Fab benefits from an efficient operator interface combining frontside/backside macro inspection with wafer randomization

FOA - Fab Star Webinar Series

May 23, 2024

Presenter:

Microtronic: Errol Akomer

Abstract

Enhancing yield, reliability, and operator efficiency is paramount in semiconductor manufacturing. Performing macro inspection is pivotal for identifying defects that compromise yield. High-speed macro inspection with wafer randomization allows for early detection, limits active excursions, and identifies long-term chronic yield issues.

Slot-positional analysis of randomized wafers has been around for decades. Fab's systematically alter and track wafer positions at multiple points throughout the line. Correlating yield patterns to wafer positions allows process/equipment issues to be quickly identified.

Microtronic's EAGLEview EV6 can automatically inspect 3,000 WPD while simultaneously randomizing wafers, the platform has become integral to our customer's inspection strategy.

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Outline:

Intro to EAGLEview (Automated Macro Inspection Platform)

ProcessGuard with LotView – the ultimate interface for macro-inspected wafers

The power of randomization in a semiconductor fab

EAGLEview puts it all together; Frontside, Backside, LotView, & Randomization

Case Study Examples

Questions & ProcessGuard Live Demo

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Intro to EAGLEview (Automated Macro Inspection Platform)

- EAGLEview is a high-speed automated macro inspection platform, capable of inspecting >3,000 wafers per day without the need for device-dependent recipes. The tool comes standard with ProcessGuard software (unlimited licenses), automated sorting capability, digital guardbanding, wafer randomization with slot-positional analysis, and much more.

EAGLEview Configurations

Standard

Wafer Diameters: 75mm – 300mm

Multi-Diameter: Yes (i.e. 100/150/200mm system)

Carriers: OPEN, SMIF, FOUP, FOSB (or any combination)

OCR: Top and/or Bottom, In-House or Vendor Scribe

Full Randomization and Automatic Sorting

ProcessGuard Server (~35Tb) and unlimited ProcessGuard Clients

Options

Backside Inspection Module

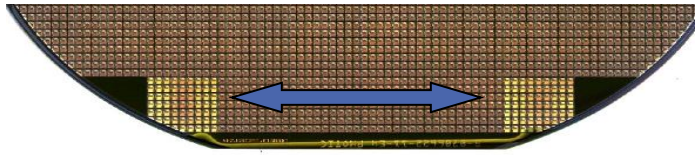
MicroView Camera Capture (External or Internal)

EVdlADC: Deep Learning ADC for Residual CMP and Pinholes

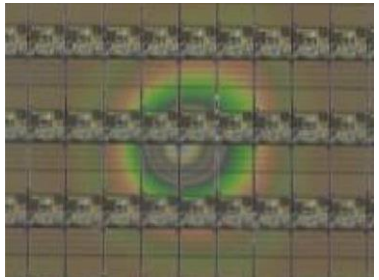
ProcessGuard Xtensis: Automatic Defect Detection for External Images

Typically, EAGLEview is deployed in-line Photolithography ADI

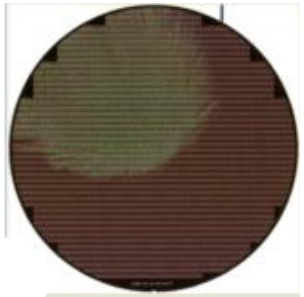
Flash Field Issues



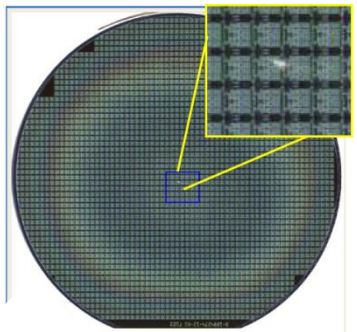
HDP Chamber Overheating



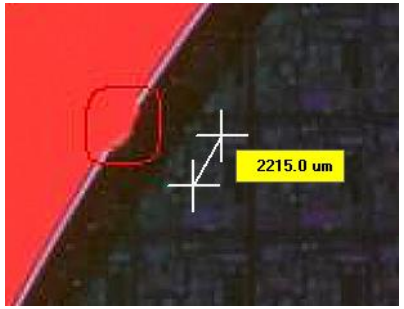
Hotspots



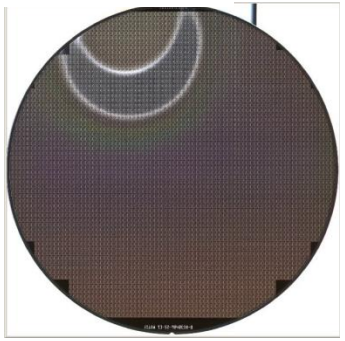
Rinse Issues



Scratches

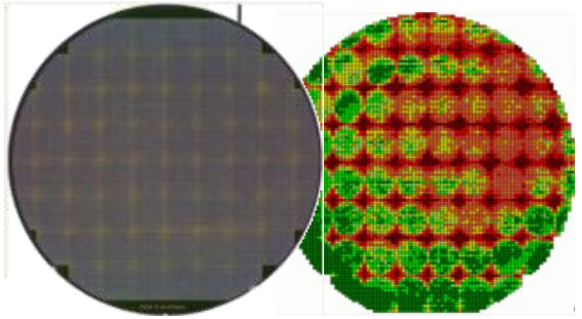


Chip Detection



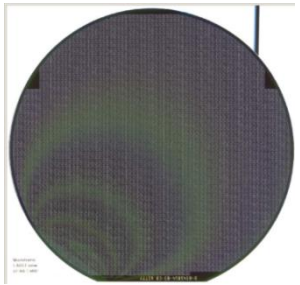
Blocked Etch

Spin Defects

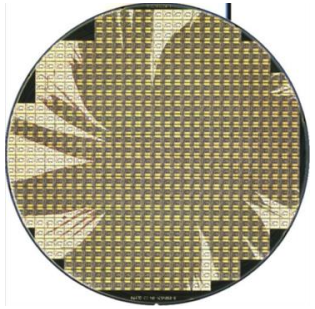


Stepper Lens issues

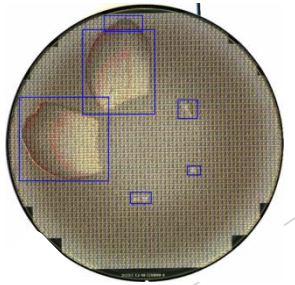
Reticle Tilt issues



Tee-Pee



SOG Bottle Purge



IPA Drips

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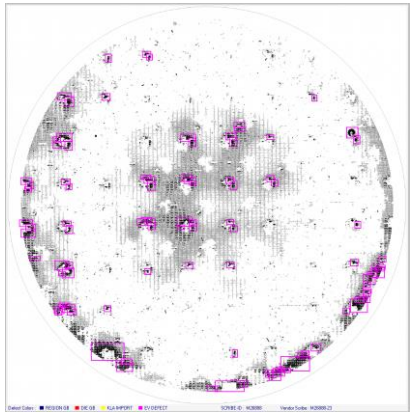
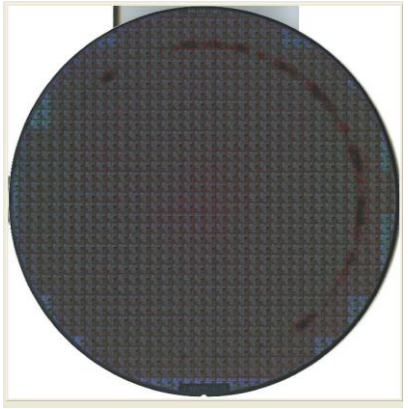
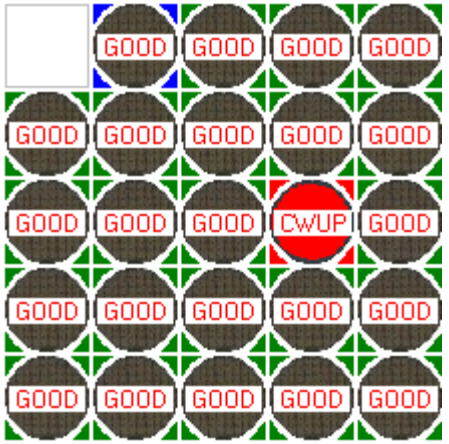
EAGLEview is also deployed in CMP, YE, and Outgoing Insp

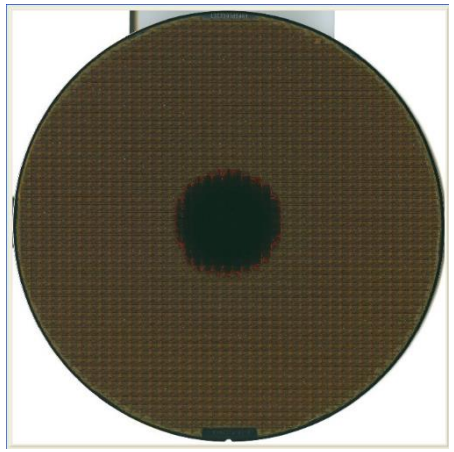
Residual Tungsten

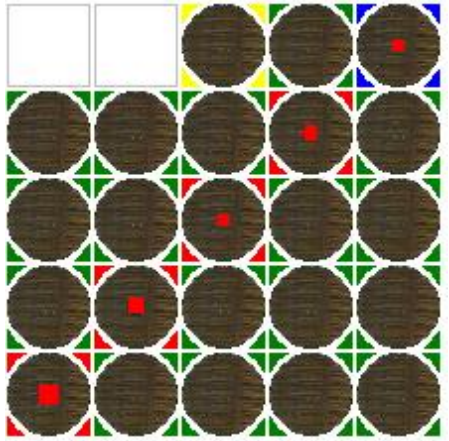


4-Chamber Residual

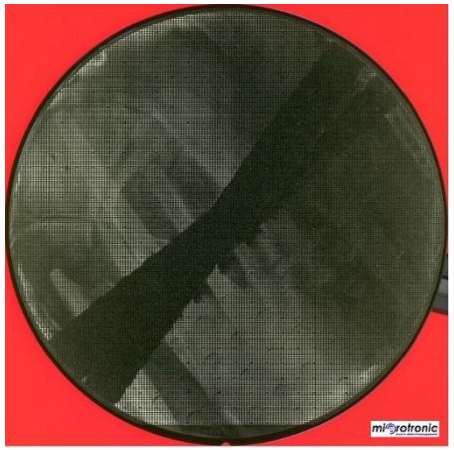


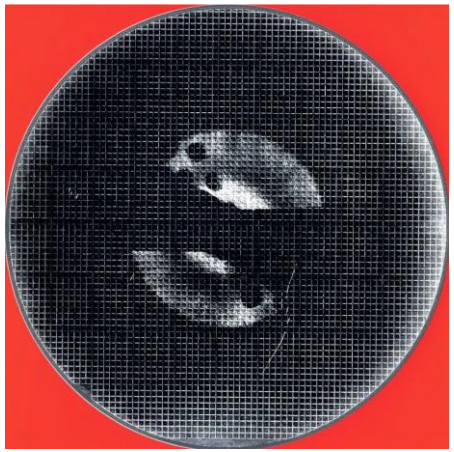






Residual Tungsten - 5 Chamber Signal





Brush Scrub Defects

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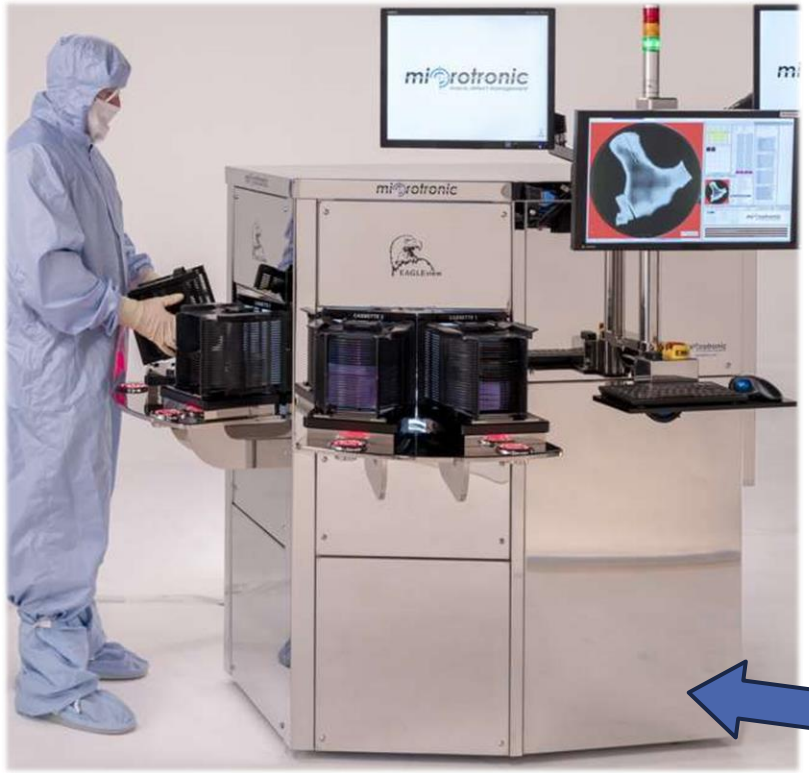
ProcessGuard Live Demo

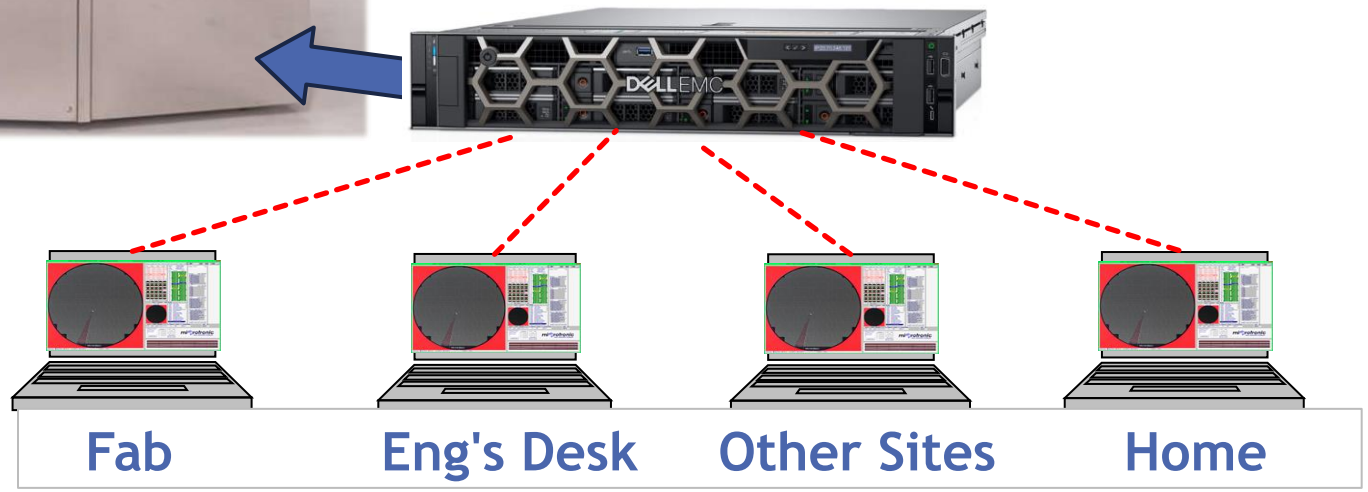
Questions

ProcessGuard with LotView - the ultimate interface for macro-inspected wafers



The ProcessGuard Server (~35Tb) is rack mounted within the EAGLEview tool in the fab or can be relocated to the Fab's data center.

The EAGLEview platform has unlimited ProcessGuard Clients



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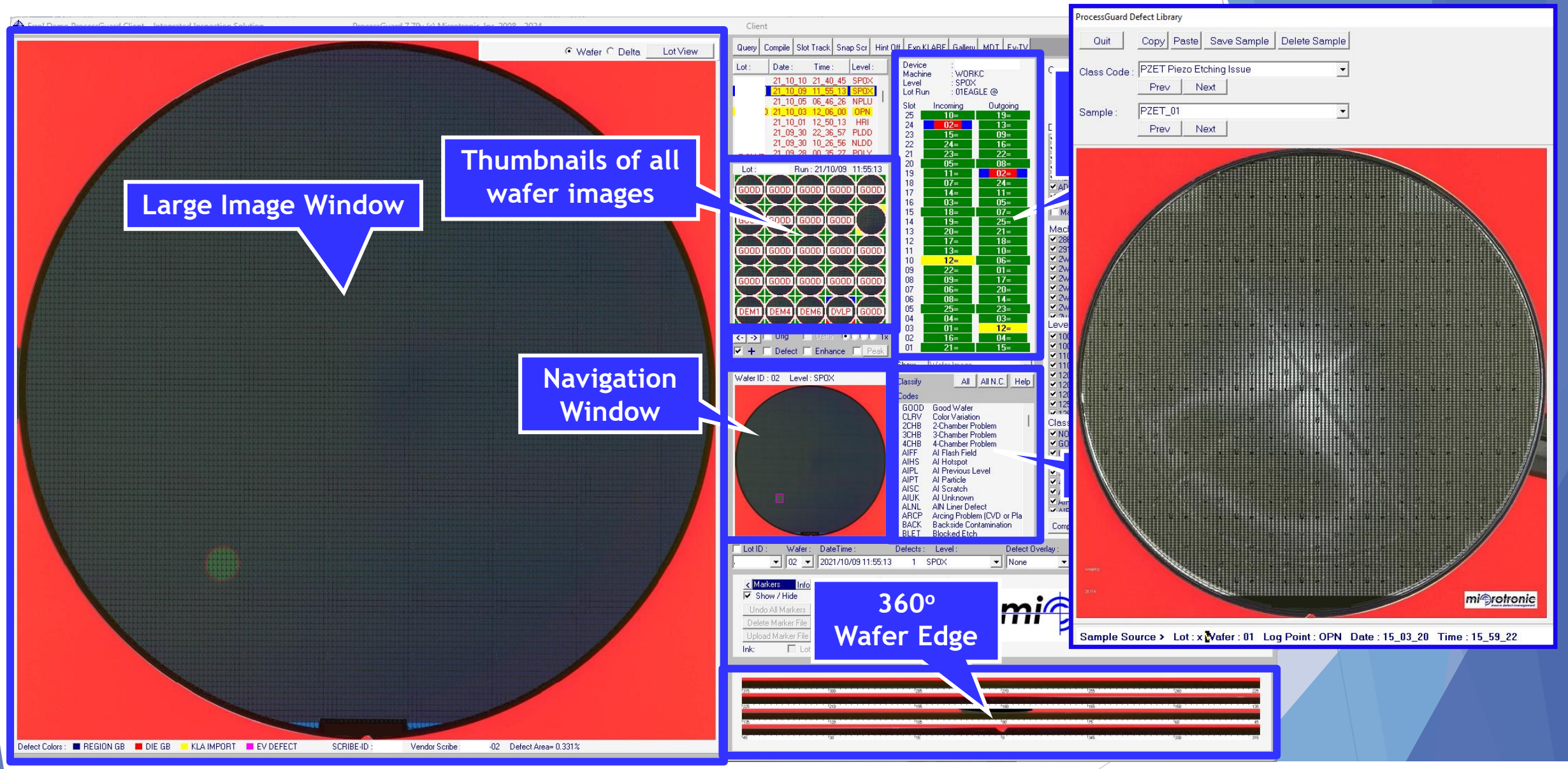
ProcessGuard with LotView – the ultimate interface for macro-inspected wafers



