

Standardisation of milk MIR spectra, Development of common MIR equations



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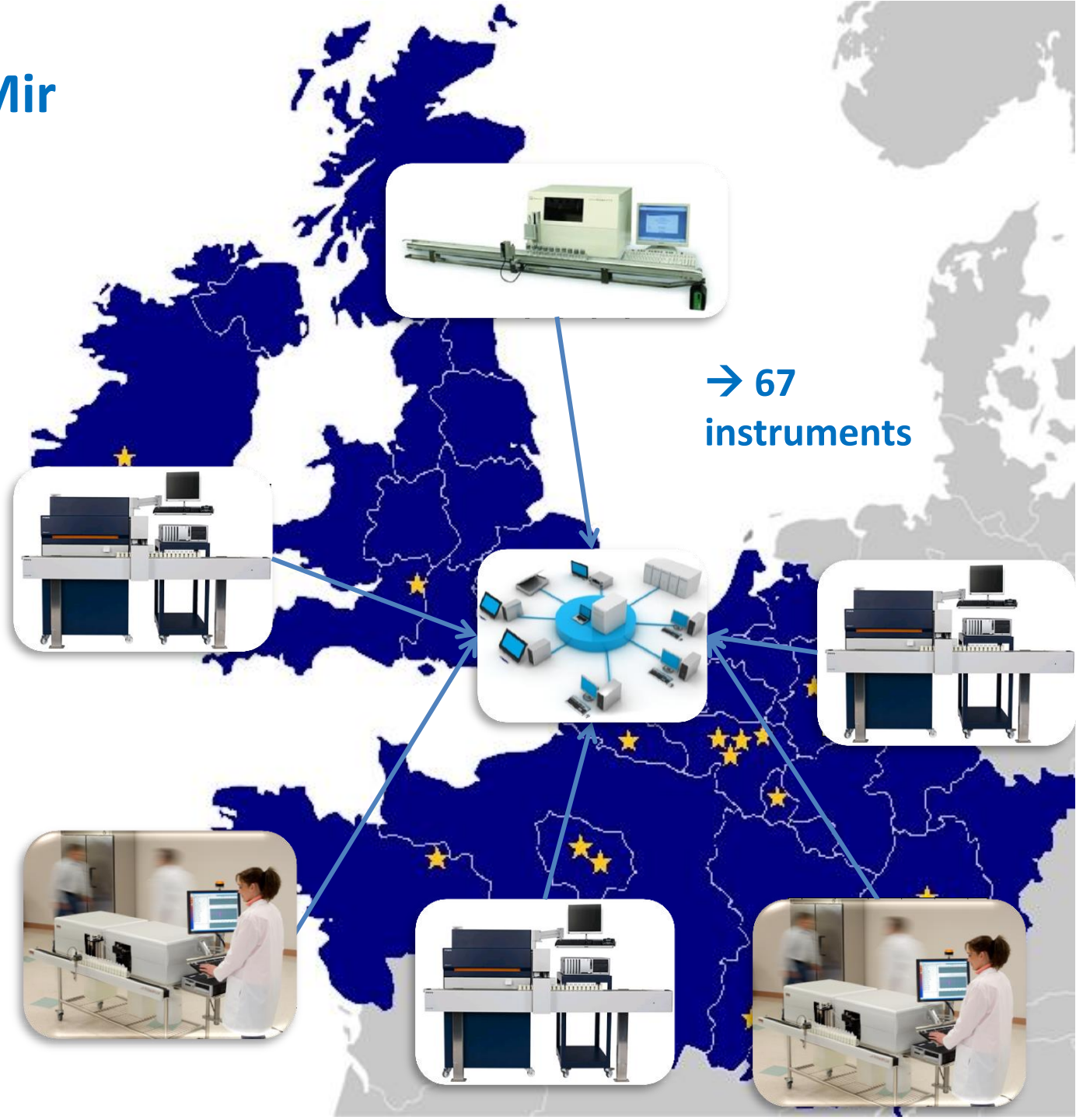


OptiMir

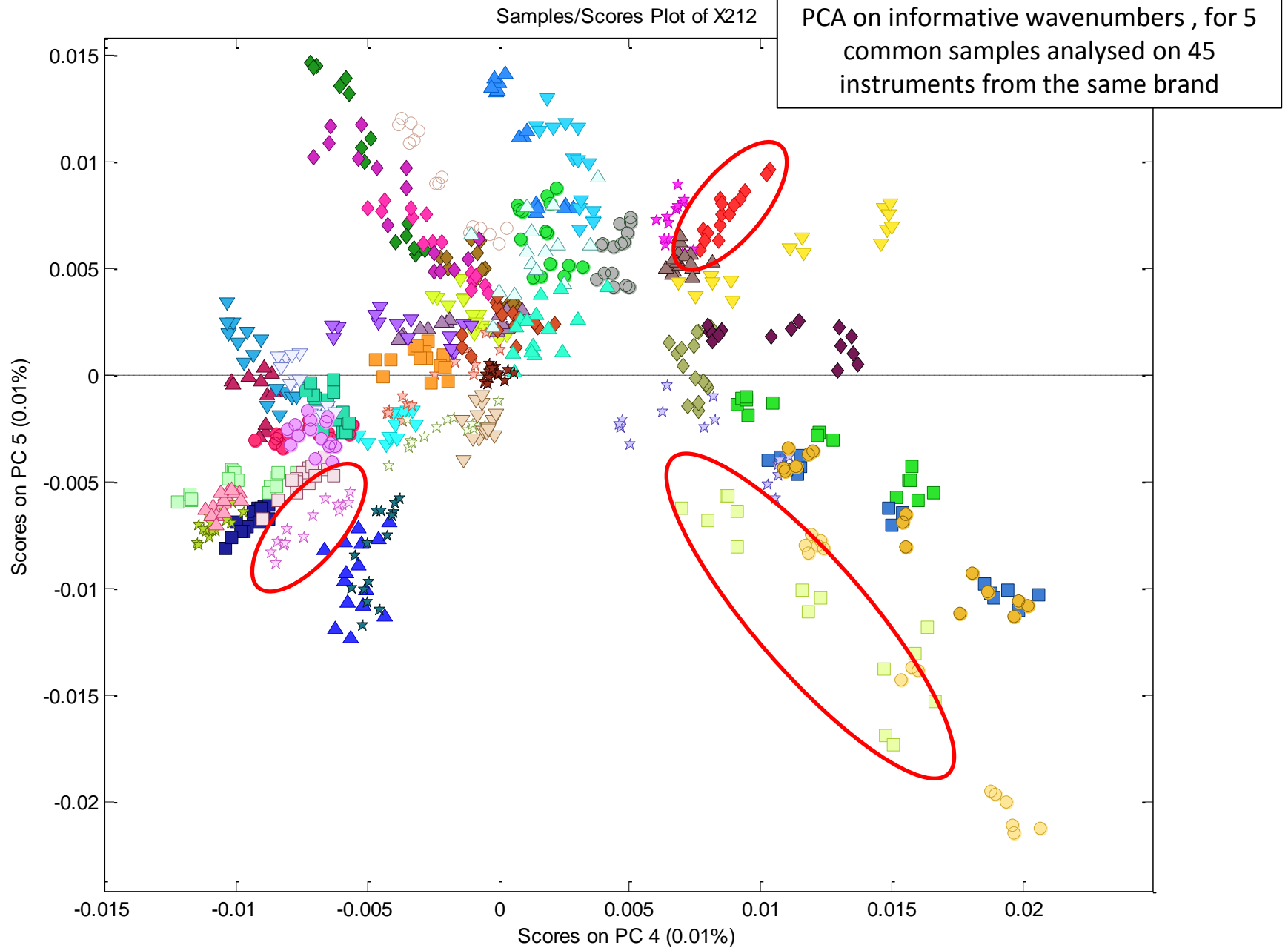
Develop MIR models predicting cow state:

