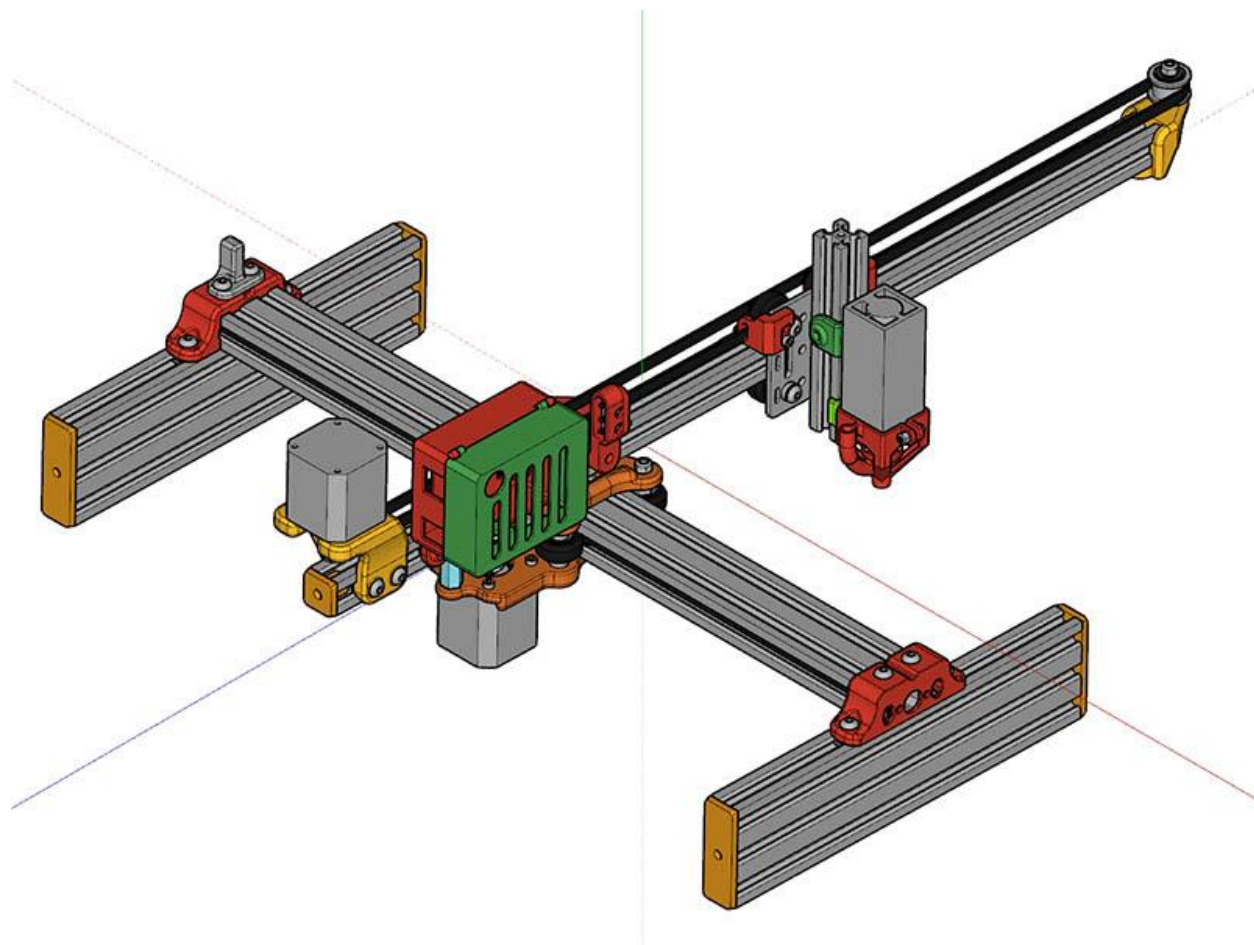


# Assembly Guide for Cantilever Laser Engraver V821



## Warning:

**Be sure to get some good laser safety glasses that protect your eyes against the wave length laser you are using. I found the electronics the most difficult part of this build because of the laser connections. Be sure to understand how to connect your particular laser before attempting this project because you could easily destroy your laser. Soldering maybe required for the laser wiring depending on your laser & controller board.**

I am using a 600mm length of V-Slot 2040 for the main beam which is my X-Axis & a 600mm length of V-Slot 2020 extrusion for the Cantilever which gives me 390mm (15.35") along the V-Slot 2040 (X-Axis) and 305mm (12") along the V-Slot 2020 (Y-Axis). I am using stainless steel screws & Locknuts, Socket Button Head M5 screws and M3 Socket cap screws. I don't use the M3 button heads as they take too small of an Allen wrench for my liking. There are no clearance problems with using standard Socket head M5 screws. There are no tapped holes needed in this build as there were before. The short 125mm length of V-Slot 2020 for the Z-axis was cut from a 250mm length with a hack saw. The Z-axis does not have to be a perfect cut. The controller board I am using is an EleksMaker Mana 3 board, but I have successfully setup an Arduino UNO

clone with a CNC Shield V3 and also setup a Keystudio CNC Shield V4 board. The laser connections are simpler on the EleksMaker board, but the limit switch wiring on that board is not as straight forward. The end caps for the V-Slot 2060 & V-Slot 2020 are press fit, so not additional hardware needed for them.

The offset of the cantilever V-Slot 2020 can easily be adjusted after the build by loosening 3 - M5 screws attached to Tee Nuts below the V-Slot 2020. This will allow you to find a happy medium between counterbalance & burning width.

Below is a chart of the 3D printed parts info. My total print time was less than 17 hours & used 7.5oz of filament. Total weight of my machine is 6lbs 5oz.

| File Name                             | Print Time | Weight(oz) | Perimeters | Infill % |
|---------------------------------------|------------|------------|------------|----------|
| BottomPlate_V821.stl                  | 2:25:00    | 1.37       | 8          | 80%      |
| TopPlate_V821.stl                     | 1:30:00    | 0.85       | 8          | 80%      |
| M5x29_2_Standoff.stl                  | 0:19:00    | 0.08       | 3          | 20%      |
| MotorMount_Above_V821.stl             | 1:42:00    | 1.1        | 8          | 80%      |
| IdlerMount_Above_V821.stl             | 1:04:00    | 0.43       | 8          | 80%      |
| CarBeltConnect_V821.stl               | 0:20:00    | 0.13       | 6          | 60%      |
| CarBeltConnect_V821_M.stl             | 0:20:00    | 0.13       | 6          | 60%      |
| LE_Z_TopSlider_V2017.stl              | 0:32:00    | 0.19       | 3          | 20%      |
| LE_Z_BotSlider_V2017.stl              | 0:09:00    | 0.04       | 3          | 20%      |
| Shim_Plate_6_4mm_V821.stl             | 0:37:00    | 0.25       | 6          | 60%      |
| LaserAirAssist_V4.stl                 |            |            | 3          |          |
| LaserAirAssist_V4_M.stl (or Mirrored) | 1:16:00    | 0.35       | 3          | 20%      |
| Laser_focus_Wheel.stl                 | 0:07:00    | 0.03       | 3          | 20%      |
| Y-Axis_Mech_LS_Bracket_V821.stl       | 0:21:00    | 0.15       | 3          | 20%      |
| X-Axis_Mech_LS_Bracket_V821.stl       | 0:35:00    | 0.15       | 3          | 20%      |
| OverHd_2040x2060_Bracket_V821.stl     | 1:43:00    | 0.7        | 8          | 80%      |
| OverHd_2040x2060_Bracket_V821.stl     | 1:43:00    | 0.7        | 8          | 80%      |
| X_LS_Stop_V821.stl                    | 0:16:00    | 0.12       | 6          | 60%      |
| V2060_EndCap.stl                      | 0:27:00    | 0.17       | 3          | 20%      |
| V2060_EndCap.stl                      | 0:27:00    | 0.17       | 3          | 20%      |
| V2060_EndCap.stl                      | 0:27:00    | 0.17       | 3          | 20%      |
| V2060_EndCap.stl                      | 0:27:00    | 0.17       | 3          | 20%      |
| V2020_EndCap.stl                      | 0:12:00    | 0.05       | 3          | 20%      |
| Total                                 | 16:59:00   | 7.5        |            |          |

Bill of Materials is in the file:

Cantilevered\_LaserEngraver\_V821\_BOM.xlsx

Build log for this started in July of 2020. Link to that log is here:

<https://forum.v1engineering.com/t/cantilevered-laser-engraver/19179>

Design files: <https://www.thingiverse.com/thing:4934772>

## Start off with the Main Plate Assembly



### Need 3 Printed Parts for this Assembly

*BottomPlate\_V821.stl*

*TopPlate\_V821.stl*

*M5x29\_2\_Standoff.stl*

4 – M3x10mm screws for Nema17 motor mount

5 – M5x40mm socket head screws for wheels & back standoff

4 – M5 Locknuts

2 – M5x12mm screws for V-Slot 2020 Tee Nut mount

3 – M5 Tee Nuts

4 – 6mm spacers

4 – Eccentric spacers

4 – V-Wheels with bearings

1 – Nema 17 motor

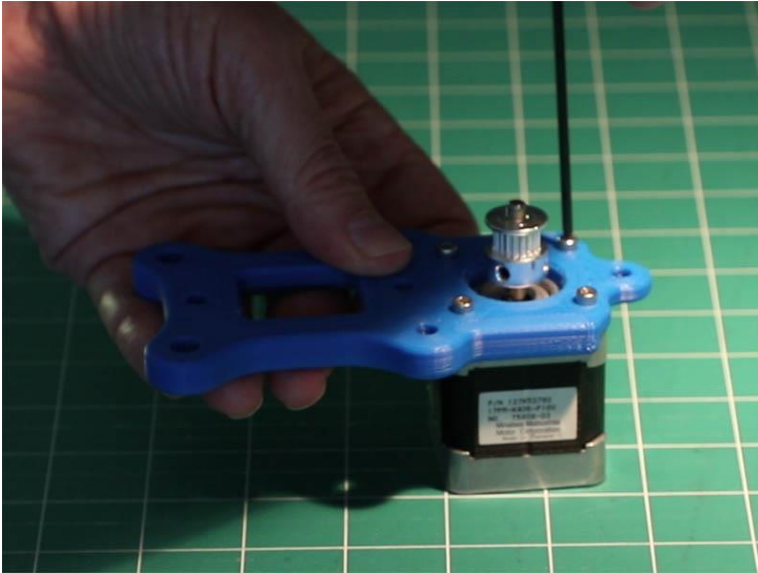
1 – 20T timing pulley (need 20T instead of 16T since the Cantilever arm needs a wider belt width for better clearance)

Allen wrench for M3 & M5 screws & wrench for Locknuts & adjusting Eccentric spacers

