Providing Leading Edge Technology to Meet Your Future Requirements

Advances in Probe Card Analyzers

Test and Maintenance of Very High Pin Count Cards

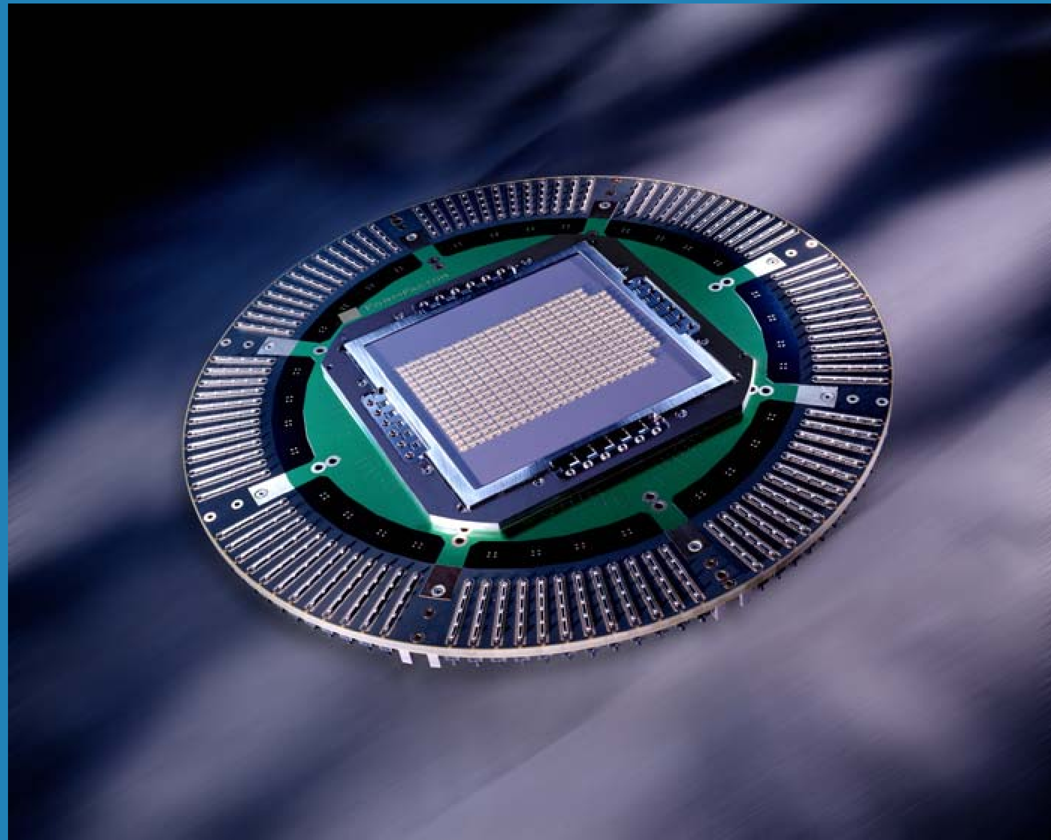
Rod Schwartz
VP & Technical Director
Integrated Technology Corporation

Dan Kosecki
VP SW Development
Integrated Technology Corporation

Purpose

- Provide Overview
  - What is high probe count?
  - Test requirements
  - Importance of procedures/PM
  - Test speed
  - Rework
  - Identifying/preventing problems graphically

Form Factor PH150 Array



CPU (ITRS Data)

PARAMETER	2003	2004	2005	2006
Signal I/O	1024	1024	1024	1024
Pwr/Gnd	2048	2048	2048	2048
MUX CH REQ	1600	1600	1600	1600
Pitch	107	90	80	70
Tip Dia. (ptd)	20 u	20 u	20 u	20 u
Tip Dia. (flat)	100 u	100 u	100 u	100 u
Total Force	40 kg	40 kg	40 kg	40 kg

ASIC (ITRS Data)

PARAMETER	2003	2004	2005	2006
Signal I/O	1700	1800	2000	2100
Pwr/Gnd	1700	1800	2000	2100
MUX CH REQ	2048	2048	3072	3072
Pitch	107	90	80	70
Tip Dia. (ptd)	20 u	20 u	15 u	15 u
Tip Dia. (flat)	100 u	90 u	80 u	70 u
Total Force	40 kg	45 kg	50 kg	50 kg

MEMORY

PARAMETER	2003	2004	2005	2006
Signal I/O	2500	3000	???	
Pwr/Gnd	4500	5000	???	
MUX CH REQ	5000	6000	>6000	
Pitch	100	80		
Tip Dia. (ptd)	20	15		
Tip Dia. (flat)	NA	NA		
Total Force	85 kg	100 kg		

