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# Automatic identification of very thin dairy goats using image technology

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Body Condition Score (BCS) is correlated with animal fat deposits and is an important indicator of animal welfare and nutritional management.

# BODY CONDITION SCORE IN DAIRY GOATS

- **Hervieu & Morand-Feher (1999)**
  - **Low feasibility – requires handling for lumbar and sternal palpation.**
  - **Good accuracy – ideal for nutrition research etc**

- **Image technology could develop:**
  - **Quick method**
  - **No need for restrain**
  - **Identify the extreme**
    - **Enough for welfare assessment**
    - **Good management tool.**

## What and how to measure?

- **Data acquisition**: 171 photos from the rump and sternal region.
- **Classification:** BCS with the golden standard method.

- **Development of representative and threshold images:**
  - BCS categories:
    - **0** - Very thin (BCS≤2),
    - **1** - Normal (BCS>2 and ≤ 3.5)
    - **2** - Very fat (BCS>3.5)
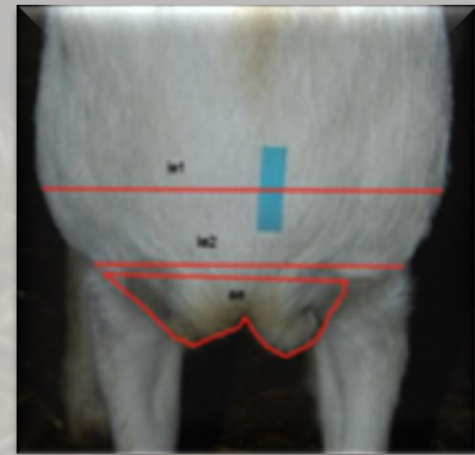
## The rump region gave the best representation of the BCS levels

Table 1. Equations by stepwise multiple regression to estimate BCS using measurements from digital image analysis from sternum and rump region (n=32)
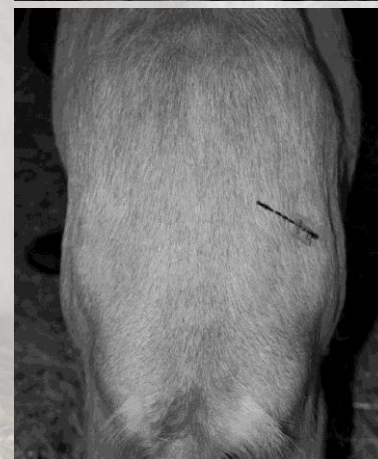
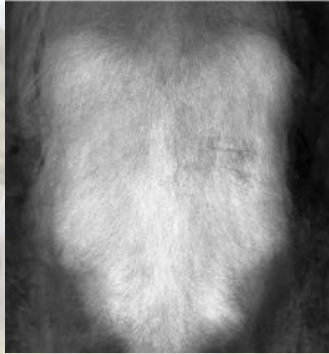|  | $R^2$ | p | b | a |
|---|---|---|---|---|
| **sternum** (P<0.001) | | | | |
| ae1 | 0.362 | <0.001 | $3.3 \times 10^{-6}$ | 1.628 |
| **rump** (P<0.001) | | | | |
| av1 | 0.663 | <0.001 | $-1.2 \times 10^{-5}$ | 1.730 |
| ba1 | 0.805 | <0.001 | $4.5 \times 10^{-7}$ | |