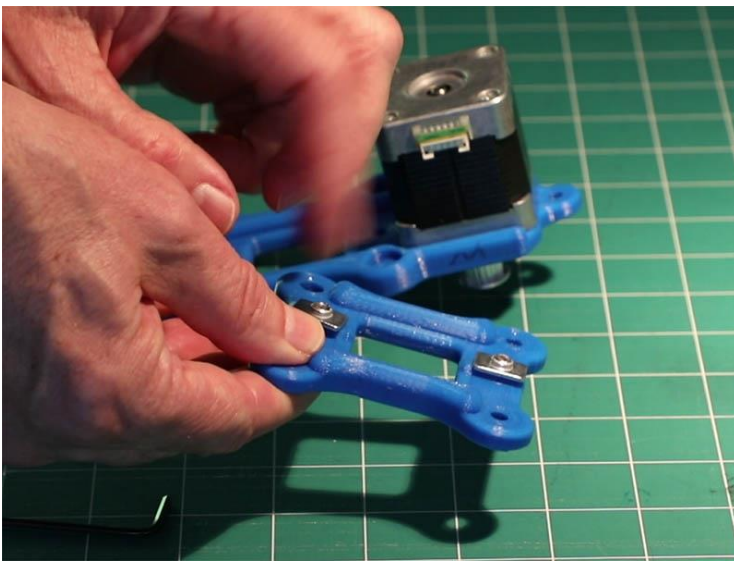
Attach the 20T timing pulley to Nema 17 motor with grub screws. Use a 6mm Allen wrench to space bottom of the pulley to bottom of motor. Tighten screws just enough to keep it in place as it might need a little adjusting once attached to the V-Slot 2040 beam.

Attach the Nema 17 motor to the bottom plate 1<sup>2nd</sup> using the 4 – M3x10mm screws. My motor is 42mm deep. A shorter 34mm deep motor will work & pancake 22mm deep motors might work, but I would not go

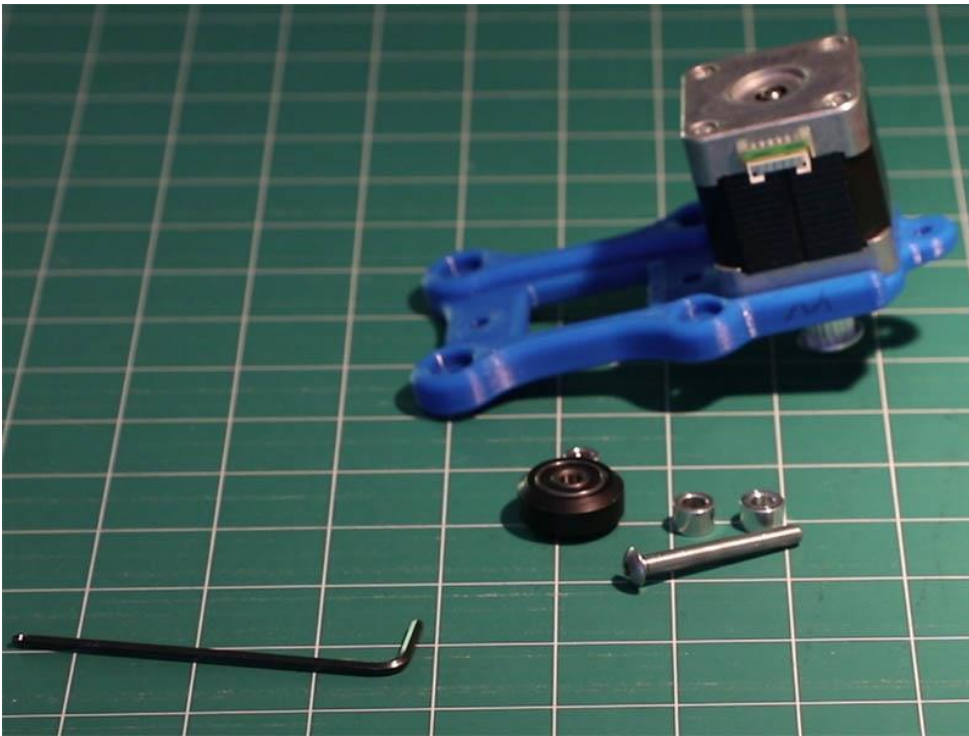
any deeper than 42mm as you might have clearance problems. Note the location of wire connection for motor on 2<sup>nd</sup> photo.



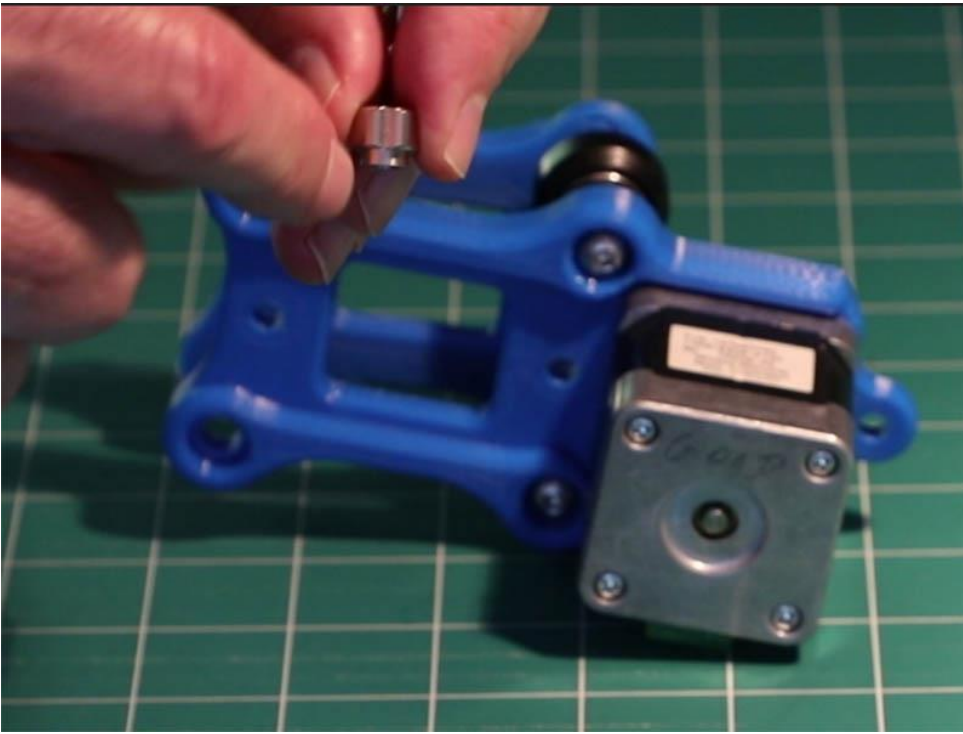
Next attach the 2 – M5x12mm & Tee Nuts to top plate as shown below.



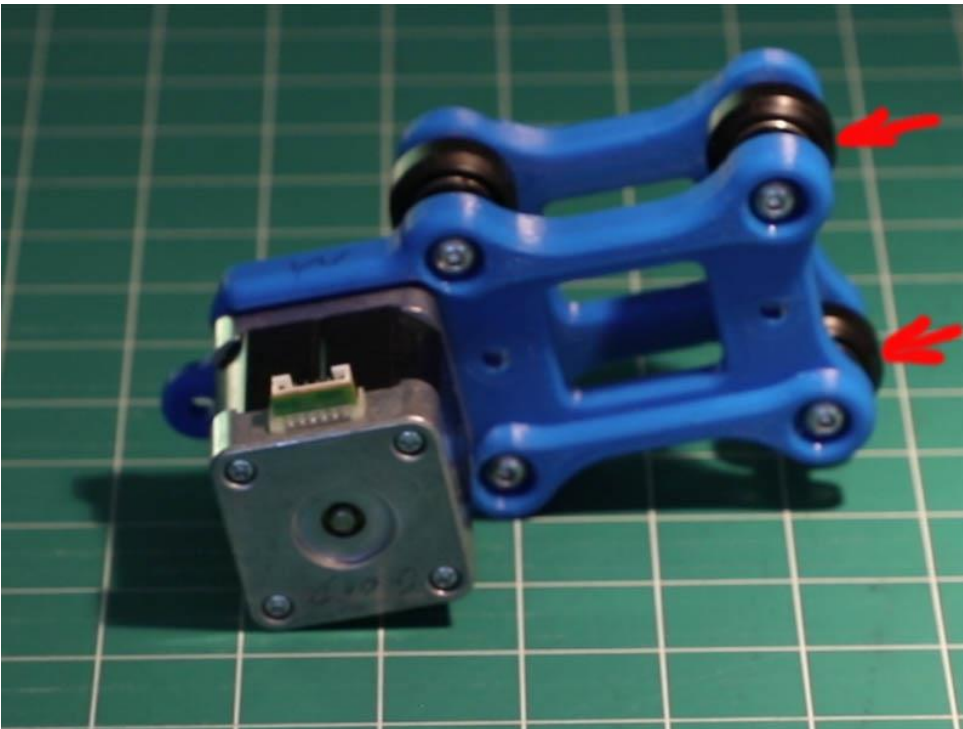
Then attach the wheels with spacers 1<sup>st</sup> using a M5x40mm screw going thru the bottom plate 1<sup>st</sup> & 2 – 6mm aluminum spacers on each side of the wheel with a locknut on the top plate. Do this for each of the inside wheels.



Next attach the wheels that have eccentric nuts on them. The eccentric nuts should have the groove marking to the outside of the plates which will be the outside of V-Slot 2040 beam. This gives the widest wheel width and then you can adjust the eccentrics for a good fit after attached to V-Slot 2040.



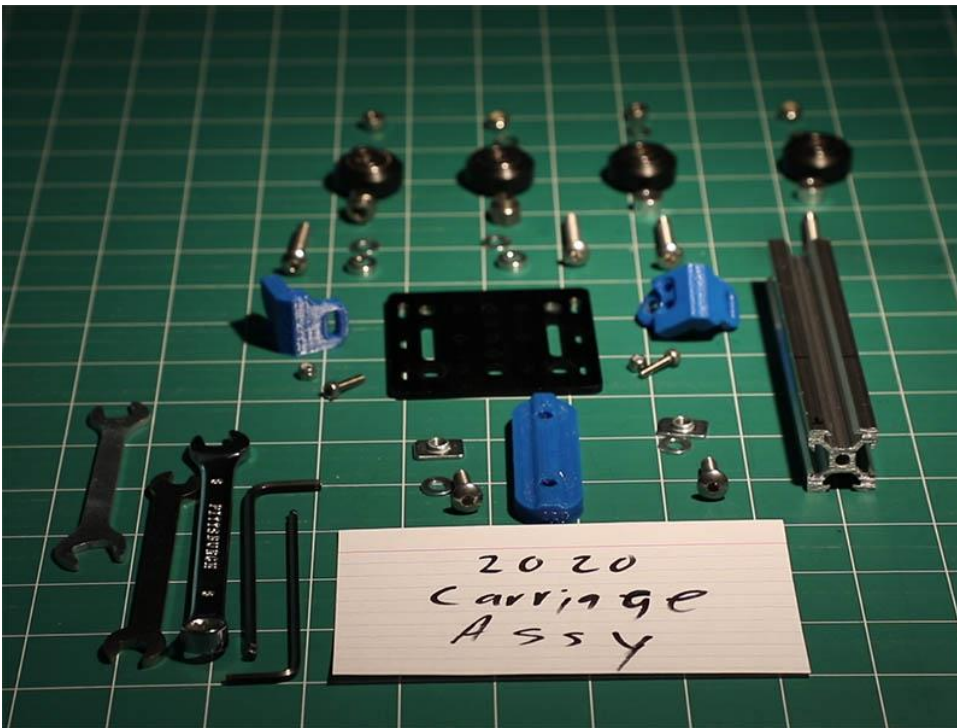
Red arrows in below photo show where eccentric grooves should be set to begin with. This completes main plate assembly.