SOC

PARAMETER	2003	2004	2005	2006
Signal I/O	3000	4000	???	
Pwr/Gnd	7000	8000	???	
MUX CH REQ	6000	6000	12,000	
Pitch	100	80		
Tip Dia. (ptd)	15	10		
Tip Dia. (flat)	90	80		
Total Force	60 kg	75 kg		

Display Driver

PARAMETER	2003	2004	2005	2006
Signal I/O	3000			
Pwr/Gnd	50			
MUX CH REQ	3072			
Pitch	45			
Tip Dia. (ptd)	15			
Tip Dia. (flat)	NA			
Total Force	10 kg			

Follow Defined Procedures

- Defining procedures is the most important thing you can do
  - How should the analyzer be configured?
  - What tests can be run without damaging card?
  - What tests should be run in what order?
  - What to do when repair needed?
- Without defined procedures you may end up chasing your tail

Goals of Procedures

- Minimize card maintainance cost
- Maximize sort process efficiency
- Know your results will be correct
- Know your analyzer results will correlate to the prober
- Avoid damaging the card
- Consistent results between operators

Goals of Procedures (Cont)

- Thoroughly test card without running unnecessary tests
- Minimize repair time
- Better understand probe card characteristics

Proper Maintenance

- Tool performs self diagnostics
  - Key functions tested automatically
- Follow a defined maintenance schedule
  - Start with manufacturers suggestions
  - Use NIST tools provided
  - Additional tasks based on environment or requirements
- Perform regularly scheduled Gage R&R
- Have factory do yearly PM

Configuring the Analyzer

- Different technologies may require different setups
- Analyzer provides methods to
  - Store offsets & limits
  - Configure Relays
  - Set up probe capture parameters

Valid Tests

- Use test program to protect card
  - Specify any instructions needed to setup card
  - Specify technology
  - Specify valid tests for a probe card
  - Specify capture recipe
  - Specify overdrive for tests and max for card
  - Specify test parameters
  - Specify what cleaning methods won't damage probes

Goals of Test Procedures

– Save time by not running unnecessary tests
– Avoid running long tests to find problems with your card or setup
– Avoid damaging the card

Specifying Test Procedures

- What tests need to be run at different stage of card life?
  - New card/first article
  - Production card
  - Card nearing end of life

- Procedures will change depending on technology and requirements

New Card Test Procedure

- Testing dominated by need to verify card and test program is correct
- Sample test order
  - Run leakage and use diagnostic probe to verify card orientation and continuity
  - Bulk planarity to verify continuity & tilt if applicable
  - Alignment to verify probes in correct position
  - Wire check to verify wiring
  - Planarity, CRes, components, gram force as needed

Production Card Test Procedure

- Tests required during this phase are dictated by technology & throughput
- Sample Test Order
  - Run bulk planarity & CRes to verify cleanliness & Tilt
  - Clean as necessary
  - Run leakage, alignment, planarity, CRes
- Run only bulk planarity and CRes to save time
- No need to run wire check every time
- Special tests to analyze any problems

Card Nearing End of Life Procedure

- When is card nearing end of life?
  - Might be number of probes removed, number of touchdowns, length of time probing before problems, GF changing
  - Use SPC
- Tests depend on problems associated with end of life
- May require special test methods to look for & identify problems

Tools

- Some technologies may require custom tests
  - Probe Stuck
  - Probe Float
  - Tilt Correction

Repair Procedures

- How to proceeded when repairs needed?
- Can probe be repaired/replaced?
- How many pwr/gnd probes can be missing before card has to be retired?
- Order of repairs?

Increasing Throughput

- Faster microprocessor & more memory
  - Faster screen updates
  - System more responsive
  - Time for some of algorithms doesn't increase linearly

Increasing Throughput (Cont)

- Offload more processing to other microprocessors
  - Allows Pentium to do calculations it is good at while other testing going on
  - Especially important when you use Windows NT

Increasing Throughput (Cont)

- Software improvements
  - Each new software release brings brings speed improvements
  - Overlapping tests
    - Run leakage during alignment
    - Overlap planarity/gram force with wire check

Increasing Throughput (Cont)

- Optimizing tool performance
  - Speed versus accuracy & repeatability
  - Prober taking big steps should the analyzer?
- Optimize test order
  - Run tests likely to fail before tests less likely to fail
  - Run fast tests before slower tests

Where do we go from here for more speed?

