

# Bolus platform development for data acquisition in small ruminants

---

*Joan Oliver<sup>1</sup>, Carles Ferrer<sup>1</sup>, Marta Prim<sup>1</sup>, Lu Wang<sup>1</sup>,  
Ahmed A.K. Salama<sup>2</sup> & Gerardo Caja<sup>2</sup>*

*<sup>1</sup>Departament de Microelectrònica i Sistemes Electrònics*

*<sup>2</sup>Departament de Ciència Animal i dels Aliments, G2R*

*Universitat Autònoma de Barcelona*

*Bellaterra (Barcelona), Spain*



COST ACTION  
FA1308

**Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016**

# Outline

---

- ◆ Motivation
- ◆ Methodology
- ◆ Hw platform architecture
- ◆ In-lab tests essays
- ◆ In-vivo tests essays
- ◆ Boluses
- ◆ Bolus performance
- ◆ Conclusions

# Motivation

---

- ◆ Currently available rumen bolus equipped with sensors were developed for cattle monitoring → but not for small ruminants



due to the large size capsules

With the aim of solving this limitation → we developed a small rumen bolus designed to monitor the rumen temperatures and movements of sheep and goats

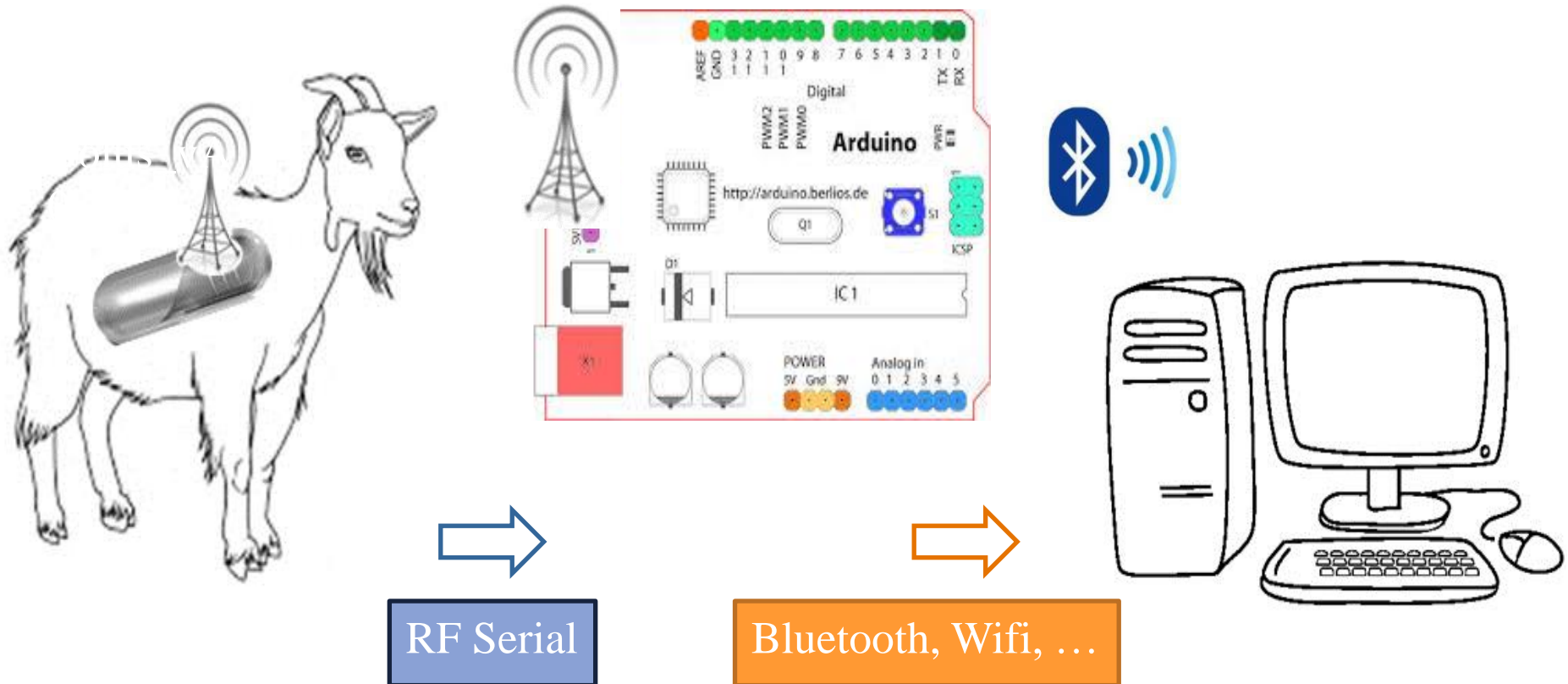
**BIOSENS bolus: external diameter, 22 mm; length, 80 mm, weight, 40 g**