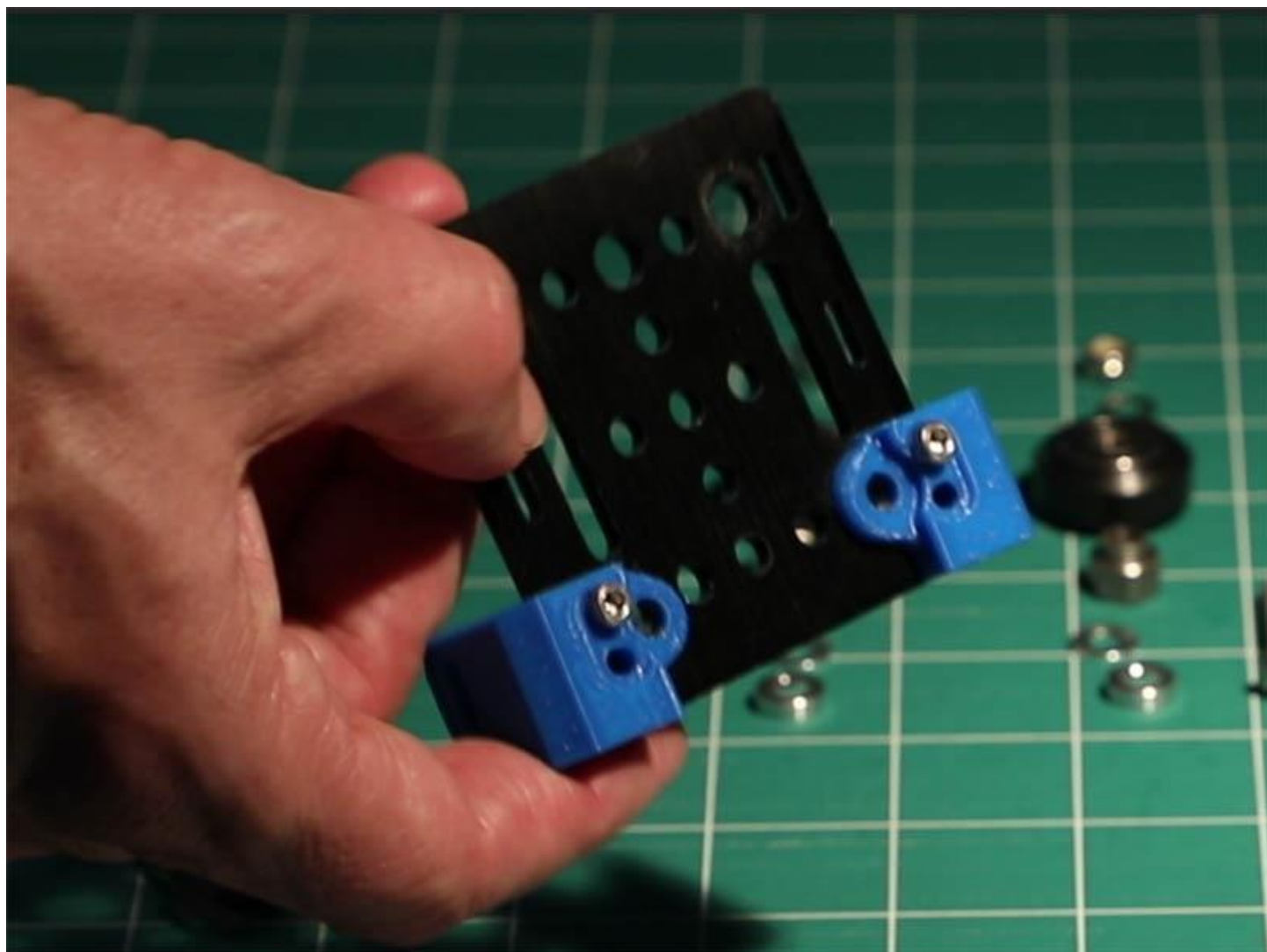
## V-Slot 2020 Carriage Assembly

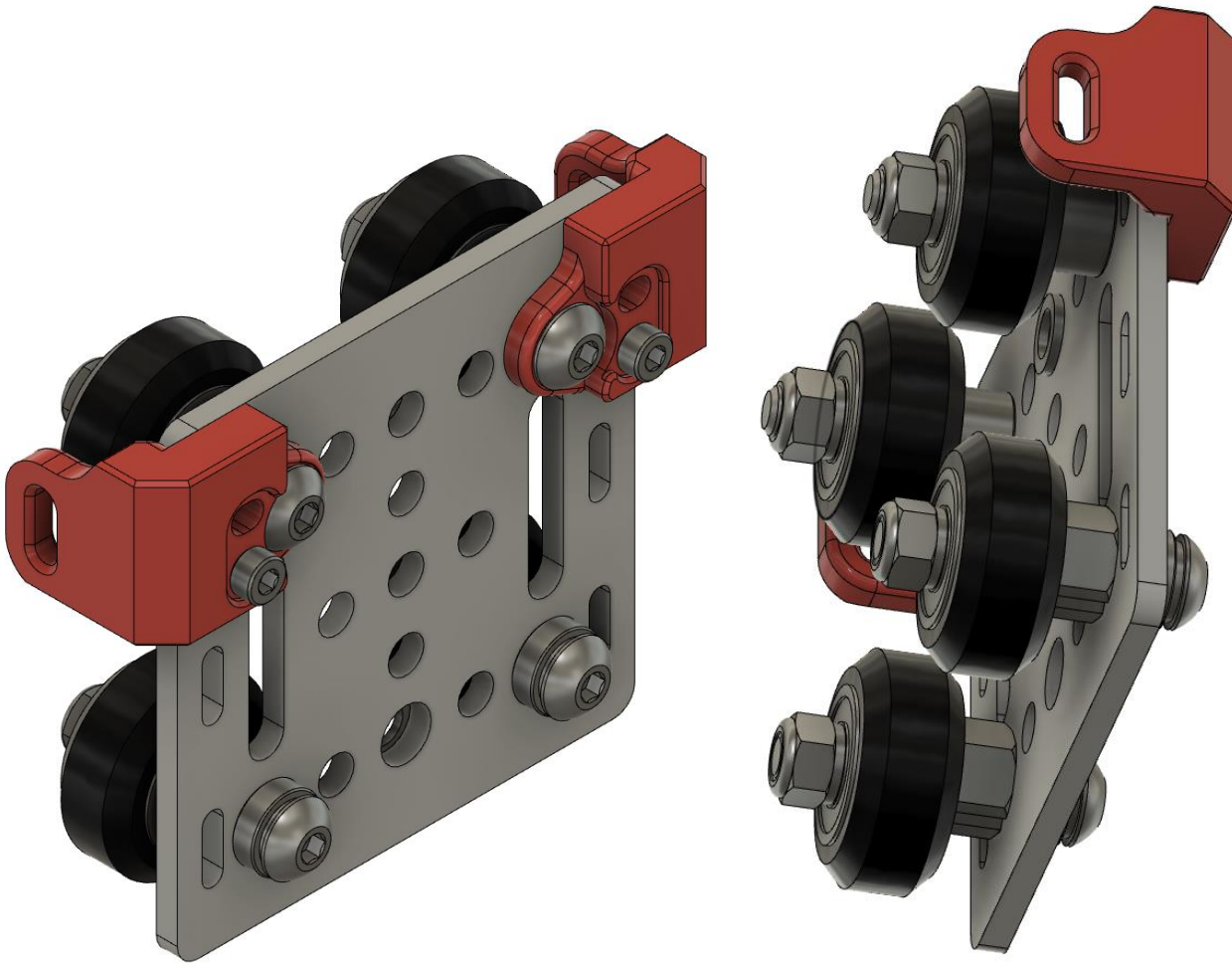
- 3 – Printed parts, *CarBeltConnect\_V821.stl*, *CarBeltConnect\_V821\_M.stl*, *Shim\_Plate\_6\_4mm\_V821.stl*
- 1 - Gantry Plate for V-Slot 2020
- 1 – V-Slot 2020x125mm aluminum extrusion
- 4 – M5x30mm screws for wheels

2 – 6mm aluminum spacers  
2 – Eccentric spacers  
4 – V- Wheels with bearings.  
8 – 10x5x1mm shims  
2 – 3mm aluminum spacers  
4 – M5 Locknuts  
2 – M5x16mm screws (mounts Shim plate to V-Slot 2020)  
2 – M5 Tee Nuts  
2 – M3x12mm screws (Carriage Belt clamp mount)  
2 – M3 locknuts  
Tools, Allen wrenches & wrenches for locknuts & eccentric spacers.



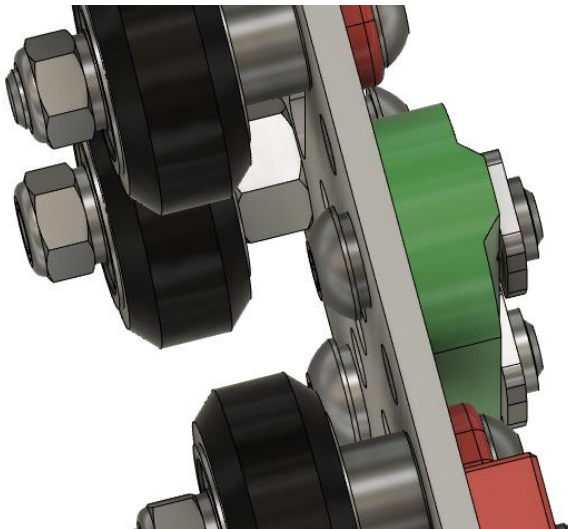
Attach *CarBeltConnect\_V821.stl* & *CarBeltConnect\_V821\_M.stl* to Gantry plate with 2 - M3x12mm screws & leave the 2 – M5 holes lined up to install wheel screws. There are 2 holes for M3 screws, but one is all that is needed on each side since the M5 wheel screws will hold it further in place & keep it from twisting.



