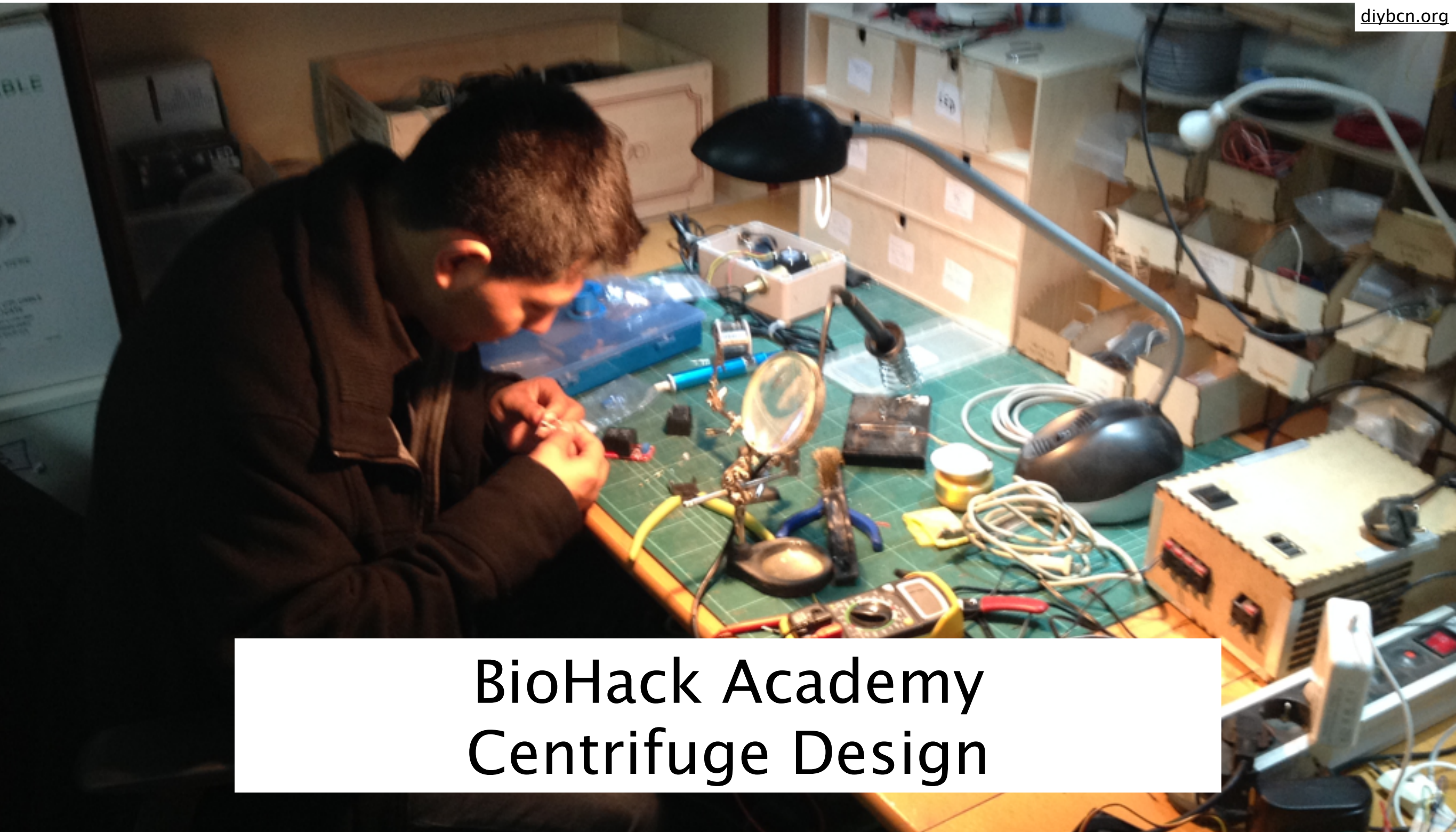




waag society

institute for art, science and technology

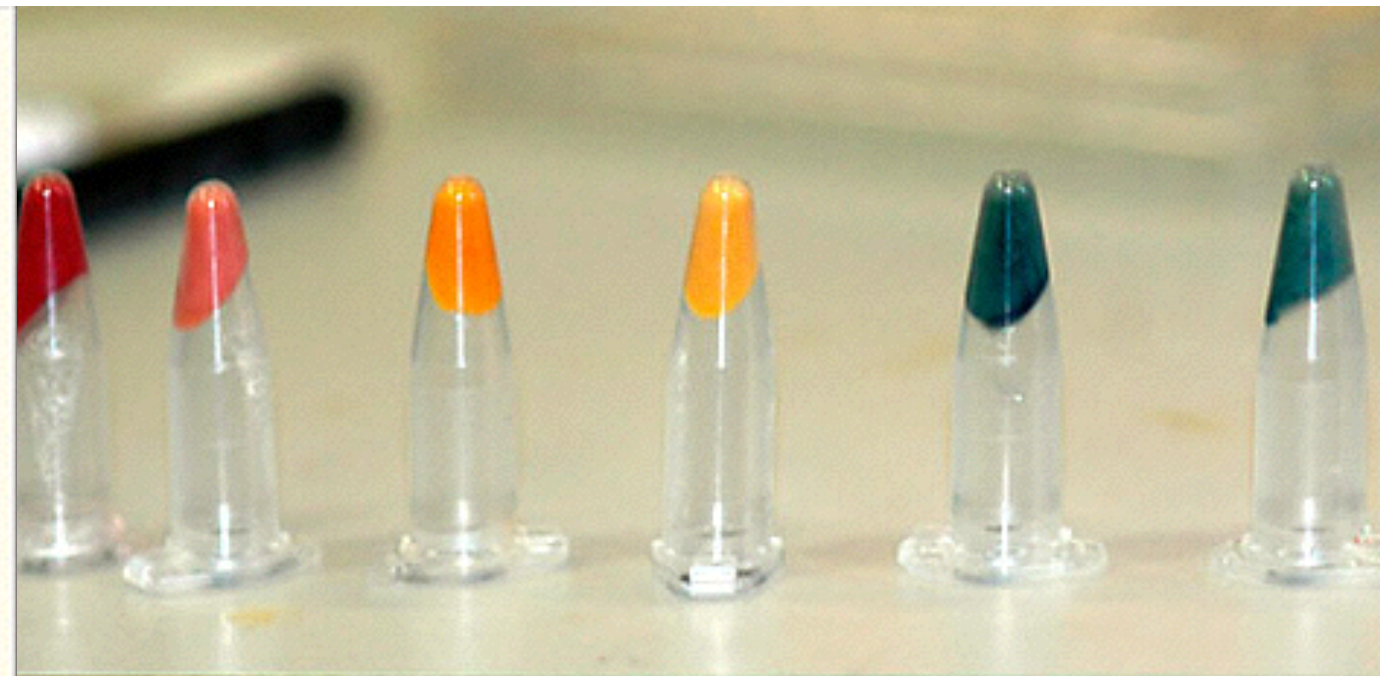
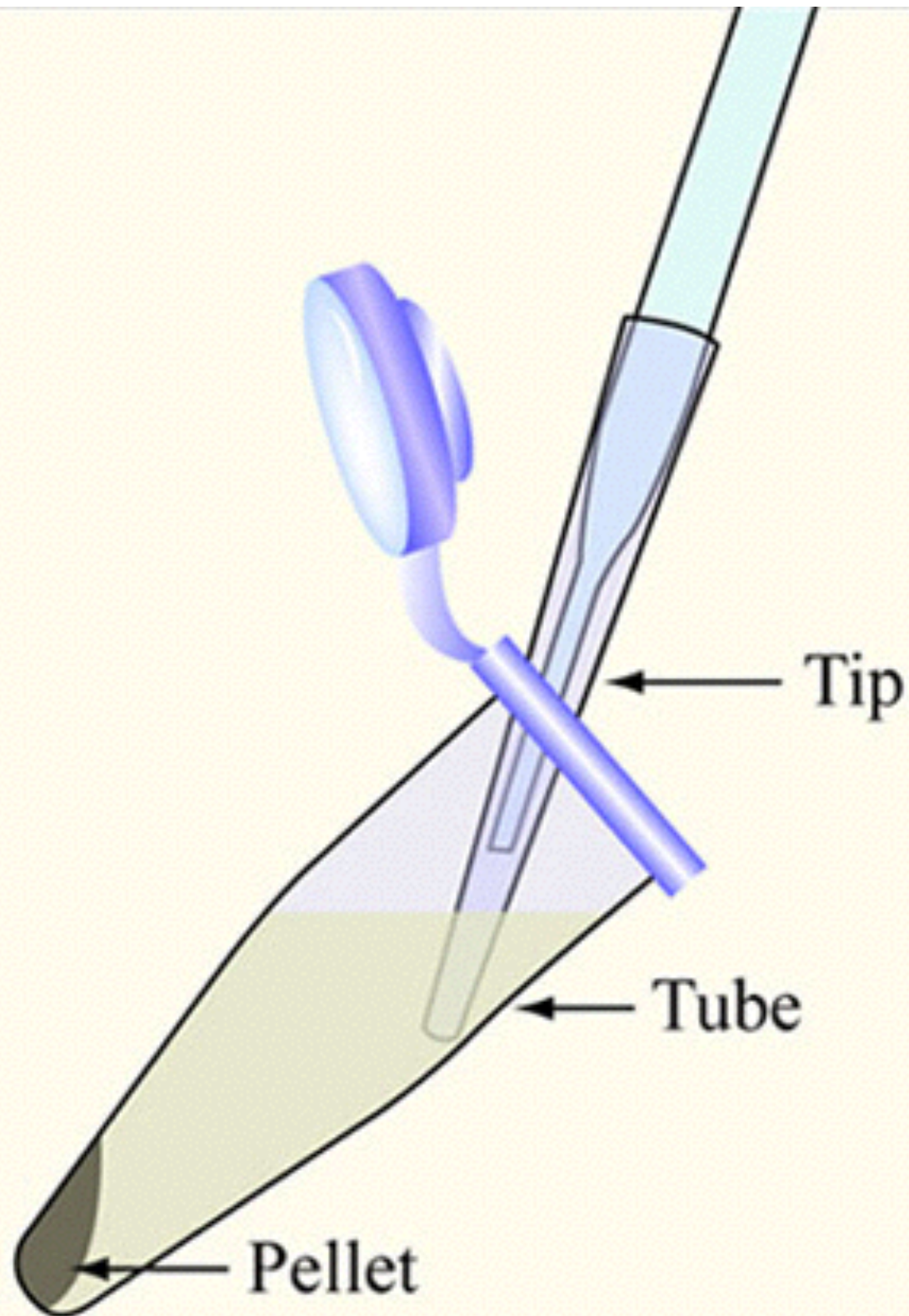
diybcn.org