# Methodology

---

- ◆ Internal device development (bolus)
- ◆ Test in laboratory
  - Open air
  - Fantom solution
- ◆ Test in-vivo
  - Rumen cannulated cow (applied through the cannula)
  - Small ruminants (4 ewes orally administered)

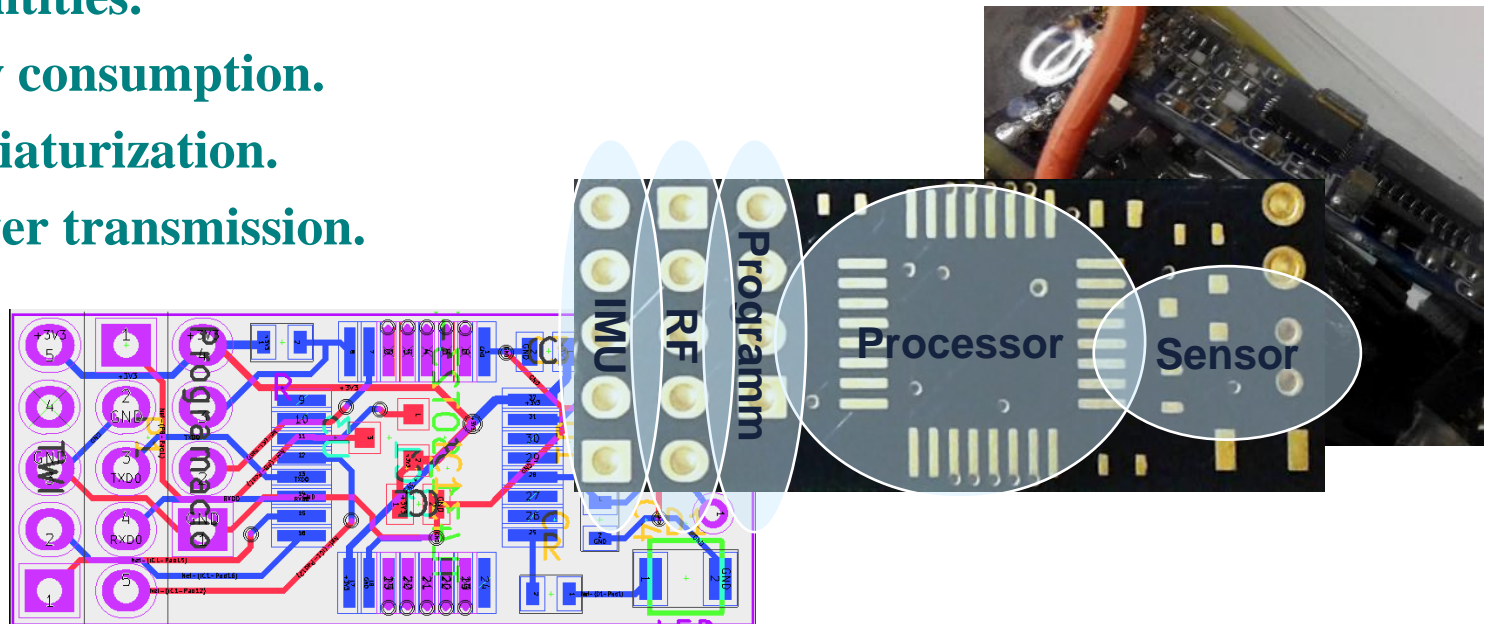
# Methodology: General Setup



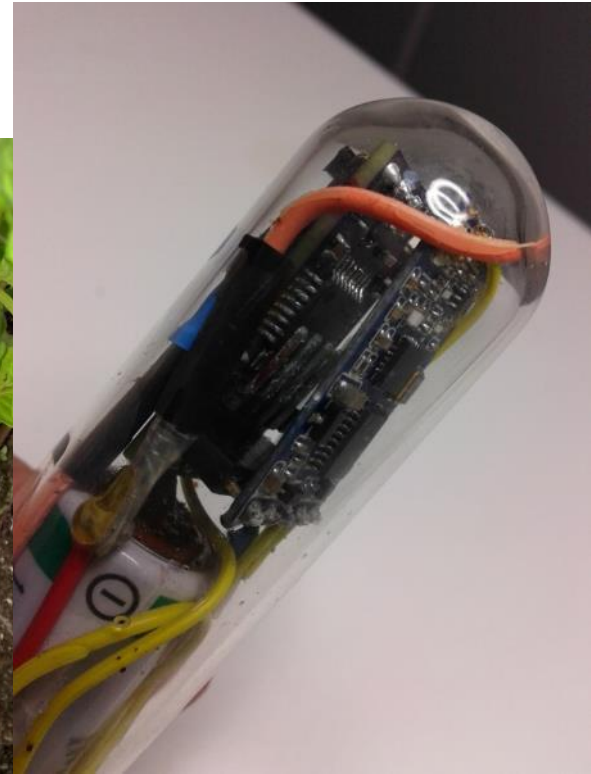
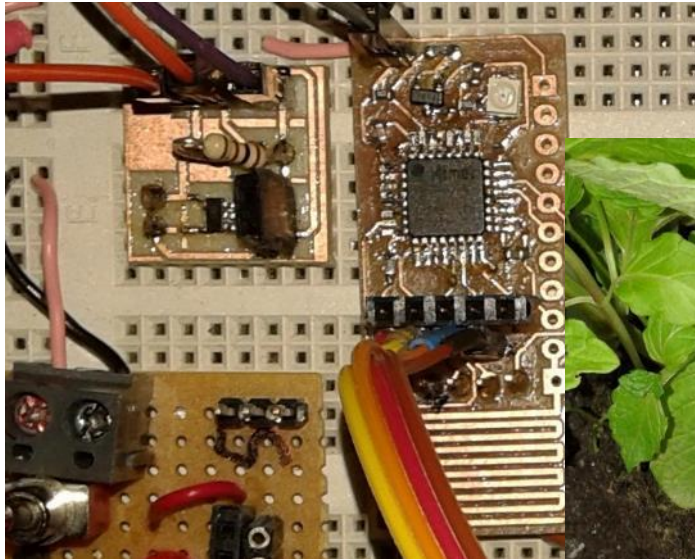
# HW Platform Architecture

## ◆ Bolus internal circuitry requirements:

- Though at the moment it senses temperature and movement, the general setup allows the sensing of other physical quantities.
- Low consumption.
- Miniaturization.
- Power transmission.