Very thin

Normal

Very fat

# The scientific illustrations increased clarity and reproducibility
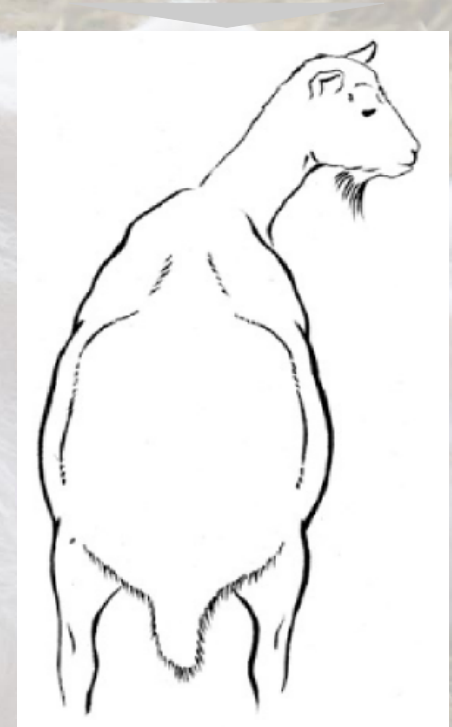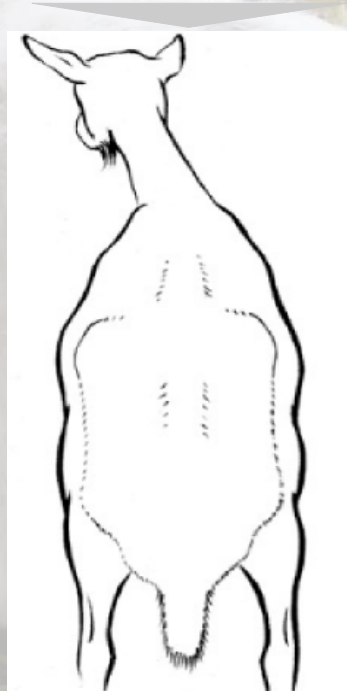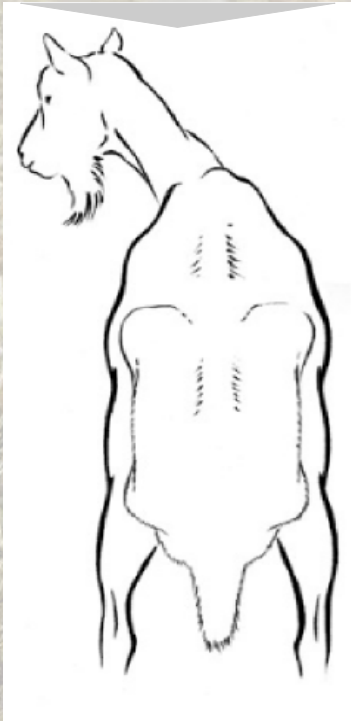
a) Very Thin  b) Threshold  I  c) Normal  d) Threshold II  e) Very Fat

# Reliability and repeatability were high...

| Observers | Before training (n = 45) | | | | After training (n = 49) | | | |
|---|---|---|---|---|---|---|---|---|
| | Exact agreement (% / n) | One point difference (% / n) | kappa (95% CI) | Kappa weighted (95% CI) | Exact agreement (% / n) | One point difference (% / n) | kappa (95% CI) | Kappa weighted (95% CI) |
| Experient | 66.7 / 30 | 100 / 45 | 0.49 (0.29-0.69) | 0.70 (0.55-0.86) | 85.7 / 42 | 100 / 49 | 0.75 (0.58-0.92) | 0.83 (0.70-0.95) |
| Non-experient | 82.2 / 37 | 100 / 45 | 0.70 (0.51-0.89) | 0.80 (0.66-0.94) | 81.6 / 40 | 100 / 49 | 0.70 (0.51-0.88) | 0.80 (0.67-0.93) |

## ...after training.

**AWIN Visual Body Condition Scoring** is a simple, expeditious and replicable method showing that the rump region has several visual cues strongly correlated with animal's BCS.

It requires trained evaluators.

