Ciclo de Conferencias

LA REVOLUCIÓN TECNOLÓGICA EN EL CAMPO

Uruguay y el Reino Unido demuestran cómo la ciencia, la tecnología y la innovación son factores claves para maximizar la producción y proteger el medioambiente.

INNOVATION IS GREAT
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Precisión dirigida a producción animal

BUSINESS IS GREAT
BRITAIN & NORTHERN IRELAND

SRUC

Department of International Trade

UK Trade & Investment

Agritech solutions and Smart Farming: Improving Management for Better Animal Productivity, Health and Welfare (1):

Malcolm Mitchell

Chair in Physiology and Animal Welfare,
SRUC, Edinburgh

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Improving Management for Better Animal Productivity

21st Century Challenges in food animal production:-

- Population
- Climate Change
- Demand
- Food Security / Hygiene
- Human Health / One Health
- Product Quality
- Environment
- Animal Health and Welfare

Expanding markets changing geographical distributions of production and consumption – increasing homogeneity of global food

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Improving Management for Better Animal Productivity

Key features of increasing sustainable animal production are:-

- Full Exploitation of the genetic improvements in livestock
- Optimization of the efficiency of production – reduction of waste
- Maximization of the health and welfare of the animals
- Provision of appropriate adaptations to meet the range of environmental challenges and resource limitations
- Improved monitoring of animal health, performance, productivity and welfare

Measurement, monitoring and recording of key parameters are central to the development of improved control systems – (Technology)

Agri-Tech and Smart Farming solutions

- Animal, production and environmental monitoring systems are the key areas for technological development

- New or novel sensors, platforms, models, control systems and data bases must be developed and applied

Smart Farming / Agri-tech represents the integration of all these approaches to address the pressing issues and challenges

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The way forward?

Demand is increasing

Environmental and climatic challenges

Constraints and limits upon resources

Increases in “scale” may prove essential

SMART FARMING or PRECISION AGRICULTURE

SMART FARMING

Smart Farming Technology

The concept of smart farming encompasses many different technologies that can be used individually, or together, to increase the efficiency of agricultural operations

Precision Agriculture

The definition and development of Decision Support Systems (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources

21st Century Challenges

Increasing Population

- 9 billion by 2050
- At present, nearly 1 billion malnourished

Improved Nutrition in China and India

- Double food needs

Environmental issues

- Aquifers being depleted
- Livestock impact

Global meat demand is projected to double by 2050

The Perfect Storm

“It is predicted that by 2030 the world will need to produce around 50 percent more food and energy, together with 30 per cent more fresh water, whilst mitigating and adapting to climate change. This threatens to create a ‘perfect storm’ of global events…There's not going to be a complete collapse, but things will start getting really worrying if we don't tackle these problems.”

Prof John Beddington 2010

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The paradox?

Must produce more food (more animal protein) more efficiently but sustainably in the face of climate change!

Intensification accompanied by more efficient extensive production are the options?

All must be sustainable

True cost benefits must be calculated

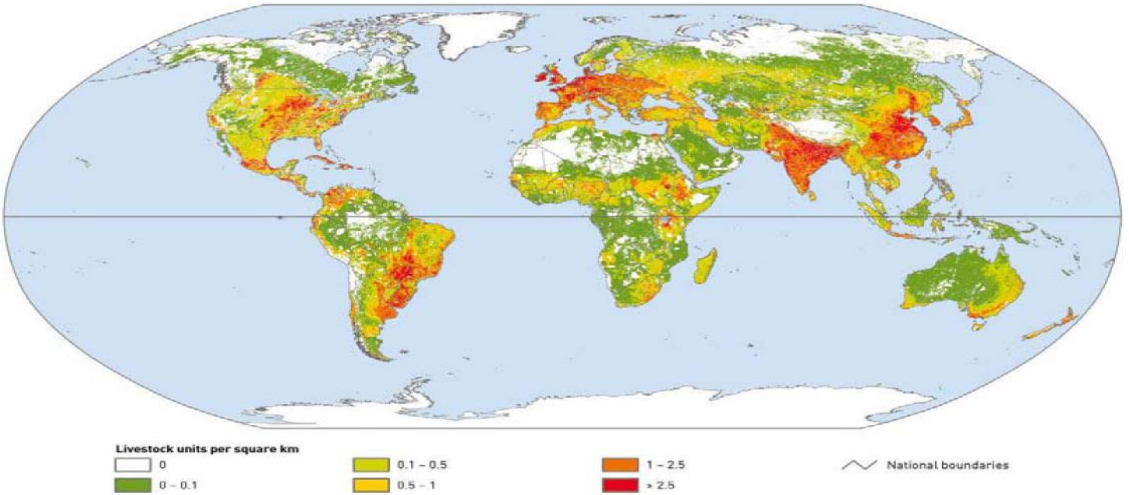
Animal science can provide the decision base

Animal Science

Animal science has a lot to contribute in order to fit livestock production to (all of) the challenges arising from the concerns related to global warming, resource constraints (and loss of biodiversity)

John Hermansen EAAP 2012

Global Livestock production



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World animal production 2014

Species	World production
Cattle (beef) (dairy)	324 million + 670 million
Pigs	1.6 billion
Sheep	542 million
Chickens	59 billion

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Producing Animals/Slaughtered (Head) Cattle

Country	Number (head)
Argentina	11210000
Brazil	40205000
Colombia	4124658
Uruguay (5)	2137000
Venezuela (Bolivarian Republic of)	2176000

Producing Animals/Slaughtered (Head) Sheep

Country	Number (head)
Argentina	4580000
Brazil	5312500
Peru	2917766
Uruguay (4)	1934500

Producing Animals/Slaughtered (Head) Pigs

Country	Number (head)
Argentina	3466000
Bolivia (Plurinational State of)	1760000
Brazil	35979434
Chile	5400000
Colombia	2976255
Ecuador	2192500
Paraguay	2100000
Peru	2368643
Uruguay (10)	282000
Venezuela (Bolivarian Republic of)	2593000

Producing Animals/Slaughtered (1000 Head) Chickens

Country	Number (1000 head)
Argentina	685000
Bolivia (Plurinational State of)	288000
Brazil	5242665
Chile	260000
Colombia	1112260
Ecuador	155000
Peru	575666
Uruguay (9)	88000
Venezuela (Bolivarian Republic of)	424000

Uruguay and Agriculture

- **Agriculture represents 8-10% of the economy**
- **There are about 12M cattle, 10M sheep in 13M hectares and agriculture has increased from 45,000 hectares in 2005 up to almost 2 million ha in 2013**
- **Beef production pasture based and with cattle in the range for most of the year**
- **Uruguay operates a full traceability system of all the cattle**
- **Potentially there is a huge incorporation of technology**

Animal Production (Uruguay)

- Require more investment in national agricultural research
- Wish to go forward through sustainable development
- Will seek to embrace new technologies (Agritech and Smart Farming?)
- More production intensification
- Current and new developments constitute a challenge to animal health and welfare
- Health status is currently an asset

Animal Production

Uruguay:

- Competitive export services
- Is a net exporter
- However, cannot manipulate International market price
- Small but significant domestic market.

Uruguay and Agriculture

- **Significant crop-pasture rotations - Successful system to optimise meat production and crop output**
- **Cow herds kept on the natural pasture with supplements through the winter**
- **After weaning or first winter, steers are moved to better quality pastures for finishing**
- **Some intensification of steer finishing with some feedlots or pasture-ration combination**

Uruguay and Agriculture

- **Soy Bean and Rice have led the way in moving the technical frontiers**
- **Significant use of GM soy bean and the use of ‘minimum’ or ‘zero’ tillage**
- **Very aware of all the technical developments available**

Agricultural yields http://www.yieldgap.org/uruguay

R&D investment http://www.asti.cgiar.org/sites/default/files/pdf/Uruguay-Factsheet.pdf

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Agritech solutions and Smart Farming

New technologies and approaches may be needed to meet:-

- **Increased production targets with higher efficiency**
- **Increases in scale to meet domestic and export requirements**
- **Maintain and improve health and welfare standards**
- **Meet export standards for animal (and product) welfare standards**
- **Reduce dependency on numbers of personnel**
- **Complement skilled husbandry systems**

Smart Livestock Farming and Sensors and Systems

- Increase productivity and efficiency by improving monitoring, control and decision making
- Improve animal health and welfare by improved monitoring and early detection of health problems and disease
- Facilitate increases in scale and sustainable intensification
- Enable introduction of advanced technologies into farm level practices

Complement good husbandry skills and practices NOT directly replace

Sensing and monitoring in animal production, health and welfare

Sensors for Environment

Sensors for Behaviour (condition, status, welfare and health)

Sensors for Physiology (condition, status, welfare and health)

Sensors for Performance

Sensors for Animal ID and data storage

Sensors for animal tracking / location

Integrated Systems

Sensors for behaviour

Thermal imaging (behaviour and physiology?)

