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PROBE CARD METROLOGY

HIGH TEMPERATURE TESTING OF PROBE CARDS

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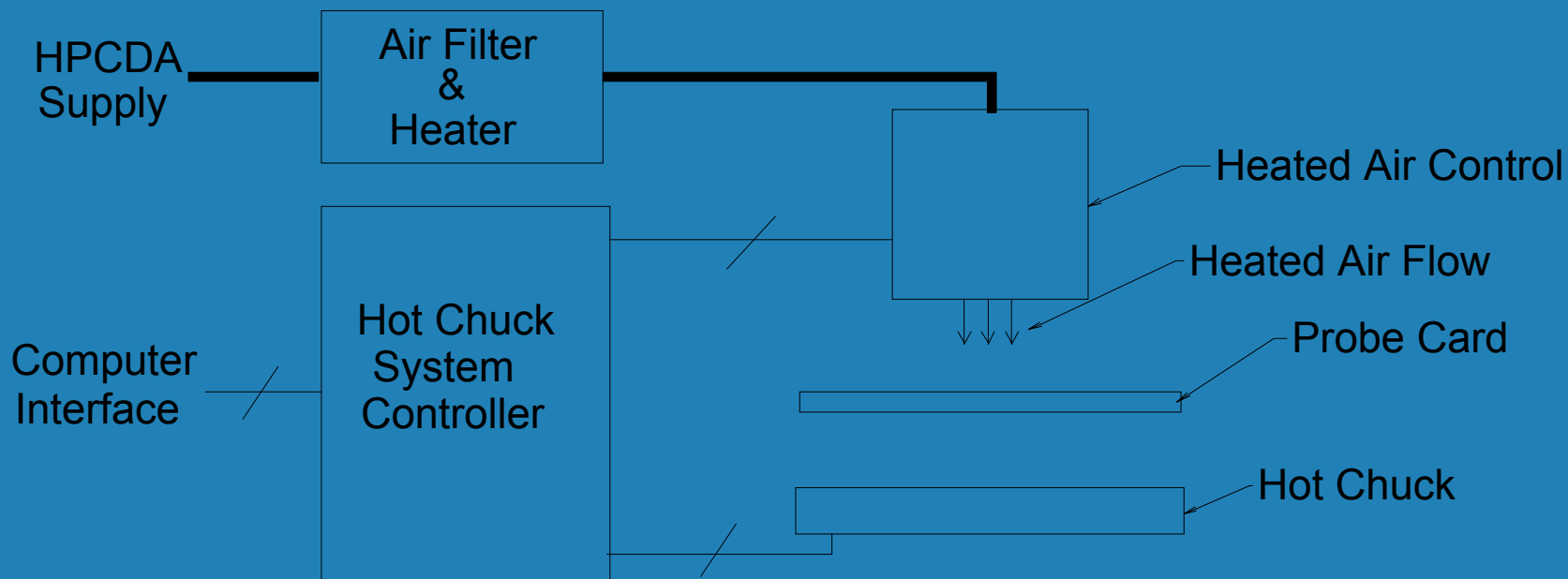
Purpose

- **To show the effects of temperature on probe card parameters**
- **To prove the usefulness of high temperature probe card metrology**
- **To highlight some differences in probe card technology & construction**

Equipment & Samples

- **Probilt PB3500 Probe Card Analyzer with Hot Chuck Option**
- **Epoxy Ring Cards**
 - **3 Identical Cards**
 - **J971 Type**
 - **Designed for High Temperature**
- **Form Factor Card**
 - **Logic Array**
- **Membrane Card**
 - **Logic Array**

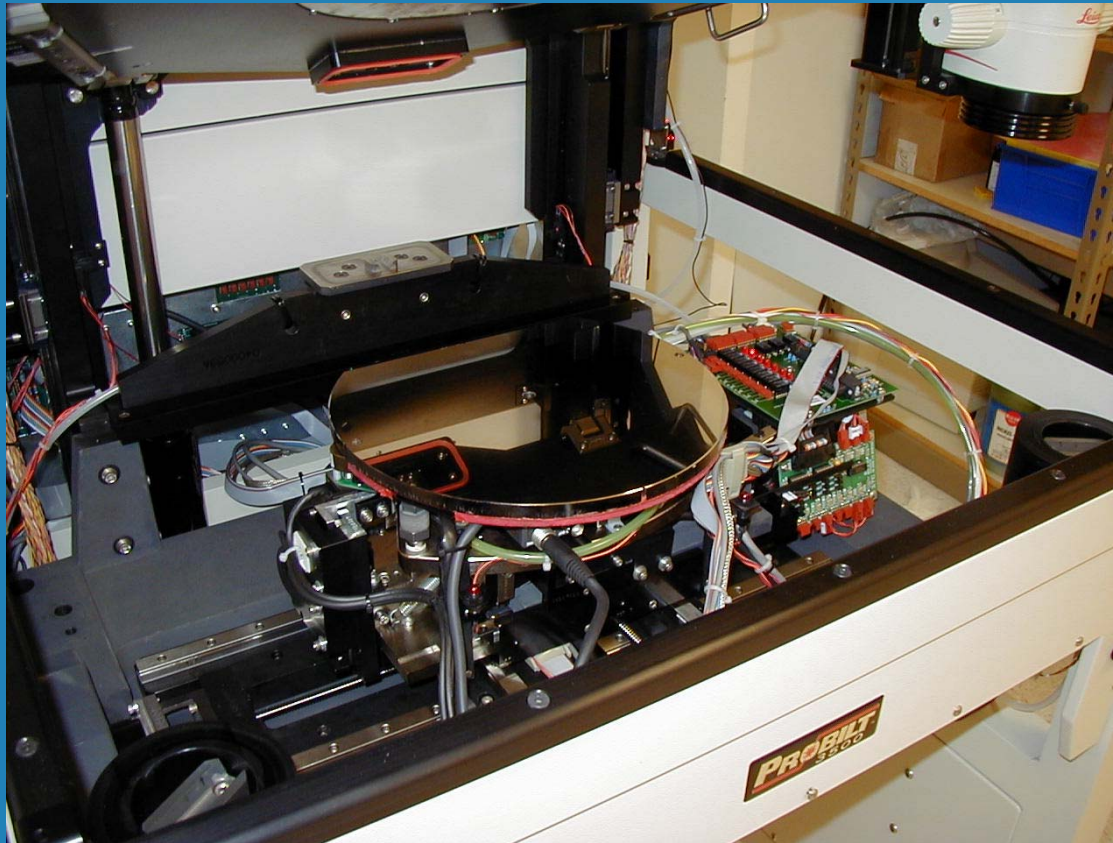
Hot Chuck Block Diagram



Hot Chuck System Controller



Heated Measurement Chuck



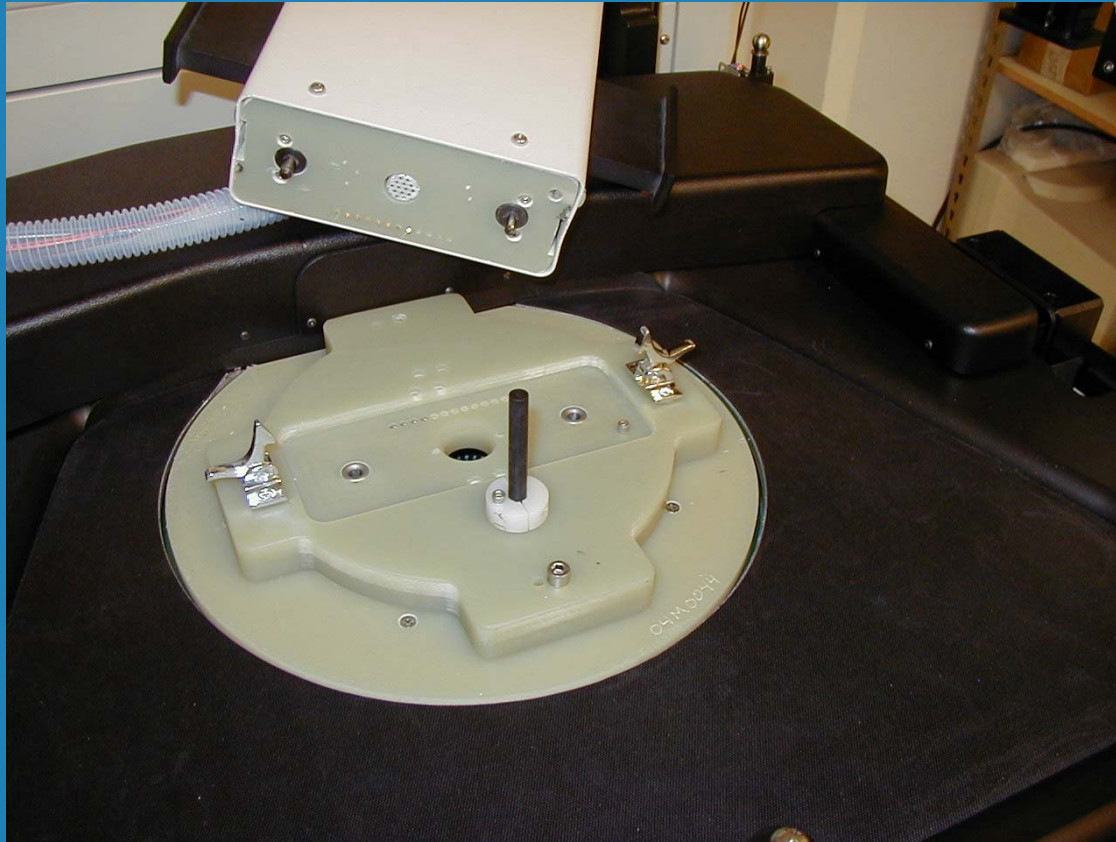
Heated Air “Top-Hat”