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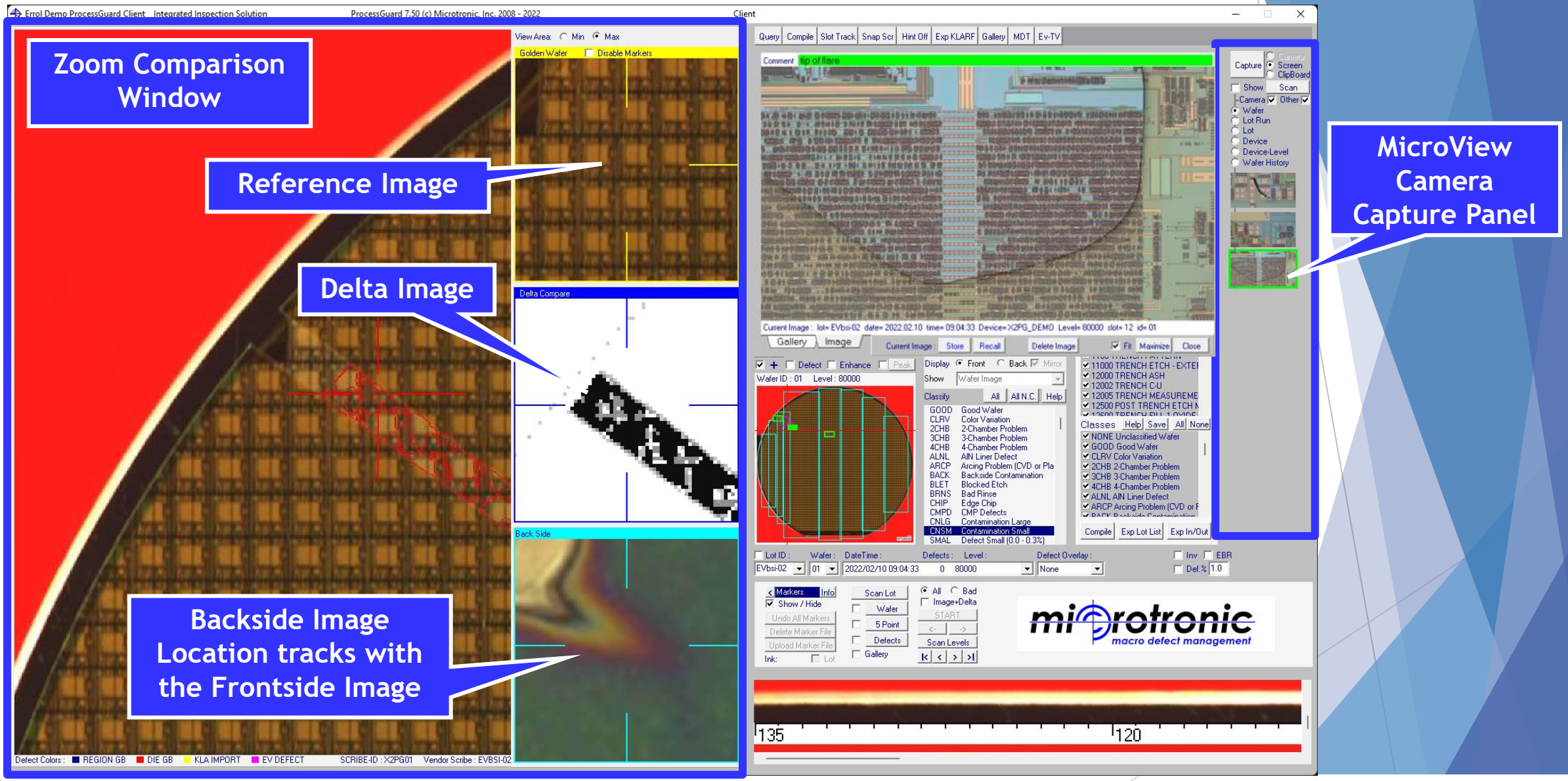
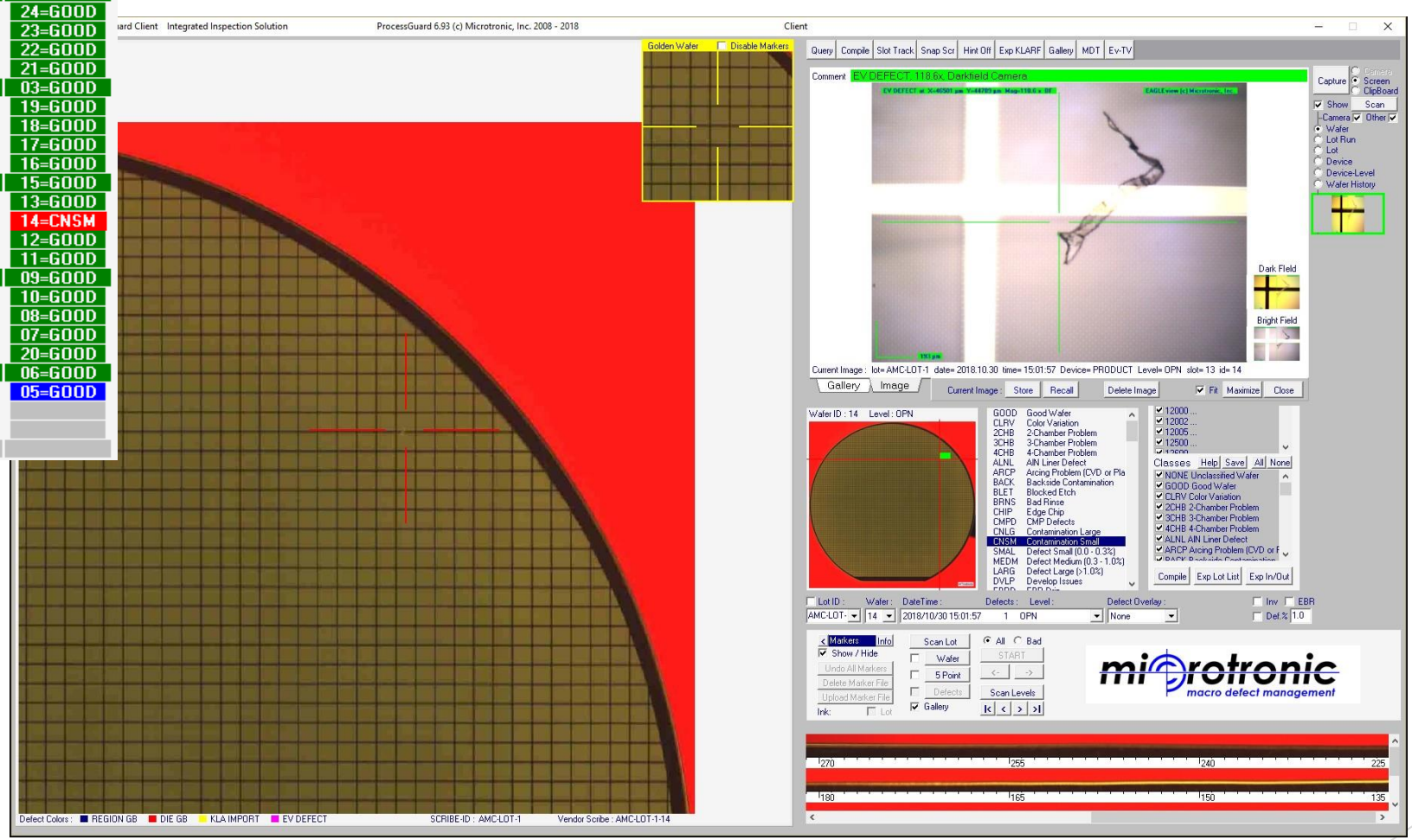
ProcessGuard with LotView – the ultimate interface for macro-inspected wafers

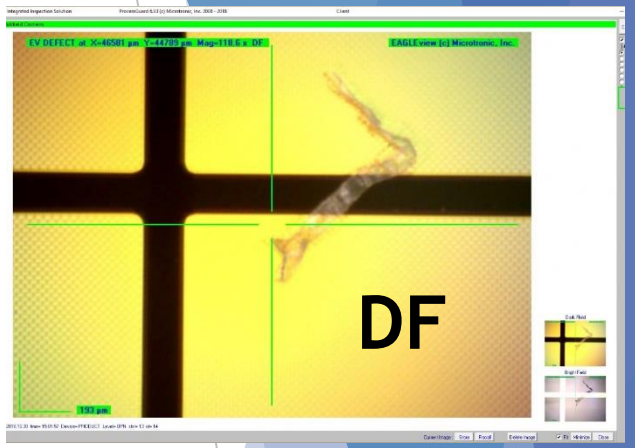


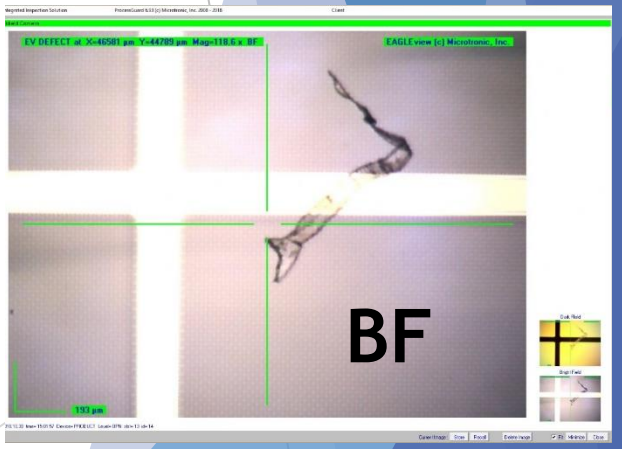
ProcessGuard with LotView – the ultimate interface for macro-inspected wafers

Internal (Automatic) MicroView (microscope) image capture

Slot	Incoming	Outgoing
25	25=GOOD	25=GOOD
24	24=GOOD	24=GOOD
23	23=GOOD	23=GOOD
22	22=GOOD	22=GOOD
21	21=GOOD	21=GOOD
20	03=GOOD	03=GOOD
19	19=GOOD	19=GOOD
18	18=GOOD	18=GOOD
17	17=GOOD	17=GOOD
16	16=GOOD	16=GOOD
15	15=GOOD	15=GOOD
14	13=GOOD	13=GOOD
13	14=CNSM	14=CNSM
12	12=GOOD	12=GOOD
11	11=GOOD	11=GOOD
10	09=GOOD	09=GOOD
09	10=GOOD	10=GOOD
08	08=GOOD	08=GOOD
07	07=GOOD	07=GOOD
06	20=GOOD	20=GOOD
05	06=GOOD	06=GOOD
04	05=GOOD	05=GOOD
03		
02		
01		







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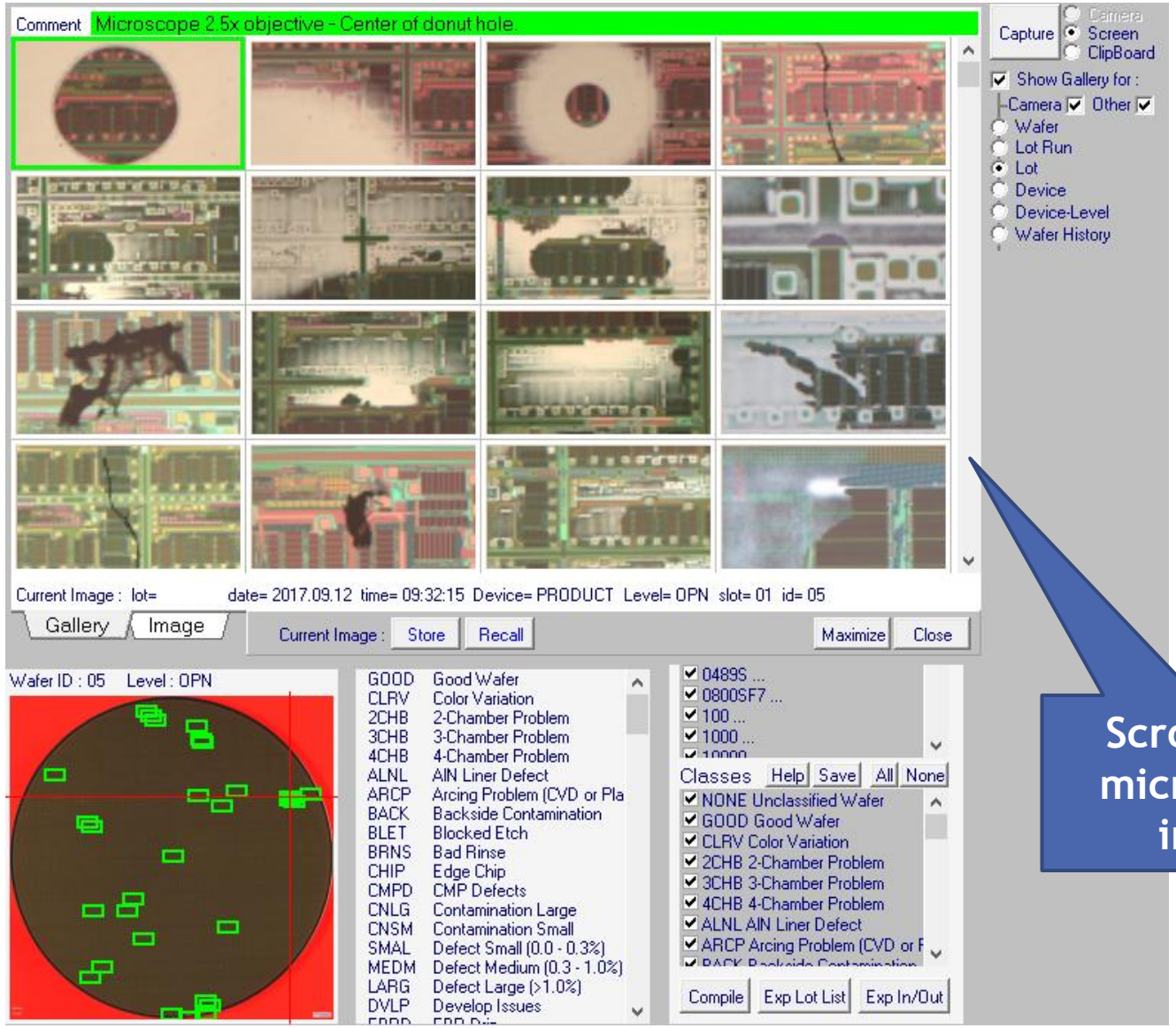

Input Options
Microscope Camera
PG Screenshot
Clipboard Contents

Gallery View Filtering

Scroll bar of micro defect images

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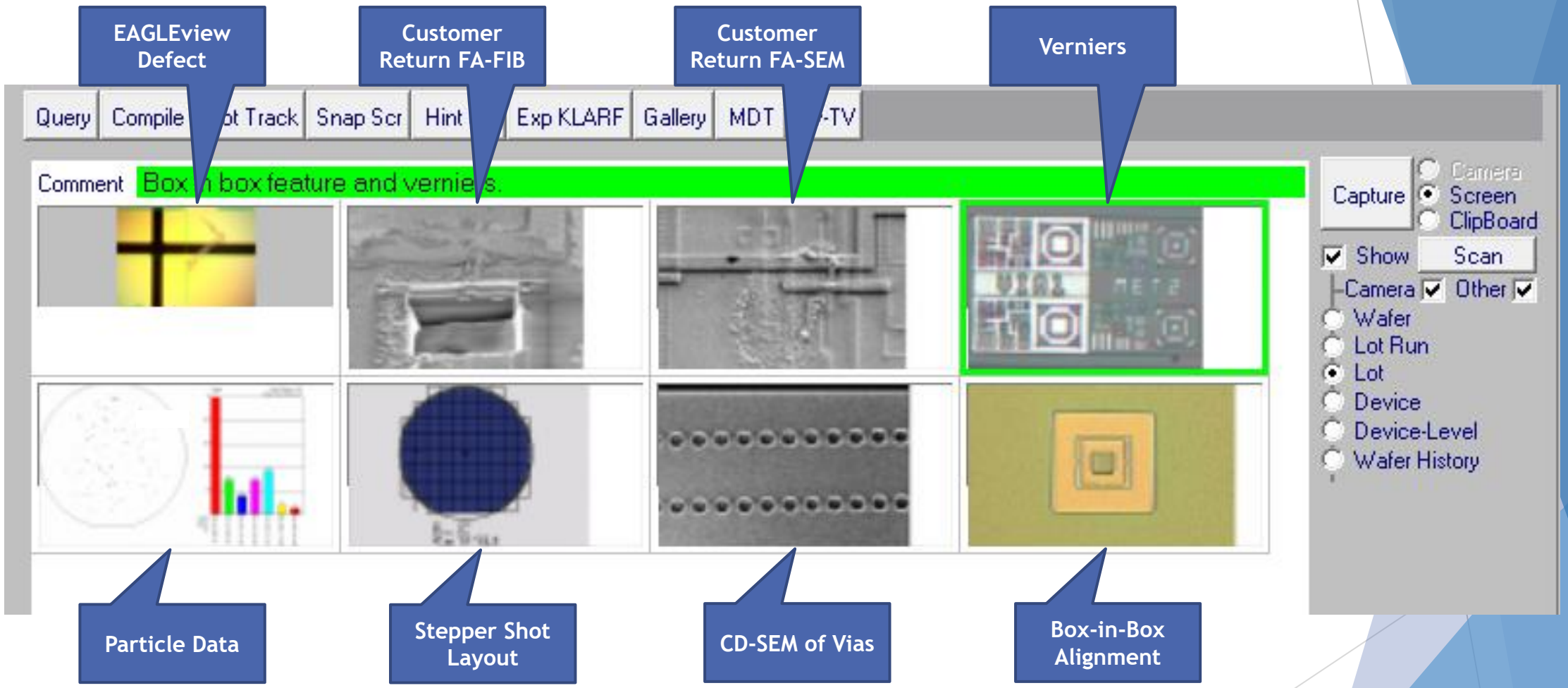
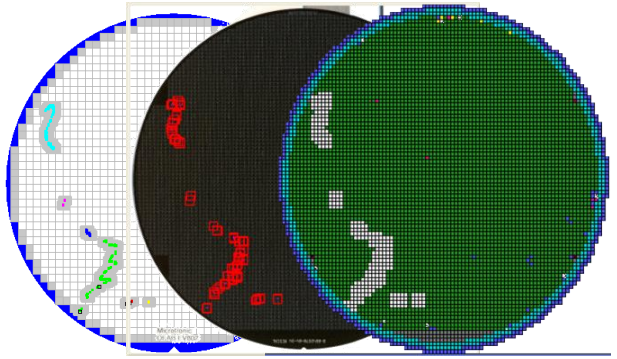
MicroView can be used as a repository for any wafer data

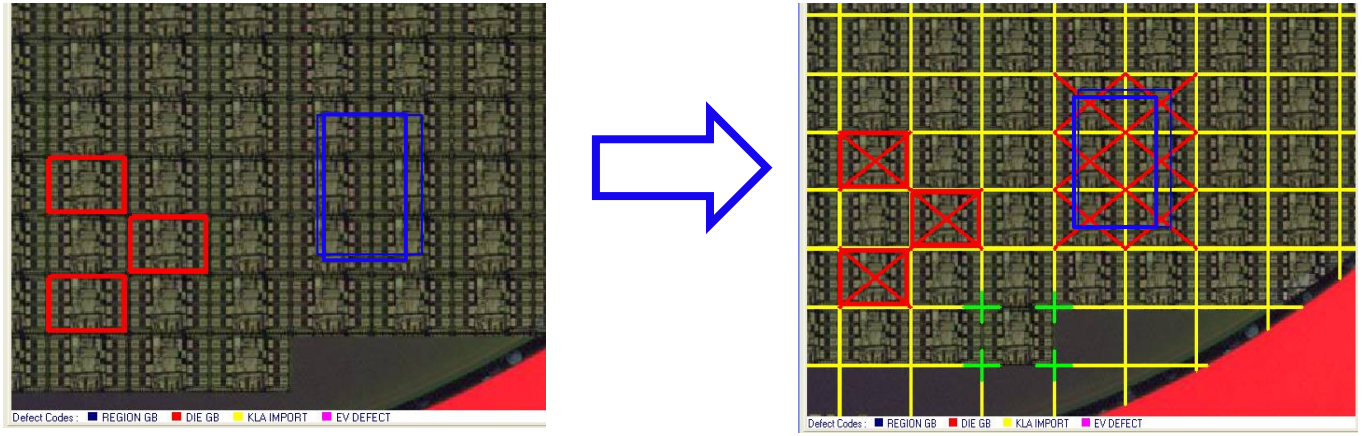


Guardbanding Capability

KLARF > EAGLEview > Probe Map



- EAGLEview guardbanding is SEMI Standard G85 Compliant
- Enhances an Automotive Zero-Defect strategy
- KLARF IMPORT - provides ***automatic*** guardbanding and a user defined ***buffer*** around the KLARF defects
- EAGLEview guardbanding can be performed by a ProcessGuard client from anywhere in the world
- With ProcessGuard, a user can draw a box or select individual die directly on the image….



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ProcessGuard with LotView – the ultimate interface for macro-inspected wafers [ProcessGuard Live DEMO]

The power of randomization in a semiconductor fab

EAGLEview puts it all together; Frontside, Backside, LotView, & Randomization

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The power of randomization in a semiconductor fab

Wafer randomization has been used for decades in semiconductor processing. Combining wafer slot positions with yield, testprobe parameters, or any other wafer data can quickly help identify tool and/or process issues.

Wafer randomization is a simple concept to understand and put into practice. In a typical deployment, sorters are used at multiple steps in the process line, wafers are randomized, and a system keeps track of each wafer's incoming and outgoing slot position.

If the wafers show variability after subsequent processing, analysis is performed to see if there is a pattern or correlation to the slot position during fabrication.

