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Frequently recorded sensor data may correctly provide health status of cows ….

If data is handled carefully and errors are filtered away …

Peter Løvendahl and Lars Peter Sørensen
Center for Quantitative Genetics and Genomics
Department of Molecular Biology and Genetics
Aarhus University, Denmark

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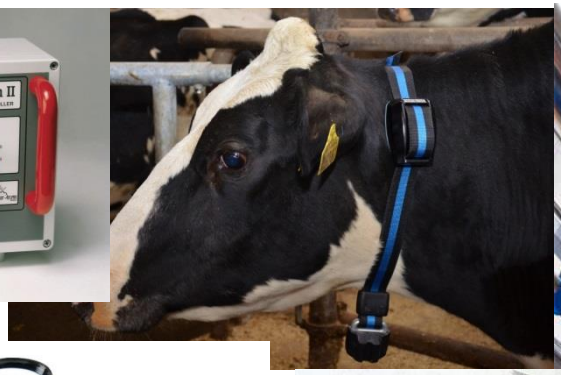
- **Collaboration**
  - Dairy herd owners
  - DeLaval – Denmark and Sweden
  - Colleagues – Martin Bjerring

Gadgets on the dairy farm



Why use sensors?

Fact:

An increasing number of dairy farms use sensor technology

Reasons:

- More cows – loss of perspective
- Labor reduction
- Better detection of estrus/diseases
- Better milk quality (increased income)
- Cost reduction (in the long run)
- Optimization
- Clever sales person!
- **Improve decision making**

Aim of this talk

- To demonstrate how a sensor has potential to improve decision making
- The OCC sensor taken as example
- Does the sensor work as promised?
- How to interpret raw data – if possible at all?
- What kind of messages are needed?
- Potential use outside the dairy farm
- Role in genetic evaluations?

So we got the OCC installed…

OCC output (raw measurements)

General	Counter (Teat level)				OCC(*1000)	
Animal Number	LF	RF	LR	RR	OCC (*1000)	Date
1125	0	0	1	0	100	2006-10-18
1198	0	0	0	1	20	2006-10-18
864	0	0	0	0	25	2006-10-18
945	0	0	0	0	23	2006-10-18
997	0	0	0	0	19	2006-10-18
976	0	0	0	0	150	2006-10-18
1013	0	0	0	0	2455	2006-10-18
1030	0	0	0	0	42	2006-10-18

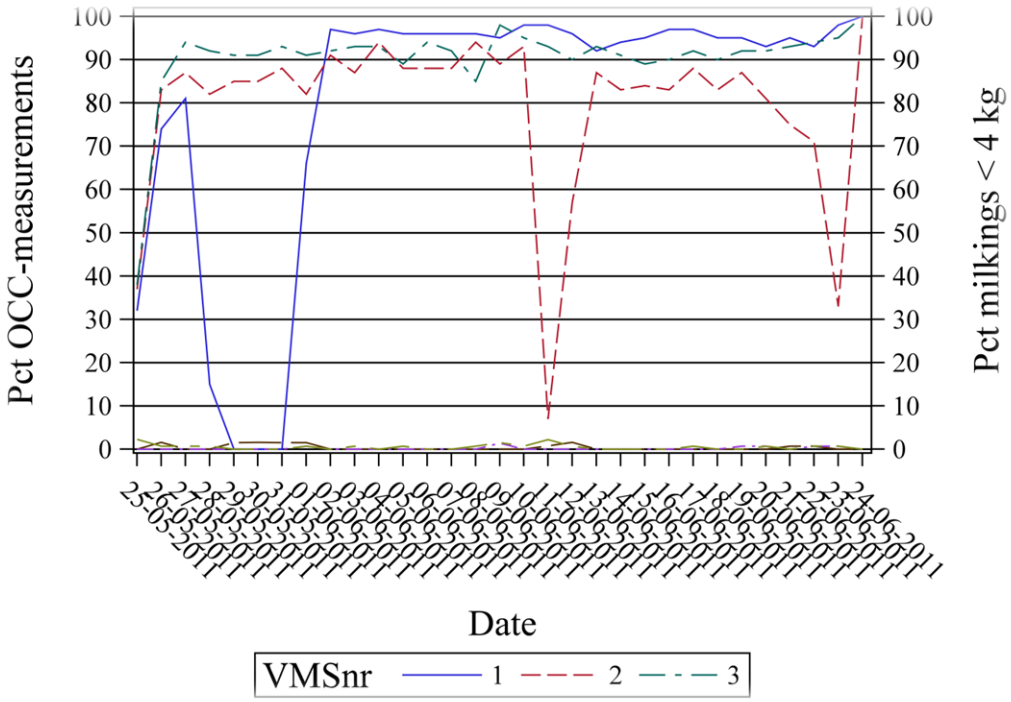
But what about this one?

We need to check this cow

Issue: ***Difficult to make decision from one value - and there are other problems!***

