ARCHIVE 2007

TRENDS IN CONTACT TECHNOLOGIES

"Next Generation Contact Technology For Semiconductor Test"

Valts Treibergs, Jason Mroczkowski
Everett Charles Technologies STG

"'Off-set' Pin Contact Innovation - An Effective Contact Solution to Pb-Free Devices for MT8704iHF (Multitest) Test Handler"

Ariel Sabellon, Eugene F. Batilo
Cypress - Philippines

"Braided Electrical Contact Element (BeCe)"

Che-Yu Li
Che-Yu Li and Company, LLC

"Elastomeric Interconnects - Reliable Enough for Production Test?"

Frank Bumb, Jack Pereschuk
Phoenix Test Arrays
Nick Langston, Sr.
Antares Advanced Test Technologies

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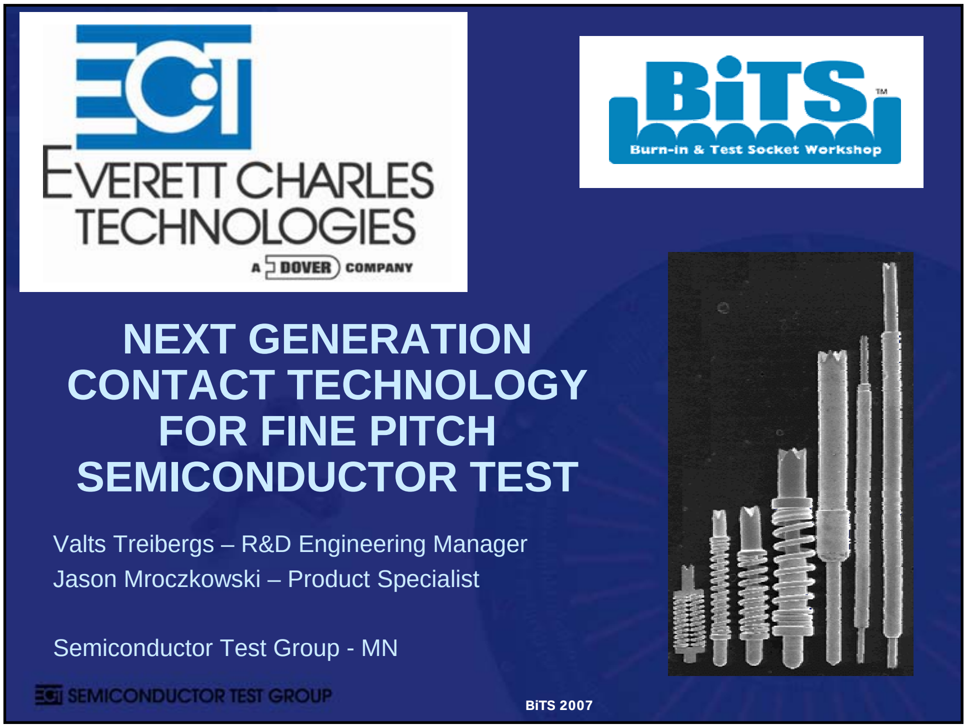

EVERETT CHARLES TECHNOLOGIES
A DOVER COMPANY

BiTS Burn-in & Test Socket Workshop

NEXT GENERATION CONTACT TECHNOLOGY FOR FINE PITCH SEMICONDUCTOR TEST

Valts Treibergs – R&D Engineering Manager
Jason Mroczkowski – Product Specialist

Semiconductor Test Group - MN

SEMICONDUCTOR TEST GROUP

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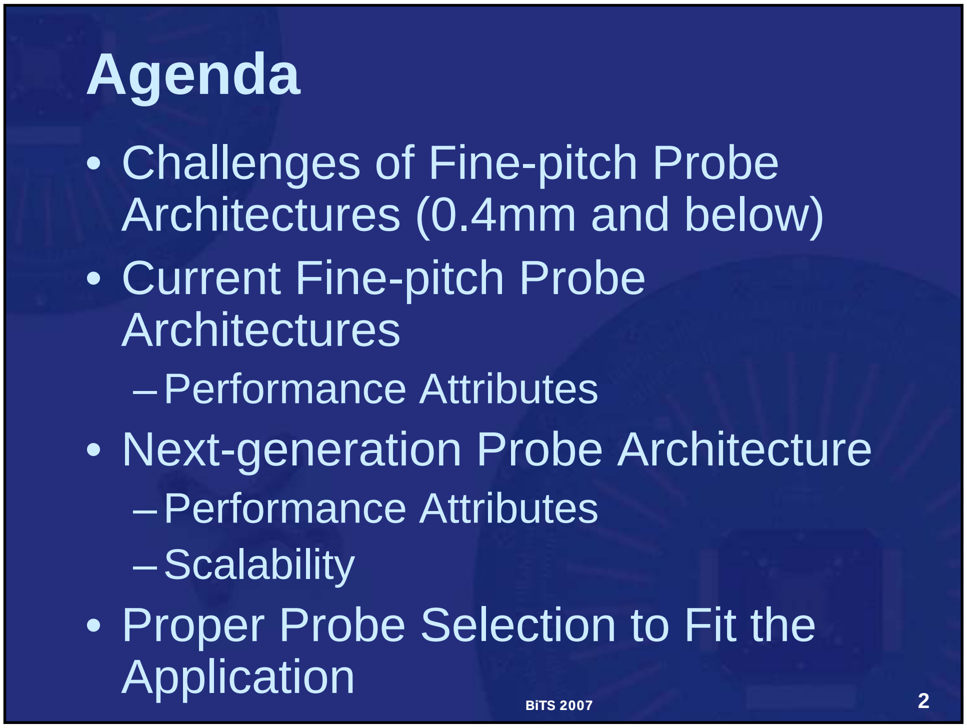

Agenda

- Challenges of Fine-pitch Probe Architectures (0.4mm and below)
- Current Fine-pitch Probe Architectures
  - Performance Attributes
- Next-generation Probe Architecture
  - Performance Attributes
  - Scalability
- Proper Probe Selection to Fit the Application

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Challenges With Current Fine Pitch Probe Architectures

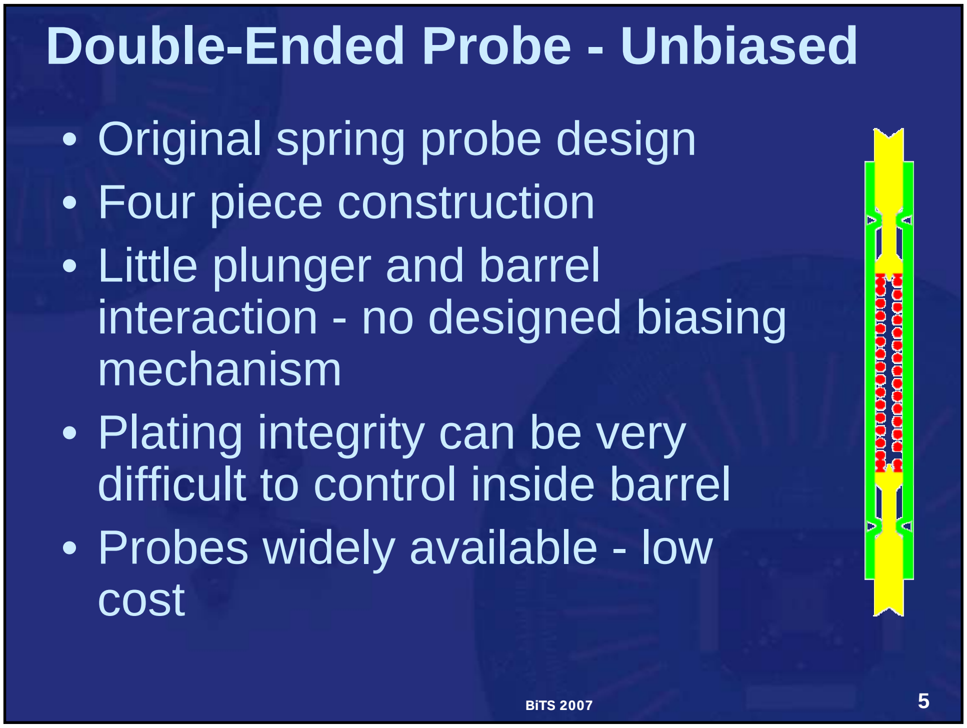
- Probe Z Axis Compliance
  - – Fine pitches typically dictate the need for long probes
    - Low spring forces - very fine springs required
    - Higher contact resistance (R_c)
    - Low current carrying capacity (CCC)
    - Low bandwidth, high inductance
  - – Some short probe designs exist, but have limited compliance
  - – Probes tend to be very fragile
- Internal Resistance Consistency - Biasing
  - – need consistent contact between plunger(s) and barrel components throughout compression
- Tip Geometries
  - – Limits to DUT tip style, excessive PCB wear due to point loading

$\cancel{C_{res}}$

Current Probe Architectures for Fine Pitch

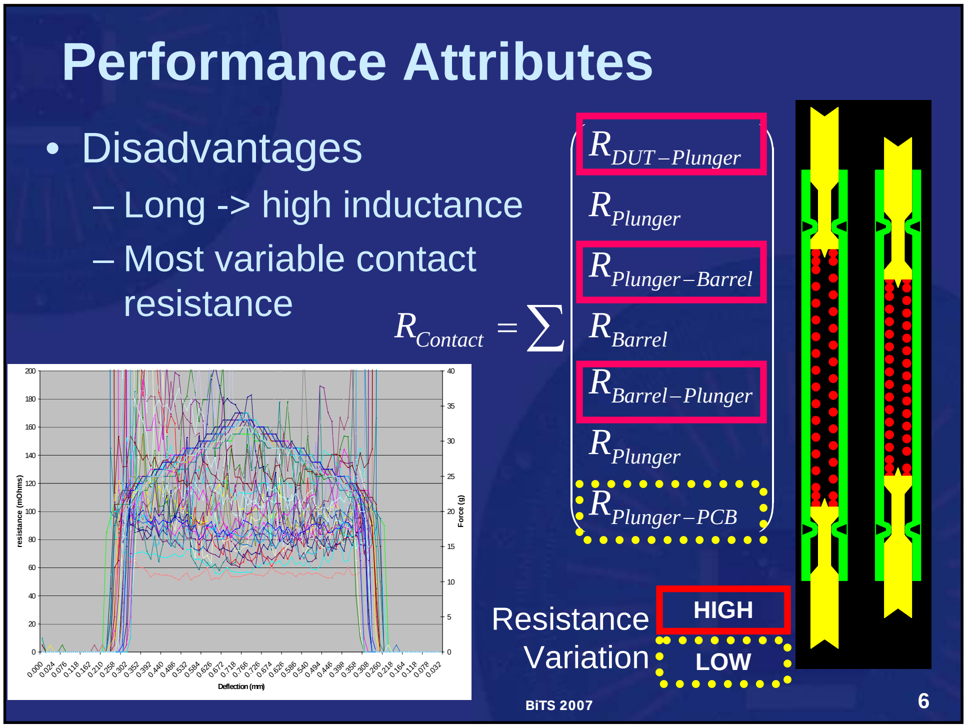
- Double Ended Spring Probe (4 Piece)
  - – Non-biased plunger
  - – Biased plunger
- Single Ended Spring Probe (3 Piece)
- External Spring Probe (3 Piece)
- Next Generation Cantilever-biased Spring Probe (4 Piece)

Note: Other variants are possible and widely used



Double-Ended Probe - Unbiased

- Original spring probe design
- Four piece construction
- Little plunger and barrel interaction - no designed biasing mechanism
- Plating integrity can be very difficult to control inside barrel
- Probes widely available - low cost

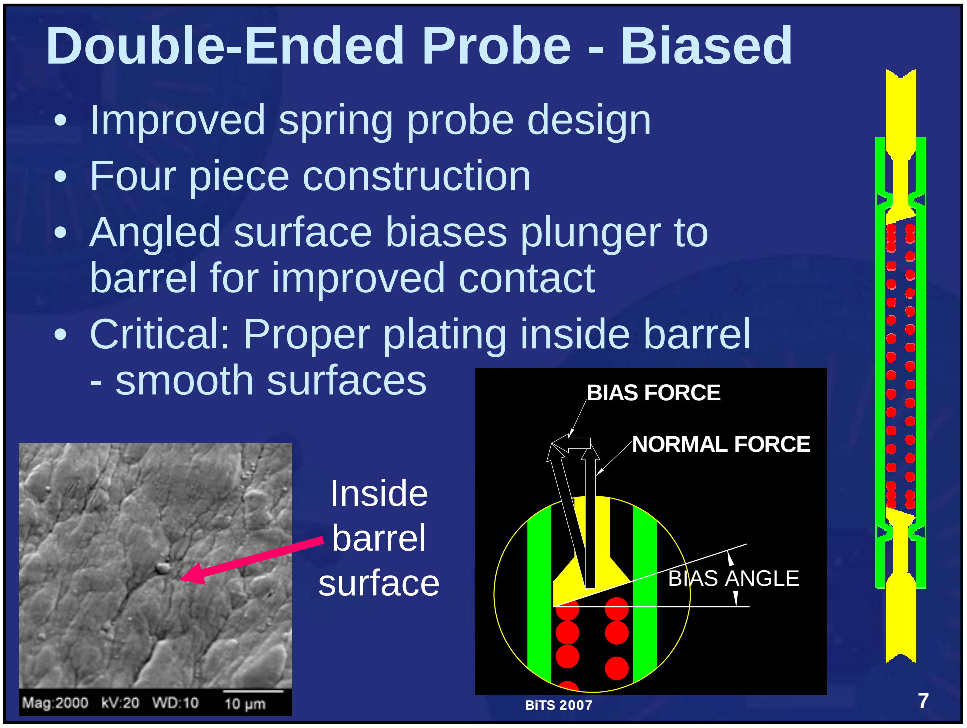


Performance Attributes

- Disadvantages
  - Long -> high inductance
  - Most variable contact resistance

$$R_{Contact} = \sum \begin{cases} \boxed{R_{DUT-Plunger}} \\ R_{Plunger} \\ \boxed{R_{Plunger-Barrel}} \\ R_{Barrel} \\ \boxed{R_{Barrel-Plunger}} \\ R_{Plunger} \\ R_{Plunger-PCB} \end{cases}$$

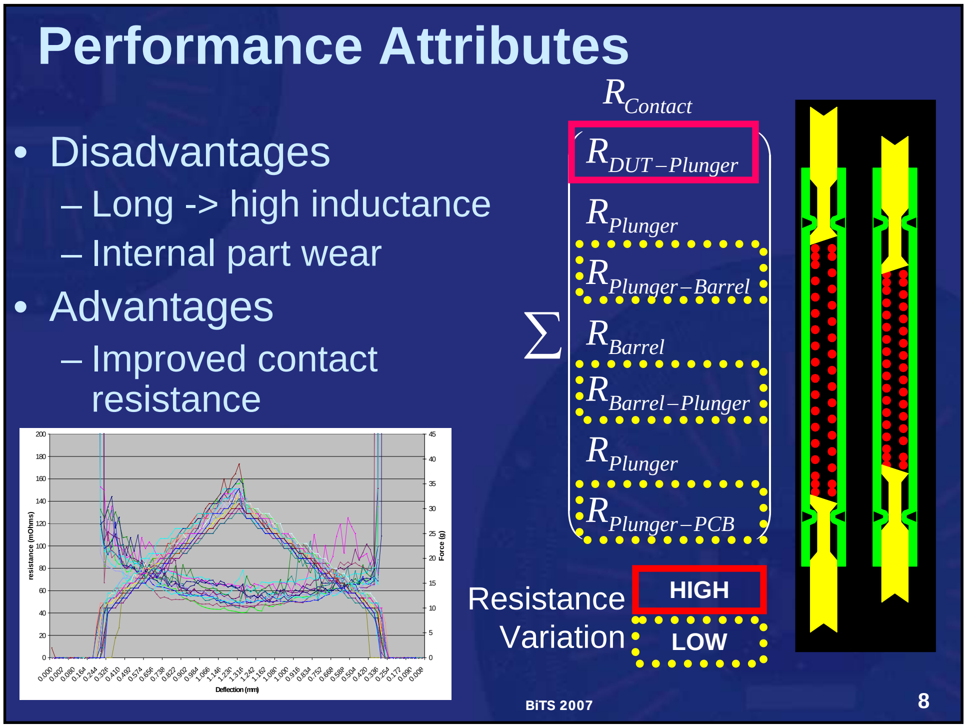
Resistance Variation HIGH LOW



Double-Ended Probe - Biased

- Improved spring probe design
- Four piece construction
- Angled surface biases plunger to barrel for improved contact
- Critical: Proper plating inside barrel - smooth surfaces

Inside barrel surface

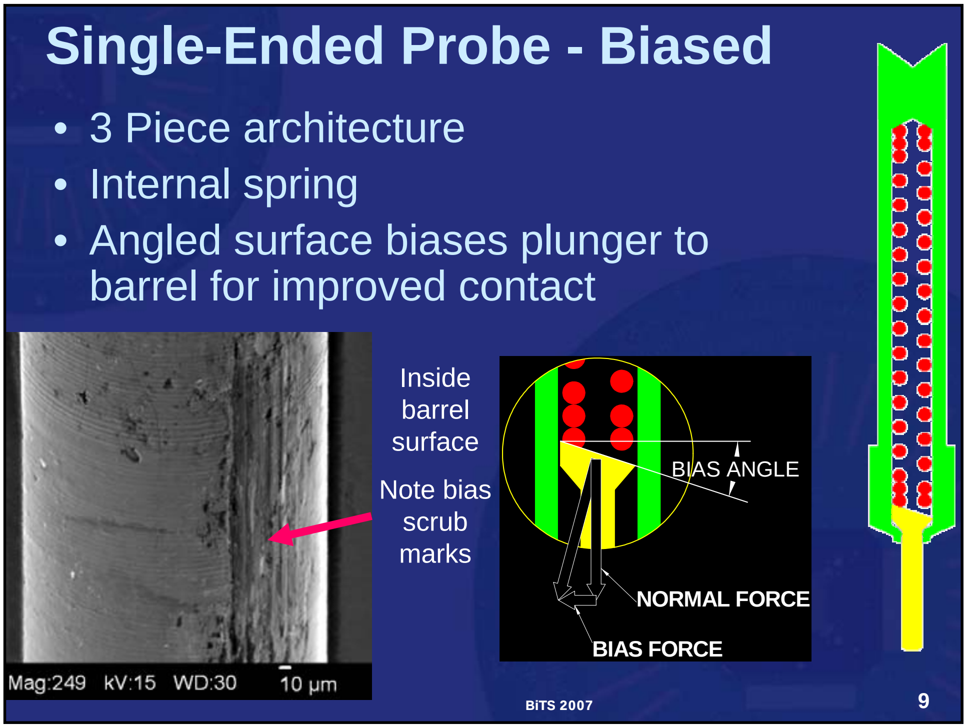


Performance Attributes

- Disadvantages
  - Long -> high inductance
  - Internal part wear
- Advantages
  - Improved contact resistance

$$R_{Contact} = \sum \left(R_{DUT-Plunger},\ R_{Plunger},\ R_{Plunger-Barrel},\ R_{Barrel},\ R_{Barrel-Plunger},\ R_{Plunger},\ R_{Plunger-PCB} \right)$$

Resistance Variation: HIGH / LOW

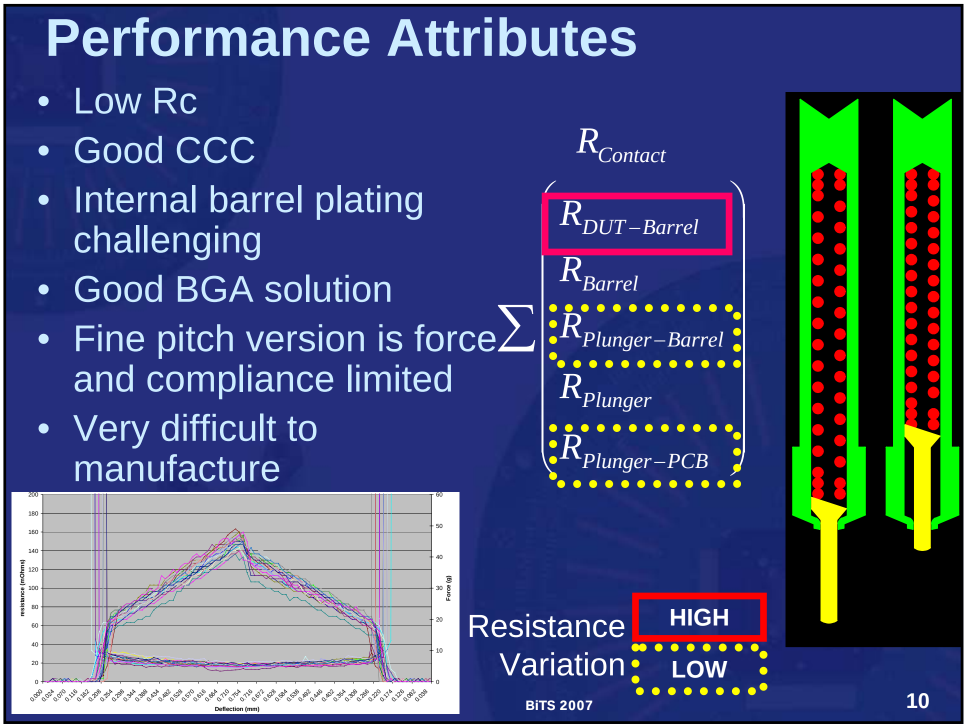


Single-Ended Probe - Biased

- 3 Piece architecture
- Internal spring
- Angled surface biases plunger to barrel for improved contact

