IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

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High-Performance Contactors for Wafer-Scale Test (WST)

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Agenda

- Traditional Test Approach – Probe and Final (Package) Test
- New Method – Final Test on Wafer
  - Economic Advantages
  - Understanding Wafer-Scale Test
- Wafer-Scale Test Vs. Wafer Probe
  - Mechanical Challenges
  - Electrical Challenges

Agenda

- New-Generation Spring Probes for WST
  - – Electrical and Mechanical Characteristics
- New Generation Probes Compared to Existing Probe Technologies for WST
  - – Traditional Spring Pin
  - – Cantilever Beam
  - – Buckling Beam
  - – Membrane

Traditional Test Approach

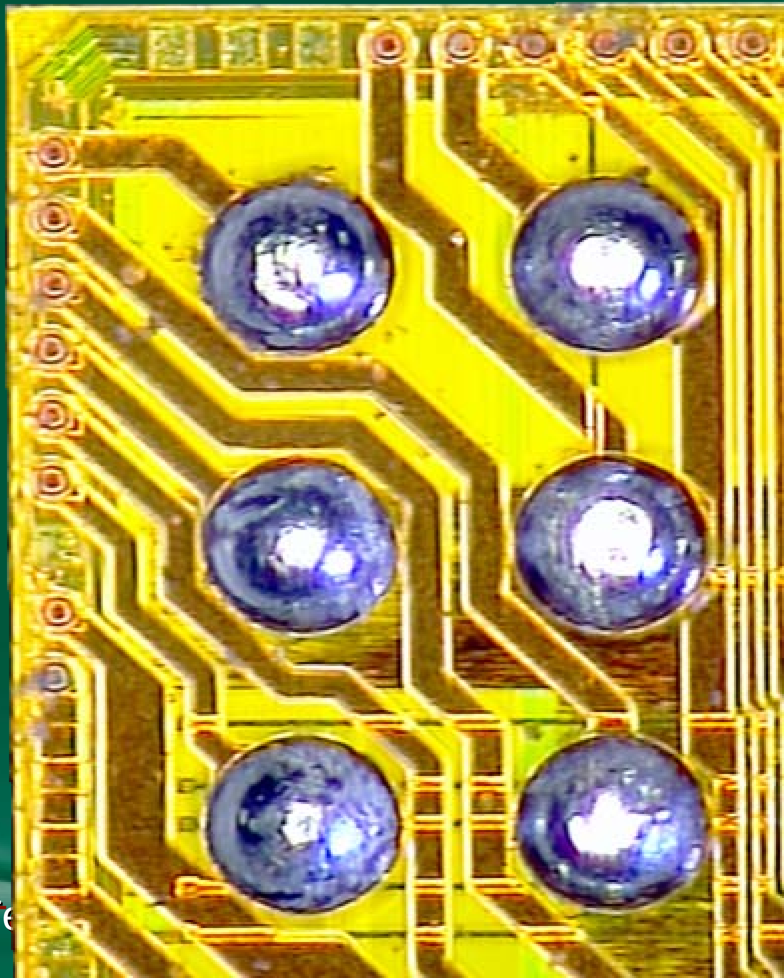
Wafer Probe / Final Test

- Wafer Probe
  - – Cannot be a complete and thorough test
  - – Confirms device functionality
- Final (Package) Test
  - – Performed at device specification limits
  - – Confirms performance with packaging effects included

New Method –
Final Test on Wafer

Wafer-Scale Test (WST)

- Packaging at wafer level allows testing at wafer level
- Redistribution layer with ball or bump attach
- Ready to be diced, boxed and shipped after test



New Method –
Final Test on Wafer

Economic Advantages

- Testing traditionally >10% of cost of device manufacture
- Testing once rather than twice has potential to halve this
- Improved possibilities of parallelism
- Shorter time to market

