

Introduction to Probe Cards

How They are Built & Tested

PROBE CARDS & PROCESS COURTESY OF CERPROBE

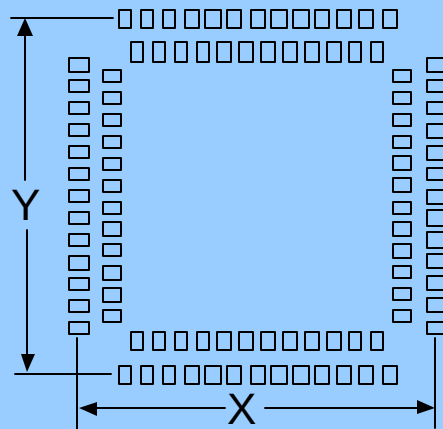


Design & Layout

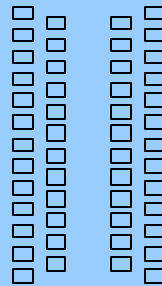


DIE PAD CONFIGURATIONS

≤ 500 mils on each side



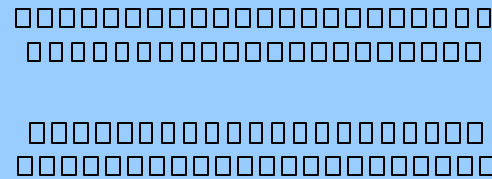
(1a)



(1b)

These configurations typically use standard rings

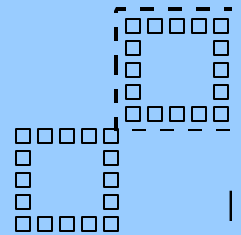
> 500 mils on any side



(1c)

These configurations typically require semicustom or custom rings

Multi-D



(1d)

Figure 1: Die and Ring Configuration Examples

BONDING PADS

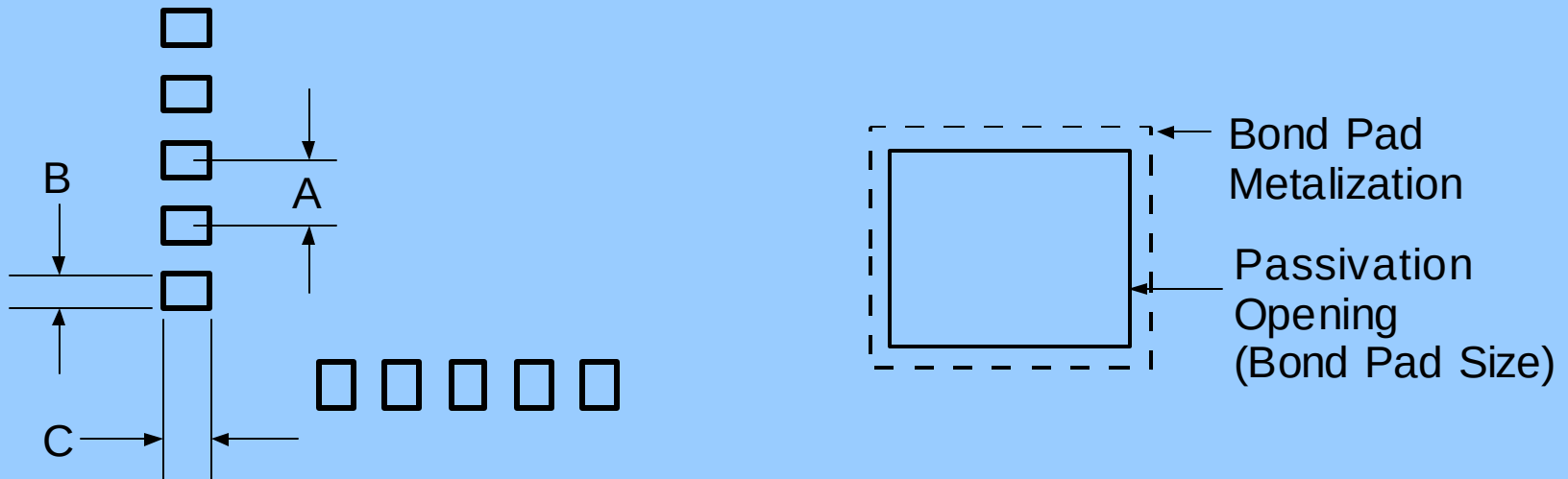


Figure 2: Bond Pad Pitch and Size

CROSS SECTION, CANTILEVER BEAM

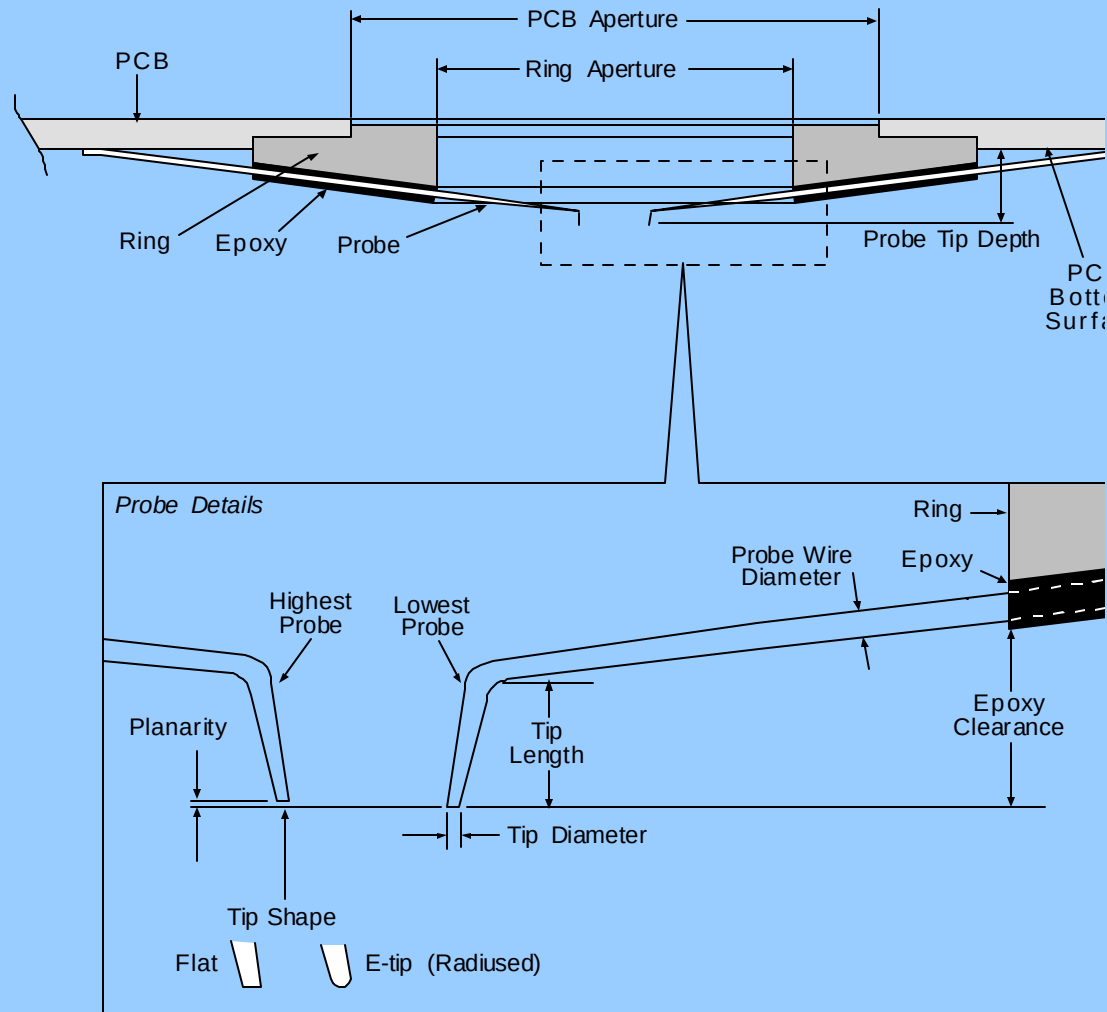
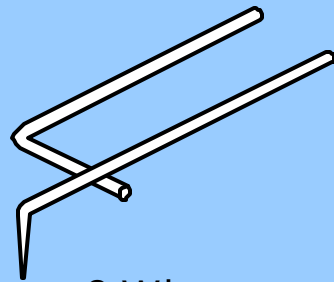
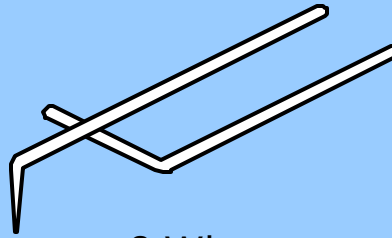


