Advanced Techniques for Post-CMP Inspection: An Evolutionary Approach

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CMP Users Group

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INSPEX
A Hamamatsu Company

Agenda

- Hamamatsu/Inspex Corporate Profile
- Wafer Inspection System Overview/Technology
- Defect Gallery
- Process Defect Management (AEC)
- Case Study – CMP Microscratches
- Discussion

Hamamatsu/Inspex Profile

- Hamamatsu Photonics K.K.- Parent Company
  - $500M Revenue (Traded TSE)
  - World Leader Photonics (PMT, Cameras, Sensors, Medical Equipment, FA Tools)
- Inspex
  - Founded 1973 by Hamamatsu
  - Product History
    - 1980- Bare Wafer Inspection
    - 1985- Patterned Wafer Inspection
    - 1988- Microscope Review Station
    - 1993/1994- Data Management System (DMS-I) Introduced
    - 1999- Eagle WIS and DMSVision Introduced
  - Large Company stability with a proven track record of global support.

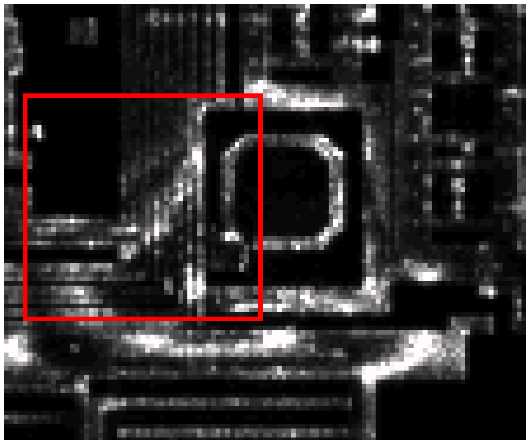
25+ Years of Semiconductor Defect Detection/Analysis/ Reduction

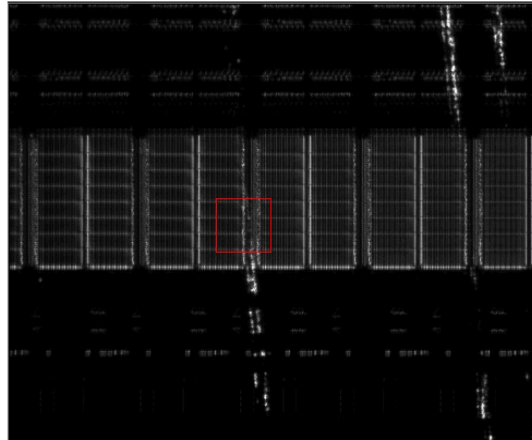
WIS Technology

Platform Details

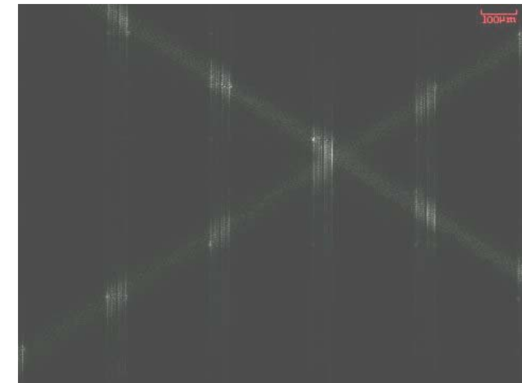
- Technology Advantages
  - Darkfield imaging with CCD Camera (4096 Gray Levels)
  - CMI™ Continuous Motion Imaging with TDI
  - Excellent stage accuracy
  - Five Bar Fourier Mask: Memory or Logic / Memory
  - Dual Laser Beams with Independent Programmable Angles and Polarization
  - ***Patented Automated Pixel-Level Thresholding***

