



# IEEE SW Test Workshop

Semiconductor Wafer Test Workshop

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**A New Probe Card Changer to  
Increase Tester Utilization and  
Improve Data Integrity**

CELADON™

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**John Dunklee**

Celadon Systems

# Overview

- **Why is it needed**
- **Background**
- **What is a Celadon Indexer**
- **Data**
- **Summary**
- **Acknowledgements**



# Customer request

## 1<sup>st</sup> Increase Test system utilization

- No more waiting

## 2<sup>nd</sup> SPC driven System health and diagnostics “on the fly”

- Swap in calibration/debug cores



# Test system Utilization

- **What is up-time?**

- The Test system may be available, but not testing
  - Waiting for wafers
  - Waiting for a probe card
  - Fault condition – stop condition

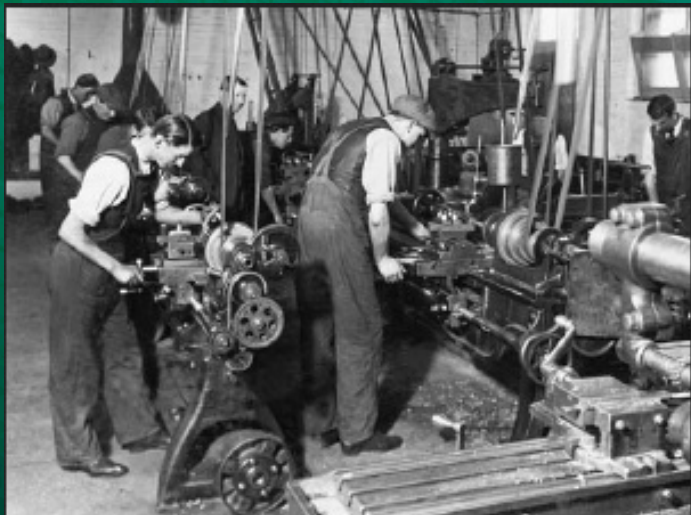


# The solution

- **No waiting for probe cards**
  - Swap probe cards in seconds
    - A *fast* probe card changer
- **No waiting to debug a fault condition**
  - SPC driven onboard instant diagnostics



