Too Hot To Test

February 9 - 11, 2021

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accelerating thermal thinking

MEPTEC - Too Hot To Test

Active Temperature Control at High Power Testing

Feb-11th, 2021

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Managing Director – ATT Systems GmbH

Too Hot To Test?

Testing conditions are changing to the extreme

Full w … C

AI dev … lts

No pr…

Advan…
Low T…

Some solutions exist – some challenges remain

Active Temperature Control is Crucial –
Thermal Chuck is an Integral Part of the Test Cell

What is a Thermal Chuck System?

Air Cooled	Modular Base Chuck System	Liquid Cooled
		
-40C to +200C	Universal chuck and controller	-20C to +200C
-60C to +200C	2 independent cooling circuits	-40C to +200C
	+20C to +200C without chiller	-60C to +200C

Today's Requirements

Power dissipation: 300 Watts to 2000 Watts

Voltag

Electr

Temp

Flatne

Multi-Dimensional Requirements:

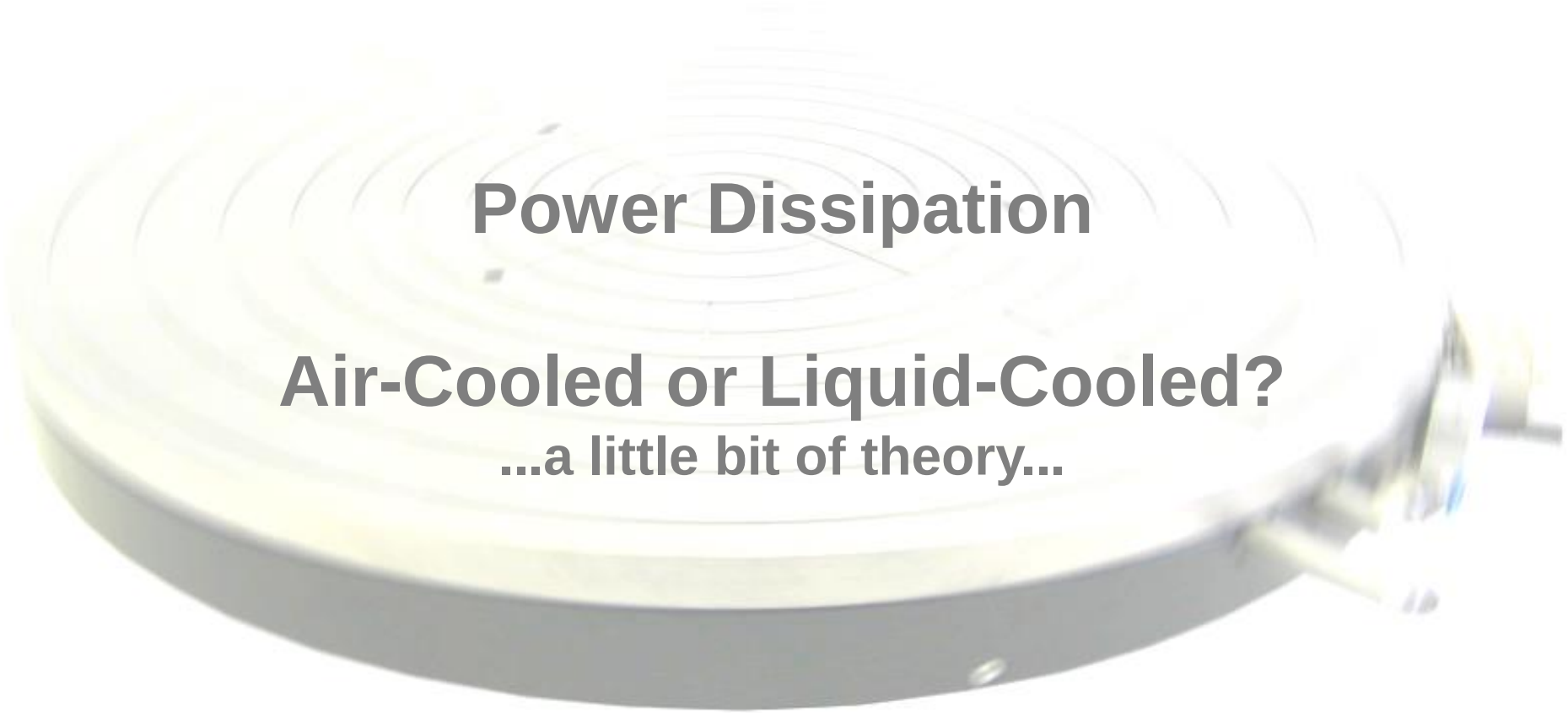
@Wide Temperature Range
@Uniformity

High Rigidity for 550 kgf load, thin wafer (50µm), warped substrates

3 Application Examples

Full Wafer Contact DRAM, Flash, HBM	100x100mm E.g. Microcontroller	20x20mm E.g. 5G or GPU devices
		
Contact Area: Large Parallelism: High	Contact Area: Medium Parallelism: Medium/Low	Contact Area: Small Parallelism: Low
Power/Die: Low Density: Low (3W/cm²)	Power/Die: Medium/High Density: Medium (10W/cm²)	Power/Die: High Power Density: High (125W/cm²)
Heat transfer: up to 2000W Temp. Range: -40°C to +125°C	Heat transfer: up to 1000W Temp. Range: -40°C to +125°C	Heat transfer: up to 500W Temp. Range: -40°C to +125°C

Roadmaps to wider temperature ranges and higher testing power!



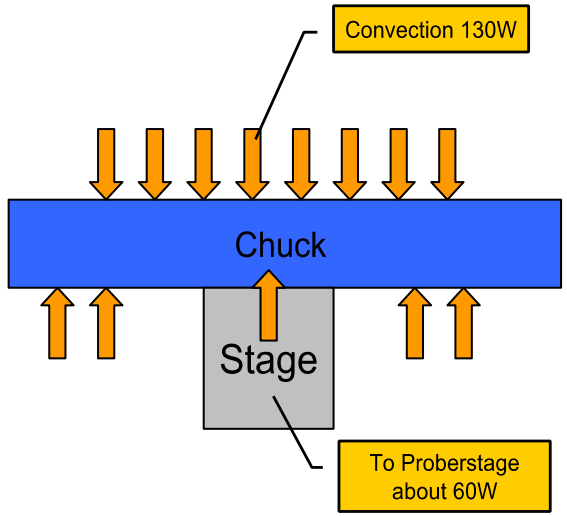
Power Dissipation

Air-Cooled or Liquid-Cooled?

...a little bit of theory...

Thermal Load – Idle Mode (Convection)

Chuck Temperature: -40°C
Thermal Load at “idle” mode



Thermal Load through convection:

The thermal load depends on:
- Temperature difference
- Surface area
- Heat transfer coefficient

$$\dot{Q} = \Delta T \alpha A$$

$$\Delta T = 65K$$

$$\alpha \approx 13W / m^2K$$

$$A = 0{,}155m^2$$

$$\dot{Q} \approx 130W$$

Additional power of around 50W transferred through prober-stage

Idle Thermal Load is around 180W

Thermal Load – During Testing

Chuck Temperature: -40°C

Therm

Thermal Load through Probecard:

At -40°C Chuck Temperature:

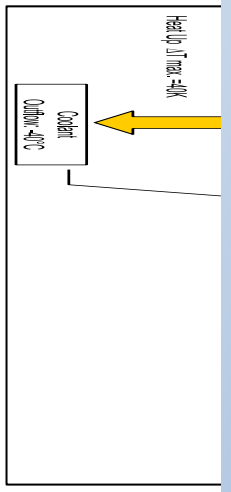
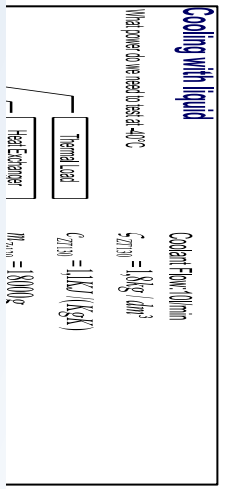
Thermal Load “Idle”: 180W

Thermal Load “Testing”: 50W to 2KW

Total Thermal Load: 230W to 2.2KW

Thermal Load during testing is >1100 Watts

Air-Cooled or Liquid-Cooled?

Air-Cooled	Liquid-Cooled
	
Max. Cooli	0W
Effective Cc	mity
ΔT high – impact on temp. uniformity	Reasonable cooling fluid consumption
High air-flow@high pressure	Wider temp range might require other fluids

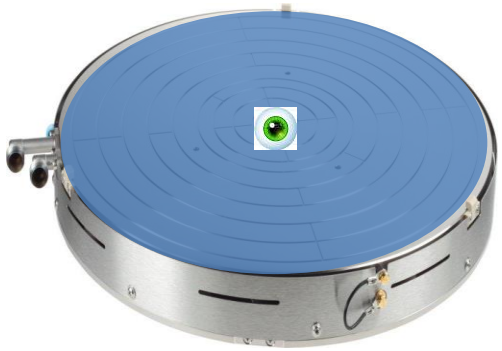
Conclusion:

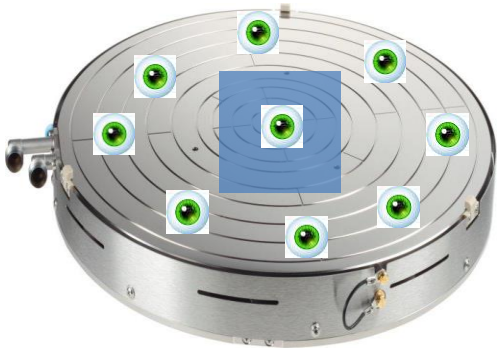
Liquid cooled systems are the tools of choice due to the high cooling power and better temp. uniformity!

