

FOR A SMARTER WORLD

SW Test Workshop Semiconductor Wafer Test Workshop

Test Cell Co-planarity Optimization

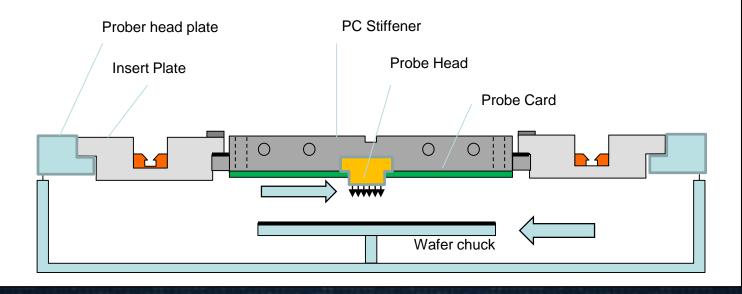


TERADYNE

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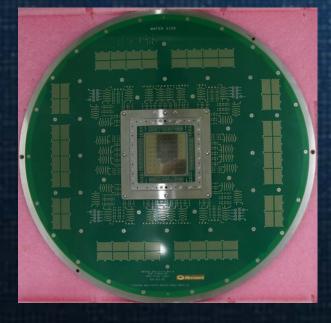
June 3-6, 2018

What is co-planarity of a test cell Parallel plane between wafer chuck and probe contacts



Why is test cell co-planarity important?

- Array sizes are increasing. Some exceed the applications space.
- Probe technologies are numerous & compliance restrictions
- Pad damage from multiple probe marks (re-probing)
- Active circuitry under pad regions are sensitive to probe forces







When is a co-planarity check recommended?

- Test cell installation / setup
- Changing instrumentation in TH
- Changing the insert plate
- Physical movement of any equipment
- Changing counter-balance weights
 Prober PM
- **Optional:**
- Production maintenance checks



Goals

- Provide repeatable docking to prober interface
- Efficient conversion or transition capability
- Maintain experience with the "production proven" tools
- Closely emulate probecard architectures
- Compatible on multiple tester platforms (UltraProbe / J750-HD)
- Compatibility on probers
- Eliminate any tool calibrations
- Achieve a test cell co-planarity of <20 microns (5.5" x 5.5")

Precision Leveling System

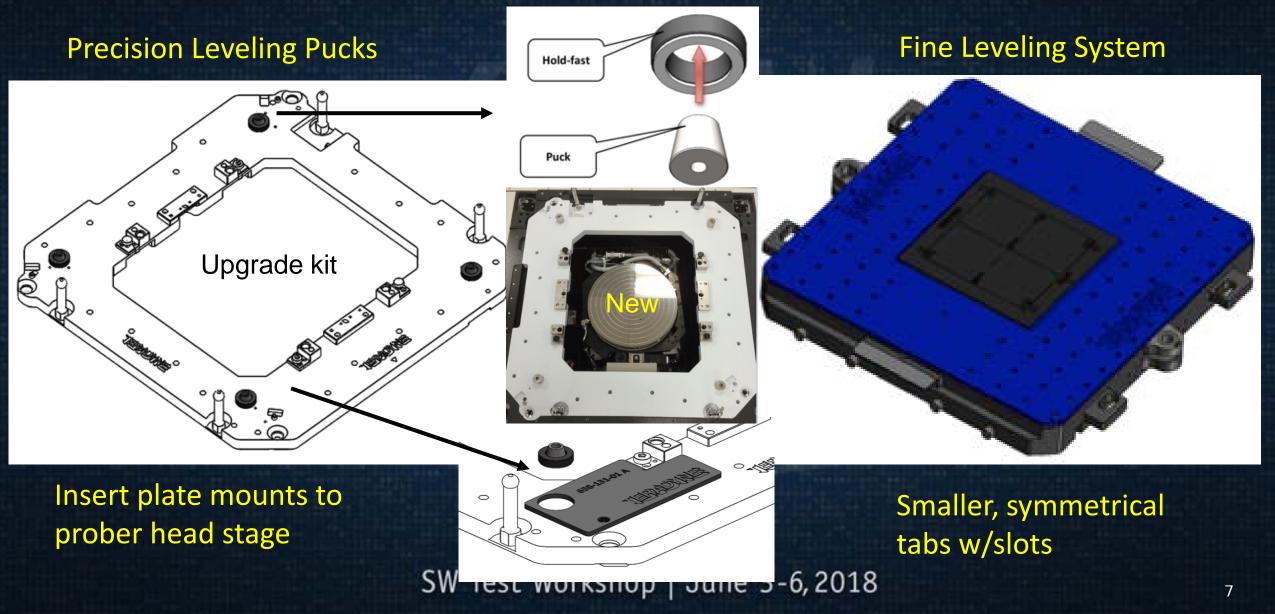
Precision Leveling Pucks (PLP)

