

# Controlling BP Damage at 129C Probing

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# Outline

- Background – the journey
- Problem Statement
- Measurement/Methodology
- Key Findings
- Solution's
- Acknowledgments

# Background

- Phase 4 automotive factory was experiencing significant bond pad damage yield loss issues between testers and devices
- Phase 5 to ramping ~ 150 systems migrating to automotive 3 insertion test methodology
- Customer requirements were limiting BPD to 50%

# Problem Statement

- Factory was experiencing significant yield loss issues between testers and devices during 3 insertion probing sequence at different temps
- BPD fails were causing significant yield loss at final inspection
- Traditional probing solutions were ineffective

# Objective

- Show the effects of 125C at probe
- Review the potential sources of bond pad damage at 125C
- Review design/hardware procedures needed to manage high temp probing
- Share key learning's – the journey

# BP/MA Sources Probe at 125C

Bond Pad Surface  
Test Times  
Cleaning Time  
Cleaning Frequency  
Chuck Temp  
Camera Heating  
Z-Axis Travel  
Interface design  
Interface Materials  
Calibration Settings  
PC Materials  
Needle Tip Size  
GPIB Communication  
Gravity Programming

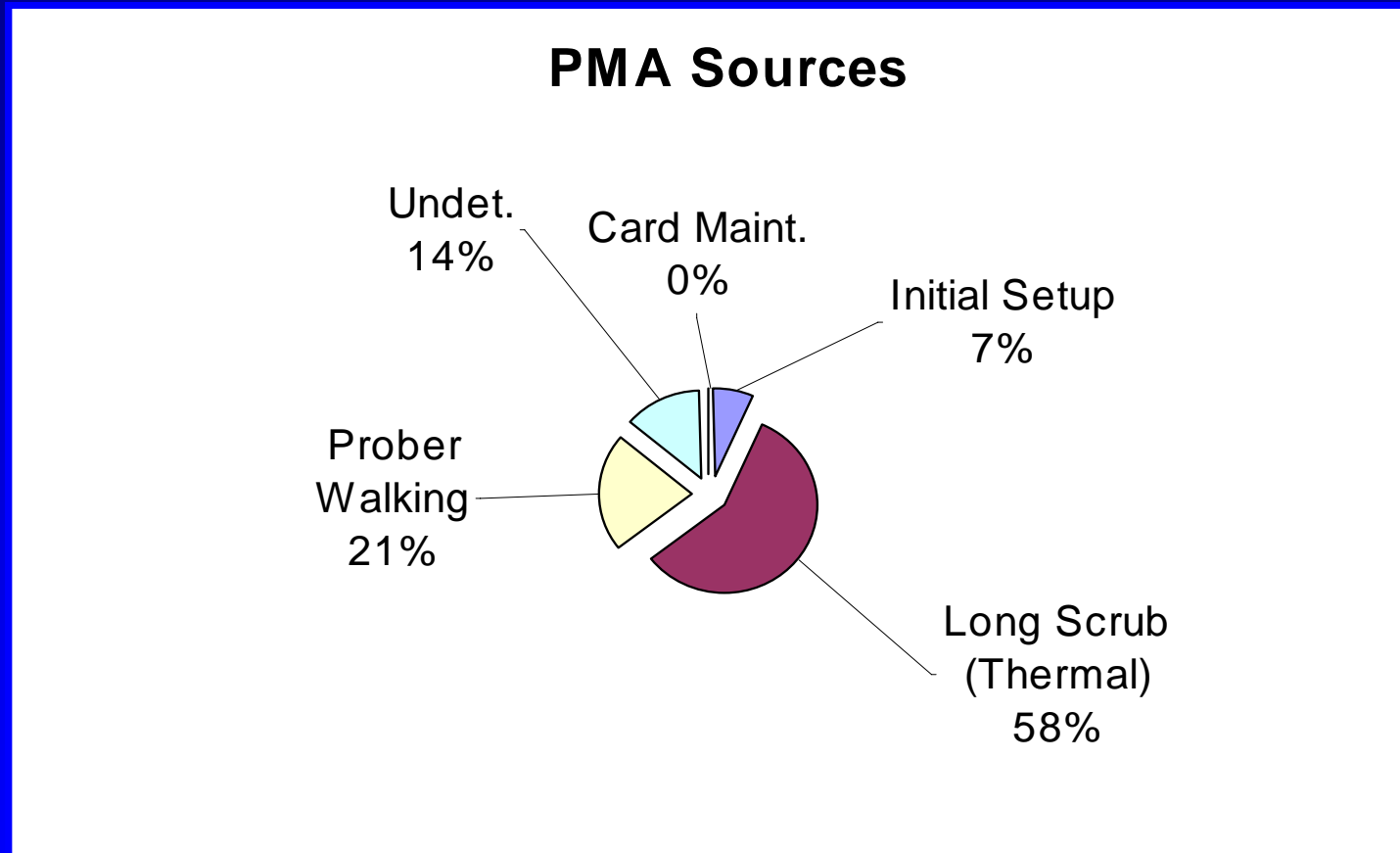
**Conditions  
that effect  
MA/Damage**



# 125C Ramp Results

| Device           | Test Logpoints          |                             |                              | Net Yield Loss |              |            |              |              |              | AVI Yield Loss |              |            |              |              |              |
|------------------|-------------------------|-----------------------------|------------------------------|----------------|--------------|------------|--------------|--------------|--------------|----------------|--------------|------------|--------------|--------------|--------------|
|                  | MP1                     | MP3                         | MP4                          | June           | July         | Aug        | Sept         | Oct          | Nov          | June           | July         | Aug        | Sept         | Oct          | Nov          |
| Saturn 48        | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    | Fusion:<br>Dual<br>(125C)    | 7.40%          | 11.20<br>%   | 3.10%      | 3.8%<br>3.0% | 2.00%        | <b>0.57%</b> | 13.10<br>%     | 21.20<br>%   | 6.00%      | 7.5%<br>1.4% | 4.30%        | <b>1.05%</b> |
| Saturn 60        | VLCLT:<br>Dual<br>(30C) | Polaris:<br>Single<br>(30C) | Polaris:<br>Single<br>(125C) | 14.60<br>%     | 3.10%        | 6.70%      | 2.60%        | <b>1.30%</b> | <b>0.29%</b> | 25.30<br>%     | 8.70%        | 12.10<br>% | 7.10%        | <b>3.90%</b> | <b>0.83%</b> |
| Pluto            | *                       | VLCLT:<br>Dual<br>(30C)     | Fusion:<br>Dual<br>(125C)    | 12.90<br>%     | 2.60%        | 3.00%      | 1.50%        | <b>0.10%</b> | <b>0.10%</b> | 14.60<br>%     | 6.10%        | 0.50%      | 1.60%        | <b>0.10%</b> | <b>0.10%</b> |
| Titan            | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    | Fusion:<br>Dual<br>(125C)    | 9.80%          | 4.10%        | 6.60%      | 2.30%        | <b>0.30%</b> | <b>0.02%</b> | 21.20<br>%     | 7.90%        | 6.60%      | 3.80%        | <b>0.50%</b> | <b>0.03%</b> |
| Venus            | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    | Fusion:<br>Dual<br>(125C)    | 10.60<br>%     | 3.50%        | 1.60%      | 1.20%        | <b>0.20%</b> | <b>0.08%</b> | 10.30<br>%     | 4.70%        | 4.20%      | 1.70%        | <b>0.30%</b> | <b>0.14%</b> |
| Jupiter          | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    | Fusion:<br>Dual<br>(125C)    | No<br>Wafers   | No<br>Wafers | 15.90<br>% | 2.30%        | <b>0.20%</b> | <b>0.59%</b> | No<br>Wafers   | No<br>Wafers | 32.70<br>% | 6.00%        | <b>0.90%</b> | <b>1.48%</b> |
| Saturn 48<br>Pkg | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    |                              | 1.00%          | 7.30%        | 0.80%      | 1.00%        | <b>0.10%</b> | <b>0.00%</b> | 1.00%          | 7.30%        | 1.30%      | 1.00%        | <b>0.30%</b> | <b>0.00%</b> |
| Titan Pkg        | VLCLT:<br>Dual<br>(30C) | VLCLT:<br>Dual<br>(125C)    |                              | 5.30%          | 4.10%        | 0.70%      | 0.20%        | <b>0.00%</b> | <b>0.00%</b> | 5.30%          | 4.10%        | 0.60%      | 0.20%        | <b>0.00%</b> | <b>0.00%</b> |