Understanding Wafer-Scale Test

Wafer-Scale Test is mechanically similar to probe test

Wafer-Scale Test must be identical electrically to package test

WST vs. Wafer probe

WST Mechanically Similar to Wafer Probe

- Devices still part of wafer
- Wafer prober used to manipulate devices for test

WST vs. Wafer probe

Wafer-Scale Test */S* Final Test

- DC tests
  - High current
  - Accurate force, measure values
- Functional tests
  - Drive inputs at thresholds
  - Sense outputs at limits & under loads
  - Power supplies at minimum / maximum

WST vs. Wafer probe

Wafer-Scale Test */S* Final Test

- Timing / AC tests
  - Full clock speed
  - Worst-case input timing combinations
  - Confirming input-to-output timing
  - RF tests (gain, SNR, THD, etc.)
- Requires clean power delivery
  - Low inductance

WST vs. Wafer Probe

WST Challenges - Mechanical

- Fine-pitch requirements
  - Currently at 0.4 and 0.3 mm pitch
  - 0.25 mm and smaller soon
- Vertical Contact
  - Support for area arrays
  - Support for high parallelism
- Adequate force requirements
  - More force required than wafer probe
  - 20 g - 30 g to pierce solder oxide and debris

WST vs. Wafer Probe

WST Challenges - Mechanical

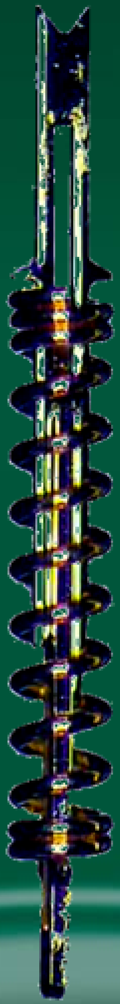
- Compliance
  - – Bumped wafers not as coplanar as wafer pads
- Cleaning
  - – Abrasive scrub for cantilever probe not appropriate
  - – New cleaning techniques required
- Stack height
  - – Probers not capable of plunging to board
  - – Additional height diminishes performance

WST vs. Wafer Probe

WST Challenges - Electrical

- High current requirements
- Low, consistent resistance
- Low inductance requirements
- High bandwidth requirements
- *Everything that is required for final test*

New-Generation Spring Pins Meet All the Requirements



New Architecture Spring Probes

- –Electrical performance
- –Mechanical performance
- –Cost-effective manufacturing method

New-Architecture Probe

New Architecture

- Single-ended
  - Two flat pieces and spring
  - No barrel
- All external surfaces allow excellent plating quality and consistency
- Scalable architecture suitable for 0.2 mm and below

