OVERALL PROBING ACCURACY AT ELEVATED TEMPERATURE

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OUTLINE

- Introduction
- Analysis of probe mark placement error
- Case Study - A 12” interface at elevated temperature
  - History of Problem
  - Work in progress - solutions tried & lessons learned
  - Further work
- General Observations

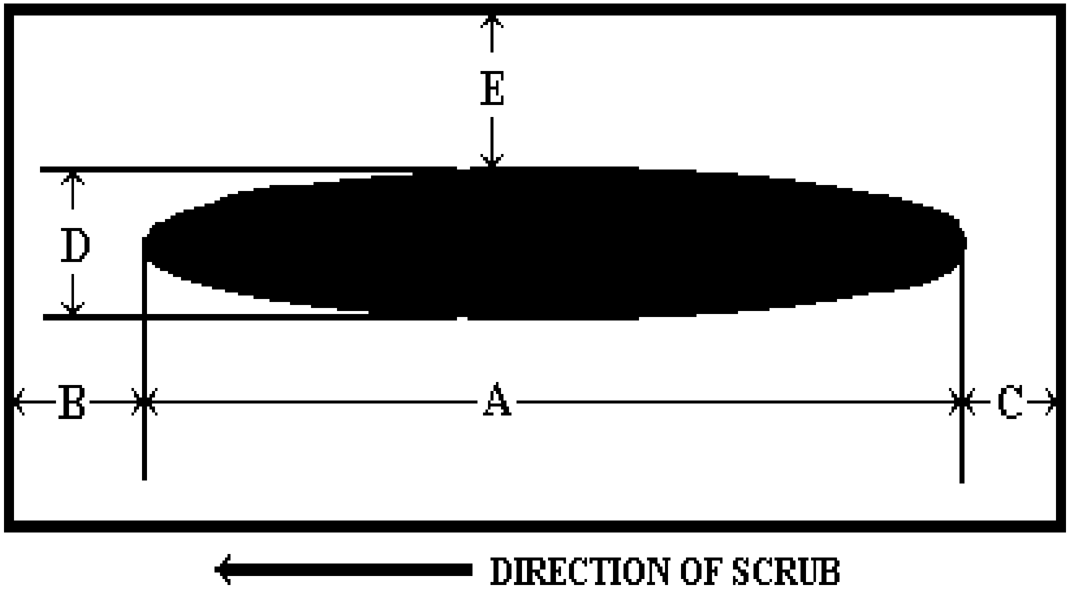
CHALLENGES TO WAFER PROBE

- Dimensions (including bond pads) keep growing smaller.
- The assembly folks (especially wire bonder suppliers) have forged ahead in capability.
  - Wafer probe is now the primary barrier that designers must conquer when they want smaller bond pads.
- More and more devices require elevated temperature wafer probe.

Analysis of Probe Mark Placement Error (Dimensional Allocation)

- Dimensional Allocation is a method developed at Lucent Technologies to compare the performance of various prober and interface combinations.
- Utilizes actual measurements wherever possible.
- Attempts to include the error effects of temperature changes.

Bond Pad Dimensional Analysis



A. Maximum Scrub Length	59.6 µm
B. Leading Damage Margin	5 µm
C. Heel Margin	5 µm
D. Maximum Scrub Width	27 µm
E. Width Margin	15 µm

F. Maximum Prober Alignment Error	5 µm
G. Probe Positional Error	6.5 µm
H. Interface Stability Error	3.0 µm

Bond Pad Dimensional Analysis

- Prober Alignment Error - manufacturer’s spec 5 µm
- Probe Positional Error - condition of probe card
  - Carefully maintained cards 6-7 µm (3↙)
  - Normal production cards 12-14 µm
- Interface Stability Error
  - Difficult to measure - uses upward-looking prober camera
  - Includes changes in position due to temperature

	Error (µm)
Tester A	6.8
Tester B	15.6
Tester B-2	1.3
Tester C	7.7
Tester D	5.5

Bond Pad Dimensional Analysis

- Combined placement error (1↙)

