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The Thermal Frontier …. High Temp Probing System Solutions and Analysis

June 6 to 9, 2010
San Diego, CA USA

The Thermal Frontier
-Goals-

- Agree on the needs/concerns
- Understanding the Environment
- Introducing an Environmental solution
- Justify the *Final Solution*

ESA Corp & Probe Solutions

- ESA Corporation:
  - Provides **E**ngineering **S**cience **A**nalysis solutions, with expertise in Research, Product Development and Business Management
    - Instituted Research and Make Product (RAMP™) methodology for product development/deployment
- Probe Solutions, *division of ESA Corporation*:
  - Specializes in system enhancements for the semiconductor test industry.

Needs/Concerns

- Thermal probing is needed as a cost measure for final product throughput and reliability … so it is here to stay
- Probing solutions vary across many technologies. (Blade, Epoxy, Vertical, Single, Multi-Dut, etc)
- Probe solutions need to support a variety of tester platforms and configurations

So to create a solution that will support this variety of requirements;

VERY CUSTOM = COSTLY ($$$) for customer

Cost Model for User

- Thermal Probing Cost Model (TPCM)

TPCM = PC Manuf Cost + Operating Cost

Cost Model for User

- Probe Card Design and Manufacturing Cost
  - Solutions have been developed to minimize effects
    - Resulting in Custom solutions and Fixed cost
- Operating Cost ***(Loss of Revenue)***
  - Dwell Time between wafers / lots
    - Variable depending on prober configuration and users modeling and acceptance range
    - “Typical” Dwell Times range from 3 minutes between wafers to 30 minute between lot changes

NOT BEING ADDRESSED

Cost Model for User

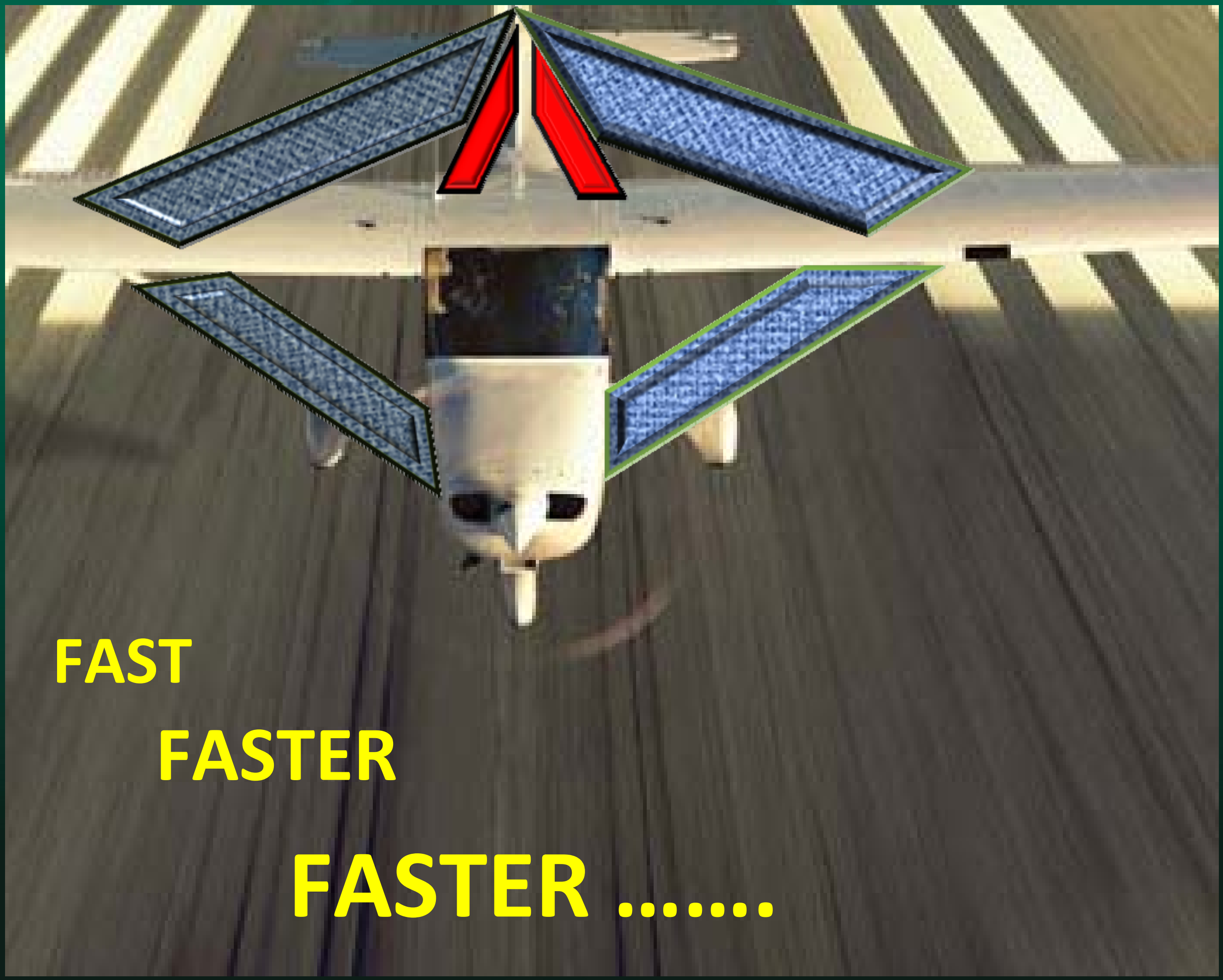
- Result of TPCM:
  - Manufacturing Cost of present day solutions, to user, have little opportunity for reduction or change
  - Operating Cost today are dependent on the evaluations performed and the users willingness to take risk to decrease down time
  - **Down Time = Results in loss of revenue and throughput ($$$$)**

Yet many solutions to date have only solved the individual component to a systematic problem

We have ignored the ***ENVIRONMENT !***

Case Study

- Design an airplane to go fast …….
  - What are in the input conditions ?
  - What are the expectations ?
  - If we do not properly understand all the environmental conditions .. We get …..


