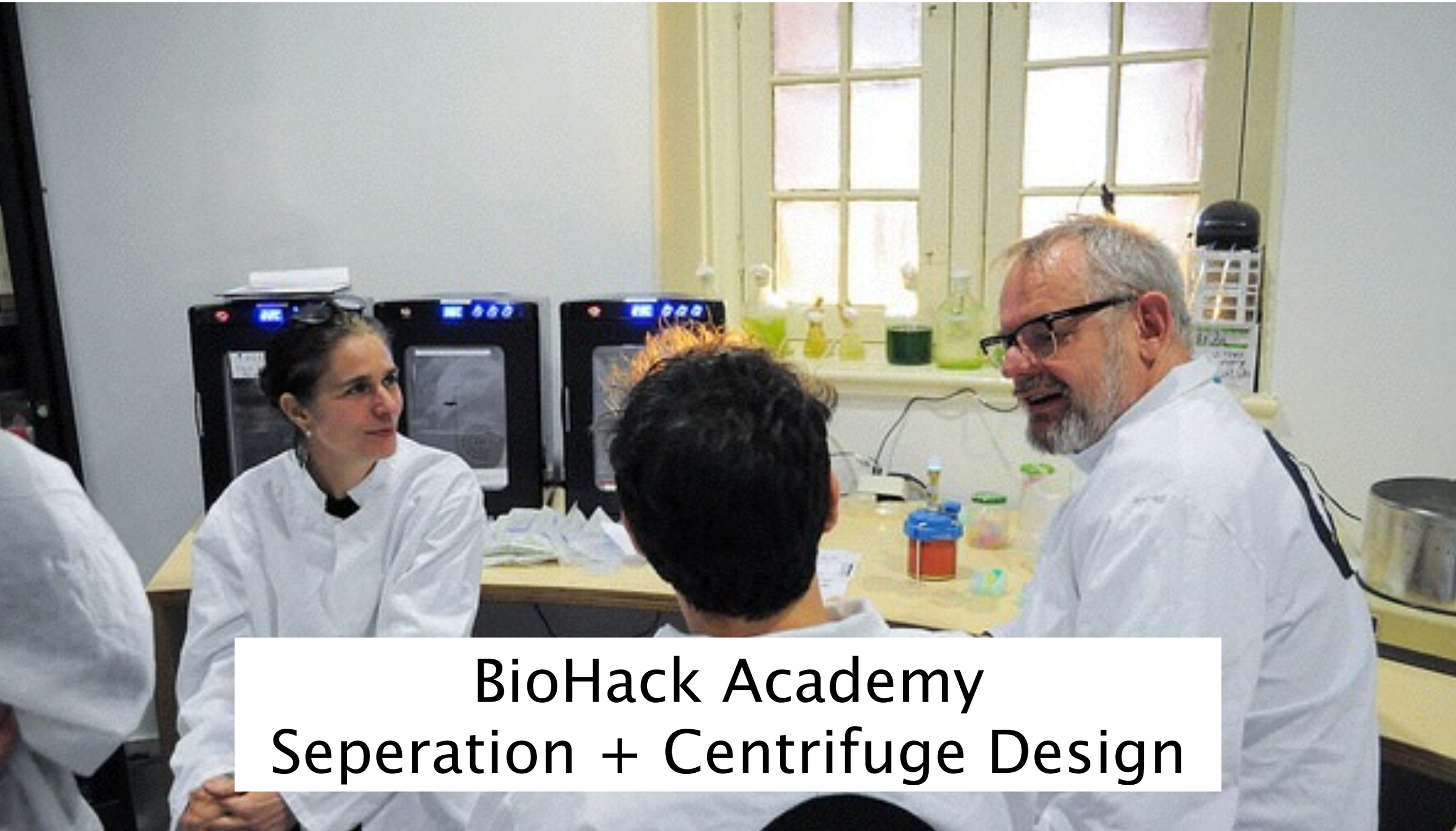
waag society

institute for art, science and technology



BioHack Academy
Seperation + Centrifuge Design

J. Lividum canvas

BioFactory canvas

open wetlab
waag society

Yes

oxigen
O_2

No light

temp.

15

volume

330 ml

absorbance

585

species

pH

?

time

48h

stirrer

No

mass

KG

1 mL?

input

C

N

P

O_2

S

Nutrient Broth
Glycerol
Tryptoph.

observations

day #	
day #	
day #	
day #	

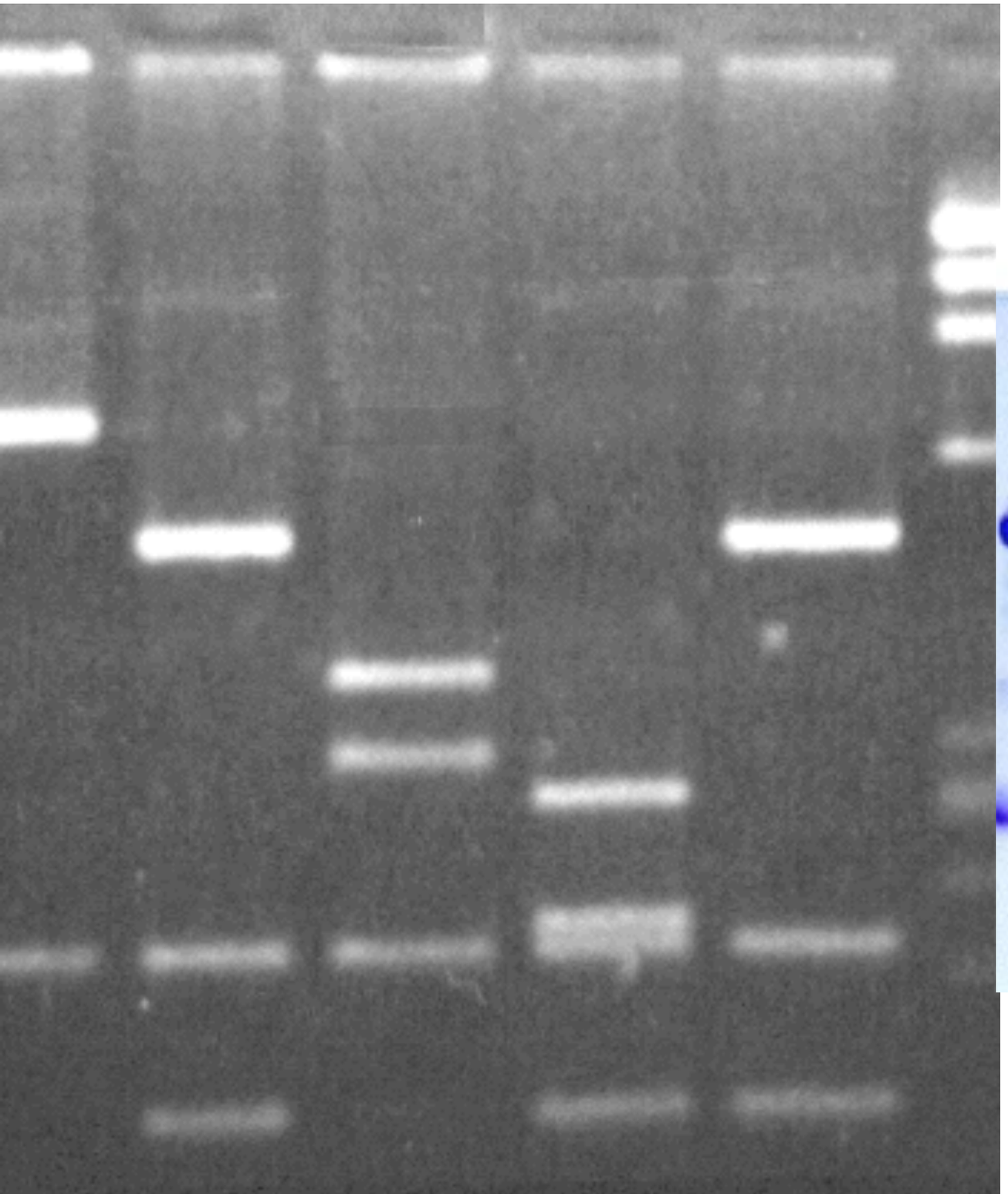
material

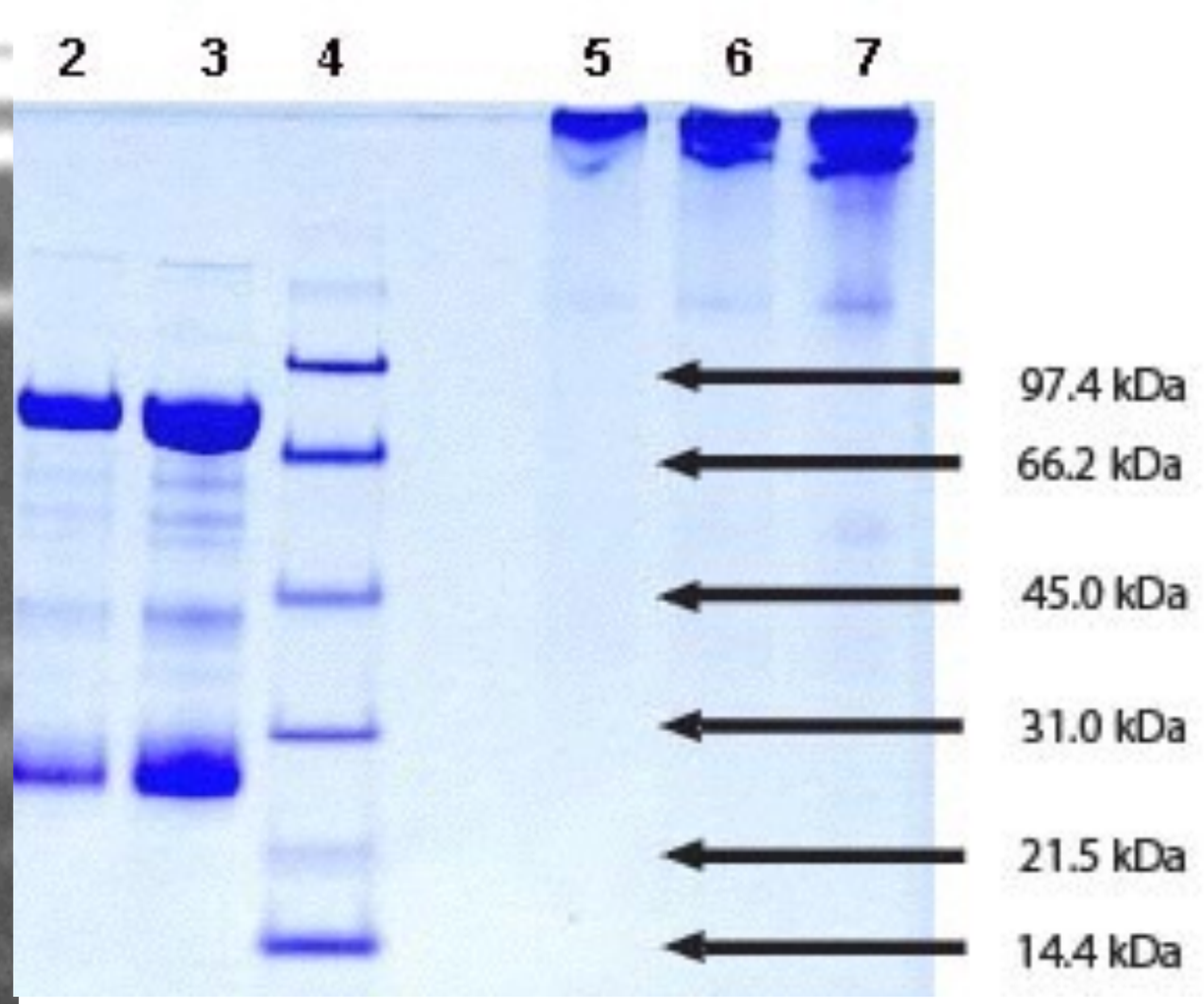
Production conditions

Growing the bacteria in culture took 5 days before the culture would turn purple due to *J. lividum* forming a biofilm in the media. Large culture growth by embedding sterile cotton mats in sterile 2L bottles with nutrient media with the added glycerol and L-tryptophan **(fig. 2)** that showed purple coloring after 48 hour incubation [9]. The mats were extracted after 5 days to harvest the violacein. Yield of violacein from after crude methanol extraction and low was about 10mg.

