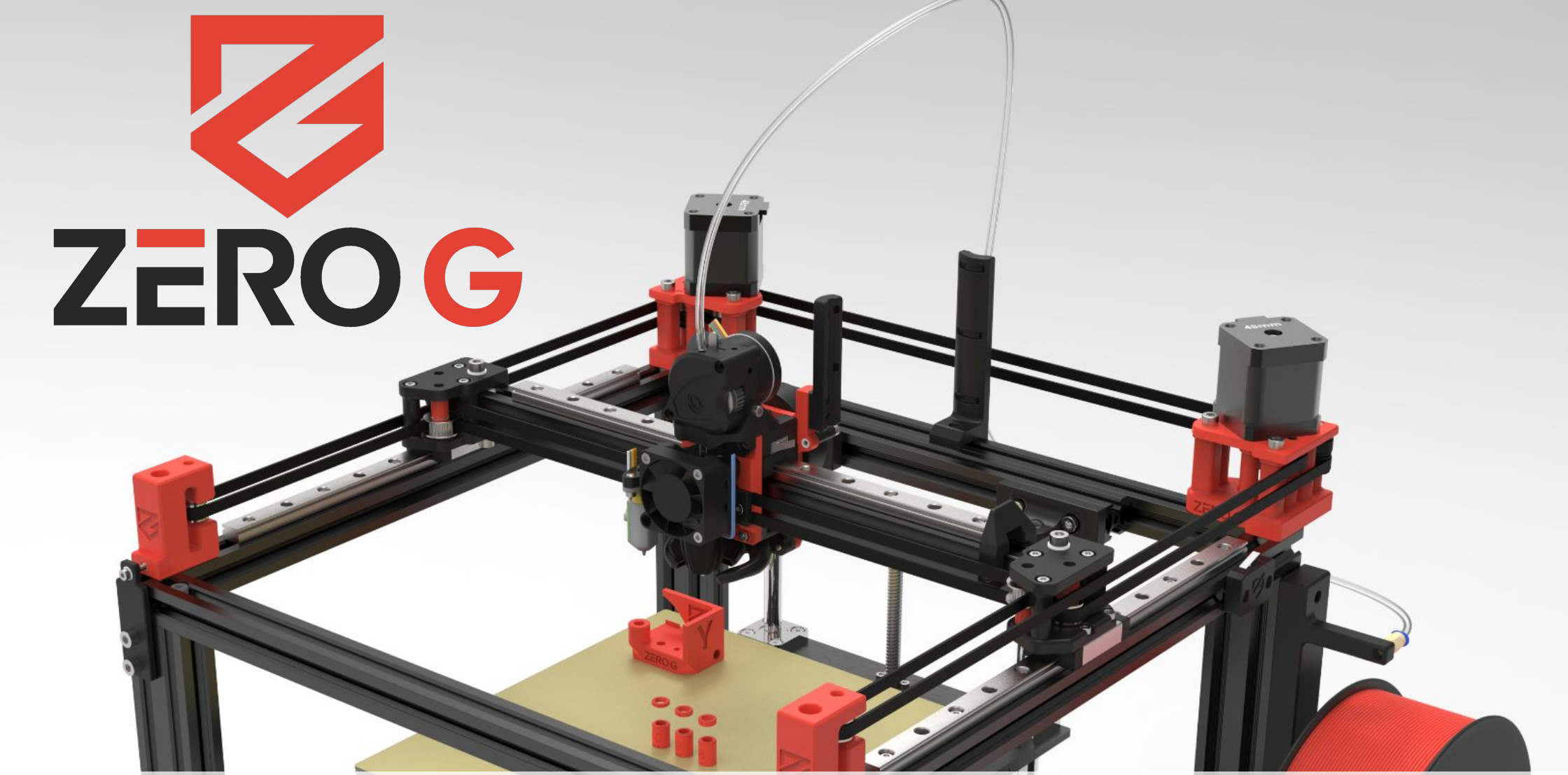
ZERO G



MERCURY ONE.1

Launch Your Ender 5 to New Horizons

(No Alien Tech Required!)

Documentation Release 2024-02-18

TABLE OF CONTENTS

INTRODUCTION

WHAT IS MERCURY ONE.1?

Mercury One.1 replaces the X and Y motion systems of your Ender 5 printer with a CoreXY design, where two stationary stepper motors power every X or Y axis move, greatly increasing speed and acceleration. Mercury One also removes the Ender 5's tricky v-wheels for the precision and reliability of linear rails.

If you want better quality prints and (much) higher speeds, this project is for you!

WHAT'S IN THIS GUIDE?

This document is specifically for modifying Ender 5, Ender 5 Pro, or Ender 5 Plus 3D printer. Others printers have been converted to Mercury One.1, but these are currently unsupported.

We don't cover the details of how to remove your existing XY motion system from the frame, nor do we cover the specifics of wiring your printer. If you need help with those subjects or anything else, don't hesitate to join our **Discord server** and ask!

DIFFICULTY

We consider this project to have **moderate** difficulty. Note that some soldering or wire extension is almost certainly necessary.

INTRODUCTION

CREDITS

We're truly grateful for the support from our community members. A thank you goes as well to the Voron team for the inspiration on the documentation theme.

A NOTE

This guide is a work by volunteers in their spare time. In order to cover the complete assembly process **and** release before never, this guide does not cover steps after assembly (e.g., wiring and advanced troubleshooting). Future guides will handle these areas.

Early versions of this documentation used black-and-white illustrations. Some images are still in black-and-white for the sake of time and will be updated later.

CONTACT US / SOCIAL LINKS

Discord	**https://discord.gg/zerog**
Web	**https://zerog.one**
YouTube	**https://youtube.com/@zerog3d**
X.com	**https://x.com/zerog3d**

CAUTION

Building a 3D printer has the potential to cause injury, including burns and electric shock.

Always exercise caution during assembly, particularly when working with electricity!

CALL-OUTS AND SYMBOLS

We use call-out boxes to “call out” information. These boxes are color-coded and contain an icon to mark how important the call-out is. An explanation of each type is below:

CAUTION

⚠️ Cautions are key information. You **need** to know this to avoid injury or properly complete the current step.

NOTE

📝 Notes are helpful, but not quite so urgent as Cautions. They often contain tips on solutions to common issues.

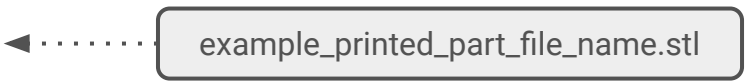
INFORMATION

ℹ️ Anything else, such as alternatives or background information, gets an Information box.

You’ll see these types of call-outs along with illustrations:

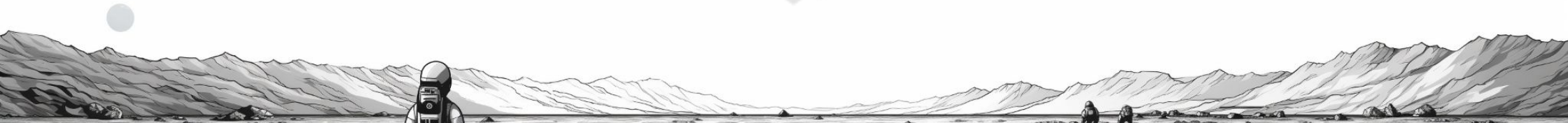
- Gray boxes and dotted lines to point out printed part names; and
- Solid red boxes and dashed lines for important details.

