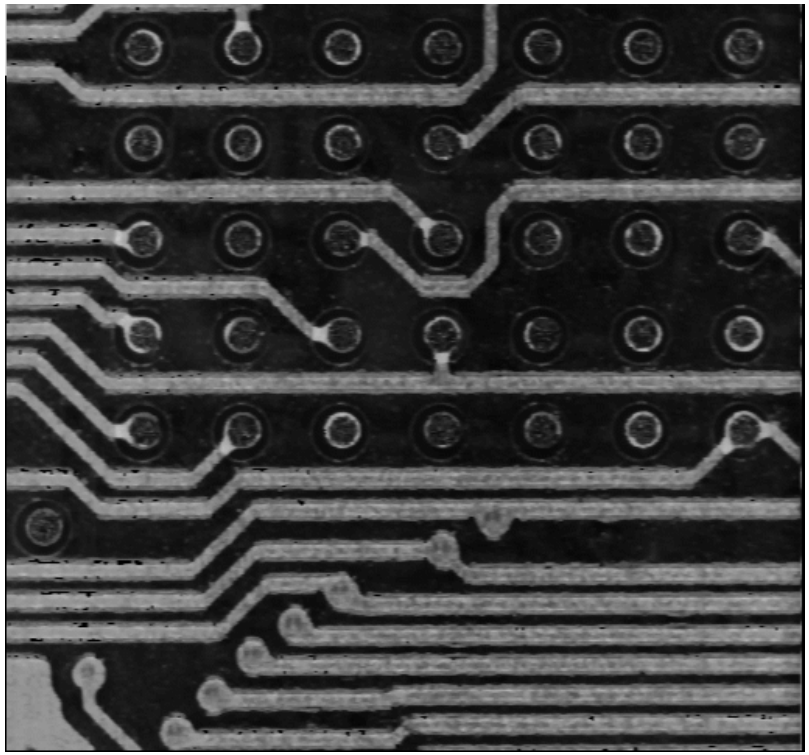
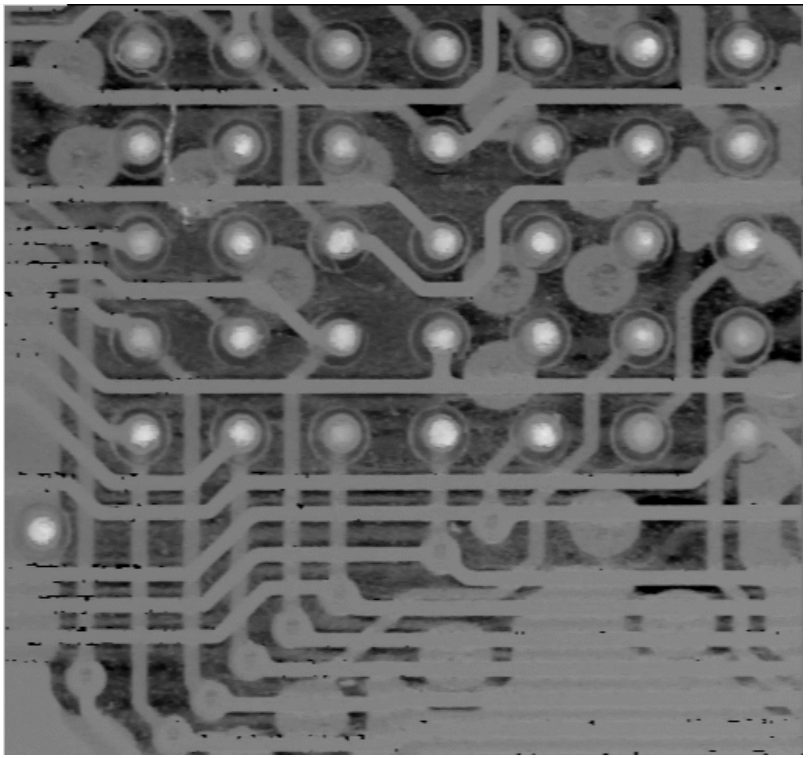
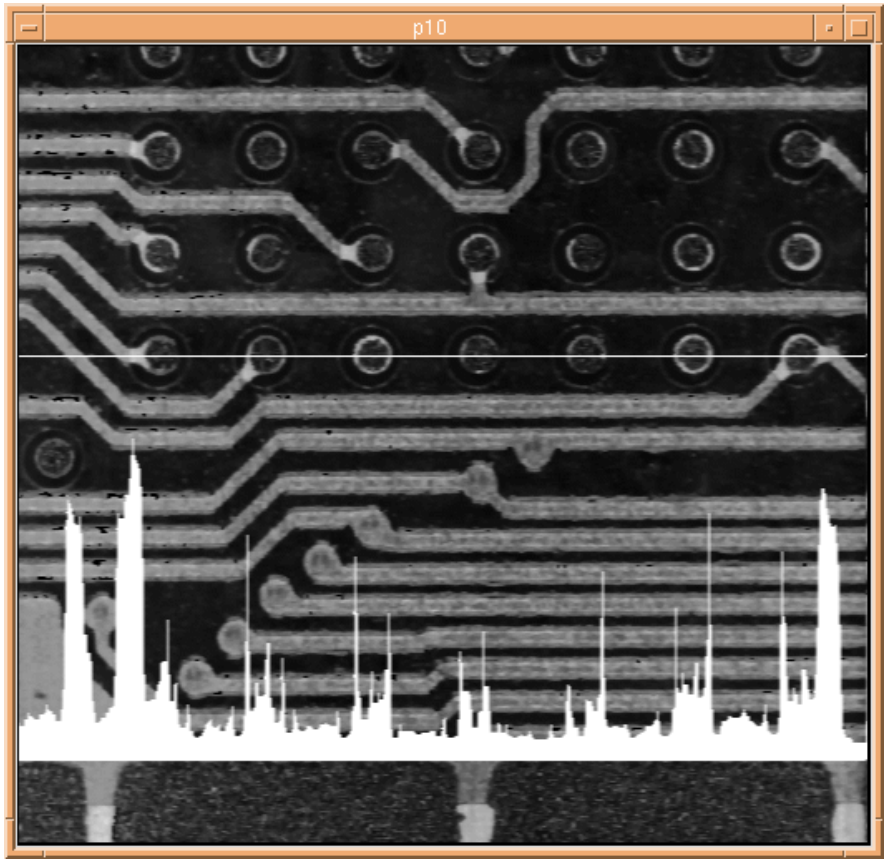
Laser-Based 3D AOI for SMT Assembly Processes





