

LITH 145 Project Overview and Results

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LITH 145 Overview

Purpose

- Evaluate current reticle handling, shipping and storage methods to determine effects on plate contamination
 - benchmark reticle SMIF pod (RSP) storage and shipping capability
 - cross-section of reticle handlers currently in use

Method

- Utilize laser scattering inspection tools to measure plate contamination pre/post various handling, shipping and storage activities

Schedule

- Initiate project 3Q03
- Complete project 1Q04

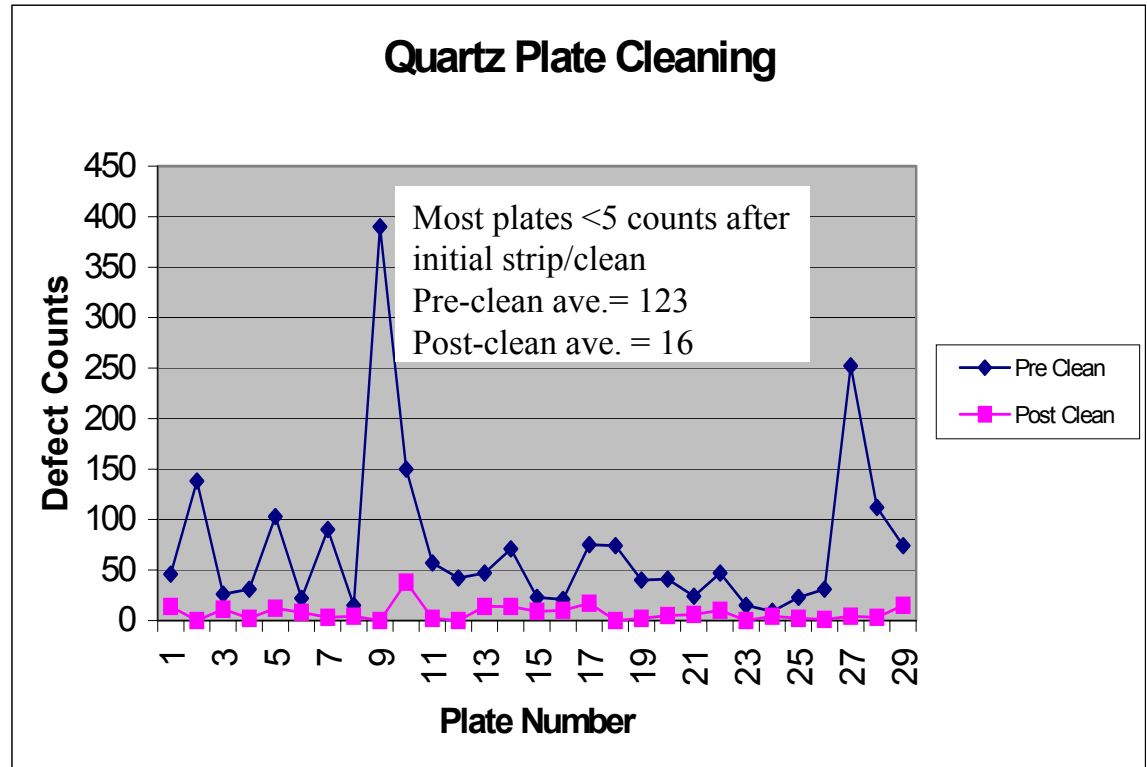
LITH 145 Activities

Activites

- Clean reticles and measure contamination
- Clean RSP's and pre-count particles (100nm sensitivity)
- Reticle shipment in RSP's and clamshells
- Limited cycling thru mask handling tools with pre/post measurement
- Limited testing of RSP rough handling and non-clean room storage
- Storage of reticles in RSP's and clamshells

Reticle Preparation

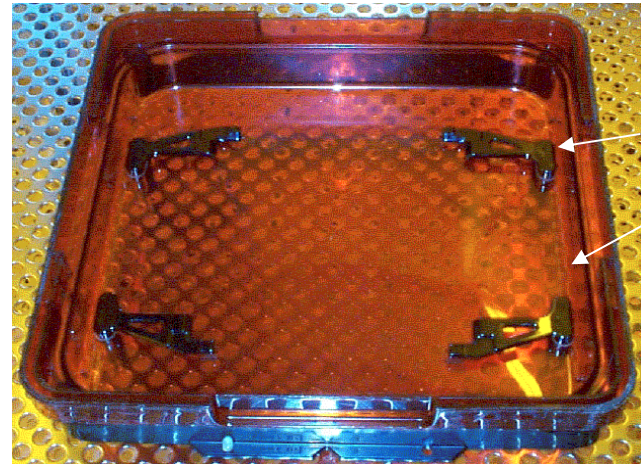
- Rejected COG mask blanks were used for all tests
- Films were stripped and quartz reticles cleaned
 - Single plate spray tool used with acid/peroxide
 - Only plates with counts less than 20 were used for testing



RSP Preparation

- RSP Cleaning/Inspection

- All RSP's were cleaned at the initiation of the project
- Bases were cleaned with dilute alcohol wipe down and vacuum wand of "O" rings and base surface, then base was inspected under UV light
- Base counts were 0-5 counts after cleaning
- Domes were submerged in DI/surfactant ultrasonic tank, rinsed and blown dry with hot filtered air
- Clean plates were stored in the RSP's for 2 wks prior to use
- RSP's were re-used without re-cleaning when plate counts were <20



