SWTEST
PROBE TODAY, FOR TOMORROW
2023 CONFERENCE

SW23_48_IBELE

Automated Thermal Chuck Calibration for 200mm and 300mm Wafer Probers

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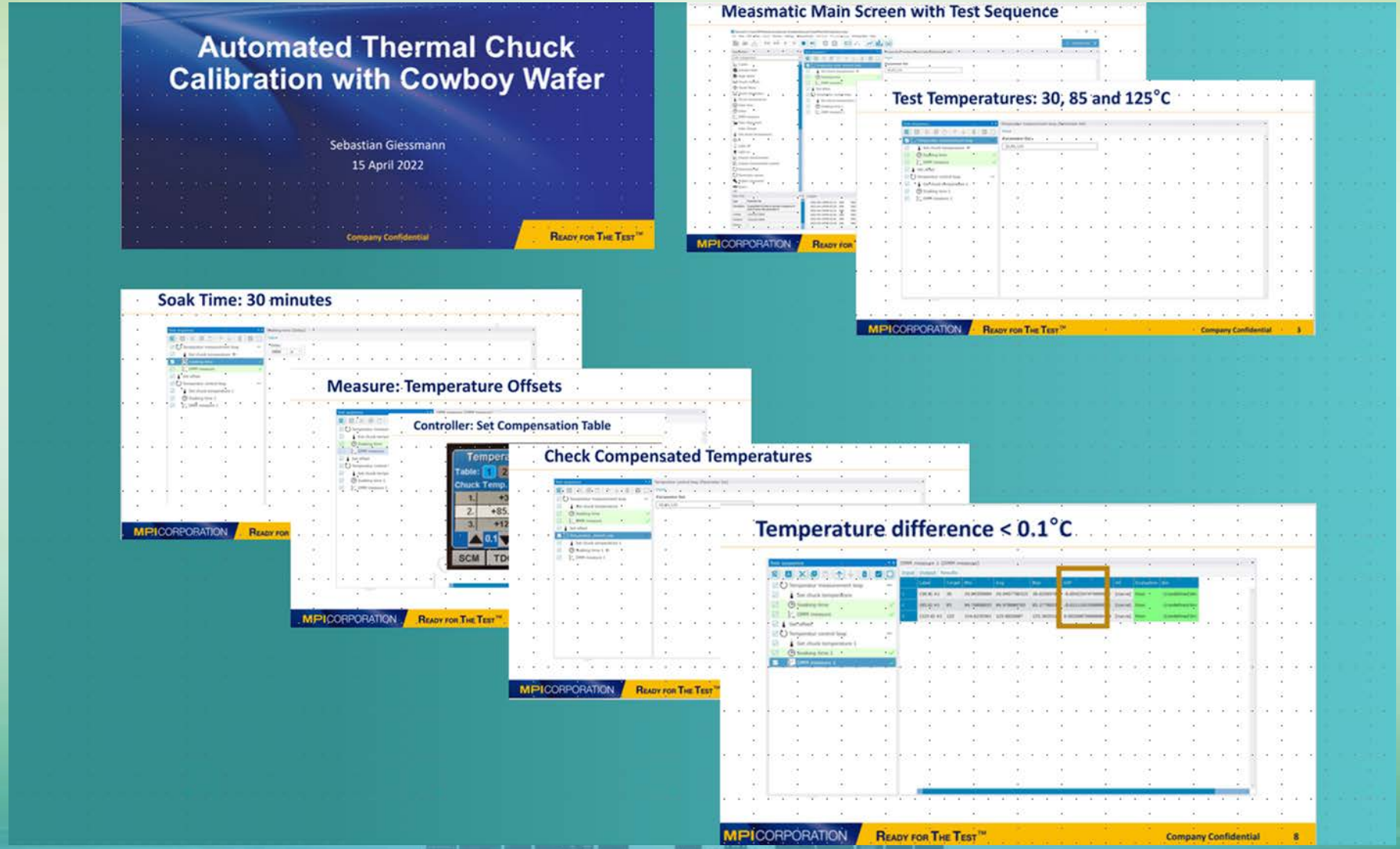
Follow-up to Poster SW22_33



Overview

- Defining Calibration
- Calibration Techniques
- Cowboy Wafer
- Benefits of Automating Calibration
- Real-World Feedback and Results
- Summary
- Future Enhancements

Defining Calibration

- Calibration: Measuring a property against an established standard.
- In the context of temperature, the calibration standard is the International Temperature Scale 1990 (ITS-90), which defines the fixed points of different elements and chemicals.
- If the value is adjusted, a verification is needed via a second measurement.
- Calibrations can be accredited, with ISO17025:2017 being the standard.

