



OSIsoft.

REGIONAL SEMINAR

2012

A P A C

The **Power** of **Data**

INDIA



Opportunity to Monitor the Health of Biomanufacturing Process Using Soft Sensors

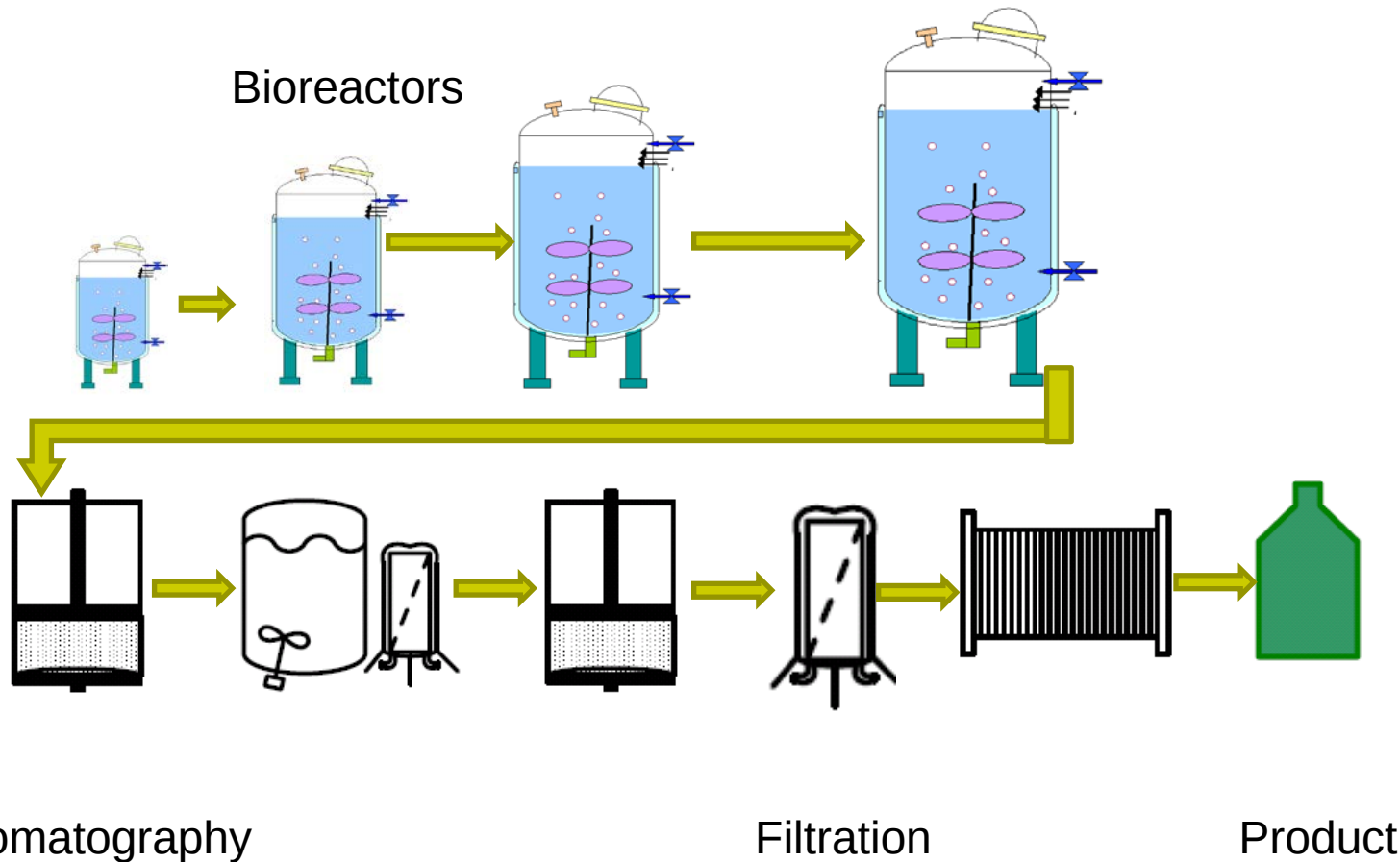
Presented by

Velu Mahalingam

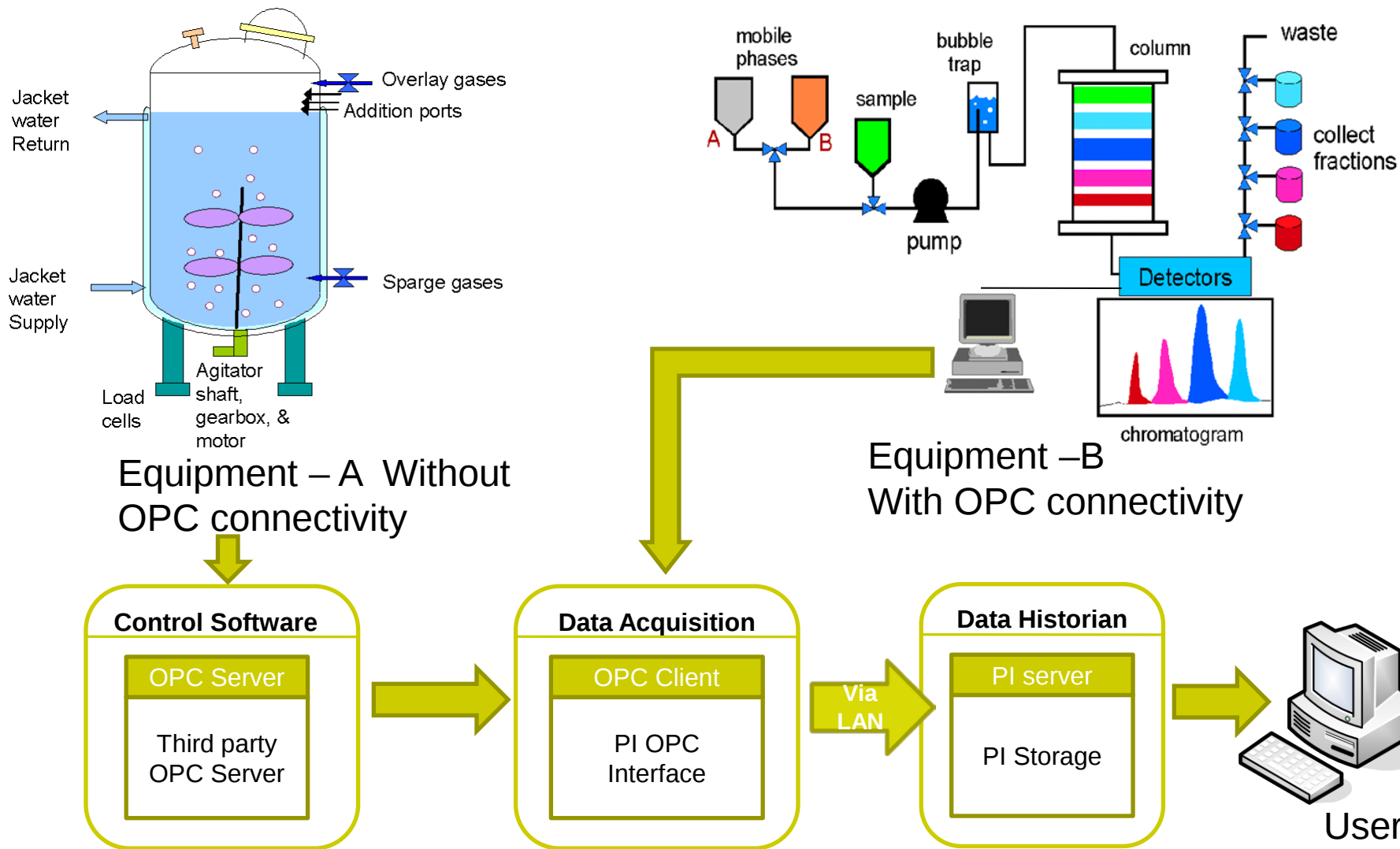
Outline

- **Biopharmaceutical Processes**
- **Data Collection and Archiving Systems**
