Thermal Characterization for COVID-19 Point of Care Testing Device

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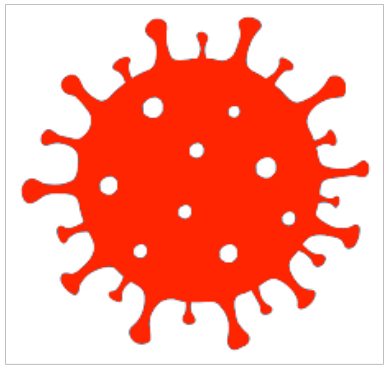

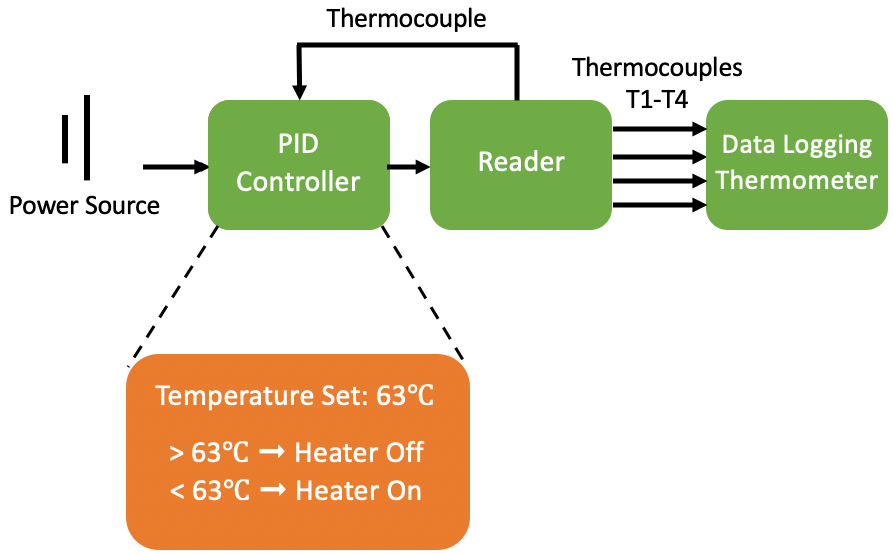

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MOTIVATION

- **Shortcomings of conventional saliva testing:**
  - **Time consuming (24-48 hours)**
  - **Expensive lab equipment required**
- **Thermal characterization and design [1] of point of care (PoC) reader is necessary:**
  - **Ensure proper DNA amplification by loop-mediated isothermal amplification (LAMP) [2]**
  - **Printed circuit board (PCB) component operation [3]**

The REU supplement is funded by the NSF NCSS/SenSIP I/UCRC Award 1540040.

RESEARCH PROBLEM/PROJECT AIM

- Obtain PoC device's thermal characteristics
- Ensure proper heating of reaction wells
- Determine discrepancies in heating
- Optimize thermal design of reader

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CHALLENGES

- Heat spreader/spring design
- Proper modeling of heat dissipation
- PID operation and tuning
- Data collection and ML analytics

