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Online Quality Control of Polymers and Extruded Films

Oliver Hissmann

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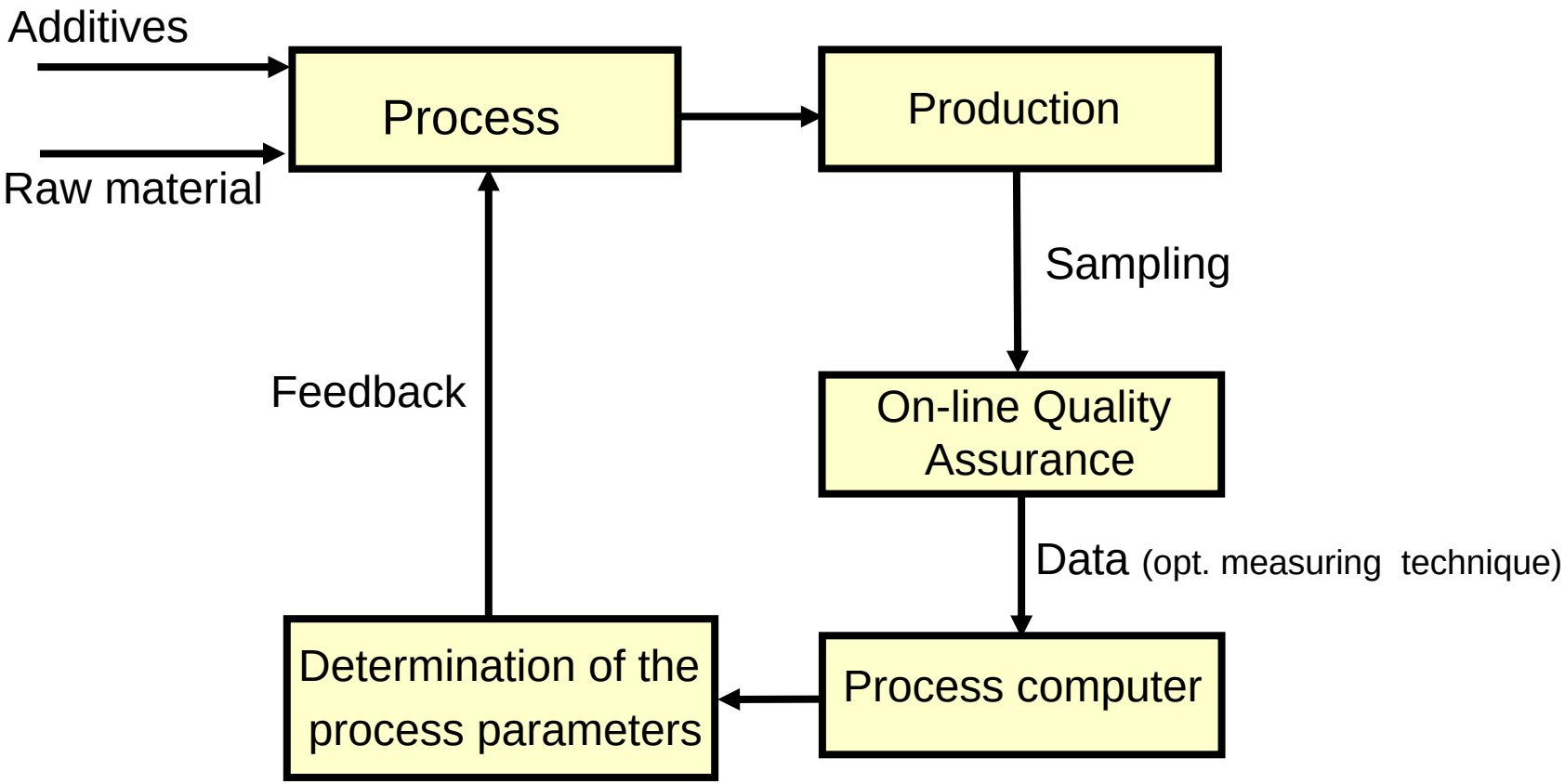
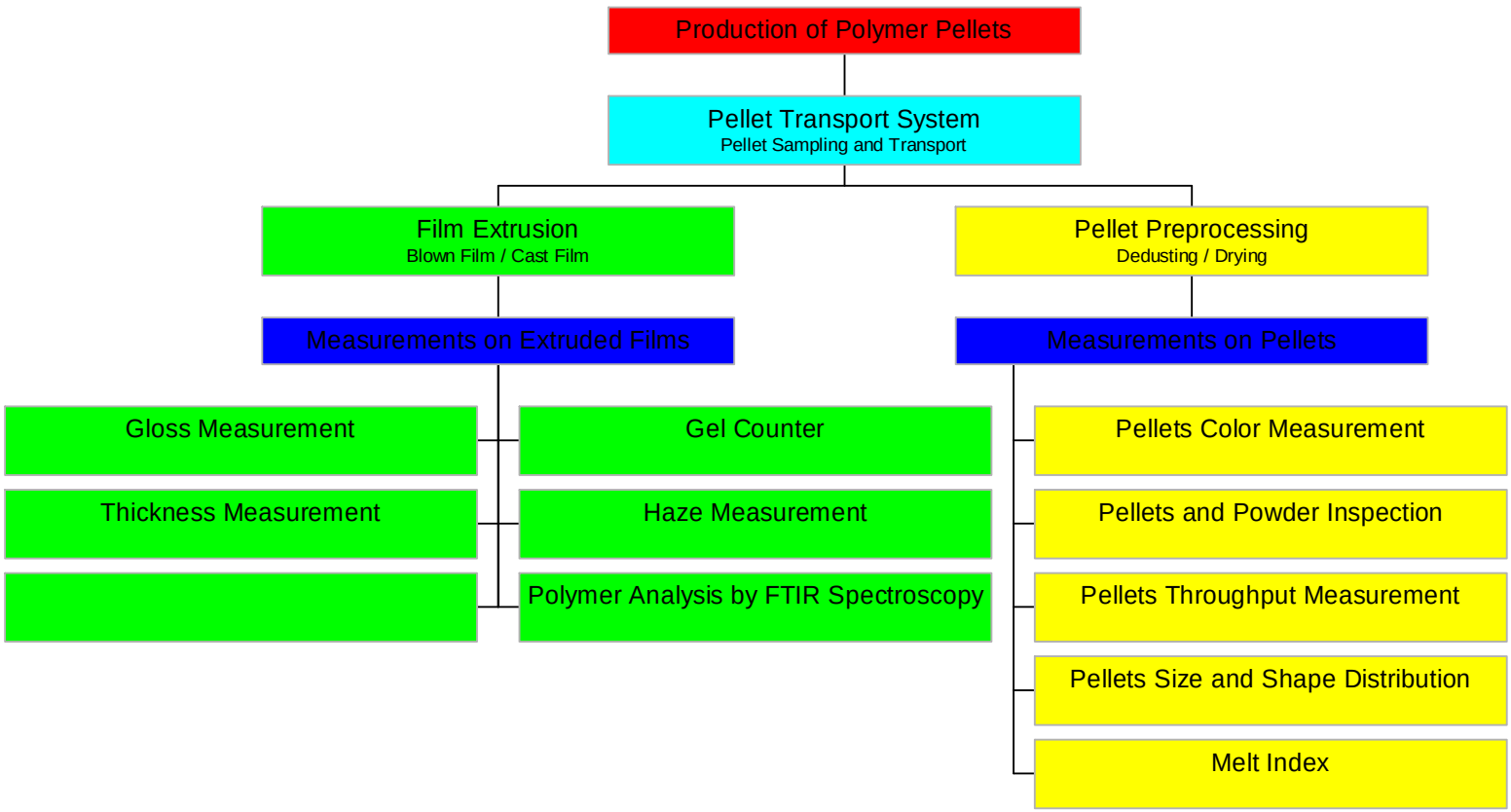
- Online Quality Control in Polymer Plants
  Technology, Benefits, Online Lab, Close Loop Concept
- Web Inspection in Film Extrusion
  Technology, Benefits, Integration
- Interrelationships and Correlation
- Practical Examples
- Summary

Online „Closed Loop Control“-Concept



Principal of Online Quality Control



Benefits of Online Control

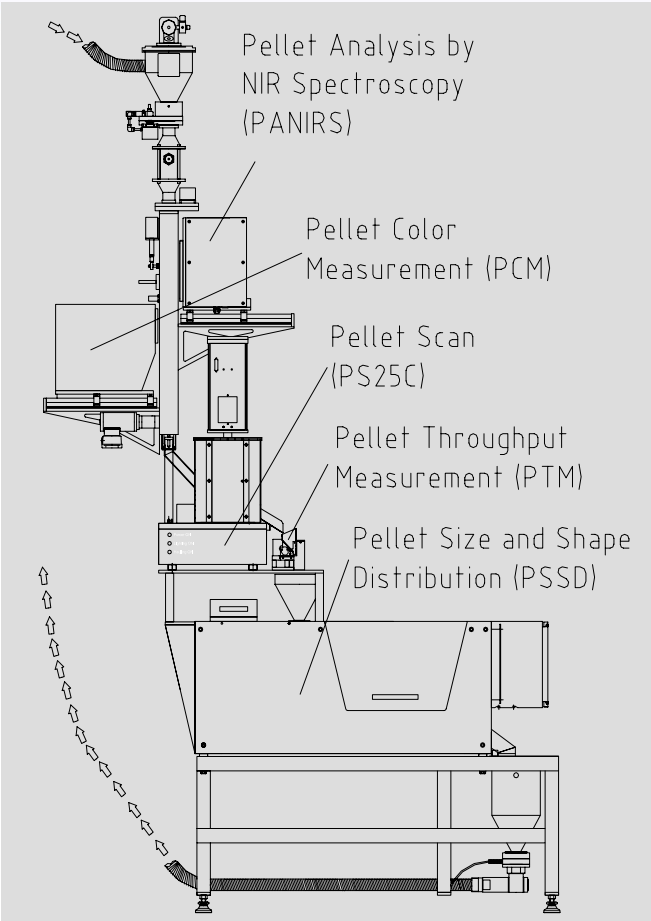
- **Process Control**

  (Optimisation, capacity, cleaning, waste)

- **Product**

  (better quality, customer satisfaction/relation, less claims, more competitive products)

Online Measurement of Pellets



Measurements on Pellets

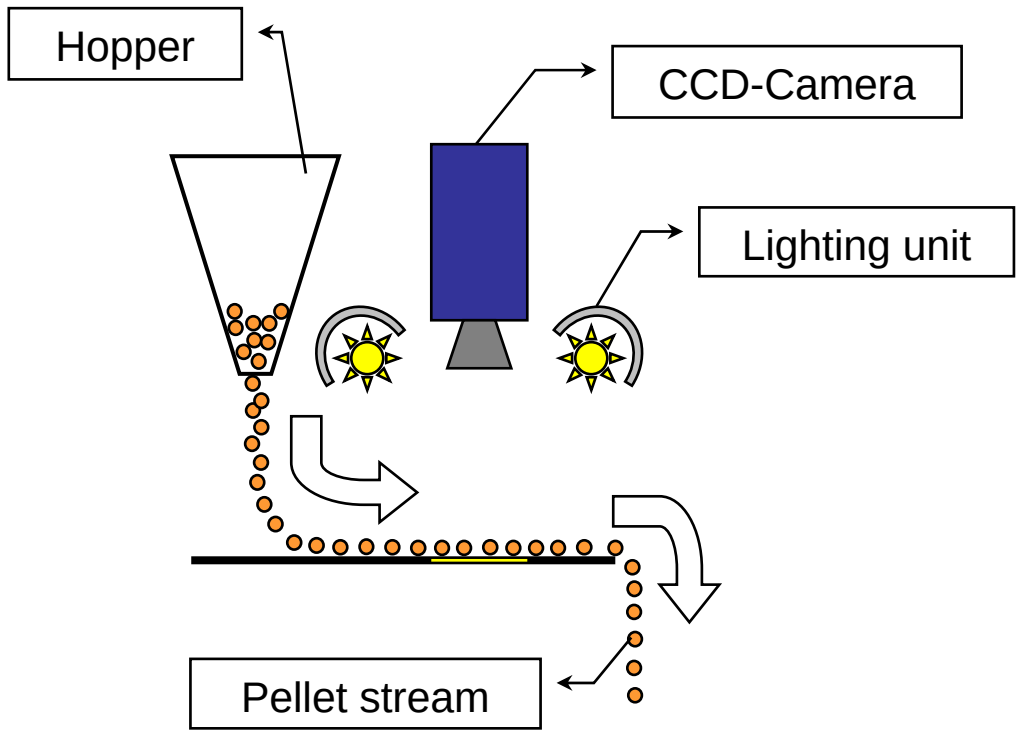
Pellets Color Measurement
PCM
Measurement of LAB Color Values
and Yellowness Index

Pellets and Powder Inspection
PS 25C, PS 25, PS 2 PT 2
Detection and Evaluation of
Impurities in Pellets and Powder

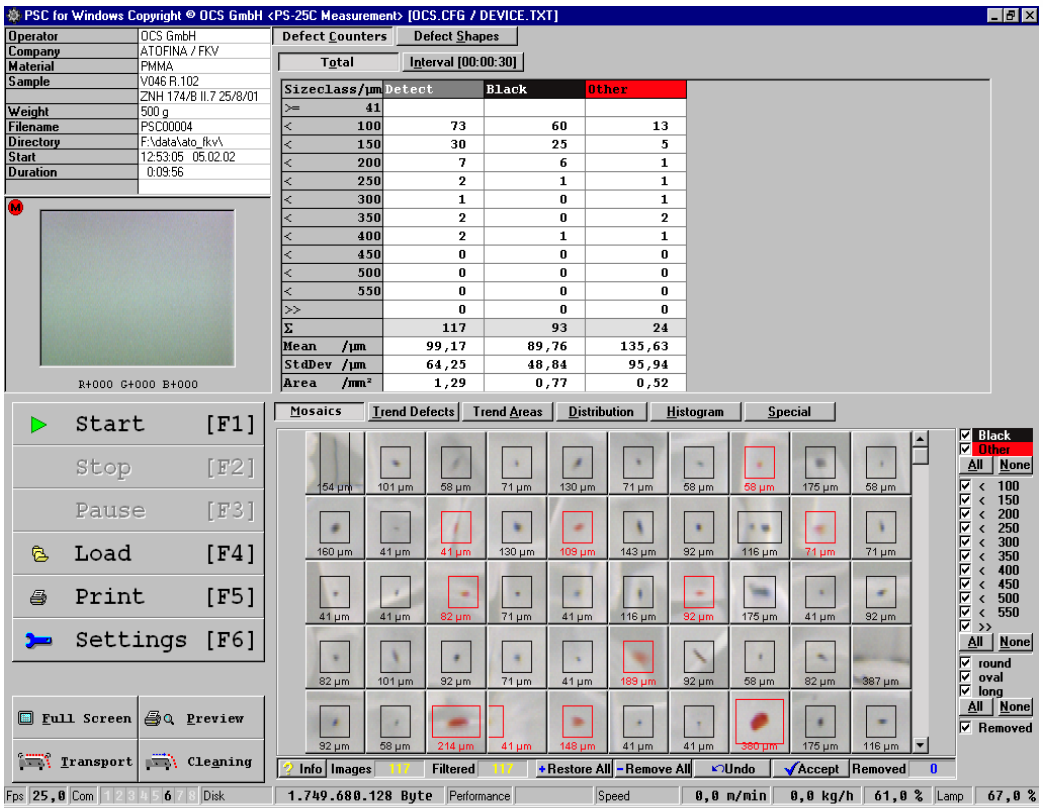
Pellets Throughput Measurement
PTM
Weight Measurement of the inspected Pellets
over the time