Bottom of “Top-Hat”



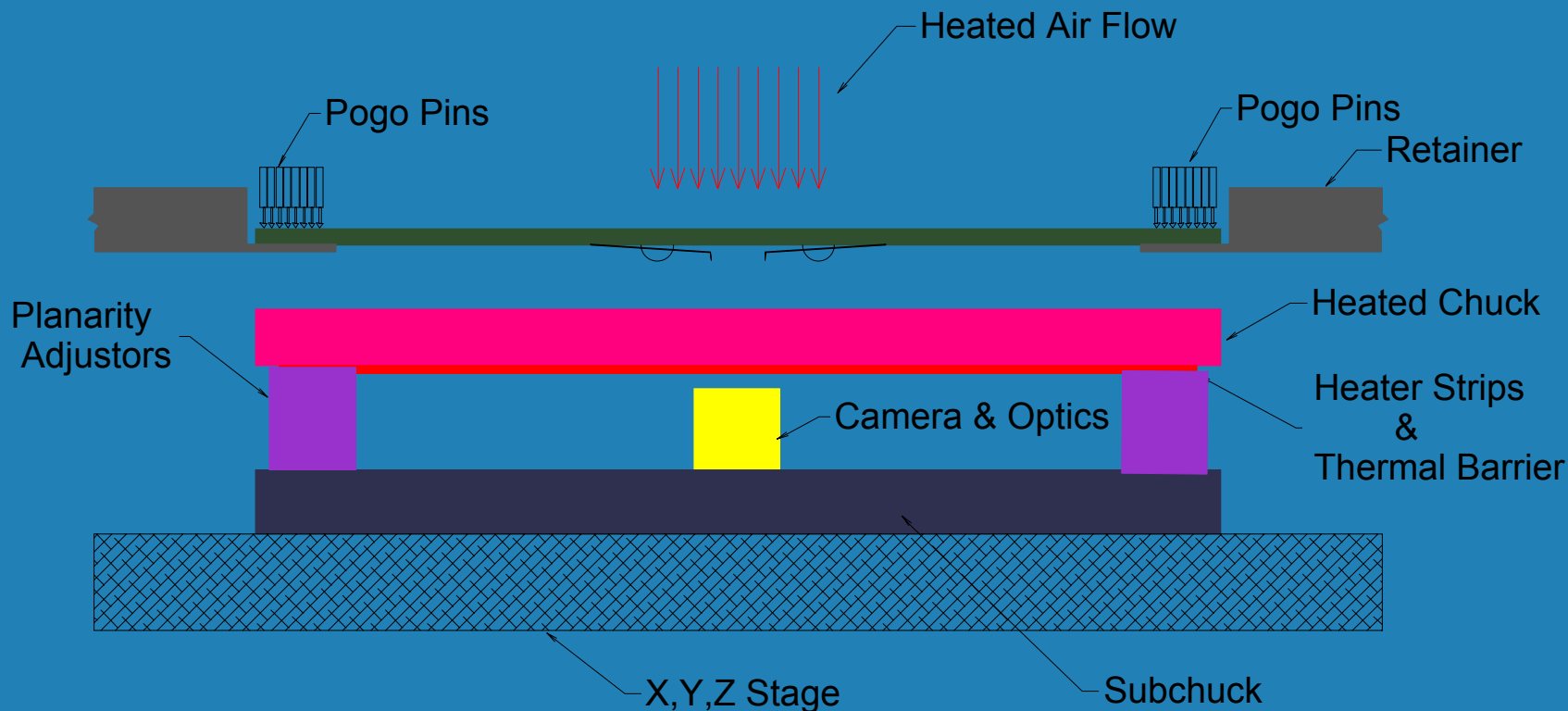
“Top-Hat” & Adapter



Hot Chuck Specifications

Control Point	Minimum Temp.	Maximum Temp.	Control Stability
Heated Chuck	Room	125 C	+/- 1.0 C
Heated Air Stream	Room	125 C	+/- 1.0 C

