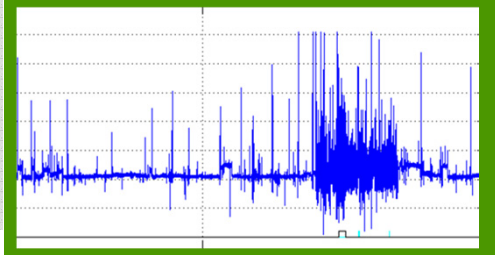
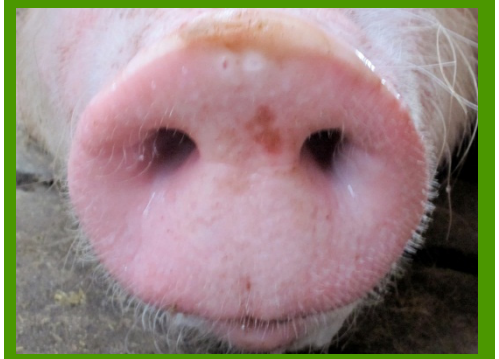
Faculty of Agricultural and Nutritional Science

Christian-Albrechts-University Kiel
Institute of Animal Breeding and Husbandry

Lameness Detection in Sows using Accelerometer Data





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65th Annual EAAP Meeting Copenhagen, Denmark, August 25th to 29th, 2014
Session 05, abstract number 19004, cscheel@tierzucht.uni-kiel.de

Background and objective

Why to detect lameness automatically?

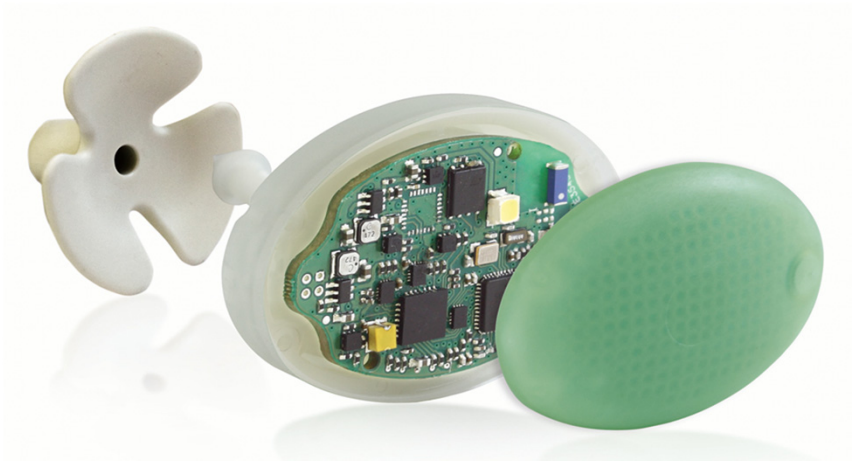
- Group housing in gestation units is mandatory (per EU norm 2001/88/EG)
- Lameness is a common problem in group housing
- Increasing number of animals per farm, constantly monitor health status manually is time consuming

Objective

Predict beginning lameness automatically and reliably from analyzing an acceleration signal supplied by a monitoring system.