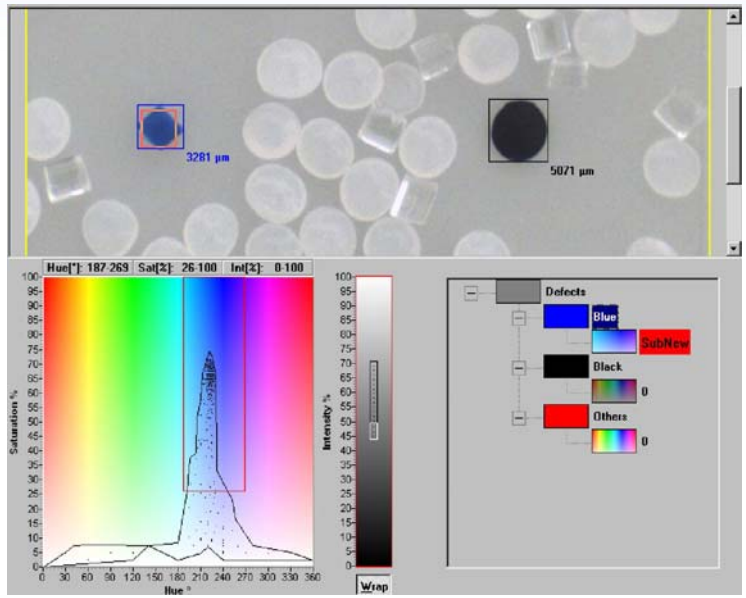
Pellets Size and Shape Distribution
PSSD
Measurement of Size and Shape of the Pellets
Detection of Twin, Triple and Multiple Pellets

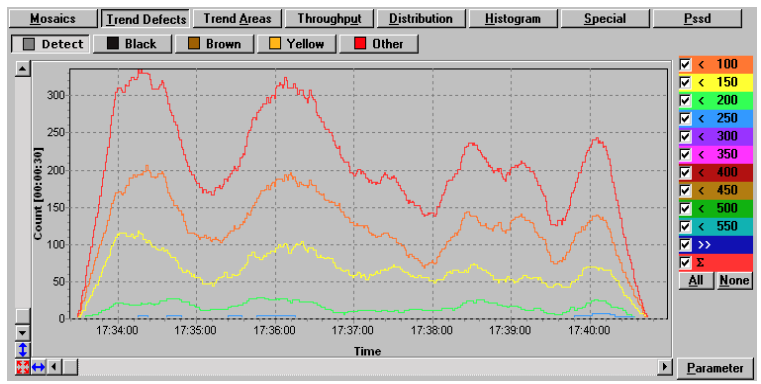
Pellet Scan System



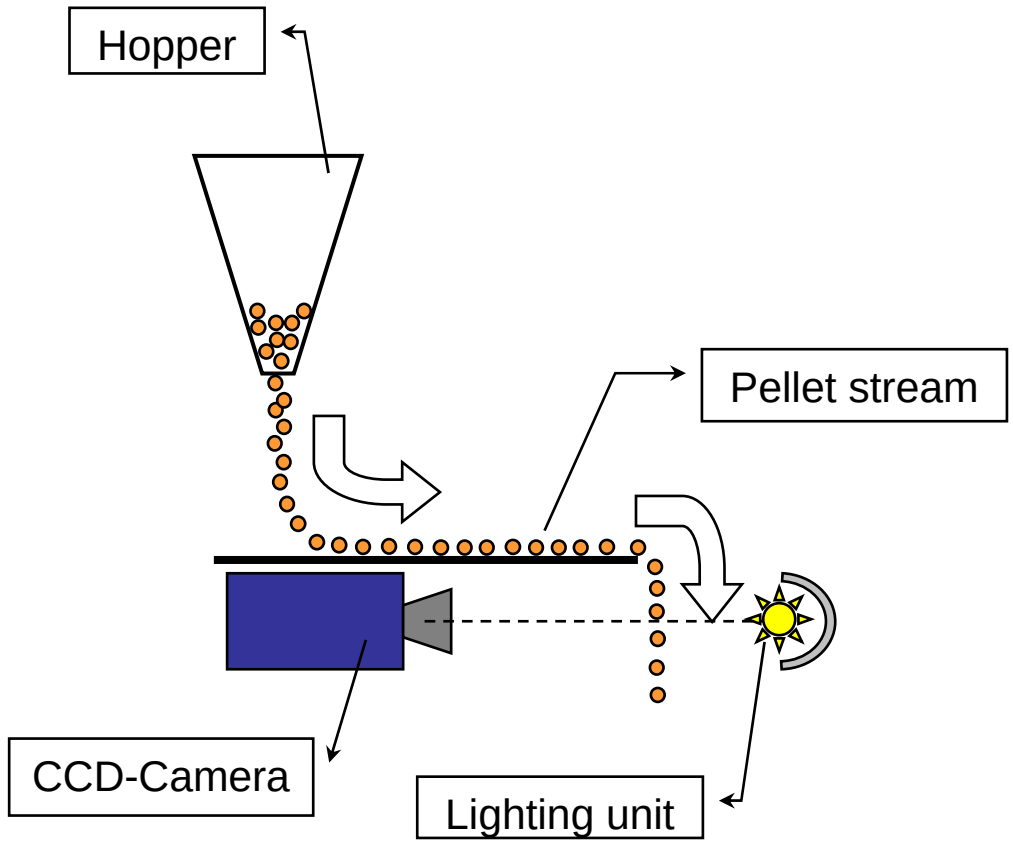
Pellet Scan System



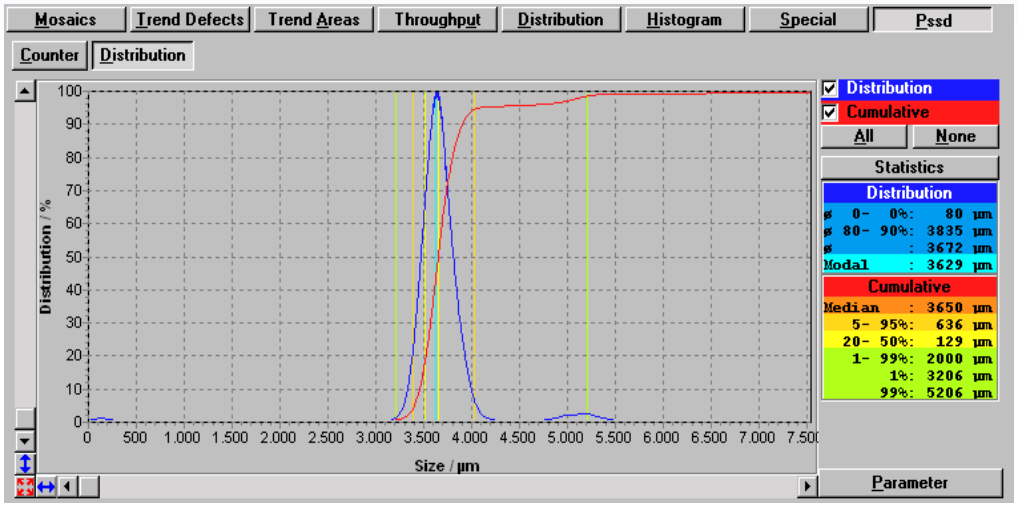




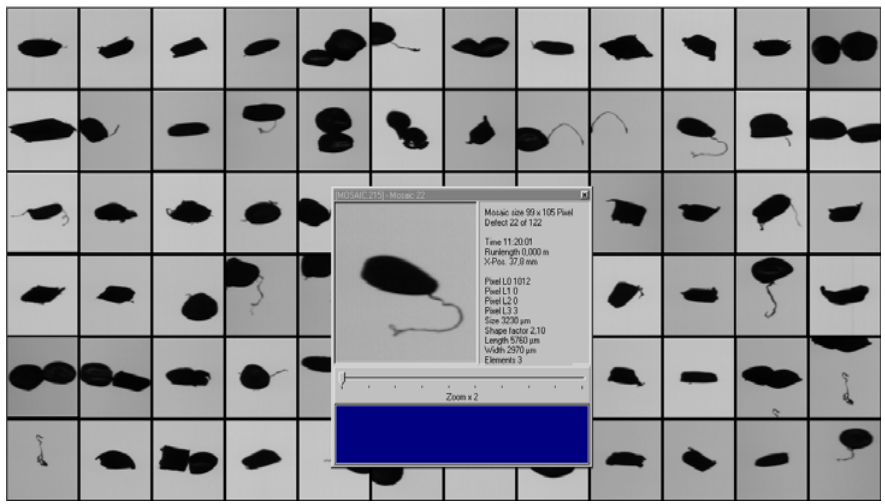
Pellet Size & Shape Distribution



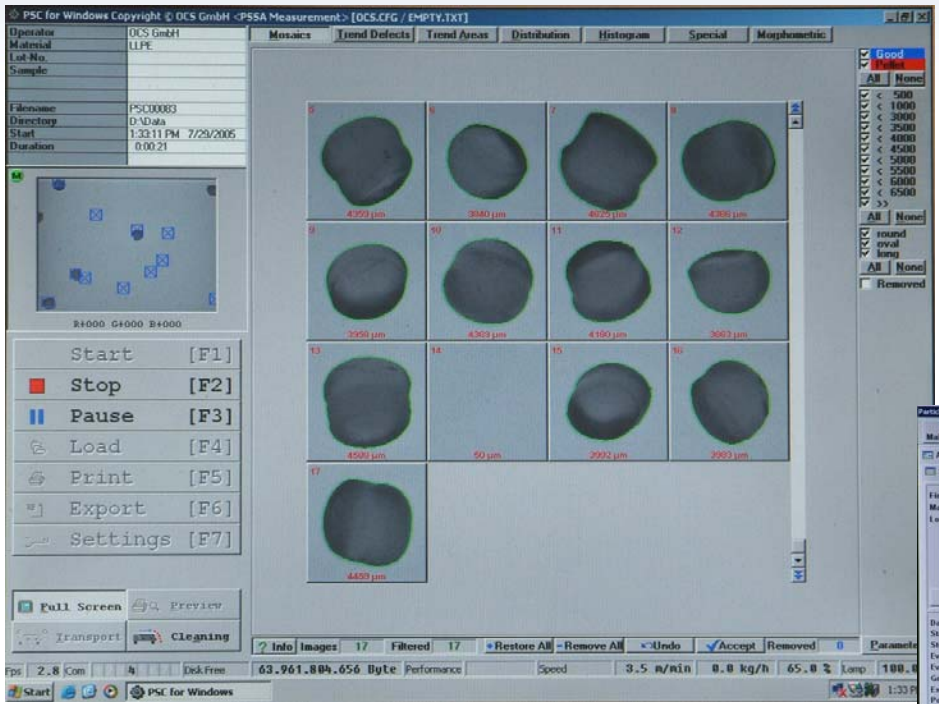
Pellet Size & Shape Distribution

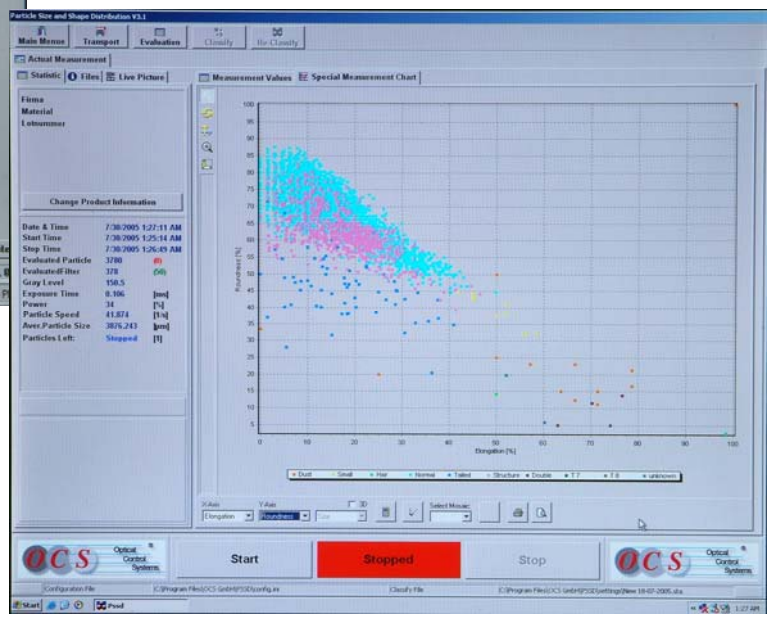


Pssd	Percent				
Sizecl./µm	Total	SF-1,8	SF-3,5	SF-5,0	SF>5,0
- 500	463	337	108	14	4
- 1000	12	1	5	2	4
- 2000	1	0	0	0	1
- 3000	37	35	1	0	1
- 4000	62499	62469	29	1	0
- 5000	1878	1727	149	1	1
- 6000	1423	655	758	9	1
- 7000	54	1	51	2	0
- 8000	3	0	2	1	0
> 8000	1	0	1	0	0
Σ	66371	65225	1104	30	12
Mean /µm	3671,90				
StdDev /µm	432,45				
Weight/kg	-----.--				