RSP Top Showing Plate Hold-down Springs and "O" Ring Knife Edge

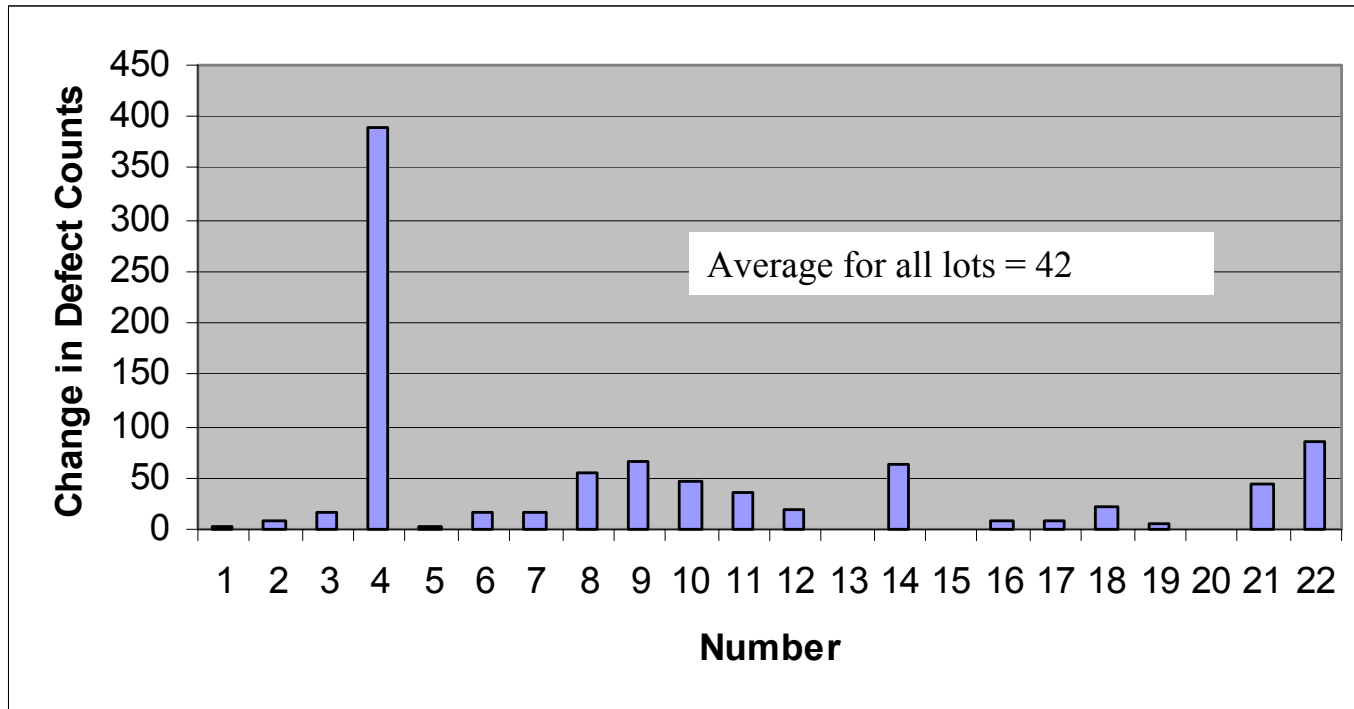


RSP Base Showing Plate Holder Posts "O" Ring and Filters

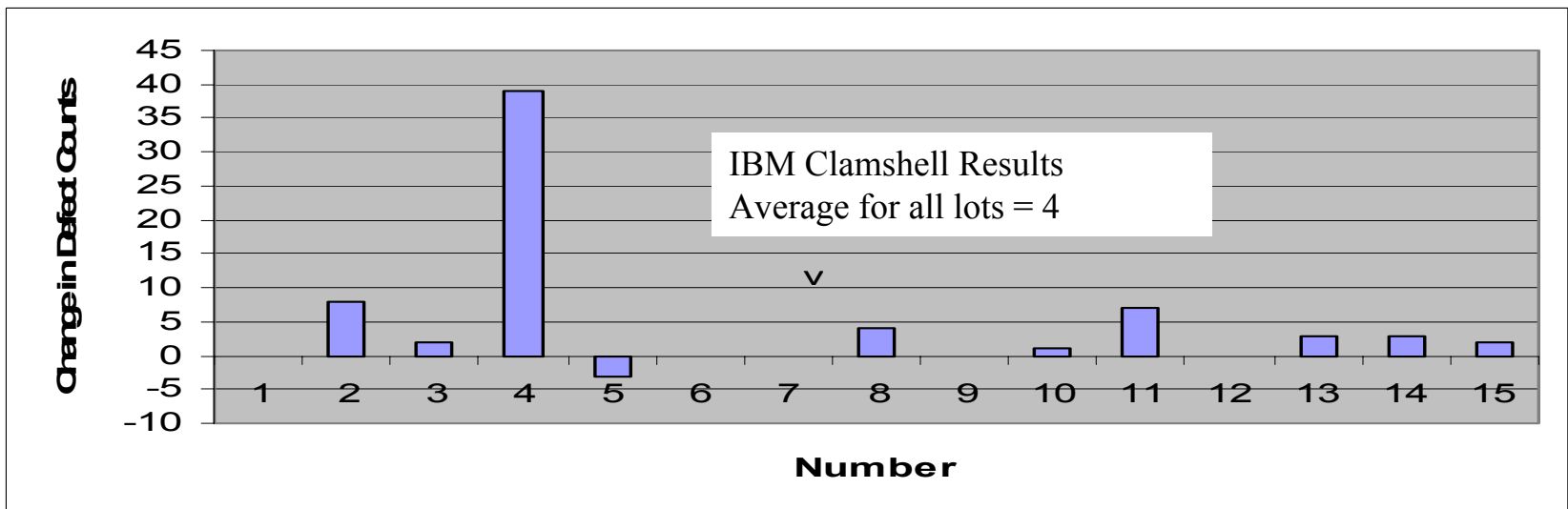
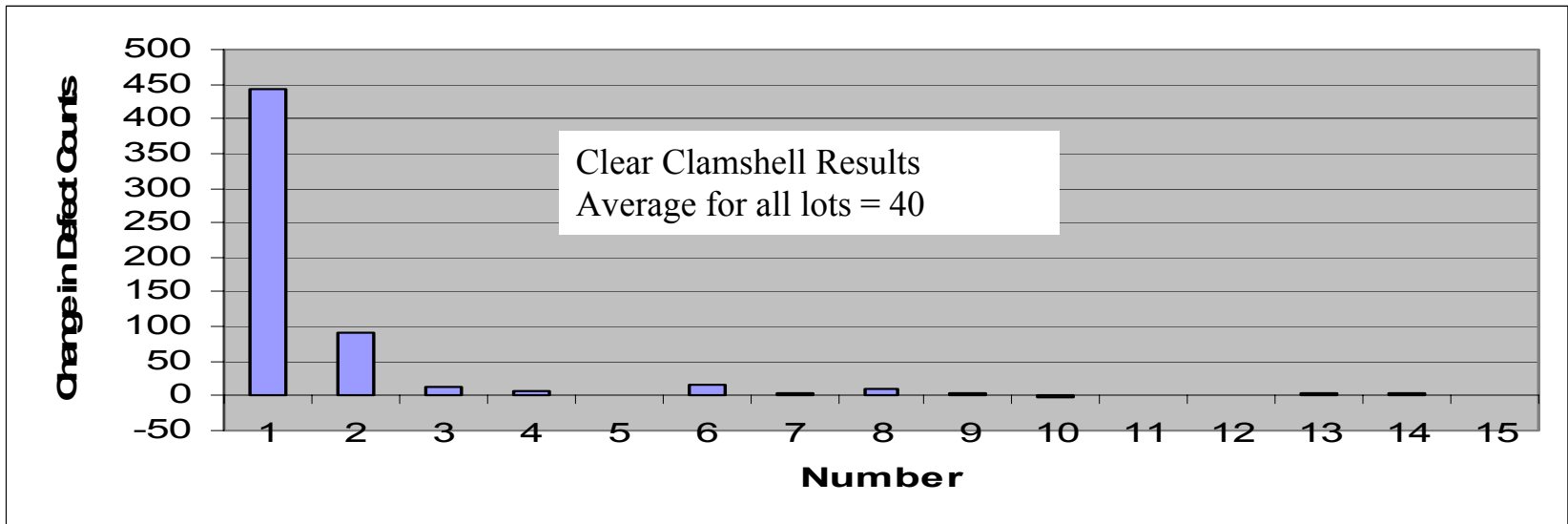
Shipping Tests

- Reticles were pre-measured and placed in RSP's or clamshells
 - Only plates with <20 counts were used
- Reticles were shipped round trip in RSP's, then re-inspected
 - East coast to Austin, TX
 - palletized large boxes with eight RSP/reticles, plus 1 plate in clear clamshell and 1 in blue IBM clamshell
 - small boxes with four RSP/reticles, plus 1 plate in clear clamshell and 1 in blue IBM clamshell

Small Box Shipment RSP Results – All Lots



Small Box Shipment Clamshell Results – All Lots



Lot 4 - Large Box Shipment



Pre shipment at IBM dock



Post-shipment at ISMT dock

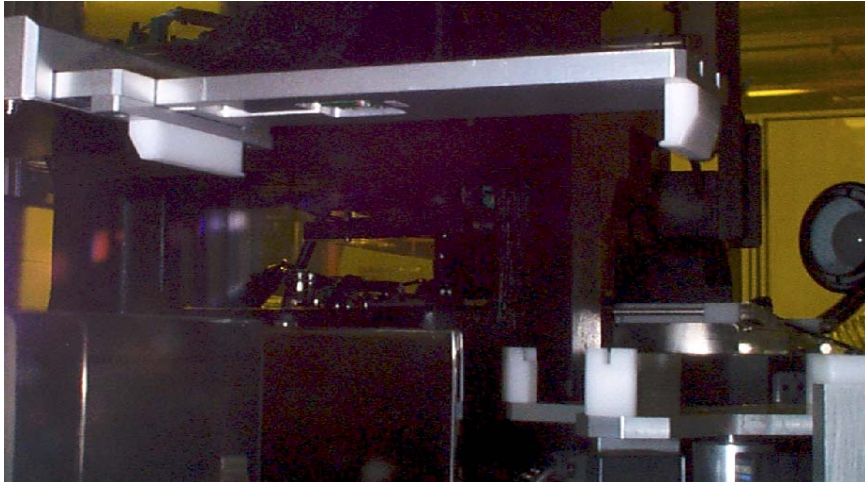
Reticle Handling Tests

- A variety of grippers and end effectors were tested using 4 mask processing tools
 - Tool 1 = Automated laser inspection system
 - Tool 2 = Reticle flipping and orienting system
 - Tool 3 = Cassette to RSP transfer system
 - Tool 4 = Wet etch system
 - Tool 5 = Manual RSP opener
- Reticles were placed in clean RSP and pre-inspected
- RSP's were opened automatically and reticles were removed from the RSP's with end effector or gripper
- Reticles were manipulated with tool grippers and end effectors and replaced in RSP's
- Number of events was tool and gripper dependent

Tool 1 (Laser Inspection) Reticle Handling (50 cycles)

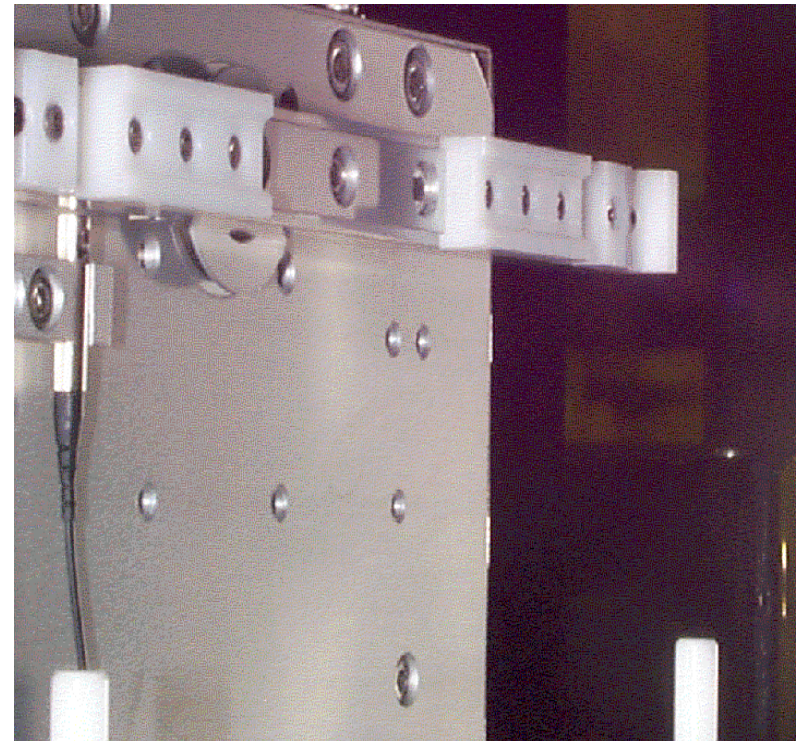
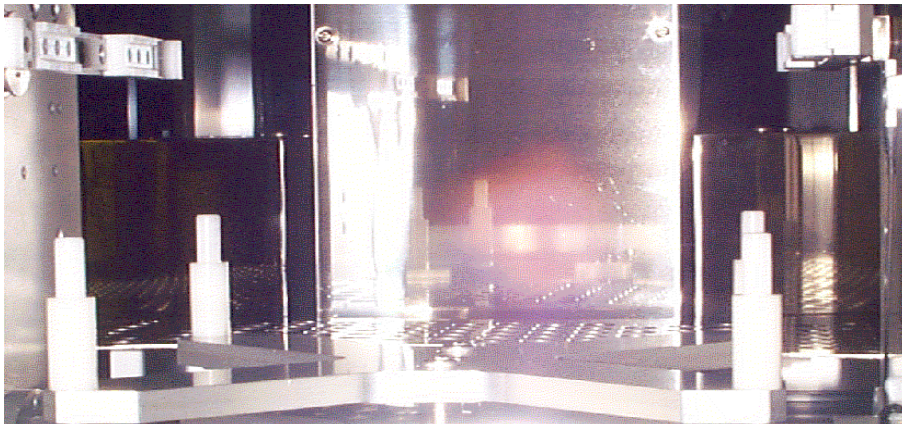
- RSP opens automatically
- Main gripper picks up reticle in RSP and places on flipper posts
- Flipper gripper picks up reticle, turns it over and replaces on flipper posts
- Main gripper picks reticle from flipper posts and returns it to RSP
- RSP closes automatically
- Number of contact events
 - Main gripper (2x) = 100 events
 - Flipper posts (1x each side) = 50 events/side
 - Flipper gripper (1x) = 50 events
 - RSP posts (1x each side) = 50 events/side
 - RSP open/close cycles (1x) = 50 events