Sensor monitoring

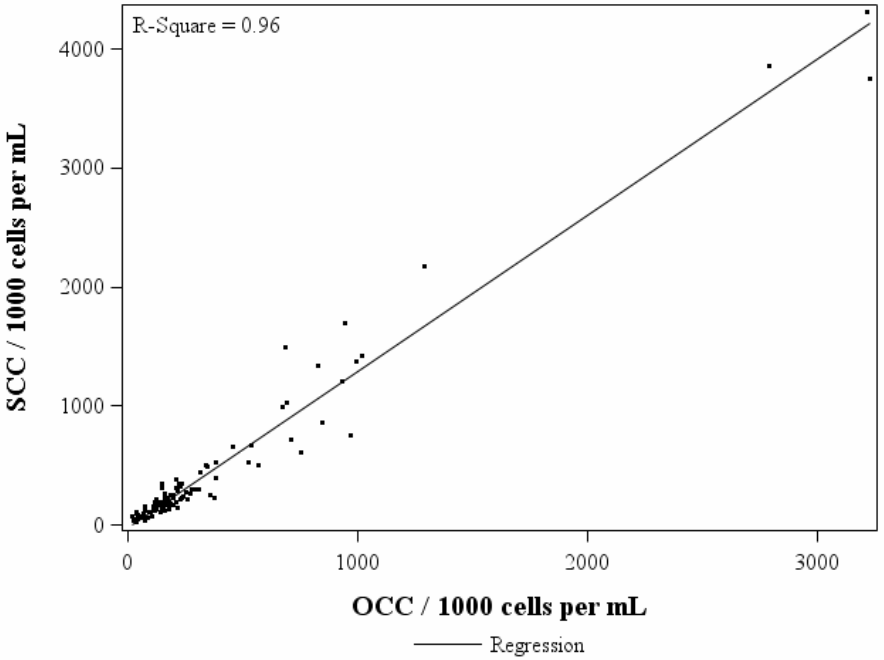
- **Is the device running? Failures are expected!**