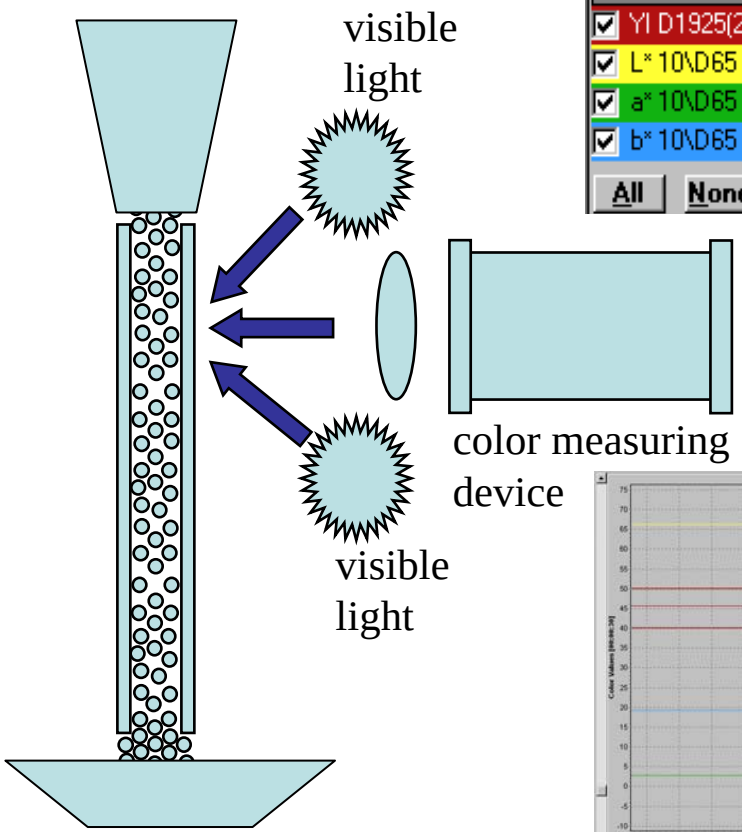


Pellet Size & Shape Distribution



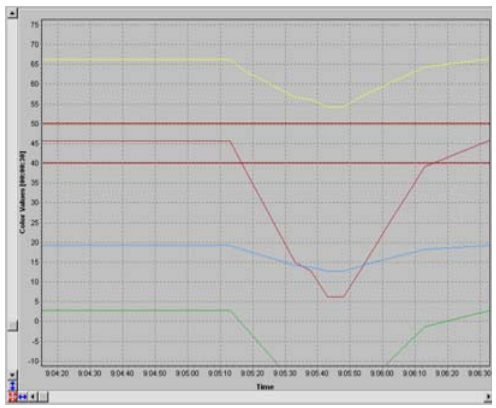


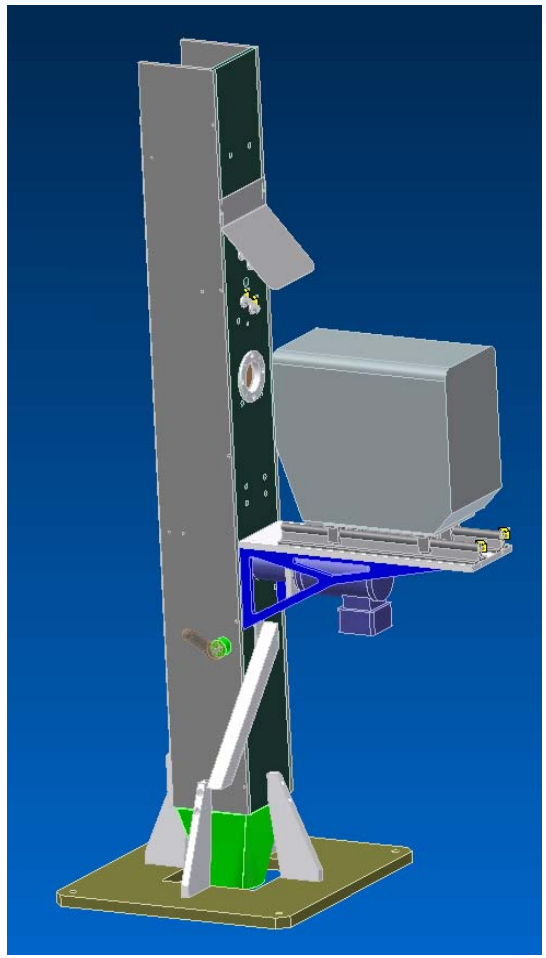
Pellet Colour Measurement



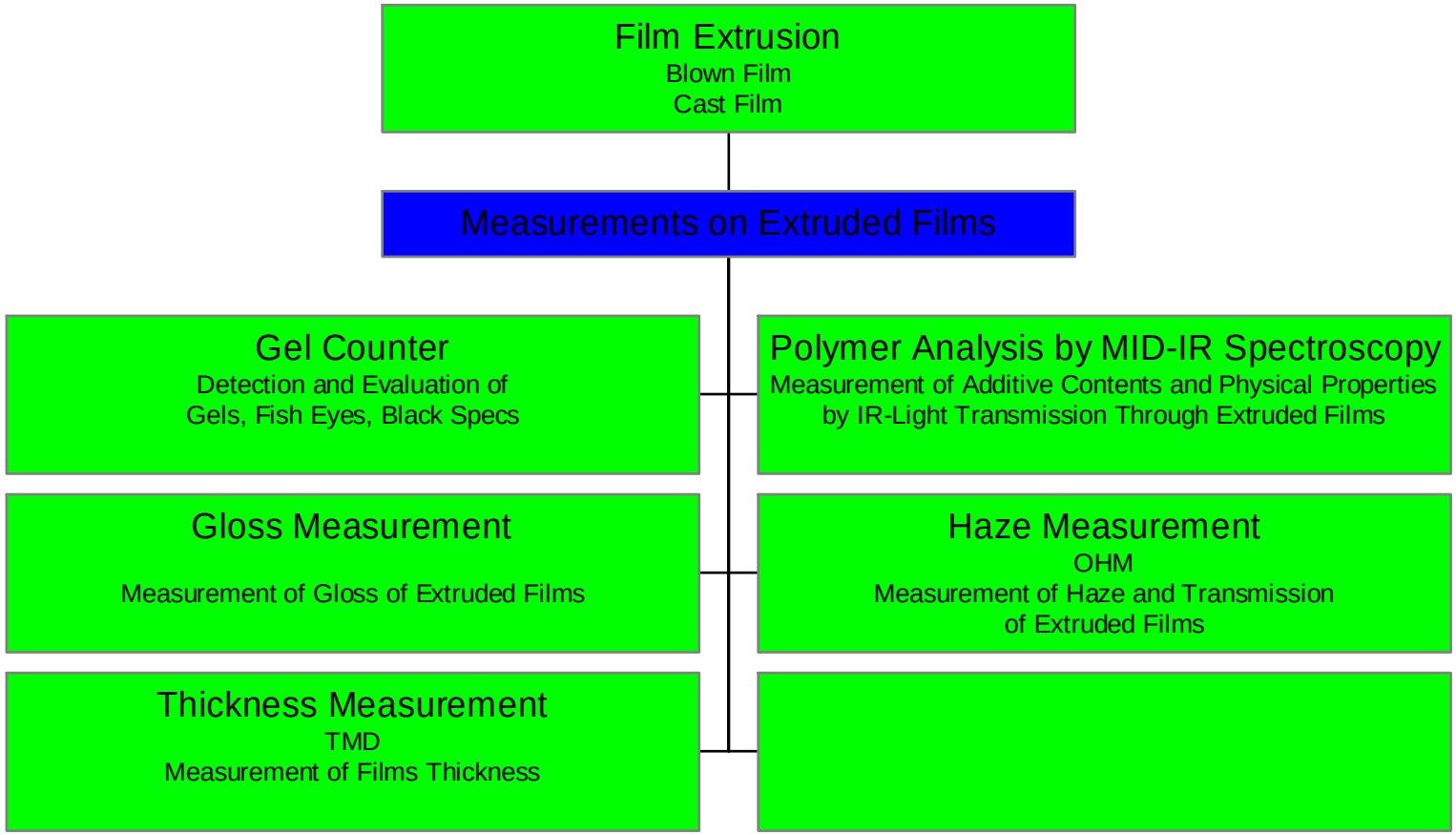
Standard = <empty>			
Color Values	Average	Std-Dev	Interval
YI D1925(2/	35,83	18,85	45,77
L* 10\D65	63,26	5,85	66,33
a* 10\D65	-3,21	11,53	2,84
b* 10\D65	17,67	3,09	19,32

All None Parameter





Online Measurement on Extruded Films

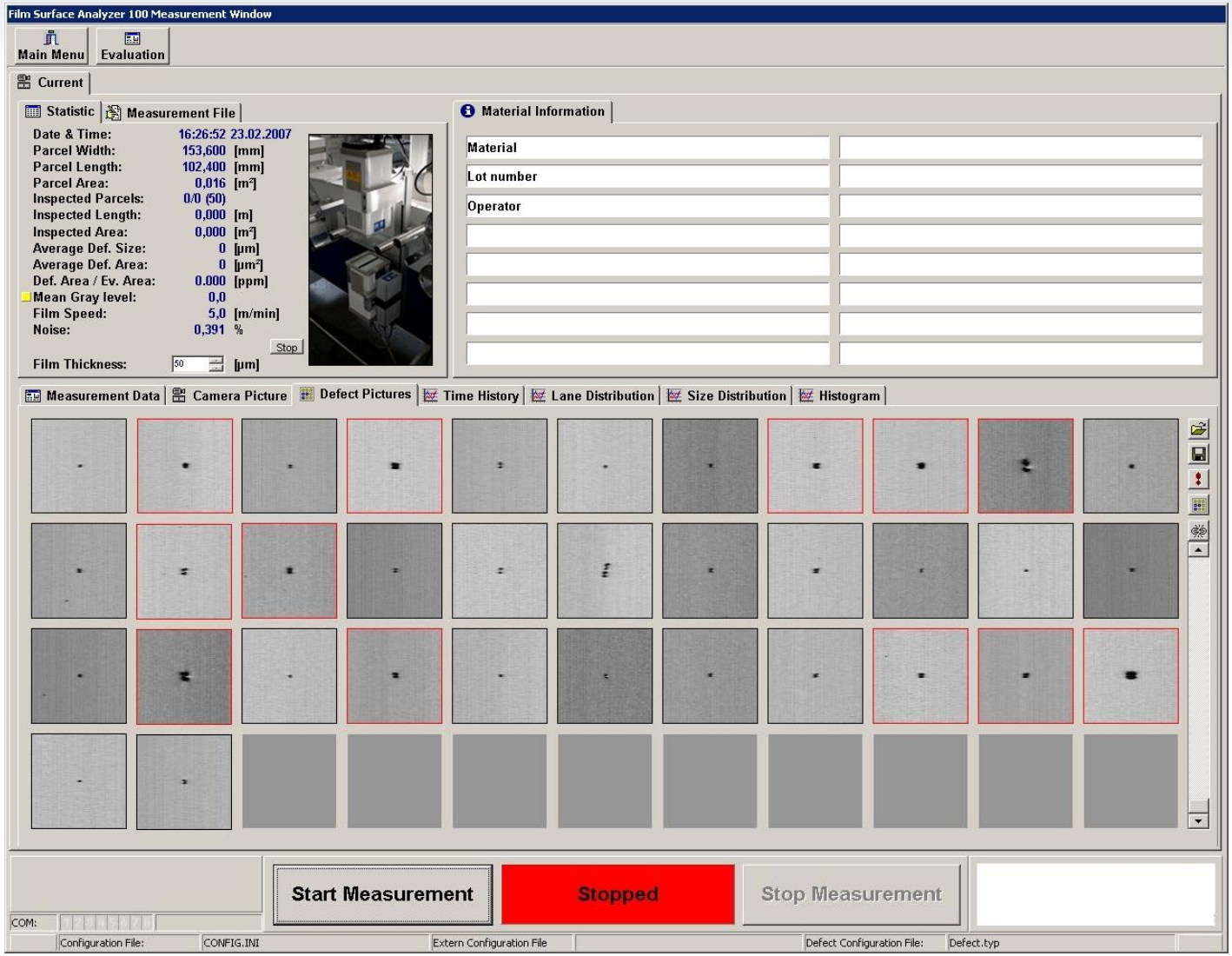


Online Quality Control

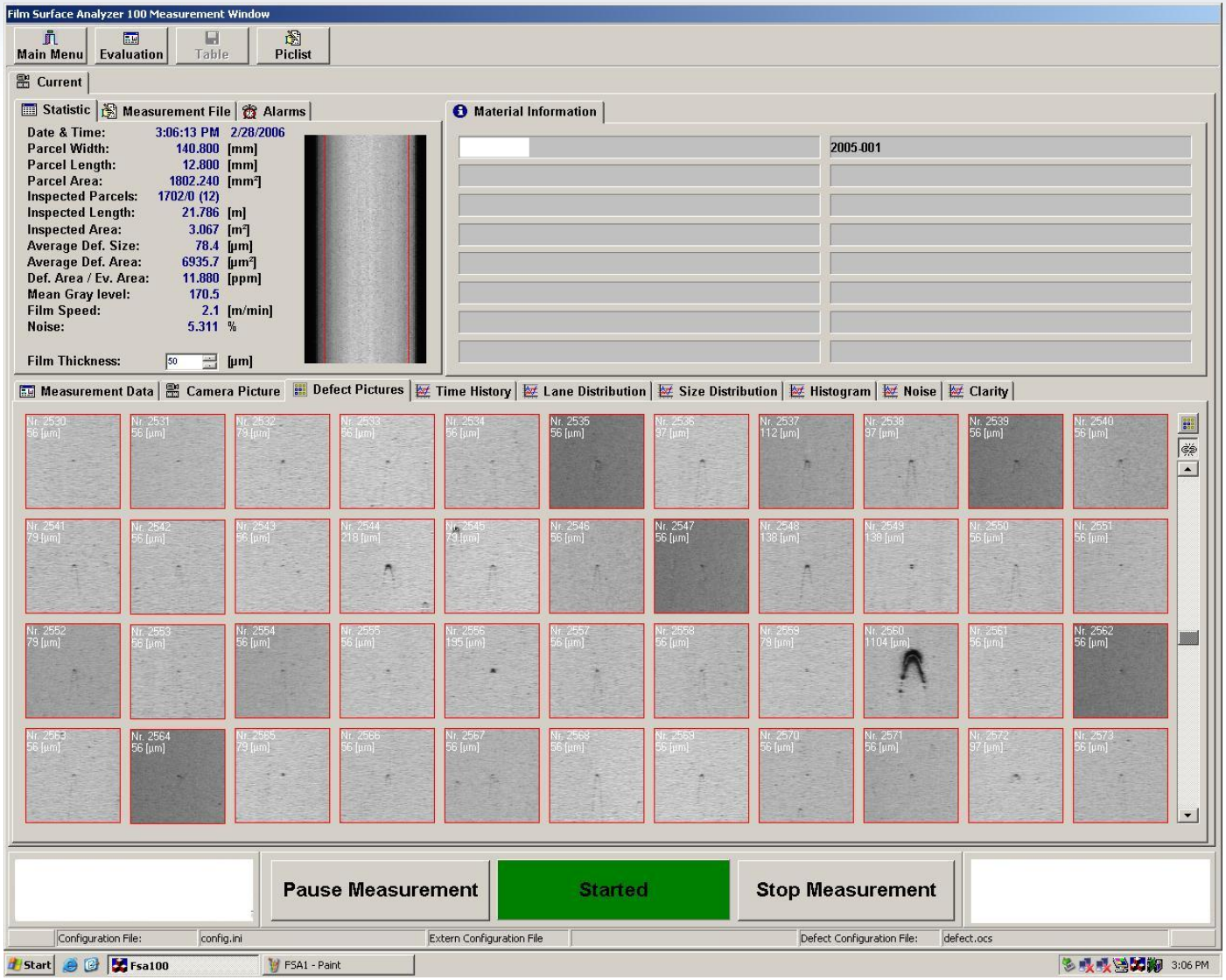
Online Integrated Measurement Solution

Online Integrated Measurement Solution

Online Gel Count

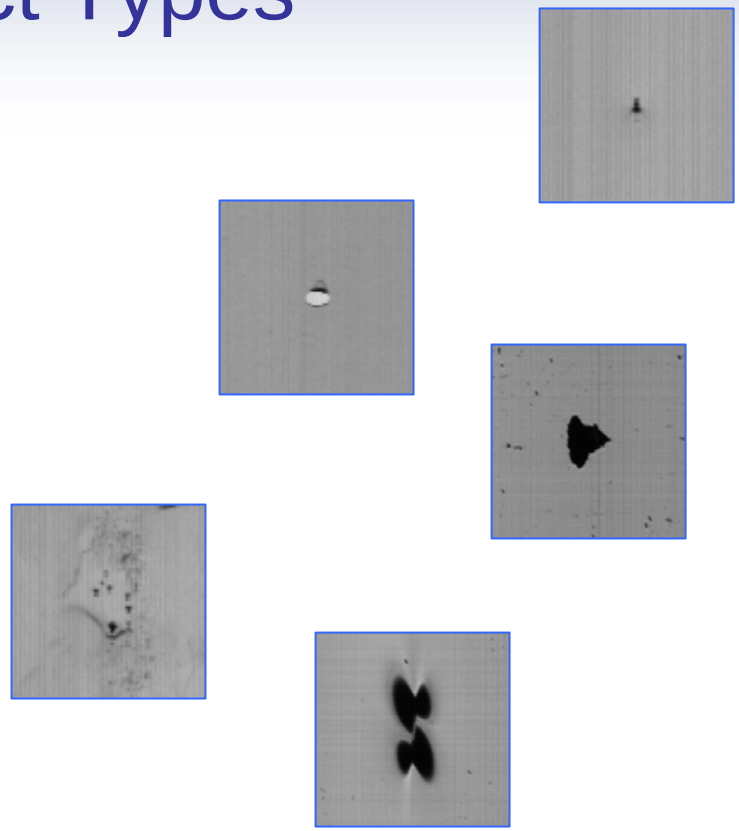


Online Gel Count



Defect Types

- Gels
- Black Specs
- Contaminations



Web Inspection in Film Extrusion

100 % Optical Control of the Web

- Photo of every defect
- Position of every defect
- Database Interface
- Reports
- Alarms

Benefits of Web Inspection

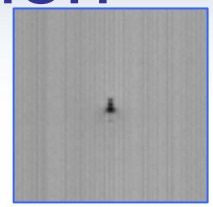
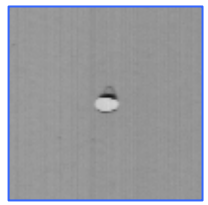
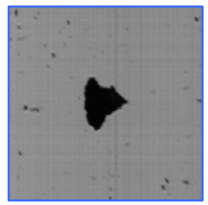
- **Process Control**
  (Optimisation, capacity, cleaning, waste)
- **Raw Material**
  (Optimisation material + recipe, control material)
- **Product**
  (better quality, customer satisfaction/relation, less claims, more competitive products)

