code: re-farm

New tool to accurately analyse the concentration of gases of interest in livestock housing

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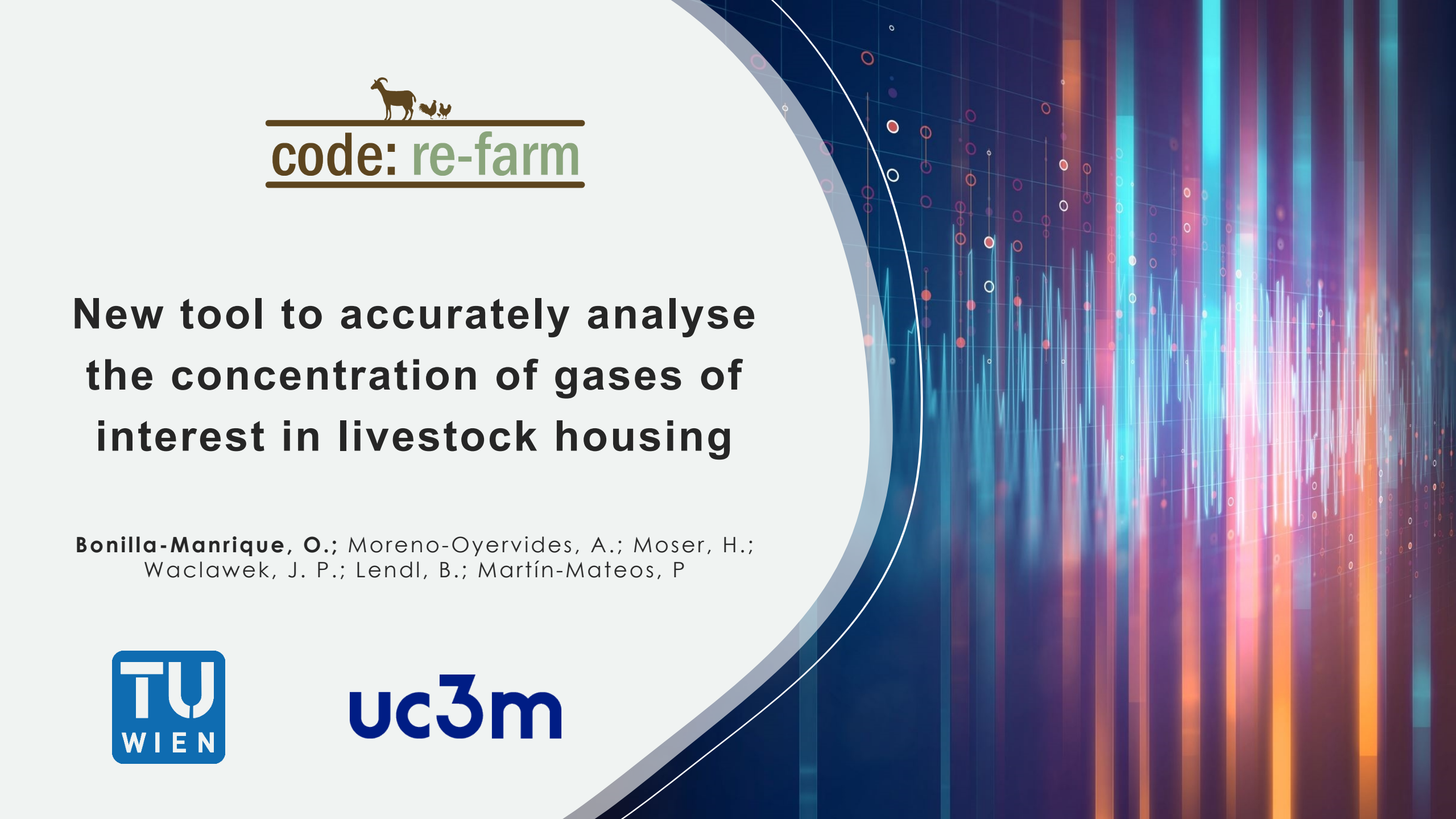