# How the machine tool industry solved this problem



# Tool Changer

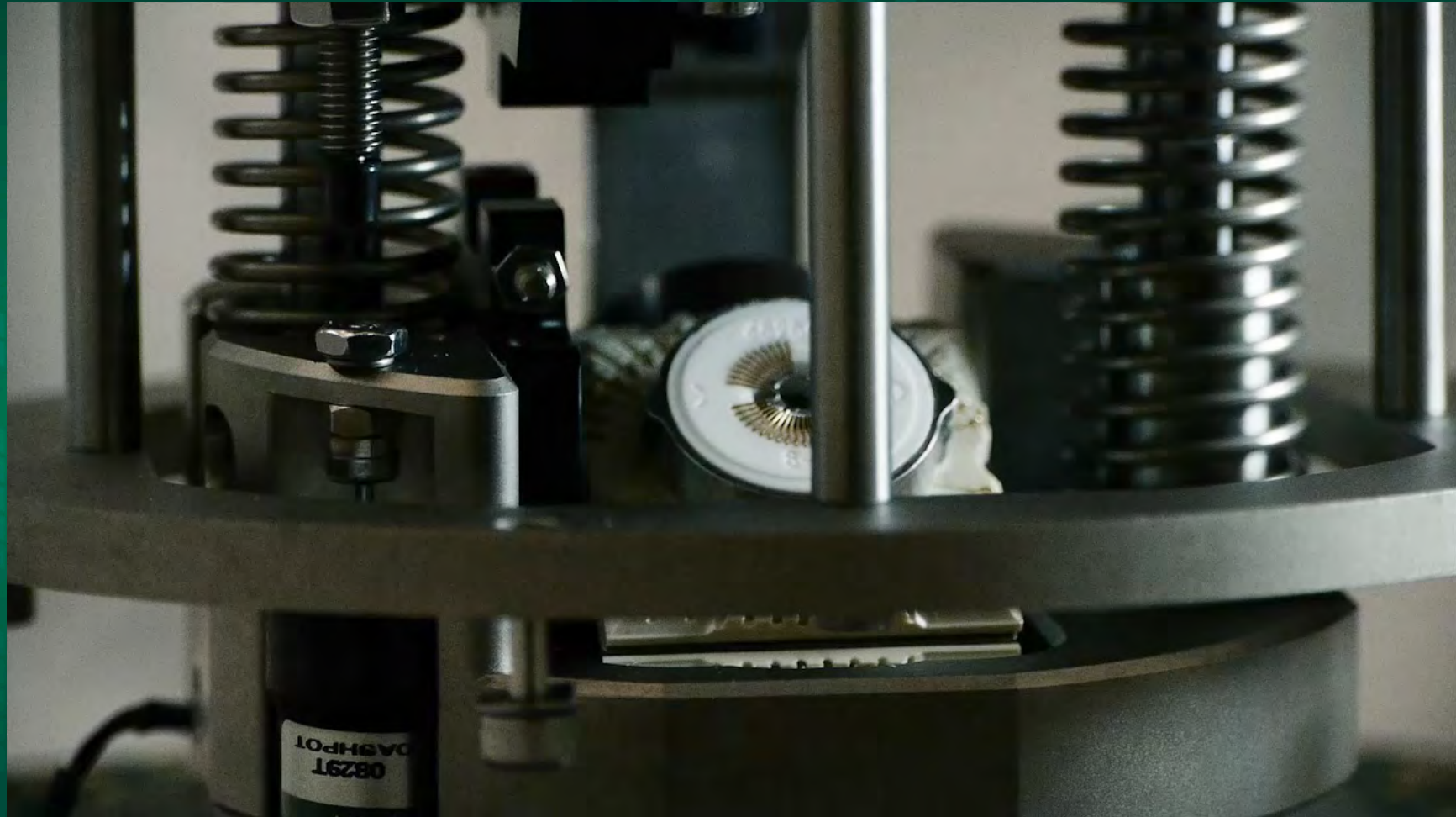


**So why not apply the same  
solution to our industry?**





# Celadon Indexer™



# A little bit of Background

- **Celadon's Focus:**
  - Low Leakage, low noise measurements
  - Wide operating temperature range
  - Multi-site



