The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

Field-scale study of rumen function, efficiency and emissions in dairy cows

'The 1000 cow study'

Phil Garnsworthy

Sources of variation in methane

- Methodology (Chambers, SF_6, Sniffers, Proxies)
- Animals
  - Feed Intake, diet composition, digestibility
  - Physiological state (lactating, growing, pregnant)
  - Level of production (milk yield)
  - Individual variation in efficiency (Genetics ???)
  - Rumen microbial population (Genetics ???)

Work Package 3 - Phenotypes

Aim: to provide phenotypic data and samples of rumen fluid, faeces and blood for 1,000 cows

UK (UNOTT) 400 cows

Italy (UNICATT) 400 cows

Sweden (SLU) 100 cows

Finland (MTT/Luke) 100 cows

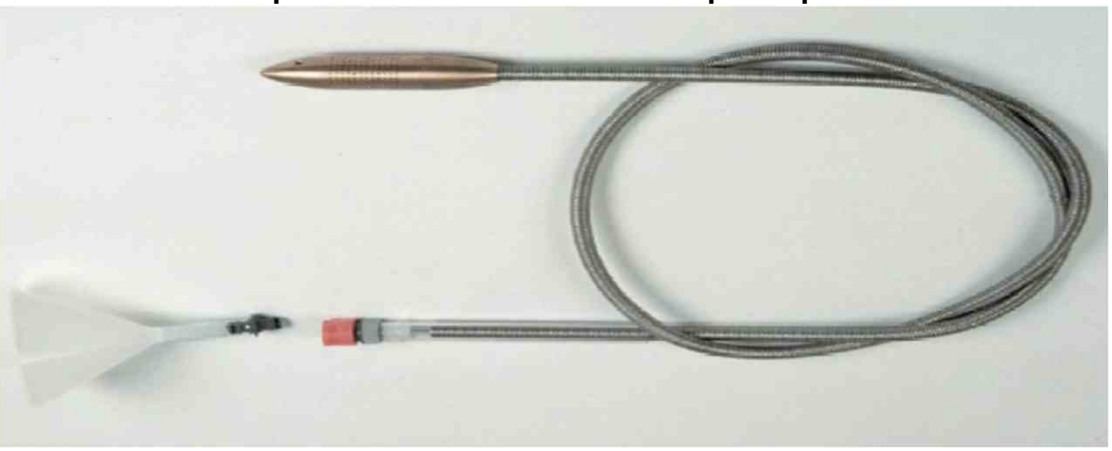
Measurements and samples required

Cow data	
Milk yield, live weight	Automatic
Milk composition	Routine
Blood samples	Routine
Methane	During milking/GreenFeed Respiration Chambers
Rumen samples	Rumen sample probe
Feed intake	Direct measurement / Alkanes
Digestibility	AIA / iNDF

SOP 9 - Collection of ruminal fluid

The instrument:

oro-ruminal probe and a suction pump



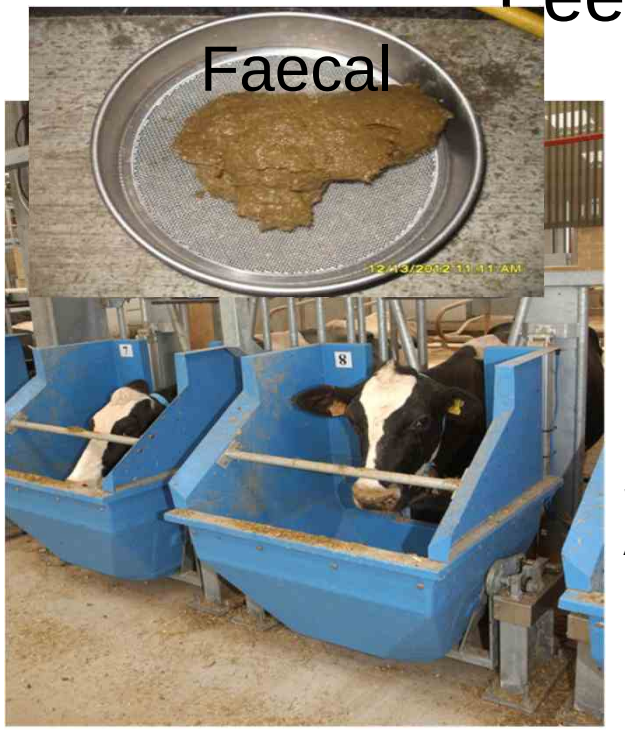
Feed intake - The Alkane Method

We cannot measure intake directly on commercial farms

Odd-chain alkanes naturally present in feeds
Even-chain alkane fed at fixed or known rate per day
Intake estimated from faecal ratios of even to odd chain alkanes

