

MICRO SLICE

V2.5



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Build Manual

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To build a MicroSlice you will need the following tools;

- Needle Files.
- Screw Drivers.
- Mini Clamps.
- 120 Grit Sandpaper.
- Sanding Block.
- Craft Knife.
- Small Hammer
- Glue | PVA for plywood or Tensol 12 for acrylic.
- Soldering Iron.
- Multimeter.
- Suitable Work-Space.
- Needle-Nose Pliers.
- Ruler.
- Set-Square.

I recommend using toughened glass panes to build your MicroSlice on. They are good for several reasons; one, they are perfectly flat, two, they do not bend and three, the parts won't permanently stick to the glass. Check your local £1, \$1, €1 etc. store for low-cost glass chopping boards, or up-cycle the glass from old flatbed scanners as I have done.

Take your time and don't rush things.

I highly recommend building each section of the MicroSlice without using any glue so that you can better understand how the MicroSlice is assembled. This will help eliminate any errors and help identify any parts which may be missing or damaged.

There is a high-resolution archive of all the images used in this build-manual available to download from

<http://thelittlebox.co/images>

If anything goes wrong, or if you're not sure about something,

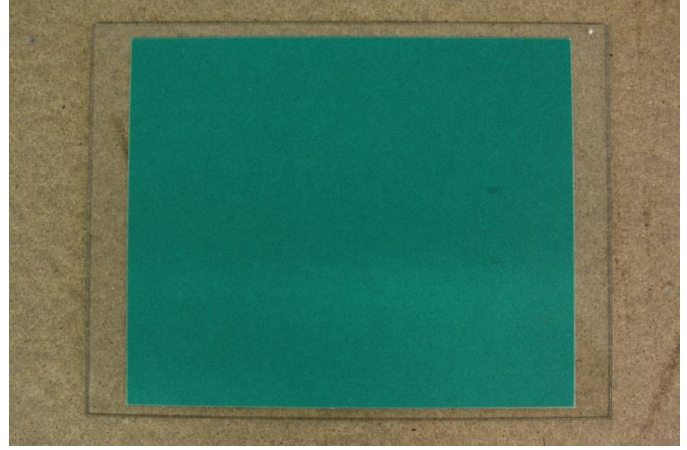
DON'T PANIC

Check the forum <http://thelittlebox.co/theforum>, the wiki <http://thelittlebox.co/thewiki>

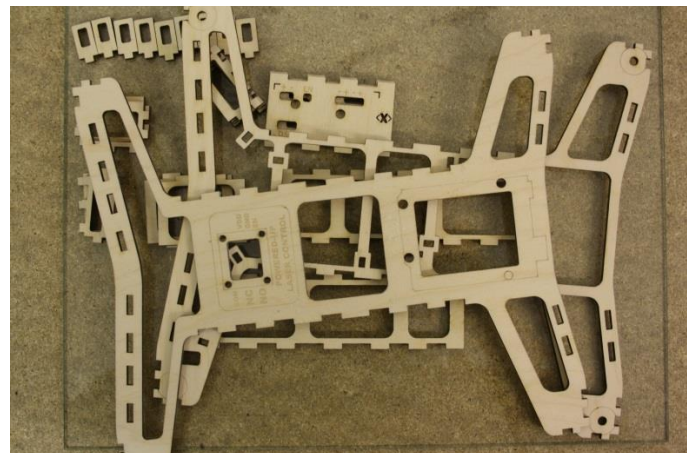
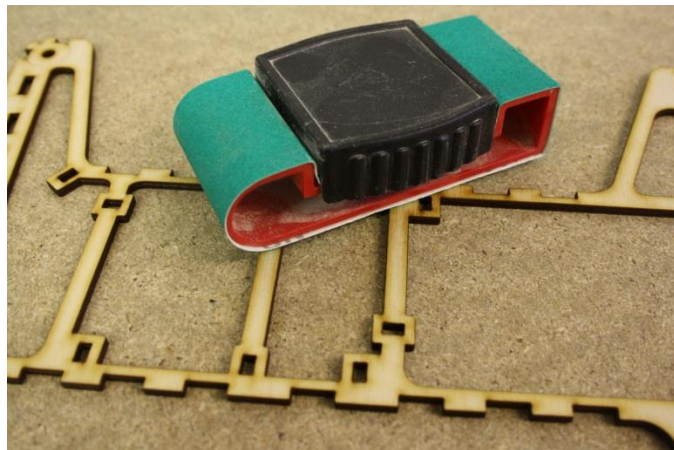
then email info@thelittlebox.co if you're still having problems.

Section 1 | Hardware Assembly.

[Preparations]

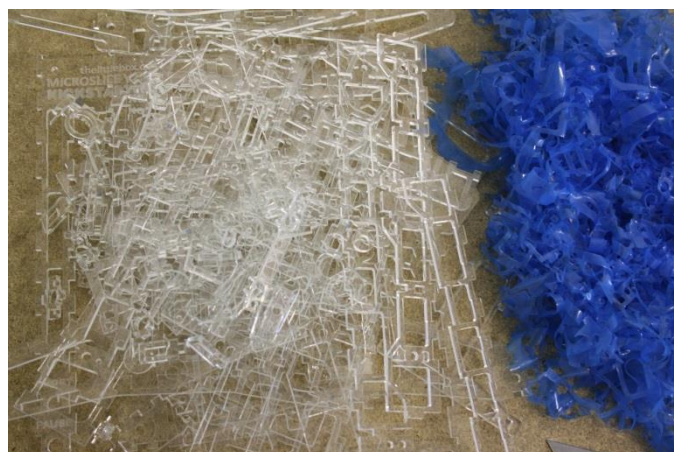


All the Plywood Laser-Cut parts need a light sanding on both sides with 120 Grit paper to remove any rough surfaces or scorch marks. I used several strips of double-sided tape to attach some 120 grit paper to a toughened glass pane.

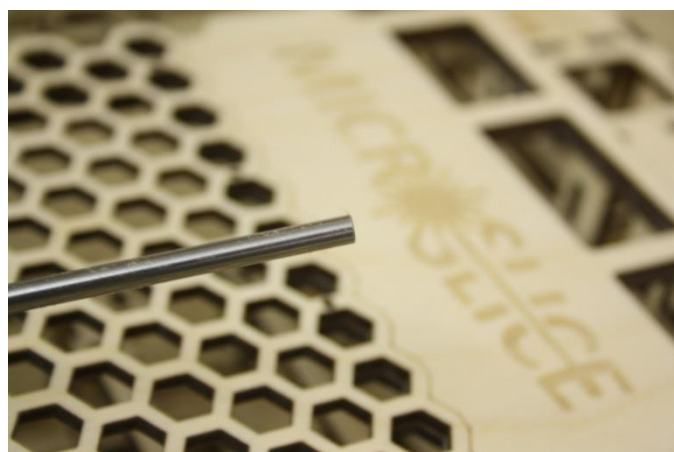
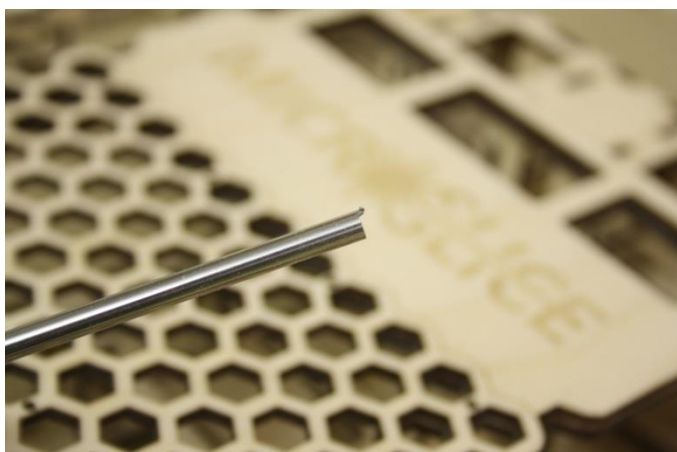


The Acrylic Laser-Cut parts are protected on each side with a thin polymer film. The film needs to be removed from each Laser-Cut part. Use the point of a sharp knife to lift the edge of the film so you can peel it back.

Some of the Laser-Cut Acrylic parts may be covered in a layer of black soot caused during the cutting process. Please make sure you are working in a safe area where the transfer of soot will not cause any damage to property.



The 3mm & 4mm Silver Steel rods on which the linear bearings run will need any burs removing from the end. Using a flat needle file carefully remove any burs from the ends of the rods. You can slightly round of the ends if you like. It will make them a little easier to fit.



Hardware Assembly | Part 1 - The Lower-Deck.

4x LD01



12x LD02



2x LD03



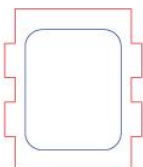
4x LD04



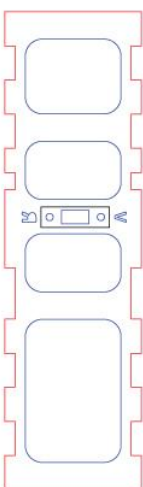
2x LD05



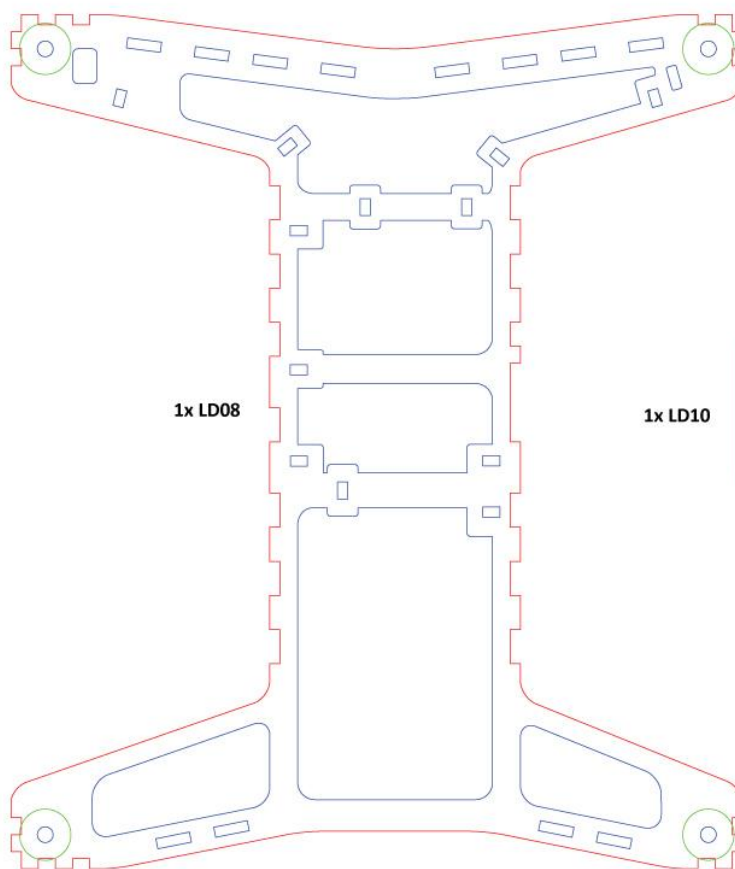
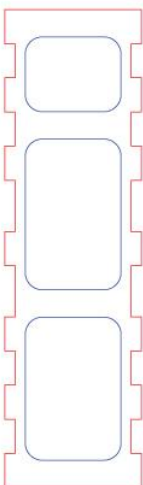
2x LD06



1x LD07

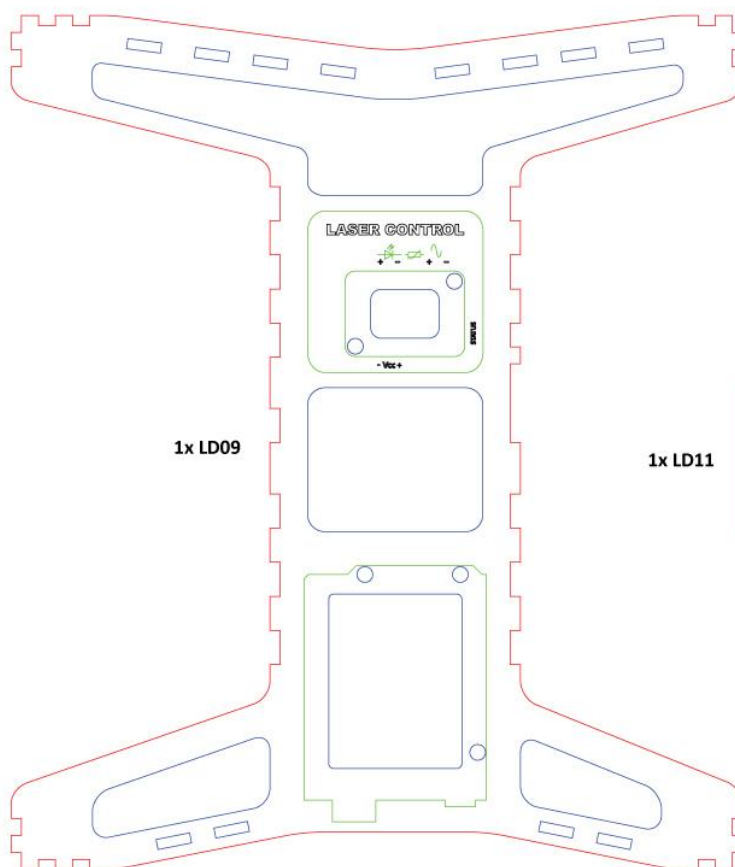
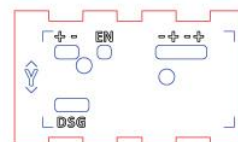


1x LD08



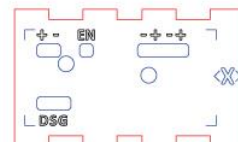
1x LD08

1x LD10

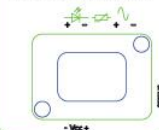


1x LD09

1x LD11



LASER CONTROL



- Vec+

You will also need

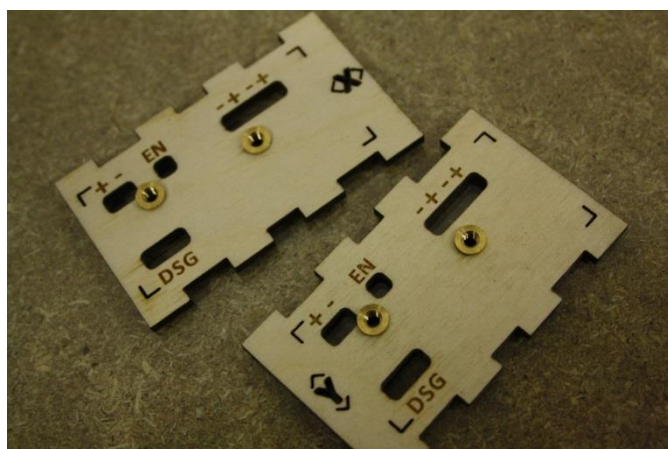
- 13 x M3 Microbarb Brass Inserts.
- 4 x Rubber Feet.

To begin; press-fit 5x M3 Microbarbs into part **LD09** from the underside as shown in the image.

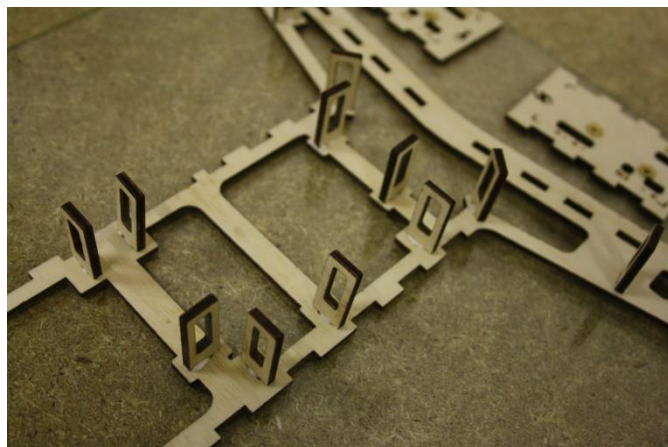
Some of the holes for the Microbarbs may need widening before the inserts can be fitted. To widen the holes use a round needle-file.



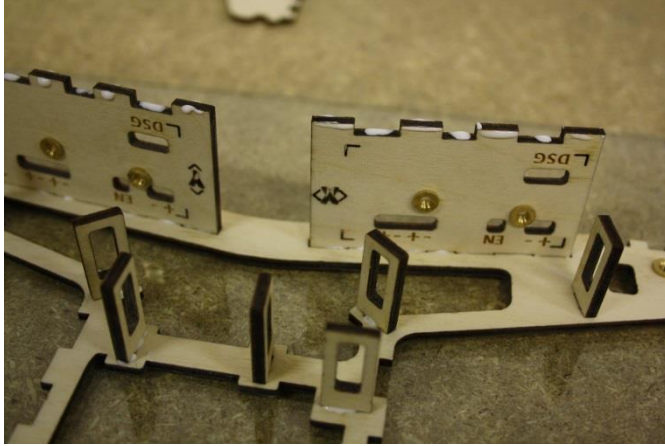
Press-fit 4x M3 Microbarbs into part **LD08** from the underside and 2x M3 Microbarbs into parts **LD10** & **LD11**.



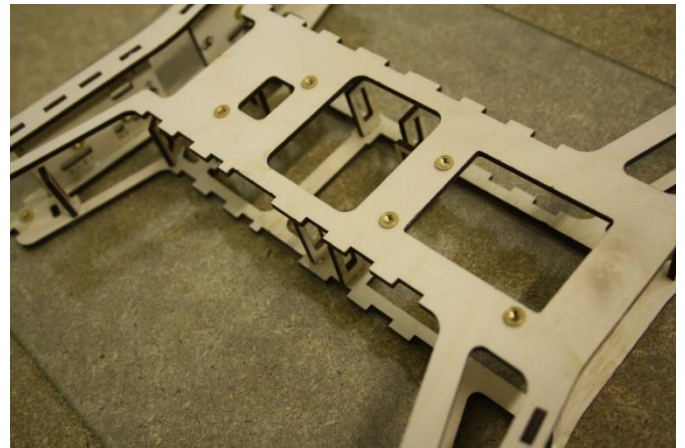
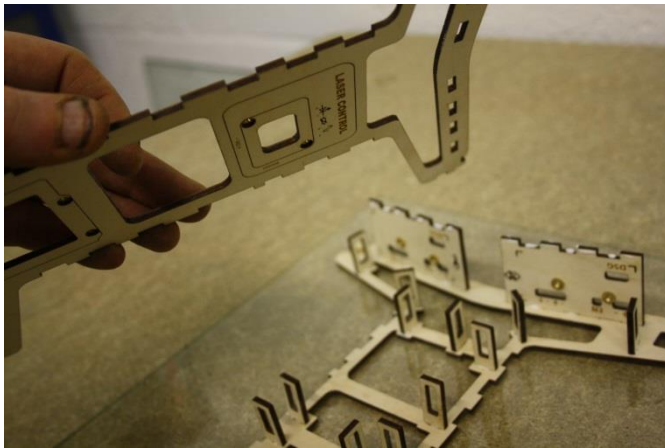
Place **LD08** face-down on your work surface. Glue 12x **LD02** Cable Conduits into part **LD08**.



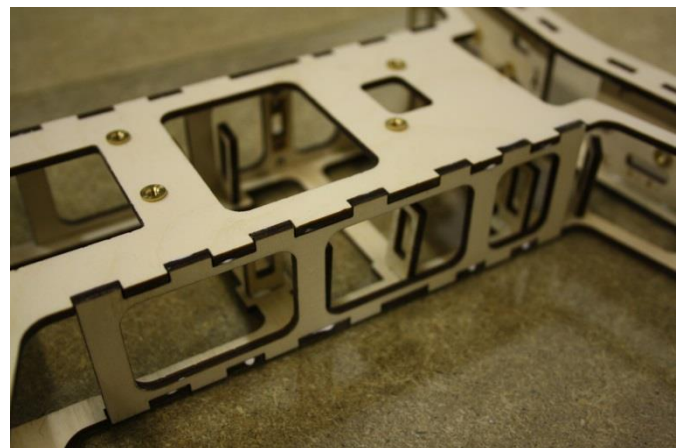
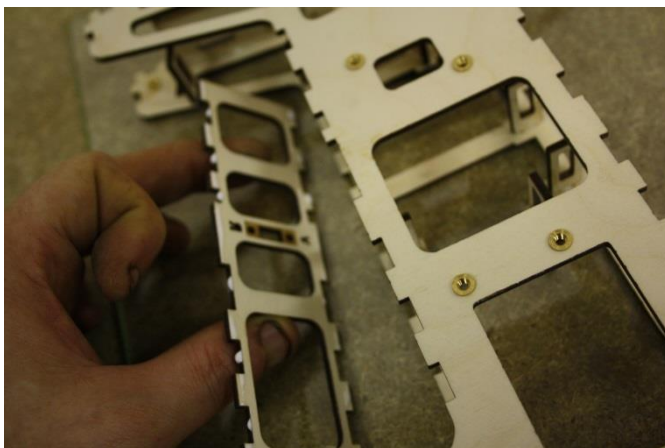
Glue **LD10** & **LD11** to **LD08**, make sure you have them in the correct orientation with the text upside-down and with the Microbarbs facing in towards the Cable Conduits. Then glue 2x **LD06** at the front of **LD08**.



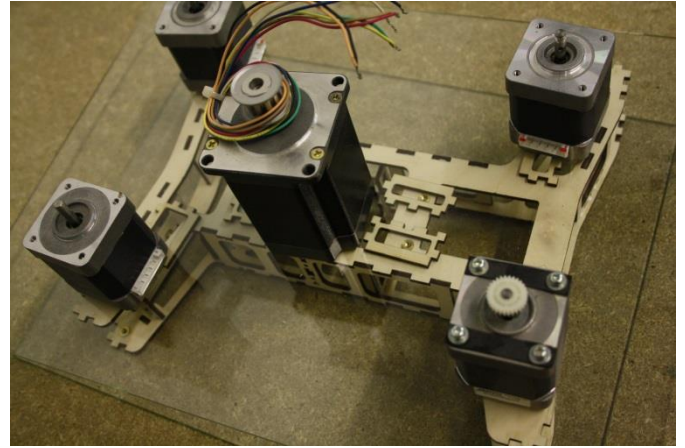
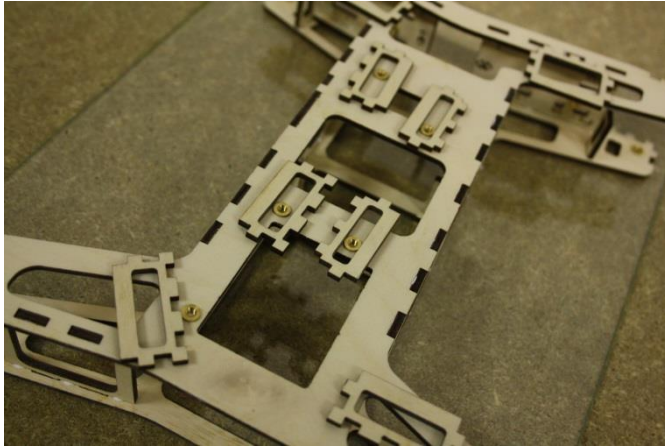
Glue **LD09** to the assembly.



LD07 must be glued to the left side of the face-down assembly; the recessed cut-out needs to face inwards. **LD08** is glued to the opposite side.



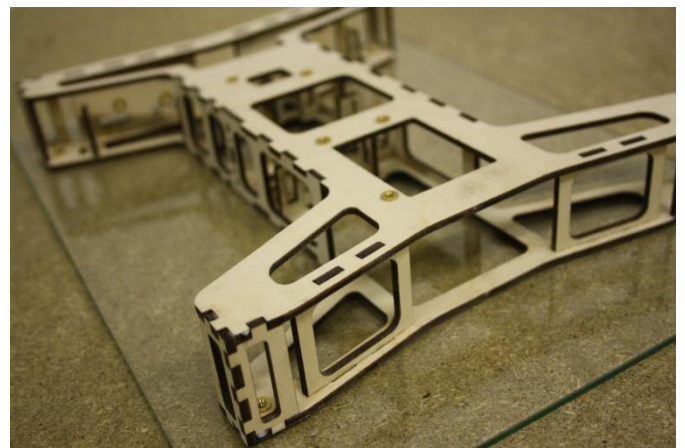
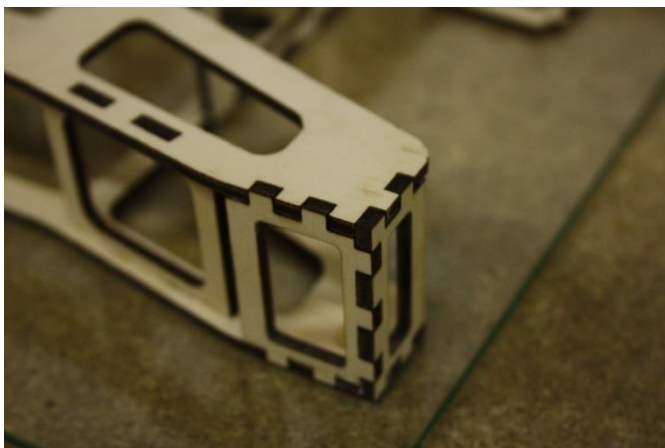
I have placed the remaining parts for the Lower-Deck on top of the assembly while taking care to make sure they do not get glue on them. I have placed another sheet on glass and weights on top to keep the assembly flat while the glue dries.



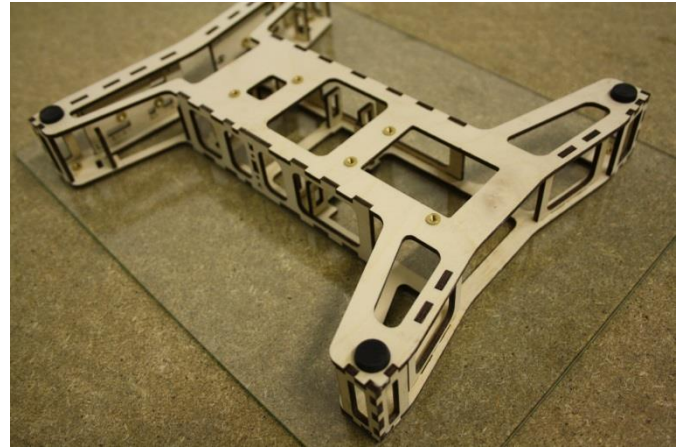
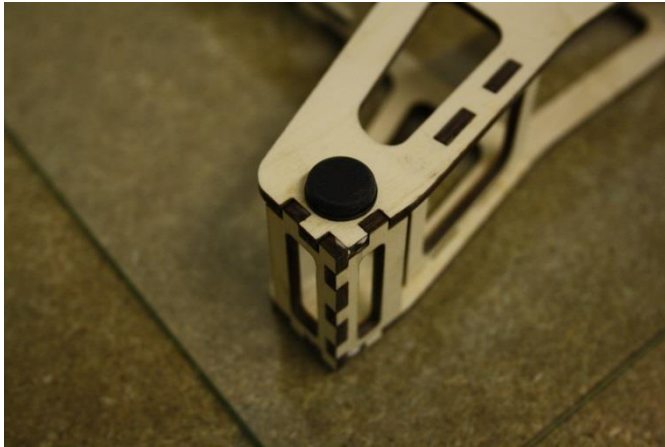
Next are the corners. Each corner uses an **LD04** and either an **LD05** or the smaller **LD03**.



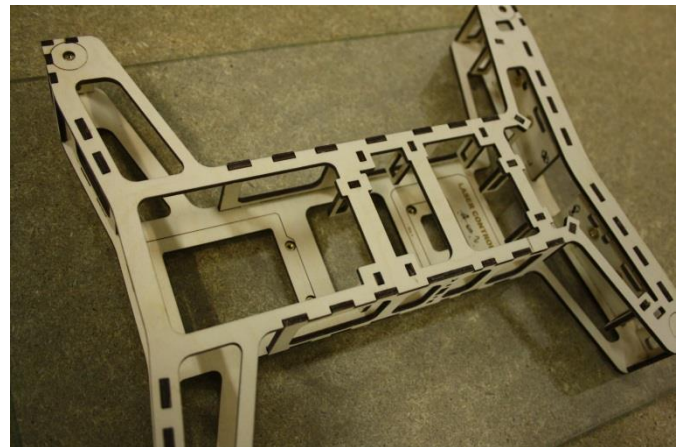
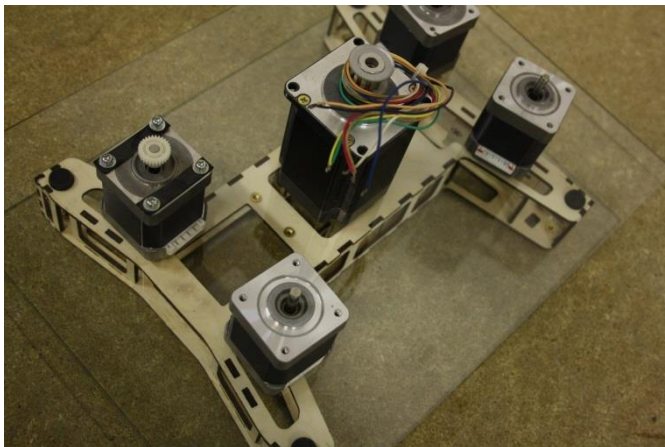
Make sure to check which side each part goes before applying glue.



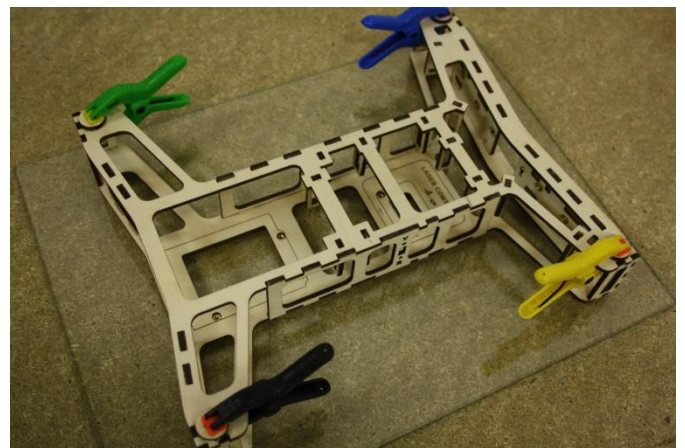
Stick 4x **Rubber Feet** to the corners of the Lower-Deck.



I have put the glass sheet and weights back onto the Lower-Deck while the glue sets. Once the glue has cured remove the weights and turn the Lower-Deck face up.

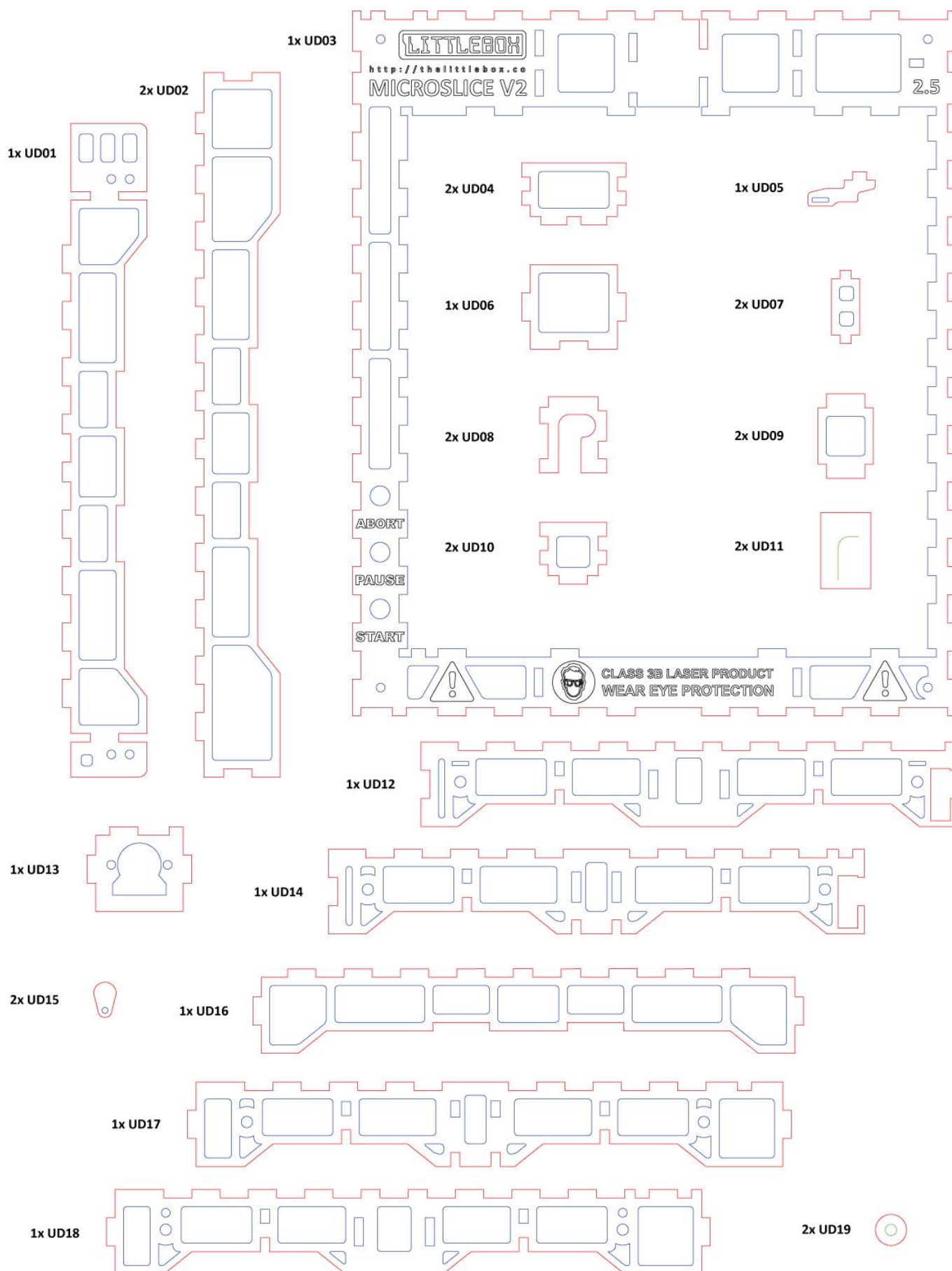


To each corner glue an **LD01**.



The Lower-Deck is now complete.

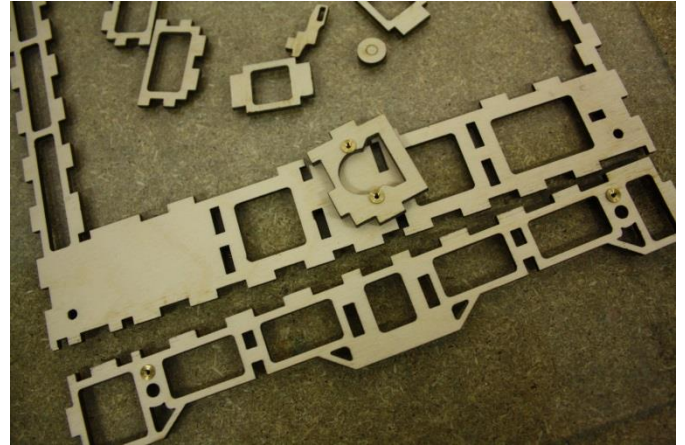
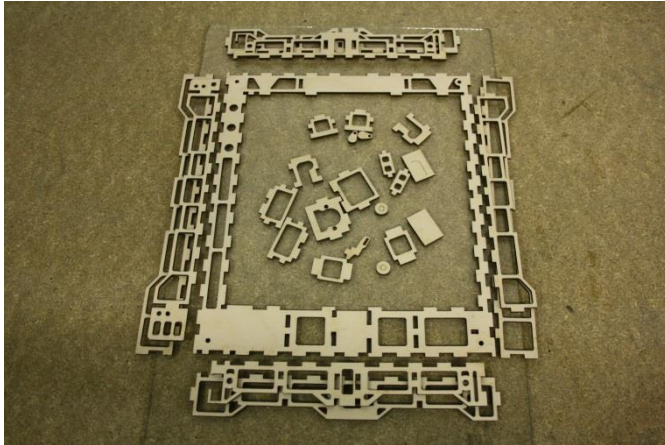
Hardware Assembly | Part 2 - The Upper-Deck.



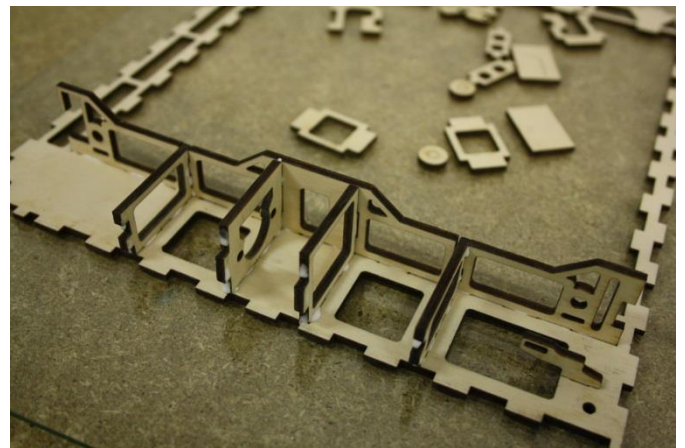
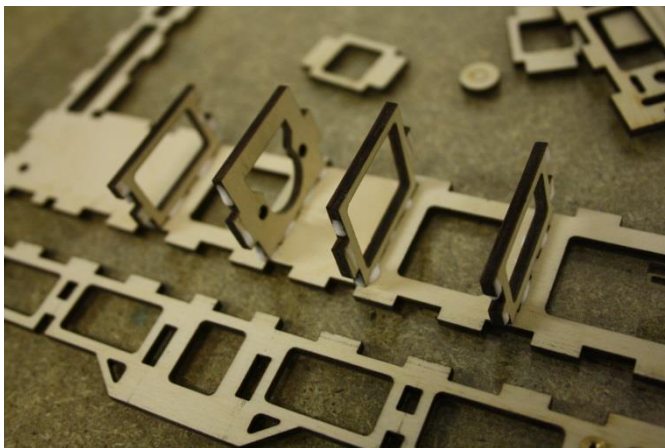
You will also need

- 8 x M2 Microbarb Brass Inserts.
- 2 x M2 8mm Screws.
- 2 x 4mm x 250mm Bars.

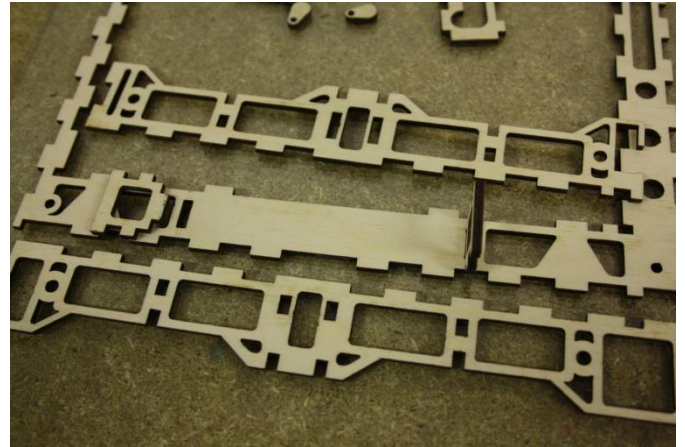
Lay the Upper-Deck parts out on your workspace with **UD03** face-down as shown in the photograph. Fit 2x M2 Microbarbs to **UD13** and 2x M2 Microbarbs to **UD18** making sure the inserts are fitted from the correct sides.



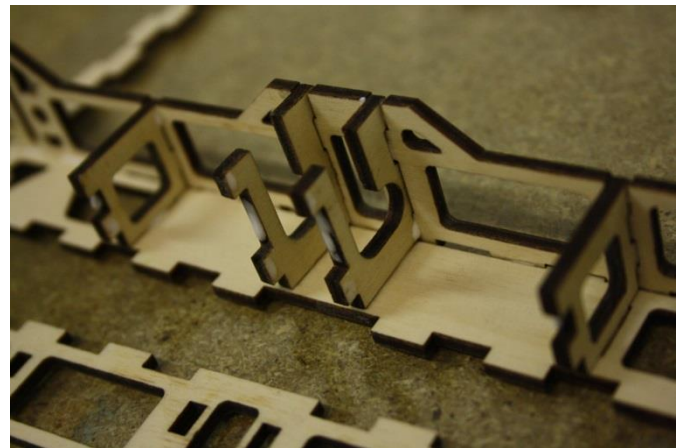
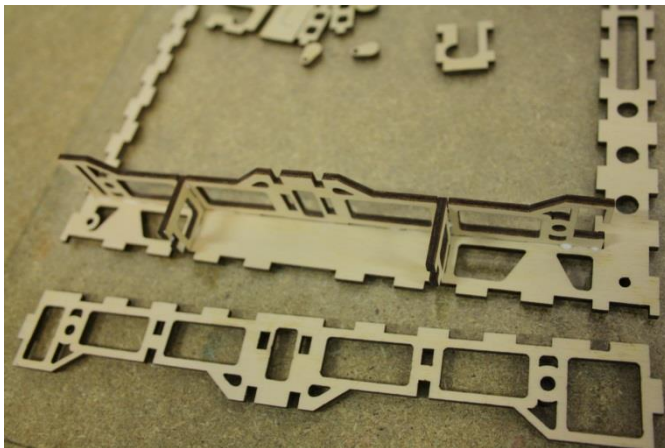
First glue 2x **UD04**, **UD13**, **UD06** and **UD05** to the face-down **UD03**, then glue **UD12** in place.



Glue in UD18 and weigh down the assembly. Turn the assembly around to work on the opposite end.

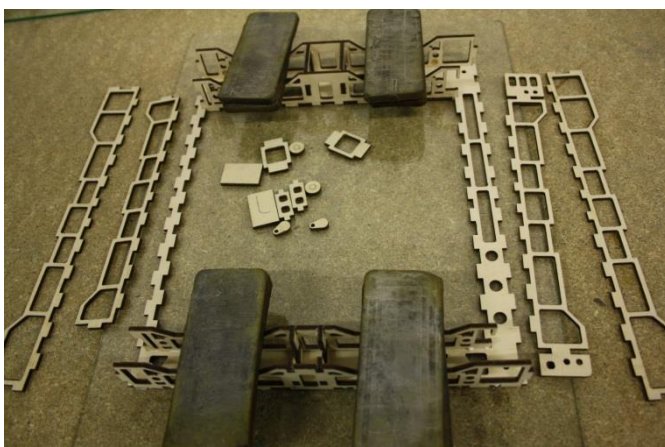


Glue 2x **UD10** and **UD14** to the face-down **UD03**. Glue 2x **UD08** to **UD14** and **UD03**.

