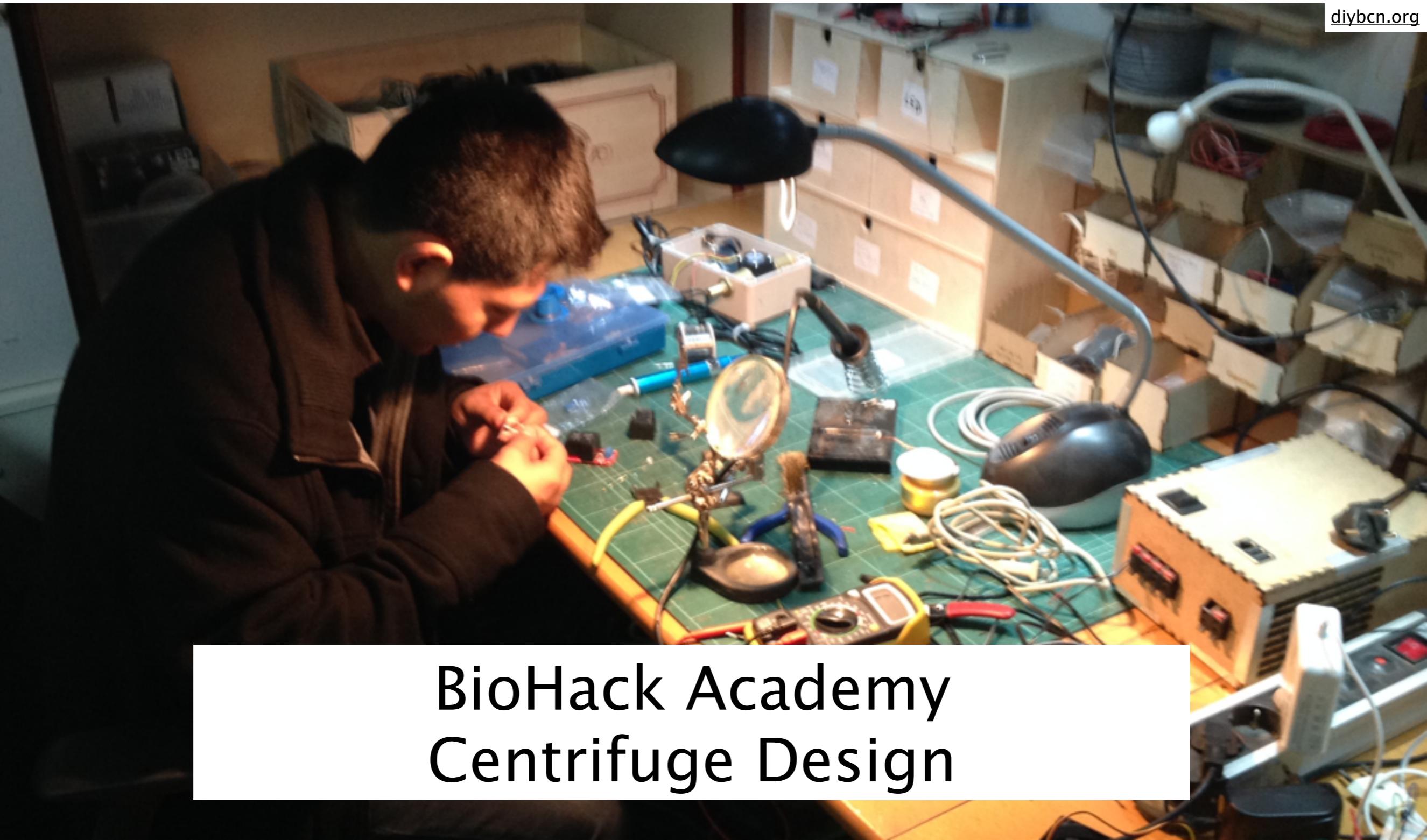




waag society

institute for art, science and technology

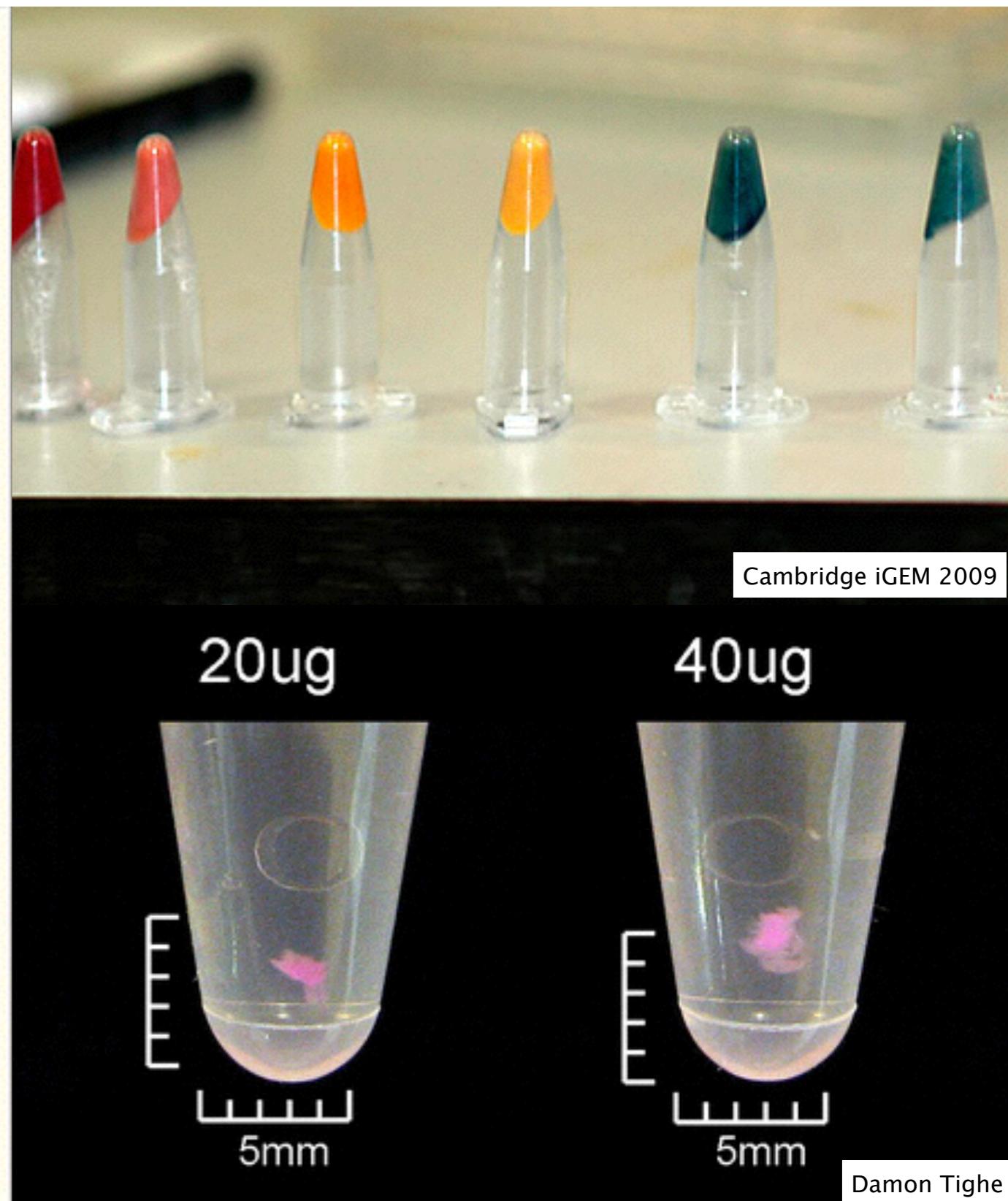
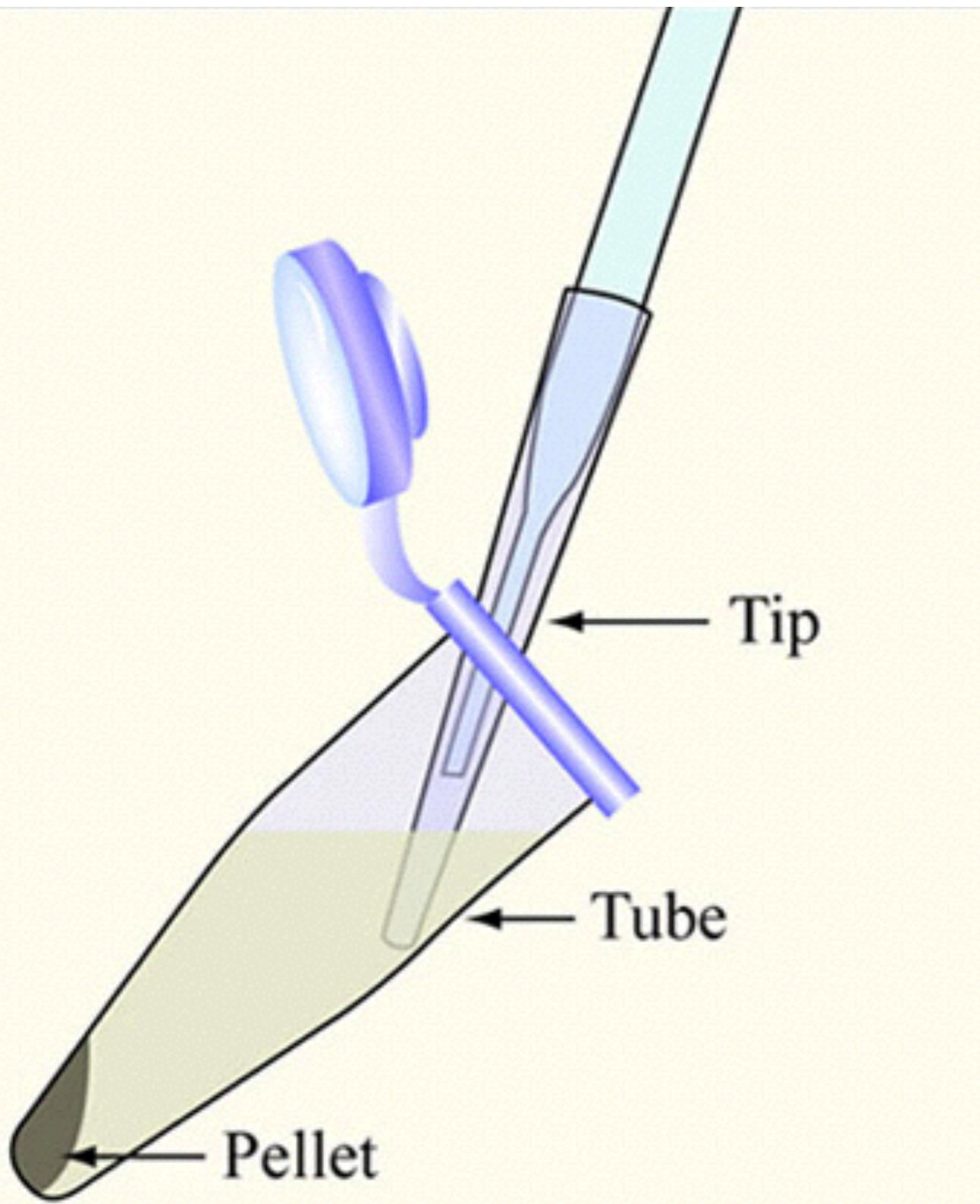
diybcn.org



