Detector Building C

2022 New Mexico Coaches' Clinic
Rio Sessions

Event Objective

Build the most accurate digital probe.

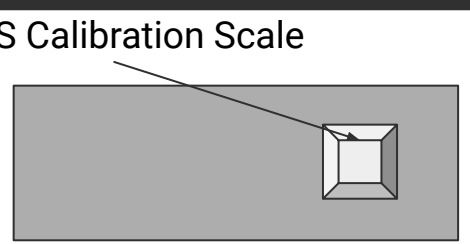
This year, we’re measuring weight.

Rough Sketch of The Competition (Demo)

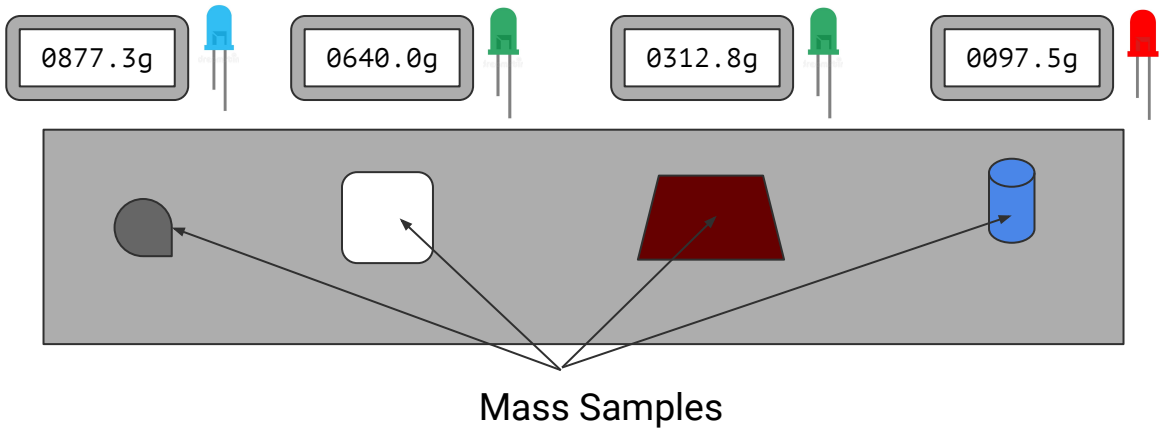
Color Ranges

- 30g - 127g
- 127g - 690g
- 690g - 1000g

1 Calibration & Setup
(5 minutes)



2 Device Testing (1 minute per sample)



3 Written Exam
(Remaining Time)

Basic Analog Detector (Demo)

Basic Analog Detector

- This is just the most basic of detectors.
- Start Here.
- can get more complicated, if you decide to go that route.

Things to think about for this design:

- Fixed resistor values
- Sensor ranges

Construction Materials

Non-Sensor Things

- Breadboard
- Microcontroller (the board like the Arduino I’m using)
- Laptop or calculator to display data
- Three LEDs (red, green, blue)
- Wires
- Resistors
- Other electrical components your team decides to work with
- A case/label for your device, if you’re feeling classy

What's It Going To Look Like?

Honestly? I can't tell you.

Student creativity will be necessary here.

If you're totally stumped, maybe start thinking about a digital scale and go from there.

Sensor Possibilities

Some possibilities that come from the rules:

- Force-sensing resistors
  - Similar to a normal resistor, but the resistance changes with applied force
  - Legal to purchase
  - Can be built

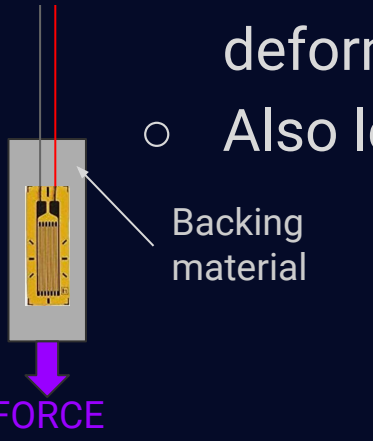
One possible configuration

EXAMPLE:
FSR01CE sold for ~$11 on DigiKey (Link)

Sensor Possibilities

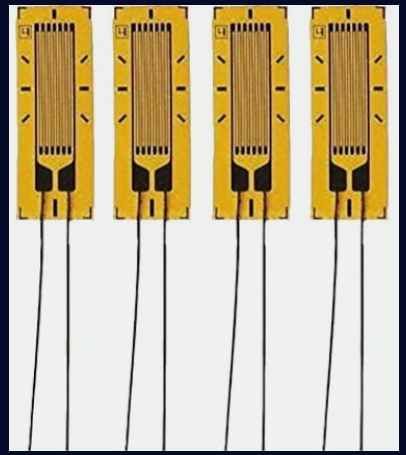
Some possibilities that come from the rules:

- Strain gauges
  - When a force is applied, the cell deforms, the conductor deforms, and it changes the resistance
  - Also legal to purchase



One possible configuration

EXAMPLE
Culler Strain Gauge ~$30 on Amazon (link)



Sensor Possibilities

Some possibilities that come from the rules:

- Student-constructed load cells
  - *Commercial* load cells may not be purchased
  - How they work varies
    - Hydraulic: Pressure of fluid inside changes when a force compresses the container
    - Strain-Gauge: Uses strain gauges
    - Pneumatic: More complicated

Sensor Possibilities

- Any other ideas can your team come up with?
- Anything unconventional that may still work well?
- Any creative ways to utilize or arrange conventional sensors?

Solid understanding of circuitry and how these sensors work will be key.

Getting the Detector to Do Stuff (Demo)

Getting the Detector to Do Stuff

- **The internet is your friend when writing code.**
- Creative programming can be just as useful as creative building.
  - Is there a way you can code your device to work better?

Good Question to Ask Before A Competition

Teams need to display the voltage across the sensor.

Does your sensor display the voltage in VOLTS or an ADC reading?

Raw Data is Not Useful To Us

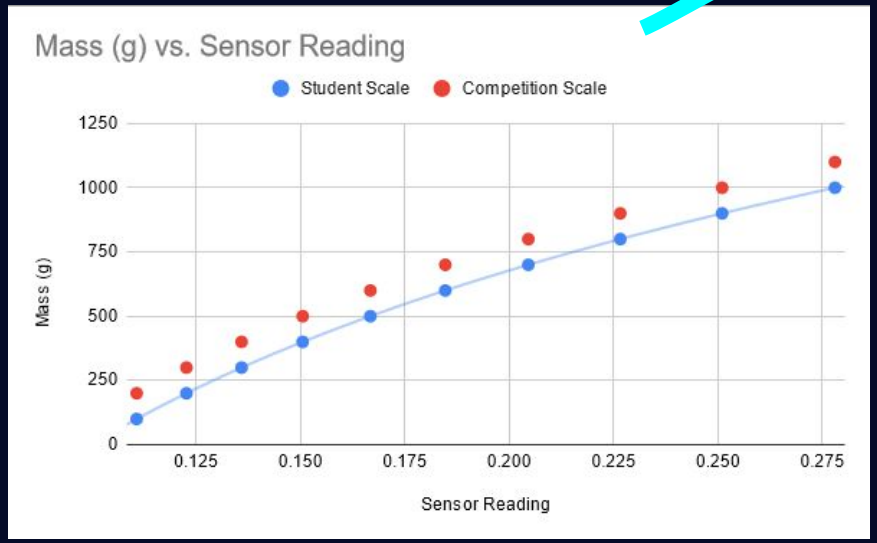
- Tables and tables of raw data
  - This is where practice comes in handy
- Find a mathematical model that fits your data
  - Spreadsheets!

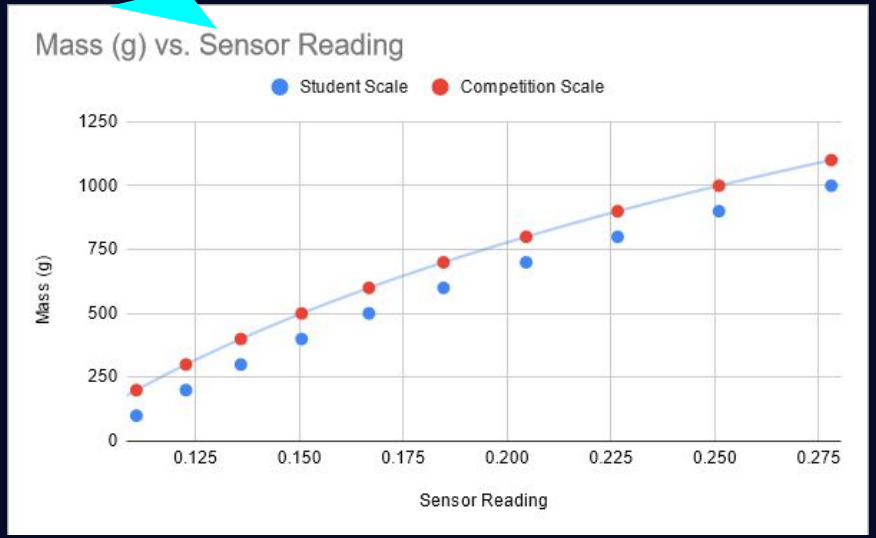
Calibrating the Sensor

- “Adjusting” the sensor.
- Your scales and my scales and their scales are different.
  - The Event Supervisor will provide you with the scale they used to weight the masses.
- How will you adjust your reading so that it matches theirs?