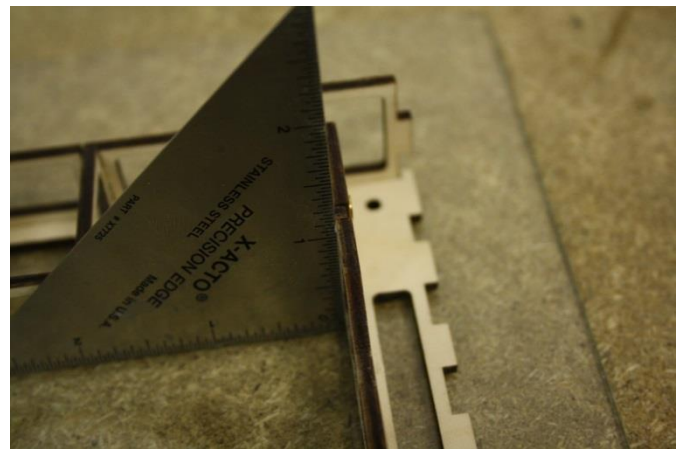
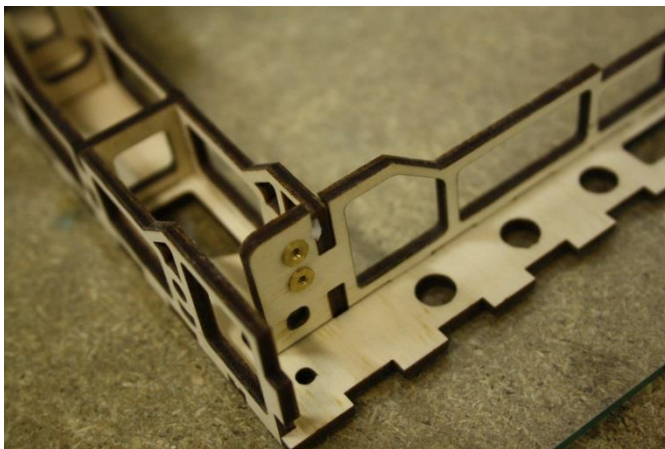


Glue **UD17** to the structure and weigh down the assembly while the glue cures.

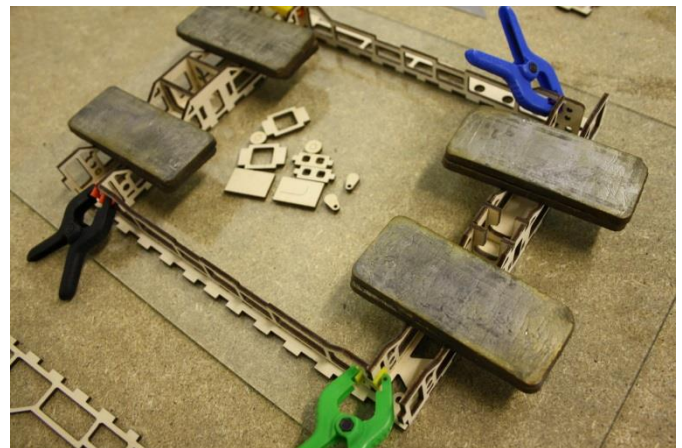
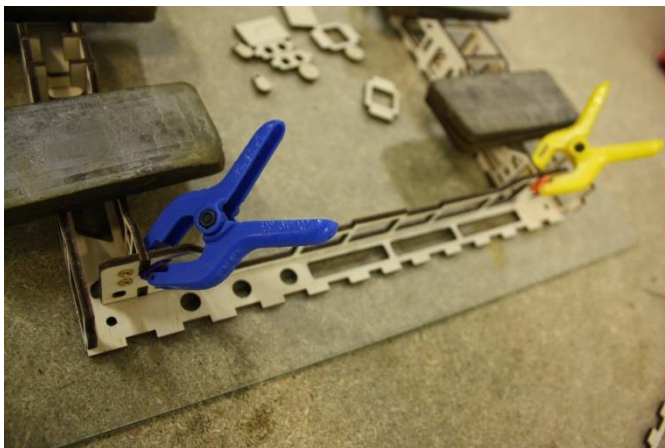
Fit 4x M2 Microbarbs to **UD01** making sure they are fitted to the correct side.



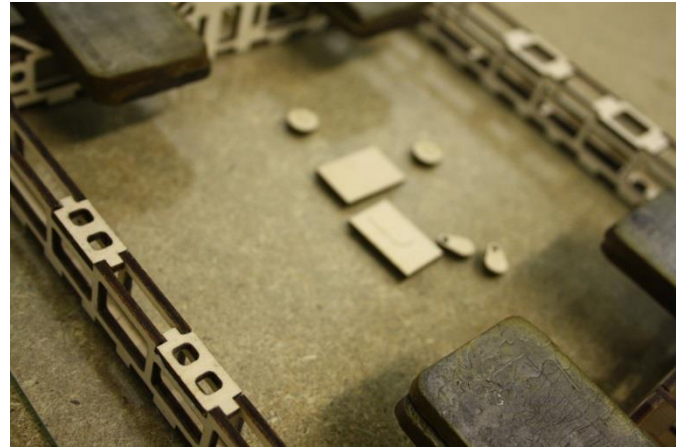
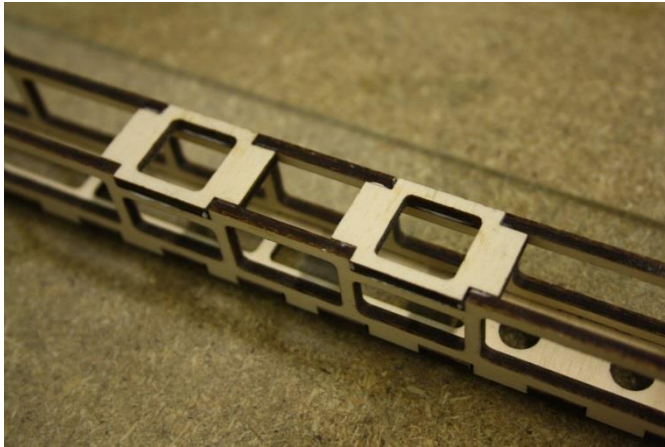
Glue **UD01** to the assembly and check for square-ness.



Glue in **UD16**, weigh down and clamp the assembly while the glue dries.



Glue the support braces 2x **UD07** & 2x **UD09** to the structure.

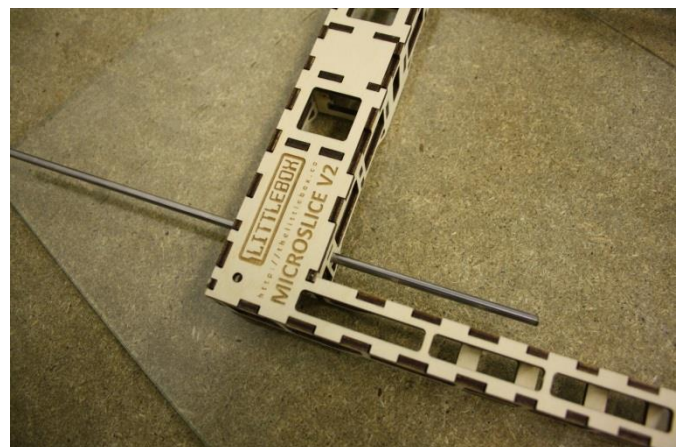
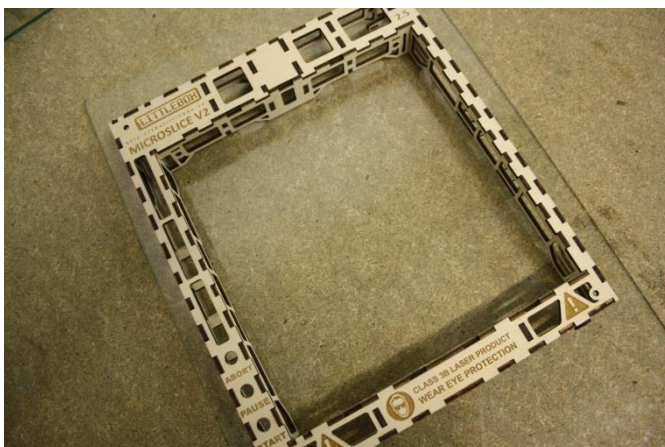


Glue 2x **UD19** to the assembly over the two holes on **UD17**. Fit 2x **UD011** bearing retainers up against the outside of each **UD08**.

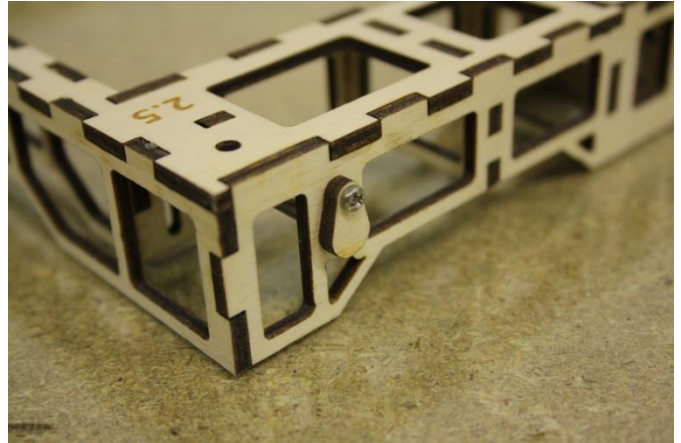
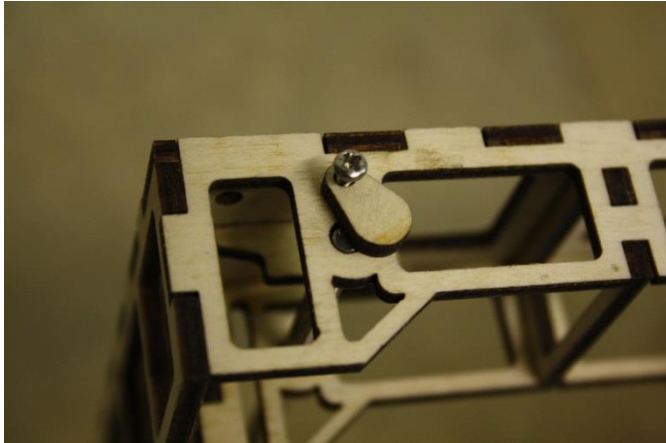


Allow the glue to fully cure before removing the Upper-Deck from the workspace.

Slide 2x 4mm x 250mm bars into each hole at the rear Upper-Deck.



Secure each bar with an M2 8mm screw and a **UD15** hole-cover.



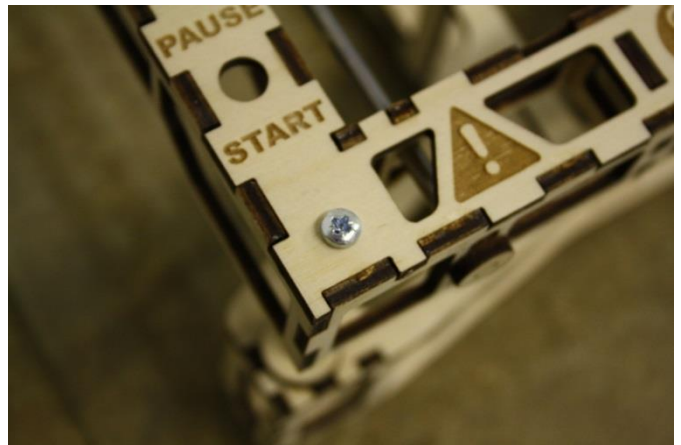
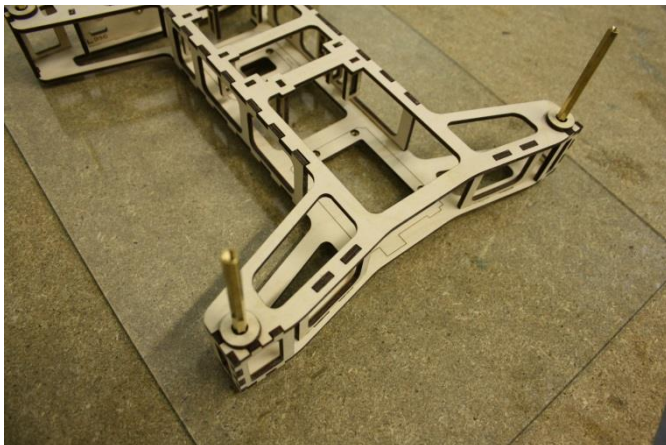
The Upper-Deck is now complete.

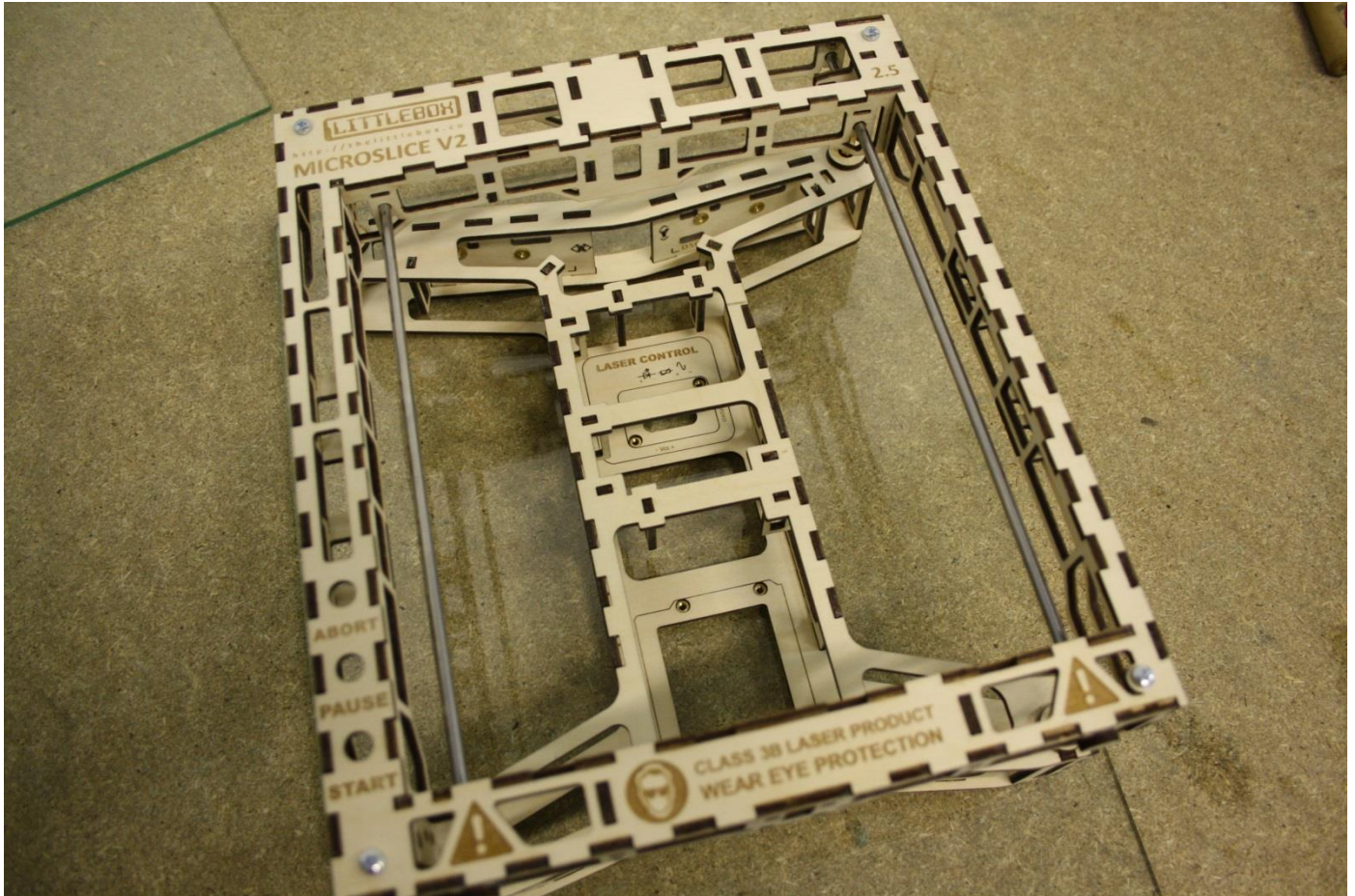
Hardware Assembly | Part 3 - The Frame.

You will need

- 4 x M3 50mm Brass Stand-Offs.
- 4 x M3 8mm Screws.

To the Lower-Deck screw into each corner an M3 50mm Brass Stand-Off. Place the Upper-Deck on top of the Stand-Offs and secure it in place with 4x M3 8mm Screws.





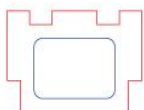
The Frame is now complete.

Hardware Assembly | Part 4 - The Gantry.

4x GT02



1x GT03



1x GT04



2x GT05



1x GT07



2x GT08



2x GT09



4x GT10



2x GT12



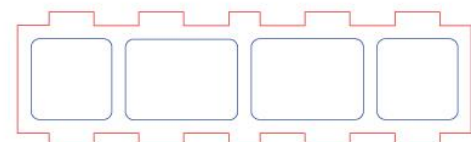
4x GT13



4x GT15



1x GT16



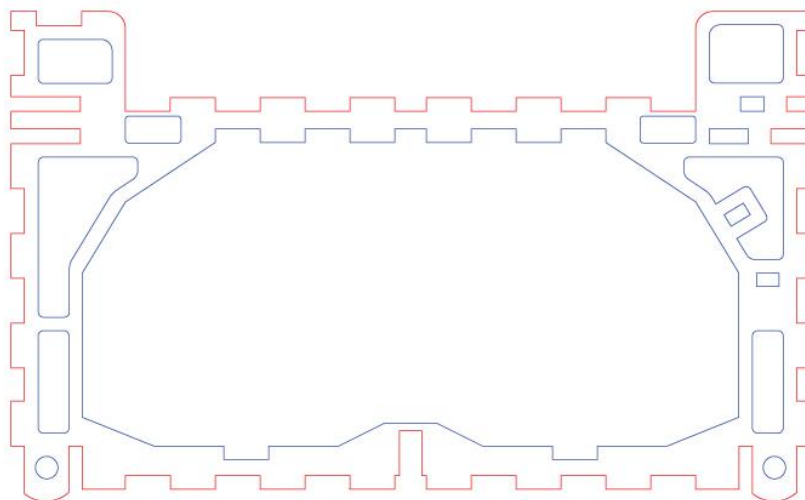
1x GT17



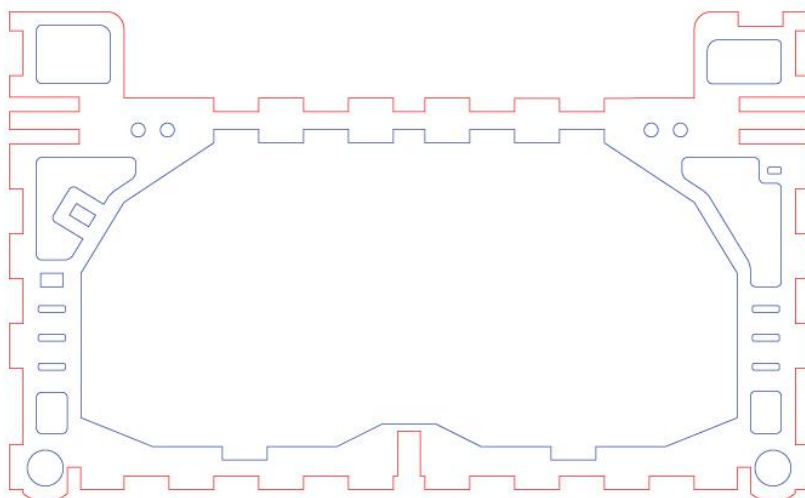
1x GT18



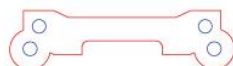
1x GT01



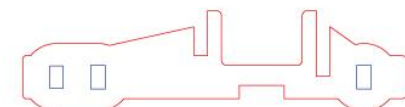
1x GT06



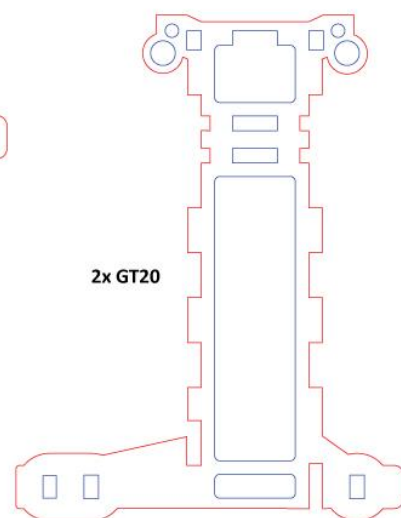
2x GT11



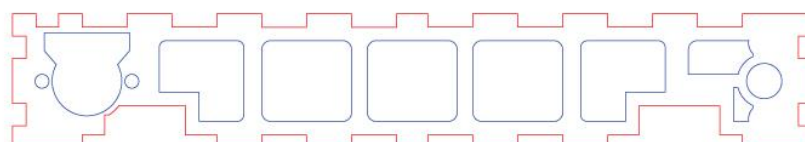
2x GT14



2x GT20



1x GT19



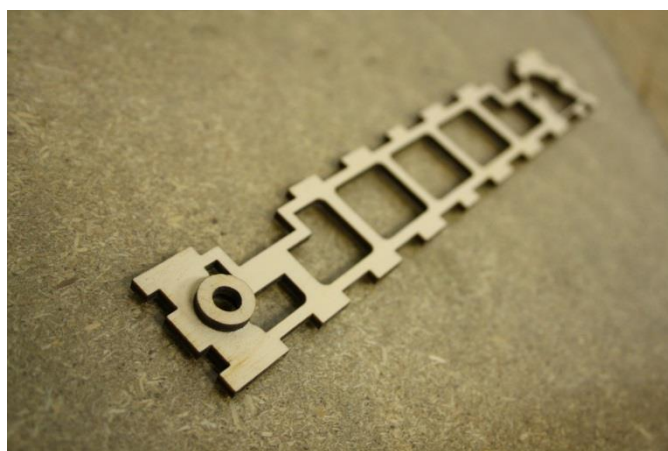
You will also need

- 22 x M2 Microbarb Brass Inserts.
- 8 x M2 10mm Screws.
- 4 x M2 8mm Screws.
- 4 x 4mm ID Linear Bearings.

Glue parts **GT12** & **GT13** together to create a Bearing –Support, repeat this to create 2x Bearings-Supports.

Glue **GT18** to the underside of **GT19**, check carefully that it is bonded to the correct side.

Allow the glue to dry completely before continuing.



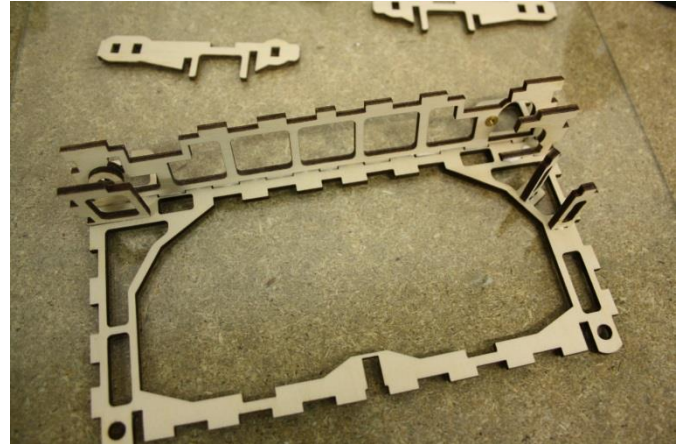
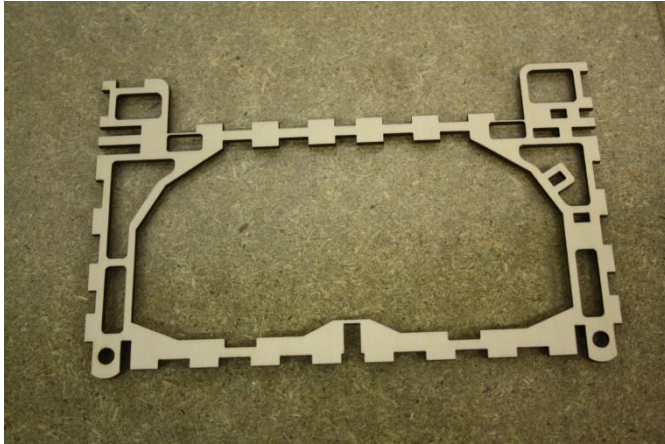
Fit 4x M2 Microbarbs into the back of **GT06**.

Fit a further 2x M2 Microbarbs into the underside of **GT19**.

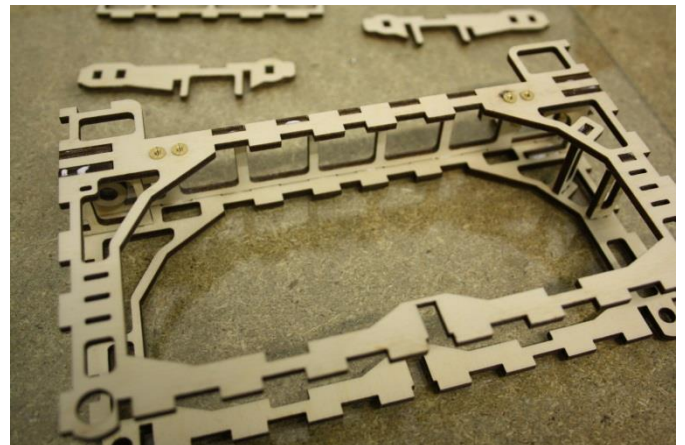
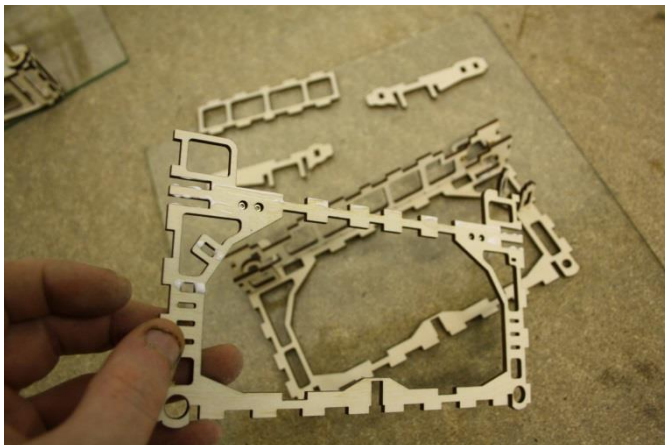


It is important carry out the next few steps in sequence without allowing the glue to set until the assembly is supported in an upright position.

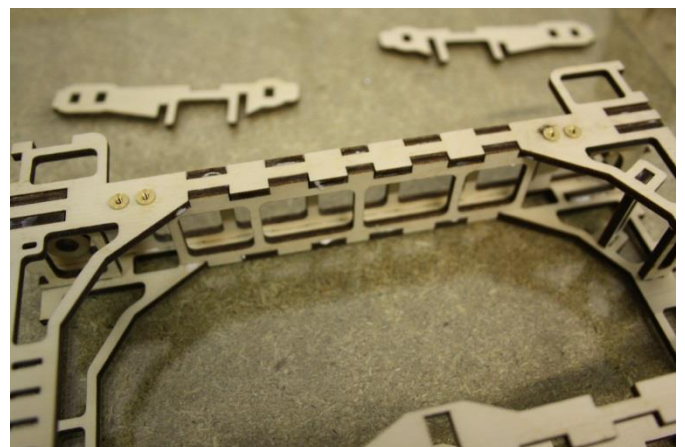
Place **GT01** face-down onto your workspace. Glue **GT19** into the top row of **GT01**. Glue **GT04** on the right-side below **GT19**. Glue **GT03** on the left-side. Glue 2x **GT08** into the slots on the right side of **GT01**.



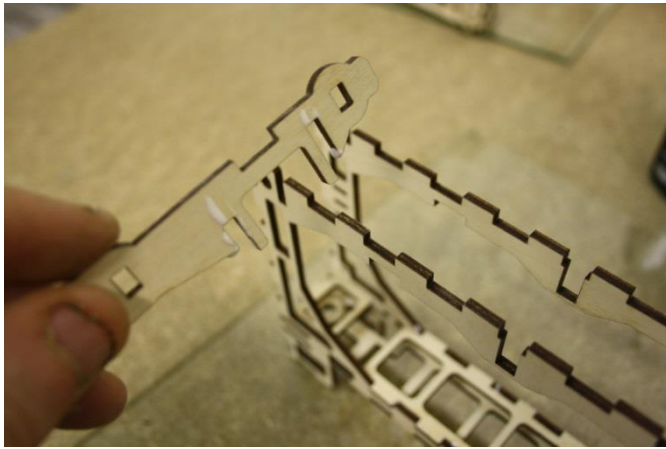
Apply glue to **GT06** and place it on top of the assembly making sure to align all the other parts.



Apply glue to **GT16** and fit in place.



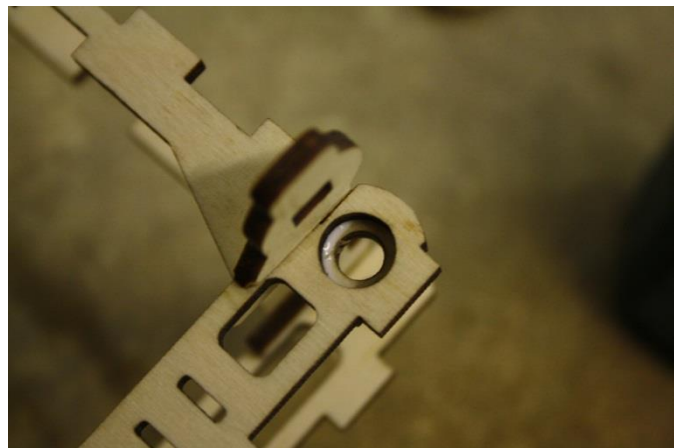
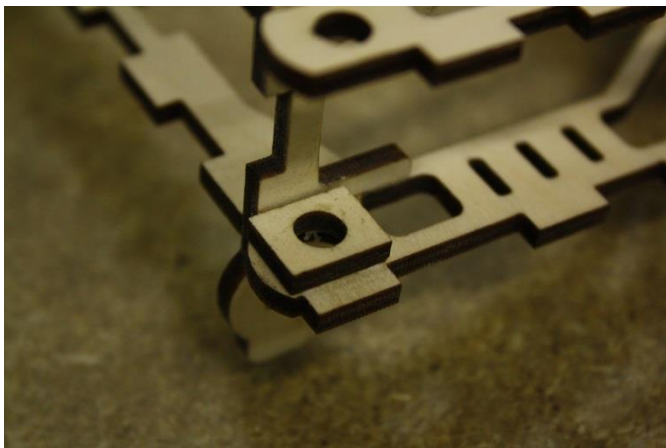
Carefully pick up the assembly and turn it upside down. Apply glue to 2x **GT14** and fit them in the slots.



Turn the assembly over, place it onto a flat surface and support it in an upright position while the glue dries.



After the glue has cured glue a **GT13** on the back of each side of **GT06**.

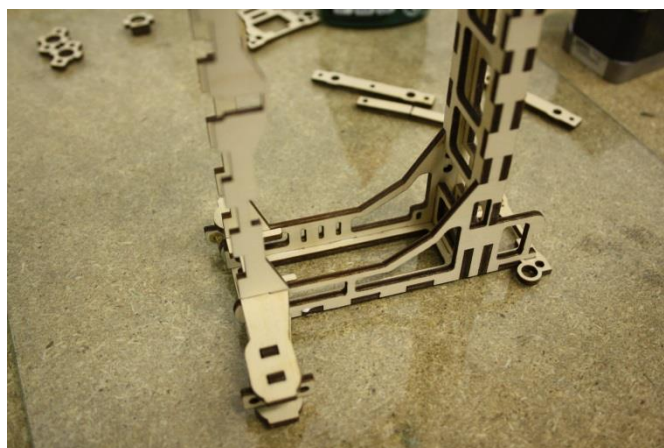


Fit 2x M2 Microbarbs into each of the 4x **GT02**.

Place the Gantry assembly onto its side. Glue a single **GT02** to the front of **GT14**. Place a Bearing-Support directly behind it and a further **GT02** at the rear, **DO NOT GLUE THEM IN POSITION**.

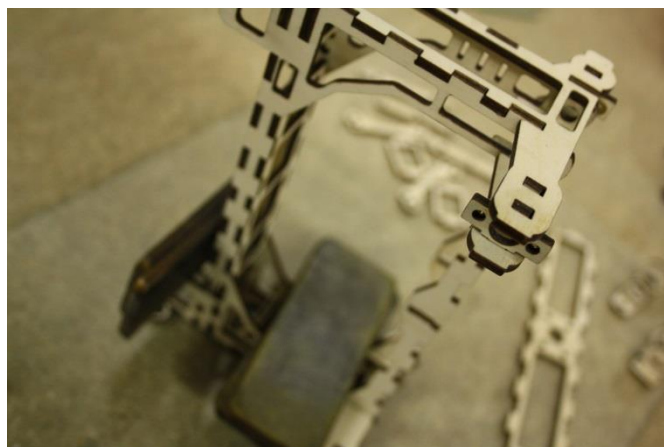


Apply glue to one **GT20** and place it on top of the assembly making sure to align all the other parts. Turn the assembly over with the newly fitted **GT20** face-down on the workspace.



Weigh down the assembly while the glue dries.

Repeat the process on the other side.



Unpack 4x 4mm ID Linear Bearings onto tissues paper and wipe off the oil from their outside. Place a bearing into a slot on the Gantry.

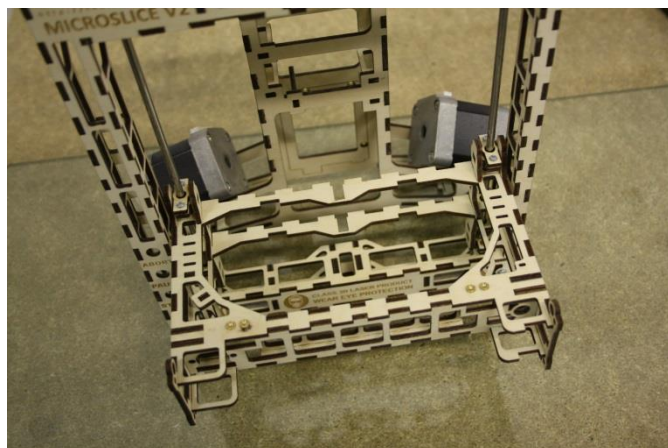


Secure the bearing in place with a **GT10** Bearing Retainer and 2x M2 10mm Screws. Repeat for each slot.

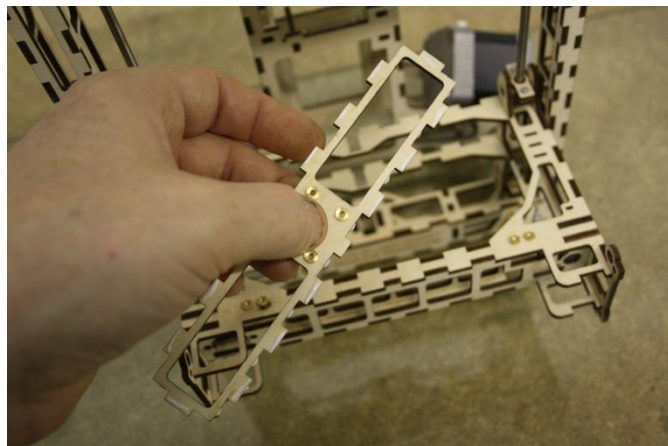
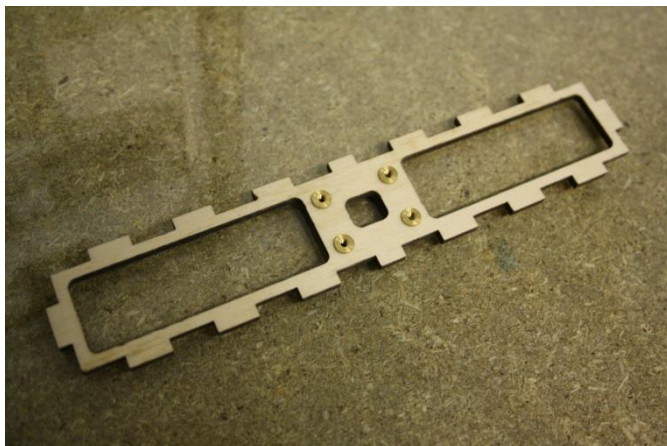


Place the Frame in an upright position on your workspace and weigh it down at the back.

Slide the 4mm Bars out of the Frame and fit the Gantry into the Frame feeding the 4mm Bars through the Bearings in the Gantry.

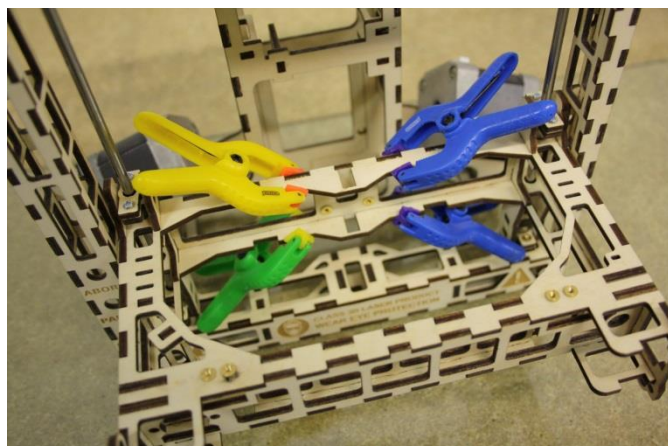
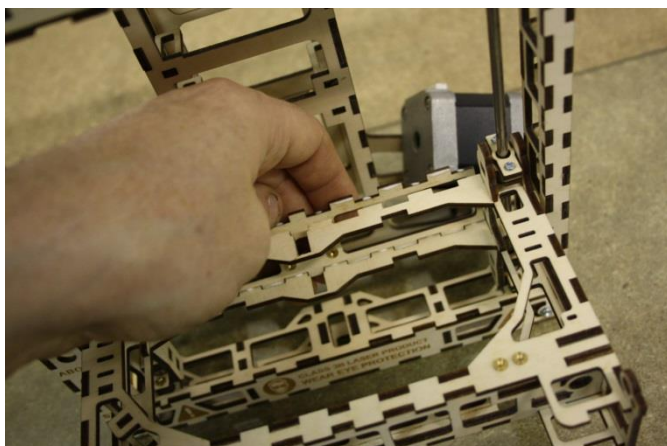


Fit 4x M2 Microbarbs to **GT17** and apply glue.



Fit **GT17** in the base of the Gantry, make sure the Microbarbs are the correct way round. Use clamps to hold the parts together while the glue dries.

If the Gantry does not sit flat against the frame it is possible to use weights to keep it flat while the glue sets.



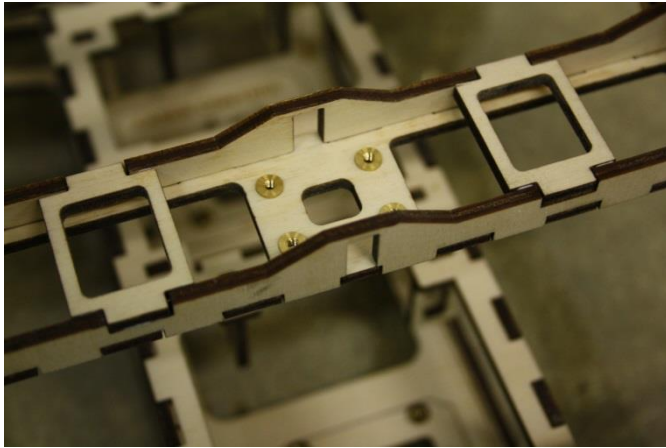
After the glue has dried; move the MicroSlice into the correct orientation.

Fit 2x M2 Microbarbs into each of the 2x **GT11** Gantry-Ends.

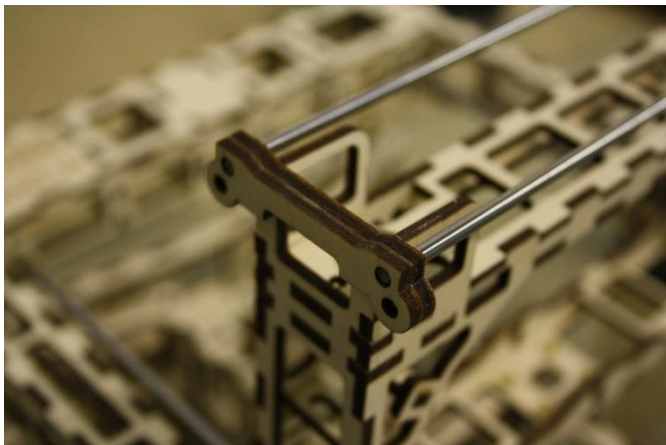


Glue 2x GT05 Gantry Braces to the Gantry.

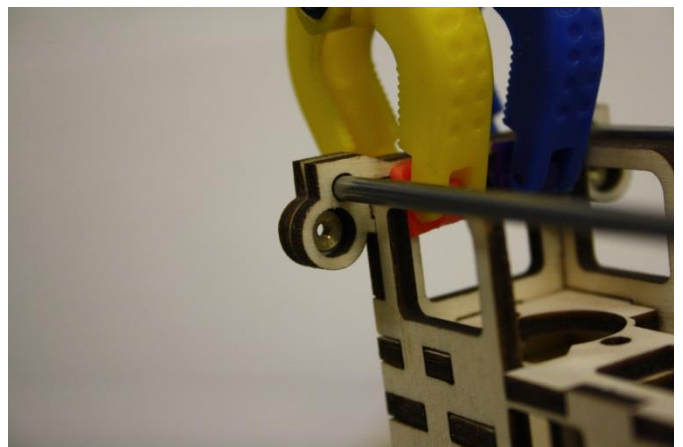
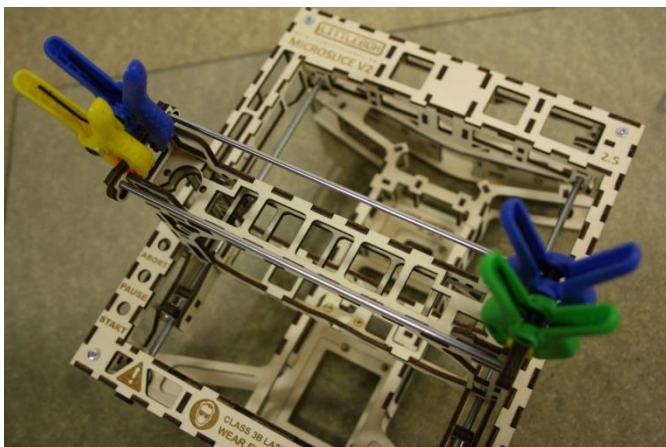
Slide 2x 3mm Bars into the guides at the top of the Gantry.