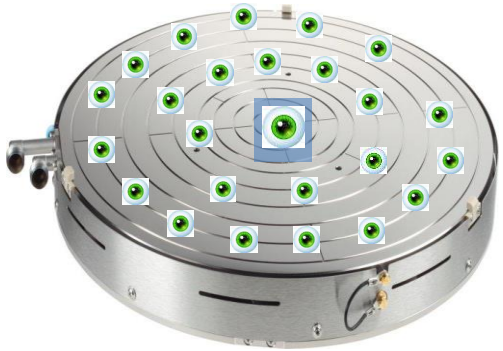
Why MultiSense?
You can‘t control what you can‘t see!

Temperature Detection - MultiSense

Full Wafer Contact	100x100mm	20x20mm
Up to 2000 Watts	Up to 1000 Watts	Up to 700 Watts



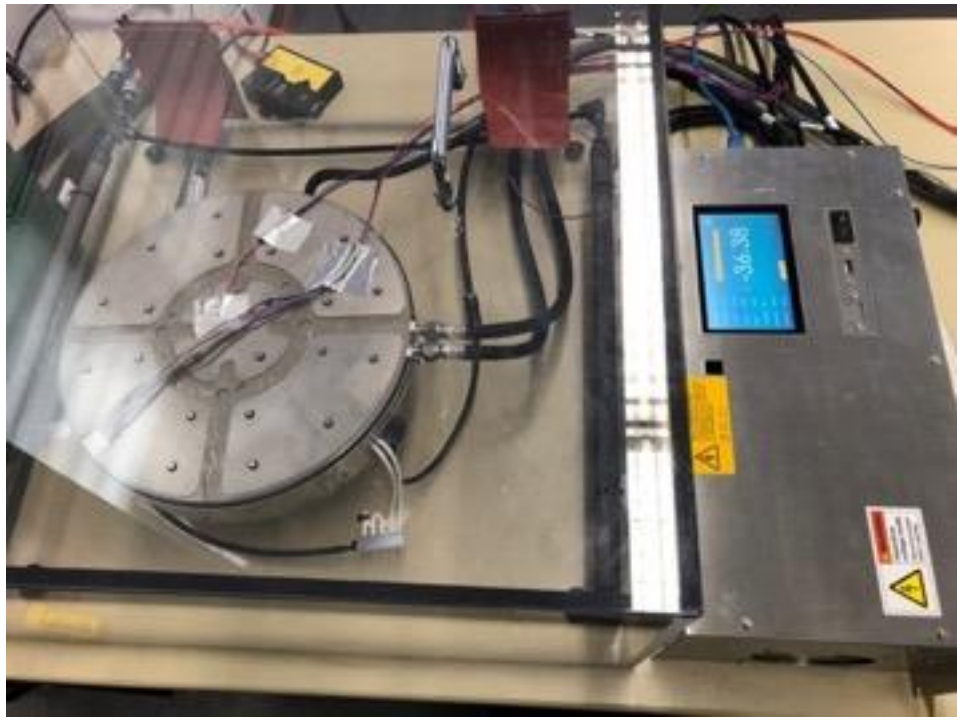




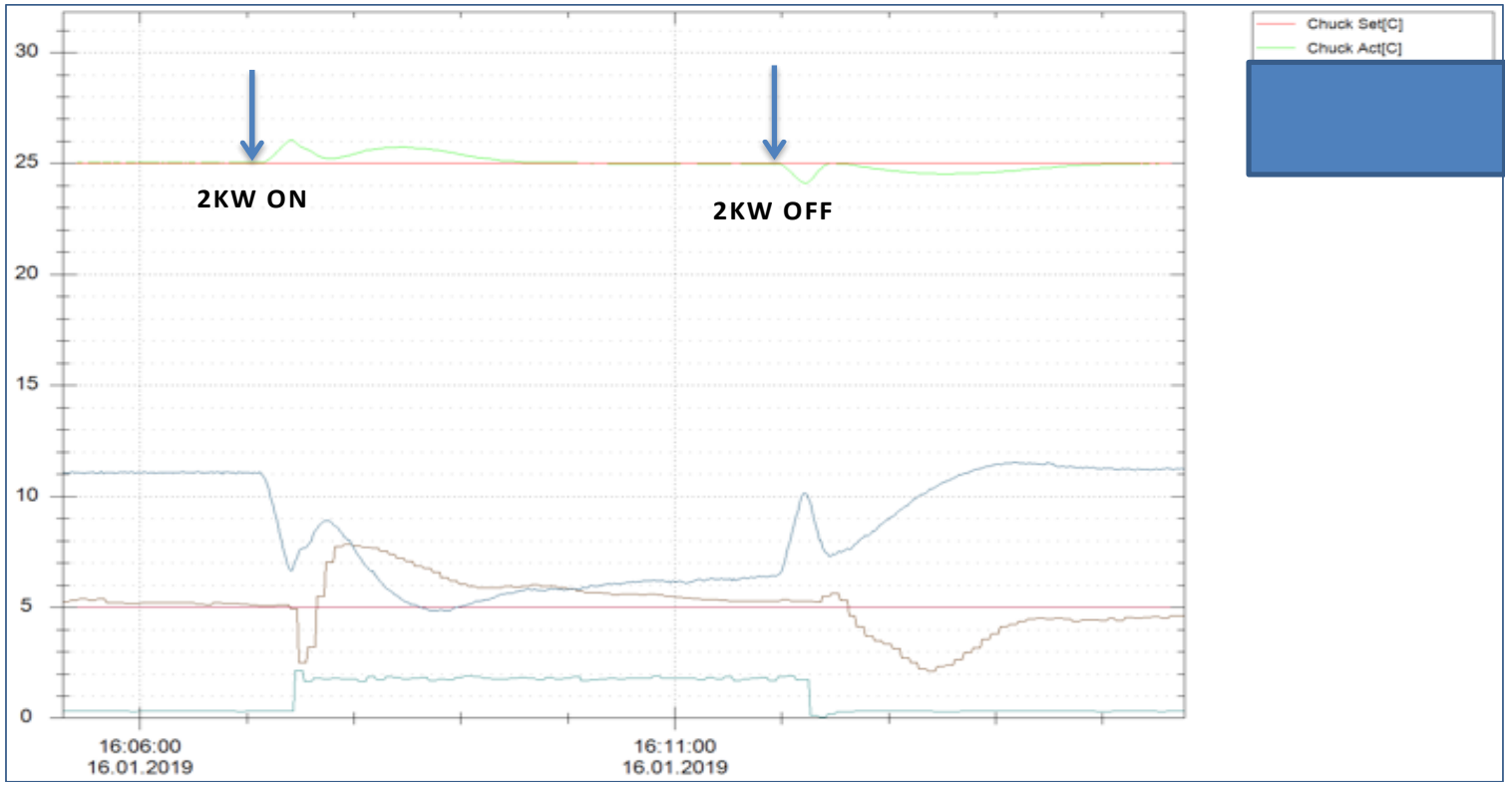
For Full Wafer Contact applications one control sensor is enough
Smaller contact areas require multiple control sensors to detect temp changes
Number of in-built sensors is limited due to chuck complexity
Number of AddOn sensors is scalable, currently up to 25 sensors
Requires advanced temp control algorithms

Full Wafer Contactor

- ATT Sealed Test Box
- Chuck – L300T-EX LTR HP
- Chiller – L80J (liquid cooled)
- Power Plate (up to 2000W)