- Provides repeatable docking interface "UltraProbe only"
- Solid engagement of TH with insert plate at corners
- Utilizes the thickest area of insert plate

• Fine Leveling System (FLS)

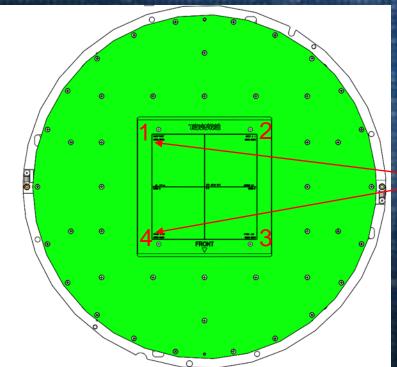
- Provides high-precision accuracy without tool calibration
- Compatible on all UltraProbe or J750 tester and prober combinations
- Software calculator tool as a guide for prober adjustments

UltraProbe Components



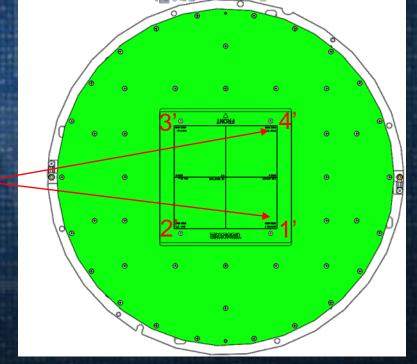
FLS Rotation – How it works

The calibration concept is easy to understand and uses the calibrated optics of the prober. There are 4 Z-height measurement points (one in each corner) taken in the 0 degree position. These Z-values are then compared to the Z-values after rotating the tool 180 degrees. If the co-planarity is perfect, each Z-value "pair" will equal the measurement in the opposing corner. Example: 1 = 1' 2 = 2' etc. If not equal, this provides the delta from perfect co-planarity and the height difference can be determined whether "+" or "–" from any given corner.



