SWTEST

PROBE TODAY, FOR TOMORROW

Temperature Probing Process

Achieving thermal stability at extreme conditions

Texas Instruments

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Overview

- Intro
- Objectives
- Methods
- Projects/Results
- Summary

Intro / Background

- Wafer probing on a production manufacturing level has evolved beyond just room temperature. It has expanded its limits to extremes at both ends of the temperature spectrum, with applications demanding test from -50C all the way up to 200+C.

- With these extreme requirements now in play in the thermal environment, physical probe mark integrity has also become a challenge to maintain, specifically relating to horizontal and vertical probe accuracy on the bond pads.

Intro / Background

- Introduction of more advanced vertical card technologies in the industry has helped tremendously with these factors, with probes that are designed to better perform in these conditions.

- Another component that becomes important to implement and optimize is the prober’s automatic alignment routine. Having these standardized control systems in periodic intervals is the best way to ensure thermal compensation for the probes in an extreme temperature environment.

Objectives

- **This paper will give an overview of:**
  - how these automatic re-alignment functions work together on the Accretech TSK prober
  - other control systems (both hardware and process) put in place to best achieve thermal stability during temperature probing.

Probe Overview at TI

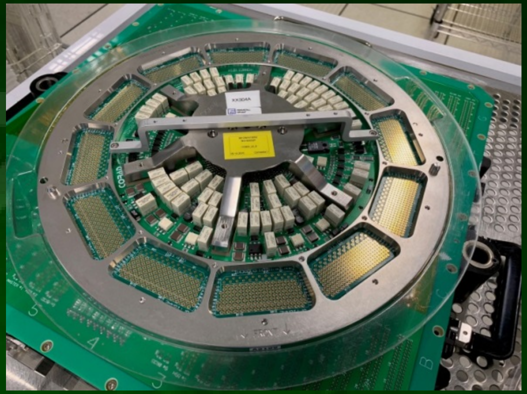
- **TI probes at a variety of temperatures on production test floors**
  - Ranging from extreme low temp → extreme high temp

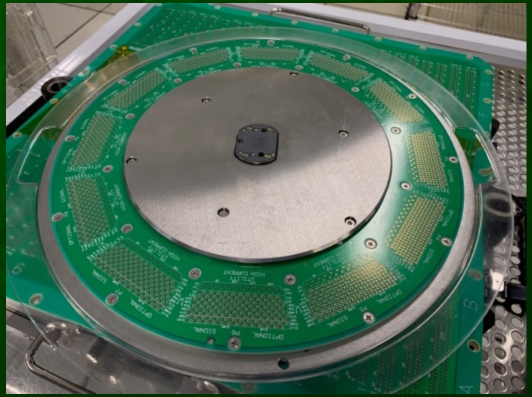
- **Many physical and process recipes are required for proper probing**

- **Why do we do it?**
  - Device requirements from the customer
  - Verify electrical, physical, and functional integrity of the chip @ various temps, depending on the application
    - ***Automotive***

Methods / Requirements to probe at temp.

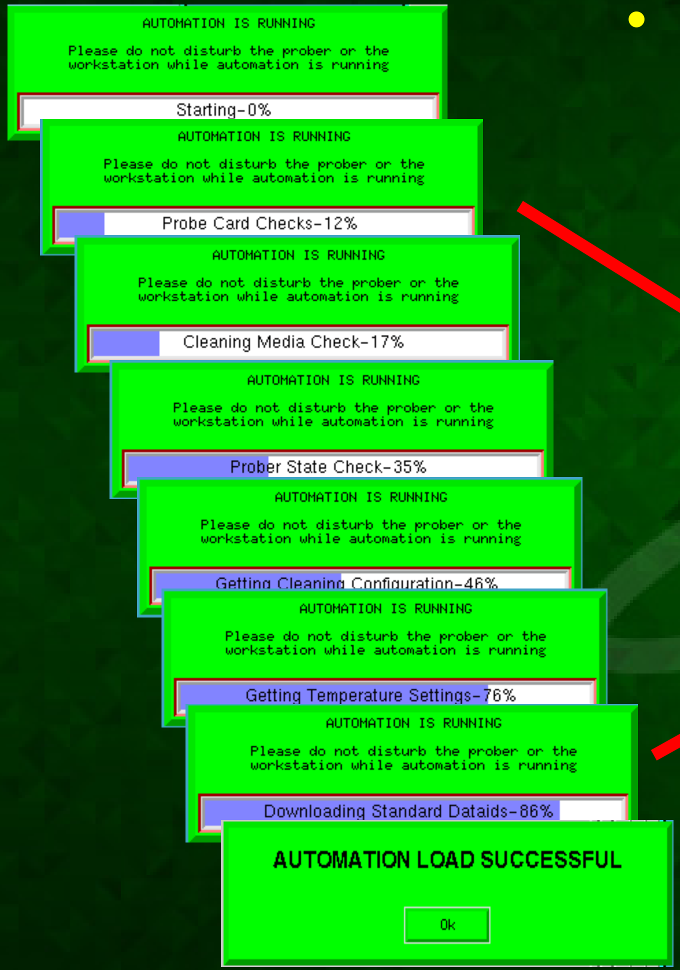
- **Hardware:**
  - Accretech TSK prober
  - Hot chuck
    - ERS, Accretech, ATT
  - Temp. Controller Unit for prober
  - Chiller Unit (ERS, Accretech)
    - CDA, purge
  - Qualified Probe Card technology
    - Vertical card suppliers
    - Pcb stiffeners, heat shields





- **Process:**
  - Prober Automatic Download Logic (by device spec)
    - Temp. Range settings
    - Soak/Needle realignment intervals

Automation solutions for a production probe floor

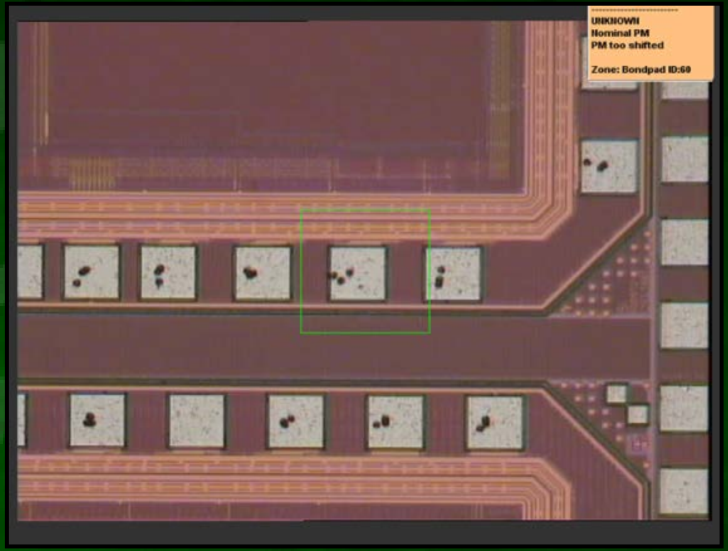


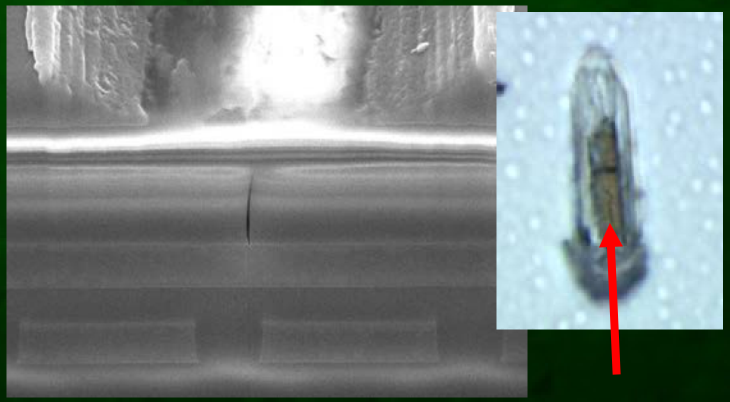
- **By specifying the probe card technology within production automation scripts, the prober settings can be optimized for production needs.**