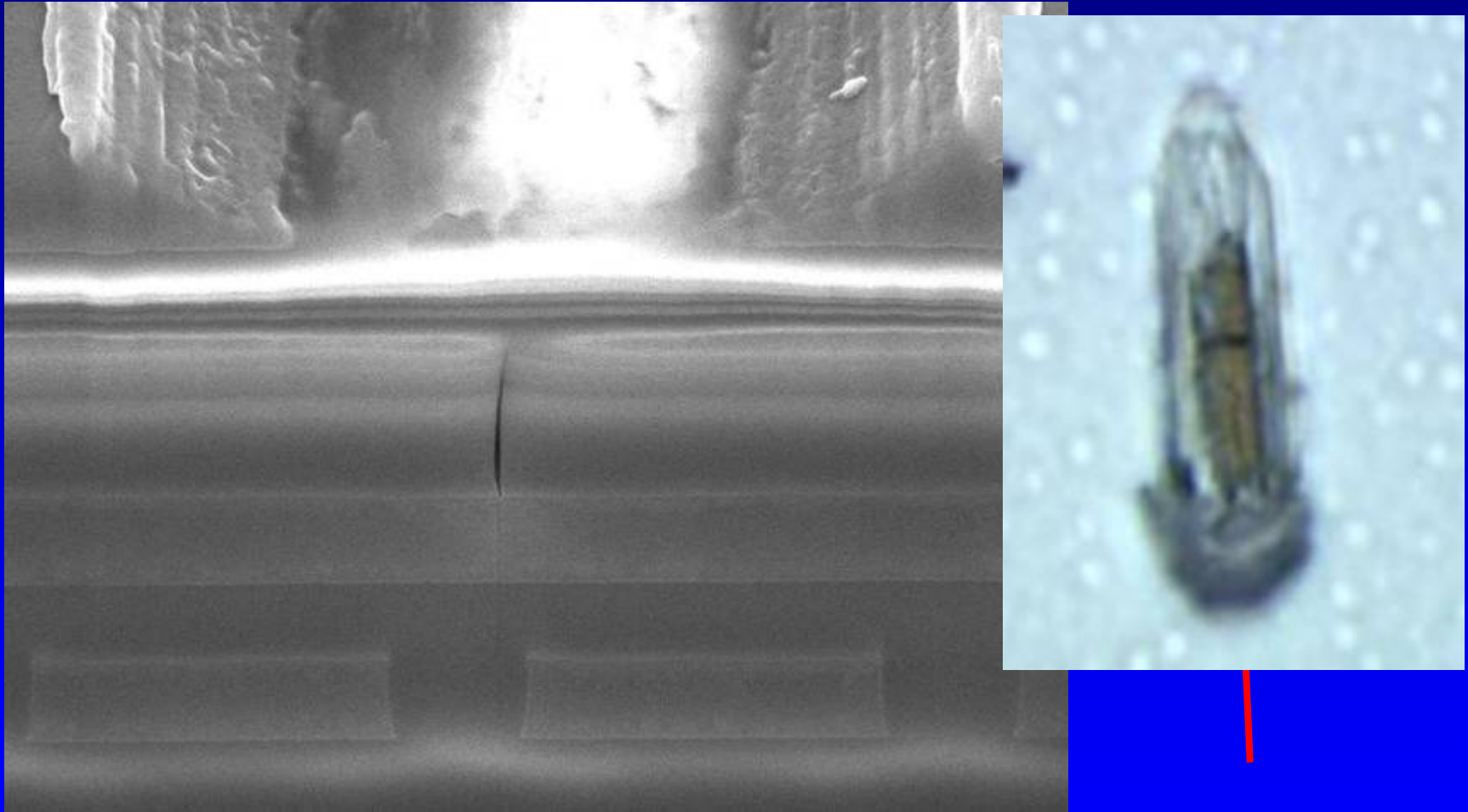
# High Level PMA Sources



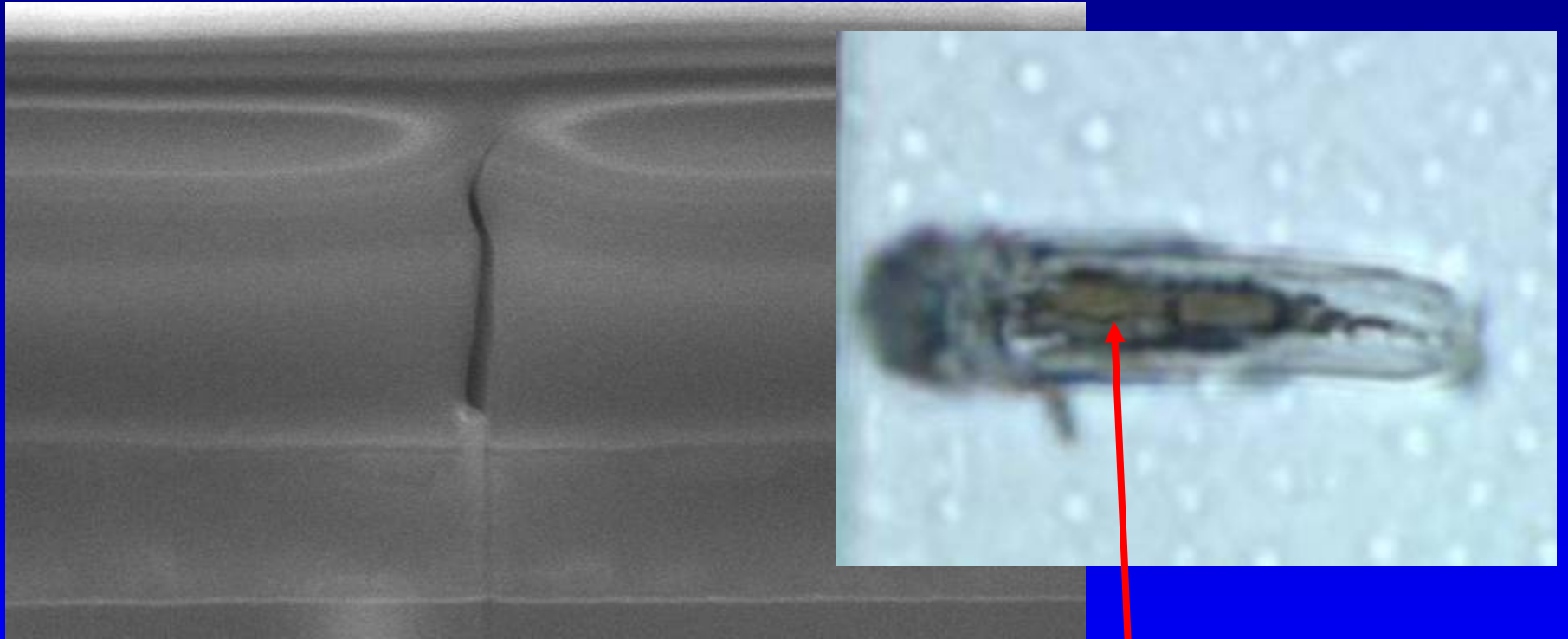


# Radius Tips

# FIB at 4 TD Radius Tip



# FIB of Alt. Device at 4TD



# Nominal Tips 1 to 20 TDs on same pad



**1 TD**



**2 TD**



**3 TD**



**4 TD**



**6 TD**



**8 TD**

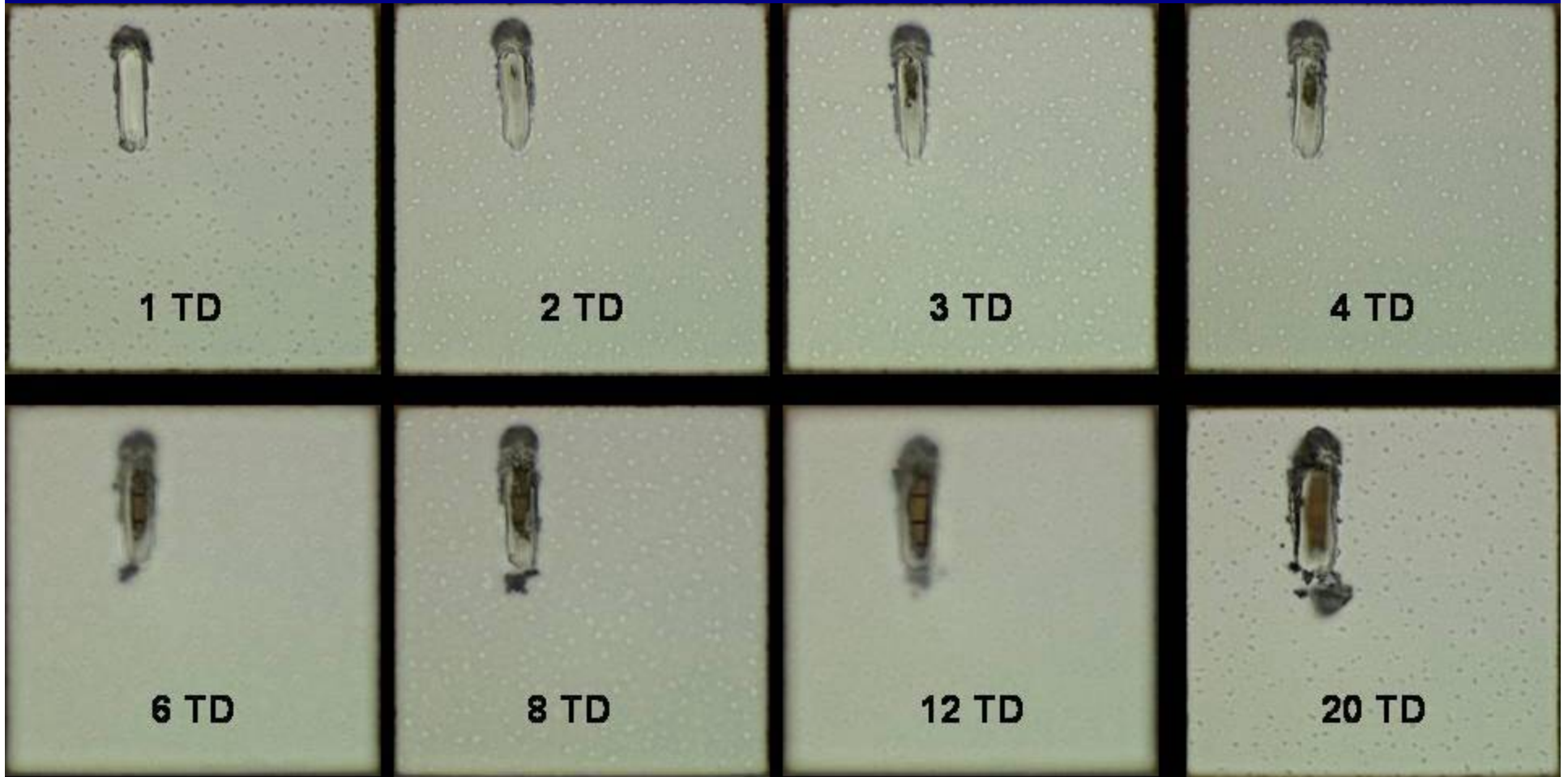


**12 TD**



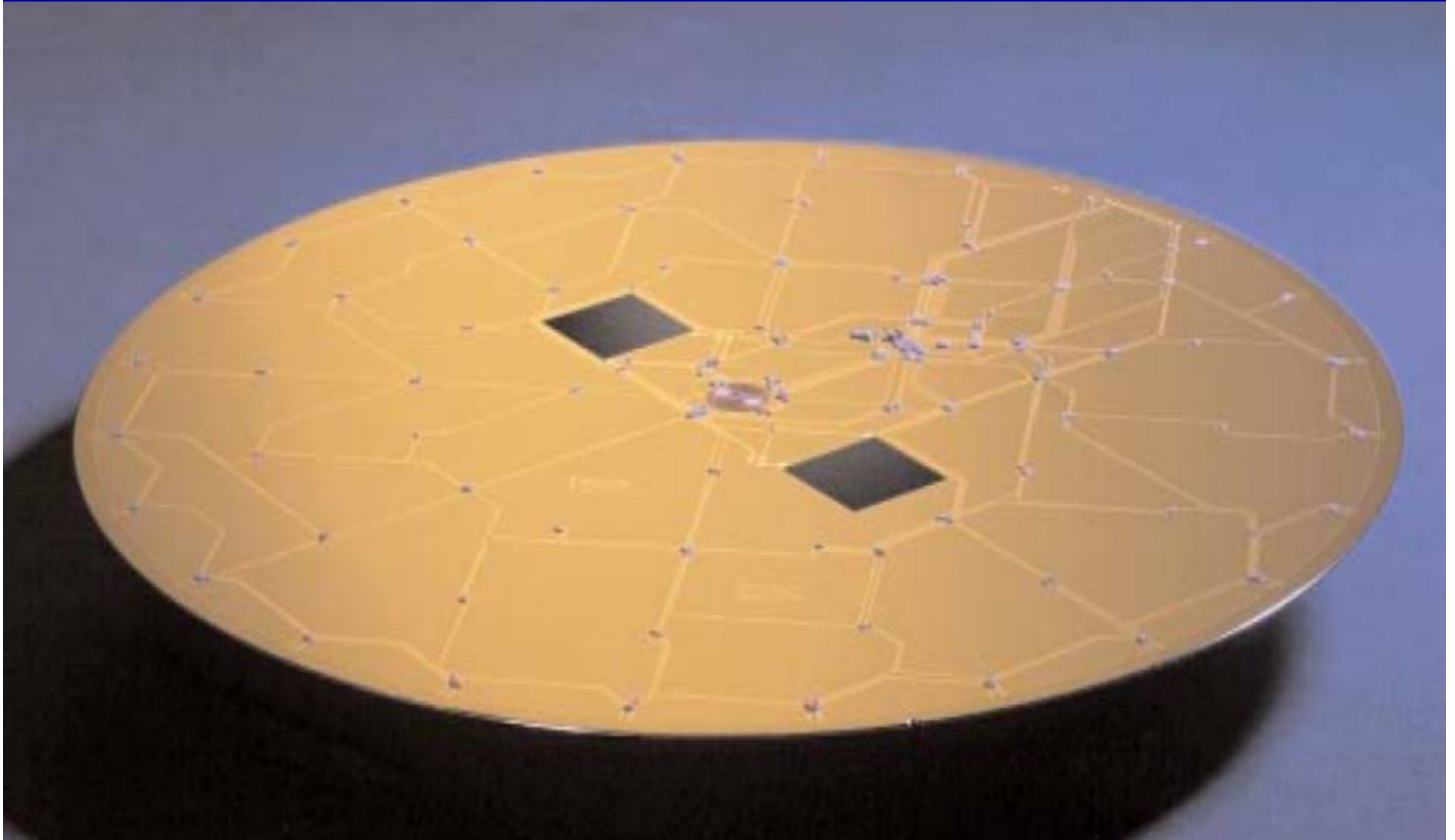
**20 TD**

# Radius Tips 1 to 20 TDs on same Pad



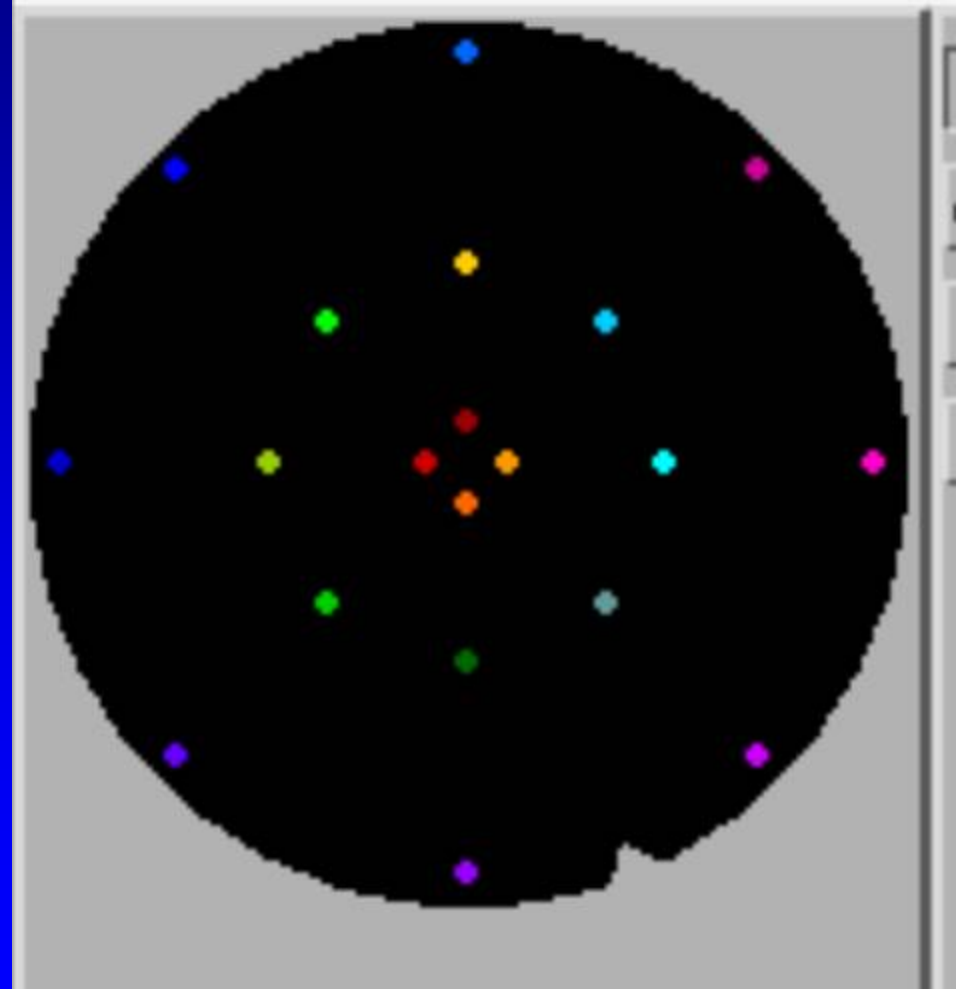
# Chuck Temperature

# SensArray Integrated Wafer

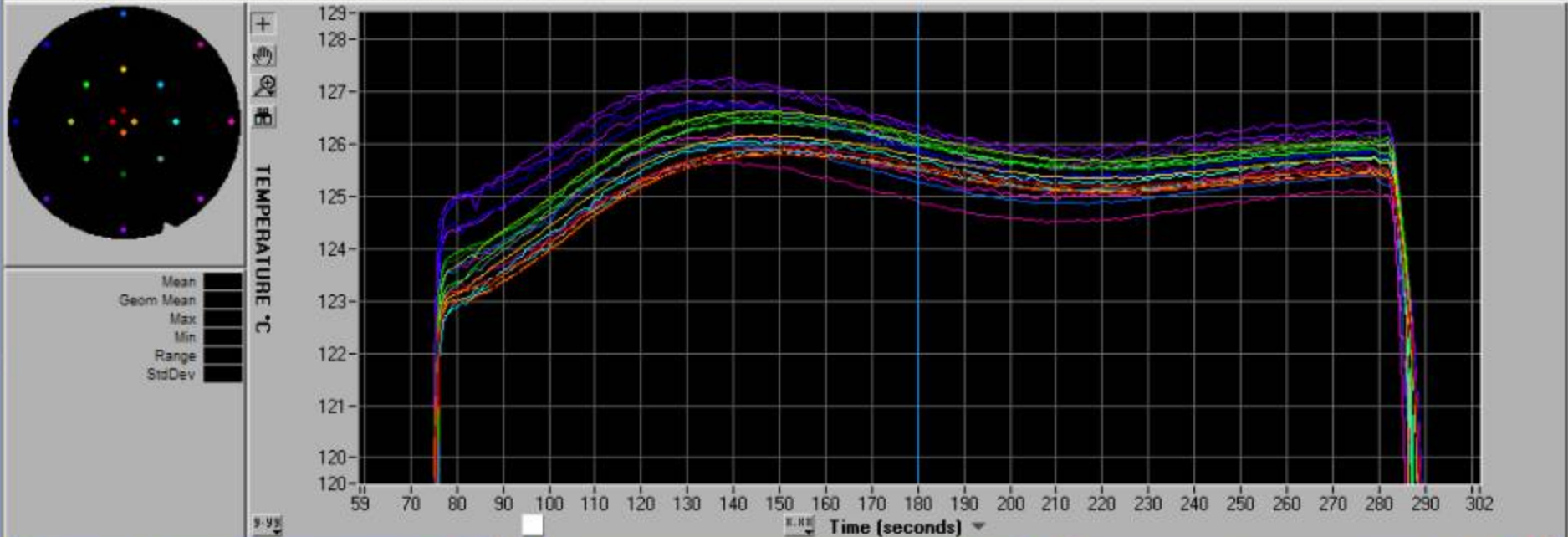


# SensArray Integrated Wafer

- Enabled 17 sensors
- Set sample rate at 1/sec after a 3 min delay
