MZBOT

VORON B

The Manual

DRAFT

SECTION A : PREP

A.1 Printing Parts

Material

For majority of the parts on the printer, I recommend using ABS plastic (Black if you really want to replicate the look). Electronics enclosures can be printed with PLA as they don't really have to handle mechanical loads or high temperatures.

Nozzle size

With exception of the X Carriage components, everything is designed to be printed with a 0.6mm nozzle. You can use a smaller nozzle, of course, but be warned that some of the parts will take a significant time to print, and won't be as strong.

Print settings

In my experience the minimum settings to produce mechanically sound parts are:

- Layer height 50% of the nozzle width
- 5 layers for top and bottom
- 3 shells
- 40% infill (grid or honeycomb work equally well)

A.2 Tools

Although no specialty instruments are required, you will need some basic tools to build this bot. If you've built a RapRap before, you already have almost everything you need.

- Set of metric hex keys (I highly recommend ball-end ones)
- Set of metric drill bits (for cleaning out holes and making mount points in the bed)
- Drill
- Small knife
- Torx T25 driver
- Phillips screwdriver (#1)
- Soldering iron
- Pliers
- Wire cutters
- Ruler

Optional tools (they make the process less painful)

- Dupont connector crimpers (I highly recommend Engineer PA-09)

A.3 Greasing the bearings

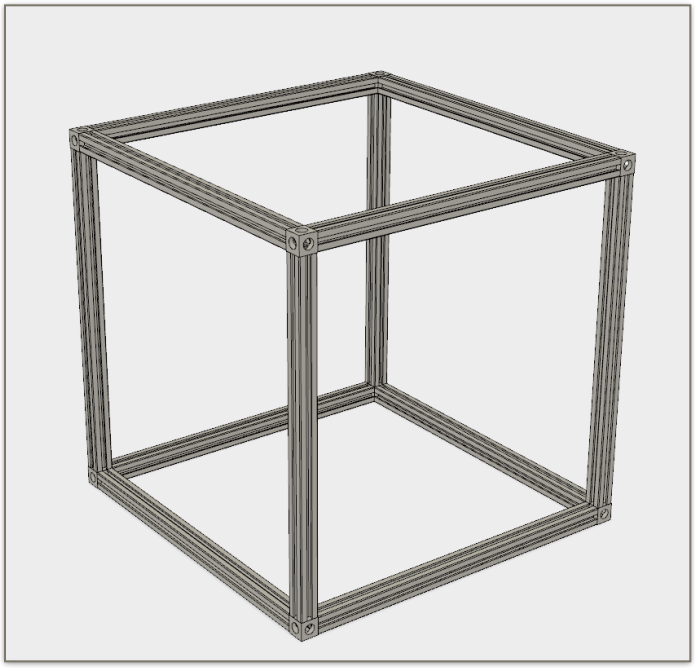
Linear bearings usually come covered in a thin oil. This oil is intended for **transport only**, and should not be used as the only means of lubrication. You'll need to pack the linear bearings with grease.

I recommend using a PTFE impregnated grease, as it has a lower coefficient of friction than most bearing greases, and will ensure smooth and quiet operation. Having grease in a squeeze tube makes this step easier.

It's almost impossible to over-pack the bearings, as the shafts will push out any access grease when inserted.

To pack the bearings, squeeze some grease into the end of the bearing, and use a piece of filament to gently swirl it around, distributing it into the ball bearing raceways. **Be careful not to dislodge any balls in the process**, or you'll have to figure out which raceway they belong in. If the bearing looks like it soaked up the grease, add more. You want to see a nice even coating of grease inside the bearing.

SECTION1 : FRAME

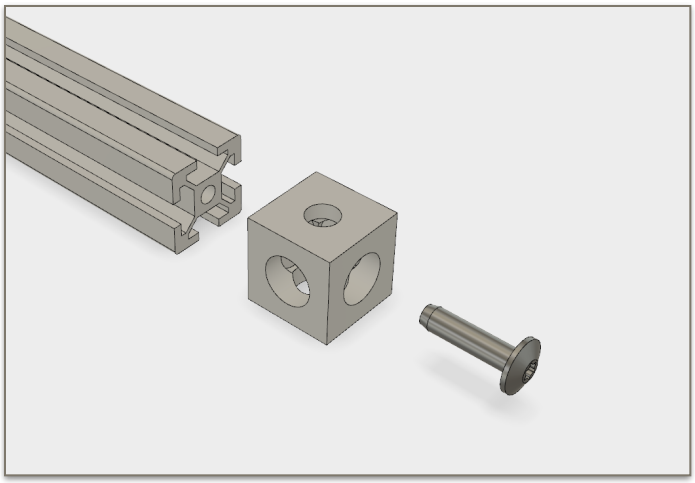


Items required:

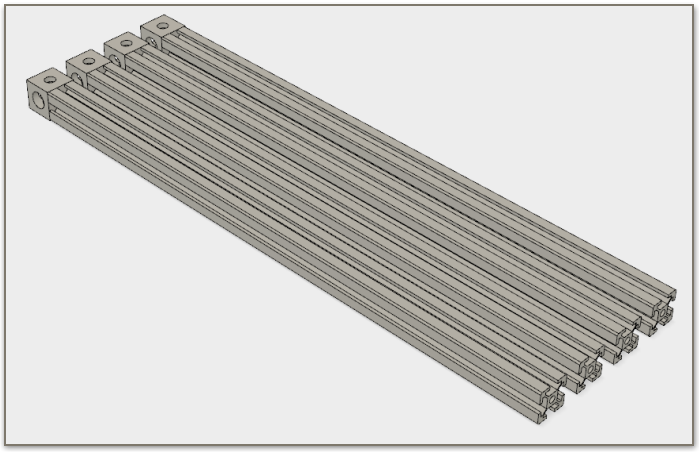
- 370mm 2020 Aluminum extrusions
- Cube Corner Connectors
- Self Tapping Torx Screws
- T Slot Nuts (M5)

We'll be building 2 squares and joining them together. Each length of 2020 extrusion needs to have the T Nuts inserted during indicated step as they will be sealed inside the structure afterwards.

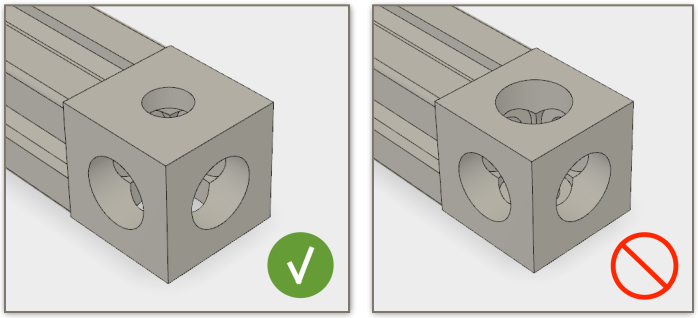
TIP: Put a piece of tape with a label on the top of each extrusion for easier orientation.



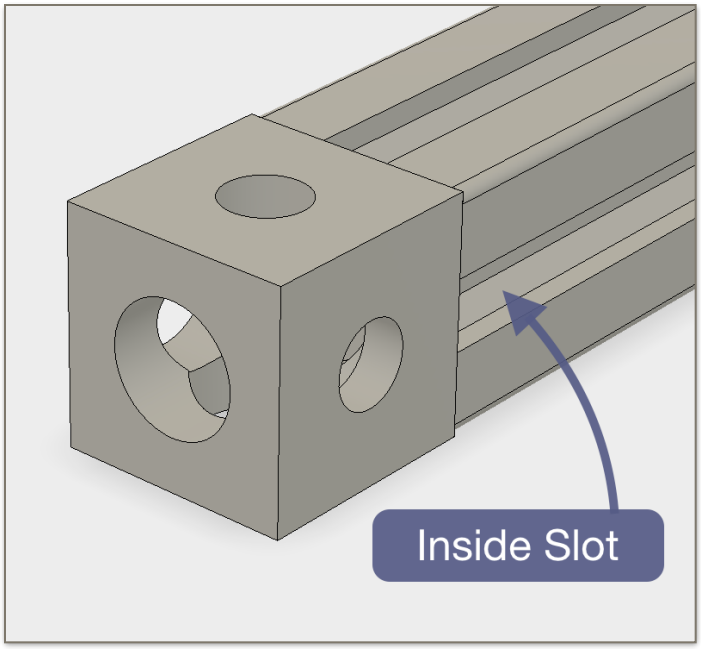
Step 1: Pre-assemble 4 lengths of bottom square. Start with the lower square. Take one of the extrusions and secure a corner connector on it using the self tapping screw. Tighten it slightly, and back it out 1/8 of a turn so it can rotate. Repeat for the remaining 3 bottom extrusions.



You now have 4 extrusions that are closed off on one end.

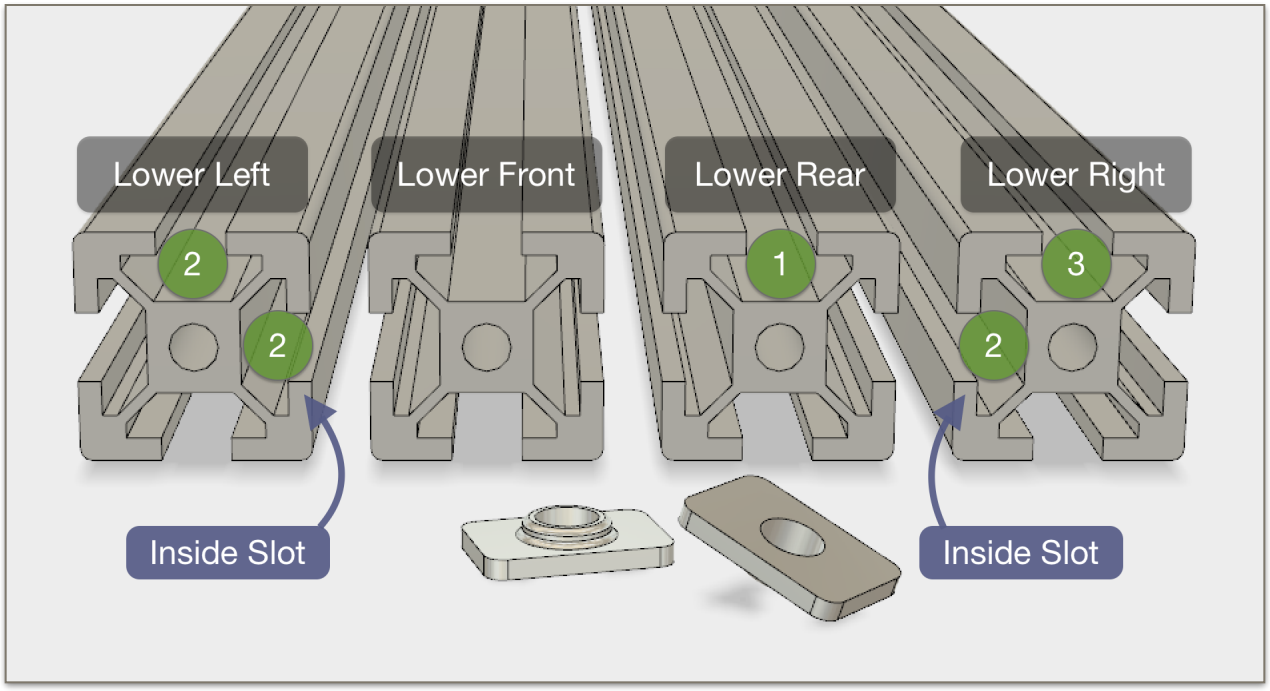


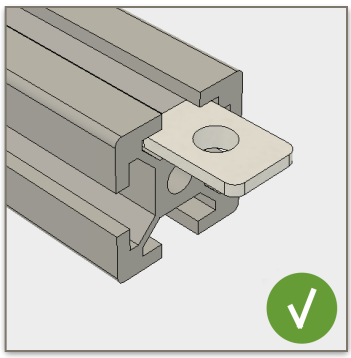
Before we insert T Nuts, make sure the extrusions are oriented correctly. For bottom extrusions, the smaller hole on the Cube Connector should face the top.

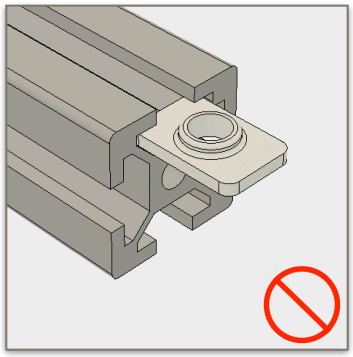


Another important thing to note is the inside vs outside slots on the rails. Inside slots face the inside of the square. The smaller hole on the Cube Connector will always be on the side of the inside slot.

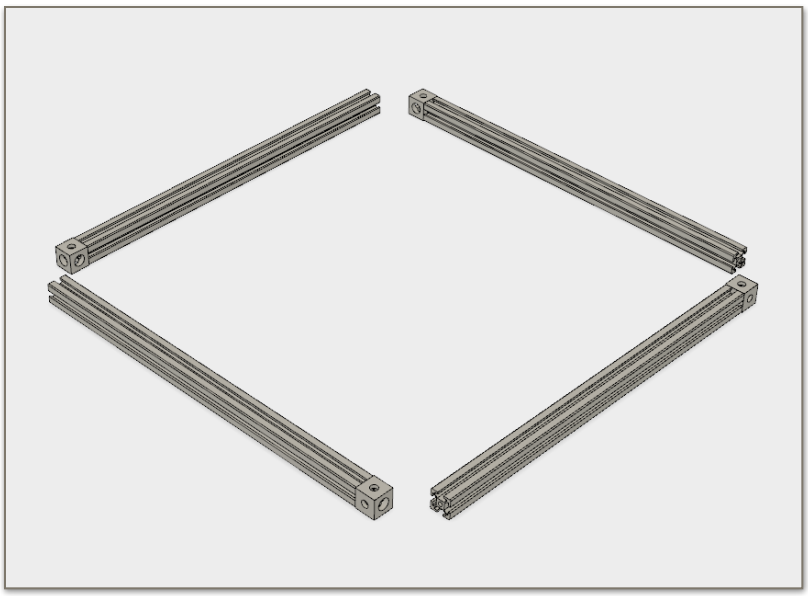
Step 2: Insert the required number of T Nuts (indicated by the green circles) into each side of the lower extrusions.



