

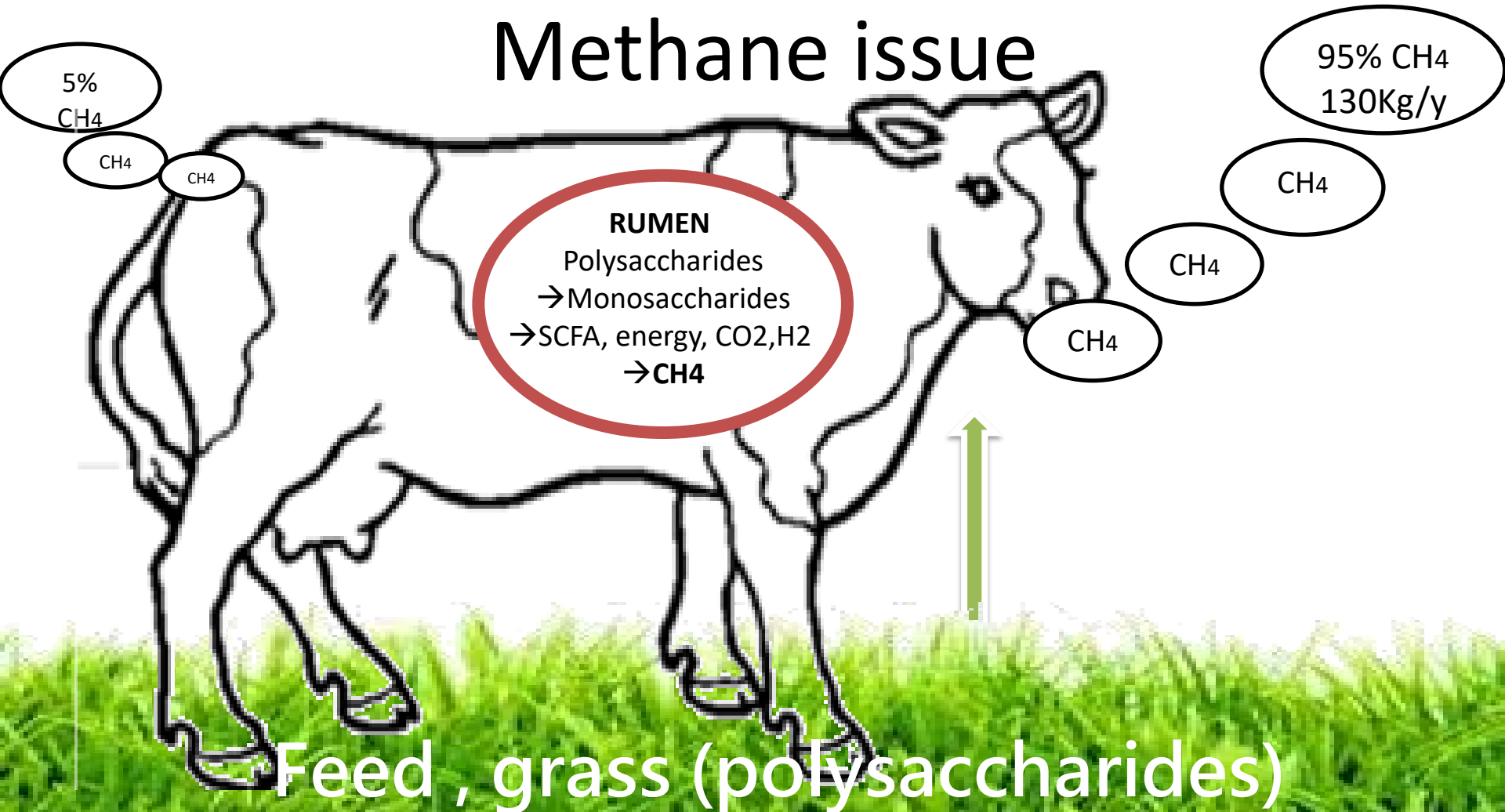
High rate monitoring of CH₄ production dynamics and their link with behavioral phases in cattle

Yannick Blaise, F. LEBEAU , A.L.H. ANDRIAMANDROSO, Y. BECKERS,
B. HEINESCH, J. BINDELLE

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Methane issue



5%
CH₄

CH₄

CH₄

RUMEN
Polysaccharides
→ Monosaccharides
→ SCFA, energy, CO₂, H₂
→ CH₄

95% CH₄
130Kg/y

CH₄

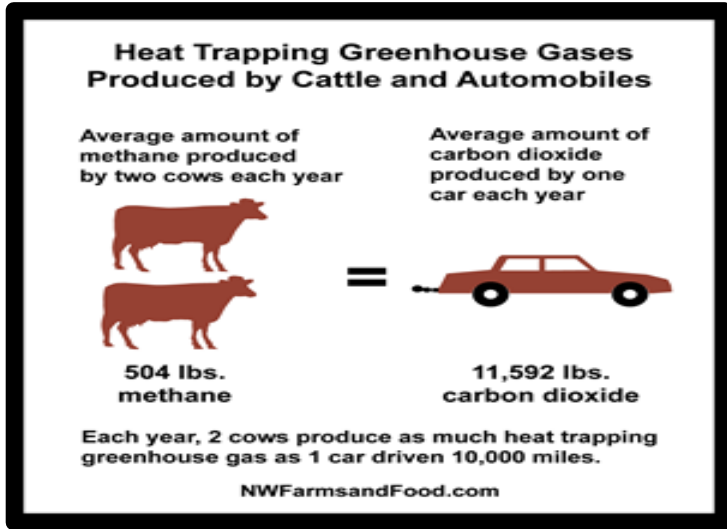
CH₄

CH₄

Feed, grass (polysaccharides)