Video / image capture

Video / image analysis

Movement, activity, forces and acceleration

Sensors for behaviour (and physiology?)

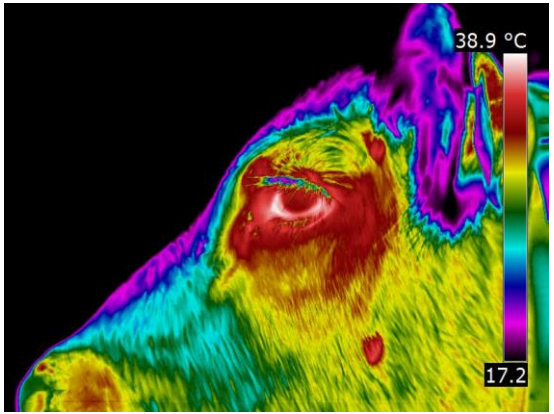
Thermal imaging (behaviour and physiology?)

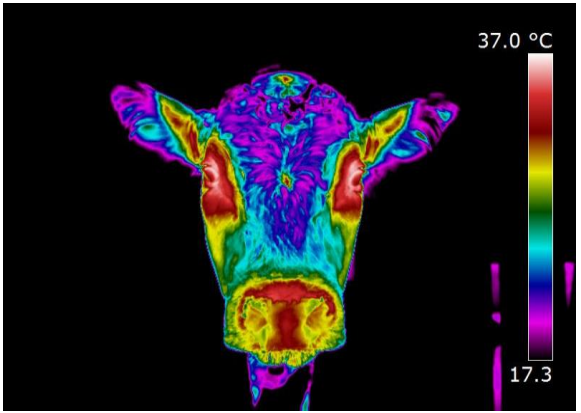
What can this technology be used to monitor and/or detect?

Specific injuries, pathologies and physiological and behavioural changes (diagnostics)

As part of integrated management systems

Thermal imaging





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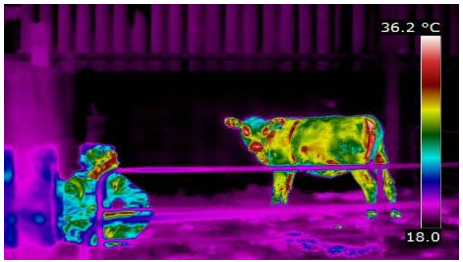
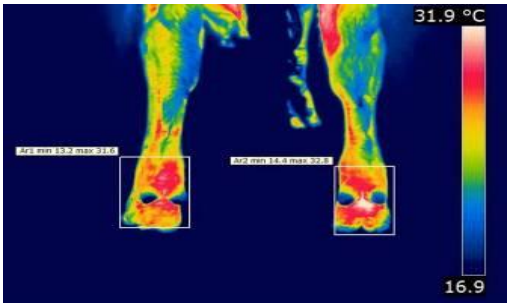
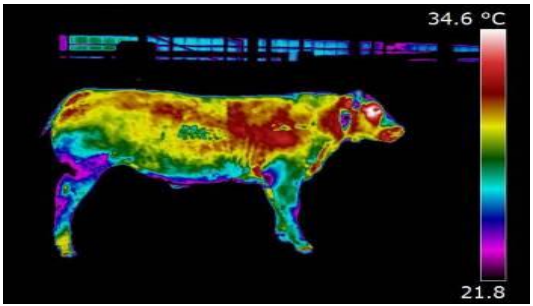
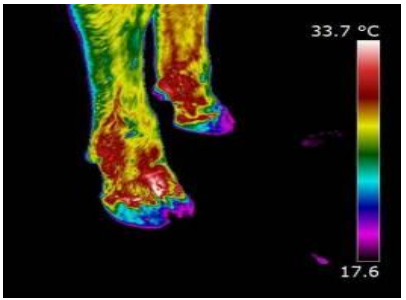
Thermal imaging in agriculture and veterinary science









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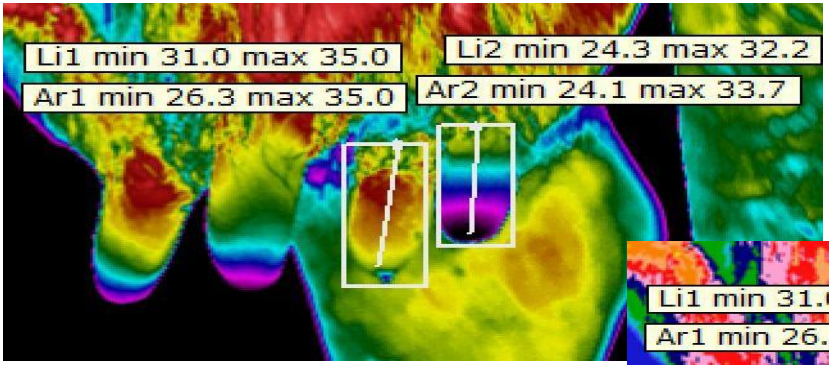
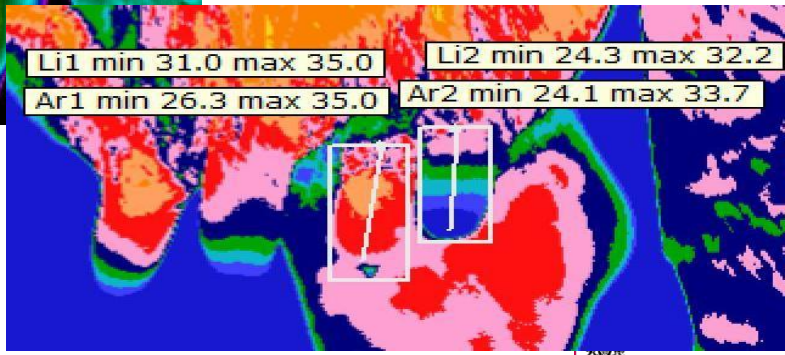
Thermal imaging

Mastitis





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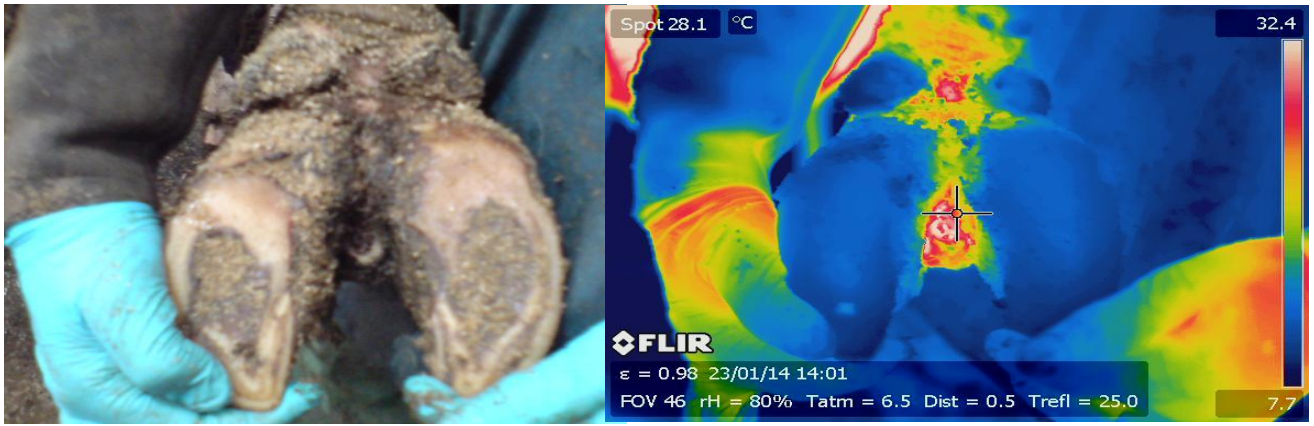
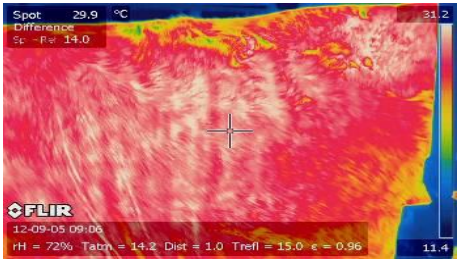
Thermal imaging