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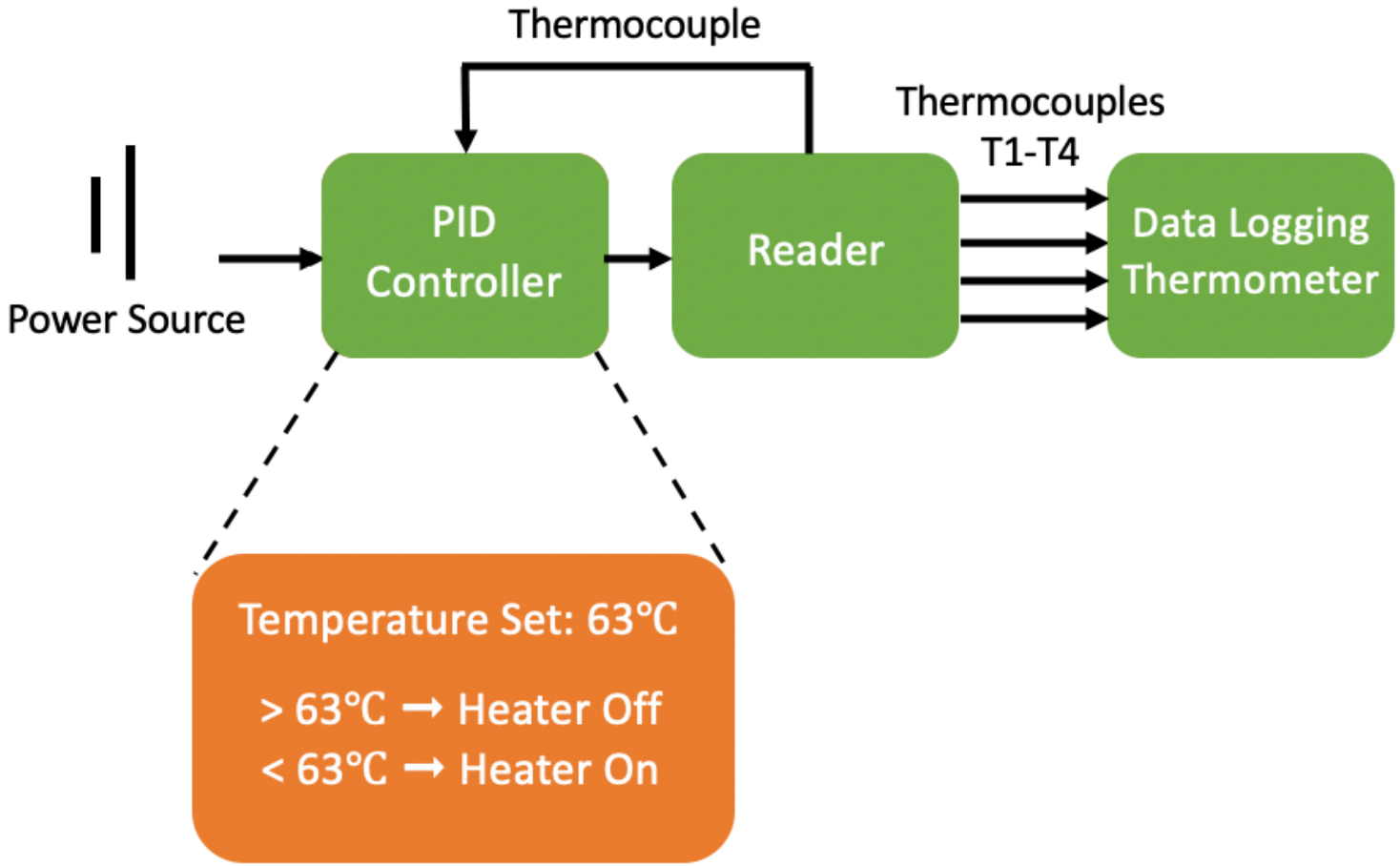
THERMAL TESTING DESIGN



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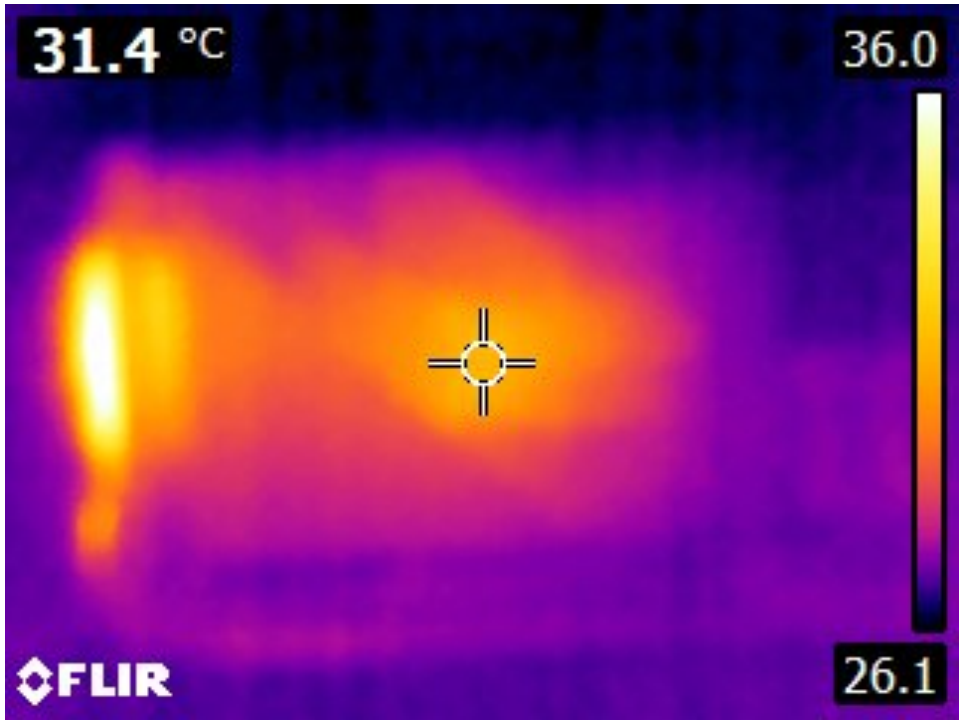
CONTRIBUTIONS

