“Calibration, monitoring and control approach for multi-devices system performing analysis in rough environment”

Eva Ishay, Liubov Lemberskiy-Kuzin, Gil Katz and Niv Pinsky

afimilk (S.A.E. Afikim), Kibbutz Afikim, 15148, Israel

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Outlines

- In-line milk analysis
- Multiple sensor system as part of an automated data collection system
- Calibration, monitoring and control
- Summary

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In-line Real time milk analyzer

- ✓ **Free flow - Continuously measures milk components during milking**
- ✓ **Non destructive Measurement – No use of reagents needed**
- ✓ **Provides daily milk analysis for animal health and performance**
- ✓ **Easy maintenance**
- ✓ **Part of the regular cleaning system in the milking parlor**

Automated coupling of the “lab” to each stall in real time at an affordable price

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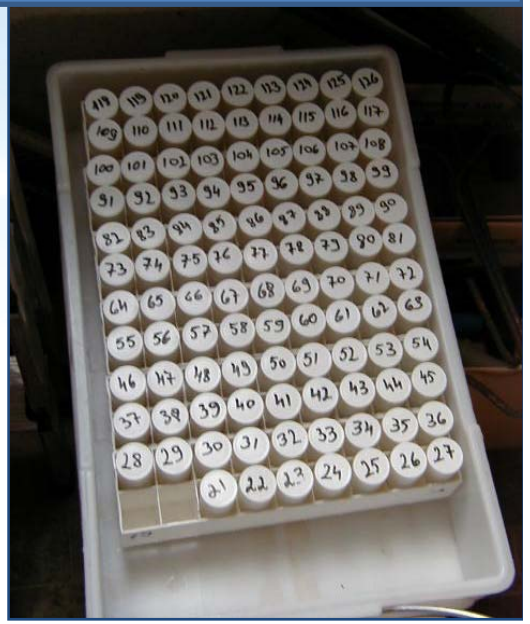
Daily analysis of milk components shifts the emphasis in the data from genetic improvement to farm management.

The same evolution that occurred with the introduction of the first electronic milk meter - is now expected.

Requirements:
Low cost
Robust
Easy to maintain

Trade off:
Accuracy cannot be as good as the lab



AfiLab is an extension to the milk meter adding extra abilities evaluating milk components daily.

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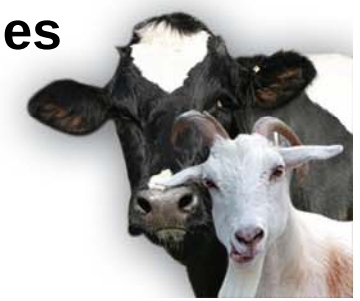

Stand-alone analytical device – QA/QC

Any analytical technique requires careful calibration.

QA/QC demands calibration through several steps including check sample, calibration verification and calibration standards.

The standard lab maintenance and calibration routine is not practical in the parlor

New approach is required

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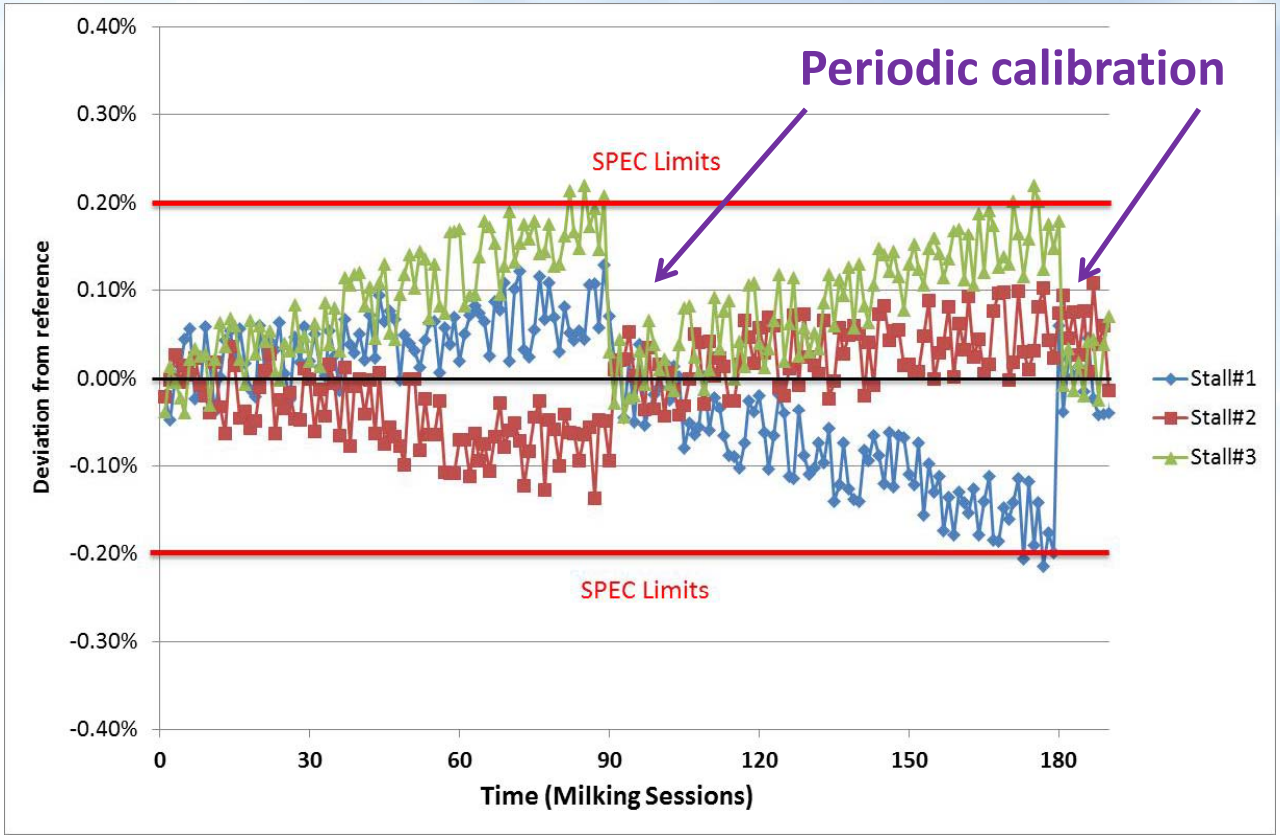
The problem: Stability between periodic calibrations (illustration)



