# Introduction to Probe Cards

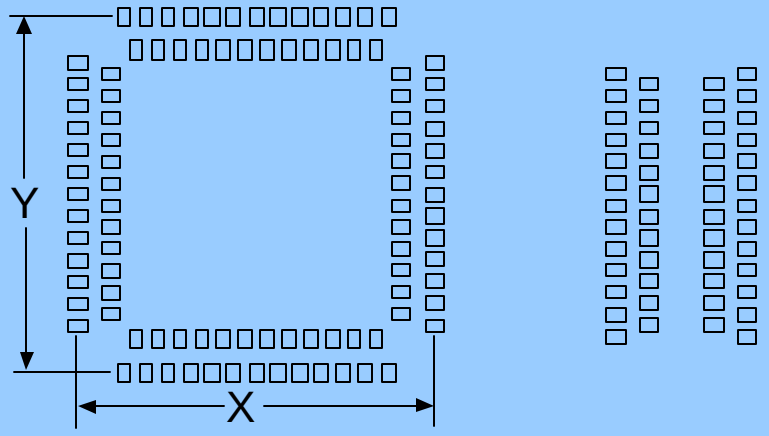
How They are Built & Tested

# PROBE CARDS & PROCESS COURTESY OF CERPROBE

# Design & Layout

# DIE PAD CONFIGURATIONS

≤ 500 mils on each side



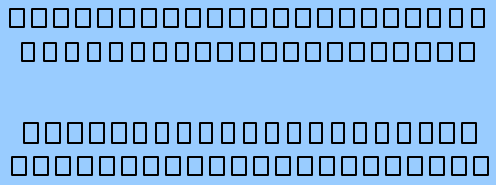

(1a)



(1b)

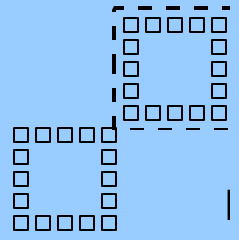
These configurations typically use standard rings

> 500 mils on any side



(1c)

Multi-D



(1d)

These configurations typically requ semicustom or custom rings

***Figure 1: Die and Ring Configuration Examples***

# BONDING PADS

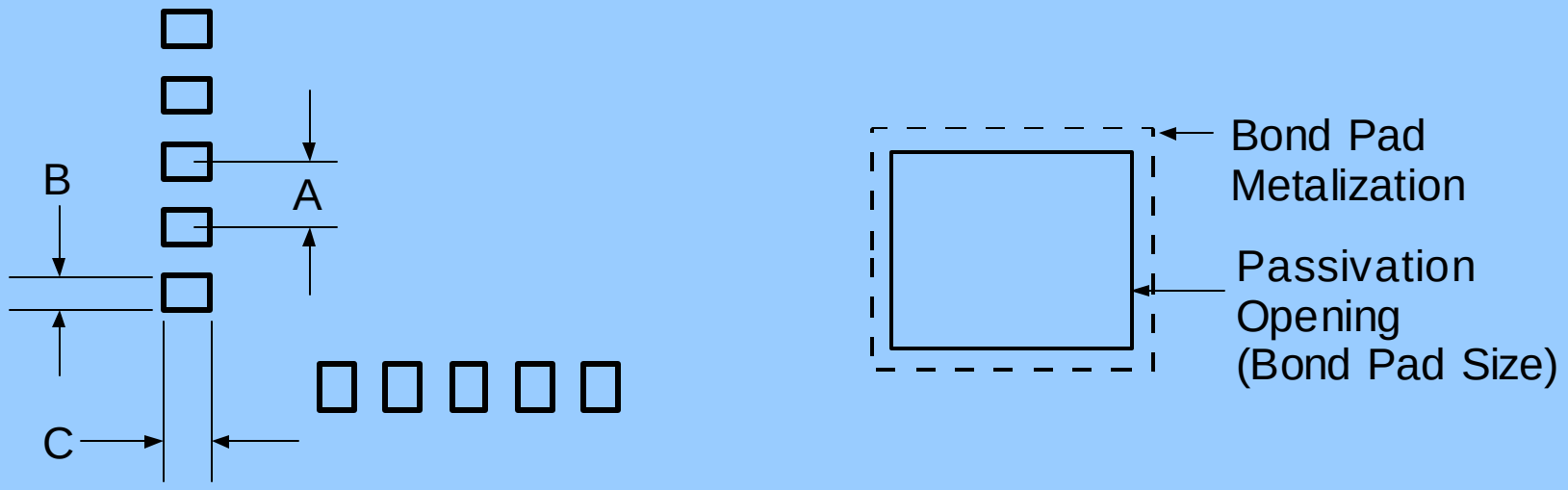



***Figure 2: Bond Pad Pitch and Size***

# CROSS SECTION, CANTALEVER BEAM

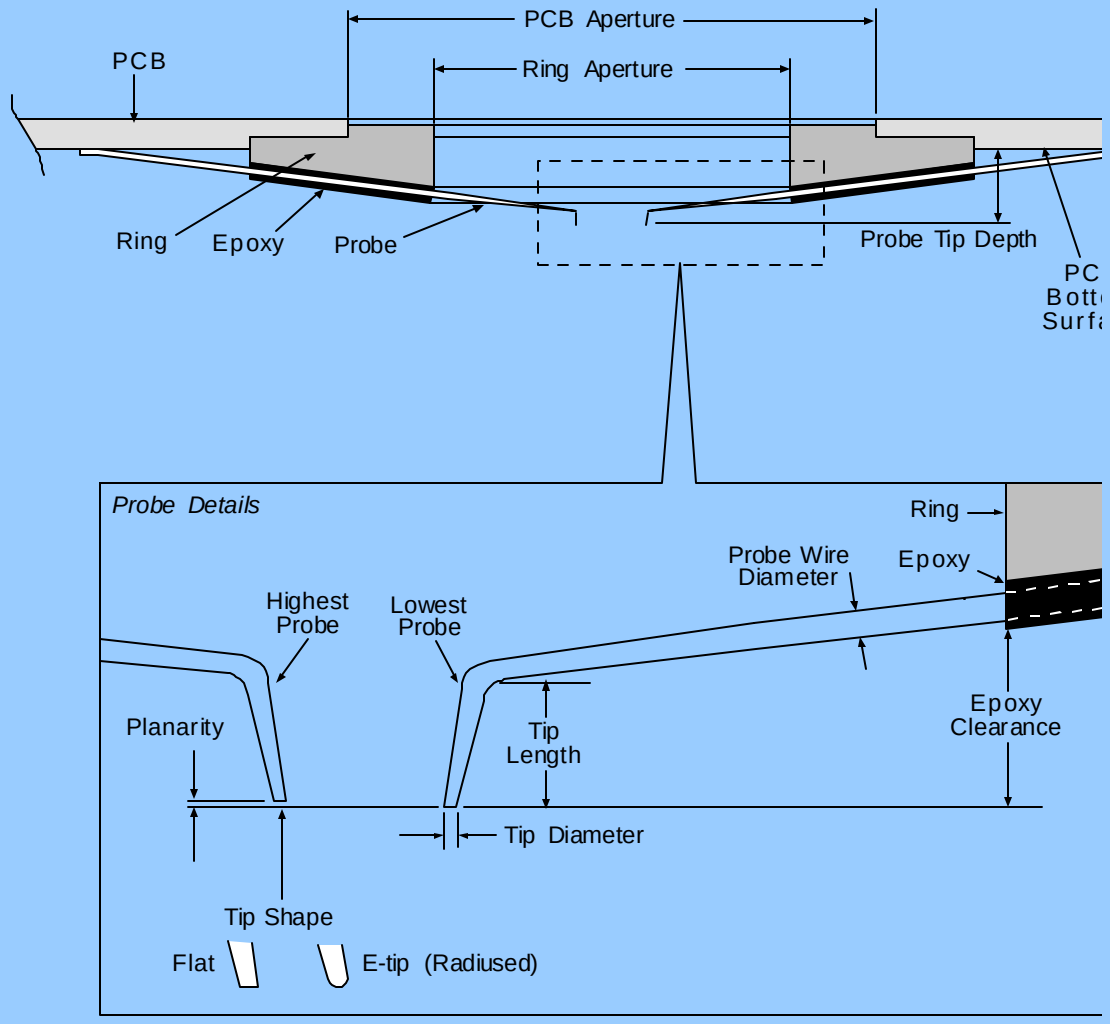



*Figure 3: PCB and Epoxy Ring Assembly*

# EDGE SENSOR TYPES

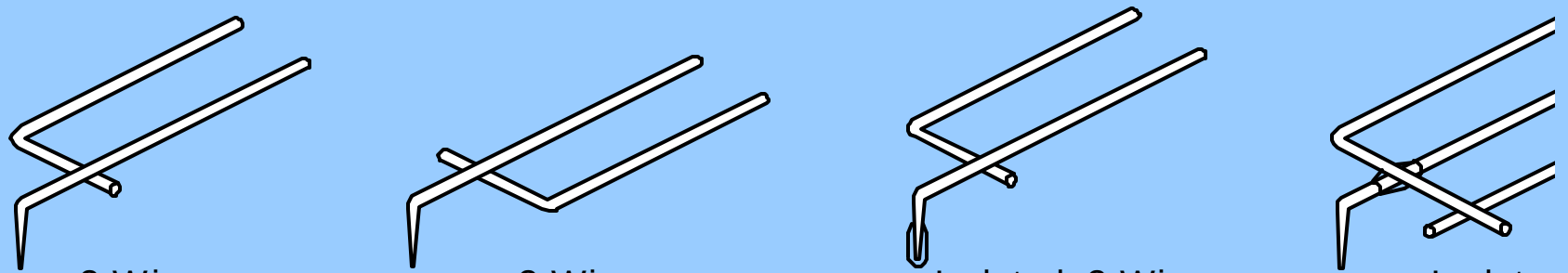
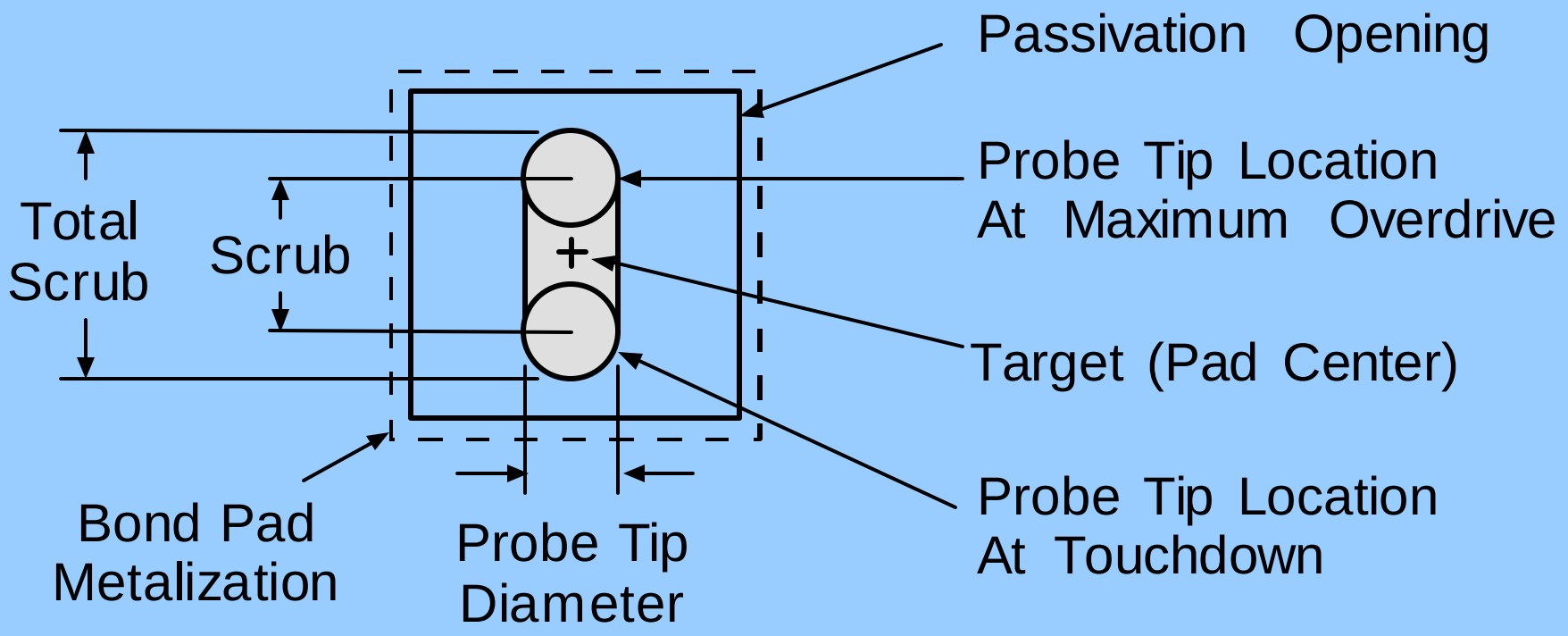
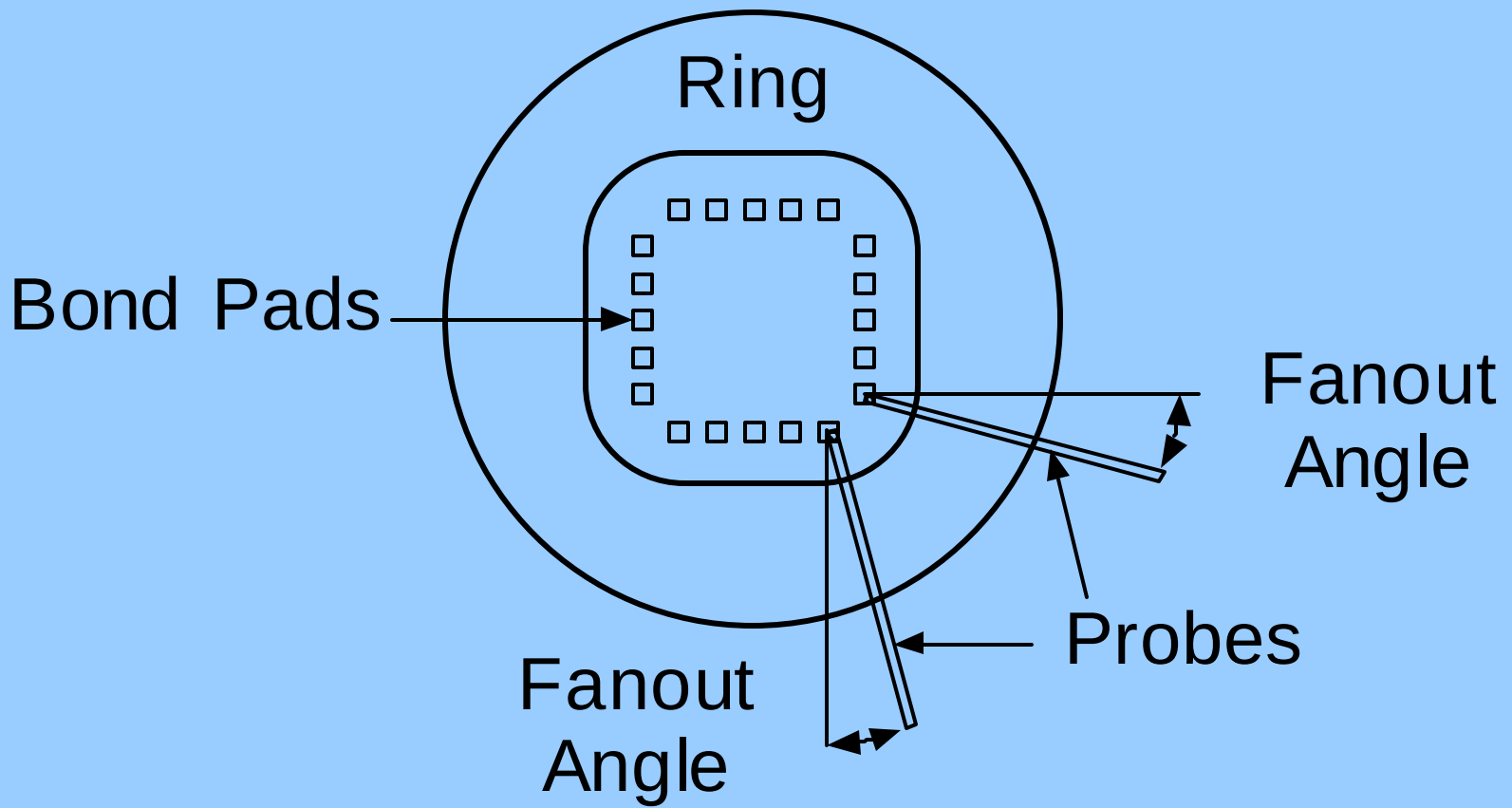



