Thermal Cycling of Pixel Modules using LabRemote

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A Bit of Background

CERN

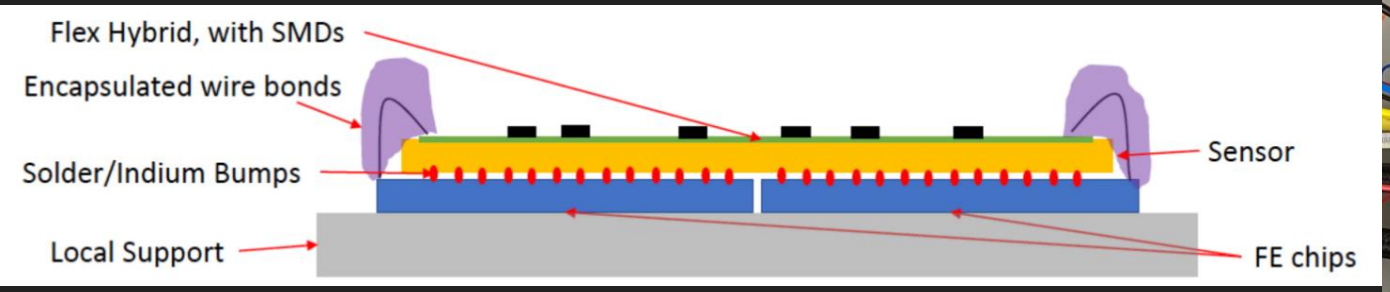
- Particle physics research facility in Switzerland. Home to the LHC where particles are collided at High Speeds

ATLAS

- Massive structure designed to detect the resulting particles from hadron collisions

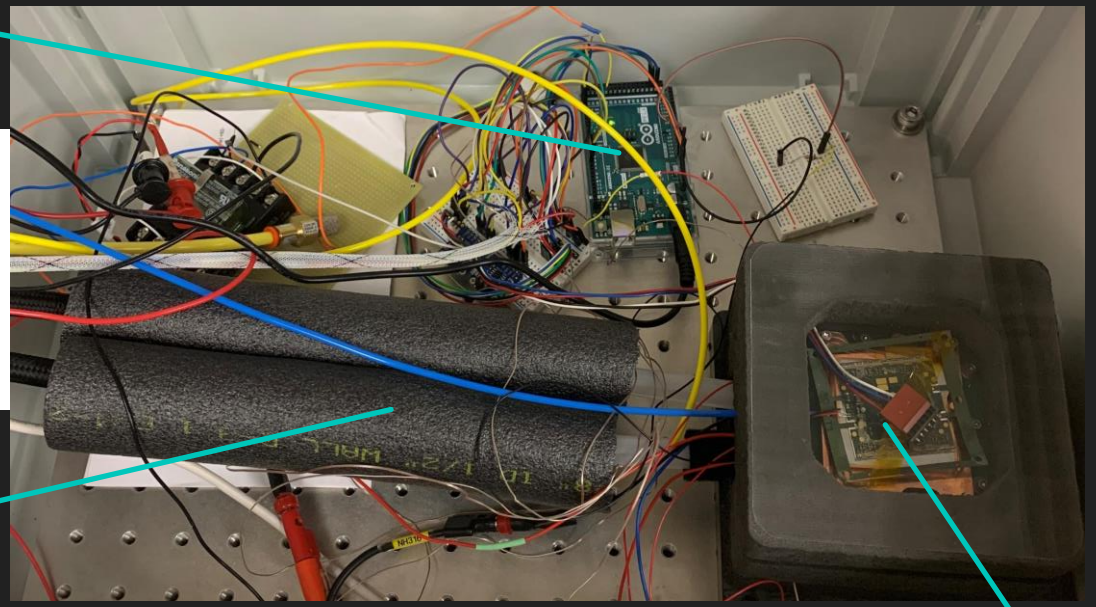
Pixel Detector

- The innermost layer of the detector is made up of trackers, and one such tracker is called a pixel detector