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The solution: Routine maintenance protocol for in-line milk analysis system

- Daily monitoring
- Calibration inspection
- Problem detection and classification (internal device problems, maintenance problems in the parlor, Cow's & Group problem)
- Compensation and/or Alarm

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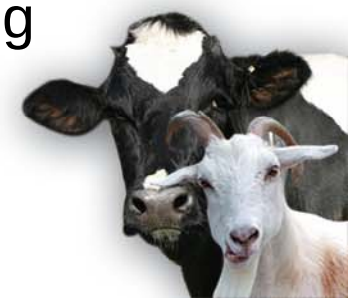
Multi devices system performing in-line analysis in rough environment

The system can conduct self surveillance and monitoring exploiting it’s device multiplicity



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Monitoring and Control Scheme

Observation of variations

Milk Components Domain

Analysis

- **Herd & group level**
- **Time domain**
- **Cow domain**
- **Device domain**

Diagnosis and Response

<u>Cow/Herd</u>
Feed, Health status, lactation, Gynecological status, …..

<u>Interface</u>
Parlor maintenance, Staff, Cow preparation, Washing system …

<u>Devices</u>
Calibration, Technical malfunction, .

Validity of data

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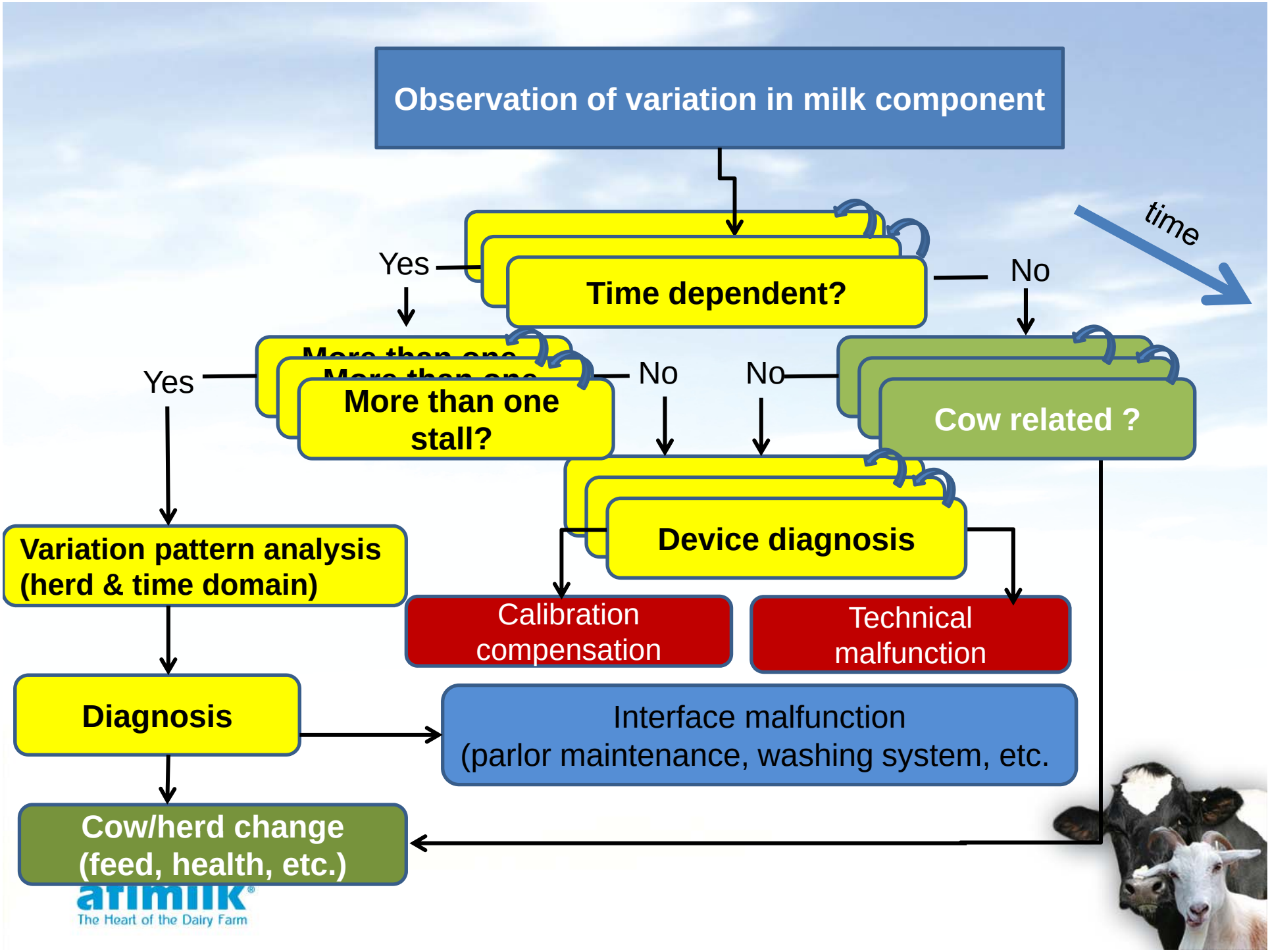
Observation of variation in milk component
Time dependent?
Yes
No
time
More than one stall?
Yes
No
Cow related ?
No
Device diagnosis
Variation pattern analysis (herd & time domain)
Calibration compensation
Technical malfunction
Diagnosis
Interface malfunction (parlor maintenance, washing system, etc.
Cow/herd change (feed, health, etc.)
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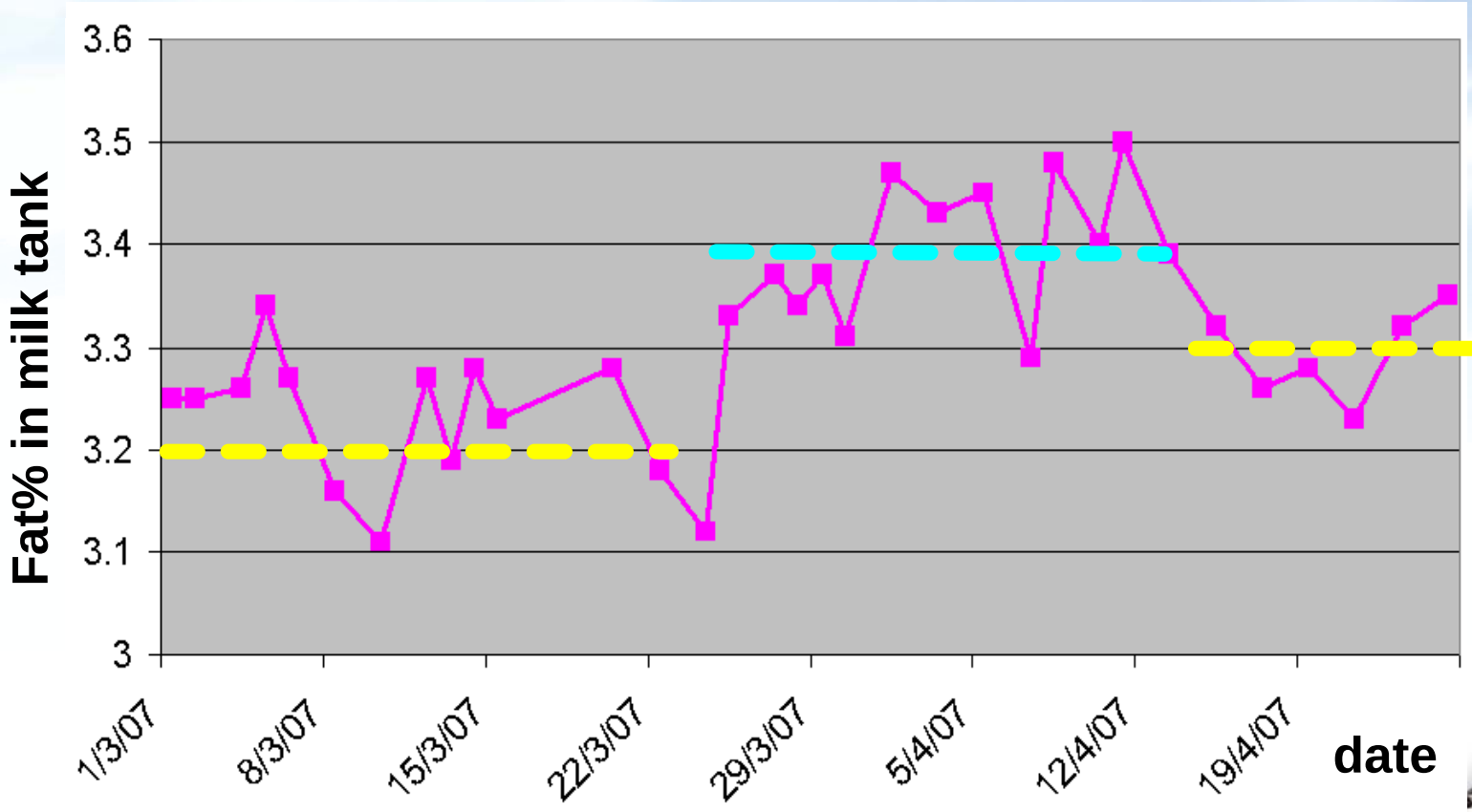
Herd Variation Diagnosis
Feed Change



