



Technology Overview of PAT in Biochemical Manufacturing

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Summary of Current Measurements

- ◆ Optical Density
- ◆ Temperature
- ◆ Pressure
- ◆ Volume
- ◆ pH
- ◆ Dissolved O₂
- ◆ O₂ and CO₂ flow
- ◆ Conductivity
- ◆ Flowrate (air & liquid)
- ◆ Turbidity



Future Areas for Growth

Sensors that could be implemented now

- ◆ Capacitance (viable cell density)
- ◆ NIR (moisture & vacuum detection in lyophilized vials)

Sensors for the near future

- ◆ Biosensors

Sensors for the more distant future

- ◆ NIR in aqueous streams
- ◆ Fluorescence
- ◆ Raman

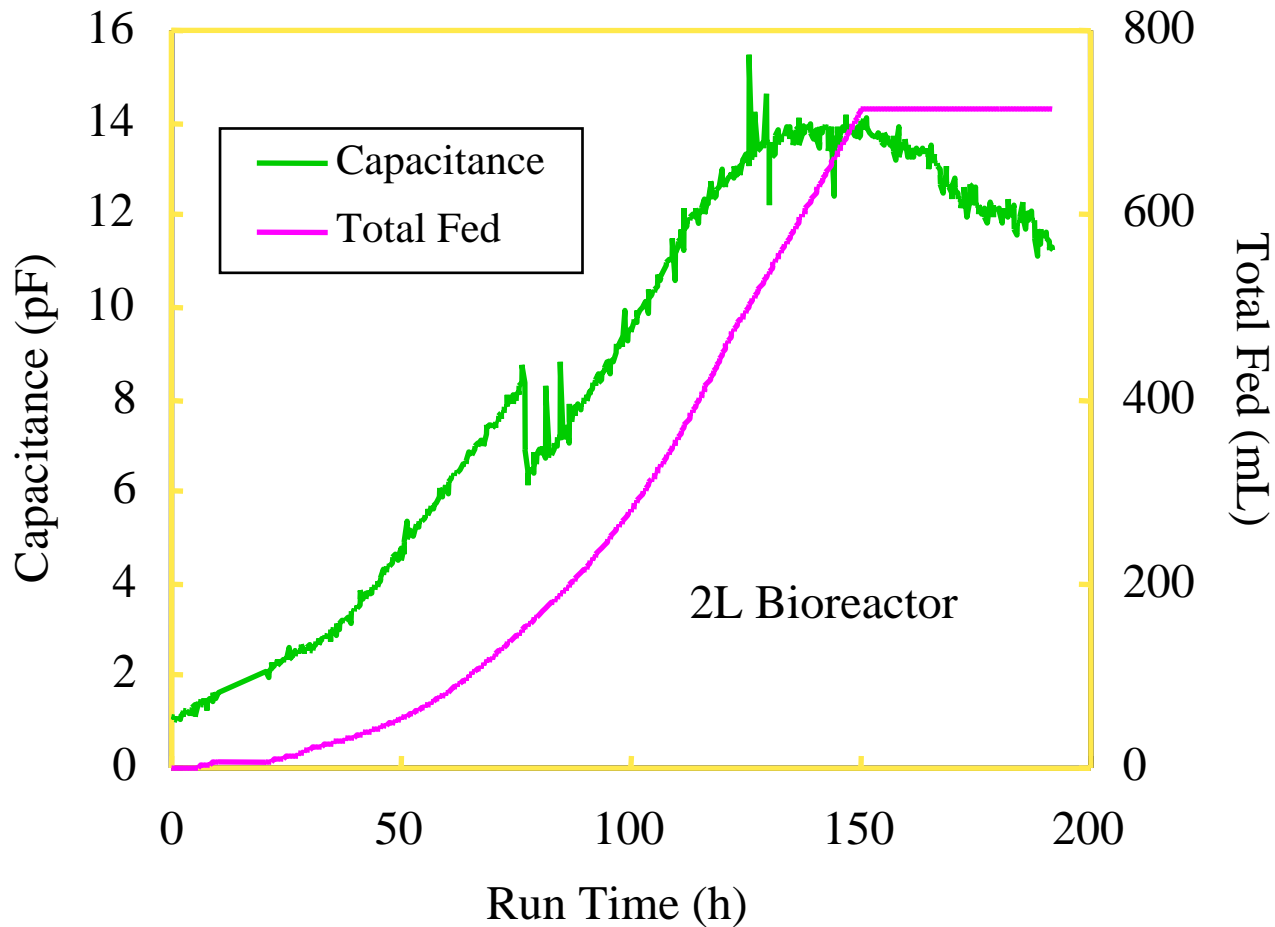


Future Areas for Growth

Technologies other than sensors

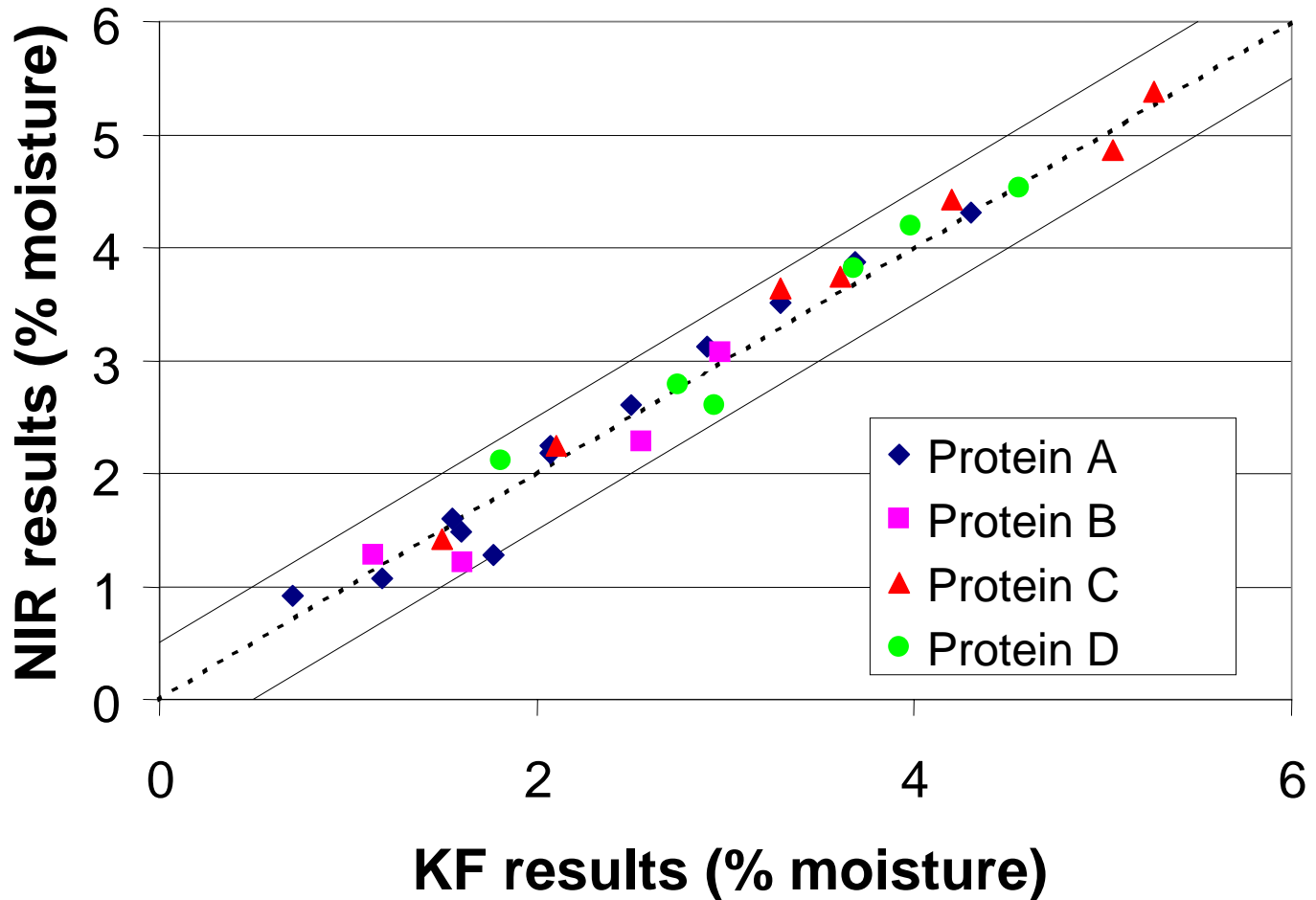
- ◆ Data technology
- ◆ Raw Material Characterization
 - ❖ NIR, Raman, ICP, etc.
- ◆ Rapid Microbial Detection