# Hw Platform Architecture: Versions



Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016

# In-Lab Test Essays

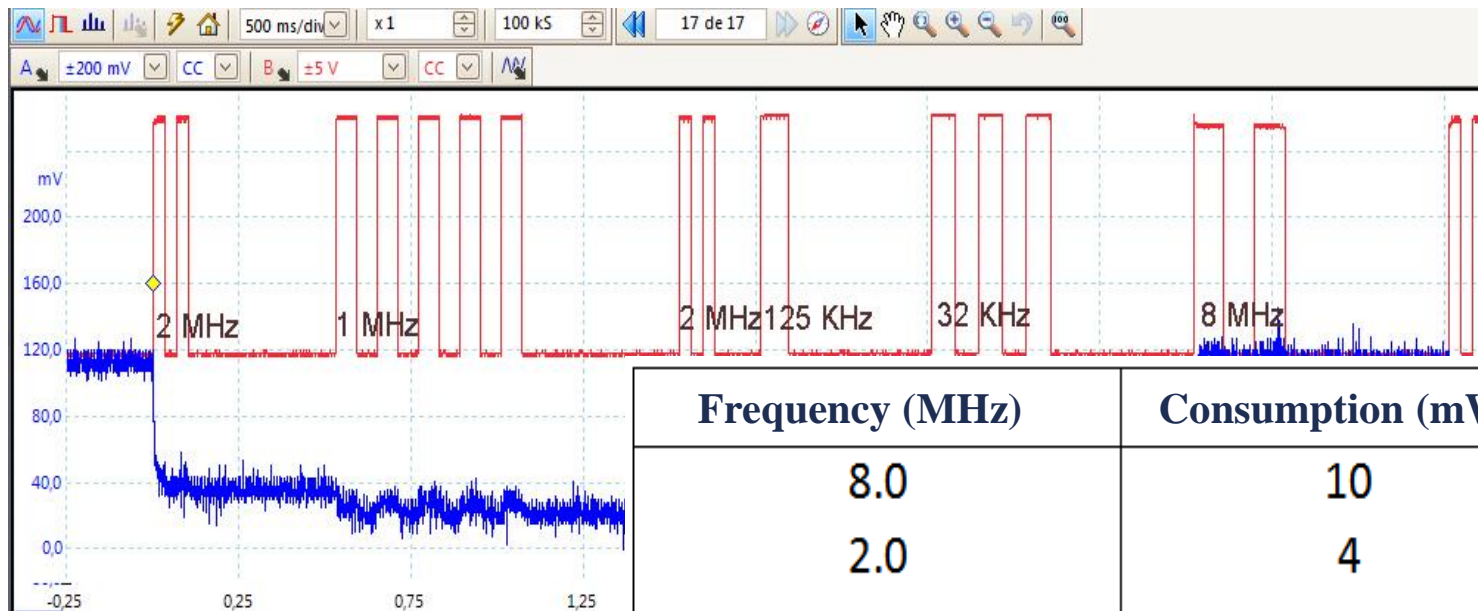
---

- ◆ In-lab testing of the bolus addressed the study of the best operation frequency bolus. A compromise between processor operation frequency, IMU operation frequency, power supply, transmission baudrate and low consumption is difficult.
  - Transmission baud rate influences transmission time and distance of transmission.
  - Processor clock frequency influences processor activity time.
  - IMU clock frequency is critical in I2C communication.
  - All influences consumption