→ Variability is needed to build robust models

→ 67 instruments

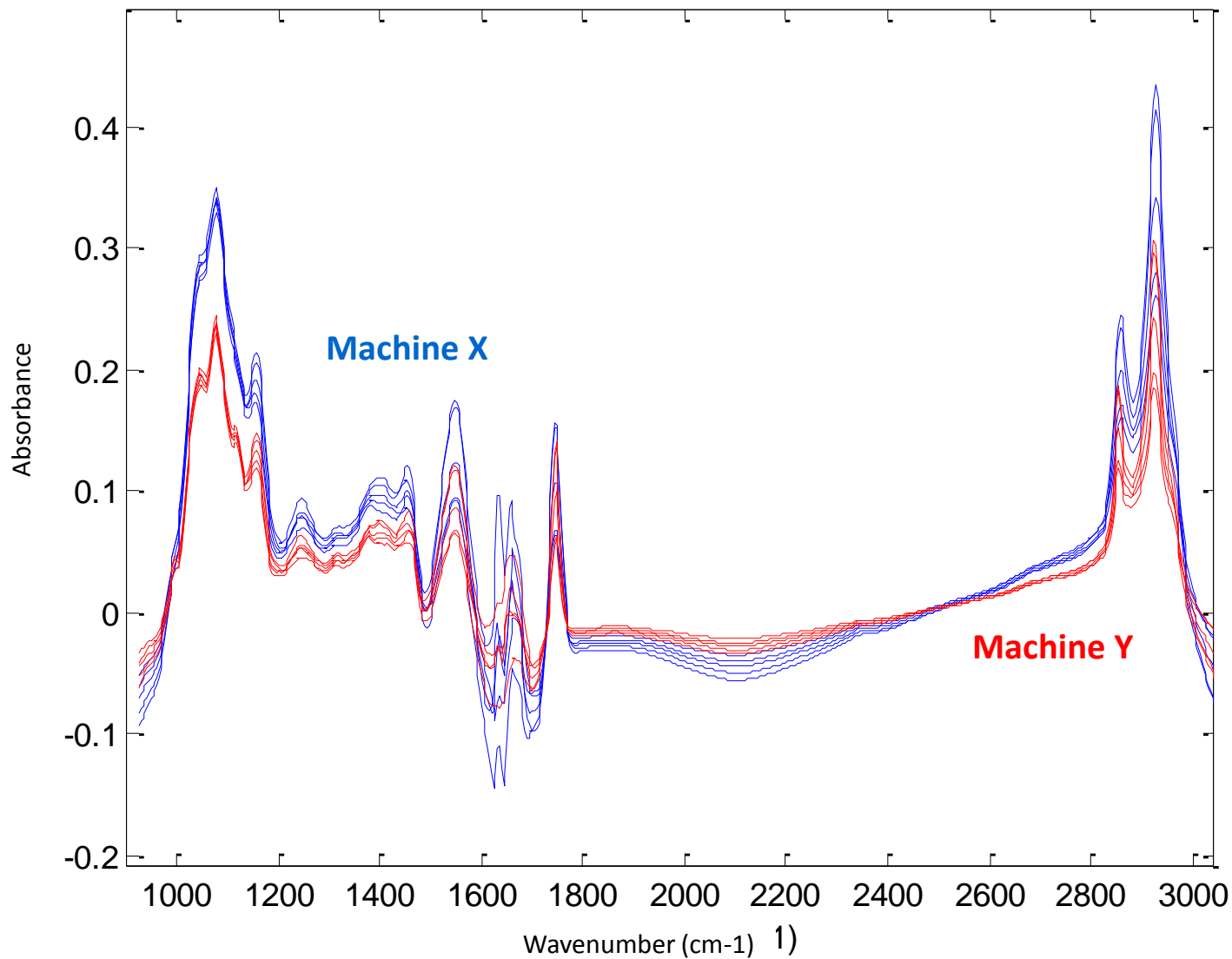


Variability of instruments



Instruments are different

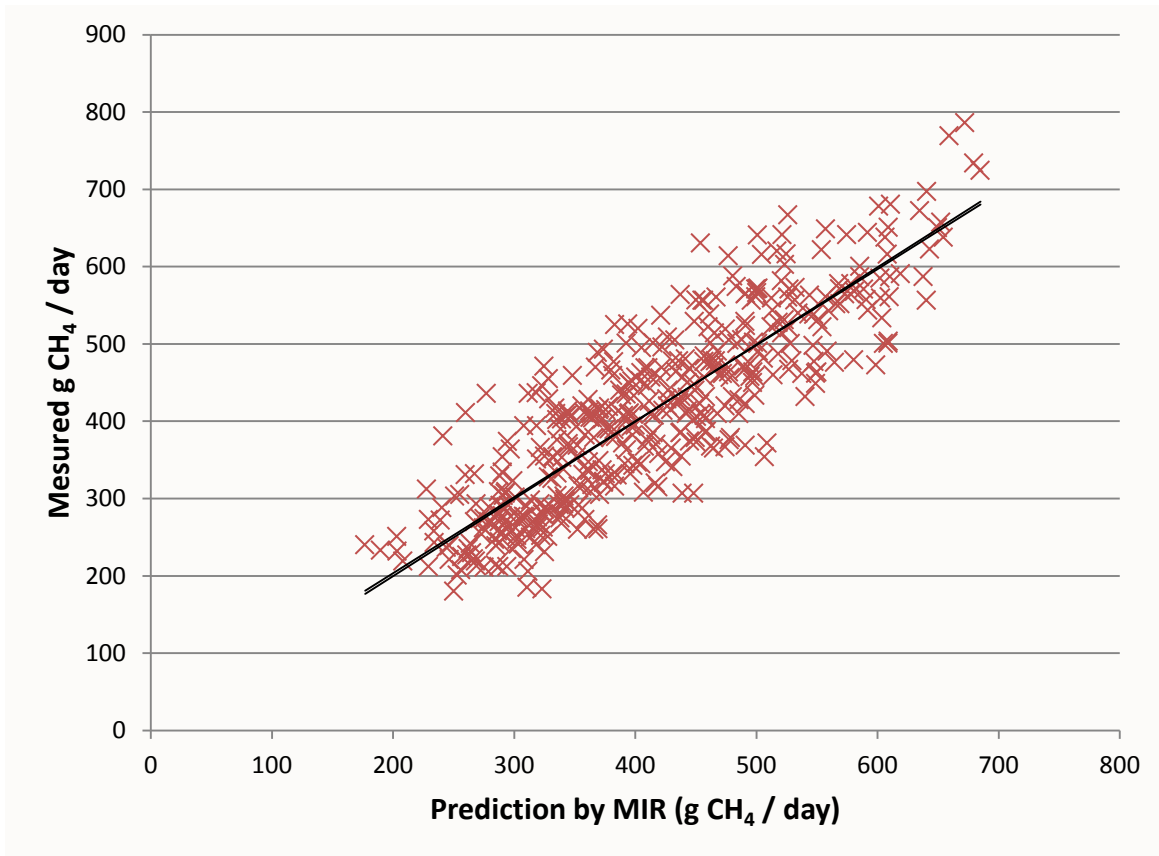
→ Common milks analysed on 2 instruments from 2 brands



Creation and use of common models?

→ Common milks analysed on 2 instruments **from 2 brands**

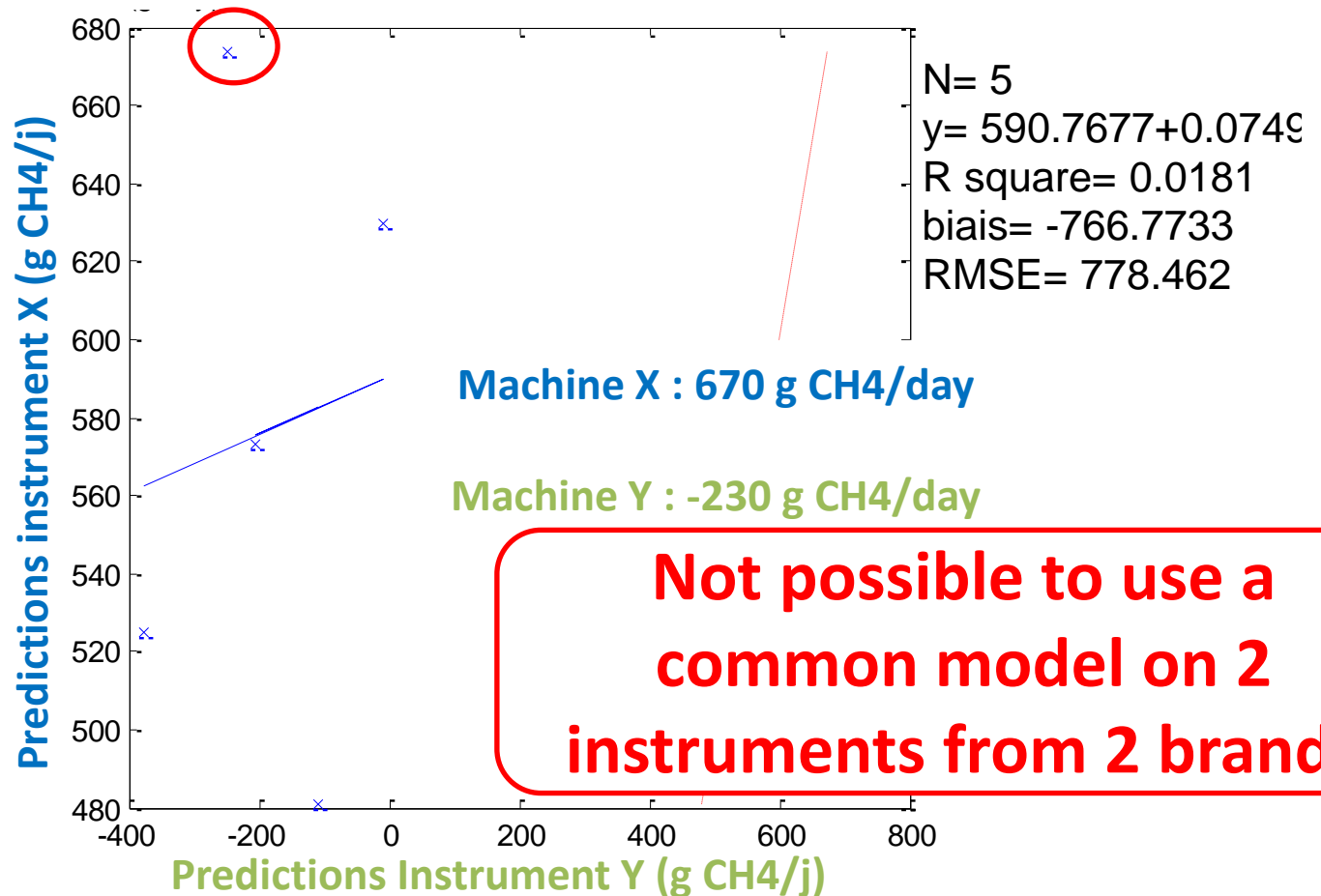
→ Methane model (A.Vanlierde, 2013)



Creation and use of common models?

→ Common milks analysed on 2 instruments **from 2 brands**

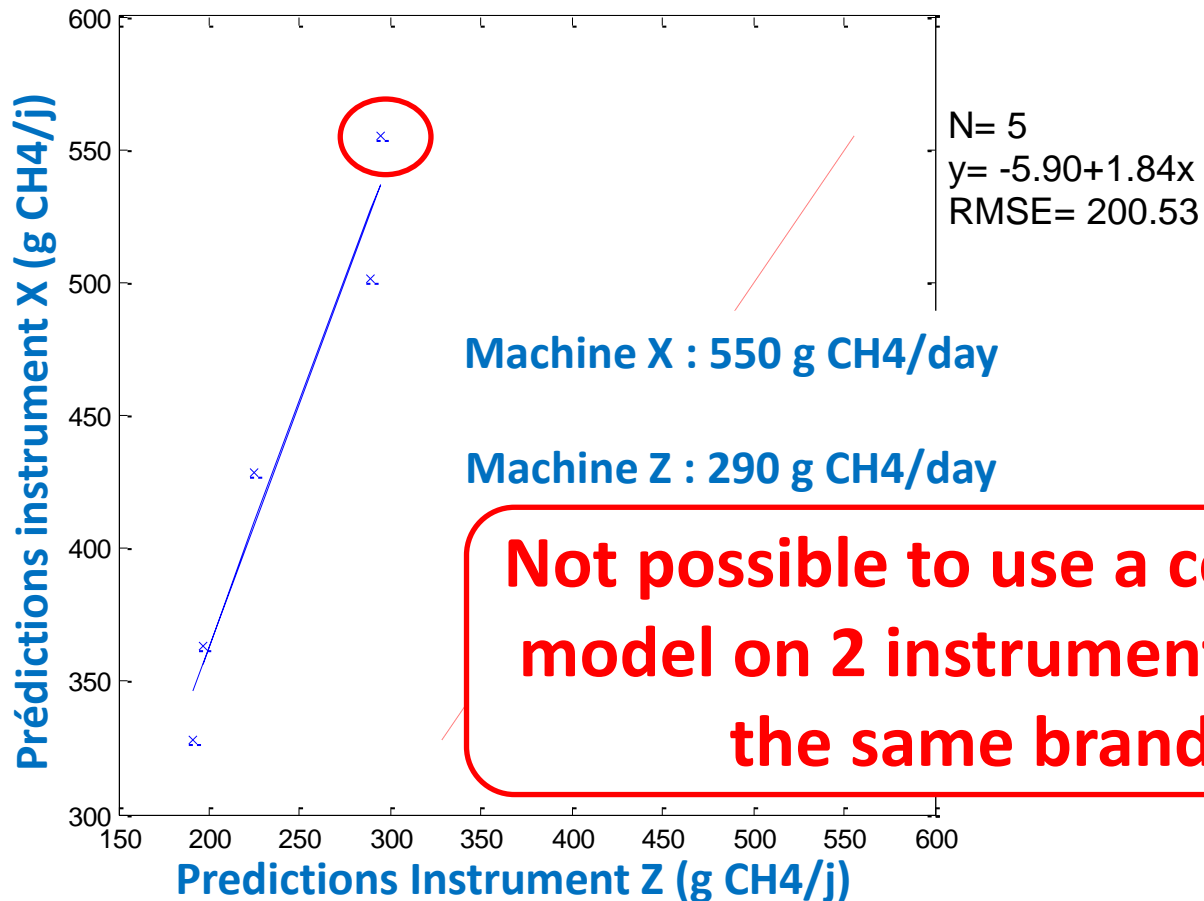
→ Methane model



Creation and use of common models?