Arduino + Sensors

Chiller Tubes



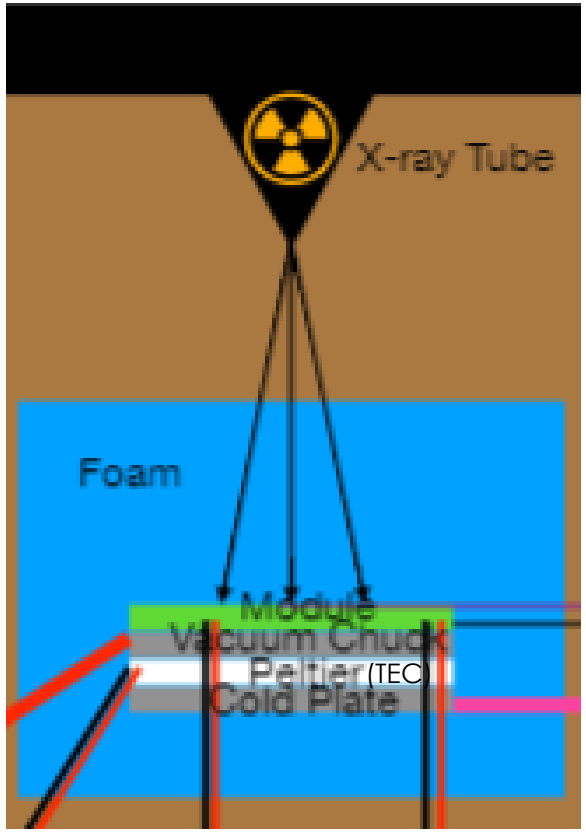
The Module

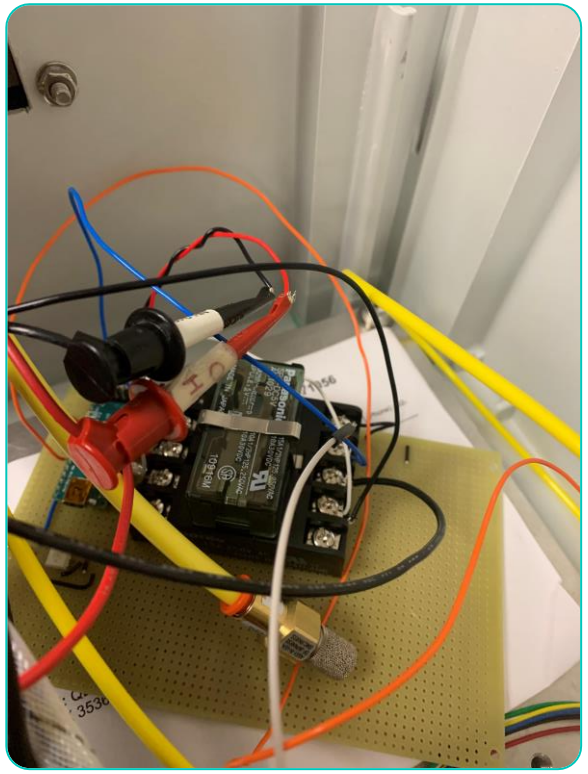
Thermal Cycling

- Due to ATLAS needing regular upgrades, we try to make each tracker better than the last
- Tests the indium bonds in the pixel module detector by cycling the temperature from -50 to 50 degrees Celsius
- This simulates the environment inside of the ATLAS detector, but allows for quality checks after tests