***Figure 4: Edge Sensors***

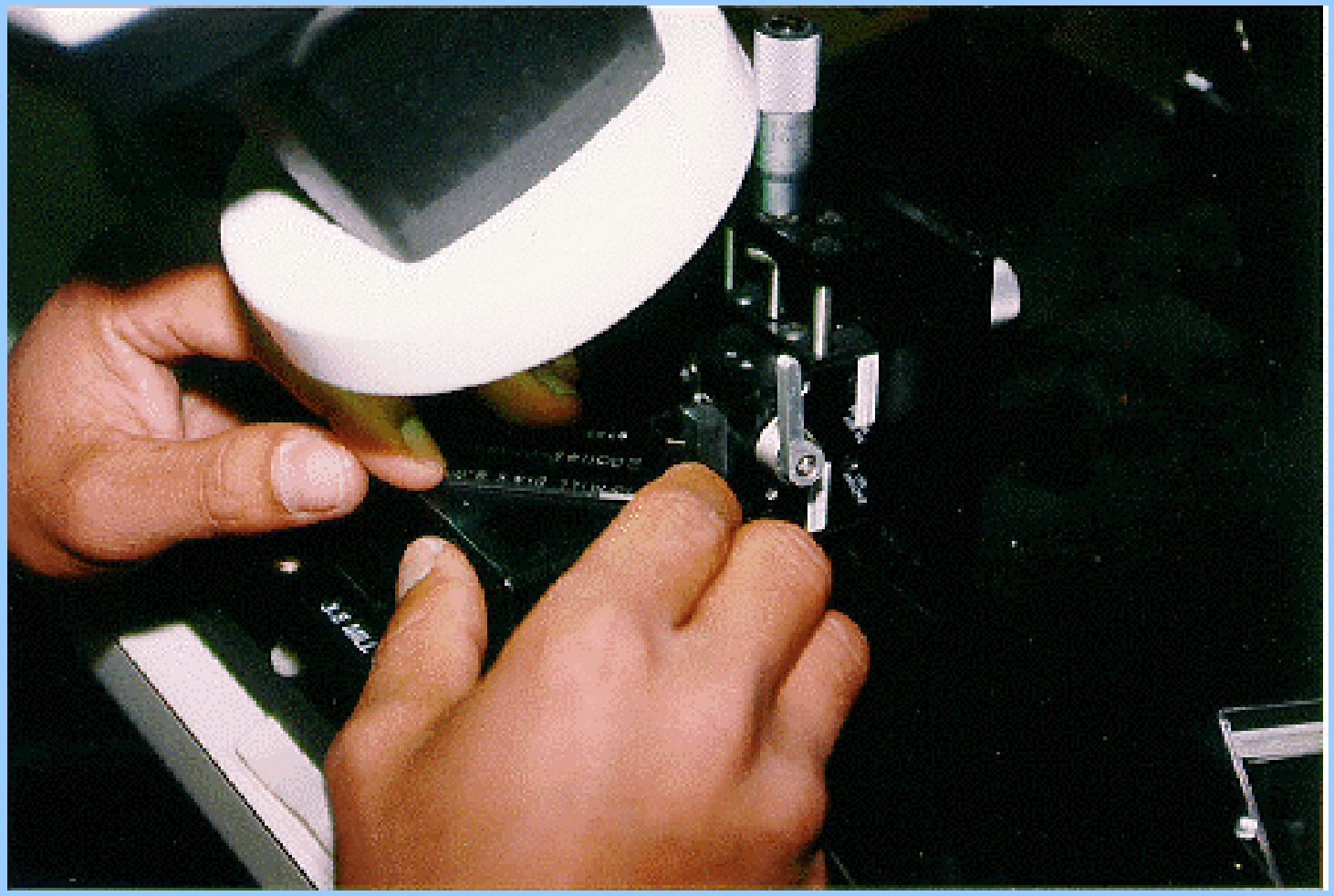
# PROBE TO PAD POSITIONING



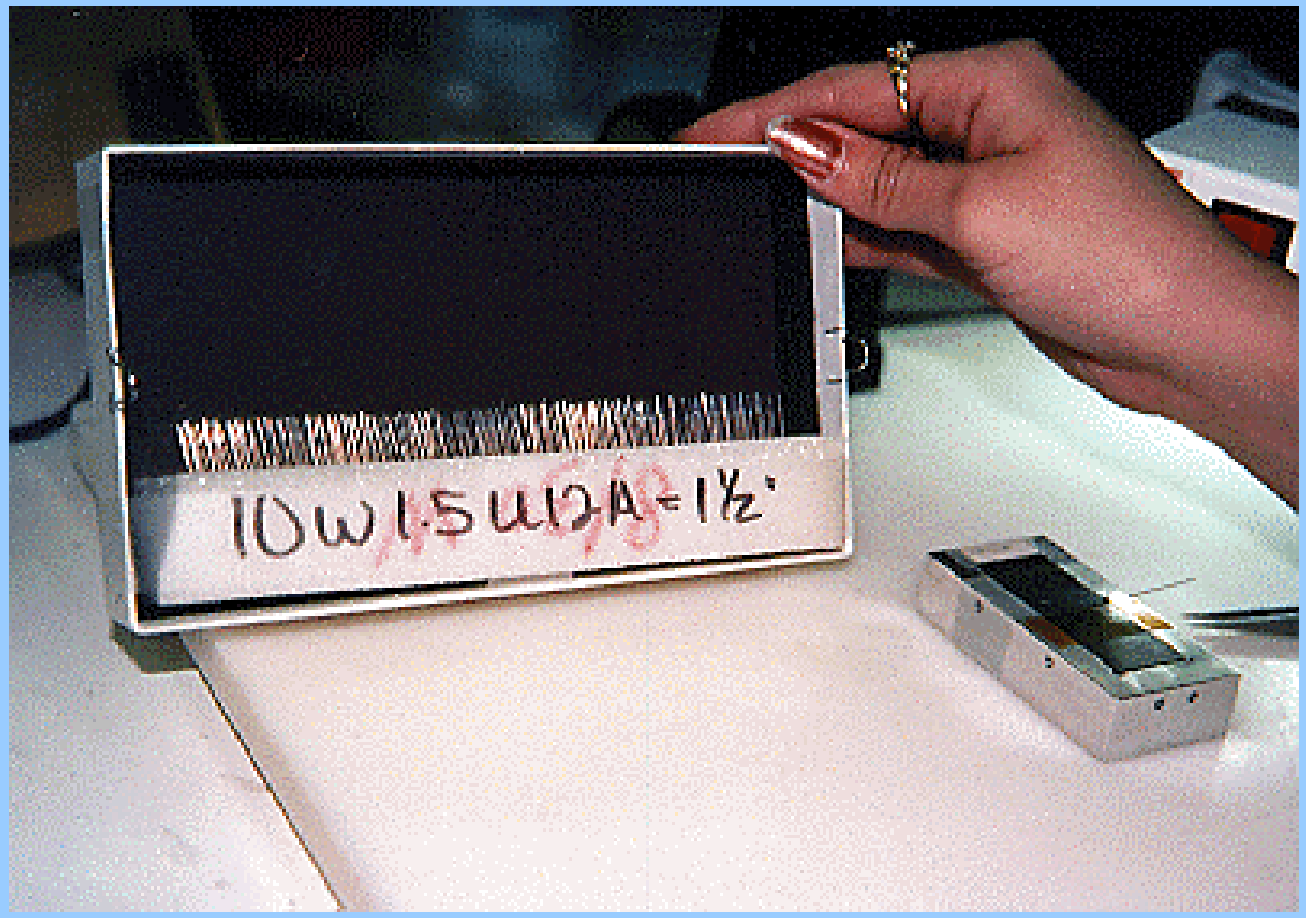
# PROBE FANOUT ANGLE



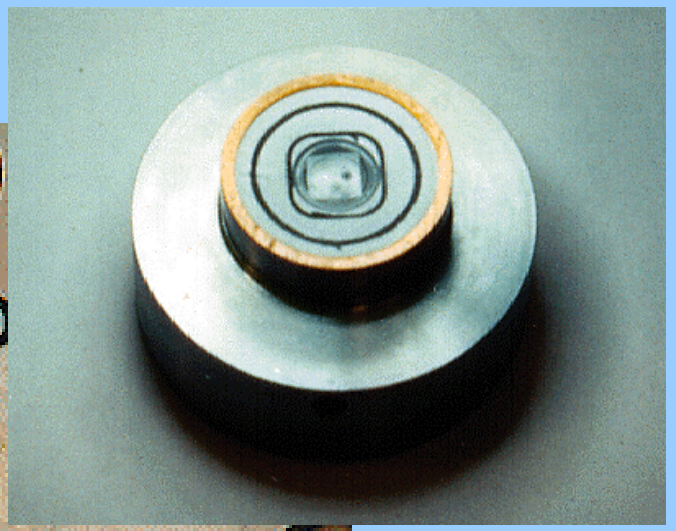
# Wire Bend



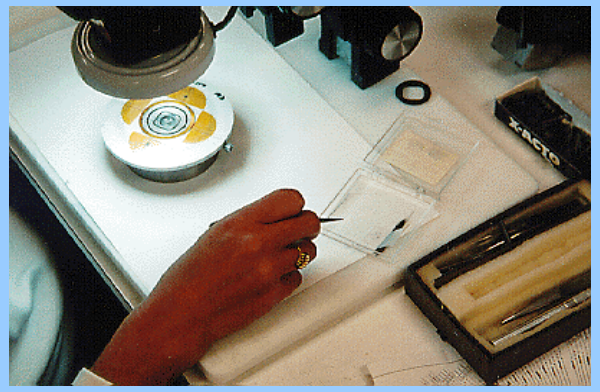
# Wire Bend - Replacement Probes

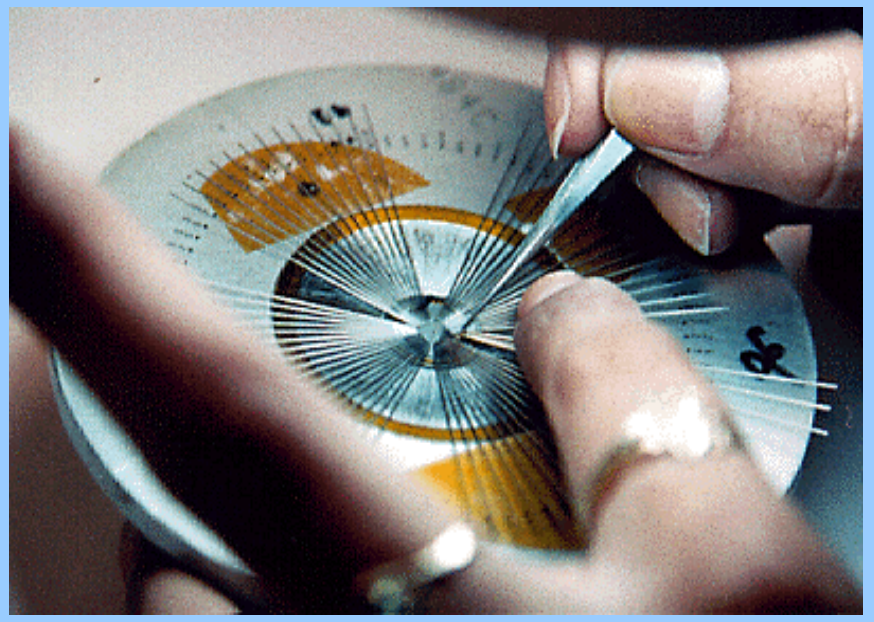


# Ring Build & Fixture

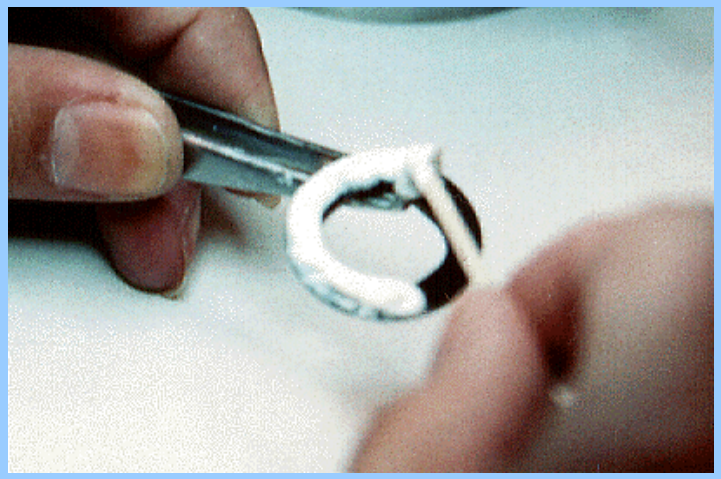


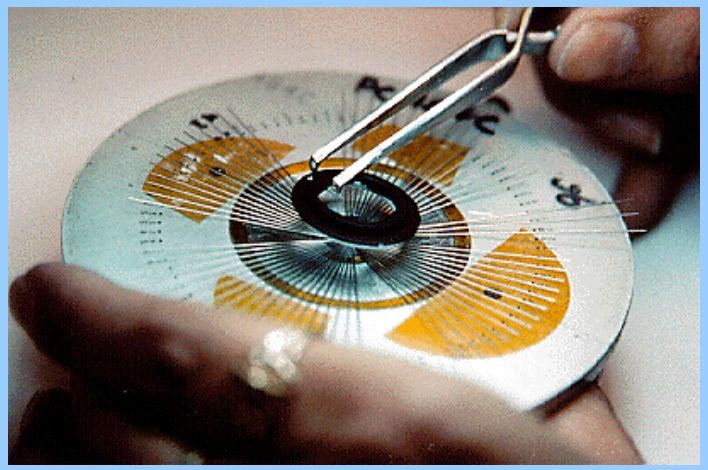