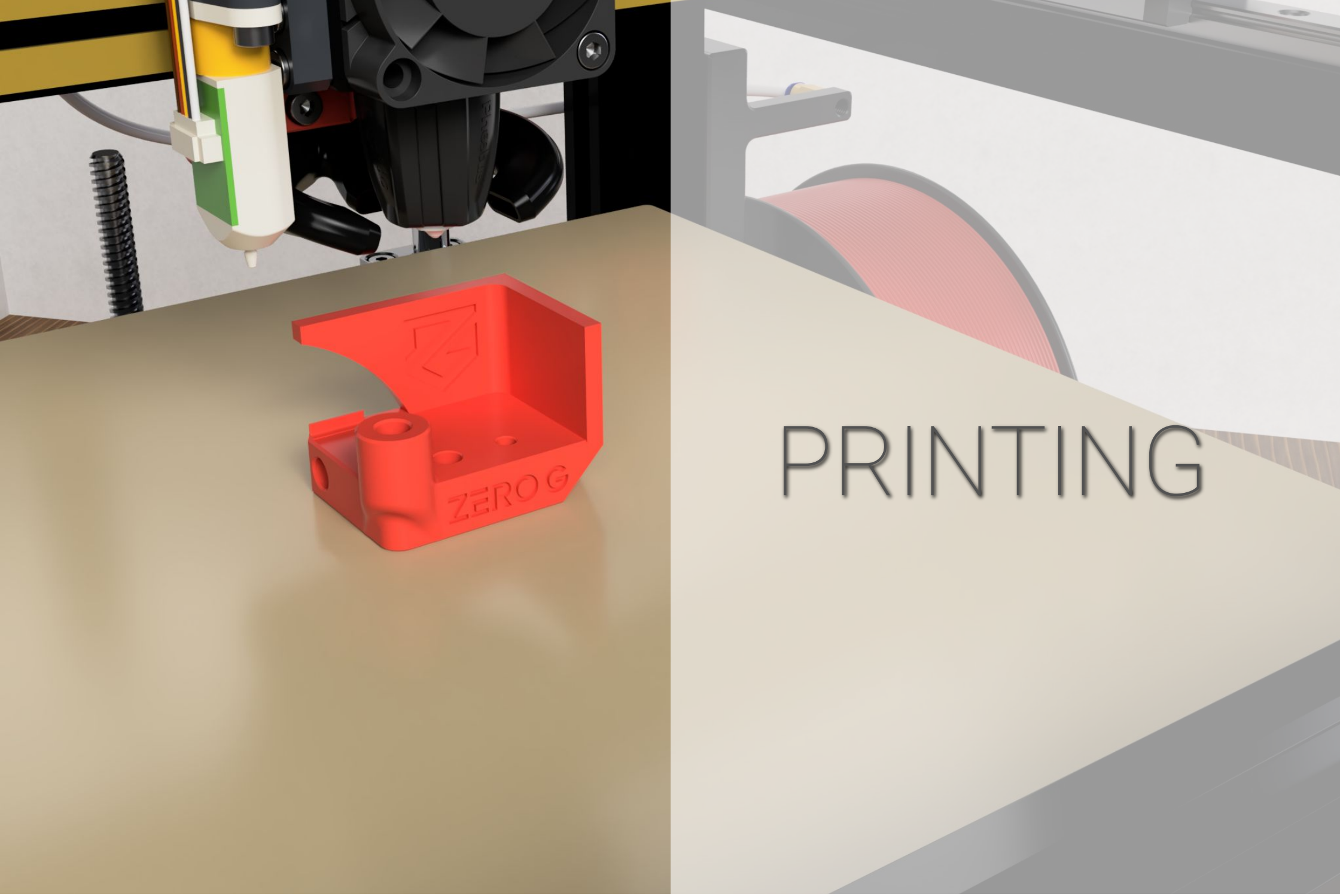
PRINTED FILE



IMPORTANT DETAIL

PART 1:
PRE-FLIGHT CHECKS





PRINTING

PRINTED FILES

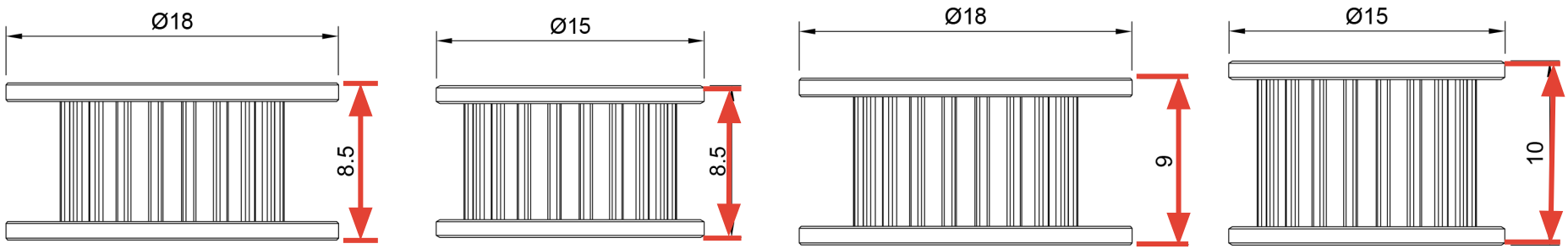
A complete Mercury One.1 build includes both the Mercury One motion system and a compatible toolhead of your choice. Our stock, supported toolhead is a modified EVA 2.4.

Our doc site has Configurator tools for both Mercury One.1 and EVA 2.4. The Configurators generate ZIP files that are customized to your configuration and contain all of the files to print: https://docs.zerog.one/manual/build/mercury_eva/printed_files.

Alternatively, you can browse and download the files directly from GitHub here for Mercury One.1 and here for EVA 2.4.

MEASURE YOUR TOOTHED IDLER

We support several types of toothed idlers. To find the correct spacers, measure your idler's height and check the next page for the corresponding spacers.

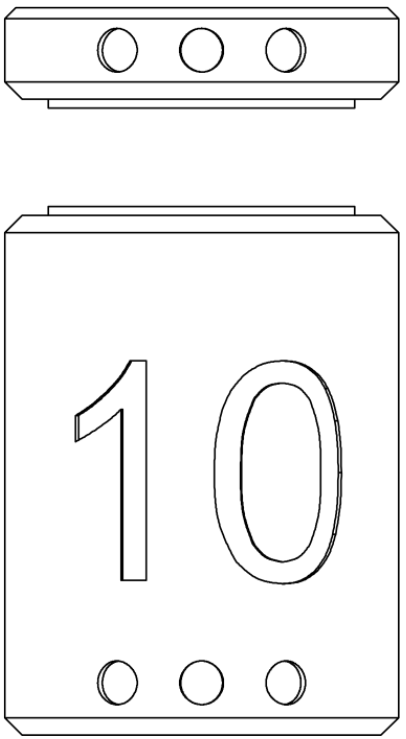


FIND YOUR SPACER

Print the matching spacer to your idler's height. Each spacer has one (1) dot for 8.5mm, two (2) for 9mm, and three (3) for 10mm. The Configurator should include the correct file for you, but we've also included direct links below.