Figure 3: PCB and Epoxy Ring Assembly

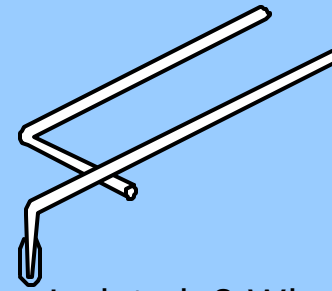
EDGE SENSOR TYPES



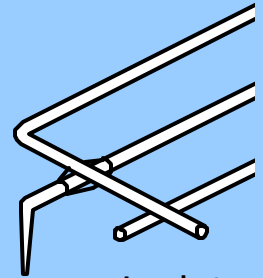
2-Wire
Left-Hand E/S



2-Wire
Right-Hand E/S



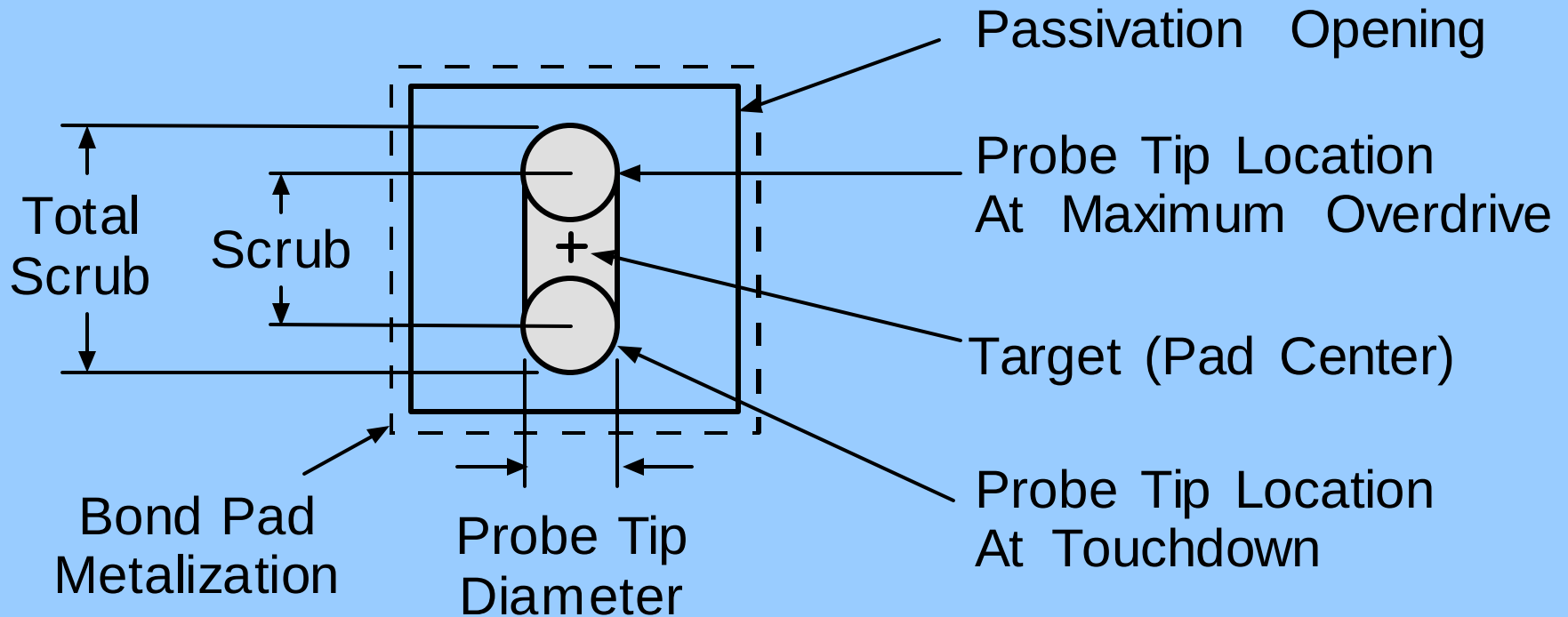
Isolated 2-Wire
Left-Hand E/S



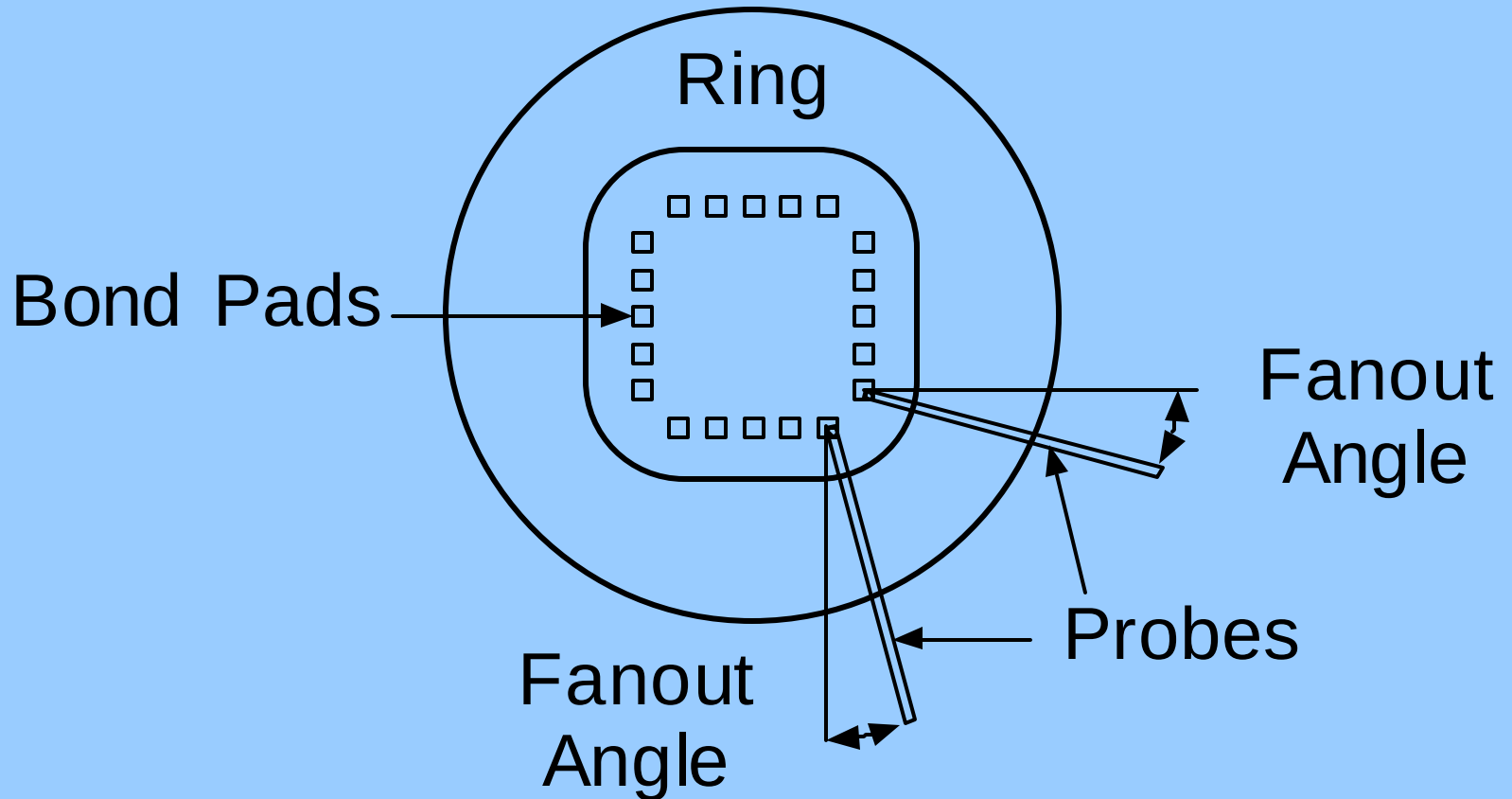
Isolated
3-Wire E

Figure 4: Edge Sensors

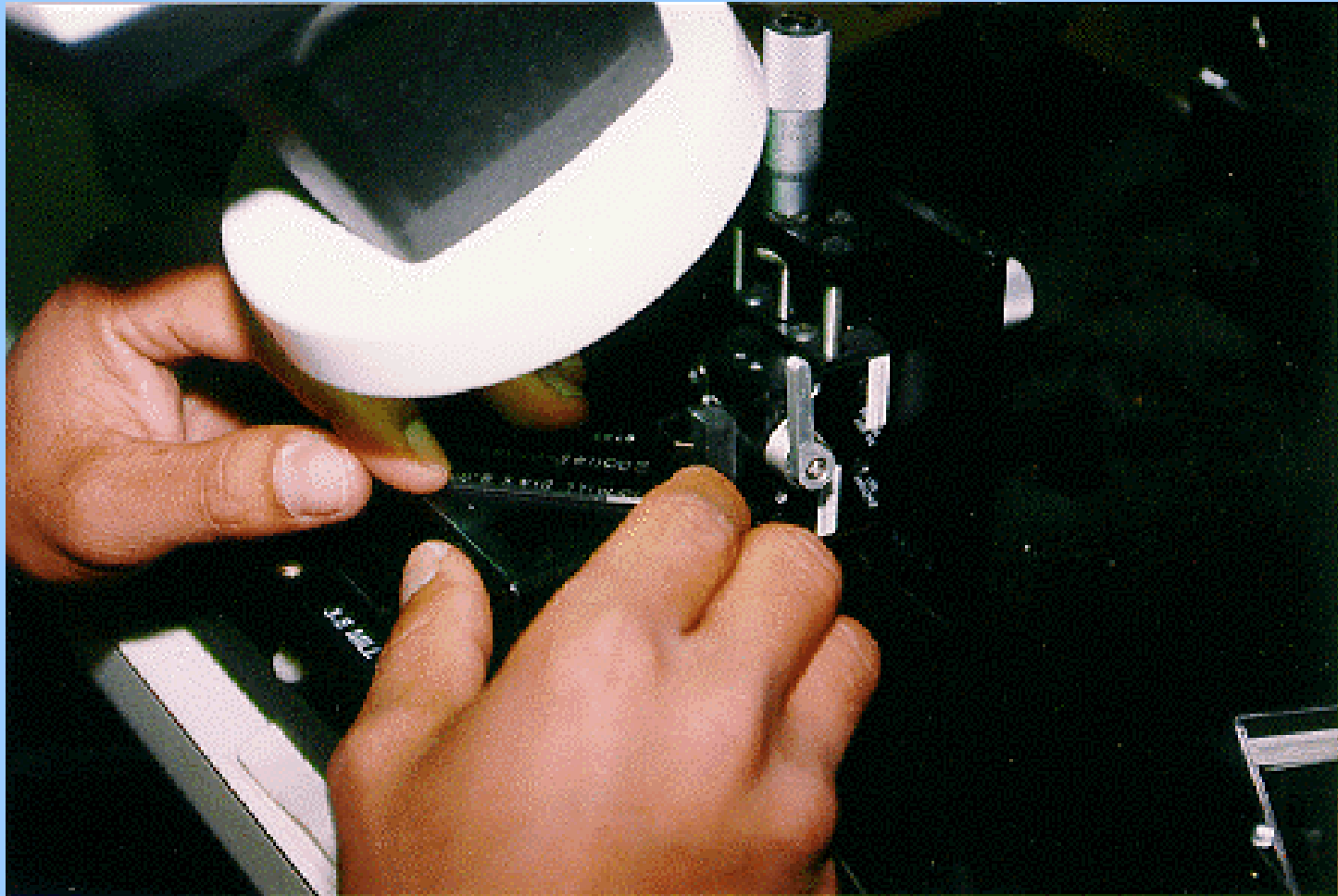
PROBE TO PAD POSITIONING



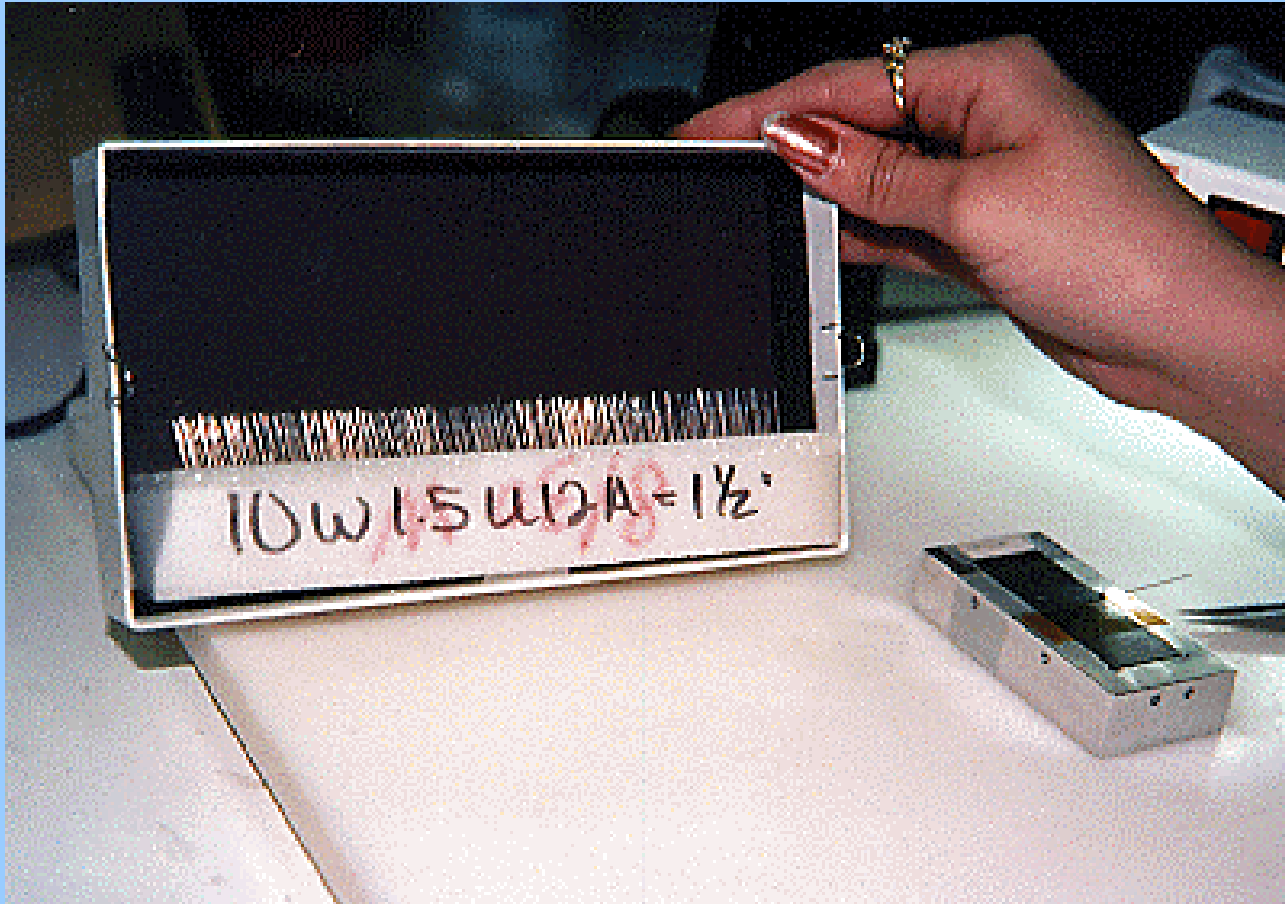
PROBE FANOUT ANGLE



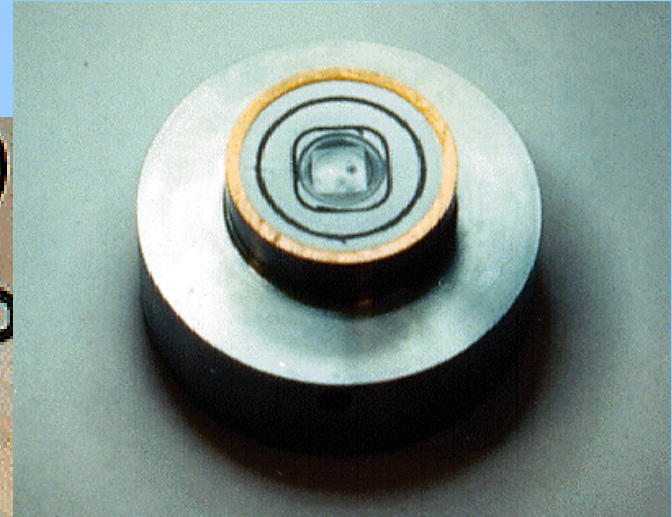
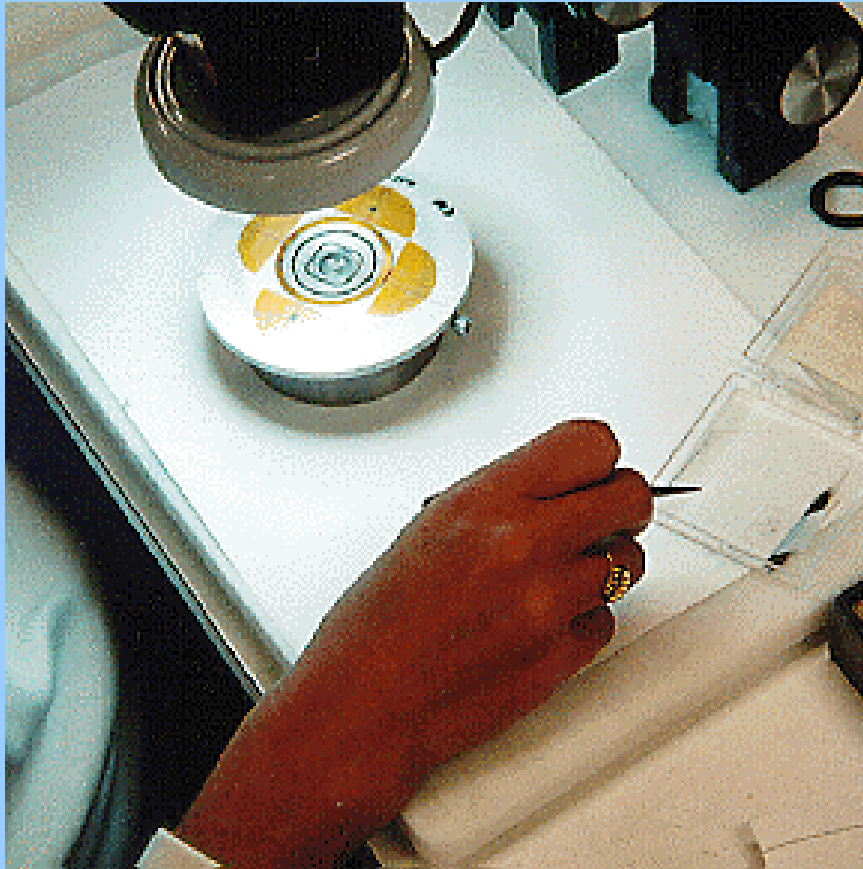
Wire Bend



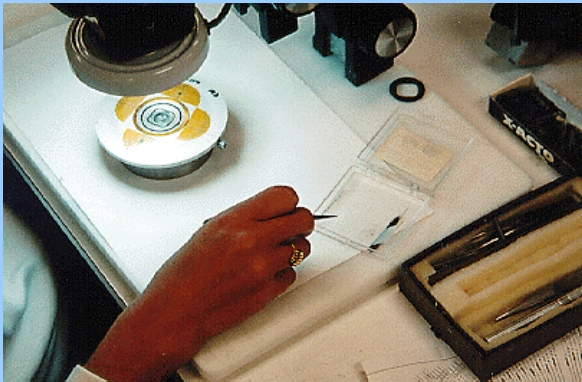
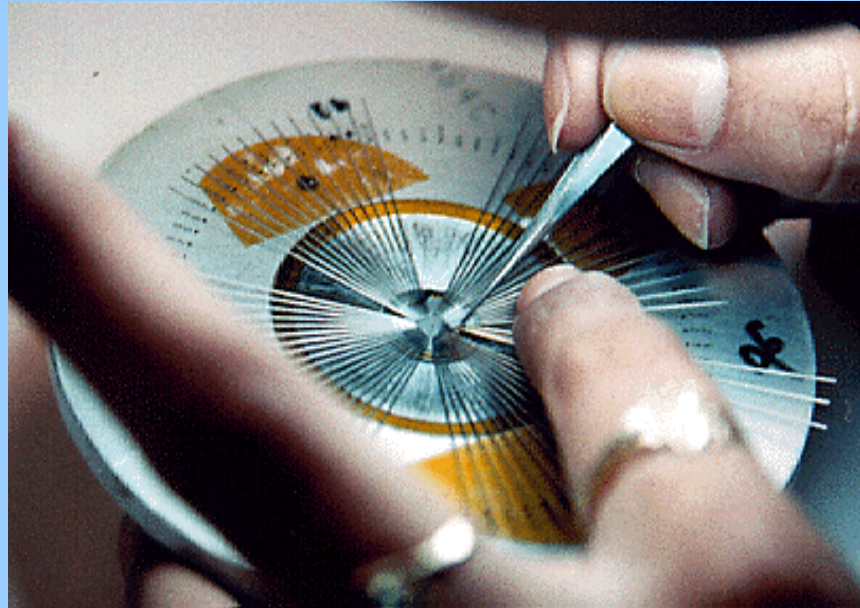
Wire Bend - Replacement Probes



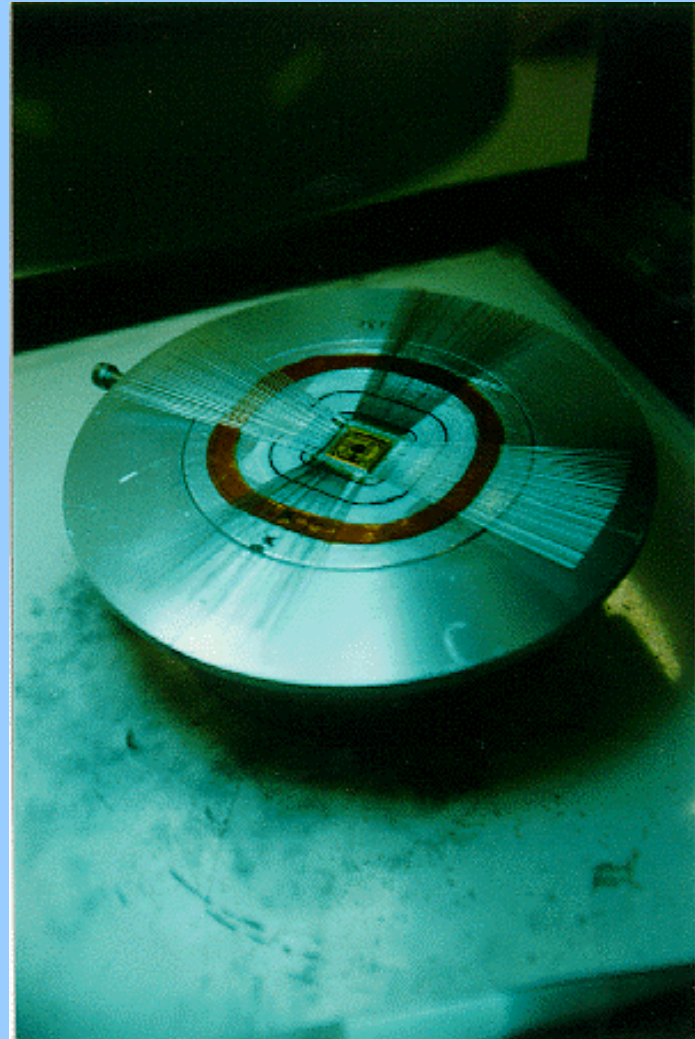
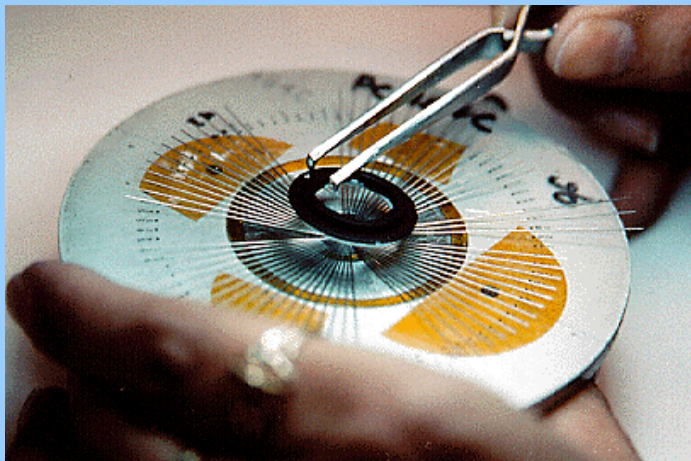
Ring Build & Fixture