Capacitance probes can measure viable cell count

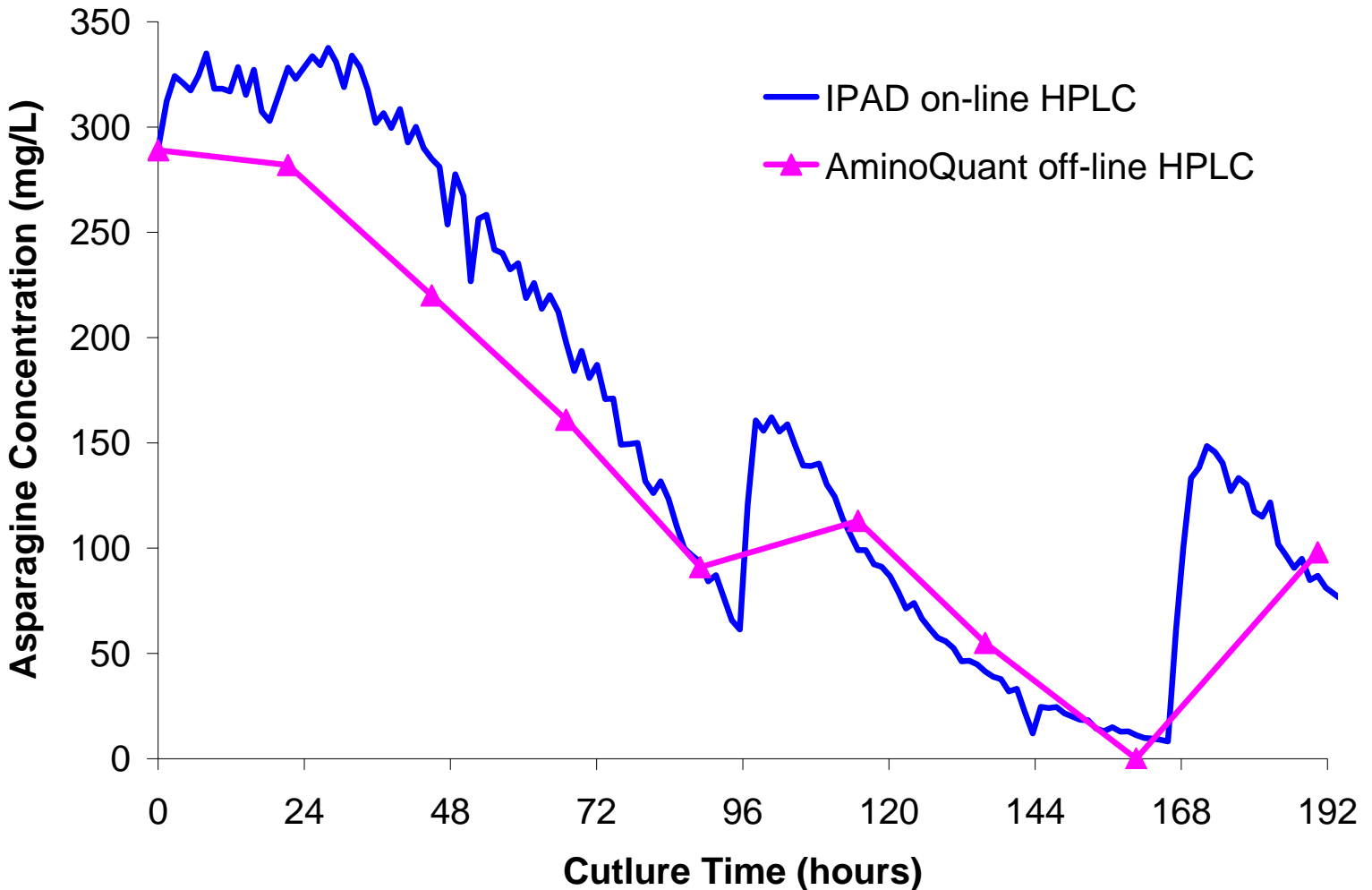


Data courtesy of Bob Kiss and Paul Magreta