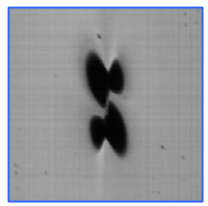
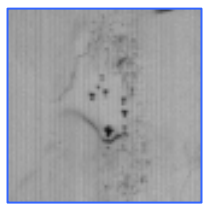
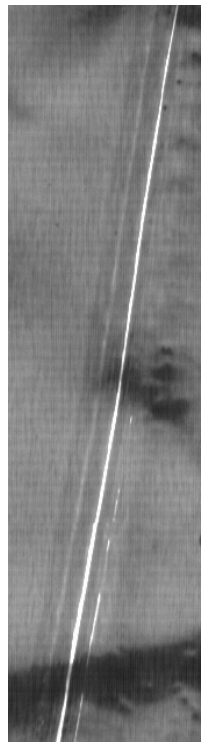
Origin of Defects in Extrusion

- Extrusion Line
  (screw geometry / dead zones)
- Resin
  (contamination, recipe)
- Production Process
  (extruder temperatures, screen change)

Defect Types in Film Extrusion

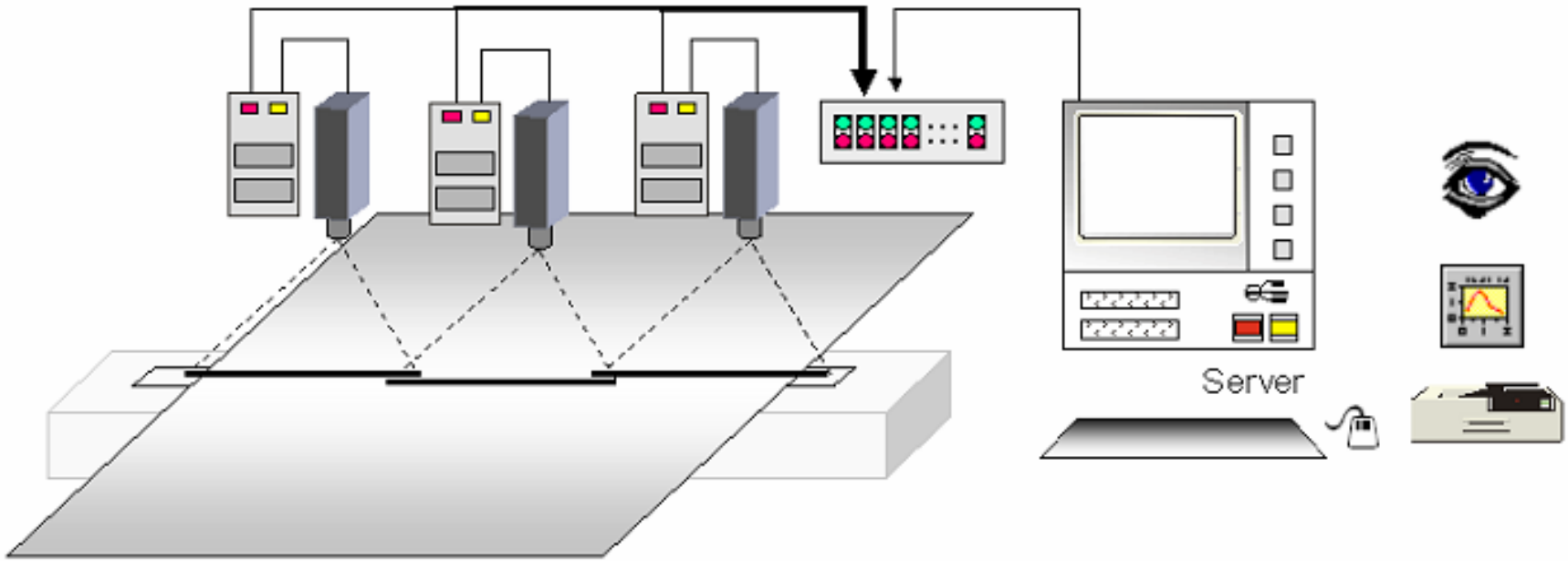
- Gels
- Black Specs
- Contaminations
- Die Lines
- Insects
- Lamination Defects
- Oil Stains
- Fish Eyes
- etc.

Web Inspection System

Embedded Multiple Camera Solution



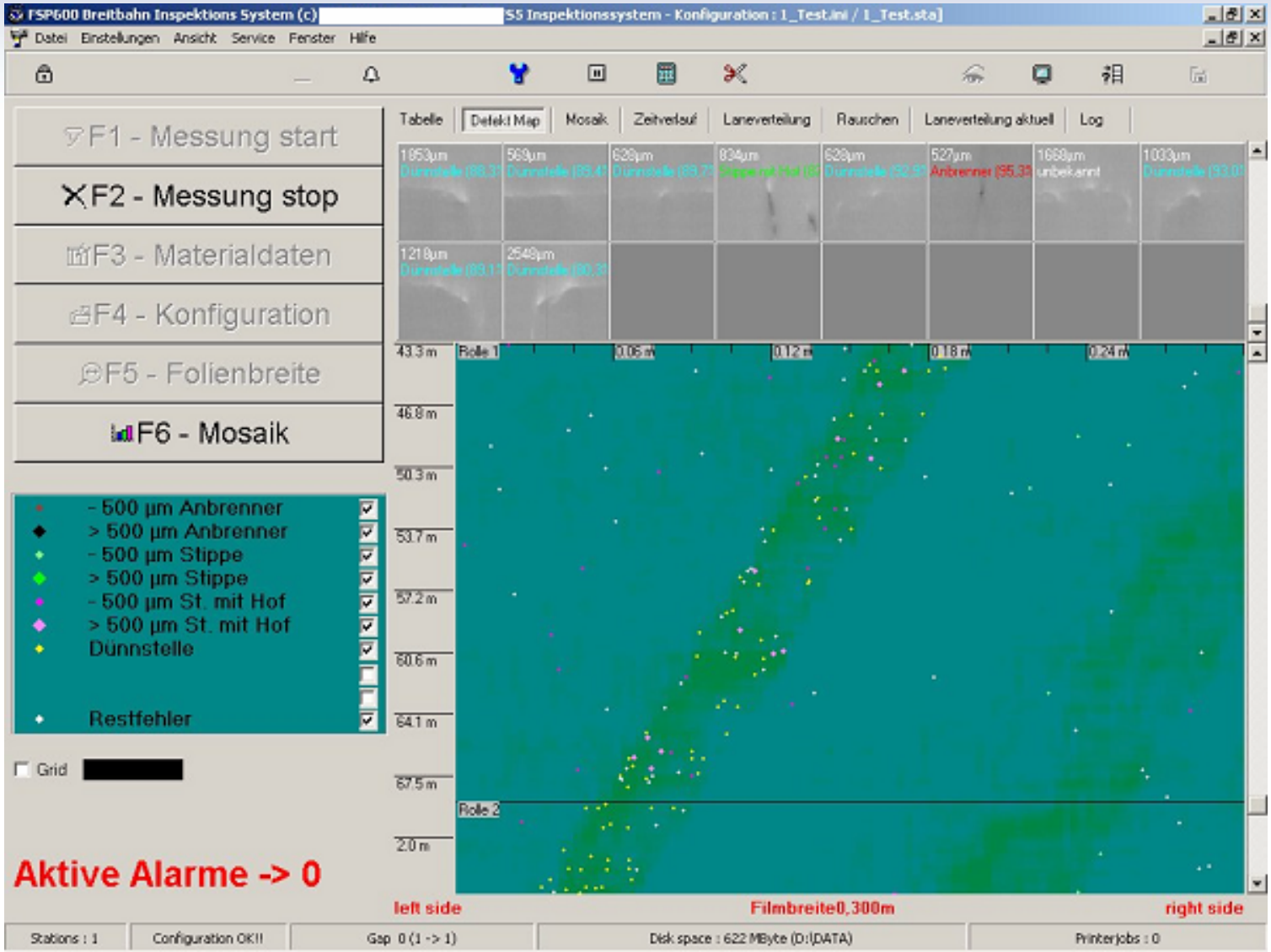
Embedded Solution Technology

- High Speed CCD Line Scan Cameras
  80 – 160 MHz, 512 – 8192 Pixel
- Embedded PC with High Speed Framegrabber
- Windows XP Server (network)
- Exact information on defects within the web
  (mosaics, position, alarms, protocols, storage)

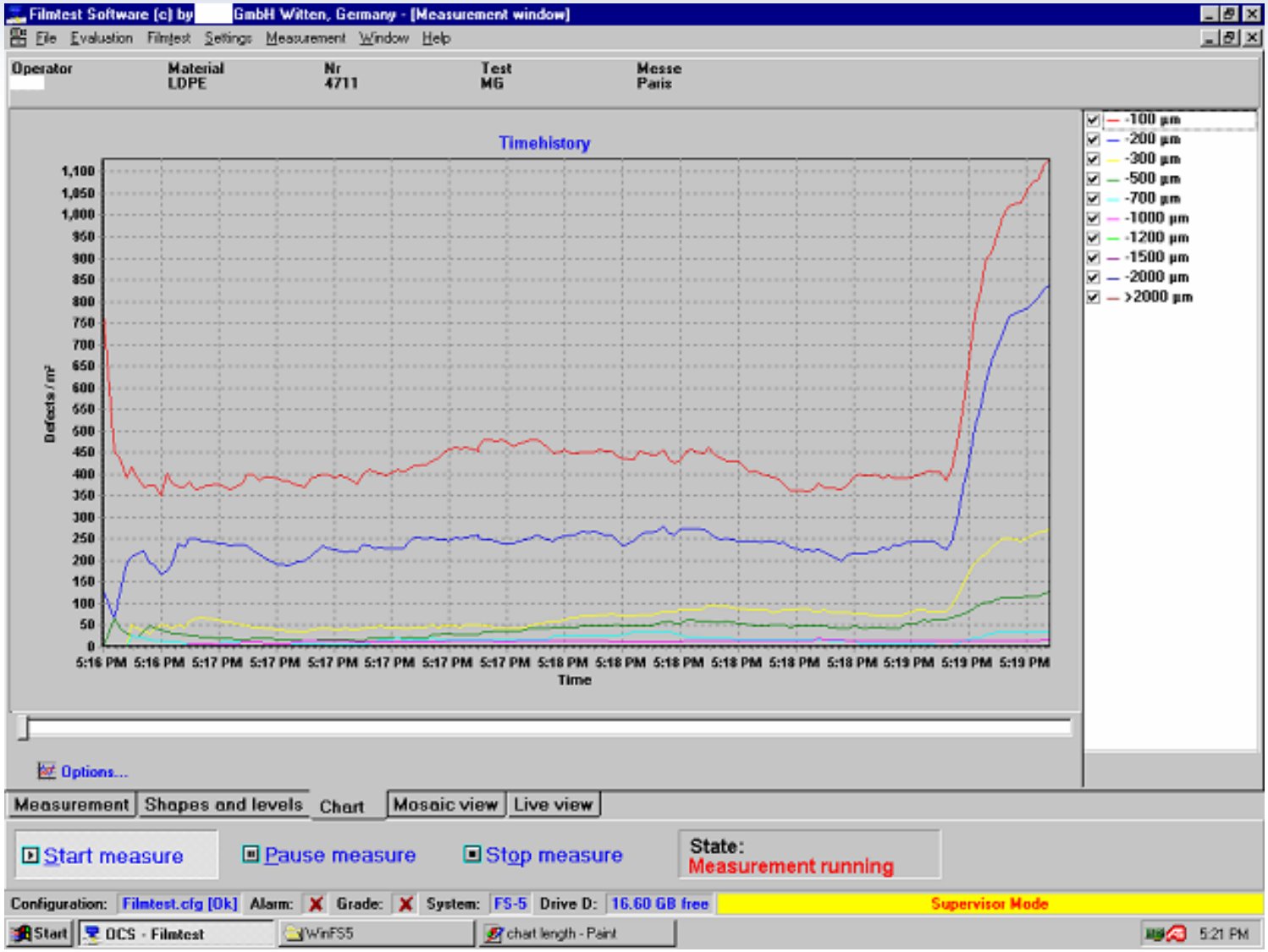
Quality Reports / Alarming

- Single Defect
- Trend Defects (20 gels per m^2)
- Slit Defects
- Repeating Defect
- Gel Shower / Cluster
- Roll Defects