Environmental issue of dairy cows

- Livestock: 25% of total anthropogenic CH₄ sources
- CH₄ production: loss of dietary energy between 6 to 12%

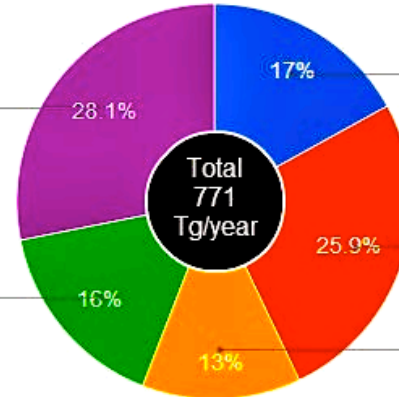


Methane emissions estimates

Emissions in Tg per year

wetlands - 217
28.1%

other natural sources
(geological, lakes, wildfires,
termites, etc.) - 123
16%



fossil fuels and biomass
burning (incl. biofuels) - 131
17%

ruminants, rice, landfills and
waste - 200
25.9%

hydrates and permafrost - 100
13%

Created by Sam Carana for Arctic-news.blogspot.com based on estimates by Sam Carana and on data by IPCC AR5 WG1

Measurement methods on pasture

SF6 method



→ Individual daily production

GreenFeed



→ Individual short-term measurements

What about the CH₄ dynamics?

Measurement methods on pasture

Eddy covariance:

- Herd CH₄ daily production
- GPS
- Behaviors

- Measurement of CH₄ and CO₂ fluxes using eddy covariance (Picarro G2311-f)
- Measurement of micro-meteorological variables



P. Dumortier et al., 2015

Each cow was equipped with a GPS (position) and accelerometer (behaviour) device

Questions

- ✓ What is the link between emission dynamics and feeding behavior?



Rumination



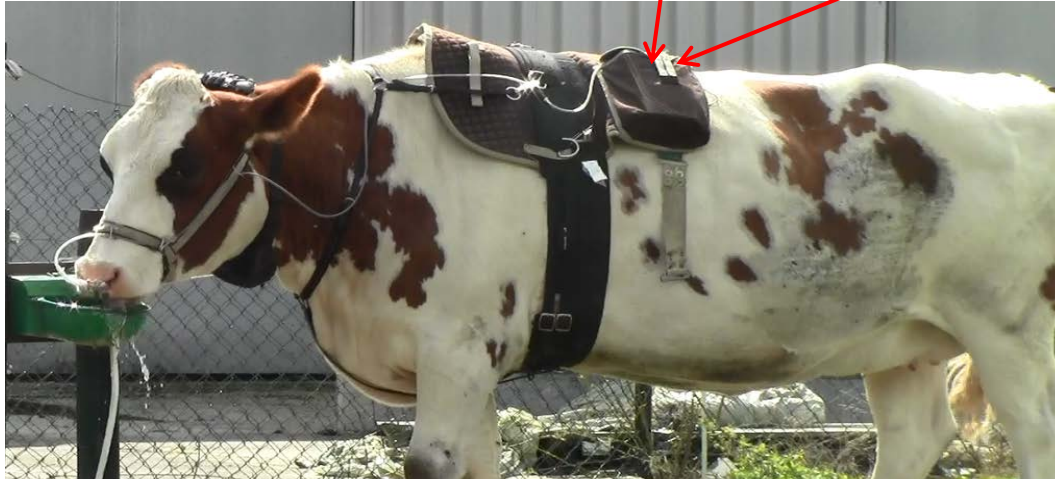
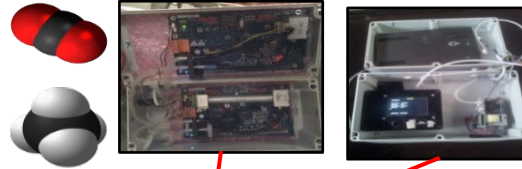
Grazing or eating