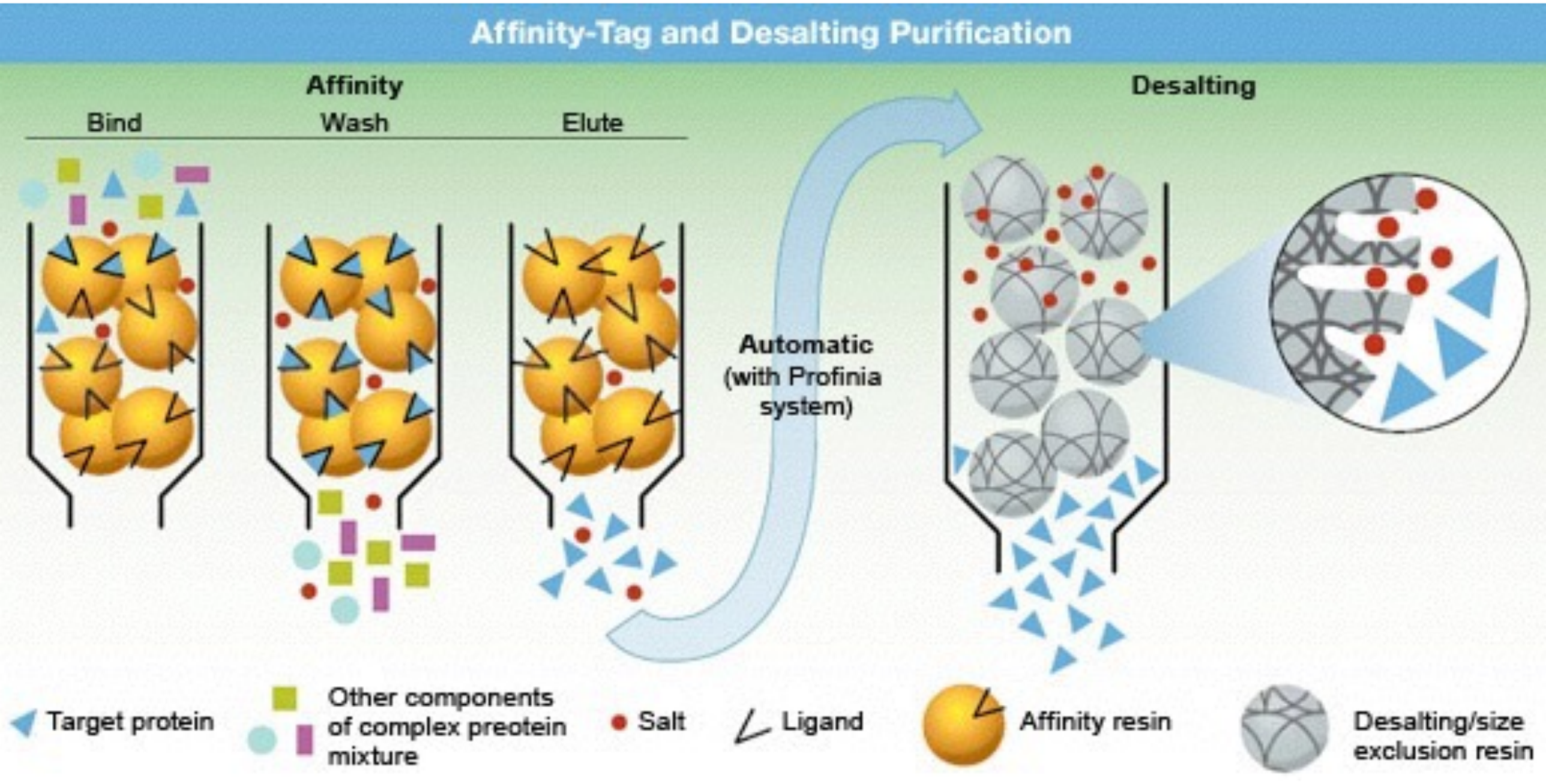
Figure 2: Violacein optimization. 1% Glycerol and 250μM L-tryptophan were added to the nutrient broth media to enhance pigment development. Cotton mats were used to allow bacteria to become sessile and produce violacein faster than with liquid cultures.

Gel electrophoresis (Agarose, SDS)