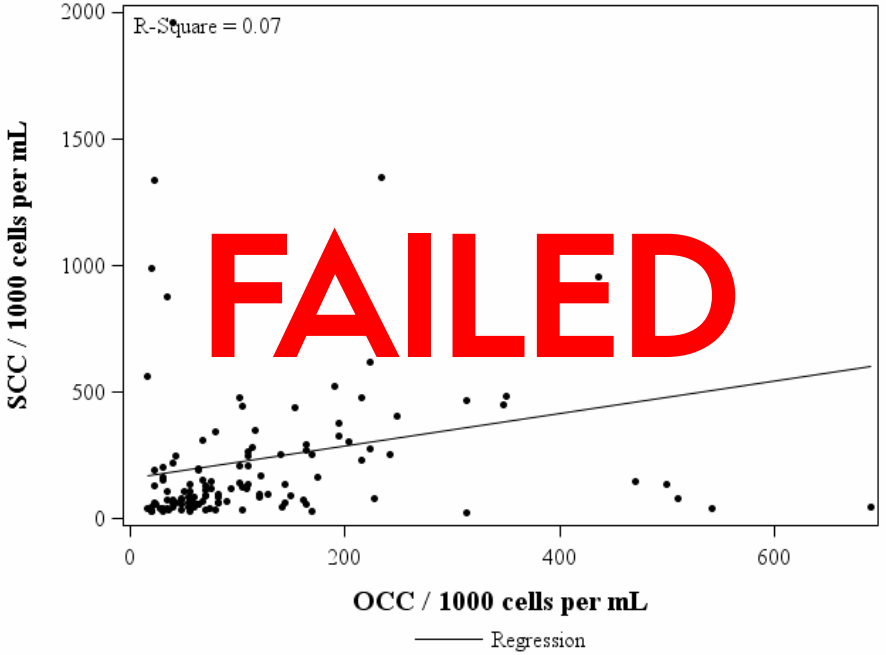


- **Is the device measuring correctly?**

First requirement – reliable data

- Are the measurements correct?
- Compare against gold standard – test-day SCC

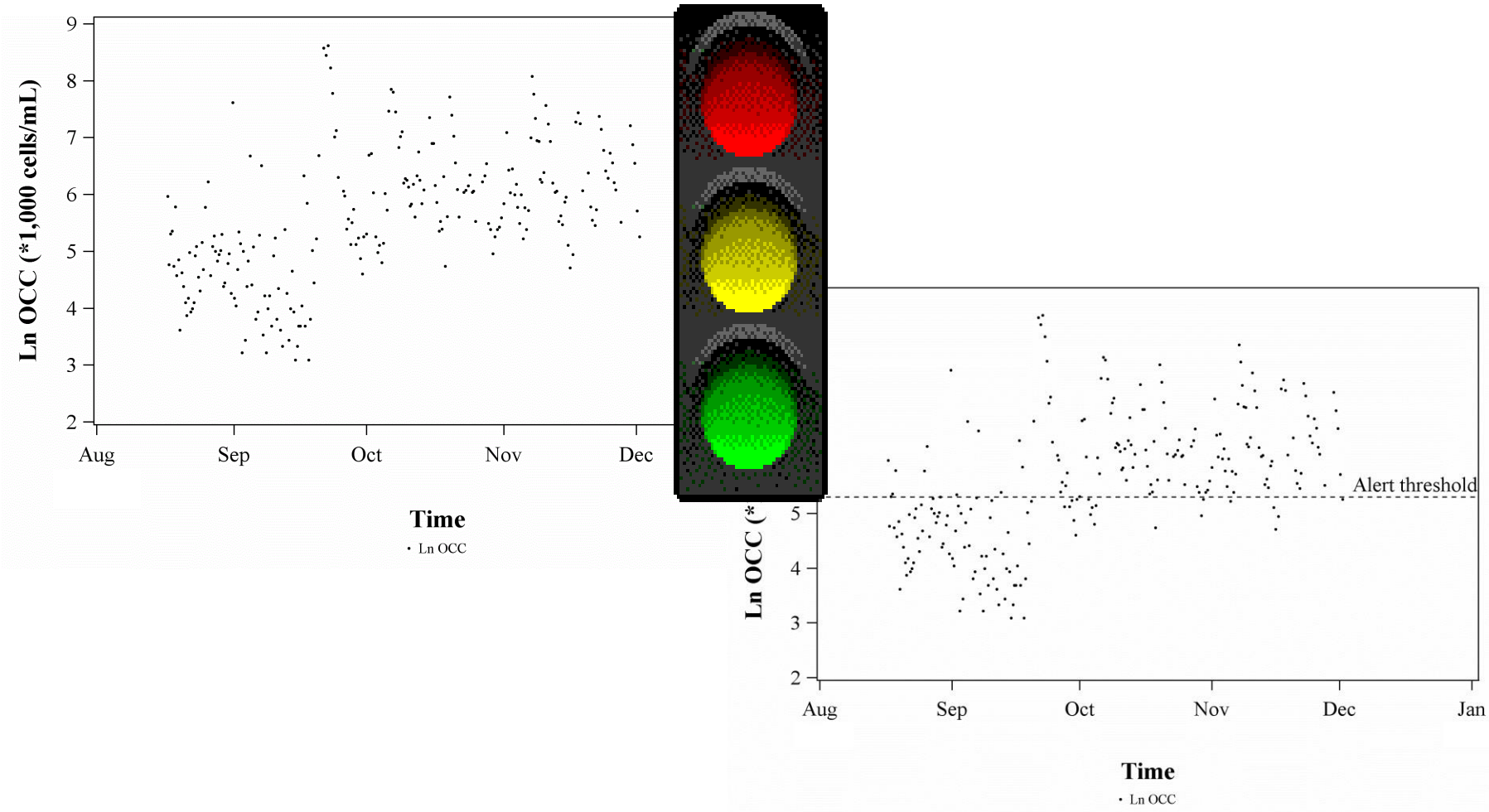




Requirement: monitoring module

Data: noise or signal ?

Cow 653



Filtering and standardisation

- **Fixed filter to take out obvious errors**