0° POSITION

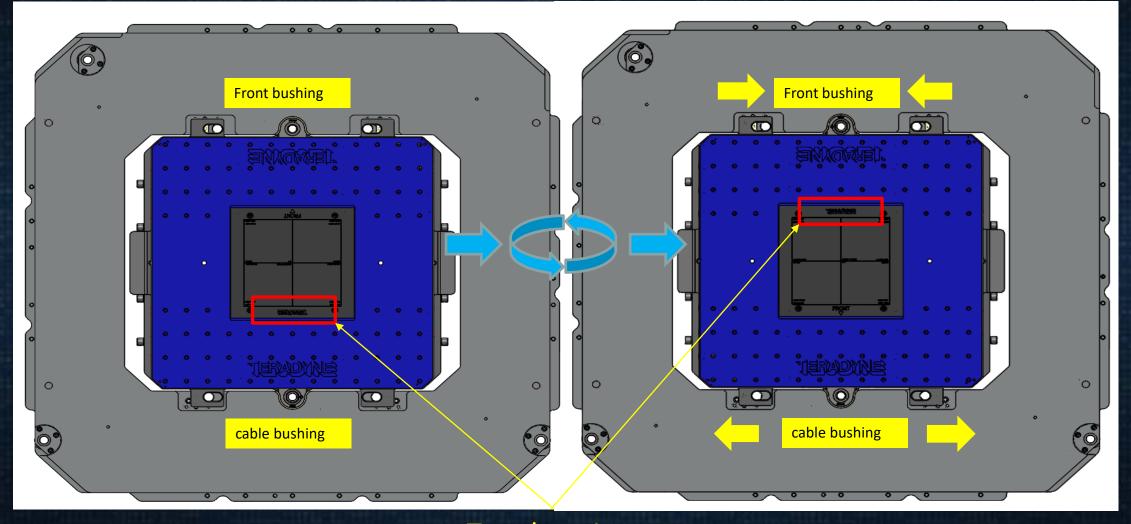
180° ROTATION



FLS Rotation Overview

0° POSITION

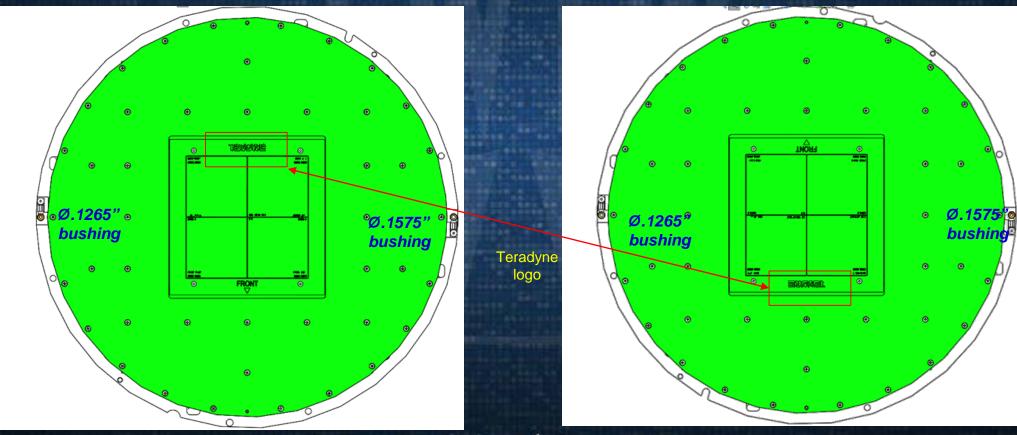
180° ROTATION



J750-440J FLS Rotation Overview

0° POSITION

180° ROTATION



FLS Bushing Exchange Feature

Tool-less design has dual purpose:1. Enhance tool accuracy2. Efficiency of rotation process

A

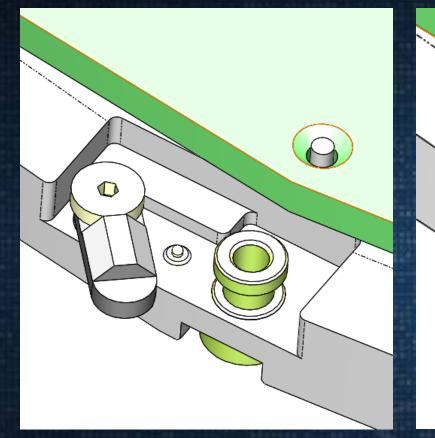
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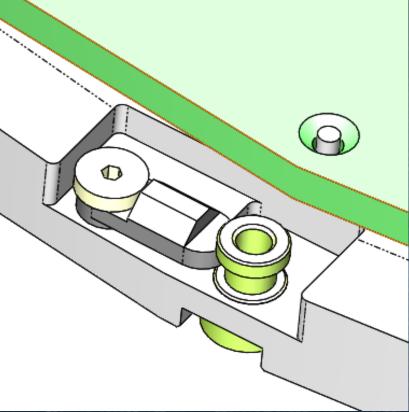
Open state

Bushing exchange allows for rotation on PC loader tray

Latched state

J750 Bushing Exchange





0.1265" Bushing

ATTACKED

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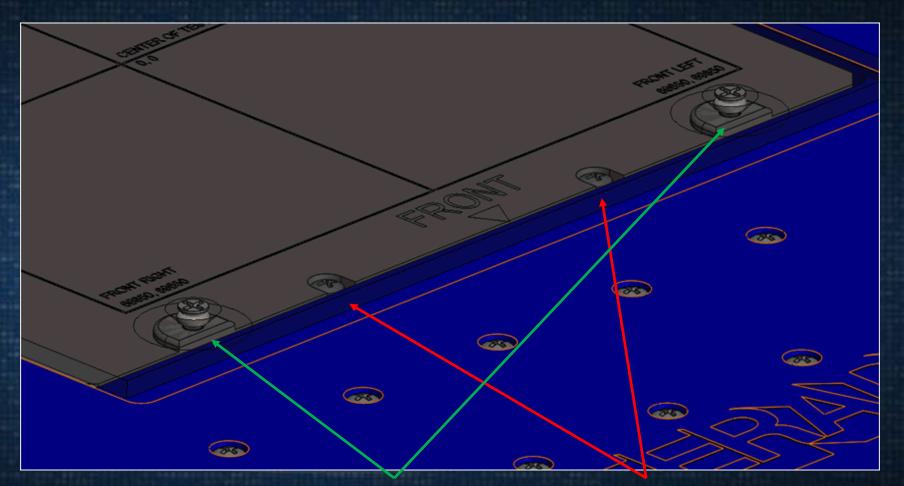
Open state

