



# CAF

## Where we are and where we are going?

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PWB INTERCONNECT SOLUTIONS INC.



# Agenda

- PWB INTERCONNECT – CORPORATE OVERVIEW
- WHAT IS CAF
- CURRENT TESTING METHODS
- FUTURE TESTING METHODS
- PWBI TVS
- PWBI EQUIPMENT AND TEST SERVICES
- REVIEW OF RESULTS
- CONCLUSIONS
- Q & A

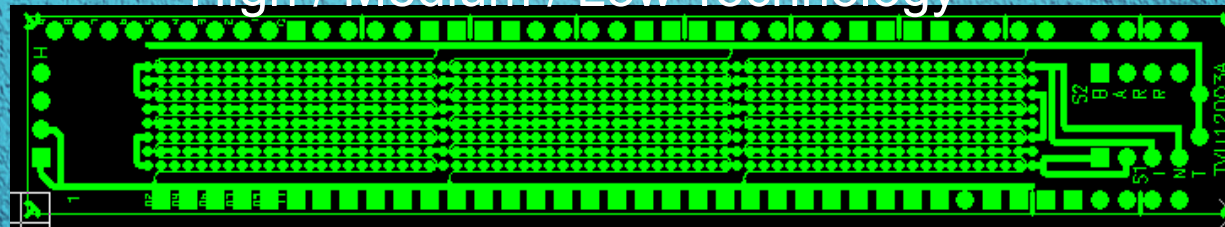
## PWB INTERCONNECT SOLUTIONS – CORPORATE OVERVIEW

- IST technology originated at Nortel/Digital Equipment in early 1990's
- PWB Interconnect Solutions incorporated in 1996
- Business – IST/DELAM/FACE equipment / IST reliability test services
- IST method accepted into IPC TM-650 manual (2.6.26A) in 2000
- Global Representation throughout Asia and Europe
- PWB USA Incorporated - ITAR Certified
- Currently 250+ IST systems globally deployed and supported
- Responsible for major consortium reliability testing programs
- All business segments now specifying IST performance criteria
- Strategic global IST test services partnership with UL LLC
- Introducing standardized IST designs and CAF capability



# Example of Cross Functional/Industry Test Vehicles

12 Layer PTH Coupons  
High / Medium / Low Technology



Coupon Name	Grid	Drill	Pad	Clearance
TVU12001A	0.8	0.203	0.457	0.660
TVU12002A	1	0.305	0.610	0.864
TVU12003A	1.27	0.406	0.813	1.118
all dimensions in millimeters				

Possible Industrial Segments = Consumer / Computer + Peripherals / Low End Telecom / Industrial and Automotive (passenger) / Commercial Aircraft



## PWB INTERCONNECT SOLUTIONS RELIABILITY TESTING

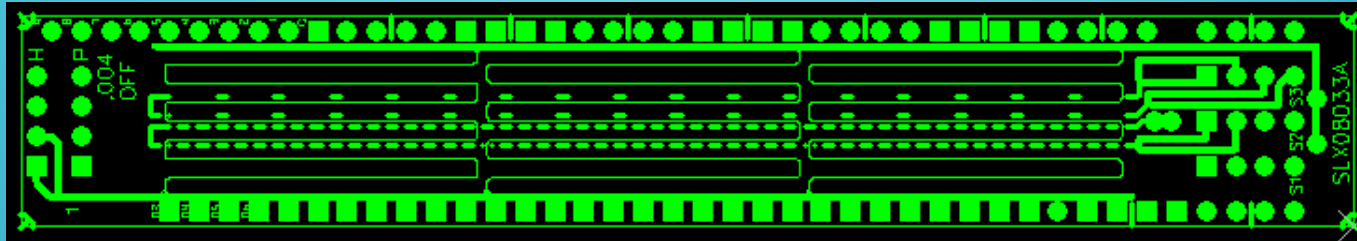
- The PCB is the foundation of the system
- If three pillars support the foundation, It only takes one weak pillar for the foundation to collapse

### PWB Reliability Testing Looks at:

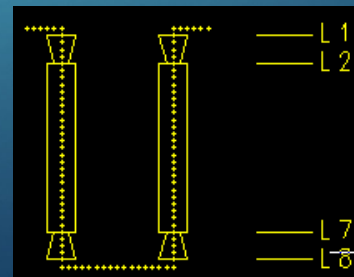
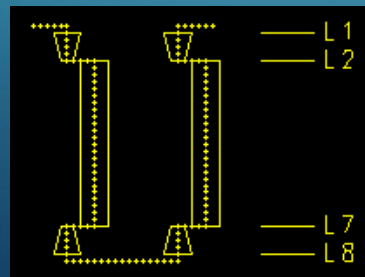
- 1 - Via and interconnect reliability - IST
- 2 - Material and construction confirmation - DELAM
- 3 - Shorting and parasitic leakage - CAF System

# Example of Automotive Industry Test Vehicles

8 Layer Buried + Microvia Coupons  
High / Medium / Low Technology

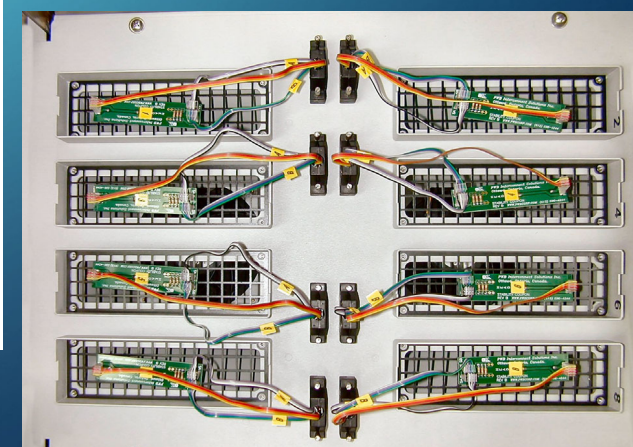
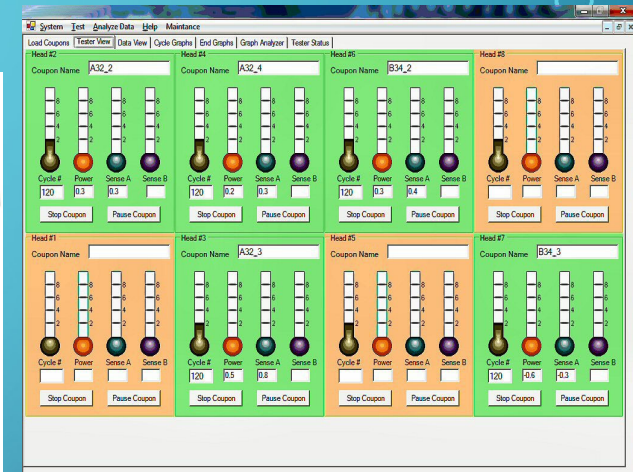
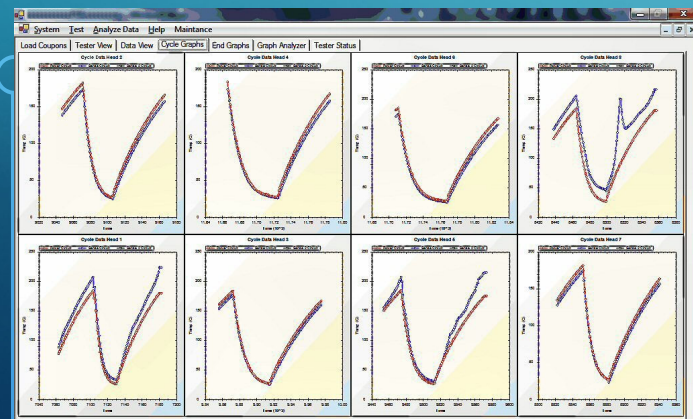
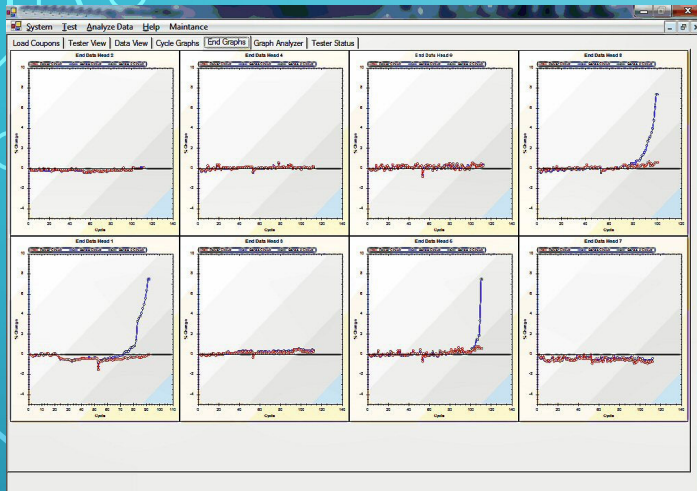


Coupon Name	Description	Grid	MicroVia	
			Hole	Pad
slx08033a	micro staggered off buried	0.8	0.10	0.33
slx08034a	micro staggered off buried	0.8	0.13	0.33
slx08035a	micro staggered off buried	0.8	0.15	0.33
slx08036a	micro stacked on buried	0.8	0.10	0.33
slx08037a	micro stacked on buried	0.8	0.13	0.33
slx08038a	micro stacked on buried	0.8	0.15	0.33
all dimensions in millimeters				



