AfiLab™

"A new approach to perform analysis of milk components incorporating statistical methods adapted in a real time sensor"

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Impact of new technologies on performance recording and genetic evaluation

36th ICAR Session and Inter bull Meeting 16-20 June 2008

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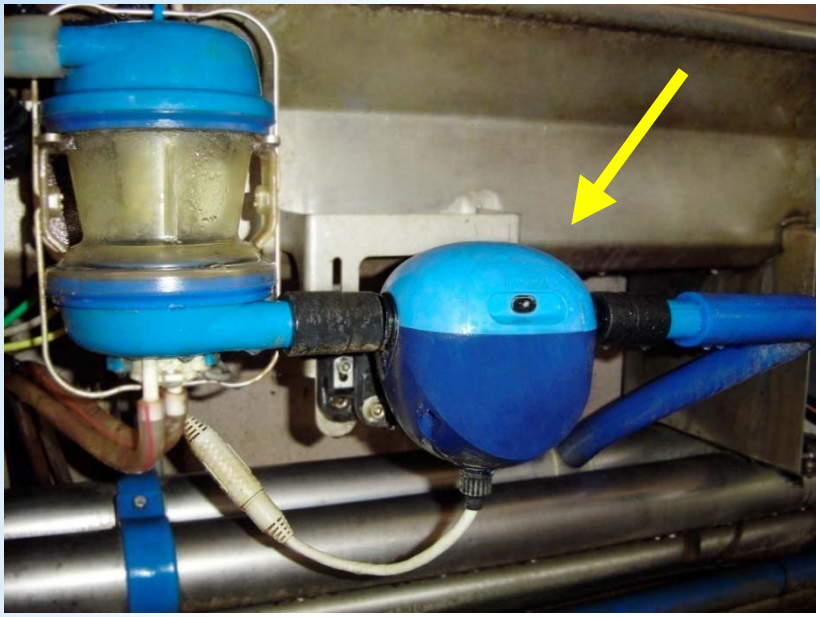
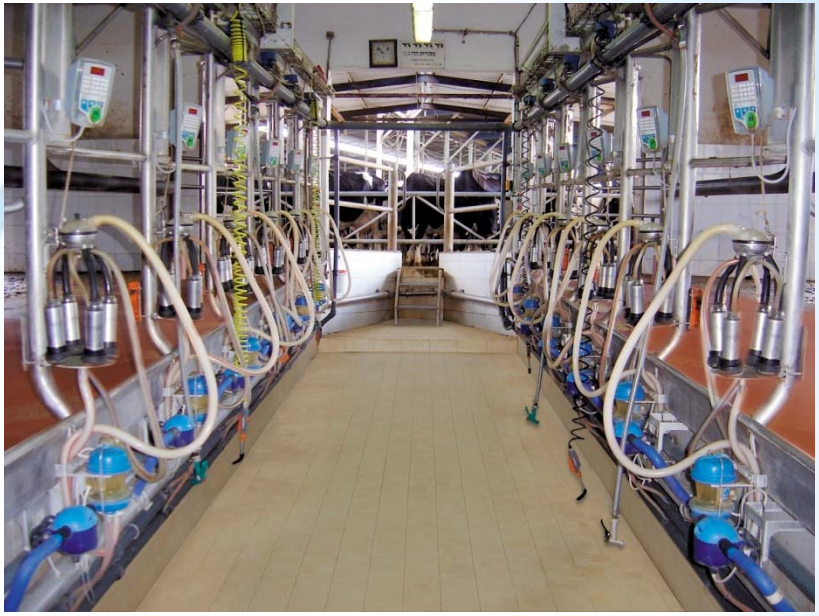
Real Time Milk Analyzer

The Concept

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



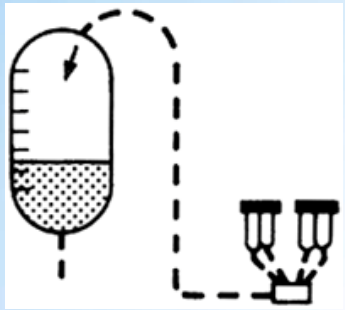


* Free flow
* Non-interfering measurement
* Continuous real time acquisition of milk components
* Data is acquired automatically for the individual cow during its milking

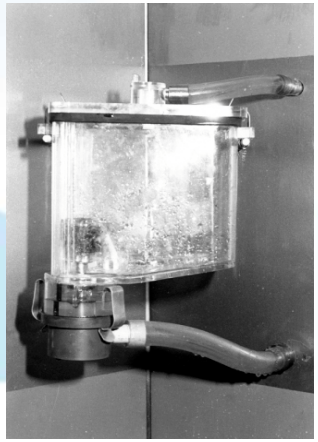
Performs Real time analysis of Milk Components

- **Fat**
- **Protein**
- **Lactose**
- **Blood**
- **Detection of SCC distributed to four levels:**
  - **Less then 200K**
  - **200-400K**
  - **III. 400-800K**
  - **IV. More then 800**