BioHack Academy Centrifuge Design

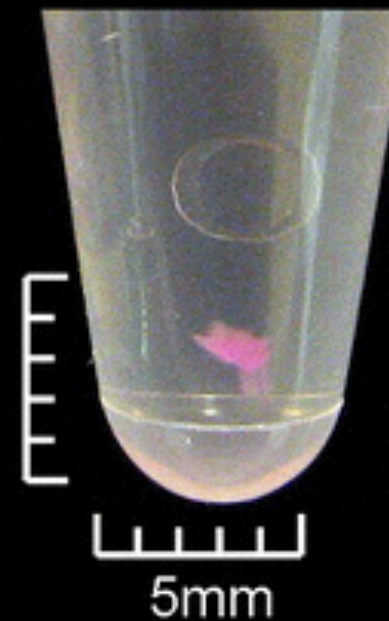


Why we need a centrifuge

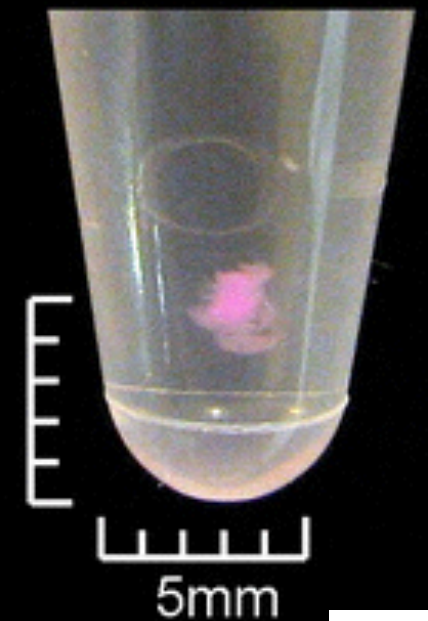


Cambridge iGEM 2009

20ug



40ug





Industry standards



Magnus Manske – CC-BY 1.0



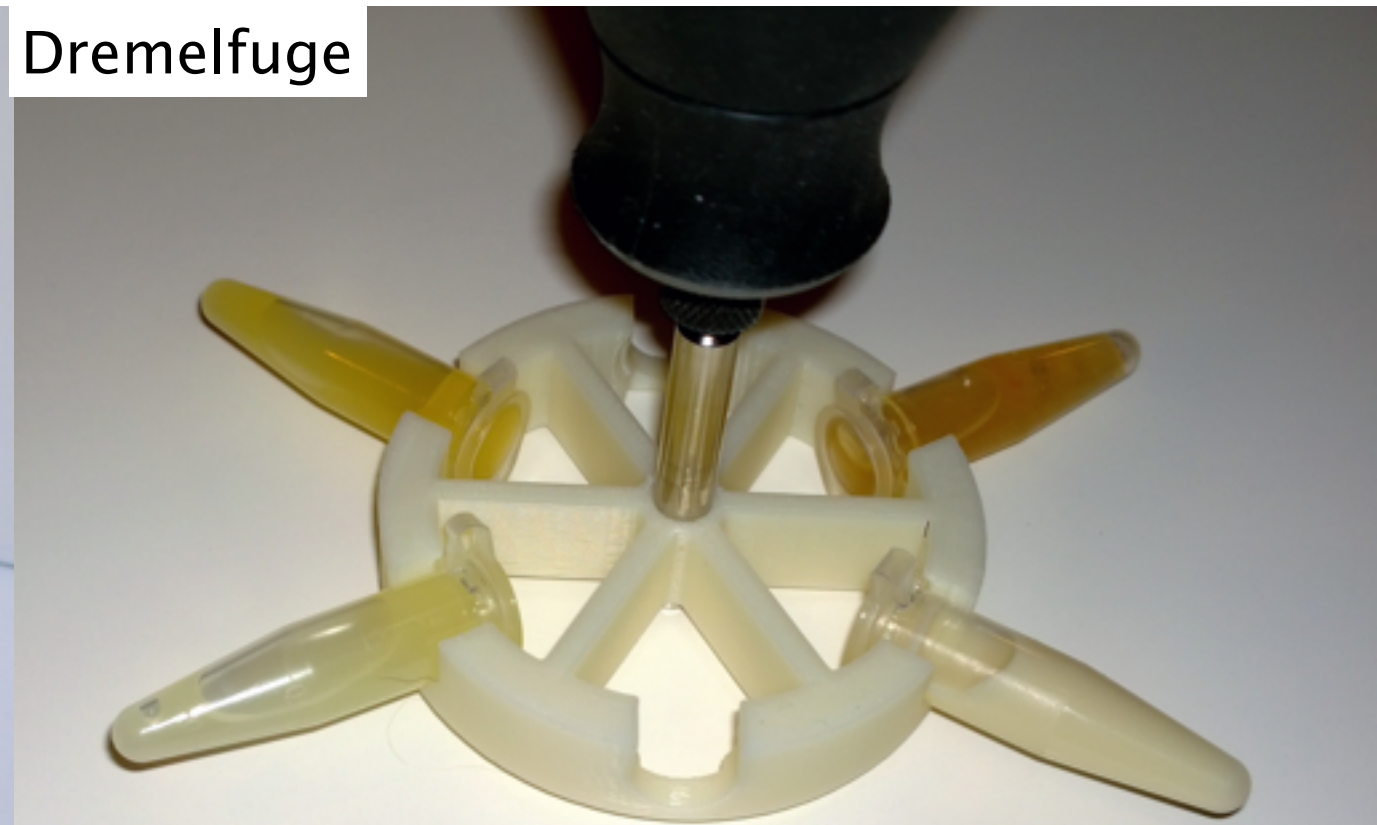


