Contents

Assembly instructions for a single Modular wheel platform

Before using this document, you will need to purchase the list of materials detailed in the bill of materials section of this repository:

InorganicClusterDiscovery/clusterbot/hardware/CommercialComponents/BOM.md

The repo contains all parts, 3D printed and commercially available needed for this assembly + other custom modules you can add to the platform. Each stage of construction will begin with a list of components and tools needed. A virtual representation of the finished platform can be viewed on the Cronin group team Onshape and may be useful as a visual aid.

Hardware

1. Base frame construction

- 2 x 310 mm v-slot profile
- 2 x 350 mm v-slot profile
- 4 x single L-bracket
- 8 x drop in tee nut
- 8 x 6 mm M5 screw
- M5 Hex screw driver

Construct the frame as seen in Figure 1 using 4 x L-brackets and drop in tee nut/M5 bolts. Use any method to ensure a level and perfectly aligned square unit. (An image of how the M5 screw, drop in tee nuts and L-brackets are used is included in step 2 top right image.)

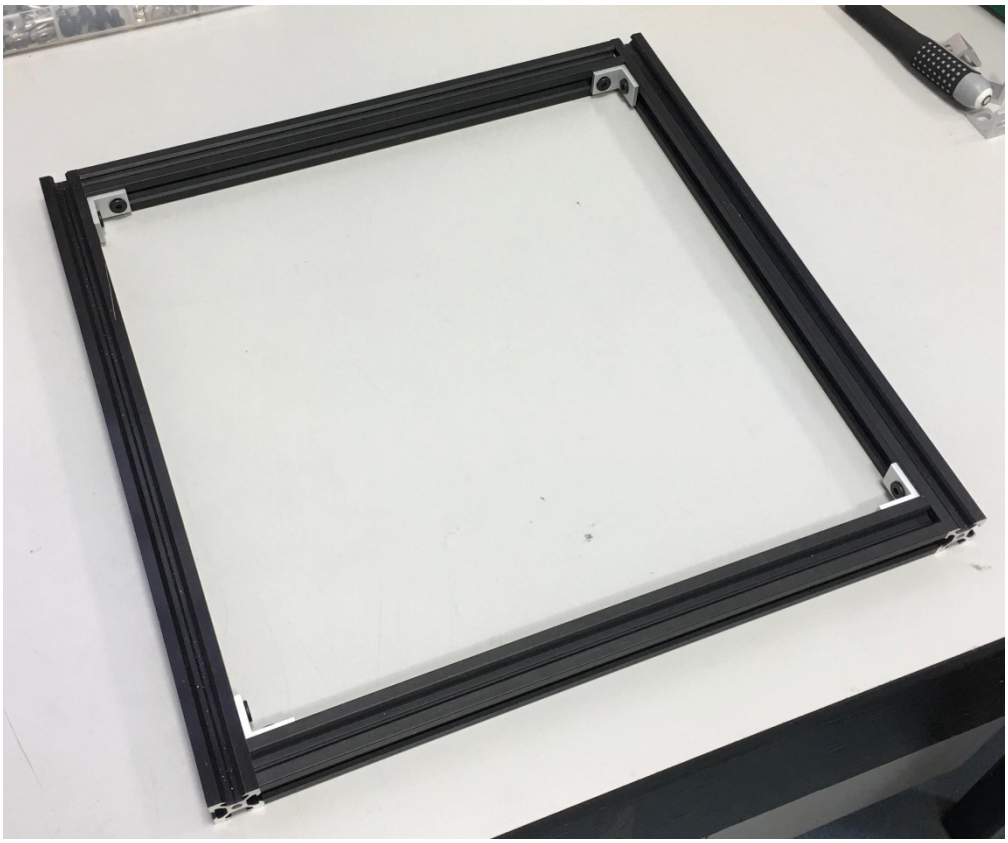

Figure 1 Base frame

2. Uprights prepared and fixed to base frame

- 4 x 135 mm v-slot profile (this height can be varied as needed but modifications to other parts must be considered as well)
- 16 x single L-bracket
- 24 x drop in tee nut
- 24 x 6 mm M5 screw
- M5 Hex screw driver

First prepare 4 uprights with L-brackets, drop in tee nuts and M5 x 6 mm screws as seen below in Figure 2 top left. It is vital the flat exposed face of the L-bracket is perfectly flush to the ends of the v-slot profile. Drop in tee nut example (Figure 2 Top right). Frame up uprights attached Figure 2 bottom.

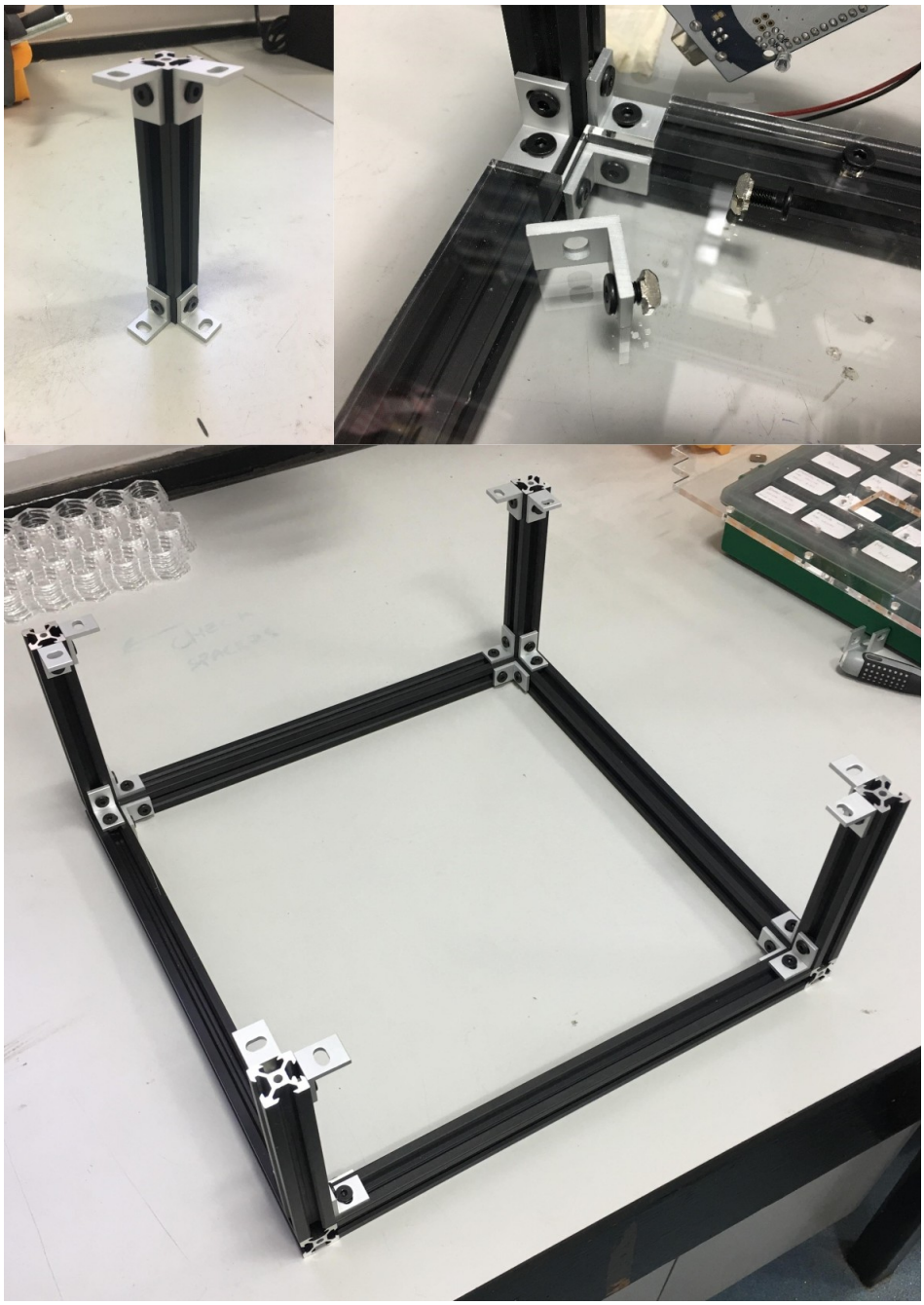

Figure 2 Base frame with uprights

3. Acrylic base plate

- 4 x M5 x 8 mm screws
- 4 x drop in tee nuts
- Base acrylic plate (6 mm acrylic cut found in the repository ‘cuts’ folder)
- M5 Hex screw driver

Lower the base plate onto the base frame and secure to the profile in any direction, using drop in tee nuts and 8 mm M5 screws at the central position along each side (Figure 3).

This piece is the guide to all subsequent parts on this assembly. The accuracy of the frame construction and hence the position of this plate is crucial to ensure all part coincide with one another as intended.

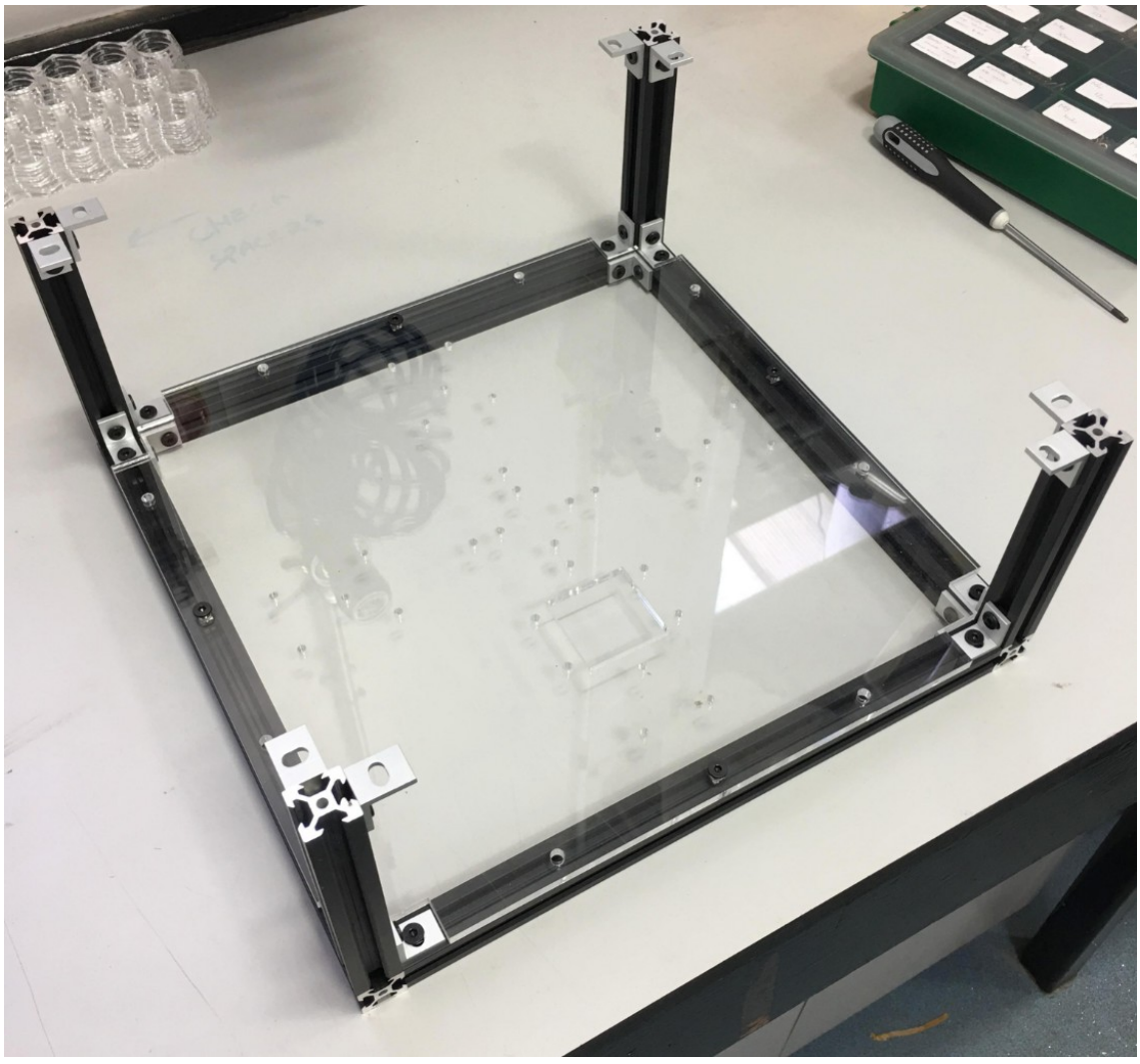

Figure 3 Frame with acrylic base plate

4. 3D prints secured to the base plate

- **3D prints:**
  - 1 x Central Mounting column for driven wheel
  - 3 x Levelling arc
  - 4 x Stirring ring tripod
  - 2 x Nema17 motor securing brackets
- 12-16 mm M3 steel screws + nuts (using appropriate screw length to ensure the parts are secure without excess)
- M3 Hex screw driver

Secure each part as seen below using the base plate as a guide (Figure 4):