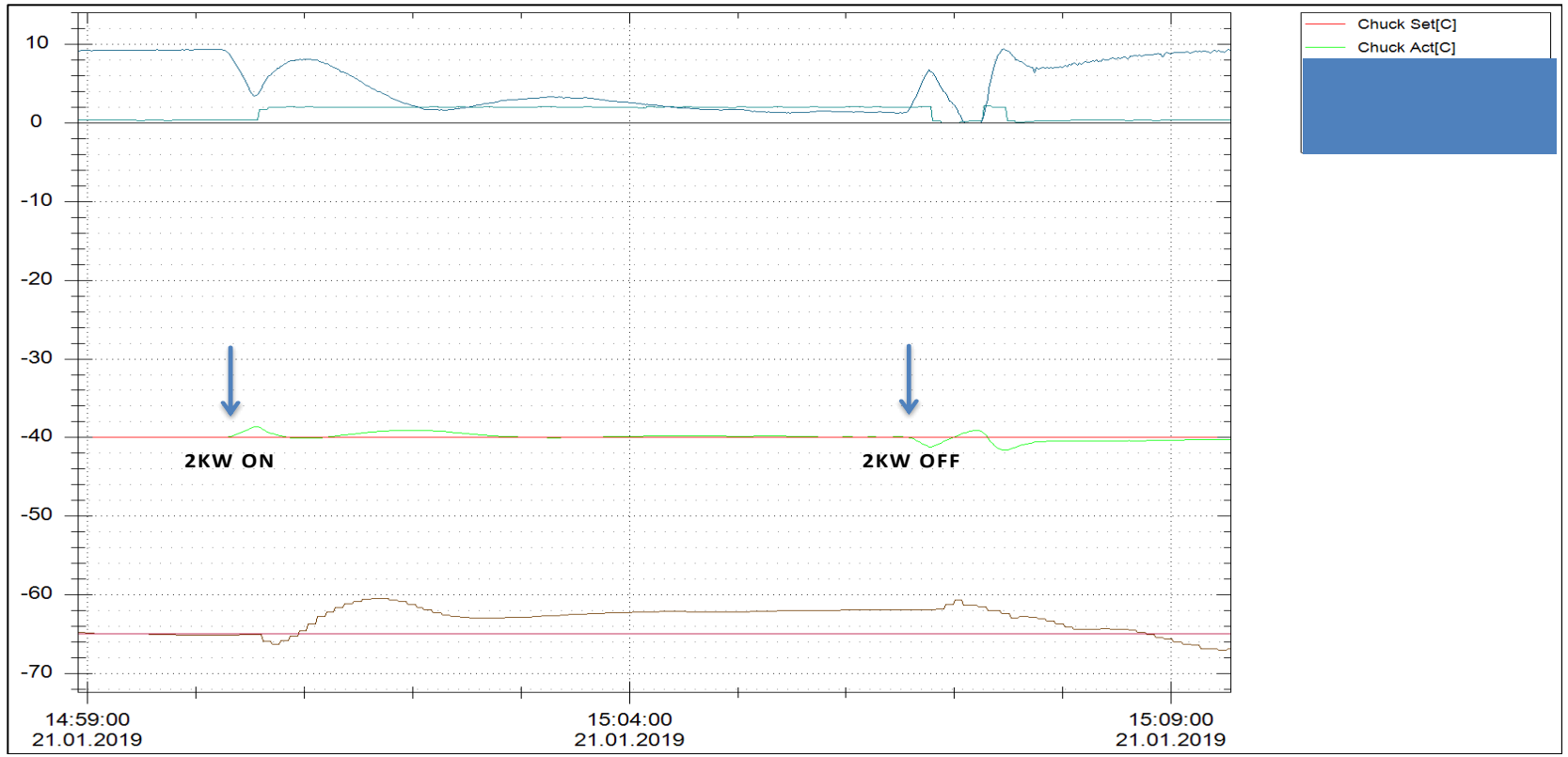


Full Wafer Contactor +25C 2KW



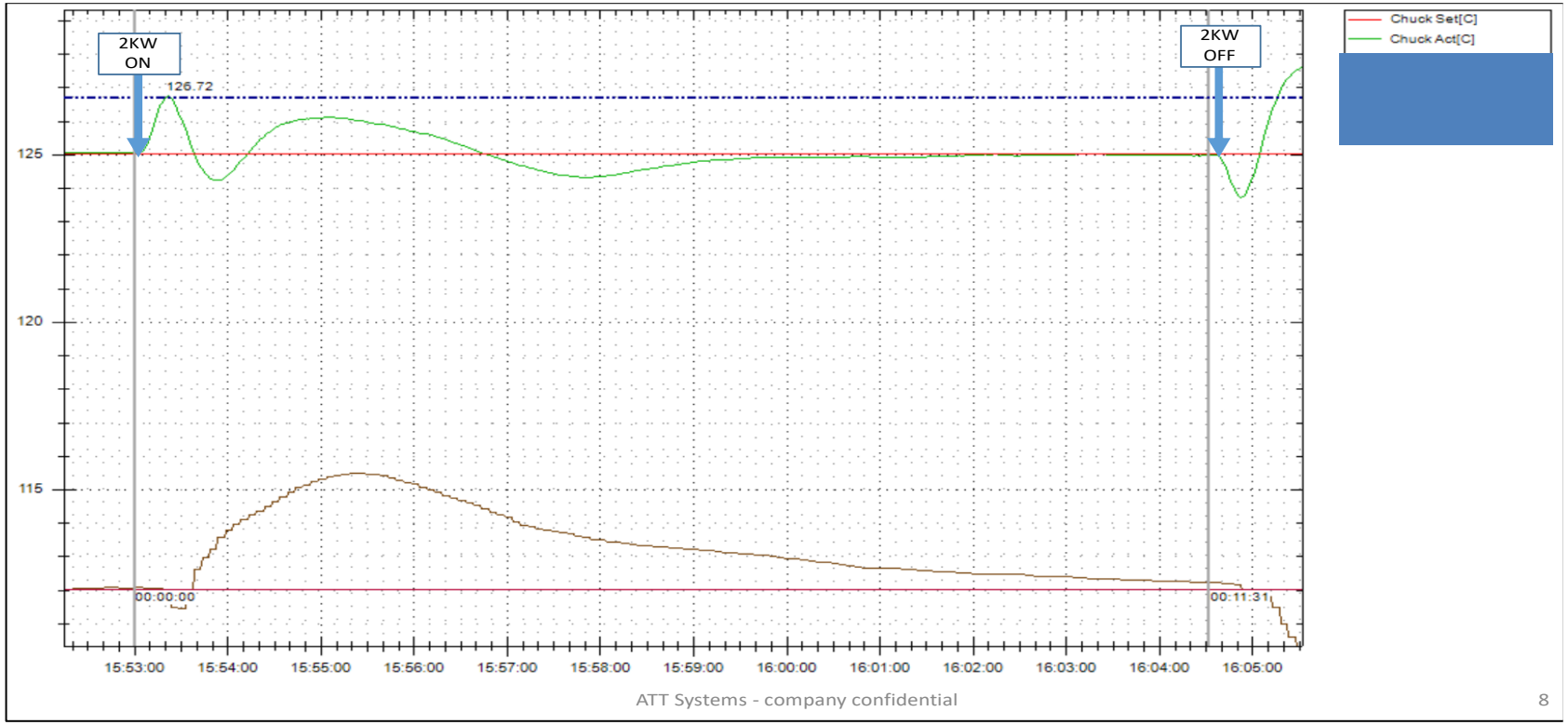
Able to dissipate 2KW – Temperature control within 1K