The evolution of in-parlor in-line milk recording devices

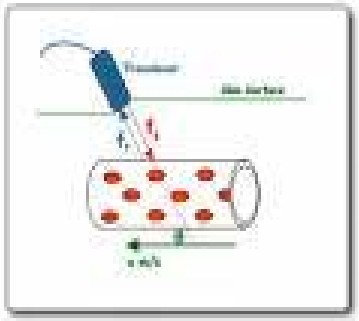


In the beginning: approved jars



1980's – present:
approved electronic milk meter
And fat sampler

One more step in the evolution



In-line on line RT milk components analyzer

Essentially – a milk meter that records milk components

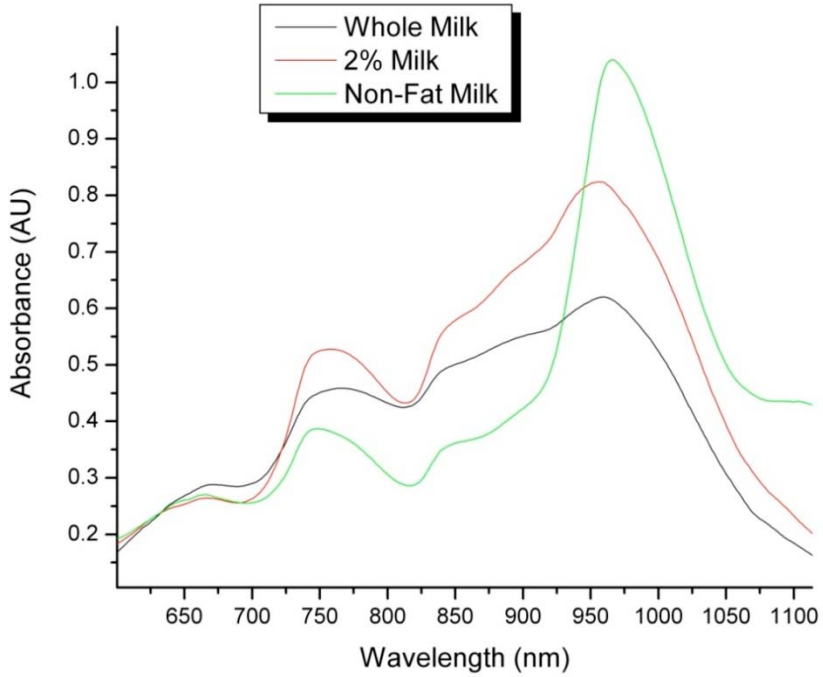
AfiLab™ Advantages

- **Free flow**
- **Easy accessibility to data**
- **Applicable accuracy**
- **Continuously measures milk components during milking**
- **Provides daily milk analysis for animal health and performance**
- **Low maintenance**
- **Part of the regular cleaning system in the milking parlor**
- **Clean Measurement – No use of reagents needed**
- **Cost allows installation in every milking point**

Technological discipline

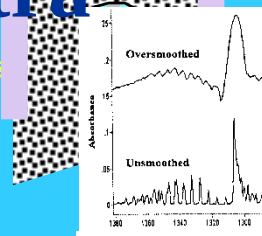
Optical characteristics of light scattering off matter in the NIR regime (low priced technology)

Multivariate analysis of milk Spectrum in near infra-red extracting data from the non specific lines. (Z. Schmilovitch et Al, R. Tsenkova et Al.)

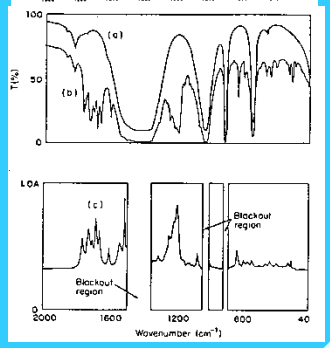


IR Spectra

Spectra of methane

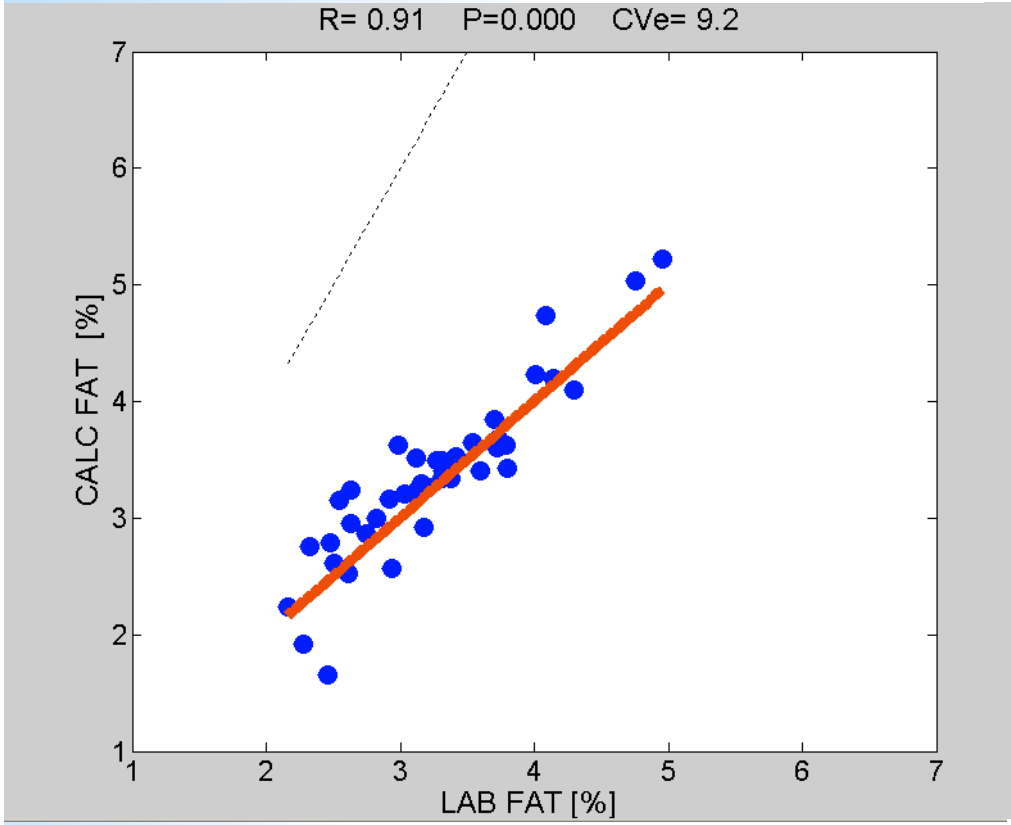


Spectra of multicomponent anlgesic mixture
a-acetonitrile solvent
b-analgesic mixture in solution
c-absorbance difference spectrum of analgesic components