 - PI ProcessBook
 - PI BatchView
 - PI DataLink
- **Soft sensors**
- **Statistical Process Control**

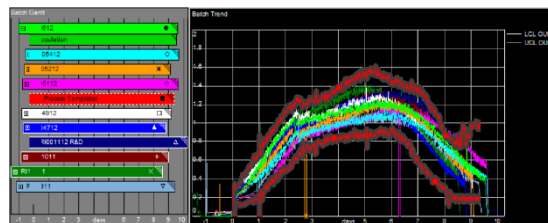
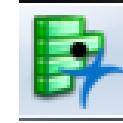
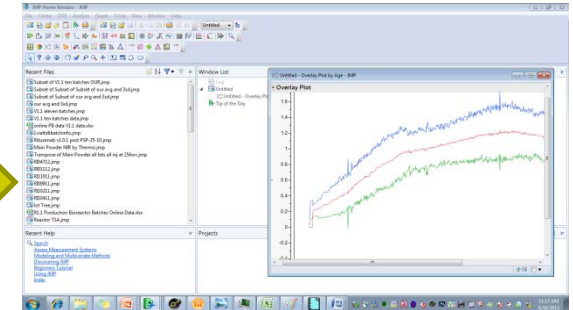
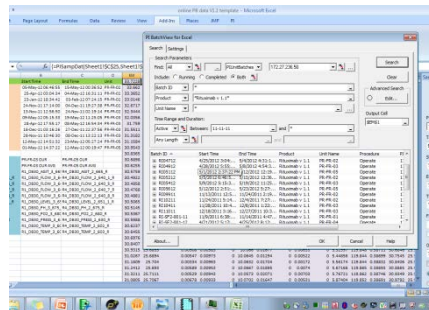
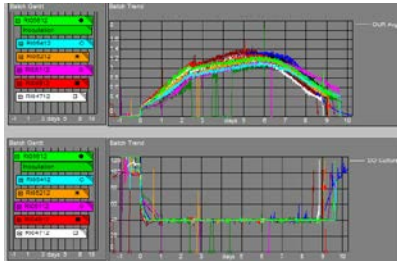
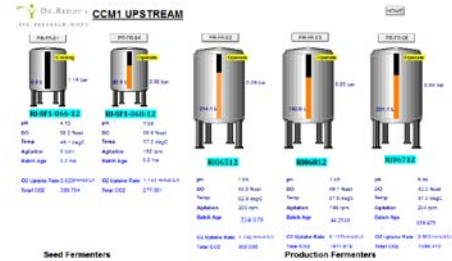
A Typical Biopharma Process