- Your goal is to make sure that the card will work on the prober
- Does it make sense to optimize for repeatability instead of speed?
  - You know your system is capable
  - You want to know if card is good
  - Statistical approach - prove it passes

Where do we go … (Cont)

- New Test Methods
  - Planarity
    - Go to first touch + planar window and see if everything touching
  - Other tests could be optimized as well
    - Make quick test first
    - Guard bands
    - Possible run tests in 2 passes

Rework/Inspection

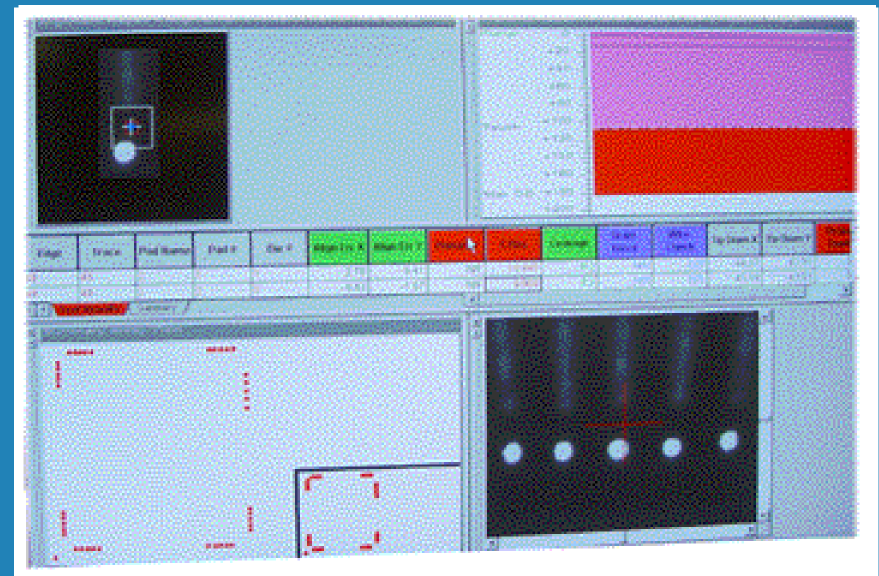
- Some cards can't be repaired but still need inspection
- Much more difficult on large cards
  - Number of probes
  - Identifying probes is problematic because it is harder to find identifying features
  - Usually have to repair with tips up
  - Can't do live probe repair
    - Flip, Find Probe, Repair some, flip, retest & try again

ProbeTracker™

- Easily identify probes
- Automatically move to probe
- Works with stereo microscope and live image
- Repair all probes in one flip
- Automatically move probe to probe no looking up
- Top & Bottom Reference

Card Repair With ProbeTracker™

- Align Crosshair
- Quick Calibration
- Live Alignment Repair
- Capture Probe Position



Analyzing Data Graphically

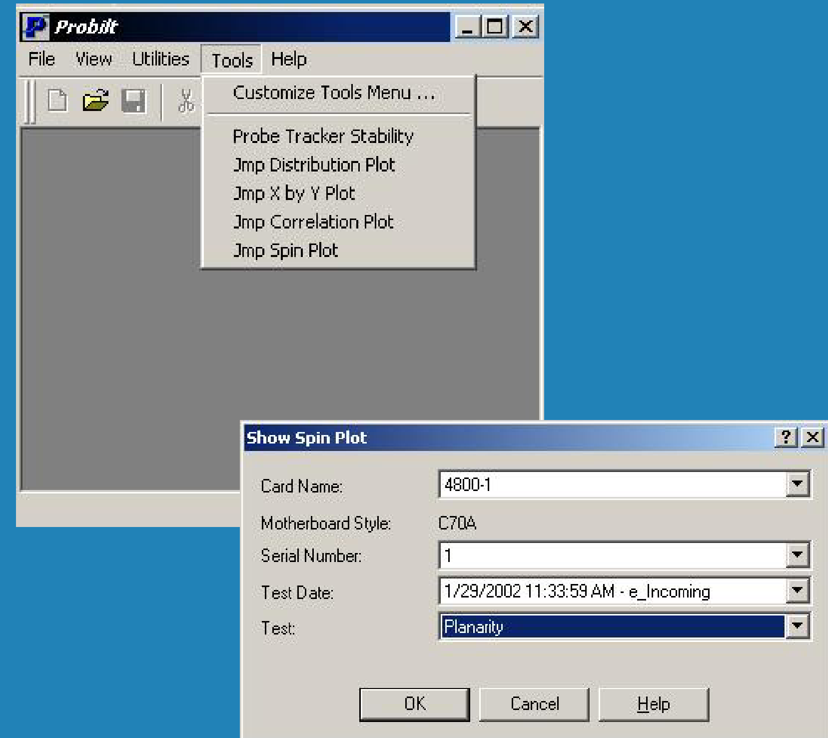
- Allows you to organize data and see trends
- Not analyzer dependant
- Debug card problems
- Verify analyzer working
- Analyzer to prober correlation
- Can lead you down the wrong path

Graphical Analysis (Cont)