- **Automatic prober download script (dataID's for temperature settings, Needle Re-alignment intervals, etc.)**

Methods

- **Probing @ temperature requires Needle Realignments (X, Y, Z corrections), due to thermal fluctuations of the prober and probe card**
  - At set, downloaded intervals:
    - **4 pin-average realignment**
    - At start of wafer
    - Every x mins for initial time period of wafer,
    - Every y mins after, for the rest of the wafer
  - **To keep probe marks controlled, <u>centered</u> on pad (X, Y)**
  - **To maintain proper probing overdrive throughout the lot (Z), in order to prevent:**
    - Unexpected added probing over travel
    - Contact related issues
    - Crashed probe cards

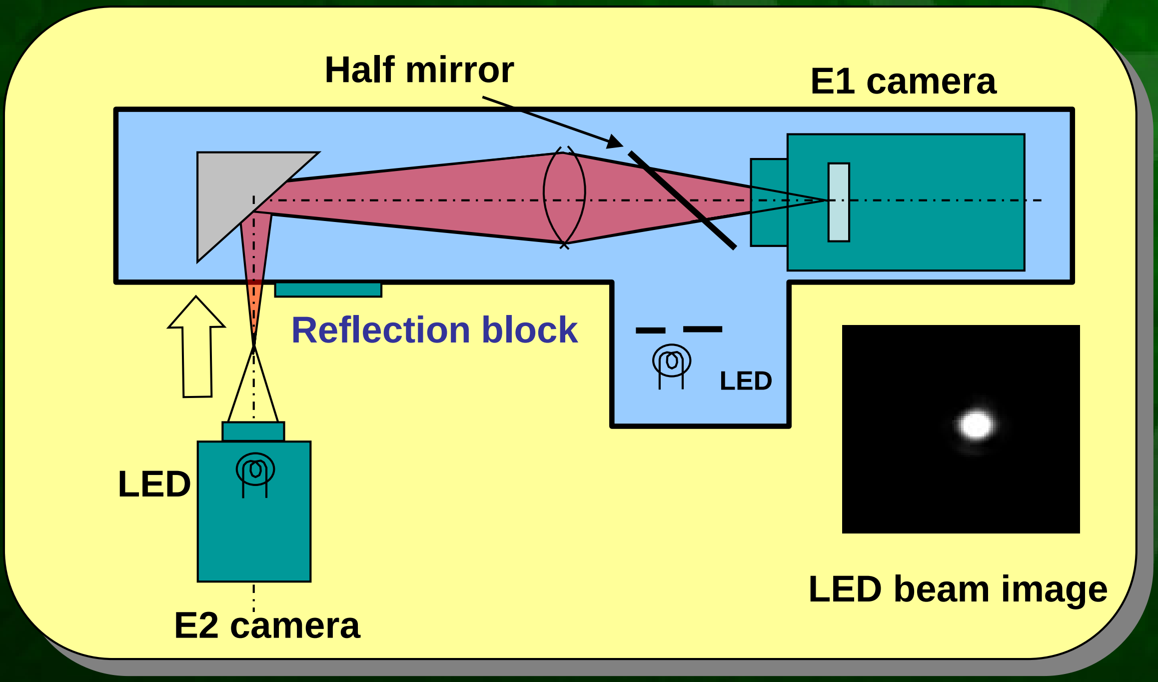


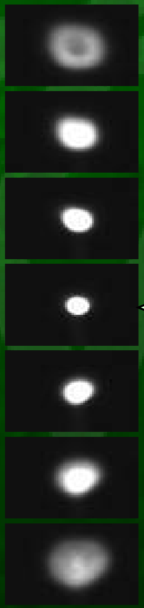


Re-alignment action on TSK UF3000

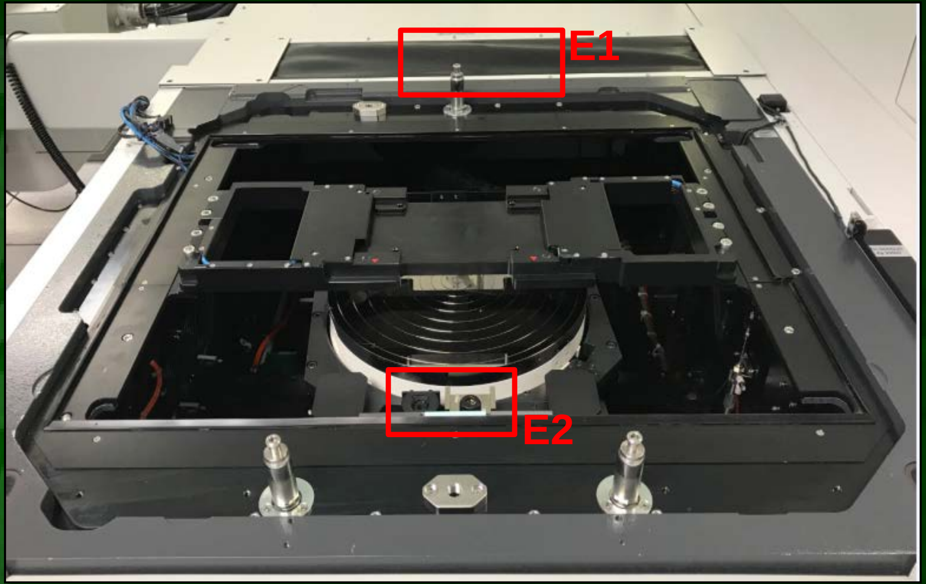
1. E1 camera checks beam position of E2 camera

E1 camera: wafer alignment
E2 camera: needle alignment
E1 + E2 = full re-alignment sequence