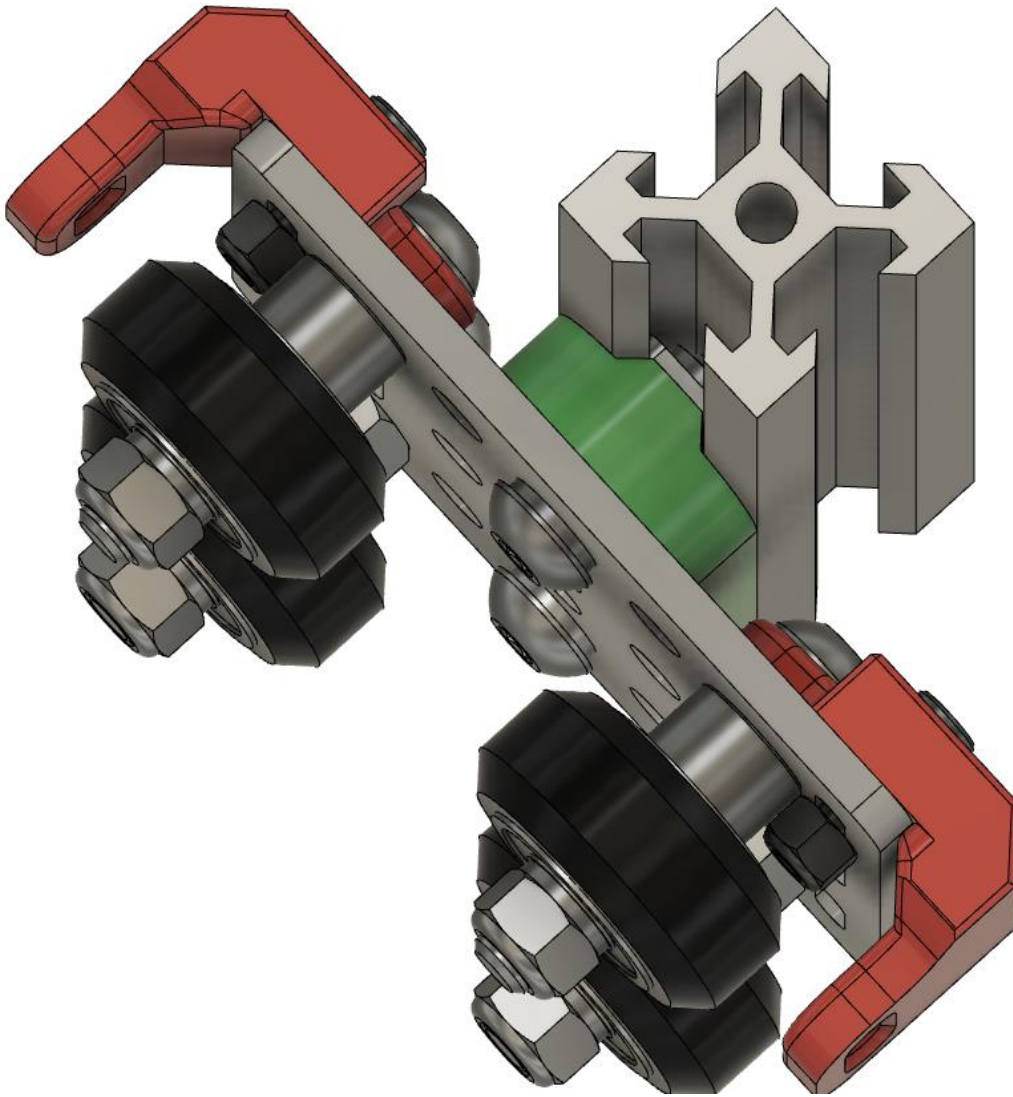


Bottom wheels with eccentrics have a 1mm & 3mm thick washer to balance out the carriage belt clamps at the top. You could probably use 3d printed plastic spacers if you wanted. Top wheels have a M5x30mm screw going thru the plastic belt clamps with 6mm aluminum spacer on the plate side of the wheel with a 1mm spacer & locknut on the other side of wheel. The bottom wheels have a M5x30mm screw with a 1mm & 3mm spacer then thru the plate with an eccentric nut, the wheel with a spacer & locknut. Note the initial location of the notch in the eccentric nuts.

Attach the 2 – M5x16mm screws with 1mm spacers, ***Shim\_Plate\_6\_4mm\_V821.stl*** & Tee Nuts as shown in below image. Tee Nuts should be loose.



Slide the short V-Slot 2020 for the Z-Axis into place as shown in photo below. I have the V-Slot 2020 positioned about 14mm below the bottom of the Gantry plate, but is easily adjusted later by loosening those 2 – M5x16mm screws. Below is what this assembly looks like.



## Motor and Idler Mounts for Cantilever Beam

2 – Printed parts *MotorMount\_Above\_V821.stl* & *IdlerMount\_Above\_V821.stl*

1 – Nema 17 Motor

1 – 20T timing pulley

1 – Smooth Idler Pulley Kit

4 – M3x10mm screws

5 – M5x12mm screws

5 – M5 Tee Nuts

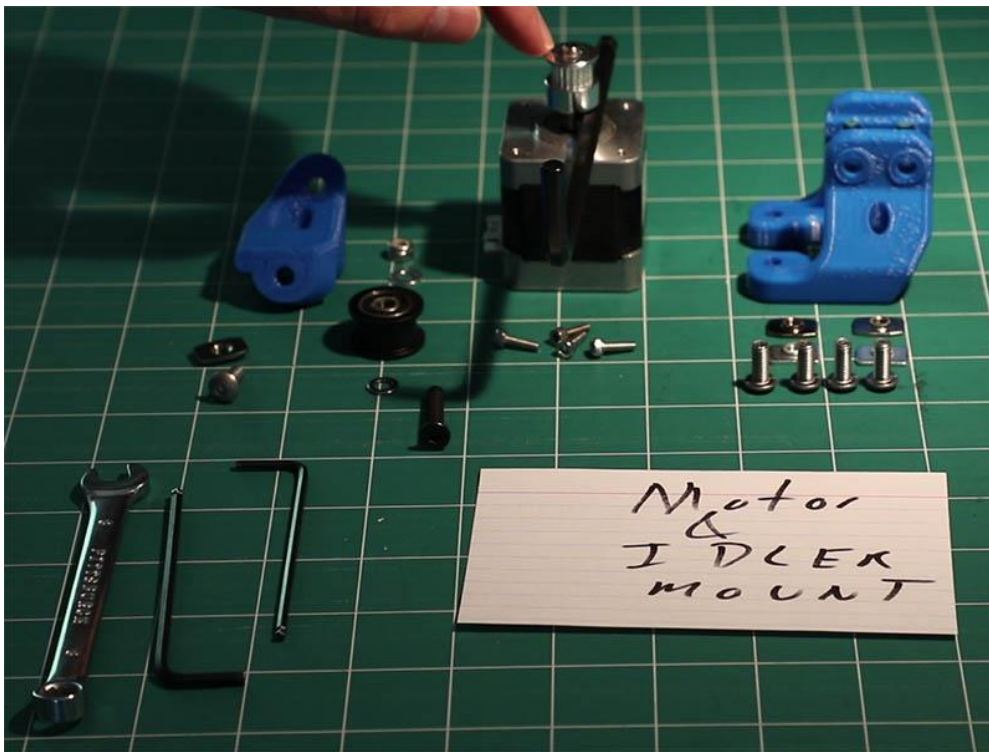
1 – M5x25mm screw

2 – 1mm aluminum spacers

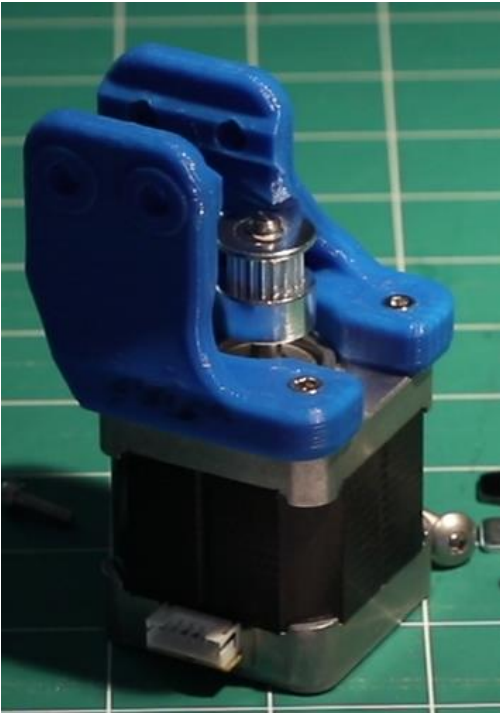
1 – M5 Locknut

Allen wrenches for M3 & M5 screws & wrench for M5 locknut

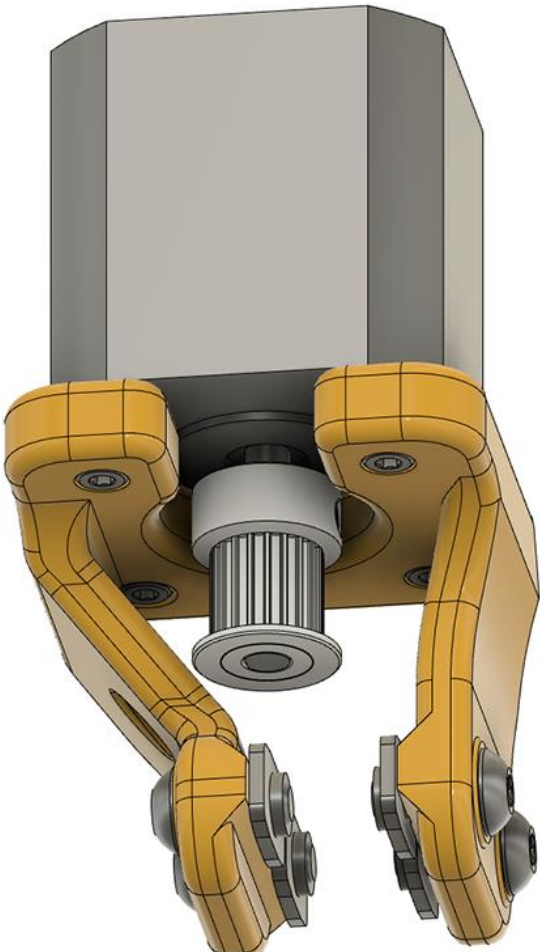
Mount 20T timing pulley to motor using a 6mm Allen wrench to adjust the offset of pulley to motor as shown below. Tighten the grub setscrews enough so that shaft with one screw against flat part of shaft if it has one. Do final tighten later when we attach the belt.



