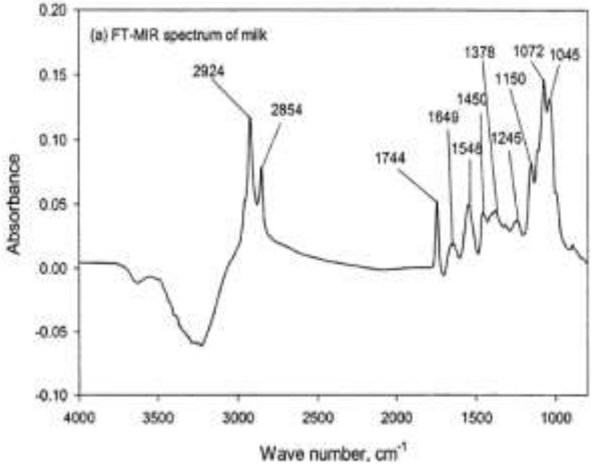
Innovative use of MIR spectra

Principle to build the equation

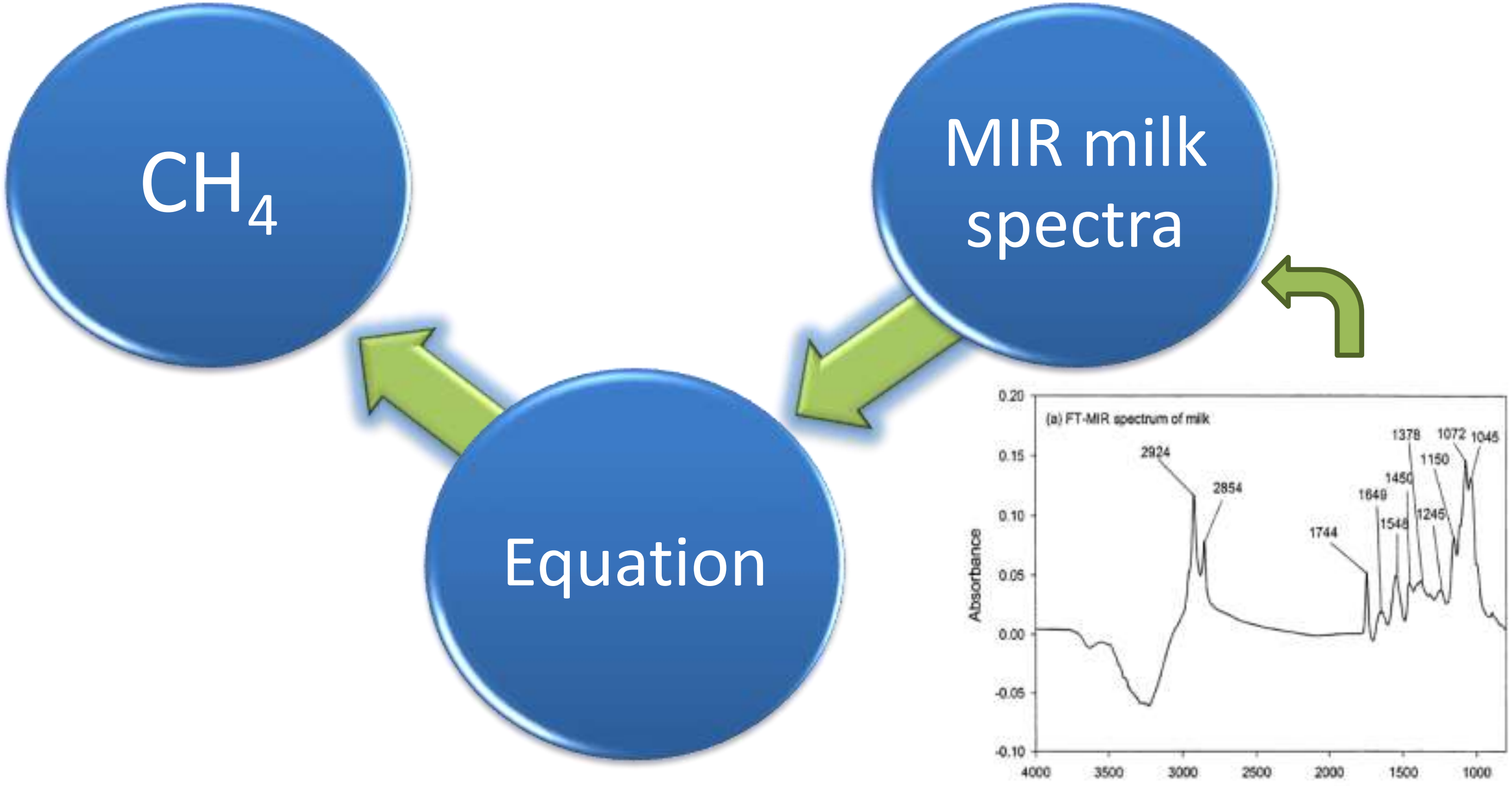
CH_4

MIR milk spectra

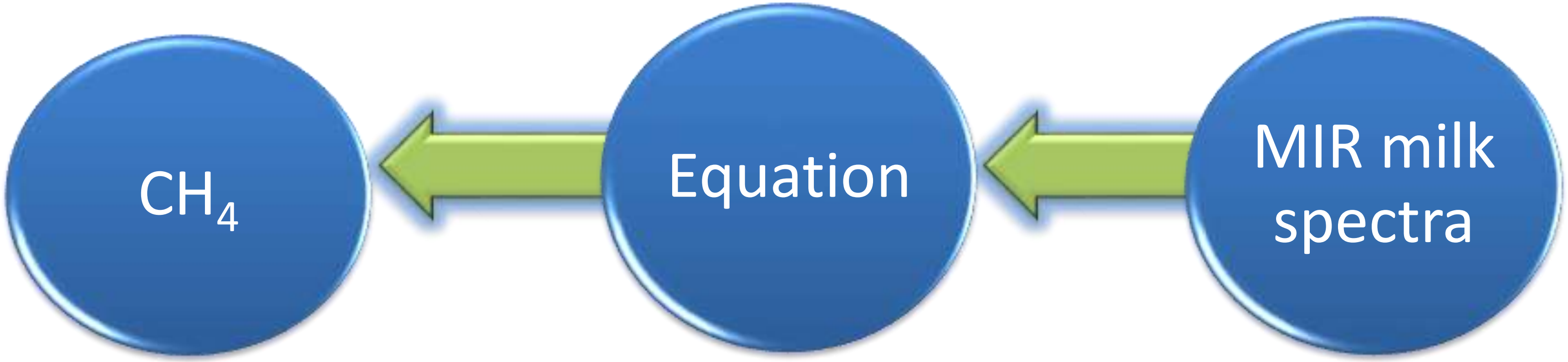
Equation



Principle of prediction



First equation of prediction



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animal

Potential use of milk mid-infrared spectra to predict individual methane emission of dairy cows

F. Dehareng[1*†], C. Delfosse[1*], E. Froidmont[2], H. Soyeurt[3,4], C. Martin[5], N. Gengler[3,4], A. Vanlierde[1] and P. Dardenne[1]

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First equation of prediction