- Probilt™ Plots
  - Distributions
  - Scatter Plots
  - Results
- Excel
  - Scatter Plots
  - Line Plots
- Jmp
  - Automated in Problt™
  - Graph types
    - Spin Plots
    - Distributions
    - X by Y
    - Multi Variant
    - Control Charts

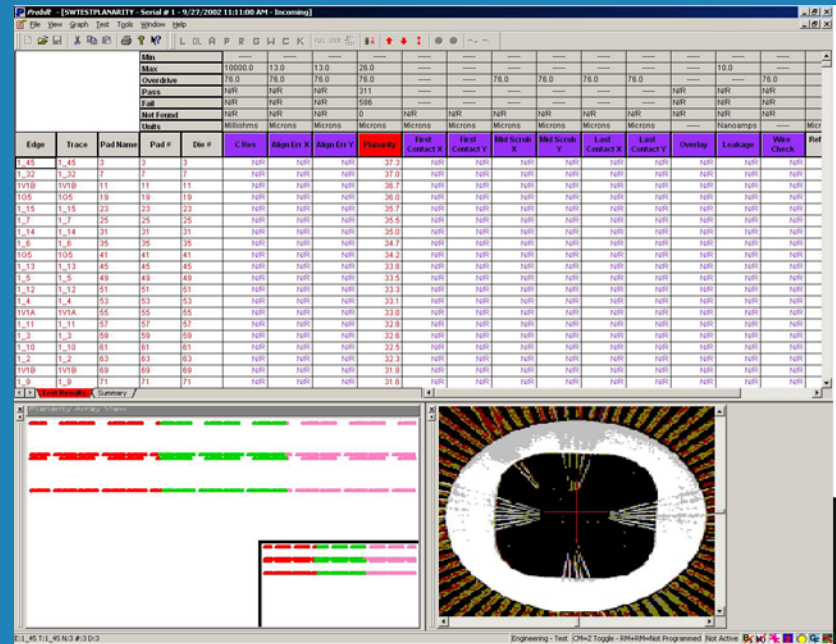
Automating Jmp

- Jmp is very powerful but it can be intimidating so Probilt™ automatically generates many plots
- Implemented as an extension



Array View

- Always a good place to start
- Available for all tests
- Look for groupings of errors



Example, notice tilt in planarity results

XY Scatter Plots

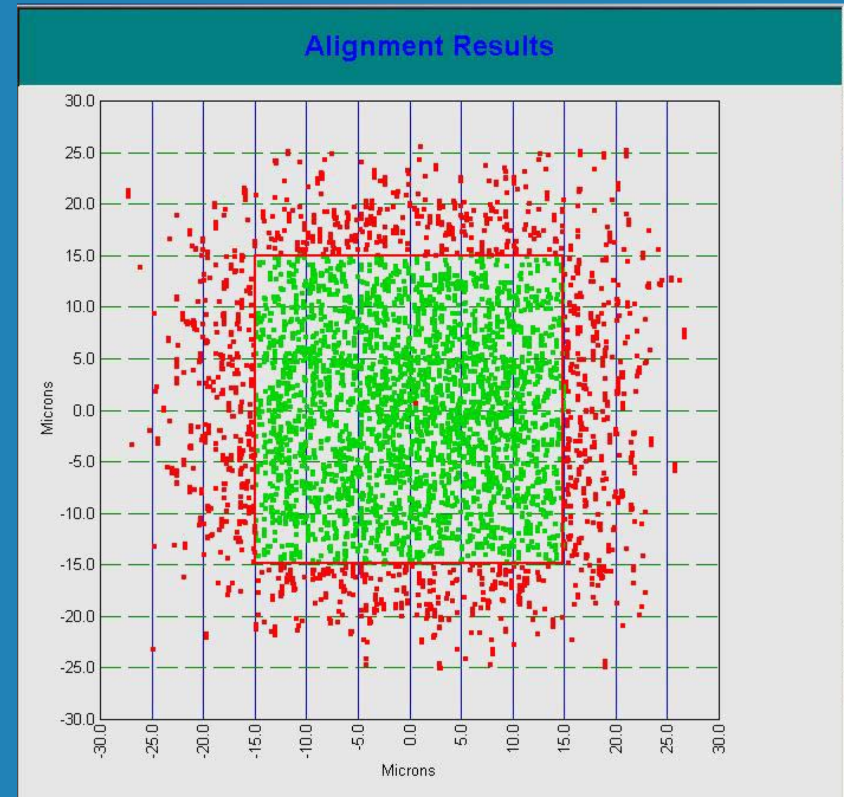
- Scatter Plots
  - Helpful for finding alignment/scrub problems

PROBILT™

Providing Leading Edge Technology to Meet Your Future Requirements Today

XY Scatter Plot (Cont)

- Good Scatter Plot
  - Even XY Distribution
  - Magnitude of XY values consistent