Electrical and Source Tests

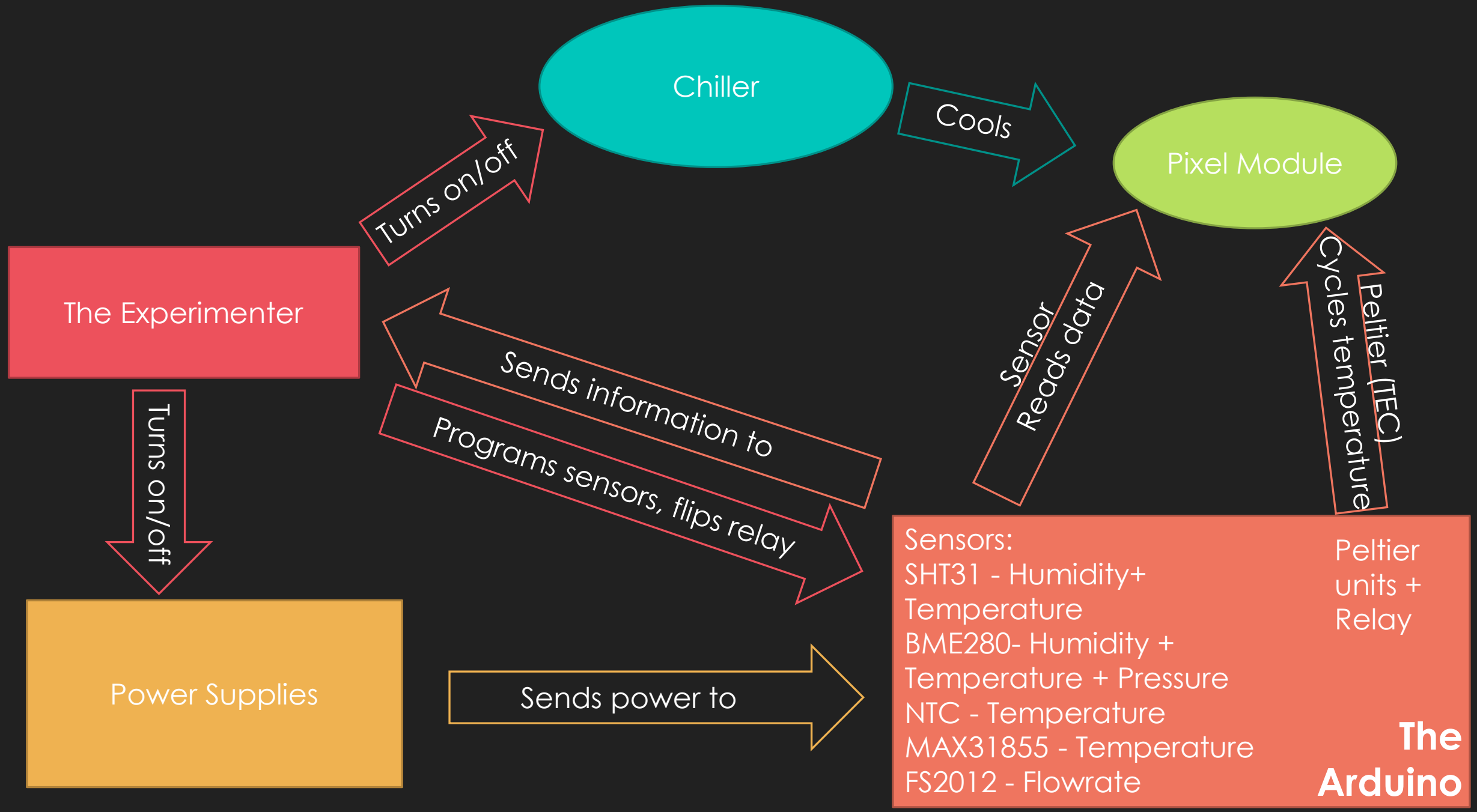
- After mechanical testing, these test module performance
- Electrical Testing: Uses dedicated circuitry, charges are inserted to each individual pixel to test performance
- Source Testing: Using an x-ray source, the module is bombarded with x-rays, ionizing the silicon pixels to read hits