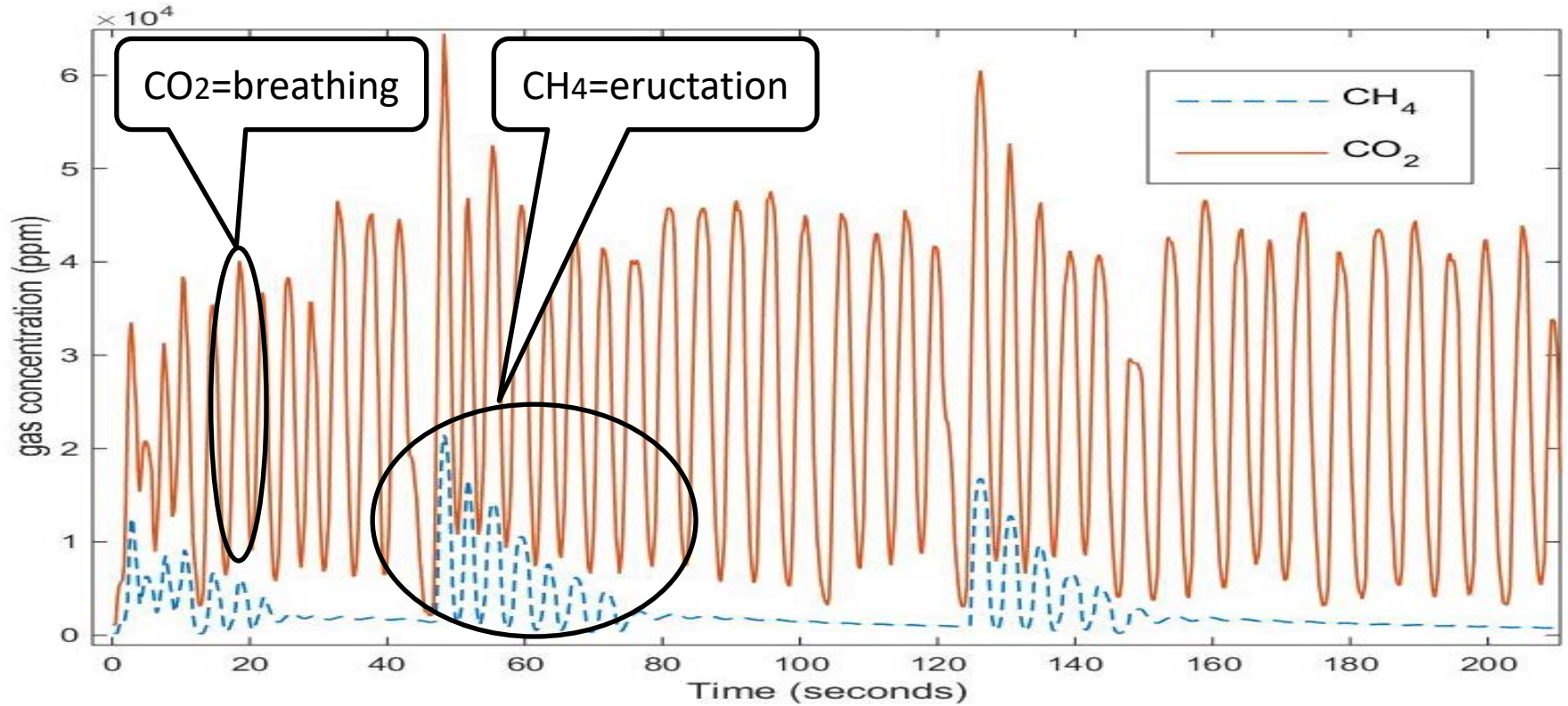
Rest

Methane measurement

- ✓ 2 infra-red gas analysers (CH₄ and CO₂ concentrations)
- ✓ Ratio CH₄:CO₂
- ✓ measurements in barn or on pasture
- ✓ continuous measurements



Methane measurement

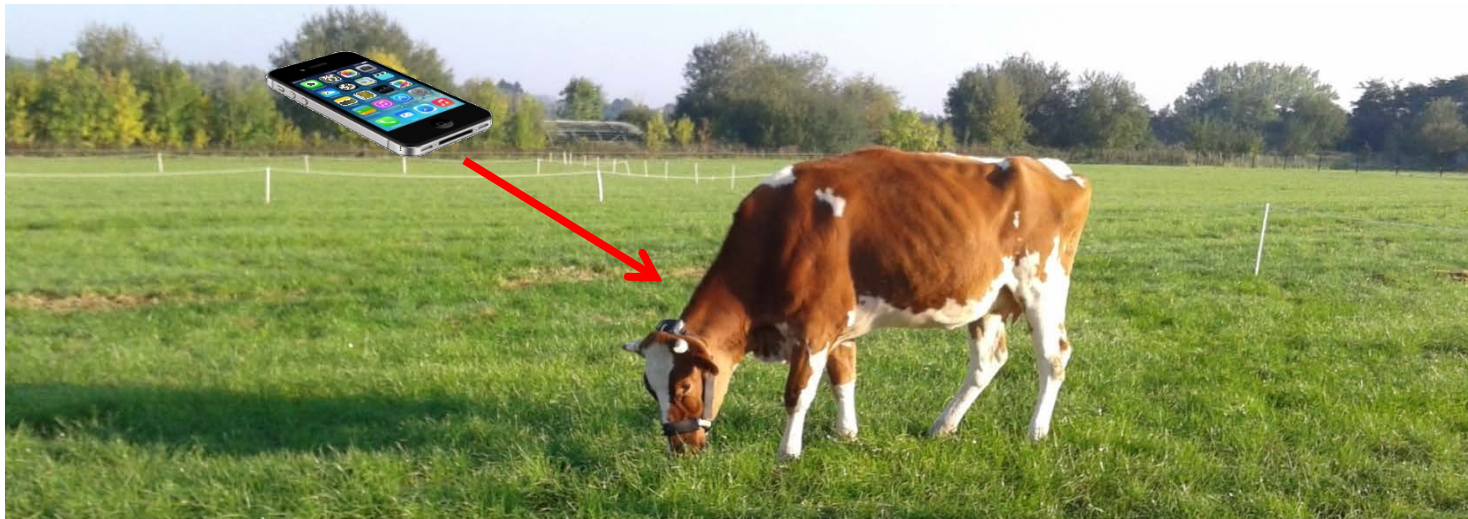


Inertial measurement unit of an iPhone to detect behaviors

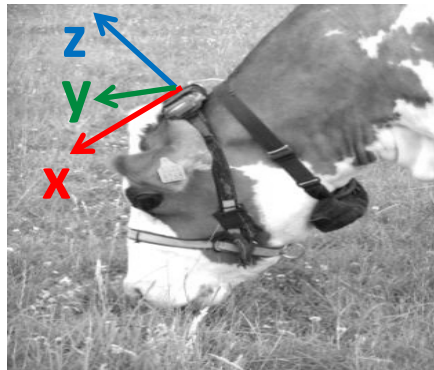
“Development of an open-source algorithm based on inertial measurement units (IMU) of smartphones to detect cattle grazing and ruminating behaviors”