Equipment Communication to PI



Data Flow Overview



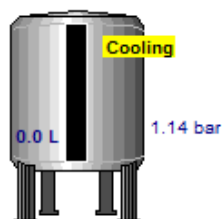
PI ProcessBook



UPSTREAM

HOME

PR-FR-01

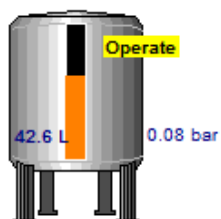


SF1-066-12

pH 4.13
DO 98.2 %sat
Temp 49.1 degC
Agitation 0 rpm
Batch Age 0.0 hrs

O2 Uptake Rate 2.823mmol/Lh
Total CO2 398.764

PR-FR-04

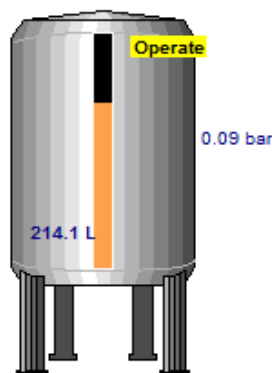


SF1-068-12

pH 7.06
DO 56.6 %sat
Temp 37.2 degC
Agitation 152 rpm
Batch Age 0.0 hrs

O2 Uptake Rate 1.141 mmol/Lh
Total CO2 277.601

PR-FR-02

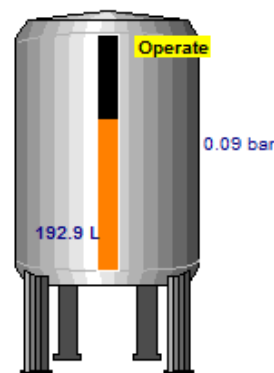


I06512

pH 7.05
DO 40.0 %sat
Temp 32.9 degC
Agitation 203 rpm
Batch Age 234.079

O2 Uptake Rate 1.140 mmol/Lh
Total CO2 989.096

PR-FR-03

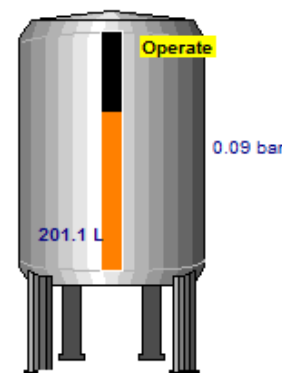


I06812

pH 7.06
DO 49.1 %sat
Temp 37.0 degC
Agitation 199 rpm
Batch Age 44.2518

O2 Uptake Rate 0.117mmol/Lh
Total CO2 1917.919

PR-FR-05



I06712

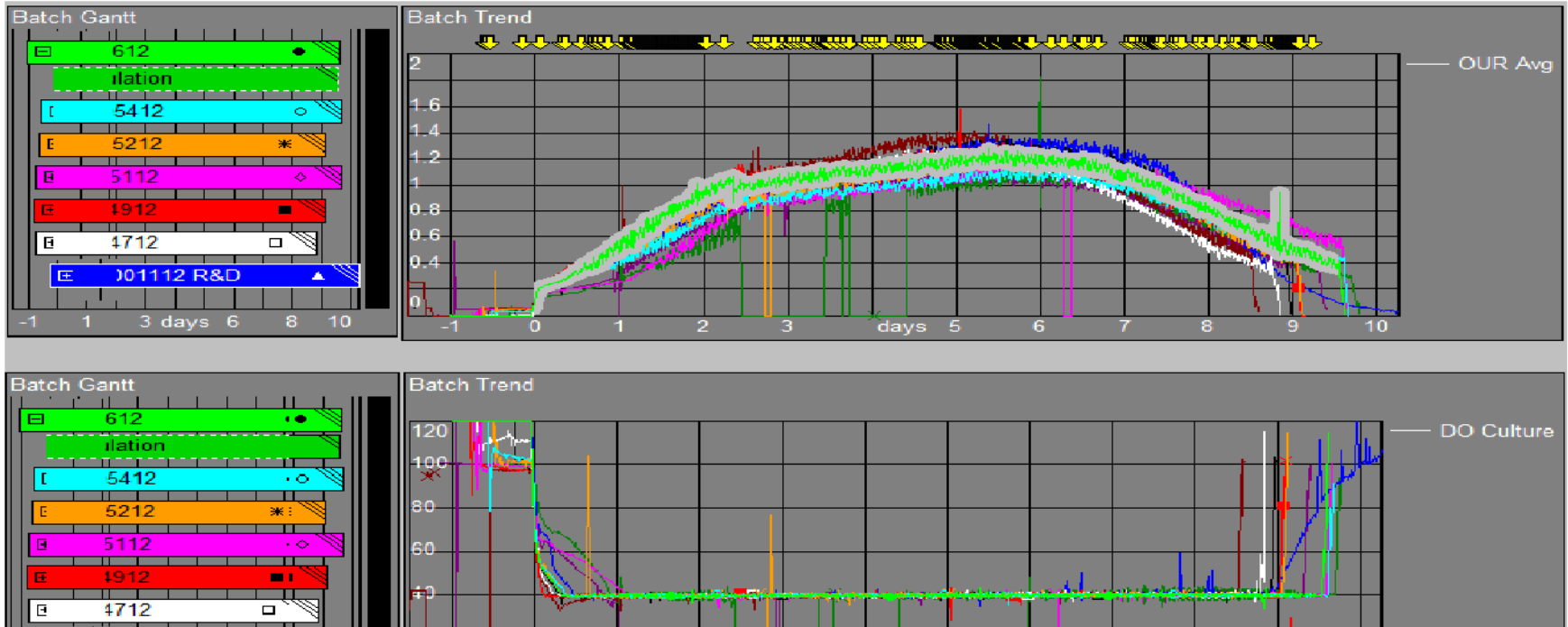
pH 6.94
DO 40.0 %sat
Temp 37.0 degC
Agitation 204 rpm
Batch Age 139.475