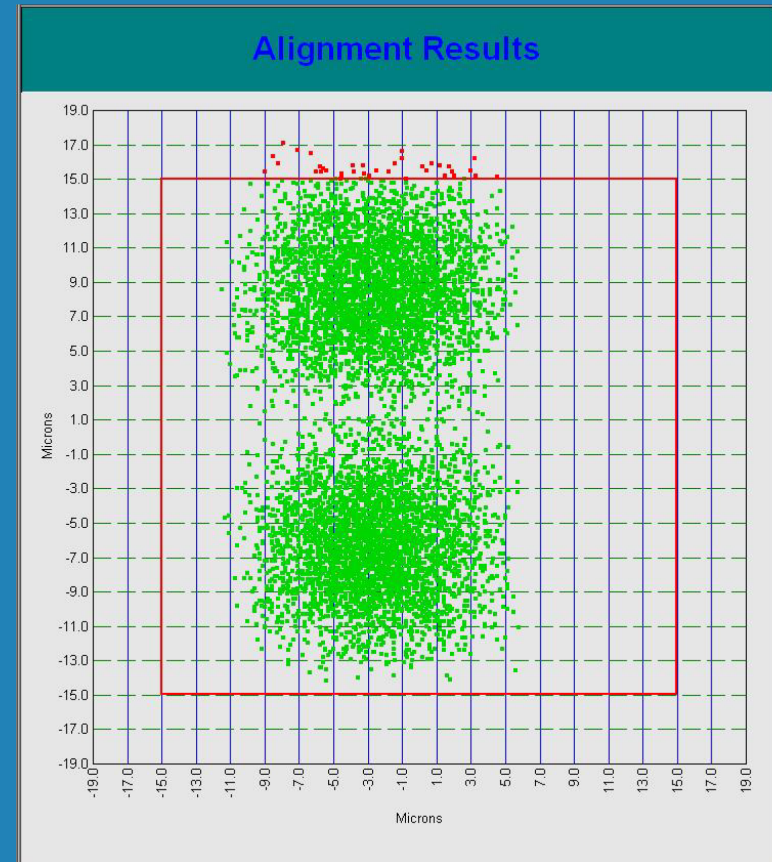


PROBILT™

Providing Leading Edge Technology to Meet Your Future Requirements Today

XY Scatter Plot (Cont)

- Bad Scatter Plot
  - Different X & Y Distribution
  - Two distinct groups
  - Scrub Problem