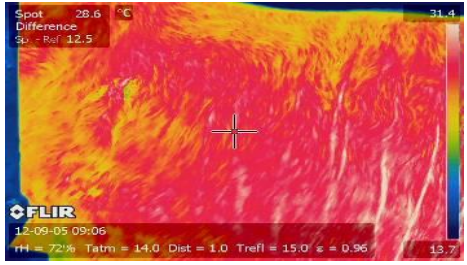
Interdigital dermatitis in dairy cattle

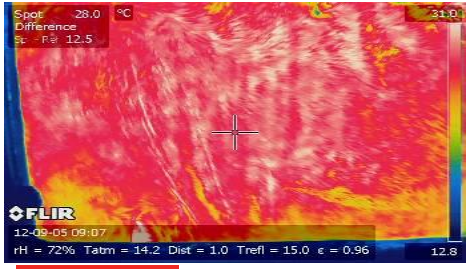


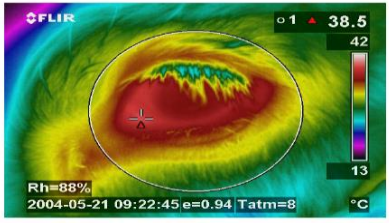
Thermal Imaging and rumen function

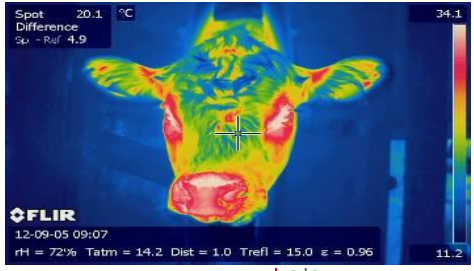
- Sub-Acute Rumen Acidosis (SARA) in beef, (the reticulum and the eye temperature)











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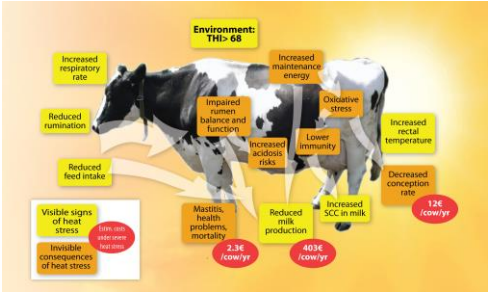
Thermal imaging

- **Thermal imaging can assist in the identification and diagnosis of inflammations, bruises, muscle or tendon injuries, superficial tumours, nerve damage and blood circulation issues.**

- **It can be used to assess the physiological status of an animal and the degree of stress an animal is experiencing**

- **It can be used to assess the extent of heat stress or cold stress experienced by an animal in a wide range of environments**



- **It is an important tool in the determination of an animal's welfare state or well being.**

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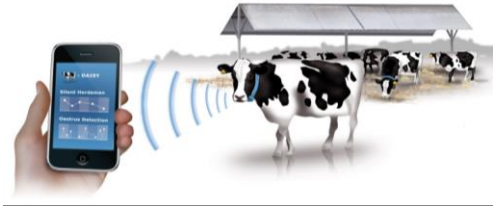
Animal mounted sensors



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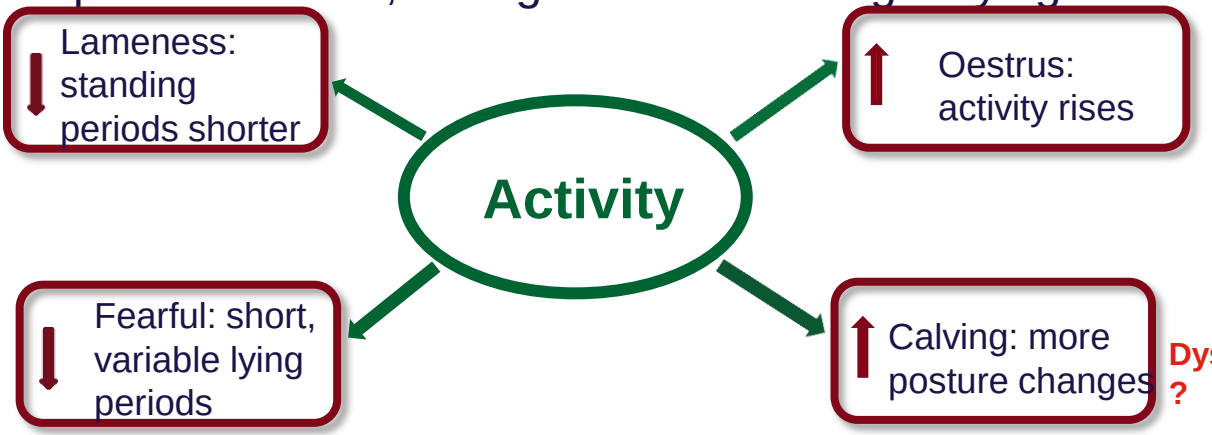
Activity

Activity measures: amount of time standing, number of steps/movements, changes from standing to lying



"Silent Herdsman" – activity and physiological status

Wireless technology

Detect oestrus/calving

- Indoors/outdoor environments

Detect health problems e.g. lameness, SARA

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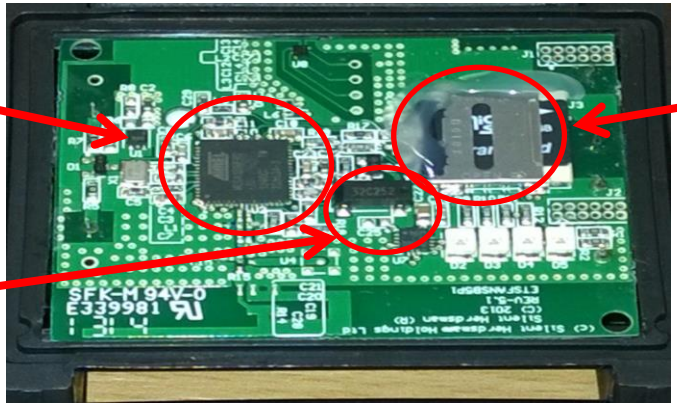
How it works

Radio Microprocessor

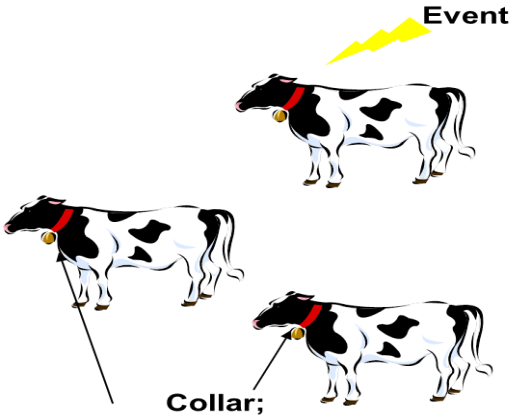


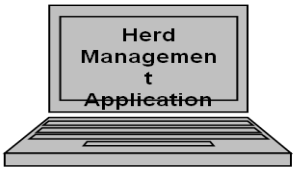
SD Card

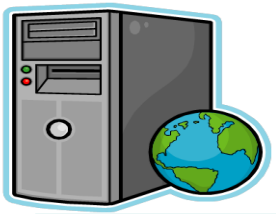
Accelerometer

Complex algorithms compute animal behavioural state based on accelerometer readings.