Full Wafer Contactor -40C 2KW



Able to dissipate 2KW – Temperature control within 2K

Full Wafer Contactor +125C 2KW

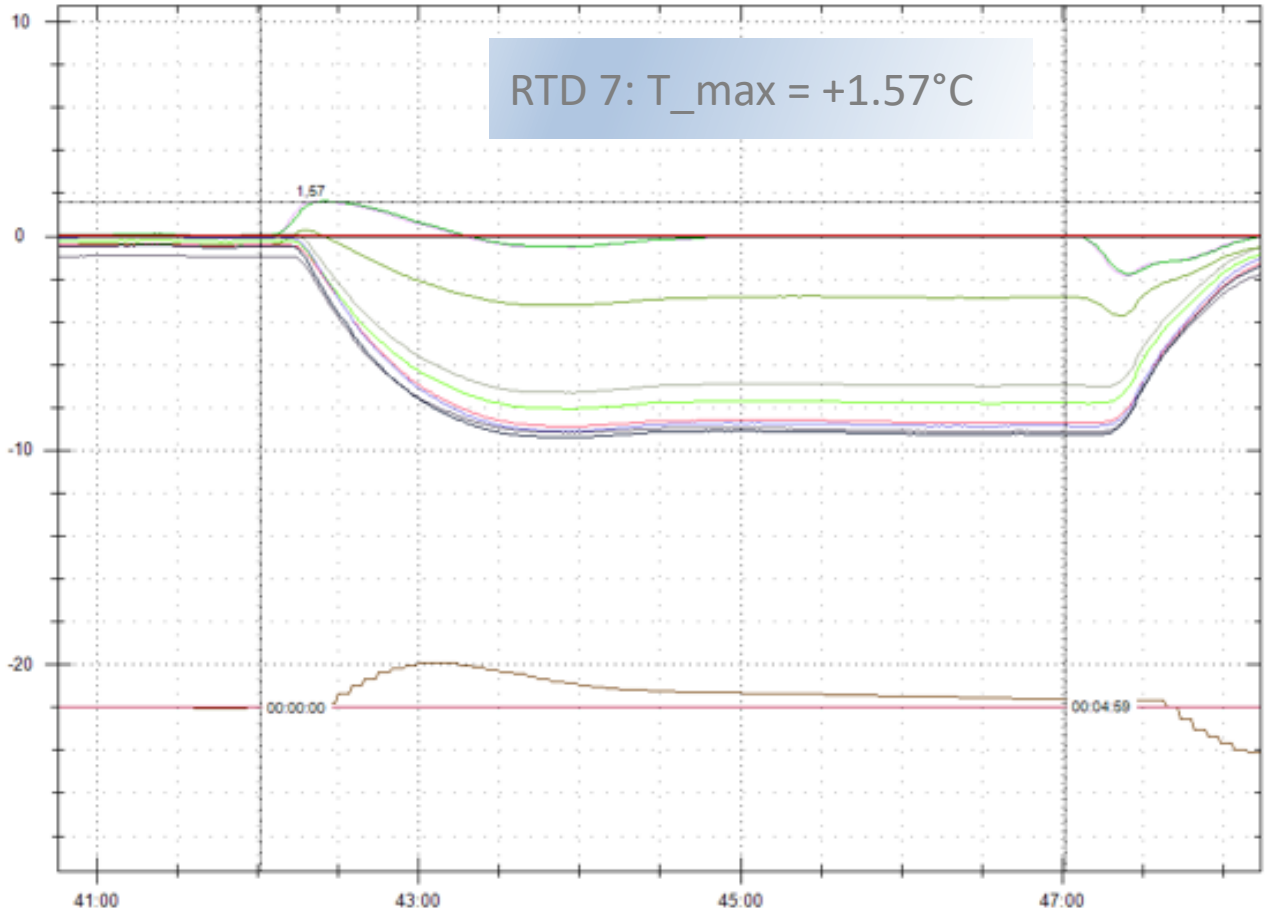


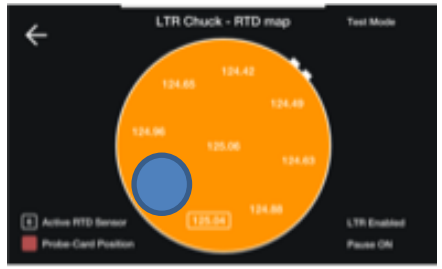
Able to dissipate 2KW – Temperature control within 2K

100x100mm

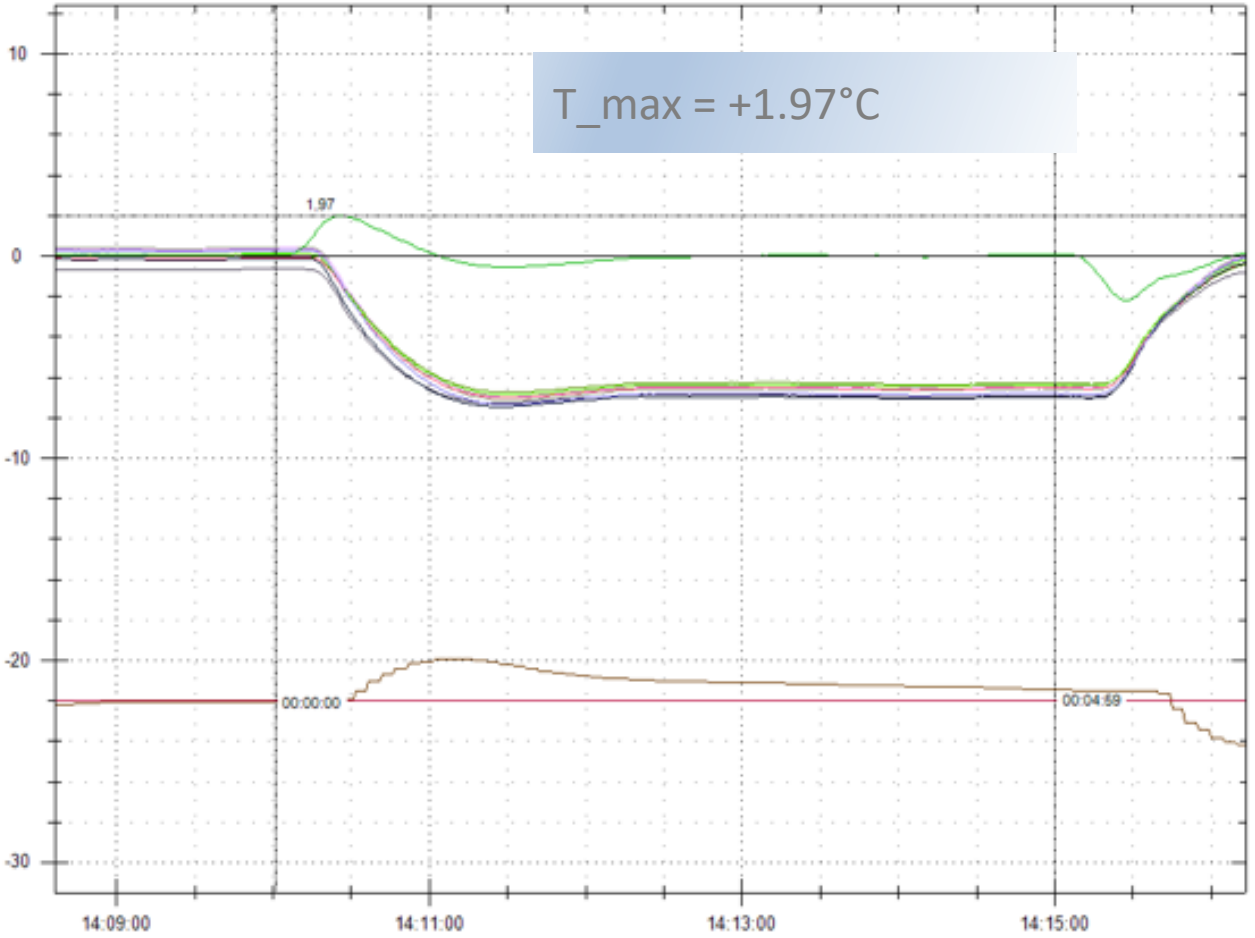
- ATT Sealed Test Box
- Chuck – L300T-EX LTR – 9 Sensors
- Chiller – L60J (liquid cooled)
- Power Plate (100x100mm)

