



EAAP 2015



Can chamber and SF₆ methane measurements be combined in a model to predict CH₄ from milk MIR spectra?

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Context



- Methane emitted by ruminants → greenhouse gas
→ loss of gross energy intake (6 to 12%)



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- BUT! Only two breeds (HO - JER), two countries (BE – IRL) and relative diet / management of herd
- Unreliable performances on other breeds, diets, countries (T°, management, genetics,...)



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- Inclusion of relevant local data (new variability) will :
 - ensure consistency of methane prediction in a new area
 - increase global accuracy and robustness of predictions





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- Can we put them in the same database?
 - yes → one global equation is conceivable
 - no → one equation /technique or /team
(more time & less robust)





Material and Methods



Test the performance of the equation on an external dataset
using another technique to measure methane emissions





Material and Methods



Test the performance of the equation on an external dataset
using another technique to measure methane emissions

Calibration dataset

532 reference data : milk MIR spectrum // CH₄

- **SF₆**
- Belgium (CRA-W, n=268) and Ireland (Teagasc – Moorepark, n=264)
- 165 cows
- Lactations : 64 x1st, 43 x2nd, 58 x3rd and more
- Holstein, Jersey and Cross-breed (Hol x Jer)
- Different diets : basic diet enriched in - maize - fresh grass - linseed
classic total mixed ration
starch morning, fiber evening
grassland





Material and Methods



Test the performance of the equation on an external dataset
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Test dataset

60 reference data : milk MIR spectrum // CH₄

- **Open-circuit chambers**
- Switzerland
- 30 cows
- Lactations : 7 x 1st, 6 x 2nd , 17 x 3rd or +
- Brown Swiss
- Diets : half → forage exclusively (grass hay, corn silage, pellets of dried grass)
half → same forage mix + limited amounts of concentrate





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Calibration set

VS.

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SF₆

← Method →

Open-circuit chambers



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← Method → **Open-circuit chambers**



Credit : Kathrin Buehler, UZH

Material and Methods

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Calibration set

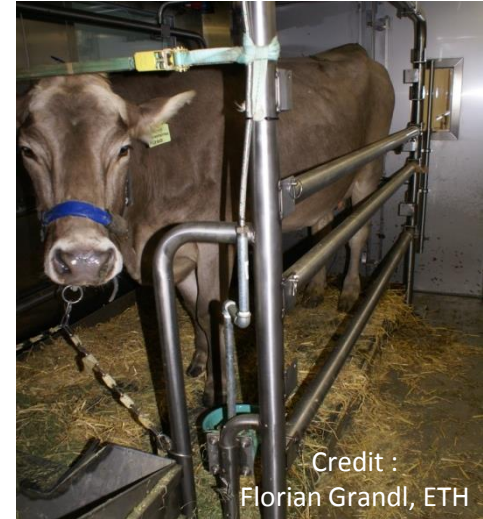
VS.

Test dataset

SF_6

← Method →

Open-circuit chambers



Credit :
Florian Grandl, ETH



Material and Methods



Test the performance of the equation on an external dataset
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Calibration set

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Test dataset

SF₆

Belgium + Ireland

← Method →

← Country →

Open-circuit chambers

Switzerland





Material and Methods



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SF₆

Belgium + Ireland

← Method →

Open-circuit chambers

← Country →

Switzerland

Holstein + Jersey + HolxJer ← Breed →

Brown Swiss





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Belgium + Ireland

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Diet





Material and Methods



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Calibration set

VS.