Note the location of the Nema 17 wire connection on the flatter side of the plastic mount.



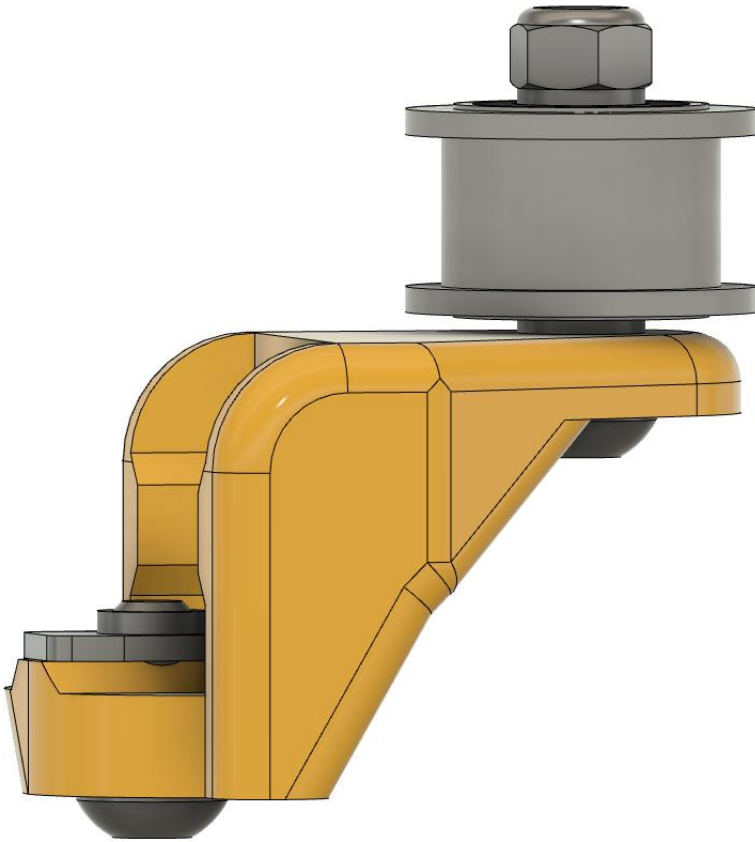
Tighten the motor to *MotorMount\_Above\_V821.stl* with the 4 – M3x10mm screws & add the 4 – M5x12mm screws with M5 Tee Nuts to the Plastic mount as shown in the image below. Put this part aside.



## Idler Mount Assembly

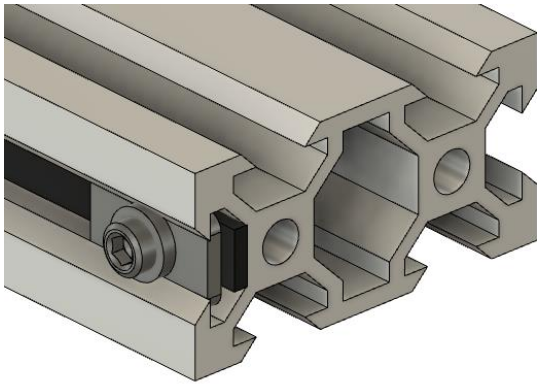
As shown in image below, add a M5x12mm screw with M5 Tee Nut to *IdlerMount\_Above\_V821.stl*

Add a M5x25mm screw thru plastic part with 1mm spacer on each side of idler pulley assembly & a M5 locknut on top. Put this part aside.

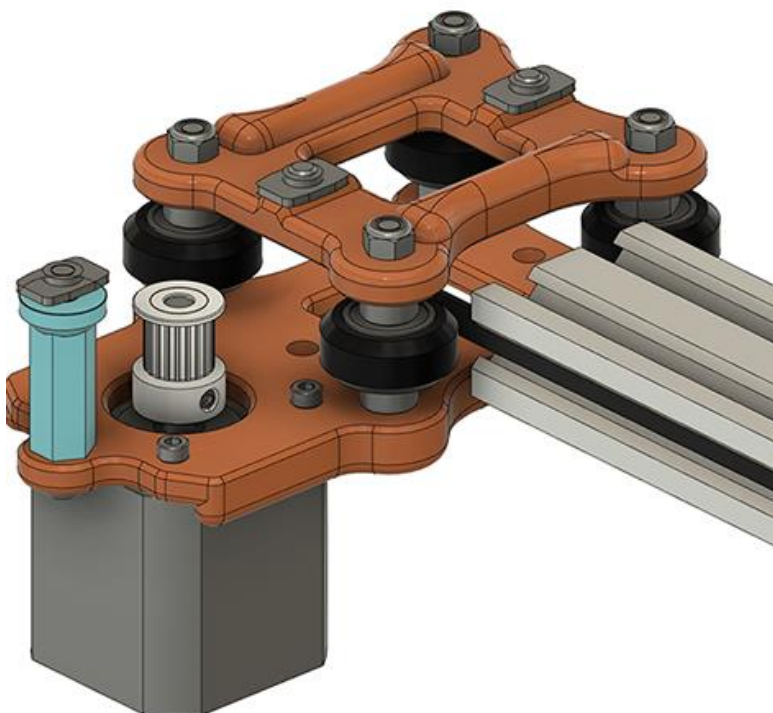


## Assemble the Main plate assembly with belt to V-Slot 2040 beam with the Two V-Slot 2060 Feet

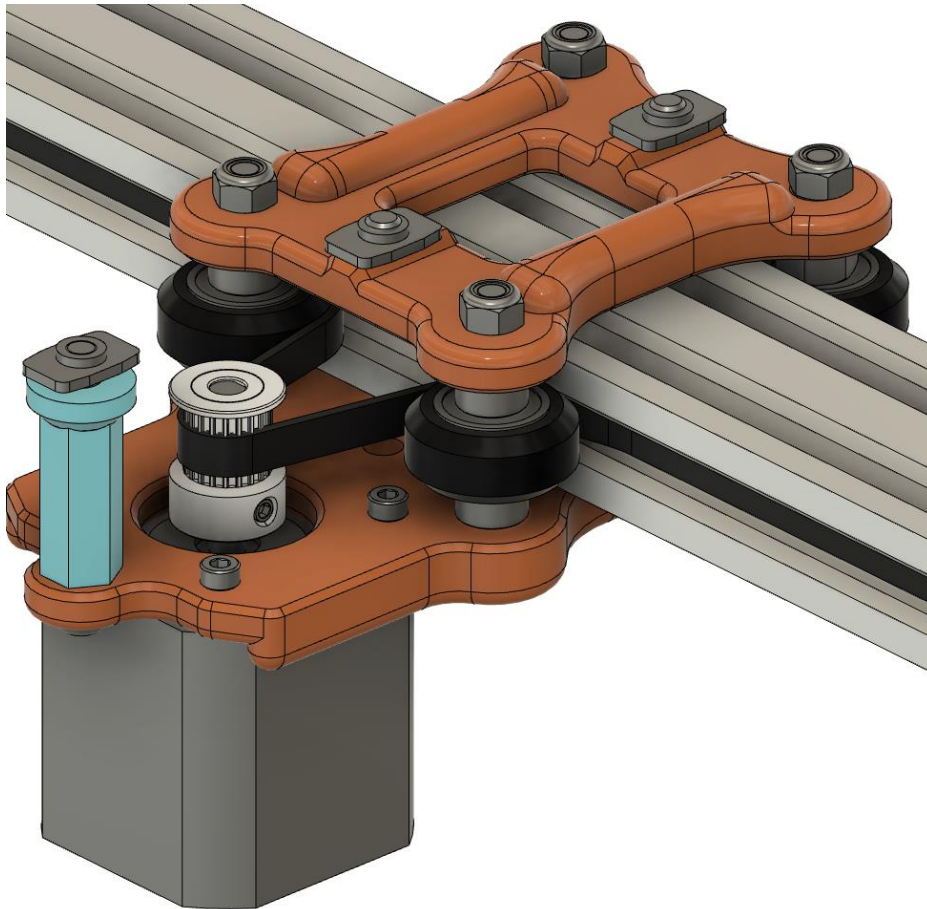
1. Insert one end of the GT2 belt you cut for the V-Slot 2040 axis with the teeth of the belt against the inside of the V-Slot. Mine is 800mm for a 600mm length of V-Slot 2040.
2. If you are considering making this V-Slot 2040 longer in the future, you could use longer belt.
3. Extend it 20mm or so beyond the end of the V-Slot 2040. Mine extends about 35-40mm on both sides.
4. Take a M5 Tee Nut with the M5x5mm set screw as shown in picture below.  
This will be the right side as viewed from the back of the machine.
5. Insert the Tee Nut at that end & tighten the set screw against the belt.
6. If you are using a M5 screw instead of a set screw, you will not be able to have the Tee Nut at the end as it will hit the plastic part *V2040x2060\_Bracket\_V821.stl*.



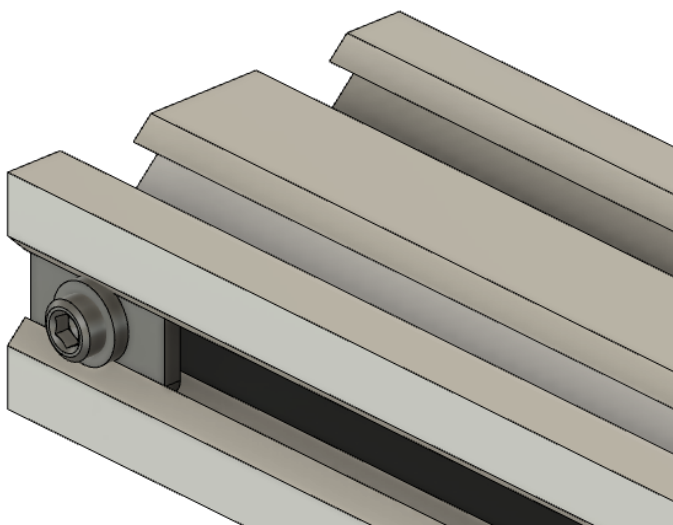
7. Slide the Main Plate assembly onto the V-Slot 2040 from the opposite side with the belt resting against the inside of the V-Slot 2040 extrusion.
8. Let the belt ride against wheels.



9. Roll the plate assembly 150mm or so inward to make it easier to attach belt & clamp.
10. Pull the belt around the timing pulley by pushing on the unattached end of belt or using a small tool or needle nose pliers and wrap it around the 20T timing pulley. This should be fairly easy to do. Should look like picture below.