FAST
FASTER
FASTER …….

- Will the plane fly?
- Will it go faster?
- Does it meet the environmental conditions?
  – As currently Understood/Defined
- Maybe YES, but is it the best solution, or are the additions just "band-aids/overdesigning" to the real problem, the environment


- Yet if we understood all the requirements , or better controlled /understand the environment while clearly defining the expectations then the original solution could have been adequate

Probing Application

- Apply similar thinking in understanding the Probing Environment

- Stop developing solutions that are not addressing the real issue … the environment

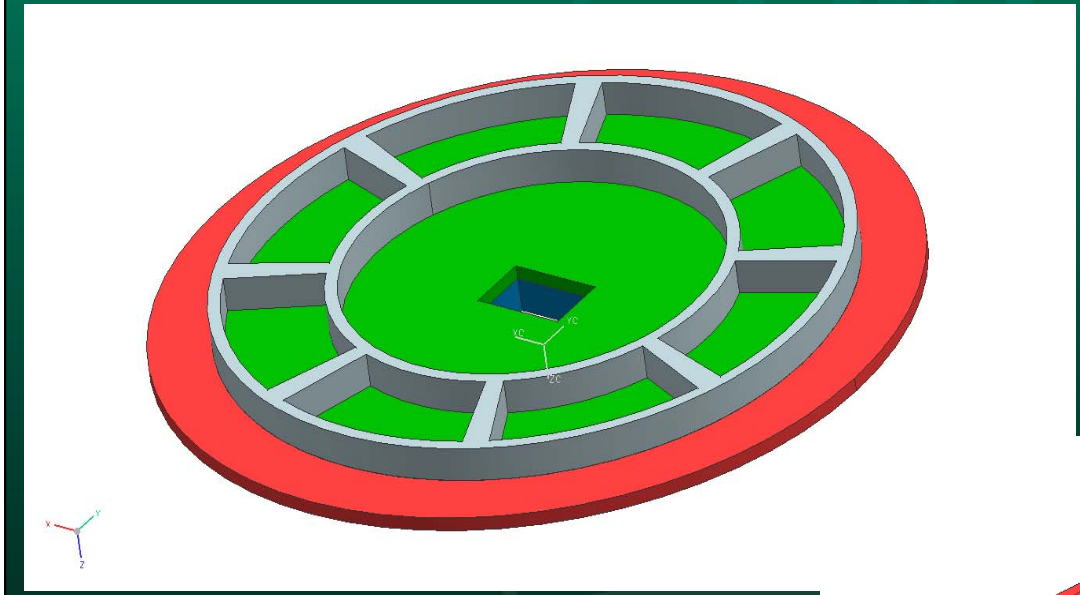
Environmental Probe Card Control Unit
(PCECU)

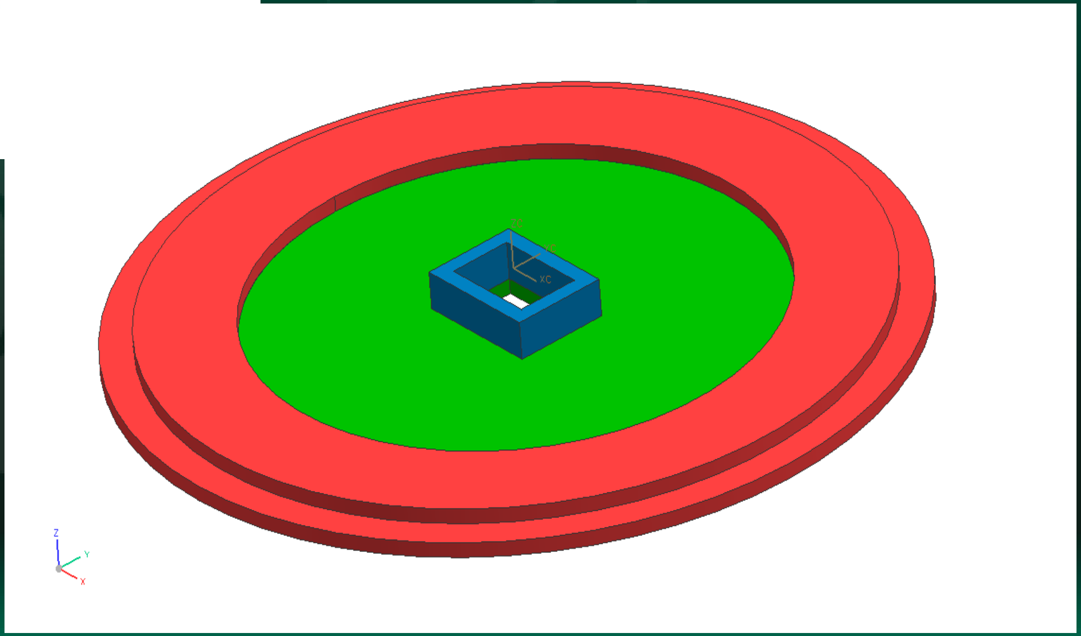
- *A solution that addresses the environmental conditions, while addressing cost and operational factors of the end user*