Ramat Zvi Farm (n=60) milk fat % in milk tank

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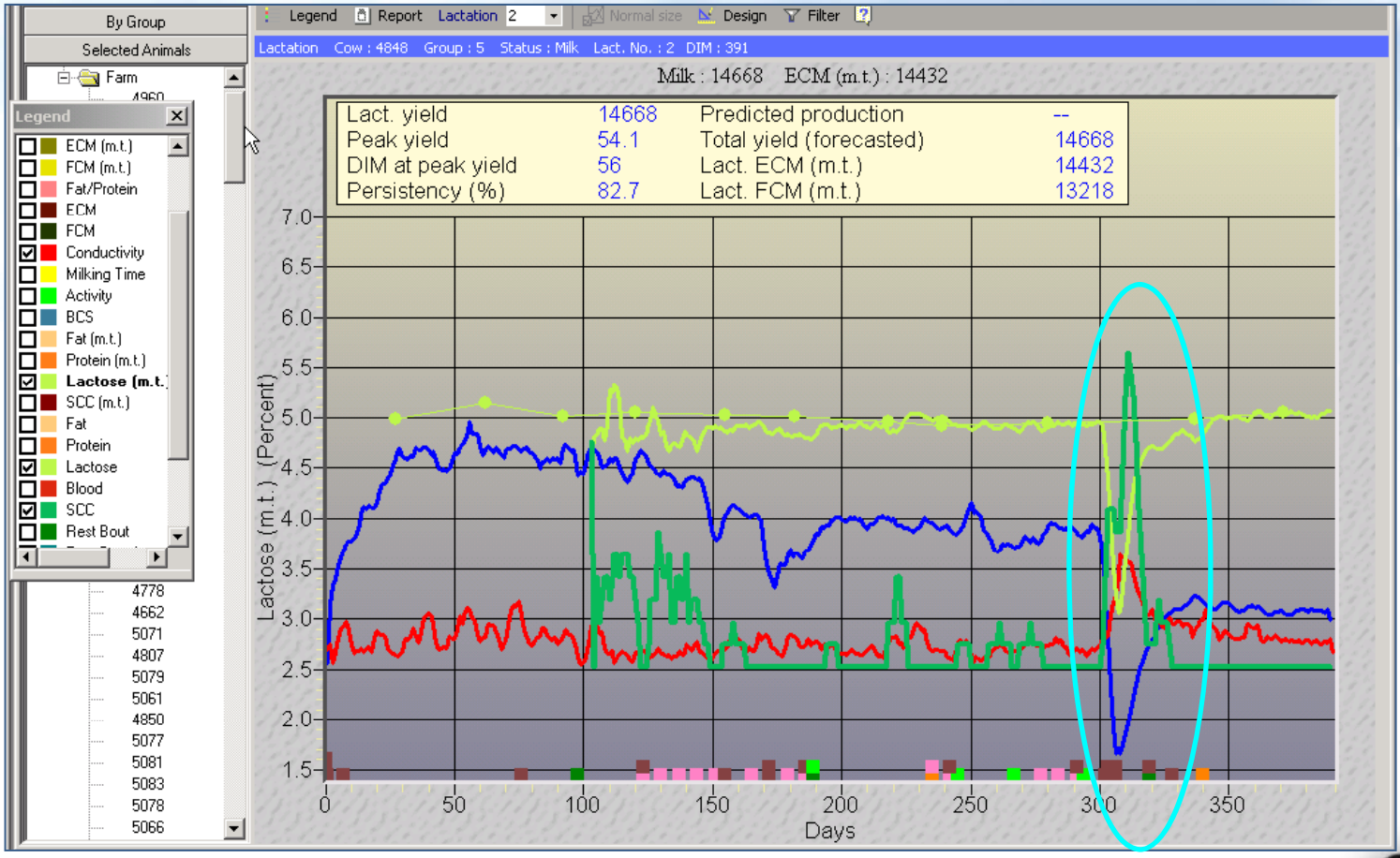
Cow Variation Diagnosis

