

EXPERIENCES WITH CH₄ SNIFFERS

WHAT HAVE WE LEARNED SO FAR?

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Aim of presentation

Multiple countries have/will invest in **sniffers** for genetic evaluation of methane, which is not a plug-and-play technology

What hardware is available?

How do we best install sniffers?

Best surveillance practices of sniffers?

Data processing of raw to final phenotype

Expected ranking with other systems

Holstein SOP project

International collaboration developing standards and quality control measures for phenotyping with a used in breeding programs, and accelerating the phenotyping

WP1 - Establishing quality standards for **sniffers** and test facility (lab and on farm) for different sniffer types that will serve as guidelines when starting to collect methane records



Global Methane Genetics initiative

Led by



WAGENINGEN
UNIVERSITY & RESEARCH

In Partnership with

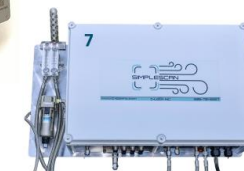


BEZOS
EARTH
FUND



Global
Methane
Hub

Commercially available sniffers



<https://carltech.nl/en/products>

<https://agscent.com/products/agscent-air/>

<https://gasera.fi/product/gasera-one-pulse/>

Arcoflex: <https://doi.org/10.1016/j.cej.2025.165629>

<https://edinburghsensors.com/products/gas-monitors/>

<https://www.tecnosens.it/en/Tecnosens-products/moologger>

<https://www.c-lockinc.com/products/emissions-monitoring/simplescan>

<https://www.gasmet.com/products/category/portable-gas-analyzers/gt5000-terra/>

Sniffer
comparison

Measurement
standardization

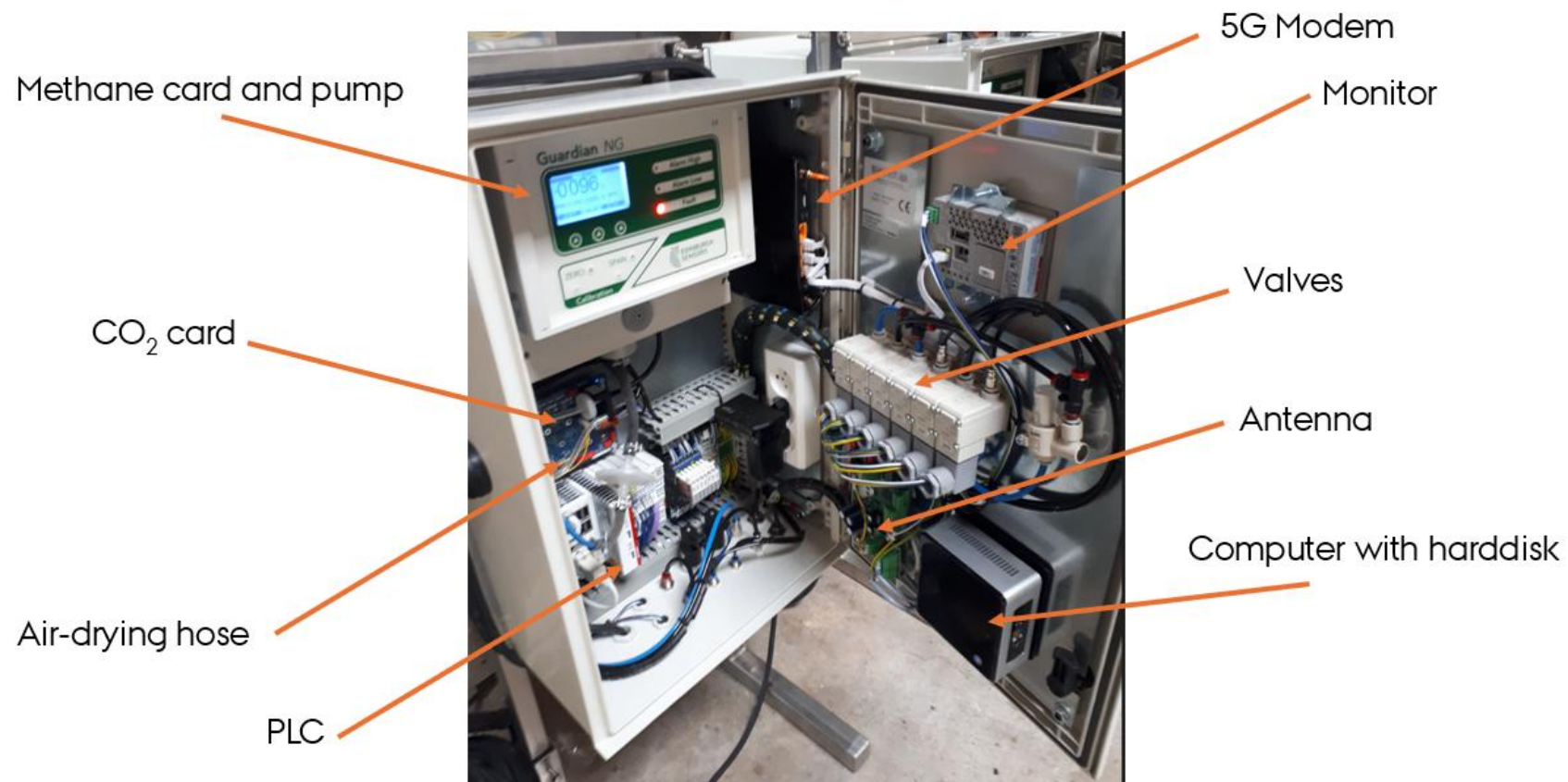
Protocol to
align/edit
standardization

Genetic
Evaluation
Model
countries/credit
system

Increase global
CH₄ reference
population –
Holstein

CH₄ concentration
phenotypes in
20K new cows

Guardian sniffer



Installation of Guardian sniffer



Delaval



Lely A4+A5

Installation of Guardian sniffer



Reference measurement

11 am in 3 minute

11 pm in 3 minute

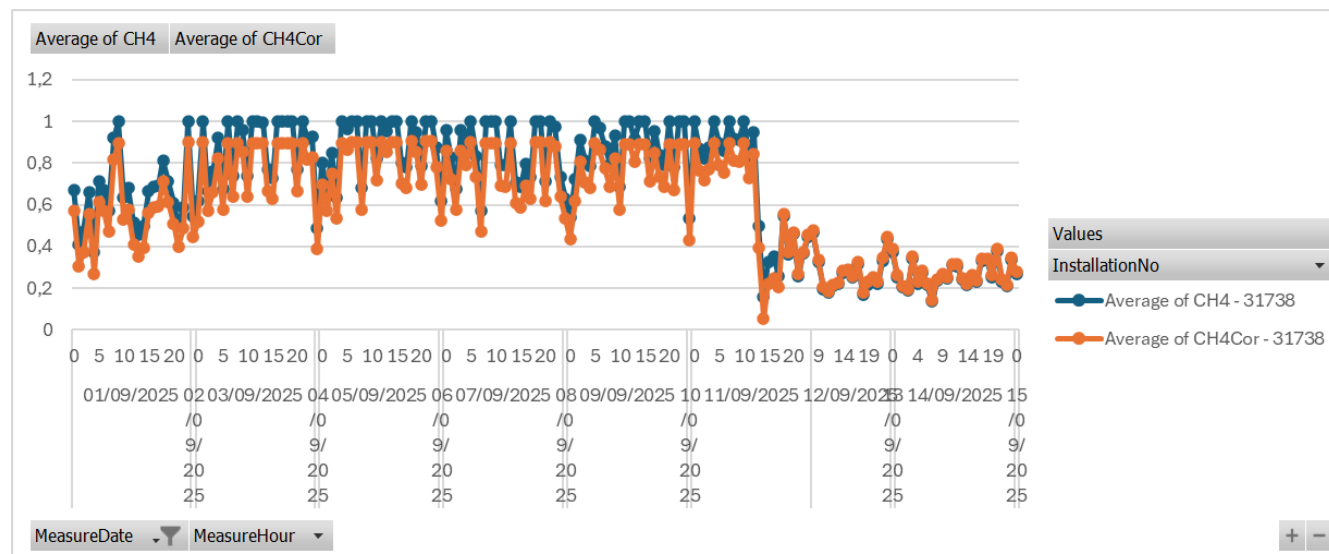
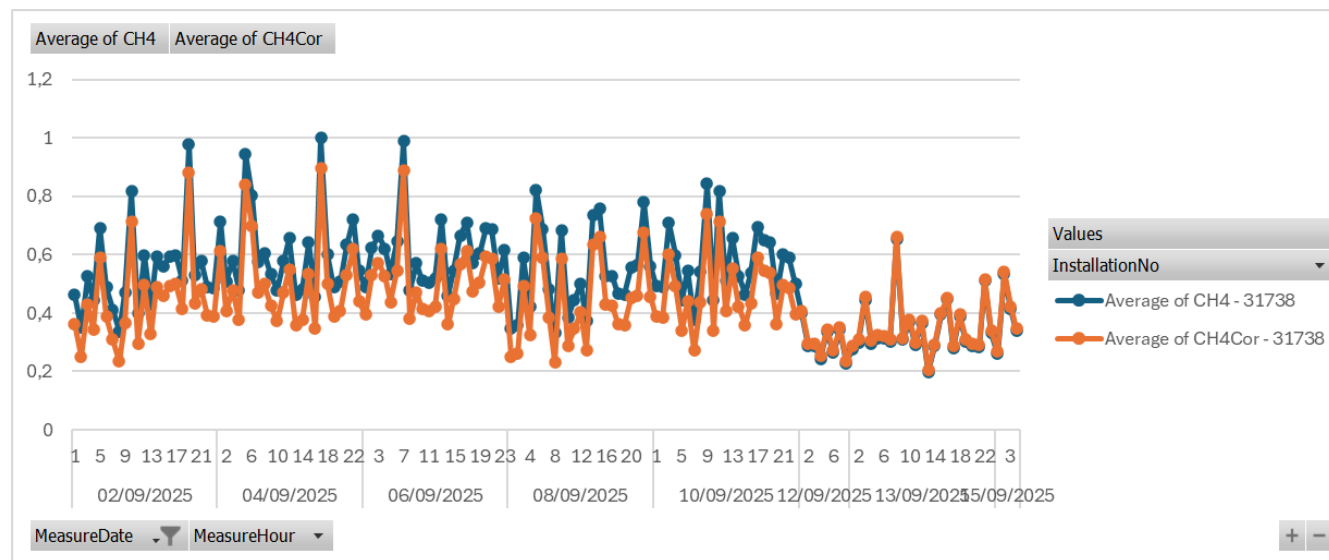
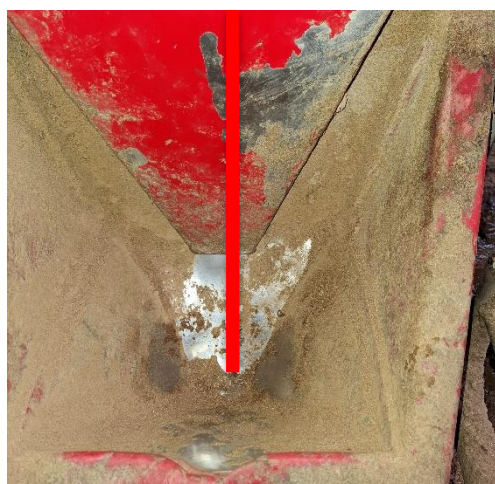
Surveillance of Guardian sniffers

Operational surveillance tool for our 38 sniffers

AmsCompany ▼	Ams ▼	Sniffers ▼	Calibration ▼	Placement ▼
Lely A5	4	3	1	
Delaval	4	2		1
Delaval	2	1	1	1
Delaval	3	2	1	
LELY A5	6	3		1