BioHack Academy
Centrifuge Design



Why we need a centrifuge





Industry standards



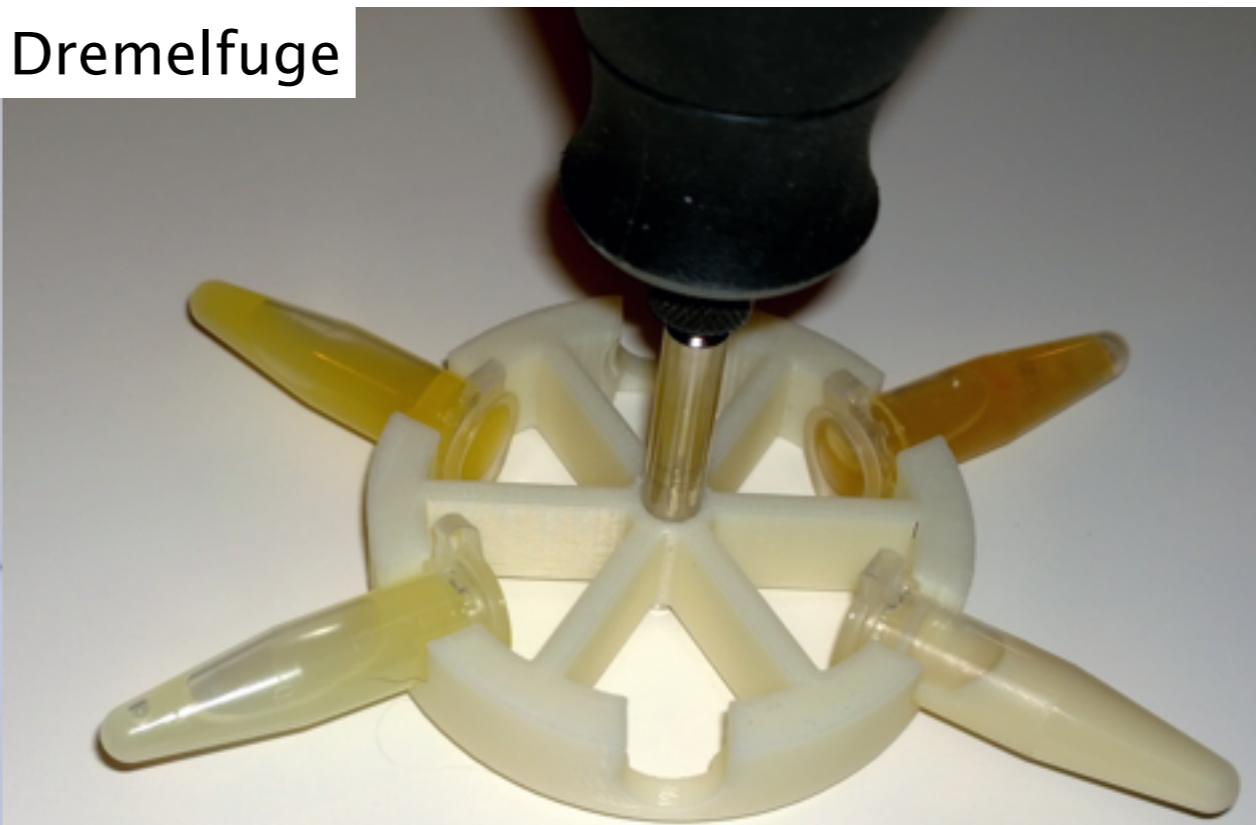


Centrifuge hacks

GoGoFuge



Dremelfuge



OpenFuge



Hackteria harddrive hack





