IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

Ultra High Temperature Probing

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Agenda

- Introduction
- Strategy
- Test Cell Evaluation
  - Prober Chamber
  - Chuck Temperature Ramp & Profile
- Device Testing
  - Overview
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  - Test Results
- Summary
- Acknowledgements

Introduction

- Current test temperatures do not meet the new production requirements demanded by our multiprobe customers.
- TI had two product groups driving the effort behind 200°C probing
  - High Reliability needed to ensure devices would survive in harsh environments, probing at 200°C exercises the device and culls out weaker units that would not survive in the targeted field application environment.
  - Automotive Applications needed higher probing temperatures to ensure temperature capability for 0 dppm devices intended for automotive use in equipment and sensors.
- While the goals are different, the method for testing is still the same.

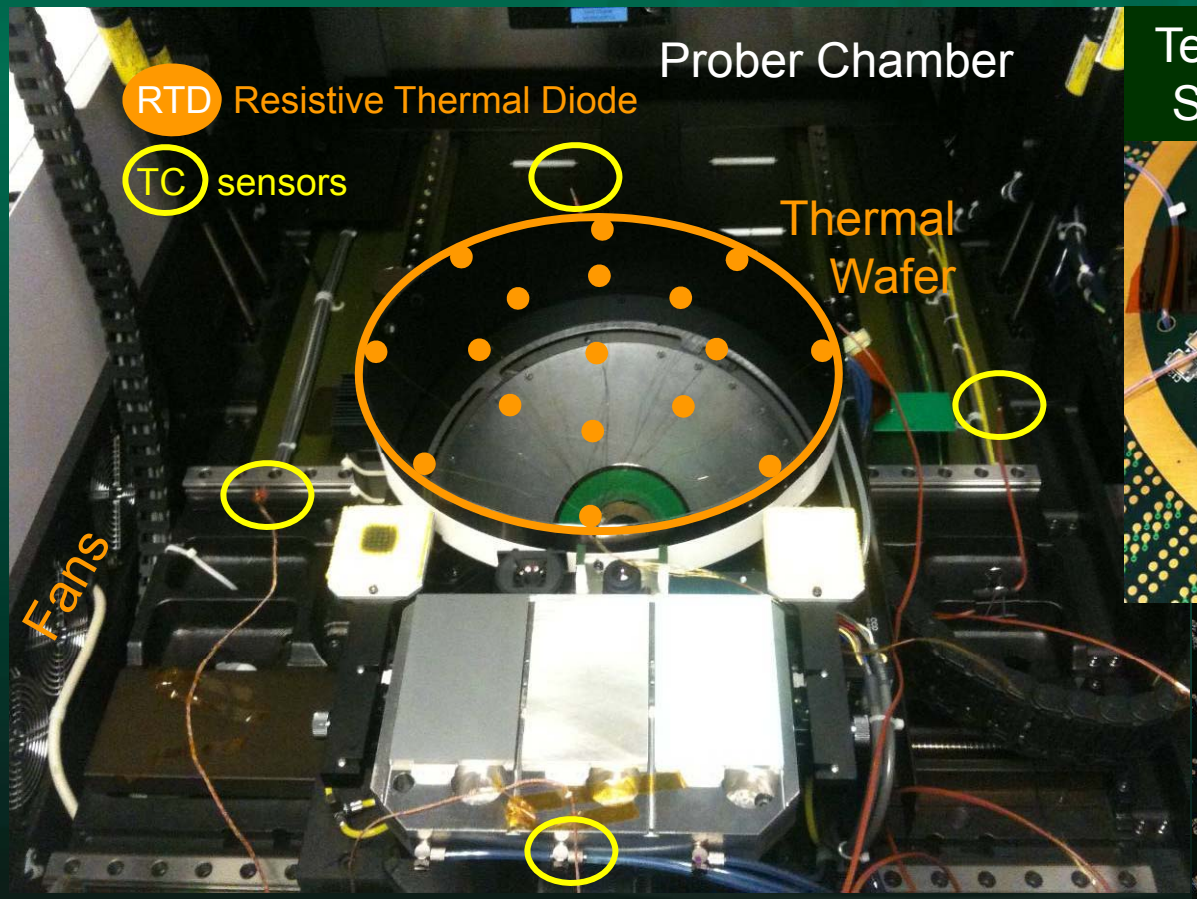
Strategy

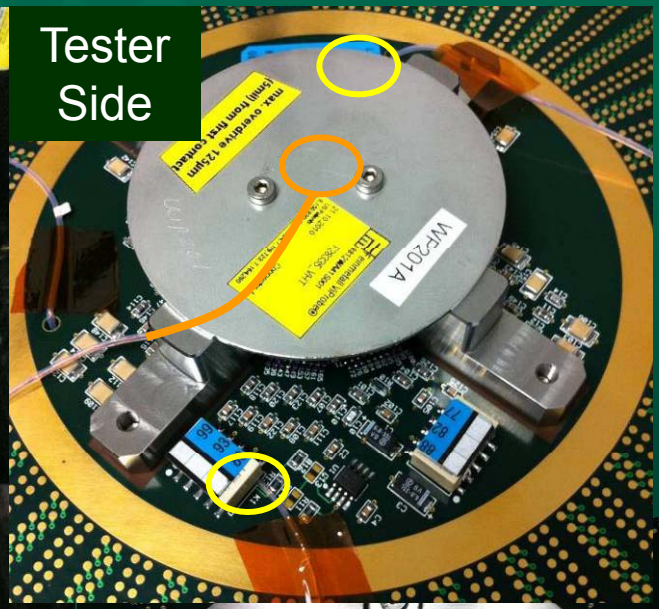