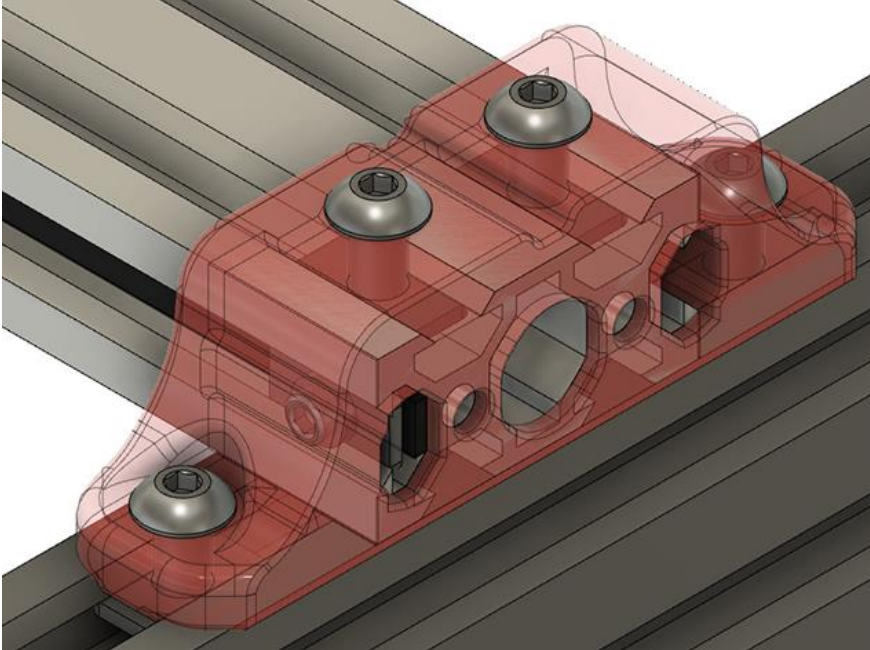


11. Add the M5 Tee Nut & M5x5mm setscrew to the other end.
12. Pull on unattached end of belt & tighten the set screw. You should have some belt extended beyond Tee Nut.

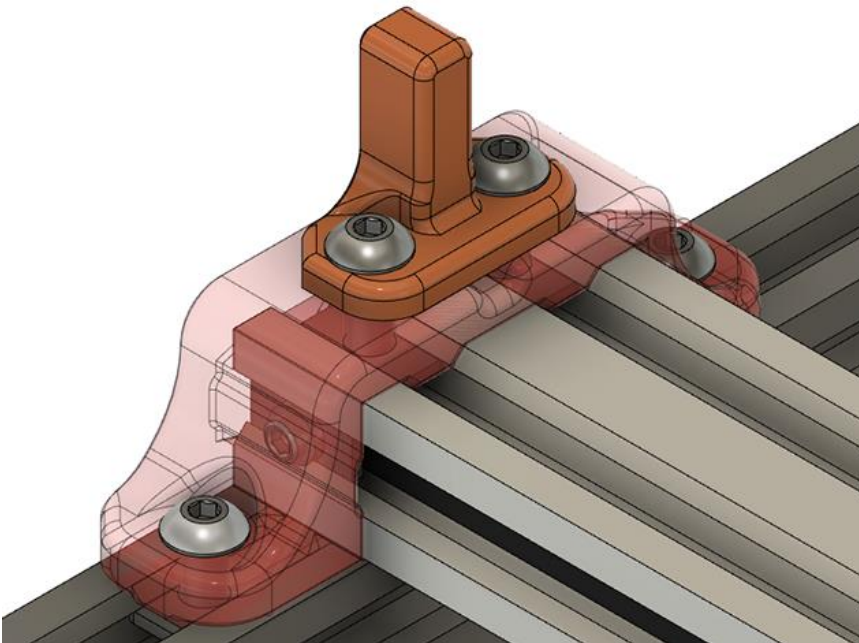


## Add the V-Slot 2060x250mm feet to each end

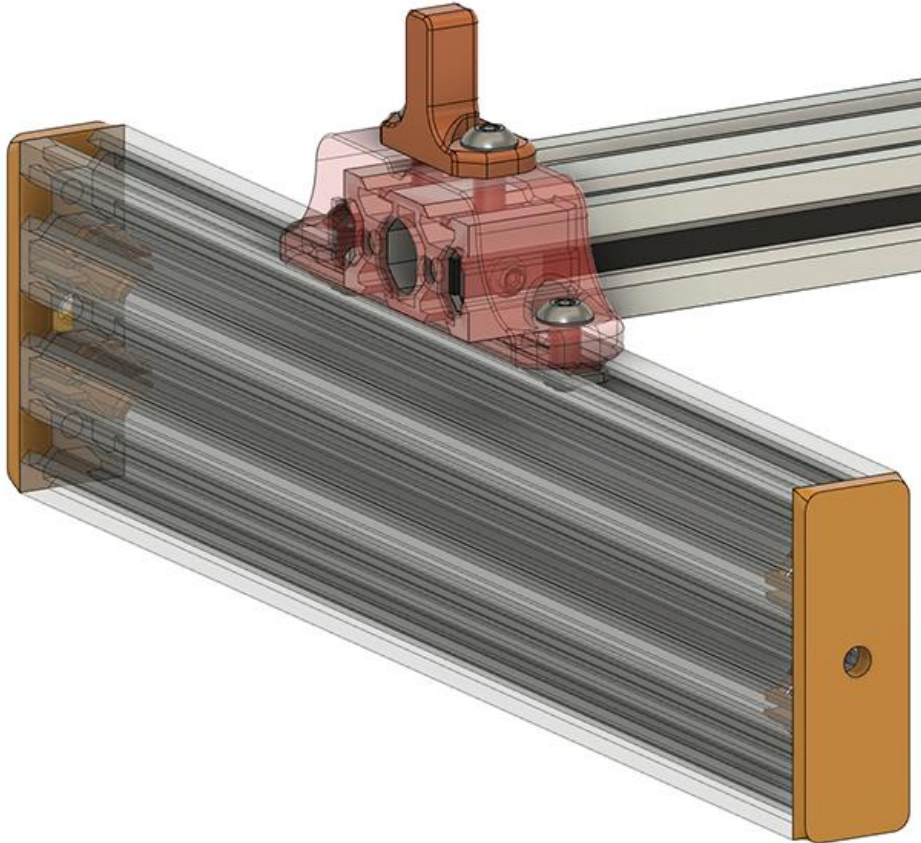
1. A *V2040x2060\_Bracket\_V821.stl* printed part is used on both feet. They are both the same.
2. Using 4 – M5x12mm screws with Tee Nuts attach the side shown.
3. Note the orientation of where the belt is in photo as the other side has an additional part.
4. Push the V-Slot 2040 all the way into the plastic part.
5. Tighten the 4 - M5x12mm screws down.
6. The plastic part is shown slightly transparent in picture for clarity.



7. Other side has the printed parts *X\_LS\_Stop\_V821.stl* & *V2040x2060\_Bracket\_V821.stl*
8. Use 2 – M5x12mm screws with Tee Nuts on V-Slot 2060 connection
9. Place the *X\_LS\_Stop\_V821.stl* part with slotted holes on top of the *V2040x2060\_Bracket\_V821.stl*
10. Use 2 - M5x16mm screws with Tee Nuts to attach the bracket to the V-Slot 2040 beam.
11. Make sure the V-Slot 2040 is all the way in the bracket & tighten all the screws.