DF Inspection Camera Images



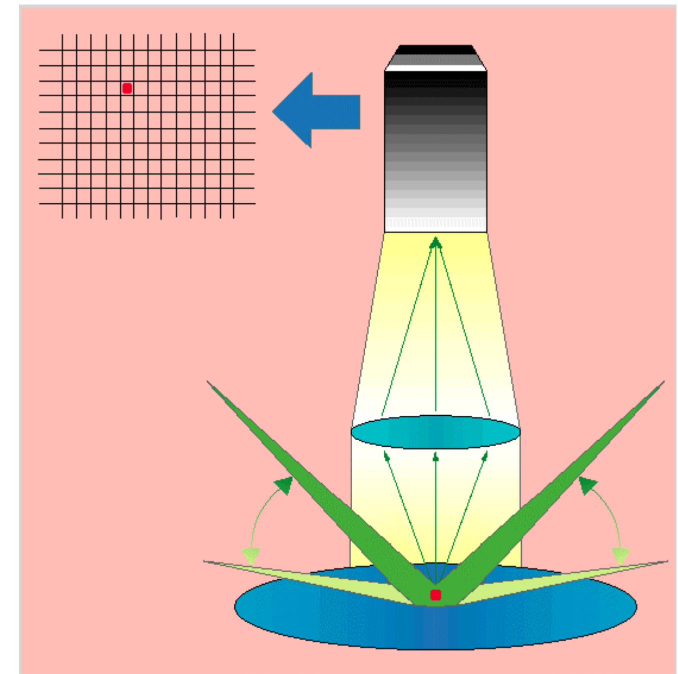


Fourier Mask Application

	Fourier Pattern	Laser Image
Before Fourier Mask		
After Fourier Mask		

Process Optimization - Optics

- Illumination and Collection Optics
  - ***Independent variable laser angles and polarization*** illuminate target defects and particles in trenches, contacts, etc.
  - ***Dual approach angles*** increase sensitivity by increasing preferential scatter
  - Optimization for any process
    - Ideal for post-CMP, post-ETCH and POLY applications.



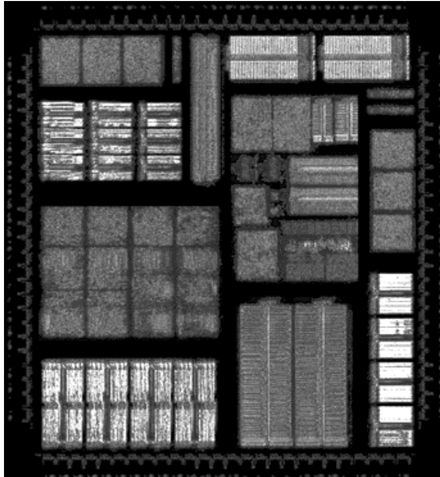
Pixel-Level Thresholding

Raw image contains features of different intensities. Without multiple thresholds, a global threshold higher than the brightest feature is used.

Regional Masks, developed by Inspex and still in use by the competition, can miss critical defects - especially in logic or high-topology areas.

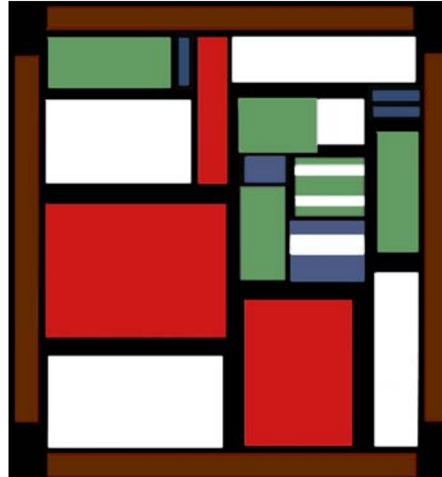
Patented –Automated Pixel-Level Thresholding allows the Eagle to capture more defects and smaller defects by providing the highest threshold resolution.