Mastitis Detection



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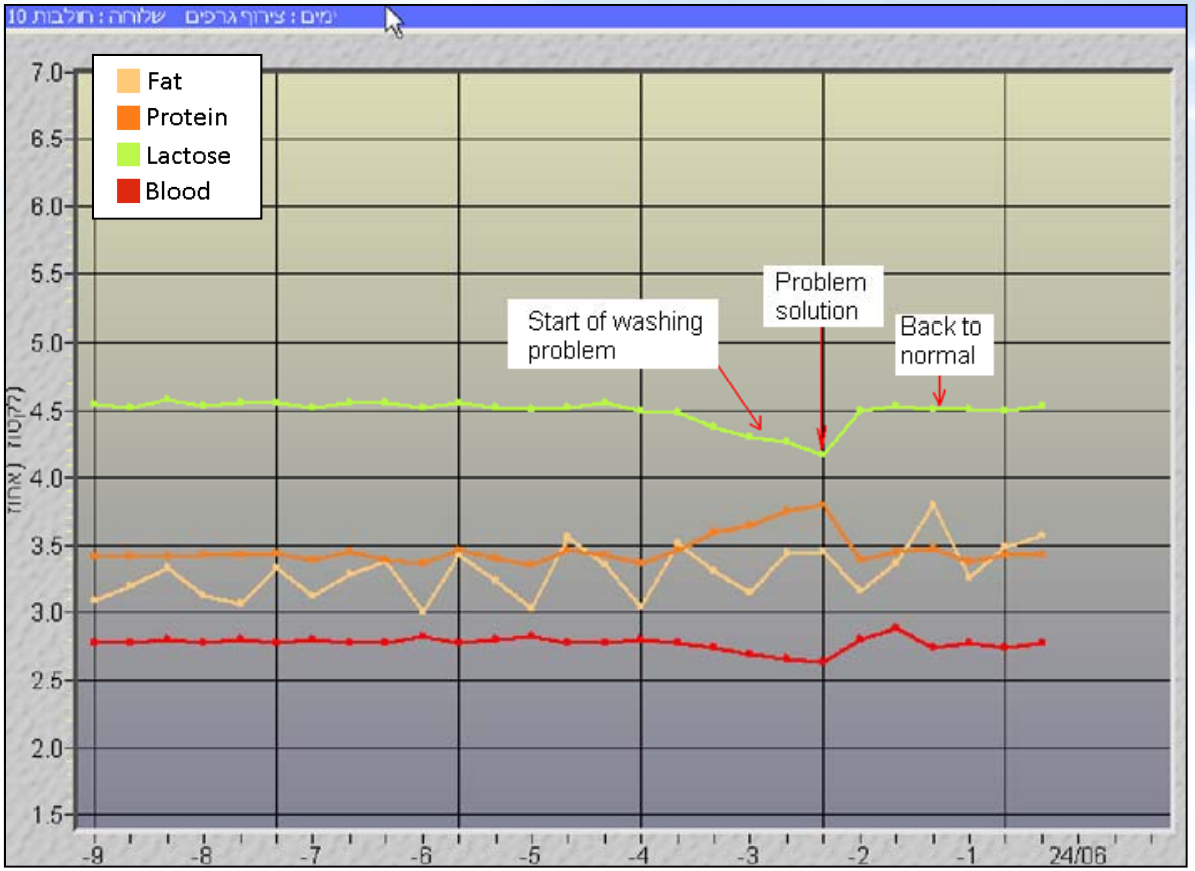
Interface Diagnosis

An example of maintenance (washing) problem and it correction for AfiLab



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Devices Malfunction diagnosis