- Reader temperature testing
- Thermal imaging
- Heater fabrication
- Heat dissipation model calculations



Thermal Imaging of PoC Reader

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APPARATUS USED FOR THERMAL TESTING

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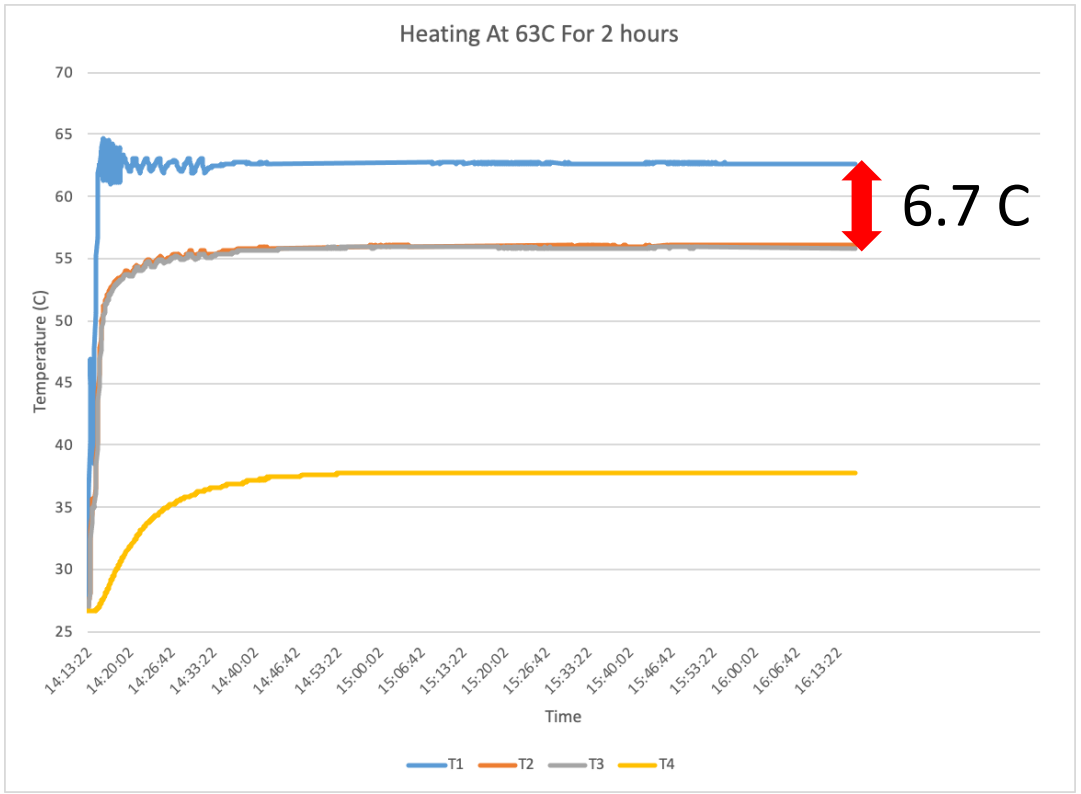
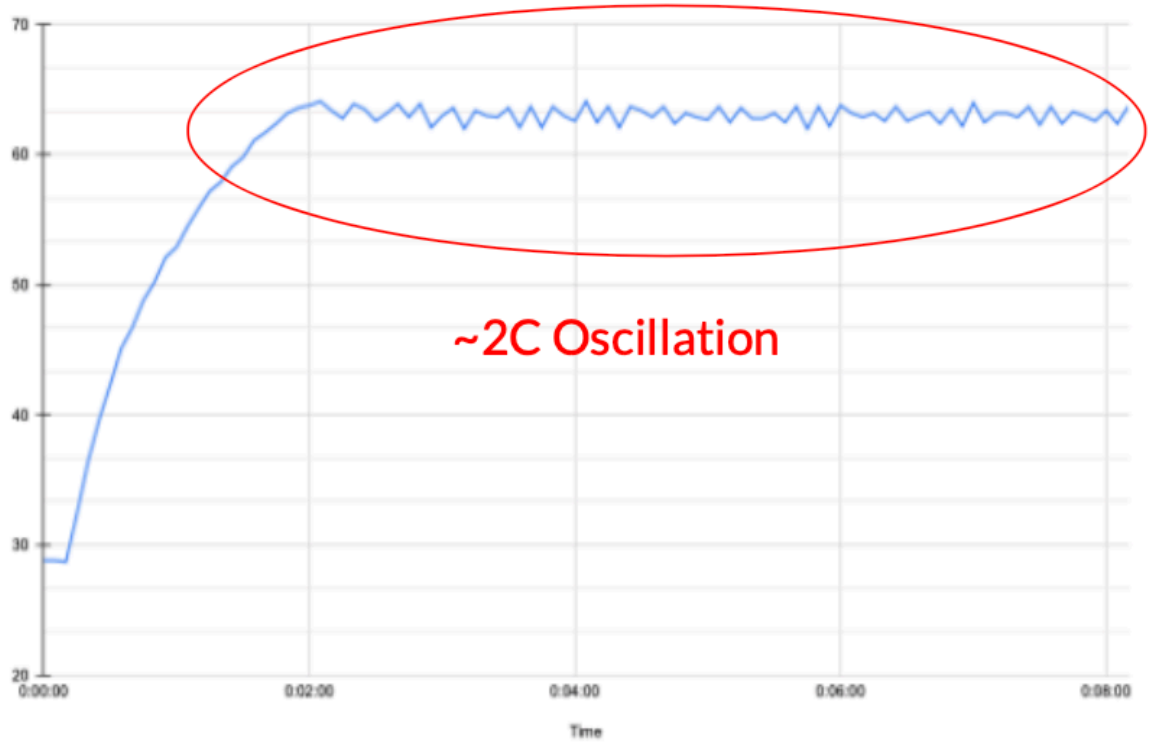
RESULTS





