Presentation to
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Hybrid Buckling Beam Contact for Vertical Probe Cards

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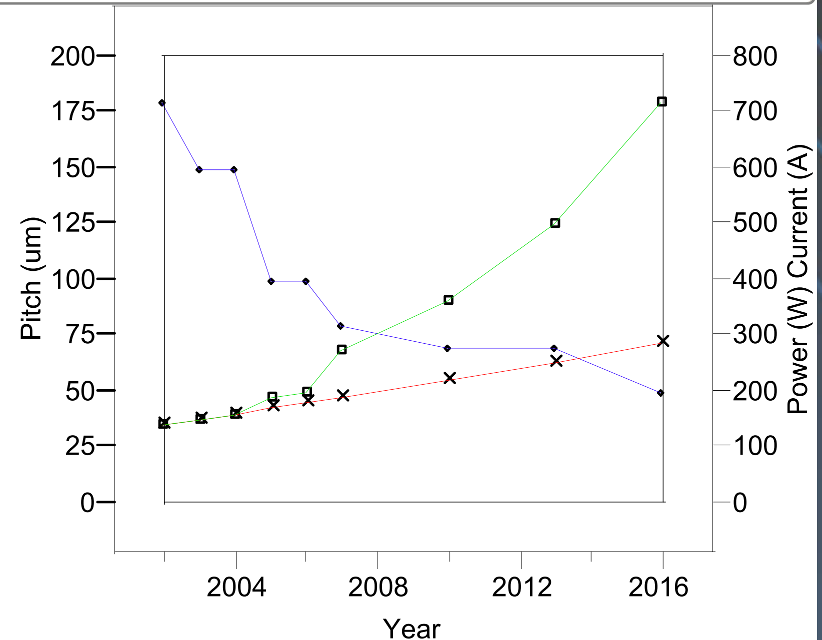
Overview

- Test Challenges
- Balancing Act
- Photolithographically Produced Contact – the Saber™ Probe*
- Pitch Capability
- Current Carrying Capability
- Life
- Gram Force Variability
- Cost of Ownership
- Quality
- Future Development
- Conclusion

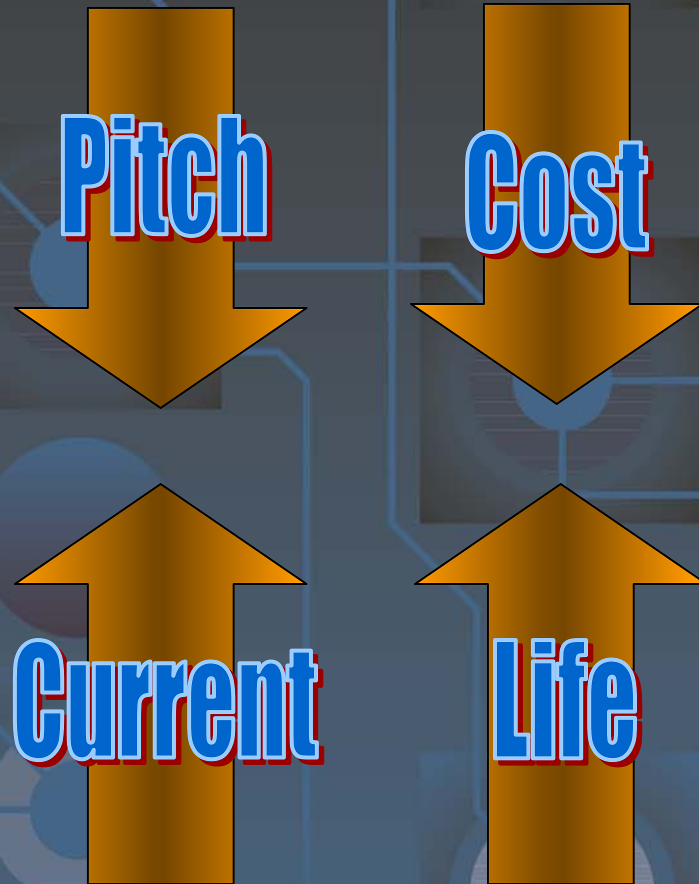
* Patent Pending

Challenges Faced in Wafer-Level Test

- Substantial increase in current carrying requirements
- Ongoing decrease in pitch requirements
- Wafer level testing must be equipped to address “worst case” process corners



How To Balance These Opposing Forces?