Centrifuge hacks

GoGoFuge



Dremelfuge



OpenFuge



Hackteria harddrive hack





Design constraints



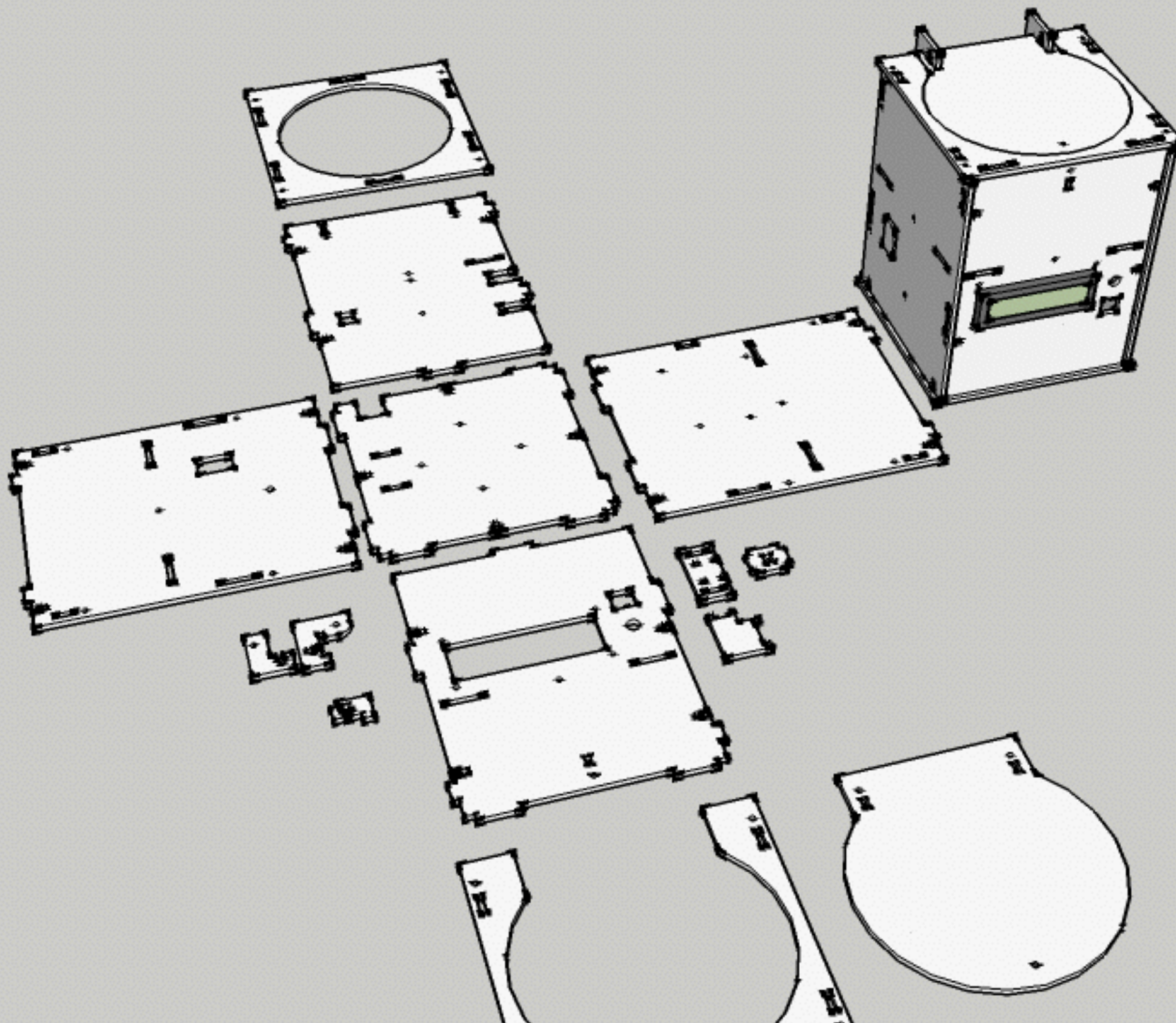


Notice

- NEVER test your centrifuge with a rotor attached

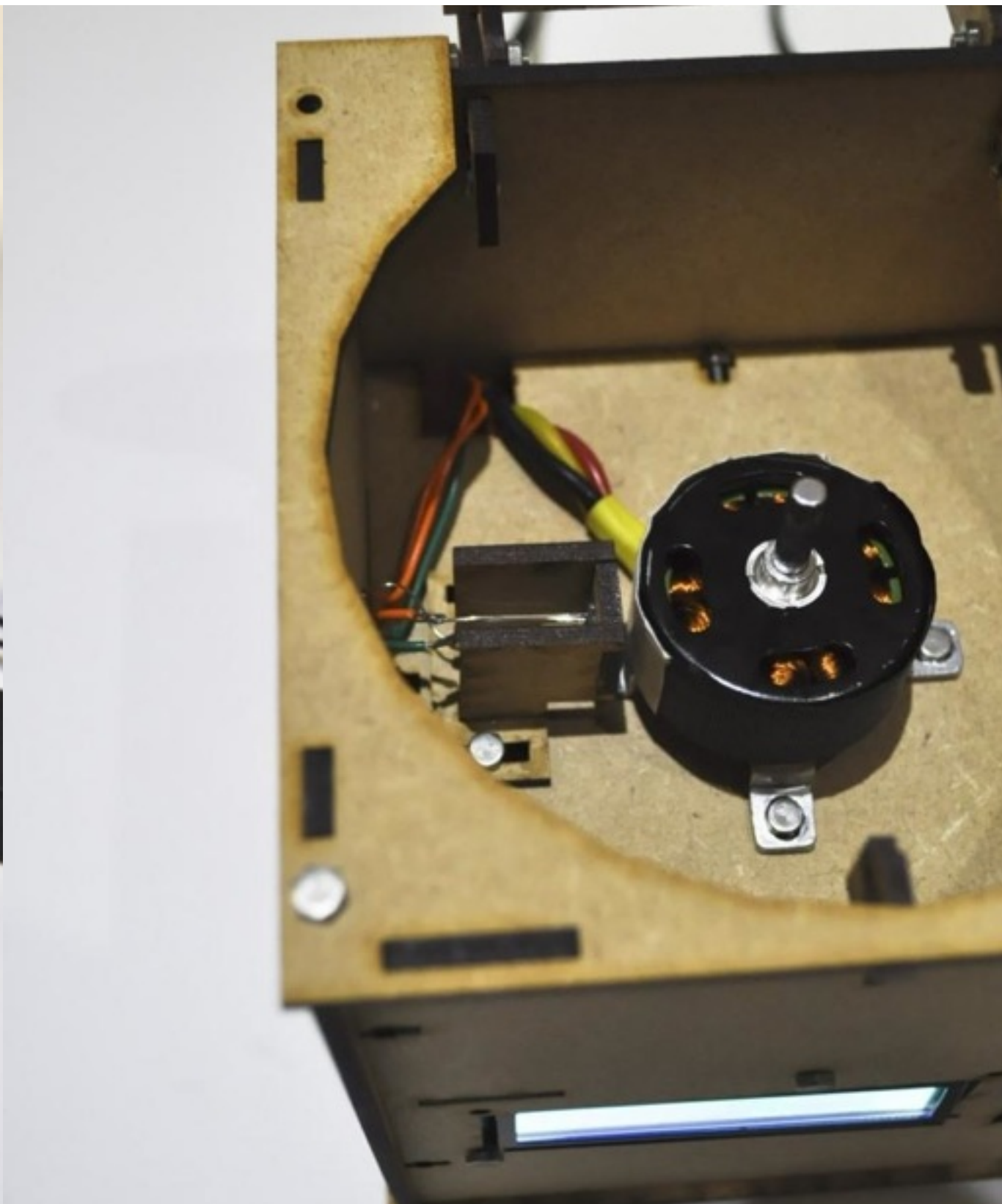
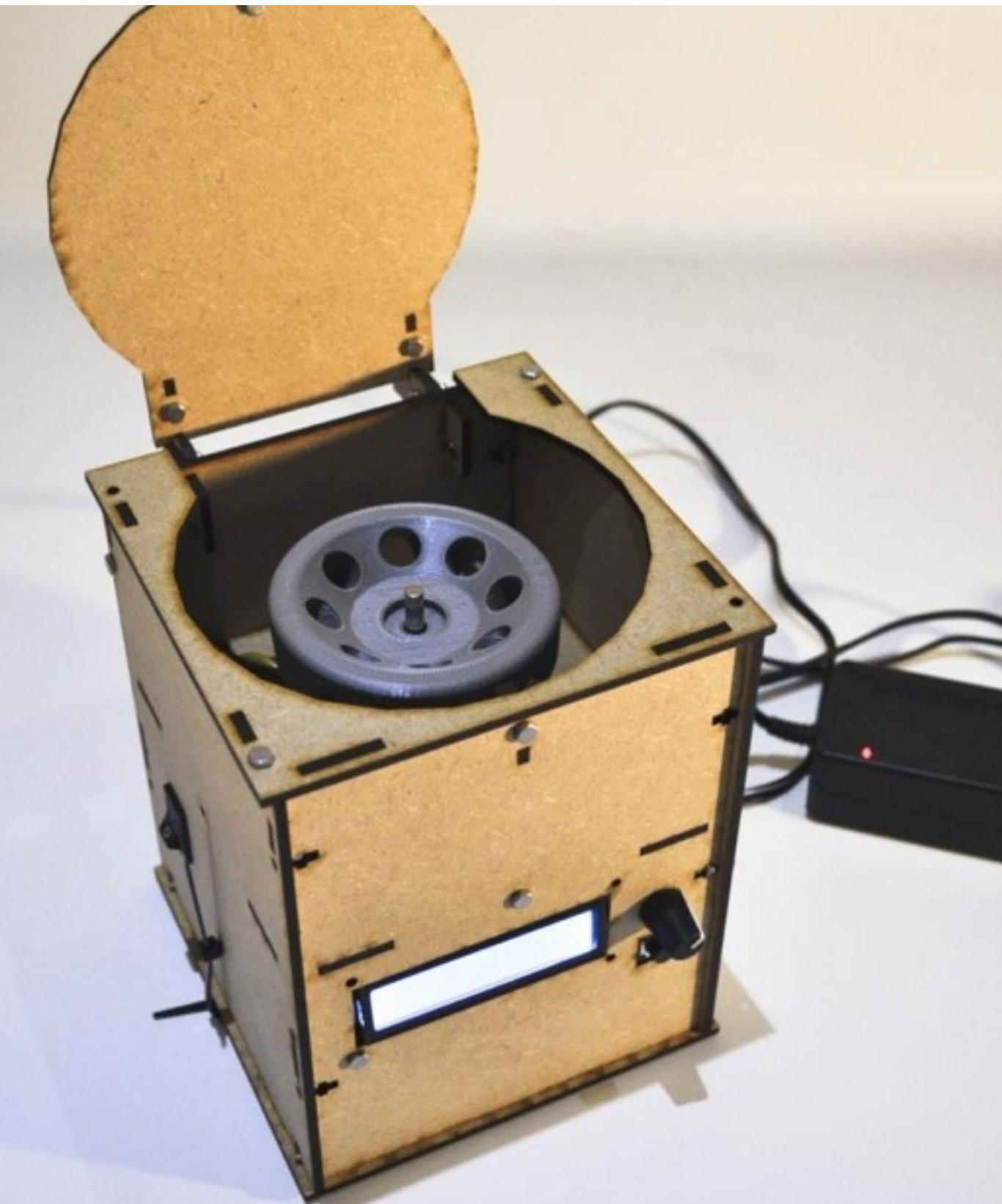