O2 Uptake Rate 0.903 mmol/Lh
Total CO2 1398.413

Seed Fermenters

Production Fermenters

PI BatchView



PI DataLink

The screenshot displays the PI DataLink software interface, which is integrated with Microsoft Excel. The Excel window shows a spreadsheet titled 'online PB data V1.1 template - Microsoft Excel'. The data table in the spreadsheet has the following columns: Batch ID, Start Time, End Time, Unit, and EM. The data rows show various process units and their associated times and values.

The 'PI BatchView for Excel' dialog box is open, showing search parameters and a list of batches. The search parameters include:

- Find: All
- PIUnitBatches: 172.27.236.50
- Include: Running, Completed, Both
- Batch ID: *
- Product: mab v 1.1*
- Unit Name: *
- Time Range and Duration: Active, Between: 11-11-11 and *
- Any Length: *

The list of batches shows the following columns: Batch ID, Start Time, End Time, Product, Unit Name, Procedure, and PI. The data rows show various process units and their associated times and values.

The 'Sampled Data' panel on the right shows the following settings:

- PI Tag: PI Expression
- PI Server (optional): 172.27.236.50
- Tagname(s): \$C\$14:\$C\$26
- Start Time: 'Sheet1'!\$B\$11
- End Time: 'Sheet1'!\$C\$11
- Time Interval: 10 s
- Filter Expression (optional):
- mark as filtered: ☐
- Output Cell: 'Sheet1'!\$E\$1
- show timestamps: ☐
- column: ☒
- row: ☐

The Need

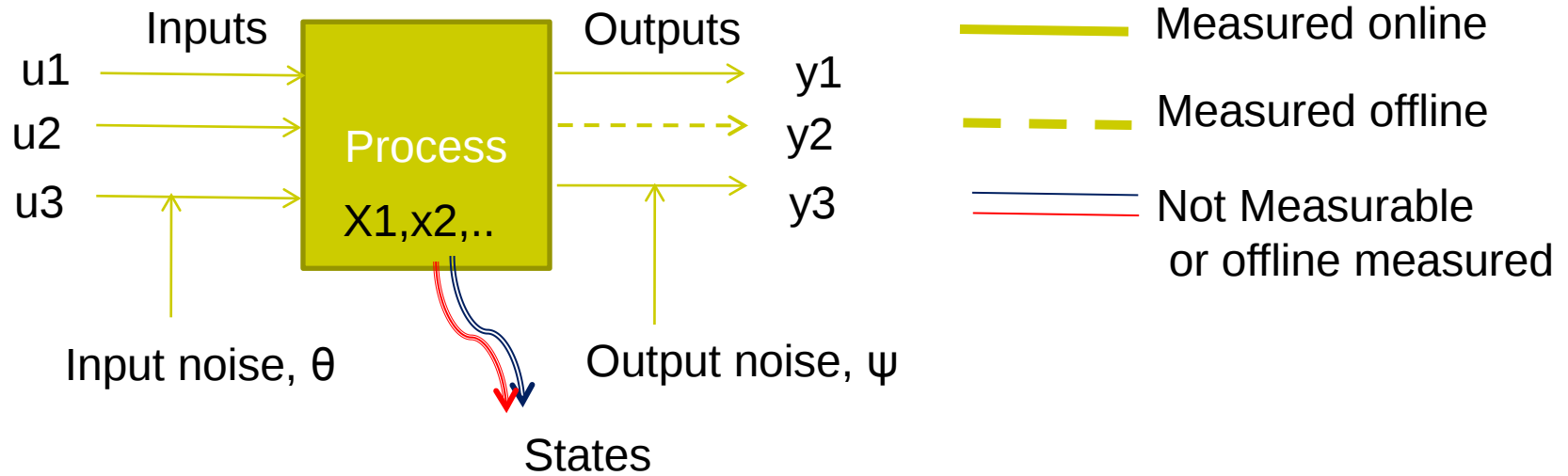
- Measurement of key process variables
- Issue
 - Available only offline
 - Measurements not reliable
 - Corrupted with sampling and measurement error
- Solution
 - Soft Sensors