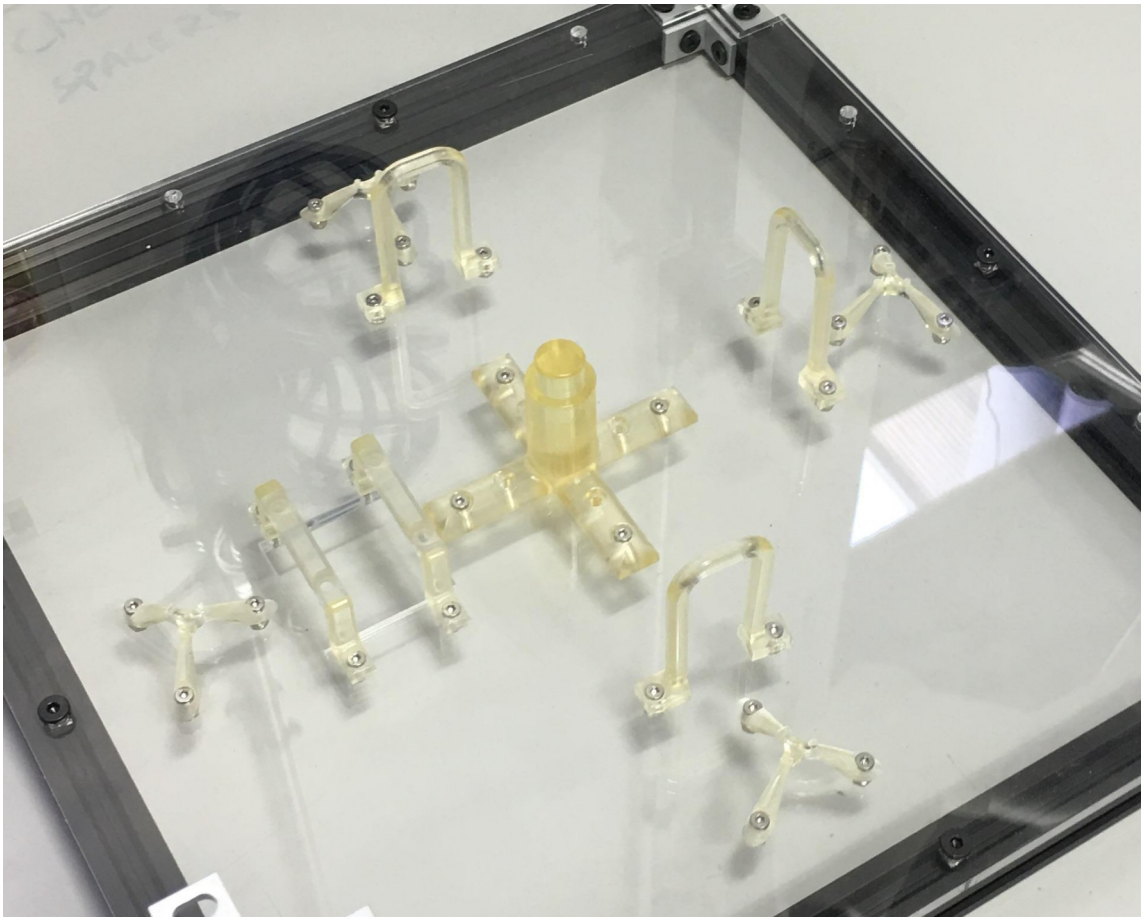

Figure 4 Base acrylic plate with 3D prints attached

5. Profile frame completed

- 2 x 310 mm v-slot profile
- 2 x 350 mm v-slot profile
- 8 x drop in tee nut
- 8 x 6 mm M5 screw
- M5 Hex screw driver

Complete the upper square of the platform frame by creating a mirror of the base frame using the L-Brackets secured to the uprights from step two. It might be necessary to stand the unit on its side to access the M5 nuts easily when securing the profile (Figure 5).

Additional L-brackets can be added to the corners of the top square for extra rigidity if wanted but this is not essential.

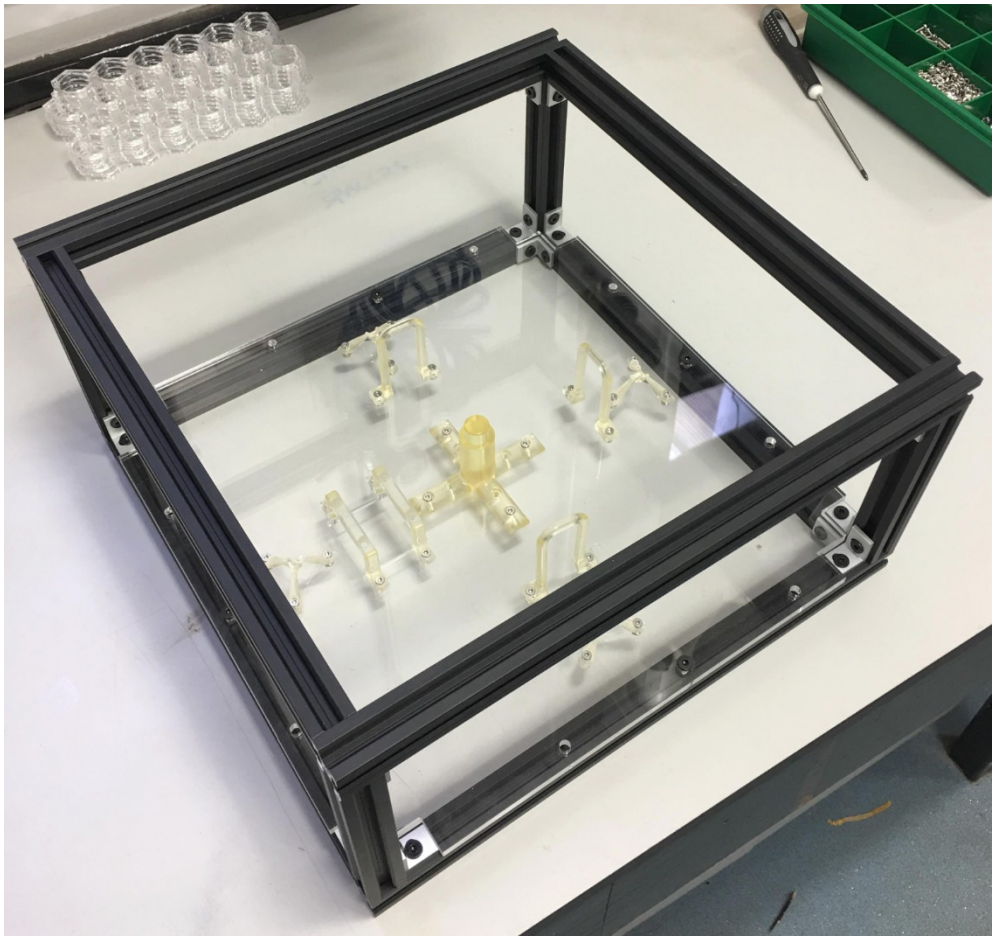

Figure 5 Completed frame and base plate

6. **Drive motor assembly built and secured to base plate**
    - **3D prints**:
        - Drive wheel
    - Nema17 motor 40mm
    - Drive motor mounting hub (Pololu)
    - 4 x 6 mm M3 screws
    - 4 x M3 x 10-12 mm screws

First add the Pololu mounting hub flush to the top of the motor column using the grub screw and hex key provided in the package. Second push the motor, oriented so the cables run toward the nearest profile beam, through the square slot in the base plate and secure to the 'Nema17 motor securing brackets' using 4 x 6 mm M3 screws. This motor must be very secure at all joints but be careful as the print can be fragile. (Figure 6 left image)

Next attach the drive wheel in any orientation to the drive motor via the mounting hub using the 4 M3 x 10-12 mm screws. All 4 screws are needed, don't be tempted to use 2, and again these joints must be very secure. (Figure 6 right image)

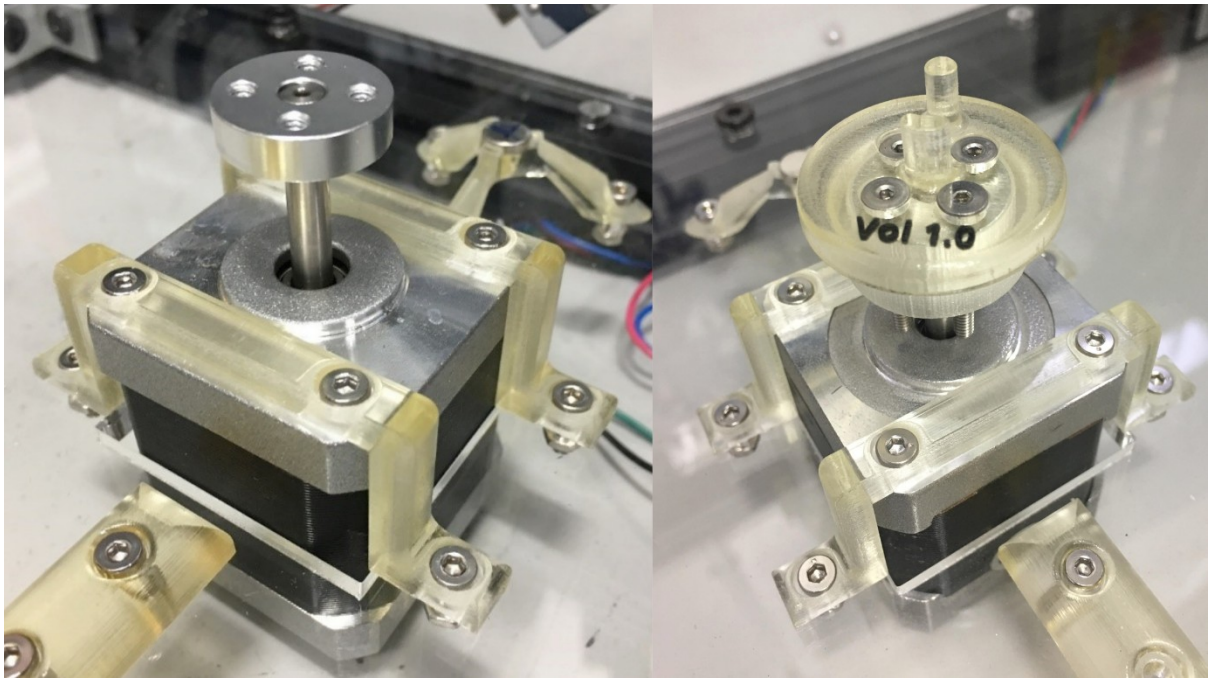

Figure 6 Nema 17 motor preparation with Pololu mount hub and Geneva drive wheel, secured to the base plate via the base plate mounting brackets

7. Stirring ring

The next step is to build the stirring fan ring subassembly. This process is by far the most involved part of the platform and requires 50% + of the total construction time. It has thus been split into multiple sub-steps.

7.1 Preparation of the stirring fans

- 24 x (25 x 25mm) DC 12V fans
- Wire cutters and strippers
- Molex crimping tool (bill of materials)
- JST short crimps with female housings (fan specific models all linked in the Github repo)
- M3 hex screw driver

These cables of the fans must all be shortened, crimped and new female housings added to fit the PCB used to power these units. **IMPORTANT** 20 of the fans need to have cables of length 50-70 mm and 4 need cable lengths of 80-100 mm (this will be explained later). Having cables longer or shorter will cause problems in operation. The fan type is not important as long as the size is 25 x 25 mm, but they must be identical as different brands spin at different speeds with the same current.

A-G (Figure 7 and Figure XXX) are a series of images describe:

a. 25 x 25 mm 12V DC fan with cables cut to 50-70 mm and approx. 3mm sheath stripped
b. Specific crimping tool used for these units
c. Two clicks of the crimping tool will allow you to trap this crimp in the orientation shown, ready to insert the cables
d. As above
e. Insert the wire so the first 1.5mm of sheath will be trapped in to crimp and the exposed wire crushed at its centre. This specific tool will only release after it has sufficiently crushed the crimp i.e. it guides itself, squeeze hard once and it will release a perfect crimped wire
f. One wire complete, do the next
g. The crimps click securely into the housing in one orientation and so that is set. However, you must ensure the **red/black arrangement is the same in ALL cases.**

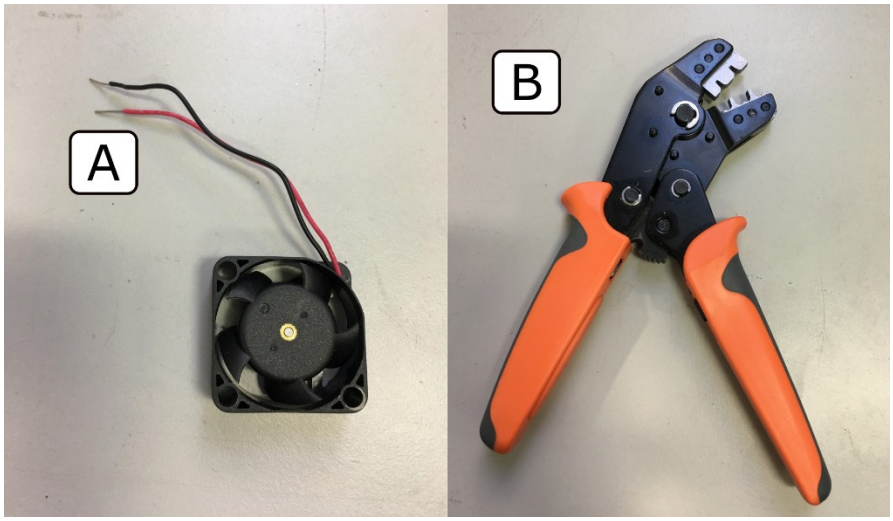

Figure 7 **A)** 25 x 25 mm DC fan with shortened and stripped wires **B)** Crimping tool

Repeat this process for all 24 fans

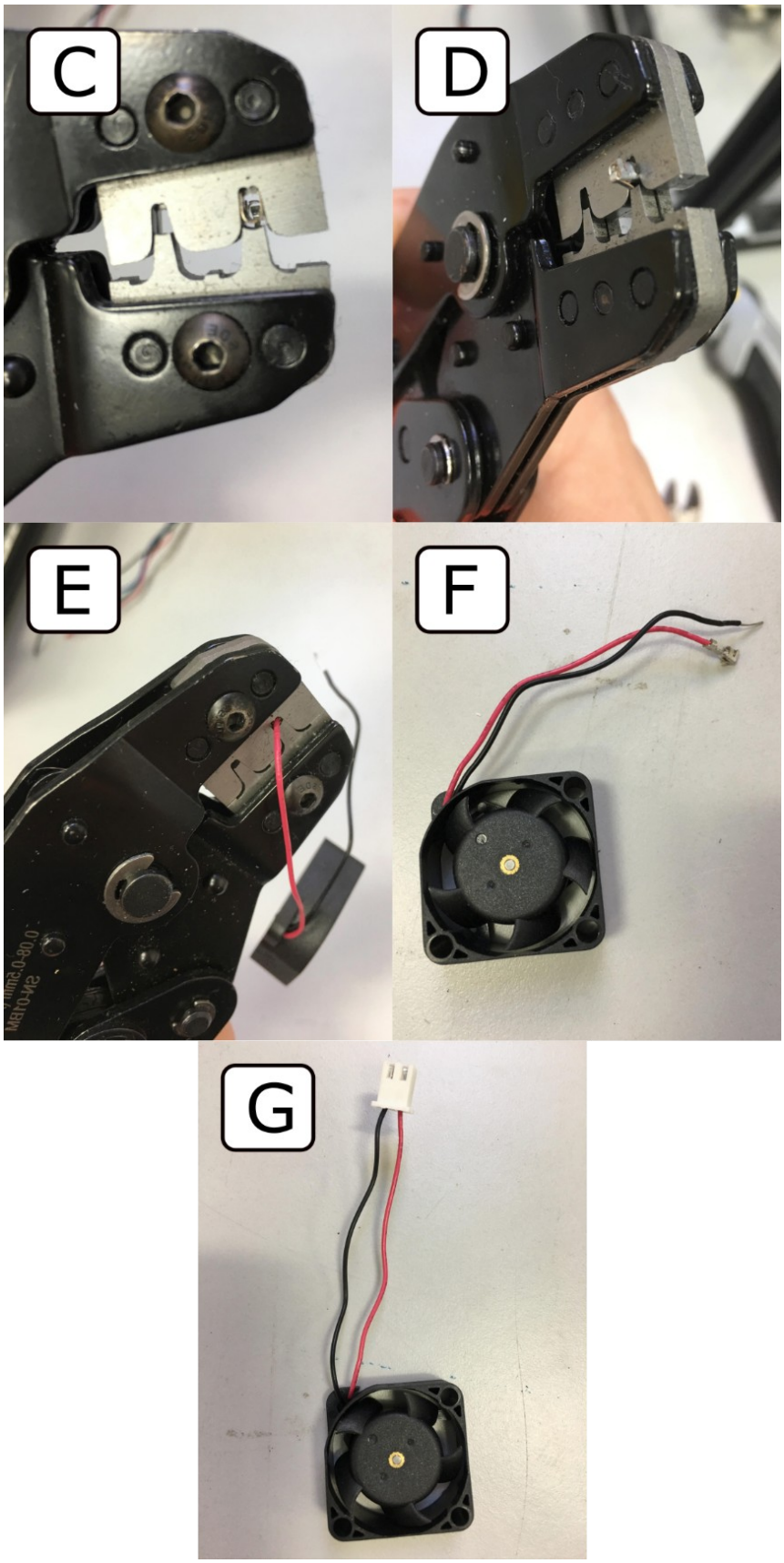

Figure 8 Images of fan preparation listen in section 7.1.