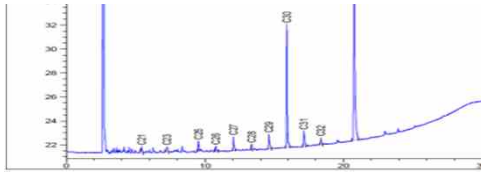
Alternative methods
Dose cows with even-chain alkane in concentrates or by gun
Feed known amount of concentrates containing high C30
Use partial least squares analysis (PLS) for calibration

Feed Intake Estimation

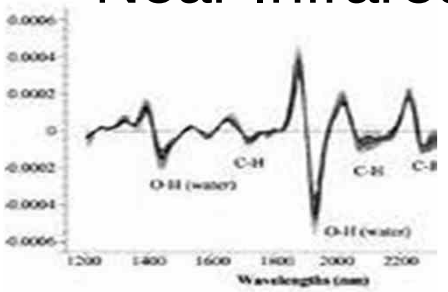


Alkanes

CH_3-CH_2- -CH_2-CH_3



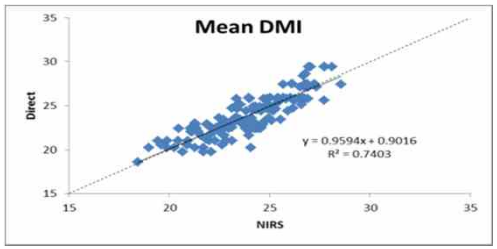
Near Infrared



Standard errors of prediction

Alkanes 1.81 kg/d (7.5%)

NIR 1.19 kg/d (4.9%)