Modeling Analysis

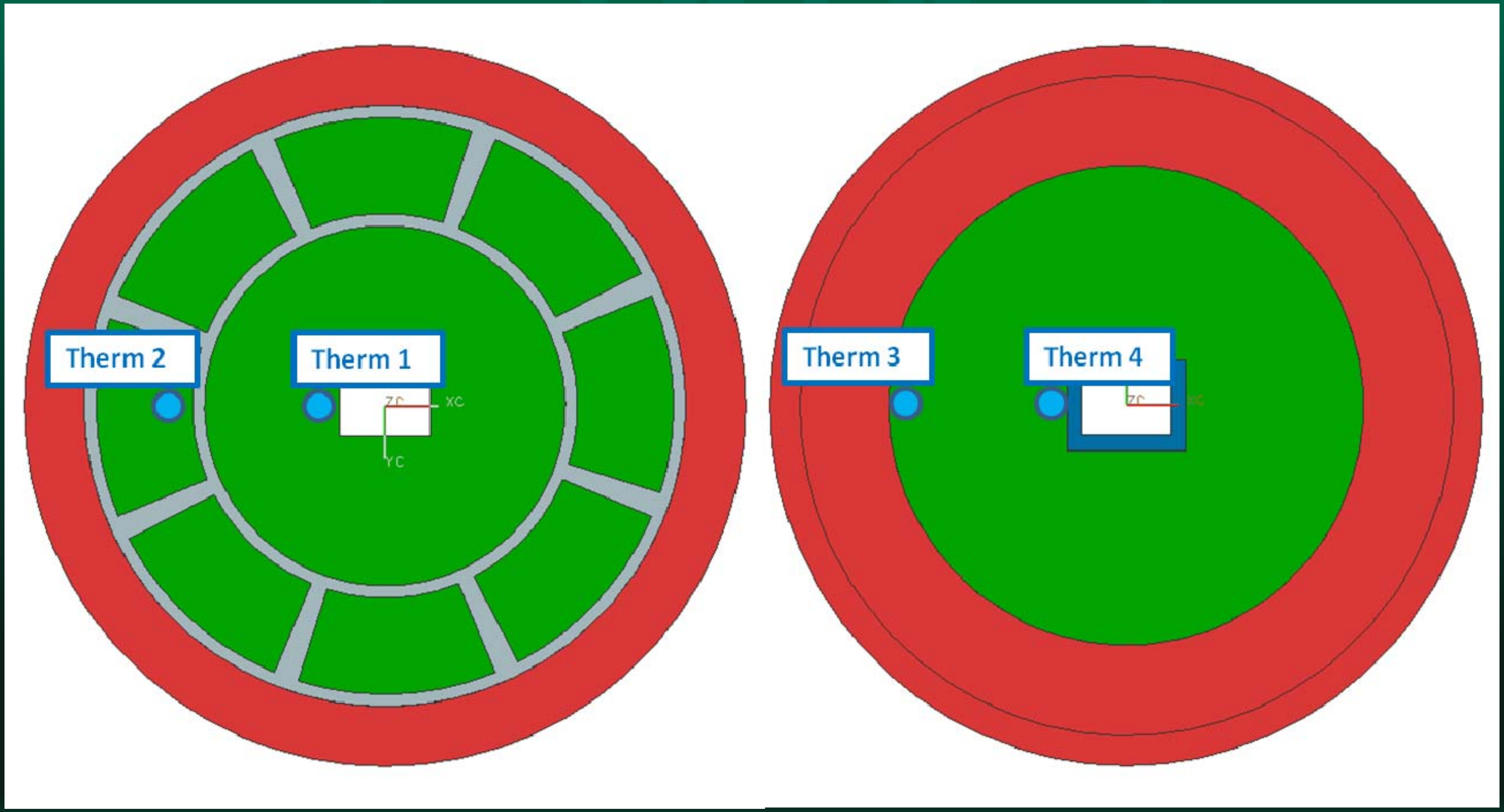
- The focus of this analysis is to understand and demonstrate the impacts due to the environment
- This presentation will not cover the secondary mechanical solutions developed to date
  - But what drove them to be developed