Metrology Environment



Probe Card Construction

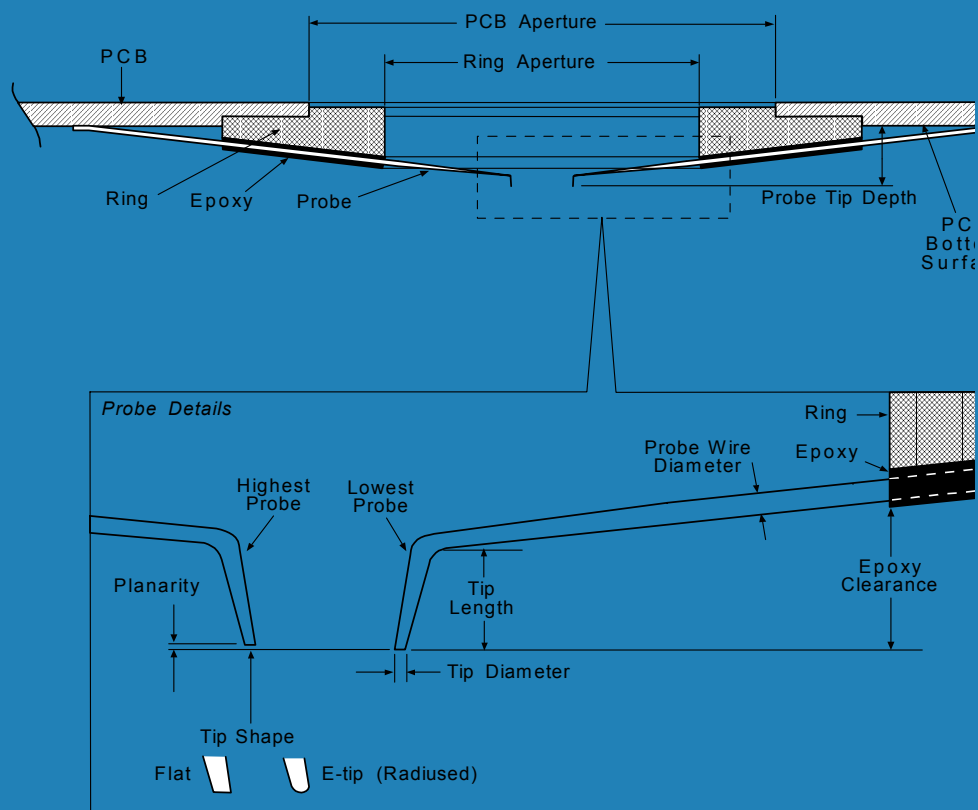
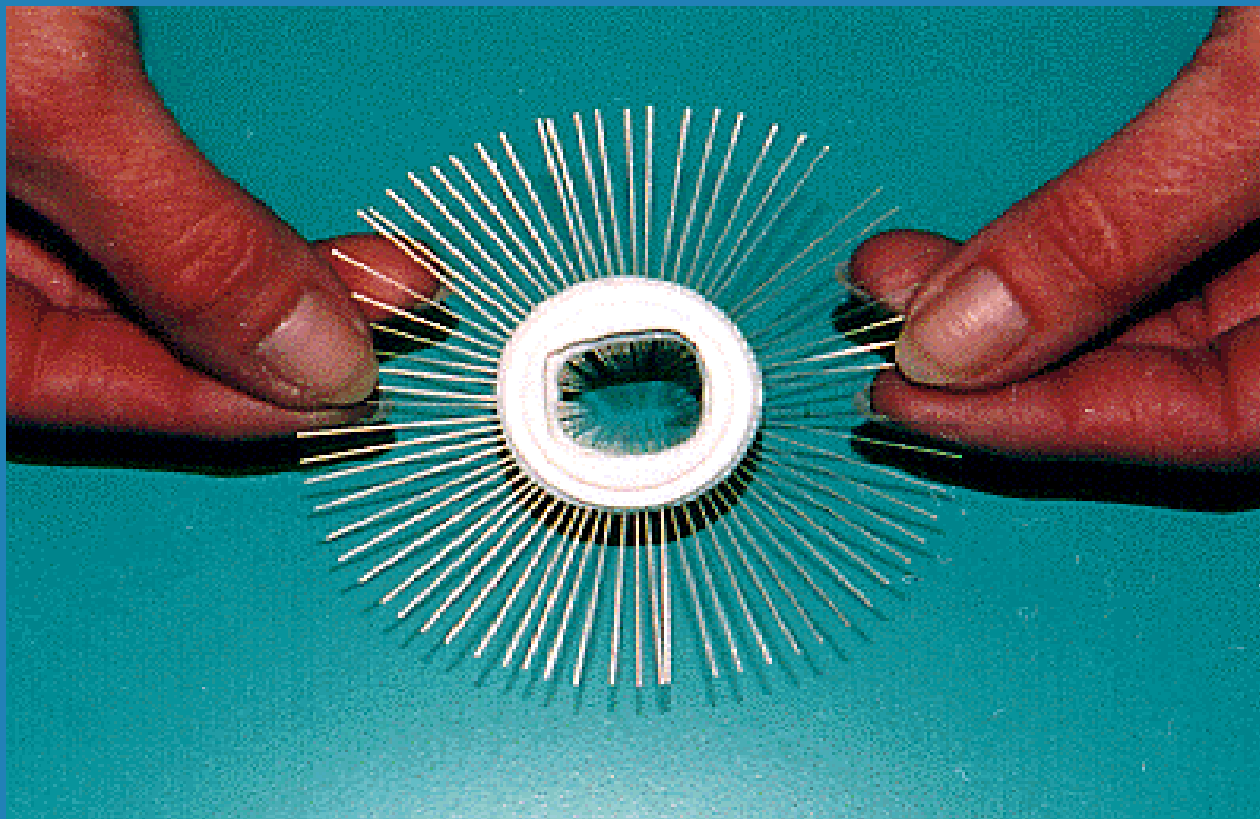
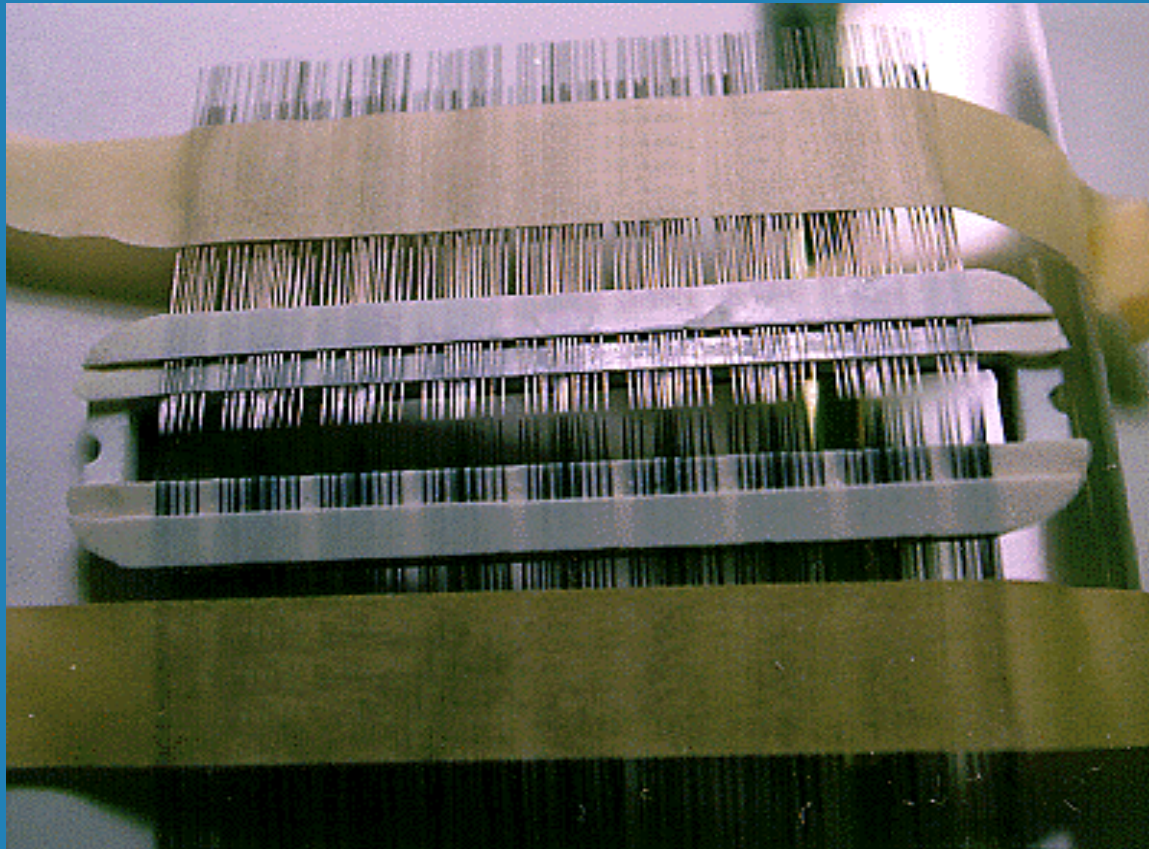