Understanding Randomization

Slot	Proc Step #10		Proc Step #50		Proc Step #90		Proc Step #130		Proc Step #170		Proc Step #210		Proc Step #250	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Example: EAGLEview deployed at 7 levels without Randomization.
5 low-yielding wafers (#21-25), maintaining Slot Integrity provides no insight.

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Understanding Randomization

Slot	Proc Step #10		Proc Step #50		Proc Step #90		Proc Step #130		Proc Step #170		Proc Step #210		Proc Step #250	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #
25	25	7	7	22	22	23	[illegible]	24	24	22	22	19	19	25
24	24	19	19	14	14	17	17	21	21	[illegible]	25	16	16	24
23	23	3	3	2	2	8	8	7	7	[illegible]	8	7	7	23
22	22	11	11	21	21	15	[illegible]	15	15	[illegible]	11	3	3	22
21	21	25	25	6	6	2	[illegible]	9	9	2	2	18	18	21
20	20	8	8	19	19	11	11	[illegible]	[illegible]	23	23	22	22	20
19	19	16	16	1	1	5	5	12	12	13	13	8	8	19
18	18	23	23	9	9	18	18	14	14	5	5	15	15	18
17	17	21	21	16	16	24	24	6	6	14	14	6	6	17
16	16	1	1	3	3	25	25	8	8	3	3	4	4	16
15	15	10	10	11	11	14	14	2	2	18	18	23	23	15
14	14	14	14	4	4	20	20	3	3	24	24	20	20	14
13	13	17	17	5	5	10	10	22	22	9	9	10	10	13
12	12	2	2	17	17	9	9	11	11	12	12	9	9	12
11	11	24	24	7	7	4	4	13	13	15	15	1	1	11
10	10	6	6	24	24	1	1	17	17	17	17	12	12	10
9	9	18	18	23	23	16	16	20	20	4	4	14	14	9
8	8	13	13	8	8	7	7	18	18	6	6	17	17	8
7	7	5	5	18	18	19	19	4	4	20	20	5	5	7
6	6	20	20	20	20	21	21	5	5	21	21	13	13	6
5	5	4	4	12	12	22	22	10	10	1	1	24	24	5
4	4	22	22	10	10	13	13	16	16	10	10	25	25	4
3	3	9	9	13	13	12	12	23	23	19	19	21	21	3
2	2	12	12	15	15	6	6	25	25	7	7	2	2	2
1	1	15	15	25	25	3	3	1	1	16	16	11	11	1

If the customer uses Full Wafer Randomization at all 7 EAGLEview levels, the slot position of the 5 low-yielding wafers indicates the problem occurred on the last 5 wafers in the cassette between Process Step #130 – Process Step #170.

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Understanding Randomization

Slot	Proc Step #10		Proc Step #30		Proc Step #50		Proc Step #70		Proc Step #90		Proc Step #110		Proc Step #130		Proc Step #150		Proc Step #170		Proc Step #190		Proc Step #210		Proc Step #230		Proc Step #250		Proc Step #270	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #	Wafer #
25	25	7	7	22	22	23	23	16	16	22	22	19	19	7	7	15	15	18	18	8	8	6	6	13	13	19	19	25
24	24	19	19	14	14	17	17	21	21	25	25	16	16	5	5	21	21	11	11	24	24	7	7	11	11	1	1	24
23	23	3	3	2	2	8	8	17	17	8	8	7	7	17	17	24	24	8	8	14	14	12	12	18	18	6	6	23
22	22	11	11	21	21	15	15	1	1	11	11	3	3	16	16	7	7	25	25	11	11	25	25	1	1	14	14	22
21	21	25	25	6	6	2	2	14	14	2	2	18	18	11	11	9	9	15	15	20	20	18	18	22	22	15	15	21
20	20	8	8	19	19	11	11	19	19	23	23	22	22	10	10	22	22	9	9	16	16	5	5	4	4	18	18	20
19	19	16	16	1	1	5	5	12	12	13	13	8	8	25	25	6	6	20	20	3	3	11	11	8	8	11	11	19
18	18	23	23	9	9	18	18	9	9	5	5	15	15	24	24	17	17	12	12	2	2	1	1	2	2	3	3	18
17	17	21	21	16	16	24	24	6	6	14	14	6	6	15	15	4	4	19	19	12	12	14	14	17	17	13	13	17
16	16	1	1	3	3	25	25	8	8	3	3	4	4	2	2	14	14	14	14	17	17	21	21	15	15	17	17	16
15	15	10	10	11	11	14	14	2	2	18	18	23	23	12	12	8	8	10	8	21	10	20	21	20	20	16	16	15
14	14	14	14	4	4	20	20	3	3	24	24	20	20	22	22	12	22	1	12	9	1	16	9	16	16	20	8	14
13	13	17	17	5	5	10	10	22	22	9	9	10	20	8	8	13	13	17	13	13	17	17	13	17	17	14	14	21
12	12	2	2	17	17	9	9	11	11	12	12	9	9	14	14	10	10	16	10	22	16	3	10	3	3	23	23	12
11	11	24	24	7	7	4	4	13	13	15	15	1	1	4	4	2	2	22	22	22	22	10	22	10	10	7	7	10
10	10	6	6	24	24	1	1	7	7	17	17	12	12	9	9	3	3	23	23	25	25	4	25	4	4	12	12	2
9	9	18	18	23	23	16	16	20	20	4	4	14	14	21	21	11	11	7	7	15	15	2	15	2	2	9	9	4
8	8	13	13	8	8	7	7	18	18	6	6	17	17	3	3	25	25	6	6	1	6	8	1	8	8	3	3	5
7	7	5	5	18	18	19	19	4	4	20	20	5	5	19	19	5	5	2	2	7	7	15	7	15	15	24	24	7
6	6	20	20	20	20	21	21	5	5	21	21	13	13	18	18	19	19	4	4	5	13	6	5	22	22	6	6	25
5	5	4	4	12	12	22	22	10	10	1	1	24	24	1	1	16	16	13	16	6	24	4	6	24	24	10	10	24
4	4	22	22	10	10	13	13	24	24	10	10	25	25	6	6	1	1	24	24	4	4	13	4	13	13	21	21	7
3	3	9	9	13	13	12	12	23	23	19	19	21	21	13	13	20	20	5	5	23	21	18	23	19	19	19	19	12
2	2	12	12	15	15	6	6	25	25	7	7	2	2	20	20	23	23	21	18	3	3	19	18	23	23	5	5	23
1	1	15	15	25	25	3	3	15	15	16	16	11	11	23	11	18	18	3	9	19	9	9	9	25	25	9	9	1

If EAGLEview capacity is increased, additional levels can be added which will partition the line further.

With a similar 5 wafer example, the problem can be isolated between Process Step #130 – Process Step #150 (within 20 process steps instead of 40).

Slot Position Example Signatures

Slot
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

X wafers

Proc Step #X	
IN	OUT
Wafer #	Wafer #
23	24
17	21
8	7
15	15
2	9
11	19
5	12
18	14
24	6
25	8
14	2
20	3
10	22
9	11
4	13
1	17
16	20
7	18
19	4
21	5
22	10
13	16
12	23
6	25
3	1

Neighboring Slots

12 wafers

Proc Step #X	
IN	OUT
Wafer #	Wafer #
23	24
17	21
8	7
15	15
2	9
11	19
5	12
18	14
24	6
25	8
14	2
20	3
10	22
9	11
4	13
1	17
16	20
7	18
19	4
21	5
22	10
13	16
12	23
6	25
3	1

2-Chamber

8 wafers

Proc Step #X	
IN	OUT
Wafer #	Wafer #
23	24
17	21
8	7
15	15
2	9
11	19
5	12
18	14
24	6
25	8
14	2
20	3
10	22
9	11
4	13
1	17
16	20
7	18
19	4
21	5
22	10
13	16
12	23
6	25
3	1

3-Chamber

6 wafers

Proc Step #X	
IN	OUT
Wafer #	Wafer #
23	24
17	21
8	7
15	15
2	9
11	19
5	12
18	14
24	6
25	8
14	2
20	3
10	22
9	11
4	13
1	17
16	20
7	18
19	4
21	5
22	10
13	16
12	23
6	25
3	1

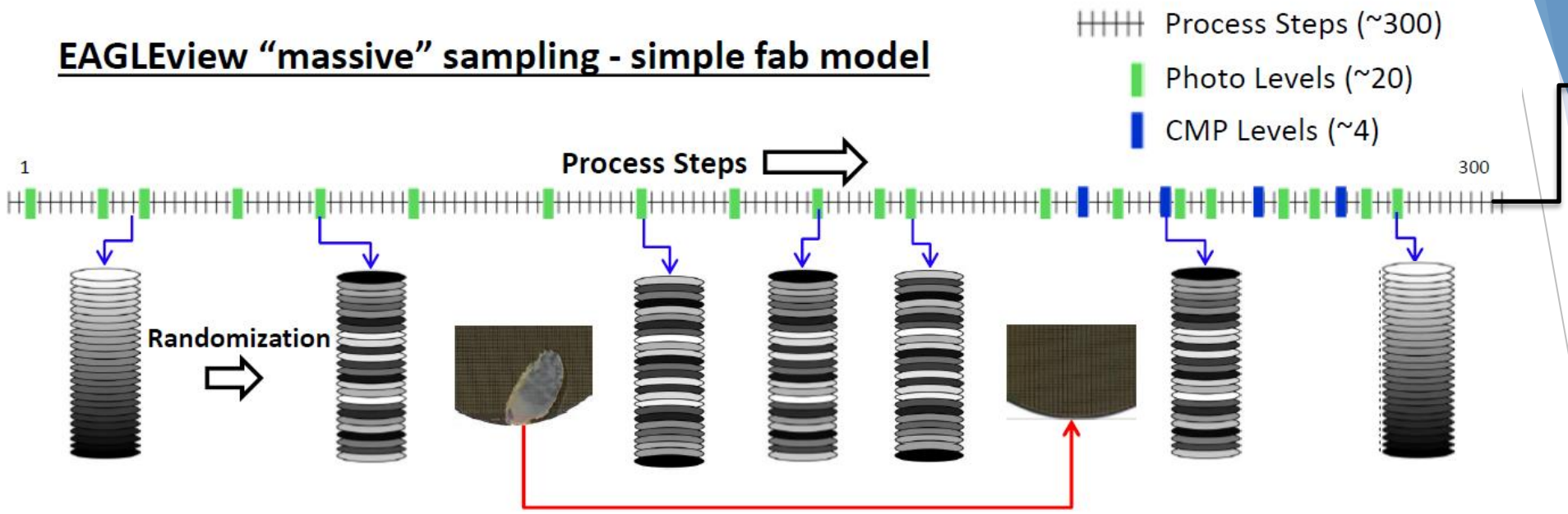
4-Chamber

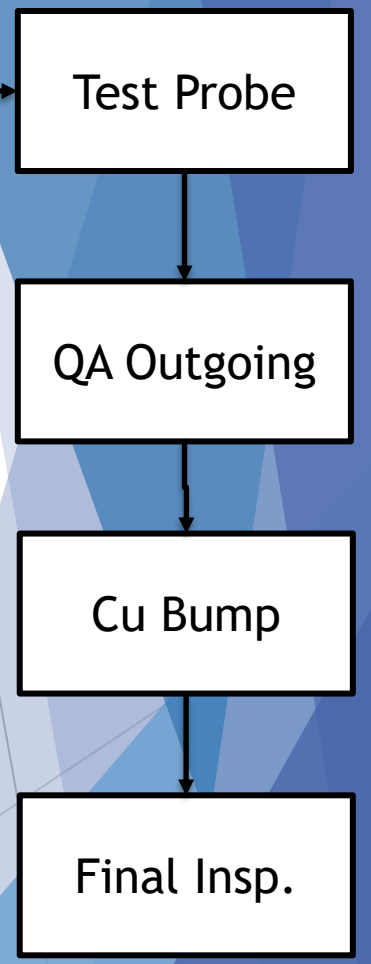
12 wafers

Proc Step #X	
IN	OUT
Wafer #	Wafer #
23	24
17	21
8	7
15	15
2	9
11	19
5	12
18	14
24	6
25	8
14	2
20	3
10	22
9	11
4	13
1	17
16	20
7	18
19	4
21	5
22	10
13	16
12	23
6	25
3	1

½ the boat

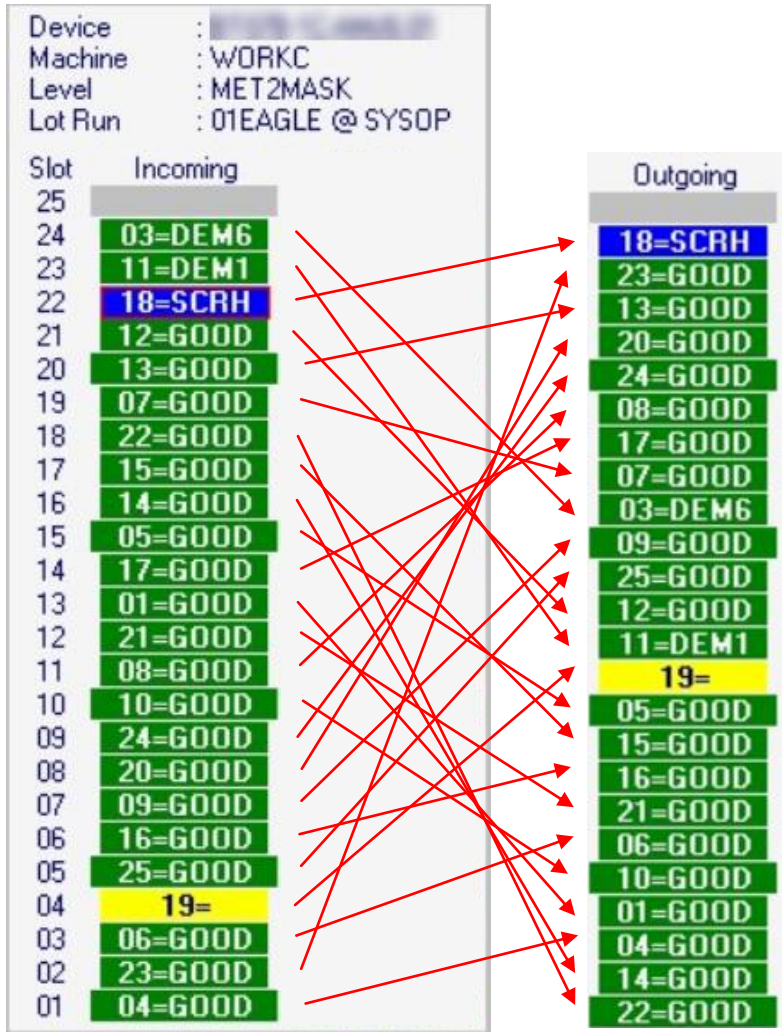
EAGLEview Randomization



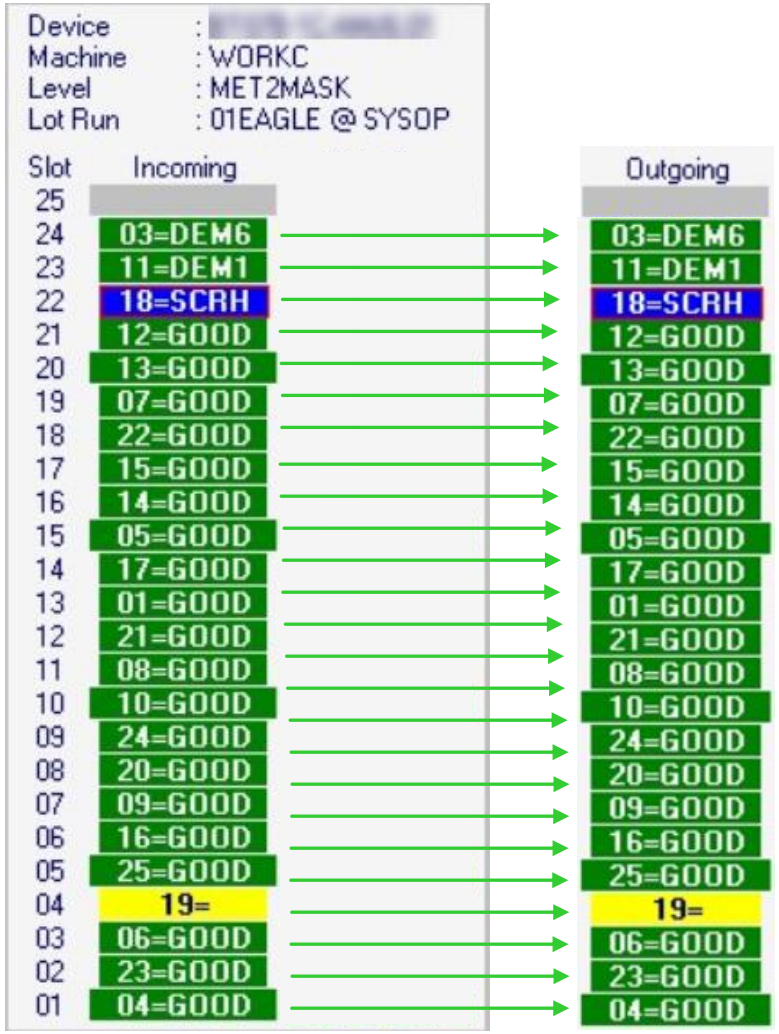


- A lot starts with all wafers in order (Aligned).
- Wafers are randomized at each EAGLEview inspection, and the incoming and outgoing slot positions are tracked.
- At the last EAGLEview inspection, wafers are put back in order automatically.

Understanding EAGLEview Simultaneous Randomization



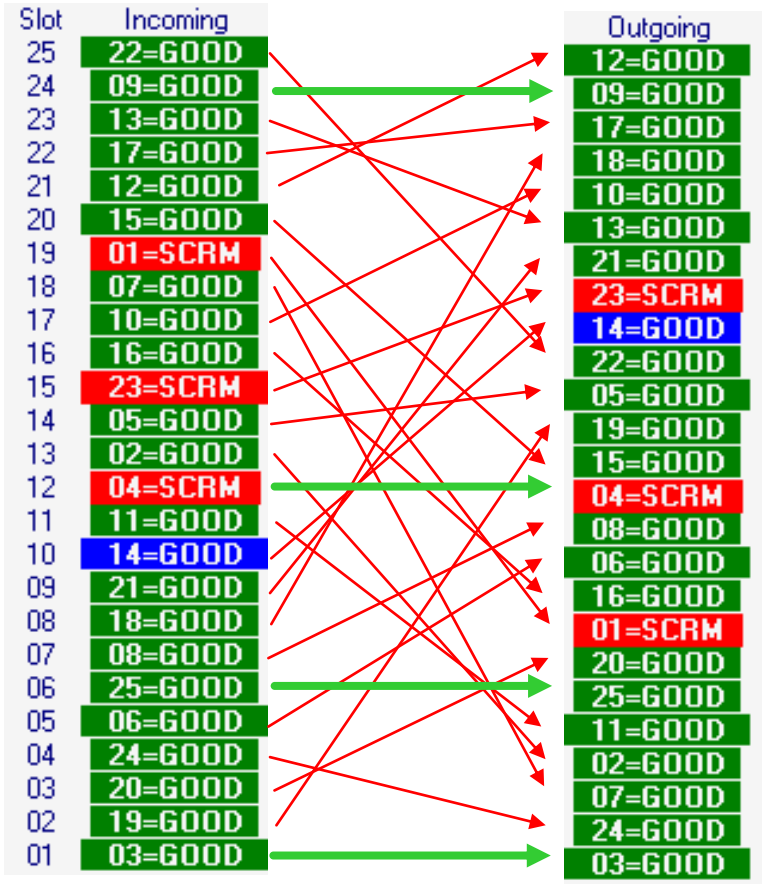
Full Randomization



Slot Integrity

microtronic macro defect management

Understanding EAGLEview Pseudo Randomization for Metrology Sampling



Pseudo Randomization

Pseudo Randomization

User specifies which slots are NOT randomized. In this case, wafers in slots 1, 6, 12, 24 maintain slot integrity.

All wafers in the remaining slots are fully randomized.

With this development, fabs can overcome another barrier by ensuring that metrology pre/post etch deltas are measured on the same wafers allowing randomization on the EAGLEview tools.