Tool 1 Grippers



Main Gripper

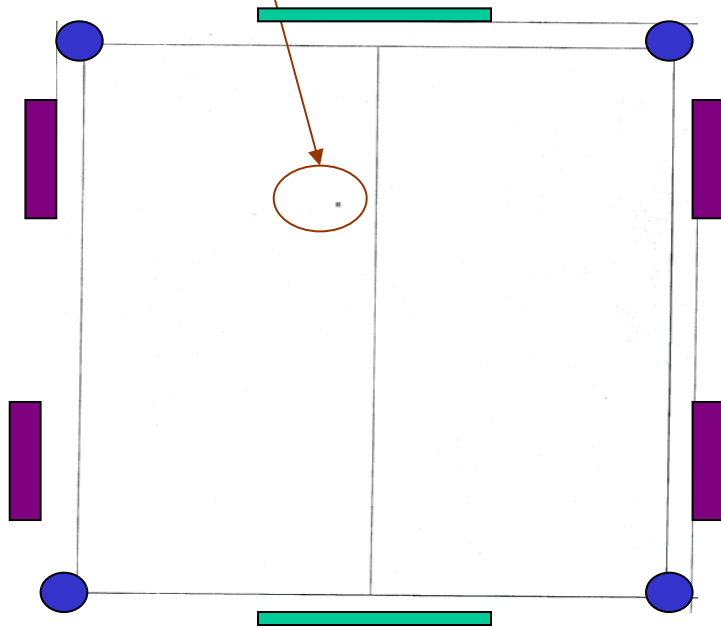
Flipper Gripper and Posts



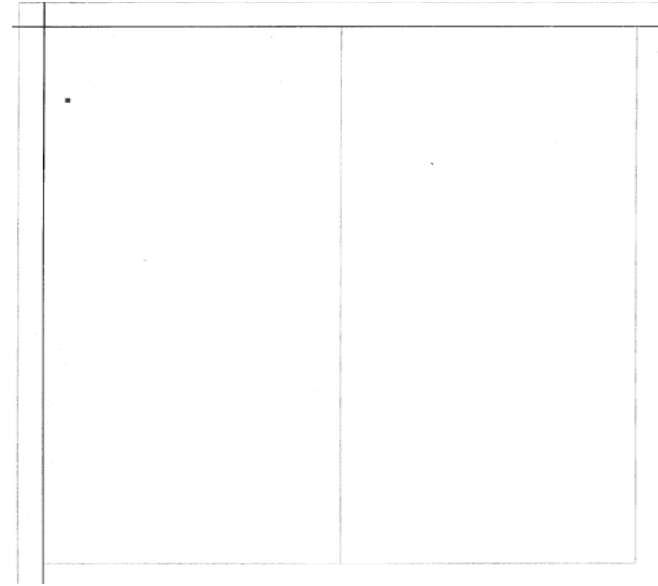
Close-up of Flipper Gripper and Posts

Tool 1 Handling Results From Inspection Tool #1

False Defect






Pre Handling



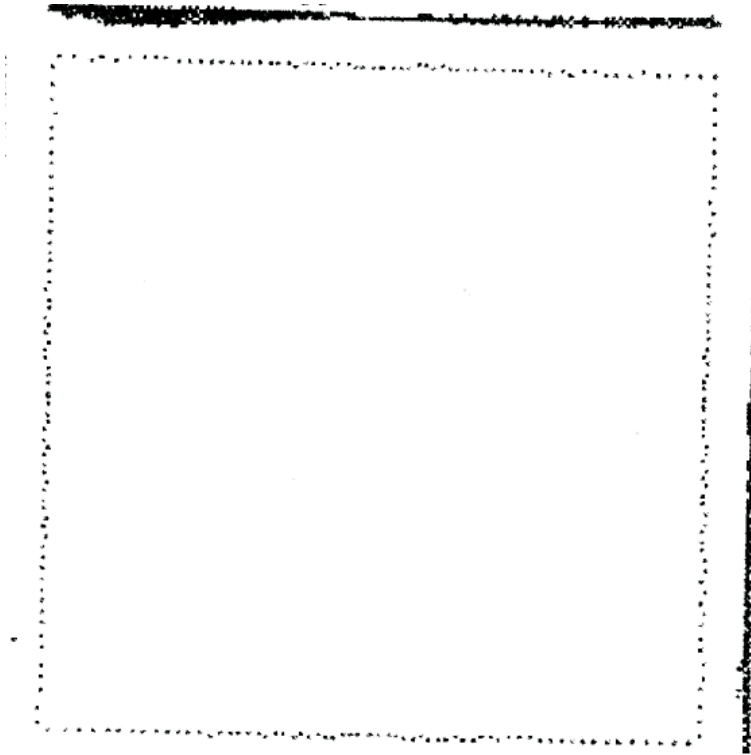
Post Handling

Defect increase = 1

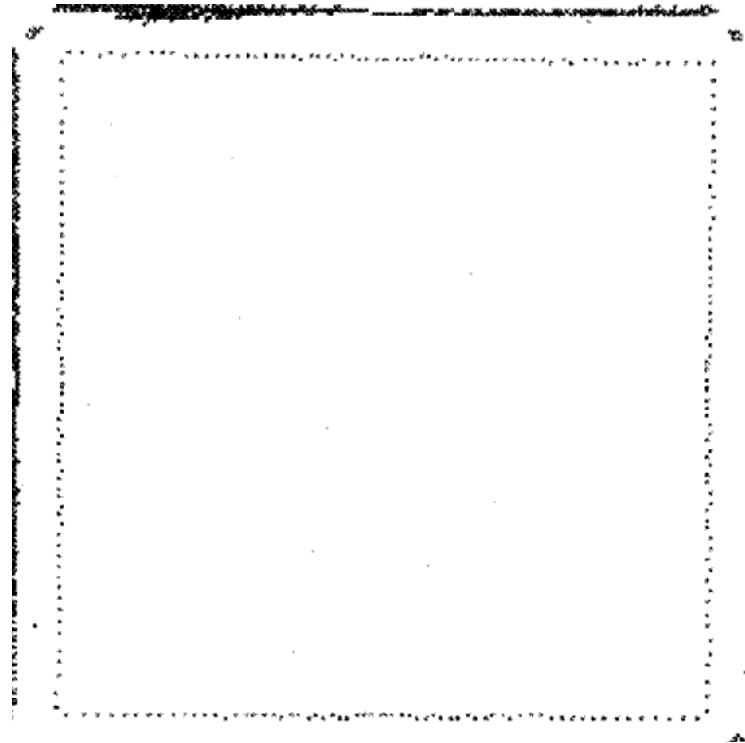
No gripper patterns visible!

-  = Main gripper contacts plates edges (100 events)
-  = Flipper gripper contacts plate edges (50 events)
-  = Flipper posts contact frontside and backside at corners (50 events/side)
- RSP posts (50 events)
- RSP open/close (50 events)

Tool 1 Handling Results – Inspection Tool #2



Pre Handling

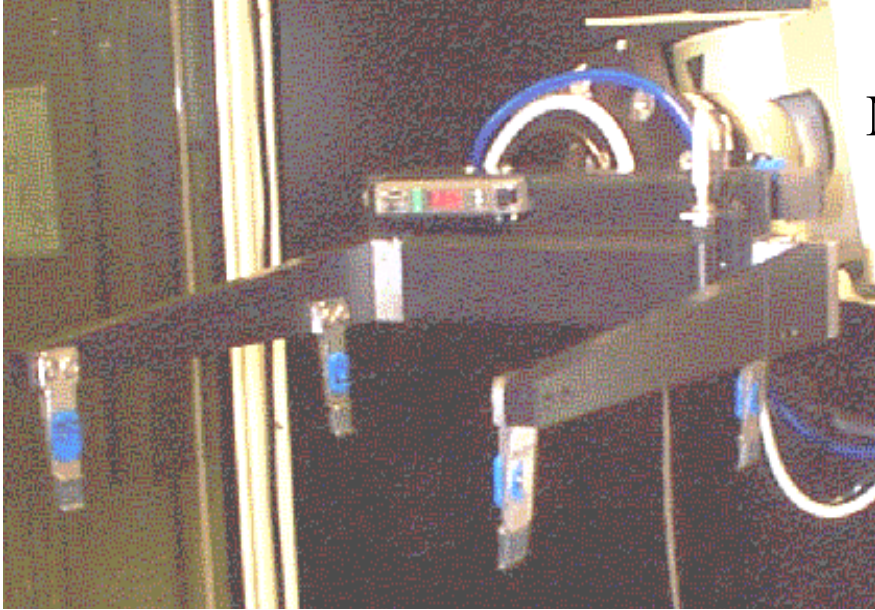


Post
Handling
No gripper patterns visible!

Tool 2 (Reticle Flipper) Reticle Handling (33 cycles)

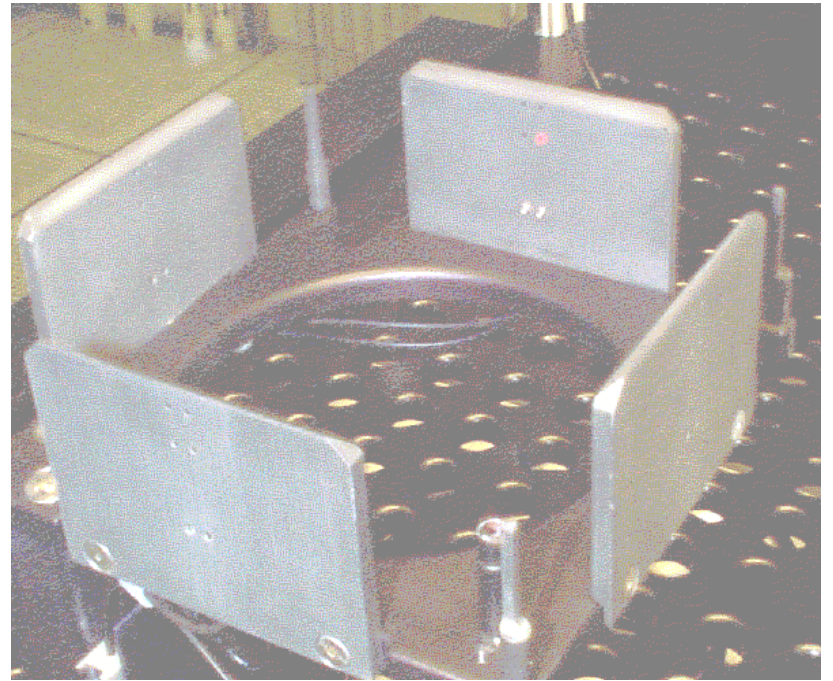
- RSP opens automatically
- Main gripper picks up reticle in RSP and moves to check station posts
- Main gripper picks reticle from check station posts and returns it to RSP
- RSP closes automatically
- Number of contact events
 - Main gripper (3x) = 99 events
 - Check station posts (1x each side) = 33 events/side
 - RSP posts (1x each side) = 33 events/side
 - RSP open/close cycles = 1x