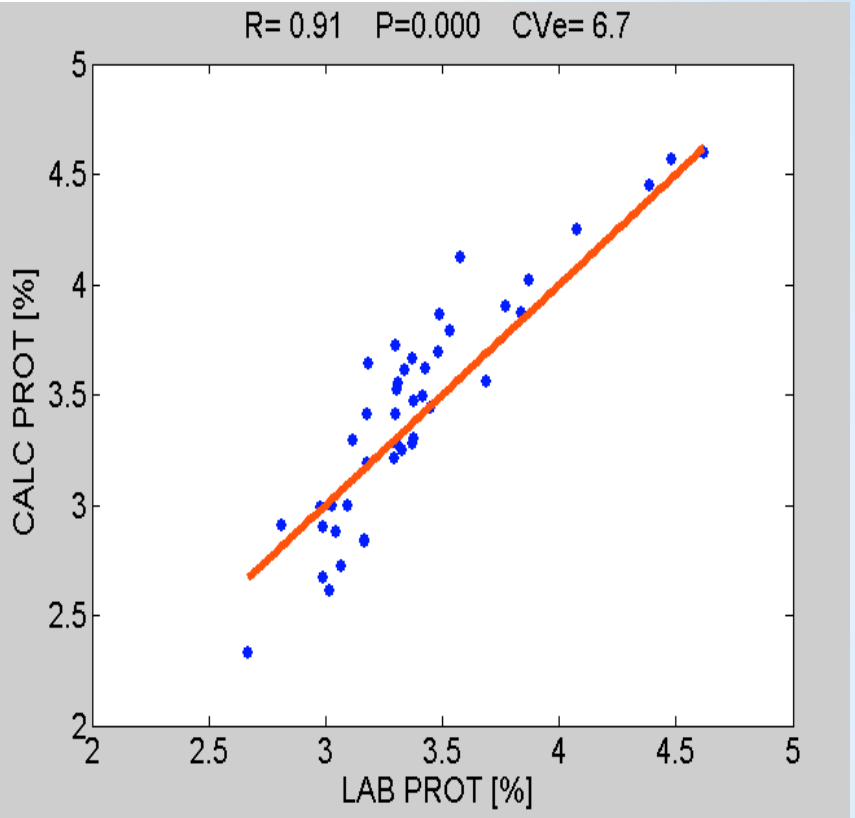


Field test results comparing analyzer to Lab

Fat



Protein



Data Recording: **Analyzer(AfiLab™) continuously measures during each milking session at the milk pipe line at each milking post as opposed to manually periodic sampling at test day**

Demands:

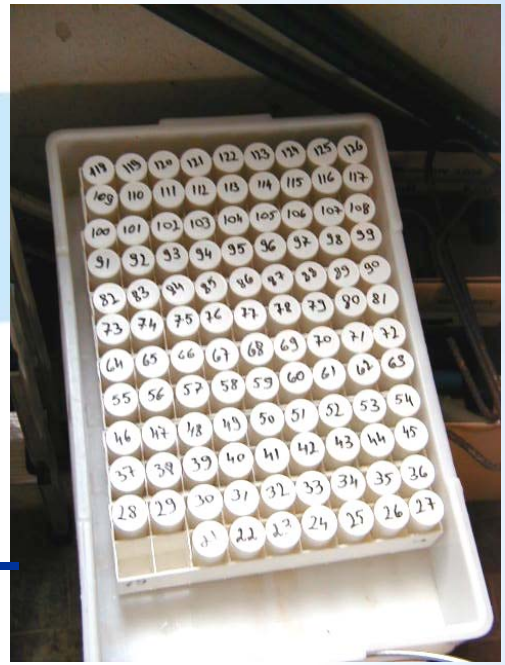
Low cost

Robust

easy to maintain

Tread off:

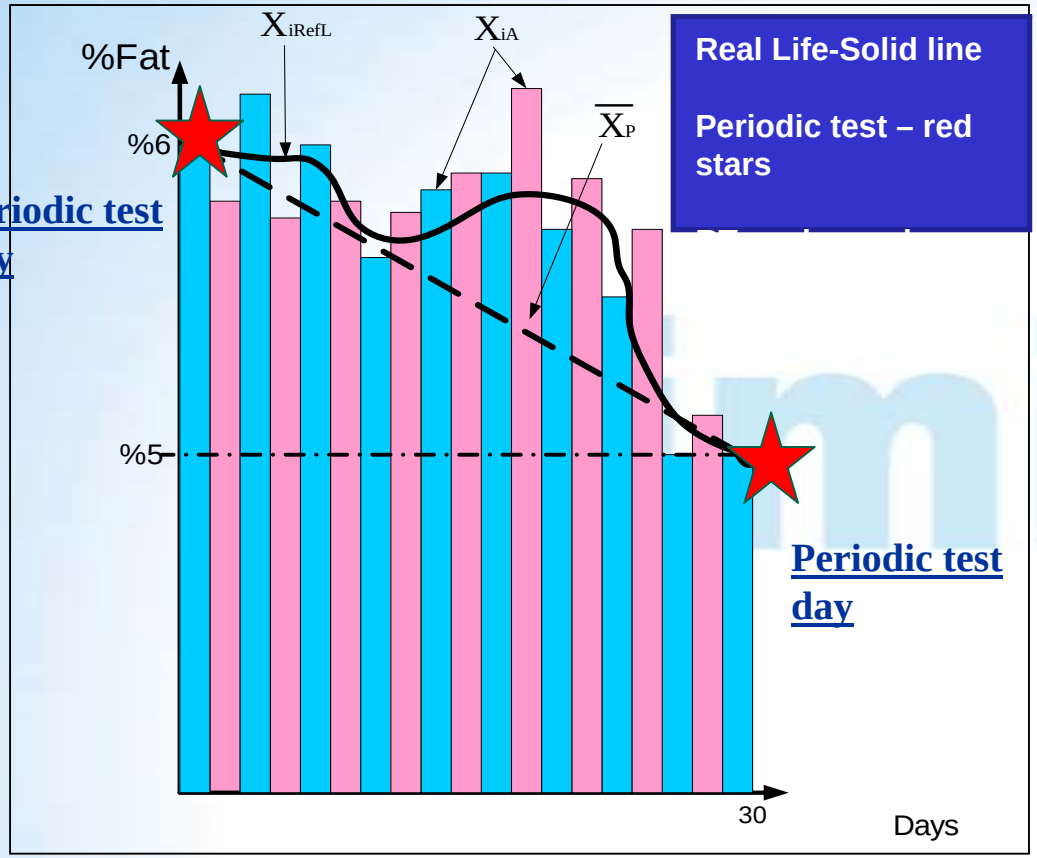
Accuracy can not be as good as the lab



What is the required performance for reliable data?
How do we evaluate this approach for milk analysis?

The compensation for lower accuracy(than the lab)

Multiple Sampling VS. Single Periodic Sampling



The real story is given by integrating over the solid line.

The story given by periodic
test day is the integral over
the dashed line between the stars

The story told by multiple Sampling method is the sum
of all bars

Analogy: low resolution motion picture unravels a story that cannot be observed in a high resolution snap shot

Can we evaluate all milk analysis methods with The same approach?

* What is the accuracy required from a multi sampling measuring device for a reliable representation of the periodic test day??????????

What are the factors that will determine it?

* Duration between test days
* Total variance between samples of the individual
* The average variance of all samples for a given duration

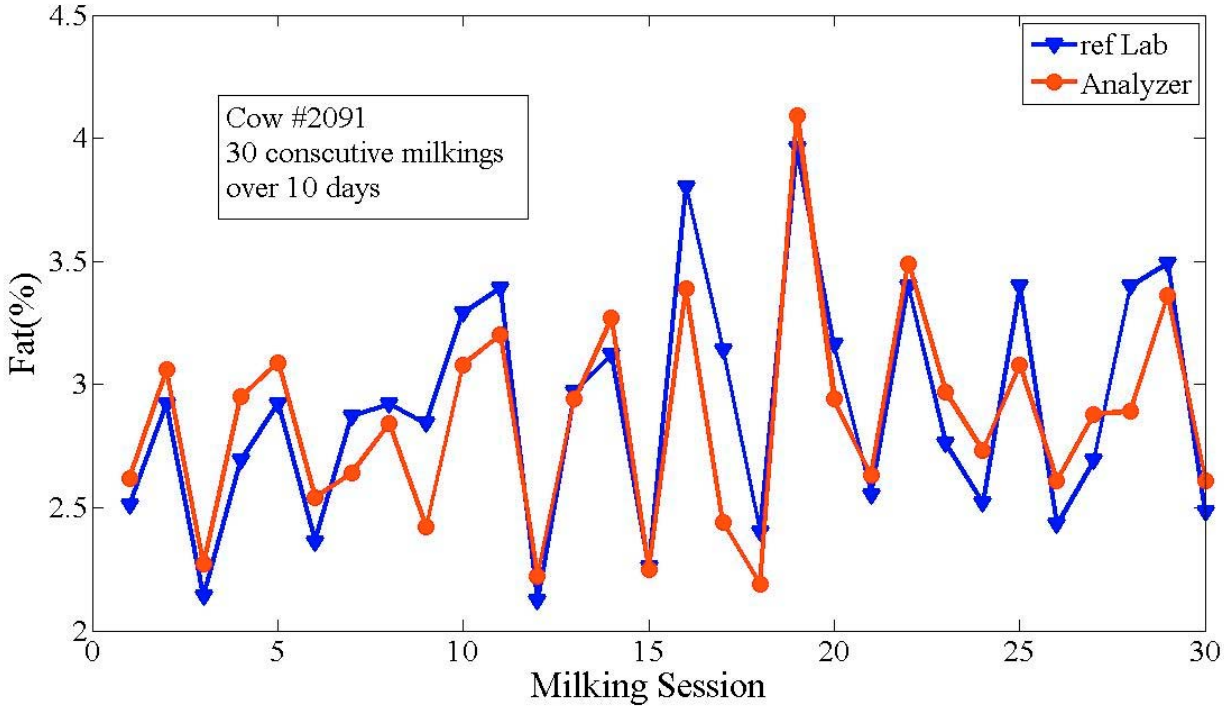
The variance of the measuring system must be smaller than the variance of the measured ensemble in the given time

What is the variance of the measured ensemble?
Fat concentration fluctuations between milking sessions

mean sd = 0.57 fat% , mean peak-to-peak = 2.16 fat %

Max Peak to peak fluctuation for all cows during experimental session

Comparing lab results to online Analyzer for a typical Holstein cow



The range of our ensemble for a given

30 consecutive milking sessions in 10 consecutive days was sampled in the lab and by the analyzer (A.R.O farm, n=88 Holstein cows).