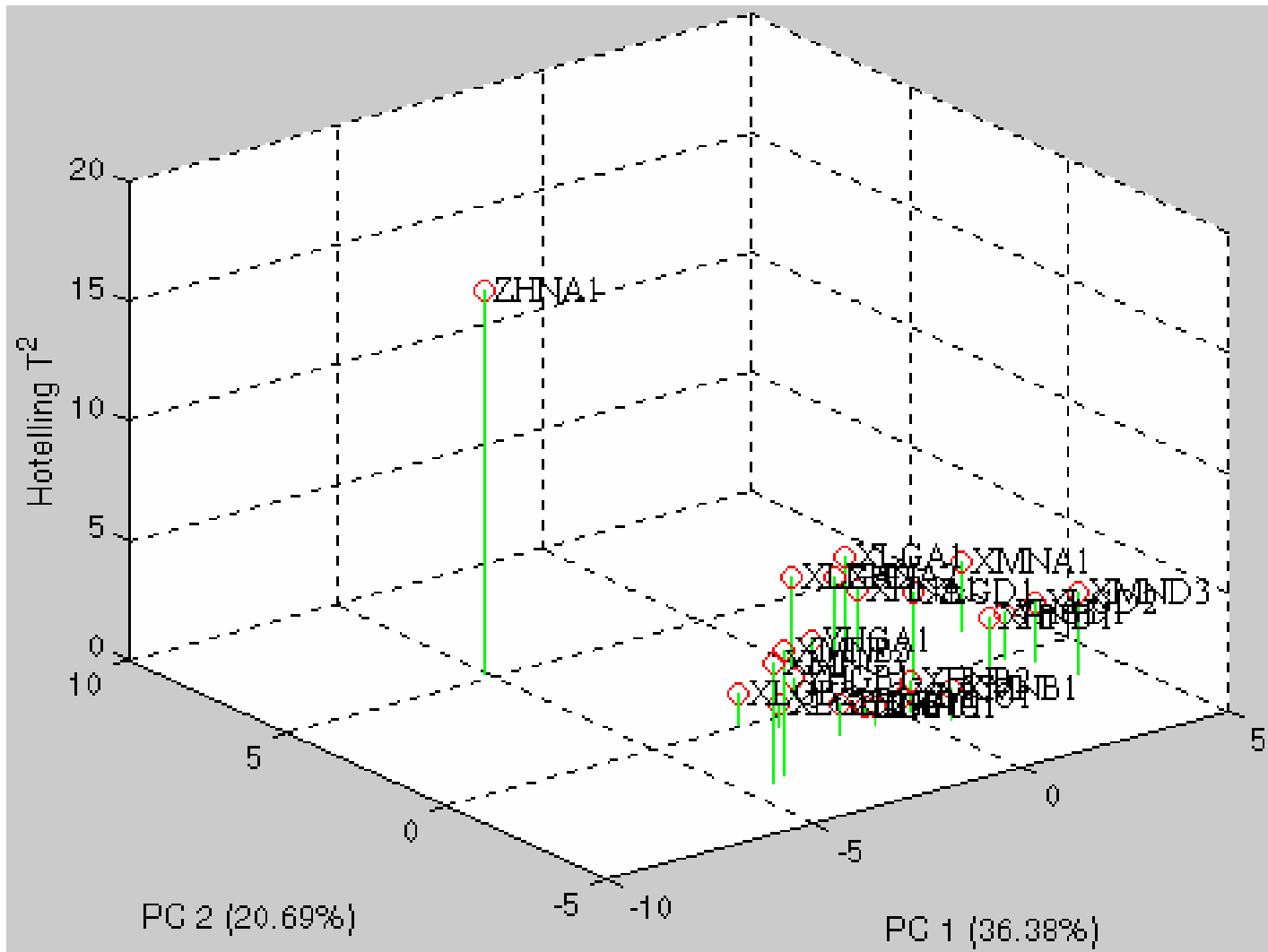
NIR to replace destructive moisture detection in lyophilized vials