ALH **Andriamandroso**, F. Lebeau, Y. Beckers, E. Froidmont, I. Dufrasne, B. Heinesch,
P. Dumortier, G. Blanchy , Y. Blaise, J. Bindelle

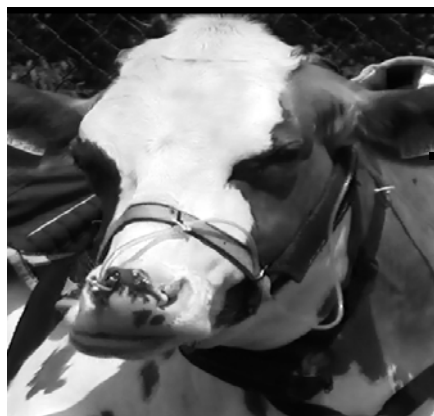
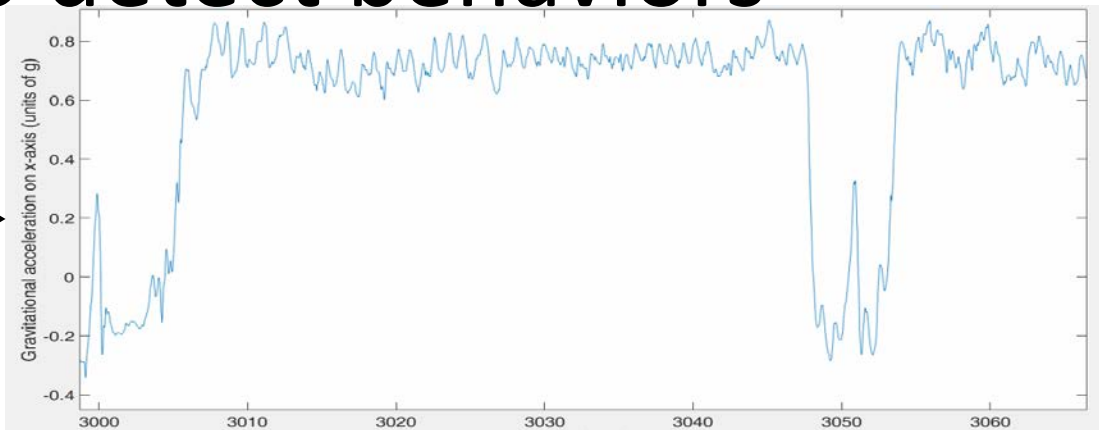
Submitted to Computers and Electronics in Agriculture.



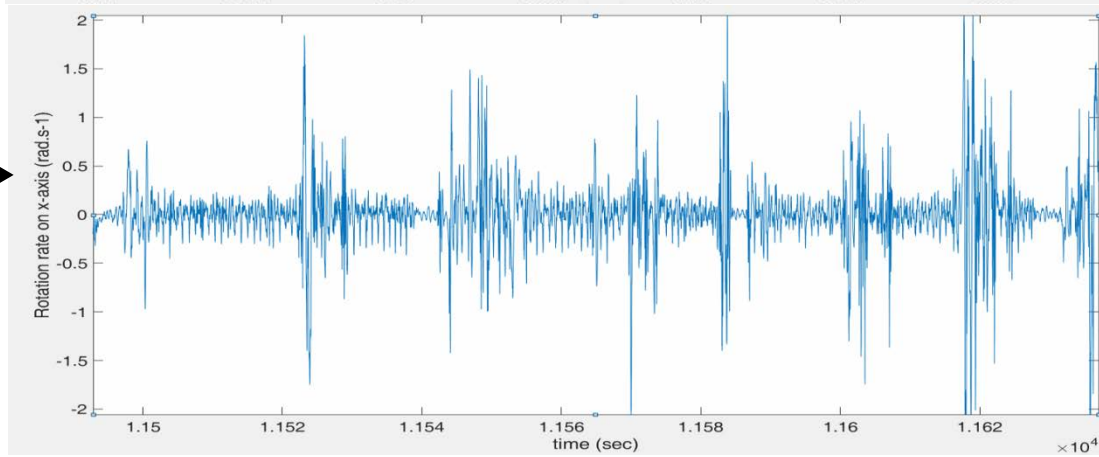
Inertial measurement unit of an iPhone to detect behaviors