- Started the data collection sequence
- Loaded the wafer on the chuck for approx. 7 min

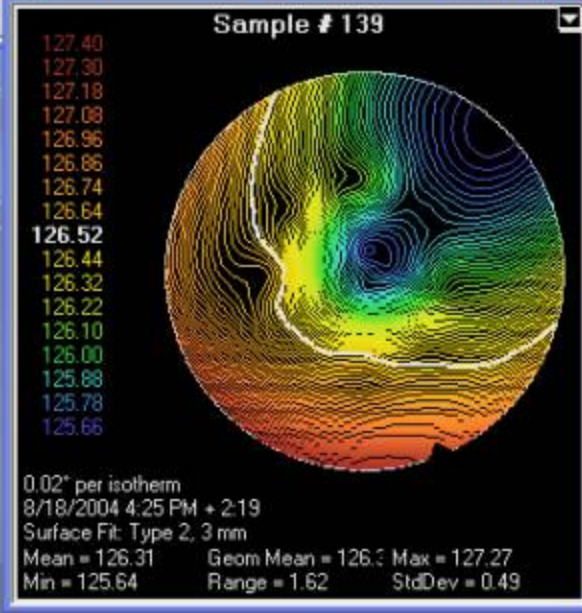




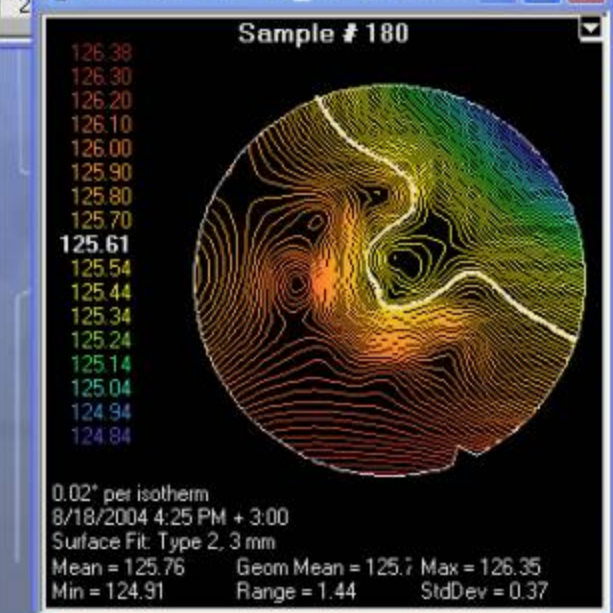


Mean  
Geom Mean  
Max  
Min  
Range  
StdDev

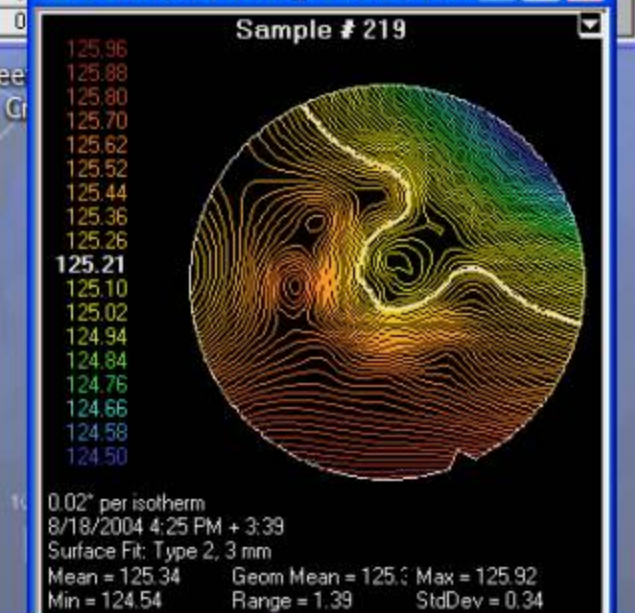
KB4 2004-08-18\_16-24-20....

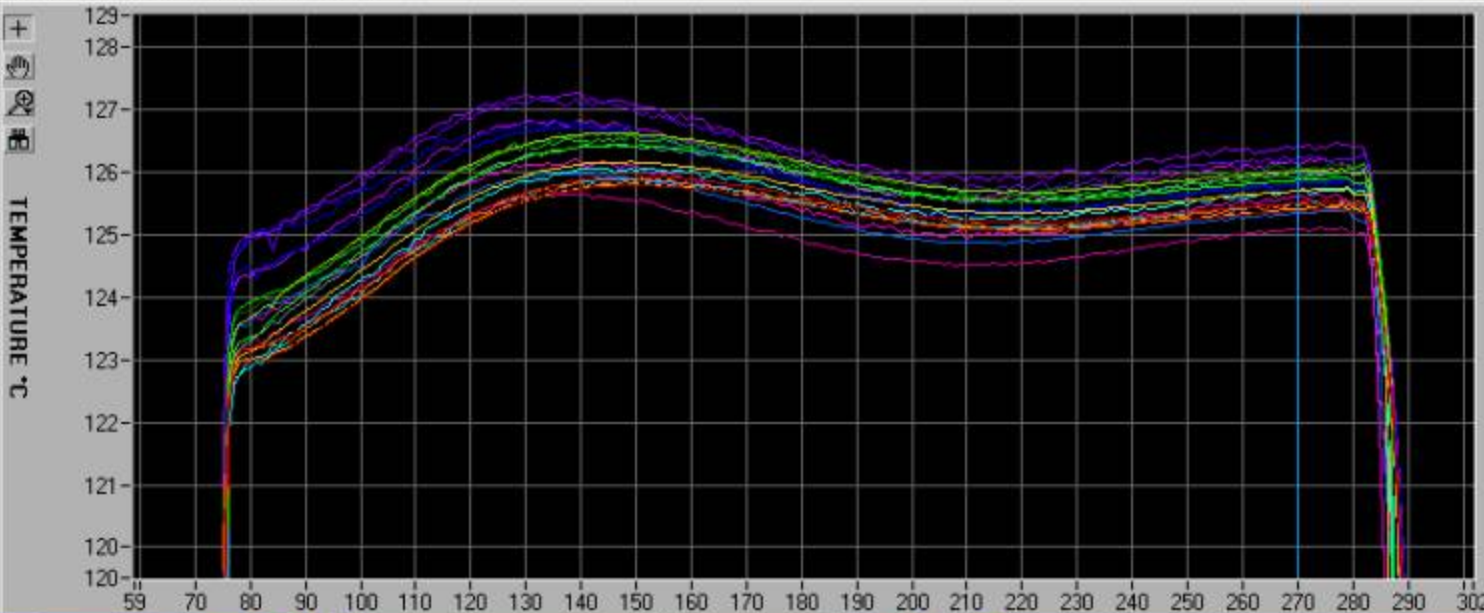
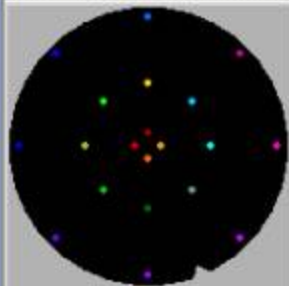


KB4 2004-08-18\_16-24-20....



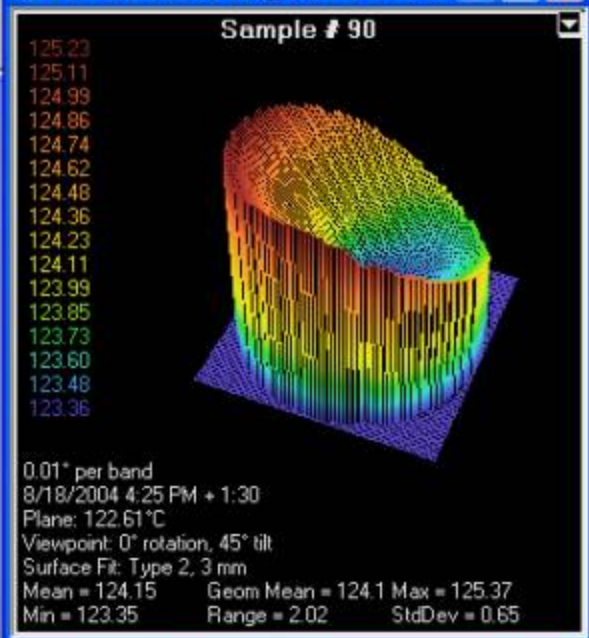
KB4 2004-08-18\_16-24-20....



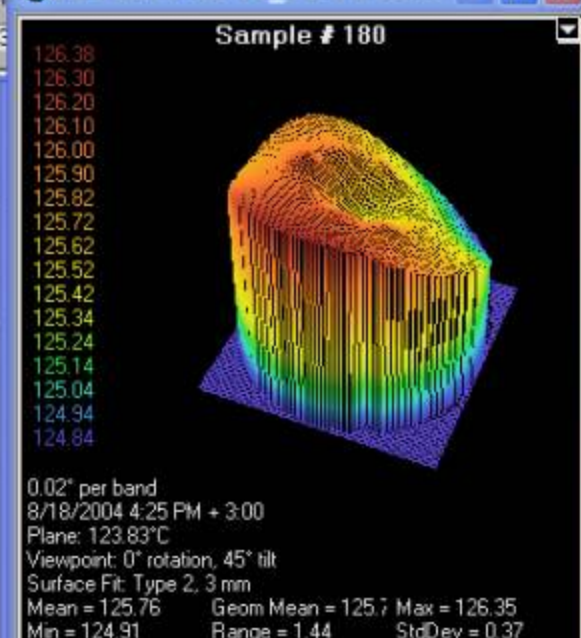


Mean  
Geom Mean  
Max  
Min  
Range  
StdDev

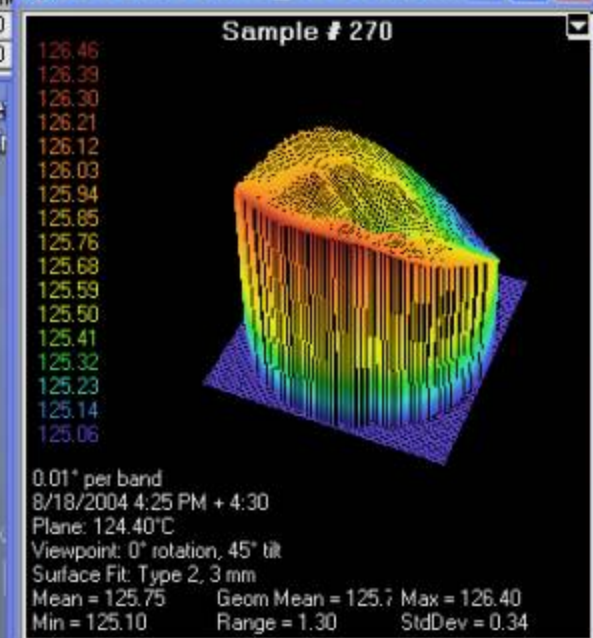
KB4 2004-08-18\_16-24-20....