Soft Sensors

Models that provide **online estimation** of **variables** that can not be measured online **using** several **other measurements**

- Provides Opportunity
 - To **monitor** process **measurements** where physical **equivalents** are **unrealistic** or even impossible.
- Sensor output
 - Can be a **control signal**, advisory information for operators, **predictions of product quality**, information on process faults or outliers in data.

Models



$$X = f(u, y, \theta, \psi)$$

Performance Equation

The screenshot shows the 'Performance Equations - PI System Manager' application. On the left, a tree view lists various system components like 'Servers', 'Alarms', 'Data', and 'Security'. The main area is divided into a list of servers (DRLINBIOPISRV01) and a large equation editor. The equation editor contains a complex mathematical formula with a yellow highlight over the top part. Below the equation editor, there's a 'Session Record' table with columns for 'Timestamp' and 'Value'. The status bar at the bottom shows the user 'CORP\piadmin' and the system 'piadmin, PIWorld'.

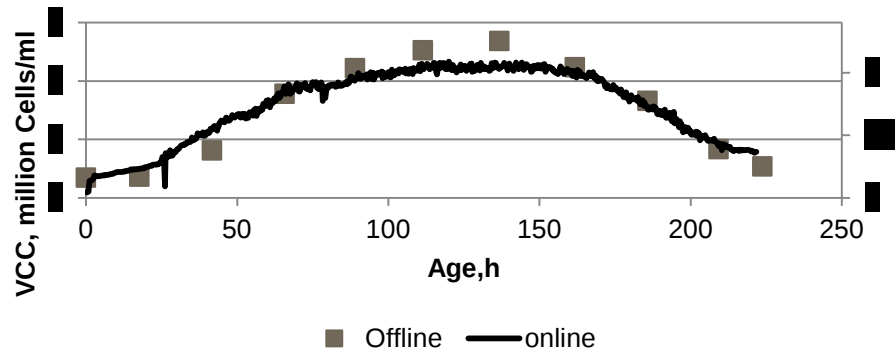
max(0,if 'R1_DB30_TEMP_3_602_R'>35
then
((0.21*'R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')/('R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')*((1+('R1_DB30_PRESS_3_630_R'/1.01325))*(1-0.06028)*0.973/0.920615339)-
(0.00204*'R1_DB30_PO2_3_680_R'))*(2.28*('R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')+1.542)
else
((0.21*'R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')/('R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')*((1+('R1_DB30_PRESS_3_630_R'/1.01325))*(1-0.06028)*0.973/0.942530876)-
(0.00204*'R1_DB30_PO2_3_680_R'))*(2.28*('R1_DB30_FLOW_3_640_1_R'+*R1_DB30_FLOW_3_640_8_R')+1.542))