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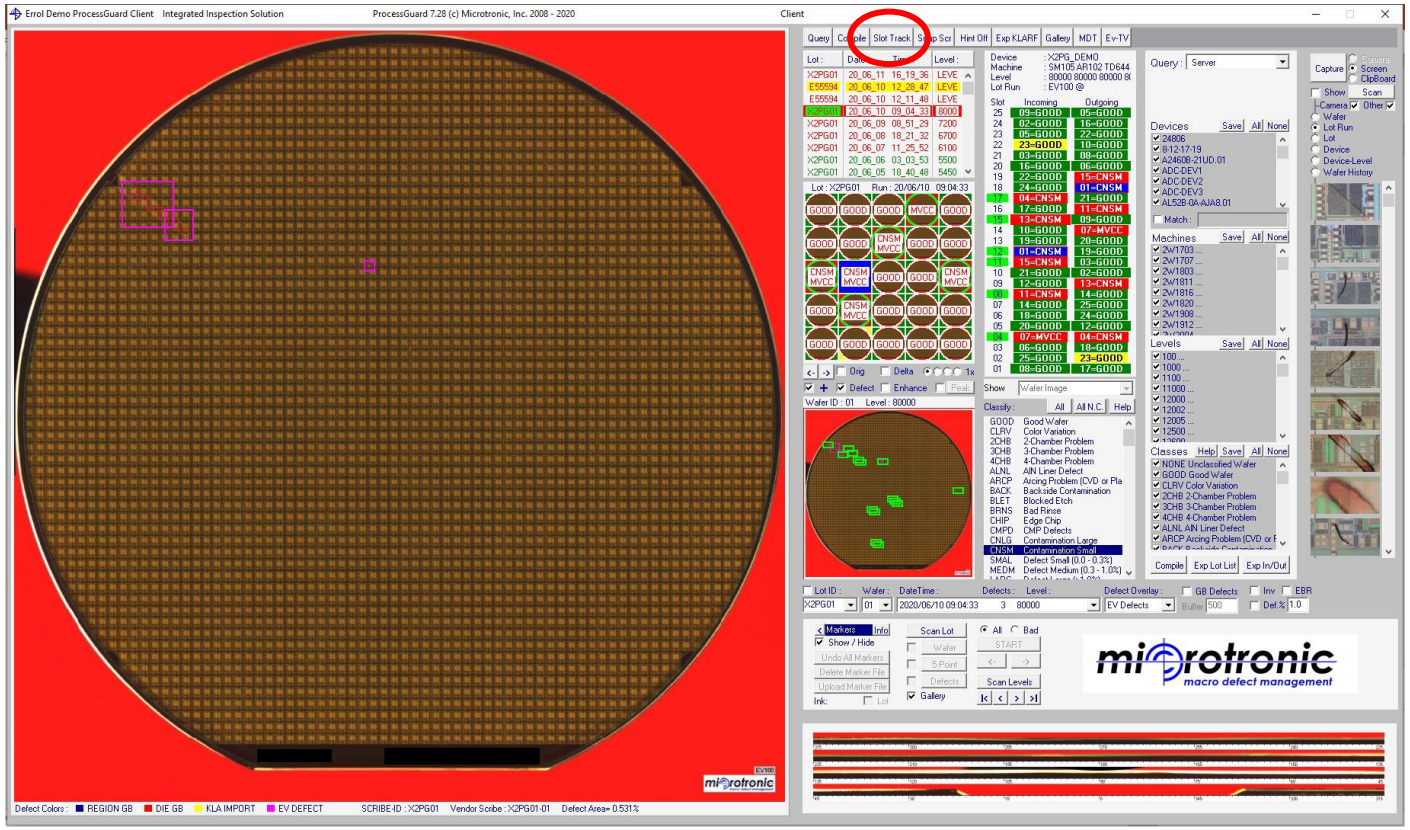
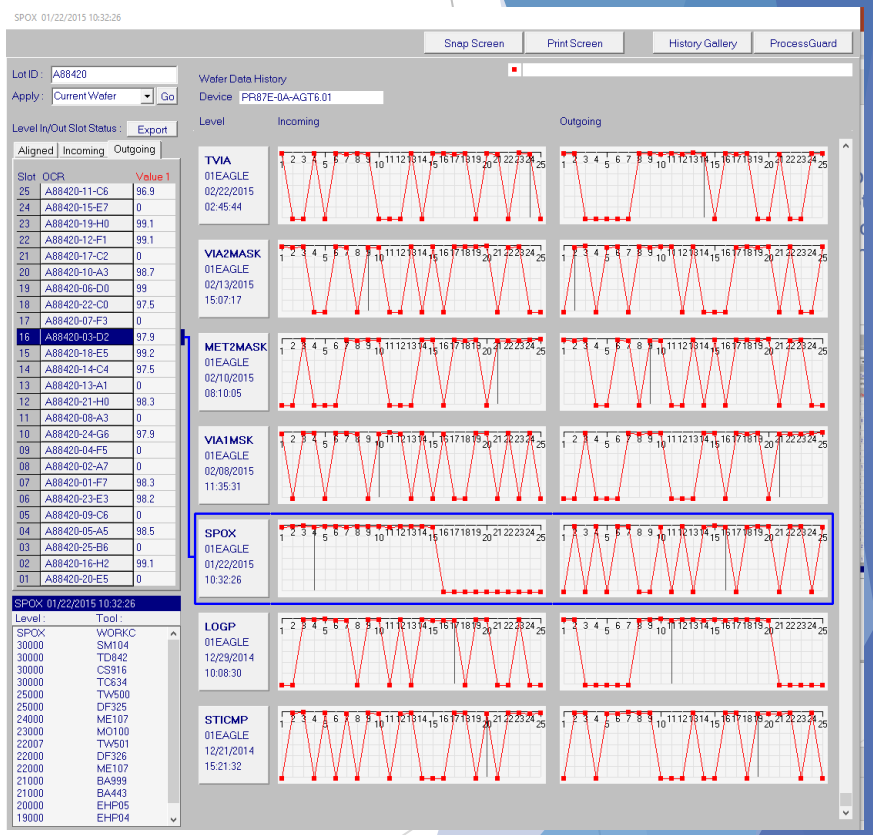
EAGLEview puts it all together; Randomization (SlotTrack)

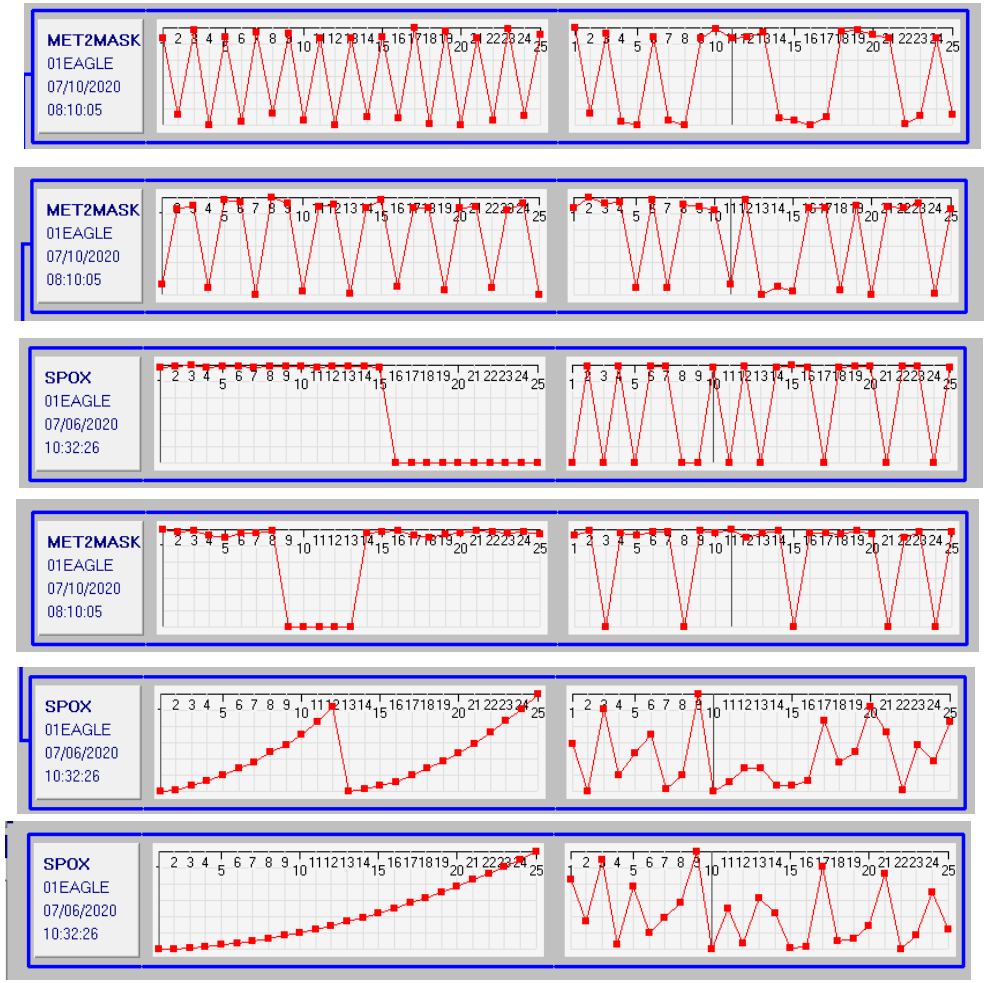
Slot positional analysis can be performed using the integrated SlotTrack software built into ProcessGuard.





EAGLEview puts it all together; Randomization (SlotTrack)

Correlation signatures may appear as many pattern types, such as cyclical trends, linear correlation, continuity or grouping with and without breaks, etc. The signature may point to the process level or tool, causing the wafer-to-wafer variation.



2-Chamber

3-Chamber

Abort (end of the boat)

Abort (middle of the boat)

In-Situ Clean (after 12 wafers)

Across the boat

Quickly identify signals
- ✓Across the boat (furnace)
- ✓2 or 3 chamber issues
- ✓Tool aborts
- ✓Implant beam oscillations
- ✓Fallout from wafer damage

microtronic macro defect management

Outline:

Intro to EAGLEview (Automated Macro Inspection Platform)

ProcessGuard with LotView – the ultimate interface for macro-inspected wafers

The power of randomization in a semiconductor fab
[ProcessGuard Live DEMO]

EAGLEview puts it all together; Frontside, Backside, LotView, & Randomization

Case Study Examples

Questions & ProcessGuard Live Demo

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Case Study Examples

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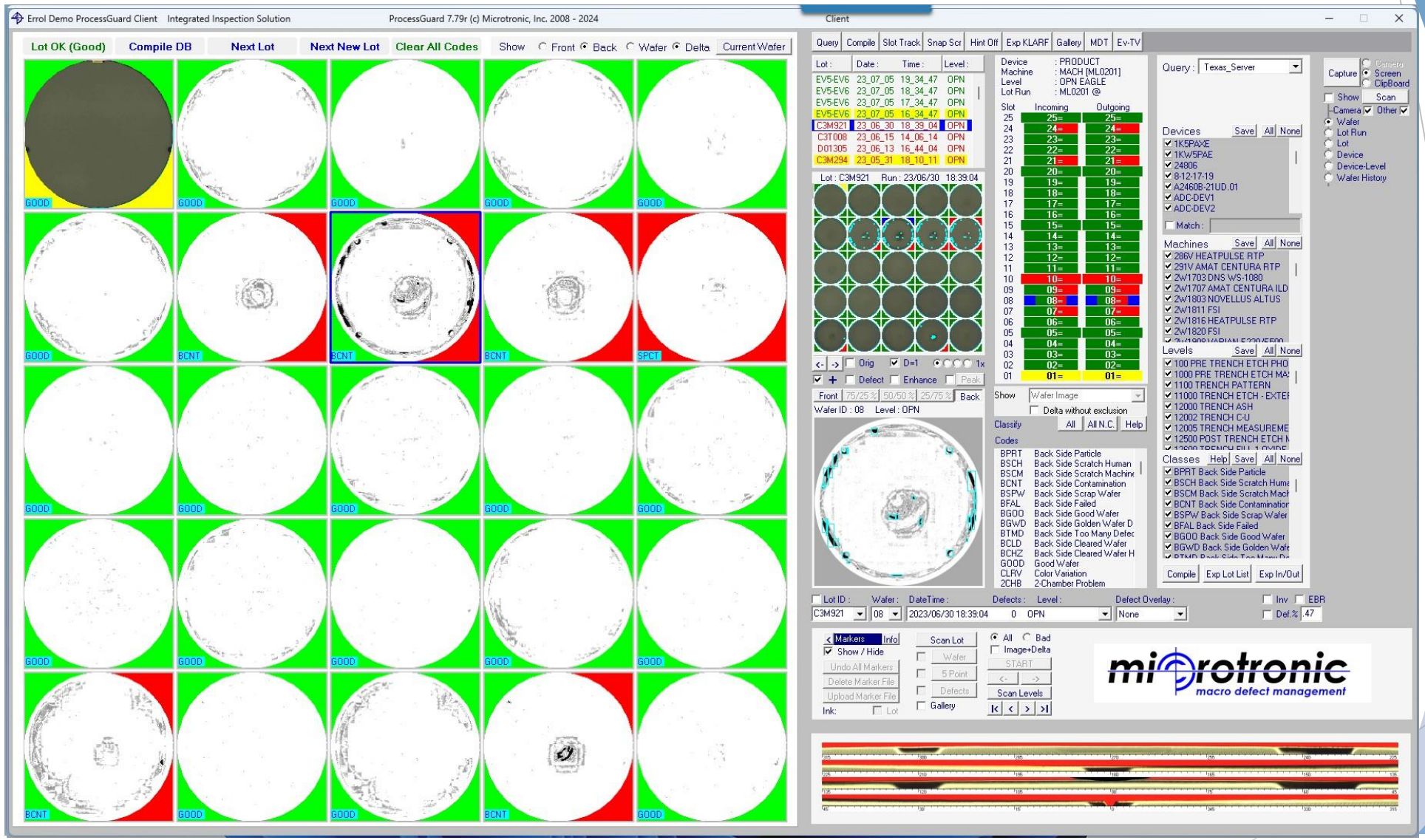
EAGLEview puts it all together; LotView

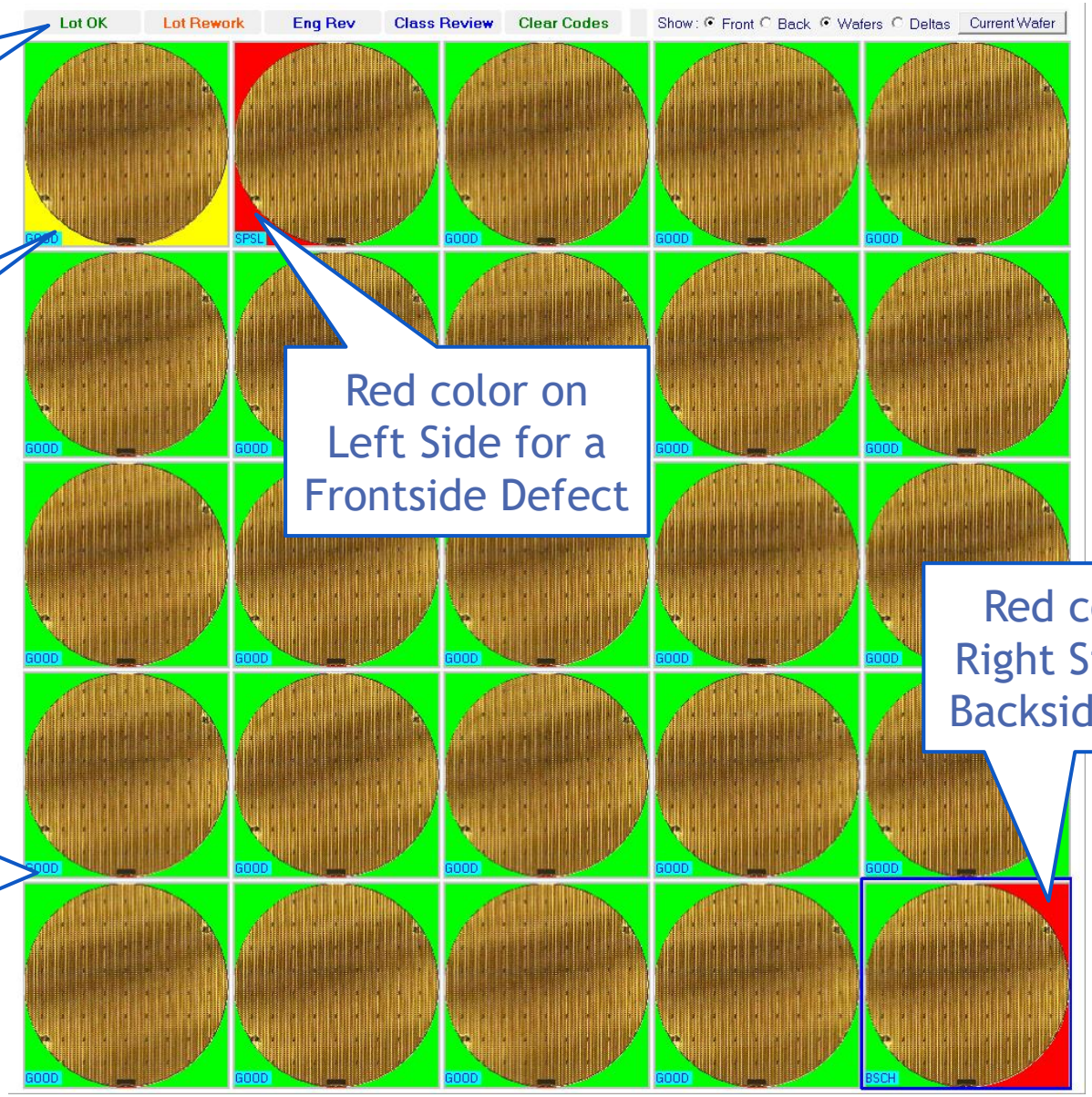


EAGLEview puts it all together; LotView

Customizable Toolbar

Gold color for the Golden (reference) Wafer

Class Codes displayed in LotView



Red color on Left Side for a Frontside Defect

Red color on Right Side for a Backside Defect

microtronic macro defect management

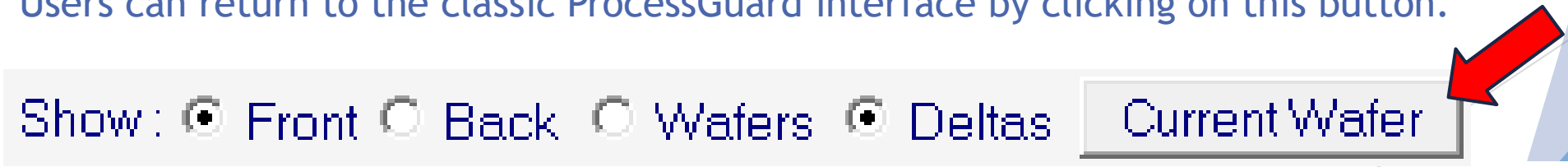
EAGLEview puts it all together; LotView

Toolbar Buttons

LotView provides an unlimited number of user-customizable classification buttons.

The simple operator interface allows users to navigate between lots, Accept (Pass), or Reject (Fail) a lot with one click.

There are four LotView formats (Front, Back, Wafers, Deltas)
Users can return to the classic ProcessGuard interface by clicking on this button.