Silent Herdsman







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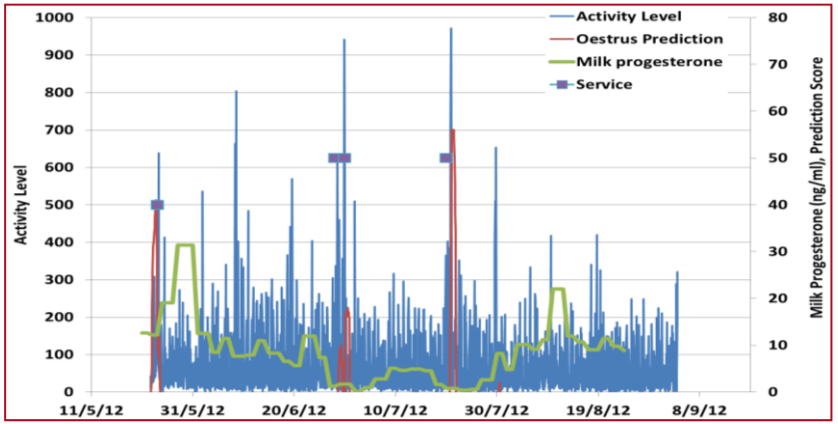
Oestrus detection

Increase detection ability

Validated through progesterone profiling

Collar based sensor technology



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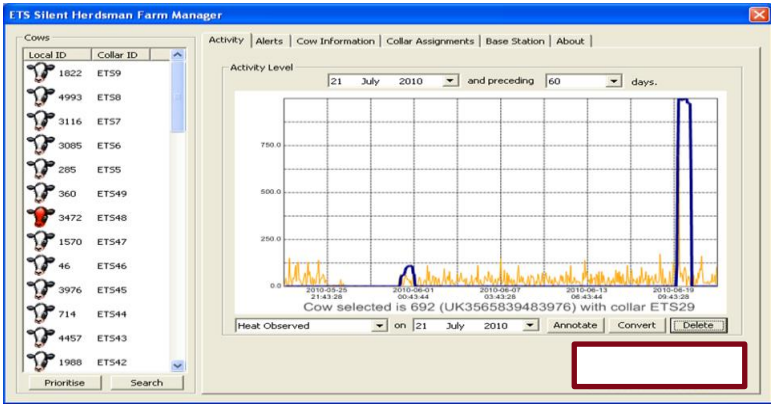
Silent Herdsman

Current outputs detect activity patterns

Alerts sent



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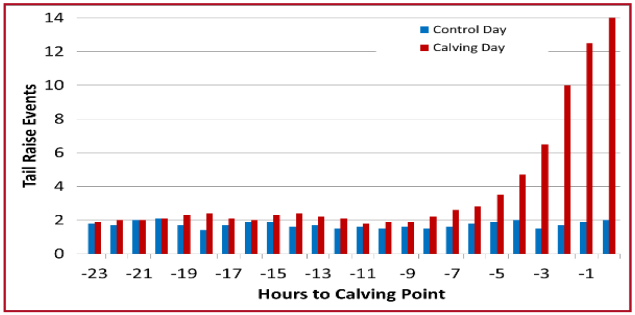
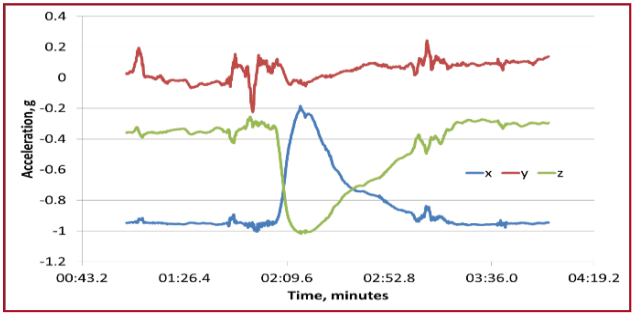
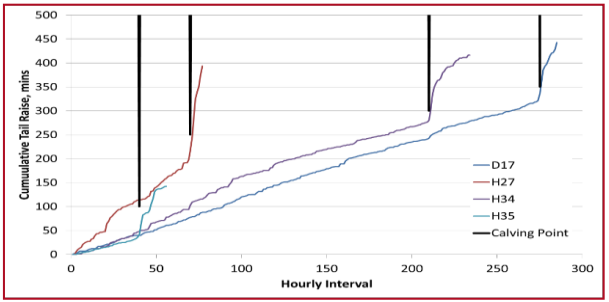
Calving Detection (Beef and Dairy)



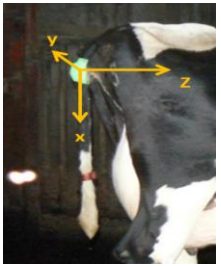


Tail Raise Increase to calving point



Cumulative Tail Raise

Tail Raise Signature



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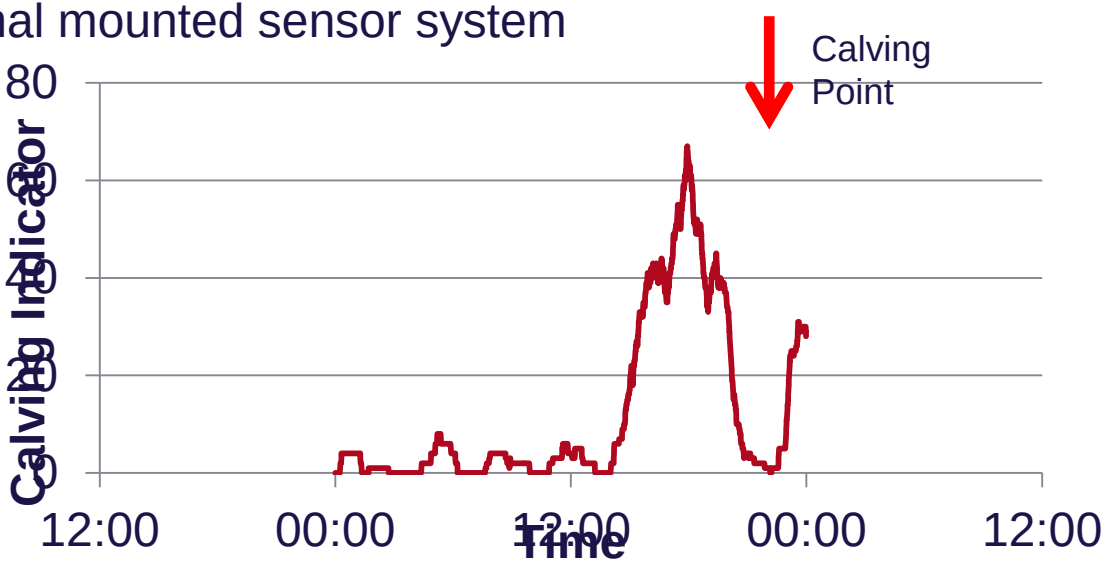
Calving Prediction

Animal mounted sensor system



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Detection of feeding behaviour/intake

Eating and rumination to give a measure of welfare and efficiency

Methods on farm currently at batch level

Potential from combination of technologies?

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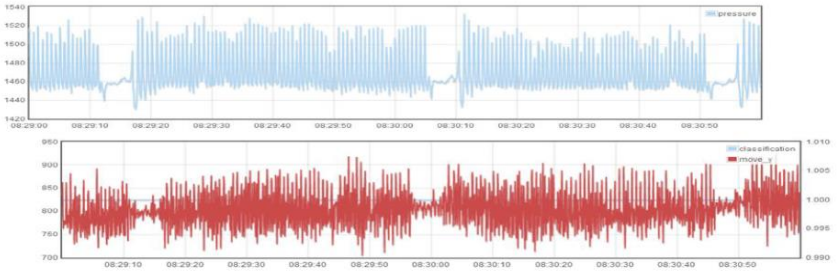
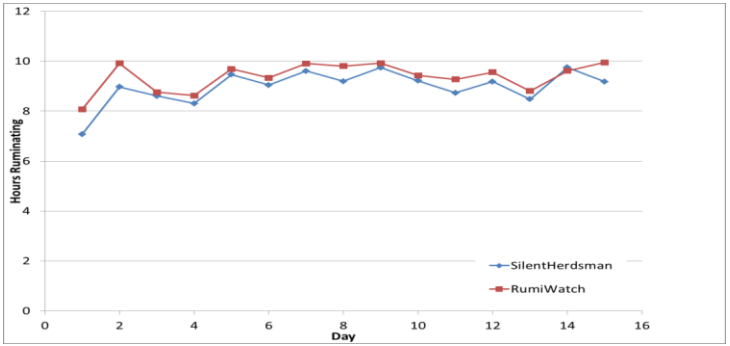
Rumination

Jaw movement from pressure sensor (Rumiwatch)



Silent Herdsman



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Sub-Acute Ruminal Acidosis (SARA) in cattle

Sub-Acute Ruminal Acidosis occurs when there are high levels of “fermentable carbohydrate in the diet”

There is increased production of VFAs and lactic acid

The rumen becomes more acid (lower pH)

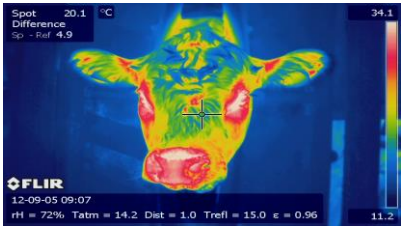
- pH (rumen)
  - Acute < 5.0
  - Sub acute <5.5