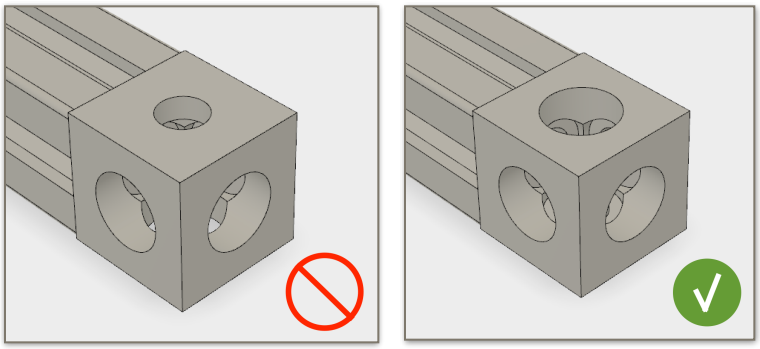




NOTE: The flat side of the T Nut should always face the outside of any extrusion slot

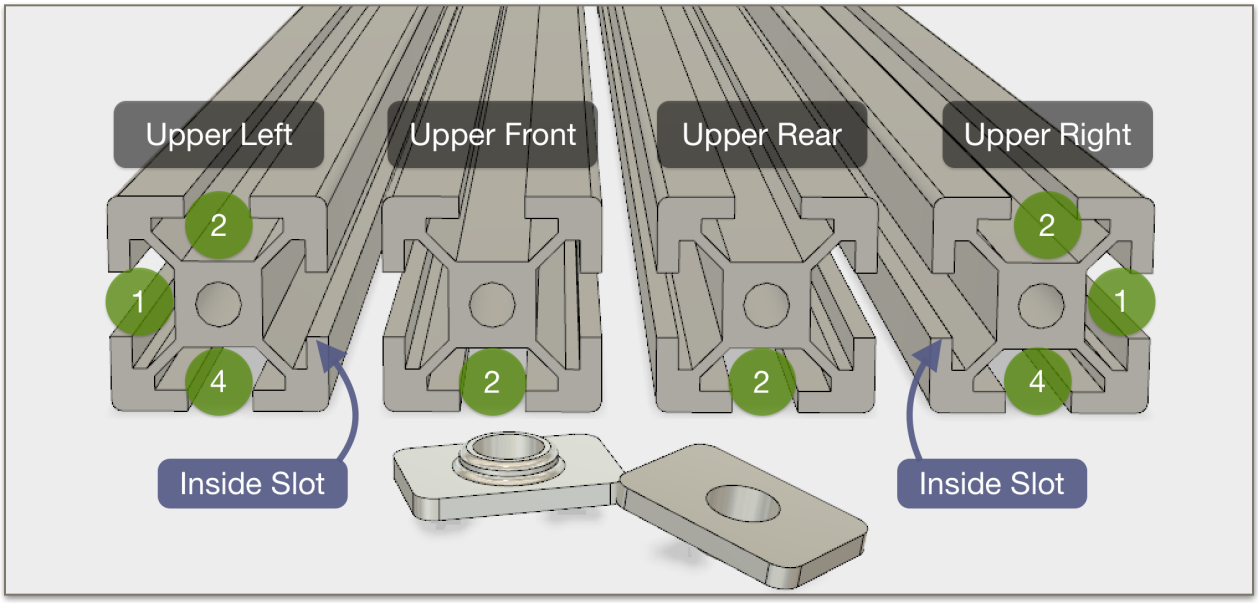


Step 3: Join the 4 pieces into a square, being mindful of the orientation and the label of each extrusion. You'll have to apply some force to get the screws to go in all the way. It's a really tight fit inside the cube. Don't worry, it'll connect. Just go slow and make sure the screws are all the way in. You can then back them out 1/8 of a turn. Make sure you are applying ample thrust so the Torx drive doesn't slip. Make sure you are on a flat surface, and tighten the screws while pushing down on extrusions.

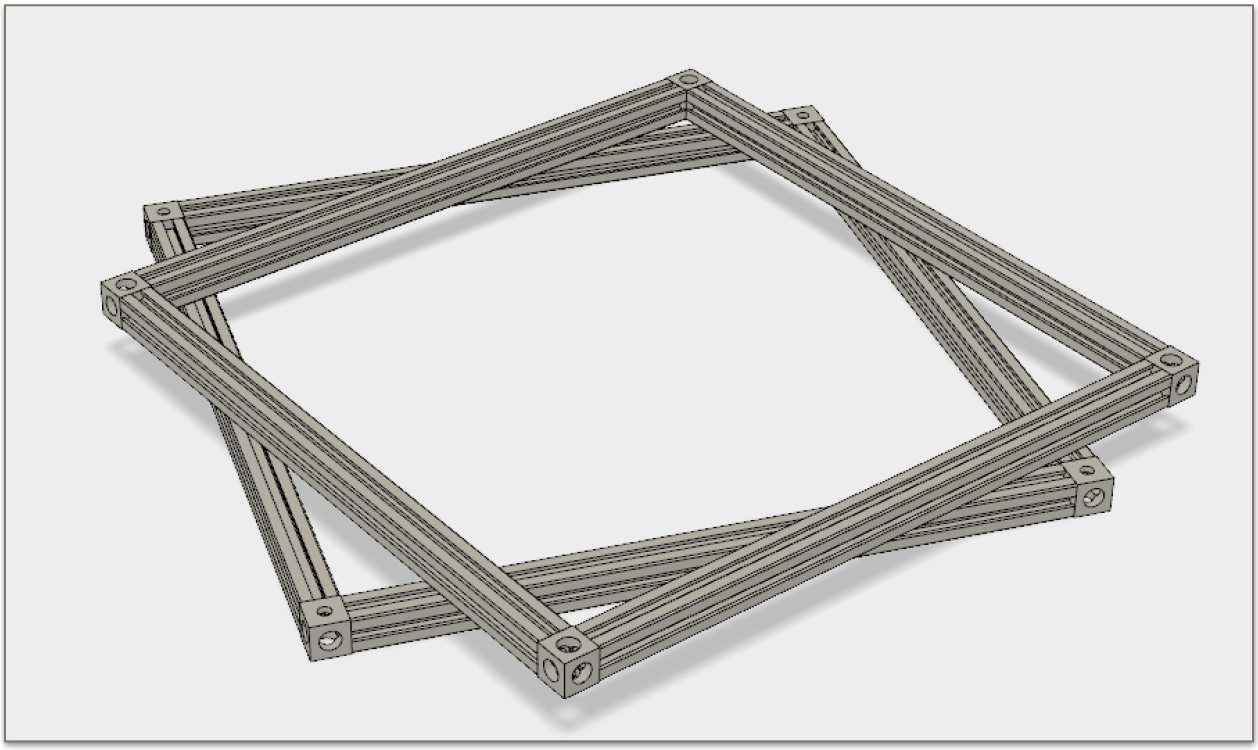


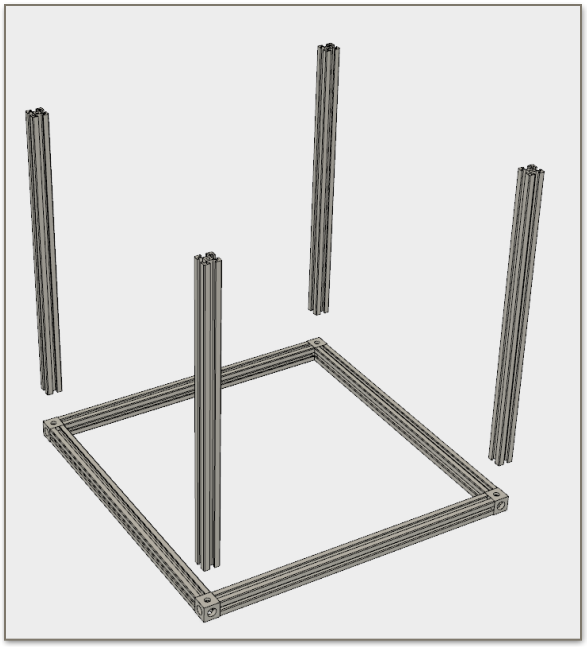
Step 4: Repeat Step 1 for the upper 4 extrusions, making sure the smaller holes on the Cubes are facing the bottom this time. This will orient them properly.

Step 5: Insert the required number of T Nuts (indicated by the green circles) into each side of the upper extrusions.



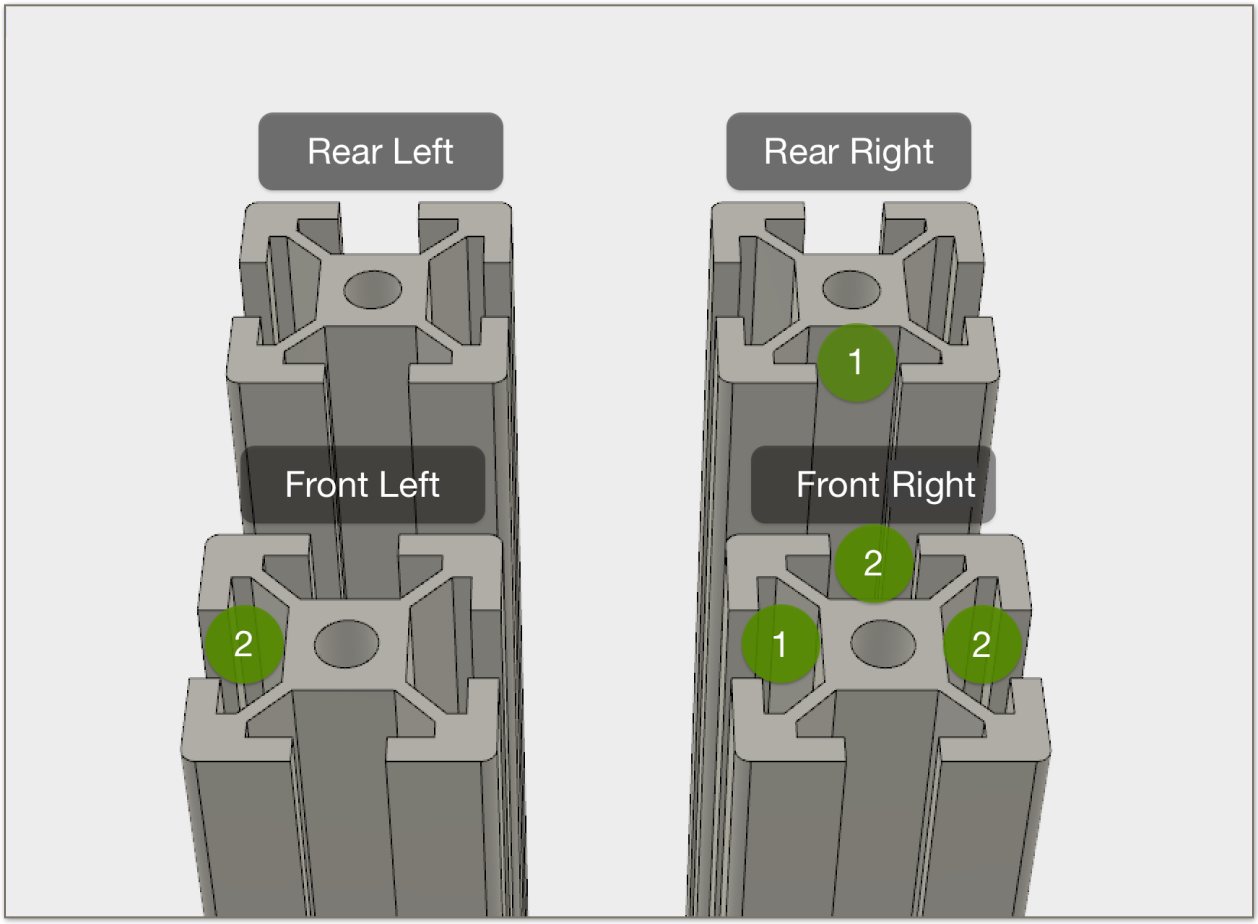
Step 6: Join the upper extrusions together same way you did the bottom ones. You should now have 2 squares full of T Nuts.



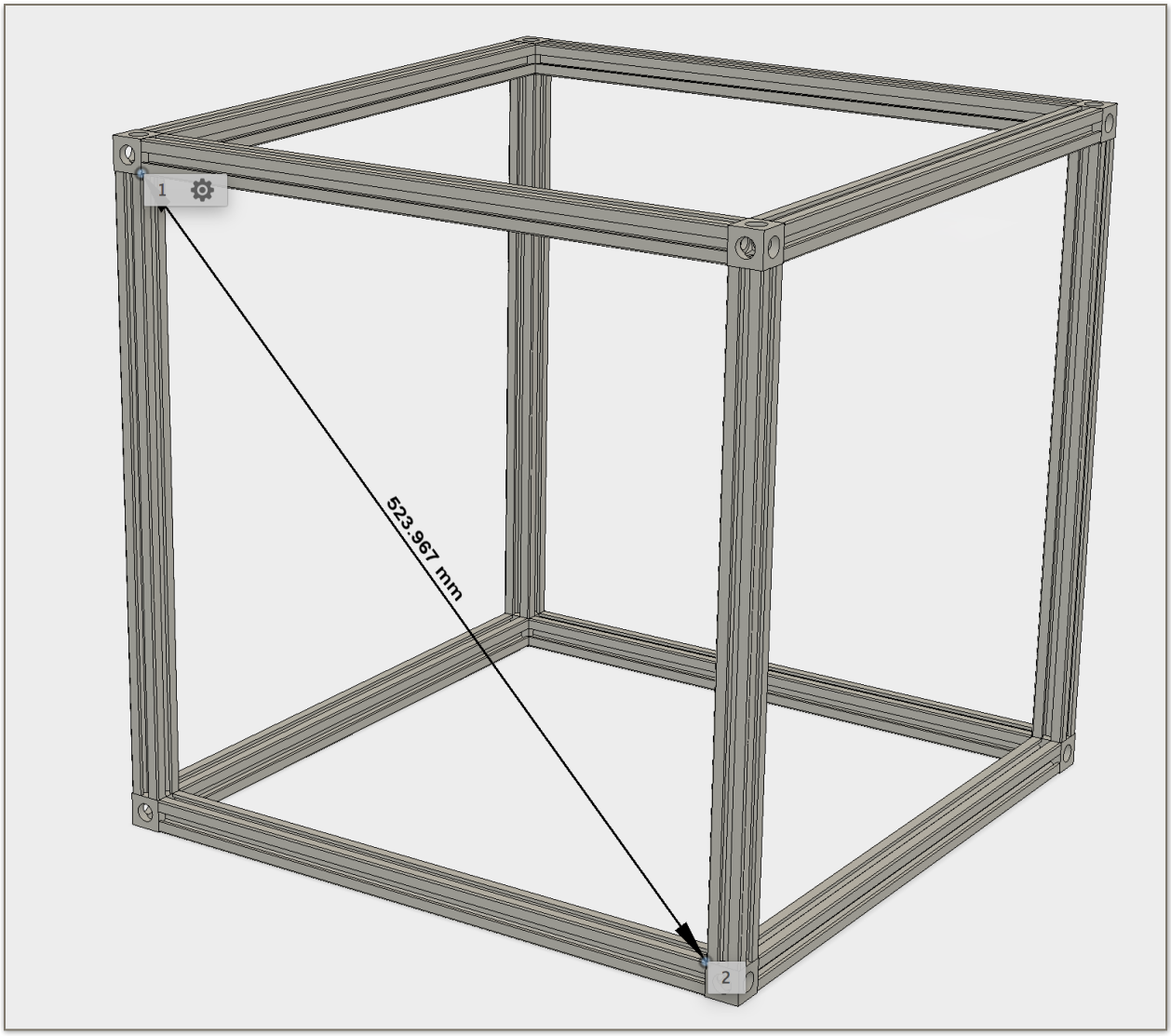


Step 6: Screw in the verticals. Make sure they don't look rotated after you've tightened them. This will throw off some dimensions later on.

