Precise Temperature Control of a Laser Room at the Argonne Wakefield Accelerator

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Abstract

At the Argonne Wakefield Accelerator, the laser that is used in the research is delicate when it comes to the change in temperature of the laser room. Within the room, there are multiple factors that affect the temperature change and are in need to be defined. With an advancement of having a system of wireless thermocouples that are put in multiple areas of the room, the factors of the temperature change may be defined. This newly found data may then be incorporated into the current airflow simulation to help improve the efficiency of the airflow coming from the HVAC unit.

Introduction

The researchers are in need of obtaining a constant temperature of 70 degF with a stability of +/- 0.5 degF. This is the ideal temperature for the laser to run without encountering any abnormalities in data collection. In order for the room to be at this desired temperature, the factors causing the temperature change must be defined and addressed. With these factors, the efficiency of the current HVAC system is too poor and isn't treating the temperature changes appropriately as seen in Fig 1.

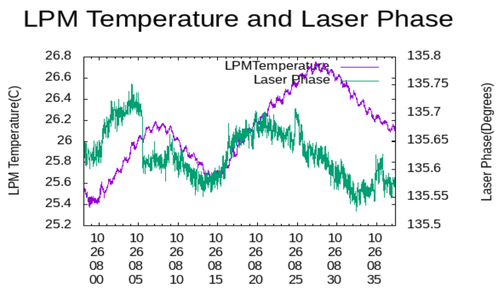

Fig 1. Laser Phase Monitor

Methods and Materials

The wireless thermocouple system consists of the following:

- SHT-25 Temperature and Humidity Sensor
- Arduino MKR WIFI 1010
- 3.7V, 2.2Ah Li-Po Battery
- Raspberry Pi 4
- 3D Printed Housing Unit

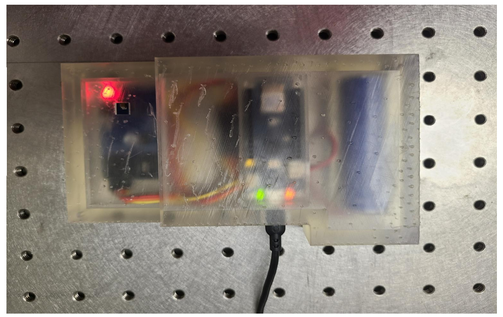

Fig 2. Wireless Thermocouple System

The setup connects wirelessly to the Raspberry Pi where it sends the collected data through Node-RED and is placed in InfluxDB and Grafana where it is stored for future reference. The data can be monitored and accessed remotely anywhere through the use of a VPN. A thermal simulation was also created to better understand the airflow of the laser room.

Results/Discussion

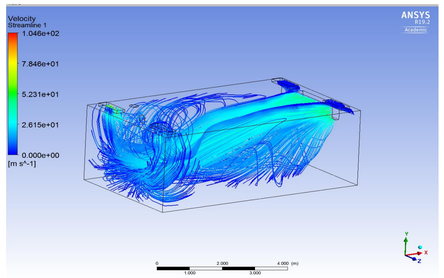

Fig 3. ANSYS Fluent Airflow Simulation

Fig 4. Grafana Temperature and Humidity Interface

From Figure 3, the current airflow direction and intensity were found for better understanding of the current HVAC system. In Figure 4, a Grafana graph can be seen where the temperature and humidity are being recorded from 3 of the setup devices simultaneously.

Conclusions

The final product of the wireless thermocouple setup has the capabilities to monitor and define the locations of the room where there are temperature inconsistencies present. The simulation also aids to the observation of the airflow efficiency emerging from the current HVAC system. With further adaptation, the temperature data may be incorporated into future simulations for the new system that will be installed in place of the current system.

Acknowledgements

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