Latched state

Emulates Probecard Architecture

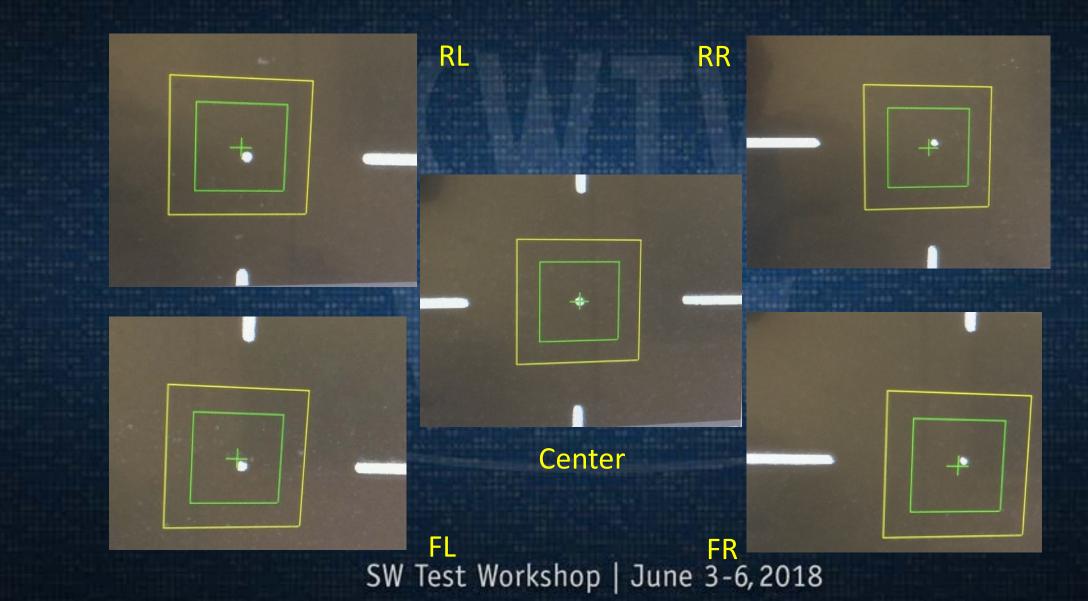
 Rigidly attached structures

Provides optimal PC correlation



PCB targets mounted securelyPlate mounted securely tothrough Plate to PC stiffenerPC stiffener under PCBSW Test Workshop | June 3-6, 2018

FLS Targets – Prober Macro View



FIS Calculator

						ulator		Co-planality
	Enter FLS Data at 0°					FL	S Range	of test cell
	FLS Points	INPUT DATA (um)	Inpu	it 4 Z-va	alues		2	
	Rear Left	-3		0 degr			Z	
	Rear Right	-19		i ucyi	662	Visu	al Reference	
	Front Right	17				Rear Left Target 1	Rea	ar Right Target 2
	Front Left	5	Input 4	4 Z-valı	Jes			
			, from 1		irees			0
	Enter FLS Data after Rota	ting 100				-1		0
	FLS Points Rear Left (0° Front Right)	INPUT DATA (um) 16	Delta(um) -1			-		
	Rear Right (0° Front Left)	5	-1					
	Front Right (0° Rear Left)	-3	0			Front Left Target 4	Fro	nt Right Target 3
	Front Left (O° Rear Right)	-18	1					
Adjust corner up or down		2		Zgu	uide	1		0
A CONTRACTOR OF THE OWNER OWNER OF THE OWNER	Head State Adjustments	(reference)		Z-Mover	nent Ref.			
	FLS Points	Move (um)		Turn	Z (um)	Adjustment Instruction	ns	
	Rear Left	1		"1/128"	5	1. Start with front corner largest value fr		left /ciebt commenter
	Rear Right	0		"1/64"	9	2. Next, adjust both front corners equally		iert /ngnt symmetry.
	Front Right	0		"1/32"	18	 Avoid adjusting rear (hinge area). 	y to match rear.	
	Front Left	-1		"1/16"	36	4. Only make small adjustment in rear fo	r left / right symmetry.	Tips
	Upward	Upwards Towards Test h	and	"1/8" "1/4"	73 145			
	Downward	Downward Into Prober	cau	1/4	145			
		THE OWNER AND ADDRESS OF TAXABLE PARTY.		THE R. LEWIS CO., LANSING MICH.	The second second	AND INCOMENTS OF A REAL PROPERTY	A REAL PROPERTY AND ADDRESS OF TAXABLE PARTY.	second state of the local division of the lo