Figure 3: PCB and Epoxy Ring Assembly

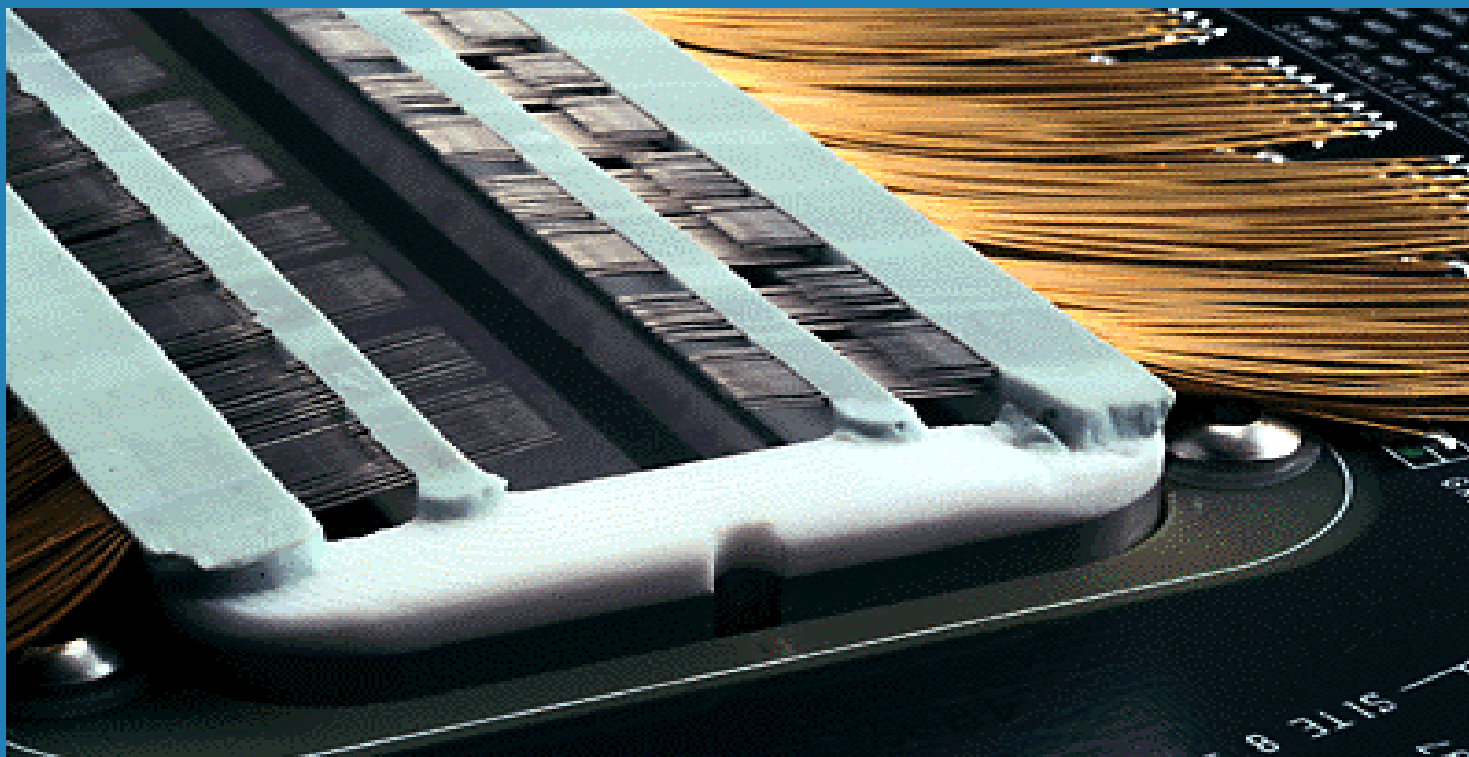
Probe Ring



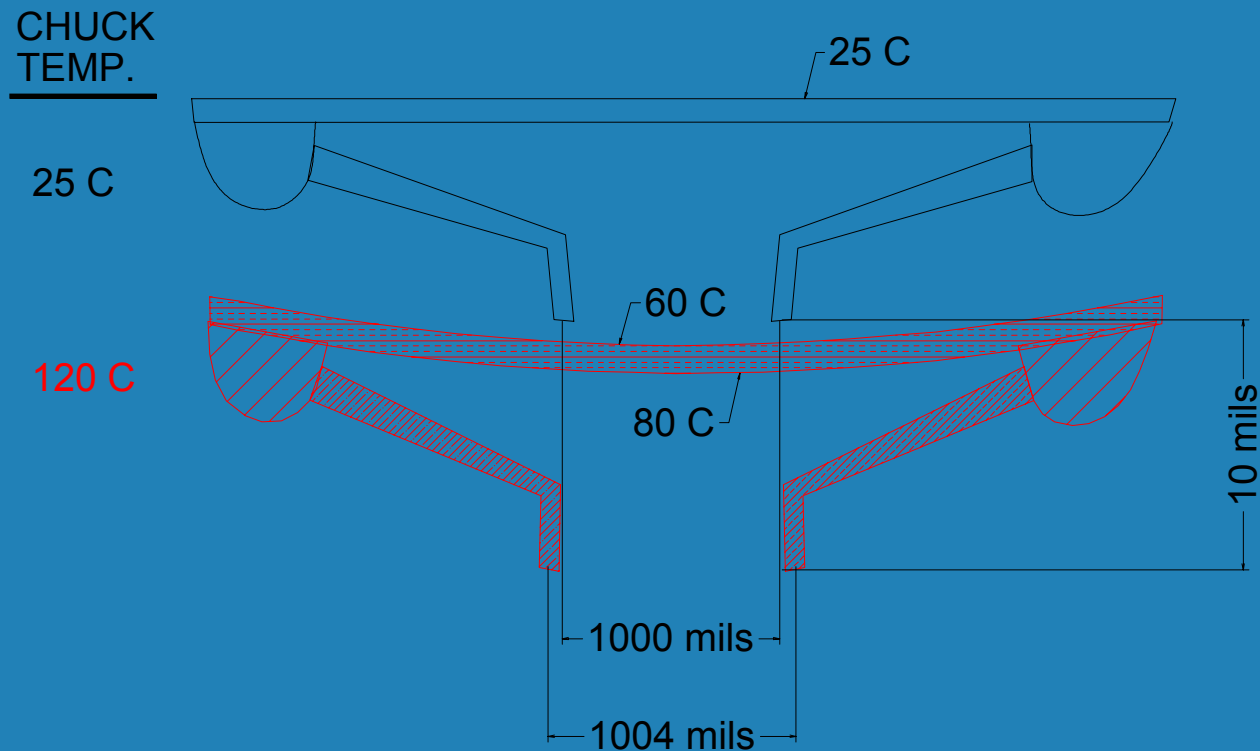
Large Ceramic Probe Ring



Large Array on Probe Card



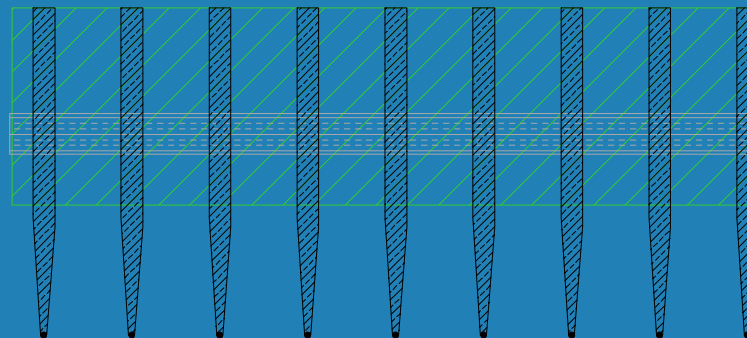
Cross Section View



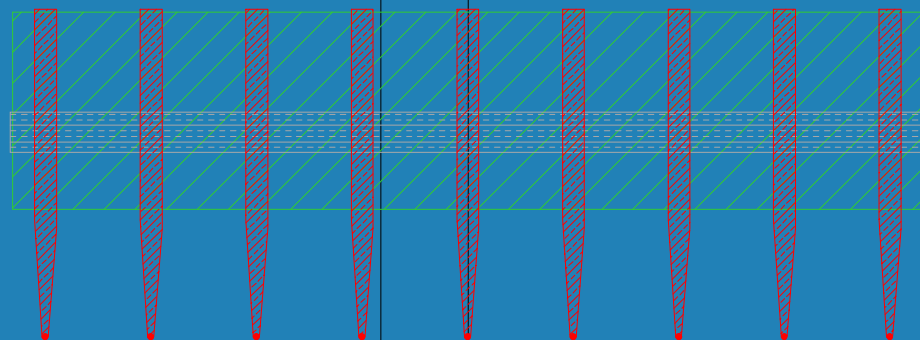
Pitch Change with Temp

CHUCK
TEMP

25 C



120 C



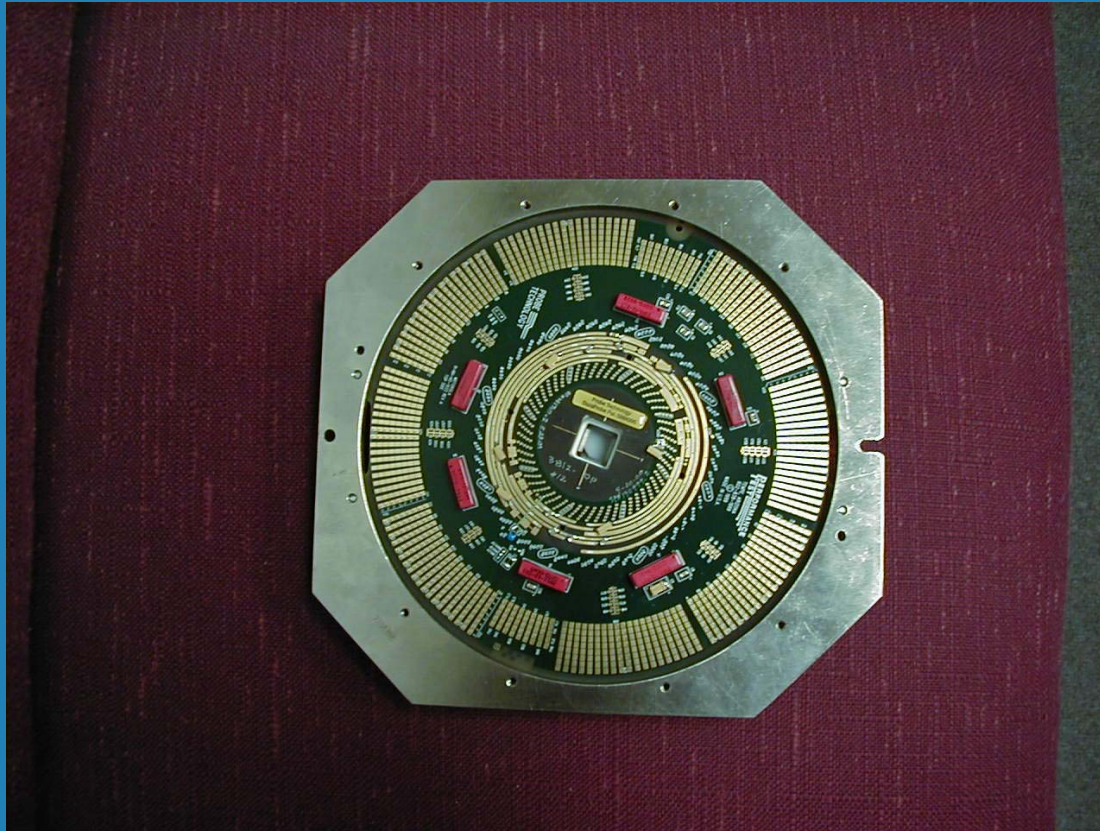
70 u

80 u

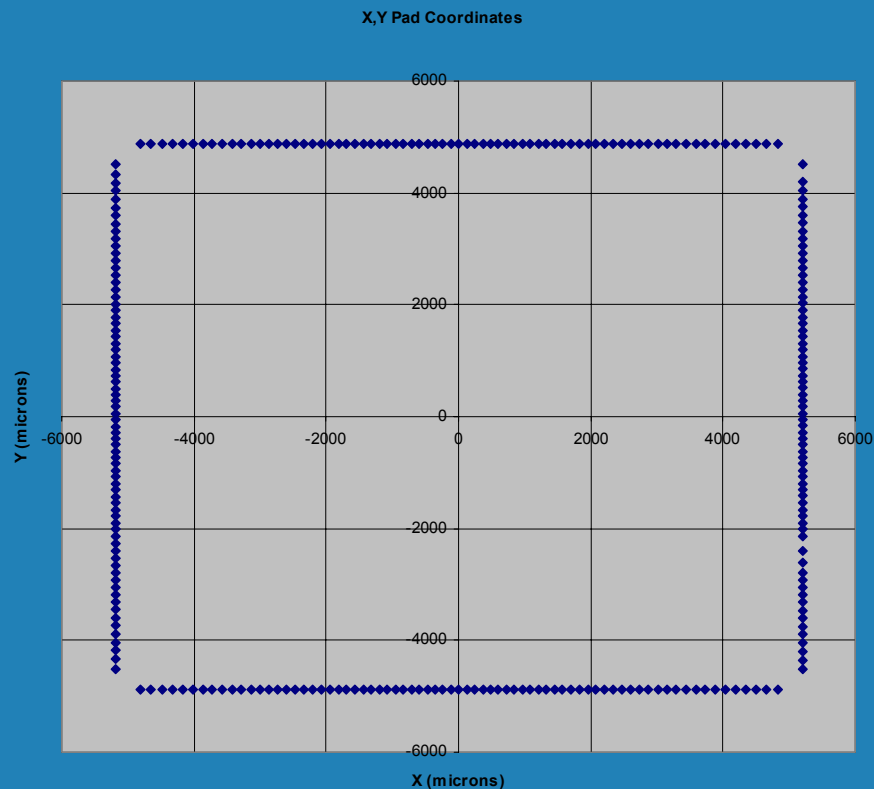
Alignment Shifts (3 Cards)

- **Averages of 6 groups of 5 probes**
- **3 groups each side, evenly spaced**
- **Boxes represent +/- 5 microns movement**