7.2 Preparation of the acrylic mounting ring

- **3D prints:**
  - 4 x Stirring ring tripod
- Acrylic cut mounting ring 6mm thickness
- 12 x 10mm M3 screws and nuts (for tripods)
- 48 x 20mm M3 screws and nuts (for fans)

First secure the 4 stirring tripod prints to the acrylic ring using the 12 x 10mm M3 screws (Figure 9).

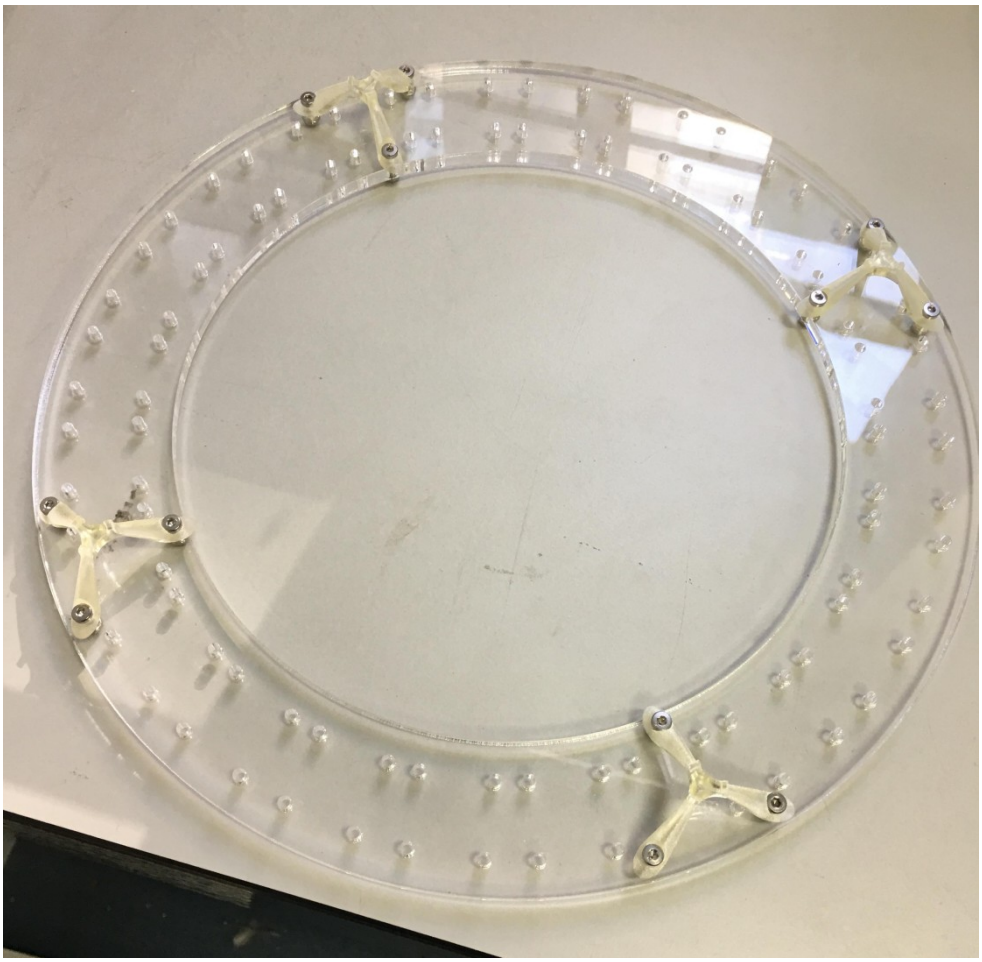

Figure 9 Stirring ring with 3D printed tripod mounts attached

7.3 Mounting the fans

- 48 x 20 mm M3 screws and nuts
- 24 pre-prepared fans (20 normal length cable, 4 extended)
- M3 hex screwdriver

Mount the 20 short length fans to the ring on the opposite side to the tripods in the positions not occupied by a tripod, using 2 x 20 mm M3 screws per fan diagonal from one another. Each fan needs to be in the same orientation with the cables directed toward the centre of the ring in the left position relative to looking out from the centre of the ring (Figure 10).

Finally mount the 4 longer length fans to the remaining positions using the 2 inner fan holes for the screws. These 4 fans should be turned clockwise 90^{O} relative to the other 20 (viewed from above) so that the cable is directed outward from the centre of the ring. (Figure 11).

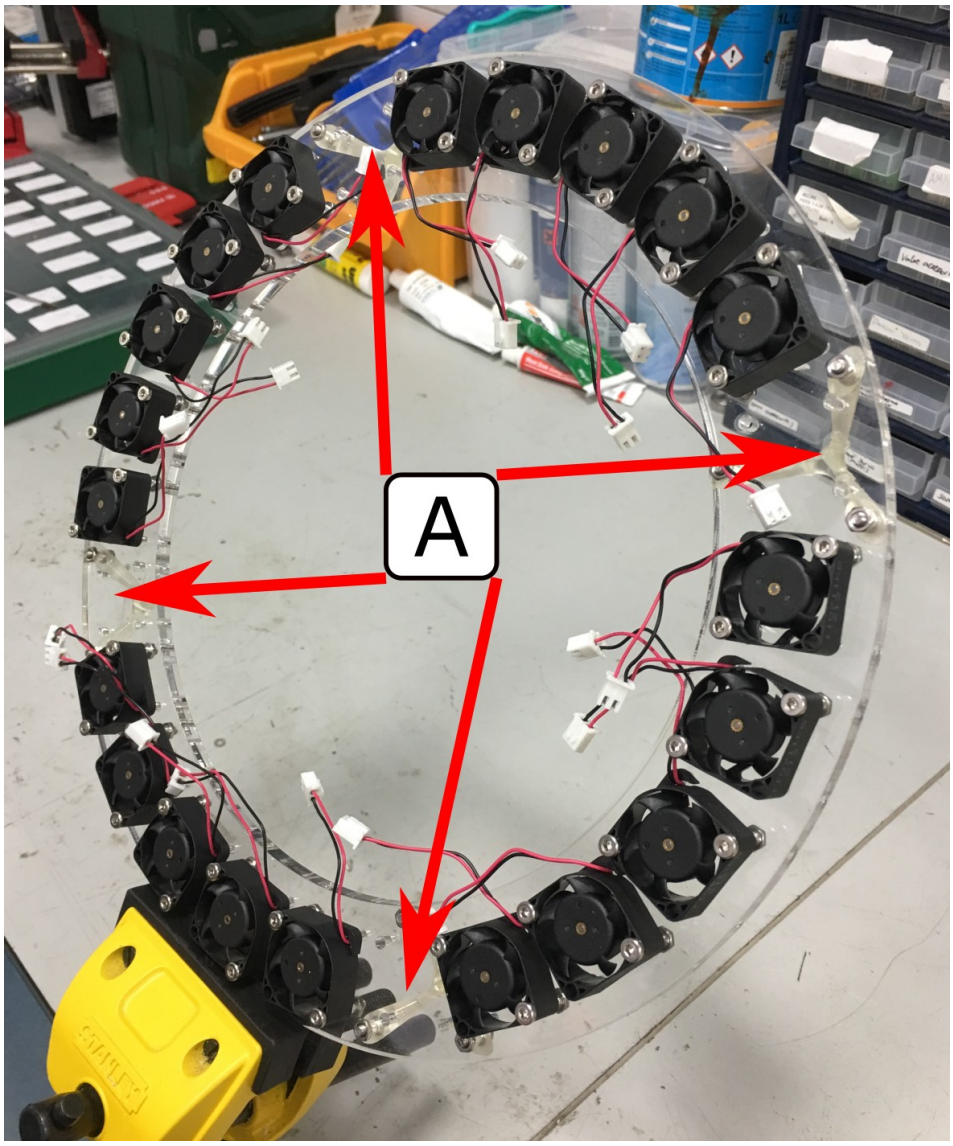

Figure 10 20 x Short cable fans mounted. **A)** Positions directly over the tripods to be left clear

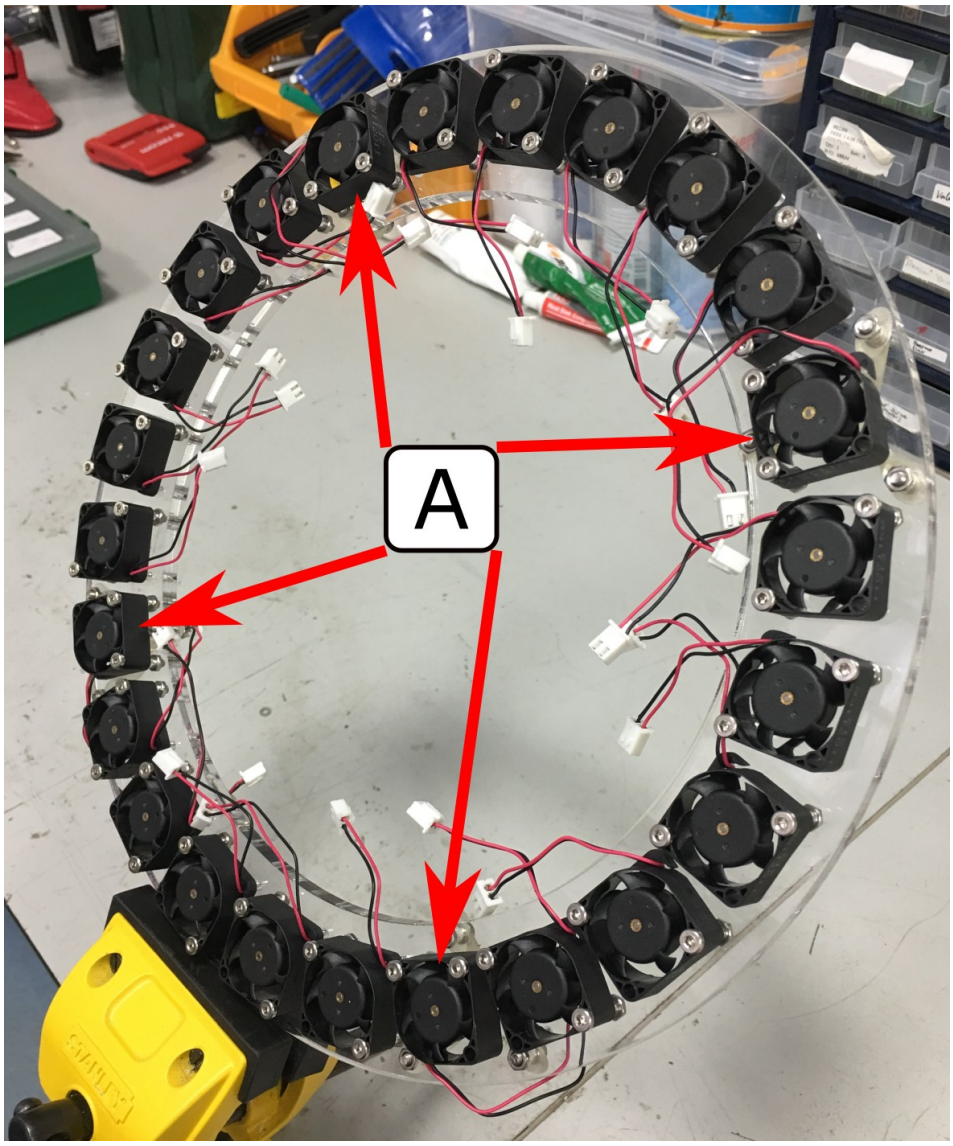

Figure 11 Final 4 long cable fans mounted. **A)** Filled positions

7.4 Tinning and soldering the PCB ring

- PCB sheet with 4 x ¼ circle PCB outlines (design documents for this piece are on the GitHub repo: Hardware/Stirring ring PCB)
- Soldering Iron
- Soldering flux
- Isopropanol
- Blue role
- Straight cut plastic/metal snips
- Dremel drill
- JST angled male housings (opposite piece for the fan male housings)

This step is to cut, tin (cover the PCB treads with a thin layer of solder) and solder housings onto the PCB board used to power the fans. Firstly, if you don't know anything about soldering seek help from a person in the lab/YouTube and do not try this without instruction, molten metal isn't great for the skin… If you are familiar with the process simple neatly cut out the 4 ¼ pieces from the sheet making sure to cut the end of the designs to sever the link between the two tracks and drill the connector holes with a Dremel. Next, tin all 4 of the ¼ circle pieces making sure to cover the entire surface of copper (except the lettering) but not to connect one side of the track to the other at any point (Figure 12A)

Second solder the housings onto the boards pins facing inward. Each housing has 2 pins that will protrude through the board. Solder the housing to the side of the board with the writing/tining with the connection facing toward the centre of the ring. The final orientation of the board is the wording facing the floor (Figure 12B).