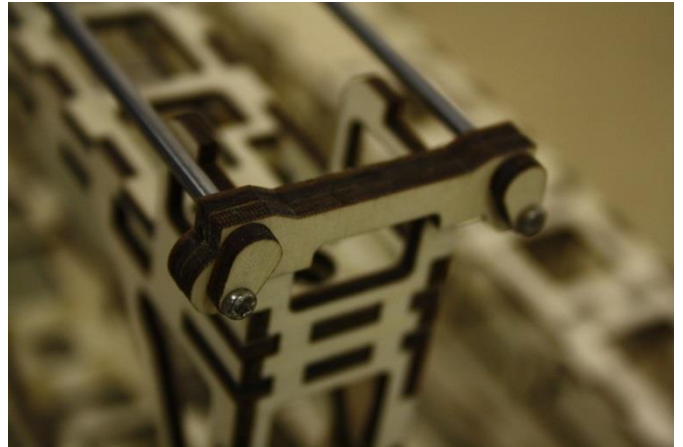
Glue a **GT11** at each end of the Gantry using the 3mm Bars to help guide them into the correct position.



Clamp and leave to dry.



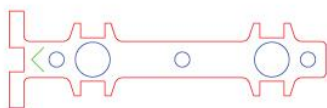
Using 4x M2 8mm Screws attach each GT15 End-Stop to the Gantry securing the 2x 3mm Bars.



The Gantry is now complete.

Hardware Assembly | Part 5 - The Cutting-Head Slider.

2x CH01



2x CH03



2x CH05



1x CH06



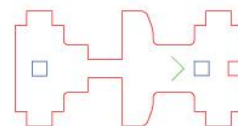
1x CH08



1x CH10



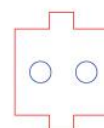
1x CH02



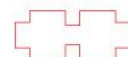
1x CH04



1x CH07



1x CH09



1x CH11



You will also need

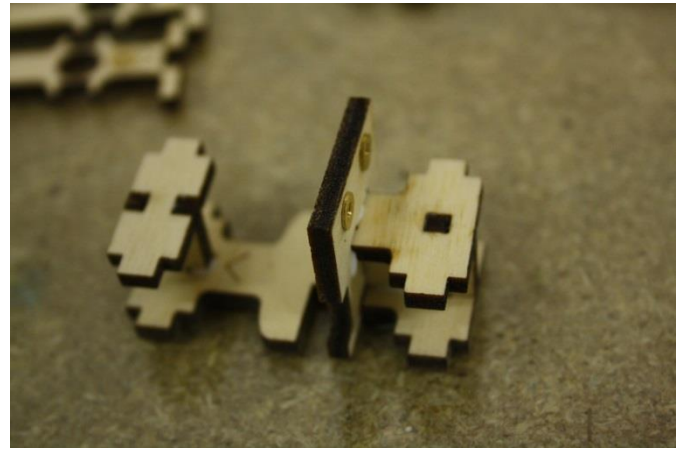
- 8 x M2 Microbarb Brass Inserts.
- 2 x M3 Microbarb Brass Inserts.
- 8 x M2 10mm Screws.
- 4 x M3 Nylon Washers.
- 4 x 3mm ID Linear Bearings.

Fit 3x M2 Microbarbs into 2x **CH01**, 2x M2 Microbarbs into **CH04** and 2x M3 Microbarbs into **CH07**.

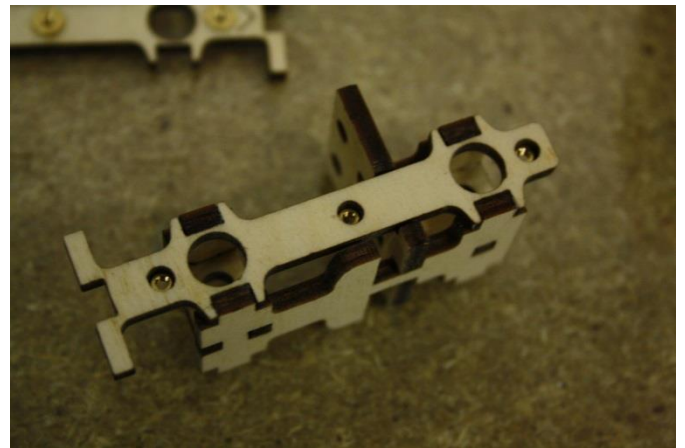
Place **CH02** down on your workspace and glue in **CH08** and **CH10** as shown.



Glue **CH09** to the top of **CH08**. Glue **CH11** to the top of **CH10**. Glue **CH04** to the assembly making sure the M2 Microbarbs are in the correct orientation.

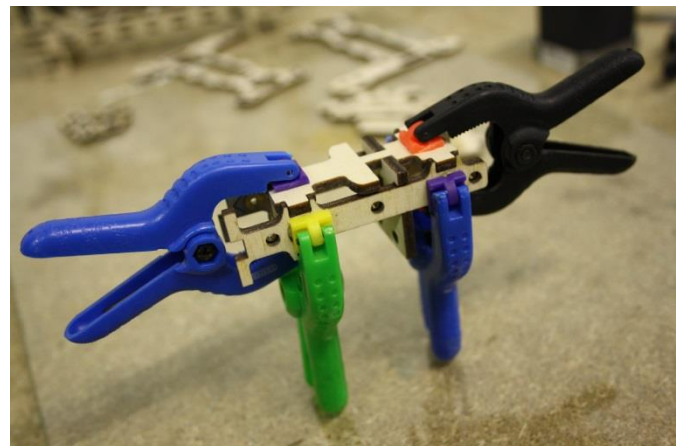
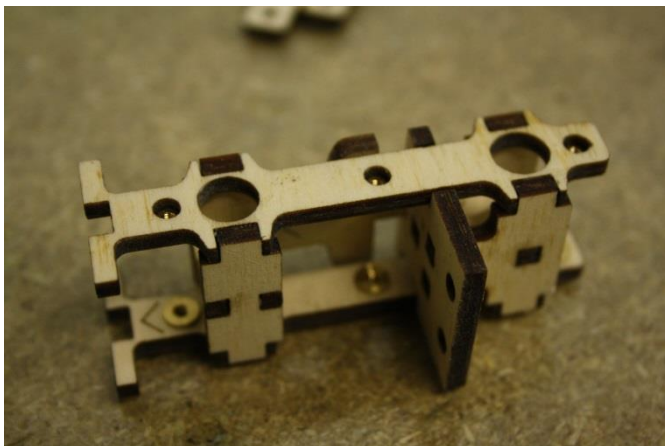


Lay the assembly over on its side and glue a **CH01** in place.

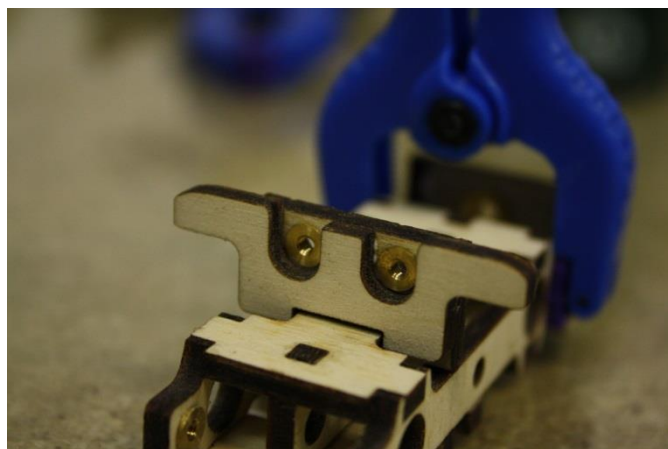
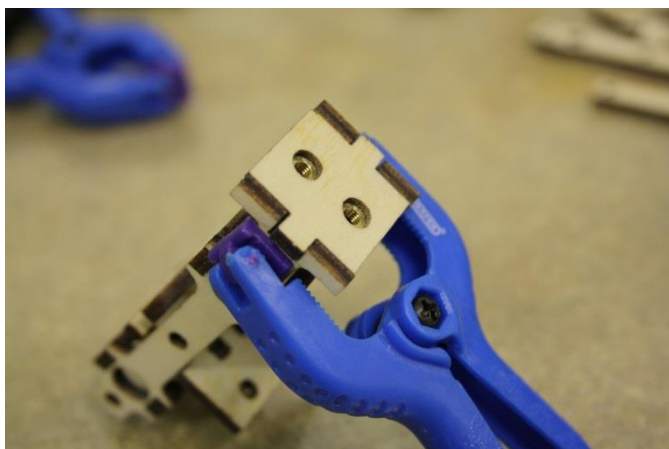


Flip the assembly over and fit the other **CH01**. Clamp the Cutting-Head Slider while the glue dries.

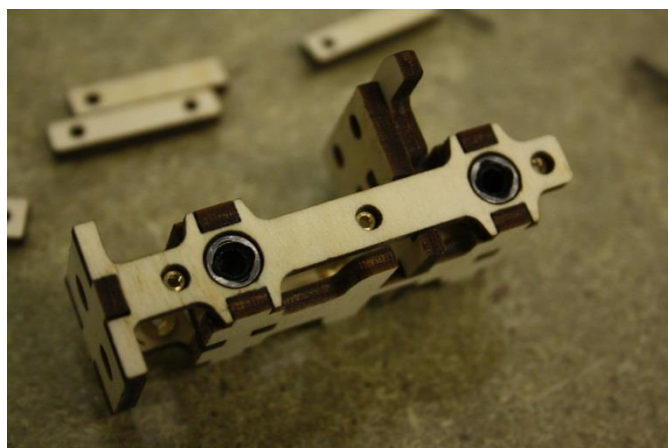
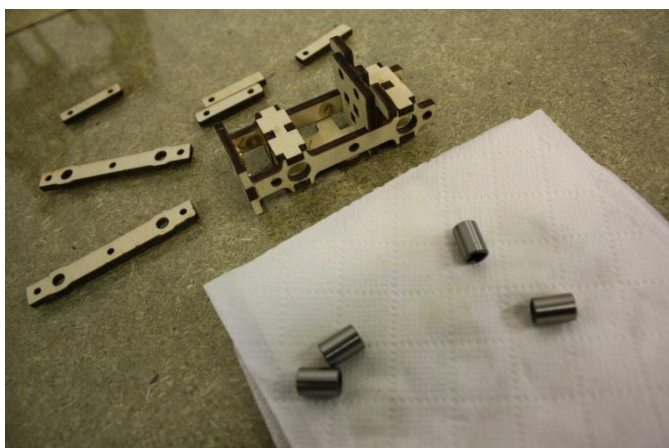
Check that all the parts are square and that the assembly is not slanted or angled over slightly.



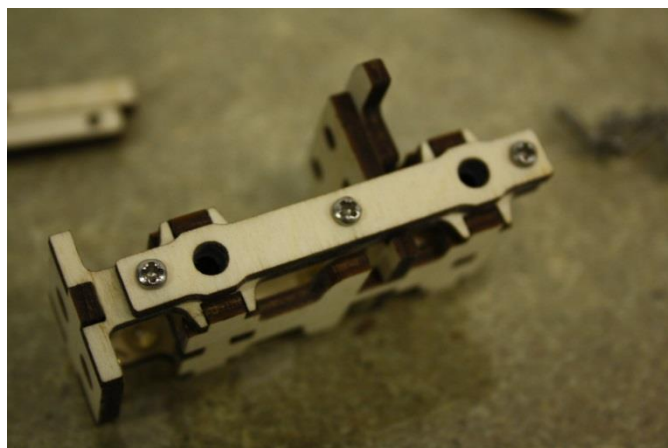
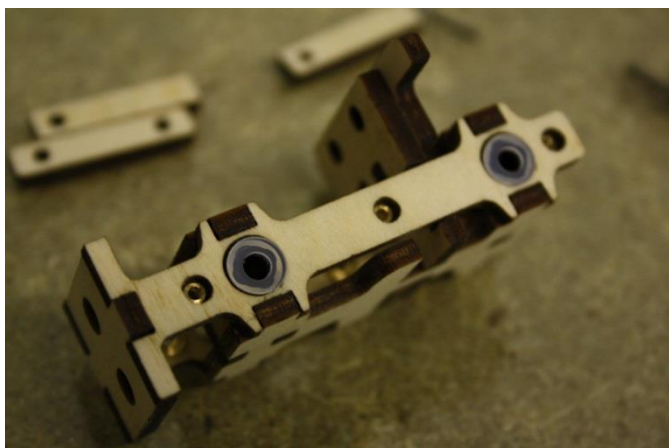
Glue **CH07** to the front of the Cutting-Head Slider. Glue **CH06** to the back of **CH04**. I recommend using clamps to secure both parts while the glue dries.



Remove any oil from the outside edges of 4x 3mm ID Bearings. Fit 2x Bearings into the slots on the side of the Cutting-Head Slider.

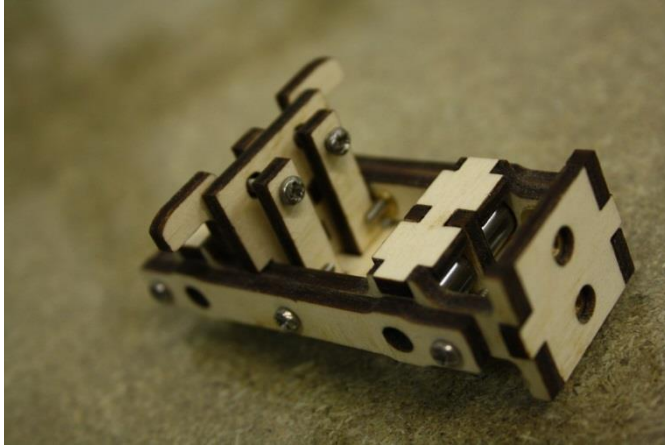


Place a single M3 Nylon Washer on top of the Bearings. Secure them with 3x M2 10mm Screws and a **CH03** Bearing-Retainer.



Repeat the last few steps with the other side of the Cutting-Head Slider and fit two more 3mm ID Linear Bearings and M3 Nylon Washers with a **CH03** Bearing-Retainer.

Turn the assembly over and secure 2x **CH05** Belt-Clamps with 2x M2 10mm Screws.



The Cutting-Head Slider is now complete.

Hardware Assembly | Part 6 - The Diode Module Mounts.

1x DM01



1x DM02



2x DS01



1x DM03



1x DM04



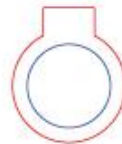
1x DS02



1x DM05



2x DM06



Glue **DM03** & **DM05** to **DM01**.

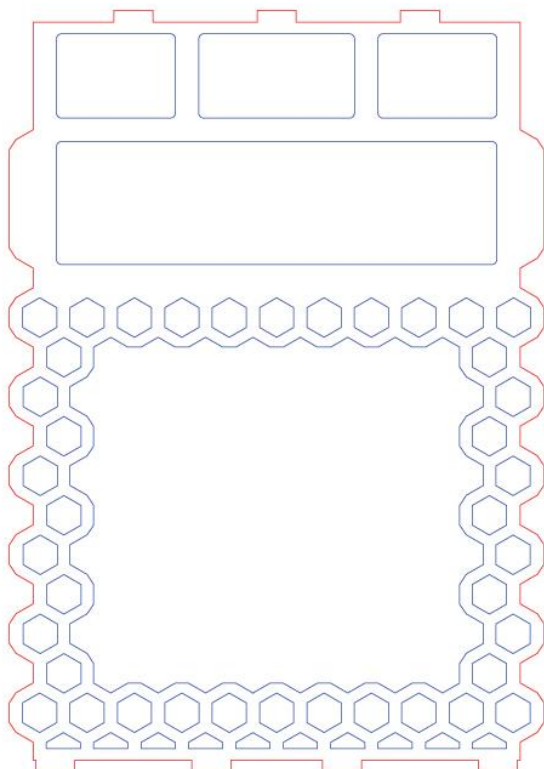


Glue 2x **DM06** & **DM04** to **DM02**. **DS01** and **DS02** are spacers used to raise the Diode Modules in their mounts.

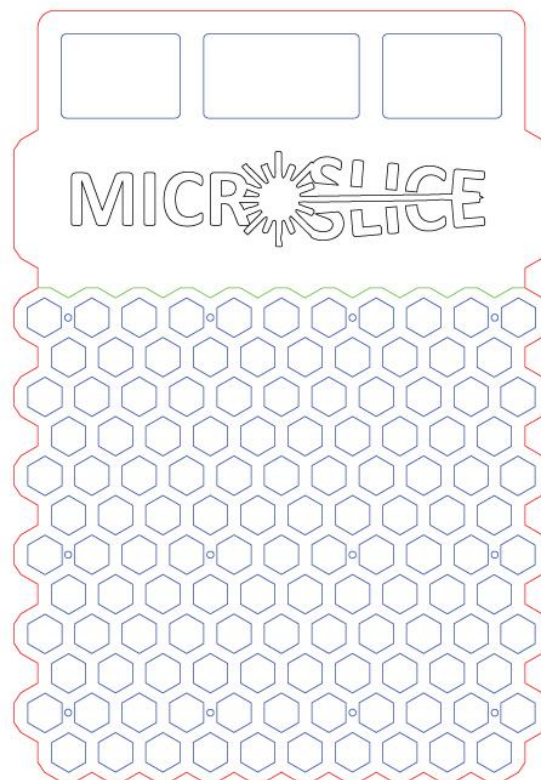


Hardware Assembly | Part 7 - The Cutting Table.

1x CT02



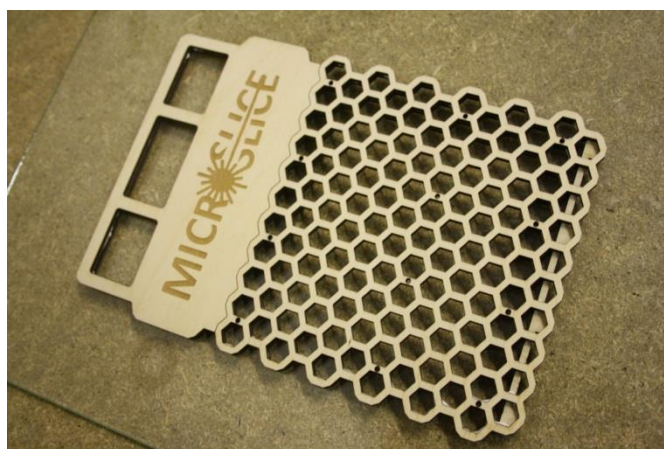
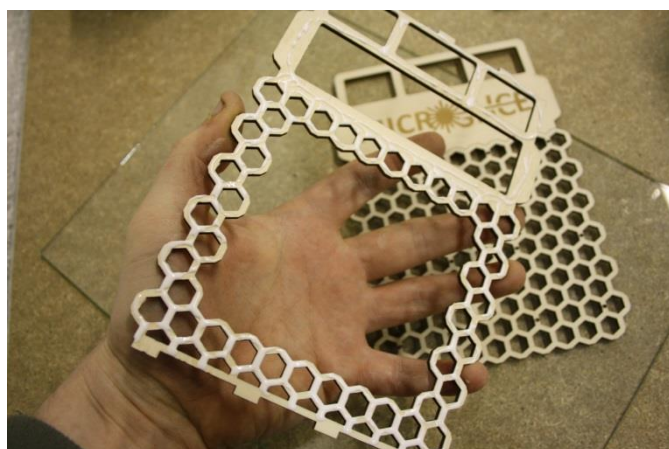
1x CT01



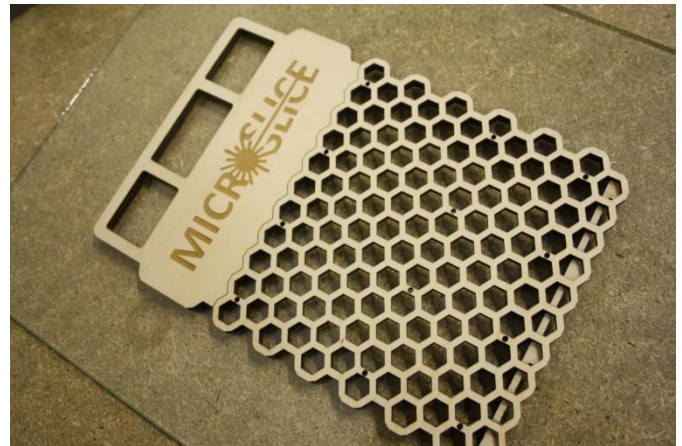
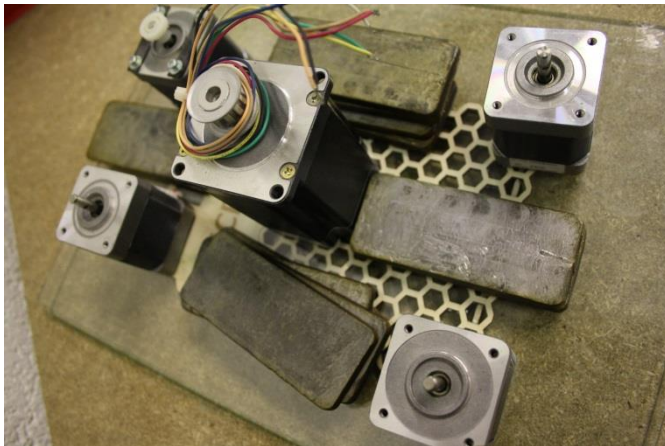
You will also need

- 12 x Neodymium Magnets.
- Tin foil.

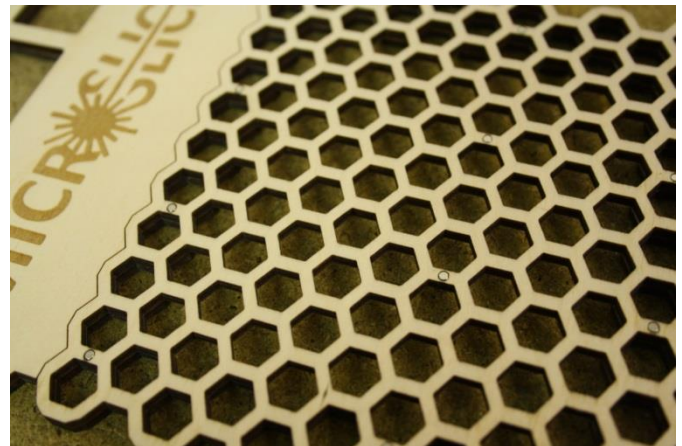
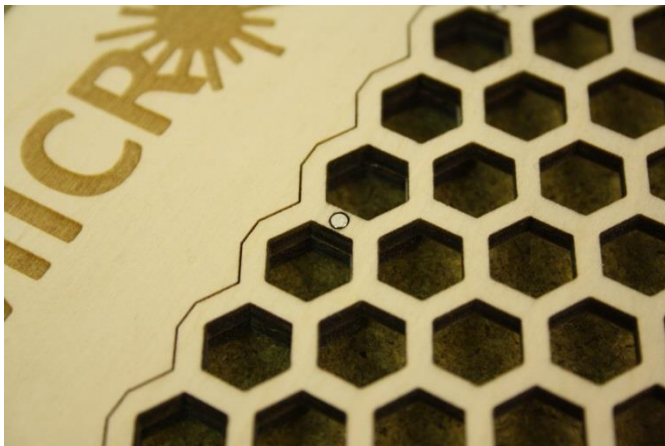
Apply glue to one side of **CT02**. Place **CT01** onto the glued side of **CT02**.



Weight down the Cutting Table while the glue dries.

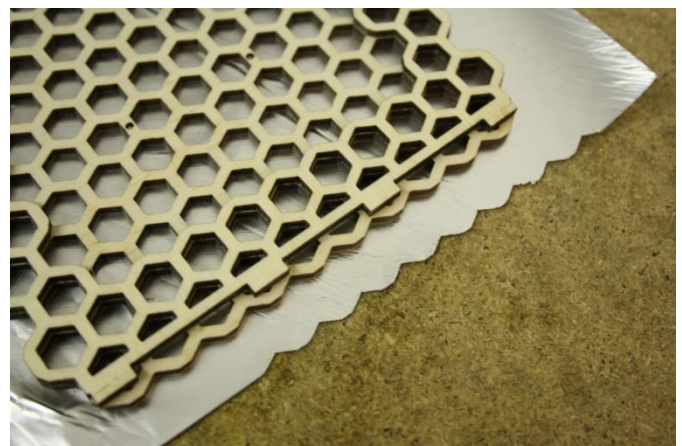
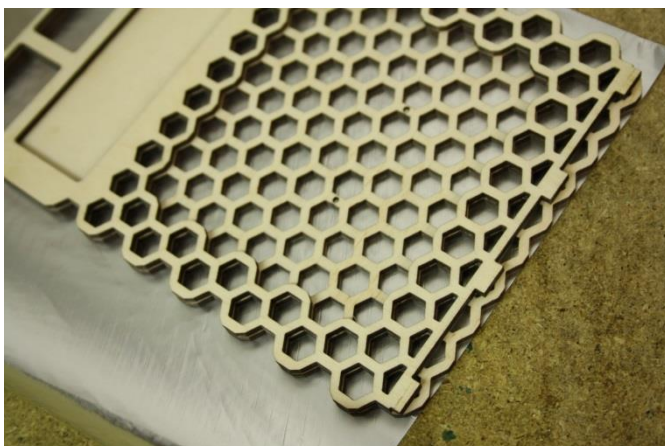


After the glue has set press-fit a magnet into the 12 small holes in the Cutting Table.

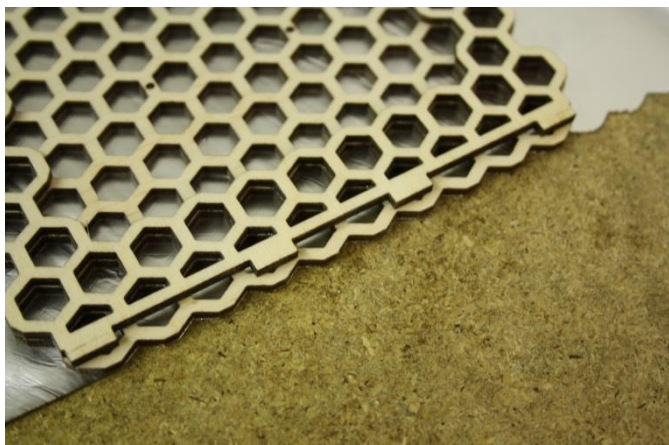


Next take a small section of Tin foil, use Thick Foil if you can. Lay the cutting table face-down and align it to a straight edge on the foil.

Using a sharp knife cut off the excess foil following the edge of the cutting table.

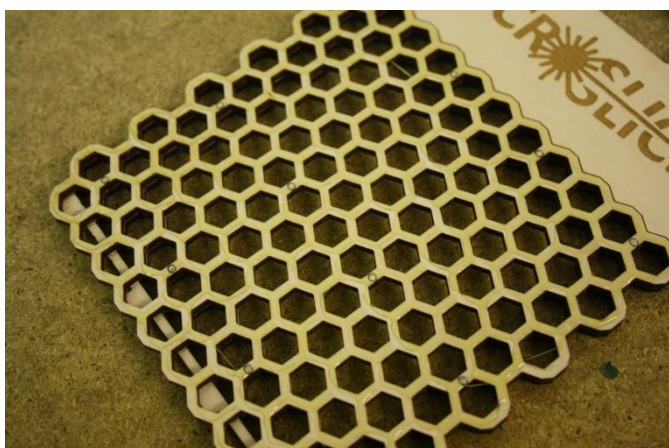


Move the table along to get a section which is longer than the width of the Cutting Table. Check the foil against the Cutting Table.



Apply a thin layer of Contact Adhesive to the honeycomb area of the Cutting Table.

Begin to apply the foil by aligning it to the top edge of the honeycomb pattern.



Gently press down the foil so it sticks to the Cutting Table. You can rub your finger over the foil to bring out the honeycomb pattern.



Leave the glue to dry overnight.

Carefully remove any excess foil from the edges of the Cutting Table using a sharp blade or knife.



Continue to work until all the foil has been removed from the edges.



If you want to spend a few extra minutes on the Cutting Table you can remove the foil individually from each cell.

If you have the 500mW Laser Module I recommend that you do not remove the foil from each cell as it will help protect the electronics below.



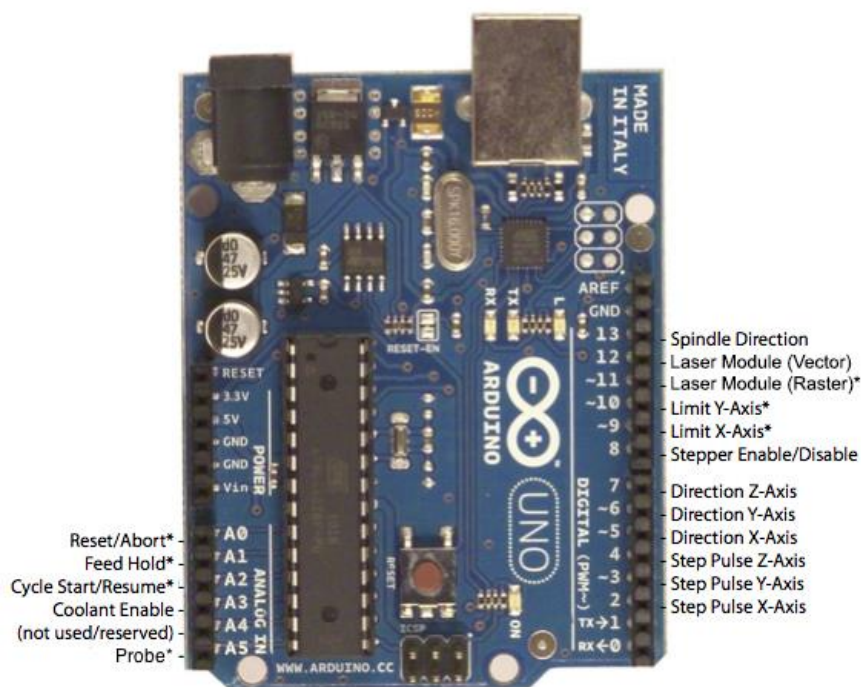
The Cutting Table is now complete.

Section 2 | Wiring.

Wiring | Part 1 - The Lower-Deck.

You will need

- 5 x M3 8mm Nylon Screws.
- 4 x M3 6mm Nylon Screws.
- 5 x M3 Nylon Spacers.
- 1 x Arduino.
- 1 x Analogue Module & Components.
- 2 x EasyDrivers.
- 1 x Switch.
- 1 x Heatsink & Components.
- 1 x Strip of Pins.
- 1 x Length of 20-Way Ribbon Cable.
- Various Connectors.

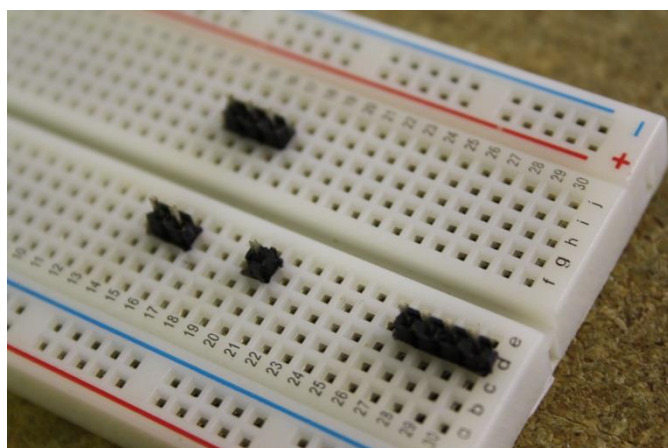
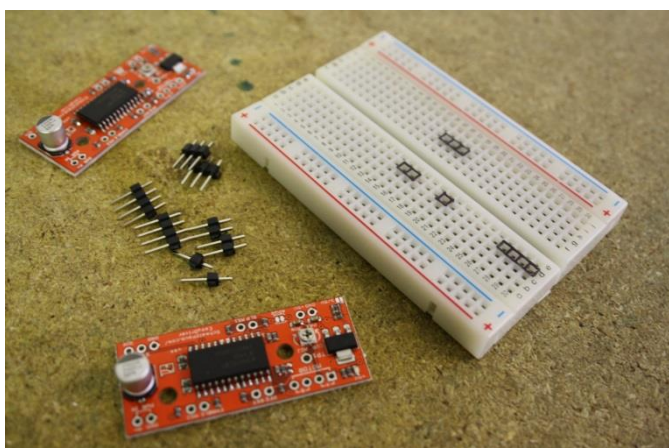


Dismantle the MicroSlice & gather the required parts.

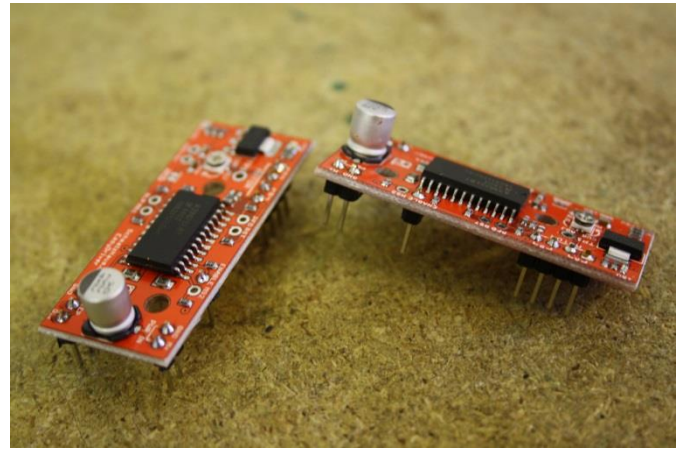
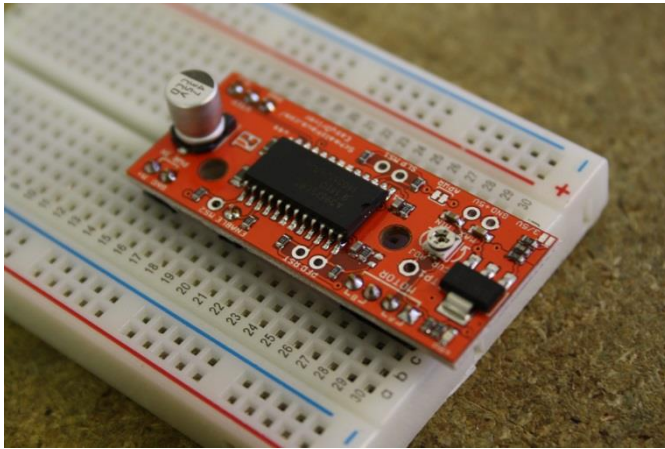
* - Indicates input pins. Held high with internal pull-up resistors.



I have made a template with a cheap breadboard to help solder the pins into the two EasyDrivers. You will need two of; 1-pin, 2-pin, 3-pin and 4-pin. The pins go to; ENABLE(1), PWR-IN(2), STEP(3) & MOTOR(4).

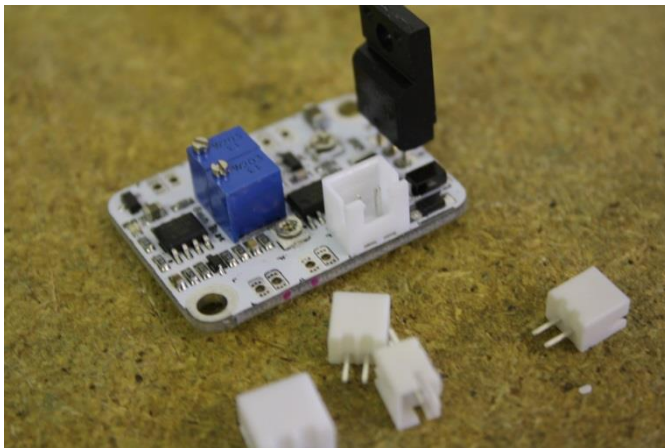


Solder the pins to two EasyDrivers.

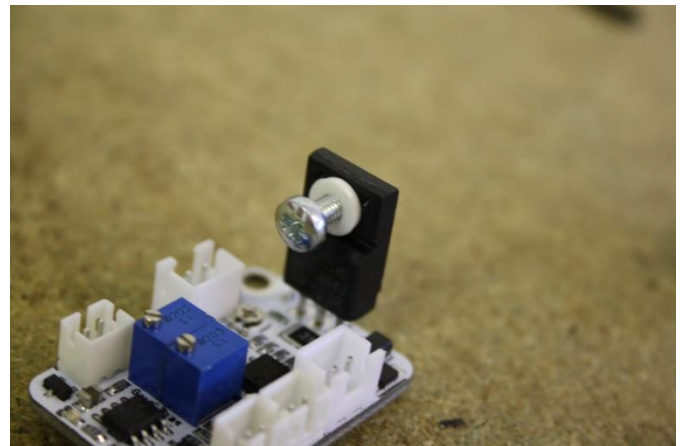
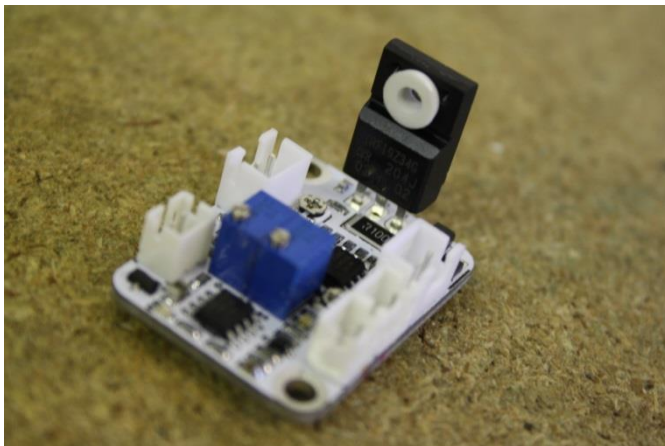


The Analogue Driver Module requires some assembly. Solder the JST-PH sockets to the boards.

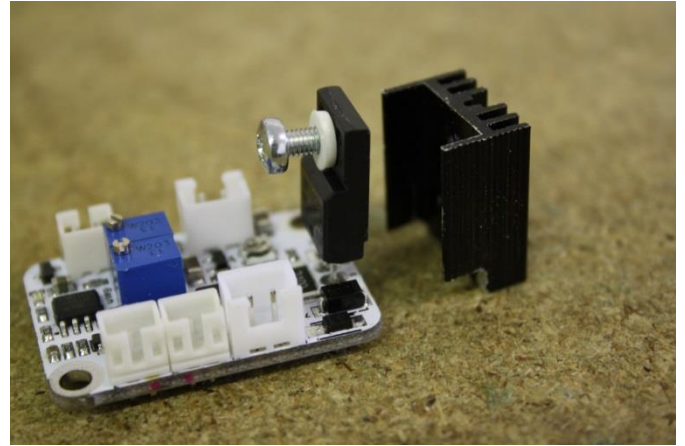
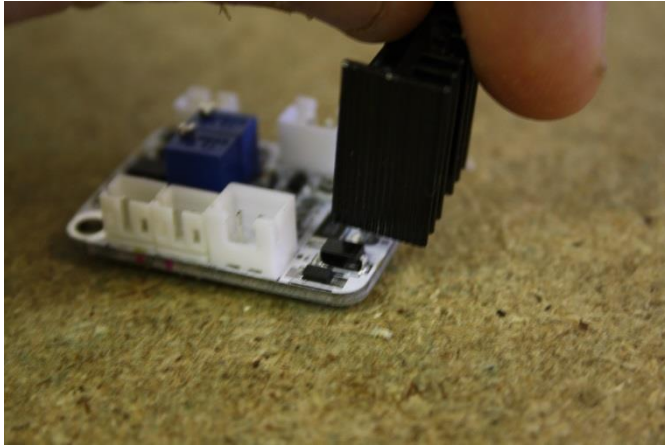
You can skip this stage for the moment if you do not feel comfortable with later crimping the connectors to the wires. It is possible to solder the wires directly to the board.



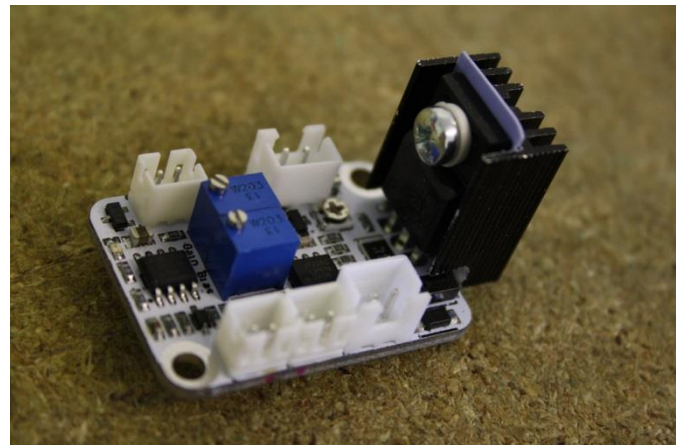
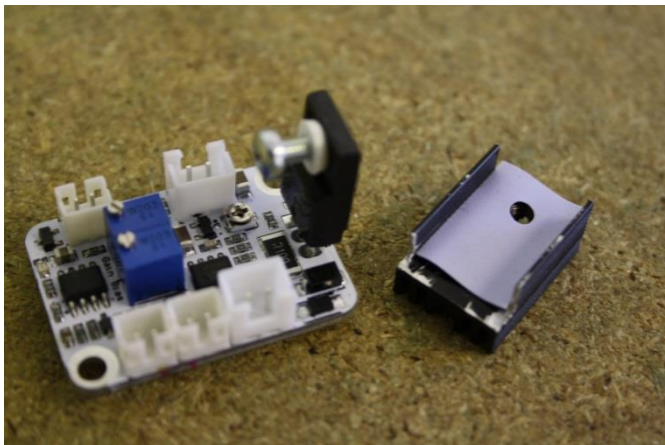
Press the insulator into the TO-220 Package and partly screw in the screw



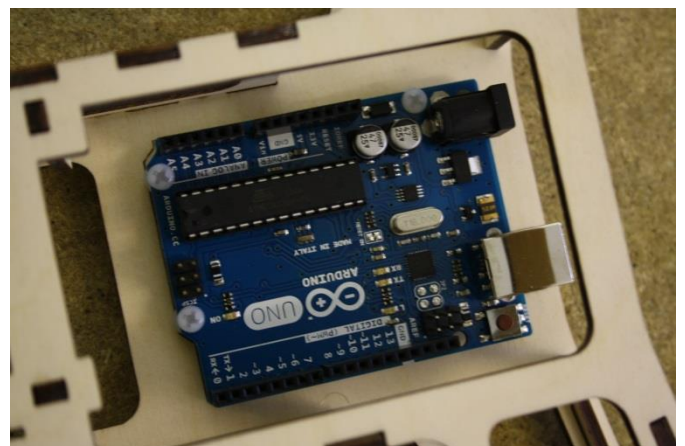
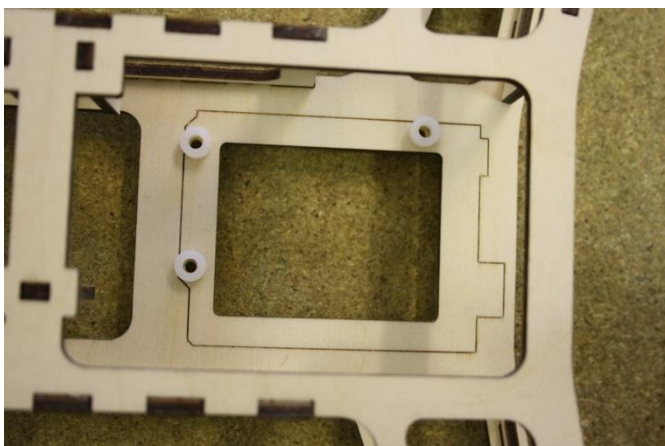
The heat-sink will likely touch against some of the components on the board and so the lower fins need to be filed to create space.