  = $((F/3)^2 + (G/3)^2 + (H/3)^2)^{½}$

- For Tester B:

  = $((5/3)^2 + (6.5/3)^2 + (15.6/3)^2)^{½}$ µm

  = 5.85 µm

- Resulting 3↙ placement error:

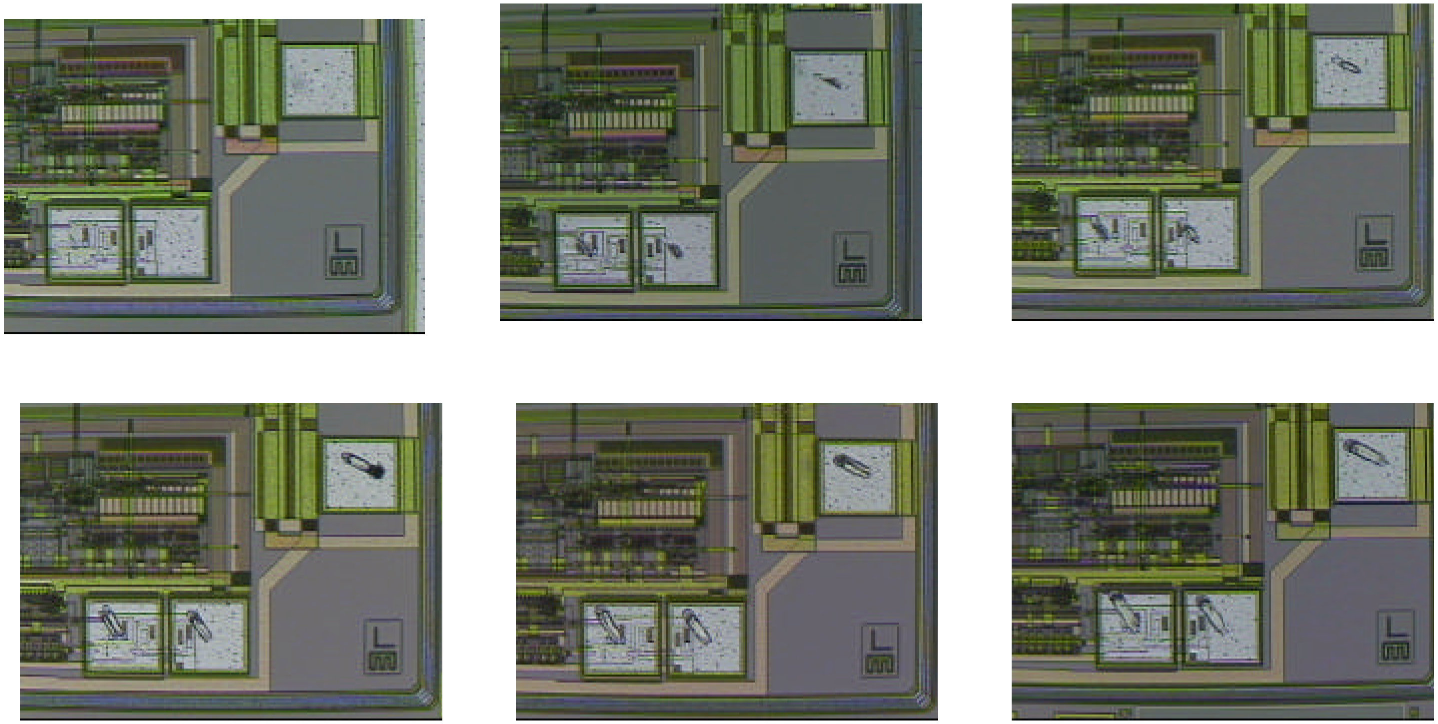
  = 17.55 µm

CASE STUDY - A 12” Probe Card - WAFER PROBER INTERFACE

- Issues apply to many large test heads.
- Issues are not new - most if not all have been discussed here before.
- Much support has been provided by test system, probe card, and prober vendors.