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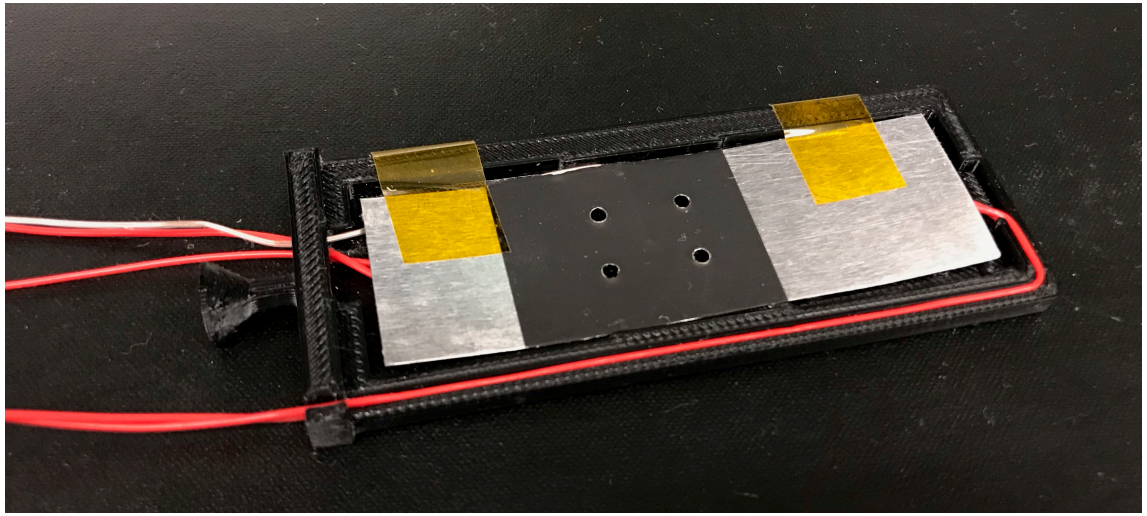
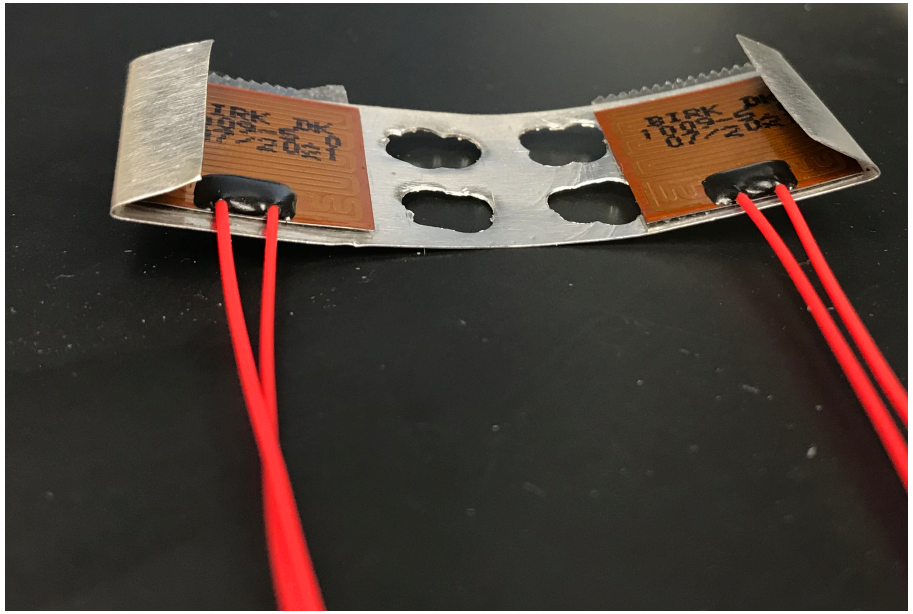
IMPROVED HEATER DESIGN