Sub-Acute Ruminal Acidosis (SARA) in cattle

Reduced intake – dry matter

Reduced fibre digestion

Reduced growth

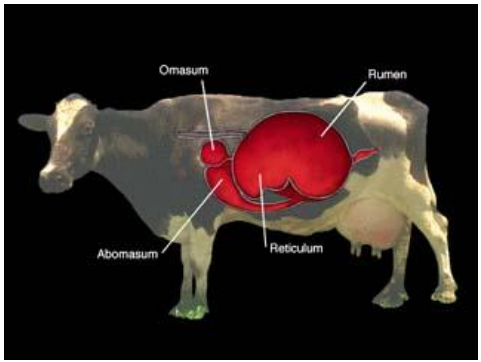


Change in milk composition and volume

Diarrhoea / faecal composition

Lameness / laminitis

Poor health status



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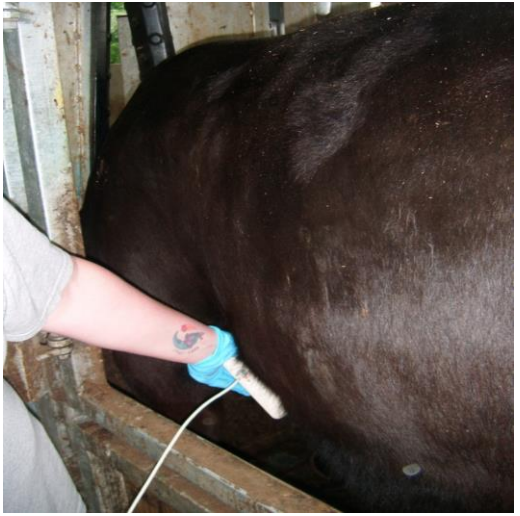
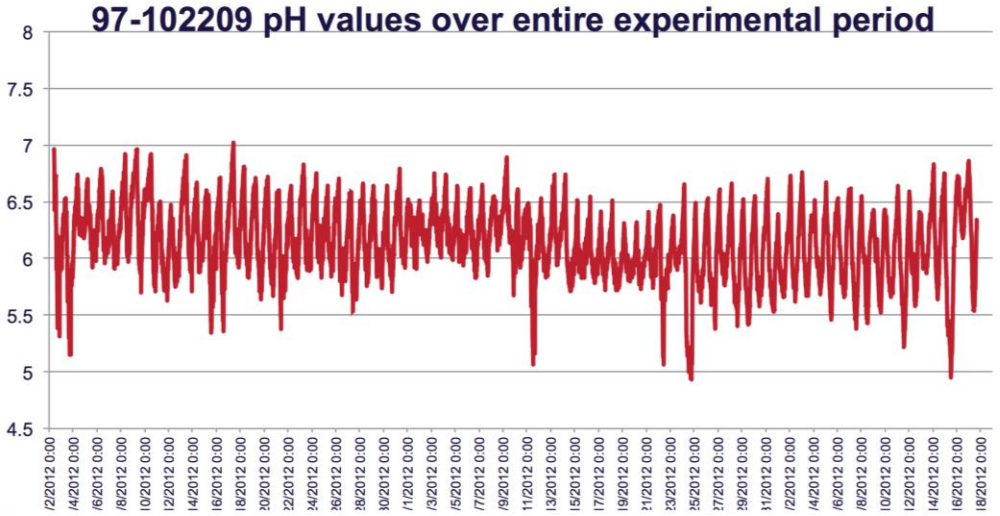
Rumen Bolus to measure pH

Rumen Bolus – scanning to download data



Rumen pH – single animal



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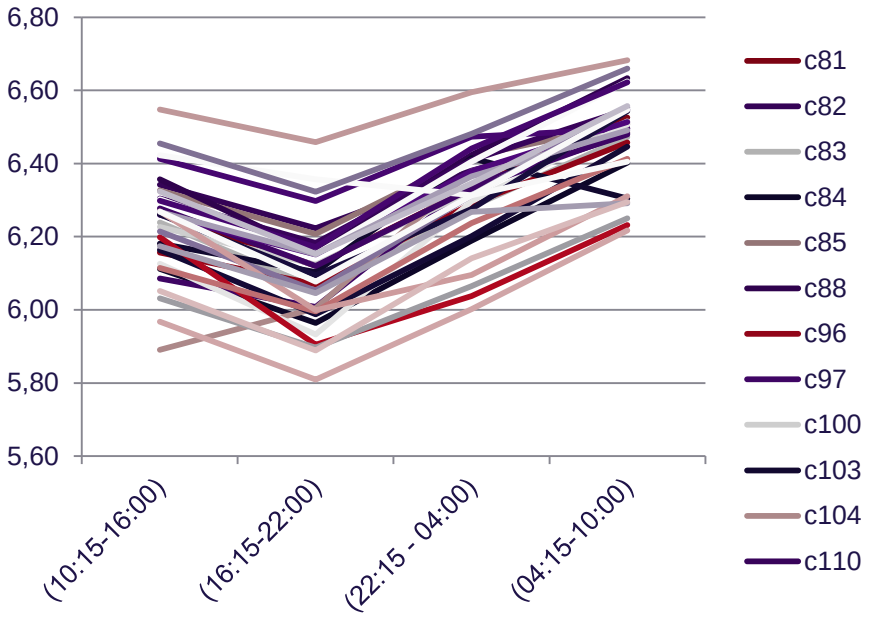
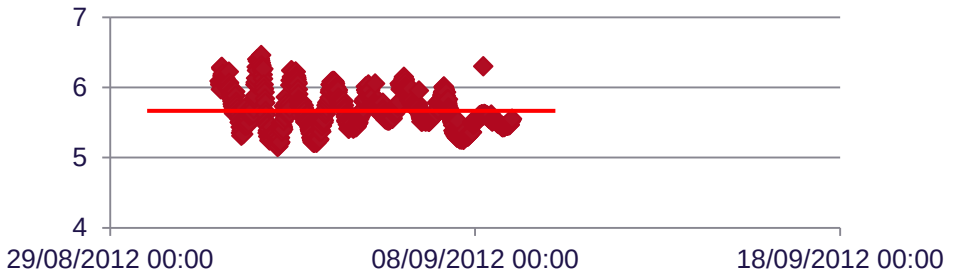
Rumen pH – control period

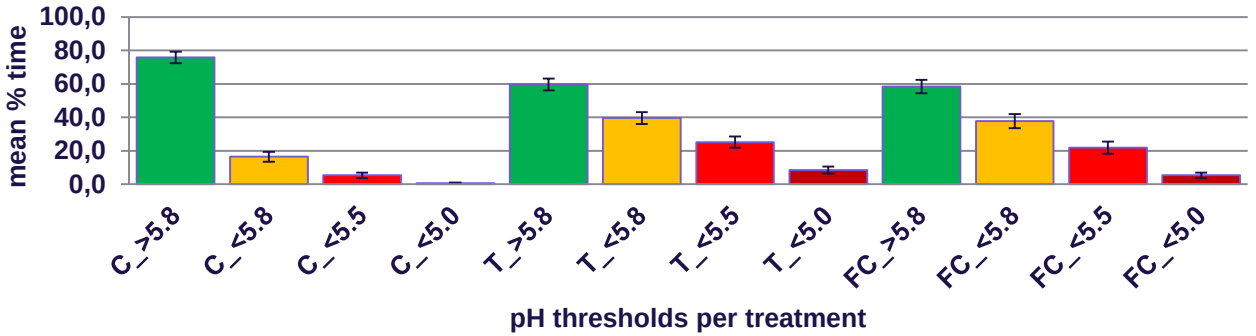


Rumen pH



Rumen pH – time in pH category

Mean percentage of time animals spent in different pH SARA thresholds



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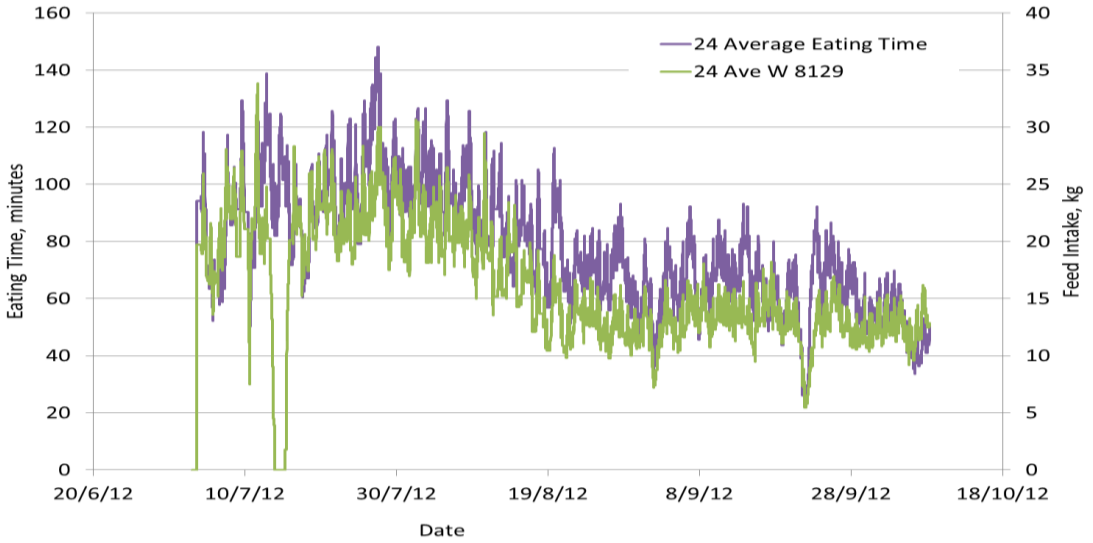
Feed Intake over Time 8129