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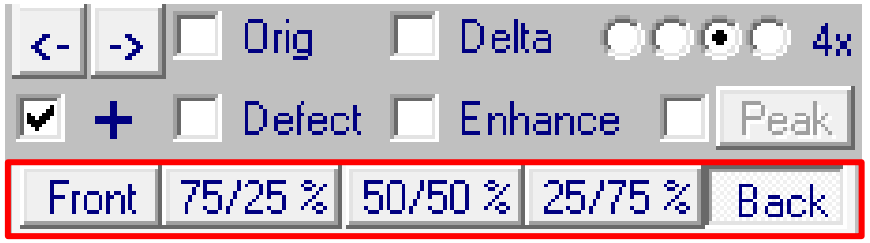
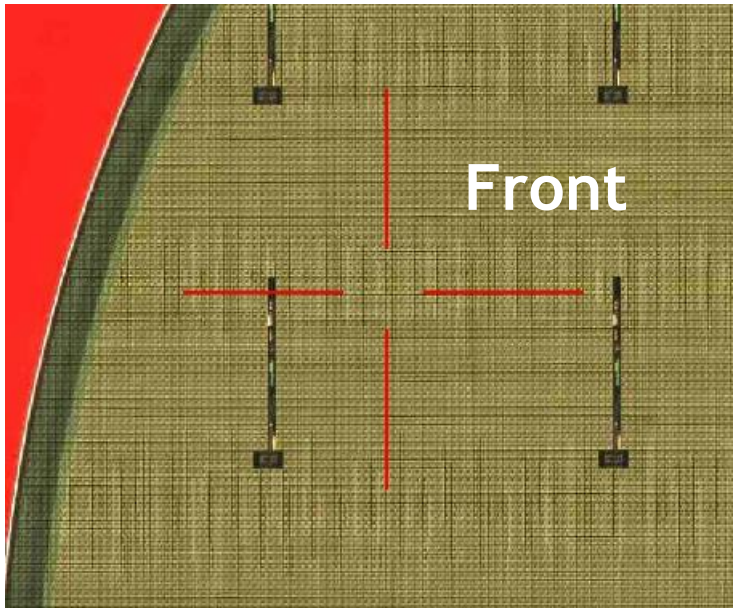
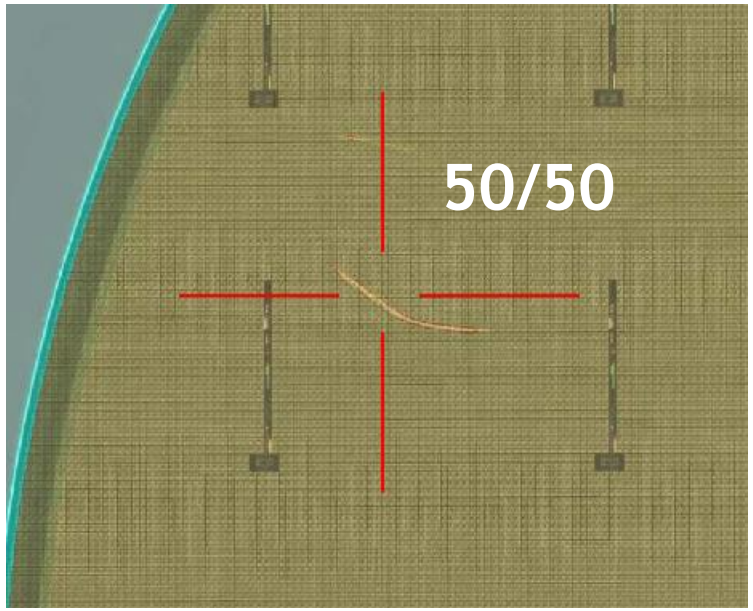
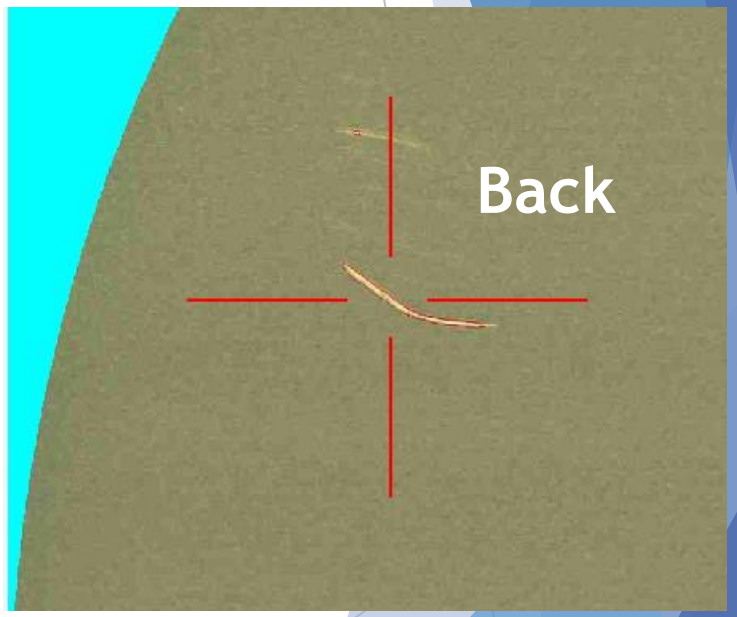
macro defect management

EAGLEview puts it all together; Backside Inspection Option

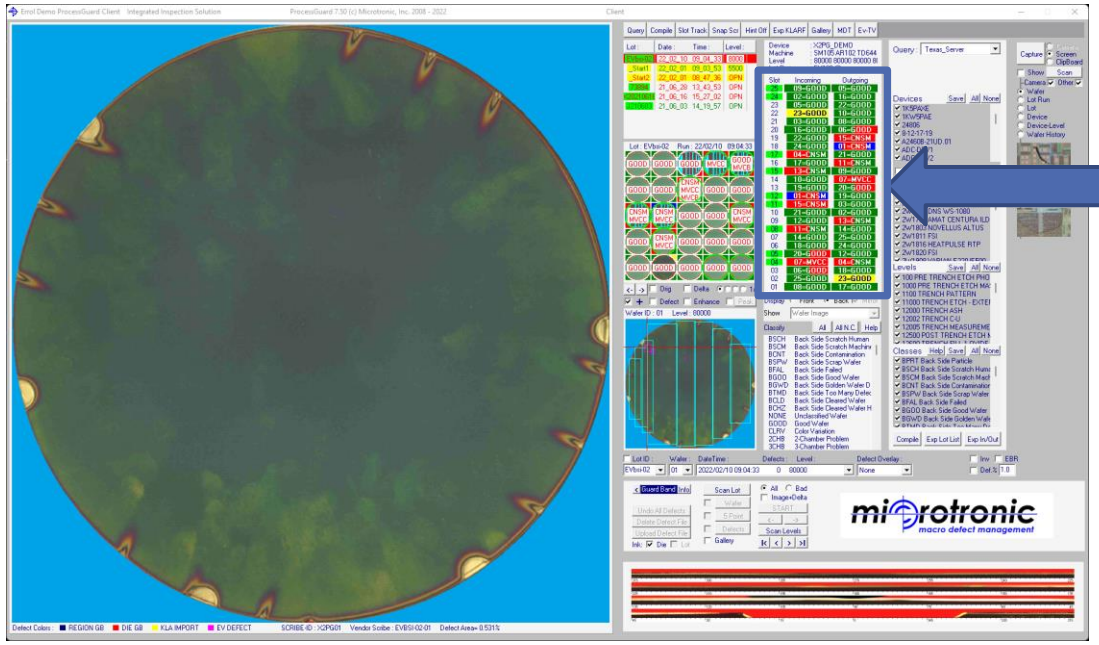








EAGLEview puts it all together; Randomization



Slot	Incoming	Outgoing
25	09=GOOD	05=GOOD
24	02=GOOD	16=GOOD
23	05=GOOD	22=GOOD
22	23=GOOD	10=GOOD
21	03=GOOD	08=GOOD
20	16=GOOD	06=GOOD
19	22=GOOD	15=CNSM
18	24=GOOD	01=CNSM
17	04=CNSM	21=GOOD
16	17=GOOD	11=CNSM
15	13=CNSM	09=GOOD
14	10=GOOD	07=MVCC
13	19=GOOD	20=GOOD
12	01=CNSM	19=GOOD
11	15=CNSM	03=GOOD
10	21=GOOD	02=GOOD
09	12=GOOD	13=CNSM
08	11=CNSM	14=GOOD
07	14=GOOD	25=GOOD
06	18=GOOD	24=GOOD
05	20=GOOD	12=GOOD
04	07=MVCC	04=CNSM
03	06=GOOD	18=GOOD
02	25=GOOD	23=GOOD
01	08=GOOD	17=GOOD

Green Highlight indicates a MicroView image is available for this wafer

Color	Meaning
Blue	Current Wafer
Yellow	Golden Wafer
Green	Good Wafer
Red	Bad Wafer

Left	Right
Frontside	Backside

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The power of randomization in a semiconductor fab

EAGLEview puts it all together; Frontside, Backside, LotView, & Randomization [ProcessGuard Live DEMO]

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Questions & ProcessGuard Live Demo

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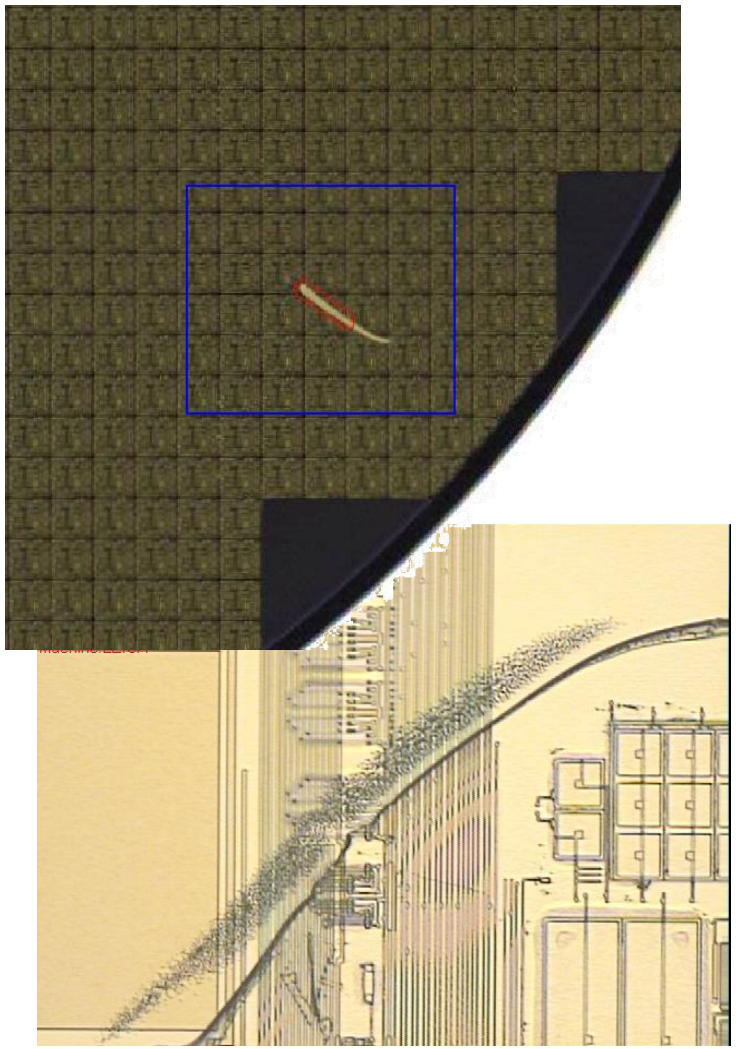
Case Study Examples

- **#1 EBR Drip Excursion**
- **#2 [3-Chamber BPSG Issue]**
- **#3 [Photo Flash Field Defects]**
- **#4 [AI Deep Learning ADC]**

Questions & ProcessGuard Live Demo

microtronic macro defect management

Case Study Examples - #1 EBR Drip Excursion



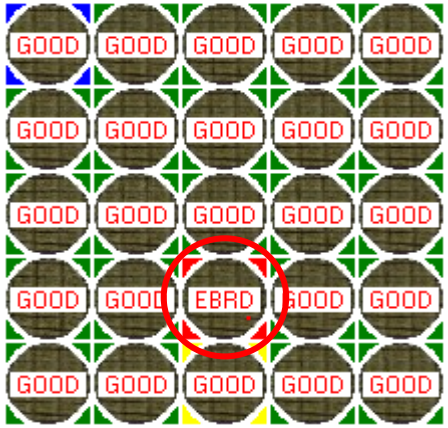
- Intermittent Low Frequency Macro Defect:
  1 wafer per lot
  24 of 175 lots = 13.7%
  24 of 3,792 wafers = 0.6%
- Microscope inspection confirmed the defect to be an EBR drip.
- Jeopardy list was quickly generated with EAGLEview 100% Inspection.
- Commonality Analysis failed as many tools and levels were affected.

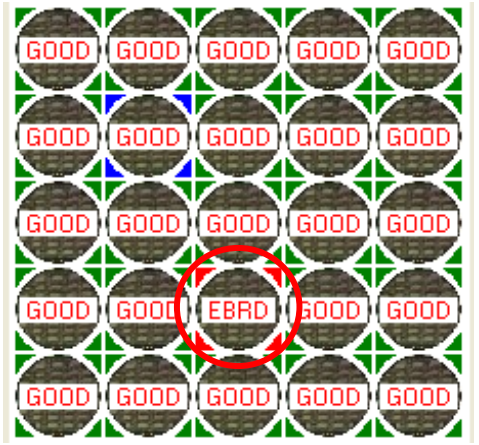
Case Study Examples - #1 EBR Drip Excursion

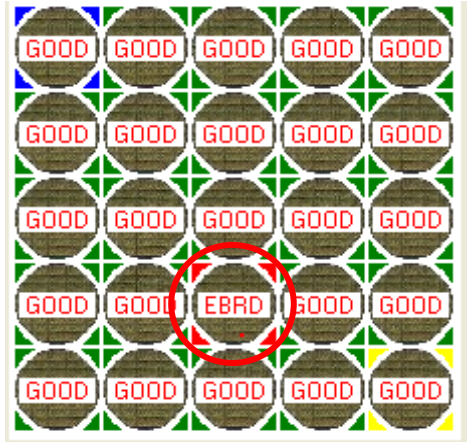
The EAGLEview slot positions were studied and a clue was found.

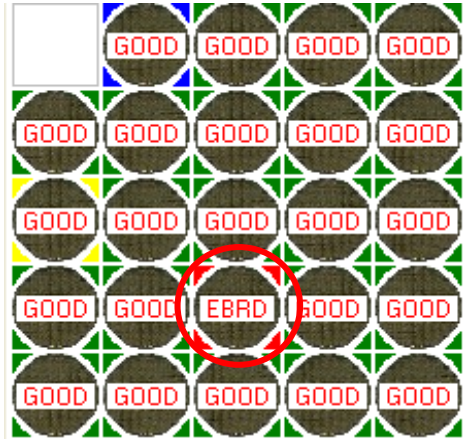
The majority of affected wafers were in slot #18.

Slot	Incoming	Outgoing
25	20=GOOD	07=GOOD
24	10=GOOD	19=GOOD
23	21=GOOD	17=GOOD
22	18=GOOD	05=EBRD
21	08=GOOD	24=GOOD
20	12=GOOD	20=GOOD
19	24=GOOD	23=GOOD
18	05=EBRD	09=GOOD
17	23=GOOD	01=GOOD
16	09=GOOD	12=GOOD
15	03=GOOD	06=GOOD
14	17=GOOD	08=GOOD
13	06=GOOD	25=GOOD
12	02=GOOD	22=GOOD
11	07=GOOD	14=GOOD
10	19=GOOD	03=GOOD
09	16=GOOD	02=GOOD
08	11=GOOD	04=GOOD
07	13=GOOD	21=GOOD
06	04=GOOD	15=GOOD
05	01=GOOD	18=GOOD
04	14=GOOD	11=GOOD
03	25=GOOD	16=GOOD
02	22=GOOD	13=GOOD
01	15=GOOD	10=GOOD









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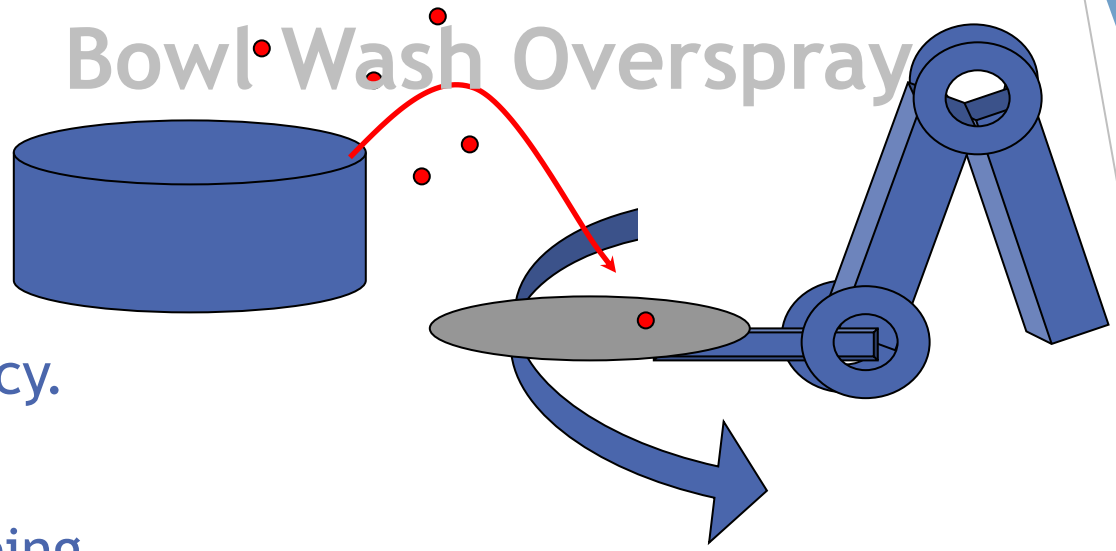
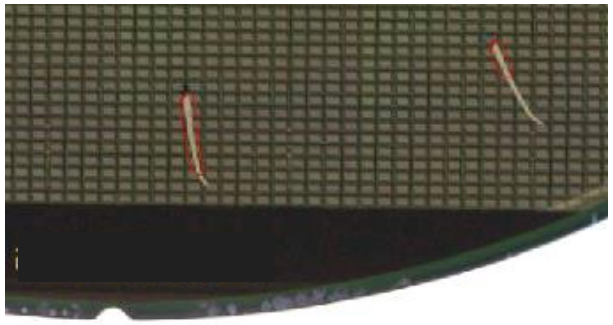
Root Cause Identified

An enhanced bowl wash was recently qualified to clean the photoresist after each run to extend the cup change frequency.

Although the lot completed resist coat, wafers were still being processed in the workcell (expose and develop). Intermittently, one of the wafers on the robot arm would pass by the "overspray" from the bowl wash and a small droplet of PGMEA would contact the wafer surface.



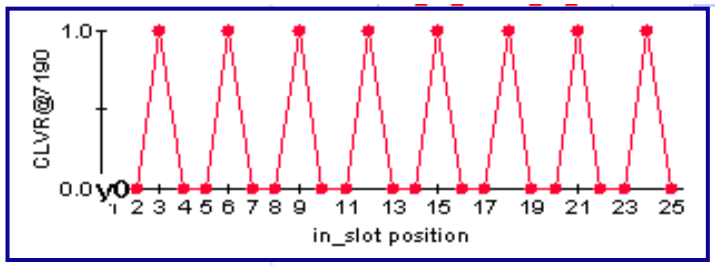


Robot movement timing caused the wafer in slot #18 to pass through a "cloud" of EBR.

Case Study Examples - #2 [3-Chamber BPSG Issue]

EAGLEview inspection at Metal 1 revealed that 1/3 of the wafers were a different color.

Wafer randomization (SlotTrack) data pointed to a 3-chamber issue prior to Contact Photo.



Slot	Incoming	Outgoing
25	25=CLVR	15=CLVR
24	21=CLVR	05=GOOD
23	19=CLVR	07=GOOD
22	04=GOOD	08=CLVR
21	13=GOOD	16=GOOD
20	06=GOOD	24=GOOD
19	08=CLVR	11=CLVR
18	10=CLVR	20=GOOD
17	07=GOOD	04=GOOD
16	03=GOOD	14=GOOD
15	01=GOOD	03=GOOD
14	20=GOOD	09=CLVR
13	23=GOOD	13=GOOD
12	14=GOOD	02=GOOD
11	18=GOOD	21=CLVR
10	11=CLVR	22=GOOD
09	09=CLVR	23=GOOD
08	02=GOOD	25=CLVR
07	15=CLVR	18=GOOD
06	17=GOOD	06=GOOD
05	22=GOOD	12=GOOD
04	05=GOOD	10=CLVR
03	12=GOOD	01=GOOD
02	16=GOOD	17=GOOD
01	24=GOOD	19=CLVR

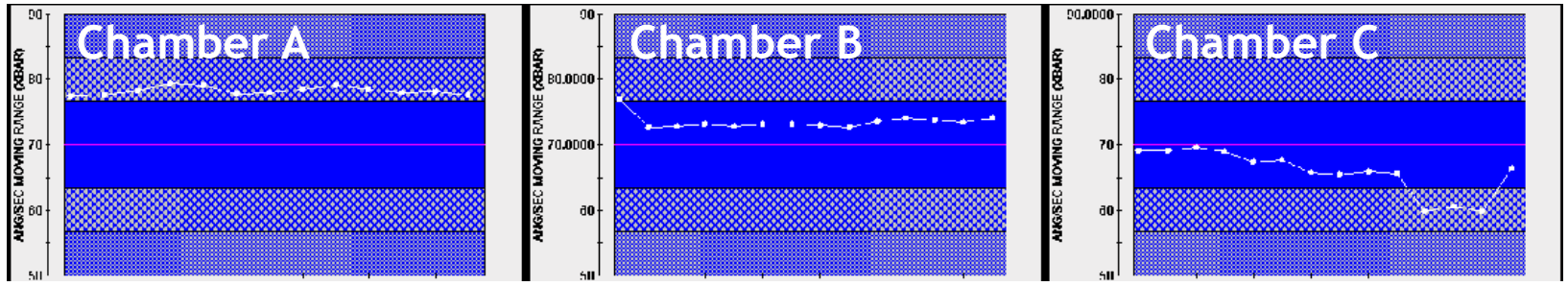
microtronic macro defect management

Case Study Examples - #2 [3-Chamber BPSG Issue]

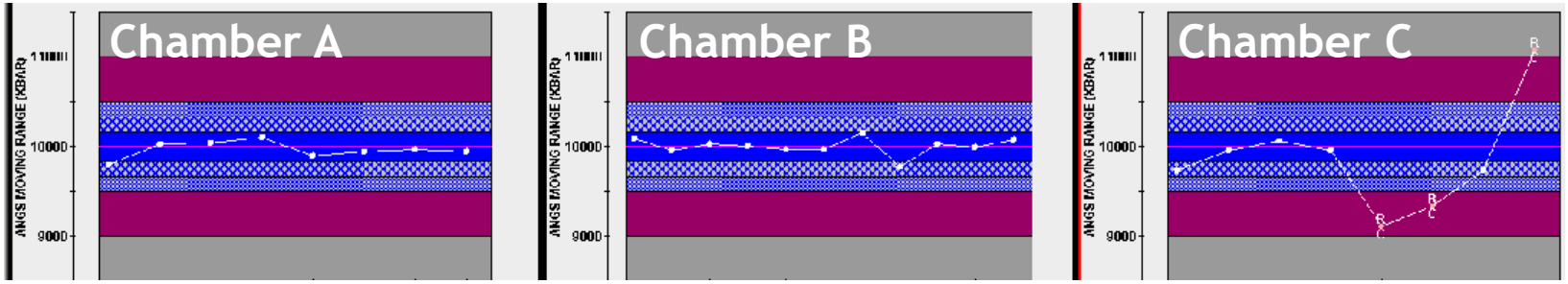
Given the 3-chamber pattern, the issue was traced back to a uniformity issue on one of the three chambers of a BPSG tool.