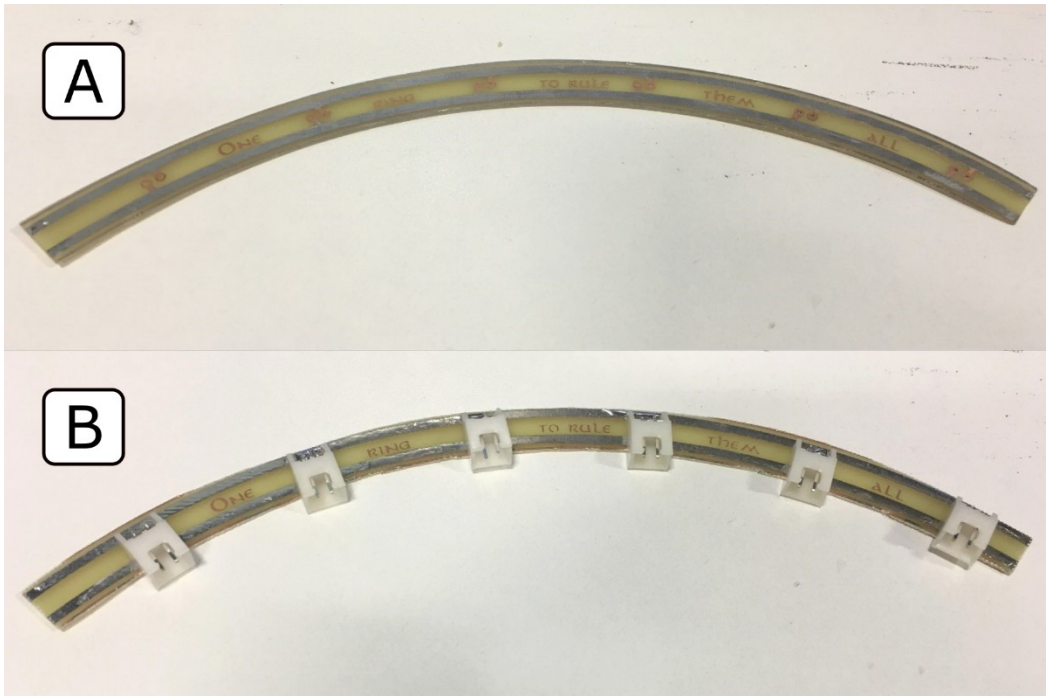

Figure 12 ¼ piece PCBs. **A)** Board cut, tinned and drilled **B)** JST housing soldered to the board

7.5 Mounting the PCB

- **3D prints**:
  - 8 x PCB mounting blocks
- Loctite liquid super glue (or equivalent fast drying plastic glue)

The PCB is mounted on the underside of the acrylic ring using 3D printed mounting blocks. The placement of the PCBs is crucial to navigate around the tripods. Below an image showing the ideal placement of each unit is shown. Each unit shares blocks with the next at either end of the piece and has one centrally for support. The blocks at the end act as a support for joining the boards later so having them secure at these positions is crucial. Figure 13A shows an exploded view for the approximate placements of each of the 8 blocks. Figure 13B shows the under side of the ring now with the mounted PCB

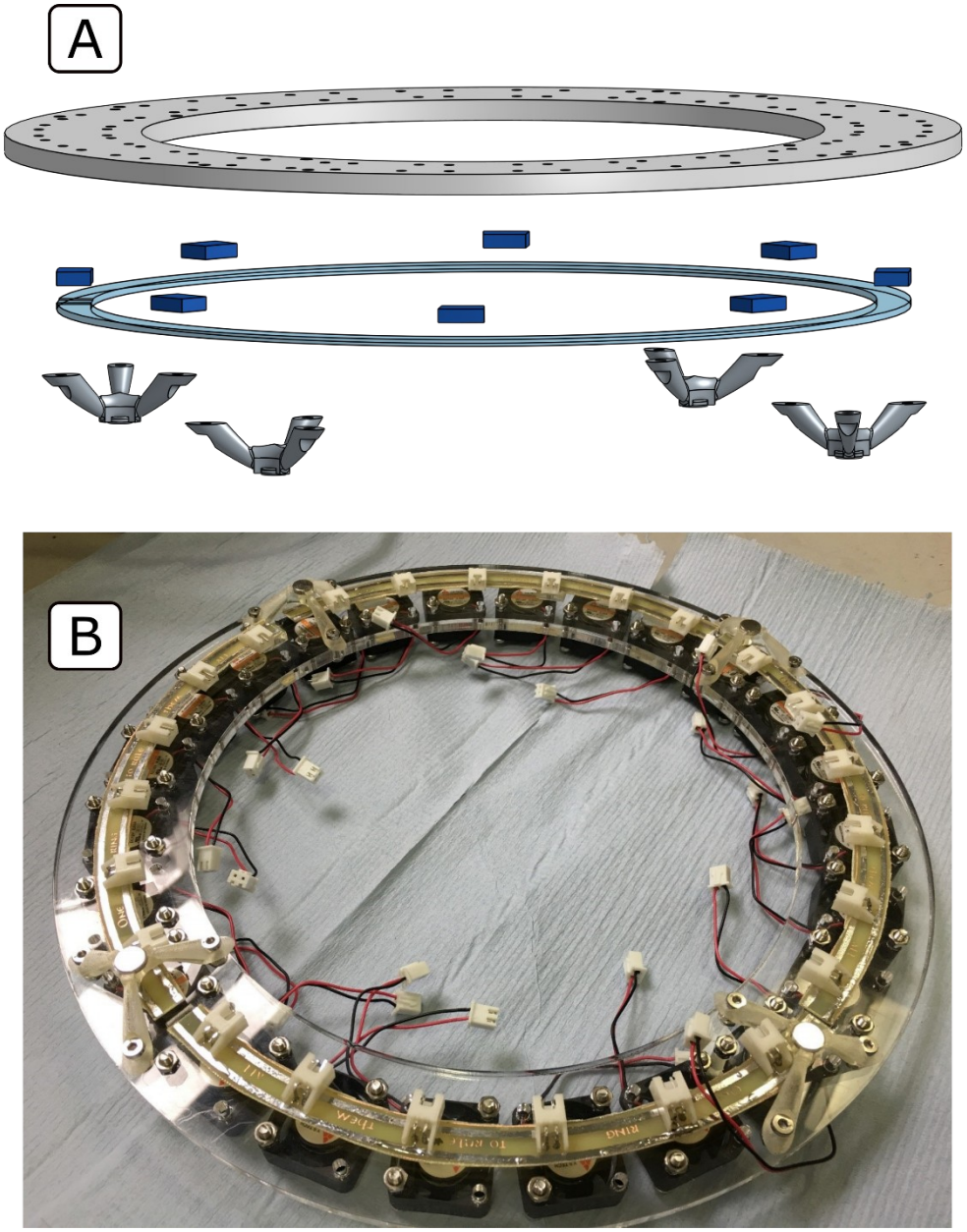

Figure 13 Mounted PCB on the underside of the stirring ring.

7.6 Joining the 4 PCB units and inserting the fans

- Solder iron + flux
- 8 x 1cm fully stripped single core wire

To join the 4 pieces a small single core wire is soldered from one track to another to make the connection. The best way to do this is melt a small amount of solder onto each join position and using a flat nose plyers place each end of the single core wire on top of these think solder positions. Heating from the top of the wire + wait for the solder to melt underneath. A small amount of pressure is enough to submerge and secure the wire in place.

Next carefully insert all 24 fans into the female housings on the boards. **This is a good time to check that all cables are identically orientation in the order you chose**. In the case below the red wire are on the right of the image and therefore are connected to the inner track of the PCB.

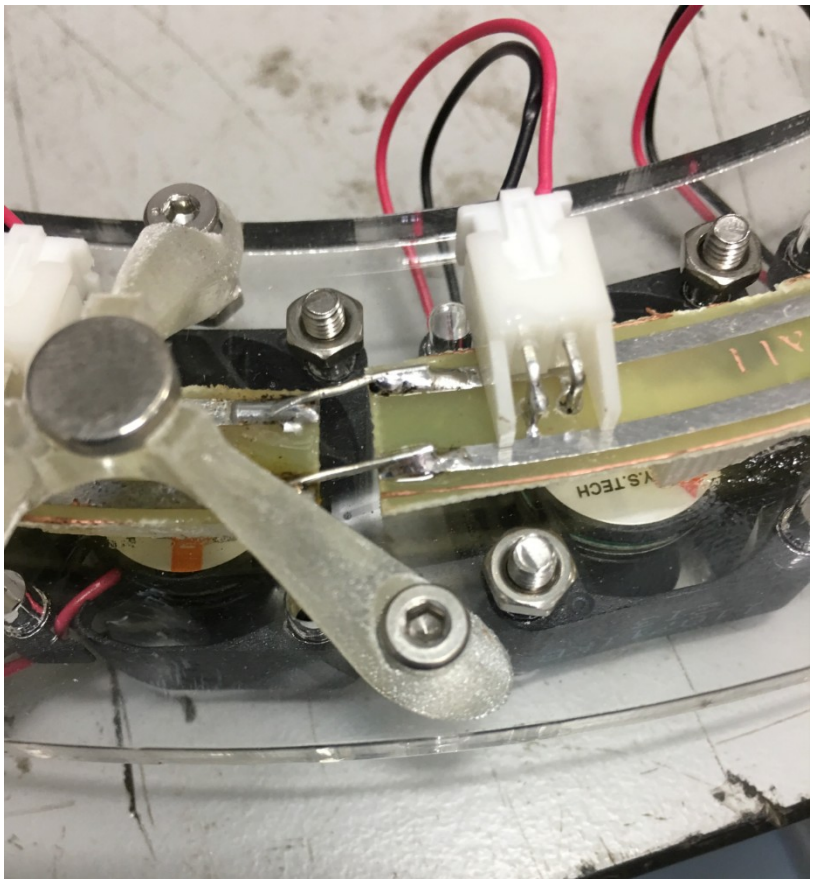

Figure 14 Joining the PCBs. Also, insertion of the fan female housing onto the male housing soldered to the PCB.

NB. The placement of these magnets shown in this image are explained later.

7.7 Power cables attached to the complete PCB ring

- 1 x 15cm red and black cables stripped 4-5mm at one end.
- Soldering iron + flux

The boards are powered via a single source connected to the tracks at any convenient position. The ideal position is in the middle position between two tripod positions. Making sure the wire being attached matches the track colour dictated by the fan wire arrangement. Using the same method as the join single core pieces, connect each wire to the appropriate tract (Figure 15).

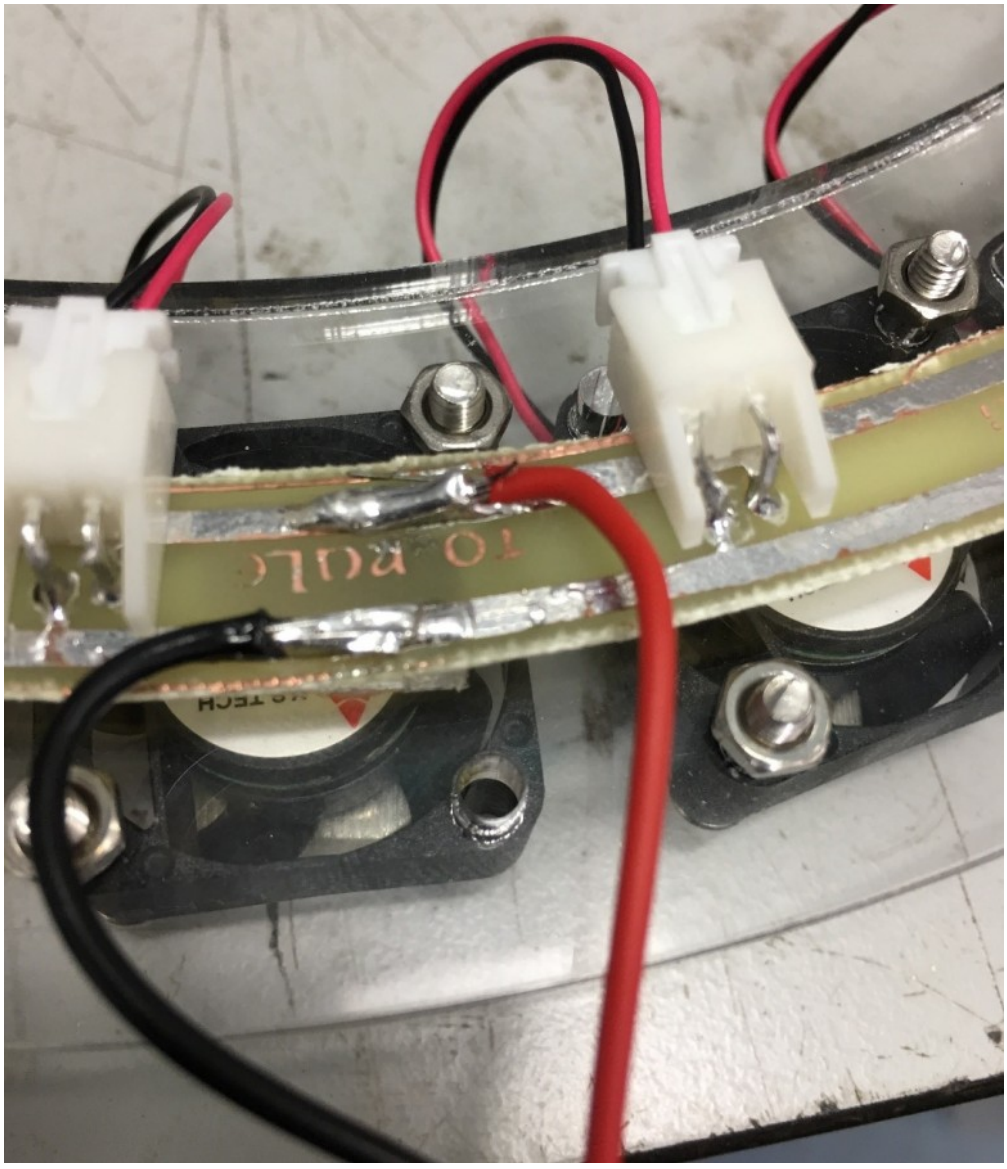

Figure 15 Based on the chosen orientation of the Red/black wire of the fans, red and black are soldered to one of the two tracks.