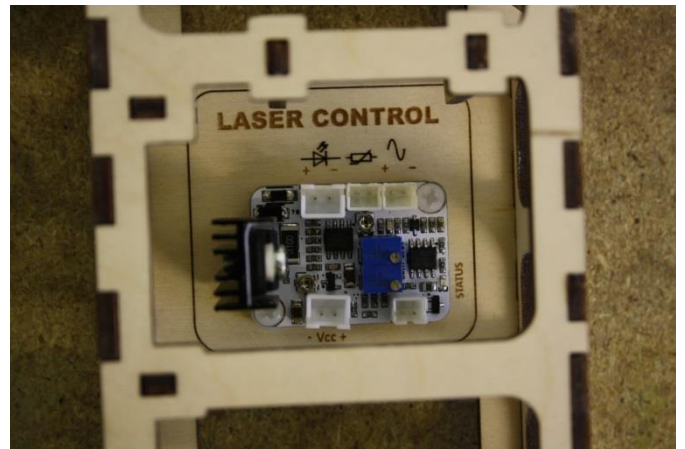
Fit the silicone insulator to the heat-sink and secure it in position with the screw.



Locate 3x Nylon Spacers on the Lower-Deck. With 3x 8mm Nylon Screws secure the Arduino to the Lower-Deck.

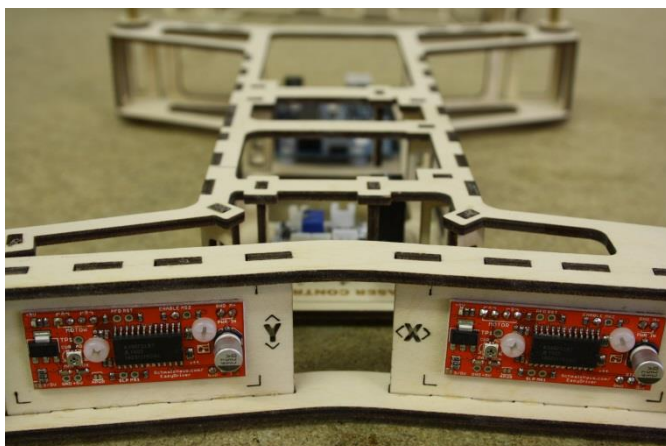


Secure the Laser Module to the lower-Deck on 2x Nylon Spacers with 2x 8mm Nylon Screws.

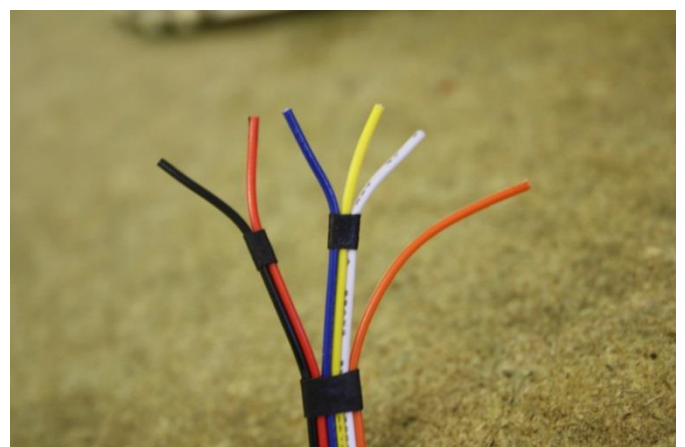


Affix the two EasyDrivers at the rear with 4x M3 6mm Screws.

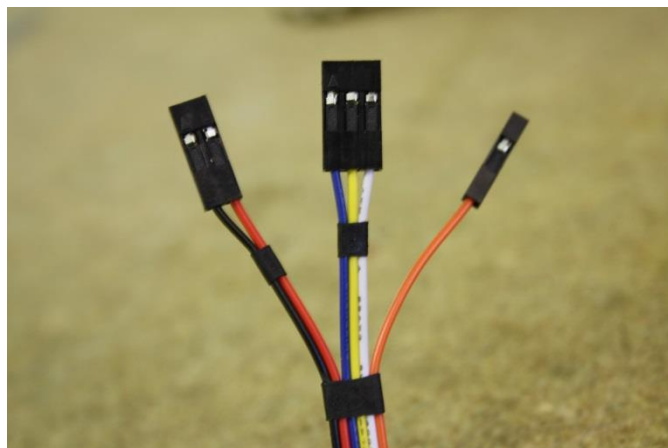
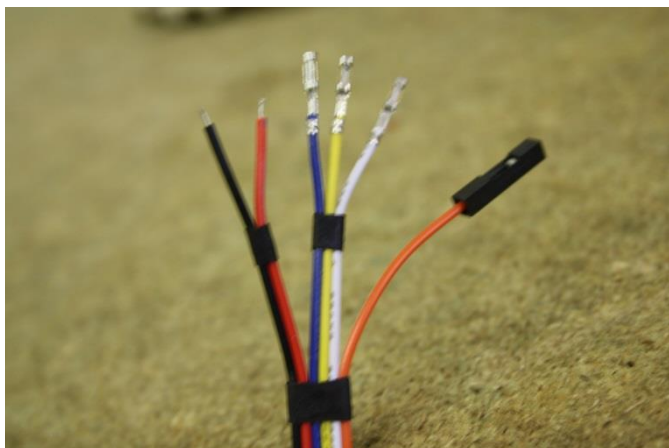
Tear off a 6-Way strip of cable as shown.



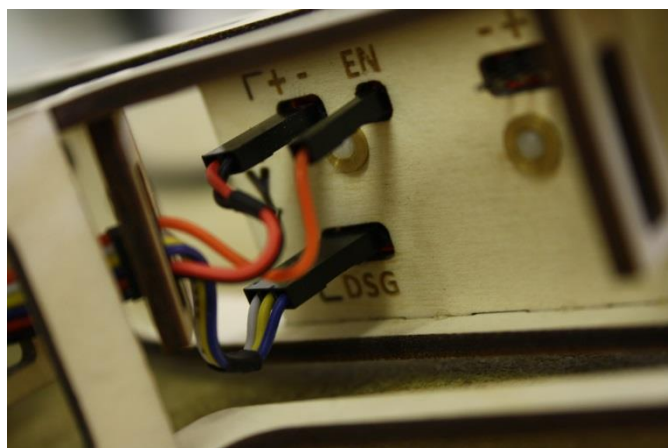
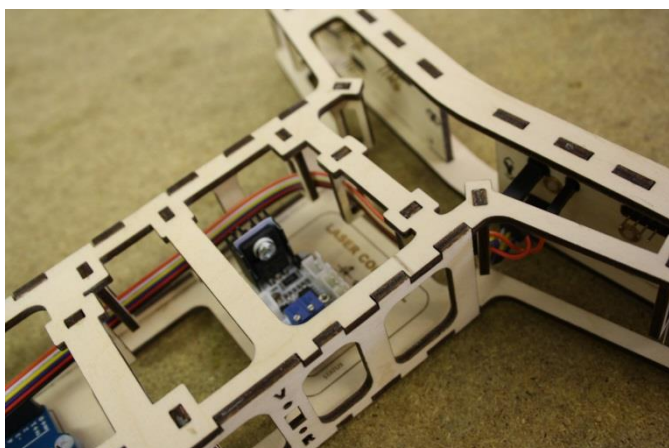
Using heat-shrink split the 6-Way cable into 1-Way, 2-Way and 3-Way groups as shown.



Add female DuPont pins to each end of the wires and attach plastic housings as shown.

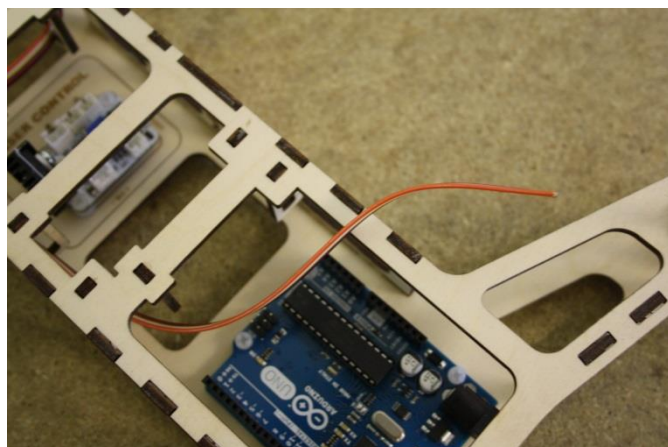
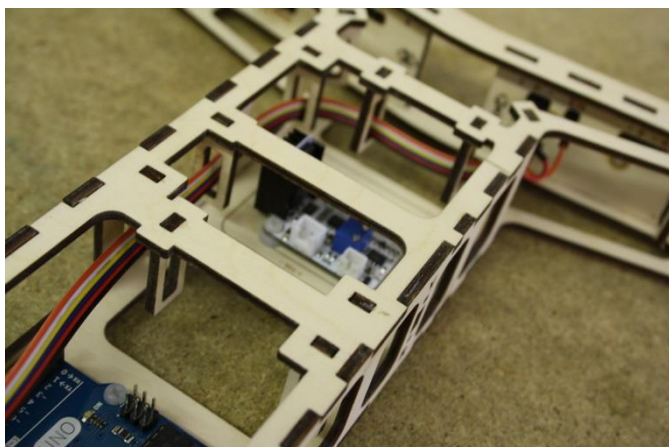


Plug the connectors to the Y-Axis EasyDriver; the single Orange wire connects to EN [En]able(o), the Red & Black connect to [+]Positive(R) & [-]Negative(B) and the White, Yellow and Blue connect to DSG [D]irection(w), [S]tep(y), [G]round(B).



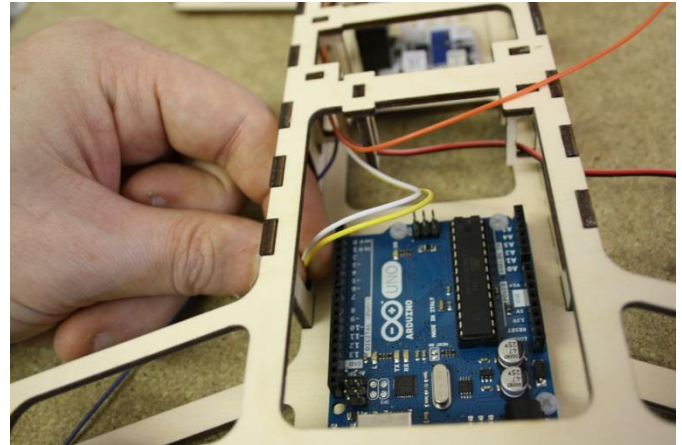
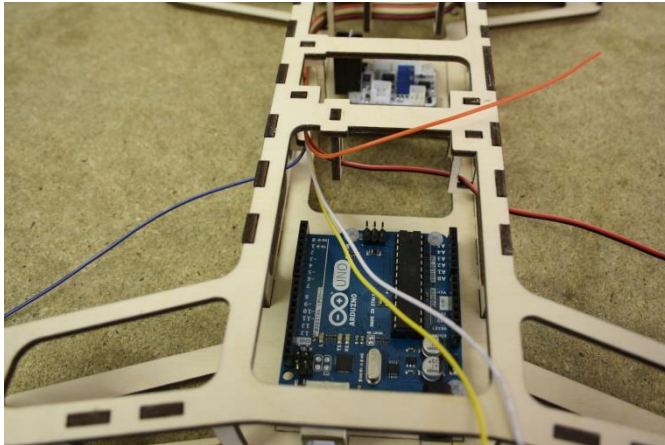
Feed the cable through the Cable Conduits towards the Arduino.

Cut the excess cable off and keep for later.

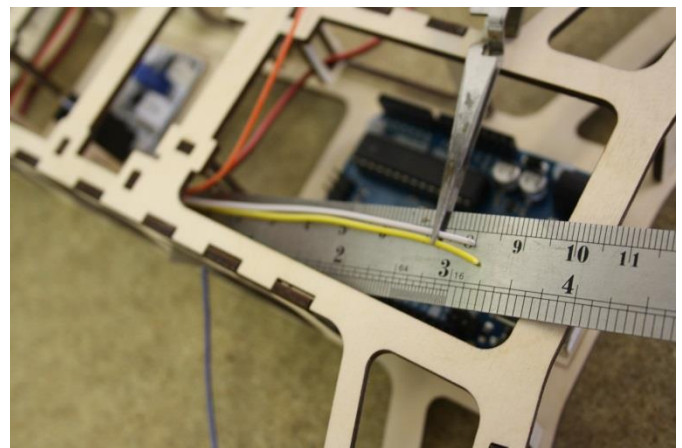
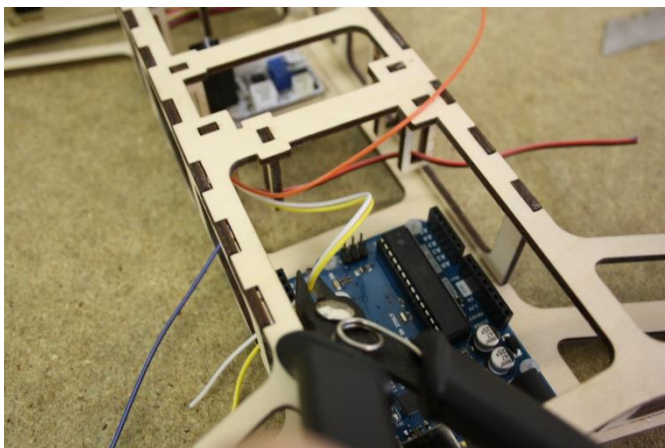


Split the cable taking the Red & Black wires off to the right, the Blue wire to the left, and the White & Yellow wires over the Arduino.

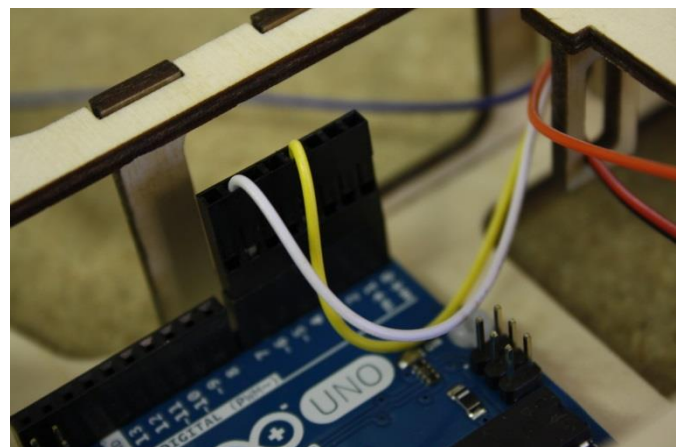
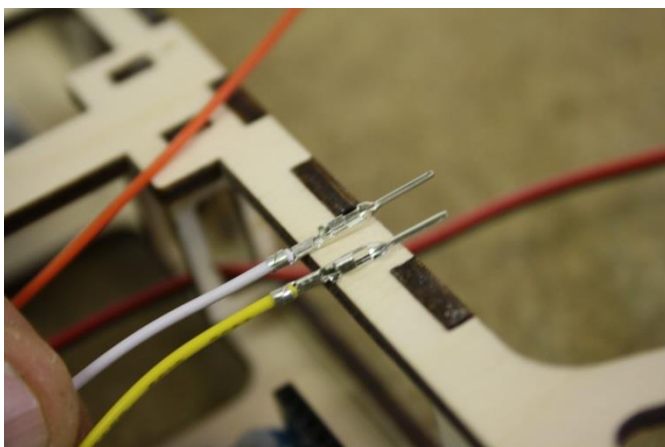
The White & Yellow wires need to plug into the Arduino.



Measure and trip the White & Yellow wires to length.

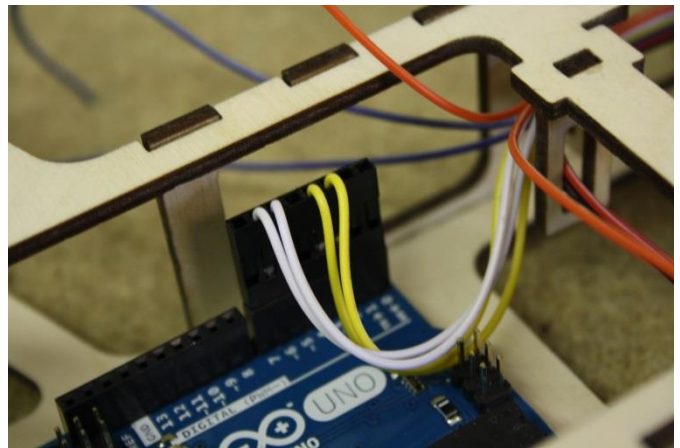
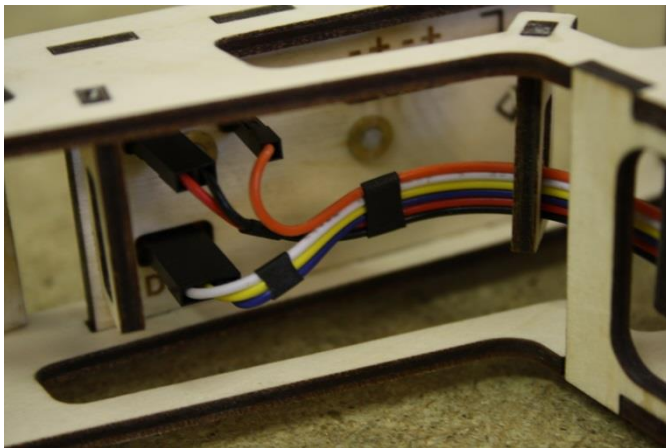


Crimp male DuPont pins to the wires and fit the White (Direction) wire to Pin-6 on the Arduino and the Yellow (Step) wire to Pin-3 on the Arduino. Use an 8-Pin Housing.

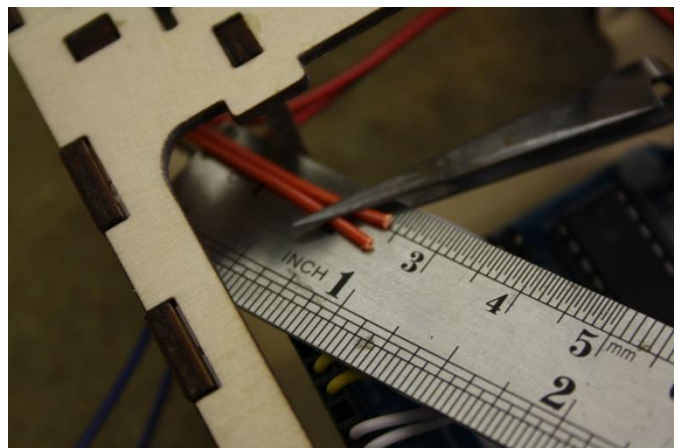
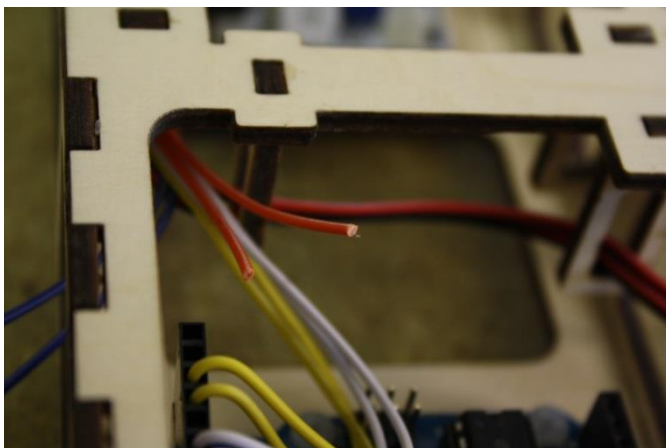


Make another 6-Way wire as before and plug it to the X-Axis EasyDriver in the same way as the Y-Axis. Route the cable through the Cable Conduits to the Arduino, cut off and keep the excess cable for later. Split the cable at the end in the same way again.

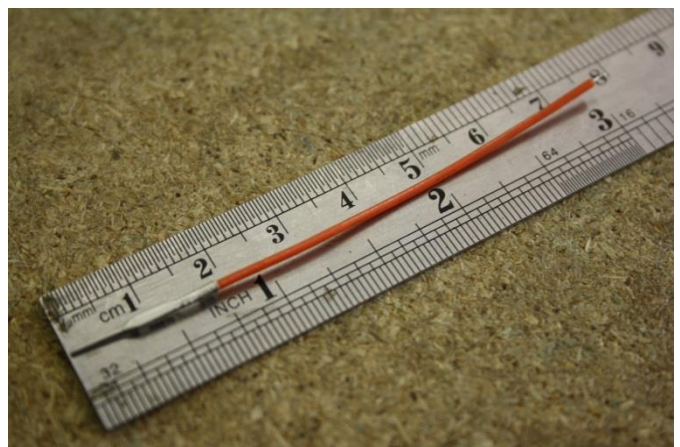
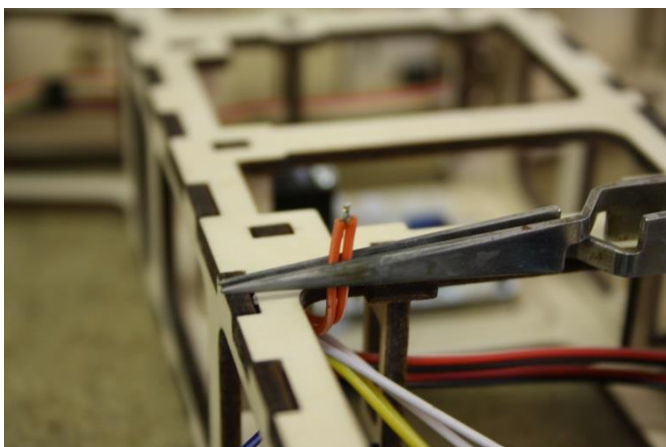
Crimp and plug the White (Direction) wire to Pin-5 on the Arduino and the Yellow (Step) wire to Pin-2 on the Arduino.



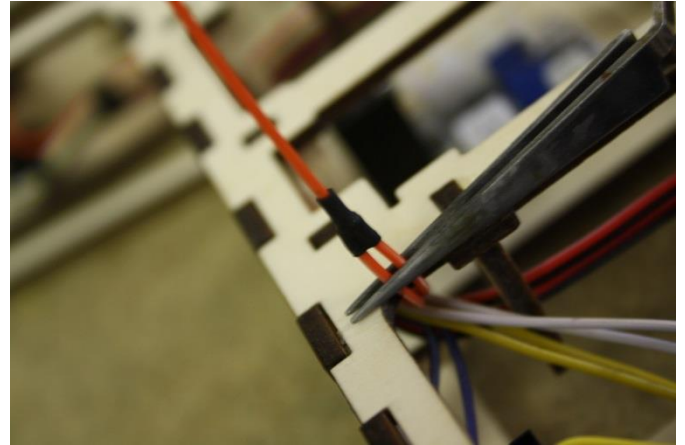
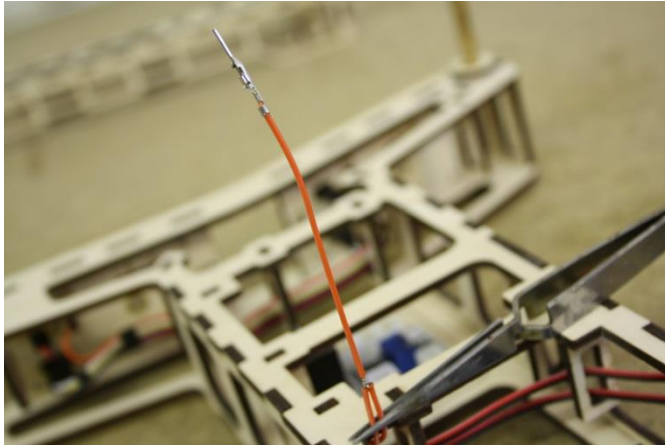
Gather the two Orange (Enable) wires together and cut to length.



Join the two wires together and using some of the cut-off cable; create an Orange wire with a male DuPont connector.

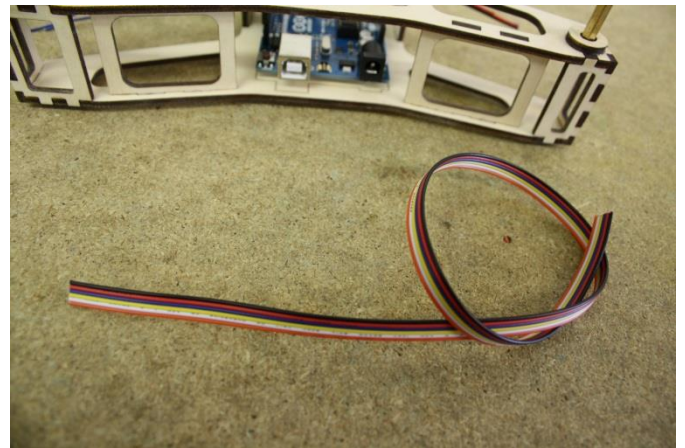
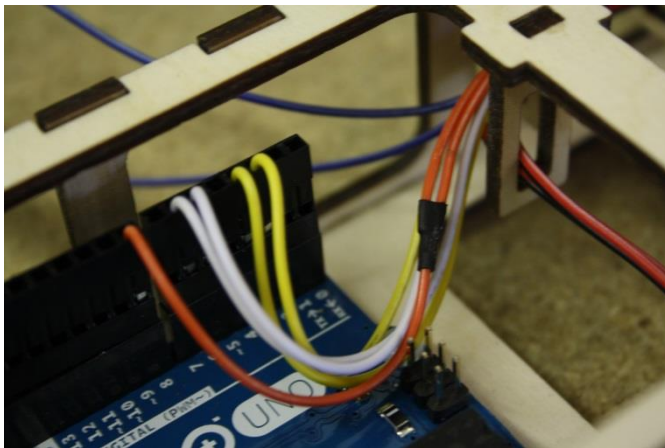


Solder the wires together and insulate with a section of heat-shrink tubing.



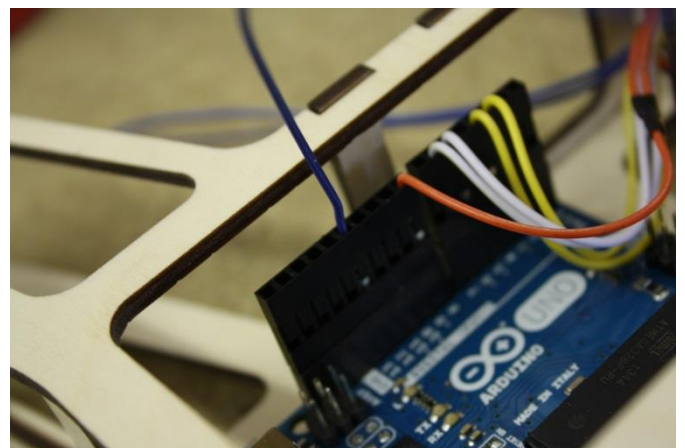
Plug the Orange cable into Pin-8 on the Arduino. Use a 10-Pin Housing.

Get the excess wire saved from earlier.

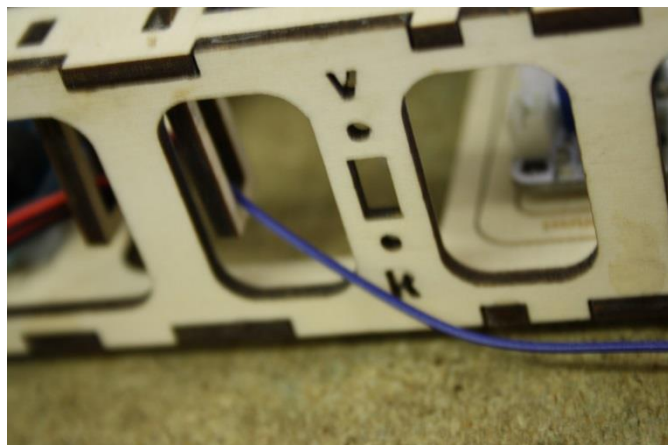
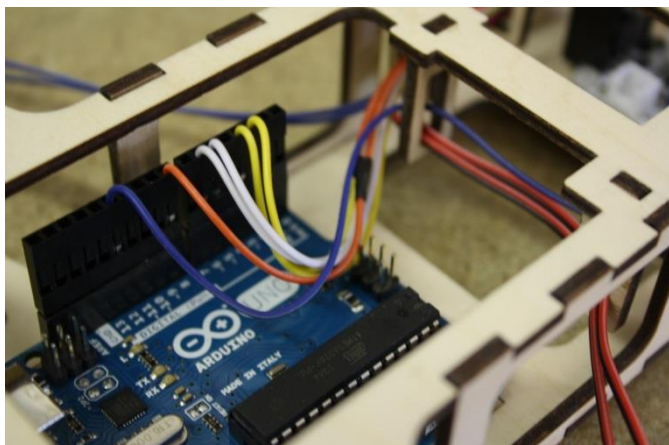


Split off the Blue wire and the Red & Black cables making sure to keep those two together.

Crimp a male DuPont connector to the end of the Blue wire and plug it into Pin-12 (laser Module – Vector) on the Arduino.

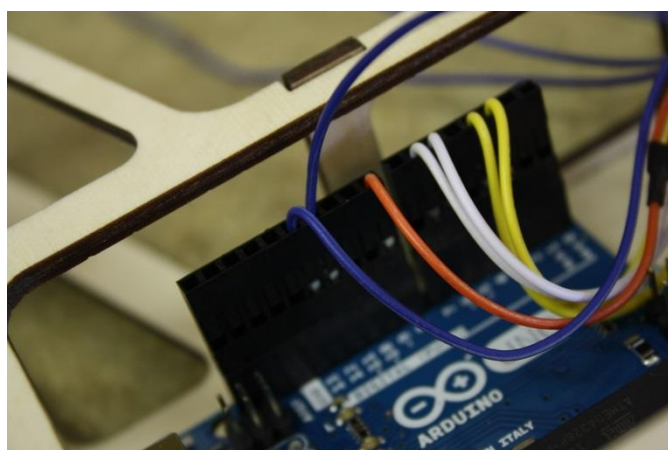
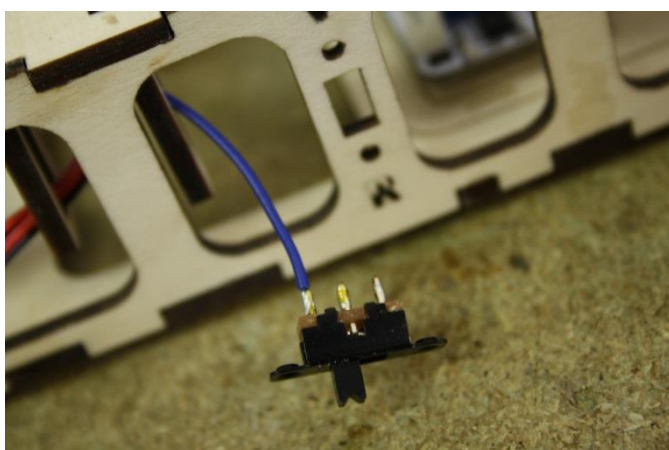


Route the Blue wire through the Cable Conduits to the right side of the Lower-Deck taking the wire out the side near the V & R switch recess.



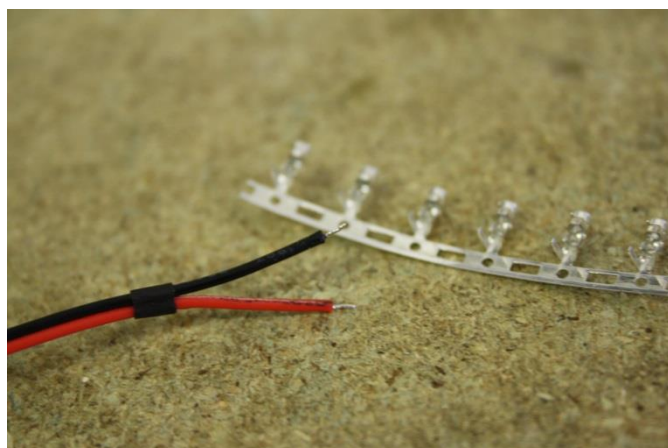
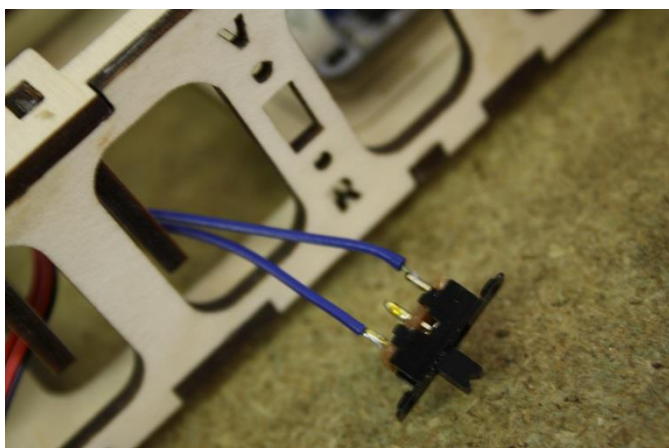
Cut the wire and solder the end to the SPDT Switch. Make sure it is soldered to the pin nearest the toggle. This will make it easier to orientate the switch later.

With the remainder of the Blue wire crimp another Male DuPont to the end and plug it into Pin-11 (laser Module – Raster) on the Arduino.



Route the Blue wire through the Cable Conduits towards the switch and solder the end to the opposite tab.

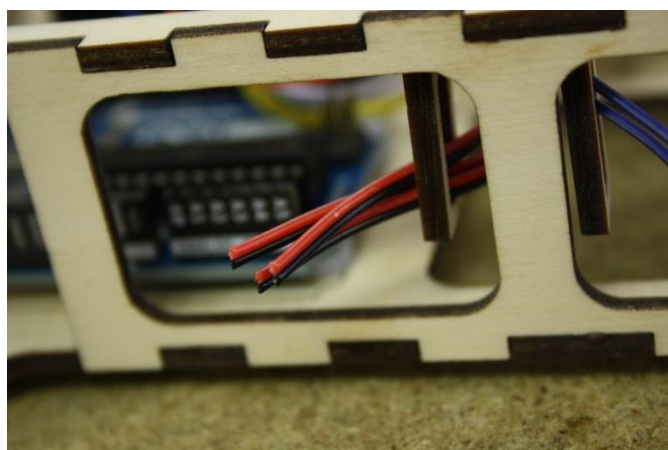
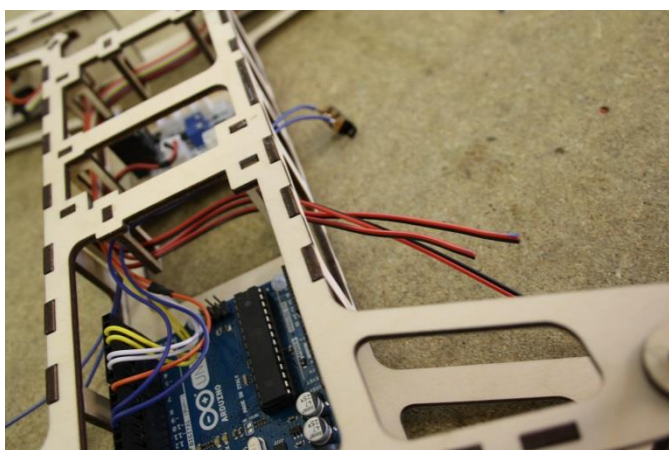
Take the Red & Black wire and attach a small length of heat-shrink to the wire. Expose and tin the ends with solder.



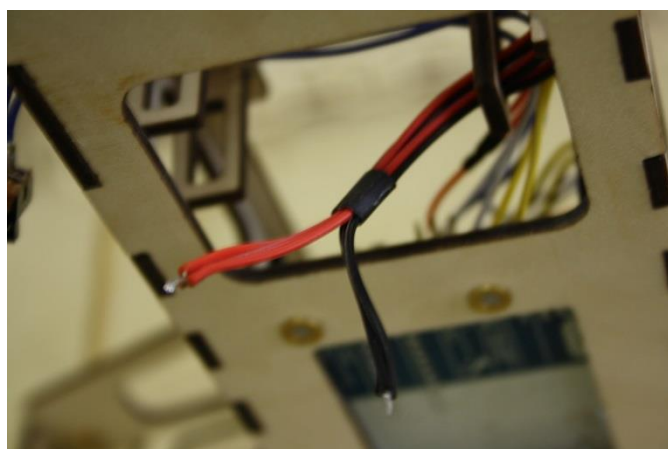
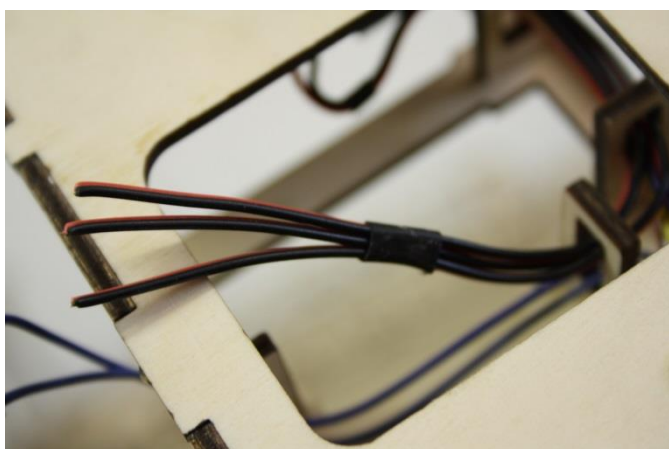
If you have decided against using the crimps simply solder the Red & Black wires into the Laser Module at Vcc. Otherwise affix the larger JST-PH crimps and housing to the cable and plug into the Vcc socket on the Laser Module.



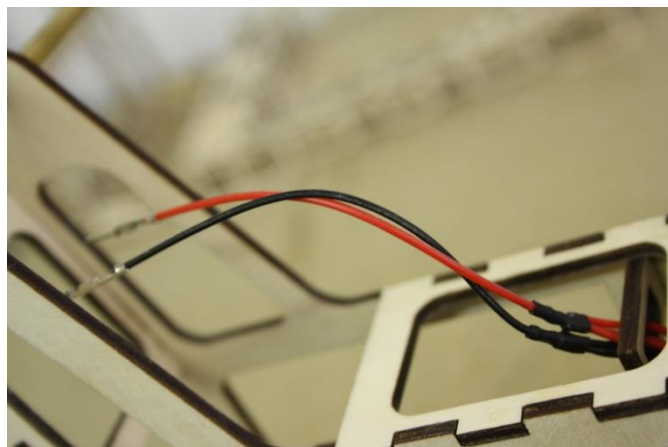
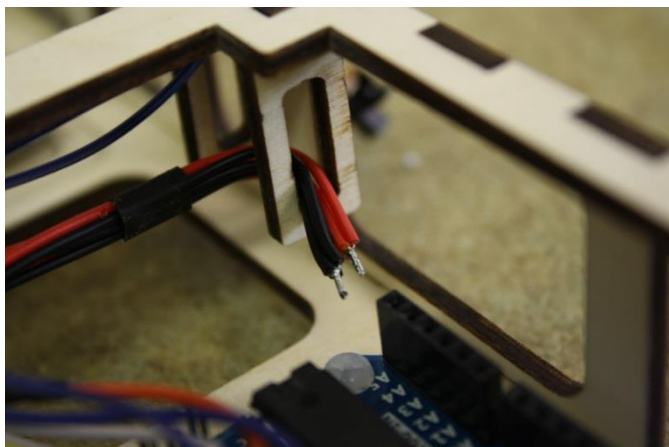
Route the Red & Black cable through the Cable Conduits to the right side of the Lower-Deck. Trim all three cables to length.



Group the wires, secure with a short length of heat-shrink tube and then split the wires into Red & Black. Solder the wires together.

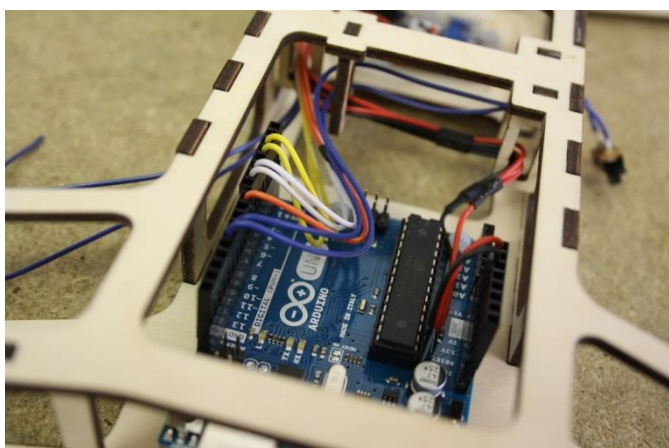


Attach single lengths of Red & Black wires with male DuPont connectors to the grouped cables, insulate the joints with heat-shrink.



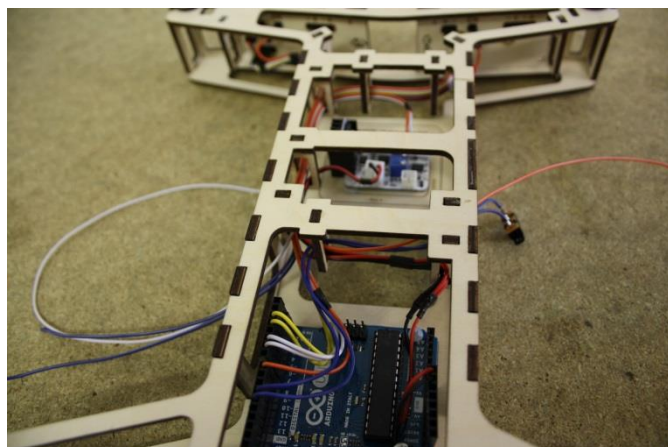
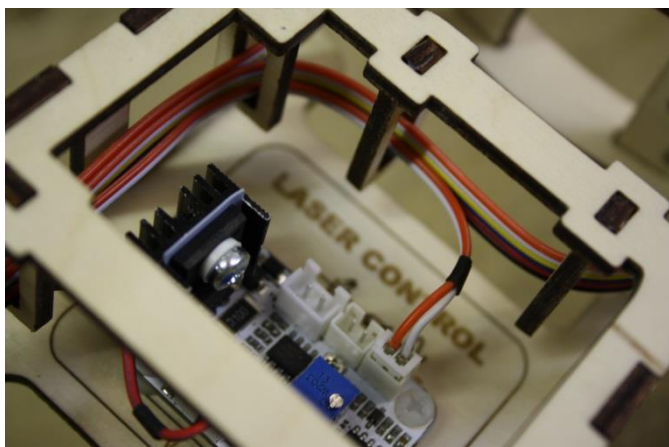
Plug the Red wire to Power Vin on the Arduino and plug the Black wire to Power GND. Use an 8-pin Housing.

Prepare an Orange & White cable with either tinned ends or with smaller 2mm JST-PH crimps and housing.