KB4 2004-08-18\_16-24-20....



KB4 2004-08-18\_16-24-20....

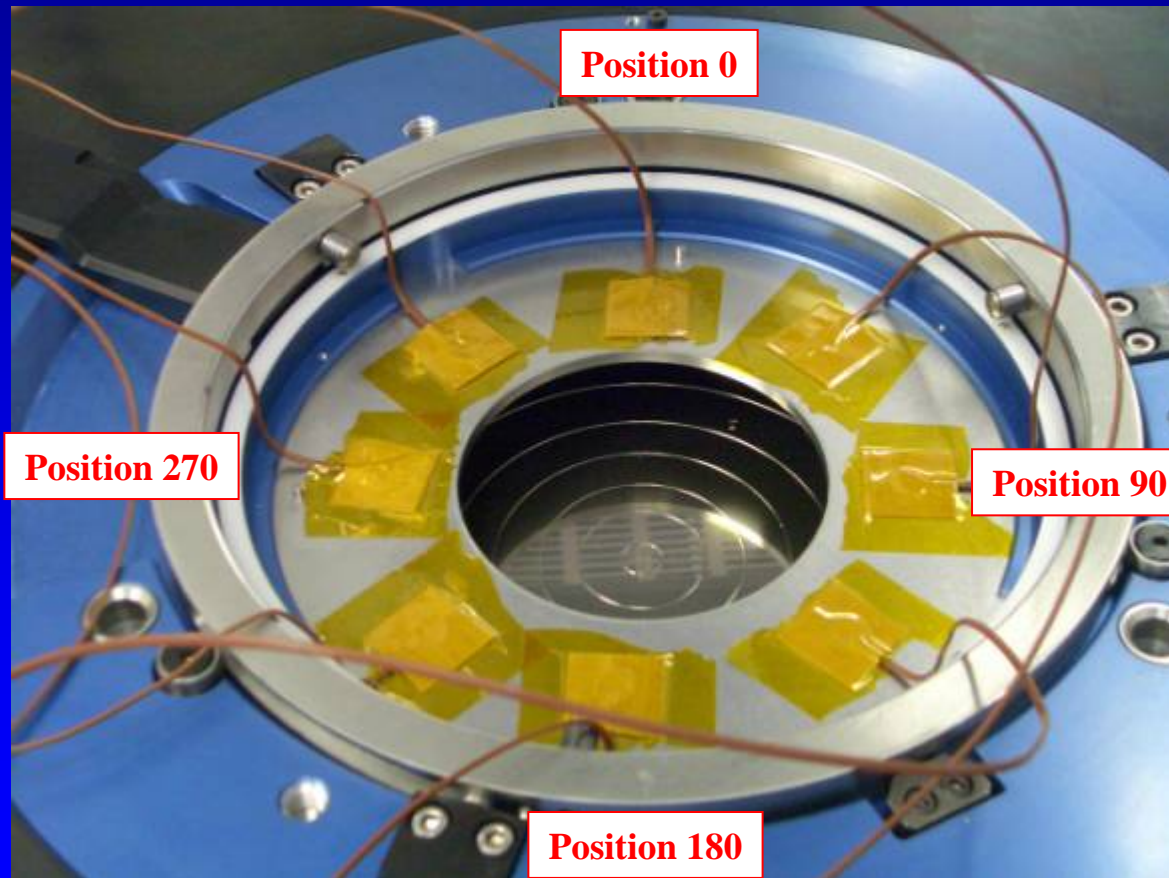


# Interface Temperature

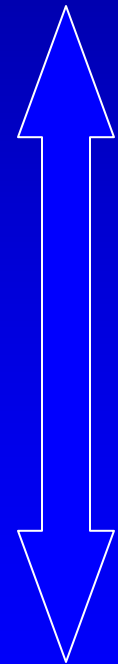
# TKB 197 Thermal Profile

## Standard Steel VLCT Ring

### Thermocouple Setup & Location



**Prober Rear**

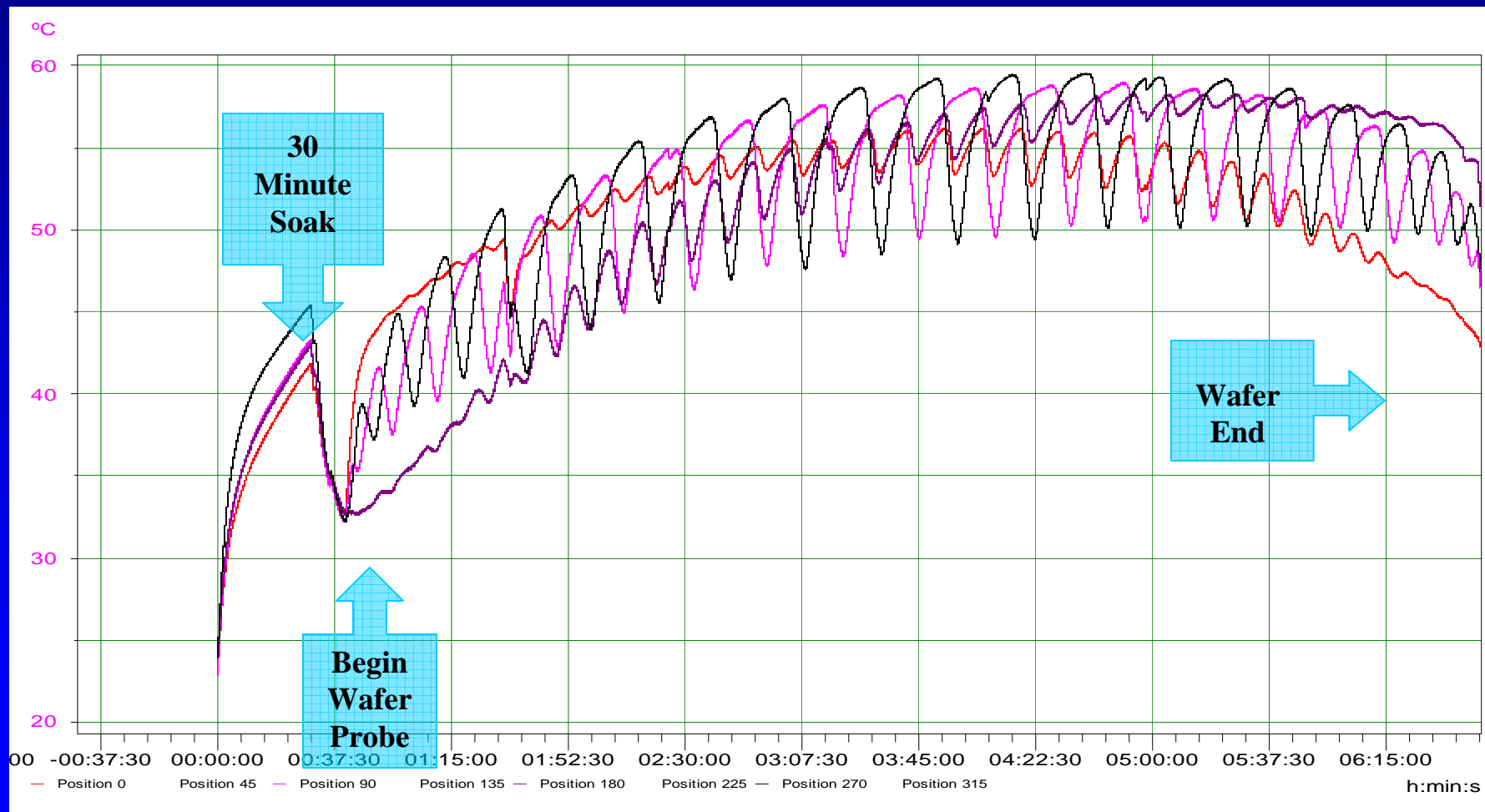


**Prober Front**

# TKB 197 Thermal Profile

Standard Steel VLCT Ring

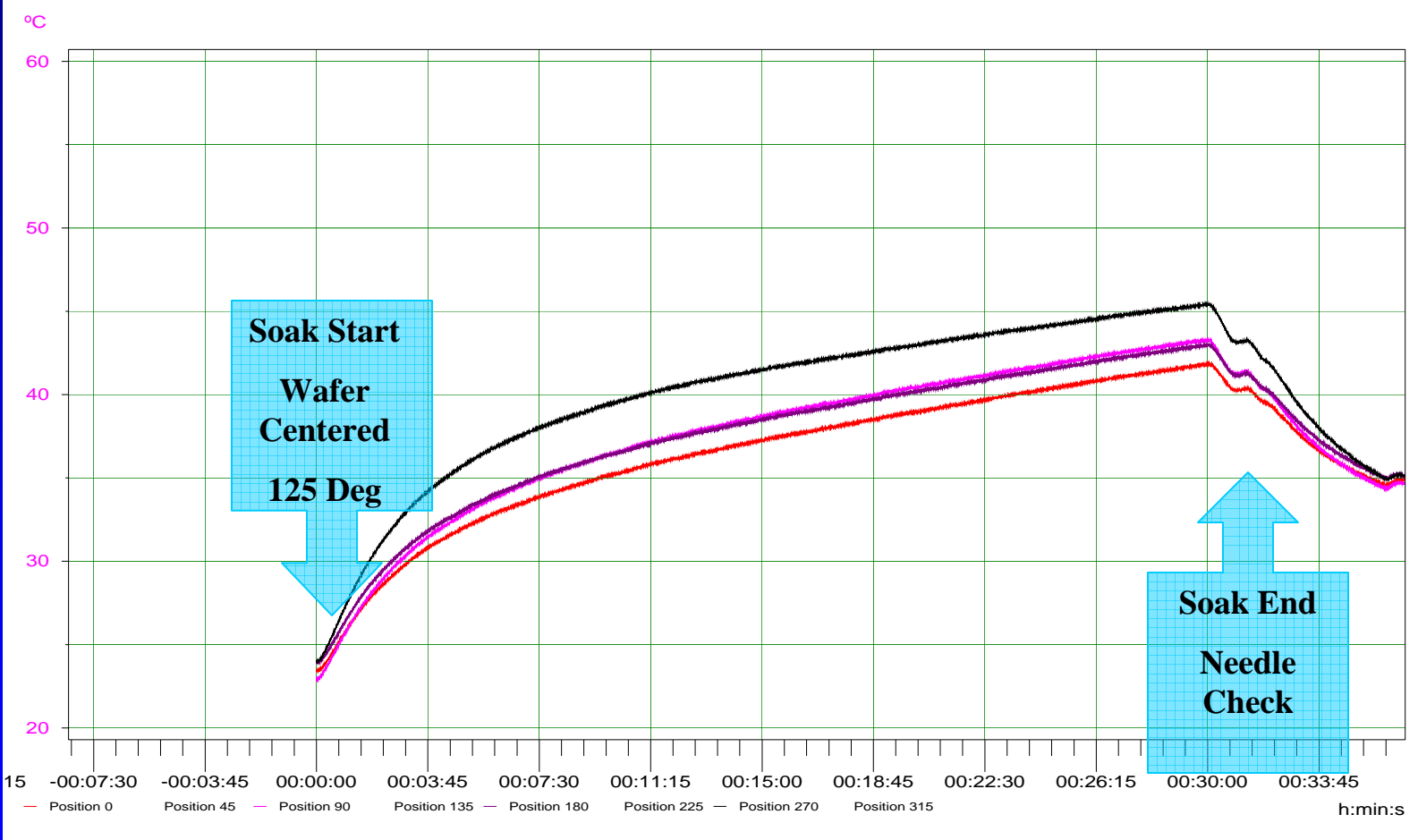
Complete wafer probe



# TKB 197 Thermal Profile

## Standard Steel VLCT Ring

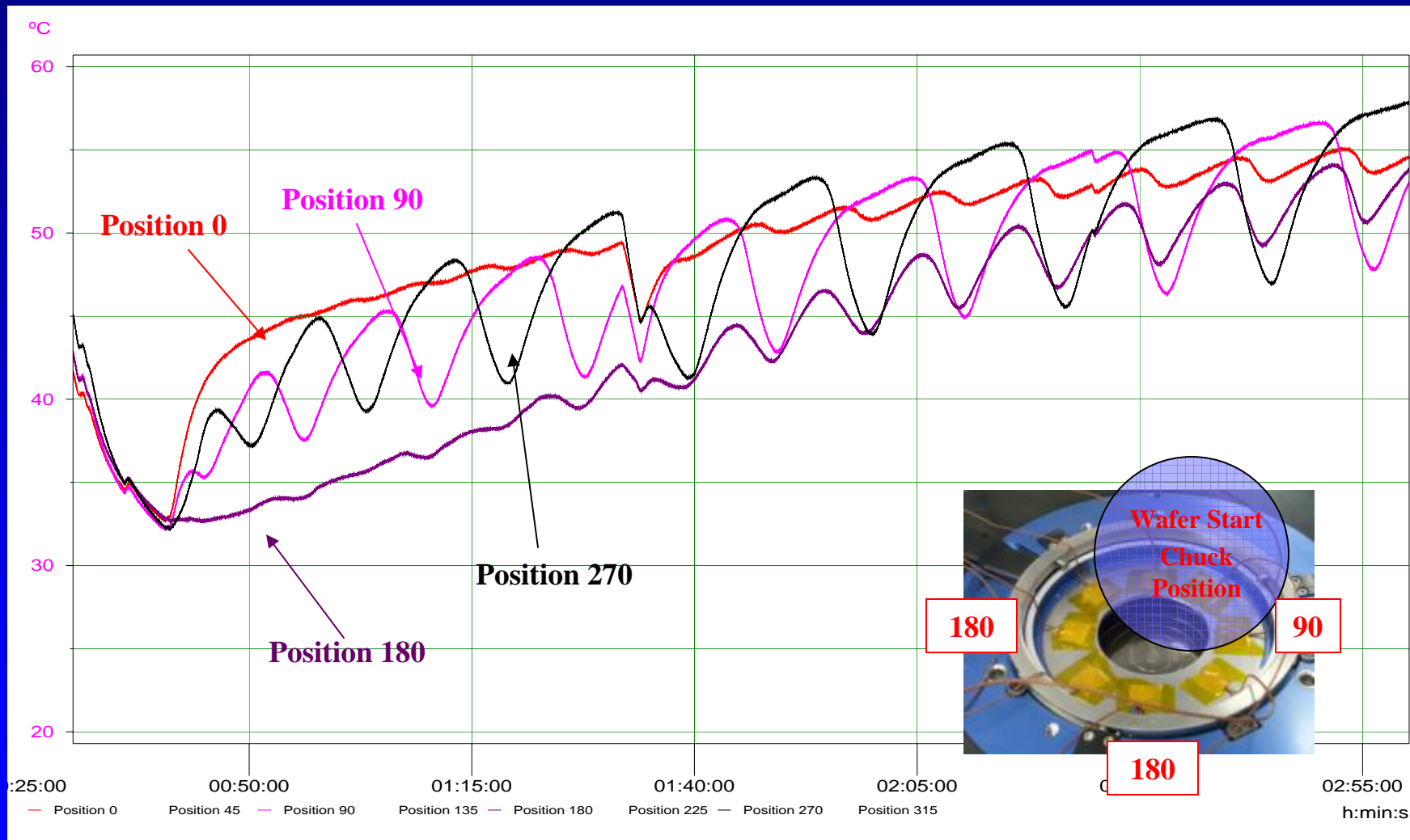
### 30 Minute Soak



# TKB 197 Thermal Profile

## Standard Steel VLCT Ring

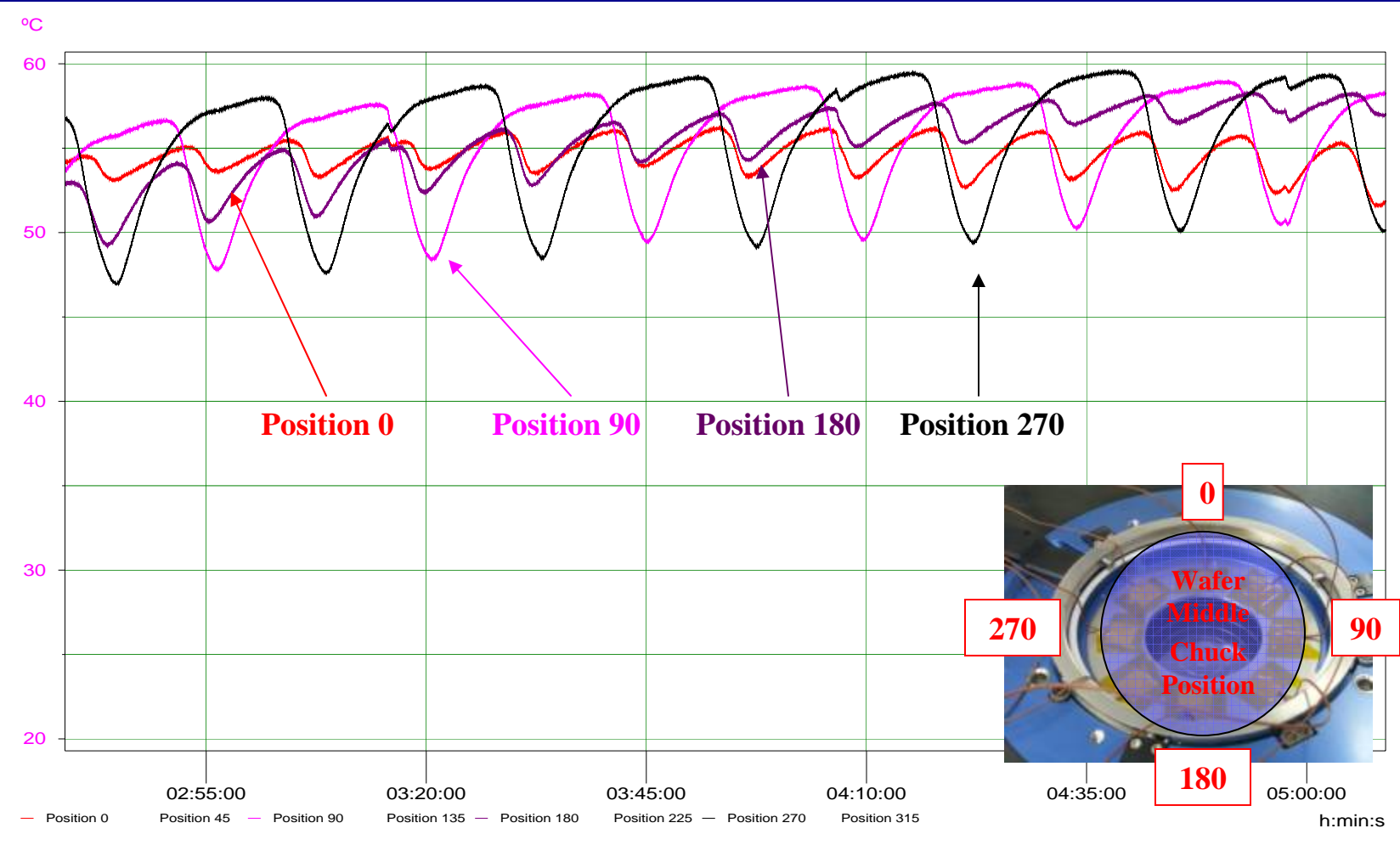
### Beginning of wafer



# TKB 197 Thermal Profile

## Standard Steel VLCT Ring

Middle of wafer