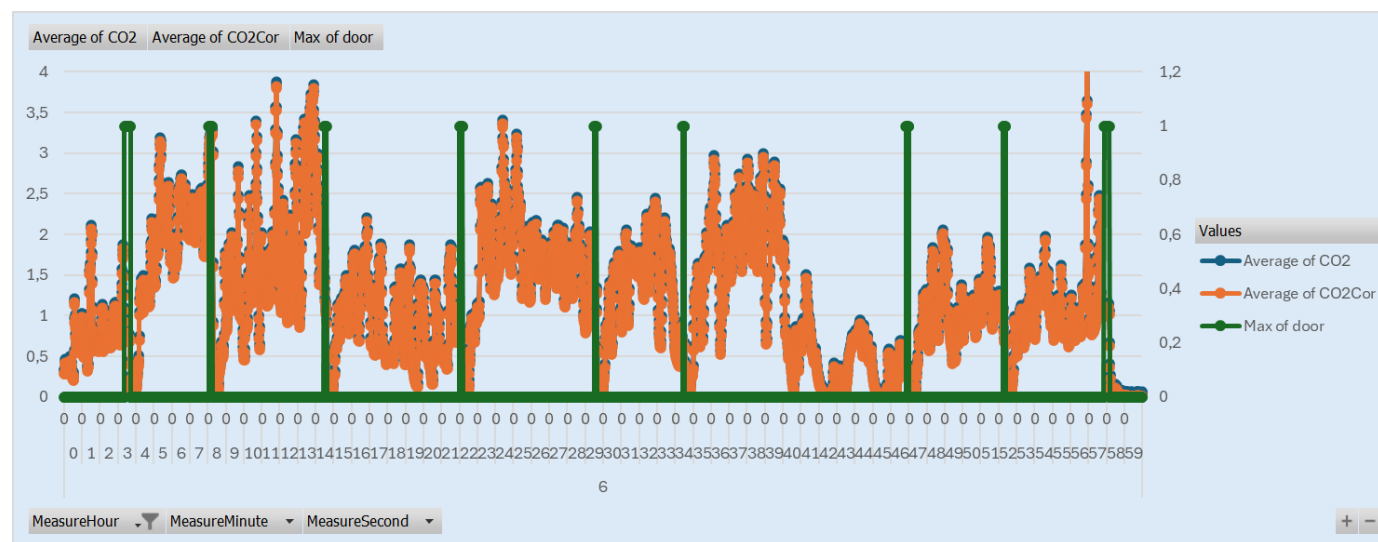
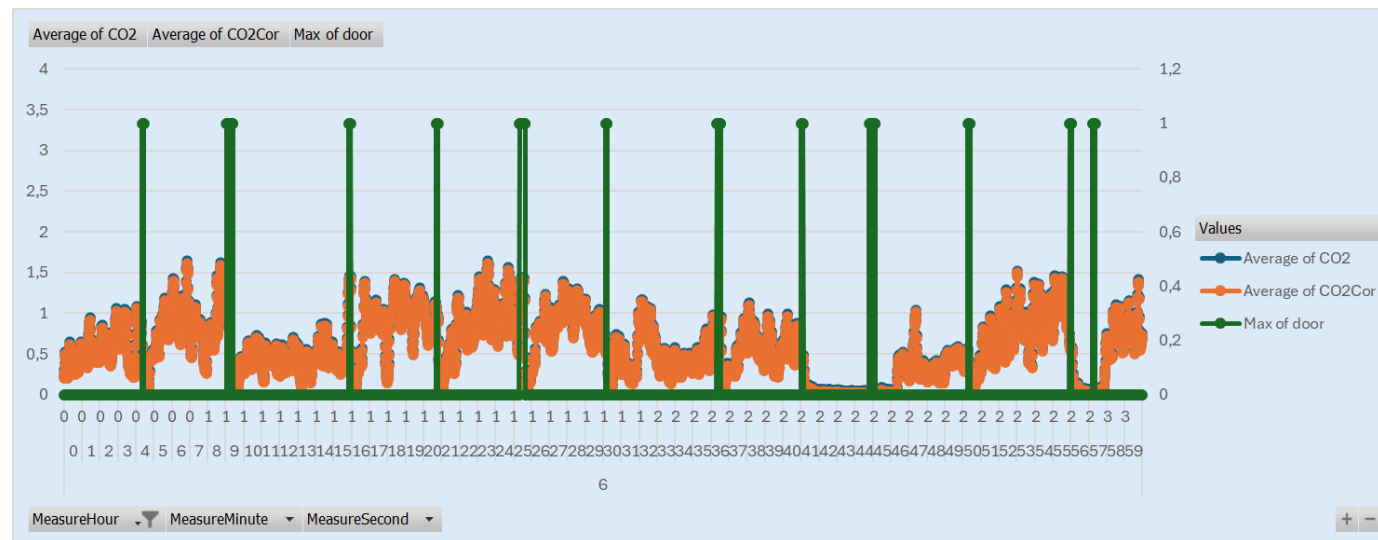
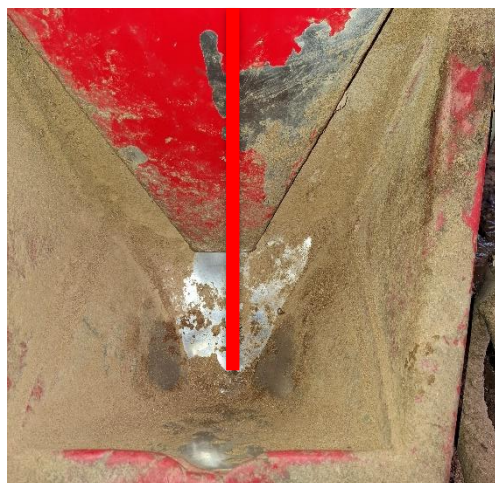
Placement of filter in Guardian sniffers