Tool 2 – Handler Composite



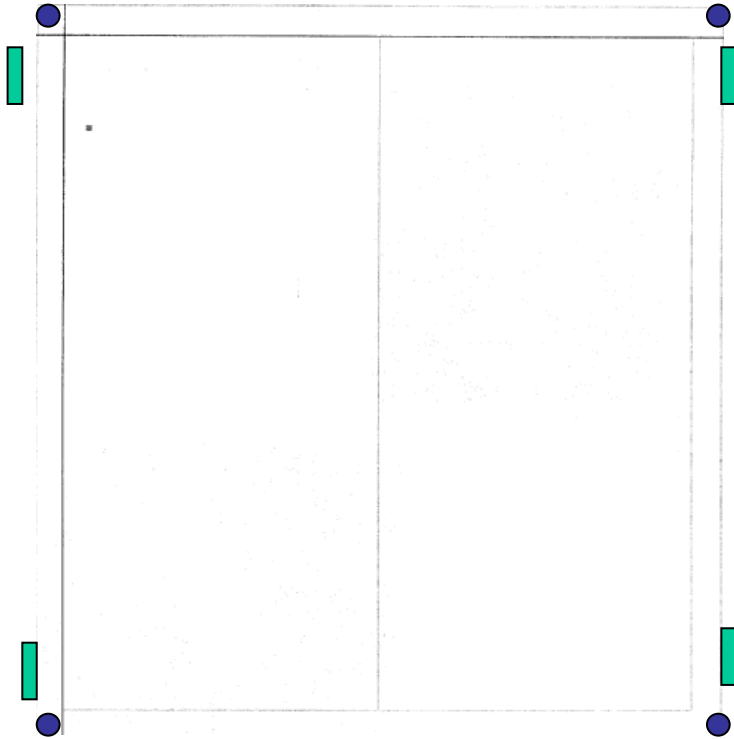
Main Gripper

Check Station Posts





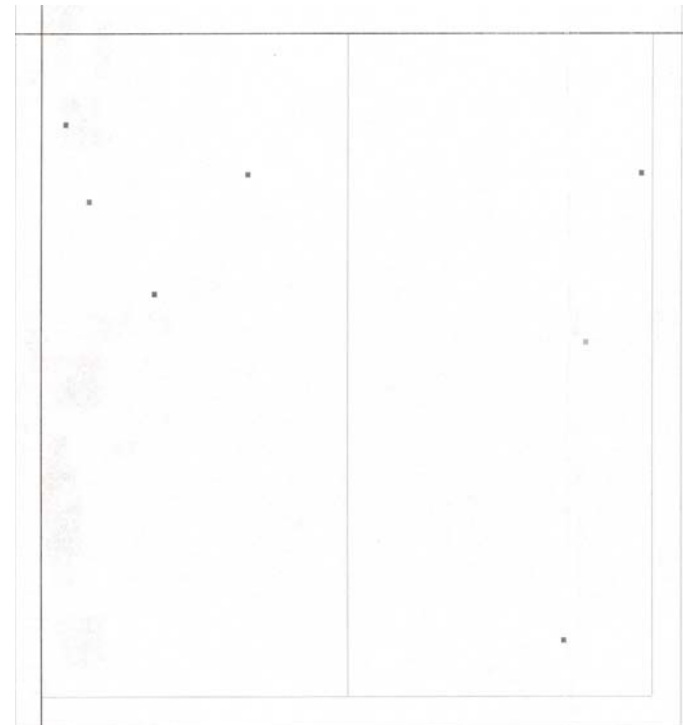
Tool 2 Handling Results – Inspection Tool #1

Run 1



Pre Handling

-  = Main gripper contacts plates edges (99 events)
-  = Check station posts contact front side and back side at corners (33 events/side)
RSP posts (33 events)
RSP open/close (33 events)

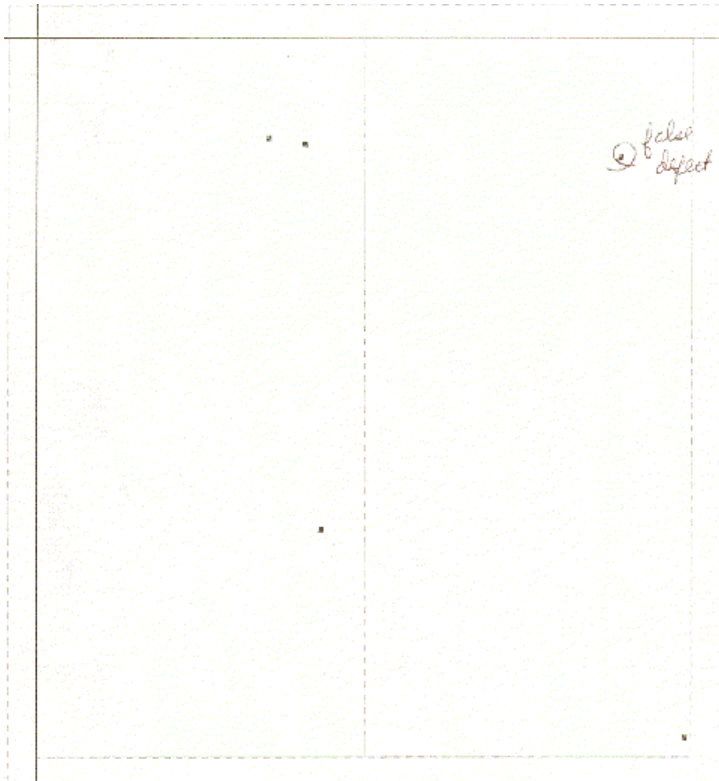


Post Handling

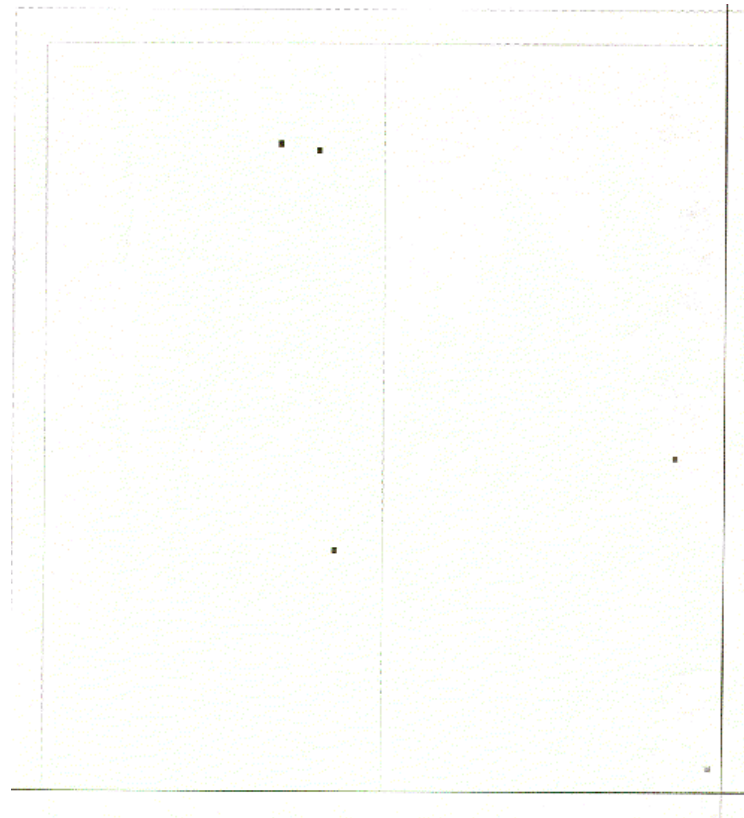
Defect increase = 6
No gripper patterns visible!
Tool cleaned and re-tested

Tool 2 Handling Results – Inspection Tool #1

Run 2



Pre Handling



Post Handling

After tool cleaning defect increase = 1
No gripper patterns visible!

Tool 3 (Box to RSP Transfer) Reticle Handling (100 cycles)

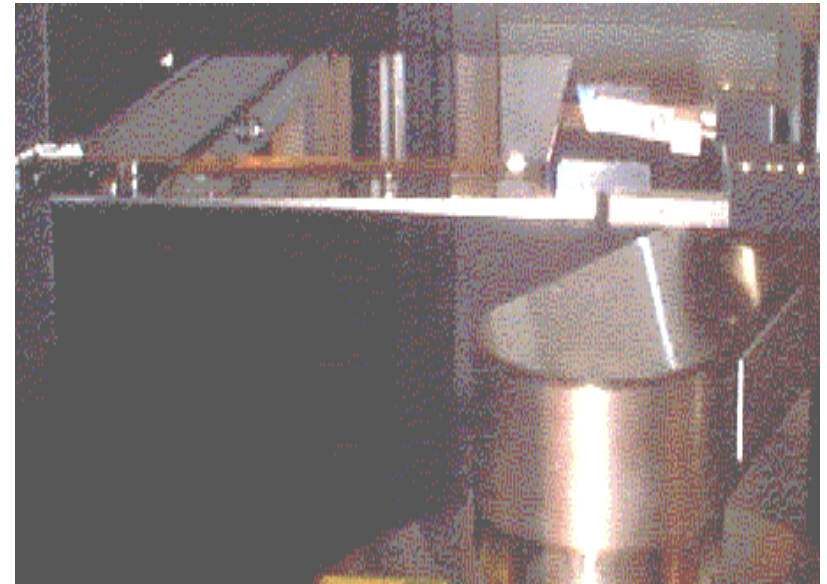
- RSP opens automatically
- End effector picks up reticle in RSP and moves it into tool
- End effector returns reticle to RSP
- RSP closes automatically
- Number of contact events
 - End effector (1x) = 100 events
 - RSP posts (2x bottom only) = 200 events/bottom
 - RSP open/close cycles (1x) = 100 events

Tool 3 - Handler Composite

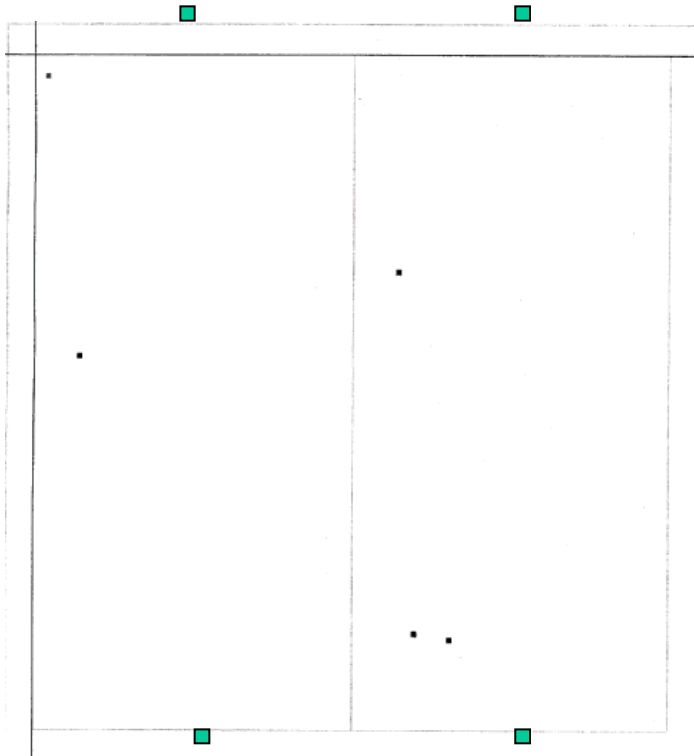


End Effector

End Effector With Plate

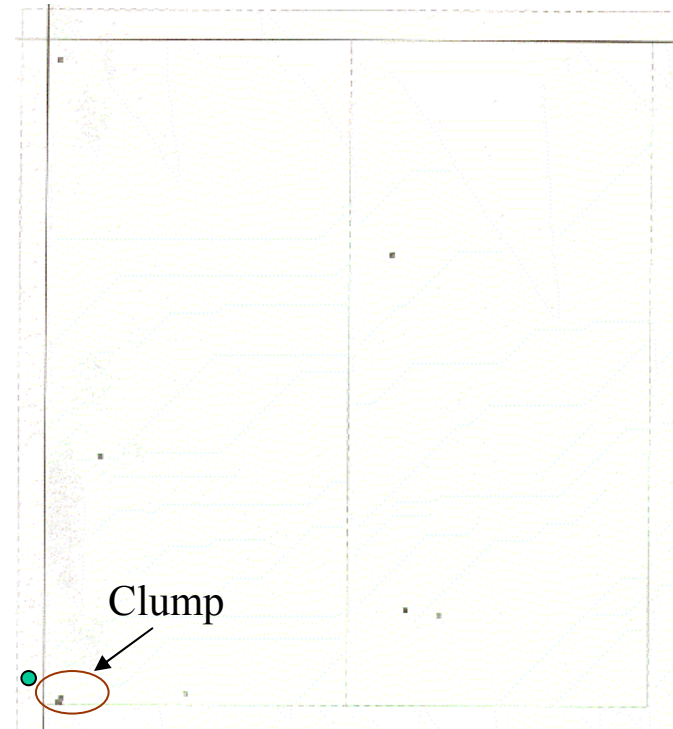


Tool 3 Handling Results – Inspection Tool #1



Pre Handling

- = End effector contacts plate back side bevelled edges (100 contact events)
- RSP posts (200 events)
- RSP open/close (100 events)