Step 7: Insert the remaining T Nuts into the verticals:



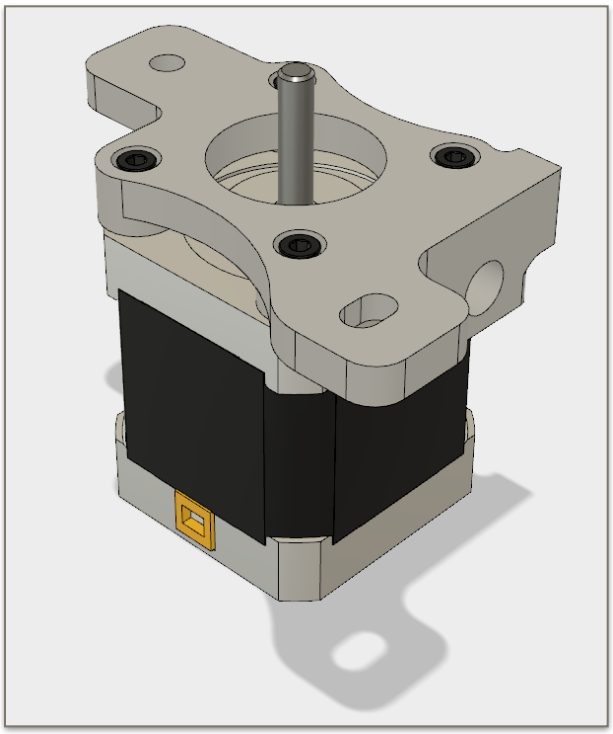
Step 8: Attach the upper square to the verticals. Tighten everything and check the diagonals with a ruler. The diagonals need to be as close to 524mm as possible. If they are off too much, you'll need to loosen some screws and re-tighten them on a flat surface. If they are still tweaked, you can gently guide them into true with some strategically applied pressure. Having a square frame will save you a lot of calibration headaches in the future.



Congrats! You now have a solid frame to build your printer on. On to the more fun bits.

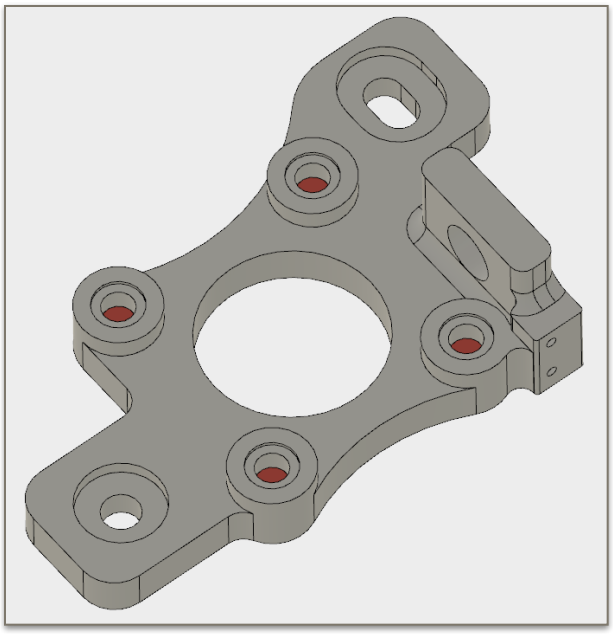
SECTION2 : GANTRY

2.1 A/B Motor Mounts



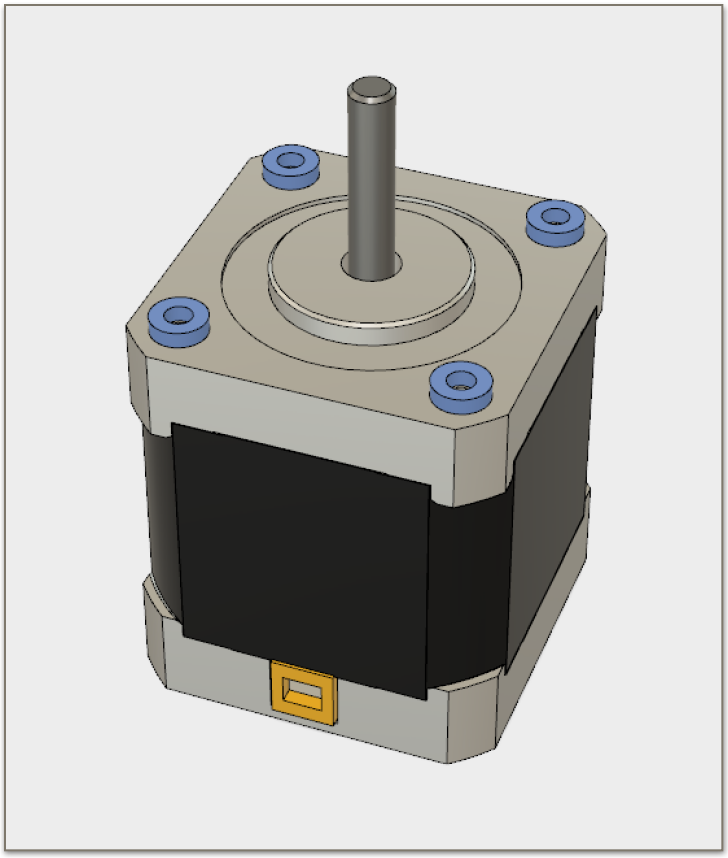
Items required:

- A and B Motor Mount printed parts
- NEMA17 Stepper Motors
- M3 Silicone Washers
- M3 8mm screws

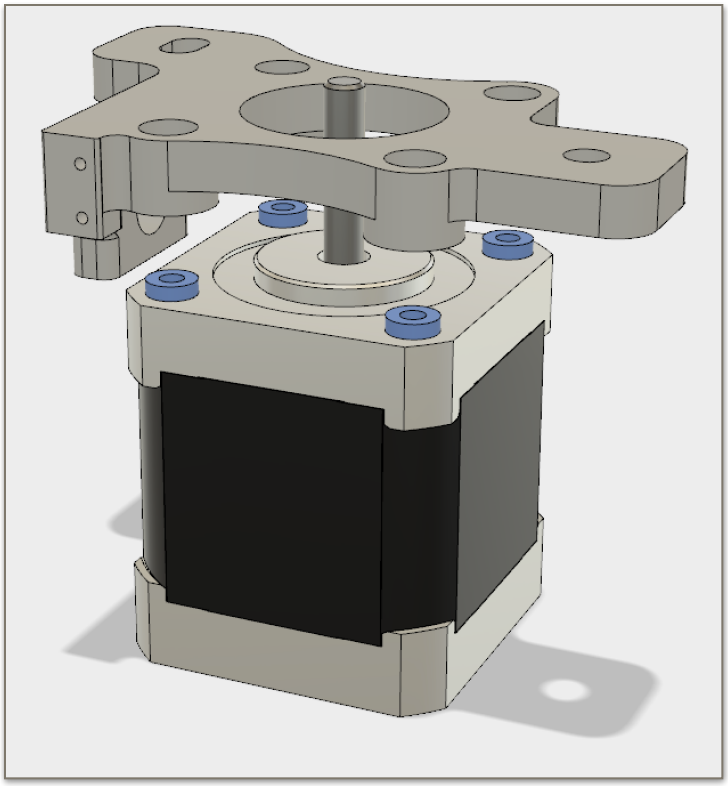


Step 1: First, a little cleanup. You'll need to remove some bridging support material from the motor mount holes (colored red in the illustration). 4mm drill bit does the job quite well, but a small knife will do the trick.

Now is a good time to check if the 8mm shaft fits into its mount point. It should be a snug fit, but go in with only a little pressure. If you feel you have to hammer it in, *stop* and clean out the hole a little.



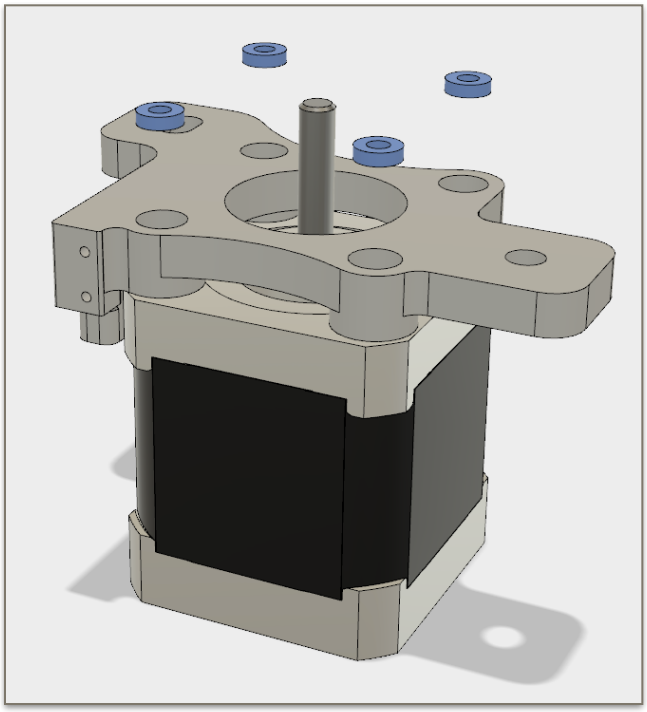
Step 2: Place the NEMA17 stepper on a level surface, and place 4 silicone washers on top of it, aligning them with the holes on the stepper. The washers are a little sticky and should stay in place.

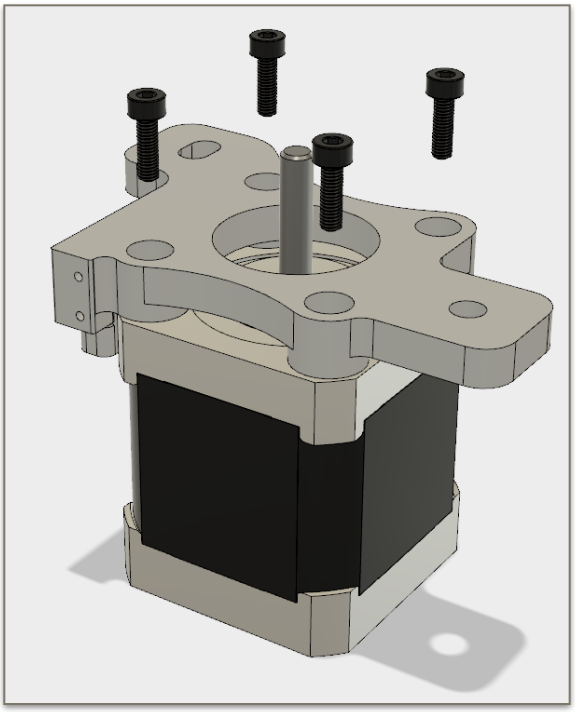


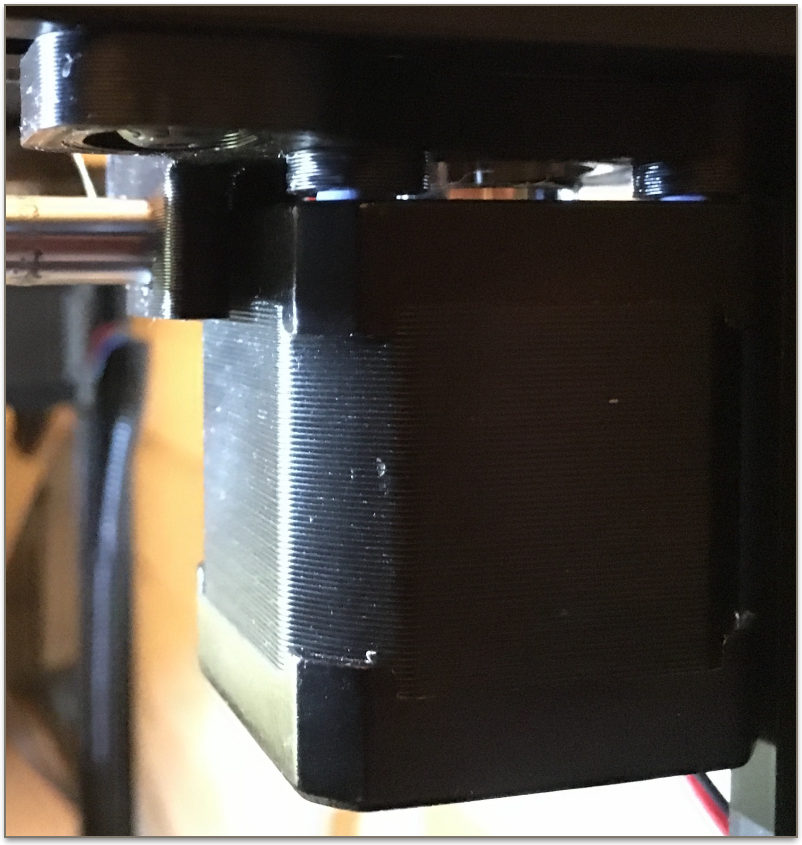
Step 3: Line up the motor mount over the 4 holes, and lower it on top of the washers. The small shoulders on the A/B mount should catch the washers, so if you have to move the mount to get everything to line up properly, the washers should now move with it.

Make sure the motor wires are on the opposite side of the 8mm mount point, so they face the rear when installed on the frame.

Step 4: Insert 4 silicone washers into the top holes, and secure the motor with 4 M3 8mm screws



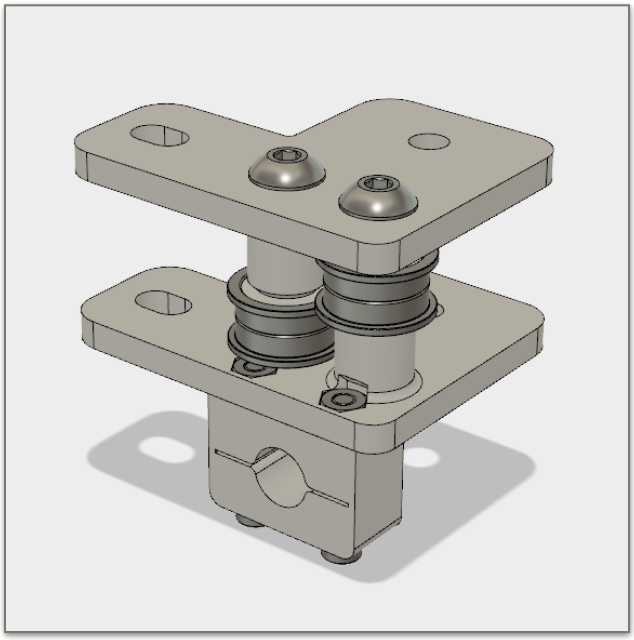




Tighten the screws until there's about 0.5mm gap between mount and the motor. You should still be able to see the blue washers between the stepper and the mount. We're trying to stiffen the joint, while preventing the stepper from making contact.

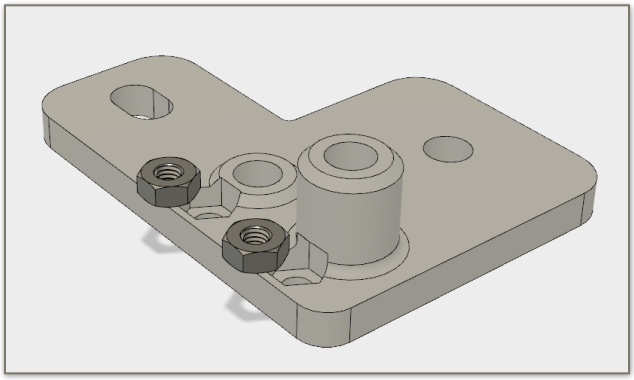
Repeat this process for the other motor mount.