Inside barrel surface

Note bias scrub marks

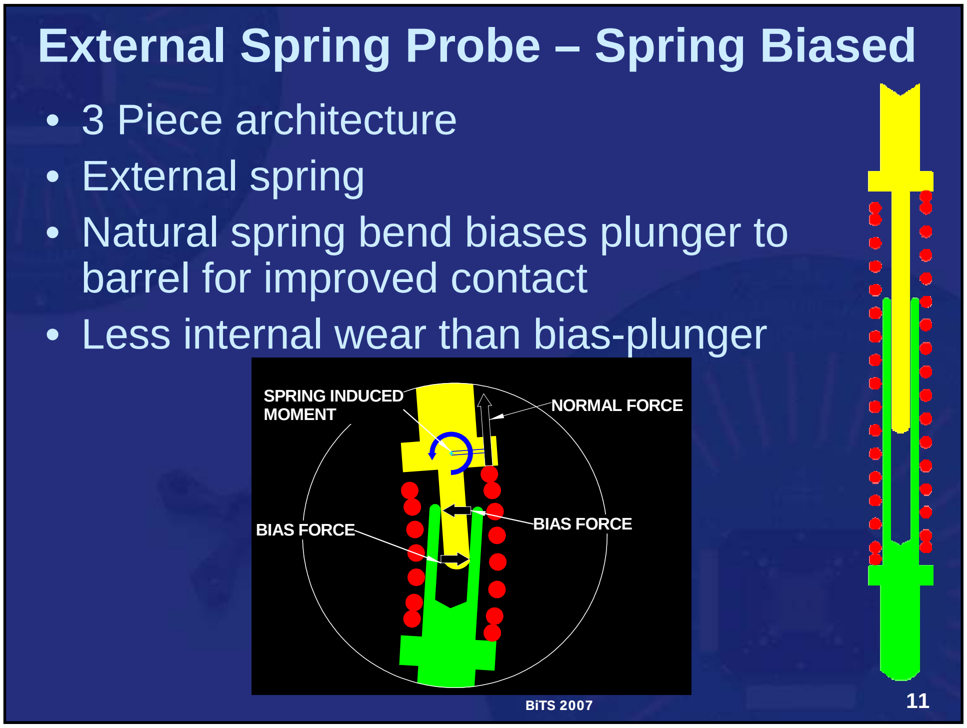


Performance Attributes

- Low Rc
- Good CCC
- Internal barrel plating challenging
- Good BGA solution
- Fine pitch version is force and compliance limited
- Very difficult to manufacture

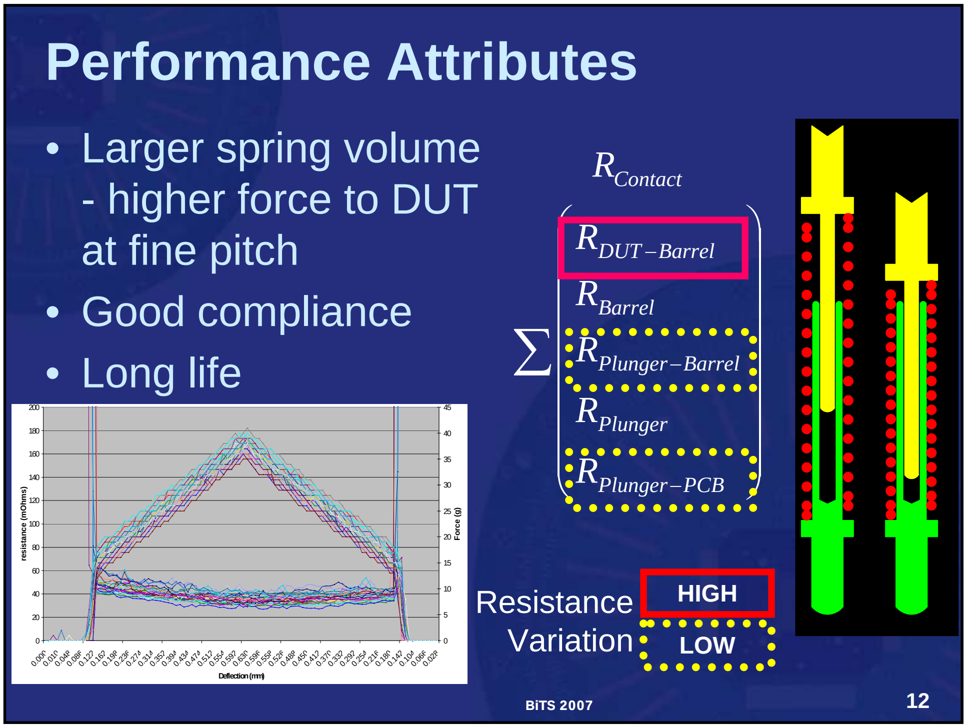
$$R_{Contact} = \sum \begin{pmatrix} \boxed{R_{DUT-Barrel}} \\ R_{Barrel} \\ \boxed{R_{Plunger-Barrel}} \\ R_{Plunger} \\ \boxed{R_{Plunger-PCB}} \end{pmatrix}$$

Resistance Variation: HIGH / LOW



External Spring Probe – Spring Biased

- 3 Piece architecture
- External spring
- Natural spring bend biases plunger to barrel for improved contact
- Less internal wear than bias-plunger

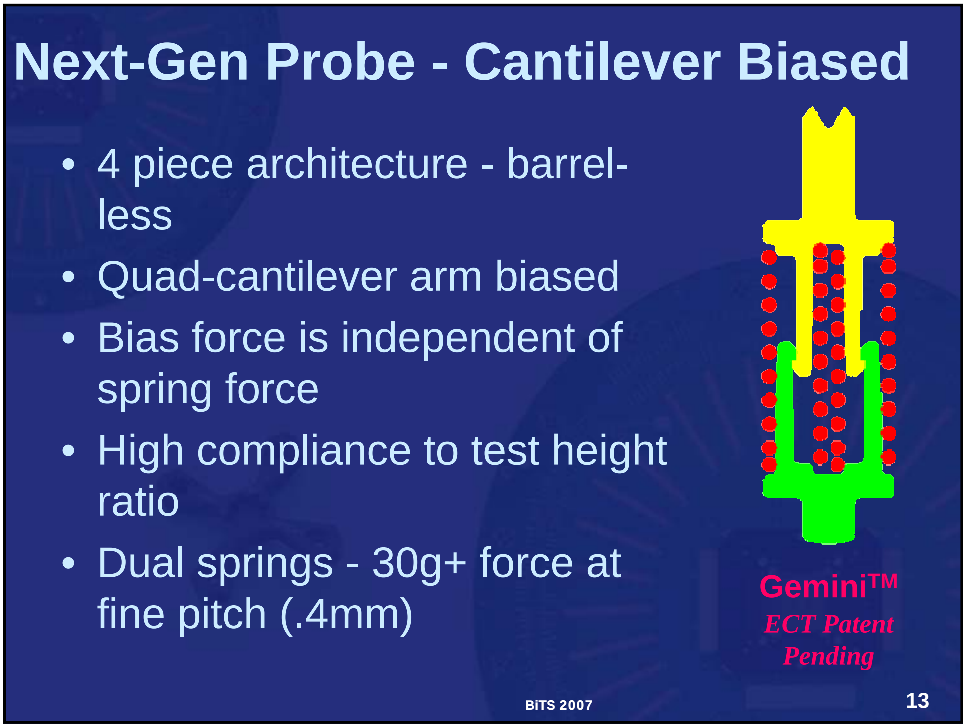


Performance Attributes

- Larger spring volume - higher force to DUT at fine pitch
- Good compliance
- Long life

$$R_{Contact} = \sum \begin{pmatrix} R_{DUT-Barrel} \\ R_{Barrel} \\ R_{Plunger-Barrel} \\ R_{Plunger} \\ R_{Plunger-PCB} \end{pmatrix}$$

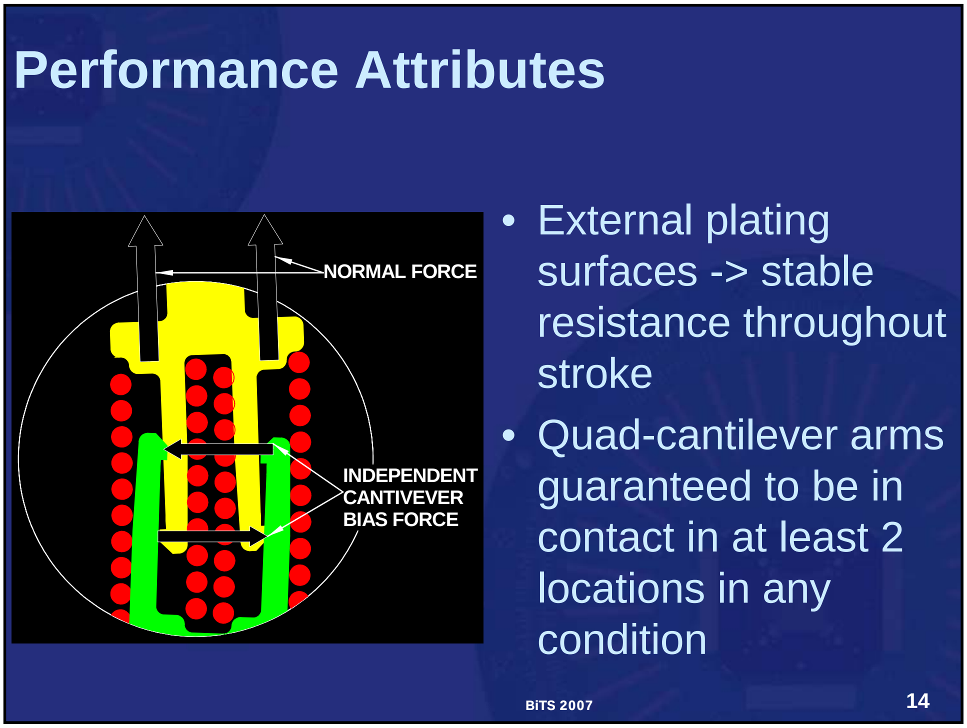
Resistance Variation: HIGH, LOW



Next-Gen Probe - Cantilever Biased

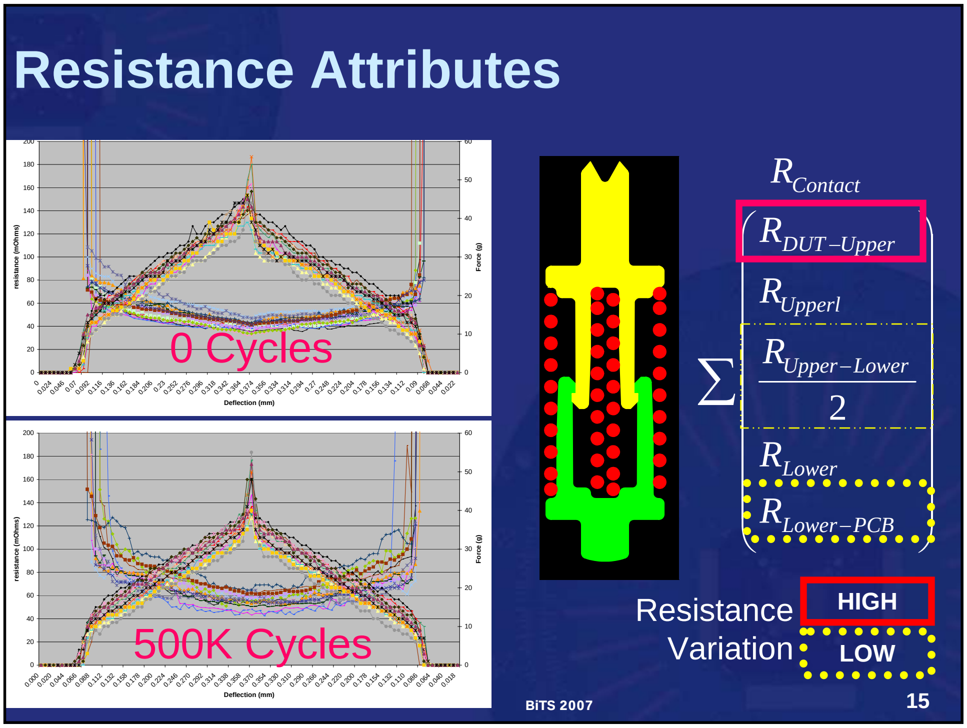
- 4 piece architecture - barrel-less
- Quad-cantilever arm biased
- Bias force is independent of spring force
- High compliance to test height ratio
- Dual springs - 30g+ force at fine pitch (.4mm)

Gemini™
ECT Patent Pending



Performance Attributes

- External plating surfaces -> stable resistance throughout stroke
- Quad-cantilever arms guaranteed to be in contact in at least 2 locations in any condition



Resistance Attributes

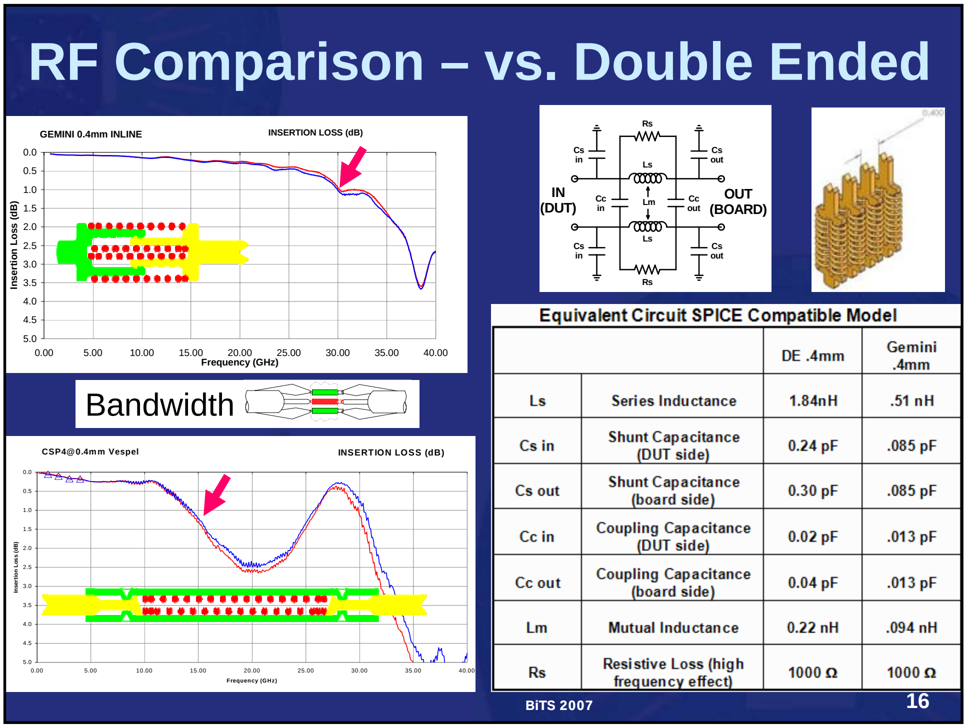
$$R_{Contact}$$

$$\sum \begin{pmatrix} R_{DUT-Upper} \\ R_{Upperl} \\ \frac{R_{Upper-Lower}}{2} \\ R_{Lower} \\ R_{Lower-PCB} \end{pmatrix}$$

Resistance Variation

HIGH

LOW



RF Comparison – vs. Double Ended

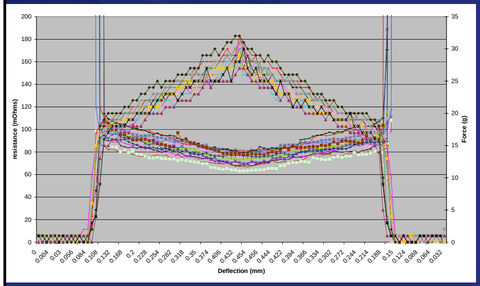
Bandwidth

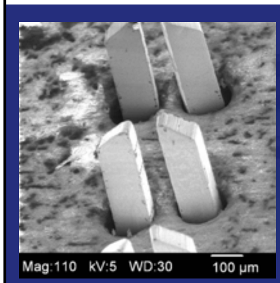
Equivalent Circuit SPICE Compatible Model

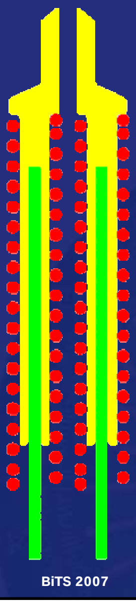
		DE .4mm	Gemini .4mm
Ls	Series Inductance	1.84nH	.51 nH
Cs in	Shunt Capacitance (DUT side)	0.24 pF	.085 pF
Cs out	Shunt Capacitance (board side)	0.30 pF	.085 pF
Cc in	Coupling Capacitance (DUT side)	0.02 pF	.013 pF
Cc out	Coupling Capacitance (board side)	0.04 pF	.013 pF
Lm	Mutual Inductance	0.22 nH	.094 nH
Rs	Resistive Loss (high frequency effect)	1000 Ω	1000 Ω

Paper #1

Design Flexibility - Scalability



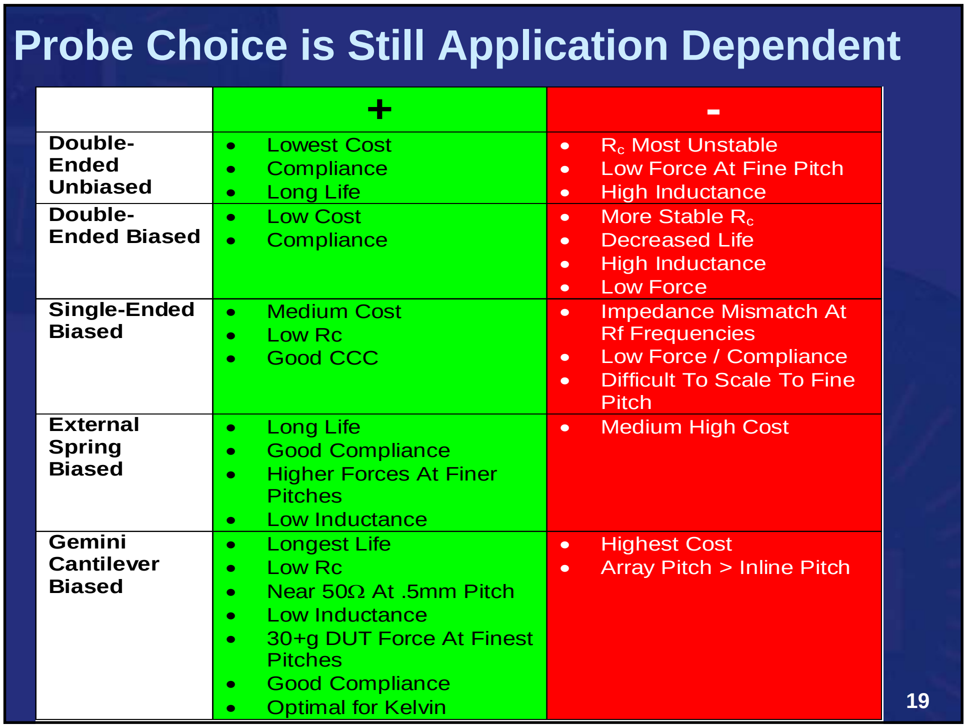




- Kelvin QFN
  - 0.15 mm force/sense tip spacing
  - 0.45mm PCB spacing
  - 30g
  - Cantilever biased
- BGA Kelvin

Proper Probe Selection Requires Understanding of the Test Application

- DUT performance characteristics
  - RF, power, resistance sensitivity, geometry
  - Test program pass/fail criteria
- Handler requirements
  - Alignment accuracy, available force, Z-stack variability
- Cost
  - Cost per probe – you get what you pay for
  - Cost over lifetime of socket - COO
  - Cost of test-cell down-time for socket maintenance
  - Test floor support



Probe Choice is Still Application Dependent

	+	-
Double-Ended Unbiased	Lowest Cost Compliance Long Life	R_c Most Unstable Low Force At Fine Pitch High Inductance
Double-Ended Biased	Low Cost Compliance	More Stable R_c Decreased Life High Inductance Low Force
Single-Ended Biased	Medium Cost Low Rc Good CCC	Impedance Mismatch At Rf Frequencies Low Force / Compliance Difficult To Scale To Fine Pitch
External Spring Biased	Long Life Good Compliance Higher Forces At Finer Pitches Low Inductance	Medium High Cost
Gemini Cantilever Biased	Longest Life Low Rc Near 50Ω At .5mm Pitch Low Inductance 30+g DUT Force At Finest Pitches Good Compliance Optimal for Kelvin	Highest Cost Array Pitch > Inline Pitch

Thank You – Questions?