BioHack Academy design





Some pictures





Bill of Materials

#	Amount	Description
1		1 DC Brushless motor 800 RPM/V & Electronic Speed Controller
2		1 3.5mm connector
3		1 Rotary encoder
4		1 Knob
5		1 Power switch
6		1 DC power jack
7		1 12V 5A Power supply
8		1 Push button
9		4 Rubber feet
10		1 Sheet of 45cm x 95cm 3mm MDF
11		1 Heavy weight max 12cm diameter
12		1 Infrared sensor
13		1 I2C LCD display
14		1 6.8 KOhm resistor
15		1 220 Ohm resistor



Motor

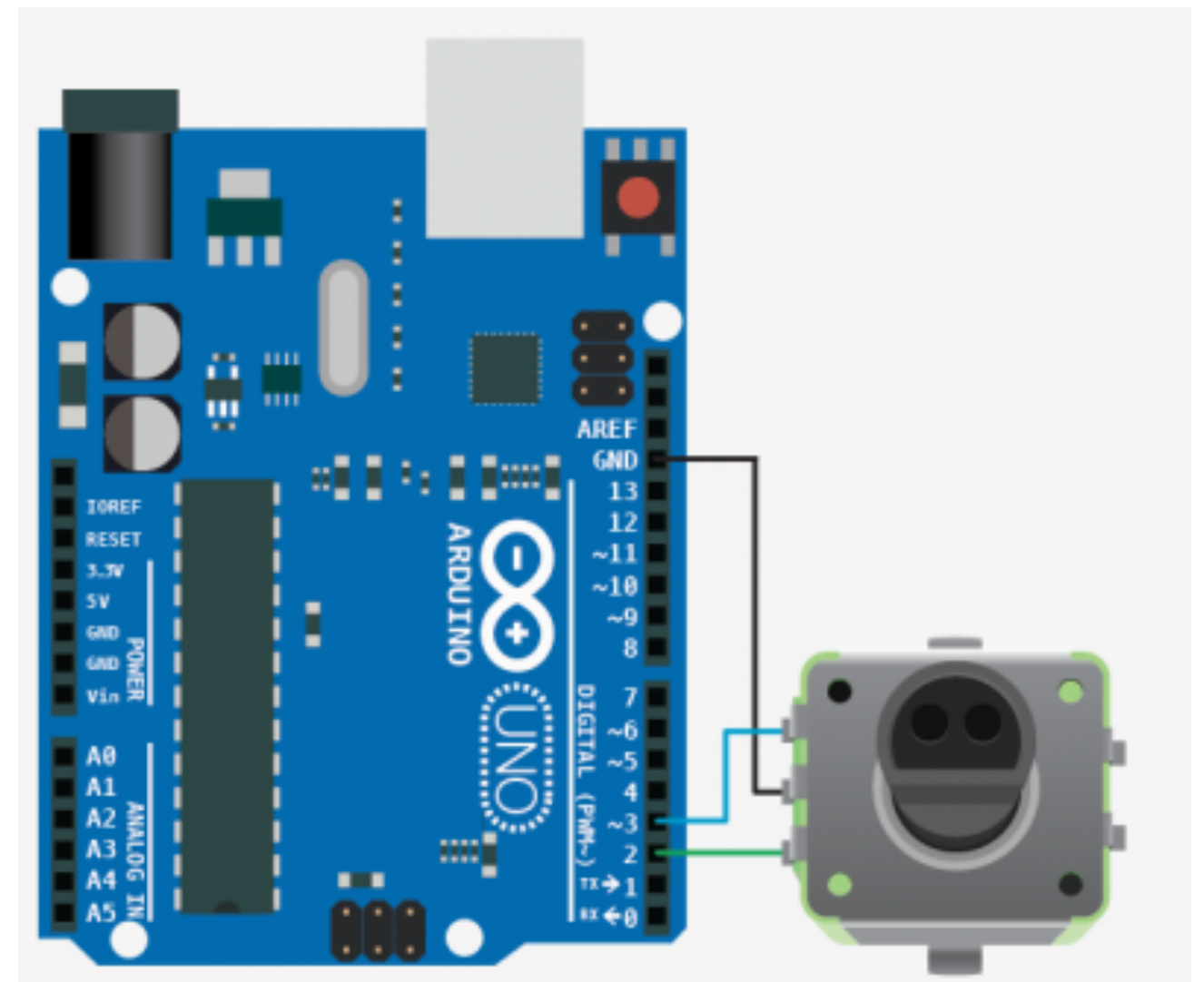
- Brushless
 - $\text{RPM} / \text{V} = 810$
 - 12V, so 9720 RPM
- ESC
 - power limit
 - voltage regulator