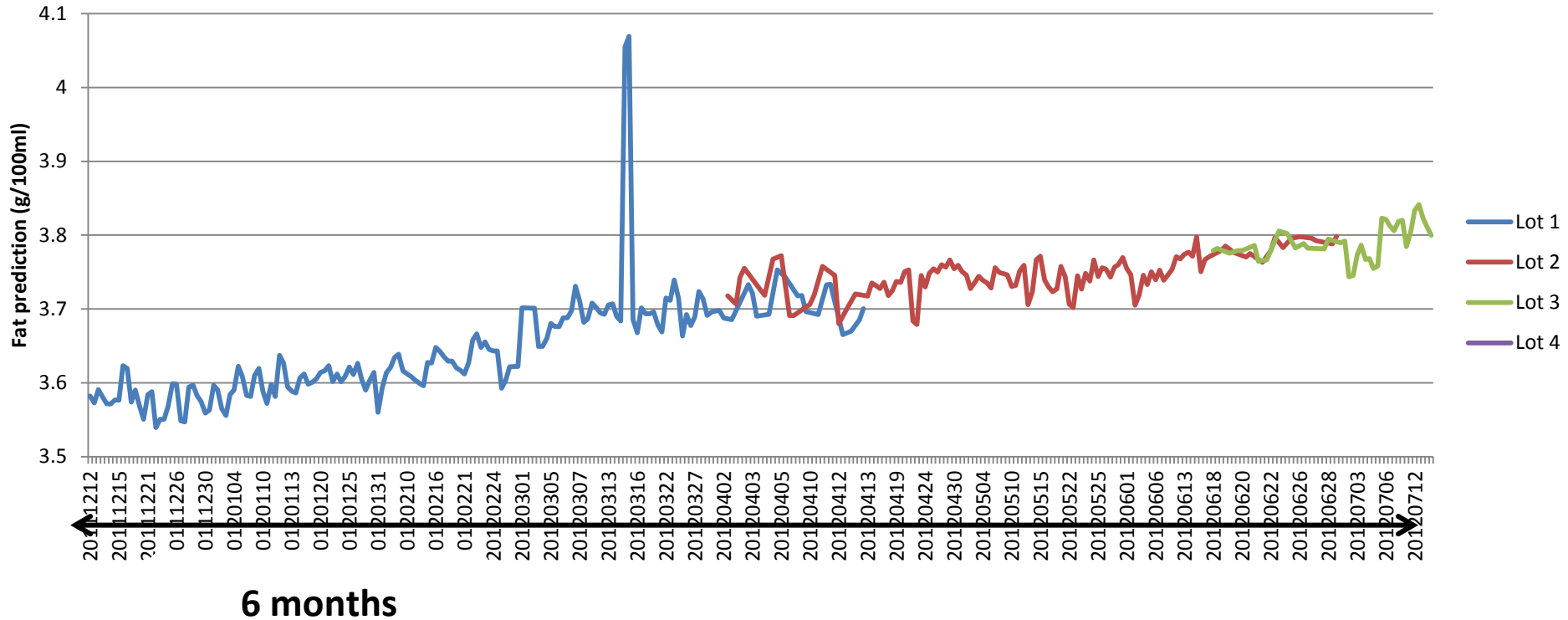
→ Common milks analysed on 2 instruments **from the same brand**

→ Methane model

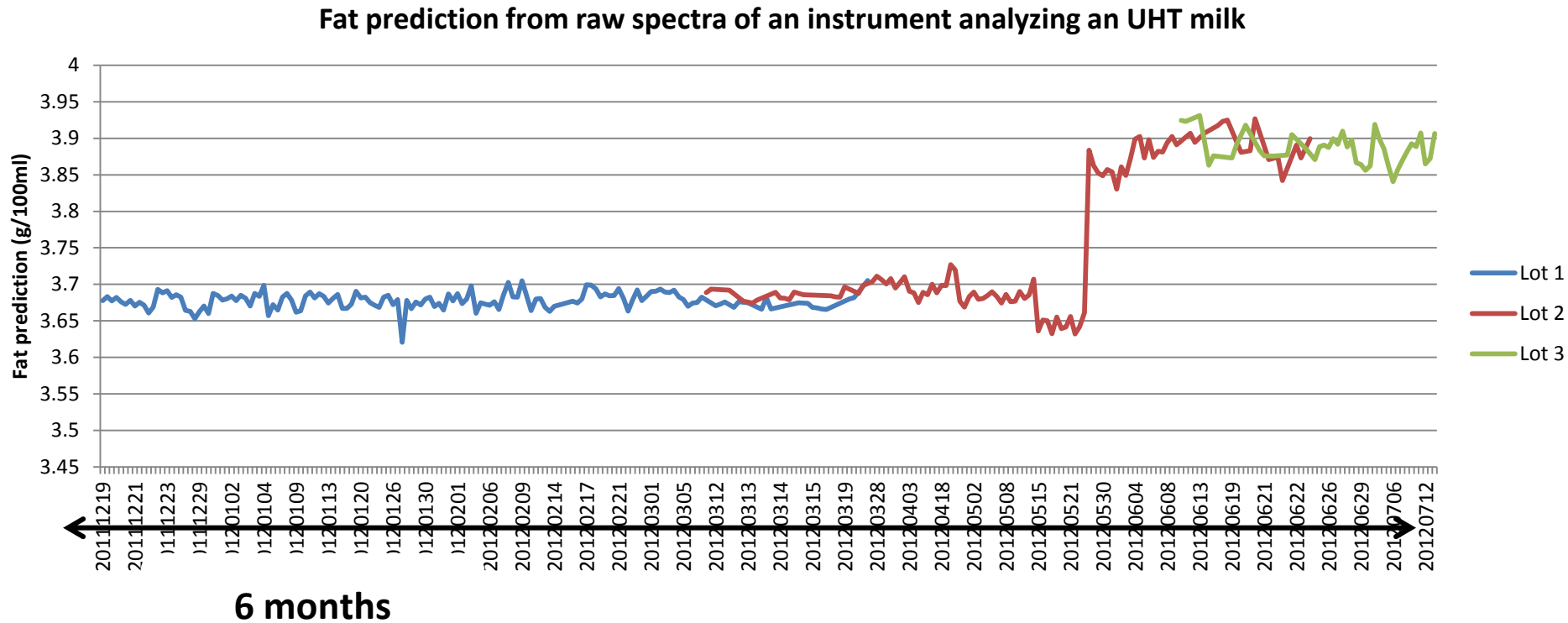


Instruments are not stable in time

Fat prediction from raw spectra of an instrument analyzing an UHT milk



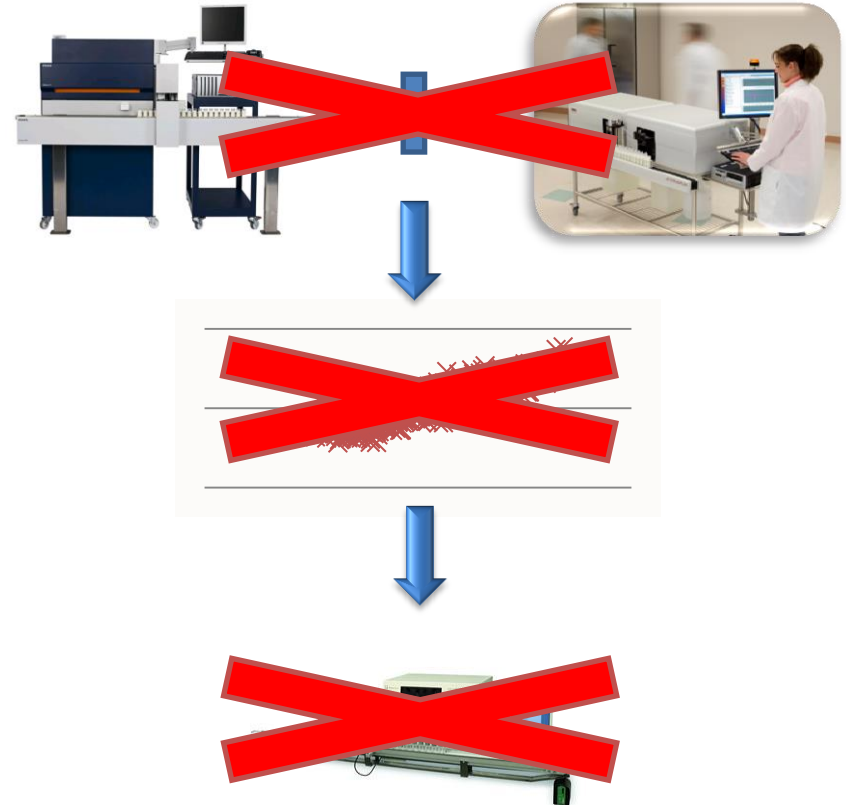
Instruments are not stable in time



**Instruments also suffer from big perturbations
→ maintenance operation, piece replacement**

Issues:

- Not possible to create common tools
- Not possible to transfer a model on other instruments
- Instruments not stable in time



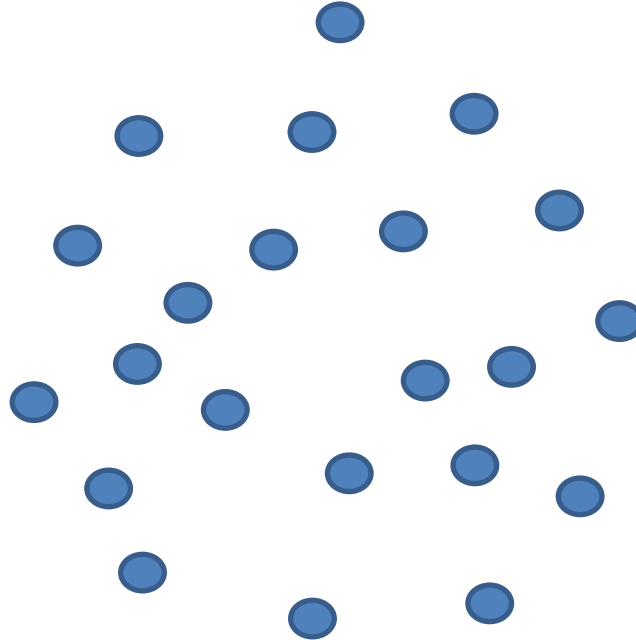
→ A model can be used on only 1 instrument and within a limited time