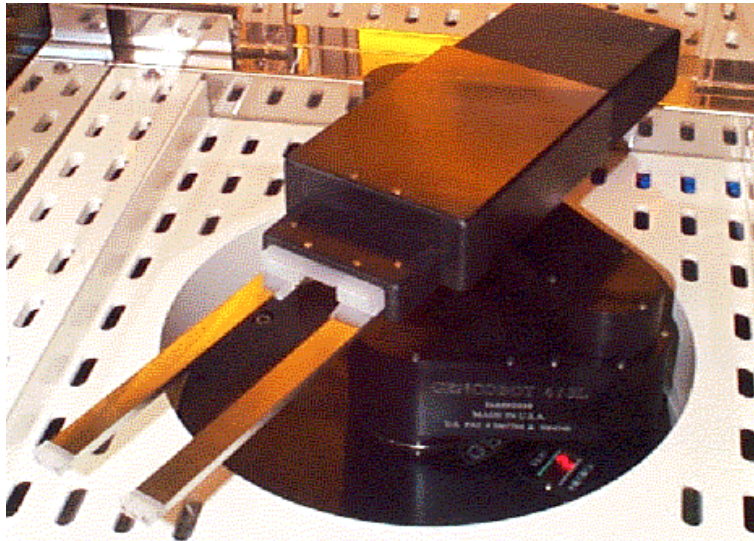
Post Handling

Defect increase = 6 (1 clump)
No gripper patterns visible!

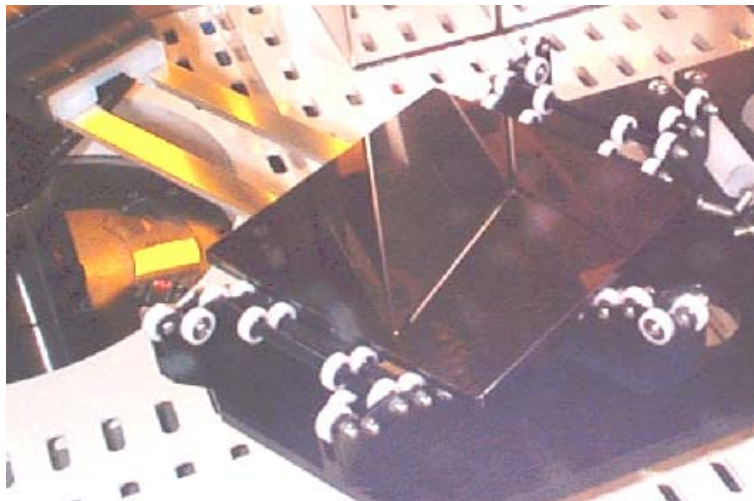
Tool 4 (Wet Etch) Reticle Handling (33 cycles)

- RSP opens automatically
- End effector picks up reticle in RSP and places on check station rollers
- End effector picks up reticle from roller check station and places on spinner posts
- End effector picks reticle from spinner posts and returns it to RSP
- RSP closes automatically
- Number of contact events
 - End effector (3x) = 99 events
 - Check station rollers (1x) = 33 events
 - Spinner posts (1x) = 33 events
 - RSP posts (2x bottom only) = 66 events
 - RSP open/close cycles (1x) = 33 events

Tool 4 - Handler Composite

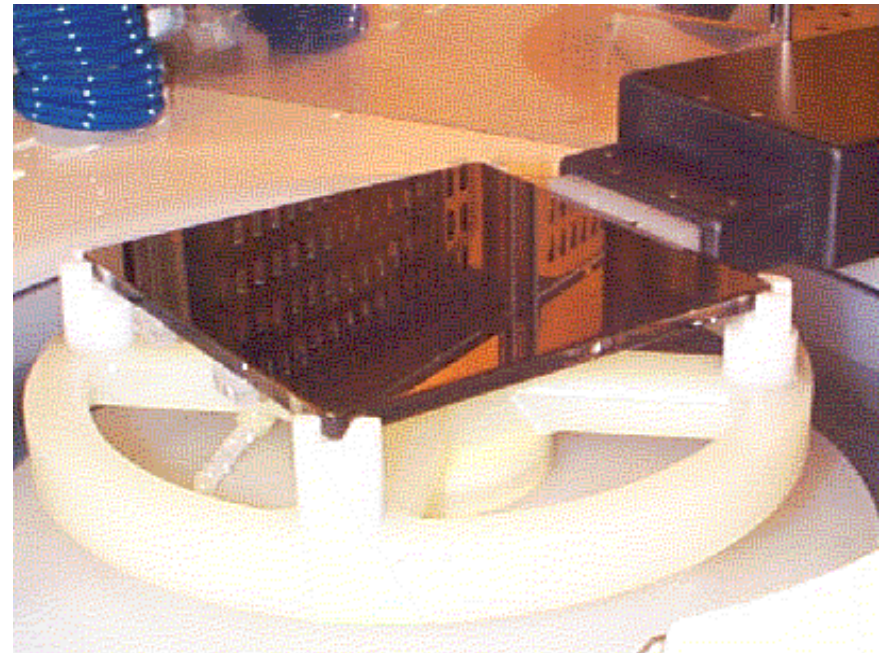


End Effector

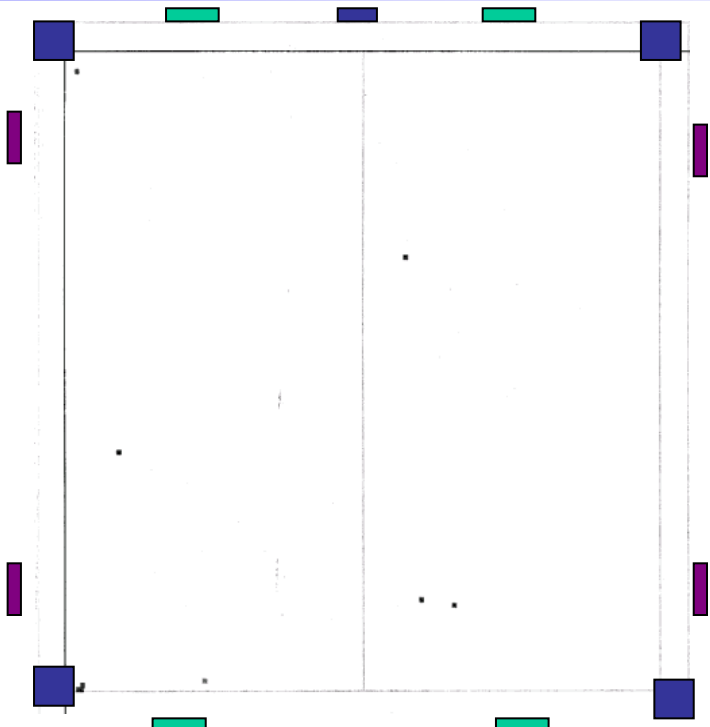


Check Station Rollers With Reticle




Spinner Posts With Reticle

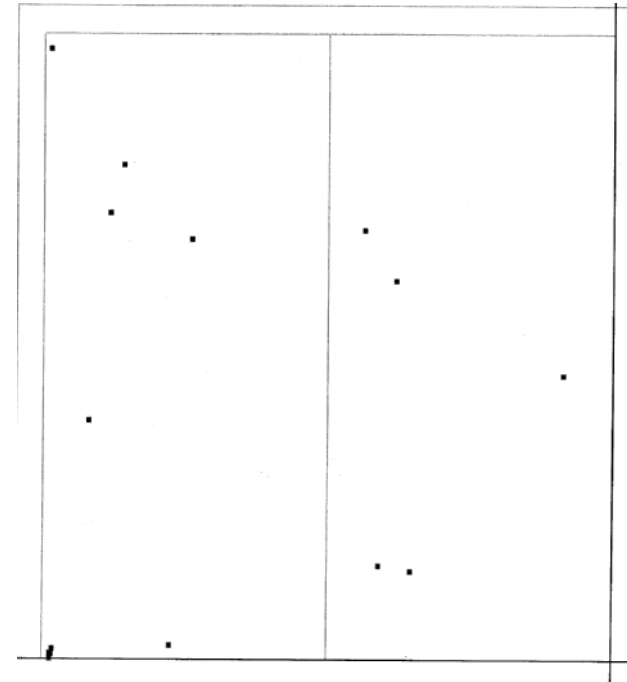


Tool 4 Handling Results



Pre Handling

-  = Main end effector contacts plate back side (99 contact events)
-  = Rollers contact plate edges (33 contact events)
-  = Spinner posts contact corner edges and back side (33 contact events)
- RSP posts (66 events)
- RSP open/close (33 events)