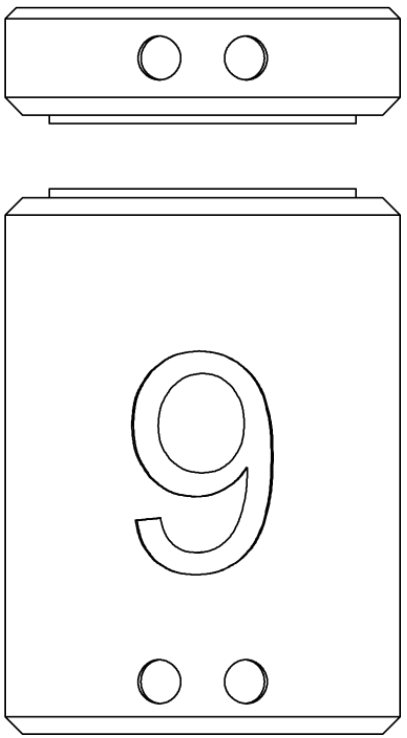
10MM

a_Xjoint_10mm_Idler_Spacers.stl



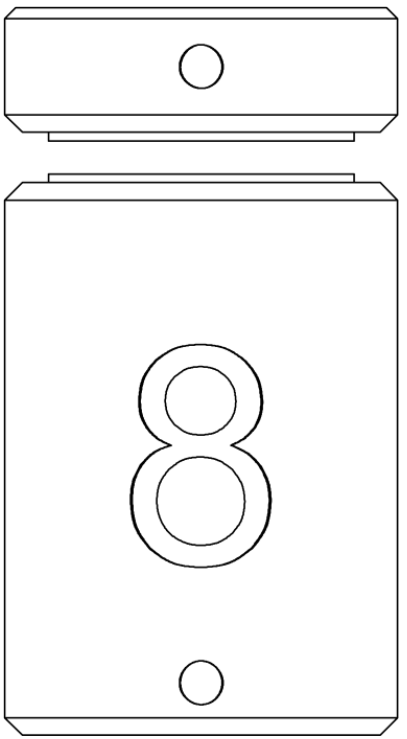
9MM

a_Xjoint_9mm_Idler_Spacers.stl



8.5MM

a_Xjoint_8mm_Idler_Spacers.stl



PRINT SETTINGS

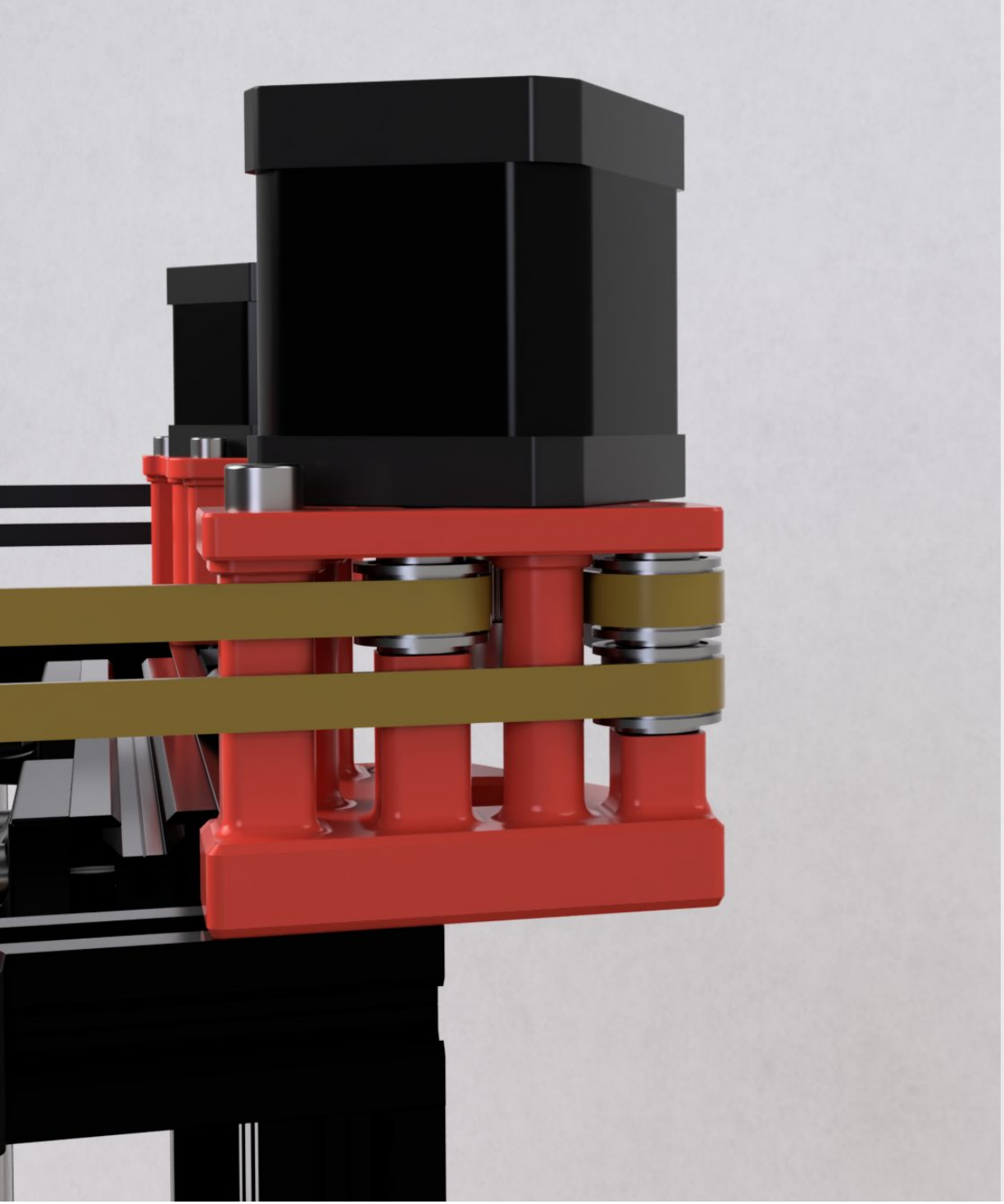
Our parts are designed for the settings below, both to ensure print quality and strength. If you're not happy with your print quality, ask for help in our Discord.

These settings are also available on our site.

First Layer Height	0.25mm	⚠️ *This is important!*
Layer Height	0.2mm	
Extrusion Width	0.4mm, forced	
Infill	40% cubic	Alternatives: adaptive cubic, grid, gyroid, honeycomb, triangle
Walls/Perimeters	4 solid	
Top/Bottom Layers	5	
Seam Placement	Rear	⚠️ *This is important!* Our parts contain seam relief features.

📝 Over-extrusion leads to top layers with an inconsistent finish and/or blobbing. Check the top surfaces on the stepper towers and X joints, as these are mating faces.

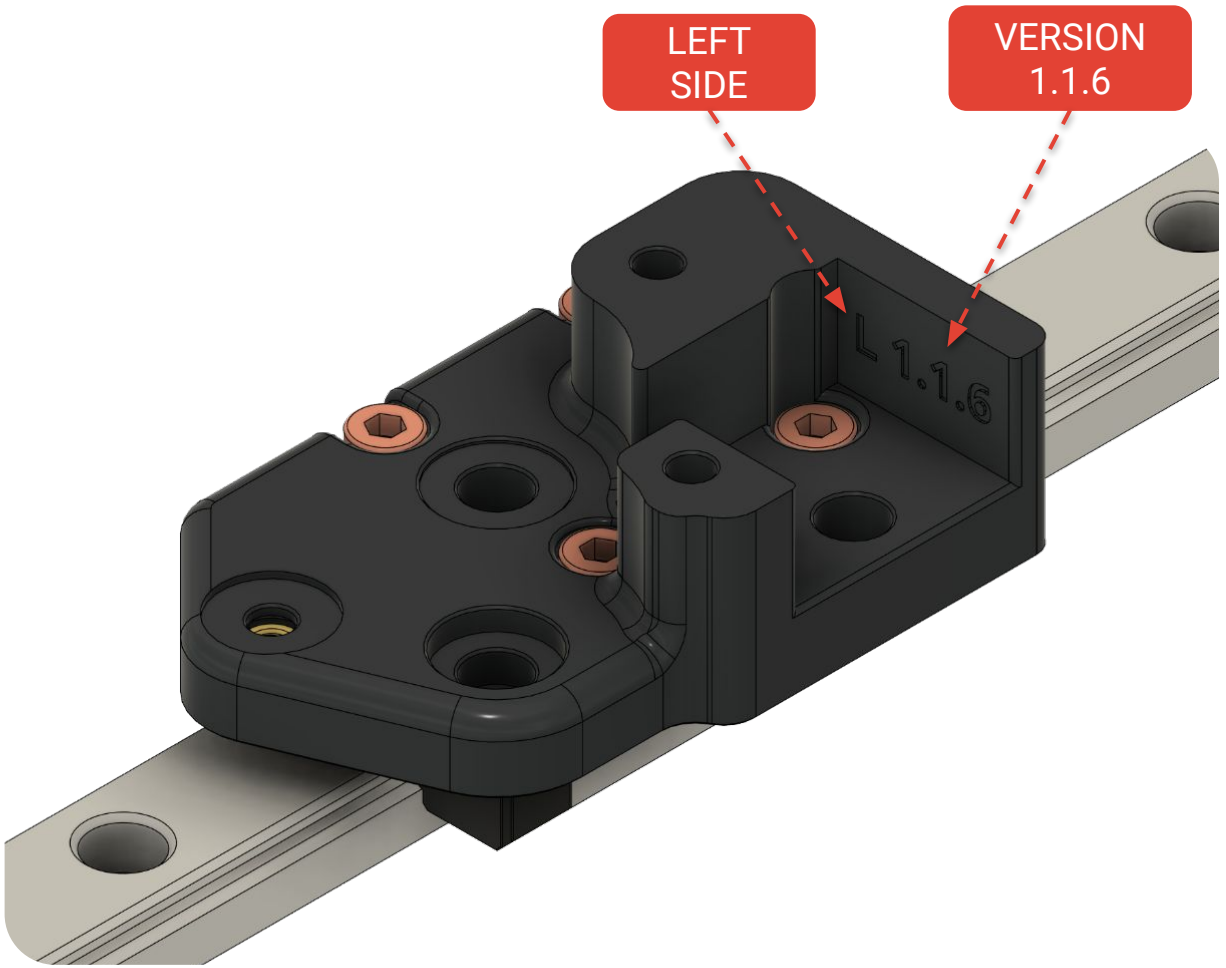
Light sanding with sandpaper can help remove rough surfaces and ensure a proper fit between parts.