## Can it be automated to routinely collect each animal BCS?

# Previous work in calves also used 3D rumps to assess animals weight
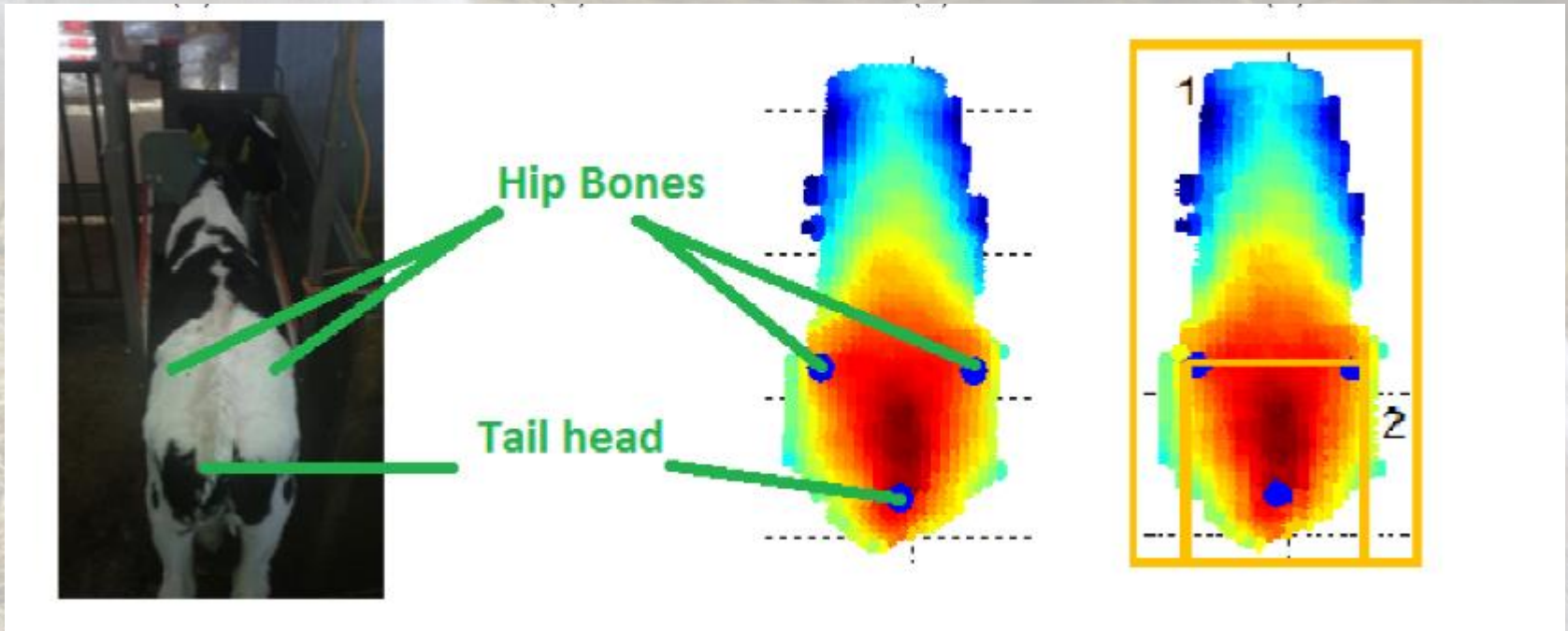
X. Song, J. Schuttea, P. van der Tol, F. van Halsema, and P. Groot Koerkampa. Body measurements of dairy calf using a 3-d camera in an automatic feeding system. In International Conference of Agricultural Engineering, 2014.

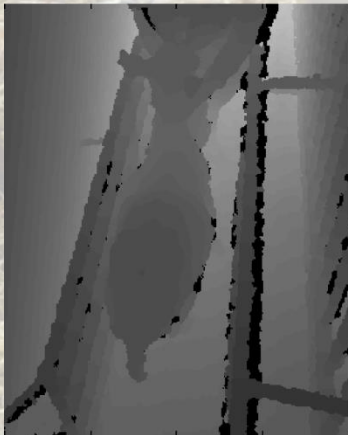# Image collection used to create the training material required still animals



Tuber Sacrale
(hip or hook bones)

Tuber Ischia
(pin bones)
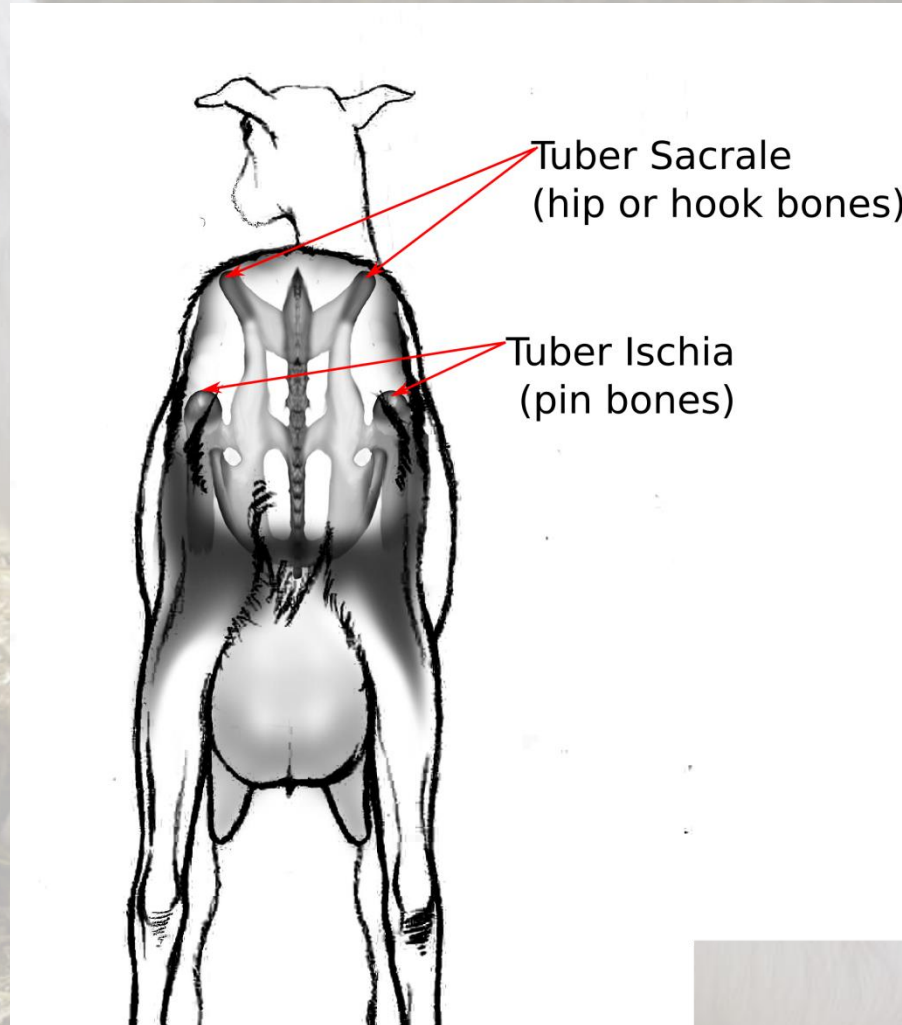
# We want to collect 3D data of animals moving unrestrained
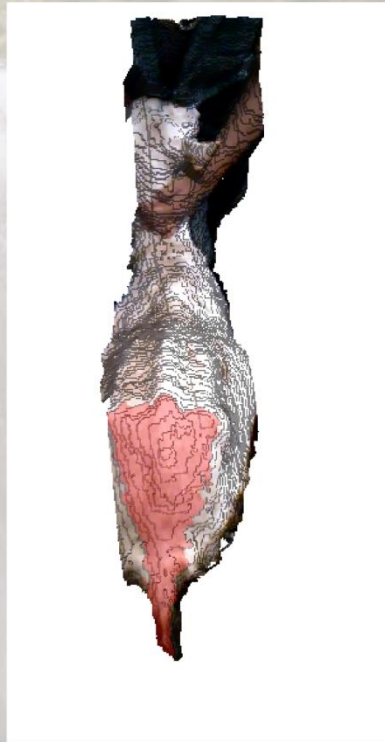
RGB Image