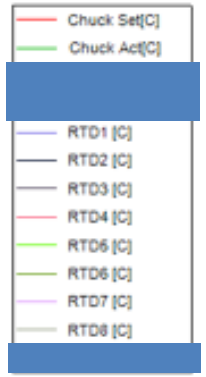
0C – Top Position 400W

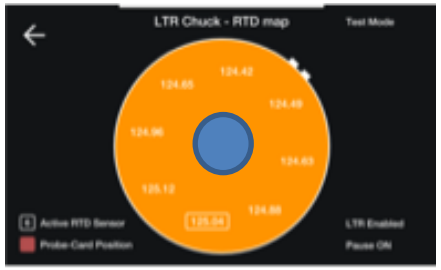




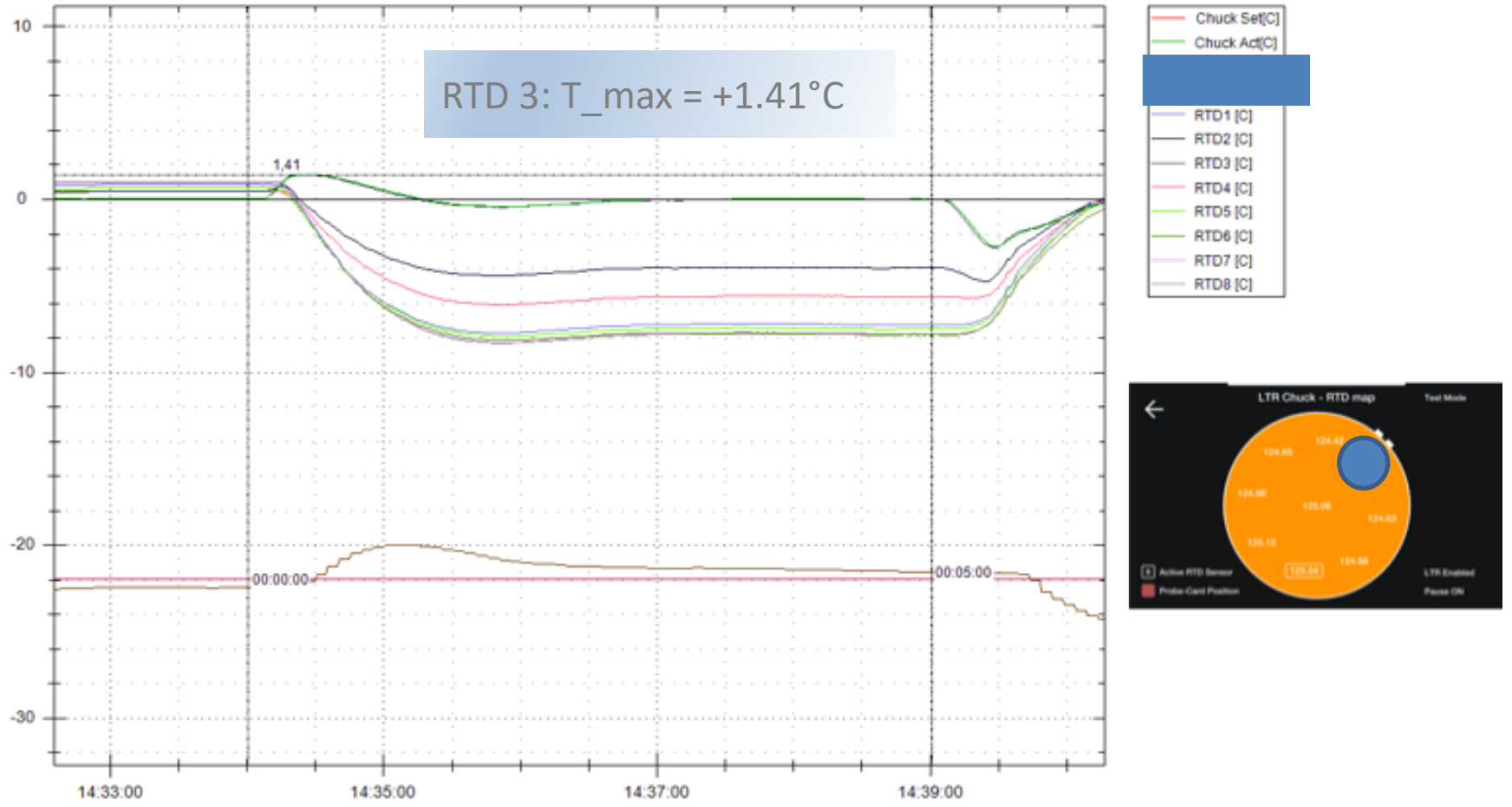
0C – Center Position 400W



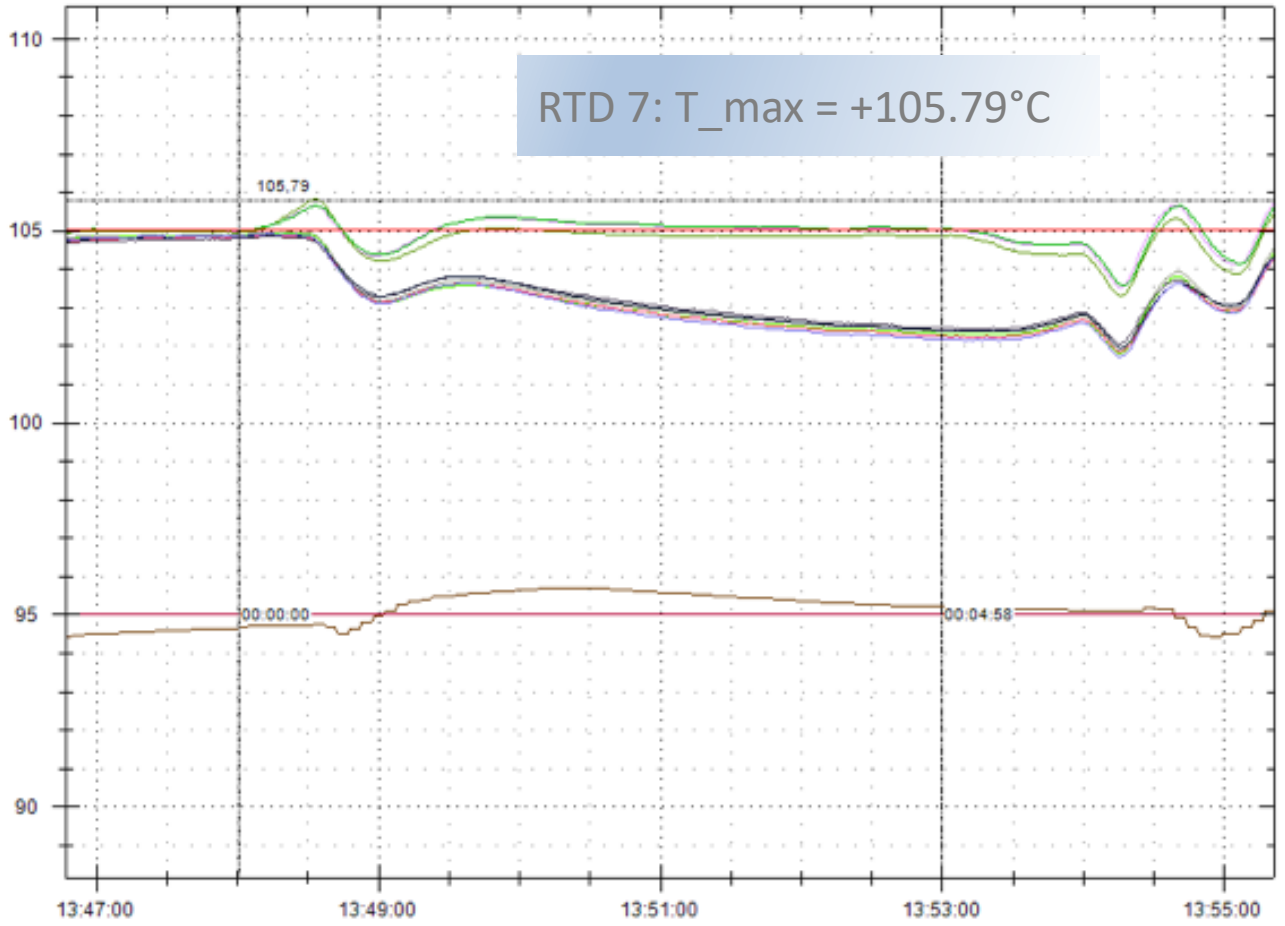


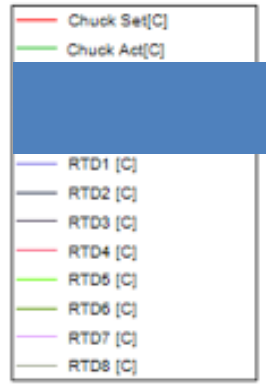


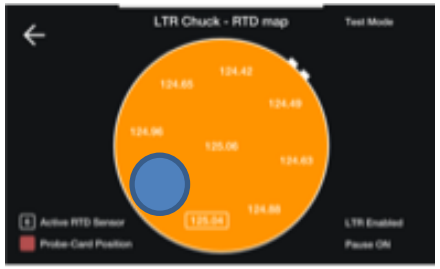
0C – Tube Position 400W



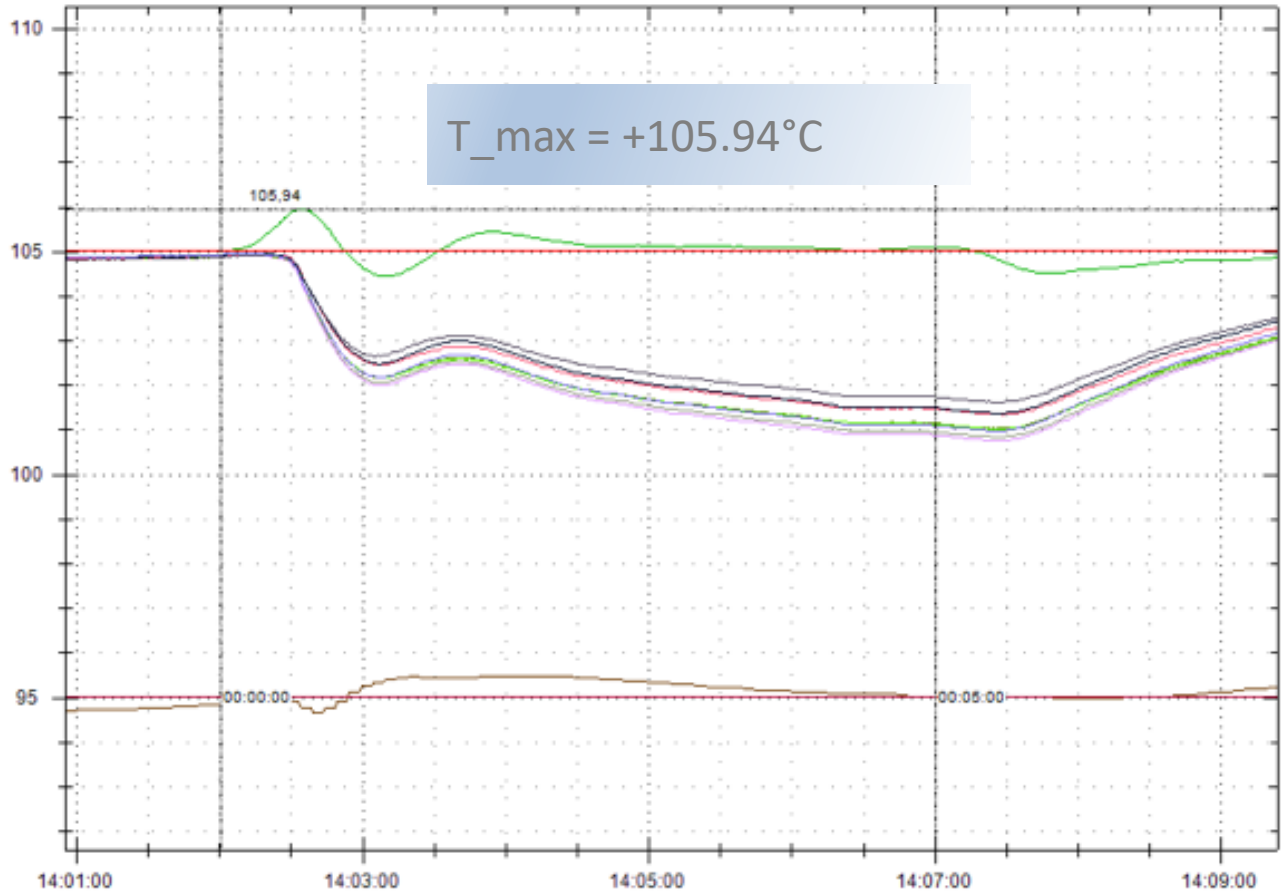