# Ring Assembly

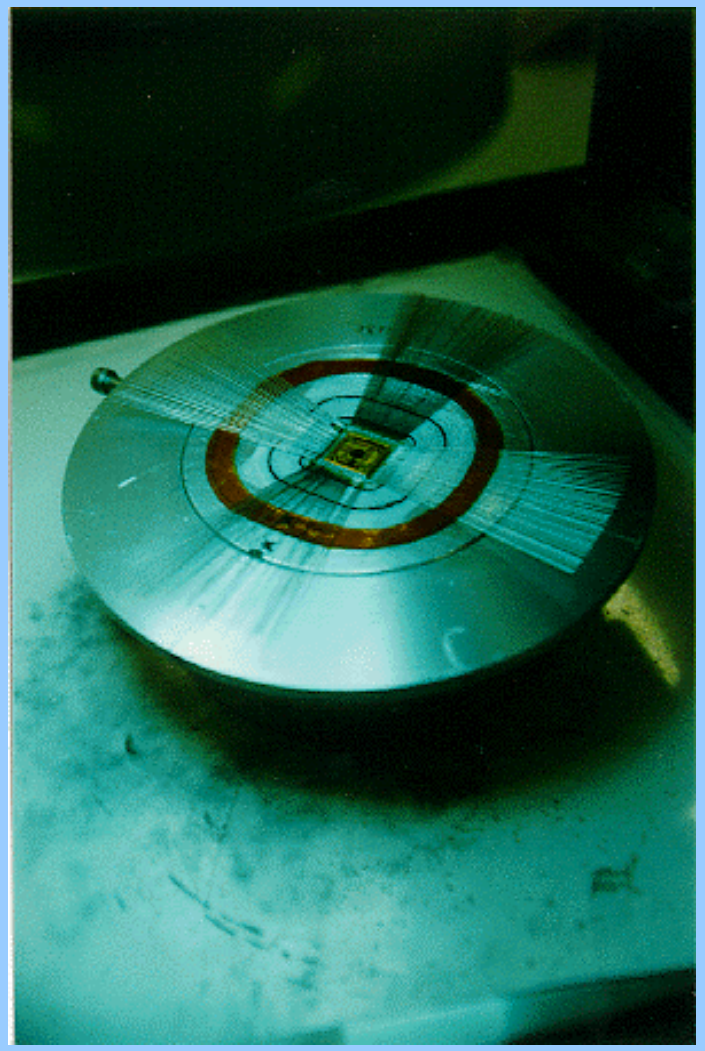


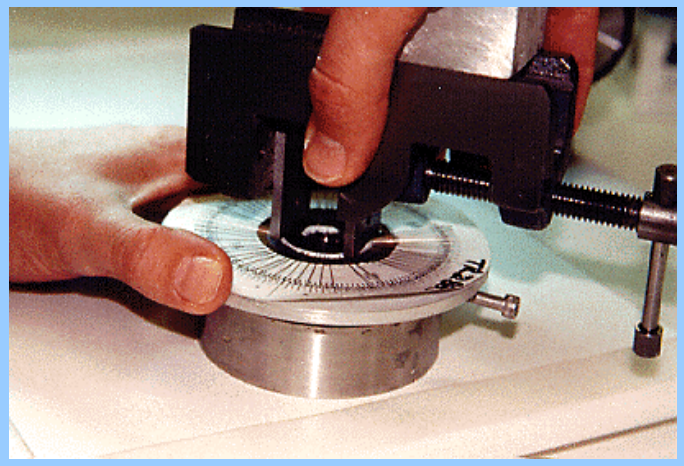
# Ring Assembly

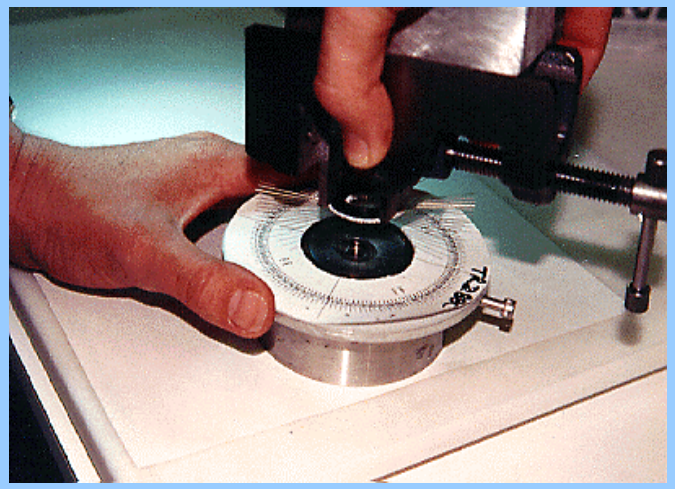


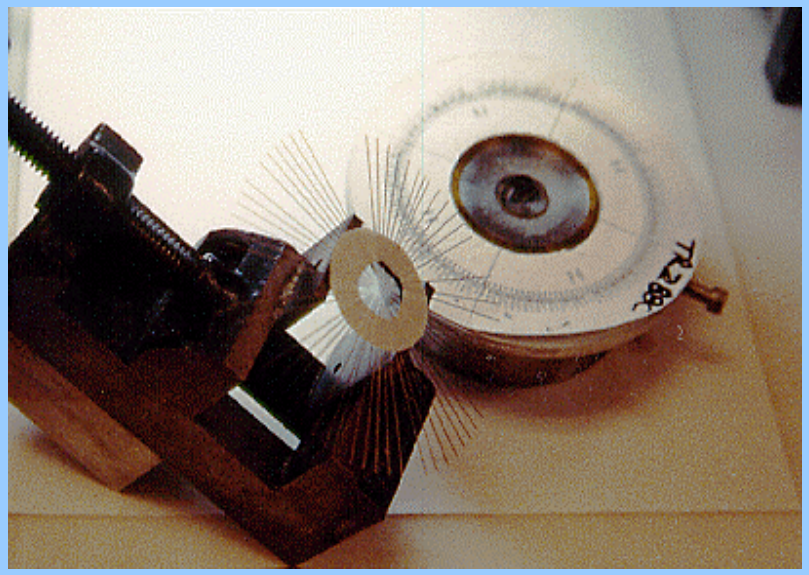




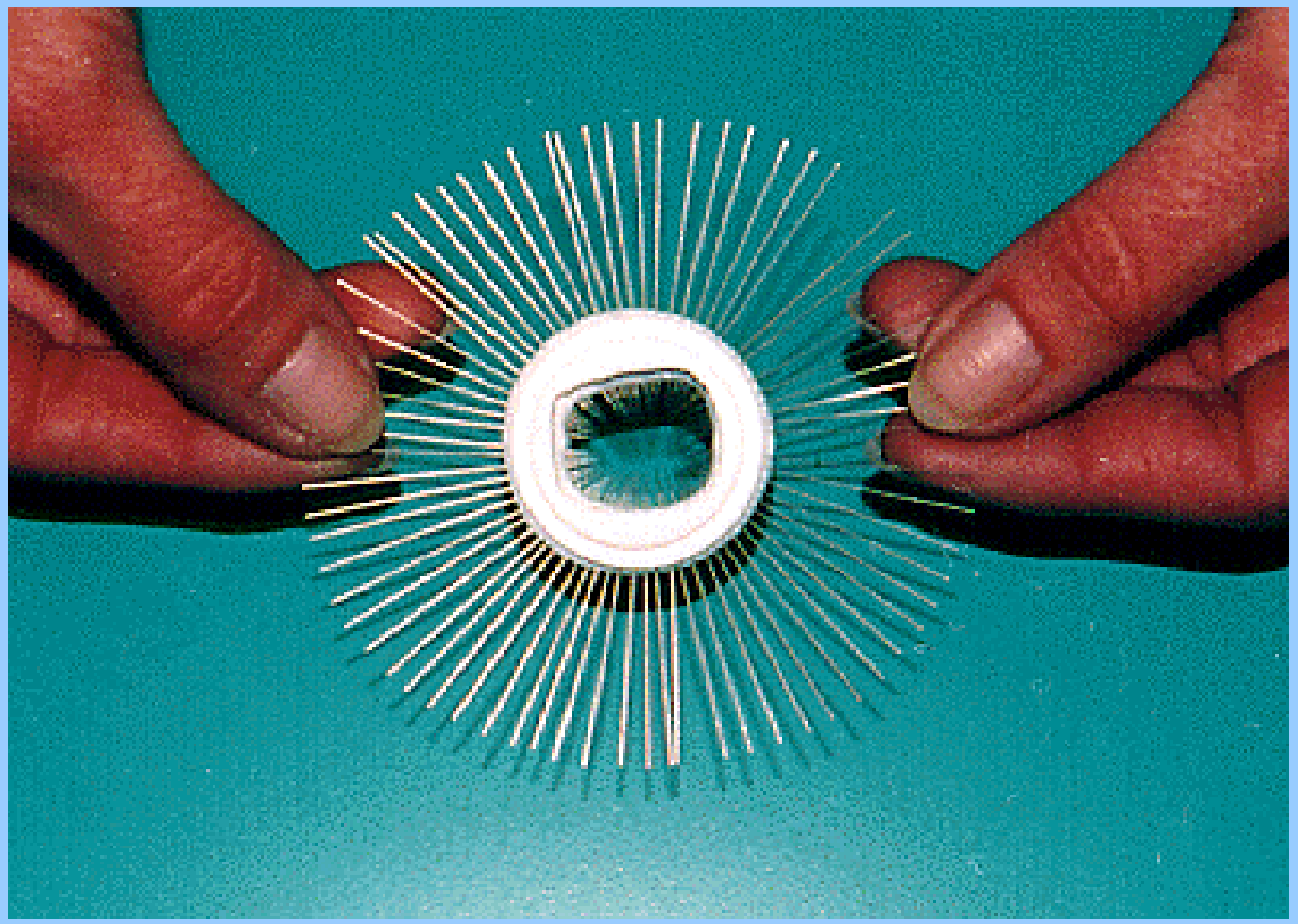
# Ring Removal



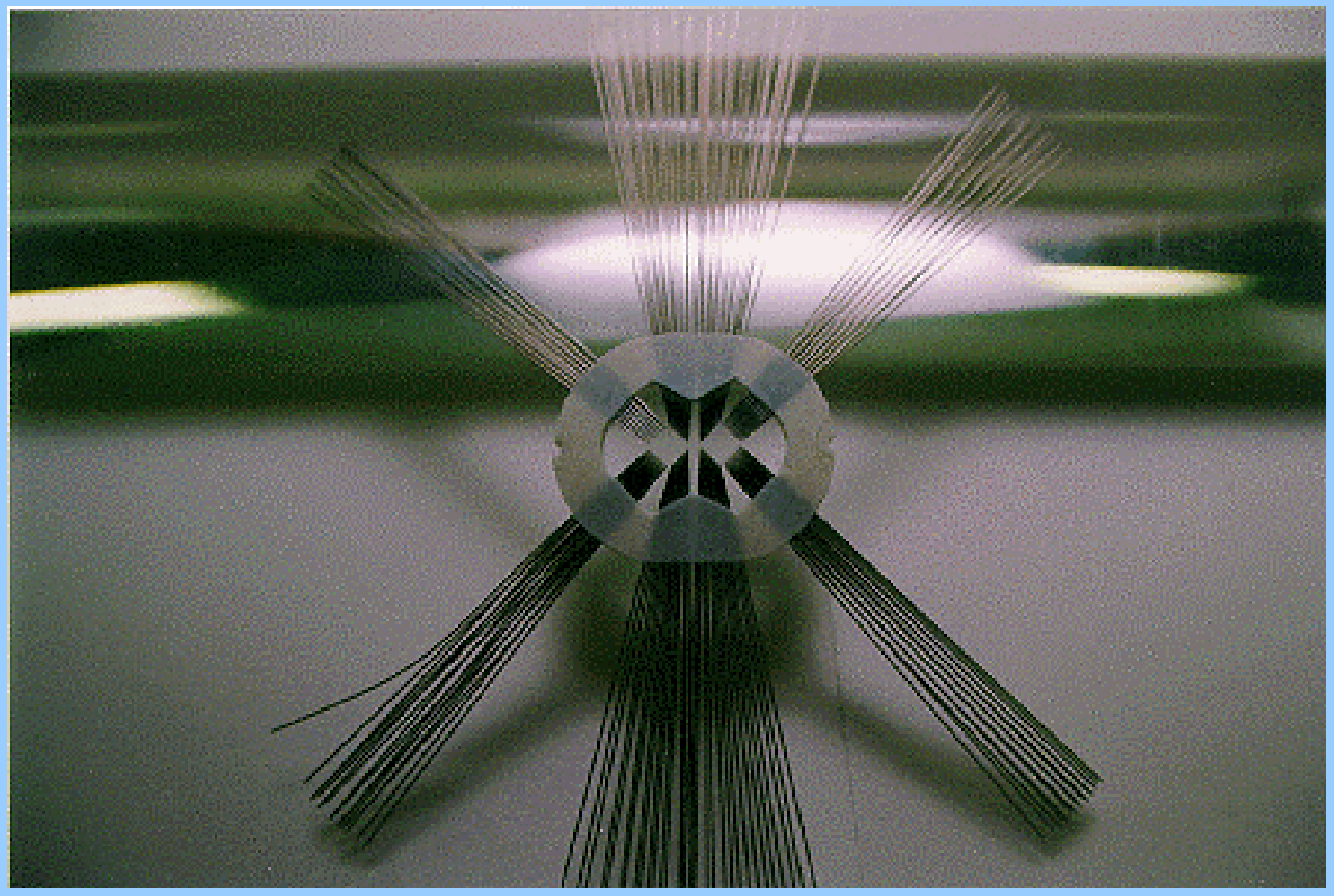




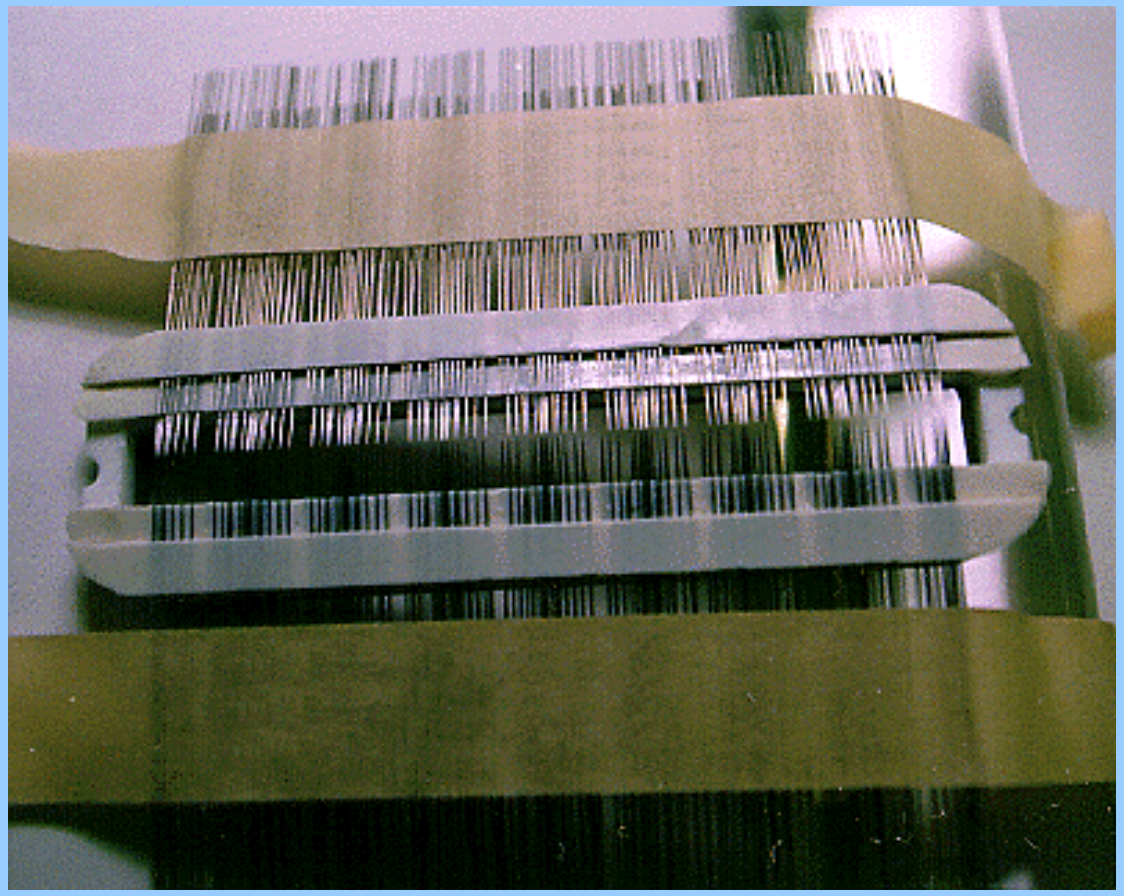
# COMPLETED PROBE RING



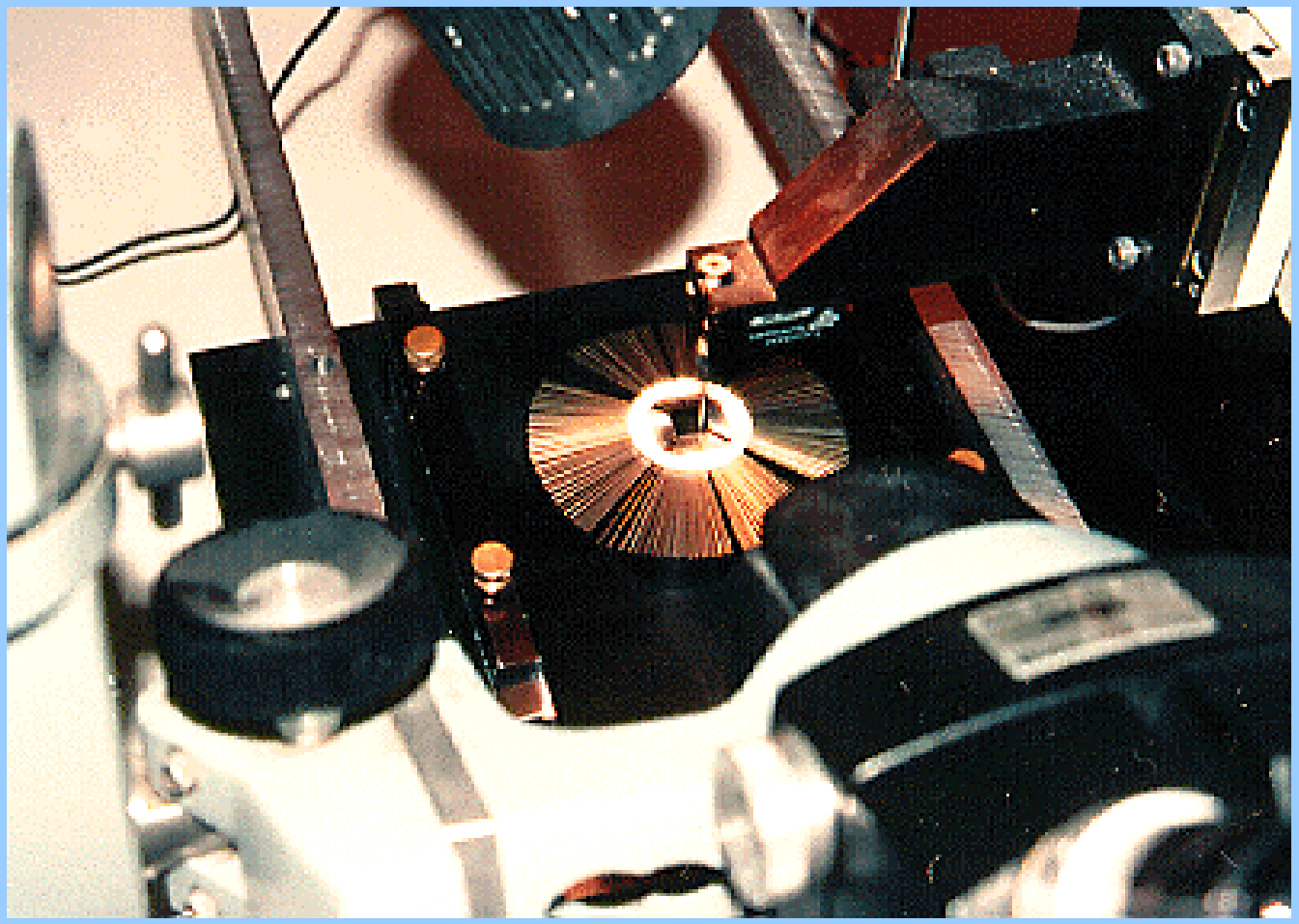