CONCEPTS

Our parts have printed codes to aid assembly. A part code identifies:

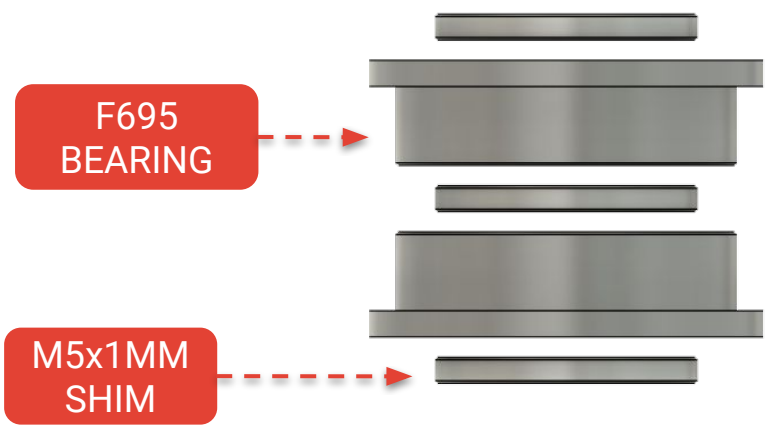
1. If the part belongs on the **left ('L')** or **right ('R')** side of the printer; and
2. The **version** of the part.



Flange stacks (along with 5x30mm dowel pins) are used to create smooth idlers. Reliable, quality idlers–both smooth and toothed–are a critical part of your printer's performance. We use flange stacks throughout the assembly process; see the next page for more about idlers.

Note that single flange stacks use **three (3)** shims and **two (2)** bearings, while double stacks uses **five (5)** shims and **four (4)** bearings.

SINGLE FLANGE STACK



DOUBLE FLANGE STACK

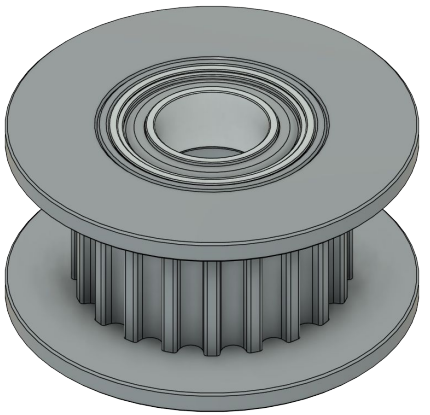
SMOOTH IDLERS

Smooth idlers are the most common idler that we will use; they turn the belt around its smooth side.

A **single flange stack** has **one (1)** smooth idler; a **double flange stack** has **two (2)**.

TOOTHED IDLERS

Toothed idlers are used on the **X joints only**. These are used when the belt turns towards its toothed side.



COREXY BASICS

CoreXY is different than the Ender 5's Cartesian motion system. On the Ender 5, one stepper is responsible for movements along the X axis (side-to-side) and another for the Y axis (front-to-back).

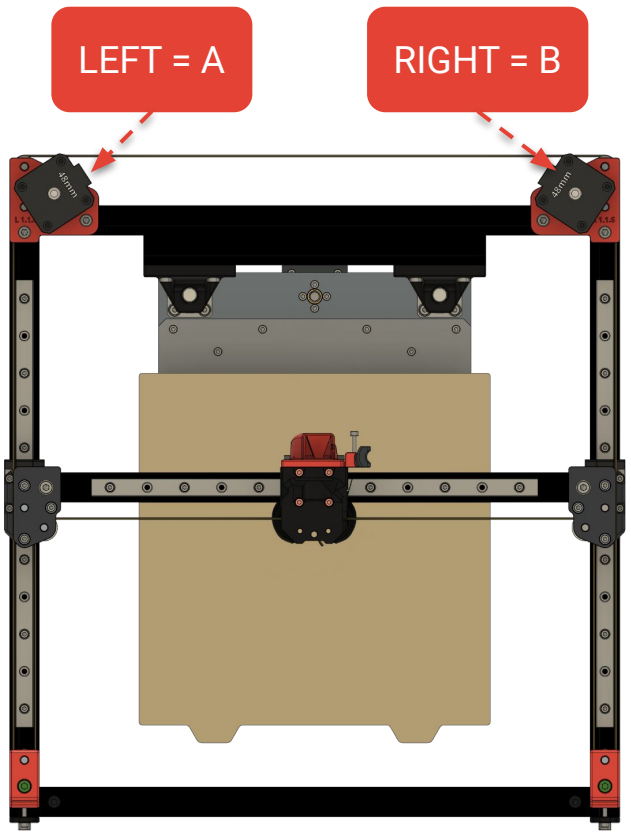
Mercury One.1's CoreXY motion system instead uses two steppers, working together, for every move. As a result, the steppers are called A and B instead of X and Y.

The two belts travel similar paths with the B stepper's belt above the A stepper's belt. As a result, they are often simply called upper and lower belts.

This gets confusing, so here's a cheat sheet on which stepper, belt, and tensioner is which:

- The **left stepper** is **A** and drives the **lower** belt. It is tensioned by the **left tension tower**.
- The **right stepper** is **B** and drives the **upper** belt. It is tensioned by the **right tension tower**.

ℹ️ Klipper still calls the steppers X and Y. When configuring Klipper, A is "*stepper_x*" and B is "*stepper_y*".



TEST, ADJUST, RE-TEST

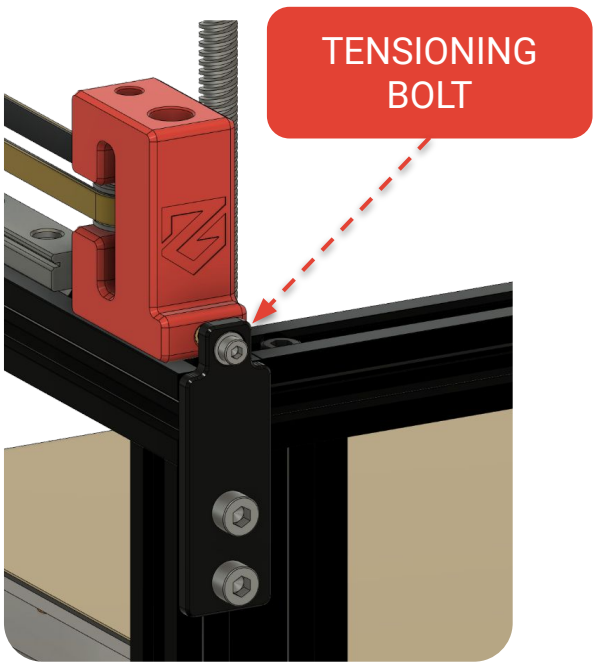
Correctly tensioned belts are key to a well-tuned CoreXY motion system. Small adjustments and frequent tension measurements are the best way to equally tension your belts with the correct amount of force.

One way to measure belt tension is to strum like a guitar string a length of belt and measure the frequency of the resulting note. We will use this method during assembly.

TIPS ON TENSION TUNING

1. Using **Spectroid** (Android), **Sound Spectrum Analysis** (iOS), or another spectrum analysis tool on a smartphone or tablet helps to measure each belt's frequency.
2. When strumming a belt, **higher frequencies/notes** come from **tighter belts**.
3. Initially tune for the range **110 to 120Hz**, approximately the range between the musical notes **A2** and **B2**.
4. Tightening one belt **tightens the other** belt, as well. Because they **both** pull on the toolhead, they **also** pull on one another.
5. Recheck the tension of **both belts** after **each adjustment** (see above).
6. Adjust each tensioning bolt at **most one fourth (¼) of a turn at a time**.

