# Harris Corporation Cold Plate Test Rig

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Sponsered by Harris Corp.

In collaboration with MAE department

## **Project Description**

We are looking to develop an experimental apparatus to test various compact heat exchanger cores under pulsating mass flow or inlet velocity conditions. The motivation for this project comes from a phenomenon that Harris engineers have noticed in which heatsink-cooled computer components showed uncharacteristic temperature readings when air flow through the heatsink was pulsating rather than a steady flow. We, in collaboration with a team of MAE students, have been tasked with designing a test box that simulates this situation.

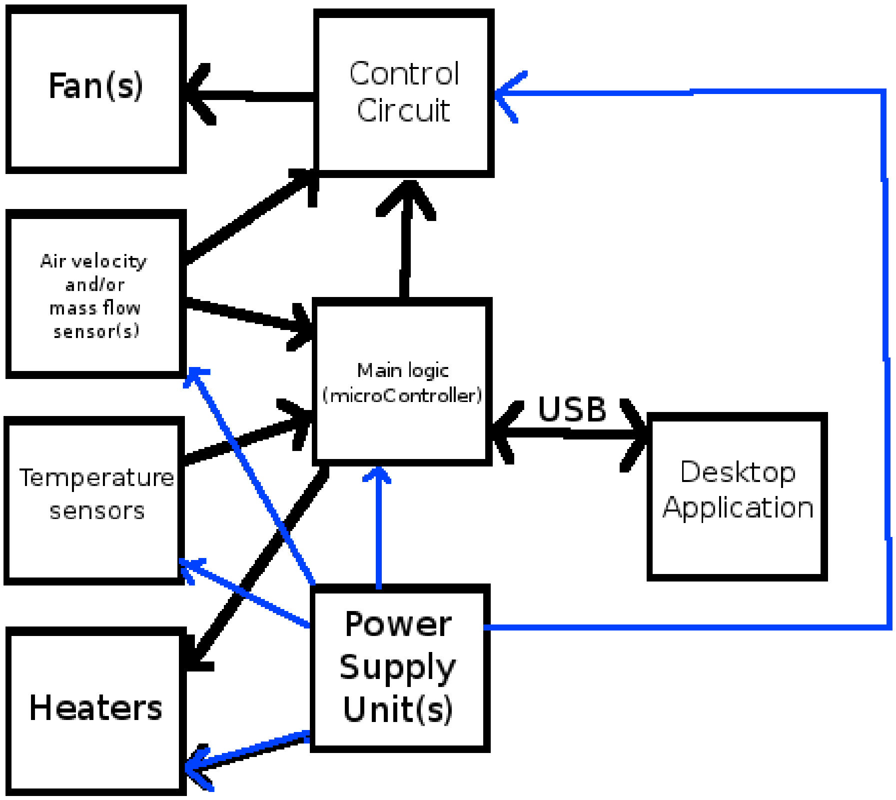
The mechanical team will be responsible for handling the thermodynamic-heavy portions of the project including determining heat transfer coefficients and pressure drop (f and j factors) in the entry region. We will be essentially supporting them by handling the electronics and data acquisition necessary for them to get the result they want.

Our main contributions will be designing and implementing the power supplies, heat supply, cooling, data acquisition (sensors), data interpretation, and user interface. Accuracy and speed of data acquisition will be a very large part of our design as the phenomenon they are experiencing is thought to be seen in a very short window of time. Although not a specific requirement of the project given to us, we will be attempting to keep everything light weight, power efficient, and compact in size in order to allow for easy break-down and transport.

**Specifications and Requirements**

- Input pulsation for fan is ideally a sinusoidal velocity oscillation on a steady state flow.
  equation used: $v(in) = A(o)(1 + \beta cos(2\pi f t))$
- Pulsation frequency: 0.1 HZ to 10 HZ
- Pulsation amplitudes: 0.3 to 0.8
- power supply: in the range of 10w to 200w(TBD), 80 to 95% power efficiency.
- heat supply: at least 10℃ temperature change inside of system, constant heat flux boundary on both sides.
- temperature sensor: we may use thermocouple sensor, Advantage: fast response time, in the order of ms; measure a wide range of temperature. Disadvantage: system errors of less than one degree Celsius can be difficult to achieve.
- Pressure sensor: pressure manometer or pressure transducer, 0.5 to 0.7 response time or faster.
- Data output in transient and time average form
- The test rig must be capable to adapting to test articles with heights from 0.25 inch to 1.5 inch; width from 3 inch to 5 inch and length is variable( at least 30 hydraulic diameter).
- Control circuit: to follow the input as close as possible
- main logic: the sampling rate should be large, fast, able to communicate USB.

**Block Diagram:**




**Fans:**
PIC: Eric
Status: Research
Description: The fans physically move air over the heat-sink. We don't know yet what type of fan (DC,AC,PWM, etc) or how much air or how fast.
Input: Electric signal from the controller block
Output: Movement of air

**Controller:**
PIC: JinJin
Status: Research
Description: The controller that powers the fans. It is in charge of following the input velocity profile and compensating for dynamic elements in the fan-air system. This element relies on data from the MAE team. We will start with a greatly simplified model.

Input: Electronic signal from the micro controller, airflow/air velocity sensor signal and power from the PSU
Output: Electric signal (DC/AC/PWM)

**Air velocity/Mass flow sensors:**
PIC: Adam
Status: Research
Description: Sensors to determine the velocity and amount of the air moving through the box. How many and what type is TBD. Data from the MAE team is required to make the final decision. But we will start with a simplified model.
Input: Air velocity/ mass flow
Output: Electronic signal

**Temperature sensor:**
PIC: JinJin
Status: Research
Description: Sensors to determine the temperature in parts of the box. What type is still TDB. But speed and accuracy are important.
Input: A temperature
Output: An electronic signal

**Heater:**
PIC: Adam
Status: Research
Description: Heating elements to provide heat to the heat-sink. Likely to be heating strips. Size and power TDB.
Input: Electric signal from PSU and micro controller
Output: Heat energy

**Main Logic:**
PIC: Patrick
Status: To be acquired
Description: The micro controller that will command the fan controller, switch the heaters, acquire sensor data and relay it to the PC. A fast micro controller is necessary. (ARM core likely)
Input: Sensor data as electric signals, commands from the PC
Output: Commands for controller as an electric signal, switching for the heating elements, and data to the PC

**PSU:**
PIC: Eric
Status: Research
Description: One or more power supplies (likely 3 total) for the 2 heaters and the DC voltage for the digital logic
Input: AC power from the wall

Output: DC power for digital logic. Power for fans and heaters (TBD) and sensors

**Desktop Application:**
PIC: Patrick
Status: To be designed
Description: A graphical interface to control the box and record and analyze data coming from it
Input: Data from the micro controller
Output: Commands to the micro controller

## Budget

Funding provided by Harris Corporation at the amount of $10,000.

## Milestones

Throughout the semesters, we will be responsible for providing a multitude of deliverables to the customer. This means we will need to define semi-concrete milestones that will be marked by the acquisition of artifacts. This will include development steps such as:

- system requirements description
- block diagram
- trade studies / research
- part selection
- system design
- preliminary and critical design review
- prototyping
- system assembly
- testing and verification
- final design review