Setting up device file, training targets or manual measurements: Always start in Rear Left location, continue clockwise. SW Test Workshop | June 3-6,2018

Co-planarity

Prober Optics Results

FLS Target Acquisition Repeatability

Variability Chart for Z value Z value Microns 2 0 -2 -6 Run # Front Left Front Right Rear Right Rear Left Position

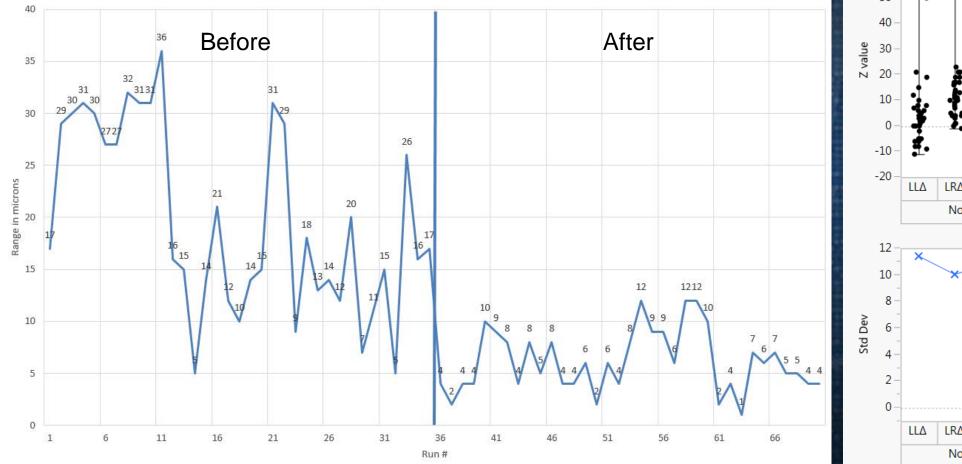
UltraProbe Results

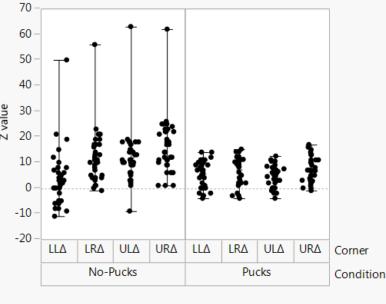
Test Cell Docking

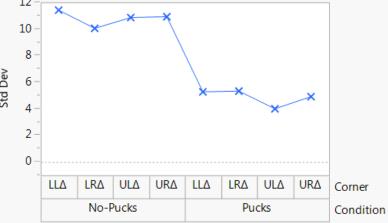
Variability Chart for Z value

Test Cell Co-Planarity

Z Plane range by run







J750 Results

Enter FLS Data at 0°						FLS Range		Ent
FLS Points	INPUT DATA (um)					212		
Rear Left	50							Real
Rear Right	-28					isual Referen		Rear
Front Right	-39				Rear Left Target 1	_	Rear Right Target 2	From
Front Left	17				-			From
Enter FLS Data after Rota	ting 180°				105		-41	Ente
FLS Points	INPUT DATA (um)	Delta(um)			105		-41	Ente
Rear Left (0° Front Right)	66	105						Rear
Rear Right (0° Front Left)	-24	-41						Rear
Front Right (0° Rear Left)	-57	-107			Front Left Target 4		Front Right Target 3	From
Front Left (0° Rear Right)	14	42						Fron
FLS Range	212				42		-107	
Head State Adjustments	(reference)		Z-Moven	nent Ref.				Hea
FLS Points	Move (um)		Turn	Z (um)	Adjustment Instruction	onci		
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Front Left	-42		"1/16	73	4. Only make small adjustment in rear	r for left / righ	t symmetry.	Fron
Upward (CW)	Upwards Towards Test h	nead	"1/4"	145				
Downward (CCW)	Downward Into Prober							
Enter FLS Data at 0°						FLS Range		Ente
FLS Points	INPUT DATA (um)					136		
Rear Left	31							Real
Rear Right	-16 -20					isual Referen		Real
Front Right Front Left	-20				Rear Left Target 1		Rear Right Target 2	From
Front Left	в							From
Enter FLS Data after Rota	ting 180°				67		-24	Enter
FLS Points	INPUT DATA (um)	Delta(um)						
Rear Left (0° Front Right)	47	67						Real
Rear Right (0° Front Left) Front Right (0° Rear Left)	-18 -38	-24 -69			Front Left Target 4		Front Right Target 3	Real
Front Right (O' Rear Left) Front Left (O' Rear Right)	-38	-69 25			Front Left Target 4		Front Right Target 3	From
(Sit Leit (O' Rear Right)	9	23						From
FLS Range 136					25		-69	and the second second
Head State Adjustments	(reference)		Z-Moven	ant Pef				ALC: NOT BE