- Malfunction example
- Calibration example

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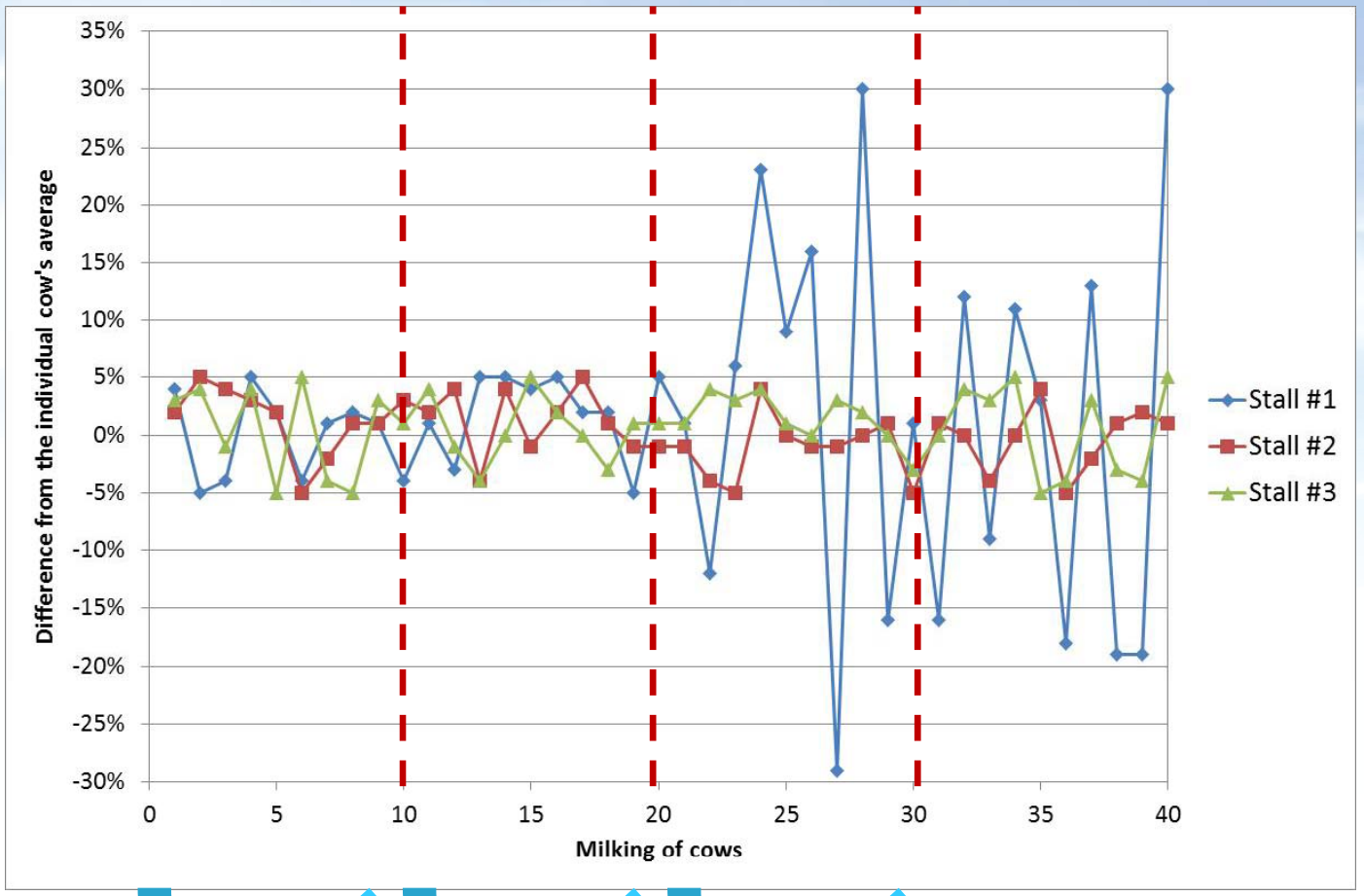
Spotting a Malfunctioning Device



Day 1 Day 2 Day 3

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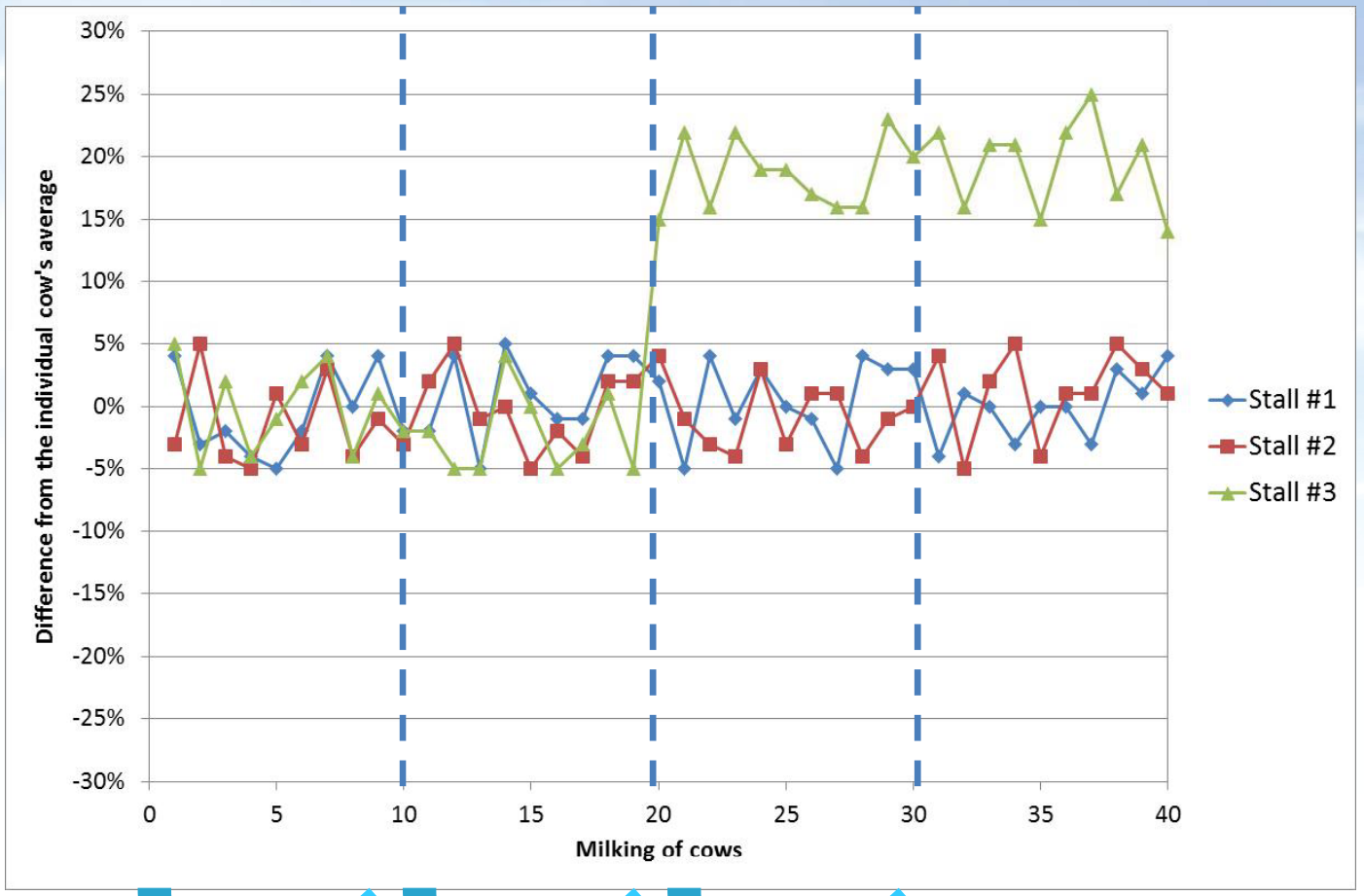
Spotting a Calibration Malfunction