- **Lines represent direction and magnitude of movement (25 °C to 125 °C)**
- **The “+” is 25 °C location**
- **#11-Red, #12-Blue, #14-Green**
- **Repeatability of multiple runs affected by stabilization time**

Epoxy Ring Probe Card



Epoxy Card Array



Alignment Shift (Epoxy Card)

*Box = +/- 10u

*The + in center of box is 25 °C location

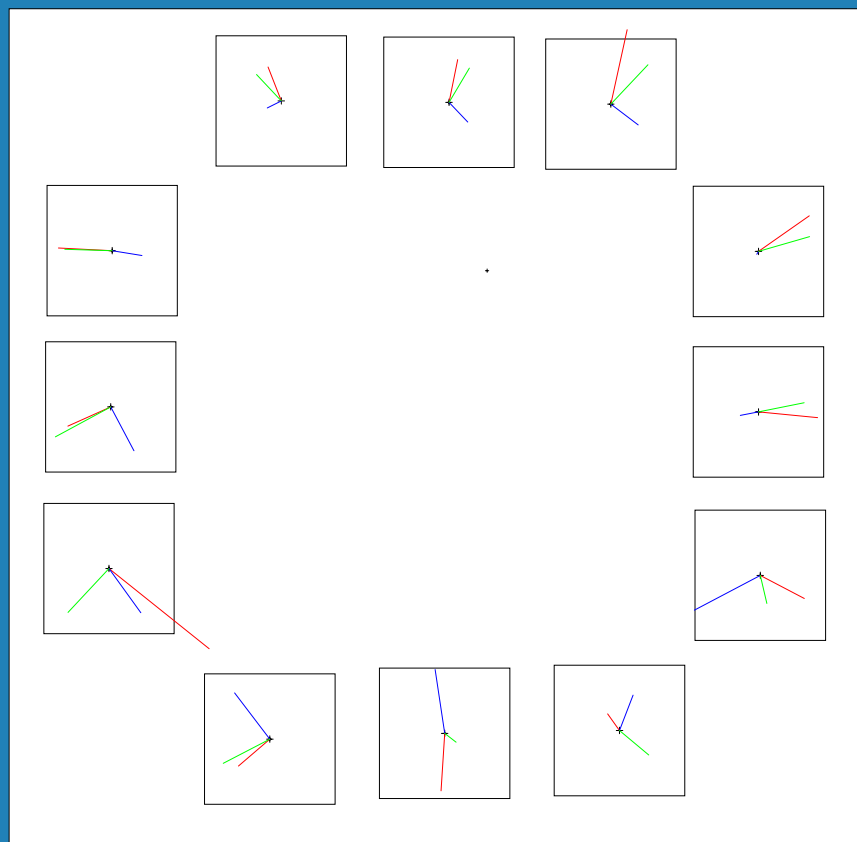
*Each line is 5 probe average

*Card 11 – Red

*Card 12 – Blue

*Card 13 – Green

*Length of line represents the shift in position from 25 °C to 125 °C.

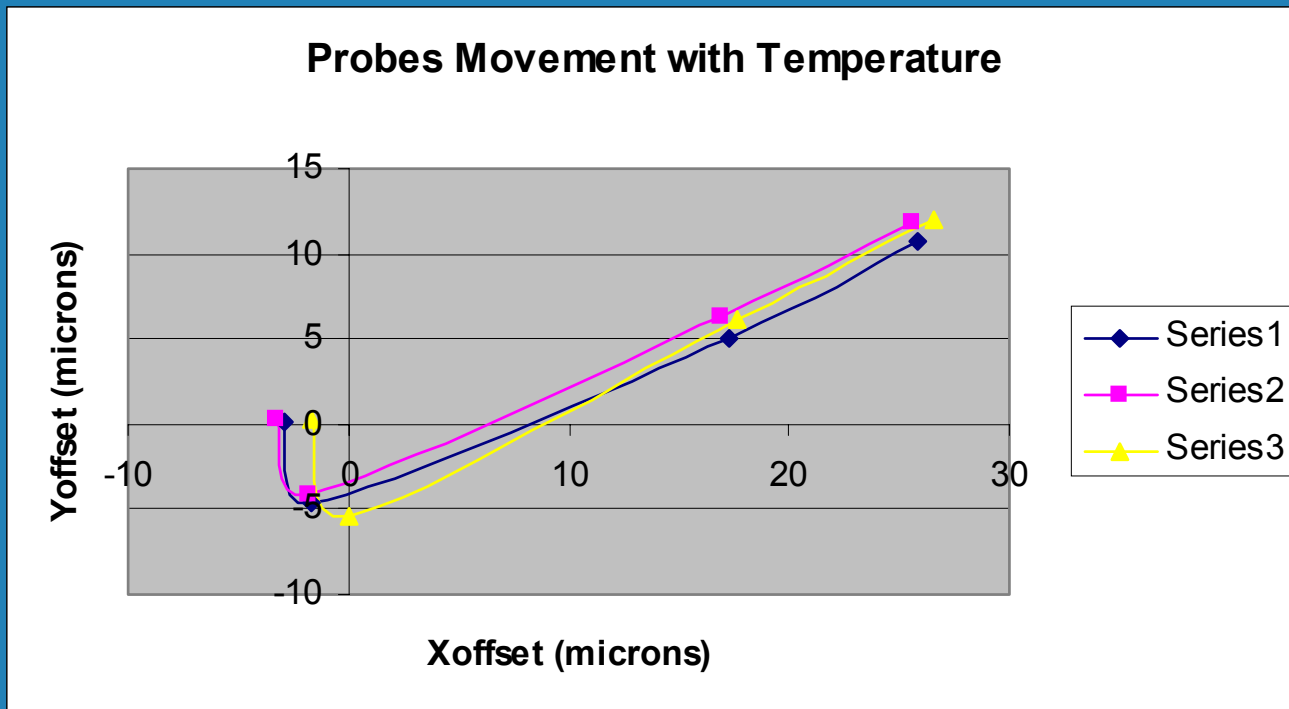


Other Shifts (Epoxy Card)