Grazing



Rumination



Experiment in barn

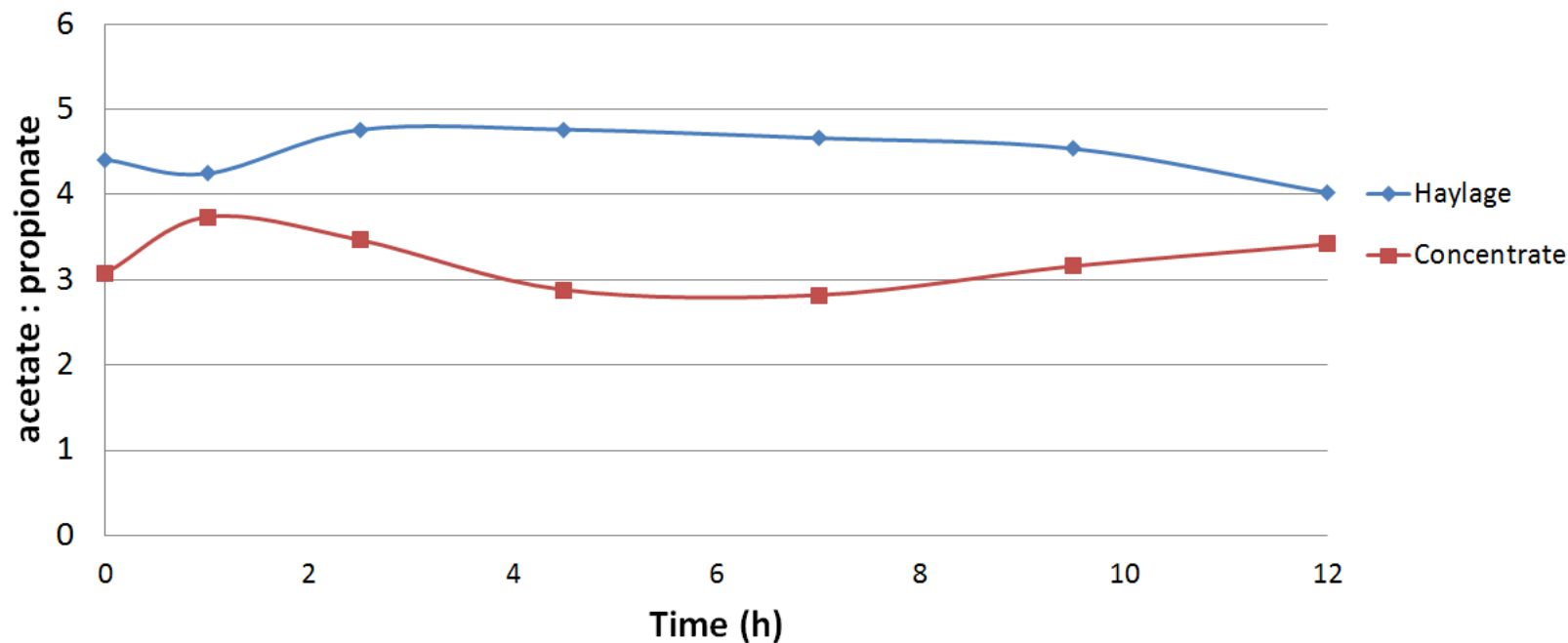
- ✓ 4 cows
- ✓ 2 diets: haylage v.s. concentrate diet
- ✓ **isoenergy and iso-nitrogen diets**
- ✓ 2 modalities: full diet v.s. 70% DMI
- ✓ Latin square

Composition	Diet tested		
		Haylage	Concentrate
Haylage	MS (Kg)	6.34	2.05
Linseed Nutex 68	MS(Kg)	0	1.80
Cracked wheat	MS(Kg)	0	0.90