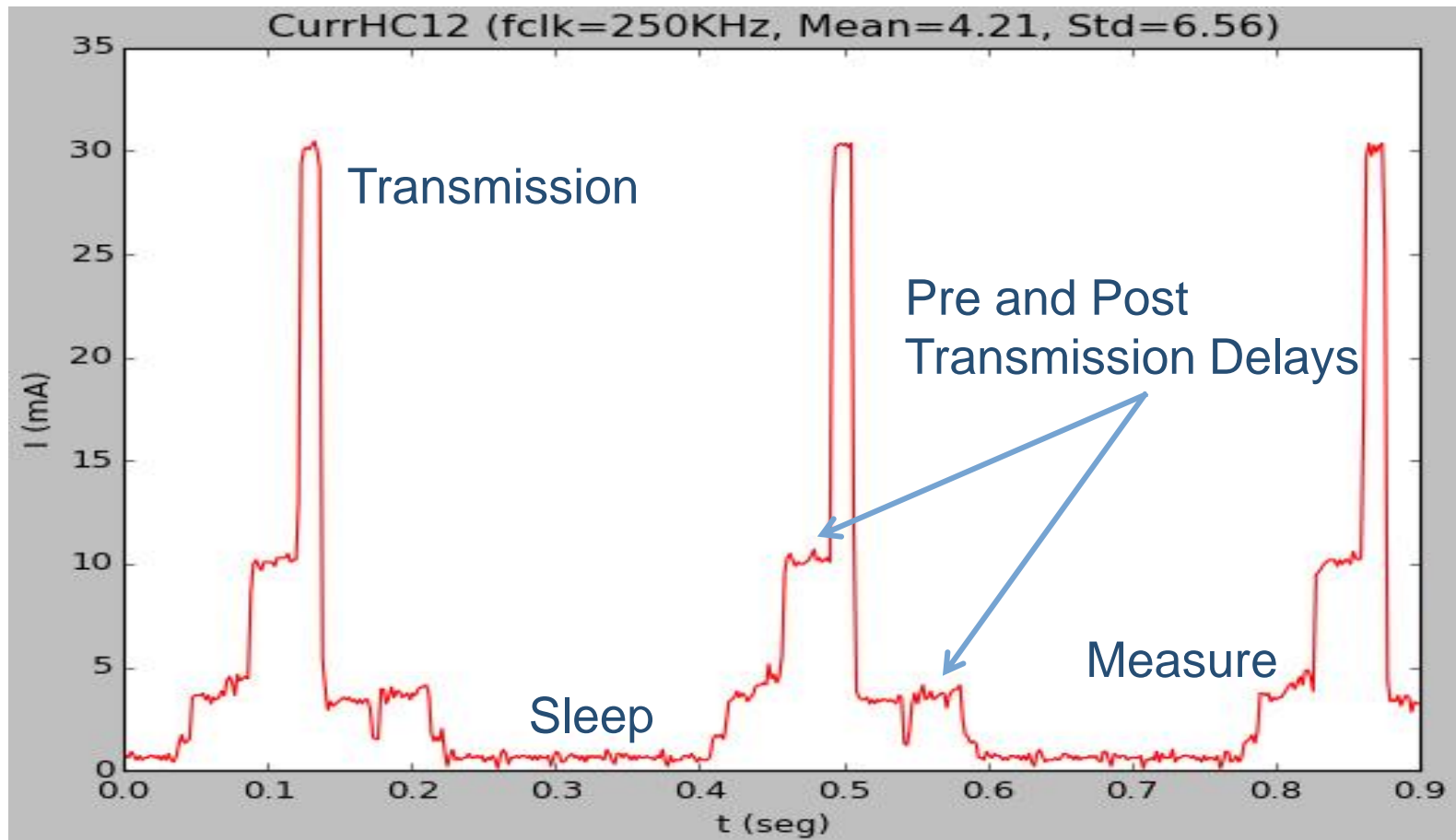
# In-Lab Test Essays: Clock Influence

## ◆ Processor clock influences power consumption