→ Slope/bias correction not possible for models predicting methane, fertility, ketosis... → **Direct Standardisation of the spectra**

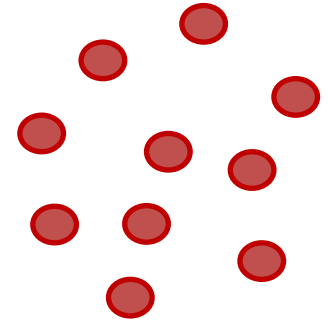
How it works

Variability between instruments

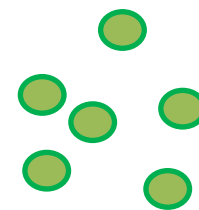
Brand C



Brand B



Brand A

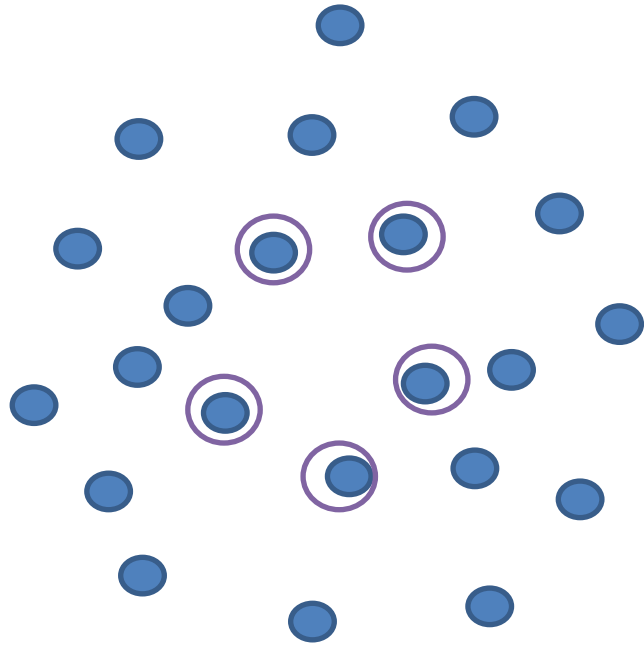


How it works

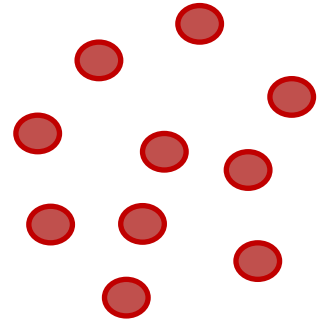


Selected instruments for
Master creation

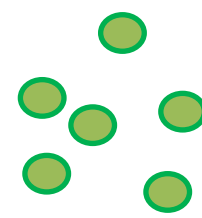
Brand C



Brand B



Brand A



How it works

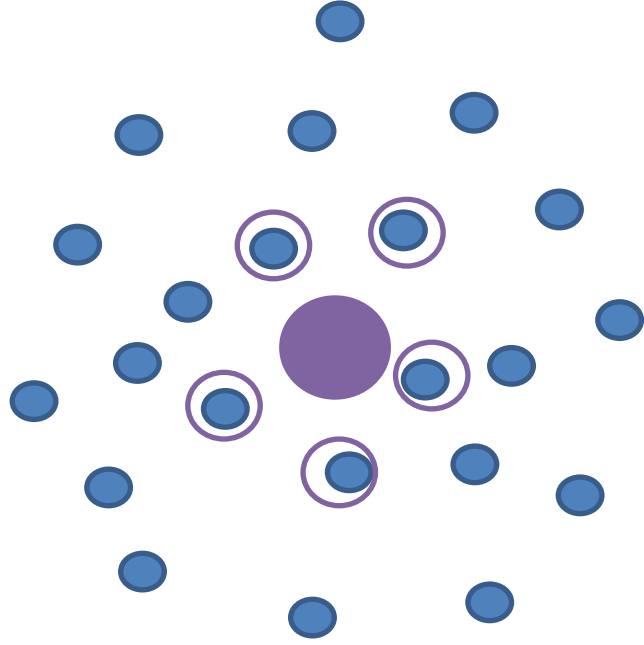


Selected instruments for Master creation

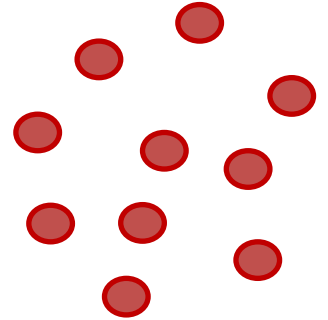


Master

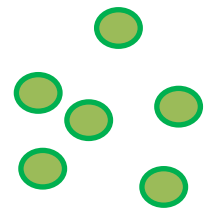
Brand C



Brand B



Brand A



How it works

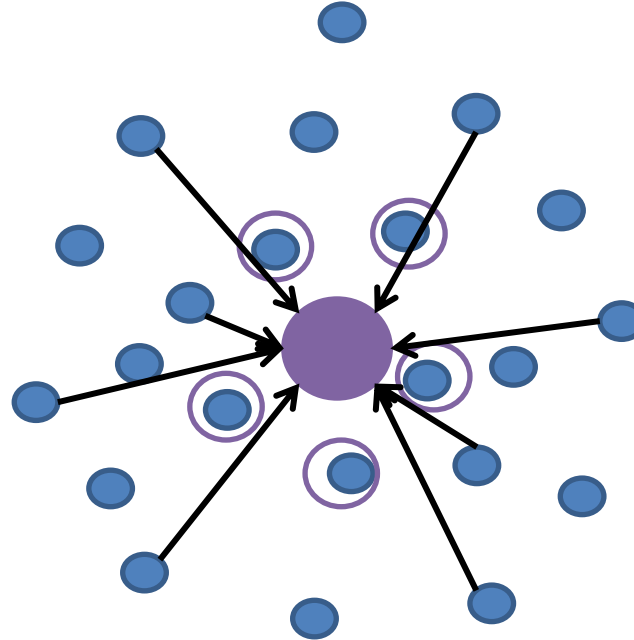


18 Selected instruments for Master creation

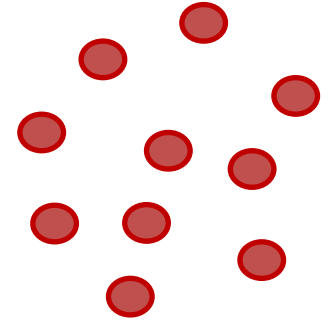


Master

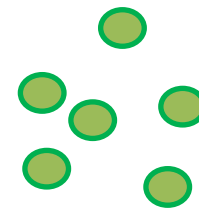
Brand C



Brand B