PROBLEM: Testing at 100º C

First site



Last site

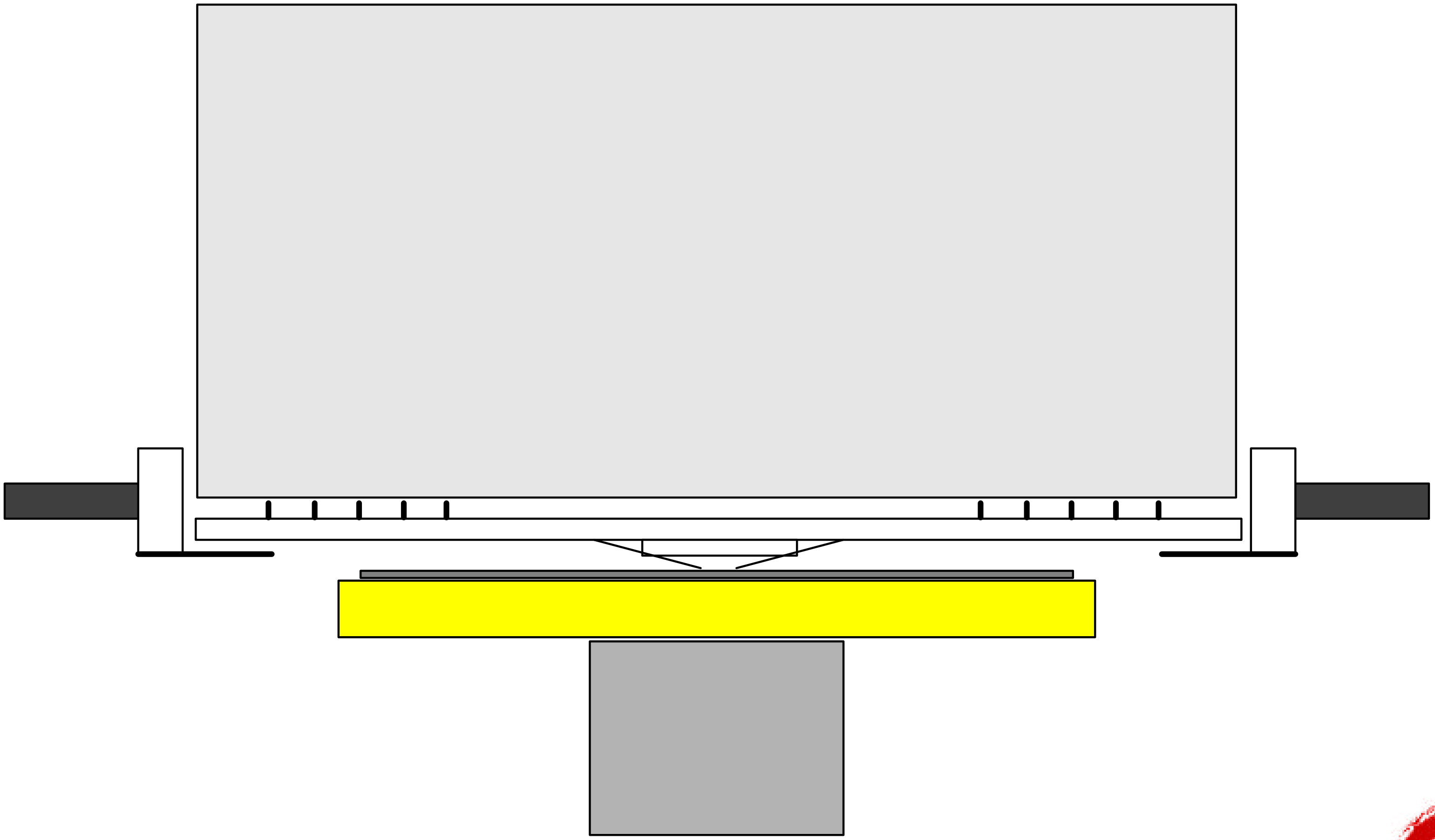
Performance of Standard 12” Probe Card Interface