Outline

- Introduction and Motivation
- State of the art
- System design and capabilities
- Conclusions

Introduction and Motivation

Introduction and Motivation

- Intensive production is a widely used system nowadays. It is **more efficient** and **flexible.**
- **Enclosed spaces**
  - Carbon dioxide
  - Ammonia
  - Methane
- Consequences:
  - High animal health risks
  - Decreases product quality
  - Generates greenhouse gases
  - Bad odor

State of the art

State of the art

- Single point: Principle of operation

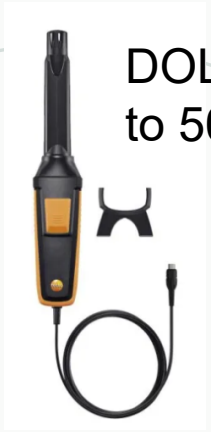
Electrochemical **_Optical_** Metal oxide semiconductors (MOS)

- **Significant variations in gas concentration:**
  - Position of sensors,
  - Proximity to ventilation,
  - Distance to animals, etc.

Nikolajs Bumanisa, et all. “Data Conceptual Model for Smart Poultry Farm Management System”. ScienceDirect. 2022

State of the art

- Single point

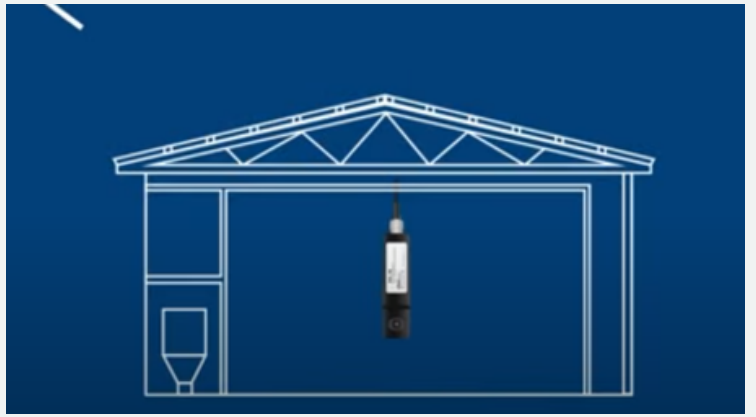


DOL: 119 CO2 Sensor 0 to 5000/10000 ppm

Handheld CO_2 Meter GM70 0 to 2000 ppm

Testo: CO_2 probe, 0 to 10000 ppm

Where?
How?
are they reliable?