2D versus 3D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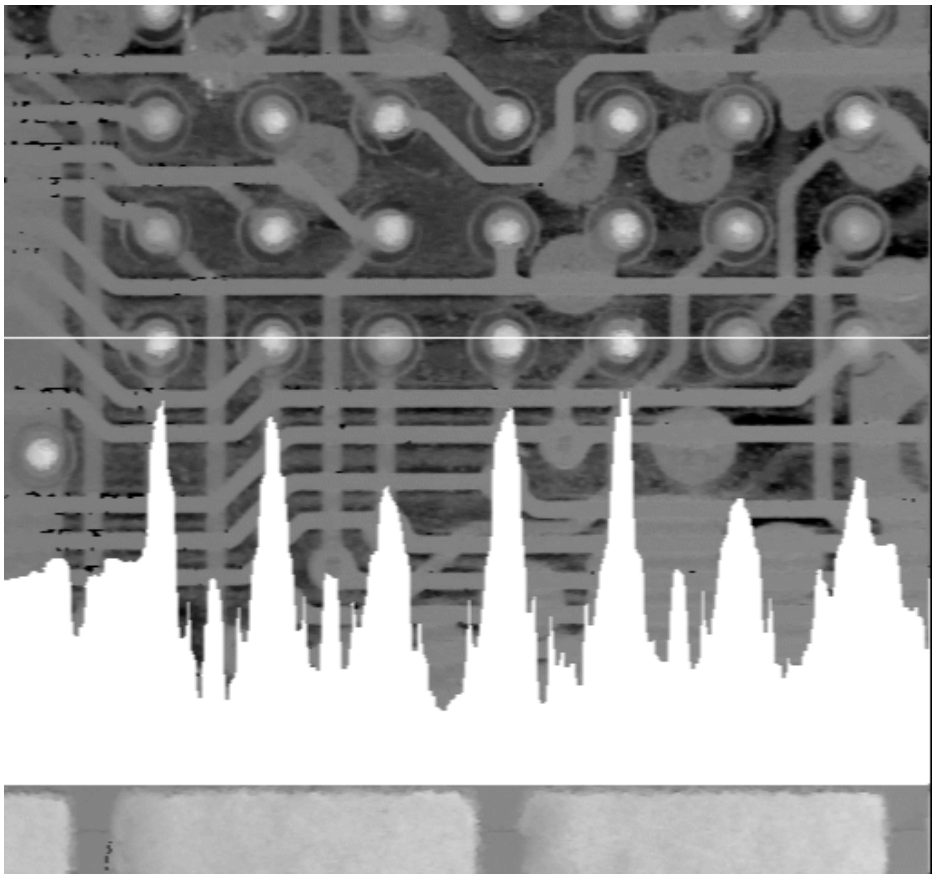
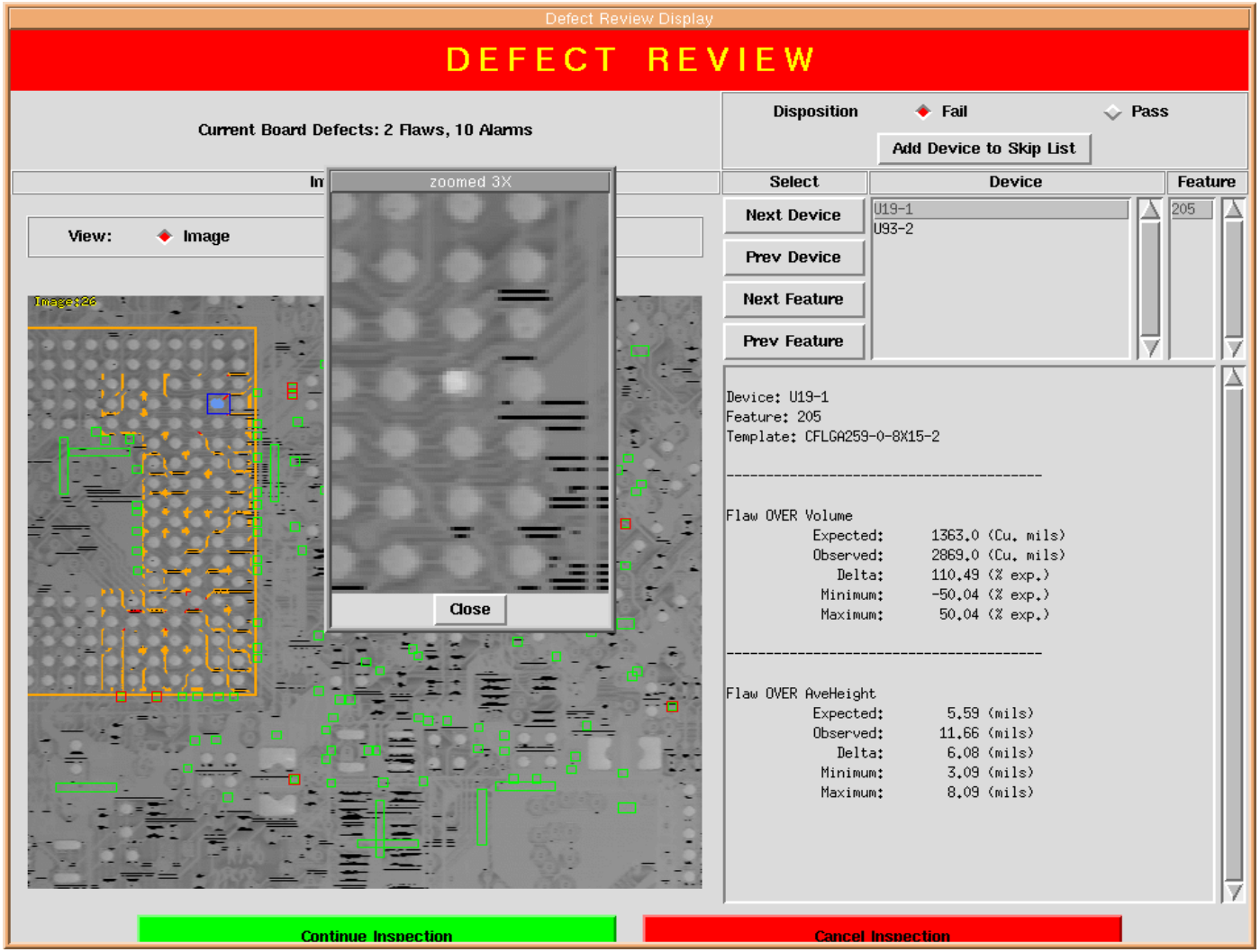
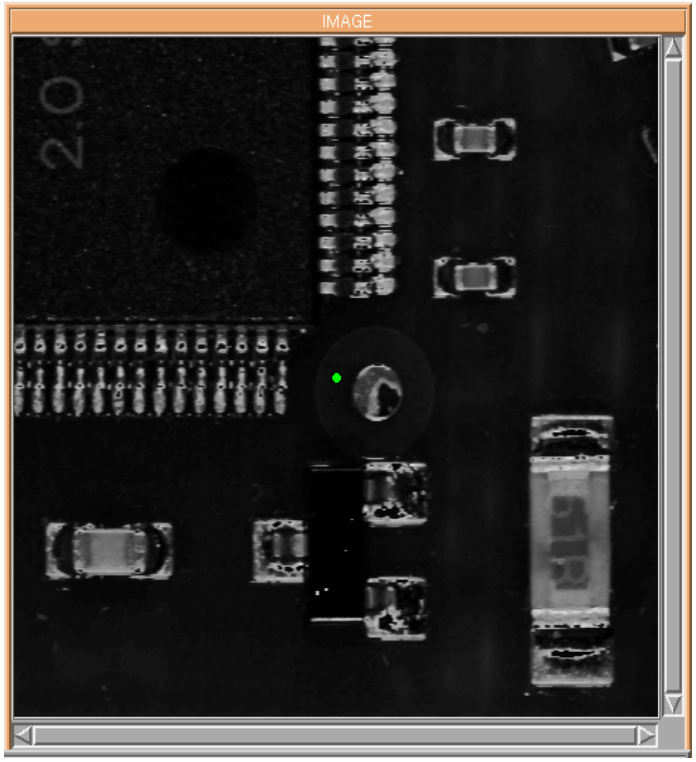




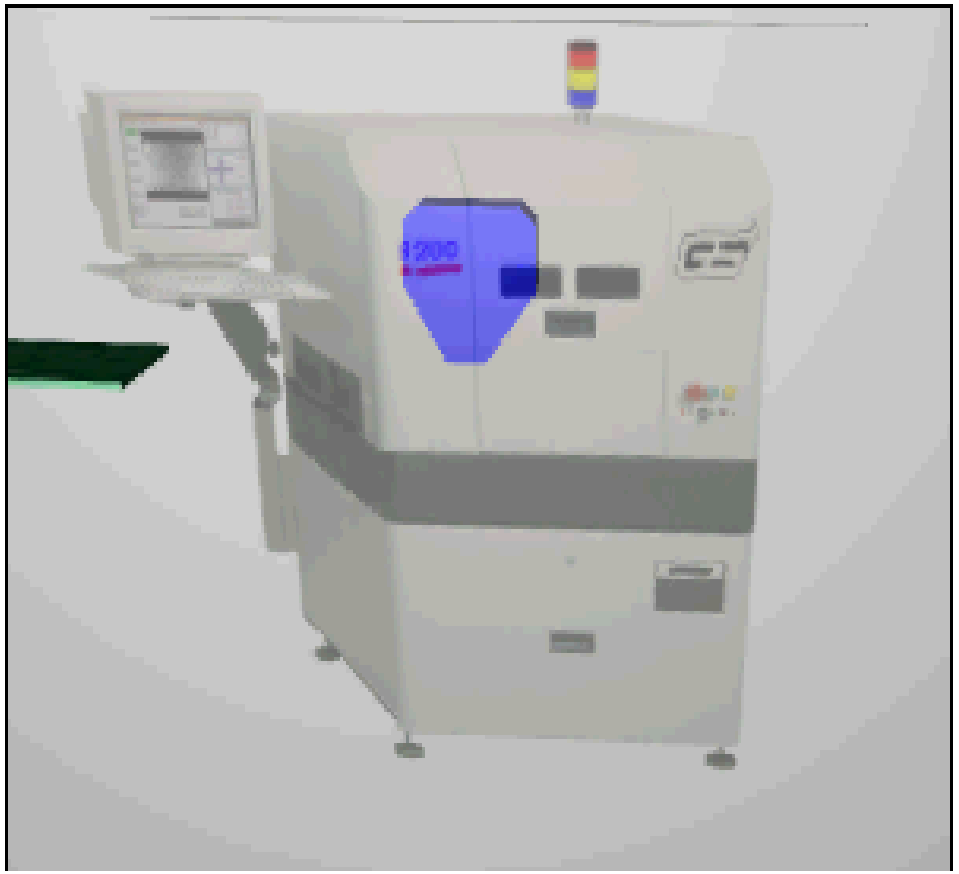
Example of a BGA pad which passes area but fails volume and height