24 steps rotary encoder

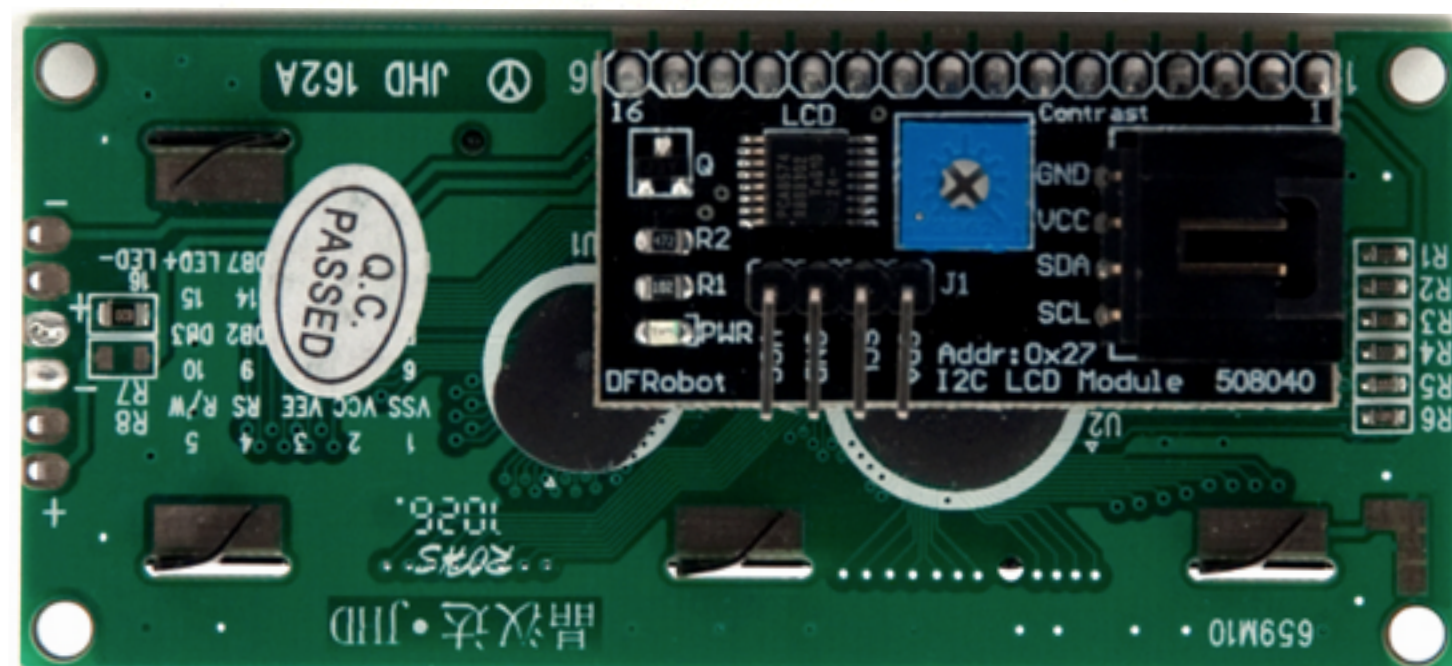
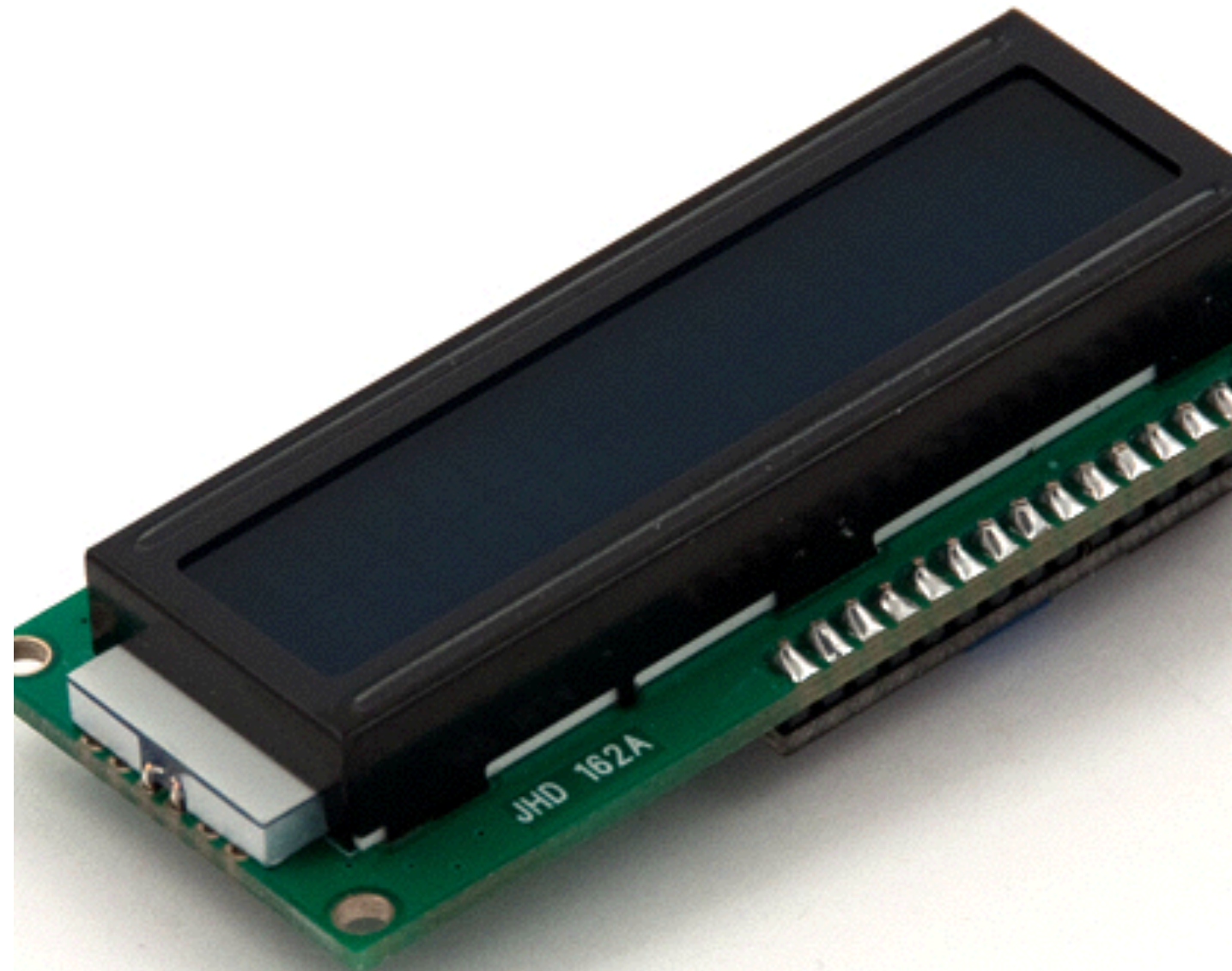
- Rotates infinitely
- 3 pins:
 - GND
 - State1
 - State2
 - 2 bits:
 - 00
 - 01
 - 11
 - 10
- Interrupt pins
 - `attachInterrupt()`
- Demo code in Syllabus





I2C Display

- Arduino I2C ports
 - SCL -> A5
 - SDA -> A4
- Libraries
 - Wire
 - LiquidCrystal_I2C
- Demo code in Syllabus





Heavy weight

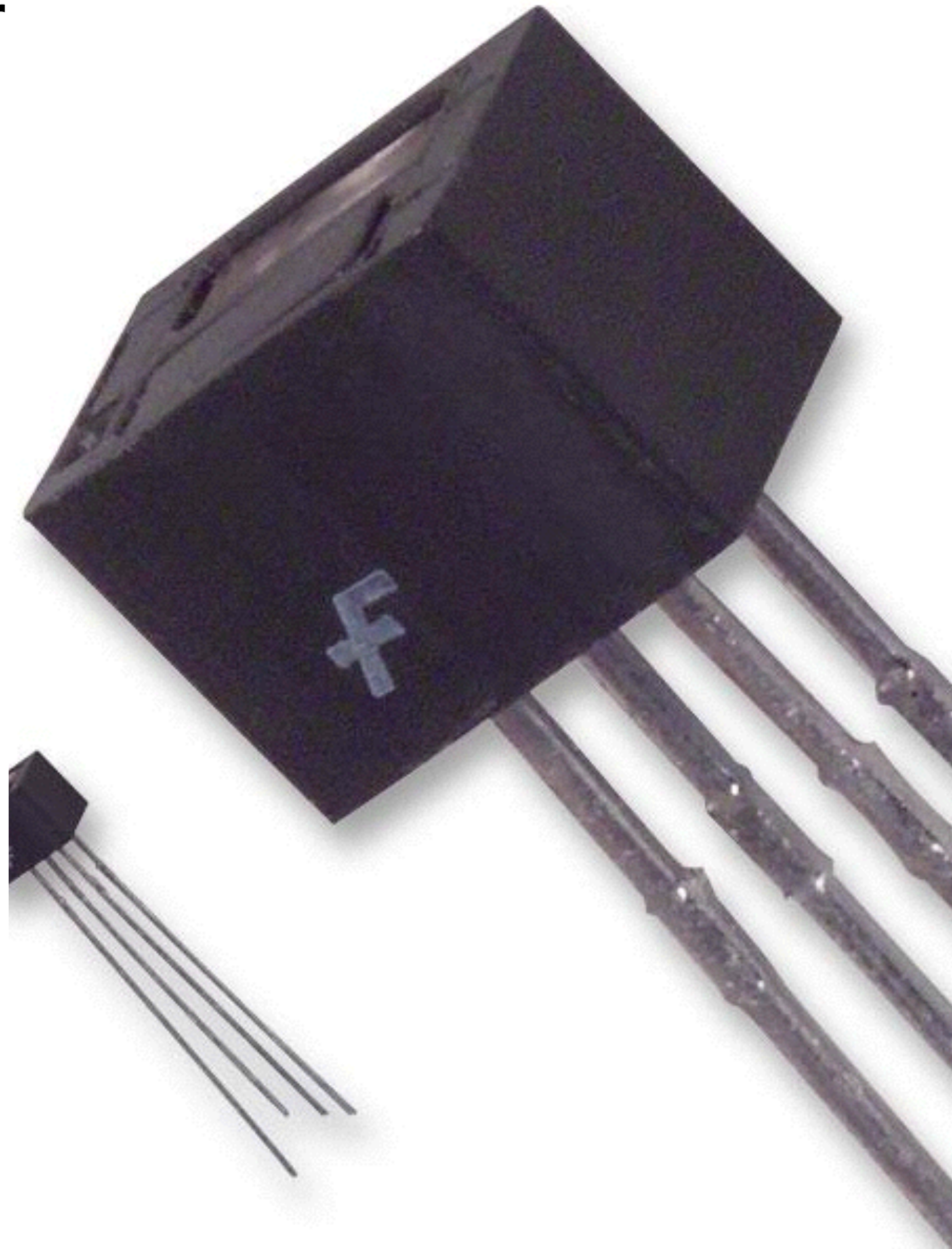
- Stabilizing the machine





Infrared sensor

- Emitter
- Detector
- `pulseIn()` function
 - <http://arduino.cc/en/Reference/pulseIn>