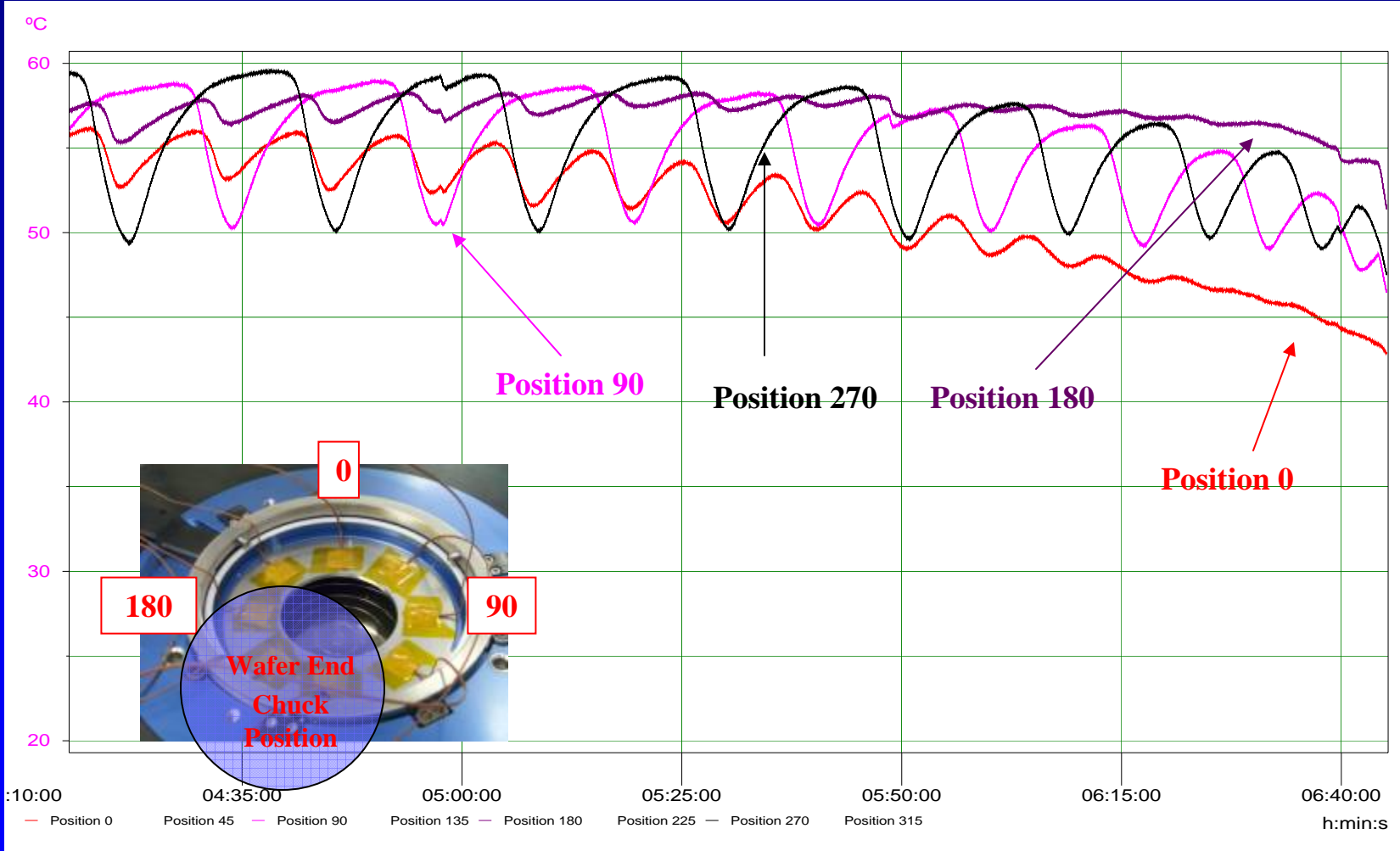




# TKB 197 Thermal Profile

## Standard Steel VLCT Ring

End of wafer

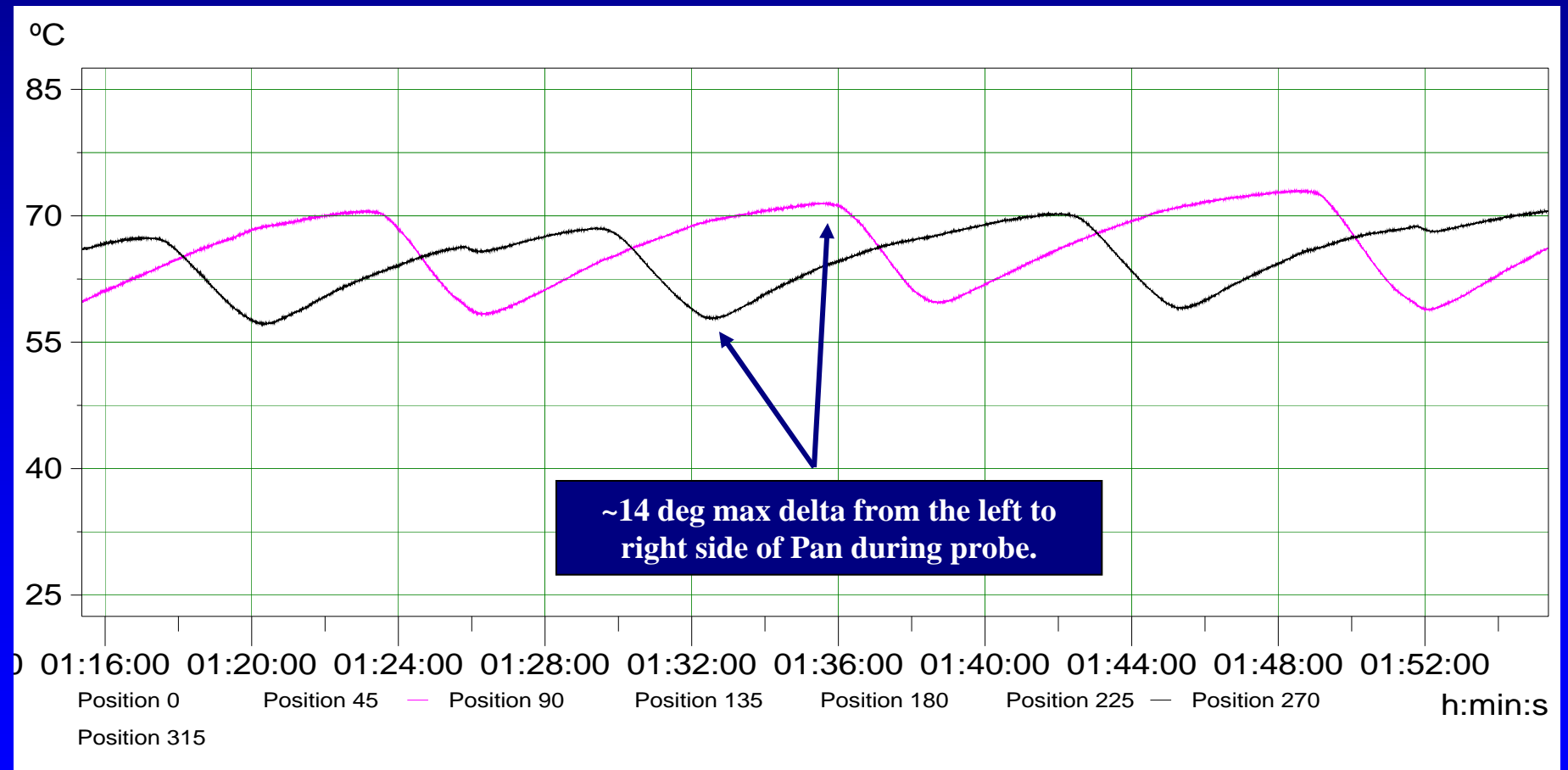


# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

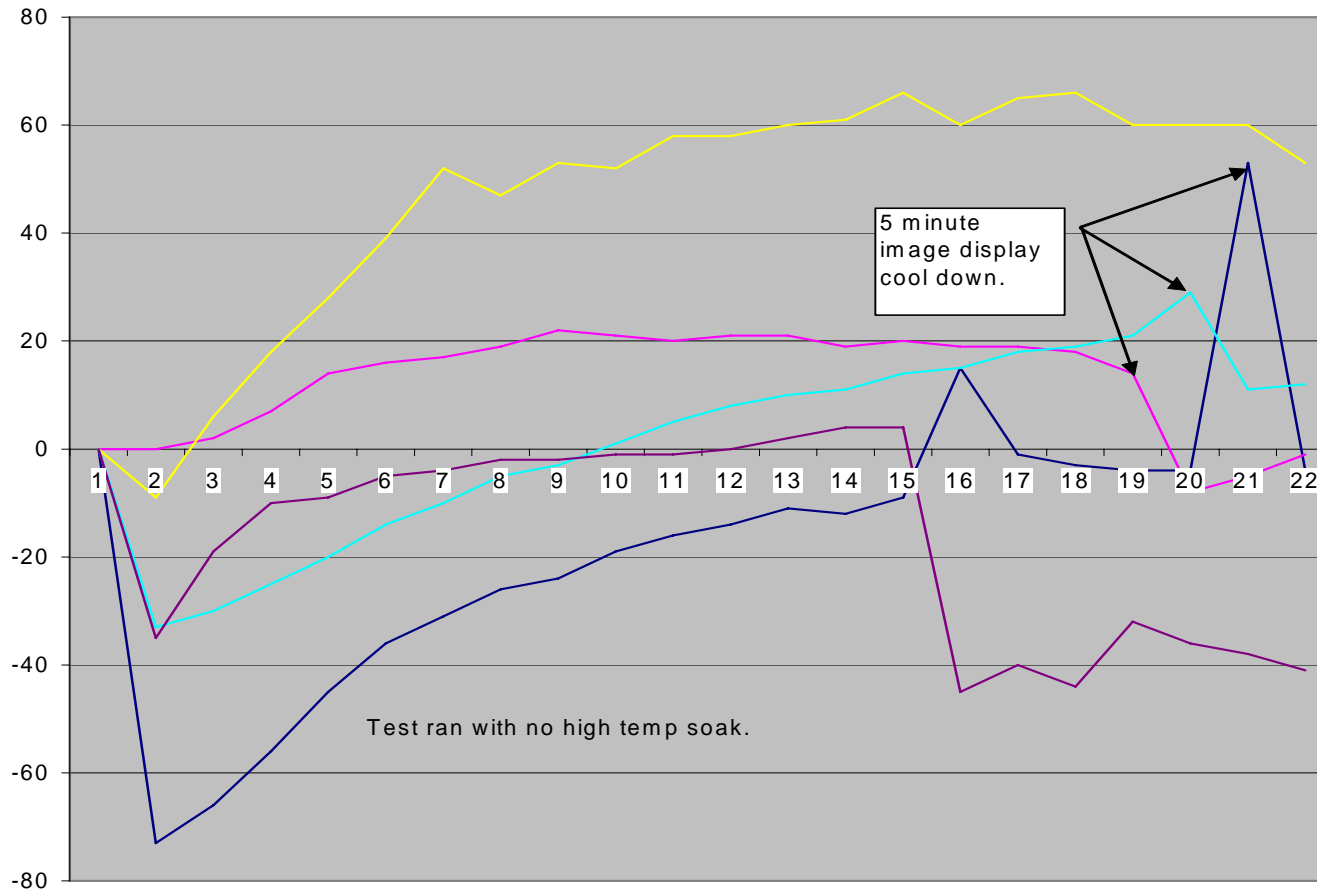
Center of Wafer

Position 90 & 270 Temperature Track



# Interface Movements

Alumina / Blue Ring



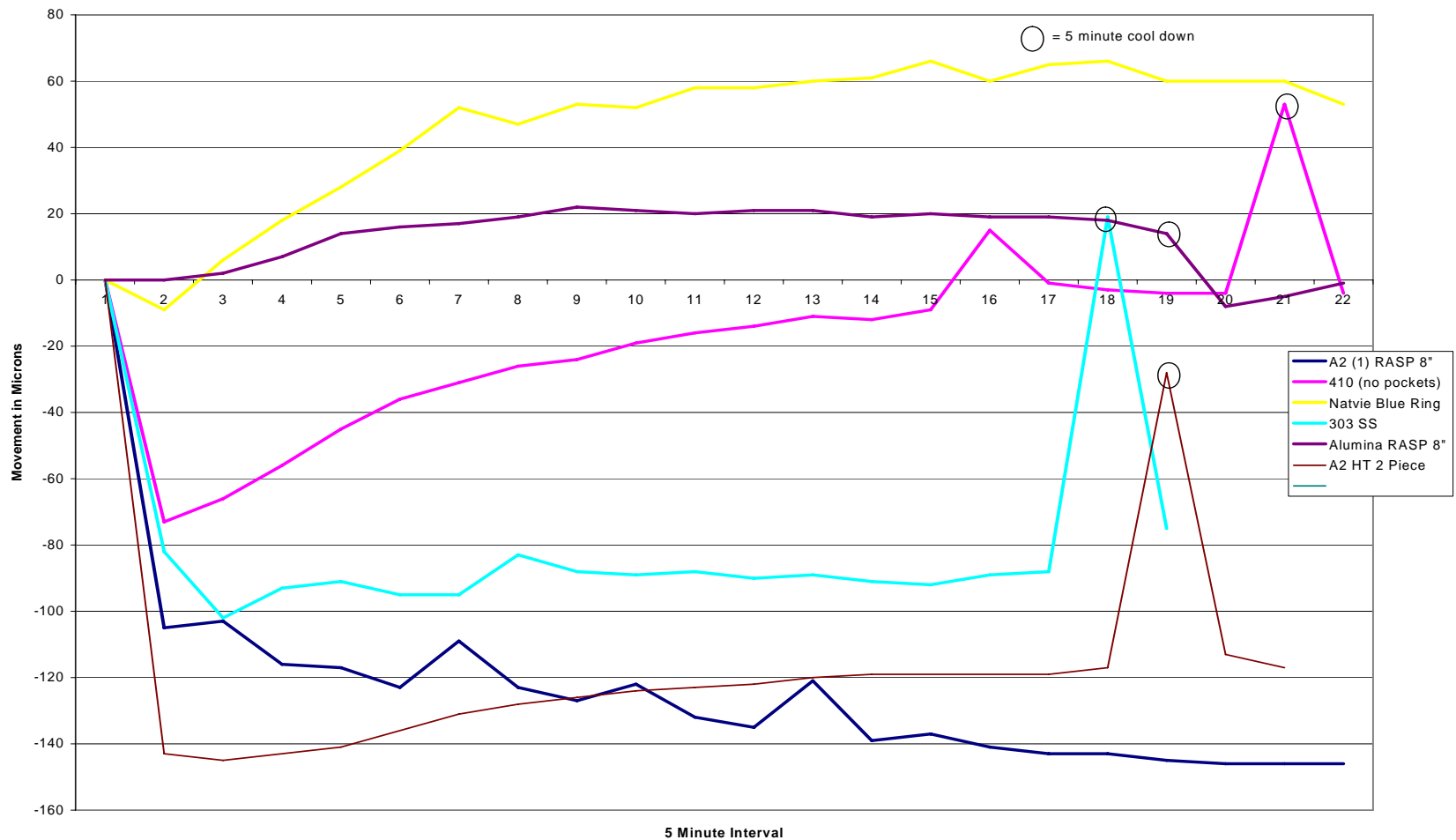
All test were ran with CE 8" UPP8Meg probe card except for Alumina 12" UF200 where a non-high temp leveling card was used.

- 410 (no pockets UF3000)
- Alumina RASP 8" (UF3000)
- Natvie Blue Ring (UF3000)
- Alumina (Pockets 8" UF200)
- Alumina (Pockets 12" UF200)

Note: Blue Ring has an 8" pan. All others were with an 12" pan.

