ATOFINA

H. Amort, P. Robinson

Targeted Quality Control

PI Batch in QC

Contents

1 Company Info

2 The Idea

3 Implementation

4 Current Status

5 Future Plans

Company Info

Total

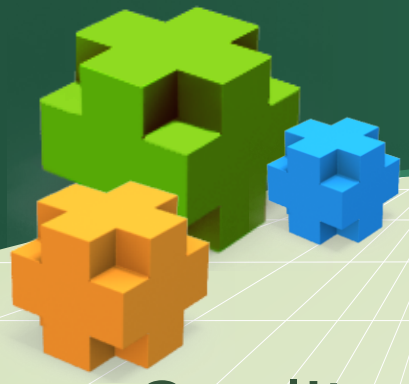
ATOFINA

ATOFINA Chemicals, Inc.

HQ: Paris, France
Emp: 121,500
Sales: $118 billion

HQ: Paris, France
Emp: 61,000
Sales: $19 billion

HQ: Philadelphia
Emp: 2,600
Sales: $1.5 billion

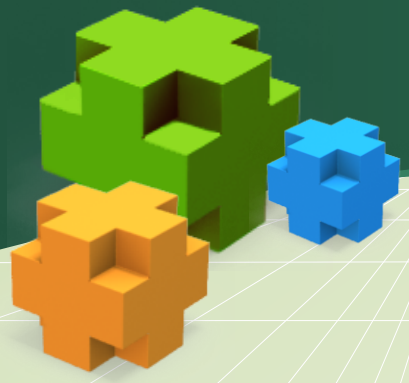


Introduction

Quality control (QC) necessary step in production to assure critical product properties.

But QC is expensive:

- Labor and equipment
- Batch delay awaiting results before transfer



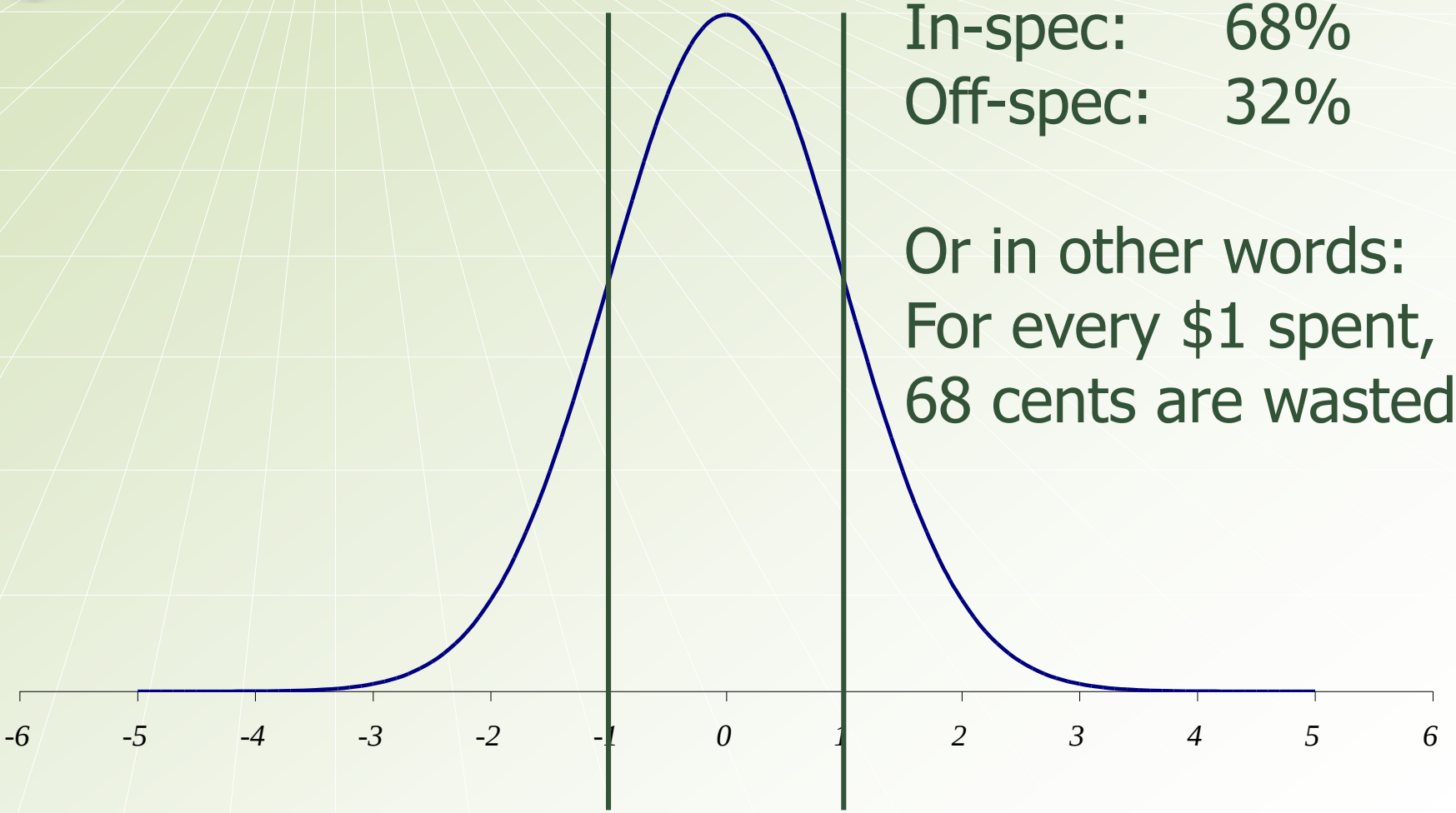
Quality control limits

Commonly QC limits are set symmetrically around a target value.

There is a lower and upper spec limit.

All products that fall between this limits are in-spec, all other products off-spec.