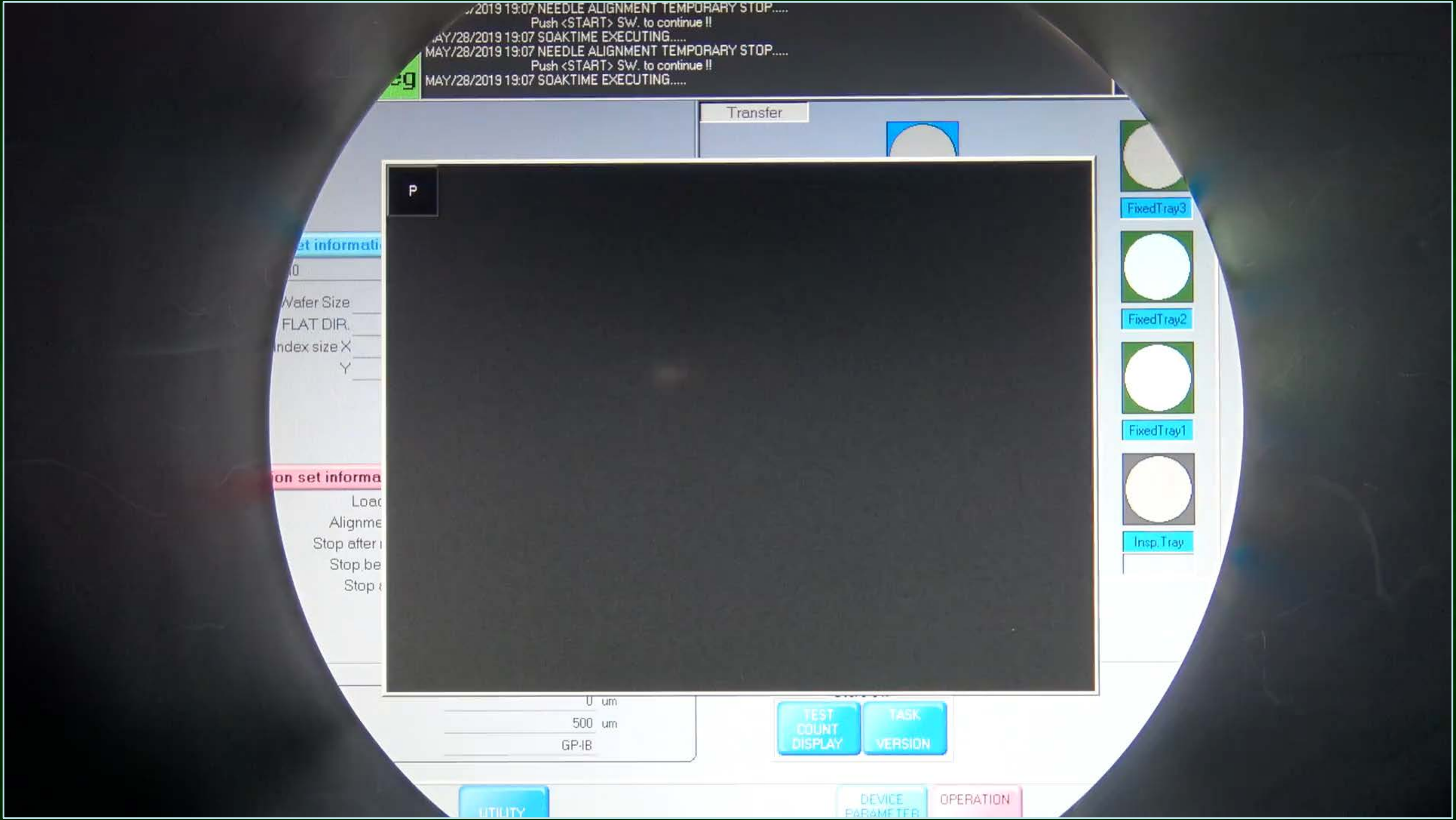




Focal position



Needle Optical Re-alignment video



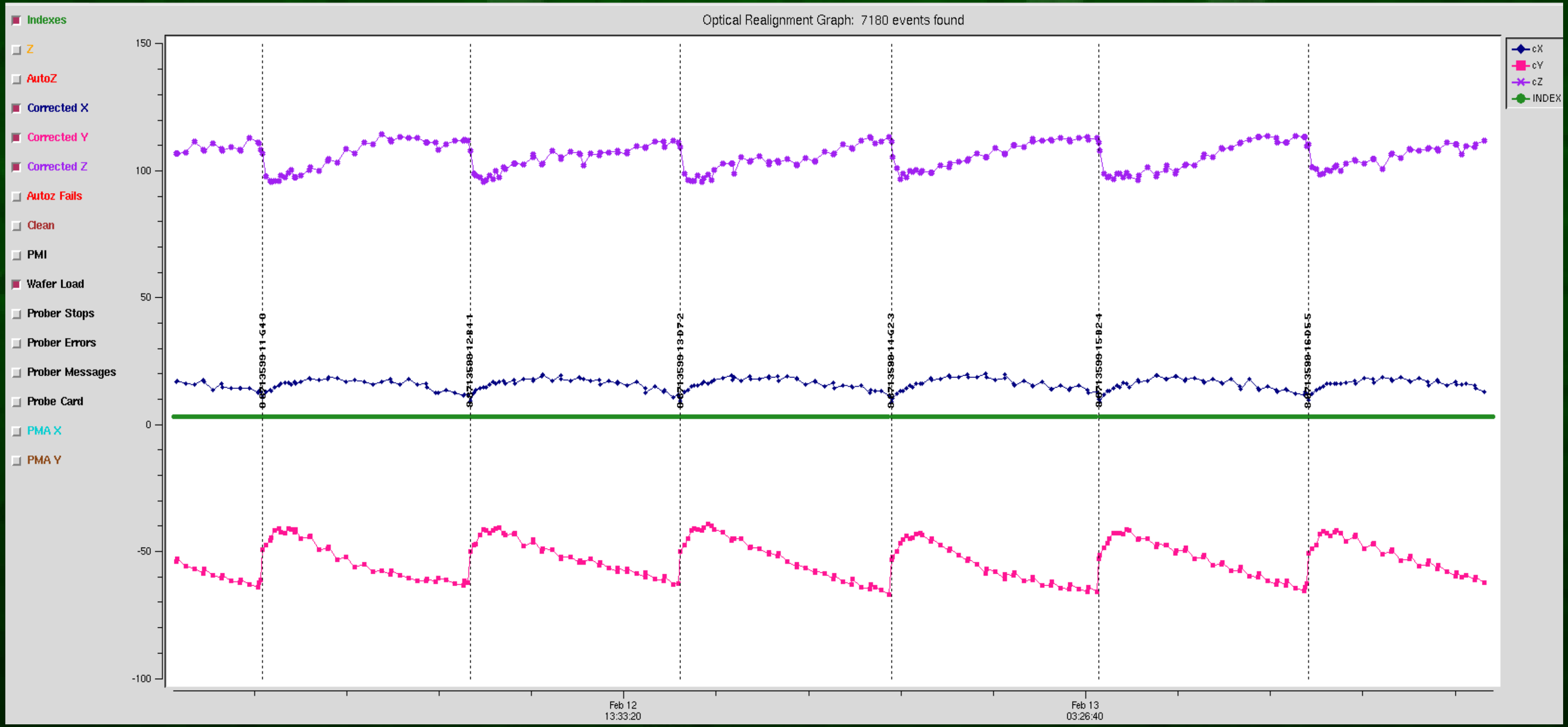
Methods

- All the prober's Needle Re-alignments (corrected X, Y, Z positions) can be pulled from the prober's dump logs

- Prober Log Compiler utility extracts this raw data and spits it out into an interactive graphical interface

Prober Log Compiler graphs – Needle Re-alignments

- Re-alignment every X mins for beginning of wafer, every Y mins thereafter, and @ start of wafer
- Used for investigating needle thermal movement data, characterizing prober, and new card technologies @ temp.