+105C – Top Position 400W



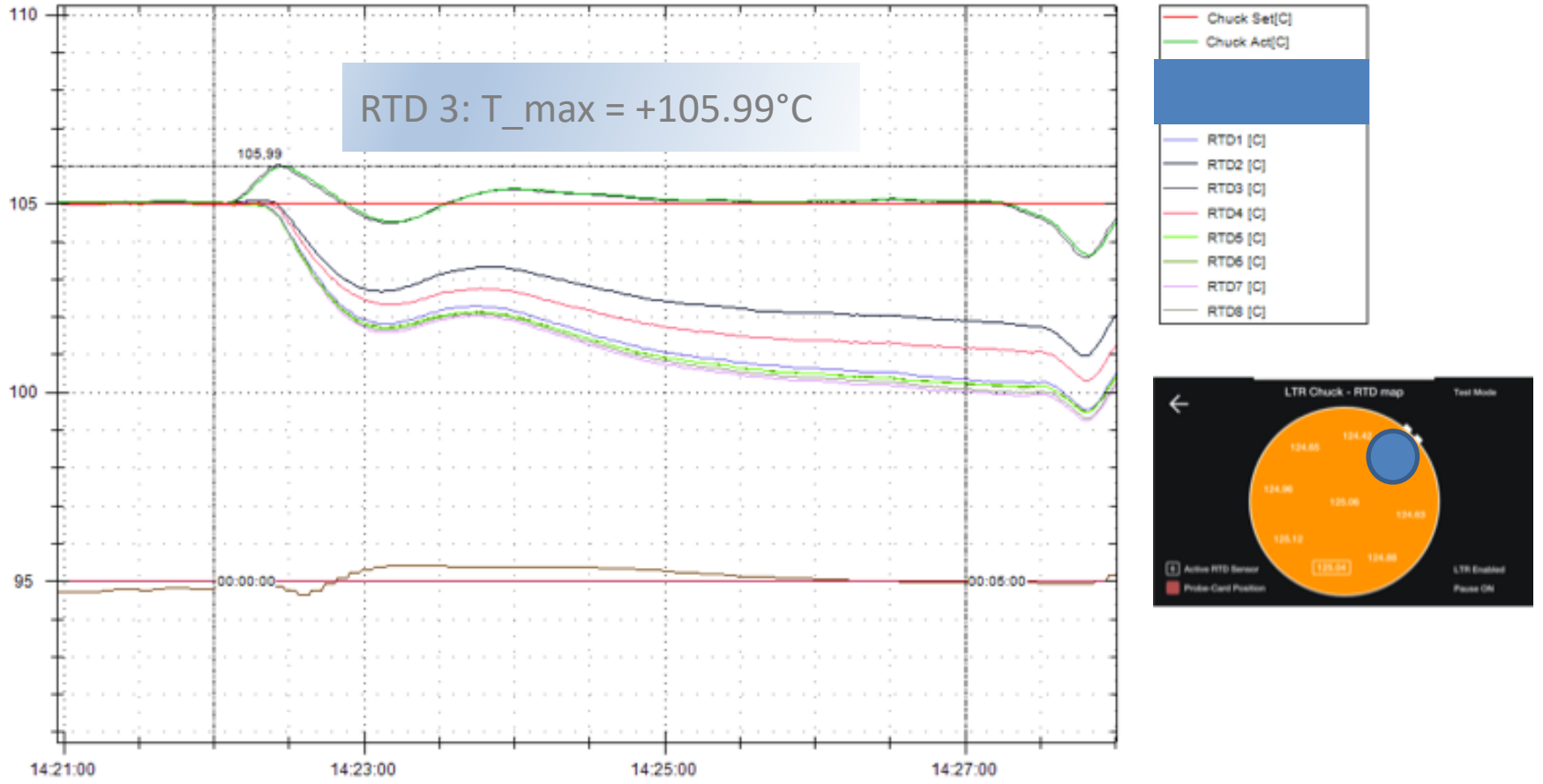




+105C – Center Position 400W

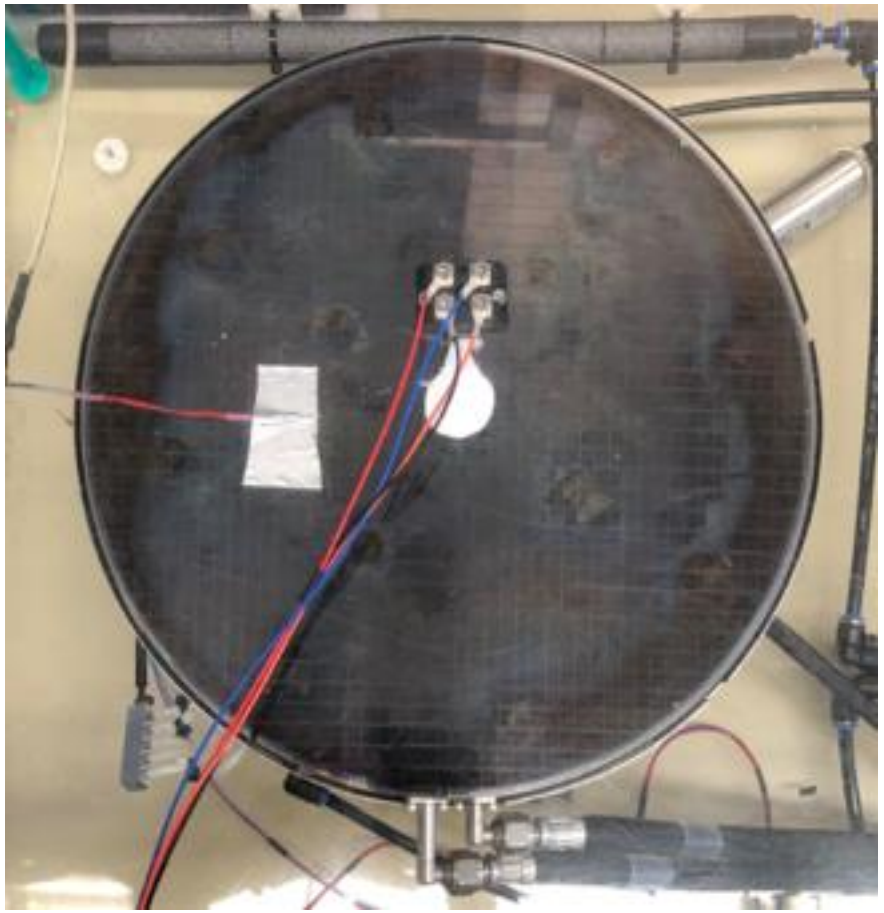


+105C – Tube Position 400W



23x23mm Contact Area - Test Set Up

- ATT Sealed Test Box
- Chuck – L300T-EX LTR – 9 Sensors
- Chiller – L60J (liquid cooled)
- Heater Plate 23x23mm (200W max)