- Industry roadmap calls for more probe in less space – higher current carrying capability, more robust performance, tighter pitch - at lower cost
- Photolithographic process provides a means

Why go photo?

- Pitch
  - Smaller feature sizes drive pitch
  - Potential for 33% reduction in pitch compared to conventional buckling beam probes
- Cost
  - Leverages batch processing
  - Economies of scale
- Current
  - New more efficient designs possible
  - 30% increase in cross-sectional area at the same outer dimension
- Life
  - No built-in mechanical stresses or micro cracks

Why go photo?

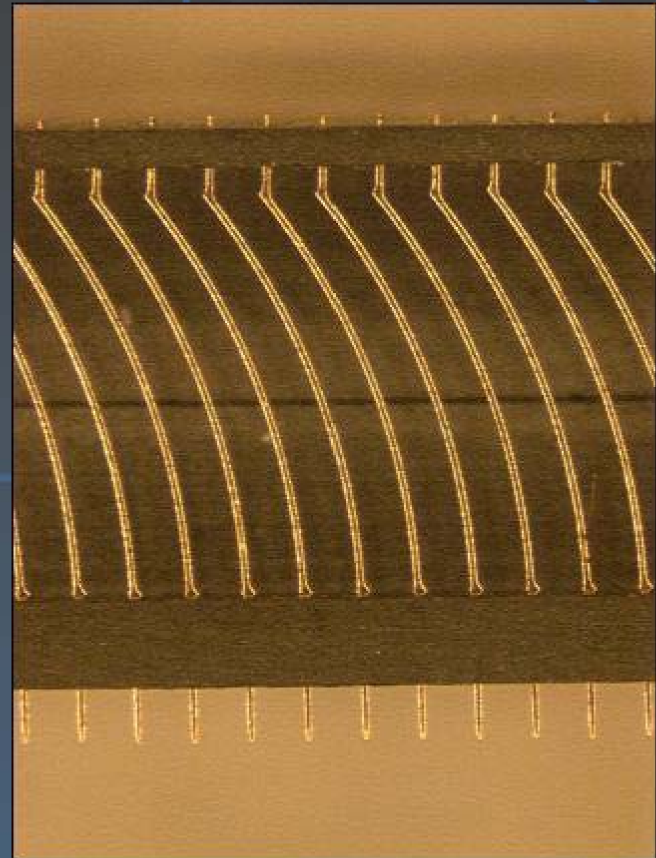
- Additional Benefits
  - Increased probe uniformity reduces variation in gram force
  - No hard tooling for reduced design cycle time and reduced NRE costs
  - Testability and manufacturability features easily added to designs

Introducing the Saber™ Probe

Saber is photolithographically created to replace conventional buckling beam probes.