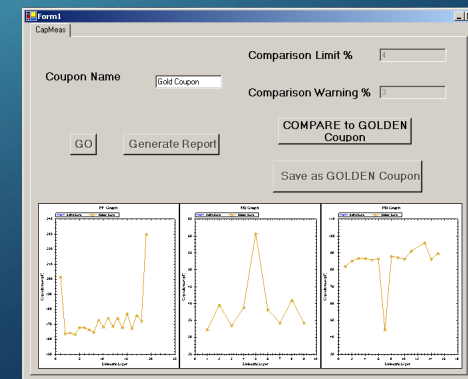
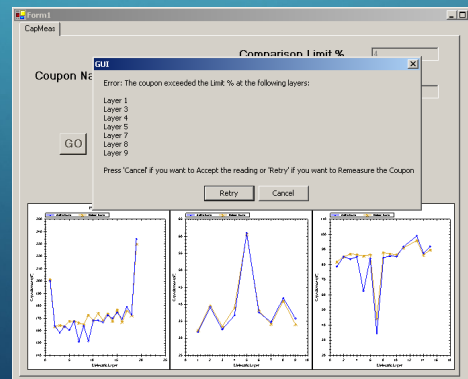
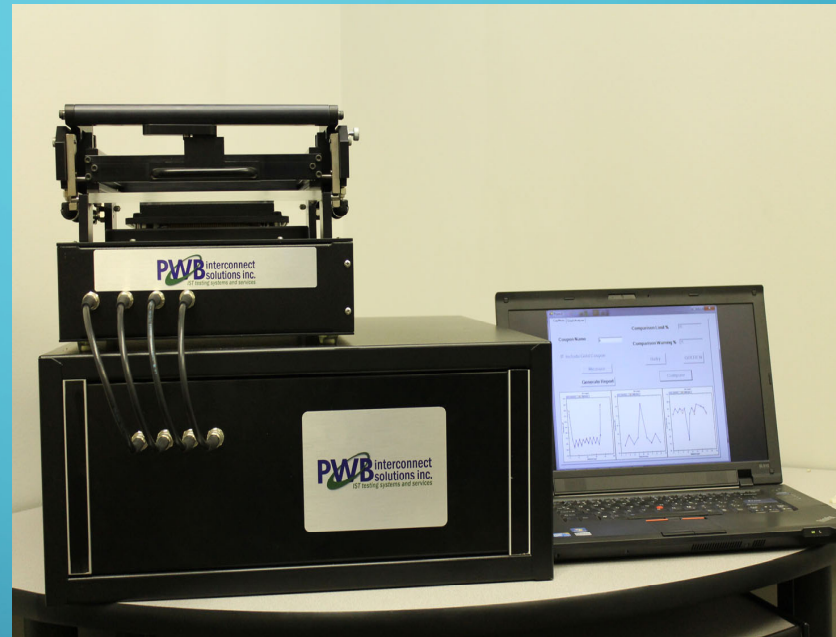
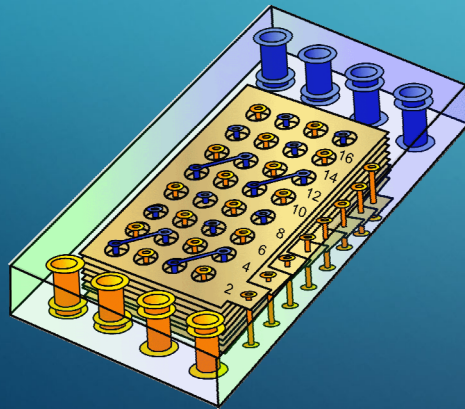


# AUTOMATED **IST** HARDWARE AND SOFTWARE



# DELAM TESTER

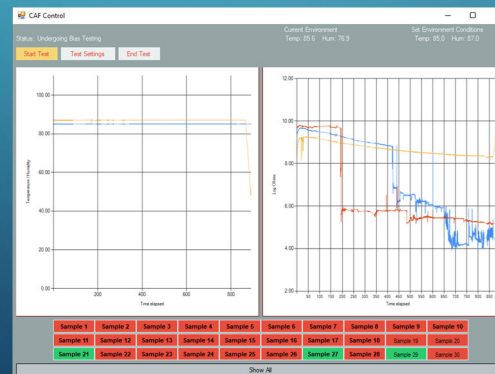
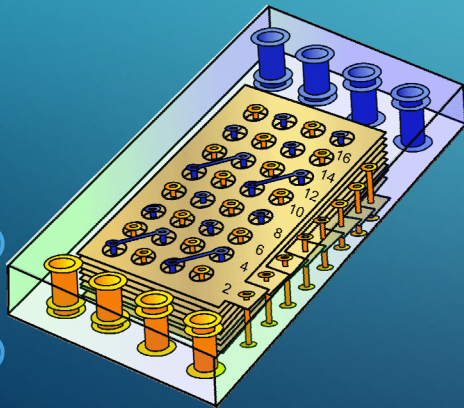
**D**ielectric  
**E**stimation  
**L**aminate  
**A**ssessment  
**M**ethod





# FULLY AUTOMATED **CAF** EQUIPMENT

**RH** control  
**Temperature** control  
**V Bias** control  
**Custom** profiles  
**Remote** reporting

A screenshot of the 'Test Settings' software interface. It shows a 'Test Phase' section with various settings for Temperature, Humidity, and Duration. Below this is a 'Power Supply' section with settings for Test Voltage, Max Curr, and Oven. At the bottom, there are 'File Settings' for File Name, Save Location, and PreSet.

# What is CAF

- CONDUCTIVE ANODIC FILAMENT
- IDENTIFIED IN 1970'S
- SUB-SURFACE SHORT
- DELAYED FAILURE FOUND IN POPULATED BOARDS
- ELECTROCHEMICAL INDUCED FAILURE
- CONDUCTIVE COPPER-CONTAINING SALT







# What are the influences of CAF

- THB (TEMPERATURE HUMIDITY AND BIAS)
- MANUFACTURING ISSUES
- CLEANLINESS
- DRILL DAMAGE
- MECHANICAL STRESS
- DESIGN
- MATERIAL
- CONDUCTOR SPACING
- PROCESSING TEMPERATURE



# Current CAF Test methods

- IPC TM 650 MOST COMMON (2.6.25)

  - 6 X 260°C SIMULATED REFLOW

  - BAKE SAMPLES 30 MINS 105°C

  - 65°C/87% RH OR 85°C/87% RH

  - 10V OR 100V DC BIAS

  - 96 HOUR STABILITY NO BIAS

  - 500 HOURS OR 1000 HOURS WITH BIAS

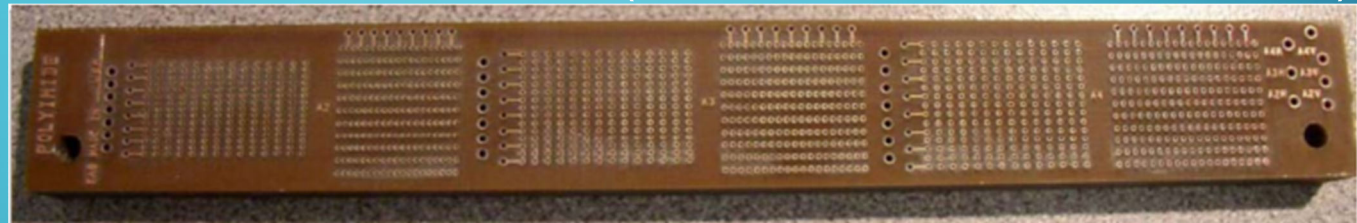
  - MEASUREMENTS TAKEN 24/100 HOURS

  - ONE DECADE DROP CONSIDERED FAILURE

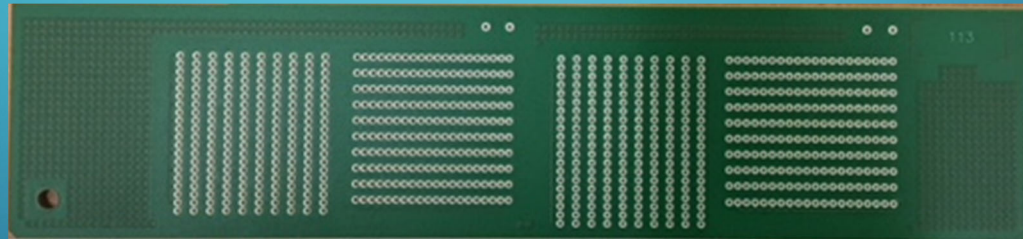


# Currently used CAF Test vehicles

-IPC HW-HW .26MM - .65MM ( DRILLED HOLE .75MM - .37)



MRT5 TEST PANEL (.4MM AND .5MM HW-HW)



-OEM???



# Future CAF Testing

- HDPUG ([WWW.HDPUG.ORG](http://WWW.HDPUG.ORG))
  - BETTER CAF ACCELERATION EQUATIONS
  - CAF TV FOR MATERIAL CHARACTERIZATION
- IPC
  - SURFACE FLASHOVER MITIGATION
- OEM
  - BASED ON PRODUCT??