## T40 AttoFast™

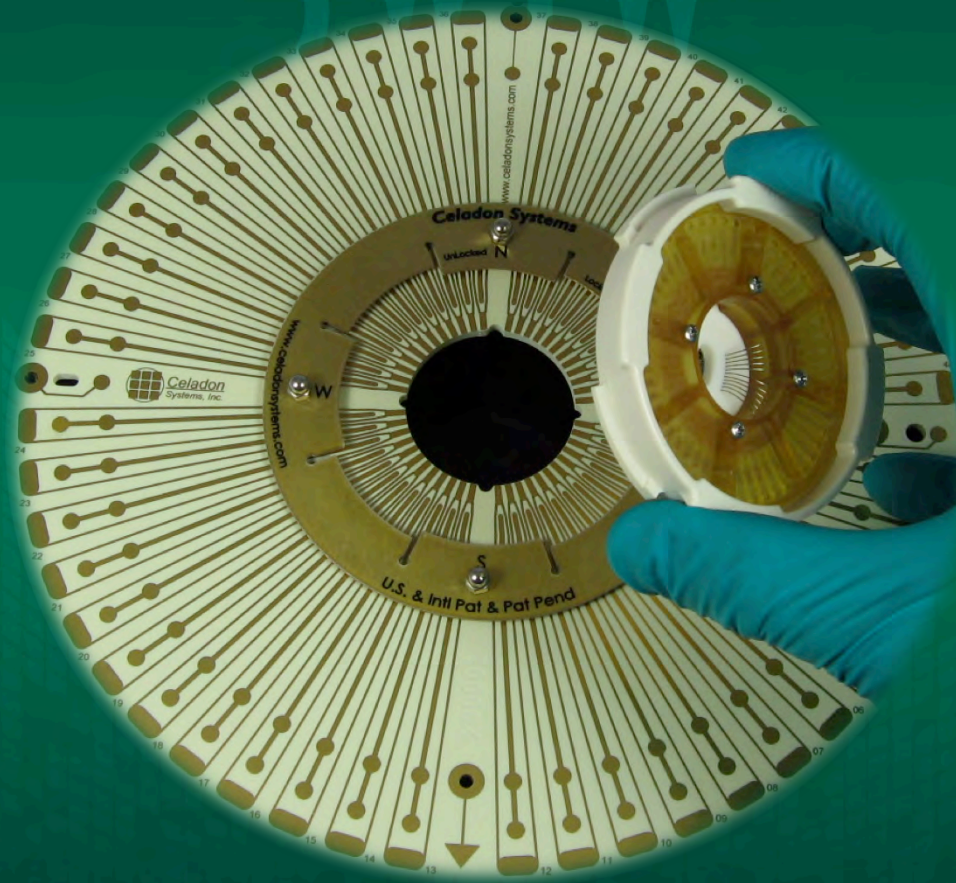
Operating Temperature:  
-65°C to 300°C  
Leakage: 1fA/V @ 25°C  
4fA/V @ 300°C



## VersaTile™

Operating Temperature:  
-65°C to 300°C  
Leakage: 5fA/V @ 25°C  
1pA/V @ 300°C

# VersaCore™ VC40

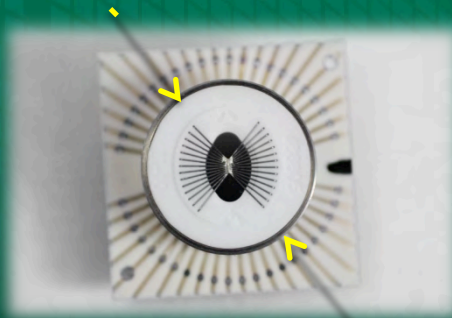
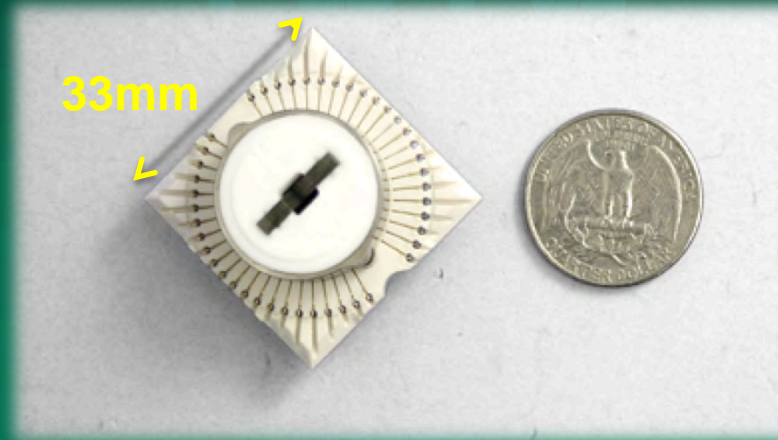