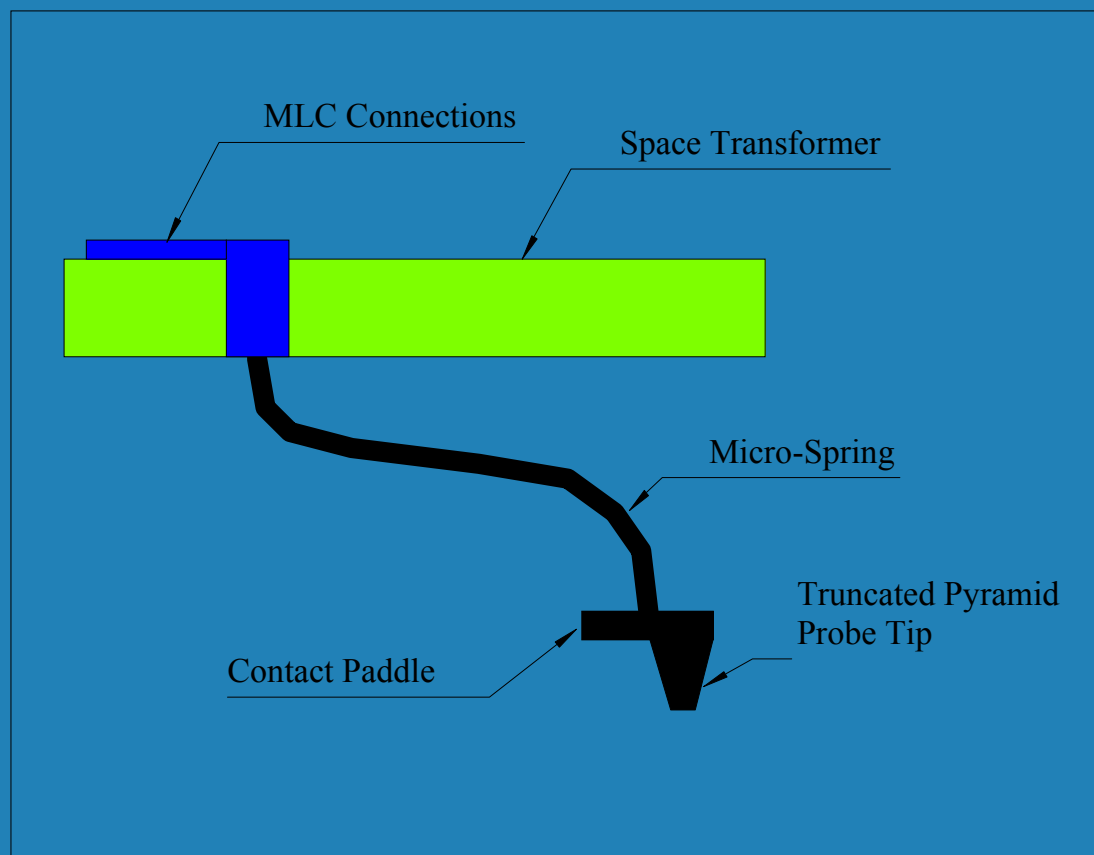
Parameter	Card 11	Card 12	Card 14
Z Shift	-221 u	-147 u	-148 u
Planar Window	55u (25) 50u (125)	58u (25) 54u (125)	30u (25) 33u (125)
Leakage Increase	6-10 uA	6-9 uA	6-10 uA