- To successfully probe at 200°C a complete systematic approach was required to determine which areas of the test cell could not handle the extreme temperatures required to meet the new test demands.
- Characterization of all aspects of the probe environment and test cell were considered.
  - Prober
  - Probe Card
  - Probe Card Interface Hardware
  - Test Head Docking
  - Tester
- During the characterization of the test cell, the docking hardware and tester were found to have very little impact to the overall stability of the test setup.

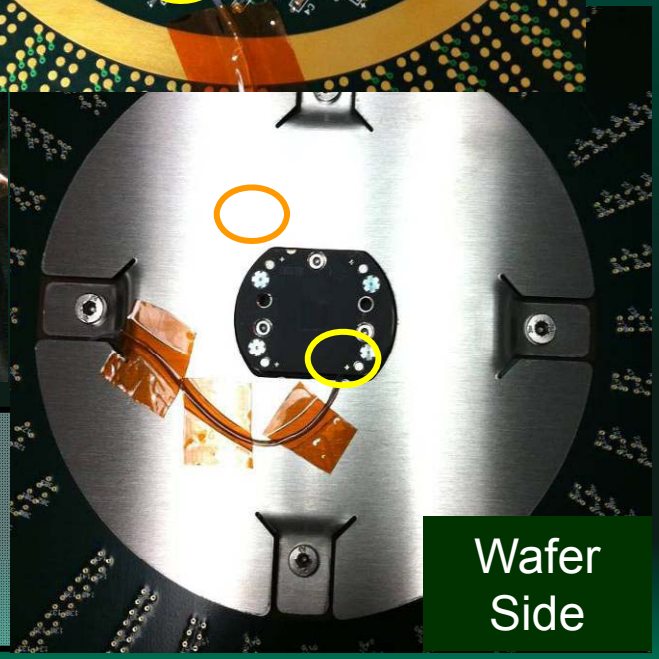
Evaluation of Test Cell Conditions

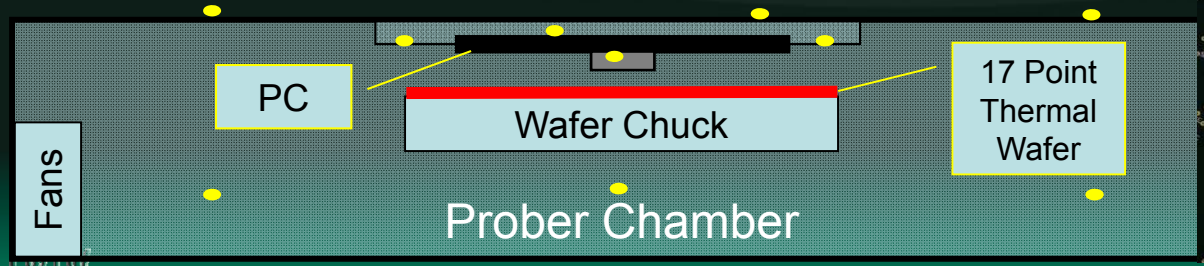
- Platform : LTX Fusion & UF3000EXe Prober
  - Wafer chuck type Accretech 02.200ºC
- Probe card : Feinmetall single site ViProbe® card
- Wafer chuck starting temperature ~30ºC (ambient), ramped to prober set point of 200ºC
- A 300mm thermal wafer to profile chuck temperature.
- Thermal measurements collected at -
  - Wafer chuck surface (17 RTD positions)
  - Prober chamber environment (4 TC positions)
  - Prober head stage (4 TC positions)
  - Probe card (8 TC positions)