# Solution demands ultra-reliability

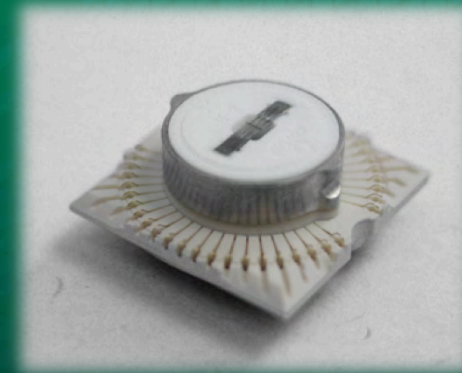
- Has to operate on an Agilent 407X/408X
- MEMs or Cantilever Probe Cores
- Ultra-Reliable



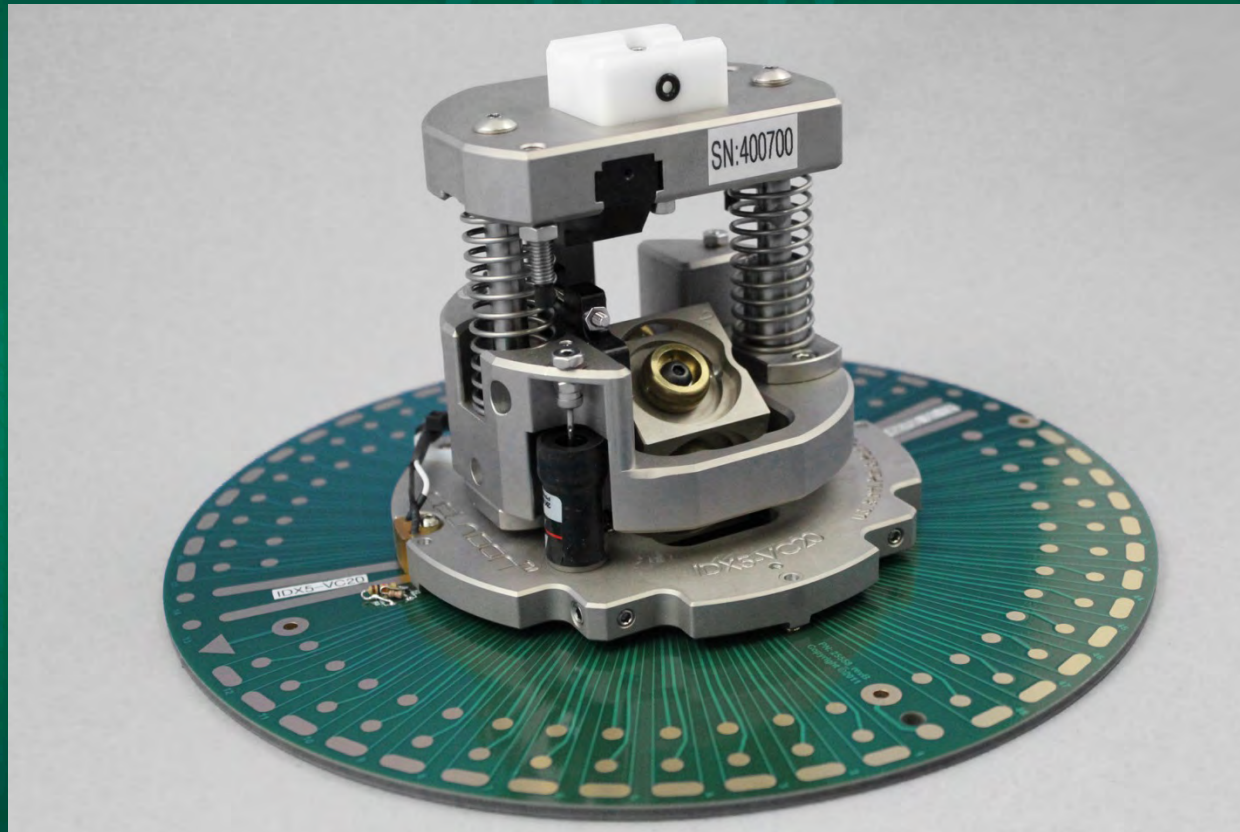
# VersaCore™ VC20



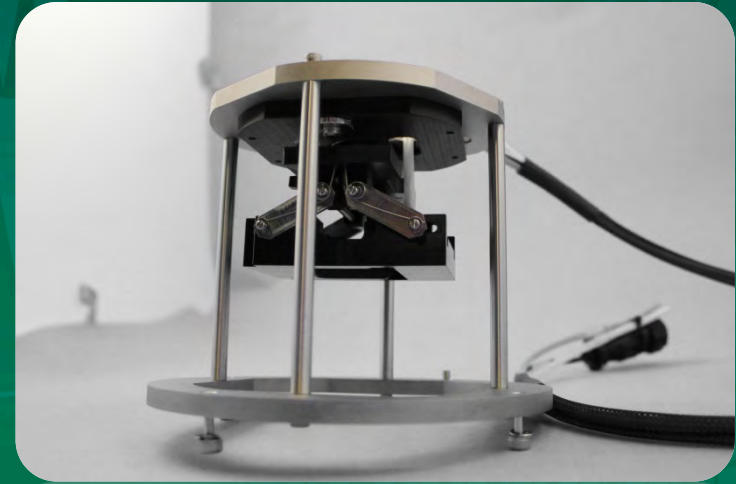
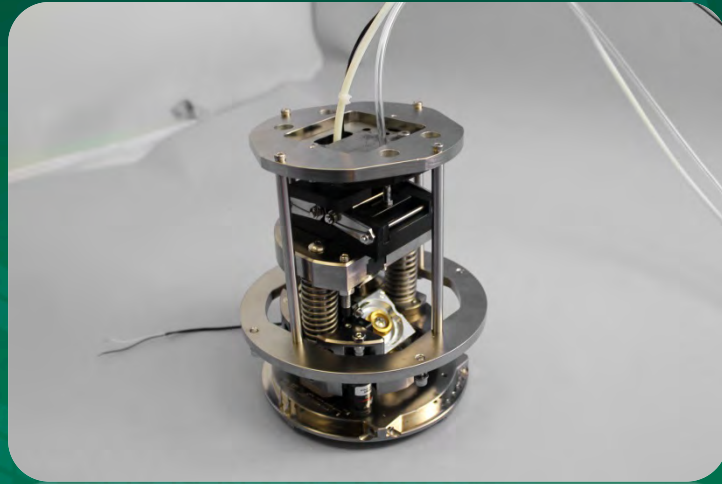
20 mm ceramic