Design constraints



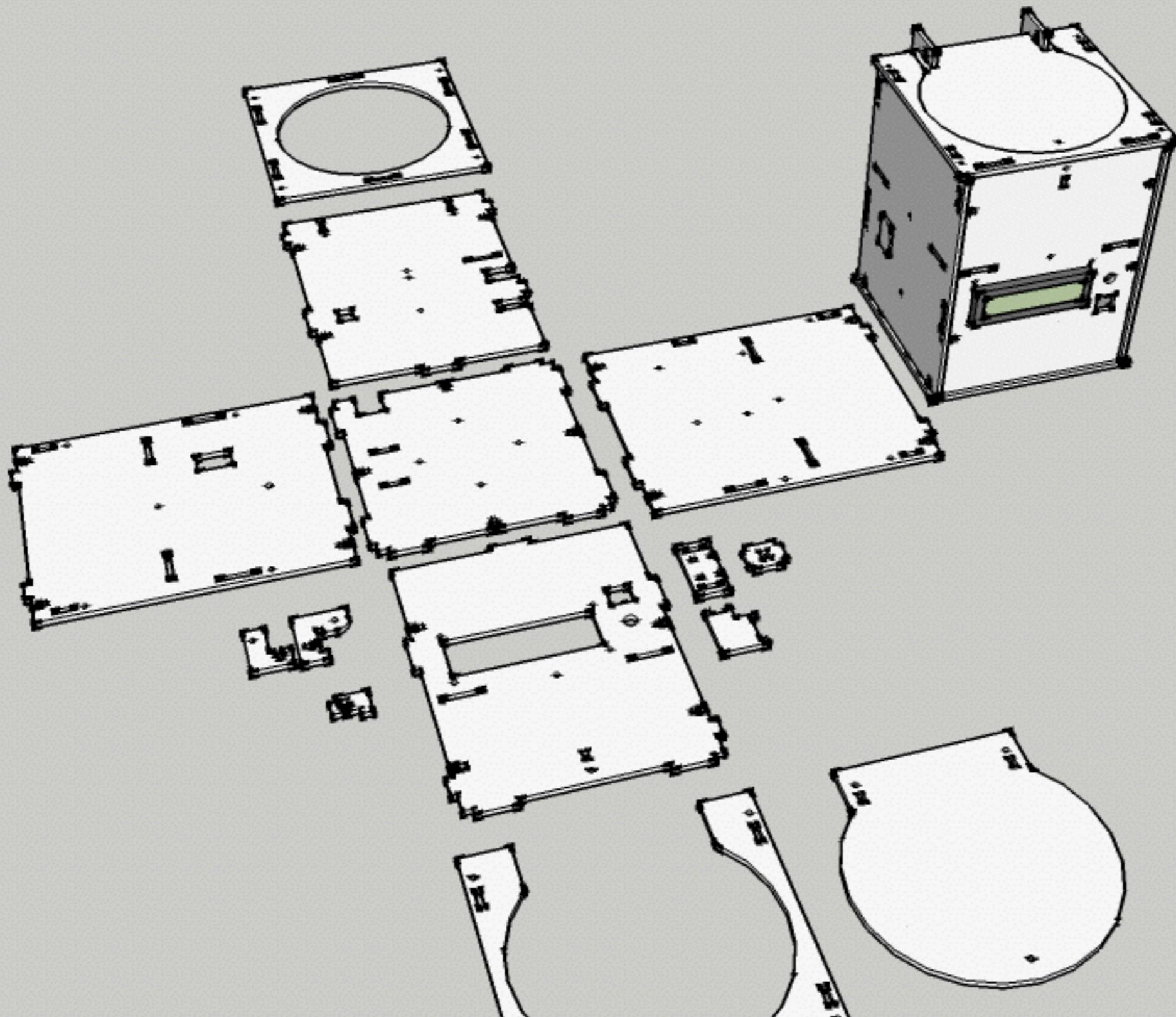


Notice

- NEVER test your centrifuge with a rotor attached

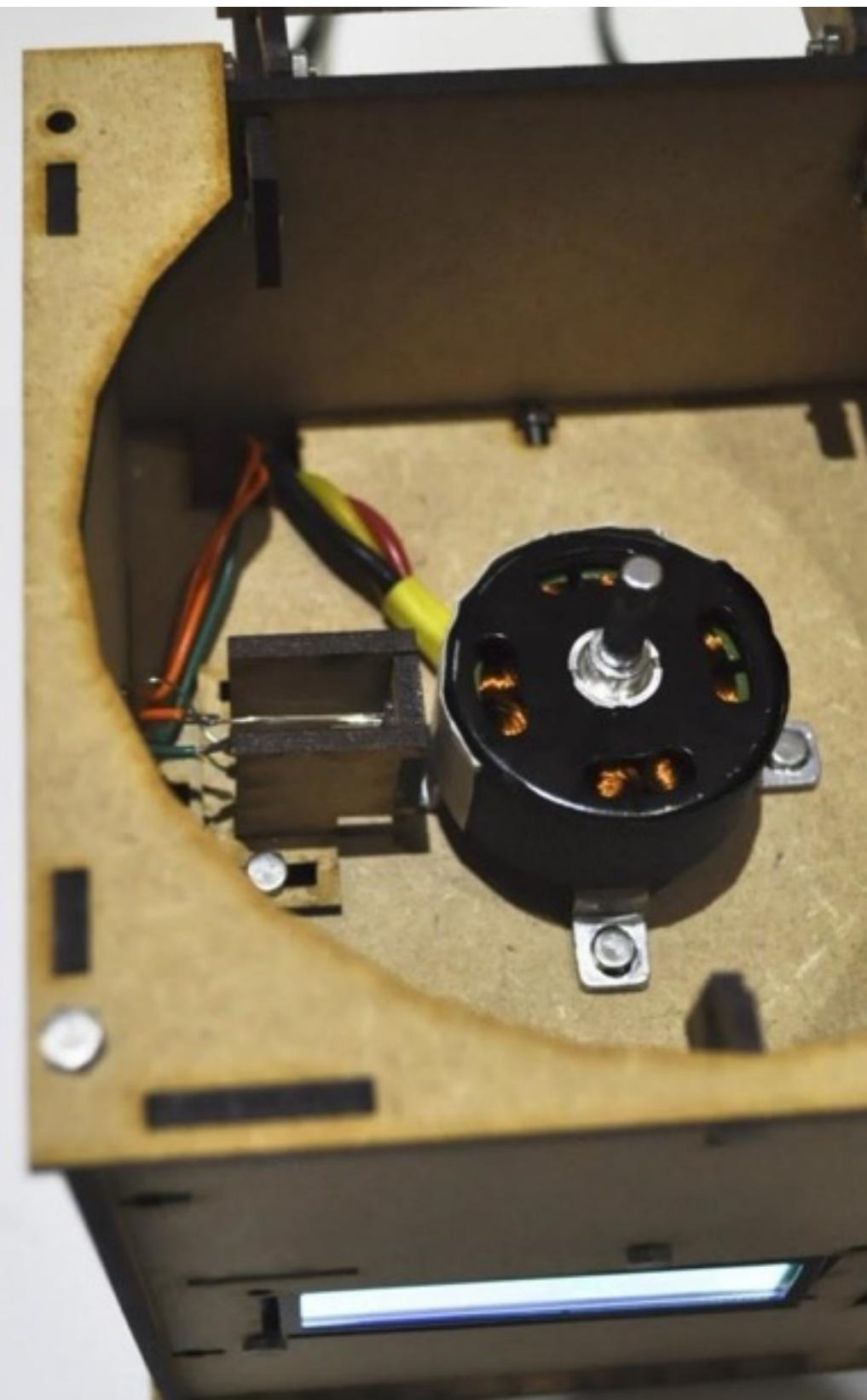
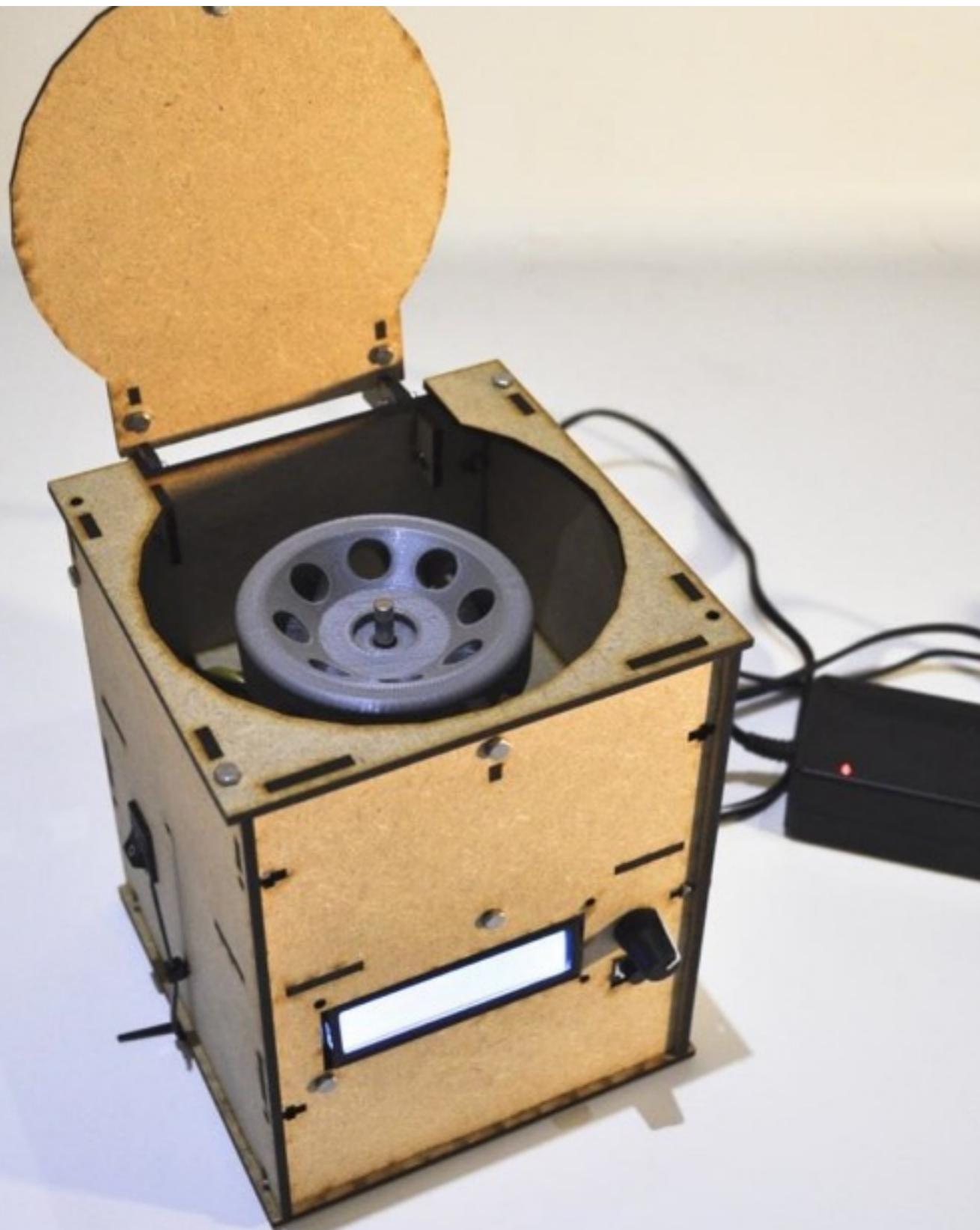