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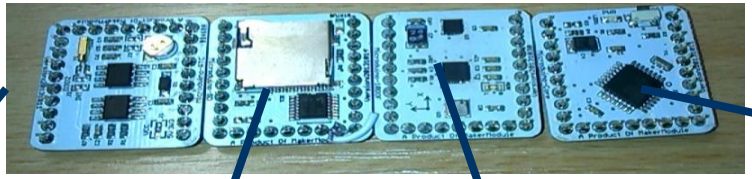
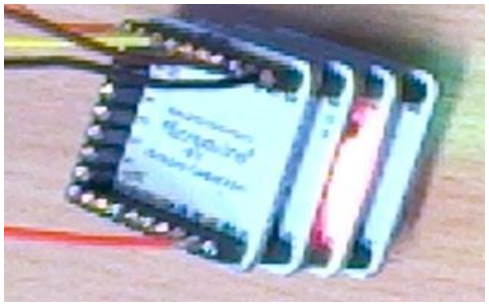
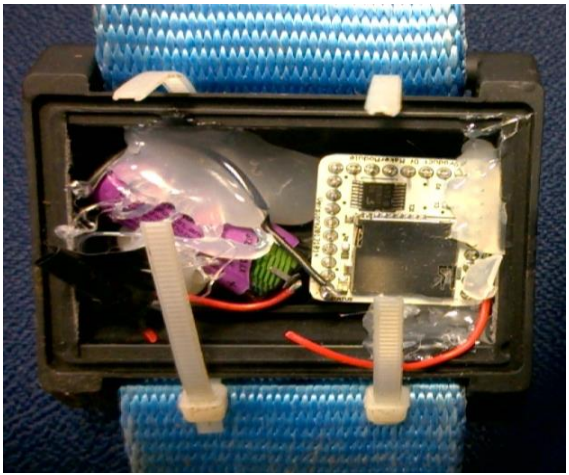
Prototype Gyroscope Collar



Collar Compatibility





Rumiwatch Halter

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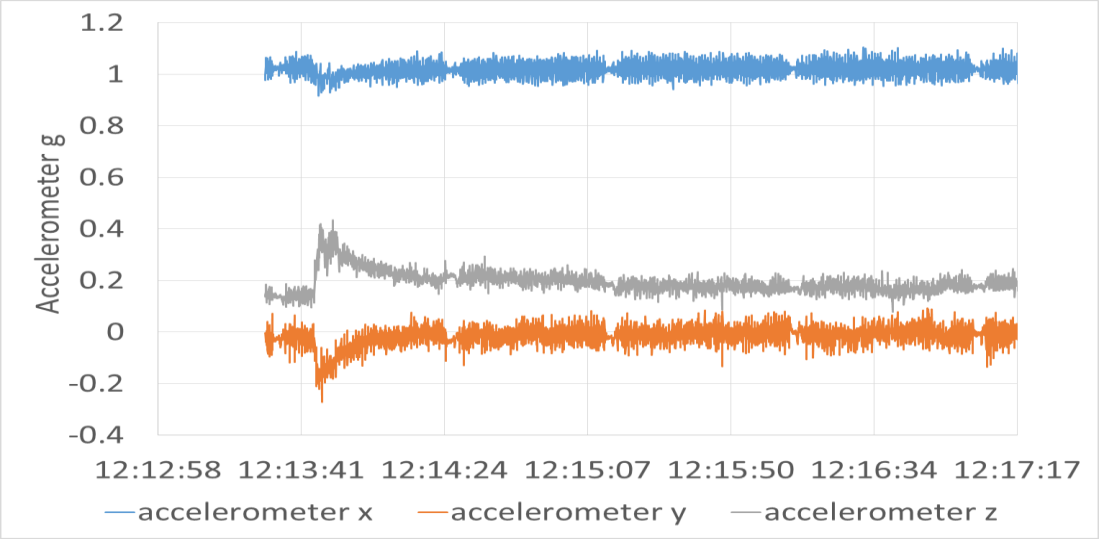
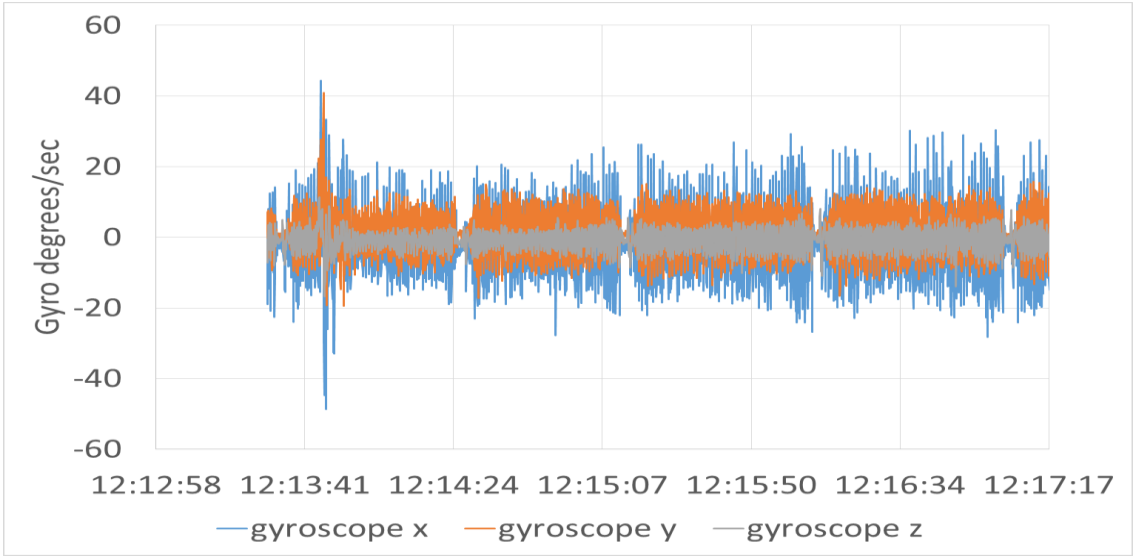
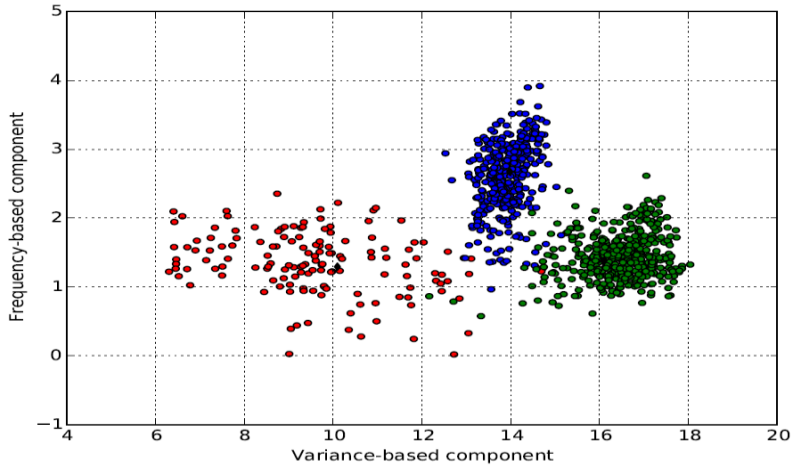
Accelerometer: Rumination Period



Gyroscope: Rumination Period



Scatter plot Gyroscope (16 bit)



Accelerometer – leg mounted - measurements

Motion Index (measure of intensity of activity)