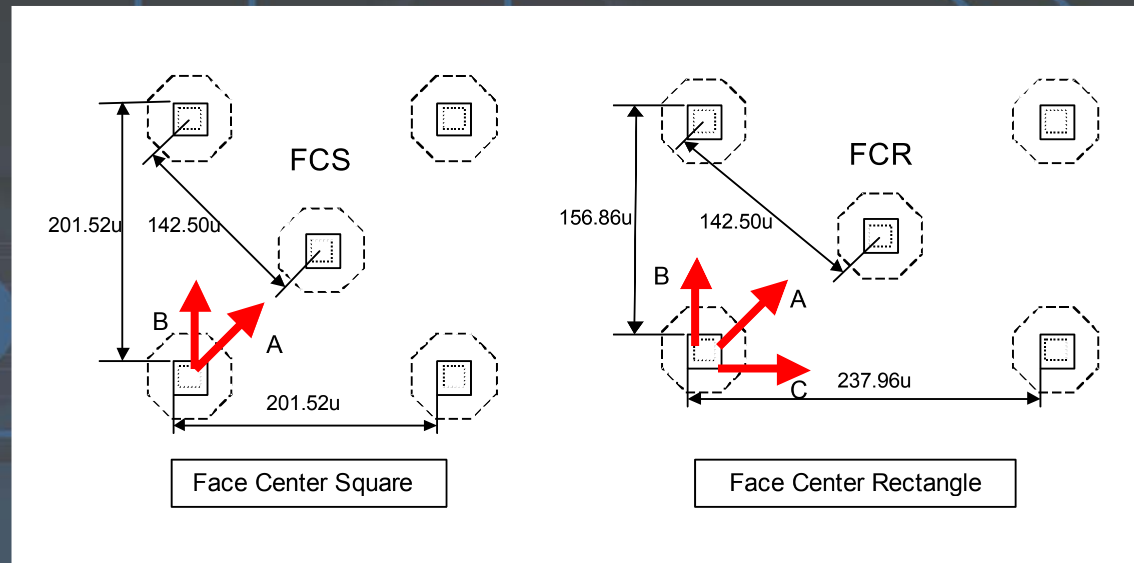
Introducing the Saber™ Probe

- Initial design targeted to replace most commonly used 4 mil probe
- Allows Saber to be compared against conventional baseline
- Future versions will enable even smaller pitches and new designs



Probe Orientation Studies

- FEA Modeling
  - Pitch = 142µm
  - 6 mil over-travel
- Model verified using a test fixture at minimum pitch
- Currently projected to handle 130µm minimum pitch

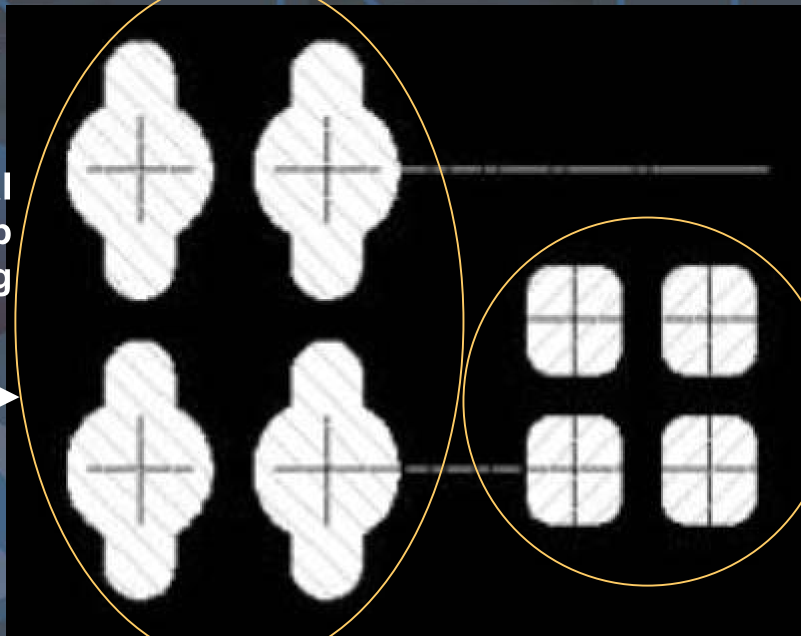


142µm Bump Layouts

Enabling Greater Current Density

- 30% more cross-sectional area at the same outer dimension
- Rectangular geometry more efficient for packing