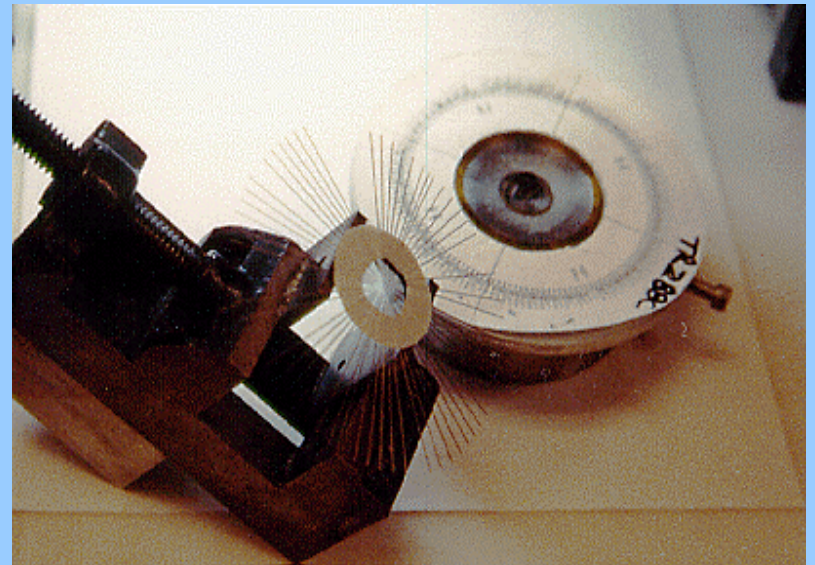
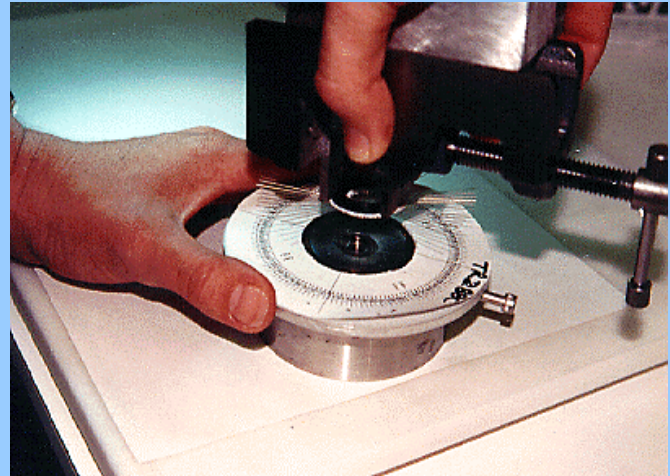
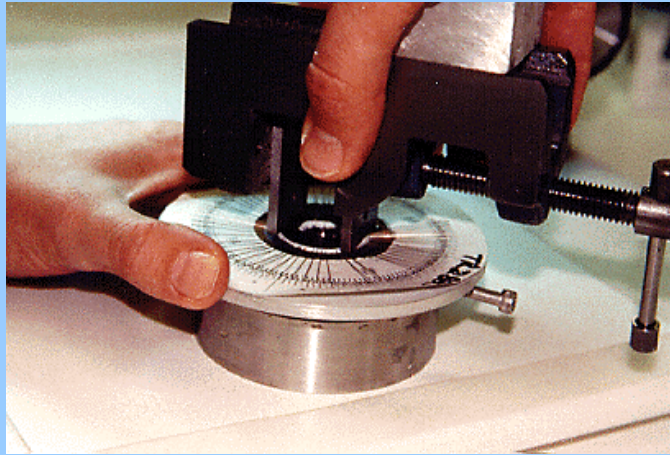
Ring Assembly