Offered Calculation for the required accuracy /error to represent periodic day test

σ_T^2 the general total variance of any measurement system

σ_L^2 the variance of the lab accuracy

σ_C^2 -Total variance between cows

σ_P^2 the average variance of all the ensemble for a given duration

σ_A^2 -Total variance of RT analyzer ?

$$\sigma_T^2 = \sigma_C^2 + \sigma_P^2 + \sigma_L^2$$

the general total variance of any measurement system

$$\sigma_T^2 = \sigma_C^2 + \frac{\sigma_P^2 + \sigma_A^2}{N}$$

total variance of the suggested system with the multiple measurements of the RT analyzer (neglecting lab error) for a given N days duration

$$\sigma_P^2 = \frac{\sigma_P^2 + \sigma_A^2}{N}$$

From the two equalities above -the average variance of the ensemble for a duration of N days

$$\sigma_A^2 = (N-1)\cdot\sigma_P^2$$

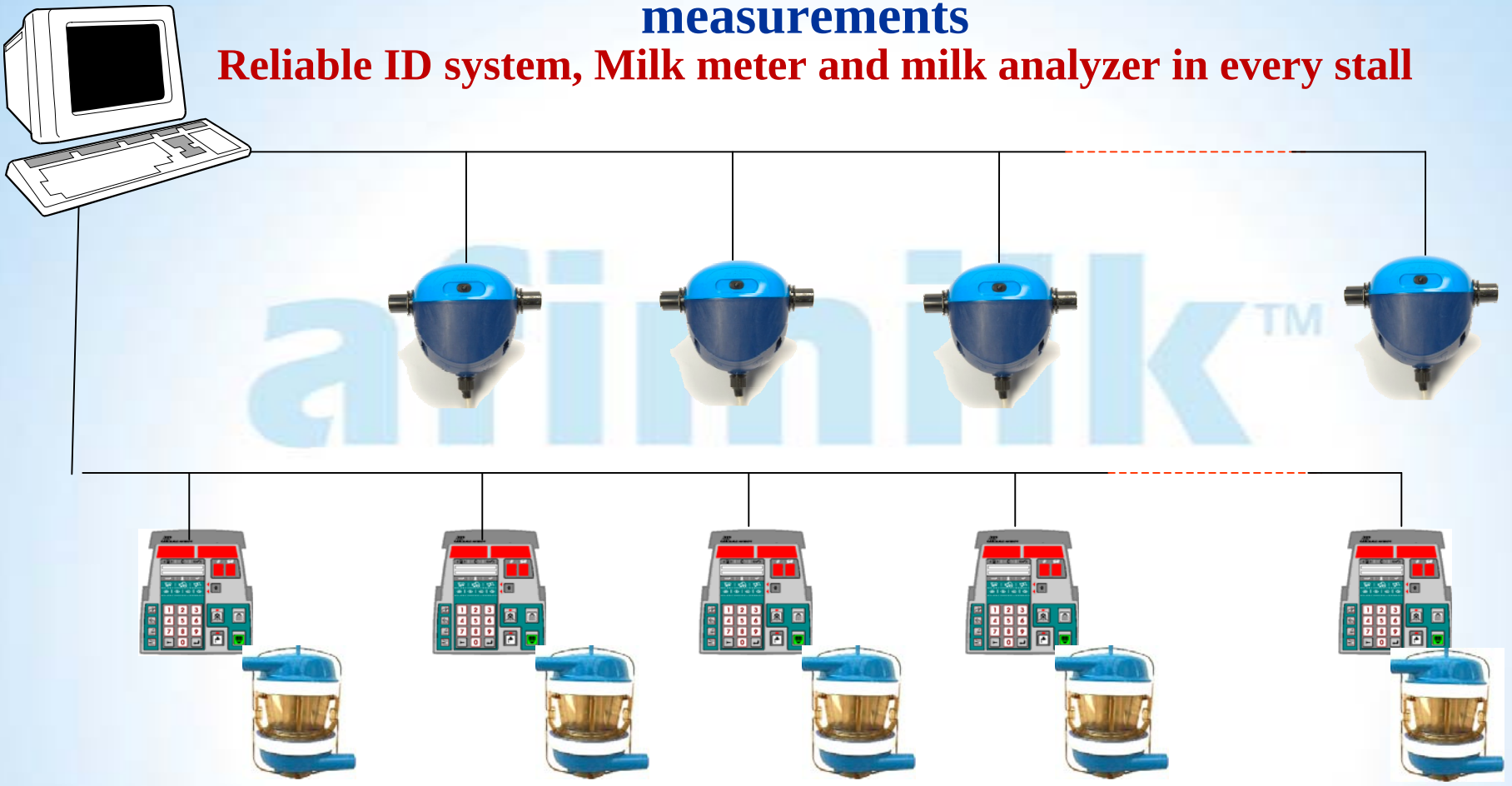
The required accuracy from daily measurements to represent a periodic test consisting of N days

Linear dependence of the error in the duration between periodic tests

Evaluating On-line Milk Analysis system

multi-sensor automated data collection system performing multi-measurements

Reliable ID system, Milk meter and milk analyzer in every stall



How do we evaluate a multi-sensor multiple measurements framework?