3D and 2D Post-Placement Images

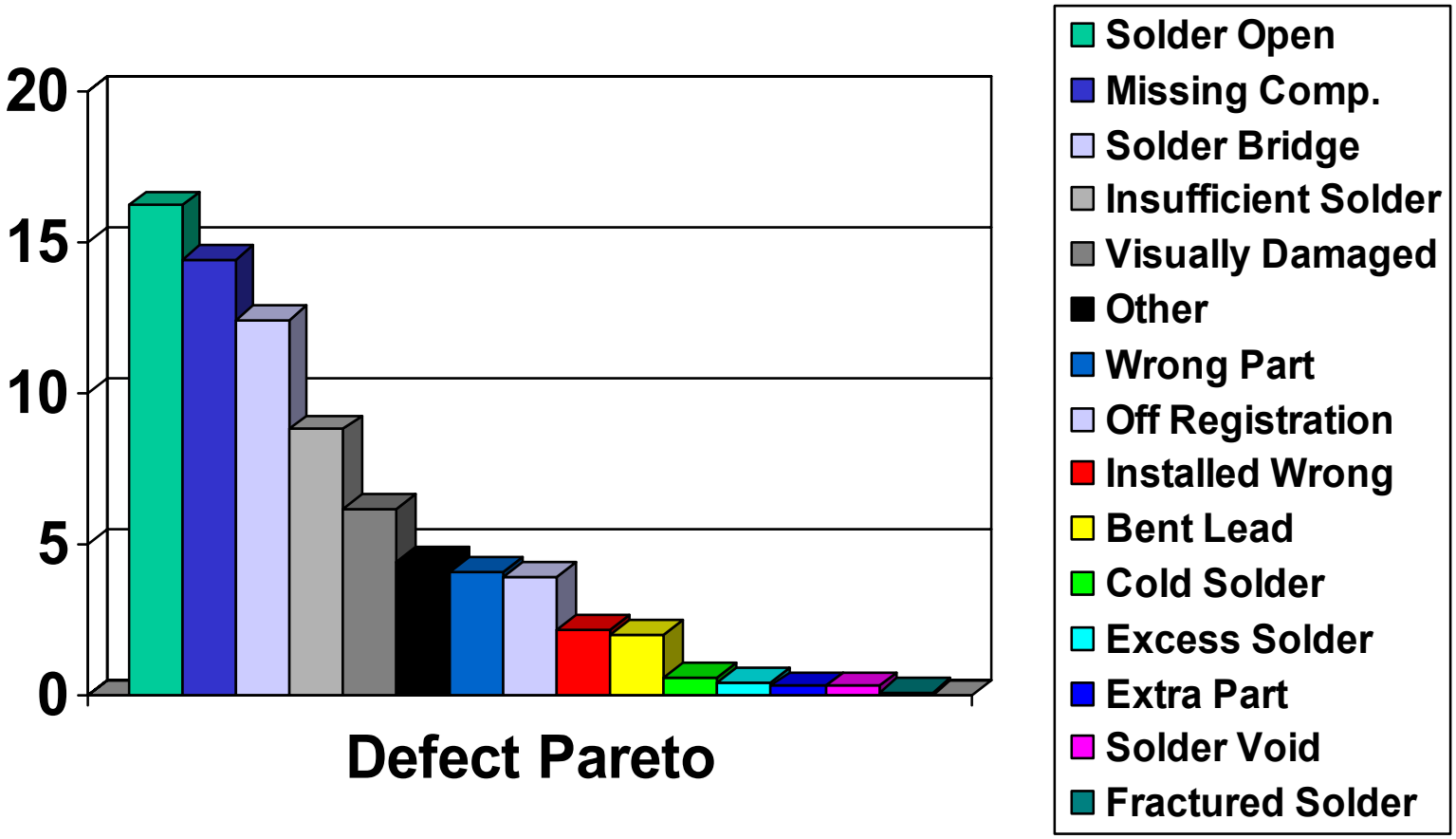


100% In-Line 3D Inspection

- Captures both random and systematic defects as they occur, at the most cost-effective stage of production
- Provides real-time data for SPC and feedback as each PCB is built
- Improves first-pass yields

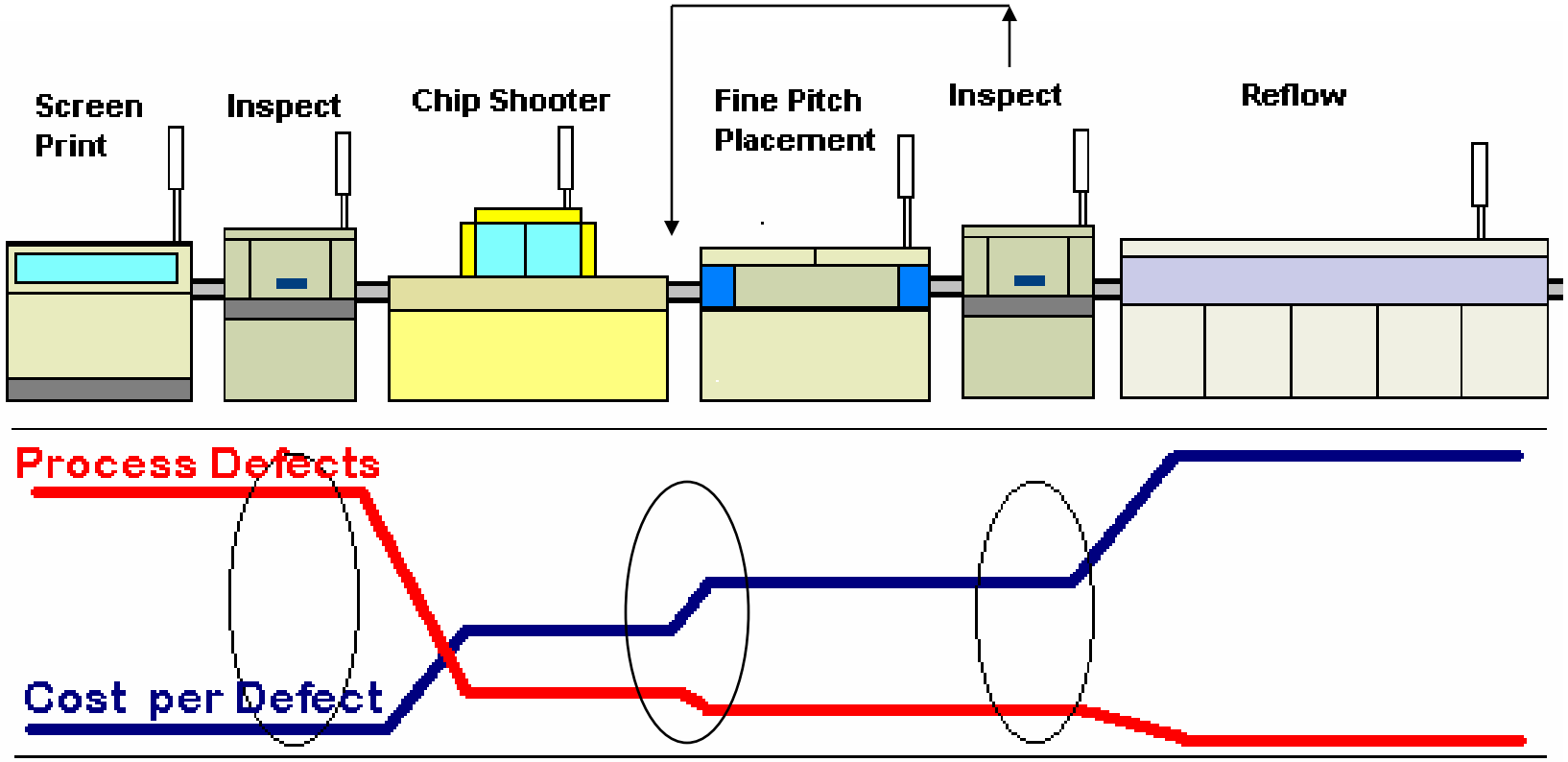


Typical SMT Defect Spectrum



Dave Mendez, "An Integrated Test And Inspection Strategy", APEX Proceedings, 2000

Defect Sources and Costs in SMT Assembly

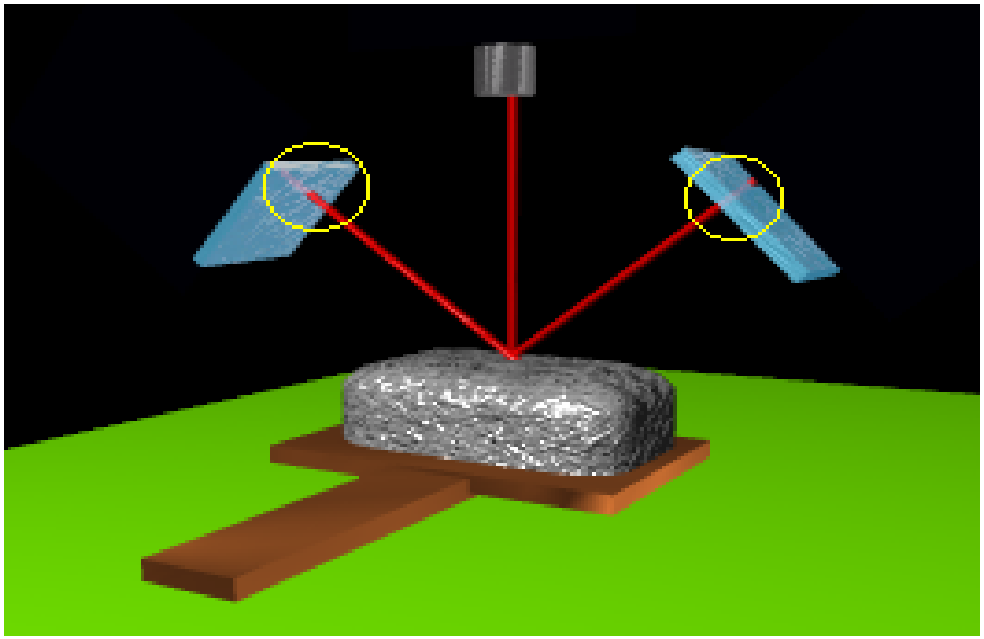


Most SMT defects can be traced to poor solder paste printing. At the same time, as the product moves down the line, rework becomes more difficult and expensive.