# 5 position Indexer

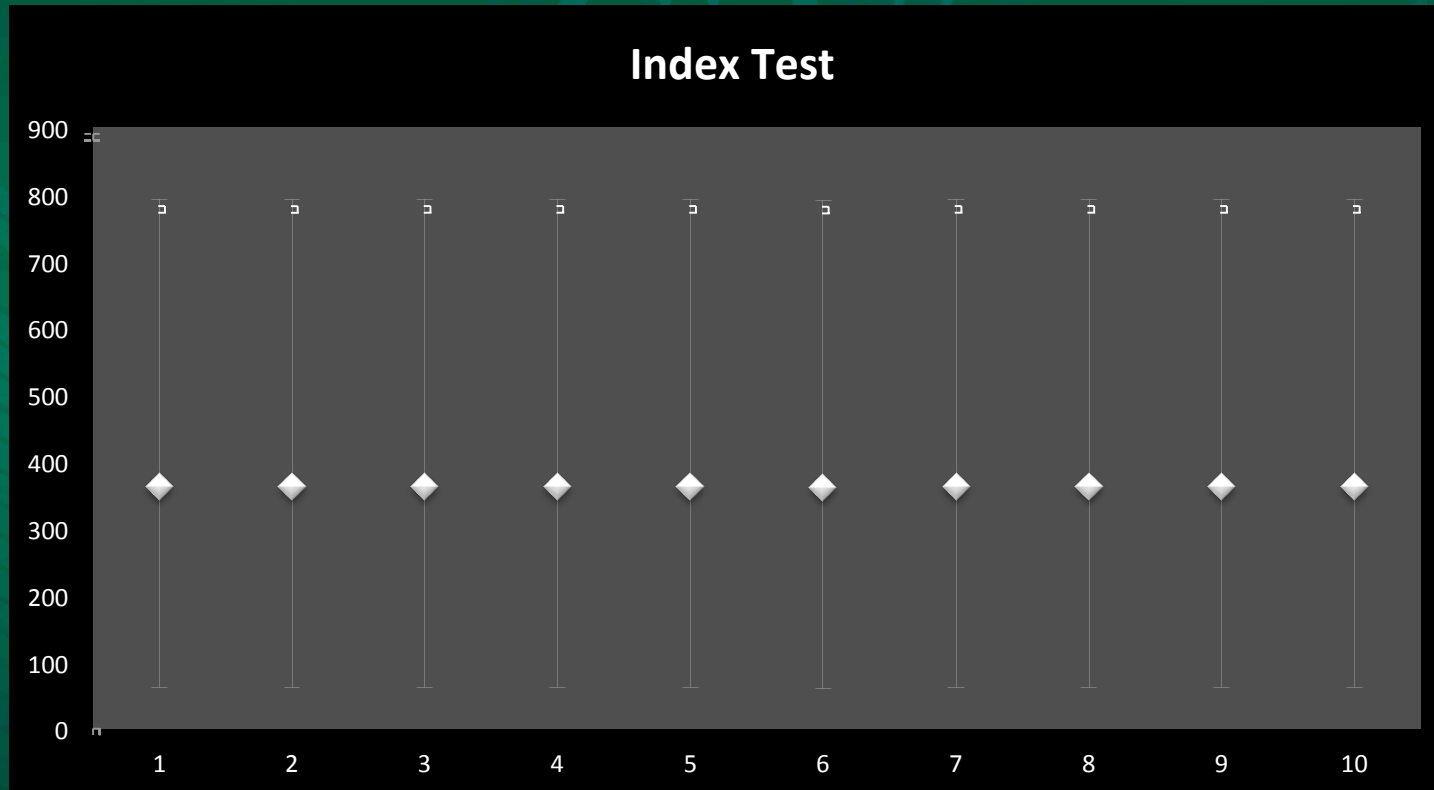


# Pneumatic Dock



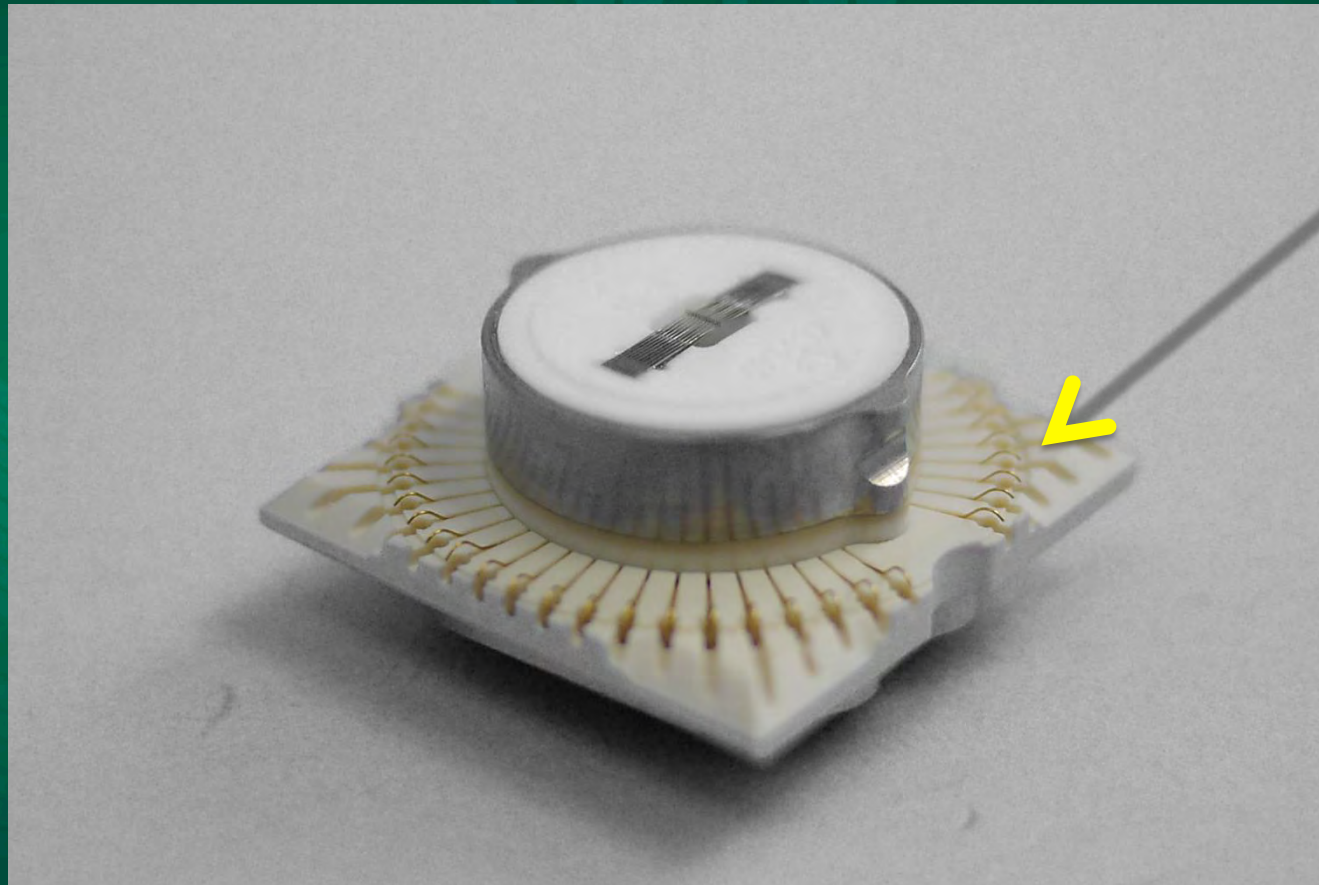
# Indexer

- Cannot miss an index and jam





# Core to Motherboard contacts



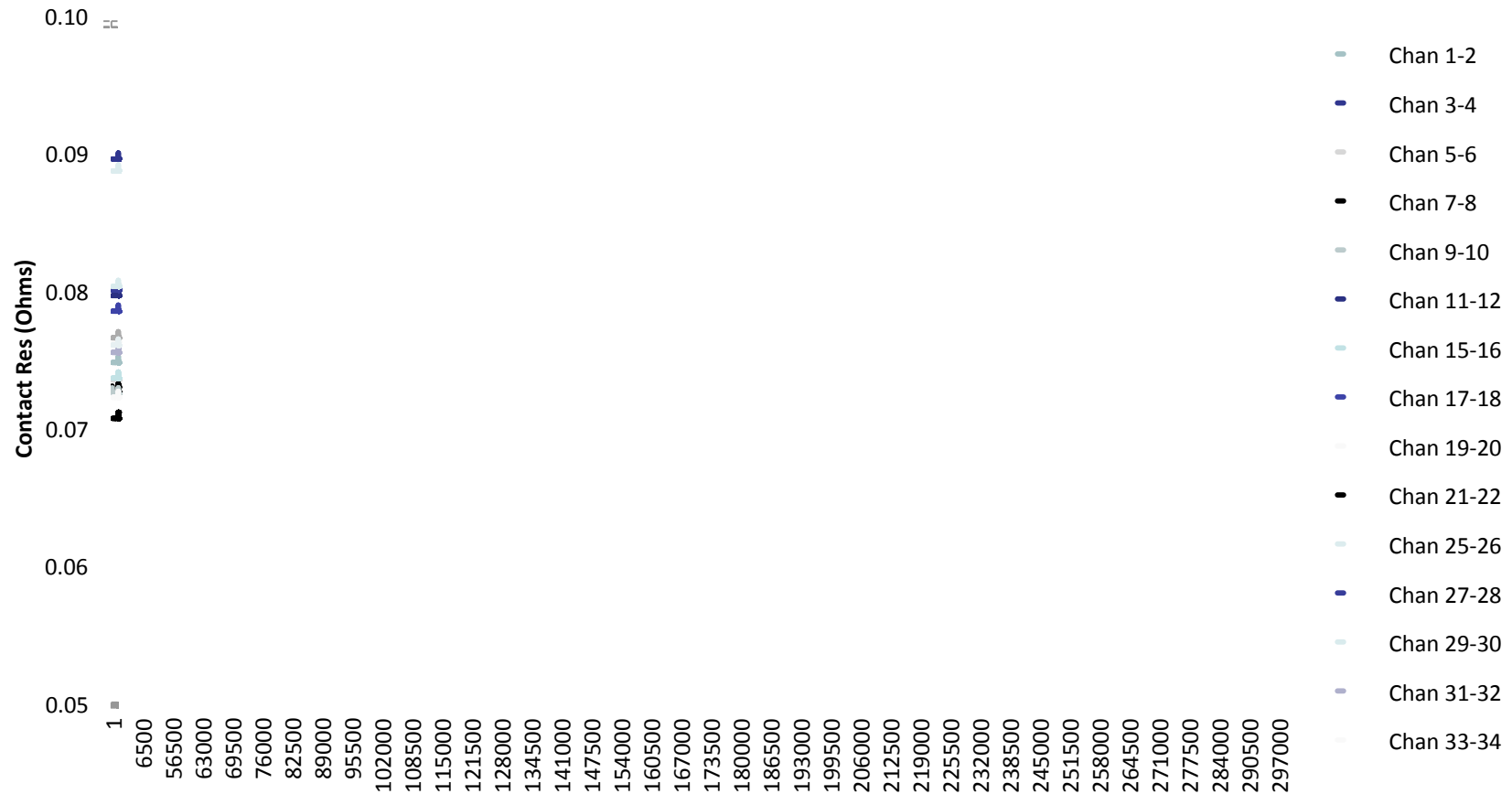
# Core to Motherboard contacts

- **Must be ULTRA-RELIABLE.**
- **Tested motherboard contact reliability**
  - Typical user 1000 contact cycles between rebuilds.
  - We tested out to 300,000 contact cycles without failure



# Core to MB Contact

Dimple Cres by Touchdowns (Logarithmic, Ohms)



# Indexer repeatability

- Index a core does it come back to the same spot?