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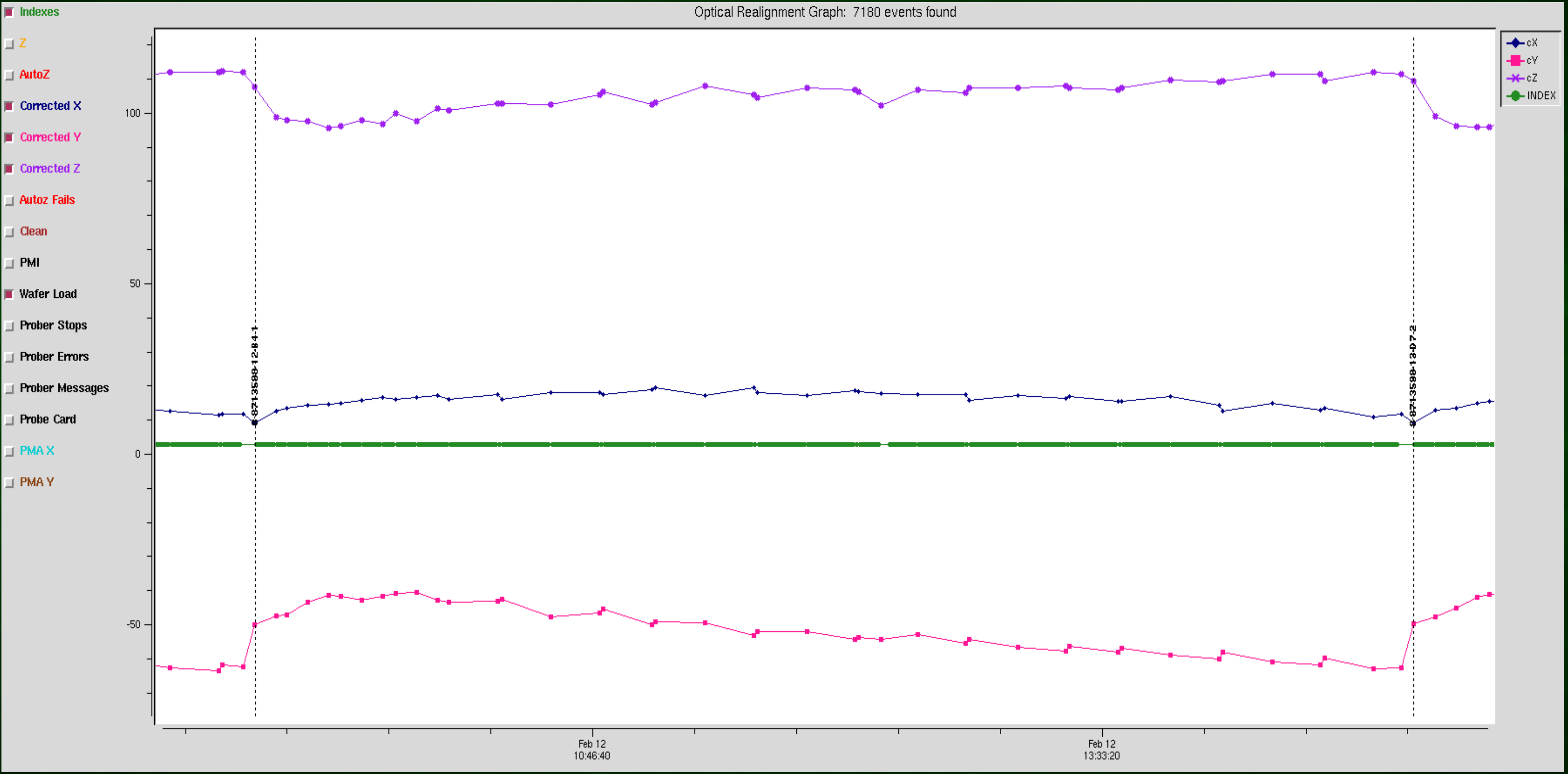
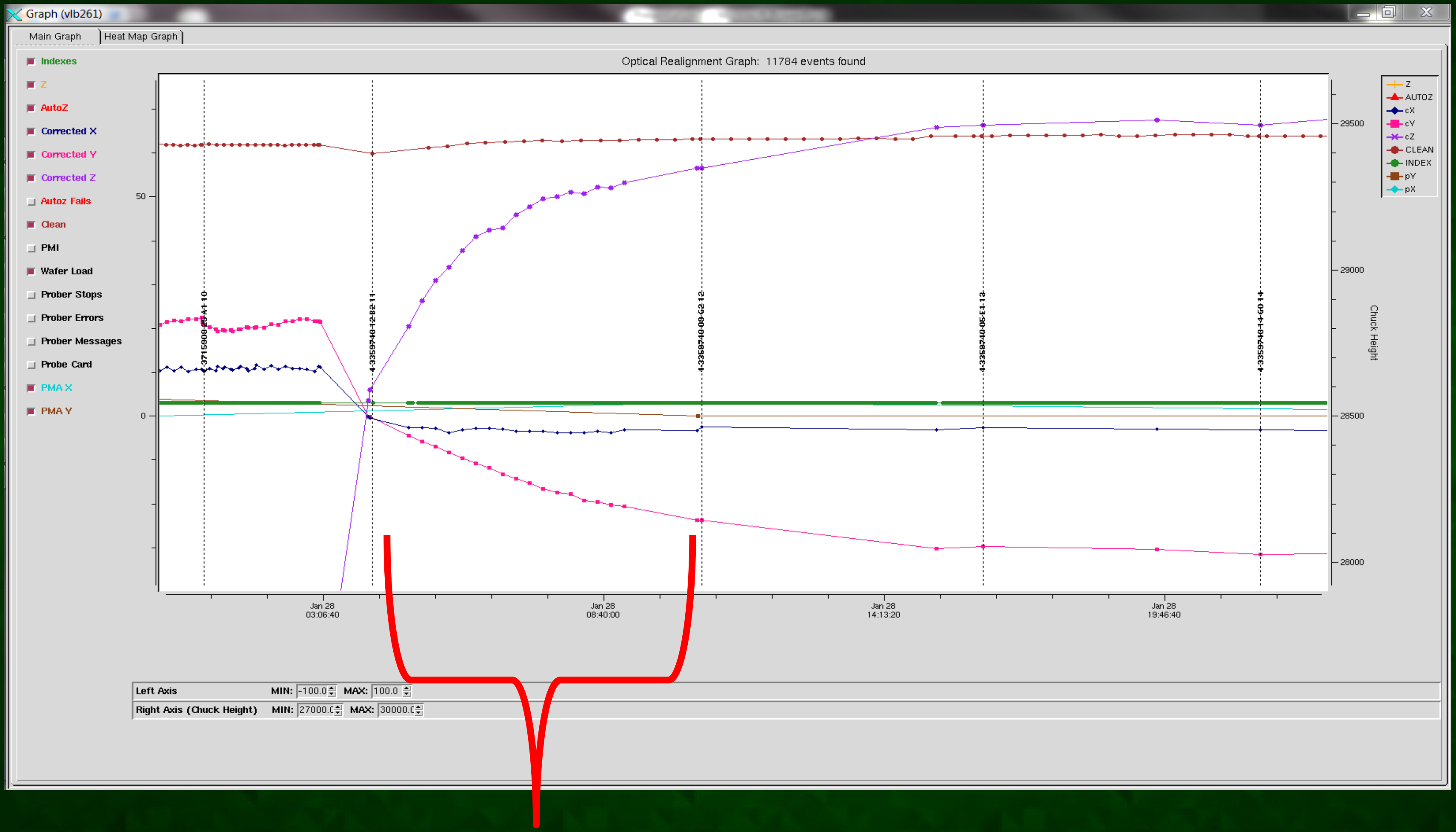