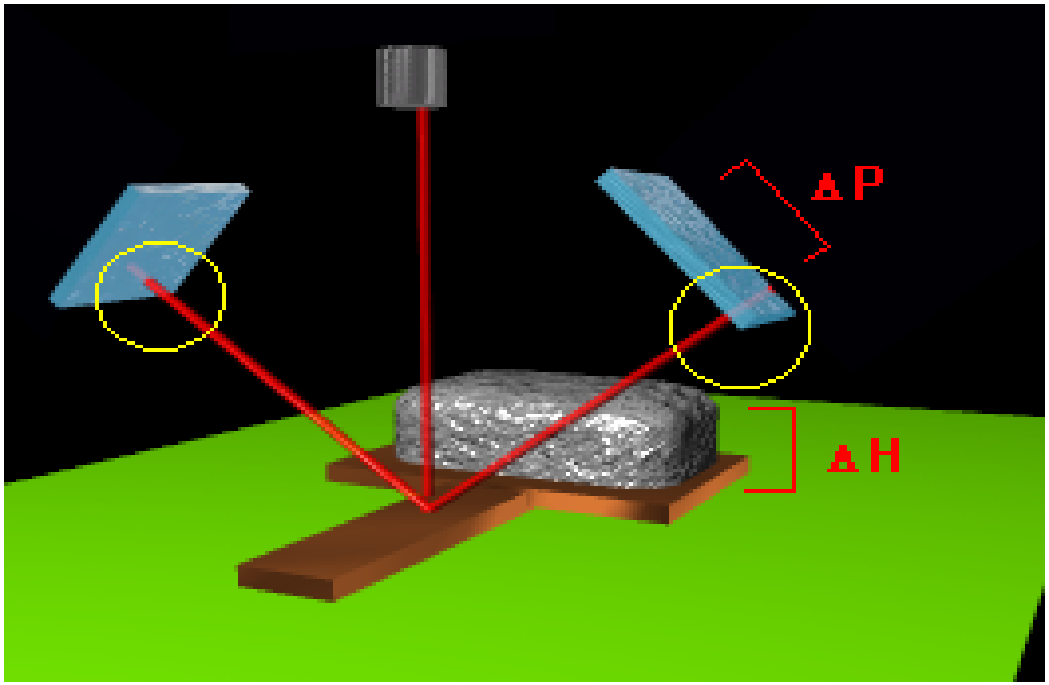
How Does 3D Laser Scanning Work?

Laser-Based Triangulation for Volumetric Imaging

Height measurements are made from laser light reflected on position-sensitive detectors.

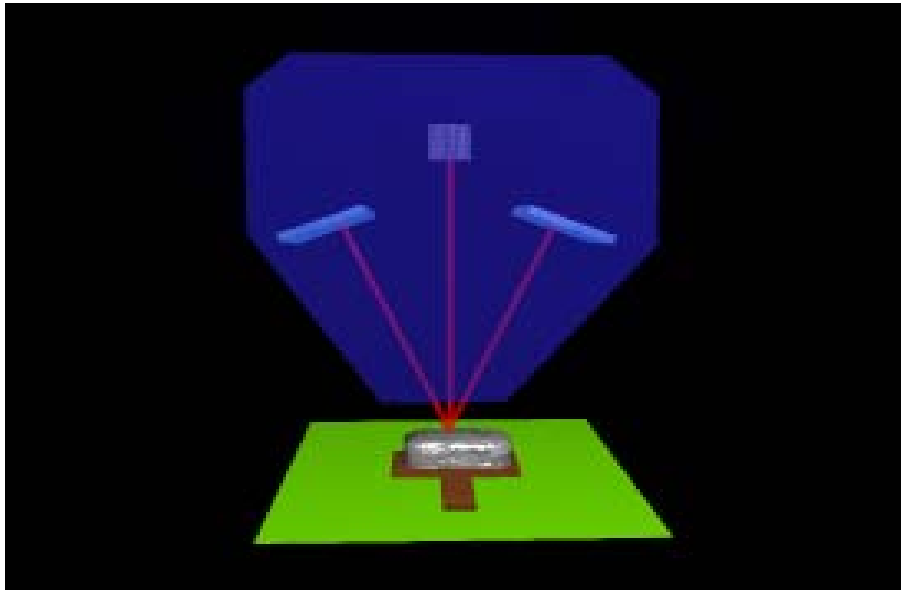


Changes in height are measured as changes in the position of the reflected light.

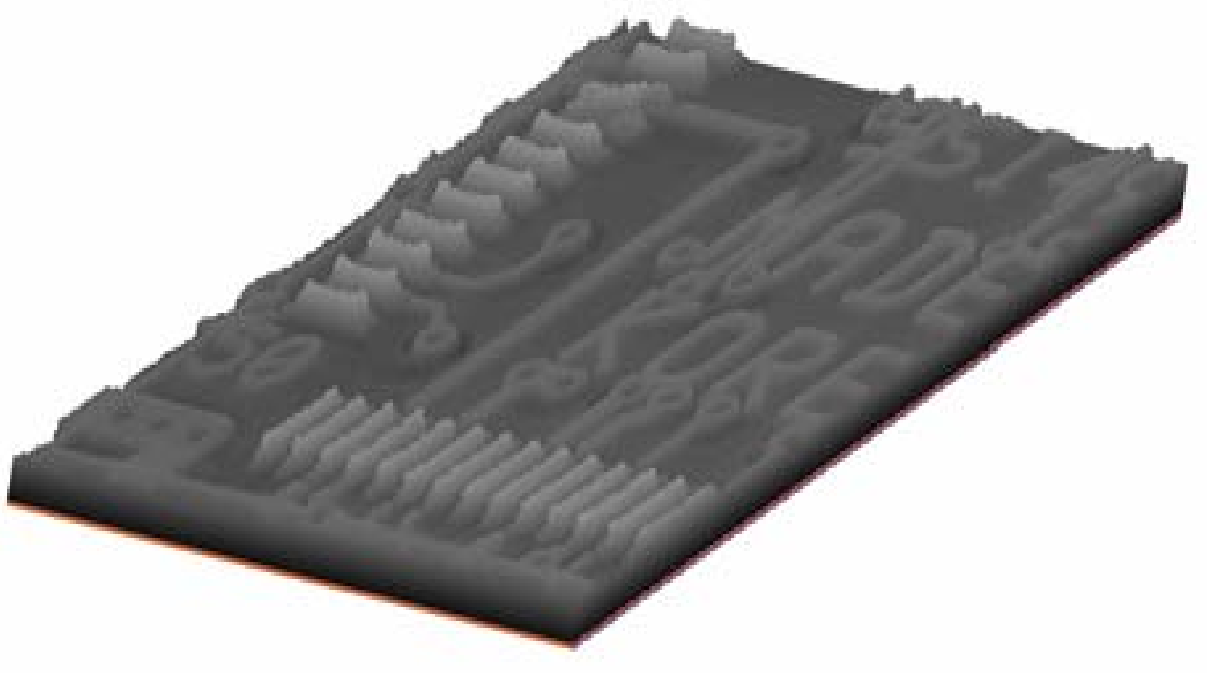


DUAL-VIEWPOINT TRIANGULATION:

- Allows choice of opposing viewpoint if one view is occluded
- Improves data quality through viewpoint averaging if neither view is occluded



High-speed scanning enables data collection from the entire board surface for accurate height and volume measurements.

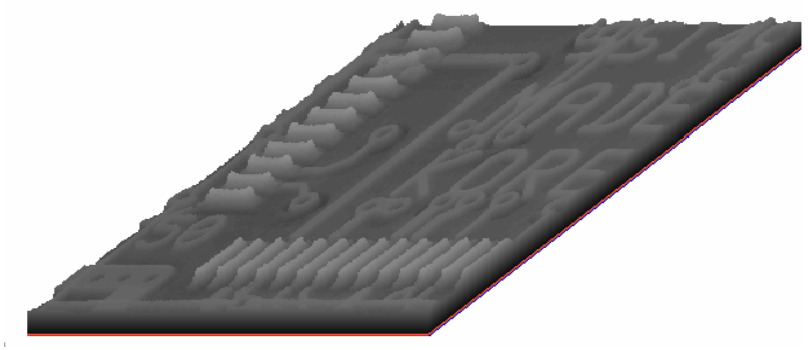


Solder Paste Inspection

Solder Paste Inspection

Key Measurements:

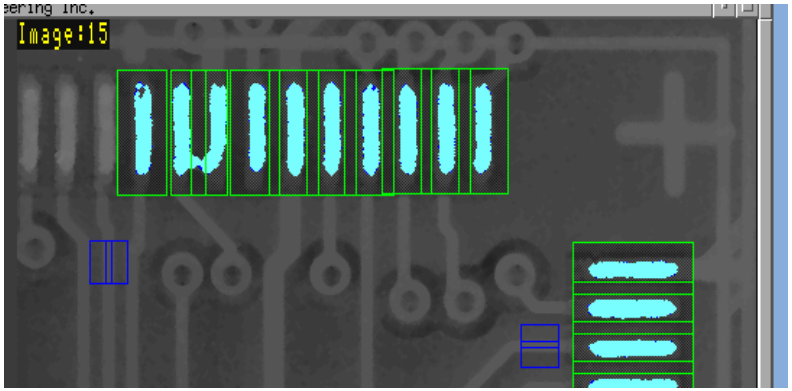
- -volume
- -height
- -area
- -registration
- -bridging