Acquisition of milk components in the offered automated framework differs from the existing periodic manual method

* Multi sensor system (as opposed to the current method)

Need a pragmatic viable approach for evaluation, maintenance, surveillance and control of the global system for real time in parlor milk analysis

the sensor is not a stand alone analytic device but part of an automated data collection system – like milk recorder and fat sampler

* Sensors installed on the pipe-line(as opposed to current method)

milk flows directly instantaneously to the analysis device

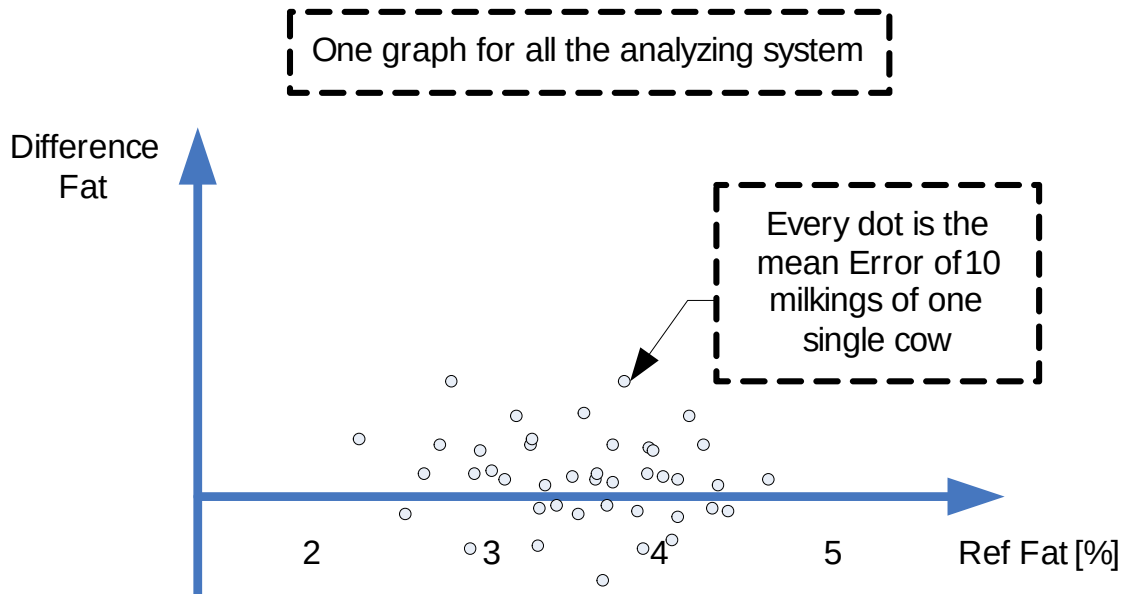
* Automated Sampling

No manual sample collection no human interference

Offered principles for Evaluation of a multi-sensor multiple measurements milk analysis system

- **Analyzing devices are coupled to ICAR approved milk meters and ID**
- **Statistical ensemble for the evaluation of a single device should be large enough to represent normal dispersion**
- **Evaluation of concentration analysis of RT devices should be a comparison to ICAR approved Lab test.**
- **Sample for comparison should represent directly the cow's milk (not from sampler)**
- **The main evaluation parameters should be based on average deviation and variance of errors(similar to evaluation of fat samplers and milk meters)**
- **Required accuracy of device should be derived from the natural fluctuations of milk components concentration between different cows at a defined duration**
- **The evaluation of the global system is acquired by performing the same evaluation as that of one device on the herd**