  - Zero readings → ”missing” / omit and repair
  - Extreme values → detection ? / omit and repair
  - Fixup routine → get the process going again – fast

- **Time series approach to monitor instrument:**

  Weighted exponential smoothing

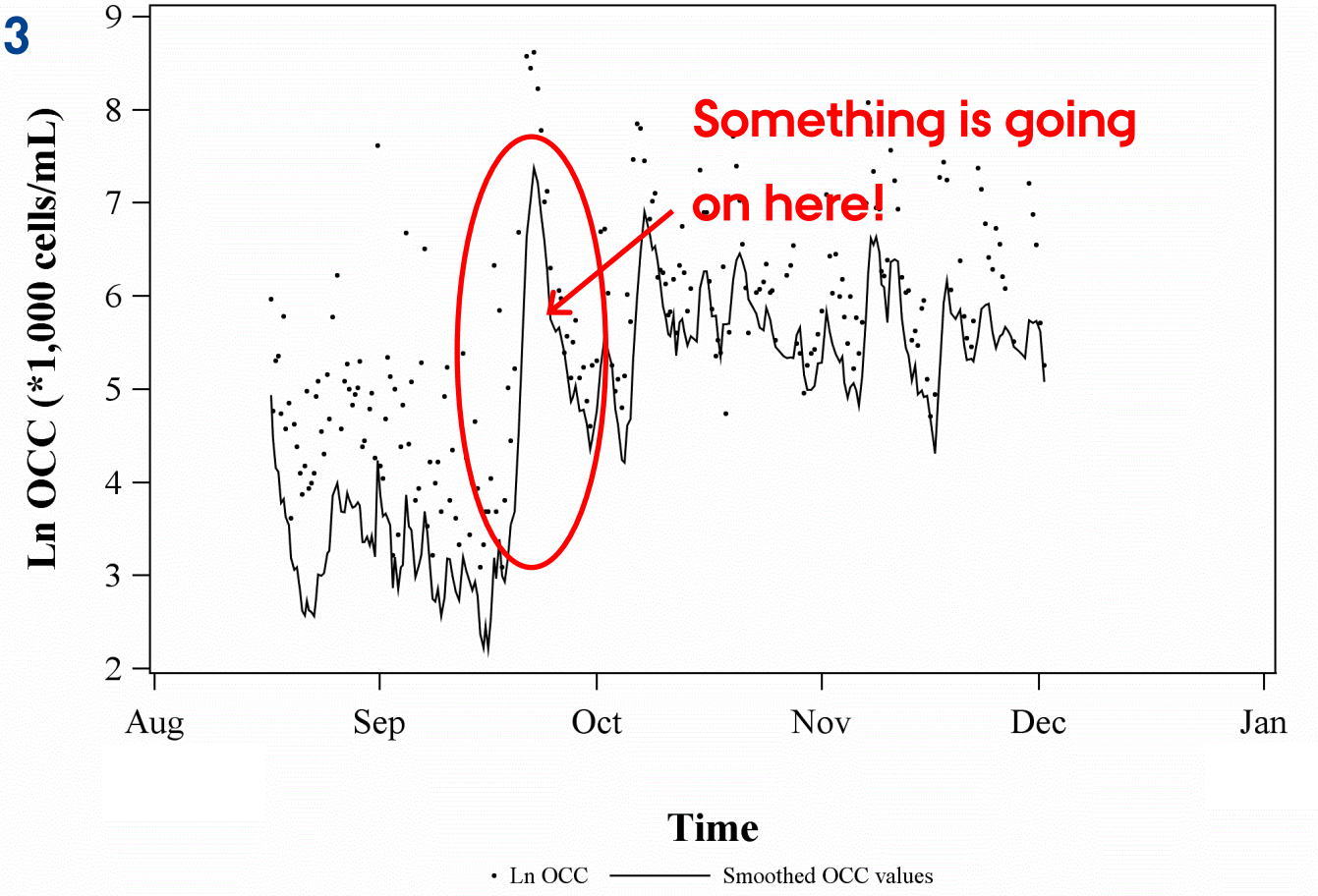
  $s_t = (1 - \alpha)s_{t-1} + \alpha y_t$ α *is the smoothing constant*