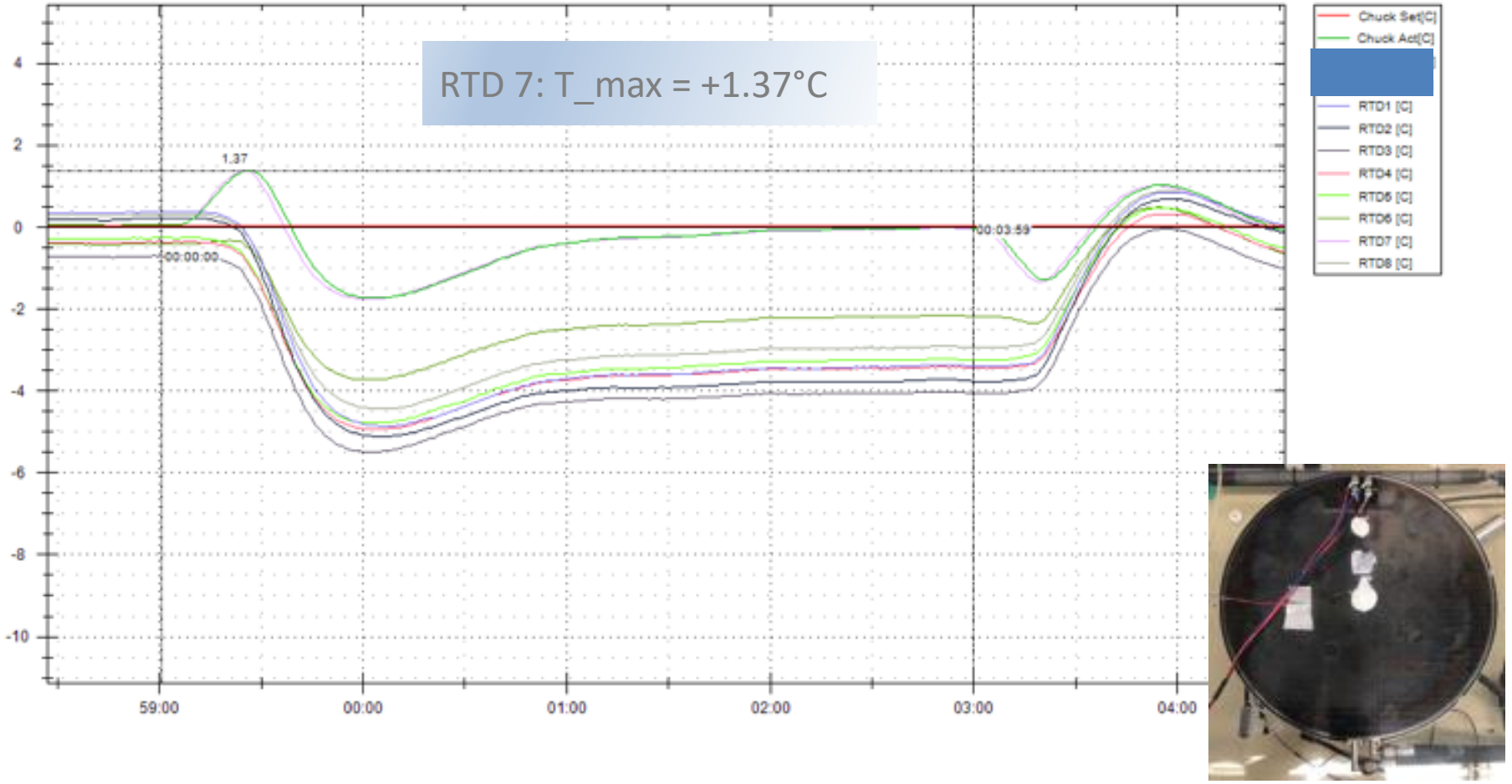
Test Conditions

Advanced Control Parameter

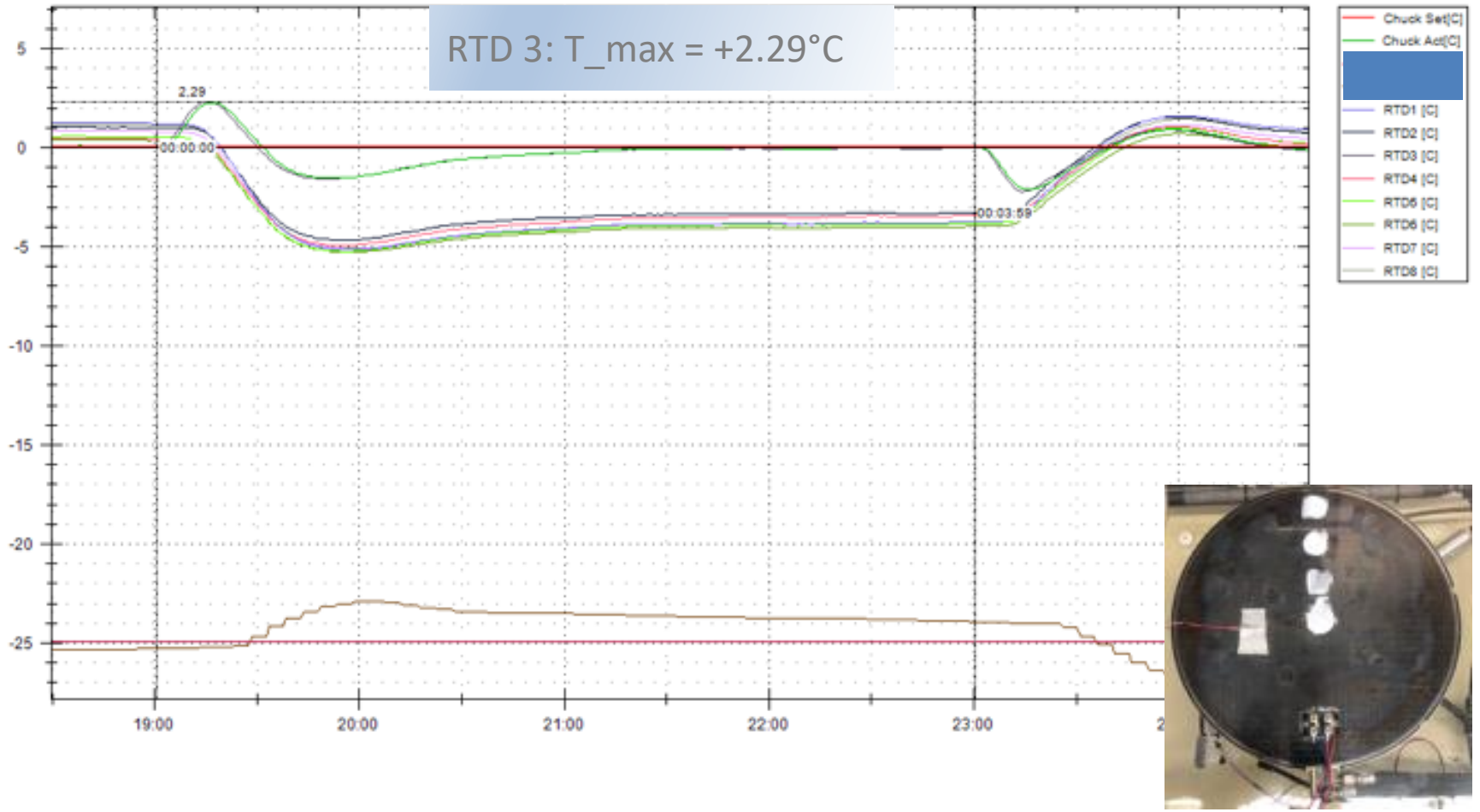
0°C: 100W - +105°C: 160W

Test Time: 4 minutes at 0°C, 15 seconds at +105°C

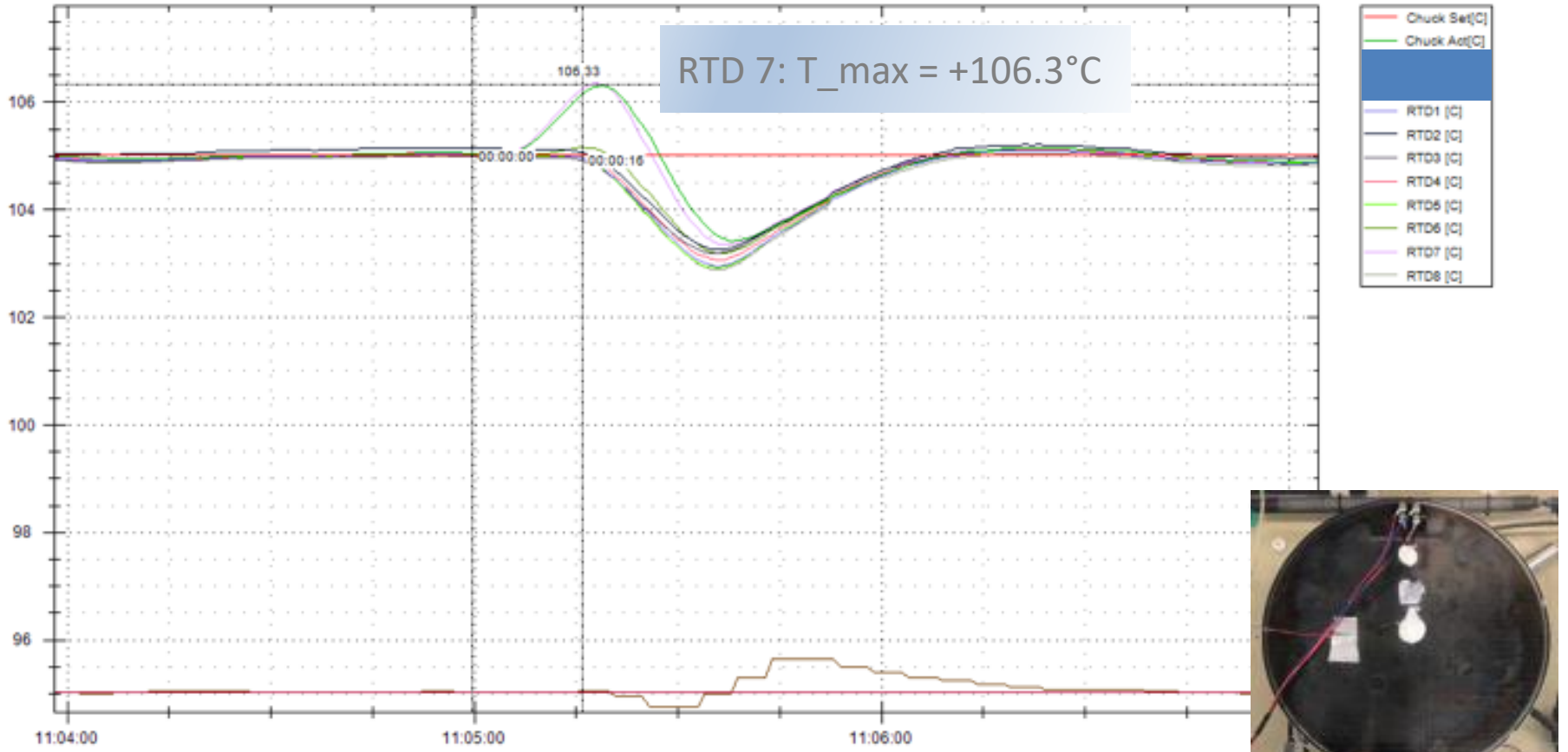
0C – Top Position 100W



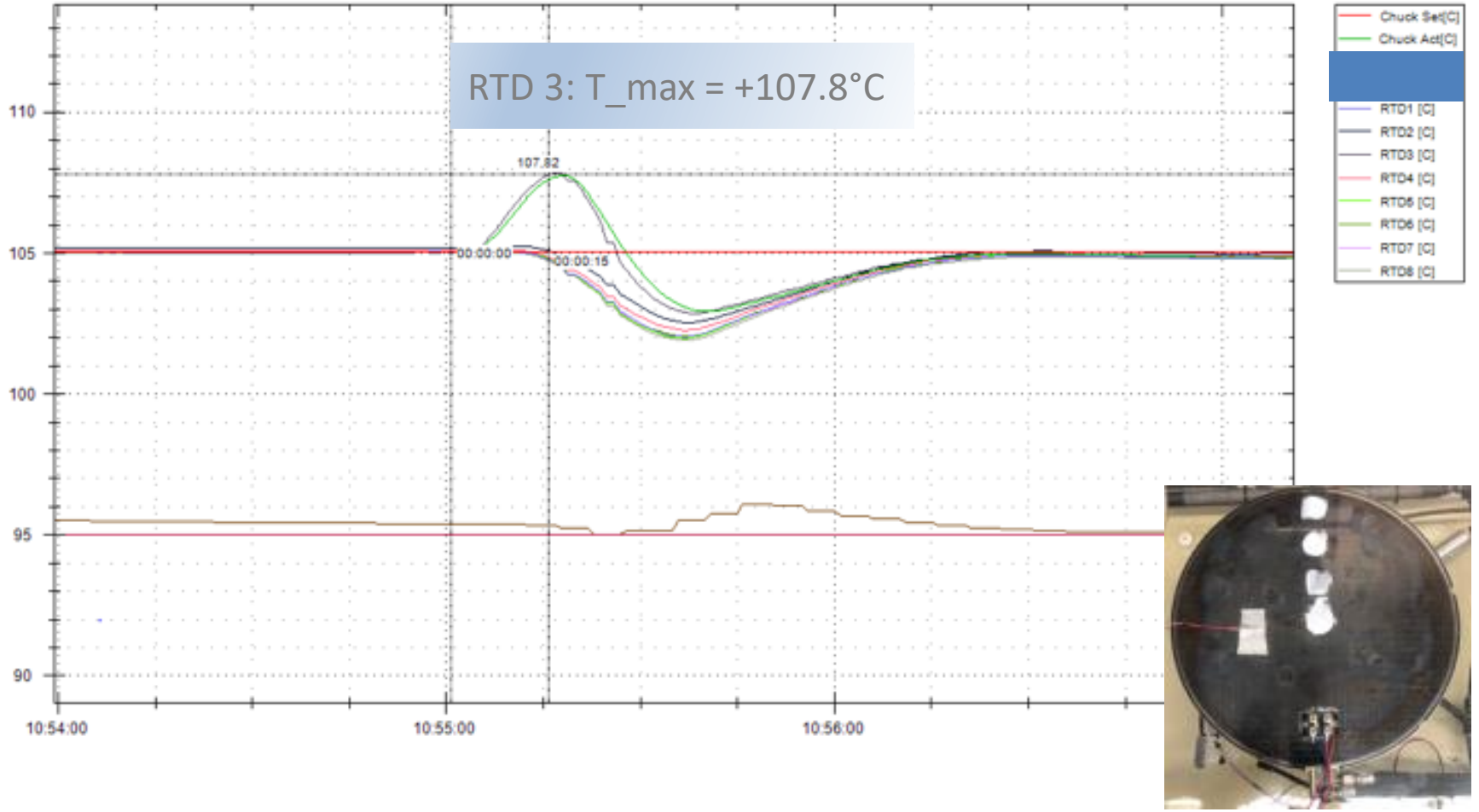
0C – Tube Position 100W



+105C – Top Position 160W



+105C – Tube Position 160W



Summary

- High Power Dissipation requires Liquid Cooled Systems
- Full Wafer Contact up to 2KW – doable