TC & RTD Locations

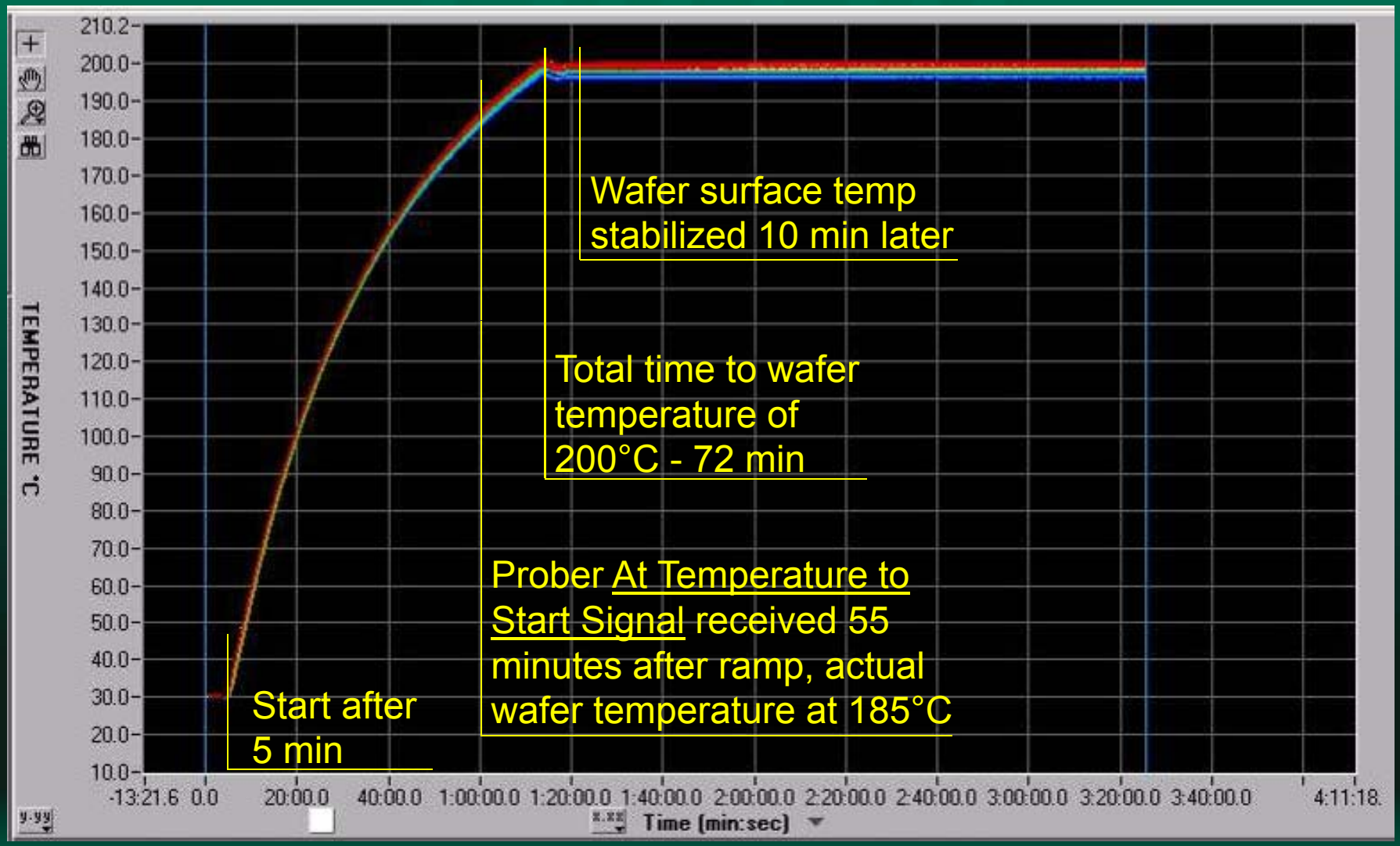




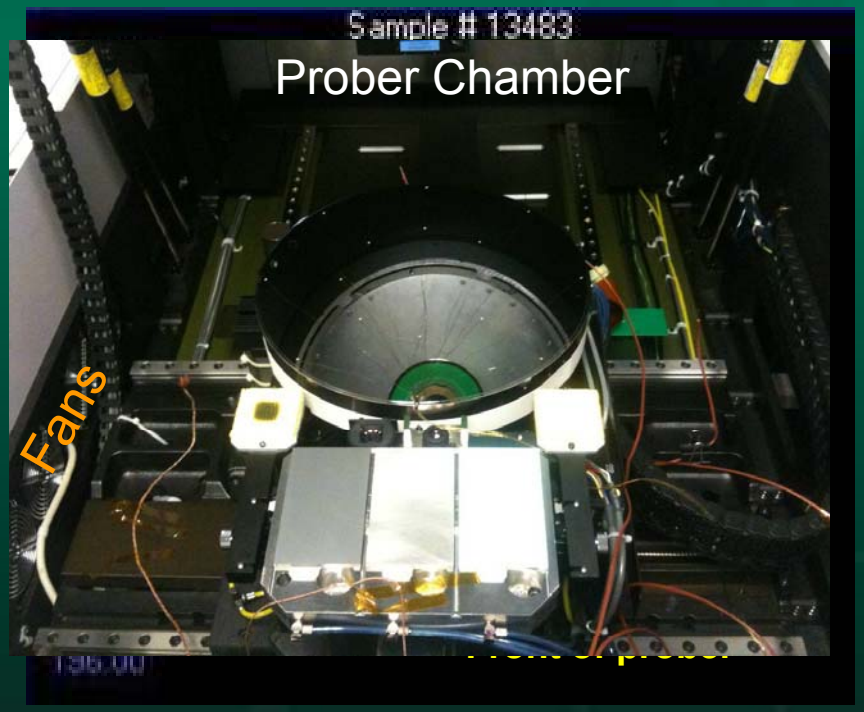


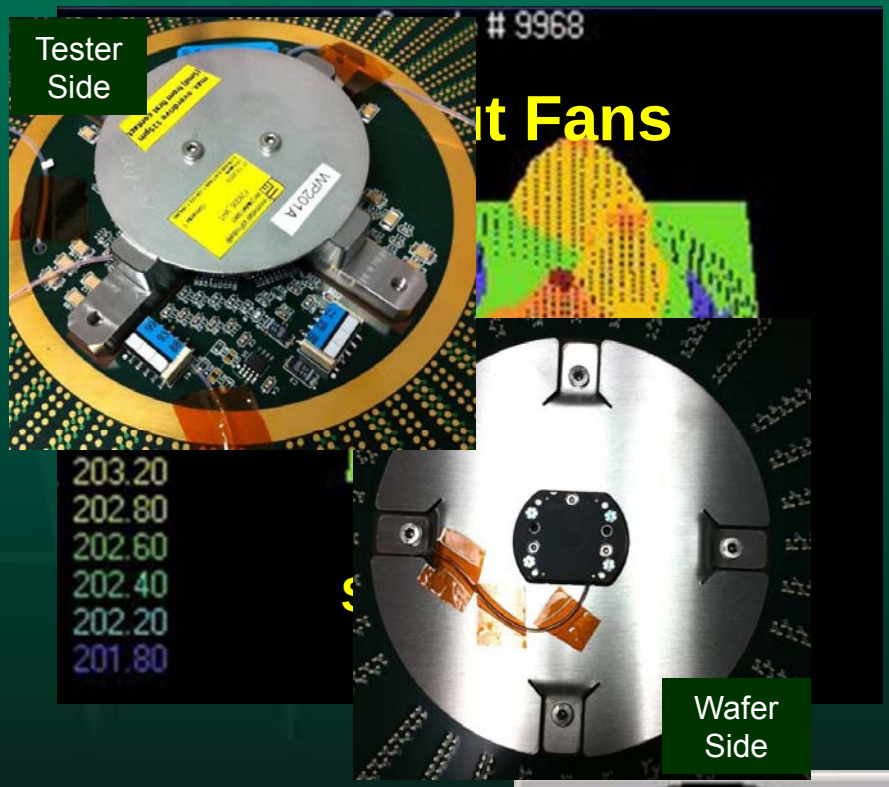


Thermal Wafer Ramp to 200ºC

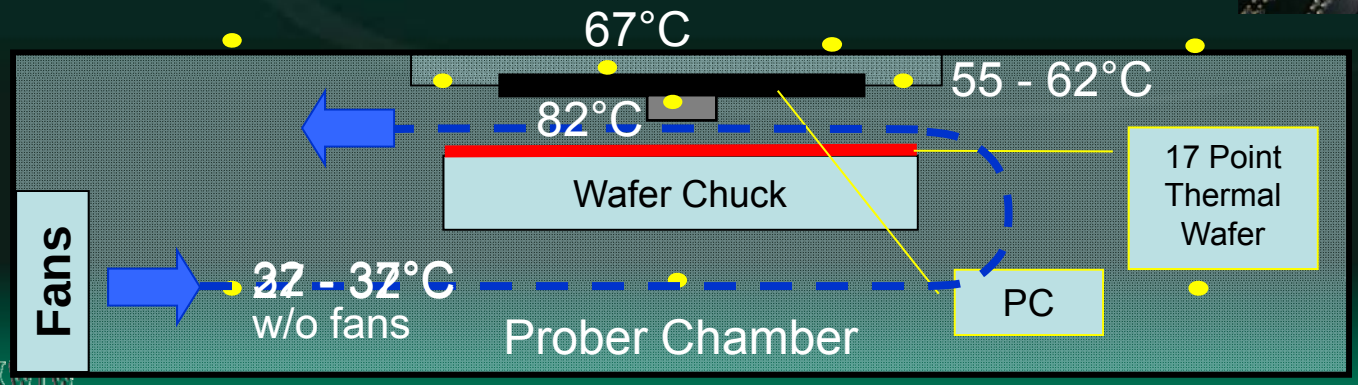


Chuck Profile at 200ºC





2 hour non-contact soak



Device Testing

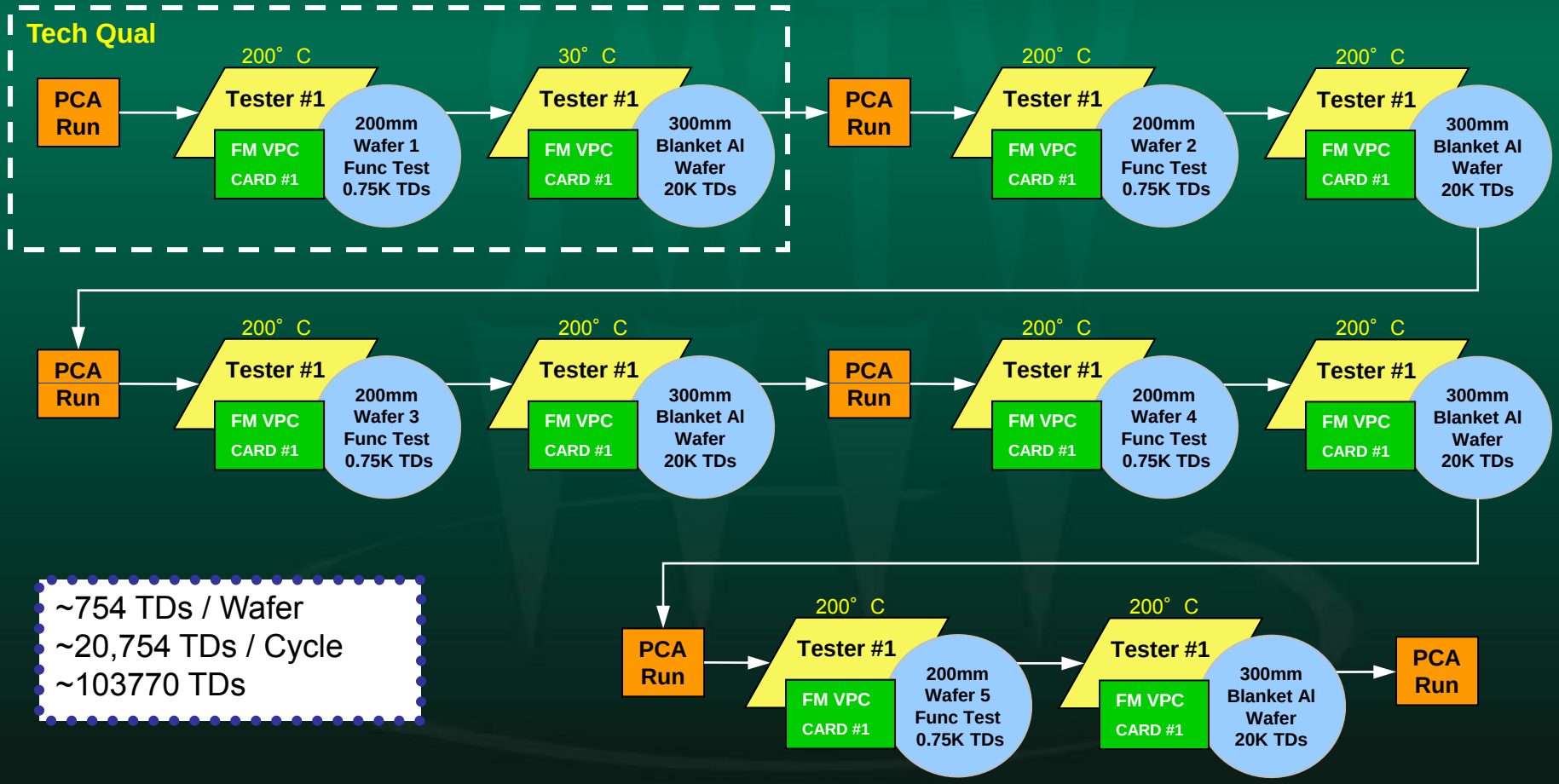
Test Plan Overview