Indexes
Z
AutoZ
Corrected X
Corrected Y
Corrected Z
Autoz Fails
Clean
PMI
Wafer Load
Prober Stops
Prober Errors
Prober Messages
Probe Card
PMA X
PMA Y
Optical Realignment Graph: 7180 events found
cX
cY
cZ
INDEX
100
50
0
-50
8713598-12-B4-1
8713598-13-D7-2
Feb 12
10:46:40
Feb 12
13:33:20

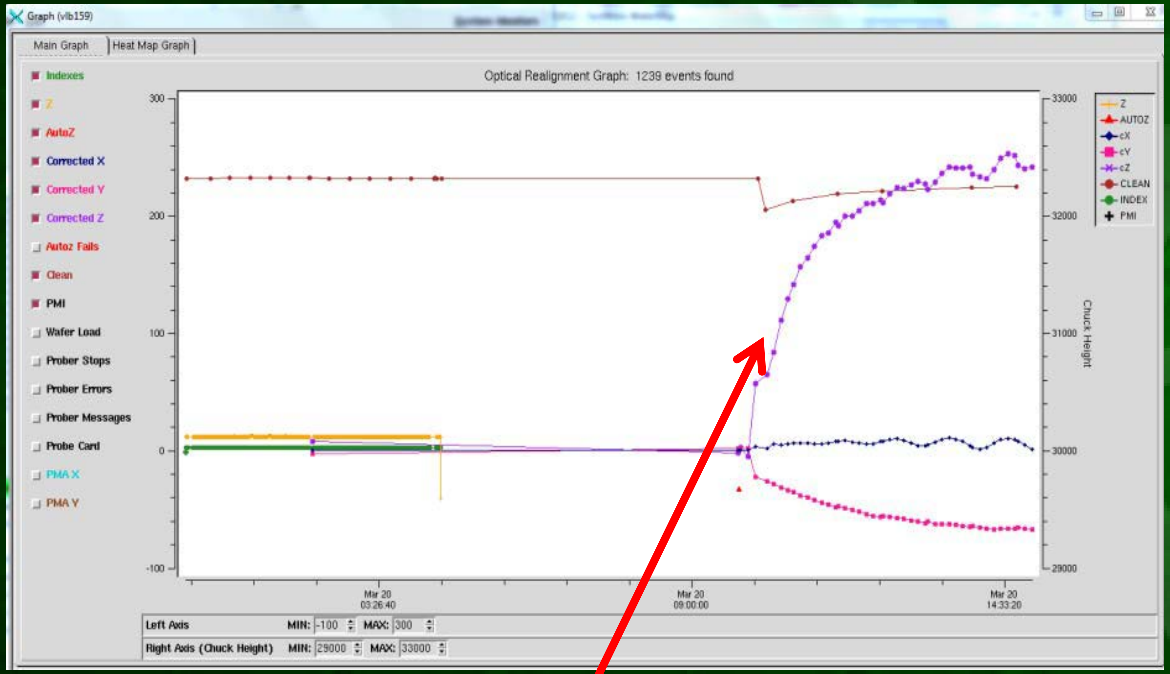
Example: Cold temp setup stabilization

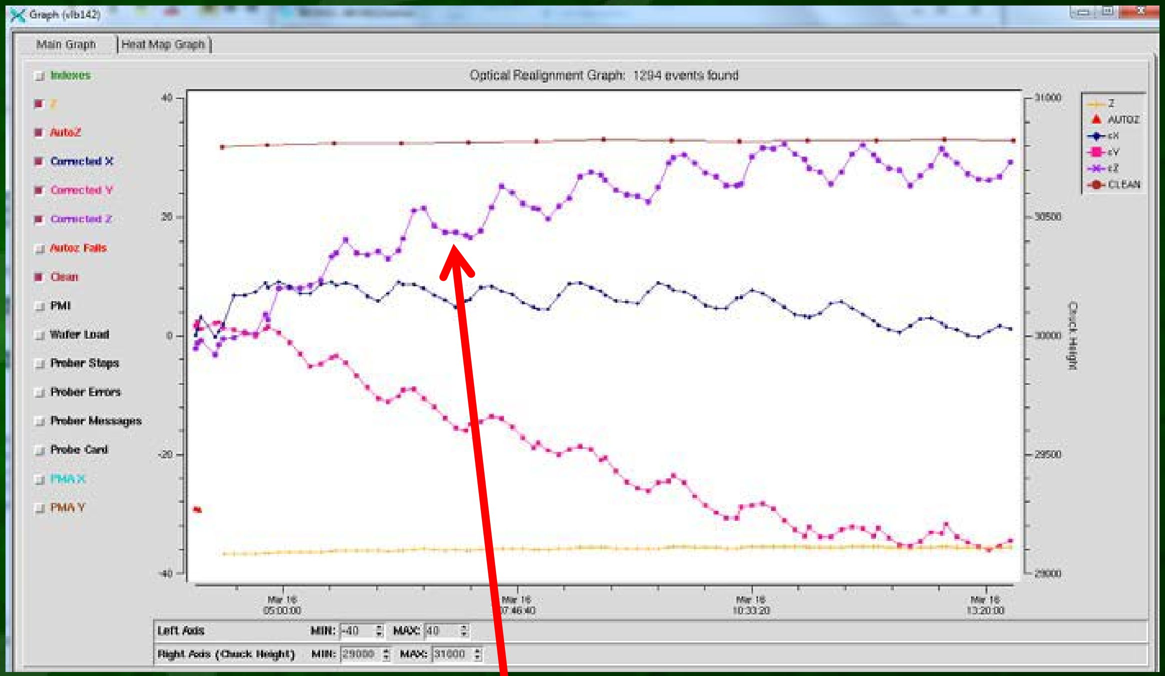


- Takes ~5 hours for prober environment to stabilize in Z-movement when going to cold temp

Example: Large needle movements at high temp

- Same probe card showed different thermal curves on 2 testers





140um Z-movement

40um Z-movement

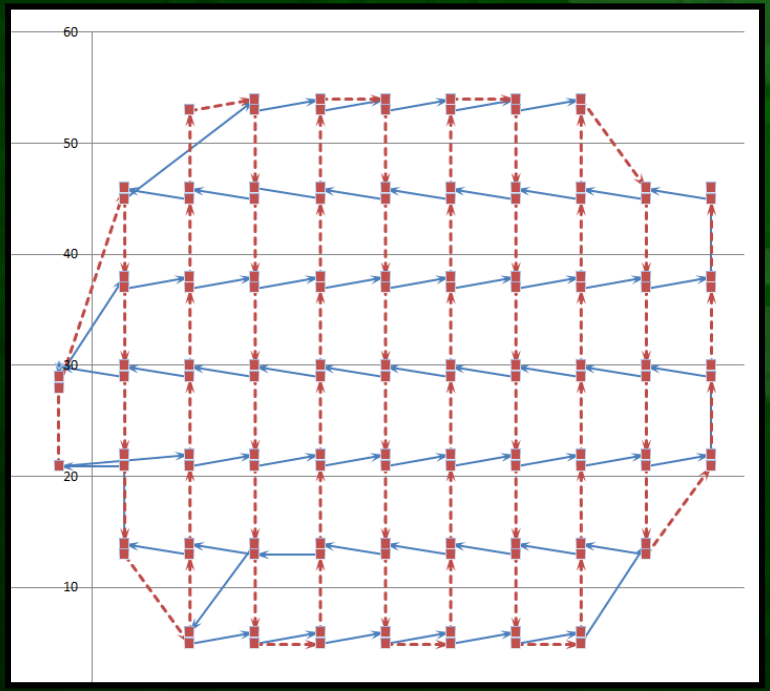
- Found the probe card pan hardware was causing changes in thermal movement