Modeling Analysis





Modeling Analysis



Modeling Analysis

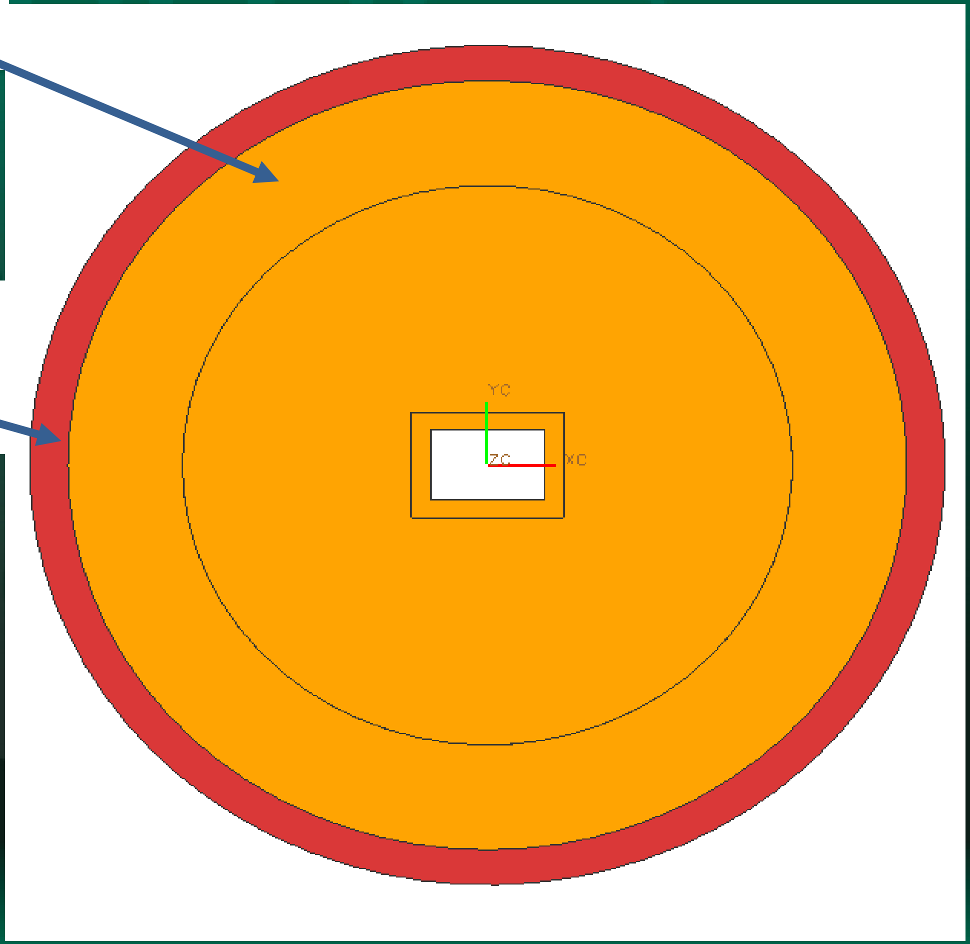
Determine PCECU Effectiveness

- Environment Conditions:
  - – Hot Chuck and PCECU heater activated simultaneously
    - Probe card temperature to monitored (stability = Δ > 0.5 deg. C)
    - 120 deg. C = Hot chuck temp
    - Tray lip is insulated
    - PCECU Heater thermostat is set to 105 deg. C
  - – Consistent with normal ATE process (wafer re-load process)
    - Hot chuck is removed from proximity for a period of 60 sec
    - Probe card temperature is monitored at 4 locations
    - Temperature readings are taken at 30 & 60 sec intervals
  - – Hot chuck is moved back to probing position
    - Probe card temperature to monitored (stability = Δ > 0.5 deg. C)

Model Properties

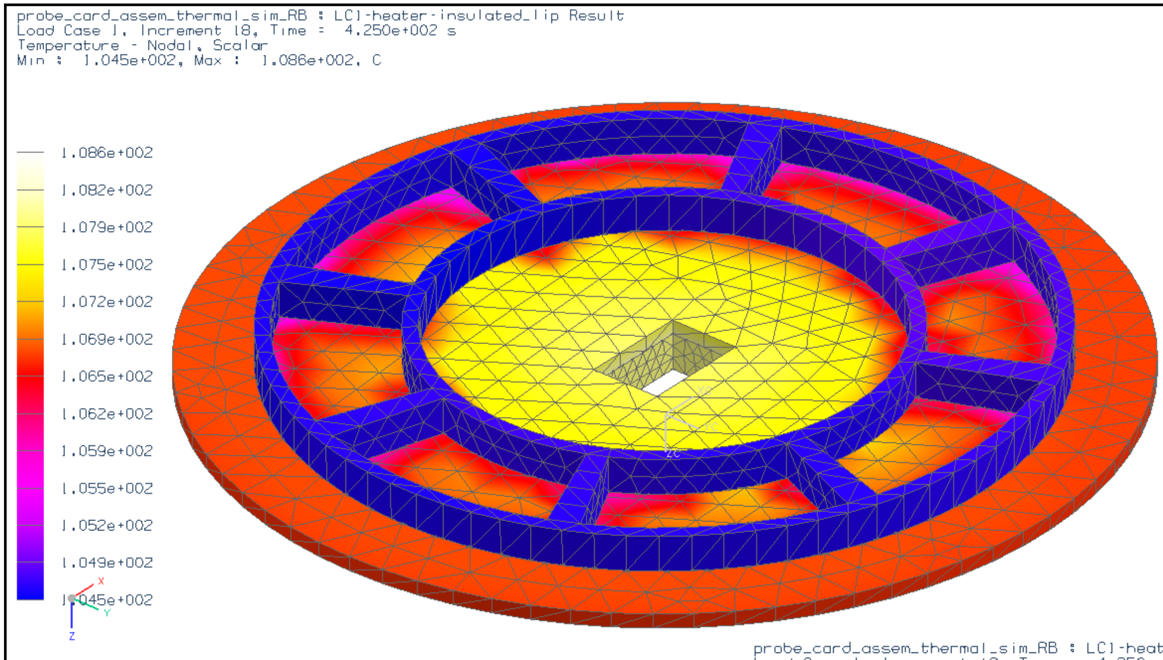
Convection and radiation boundary conditions applied to orange faces.

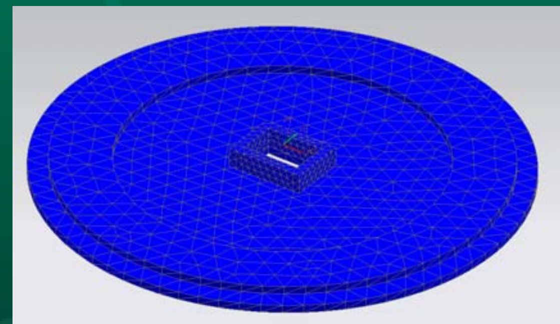
Tray Lip (red) is kept perfectly insulated.