QC benefit and cost



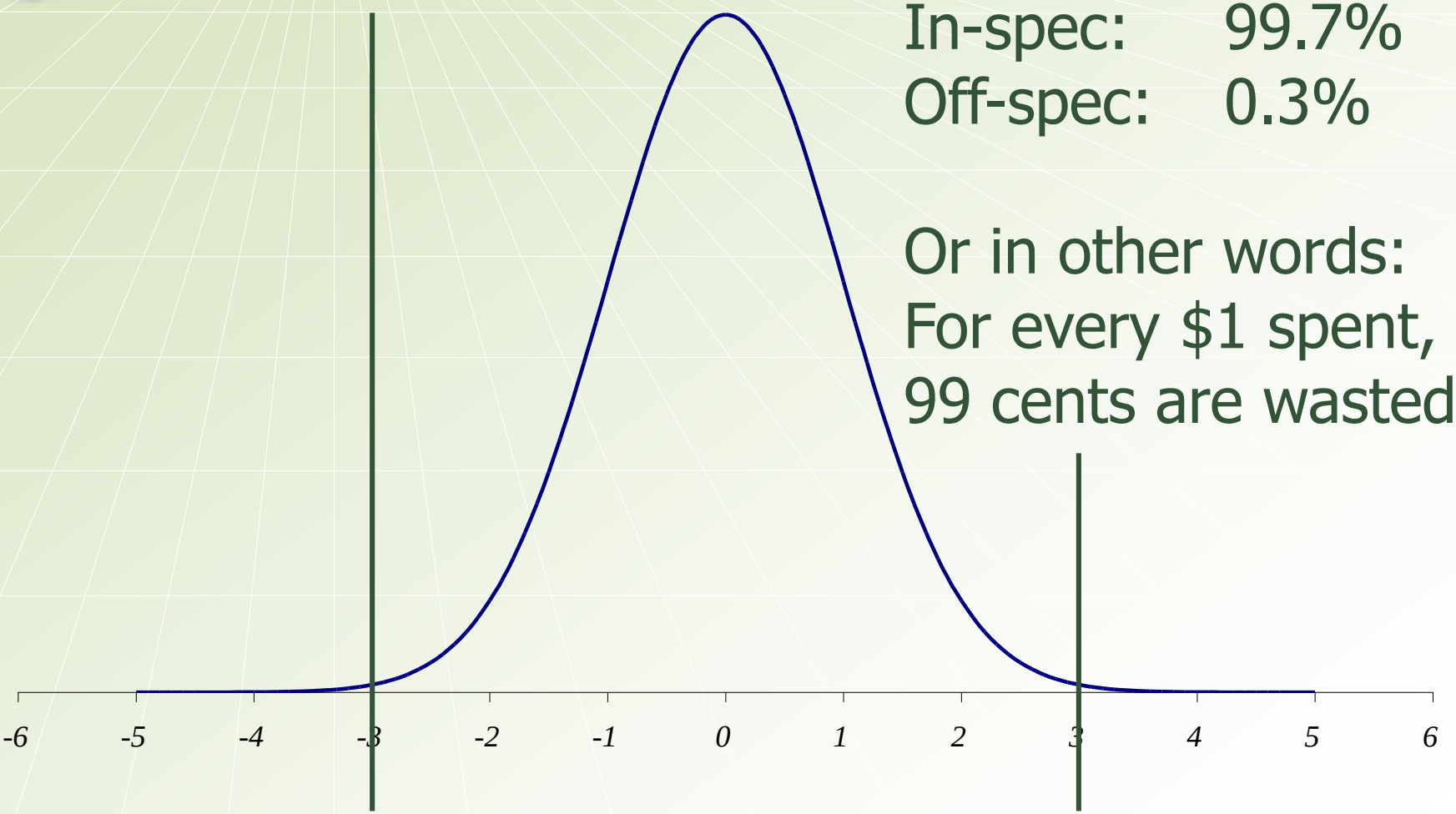
Limits = ± 1 stdev.
In-spec: 68%
Off-spec: 32%

Or in other words:
For every $1 spent,
68 cents are wasted.

More realistic

Limits = ± 3 stdev.
In-spec: 99.7%
Off-spec: 0.3%

Or in other words:
For every $1 spent,
99 cents are wasted.



Targeted quality control

Rather than sample every batch why not just sample the batches which look unlike previous good batches?

The potential cost savings are substantial.

Example: 150 batches / year

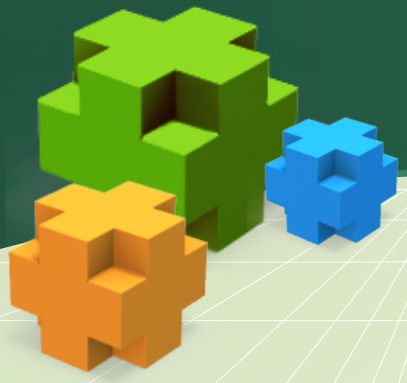
3 h. lag time

3,500 $/operational hour

= 1.6 M$

70% reduction = 1.12 M$

Targeted Quality Control



- Instead of 100% now sample only 30%
- A question of where to draw the line
- Tighter limit -> greater savings -> more risk of missing a “bad” batch
- As confidence grows, limit can be tightened further
- More data allow correlation improvements

Situation in Atofina's Mobile plant

Some key properties difficult/time consuming to measure

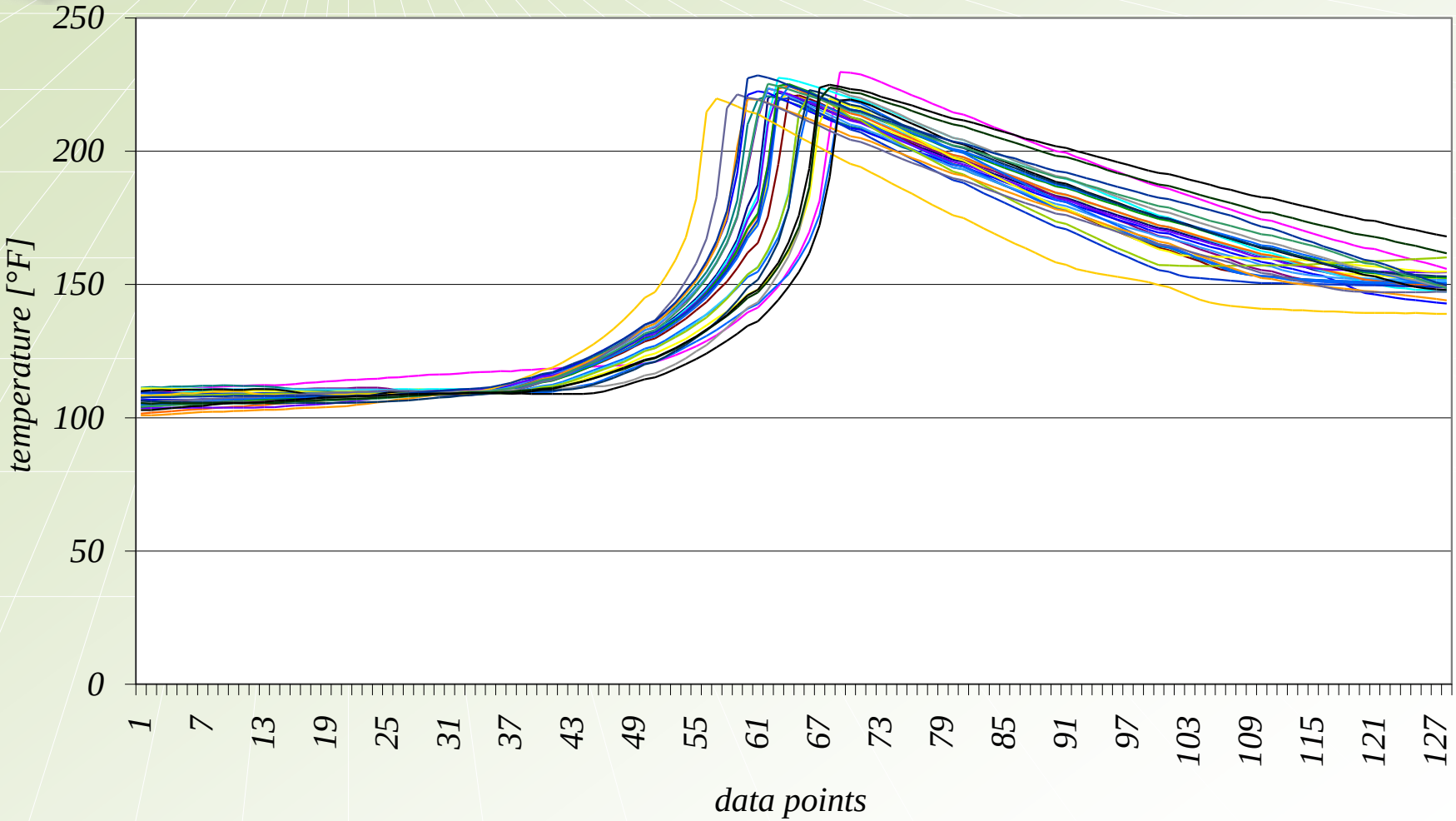
Specification limits are set appropriately (> 99%)