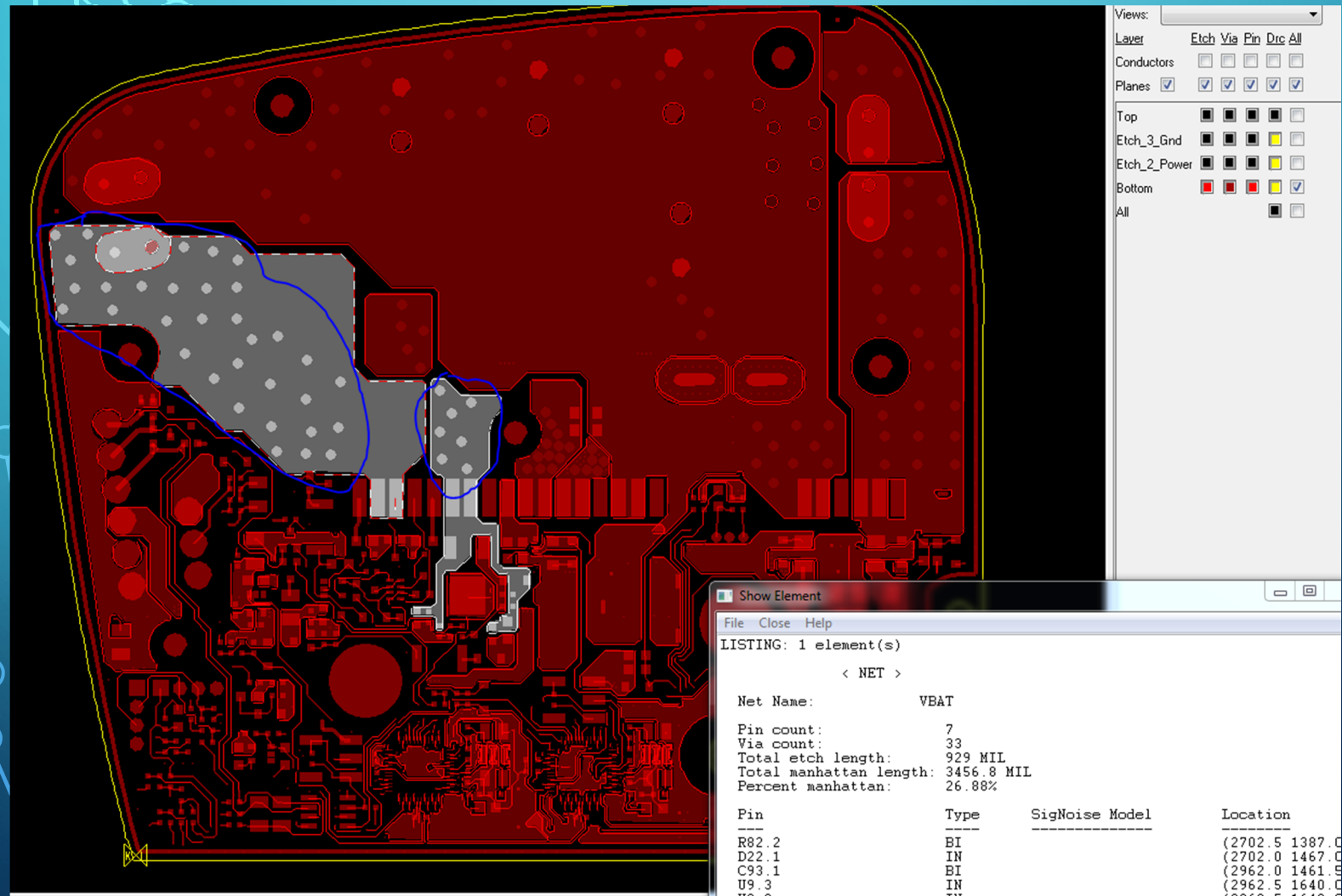


# Future CAF Reliability

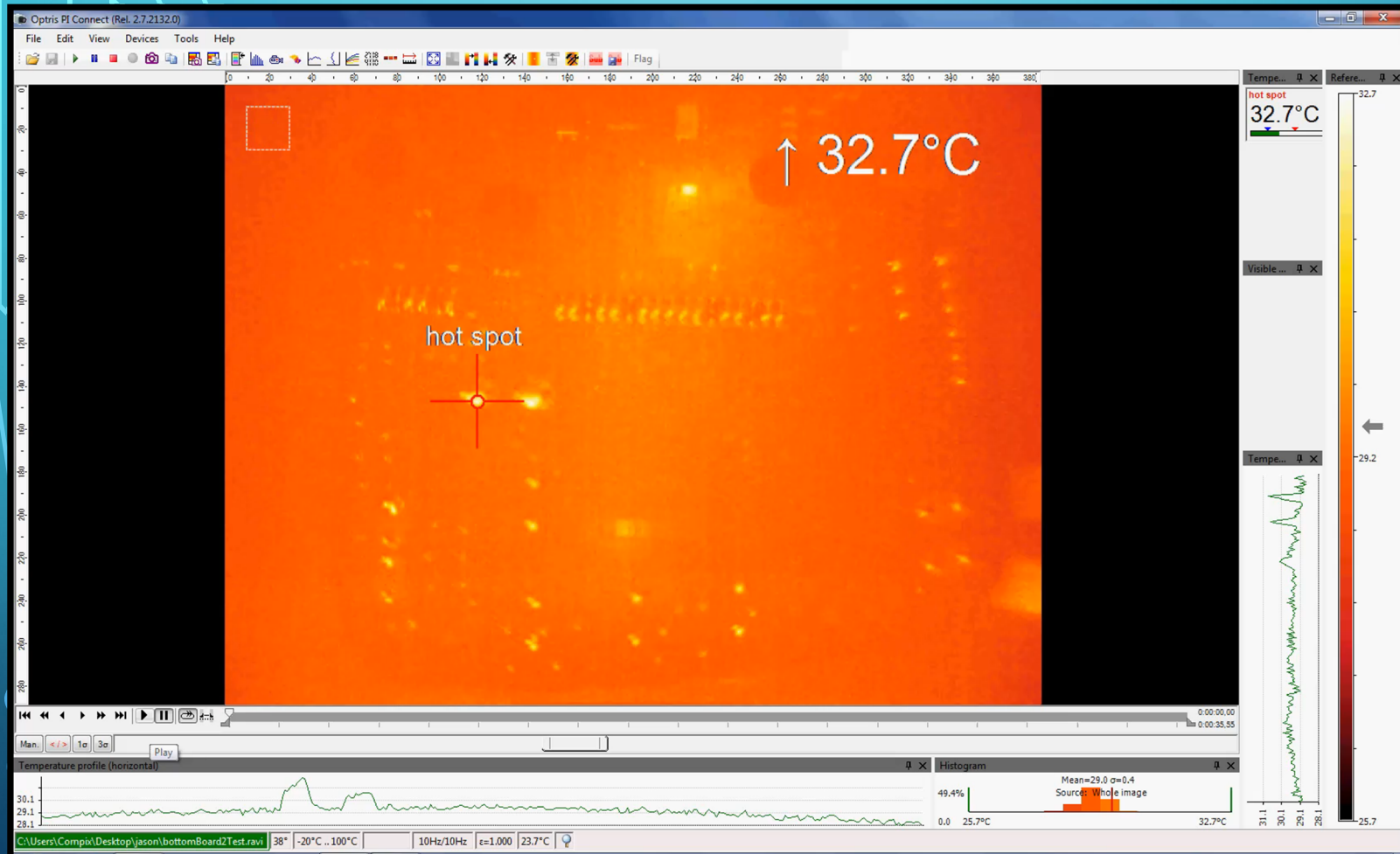
DESIGN CAN LEAD TO CAF FAILURE.....



# Future CAF Reliability



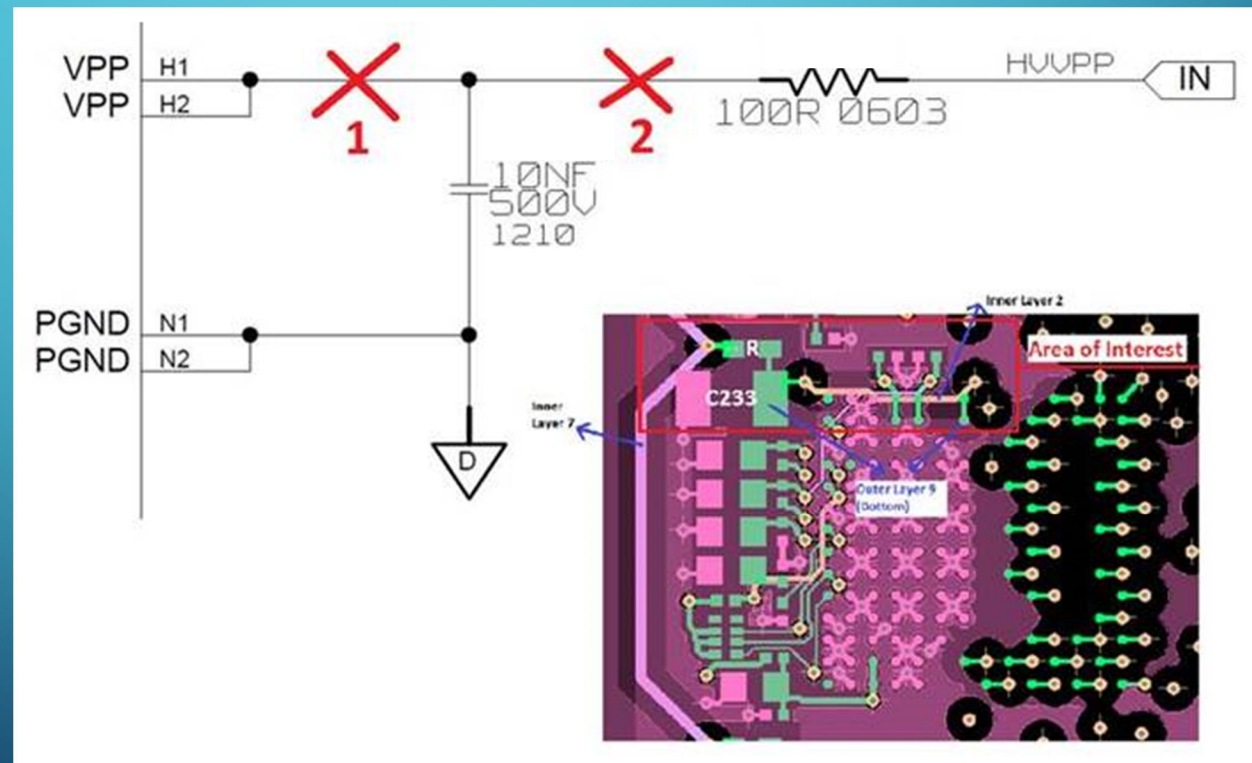
# Future CAF Reliability





# Future CAF issues

DESIGN CAN LEAD TO CAF FAILURE.....