Time series were also applied to each cow

OCC model - noise reduction

- **Standardization and smoothing of data**

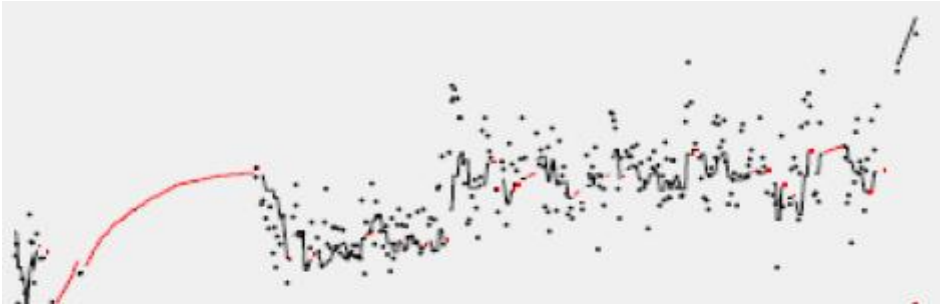
Cow 653



OCC model – unusual data

- **Filtering of very low OCC values**
  - Likely measurement error
  - May result in false positive alerts

- **Dealing with missing measurements**
  - No data → bad update = no new info
  - Gradual increase (or decrease) of OCC values

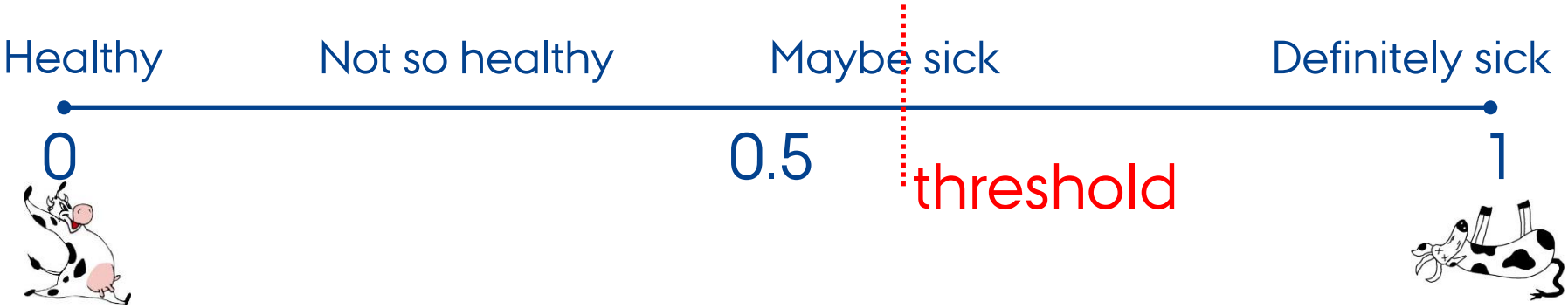


Ready to use data - focus on the cow

Elevated mastitis risk

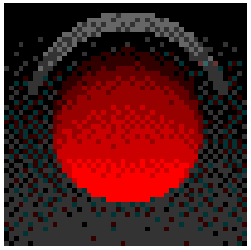
From smoothing we get OCC level and trend →

calculate Elevated Mastitis Risk (EMR)



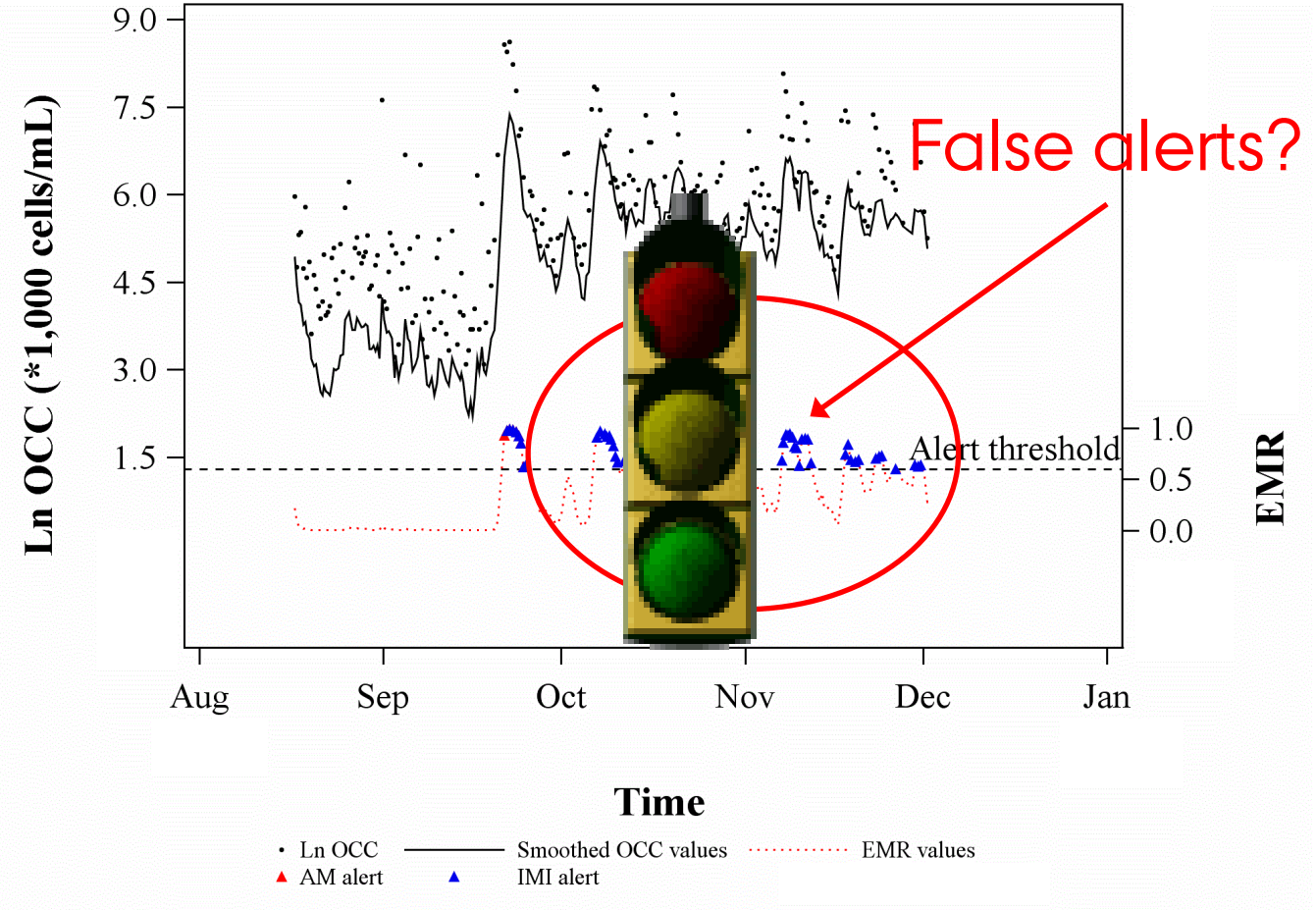
- **Simple alert based on EMR threshold**