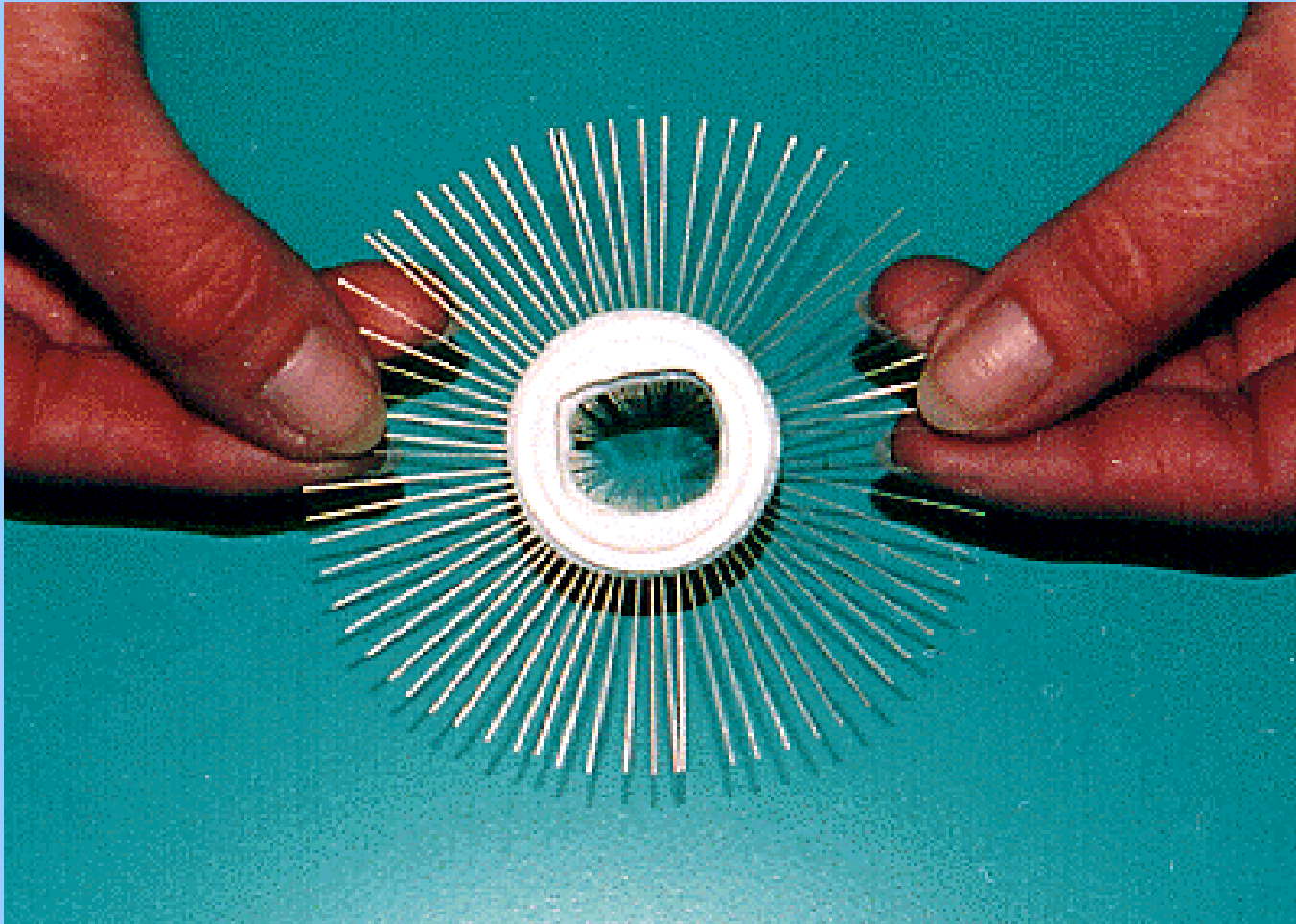
Ring Assembly



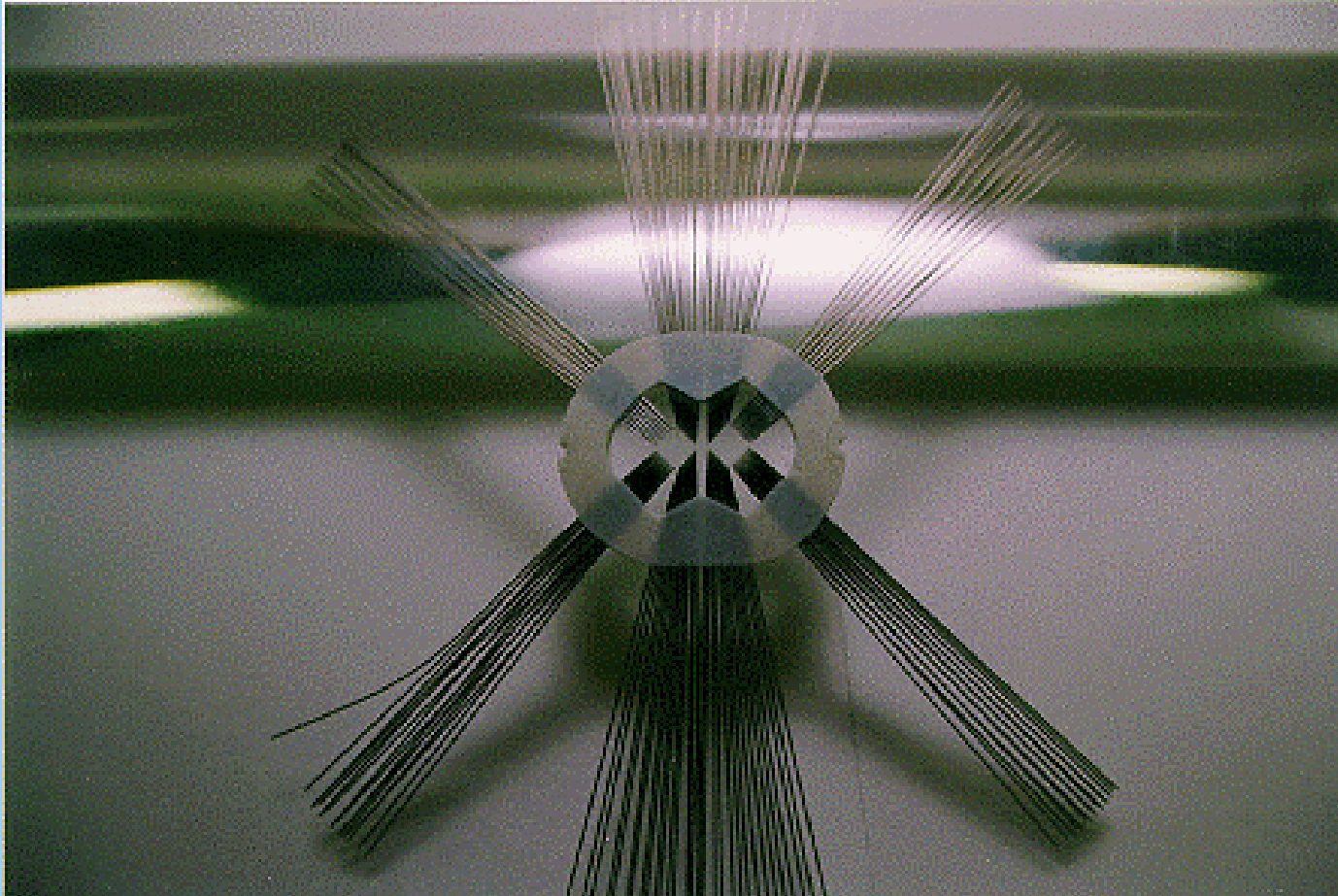
Ring Removal



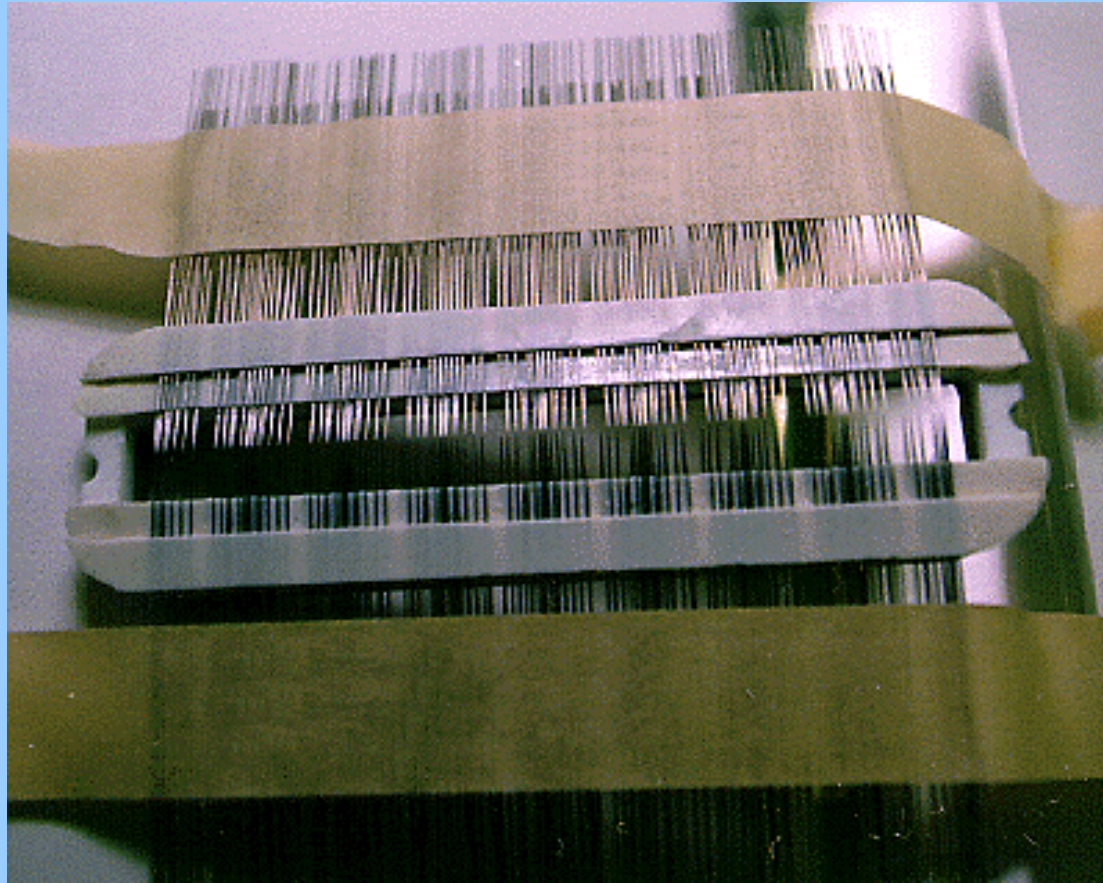
COMPLETED PROBE RING



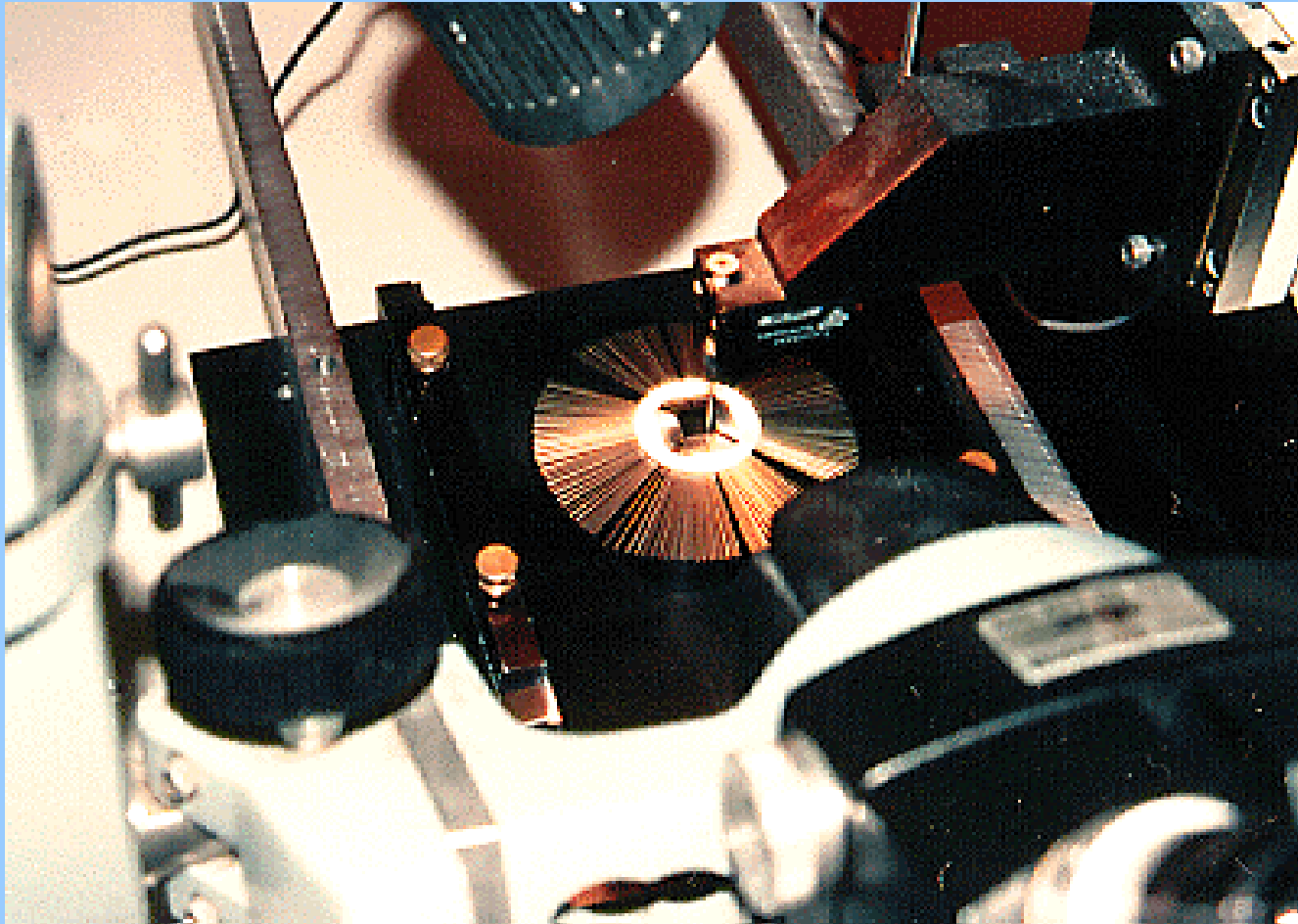
Completed Probe Ring



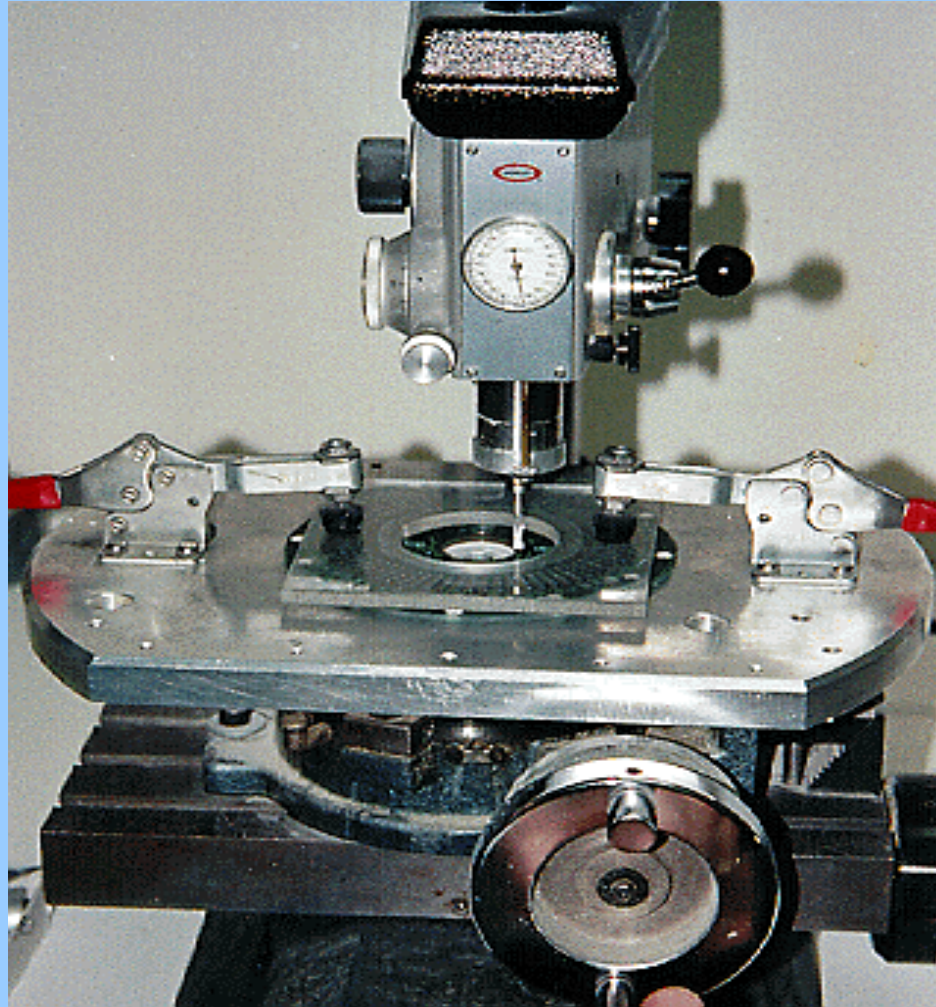
Multi Layer Ceramic Ring