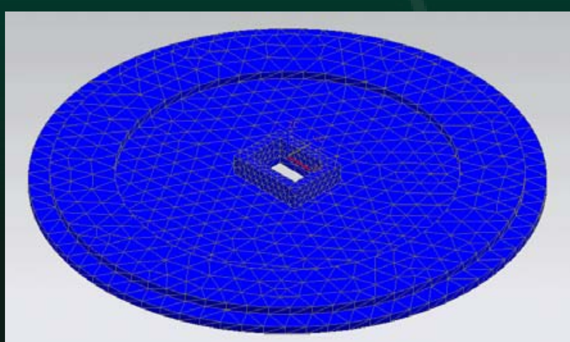


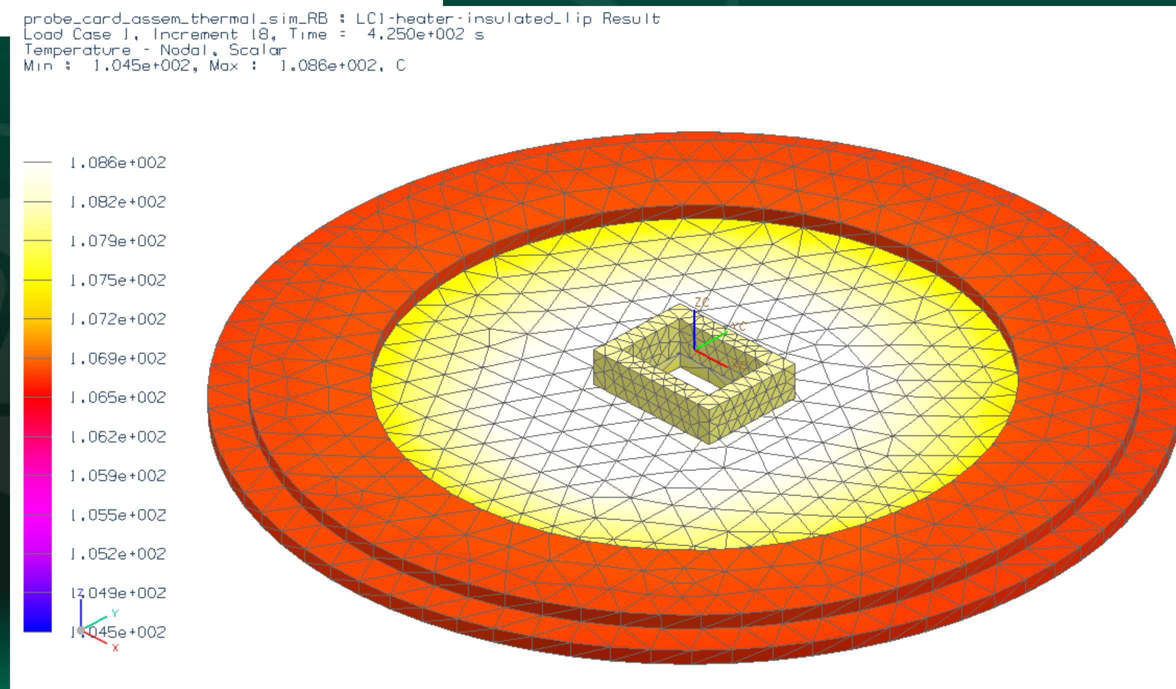
Fringe Plots

Model

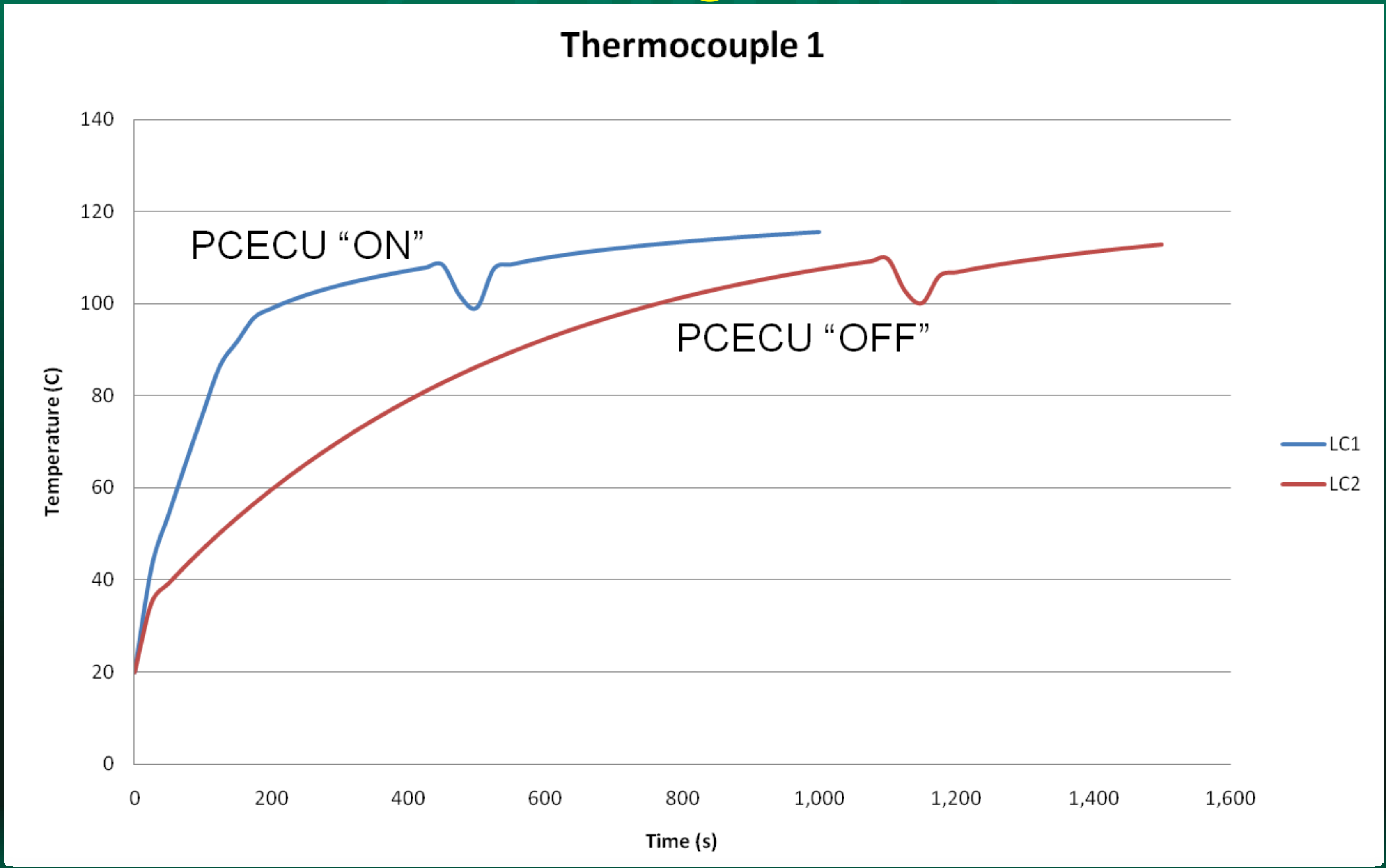








Modeling Results



Modeling Conclusions

- Probe Card stabilizes at 109 deg C, both modes
- PCECU reaches stability with 60% improvement
- No significant delta seen with a 60 sec reload