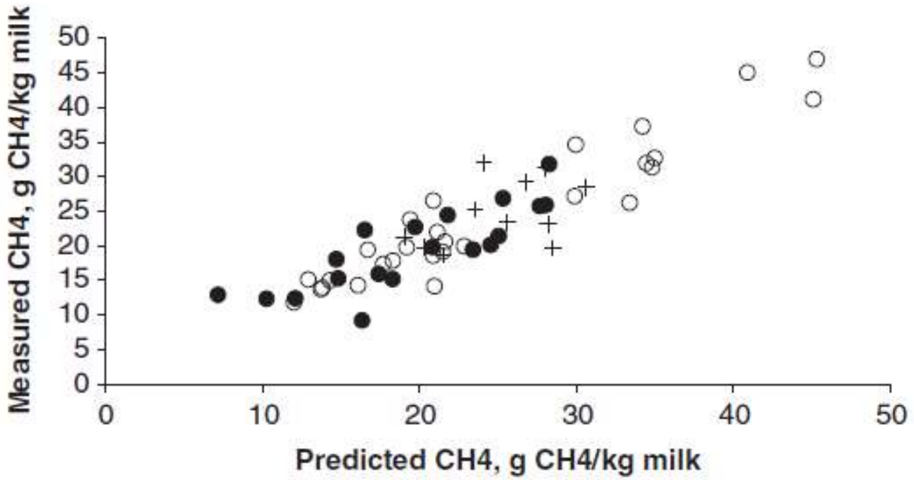


Figure 3 Infrared methane prediction on the basis of milk spectra of the day 1.5 for the different diets: corn silage (●), fresh pasture (○) and grass silage (+). PCA = principal component analysis.

Equation	N	SD	R^2c	R^2cv	SEC	SECV
CH_4 (g of CH_4/Kg of milk)	60	7.3	0.85	0.75	4.25	5.61
CH_4 (g/day)	60	128	0.77	0.70	87.8	100.6

N = number of observations; SD = standard deviation; R^2c = calibration coefficient of determination; R^2cv = cross-validation coefficient of determination; SEC = calibration standard error; SECV = cross-validation standard error