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SF₆

← Method →

Open-circuit chambers

Belgium + Ireland

← Country →

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Holstein + Jersey + HolxJer

← Breed →

Brown Swiss

Diet

→ Datasets very different





Material and Methods



Equation to predict methane from milk MIR spectra





Material and Methods



Equation to predict methane from milk MIR spectra

- Calibration on 532 reference data (SF_6)





Material and Methods



Equation to predict methane from milk MIR spectra

- Calibration on 532 reference data (SF_6)
- Spectral modification to take into account the expected metabolic status of cows in function of the DIM

→ Use of Legendre Polynomials (EAAP2014 & Vanlierde *et al.*, 2015)



Equation to predict methane from milk MIR spectra

- Calibration on 532 reference data (SF_6)
- Spectral modification to take into account the expected metabolic status of cows in function of the DIM

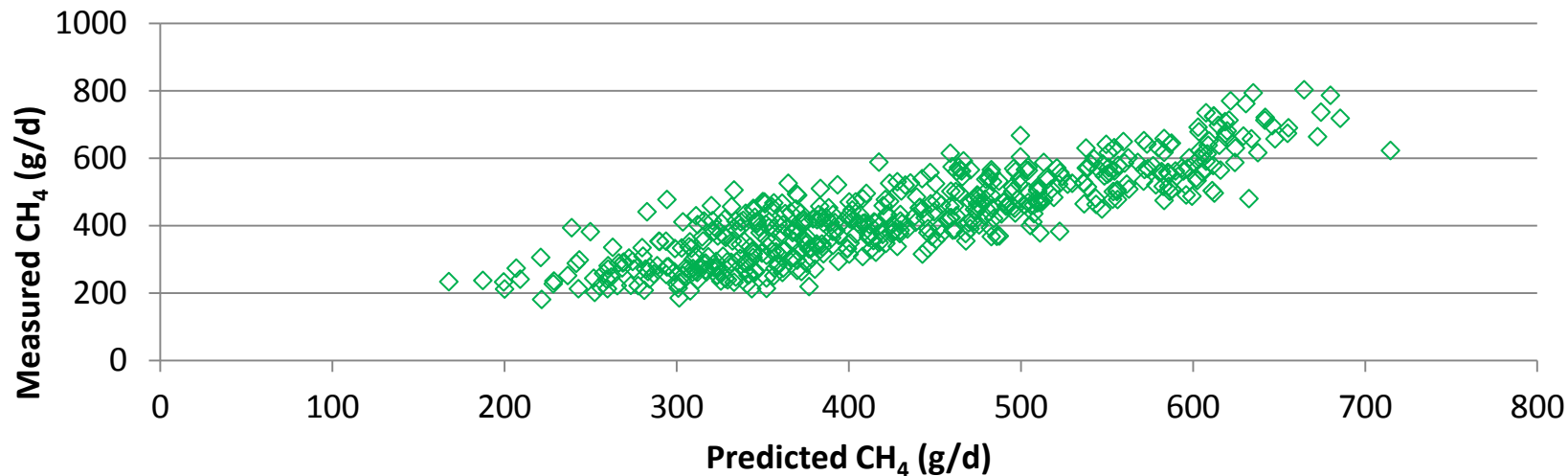
→ Use of Legendre Polynomials (EAAP2014 & Vanlierde *et al.*, 2015)

○

	N	SD	R ² _c	R ² _{cv}	SEC	SECV
g CH ₄ /day	532	129	0.74	0.70	66	70

SD : standard deviation ; SEC : standard error of calibration ;
SECV : standard error of cross validation

Equation to predict methane from milk MIR spectra



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- 1) → Application of the existing equation on Swiss data
 - Swiss data : predictions // chamber measurements?





Material and Methods



- 1) → Application of the existing equation on Swiss data
 - Swiss data : predictions // chamber measurements?

- 2) → Integration of Swiss data in the calibration set
 - equation including SF₆ and Chamber data
 - statistical parameter of this new equation?
 - influence on previous data prediction? (noise?)
 - Swiss data : predictions // chamber measurements?