- Model demonstrates effectiveness of PCECU

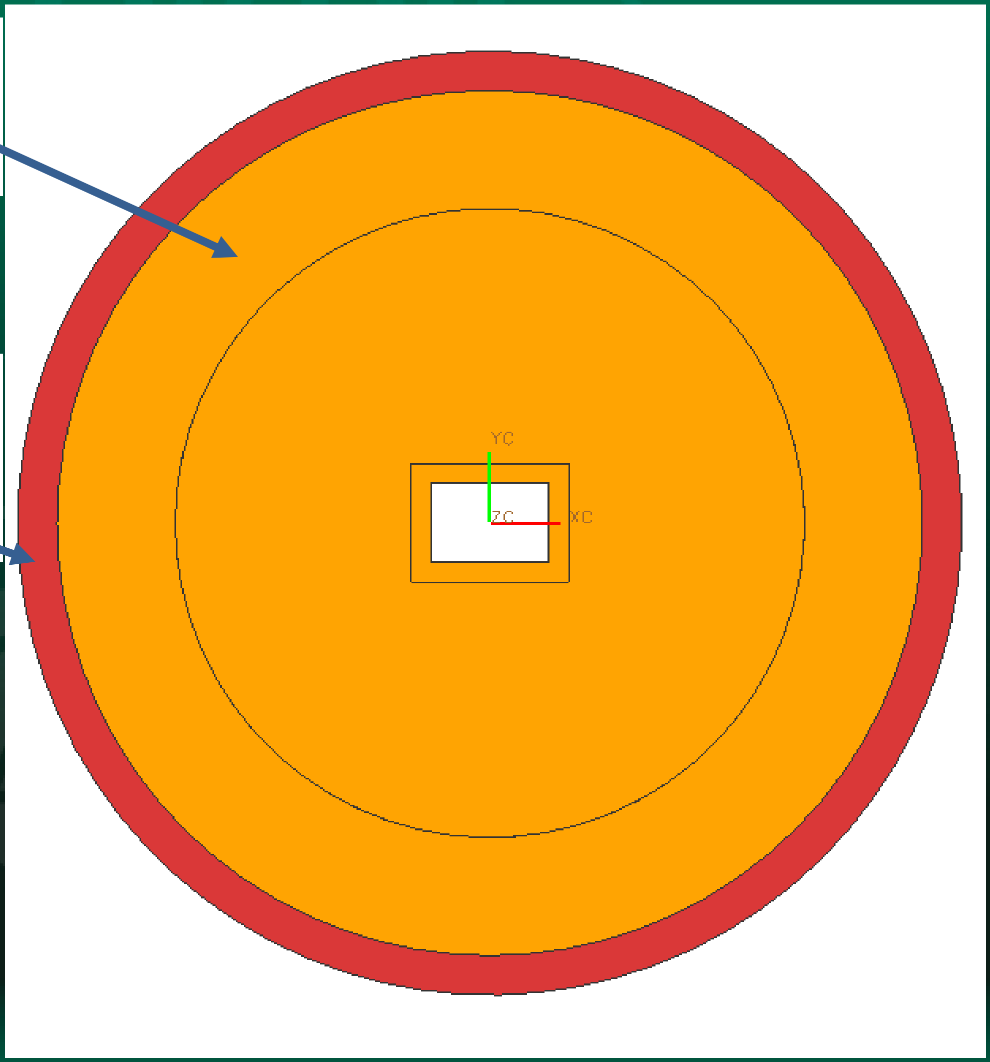
Environment Implementation

- Environment Conditions:
  - Hot Chuck and PCECU heater activated simultaneously
    - Probe card temperature to monitored (stability = Δ > 0.5 deg. C)
    - 120 deg. C = Hot chuck temp
    - **Support lip not insulated and conducts to a temperature of 20 deg. C**
    - **PCECU Heater thermostat is set to 90 deg. C**
  - Consistent with normal ATE process (wafer re-load process)
    - Hot chuck is removed from proximity for a period of 60 sec
    - Probe card temperature is monitored at 4 locations
    - Temperature readings are taken at 30 & 60 sec intervals
  - Hot chuck is moved back to probing position
    - Probe card temperature to monitored (stability = Δ > 0.5 deg. C)

Environment Properties

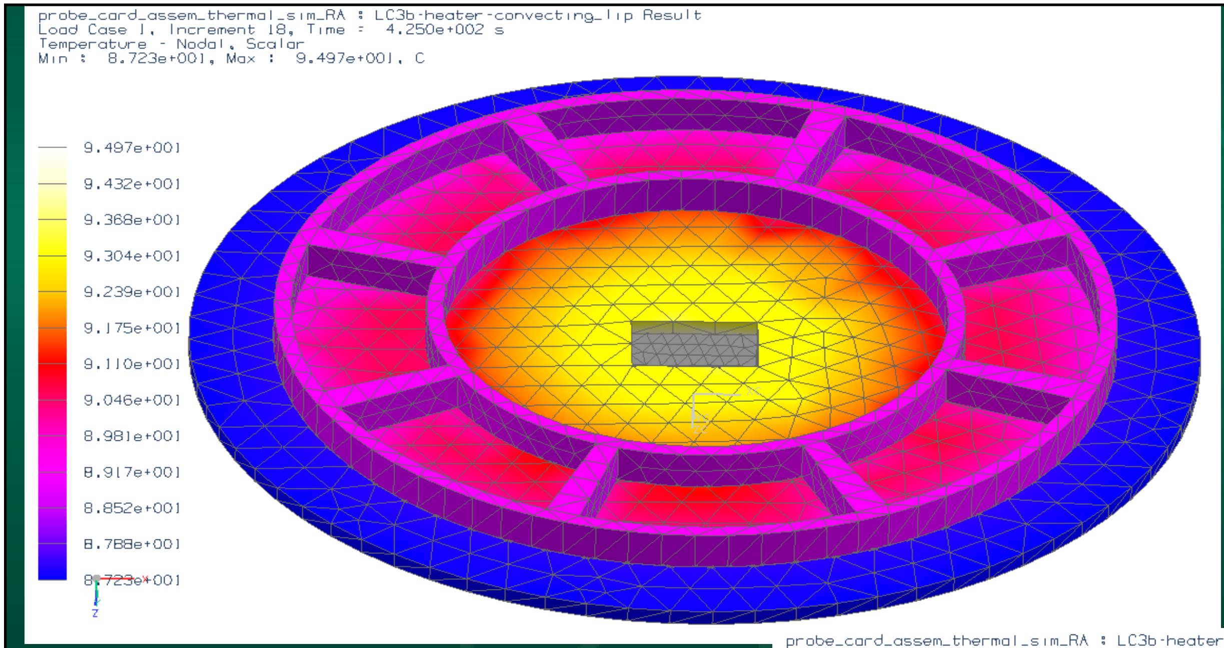
Convection and radiation boundary conditions applied to orange faces.