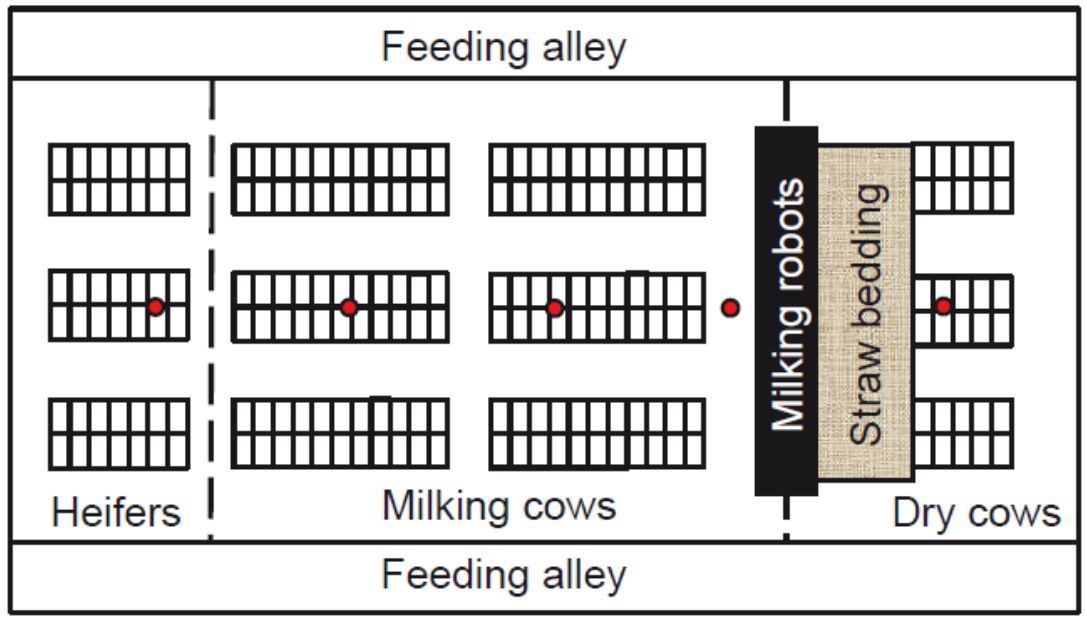


State of the art

- One way to have better coverage is to use multiple sensors
  - Currently, the sensors have shortcomings (Accuracy, influenced by the installation position, dust, etc)

VERA protocol

  - Recommends not to use this type of system and sensors.

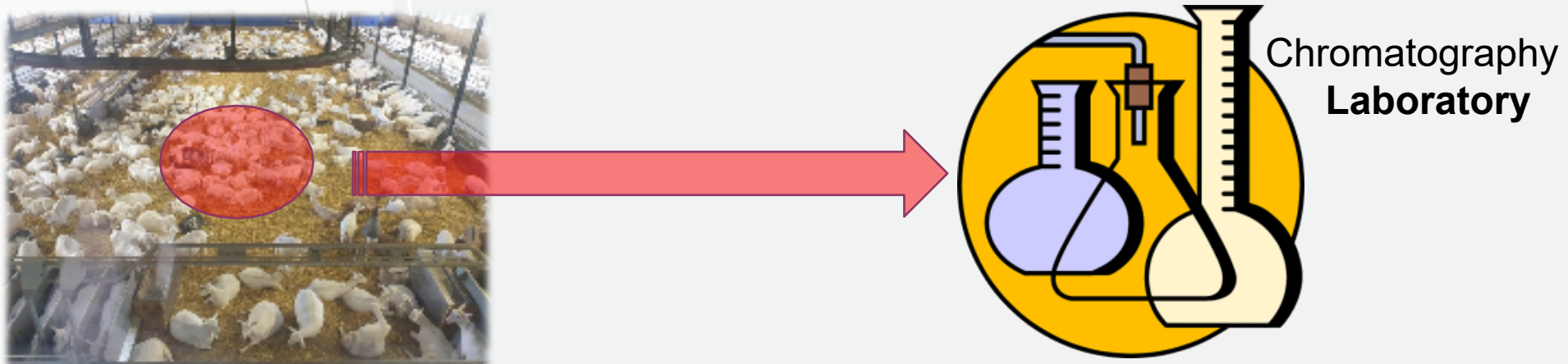


VERA TEST PROTOCOL for Livestock Housing and Management Systems Version 3:2018-09

State of the art

VERA: Verification of Environmental Technologies for Agricultural Production

- It proposes **different strategies** for **spatial sampling** and **laboratory analysis** of representative **samples from the barn**.
- Proposes the use of gas **chromatography (laboratory test)**.
- Testing the gas recovery of the sampling system



Introduction and Motivation

Code-Refarm System

- It allows to analyze concentration along the entire optical path.
- There is no need to take samples and send them to a laboratory.
- Real-time measurements.
- Detection of multiple gases with the same device (CH_4-NH_3-CO_2)

✓ **A more complete sampling**

✓ **A better accuracy of +/- 2%** of FS for all gases (about 5 ppm).

System design and capabilities

System design

- Initial study - To identify the circumstances inside the barns.
  - Presence of many trace gases (3 of great interest).
  - Very dusty environment
  - Preserving animal health
- Consult various studies/systems for gas detection in barns.