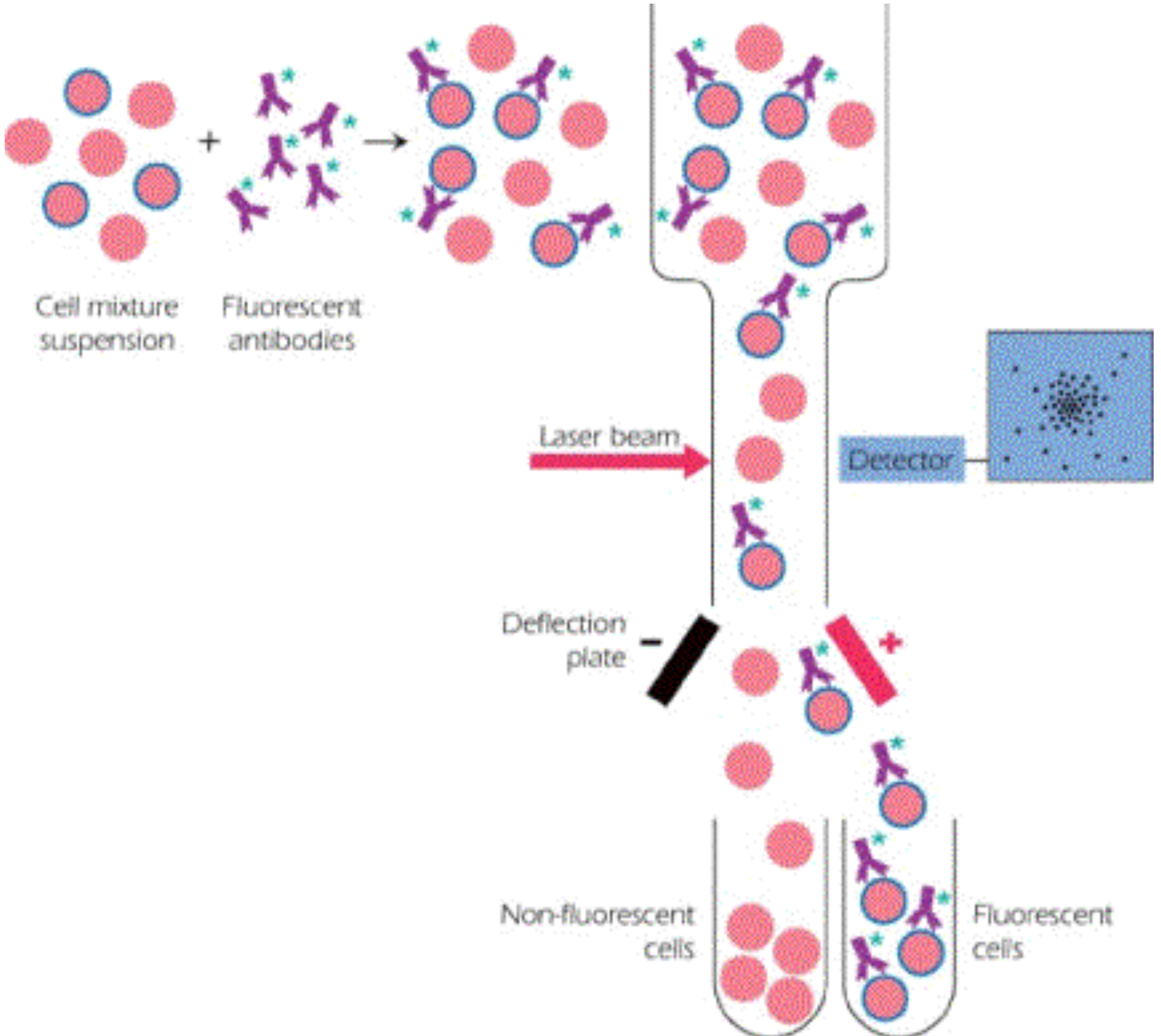




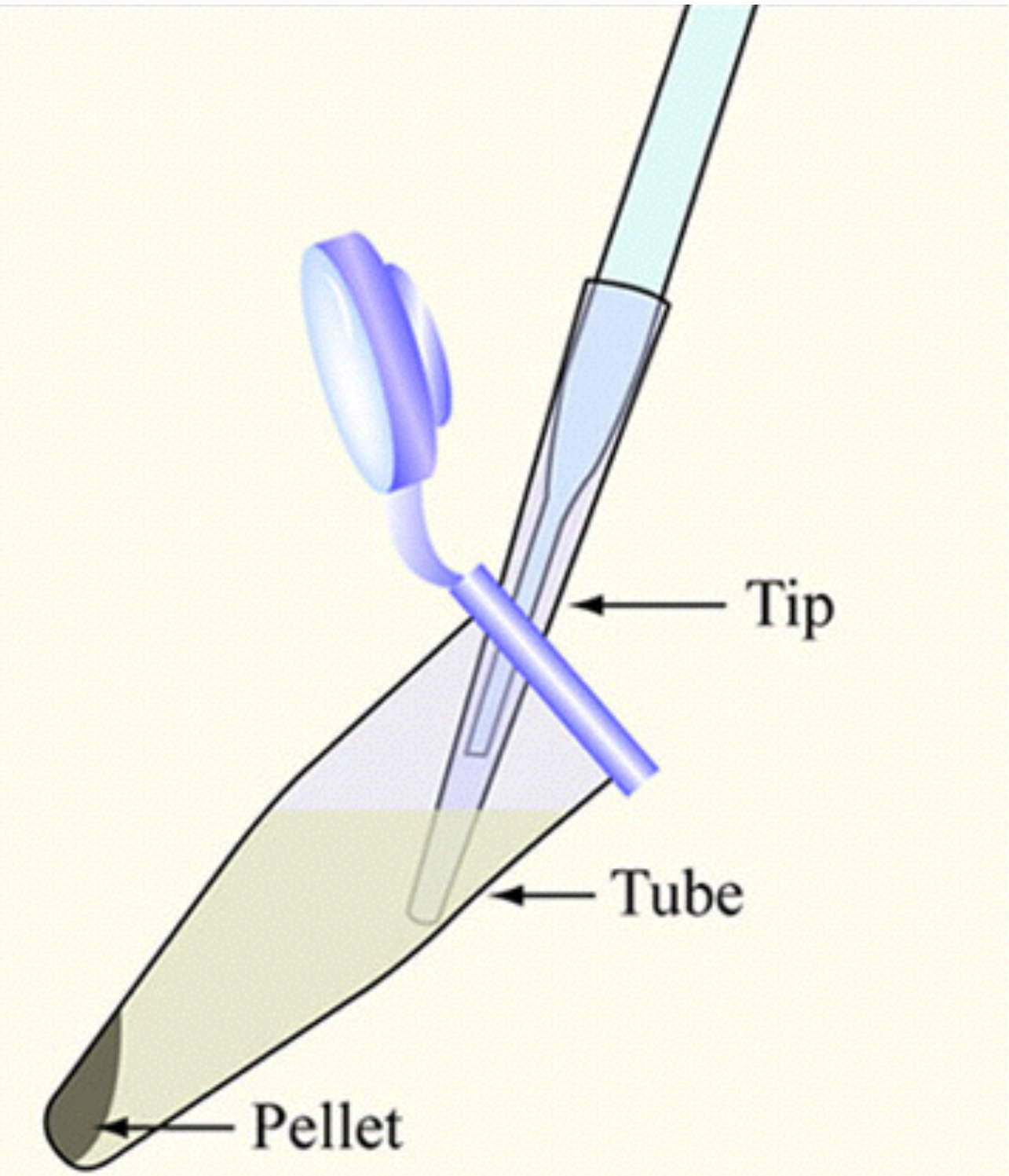
Affinity columns – HPLC

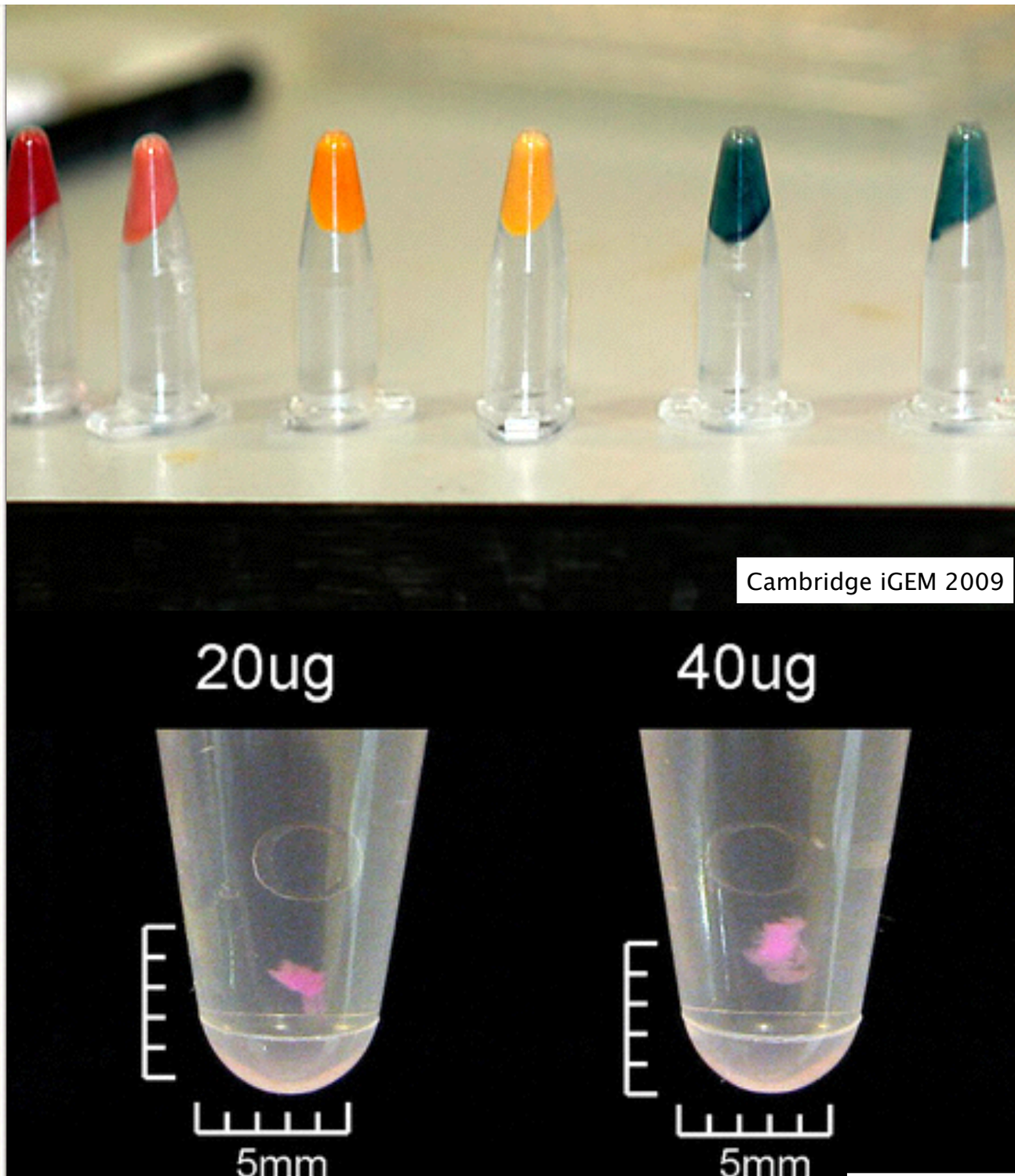


Antibody binding + FACS



Centrifugation

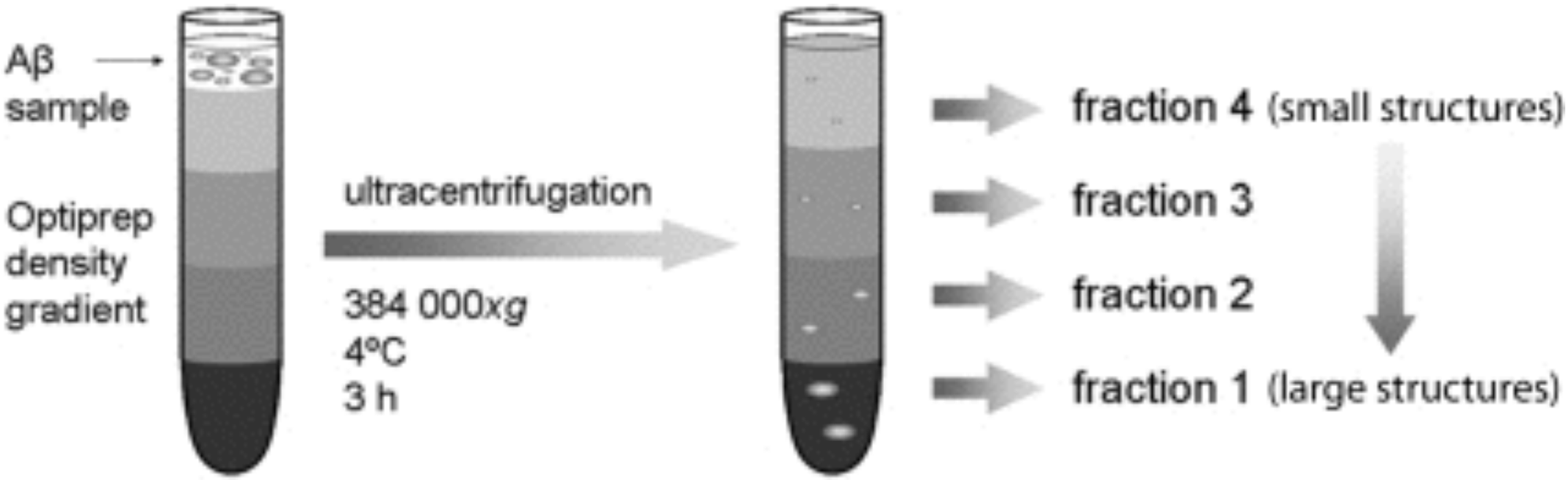




Cambridge iGEM 2009

Damon Tighe

Density gradient

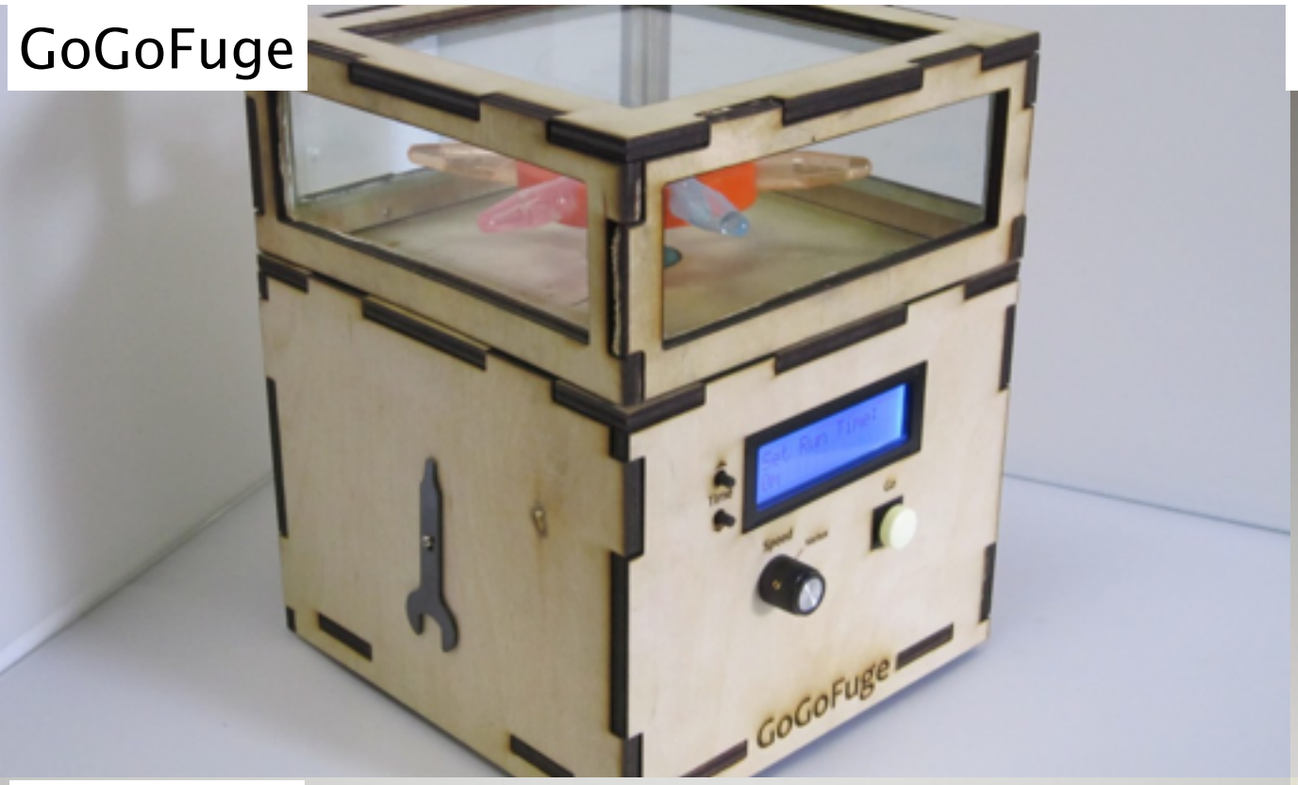


Industry standards

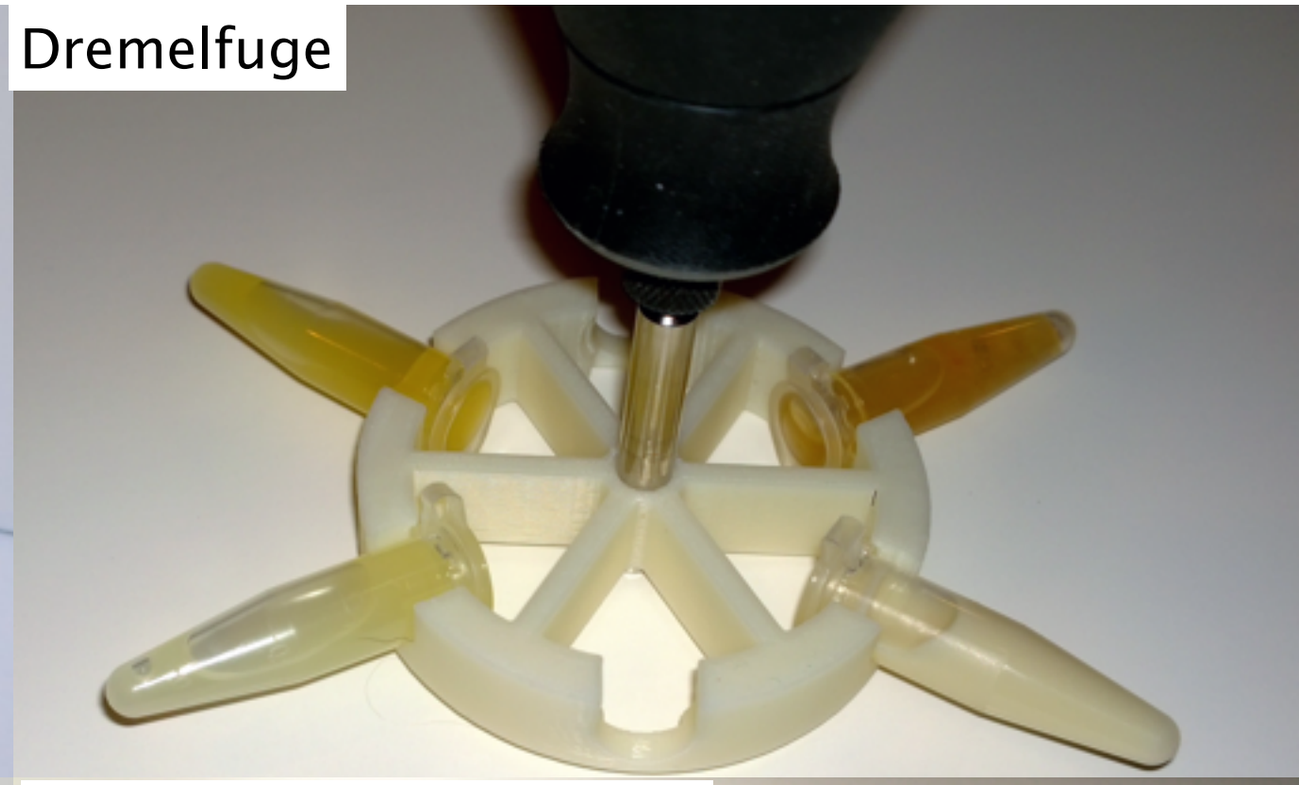