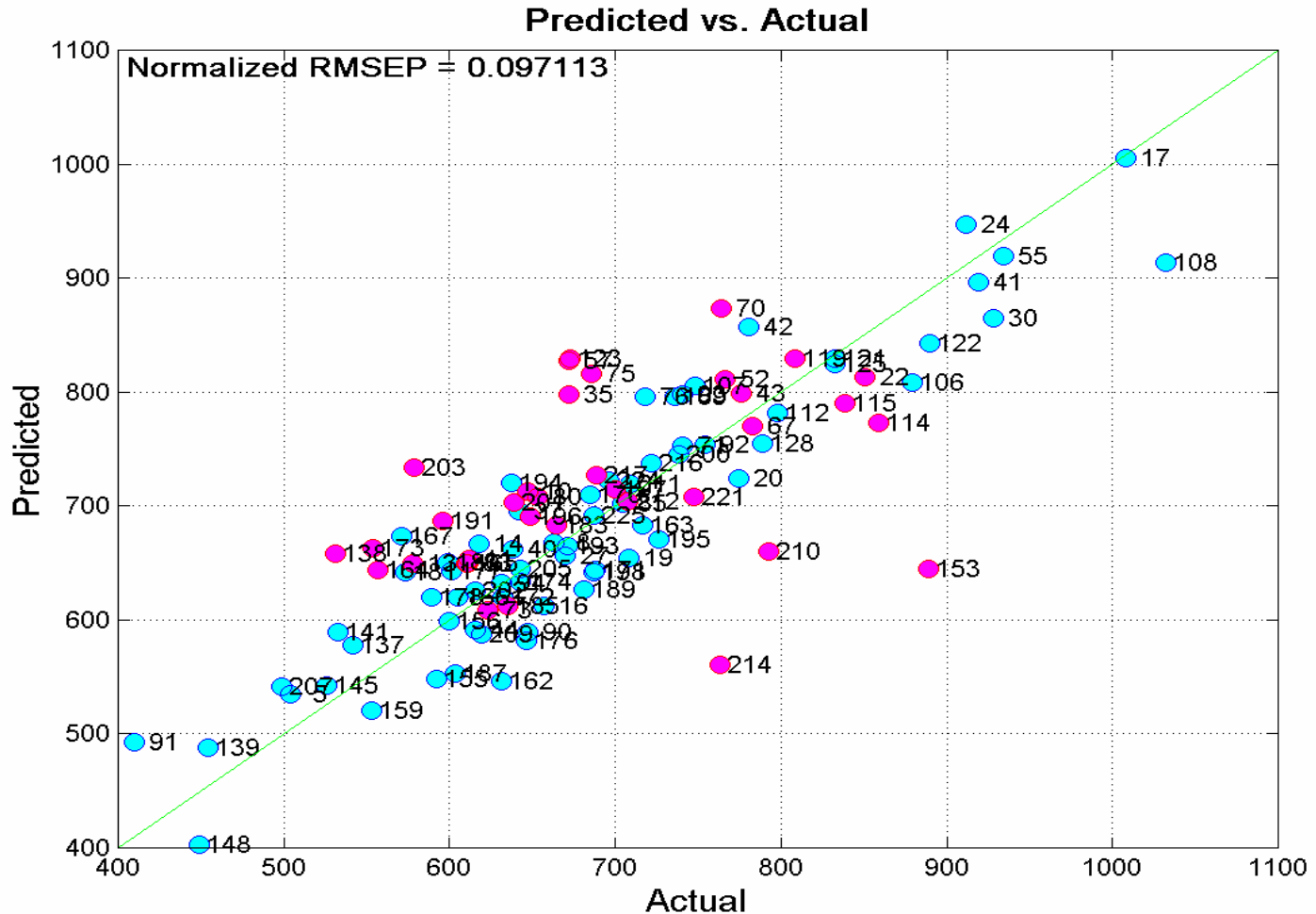
Amino acid & sugar analysis (HPLC shown, biosensor better)