Annotated 3D model

Depth Image

# Automatic BCS Assessment Tool

- Goat rump's 3D surfaces, collected by an RGB-D camera fixed on top of the animals' normal path.

- Allows for data collection without requiring animal handling and when animal is moving.



(a) Very thin    (b) Normal    (c) Very Fat

# However… goats present a very high variability in sizes and shapes

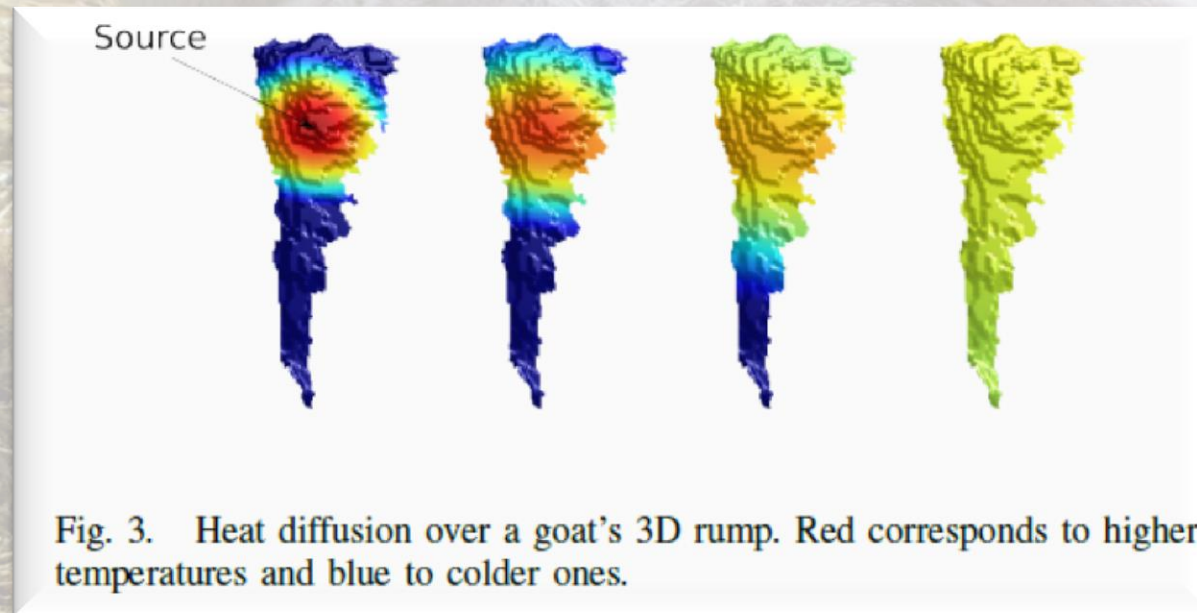# We tackle the animal's natural variability by