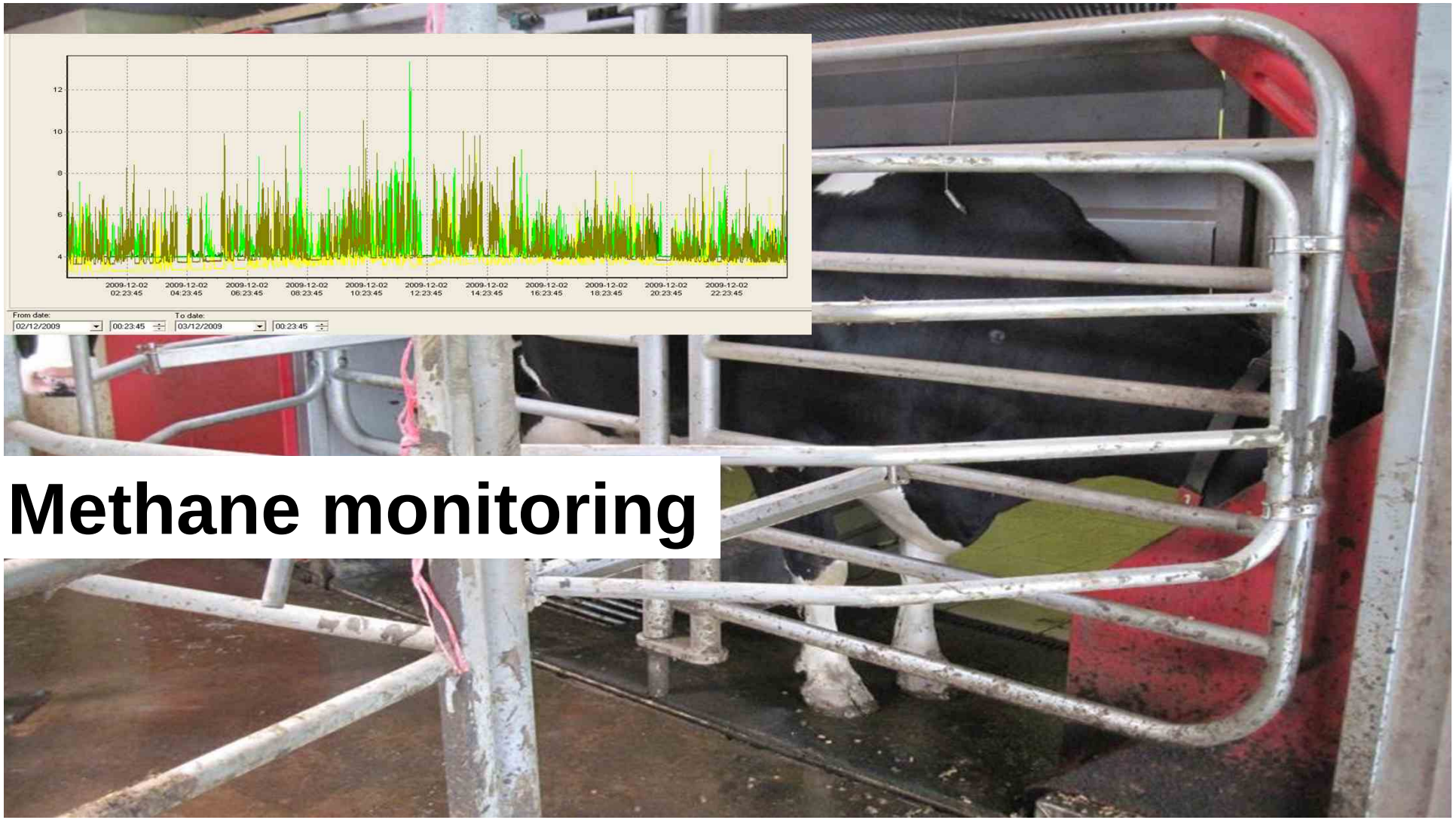


Metabolic chambers in Minkiö Dairy Research Barn

High pressure blowers

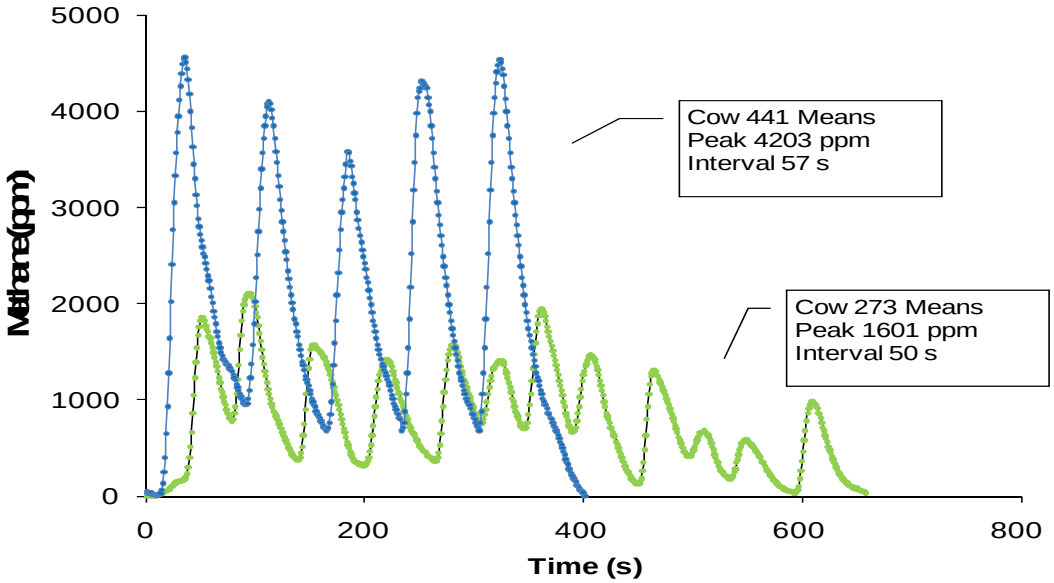