Effect of nose placement
in feed bin

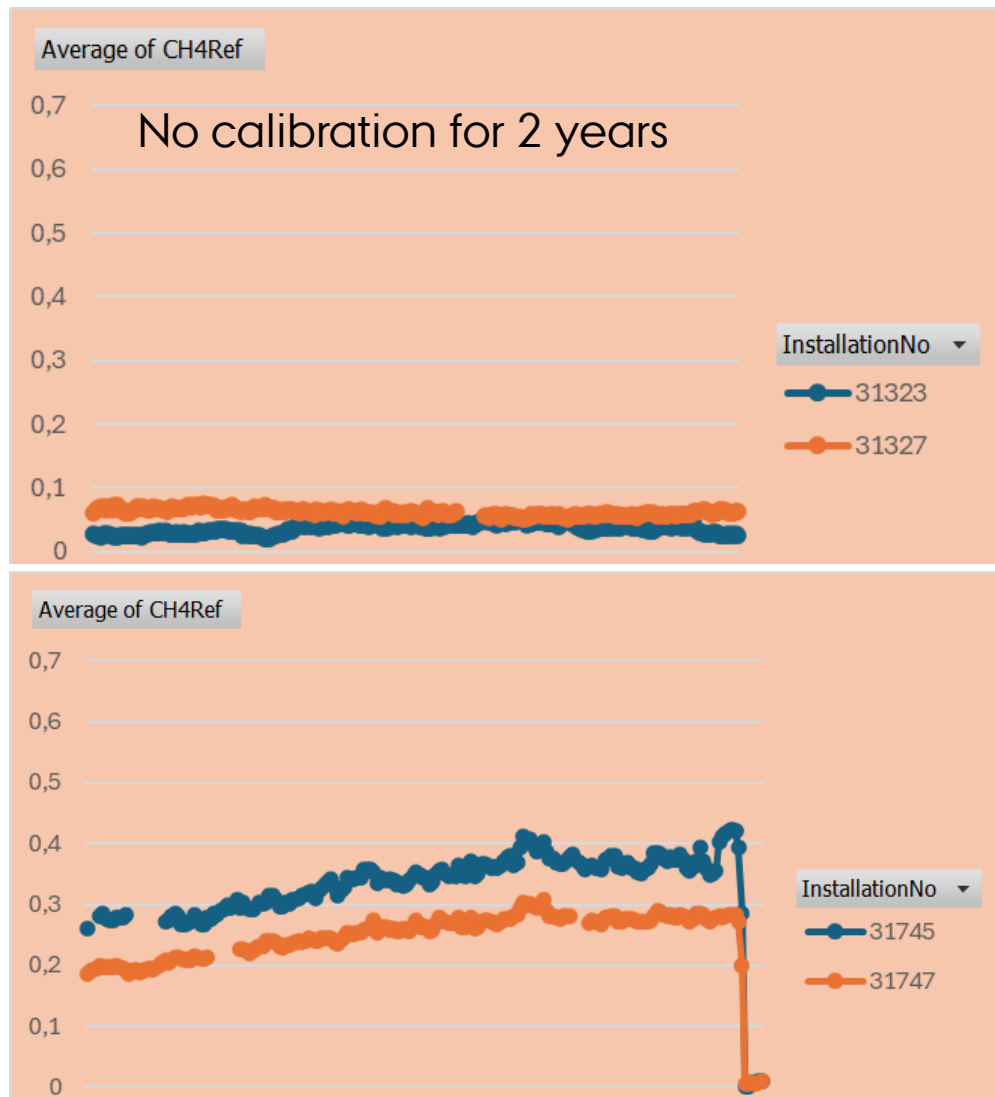


Placement of filter in Guardian sniffers

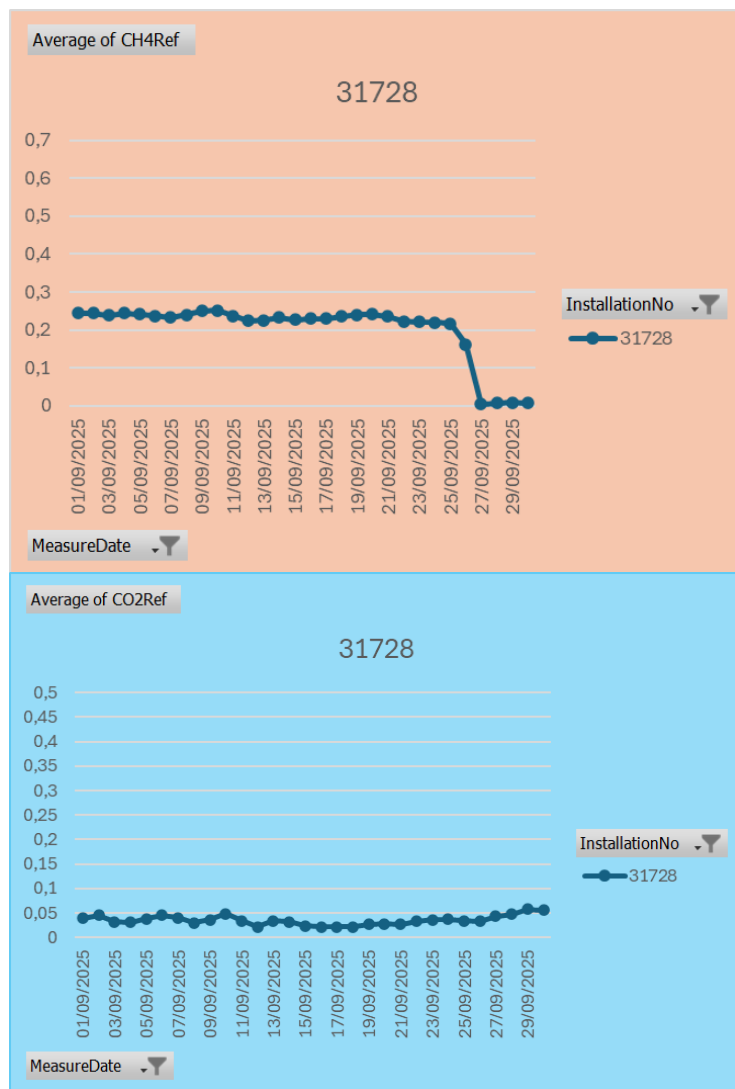
Effect of nose placement
in feed bin



Calibration Guardian sniffers



Calibration Guardian sniffers

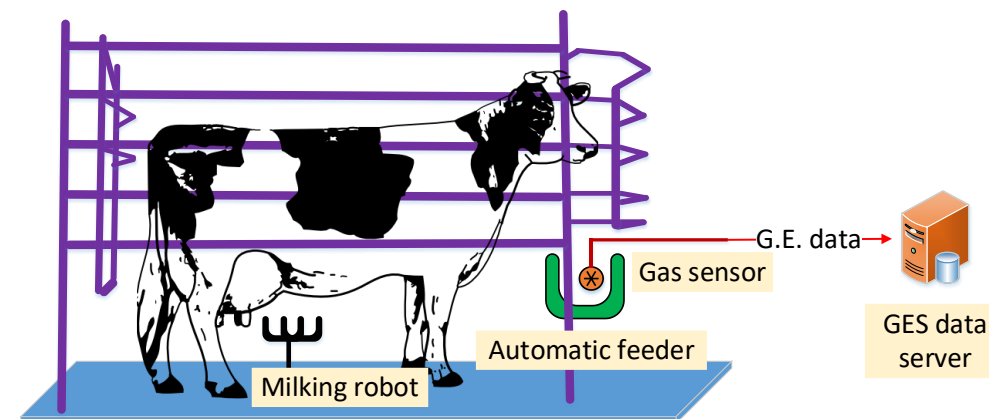
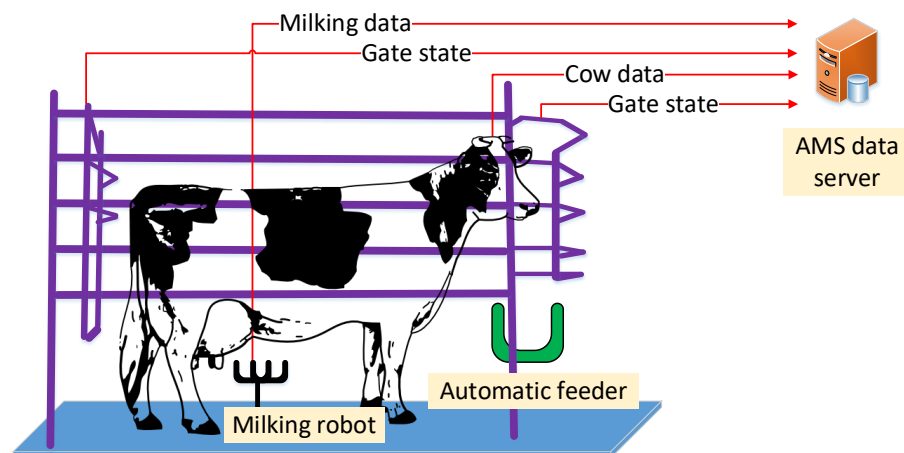


Key messages on practical experience with sniffers

1. Important to place filter close to mouth of the cow,
but also hidden – curious animal
2. Important to have surveillance tool of sniffers
(calibration + malfunctioning)
3. CO₂ more stable (calibration) than CH₄ in Guardian