1. Comparing each rump to a standard shape, by computing a shape dependent function
   - Comparing between rumps based on how different they are of the standard form

2. Using heat diffusion as a shape dependent function
   - Heat diffusion provide a natural soft-segmentation of the interest region

# We know that heat diffusion depends on the surface shape especially near the source
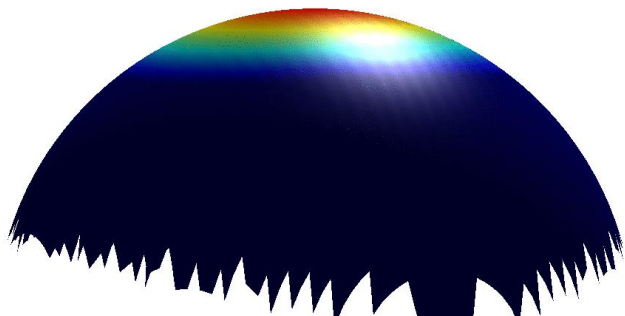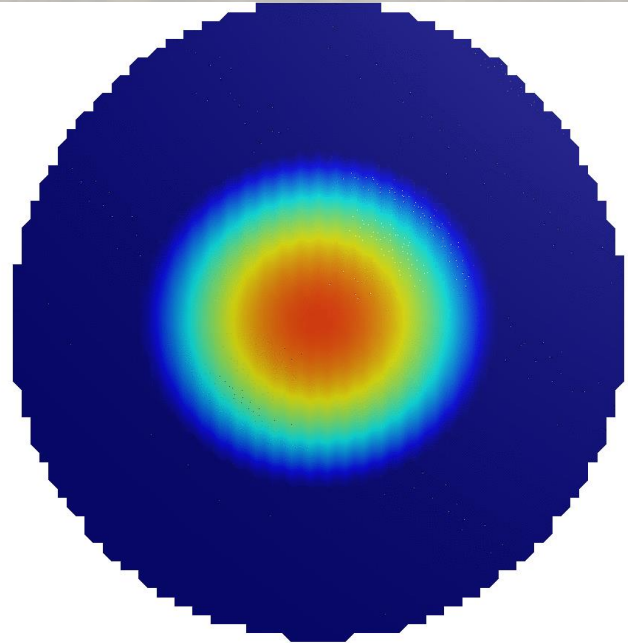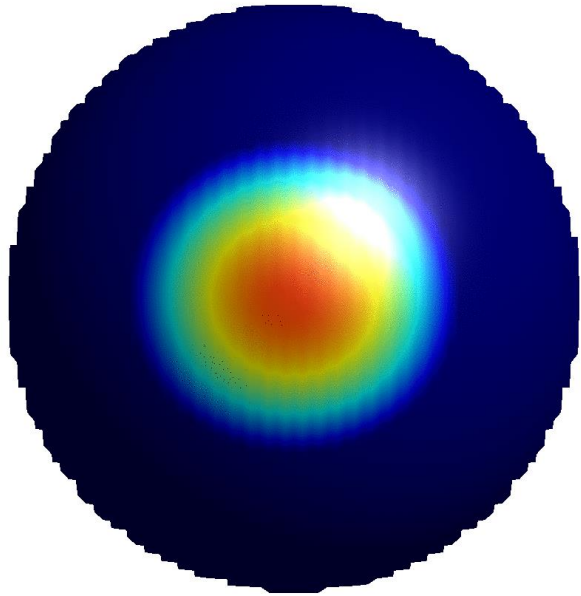
# The basis…

- Animals with rumps more similar to a plane have **low fat deposits**
- Heat Kernel Signatures describe how connected a point is to its neighborhood by simulating **heat propagating** over a surface.
- It describes the rump by comparing it against a default shape, in this case a plane.