Product Z exhibits variation inside of the model



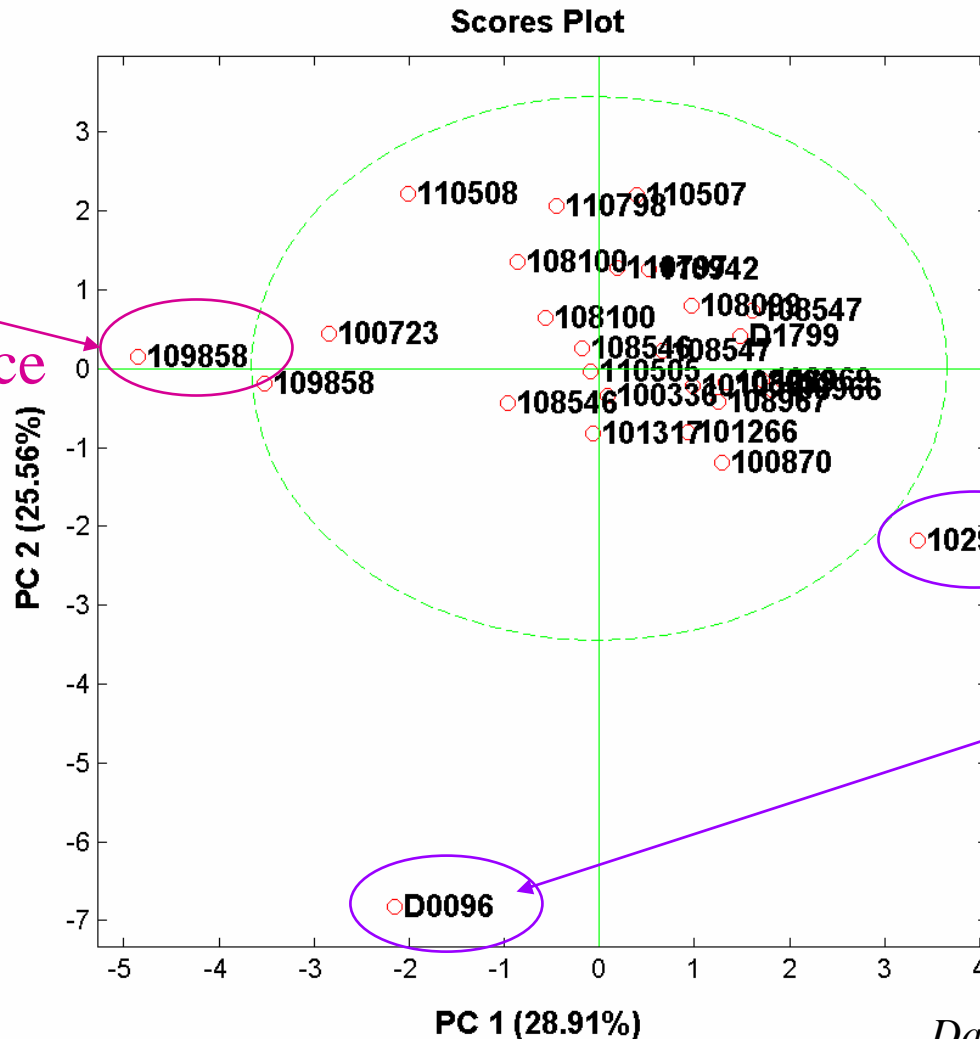
PLS model to predict titer based on 1695 variables