2.2 A/B Idler



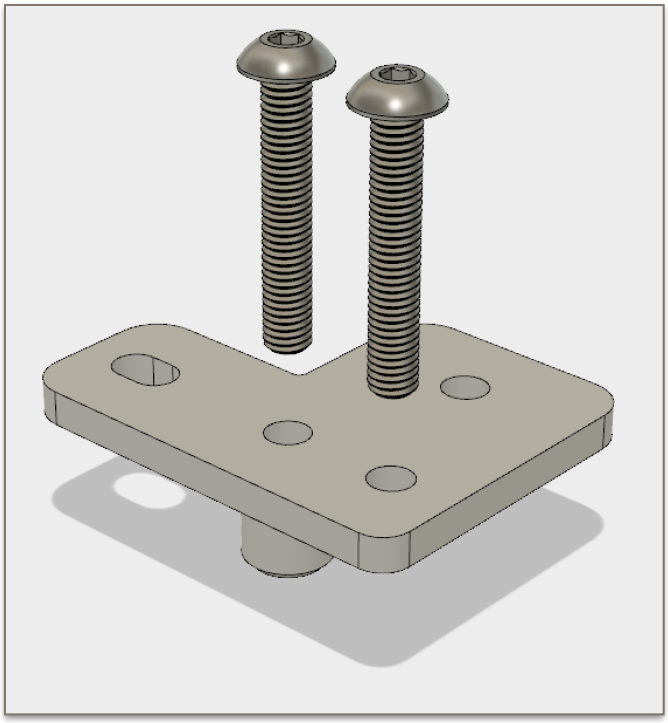
Items required:

- A and B Idler Mount printed parts
- M5 30mm screws
- F695 bearings
- M3 hexnuts
- M3 20mm screws

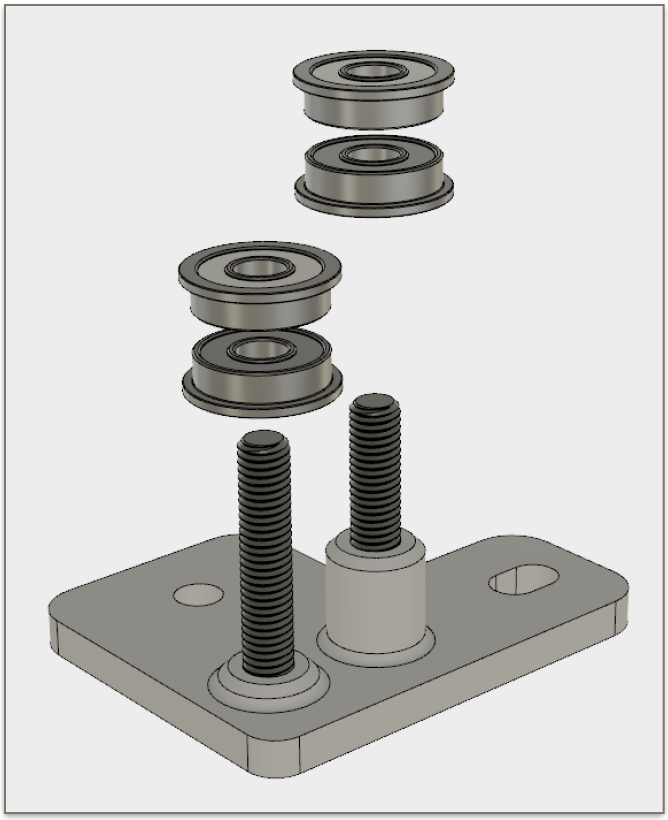


Step 1: Insert M3 hex nuts into the lower idler plate.

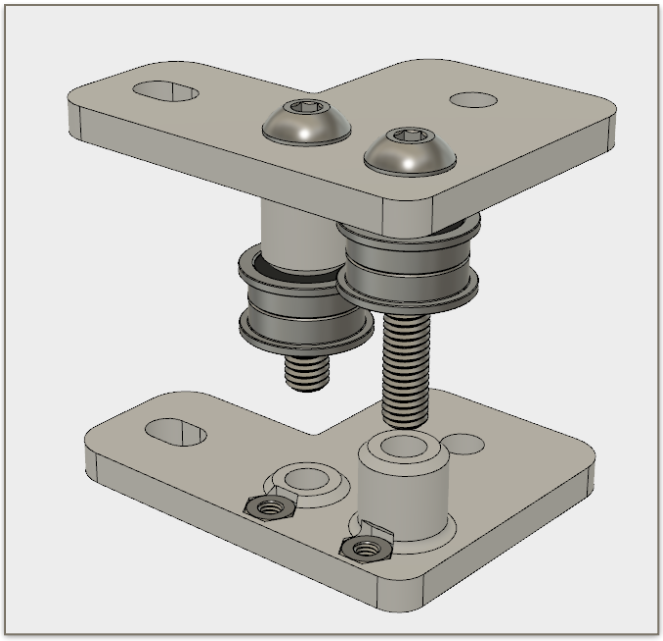
WARNING: Do not drill out the bottom 2 idler posts. We need them to be snug so the screws have something to form threads in.



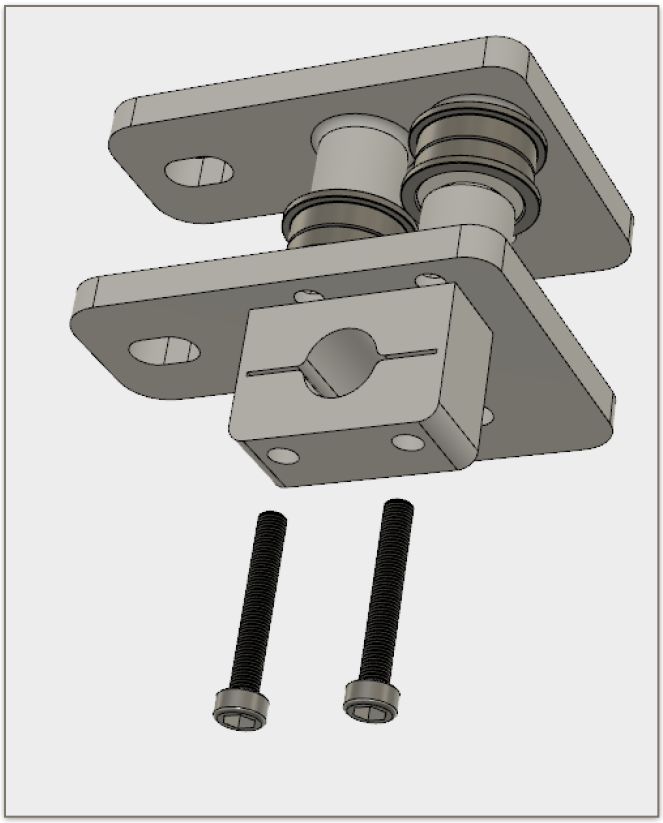
Step 2: Screw the M5 30mm screws into the upper idler plate, and give them a few twists so they break the threads they just formed in the plastic. These holes have intentionally tight tolerances.



Step 3: Slide the F695 bearings over the screws as pictured. The flanges will form the shoulders of the belt idler.



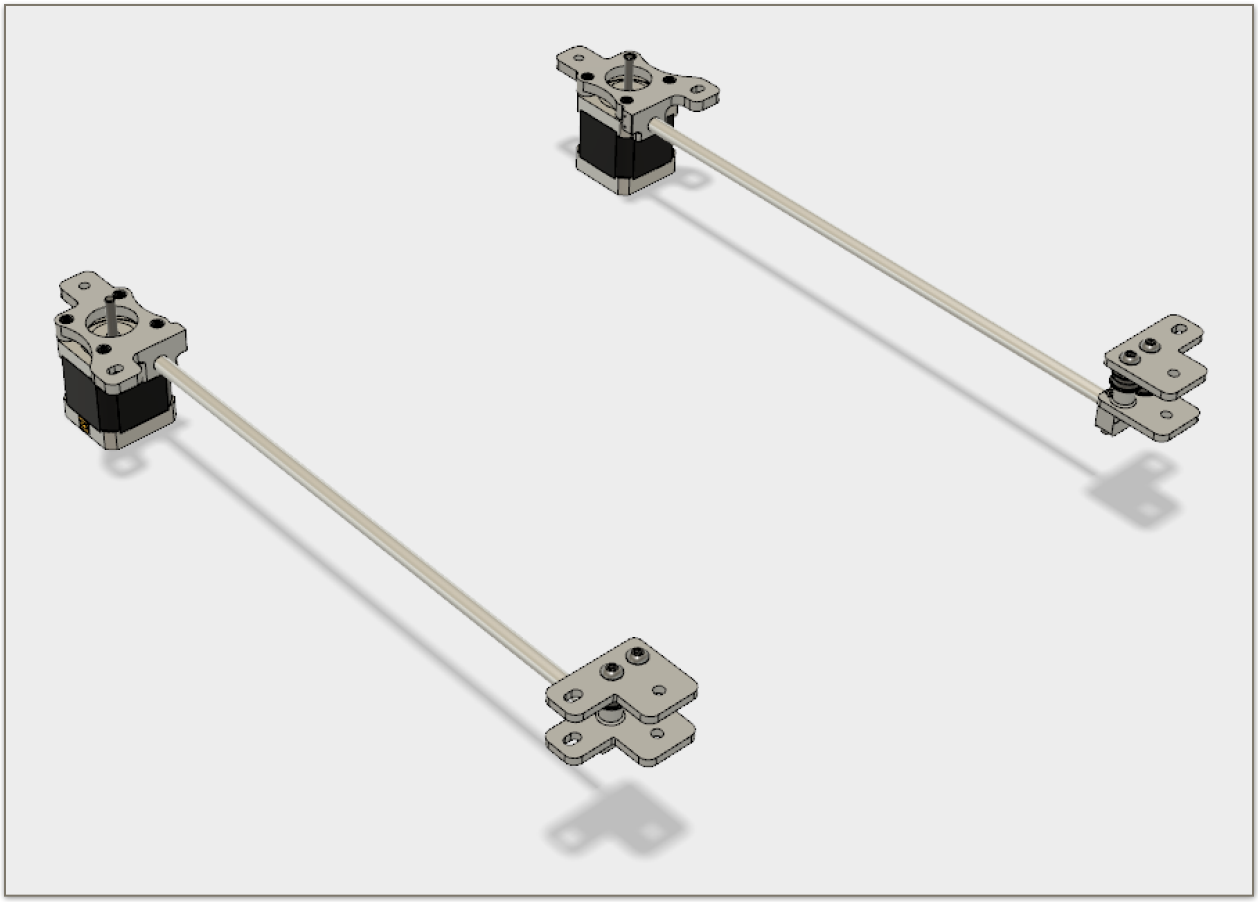
Step 4: Screw on the bottom idler plate. Do one turn per screw and alternate to keep them level with each other. Don't over-tighten. Remember, you are threading into printed plastic. These screws are only going to experience lateral forces, and the actual force of keeping the two plates together will come from the 4 screws that will secure this part to the frame.



Step 5: Using 2 M3 20mm screws, secure the Y shaft retainer into the lower idler plate. We're not tightening these yet, just keeping them in place for later.

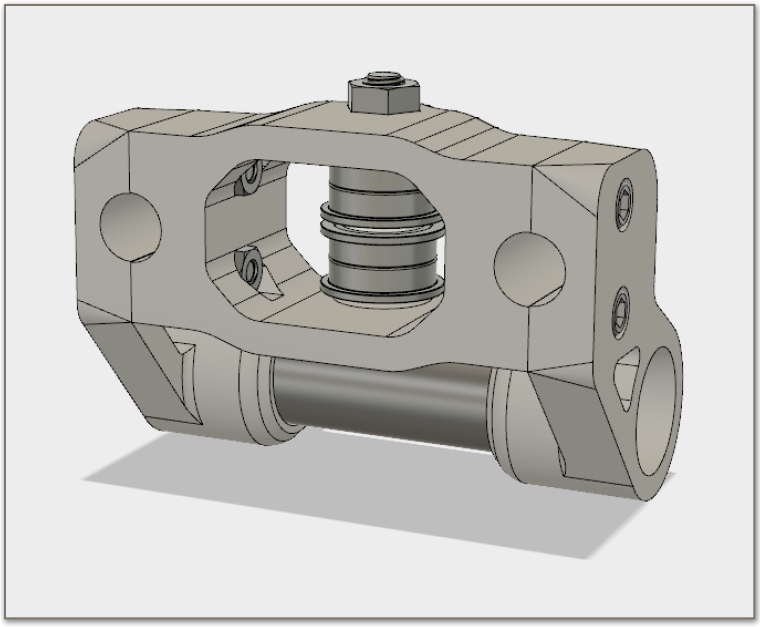
Repeat these steps for the other idler.

Woo! You now have a Y axis!



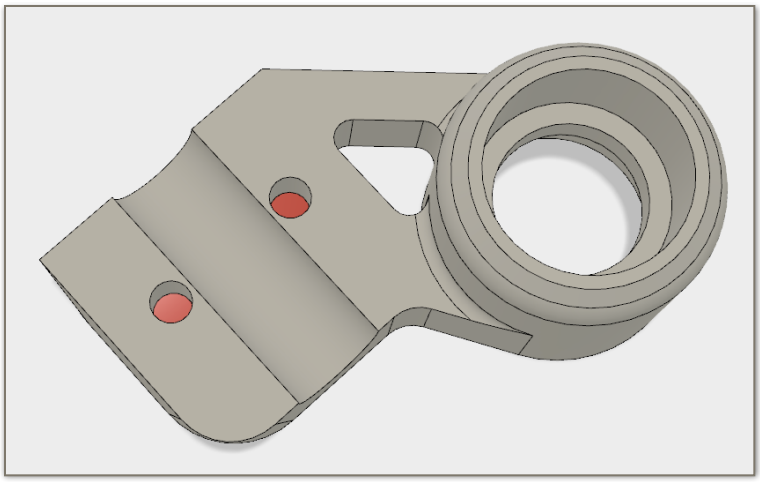
After you're done admiring your handiwork, remove the Y shafts. They will be installed after the components are bolted into the frame.