7.8 Crimp and house the power cables

- Large male power source housing from Molex (Git) and matching crimps
- Regular crimping tool

Strip and crimp the end of the power cable you have just attached to the board. The power supply with need a female equivalent of this housing. You may choose the position of the red and black cables in the housing but ensure you select one arrangement and make all subsequent connects in the same fashion. Power supplied to mismatched cables will melt the cable sheaths in seconds and most likely destroy the components connected.

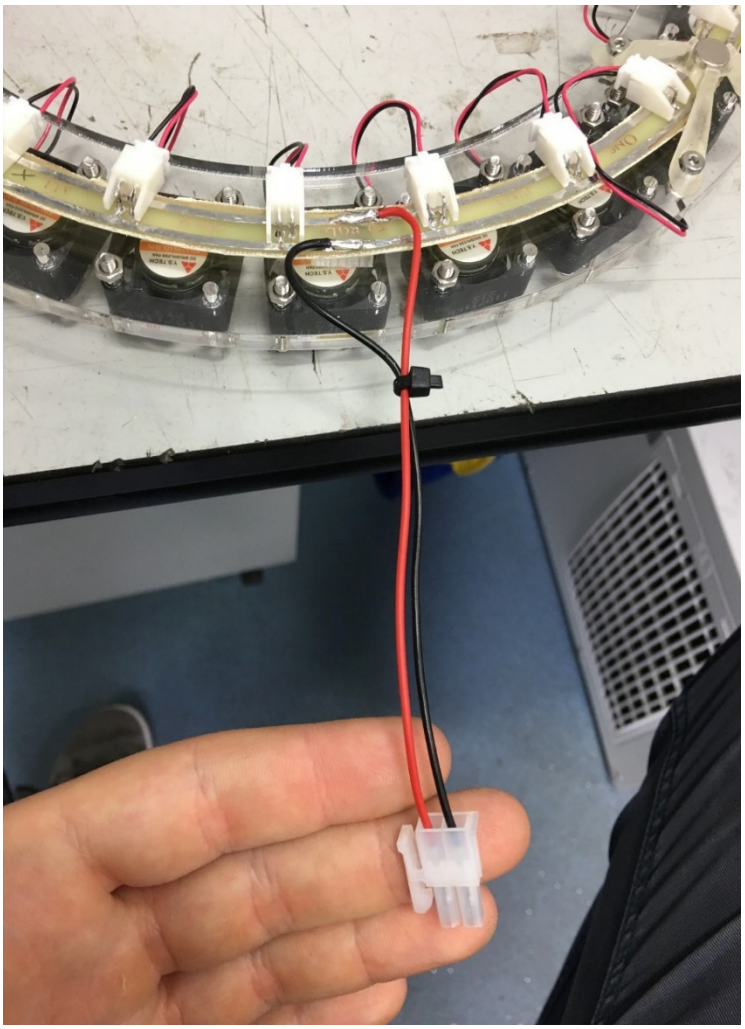

Figure 16 Molex crimps/housing connection from the stirring ring

<u>This step completes the PCB ring. The following steps are returning to the overall assembly</u>

8. Magnet placement on the tripod mounting prints

- Loctite liquid super glue (or equivalent fast drying plastic glue)
- 8 x (8 x 2mm) Nd disc magnets
- Permanent marker

The tripod mounts on both the base frame and the stirring ring are fitted with medium strength magnets to ensure perfect placement and easy removal. However, to ensure the ring can be placed in any arrangement the magnets must all be aligned identically. If not, certain positions will repel one another making an annoying mess.

The magnets form long columns face to face in the packaging, use this to the mark out the faces that attract each other. The opposite side to this mark should be glued to the tripods. Repeat this process for all 4 tripod pairs.

Figure 17 Stirring ring tripod magnets marked for alignment, glue to the tripod 3D prints

Test the alignment of the magnets by combining the stirring ring and base frame before continuing. Figure 18 shows what this assembly point should look like.

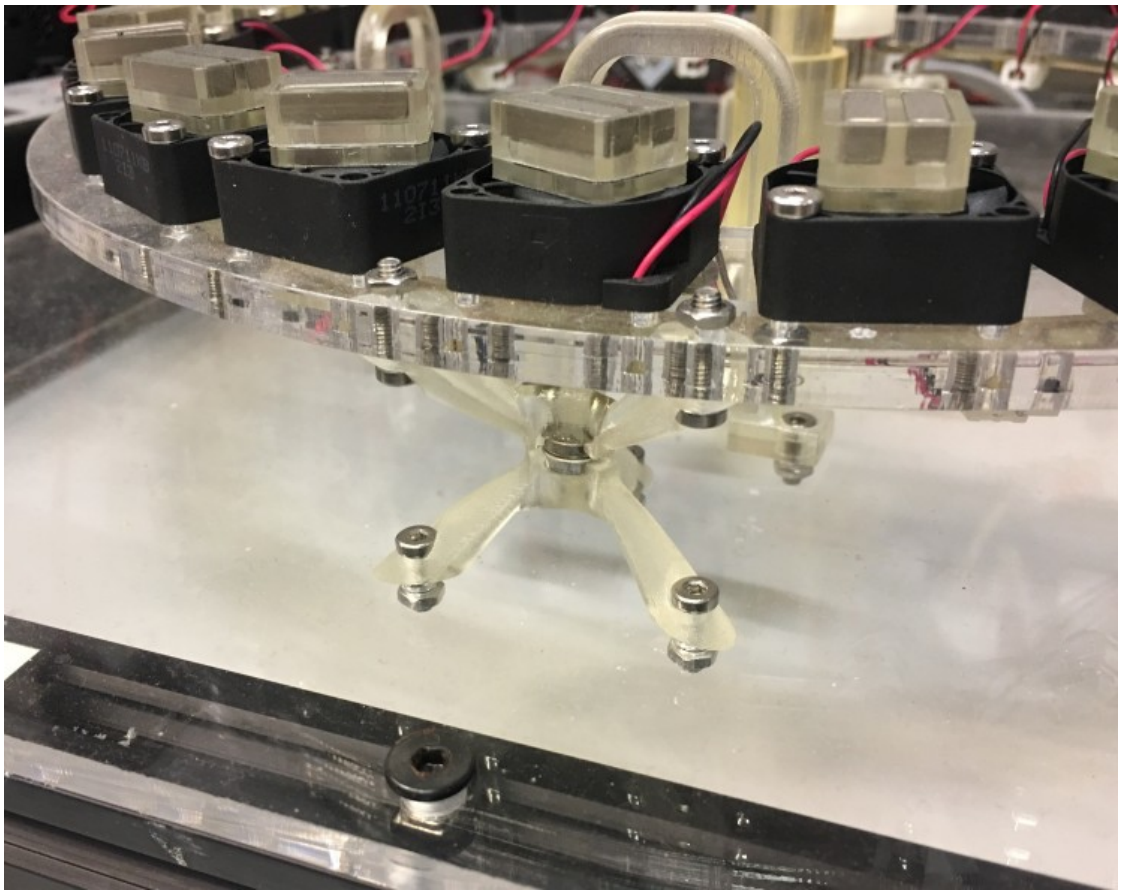

Figure 18 Tripod magnet relationship, base to stirring ring

9. Driven wheel preparation

- **3D prints**:
  - Driven wheel X
- Deep grove ball bearing 6206-2RSH 15mm ID, 35mm OD
- 4 x M3 nuts
- Loctite liquid super glue (or equivalent fast drying plastic glue)
- Calibration hammer…

The bearing that allows the driven wheel to turn smoothly on the central column needs to be carefully inserted into the base of the driven wheel 3D print. Make sure to keep the bearing level as you hammer it lightly into position. (Figure 19A)

Glue 4 nuts into the underside positions of the driven wheel making sure to not fill the inner threads with the glue. (Figure 19B)

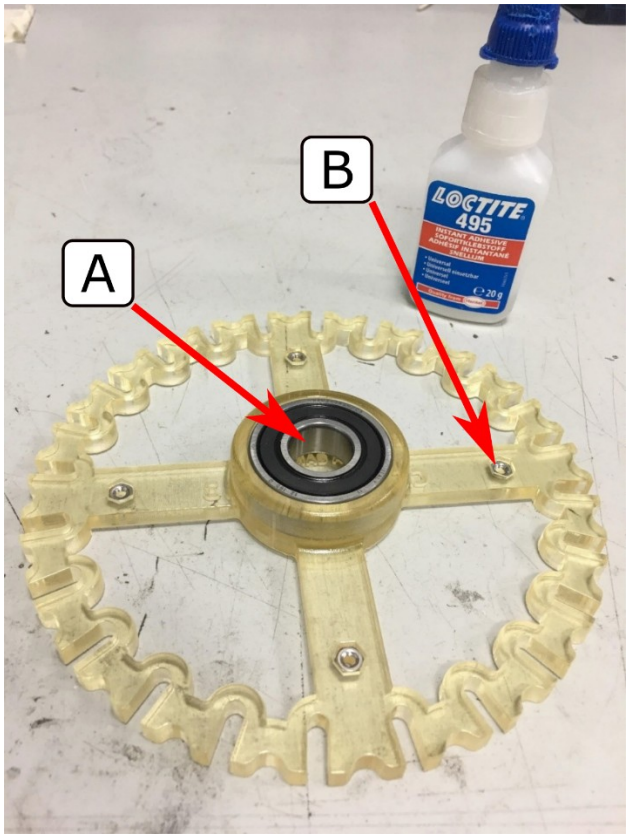

Figure 19 **A)** Bearing press fit into the driven wheel. **B)** 4 M3 nuts glued into the allocated slots

10. Testing the driven wheel and gluing magnet mounts

- **3D prints:**
  - 24 x ‘Magnet housing base’ units
- Loctite liquid super glue (or equivalent fast drying plastic glue)

Apply 2 small drops of glue opposite each other on a single fan, making sure not to allow the glue to reach the central press fit column. Carefully place a single ‘Magnet housing base’ onto the fan aligning the central hole to the centre of the fan column. This placement must be very accurate as 2 large Nd magnets will be rotated at up to 1000 RPM using this piece, slight deviation could result in detachment. Repeat 24 times. NB you will notice the 7-needle dispensing 3D print attached to the frame in this image. Attached via a drop-in tee nut and appropriate M5 bolt it can be attached at any time.

Also place on the column and test the rotation of the driven wheel prepared in the previous section. (Figure 20)

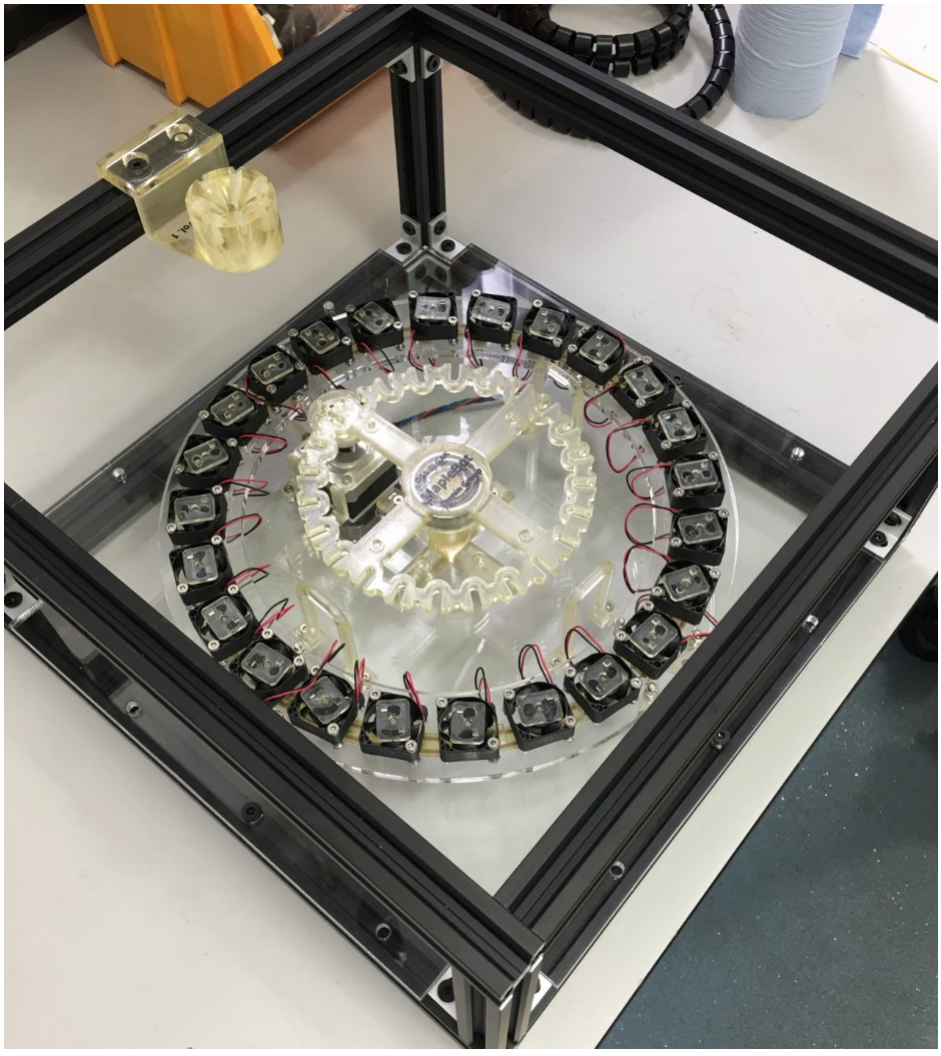

Figure 20 Stirring ring and Driven wheel added. A magnet mount base is glued to each fan.

11. Attachment of the vial tray base acrylic cut

- Vial tray base acrylic piece
- 4 x M3 x 12 mm screws
- M3 hex screw driver

Attached the vial tray base acrylic piece to the driven wheel using the M3 x 12mm screws. To ensure you do not damage the central column it is advised to remove the driven wheel and separately perform this step (Figure 21).