Results and discussion



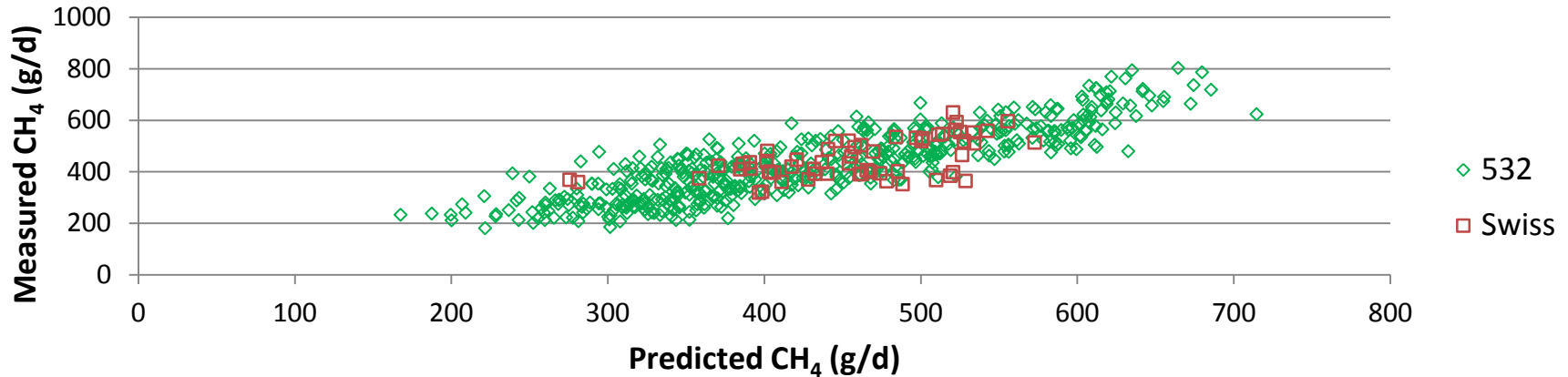
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Results and discussion

1) → Application of the existing equation on Swiss data

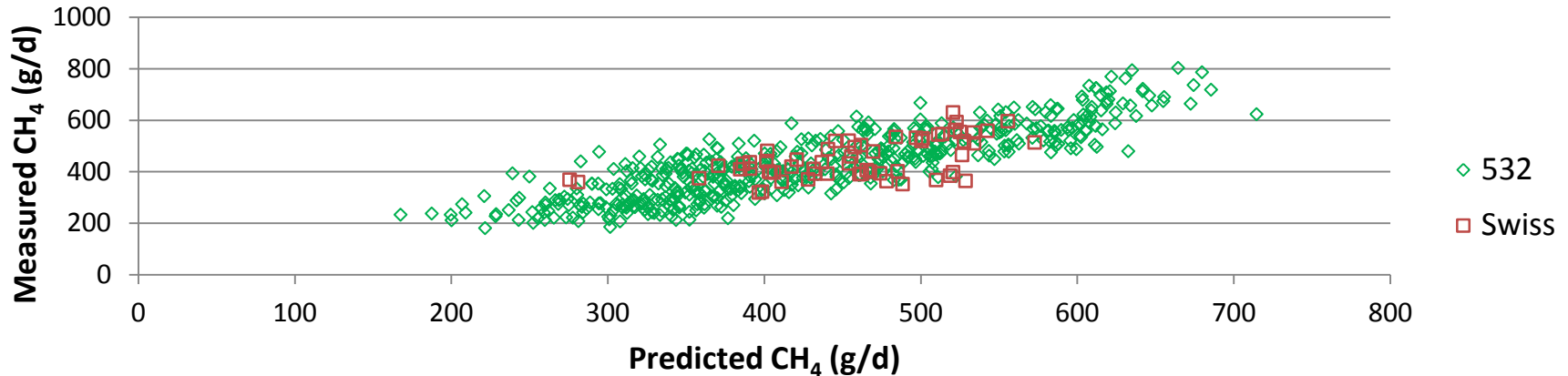
Before inclusion of swiss data in the calibration set