Important Factors for Height Referencing:

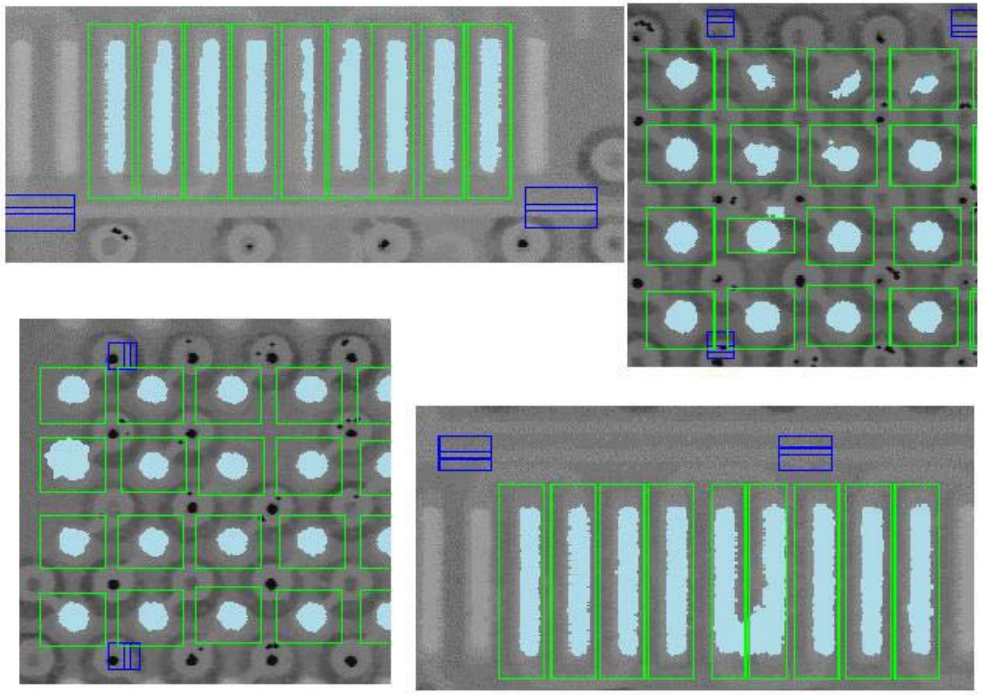
- reference metal surfaces, not solder mask or FR4

- correct for local warping

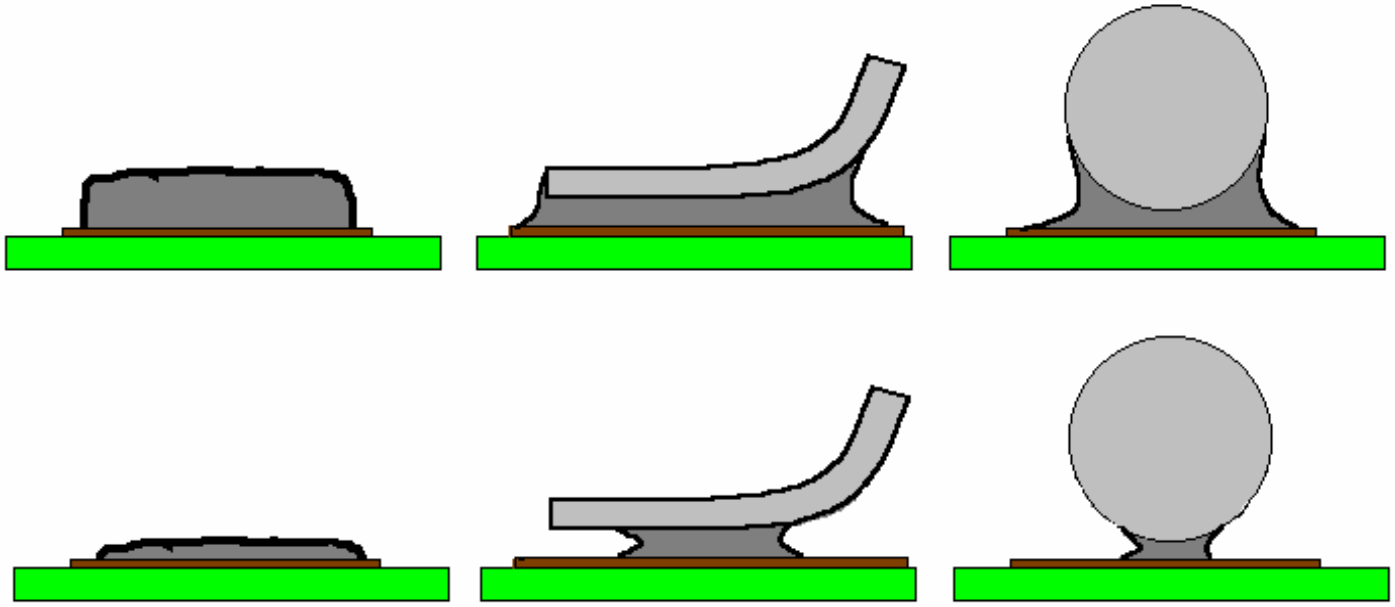


Solder Paste Print Defects

Solder paste print defects are the primary cause of solder joint failures. Too little paste causes opens or weak solder joints, and too much paste can cause short circuits.



Solder Paste Volume = Solder Joint Quality



Solder paste volume is the key process parameter that affects solder joint quality. Low solder paste volumes can produce solder joints that pass electrical test but have low mechanical strength and high failure rates.

Benefits of 3D Method for SPI

- Performance and set-up un-affected by normal process variation and changes
- Provides accurate, repeatable volume measurements which is the best indicator of solder joint quality
- Allows simpler, more robust algorithms and processing techniques to be used
- Typically capable of 100% inspection at line rates

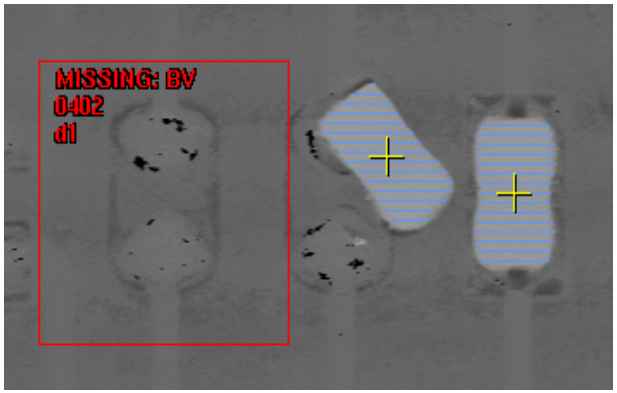
Component Placement Inspection

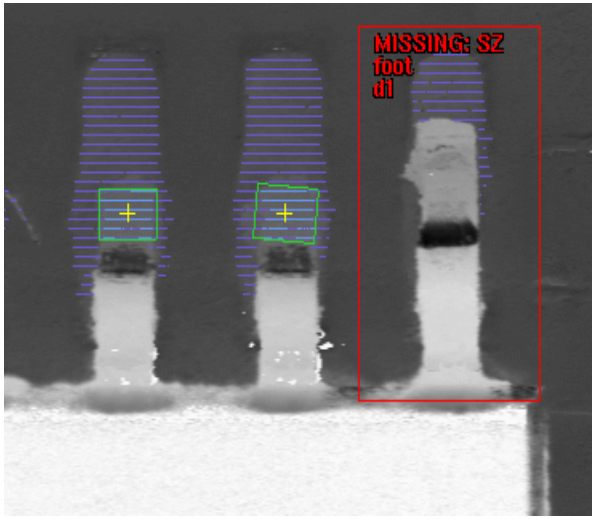
Component Inspection

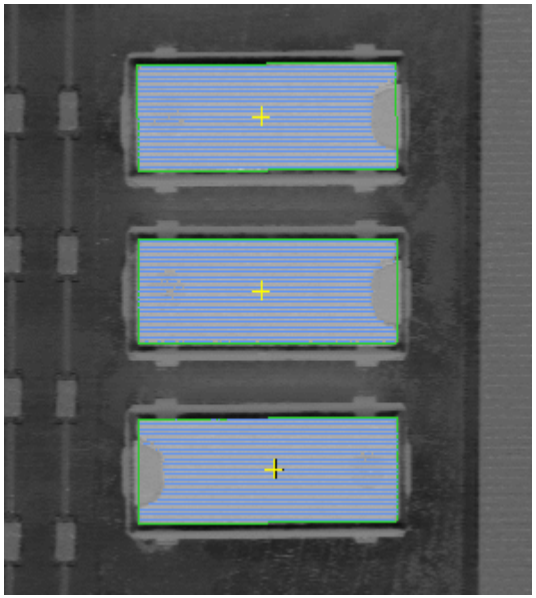
- Key Process Parameters Requiring Inspection:
  - X-Y Position
  - Theta
  - Size Check
  - Height Check
  - Lead Coplanarity
- Pre-Reflow vs. Post-Reflow Inspection Tradeoffs
  - Reworkability
  - Total Defect Detection

Component Defects

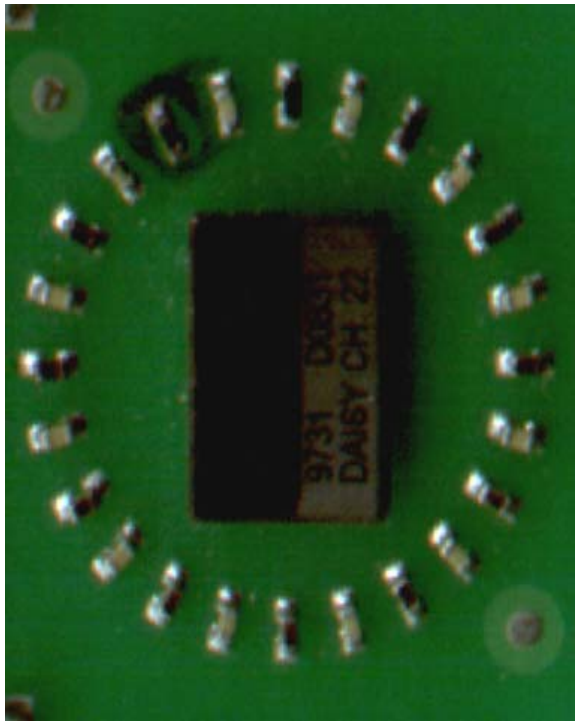
Component placement defects often result in non-functioning products. Locating these defects early in the process reduces scrap and rework costs.