# Completed Probe Ring



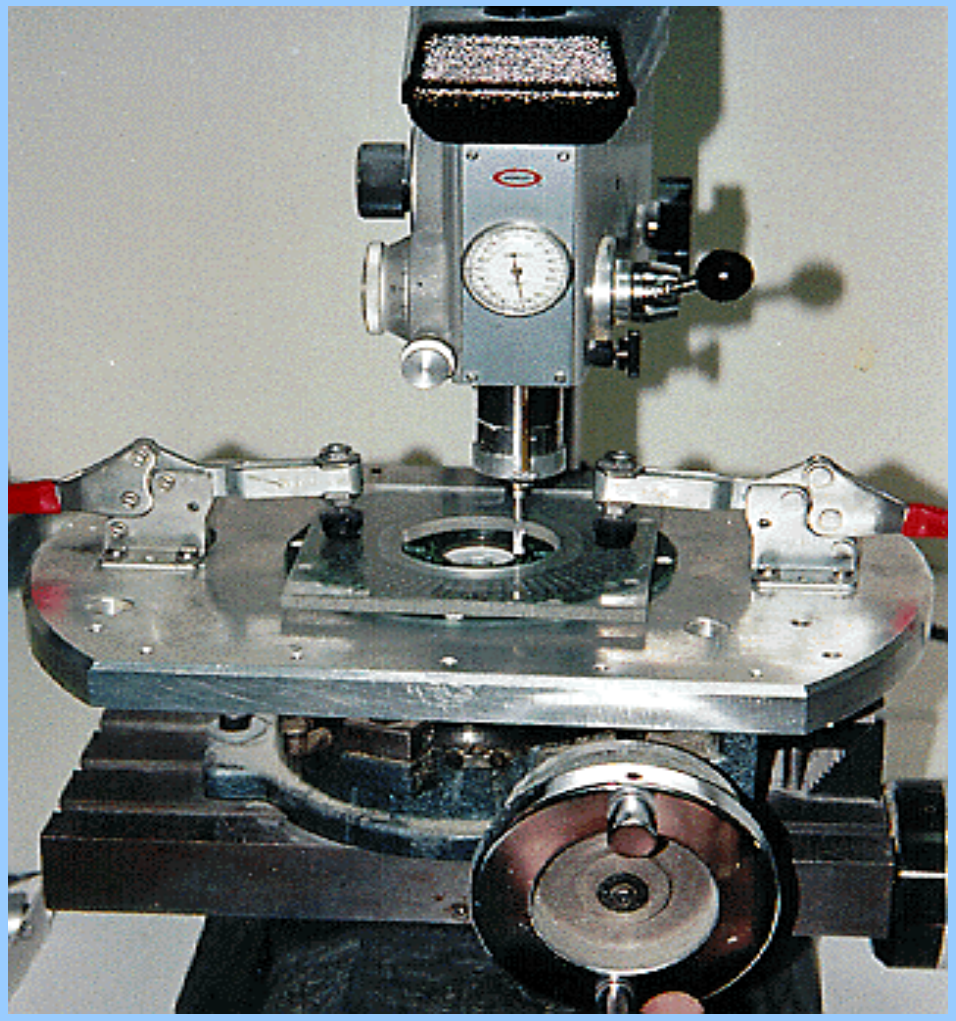
# Multi Layer Ceramic Ring



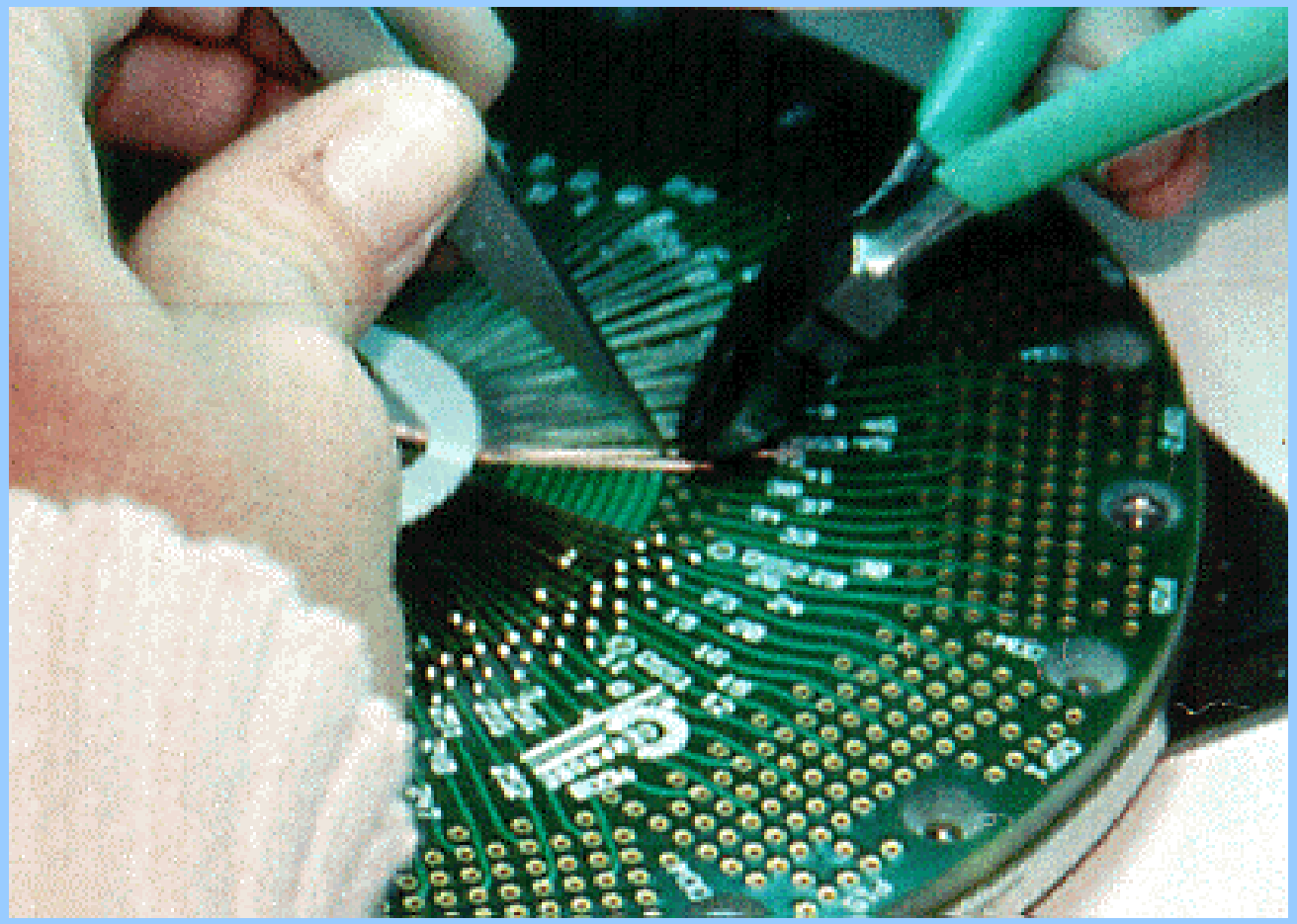
# Measuring Contact Force



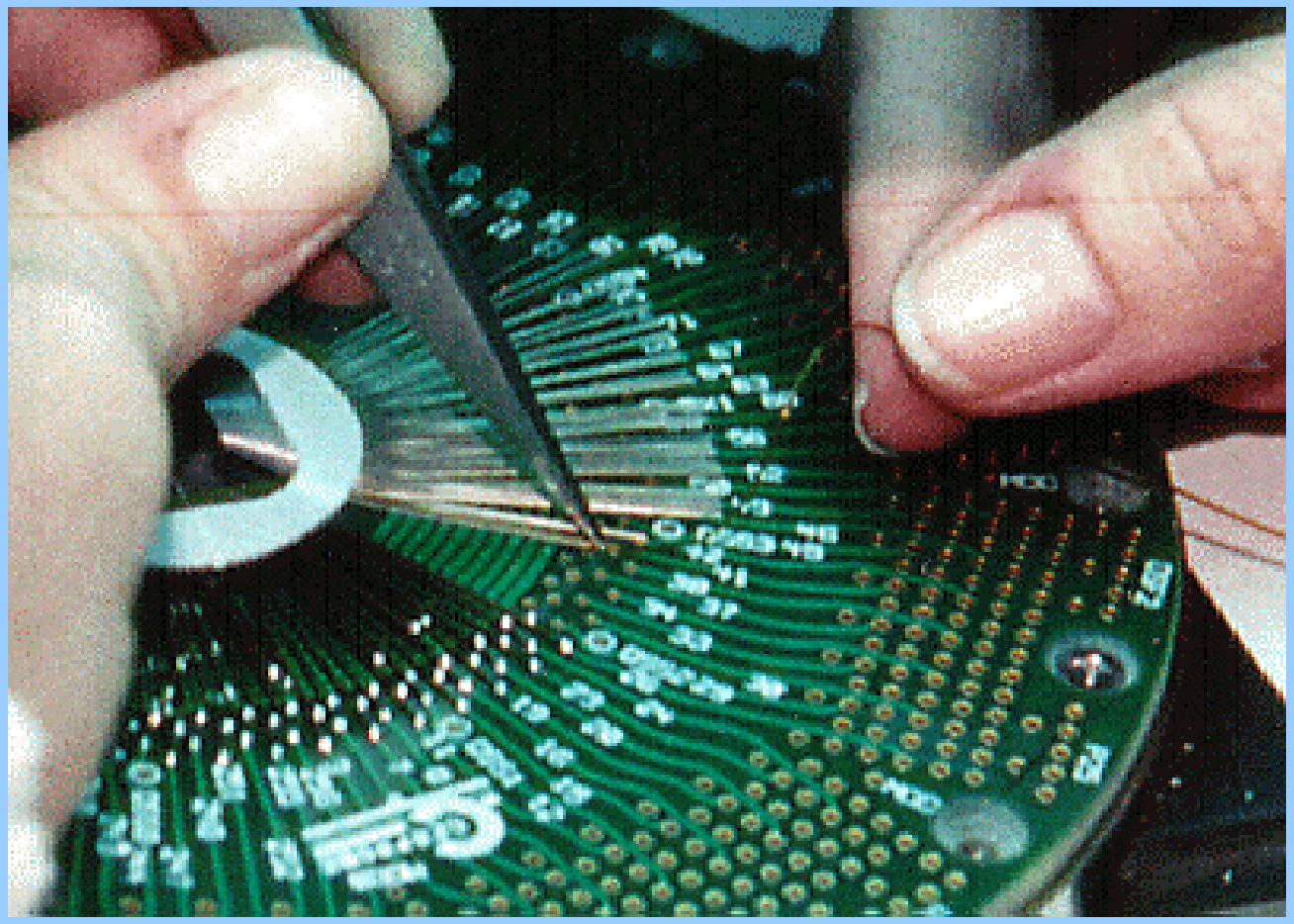
# PCB Counterbore



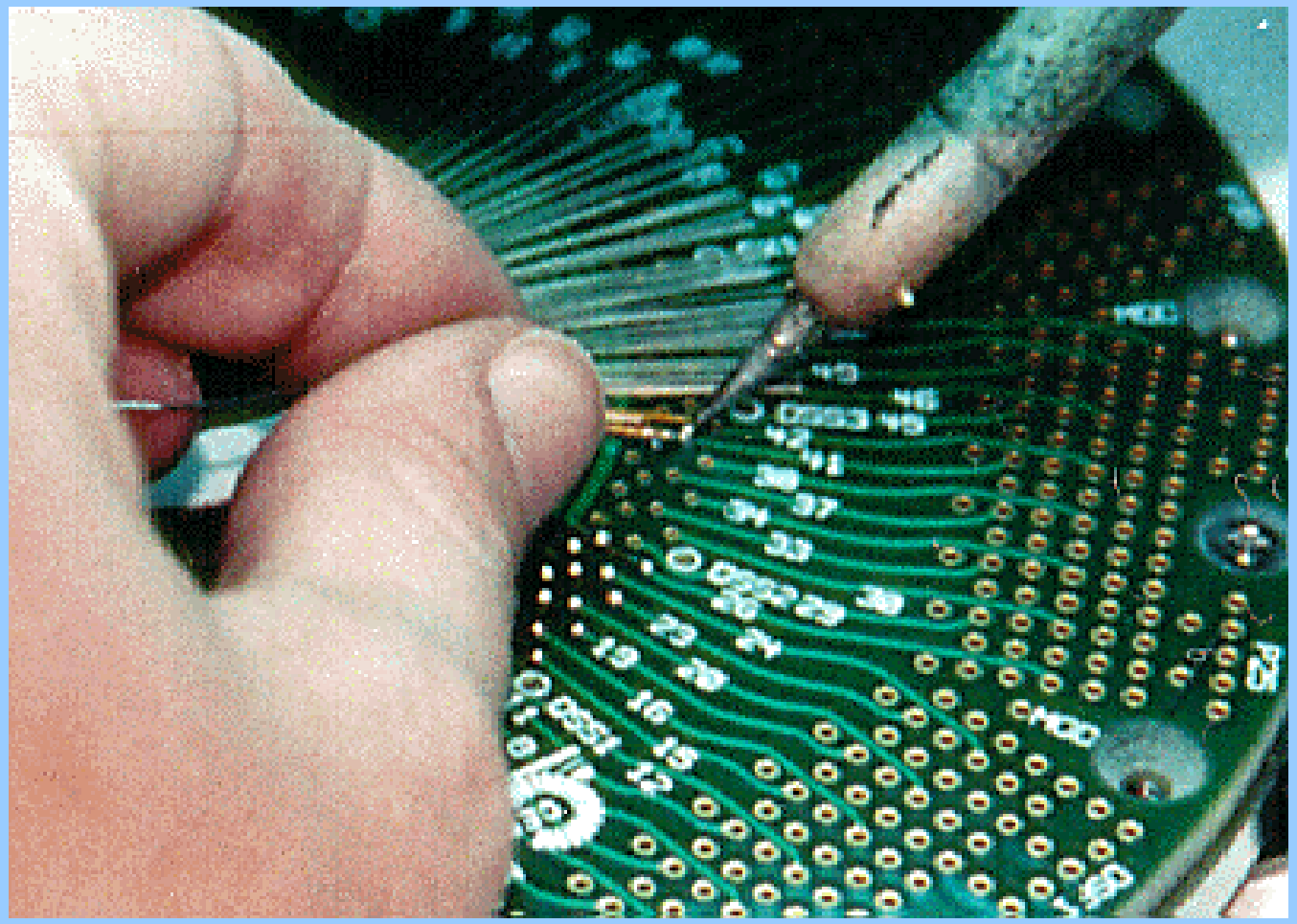
# Trimming



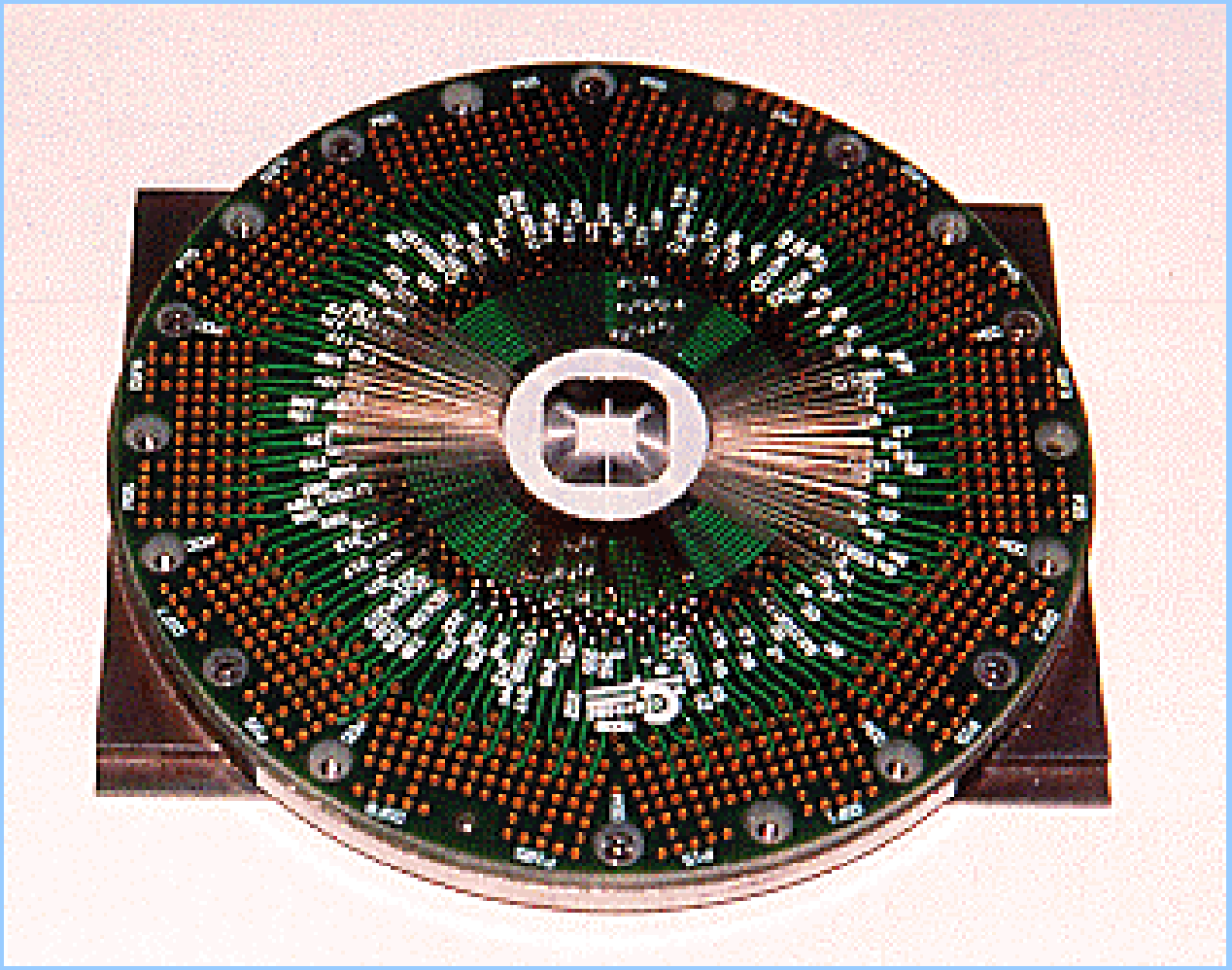
# Isolative Sleeving



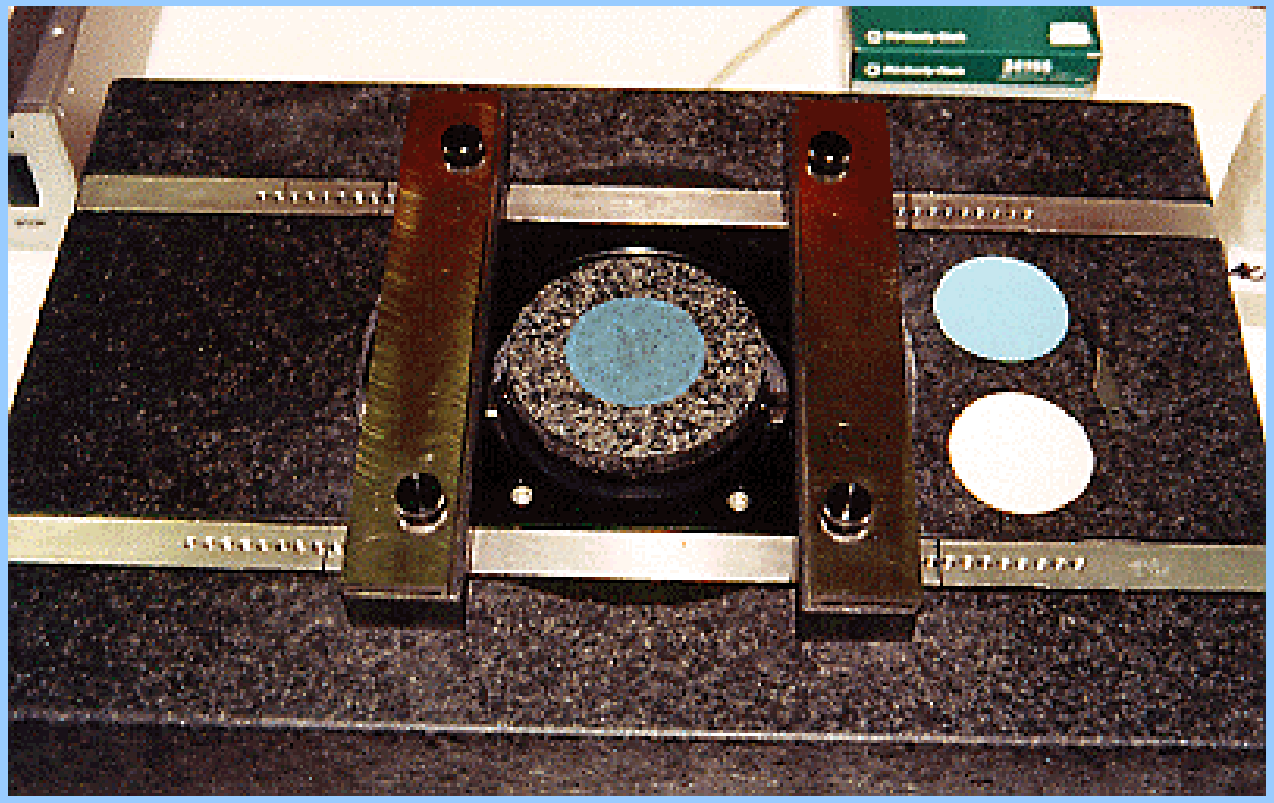
# Probe Attachment



# Probe Card on Build Plate



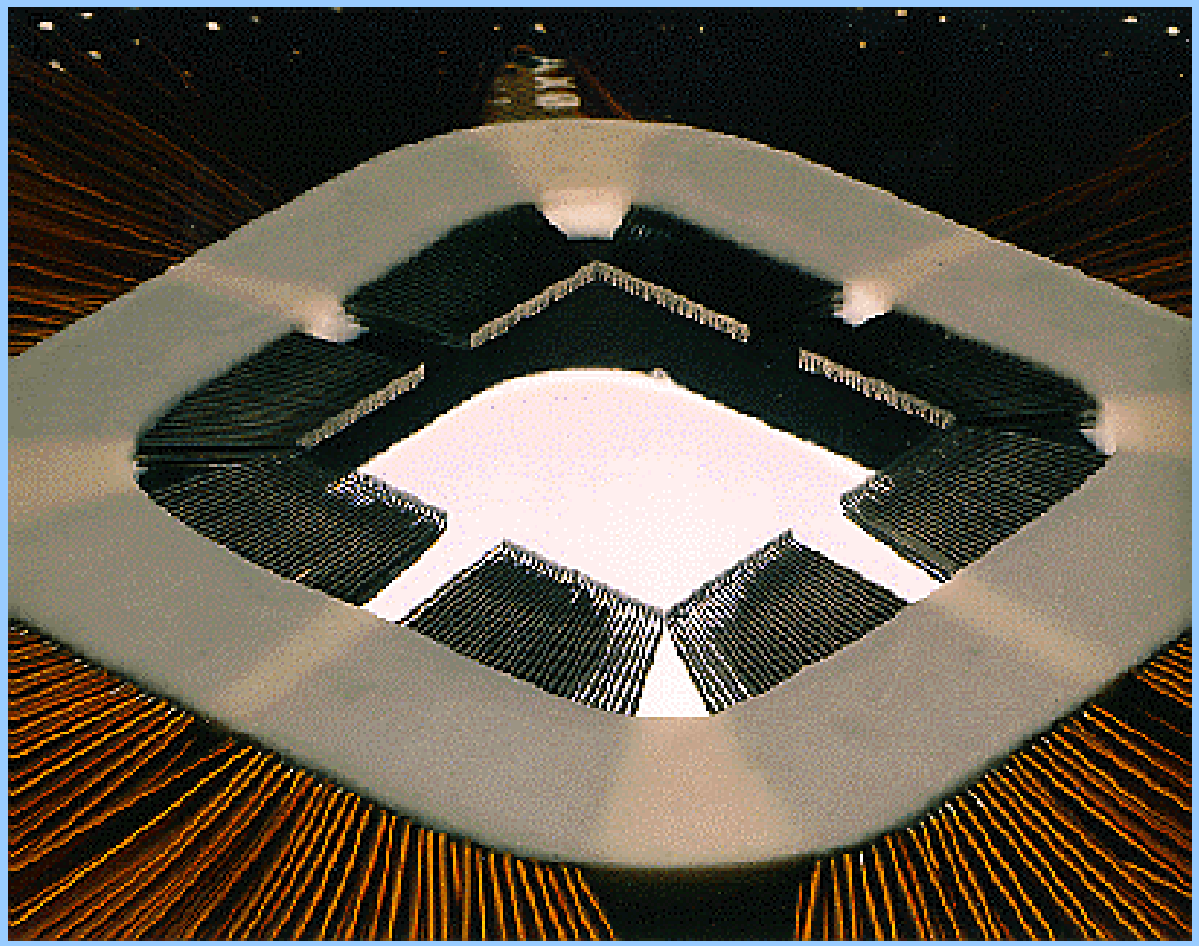