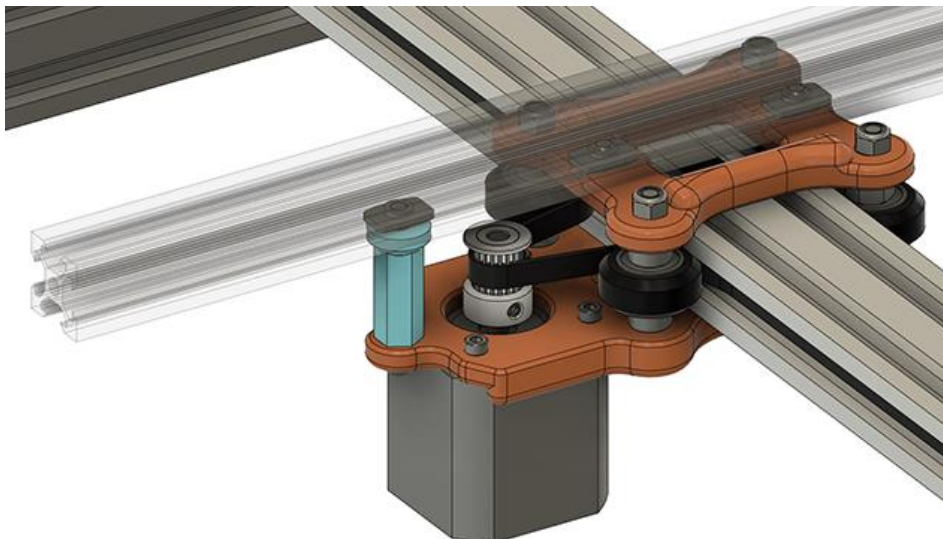


**12. Press fit the 4 - *V2060\_EndCap.stl* into the ends of the V-Slot 2060 feet.**

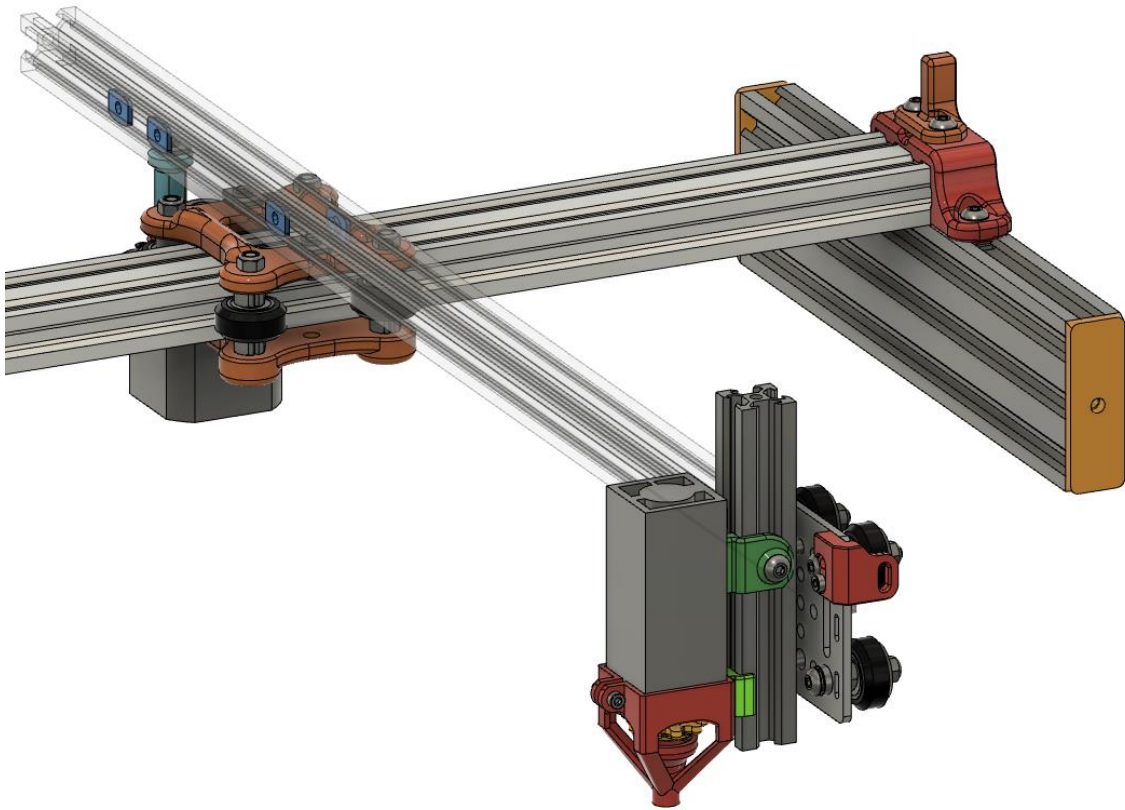


**Assemble the Cantilever V-Slot 2020 and related parts.**

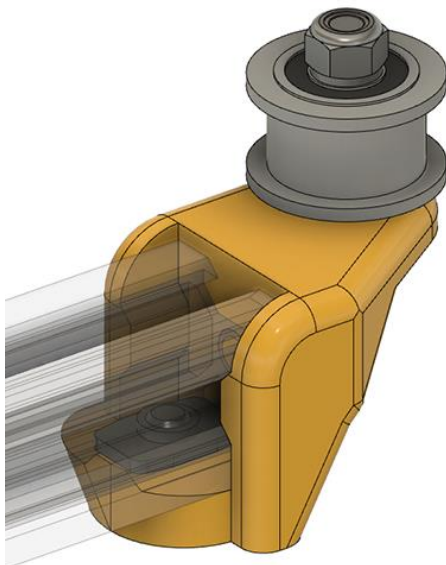
- 1. Loosen the 3 – M5 Tee Nuts attached to top plate & standoff.**
- 2. Slide the V-Slot 2020 extrusion in from the front or back.**
- 3. My setup has about 158mm of the V-Slot 2020 extended from the back of the V-Slot 2040 beam.**
- 4. Tighten the 3 M5 screws once it is in place.**
- 5. You can easily adjust this to meet your needs after it is all together by just loosening these same 3 screws attached to the Tee Nuts.**



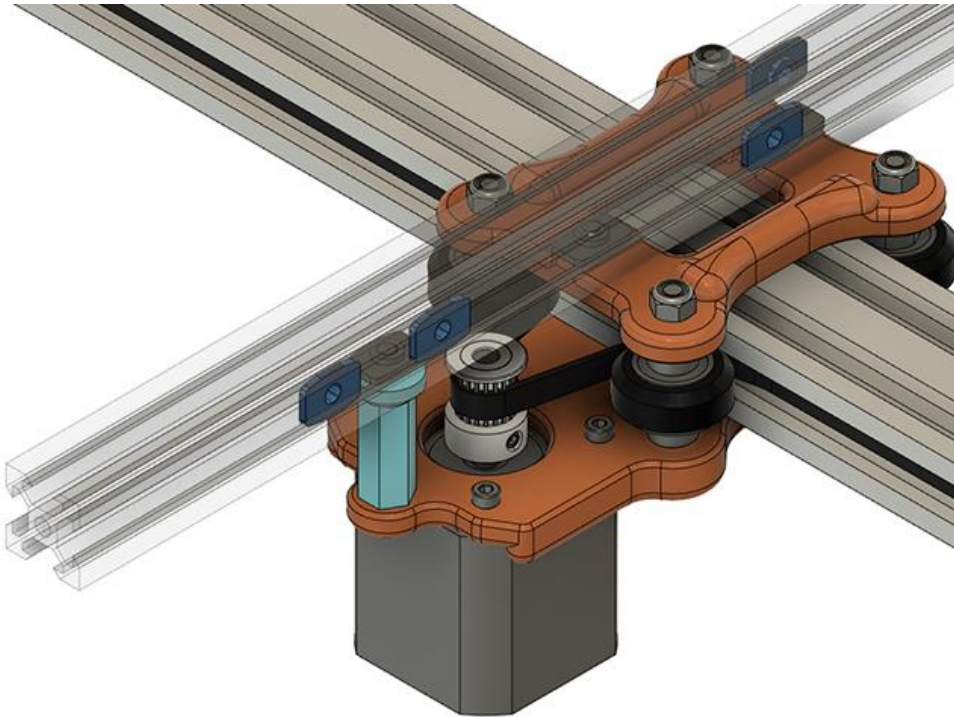
6. Attach the V-Slot 2020 carriage assembly to the V-Slot 2020 cantilever as shown in picture below and slide it all the way on.
7. Check the play in the carriage & adjust the 2 eccentric nuts if needed.
8. Laser is shown attached to the carriage, but I would not add that until the end.



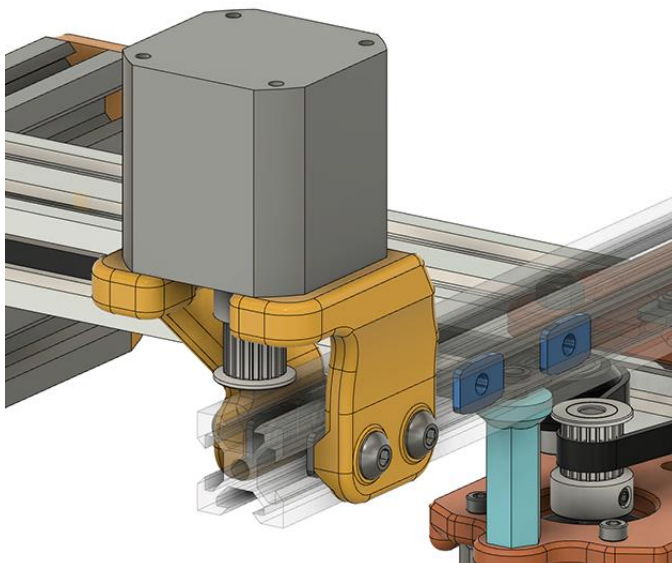
9. Attach the Idler assembly as shown in picture & tighten the M5x12mm screw underneath the V-Slot 2020.



10. From the back of the V-Slot 2020 slide in 4 – M5 Tee Nuts as shown light blue in photo below.
11. The back 2 Tee Nuts on one side are for attaching the controller board mount.
12. The other 2 Tee Nuts are for the X & Y Mechanical limit switch brackets.
13. These need to be added before attaching the motor mount in the rear.

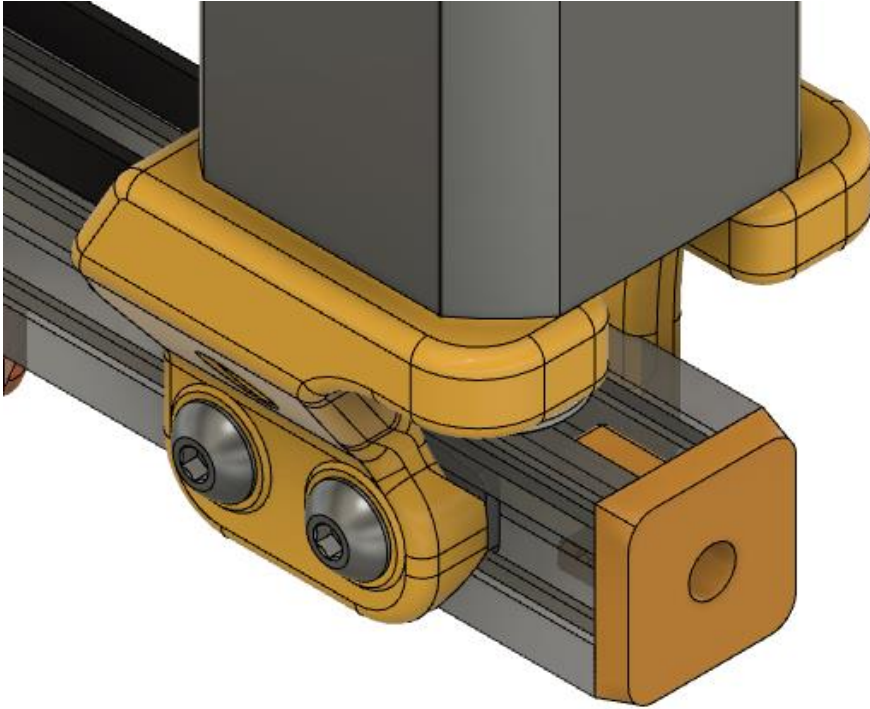


14. Attach the motor from the back of the V-Slot 2020 cantilever as shown in photo.
15. It will probably be easier to take the 4 – Tee Nuts off & slide them in as it is sometimes difficult to line up 2 Tee Nuts at a time.
16. Leave a little room at back of V-Slot 2020 to allow for moving the motor back during belt tightening process.
17. Also the V-Slot 2020 endcap extends 12mm into V-Slot 2020 side grooves, so allow clearance for that also.
18. Tighten up 1 Tee Nut screw on each side for now.

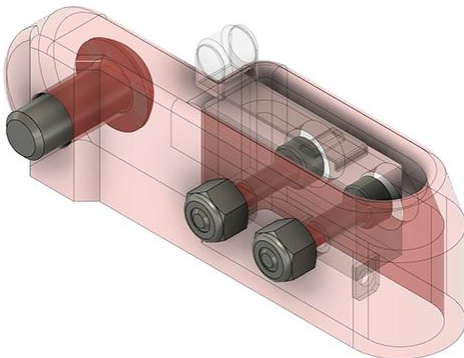




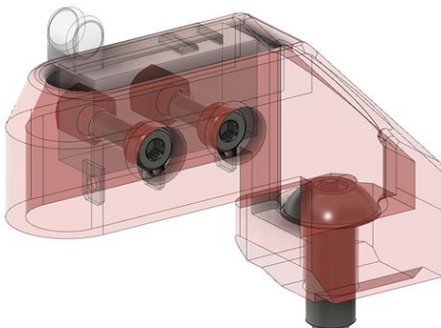
22. Add *V2020\_EndCap.stl* to back of the V-Slot 2020. Internal 2 connections should be above & below to allow for motor to be pulled back as far as possible if needed.
23. Loosen the M5 screws on the Motor Mount with your palm resting against the V-Slot 2020 endcap & pull it back to tighten belt further.
24. After you are happy with the tension, tighten the 4 – M5x12mm Motor mount screws.