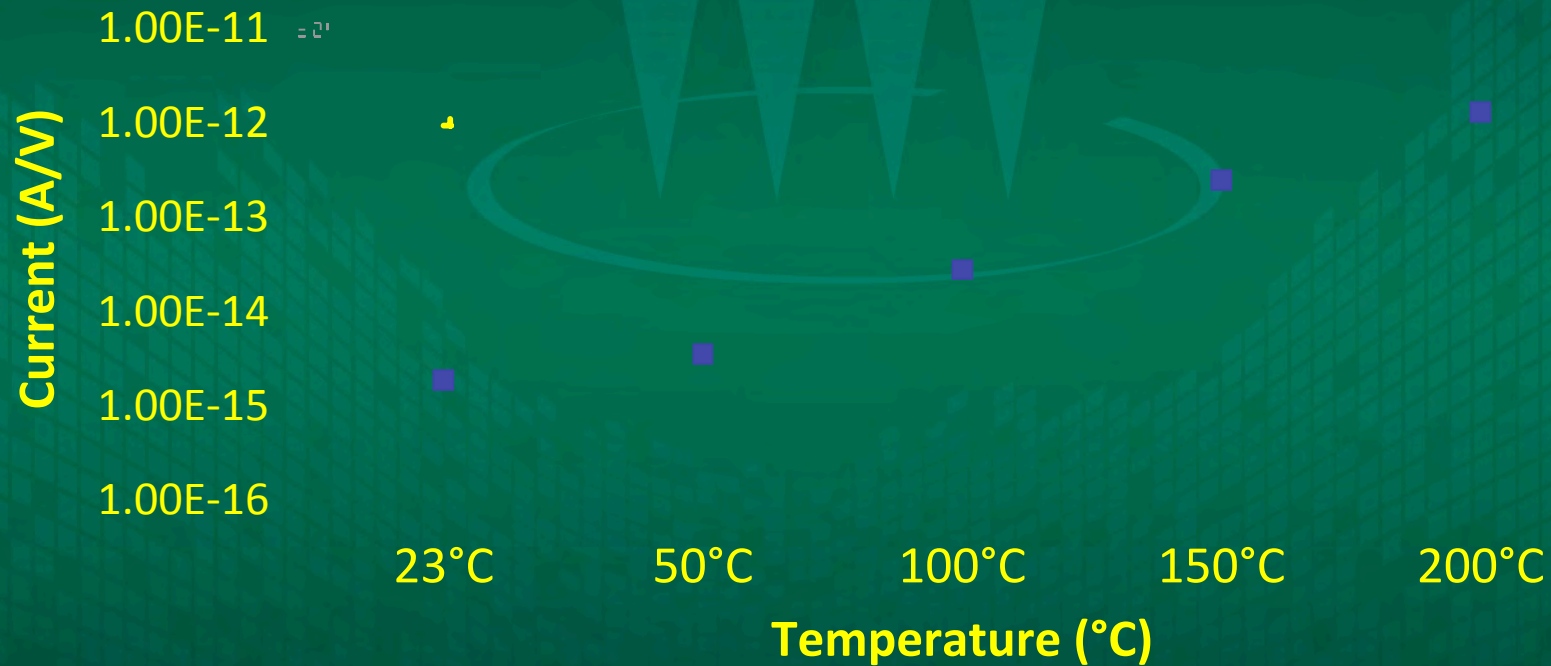
The screenshot displays a software interface for a probe system. At the top, status bars show 'PROBING', 'Z UP', 'OFFLINE', 'Now temp: 33.1deg', 'Set temp: 33deg', 'Ver. 3S14B6YZ', and 'JUL/18/2012 07:40'. The main window features a central image of a probe tip on a core, with a square box around the contact point. To the right of the image is a control panel with a central 'JOG' button, surrounded by eight directional arrows. Below this are buttons for 'JOG', 'SCAN', and 'INDEX', along with a 'SIZE' selector (1, 2, 3, 5, 10). Further right are buttons for 'INTENSITY UP/DOWN', 'MAG. CHANGE', 'SEARCH', 'SAVE', and 'IMAGE'. At the bottom of the main window are 'PREVIOUS PAD', 'NEXT PAD', 'TRAVEL PAD CHANGE', and 'EXIT' buttons. A bottom navigation bar includes 'LOADER SW', '3KEY SW', 'MAINT. AND ADJUSTMENT', 'UTILITY', 'DEVICE PARAMETER CHANGE', 'OPERATION SETTINGS', and 'STOP'. A status bar at the very bottom reads 'STOP AFTER AUTO NEEDLE ALIGNMENT SETTING DONE....'.

X= 0.0u, Y= 807.4u, F= 0.0u, (height= 3.7+ 0.0mm)  
Site No. : 1 Pad No. : 6  
Position (X): 10 um Check result: OK Lighting : coaxial  
Position (Y): 0 um Mode : All Pad Brightness : 60  
Position (Z): -4 um AREA: 68 um<sup>2</sup>



# VC20 Leakage over temperature

## Pin-to-Pin Leakage



## 2<sup>nd</sup> problem we are solving

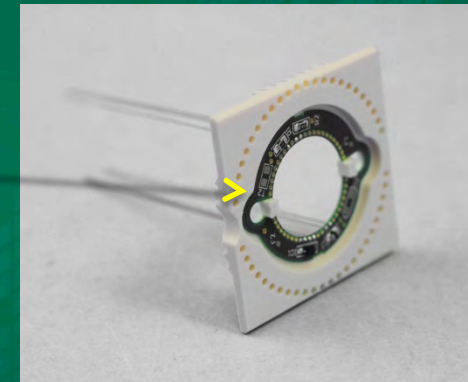
- **Maximize the quality of the data**
  - Preflight the Test System, Post flight the test system
- **Diagnose and correct fault conditions on the fly**
  - Cres, bent probe, particles, worn out probes