Merging of reference data sets

More data are needed to - include more variability

- improve performance of the equation

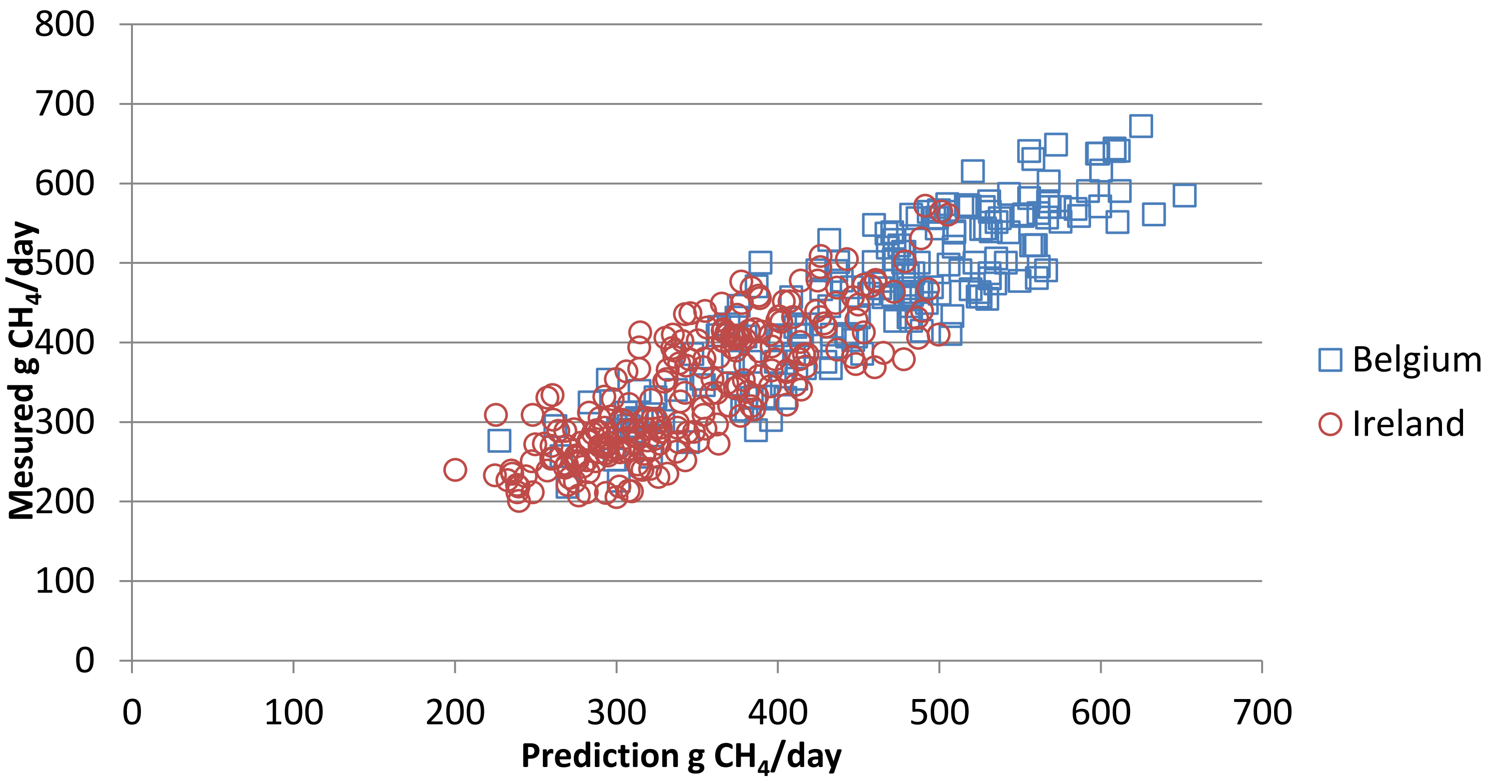
Merging of reference data sets

Use of different instruments

Standardisation step needed

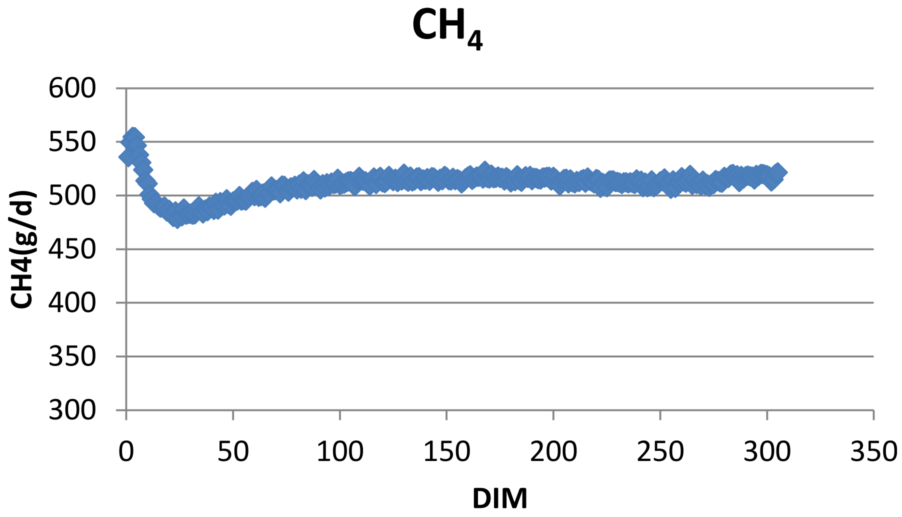
EMR procedure (OptiMIR Project)