"In 2003 some products never failed quality control … but we still measured all of them."

Model Creation

1. Collect historical batch profiles and QC results

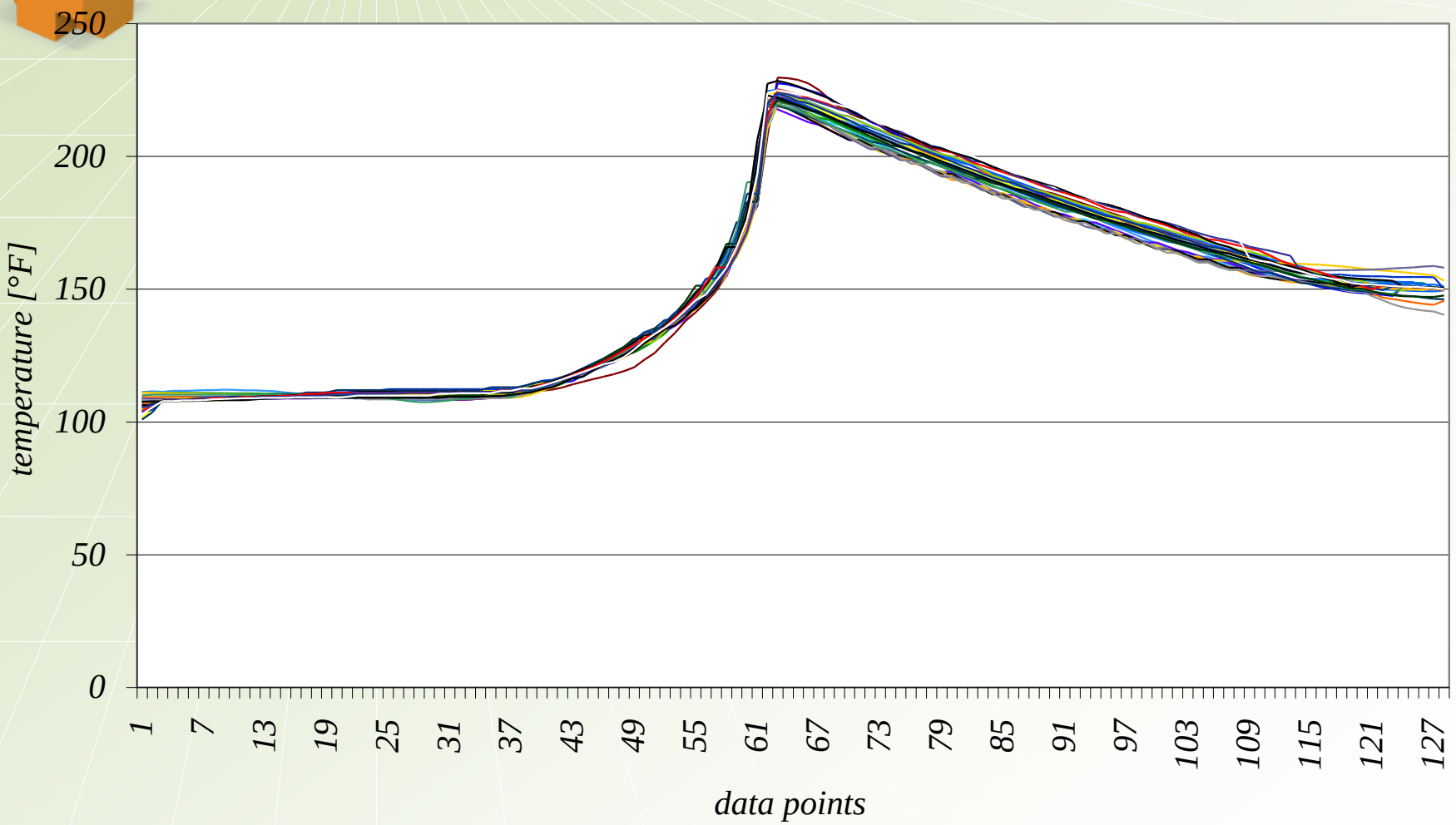
Model Creation



Model Creation

1. Collect historical batch profiles and QC results
2. Batch Alignment (Dynamic Time Warping)

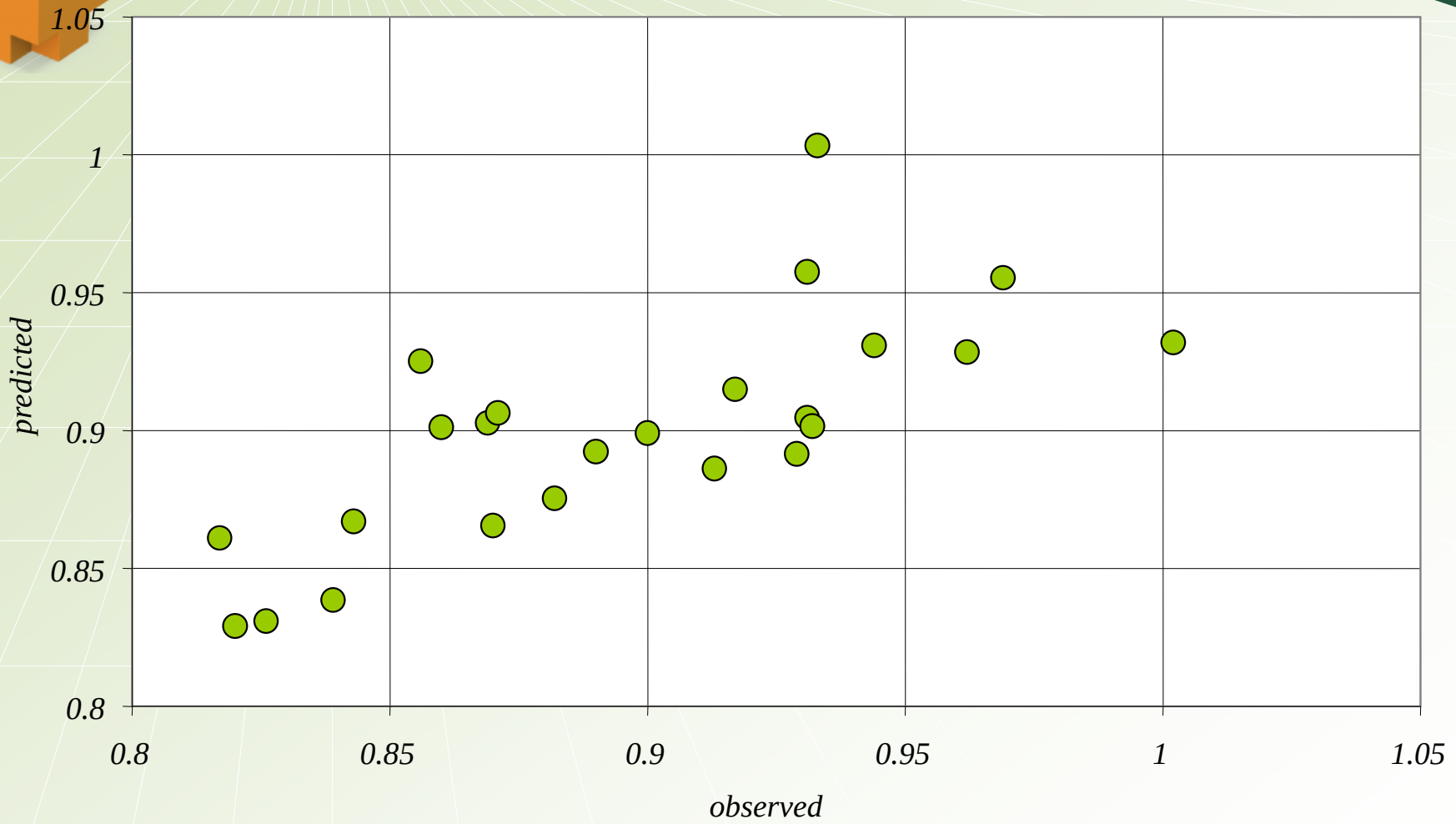
Model Creation



Model Creation

1. Collect historical batch profiles and QC results
2. Batch Alignment (Dynamic Time Warping)
3. Data centering
4. Model generation
5. Relevant factors
6. Calculated values

Model Creation



Model Creation

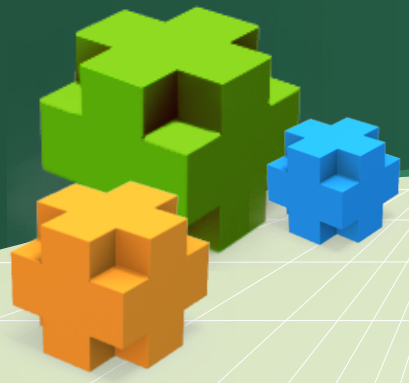
1. Collect historical batch profiles and QC Results
2. Batch Alignment (Dynamic Time Warping)
3. Data centering
4. Model generation
5. Relevant factors
6. Calculated values
7. Control limits
8. Output to .csv

TQC elements

Profile Processing:

1. New batch profile
2. Input from .csv model file
3. Batch Alignment
4. Data centering
5. Calculate parameter
6. Submit to testing (Pass/Fail)

Fail means "sample to QC"



PI-Global Support Team

- Team formed to facilitate PI developments worldwide within Atofina Chemicals
- Assist in PI installations, upgrades, new interfaces, etc.
- Particularly interested in plant-based initiatives with application across the company
- TQC a perfect example

PI Implementation

Two Parts (for PI-Global Support Team):

- Real-time profile processing
  - ProcessBook-based VBA code
  - To be used in unit by operators to determine whether batch should be sampled
  - Simple yes/no answer
- Semi-Automated Model Generation
  - Excel-based VBA code
  - Makes model generation more convenient
  - Includes simple outlier identification

Profile Processing

- Equations working fine in Excel with manually collected batch data
- ProcessBook created with equations pasted in as modules
  - Simple BatchView control used to select a batch (nice functionality for testing)

File Edit View Insert Tools Draw Arrange Window Help

100%

atch Number:

Recipe:

Batch Search

Plot-0
260
200
150
100
3/9/2004 10:02:26 AM

Plot-0
260
220
170
120
3/9/2004 11:48:28 AM

Batch query configuration

Main | Filter | Results

Records to find: all

PI server: Connections...

Search time
From: * To: *-50d

Ignore batch records which are still in progress

Contents
Batch: all
Unit: is
Product: is

Please select one or more results before clicking OK.