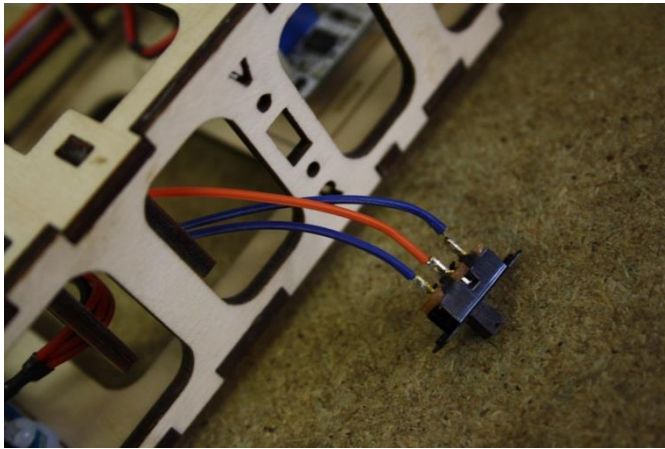
Plug / Solder the Orange & White cable into the PWM socket / Through-Holes on the Laser Module.

Route the cables through the Cable Conduits towards the Arduino. Split the cable taking the White wire off to the left side and the Orange wire out to the left towards the V & R SPDT Switch.

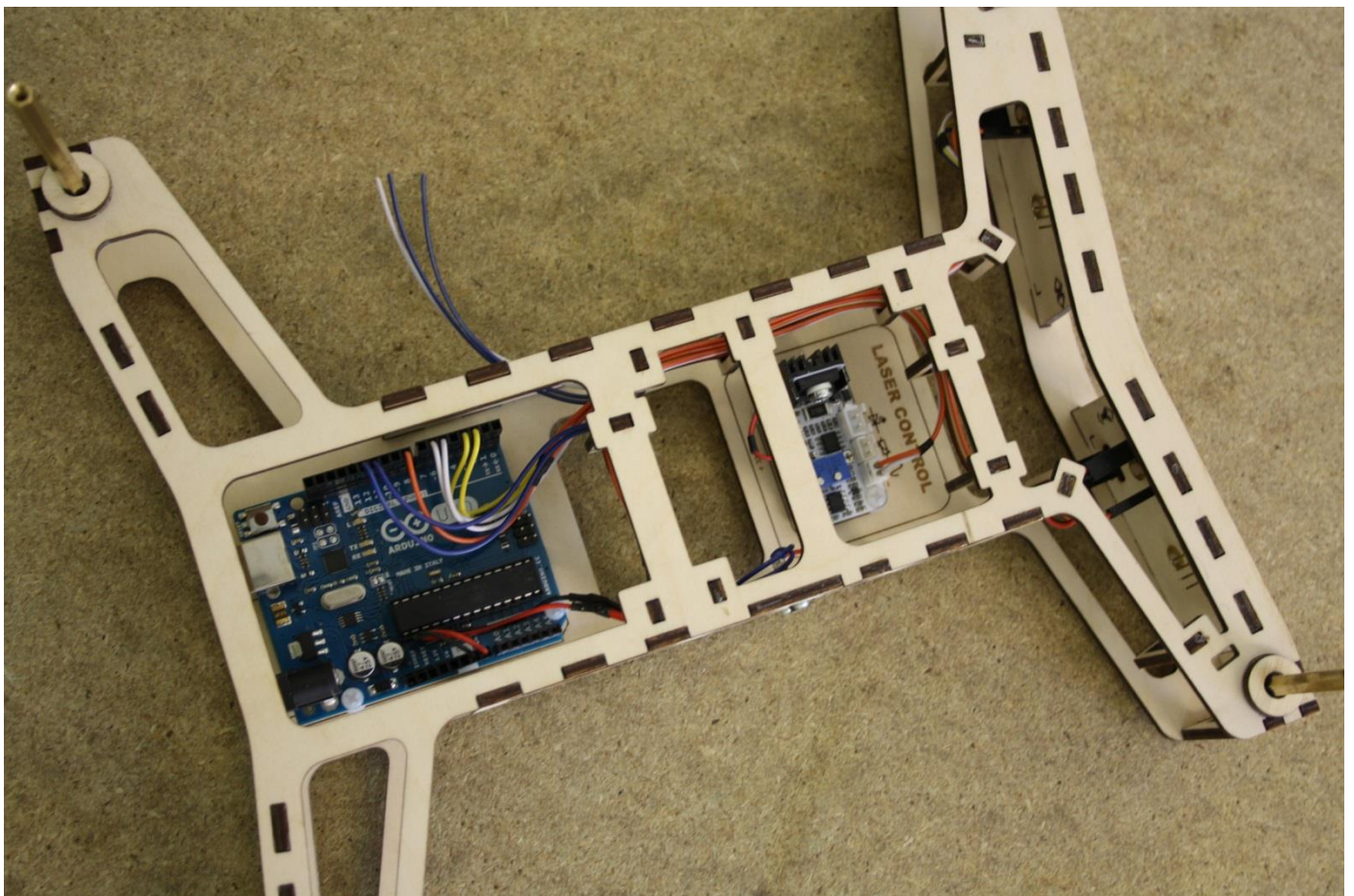


Trim the Orange cable and solder it to the centre tab on the switch.

Orientate the switch with the toggle at the top. Secure the switch to the Lower-Deck with 2x M2 6mm Screws.



Trim the GND wires on the left.



This stage of the Lower-Deck wiring is now complete.

Wiring | Part 2 - The Upper-Deck.

You will need

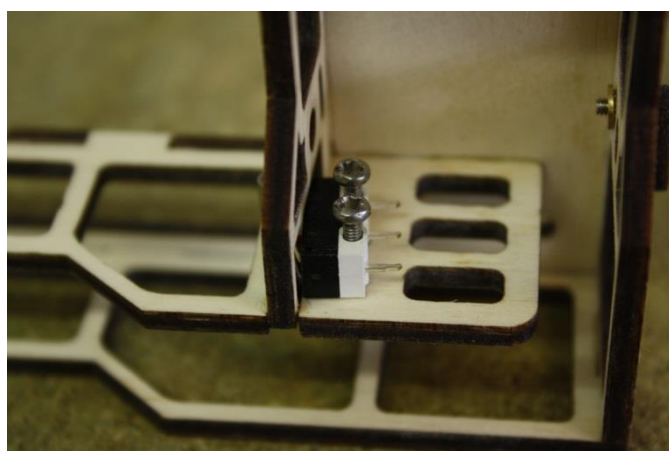
- 3 x Buttons.
- 2 x End-Stop Relays.
- 1 x Stepper Motor.
- 1 x GT2 Pulley with Grub Screw.
- 4 x M2 10mm Screws.
- 2 x M2 6mm Screws.

Remove the nuts and washers from the three buttons, the washers can be discarded.

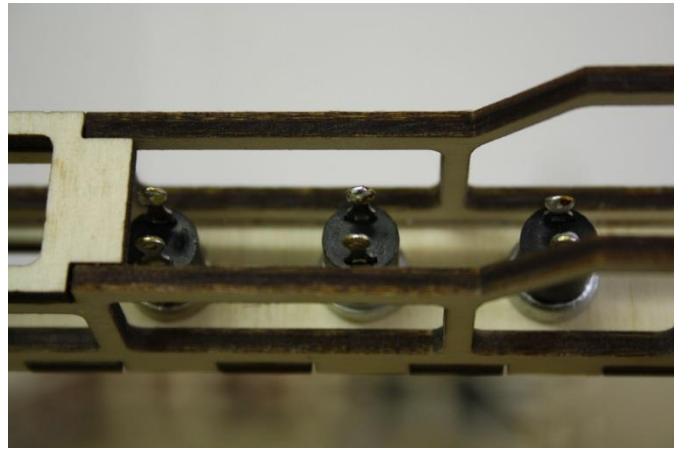
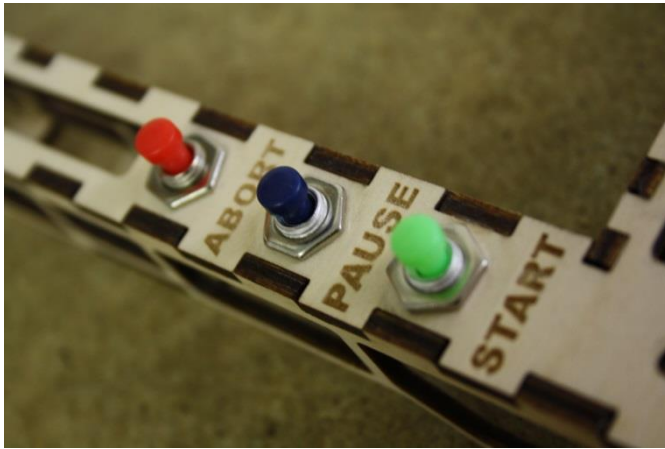
Tin the two solder tabs on each button.



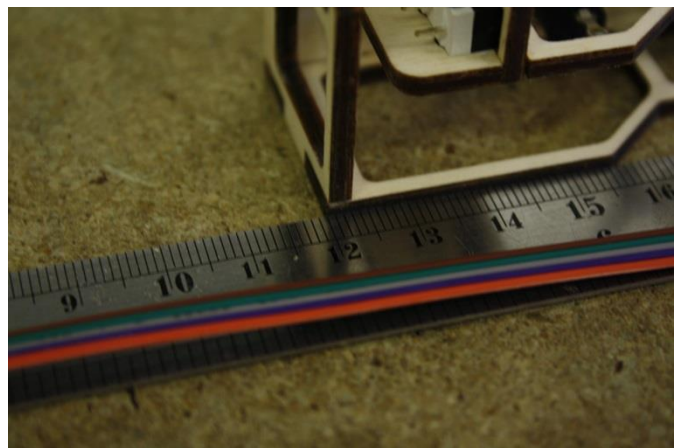
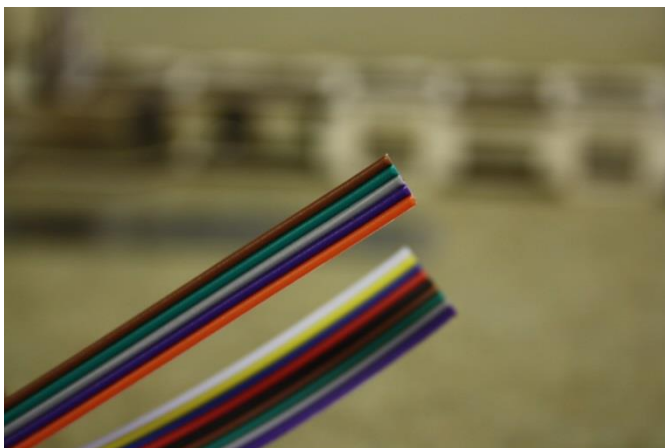
Attach the 2x End-Stops with 4x M2 10mm Screws to the Upper-Deck.



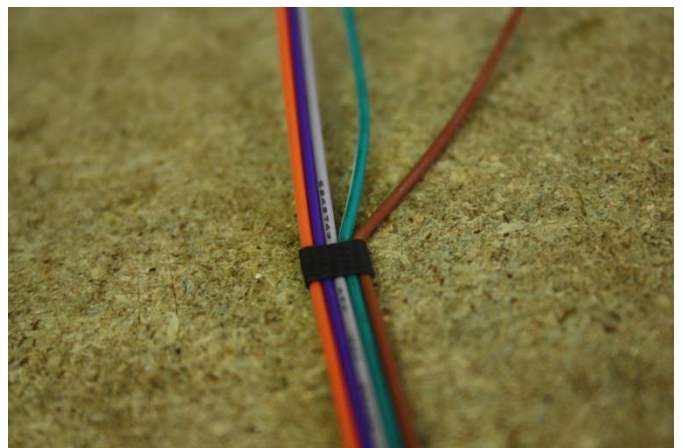
Fit the buttons through the three holes making sure that the solder tabs underneath line up as shown.



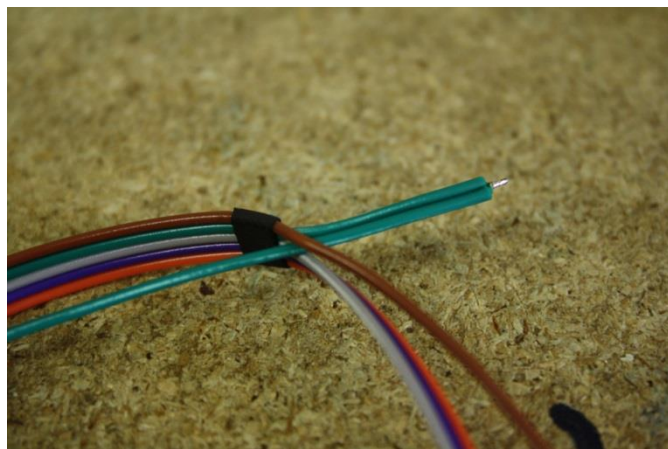
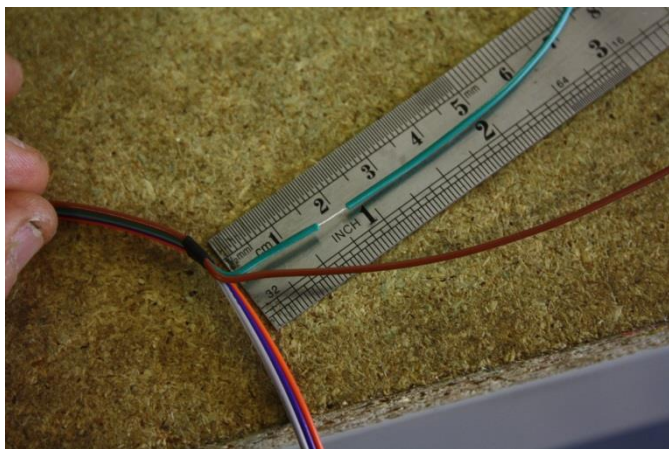
Create a 5-Way strip of cable. Lay the Upper-Deck on its side and measure 12cm from the end. Lay the cable at the end of the ruler and run it down along the length of the Upper-Deck.



Just before the end of the Upper-Deck shrink on a short length of heat-shrink. Split the Brown & Green wires from the strip.

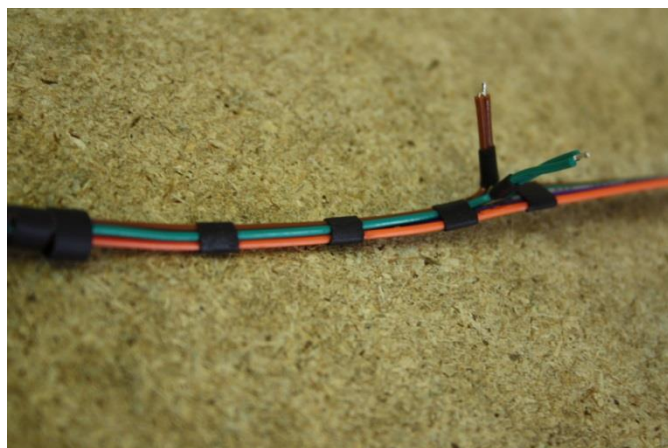
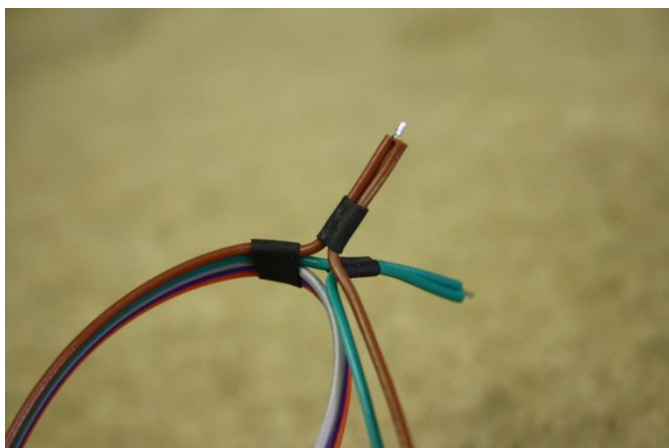


Measure 15mm along the Green wire from the heat-shrink and peel off a 5mm length of insulation from the wire. Fold over the cable and twist the exposed wire together and tin with solder.

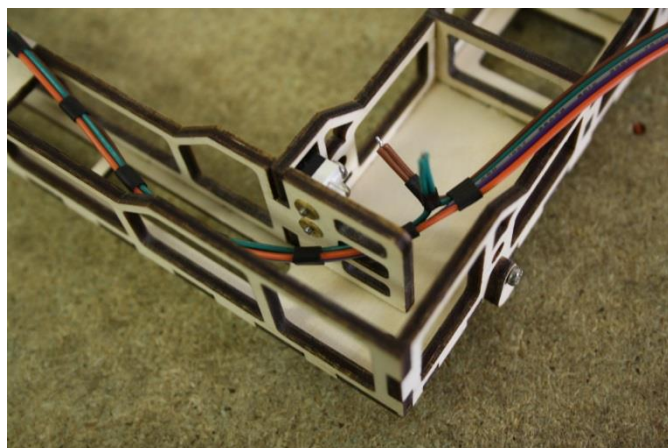
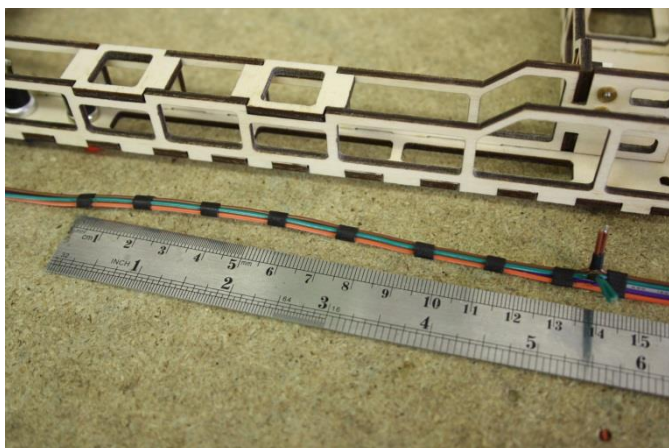


Repeat this process with the Brown wire and place a short length of heat-shrink at the bottom of the bend.

Group the cables together and place short lengths of heat-shrink along the cable to hold it together.

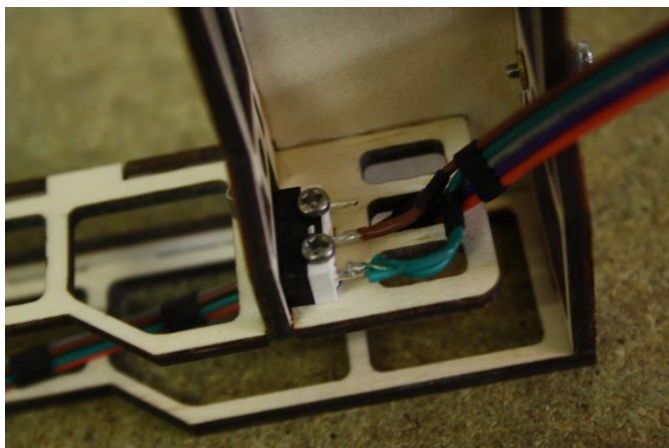


Create ~14cm of cable and then feed it through the Upper-Deck as shown.



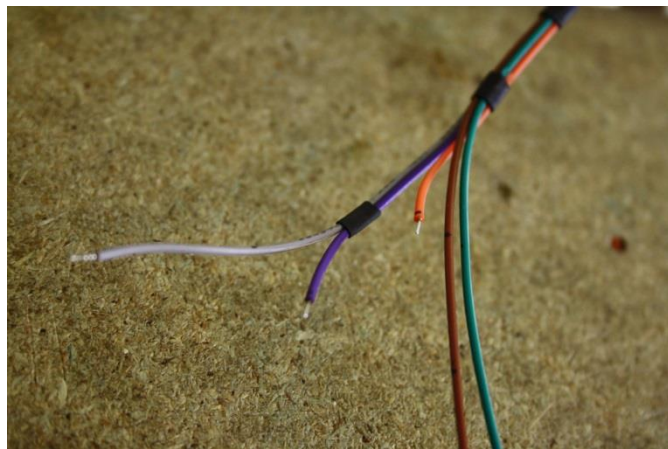
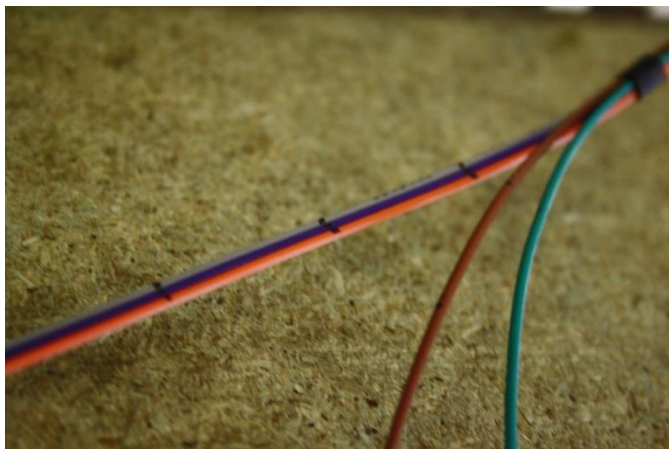
Solder the Brown & Green wires to the End-Stops COM & NO pins.

Stretch-out the cable along the Upper-Deck and mark with a pen the location of the switches solder tabs against the cables.

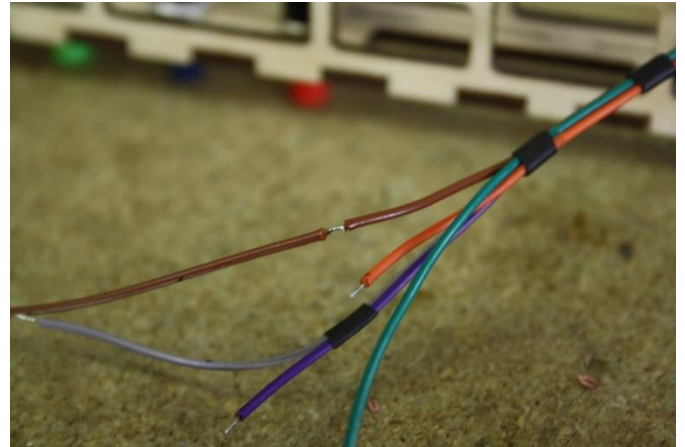
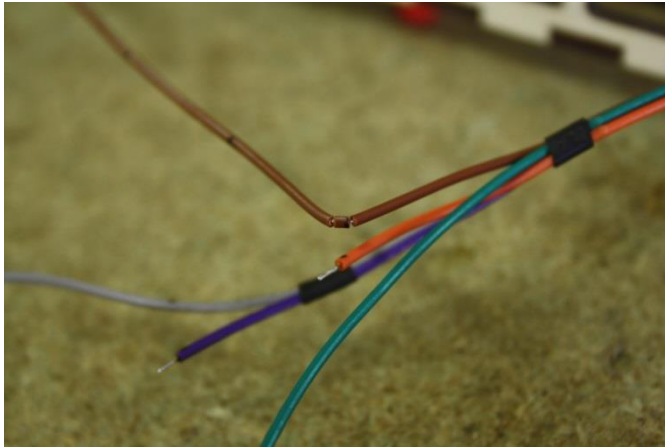


Cut the Grey/Purple/Orange wire to just past the last pen-mark.

Split the wire into three and tin each end as shown.

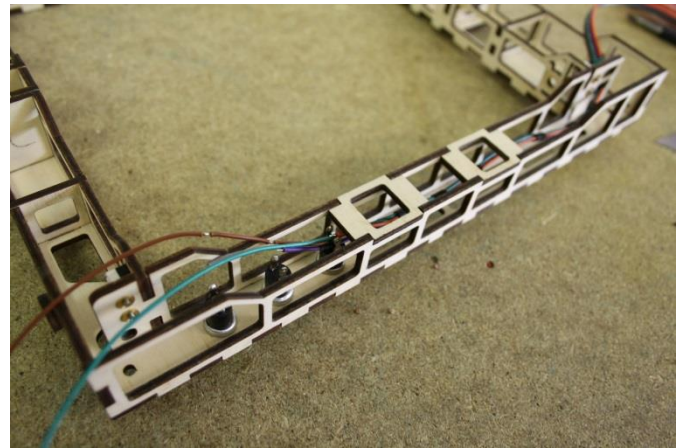


On the Brown cable remove the insulation to expose a small (2-3mm) section of wire. Tin the exposed wire with solder.



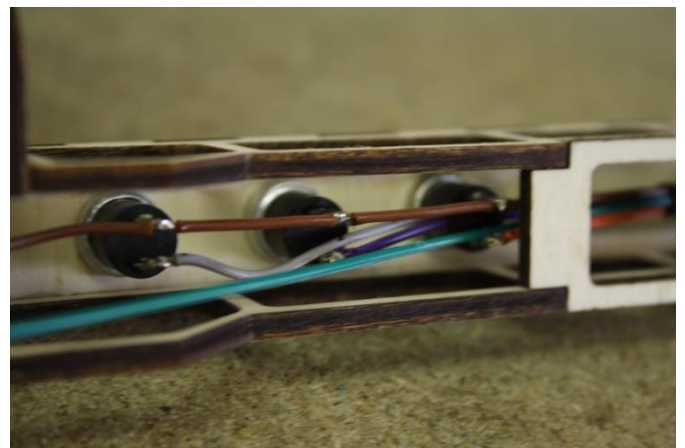
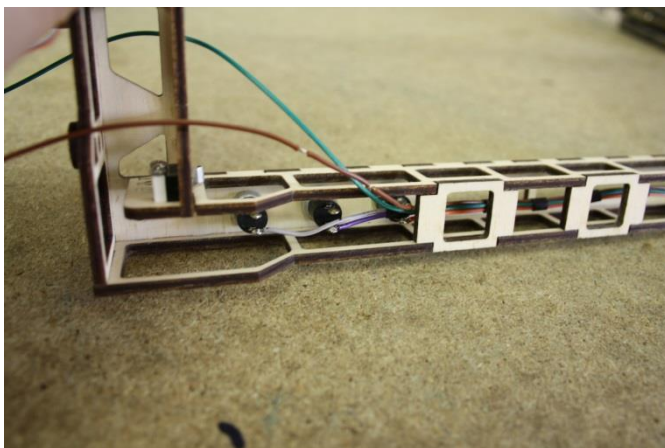
Repeat this at the two other pen marks.

Feed the cable through the side of the Upper-Deck towards the buttons.

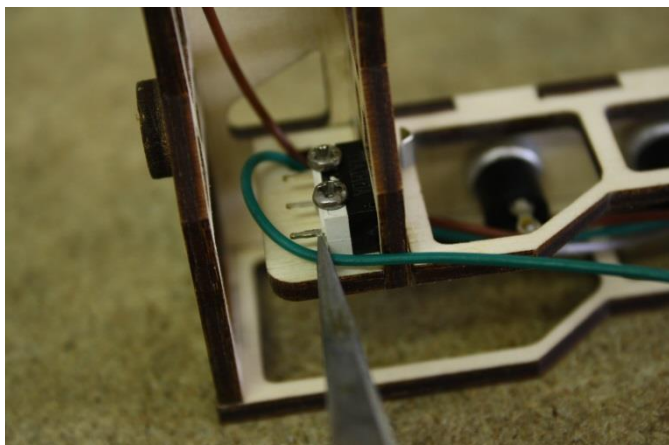


Solder the Orange wire to the Reset Button, Solder the Purple wire to the Paus Button and solder the Grey wire to the Start Button.

In sequence solder one of the exposed tinned wires of the Brown wire to a solder tab on each of the buttons.

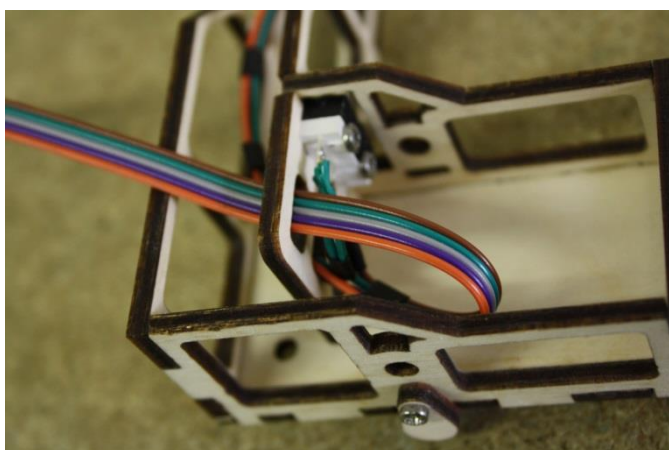


Feed the Green & Brown wires through the small hole, cut to the correct length, tin and then solder to the remaining End-Stop COM & NO pins on the Upper-Deck.



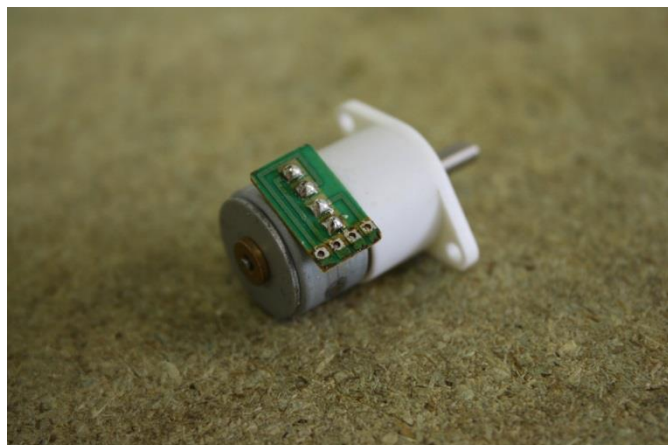
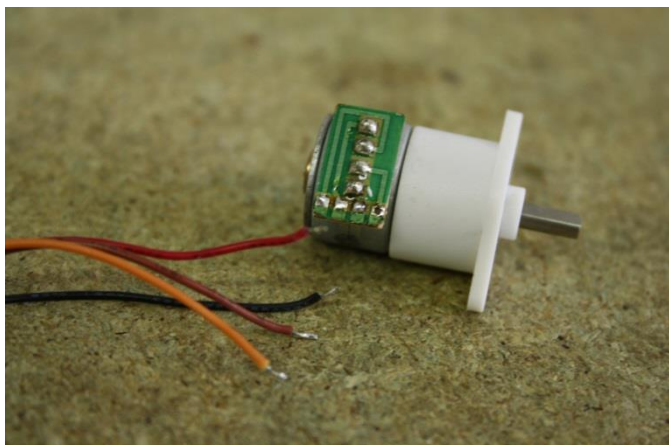
Feed the other end of the cable through one of the openings on the Upper-Deck.

From one of the Stepper Motors remove the plastic clips covering the wires.



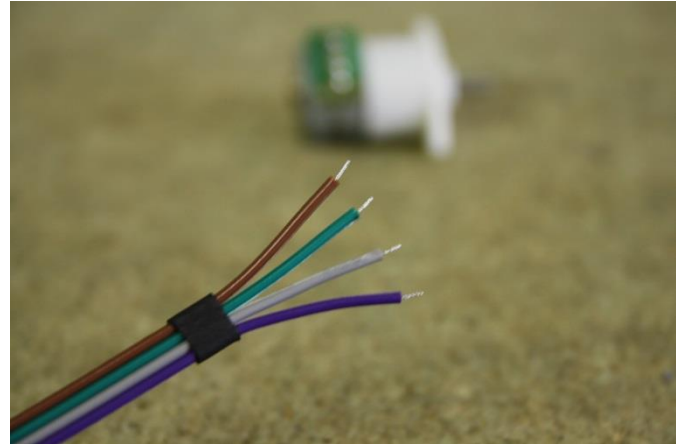
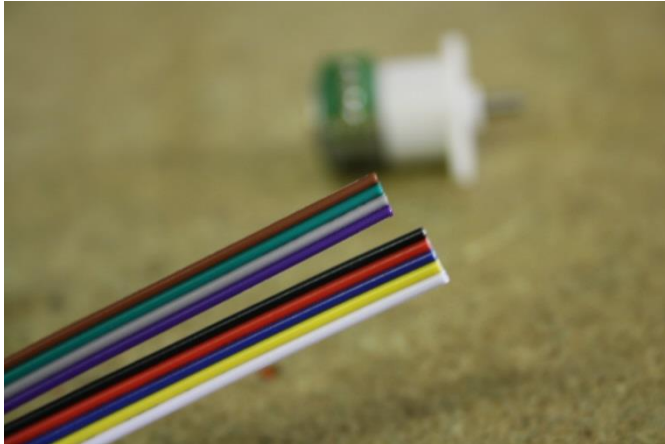
De-solder the wires from the motor.

Clean off the old solder with a solder-wick or similar.



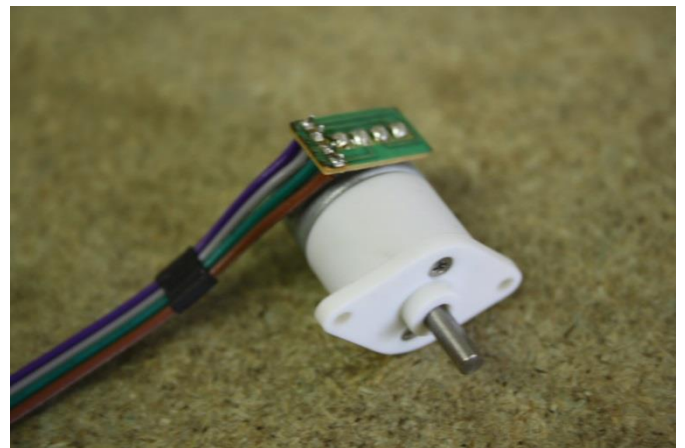
Split off a 4-Way strip of cable.

Shrink a 5mm length of heat-shrink tube about 25mm (1") from the end. Split the cable and tin the ends of the wires.



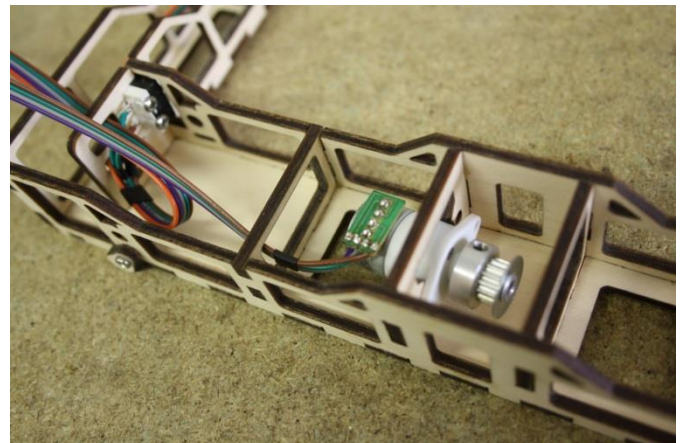
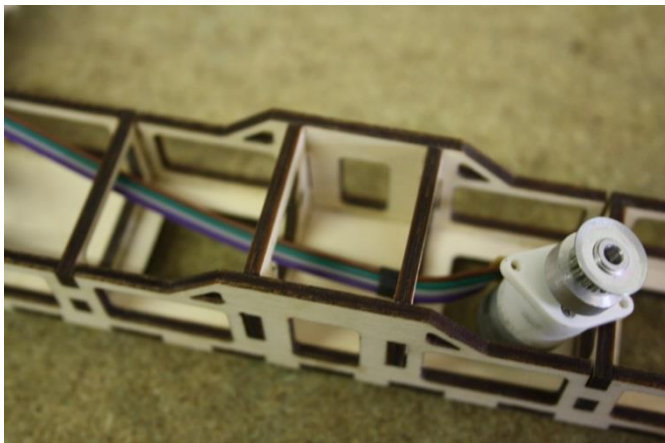
Fit the 4-Way cable into the Stepper Motor as shown.

Solder the wires to the motor.



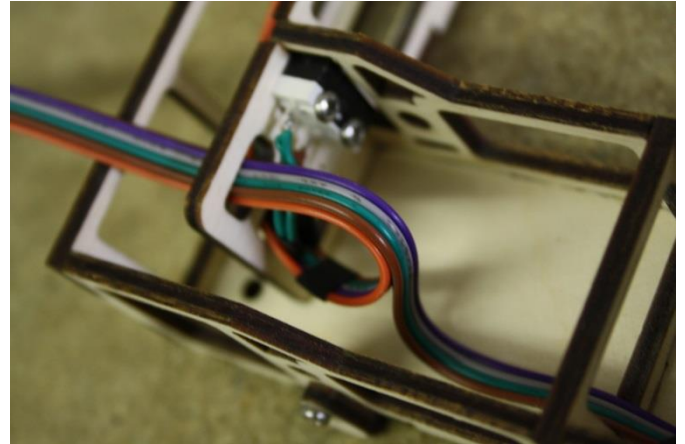
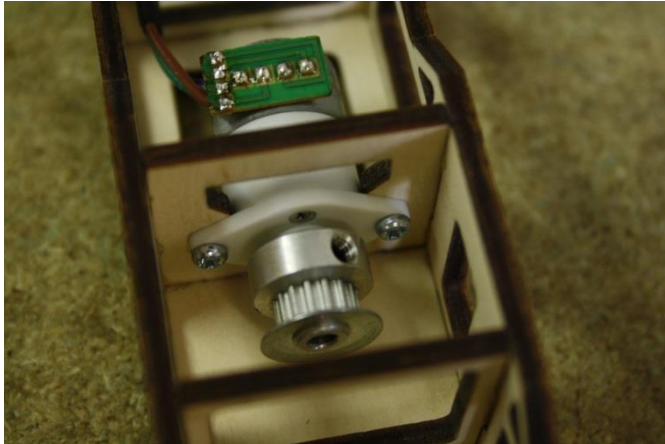
Fit a GT2 Pulley with Grub-Screw to the motor's spindle.

Feed the cable and motor through the Upper-Deck as shown.



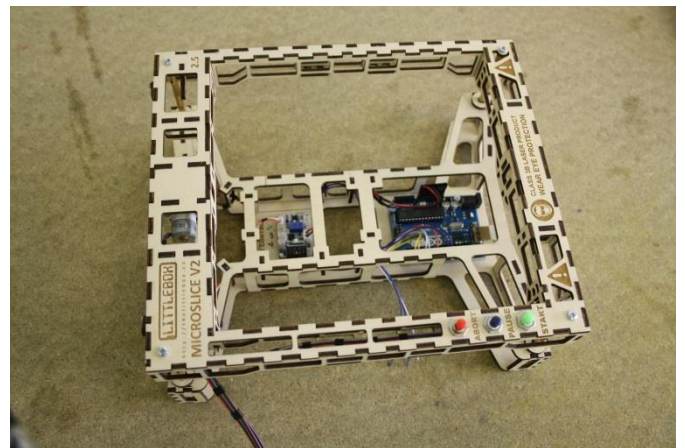
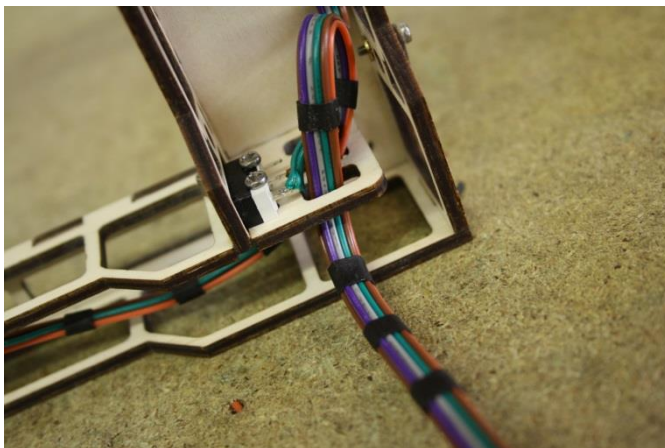
Secure the Y-Axis Stepper Motor to the Upper-Deck with 2x M2 6mm Screws.

Feed the motor's cable out through a hole.



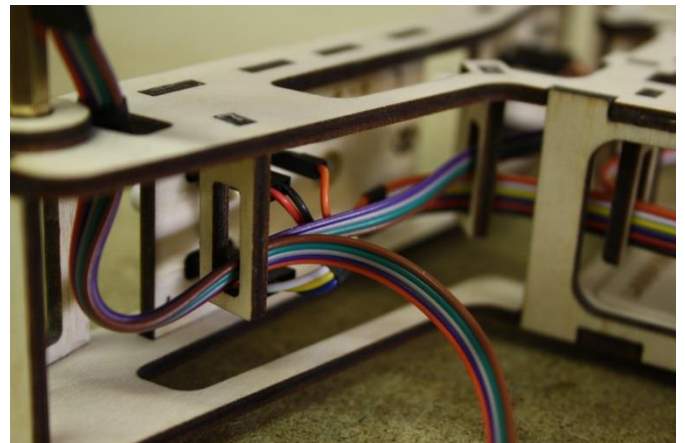
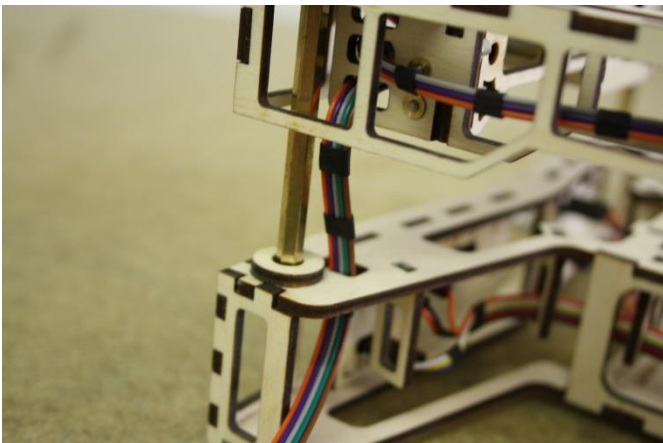
Add a few lengths of heat-shrink to group the two sets of wires together.

Place the Upper-Deck onto the Lower-Deck and secure with 4x M3 10mm Screws.

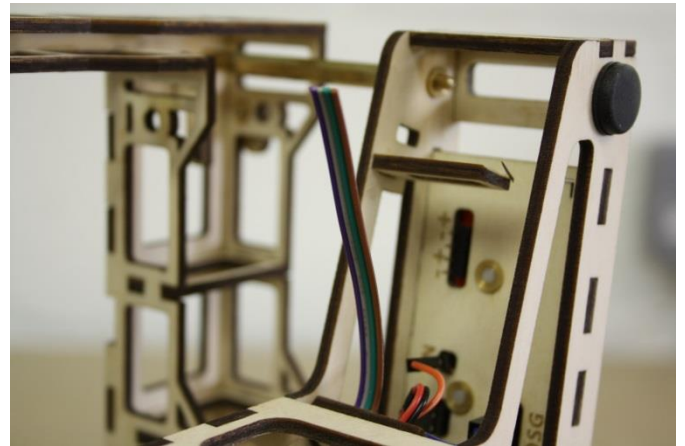
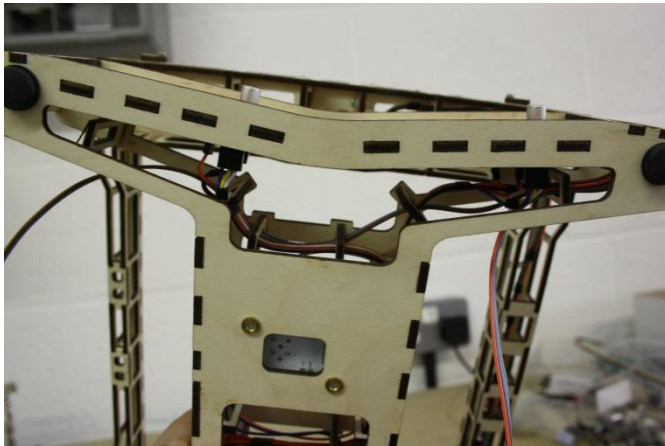


Feed the two cable through the hole in the Lower-Deck.