Correlating raw material ICP results to process performance

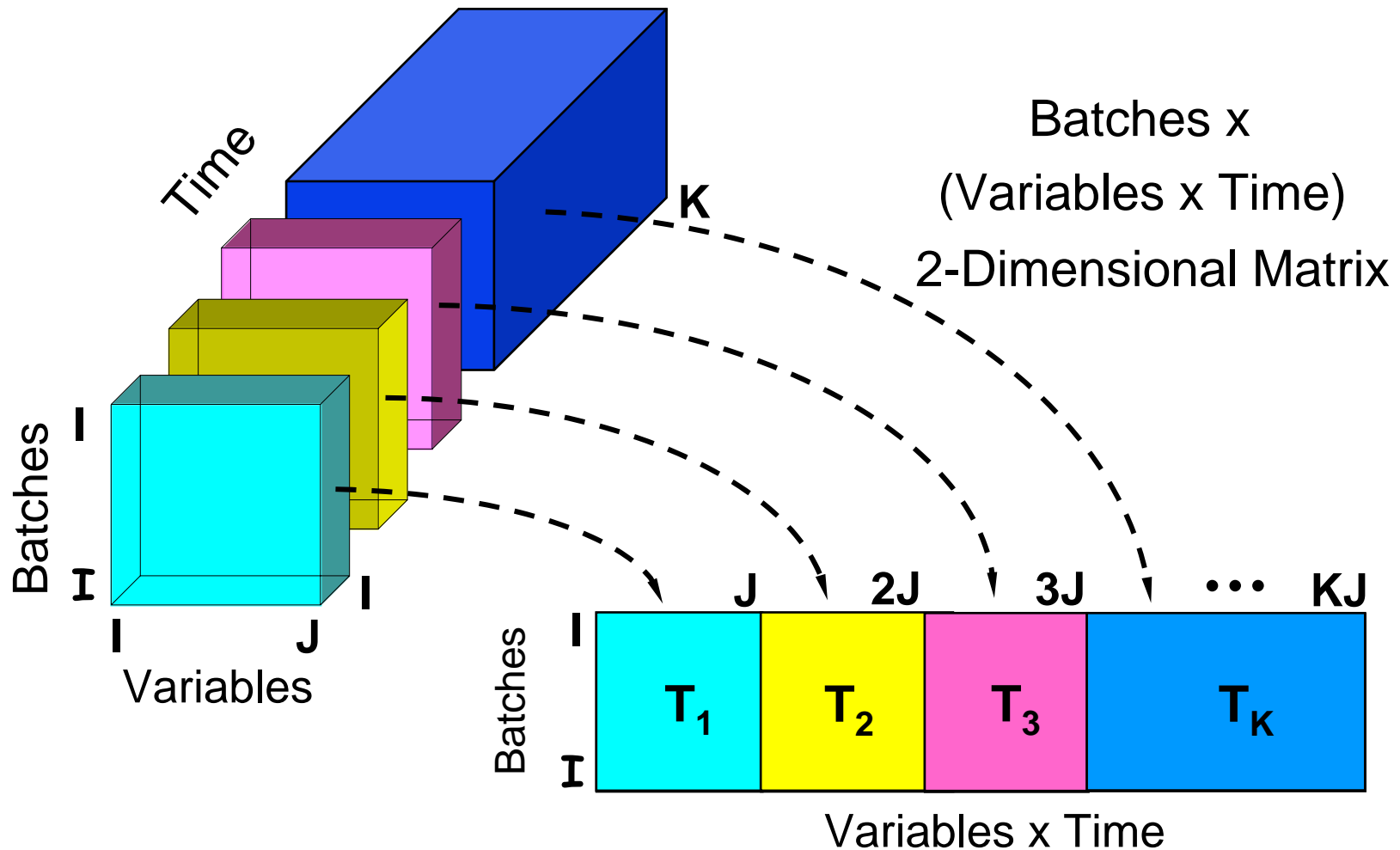


Good
Performance

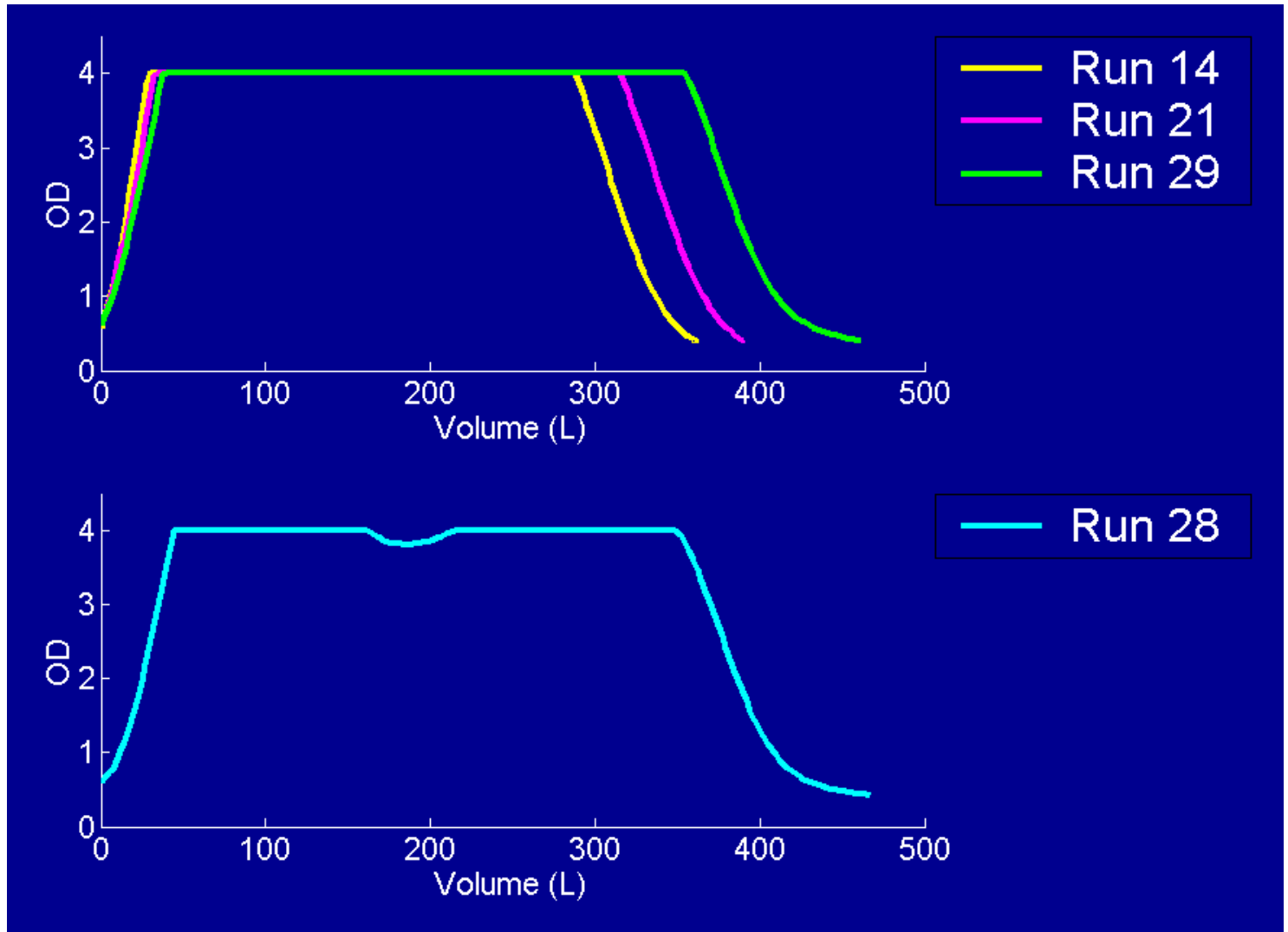


Poor
Performance