# PWBi CAF Test vechicals

- USER DEFINED
- REPRESENTATIVE
- BUILT WITH THE SAME CONSTRUCTION AS BOARD
- BUILT WITH THE SAME PROCESS AS BOARD
- CONTAINS STRUCTURES FOUND IN THE BOARD
- FLEXIBLE
- TEST BOARD OR INDIVIDUAL COUPON

# Increasing Demand for Demonstrated Reliability



Consumer Electronics



Telecom



Aerospace



Automotive

50

100

150

200

250

300

350

400

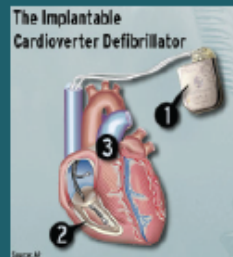
450

500

Customer Spec's for Minimum IST Cycles to Failure After Assembly



High End Computers



Medical Devices



Commercial Aviation



Space



# Characteristic Design Rules by Segment

## Via to Via Spacing (Pitch) 2016

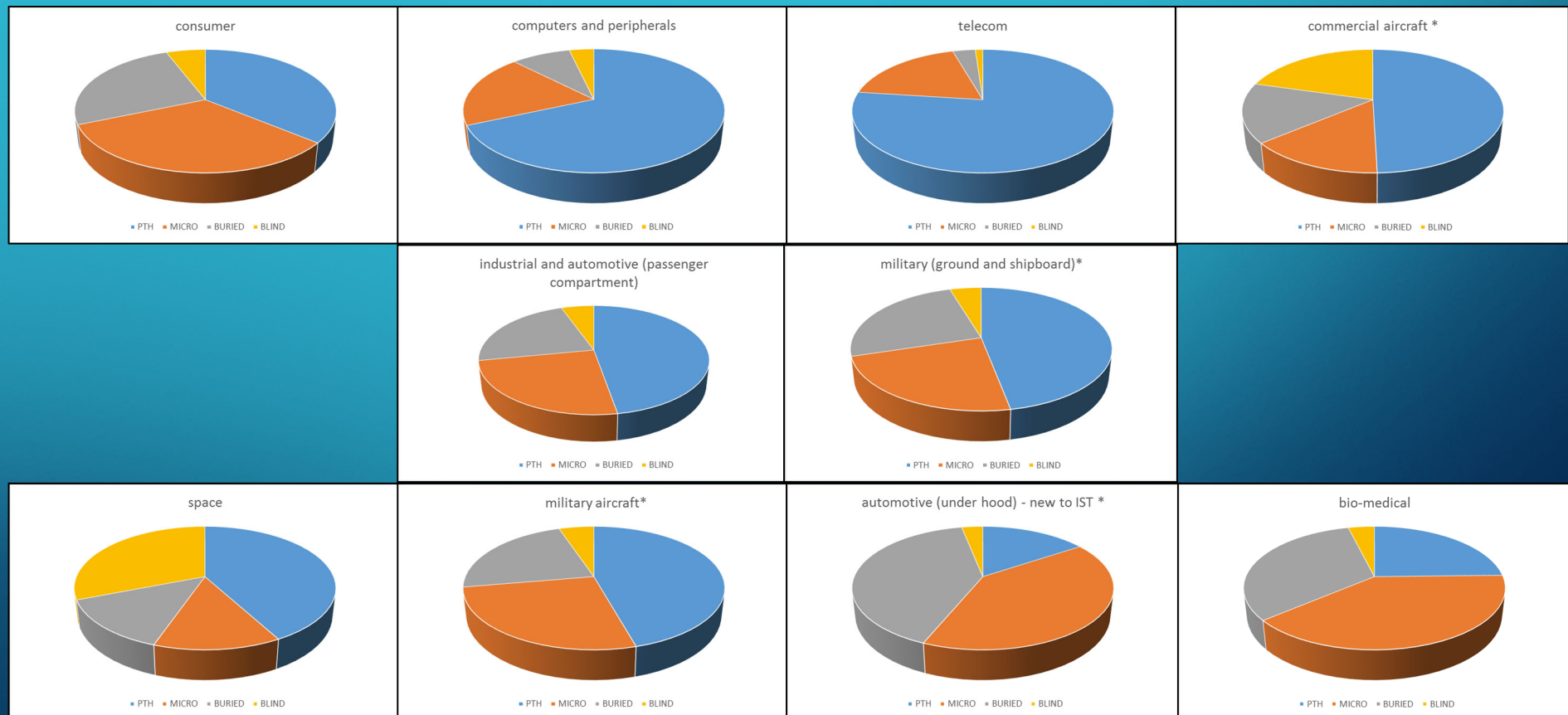
IPC categories	Grid (mm)										
	0.4	0.5	0.8	1	1.14	1.27	1.4	1.83	1.91	2	2.54
consumer		X	X								
computers and peripherals	x	X	X								
telecom			X	X			X		X		
commercial aircraft *			X	X		X			X		
industrial and automotive (passenger compartment)			X	X					X	X	X
military (ground and shipboard)*			X	X		X					
space				X		X			X	X	
military aircraft*				X		X		X	X		
automotive (under hood)*			X	X	X						
bio-medical		X	X								
* product end-use difficult to determine											

# Characteristic Design Rules by Segment Via to Via Spacing (Pitch) as of September 2018

	Grid(mm)																		
IPC Categories	0.203	0.254	0.305	0.356	0.4	0.5	0.61	0.635	0.65	0.8	1	1.14	1.27	1.4	1.83	1.91	2	2.54	
consumer		x	x	x		x	x		x	x									
computers and peripherals		x	x	x	x	x	x		x	x									
telecom			x	x		x		x	x	x				x		x			
commerical aircraft *						x				x			x			x			
industrial and automotive (passenger compartment)					x	x				x						x	x	x	
military (ground and shipboard)*										x			x						
space										x	x		x			x	x		
military aircraft *										x	x		x		x	x			
automotrive (under hood)*						x	x		x	x	x	x							
bio-medical	x				x	x		x		x									

# VIA STRUCTURES BY INDUSTRIAL SEGMENT

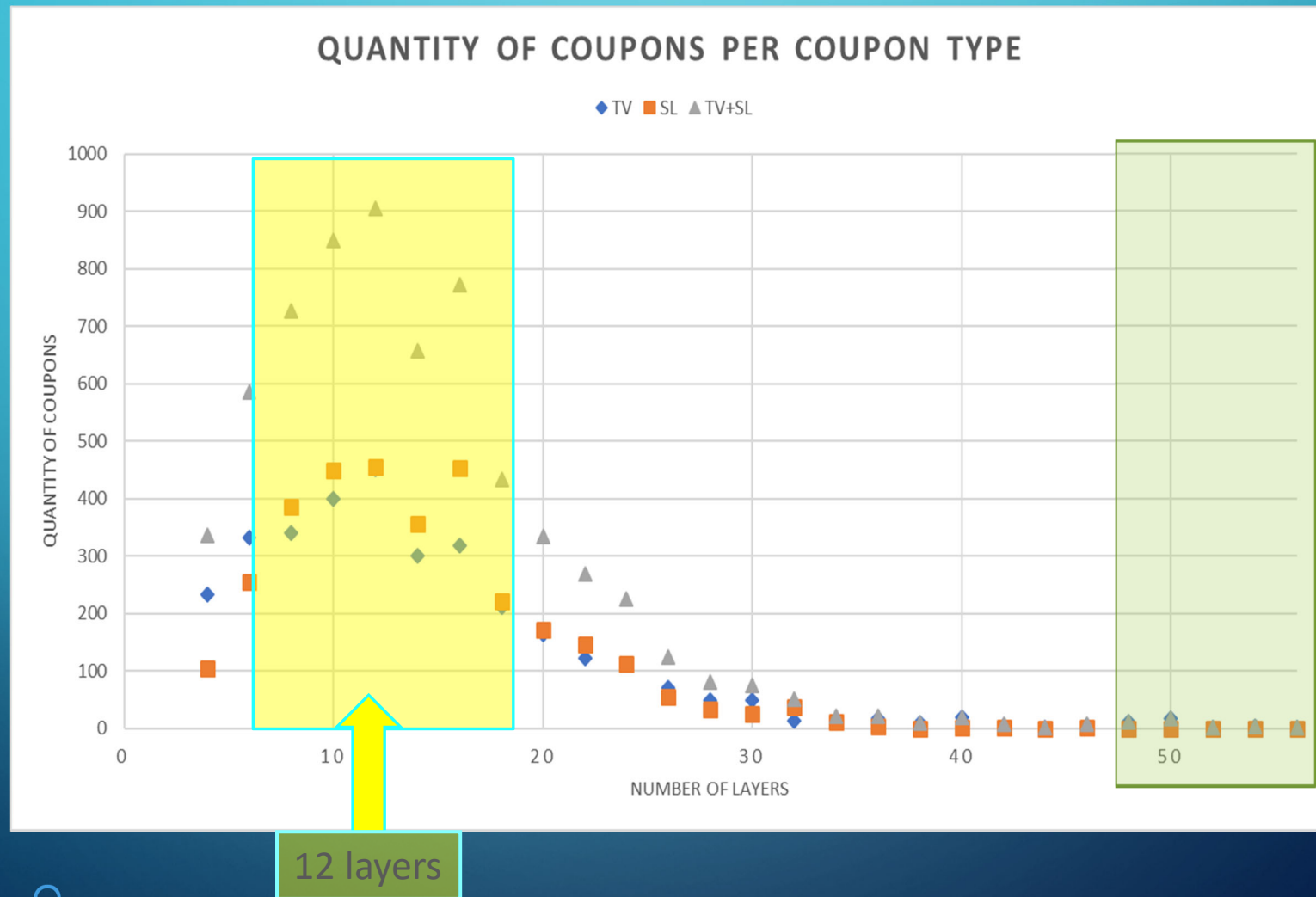
Every industry is unique, common base-lining would be impossible



Every chart must then be further dissected by layer count, thickness, construction, hole size, material type, etc. to fully understand the levels of complexity involved.