BioHack Academy design





Some pictures





Bill of Materials

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



Motor

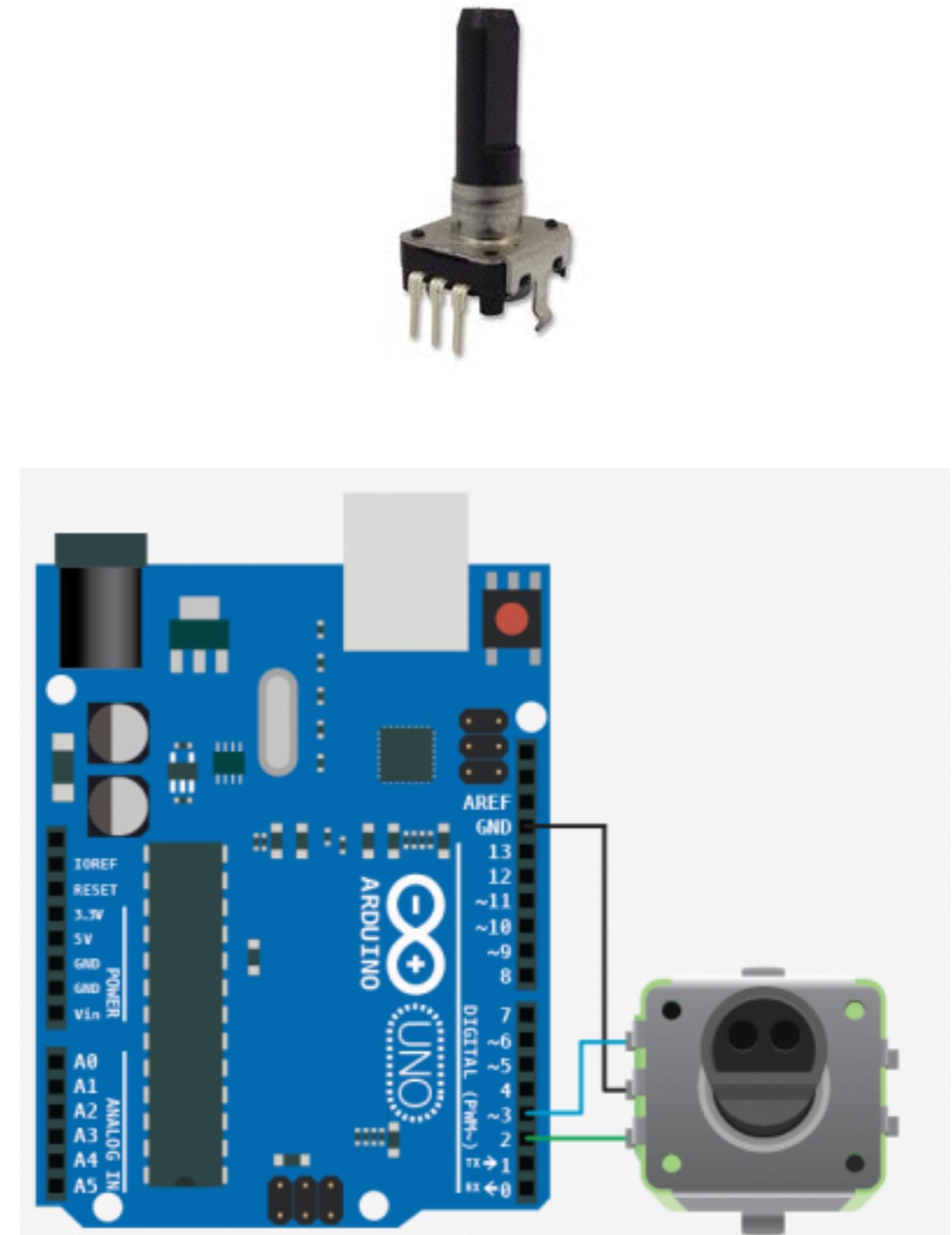
- Brushless
 - RPM / V = 810
 - 12V, so 9720 RPM
- ESC
 - power limit
 - voltage regulator