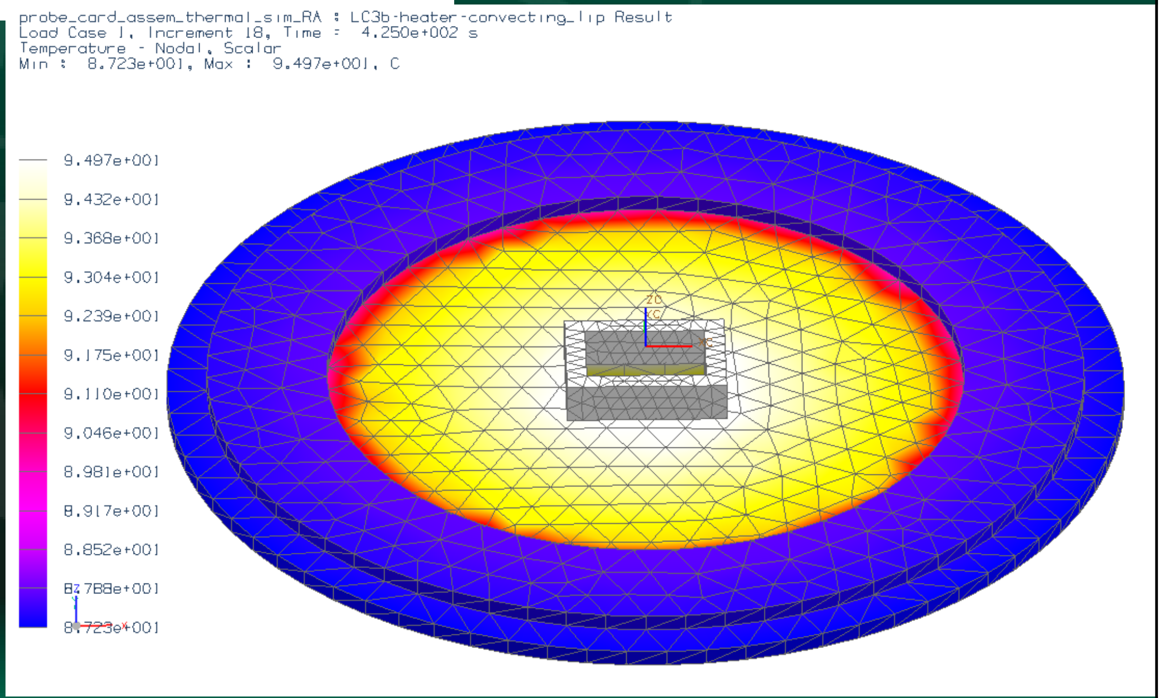
Tray Lip (red) not insulated and conducts to an ambient temperature of 20 °C