Merging of reference data sets

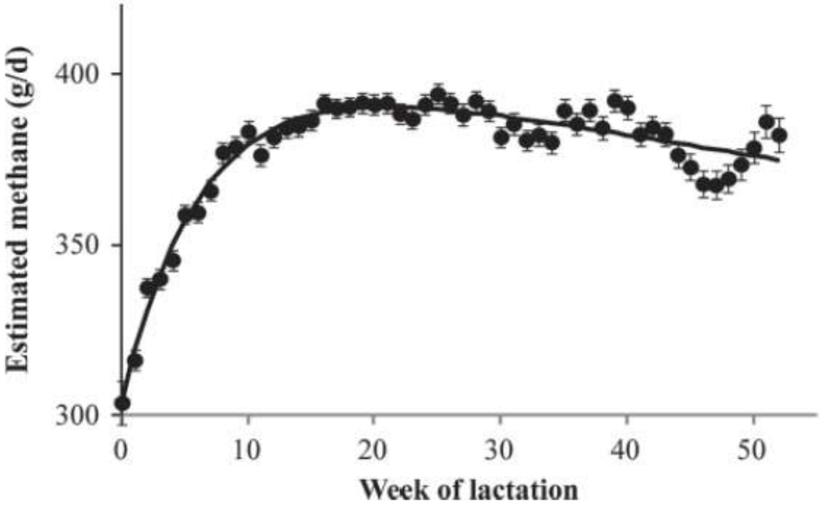


Equation (g/day)	N	SD	R^2c	R^2cv	SEC	SECV
CH_4	446	132.6	0.78	0.74	63	68

Methane predictions depending on lactation stage



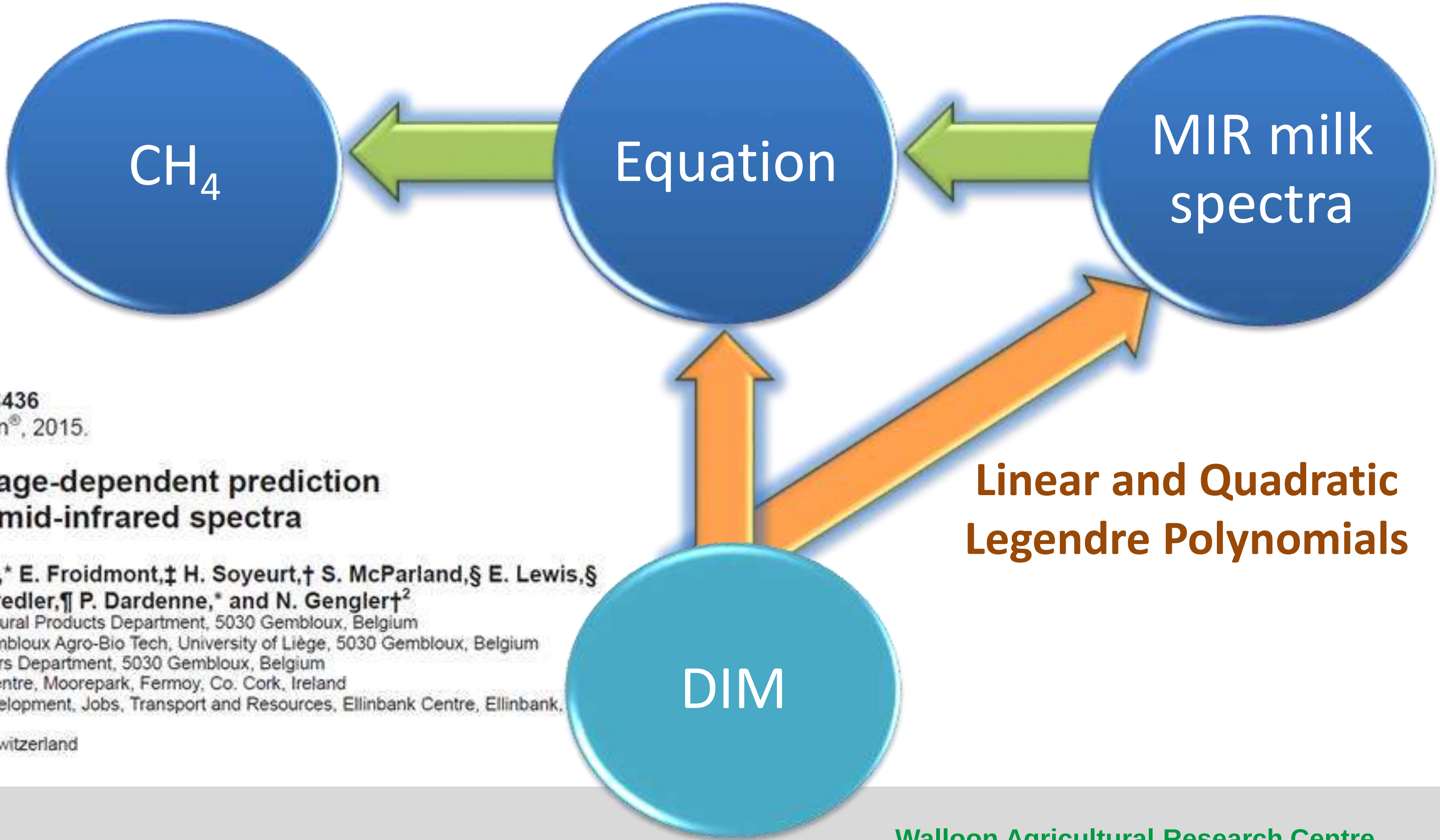
Garnsworthy *et al.*, 2012



→ Reversed curves

→ Need to improve our model

Methane predictions depending on lactation stage



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***Hot topic*: Innovative lactation-stage-dependent prediction of methane emissions from milk mid-infrared spectra**