Magnus Manske - CC-BY 1.0

Centrifuge hacks

GoGoFuge



Dremelfuge



OpenFuge

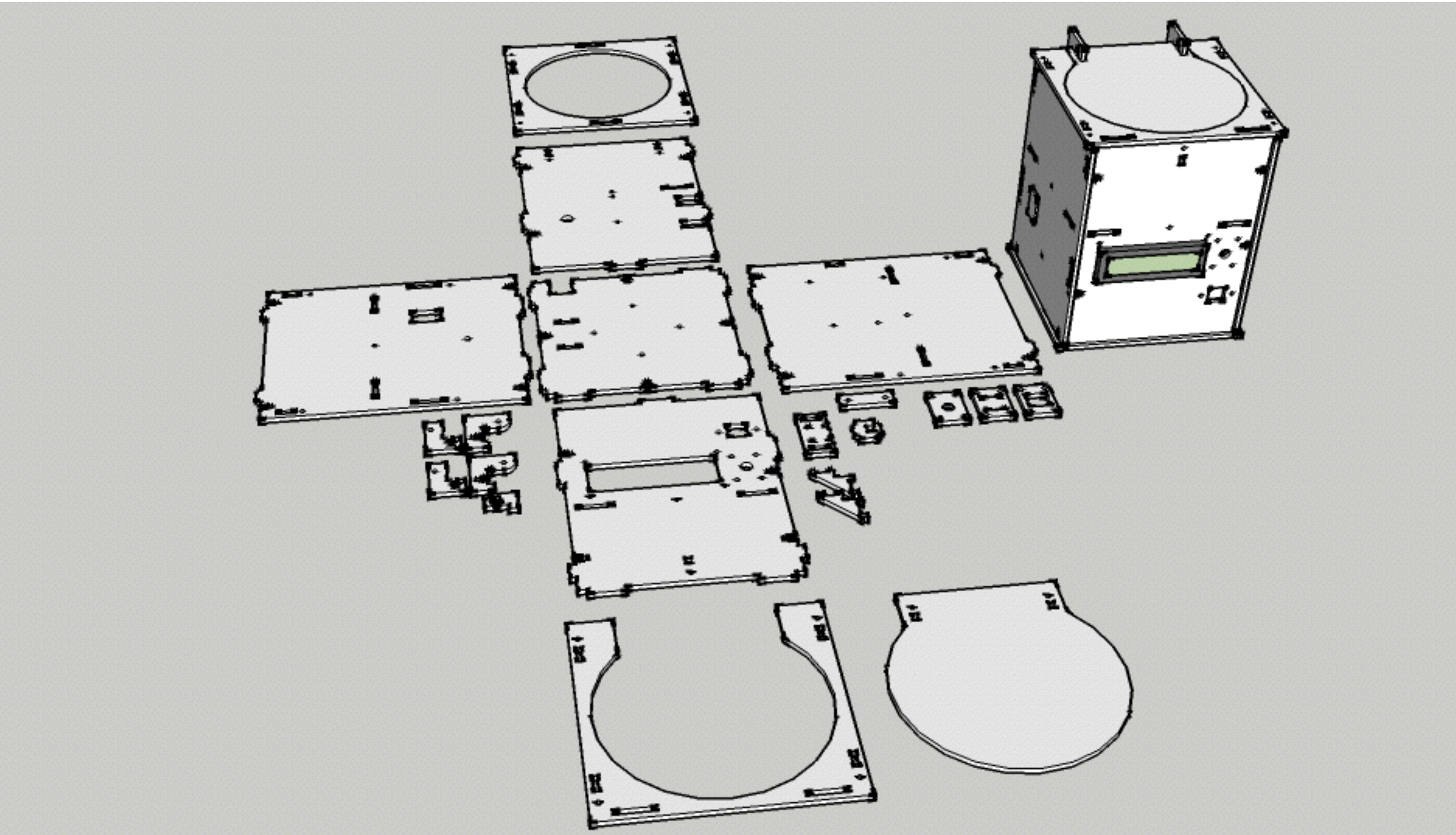
Hackteria harddrive hack

Design constrains

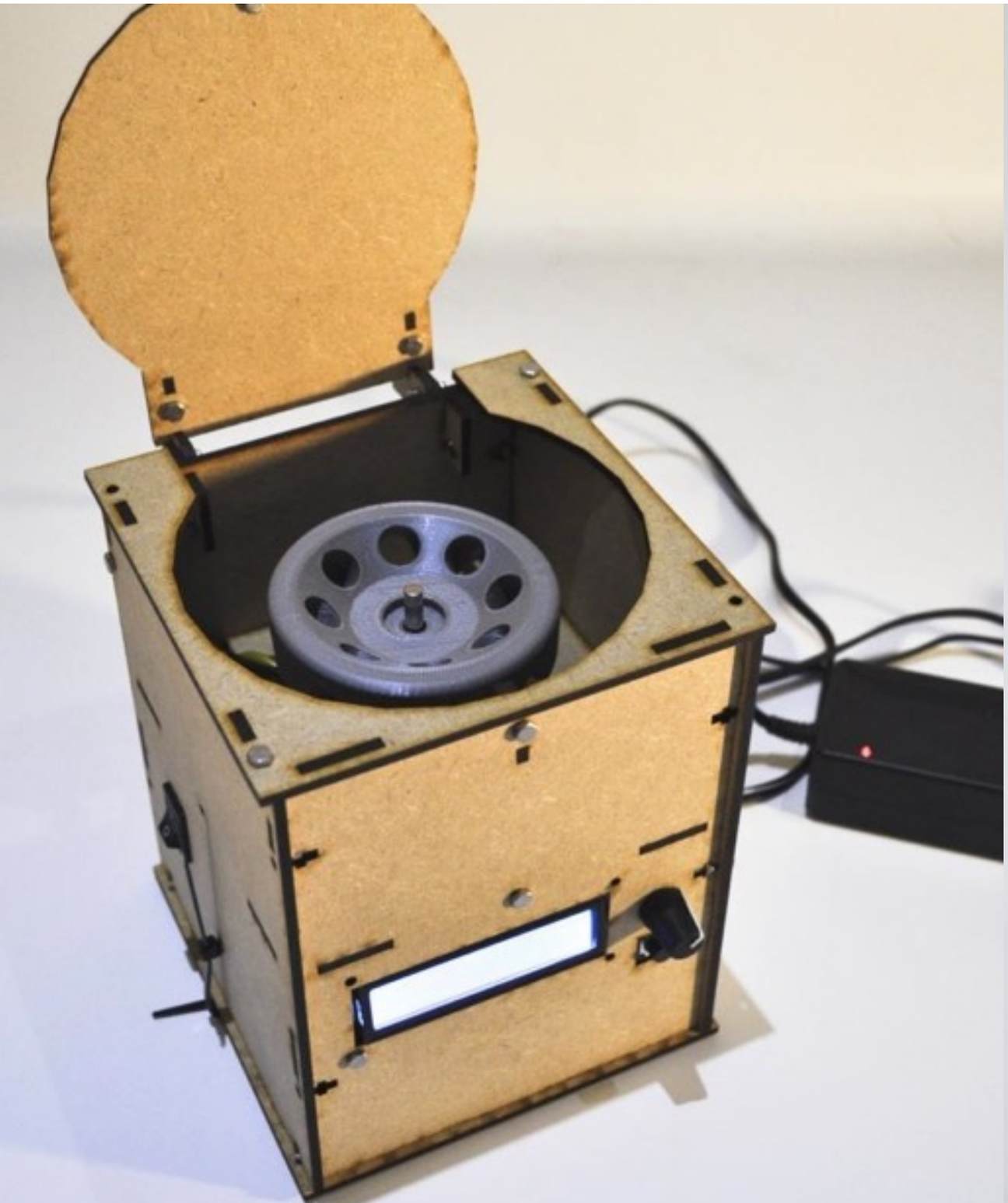
Notice

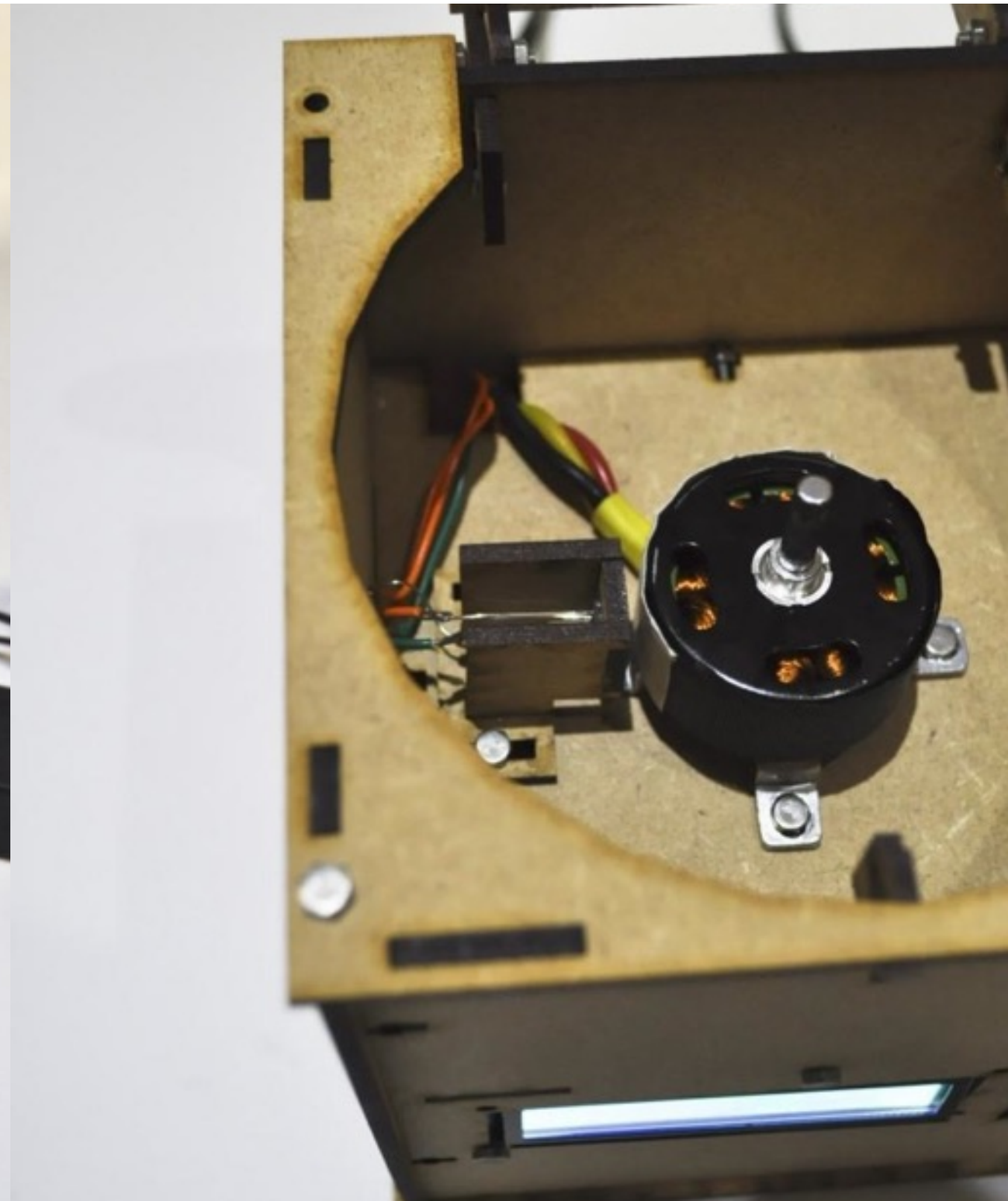
- NEVER test your centrifuge with a rotor attached

BioHack Academy design



Some pictures





Bill of Materials