Pass the Y-Axis Stepper Motor's cable through the Cable Conduits to the Y-Axis EasyDriver.

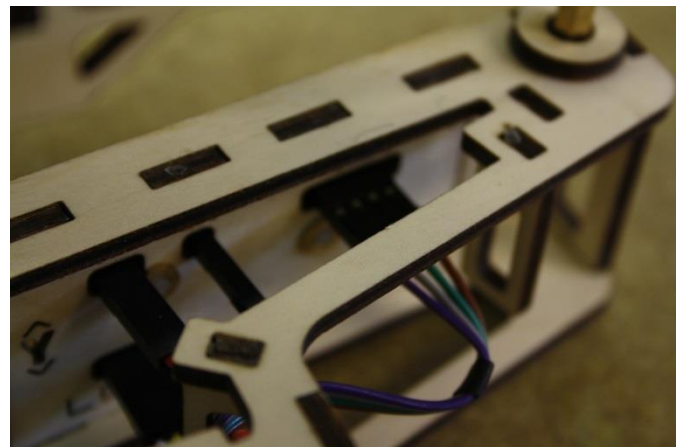
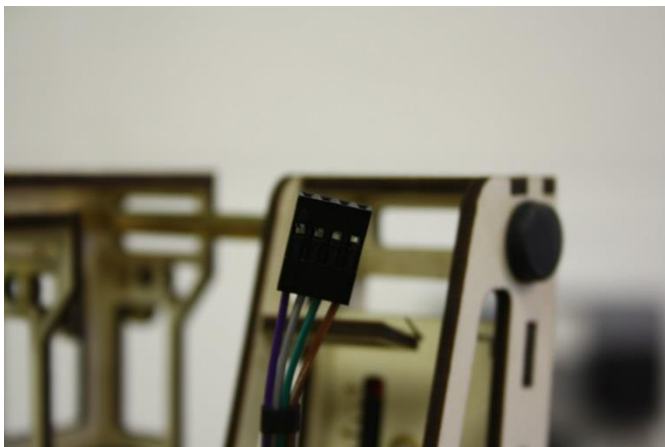


Cut off the excess cable.

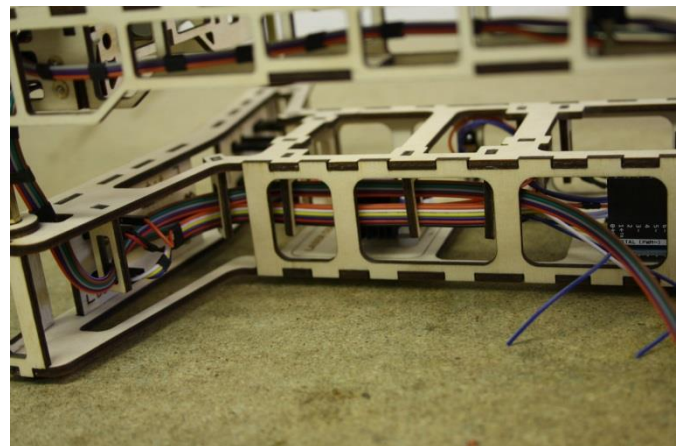
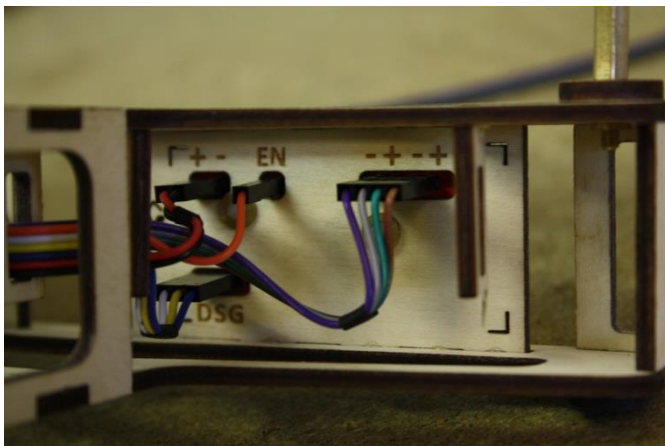


Add 4x Female Dupont connectors and a matching plastic housing to the end of the Y-Axis Stepper Motor's cable.

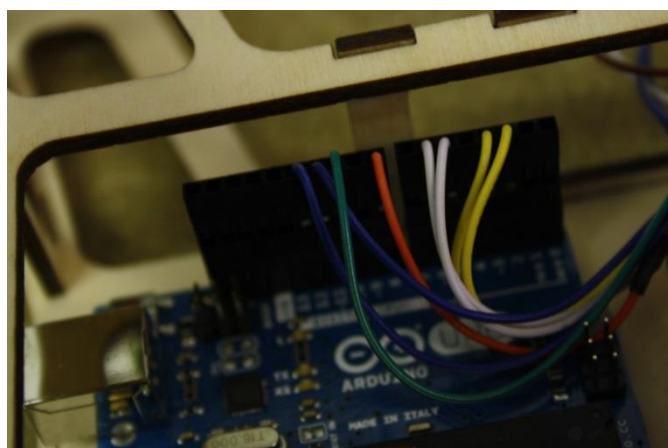
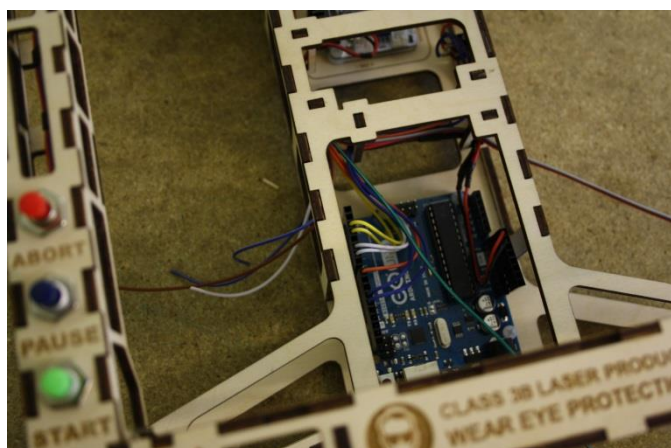
Plug the cable on to the EasyDriver.



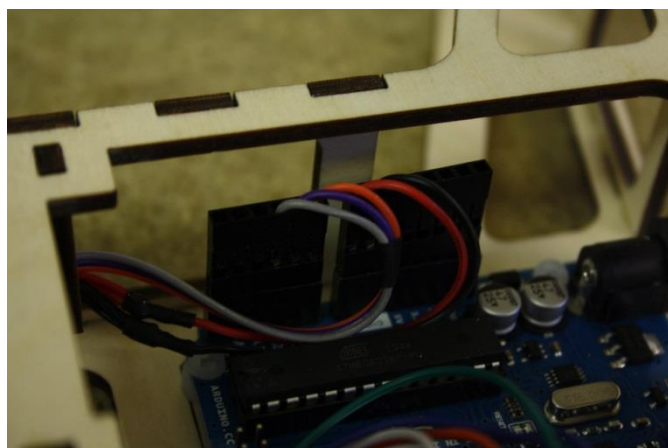
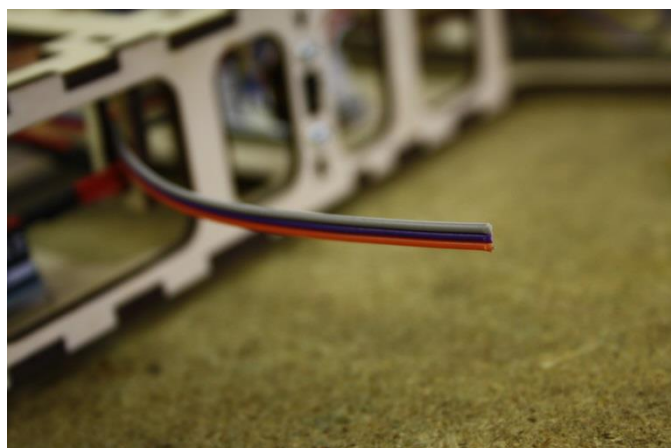
Feed the 5-Way cable from the Upper-Deck through the Cable Conduits towards the Arduino.



Split off the Brown & Green wires. Feed the Grey/Purple/Orange wires to the right-side. Pass the Brown wire to the left. Cut the Green wire to length, crimp on a male DuPont connector and plug it into Pin-10 on the Arduino.



The Grey/Purple/Orange wires can be split with the Orange wiring going to Pin-A0 (Reset), the Purple wire to Pin-A1 (Pause) and the Grey to Pin-A2 (Start). Use a 6-Way housing.



This stage of the wiring for the Upper-Deck & Lower-Deck is now complete.

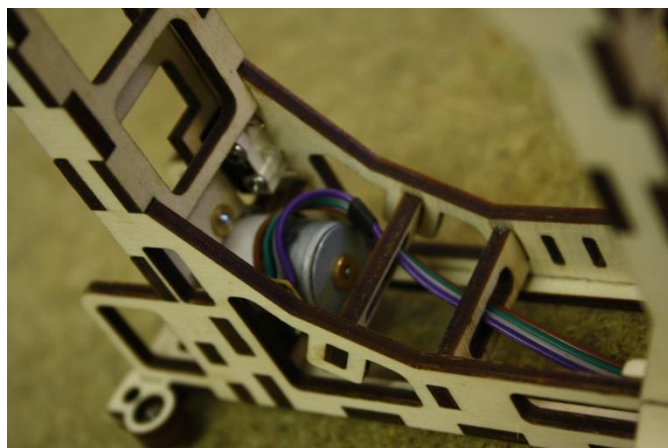
Wiring | Part 3 - The Gantry.

You will need

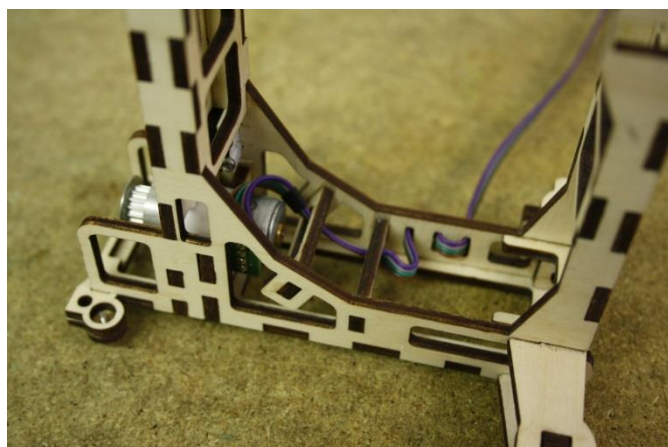
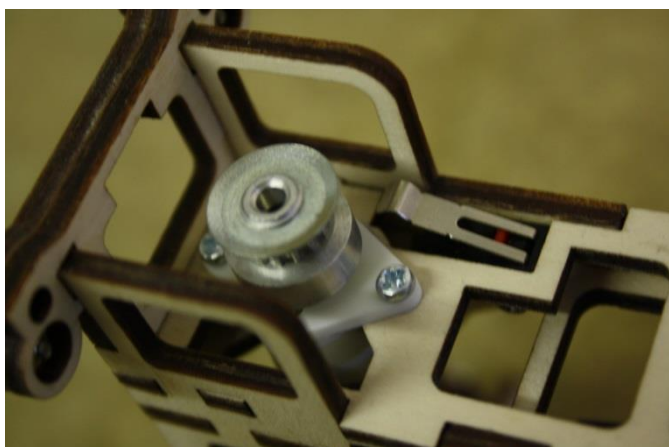
- 2 x End-Stop Relays.
- 1 x Stepper Motor.
- 1 x GT2 Pulley with Grub Screw.
- 2 x M2 6mm Screws.
- 4 x M2 10mm Screws.
- 1 x Ferrite Core.

Fit an End-Stop to each end of the Gantry. Secure them using 4x M2 10mm Screws.

Fit in the X-Axis Stepper Motor after having attached a 4-Way cable in the same way as was done with the Y-Axis Stepper Motor. Secure the motor using 2x M2 6mm Screws. Make sure to correctly route the cable when doing so.

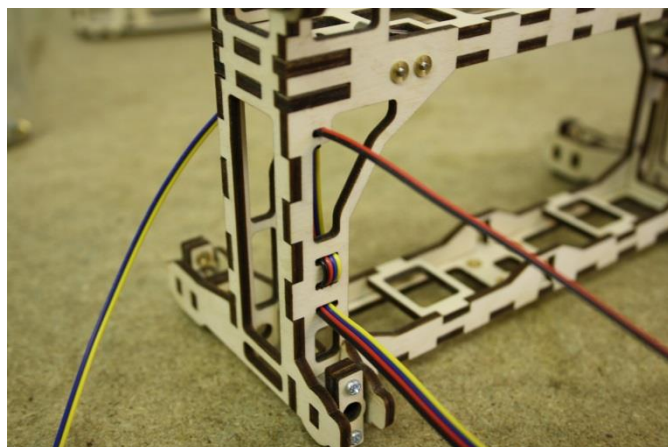


Pass the cable through the slots as shown.



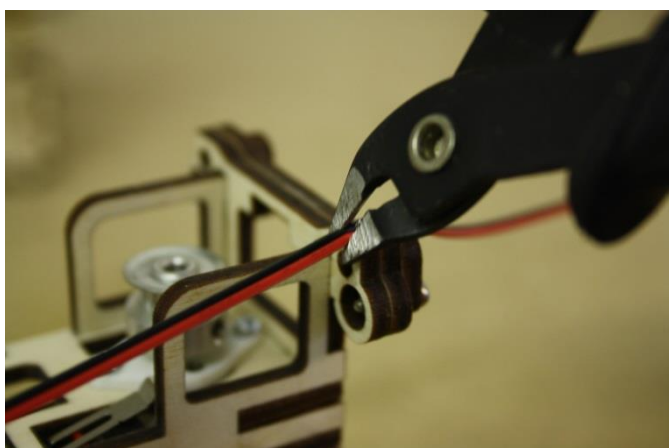
With the remaining 4-Way cable place a short length of heat-shrink tube 30cm from the end and shrink in place.

Split the cable into two pairs; Red & Black and Yellow & Blue. Feed the cable through the Gantry as shown passing the Red & Black out the back of the Gantry.

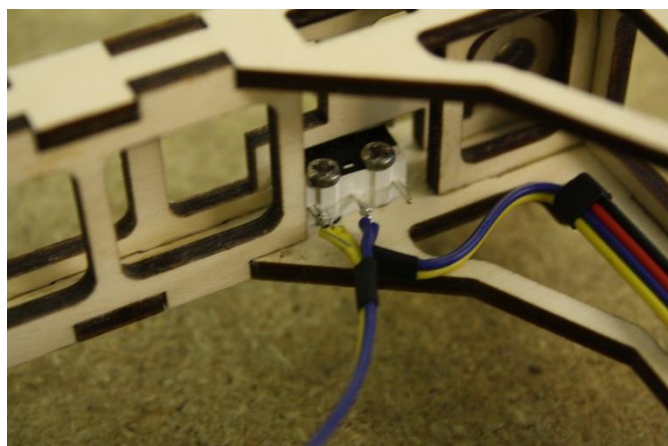
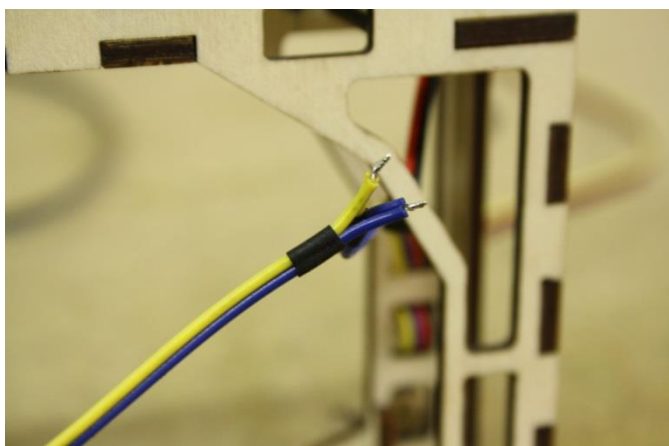


Cut the Red & Black to length using the side of the Gantry as a reference point.

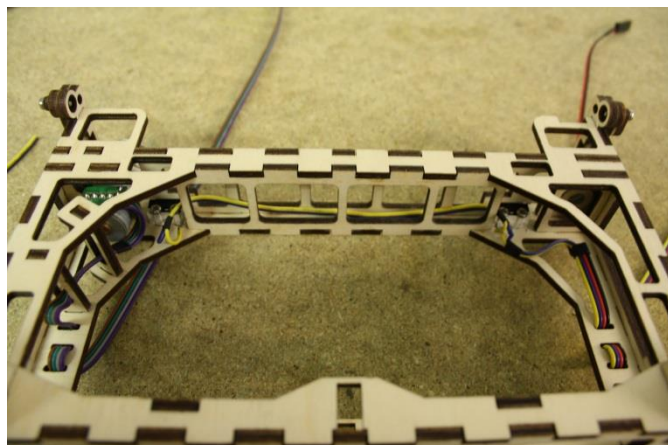
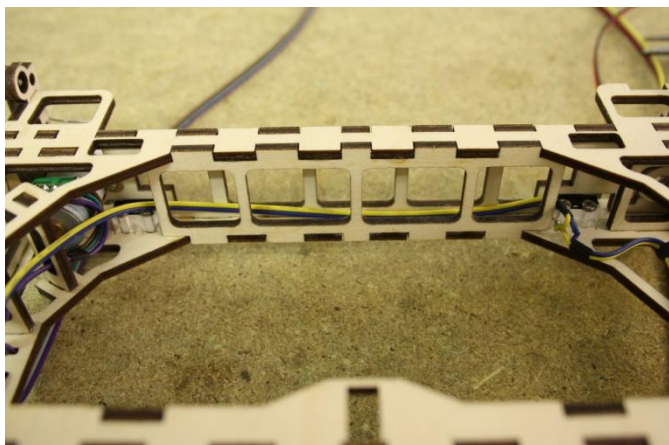
To the Yellow & Blue cable add a length of heat-shrink approximately 3cm (1") from the cable split, add another length of heat-shrink 2cm further on and split the Yellow & Blue wires apart.



Remove ~5mm of insulation from each of the two wires and twist them together (do not mix colours). Tin the ends with solder and then solder to the End-Stops COM & NO pins.

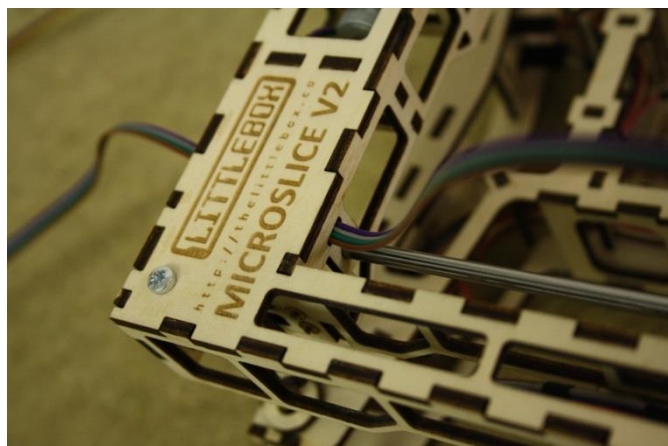
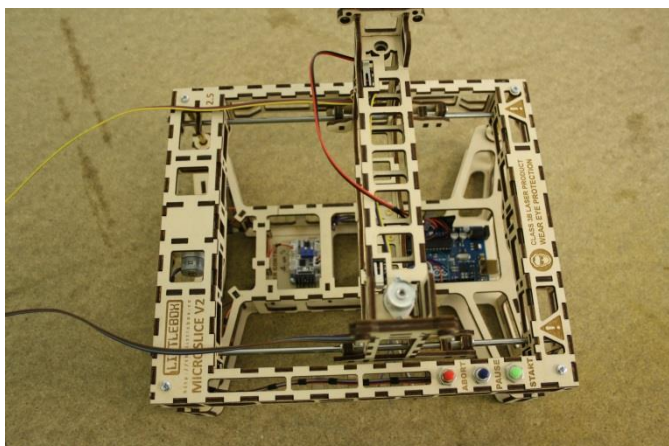


Pass the Yellow & Blue cable along the Gantry to the other End-Stop and solder to the COM & NO pins.

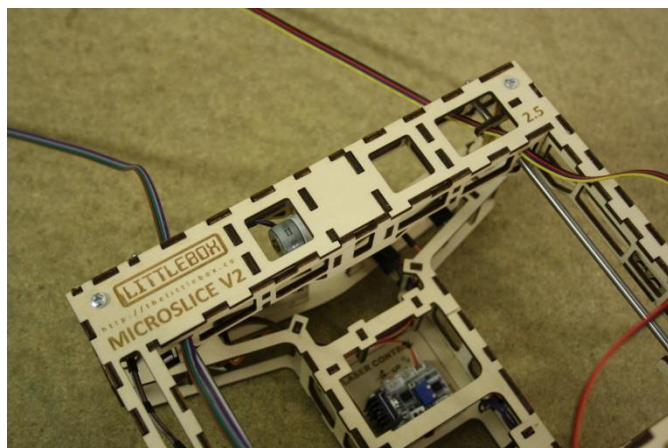
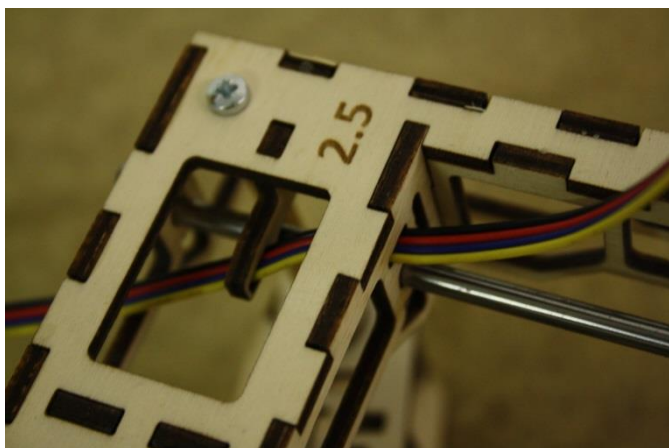


Next slide the Gantry onto the 2x 4mm x 184mm Bars of the Upper-Deck.

Pass the X-Axis Stepper Motor cable through the hole above the 4mm Bar.

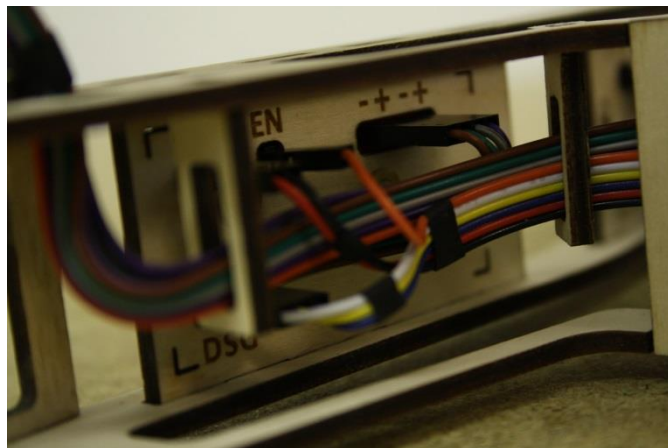
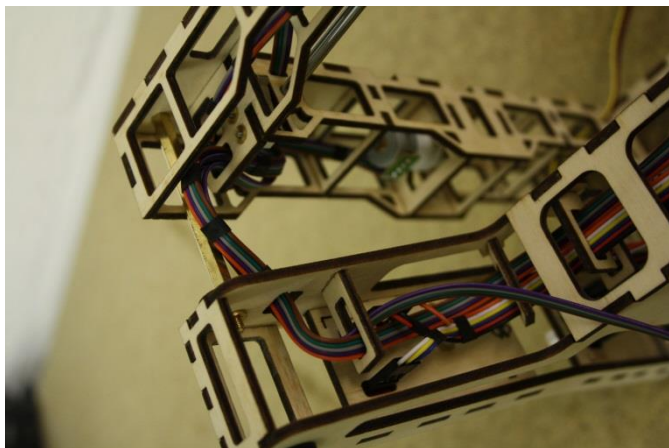


Pass the Black/Red/Yellow/Blue wire on the other side through the hole on the other side and through the Cable Bracket.

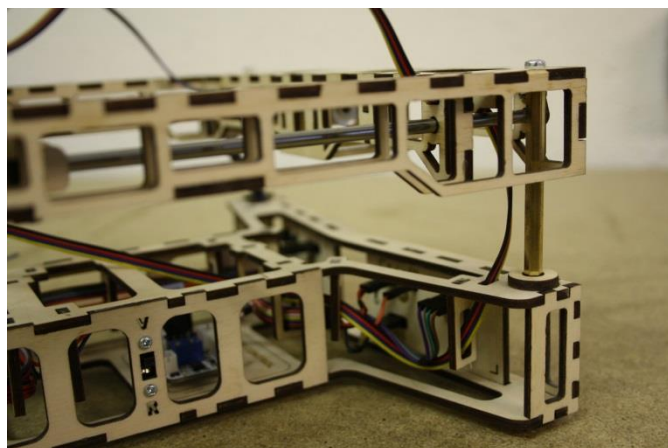
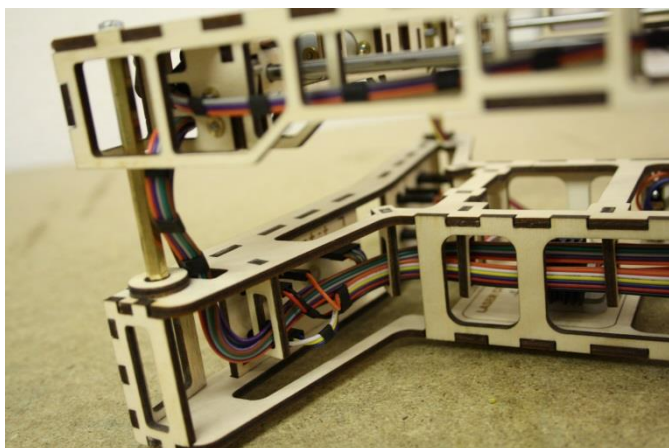


Feed the X-Axis Stepper Motor cable through the Upper-Deck, into the Lower-Deck and through the Cable Conduit.

Cut the cable to length before crimping on 4x Female DuPont pins and fitting a 4-Way housing. Plug the wire to the X-Axis EasyDriver.

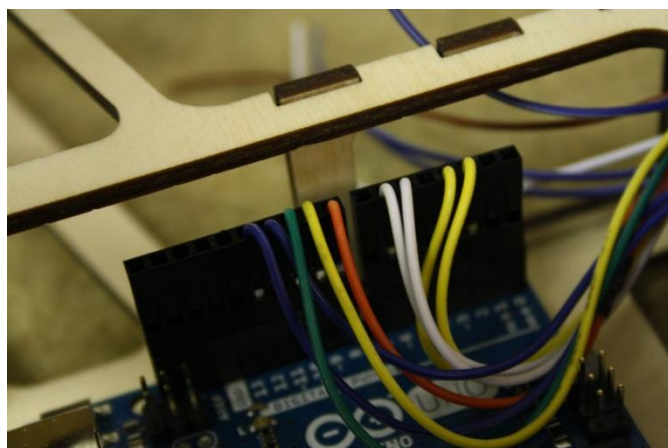
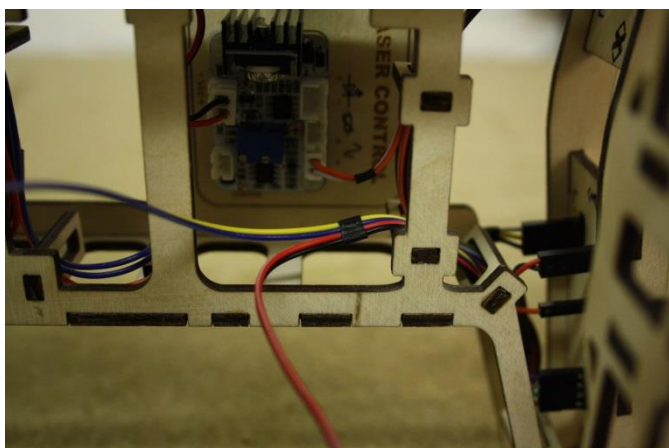


Route the Black/Red/Yellow/Blue down through the Lower-Deck.

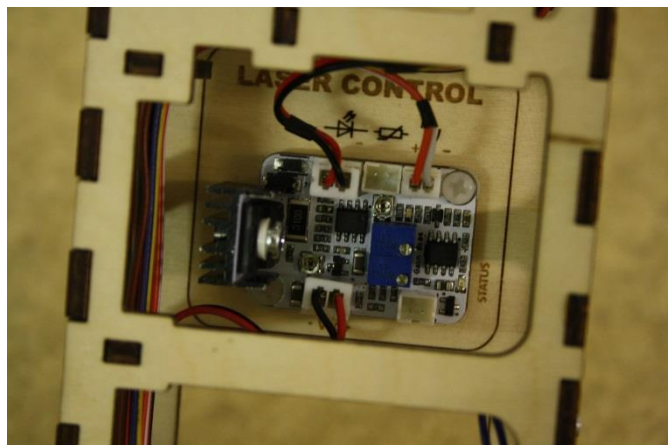
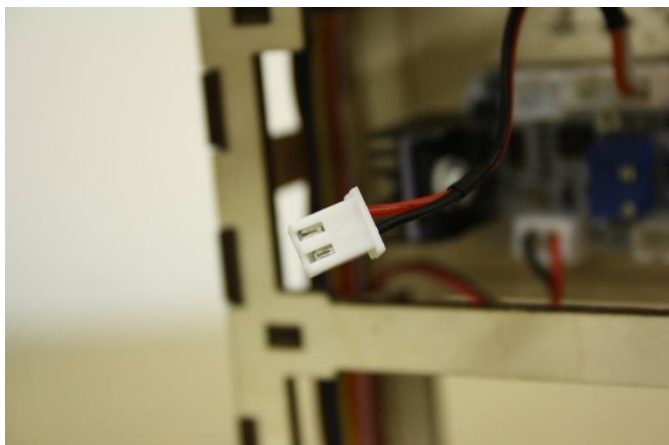


Split the Black/Red/Yellow/Blue again into Red & Black and Yellow & Blue.

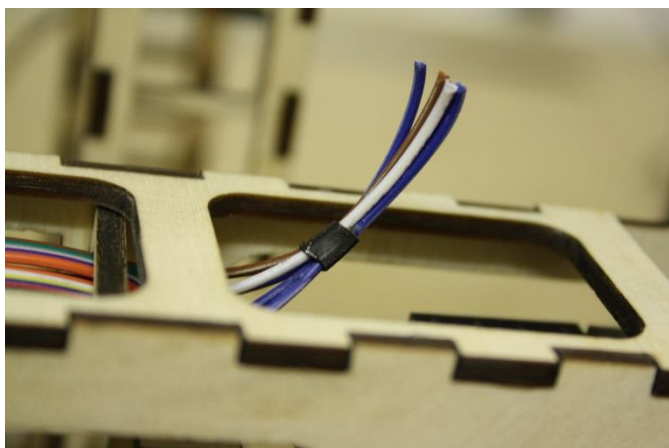
Thread the Yellow & Blue wire through the Cable Conduits to the Arduino. Plug the Yellow wire into Pin-9 on the Arduino and route the Blue wire out to the left with the other GND wires.



With the Red & Black wire coming from the Gantry attach the larger 2.54mm JST-PH Pins and plug and plug into the Analogue Laser Driver Module or tin the ends of the wires and solder in place if you do not wish to use the crimps.



At the left of the Lower-Deck bunch all of the GND cables together. Add a short length of heat-shrink and then cut the wires. Remove the insulation from the ends and twist all the ends together and tin with solder.

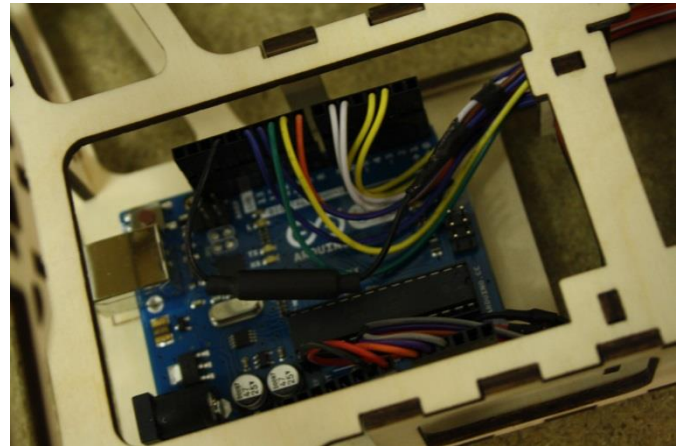


Cut a length of heat-shrink which is slightly longer than the Ferrite Core. Place the core inside and heat up the heat-shrink around it.



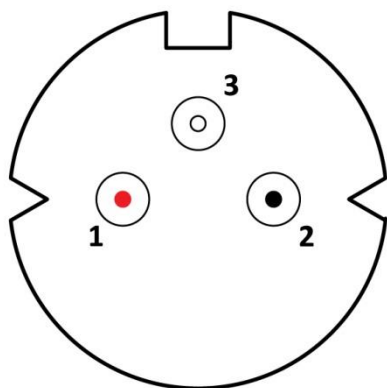
Thread a length of black cable with a female crimp attached through the Ferrite Core. Include a length of heat-shrink.

Solder the wire to the GND bunched GND cables. Plug the wire into the GND pin on the Arduino.



Wiring | Part 4 - The Laser Diode Modules.

200mW 405nm Blue 12mm x 30mm Module.



- 1 | + Positive
- 2 | - Negative
- 3 | Not Used

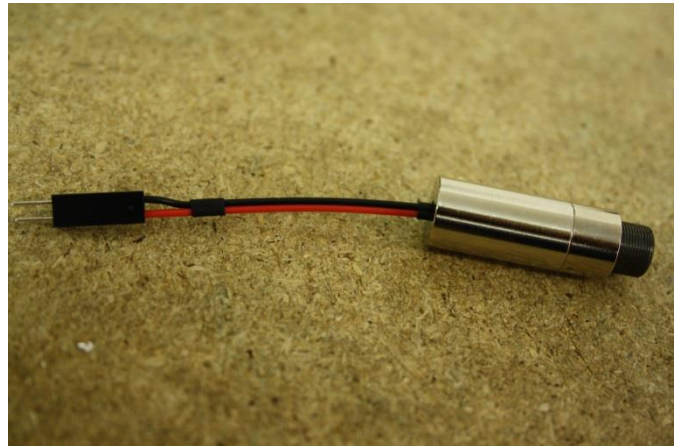
Begin by opening the case and inspecting the pins on the Diode. Identify each pin according to the diagram above.



Prepare a Red & Black cable and solder it to the Positive & Negative pins on the diode. Protect the pins with heat-shrink. Pin-3 can be removed.



Close the case and remove the ring from the front. Add 2x female DuPont crimps and a housing to the cable.



500mW 405nm Blue 16mm x 40mm Module.

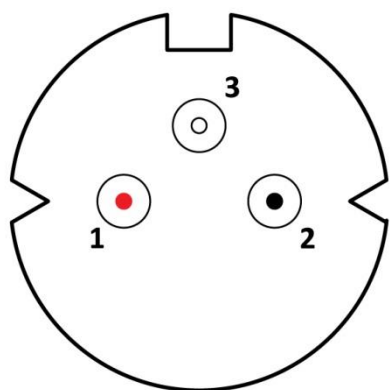
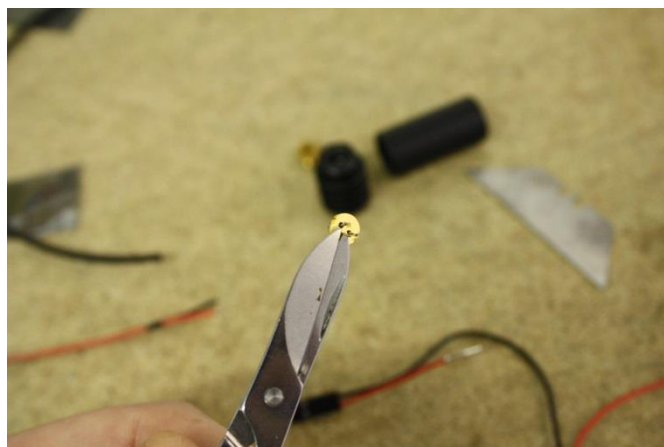
Remove the standard plastic lens from the module; be careful not to lose the spring.

Screw the 3-Element lens into the module.



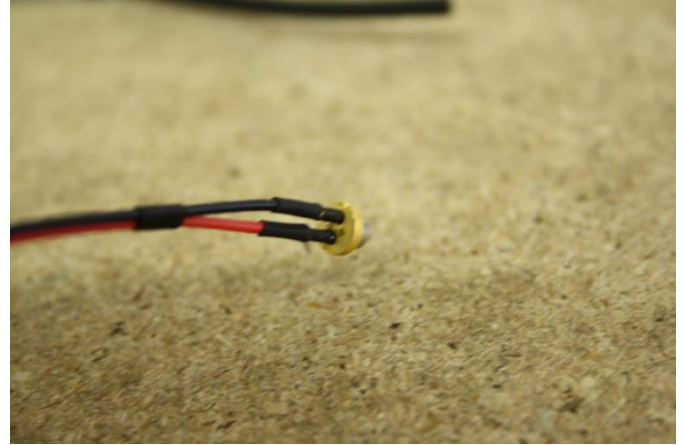
Open the module and undo the brass diode clamp.

Identify the correct pins on the diode; Pin-3 can be removed.



- 1 | + Positive**
- 2 | - Negative**
- 3 | Not Used**

Prepare a Red & Black cable and solder it to the Positive & Negative pins on the diode. Protect the pins with heat-shrink.



Feed the wire through the brass clamp. Secure the diode into the lens assembly being careful not to cause any damage. Tighten the clamp to secure the diode.



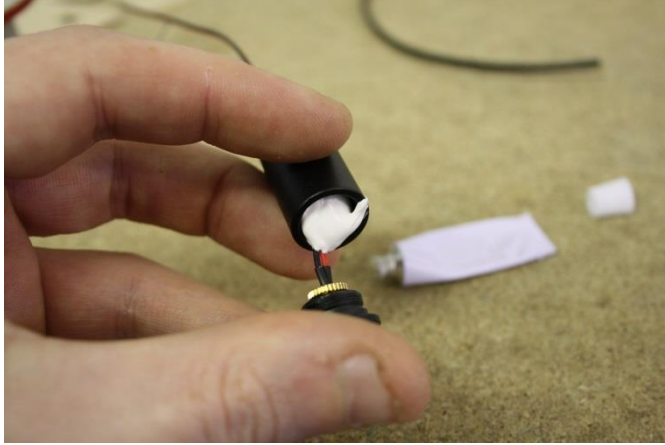
Remove the thermal potting compound from its packaging and pierce the end.

Feed the cable through the back of the Laser Module.

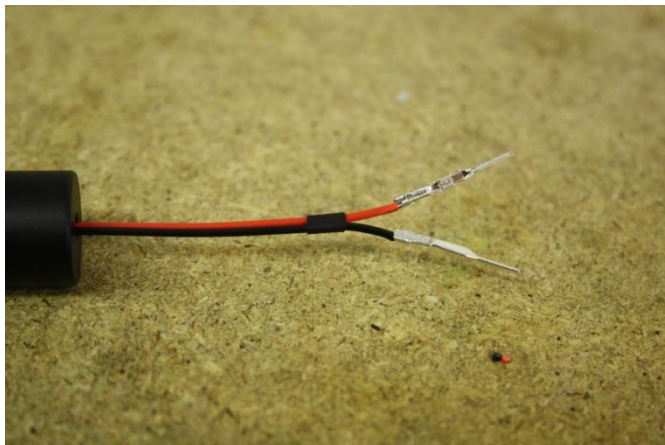


Fill the opening at the back of the case with as much compound as you can get in. Close up the case. Tap it on your workspace a few times to help the compound settle. Clean off any compound from the outside of the case.

Leave the module stood up for 24 hours while the thermal compound cures.



Once the compound has cured cut the wires to length, crimp 2x male DuPont connectors and add a 2-Way housing.



The wiring is now complete.

Section 3 | Belts & Pulleys.

You will need

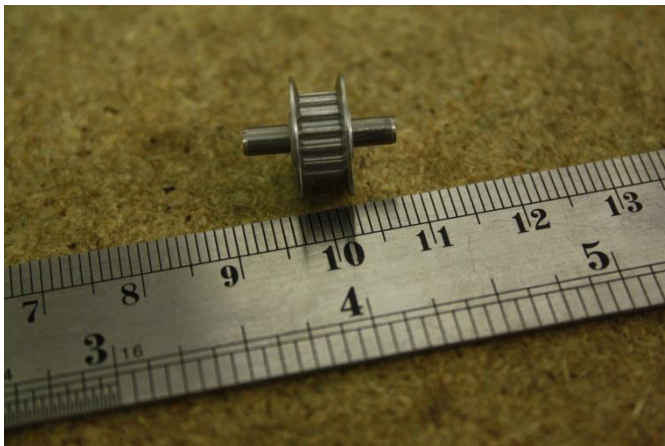
- 1 x X-Axis Return Pulley Kit.
- 1 x Y-Axis Return Pulley Kit.

Beginning with the Y-Axis; press the 3mm x 16mm Bar through the pulley.



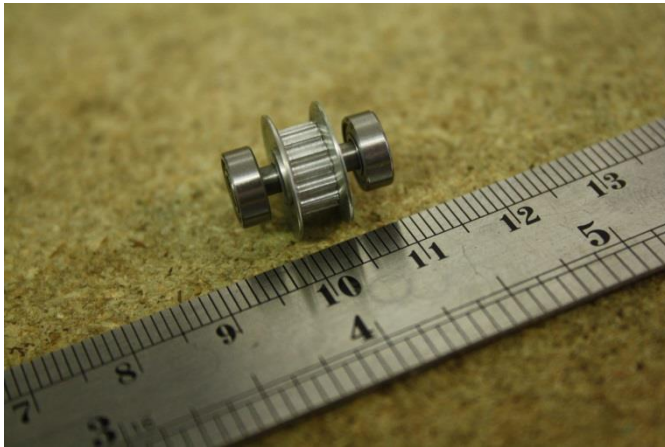
Centre the pulley on the bar.