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Methane predictions depending on lactation stage

Equation (g/day)	N	SD	R^2c	R^2cv	SEC	SECV
CH_4	446	132.6	0.78	0.74	63	68
CH_4 and DIM	446	127.5	0.75	0.67	63	72

N = number of observations; SD = standard deviation; R^2c = calibration coefficient of determination; R^2cv = cross-validation coefficient of determination; SEC = calibration standard error; SECV = cross-validation standard error

→ Statistical parameters are a slighty lower…

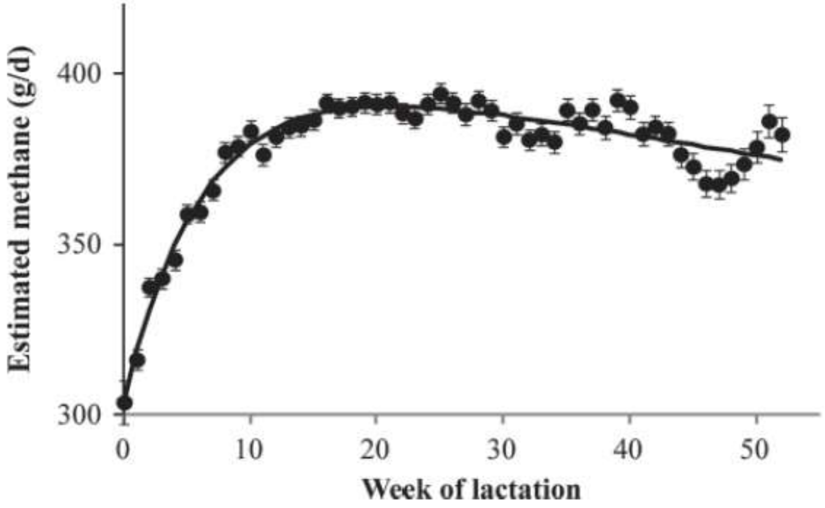
…BUT!

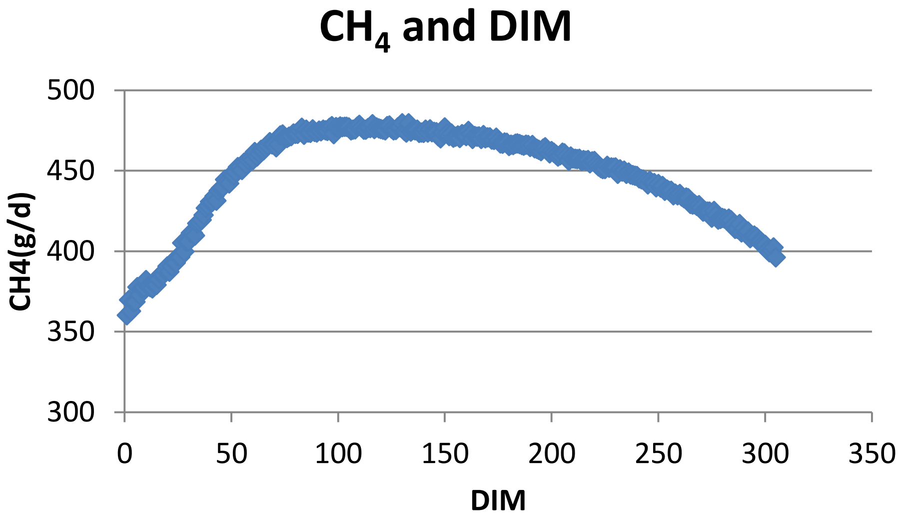
Methane predictions depending on lactation stage