Cow inside chamber

Sampling pump and analyzers



Methane monitoring

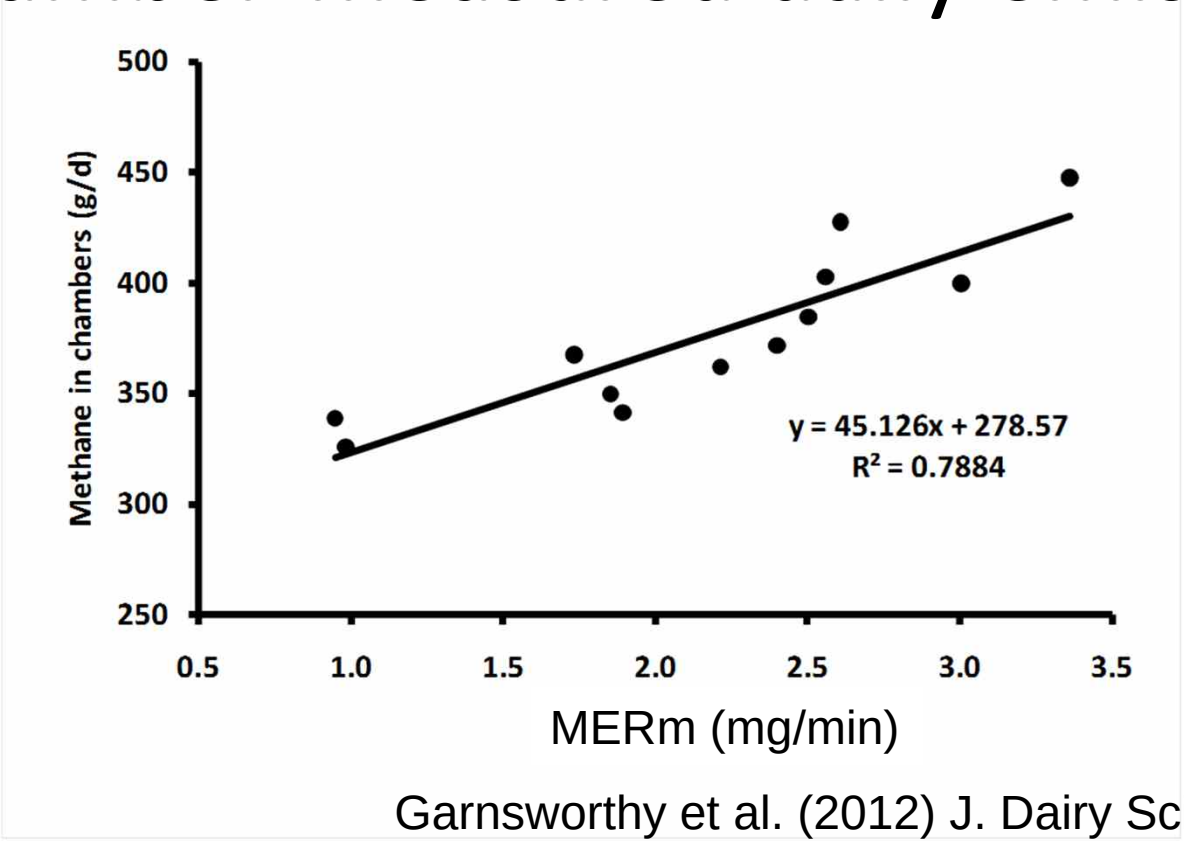
Individual Cow Methane



Individual cows vary in:

- Frequency of eructation
- Methane concentration in each eructation

Online monitoring agrees with chamber-measured daily emissions



12 cows measured on farm for 10 days then chambers for 3 days

Garnsworthy et al. (2012) J. Dairy Sci. 95 :3166–3180

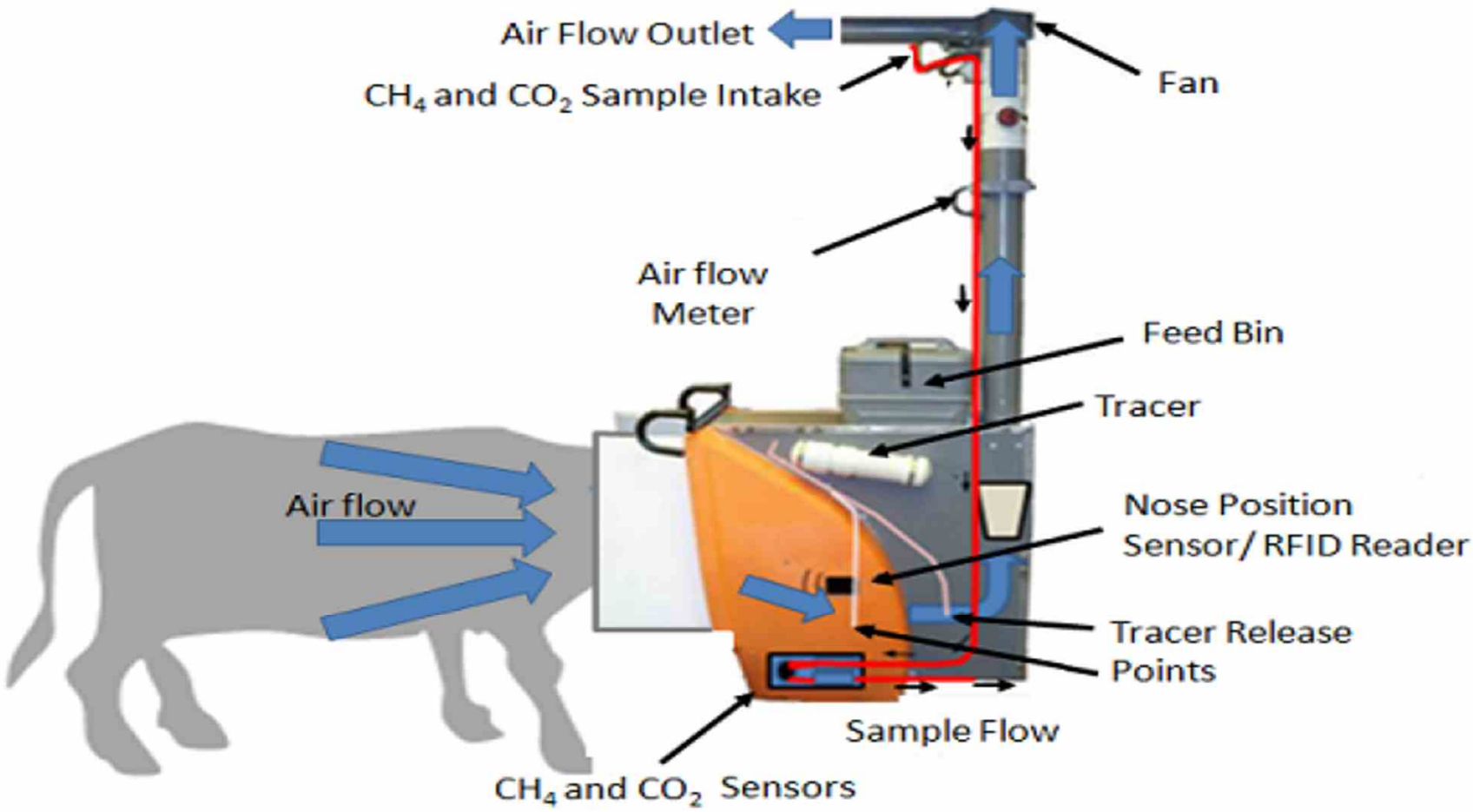
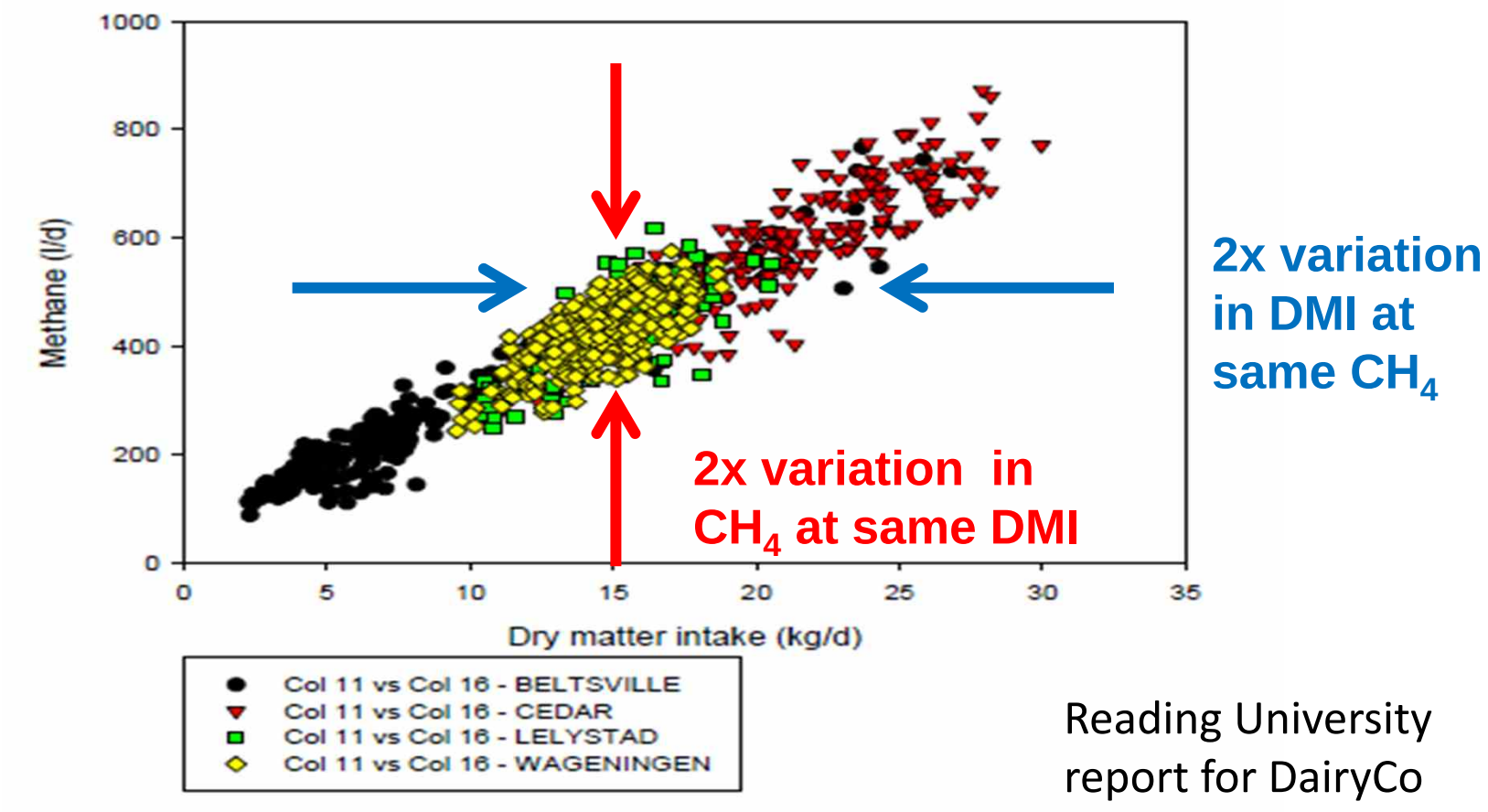