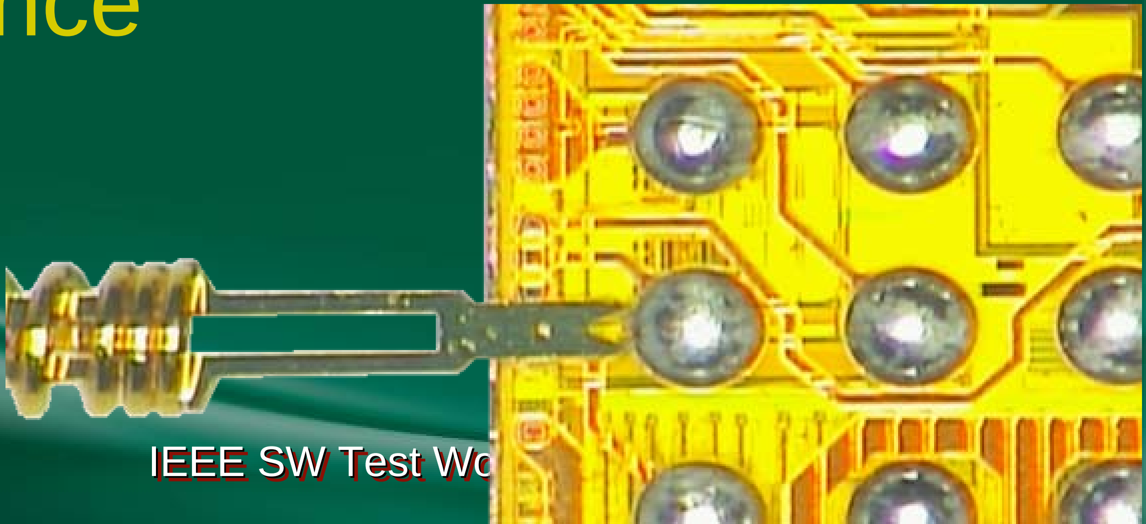
New-Architecture Probe

High Electrical Performance

- –Short, wide signal paths
- –High bandwidth
- –Low, consistent resistance
- –High Conductance
- –Low inductance

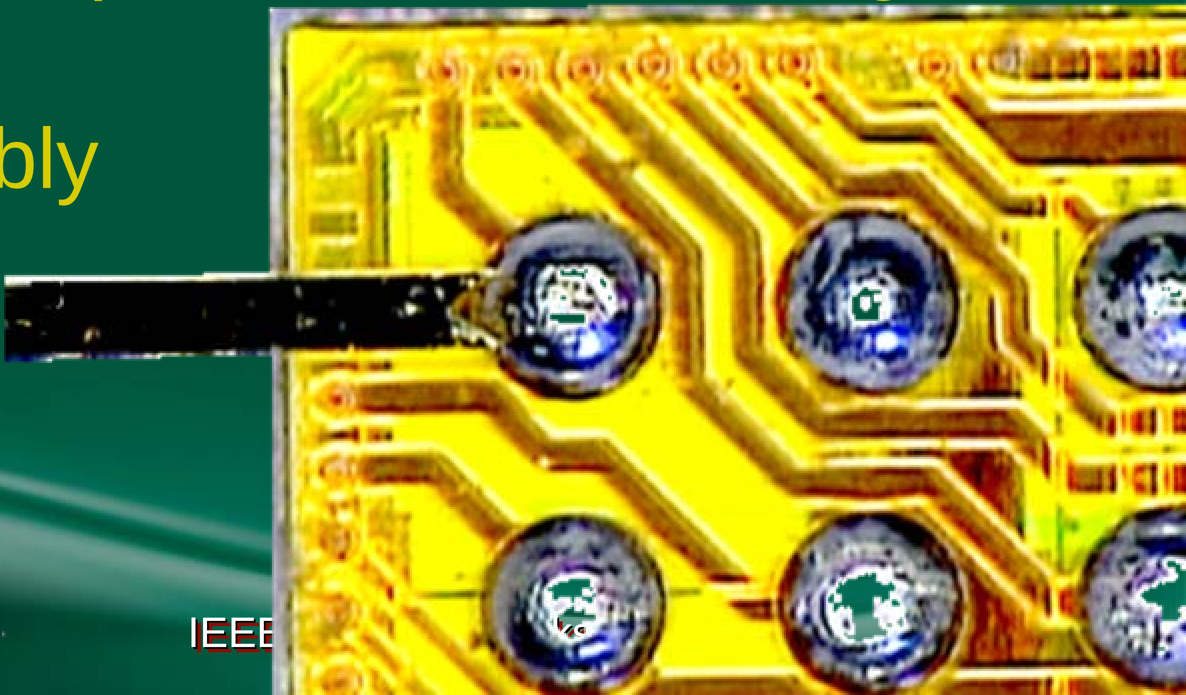
New-Architecture Probe

High Mechanical Performance
- –Short probe length
- –Good force
- –High compliance
- –Long life



New-Architecture Probe

- Cost-Effective Probe
  - Fewer probe parts
  - Lower cost than turned parts
  - Better plating improves manufacturing yield
  - Easier assembly
  - Individually Replaceable