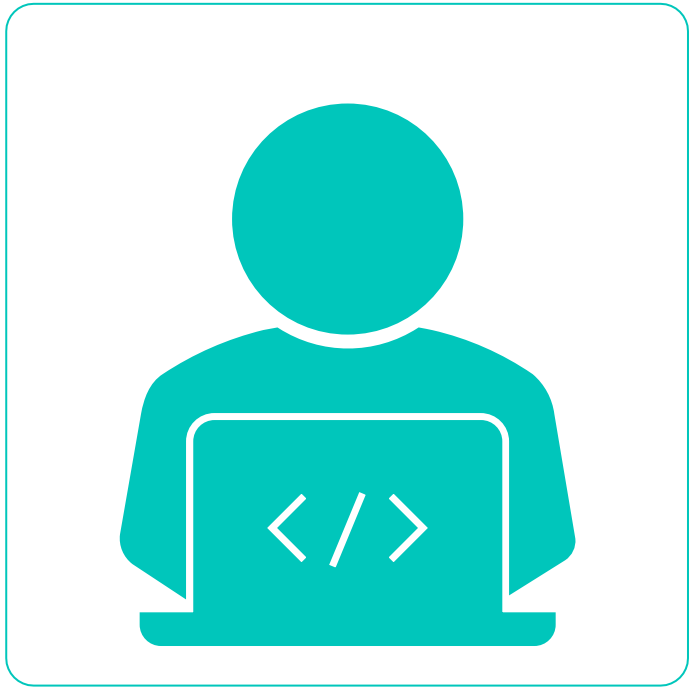




- To run the system manually one must: turn on/off and configure three different power supplies, turn on/off the chiller at specific intervals, and flip a relay switch all to cycle temperature
- A human is not the best at doing these at specific intervals
- This leads to wasted time and an abundance of potential faults when running this test
- This all must be done and accounted for during the collection of data from testing