- **Probe Card**
  - First card received was only rated to 180°C
  - Feinmetall reviewed the probe card materials & evaluated the design parameters and determined it was safe to run the probe card at 200°C
- **Target Parameters**
  - CRes – Test Program, every TD
  - Yield – Production Metric
  - Reprobe rate – Production Metric
  - Planarity & Alignment – PC Analyzer
  - Tip wear – Microscope Inspection
  - Tip diameter – PC Analyzer Measurement
  - Pad scrub damage – AVI

Test Plan Overview

- One customer application required taking a standard commodity part and retesting it at 200°C.
- Retesting of the previously probed wafers enabled testing of only known good dies.
- The low volume of wafers needing 200°C testing required a change in our standard qualification process.

Ramp to Volume Production Test



~754 TDs / Wafer
~20,754 TDs / Cycle
~103770 TDs

Input

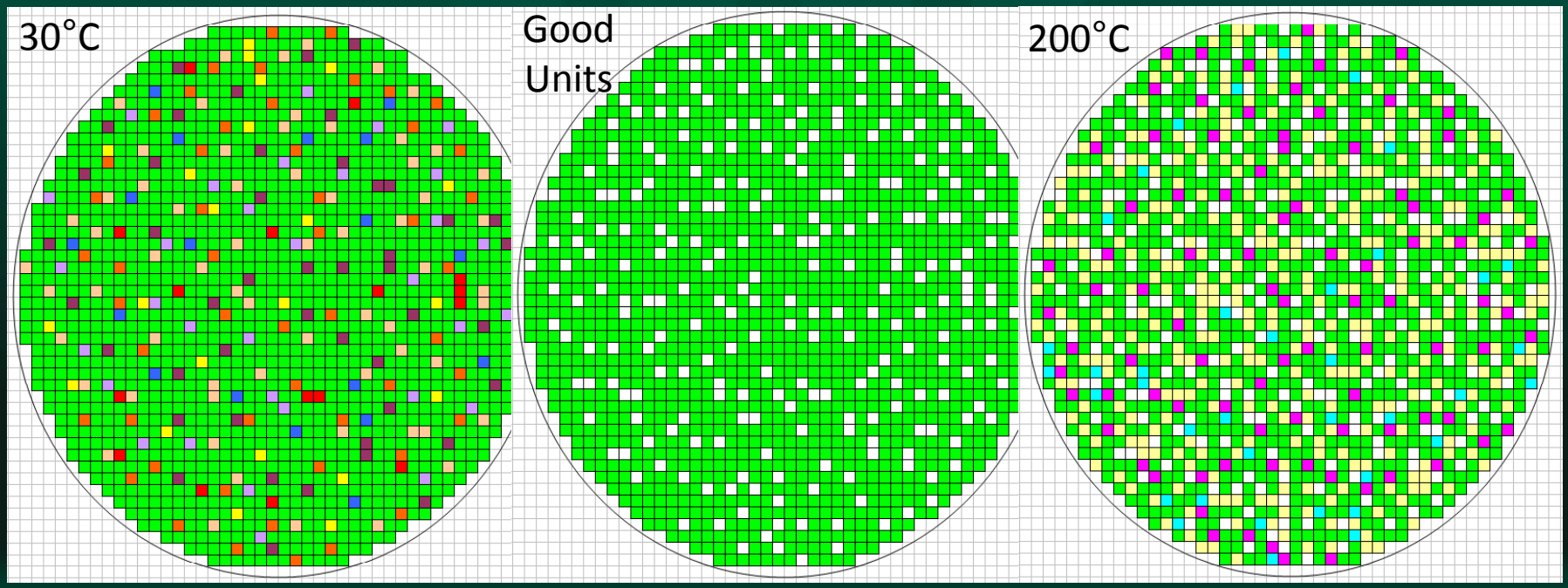
- PC to Wafer
- PC to Lifetime

Output

- CRes
- Yield
- 1st Pass Reprobe Rate
- Planarity/Alignment
- Tip Diameter
- Tip wear
- Pad Scrub Damage
- GR&R