# Interface Material

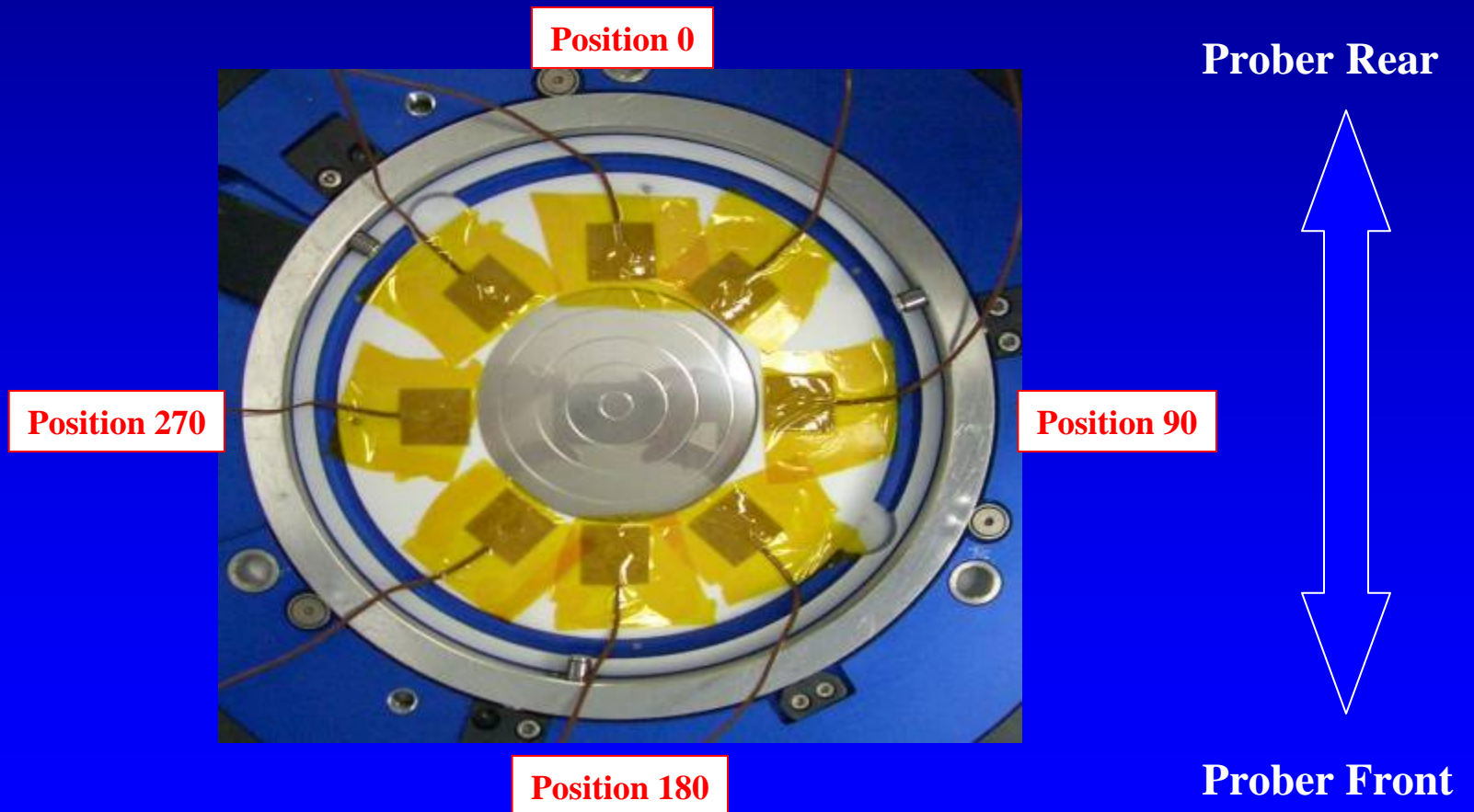
Auto-Z Movement @ 125



# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

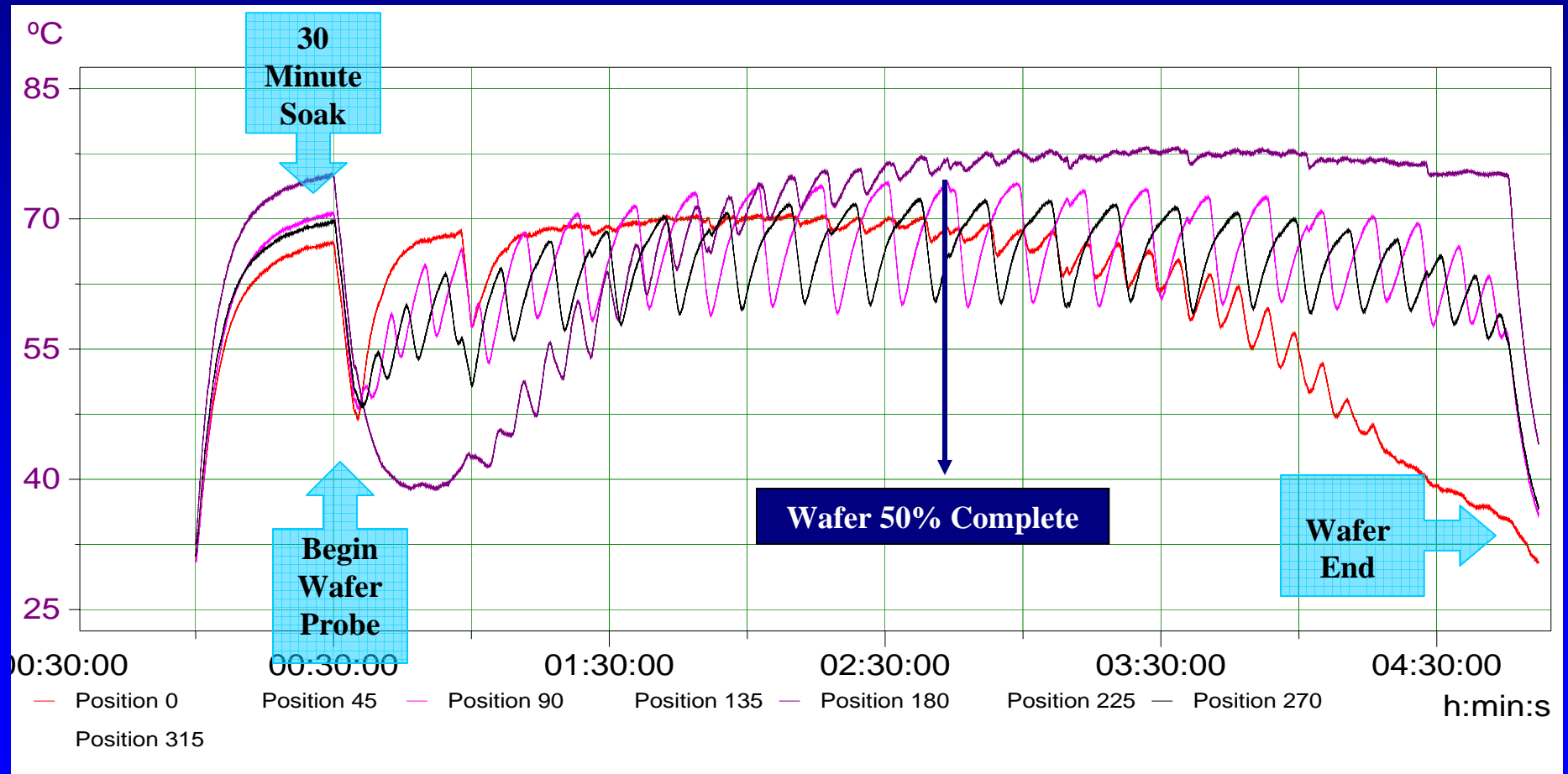
### Thermocouple Setup & Location



# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

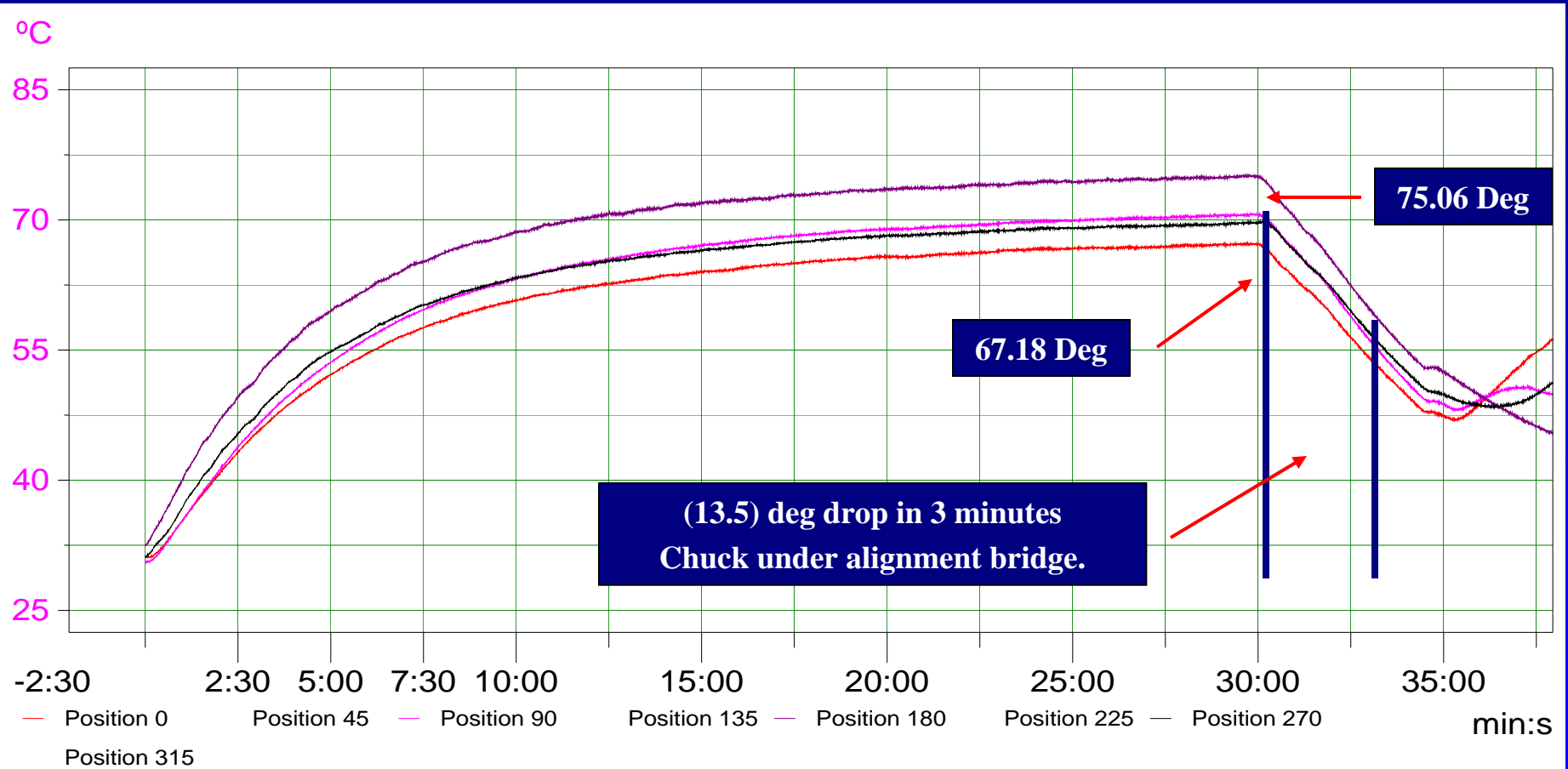
Complete wafer probe



# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

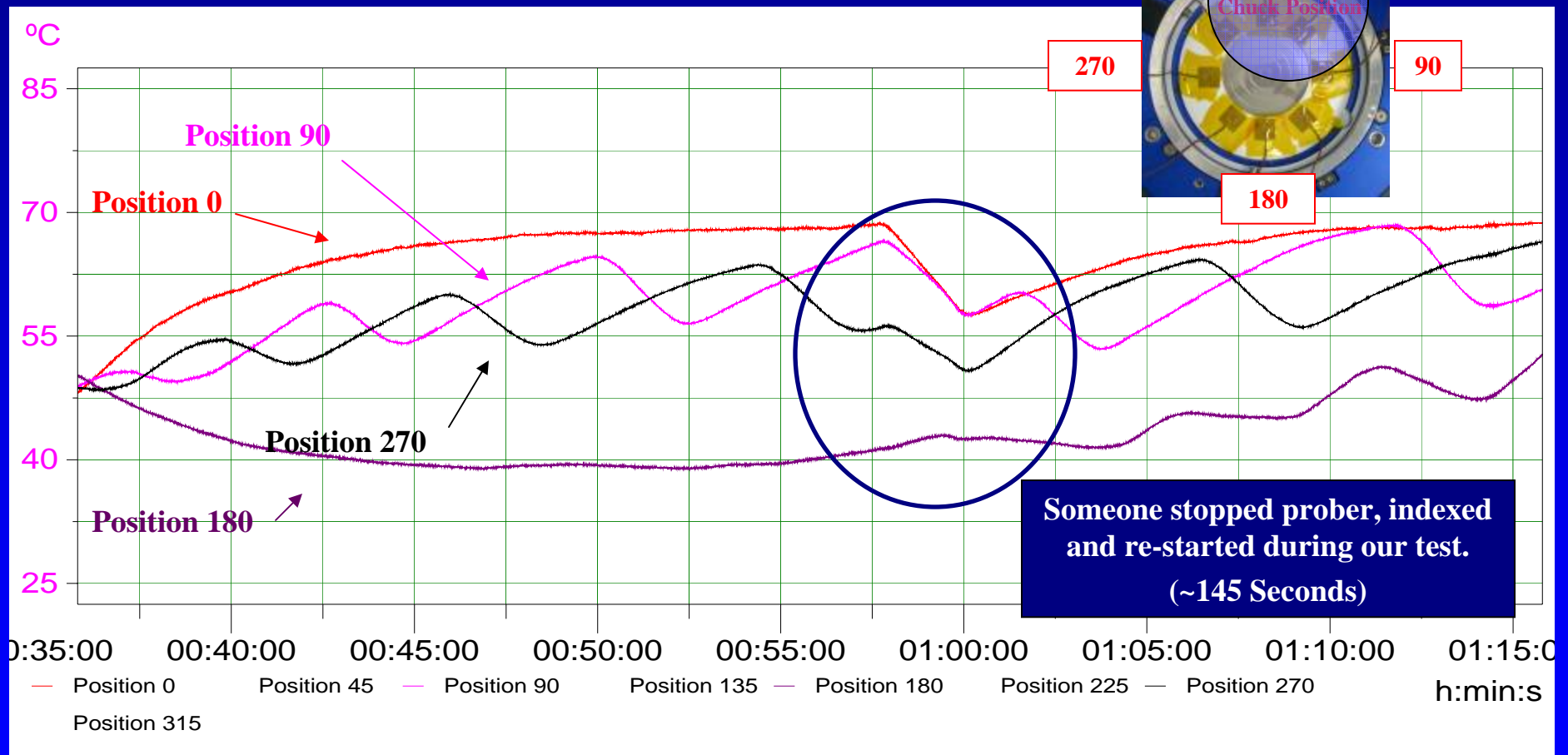
30 Minute Soak



# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

Beginning of wafer

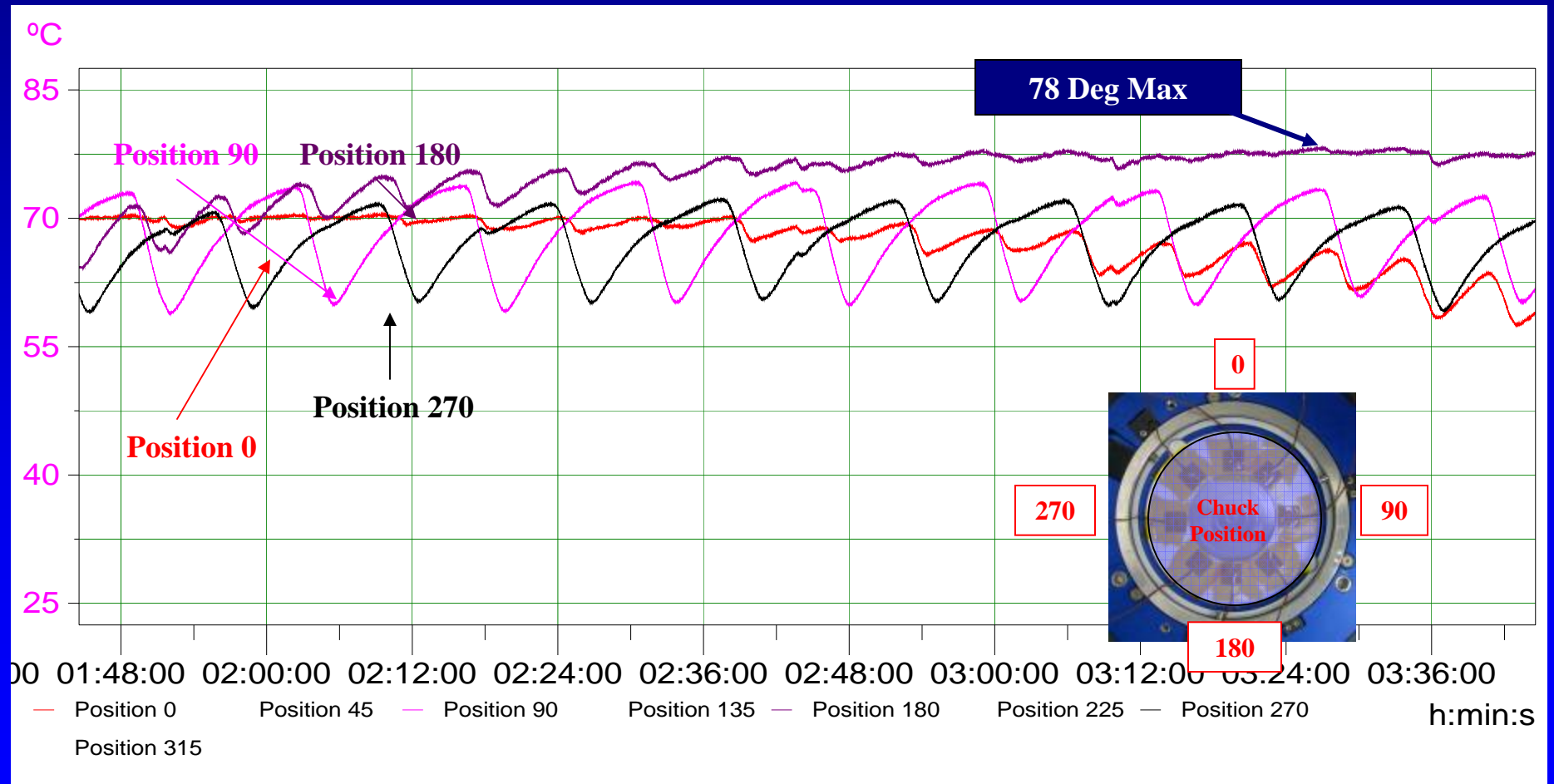




# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

Middle of wafer

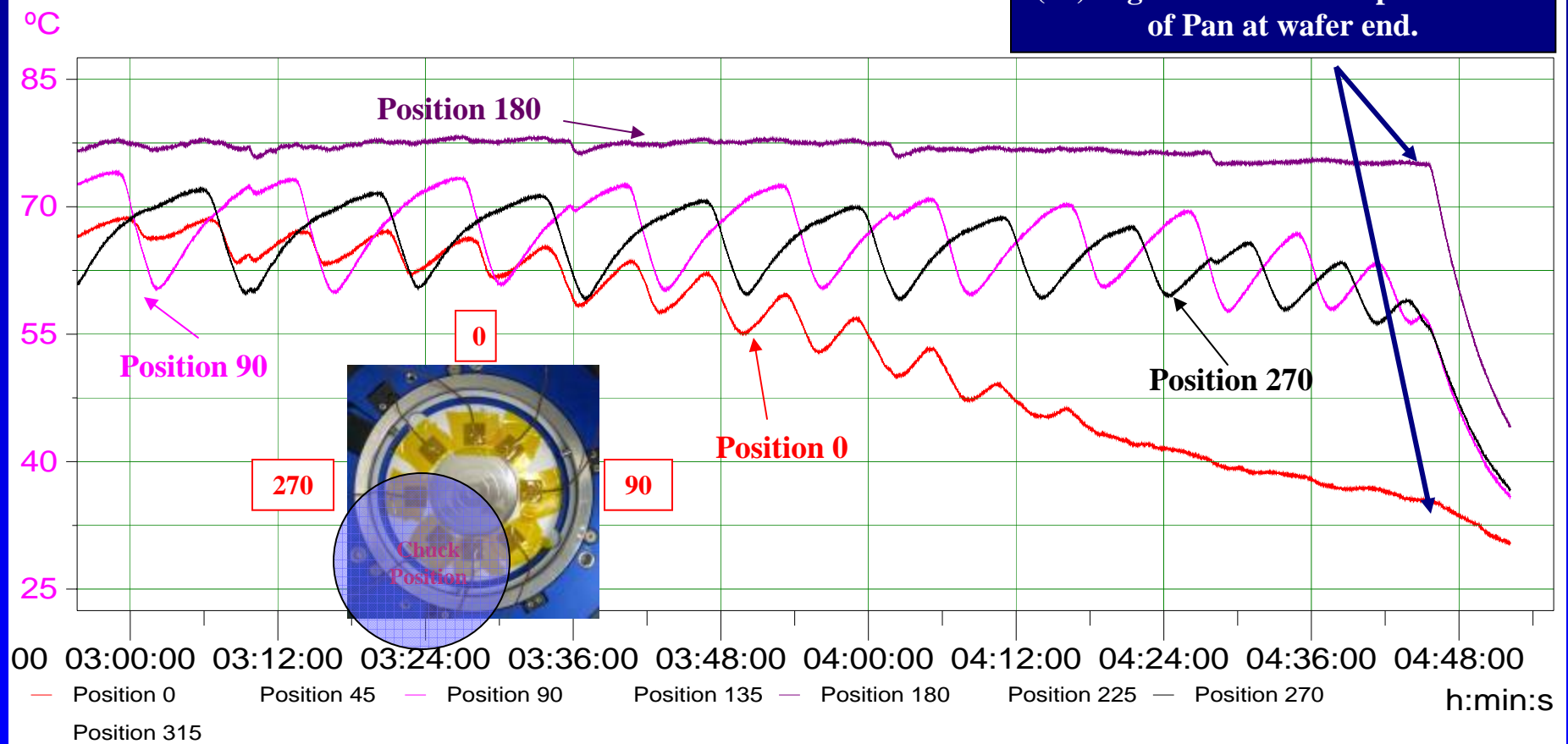


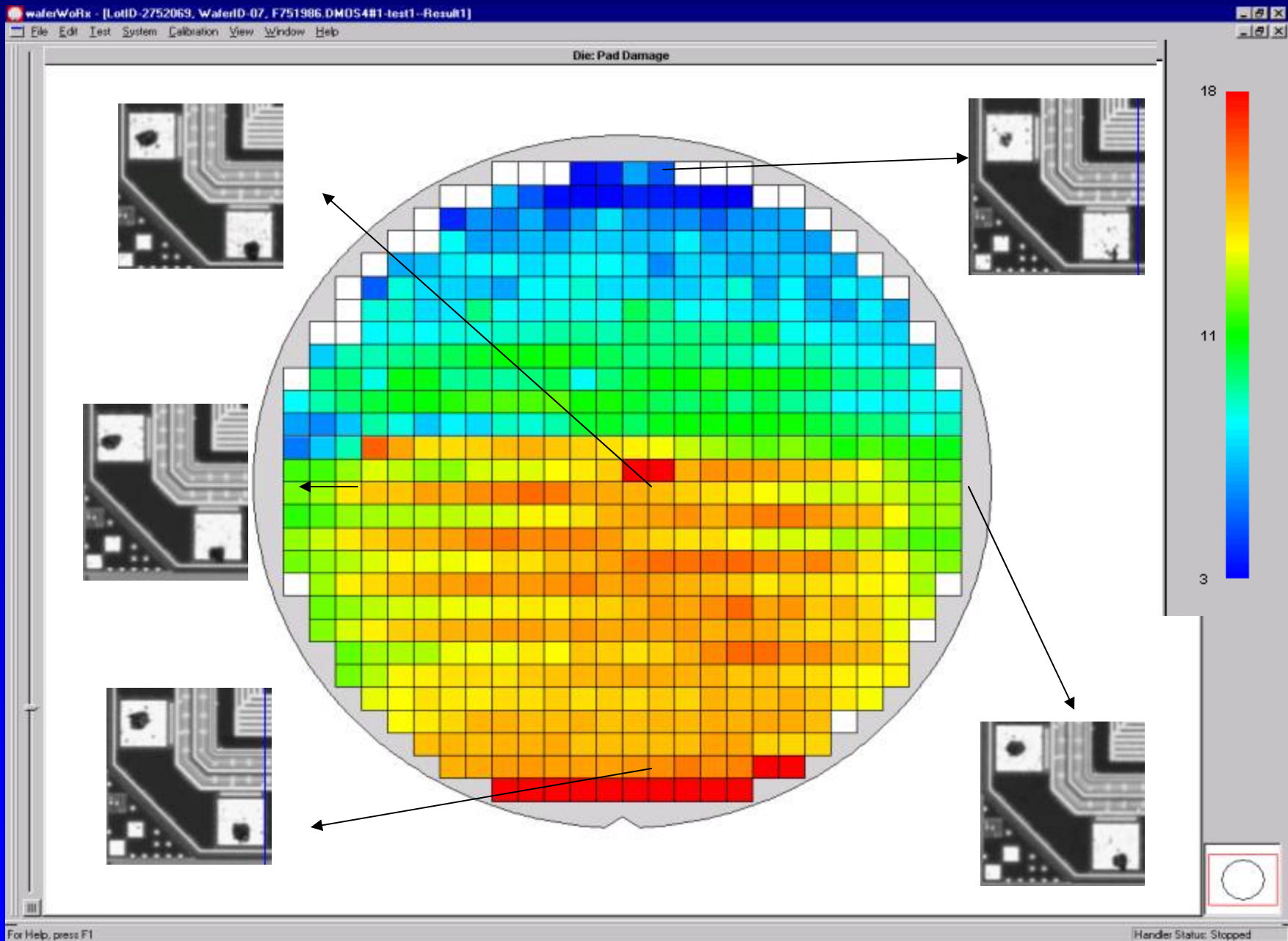
# TKB 195 Thermal Profile

## Standard VLCT Ring with Ceramic Pan

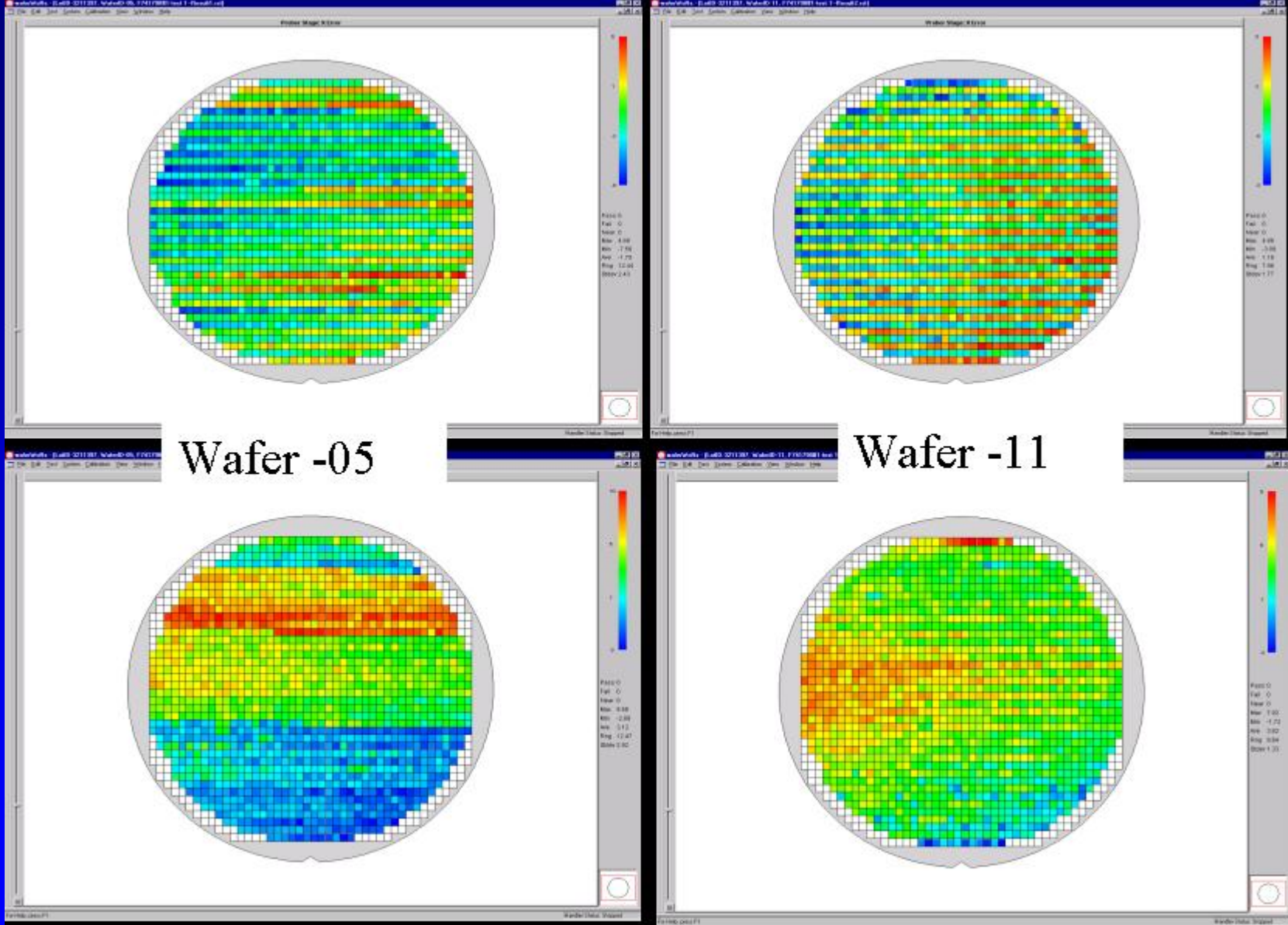
End of wafer

(40) deg delta from the top to bottom of Pan at wafer end.