Source

Fig. 3.  Heat diffusion over a goat's 3D rump. Red corresponds to higher temperatures and blue to colder ones.
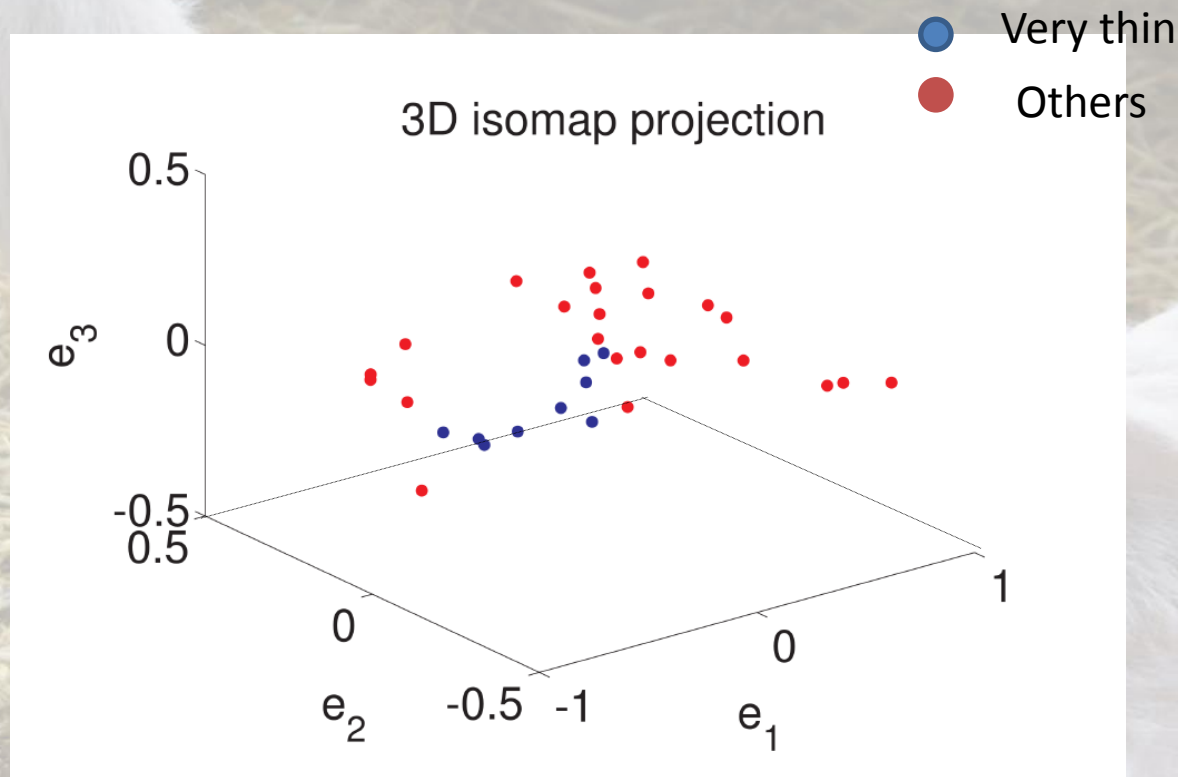
# Heat Based Rump Descriptor (HBRD)

**Assess BCS by rump volume - using heat diffusion to represent distances between points in two equivalent surfaces.**



Tuber Sacrale (hip or hook bones)

Tuber Ischia (pin bones)
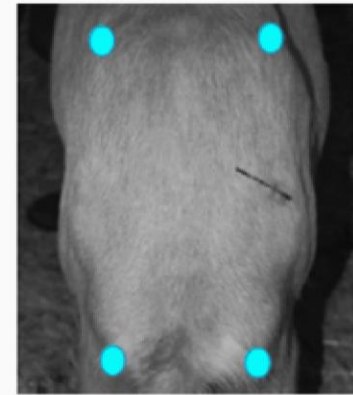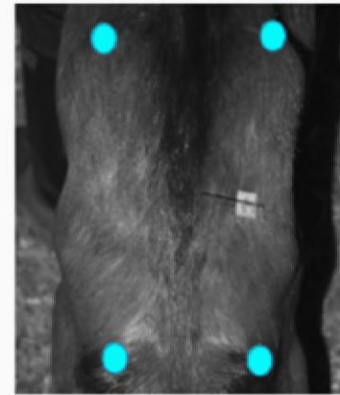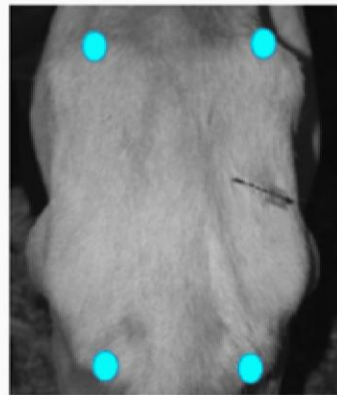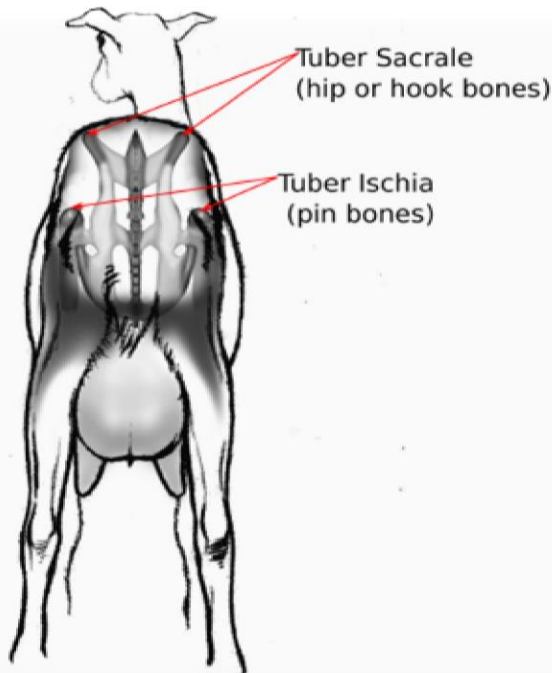
# When projected in lower dimension, thin animals are clearly clustered