Lying time Transitions

Standing time

Step count

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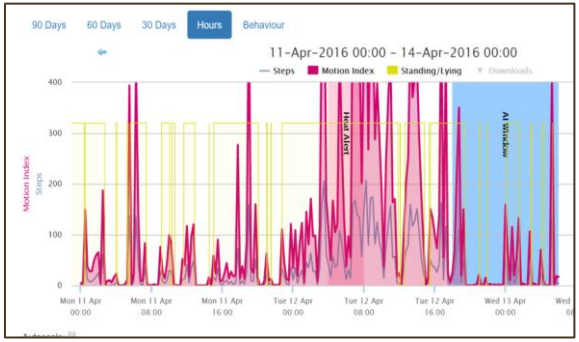
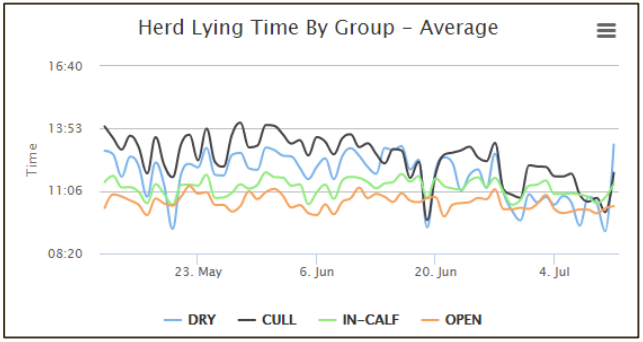
Analysed information includes:



Highly accurate heat detection



Unique lying time information, by group

Advanced health monitoring

Alert Value	Alert Date	Alert Action/Outcome
	x	
1.7	3 Jul 2016	Lameness
0.9	2 Jul 2016	Calved
0.9	2 Jul 2016	Lameness
0.8	2 Jul 2016	Lameness
0.9	2 Jul 2016	Lameness

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Easy data download and data view

Web data view

Milking parlour

Mobile data view

Automated data transmission

Manual data transmission

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Accelerometry Sensors and Systems

Detect activity patterns and movement

Can detect and identify specific activities and patterns associated with specific changes in physiogical status and/or health

Can be integrated in to monitoring platforms and systems with other sensors

Can collect continuous data on large number of animals

Provide data for automated analysis and reporting

Be an important component of farm management systems

Cow Health Monitor (new developments – robotics)

Development of a state-of-the art early-detection system for metabolic and infectious disease in dairy cattle is in progress supported by Innovate UK

It will address some of the key challenges facing the dairy sector

Early detection of :-

Lameness

Metabolic disease including

Ketosis (SCK)

Sub-acute ruminal acidosis (SARA)

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Sensing

Milk and breath analysis - Acetone, organic volatiles, metabolic and disease markers

Thermal imaging technologies - Semi-automatic thermal image capture capacity

In-line milk composition units installed within a dedicated Fullwood Merlin robotic system

Animal activity and behaviour (Accelerometry)

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Cow Health Monitor – Robotic milking

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Thermal imaging on robot

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Thermal imaging on robot

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Cow Health Monitor

Sensors:-

Animal-mounted accelerometers/gyroscopes (feeding behaviour of individual animals.

- Changes in eating and rumination patterns provide an early indicator for the development of disease.
- identify signatures associated with lameness (gait detection) and overall activity.

Thermal imaging which will be used to detect elevated temperature

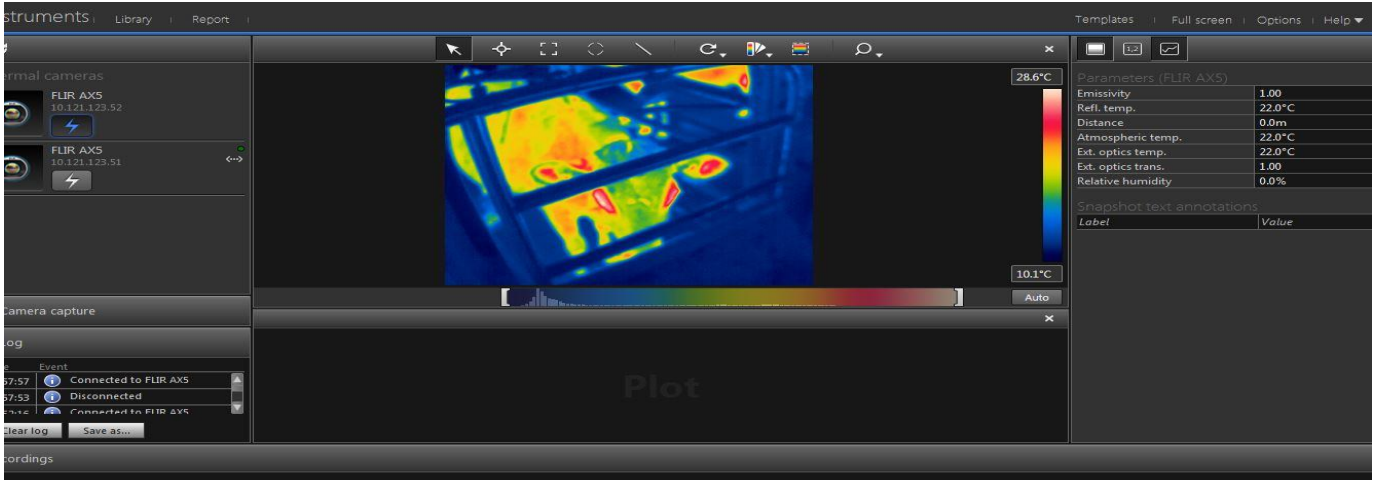
- local inflammation and early pyrexia (fever), infectious disease (the eye as a proxy for core body temperature).

In-line milk sensor,

- optical free-flow technology
- mounted within the milking system - milk yield and composition (butterfat, protein and lactose).

Complete data download for each animal during milking – Robot system

Thermal imaging on robot



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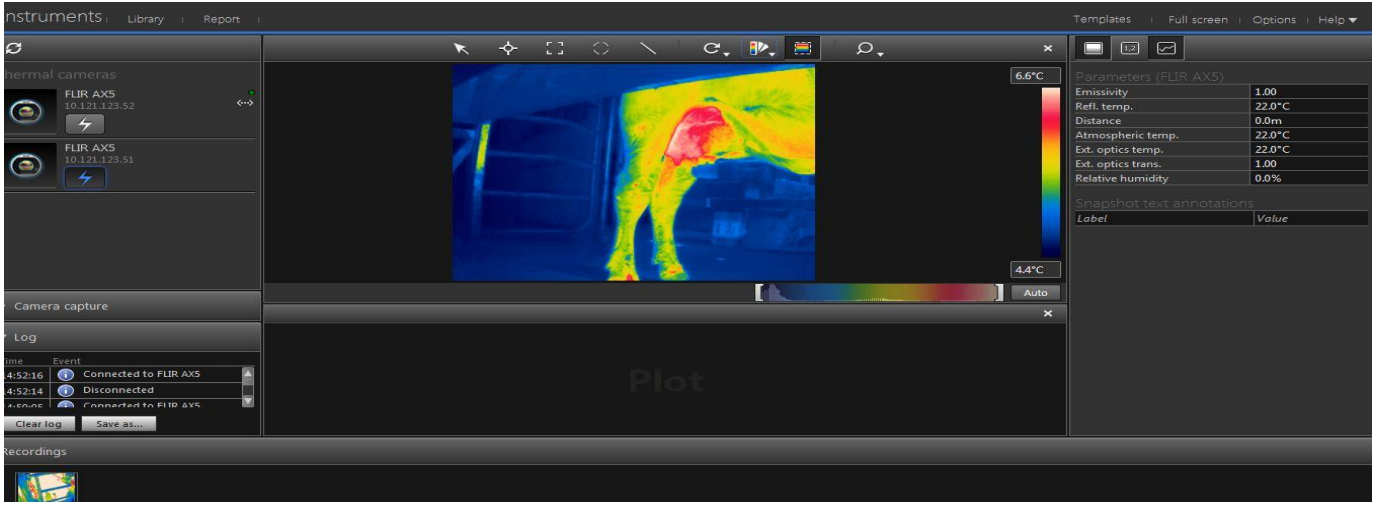
Thermal imaging on robot