1986



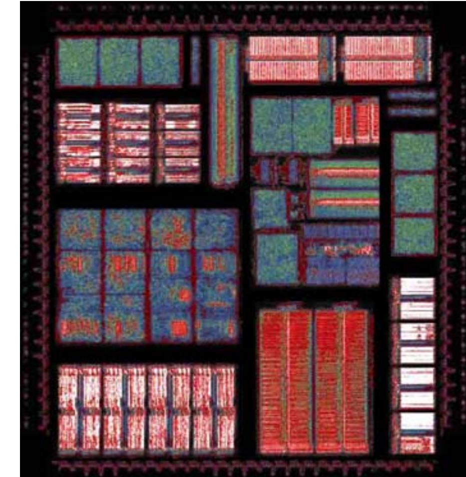
Raw image

1992



Conventional Regional Masking

1999



Pixel-Level Thresholding

Lowest ◄ Threshold Value ► Highest

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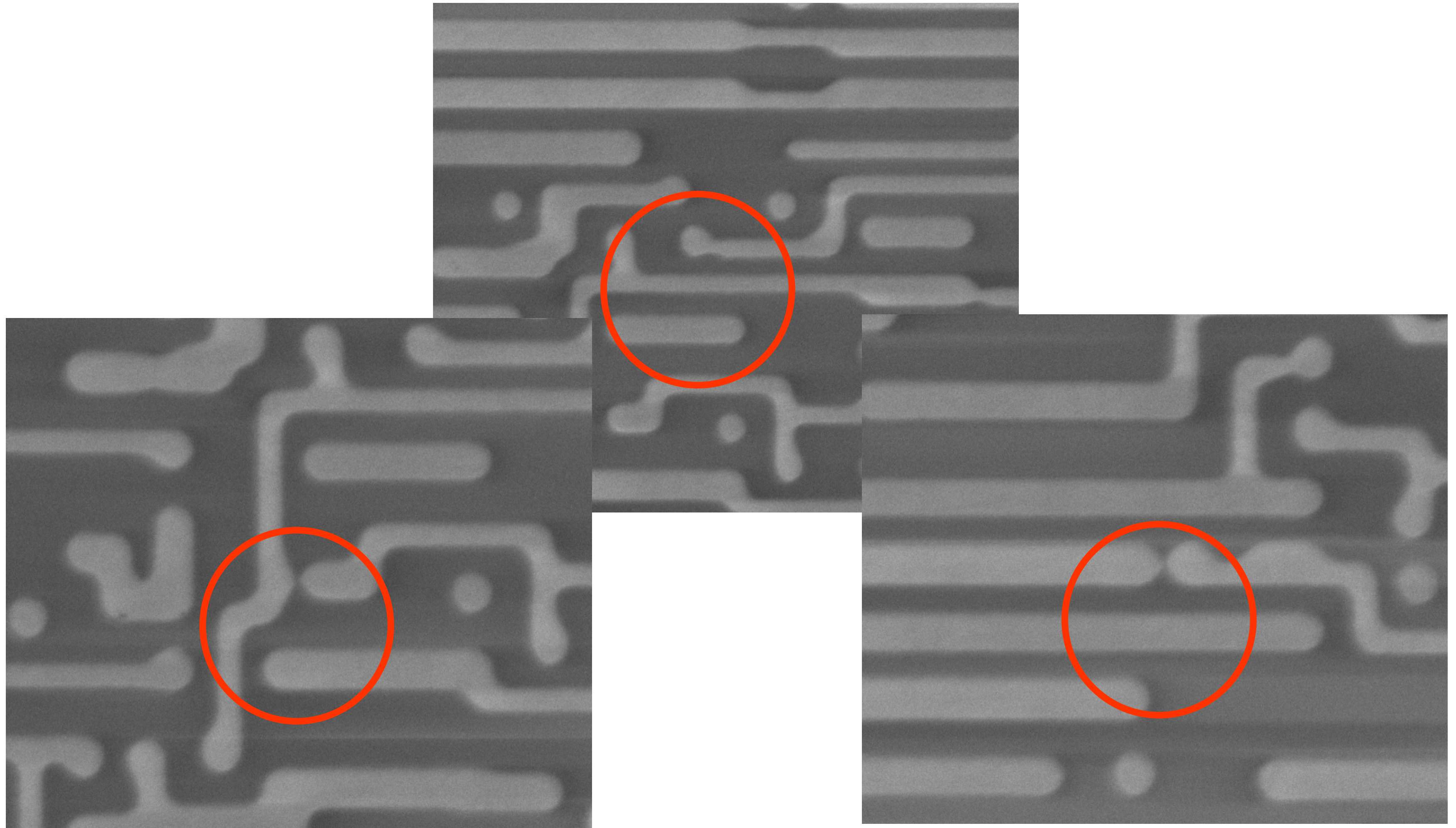
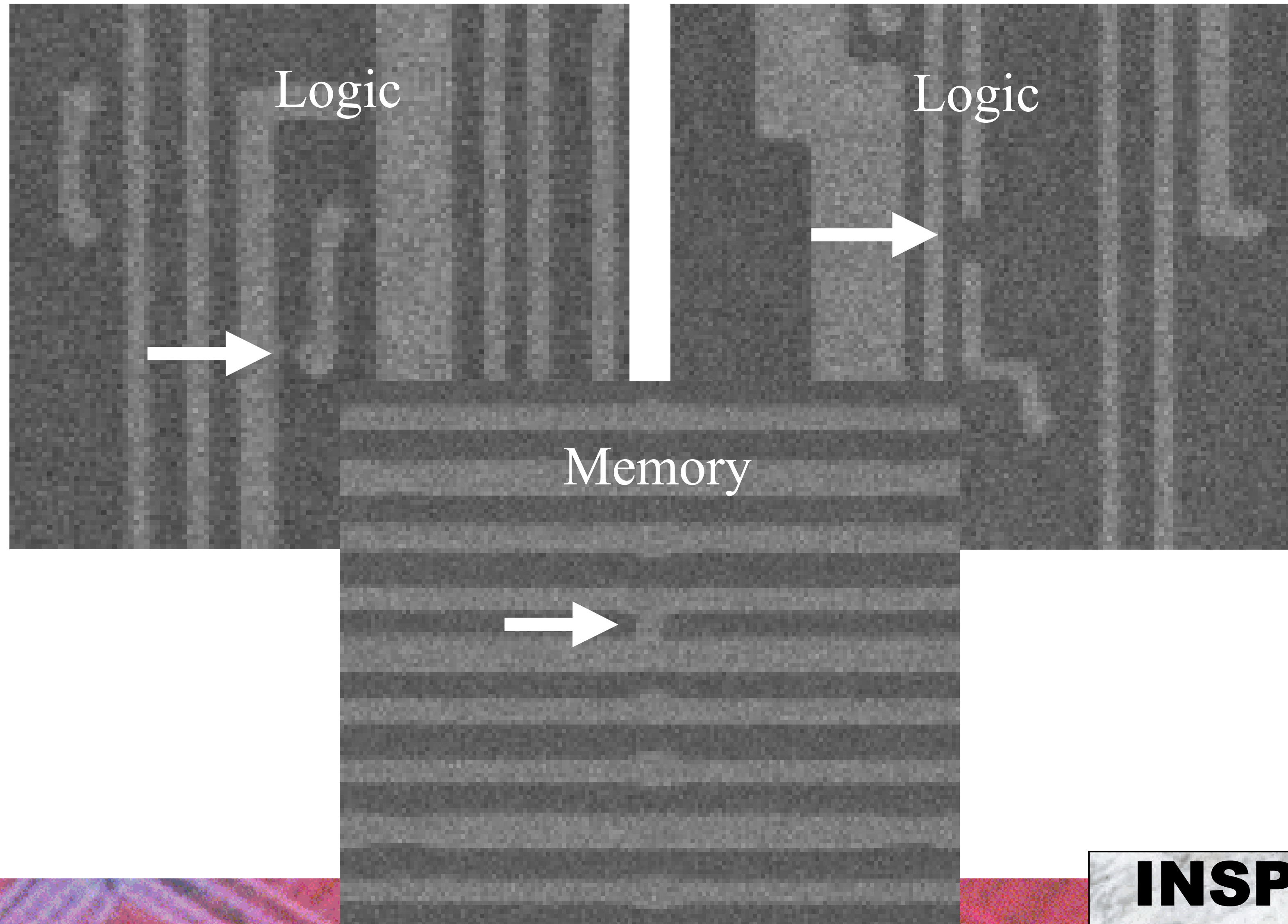
  - Five Bar Fourier Mask: Memory or Logic / Memory
  - Dual Laser Beams with Independent Programmable Angles and Polarization
  - ***Patented Automated Pixel-Level Thresholding***
- Reliable and easy to use

Sensitivity with True Production Throughput and Ease of Use!