2.3 XY Joint

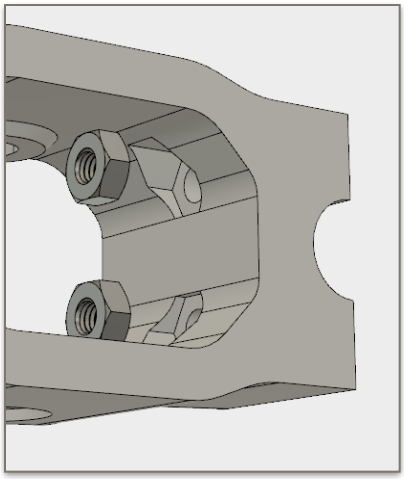


Items Required:

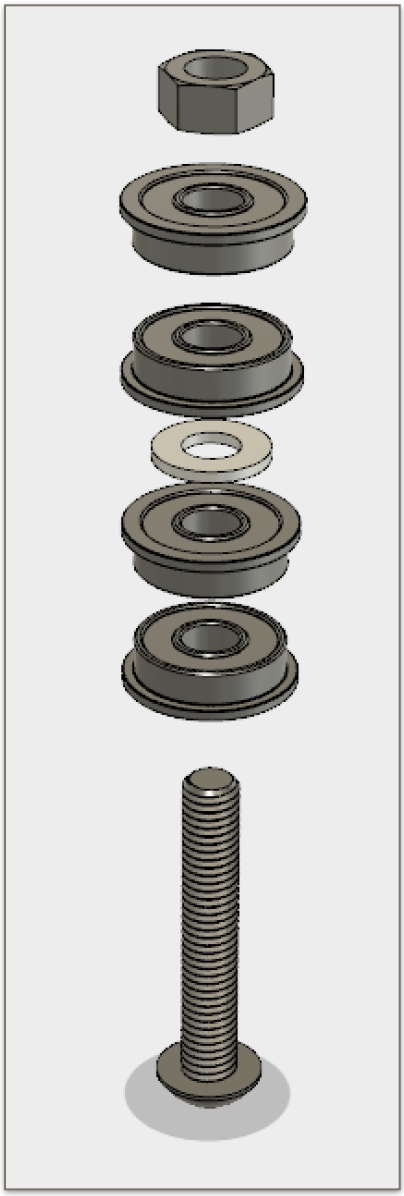
- XY Joint printed parts
- M5 30mm screws
- M5 hex nuts
- M5 washer
- M3 16mm screws
- M3 hex nuts
- F695 bearings
- LM8LUU bearings



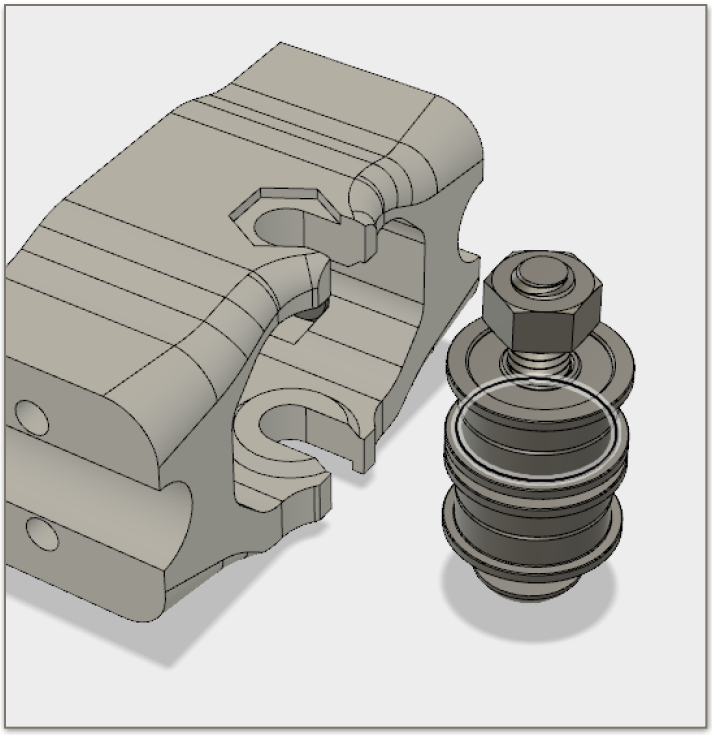
Step 1: Clean out bringing supports from the M3 holes on each side pieces of the XJ Joints. You can use a 3mm drill bit here.



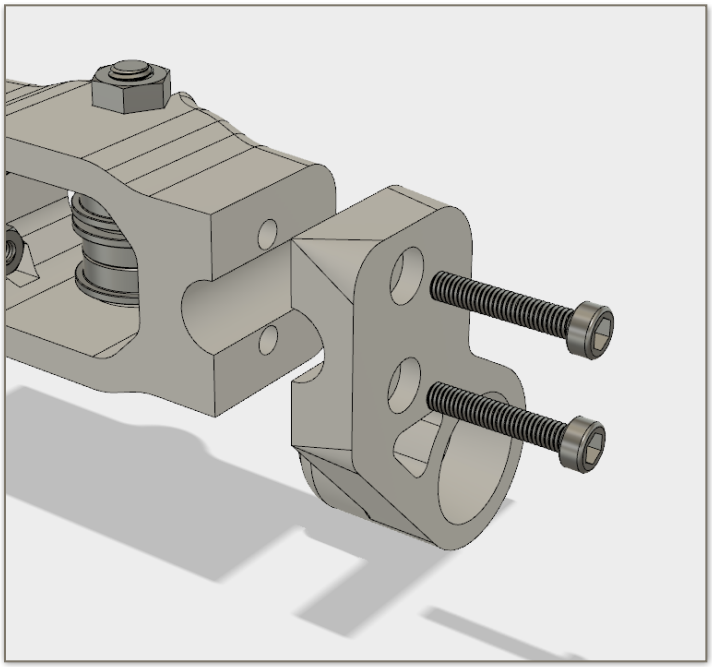
Step 2: Insert M3 hex nuts into both inner walls of the mid section.



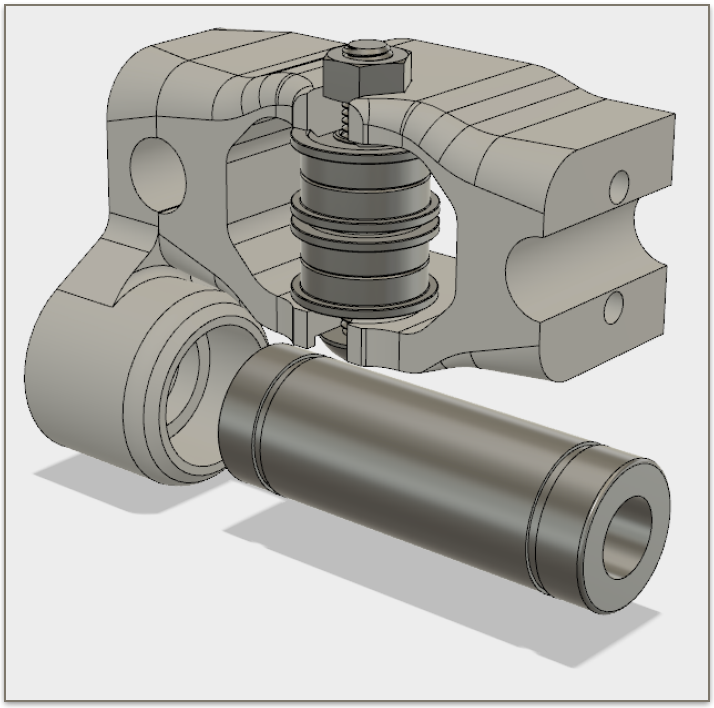
Step 3: Stack F695 bearings and an M5 washer to form an idler assembly. Close the screw off with the M5 nut, but don't tighten it yet. You just want the assembly to not fall apart.



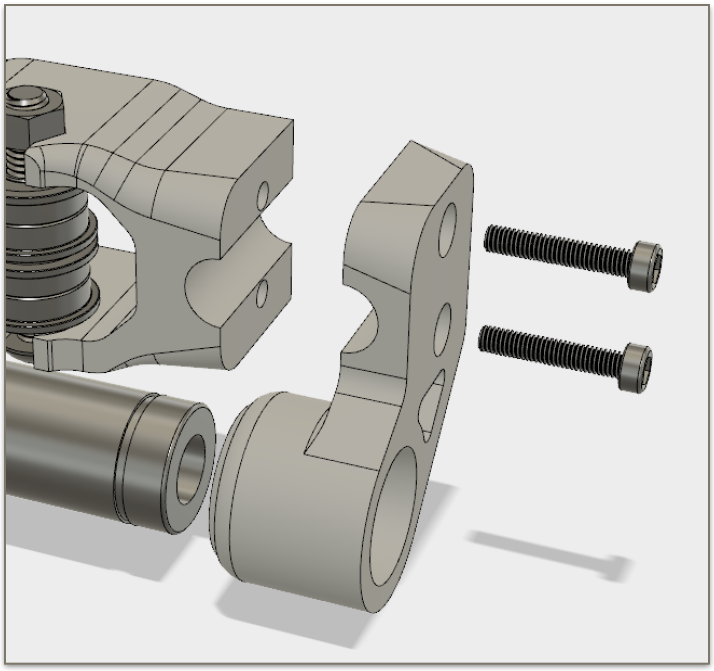
Step 4: Slide the idler assembly into the slots on the midsection. **Make sure the hex nut is facing up**. Line it up with the hex nut trap on the mid section when inserting. Tighten the assembly, but be careful not to over tighten it. Depending on the tolerances on the bearings, too much tension may cause them to bind.



Step 5: Attach one of the sides to the mid section using the M3 16mm screws. Don’t tighten them yet. Again, the M5 nut indicates the top.



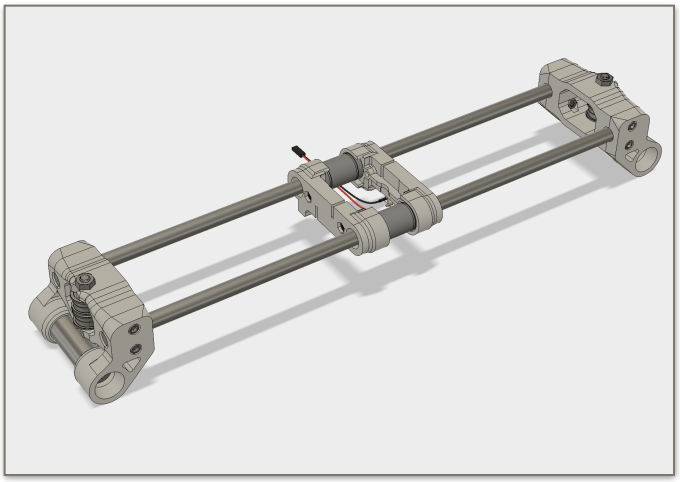
Step 6: Pack the LM8LUU bearing with grease (See section A.3 “Greasing the bearings” for details) and slide it into the side. I’ll be a snug fit. Press the bearing in until it hits the lip inside it’s retainer.



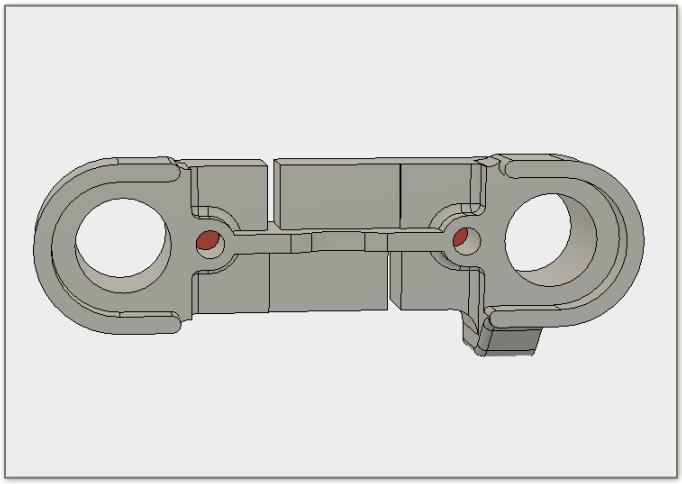
Step 7: Attach the other side of the XY Joint, while pressing it onto the other end of the LM8LUU bearing. Again, don’t fully tighten the M3 screws yet.

Repeat the steps for the other XY Joint.

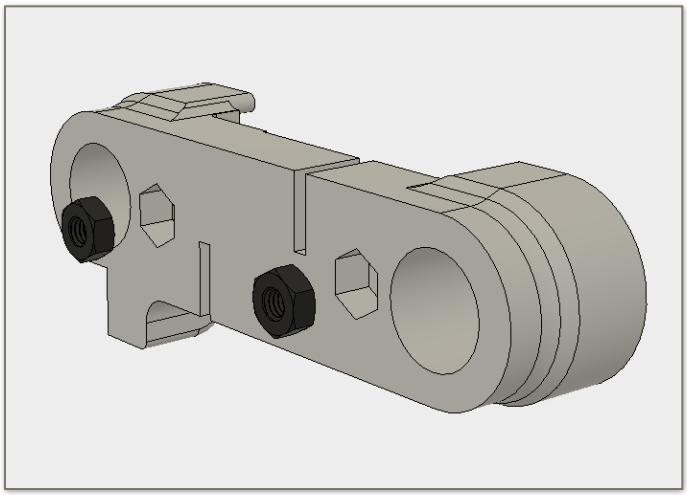
2.4 X Carriage / X Axis



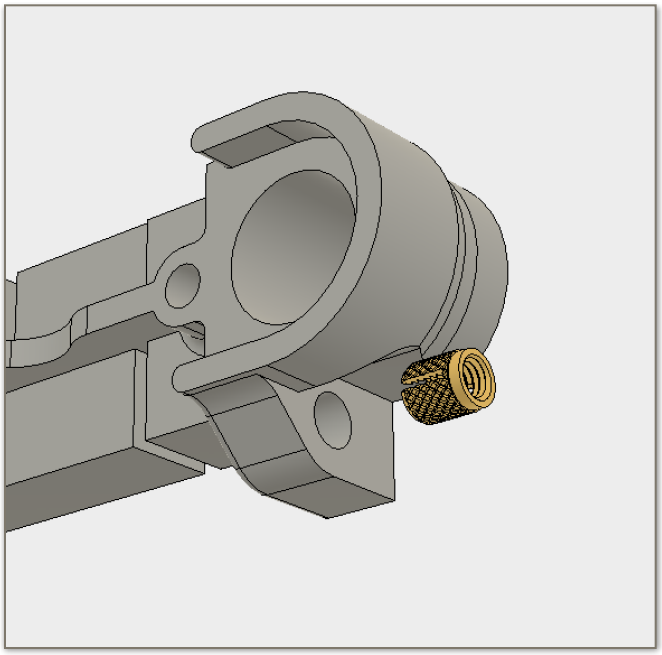
Items Required:
- Assembled XY Joints
- 8mm rods
- X Carriage printed parts
- Endstop Microswitch
- M3 hex nuts
- M3 Threaded inserts
- Phillips Screws No. 1
- LM8UU bearings



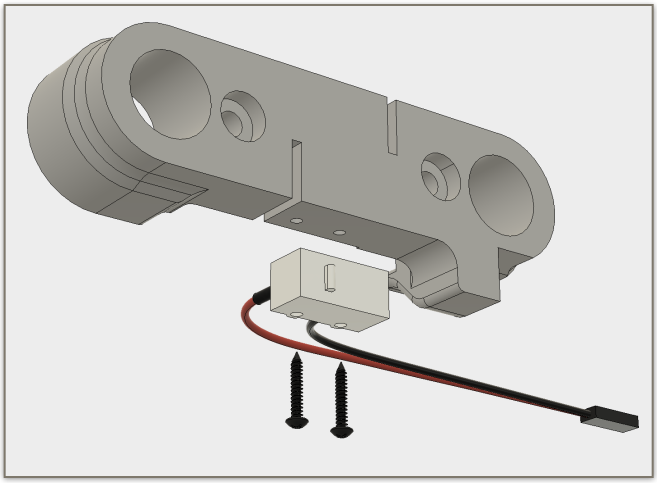
Step 1: Clean out the 3mm holes on both X Carriage Ends (indicated in red).



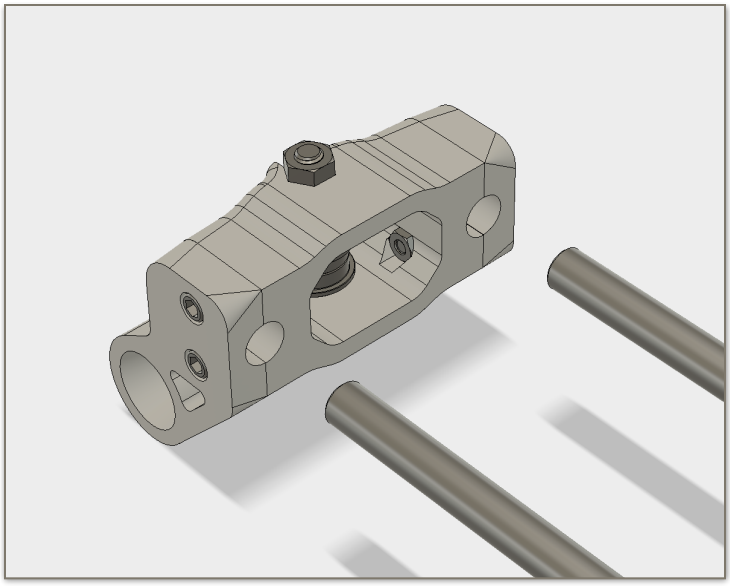
Step 2: Install M3 hex nuts into the nut traps on one of the X Carriage Ends.