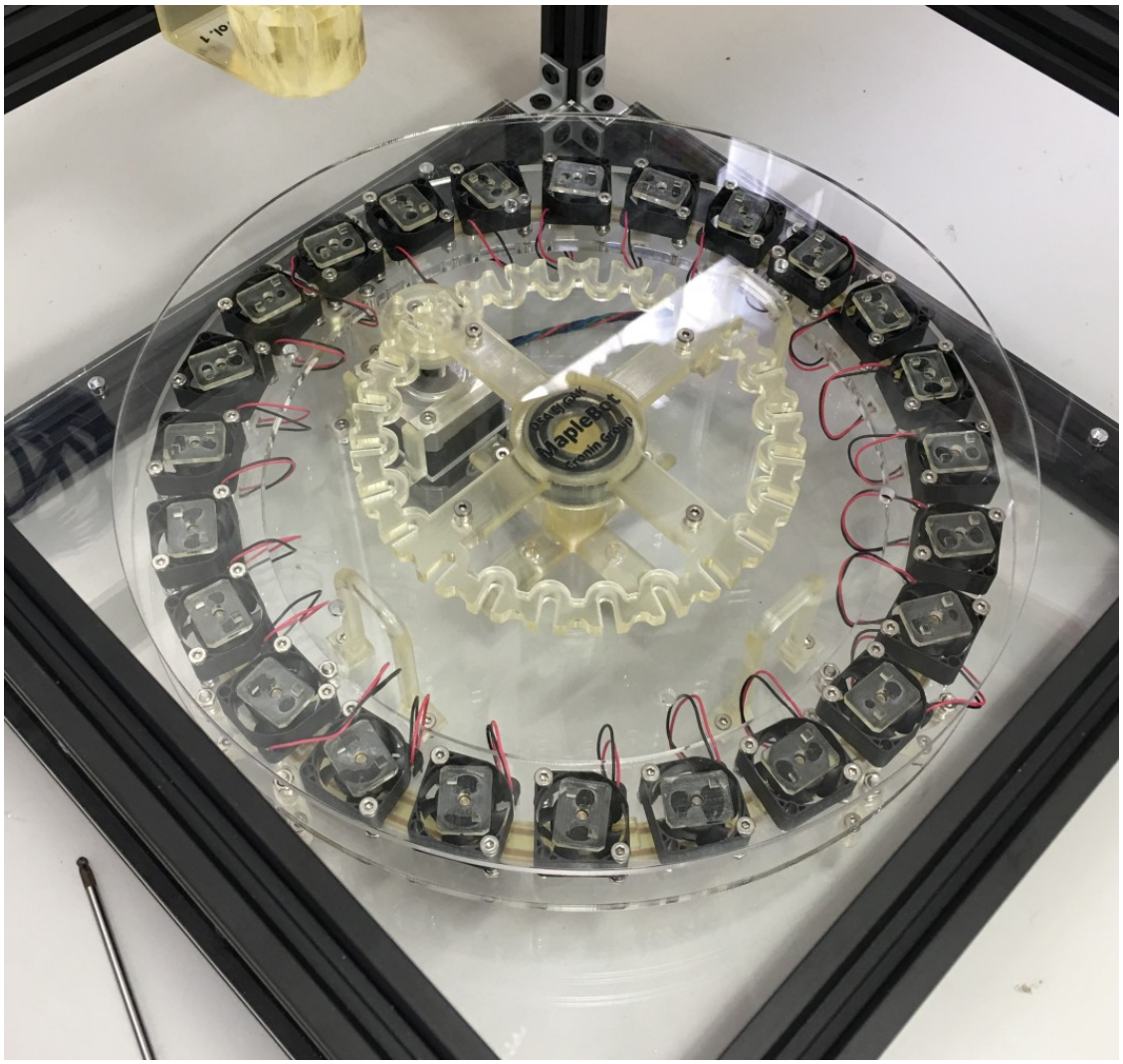

Figure 21 Attachment of the acrylic vial tray base plate to the driven wheel

12. Completion of the vial tray

- **3D prints:**
  - 3 or 6 x Hex spacers
- 3 or 6 x M3 x 30mm screws and nuts
- M3 hex screw driver
- Top vial tray acrylic cut piece

Again, remove the driven wheel/vial tray base from the central column to avoid damage. Insert the 30mm M3 screw through the bottom of the base vial tray piece, place a hex spacer over it, place the top vial tray piece over the remaining exposed screw end and secure on top with an M3 nut. Repeat with 3 or 6 spacers (Figure 22).

Figure 22 Completed vial tray

13. Stirring magnets

- **3D prints:**
  - Large 2.2kg pull magnet removable housing
- 48 (15 x 4 x 4mm) N42 Nd magnets
- Permanent marker

In order the magnets to provide consistent stirring to the vial above a pair must be arranged in the 3D printed housing in a very specific arrangement. The magnets stack in convenient lines for this process. Mark either end of the magnet stack with different symbols.

Follow the series in Figure 23 below 24 times:

a) Insert the end magnet into either slot of the 3D print.
b) Leaving the end magnet in place remove the stack in the direction shown
c) Turn the stack over 180 degrees and insert the end magnet as before into the remaining slot
d) Drag the stack in the direction indicated.

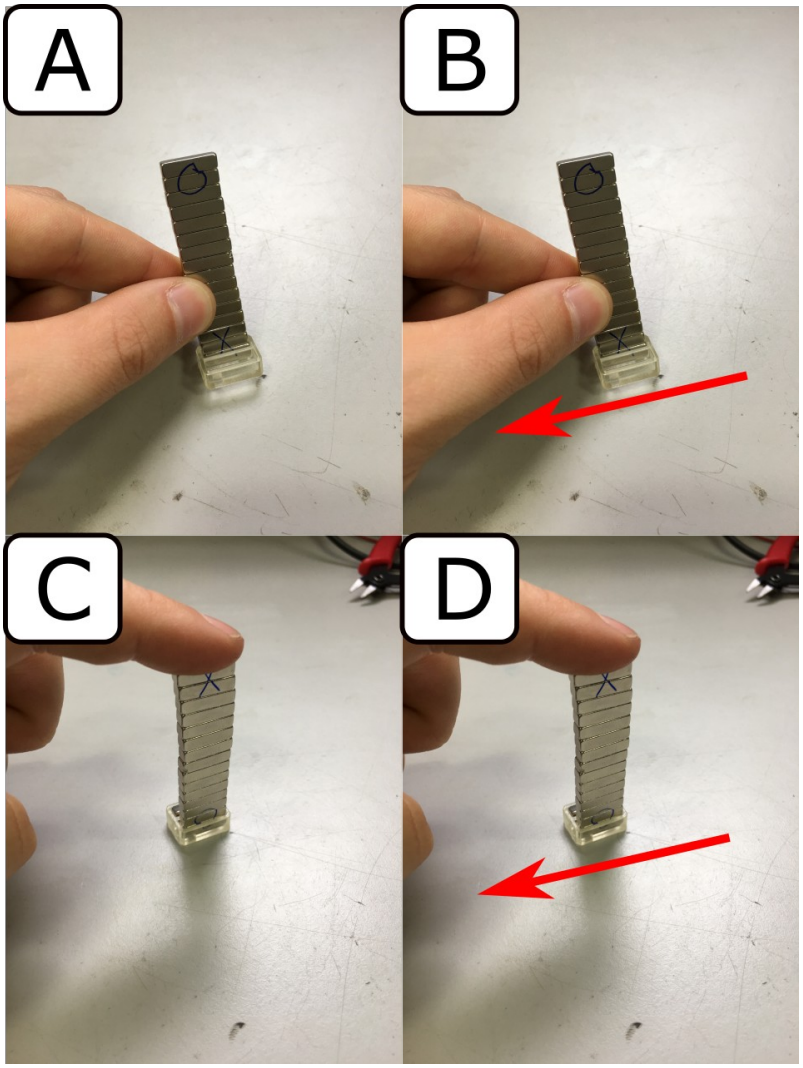

Figure 23 Method to create the appropriate relation from between each pair of magnets and to create a powerful stirring force

In this arrangement the magnet should repel each other and will be kept from jumping out of the housing by this force pushing them into the outer walls of the slot, any other arrangement will fail to stir.

When all housings are fitted with magnets carefully place them onto the base pieces' glues to the fans (in most cases I have glued the top housing to the bottom once I am sure the stirring is functioning to save the frustration of magnets jumping onto one another)

Figure 24 Magnets secured in the housings are added to the base mounts on the stirring ring

Electronics

By the end of this section the platform will be ready for use. This series of steps includes:

- Preparation of a Corsair F450 power supply
- Cable preparation for powering all required functions on an Arduino Mega
- Crimping and housing stepper motors and tuning each motor using the driver boards mounted on the RAMPs board.
- Flashing the board with the needed software

14. Power supply activation and 12V supply:

Corsair SF450 (optional, you need a 12V source, this is our preferred model)

- Two female Molex crimps
- Short piece of wire (4 cm approx.) both ends stripped
- 6 slot Molex housing (2 rows of 3)

Strip both ends of the small wire and attach the crimps

The power supplies will not activate unless two specific pins on the outlets are joined (don't ask why…)

MAKE SURE the power supply is OFF!

Connect the pins shown in Figure 25A. Next, prepare red and black cables with the same crimps into the 6 slot Molex housing as seen in Figure 25B. Either of the 'Peripheral & Sata' ports will work. By attention to the red/black arrangement. This cable will now supply 12 V and can be distributed by splitting the cable to many locations. To test, turn the power supply on, if the fans turn briefly, success.

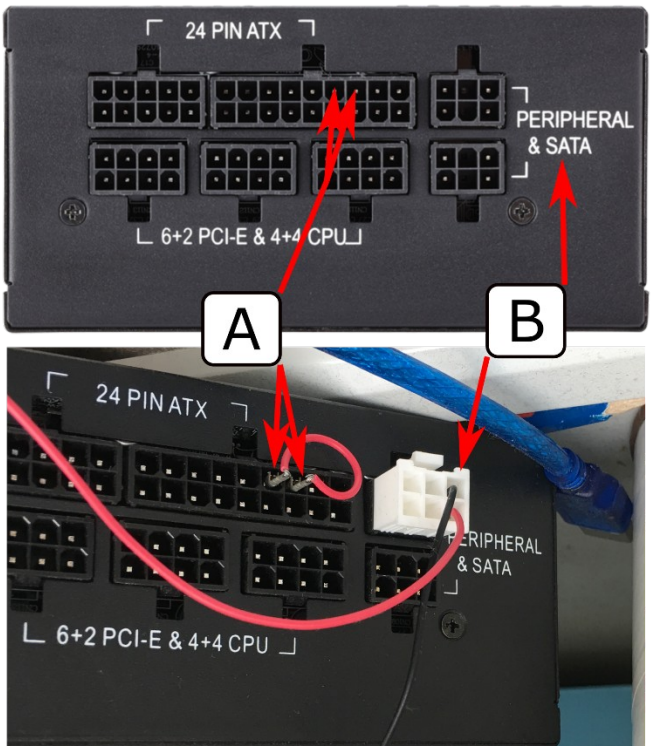

Figure 25 Corsair SF450 power supple activated with 12V outlet **A)** Activation pin **B)** 12V cable

15. Arduino and electronics preparation

- Arduino Mega2560 (Number of stepper motors / 5 = number of Arduino mega needed)
- A RAMPs 1.4 control board (premium or regular (blue or red) it doesn't matter) for each Arduino
- 2 slot Molex crimp housing connectors and crimps
- Red and black wire

The control boards for this platform are an Arduino Mega2560 and RAMPs 1.4 paired assemblies. Many different forms of powers and feedback can be supplied by these two boards, two of which are used here: PWM (pulse width modulation) and 12V output. The RAMPs board is slotted on top of the Arduino (make sure all pins are aligned between them). Each ramps board can house 5 small DVR8825 stepper motor driver boards that are used to modulate the power going from the RAMPs to a given motor. Stepper motors range hugely in the power they require to function due to their size and strength, these boards allow a variety of different motors to be powered from one RAMPs as each driver board is tuned, by the user, to give out a specific amount of power. These driven boards are described in the next section. For now, we are concerned with powering the boards.

NB. The images in the following figures show both the premium (blue) RAMPs board and the normal version (red/orange) as the image were simply taken at different times and on several different platforms. This is because we kept forgetting to take a full range of images when building each platform, sorry. However, this does show that there is virtually no difference between the boards and the set-up of both is precisely the same.

Figure 26 shows an Arduino/RAMPs pair with two cable pair attachments **A** and **B**.

A) This cable pair is bringing in the 12V power from the power supply. Notice the female Molex housing used earlier here. This is not essential but will make disconnecting the platform from power very simple and is very highly advised. **The power comes in**: Red wire left, Black right. The small cable loops seen at this part are needed to supply power to all the boards functions. Simply twist together the smaller and large pieces and trap them into the inlet as seen below making sure there is no contact between red and black wires.