Figure 1. Basic Instrument Layout of GreenFeed

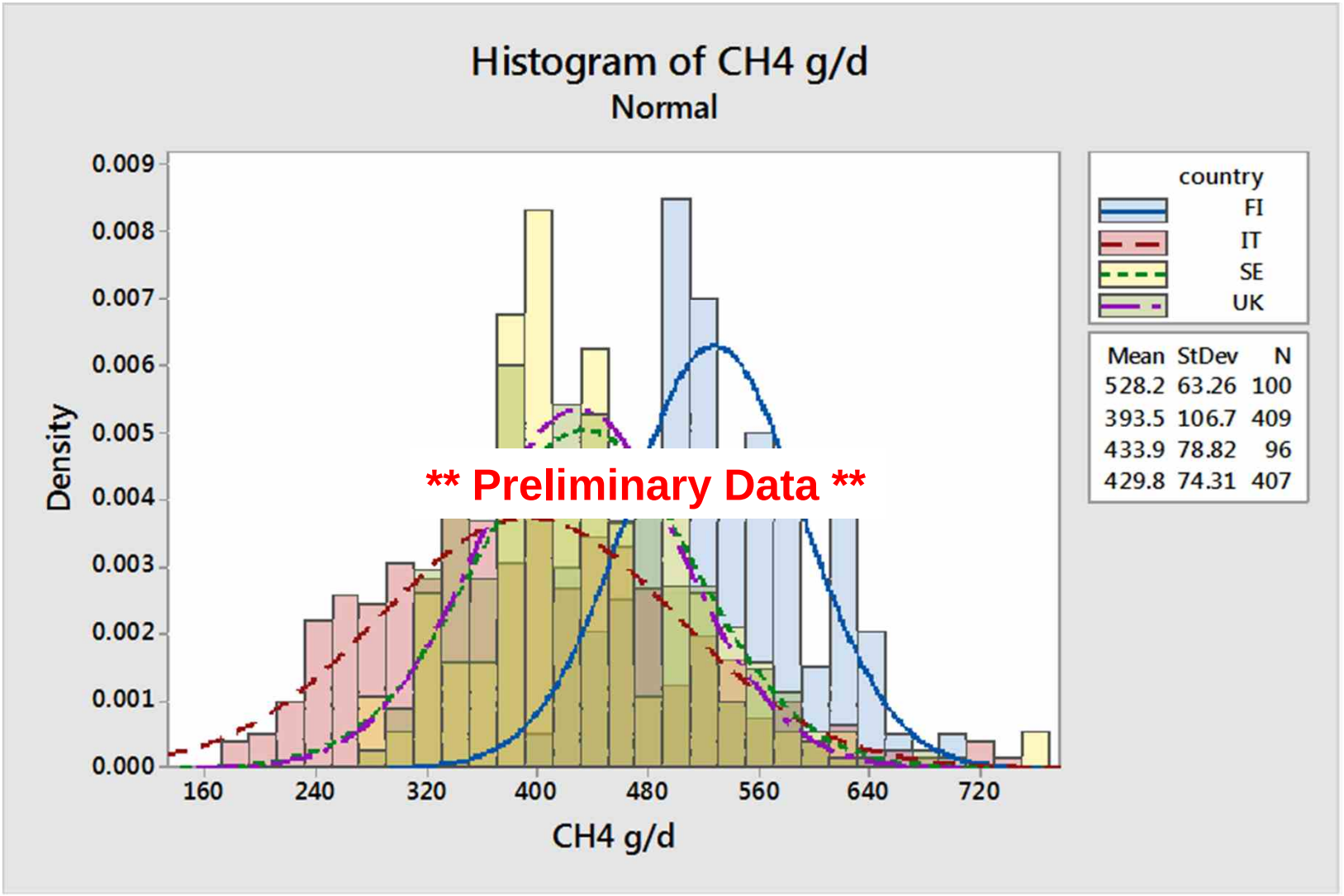
Variability among cattle in chambers

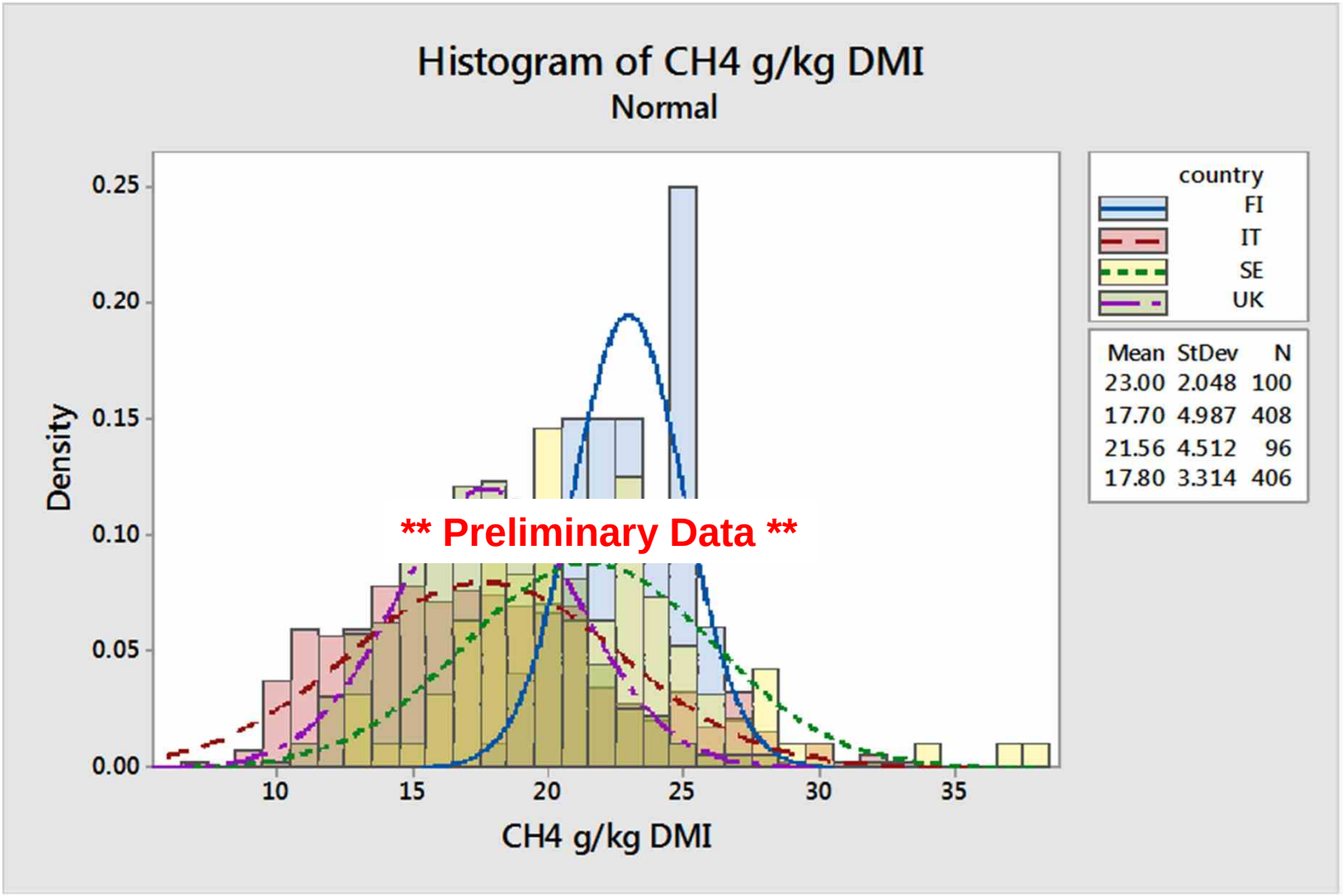


Reading University report for DairyCo

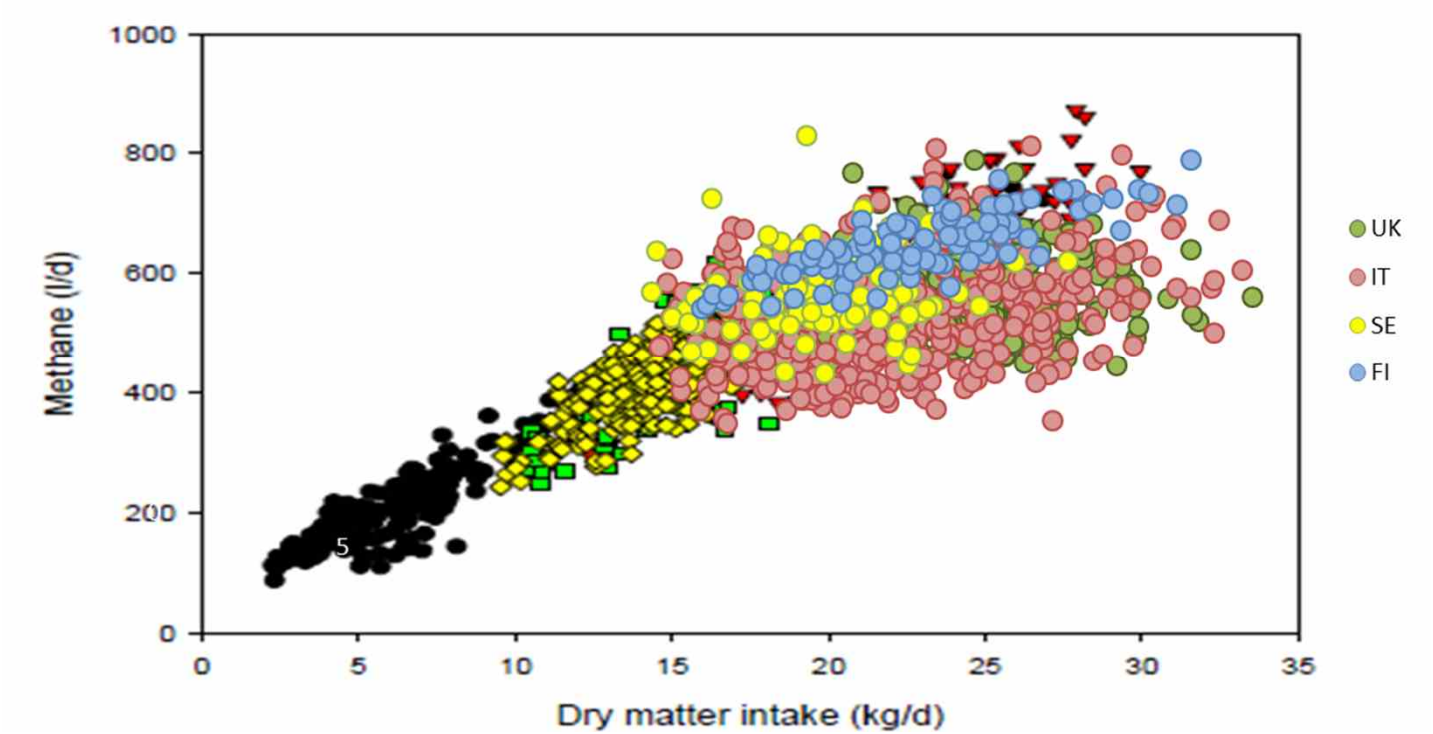
1000-cow study
Early Observations

- **UK** 407 **Italy** 410
  - Holsteins
  - Maize + Grass silage/ hay diets
- **Sweden** 100 **Finland** 100
  - Red & White
  - Grass silage diets


Histogram of CH4 g/d
Normal
Density
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
160
240
320
400
480
560
640
720
CH4 g/d
** Preliminary Data **
country
FI
IT
SE
UK
Mean StDev N
528.2 63.26 100
393.5 106.7 409
433.9 78.82 96
429.8 74.31 407


Histogram of CH4 g/kg DMI
Normal
Density
0.25
0.20
0.15
0.10
0.05
0.00
10
15
20
25
30
35
CH4 g/kg DMI
country
FI
IT
SE
UK
Mean StDev N
23.00 2.048 100
17.70 4.987 408
21.56 4.512 96
17.80 3.314 406
** Preliminary Data **

Comparison with previous datasets



Conclusions

- 1000 cows was a big challenge
- We have a good range in values for all phenotypes
- Within countries, and overall, data are normally distributed
- CH_4 emissions (g/d and g/kg DMI) vary widely between cows
- CH_4 is not necessarily related to efficiency, so genetic selection for low emitters needs caution
- Variation could be due to genetics, physiology, behaviour …

… is this reflected in the rumen microbiome or cow genome? …