Acute alert



OCC model – simple alerts

Cow 653



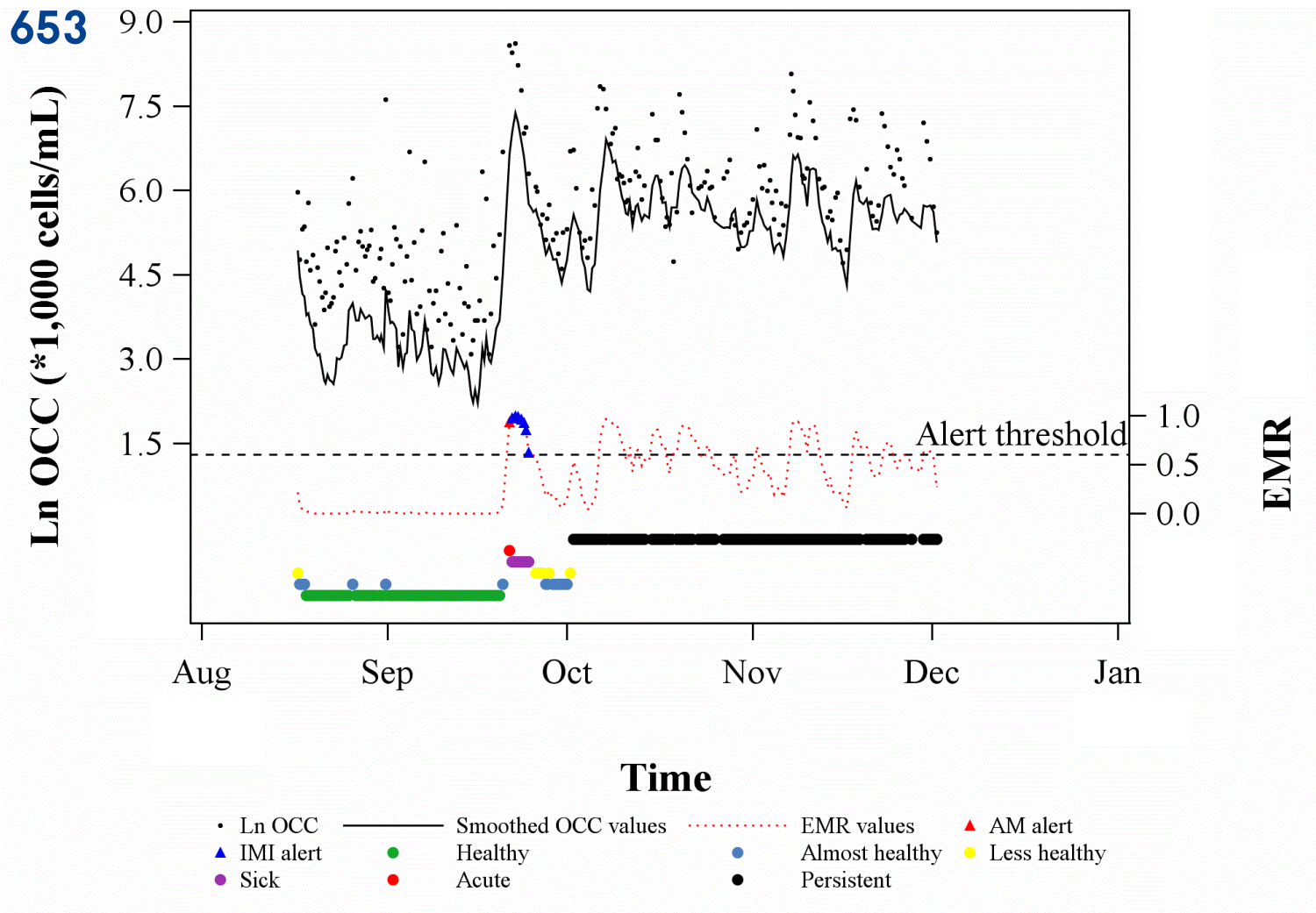
Advanced alert system

- **Mastitis can be graduated → EMR**

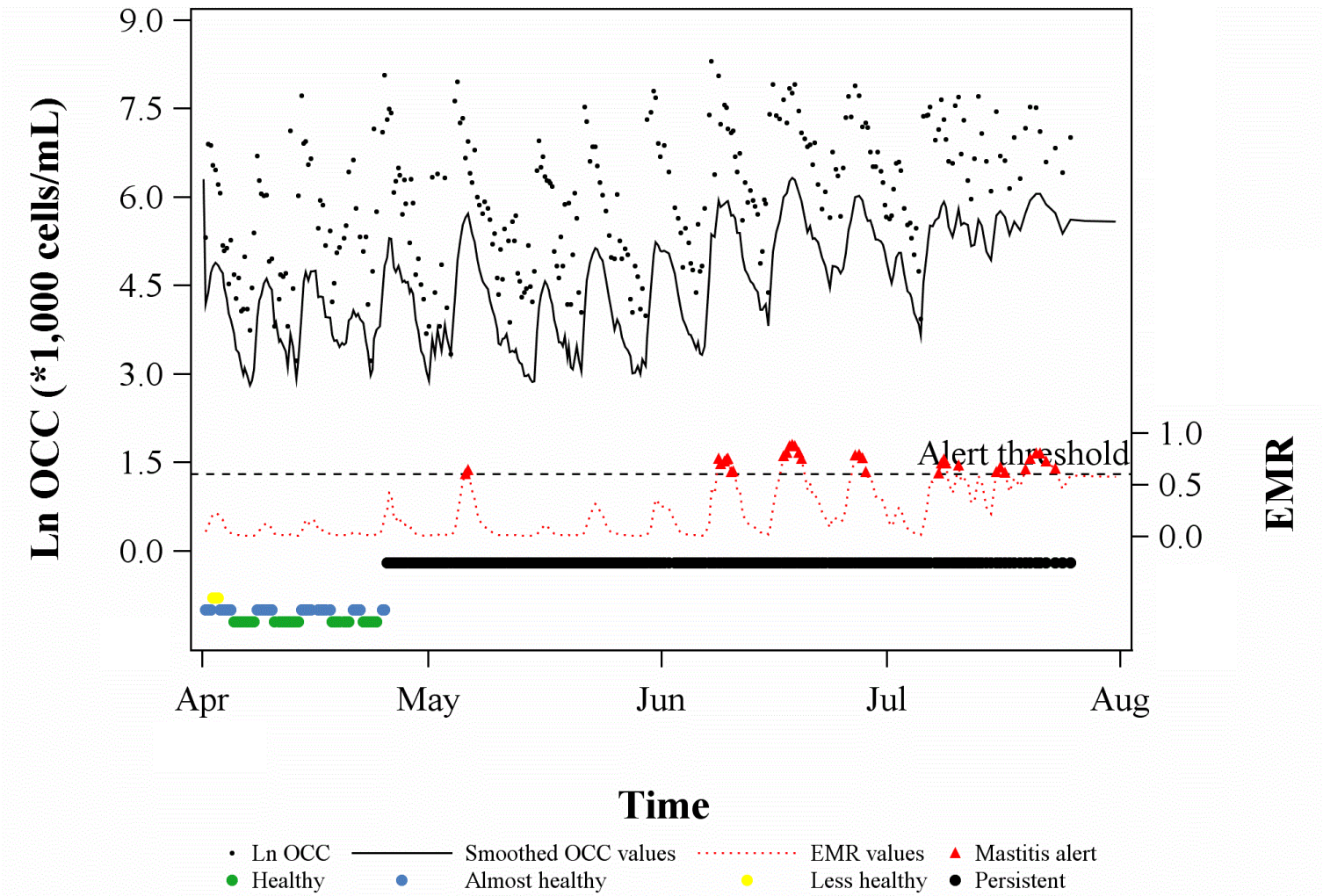
- **Persistent IMI cause ”false alerts”**
  - Fluctuating pattern → increased OCC variation
- **New definition of persistent IMI**
  - Threshold for OCC variance
  - 10-15 days delay from onset

- **Additional health class**
  - Advantage: All cows in the herd are assigned to a health class