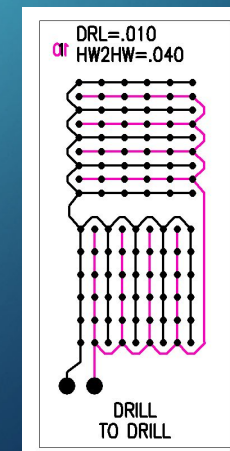
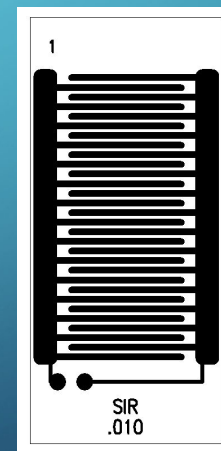
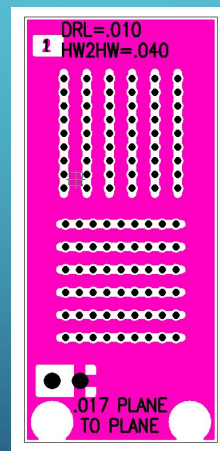
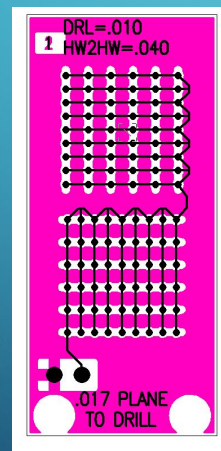


## Most Recent - 2011 to Current - Layer Count and Type



# PWBi CAF Test vehicles

- DESIGNED TO MATCH CUSTOMERS CONSTRUCTION
- DESIGNED TO MATCH CUSTOMERS VIA STRUCTURES
- DESIGNED TO MATCH CUSTOMERS SPACINGS
- SIZE IS 18MM X 40MM (WIDTH OF AN IST COUPON)

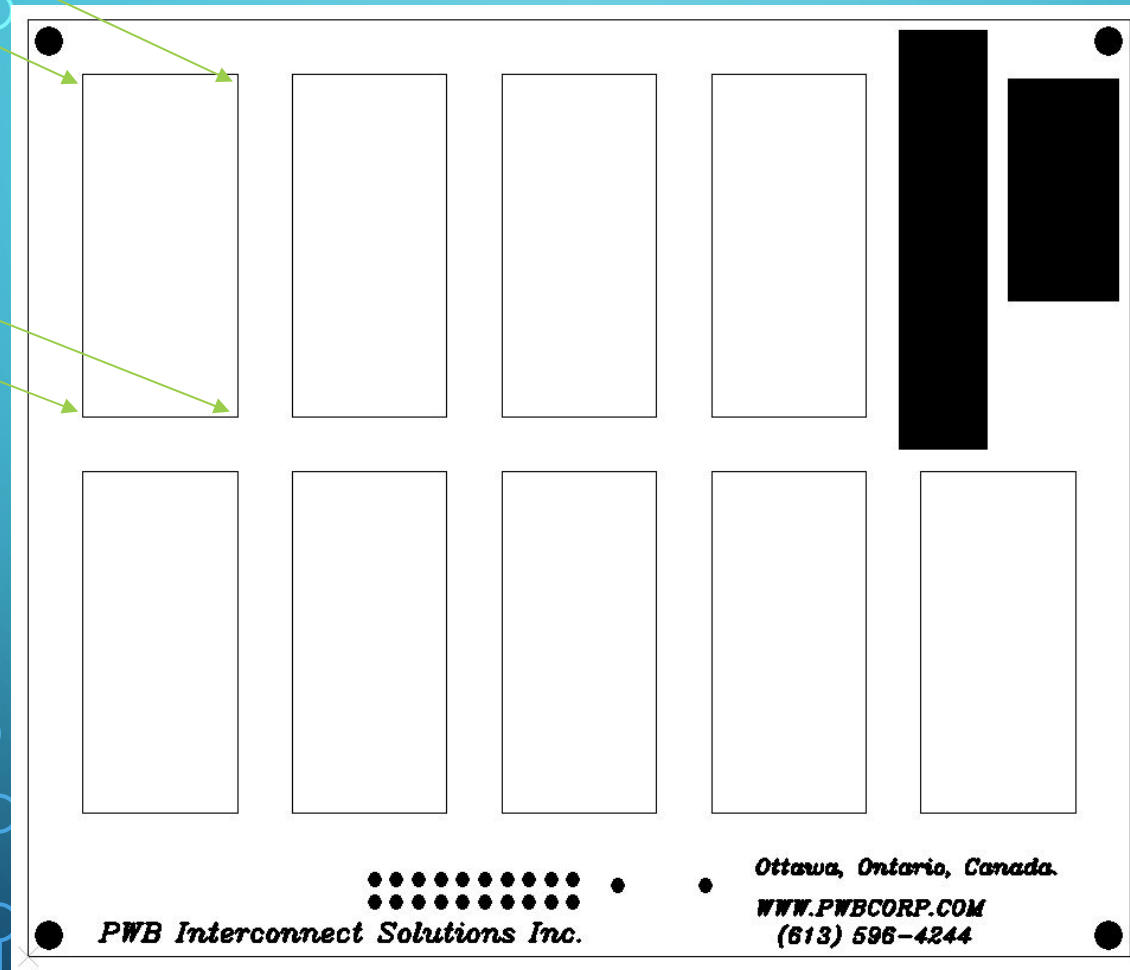
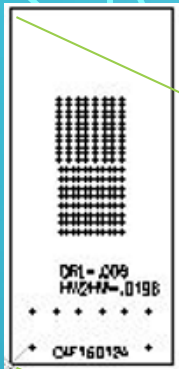


# PWBi CAF Test Vehicle

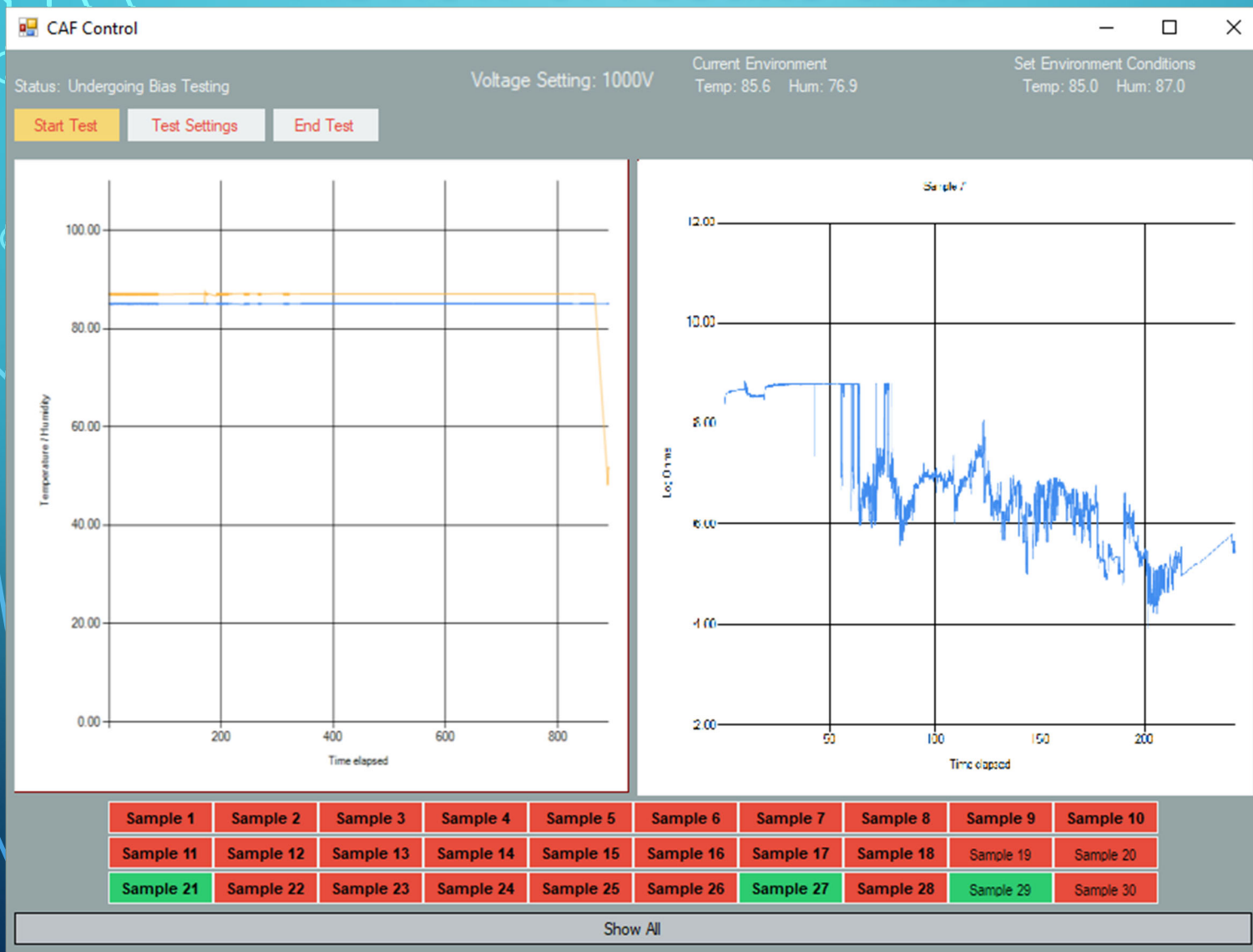
[illegible]