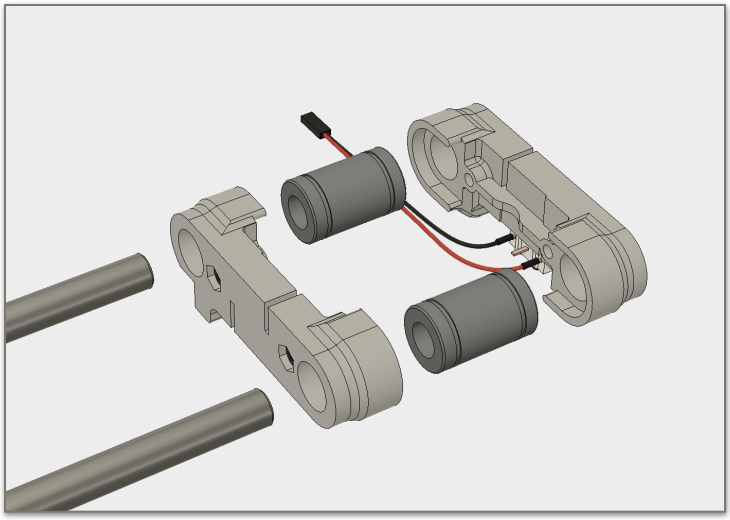
Step 3: Install the M3 threaded inserts into the back of both X Carriage Ends. Use a soldering iron to heat the inserts as you insert them. This will insure you don't break the printed part in the process, and cement the insert in place. After it cools, you can trim off any leaked out plastic with a knife.



Step 4: Attach about 100mm of wire with a Dupont connector to the end-stop microswitch. Make sure to wire it as normally closed (NC). Use the phillips screws to attach it to the Carriage End. The holes are only on one of the carriage ends. Don't over-tighten the screws.

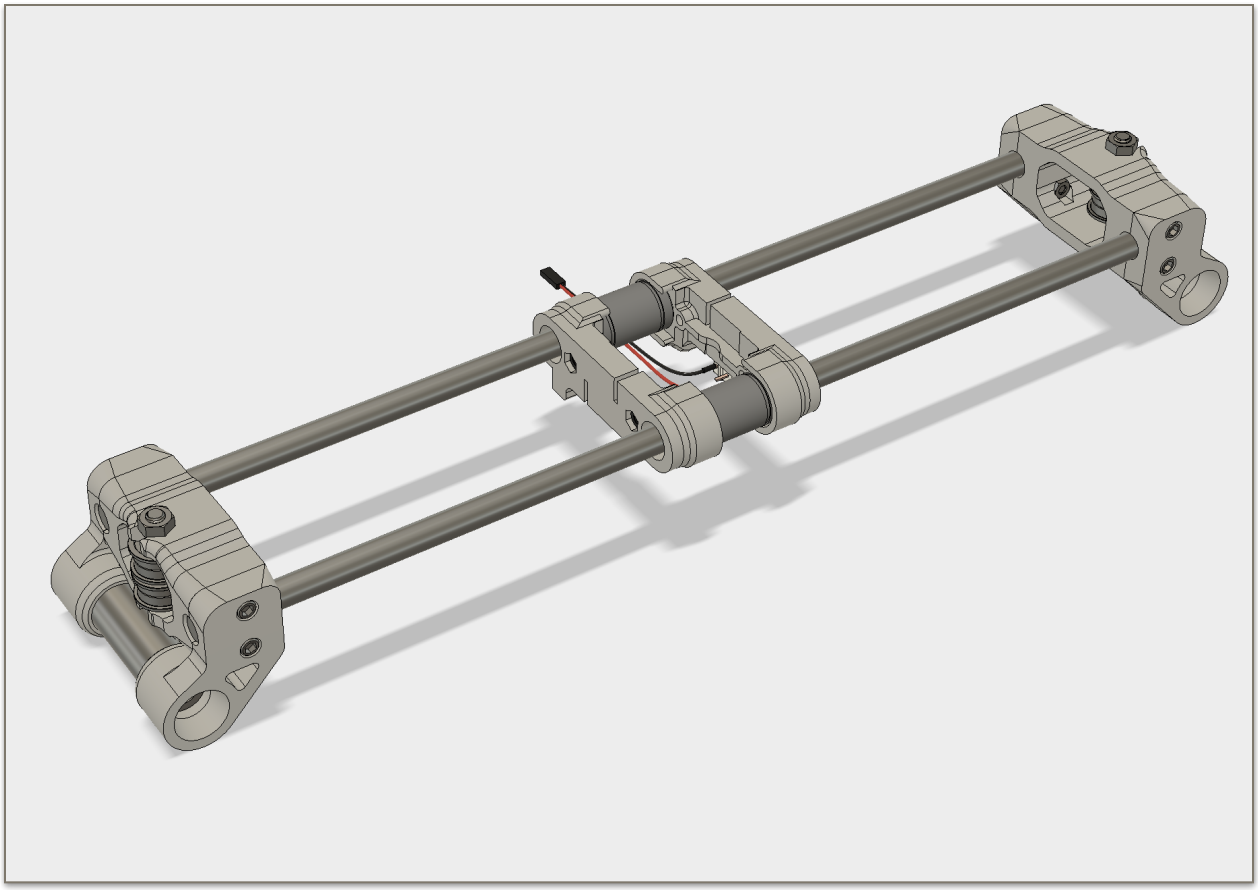


Step 5: Slide the 8mm shafts into one of the XY Joints. Tighten the side screws so the rods won't slide out, but are still able to be rotated by hand.



Step 6: Pack the LM8UU bearings with grease (See section A.3 "Greasing the bearings" for details). Slide the Carriage Ends and the LM8UU bearings onto the 8mm shafts. Make sure the threaded inserts are on the bottom and are facing the same direction.

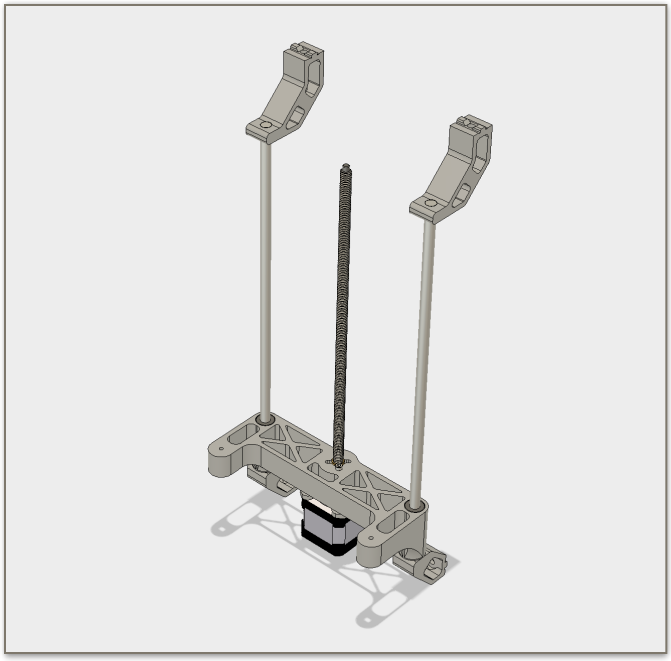
Slide the remaining XY Joint onto the shafts.



Alright! You have your X axis now, and with that your gantry is ready to be installed onto the frame.

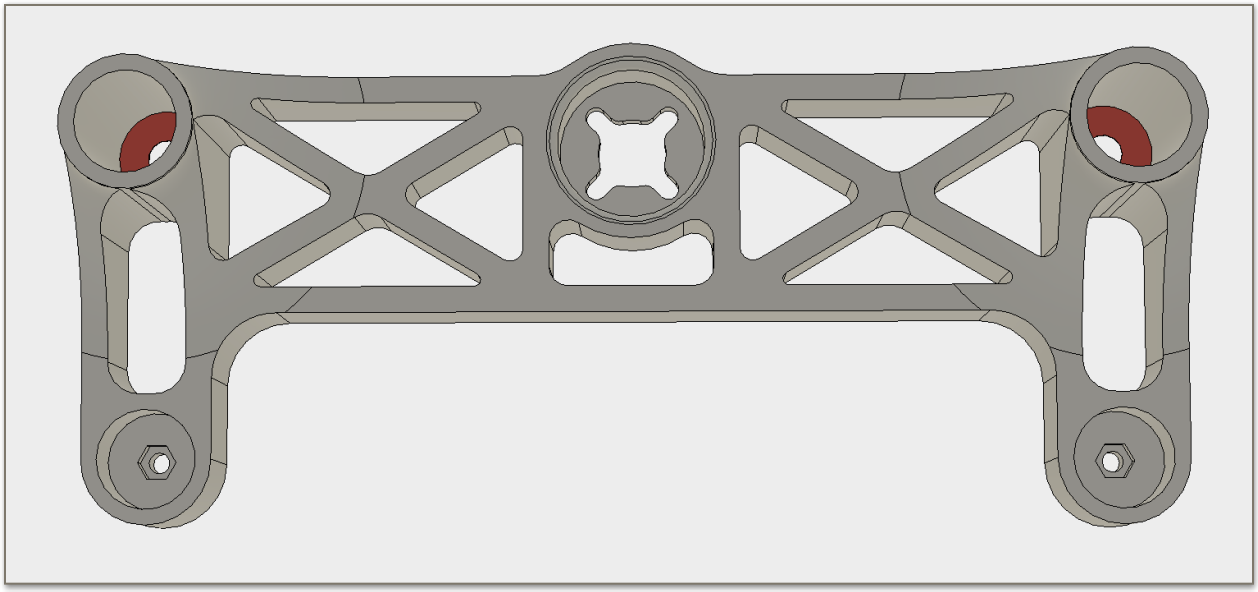
We will attach the rest of the components to it after we align everything.

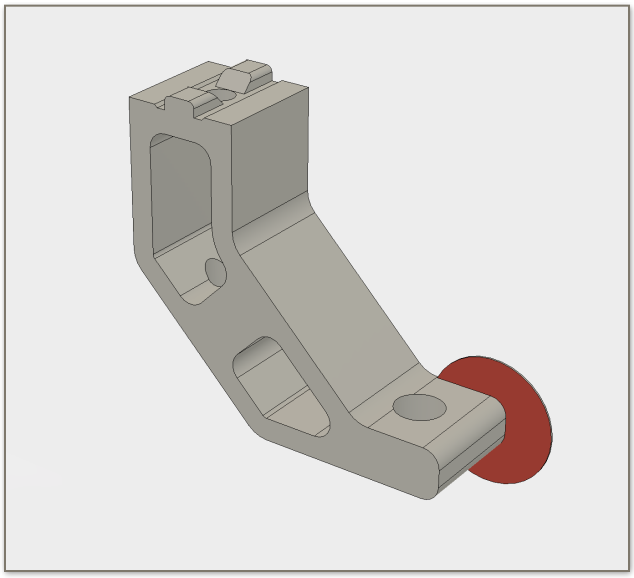
SECTION3 : Z TOWERS

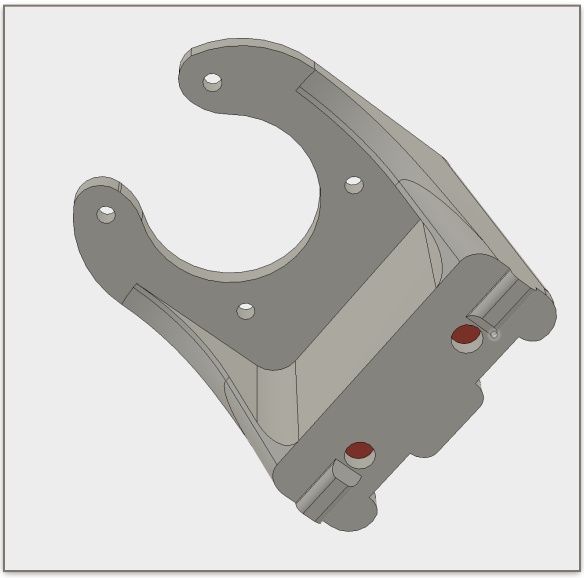


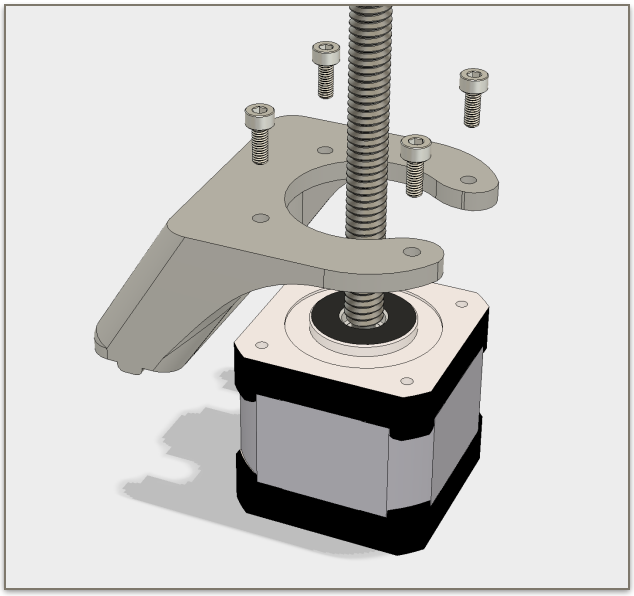
Items Required:
- Z Tower printed parts
- 8mm shafts
- TR8x2 NEMA17 linear motors
- TR8x2 nuts
- LM8LUU bearings
- M3 8mm screws
- M3 lock nuts

Step 1: Prepare the printed parts for assembly by removing adhesion tabs, and clearing out any holes that have bride supports.