Calibrating the Sensor

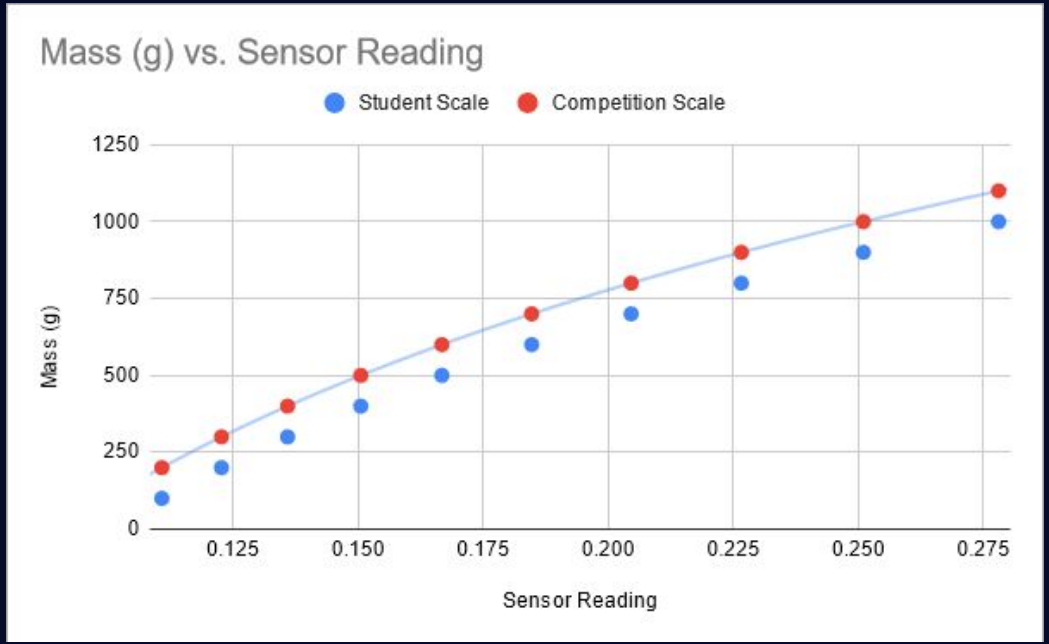
Thinking in terms of curves:





Calibrating the Sensor

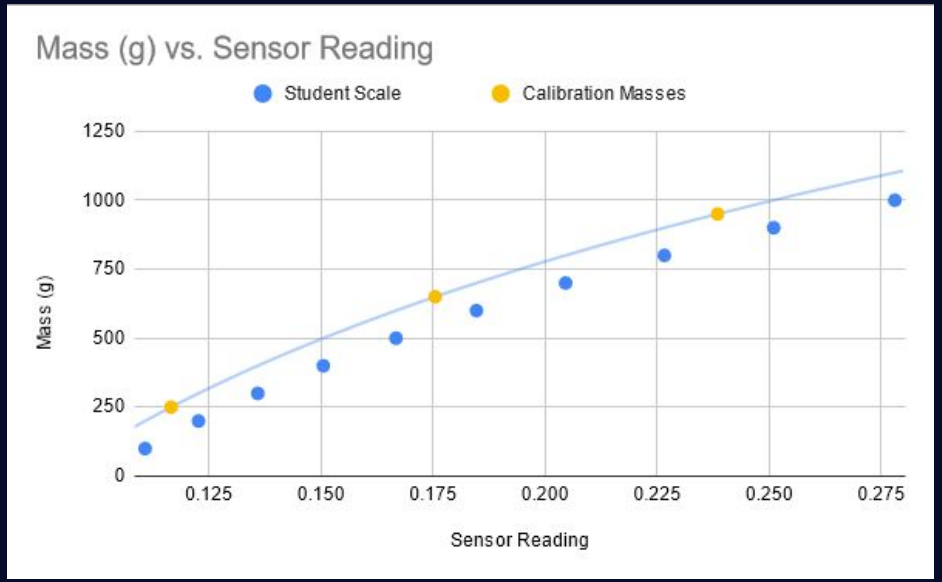
WAIT, but we don’t know what the mass readings for the ES are…



Calibrating the Sensor

AND the scale used to measure the competition masses will be available. You bring your own weights.