B) This cable pair is a PWM output from the RAMPs MOSFET functions that will be used to power the fans. The fans will turn at 9000 RPM from a raw 12V supply which is *slightly* too high for conventional reaction stirring. Using PWM, the supply of power to the fans is pulsed rather than constant simply meaning less overall power reaching the fans whilst still providing consistent function. PWM output is controlled by the user and set in the code. The default output is 35/255 which will turn the fan at roughly 800 RPM. **Notice the cable arrangement is reverse relative to the power input of A). Make sure this is correct before powering the fans as it will cook all 24 in seconds if supplied incorrectly.**

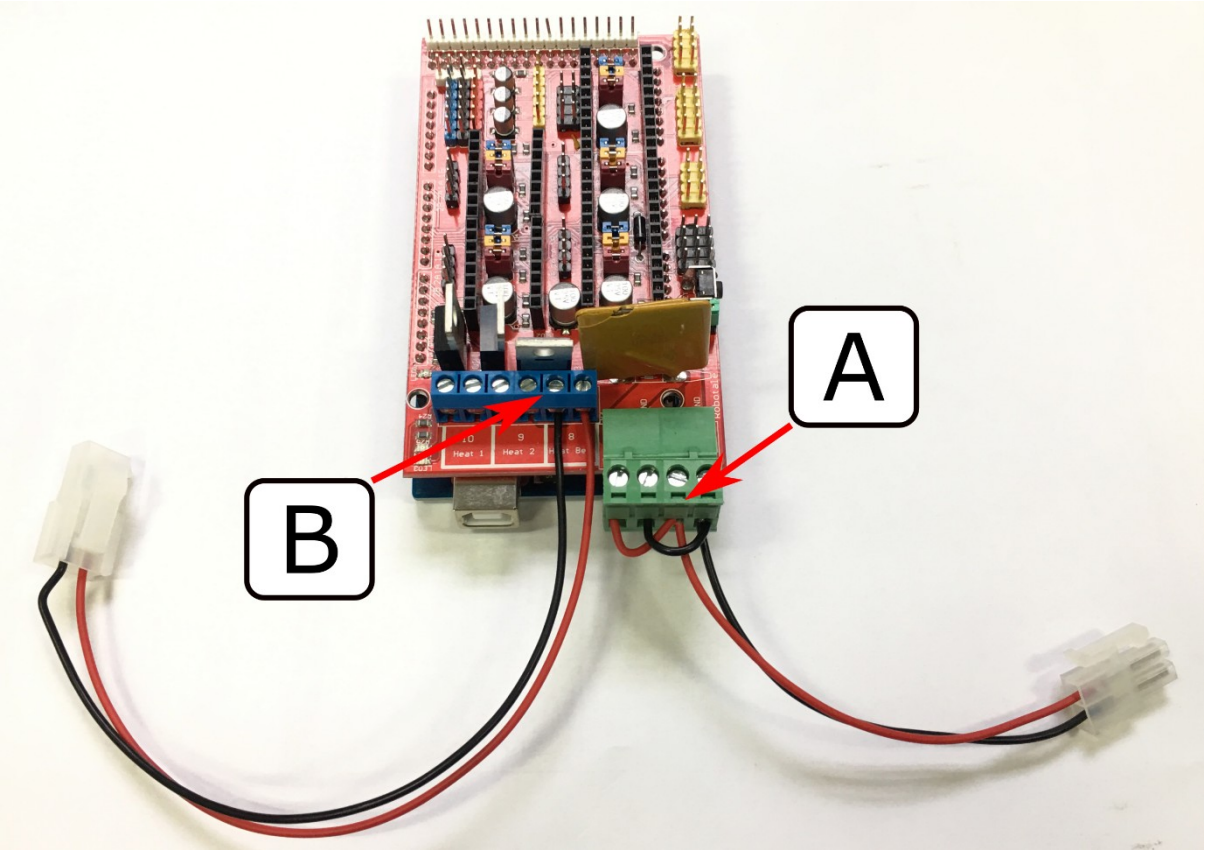

Figure 26 Aruino/RAMPs pair (Arduino is underneath) **A)** Power cables from the power supply, into the RAMPs board. **B)** PWM power coming out from the MOSFET outlets (cables revered relative to **A**))

16. Preparing stepper motors

- Nema 17 40 mm stepper motor
- SR10/30 peristaltic pumps from Gardener Denver (however many you want)
- Multimeter
- Molex KK 254 female crimps and housings (BOM)
- Standard crimping tool
- Philips precision screwdriver

There are a wide variety of stepper motors, however for the purposes of this platform we deal with only two sizes of the same type: bipolar type Nema17 (drive wheel), and bipolar type stepper motor (pumps).

Both stepper motors have the same wire arrangements however they use different colours. Being able to identify the wire pairings is vital. Here is a video to describe the method of identifying the wire pairings, how the motors work and why it is important to get this step right.

https://www.youtube.com/watch?v=kNyAcAHLET8

Once you have identified them, crimp each wire with the Molex crimps above and insert them in the housings in pairs. For the Nema17 in on our platforms this order is black, green, blue, red (from either side, it doesn't matter). For the motors the order is black, brown, yellow, orange. This is not gospel as manufactures could change the wiring used however in all examples of many platforms in our lab, these are the same. The pumps will be housed on the platform frame and so you need to ensure there is enough length in the cable to reach the Arduino board.

Once complete insert the 4-crimp housing onto the 4 pins neighbouring the stepper motor driver board locations as seen in Figure 27. The USB connection to the Arduino seen in Figure 27 can be added now order later, it doesn't matter.

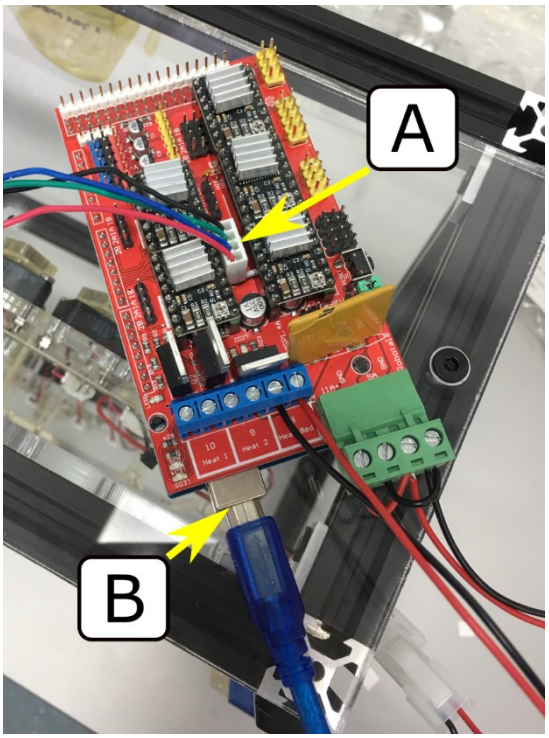

Figure 27 **A)** Stepper motor wires in Molex housing plugged to 4 pins of a DVR8825 stepper driver board. **B)** USB connection to PC

17. Adding and tuning stepper motor driver boards

- DVR8825 driver board for each stepper motor on the platform you are creating.
- Metallic screwdriver
- Multimeter
- Acrylic Arduino mount (laser cut folder)
- 4 x 20 mm M3 screws per Arduino with nuts
- 3 x 10 mm M5 screws and drop in tee nuts

This stage will add stepper drive boards to the RAMPs and tune them to the motors they will power. To make things easier, we suggest you mount the Arduino/RAMPs assemblies on the platforms via the acrylic mount (helps keep the board steady when tuning the drivers)

Screw the acrylic to the platform side closest to the drive wheel motor. Screw the Arduino to the acrylic alone and then insert the RAMPs board (Figure 28A and B). From here insert up to 5 DVR8825 boards in the orientation seen in Figure 28B onto the RAMPs. With each DVR8825 board you should have received heatsinks, you can use thermal tape to secure the heat sinks board chips, very important especially for larger motors.

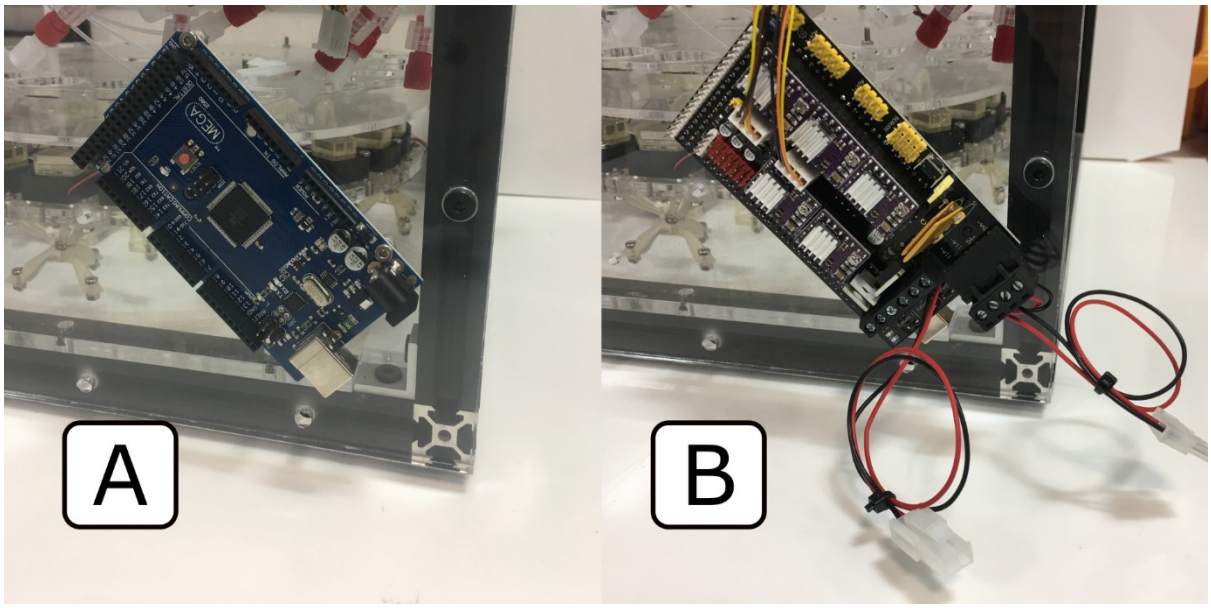

Figure 28 **A)** Arduino screwed to the acrylic mount on the platform frame. **B)** RAMPs inserted into the Arduino (premium RAMPs this time).

From this point the stepper motor driver needs to be tuned to the voltage specific to each motor. This video details the procedure as a worded description would be less efficient. This video details the procedure and requirements for the DVR8825 drivers as well as the second most common driver used, the A4988 board. If you are using DVR8825 you need the 12 V power supply, for A4988 the 5V from the USB cable is enough.

https://www.youtube.com/watch?v=oAHoovtL110

If you can manage to hold the black Multimeter to the power in terminal and the red electrode in one hand you can use the helpful method seen in Figure 29. Turn the current regulator with a metallic precision screwdriver with your free hand whilst applying the red electrode to the screwdriver shaft, with the black electrode on the power input. This will allow you to change the voltage and get a live reading.

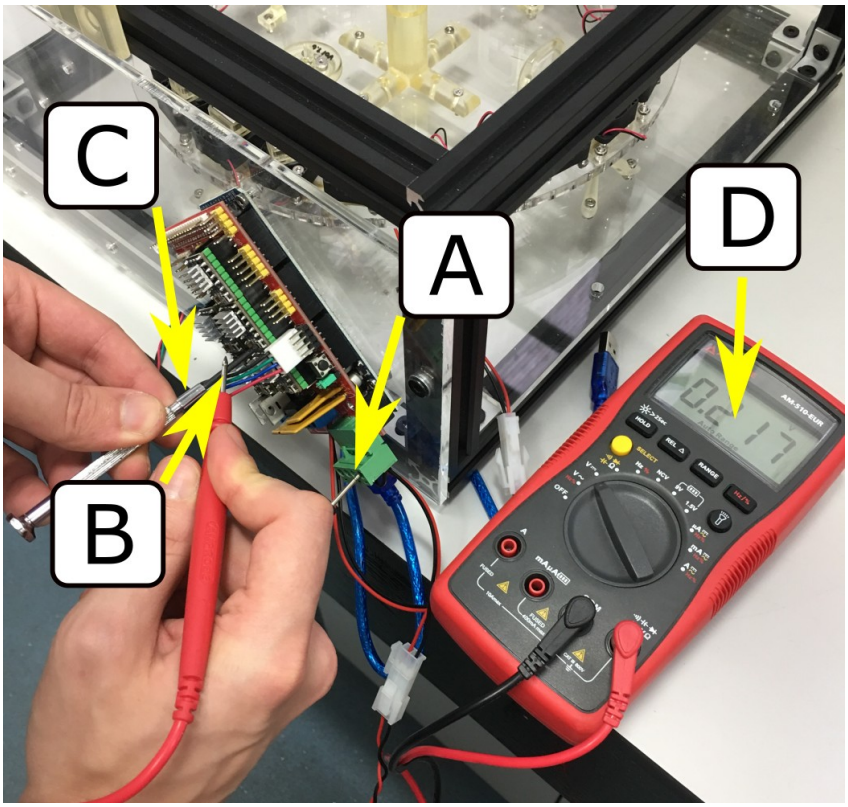

Figure 29 **A)** Black multimeter electrode on power input (black wire, outermost slot) **B) C) D)**

Roughly the Nema17 requires 0.55-0.7V and the stepper motors for the pumps require around -0.15-0.225V. A good indicator is the motor will produce a consistent high pitch ringing when you are approximately at the correct voltage, testing the motor via commands is the final text where small adjustments may be needed.

Once all drivers are tuned to the motor type you intend to place on it, begin adding the pumps.

Fluidics

18. Pumps and fluidics.

- SR10/30 peristaltic pumps (crimped and housed) with desired heads for different flow rates
- Idex flangeless fittings Nat PP 1/16” and 1/8” depending on peristaltic pump head size/flow rate
- PTFE 1/16” and 1/8” tubing
- PTFE lined precision dispensing needles.
- Masterflex fittings, PP, straight female luer with barbed fittings
- Drop in tee nuts and M5 8 mm bolts
- Drill and M5 drill bit

The peristaltic pumps are housed on the outer frame of the platform and plugged to the Arduino boards. The fluidic connections we use are detailed in X. **A)** is the pump itself with the Molex housing ready. **B)** Shows the drop-in tee nuts and the 8 mm M5 bolts in the black pump housing. The housing screw holes need to be bored to M5 using a drill. **C)** Idex 1/4-28 female Luer. **D)** Idex flangeless fitting either 1/8” or 1.16”. **E)** PTFE tubing. F) MasterFlex fittings press fit into the peri pump tubing. **G)** Optional dispensing syringes (you can use raw tubes with the “Raw tube” dispensing module in the STL folder).