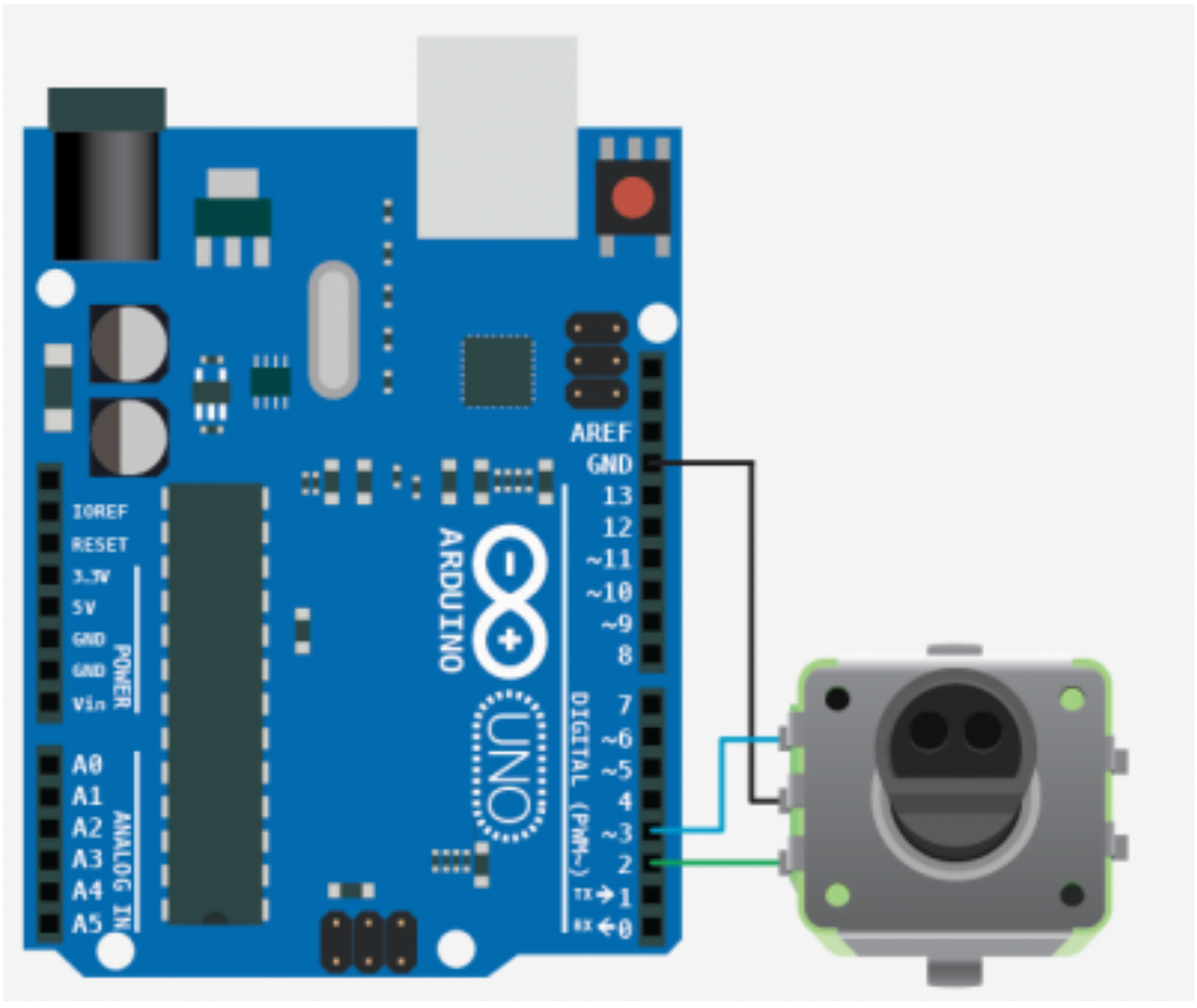
#	Amount	Description
1	1	DC Brushless motor 800 RPM/V & Electronic Speed Controller
2	1	3.5mm connector
3	1	Rotary encoder
4	1	Knob
5	1	Power switch
6	1	DC power jack
7	1	12V 5A Power supply
8	1	Push button
9	4	Rubber feet
10	1	Sheet of 45cm x 95cm 3mm MDF
11	1	Heavy weight max 12cm diameter
12	1	Infrared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