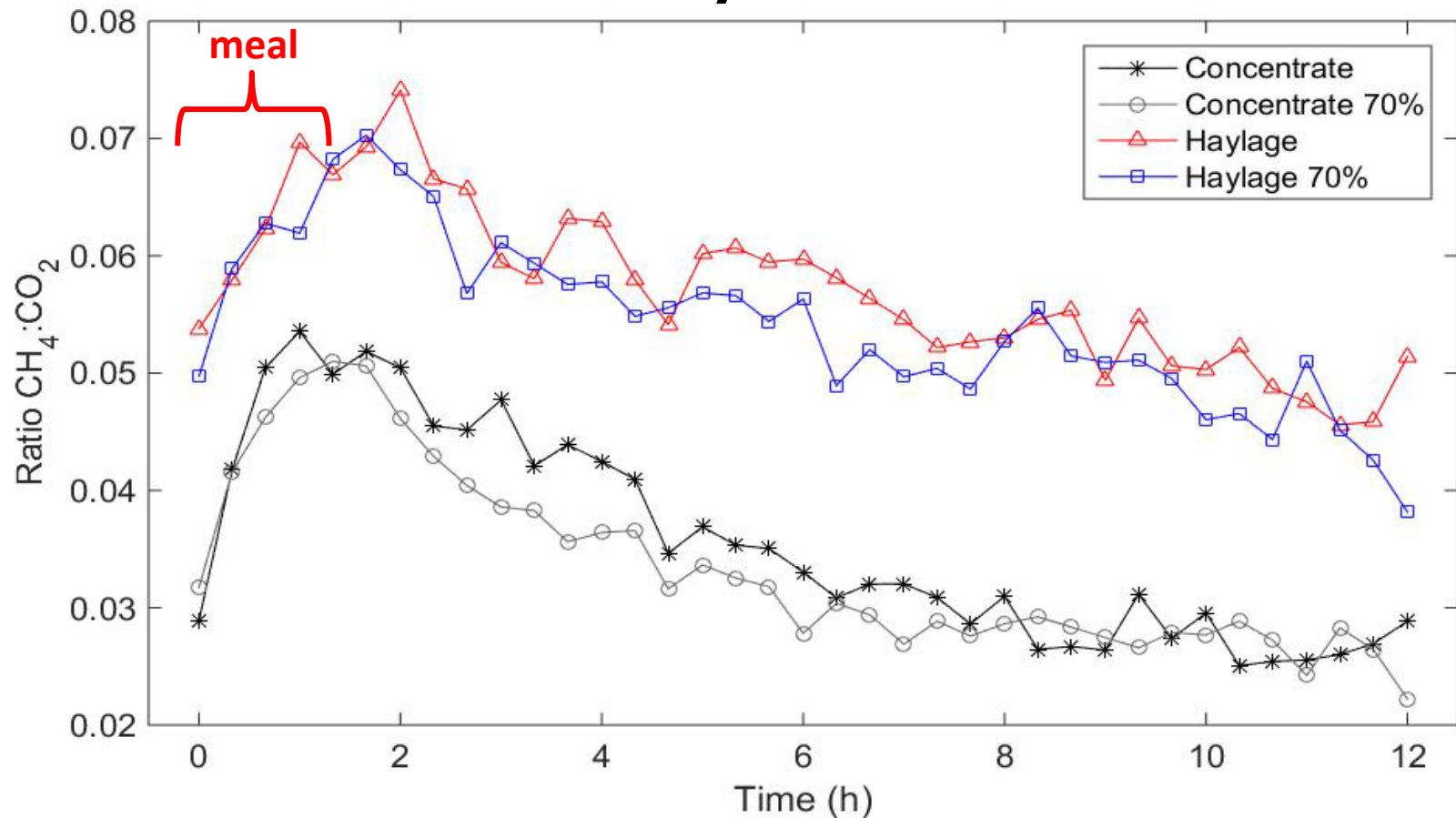
Results

Measurement	Diet			
Diet	Haylage 100%	Haylage 70%	Concentrate 100%	Concentrate 70%
N	2822	2997	2998	2826
Ratio CH ₄ :CO ₂ (Mean±sd)	0.058±0.019 a	0.056±0.020 b	0.036±0.018 c	0.035±0.017 d
Eructations /min (Mean±sd)	0.462±0.221 a	0.391±0.191 b	0.260±0.187 c	0.228±0.170 d

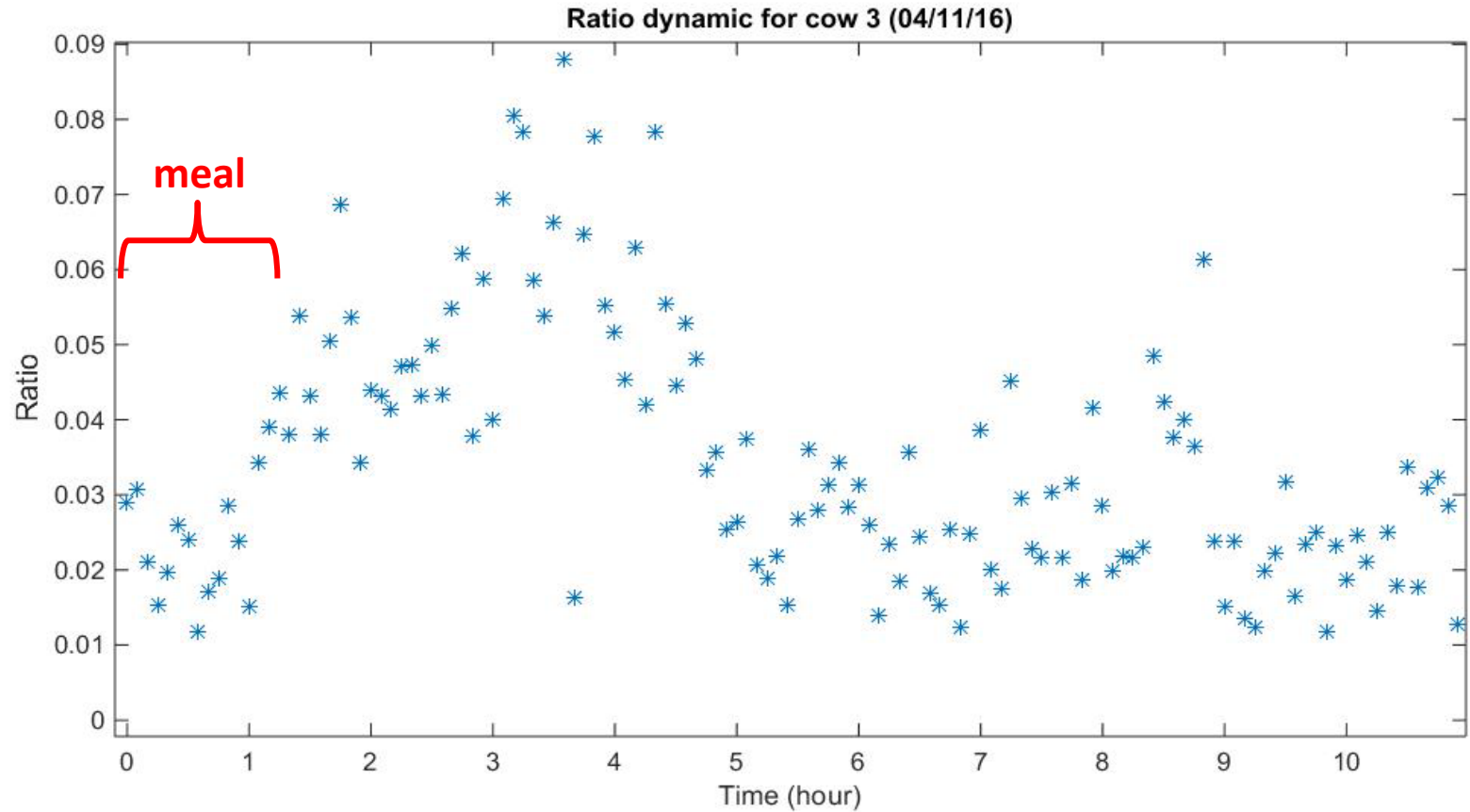
Evolution of the acetate and propionate ratio in two fistulated cows eating the haylage or the concentrate diet