Test Results

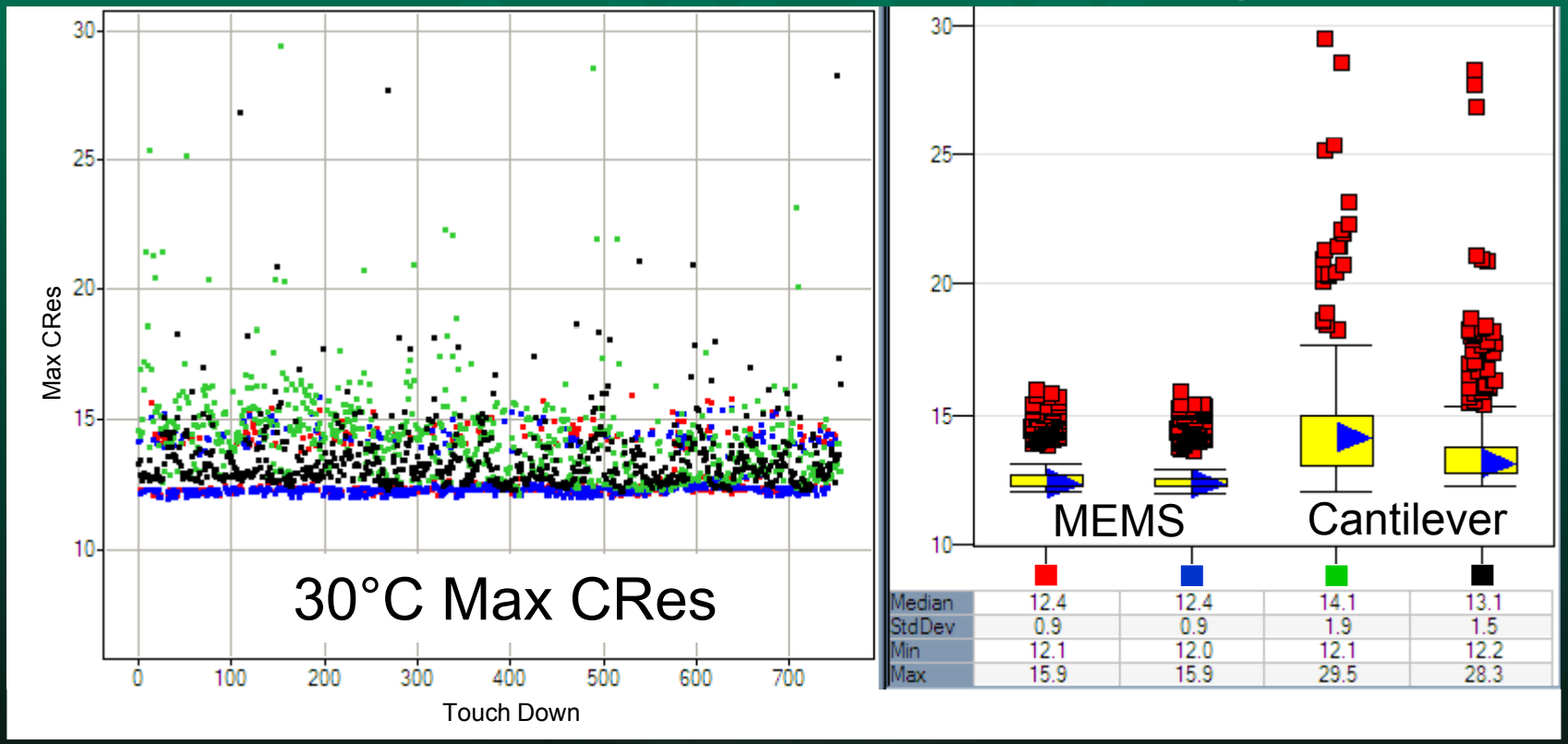
- Comparing first insertion yields to the retest yield at 200°C shows an average yield loss between the two runs of approximately 50%.