# PWBi CAF Test Vehicle Panel

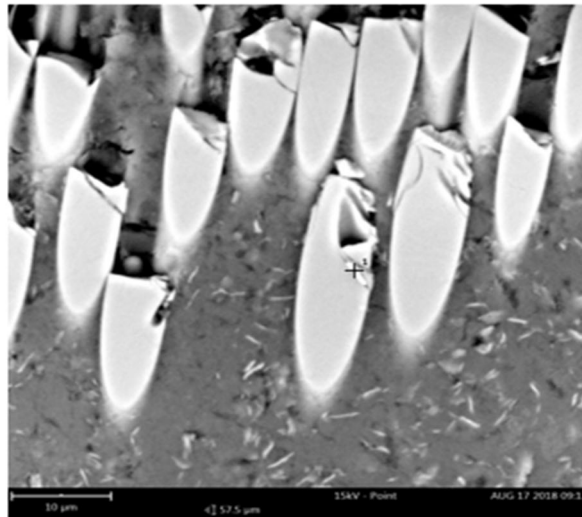


# Review of results data



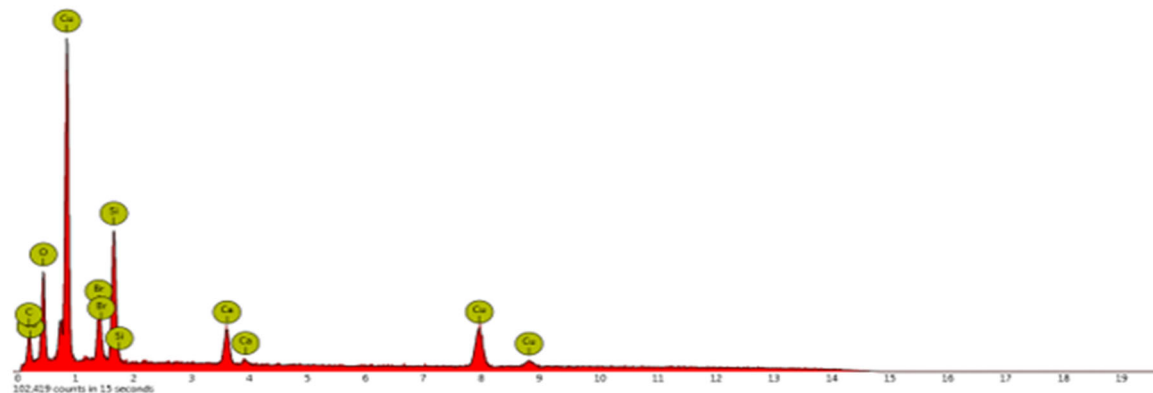
# Review of results images

## 1. spot



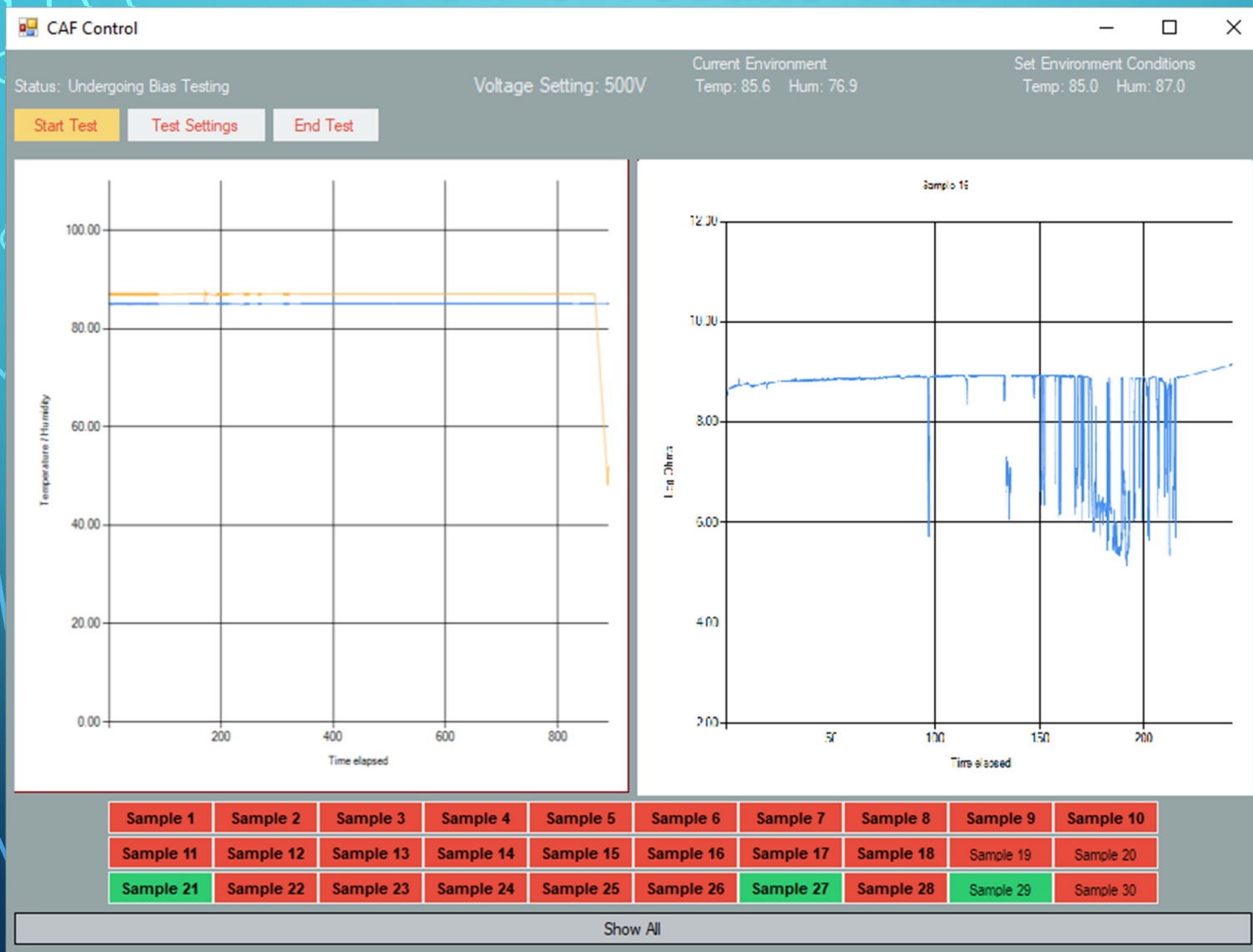
Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
6	C	Carbon	42.07	20.09
8	O	Oxygen	27.79	17.68
29	Cu	Copper	14.09	35.59
14	Si	Silicon	10.01	11.18
35	Br	Bromine	3.68	11.70
20	Ca	Calcium	2.36	3.76