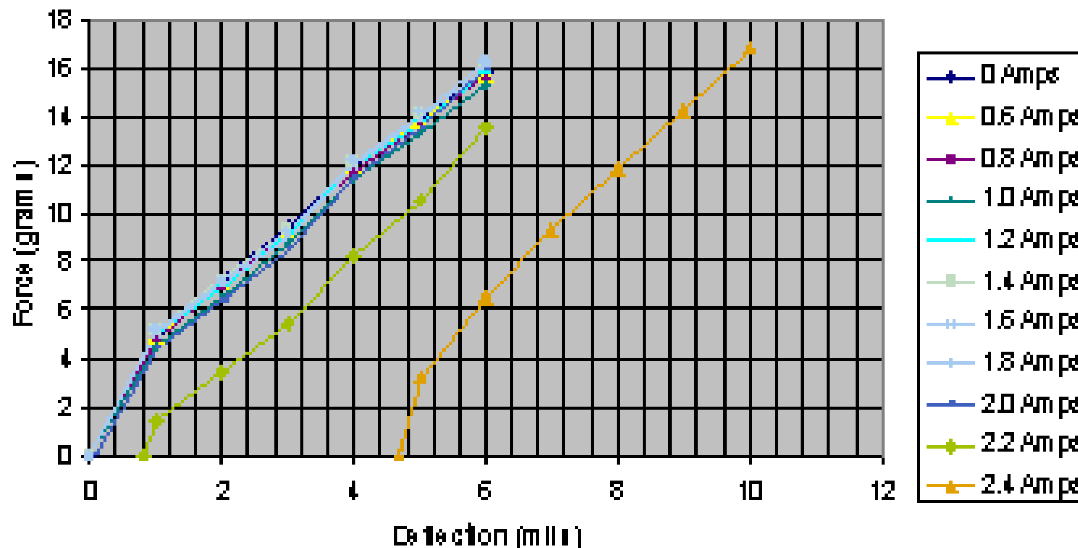
Conventional Probe, Top View Drawing



Saber Probe, Top View Drawing

Overlay Top View Drawing of Probes

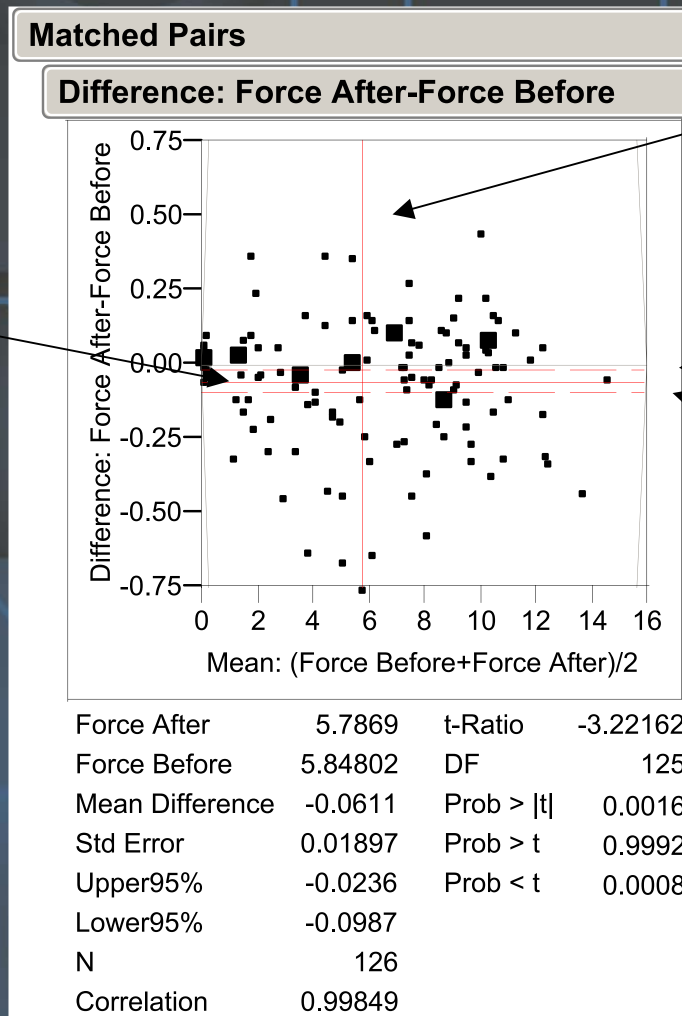
Enabling Greater Current Density



- Rectangular profile – Larger cross-sectional area with same outer dimensions as conventional profile
- Stress-free – No built-in mechanical stresses