# Calibration VersaCore™

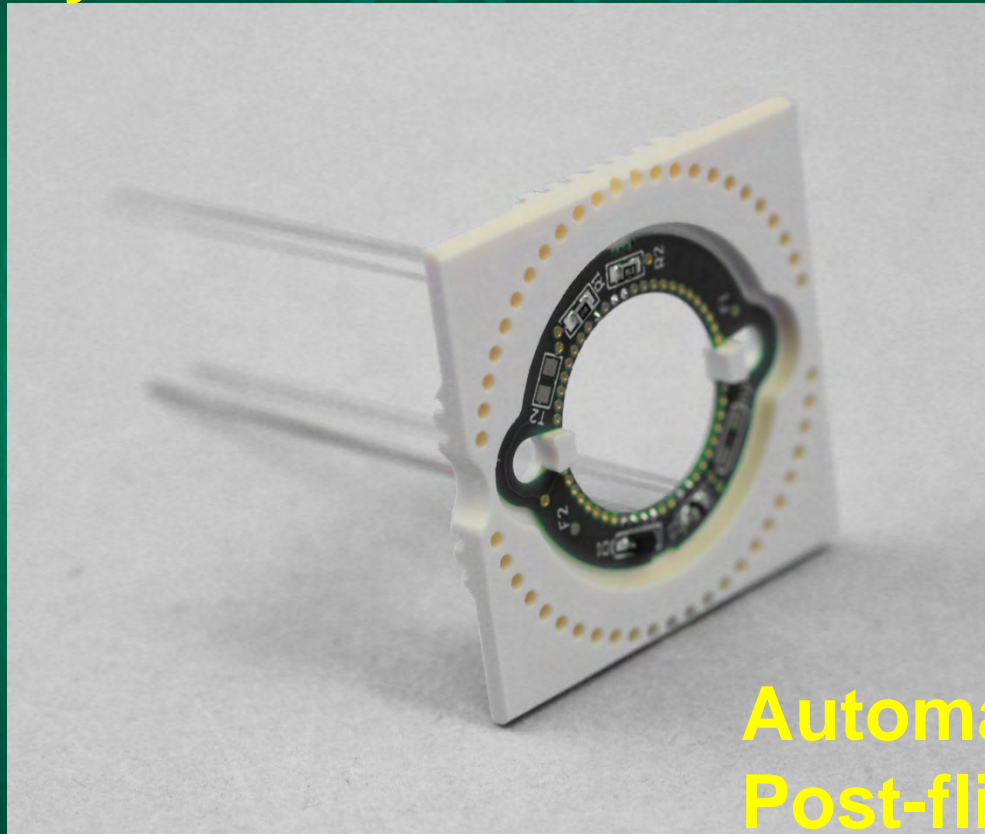


- Stainless Steel and Ceramic
- Spacer to set Probe depth
- Wire guide
- Optional User defined PCB for resistors, capacitors, inductors, diodes, transistors*
- Ball socket for handling
- Stainless steel stiffener ring



# The Magic ring

**Automatic system  
Pre-flight.**



**Automatic system  
Post-flight.**





# Test System Pre-flight

- SMU
- Software
- Relay matrix
- Pogos
- PWB
- Probe Card



# In-flight Event

- Diagnose and Correct on the fly
- Index to Calibration Core – 4 seconds
- Run in-flight checklist
  - SMUs
  - Relay matrix
  - Test head Pogos
  - Software
- Index back to Test Core – 4 seconds



# In-flight Event

- Data event
- Index to New Core – 4 seconds
- Realign
- Test
- Stay on new Core, or
- Index back to Test Core – 4 seconds



# Test System Post-flight

- SMU
- Software
- Relay matrix
- Pogos
- PWB
- Probe Card



# SPC Driven

- **All events have a signatures**
  - Cres, dirt, broken probes, worn probes
  - Sticky or worn out relay
  - Worn out Pogo



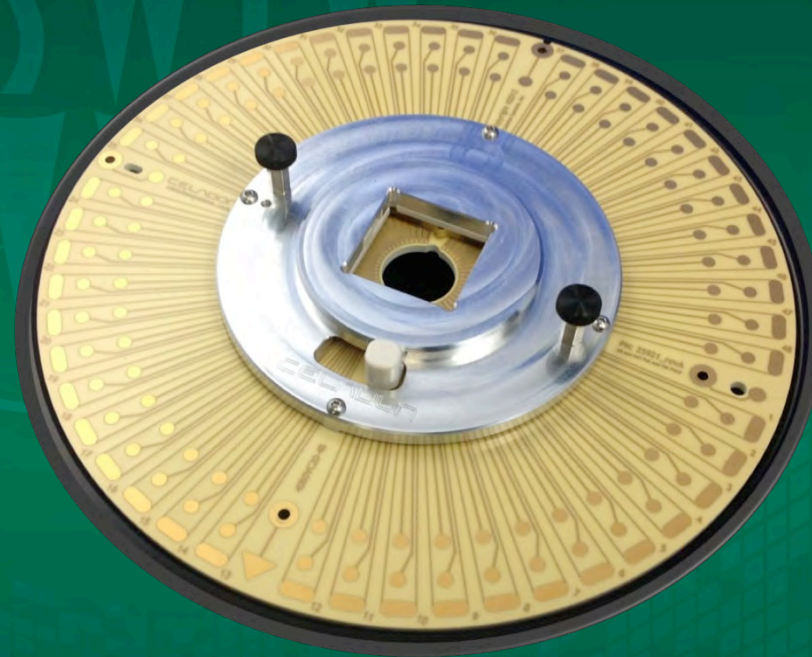
# Summary

- **Test System Utilization**
  - Double your surge capacity
- **SPC driven Debug on the fly**
  - Unquestioned data



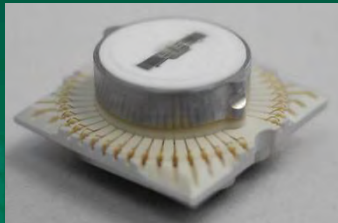
# Single Site

- Single Site VC20



# Modeling and Characterization

- Semi-Automatic





# Other Test Systems

- Keithley S400, S600, S530
- HP 4062
- Rack and Stack



# acknowledgements

- **Our Customer Partners**
- **The Project Team at Celadon!**
  - Bill, John, Al, Dennis, Dana, Matthew, Seng, Joan, Lynn, Scott