Application of CH_4 equations on Belgian spectral database

1st lactation Holstein cows

Garnsworthy *et al.*, 2012

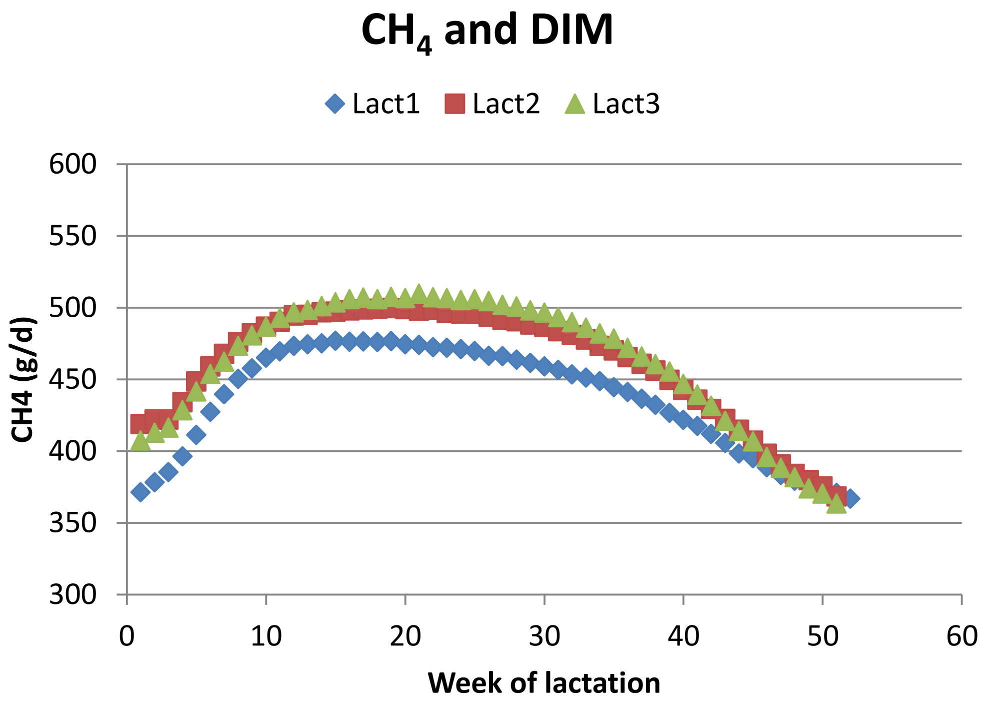




→ In accordance with literature

Methane predictions depending on lactation stage

Application of CH_4 equations on Belgian spectral database

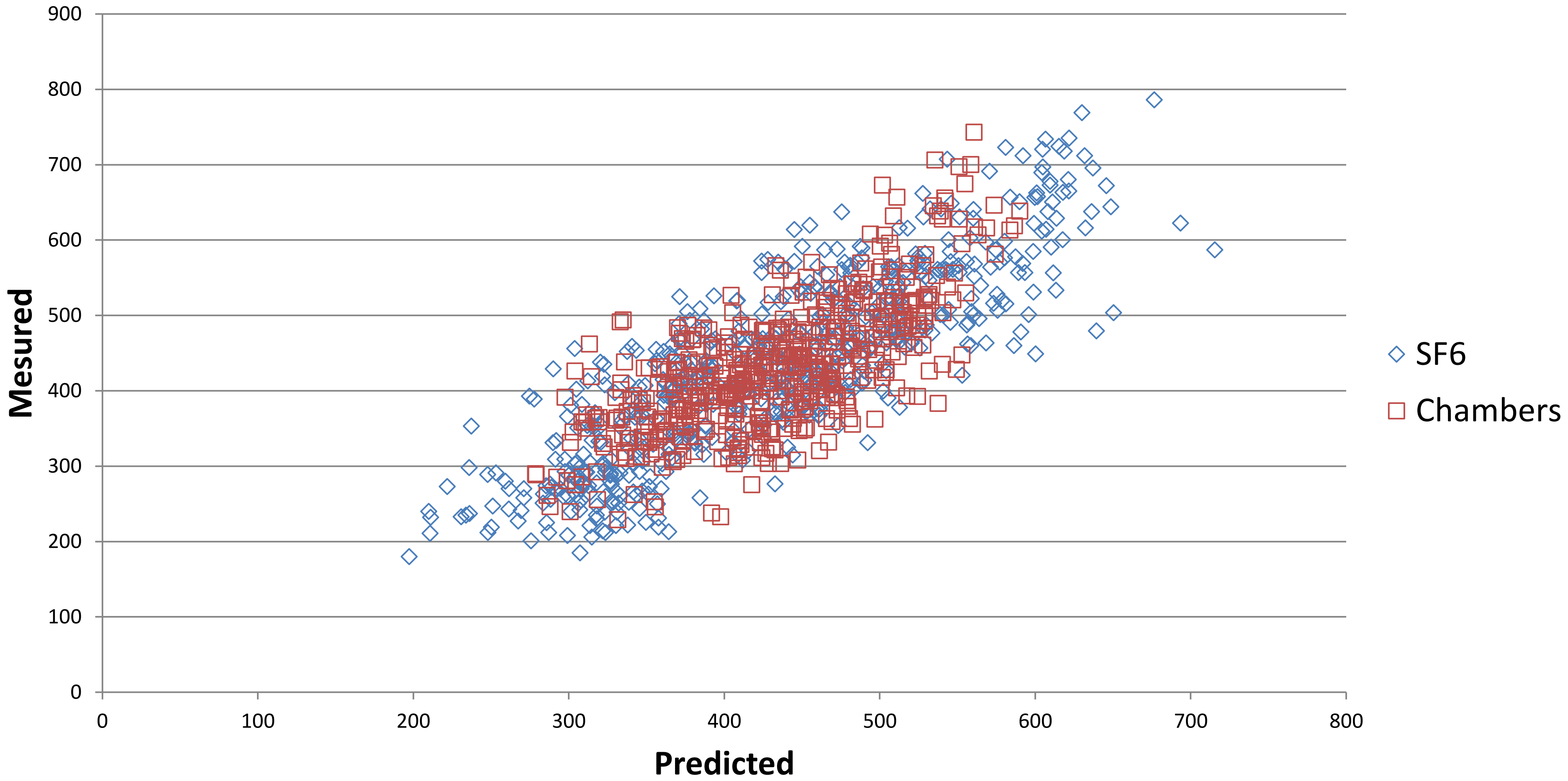