24 steps rotary encoder

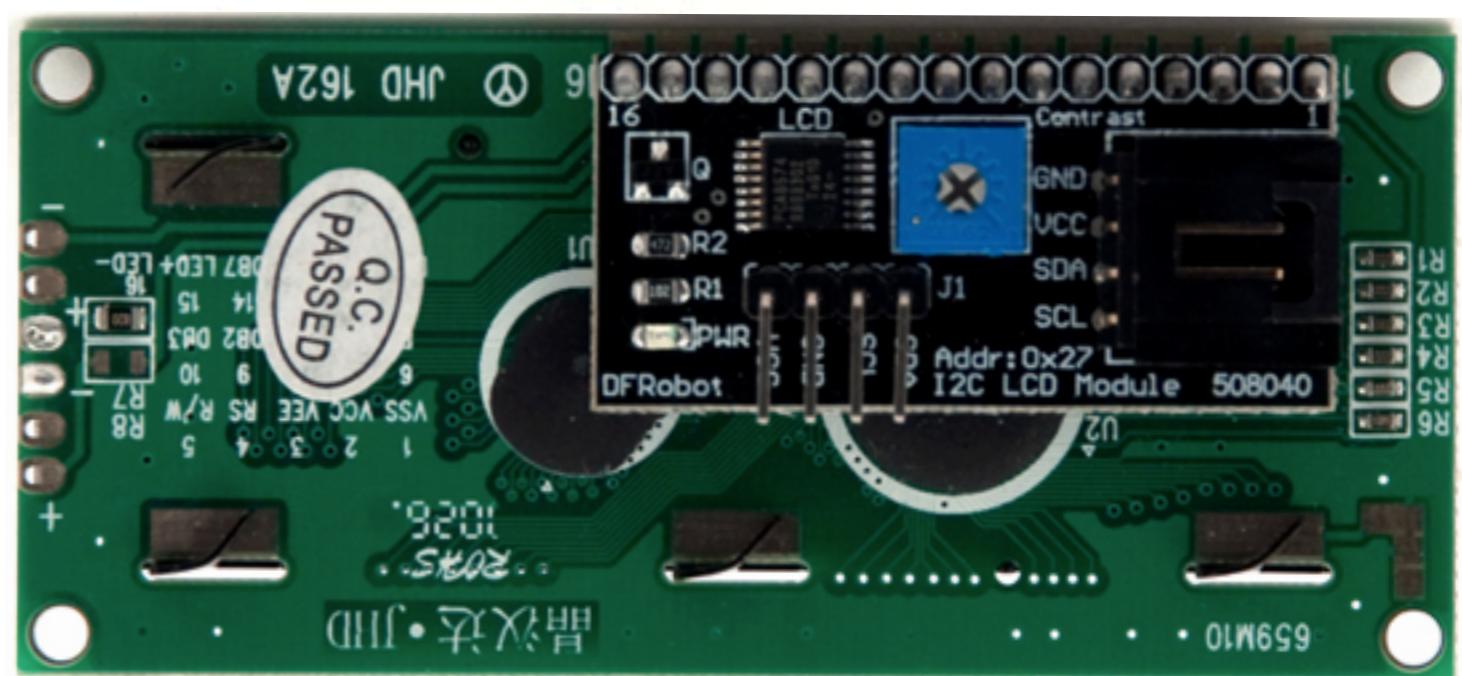
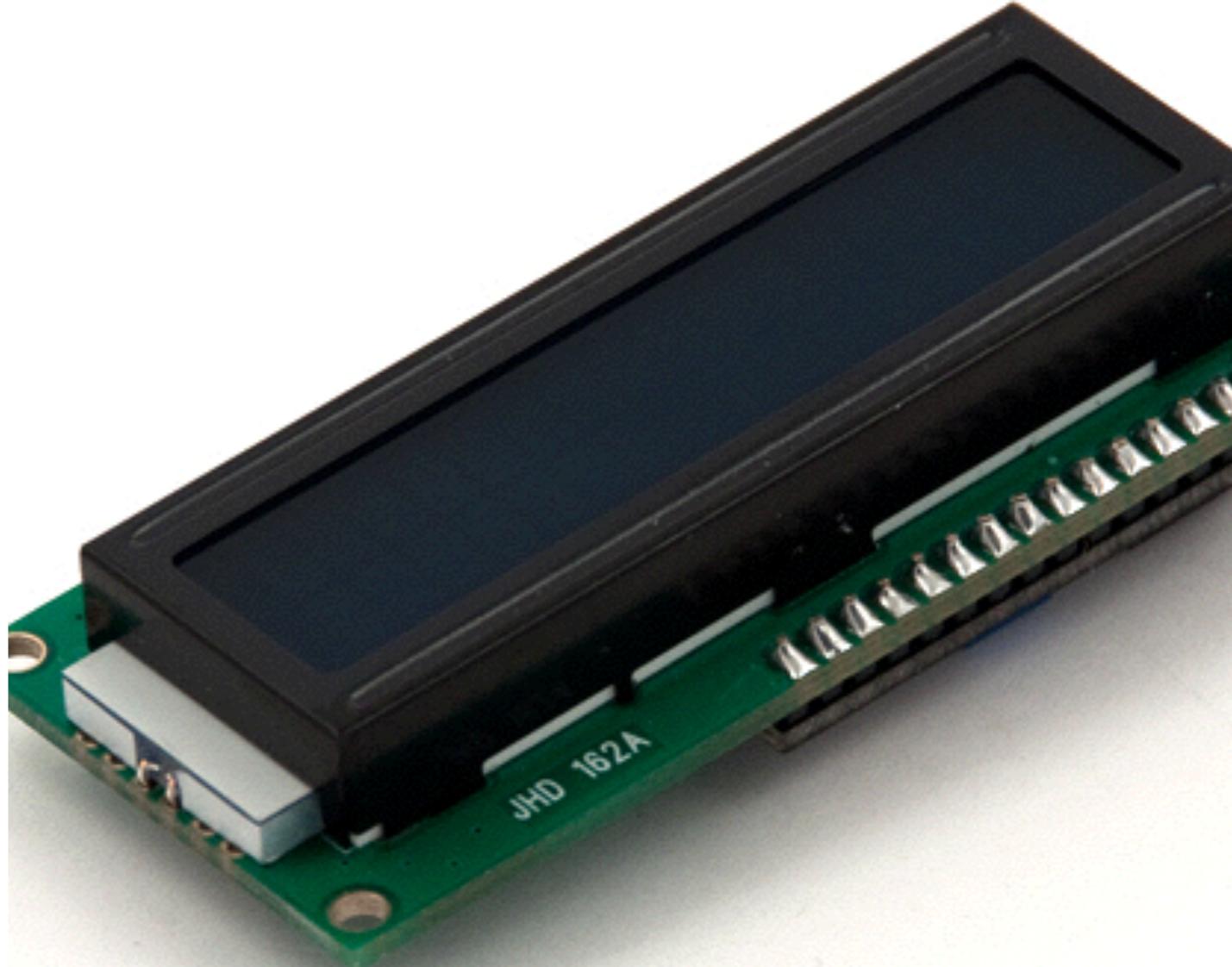
- Rotates infinitely
- 3 pins:
 - GND
 - State1
 - State2
- 2 bits:
 - 00
 - 01
 - 11
 - 10
- Interrupt pins
 - attachInterrupt()
- Demo code in Syllabus