Explanation of Matched Pairs Analysis

Mean Difference



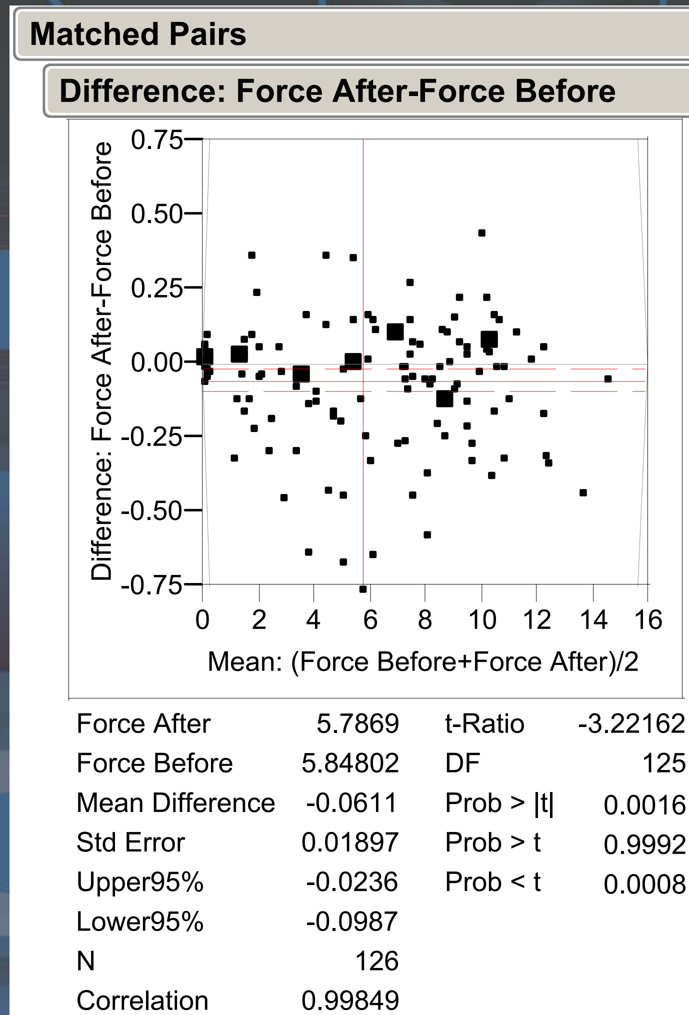
Force After	5.7869	t-Ratio	-3.22162
Force Before	5.84802	DF	125
Mean Difference	-0.0611	Prob > |t|	0.0016
Std Error	0.01897	Prob > t	0.9992
Upper95%	-0.0236	Prob < t	0.0008
Lower95%	-0.0987		
N	126		
Correlation	0.99849		