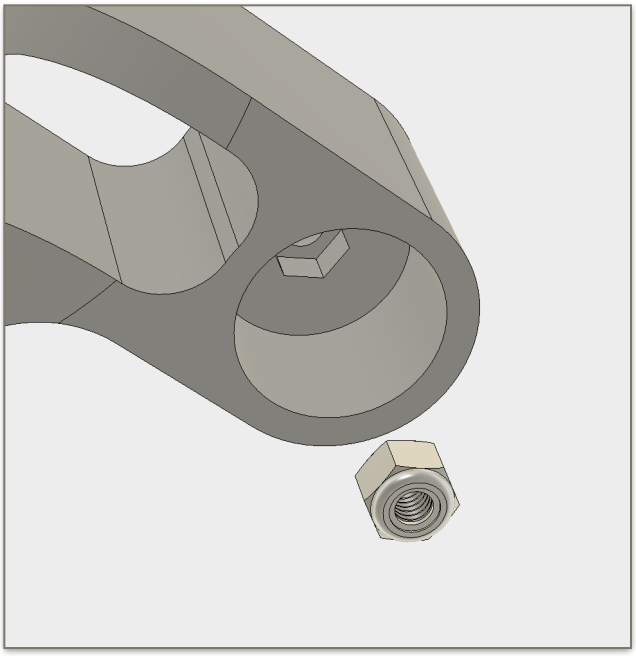




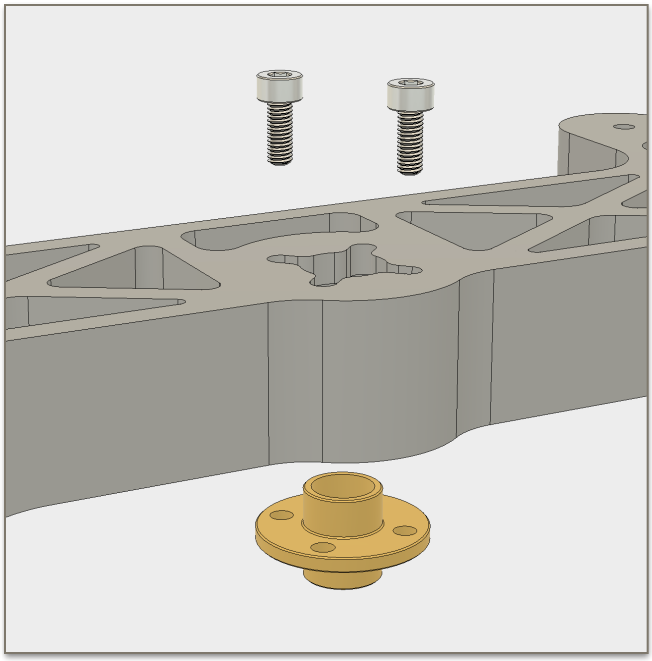




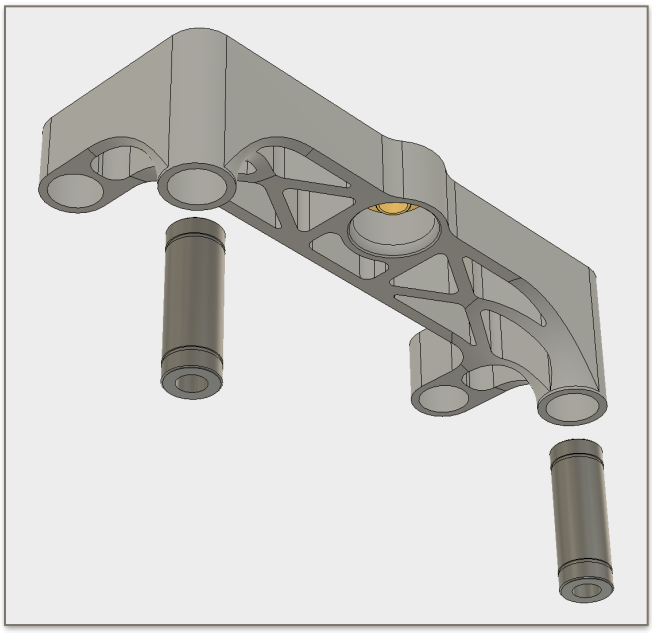
Step 2: Attach the NEMA17 linear motor to the Z motor mount using the M3 8mm screws.



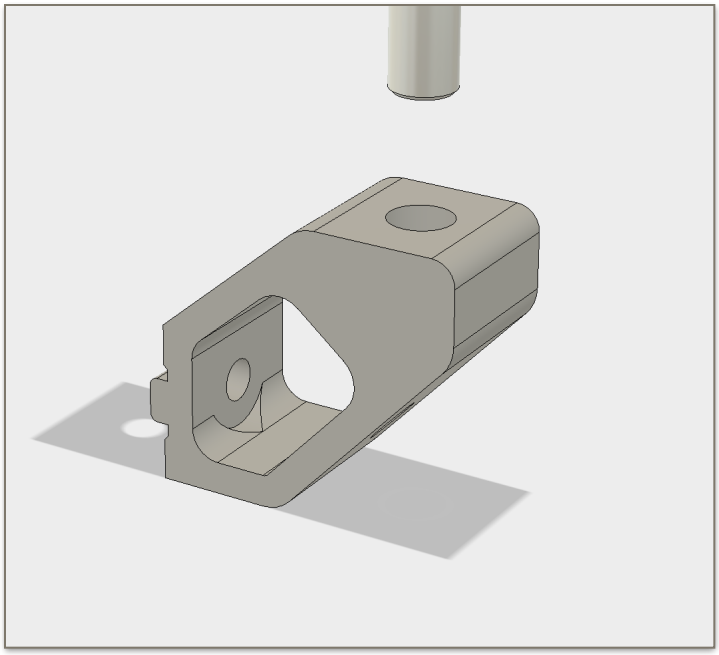
Step 2: Insert the M3 lock nuts into the nut traps on the bed carriage



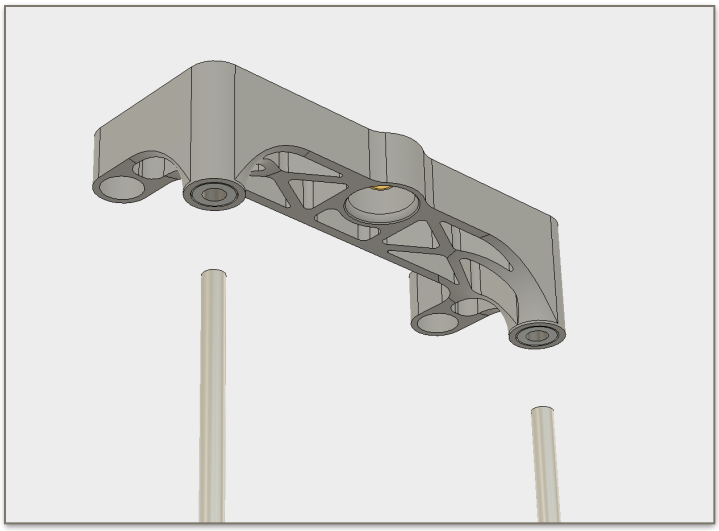
Step 3: Insert the TR8 nut from the bottom, and secure it with 2 M3 8mm screws on any of the 2 diagonal slots in the bed carriage.



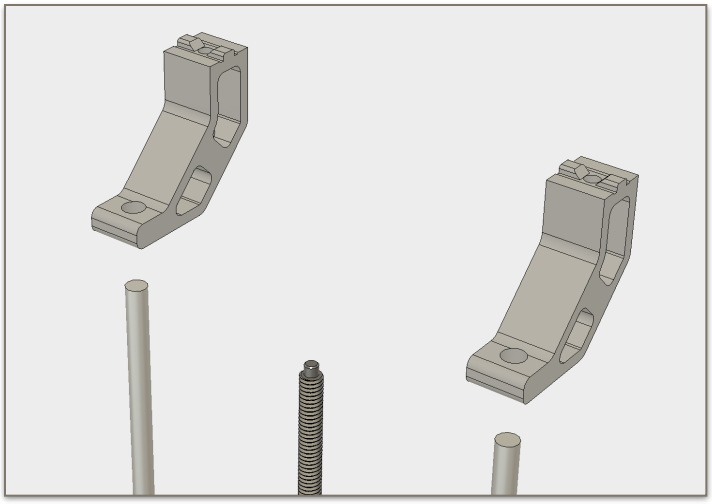
Step 4: Insert the LM8LUU bearings into its retainers. Now is also a good time to pack them with grease (See section A.3 “Greasing the bearings” for details)



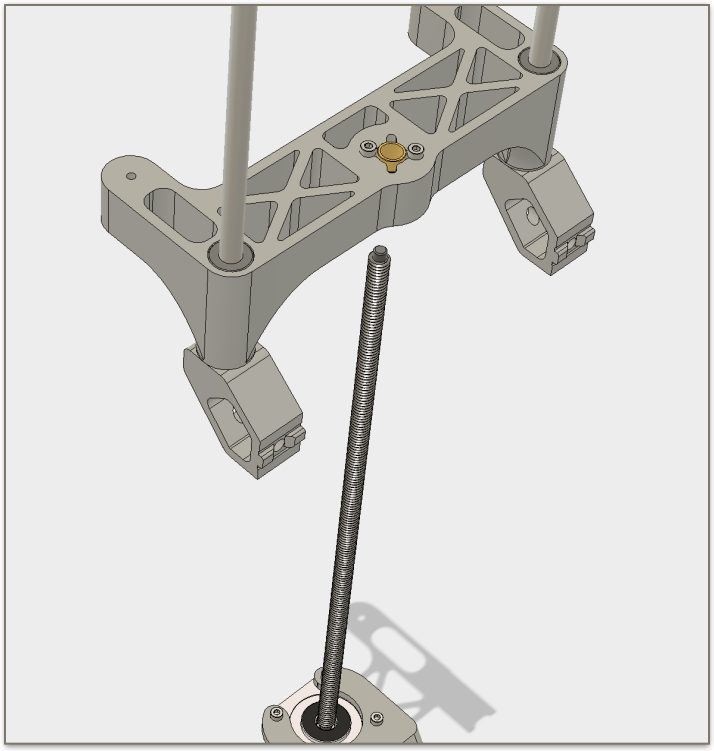
Step 5: Insert the 8mm shafts into the lower Z shaft supports. It'll be a snug fit, and you may need to clean out the hole a little.



Step 6: Insert the shafts into the bearings in the bed carriage.



Step 7: Cap the shafts with the upper Z shaft supports.

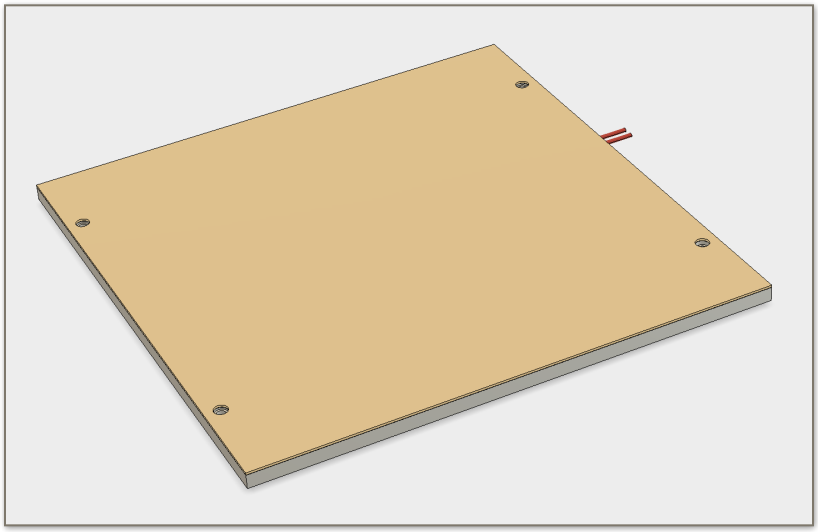


Step 8: Screw in the Z motor assembly into the TR8 nuts on the bed carriage

Repeat these steps for the other Z tower. The two towers are identical.

Nice! Let’s go drill some holes!

SECTION4 : BED PLATE

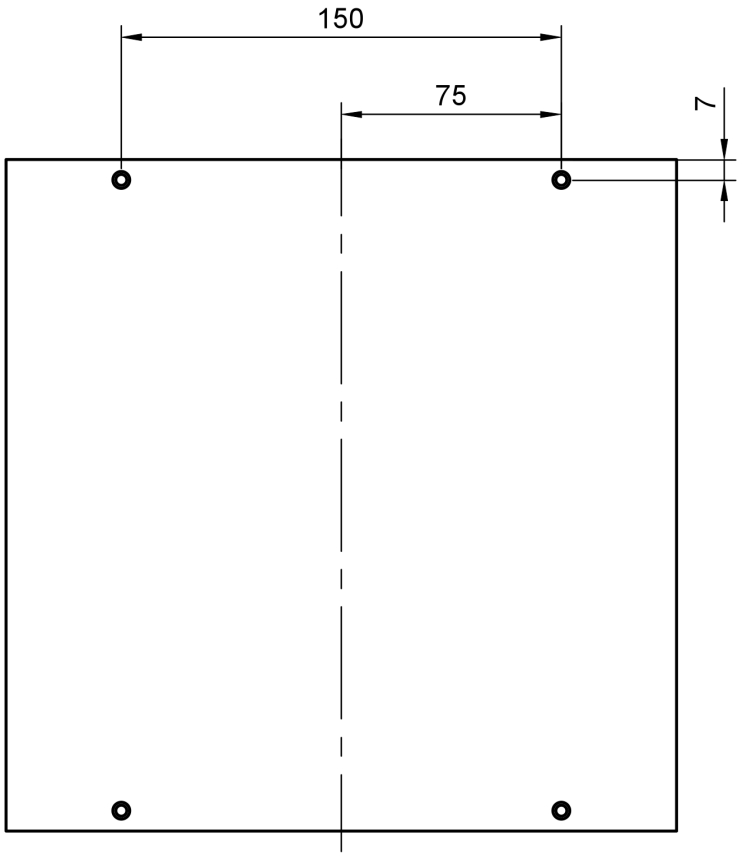


Items Required:
-MIC6 Aluminum tooling plate
-PEI sheet
-3M Adhesive sheet
-Silicone Heater Mat
-Cartridge thermistor
-Drill and some metric drill bits
- Optionally: nylon sleeving

Step 1: Cut the sheet of PEI to the dimensions of your aluminum plate. You can use a ruler and the tip of a sharp knife to make progressively deeper groves in the plastic, and once you are about half way through, you can snap off the piece along your grove. Remove any protective plastic from PEI.

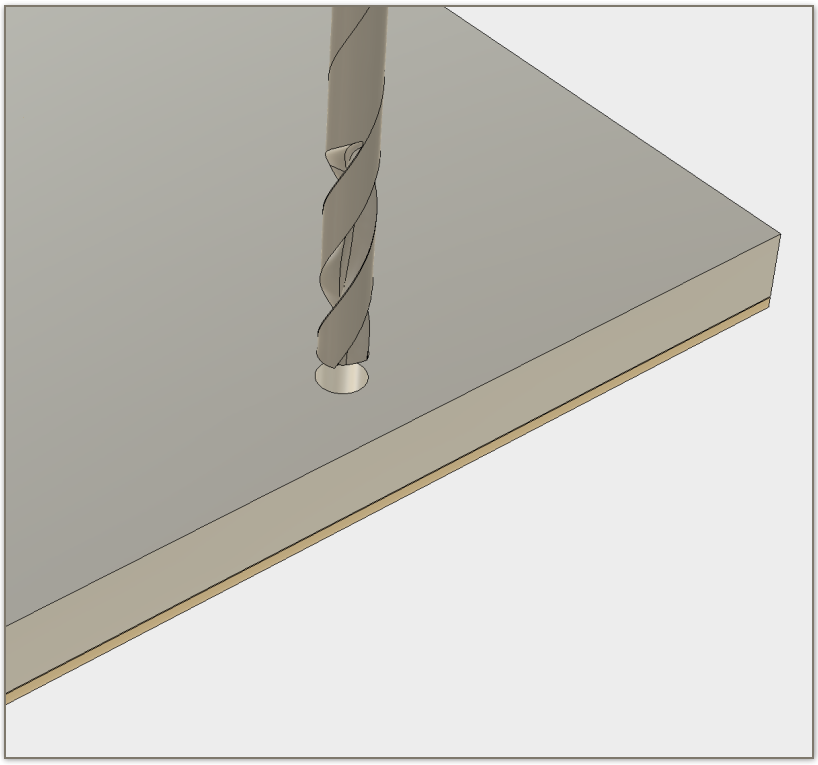
Remove the protective plastic from one of the sides of the aluminum plate and de-grease it using alcohol. You want the surface as clean as possible.

Use the 3M adhesive sheet to laminate the PEI to the aluminum plate. Trim off any overhanging adhesive with a razor.