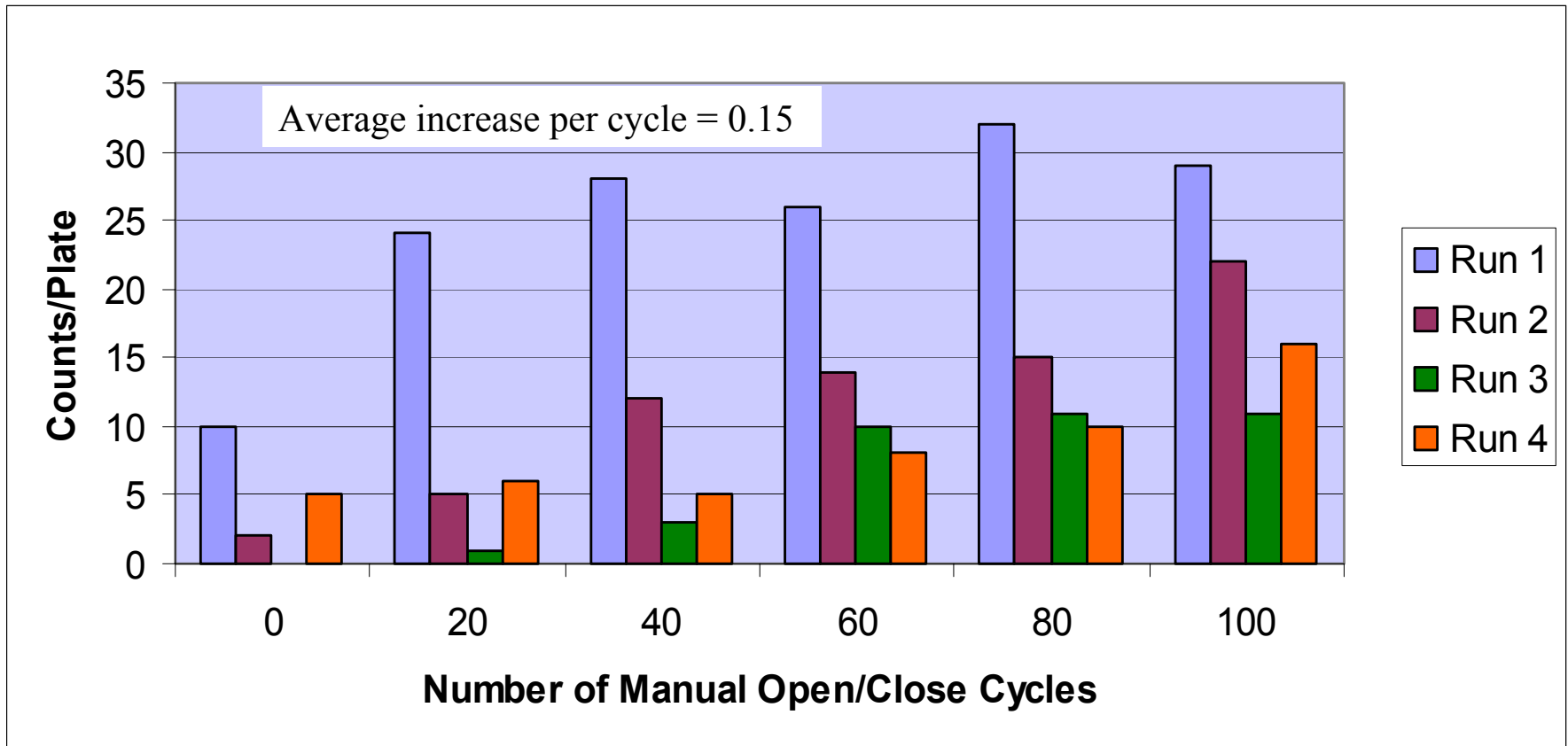


Post Handling

Defect increase = 5
No gripper patterns visible!

Tool 5 (Manual RSP Opener) (100 cycles)

- Reticle defects measured and reticle placed in RSP
- RSP opened and closed manually with re-inspection after every 20 openings

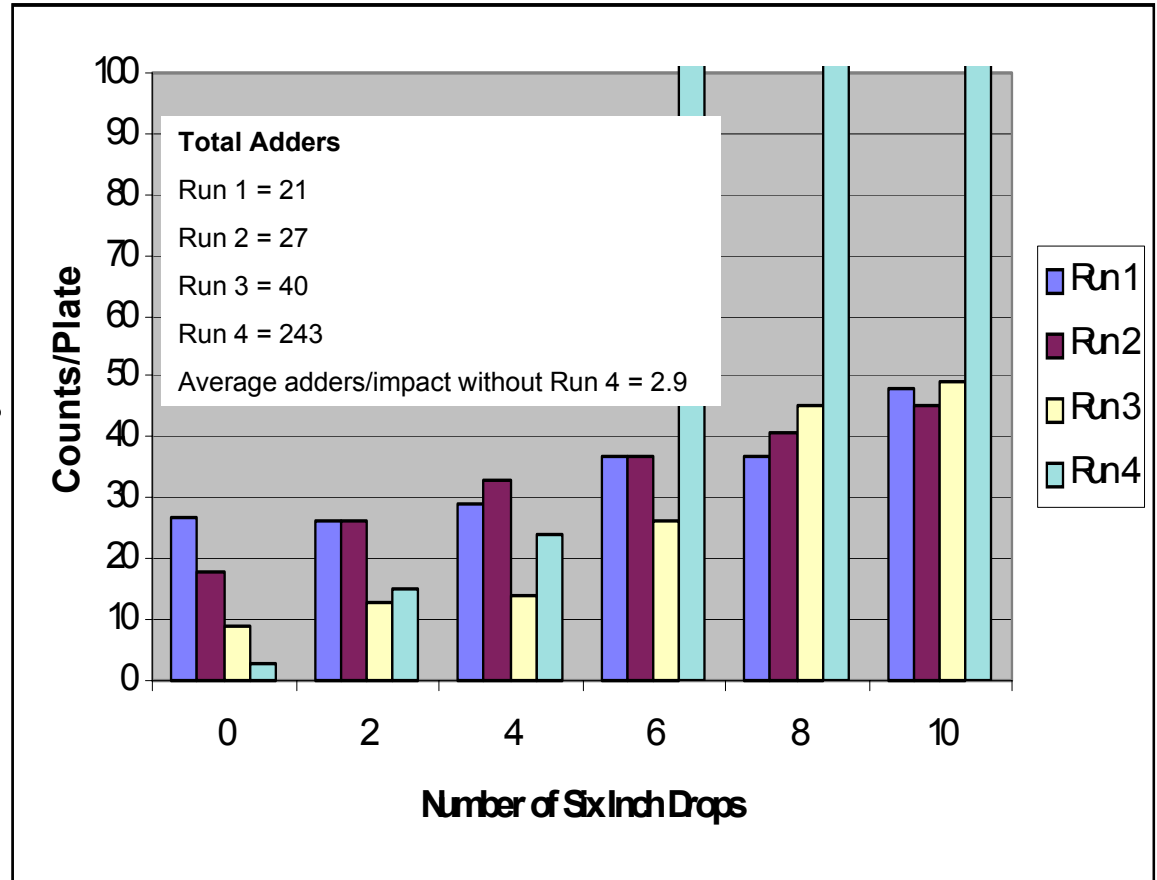


Rough Handling Tests

- Several types of rough handling testing were completed to evaluate RSP protection of plates including:
 - Base impact testing
 - Side impact testing
 - Top impact testing
 - Storage outside clean room

RSP Base Impact Test

- Reticle defects measured and reticle placed in RSP
- RSP dropped 6 inches to cleanroom table 2 times
- Reticle defects measured and above repeated
- Data indicates that RSP's do not effectively protect during dropping