FLS Points	(reterence) Move (um)		Z-Moven Turn	Z (um)	A.11	1		Hea
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Front Left	-25		"1/16"	36	 Avoid adjusting rear (hinge area). Only make small adjustment in rear for left / right symmetry. 		From	
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Downward (CCW)	Downward Into Prober	iead	1/4	145				
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FLS Points	INPUT DATA (um)							En
Rear Left	3					38		Rea
Rear Right	-5					isual Referen		Rea
Front Right	5				Rear Left Target 1		Rear Right Target 2	Fro
Front Left	-3							Fro
Entor ELS Data after Data	ting 190°				20		7	
Enter FLS Data after Rota FLS Points	ting 180° INPUT DATA (um)	Delta(um)			20	<u> </u>	/	Ent
Rear Left (0° Front Right)	25	20						Rea
Rear Right (0° Front Left)	4	7						Rea
Front Right (0* Rear Left)	-15	-18			Front Left Target 4		Front Right Target 3	Fro
Front Left (O [*] Rear Right)	-13	-8				———		Fro
					-8		-18	A REAL PROPERTY.
FLS Range 38					-0		-10	a second s
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Front Right	13		"1/32"	18	2. Next, adjust both front corners equ			shop From From Shop
Front Left	8		"1/16"	36	3. Avoid adjusting rear (hinge area).			shop Fro
			"1/8"	73	Only make small adjustment in rear	r for left / righ	t symmetry.	The second s
			21 A 4 A 4 A	145				
Upward (CW) Downward (CCW)	Upwards Towards Test h Downward Into Prober	nead	"1/4"	145				the state of the s

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Enter FLS Data after Rotating 180" Inter FLS Points Front left (0" Rear left) Front left (0" Rear left) Front Right (0" Rear left) Front Right (0" Rear left) Front Right (0" Rear left) Eter Roja (0") Front Left Target 4 Front Right (0" Rear left) Eter Roja (0") Front Right 10 1/1/2/2" 1/2/2" Adjustment Instructions: State Adjust both front corners equally to math rear. State Adjust both front corners equally to math rear. State Adjust both front corners equally to math rear. State Adjust both front corners equally to math	Front Left	0						
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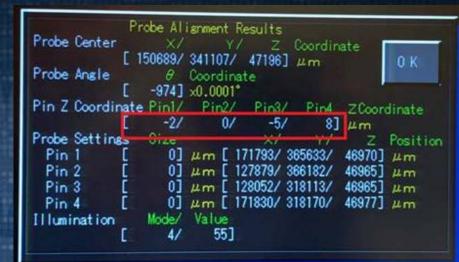
J750 Probecard Correlation Results

- New PC design array (~4" x 4")
- Four corner probes of array were within 13 microns

• (-2, 0, -5, 8).