Mean of Means

Upper 95% Difference

Lower 95% Difference

Enabling Greater Current Density

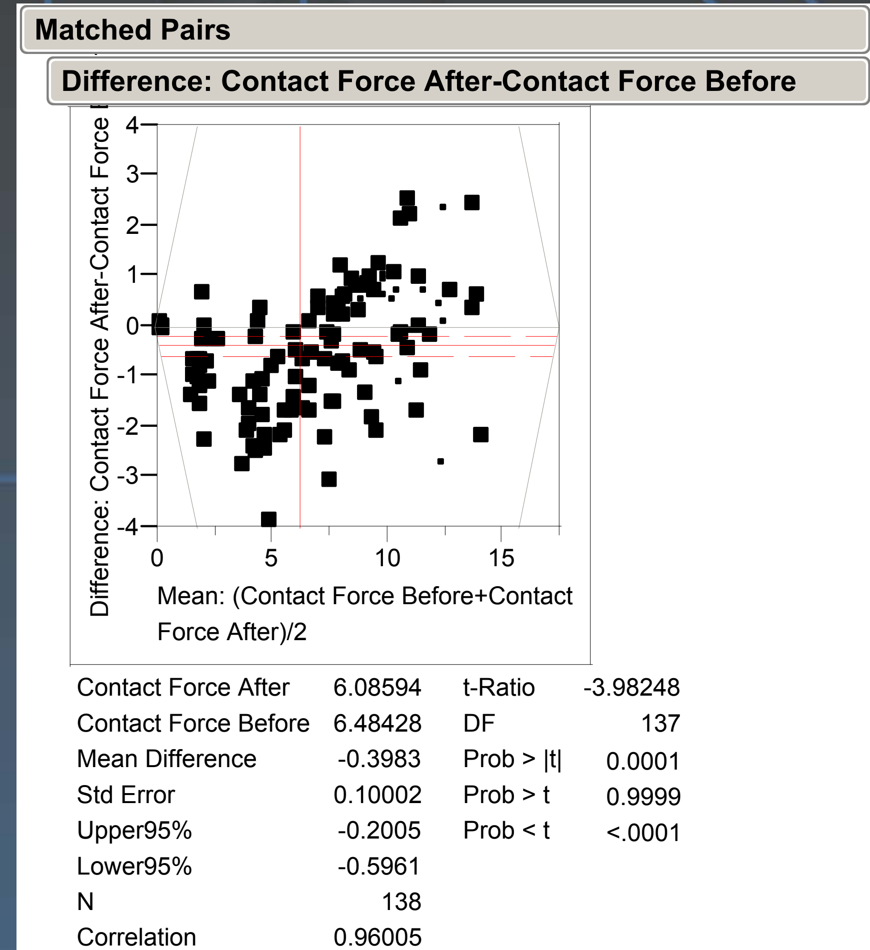


- No significant shift in gram force observed for a 500 mA pulse of two minute duration

Lithographic Process Increases Longevity

- No built-in mechanical stress during probe creation
- No micro fractures from mechanical processing

Life Test Results Through 1.7M Touchdowns

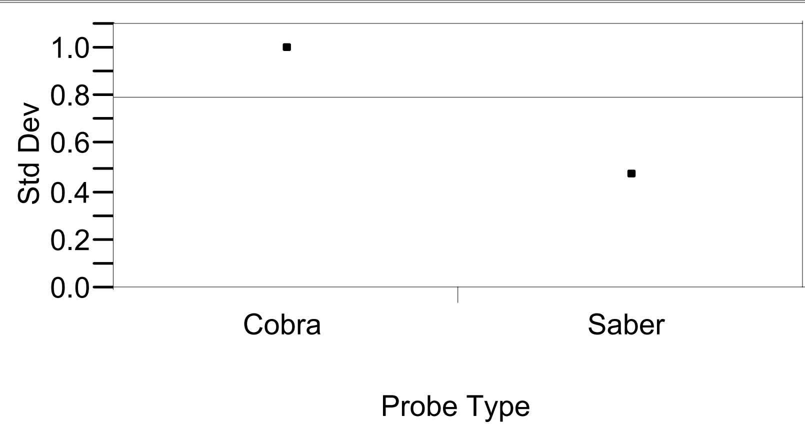


Contact Force After	6.08594	t-Ratio	-3.98248
Contact Force Before	6.48428	DF	137
Mean Difference	-0.3983	Prob > |t|	0.0001
Std Error	0.10002	Prob > t	0.9999
Upper95%	-0.2005	Prob < t	<.0001
Lower95%	-0.5961		
N	138		
Correlation	0.96005		