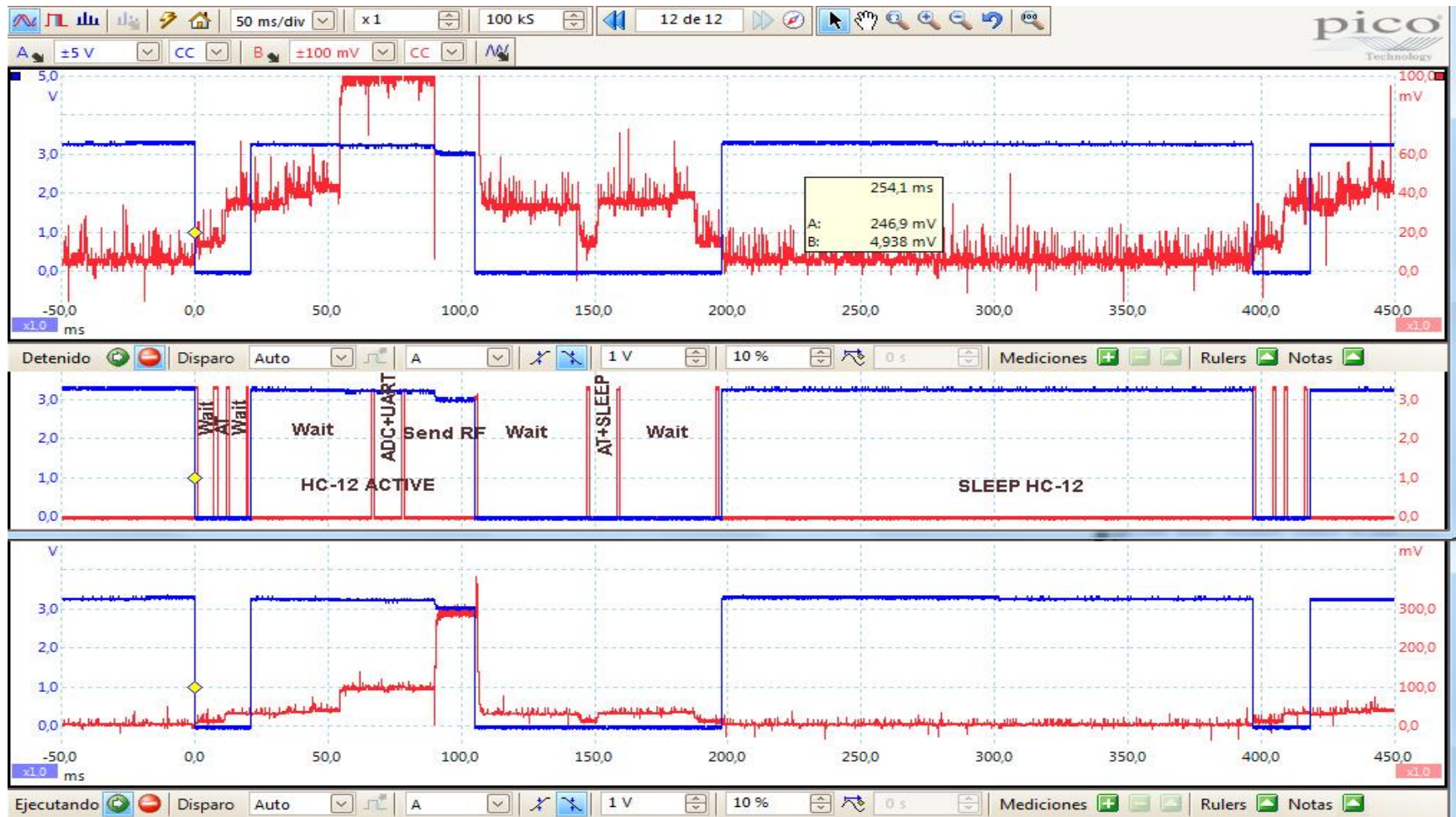


Frequency (MHz)	Consumption (mW)
8.0	10
2.0	4
1.0	3
0.125	1
0.32768	0,7