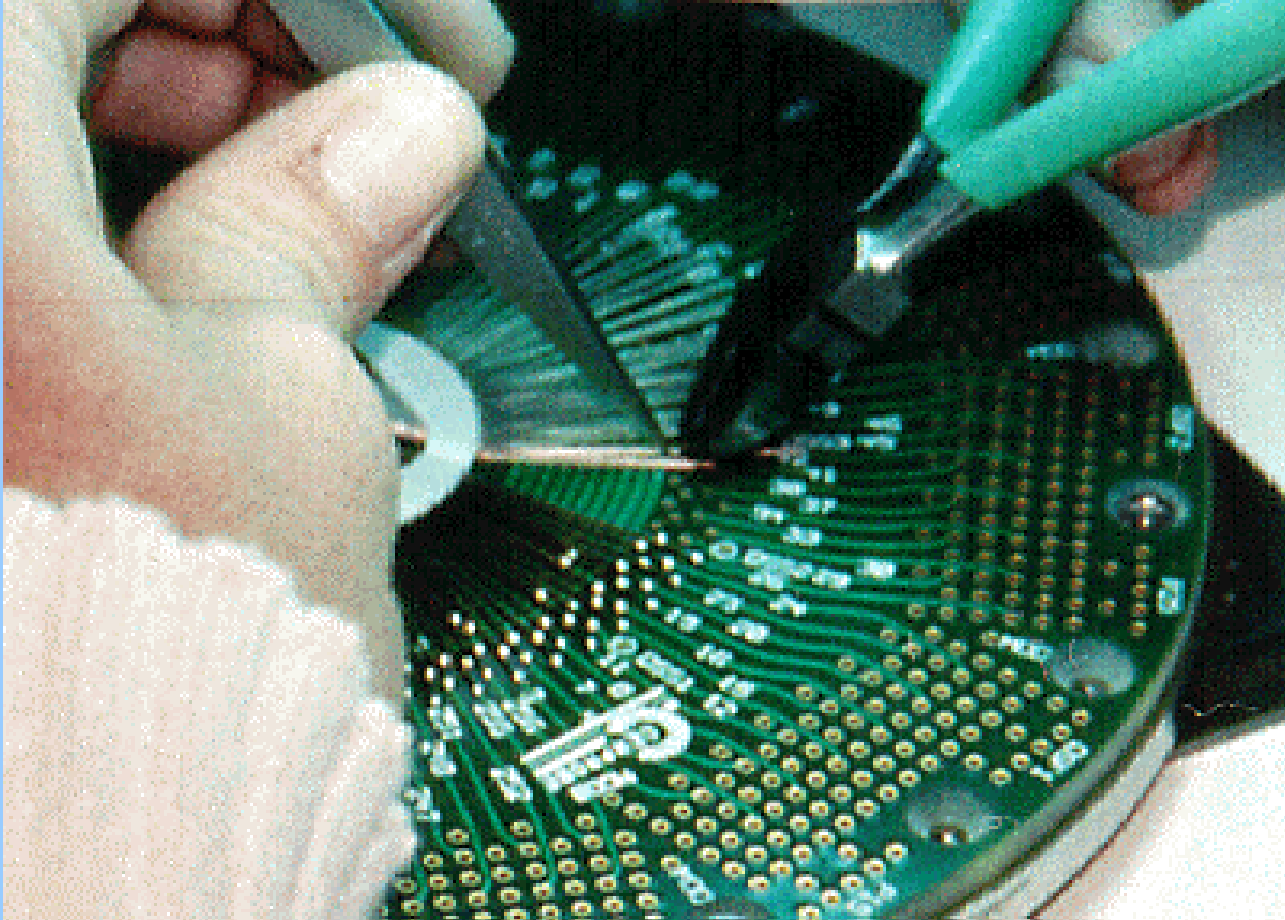
Measuring Contact Force



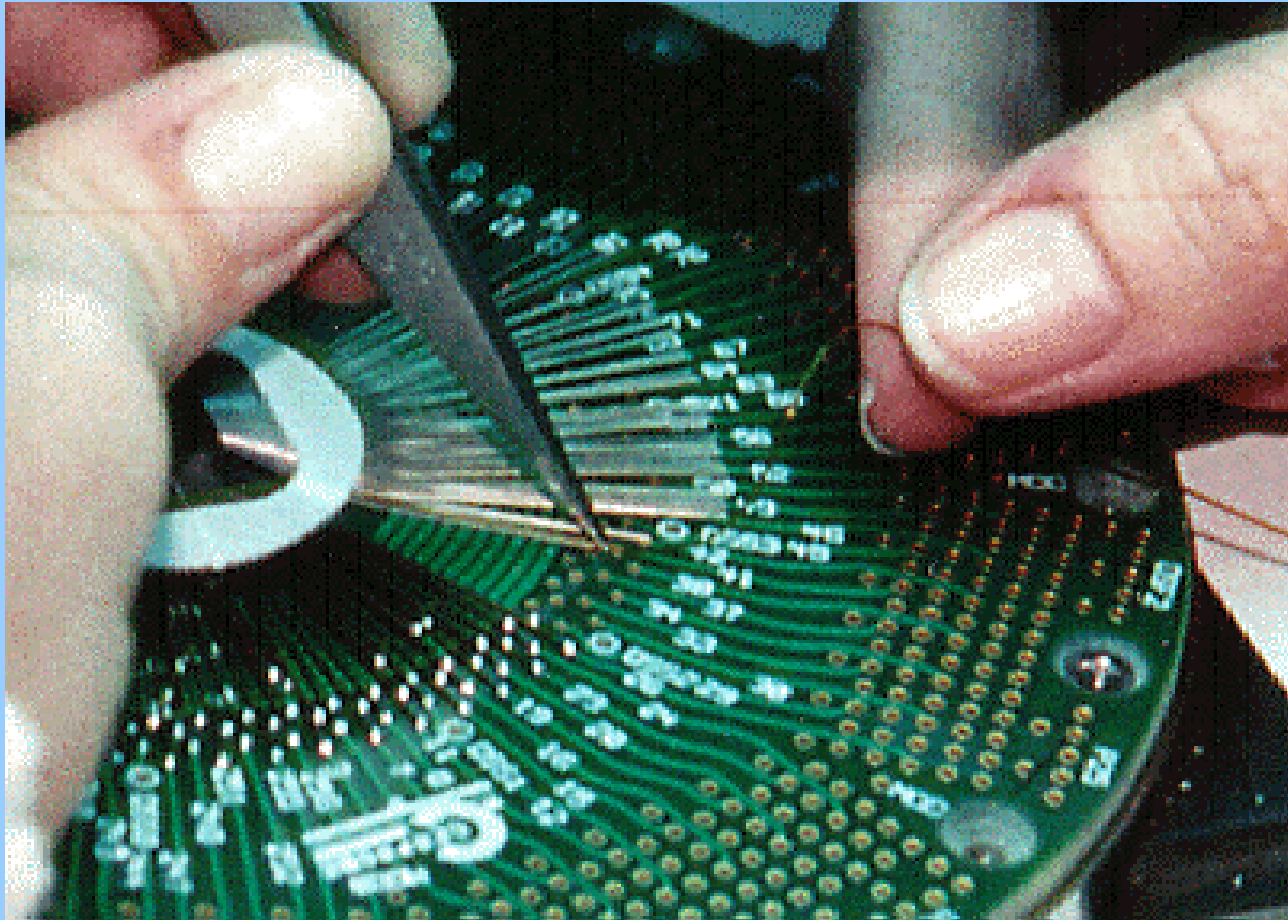
PCB Counterbore



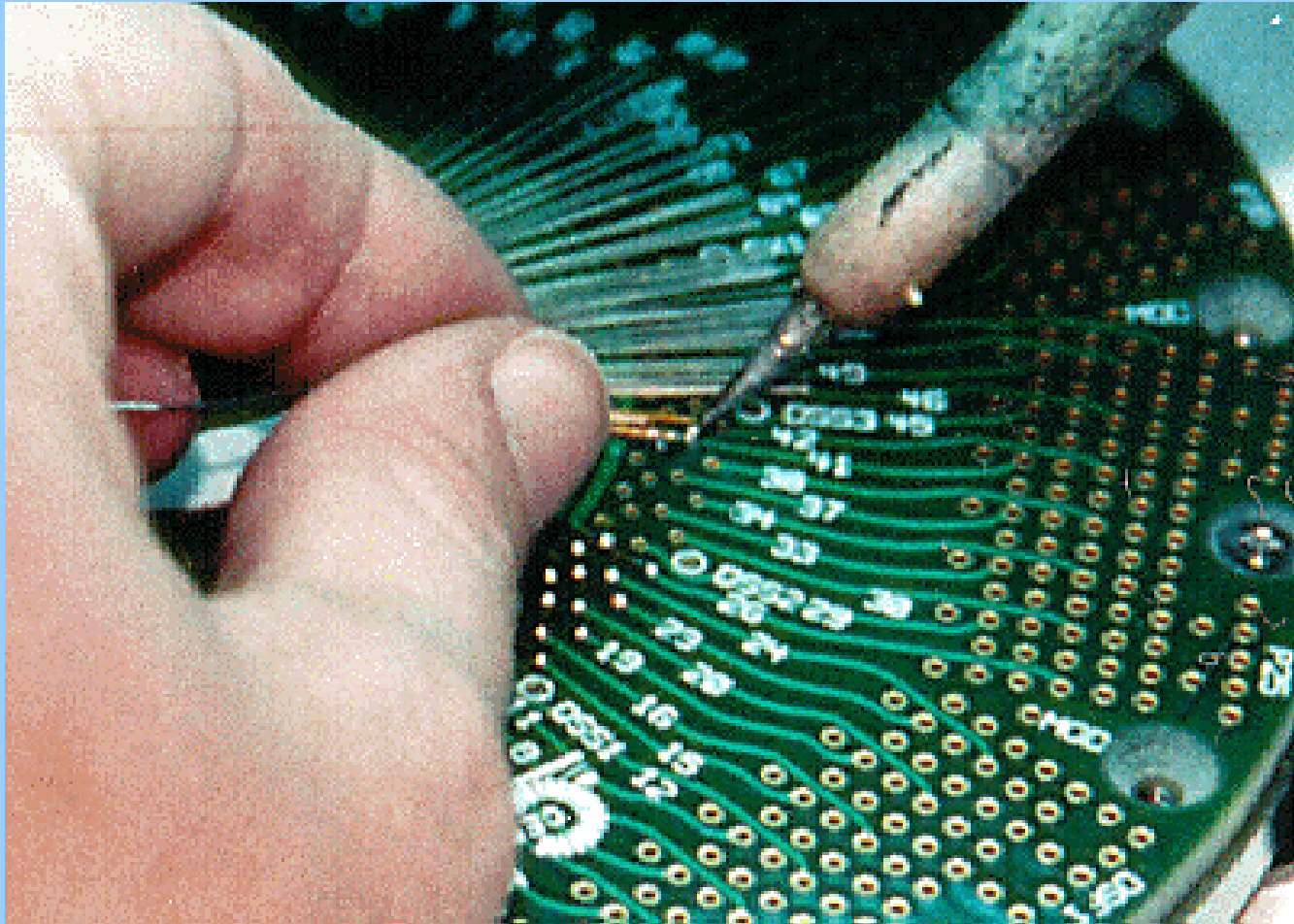
Trimming



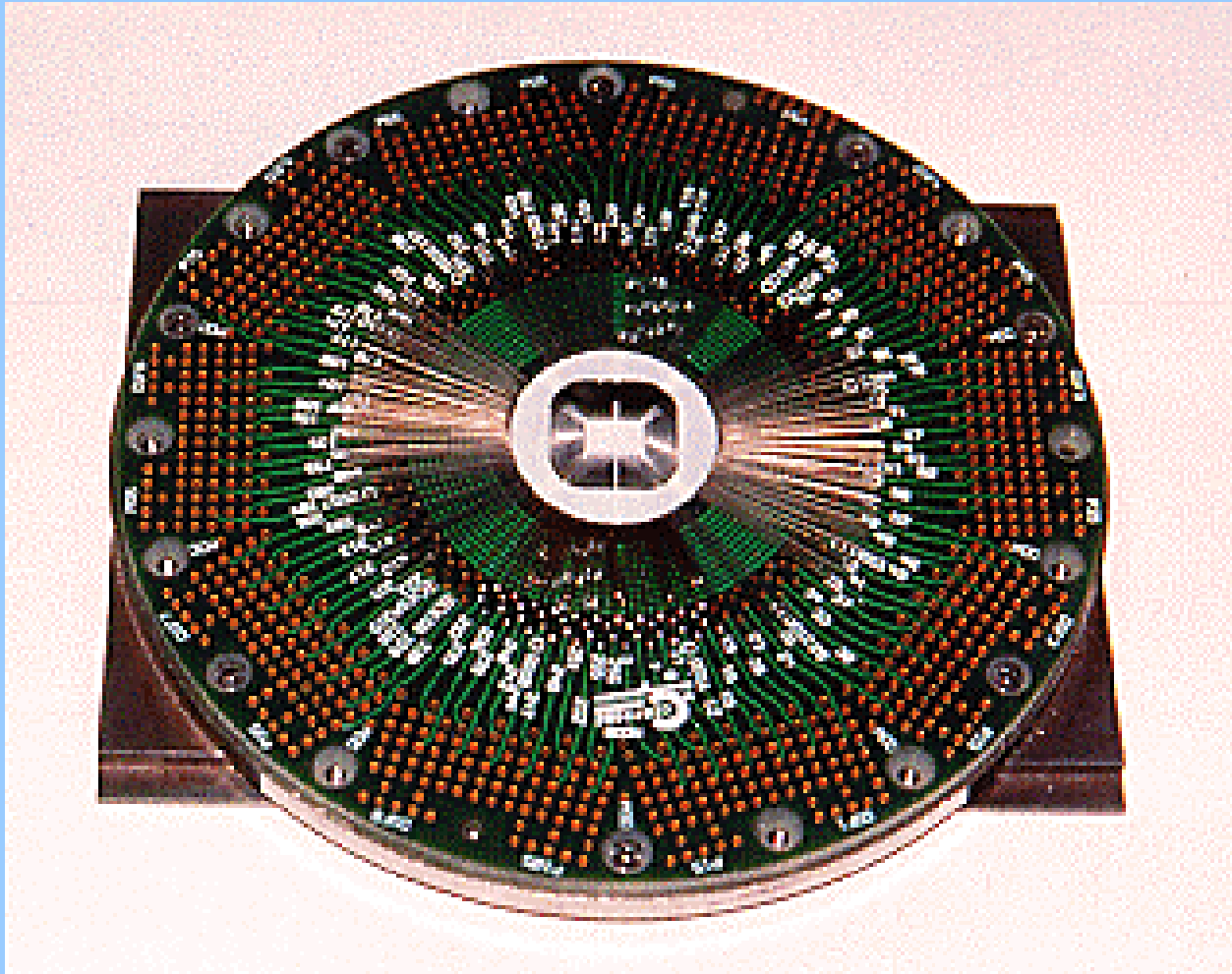
Isolative Sleeving



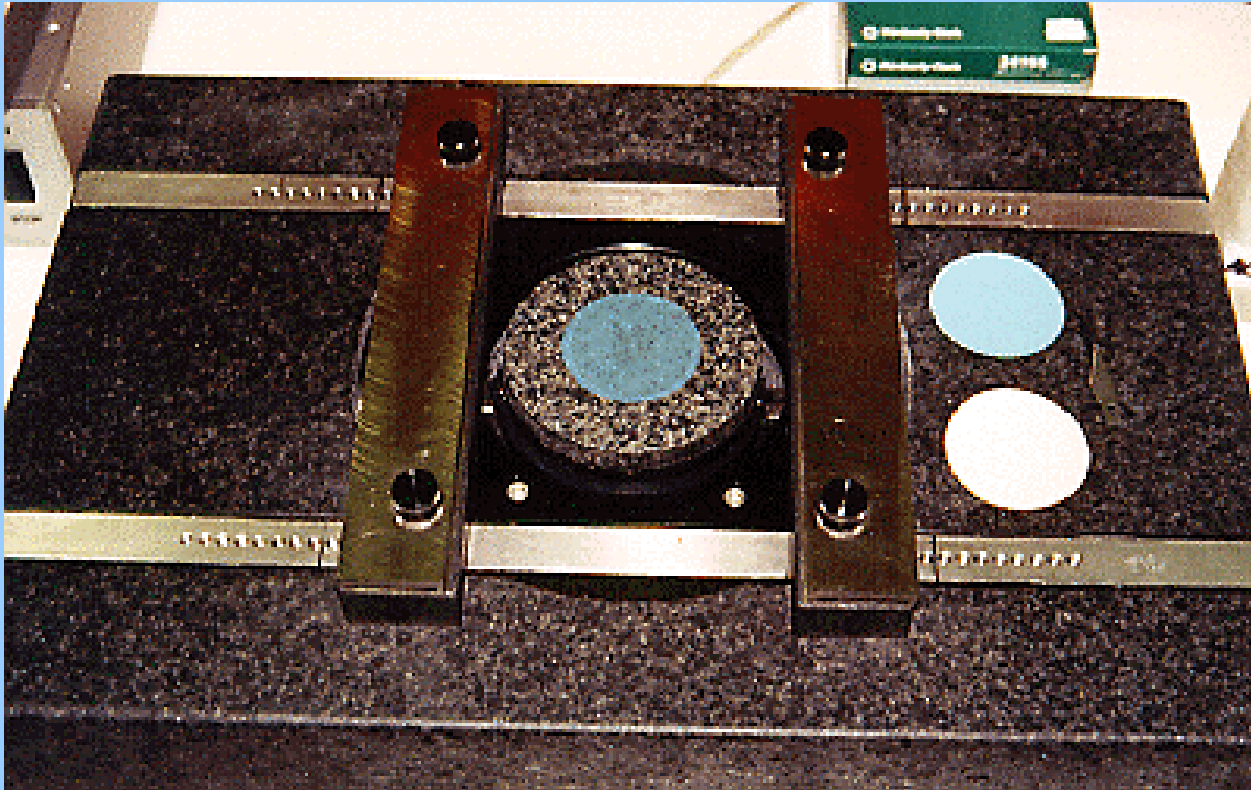
Probe Attachment



Probe Card on Build Plate