- 100x100mm up to 400W – doable (higher power possible with L80J)
- 23x23mm up to 160W – doable (higher power possible with L80J)
- 23x23mm Next tests will be done with a 21 or 25 sensor chuck
- -40°C to +125°C covered with single fluid
- Wider temp range requires new fluids (high BP and low viscosity) or
- Dedicated prober for certain temperature ranges

Thank You!

Q&A

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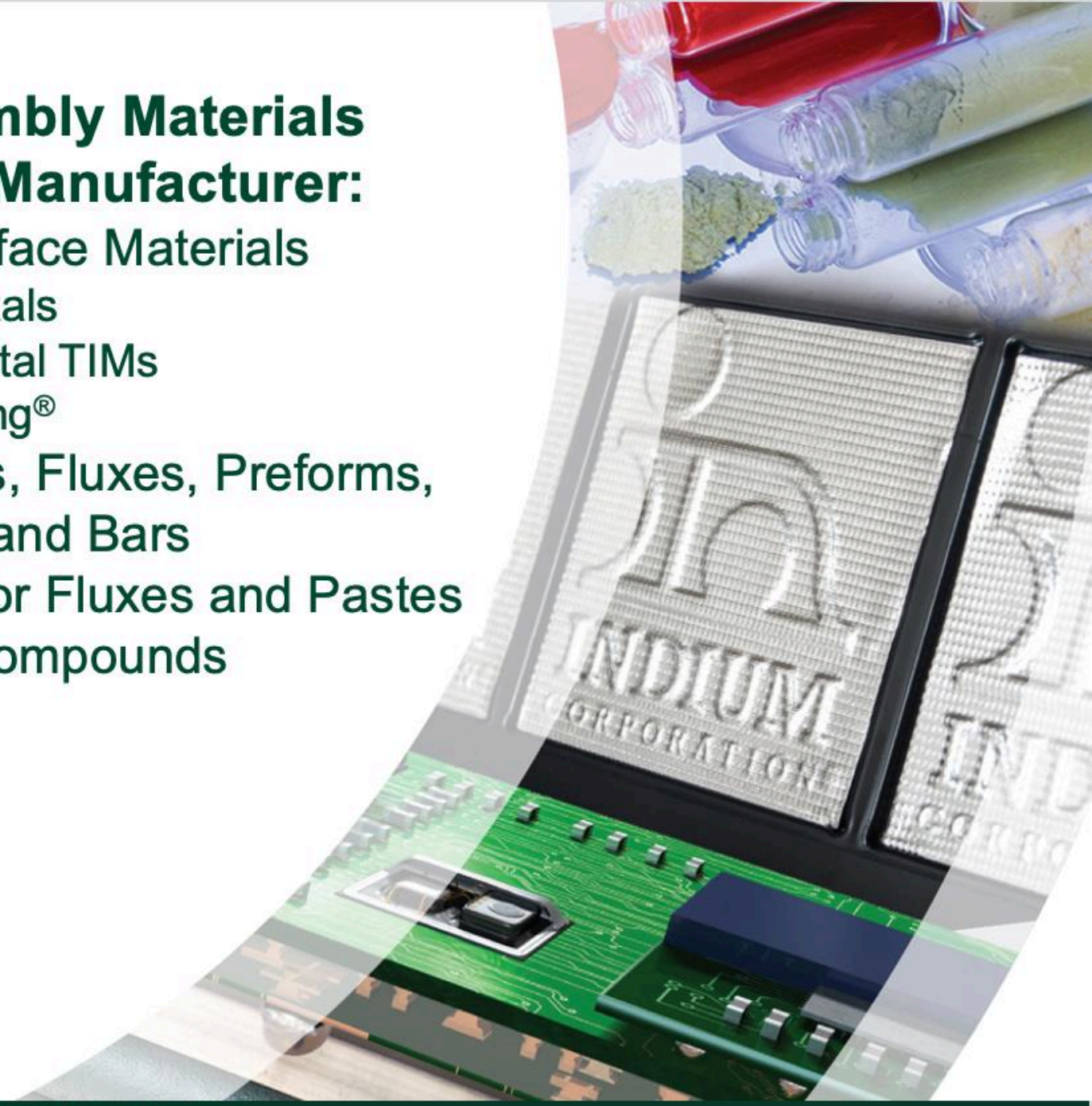

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