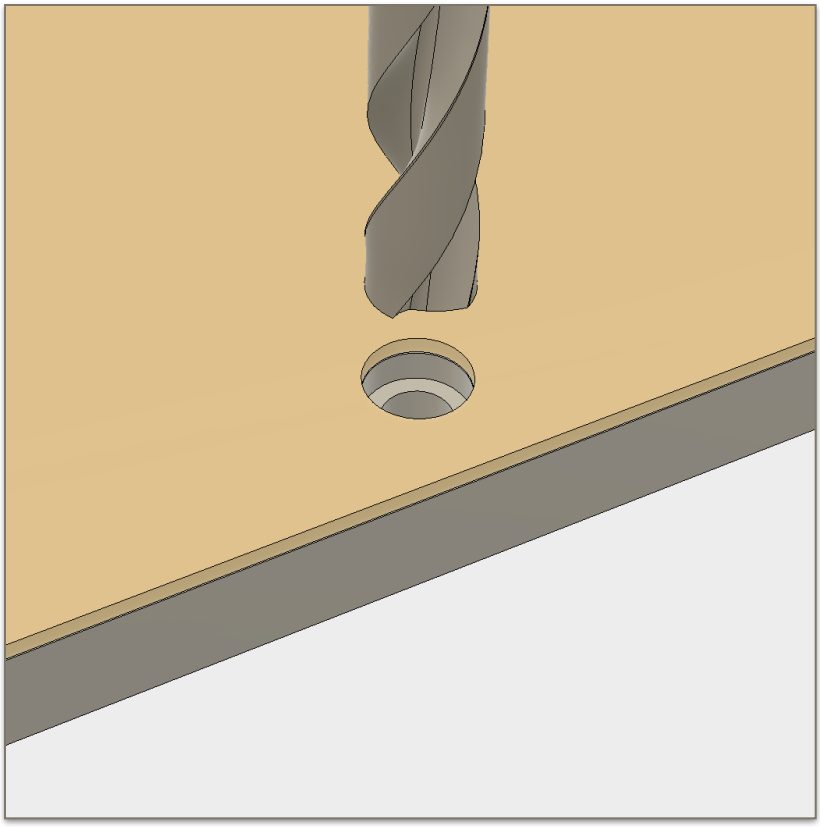
Step 2: Mark the holes for the mounting screws on the plate according to the drawing. As long as you find the center of the bed, and measure from there, the actual size of the bed doesn't matter.

Use the side that still has the plastic on it for marking it out.



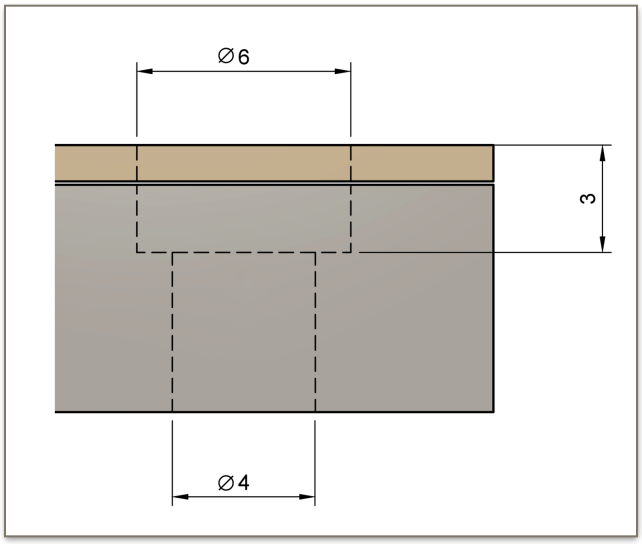
Step 3: Drill 4mm diameter holes all the way through the bed.

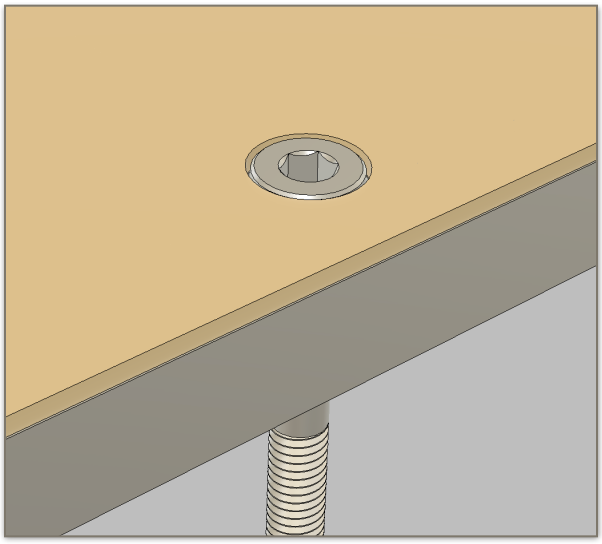
Try to keep the drill perpendicular to the plate. If you have a drill press, use it!



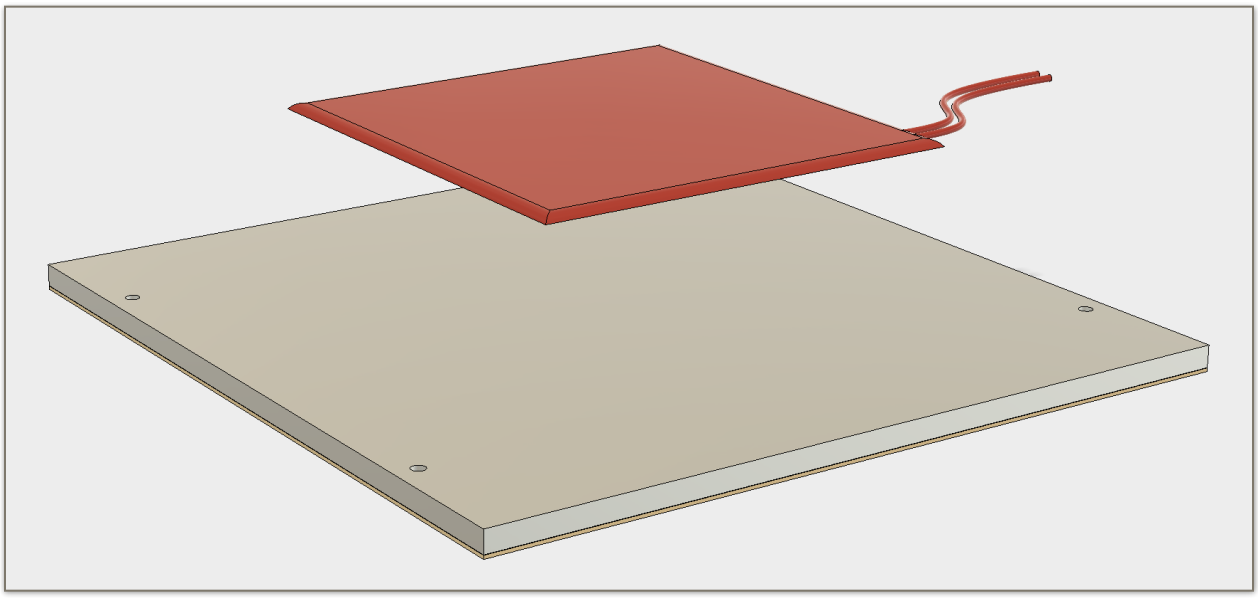
Step 4: Flip the bed plate over, and drill a 6mm diameter hole to the depth of 3mm. Basically, we're counter-sinking the M3 screw. You want just enough depth to make an M3 screw flush with the bed surface.

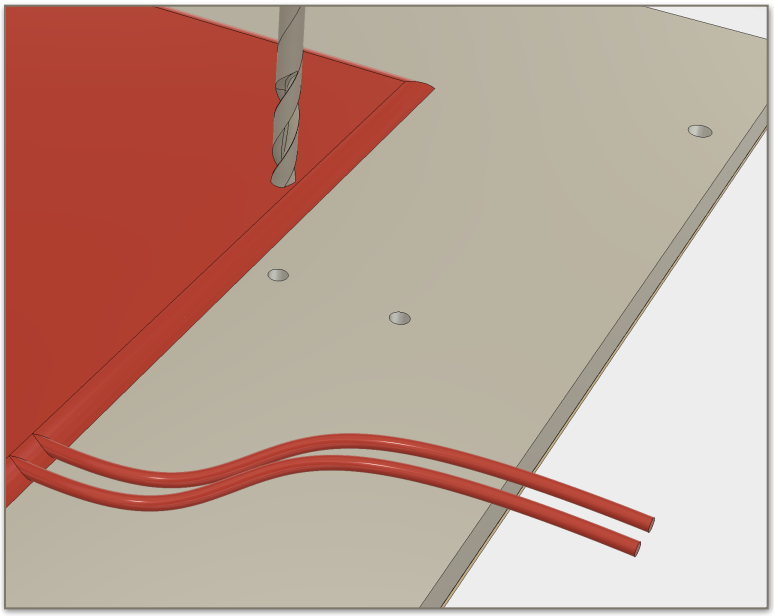
You can test the fit using any of the M3 socket head screws and drill a deeper hole if required.



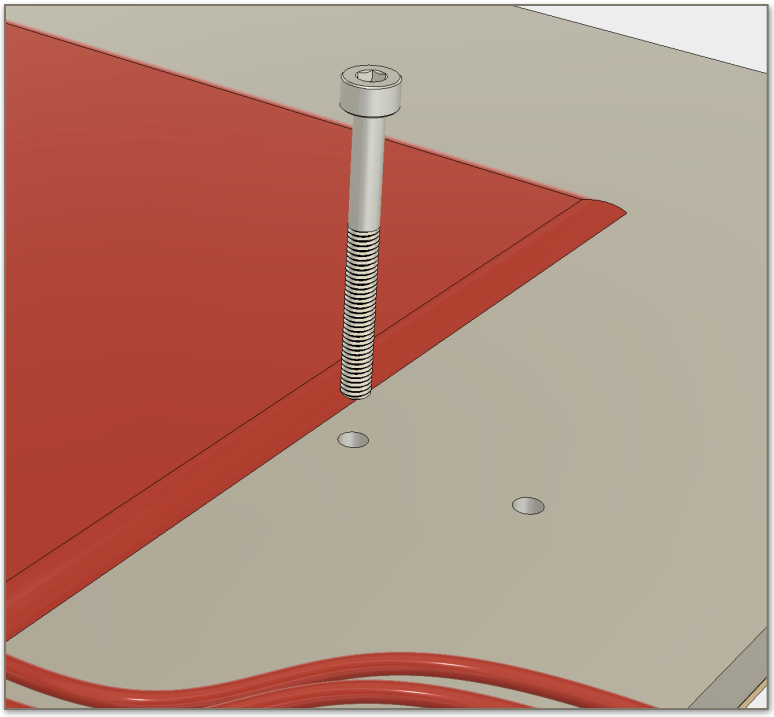


Step 5: Flip the bed plate over again, and remove the remaining plastic from it. Thoroughly de-grease the surface with alcohol. Orient the wires towards the right edge of the bed. Attach the heater to the bed plate using the 3M adhesive that should come pre-attached to the heater. Start with one corner, and roll the heater onto the plate using significant pressure. If any air bubbles get trapped in the process, the heater will over-heat the adhesive, and detach.

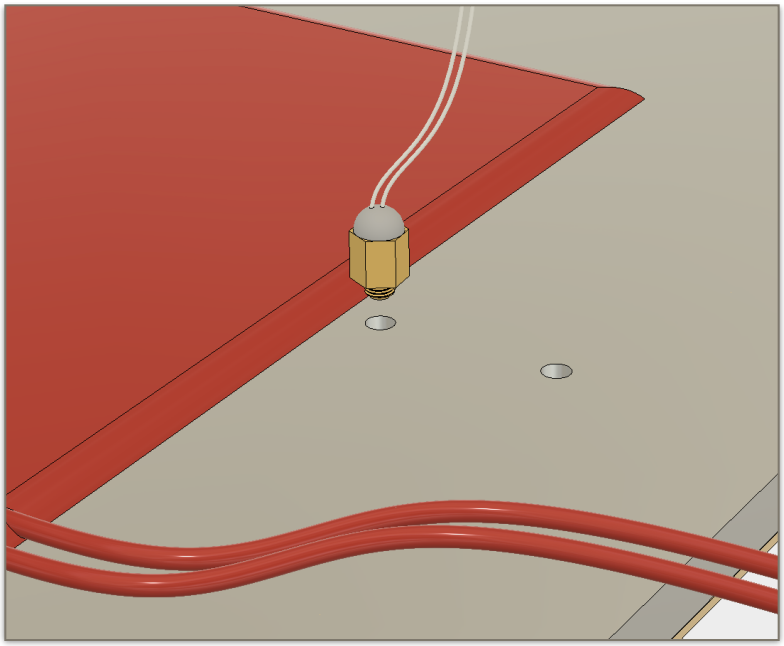




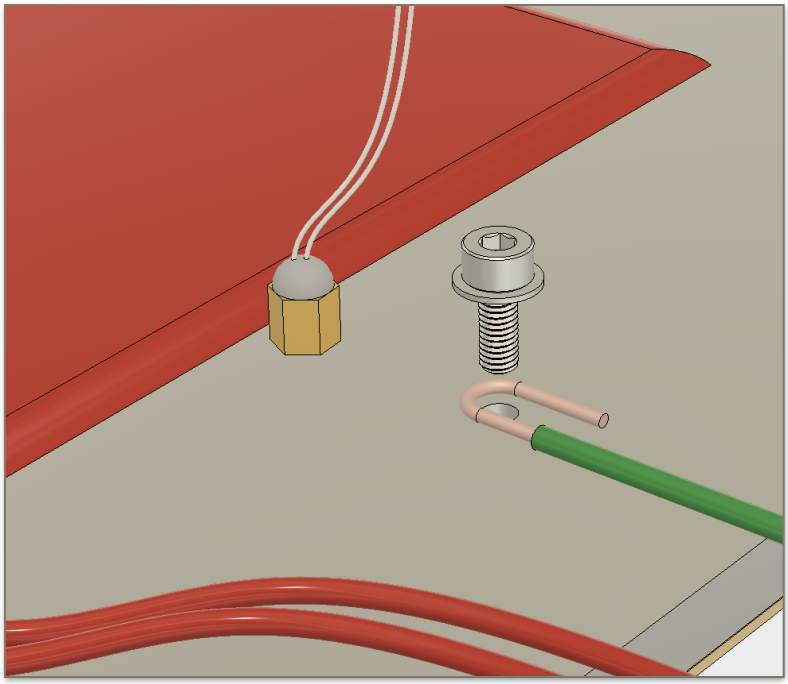
Step 6: Pick a spot close to the heater (about 5mm from the edge) and drill a 2.5mm diameter hole. You can use any close match in the imperial drill bit size for this. The hole only needs to be 4mm deep. Don't punch through the other side. Drill another hole of the same size about 15mm away from it. None of these have to be exact.



Step 7: Since MIC6 plate is soft, you can use any M3 steel screw to form threads in the holes you just drilled.



Step 8: Screw in the cartridge thermistor into the hole closest to the heater.



Step 8: Use about 400mm of wire, and ground the bed using an M3 screw and a washer. We just need a good connection to the plate. This carries any induced current off the plate, as well as protect you from shock should the heater fail and short mains voltage to the bed plate.

You'll need about 400mm for the heater wires, and close to 1 meter for the thermistor to reach the controller board. Optionally wrap the wire bundle using nylon sleeving to provide strain relief.

If you want an extra layer of safety, use the same technique to attach a thermal fuze to the bed plate (see BOM for the part number), and wire the heater through it. This adds an extra level of thermal protection. Big thanks to *codexmas* for suggesting this.

You are now a fabricator!