GasFinder3 open path laser (Boreal laser Inc.,Edmonton, Canada)

  - 30% error in measurement CO2
  - Tunable Diode Laser (TDL) - Affects by changes in signal strength (Dust)

Roessler, R.; Schlecht, E. Application of the laser methane detector for measurements in freely grazing goats : impact on animals behaviour and methane emissions. Animal 2021, 15, 100070.

System design

- **Proposed approach:**
  - Light (laser in midinfrared)
  - Spectroscopy techniques (Heterodyne Phase Sensitive Dispersion Spectroscopy (HPSDS))
  - Real-time measurement of methane, carbon dioxide, and ammonia concentration in ambient air inside the barns.

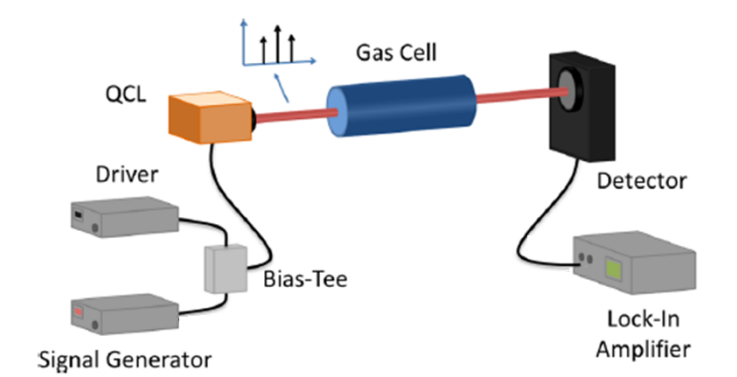
- **Technical Justification:**
  - Each compound has very specific molecular resonances.
  - Dispersion spectroscopy: it has several advantages ideals for the target application, such as baseline free, immune to power fluctuations, output linearly dependent on the gas concentration, among others.

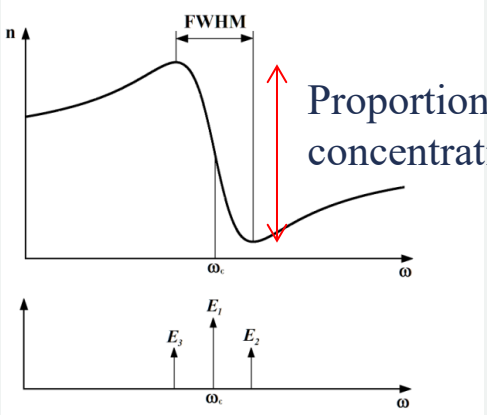
This provides **immunity to intensity fluctuation** due to particles in suspension, **flexibility** in the configuration of the measurement area and **no need for calibration.**

System design

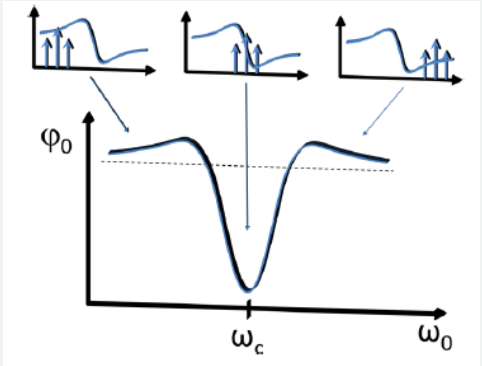
- The Heterodyne phase sensitive dispersion spectroscopy (HPSDS) technique was selected for its simplicity and high performance.

- The method accurately determines the change in the propagation speed to retrieve the concentration of gas.