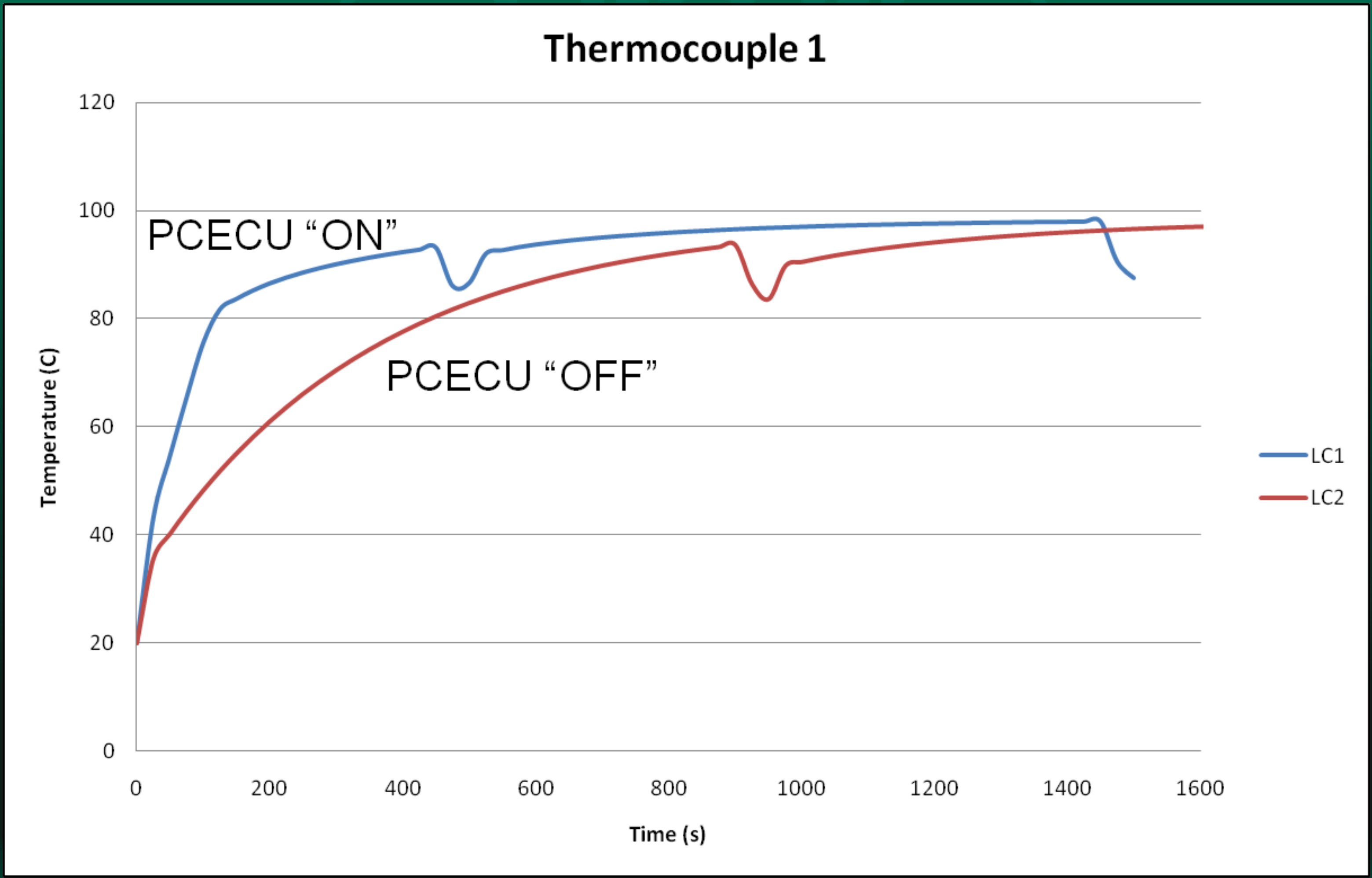
Fringe Plots

Environment

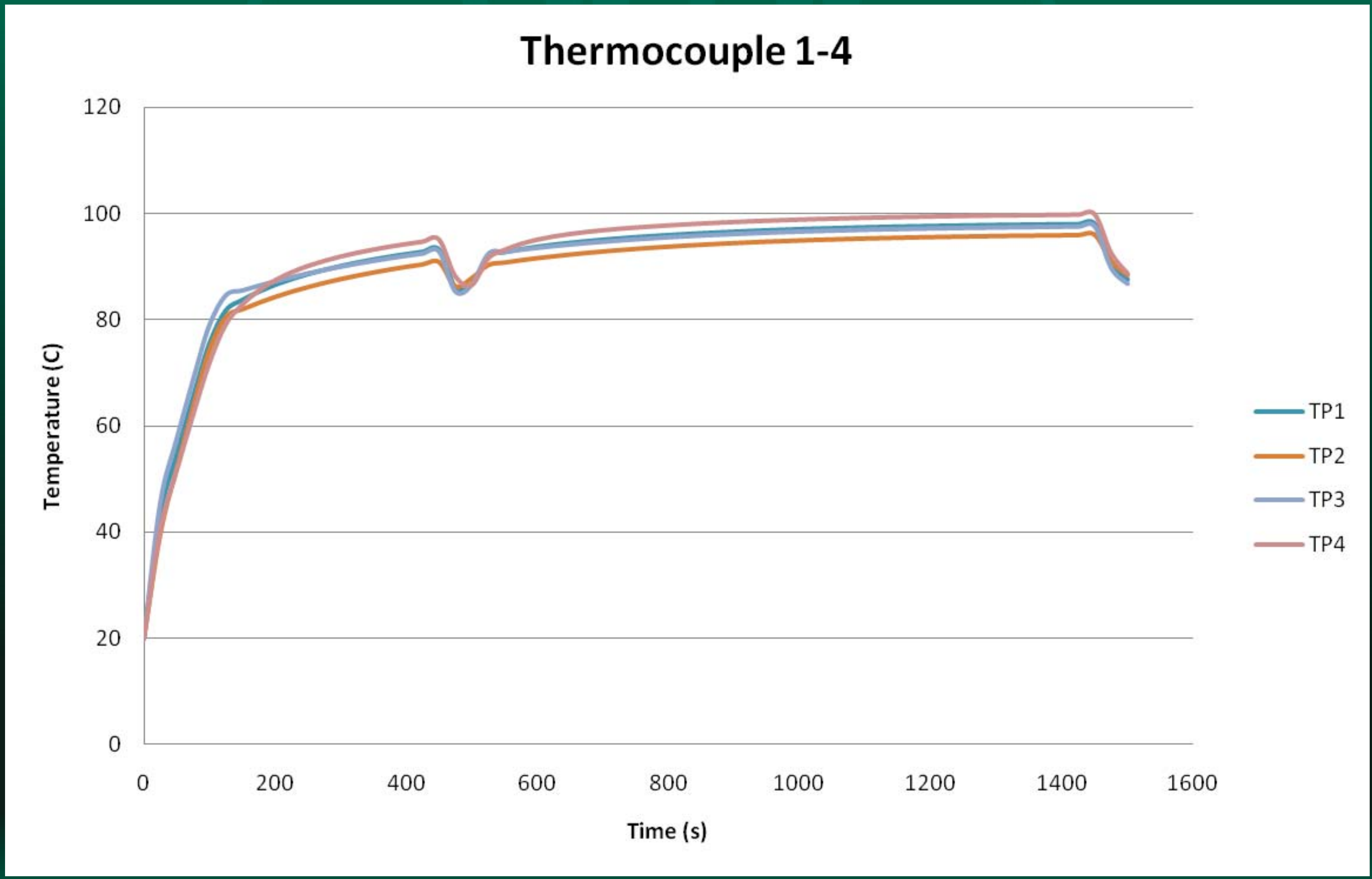




Environment Results



Probe Card Thermal Profile



Environment Conclusions

- Probe Card stabilizes at 94 deg C, both modes
- PCECU reaches stability with 50% improvement
- No significant delta seen with a 60 sec reload

Conclusion

- PCECU thermal value is set once card has been profiled for thermal stability
- PCECU reduces the amount of variation, downtime, and customization in a Thermal Probe Cost Model (TPCM) = Reduced Cost ($$$)
- PCECU is common solution across the prober, thus minimizing custom solutions to the probe card = Reduced Cost ($$$)

Understand the Environmental Conditions and you can .....

Thank you

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