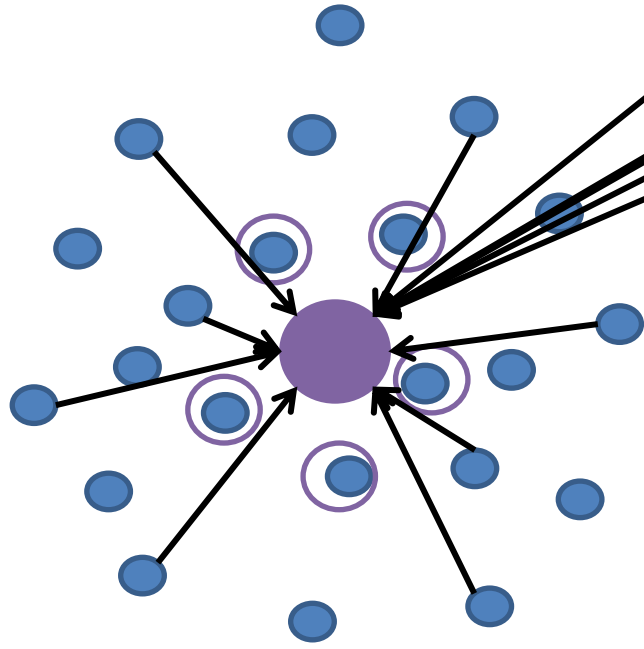
Brand A



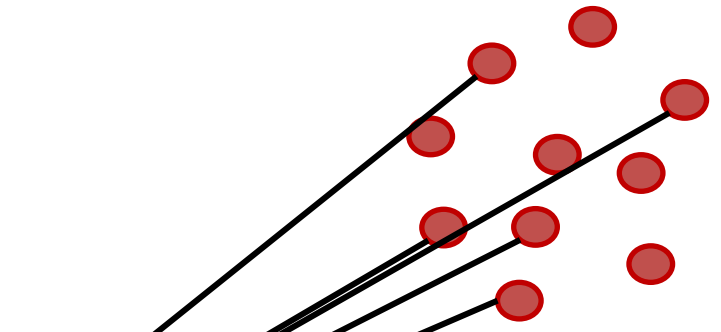
How it works

- 18 Selected instruments for Master creation
- Master

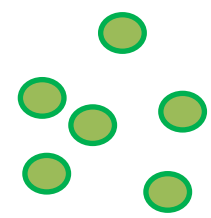
Brand C



Brand B



Brand A



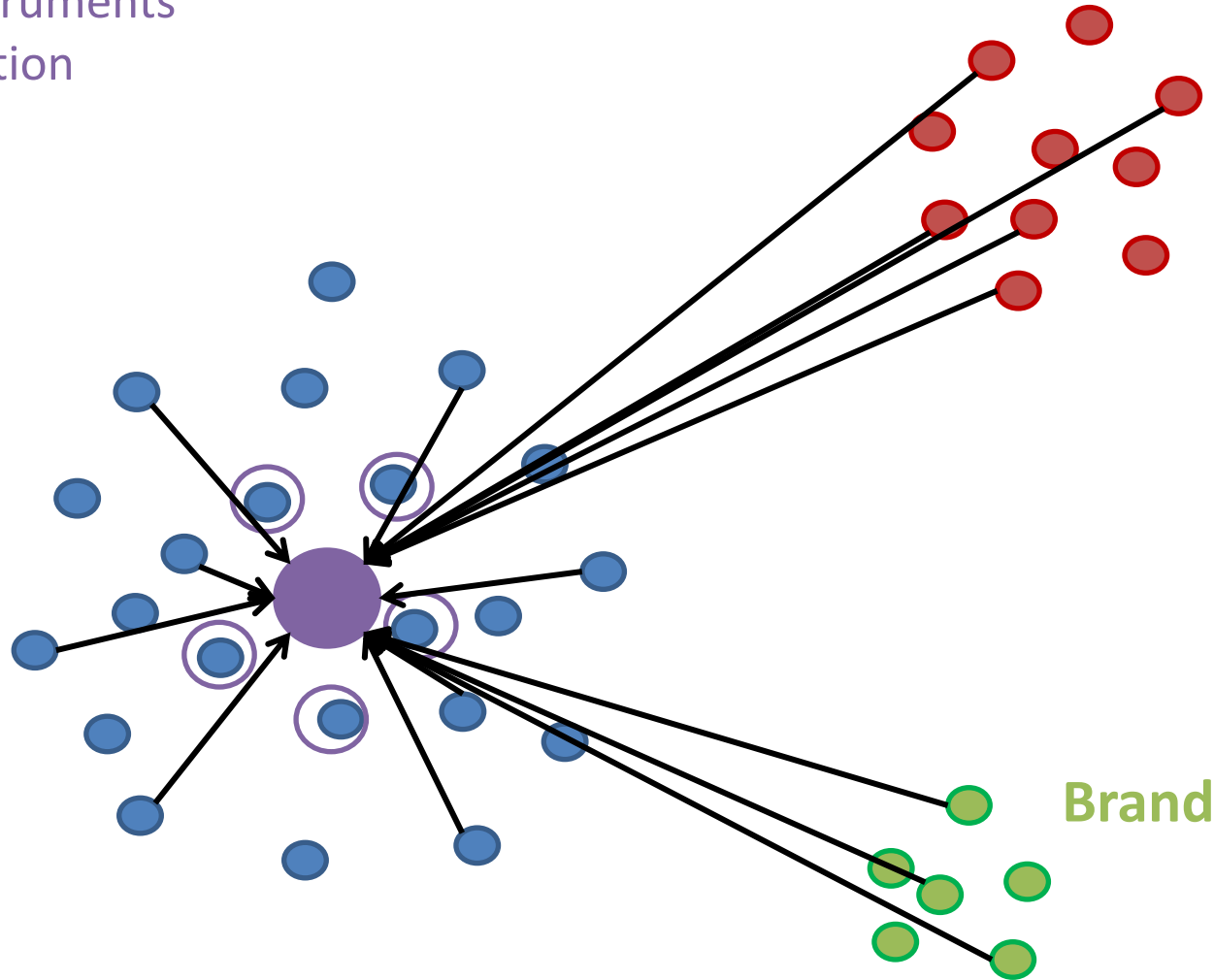
How it works

- 18 Selected instruments for Master creation
- Master

Brand C

Brand B

Brand A



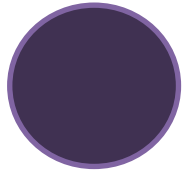
How it works



18 Selected instruments for Master creation



Master



Standardized instruments

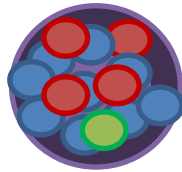
Standardised instruments for creation of equations

Standardised instruments for use of equations

Brand C

Brand B

Brand A



How it works

PIECE-WISE DIRECT STANDARDIZATION (PDS)

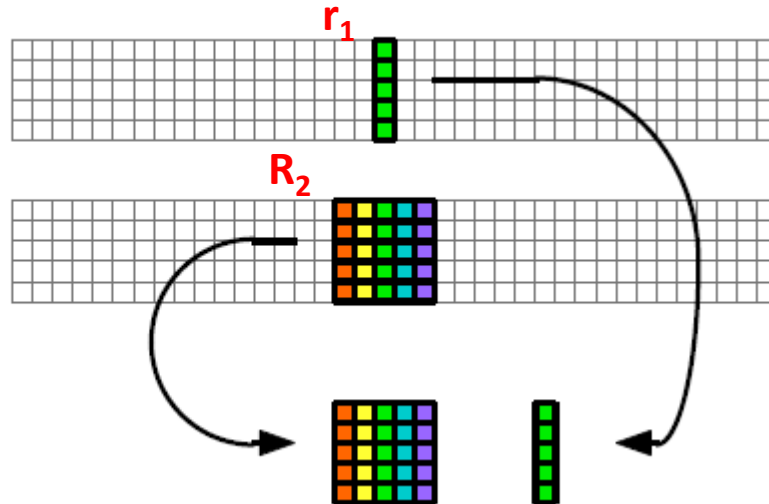
Absorbance in an area r_1 (master)

→ correlated to the absorbance within R_2 (slaves)

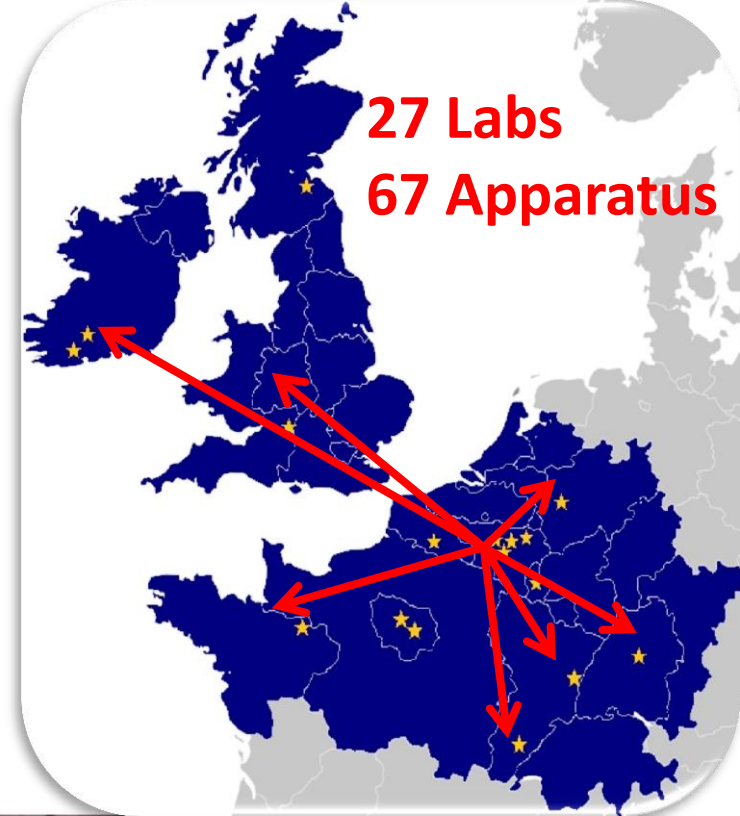
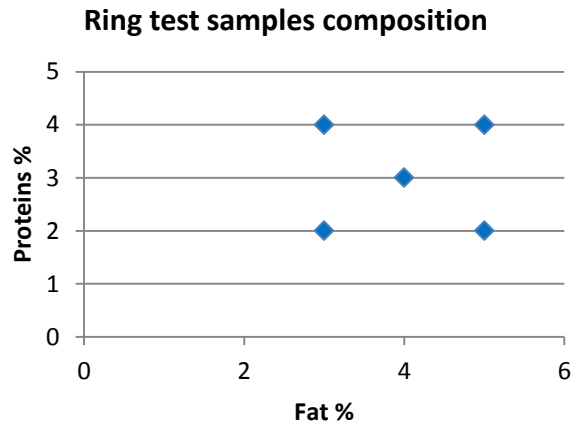
« Master »

« Slave »