sniffers



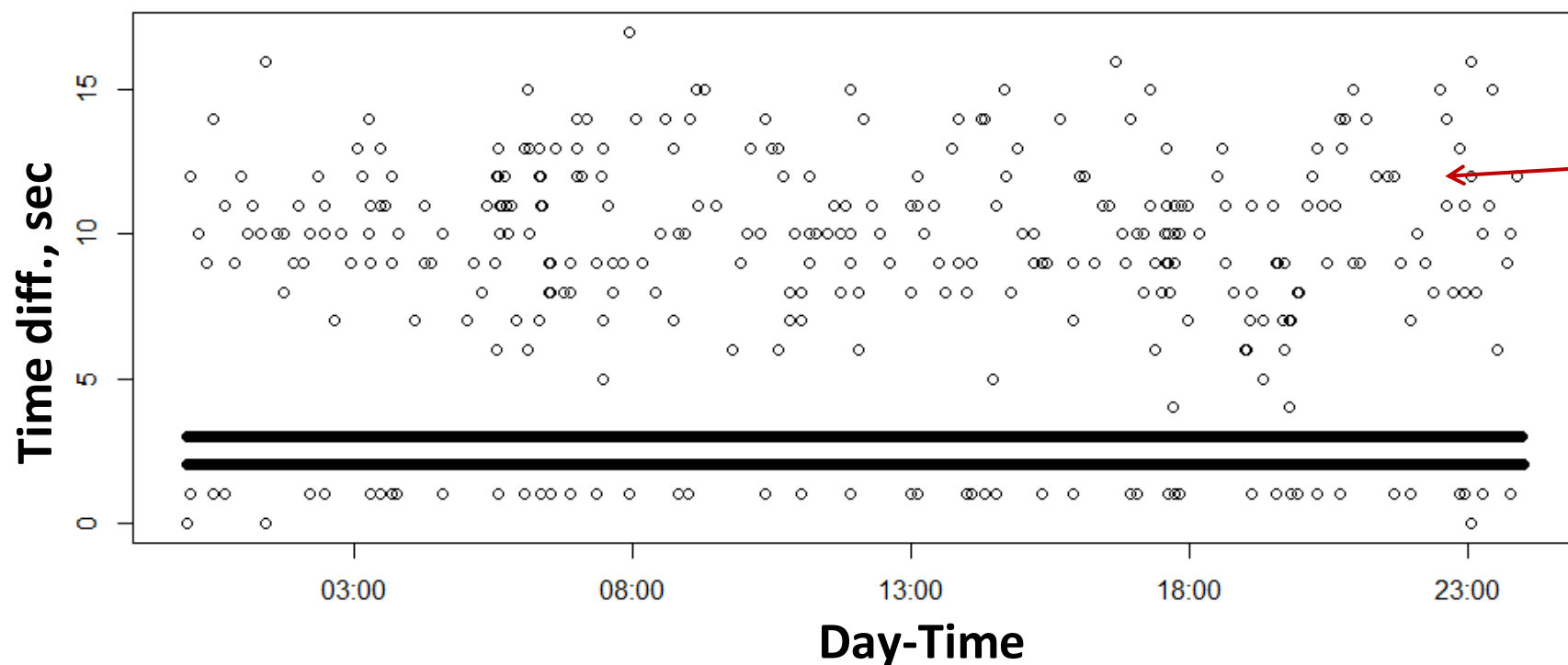
Data acquisition



Animal_ID;	StartTime;	EndTime;	Robot
11003802293;	2019-09-18 23:56:15;	2019-09-19 00:07:53;	101
11003802763;	2019-09-19 00:08:34;	2019-09-19 00:19:35;	101
11003802158;	2019-09-19 00:20:21;	2019-09-19 00:34:19;	101
11003802626;	2019-09-19 00:41:38;	2019-09-19 00:51:39;	101
11003802100;	2019-09-19 00:52:18;	2019-09-19 00:59:15;	101
11003802583;	2019-09-19 00:59:56;	2019-09-19 01:07:25;	101
11003802345;	2019-09-19 01:08:16;	2019-09-19 01:17:43;	101
11003802654;	2019-09-19 01:18:25;	2019-09-19 01:23:16;	101