FOV: 57.5 µm, Mode: 15kV - Point, Detector: BSD Full, Time: AUG 17 2018 09:13

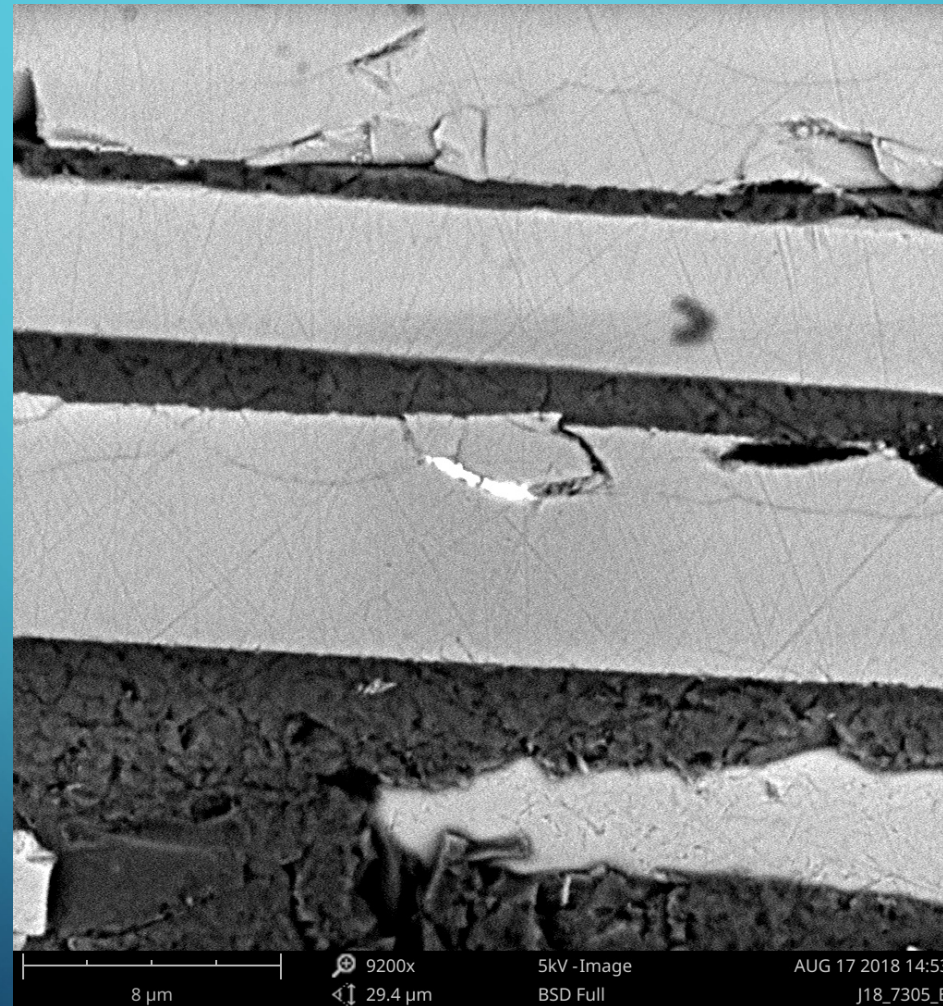




# Review of results data



# Review of results images

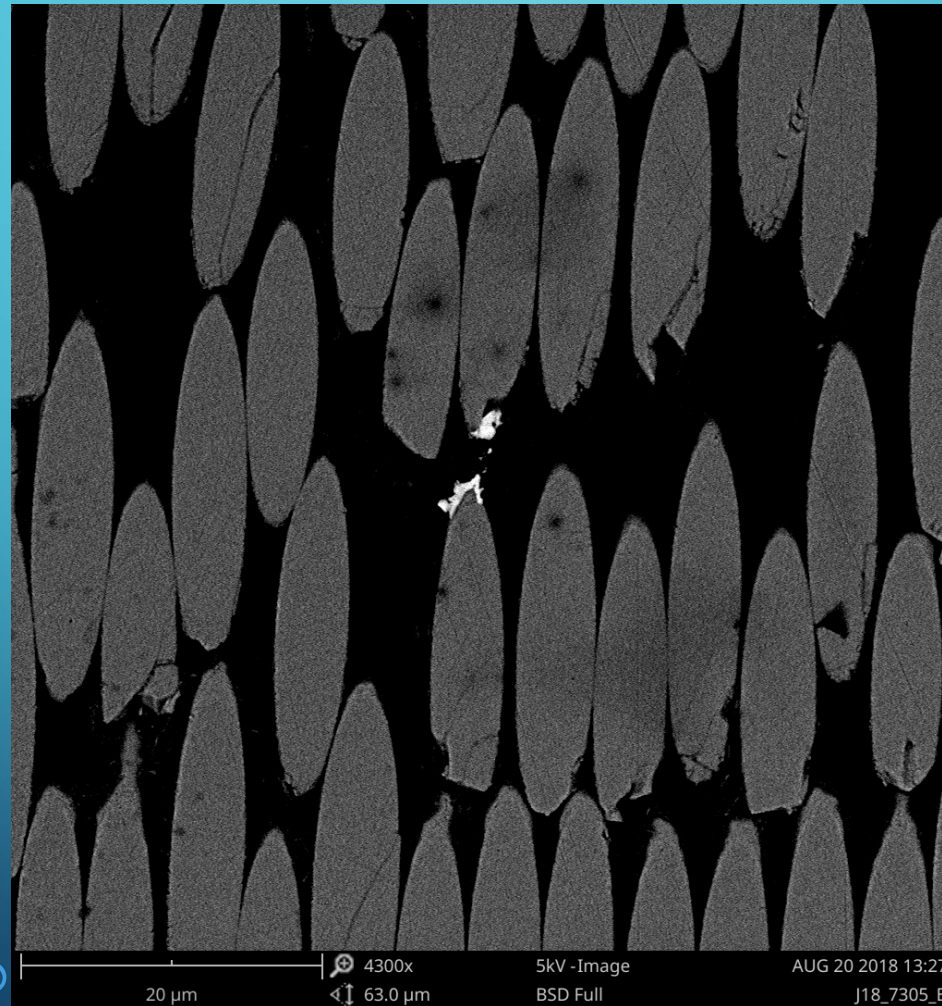


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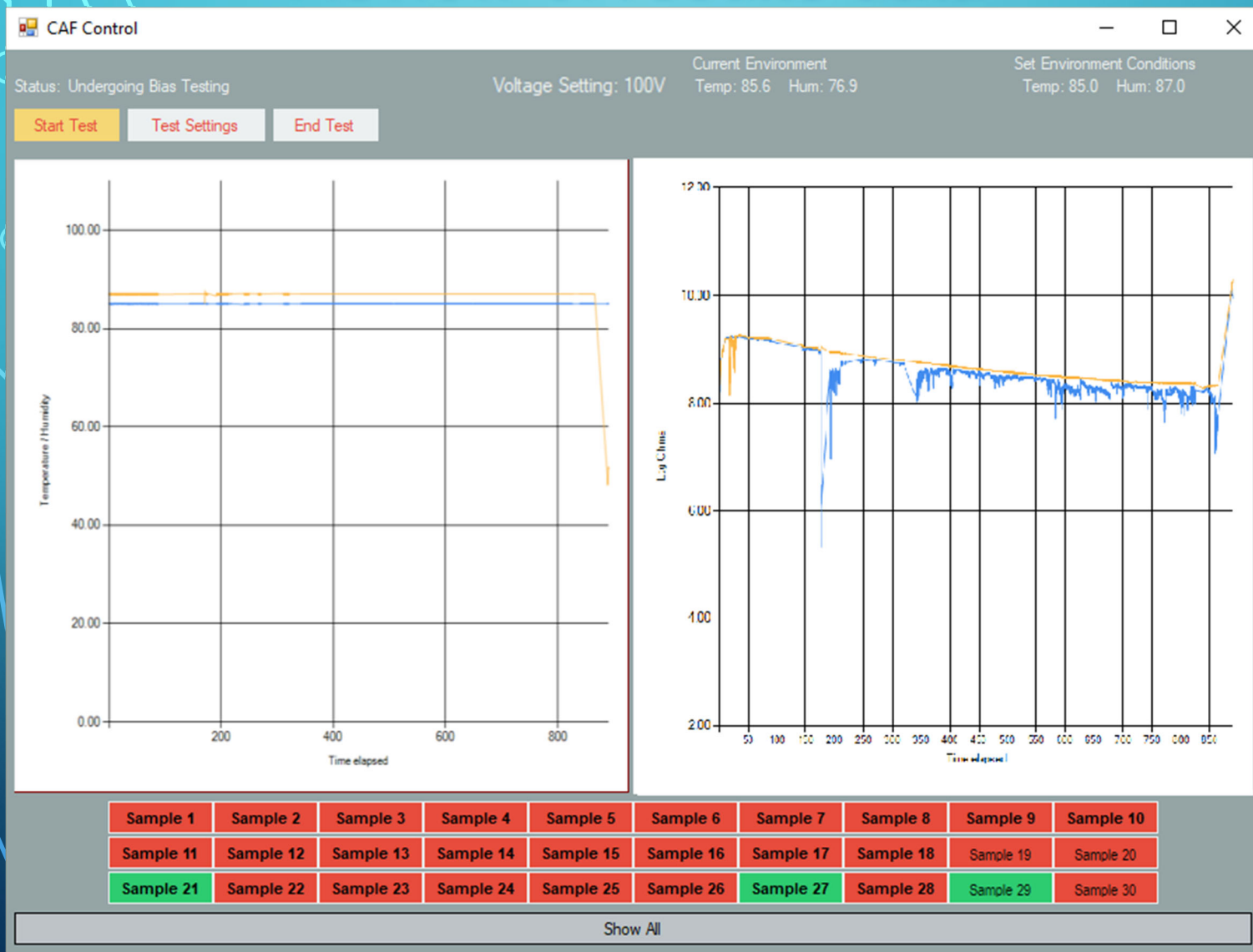