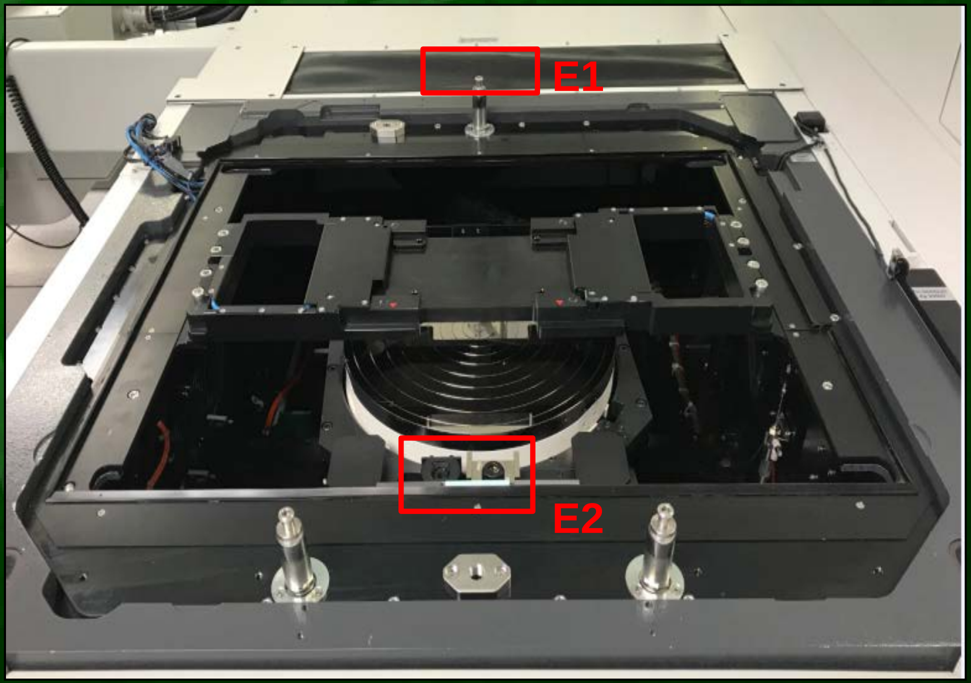
Projects / Results

Project Examples using Prober Log Compiler re-alignment data

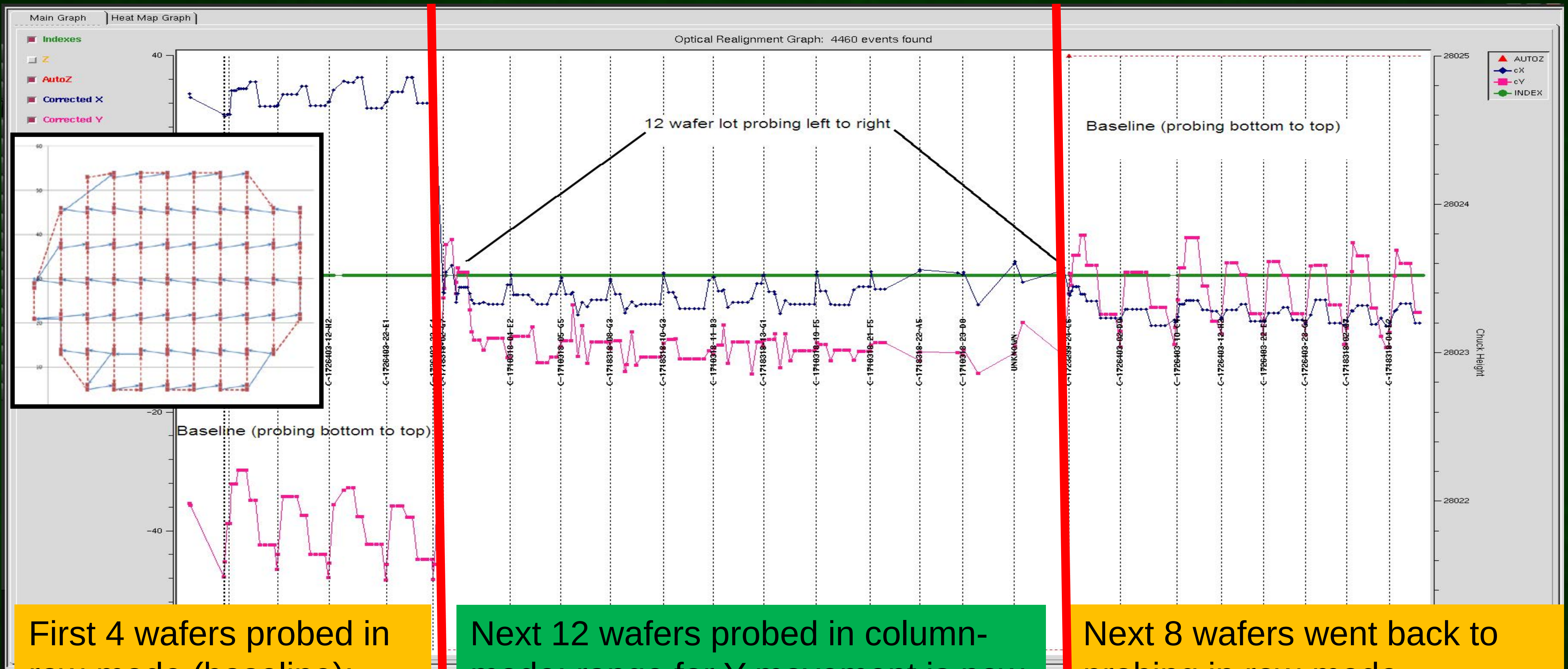
Project 1

- **<u>Problem:</u>** Probe mark shifts at start of every wafer for Cantilever style probe cards @ high temp
- **<u>Solution:</u>** Switch from Row mode to Column mode probing (next slide)