# In-Lab Test Essays: Typical Power Characteristics

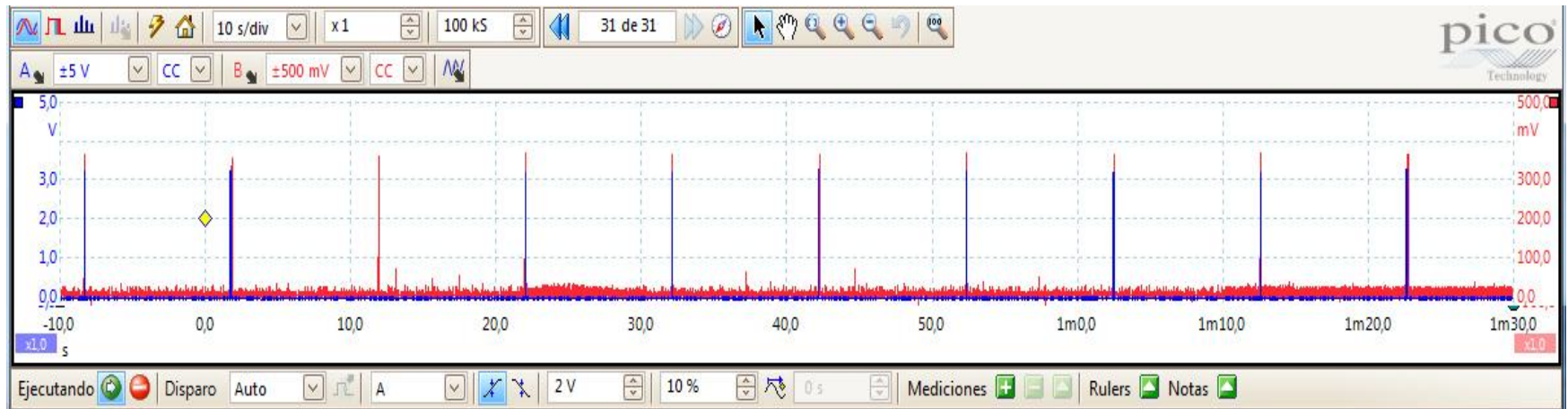
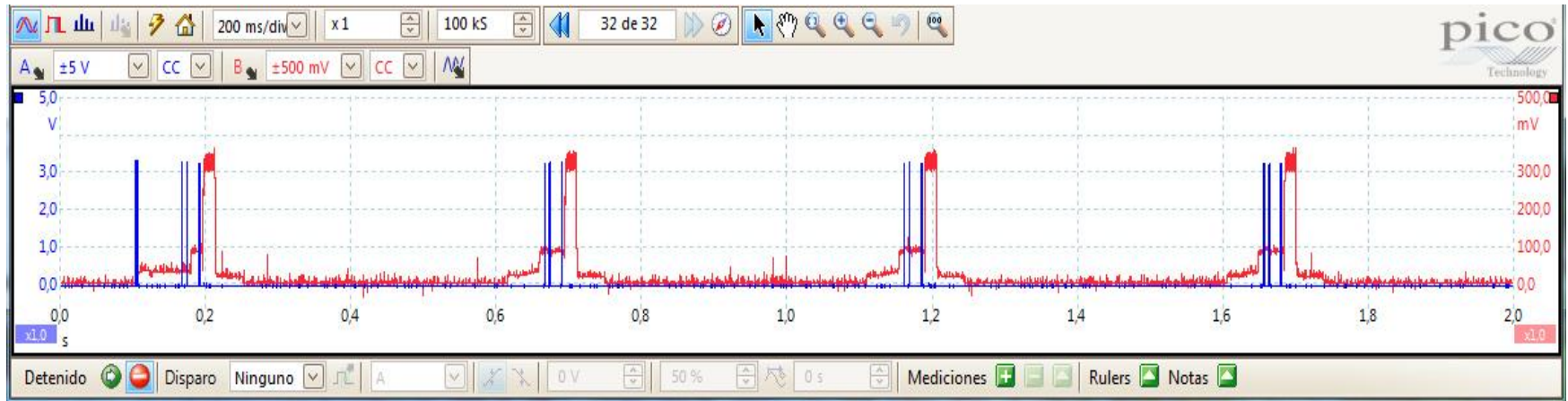