CH₄ dynamics



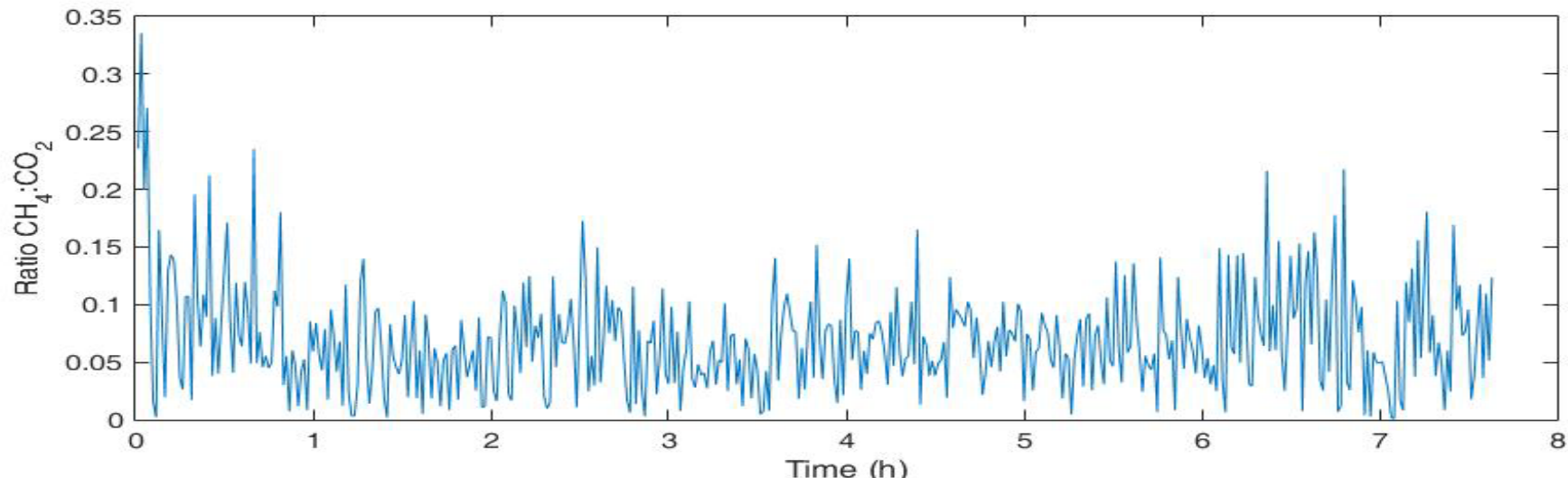
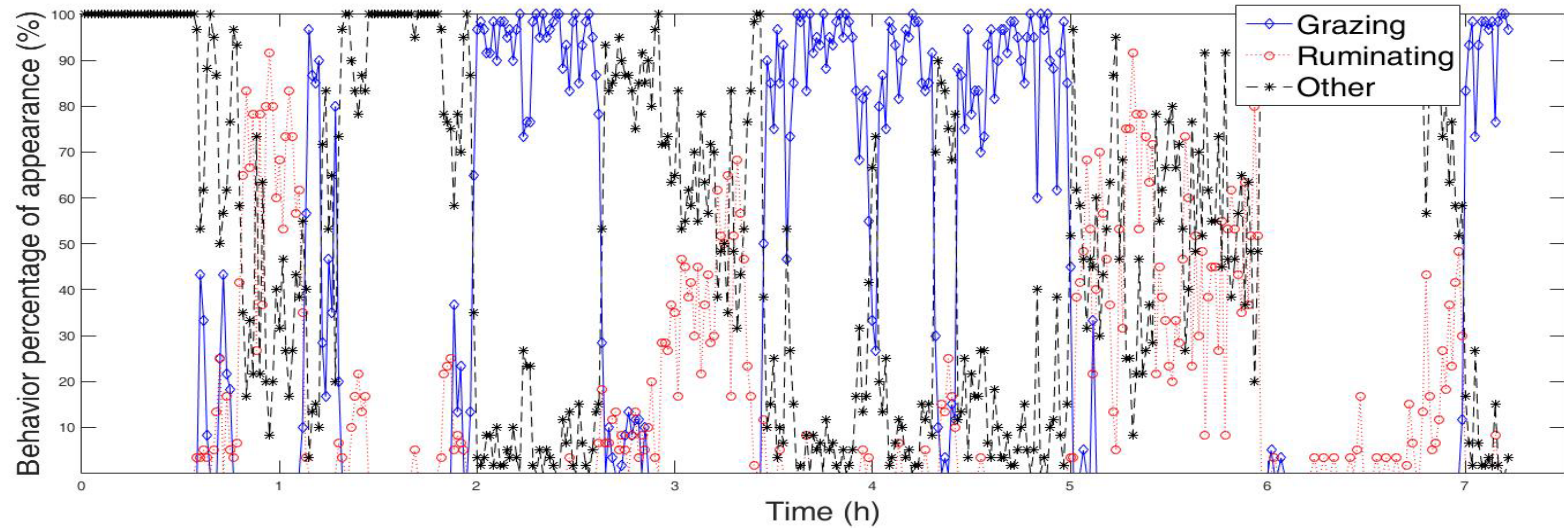
CH₄ dynamics