"Off-set" Pin Contact Innovation - An Effective Contact Solution to Pb-Free Devices for MT8704iHF (Multitest) Test Handler

2007 Burn-in and Test Socket Workshop
March 11 - 14, 2007

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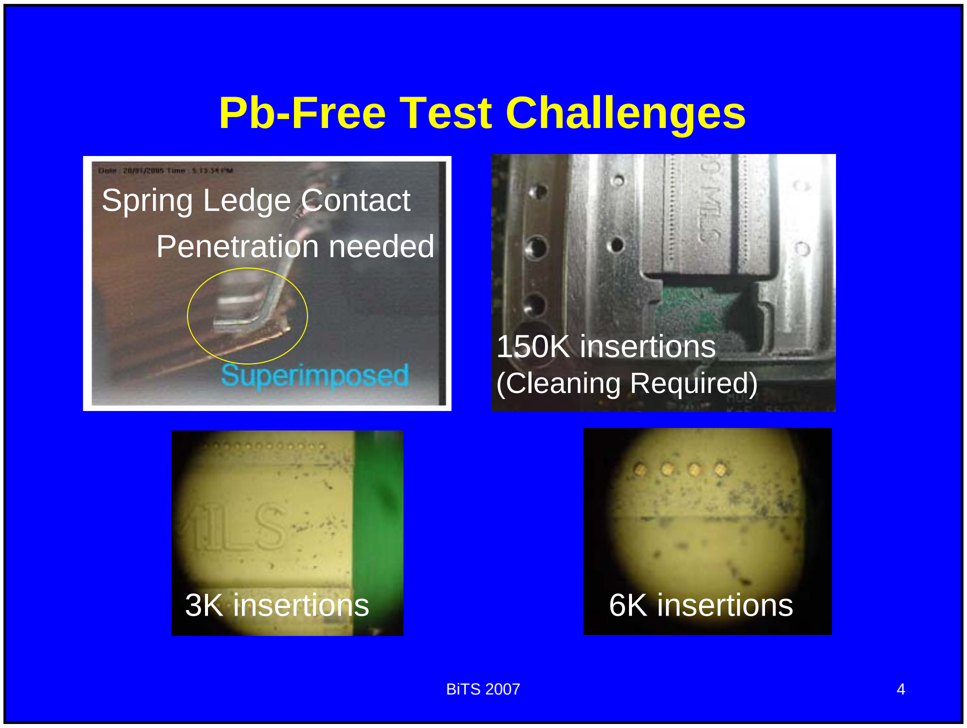
Agenda

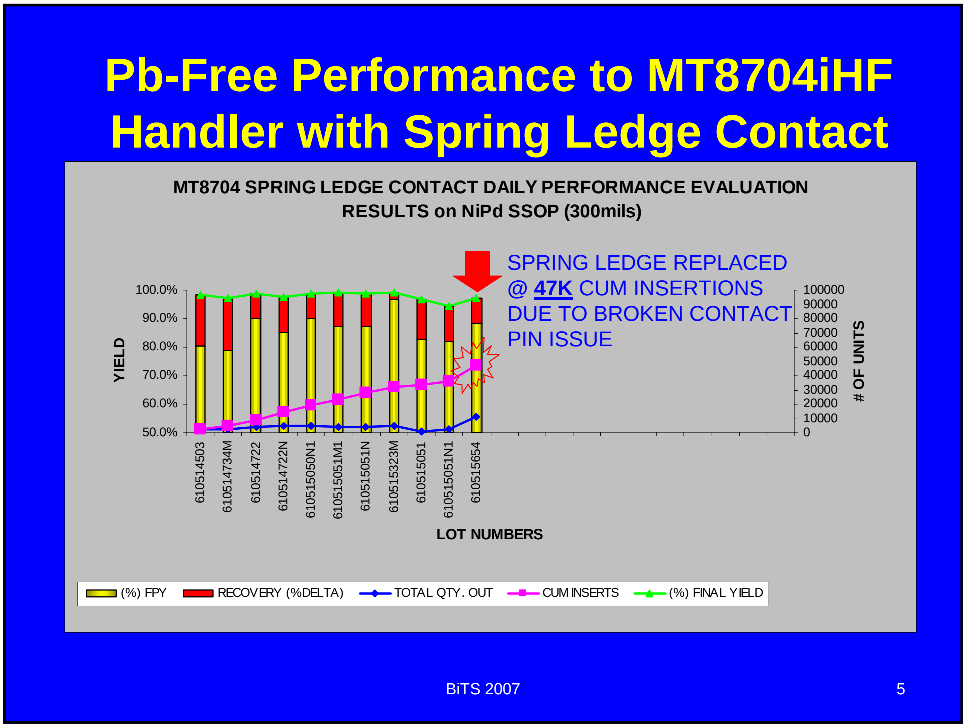
- Pb-Free Performance and Challenges to MT8704iHF Handler with Spring Ledge Contact Design
- Innovative Contactor Design Conversion without forcing to change the current set-up (DUT Boards, Lead Supports, etc)
- New Contactor Design Performance on Pb-Free Device for MT8704iHF Handler

Pb-Free Performance to MT8704iHF Handler with Spring Ledge Contact

- Low Yield with High Recovery Rate
- Poor Contact
- Early Breakage of Contact Pins
- Accumulation of Mold Debris - Contamination
- Mechanical Wear



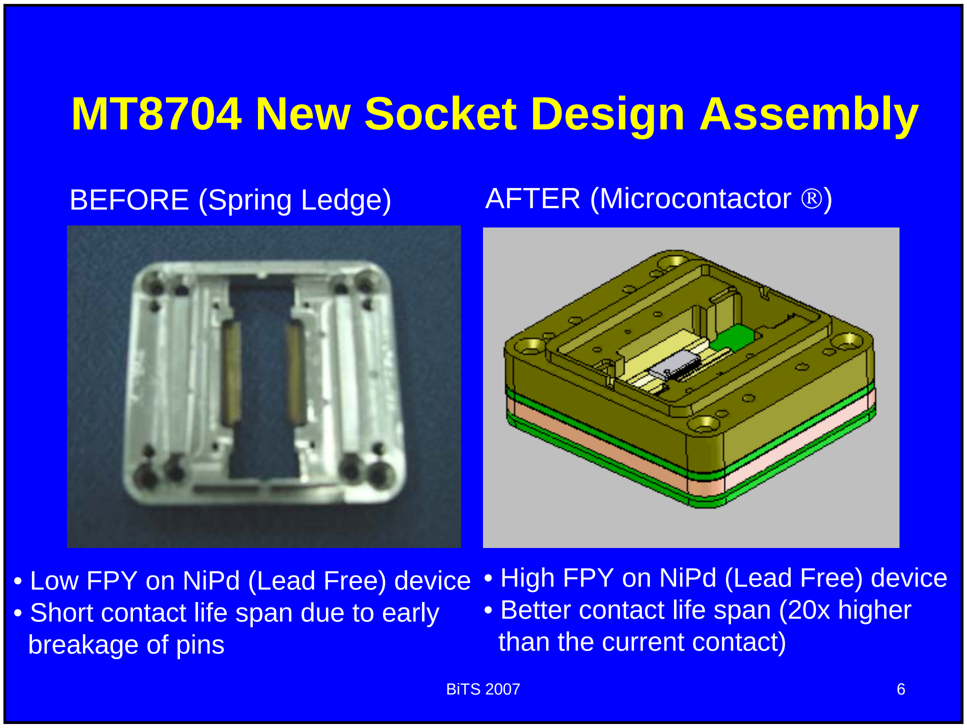
Pb-Free Test Challenges



Pb-Free Performance to MT8704iHF Handler with Spring Ledge Contact

MT8704 SPRING LEDGE CONTACT DAILY PERFORMANCE EVALUATION RESULTS on NiPd SSOP (300mils)

SPRING LEDGE REPLACED @ **47K** CUM INSERTIONS DUE TO BROKEN CONTACT PIN ISSUE



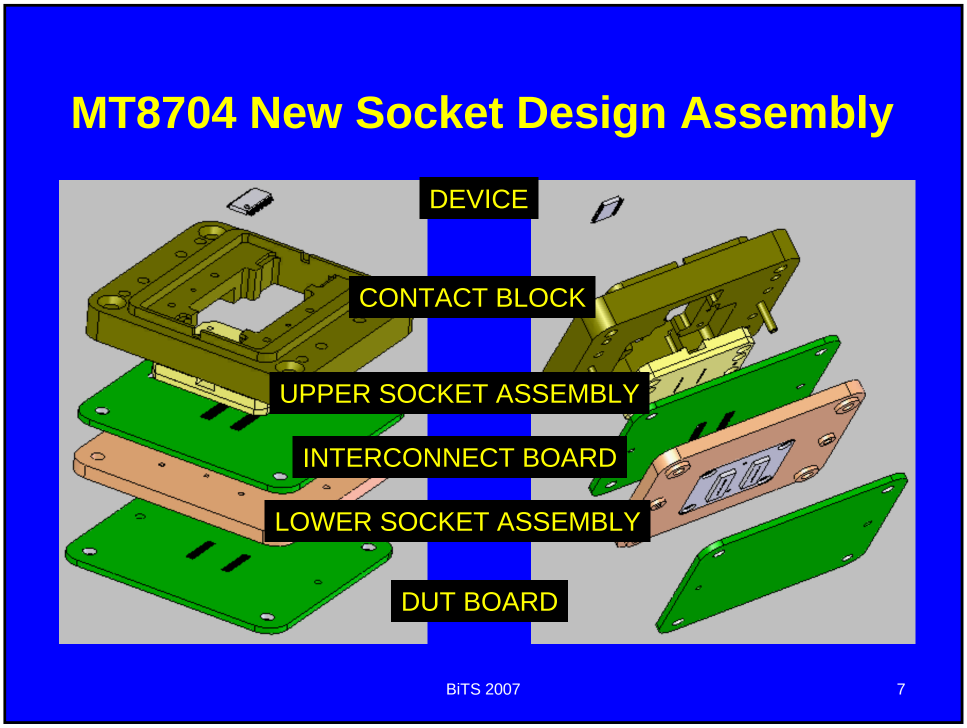
MT8704 New Socket Design Assembly

BEFORE (Spring Ledge)

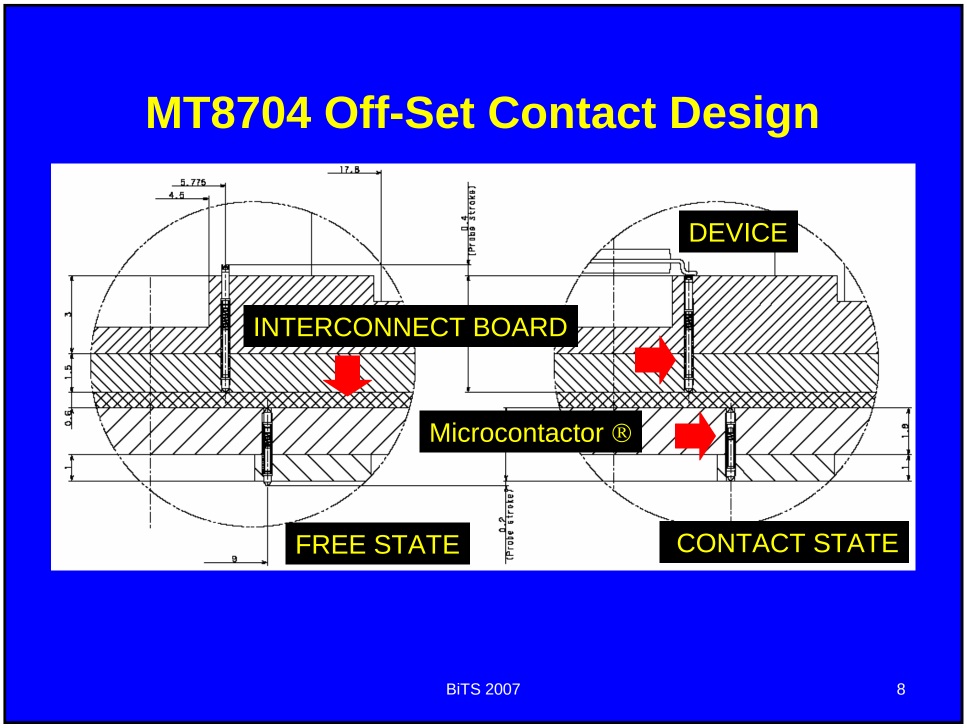
- Low FPY on NiPd (Lead Free) device
- Short contact life span due to early breakage of pins

AFTER (Microcontactor ®)

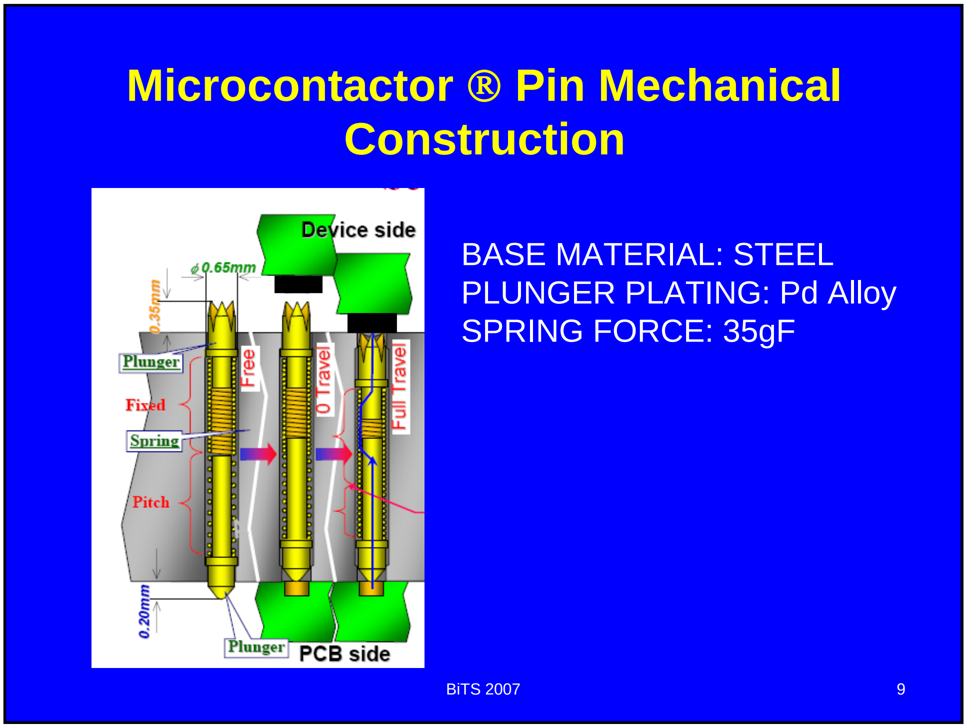
- High FPY on NiPd (Lead Free) device
- Better contact life span (20x higher than the current contact)



MT8704 New Socket Design Assembly

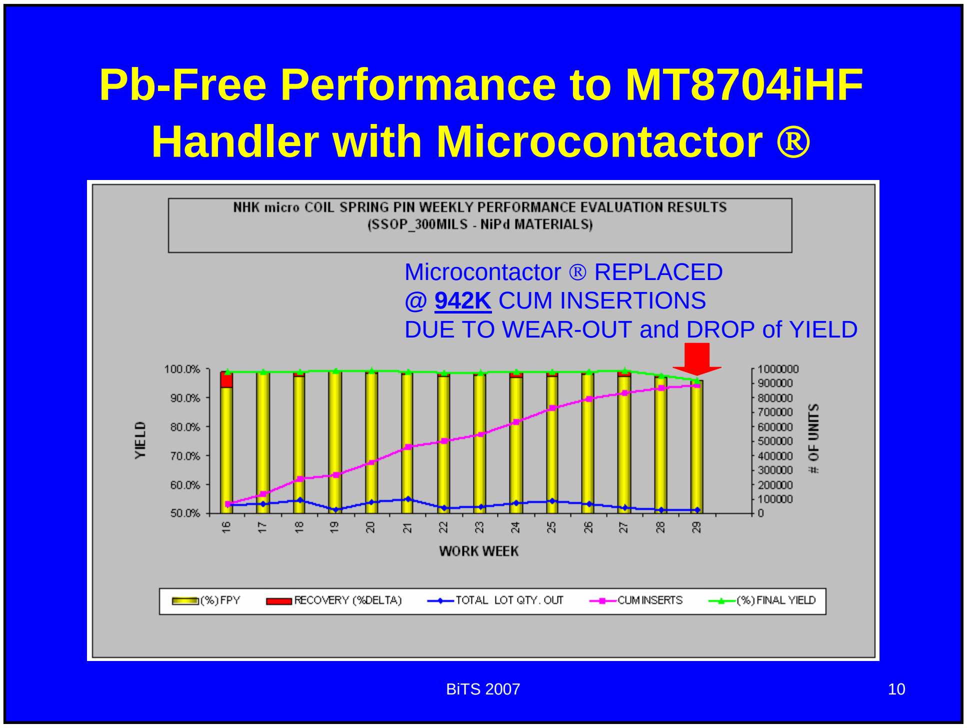


MT8704 Off-Set Contact Design



Microcontactor ® Pin Mechanical Construction

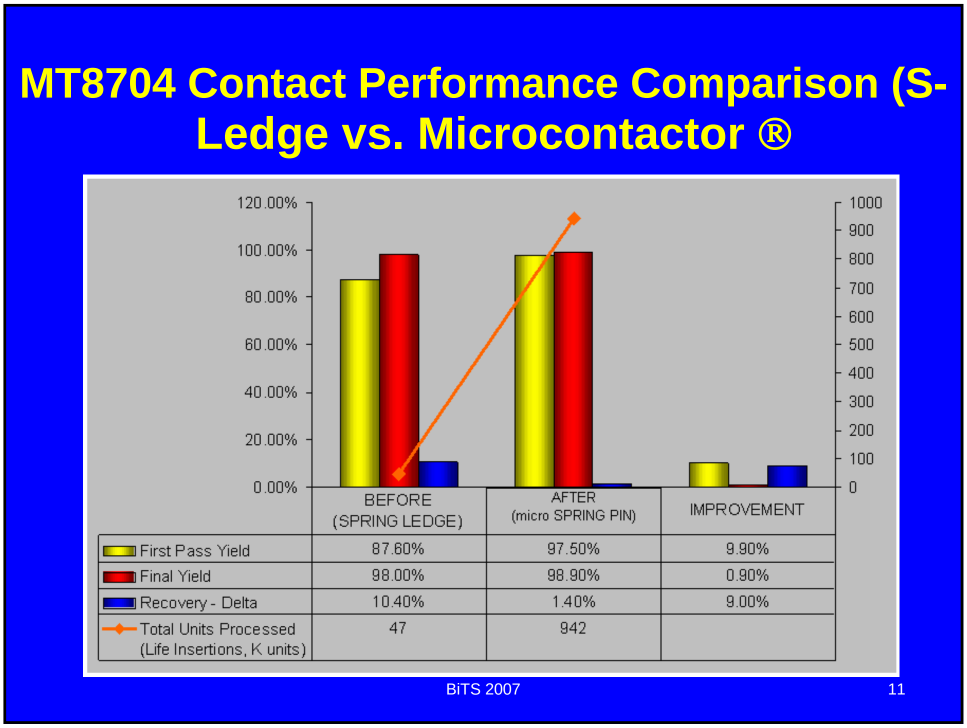
BASE MATERIAL: STEEL
PLUNGER PLATING: Pd Alloy
SPRING FORCE: 35gF



Pb-Free Performance to MT8704iHF Handler with Microcontactor ®

NHK micro COIL SPRING PIN WEEKLY PERFORMANCE EVALUATION RESULTS
(SSOP_300MILS - NiPd MATERIALS)

Microcontactor ® REPLACED
@ **942K** CUM INSERTIONS
DUE TO WEAR-OUT and DROP of YIELD



MT8704 Contact Performance Comparison (S-Ledge vs. Microcontactor ®

	BEFORE (SPRING LEDGE)	AFTER (micro SPRING PIN)	IMPROVEMENT
First Pass Yield	87.60%	97.50%	9.90%
Final Yield	98.00%	98.90%	0.90%
Recovery - Delta	10.40%	1.40%	9.00%
Total Units Processed (Life Insertions, K units)	47	942	

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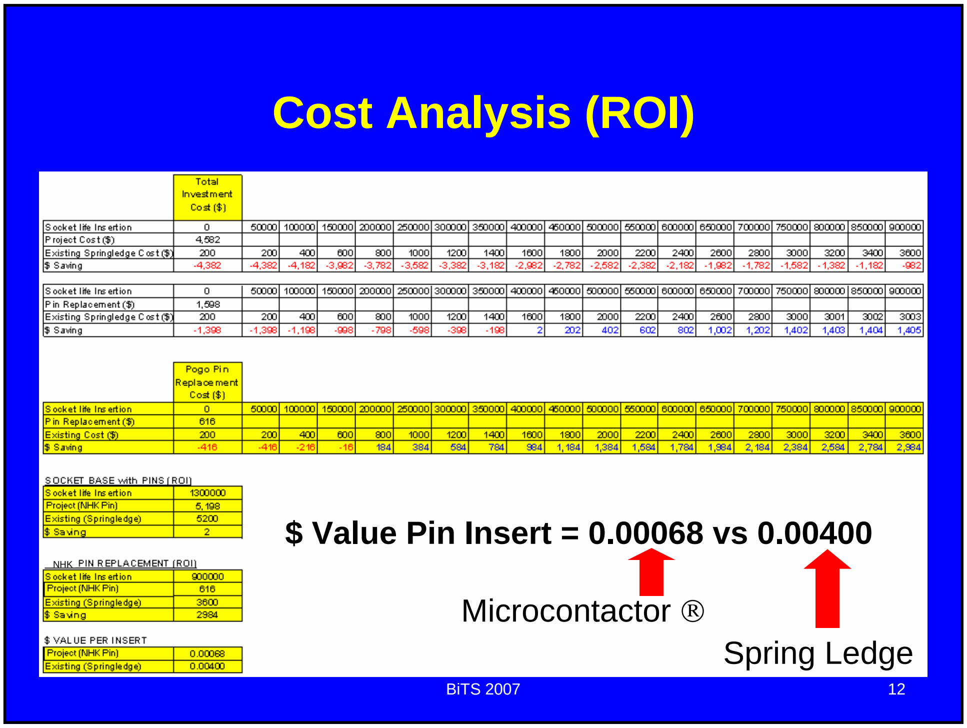