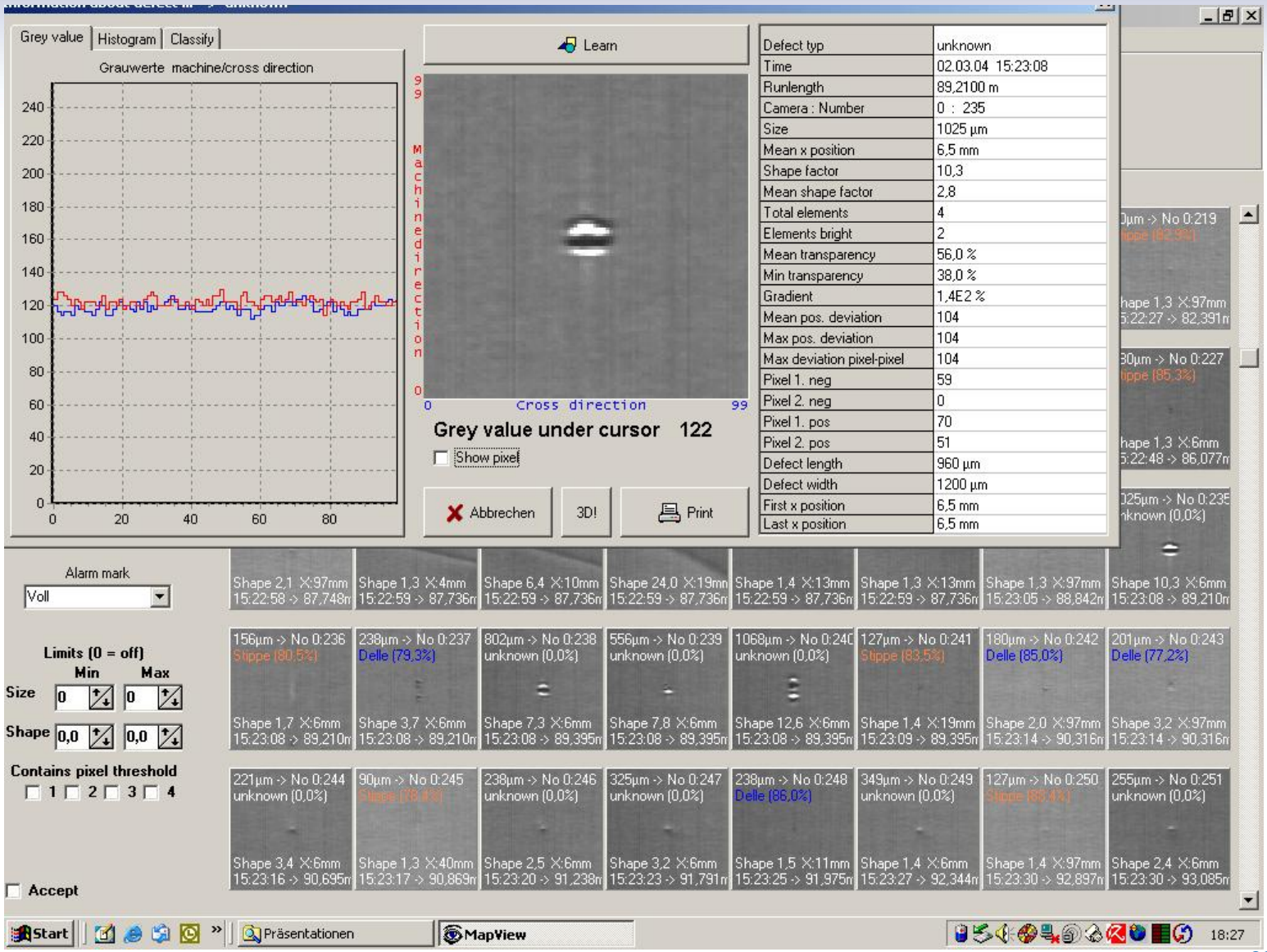
Rolling Map / Die Defect



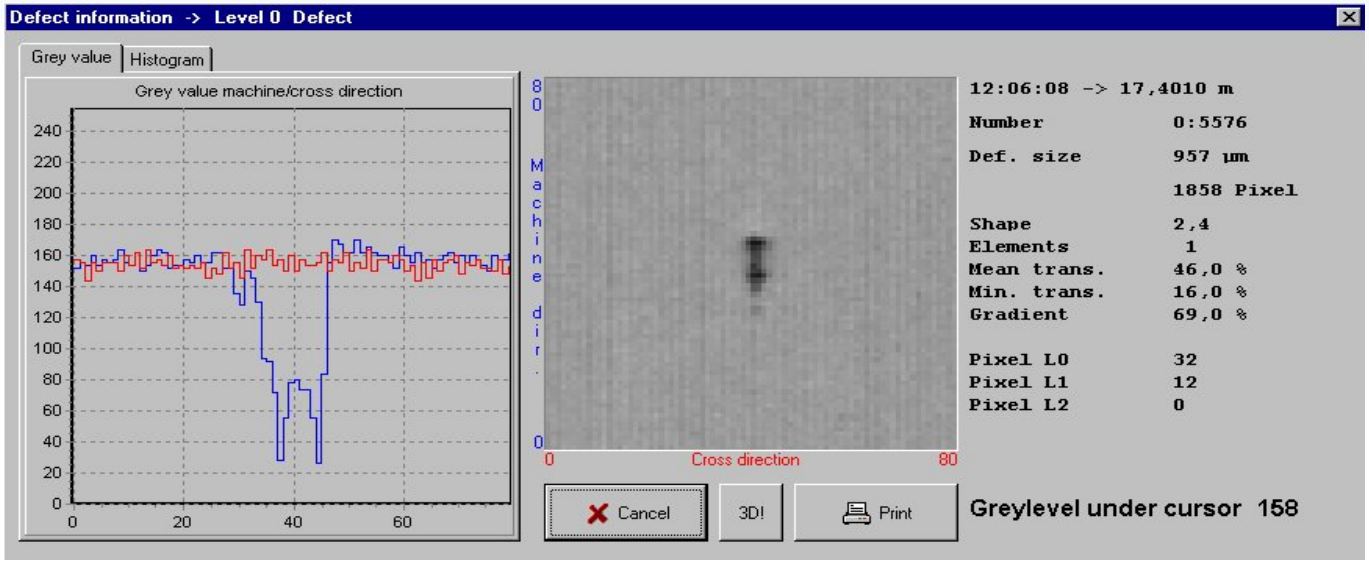
Time History (Gel Level)

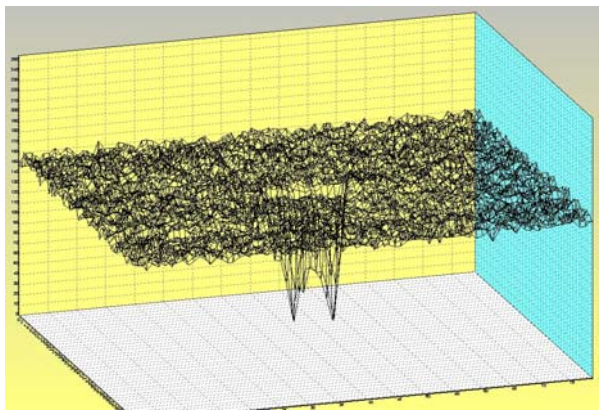


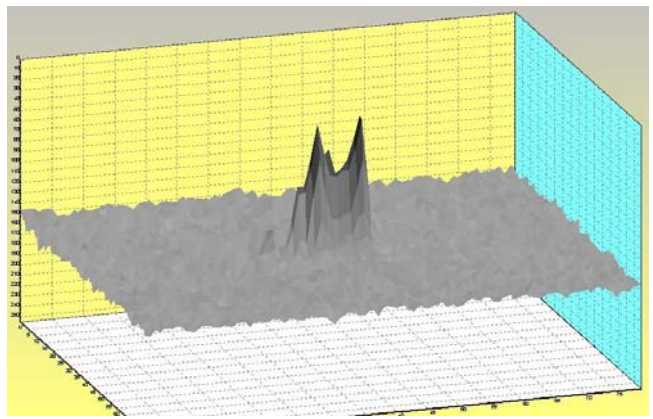
Mosaic View


Grey value
Histogram
Classify
Grauwerte machine/cross direction
Learn
Machine direction
Cross direction
Grey value under cursor 122
Show pixel
Abbrechen
3D!
Print
Defect typ unknown
Time 02.03.04 15:23:08
Runlength 89,2100 m
Camera : Number 0 : 235
Size 1025 µm
Mean x position 6,5 mm
Shape factor 10,3
Mean shape factor 2,8
Total elements 4
Elements bright 2
Mean transparency 56,0 %
Min transparency 38,0 %
Gradient 1,4E2 %
Mean pos. deviation 104
Max pos. deviation 104
Max deviation pixel-pixel 104
Pixel 1. neg 59
Pixel 2. neg 0
Pixel 1. pos 70
Pixel 2. pos 51
Defect length 960 µm
Defect width 1200 µm
First x position 6,5 mm
Last x position 6,5 mm
Alarm mark
Voll
Limits (0 = off)
Min
Max
Size
Shape
Contains pixel threshold
1 2 3 4
Accept
Start
Präsentationen
MapView
18:27