Memory Card

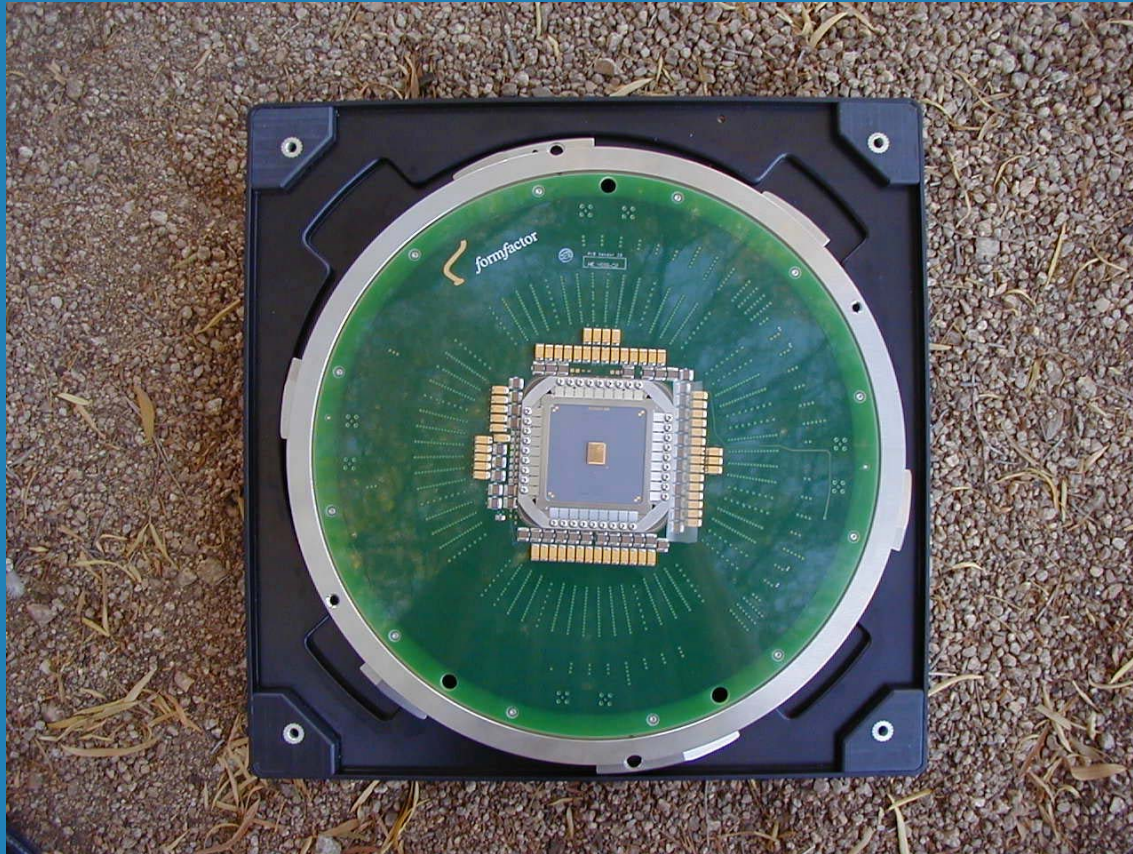
Probes at 25, 36, 70 & 90 °C



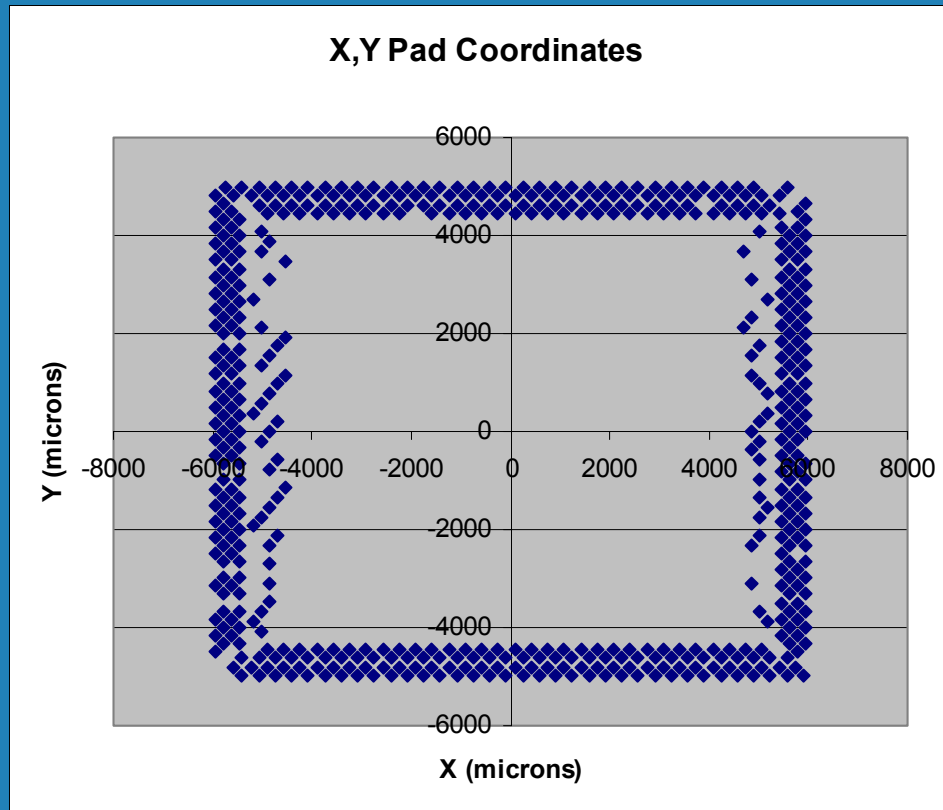
Form Factor Micro Spring



Form Factor Probe Card



Form Factor Array



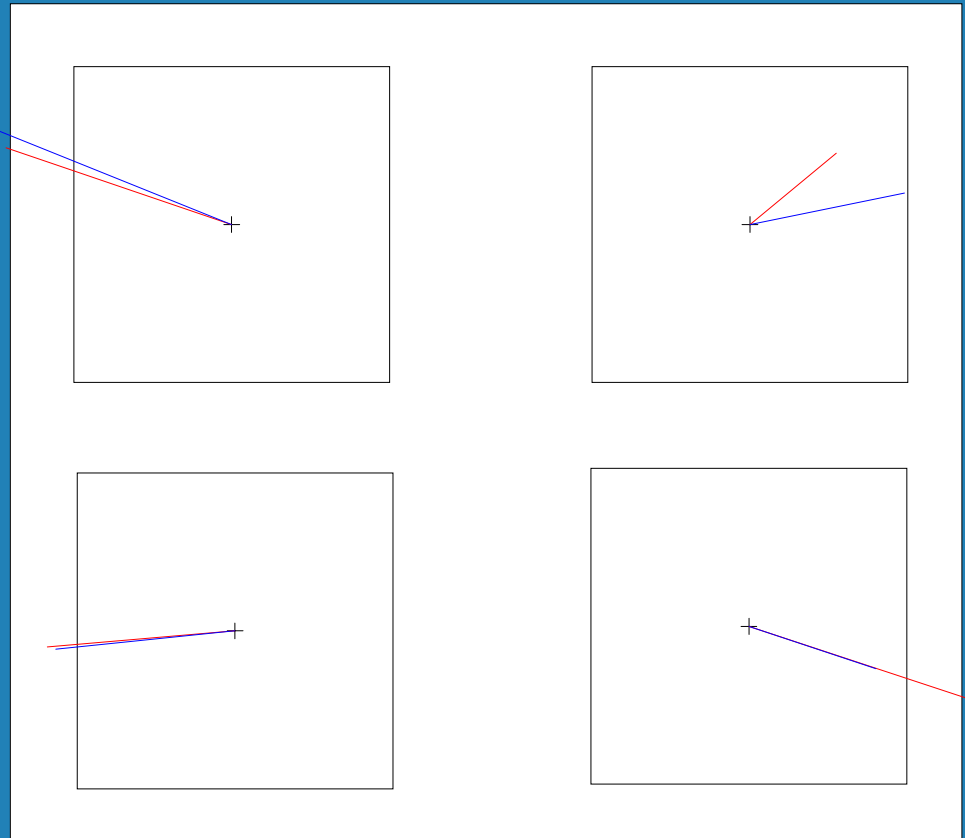
Alignment Shifts (FFI)

*Box = $\pm 10\mu$

*The + in center of box is 25 °C location

*Each line is a single probe

*Length of line represents the shift in position from 25 °C to 125 °C.



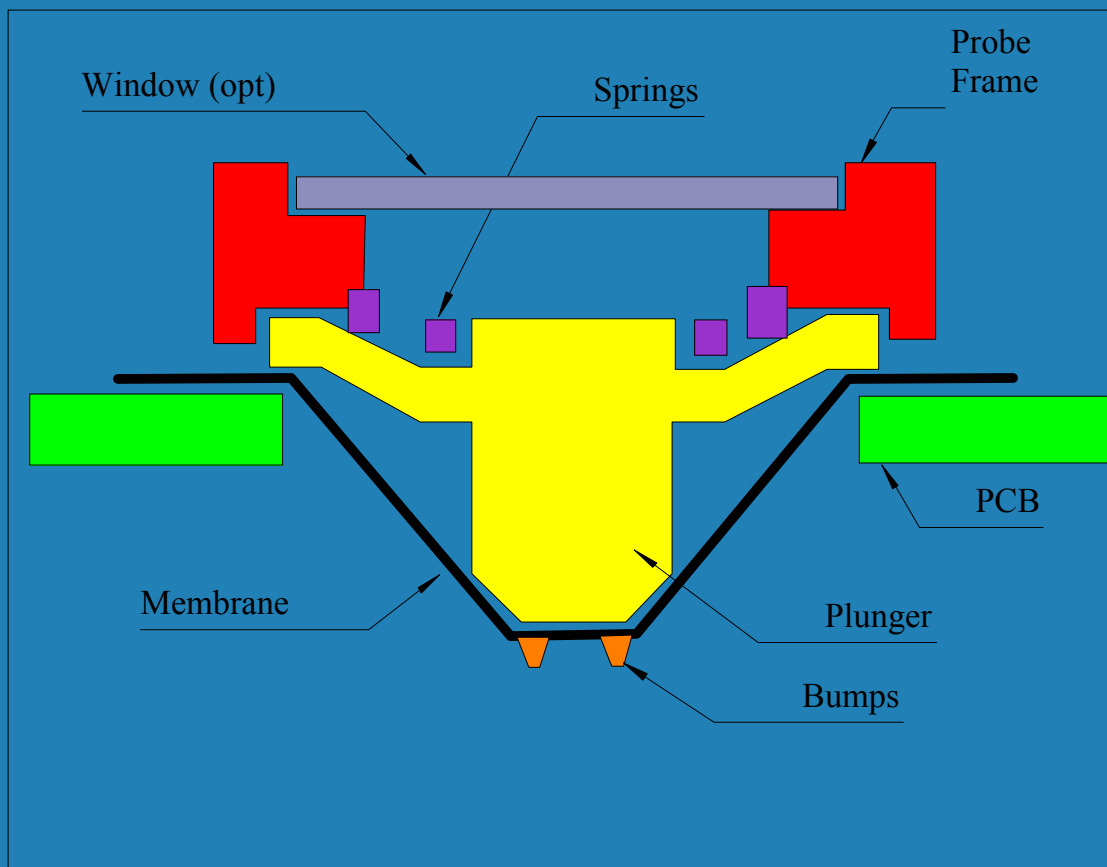
Other Shifts (FFI)

Parameter	FFI Card Value
Z Shift	-160 microns
Planar Window	36 microns (25°C) 48 microns (125 °C)
Leakage Increase	0.4 to 0.6 uA

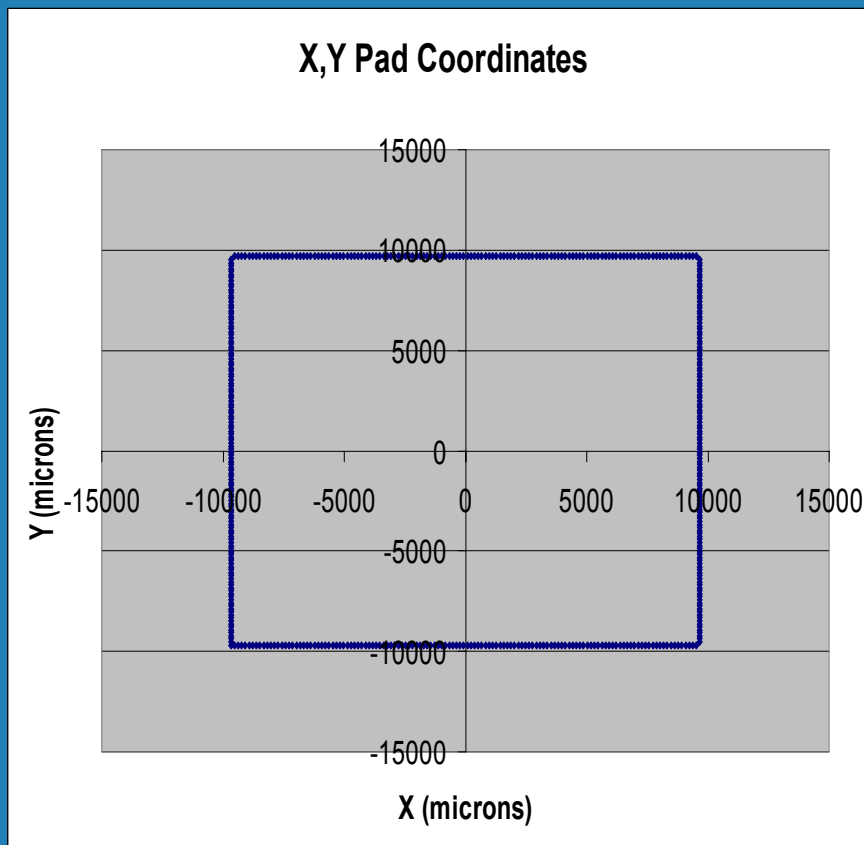
Form Factor Results

- **Fairly predictable results**
- **Larger shift than epoxy ring**
- **Not as consistent as expected**
- **Data on only one card should not be taken as representative of type**