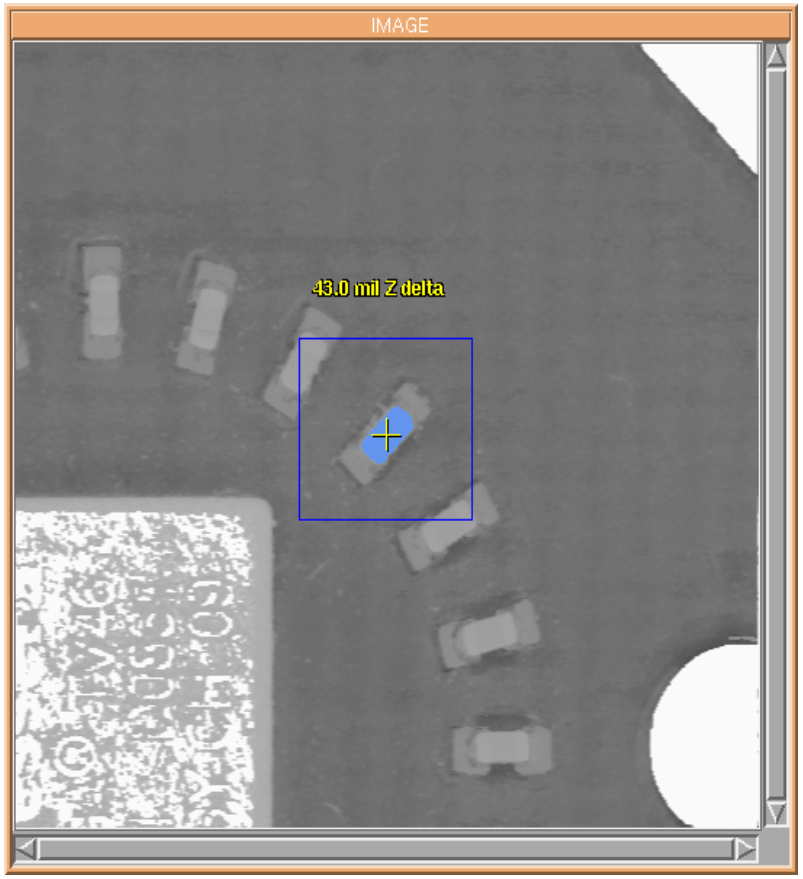




Effect of Color Change on 2D



Effect of Color Change on 3D

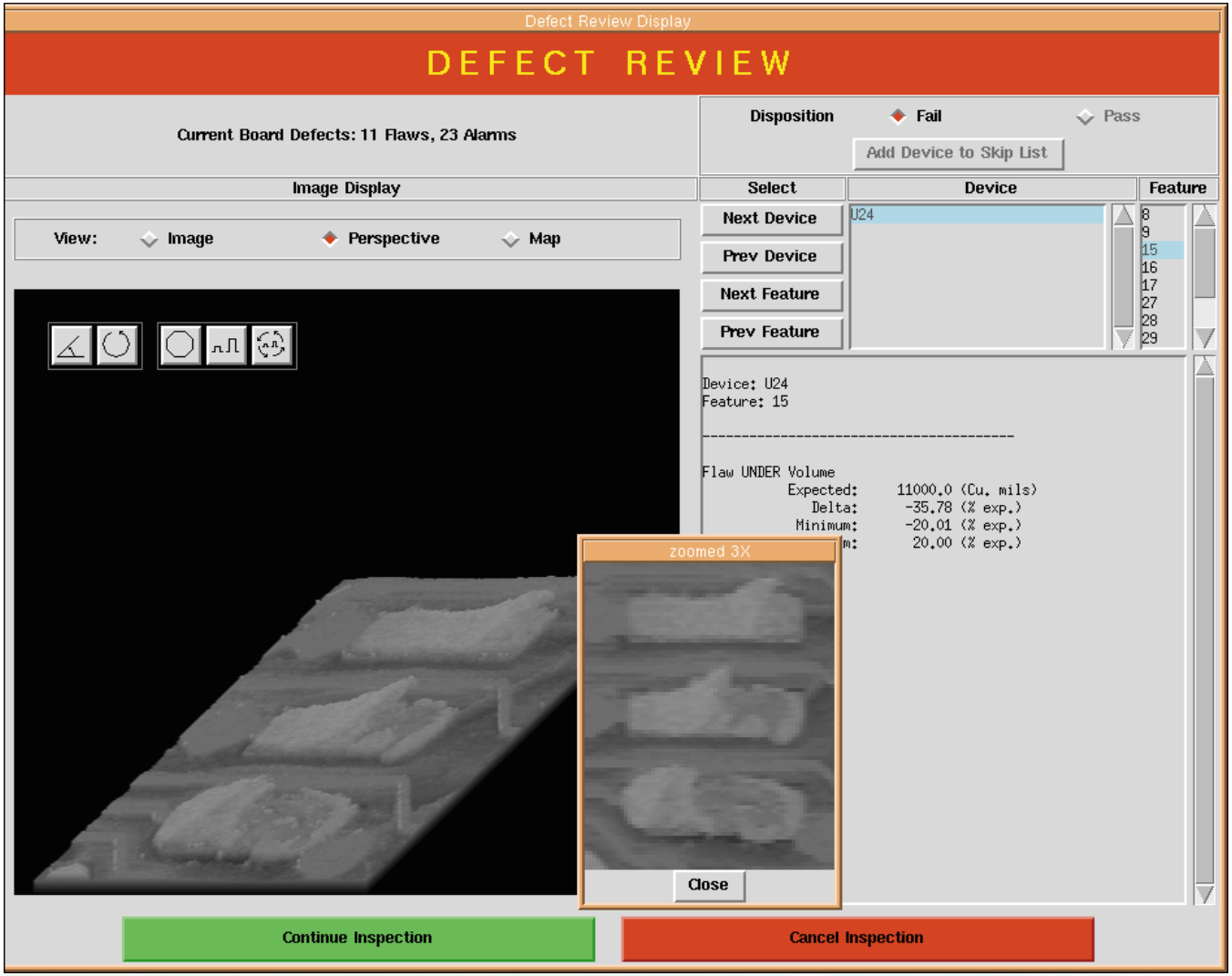


Benefits of 3D Method for CPI

- 3D systems rely upon package dimensions and shape which is inherently consistent.
- Results in programs that have low false accept/false reject rates and requires less program tweaking.
- Allows simpler, more robust algorithms and processing techniques to be used
- Same system capable of both SPI and CPI applications