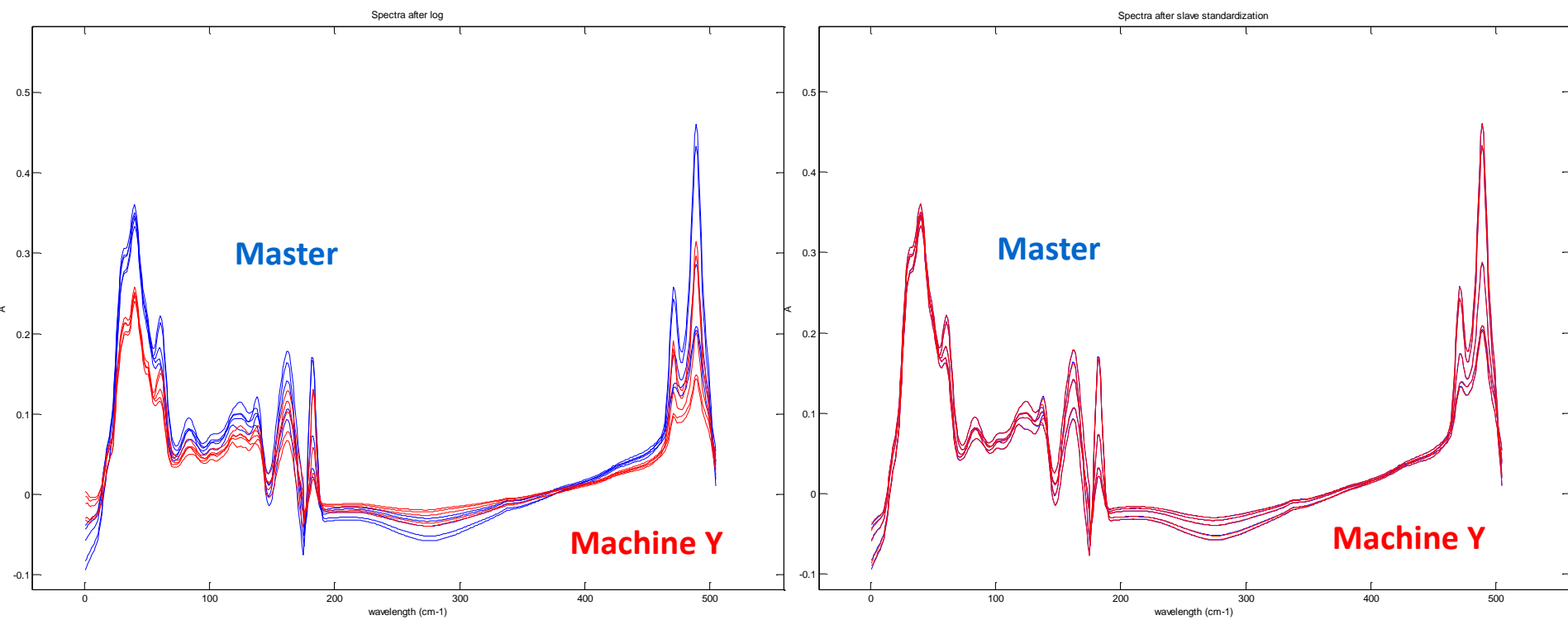
$$r_{1j} = R_{2j} b_j + b_{0j}$$



How it works

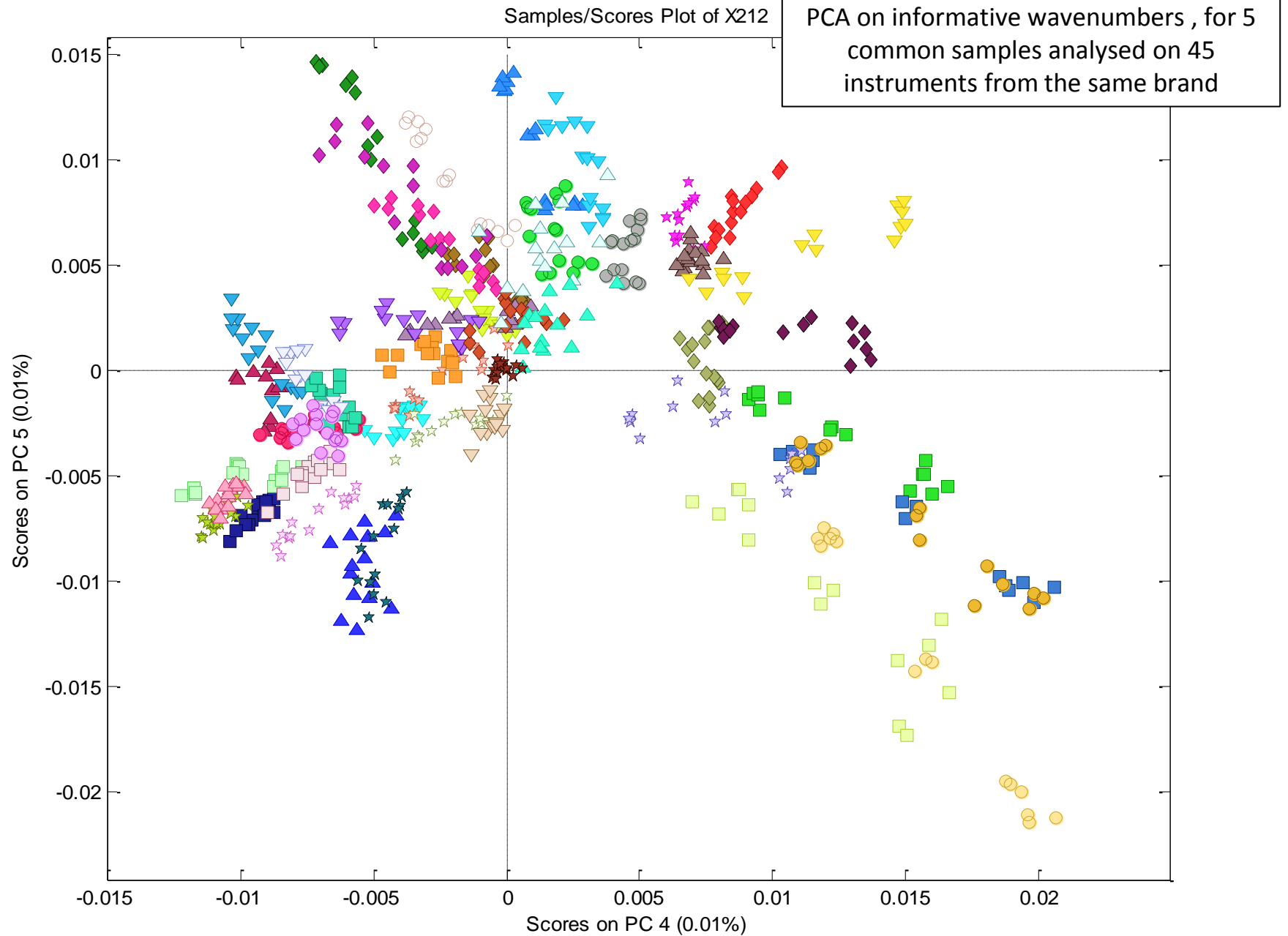


Results



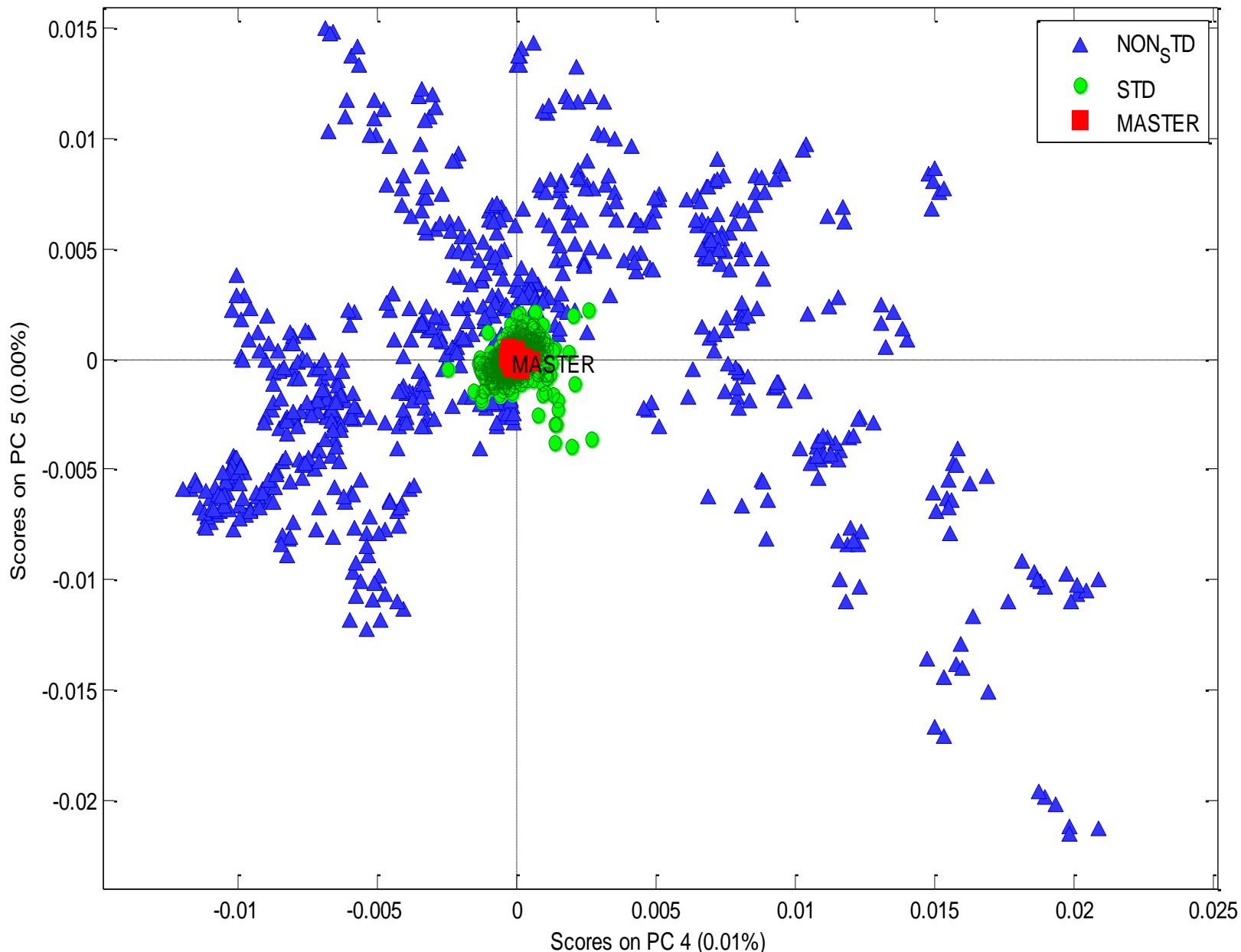

PDS

Variability of instruments



Reduce the variability of instruments

Samples/Scores Plot of X212

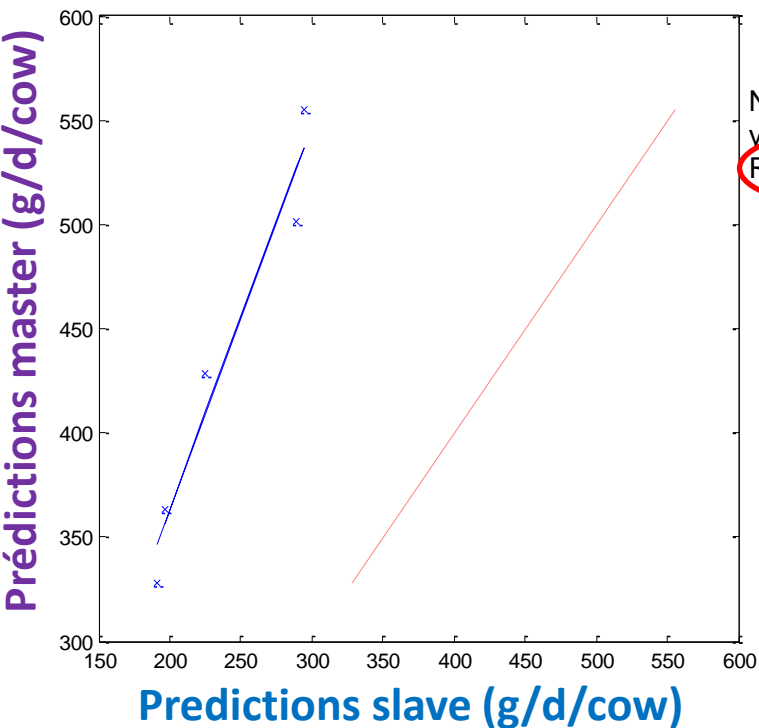


Creation and use of common models?