New-Architecture Probe

Sample Specifications:
RF / Electrical

	0.4 mm	0.3 mm
Bandwidth	25.8 GHz @ -1 dB*	12.4 GHz @ -1 dB*
Loop Inductance	0.91 nH*	1.12 nH*
Continuous Current	1.2 A @ 20° C rise	TBD
	1.7 A @ 40° C rise	TBD
Current @ 1% duty cycle	7.7 A @ 20° C rise	TBD

* Native pitch, GSG, Vespel dielectric

New-Architecture Probe

Sample Specifications: Mechanical

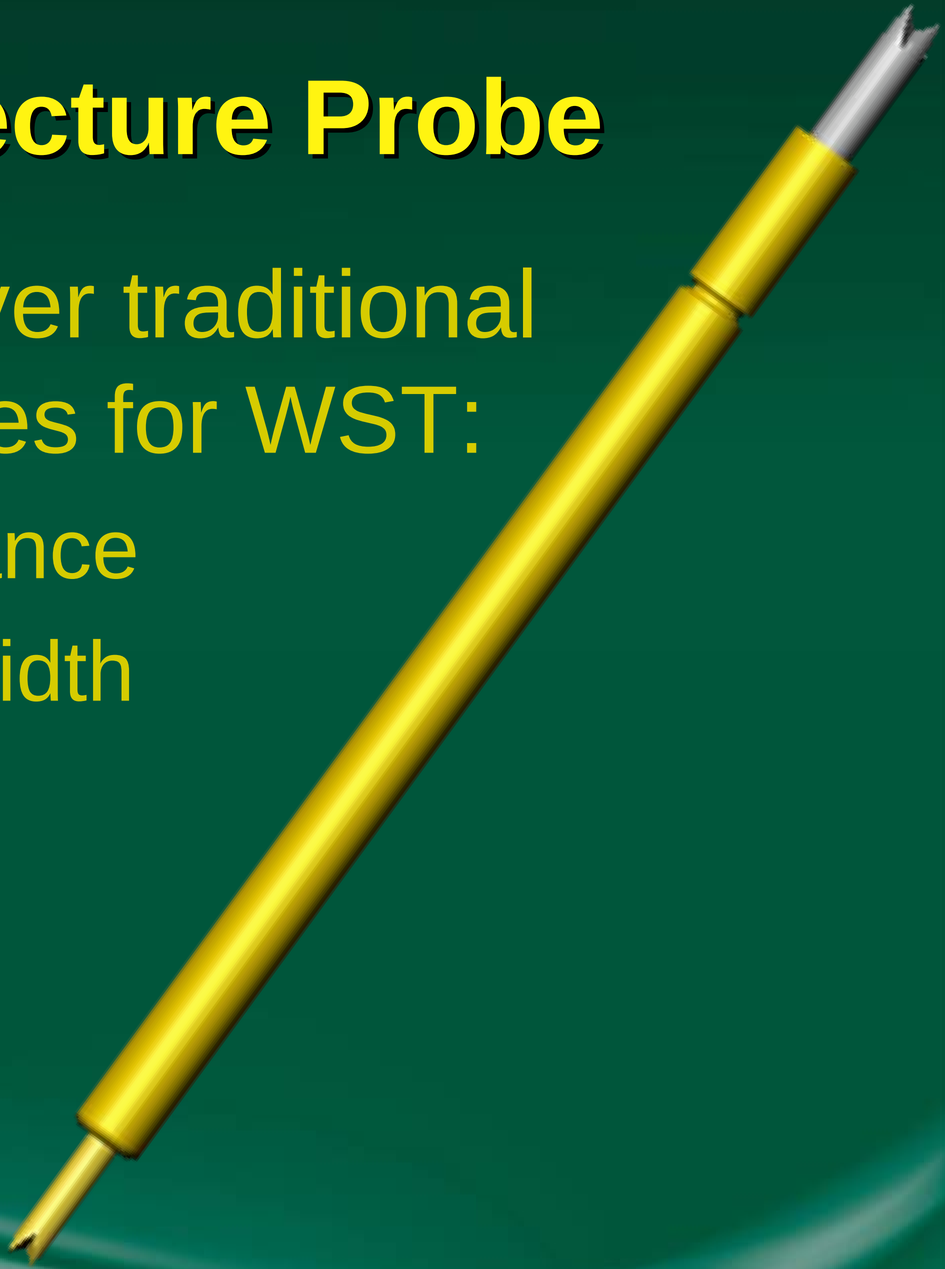
	0.4 mm	0.5 mm
Test Height	2.40 mm (0.094”)	2.73 mm (0.106”)
Compliance	0.64 mm (0.025”)	0.64 mm (0.025”)
DUT-Side Compliance	0.5 mm (0.020”)	0.5 mm (0.020”)
Force @ Test Height	30 g	25 g
Typical Life	500 k cycles*	500 k cycles*
Finish (Plating)	Hard Gold, others pending	