Membrane Probe Head



Membrane Array



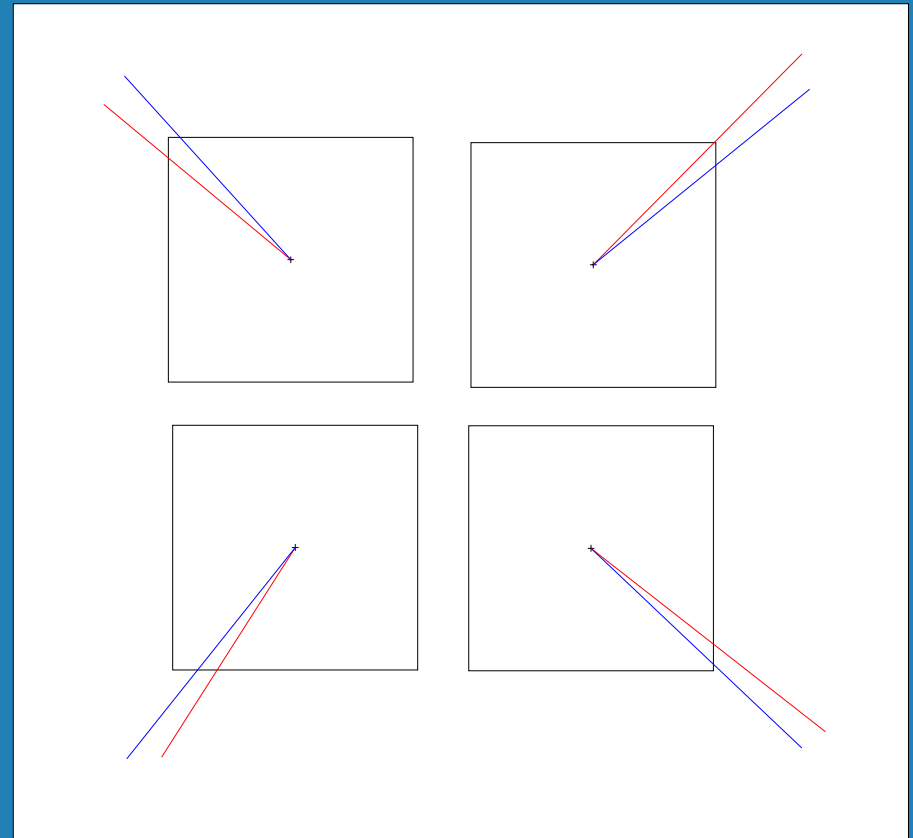
Alignment Shifts (Membrane)

*Box = $\pm 10\mu$

*The + in center of box is 25 °C location

*Each line is a single probe

*Length of line represents the shift in position from 25 °C to 100 °C.



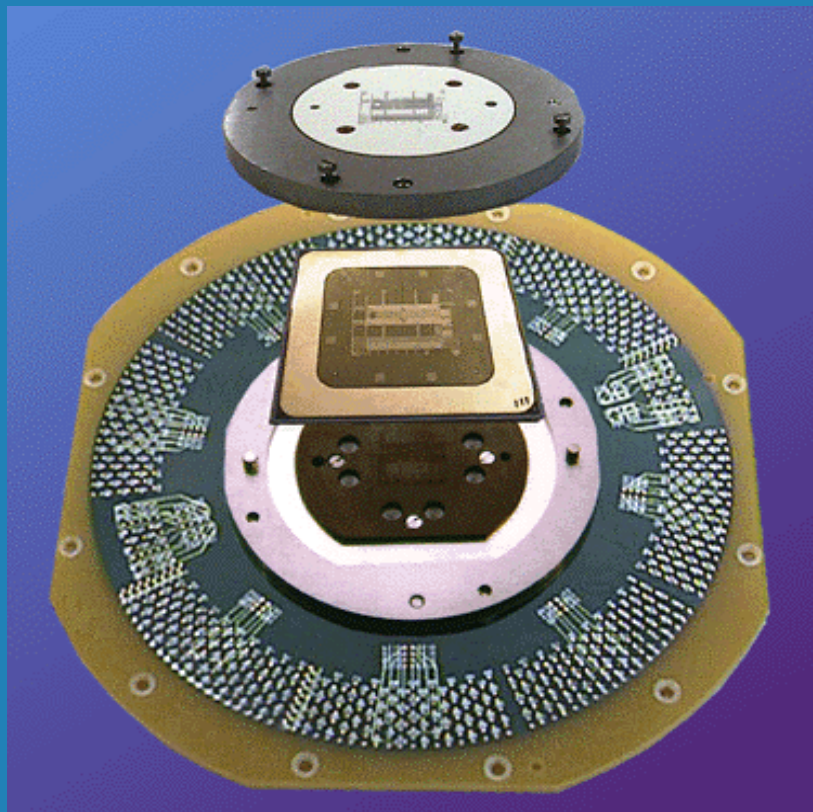
Other Shifts (Membrane)

Parameter	FFI Card Value
Z Shift	-145 microns
Planar Window	72 microns (25°C) 71 microns (100 °C)
Leakage Increase	Not Run

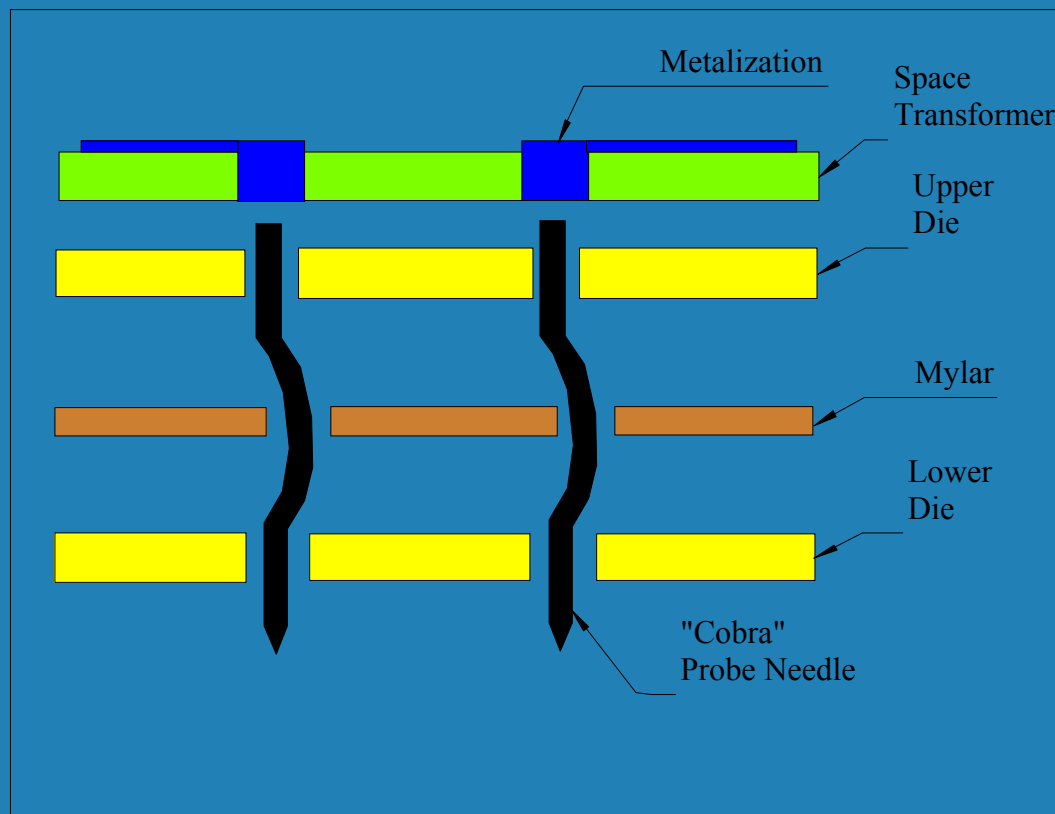
Membrane Results

- **Mylar expands and probes move a lot**
- **Very well behaved – predictable results**
- **More temperature sensitive than other technologies**
- **Requires card to be designed for temperature of use**

Cobra Probe Card



Cobra Head Cross Section



Cobra Considerations

- **Lower die is close to wafer**
 - **Heats up considerably**
 - **Test time vs. Index Time changes heating**
- **Mylar insulator may move**
- **Probe stresses**

Conclusions

- **Probe movement for most technologies with temperature is NOT predictable, but it IS repeatable**
- **Epoxy card construction techniques can make a significant difference in temperature performance**
- **FFI cards are more predictable than epoxy, but there are still variations**

Conclusions (2)

- **Membrane card is the most predictable**
- **Membrane card has largest shifts with temperature**

Future Studies

- **Other Probe Card Technologies**
- **Scrub Mark vs. Analyzer Data**
- **Probe Material Variations**
- **Card Construction Techniques**
- **Path of Probe Movement vs. Temperature Change**
- **Stabilization Times vs. Repeatability**

Acknowledgements

- **Bill Williams – Motorola**
 - **Thanks for supplying cards for this study.**
- **Russ Allred - ITC**
 - **Data Collection**
- **Hoa Do Thai - ITC**
 - **Data Collection**