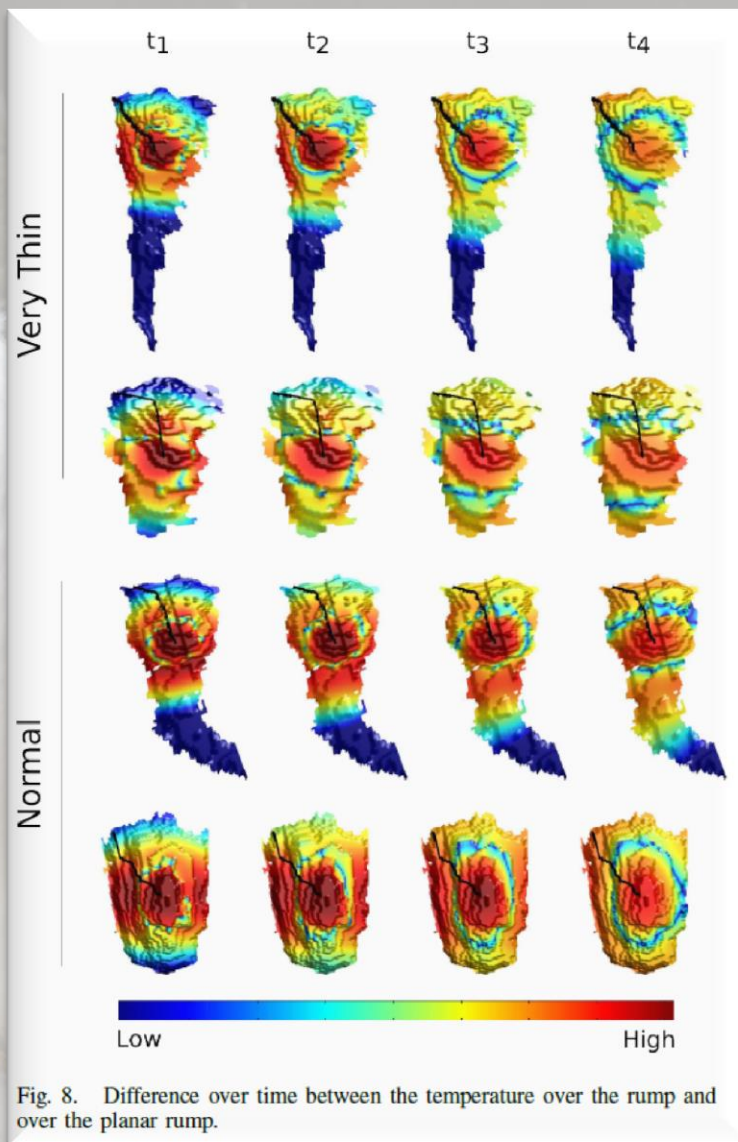Using a simple classifier, e.g., support vector machines we can identify thin animals
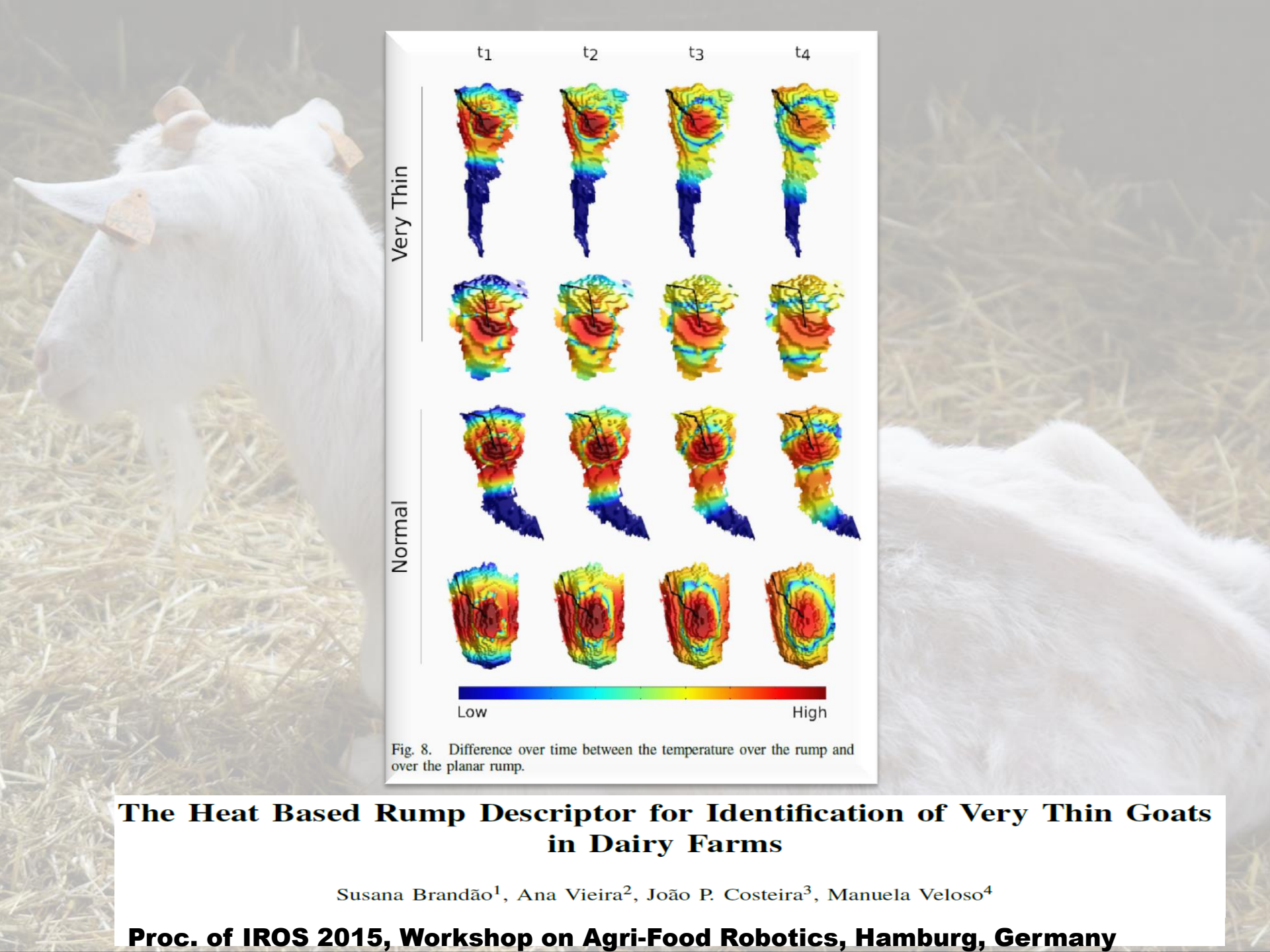
Fig. 8. Difference over time between the temperature over the rump and over the planar rump.