Results and discussion

1) → Application of the existing equation on Swiss data

Before inclusion of swiss data in the calibration set



Correlation between measured and predicted value for Swiss data : 0.58

→ Very encouraging regarding the difference between datasets





Results and discussion



2) → Integration of Swiss data in the calibration set

→ equation including SF₆ and Chamber data

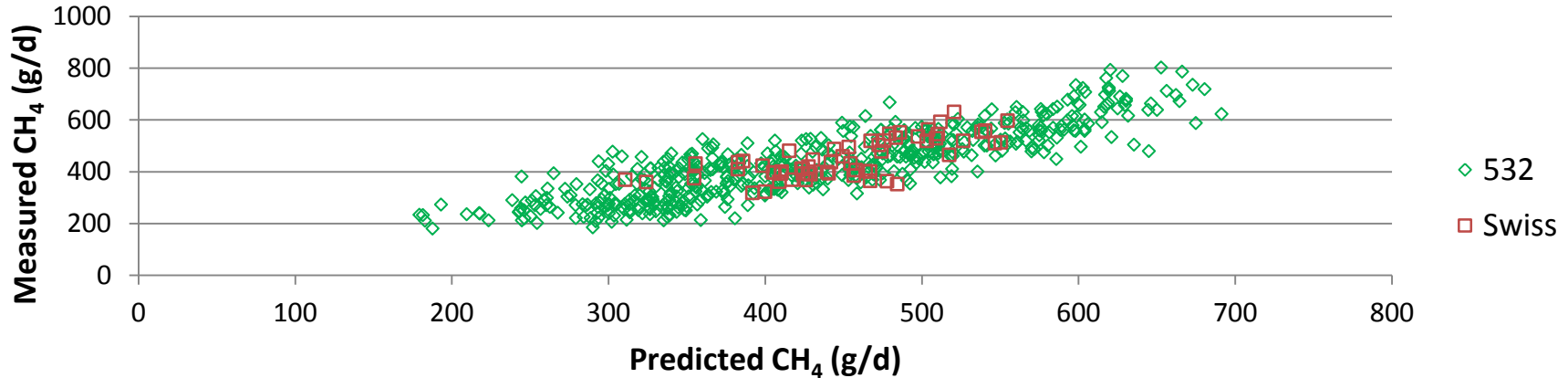


Results and discussion

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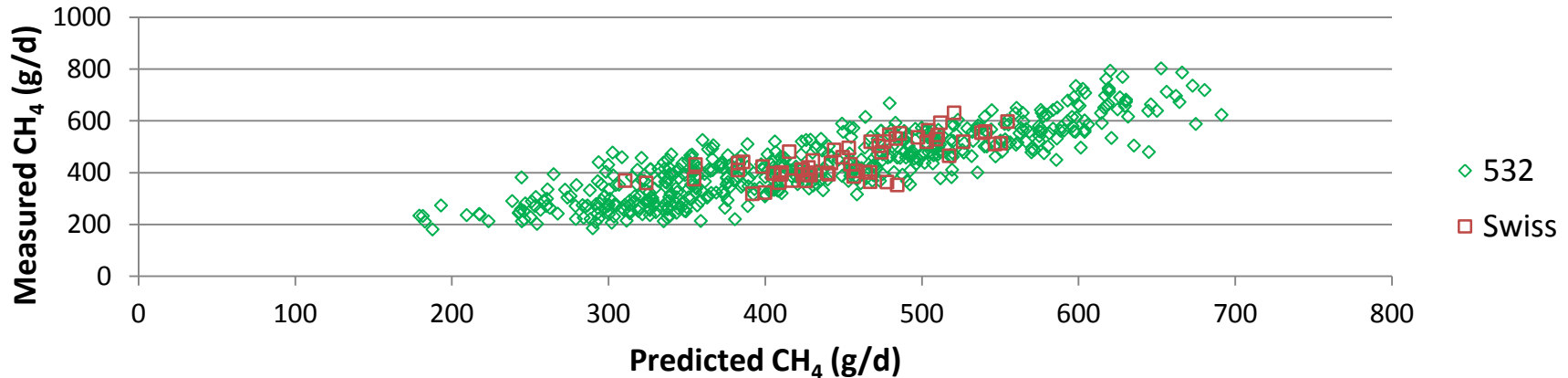
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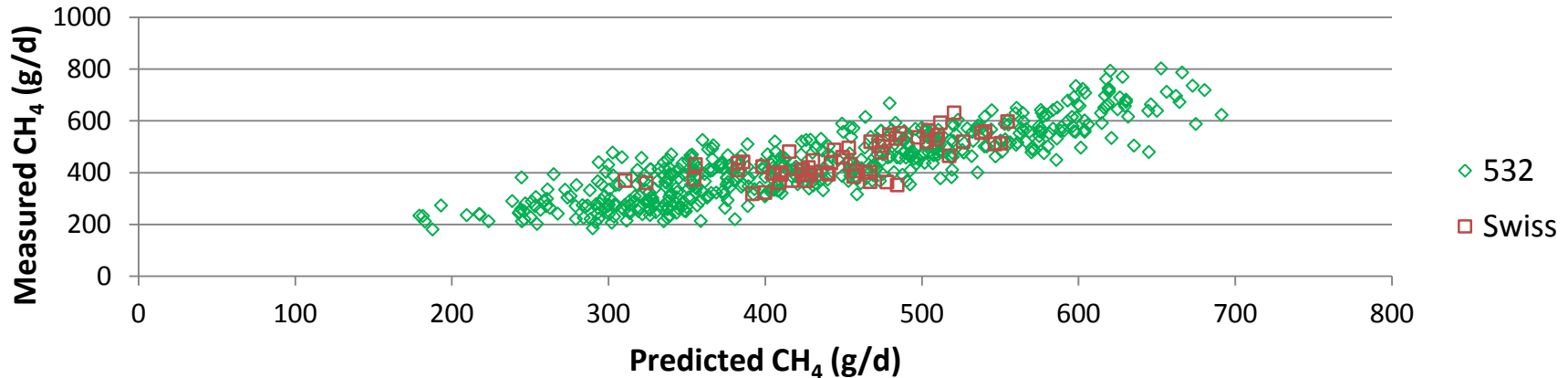
Correlation between measured and predicted value for Swiss data : 0.72