# Probe Card Sanding Station



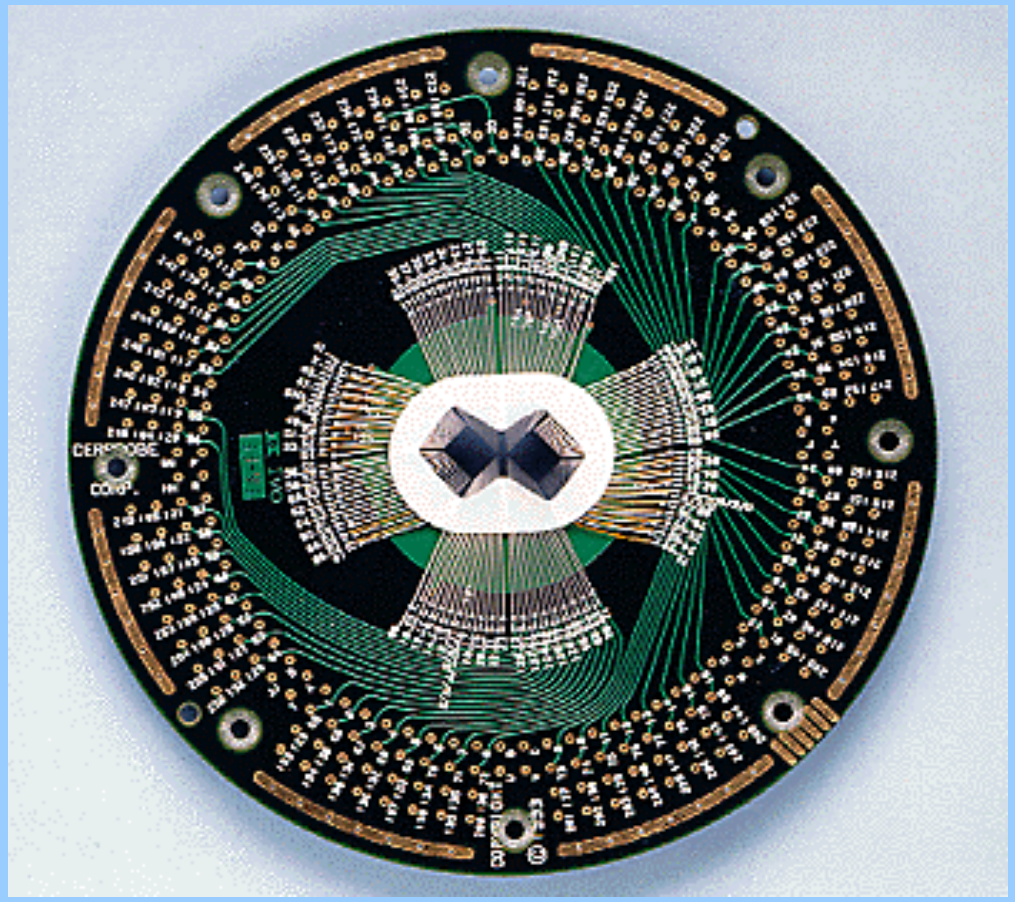
# Alignment to Wafer

# Planarization

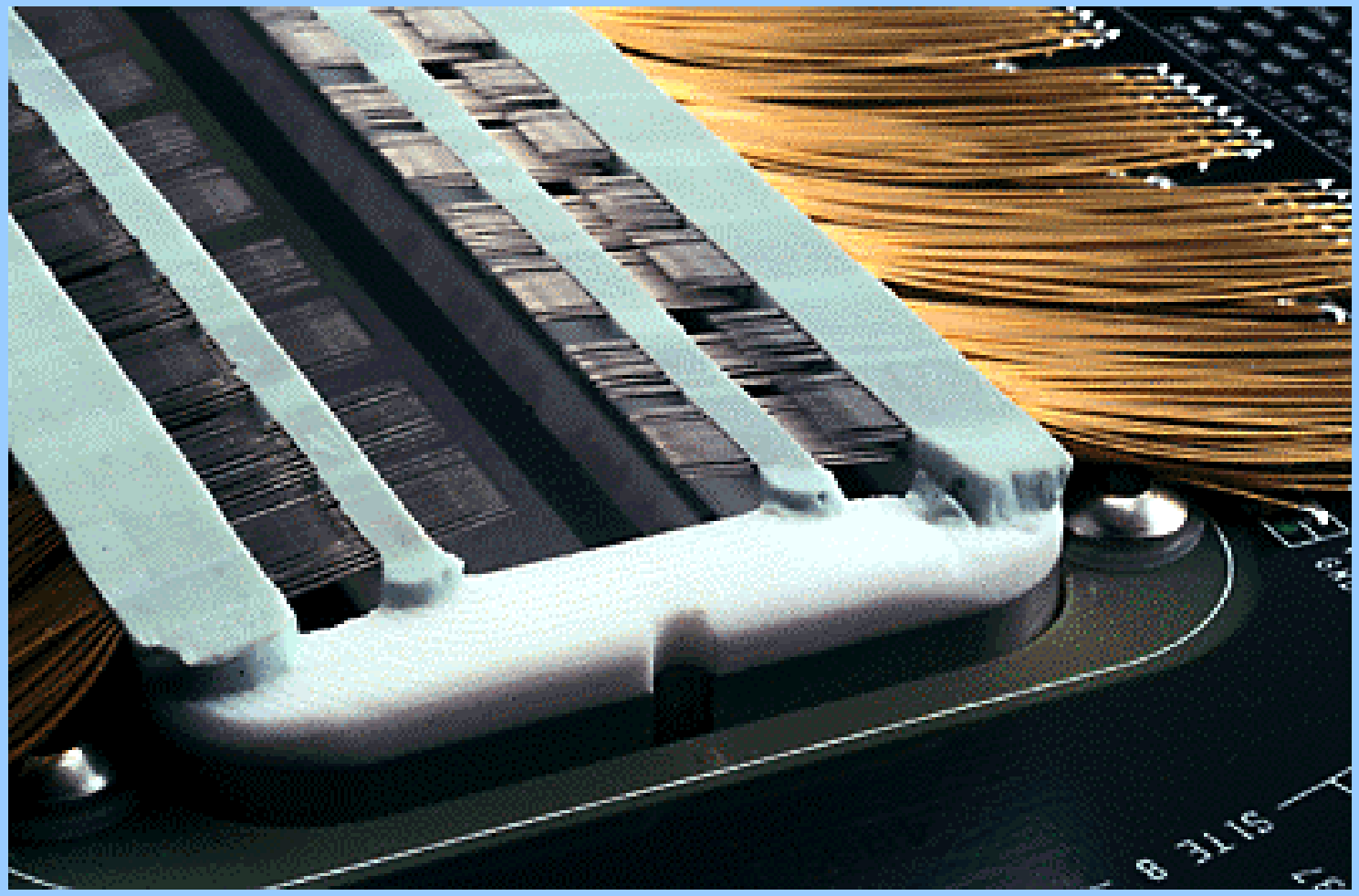
# Finished Probe Card



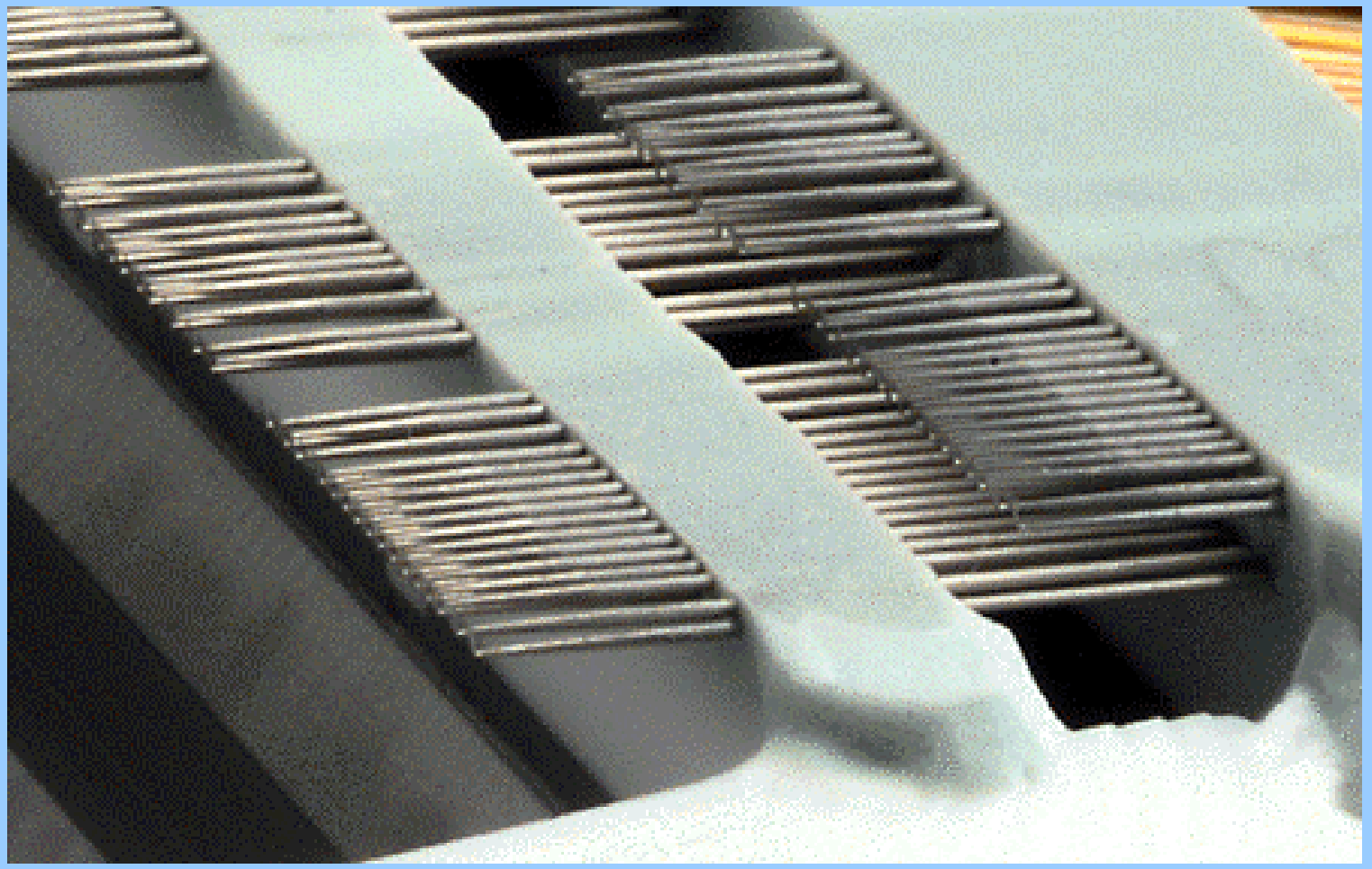
# Multi-dut Probe Card



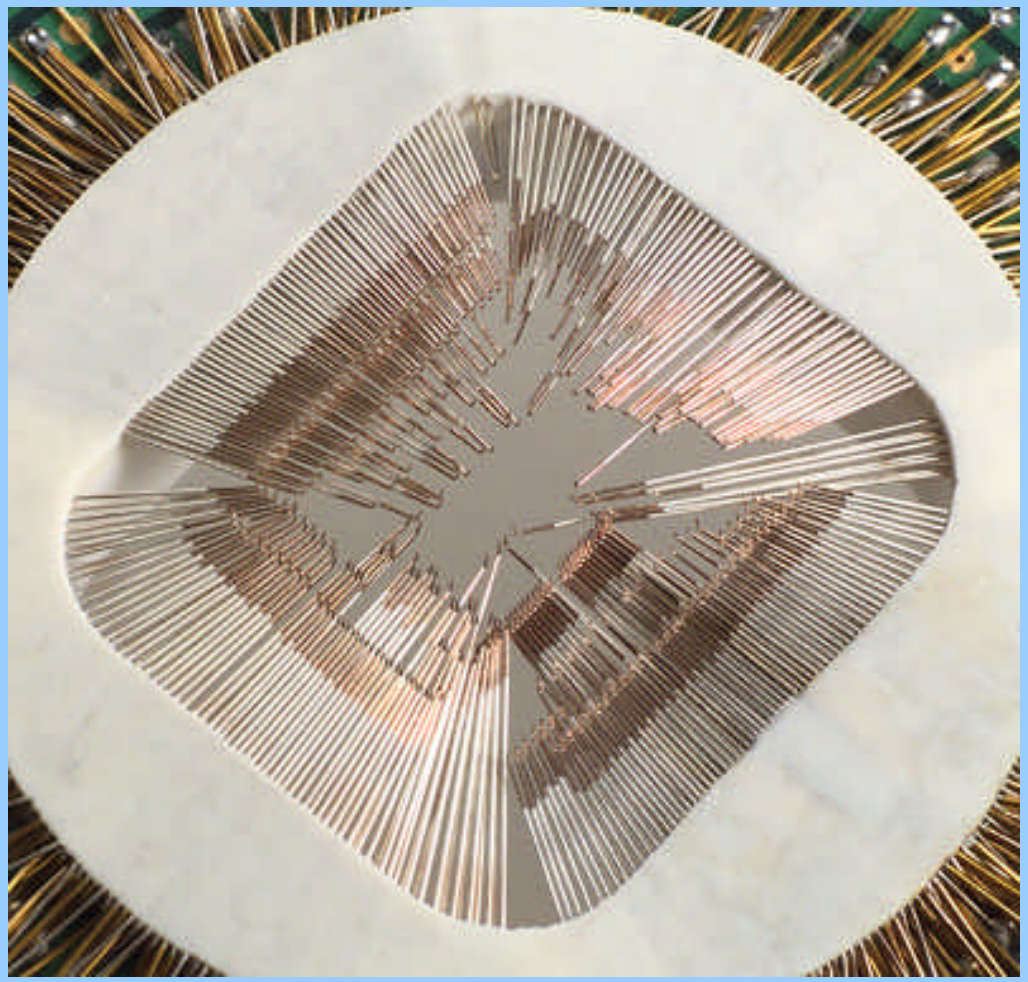
# Multi-dut Probe Card



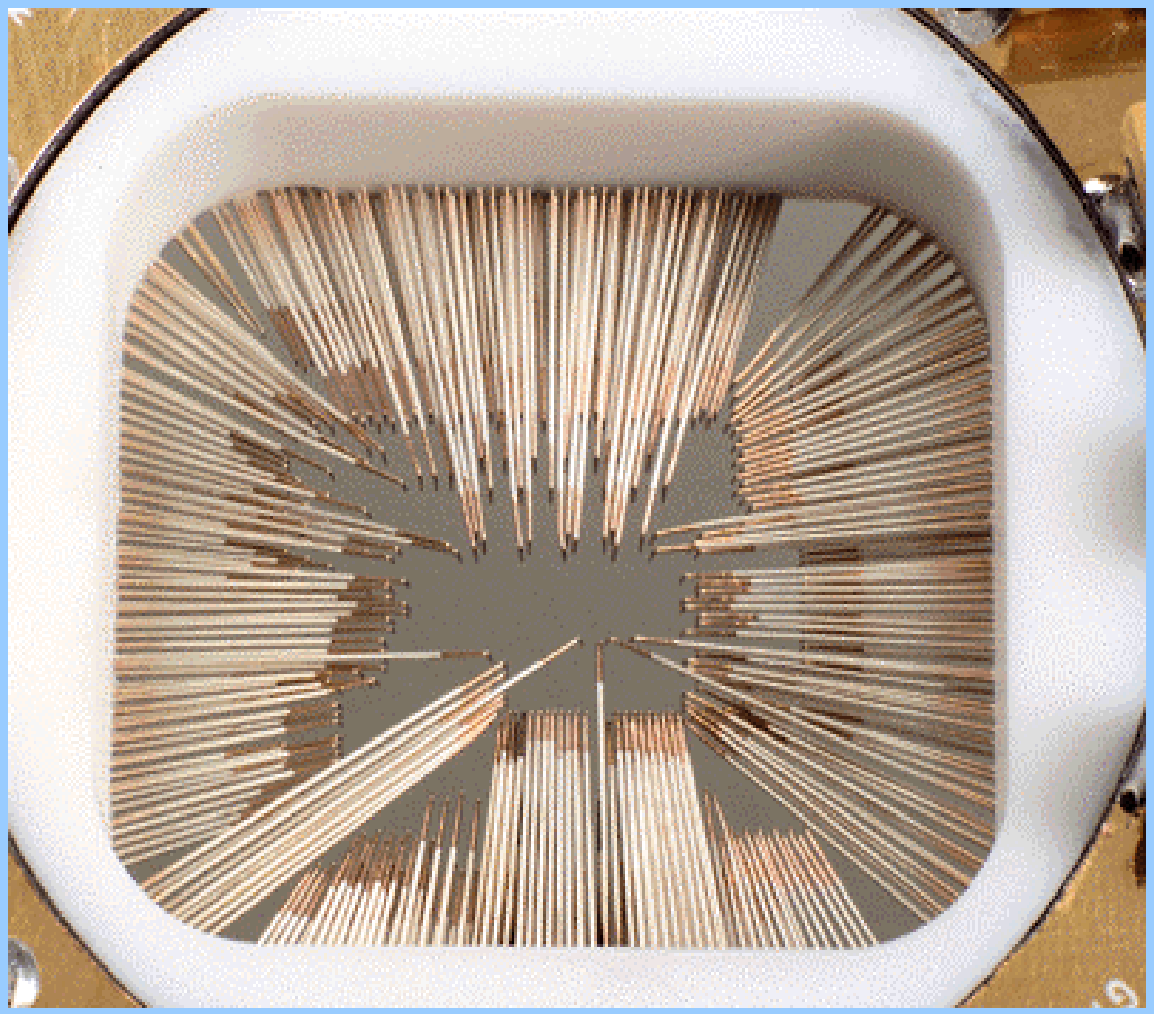
# Multiple Probe Layers



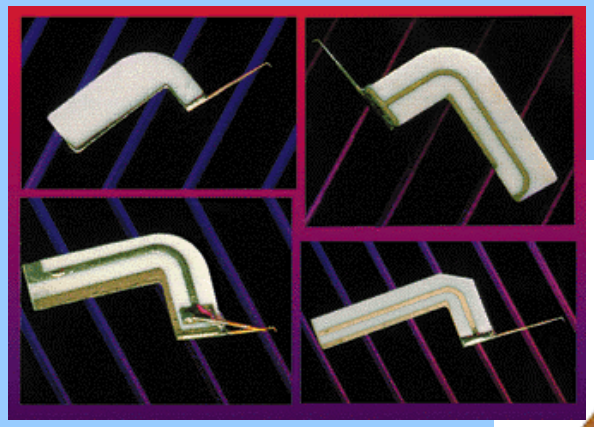