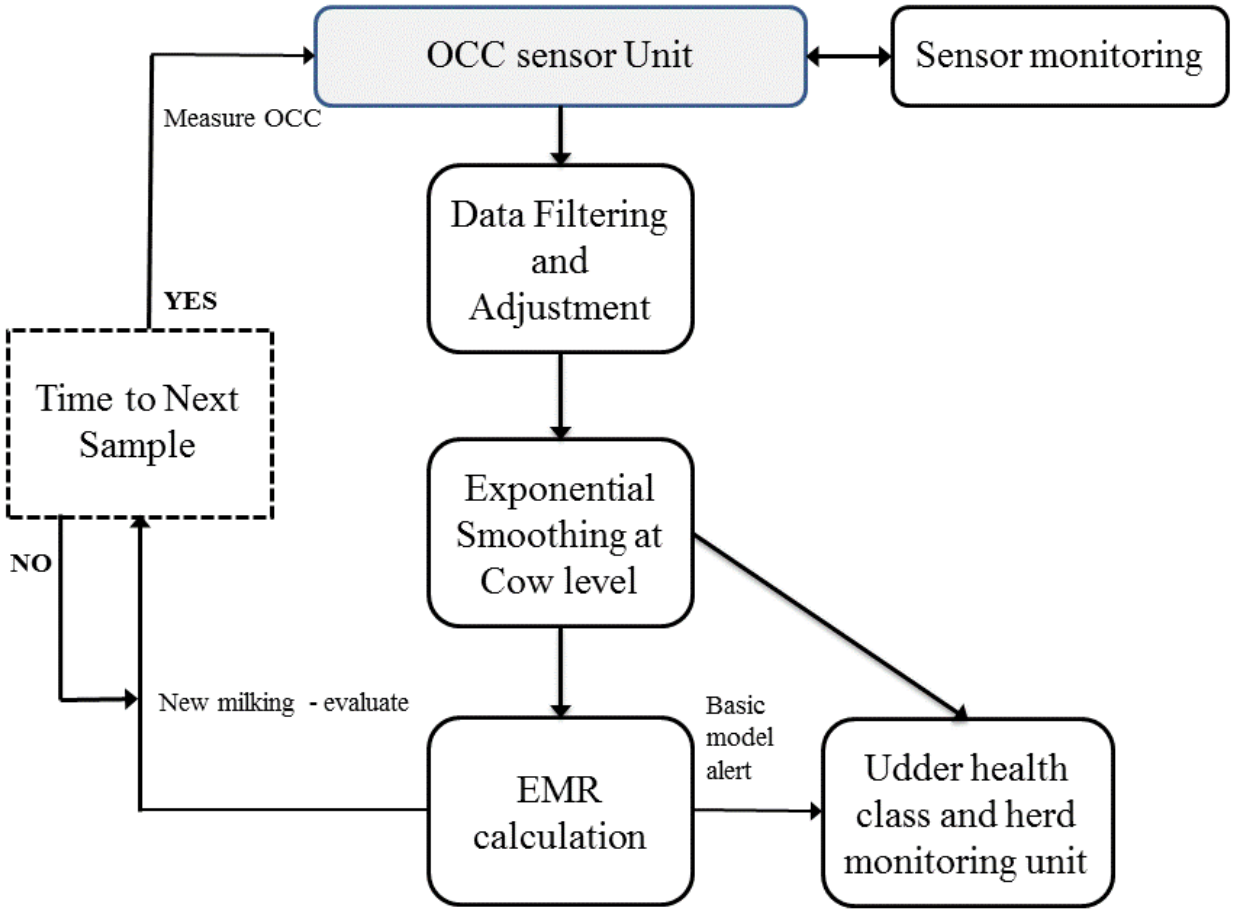
OCC model – advanced alert system



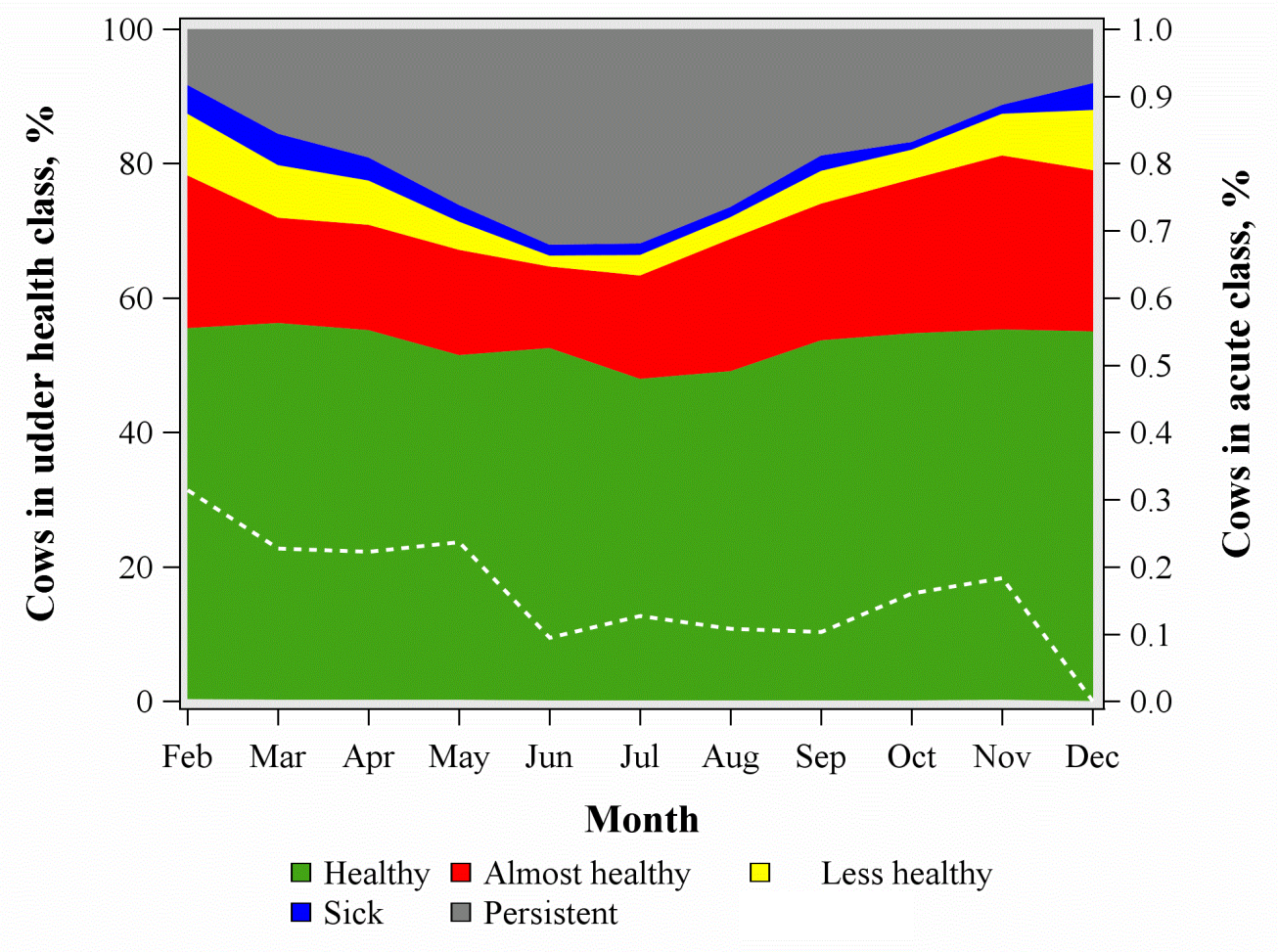
Persistent IMI – another example



OCC IMI detection system



Udder health monitoring – herd level

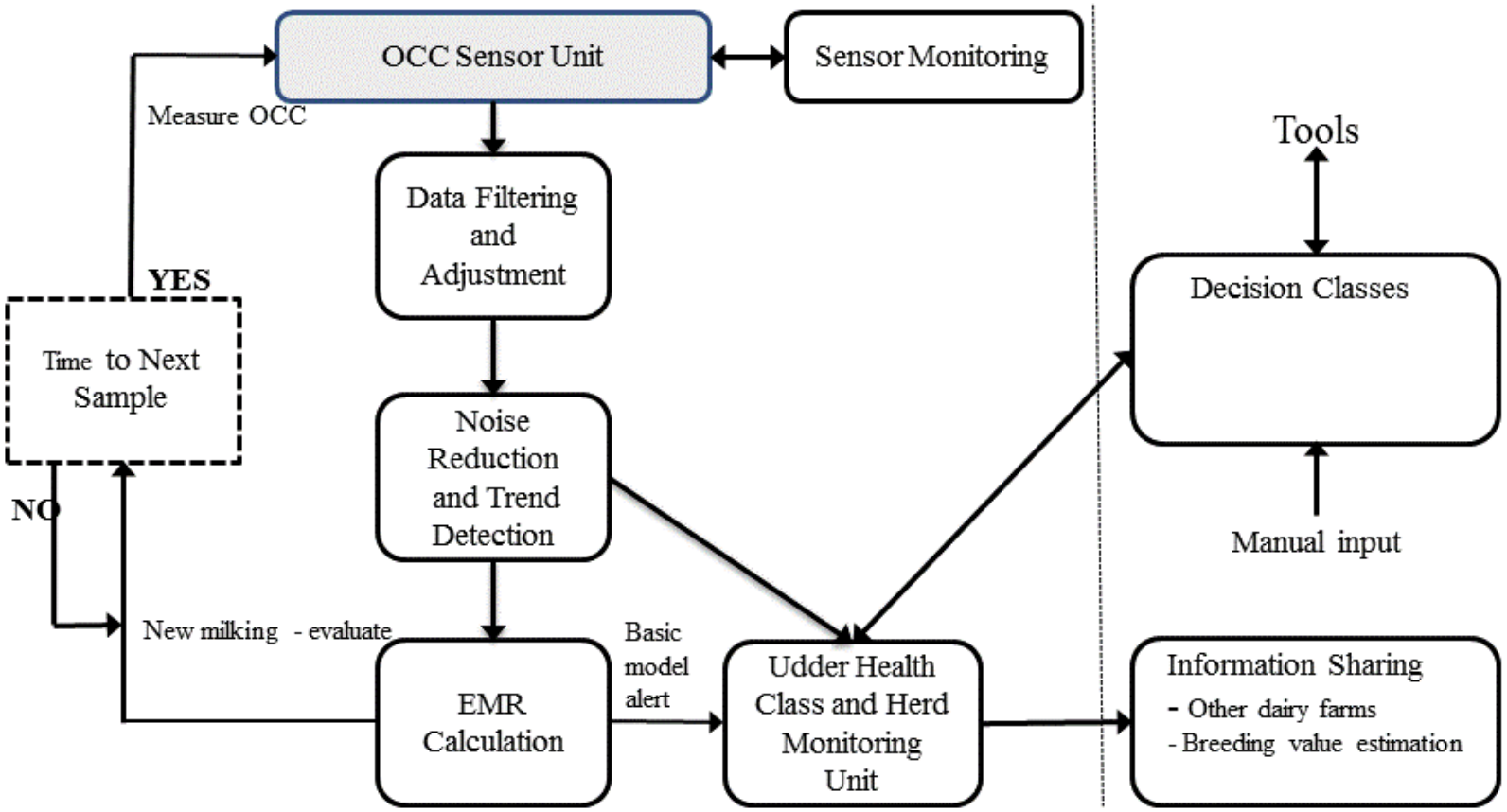


Verification of sensor alerts

- **Available gold standard for comparison?**
- **Gold standards: mastitis treatments, PCR, SCC**

- **Longitudinal study period**
  - Relatively easy – gold standard may already be available
  - Disadvantage: No udder health status on “non-treated” cows
- **Cross-sectional study**
  - Udder health status on all cows according to chosen gold stand.
  - Few “treated” cows
  - Disadvantage: costly – especially in AMS herds – manual sampling required

Potential use of OCC output



So far - conclusions

- **Filtering + calculations → more useful for decision support**
- **Sensor check is crucial**
- **Clear signal is suitable in decision support**
- **Enables monitoring at cow and herd level**
- **Potential for data sharing**
- **Do we need official test procedures for sensors? Role of ICAR?**

Then, what about genetics?

- **Many sensor systems – agreement on what biological trait to be expressed ?**
- **Or better - integrate over a number of systems recording different aspects or details**
- **Combine with traditional traits – recorded in many animals**

- ***The key is to obtain an improved phenotype*!**

Thanks …