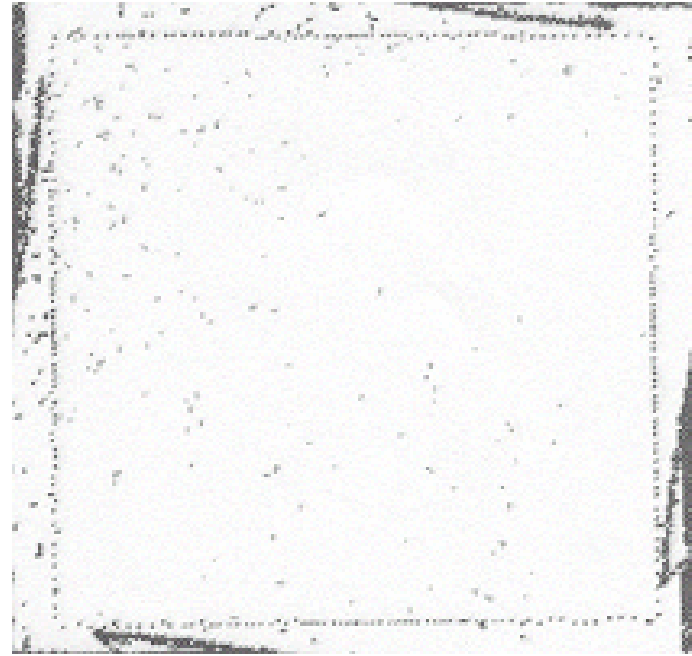
Defect Patterns After Base Impact Test

Run

2



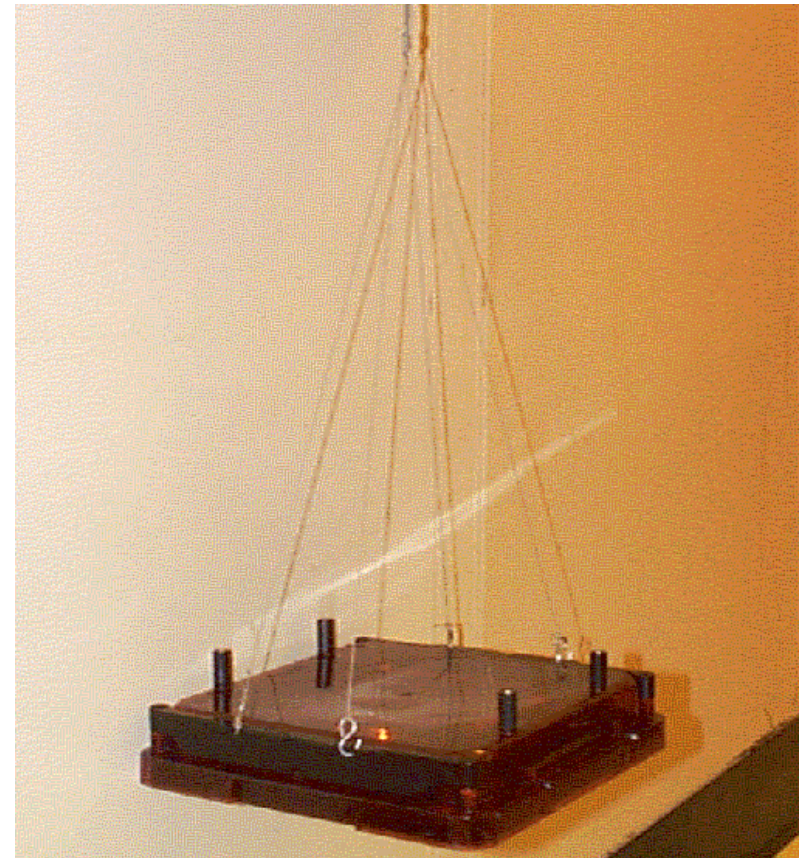
Run 4



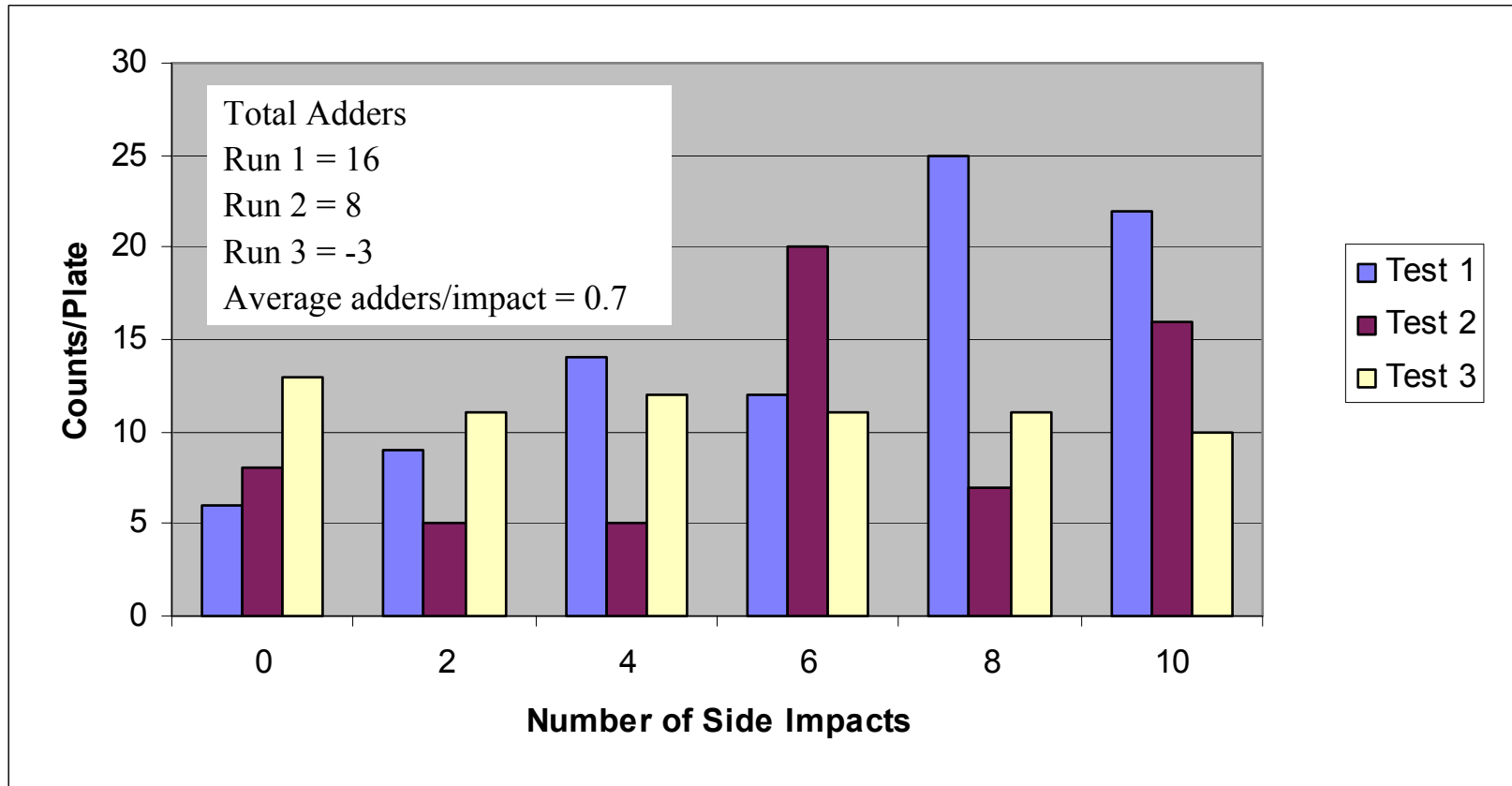
Defect pattern does not indicate source (such as reticle holder posts)

RSP Side Impact Test

- Reticle defects measured and reticle placed in RSP
- RSP suspended and allowed to swing 12 inches into wall
 - RSP rotated 90° and swing repeated
- Reticle defects measured and above repeated



RSP Side Impact Test Results

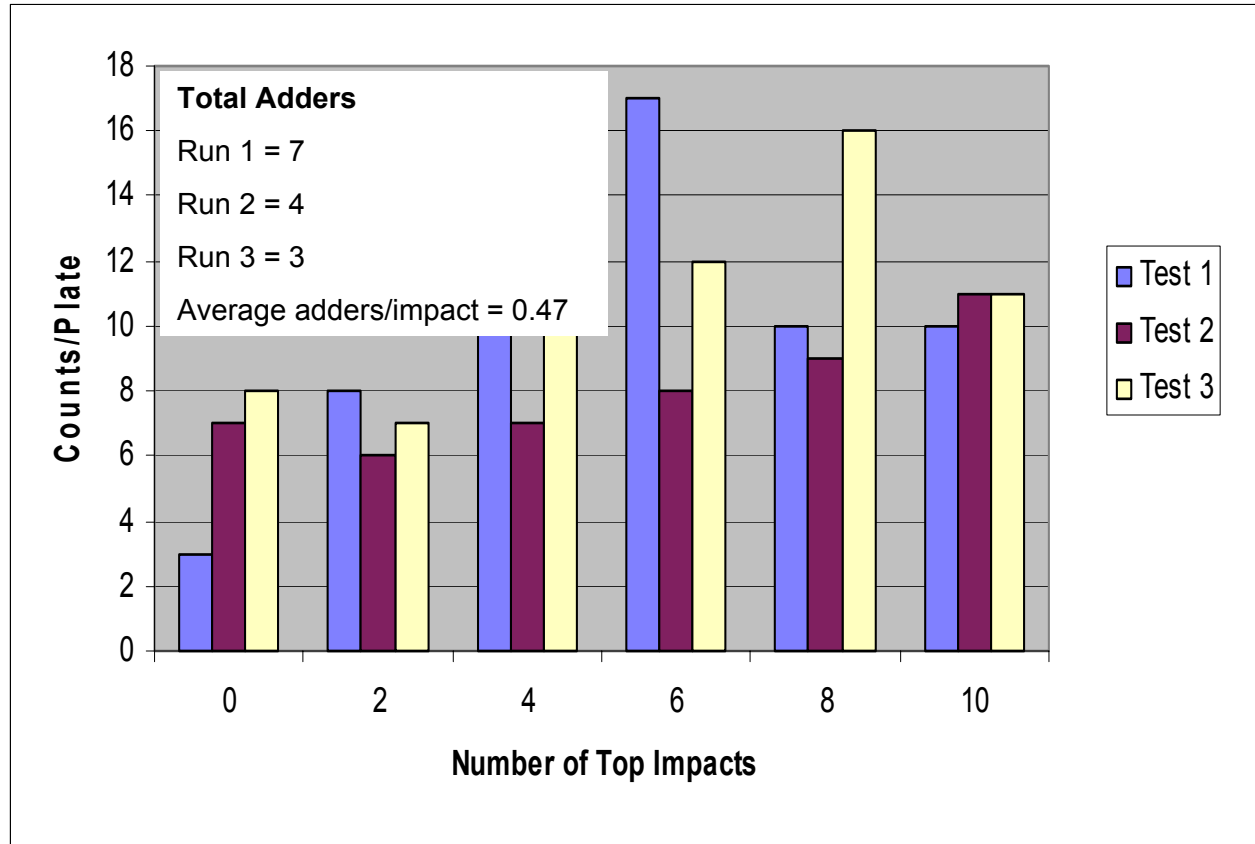


Side impacts appear to be less catastrophic than base impacts

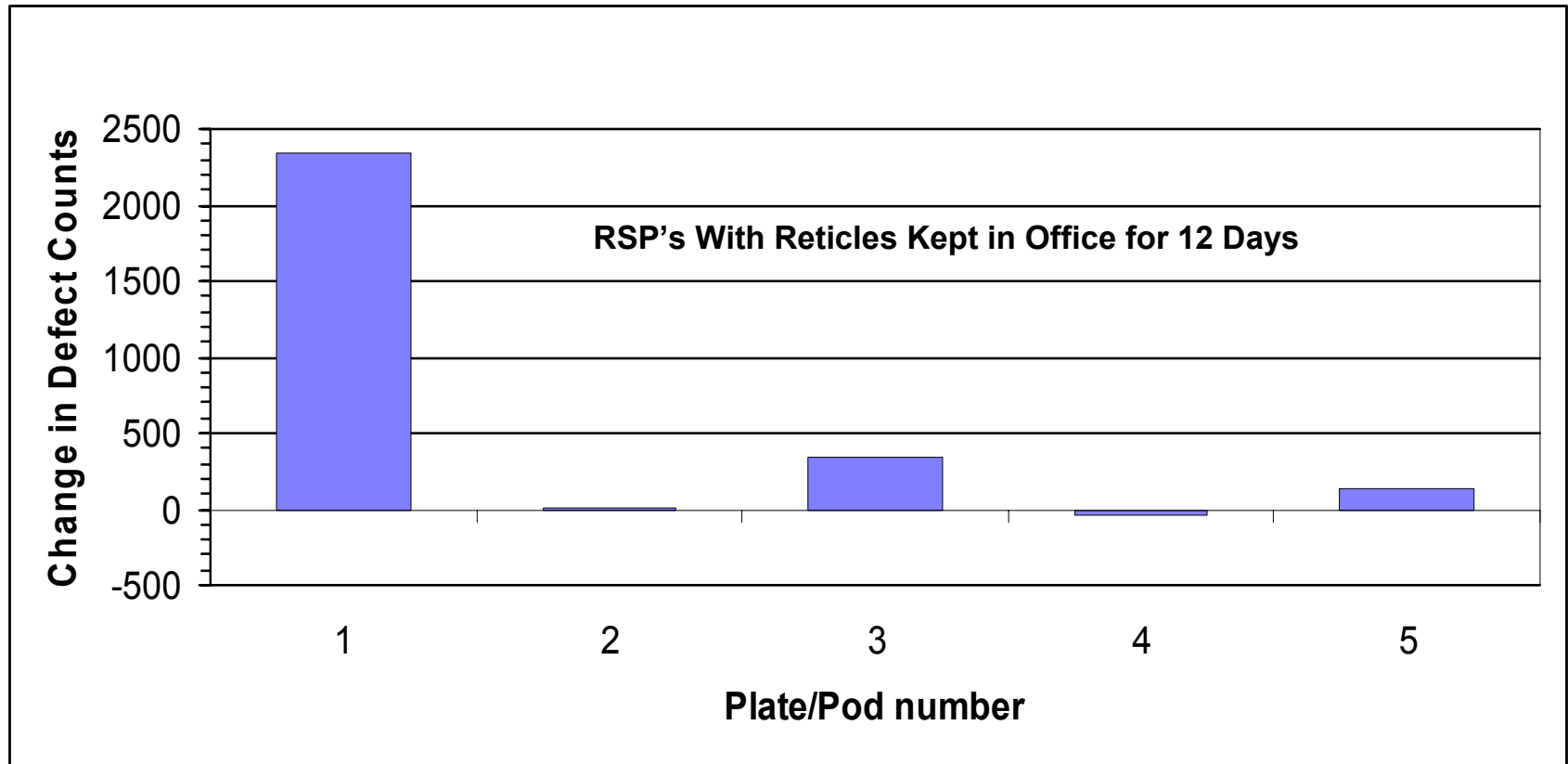
Note: No attempt was made to normalize the force used in the 3 impact tests

RSP Top Impact Test

- Reticle defects measured and reticle placed in RSP
- Golf ball dropped 6 inches on to RSP top
 - Ball dropped a second time
- Reticle defects measured and above repeated
- RSP's appear to be most effective against top impact