# In-Lab Test Essays: Typical Power Characteristics



Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016

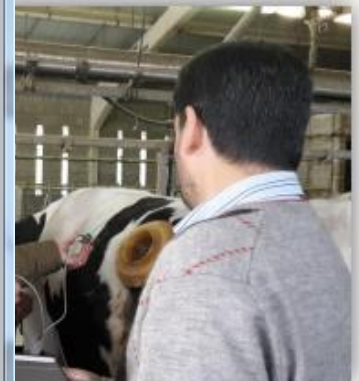
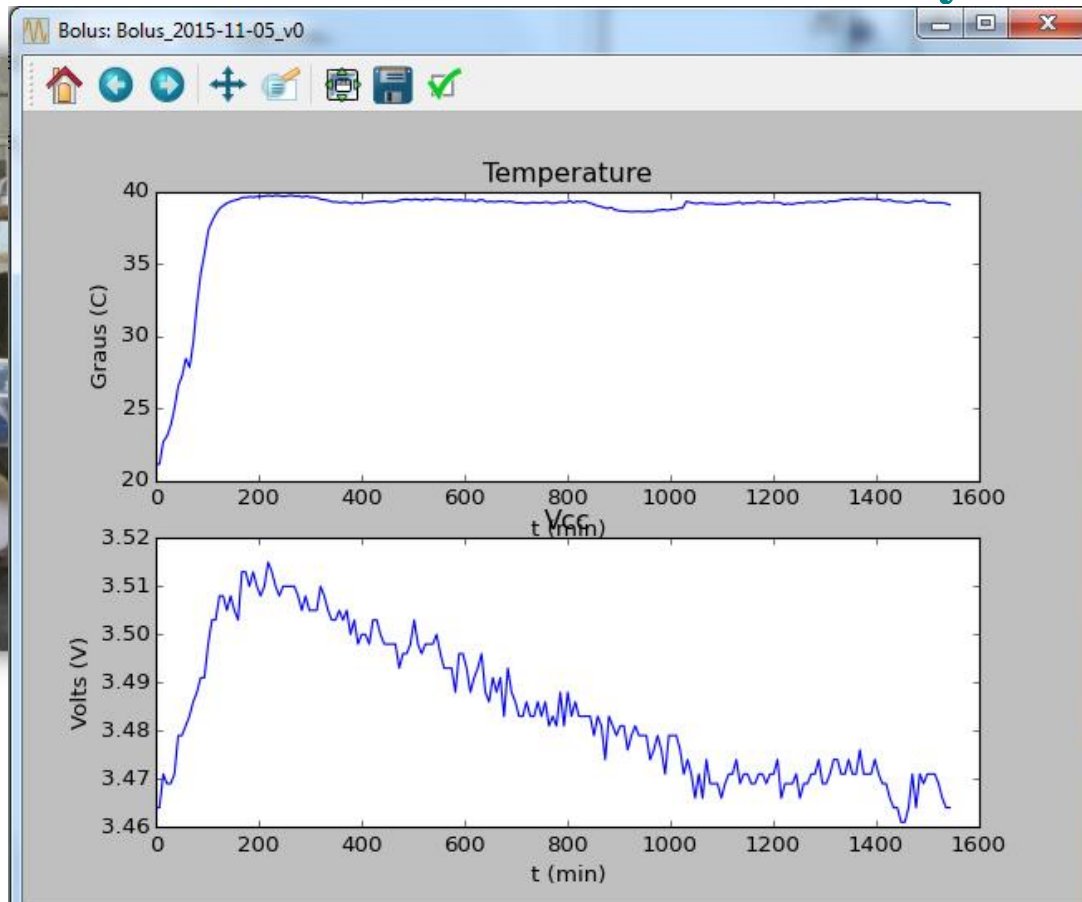
# In-Lab Test Essays: A Typical Transmission Waveform