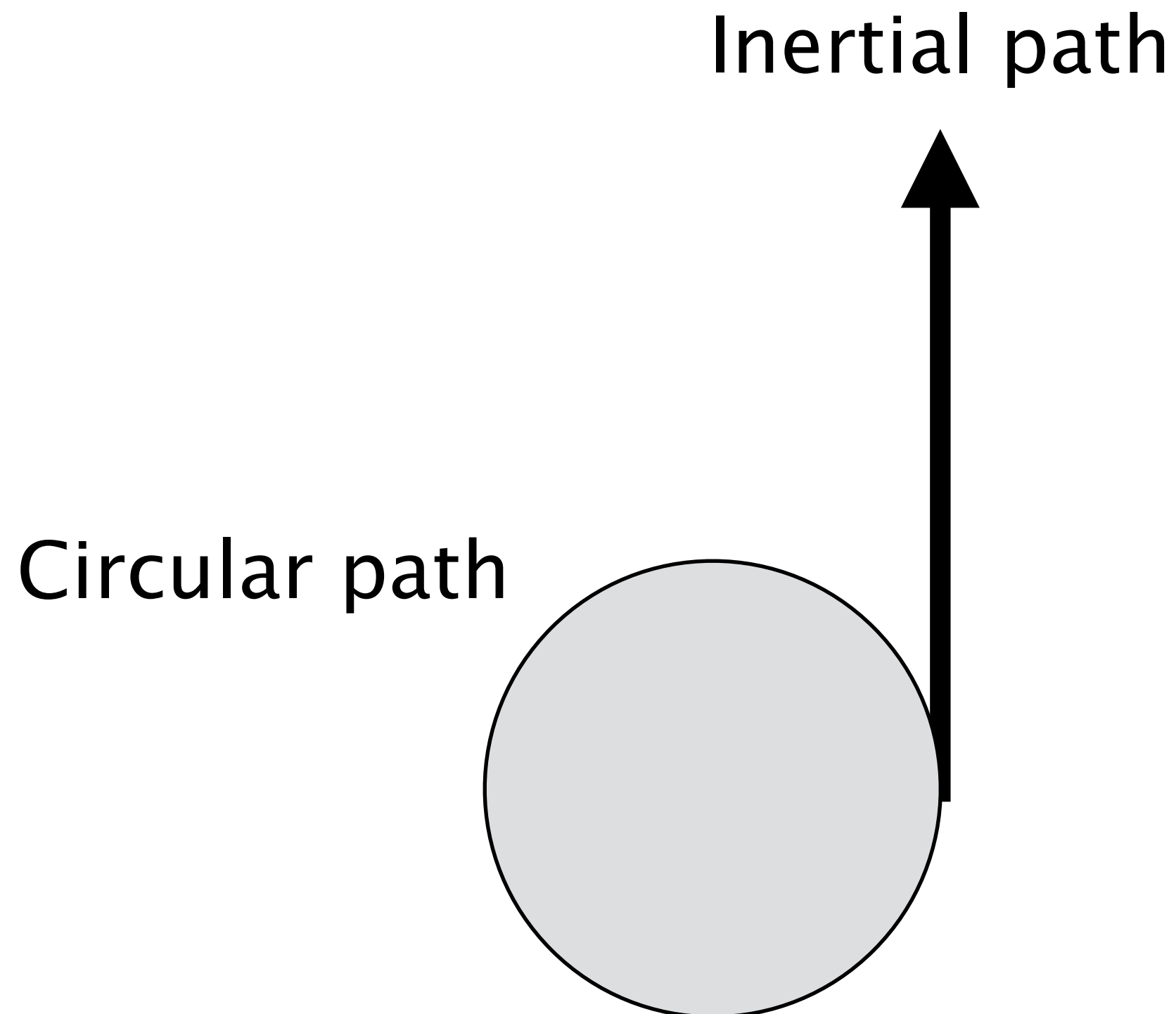


Roller coaster





Centrifugal force



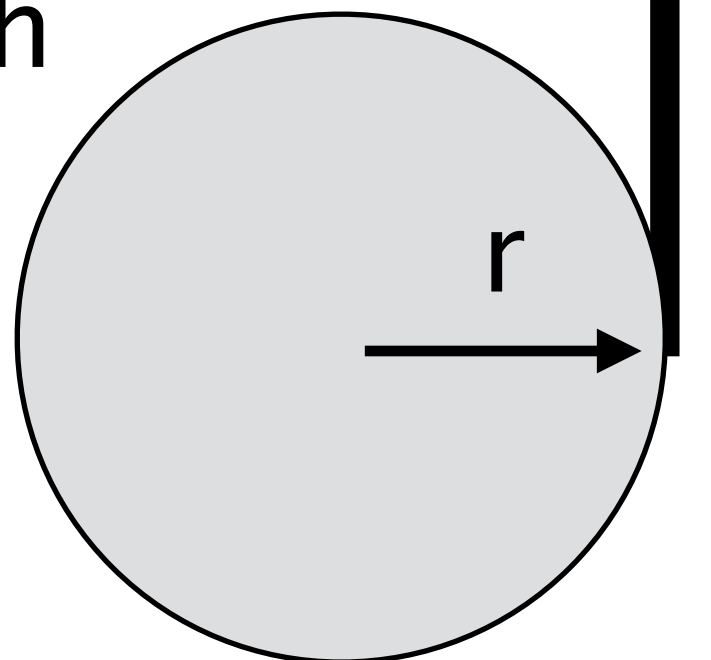


Centrifugal force

$$G \text{ force} = \left(\frac{RPM}{1.000}\right)^2 \times 1.118 \times r$$

Circular path

Inertial path





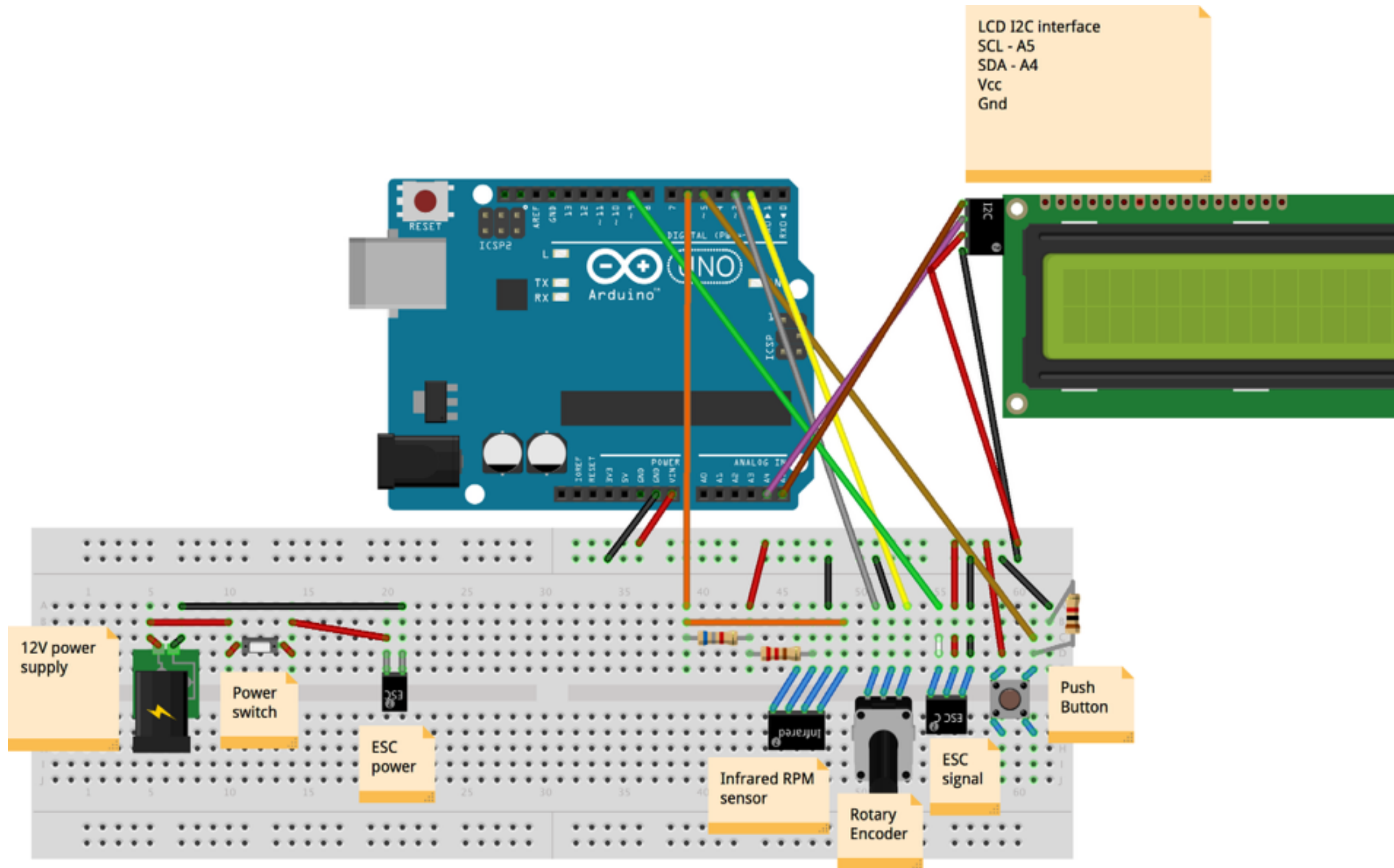
Kinetic Energy

- 2 gram mass
- 7 cm diameter
- 10,000 RPM
- Surface speed: 3.6 m/s
- Energy: 0.0134 Joules