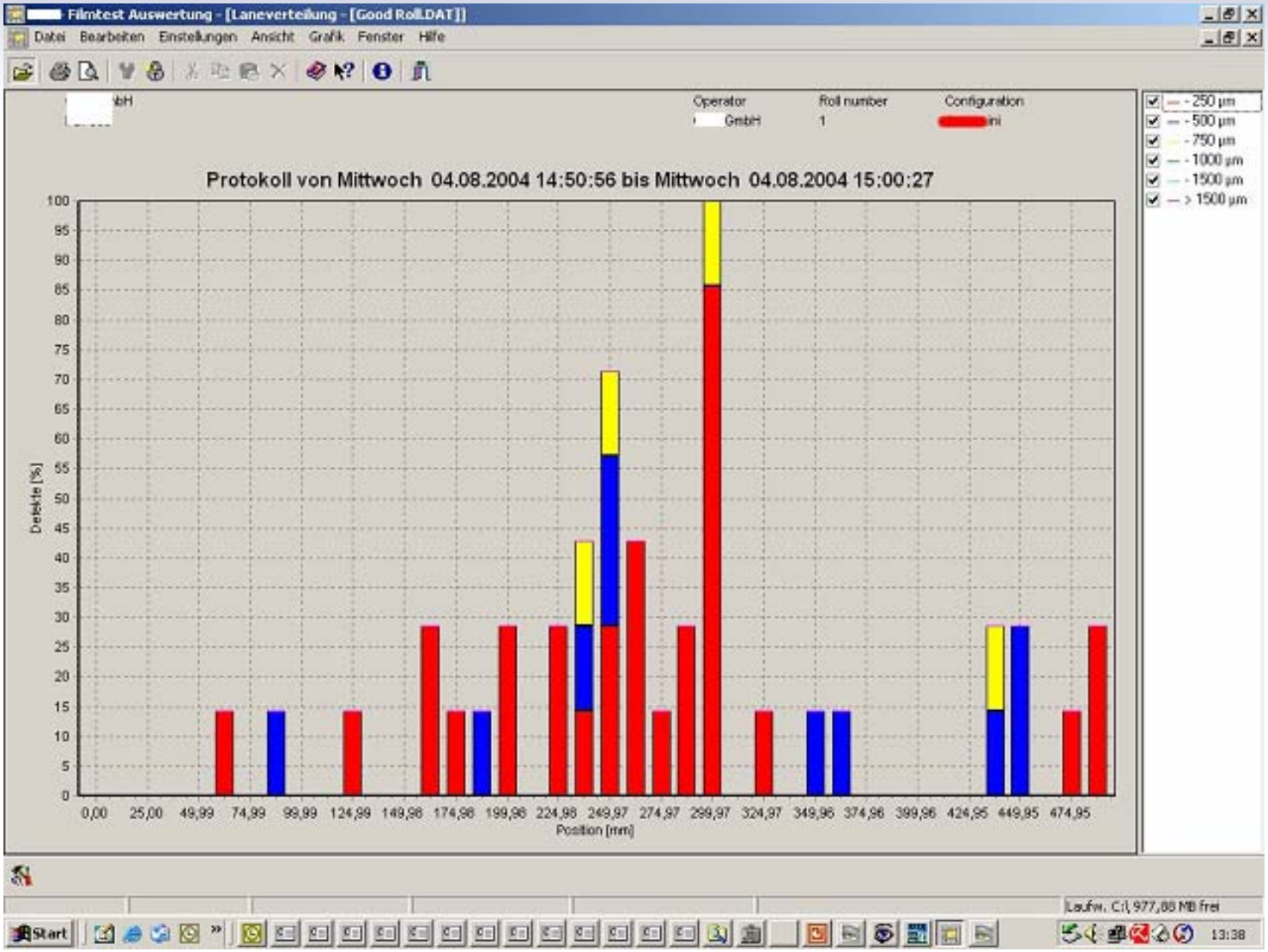
3-D Defect Analysis



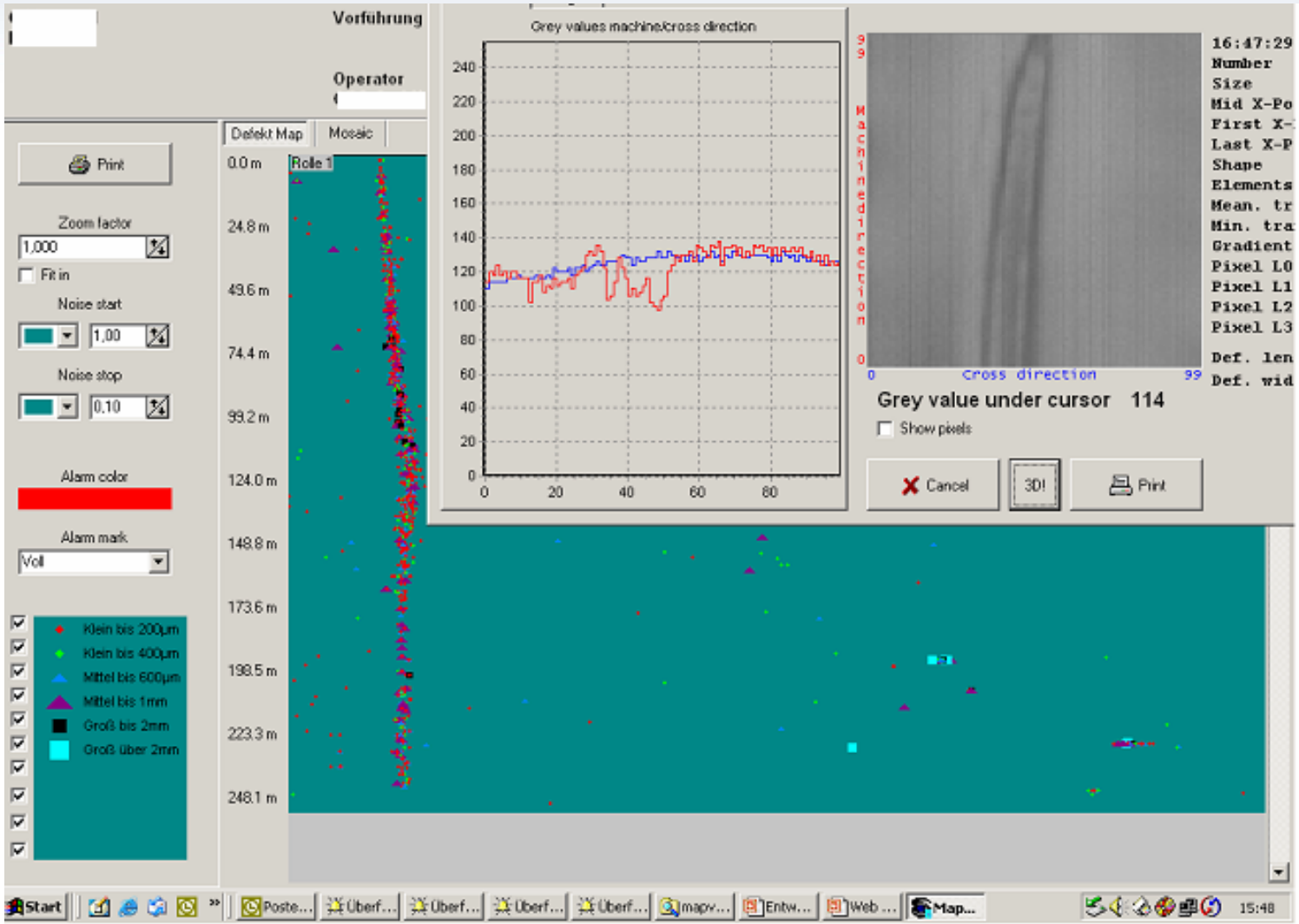




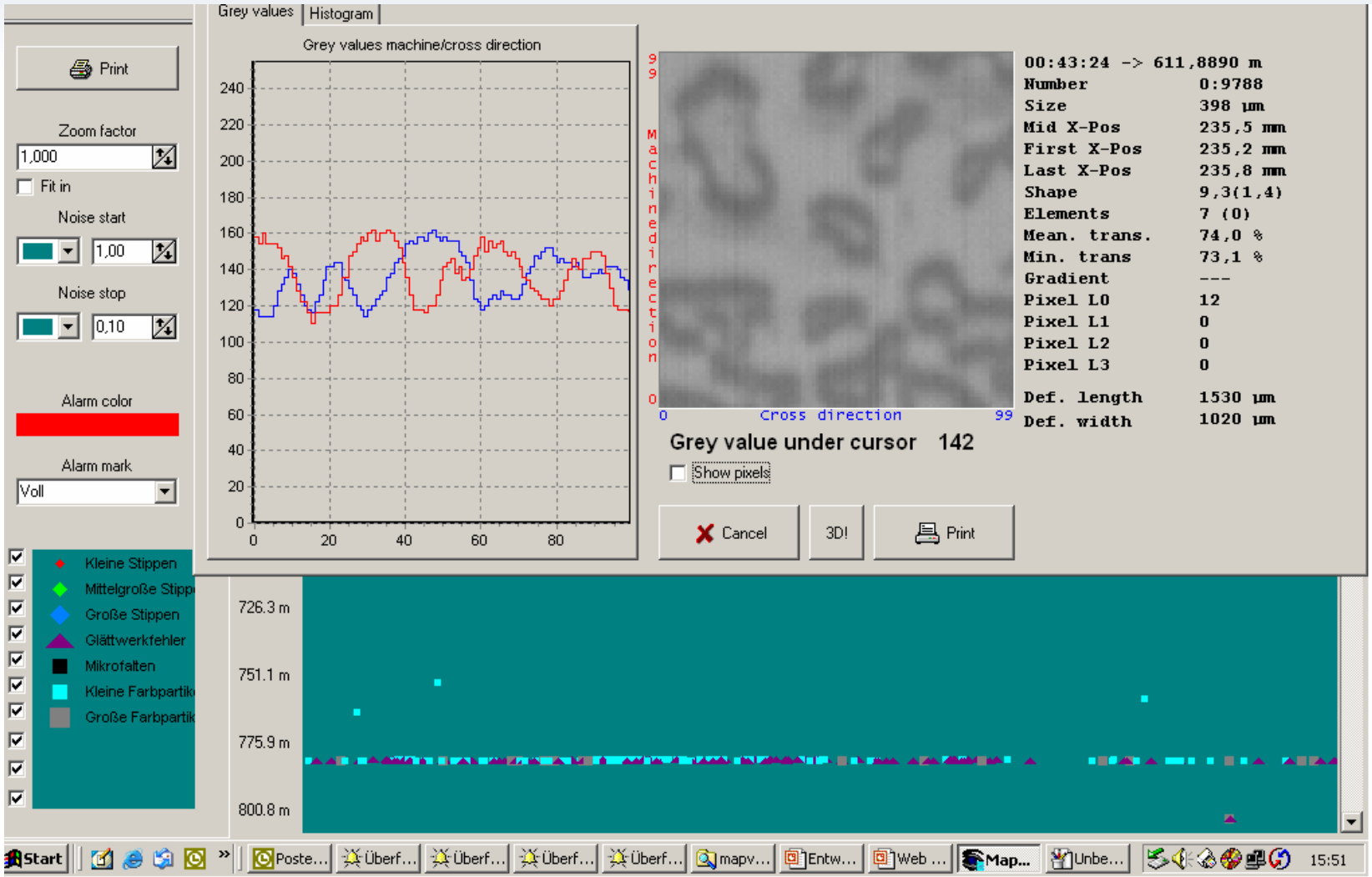
Lane Distribution



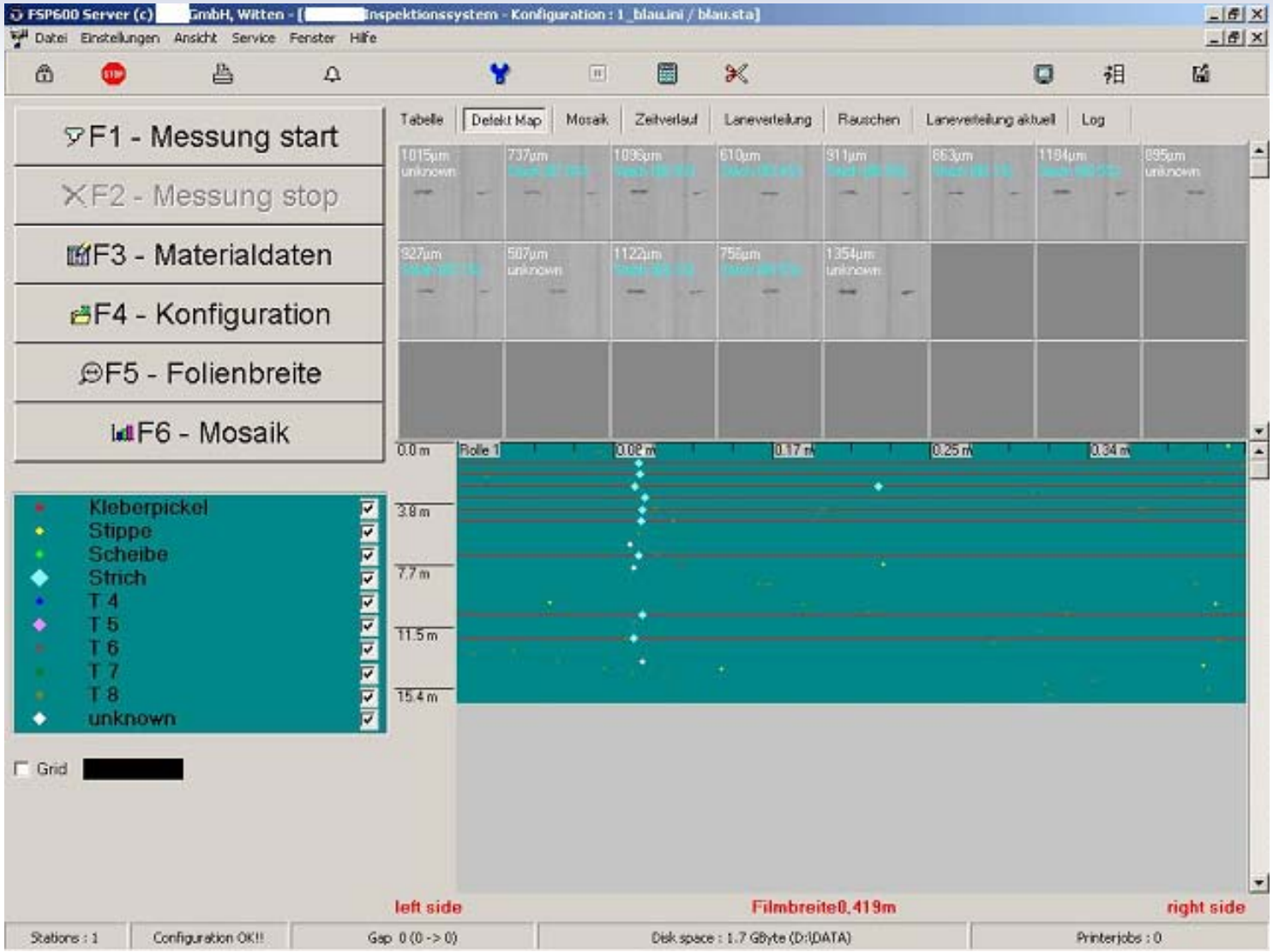
Die Defect


Vorführung
Operator
Print
Zoom factor
1,000
Fit in
Noise start
1,00
Noise stop
0,10
Alarm color
Alarm mark
Voll
Klein bis 200µm
Klein bis 400µm
Mittel bis 600µm
Mittel bis 1mm
Groß bis 2mm
Groß über 2mm
Defekt Map
Mosaic
Rolle 1
0.0 m
24.8 m
49.6 m
74.4 m
99.2 m
124.0 m
148.8 m
173.6 m
198.5 m
223.3 m
248.1 m
Grey values machine/cross direction
Machine direction
Cross direction
Grey value under cursor 114
Show pixels
Cancel
3D!
Print
16:47:29
Number
Size
Mid X-Po
First X-
Last X-P
Shape
Elements
Mean. tr
Min. tra
Gradient
Pixel L0
Pixel L1
Pixel L2
Pixel L3
Def. len
Def. wid
Start
15:48