2) → Integration of Swiss data in the calibration set

→ equation including SF₆ and Chamber data

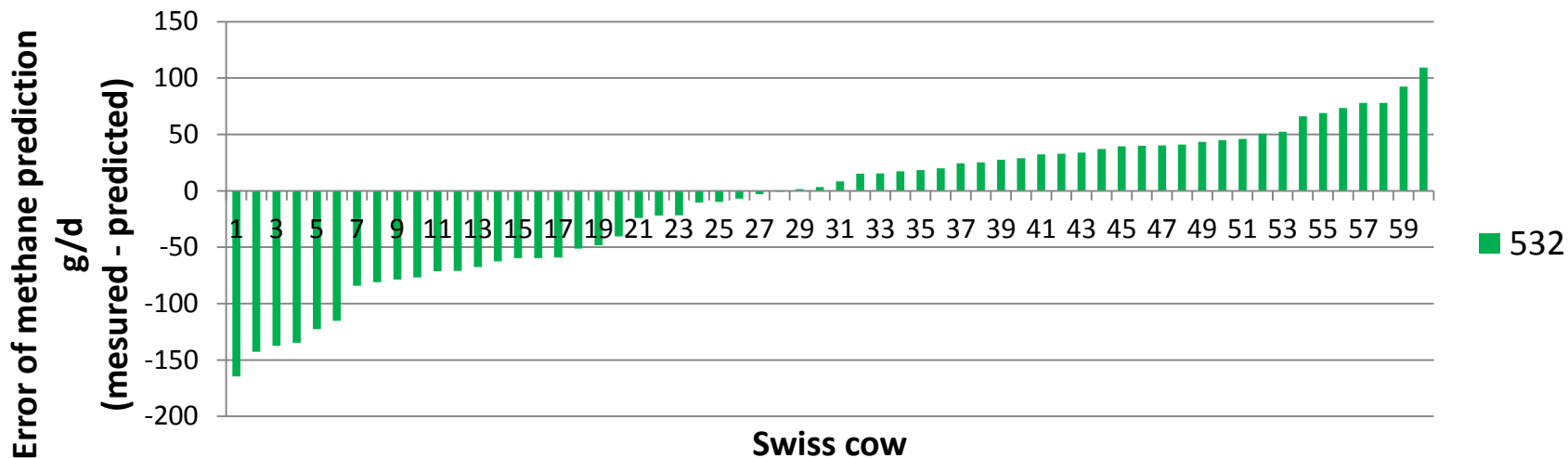
After inclusion of swiss data in the calibration set