Device A test study; prober needle movement data



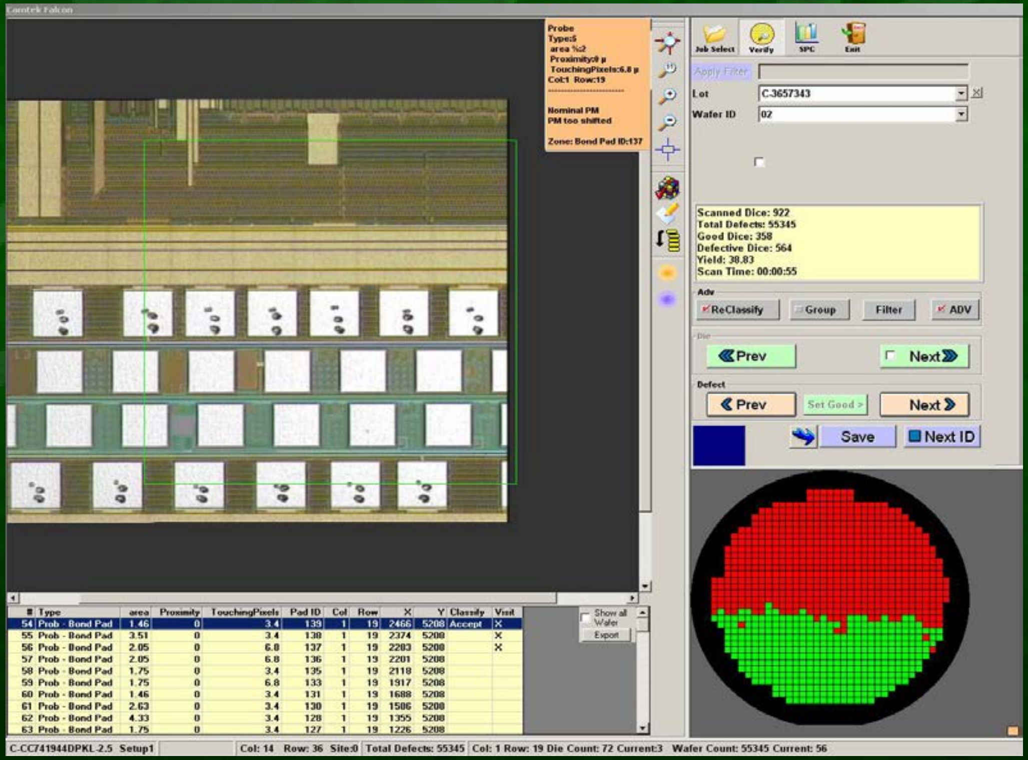
First 4 wafers probed in row-mode (baseline); range for Y-movement is ~20um

Next 12 wafers probed in column-mode; range for Y-movement is now ~8um

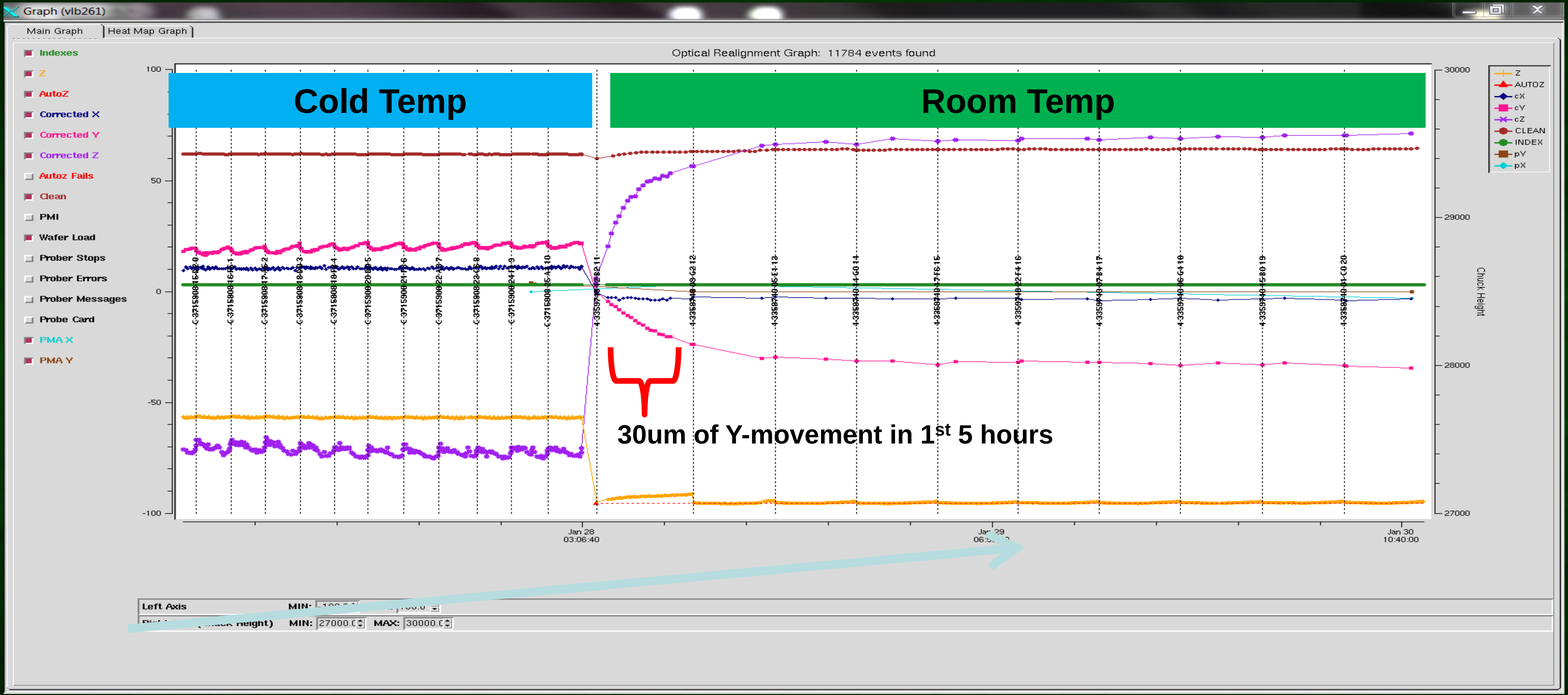
Next 8 wafers went back to probing in row-mode (baseline); range for Y-movement is back to ~20um

Project 2:

- **Problem:** Going from CT/HT → RT setup causing probe mark drifting (since no needle re-alignments at RT)
- **Solution:** Enable Needle Realignments every X mins for the 1st 5 hours when going from HT/CT → RT setup (next slide)