* Lab tests

New-Architecture Probe

Advantages over traditional spring probes for WST:

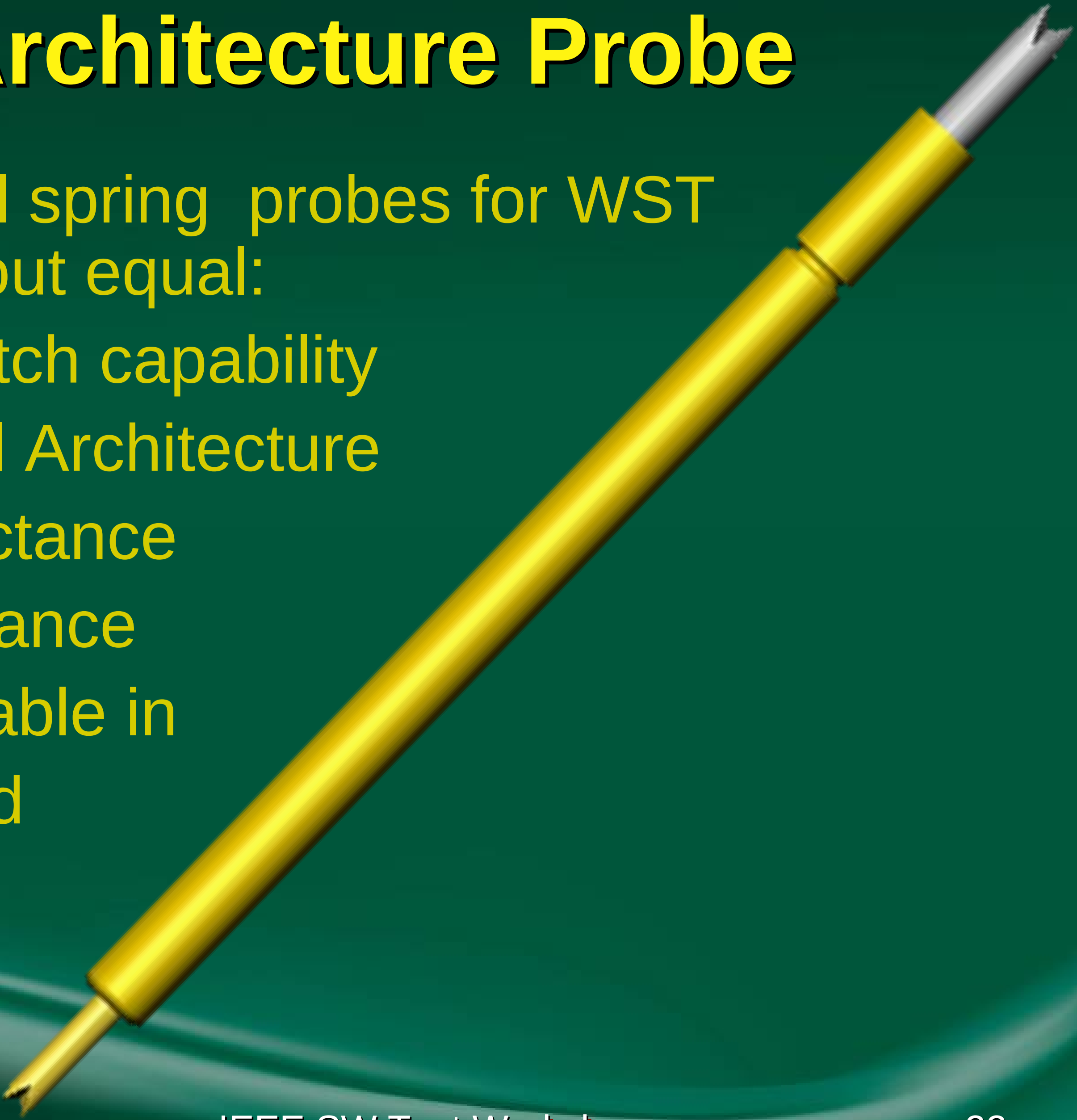
- Lower inductance
- Higher bandwidth
- Higher Force