I2C Display

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





Heavy weight

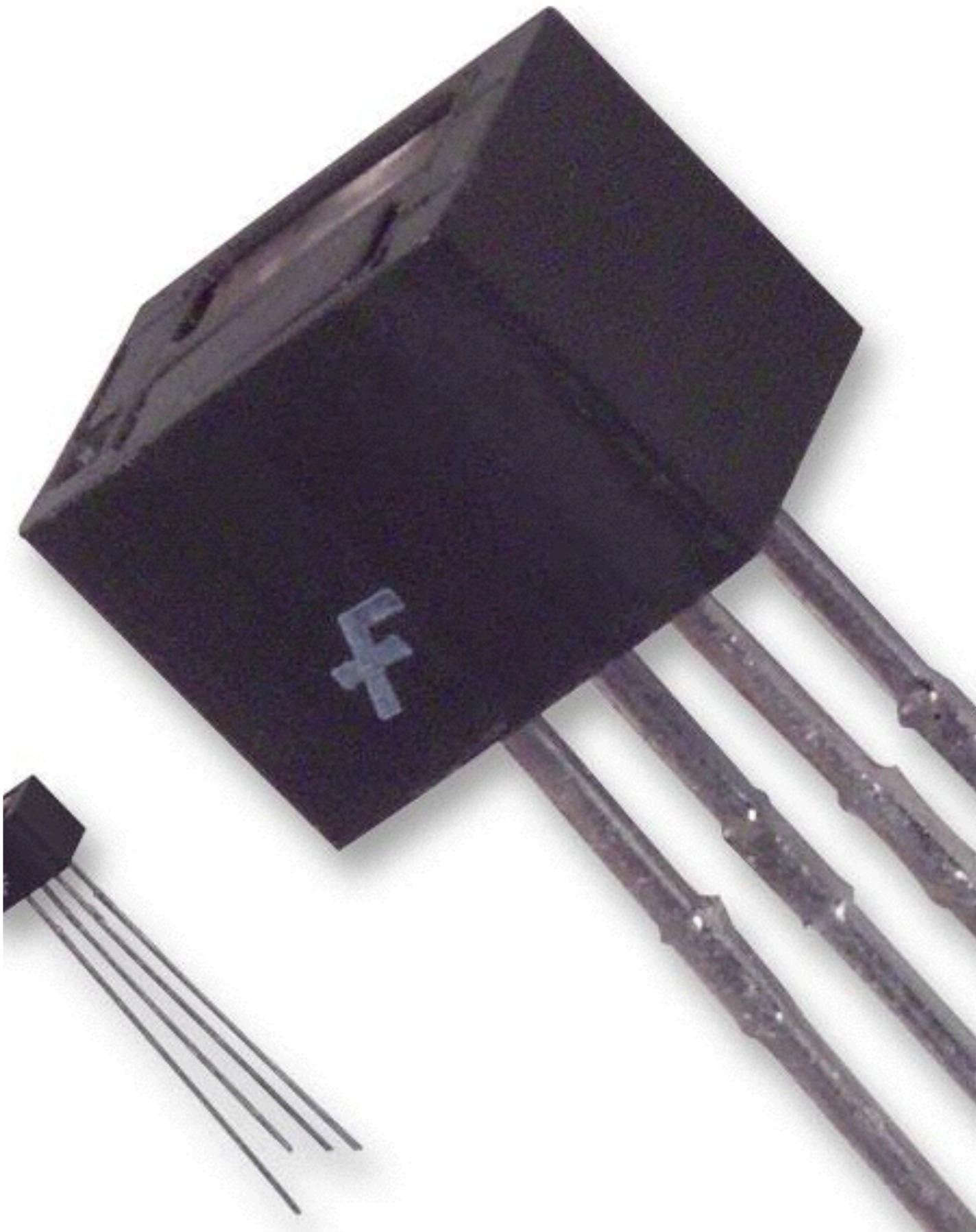
- Stabilizing the machine





Infrared sensor

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





Roller coaster

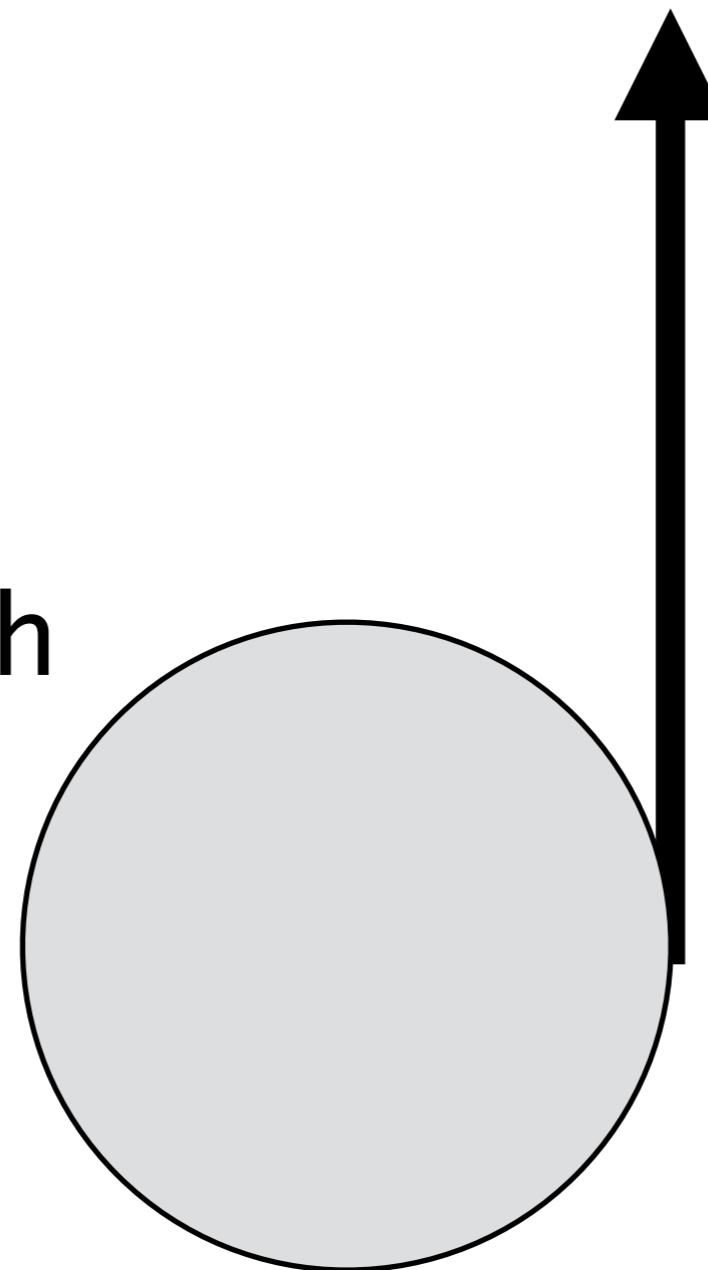




Centrifugal force

Circular path

Inertial path



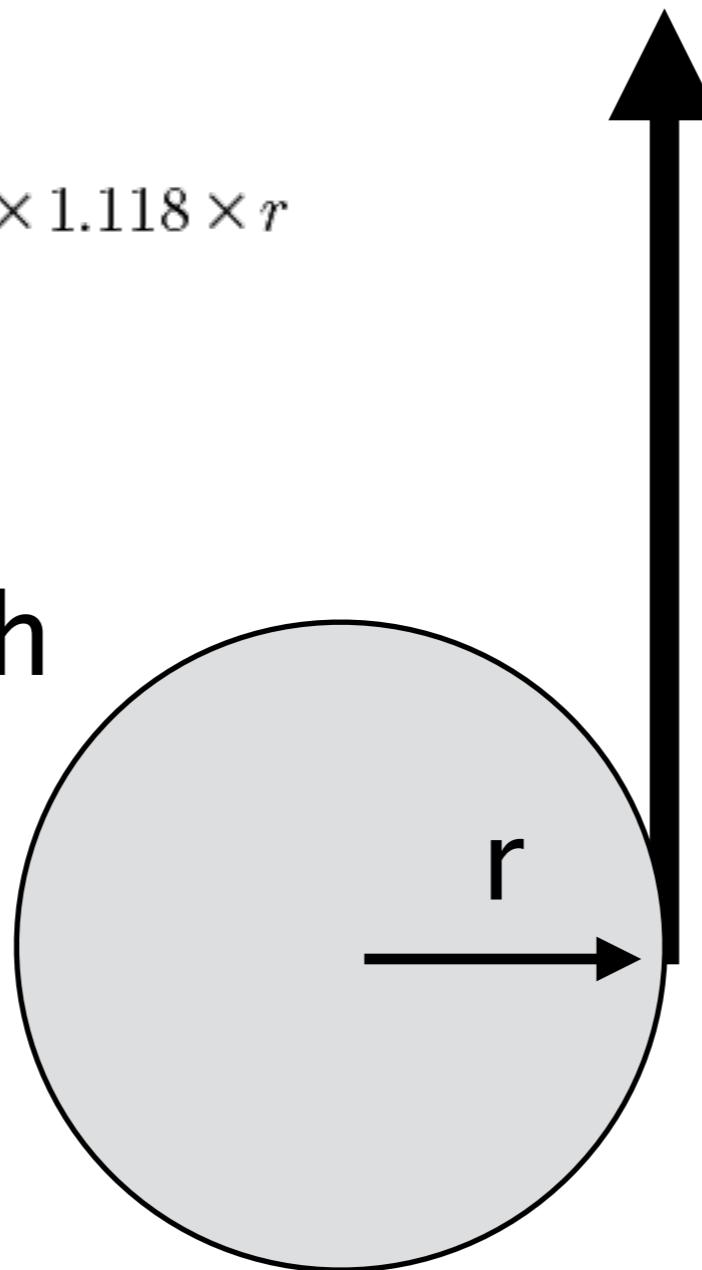


Centrifugal force

Inertial path

$$G \text{ force} = \left(\frac{RPM}{1,000} \right)^2 \times 1.118 \times r$$

Circular path





Kinetic Energy

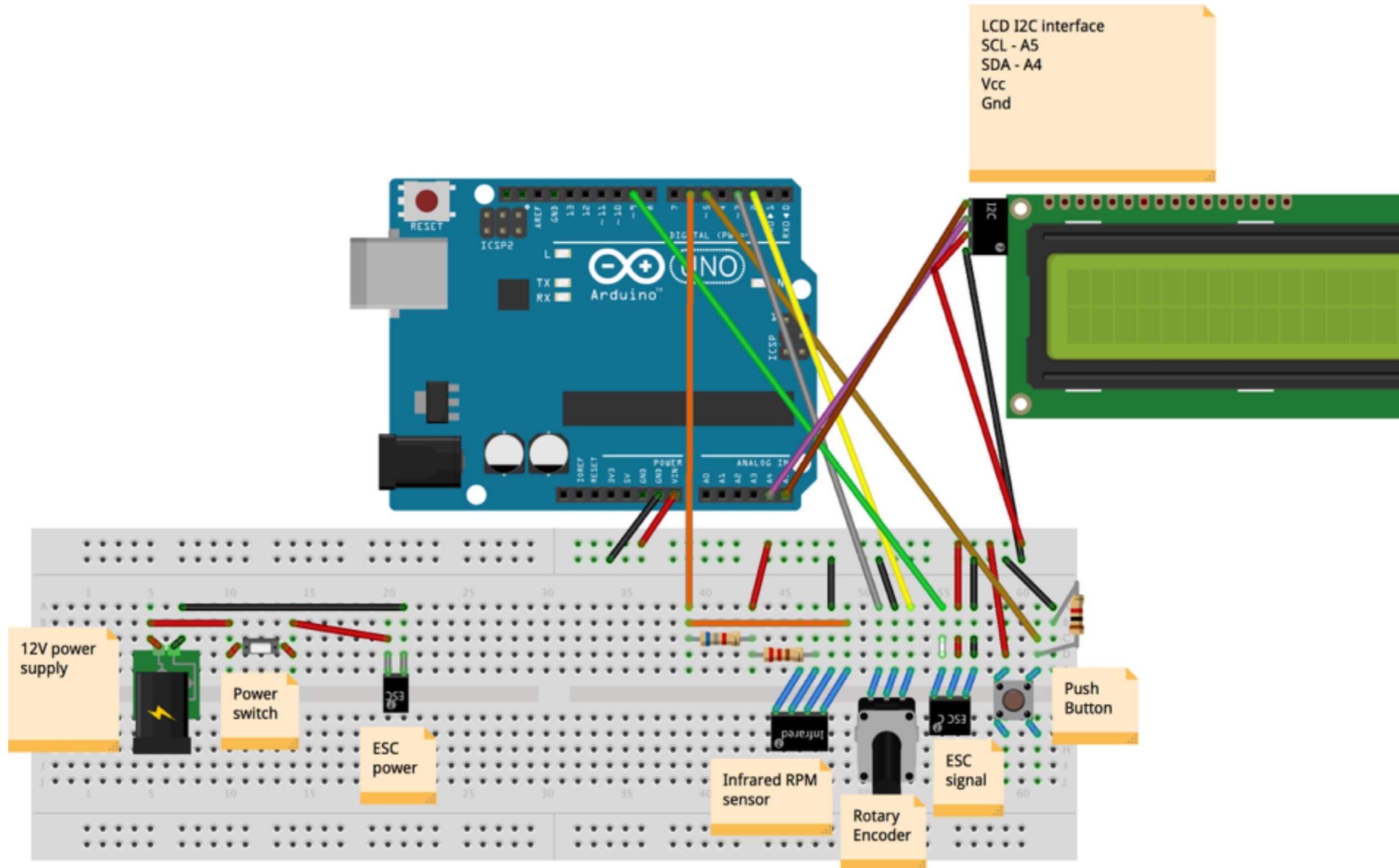
- 2 gram mass
- 7 cm diameter
- 10,000 RPM
- Surface speed: 3.6 m/s
- Energy: 0.0134 Joules