Attach Mechanical Limit switch to *Y-Axis\_Mech\_LS\_Bracket\_V821.stl* with:  
2 – M2.5x12mm socket head screws & M2.5 Locknuts  
1 – M5x12mm screw

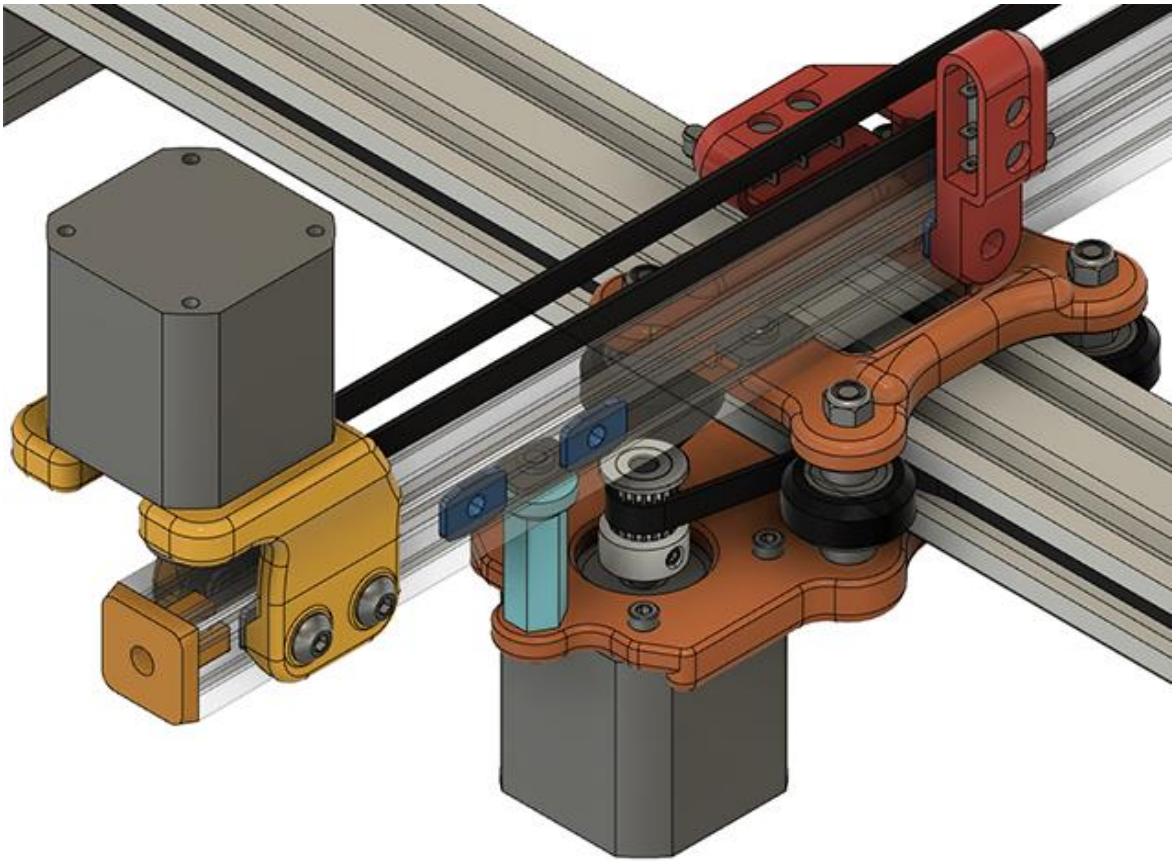


Attach Mechanical Limit switch to *X-Axis\_Mech\_LS\_Bracket\_V821.stl* with:  
2 – M2.5x12mm socket head screws & M2.5 Locknuts  
1 – M5x12mm screw



**Attach the X-Axis & Y-Axis limit switch assembly to the V-Slot 2020 cantilever as shown in this picture.**

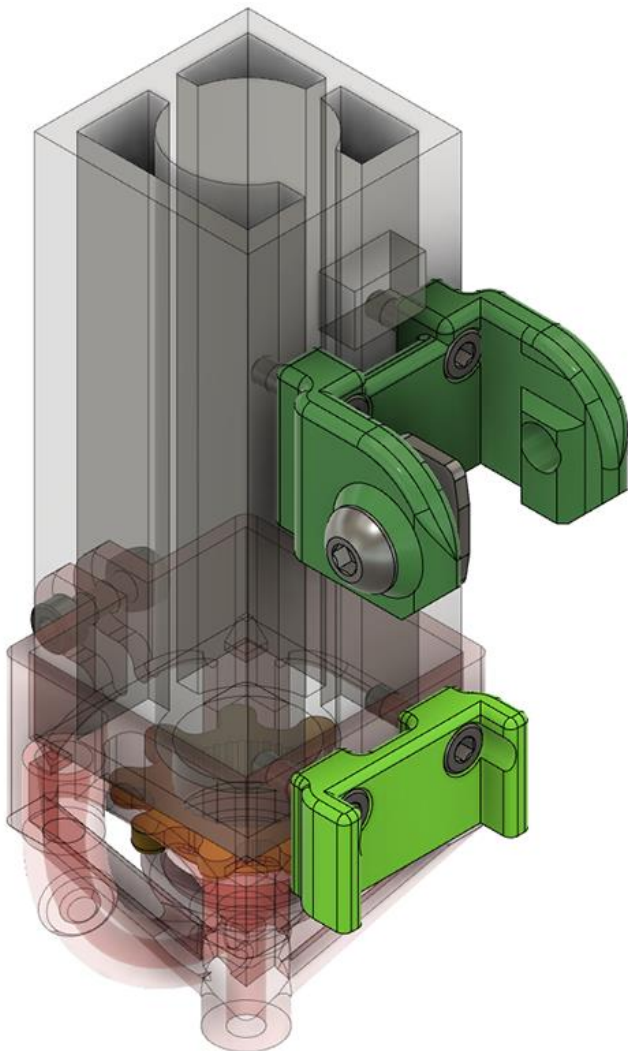
**Then attach your controller board mount of choice to other 2 Tee Nuts.**



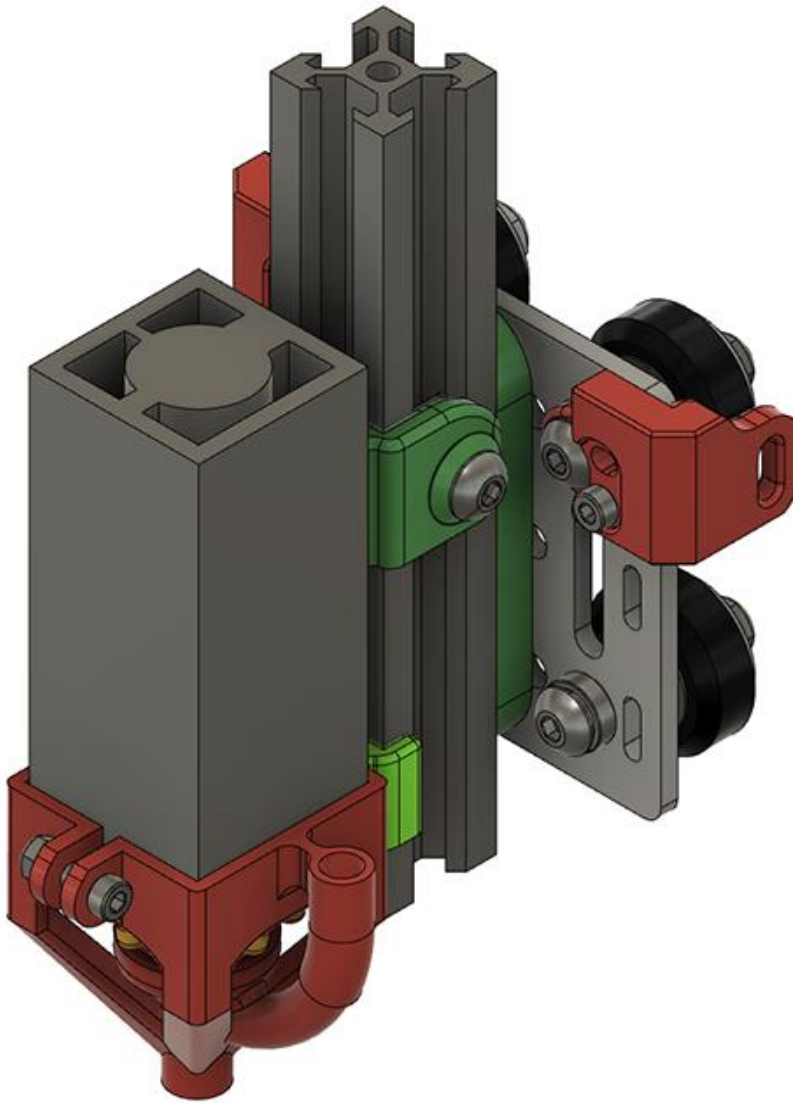
## Put the Laser Assembly Together Last

Gather the following parts.

1. Printed parts, *LE\_Z\_TopSlider\_2020\_V821.stl*, *LZ\_Z\_BotSlider\_2020\_V821.stl*, *Laser\_focus\_Wheel.stl* and *LaserAirAssist\_V4\_M.stl*  
(*LaserAirAssist\_V4\_M.stl* is used instead of other one to allow for most cantilever movement)
2. 5 – M3x10mm screws
3. 1 – M3 Locknut
4. 1 – M5x12mm screw
5. 1 – M5 Tee Nut
6. 1 – Diode Laser (Mine is a NEJE 6W)
7. Add *Laser\_focus\_Wheel.stl* to the focus wheel of the laser.
8. Mount *LE\_Z\_TopSlider\_2020\_V821.stl* to top laser threaded holes with the 2 - M3x10 screws.
9. Add the M5x12mm screw and M5 Tee Nut to one side of top slider.
10. Mount *LZ\_Z\_BotSlider\_2020\_V821.stl* and *LaserAirAssist\_V4.stl* to bottom laser threaded holes.
11. Add the M3x10mm screw with locknut to the front bracket on the laser.



12. Mount the Laser Assembly to the V-Slot 2020 Carriage Assembly by sliding the top slider over V-Slot 2020 Z-Axis.
13. Tighten the Laser Assembly to Carriage Assembly with just the 1 M5x12mm screw & Tee Nut
14. You could add a *V2020\_EndCap.stl* to the top of this V-Slot 2020 also, but it is just more weight on the carriage running on the cantilever V-Slot 2020.



Check all the screws to make sure they are tight. Adjust the eccentric wheel nuts if needed. Visually check for squareness on the cantilever to the V-Slot 2040 beam.

On a flat surface, check that the height of the cantilever beam is the same height at the V-Slot 2040 beam side as it is at the end where the idler is. If it is not, you might be cantilevering too far. Being slightly off is probably not a problem & you can verify this with your first test burn.

This completes the mechanical build.

You can find additional help with your wiring & troubleshooting from the build log listed at beginning of this guide.