Common Calibration Techniques

No calibration, relying solely on tool specifications

- Sensor with thermal paste (contamination restricts use)
- Thermocouple (TC) drop-sensor / handle-sensor
- TC calibration wafer
- Resistance Temperature Detector (typically Pt) calibration wafer

RTD Wafer

- Provides the most accurate results, depending on initial sensor calibration.
- Likely the priciest option.
- You need to be extremely careful, because…

RTD Wafer

- Existing RTD wafers tend to be fragile.
- Many Original Equipment Manufacturers (OEMs) will not repair or replace damaged wafers

Sigma Sensors Cowboy Wafer

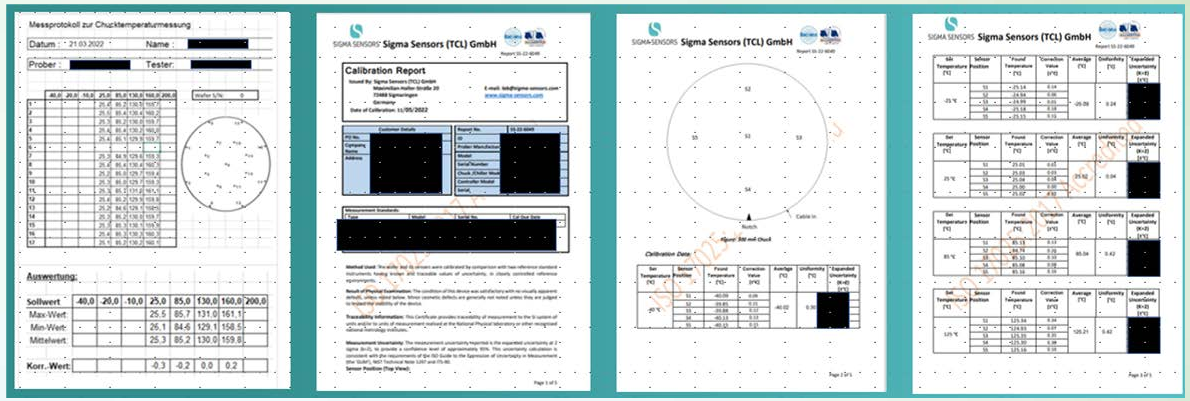
- Durable sandwich construction increases longevity and simulates the insulation against convective heat transfer that is provided by the head-stage / probe card
- Designed for everyday use with easy handling and storage
- Convenient hardware and software
  - Bluetooth Data Logger
  - Laptop included in system
  - LTE options for remote calibration
  - Data report, export to csv, pdf, {your custom choice}..
- Can integrate with either prober and/or temperature controller
  - Sigma Sensors software open to integration in any prober or controller

Data Report, Export Options

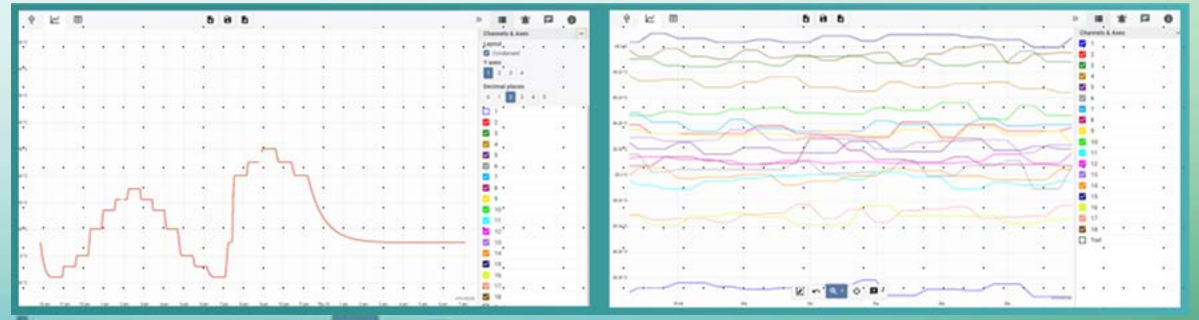
CSV data with time-stamp

- Set temperature
- Sensor Temperature
- Mean
- Max
- Min
- Median
- Range
- Temperature offset
- Before / After
- Humidity
- Ambient / Chamber Temp