Cost Analysis (ROI)

	Total Investment Cost ($)																		
Socket life Insertion	0	50000	100000	150000	200000	250000	300000	350000	400000	450000	500000	550000	600000	650000	700000	750000	800000	850000	900000
Project Cost ($)	4,582																		
Existing Springledge Cost ($)	200	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600
$ Saving	-4,382	-4,382	-4,182	-3,982	-3,782	-3,582	-3,382	-3,182	-2,982	-2,782	-2,582	-2,382	-2,182	-1,982	-1,782	-1,582	-1,382	-1,182	-982

Socket life Insertion	0	50000	100000	150000	200000	250000	300000	350000	400000	450000	500000	550000	600000	650000	700000	750000	800000	850000	900000
Pin Replacement ($)	1,598																		
Existing Springledge Cost ($)	200	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3001	3002	3003
$ Saving	-1,398	-1,398	-1,198	-998	-798	-598	-398	-198	2	202	402	602	802	1,002	1,202	1,402	1,403	1,404	1,405

	Pogo Pin Replacement Cost ($)																		
Socket life Insertion	0	50000	100000	150000	200000	250000	300000	350000	400000	450000	500000	550000	600000	650000	700000	750000	800000	850000	900000
Pin Replacement ($)	616																		
Existing Cost ($)	200	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600
$ Saving	-416	-416	-216	-16	184	384	584	784	984	1,184	1,384	1,584	1,784	1,984	2,184	2,384	2,584	2,784	2,984

SOCKET BASE with PINS (ROI)

Socket life Insertion	1300000
Project (NHK Pin)	5,198
Existing (Springledge)	5200
$ Saving	2

NHK PIN REPLACEMENT (ROI)

Socket life Insertion	900000
Project (NHK Pin)	616
Existing (Springledge)	3600
$ Saving	2984

$ VALUE PER INSERT

Project (NHK Pin)	0.00068
Existing (Springledge)	0.00400

$ Value Pin Insert = 0.00068 vs 0.00400

Microcontactor ®

Spring Ledge

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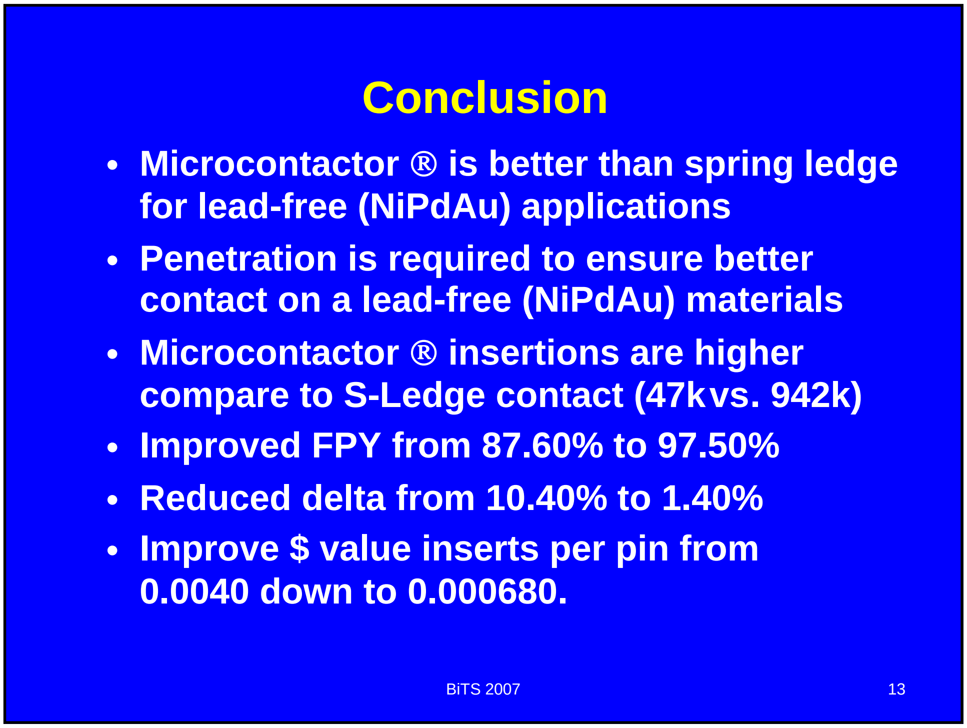

Conclusion

- Microcontactor ® is better than spring ledge for lead-free (NiPdAu) applications
- Penetration is required to ensure better contact on a lead-free (NiPdAu) materials
- Microcontactor ® insertions are higher compare to S-Ledge contact (47kvs. 942k)
- Improved FPY from 87.60% to 97.50%
- Reduced delta from 10.40% to 1.40%
- Improve $ value inserts per pin from 0.0040 down to 0.000680.

BRAIDED ELECTRICAL CONTACT ELEMENT (BeCe)

Che-Yu Li

Che-Yu Li and Company, LLC

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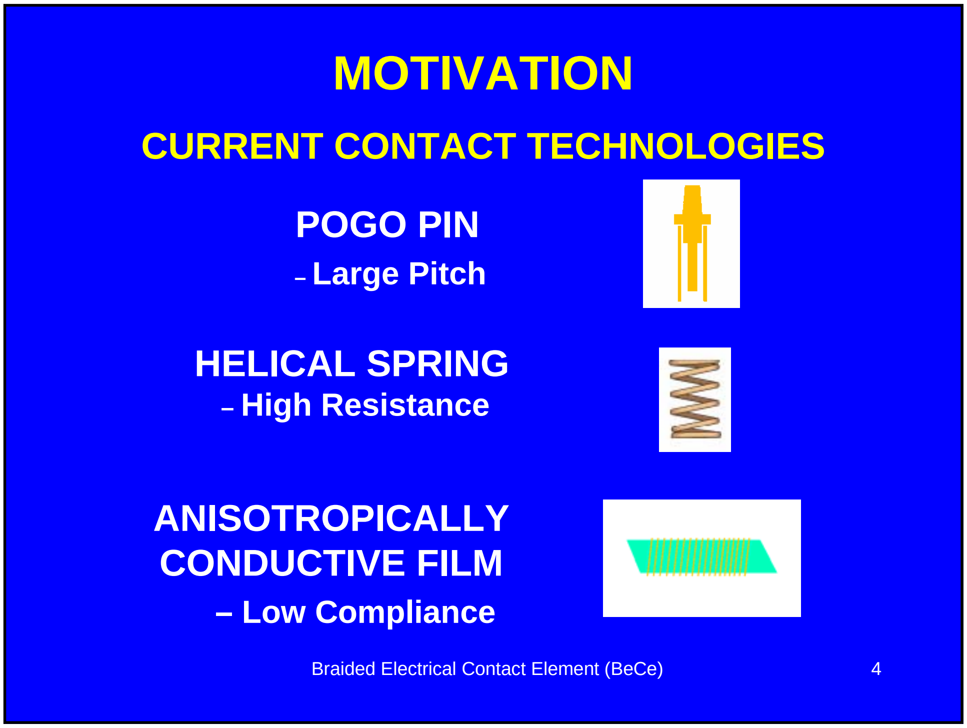
OUTLINE

- Motivation
- Braided Electrical Contact Element
  - Design
  - Performance
- Interposer
- Conclusions

MOTIVATION

- Requirements
  - Fine Pitch
  - Low Resistance and Inductance
  - Low Contact Force and High Compliance
  - High Durability and Reliability
  - High Service Temperature



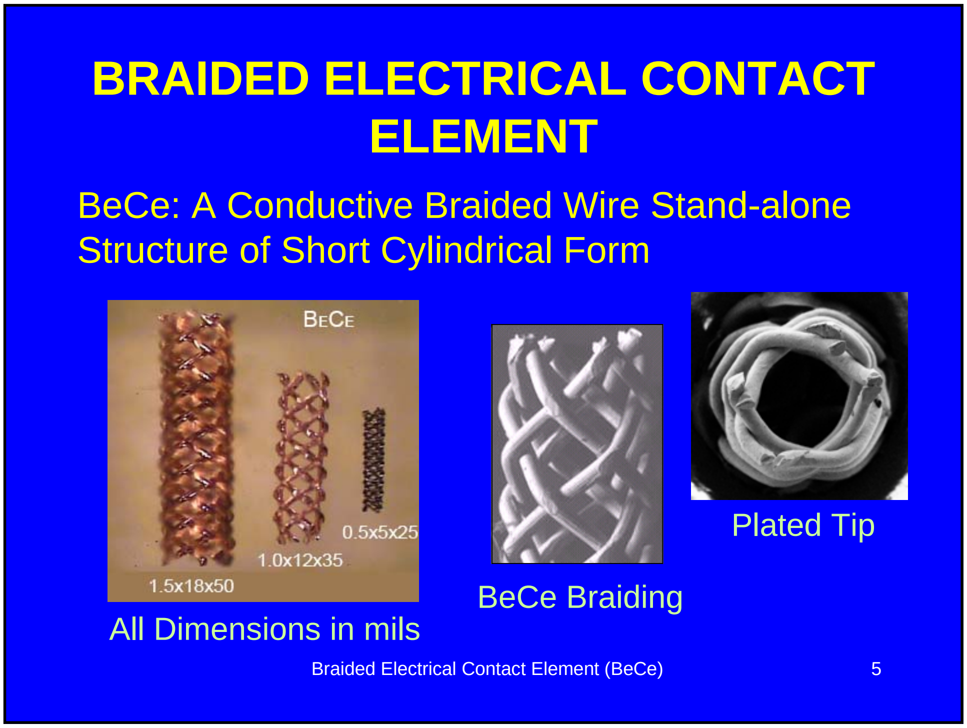
MOTIVATION

CURRENT CONTACT TECHNOLOGIES

POGO PIN
– Large Pitch

HELICAL SPRING
– High Resistance

ANISOTROPICALLY CONDUCTIVE FILM
– Low Compliance



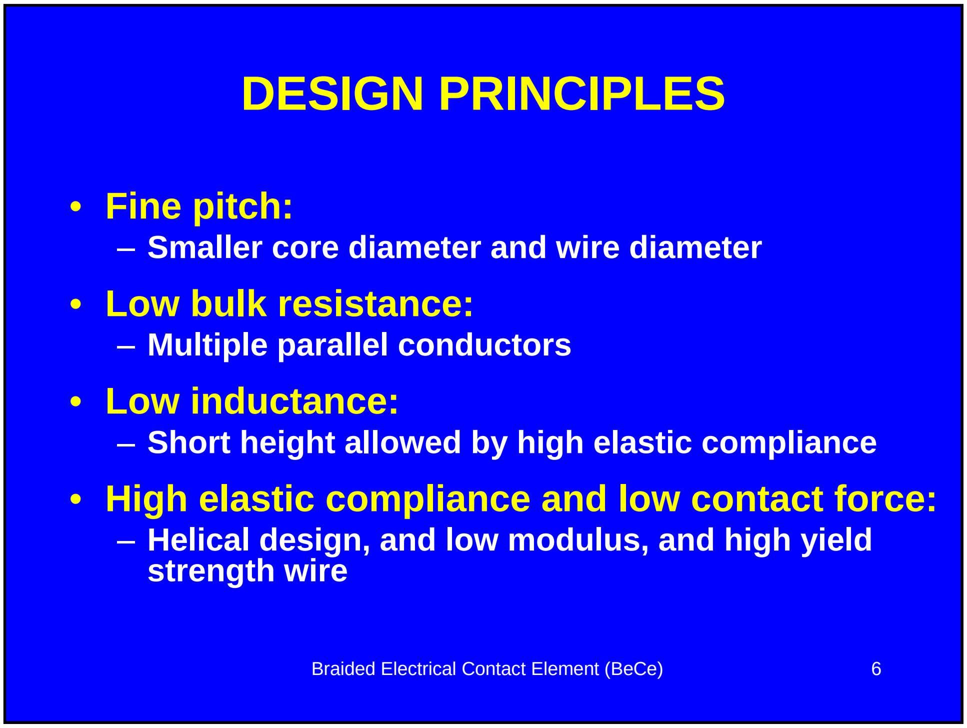
BRAIDED ELECTRICAL CONTACT ELEMENT

BeCe: A Conductive Braided Wire Stand-alone Structure of Short Cylindrical Form

All Dimensions in mils

BeCe Braiding

Plated Tip

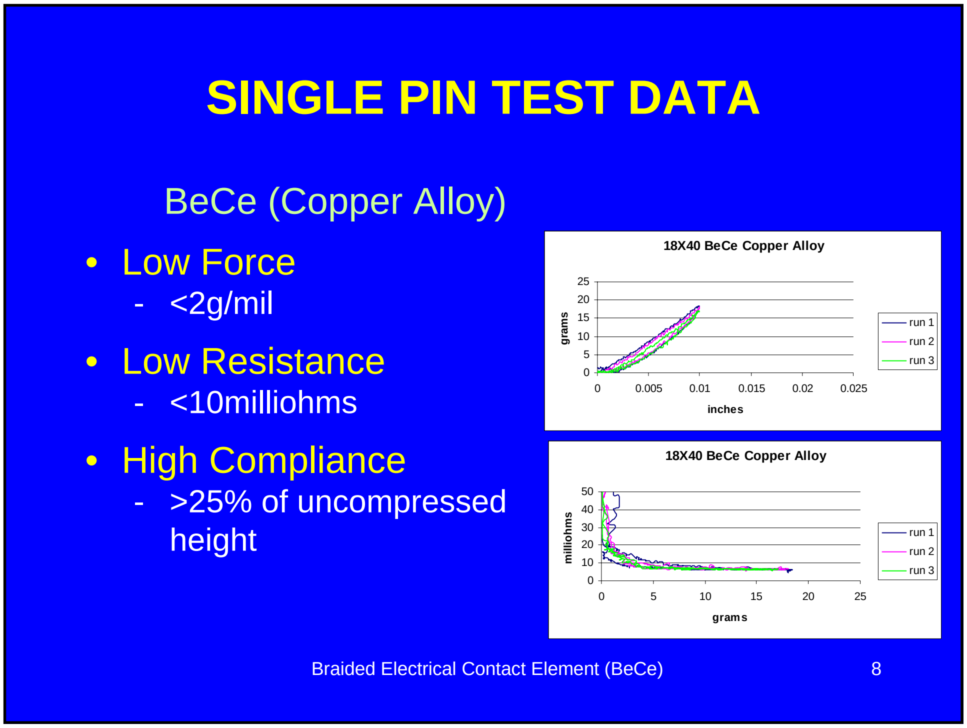


DESIGN PRINCIPLES

- **Fine pitch:**
  - Smaller core diameter and wire diameter
- **Low bulk resistance:**
  - Multiple parallel conductors
- **Low inductance:**
  - Short height allowed by high elastic compliance
- **High elastic compliance and low contact force:**
  - Helical design, and low modulus, and high yield strength wire

DESIGN PRINCIPLES (cont.)

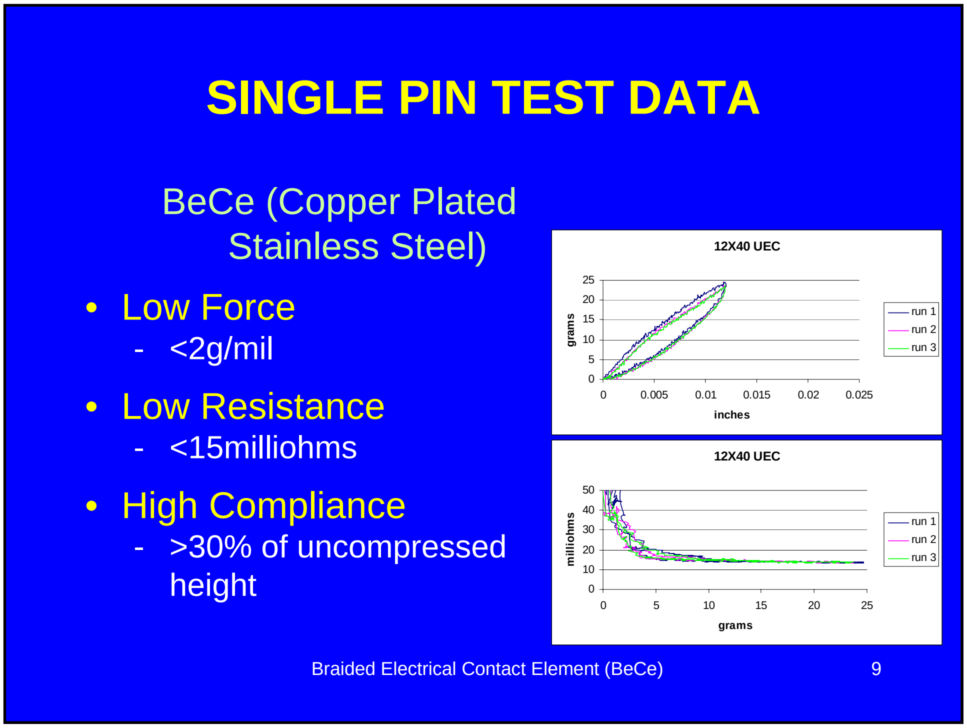
Low contact resistance and high reliability:
  - **Multiple contact tips**
- **High durability:**
  - **Vacuum melted wire stock**
- **High service temperature:**
  - **High melting temperature of wire**



SINGLE PIN TEST DATA

BeCe (Copper Alloy)

- Low Force
  - <2g/mil
- Low Resistance
  - <10milliohms
- High Compliance
  - >25% of uncompressed height

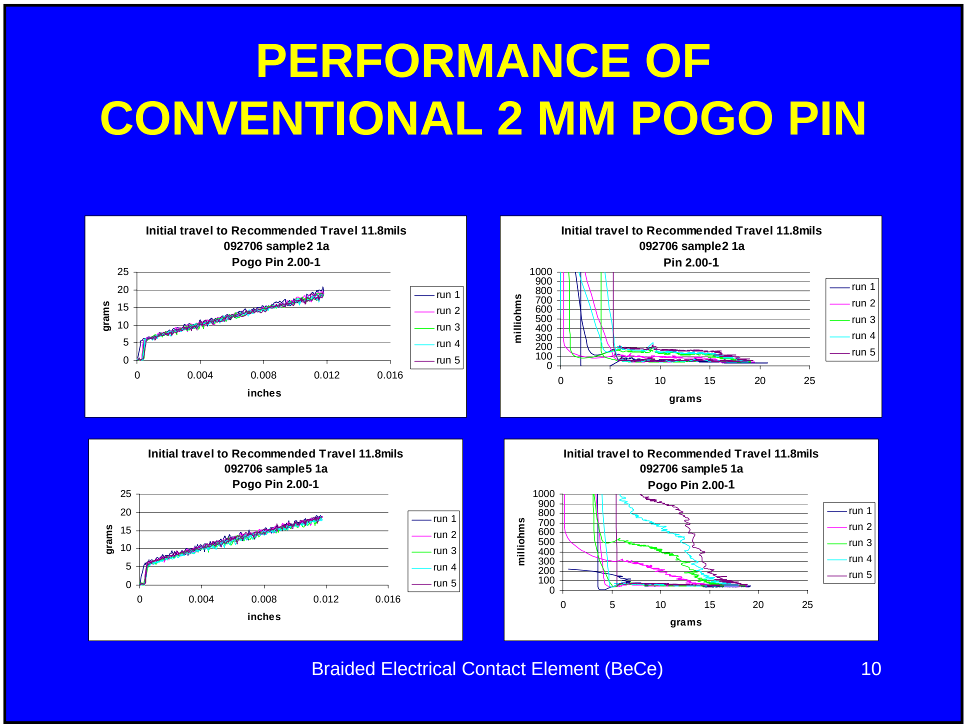


SINGLE PIN TEST DATA

BeCe (Copper Plated Stainless Steel)

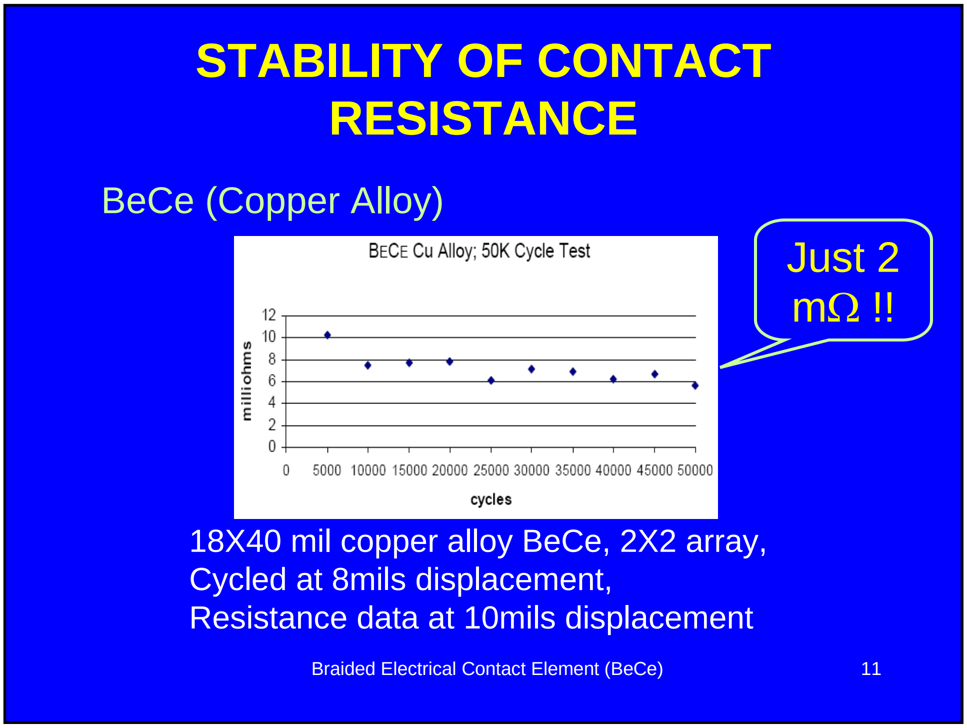
- Low Force
  - <2g/mil
- Low Resistance
  - <15milliohms
- High Compliance
  - >30% of uncompressed height