Motor

- Brushless
  - 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

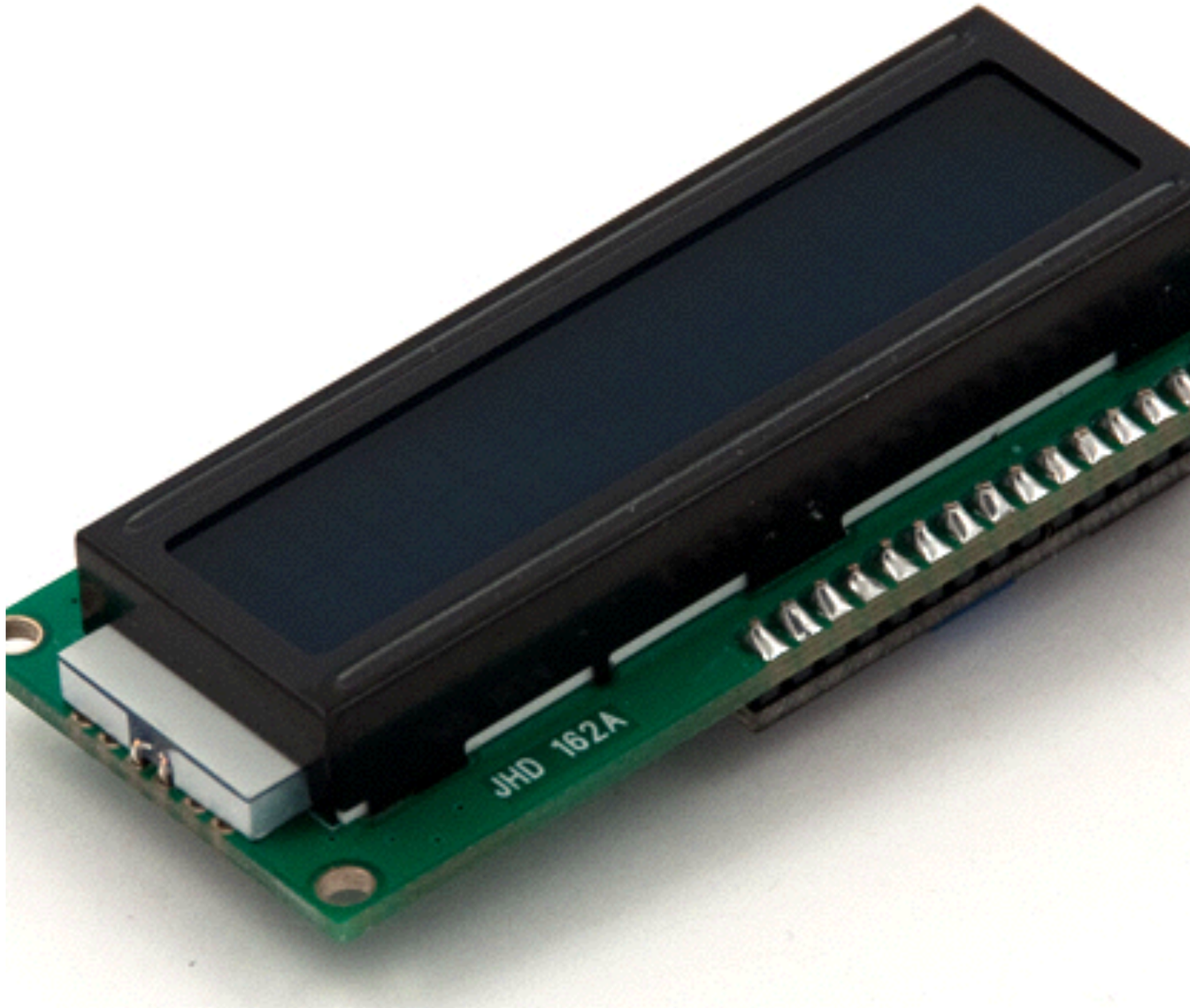


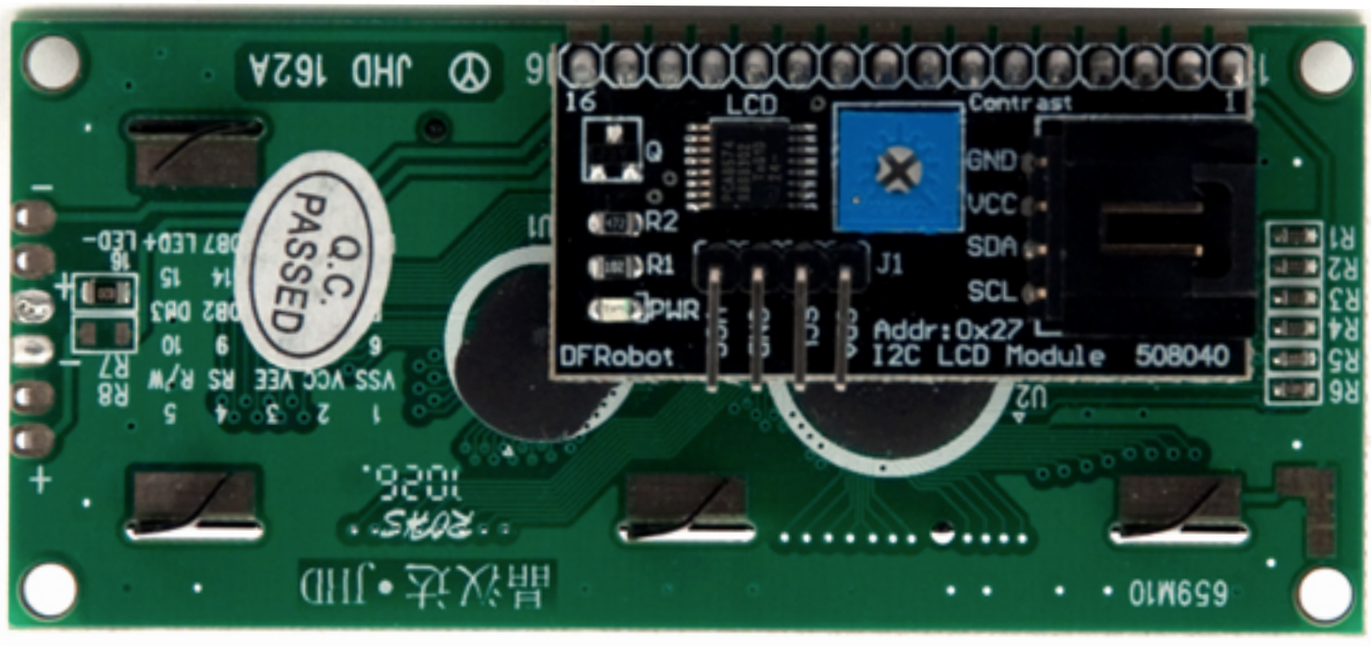
I2C Display

- Arduino I2C ports
  - SLC -> A5
  - SDA -> A4

- Libraries
  - Wire
  - LiquidCrystal_I2C

- Demo code in Syllabus





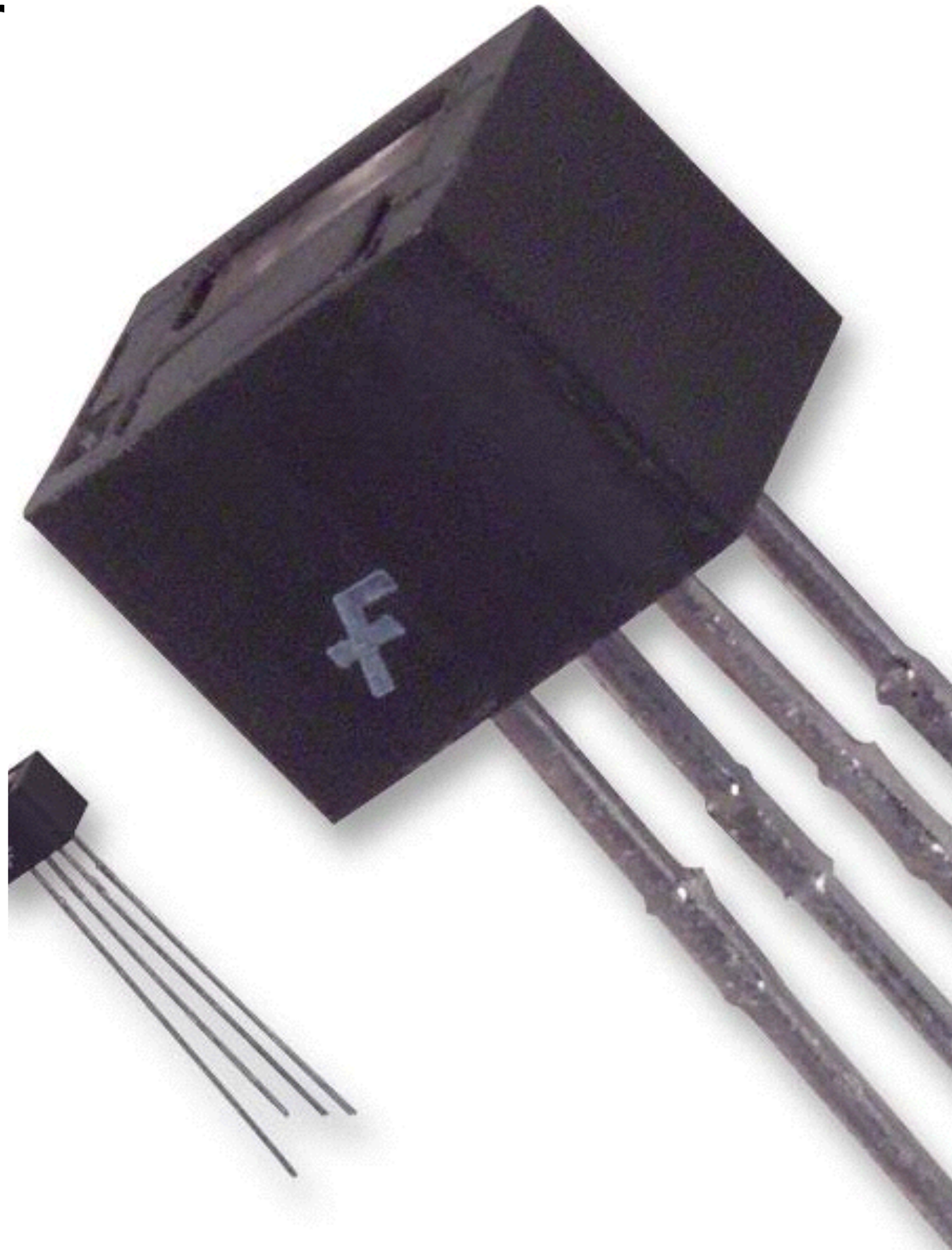
Heavy weight

- Stabilising the machine

Infrared sensor

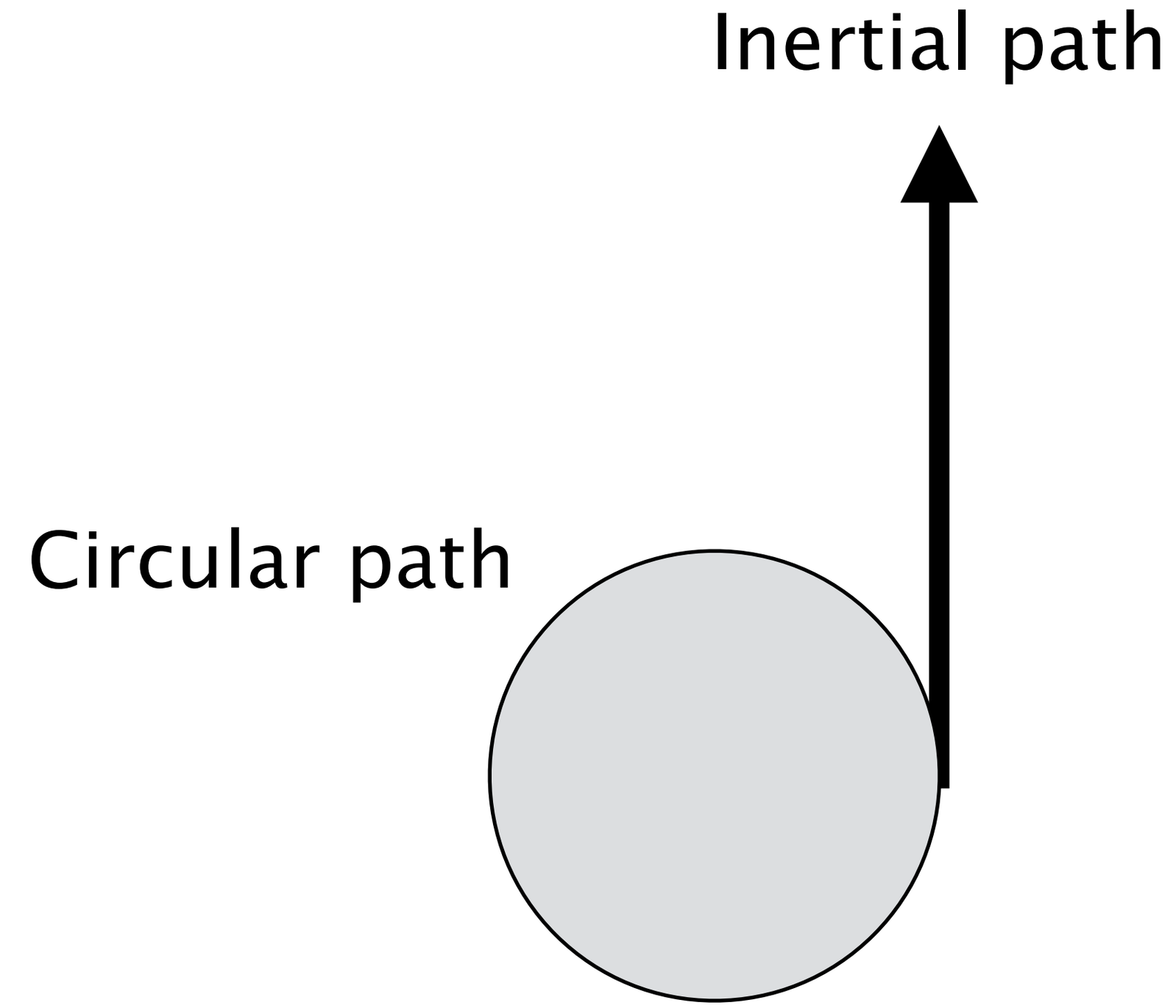
- Emitter
- Detector

- pulseIn() function
  - http://arduino.cc/en/Reference/pulseIn