"DATE";	"TIME";	"CH4";	"CO2"
"15-11-2019";	"03:53:01";	"-1";	"0,383"
"15-11-2019";	"03:53:02";	"-1";	"0,556"
"15-11-2019";	"03:53:03";	"-1";	"0,672"
"15-11-2019";	"03:53:04";	"-1";	"0,714"
"15-11-2019";	"03:53:05";	"-1";	"0,775"
"15-11-2019";	"03:53:06";	"-1";	"0,815"
"15-11-2019";	"03:53:07";	"-1";	"0,829"
"15-11-2019";	"03:53:08";	"-1";	"0,846"

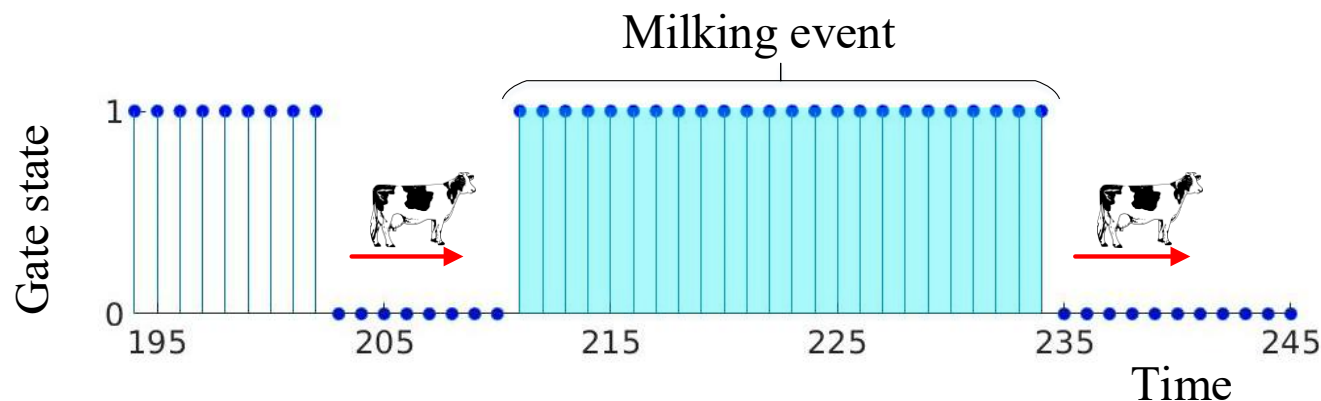
System's Issues 1: Irregular sampling and low sampling rate



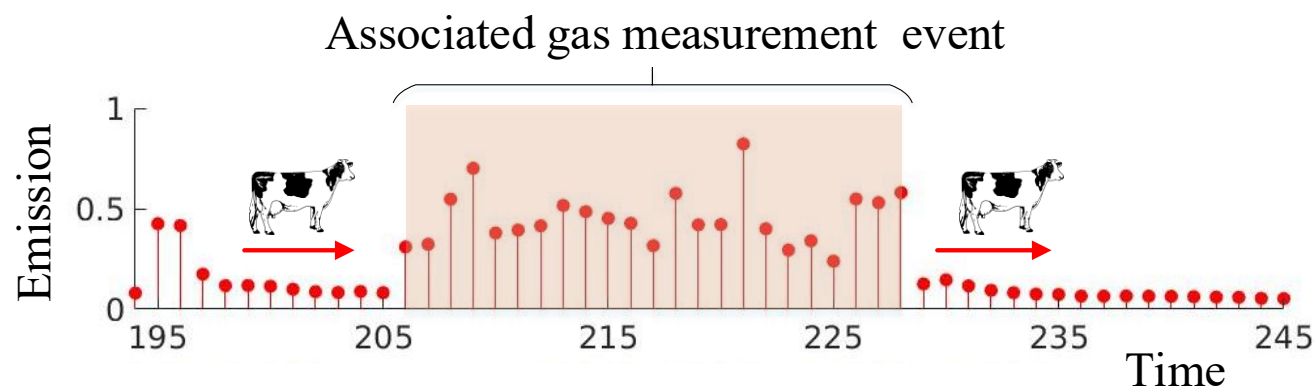
Differennce between
consecutive records:
Expected constant!