Braided Electrical Contact Element (BeCe) 9



PERFORMANCE OF CONVENTIONAL 2 MM POGO PIN

Braided Electrical Contact Element (BeCe) 10

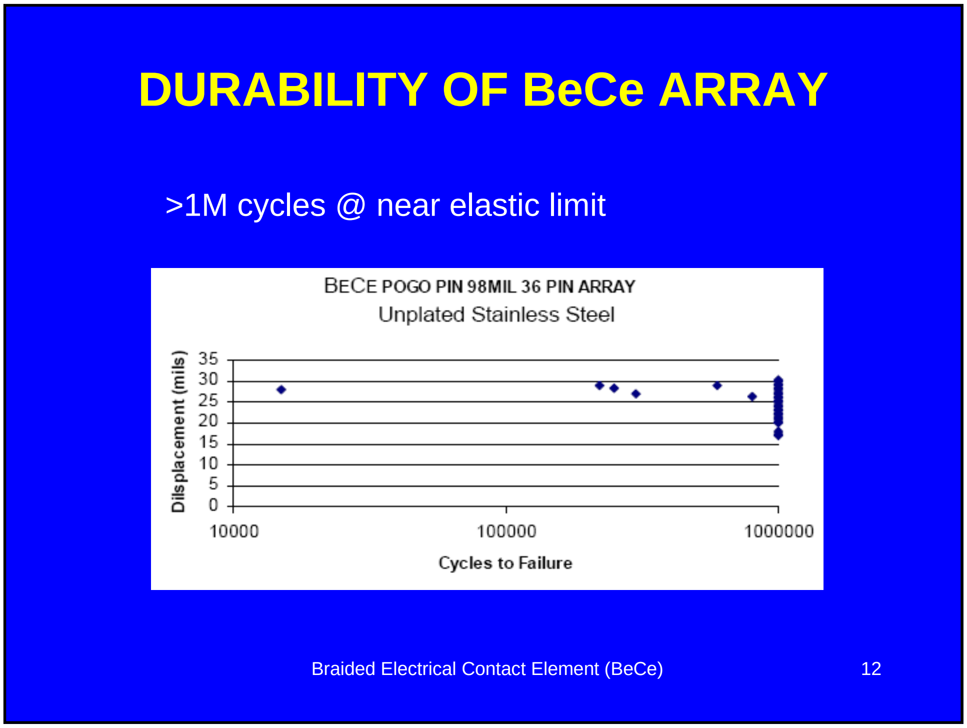


STABILITY OF CONTACT RESISTANCE

BeCe (Copper Alloy)

Just 2 mΩ !!

18X40 mil copper alloy BeCe, 2X2 array,
Cycled at 8mils displacement,
Resistance data at 10mils displacement



DURABILITY OF BeCe ARRAY

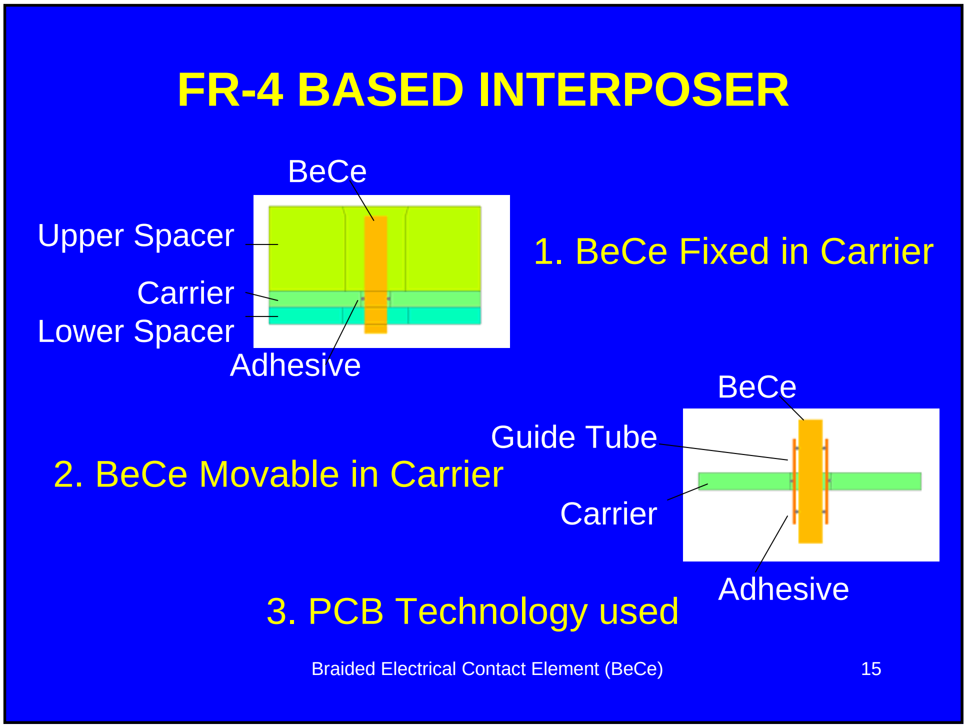
>1M cycles @ near elastic limit

SUMMARY OF ATTRIBUTES

- Normal Elastic Compliance up to 30% of Uncompressed Height and Average Contact Force of 15 Grams per BeCe or Less
- 10 mΩ or Less Total Resistance Per BeCe Contacting Solder Bump or Contact Pad, or Soldered
- 10 GHz or More Frequency Capability
- Demonstrated 1M or More Touchdowns and 50K or More Touchdowns Between Cleaning

SUMMARY OF ATTRIBUTES

- Service Temperature of >250° C.
- High Reliability: >1M cycles @ near elastic limit
- Connection Pitch to 10 mils or Less With I/O Counts to 5000 or More With Solderable Ends, or Wire-Bondable at One End
- Low Cost Manufacturing



FR-4 BASED INTERPOSER

BeCe
Upper Spacer
Carrier
Lower Spacer
Adhesive

1. BeCe Fixed in Carrier

BeCe
Guide Tube
Carrier
Adhesive

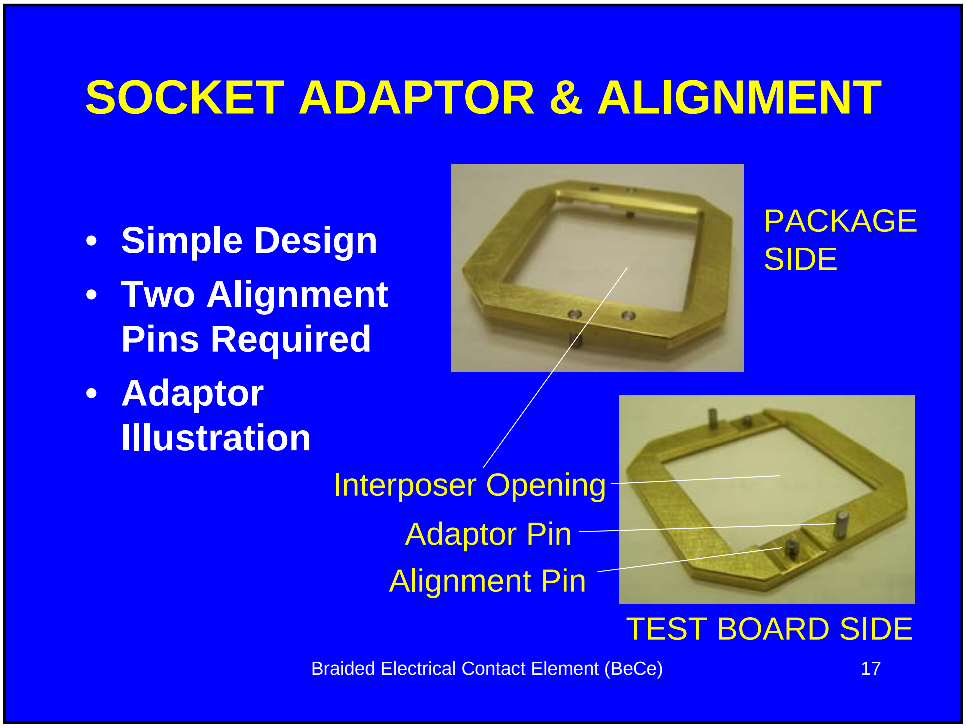
2. BeCe Movable in Carrier

3. PCB Technology used

FR-4 BASED INTERPOSER

Populated With 1247 BeCe Contacts, Fixed in Carrier

18X50 BeCe, 1247 I/O, .040” Pitch
1.65” X 1.25” Overall



SOCKET ADAPTOR & ALIGNMENT

- Simple Design
- Two Alignment Pins Required
- Adaptor Illustration

PACKAGE SIDE

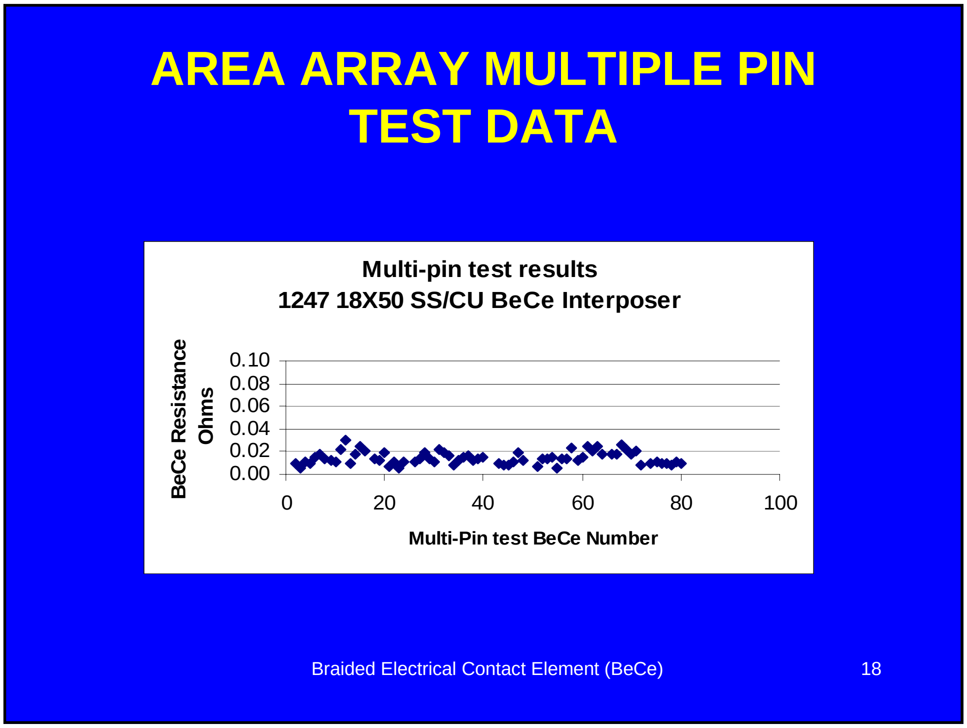
Interposer Opening

Adaptor Pin

Alignment Pin

TEST BOARD SIDE

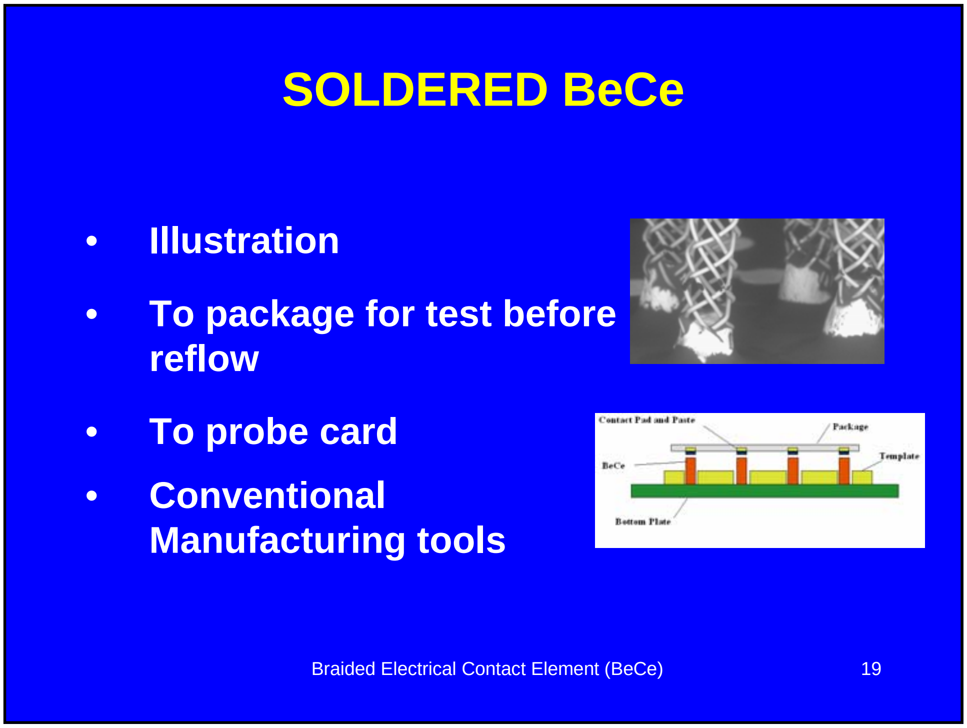
Braided Electrical Contact Element (BeCe) 17



AREA ARRAY MULTIPLE PIN TEST DATA

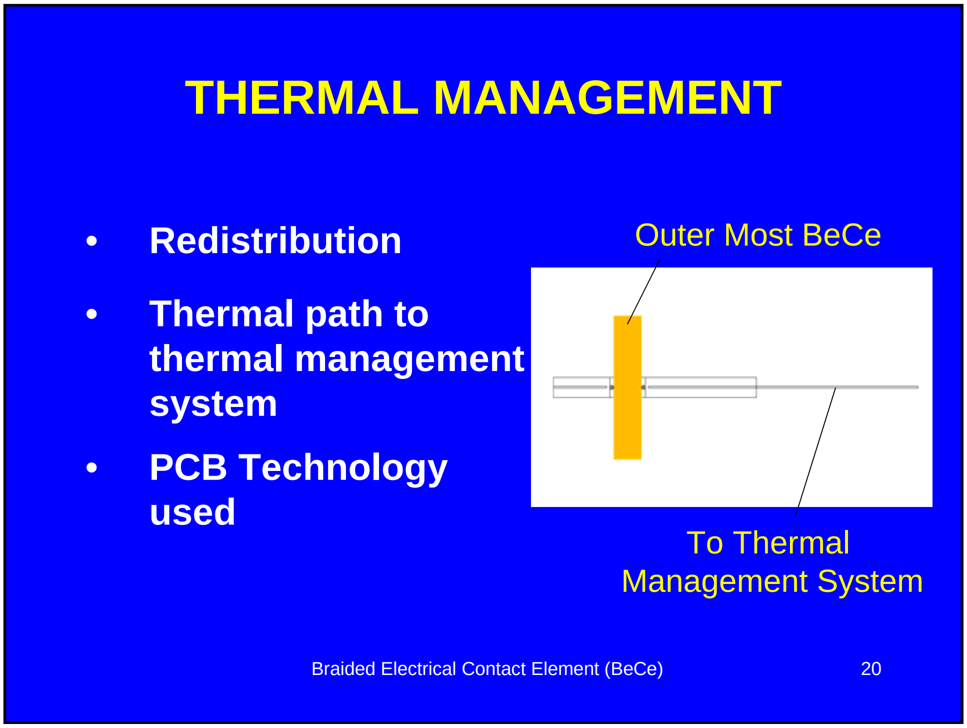
Multi-pin test results
1247 18X50 SS/CU BeCe Interposer

Braided Electrical Contact Element (BeCe) 18



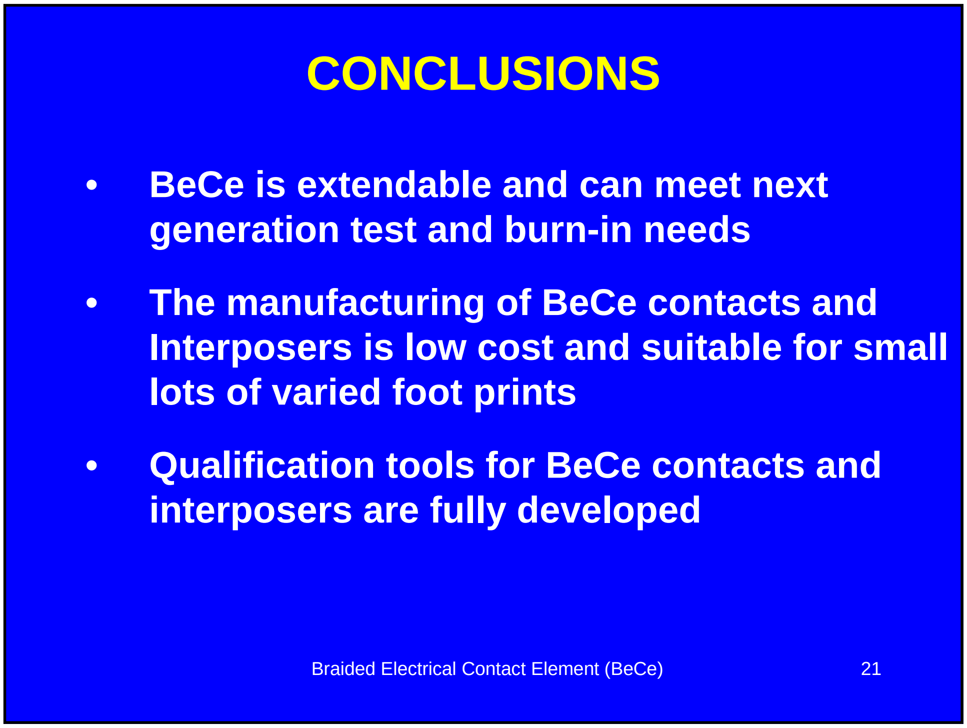
SOLDERED BeCe

- Illustration
- To package for test before reflow
- To probe card
- Conventional Manufacturing tools



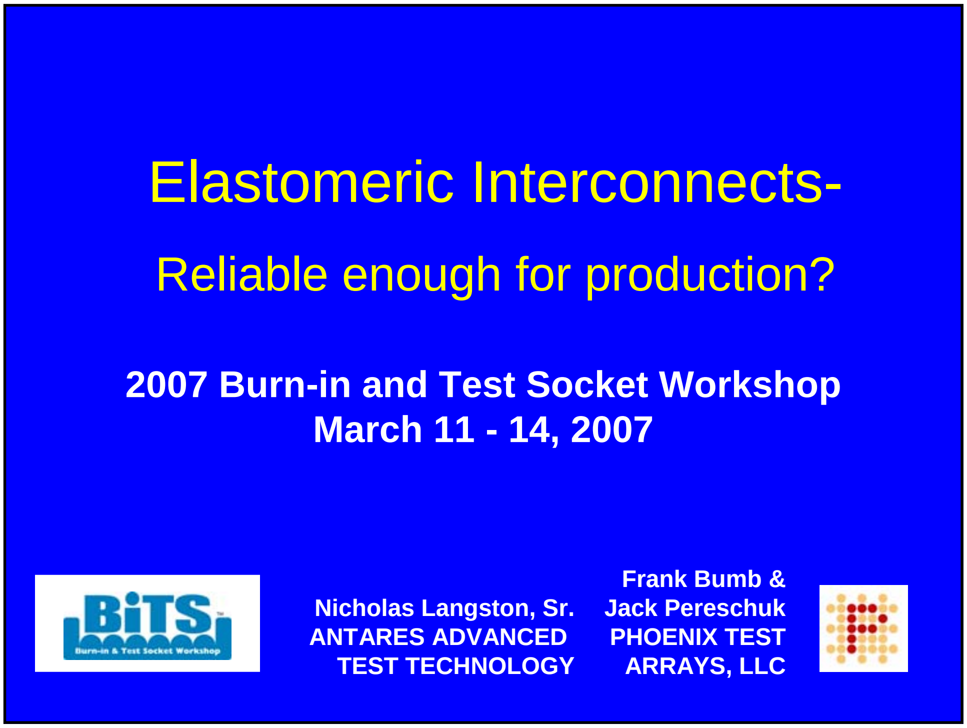
THERMAL MANAGEMENT

- Redistribution
- Thermal path to thermal management system
- PCB Technology used



CONCLUSIONS

- BeCe is extendable and can meet next generation test and burn-in needs
- The manufacturing of BeCe contacts and Interposers is low cost and suitable for small lots of varied foot prints
- Qualification tools for BeCe contacts and interposers are fully developed



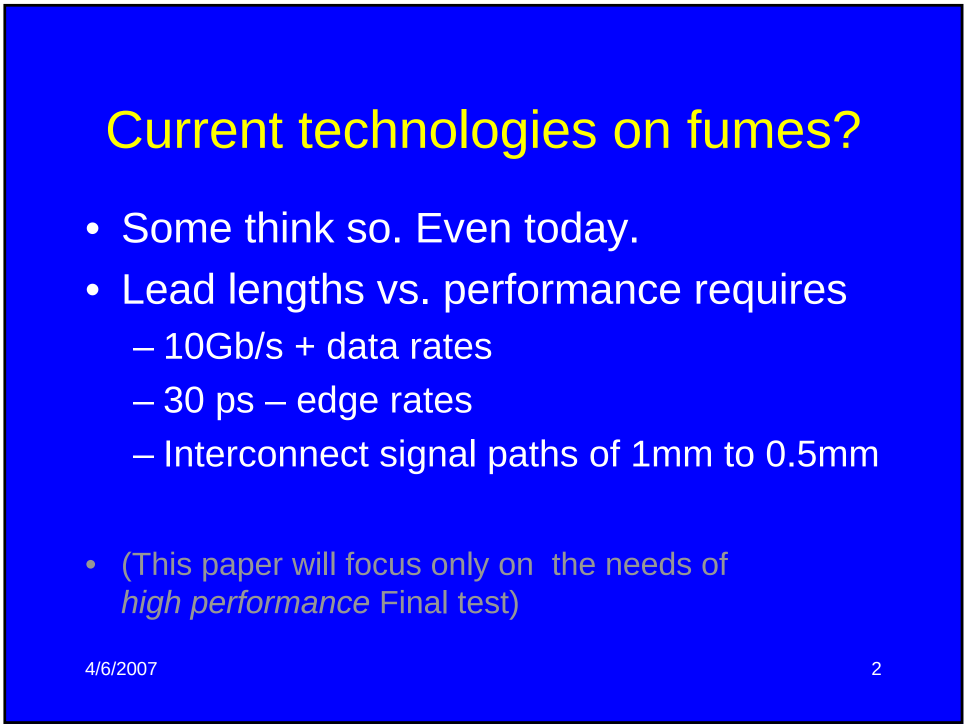
Elastomeric Interconnects-

Reliable enough for production?