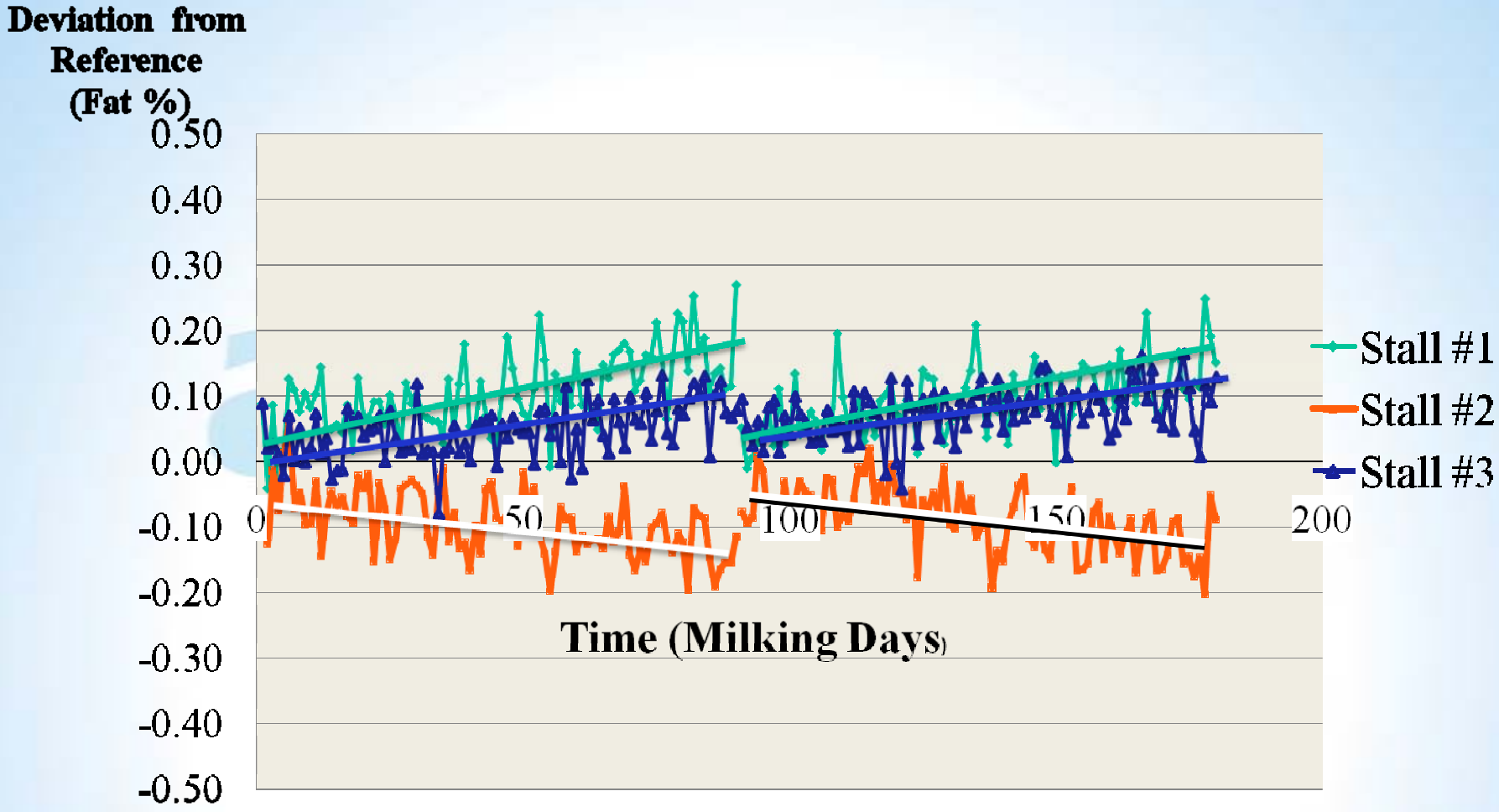
Evaluation of data supplied by the global system(parlor)



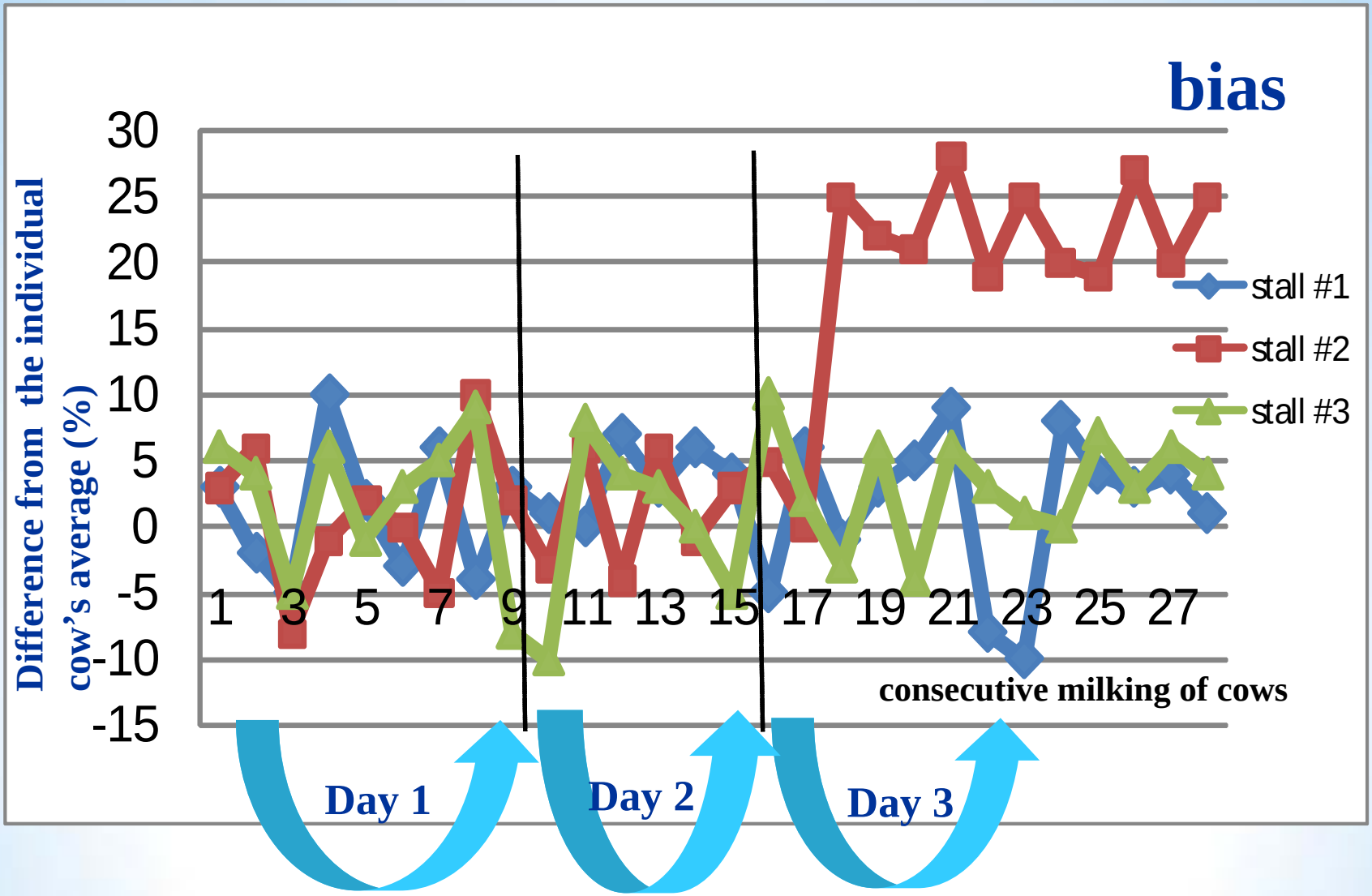
Every dot represents the mean error(y axes) of analysis for a single cow over 10 milking days with respect to the reference lab(x axes).