Thickness measurements showed a ~300 A difference (in spec).

SPC Chart - BPSG **Dep Rate** had a dip on Chamber C in the timeframe interest.



SPC Chart - BPSG **Range** became unstable in Chamber C and went OOS after a few days.



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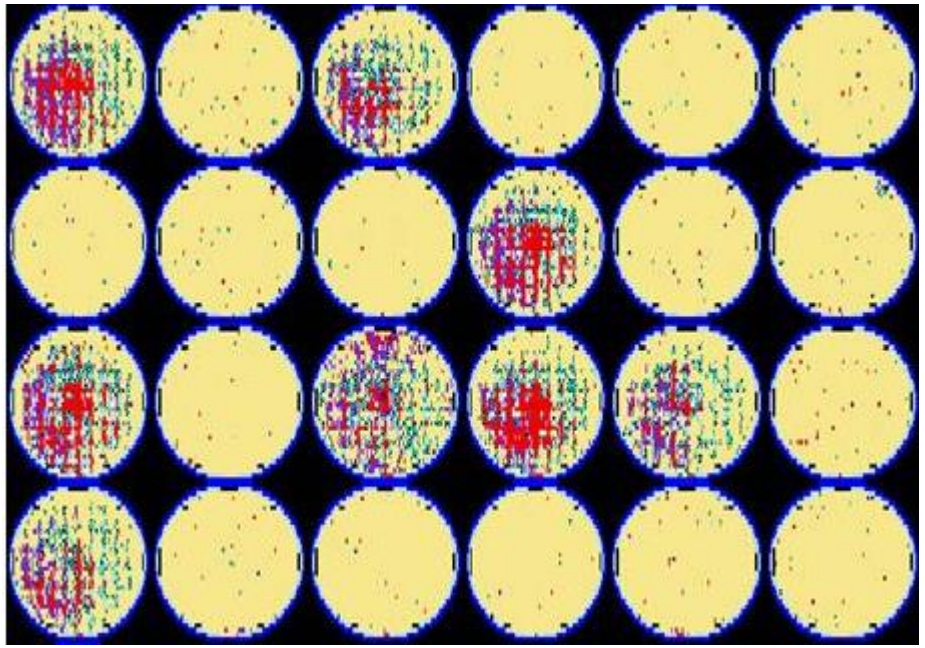
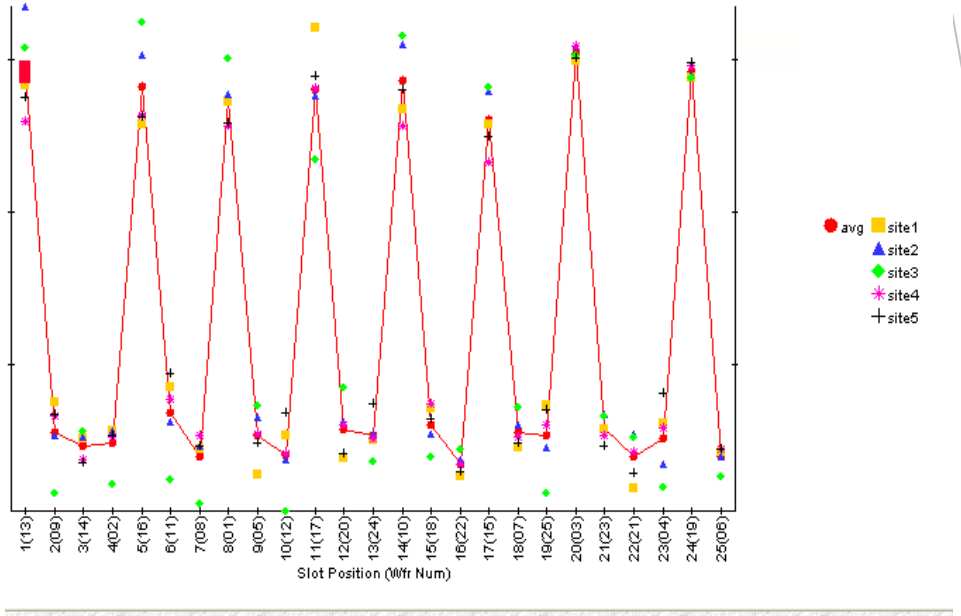
Case Study Examples - #2 [3-Chamber BPSG Issue]

The BPSG uniformity issue had a yield impact, and many were scrapped.





SlotTrack correlation of Metal 1 Sheet Resistance (yield loss) showed the 3-chamber signal incoming to Photo Contact.

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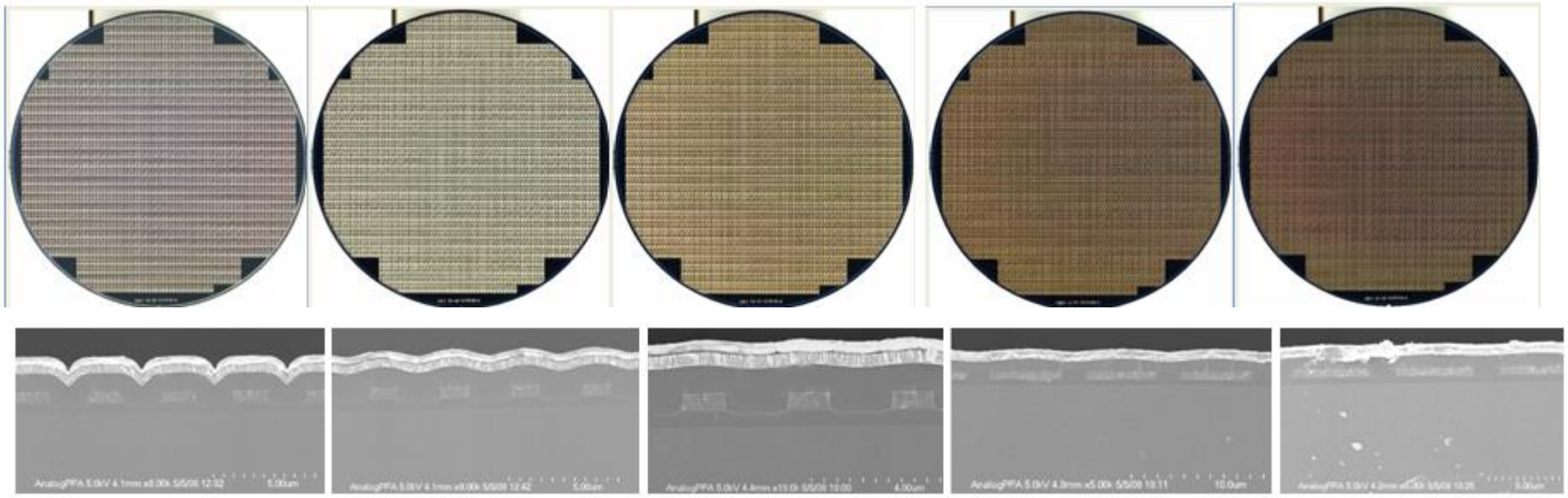
Case Study Examples - #2 [3-Chamber BPSG Issue]

The root cause of the problem was traced back to a faulty TEPO injector in chamber C. Additional work revealed that the Phosphorus content and resulting topography drive the EAGLEview signal more than the film thickness.

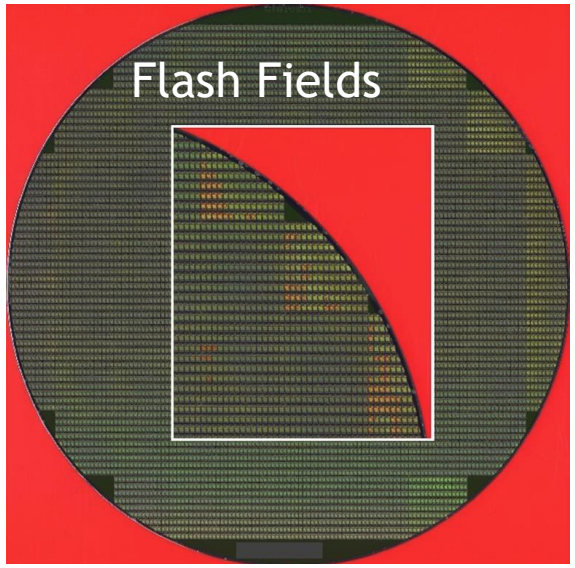
Lot X Wafer 05 TEPO Flow = 0	Lot X Wafer 09 TEPO Flow = 20	Lot X Wafer 14 TEPO Flow = 39	Lot X Wafer 18 TEPO Flow = 58	Lot X Wafer 25 TEPO Flow = 77

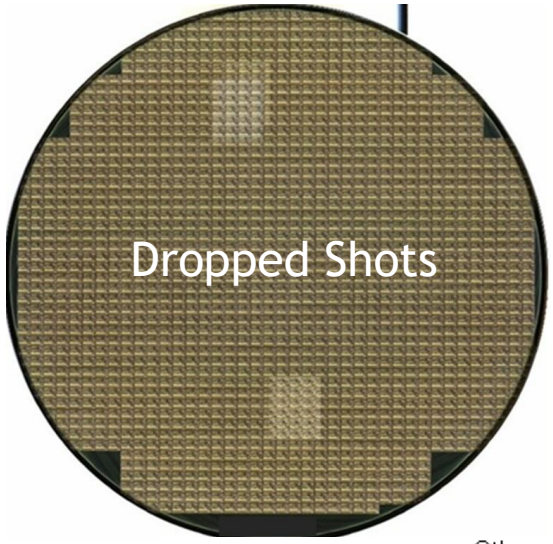


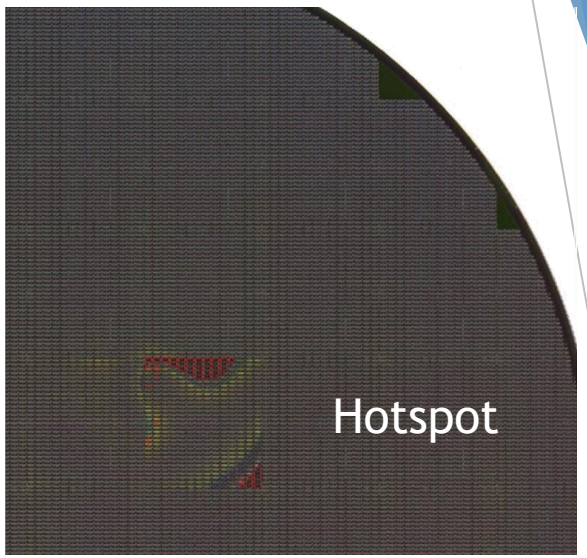
Action: a new EV class code was created and feedback to Thin Films was improved.

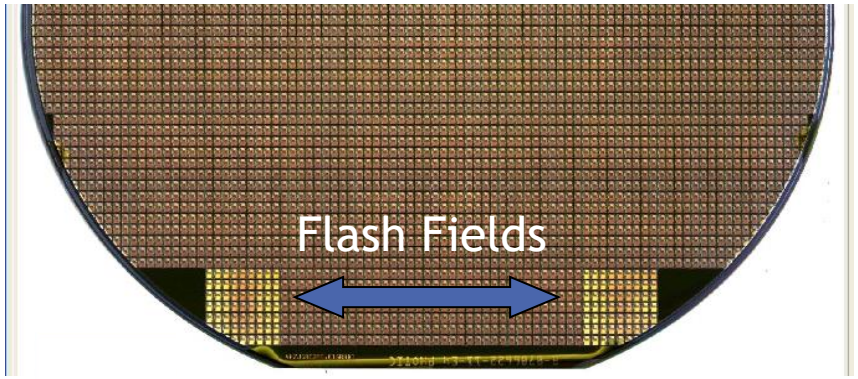
Case Study Examples - #3 [Photo Flash Field Defects]

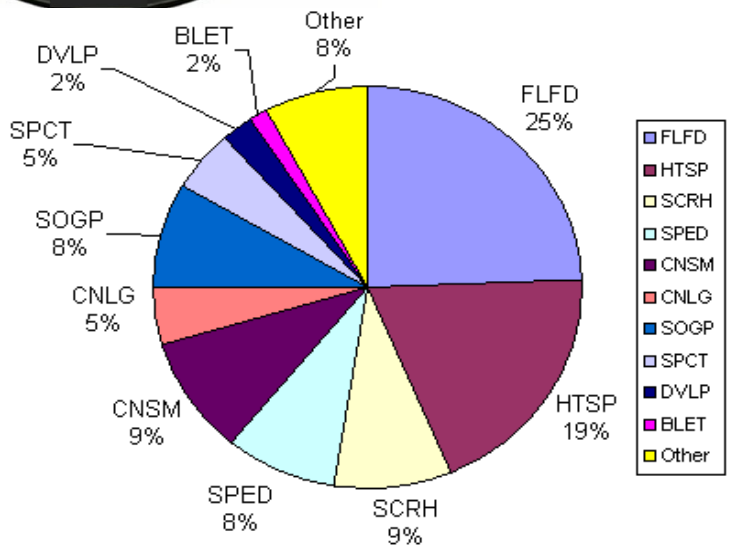
Flash Field (FLFD) problems typically occur at the wafer edge and are the most prevalent macro defect in some fabs.











Flash Field Problem
Hotspot
Scratch
Spin Defect Edge
Small Contamination
Large Contamination
Spin On Glass Problem
Center Spin Defect
Develop Problem
Blocked Etch

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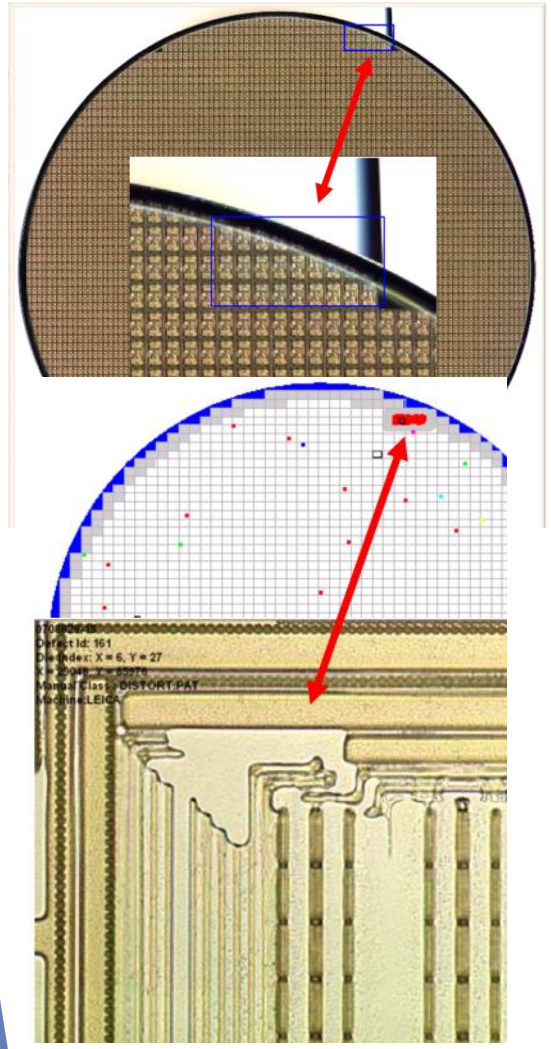
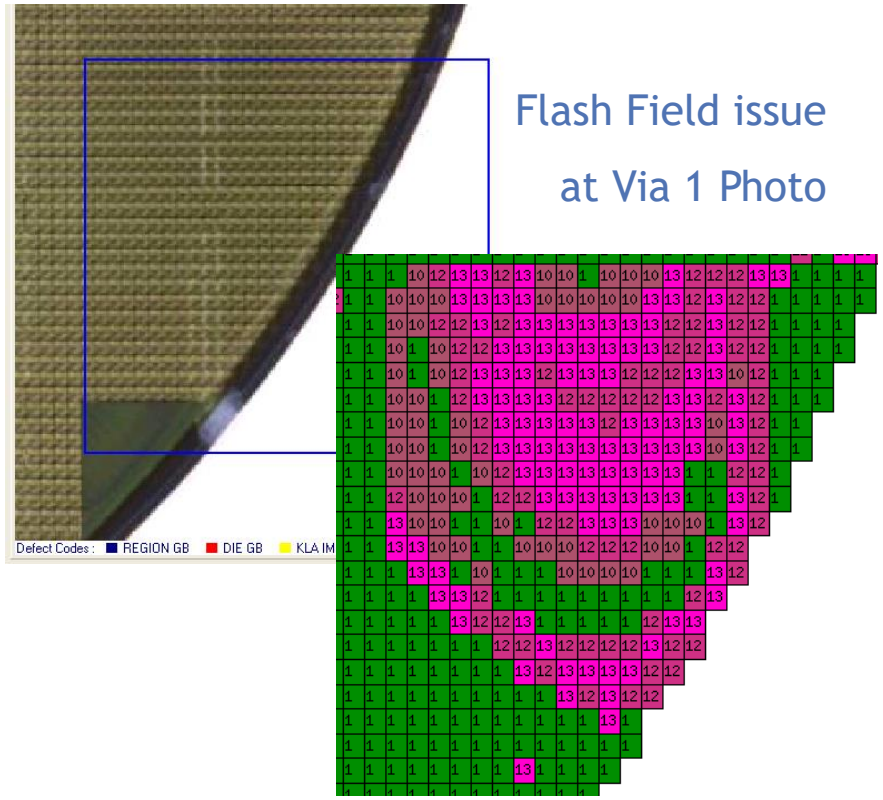
Case Study Examples - #3 [Photo Flash Field Defects]

Flash Field (FLFD) problems also present a customer return risk





Flash Field issue

at Via 1 Photo

A Flash Field defect behaves as a FEM on product wafers requiring rework or guardbanding. Marginal product may escape Probe and become reliability concerns in the field.