	Chuck Temp.	X	Y	Z	ΔX	ΔY	ΔZ
Initial reading	25.0°C	560.1µM	87.5µM	20348µM	-----	-----	-----
After Re-Docking	25.0°C	571.5µM	86.7µM	20289µM	11.4µM	0.8µM	59µM
10 minute soak	100°C	560.2µM	72.3µM	20248µM	0.1µM	15.2µM	100µM

Some Factors Possibly Affecting Accuracy

- High and/or Uneven Pogo-pin Pressure
- Inadequate Probe Card Support
- Inadequate Probe Card Stiffness
- Uneven probe card heating due to chuck position
- Temperature gradient between top & bottom of card
- Not enough clearance between card edge and holder
- Possible interference with alignment pins as card expands
- Inadequate soak time
- Possible epoxy softening

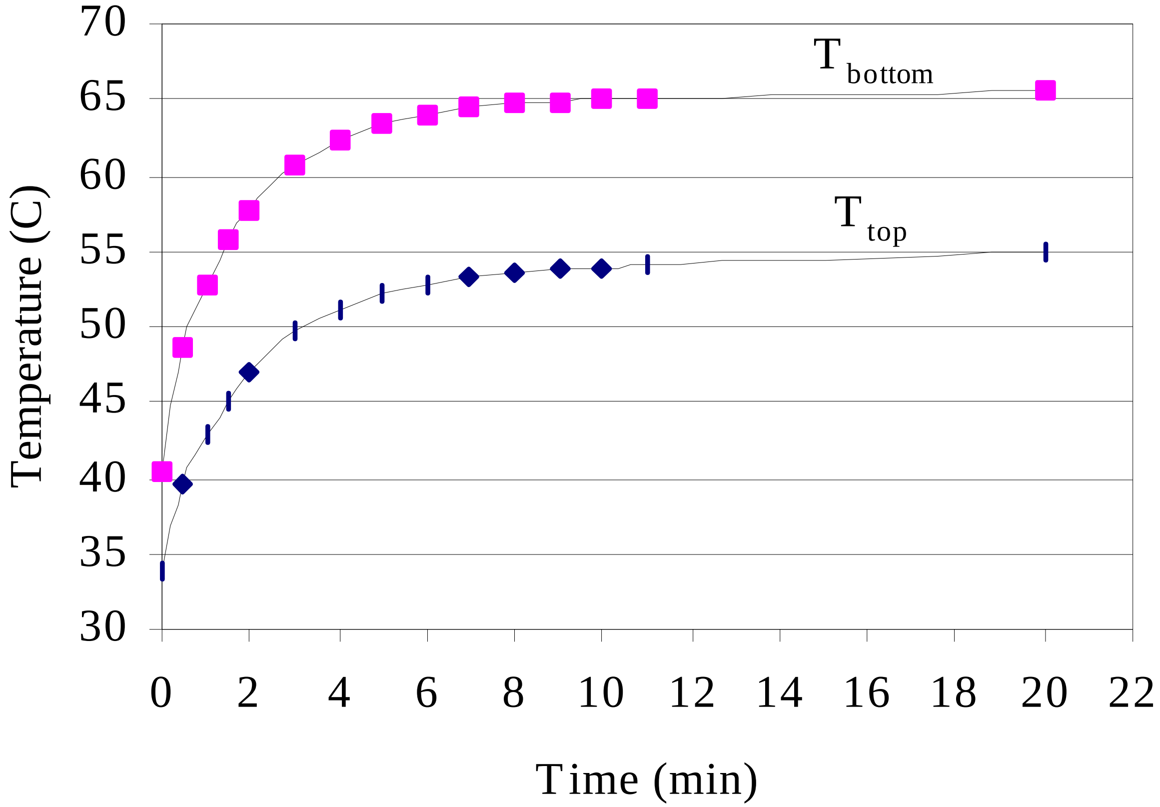
INTERFACE DIAGRAM



Corrective Strategies

- Thermal
  - Minimize the temperature seen by the probe card.
  - Minimize the temperature gradient.
  - Allow sufficient soak time.
- Mechanical
  - Revise the mechanical design of the probe card.
  - Improve the probe card holder.