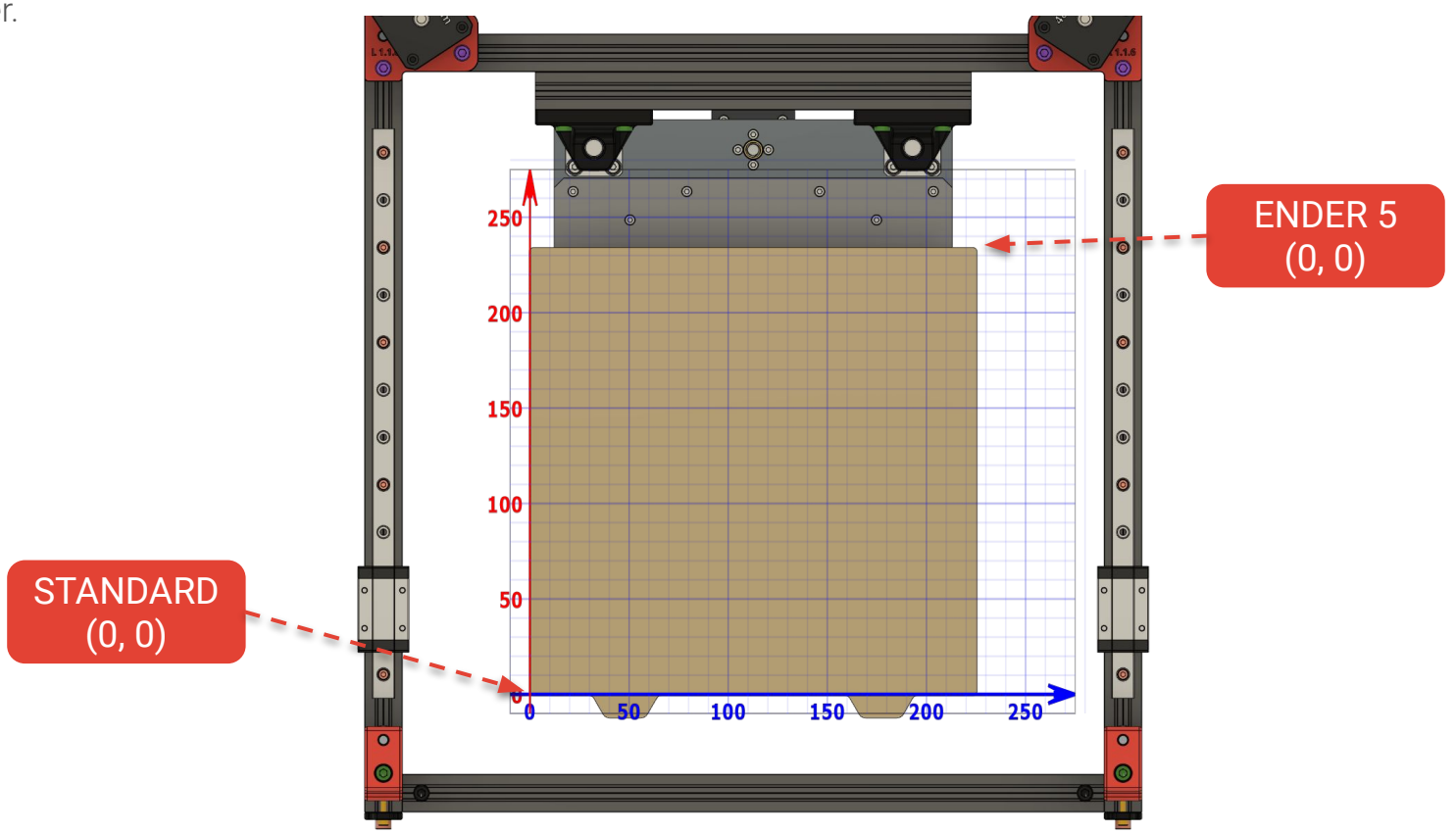
We will cover how to check and adjust belt tension in more detail during assembly.



PRINTERS AS GRAPH PAPER

A 3D printer views its build plate like a piece of graph paper. If we lay graph paper over the bed, it might look like the image below, with the X axis in blue and the Y axis in red.

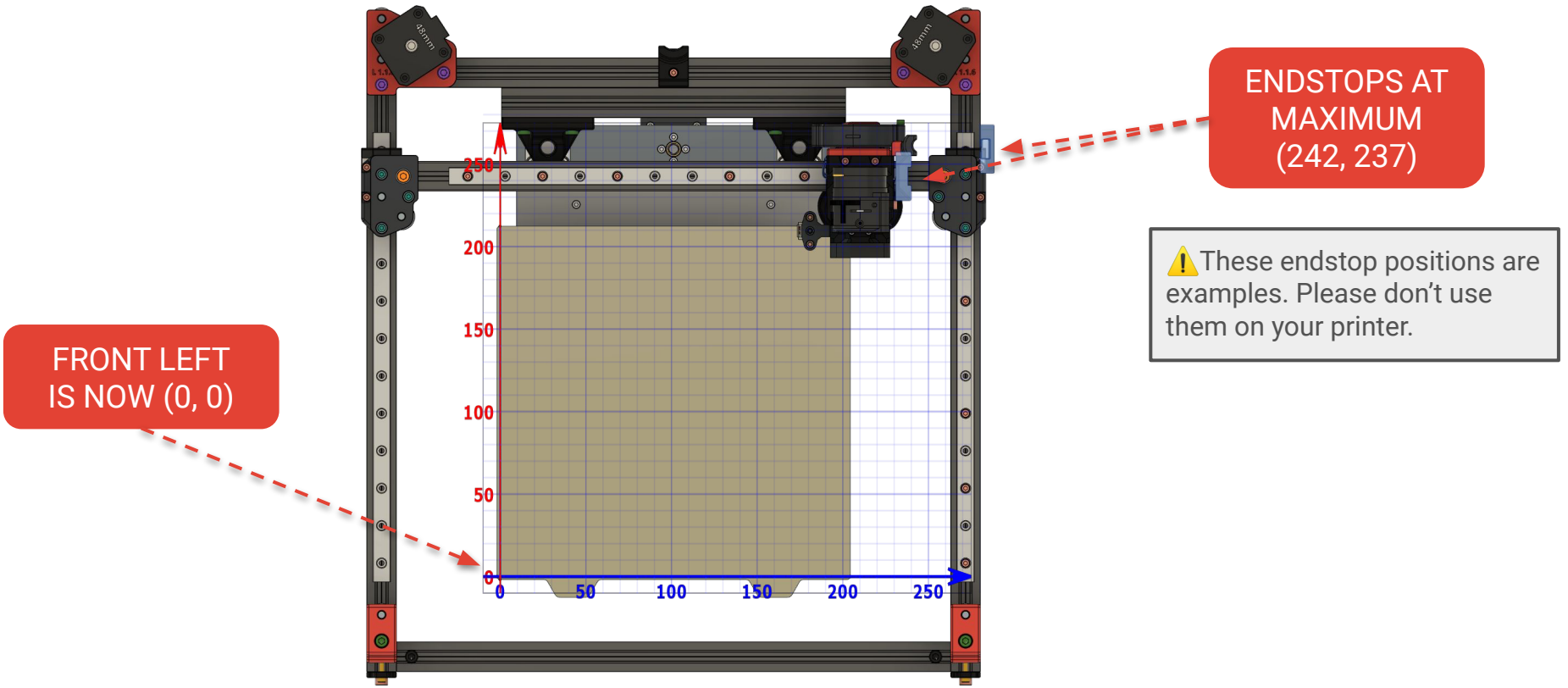
There is an origin point, or (0, 0) on the graph; normally this is the front left corner of the bed. **Although the Ender 5 ships with (0, 0) in the back right corner, this is a confusing practice.** For example, prints are rotated 180 degrees from how they look in the slicer.



BACK-RIGHT THE RIGHT WAY

CoreXY printers normally home in the back-right corner, much like the Ender 5, but they have the origin in the front-left. To do this, instead of the endstop serving as the minimum point, you can configure it in the firmware as the maximum.

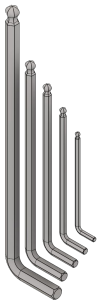
In the illustration below, the X endstop triggers 7mm beyond the edge of the 235x235mm build plate, at 242mm. The Y endstop triggers about 2mm beyond the build plate, so we would set it as 237mm in the firmware.



HARDWARE

HARDWARE

Assembly requires a few things besides the Bill of Materials to help us get the job done.



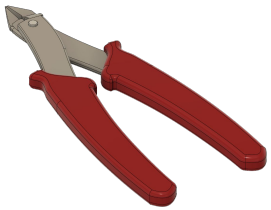
HEX KEYS

You'll need these sizes:

1.5mm, 2mm, 2.5mm, 3mm, 4mm

SANDPAPER

200-400 grit sandpaper for sanding dowel pins.



FLUSH CUTTERS

These are used to trim belts.

POWER DRILL WITH CHUCK

Useful for sanding dowel pins.

SOLDERING IRON

An M3 heat set insert tip for your iron is recommended, but not required.