To one end press-fit a 3mm x 8mm x 3mm bearing.

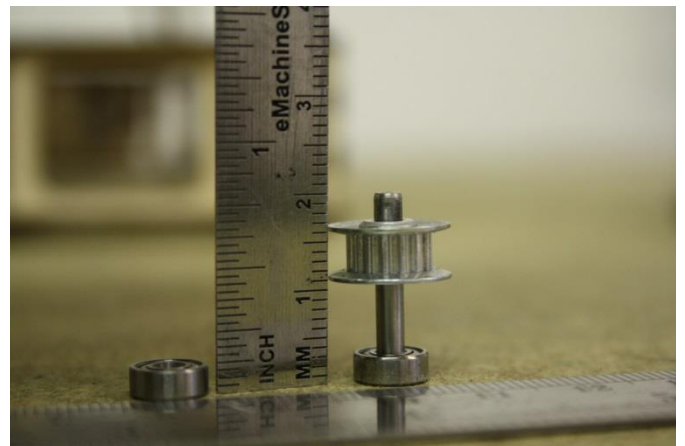
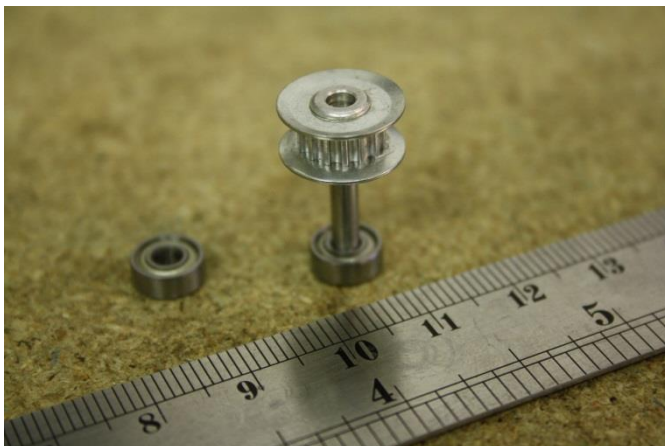


At the other end of the bar add another 3mm x 8mm x 3mm bearing.

Next add a 3mm x 8mm x 3mm bearing to one end of the 3mm x 21mm X-Axis bar.



Press down a pulley onto the 3mm x 21mm bar. Press it down until the top of the pulley is between 16mm and 17mm from the base.



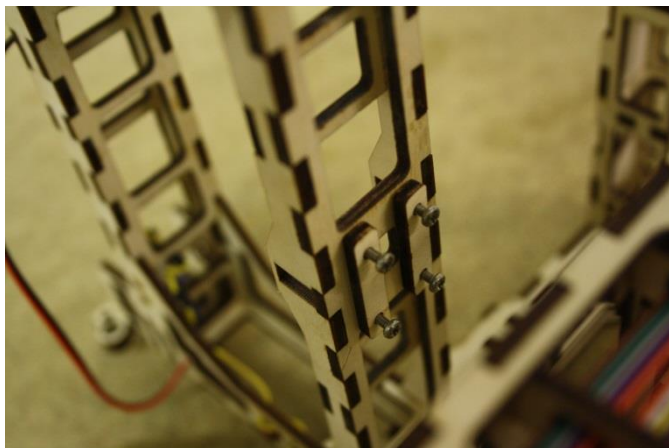
Slide the last 3mm x 8mm x 3mm bearing onto the end of the 3mm x 21mm bar.

Fit the Y-Axis Return Pulley into the front of the Upper-Deck.

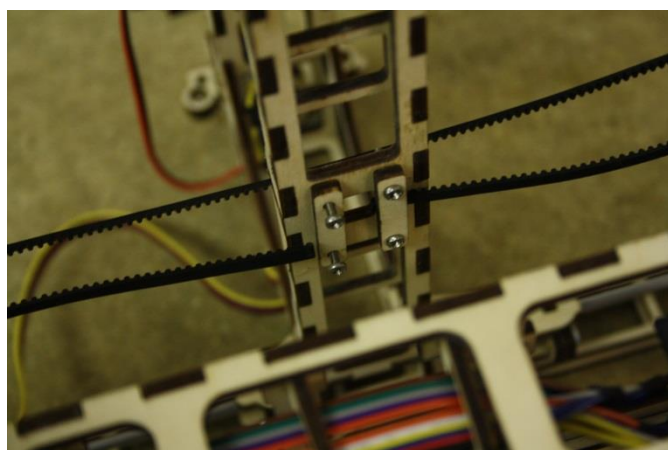
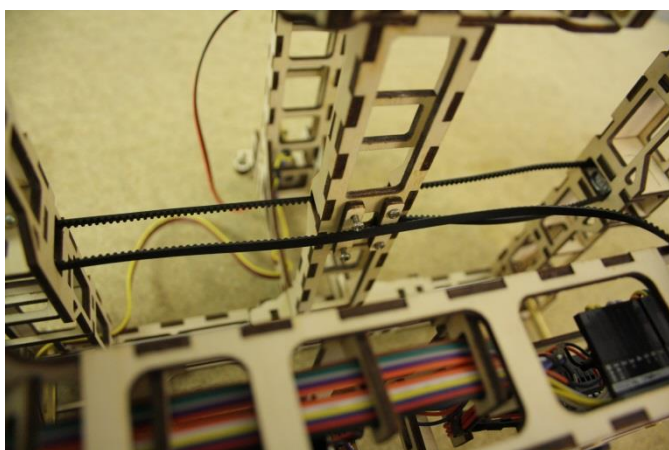


Fit 2x GT09 Belt Clamps with 2x M2 10mm Screws.

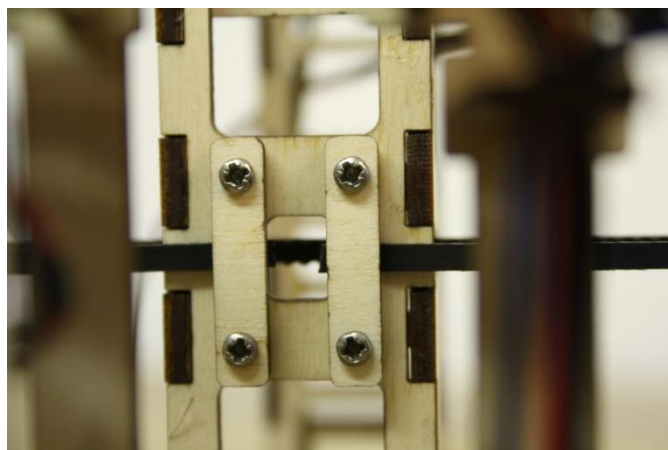
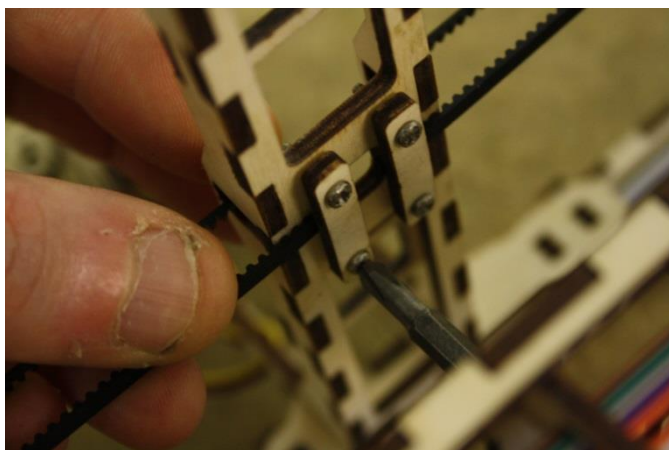
Secure one end of the belt on to the underside of the Gantry using a GT09 Belt Clamp to keep it in place. Feed the belt through the Upper-Deck, around the Y-Axis Return Pulley, through the Gantry and out towards the back of the Upper-Deck.



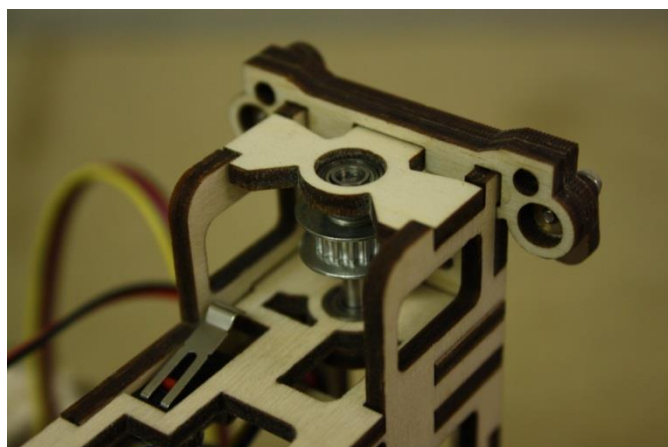
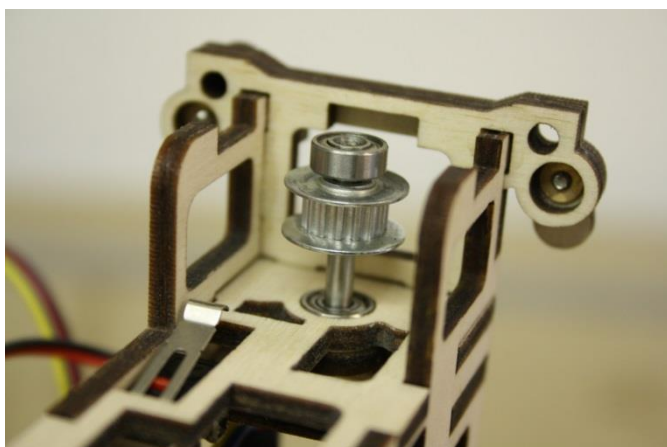
Pass the belt around the pulley on the Stepper Motor and back towards the Gantry. Measure and cut the belt to length.



While holding the Gantry pull the belt tight and clamp in place.

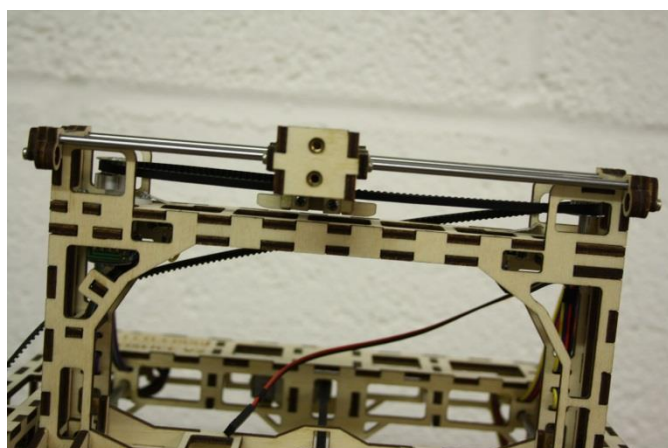


Slot the X-Axis Return Pulley into the slot in the top of the Gantry. Fit GT07 over the pulley and press into place.

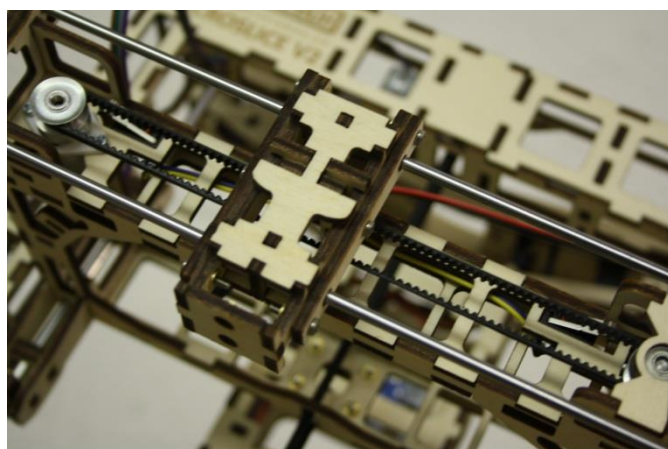
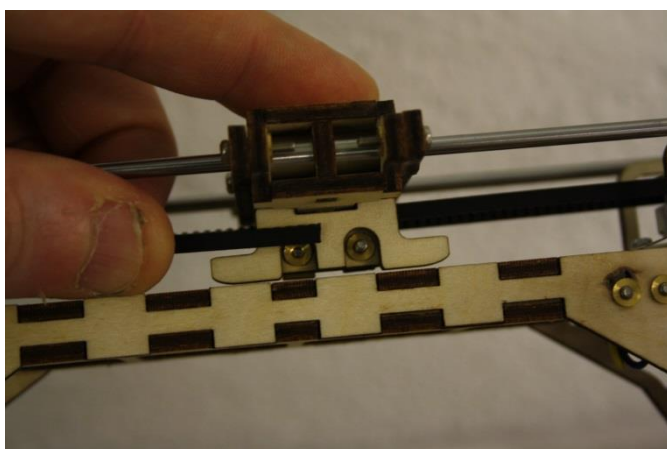


Slide the Cutting-Head Slider onto the 2x 3mm x 184mm Bars at the top of the Gantry.

Clamp one end of the belt to the Cutting-Head Slider and feed the belt around the Stepper Motor, around the Return Pulley and then back towards the Cutting-Head Slider.



Cut the belt to length. Clamp the belt to the Cutting-Head Slider making sure to keep the belt tight while doing so.



The MicroSlice hardware build is now complete.

Section 4 | The Firmware.

Part 1 – The GRBL Hex.

The MicroSlice uses a modified Grbl 0.8c. which enables the use of PWM on Pin-11.

Full details and the source code is available at <http://github.com/alsiahona/grbl/tree/LaserMode>

Download the MicroSlice preconfigured .hex from the forum at <http://thelittlebox.co/theforum/>

Part 2 – Flashing the Arduino.

Download and install the latest version of the Arduino IDE. You can download it from Arduino at <http://arduino.cc/en/Main/Software>

Follow the install guide on the GRBL Wiki at <http://github.com/grbl/wiki/Flashing-Grbl-to-an-Arduino>

Section 5 | Software & Setup.

Part 1 – Configuring the MicroSlice using Zapmaker's Grbl Controller.

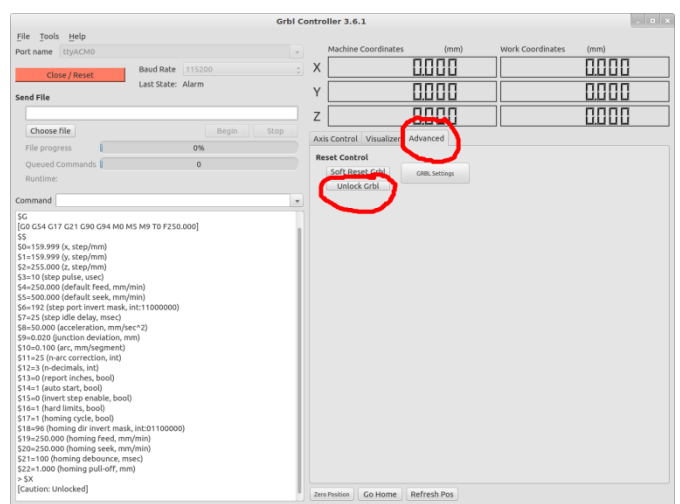
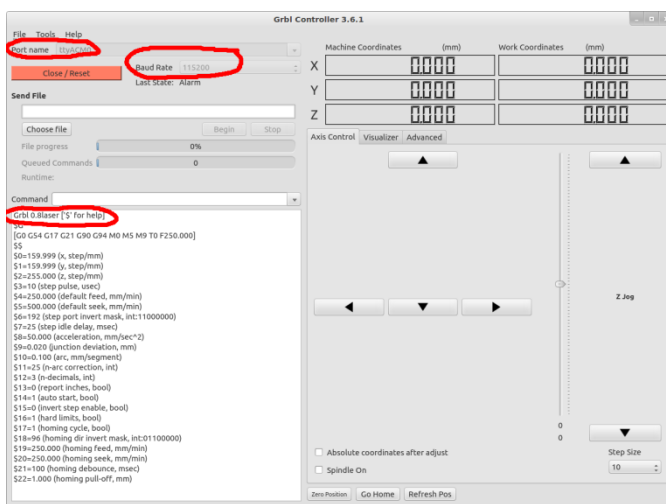
Download and install the latest version of Grbl Controller from <http://zapmaker.org/projects/grbl-controller-3-0/>

Connect the MicroSlice to your computer via USB and plug in a 12v 3A PSU into the Arduino's DC Jack.

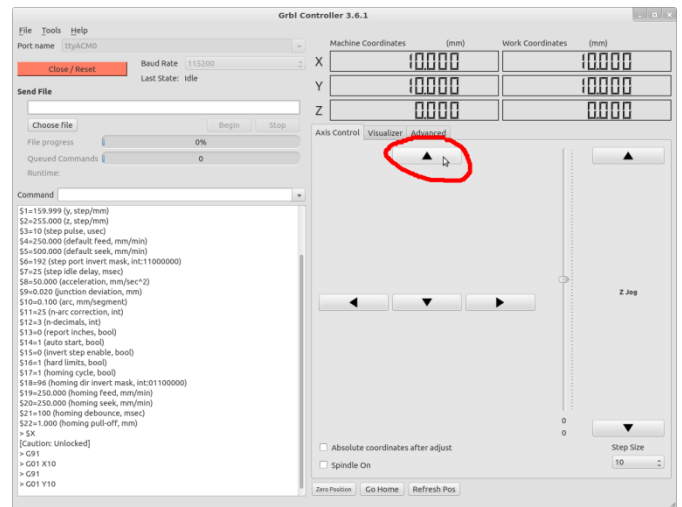
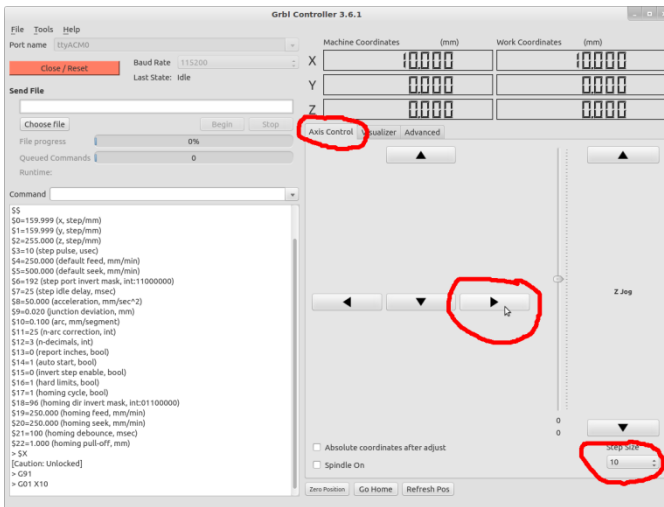
Open Grbl Controller, check the BAUD is set to 115200 and that the correct port has been selected. Click Open and Grbl Controller will attempt to connect to the MicroSlice.

If you have a successful connection you will be presented with *Grbl 0.8laser* ['\$' for help] and then a read-out of the current settings.

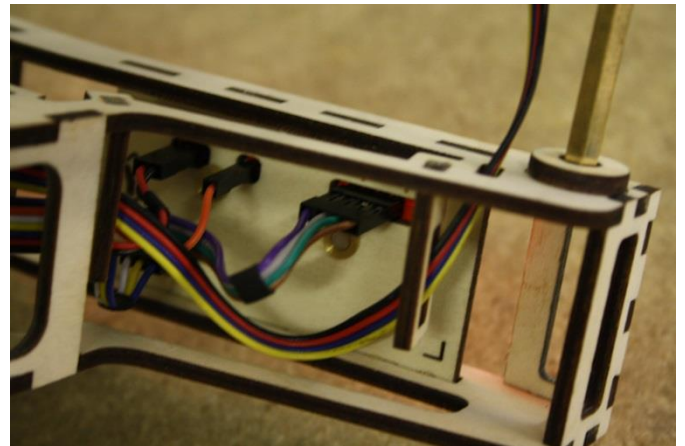
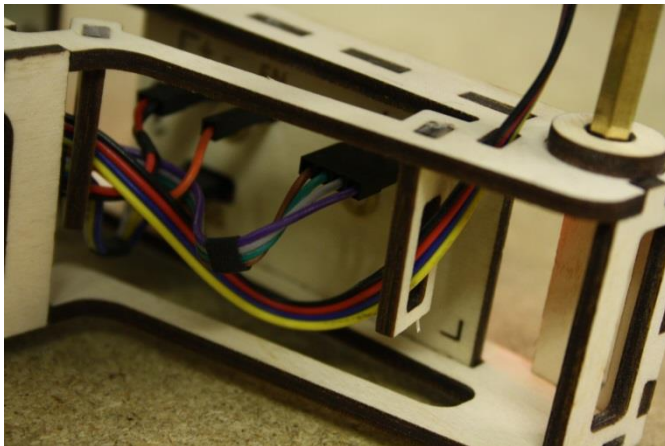
Before you can continue we must first unlock Grbl. To do this open the **Advanced** tab in Grbl Controller and click **Unlock Grbl**.



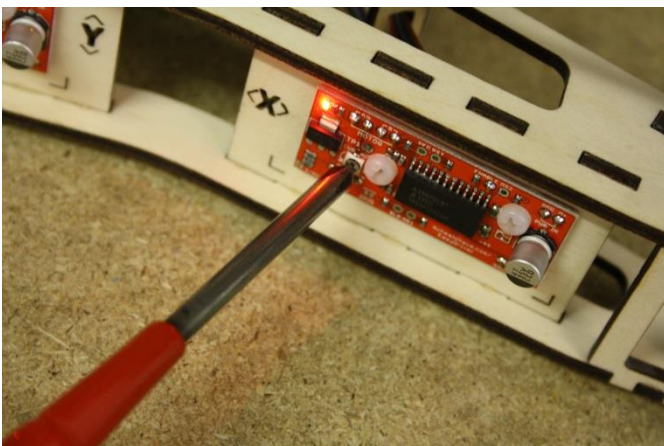
Return to the Axis Control tab and change the Step Size to 10. Check there is nothing obstructing the Gantry or the Cutting-Head Slider and click the right arrow. The Cutting-Head Slider should move to the right. Next click the up arrow and the Gantry should move away from you towards the back of the MicroSlice.



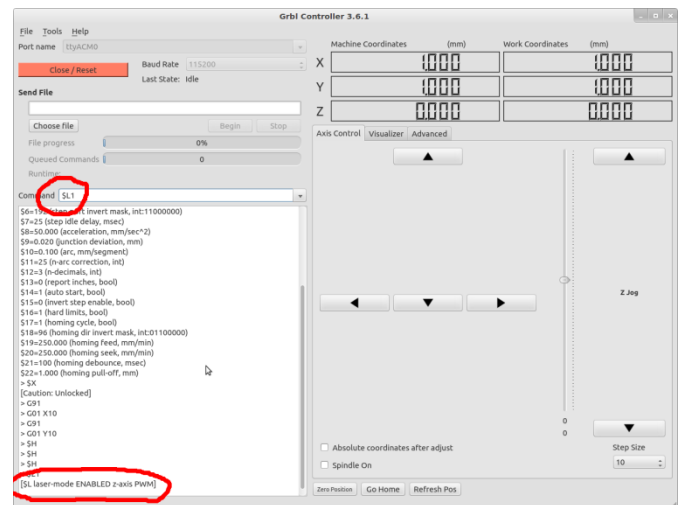
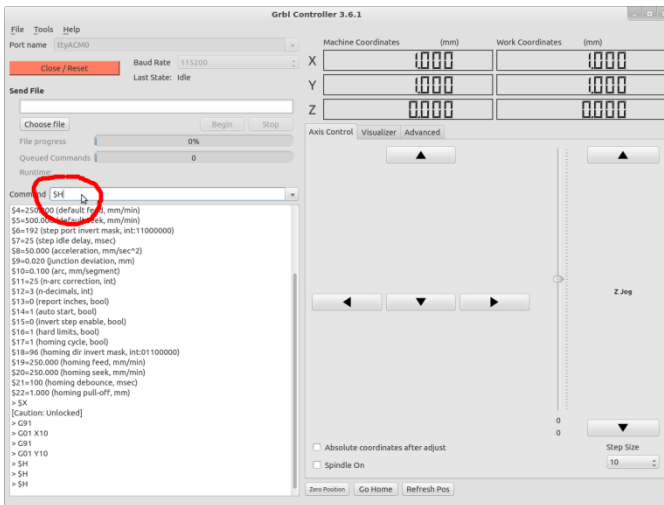
If the Cutting-Head Slider or the Gantry did not move in the desired direction you will need to flip around the connection on the relevant EasyDriver. Just simply unplug it, turn it over and put it back on again. Re-run the test and everything should now move in the correct direction.



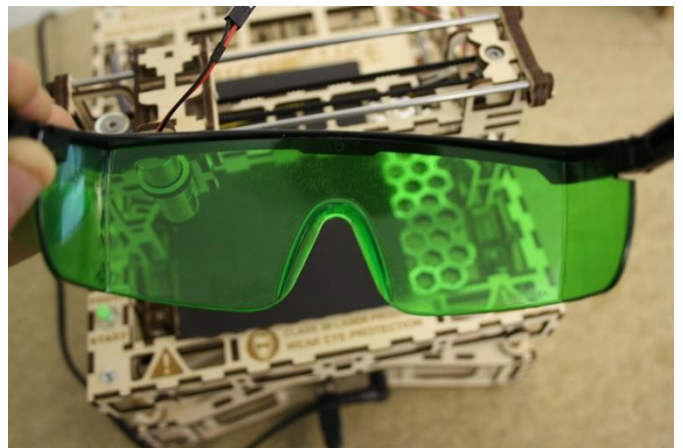
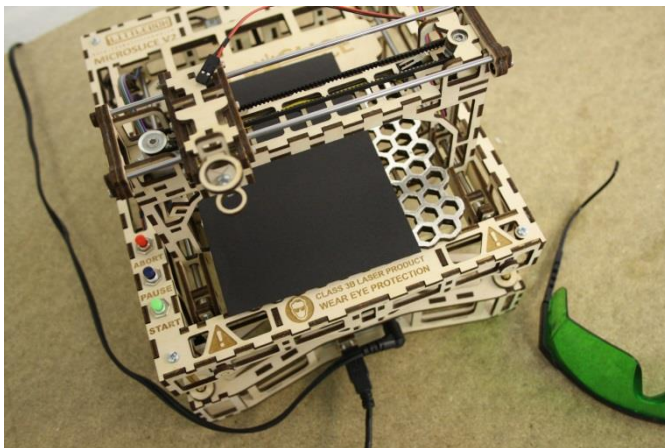
We need to set the current on the EasyDrivers; Using a screw driver, while the X-Axis is moving (click one of the arrows in Grbl Controller), turn the potentiometer clockwise until the movement stops and then turn the potentiometer anti-clockwise 90 degrees. The EasyDriver should now be correctly set, repeat this for the other Axis.



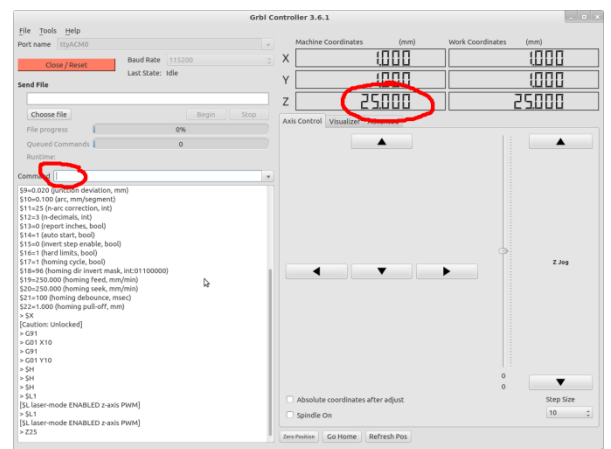
Type \$H into the command box to run the Homing Sequence. Check Laser mode works with \$L1.



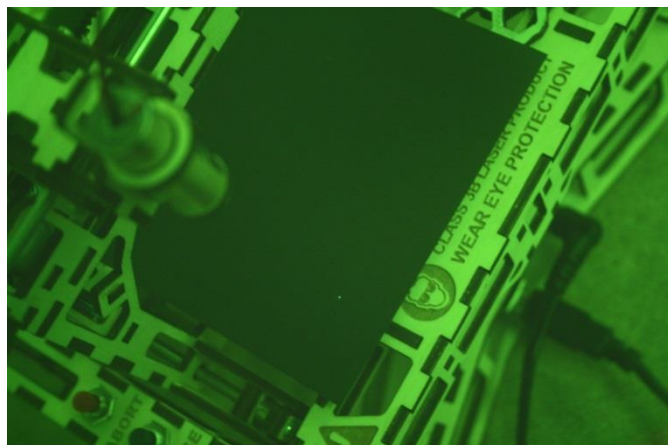
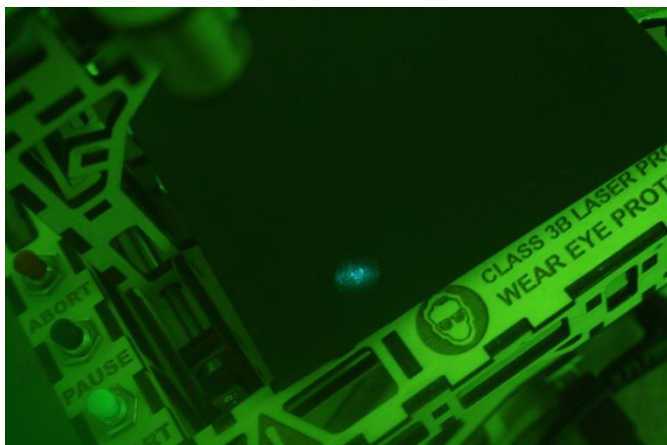
Place a blank sheet of black paper onto the MicroSlice Cutting-Table. Place the 200mW Laser Module into mount and put on your safety glasses.



Flip the switch down to R. Enter Z25 into the command box of Grbl Controller.



To focus the beam; rotate the lens in the module to get as small a point as is possible. Try to keep the paper as flat as possible while doing so. When you are finished type Z0 into the command box to turn off the laser.

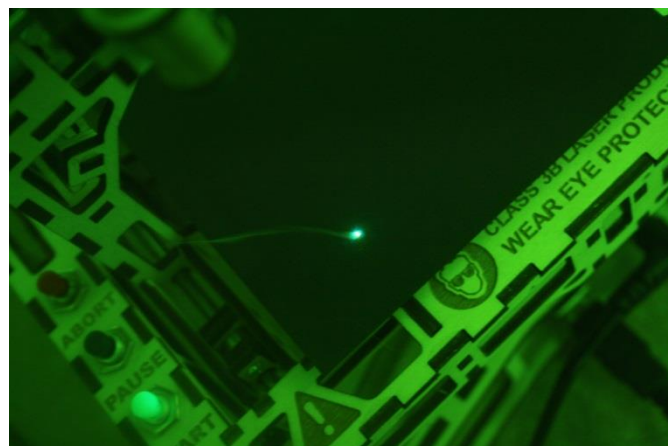
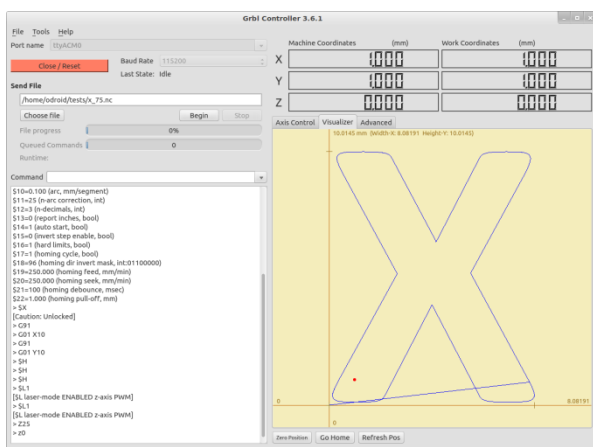


The 500mW Laser Module is focused in the same way.

Next we can run some tests to check the MicroSlice is working correctly.

Download the test G-Code .NC pack from <http://thelittlebox.co/theforum/viewtopic.php?f=10&t=43>

Load the x_75.nc file into Grbl Controller, move the switch to the **V** position on your MicroSlice and then click **Begin** to run the file.

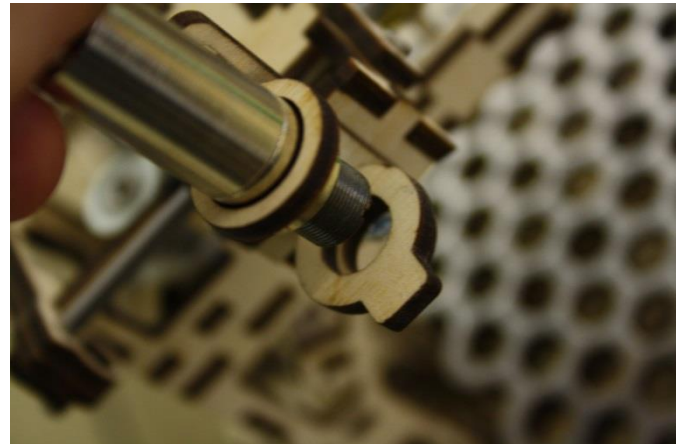
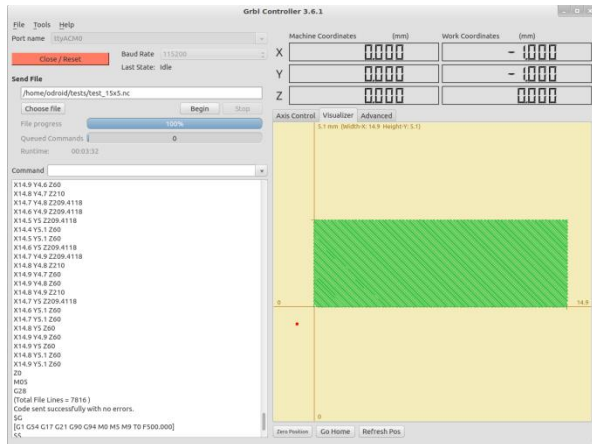


If everything has worked correctly you should have cut out an X.

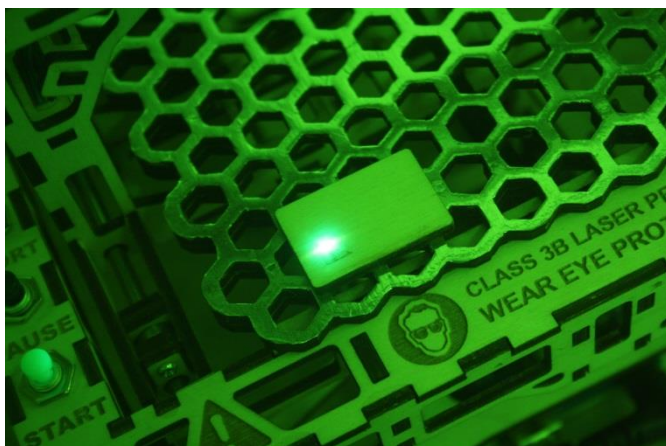


Now we can test the image engraving function. Load test_15x5.nc into Grbl Controller. Move the switch into the **R** position on the MicroSlice.

I'm engraving onto some 3mm scrap plywood so I have lifted up the laser module using a **DS02** spacer.



Click Begin and the MicroSlice will start to engrave.

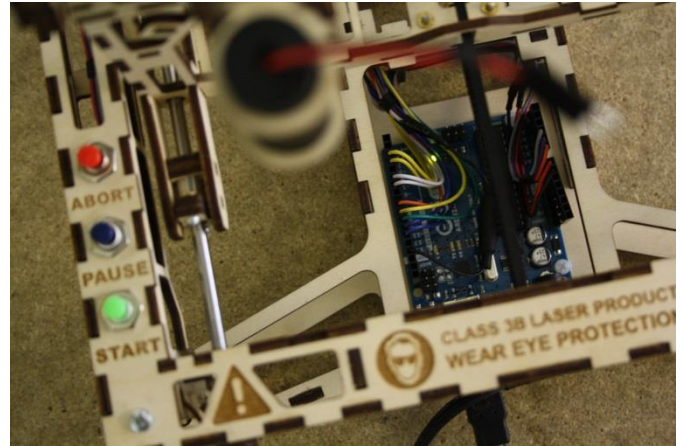
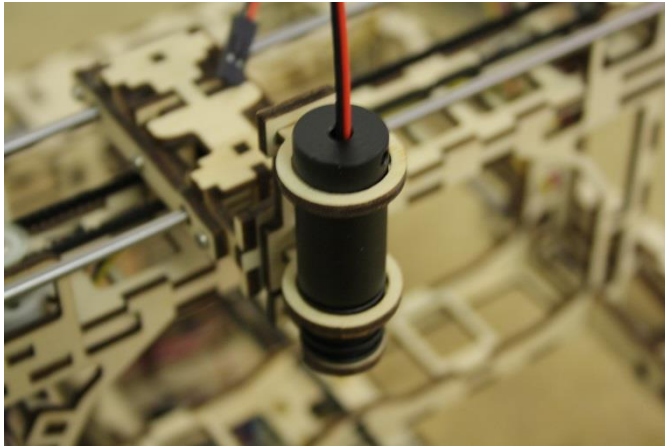


It will take about three minutes and the results can be quite different depending on what you are engraving, the important thing is to make sure it actually works.



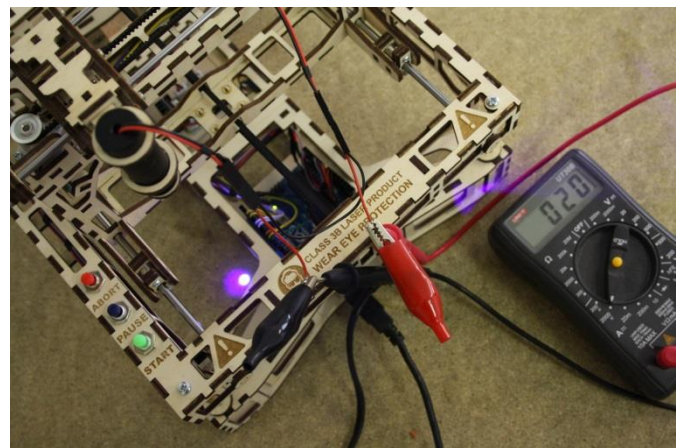
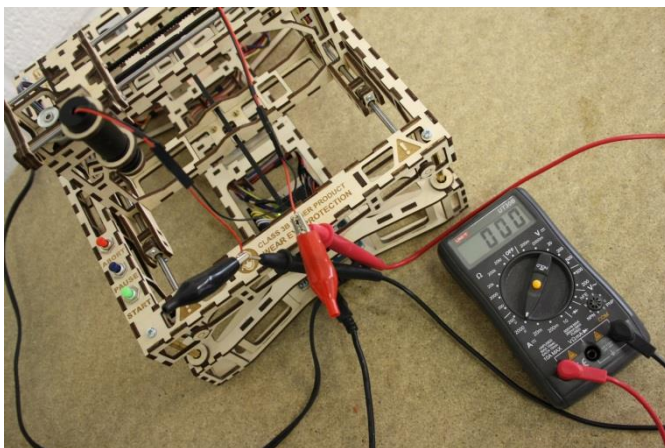
Part 2 – Configuring the MicroSlice for the 500mW Laser Module.

With the larger mount attached to the Cutting-Head Slider; place the 500mW Laser Module into the diode mount on the MicroSlice and move the laser above a gap in the machine. Make sure there is nothing directly underneath the laser which could be damaged by the beam.

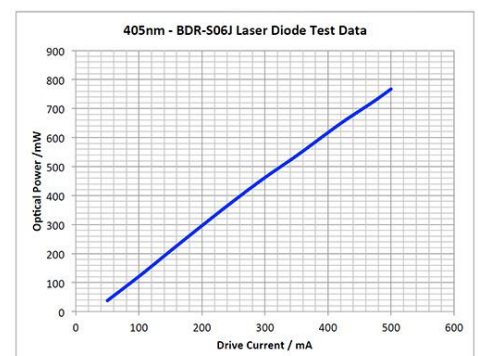


The Analogue laser Driver Module (ALDM) is preconfigured for use with the 200mW Diode. To use it with the 500mW Diode we need to turn up the gain to increase maximum power from ~200mW to ~500mW. **To do this you will need a Multimeter capable of measuring milliamps.**

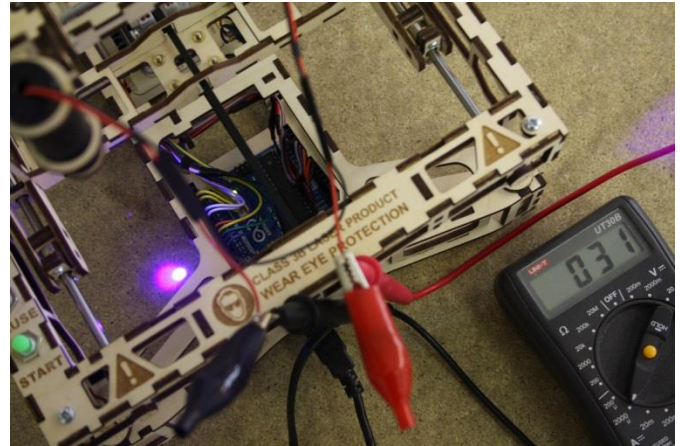
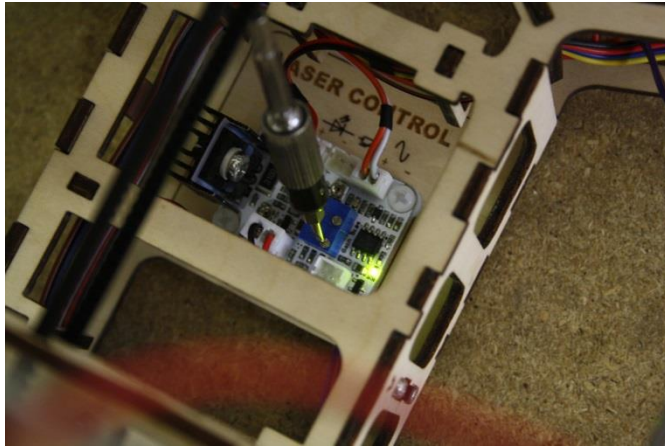
Connect your Multimeter to the MicroSlice so it is able to meter the current being supplied to the ALDM. Usually this involves placing the Multimeter in the circuit. Into the Command Box in Grbl Controller, with Laser Mode enabled, type **Z255**. This will set the ALDM to maximum power. Your Multimeter should read ~200mW at this stage.



| Diode Mounted with 3-element Lens | |
|-----------------------------------|----------|
| Current/mA | Power/mW |
| 50 | 38 |
| 100 | 121 |
| 150 | 209 |
| 200 | 296 |
| 250 | 381 |
| 300 | 462 |
| 350 | 537 |
| 400 | 617 |
| 425 | 656 |
| 450 | 692 |
| 475 | 728 |
| 500 | 767 |



To increase the power to 500mW we need to adjust the **Gain** potentiometer on the ALDM. Slowly rotate the **Gain** in the **Clockwise** direction keeping a close eye on you Multimeter. To set the power to ~500mW the Multimeter needs to show a reading of ~310mA. Do not go above this value as it will cause damage to the laser diode.