- PC metrology 50 microns planarity
- PC electrical continuity check on prober w/tester was 45 microns
- Uniform probe marks on all pads

Prober optical results

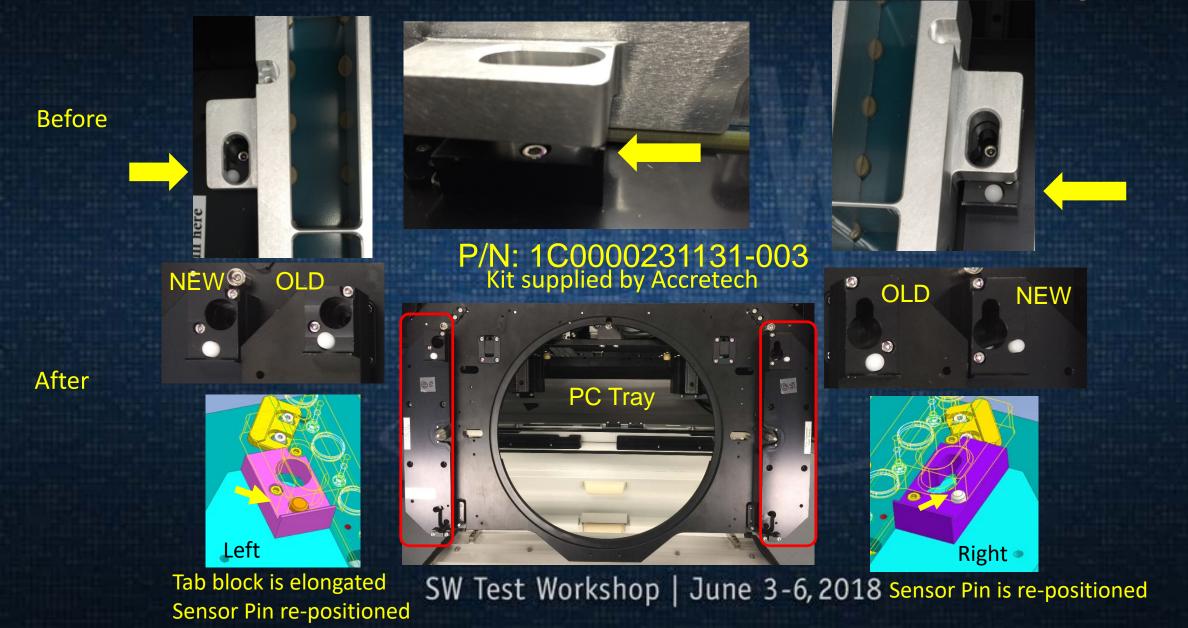


Probe marks

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Accretech kit for UltraProbe – PC Tray



Conclusions

- Repeatable docking for UltraProbe
 - Efficient PLP field conversion capability
- Maintain knowledge & experience of proven tools
- Emulate a probecard architectures for accuracy
- Compatible on multiple tester platforms
- Eliminated tool calibrations

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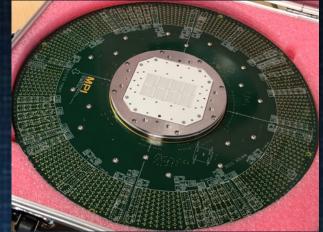
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- Achieve a test cell co-planarity of <20 microns (5.5" x 5.5")
- Compatibility on probers PC tray conversion

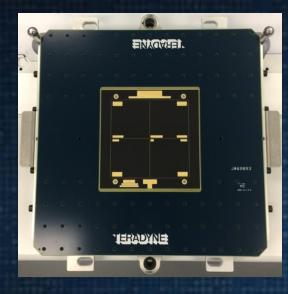
Future Work

• FLS for J750 with 300mm towers Probe array sizes are increasing FLS for ETS-800 test cells Implement Auto-leveling / Auto-tilt feature of prober with FLS Automated head plate adjustment by stepper motors Operator enables feature, only loads / unloads FLS both rotations • Prober does all calculations, adjusts, disables feature A "one and done" process for setup or verification



~18,000 probes

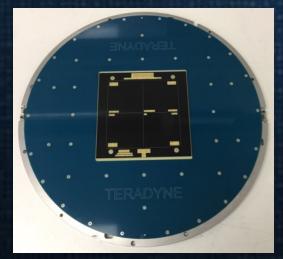
Contributor Appreciation



Doug Garrett - NXP



SECURE CONNECTIONS FOR A SMARTER WORLD



Hoang Nguyen - Microsemi