Equation (g/d)	N	SD	R ² _c	R ² _{cv}	SEC	SECV	RPD
CH ₄	532	129	0.74	0.7	66	70	1.84
CH ₄ + Swiss data	592	125	0.74	0.7	64	69	1.81

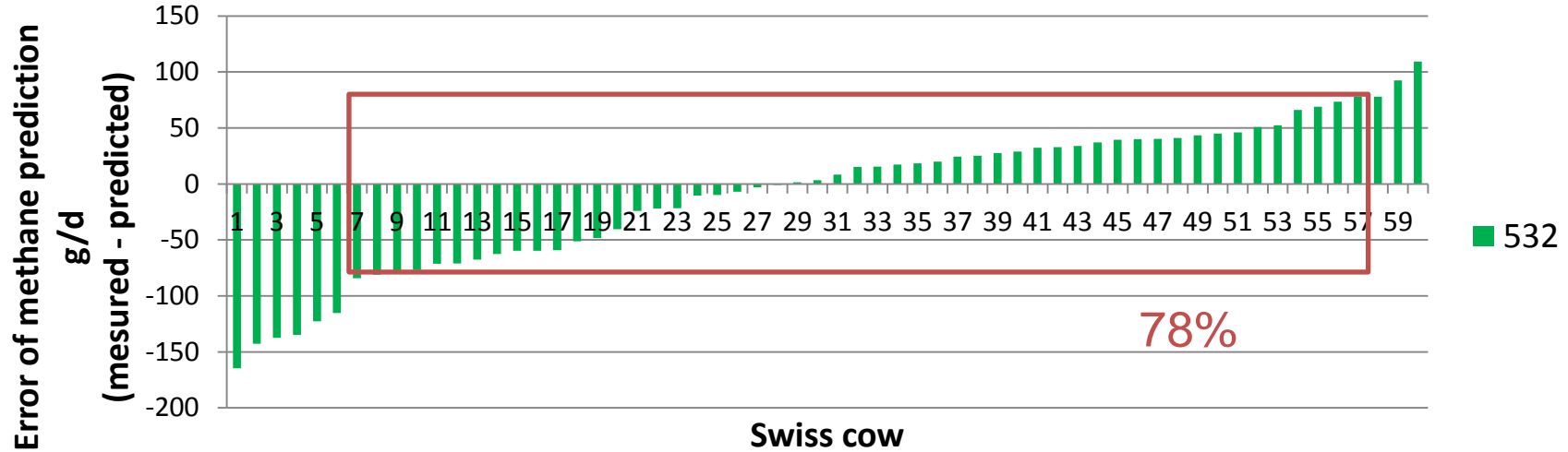
Results and discussion

Error of prediction of Swiss data



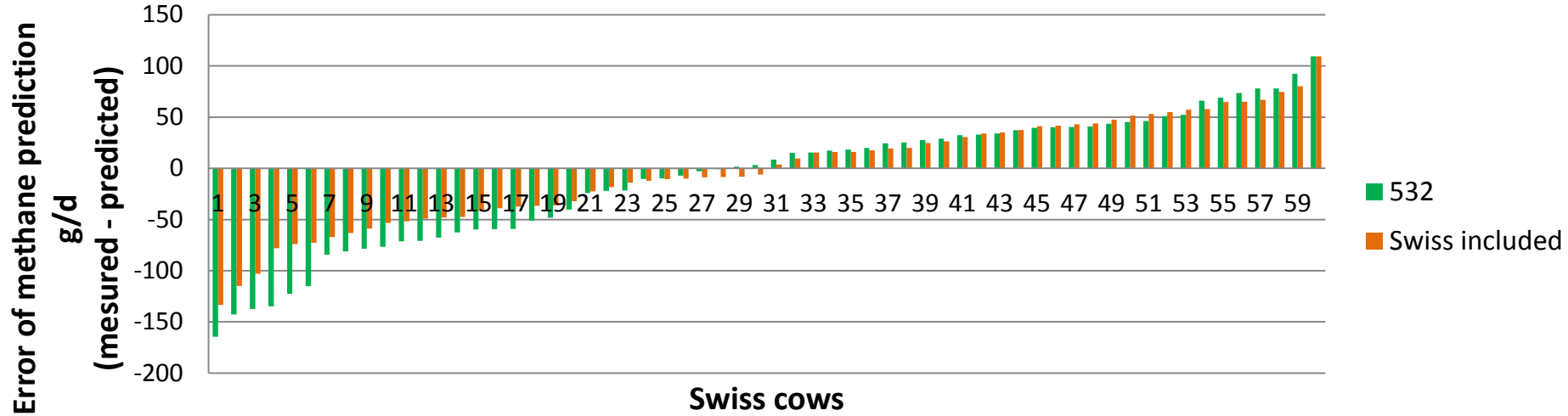
Results and discussion

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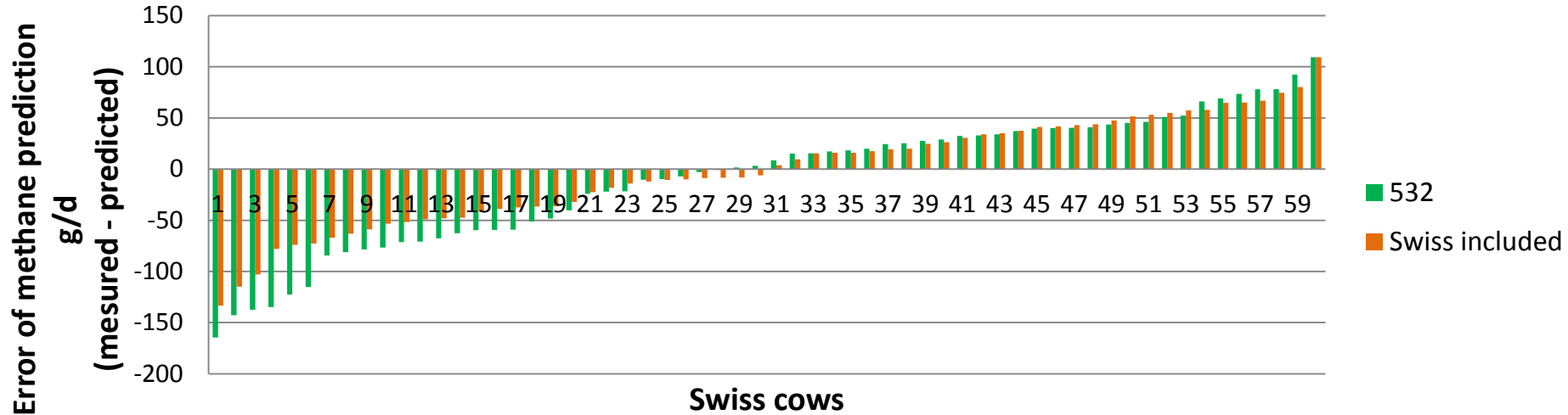
Results and discussion

Error of prediction of Swiss data



Results and discussion

Error of prediction of Swiss data



→ No fix error → no correction regarding the different technique





Results and discussion



→ Similar statistics





Results and discussion



- Similar statistics
- Datasets very different but external test is encouraging
 - no outliers
 - significant correlation between predictions and measurements





Results and discussion



- Similar statistics
- Datasets very different but external test is encouraging
 - no outliers
 - significant correlation between predictions and measurements
- Integration of reference data in the calibration set
 - increase the quality of prediction for Swiss data
 - not affect the quality of other predictions





Conclusions



- In this case it seems possible to integrate Methane measurement obtained with another technique than SF₆
- Chambers considered as “Gold standard” → confirm the relevance of the technique to predict methane emissions from milk MIR spectra
- Need to carry out similar tests with other measurement techniques
- Open the door to new collaborations



Thank you!



Measurement of gas exchange in respiration chambers