2007 Burn-in and Test Socket Workshop
March 11 - 14, 2007

Nicholas Langston, Sr.
ANTARES ADVANCED TEST TECHNOLOGY

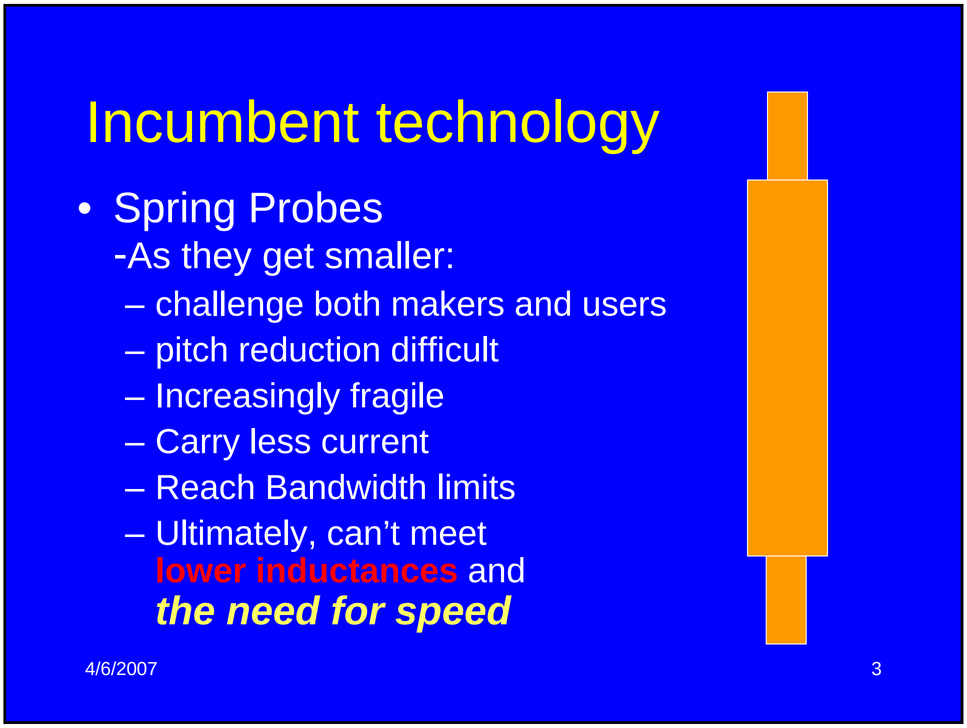
Frank Bumb &
Jack Pereschuk
PHOENIX TEST ARRAYS, LLC



Current technologies on fumes?

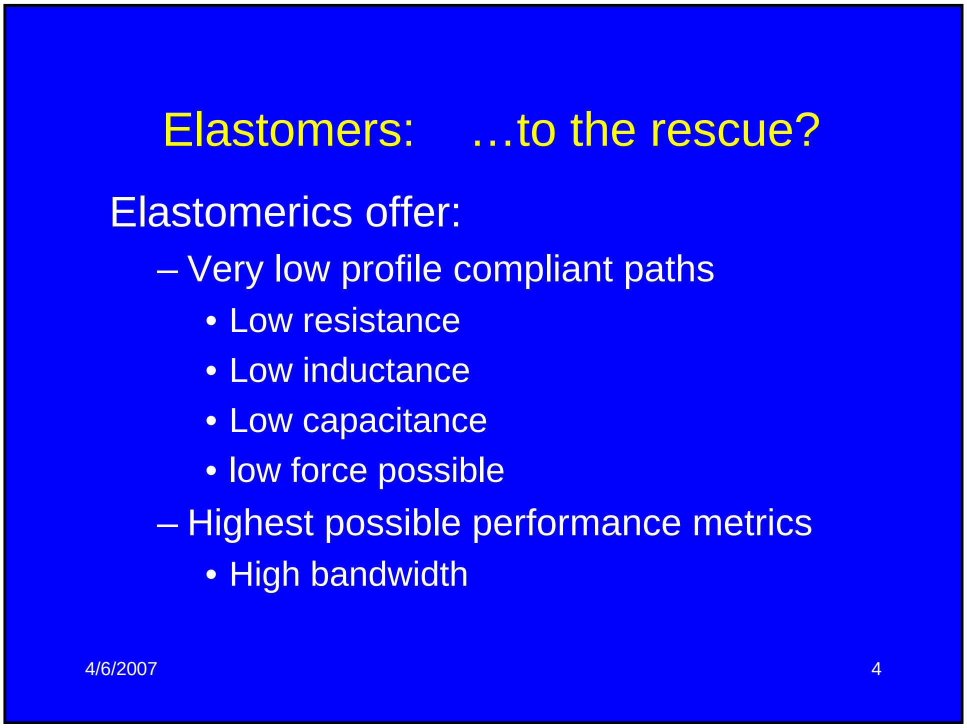
- Some think so. Even today.
- Lead lengths vs. performance requires
  - 10Gb/s + data rates
  - 30 ps – edge rates
  - Interconnect signal paths of 1mm to 0.5mm

- (This paper will focus only on the needs of *high performance* Final test)



Incumbent technology

- Spring Probes
  -As they get smaller:
  - – challenge both makers and users
  - – pitch reduction difficult
  - – Increasingly fragile
  - – Carry less current
  - – Reach Bandwidth limits
  - – Ultimately, can't meet **lower inductances** and ***the need for speed***



Elastomers: …to the rescue?

Elastomerics offer:

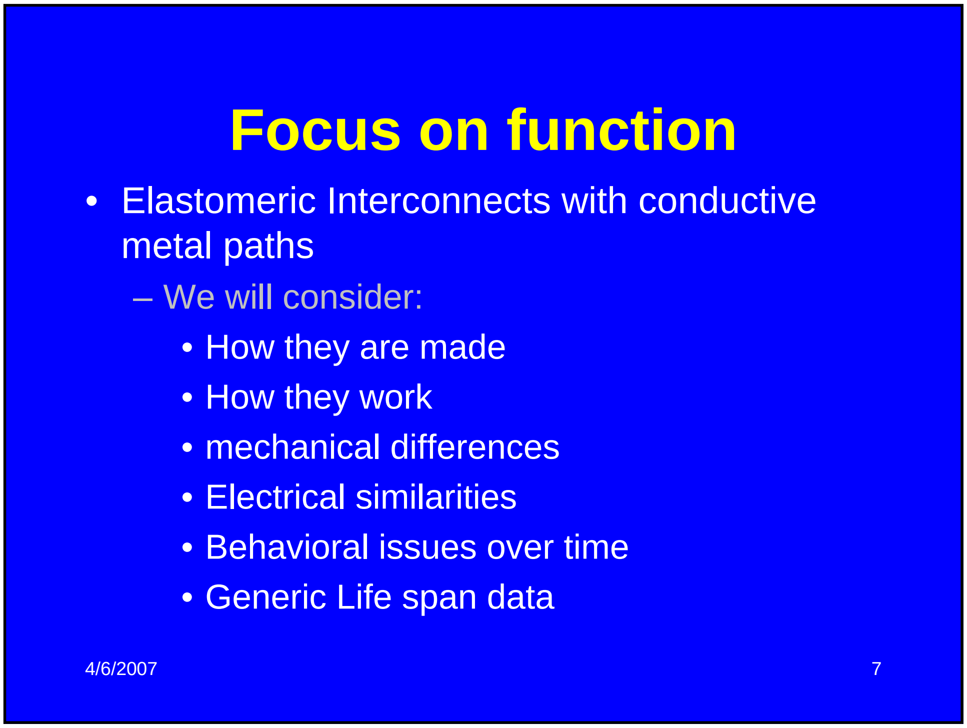
- – Very low profile compliant paths
  - Low resistance
  - Low inductance
  - Low capacitance
  - low force possible
- – Highest possible performance metrics
  - High bandwidth

“Metal Filled Polymers” (MFP)

- “Elastomers”
  - Most formed as sheets
  - Most vertical path
  - No Individual conductor assembly
  - Individual conductors not serviceable
  - Cost can be lower if volumes higher

Focus by structure

- Elastomeric Interconnects with conductive metal paths: Metal Filled Polymers (MFP)
  - **Generic**
    - Wires arrayed & embedded in Elastomer (E)
    - Cohesively stacked particles co-molded in E
  - **Dedicated Circuits**
    - Dispersed particles in E (MFP)
    - Dispersed particles in E (MFP) & on carrier



Focus on function

- Elastomeric Interconnects with conductive metal paths
  - We will consider:
    - How they are made
    - How they work
    - mechanical differences
    - Electrical similarities
    - Behavioral issues over time
    - Generic Life span data

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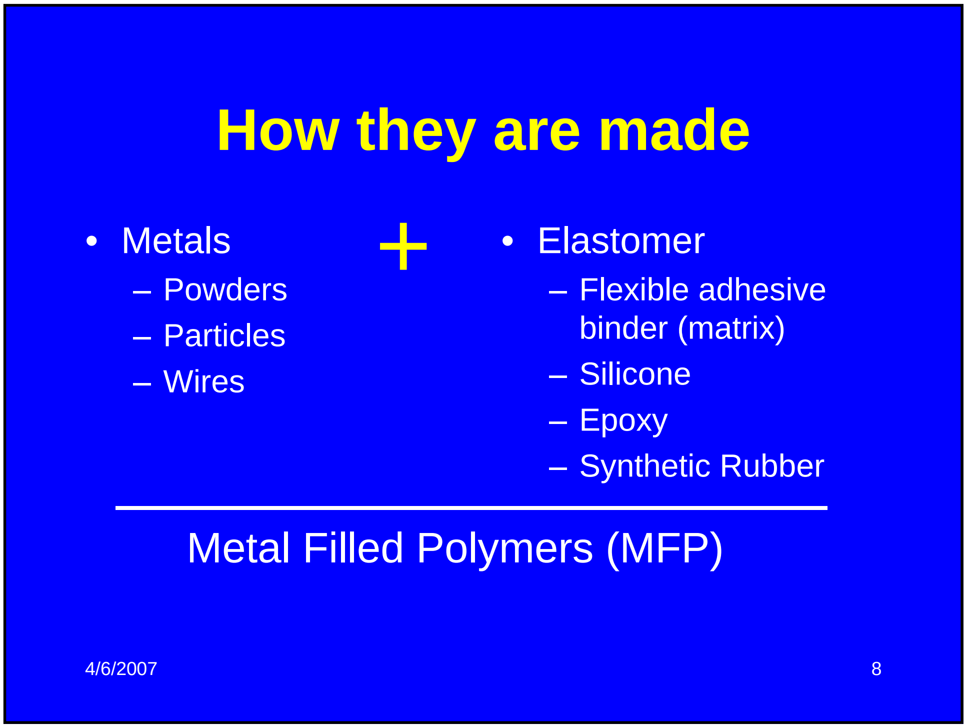

How they are made

- Metals
  - Powders
  - Particles
  - Wires

+

- Elastomer
  - Flexible adhesive binder (matrix)
  - Silicone
  - Epoxy
  - Synthetic Rubber

Metal Filled Polymers (MFP)

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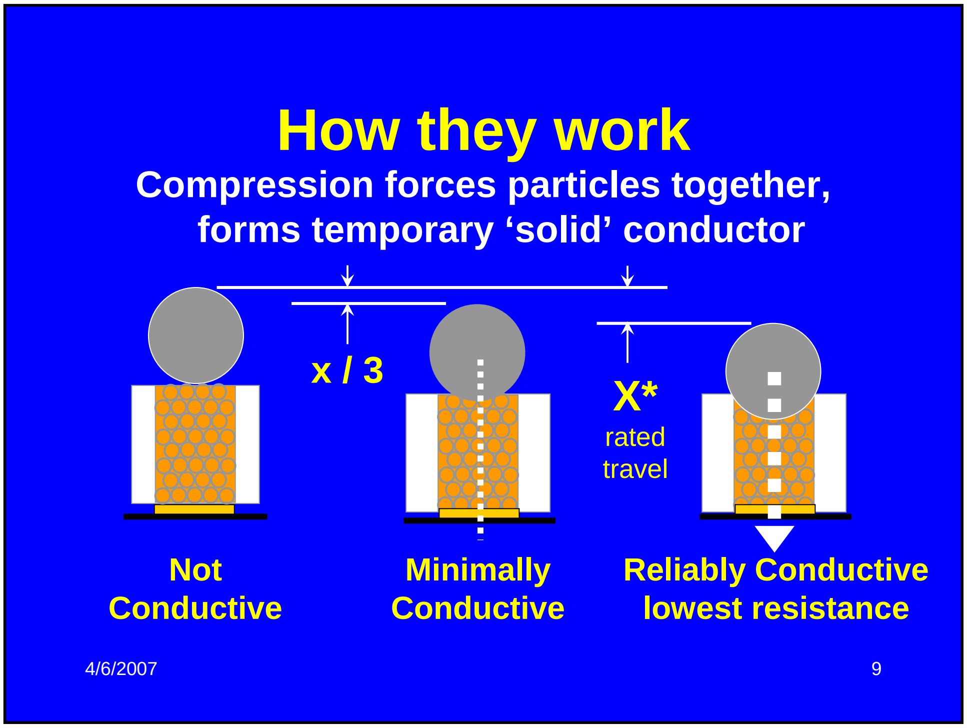


How they work

Compression forces particles together, forms temporary 'solid' conductor

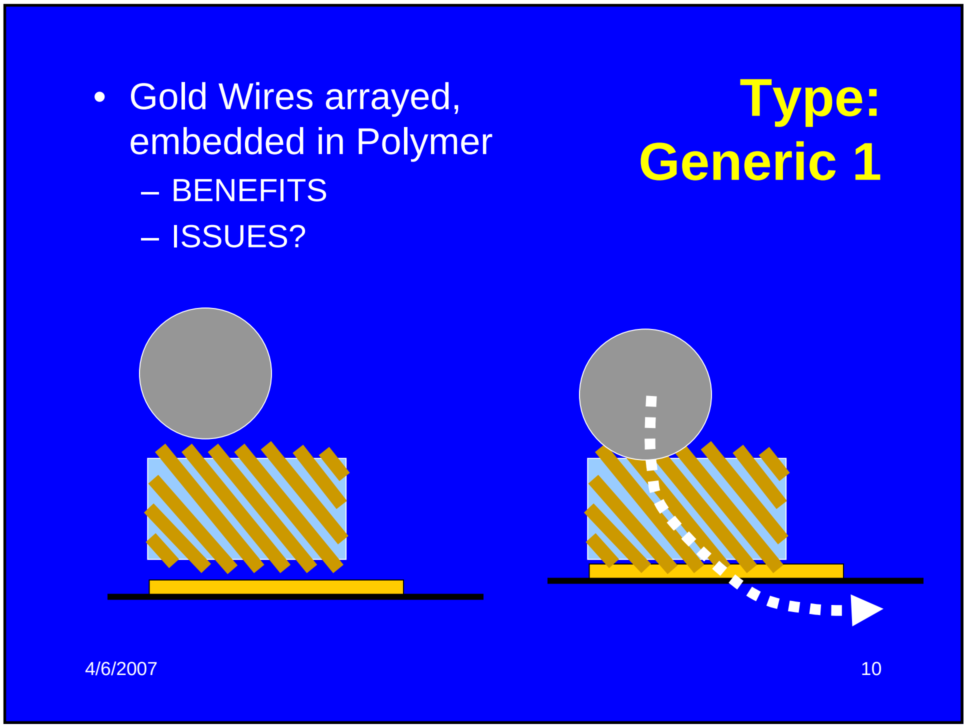
x / 3

X*
rated travel

Not Conductive

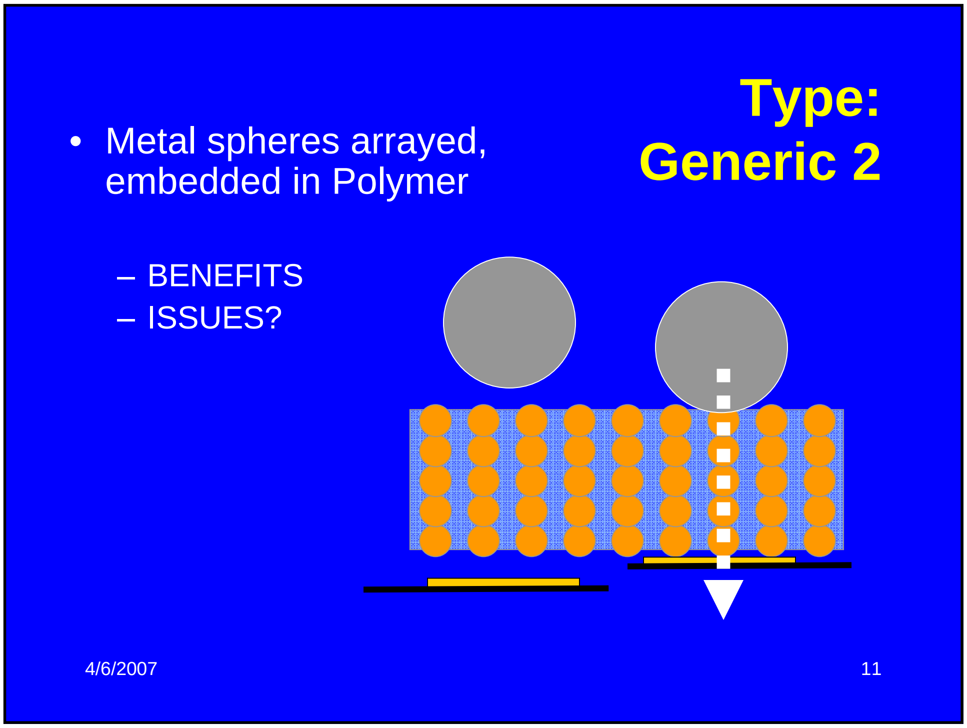
Minimally Conductive

Reliably Conductive lowest resistance



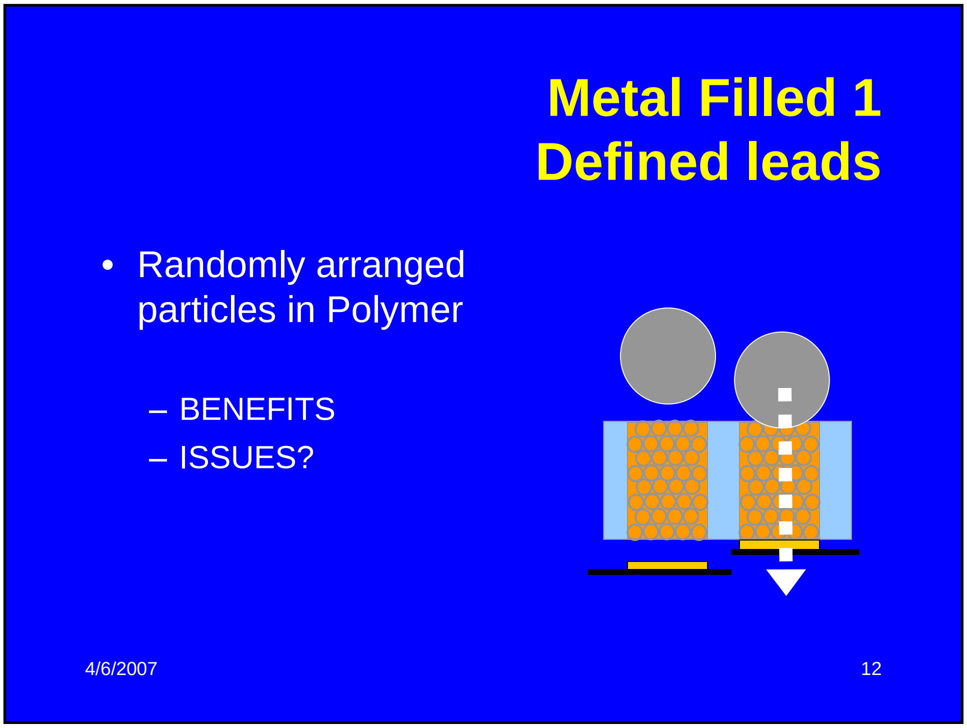
Type: Generic 1

- Gold Wires arrayed, embedded in Polymer
  - BENEFITS
  - ISSUES?