Niels Noordhoek – CC-BY-SA 3.0

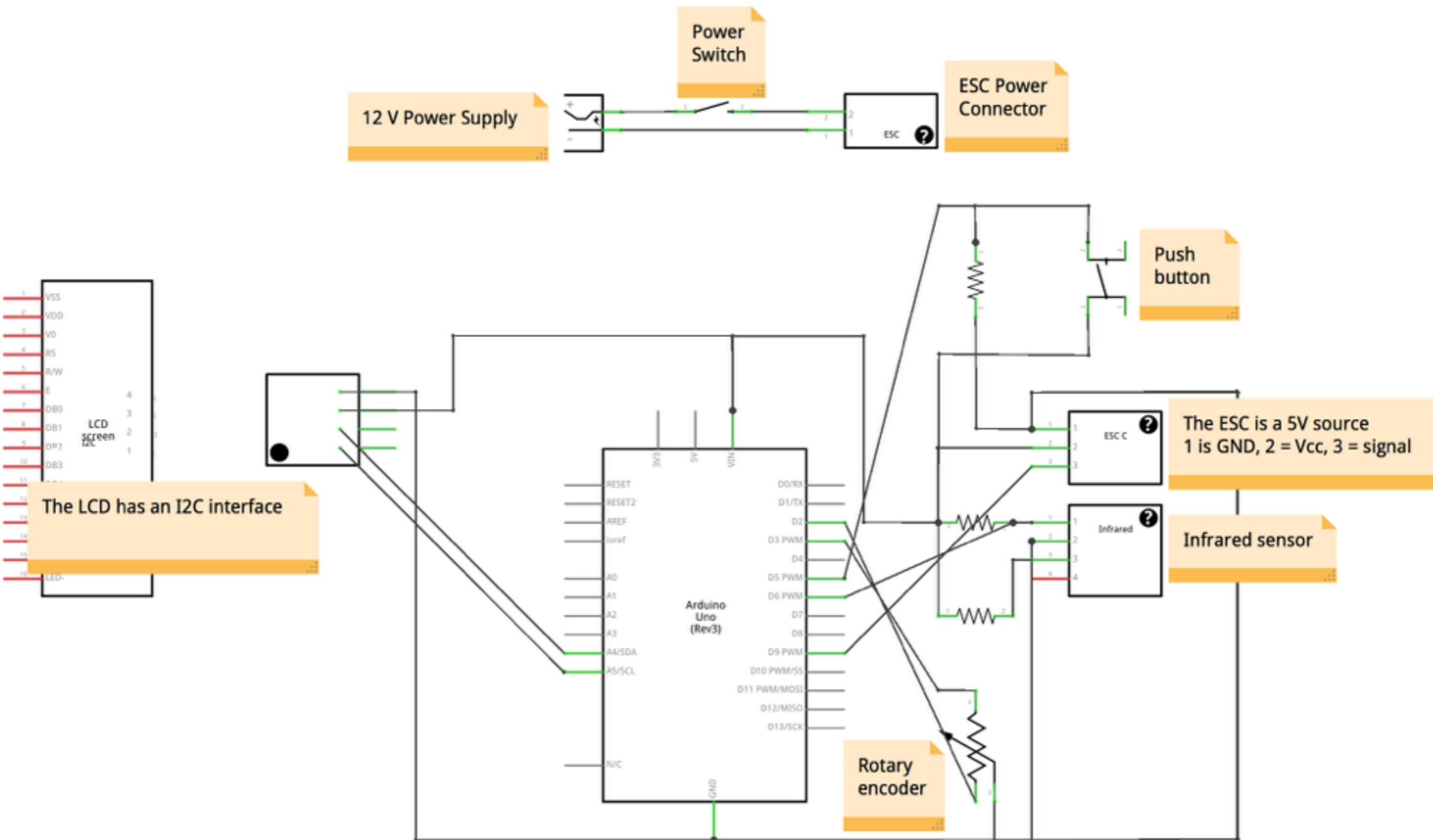


Wiring





Circuit scheme



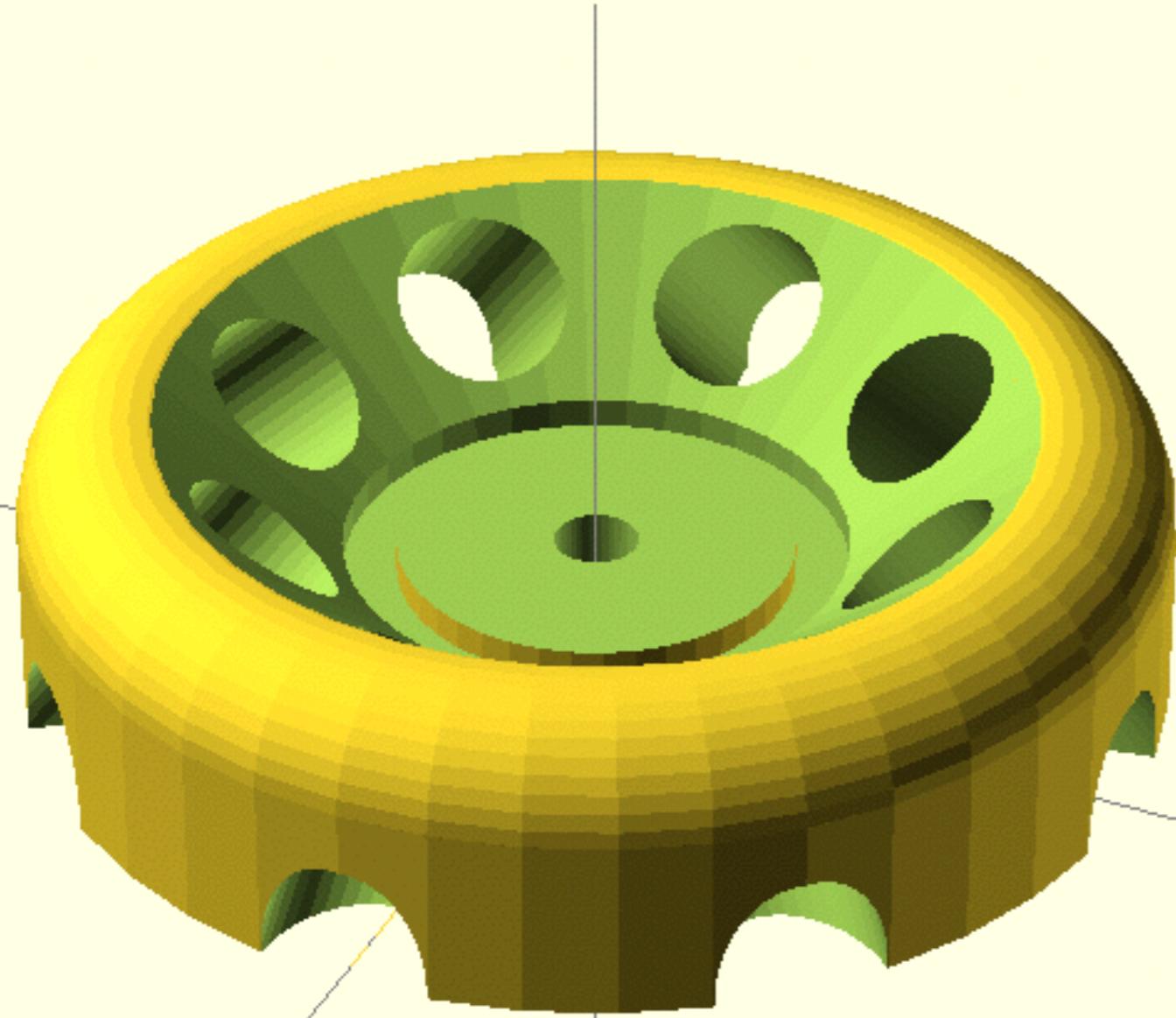


Code tutorials

- 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); // cone

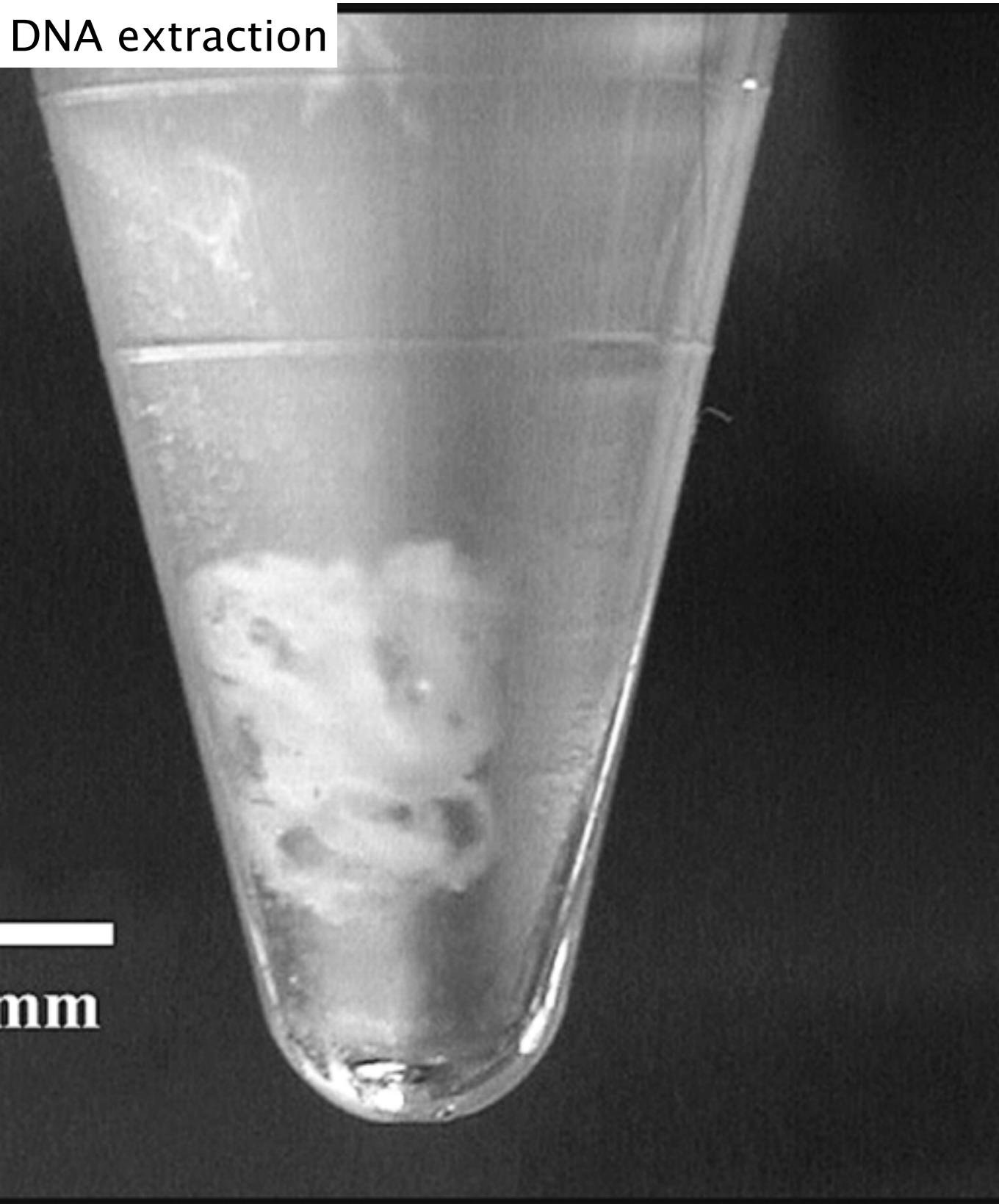