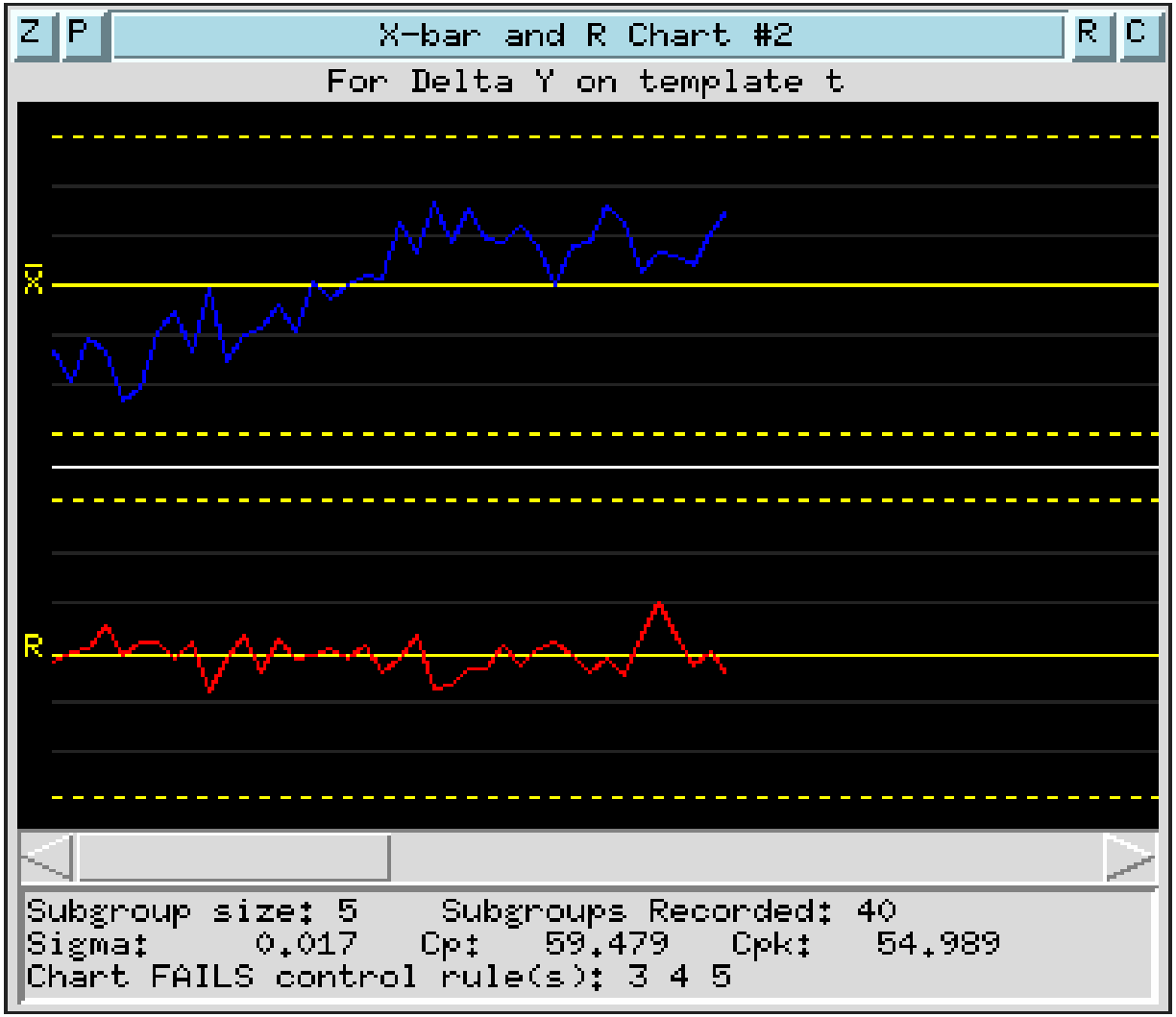
Defect Detection and SPC

Inspection Results: Defect Review

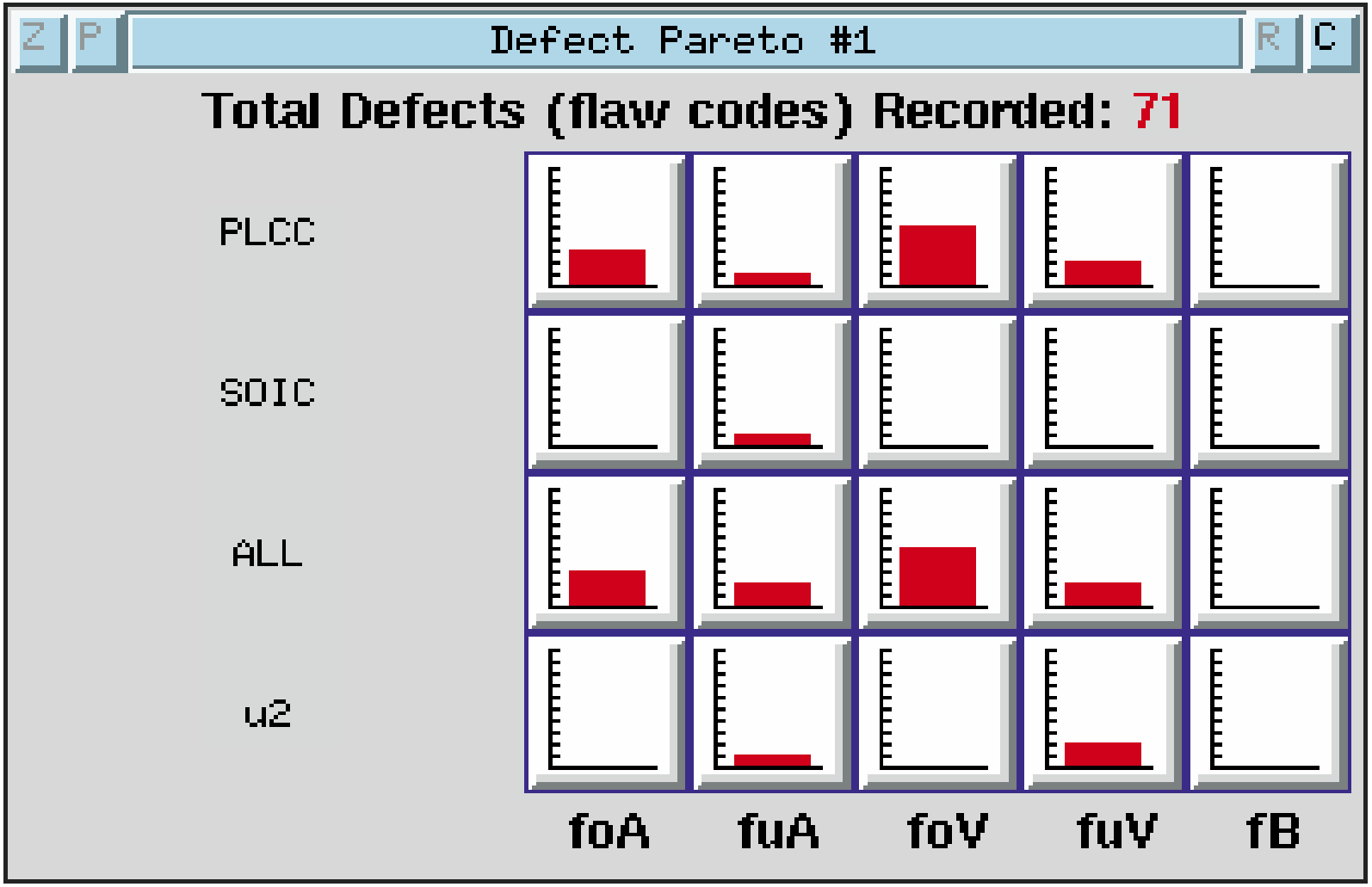


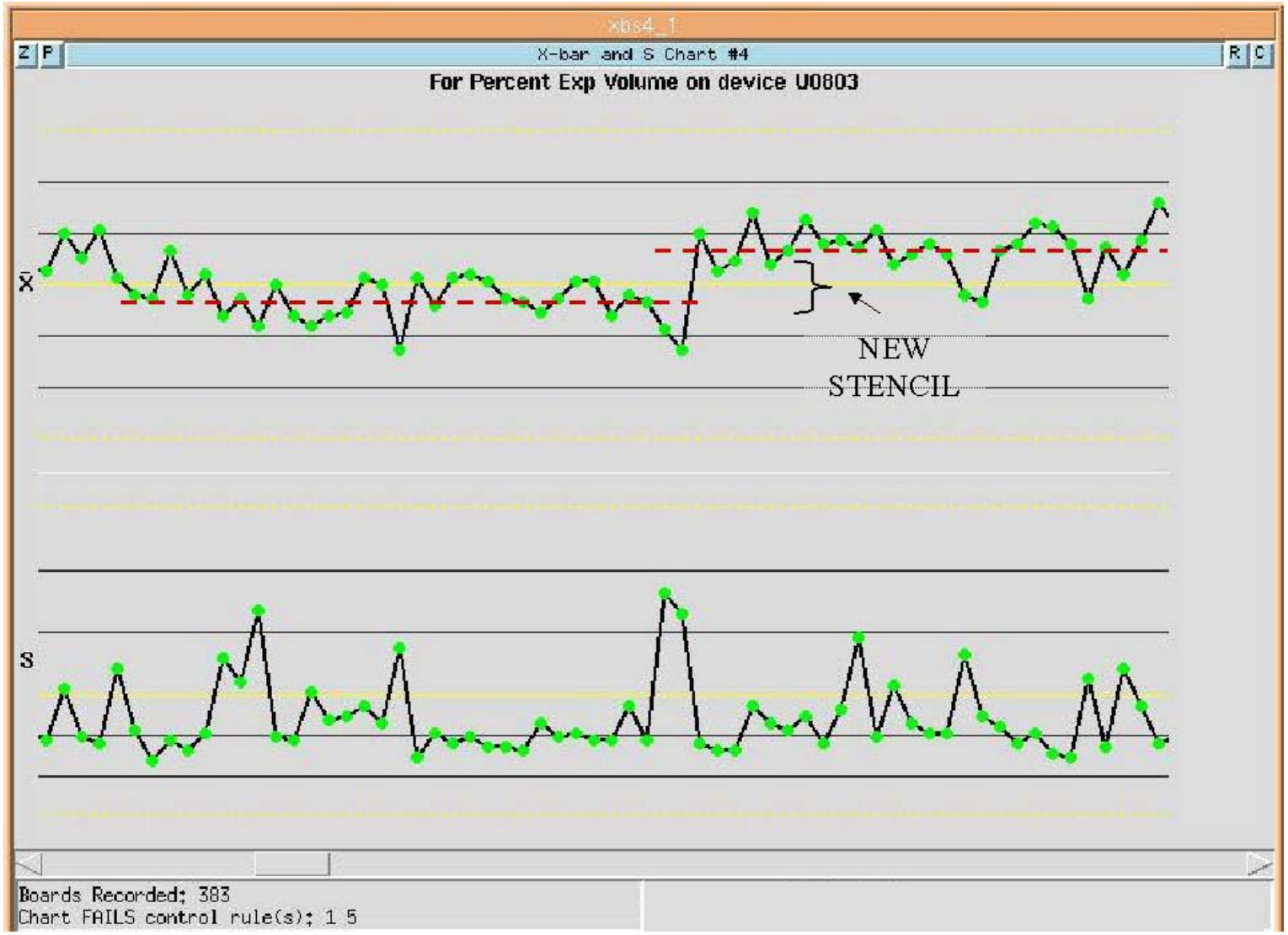
Inspection Results: Defect Review

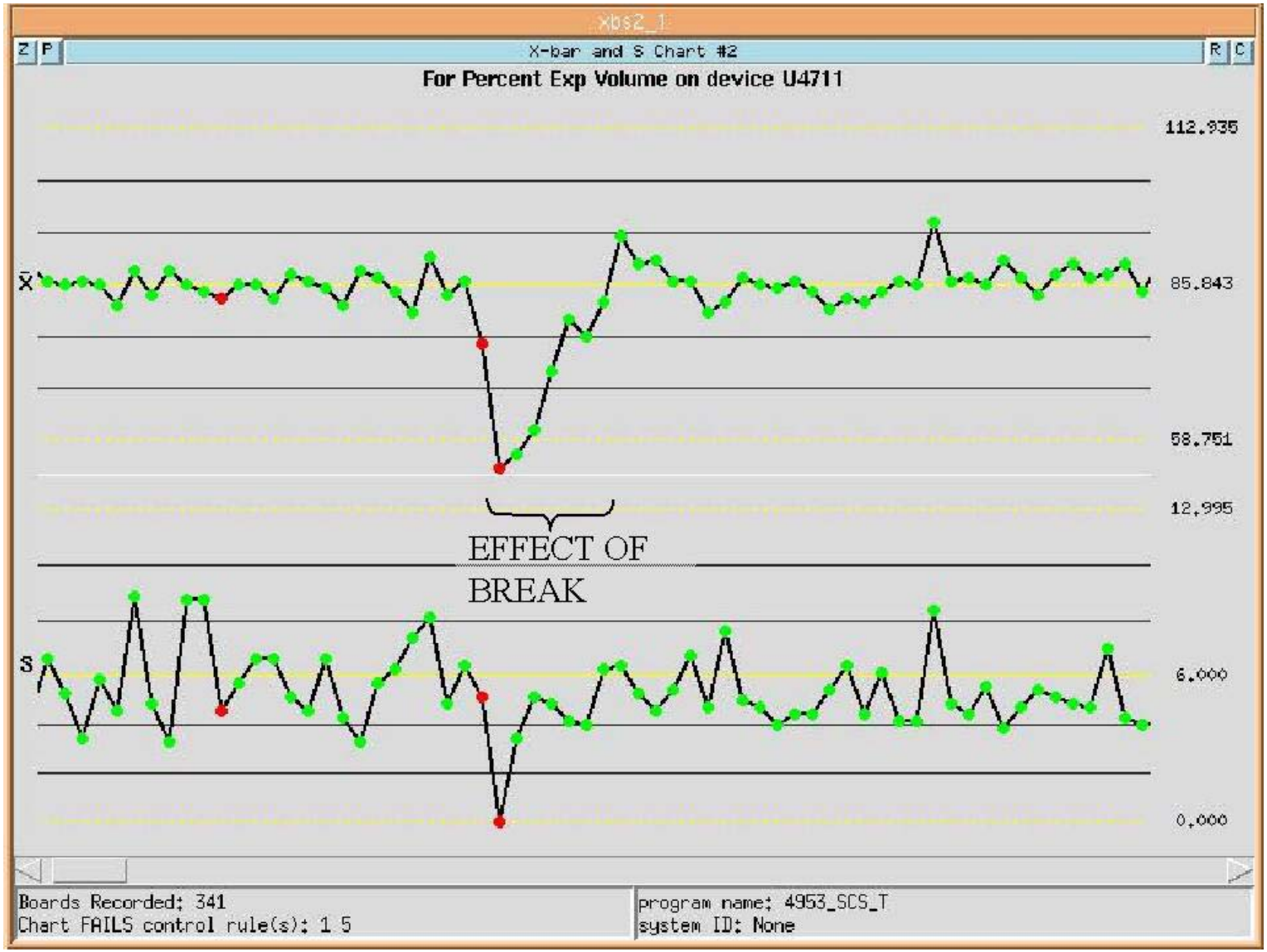
Inspection Results: SPC Charts



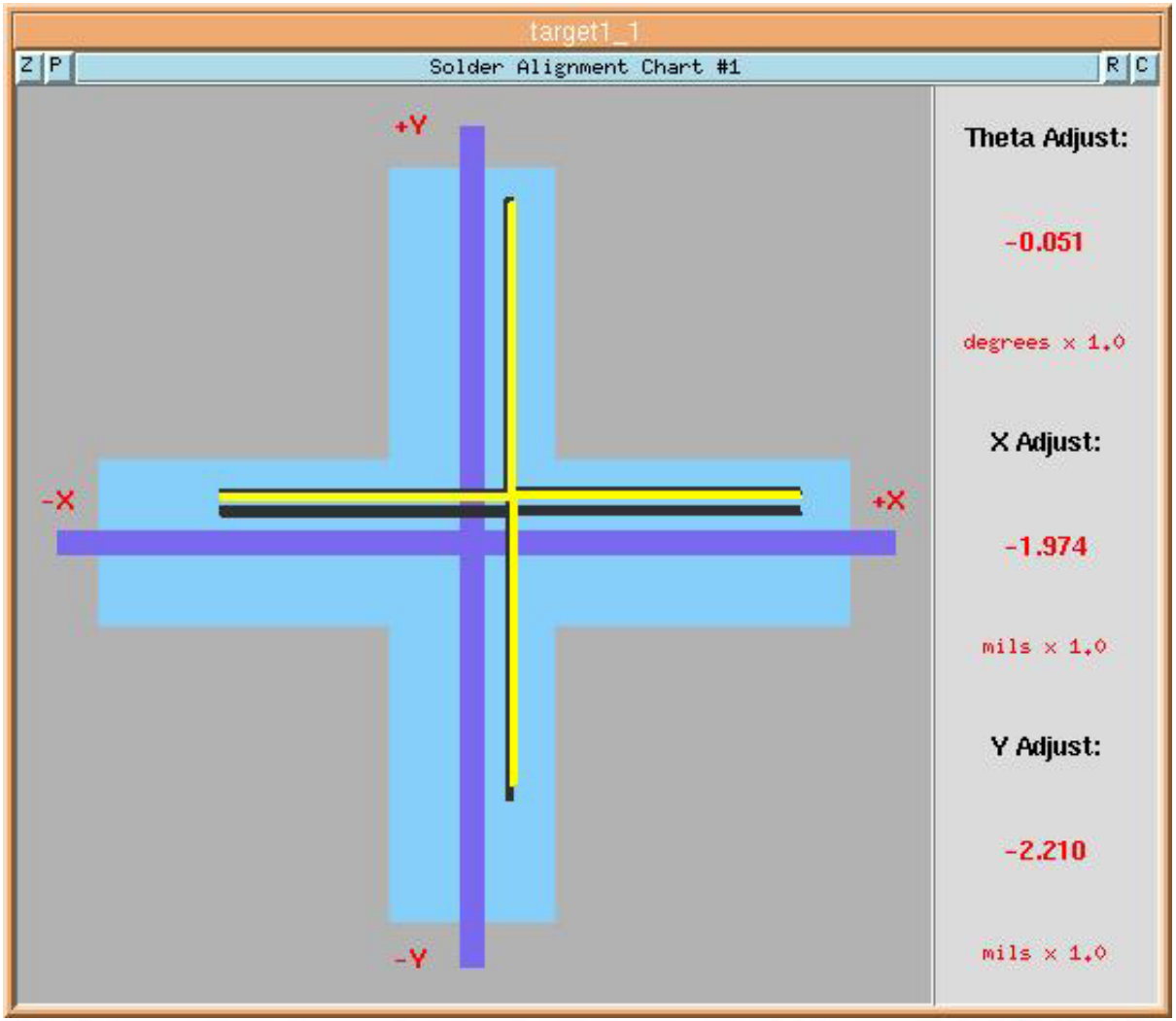
Inspection Results: SPC Charts




xbs4_1
Z P
X-bar and S Chart #4
R C
For Percent Exp Volume on device U0803
X̄
NEW
STENCIL
S
Boards Recorded: 383
Chart FAILS control rule(s): 1 5


Xbs2_1
Z
P
X-bar and S Chart #2
R
C
For Percent Exp Volume on device U4711
112.935
85.843
58.751
12.995
X̄
EFFECT OF
BREAK
S
6.000
0.000
Boards Recorded: 341
Chart FAILS control rule(s): 1 5
program name: 4953_SCS_T
system ID: None

Inspection Results: Solder Alignment Chart



Benefits of In-line 3-D AOI

- Identify defects where they originate, not at the end of the line, to reduce rework cost and provide faster corrective action
- Automated, real-time SPC helps identify and reduce process variation and determine process capability
- Process improvement is faster, easier with accurate, repeatable volumetric data