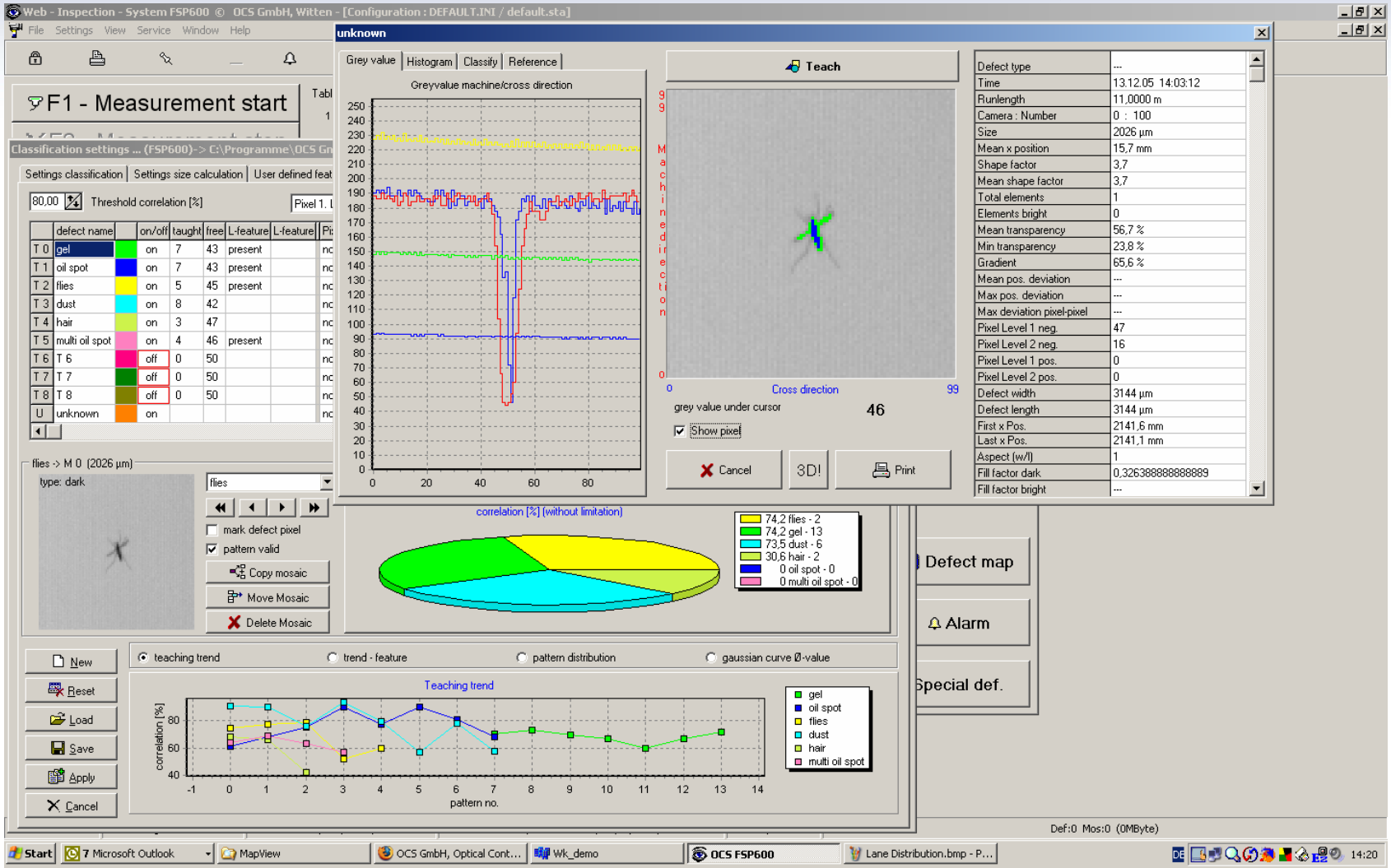
Calander Defect



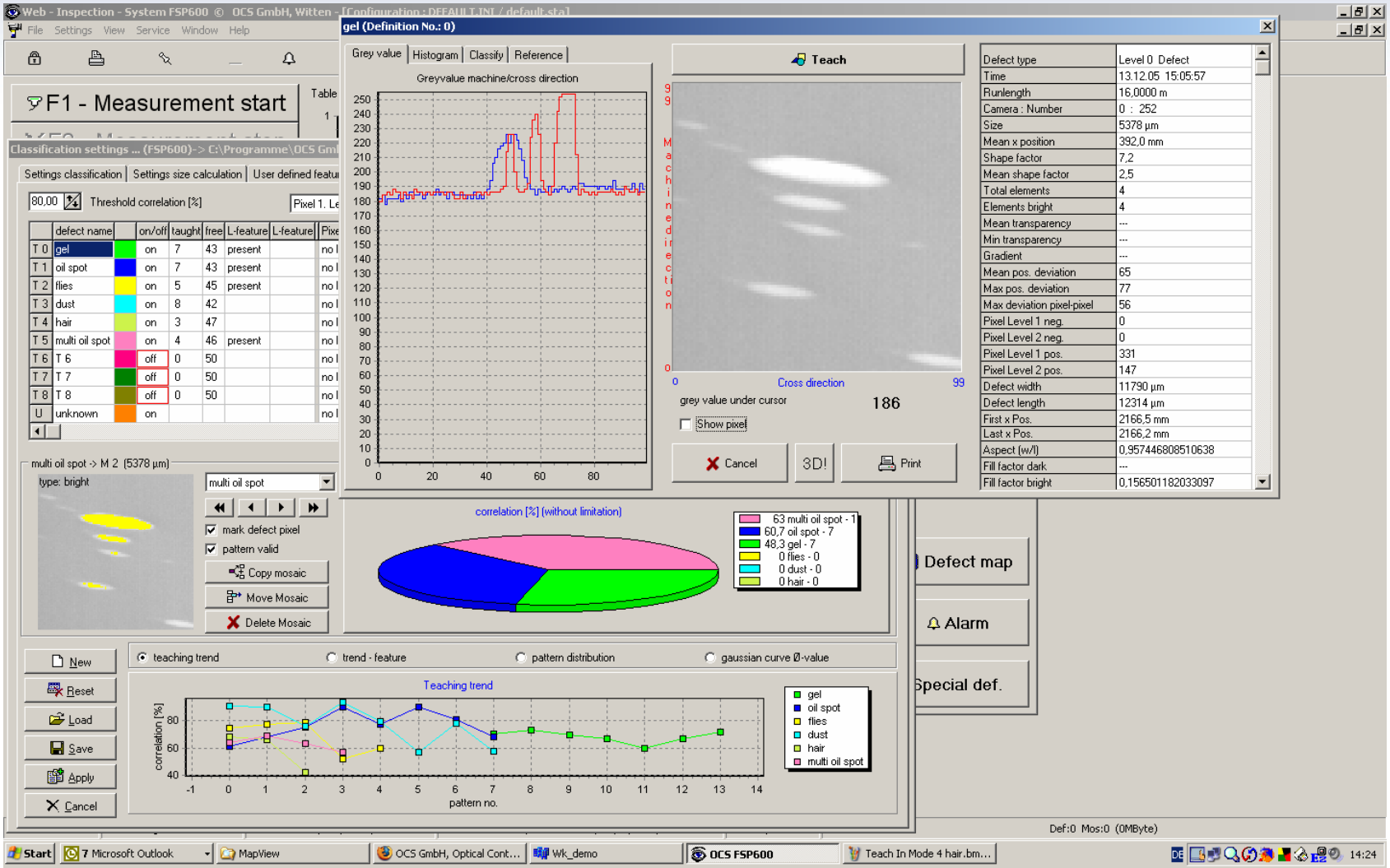
Alarms / Repeaters



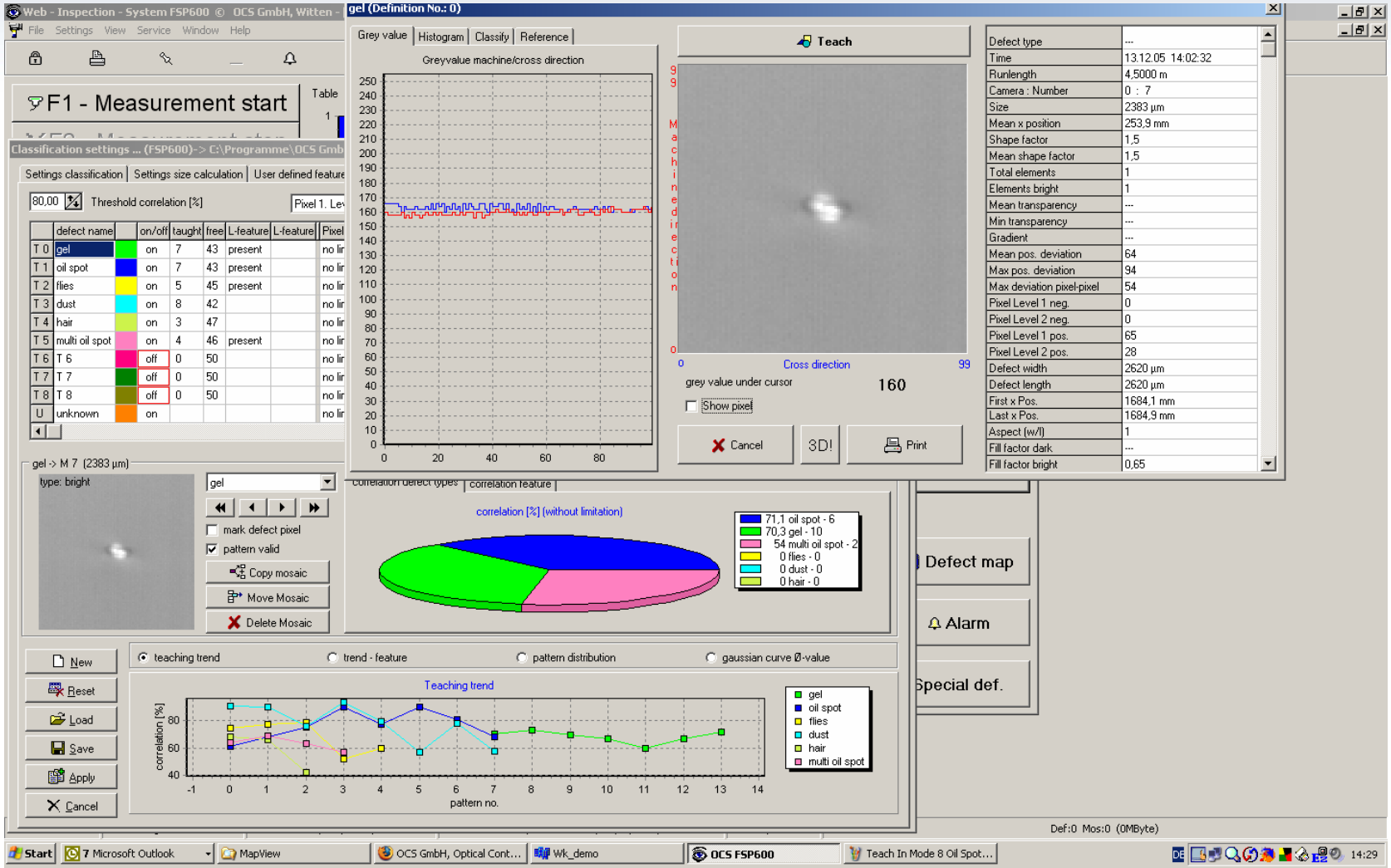
Teach-In Function - Fly



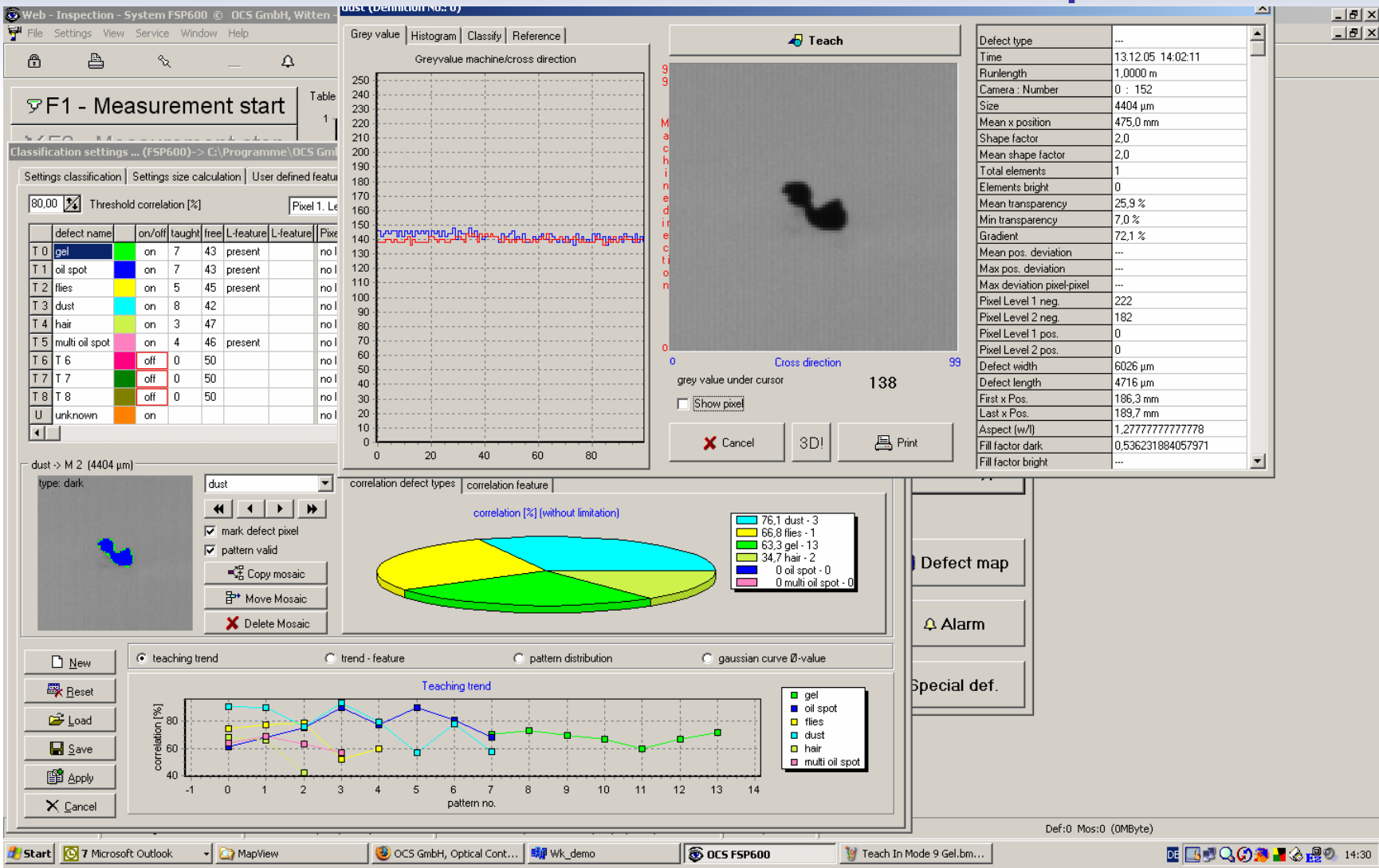
Teach-In Function – Oil Stain



Teach-In Function - Gel



Teach-In Function – Black Spec



Inspection Systems

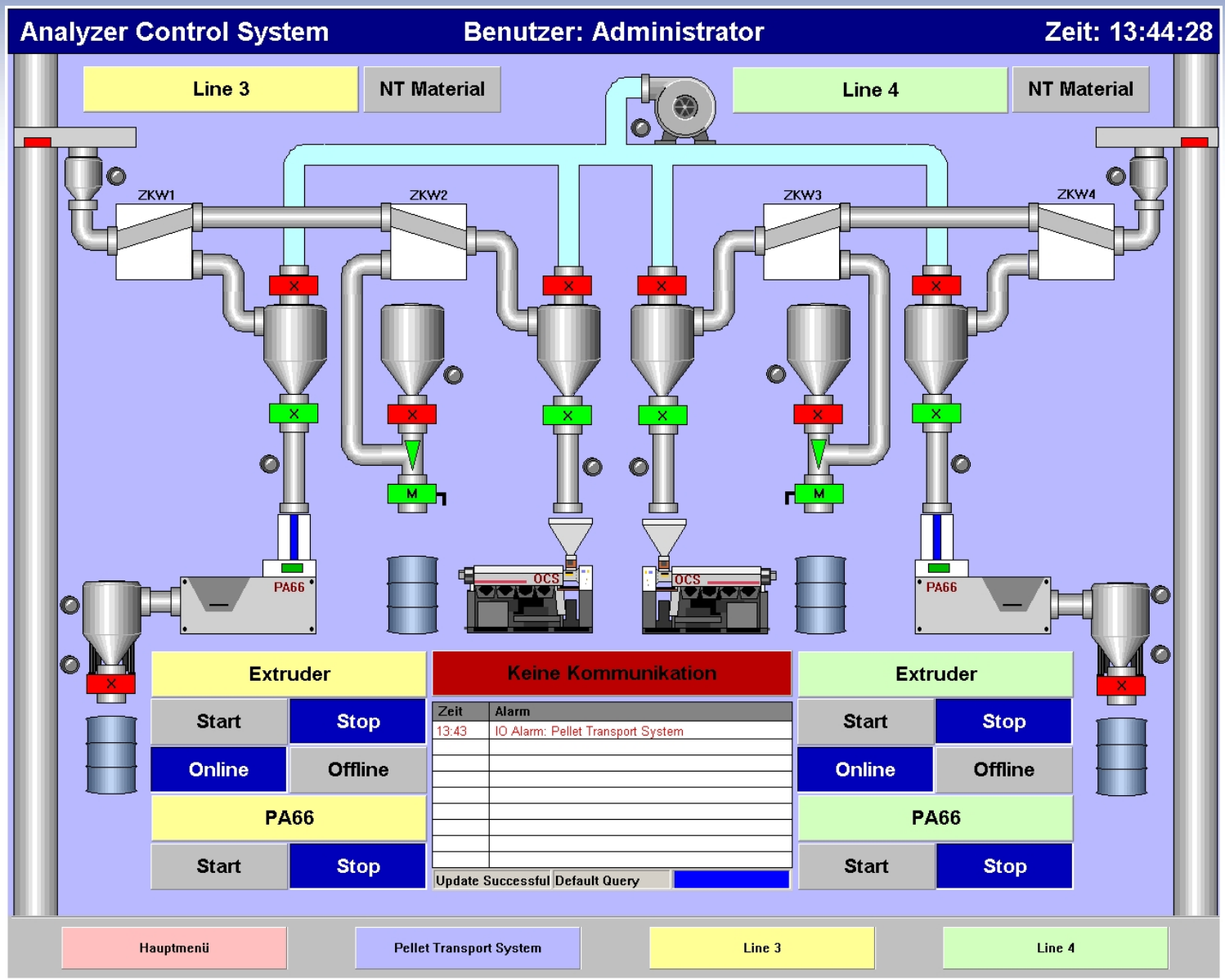
Inspection Systems

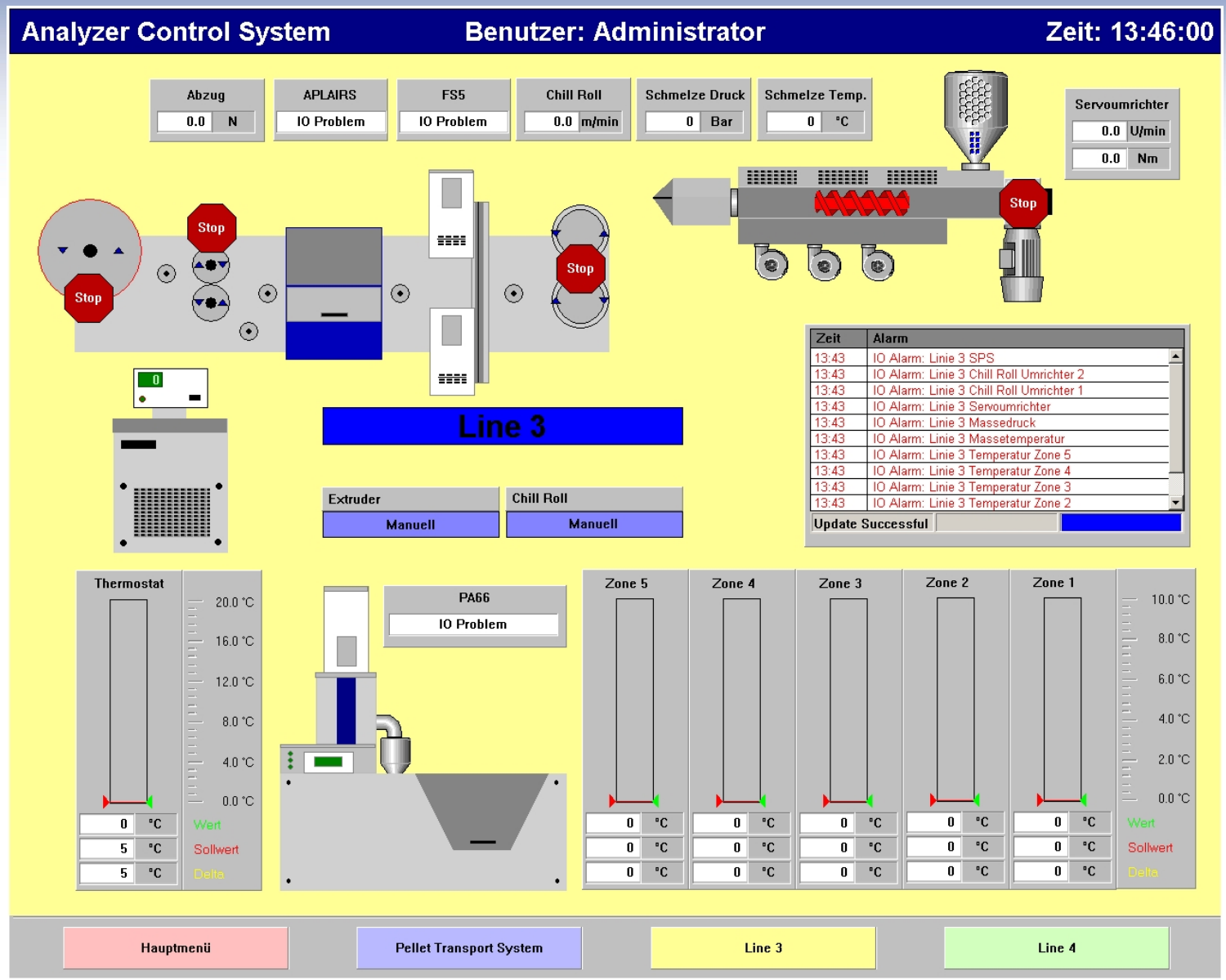
Closed Frame

Interrelationship and Correlation Example

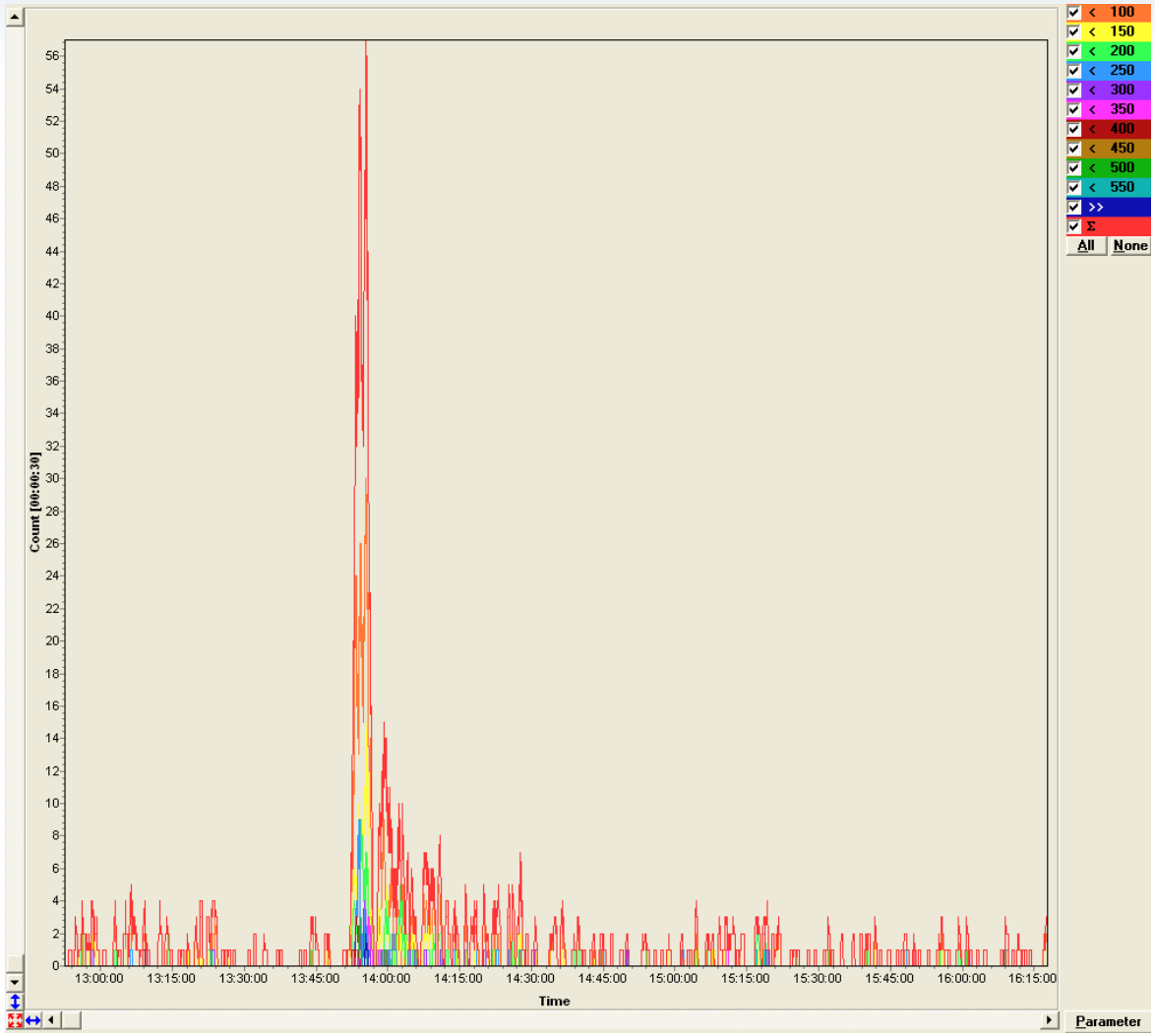
- Online Compound Control (Gel Analysis)
- Oracle Database Integration
- Decision for Film Extrusion Quality (Grading)
- 100 % Web Inspection in Cast Line (Diaper Breathable Film)