OK Cancel

Time: 3/9/2004 10:02:26 AM
me: 3/9/2004 4:21:57 PM
on: 379 minutes

Flags

Time: 09-Mar-04 11:48:28
ime: 09-Mar-04 14:17:47
on: 149 minutes

Sample Size 128

Grab Fixed Sample Size

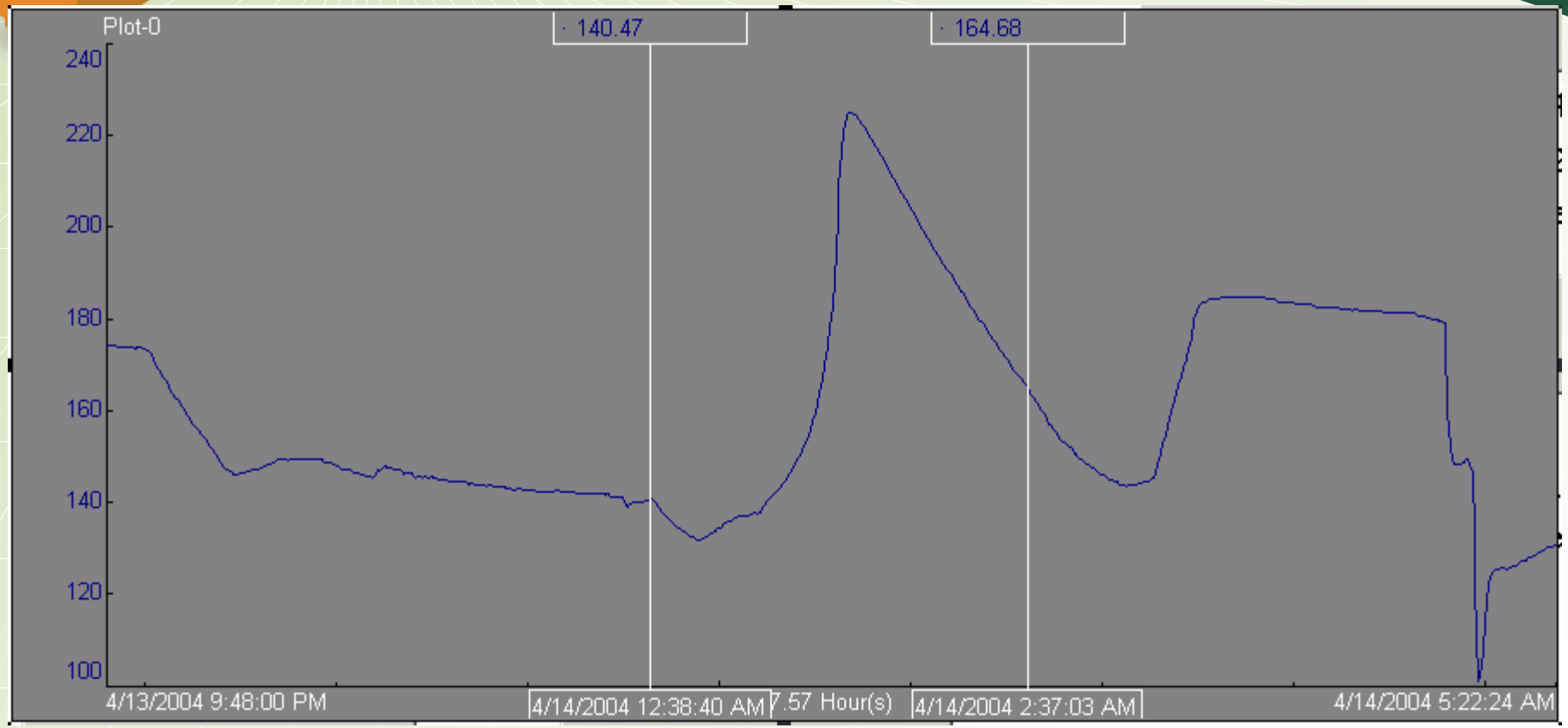
Write Out Raw Data

Check Profile

NUM

Profile Processing

- Model only requires a small portion of the batch profile (reaction step)
  - For example, beginning of Step 15 to end of Step 20
- ProcessBook code returns start and end time based on these specified flags


Plot-0
· 140.47
· 164.68
240
220
200
180
160
140
120
100
4/13/2004 9:48:00 PM
4/14/2004 12:38:40 AM
7.57 Hour(s)
4/14/2004 2:37:03 AM
4/14/2004 5:22:24 AM

Profile Processing

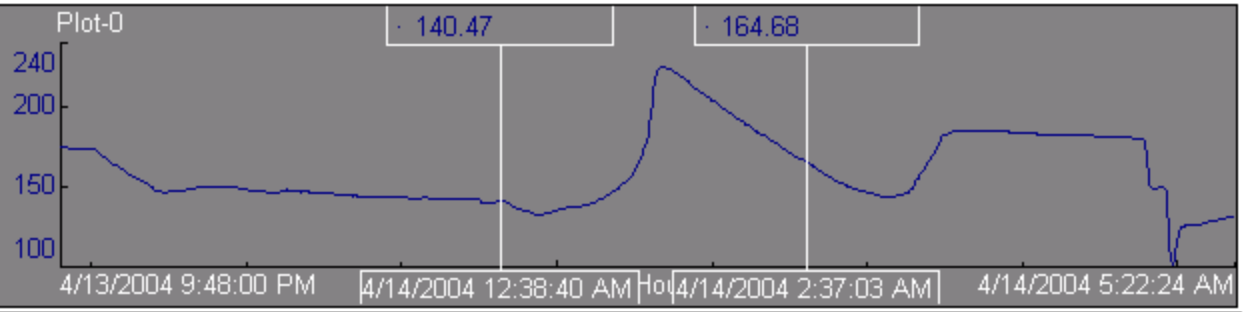
- Equations require a fixed sample size… 128 points for now
- PB code makes piar_timedvalues call to retrieve evenly spaced samples over flag-based time period

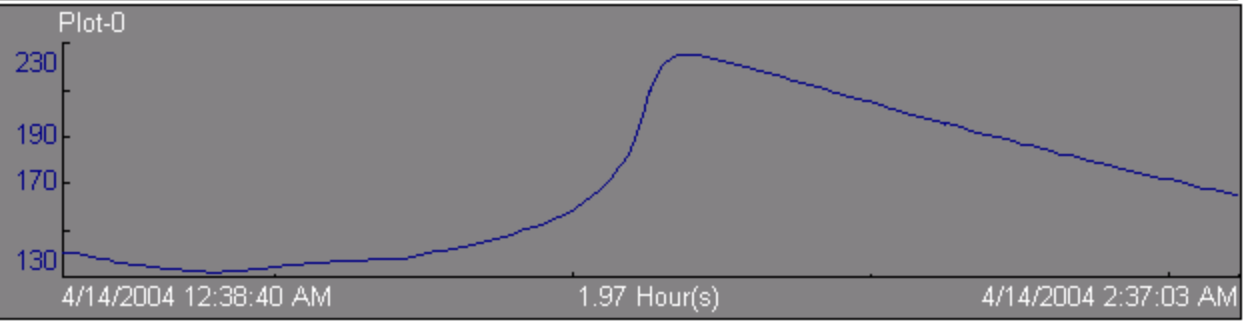
File Edit View Insert Tools Draw Arrange Window Help

100%

atch Number:

Recipe:





Batch Search

Begin Time: 4/13/2004 9:48:00 PM

End Time: 4/14/2004 5:22:24 AM

Duration: 454 minutes

Flags

Begin Time: 14-Apr-04 00:38:40

End Time: 14-Apr-04 02:37:03

Duration: 119 minutes

Sample Size 128

Grab Fixed Sample Size

Write Out Raw Data

Check Profile

NUM

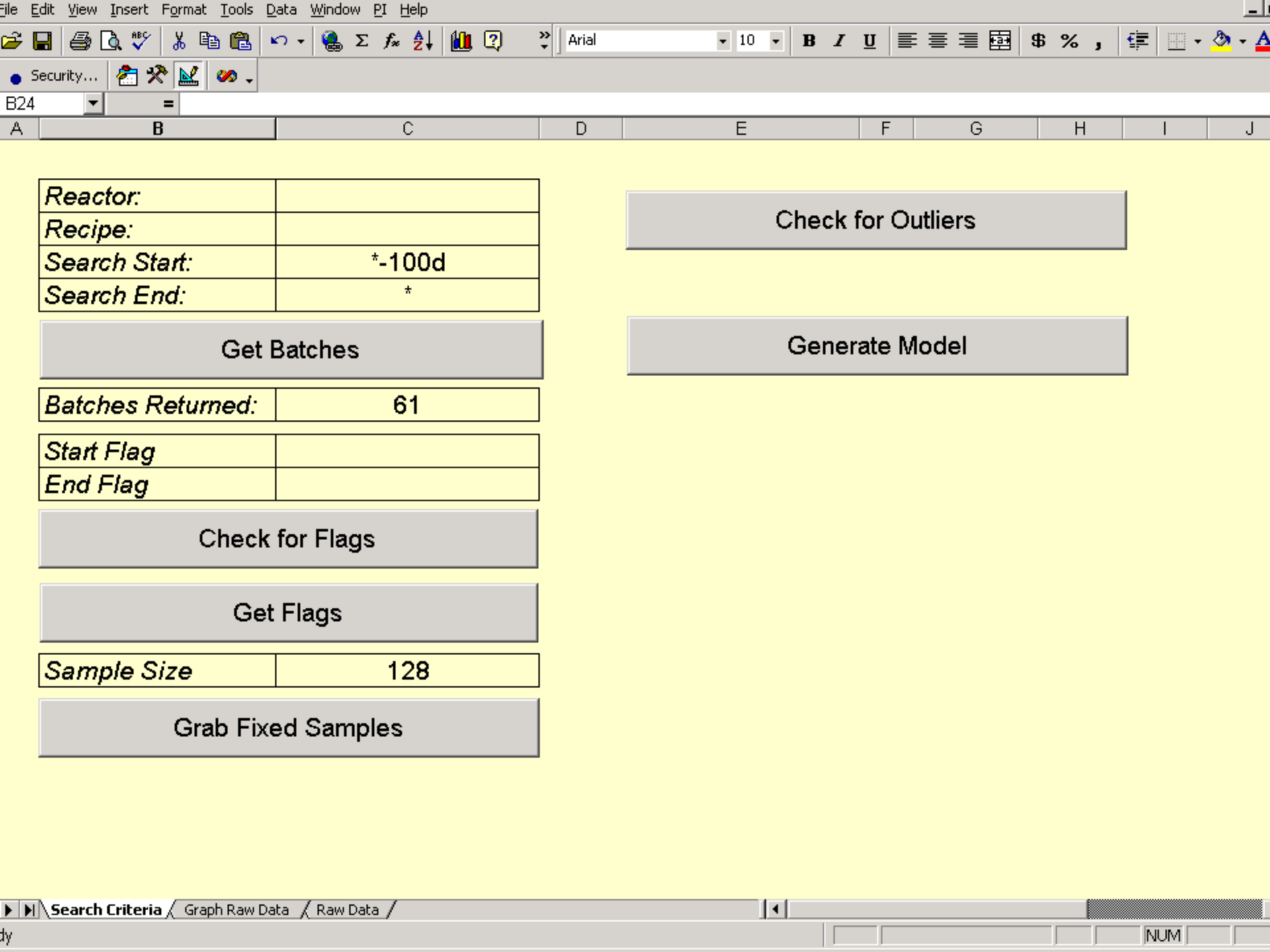
Profile Processing

- PB code imports model .csv file and runs equations…returns a Pass/Fail msgbox

- Great thing about using ProcessBook… equations imported directly into a PB…called from PB VBA code just as in Excel VBA code…only difference is the source of the data

Model Generation

- Initially, model generation was manual
- Took some time to extract data by hand using DataLink in Excel, then run modeling code like a macro
- Created Model Generation spreadsheet to make things easier
- Again, equations simply pasted into spreadsheet and called when needed.