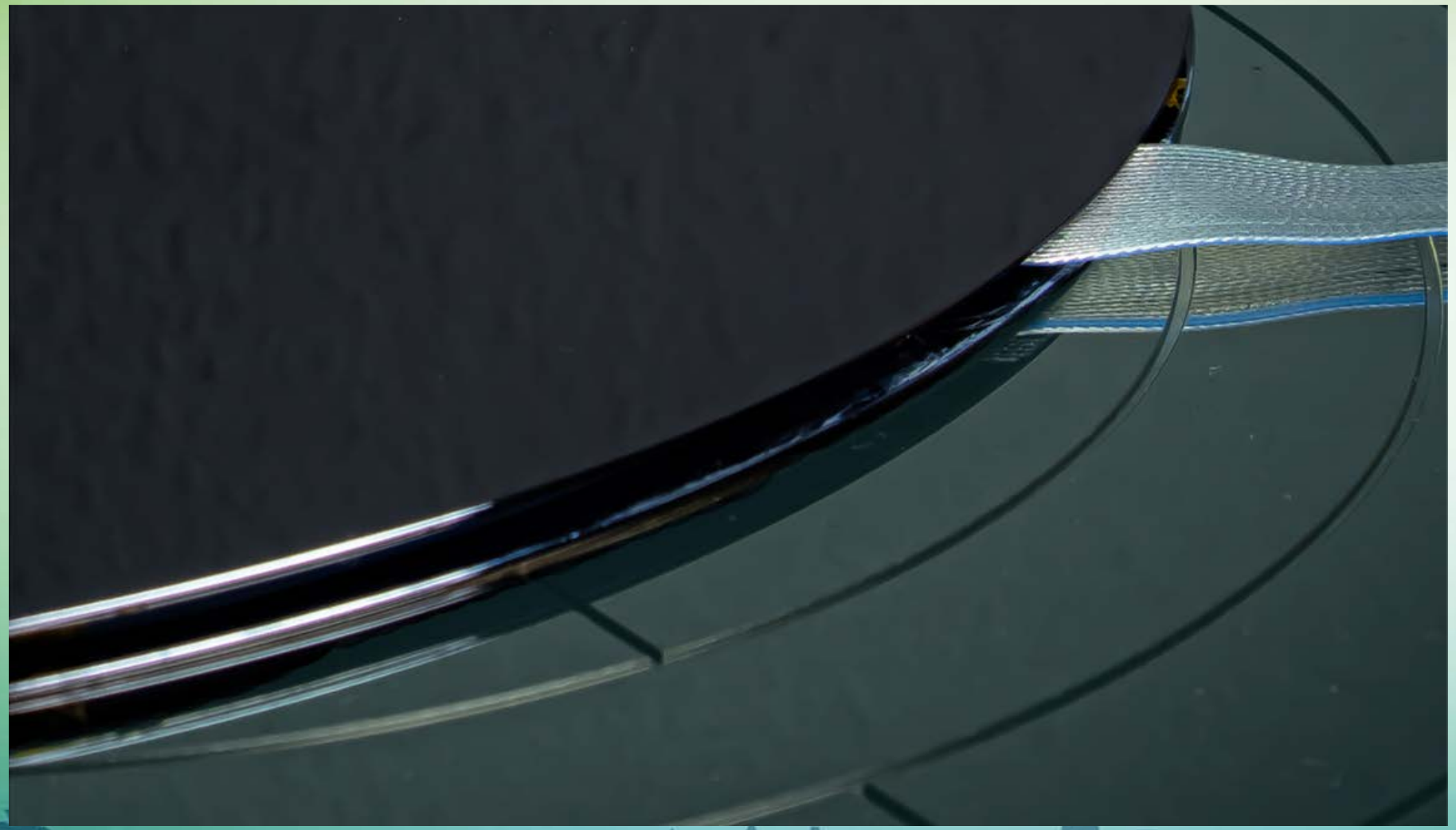
PDF reports



Graphs



Cowboy Wafer Specs



- 300mm, 200mm, < 200mm
- <4.5mm thickness
- Uses 825 micron silicon wafers
- Kapton reinforced
- Shatter-free

Wafer / Logger

Cowboy Wafer 300mm with carrier in hardshell carry case for protection and portability.