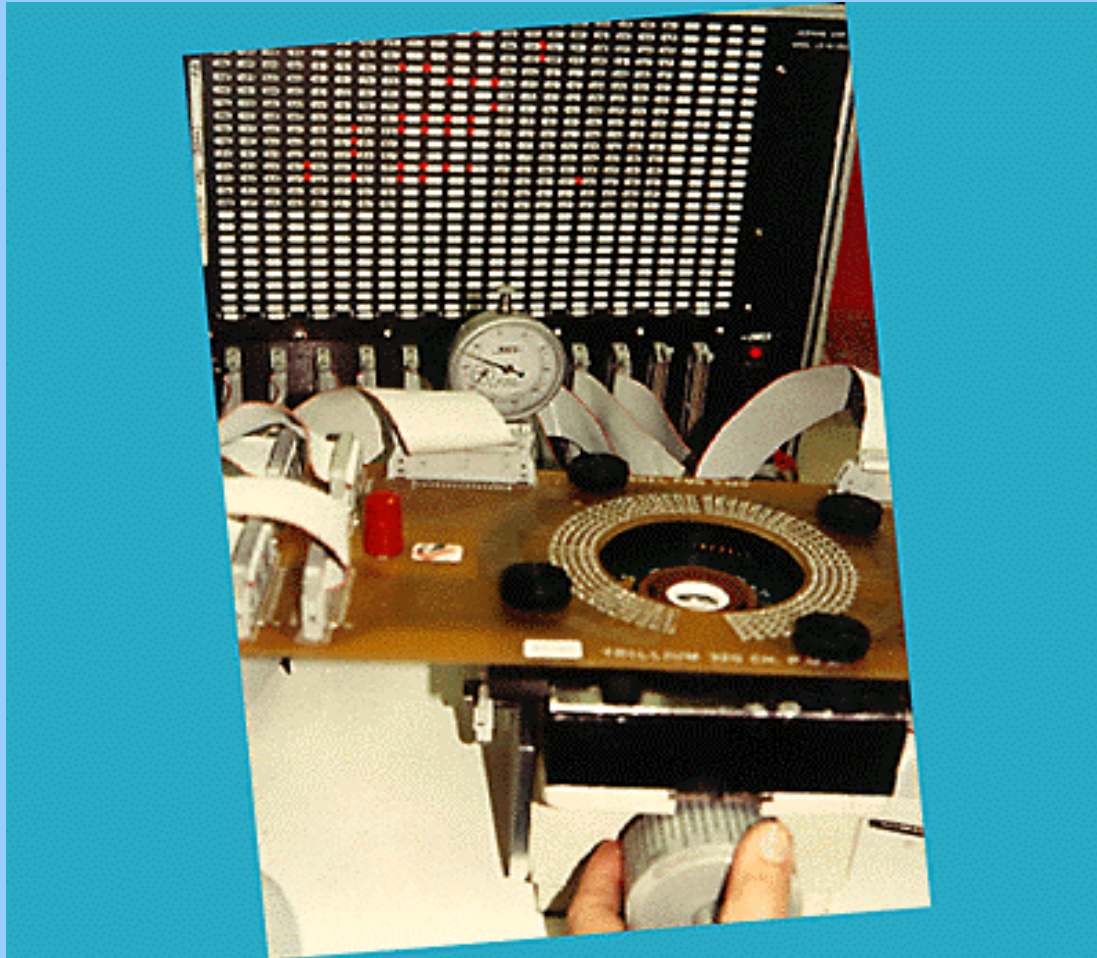
Probe Card Sanding Station



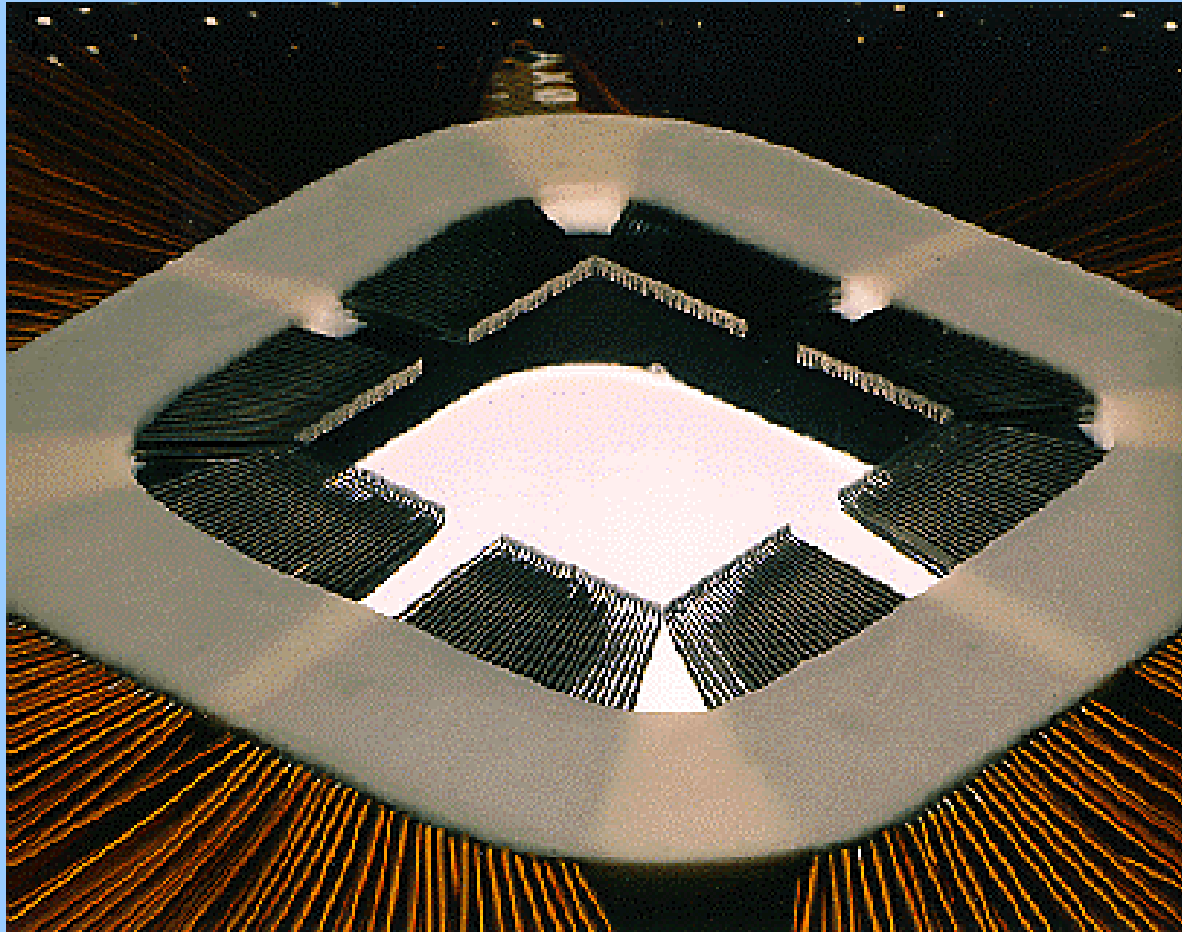
Alignment to Wafer



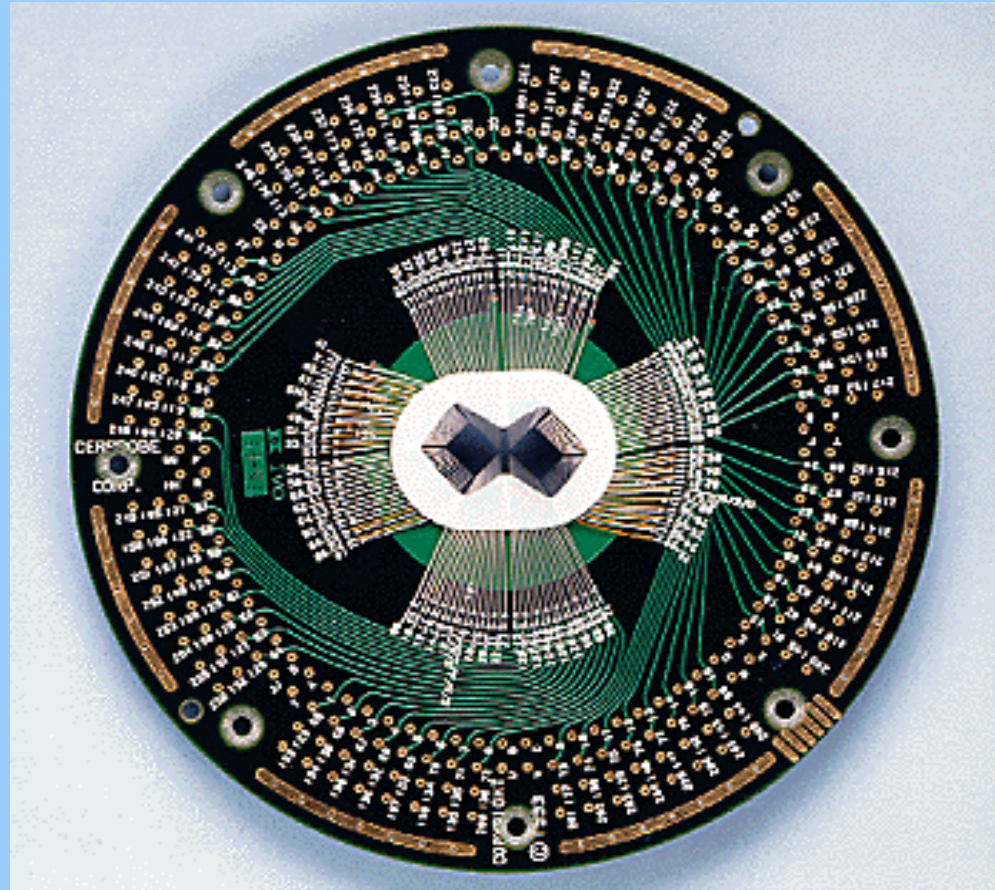
Planarization



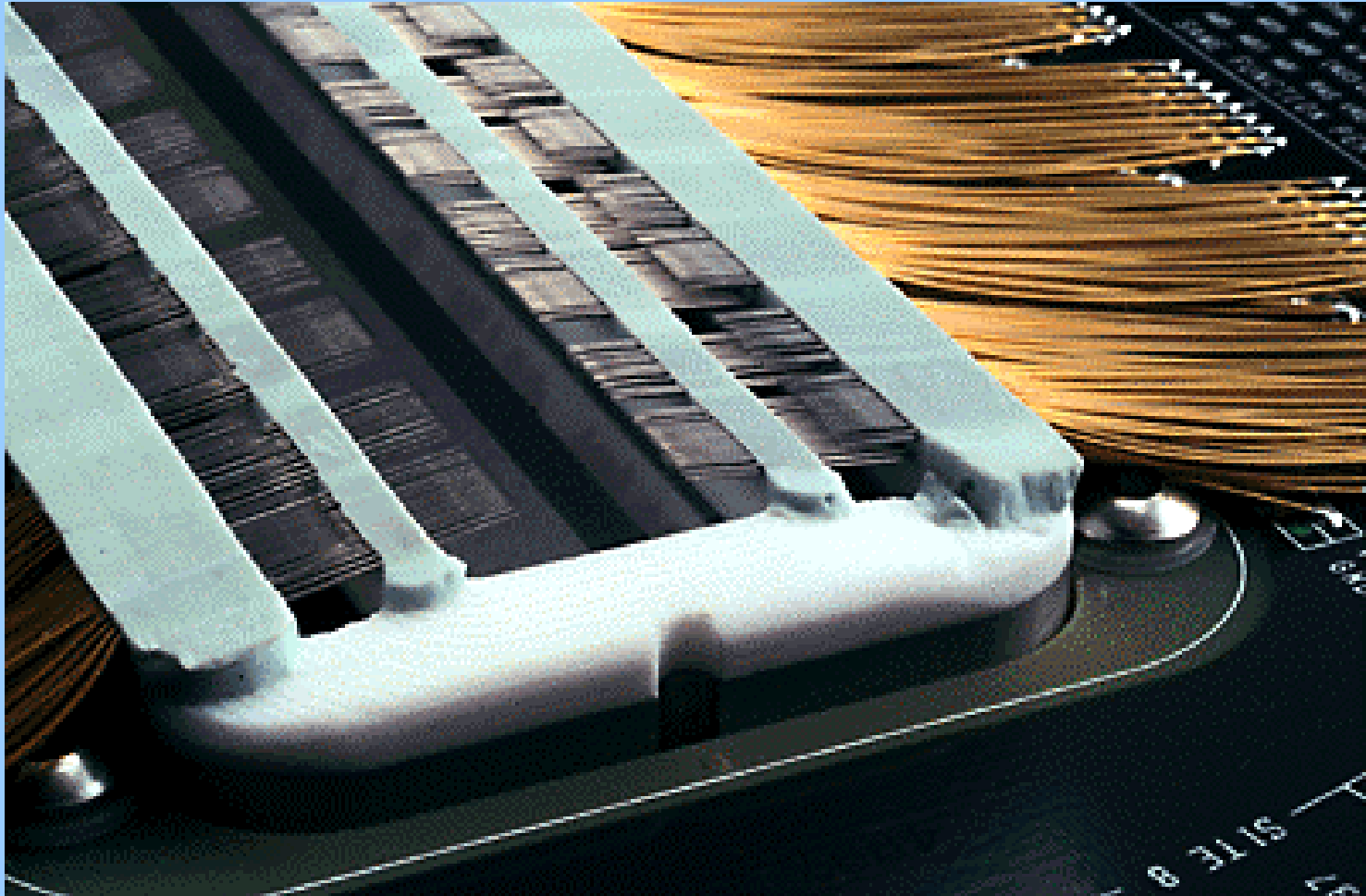
Finished Probe Card



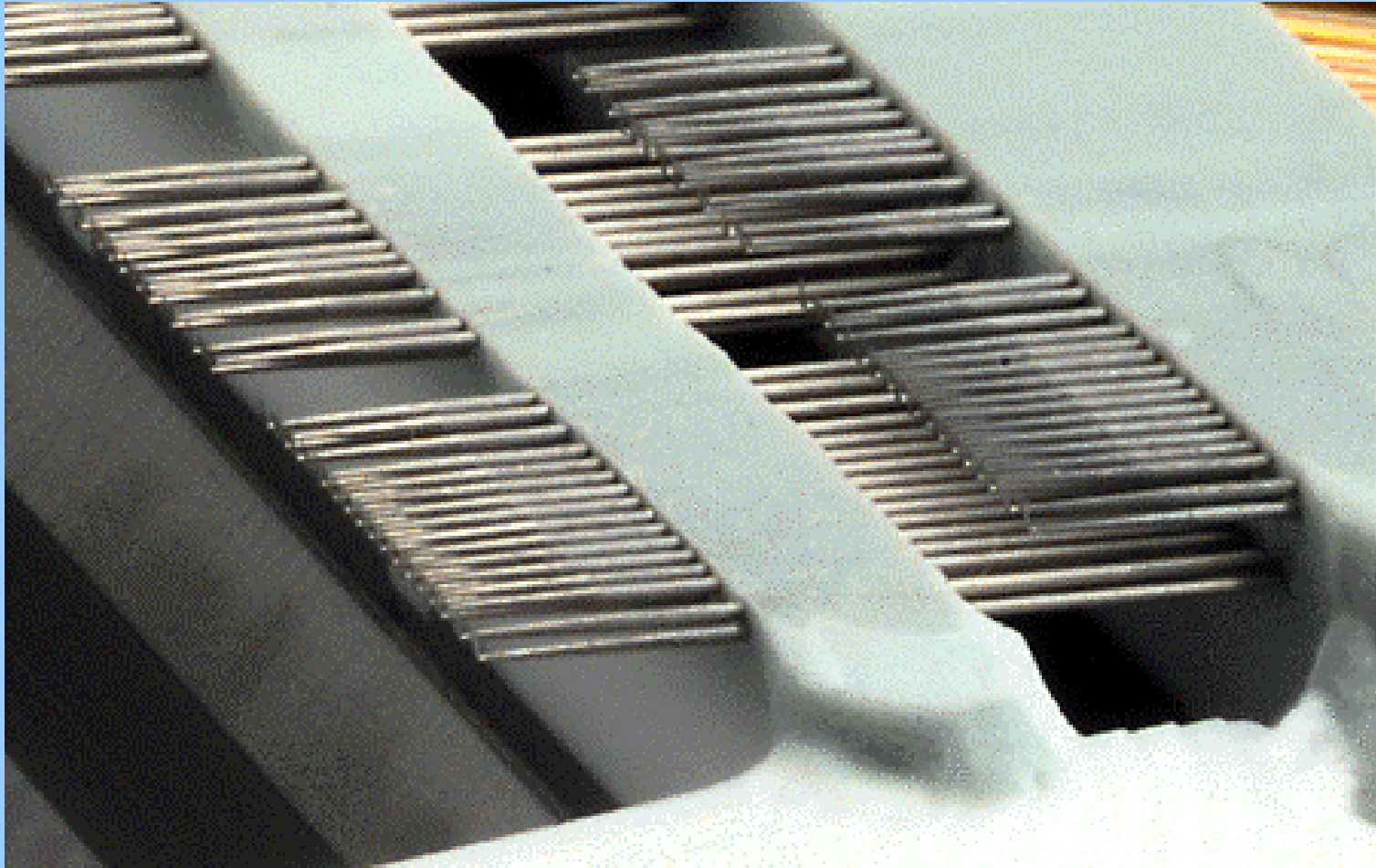