Trends over lactations correspond to what is expected

Merging of SF_6 and respiratory chamber data sets

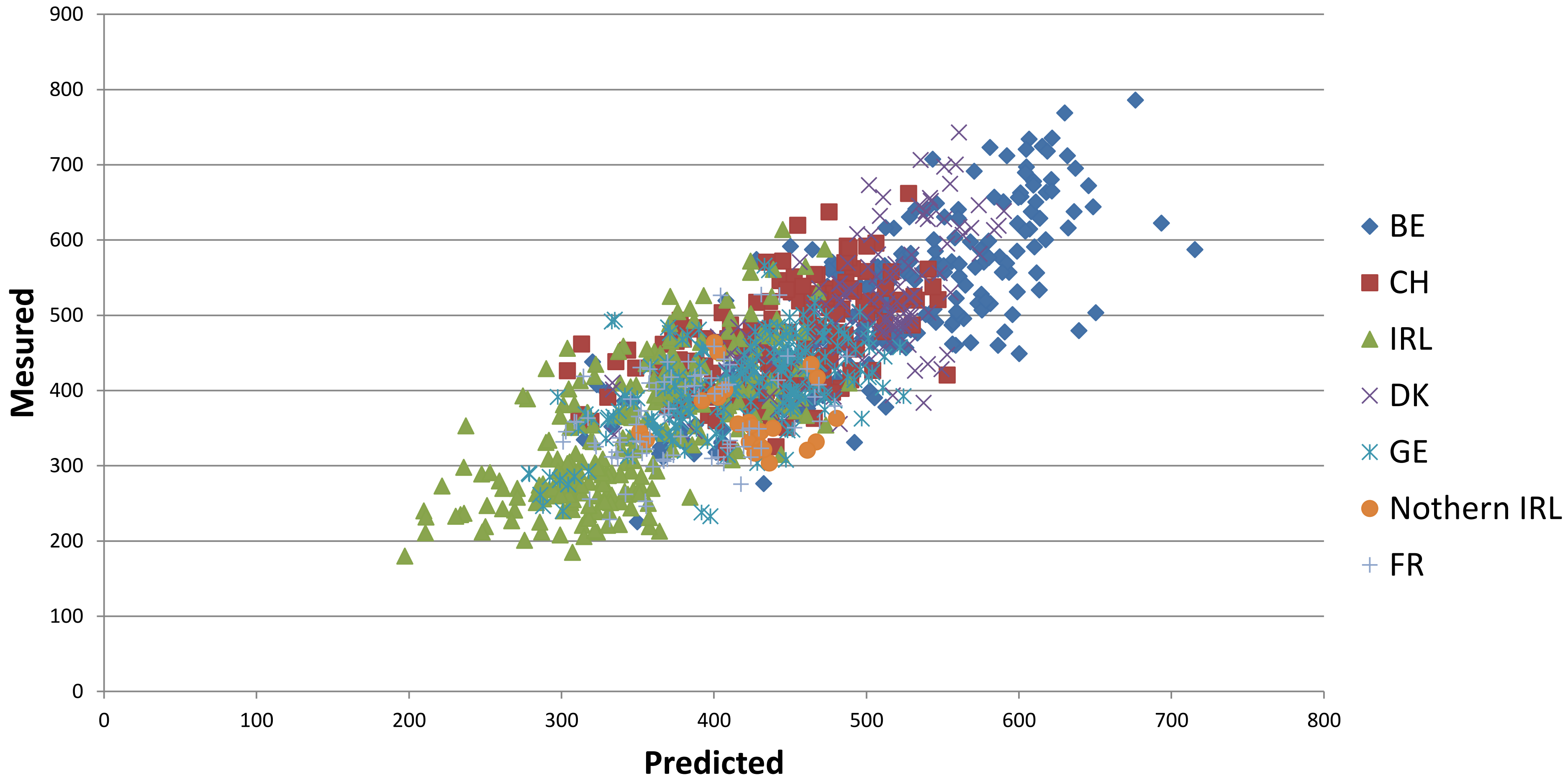
Institution	Reference Method	Number of animals	Number of data
CRA-W	SF_6	47	265
Teagasc	SF_6	110	262
AFBI	Chambers	12	24
Aarhus	Chambers	19	130
Qualitas/ETH Z	Chambers/SF_6	42 + 16	99 + 59
FBN	Chambers	52	213
Inra	Chambers	9	82
Total		307	1134