Day 1 Day 2 Day 3

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Automated Compensation can be performed daily to overcome calibration problems.

This will improve accuracy and robustness.

Assumption

The overall milk measured by each device reflects the average tank milk

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Constraints

- Multiple number of devices at the farm is required to form multi-device system.
- Statistical ensemble for the evaluation of a single device should be large enough to represent normal herd distribution.

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Variability Between Devices in the System

- High repeatability is required between the different devices.
- Self-calibration can minimize differences between the devices. This is achieved by filtering and neutralizing the effects of known noise influencing the precision of the measurement.

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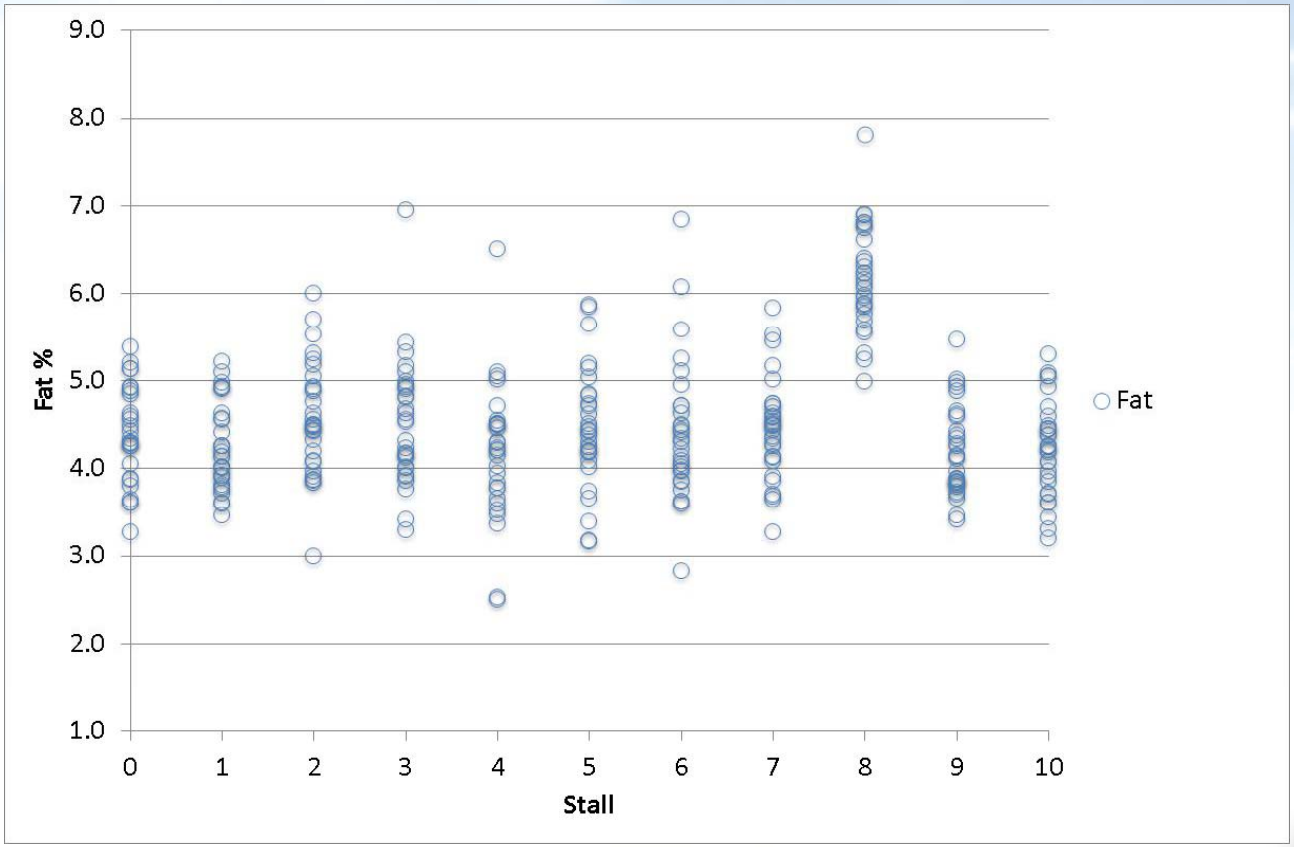
Variability between devices in same farm: fat example – device dimension