Old Heater



New Heater

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DISCUSSION/FINDINGS

- **Thermal characterization and design is necessary for accurate COVID-19 test results**

- **PoC device's thermal design can be optimized by calculating power dissipation, measuring temperature discrepancies, and altering internals of the reader**

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NEXT STEPS/FUTURE RESEARCH

- Run thermal tests using various microfluidic chips [5]
- Continue to optimize reader's thermal design
- Experiment with new metals for heater fabrication
- Machine learning analytics need to be addressed

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REFERENCES

[1] Bejan, A. (1982). Second-law analysis in heat transfer and thermal design. In Advances in heat transfer (Vol. 15, pp. 1-58). Elsevier.

[2] T. Notomi, Y. Mori, N. Tomita, and H. Kanda, “Loop-mediated isothermal amplification (LAMP): principle, features, and future prospects. *Journal of Microbiology*, 2015.

[3] K. Zhang, A. Guliani, S. Ogrenci-Memik, G. Memik, K. Yoshii, R. Sankaran, and P. Beckman, "Machine Learning-Based Temperature Prediction for Runtime Thermal Management Across System Components," *IEEE Transactions on Parallel and Distributed Systems*, 2017.

[4] Shein, W. W., Tan, Y., & Lim, A. O. (2012, September). PID controller for temperature control with multiple actuators in cyber-physical home system. In 2012 15th International Conference on Network-Based Information Systems (pp. 423-428). IEEE.

[5] Ren, K., Zhou, J., & Wu, H. (2013). Materials for microfluidic chip fabrication. Accounts of chemical research, 46(11), 2396-2406.

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