New-Architecture Probe

Traditional spring probes for WST are about equal:

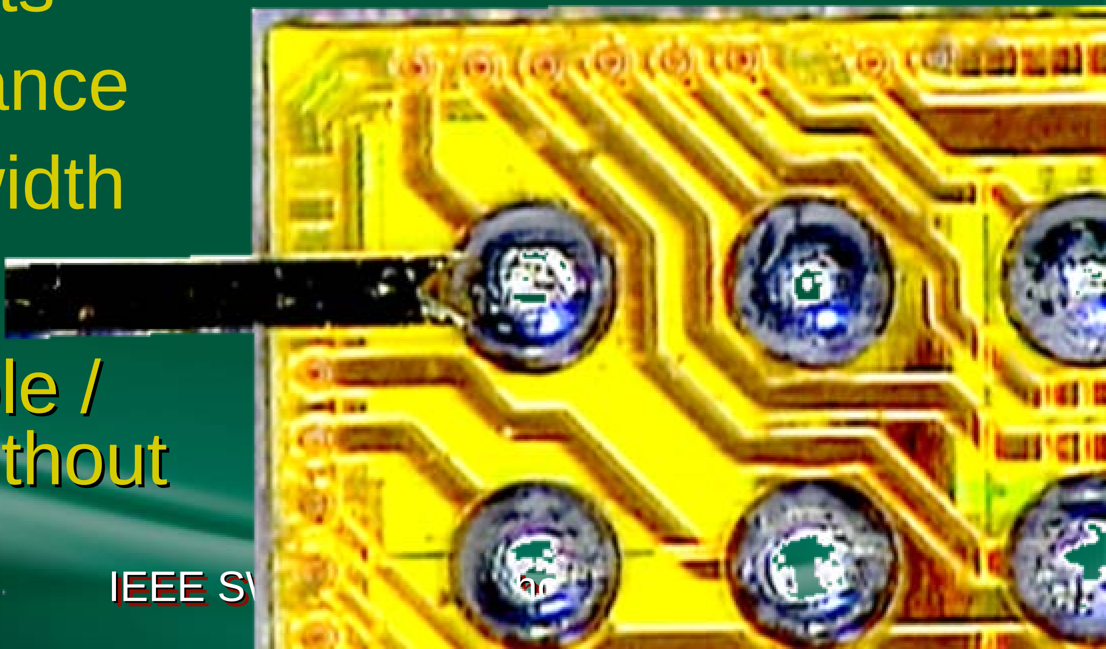
- Fine Pitch capability
- Vertical Architecture
- Conductance
- Compliance
- Repairable in the field
- Price



New-Architecture Probe

Advantages over traditional cantilever-beam probes for WST:

- Vertical architecture for area arrays and higher parallelism
- Greater compliance
- Higher currents
- Lower inductance
- Higher bandwidth
- Higher force
- Field repairable / rebuildable without special tools