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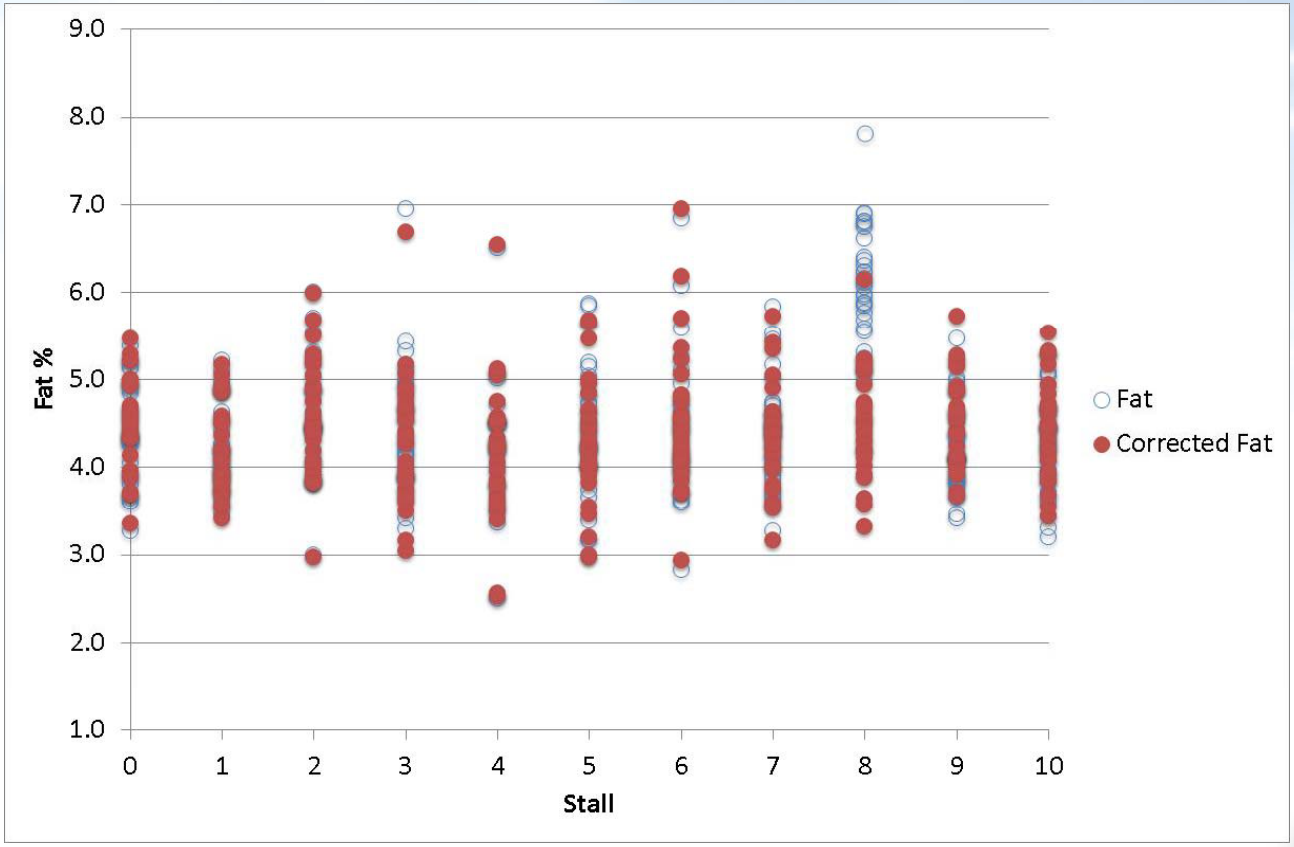
Variability between AfiLab's in same farm: fat example



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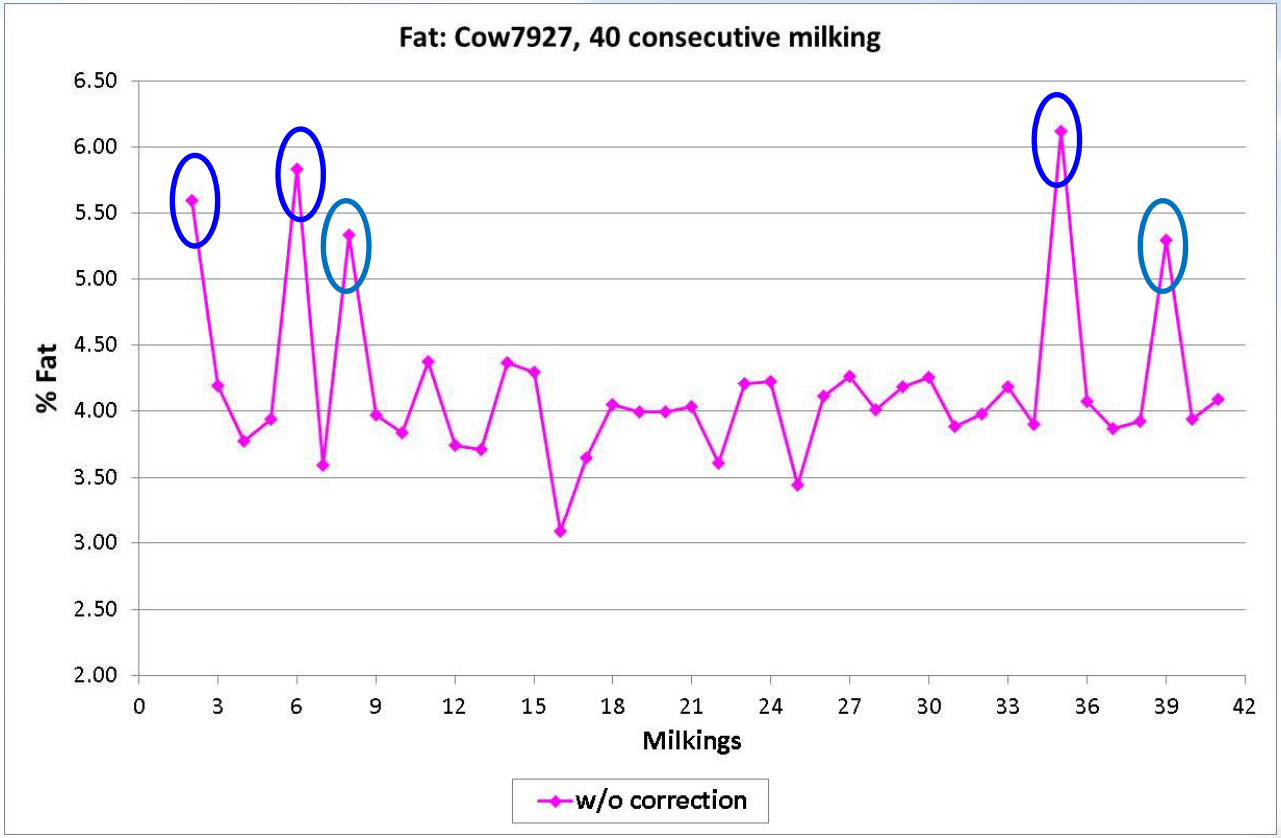
Variability between Devices in same farm: fat example – Cow dimension