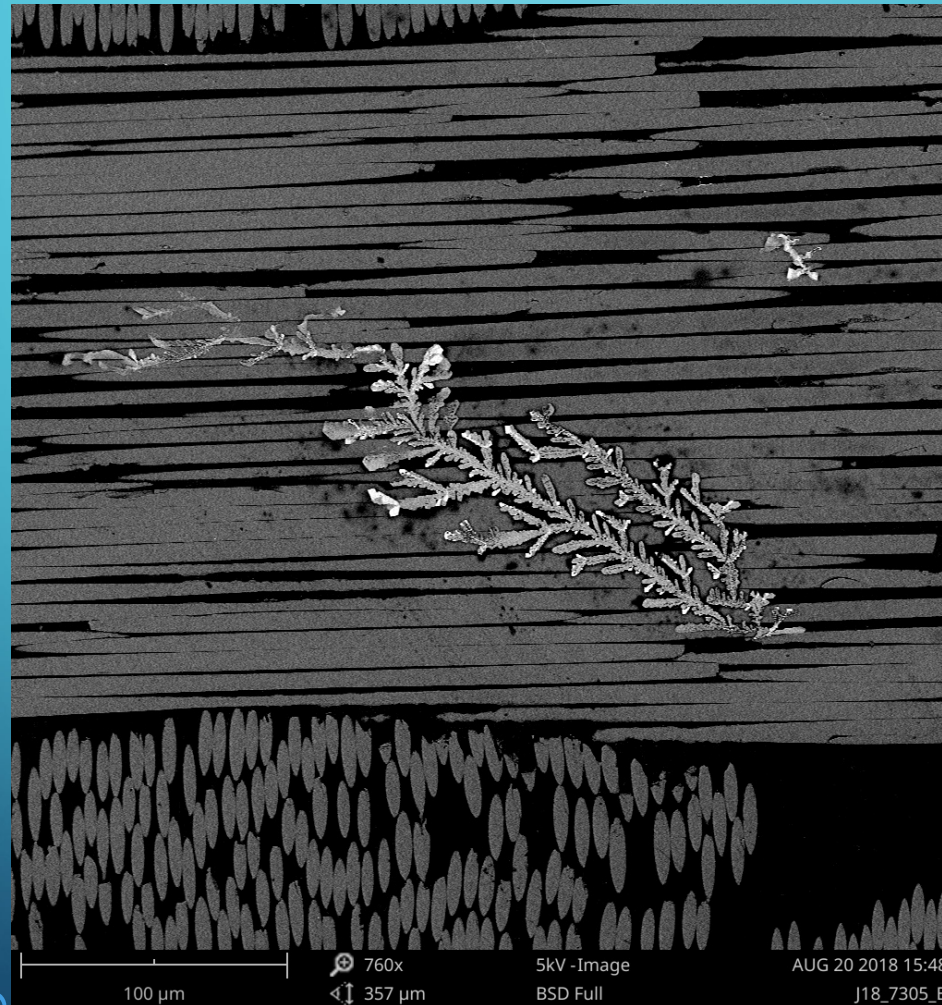
# Review of results images



# Review of results data

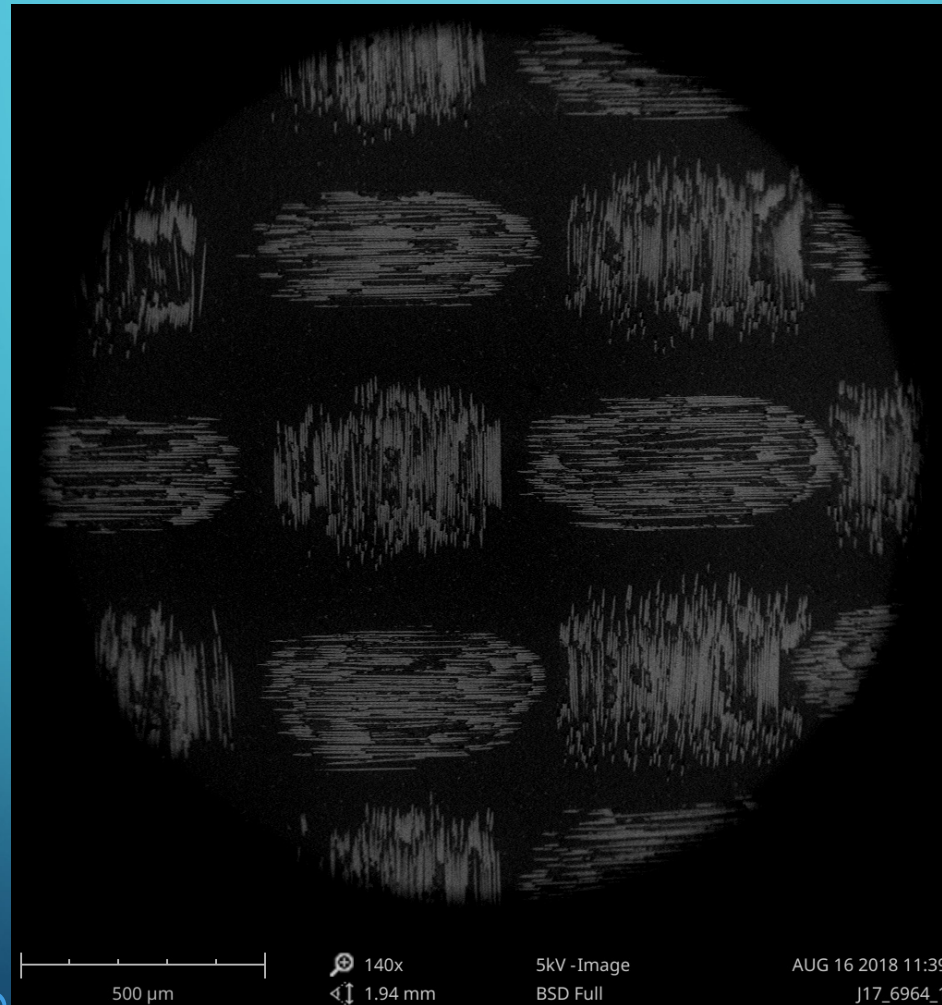


# Review of results images

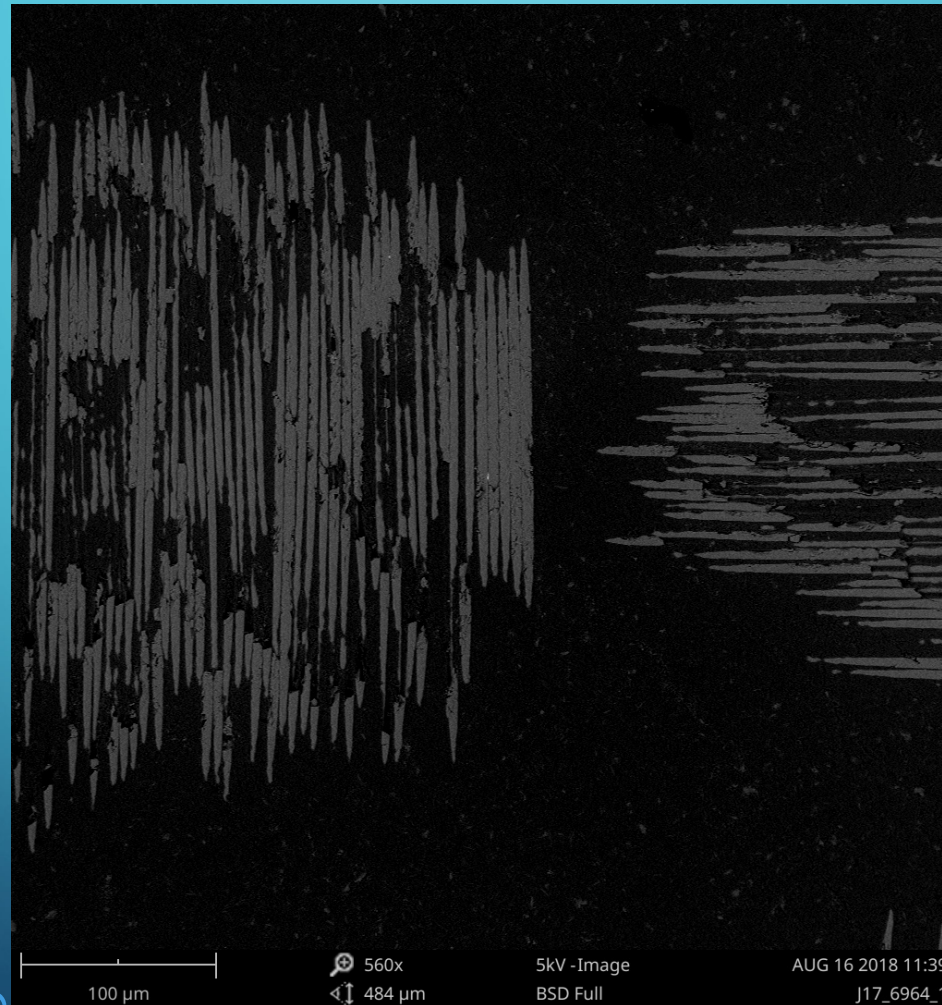




# Difficult to identify visually

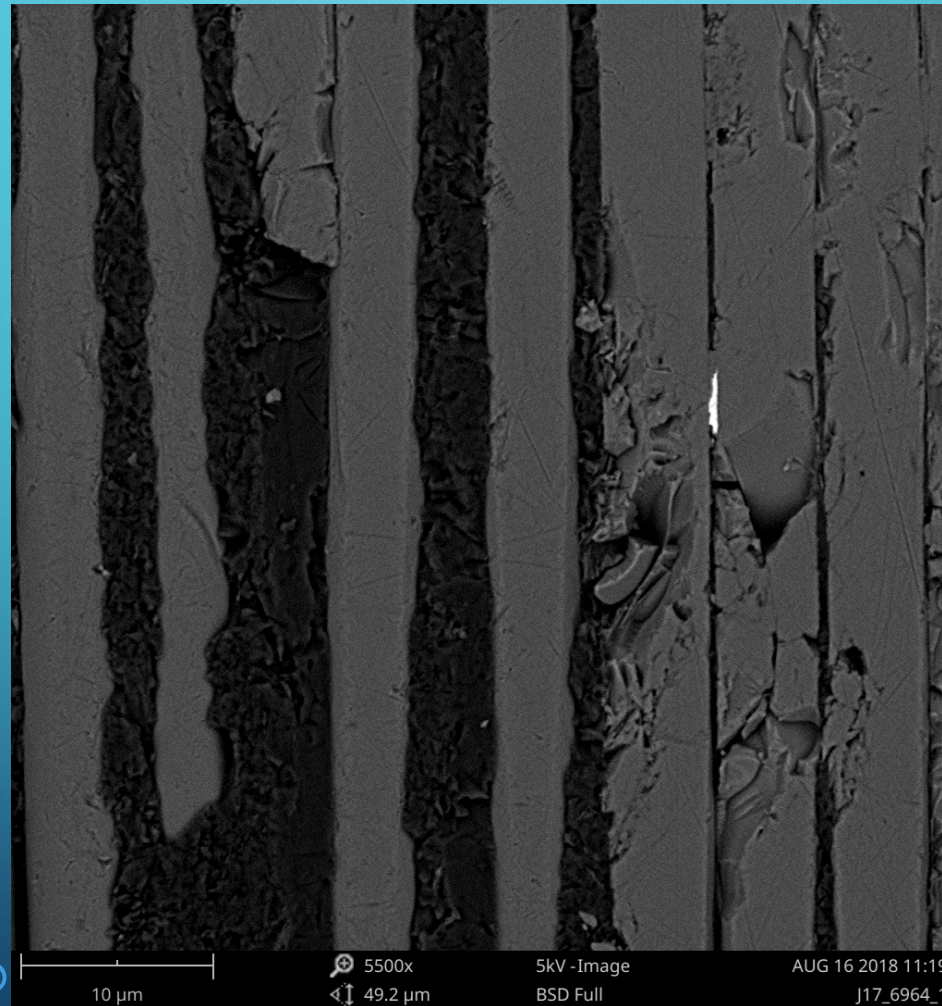


# Review of results images





# Review of results images





# Conclusions

- IF CAF TESTING IS BEING DRIVEN TO PRODUCT LEVEL WE MUST REPRESENT THE PRODUCT WITH THE TESTING

- WE HAVE TO CUSTOMIZE TEST VEHICLE

- WE HAVE TO CUSTOMIZE TEST ENVIRONMENT

- FAILURE DIFFICULT TO LOCATE IN MICROSECTION

- FAILURE MAY GO THROUGH A RECOVERY

- REVIEW OF RESULTS

- CONCLUSIONS


- Q & A

## ARE INDUSTRY STANDARDS FOR CAF PERFORMANCE POSSIBLE?

- Performance testing SHOULD be based on the industry segments product's life cycles – NOT one size fits all philosophy
- Each industry (Consumer, Computer, Telecom, Medical, Automotive, Avionic, Aerospace, etc.) has unique end-use environments, representative criteria is critical.
- PWB Performance Standardization must have :—
  - Standardized (but flexible) test vehicle designs
  - Universally available automated test equipment and protocols that quantify both materials and via structure capability
  - Documented methodologies with common data reporting format
  - Includes stresses applied during assembly/rework process
  - Performance levels that (ideally) correlate between both quality and reliability specifications

## Conclusions

- PWBIS Inc. design/performance database can be used to establish effective industry segment test vehicles and performance criteria.
- All industry segments are now specifying IST testing for measuring and confirming PWB performance/reliability.
- Standardized designs, protocols, reporting formats and performance criteria's have been developed.
- With 250+ IST test systems located at the majority of major/global PWB manufacturing facilities IST has effectively established itself as the globally accepted methodology for determining PWB reliability and material performance.
- IST Test Services will be expanded to achieve a global presence that meets the growing volume demands.

The slide features a light blue to orange gradient background. In the corners, there are decorative circuit-like patterns consisting of thin blue lines and small circles, resembling a printed circuit board (PCB) layout.

# Thank you for your attention; any Questions?

For further information please contact:

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