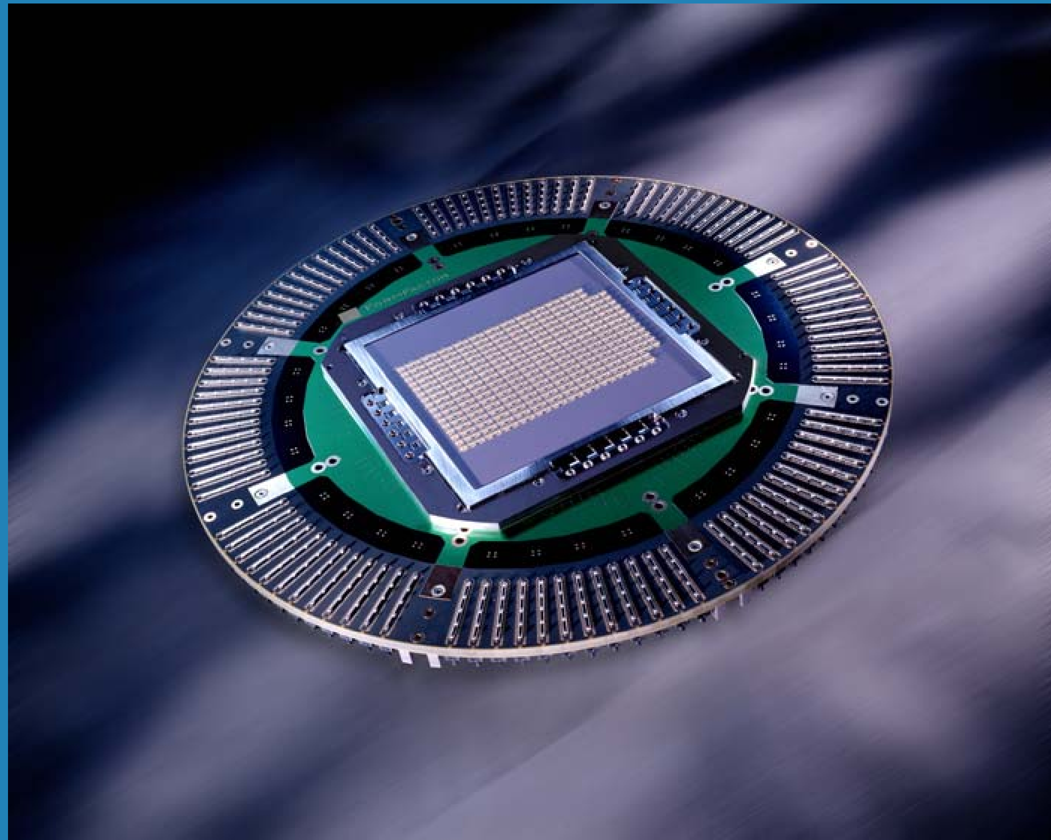


ITC
INTEGRATED TECHNOLOGY CORPORATION

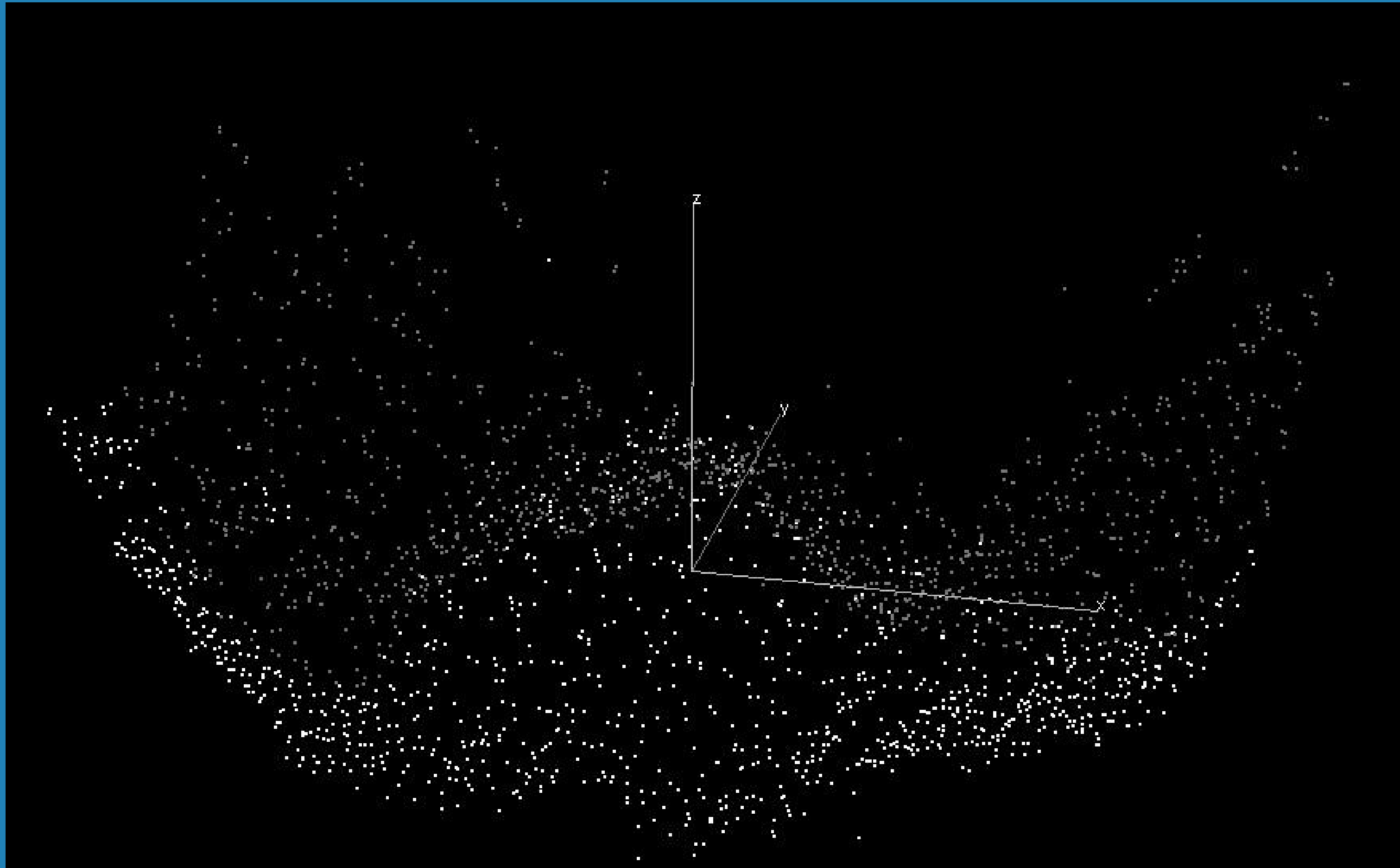
Spin Plots

- Planarity
- Alignment
- Scrub Length
- Miscellaneous

Form Factor PH150 Array



Spin Plots of Typical Form Factor Card



Spin Plots of Typical Form Factor Card (Cont)