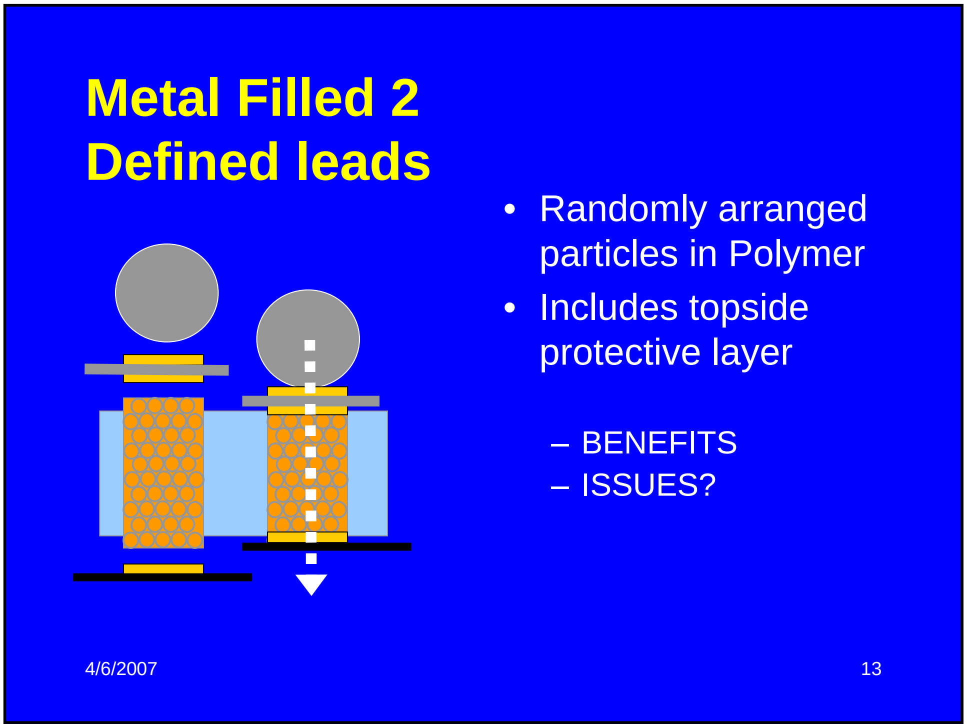
Type: Generic 2

- Metal spheres arrayed, embedded in Polymer
  - BENEFITS
  - ISSUES?



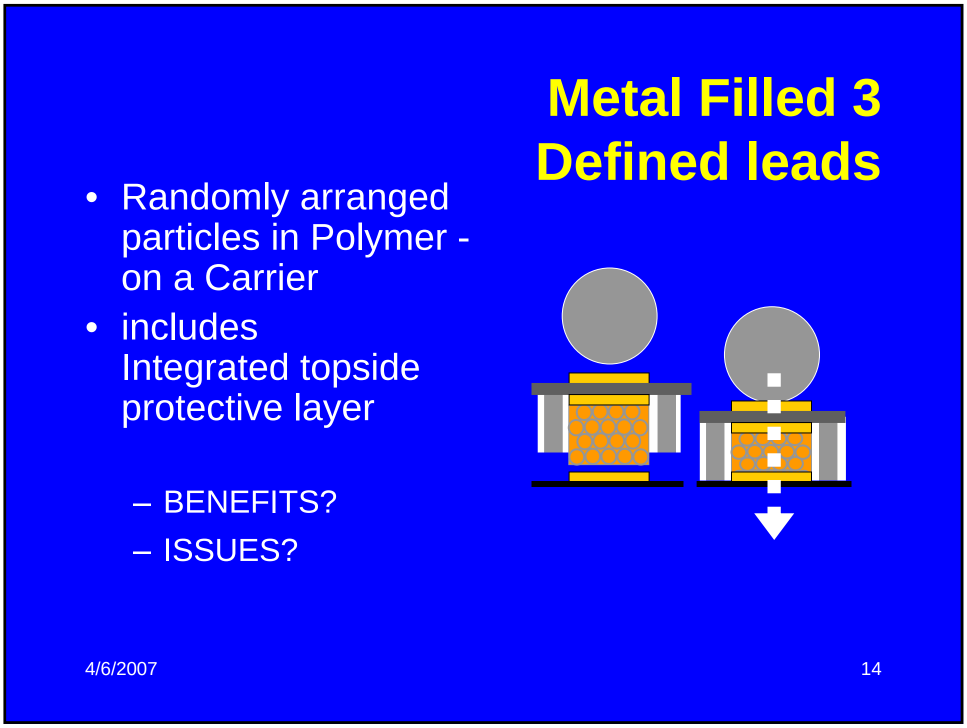
Metal Filled 1 Defined leads

- Randomly arranged particles in Polymer
  - BENEFITS
  - ISSUES?



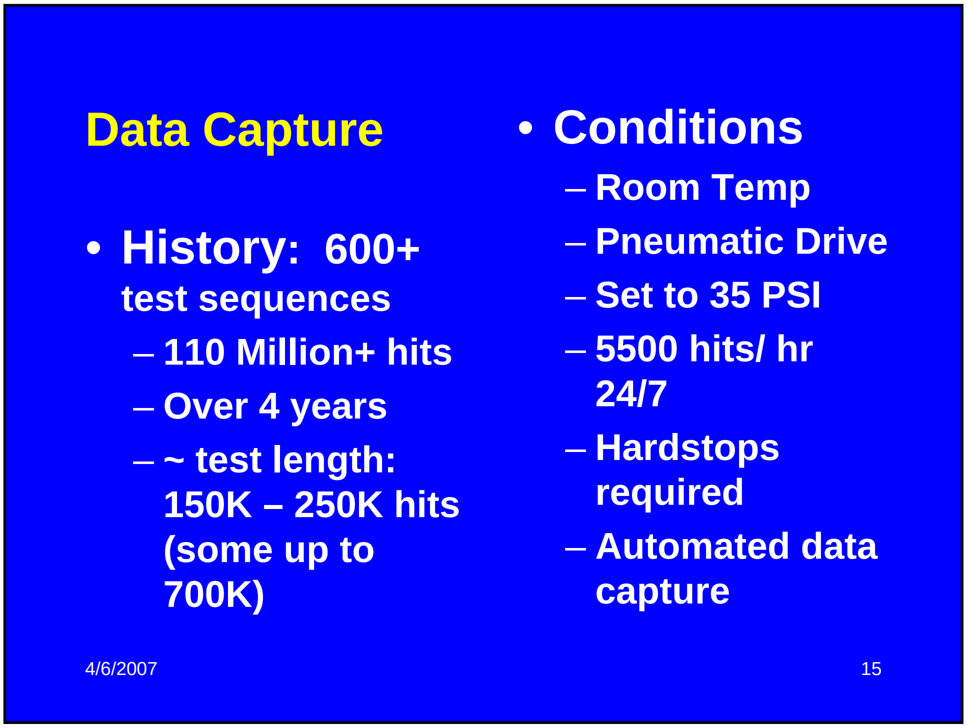
Metal Filled 2 Defined leads

- Randomly arranged particles in Polymer
- Includes topside protective layer
  - BENEFITS
  - ISSUES?



Metal Filled 3 Defined leads

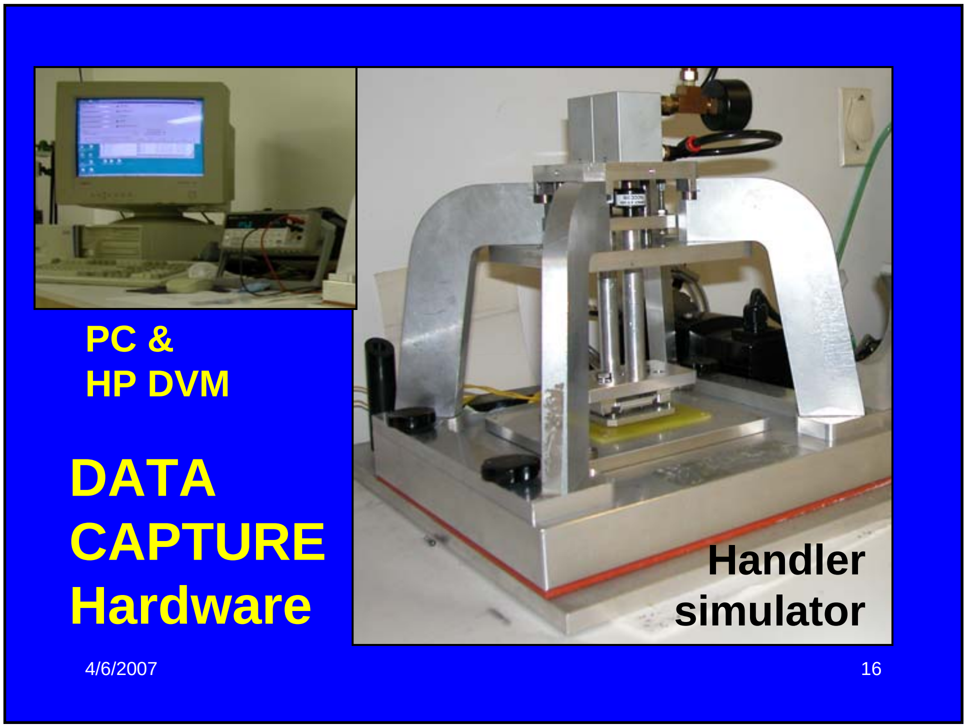
- Randomly arranged particles in Polymer - on a Carrier
- includes Integrated topside protective layer
  - BENEFITS?
  - ISSUES?



Data Capture

- **History: 600+ test sequences**
  - 110 Million+ hits
  - Over 4 years
  - ~ test length: 150K – 250K hits (some up to 700K)

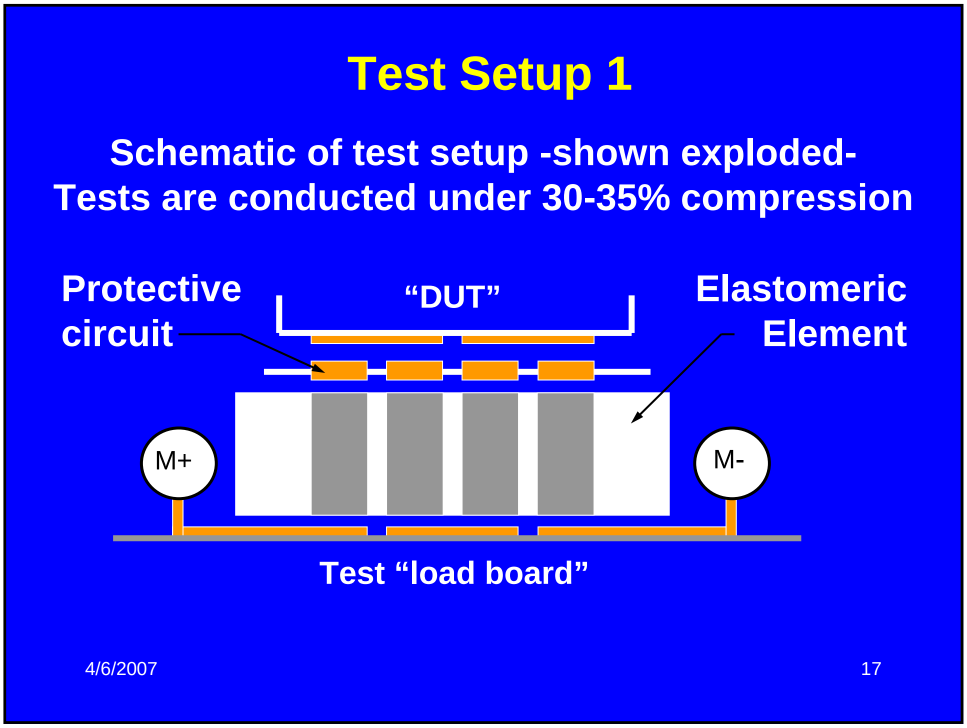
- **Conditions**
  - Room Temp
  - Pneumatic Drive
  - Set to 35 PSI
  - 5500 hits/ hr 24/7
  - Hardstops required
  - Automated data capture



PC &
HP DVM

DATA CAPTURE Hardware

Handler simulator



Test Setup 1

Schematic of test setup -shown exploded-
Tests are conducted under 30-35% compression

Protective circuit

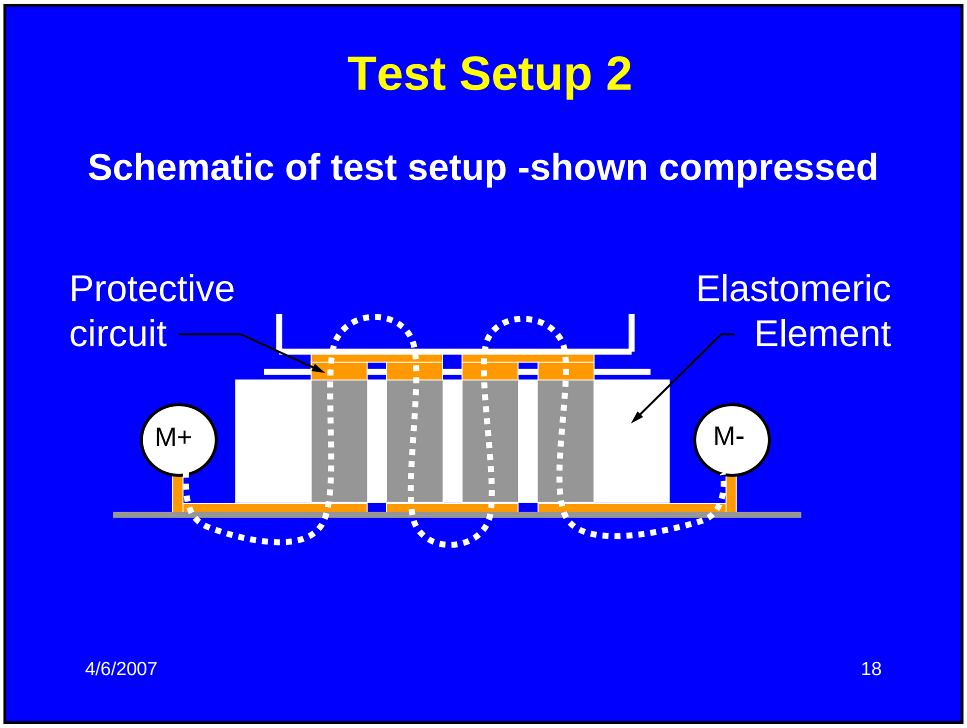
"DUT"

Elastomeric Element

M+

M-

Test "load board"



Test Setup 2

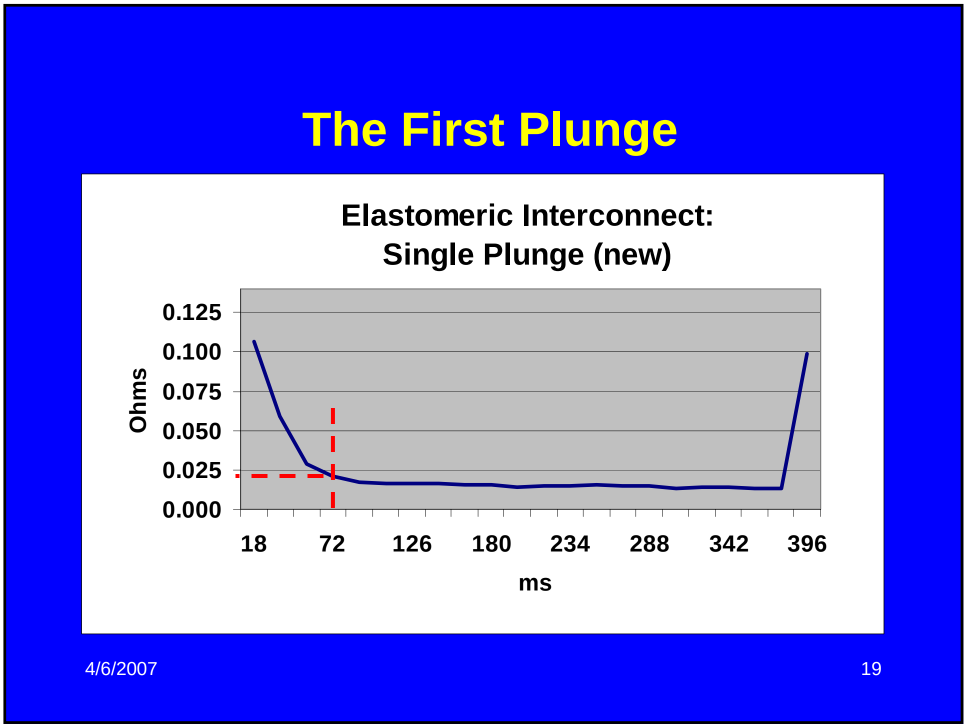
Schematic of test setup -shown compressed

Protective circuit

Elastomeric Element

M+

M-



The First Plunge

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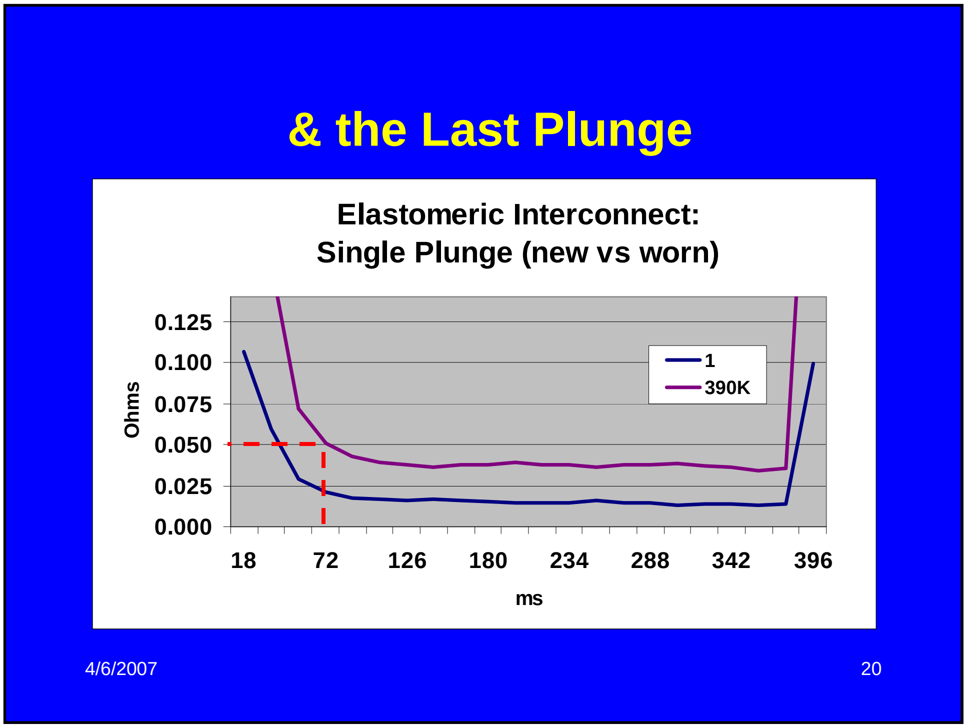

& the Last Plunge

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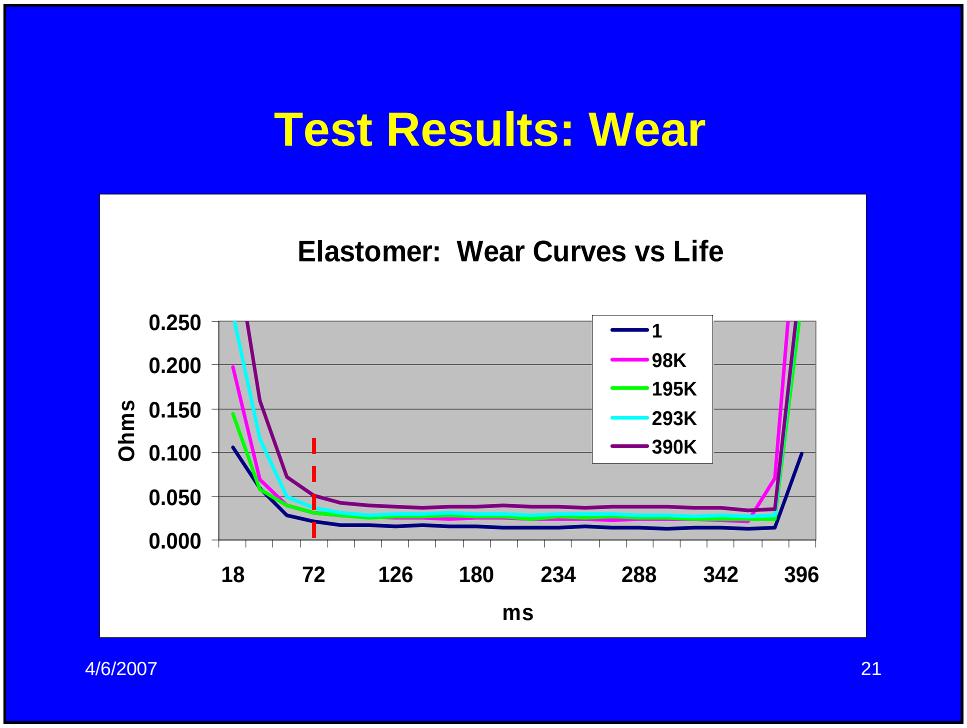