Multi-way PCA

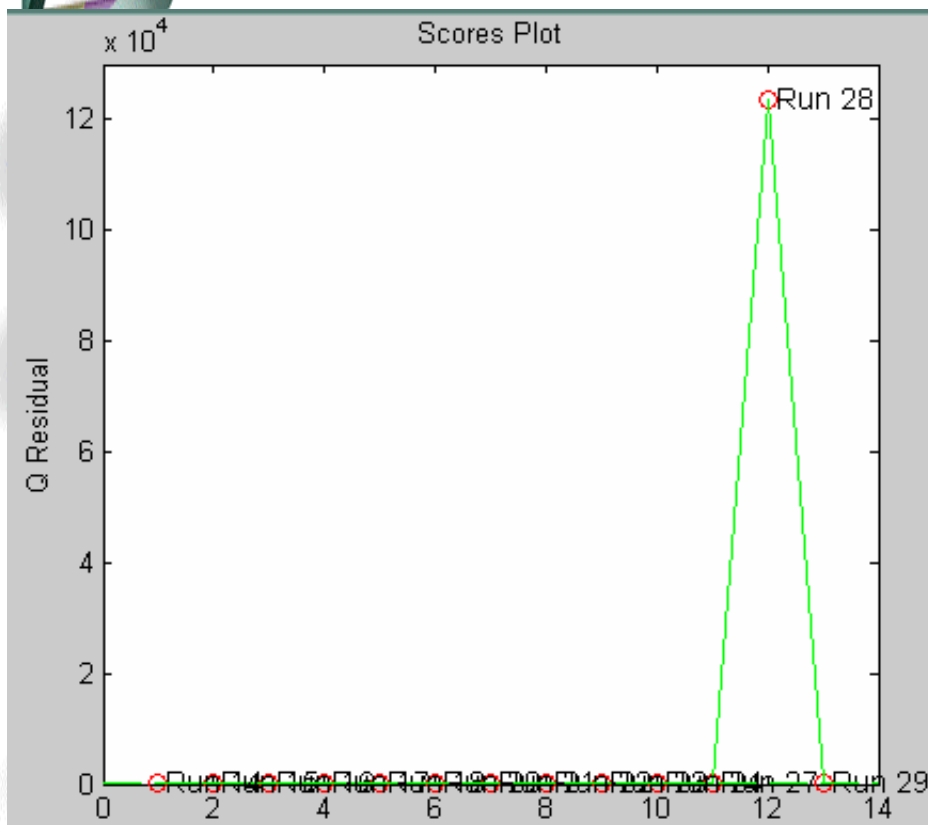


MPCA for chromatogram review



PCA analysis easily picks up change in peak shape

Q_{residual}



Hotelling's T²