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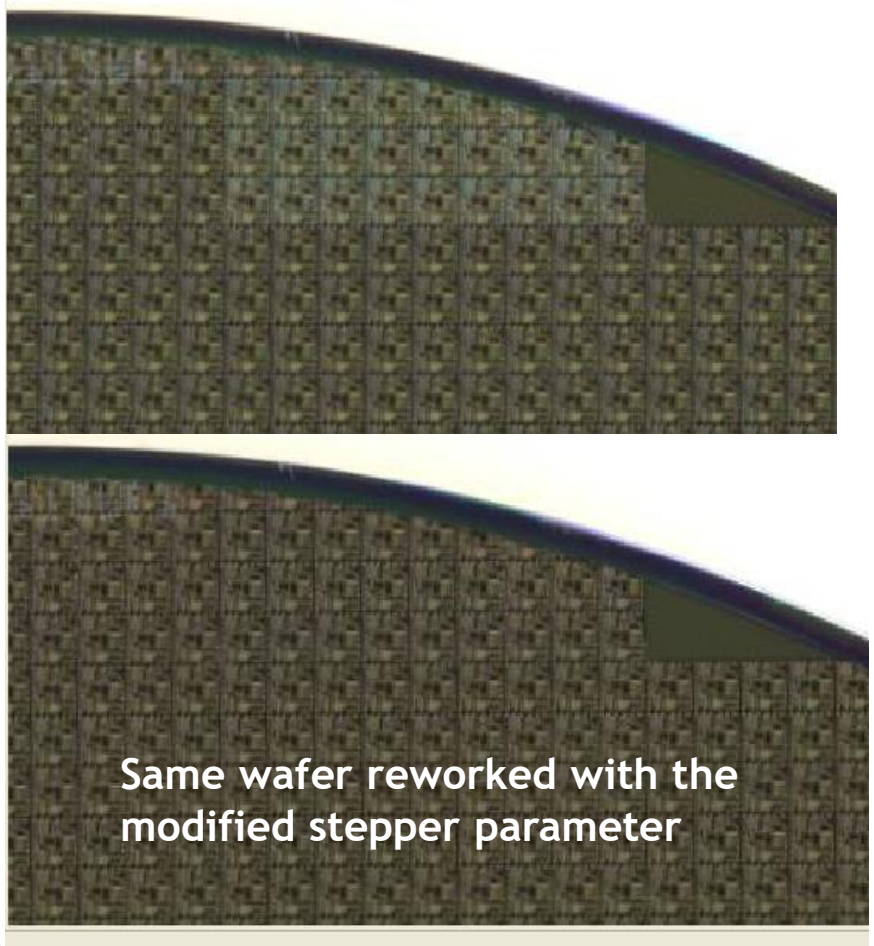
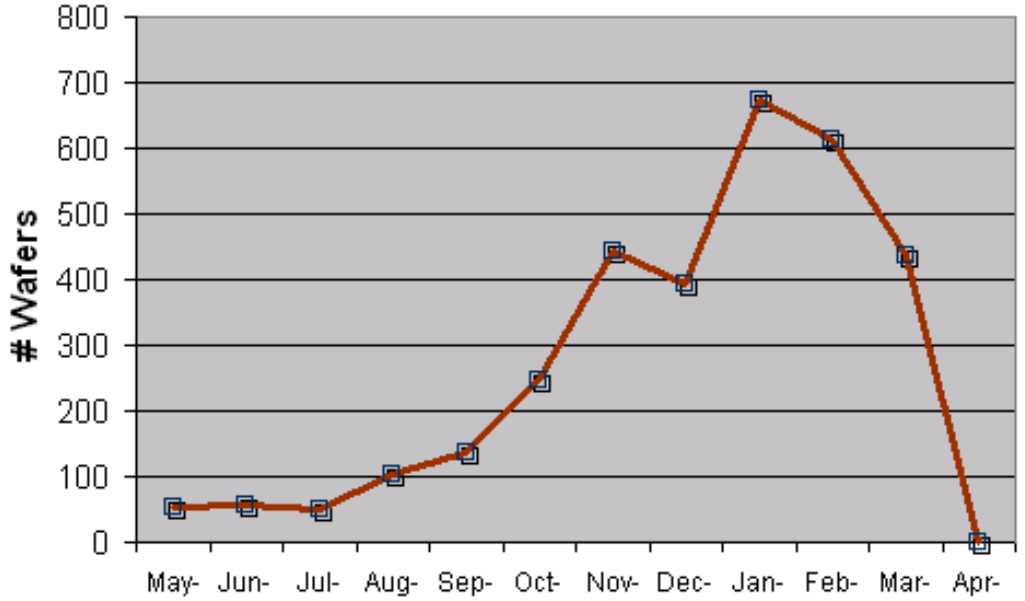
Case Study Examples - #3 [Photo Flash Field Defects]

EAGLEview data allowed the Photo PE & EE team to determine the root cause of the problem (partial exposure shot on wafer edge). A stepper parameter (auto-focus invalid area) was modified forcing the stepper to obtain focus information from a neighboring flash, eliminating the flash field problem at the wafer's edge.



EAGLEview – Flash Field Problems



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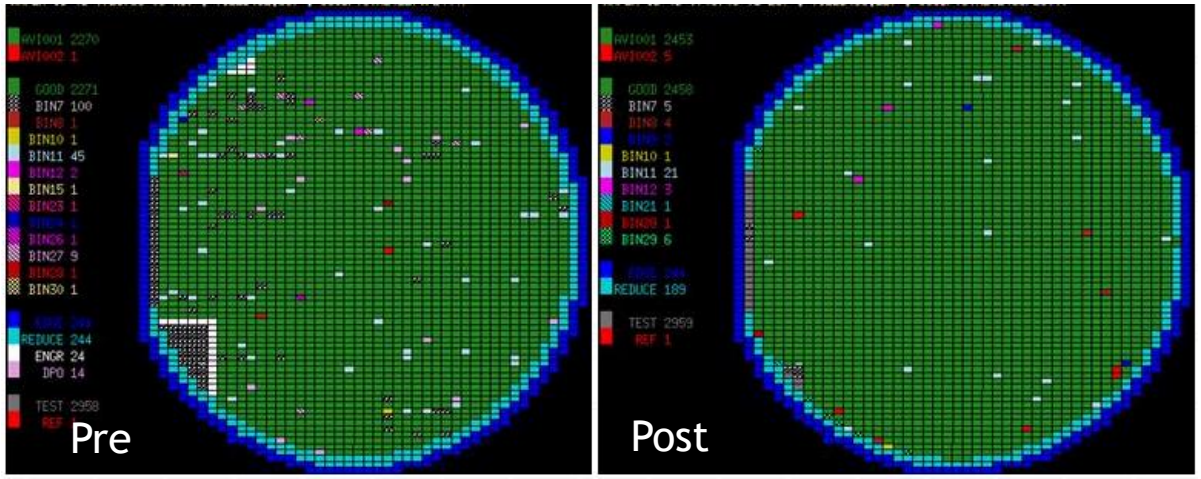
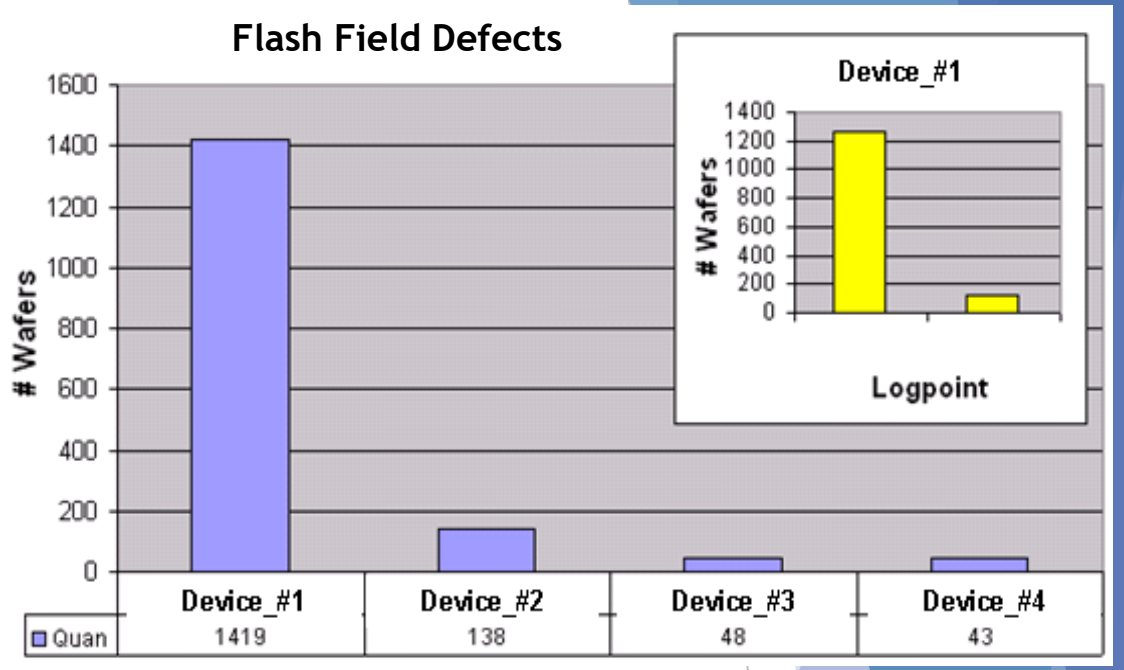
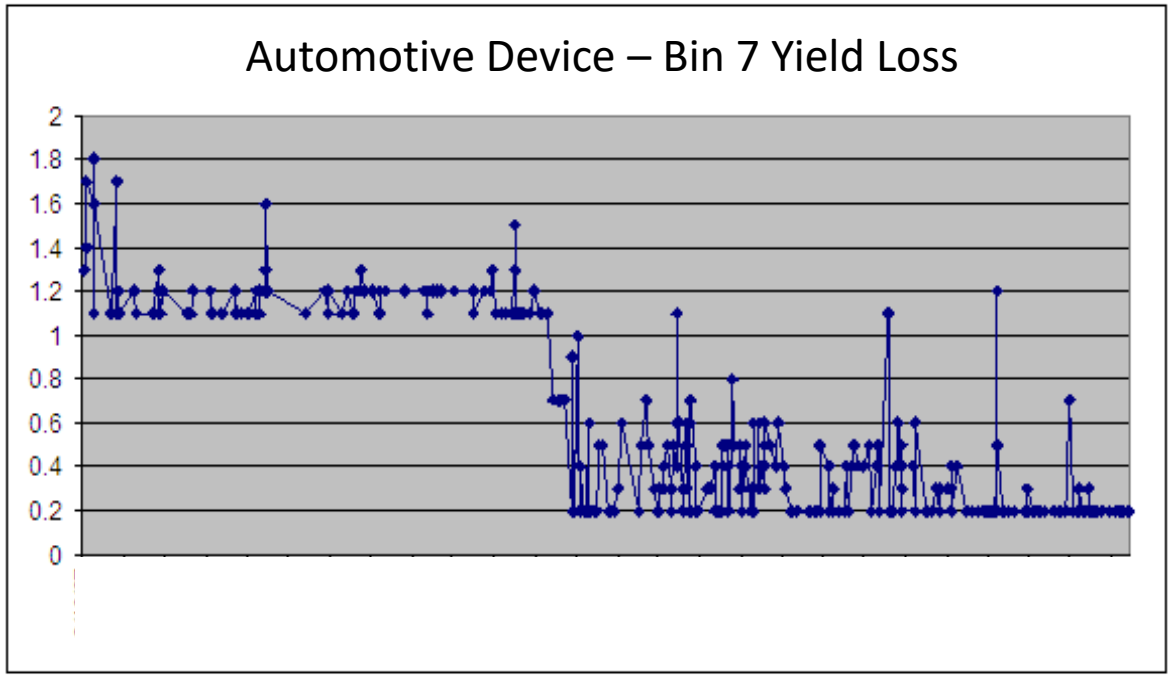
Case Study Examples - #3 [Photo Flash Field Defects]







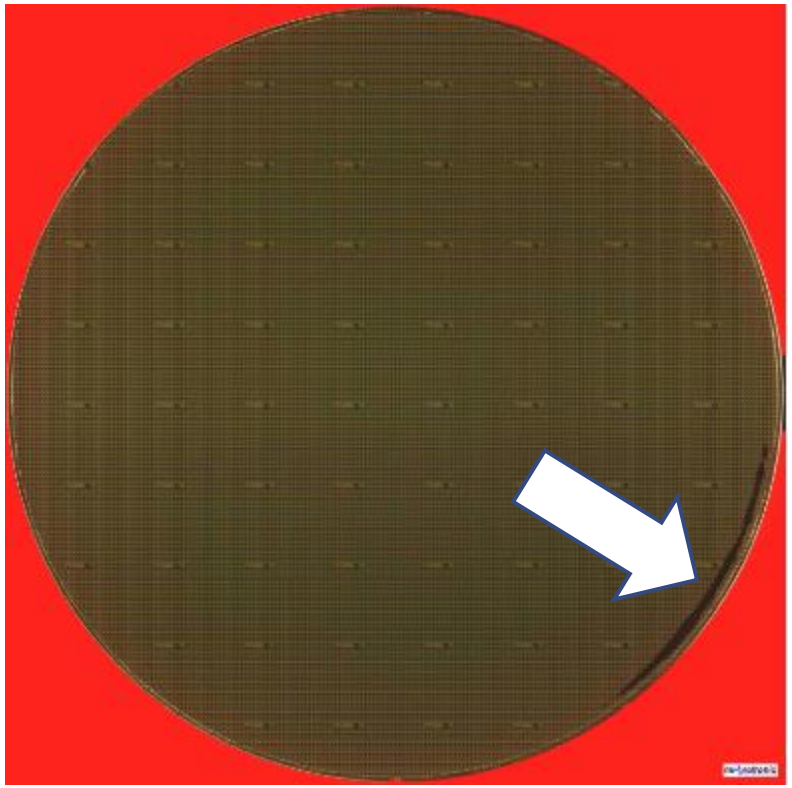
Macro data was used to identify the most vulnerable devices and levels.

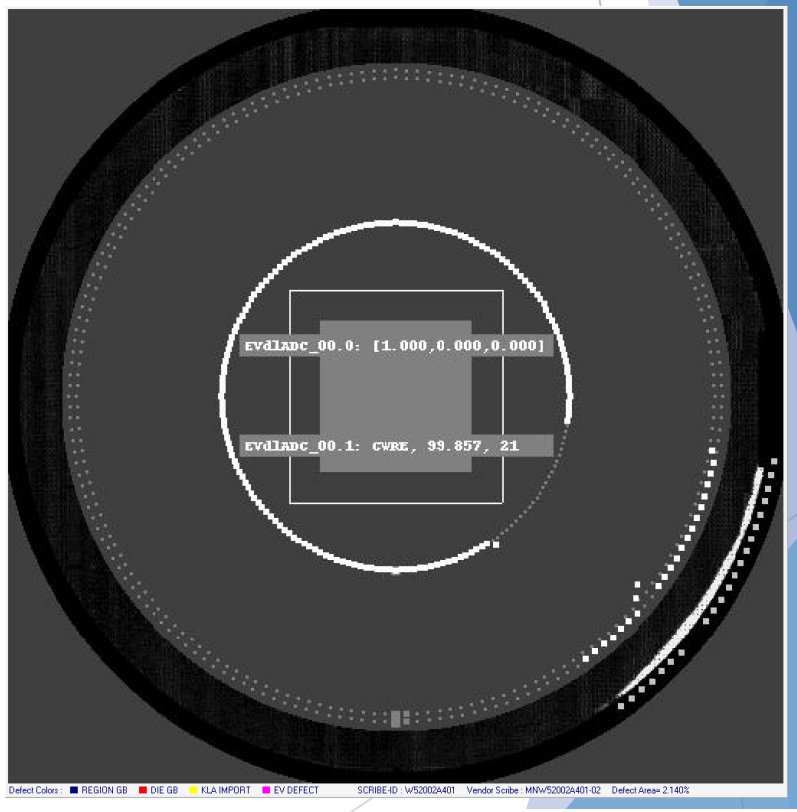
The corrective action resulted in a ~1% yield gain on a high-volume automotive device.

Case Study Examples - #4.a [AI Deep Learning ADC]

In 2020, Microtronic joined GlobalFoundries to present a case study at the FOA 8th Annual Collaborative Forum.

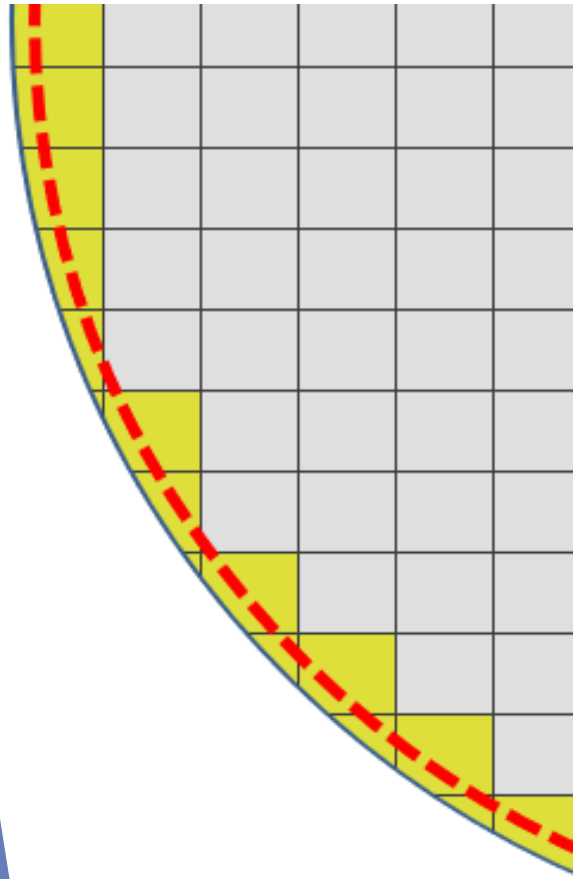
“Process and Yield Improvement with Macro Inspection of AI-Based ADC of Residual Tungsten CMP Defects”

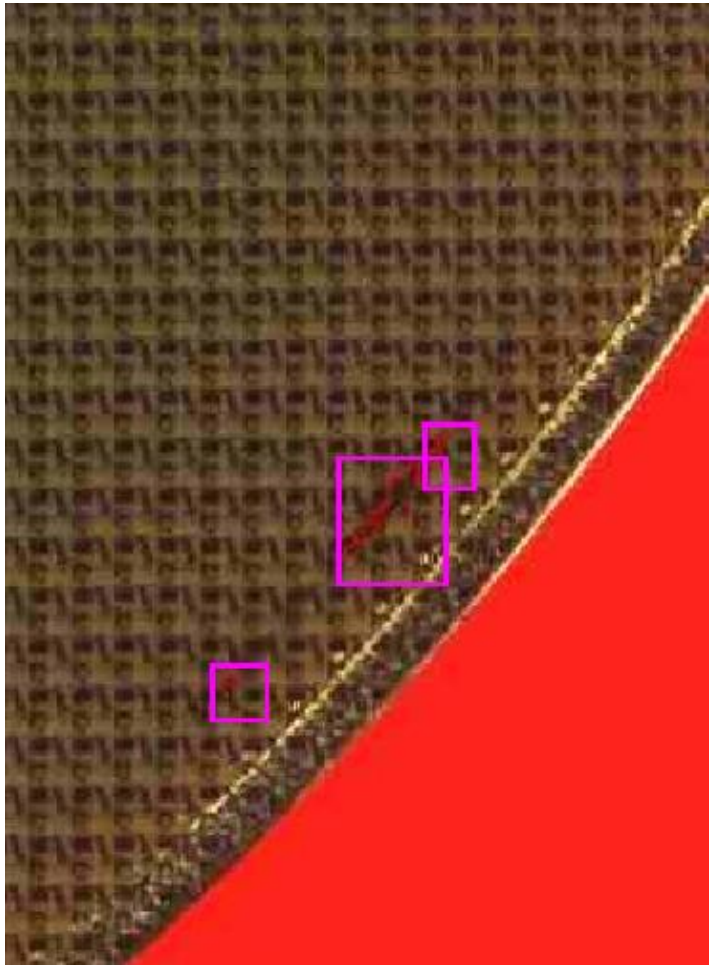


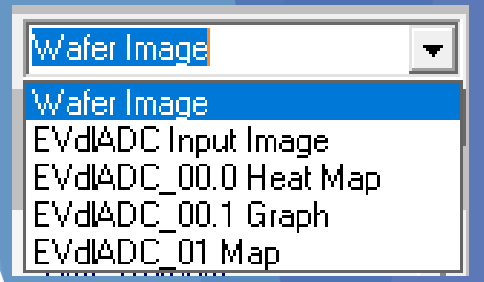


Case Study Examples - #4.a [AI Deep Learning ADC]

EAGLEview became the tool of choice for residual edge CMP defects because the defects could be detected on “partial-die”, giving users an early warning before the problems become severe.