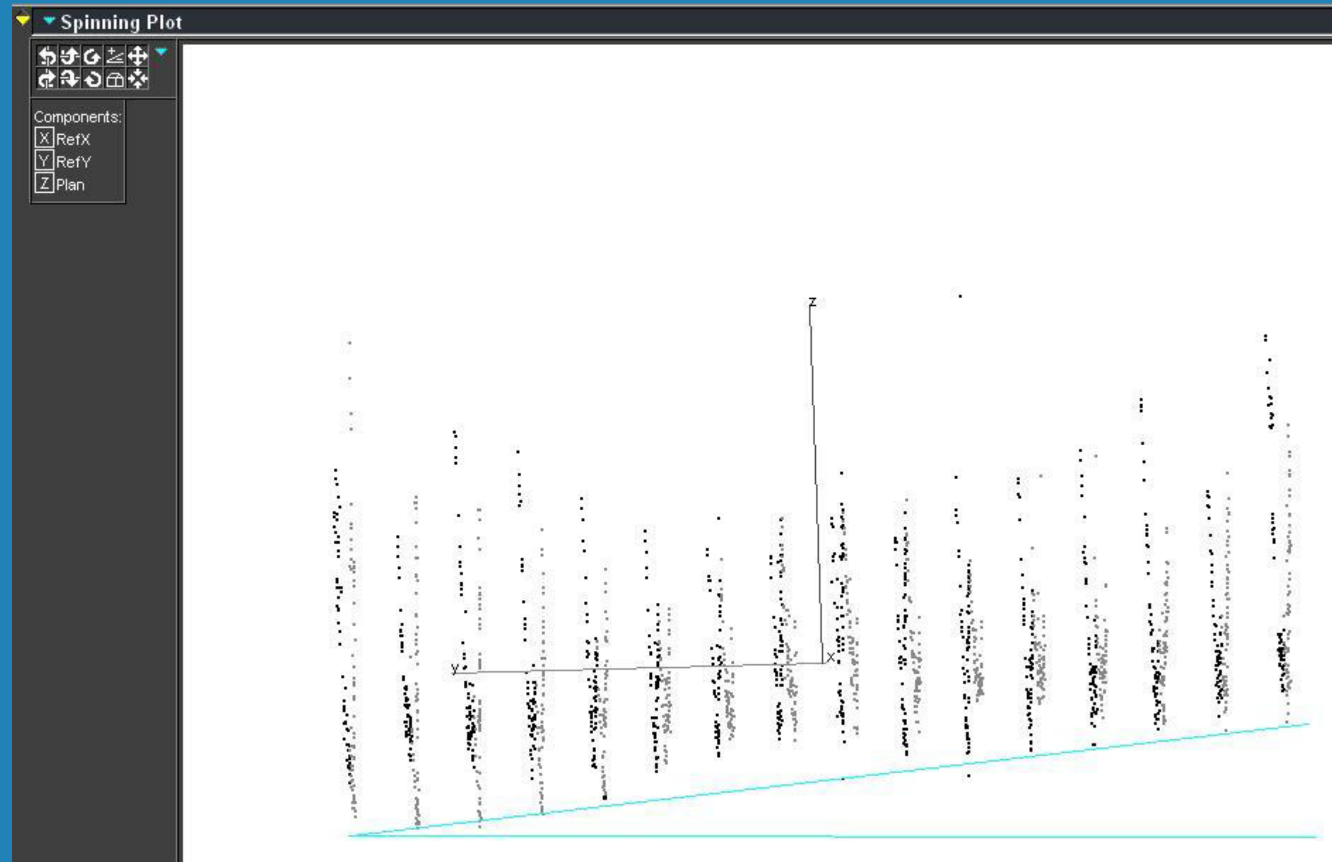
- The peaks result from Form Factors assembly process
- One disadvantage of spin plot is that it doesn't show magnitude so you can't tell this is <20 microns over 6 inches
- I have seen Form Factor continue to tune a card with < 13 micron planar window to improve the distribution

PROBILT™

Providing Leading Edge Technology to Meet Your Future Requirements Today

Spin Plot Showing Tilt

- Same as previous plot
- Planarity plot
- Notice tilt
- Need to spin to see
- Is it card or analyzer?