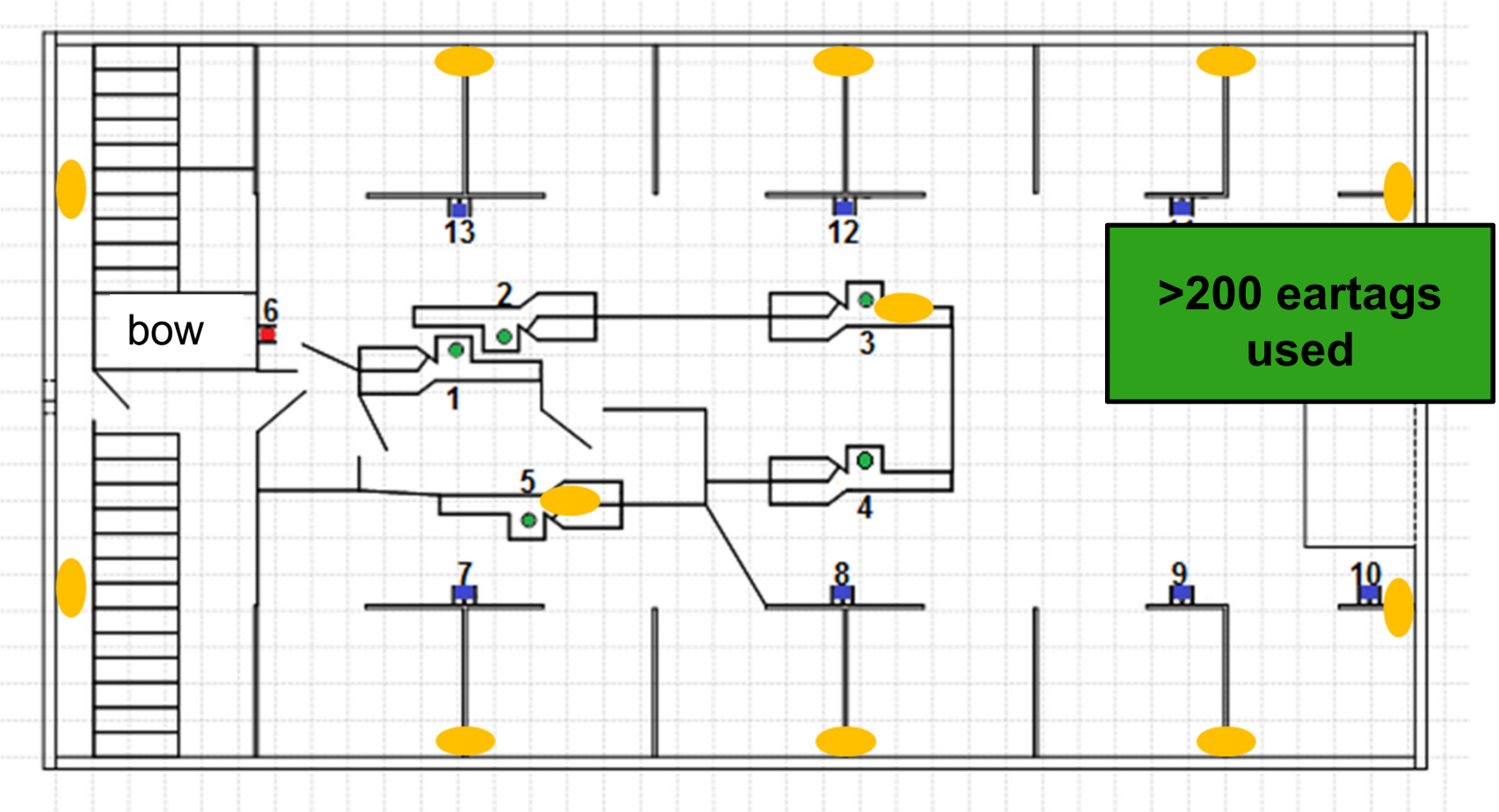
Ear tags (MKW Electronics)

- Positioning system
  - Using TOA (time of arrival)
  - Supplies 2-d coordinates
- Temperature sensor
  - Ambient temperature
  - Skin temperature
- Acceleration sensor
  - Supplies (x, y, z) - vector
  - Programmable sample range