# Cantilever Area Array

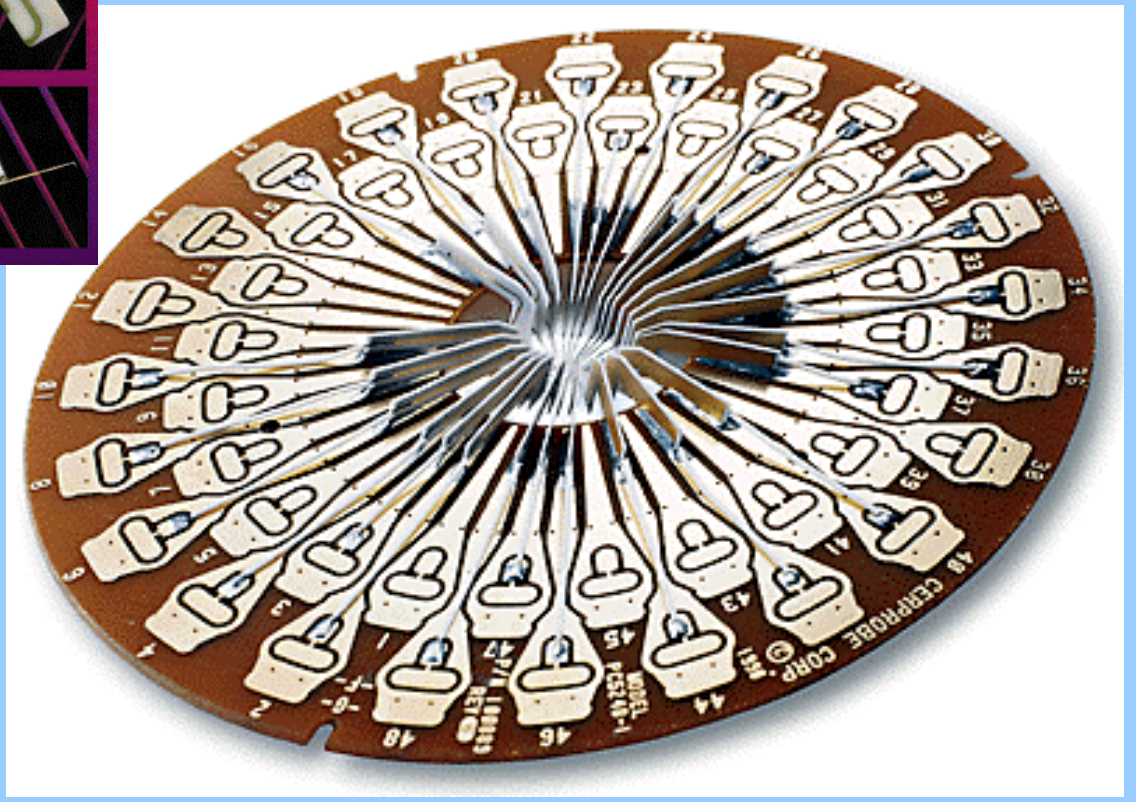


# Area Array (top)

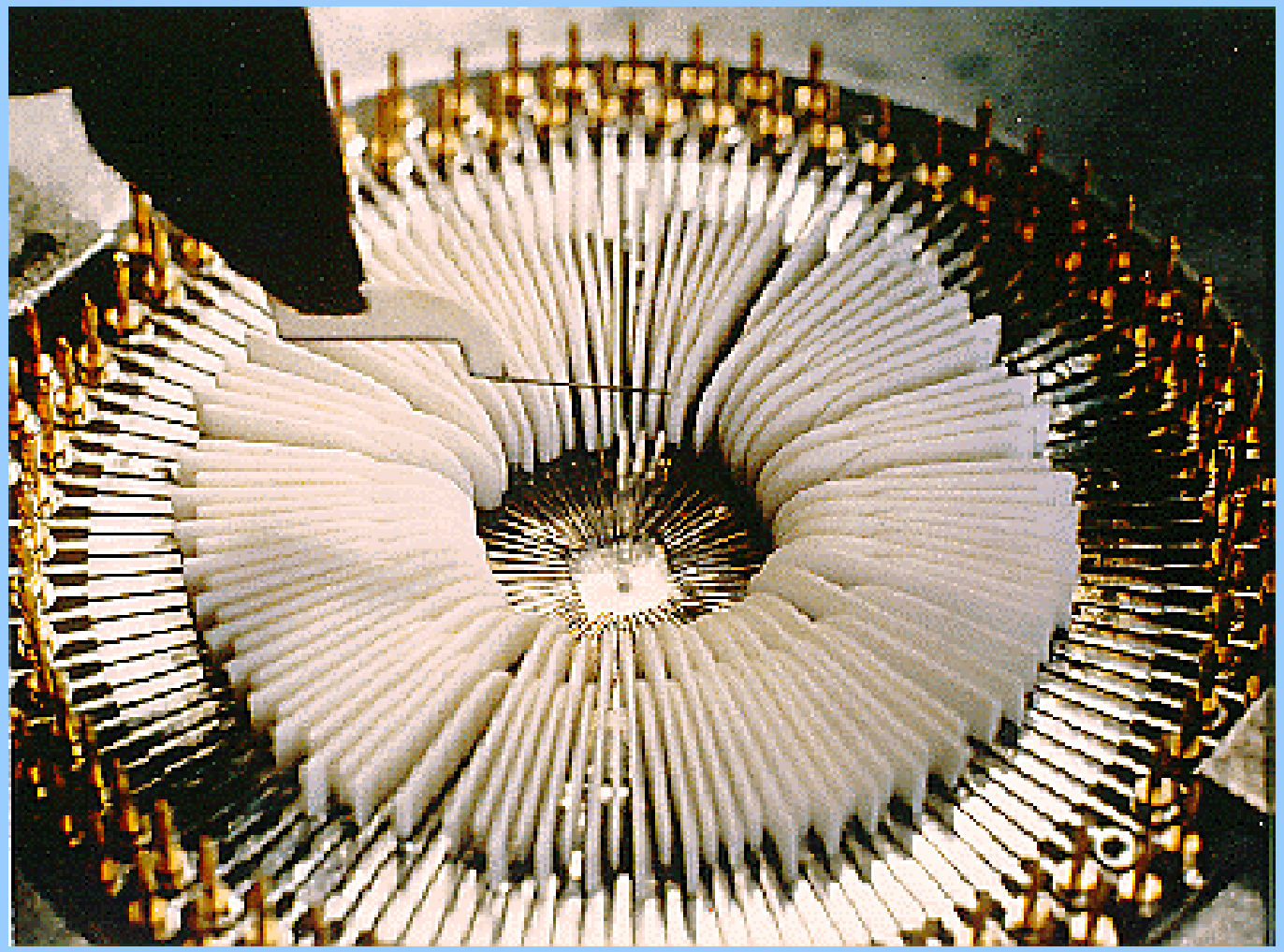


# Ceramic Blade Probe Card





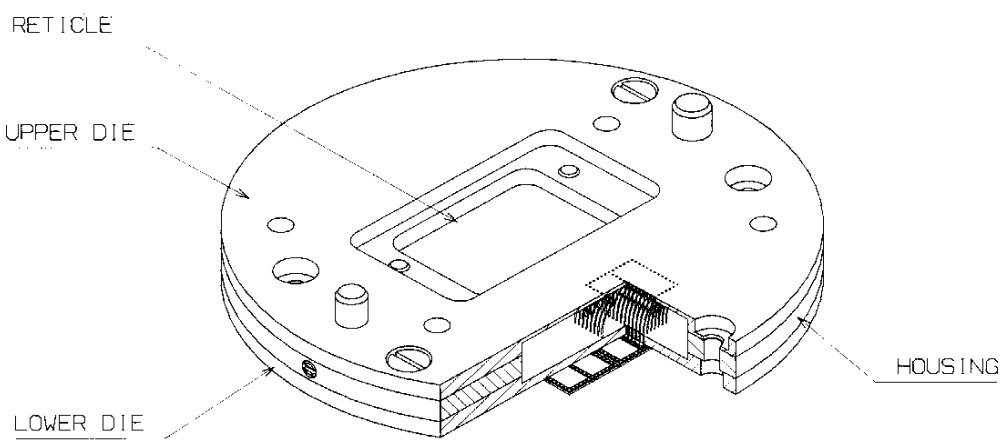
# Building a Blade Card



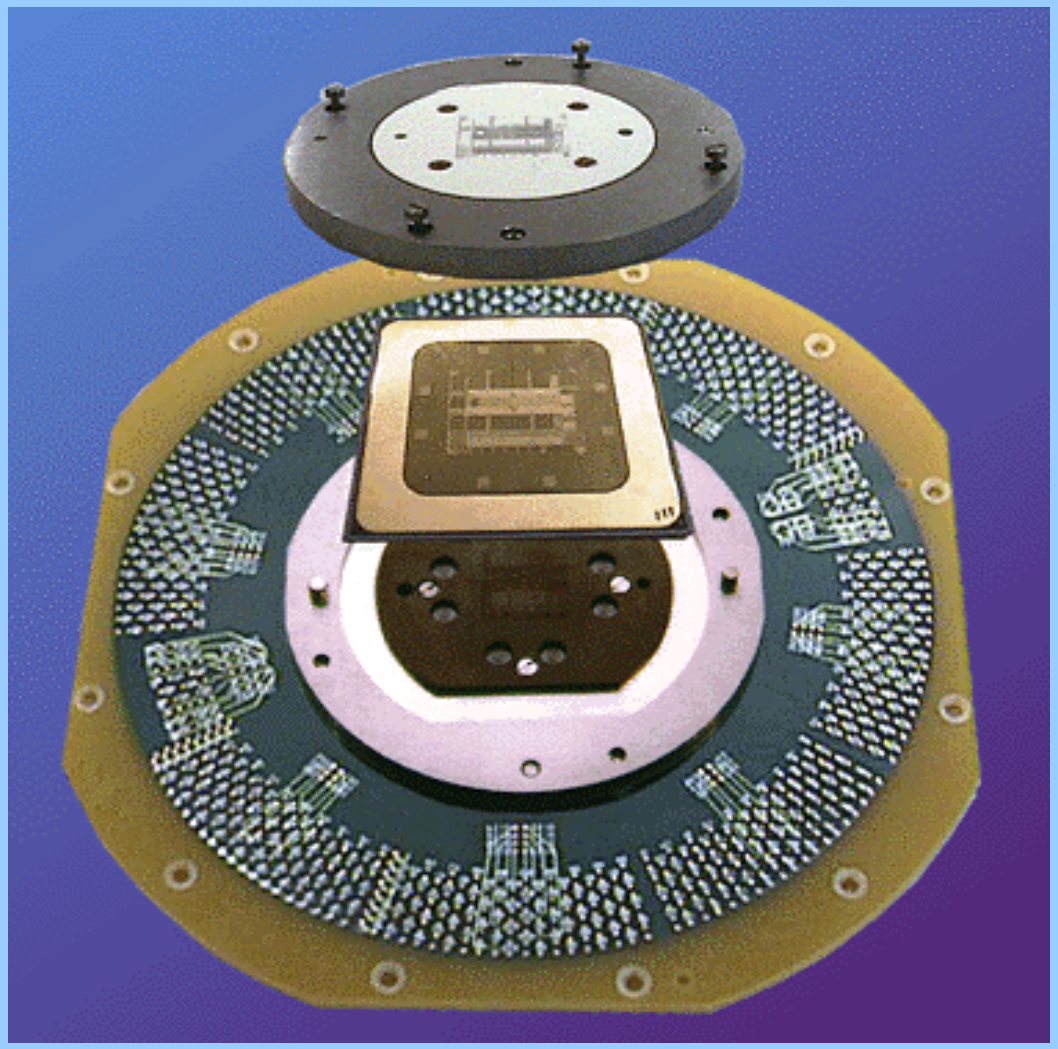
# Cobra Probe Card

# COBRA PROBE

PROBE HEAD CONCEPT

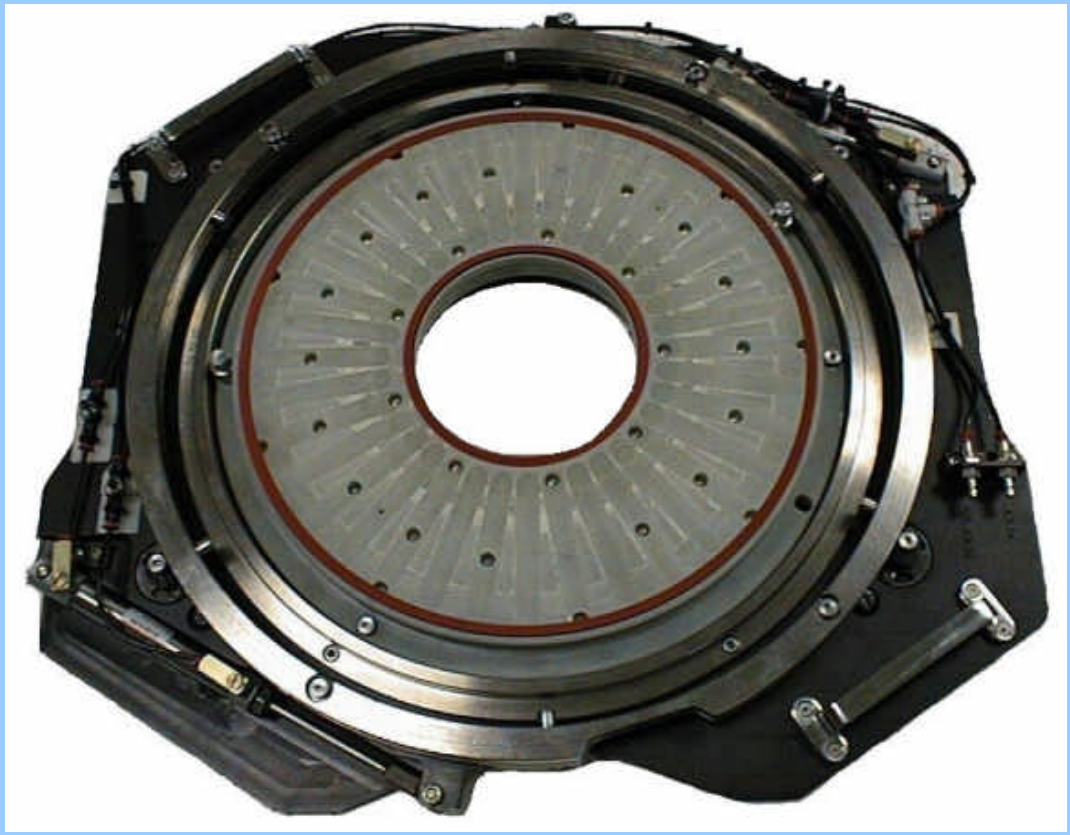