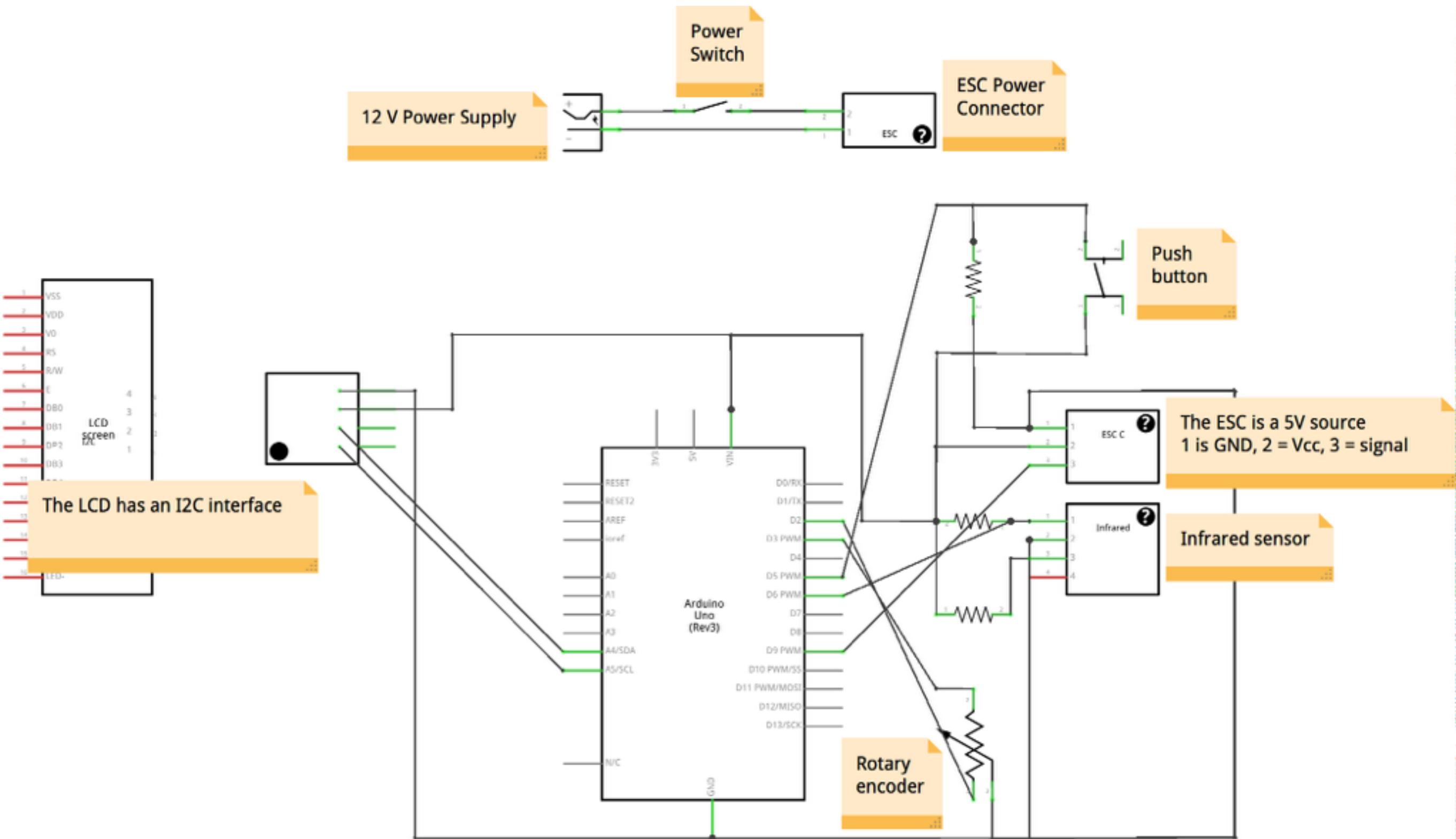


Wiring





Circuit scheme



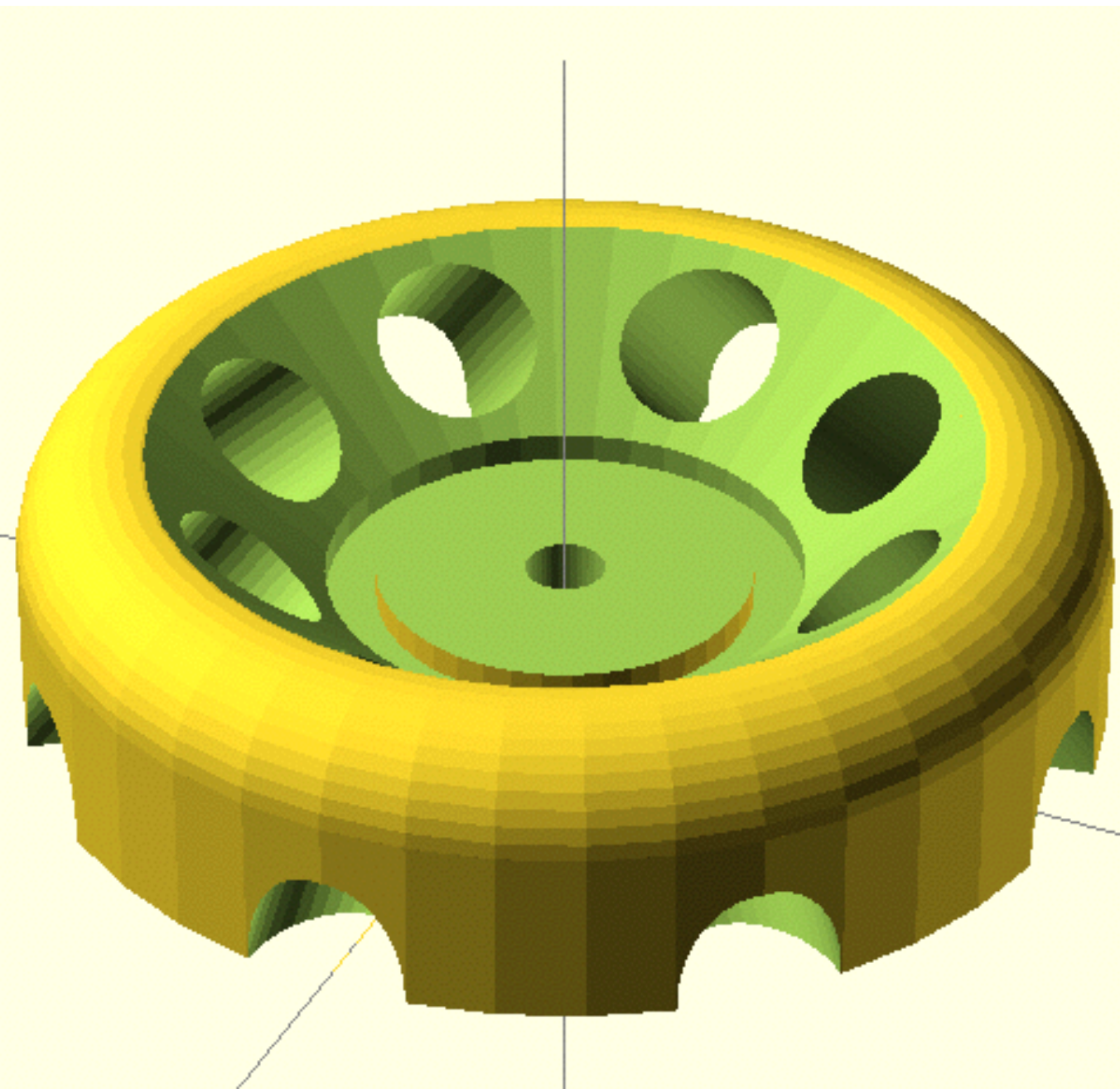


Code tutorials

- Rotary encoder
 - <http://bildr.org/2012/08/rotary-encoder-arduino/>
- I2C LCD
 - <http://playground.arduino.cc/Code/LCDi2c>
- Infrared sensor
 - <http://bildr.org/2011/03/various-proximity-sensors-arduino/>
- Arduino + Electronic Speed Controller
 - <http://www.instructables.com/id/ESC-Programming-on-Arduino-Hobbyking-ESC/>