Timestamp:	Value:
Snapshot: 6/20/2012 3:20:19 PM	1.863

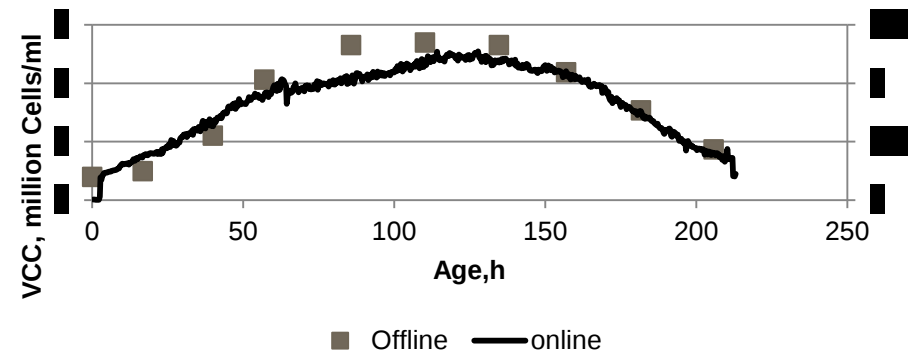
Session Record

CORP\piadmin piadmin, PIWorld

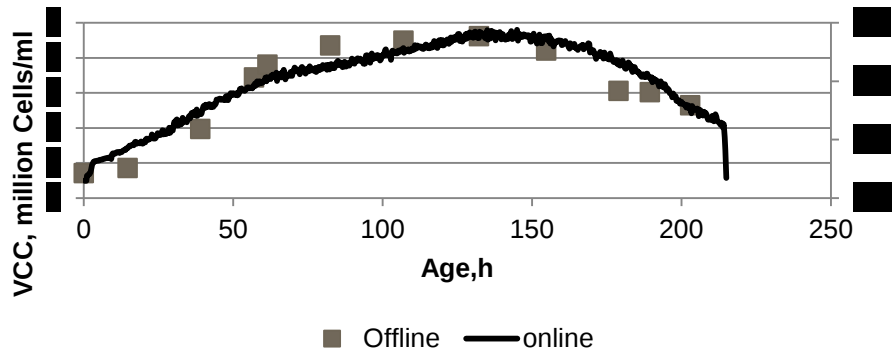
Batch1



Batch2

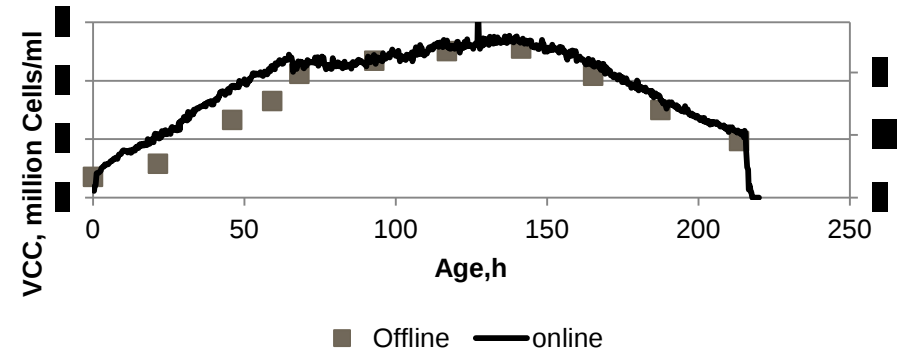


Batch3

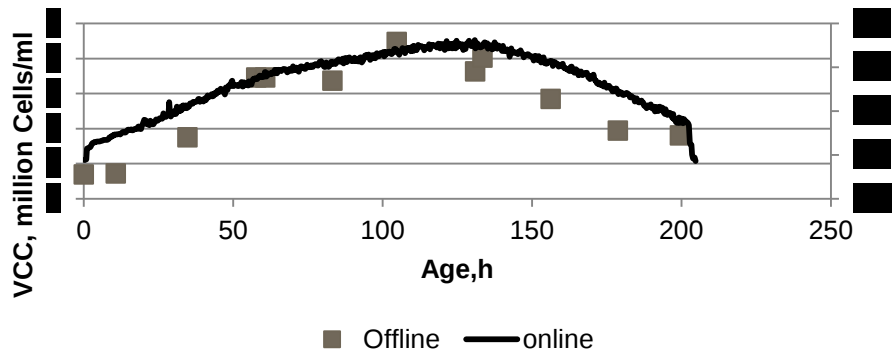