ELECTRICAL PLIERS

We'll use these to strip wires for the Y endstop.

HARDWARE (CONT'D)

Assembly requires a few things besides the Bill of Materials to help us get the job done.

BLUE THREADLOCKER

We strongly recommend ThreadLocker for your stepper pulleys' grub screws.

Do **NOT** use ThreadLocker on printed parts!

3:1 HEATSHRINK TUBING

You'll need 20-30mm for the Y endstop.

SUPERGLUE

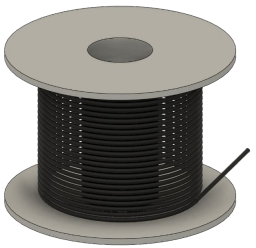
Superglue (cyanoacrylate) is an **optional** addition to the Y axis endstop.

BEARING GREASE

This should be a lithium-soap based bearing grease, preferably in a blunt-tipped applicator syringe. See the **Lubricants** section for help selecting a grease.

SOLDER

Enough to solder a pair of wires is all you need.

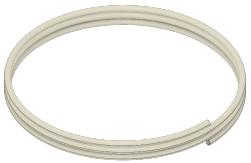


24 AWG/0.5MM STRANDED WIRE

You will generally need enough for two (2) wires to reach your MCU board.

HARDWARE (CONT'D)

Assembly requires a few things besides the Bill of Materials to help us get the job done.



4MM OD 3MM ID PTFE TUBING - QTY 2M

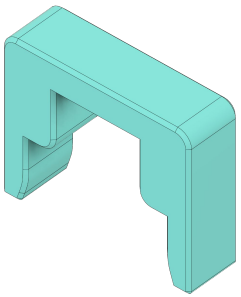
2mm ID adds additional friction to your filament path.

ISOPROPYL ALCOHOL (IPA)

91% or better.

LINT FREE TOWELS

Shop towels will work in a pinch.



RAIL ALIGNMENT TOOL - QTY 2

This is a new addition to our configurator. If you don't have this file, you can get it here: **Download Link**

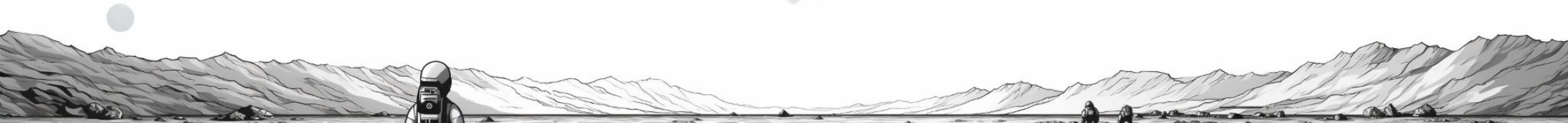
SMALL CONTAINER

An 8oz bowl is enough, preferably metal or glass (these won't react with rubbing alcohol).

STROOPWAFEL

Grab a(t least one) Dutch Stroopwafel for the assembly process. Testing shows it makes assembly 152% tastier!

PART 2: PREPARING FOR ZERO GRAVITY

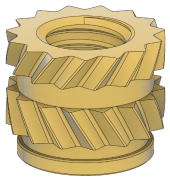


HEAT SET INSERTS

INTRODUCTION

Preparation of our parts start with heat set inserts.

HARDWARE

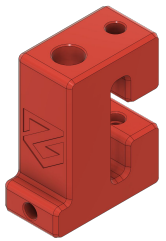


HEAT SET INSERT - QTY 8

M3 x 5mm OD x 4mm L

SOLDERING IRON - QTY 1

An M3 heat set insert tip for your iron is recommended but not required.

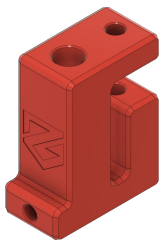


FRONT LEFT TENSION TOWER

“a_front_tower_left.stl”

LEFT BOTTOM X JOINT

“XJoint_left_bottom.stl”



FRONT RIGHT TENSION TOWER

“a_front_tower_right.stl”

RIGHT BOTTOM X JOINT

“XJoint_right_bottom.stl”

1. PREHEAT SOLDERING IRON

If you have an M3 heat set insert tip for your soldering iron, attach it while the iron is **cold**.

Preheat the soldering iron hot enough to melt your printed parts, at least **220-230C**. If your iron has a temperature control, avoid going much hotter than the maximum print temperature for your parts.

> ⚠️ Do **NOT** touch a hot iron or insert.

2. SEAT X JOINT INSERTS

The X joint bottoms take three (3) inserts each.

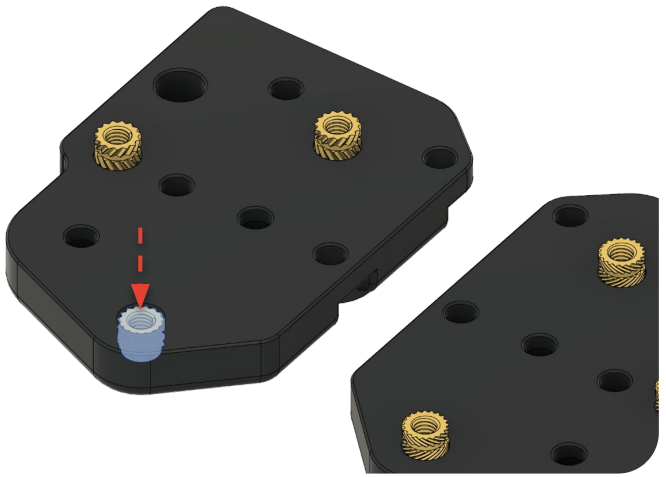
Put the narrow end of the insert in first. It should fit into the hole up to the first set of knurls.

3. HEAT AND PRESS AN INSERT

Center the tip of your soldering iron on an insert. Allow a second or two to preheat the insert, then apply gentle pressure **directly down** on the insert.

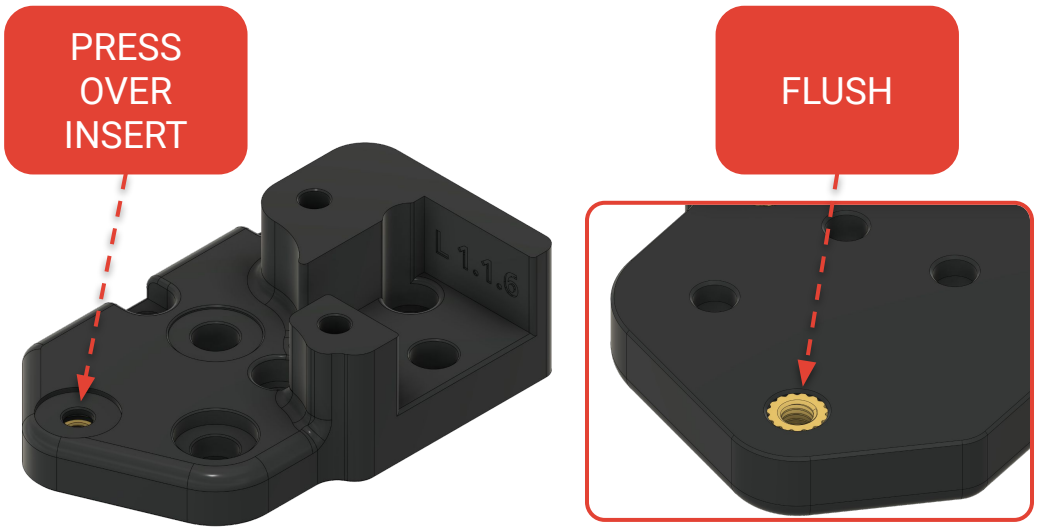
Continue applying pressure until the insert is **just above the surface**. Be careful not to touch the printed part with your iron.

⚠️ Hot inserts can take several minutes to fully cool! **Be careful!**



4. PRESS THE INSERT FLAT

Turn the part over and **firmly** press the part **against a hard, flat surface**. Press directly over the insert to ensure it is flush and even.



📝 If an insert is still not straight:

1. Re-heat the insert.
2. Thread an M3 screw partway into the insert.
3. Tilt the screw (and insert) straight.
4. Remove the screw and allow the insert to cool.