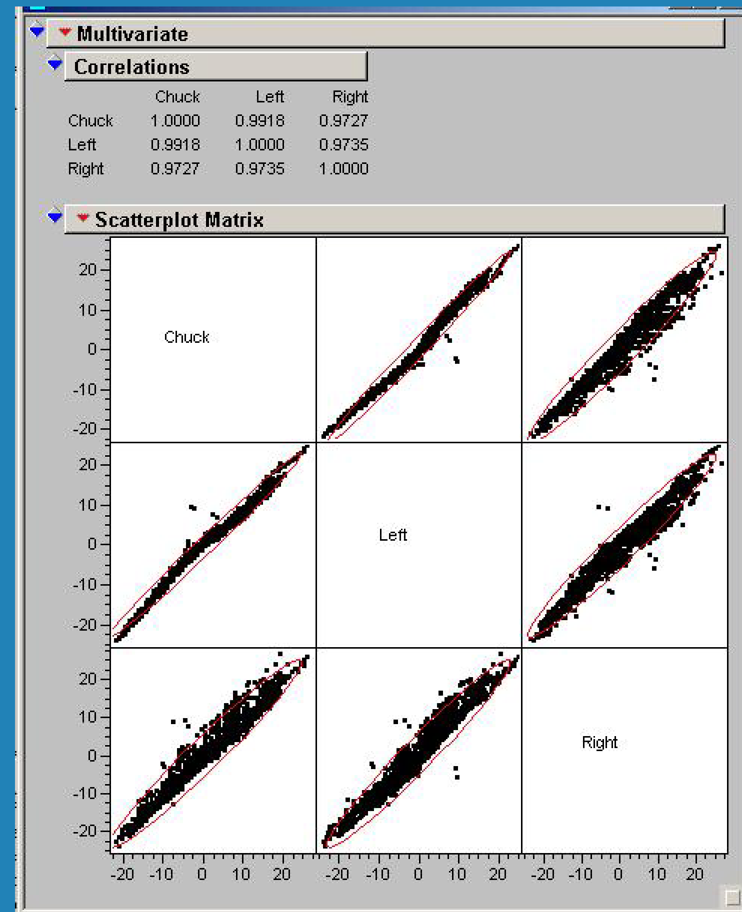
ITC
INTEGRATED TECHNOLOGY CORPORATION

Correlation/Multi Variant Plot

- Analyzer to Analyzer
- Analyzer to Prober
- Left side of card to right side of card
- Bussed probes to signal probes
- Probe scrubbing in different directions

Verify Analyzer Functions

- Chuck – Isolation
  Pin 1 – Isolation
  Pin2
- Multiple Cameras (If applicable)
- Multiple Touchdowns (If Applicable)



Analyzer to Prober Correlation

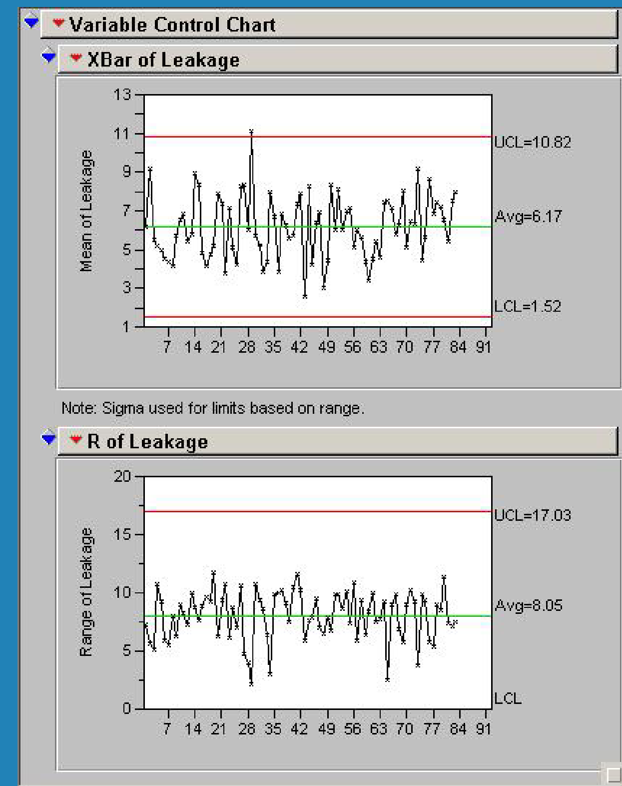
- Need the ability to get data from both
- May require new tests or reformatting results already available
- Important to feed back failures and adjust process

Correlate Analyzer to Prober

- Export alignment & planarity data from analyzer & prober
- Convert analyzer alignment offsets to match prober
  - Typically distances from the edge of pad
- After converting the data perform a multi variant plot to verify correlation of the probes tested by both

Control Charts

- **Individual Card SPC**
  - **EOL Predictions**
  - **Identify “Problem Cards”**
  - **Establish Norms**
  - **Monitor Card Performance**
- **Card Type SPC**
  - **Establish Norm for Card Type**
  - **Overall Control**



Conclusion

- **While working with high probe count probe cards presents a number of challenges these problems can be overcome by**
  - **Properly documenting and following your procedures**
  - **Properly maintaining your tools**
  - **Using the new techniques offered by analyzers**
  - **Analyzing the data graphically**
  - **Working with probe card analyzer supplier**