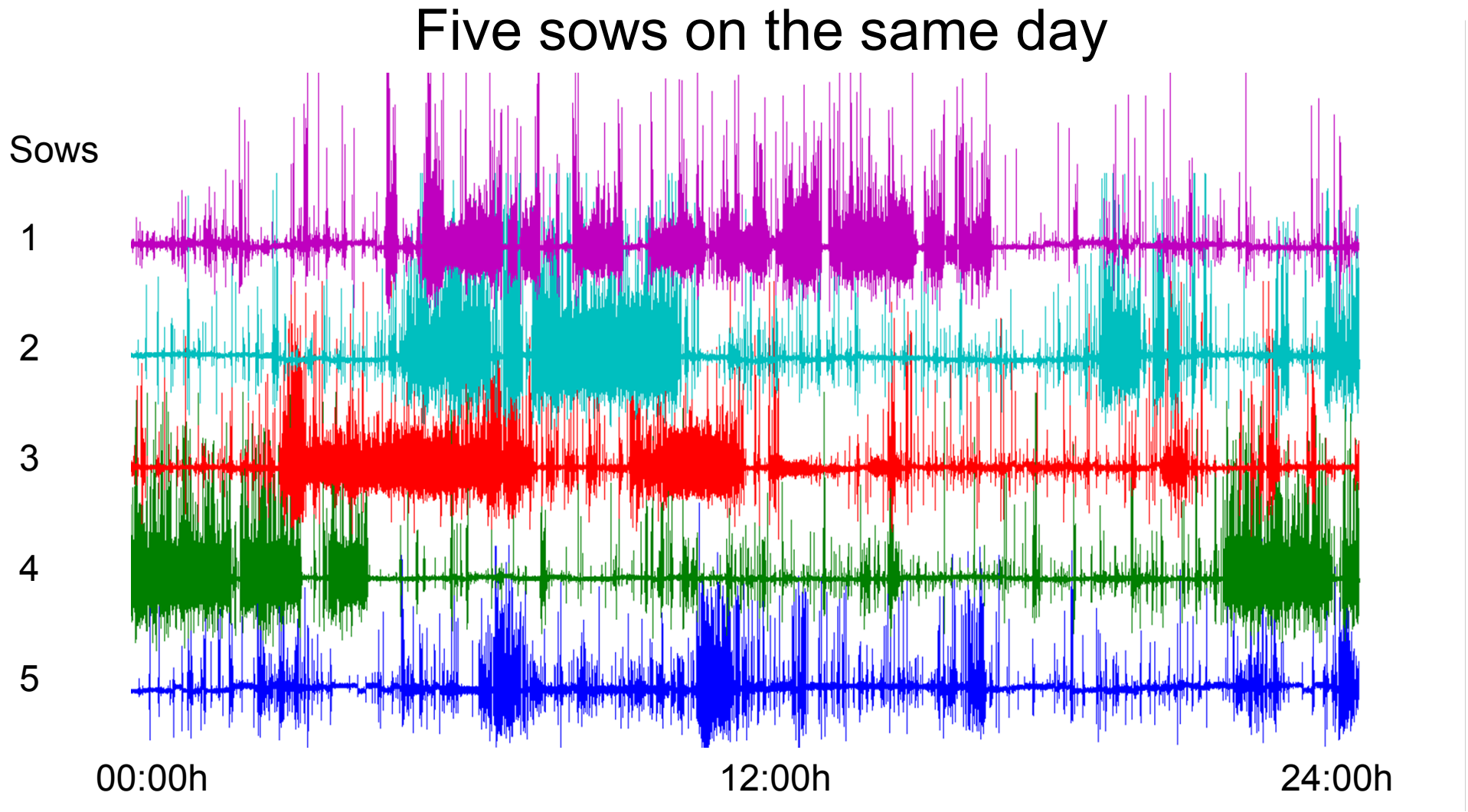


Data resolution vs. battery life ➡ tradeoff

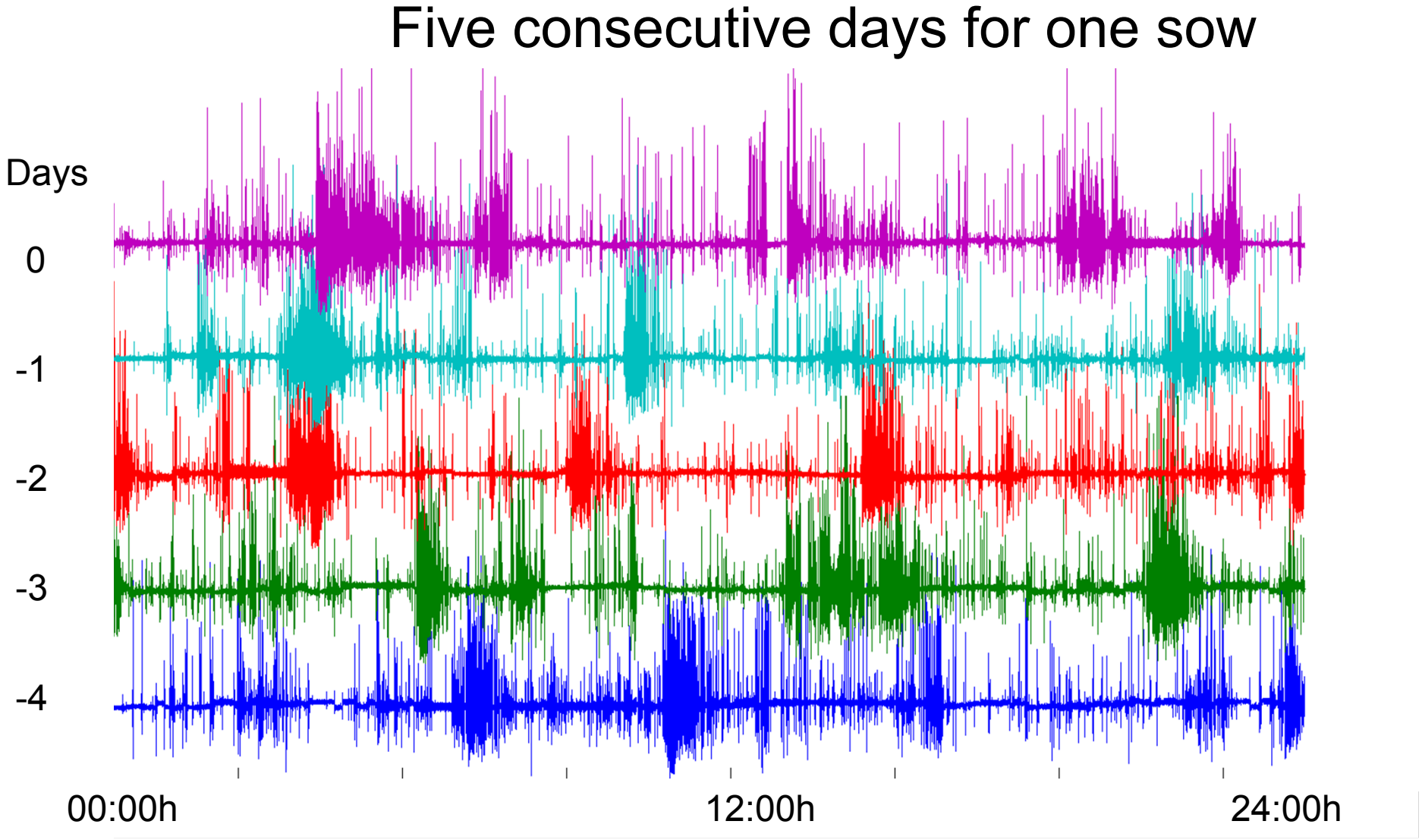
Floorplan Futterkamp Research Facility



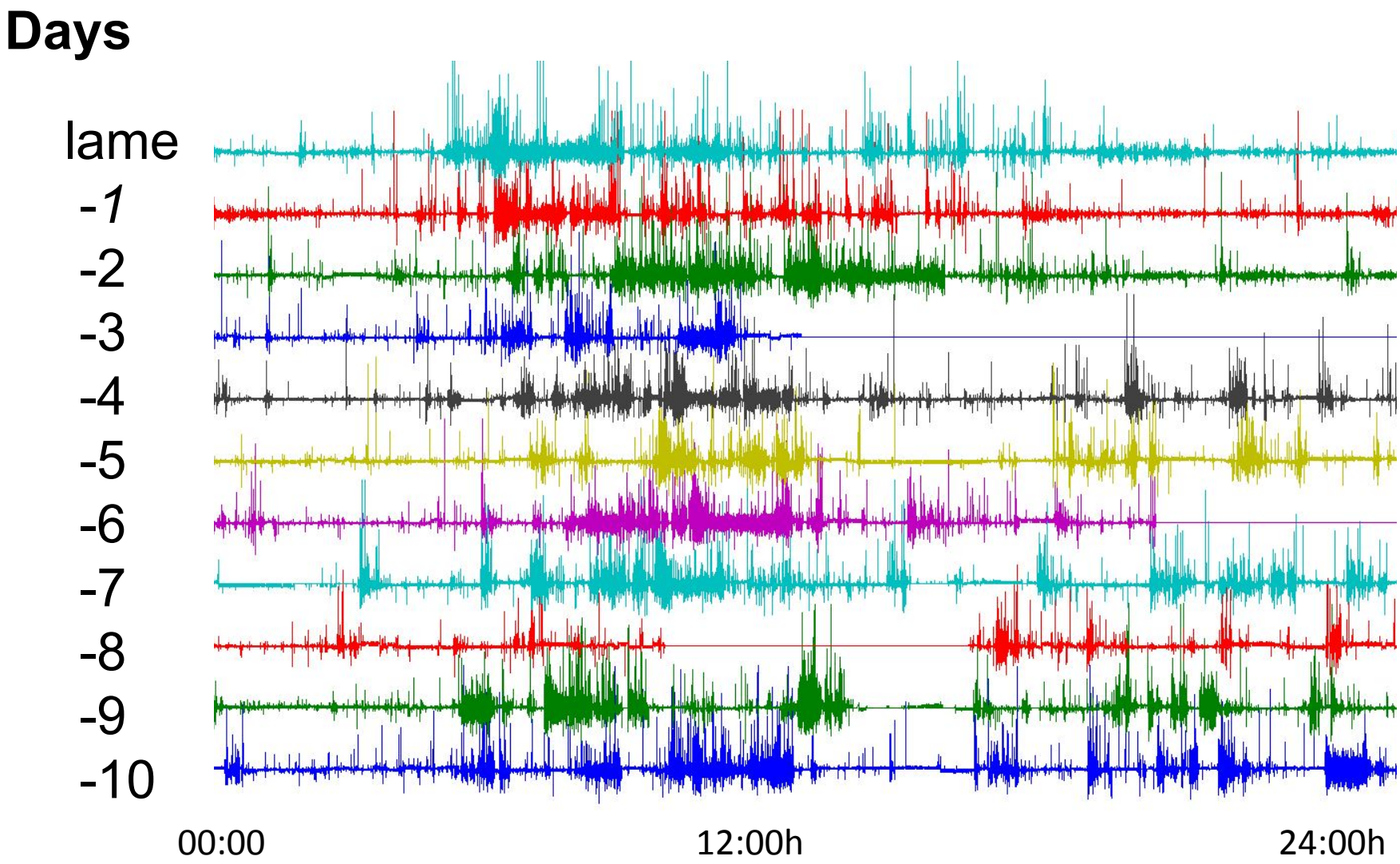
Total acceleration data example I



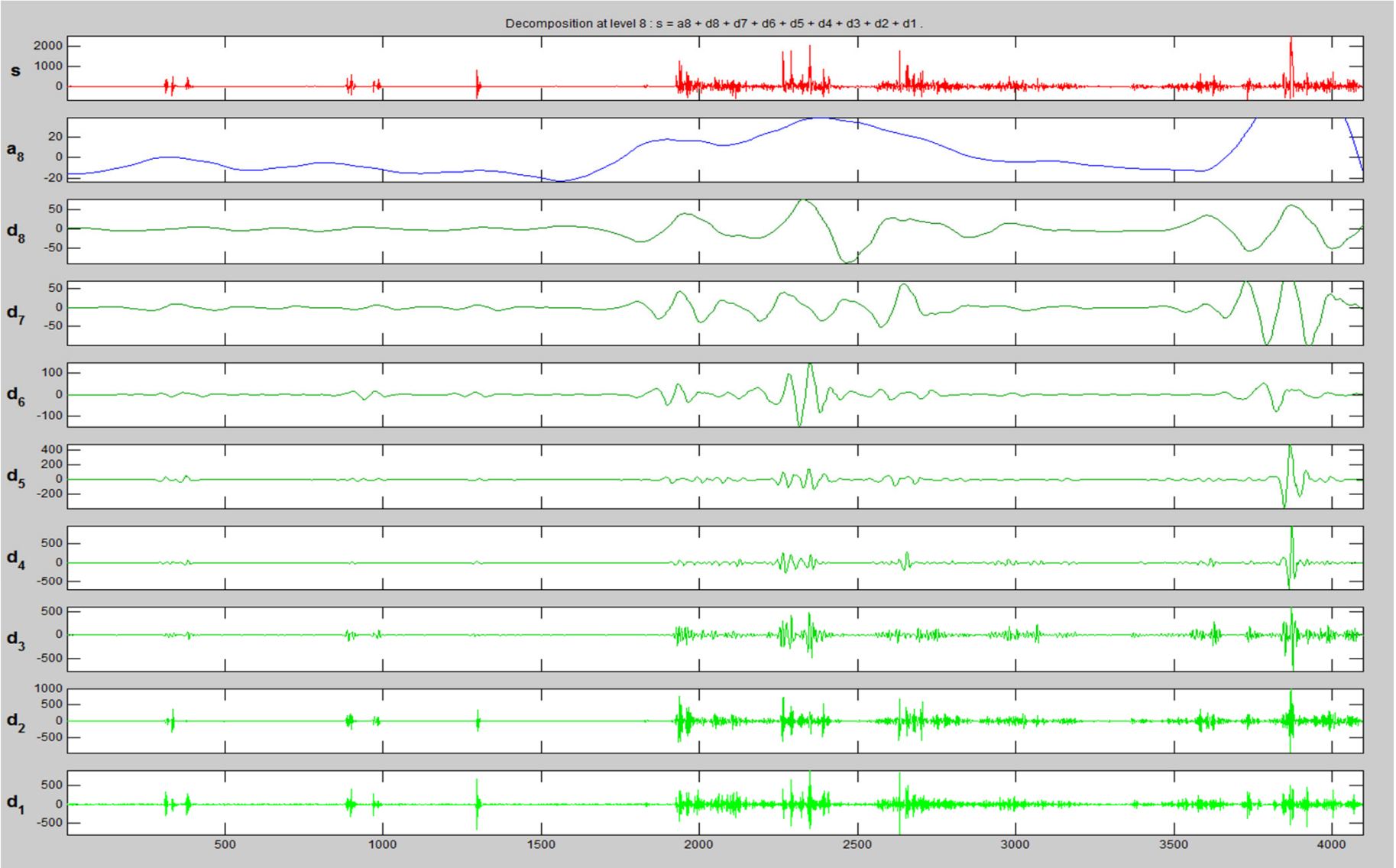
Total acceleration data example II



Data example of a lame sow (1 Hz)



Data processing: Wavelet Decomposition