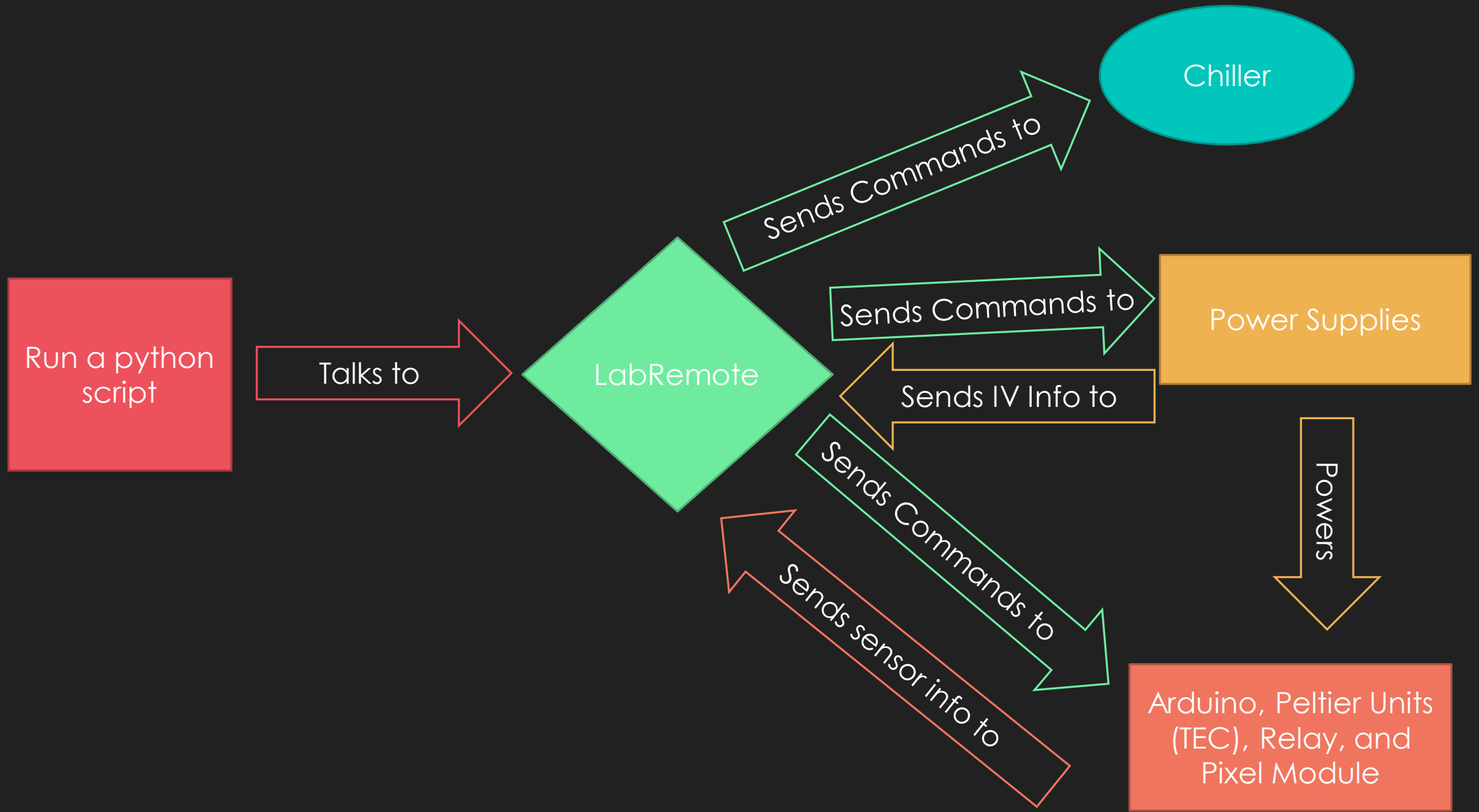
The Manual Testing Process


Chiller
Cools
Pixel Module
Turns on/off
The Experimenter
Sends information to
Programs sensors, flips relay
Sensor
Reads data
Peltier (TEC)
Cycles temperature
Turns on/off
Power Supplies
Sends power to
Sensors:
SHT31 - Humidity+ Temperature
BME280- Humidity + Temperature + Pressure
NTC - Temperature
MAX31855 - Temperature
FS2012 - Flowrate
Peltier units + Relay
The Arduino



- It is more beneficial to program a script to run the test, with specific parameters being input by the user
- A script runs the test and communicates with the various equipment through a software known as labRemote
- The various actions that had to be handled manually, can be handled by a program and python script

The Automated Testing Process


Run a python script
Talks to
LabRemote
Sends Commands to
Chiller
Sends Commands to
Power Supplies
Sends IV Info to
Powers
Sends Commands to
Sends sensor info to
Arduino, Peltier Units (TEC), Relay, and Pixel Module

The Implementation of Lab Remote

01

Hardware command libraries need to be written or pulled from GitLab

02

The libraries/drivers must be compiled for lab remote to send the correct commands

- Linking errors occurred mostly due to directory issues and less to do with the code

03

Communication protocols need to be established

- JSON files contain the hardware name and how to communicate with it

04

The cycling test script must be written and then tested

Progress so far

So far almost every device associated with thermal cycling has been implemented into labRemote

Integrated devices: Chiller, Low-Voltage Power Supply, High-Voltage Power Supply, and the Arduino board

Devices yet to be integrated: The various Arduino sensors and the DAQ multimeter

Once the test can be run remotely and without error, then the goal will be to implement other tests within the lab into labRemote as welli

labRemote improves the process

The communication protocols for each hardware are handled through labRemote, so the process can be run with python scripts

labRemote ensures that nothing is miscommunicated between the various equipment

Reduces the possibility of problems arising from human error, since the typical error-prone tasks are now automated

Functions as a sort of dictionary of equipment, that way future researchers don't have to start from scratch

Questions?