Multi-dut Probe Card



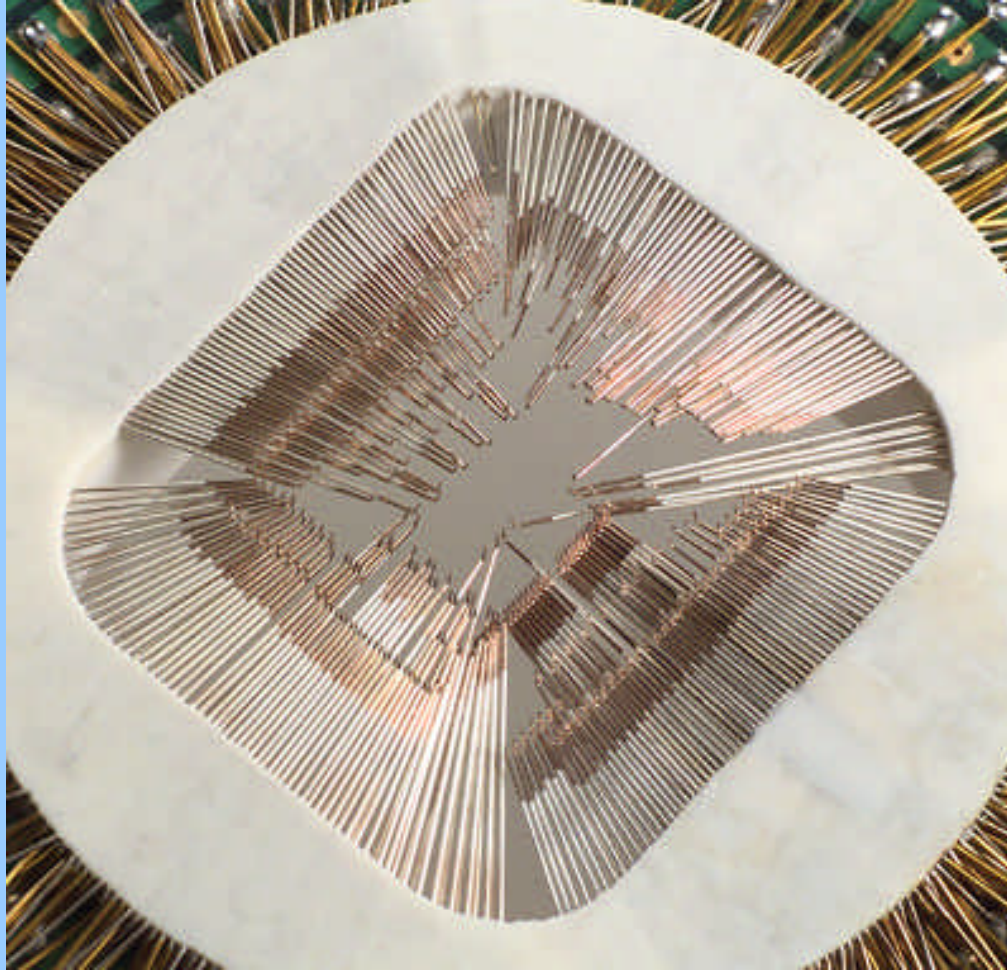
Multi-dut Probe Card



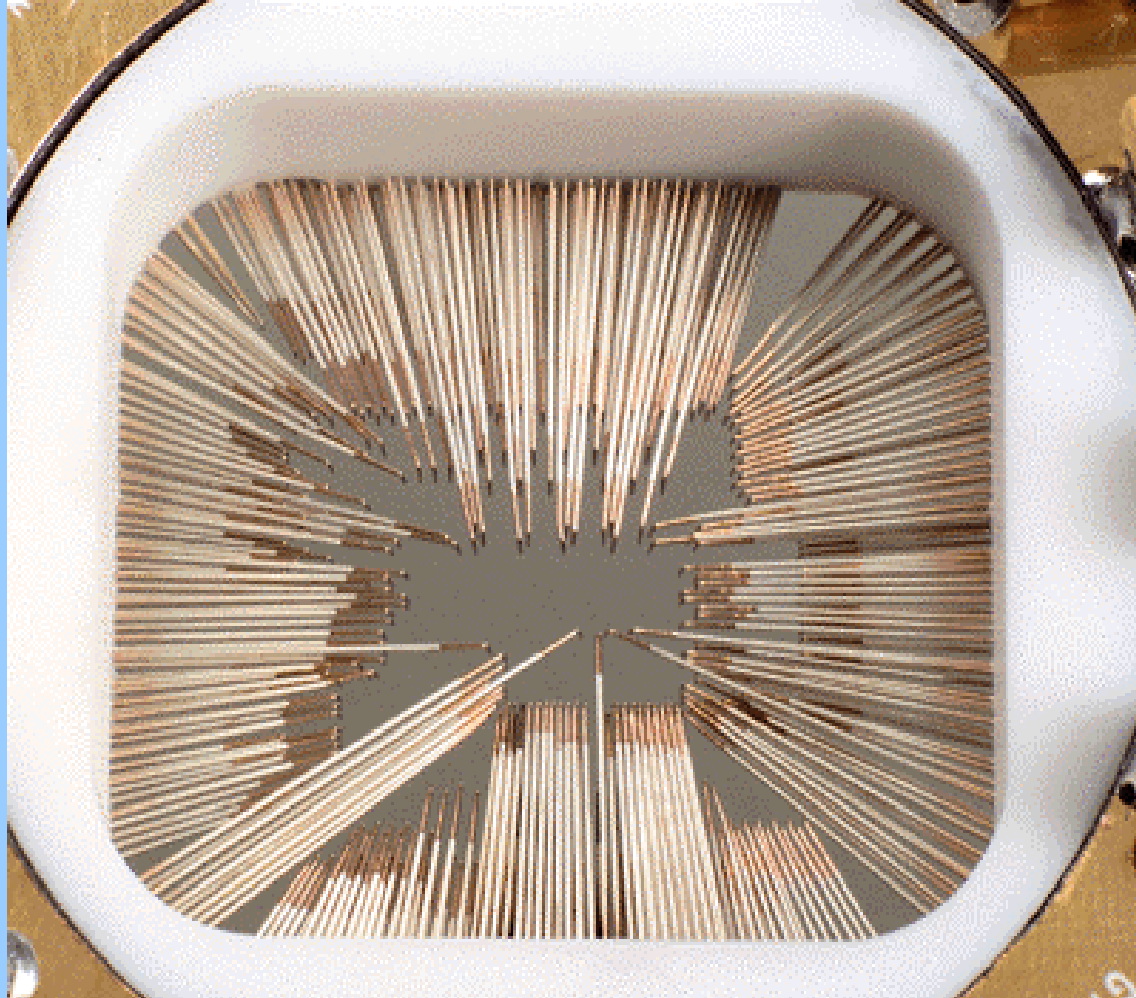
Multiple Probe Layers



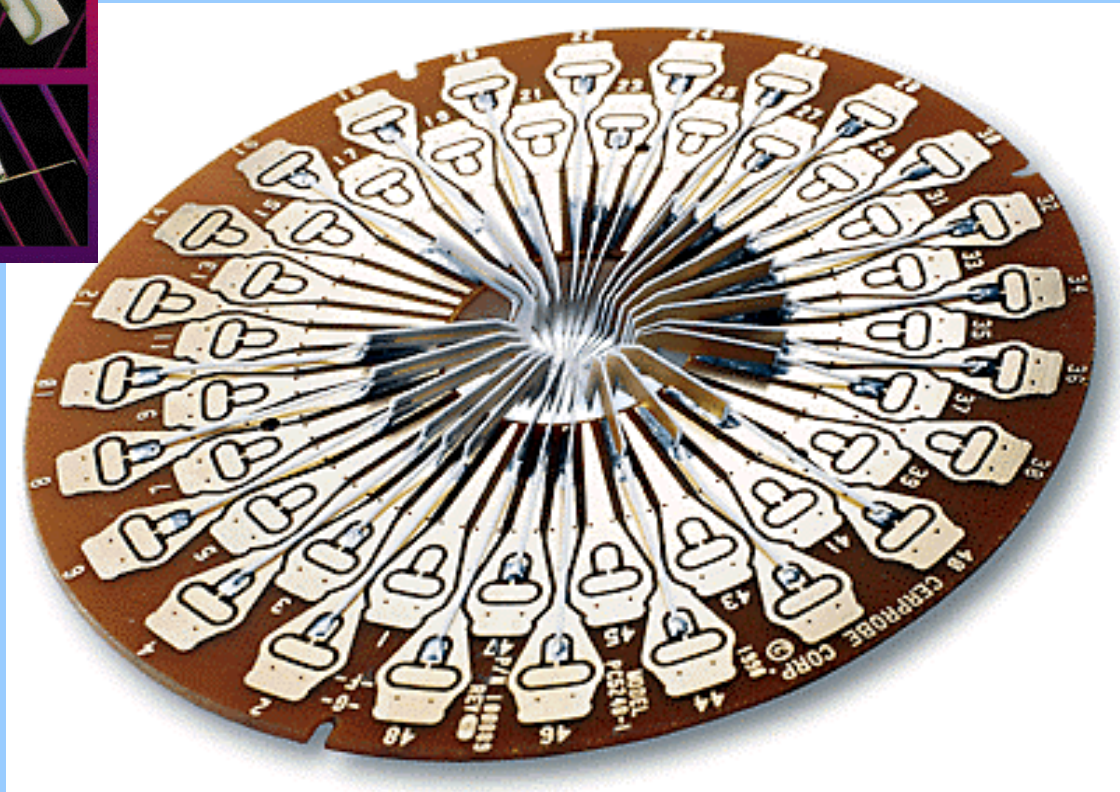
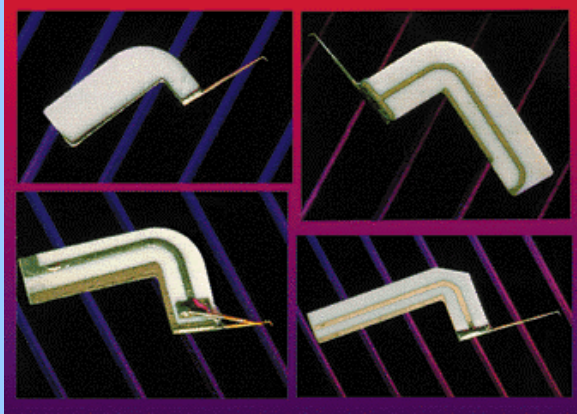
Cantilever Area Array



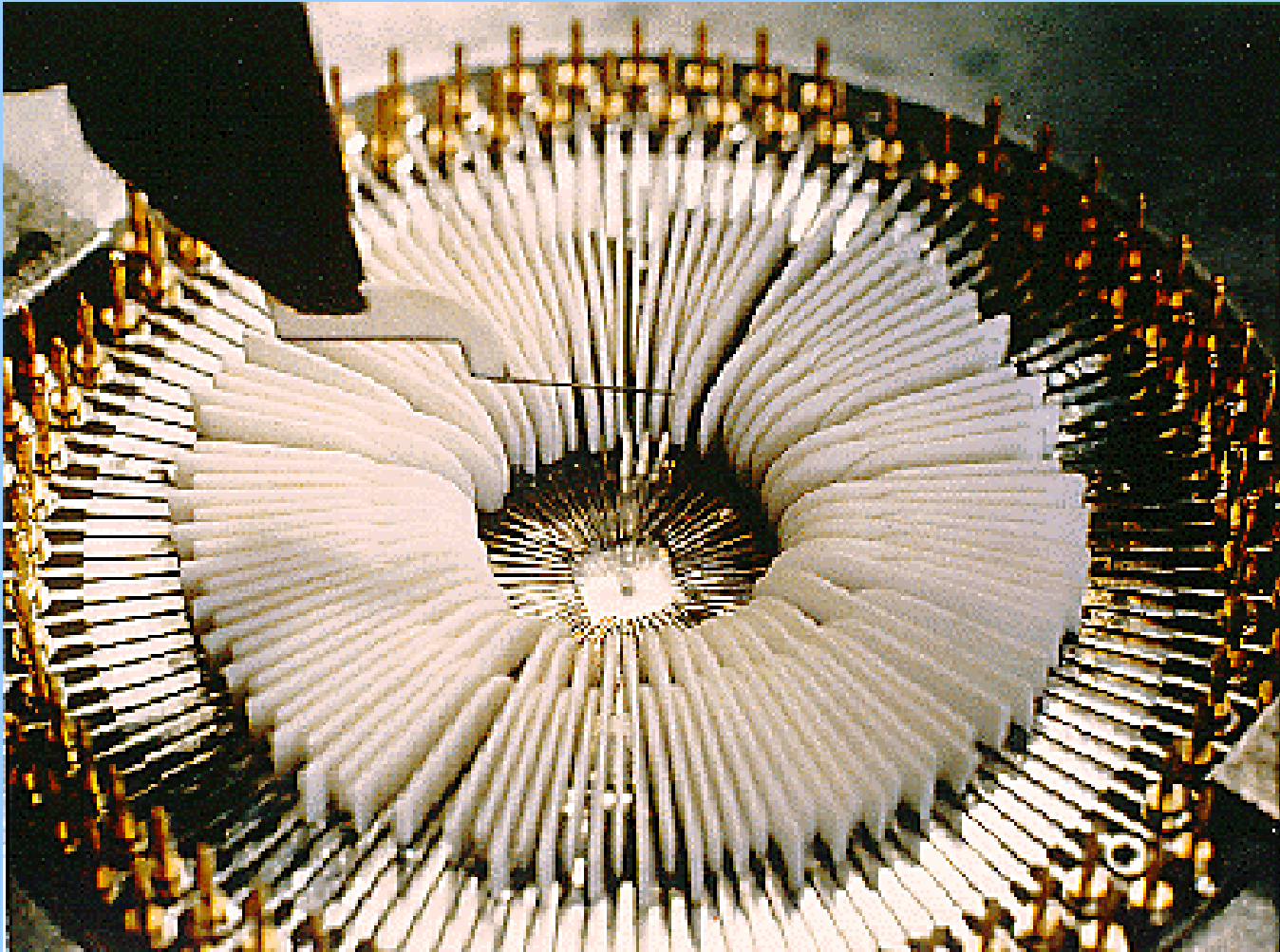
Area Array (top)