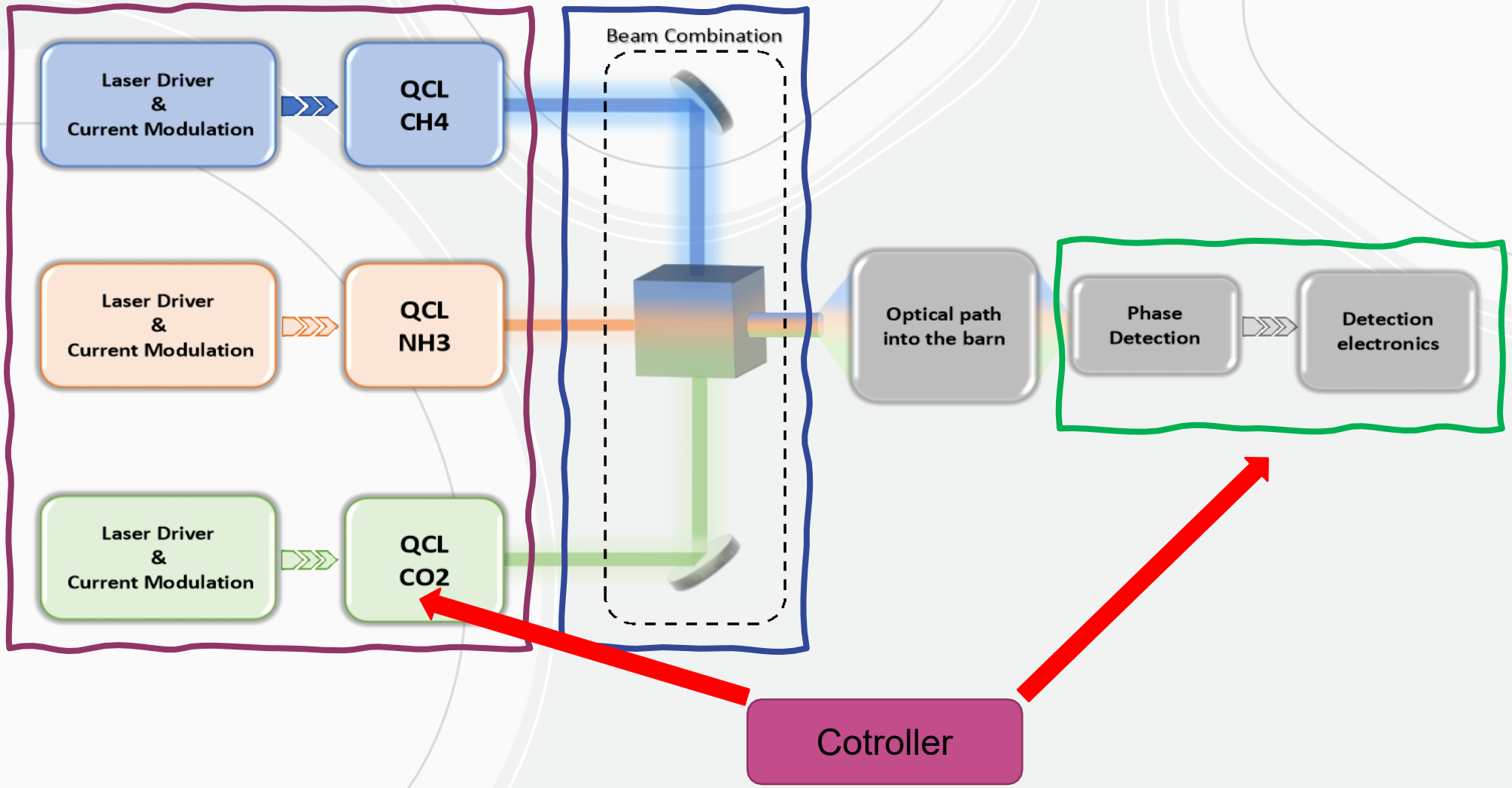




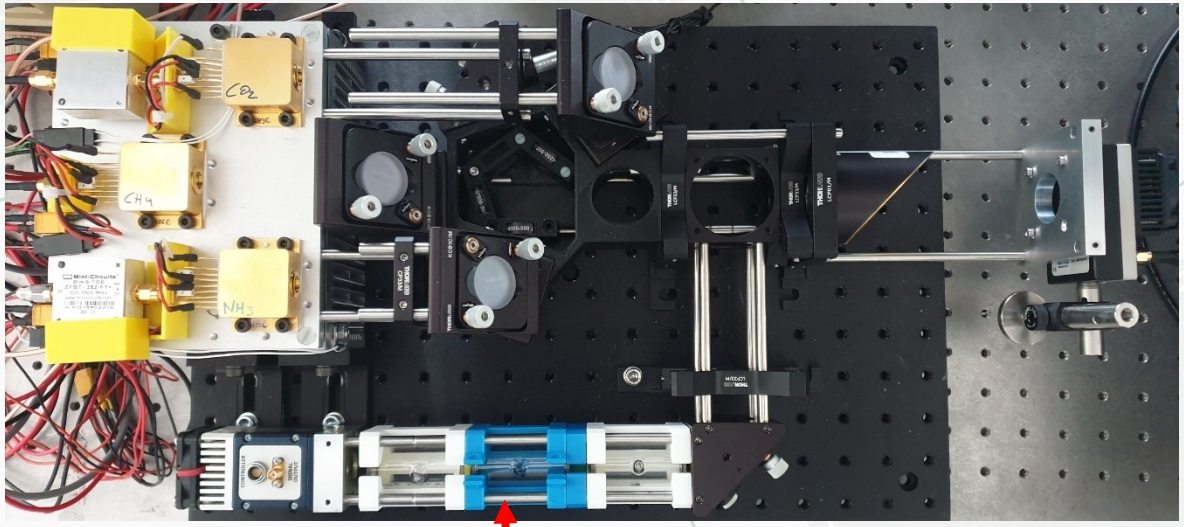
Proportional (**lineal**) to the concentration of gas