Online Container for Plant Control (Example)


Analyzer Control System
Benutzer: Administrator
Zeit: 13:44:28
Line 3
NT Material
Line 4
NT Material
ZKW1
ZKW2
ZKW3
ZKW4
PA66
OCS
OCS
PA66
Extruder
Keine Kommunikation
Extruder
Start
Stop
Online
Offline
Zeit
Alarm
13:43
IO Alarm: Pellet Transport System
Start
Stop
Online
Offline
PA66
PA66
Start
Stop
Update Successful
Default Query
Start
Stop
Hauptmenü
Pellet Transport System
Line 3
Line 4


Analyzer Control System
Benutzer: Administrator
Zeit: 13:46:00
Abzug
0.0 N
APLAIRS
IO Problem
FS5
IO Problem
Chill Roll
0.0 m/min
Schmelze Druck
0 Bar
Schmelze Temp.
0 °C
Servoumrichter
0.0 U/min
0.0 Nm
Stop
Stop
Stop
Stop
Line 3
Extruder
Manuell
Chill Roll
Manuell
Zeit
Alarm
13:43 IO Alarm: Linie 3 SPS
13:43 IO Alarm: Linie 3 Chill Roll Umrichter 2
13:43 IO Alarm: Linie 3 Chill Roll Umrichter 1
13:43 IO Alarm: Linie 3 Servoumrichter
13:43 IO Alarm: Linie 3 Massedruck
13:43 IO Alarm: Linie 3 Massetemperatur
13:43 IO Alarm: Linie 3 Temperatur Zone 5
13:43 IO Alarm: Linie 3 Temperatur Zone 4
13:43 IO Alarm: Linie 3 Temperatur Zone 3
13:43 IO Alarm: Linie 3 Temperatur Zone 2
Update Successful
Thermostat
20.0 °C
16.0 °C
12.0 °C
8.0 °C
4.0 °C
0.0 °C
Wert
Sollwert
Delta
PA66
IO Problem
Zone 5
Zone 4
Zone 3
Zone 2
Zone 1
10.0 °C
8.0 °C
6.0 °C
4.0 °C
2.0 °C
0.0 °C
Wert
Sollwert
Delta
Hauptmenü
Pellet Transport System
Line 3
Line 4

Gel Shower


Count [00:00:30]
0
2
4
6
8
10
12
14
16
18
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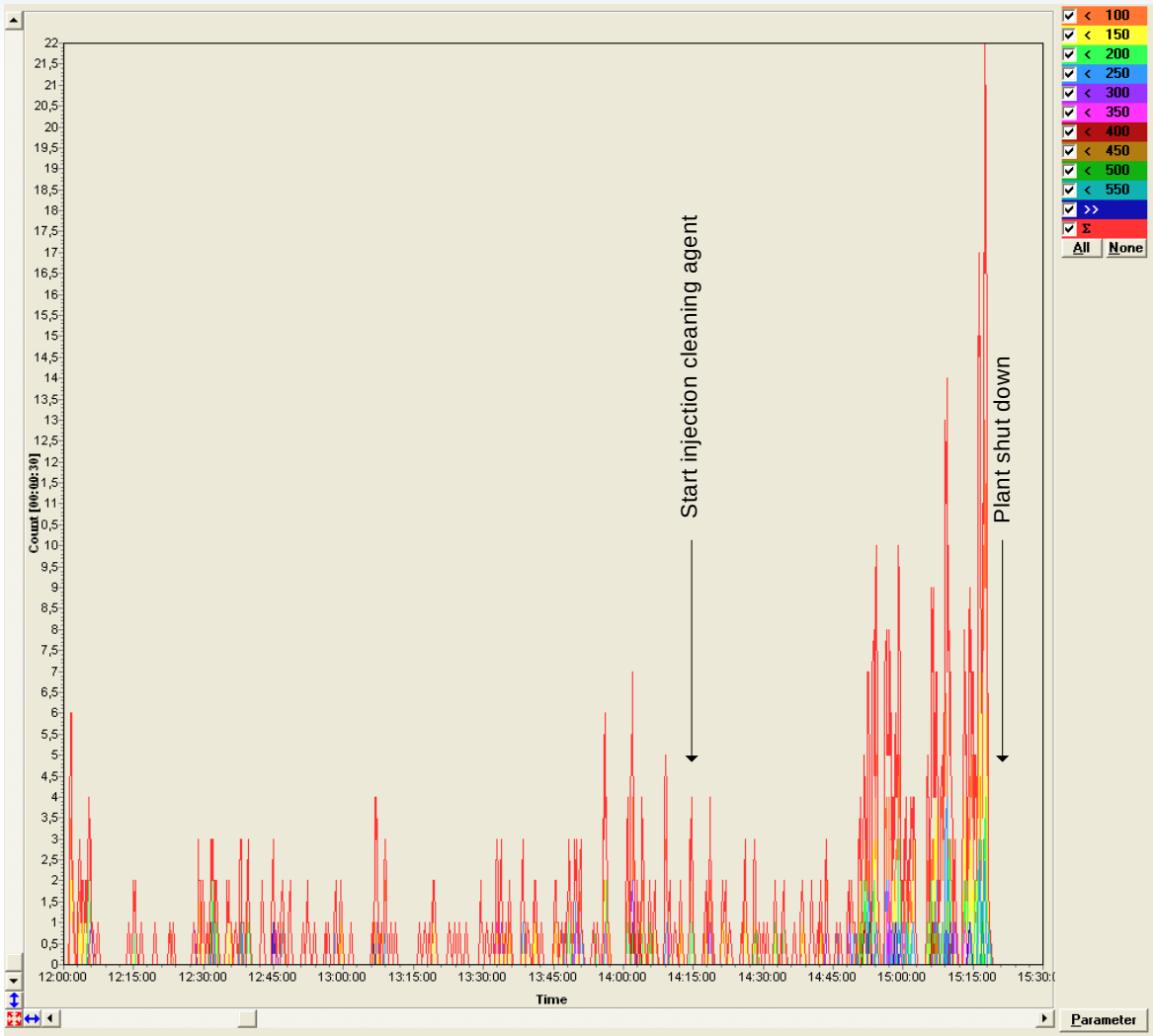
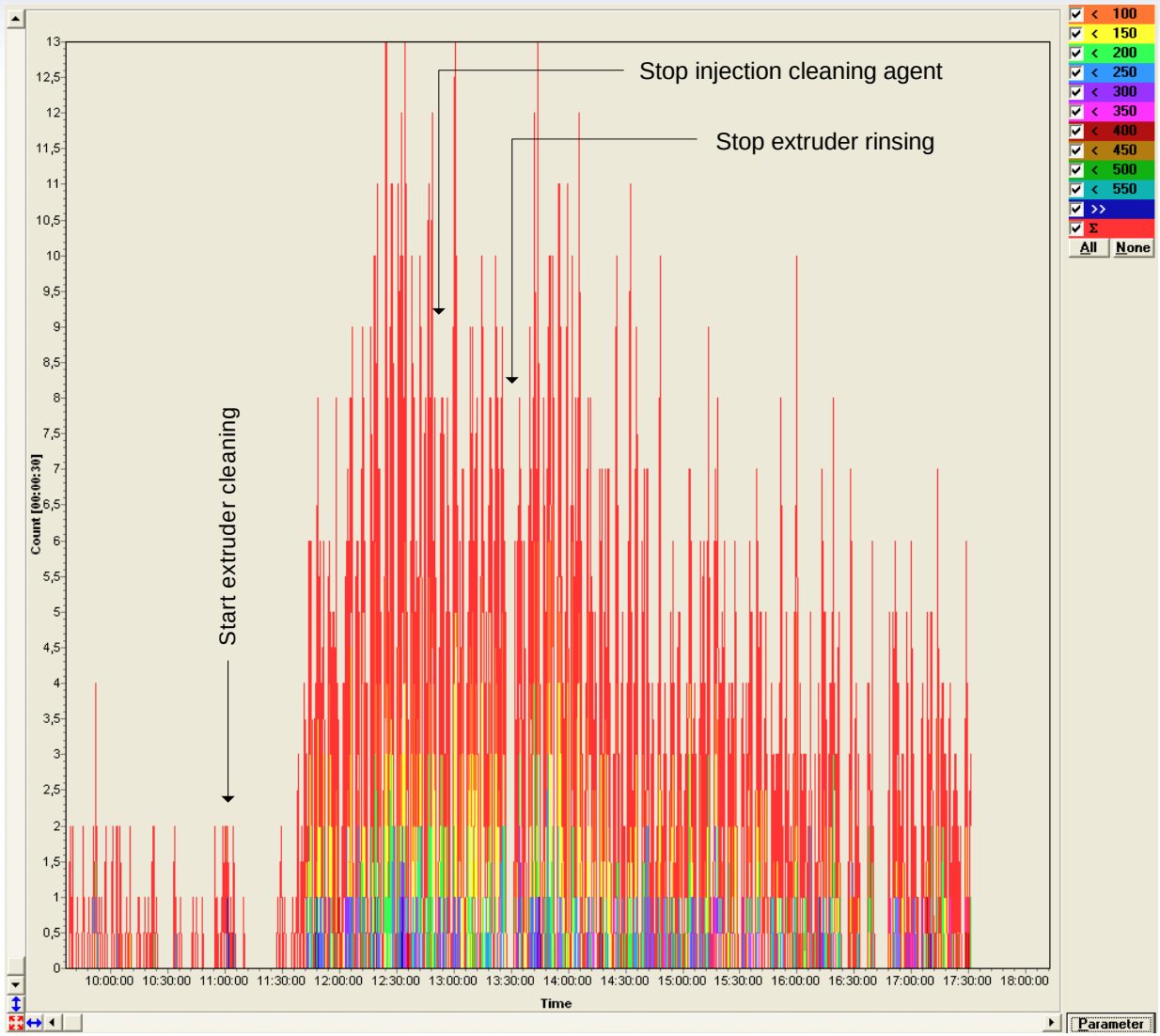
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
13:00:00
13:15:00
13:30:00
13:45:00
14:00:00
14:15:00
14:30:00
14:45:00
15:00:00
15:15:00
15:30:00
15:45:00
16:00:00
16:15:00
Time
< 100
< 150
< 200
< 250
< 300
< 350
< 400
< 450
< 500
< 550
>>
Σ
All
None
Parameter

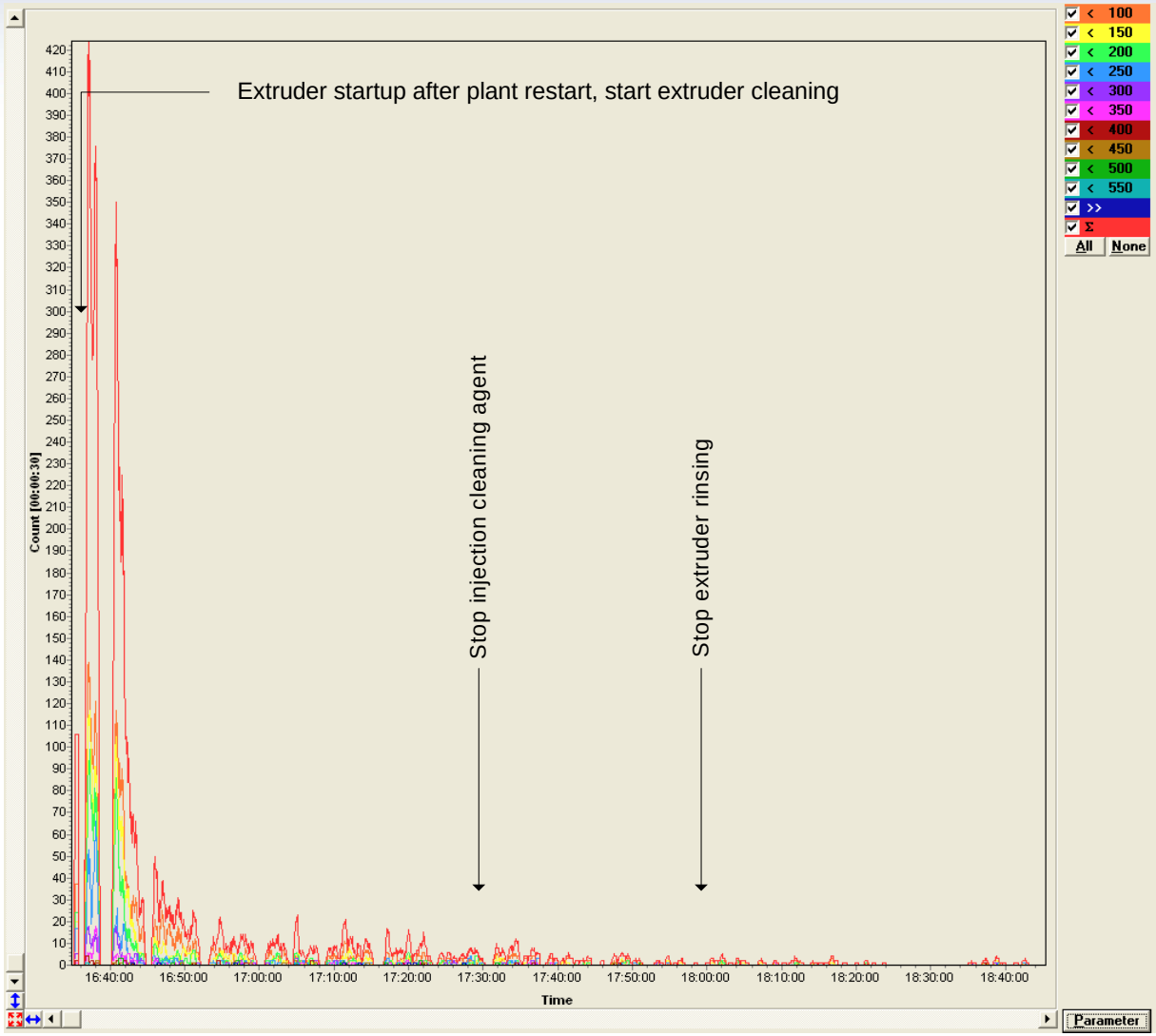
Online Anticipation of Plant Shut Down



Online Transition Control



Online Control of Extruder Start Up



Summary

- Close Loop Online Control (Process + Grading) is today‘s Standard in Polymer Plants
- 100 % Web Inspection in Film Extrusion
- Different Defect Types, but close Interrelation
- Working Together avoids Problems and improves Film Quality

Thank You

very much

for Your Attention !