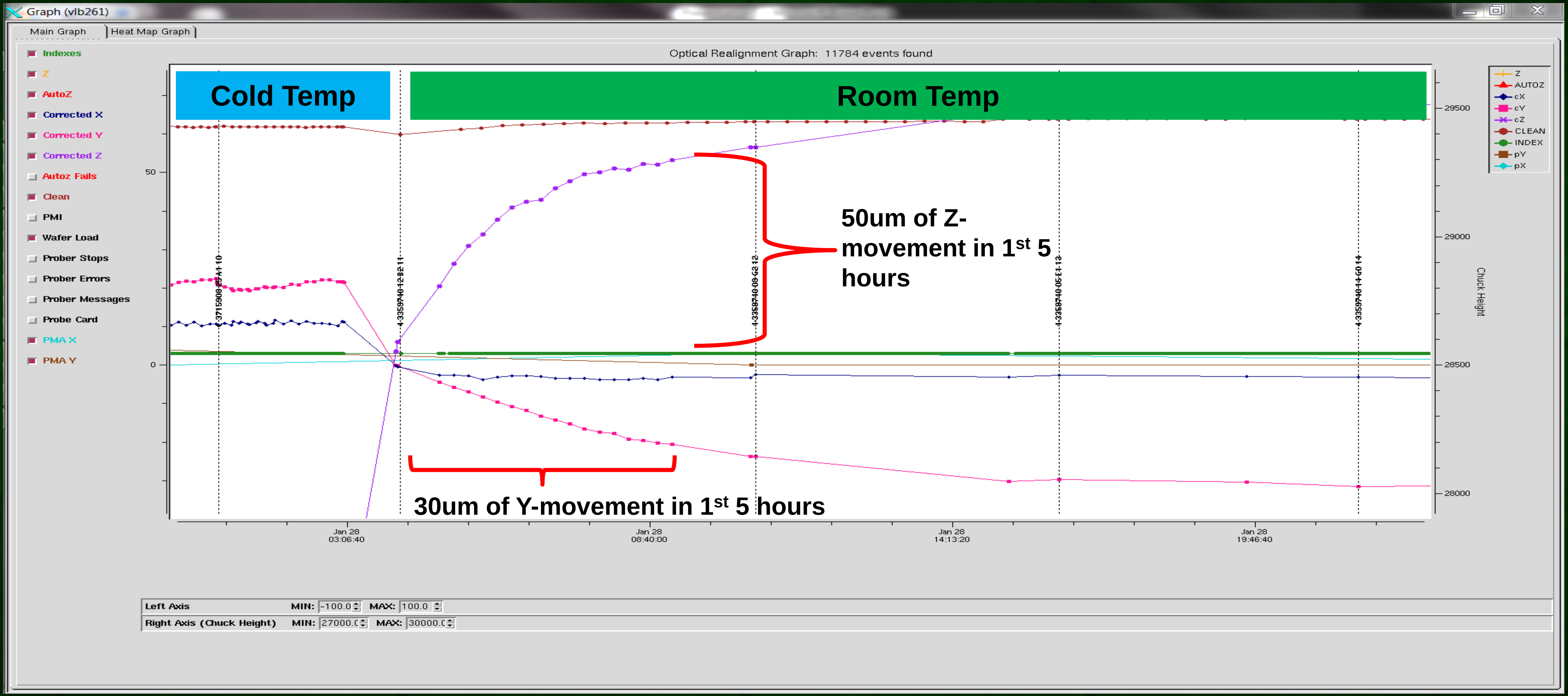


Beta testing: CT → RT (activate re-alignment settings)



- Automatic Download Logic: Needle Realignment activated every X mins for 1st 5 hours, and at beginning of every wafer for the 1st RT lot only

(zoomed in)

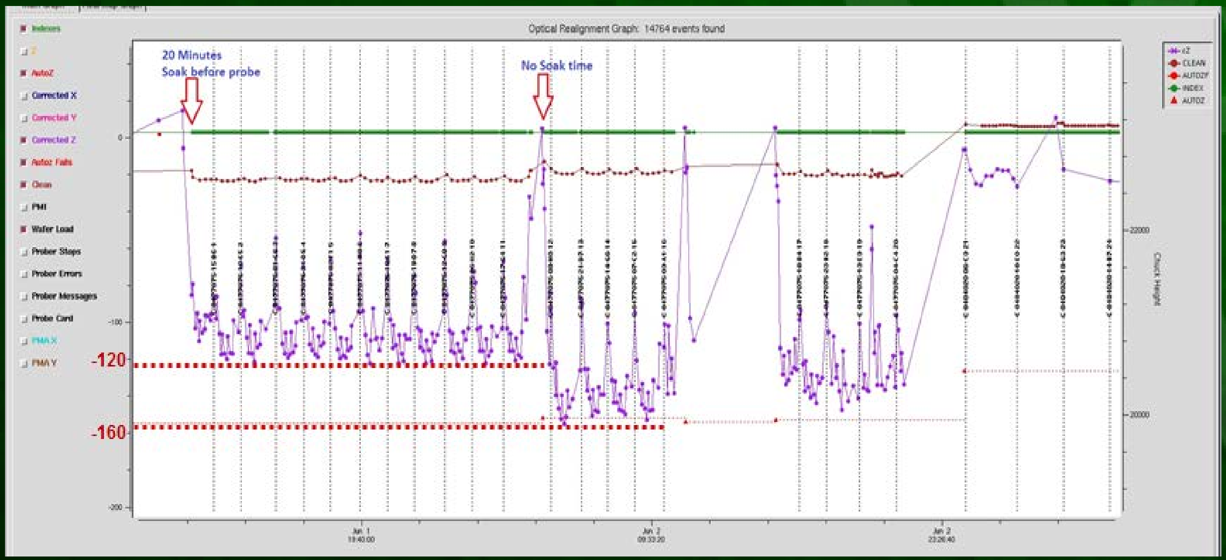


Graph (vlb261)
Main Graph
Heat Map Graph
Optical Realignment Graph: 11784 events found
Indexes
Z
AutoZ
Corrected X
Corrected Y
Corrected Z
Autoz Fails
Clean
PMI
Wafer Load
Prober Stops
Prober Errors
Prober Messages
Probe Card
PMA X
PMA Y
Cold Temp
Room Temp
50um of Z-movement in 1st 5 hours
30um of Y-movement in 1st 5 hours
Jan 28 03:06:40
Jan 28 08:40:00
Jan 28 14:13:20
Jan 28 19:46:40
Chuck Height
Left Axis MIN: -100.0 MAX: 100.0
Right Axis (Chuck Height) MIN: 27000.0 MAX: 30000.0

Project 3

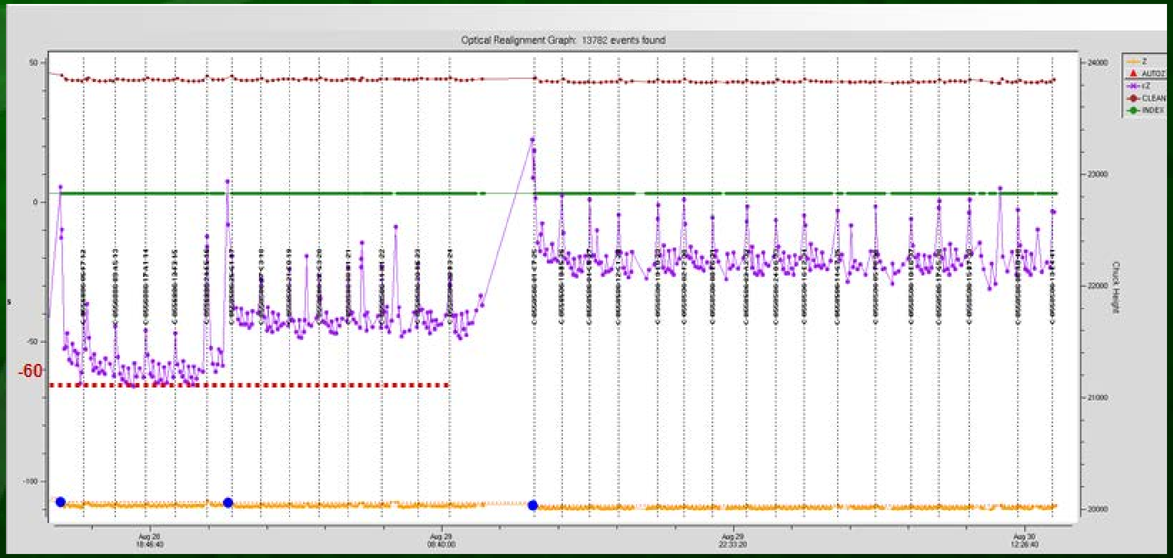
- **Problem:** Current prober pan material causing high Z-movement for ultra high temp applications (175C)
- **Solution:** New prober pan material characterization (INVAR) reduces thermal movement

Original probe card pan



120-160 um in Z drop @ 175C

INVAR probe card pan



60 um in Z drop @ 175C

Summary

- Probing at temperature requires hardware/process configurations and recipes to achieve thermal stability
- On the process side, prober needle re-alignment routines are crucial to sustain probe mark stability, electrical yield, and die/probe card health
- Prober's logs can be extracted via automatic scripts to view thermal movement data
- Specific device situations call for different thermal compensation/re-alignment routines, as well as newer hardware solutions

Acknowledgements

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