# Cobra probe card



# PB3000 PROBE CARD ANALYZER

# PROBILT PB3000 MOTHERBOARD



# PURPOSE OF TESTING

- SCREEN TO SPECIFICATION LIMITS
- ESTABLISH SPC
- ESTABLISH LIFETIME GUIDELINES
- ESTABLISH REPAIR CYCLES
- IDENTIFY POTENTIAL PROBLEMS
- IDENTIFY POTENTIAL IMPROVEMENTS

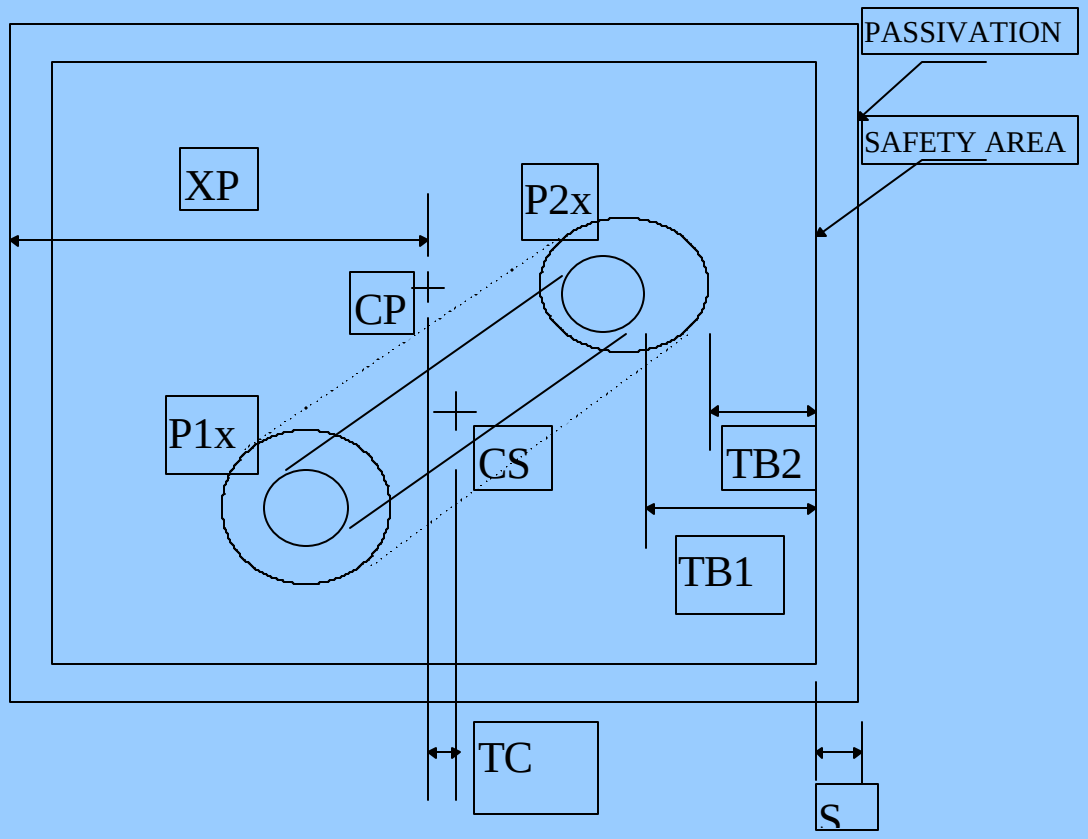
# TEST PARAMETERS

| | | |
|---|---|---|
| ALIGNMENT | TIP DIAMETER | PLANARITY |
| | GRAM FORCE | CONTACT RESISTANCE |
| EXTERNAL CAPACITOR | EXTERNAL RESISTOR | LEAKAGE CURRENT |