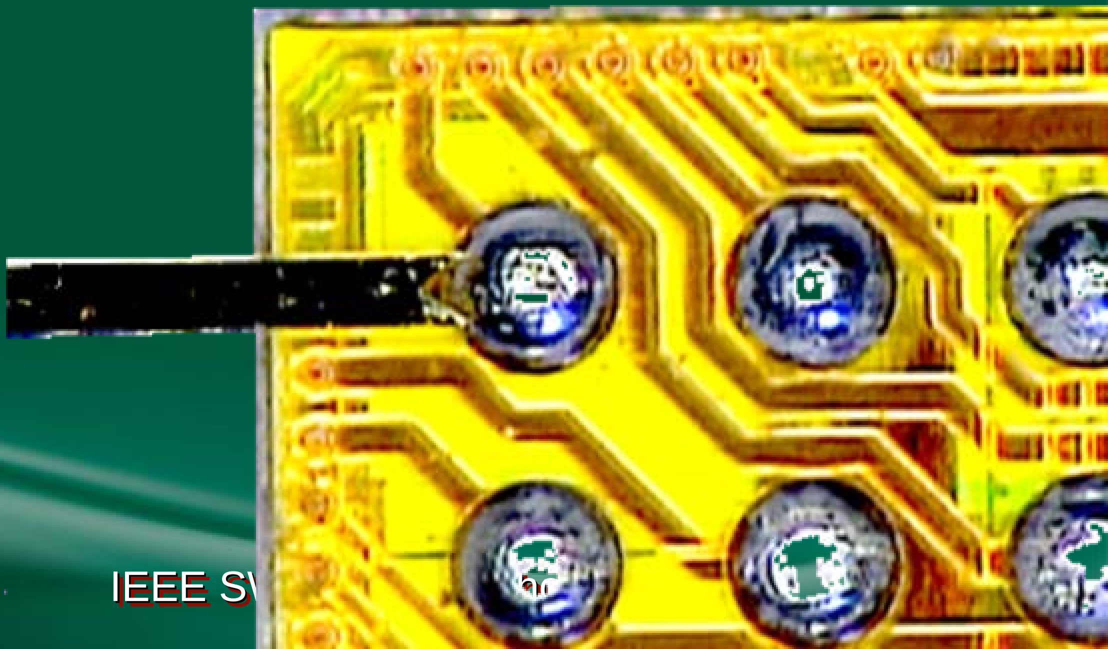
New-Architecture Probe

Advantages of traditional cantilever-beam probes for WST:

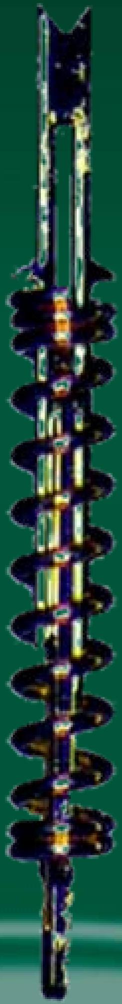
- Fine pitch capability

About Equal:

- Price



New-Architecture Probe



Advantages over buckling-beam probes for WST:

- Greater compliance
- Higher currents
- Lower inductance
- Higher bandwidth
- Higher force
- Lower price
- Field repairable / rebuildable without special tools

New-Architecture Probe

Advantages of buckling-beam probes for WST:

- Finer pitch capability

Equal:

- Vertical architecture

New-Architecture Probe

Advantages over membrane probes for WST:

- Greater compliance
- Higher currents
- Lower inductance
- Lower price / shorter leadtime
- Field repairable / rebuildable without special tools

New-Architecture Probe

Advantages of membrane probes for WST:

- Fine pitch capability
- Close position of decoupling

About equal:

- Bandwidth
- Vertical architecture

New-Architecture Probe

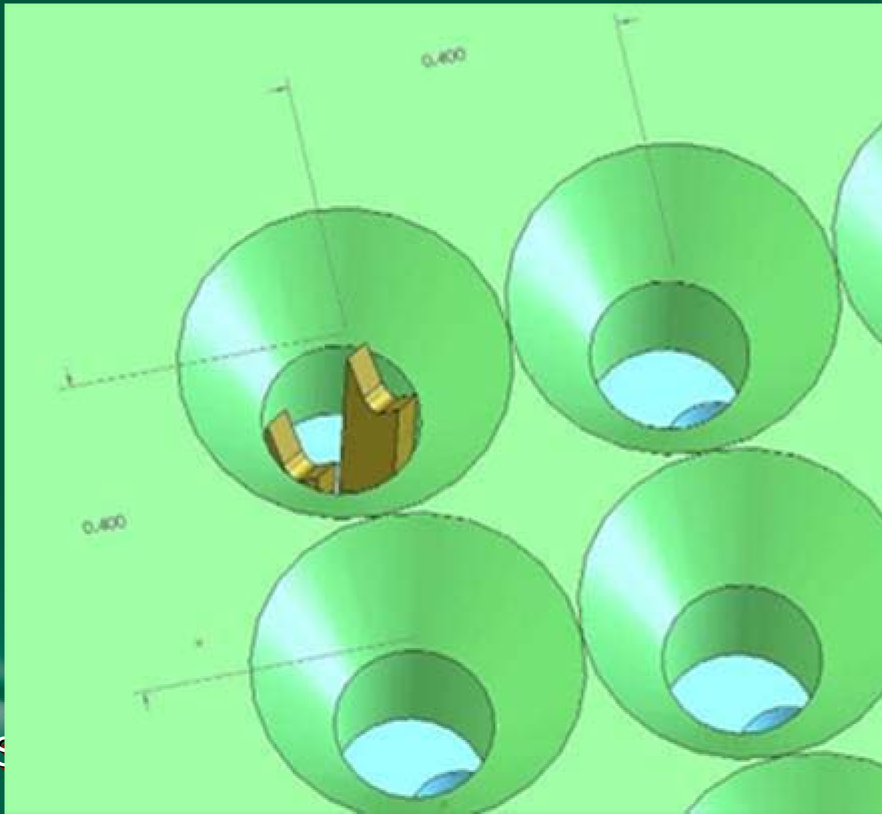
Initiating Beta Sites

- Primary considerations
  - First-pass yield
  - Final yield
  - Probe life
  - Overall cost of test
- Secondary considerations
  - Cleaning frequency
  - Ease of maintenance / use

Future

- Highly scalable architecture
- Probes designed for:
  - 0.2 mm pitch
  - Kelvin for 0.4 mm Arrays

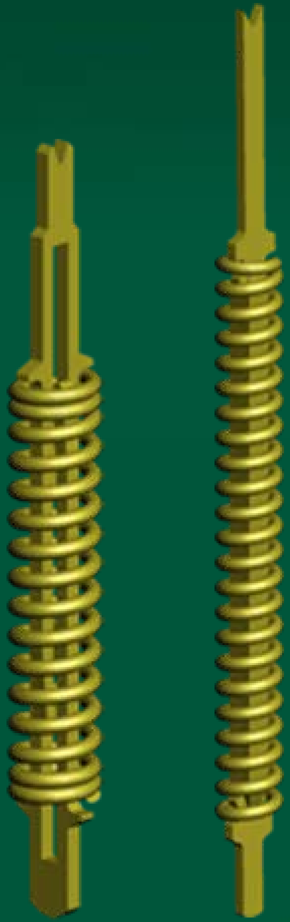
0.4 mm pitch Kelvin probe tips shown, viewed through floating alignment plate



Summary

New-technology probes are designed to be used in contactors to address:

- Mechanical requirements of WST
- Electrical requirements of WST
- Demand for reduced cost of test



Thank You

Questions?