Outline of general method

Each sow leaves a signal *s* of accelerometer data as a record of her past behaviour.

- This should contain information on her usual (to be expected) behavioural patterns
- Find or define features (functions *f(s)* of the signal) that capture these
- Compare currently calculated feature values to the to be expected values from record
- Use unusual deviation from past record to make a prediction of beginning lameness

Feature calculation

Basic feature functions are:

- Variance (deviation from mean)
- p-variation (cumulated p-th power of differences between points)
- Features derived from histograms of data

Feature functions can be applied not only to the signal, but to its wavelet representation as well.

This results in a collection of features.

A simple model for prediction

Compute features per day and sow (from 1 Hz data)

Assume each feature values uncertainty is normally ditributed

Collect sufficient statistics to fit these distributions

Declare a feature value to be ‚abnormal' or ***on***, if it lies on extreme ends of its distribution

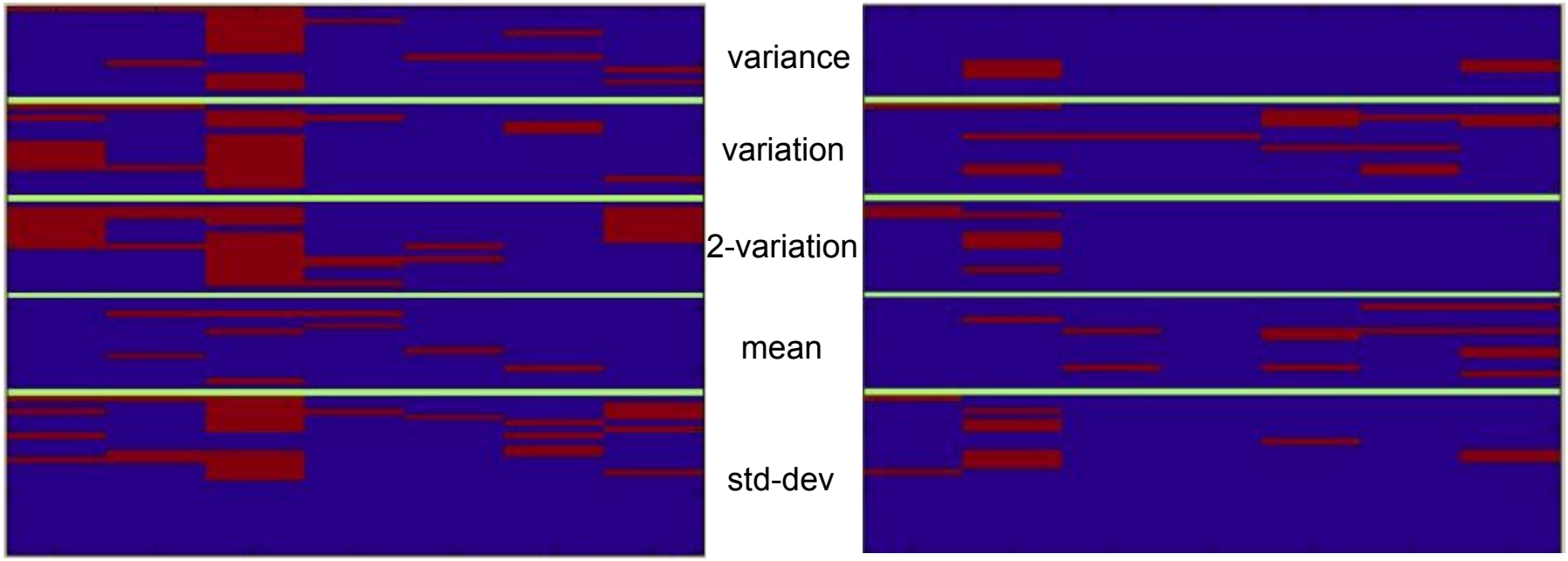
Use feature ***on*** as measure of unusual deviation