Test Results: Wear

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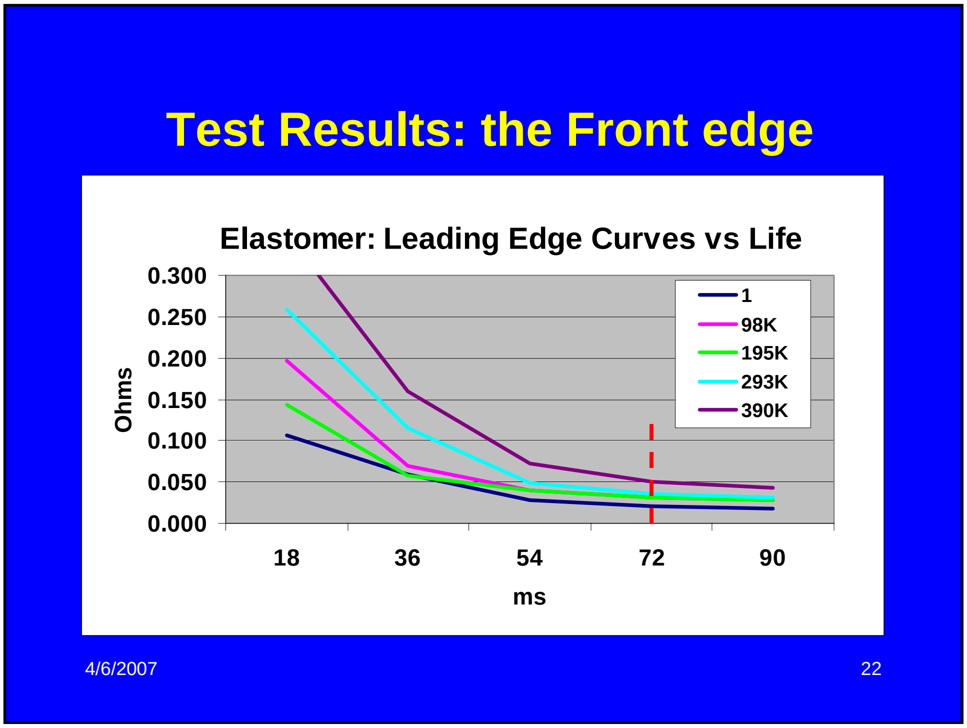

Test Results: the Front edge

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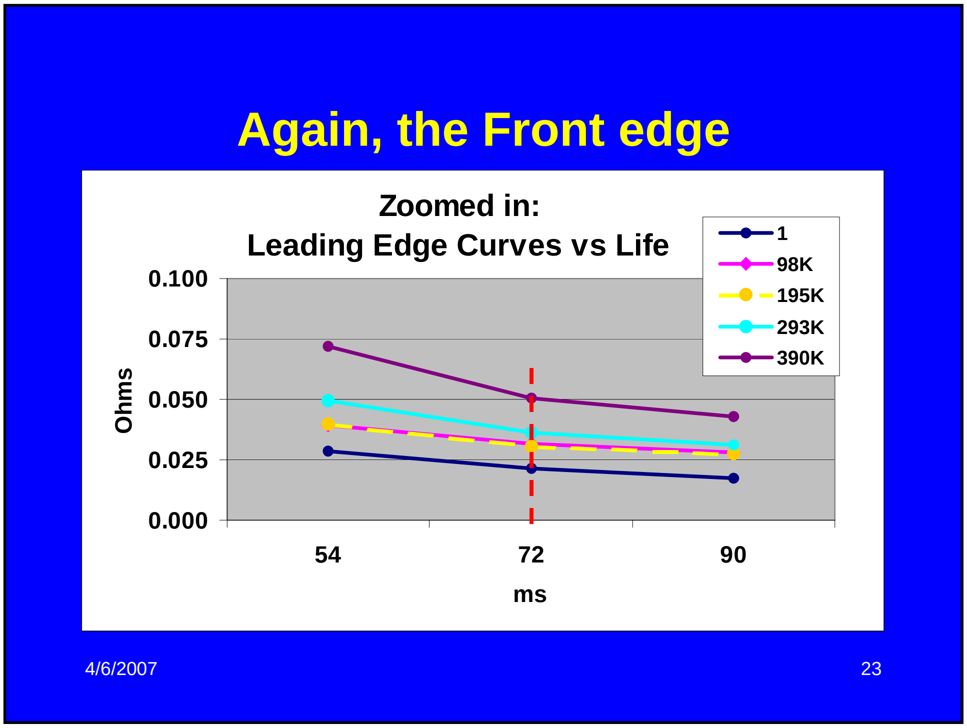

Again, the Front edge

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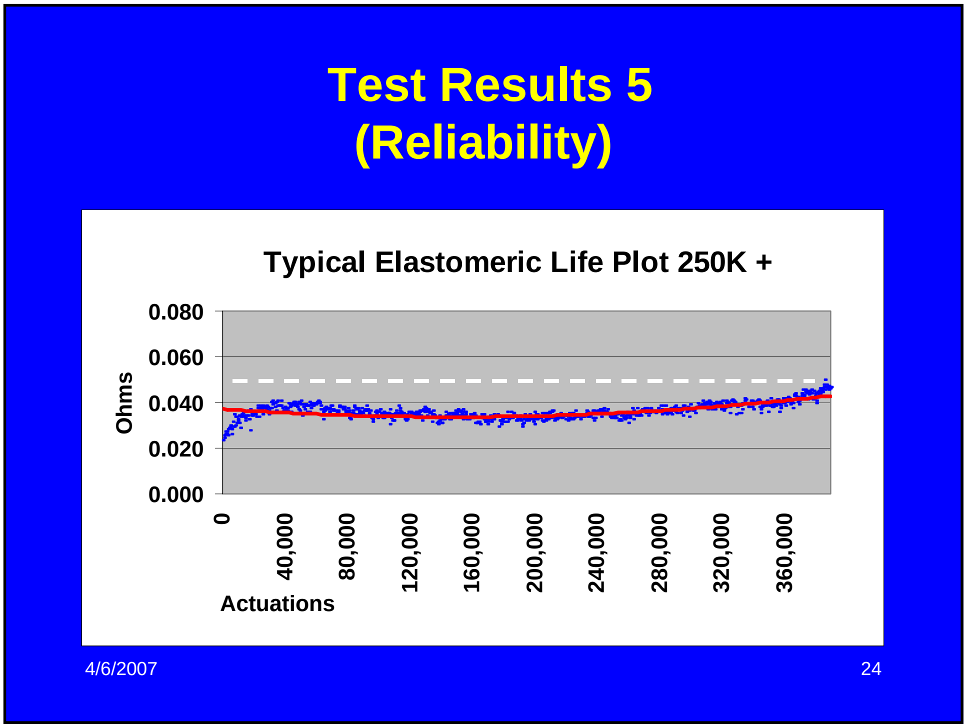

Test Results 5 (Reliability)

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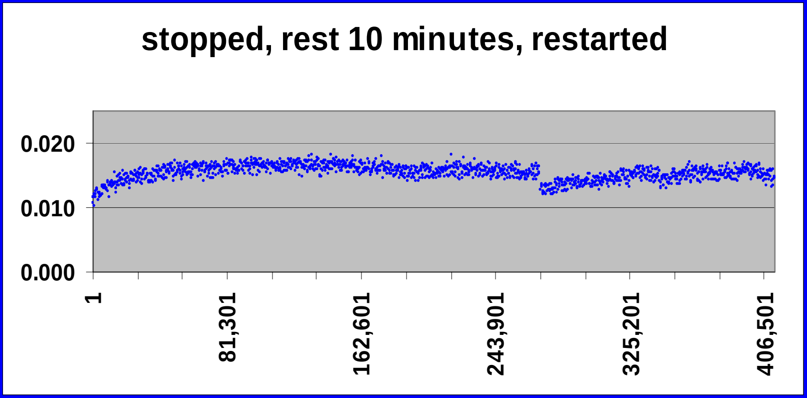
Test Results 6

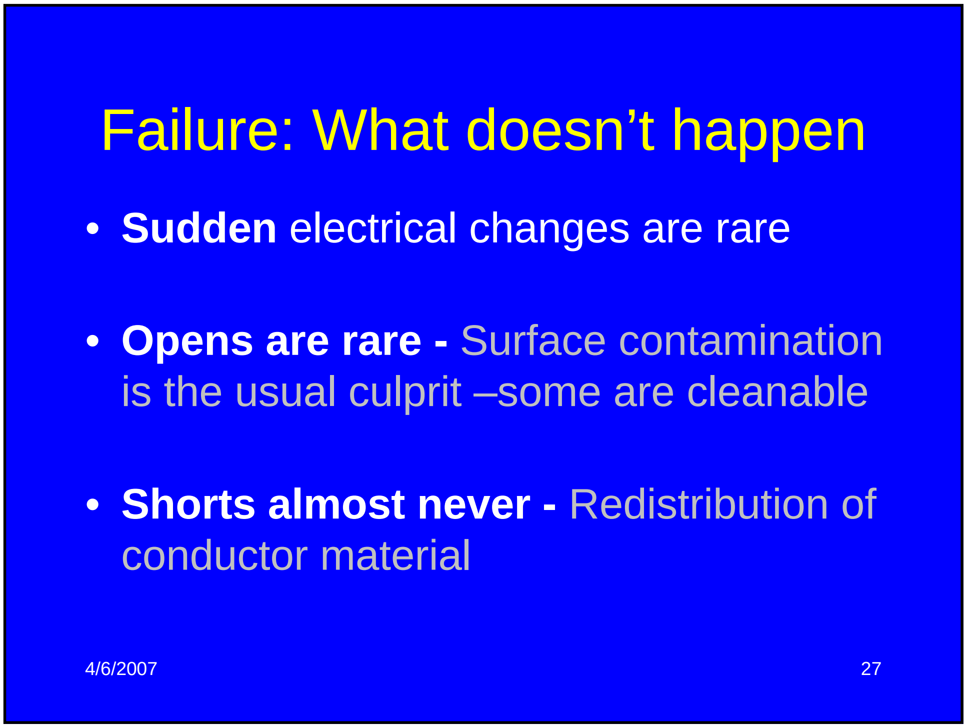
Characteristic Behavior vs. time



stopped, rest 10 minutes, restarted

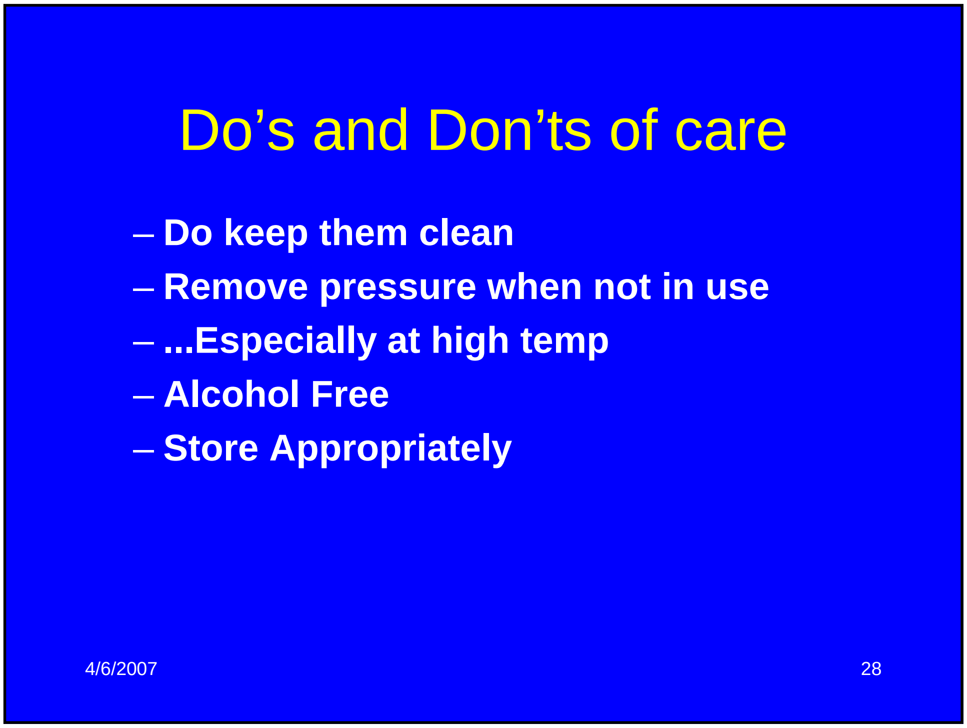
Failure: what happens

- **Resistance Rise**:
  - Strain through accumulated use (wear): Supporting structures soften with use
  - Excessive Overactuation = strain (tear)
  - Prolonged exposure to heat & compression causes reformation: mechanical compression set, loss of resilience
  - Contamination of Dut side Surfaces:



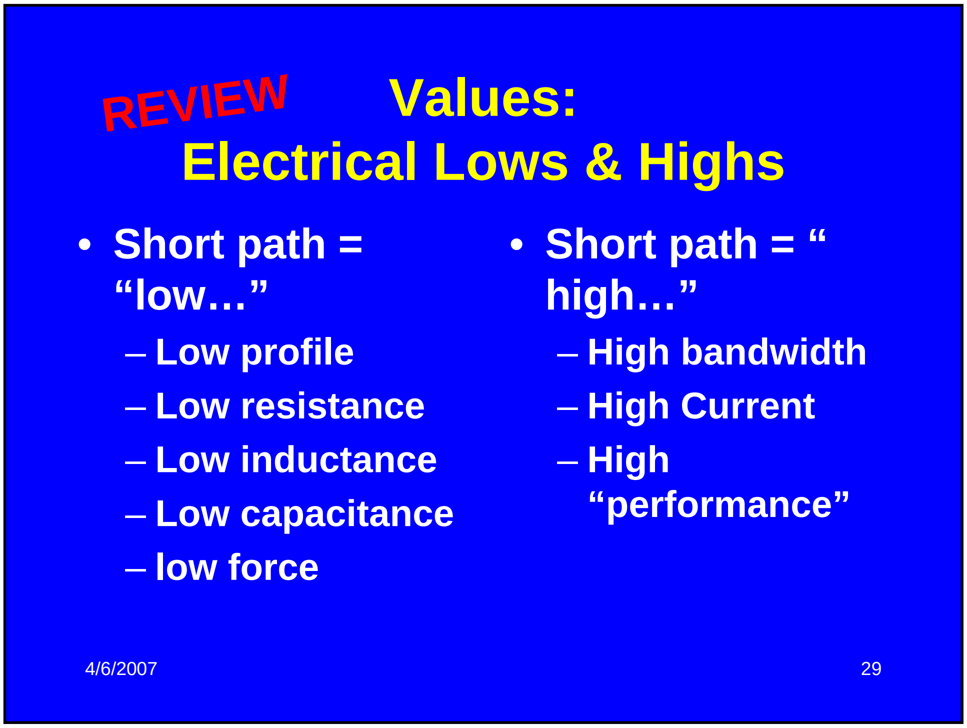
Failure: What doesn't happen

- **Sudden** electrical changes are rare
- **Opens are rare -** Surface contamination is the usual culprit –some are cleanable
- **Shorts almost never -** Redistribution of conductor material



Do's and Don'ts of care

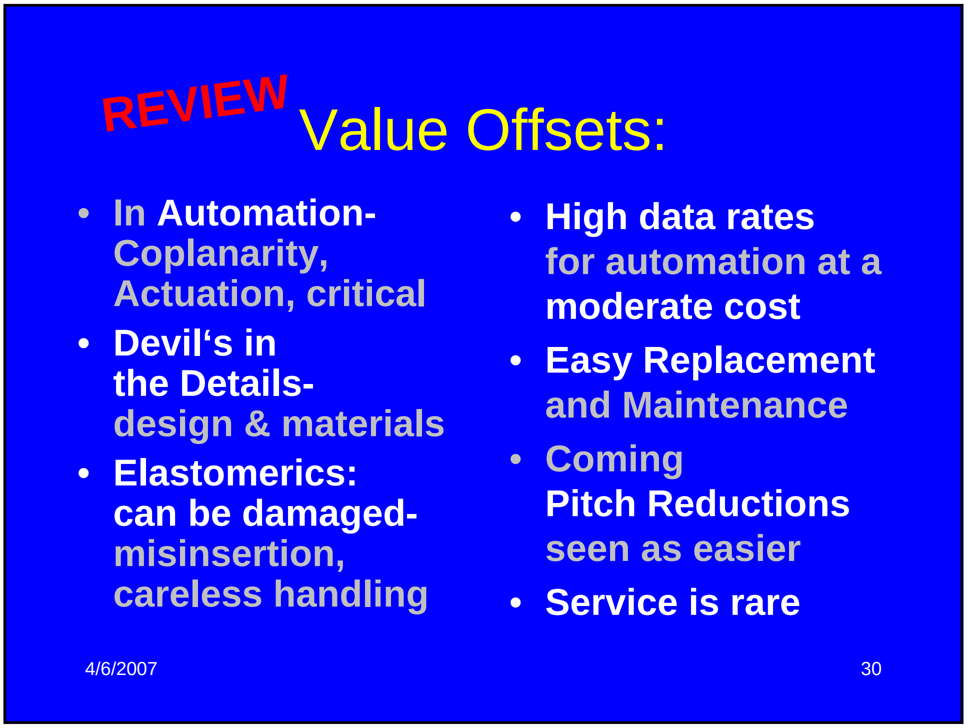
- **Do keep them clean**
- **Remove pressure when not in use**
- **...Especially at high temp**
- **Alcohol Free**
- **Store Appropriately**



REVIEW

Values: Electrical Lows & Highs

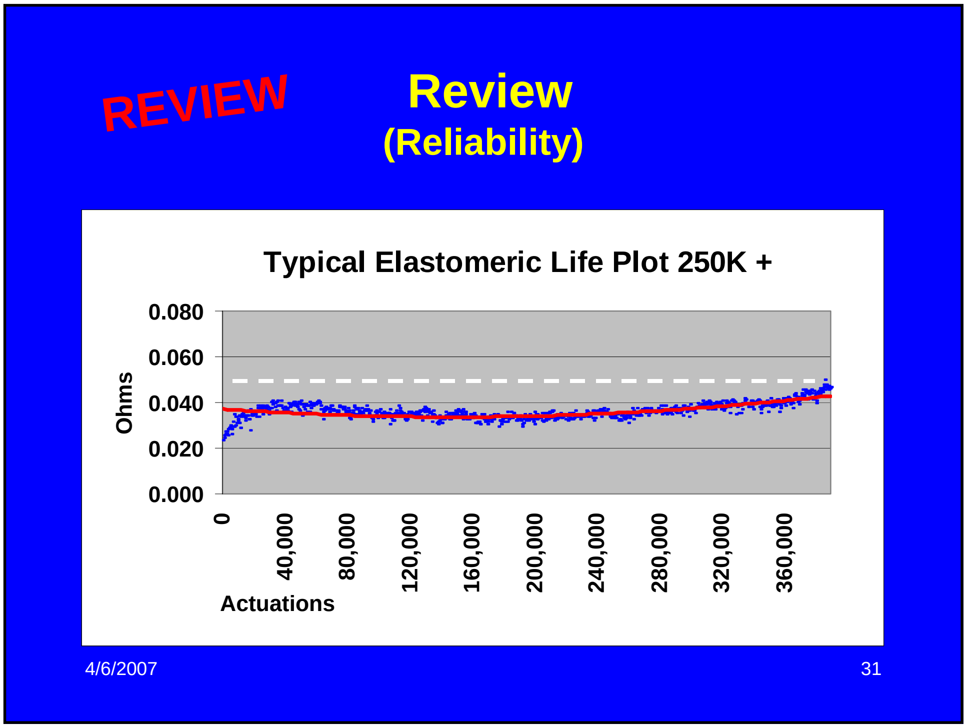
- Short path = "low…"
  - Low profile
  - Low resistance
  - Low inductance
  - Low capacitance
  - low force
- Short path = " high…"
  - High bandwidth
  - High Current
  - High "performance"



REVIEW

Value Offsets:

- In Automation- Coplanarity, Actuation, critical
- Devil's in the Details- design & materials
- Elastomerics: can be damaged- misinsertion, careless handling
- High data rates for automation at a moderate cost
- Easy Replacement and Maintenance
- Coming Pitch Reductions seen as easier
- Service is rare



REVIEW

Review
(Reliability)

Bottom line

At 10-40 GHz+ -and beyond,
The technology is here.

Elastomeric Element Lifetimes of
250K to 400K are expectable