Metal 1 Post-Cu CMP



Metal 2 Post-Cu CMP



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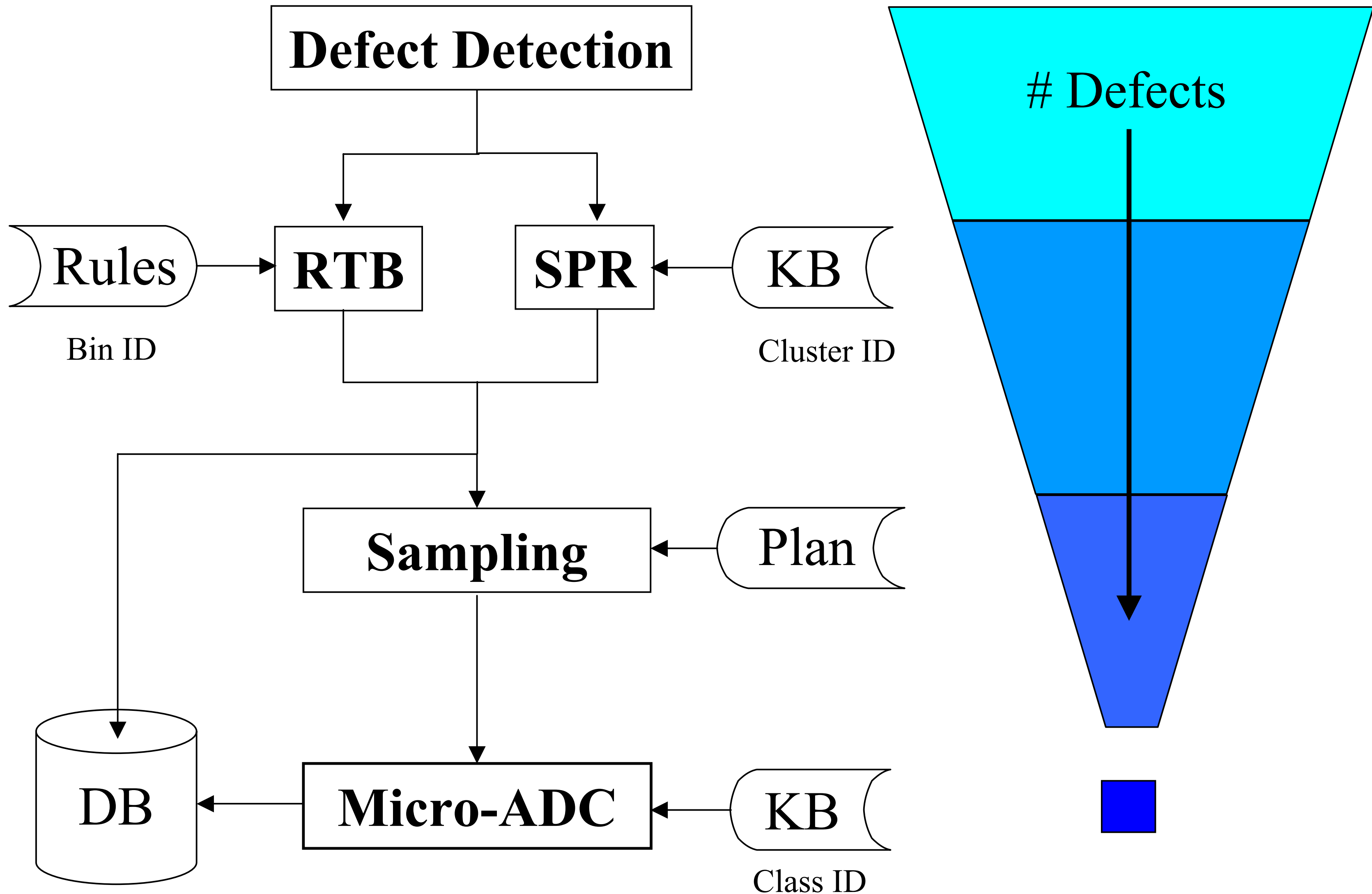
Process Defect Management Features