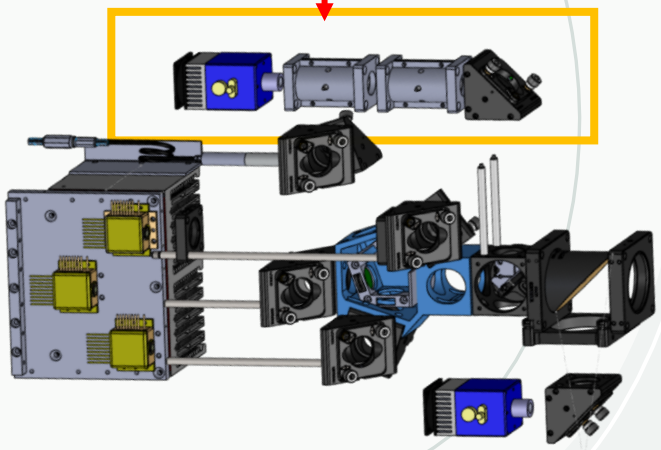
Basic system architecture

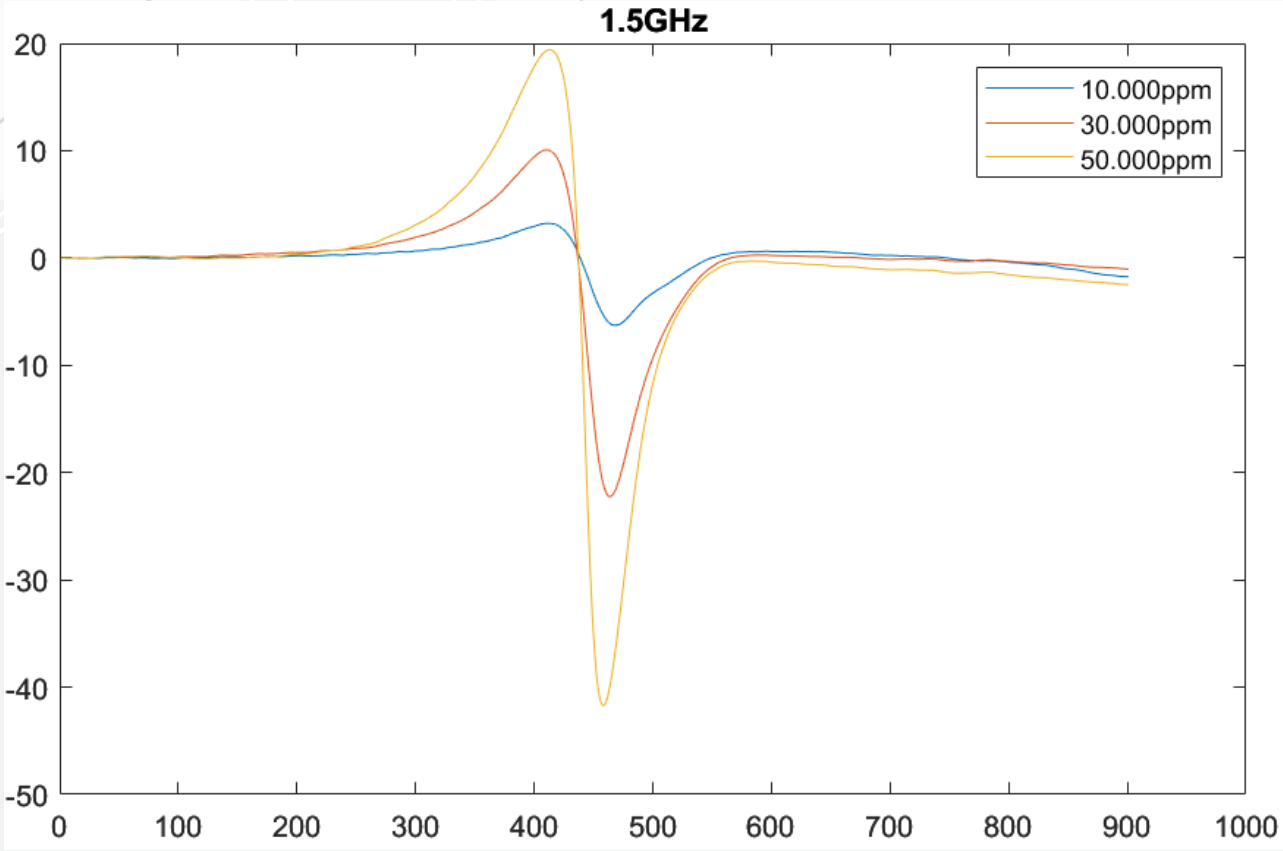


Operating point



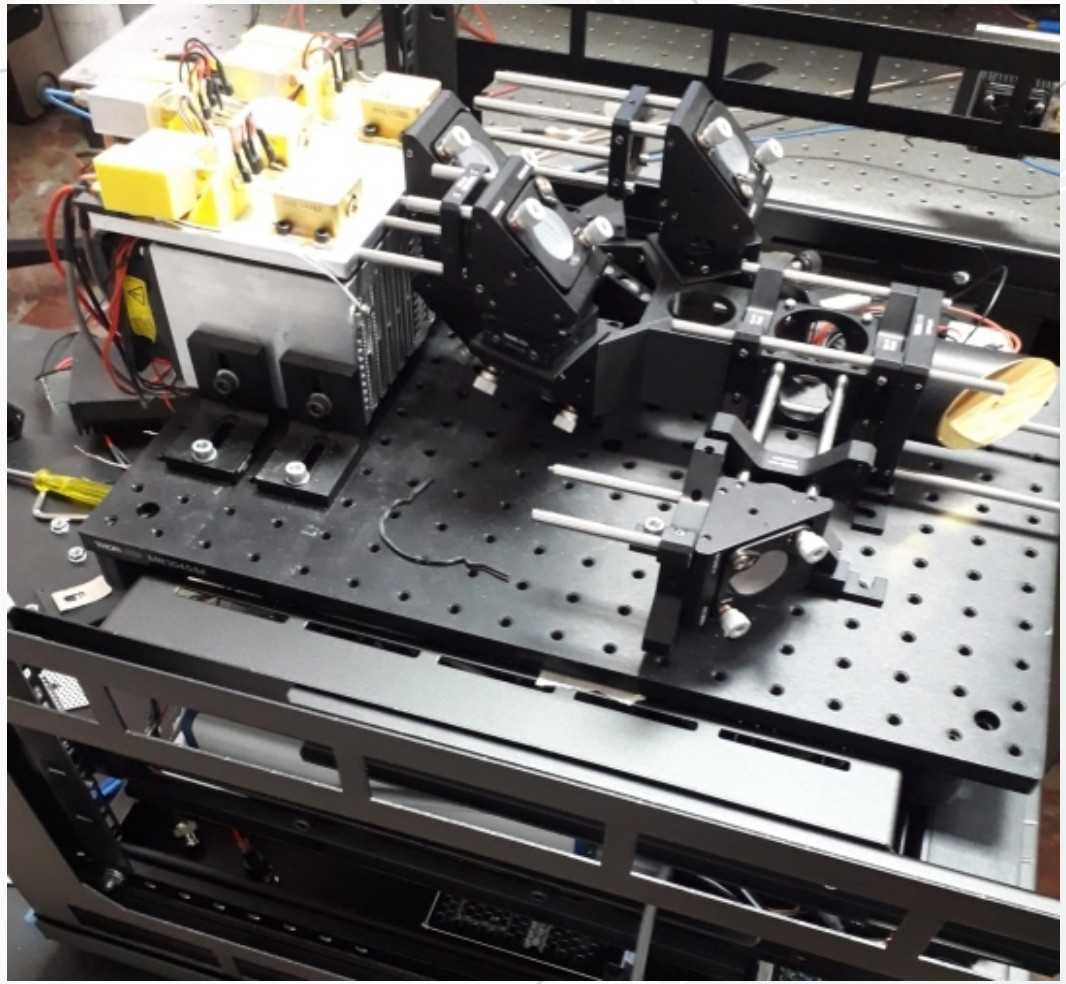
Reference





Current work

- **Portable system**



Current work

- **Timeline Project**

Portable Device

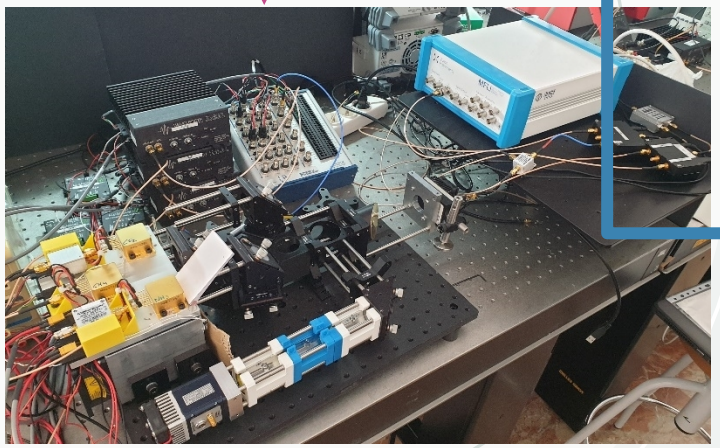
Final version and continuous field measurement

2022 - 2023

1st half of 2024
Field validation

2021 code: re-farm **2024**

1st Version and laboratory tests



2023
EAAP Workshop

End of 2024

Conclusions

- **A novel system** has been designed for the measurement of compounds inside the barn, which are very important in animal production, as has been demonstrated in several studies.
- The system allows **real-time** detection of **methane, carbon dioxide and ammonia**.
- This system attempts to **overcome some deficiencies** of current technologies.
- The first functional field prototype is currently being completed.

code: re-farm

Thank you for your attention.

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