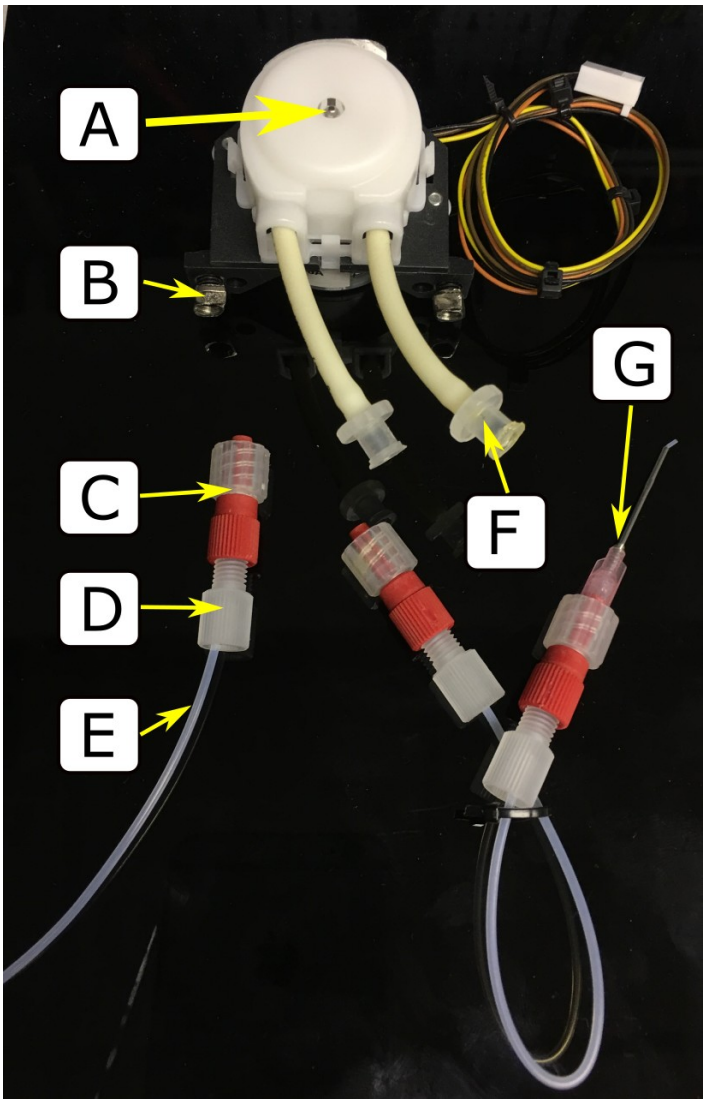

Figure 30 Pump and fluidic assembly

You can now secure the pumps to the platform frame and plug them to their respective positions on the RAMPs boards. See figure X, Y and Z for the pumps mounted, the syringe assembly and the completed platform.

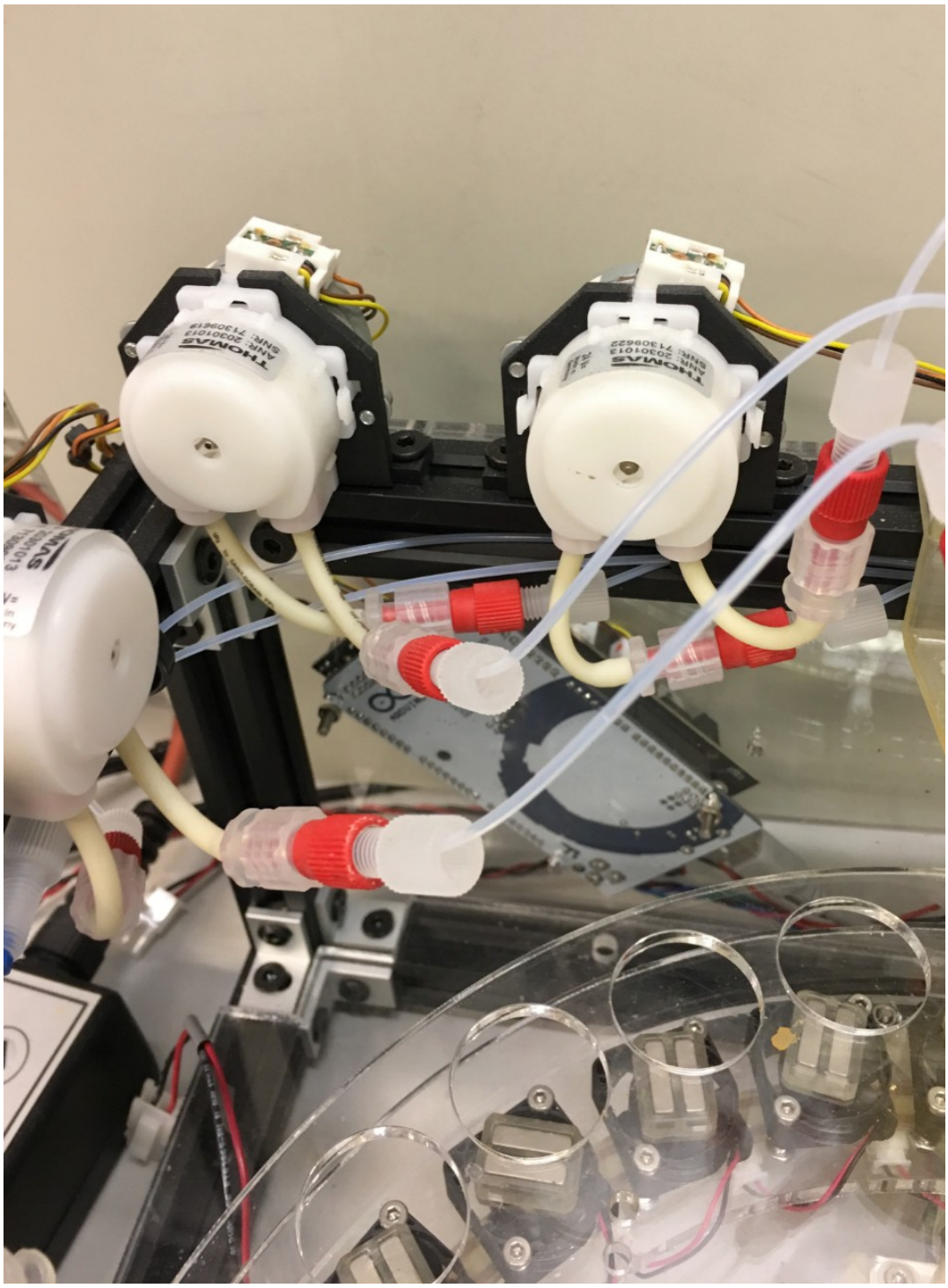

Figure 31 Pumps mounted on platform frame with fluidic attachments

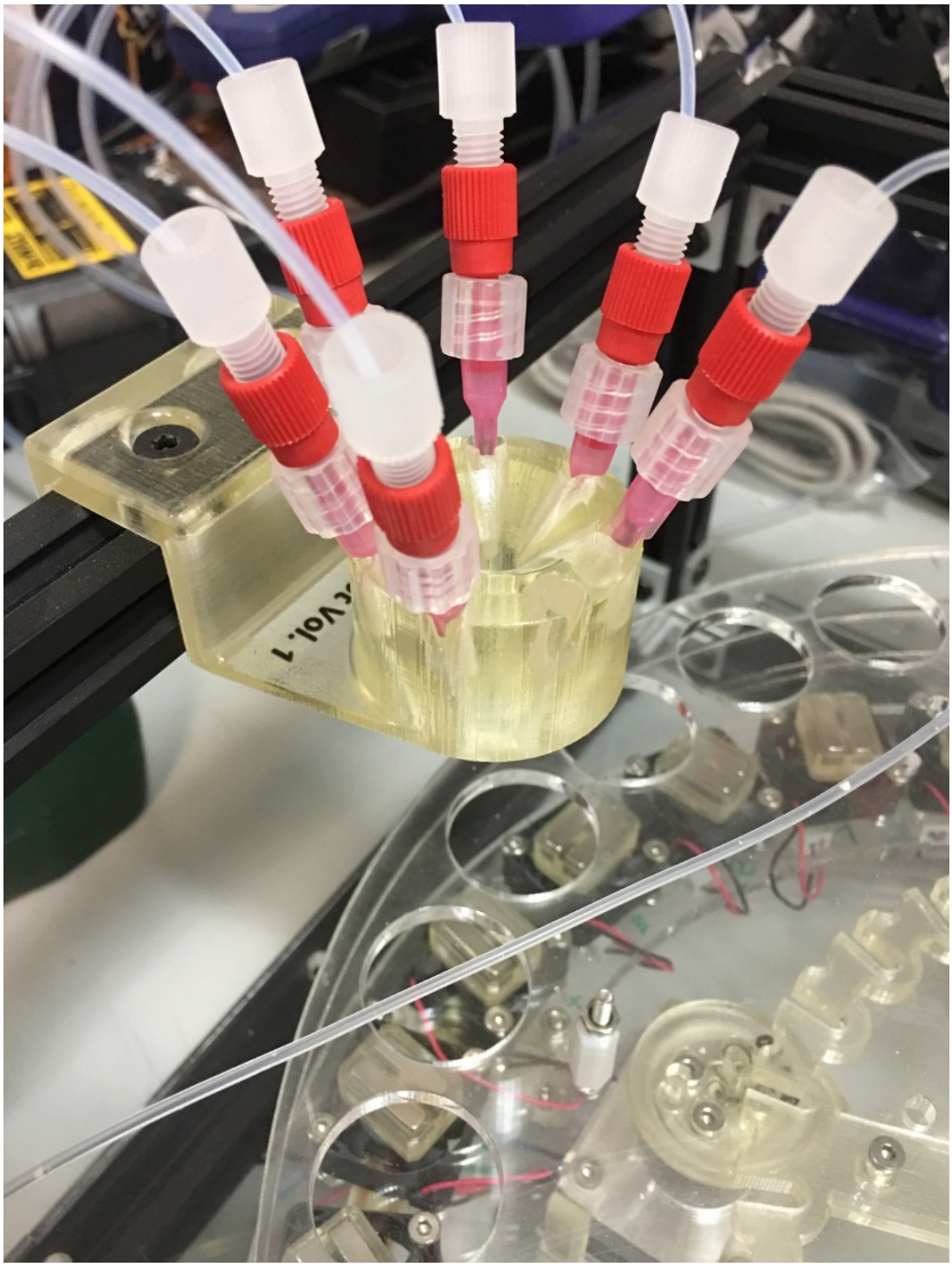

Figure 32 Syringe assembly

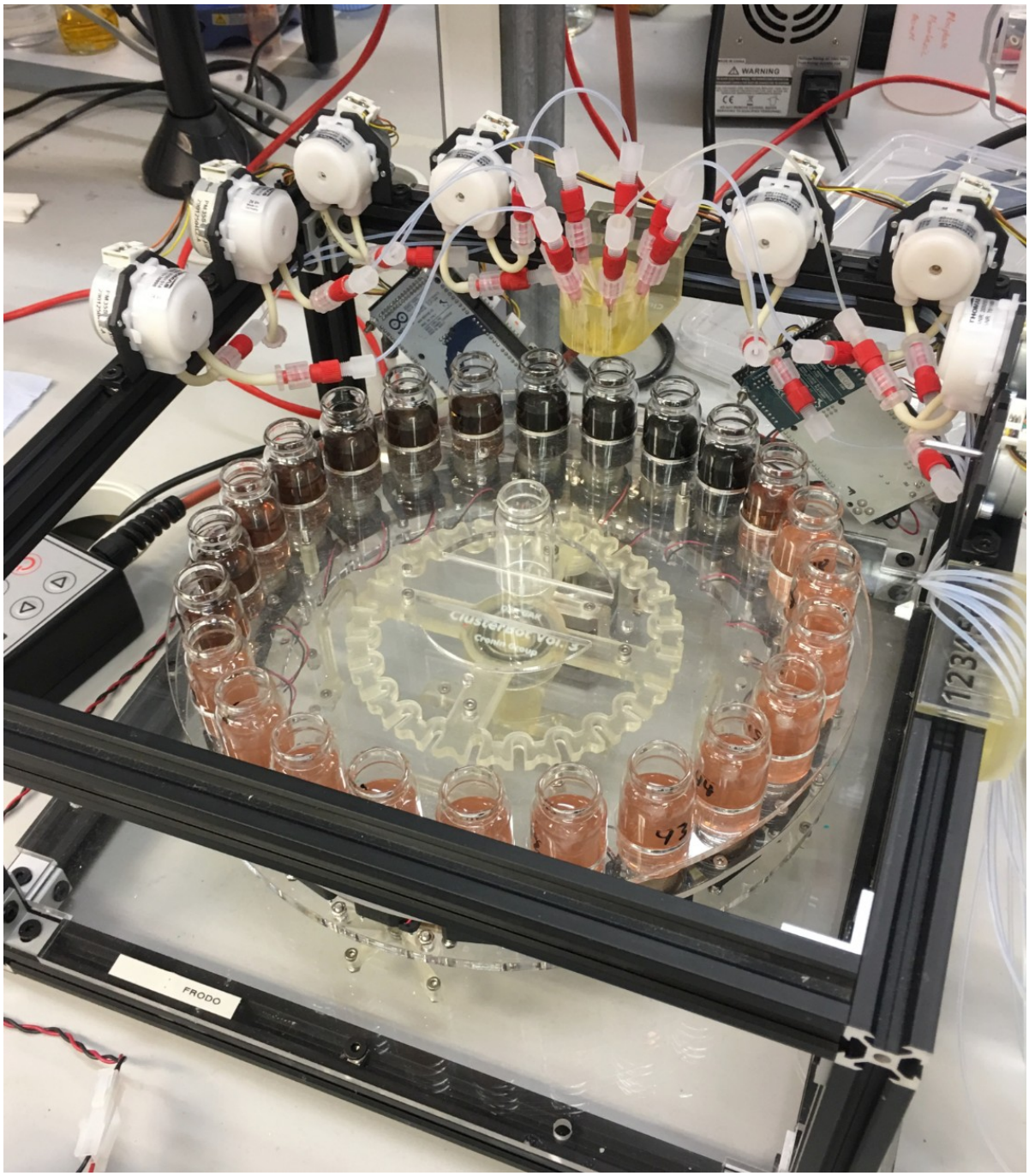

Figure 33 Complete assembly

Computer setup and running of the platform:

Following this link to the software description that details not only the implementation and use of the software, but fundamentally how it works. You will need a PC system running Linux (ubuntu preferably). A raspberry Pi will be fine to use. Finally, a monitor, mouse and keyboard.

Refer to the README for operational instructions: InorganicClusterDiscovery/README.md

Ensure all the electrical connections are made; the fan ring to PWM output, main power supply to RAMPs and pumps all plugged in. Turn on power supply and follow the software instructions for getting the platform working and enjoy…

Final notes

This platform is relatively compact given its functions, and this the base model, which is as simple as it gets. This means there is a lot going on in a confined space, **HOWEVER** if managed appropriately it can function flawlessly for a very long time. There are several items that will help hugely in organising and keeping the hardware in working order. These can be as basic as cleaning after use and simple cable ties to organise wires. You can see in Figure 33 that there is a number tube guide (model in STL folder) that can help to keep tubing out of the way and safe. You may be able to see in various images that a black plastic sheath is holding the cables and wires inside the slots of the frame, this is called a slot cover and you can be found in the BOM from Ooznest (I am sure others sell it also). This item can be cut to length as needed and is very useful.