Vertical Temperature Gradient



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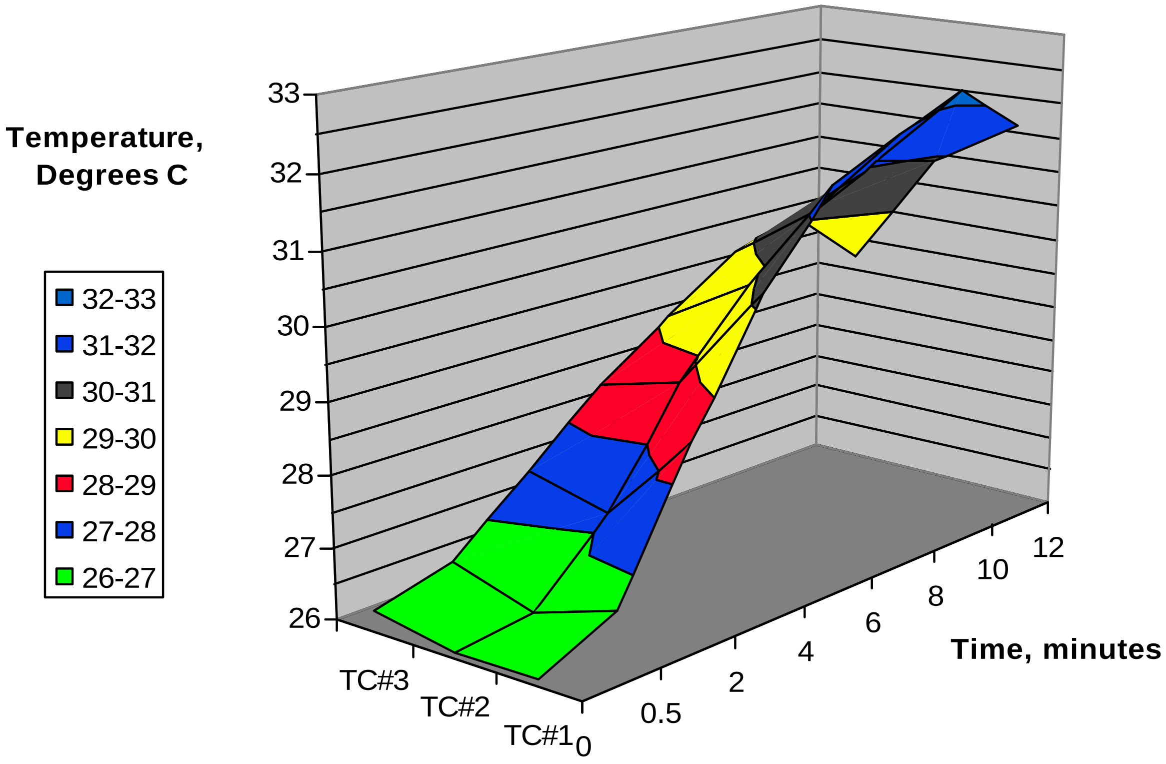
Radial Temperature Gradient