translate([0,0,-0.1])
cylinder (h = 1.2, r = axis_radius); // axis

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

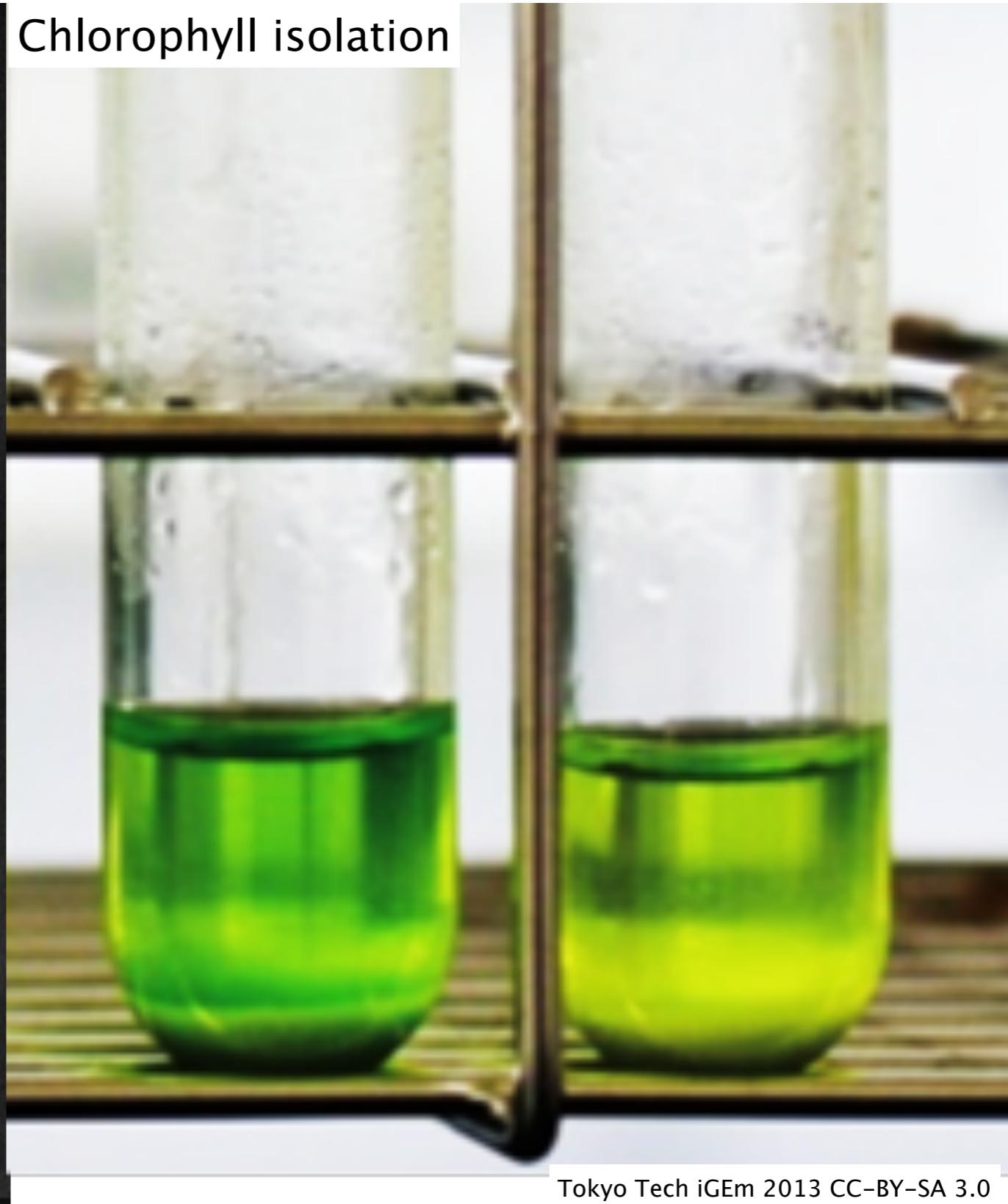


Practicals

DNA extraction



Chlorophyll isolation





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