- Built-in On-System Review
  - Precision microscope with Autofocus.
  - Image capture ability.
  - Ability to compare defect with adjacent die for verification
- Built-in Data Analysis
  - On-board DMSVision™ software
  - Delta, Compare, Overlay, Classification, Partitioning and Trend Analysis.
- Advanced Automatic Event Characterization Package

AEC



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Real Time Binning (RTB)

- Provides a coarse qualitative analysis of defects.
  - Bins out nuisance defects (grains, bumps, hillocks)
  - Bins yield relevant defects
  - Done in parallel process with inspection (on the fly)
- Improve quality of reviewed defects
- Maximize utilization of review tools

Focus Your Resources on Defects of Interest!

Case Study:
Real Time Binning of CMP Microscratches

Background

- Customer monitoring CMP process with four daily BPSG monitor wafers
- Brightfield inspection used to detect microscratches

Monitoring Issues

- Low throughput of brightfield inspection
  - allowed only 25% inspection of wafers
- Poor data for SPC decision making
  - Low capture rates
  - Forced to interpolate “total” microscratches

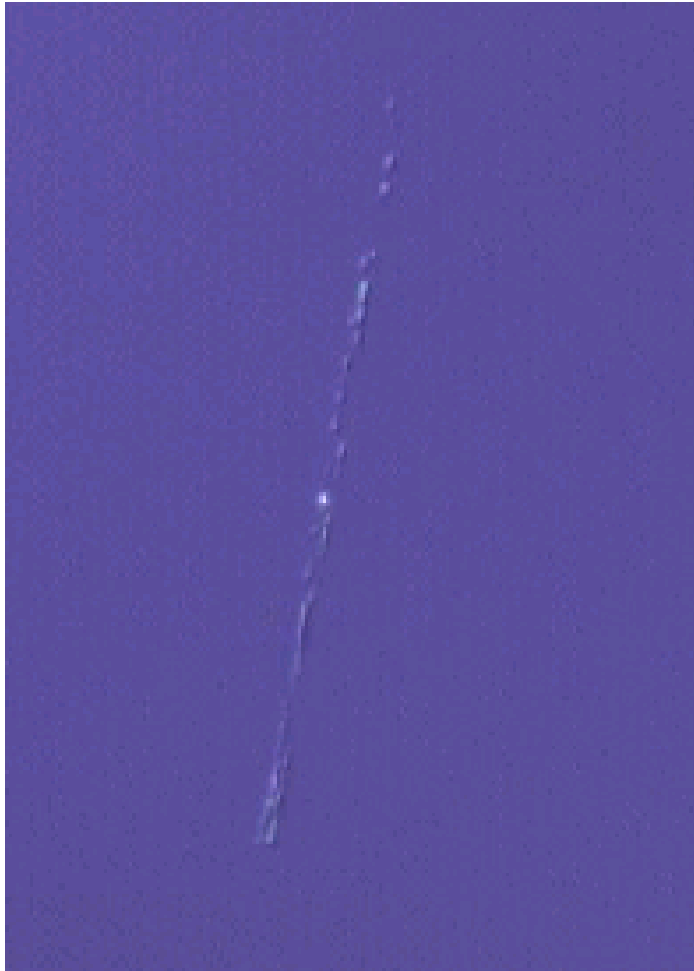
Case Study

Monitoring Replacement

- Eagle darkfield inspection system installed in customer fab
- 100% inspection of all monitor wafers
- Throughput of 50 WPH
- RTB attributes at the time not were not sufficient to accurately bin microscratches

Case Study

Monitoring Defect Examples



Microscratch

Small

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Case Study

Monitoring Solution

- New Linearity attribute added to attribute set

RTB	Chatter	Small	Total	Purity
Chatter	122	0	122	100%
Small	5	35	40	86%
Other	9	*	-	-
Total	136	-	-	-
Accuracy	90%	-	-	

90% Accuracy, 100% Purity!

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Discussion