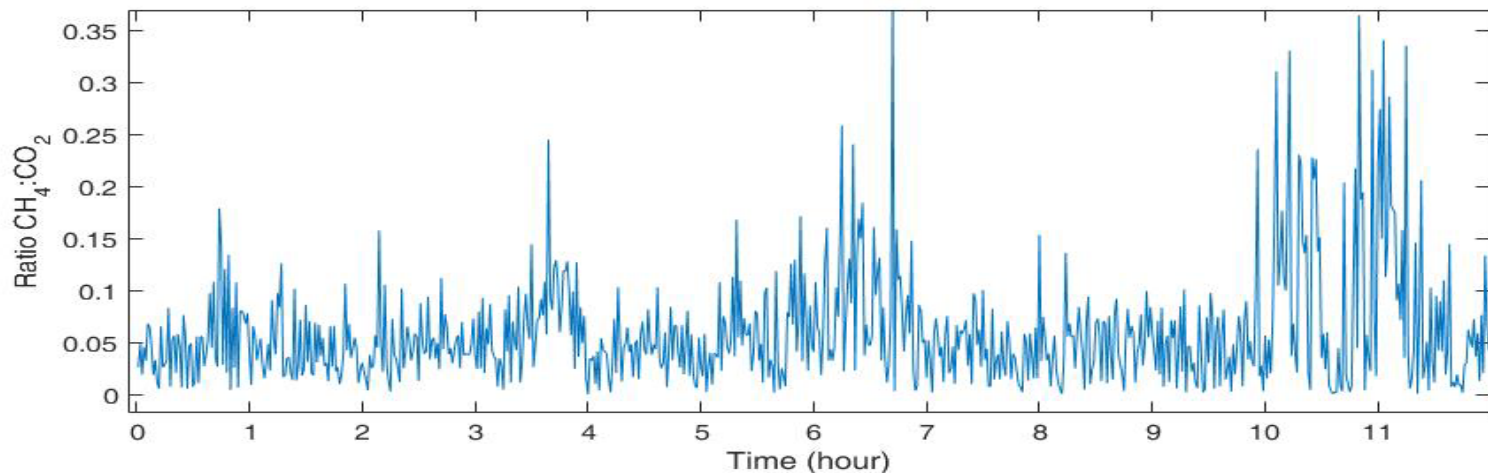
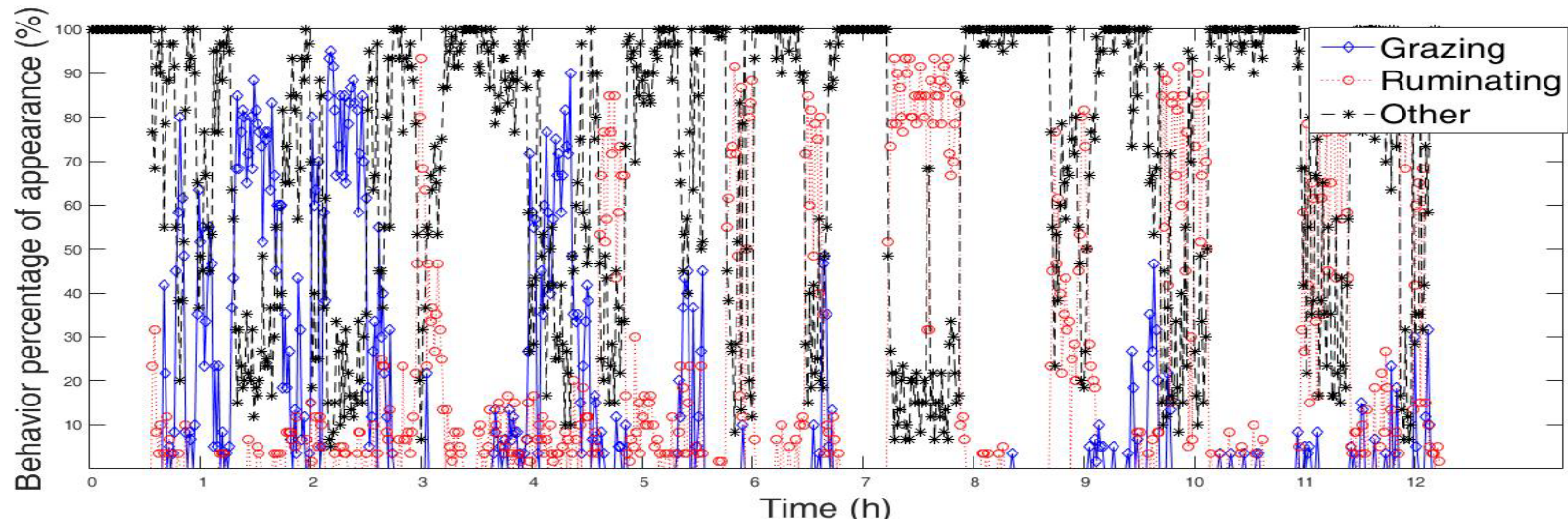


Preliminary results on pasture

- ✓ 6 cows
- ✓ diets: grass 15 cm high
- ✓ 24 hours measurement

Measure	Behavior		
	Meal	Rumination	Rest
N	693	441	2684
Ratio CH ₄ :CO ₂ Mean±sd	0.051±0.039	0.053±0.047	0.054±0.038





Conclusion

Device

- All-terrain device
- Continuous measurement system
- No lab analysis

Conclusion

Knowledge enhancement

- In barn: More CH₄ after the meal and during rumination
- On pasture: dynamics of the CH₄ excreted linked to the post-feeding and less to the animal behavior
 - Effect of the day/night?
 - Effect of supplemented diet?
- For eddy-covariance: geo-localize the animal and the meal period

Acknowledgment

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