Bluetooth Data Logger

Datalogger dimensions
8 sensors: 125x90x50mm
24 sensors: 210x125x90mm

LTE Data Logger for remote accredited calibrations

Cowboy Wafer

- Durable
- Does not shatter
- Can still use it if it cracks
- Quick repair time

Benefits of Automating Calibration

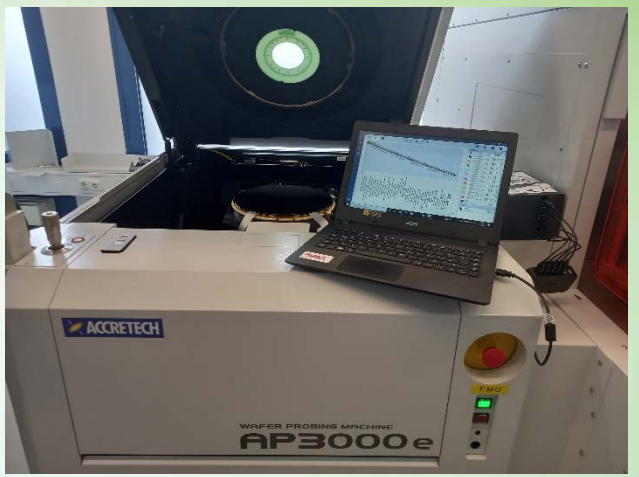
- 50% reduction in tool downtime, 80% reduction in human time
- ‘Set and forget’ is easy for operator
- Consistent calibration across all probers/chucks across multiple sites
- Documented measurement results for traceability

Traditional Calibration Method

- Manually place wafer on chuck and manually enter temperature into prober
- 4-8 hours per calibration per tool, depending on the number of temperature points
- Manually record temperatures after varying stabilization period
- Engineer intervention needed at each step
- Operator must switch focus many times to complete calibration

Set-Up

- Accretech AP3000e waferprober and ATT thermal chuck.
- Sigma Sensors Cowboy Wafer/Software Gen 2.



- NI GPIB tool for prober communication, LAN (RS232 optional) for chuck controller communication.
- Laptop processes data and coordinates calibration (stepping, updating offsets, etc)

Sigma Sensors' Calibration Methods

- Method 1: Automated data collection, manual prober/controller update, followed by automated verification.
- Method 2: Automated data collection; manual prober/controller update at each temperature; verification performed immediately after update before progressing
- Method 3: Full Automation*

* Integration in progress with ATT. Timeline to finish ~July, 2023

Method 1: 2-Step Calibrate, Adjust, Verify

- Wafer placed on chuck, prober communication established with GPIB.
- Target temperatures/hold times inputted.
- Automated prober control and data logging executed.
- Upload new offset file
- Repeat automated measurement sequence for verification

- 5 temperatures, -40°C – +200°C
  - 5 minute setup; ~4 hour data collection; 5 minute offset data entry; ~ 4 hour verification; 5 minute teardown
  - Total time = 8:15 hr (8 hours data collection, 15 minutes operator time)

Method 2: In-Situ Calibrate, Adjust, Verify

- Prober gives alarm after set point stable (5 minutes variation < 0.05°C)
- Operator manually enters calculated offset at set point
- Verify that measured temperature now matches set temperature
- Operator accepts and SW ramps chuck to next setpoint
- Repeat

- 5 temperatures, -40°C – +200°C
  - 5 minute setup; (45 minute data collection; 5 minute offset data entry; 5 minute verification)*5 temperature; 5 minute teardown
  - Total time = 4:45 hr (4:10 data collection; 35 minutes operator time)

Method 3: Full Automation

- Software steps controller through user-defined temperatures
- Temperature measured, offset calculated, offset updated
- Immediate verification after offset update
- 10 min operator time for set-up and removal

- 5 temperatures, -40°C – +200°C: 5 minute setup; (45 minute data collection, instant offset data entry; 5 minute verification)*5; 5 minute teardown
  - Total time = 4:20 hr (4:10 data collection, 10 minute operator time)
  - ~50% reduction tool down time, ~80% reduction human time

Temperature Offset Update - Comparison

- M1: Manual data transfer with USB to update offset tables
- M2: Manual entry after each set point with in-situ verification

M3: Fully automated routine without operator intervention except for setup/teardown (Accretech/ATT)

Summary

- Accredited calibration with RTD Wafer is the gold standard
- Sigma Sensors Cowboy Wafer is operator friendly
- Controller integration is immediate route to full automation (although adjustment in prober is most desirable)
- Semi-automation reduces operator demand and downtime
- Full automation further reduces operator demand and downtime
- ‘Set and Forget’ aspect of full automation preserves worker attention for other tasks
- Automation enables 50% reduction in tool downtime, 80% reduction in human time

Near-term Initiatives

- Full automation with ATT controllers ~ July, 2023
- Setup cloud service to receive data collected remotely with LTE enabled data loggers ~ August, 2023
  - Data sent to Sigma Sensors lab
  - Calibration results reviewed
  - Calibration certificate issued remotely
  - Performed on customer schedule without an on-site visit
- Method 3 support for prober ~TBD, Q1/24?

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Thank you.

Questions?