System's Issues 2: Data synchronization

Separated
data
streams



AMS



Sniffers

System's Issues 3: System Faults and Data Reliability

Hardware faults

+

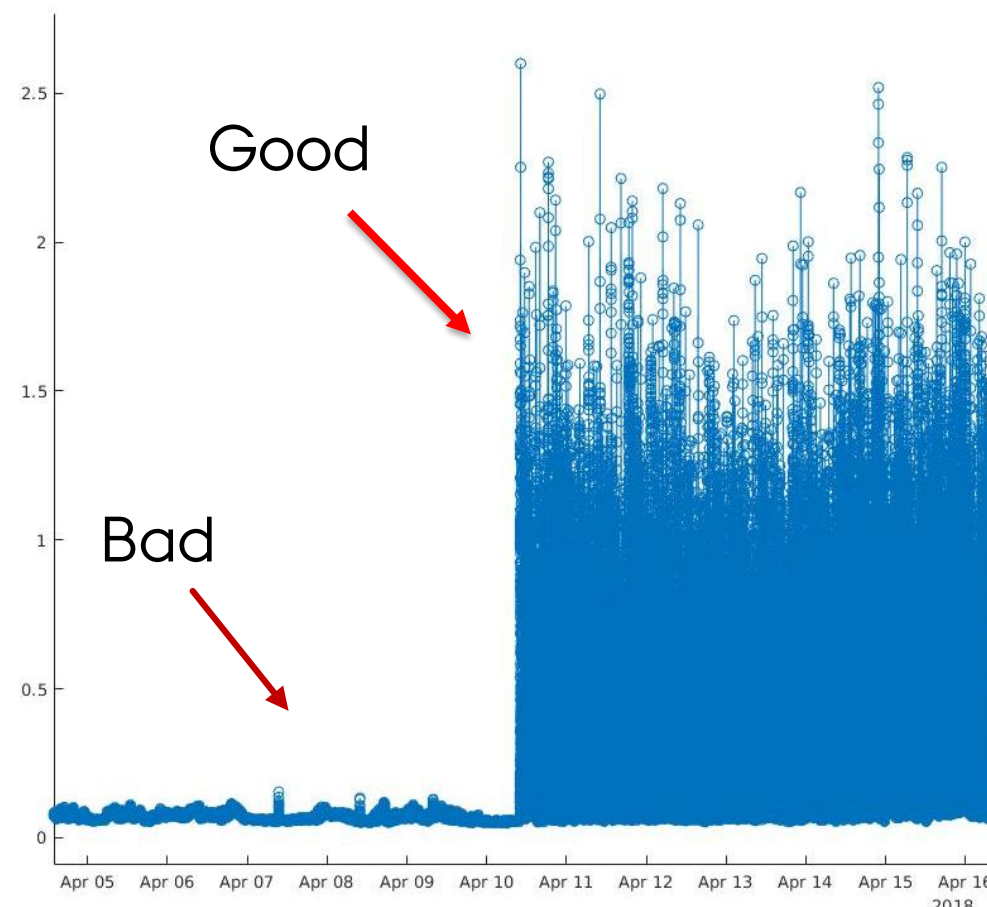
Data pipeline faults



- Interrupted recording
- Sampling variation
- Noise recording

No data

Unreliable data



Data Model: the unified approach to deal with all issues

Sniffers data

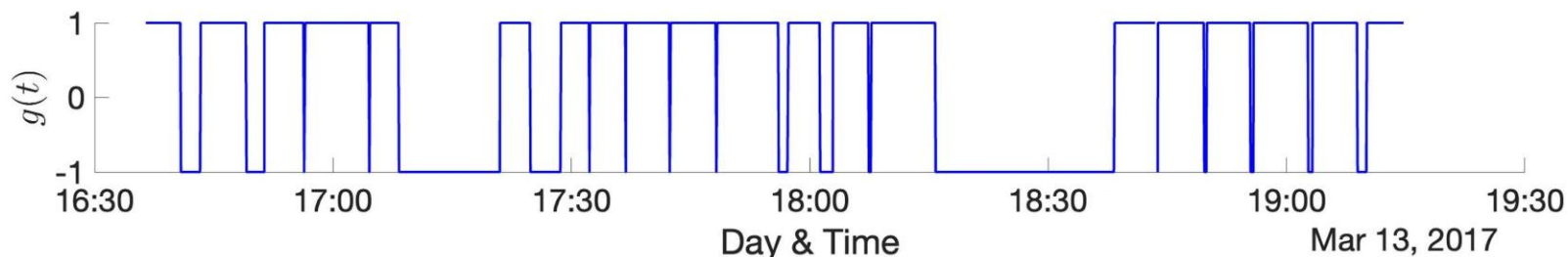
AMS data

Gas
emission

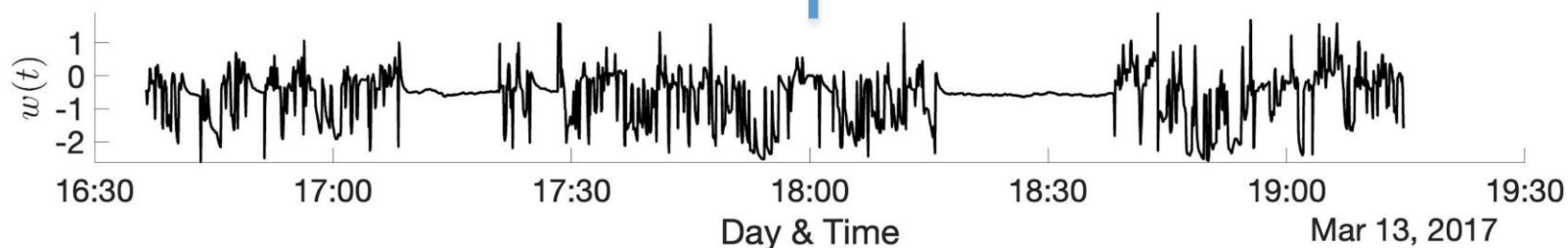
Gate
state

Noise

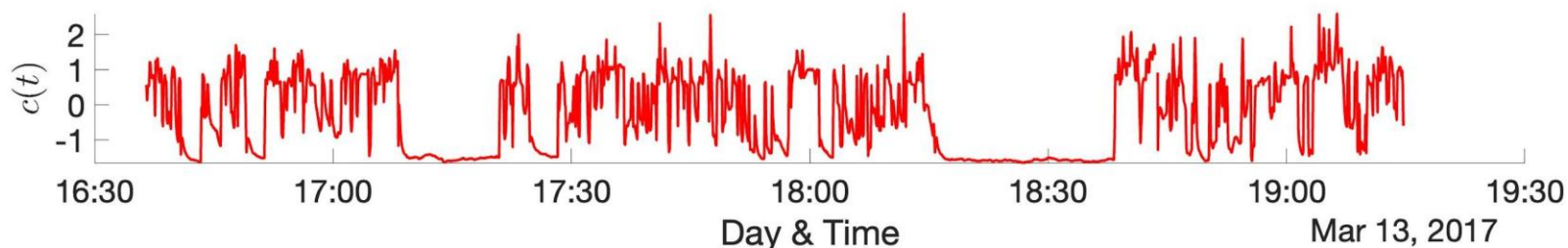
$$c(t) = g(t) + w(t)$$



+



↓



Gas Emission Data Alignment (GEDA) Software

GEDA provides:

- Initial data quality control and filtering

- Synchronization of AMS & Sniffers data streams

- Detection and filtering off an unreliable sniffer data

- On-site monitoring as GEDA processing feedback

- Emission Phenotypes (daily average gas concentration)

- Statistic of quality of estimated phenotypes

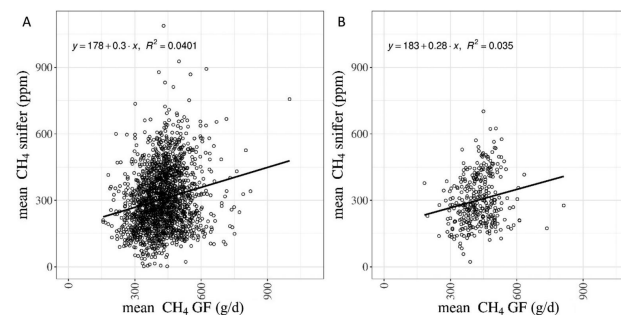
Approaches to evaluate ranking

Accurate breeding values requires large-scale recording of CH₄

Gold standard method (Respiration chamber) only in small scale

Literature study

1. Ranking of **raw** phenotypes (X,Y plot)



van Breukelen, et al. (2023)

2. Phenotypic ranking from **Mixed Model** – allows correction for environmental noise

$$y = X\beta + Za + e$$

Ranking of raw phenotypes

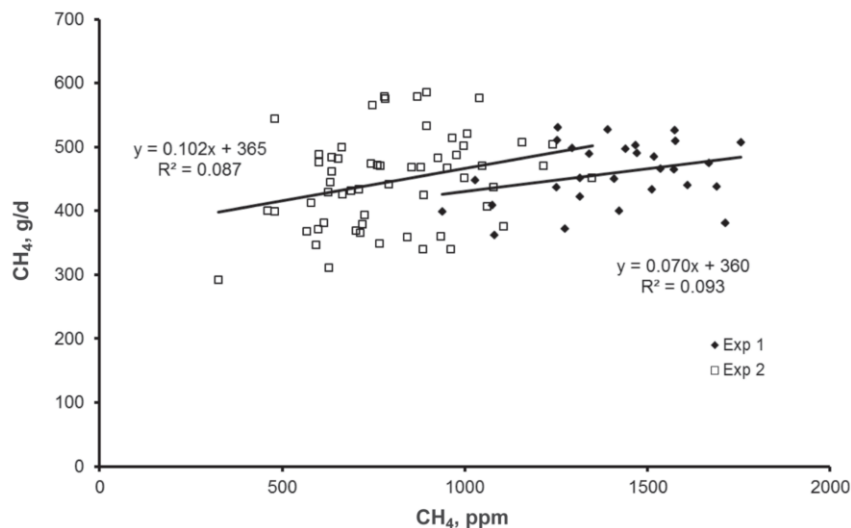
Two papers compared Sniffers and GreenFeed

Low correlations (0.30 & 0.19) in both studies

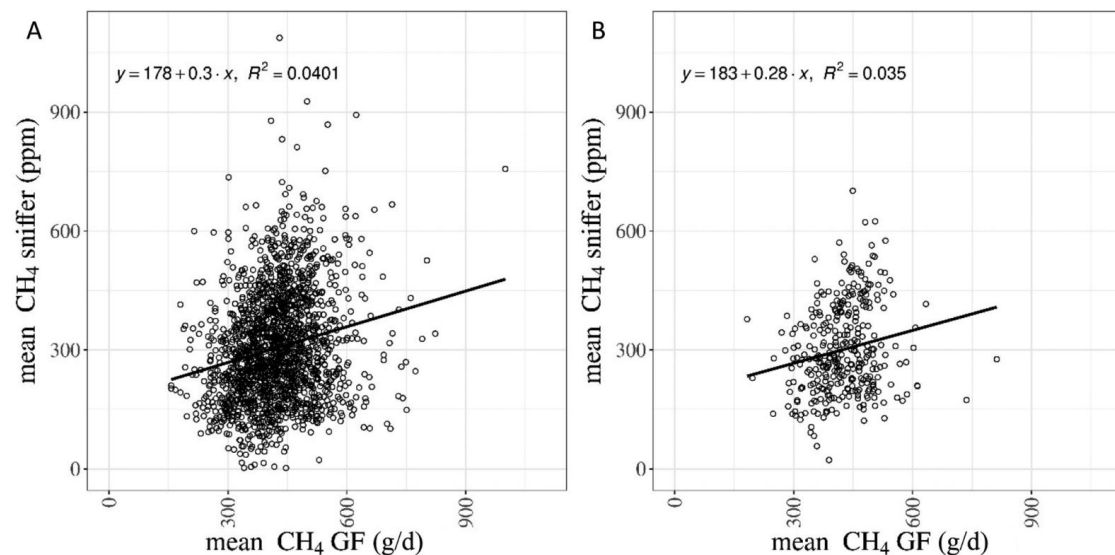
Sniffers influenced by environment - solutions:

Enhance sniffer **hardware** and **processing** of sniffer data

Use **Mixed Models** to account for environmental noise



Huhtanen, et al. (2015)



van Breukelen, et al. (2023)

Phenotypic Mixed Models

Four papers compared ranking of animal solutions from mixed models

	Study	Hardware	n cows	Correlation (SE)
Phenotypic MM	Difford, et al. (2018)	SN RC	20	0.75±0.20
	Bell, et al. (2019)		10	0.75±NA
	Garnsworthy, et al. (2019)		12	0.89±0.07
	van Breukelen, et al. (2023)	SN GF	2,430	0.37±0.05

SN=Sniffer, GF=GreenFeed, RC=Respiration Chamber

Take-home messages

Multiple manufactures on the market – 5 undergoes test in HolsteinSOP

Important to **place** filter optimal

Trade-off between close to mouth and hidden from the cow

Weekly/monthly **surveillance** important

Calibration and malfunctions on the system (filter, hose)

GEDA data processing pipeline are continued developed in HolsteinSOP

Moderate to high phenotypic **ranking** with other systems (Mixed Models)



Acknowledgements

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A special thanks to co-authors for their contributions



**THANK YOU FOR
YOUR ATTENTION**