Generic wafermaps

Test Results

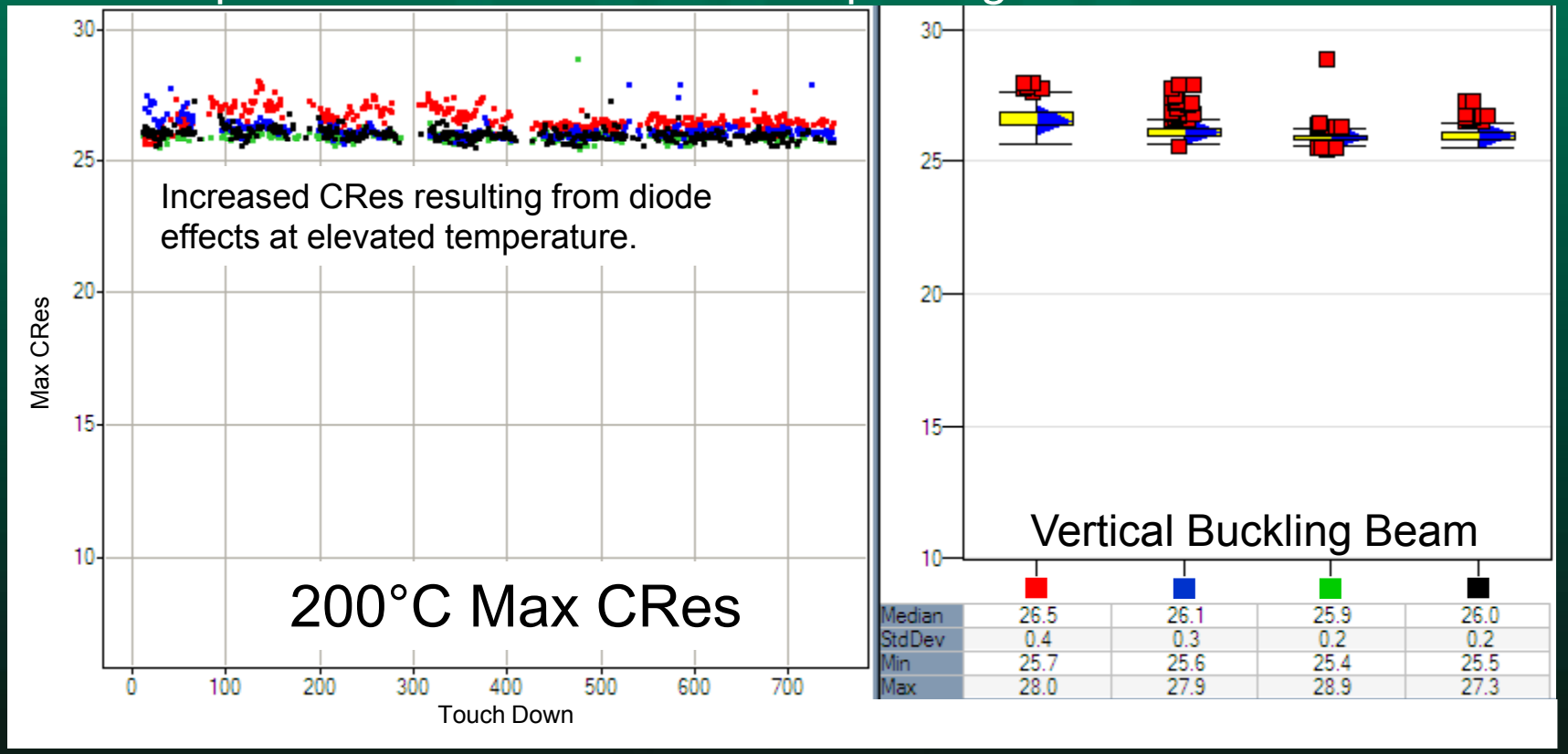
Production results of 4 wafers destined for 200°C probing



Device first released on dual site cantilever, then migrated to a x16 site MEMs probe card.

Test Results

Retest of production material at 200°C probing



Results from high temperature testing show an increase of max CRes, but extremely stable with a StdDev of 0.4Ω or less.

Summary

- Evaluation of the test cell lead to changes in the production process
  - Soak time not gated by prober chuck reading.
  - Prober cooling fans turned off during high temperature probing.
  - Probe cards are required to be built with high temperature features, such as heat shields and high temp materials.
  - Docking interface and tester found to have little impact on the stability of the setup (for this combination).
- Device testing and test programs must be adjusted to compensate for the difference in CRes seen at high temperatures.
- Further work required in
  - Optimizing the online cleaning recipe.
  - Evaluating other tester platforms for 200°C probing.
  - Increasing the temperature ceiling to 220°C.
  - Qualifying second source probe card suppliers.

Acknowledgements

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Thank you

Questions?