Rotor



NEVER test your centrifuge with a rotor attached

```
OpenSCAD - 8 Place Rotor

$fn=40; // resolution of the arcs

axis_radius = 0.275; // radius of the motor shaft

tube_radius = 0.575; // inner radius of the tube holders
tube_angle = 45; // angle in the rotor
tube_pos = 4.75; // position of tube holders

scale([10,10,10]) { // cm to mm scaling

difference () { // subtract tube holders from outer ring

    difference () { // subtract inner groove

        difference() { // subtract cone from main disk

            union() {
                cylinder (h = 1.25, r=3.75); // main disk part 1
                cylinder (h = 1.9, r=3.25); // main disk part 2

                // smoothen edge torus
                translate([0,0,1.25])
                rotate_extrude(convexity = 10)
                translate([3, 0, 0])
                circle(r = 0.75);
            }

            translate([0,0,1]) // raise cone from bottom
            cylinder (h = 1.1, r1 = 1.65, r2 = 3, center = false); // co

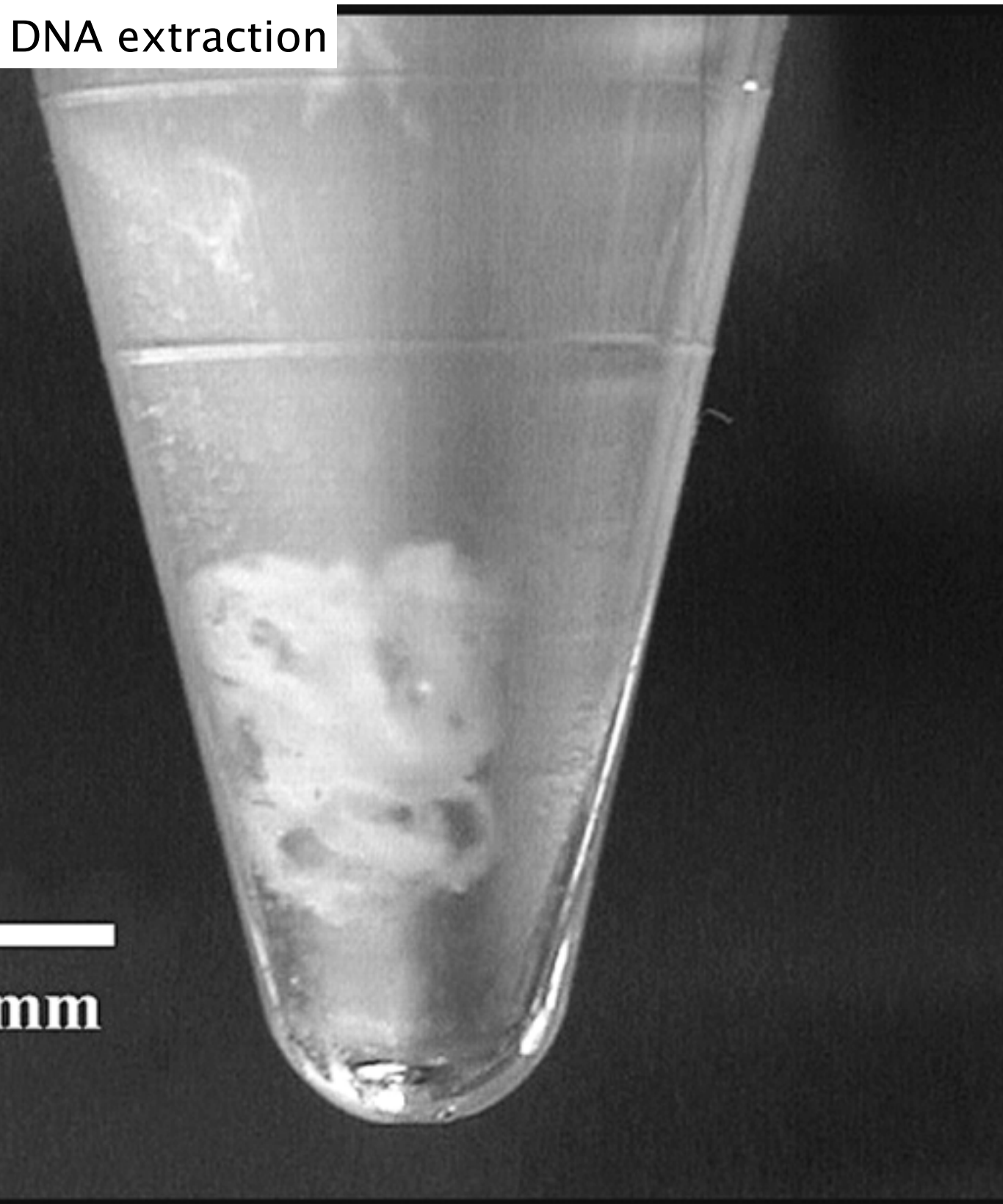
            translate([0,0,-0.1])
            cylinder (h = 1.2, r=axis_radius); // axis

            // groove under tube holders
            translate([0,0,0.8])
            difference() { // ring
```

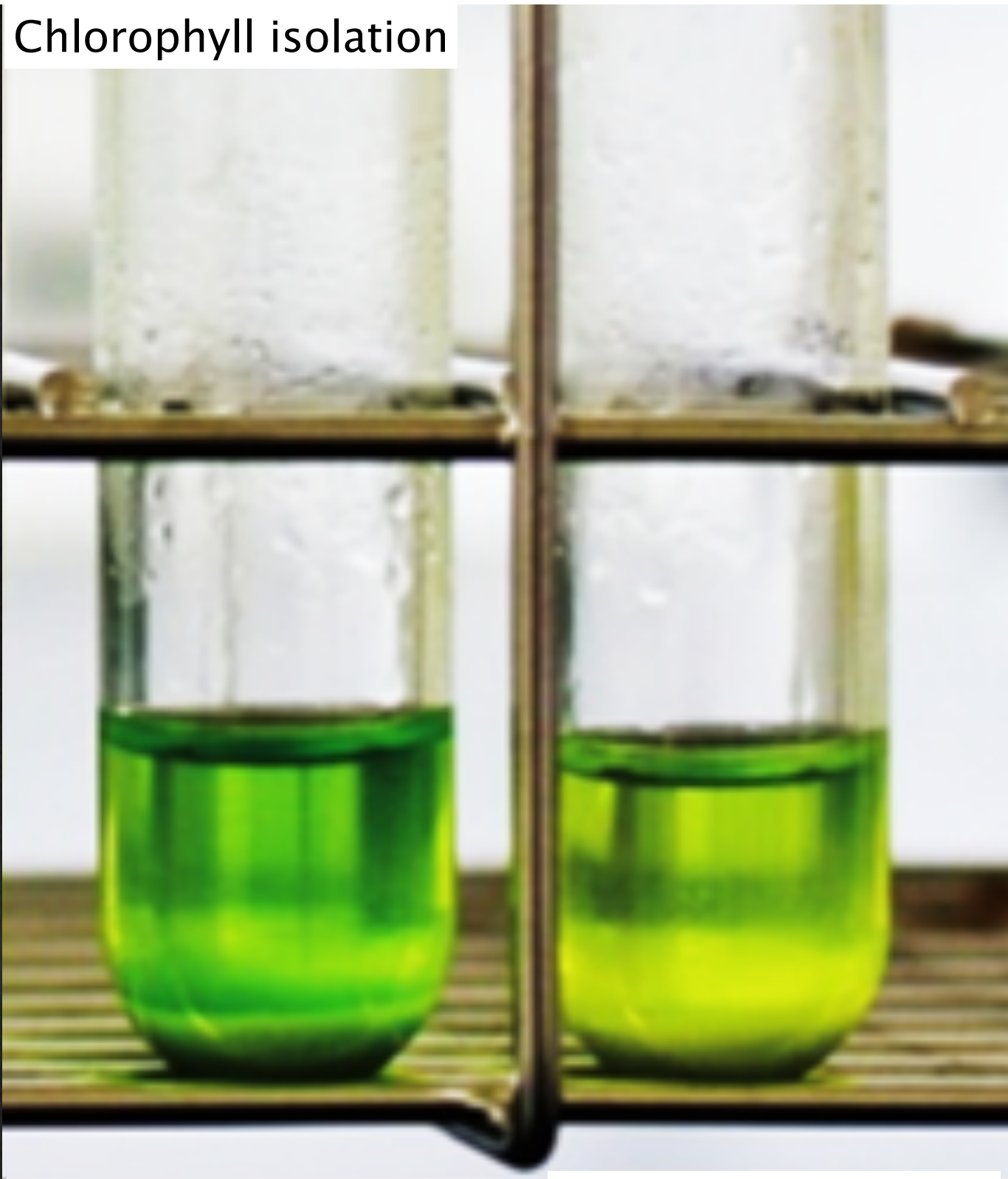


Practicals

DNA extraction



Chlorophyll isolation





Assignment

- Start sketching your bioreactor controller in Fritzing.



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