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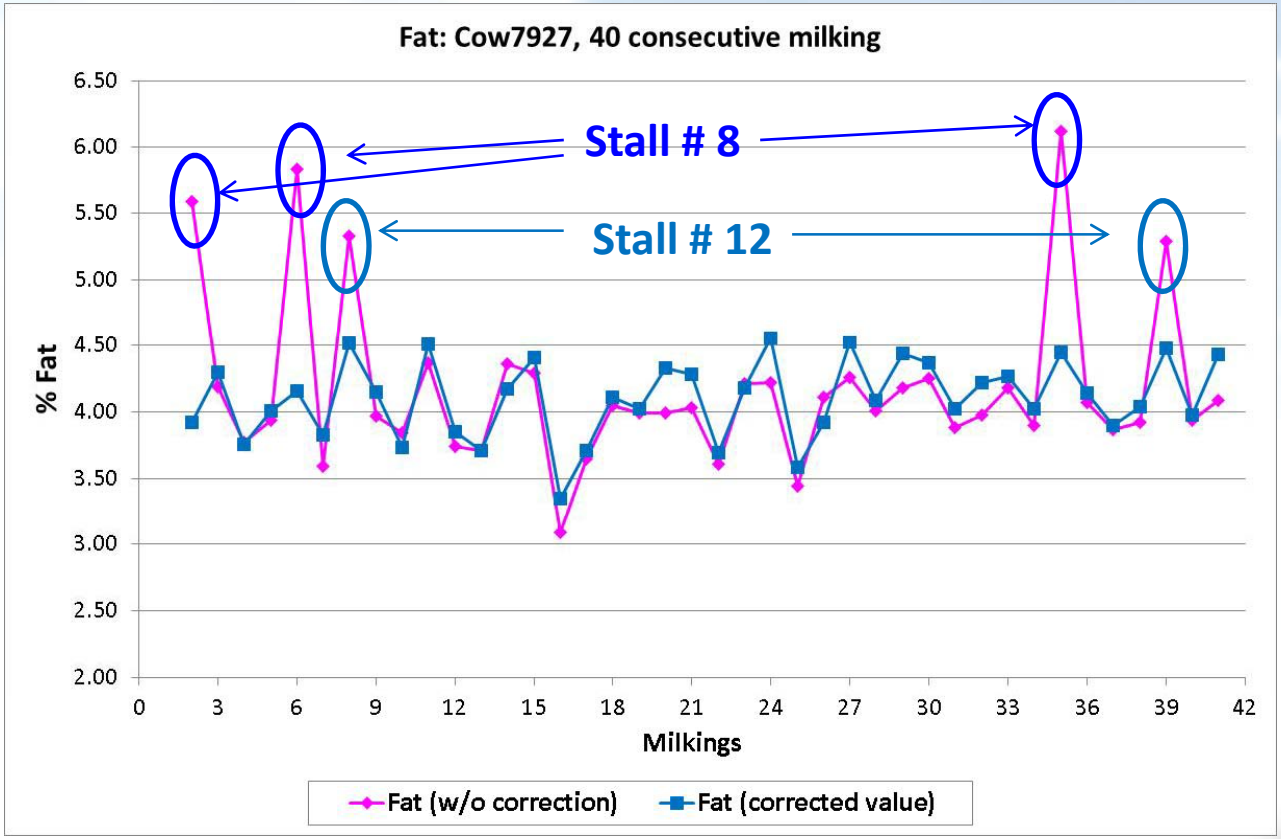

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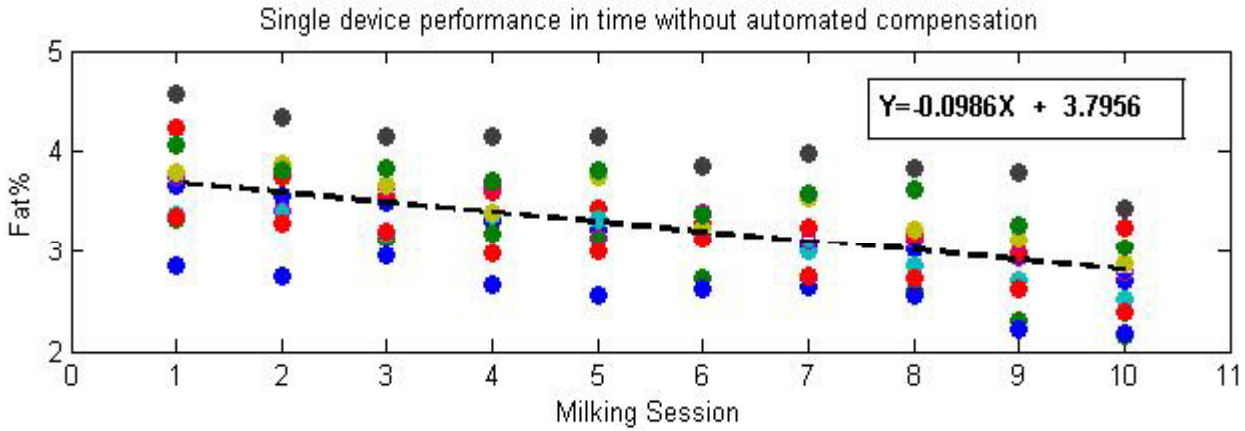
Time dimension influence on fat evaluation and its correction for the AfiLab



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Summary

- Periodic calibration of the system is based on the reference analysis for every device in the farm.
- Automated on going compensation (self-calibration) based on the approach that the sensor is not a stand-alone analytic device but a part of the automated data collection system.
- Accuracy is significantly improved by filtering the noise and neutralizing the effects of known built-in factors such as: different cows, type of session (morning, afternoon, evening), etc.

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Thank you!

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