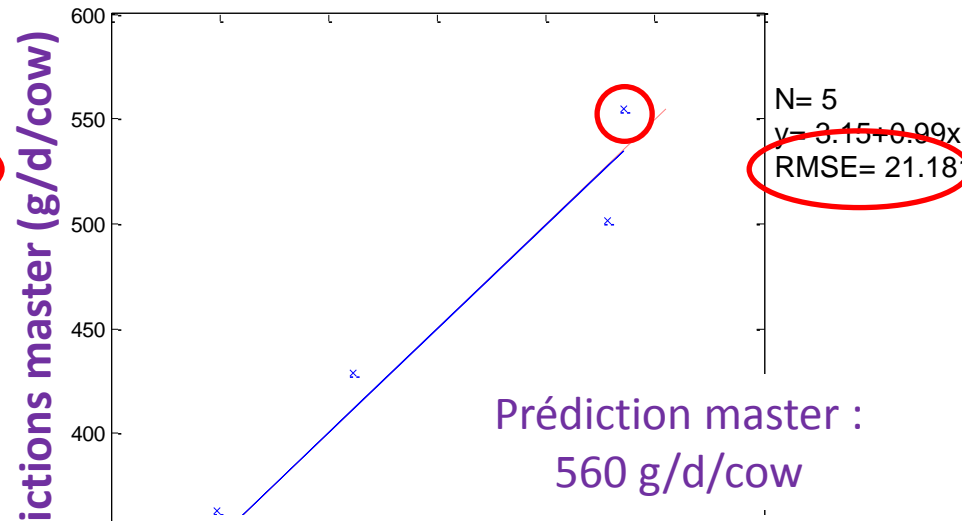
→ Common milks analysed on the master and on a slave instrument **from the same brand**

→ Methane model

Without standardisation



With standardisation



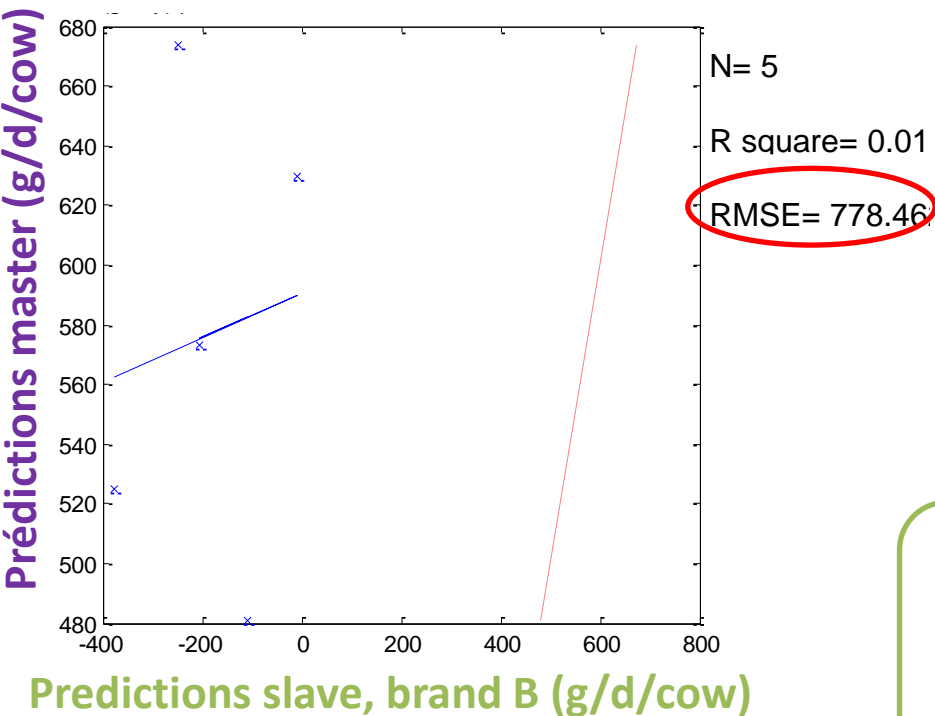
Possible to use a common model on 2 instruments from the same brand

Creation and use of common models?

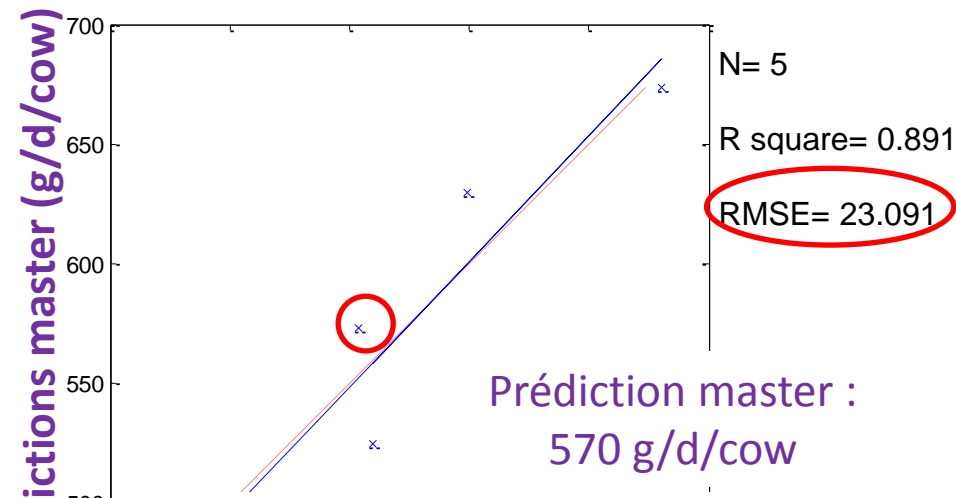
→ Common milks analysed on the master and on a slave instrument **from another brand**

→ Methane model

Without standardisation



With standardisation



Possible to use a common model on 2 instruments from different brands

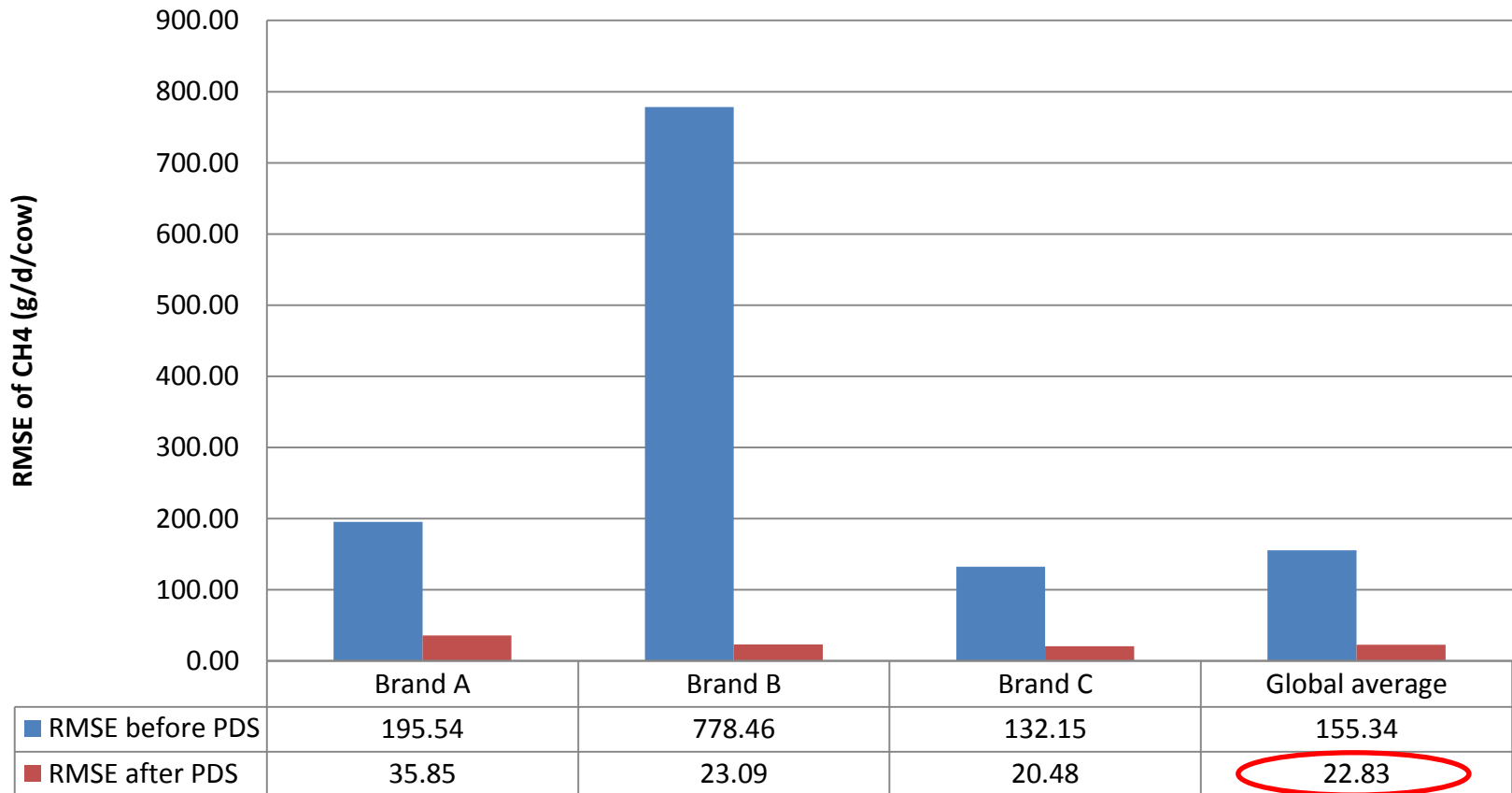
Creation and use of common models?

→ 47 instruments (7 brand A, 1 brand B, 39 brand C)

→ **Methane** model

→ RMSE between master and slaves predictions, before and after standardisation

RMSE of CH₄ predictions between master and slaves



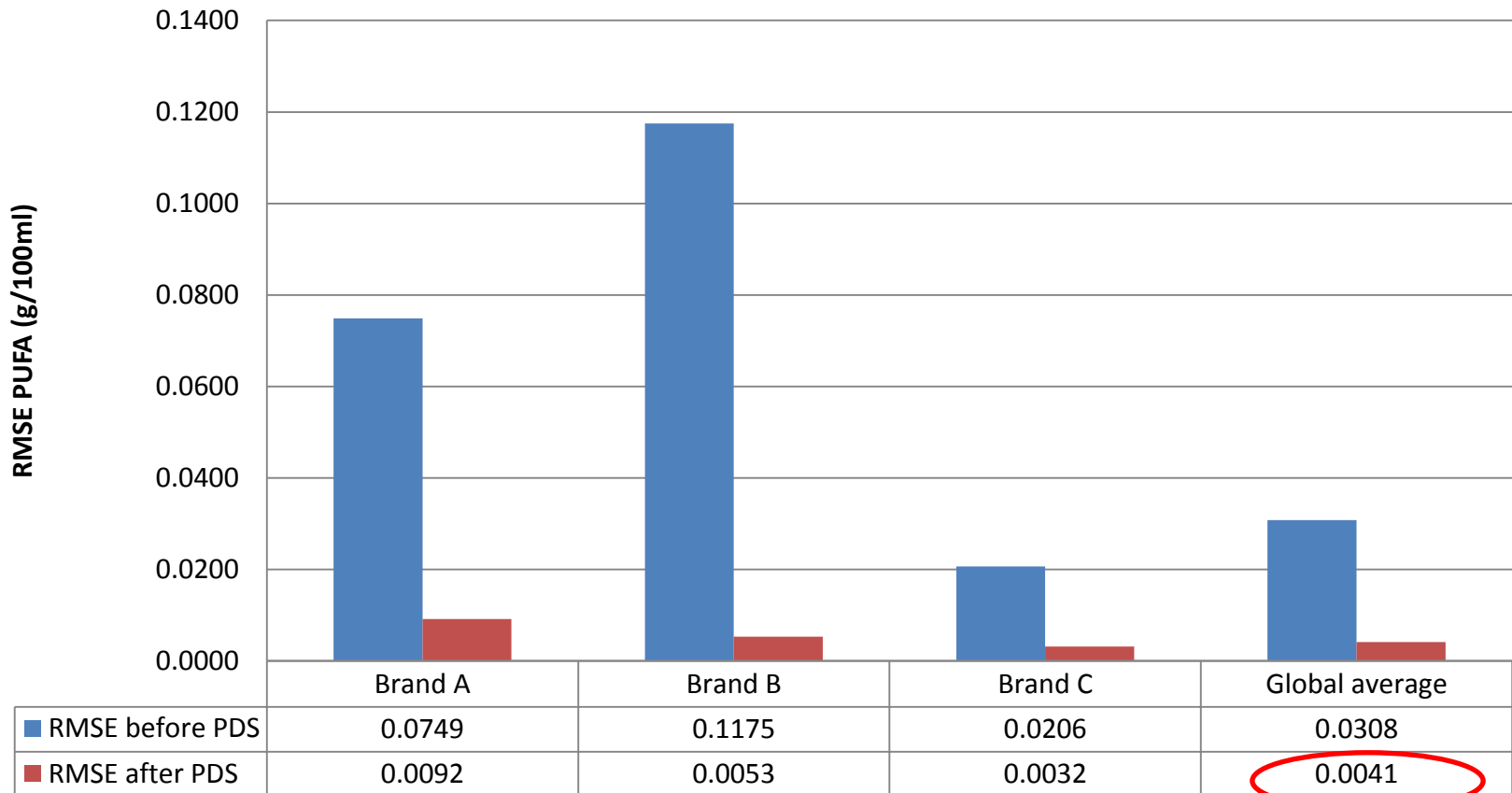
Creation and use of common models?