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Thermal imaging

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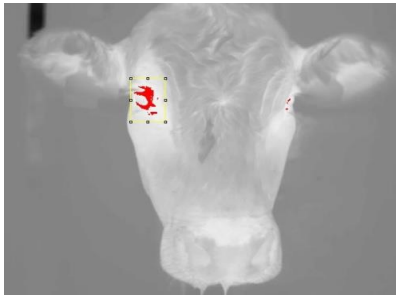
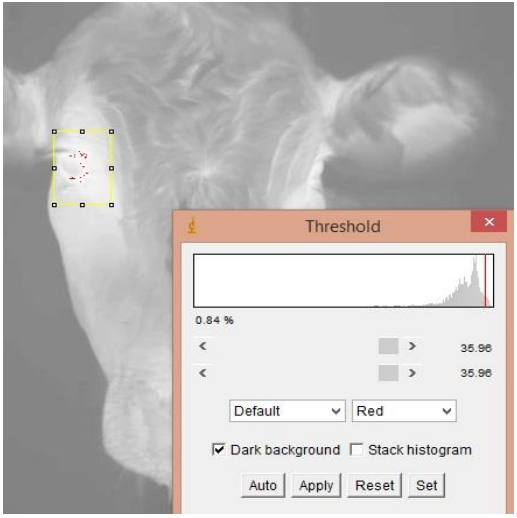
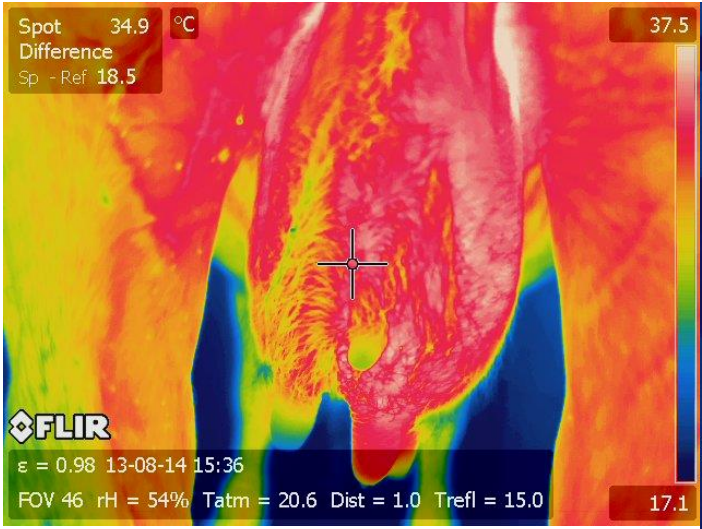
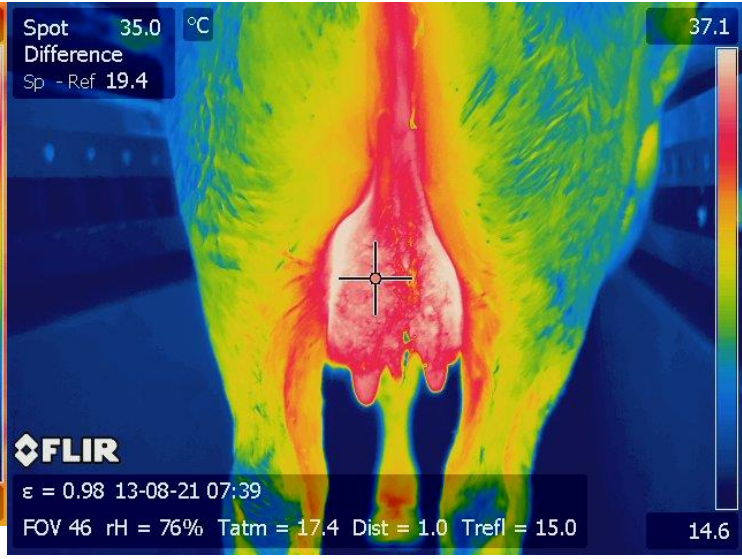
Thermal Imaging





Thermal imaging on robot





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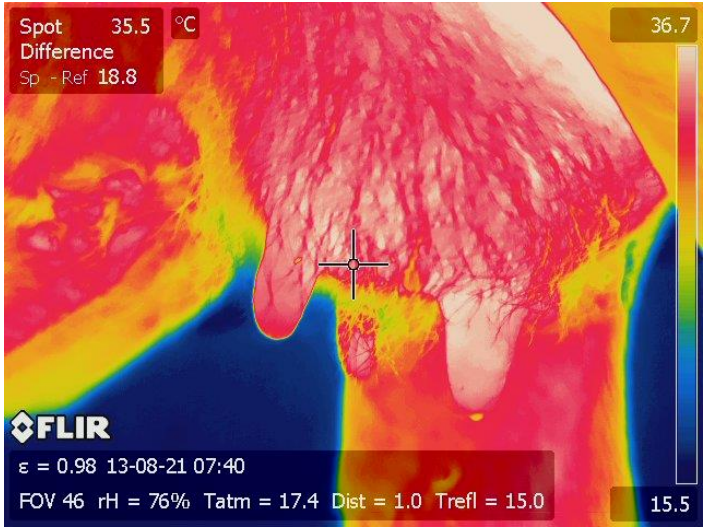
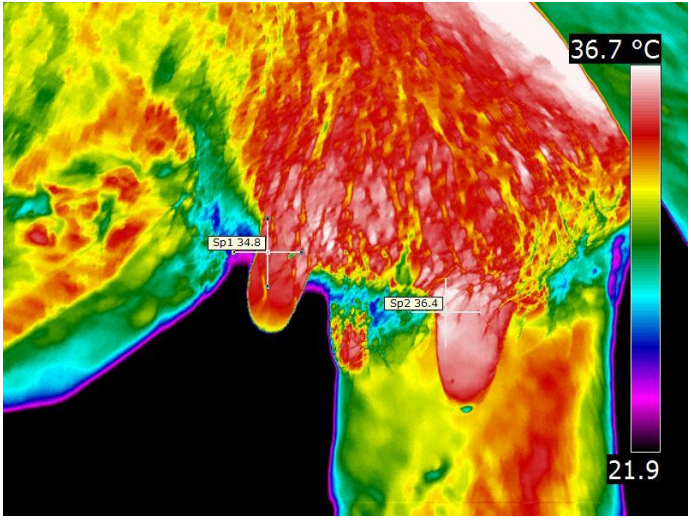
Thermal imaging on robot





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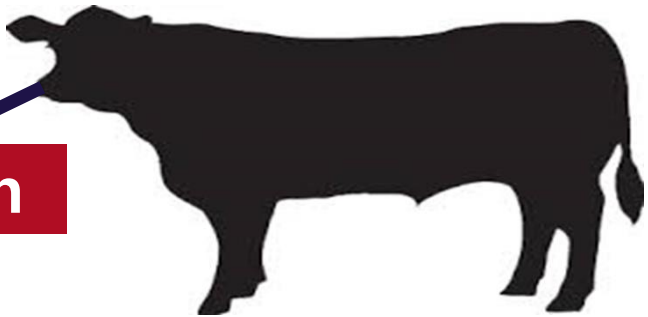
Nutrition and health status biomarkers



Acetone, organic volatiles, metabolic and disease markers

Breath analysis in real-time using SIFT-MS: selected-ion-flow-tube mass spectrometry

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UK Agritech Strategy

Vision

“We want the UK to become a world leader in agricultural technology, innovation and sustainability; exploit opportunities to develop and adopt new and existing technologies, products and services to increase productivity; and contribute to global food security and international development”.

Why now?

“Agricultural science and technology is rapidly becoming one of the world’s fastest growing and exciting markets. It is driven by global changes: a rising population, rapid development of emerging economies with western lifestyle aspirations and growing geopolitical instability around shortages of land, water and energy”

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Innovation Centres

- Multi £M Precision Agriculture 2015.
- Multi £M Centre for Agri-informatics
- Easter Bush Innovation Centre

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Agri-EPI Centre Ltd
Agricultural Engineering Precision Innovation Centre

CIELivestock Ltd
Centre for Innovation and Excellence in Livestock

CHAP Ltd
Crop Health and Protection

Agrimetrics Ltd
Big Data

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Improving Management for Better Animal Health, Welfare and Productivity

Exciting Future - New materials, sensors and technologies:-

e.g. Biosensors, Nano-technology, Nano-tubes, Graphene, wearable technology, big data, biomarkers etc.

Sensor networks – integrated systems – digital technology and telemedicine

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The future and SMART FARMING

Meeting with Bill Gates and the Gates Foundation at SRUC/Roslin Institute

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Improving Management for Better Animal Productivity

Animal science provides the basis for Agri-Tech innovation and improved animal productivity

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Improving Management for Better Animal Productivity

Development of integrated sensors, platforms and communication systems for monitoring and control will support improved productivity and sustainability and optimal animal health and welfare

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Improving Management for Better Animal Productivity

Smart Farming solutions will facilitate and enable improvements in management for better animal productivity, health and welfare

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Thank you for your attention!

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