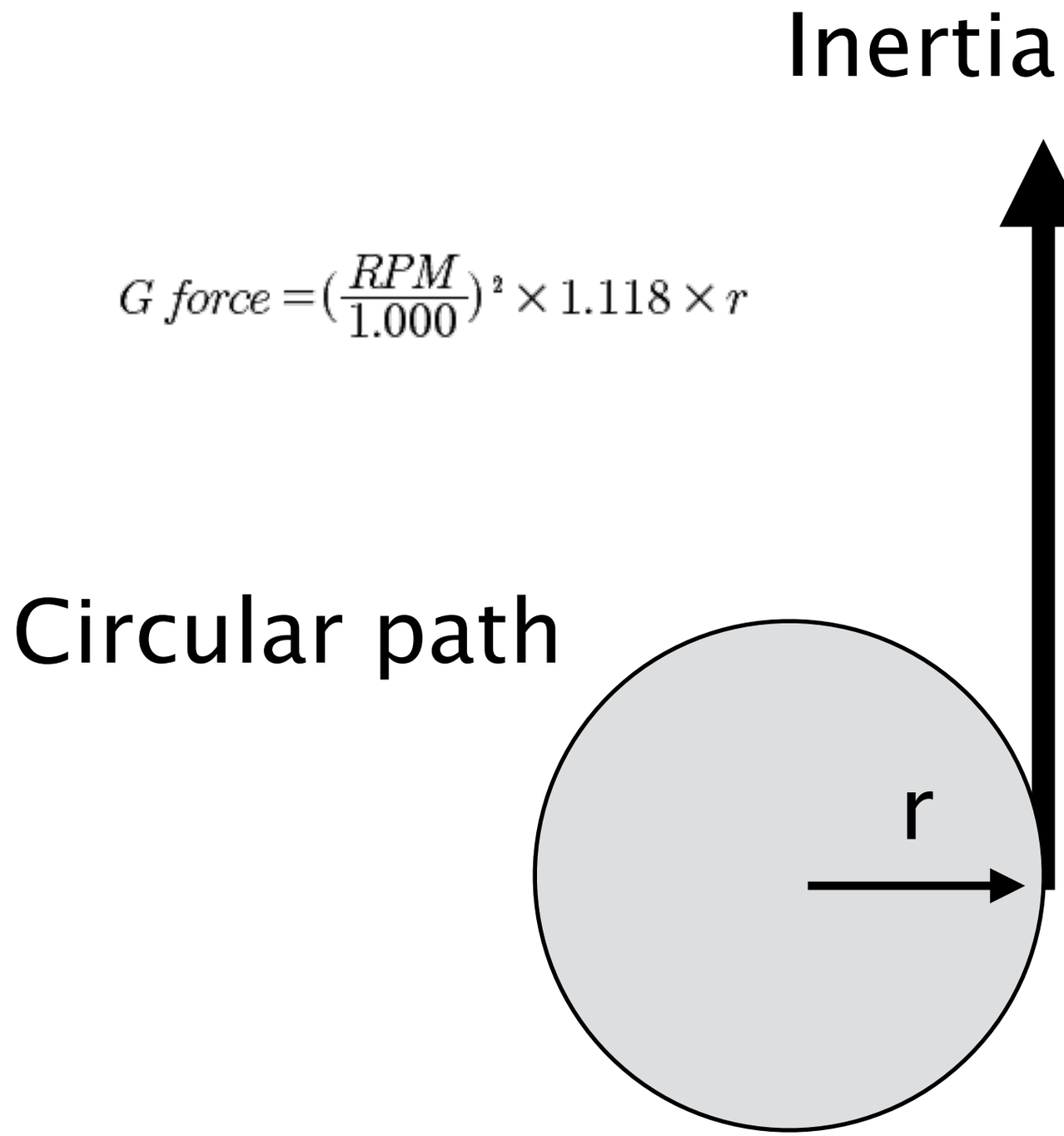
Roller coaster

Centrifugal force



Centrifugal force

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



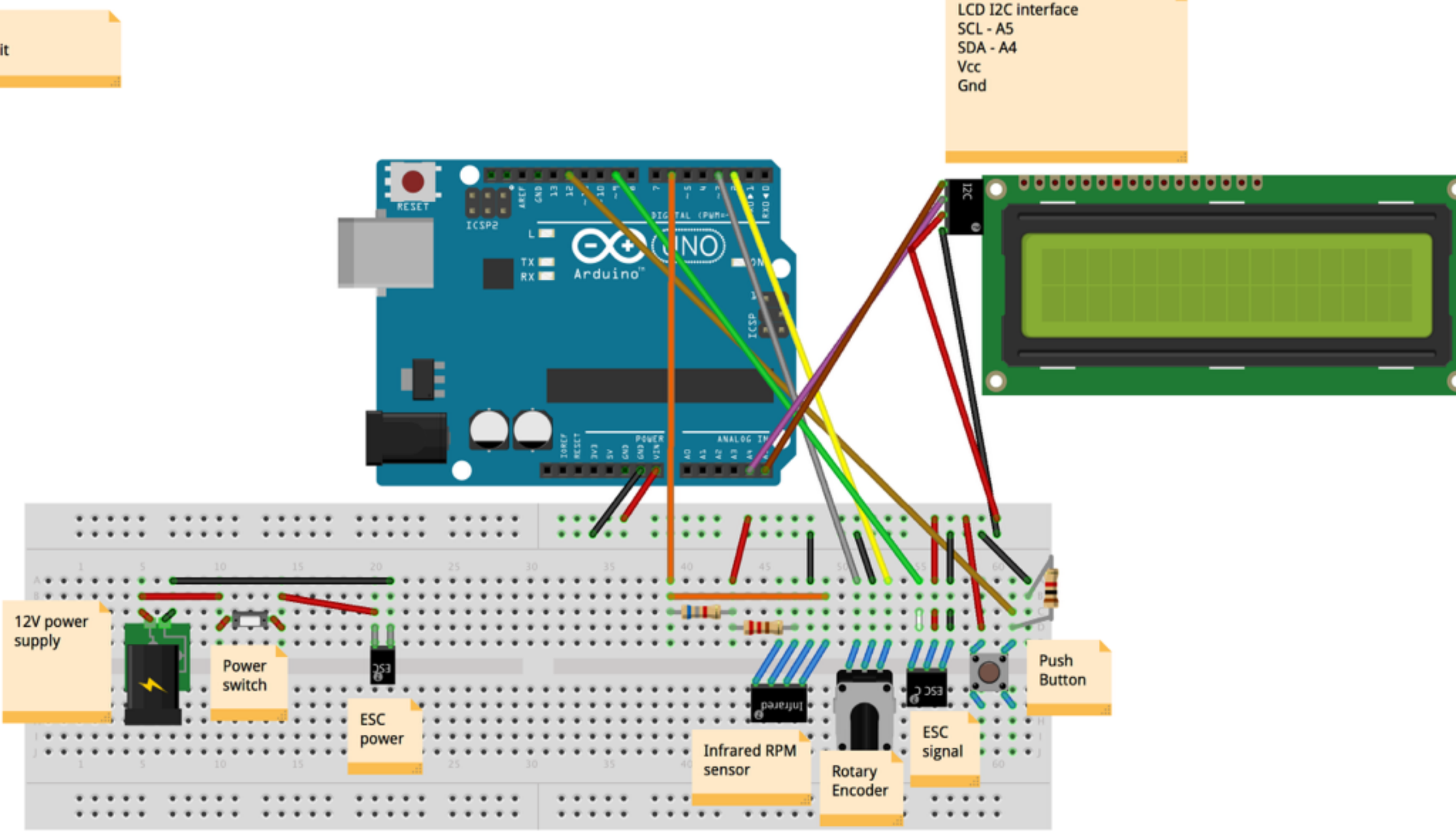
Kinetic Energy

- 2 gram mass
- 7 cm diameter
- 10,000 RPM

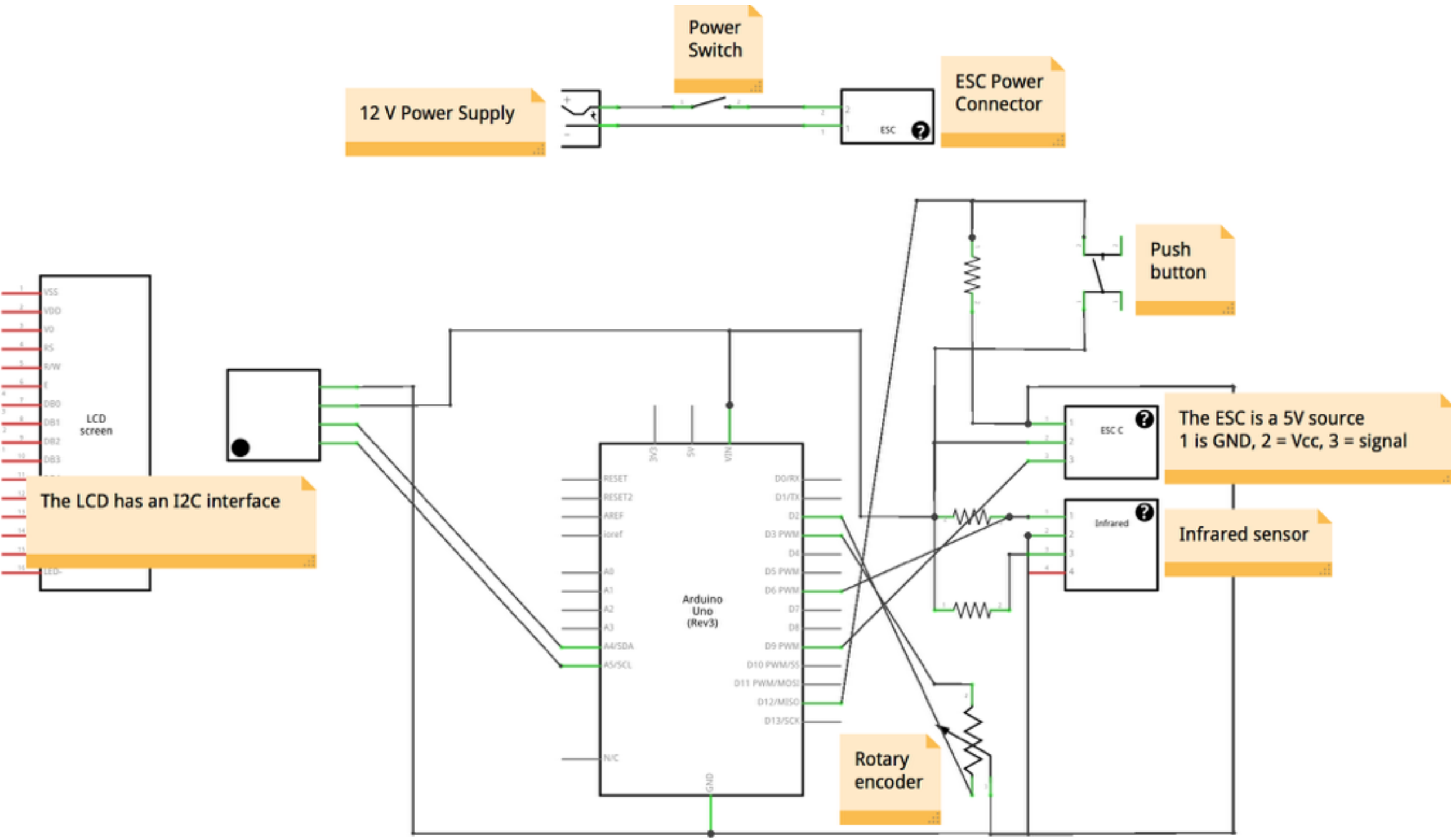
- Surface speed: 3.6 m/s
- Energy: 0.0134 Joules

Wiring

it


LCD I2C interface
SCL - A5
SDA - A4
Vcc
Gnd
I2C
RESET
ICSP2
Arduino
UNO
TX
RX
ICSP
POWER
ANALOG IN
12V power supply
Power switch
ESC power
ESC
Infrared
Infrared RPM sensor
Rotary Encoder