Training Set

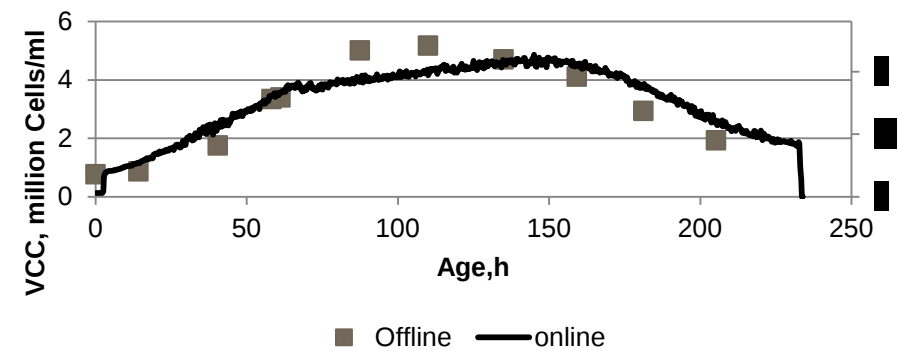
Batch4



Batch5

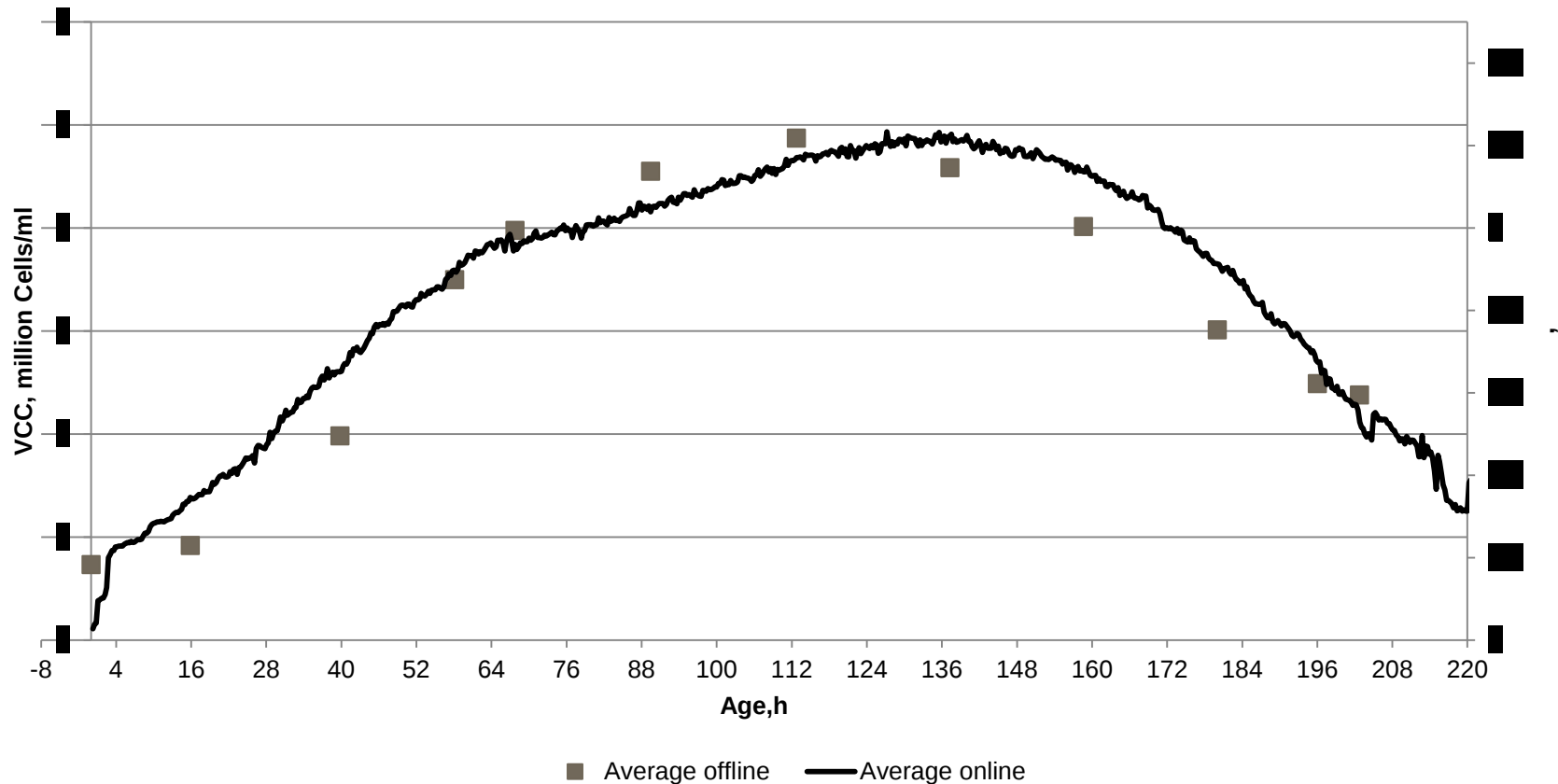


Batch6

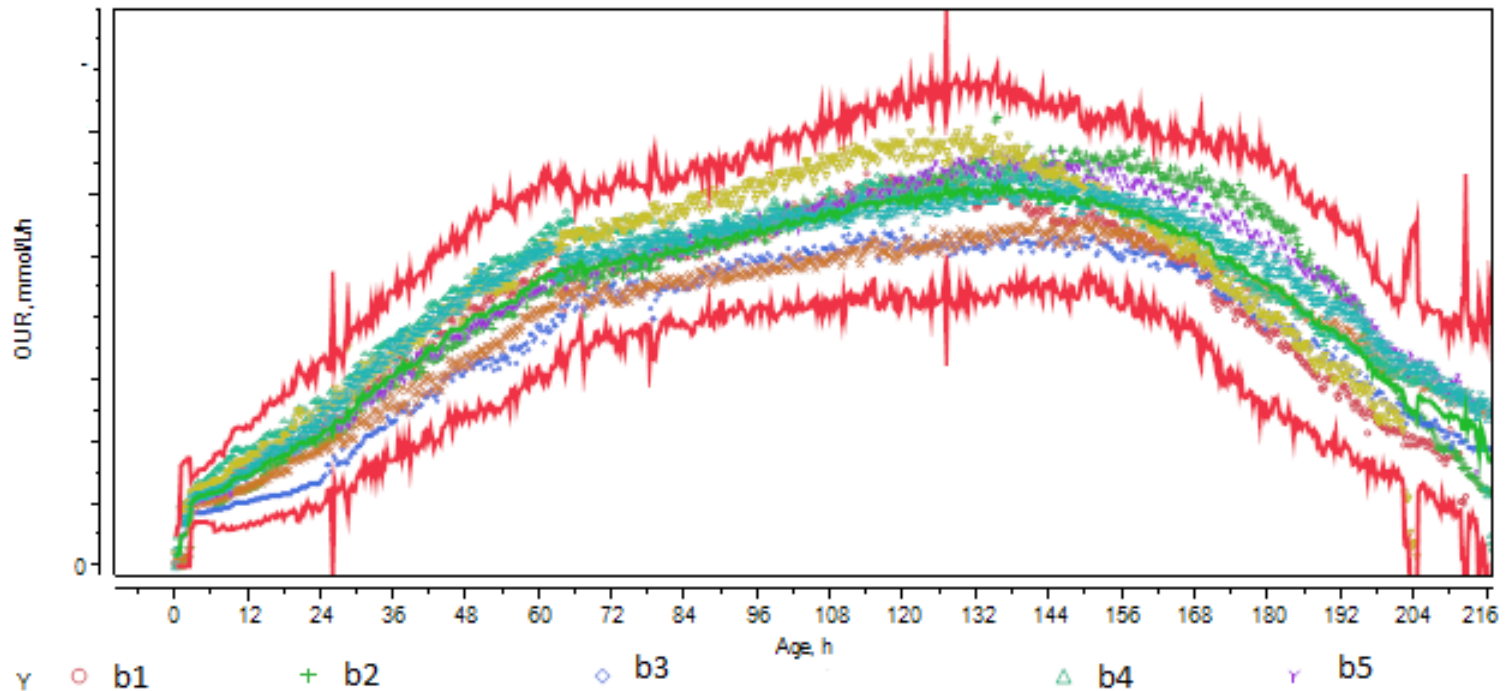


Soft-sensor Estimation

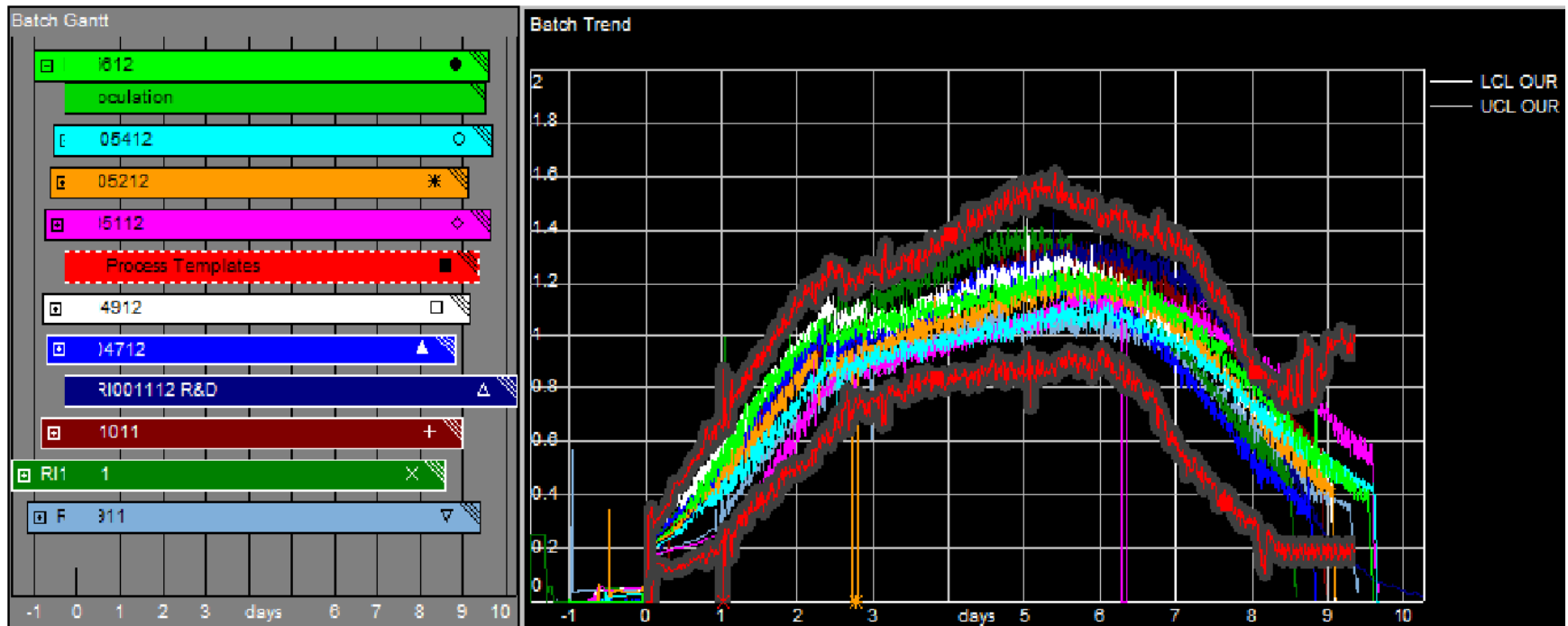
Variable Offline Measured Vs Soft-sensor Online Estimated



Statistical Process Control



Batch View with Control limits



Acknowledgements

- Ms Devi – PI Administrator
- Ms Narayani – Enterprise Systems Team
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- Manufacturing Department

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