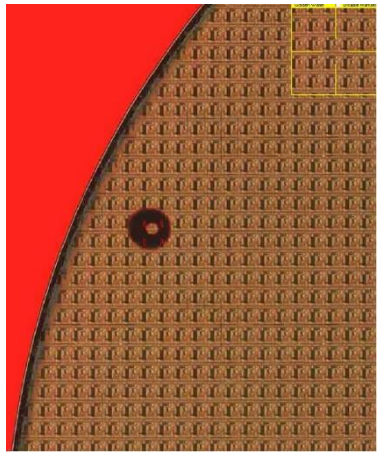


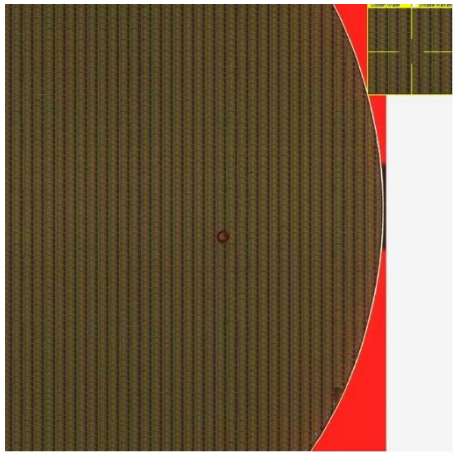


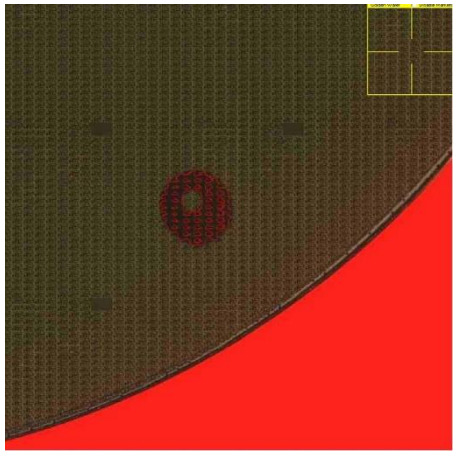


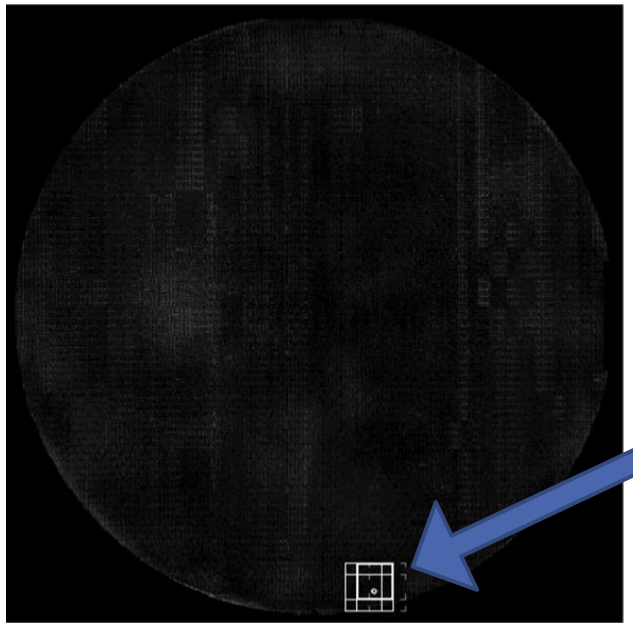
Case Study Examples - #4.a [AI Deep Learning ADC]

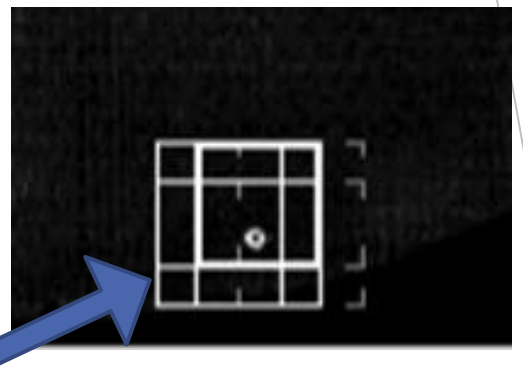
A new AI model for CMP Pinhole (PINH) defects was trained with >3,000 images and added to the EVdlADC software.

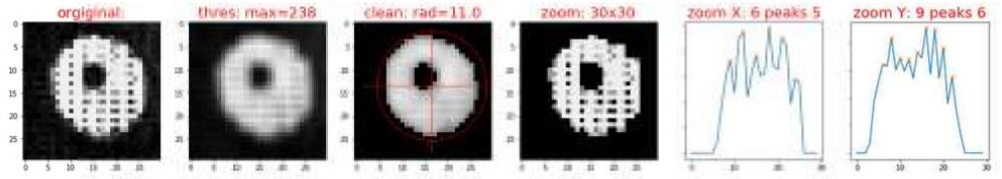












Preliminary verification results using >200 defective wafers were excellent with ZERO false fails.

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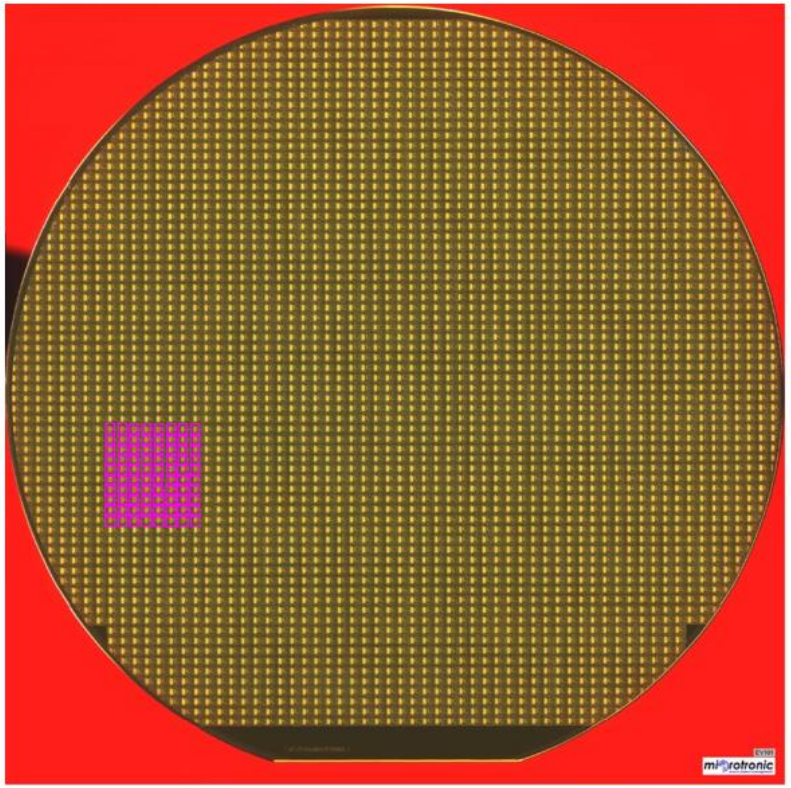
Case Study Examples - #4.b [AI Deep Learning ADC]

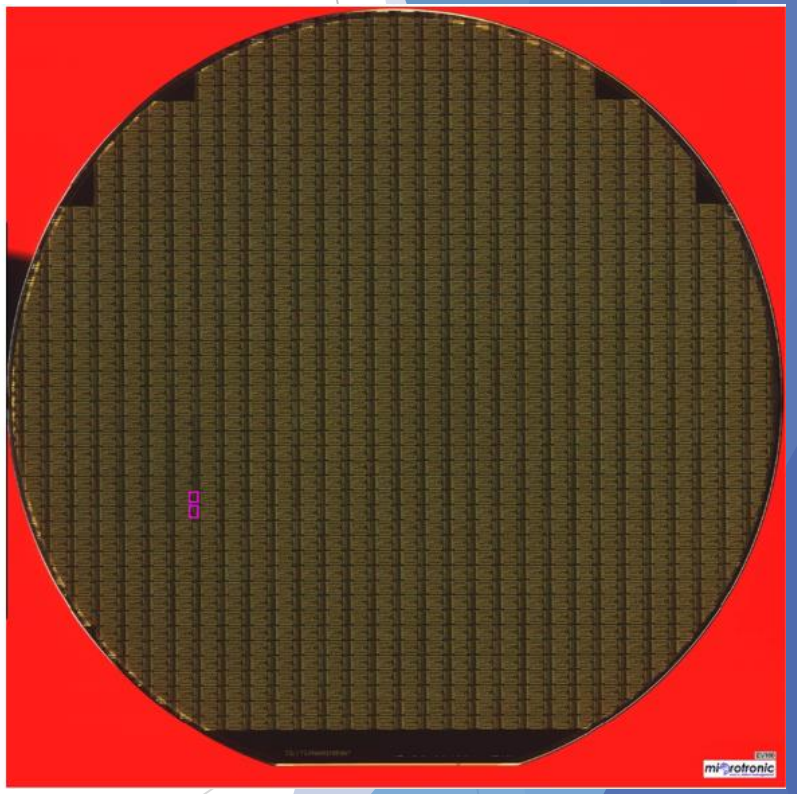
In 2023, Microtronic joined X-FAB Lubbock to present a case study at the FOA 11th Annual Collaborative Forum.

“Artificial Intelligence analysis of EAGLEview wafer images”

Microtronic collaborated with XFAB to integrate X-Fab AI results into the EAGLEview platform.

Software changes were made to allow FLFD wafers to receive an AI-generated auto-classification (AIFF) before the operators review the images in ProcessGuard.





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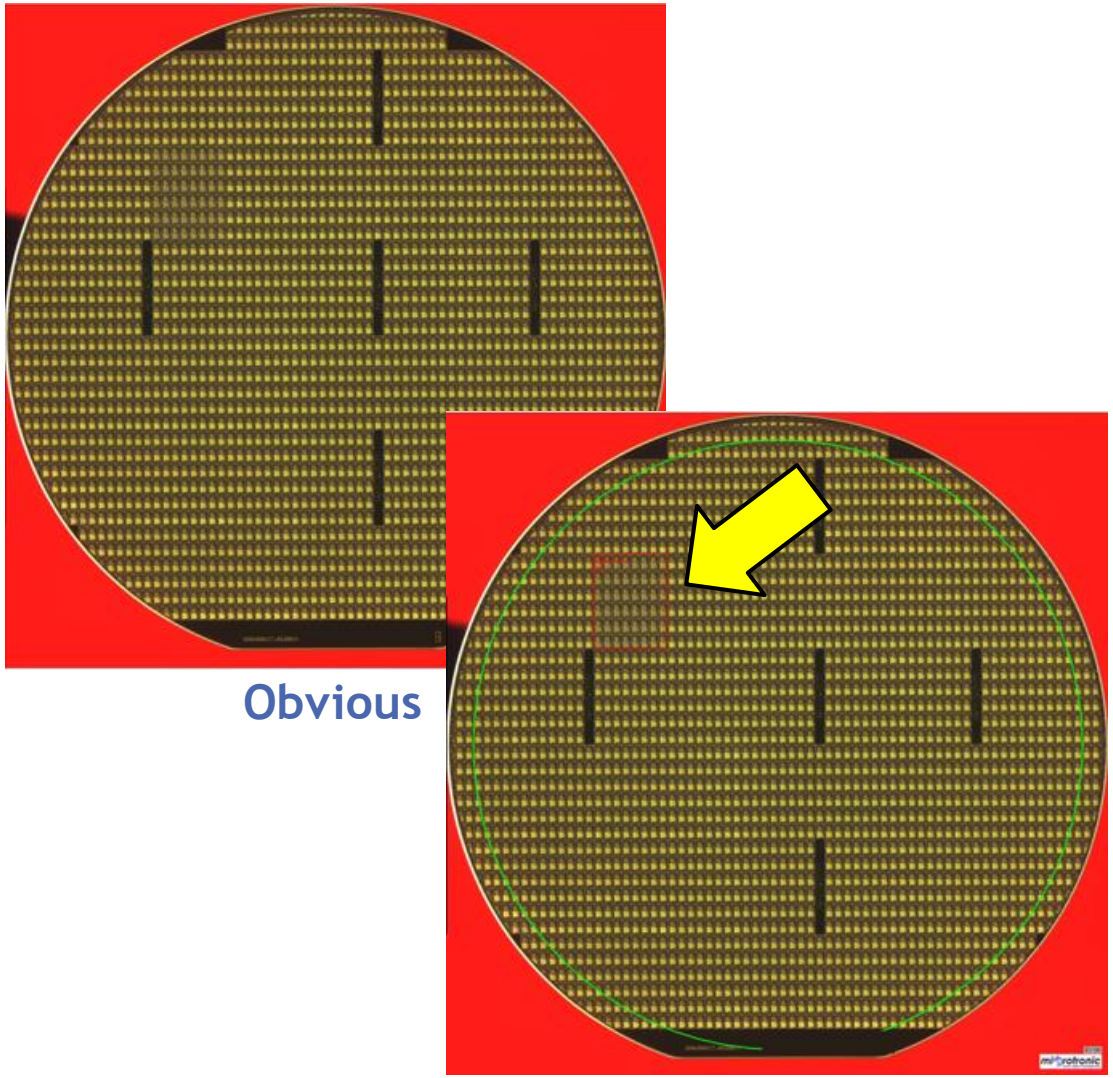
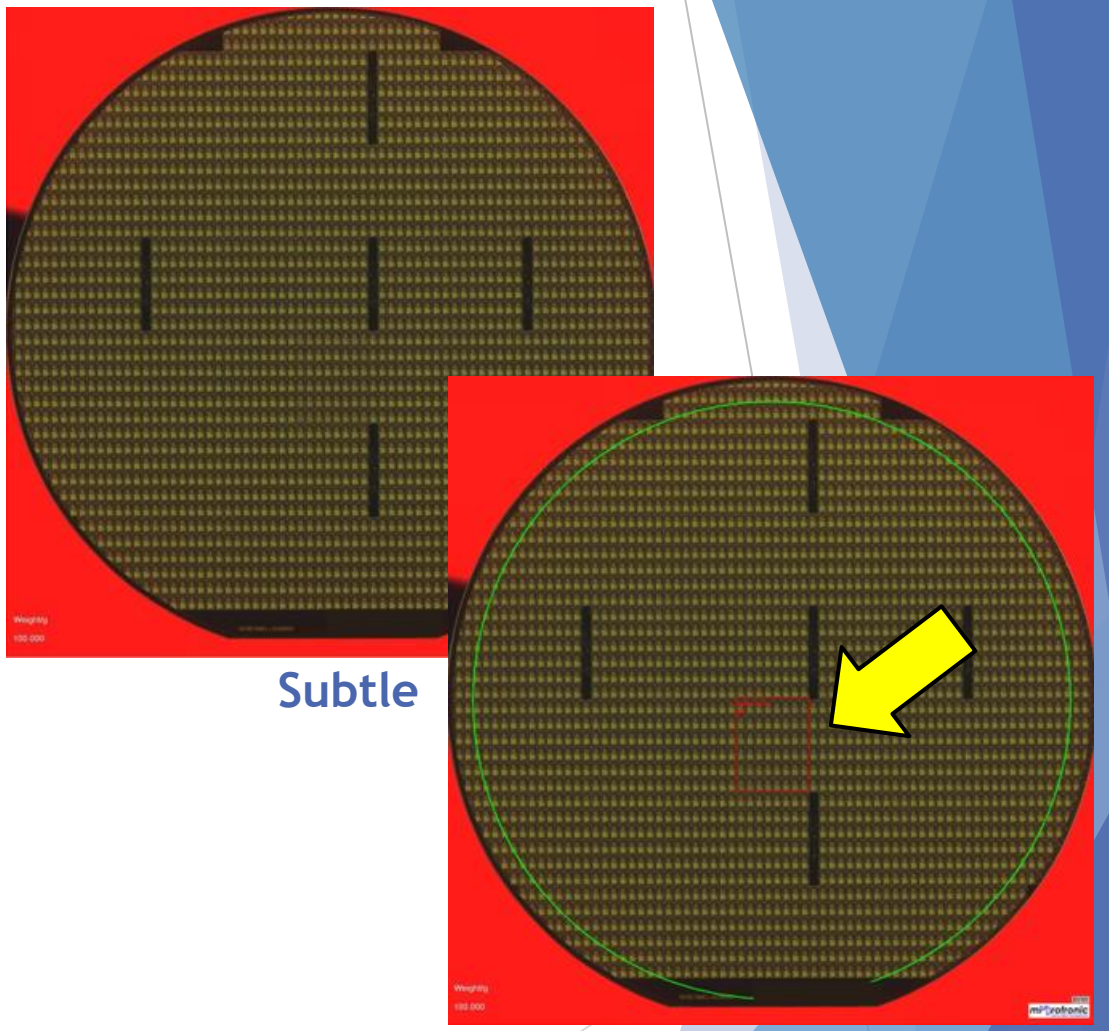
Case Study Examples - #4.b [AI Deep Learning ADC]



Obvious



Subtle

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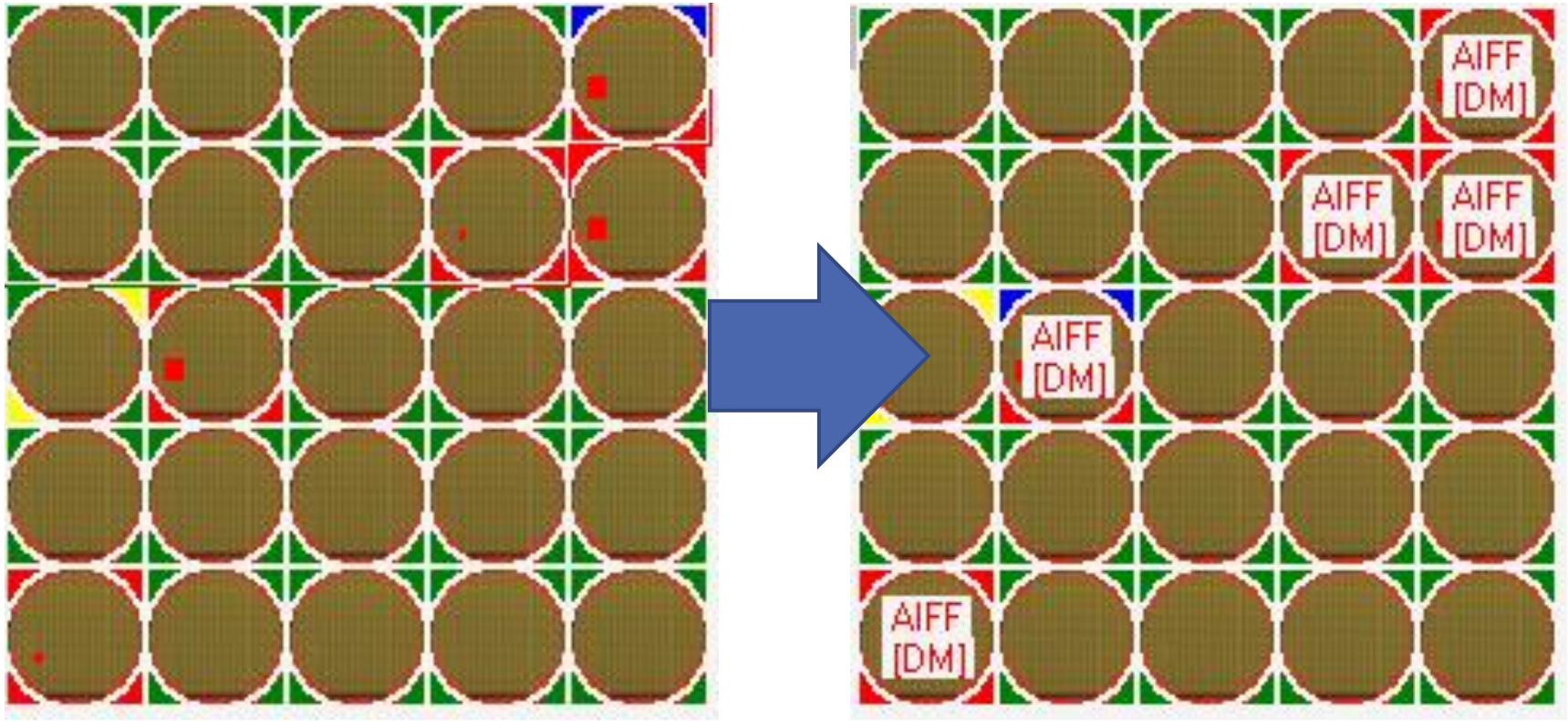
Case Study Examples - #4.b [AI Deep Learning ADC]

AI driven Auto Defect Classification (ADC) added to EAGLEview images prior to review by operators.



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Outline:

Intro to EAGLEview (Automated Macro Inspection Platform)

ProcessGuard with LotView – the ultimate interface for macro-inspected wafers

The power of randomization in a semiconductor fab

EAGLEview puts it all together; Frontside, Backside, LotView, & Randomization

Case Study Examples

Questions & ProcessGuard Live Demo

Questions & ProcessGuard Live Demo

EAGLEview Benefits

Process Yield	Scrap avoidance, massive sampling = faster detection/containment.
Multiprobe Yield	Find/fix chronic issues undetected by traditional tools/sample plans. Wafer randomization and analysis - avoid costly failure analysis.
Quality	Replace manual microscope inspection with machine vision. Find/fix issues in-line instead of screening product at end-of-line.
Cost & Cycle Time	Reduce manual inspection staffing and unnecessary rework. No need for stand-alone sorters.
Excursion Control	Huge potential, contain and prevent excursions throughout the fab!
Customer Returns	Auto-Guardband capability prevents shipment of walking wounded. A repository of full-color images of every wafer for years.