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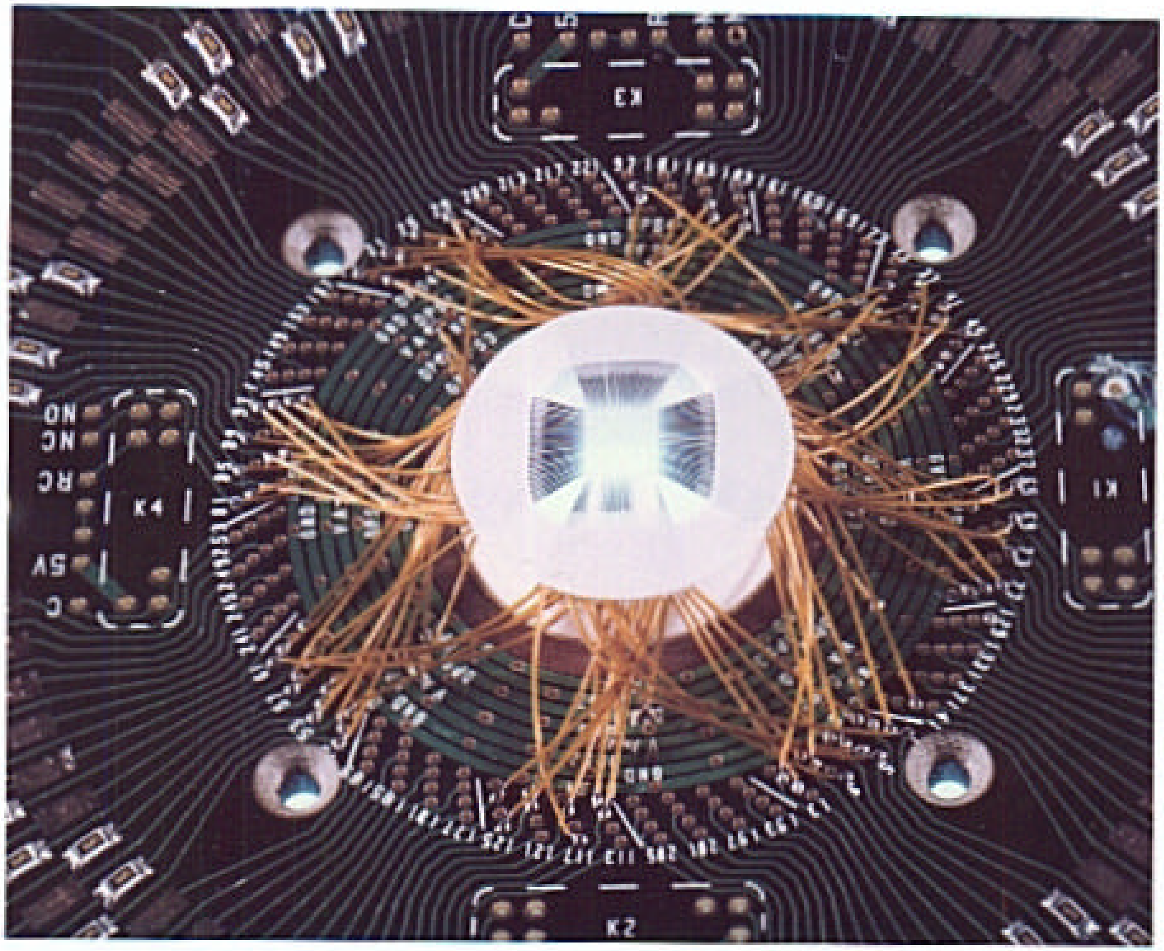
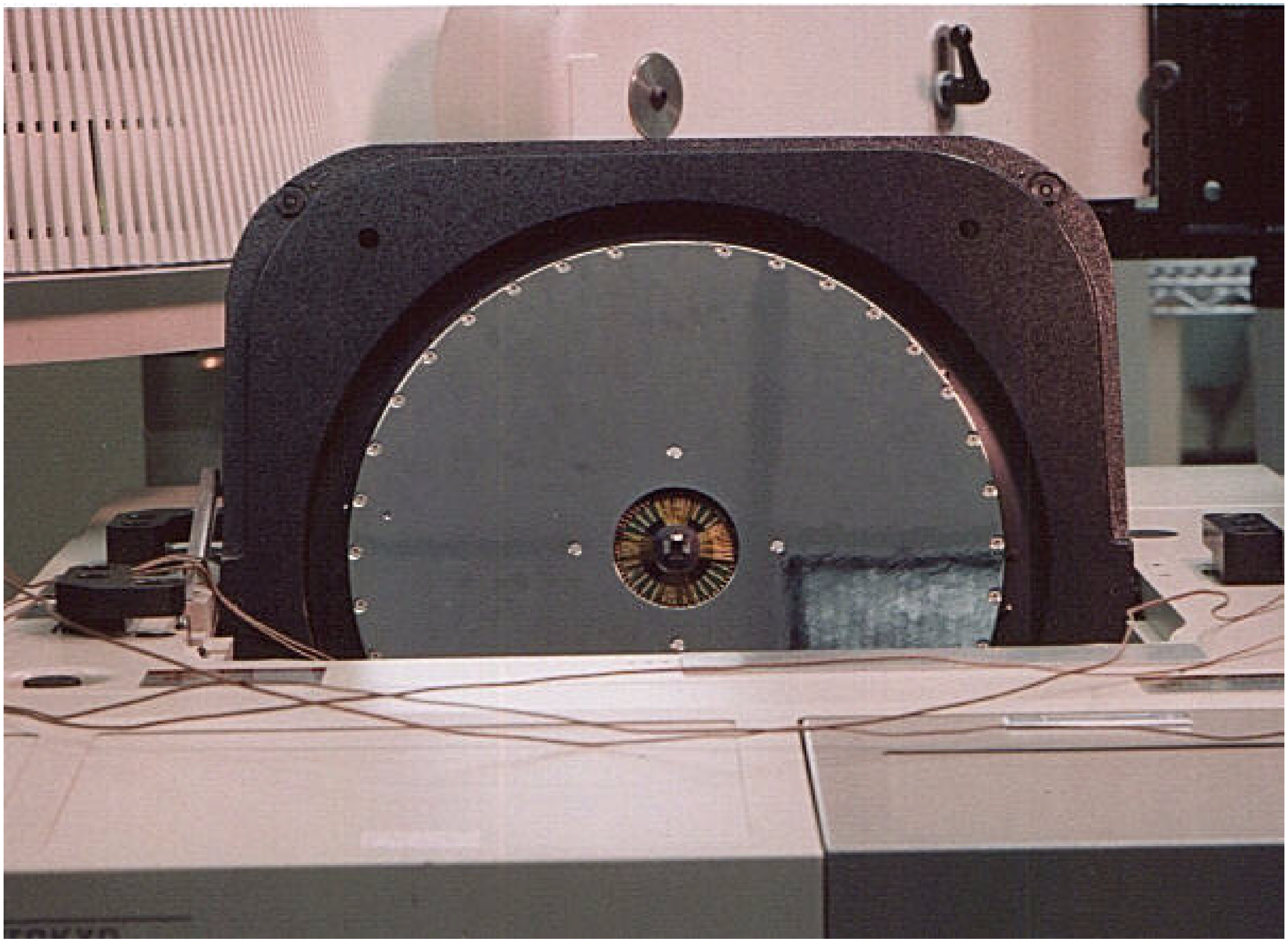
PROBE CARD HEATING

- Soak Time
  - Long soak time required for stabilization and top to bottom gradient will still exist.
  - Uneven heating from moving chuck still causes probe card x-y movement.
  - Will not solve problem.
- Heat Shield
  - Tends to increase Temperature gradient in x-y Plane.
- Probe Depth

Mechanical Effects

- Probe Card Stiffness
  - New Materials
- Interface Stiffness
  - Probe card tray as bottom side stiffener
  - Top side stiffener
- Interface Stability
  - Probe card secured to tray





EVALUATION

- Work is currently in progress.
- The impact of any single change, made separately, has not been dramatic.
- All improvements made together are expected to produce a solution capable of being used in production.

General Observations

- The prober - probe card - tester interface for many large systems is complex - mechanically, electrically and thermally.
- Industry trends are placing more and more demands on this design, requiring attention to mechanical and thermal characteristics.
- Interface stability, although difficult to measure, is an important parameter when high accuracy probing is required.

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