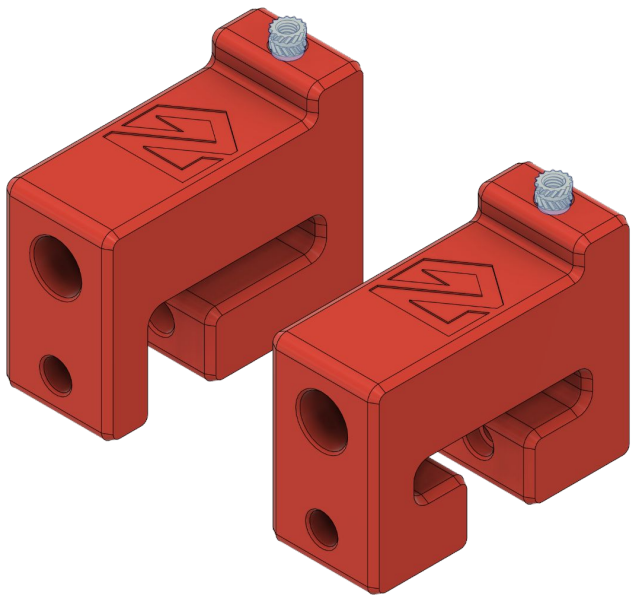
5. PRESS REMAINING INSERTS

Heat and press the remaining five (5) inserts for the X joints.

Stop after each insert to inspect your work and correct issues, if necessary.

6. SEAT TENSION TOWER INSERTS

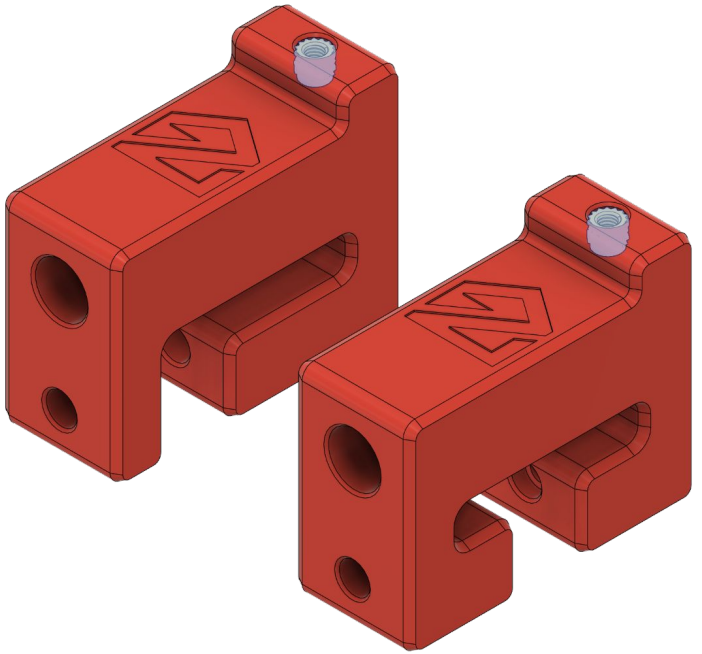
Place the tension towers with the insert hole facing up. Seat an insert in the hole in the front of each tower.



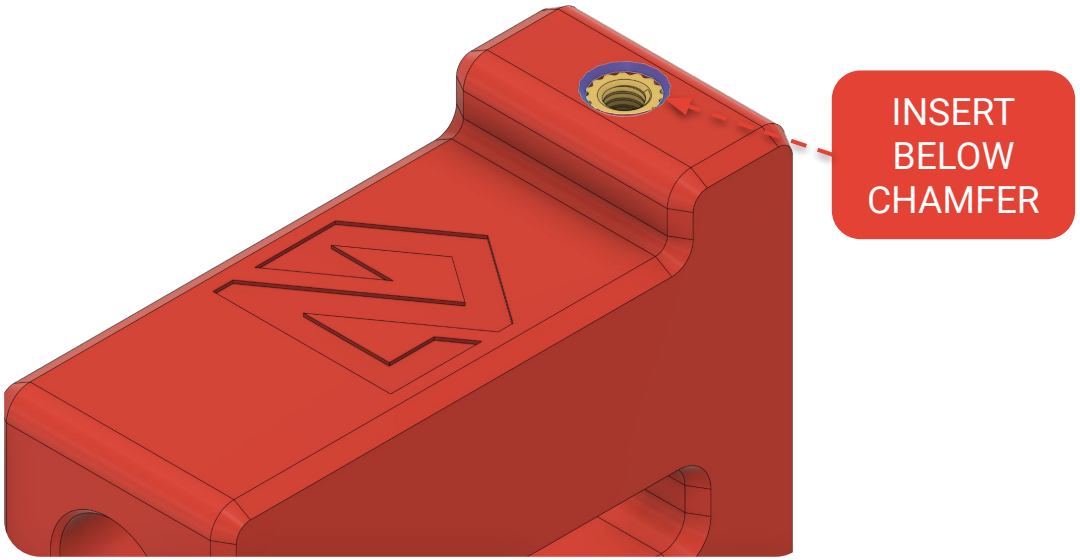
7. HEAT AND PRESS INSERTS

Press the inserts for the tension towers to **below the surface**, where the chamfer ends. When it is low enough, **hold for a several seconds** to thoroughly melt the plastic around the insert.

If a little plastic melts over the insert lip, that's good, but not necessary.



SHOULD LOOK LIKE



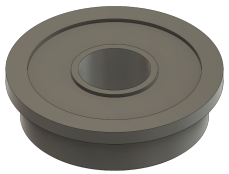
DOWEL PINS

INTRODUCTION

We need to ensure our dowel pins are within spec, since **oversized dowels will crack and ruin our bearings.**

That would be sad, so we'll sand them down to size instead.

HARDWARE



F695 BEARING - QTY 1

This is for fit testing.