Turn off the laser by typing **Z0** into the Command Box.

Remember that if you swap back to the 200mW diode that you must limit the maximum power to no more than 200mw otherwise you will damage the diode. Z155 gave 200mW on this machine. Check the output for your MicroSlice as it will probably be slightly different.

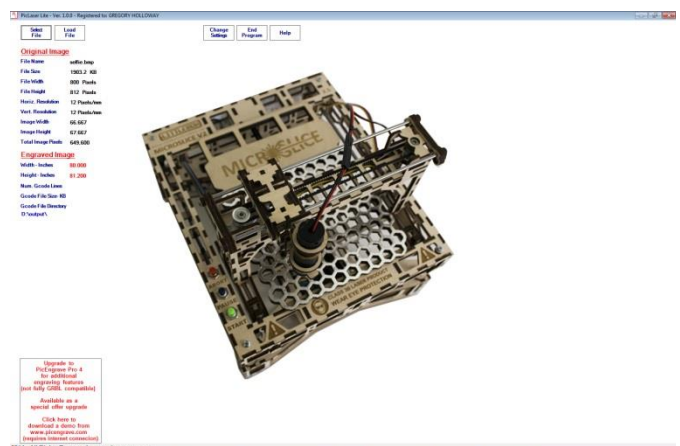
Part 3 – PicLaser Lite & PicSender.

PicLaser Lite is a program designed to generate G-Code for use with CNC machines equipped with Laser Didoes. The program uses 24bit BMP image files and generates G-Code designed to etch photo-quality images. PicSender is a G-Code sender for Grbl and is able to manage large G-Code files where other programs, such as Zapmaker's Grbl Controller, cannot.

The MicroSlice V2.5 with the Analogue Laser Driver Module has been designed to use these programs. You can download a demo and purchase a license for PLL and PS at <http://thelittlebox.co/theshop>.

For this tutorial I will be using a BMP file called selfie.bmp, the file is included as part of the Plans & Parts List package.

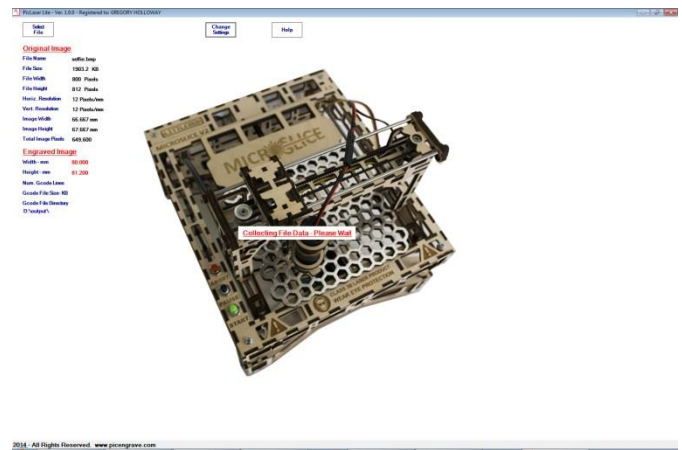
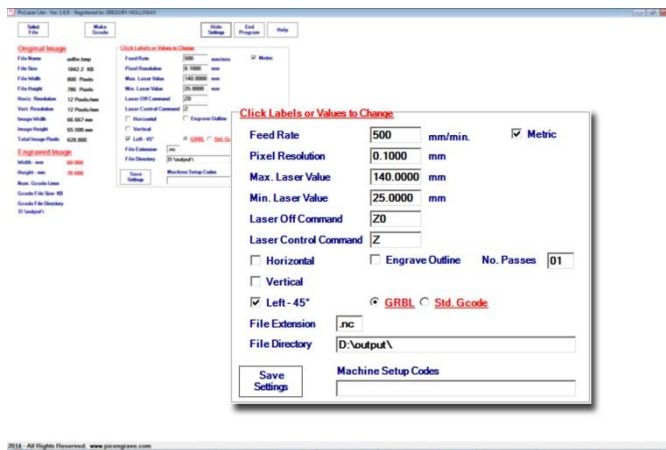
Download, install and run PicLaser lite. Click **Select File** and navigate to the directory with selfie.bmp. Double click on the image to open the file.



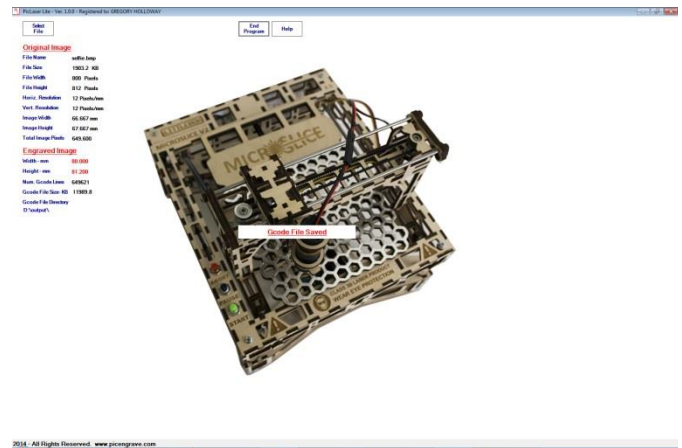
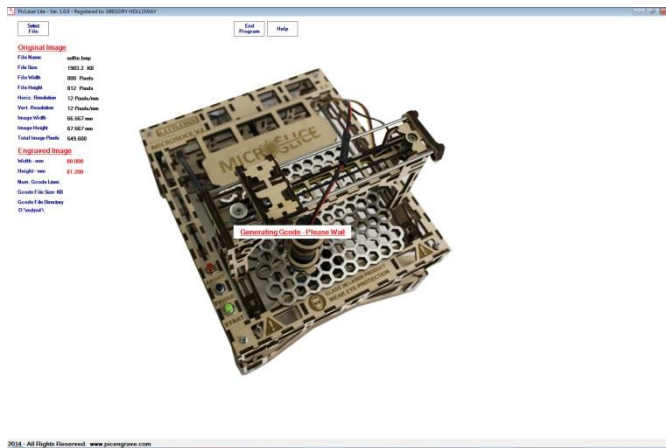
PicLaser Lite needs to be configured for the MicroSlice, the settings can be specific to the image you are working with along with the material you want to engrave. To change the settings click **Change Settings**.

To better understand the settings use Z commands with Laser Mode enabled to find the optimum power settings to give the best colour gradient. For example I have the Max Laser value set at 140 (Z140), this setting gives the darkest mark without over burning the wood whereas 25 (Z25) is just low enough not to mark the wood. PicLaser Lite will then use that range, Z25 to Z140, to engrave the image.

After adjusting the settings click **Load File** to import the image for processing.



Next click **Make G-Code**, and then when that is complete click **Save G-code** to write the file to disk.



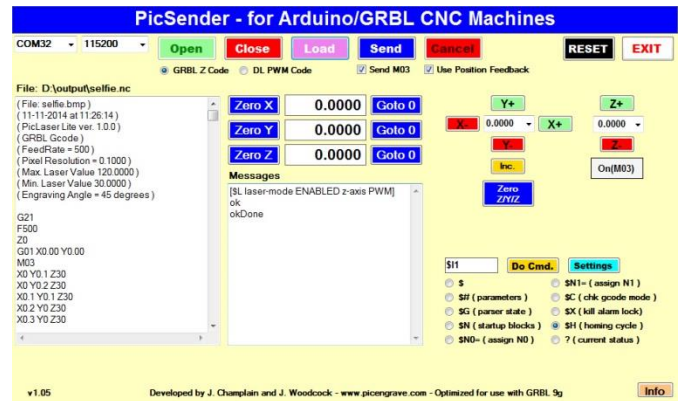
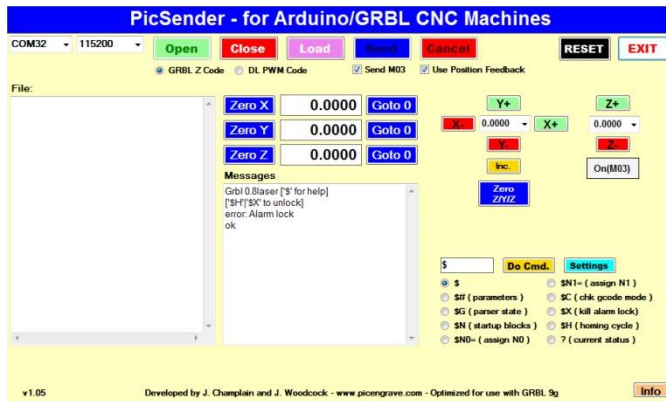
The resulting files can be anywhere from a few Kb all the way up to several hundred MB.

Programs such as Zapmaker's Grbl Controller are unable to work with large files due to the memory limitations within the programming language in which they are written. PicSender is written in a language with does not suffer these restrictions and can work with millions of lines of G-Code without falling over.

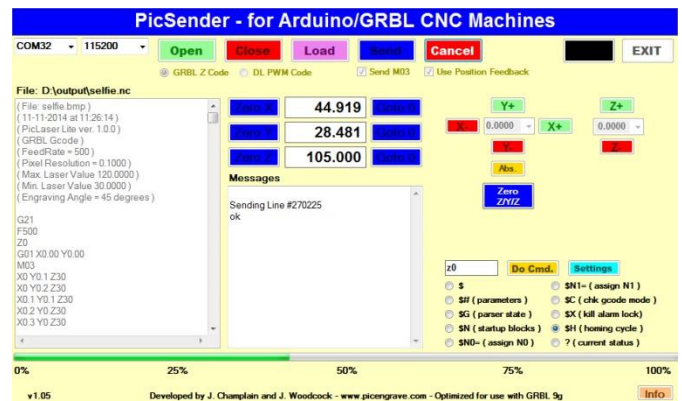
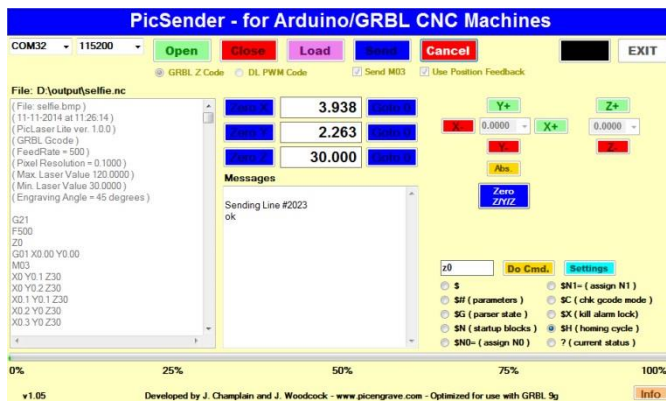
Download and install PicSender.

Open PicSender. Select the correct COM port for the MicroSlice, set the Baud to 115200 and then click Open. PicSender will attempt to connect to the MicroSlice and if it is successful you will be present with *Grbl 0.8laser ['\$' for help]* in the Messages window.

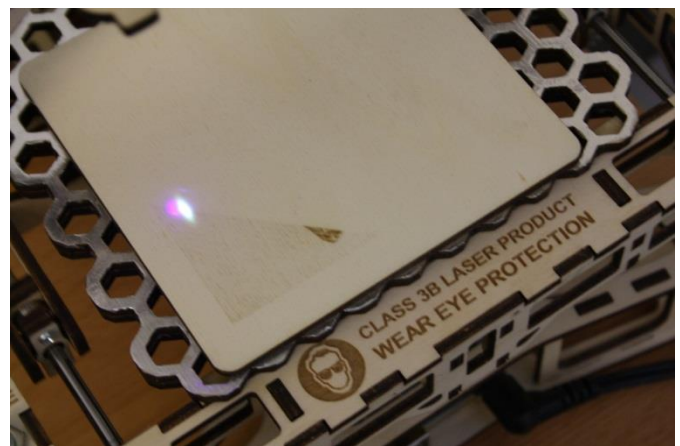
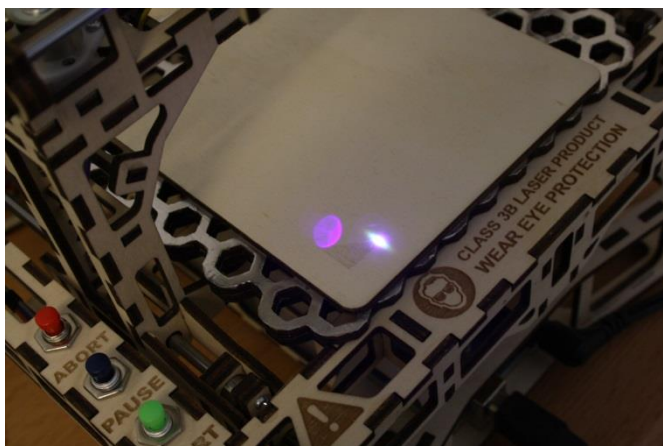
Click Load and navigate to the directory containing the G-Code file. It will take a few moments for PicSender to open the file. Run the homing cycle with \$H, position the blank on the cutting table and enable laser Mode with \$L1.



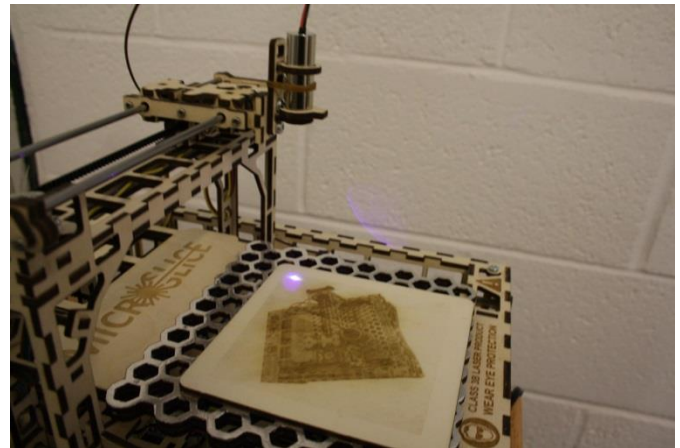
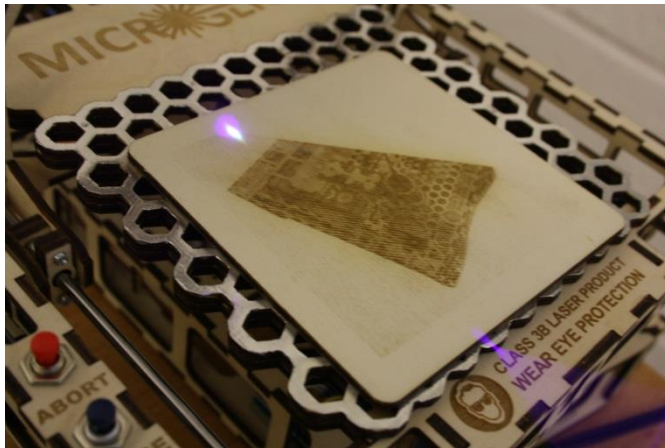
Put on your Safety Glasses then click **Send** to begin. PicSender will send the G-Code to the MicroSlice, there is a progress bar at the bottom.



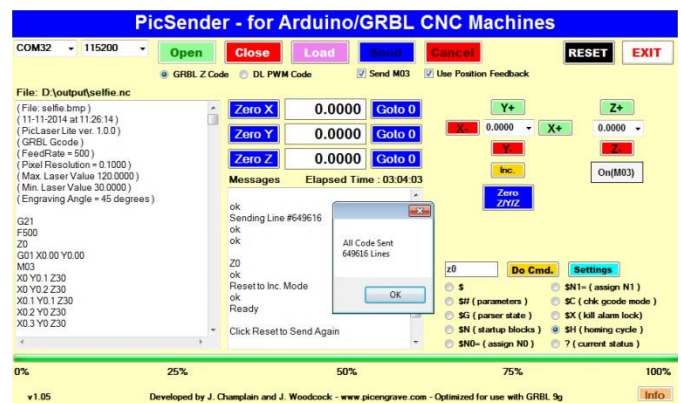
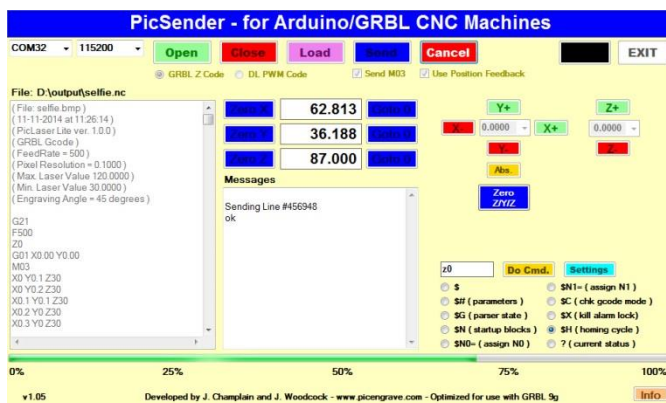
Sit back and wait while it runs.



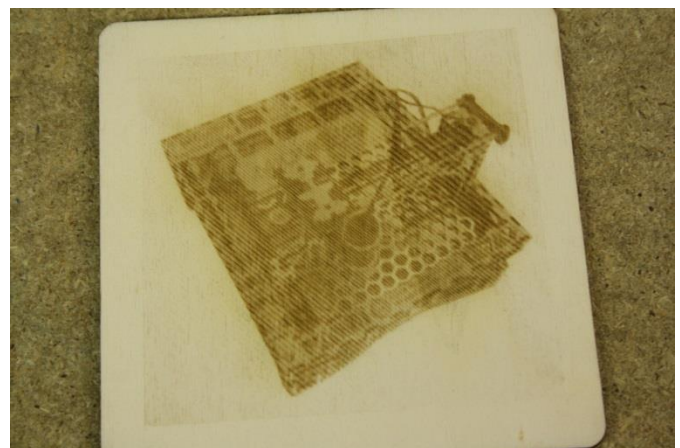
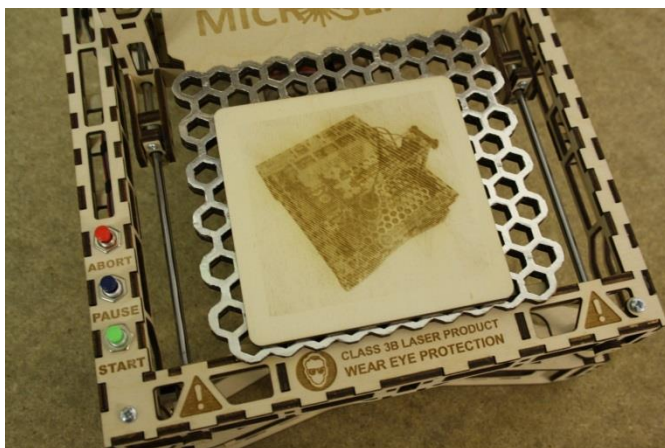
It will take a few hours to run.



When all the lines have sent PicSender will confirm completion with a dialogue box . Click **OK** to finish.



All done.



Part 4 – Inkscape.

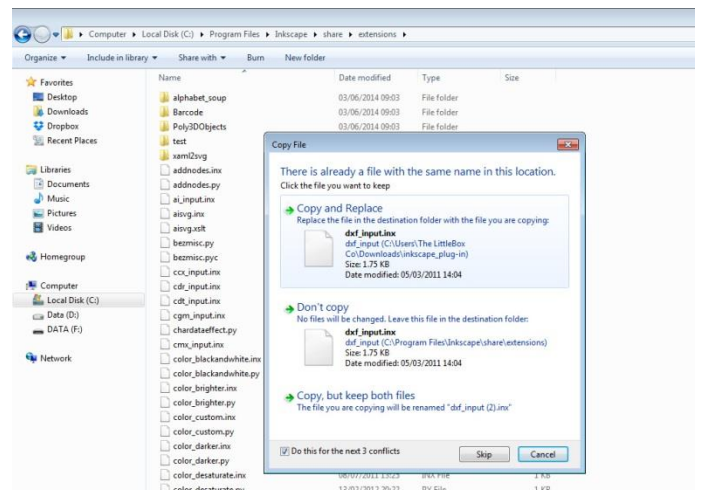
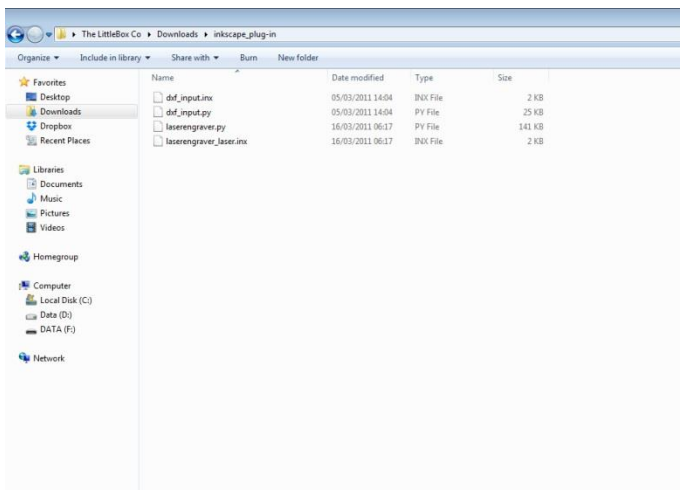
Inkscape is professional quality vector graphics software which runs on Windows, Mac OS X and Linux. It is used by design professionals and hobbyists worldwide, for creating a wide variety of graphics such as illustrations, icons, logos, diagrams, maps and web graphics. Inkscape uses the [W3C](http://www.w3.org/) open standard [SVG](http://www.w3.org/2001/10/27/svg) (Scalable Vector Graphics) as its native format, and is free and open-source software.

We'll use Inkscape with a Laser Engraver plug-in to generate the G-Code for use with the MicroSlice. In this example I'll use a **.svg** vector graphic and process it through the laser engraver plug-in to output a G-Code **.nc** file.

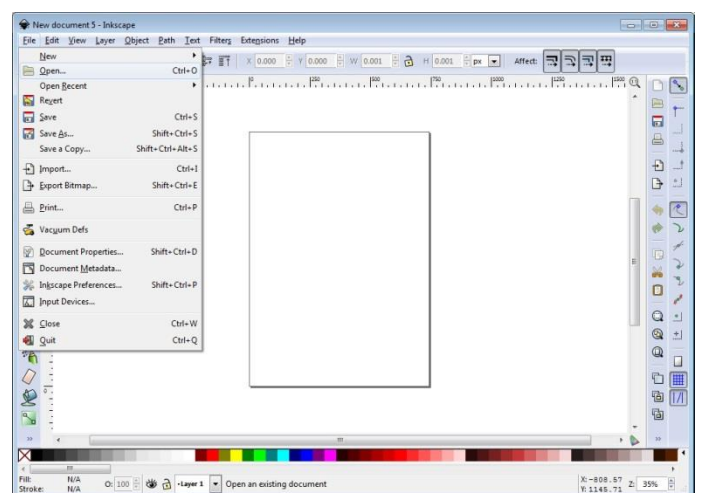
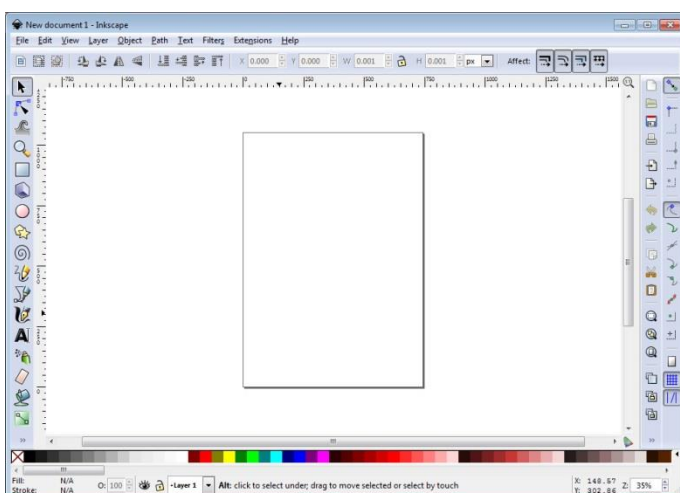
Download Inkscape from their website at | <http://www.inkscape.org/>

Download the Inkscape plug-in from the MicroSlice Wiki or from the Forum at <http://thelittlebox.co>

Install Inkscape and unpack the plug-in archive. Copy the files from the plug-in and paste them into **C:\Program Files\Inkscape\share\extensions**. Copy & Replace all files when asked at the prompt.

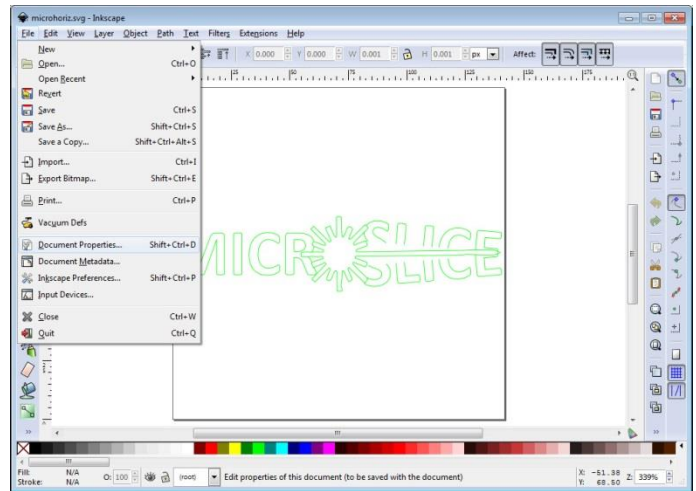
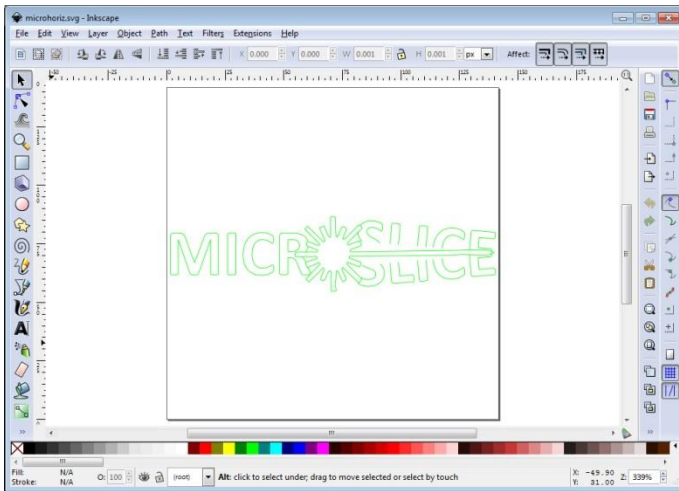


Load Inkscape, select **File** then **Open**.

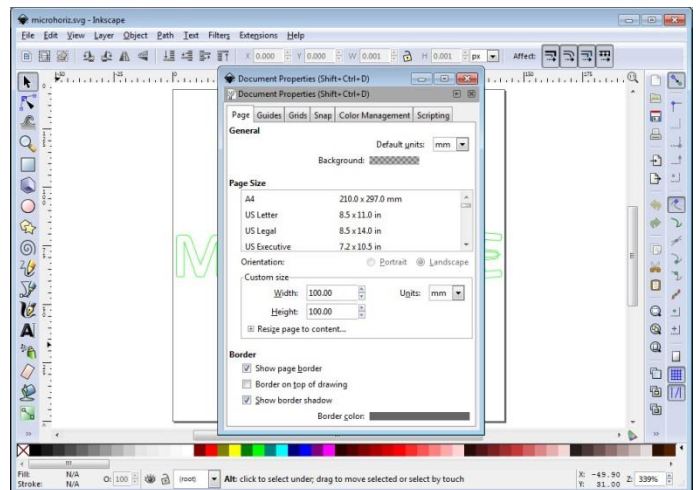
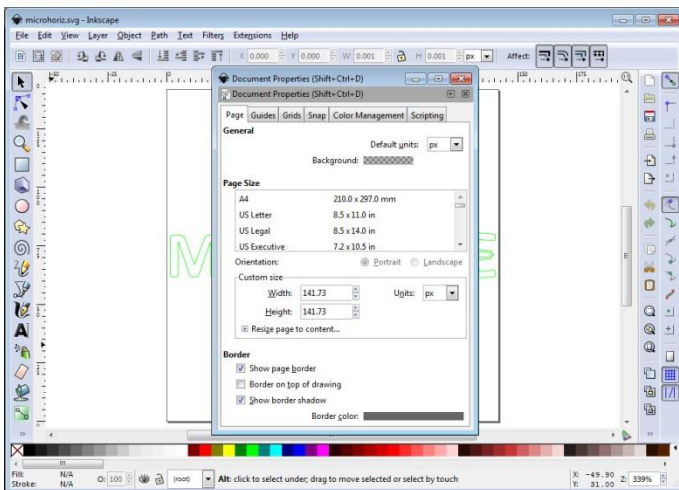


Browse to the file you wish to use and click **Open**.

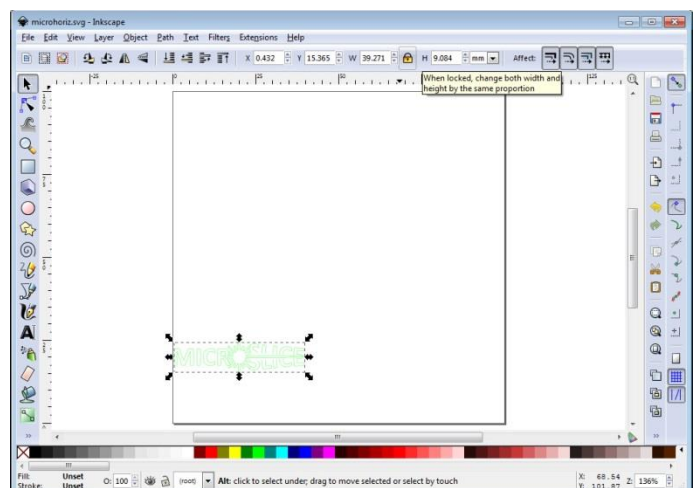
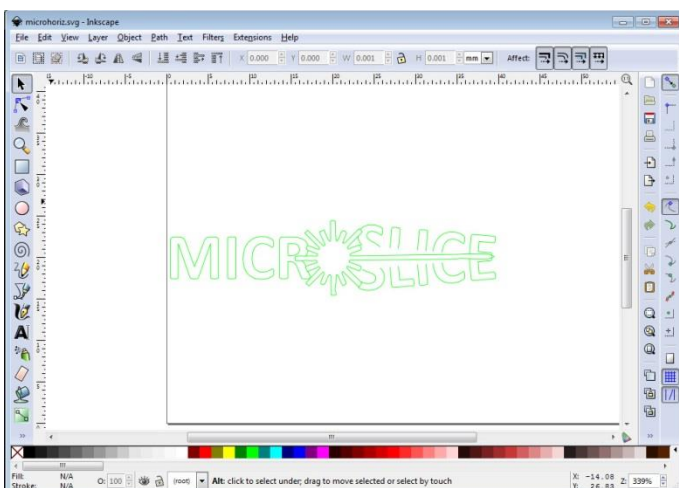
A new Inkscape window will appear with your selected file displayed. To make the workspace the same size as the MicroSlice click **File** then **Document Properties**.



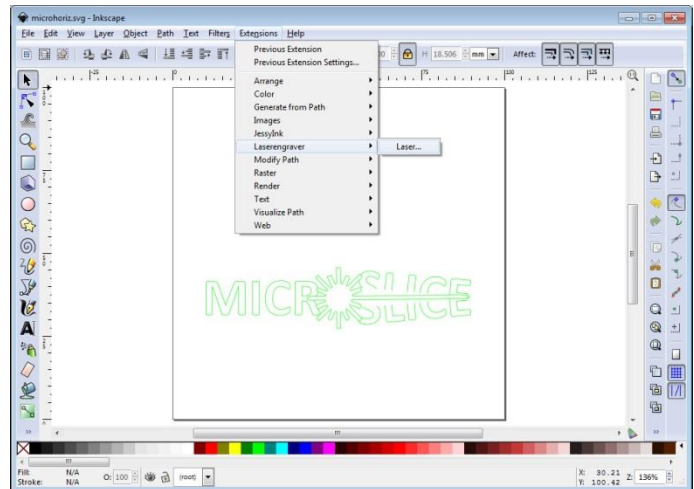
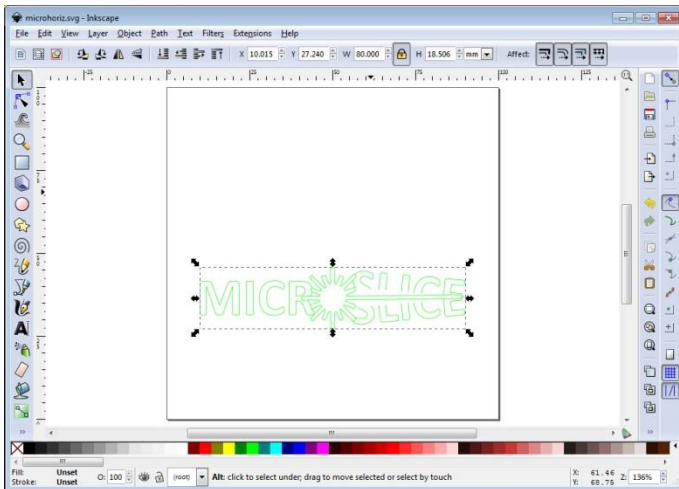
Set the **Default Units** to **mm** in the drop-down menu. In the **Custom size** box set the **Units** to **mm** and the **Width & Height** to **100**.



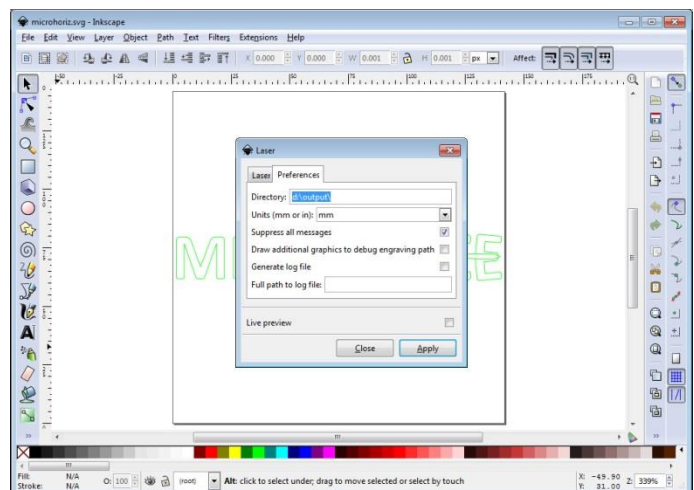
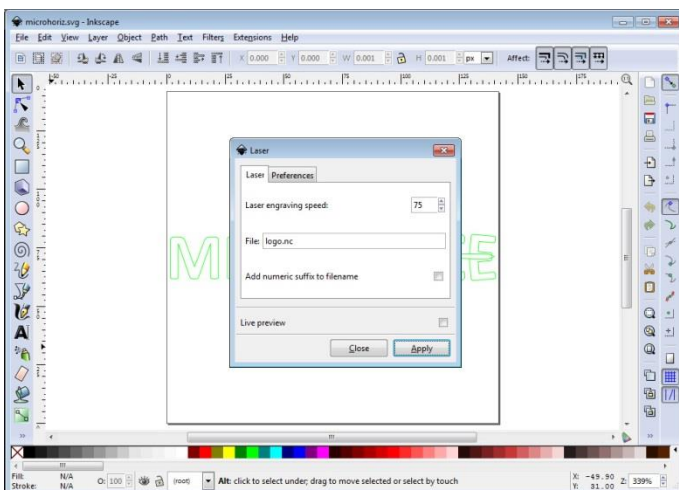
Zoom out to get the whole workspace in view. Adjust the size of the design to be cut by dragging the arrows, or click the lock at the top-centre, change the units to mm and type in a value.



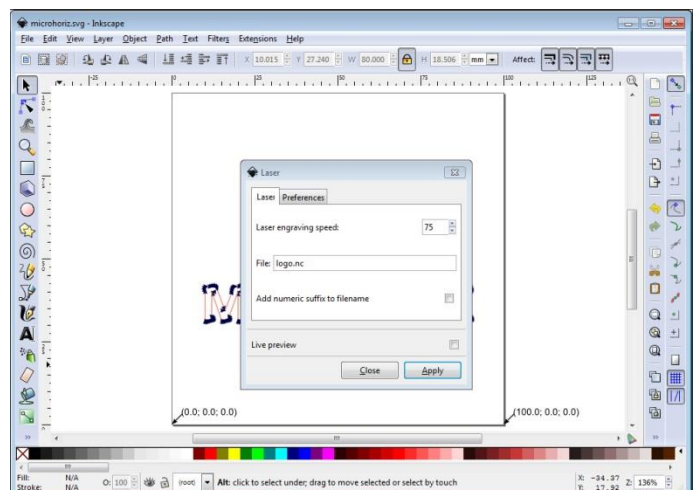
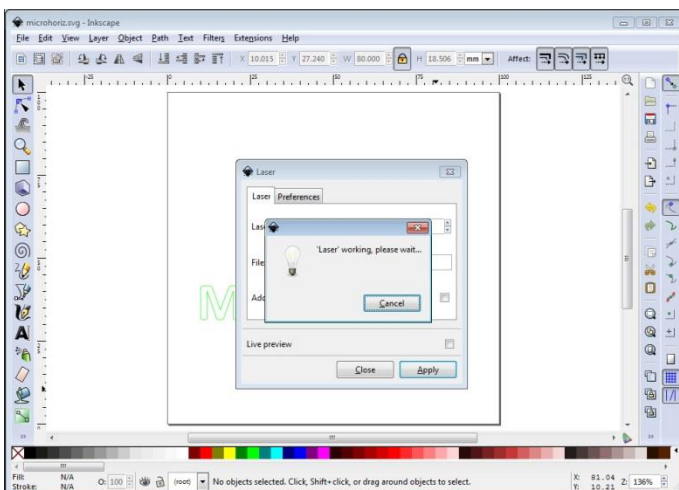
To generate the G-Code for GRBL click **Extensions, laserengraver** then **Laser...**



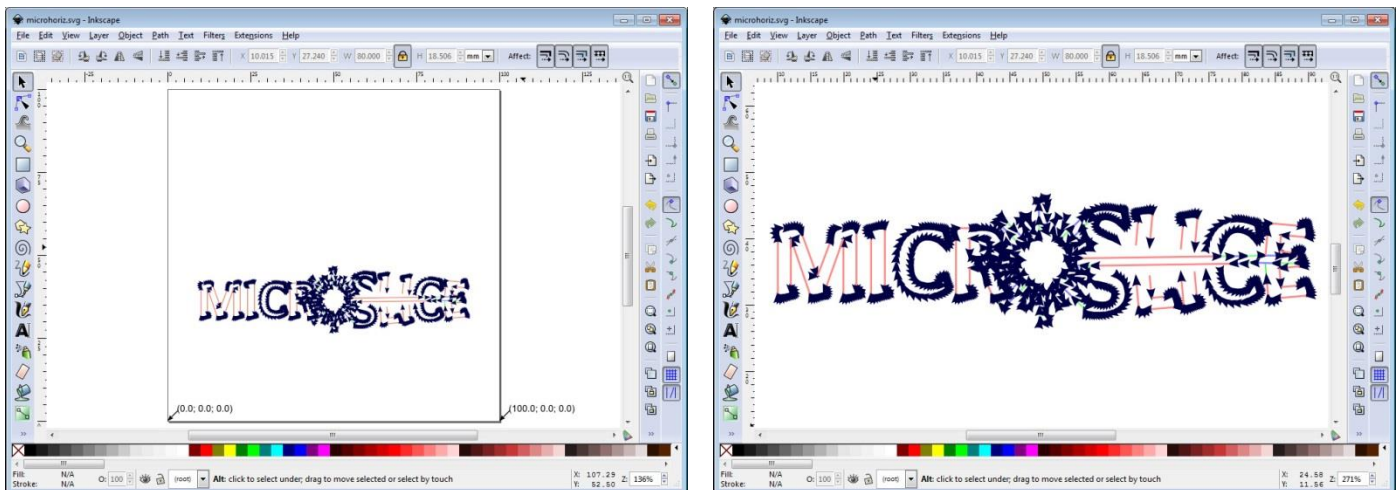
Name your file, don't forget to add the .nc file extension if it is missing and set the speed to **75mm/mm**. In the **Preferences** tab set where you would like the generated file to be saved to and make sure the units are set to **mm**.



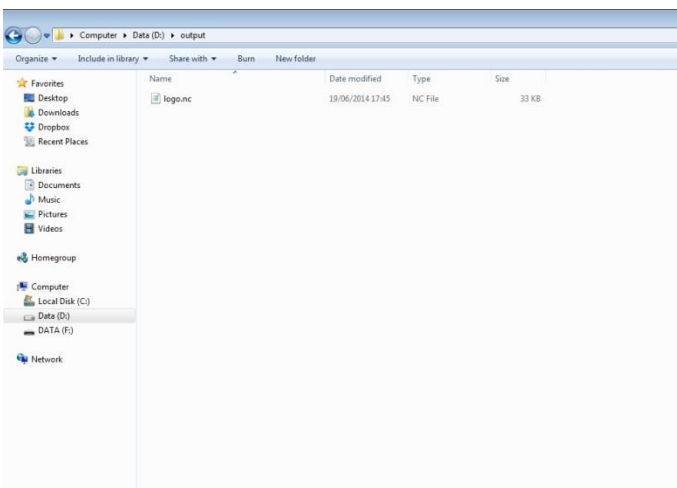
Click **Apply**. Click **Close** when the plug-in has completed its calculations.



The plug-in calculates the route for the cutting head and displays this in Inkscape as a series of paths & arrows.



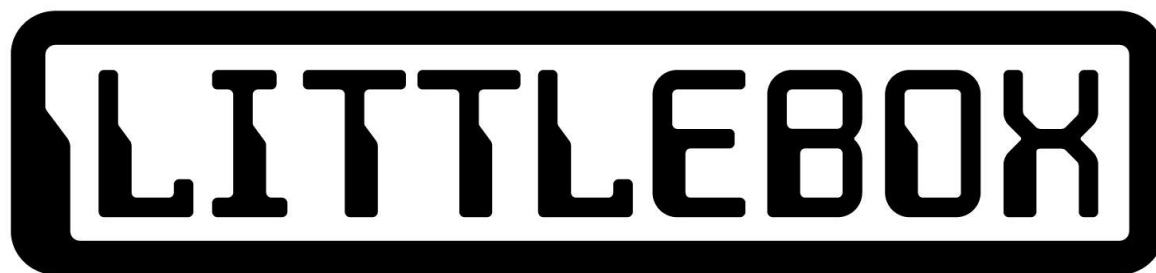
There will also be a file in your chosen directory. This file will be the G-Code used to run your design in GRBL Controller. Load the file, check your MicroSlice is ready and then click **Begin**.



The MicroSlice v2.5

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<http://thelittlebox.co>