Merging of SF6 and respiratory chamber data sets



Equation (g/day)	N	SD	R²c	R²cv	SEC	SECV
SF_6 + Chambers	1134	106.1	0.64	0.60	64	67

Merging of SF6 and respiratory chamber data sets



Equation (g/day)	N	SD	R²c	R²cv	SEC	SECV
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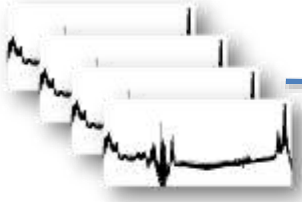
Merging of SF6 and respiratory chamber data sets

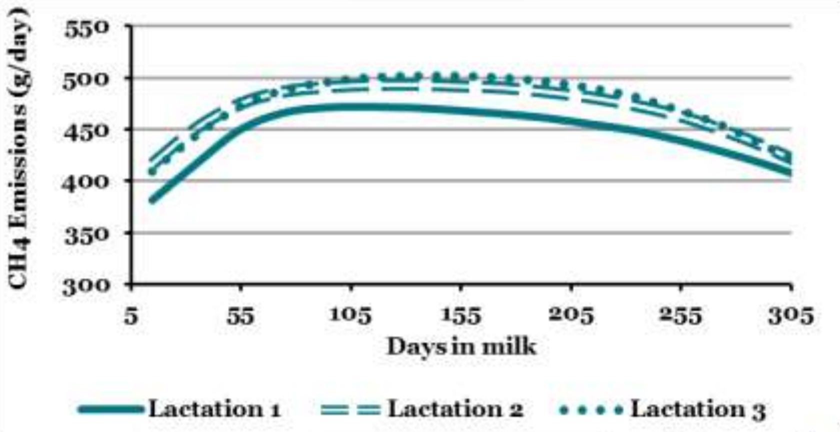
Equation (g/day)	N	SD	R^2c	R^2cv	SEC	SECV
SF_6	446	127.5	0.75	0.67	63	72
SF_6 + Chambers	1134	106.1	0.64	0.60	64	67

N = number of observations; SD = standard deviation; R^2c = calibration coefficient of determination; R^2cv = cross-validation coefficient of determination; SEC = calibration standard error; SECV = cross-validation standard error

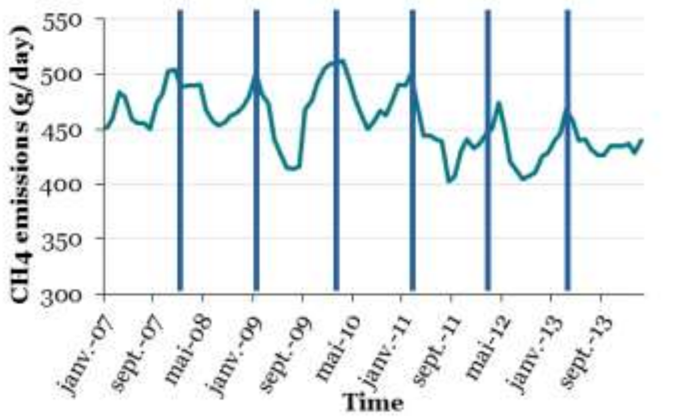
Phenotypic and Genetic Large-Scale Studies

New equation





Possibility to apply models ***a posteriori***



Phenotypic and Genetic Large-Scale Studies

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Genetic parameters of mid-infrared methane predictions and their relationships with milk production traits in Holstein cattle

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Conclusions

- It is possible to predict methane from milk MIR spectra
- Important to check if the applications at large scale are logical at a metabolic level
- Integration of DIM information seems to be a good strategy to :
  - take a better account of the metabolic status of cows
  - improve the equation
- Important to include further regions/breeds/regimes to cover the variability
- Merging of data set strategy : analytical standardisation of reference measurements is needed
- Easy and cheap method for large scale utilisation

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