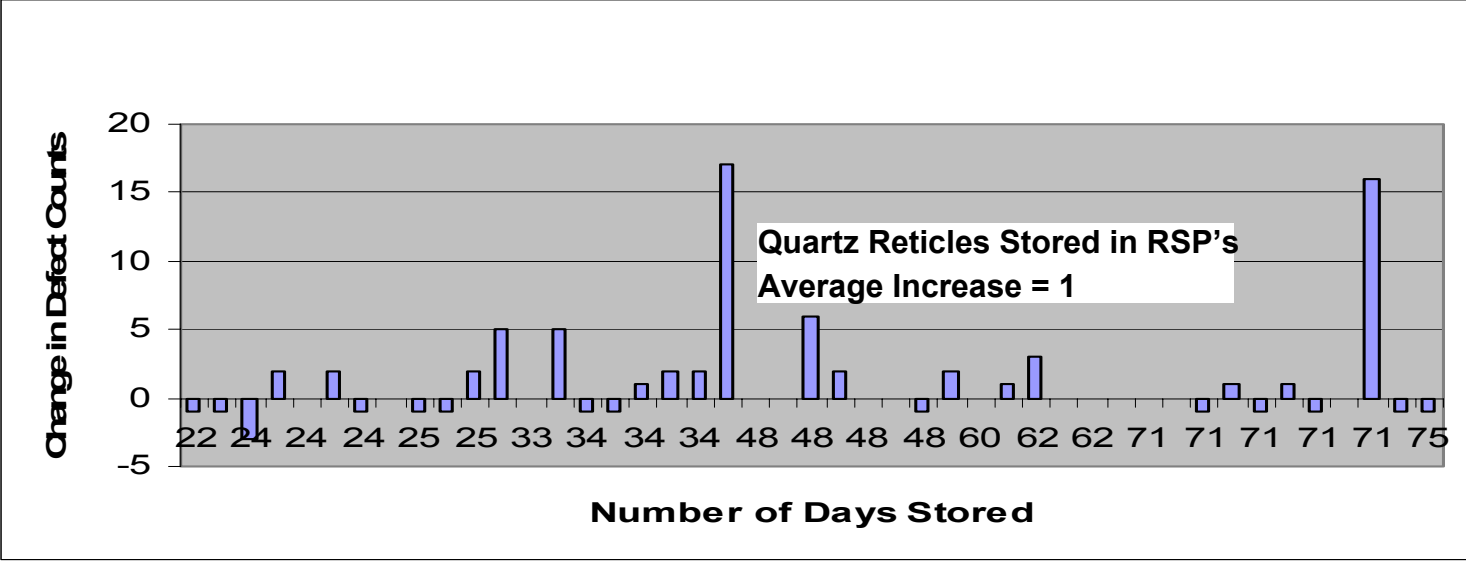
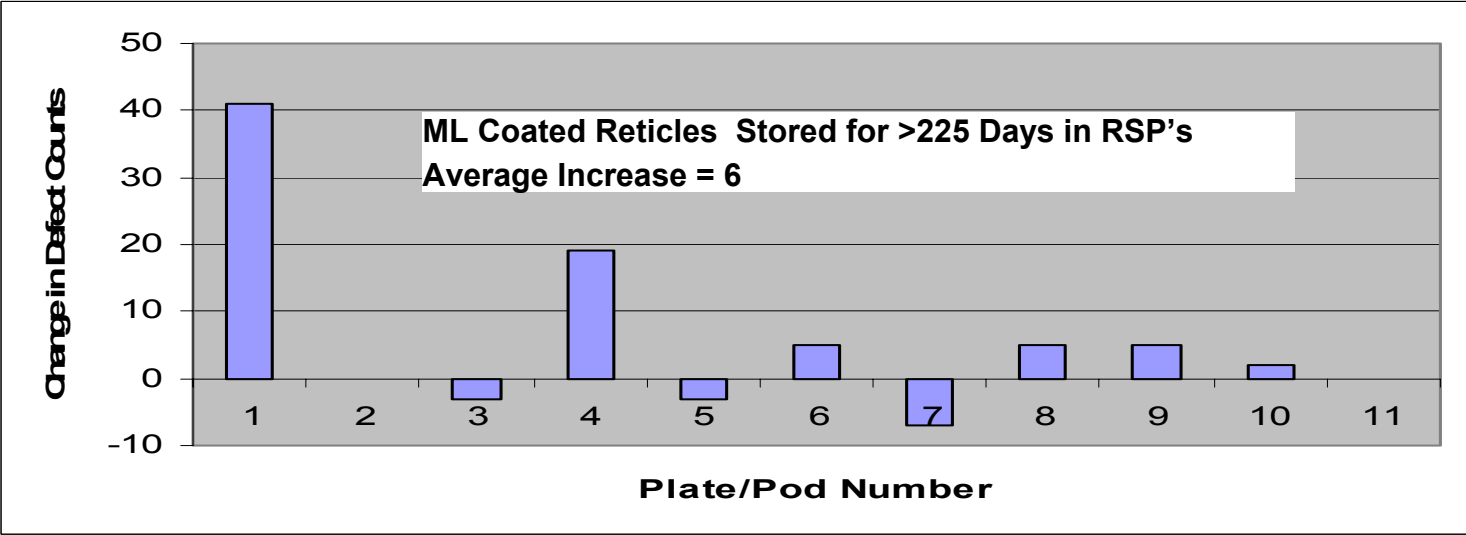


Effect of Non-Cleanroom Environment

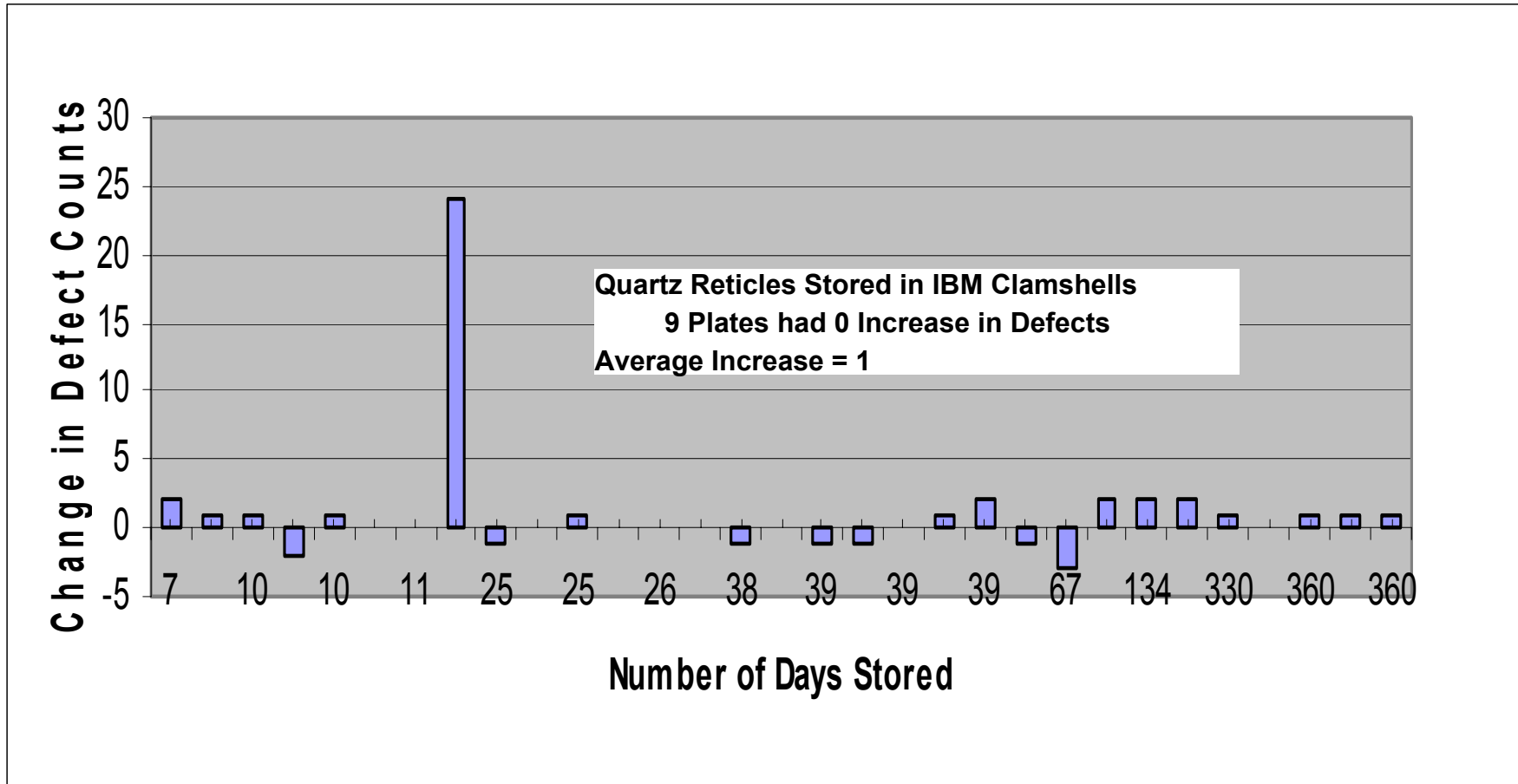


RSP's do not effectively protect against non-clean room environment

Storage in RSP's



Storage in IBM Clamshells



Results

- Clean reticles may be obtained by stripping the films from mask blanks
 - Cleaning after use with acid/peroxide is also effective
- RSP's may be effectively cleaned with dilute alcohol wipe down and vacuum of the base
- Reticle shipment in RSP's is not recommended unless extreme care is taken
 - Double bag and bubble wrap each RSP
 - Ship multiple RSP's in largest box possible on largest pallet available
 - Label with “No Stacking” and “Fragile” and use “Shock Impact Devices”
 - Request special handling from the carrier
 - Include 1 or 2 blank control plates in shipment
- Reticles shipped in IBM blue clamshells have significantly fewer particle adders even when shipped in small container
 - Top and side impact testing
 - Reticle storage in RSP's and clamshell

Results

- Current mask handling tools do not significantly add to defect contamination at 100-200nm levels
 - No gripper/end effector patterns were discovered on plates handled multiple times
 - Additional study should be undertaken at higher inspection sensitivities
- RSP's do not provide effective protection during non-clean room storage
- RSP's are susceptible to impact damage and increased contamination
 - Base Impact >> Side Impact ~ Top Impact
- RSP's and clamshells provide acceptable storage within clean room conditions for current optical requirements
 - May not be acceptable for EUVL requirements

Summary and Conclusions

- All SOW requirements completed on schedule
- Additional tasks also completed to provide additional information
 - Top and side impact testing
 - Reticle storage in RSP's and clamshell
- Fourth Milestone Report completed
- Final Report to be completed during March
- Additional testing of mask tool grippers and end effectors is required for EUVL defect specification levels
- Current RSP design and materials probably need improvement for EUVL use