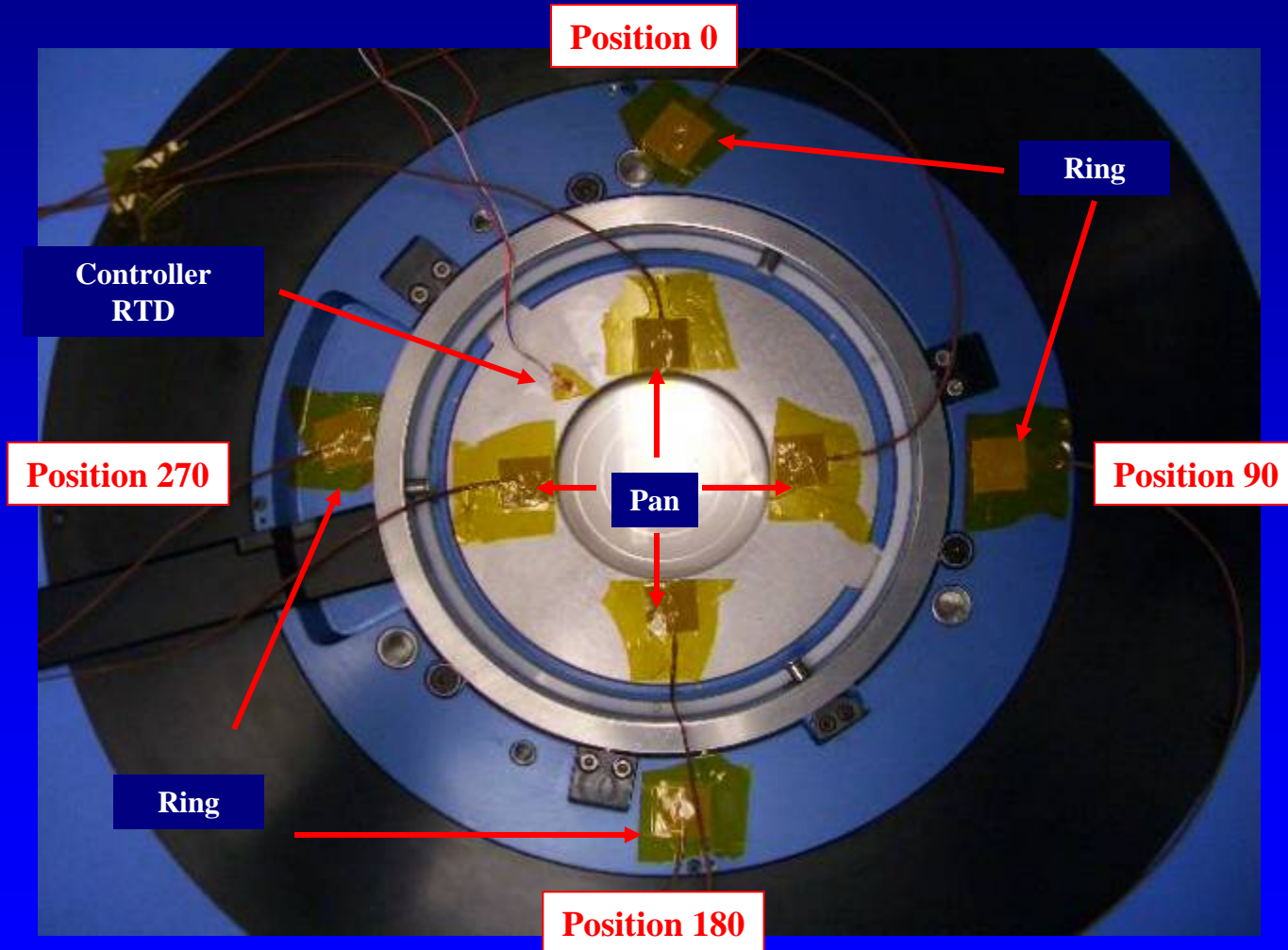


# X and Y Error



# Thermal Profile

Standard VLCT Ring with Thermofoil Heater  
TKB 196 Sensor Positions



# Heater Setup

## Standard VLCT Ring with Thermofoil Heater

### Bottom side of VLCT Pan

**Minco Thermofoil Heater**

**Part# HK5556R97.4L36B**

**8.25" OD, 4.32" ID**

**97.4 Ohm Element**

**Cost: \$111.25 (Qty 1-24)**

**Standard Product**

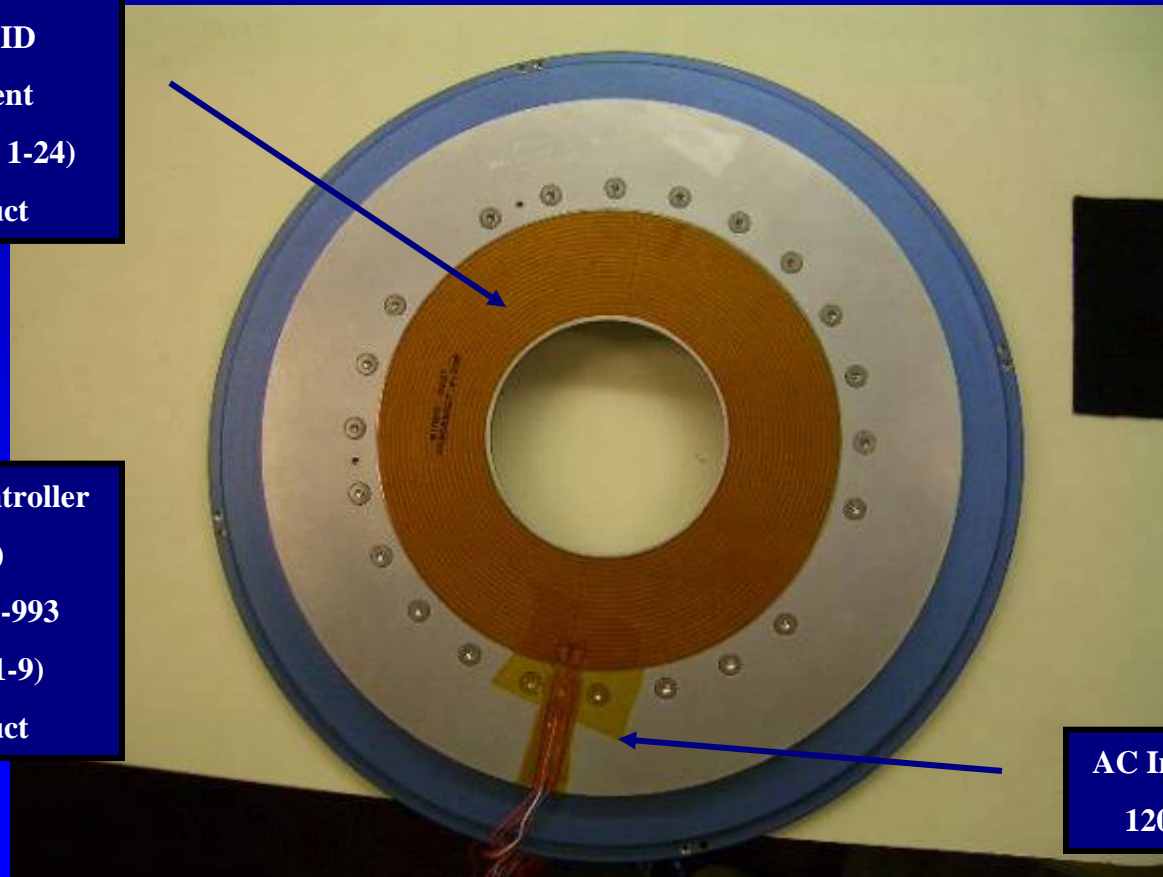
**Minco Thermal Controller**

**(Not Pictured)**

**Part# CT16A2010-993**

**Cost: \$241 (Qty 1-9)**

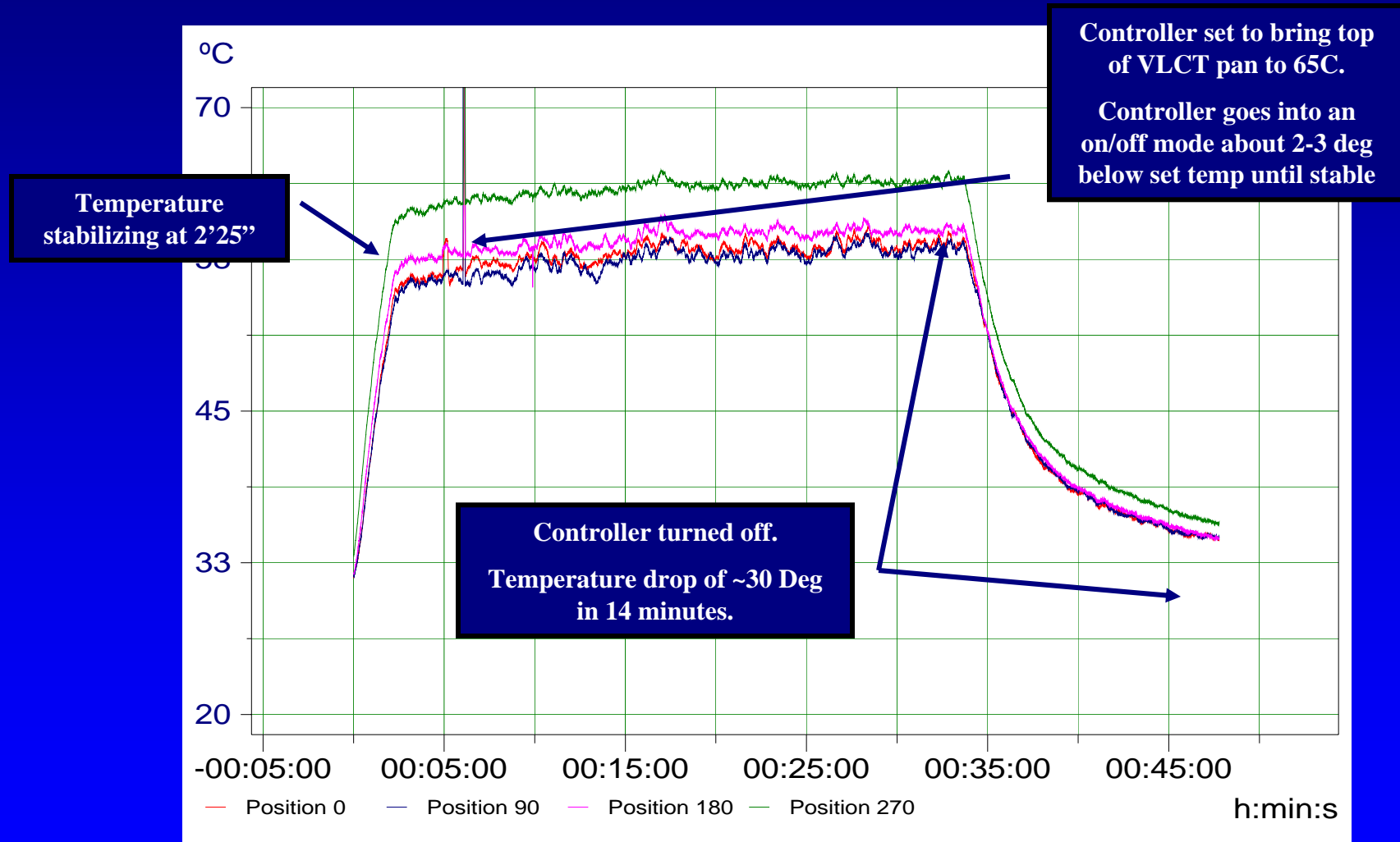
**Standard Product**



**AC Inputs From Controller**  
**120 VAC, Max 3 Amps**

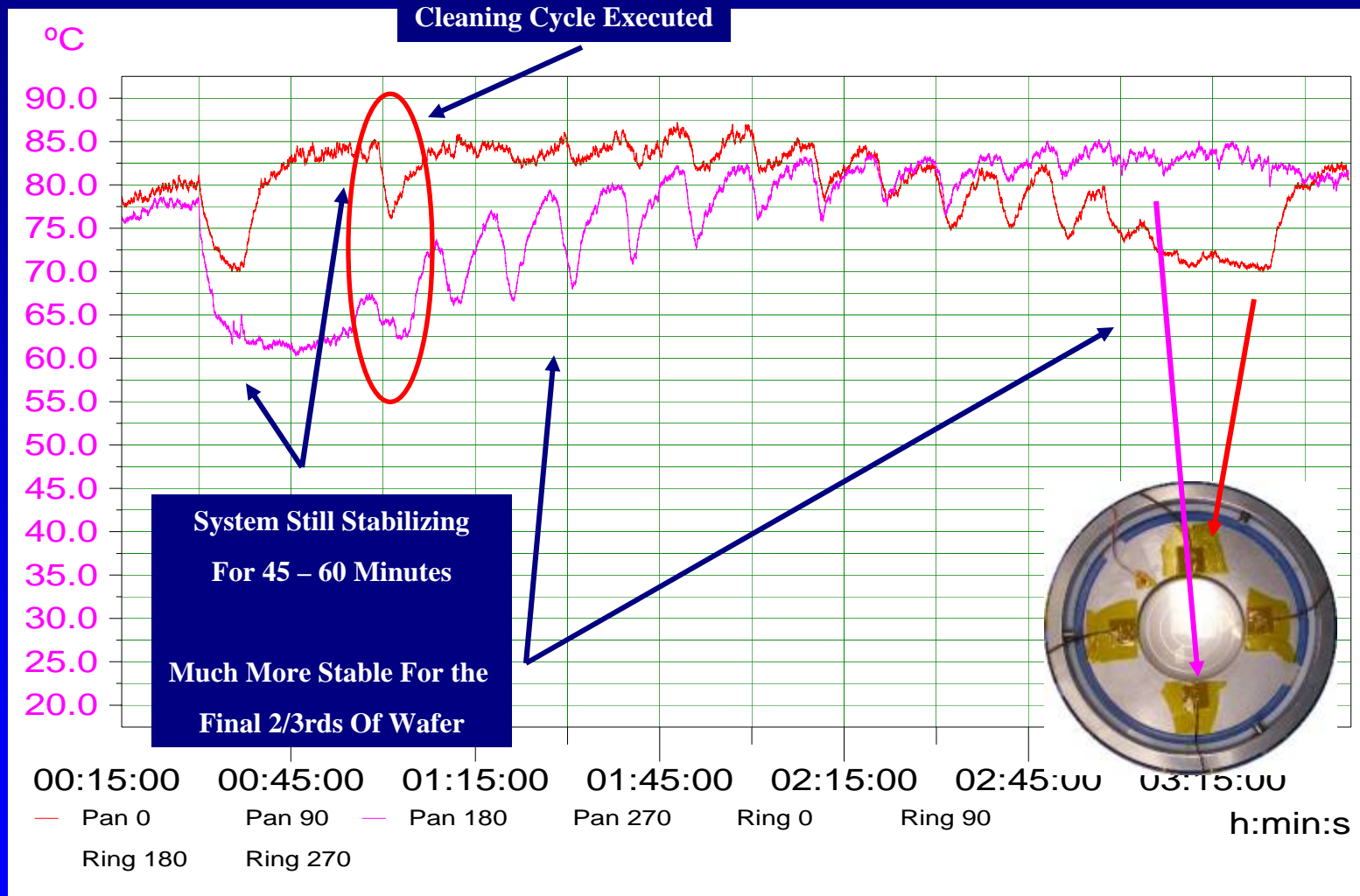
# Thermal Profile

## Standard VLCT Ring with Thermofoil Heater Stand Alone Test



# Thermal Profile

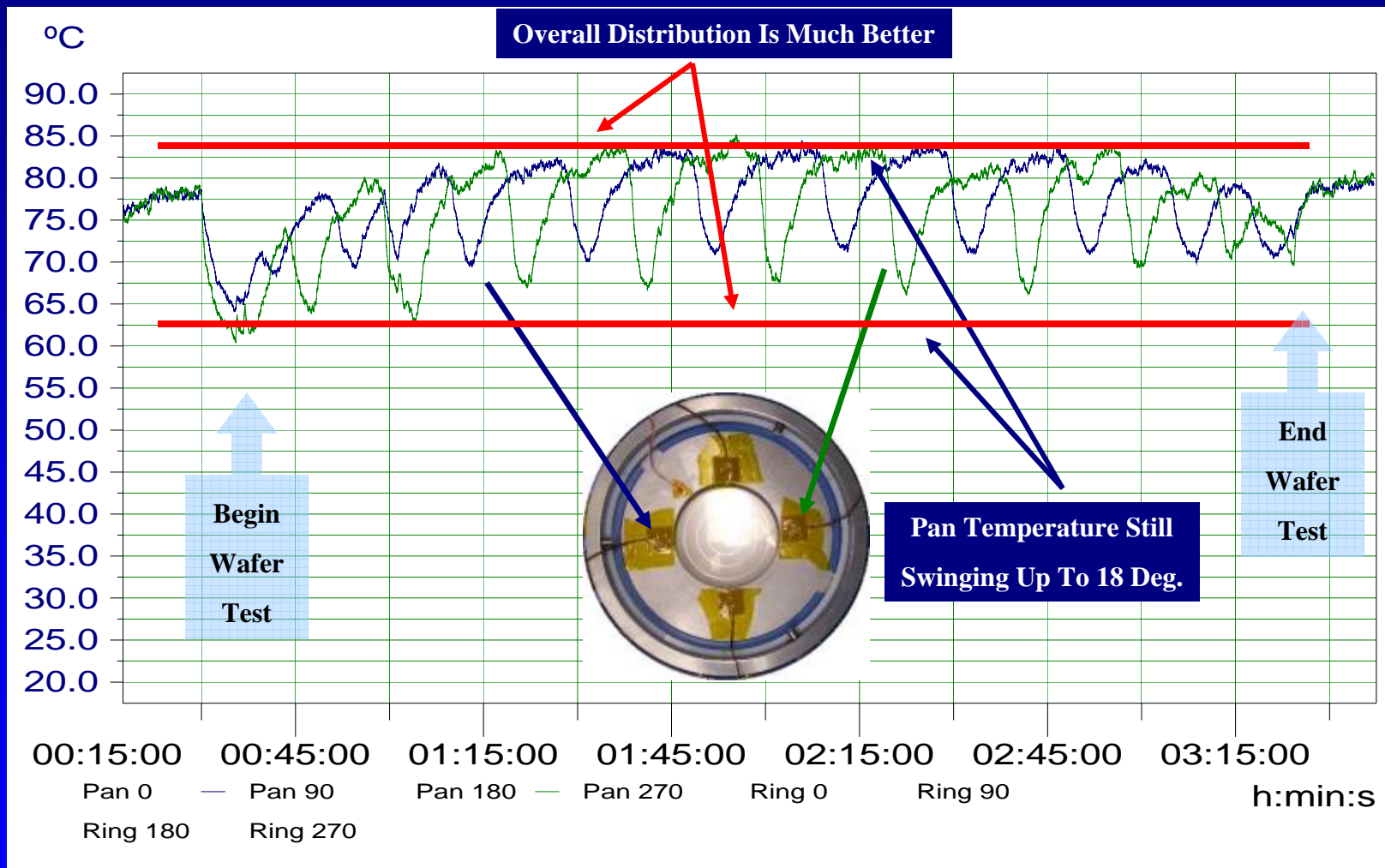
## Standard VLCT Ring with Thermofoil Heater Complete Wafer Probe





# Thermal Profile

Standard VLCT Ring with Thermofoil Heater  
Complete Wafer Probe

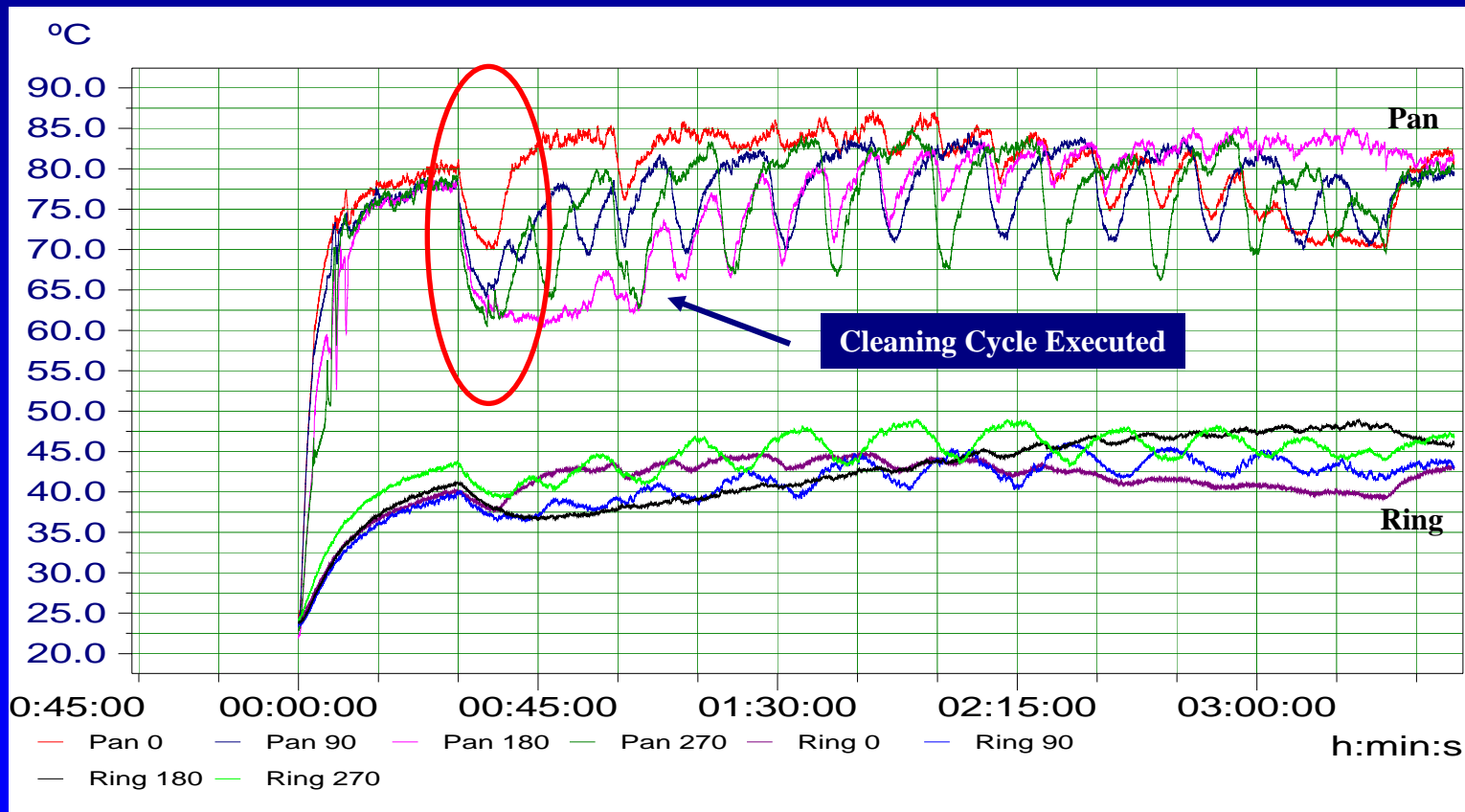


# Thermal Profile

## Standard VLCT Ring with Thermofoil Heater Complete Wafer Probe

Thermofoil heater was on 100% of the time.

Max output for this setup.



# In-line Inspection

# Operator Inspection

Probe Marks Verification (2.1)

This is a periodic check to confirm that probe marks have been checked.

Please enter ITSS id and Password to continue.

ITSS ID:

ITSS Password:

Continue

Start Time: 16:40:17 -- Elapsed 00:07

Probe Marks Verification (2.1)

Please check probe marks. What adjustments were made if any?

Moved marks left (um)  Moved marks right (um)

Moved marks up (um)  Moved marks down (um)

No adjustments

Please select reason for adjustment: Enter Additional Comments Here:

<<MUST CHOOSE ONE>>

Marks look good, no adjustments

Marks were within 4um spec, mac

Marginal alignment, no room for

Marks close to PO

Current marks breaking PO

Other

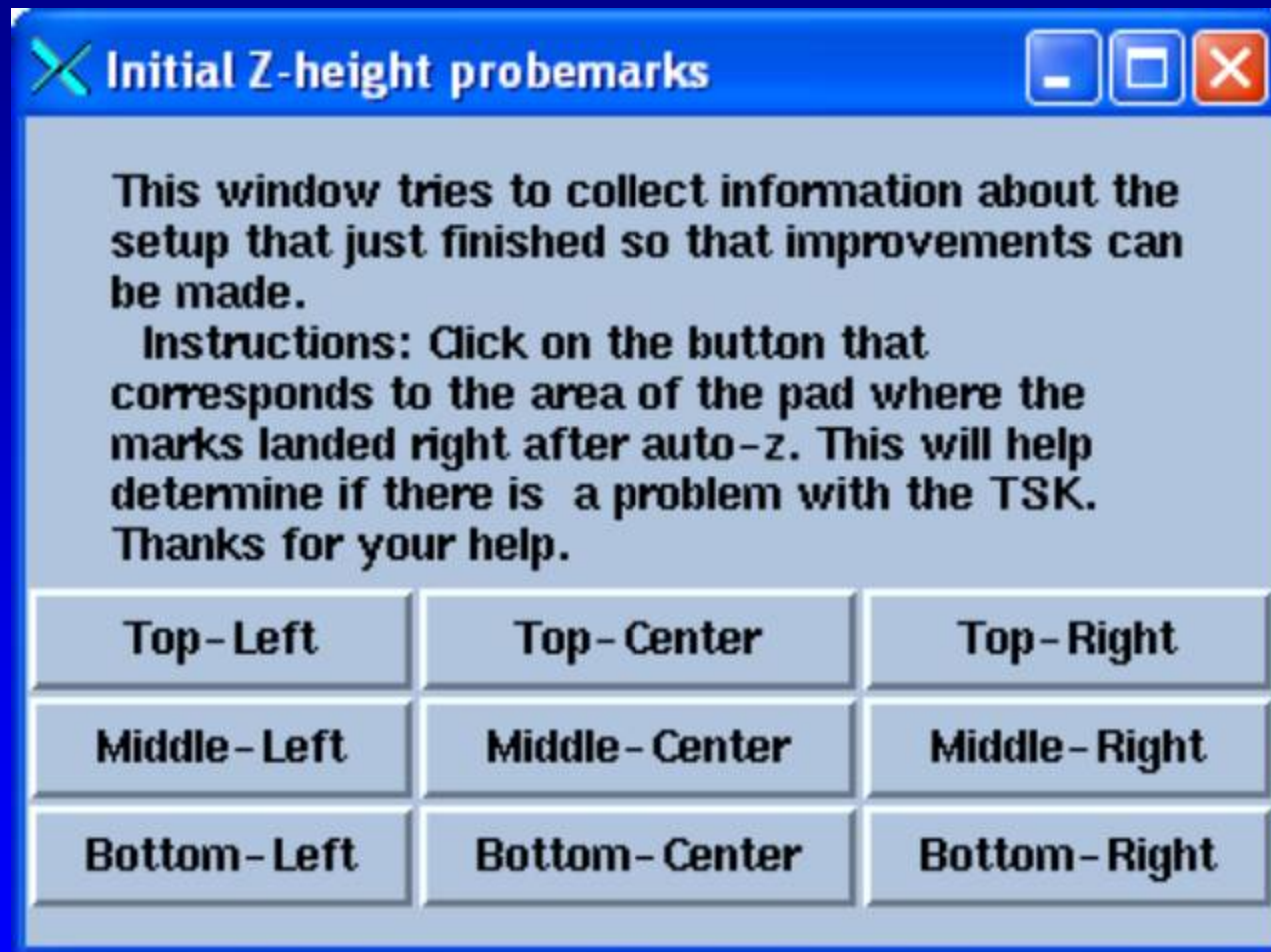
breaking PO?  YES  NO

ak PO?  YES  NO

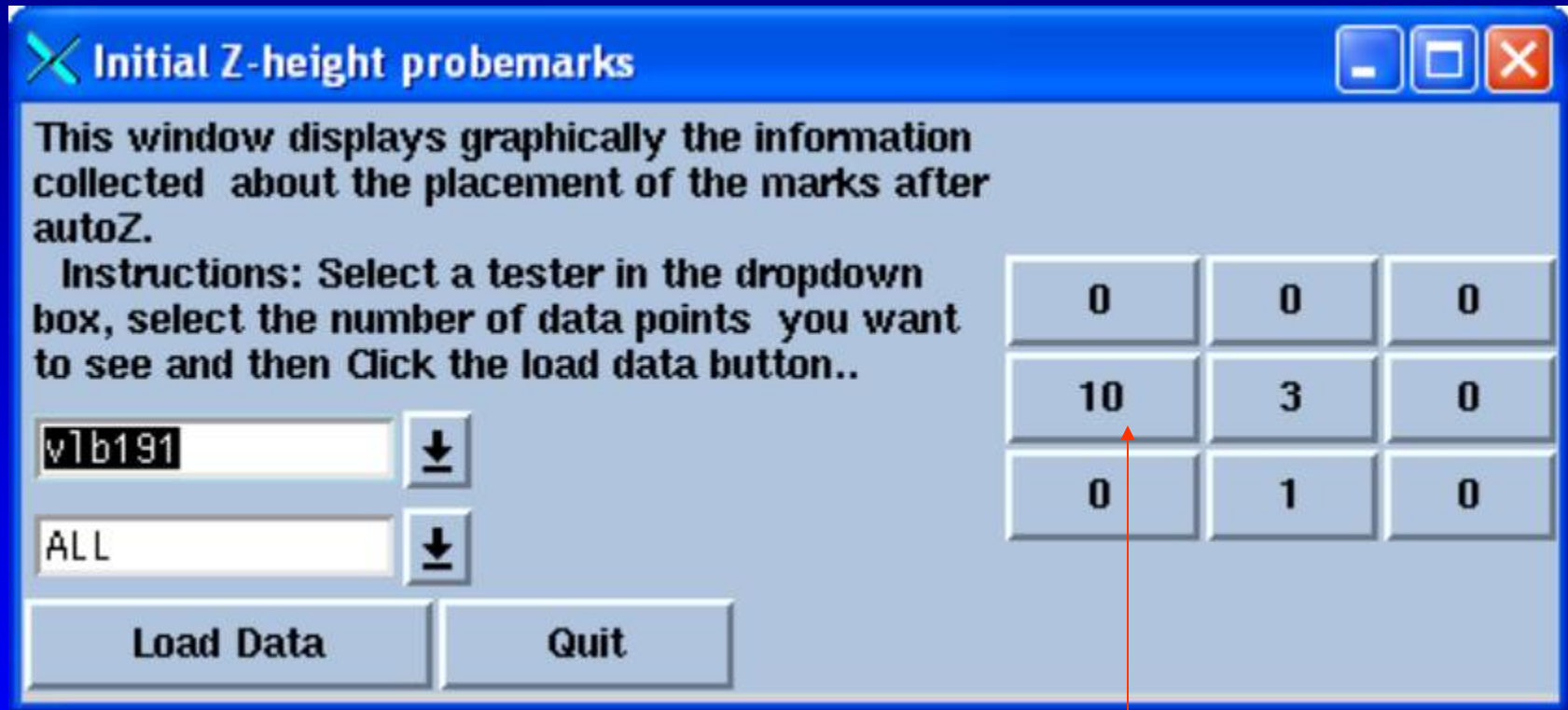
an audit

Continue

# Utility



# Utility to view results.

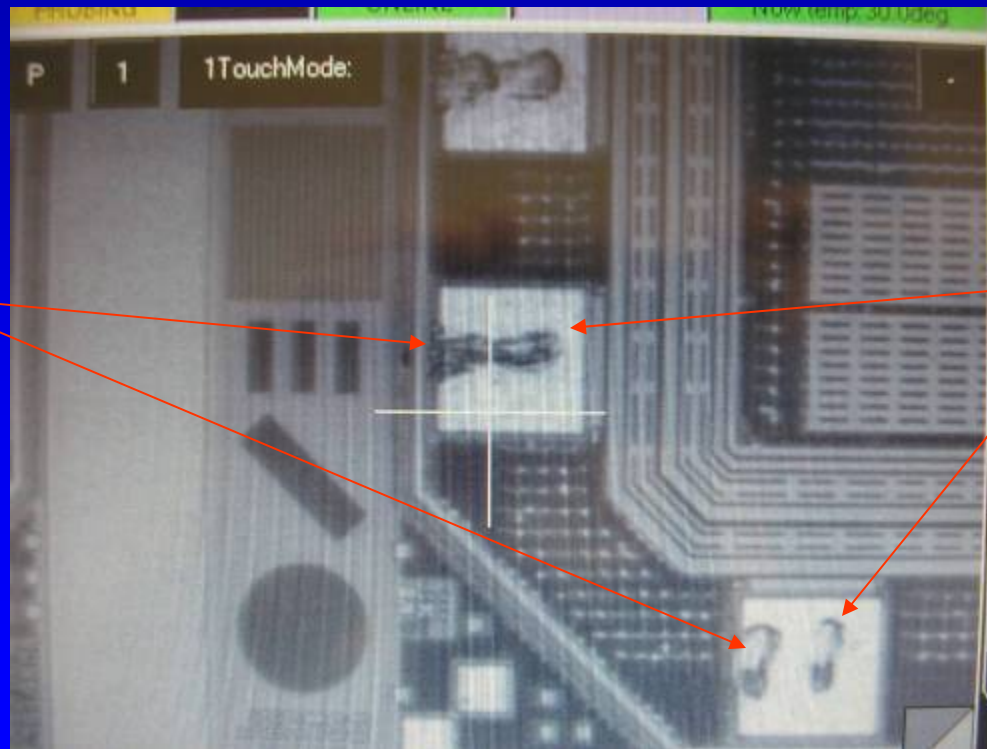


This tester aligned 10 times on the edge of the pads. A PE redid the setup and verified that there was a problem. EE corrected the problem based on PE input and data. (Focal X beam position had values corrected).

# Camera Calibration

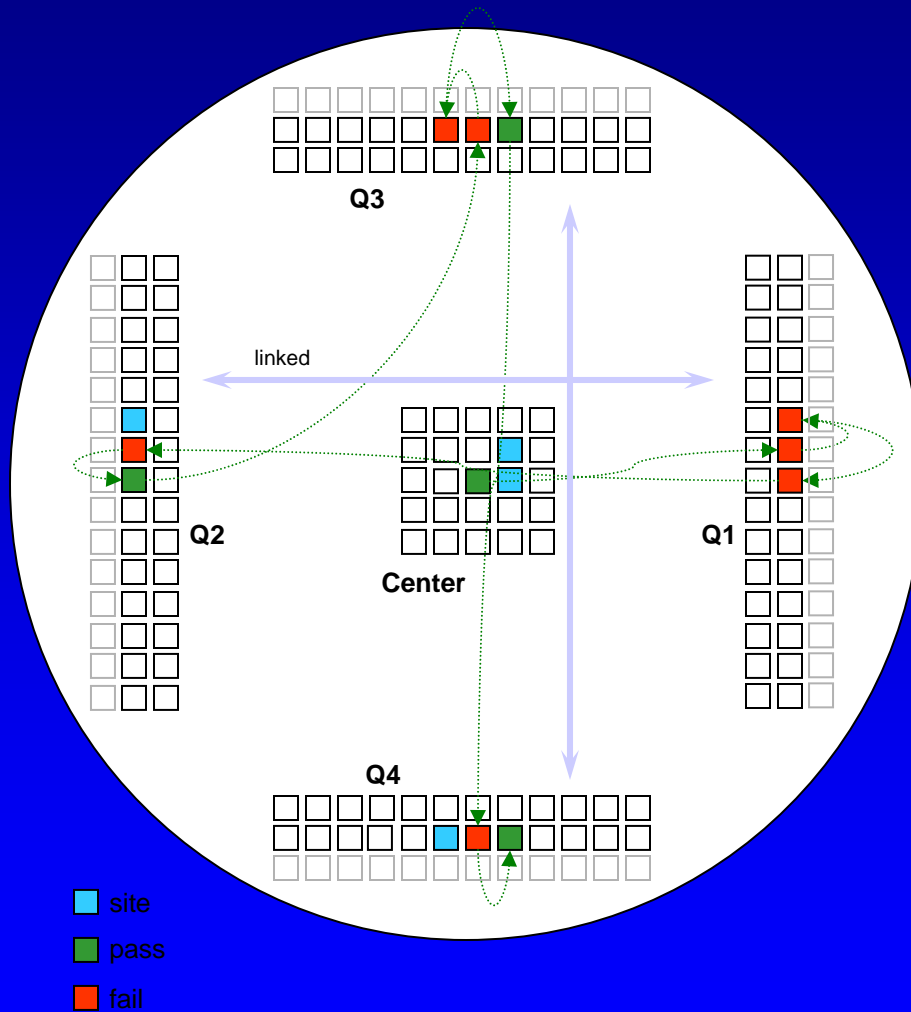
- Needles were landing on the edge of the pad on initial setup.

Marks after  
initial setup



Marks after  
correction

# Automated PMI



## Intra-group

**Rule 1:** If PMI passes for a site, then the PMI for the group passes; Else inspect the next site within the group

**Rule 2:** If PMI fails for all sites within the group, then PMI for the group fails.

## Center Group

**Rule 3:** If all dies in the group in the Center fail (ie. rule 2), then the Probe-PMI fails immediately. If Center passes, then inspect the next 2 opposing quadrants.

## Group-to-Group

**Rule 4:** If two opposite Quadrants fail, then Probe-PMI fails immediately.

**Rule 5:** If any 2 of the 4 Quadrants fail, then Probe-PMI fails; For Probe-PMI to pass, only 1 quadrant must fail.



# PMI Forces Stop

Probe Marks Verification for PMI failure (1.0)

Automated PMI fail verification.

◆ Moved marks left (um) 0 ◆ Moved marks right (um) 0  
◆ Moved marks up (um) 0 ◆ Moved marks down (um) 0  
◆ No adjustments

Please select reason for pmi fail: Enter Additional Comments Here:

<<MUST CHOOSE ONE>> ↓

Are the marks breaking PO? ◆ YES ◆ NO

Continue Display PMI Fail Info

PMI fail Info for VLB32

PMI Fail Details:

Include to comment box

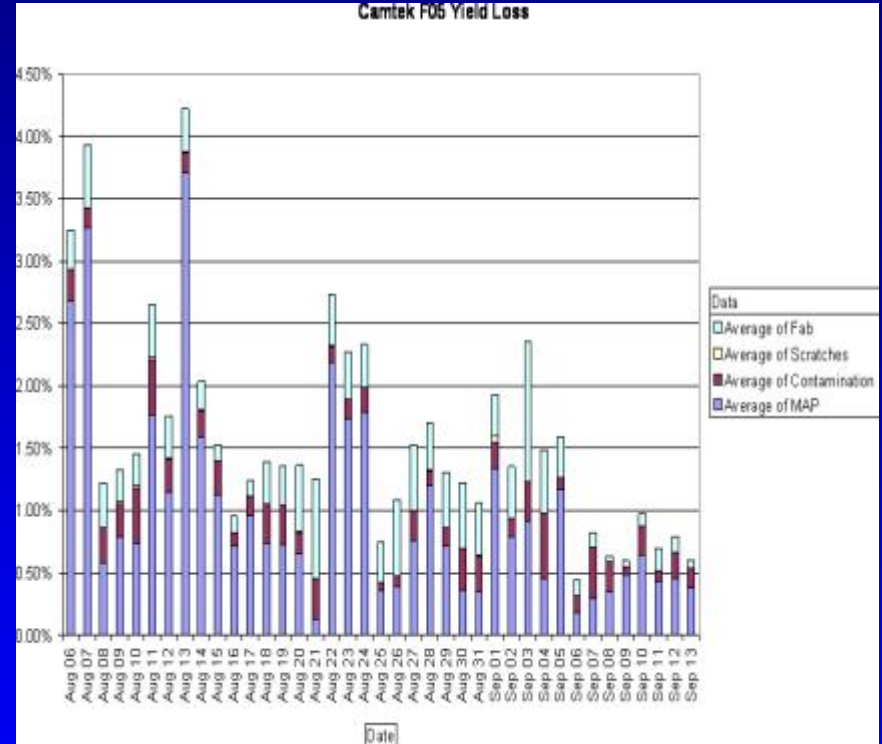
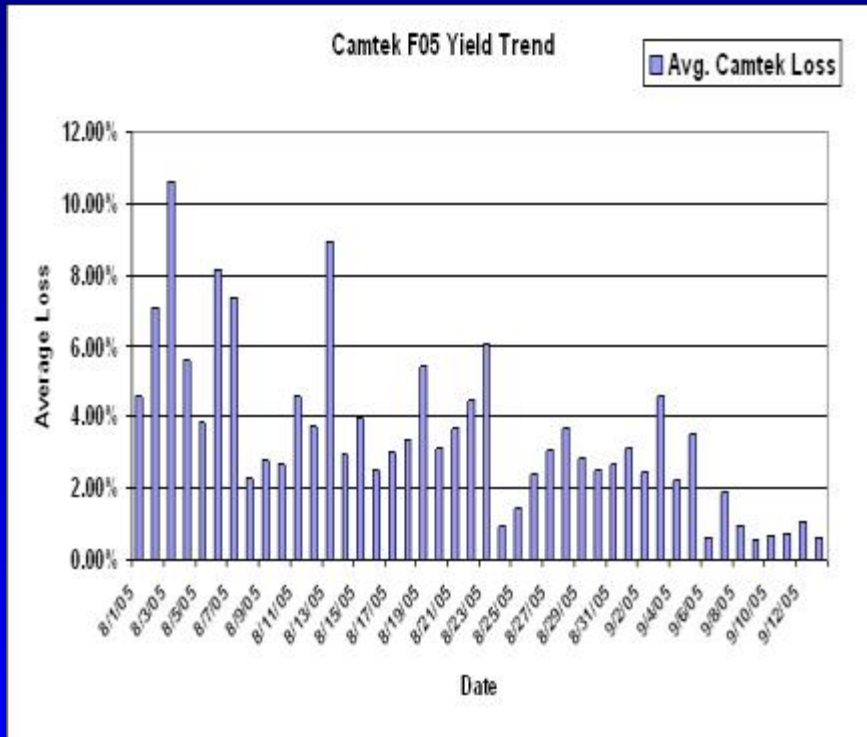
```
PPD_VERSION=1
PPD_TYPE=PMI
TEST_AREA=MULTIPROBE
PROGRAM=C539ZP1ST26
LOT=5558495
WAFER_ID=C-5558495-05
DATE=08/20/2005 18:36:44
TESTER=VLB32
PROBER=TKB32
PROBE_CARD=TW512
USER_ID=xF015435
COMMENTS=PMI=FAIL CENTER=FAIL RIGHT=NOT_TESTED LEFT=NOT_TESTED BOTTOM=
X=11 Y=12 SITE=1 PMI_ZONE=CENTER STATUS=FAIL DIE_DISPOSITION_TYPE=5
X=11 Y=11 SITE=1 PMI_ZONE=CENTER STATUS=FAIL DIE_DISPOSITION_TYPE=5
END
```

Close

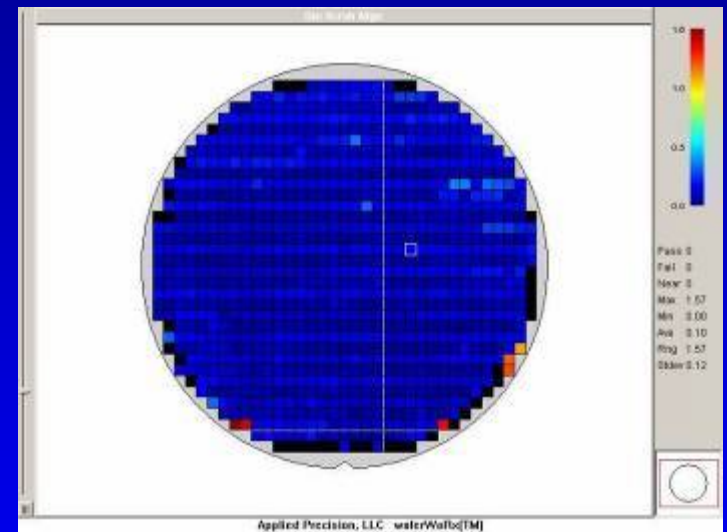
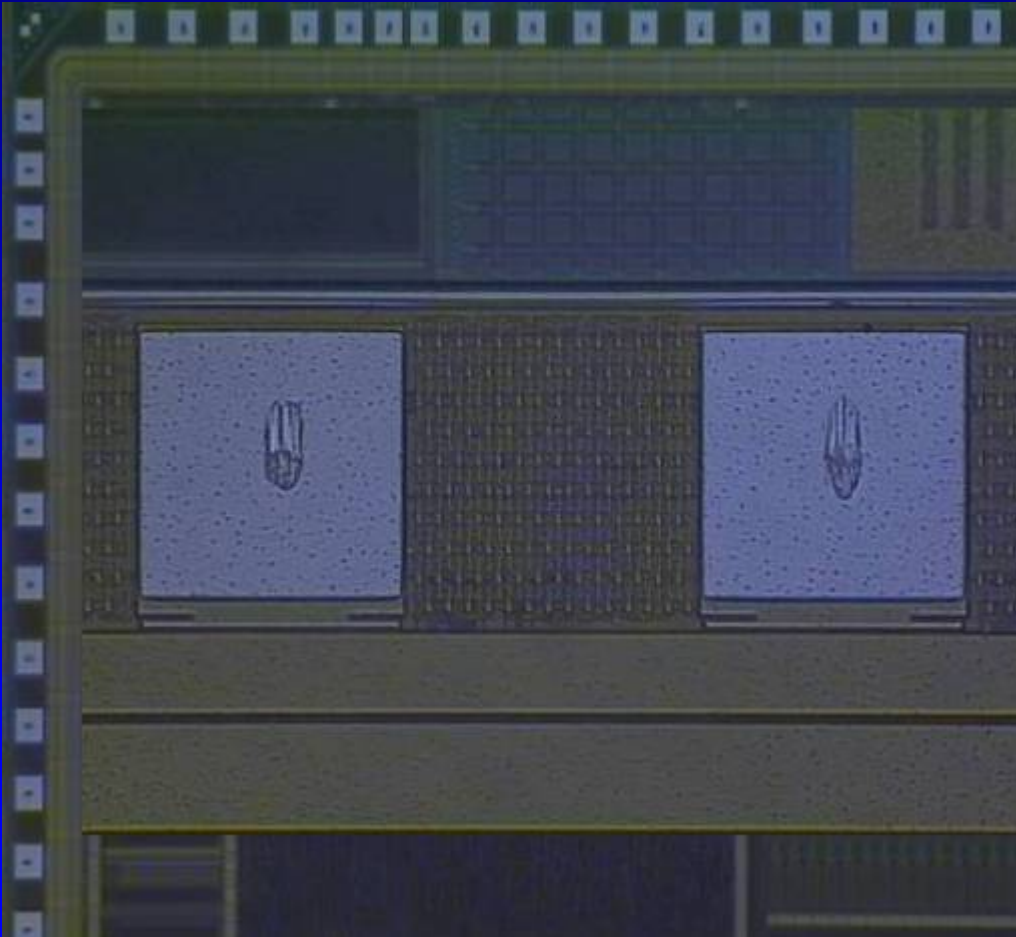
# PMI Result

| Program           | Tstr   | Prbr   | PC  | FAIL | PASS |    |
|-------------------|--------|--------|-----|------|------|----|
|                   |        |        | SM7 | 0%   | 100% | 36 |
|                   | VLB40  | UF300  |     | 0%   | 100% | 5  |
|                   |        |        | SM7 | 0%   | 100% | 54 |
|                   | VLB24  | UF300  | SM7 | 55%  | 45%  | 11 |
|                   | VLC303 | UF3000 | SM7 | 7%   | 93%  | 14 |
| <b>V1CA698D03</b> |        |        |     |      |      |    |
|                   | VLB37  | UF300  | BD2 | 0%   | 100% | 13 |
|                   | VLB44  | UF300  | BD2 | 0%   | 100% | 12 |
|                   | VLB52  | UF300  | BD2 | 0%   | 100% | 24 |
|                   | VLB73  | UF300  |     | 0%   | 100% | 2  |
|                   |        |        | BD2 | 0%   | 100% | 3  |
|                   | VLB78  | UF300  | BD2 | 0%   | 100% | 20 |
|                   | VLB79  | UF300  | BD2 | 0%   | 100% | 12 |
|                   | VLB91  | UF300  | BD2 | 0%   | 100% | 28 |
|                   | VLB99  | UF300  | BD2 | 0%   | 100% | 27 |
|                   | VLC32  | UF200  | BD2 | 0%   | 100% | 12 |
|                   | VLB42  | UF300  | BD2 | 0%   | 100% | 17 |
|                   | VLC06  | UF200  | BD2 | 10%  | 90%  | 29 |
|                   | VLB114 | UF300  |     | 0%   | 100% | 1  |
|                   |        |        | BD2 | 7%   | 93%  | 14 |

# Automated Outgoing Inspection



# Thermal Results



# Thermal Controls Used

- Requires dedicated high temp setups
- Requires minimum of two calibration tables for the prober
- Requires 30 minute pre-soak
- 15 minute realignment needed
- Contact soak needed if  $> 5$  minute interruption
- Forced operator inspection points

# Conclusion

- Thermal instability is a major contributor to BP damage and mis-alignment related issues
- Managing thermal losses requires multiple approaches
- Customers are driving to <35% total area BP damage
- Vertical probe solutions can mitigate the thermal budget and BP damage problem

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Thanks For Listening –  
Enjoy the Conference