# The Heat Based Rump Descriptor for Identification of Very Thin Goats in Dairy Farms

Susana Brandão[1], Ana Vieira[2], João P. Costeira[3], Manuela Veloso[4]
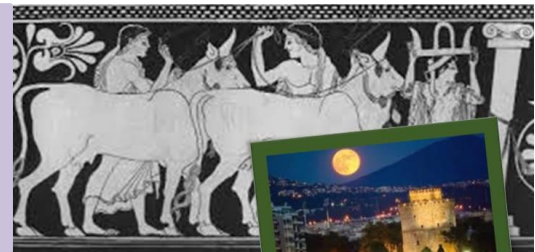
# Conclusions and future work

- We successfully framed a methodology for the identification of **very thin goats in dairy farms**

- We handled the natural variability that can be found in goats using a descriptor that represents **differences to a standard shape**

- We handled the difficulty in defining the interest region by using **heat diffusion** to represent shape

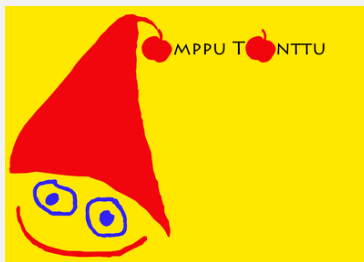- In future work, we aim for the **automatically** identification of the bone tips

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https://erasmus-anicare.eu

THANK YOU