CALIBRATION MASSES	
Student Scale	*Competition Scale*
150g	250g
550g	650g
850g	950g

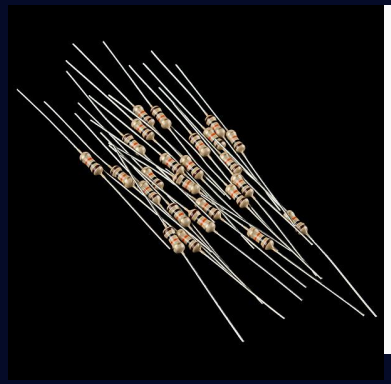


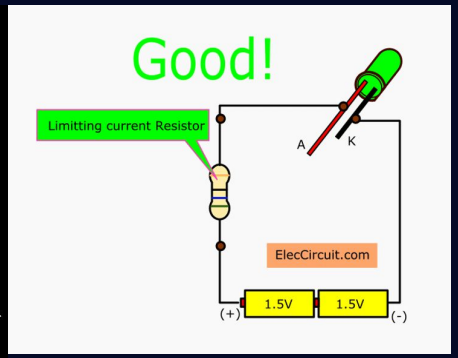
LEDs

- Exercise for the student to figure out.

- TIP: If team is new to electronics, may help to have them start with figuring out how to turn LEDs on and off.

- **USE RESISTORS!**
  LEDs can burn out with too much current through them.





Design Logs

- Don’t skip it!
- For a team formulating a good mathematical model, should be easier to tell the truth than fabricate data.
  - Keep track of old data

23% of score at regionals, 20% at state!

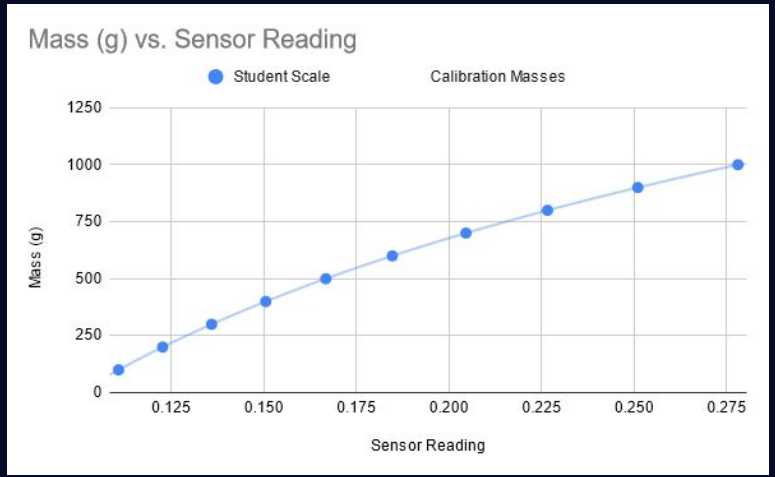
Design Logs

1. All about your design (be proud of the work you did)
    a. Labelled photograph (include function of each piece—instead of “resistor”, tell us why you bothered to put it in, as well).
    b. Brief summary about how the device was constructed.
        How does it work?
        Why did you choose to do what you did?
        What are some ways you improved it?
        Any creative implementations (hardware & software!)?

Design Logs

2. Data table with at least 10 trials per fixed resistor tried. Keep track of your calibration data, and copy/paste.
3. Scatterplot of graph… 4. …with mathematical model overlaid.

   You should also already Have both of these.



Design Logs

5. Equation of the model (should take about 30 seconds)
   Highlight this.
6. Printout of the code.
   Highlight where the above mathematical model is in the code
7. Printout of the code.
   Highlight the code that illuminates the LEDs in the right range.

Design Logs

8. Add a cover page with team name and #.

Other specifics

- Digitally manufactured parts require extra info (see rules).
  Big penalty for neglecting to do this…
- UNITS! UNITS UNITS UNITS!
  Default to SI units, unless otherwise appropriate.
- Be ready for thorough questioning!

The Exam—An Varied Topic Assortment

The list is on the rules… it’s quite strange.

- Some mechanics, some E & M, some statistics.

Some things usually mentioned, not explicitly mentioned:

- Circuit analysis (Ohm’s Law, Series/Parallel, Kirchoff’s Laws, etc.)
- Basic programming and code

You *can* use your binder, but NOT a laptop.

WHO WILL WIN?!? (Scoring Demo)

RESOURCES!

Official Detector Building Event page

- https://www.soinc.org/detector-building-c

Official webinar and TI resources

- http://www.tidetectorbuilding.com/

Scioly.org Student Center Wiki Page

- https://scioly.org/wiki/index.php/Detector_Building

2023 Practice Tests

- https://scioly.org/wiki/index.php/2023_Test_Exchange

RESOURCES!

Getting Started with Arduino Tutorial

- https://www.arduino.cc/en/Guide

Getting Started with TI Equipment Tutorial

- https://education.ti.com/en/resources/getting-started-on-ti-technology

Using Spreadsheets for Data Analysis (Brief Tutorial)

- https://www.got-it.ai/solutions/excel-chat/excel-tutorial/regression/linear-regression-in-excel-and-google-sheets