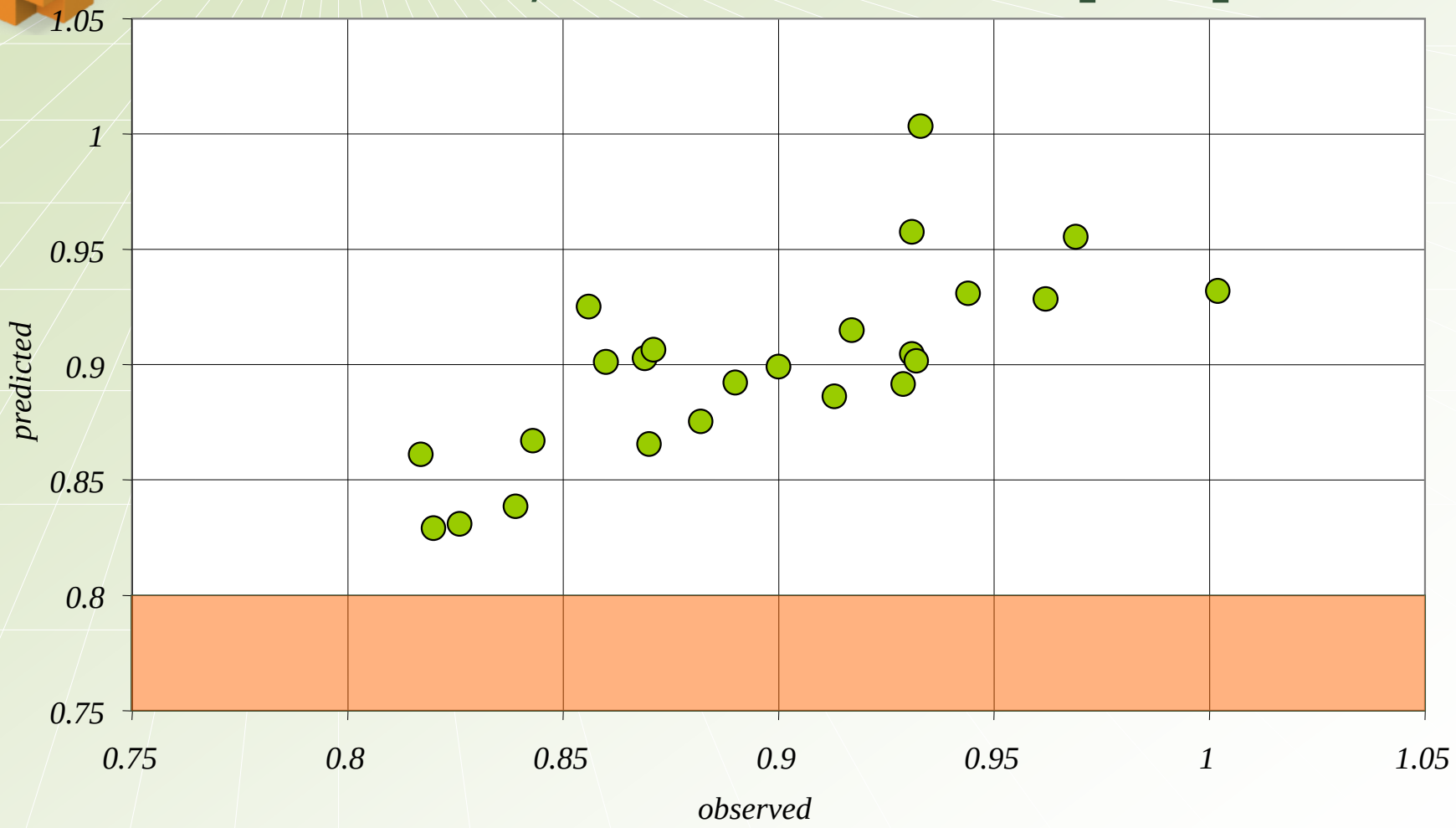

File Edit View Insert Format Tools Data Window PI Help
Arial
10
Security...
B24
=
A B C D E F G H I J
Reactor:
Recipe:
Search Start:
*-100d
Search End:
*
Get Batches
Batches Returned:
61
Start Flag
End Flag
Check for Flags
Get Flags
Sample Size
128
Grab Fixed Samples
Check for Outliers
Generate Model
Search Criteria
Graph Raw Data
Raw Data
NUM

Model Generation

- Batch selection is automatic based on user-specified search criteria
- Flags are also user-specified and can be checked for validity
  - Some steps/unit actions not used in some recipes
  - Some steps/unit actions prone to being missed by PI (slow interface)
- Simple outlier identification routine
- Generate model .csv file

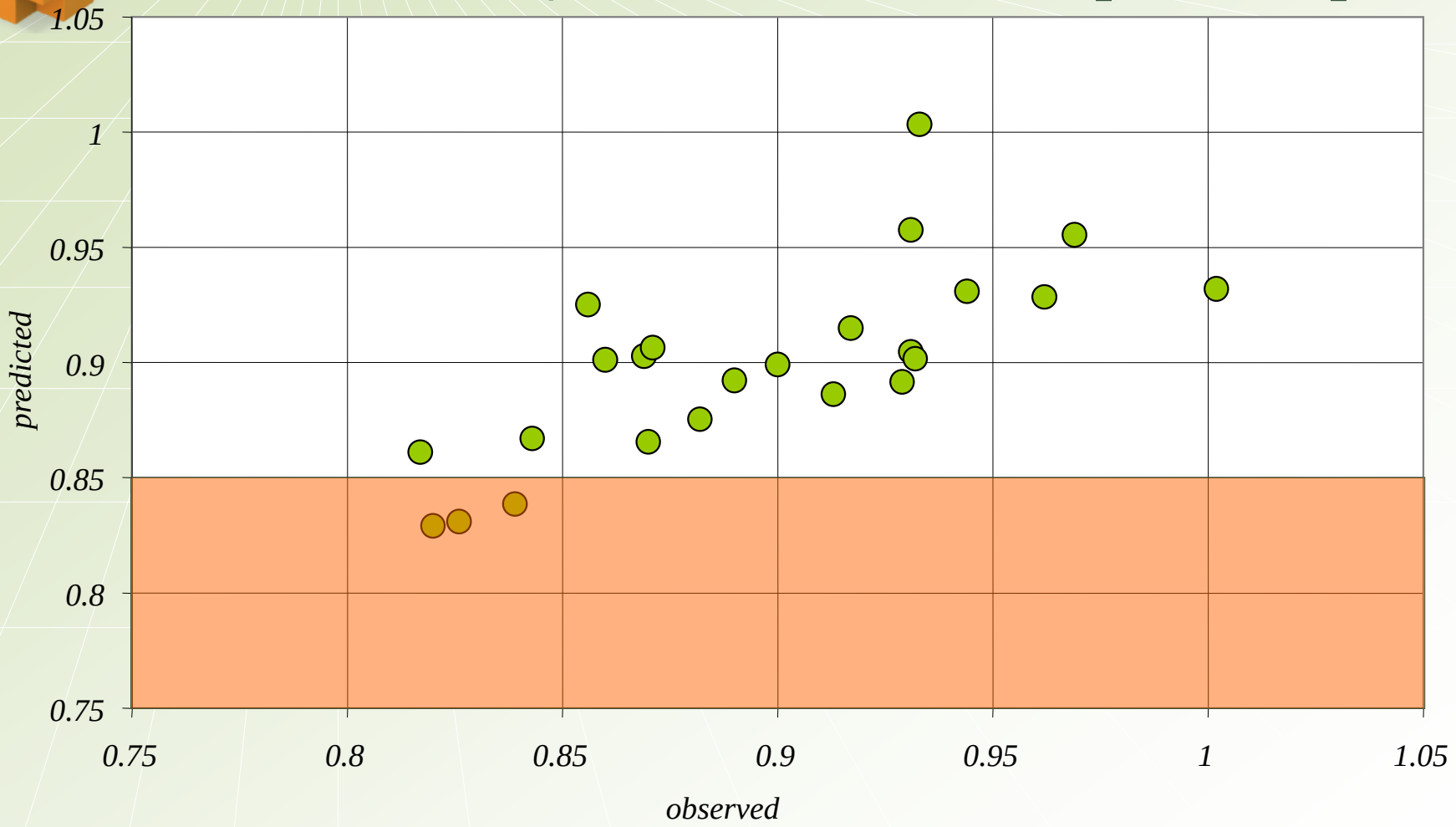
Control limits

limit = 0.8 , selected = 0 or [0%]