Milking posts are chosen randomly by the cows at each milking session so eventually all the analyzers "see" all the cows – appraisal is performed globally

Stability and maintenance over time – periodic calibration



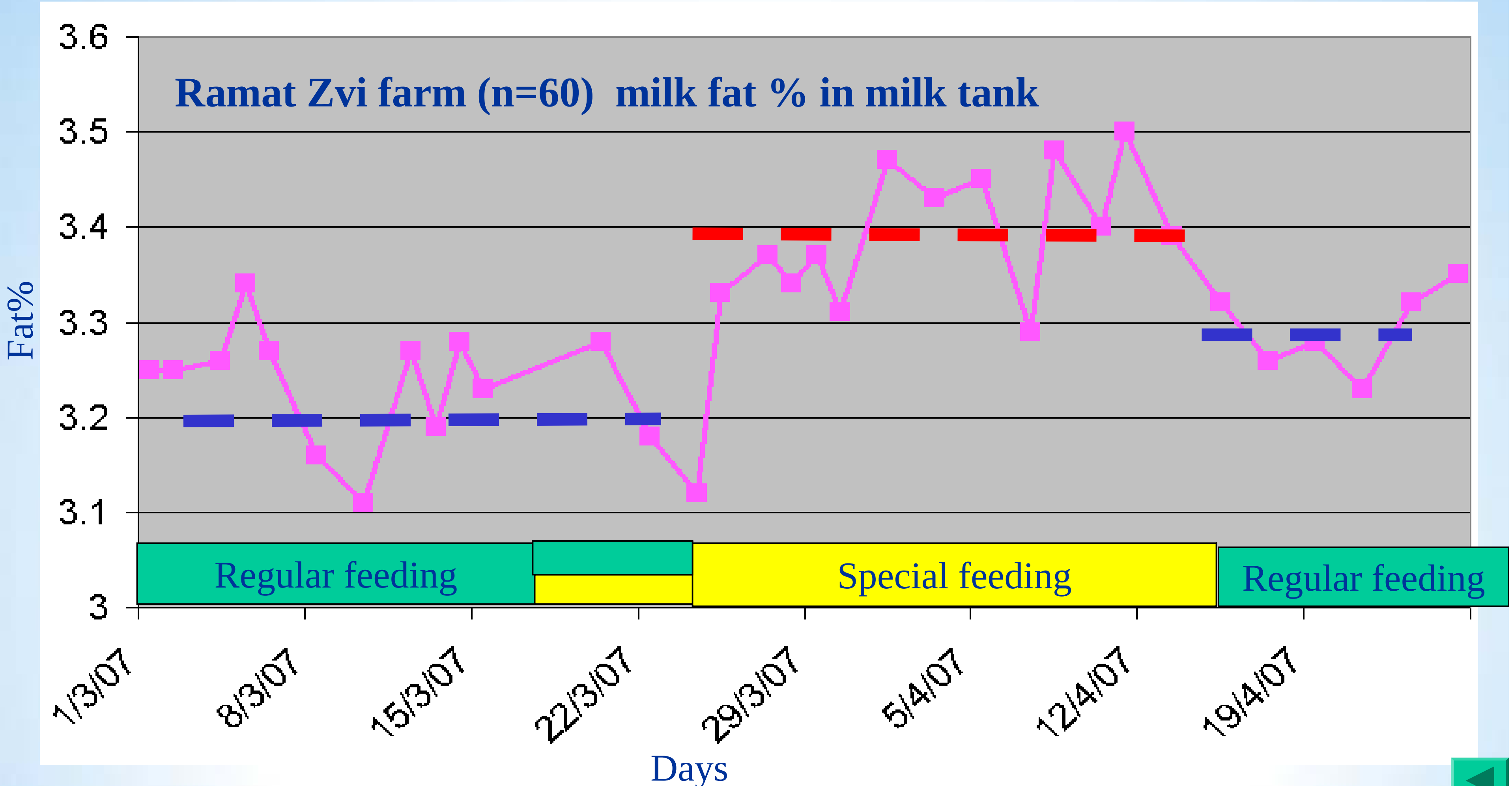
Spotting a malfunctioning device in the system



Real Time Detection of Feed Change

Big shift in overall system is not a **malfunction**

Change in feeding of total herd due to the holiday of Passover



Summary

1. A novel sensor was introduced.
   this sensor enables daily automated collection of data,

2. The RT on-line analyzer cannot be assessed by the
   common approach used for periodic test days.
   There is a need to construct an approach for evaluation

3. The advantage of multiple sampling should be
   a consideration in the construction of the approach

“A low resolution motion picture can unravel a story that cannot be observed in a high resolution snap shot”

Thank you for your attention