ESC signal
Push Button
fritzing

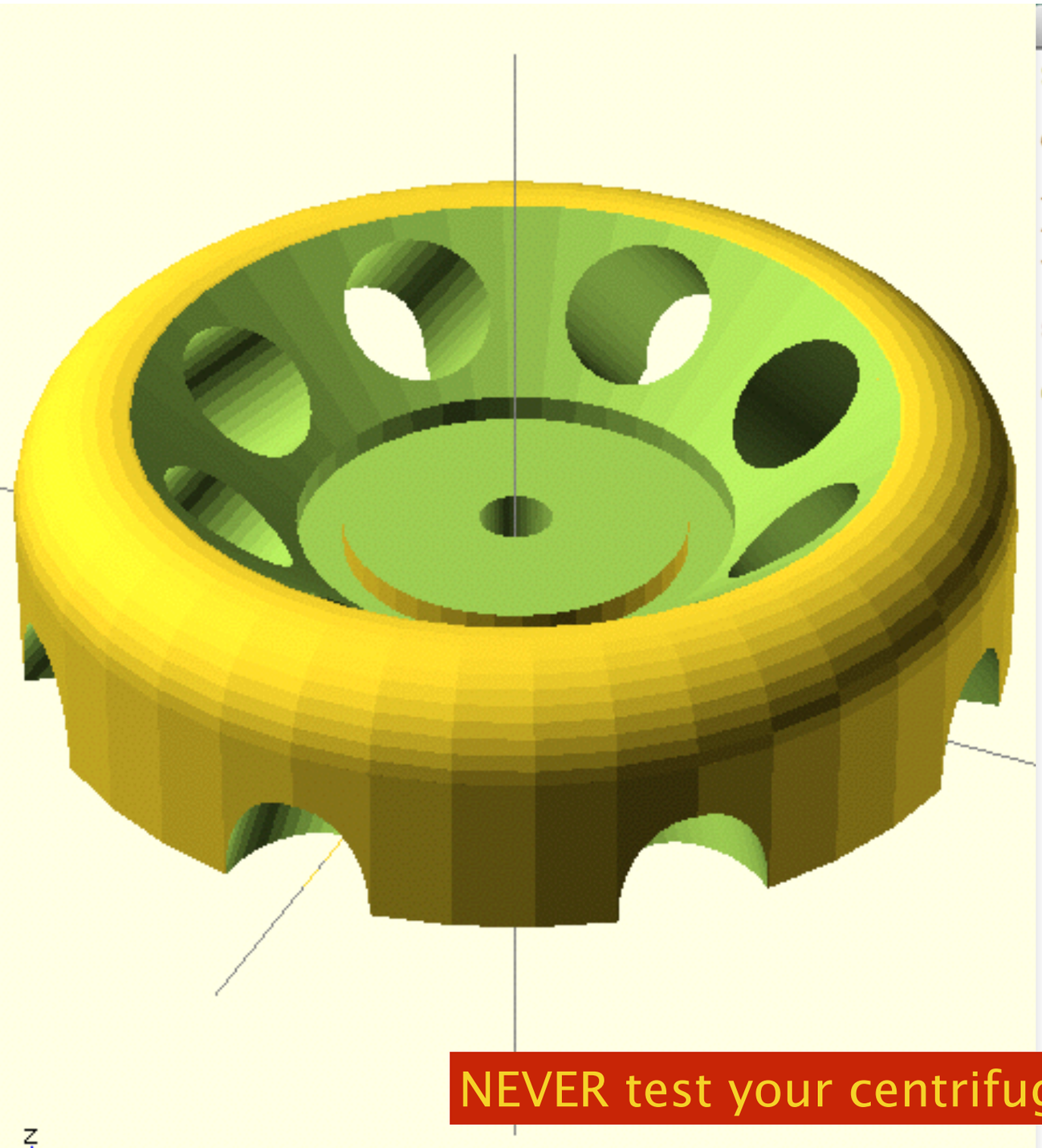
Circuit scheme



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



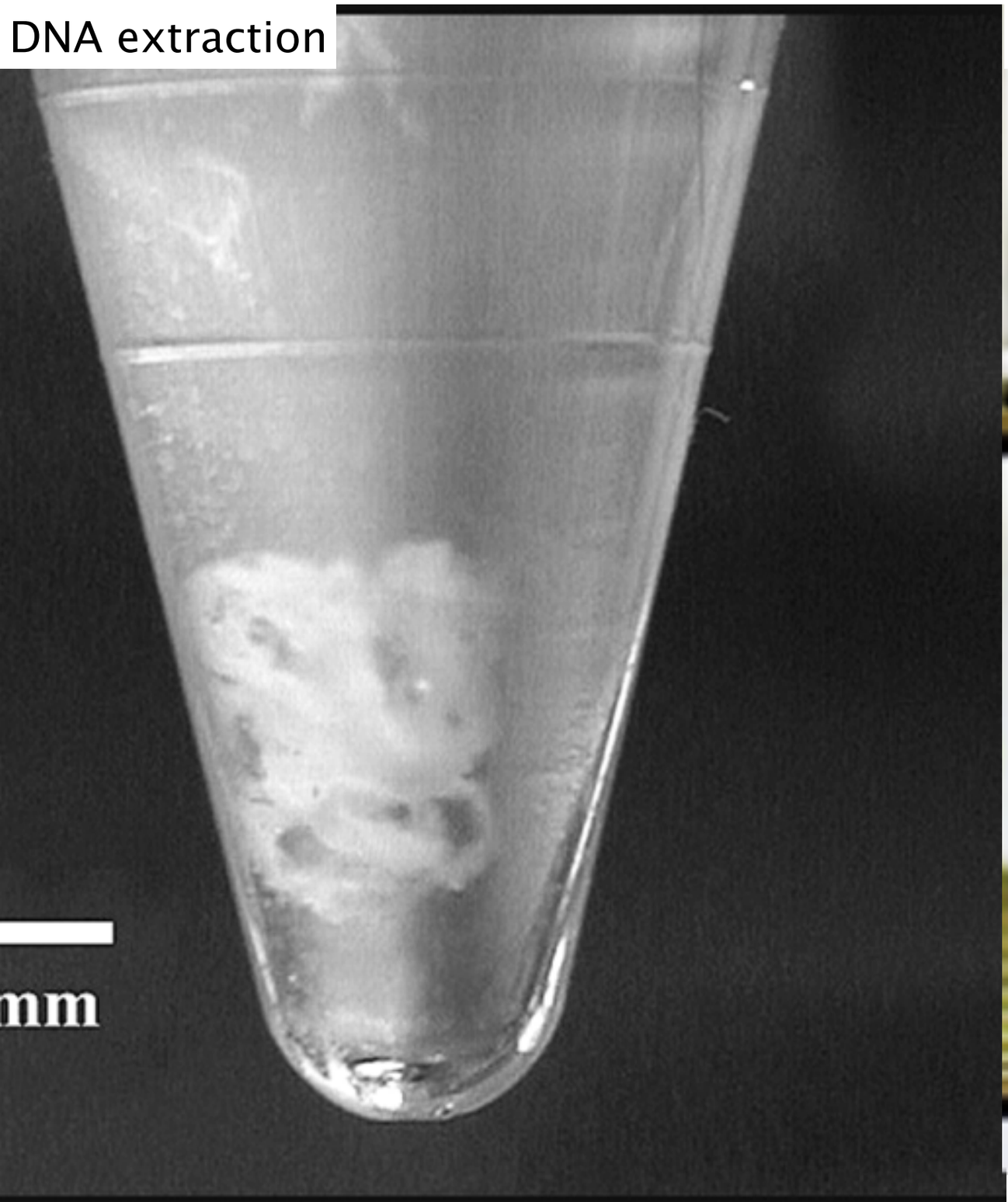
NEVER test your centrifuge with a rotor attached

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 () { // substract tube holders from outer ring

    difference () { // substract inner groove

        difference() { // substract 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])
```

Practicals

DNA extraction



Chlorophyll isolation