# ALIGNMENT & TIP DIAMETER

- INSURE PAD CONTACT
- INSURE NO PASSIVATION DAMAGE
- ALLOW MAX. SET-UP TOLERANCE
- AGING MONITOR
- LIMIT FORCE/UNIT AREA

# ALIGNMENT TO PAD



# TIP DIAMETER

- LIFETIME INDICATOR
- “TRUE POSITION” TOLERANCING ELIMINATES NEED FOR MAXIMUM LIMIT, EXCEPT FOR EOL
- FORCE / UNIT AREA

# PLANARIZATION

- INSURE GOOD CONTACT
- LIMIT SCRUB LENGTH (BENDING BEAMS)
- CONTROL SCRUB DEPTH
- LIMIT TIP FORCE

# CONTACT RESISTANCE

- LIMIT $R_{MAX}$ FOR DC PATHS
- LIMIT SWITCHING TIME CONSTANTS
- CHECK FOR CONTAMINATION
- CHECK PATH RESISTANCE
- CR (W) TYP - 300 to 500 mOHMS
- CR (BeCu) TYP - 100 TO 300 mOHMS

# LEAKAGE CURRENT

- ADDS TO CIRCUIT LEAKAGE
- DETECTION OF SHORTS
- AFFECTS SWITCHING TIMES
- GENERAL CONTAMINATION DETECTION

# CONTACT FORCE

- CONTACT RESISTANCE
- SCRUB DEPTH CONTROL
- FORCE PER UNIT AREA
- GENERAL QUALITY CONTROL
- AGING MONITOR
- PROBE GEOMETRY MONITOR
- PROBE RETENTION MONITOR

# COMPONENTS

- VERIFY PRESENCE/ABSENCE
- VERIFY COMPONENT VALUE
- DETECT AGING
- DETECT OTHER CHANGES

# PROBER
# OVERDRIVE REFERENCE

- FIRST CONTACT
- EDGE SENSOR
- PROFILER
- VISUAL

# *Wafer Probe*

## *Equipment*

- *Prober*
- *Test System*
- *Interface*
- *Probe Card*
- *Wafer Handling*

## *Product*

- *Metalized Wafers*

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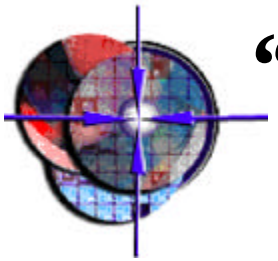

# *"Probing":Checking for the Good & Bad*

## *In-Process (Parametric Testing):*

- When wafers are being built
- Checking for possible problems

## *At the End (Etest, Sorting):*

- When wafers are done
- Etest checks test patterns
  - Process Parameters
- Sort identifies good/bad parts
  - Functional Test
  - Parametric Test
  - Clock Speed, Temperature, etc.

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# Probe Cards

PROBE CARDS

## Shapes

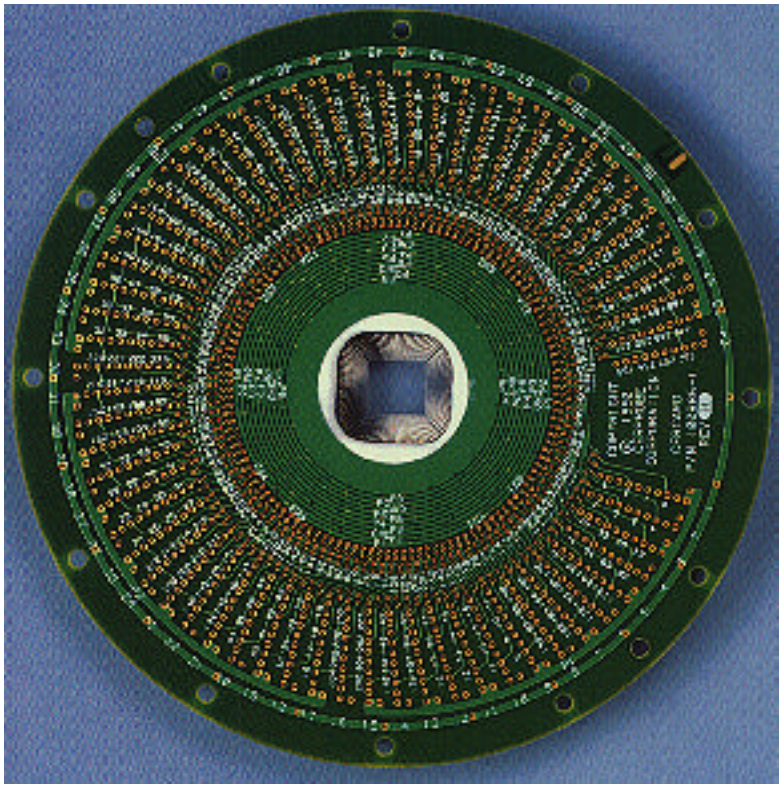
- Square to Round

## Sizes

- 4” to 16”

## Probe Tips

- Various Metalurgy, Types and Sizes



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# Probe Tips

PROBE CARDS

## Types

- Cantilever
- Vertical
- Membrane

## Size

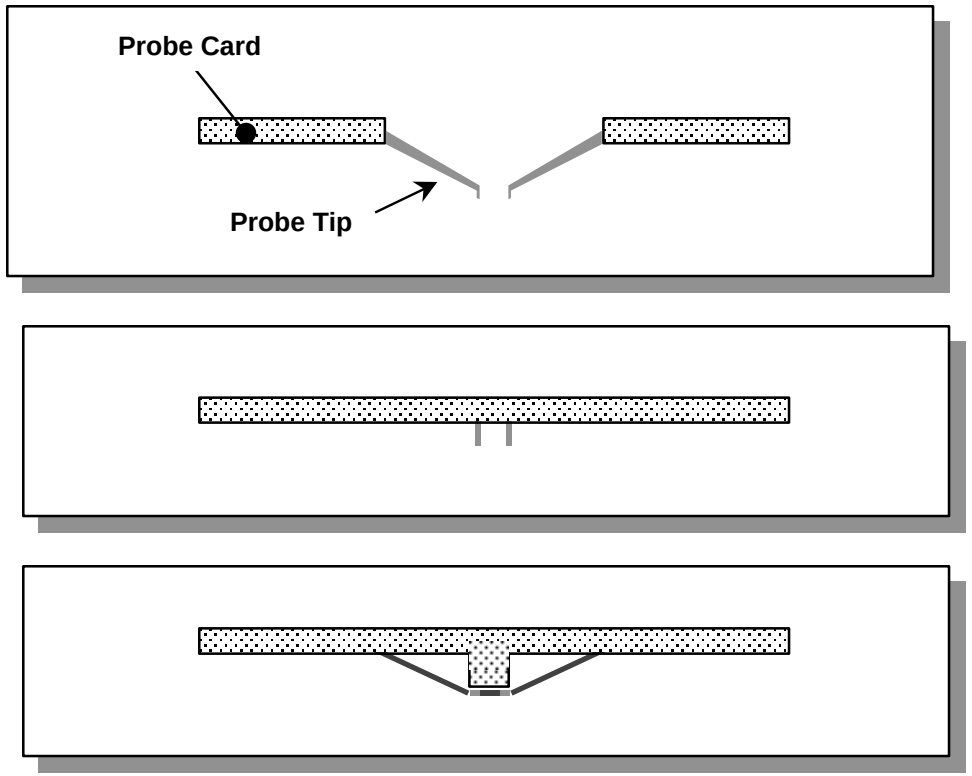
- .8 to 4 mils

## Quantity

- 10 to 2000

## Materials

- Tungsten
- WR
- Paliney
- BeCu

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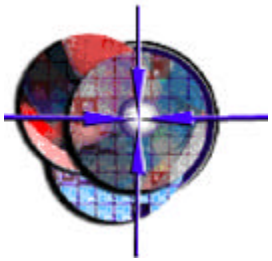

# Wafer Contact Point

## Chips may have Different Contact Points

- Al pads
- Au pads
- Solder bumps
- Tabs or Tape

## Critical Parameters

- Alignment
- Contact Resistance
- Pad Damage

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# Probe Technology Selection

## Dependent on Contact Point Technology

## Cantilever Beam Probes

- Peripheral Pads
- Al or Au Pads
- Solder Bumps (Limited)
- Tabs or Tape

## Vertical (Cobra)

- Array Patterns
- Solder Bumps (Flat Tips)
- Al or Au Pads (Pointed Tips)

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# *Pretty Close !!!*

PROBE CARDS

**Q: How close do we need to put the probe in the pad?**

*A: Within +/- 10 microns in x and y directions*

**Q: How small is a micron?**

*A: If an inch was football field, a micron would be a blade of grass.*

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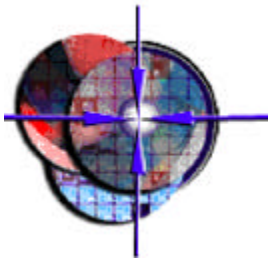

# *Types of Testers*

## *Configured for Specific Technology*

- ***Memory, uProcessor, Linear, etc.***
- ***Clock Speeds >100 MHz***
- ***Rise Times <250 pS***
- ***Parallel Testing of Memory Devices (8-32 Chips)***
- ***Every Interface is Different - NO STANDARDS!***

## *Test Head Configurations*

- ***Direct Dock***
- ***Cabled***

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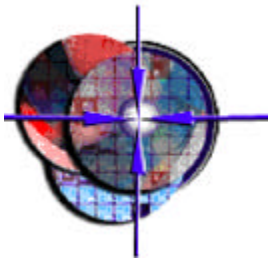

# Test Head Docking

## Cabled Interface

- Drive/Sense Electronics in Tester Mainframe
- Cables (COAX or Shielded Linear) to pogos
- Test Interface is only pogo pins to Probe Card
- Slower (Clock Rate) than Direct Docking

## Direct Docking

- Drive/Sense Electronics in Test Head
- Test Head sits Directly on the Interface
- Soft or Hard Docking - Force/Weight
- Highest Speeds Available

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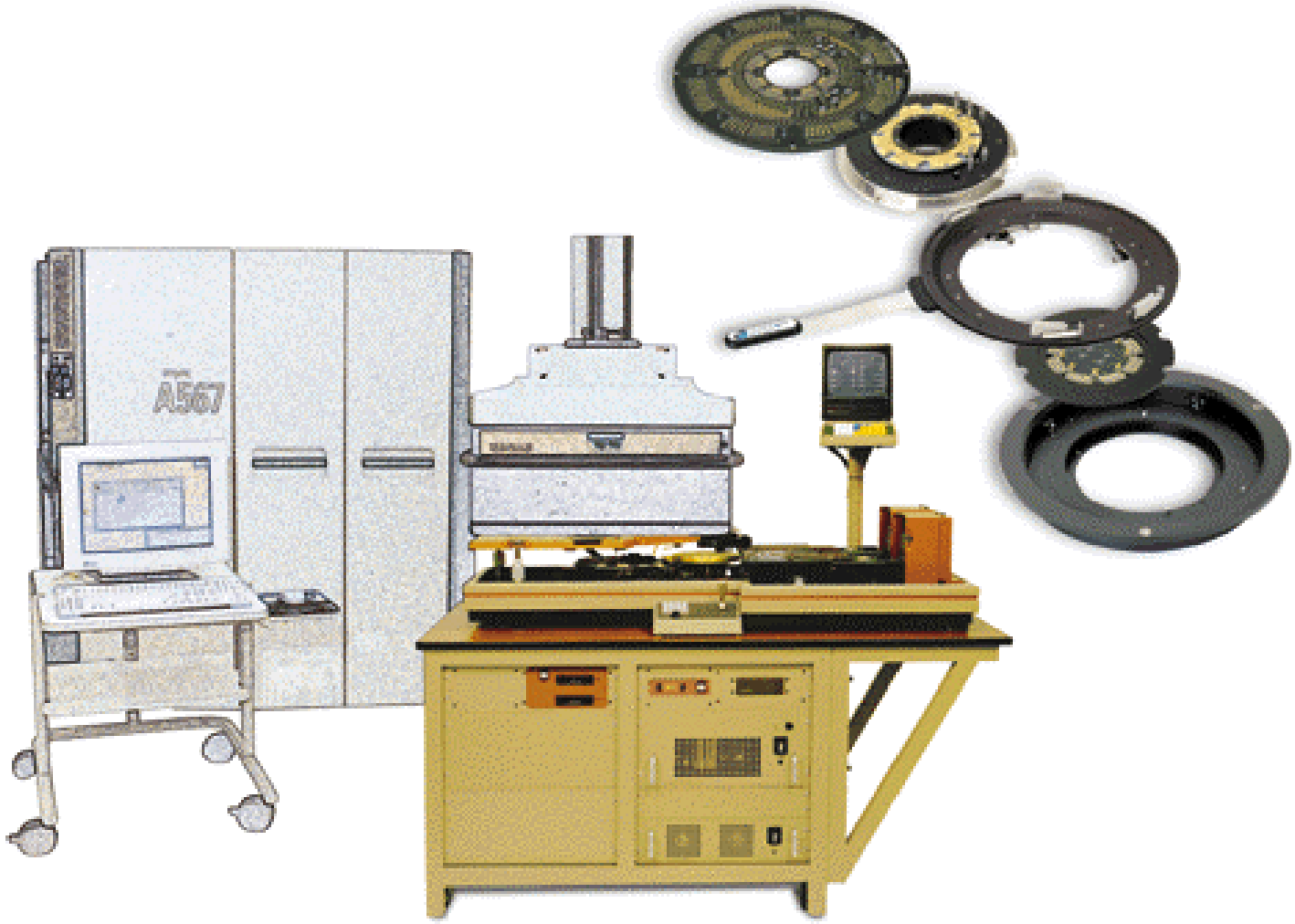
# *Direct Docking to Tester (Courtesy Cerprobe Corporation)*



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# Wafer Handling

## Loading may be Manual or Automatic

## Manual Loading

- Use Tweezer or Vacuum Wand
- Possible Damage or Breakage
- Cleanliness (Particles, Contamination)
- Very Slow

## Automatic Loading

- Cassette Wafer Holders
- One or Multiple Cassettes
- Wafer Automatically Transferred to Chuck
- Faster, Cleaner, Safer

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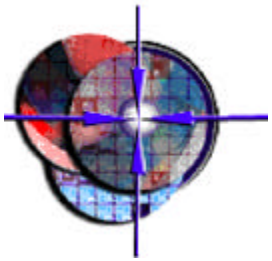

# Wafer Alignment (1)

## Align Probe Tips to Pads

- X,Y Position
- Theta (Rotation)
- Overdrive (Z Axis)

## Manual Alignment

- Rotate Chuck/Wafer to be on Prober X,Y Axes
- Rotate Probe Card (if required)
- Position Probe Tips to Touch Down on Pads
- Set Overdrive to 1.0 to 4.0 mils (Type Dependent)

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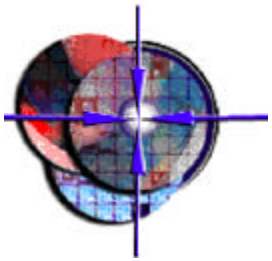

# *Wafer Alignment (2)*

## *Automatic Alignment*

***Prober Aligns Wafer Using Targets***

***Probe Card Theta not Usually Required***

***Wafer Loader Aligns Wafer from Cassette***

***Upward Looking Camera to see Probe Tips***

***Downward Looking Camera to see Pads***

***Can Readjust Alignment During Probing***

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