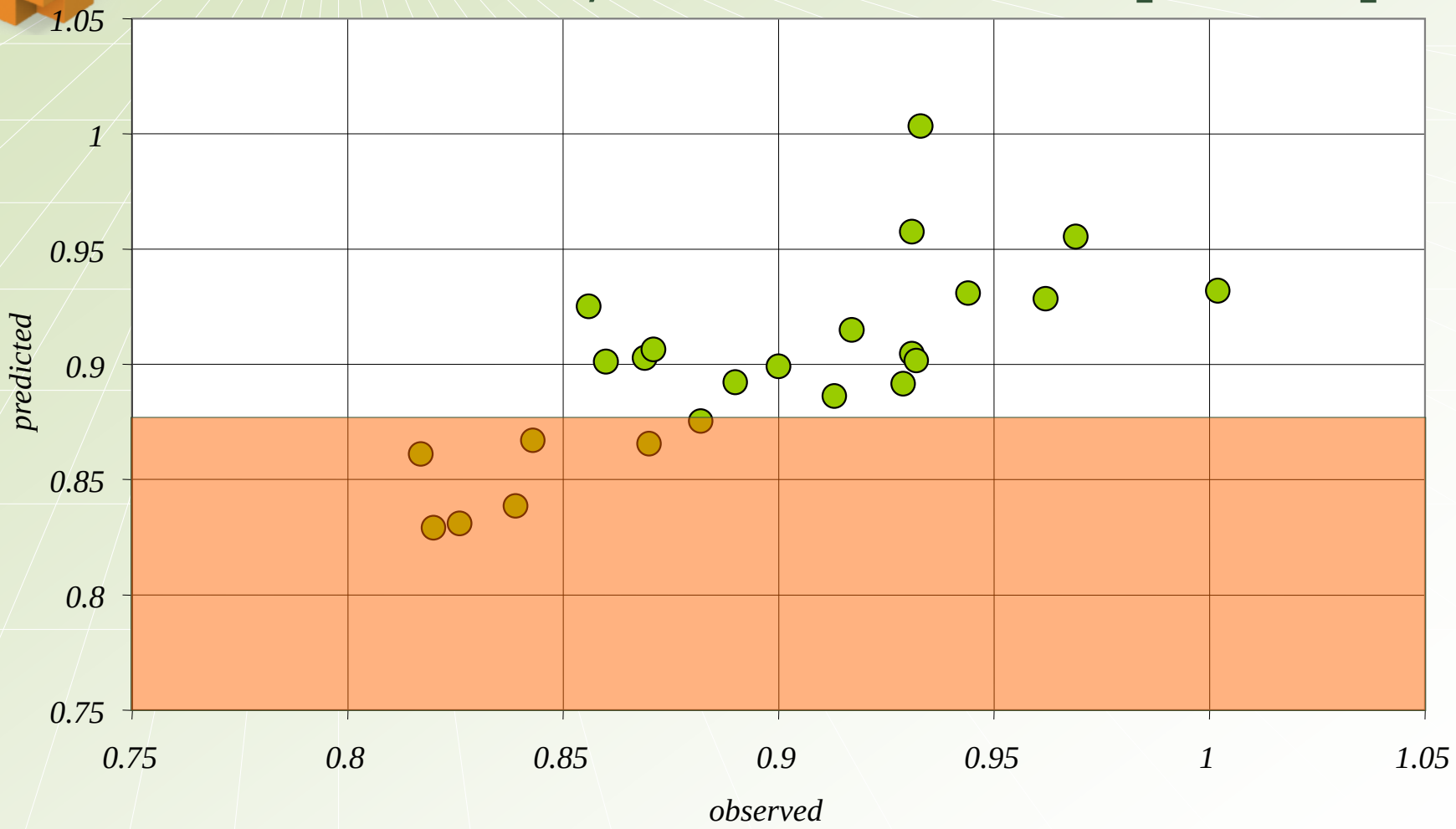
Control limits

limit = 0.85, selected = 3 or [12.5%]

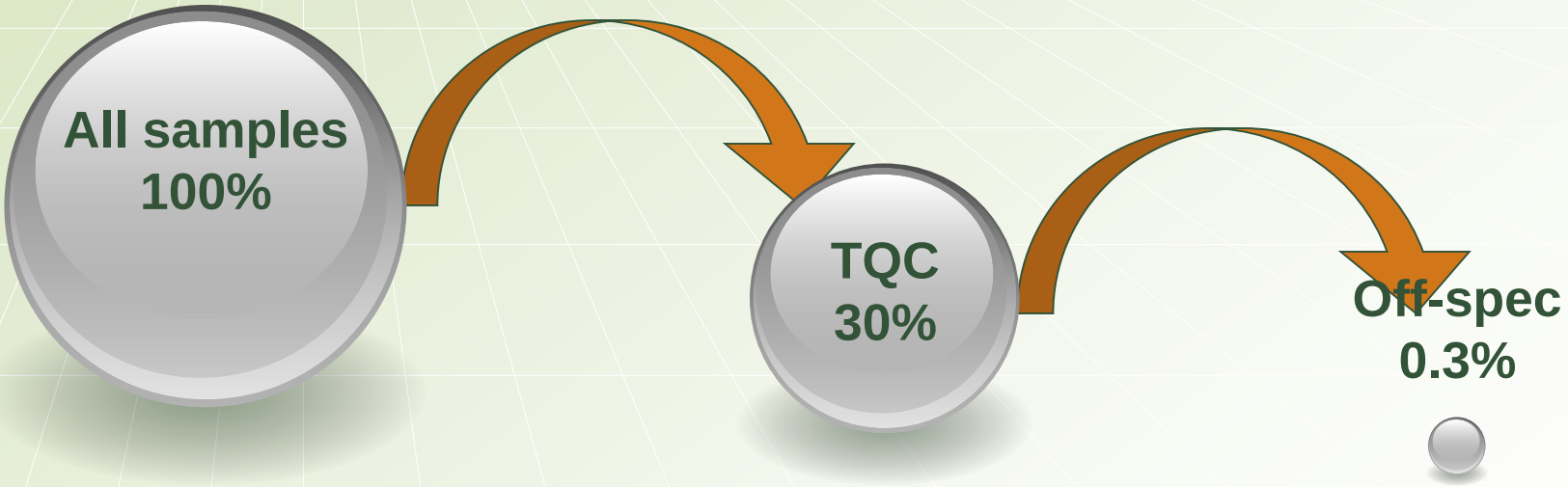


Control limits

limit = 0.875, selected = 7 or [~30%]



Targeted Quality Control



Status

- Literature review
- Implemented higher sampling rate
- Developed statistical part in VBA
- Developed user interface in PI process book
  - Prototype ready
- Models for one product in two reactors

Future Plans

- 1st implementation for single product
  - Extend to more products/vessels
  - Requires naming convention for model .csv's
  - Flag tags included in model .csv's
- Error handling
- Procedures
- Operator training
- Automatic detection of "end of profile"
- Use sub-batch functionality

ATOFINA

Thanks...

Any questions?