→ 47 instruments (7 brand A, 1 brand B, 39 brand C)

→ **Poly-Unsaturated Fatty acids** model

→ RMSE between master and slaves predictions, before and after standardisation

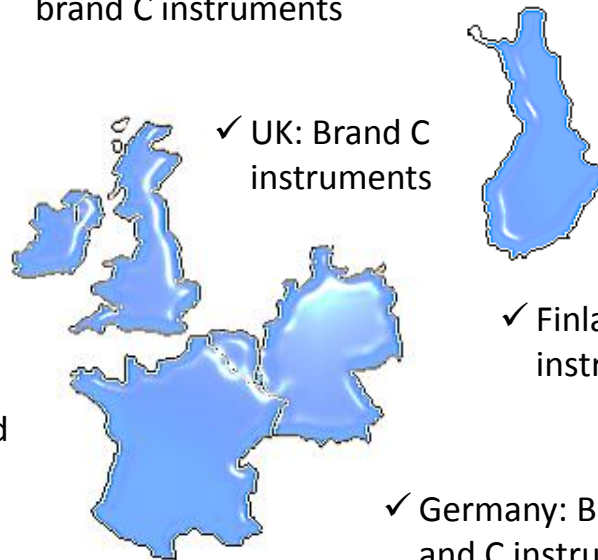
RMSE of PUFA predictions between master and slaves



Fatty acids models

- 1827 milk samples (**standardized since 2012**)
 - **Brand A**
 - **Brand C**
- Large variability of breeds (17), seasons, feeding systems and geographical areas:

✓ Belgium and Luxembourg:
brand C instruments



✓ Ireland: Brand C
instruments

✓ UK: Brand C
instruments

✓ Finland: Brand C
instruments

✓ France : Brand A and
C instruments

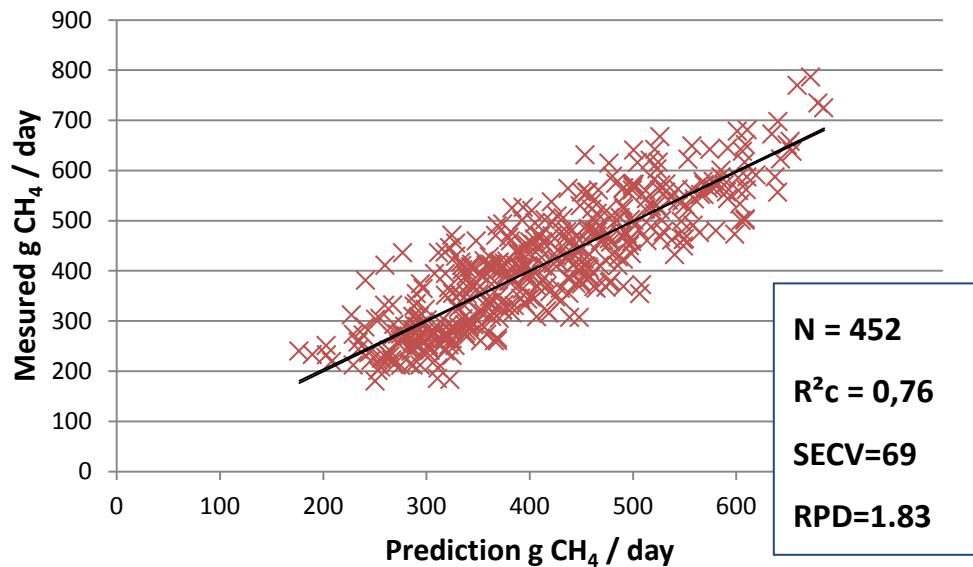
✓ Germany: Brand A
and C instruments

Description	Cross validation with 4 subsets		
	R ² cv	RPDcv	Use
C4:0	1.00	132.99	+++
C6:0	0.93	3.67	+
C8:0	0.91	3.32	+
C10:0	0.91	3.29	+
C12:0	0.92	3.62	+
C14:0	0.93	3.88	+
C14:1 cis	0.68	1.78	-
C16:0	0.94	4.18	+
C16:1 cis	0.73	1.91	-
C17:0	0.80	2.24	0
C18:0	0.84	2.51	0
Total of C18:1 trans	0.79	2.17	0
C18:1 cis9	0.95	4.35	+
Total of C18:1 cis	0.95	4.58	+
Total of C18:2	0.69	1.79	-
C18:2 cis9, cis12	0.72	1.91	-
C18:3 cis9, cis12, cis 15	0.68	1.77	-
C18:2 cis 9, Trans 11	0.74	1.95	-
Saturated FA	0.99	10.22	+++
Mono-unsaturated FA	0.97	5.83	++
Poly-unsaturated FA	0.77	2.10	0
Unsaturated FA	0.97	5.75	++
Short chain FA	0.93	3.88	+
Mid chain FA	0.97	5.53	++
Long chain	0.95	4.52	+
Bbranched FA : iso + anteiso	0.75	2.00	0
Omega 3	0.66	1.73	-
Omega 6	0.72	1.89	-
Odd FA	0.83	2.41	0
Trans FA	0.80	2.26	0
C18:1	0.96	5.18	++

Methane model

Methane emitted by dairy cows (A.Vanlierde, 2013)

- 84 from Brand B
- 368 from Brand C



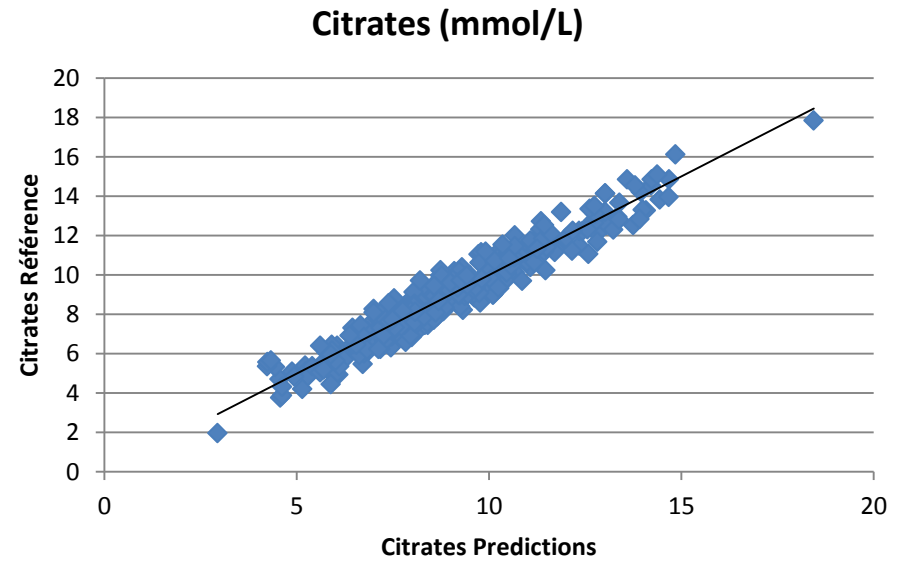
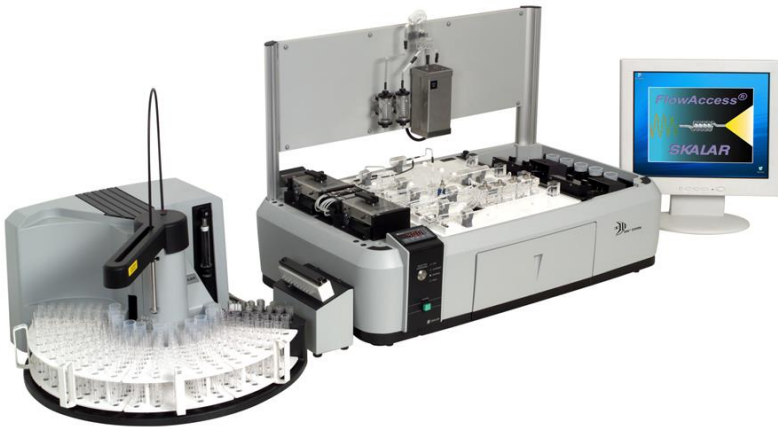
Reference values (SF6)



BHB, acetone and citrates models

- 536 milk samples **all standardized**
 - **Brand A**
 - **Brand C**

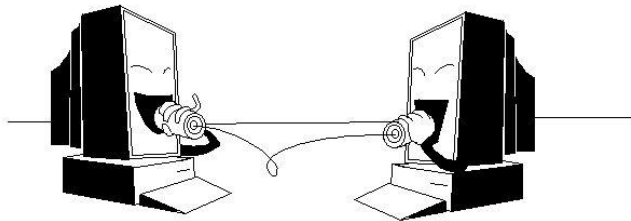
From France, Germany and Luxembourg



Conclusion

Common language for all instruments

- ✓ Monthly since January 2012, 67 instruments into 27 labs
- ✓ Merging database
- ✓ Creation of common models, more robust
- ✓ Use of the models by all instruments



→ Equations become universal

Standardisation of milk mid-infrared spectra from a European dairy network,
C. Grelet, J.A. Fernández Pierna, P. Dardenne, V. Baeten, F. Dehareng,
Journal of Dairy Sciences, 2015, 98 :2150–2160

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