Ceramic Blade Probe Card



Building a Blade Card

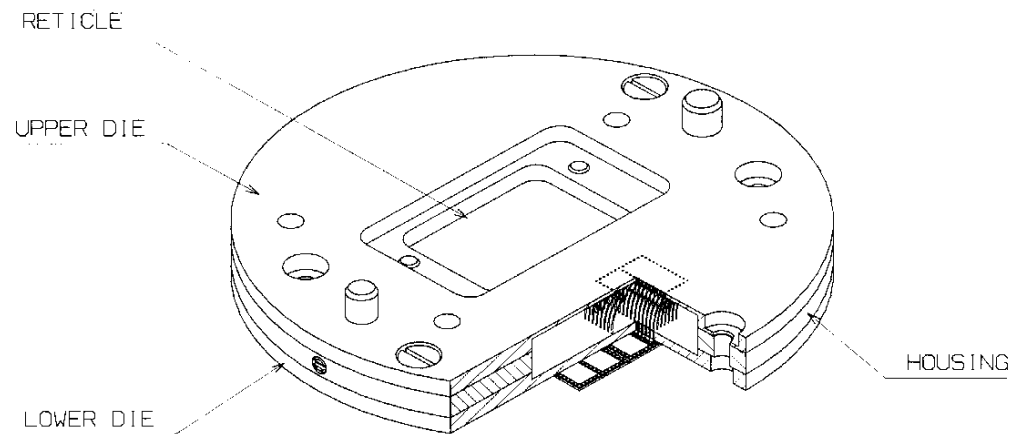


Cobra Probe Card

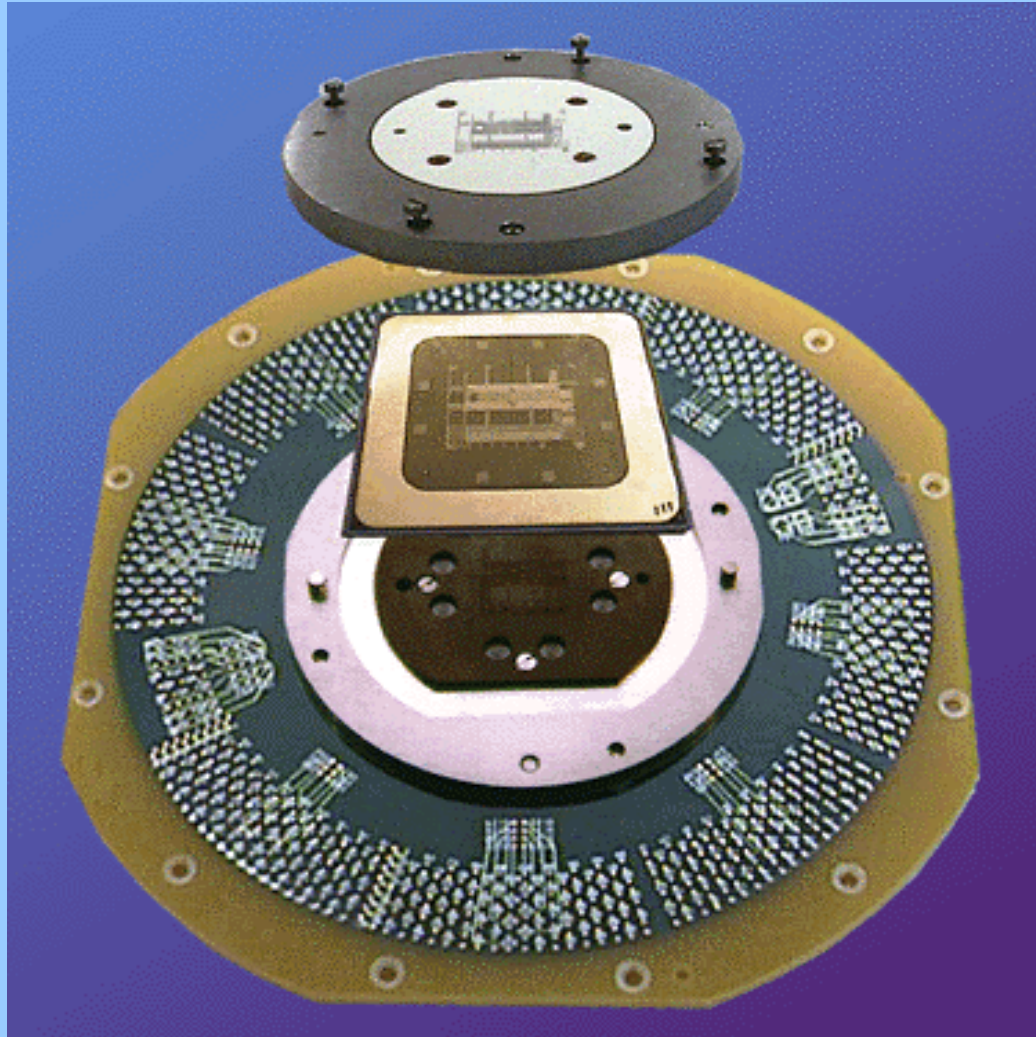


COBRA PROBE

PROBE HEAD CONCEPT



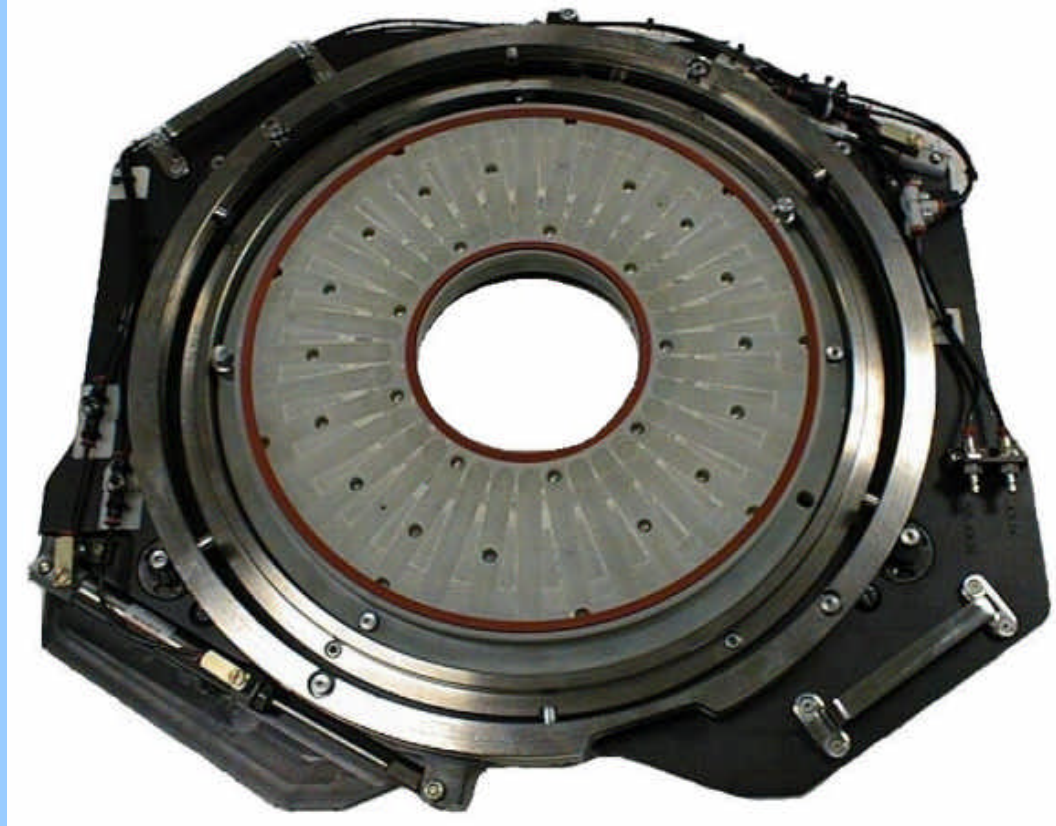
Cobra probe card



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

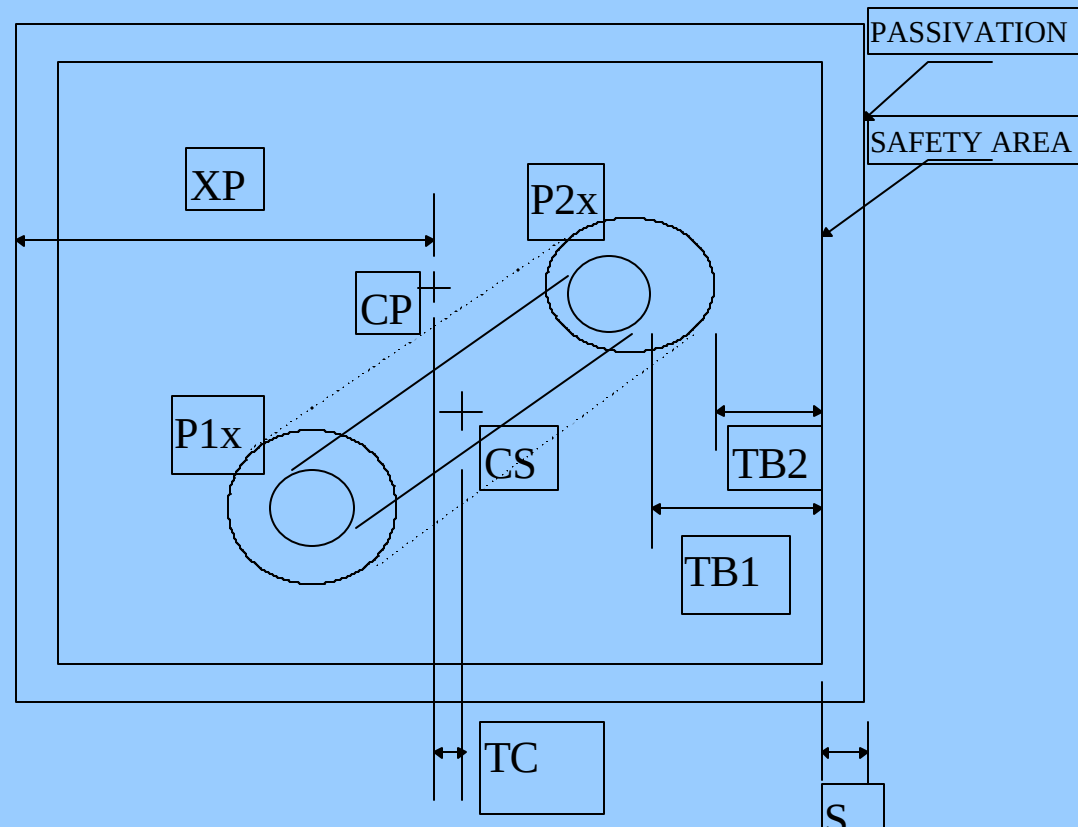
EXTERNAL
RESISTOR

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

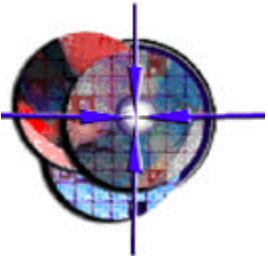
- CONTACT RESISTANCE
- SCRUB DEPTH CONTROL
- FORCE PER UNIT AREA
- GENERAL QUALITY CONTROL
- AGING MONITOR
- PROBE GEOMETRY MONITOR
- PROBE RETENTION MONITOR

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

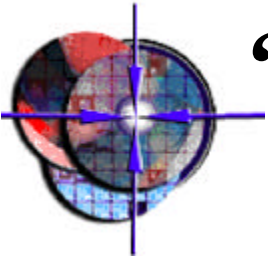
Interface

Probe Card

Wafer Handling

Product

Metalized Wafers



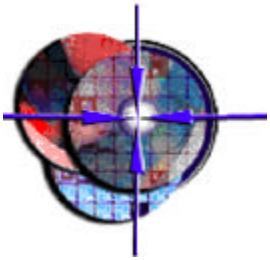
“Probing”: Checking for the Good & Bad

In-Process (Parametric Testing):

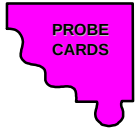
- When wafers are being built
- Checking for possible problems

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.



Probe Cards



Shapes

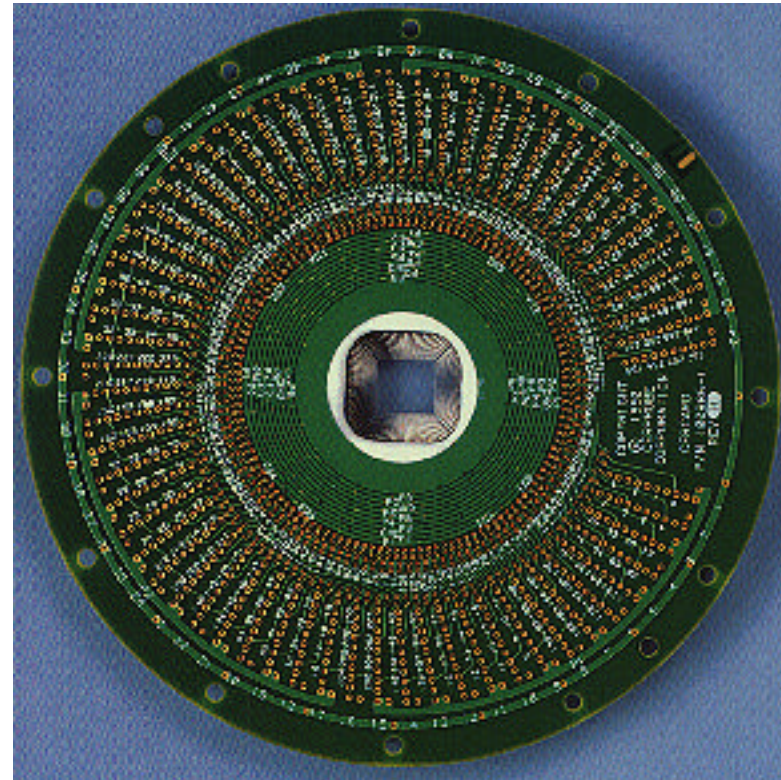
- Square to Round

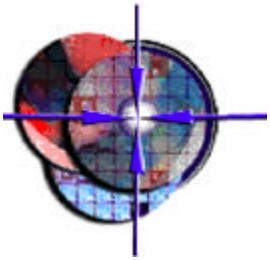
Sizes

- 4” to 16”

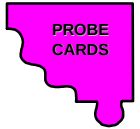
Probe Tips

- Various Metalurgy, Types and Sizes





Probe Tips



Types

- Cantilever
- Vertical
- Membrane

Size

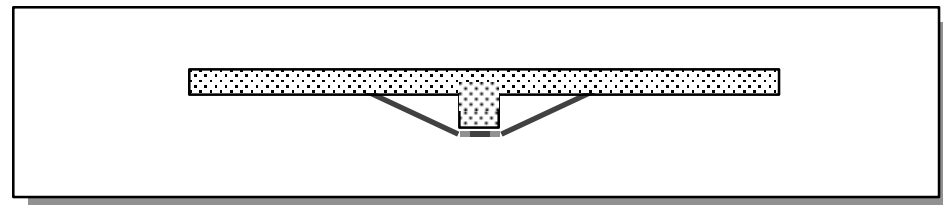
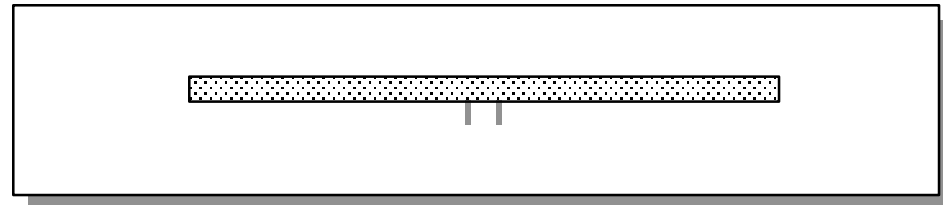
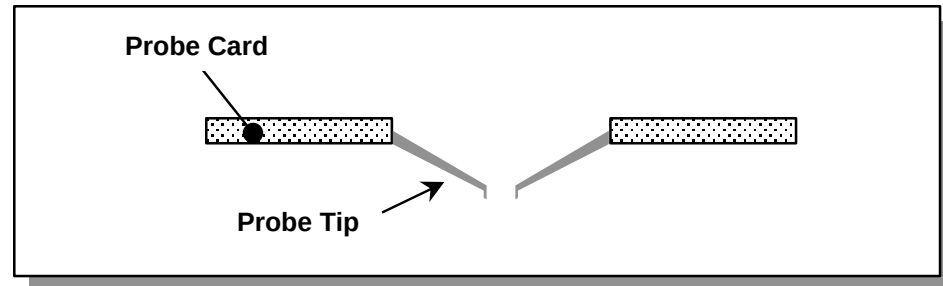
- .8 to 4 mils

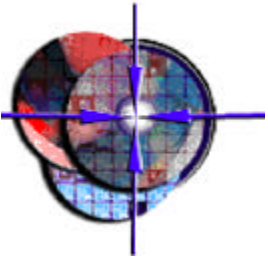
Quantity

- 10 to 2000

Materials

- Tungsten
- WR
- Paliney
- BeCu





Wafer Contact Point

Chips may have Different Contact Points

Al pads

Au pads

Solder bumps

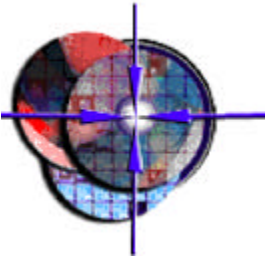
Tabs or Tape

Critical Parameters

Alignment

Contact Resistance

Pad Damage



Probe Technology Selection

Dependent on Contact Point Technology

Cantilever Beam Probes

Peripheral Pads

Al or Au Pads

Solder Bumps (Limited)

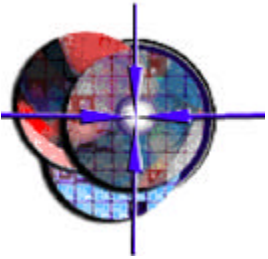
Tabs or Tape

Vertical (Cobra)

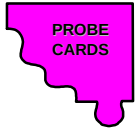
Array Patterns

Solder Bumps (Flat Tips)

Al or Au Pads (Pointed Tips)



Pretty Close !!!



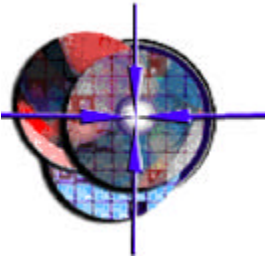
Q: How close do we need to put the probe in the pad?

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.





Types of Testers

Configured for Specific Technology

Memory, uProcessor, Linear, etc.

Clock Speeds >100 MHz

Rise Times <250 pS

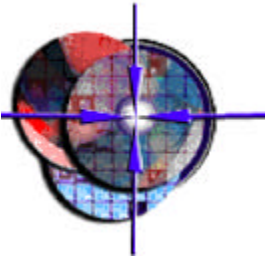
Parallel Testing of Memory Devices (8-32 Chips)

Every Interface is Different - NO STANDARDS!

Test Head Configurations

Direct Dock

Cabled



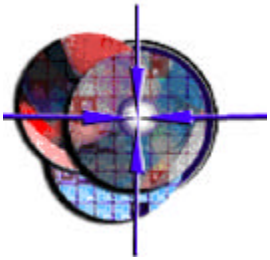
Test Head Docking

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***

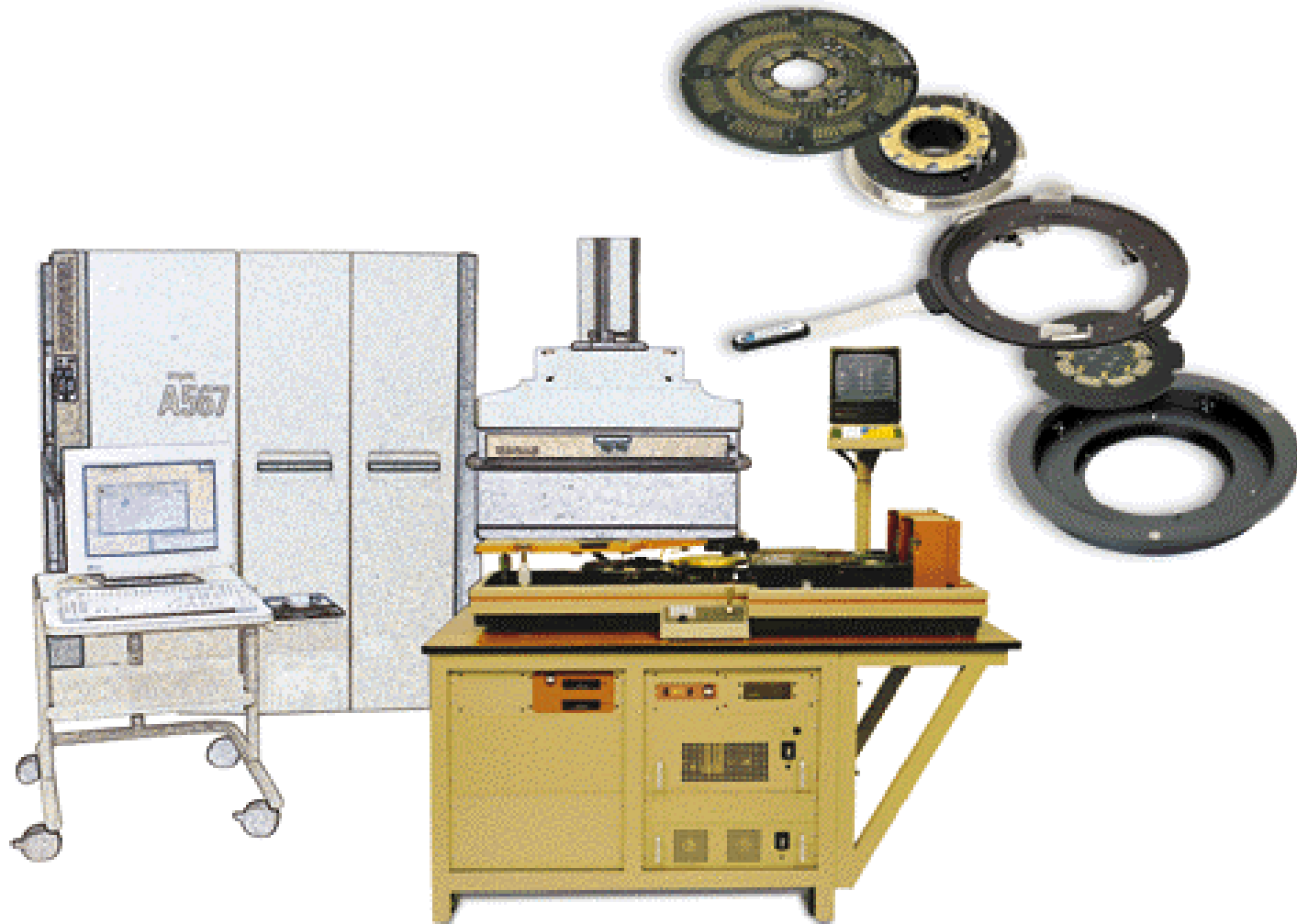
Direct Docking

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



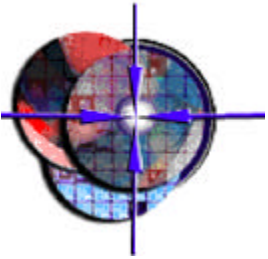
Direct Docking to Tester

(Courtesy Cerprobe Corporation)



Michael George
(408) 727-6500 x6244

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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

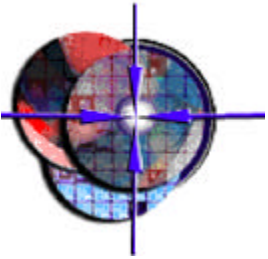
Automatic Loading

Cassette Wafer Holders

One or Multiple Cassettes

Wafer Automatically Transferred to Chuck

Faster, Cleaner, Safer



Wafer Alignment (1)

Align Probe Tips to Pads

X,Y Position

Theta (Rotation)

Overdrive (Z Axis)

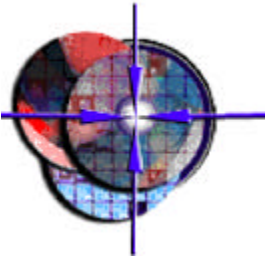
Manual Alignment

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)



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