# In-Vivo Test Essays: Temperature

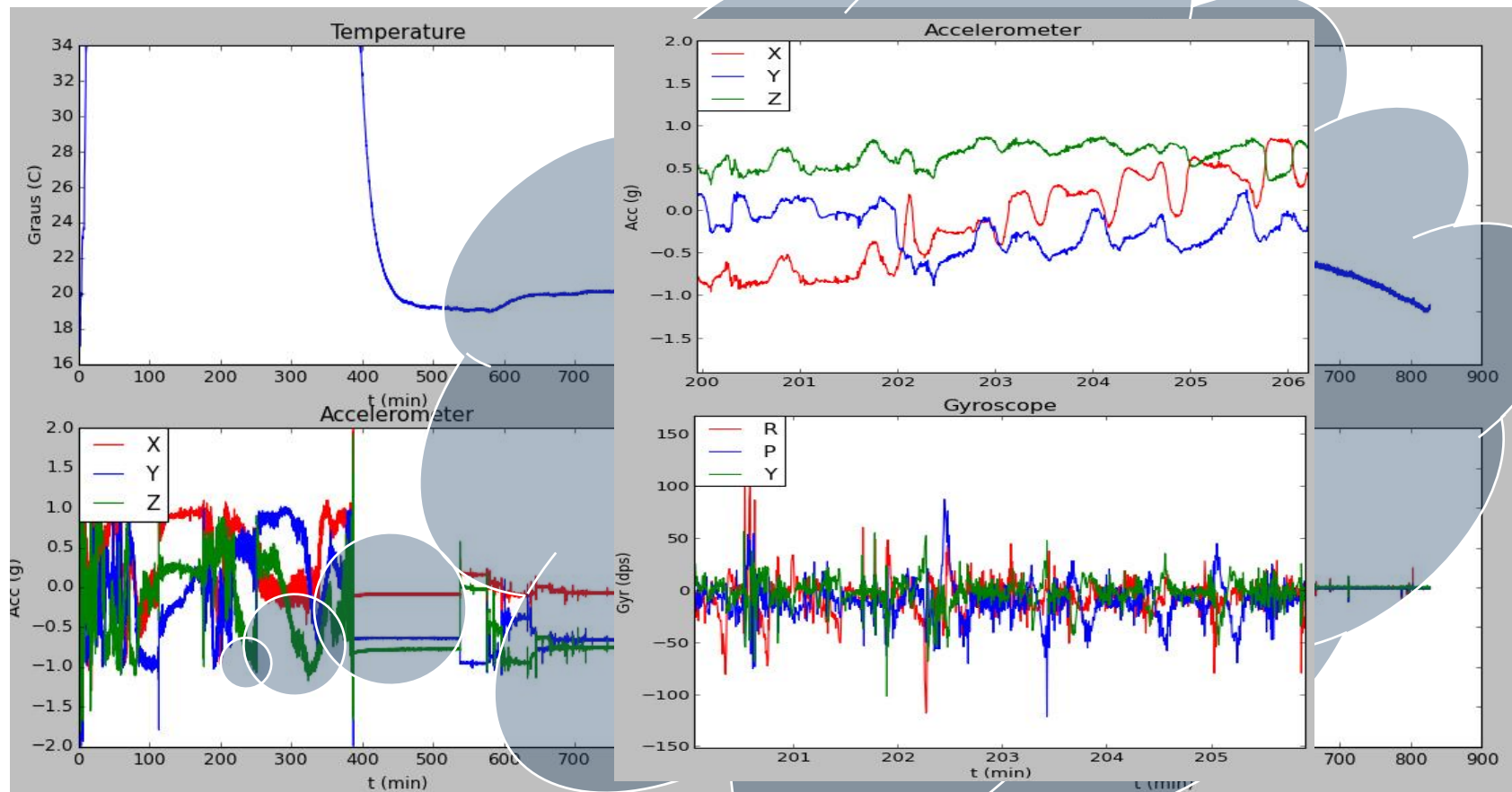
## ◆ In-vivo test at UAB's Veterinarian Faculty.



Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016

# In-Vivo Test Essays: IMU

## ◆ In-vivo test at UAB's Veterinarian Faculty.



Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016

# Boluses first prototypes evolution (BIOSENS)



Fourth DairyCare Conference, Lisbon, Portugal, 13-14 October 2016

# Actual Bolus Performance

---

- ◆ Low frequency communications
  - 433.x MHz
- ◆ High frequency communications
  - Bluetooth (Wifi)
- ◆ Consumption
  - 1-2 mA in operation
  - 40-70 mA in transmission
  - 50  $\mu$ A sleeping
  - About 1 year duration of a 2.0Ah battery in a 2 min. data transmission
- ◆ Transmission from inside the cow in comparison with open air communication has a reduction of  $\sim 15$ dBm (a reception of about 3% of the signal)



# Conclusions

---

- ◆ First results showed a new bolus architecture that matched most of the requirements.
- ◆ Mid-term research on energy consumption, RF link (antennas), packaging and selfpowered external receiver is being conducted.
- ◆ Further research will be addressed to energy harvesting solutions to replace batteries and more sensors integration among others aspects related to transferability for industrialization.
- ◆ Prototypes currently being tested in dairy ewes (n=4).

# Bolus platform development for data acquisition in small ruminants

---

**Thank you!!!**

**carles.ferrer@uab.cat**