Precise Control Over Critical Dimension Improves Gram Force Consistency

- Saber probes exhibit less variation in gram force due to better probe uniformity

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
Cobra	15	1.014176	0.7711111	0.7733333
Saber	15	0.484901	0.4053333	0.4006667

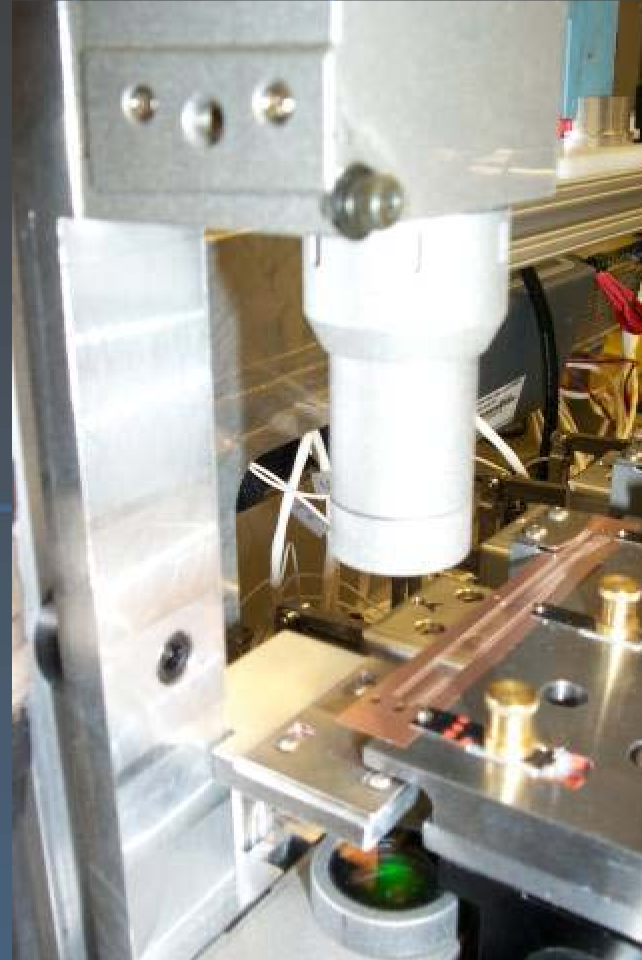
Test	F Ratio	DFNum	DFDen	Prob > F
O'Brien[.5]	4.5161	1	28	0.0425
Brown-Forsythe	4.5390	1	28	0.0421
Levene	4.4542	1	28	0.0439
Bartlett	6.7753	1	.	0.0092

Leveraging The Economies of Scale

- Batch processing allows creation of many probes at once
- Probes continue through processing as a batch (before singulation)
  - Inspection
  - Plating

Process Driven Quality

- Batch testing allows data-driven process improvements via variables data analysis
- 100% automated testing ensures quality of each probe
- Vast majority of manual handling requirements eliminated



Fully automated laser inspection prior to singulation and vacuum sorting

A Hybrid Solution … An Evolutionary Approach

- Mass produce the component used repeatedly
- Continue use of mechanically drilled dies to leverage existing infrastructure and maintain component modularity
- Align process with semiconductor production concepts

Saber Comparison Matrix

	Conventional 4 mil Buckling Beam Probe	*Saber Probe*
Minimum Pitch	195µm	142µm 130 µm (theoretical)
Cost Driver	Individually processed	Batch processed
Current Capacity @ 2 sec pulse	1.2 Amps	2.0 Amps
Life	1 million TDs	> 1.7 million TDs

Next Steps For Saber Development

- Ramp to volume on Saber 403 probe
- Qualify Saber probe in high temperature (150° C) applications
- Develop 2.5 mil and 3.0 mil equivalent Saber probes
- Achieve 80μm vertical pitch

Conclusion

The Saber probe delivers performance and cost advantages not found in conventional buckling beam vertical technology.