Results

Features ***on*** on diagnosis day for 7 lame and 7 healthy sows

7 lame sows
features ***on*** for diagnosis day

7 healthy sows
matched for day and age

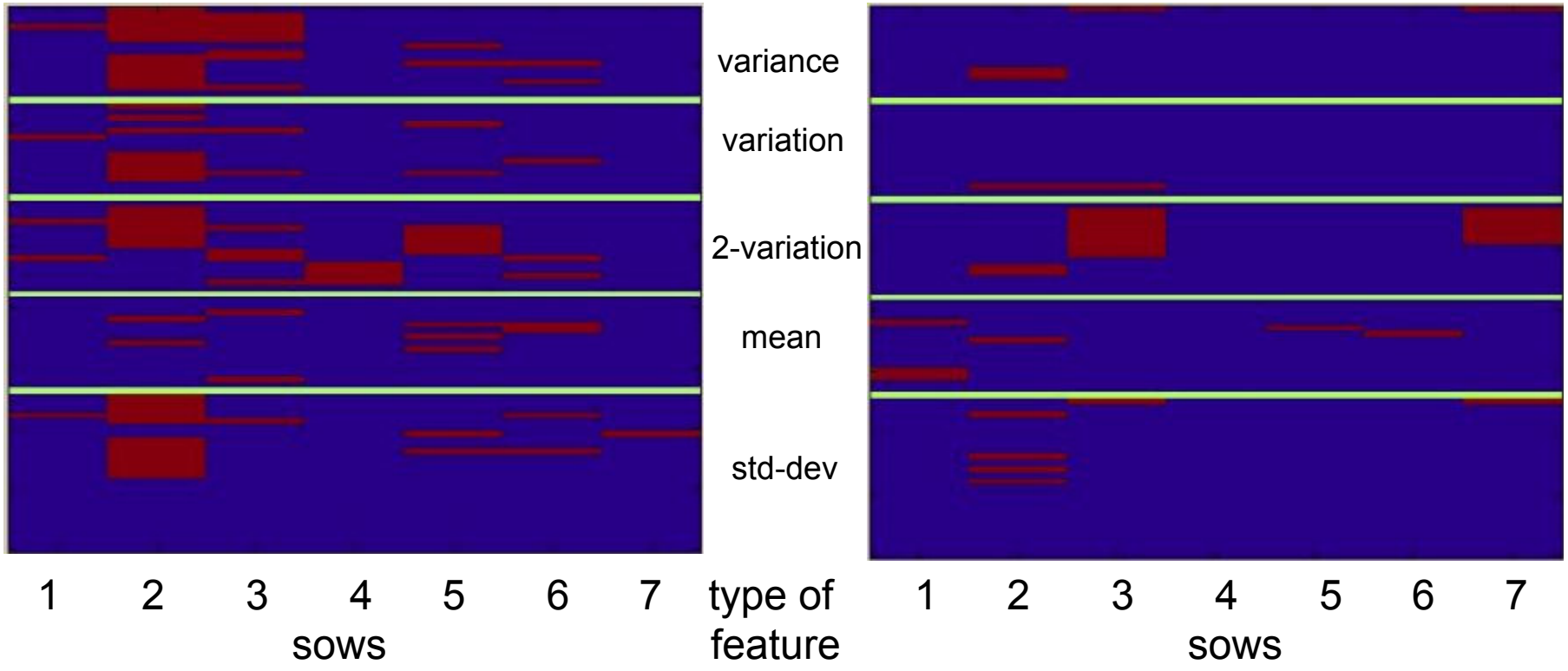


Results

Features ***on*** on day before diagnosis

7 sows to be diagnosed lame,
features ***on*** before diagnosis day

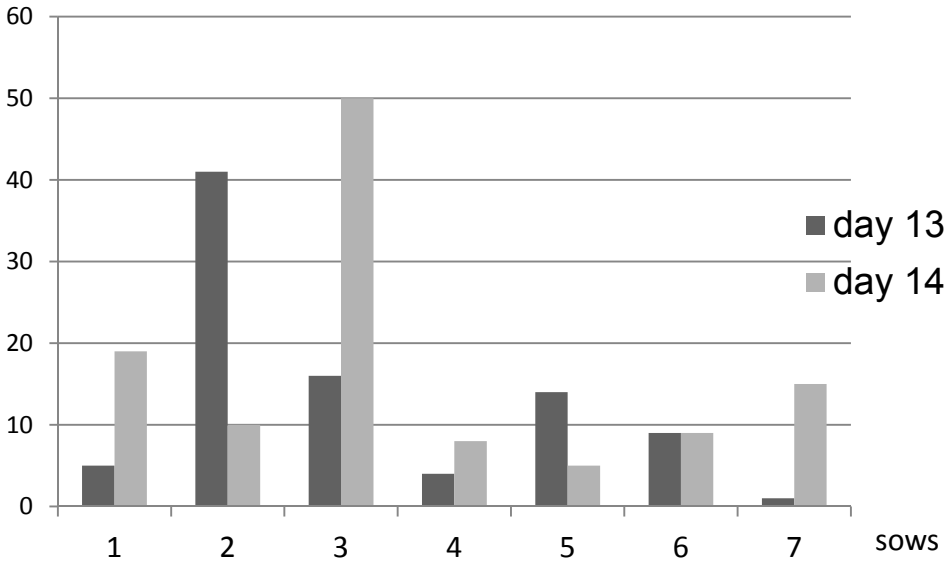
7 healthy sows,
matched for day and age



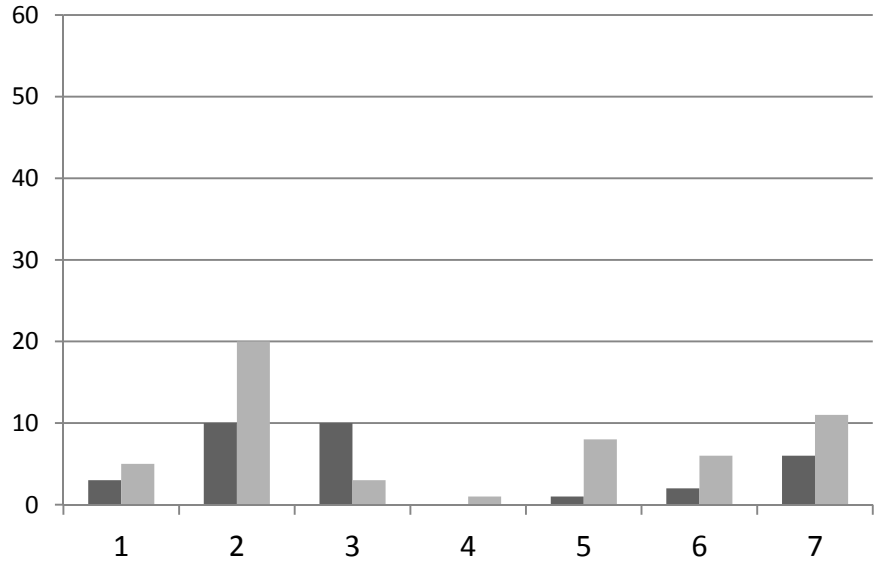
Results

Statistics of count of features ***on***

Features ***on*** for lame sows



Features ***on*** for healthy sows



- Lame/healthy were distinguishable as groups
- Individual classification would yield too many false positives/negatives

Summary and outlook

- Monitoring system is now progressed enough to produce acceleration and position data reliably (~10% data loss)
- Wavelet based feature calculation appears feasible, but:
  - We need to capture the distribution of acceleration better and thus work with smaller units of time
  - Augment feature representation with further autocorrelation features
- Too few lame samples: concentrate on representation of healthy sows‘ data and attempt to produce higher than usual reconstruction error on lame sows‘ data

Thank you for your attention!

Bundesministerium
für Ernährung
und Landwirtschaft

We are grateful to the Bundesministerium für Ernährung und Landwirtschaft(BMEL) for supporting the project.