POWER DRILL WITH CHUCK - QTY 1

5X30MM DOWEL PIN - QTY 10

SANDPAPER - QTY 1 SHEET

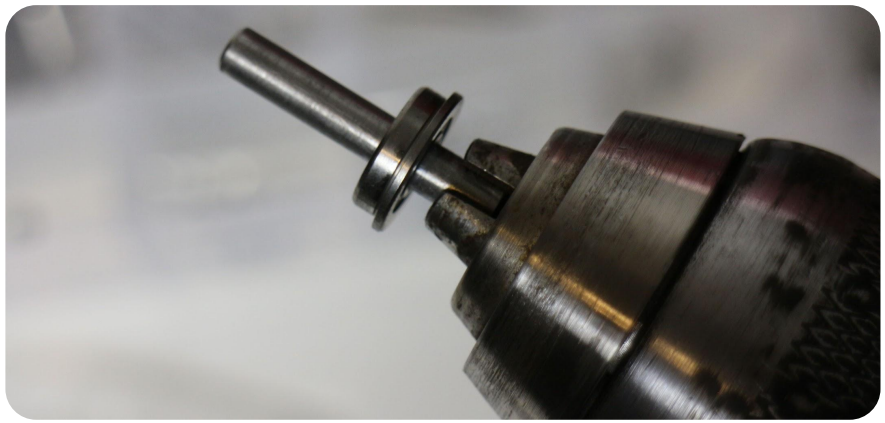
200-400 grit

TEST FIT

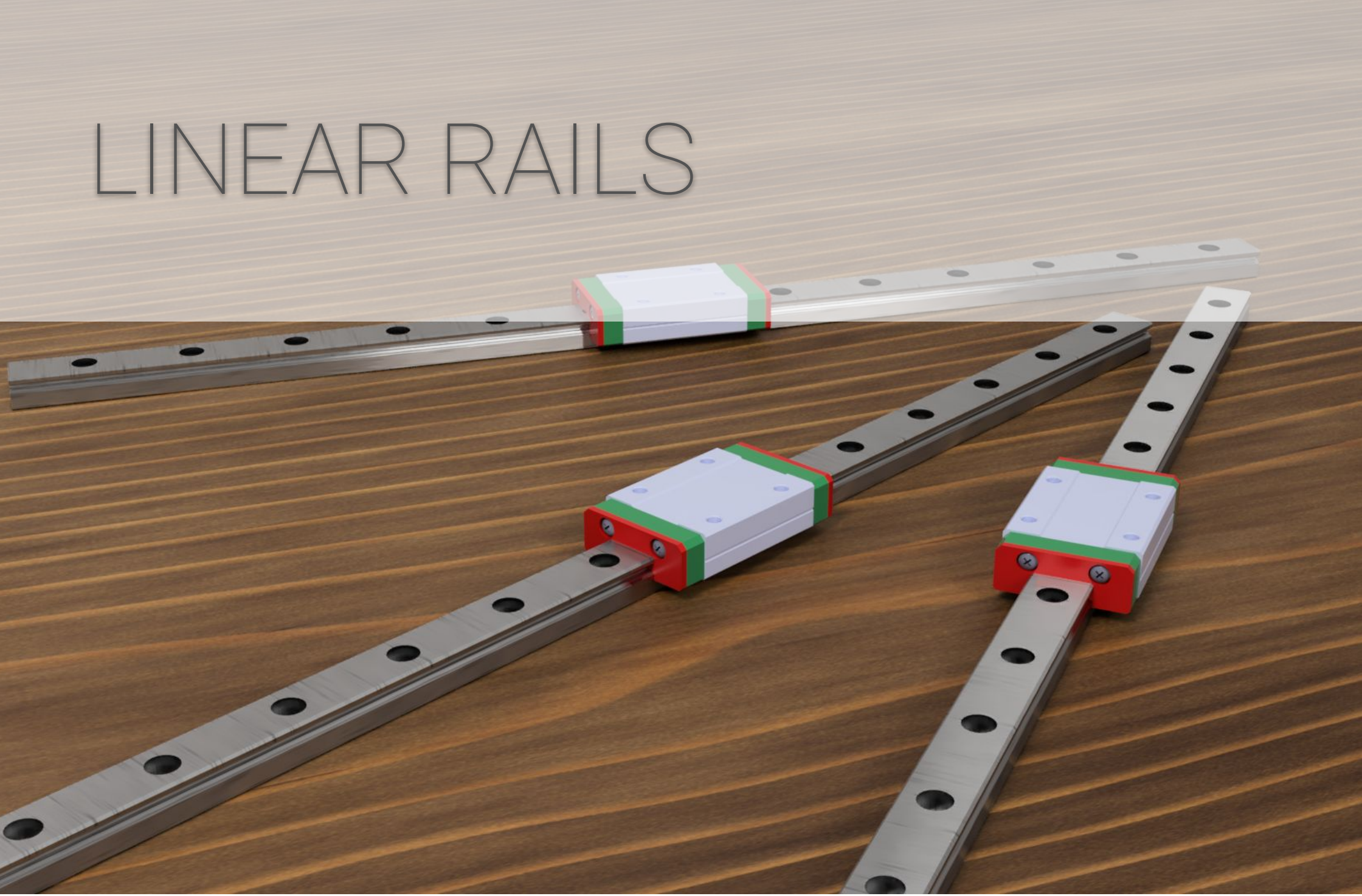
Test fit the bearing onto a dowel pin. If the fit is tight, **DO NOT** force the bearing. Instead, set aside the pin to be sanded. Test each pin, then follow the directions below to sand them.

SANDING

1. Insert the tip of a pin into your electric drill chuck and tighten.
2. Hold the sandpaper with the grit side folded around the pin (below left).
3. Run the drill at a steady speed to sand your pin.
4. Periodically stop to test fit the bearing again.
5. Stop sanding once the bearing slides on and off without resistance (below right).
6. When finished, flip the pin and repeat steps 1-5 with the remaining, unsanded portion of the pin.



LINEAR RAILS

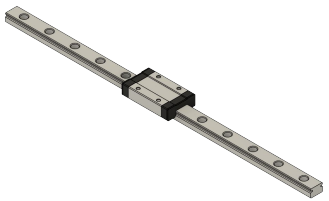


INTRODUCTION

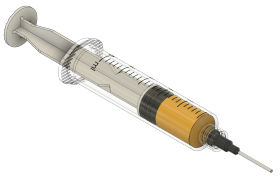
Most linear rails are shipped coated in packing grease.This is only for protection during warehousing and shipping; it should be removed and replaced with a quality lubricant.

⚠️ Some distributors, including Fabreeko, clean and pack their linear rail carriages with bearing grease before sale. If your rail is already cleaned and lubricated, you can skip to Z-Lift and Z-Drop Brackets.

HARDWARE



LINEAR RAILS - QTY 3



BEARING GREASE

See the next page for tips on choosing a grease.

LINT FREE TOWELS

Shop towels will work in a pinch.

ISOPROPYL ALCOHOL (IPA)

91% at least, 99% is ideal.

SMALL CONTAINER

An 8oz bowl is enough. Prefer metal or glass; some plastics react with isopropyl alcohol and discolor.

BE CAREFUL WITH THE CARRIAGE

The “M” in MGN-12H stands for “miniature”. Linear rails carriage blocks (typically called a “carriage”) are packed with tiny ball bearings. There are three rules for working with these bearings:

1. Do not lose any bearings.

Protective caps keep the carriage from falling off during shipping. **Only** remove the caps and carriage during the cleaning process; otherwise leave the carriage on and the caps in place. We will take the caps off at the end of assembly.

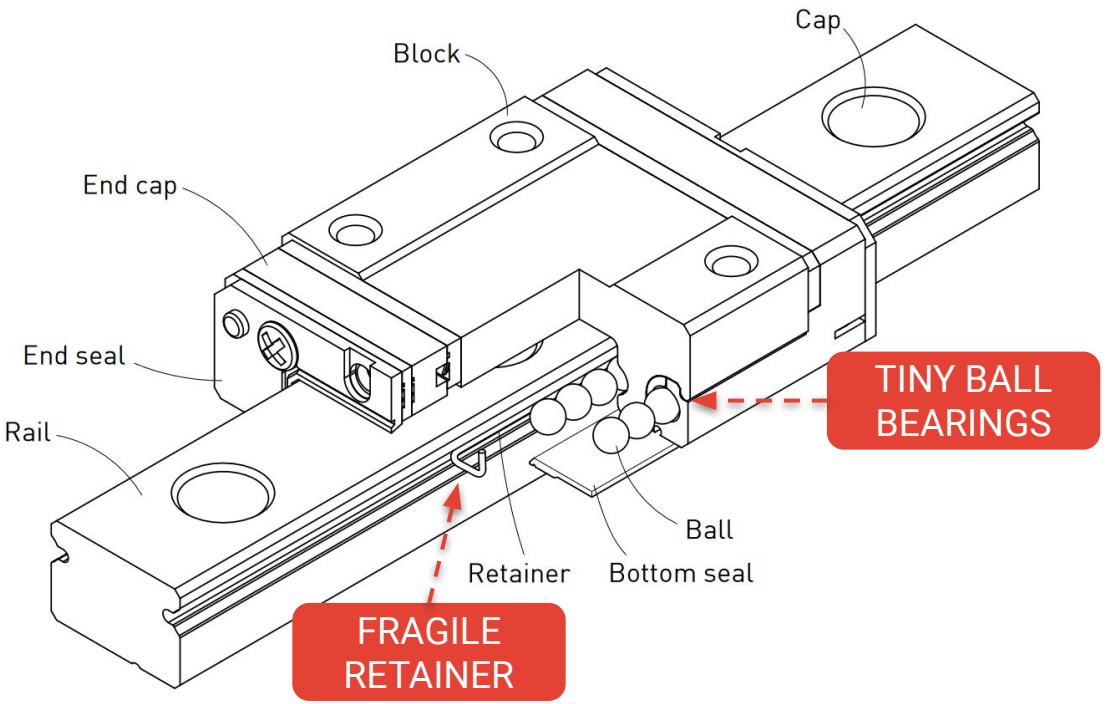
2. Do not drop the carriage.

See #1. Picture dozens of tiny bearings scattering across your floor at high speed.

3. Never force the carriage on or off the rail.

See #1. Picture dozens of tiny bearings scattering across your work surface at high speed.

📝 If you lose bearings, see if your manufacturer or distributor sells replacement carriages or bearings.



PICKING A LUBRICANT

A quality lubricant and periodic relubrication ensure your rails will work trouble-free. Here are some general rules about lubricants:

- **Use** a light- (NLGI 0 or 1) or medium-duty (NLGI 2) lithium soap-based grease. (1)
- **If possible,** use a syringe with a blunt tip to apply grease.
- Light oils (such as mineral oil) are **not recommended**. Oil is more-maintenance heavy than grease and easily picks up contaminants. (2)
- **Do not** use a dry lubricant (e.g., dry lithium or PTFE powder). (3)
- **Do not** use grease with molybdenum disulfide (MoS2) or graphite additives. These are usually a dark grey color. (4)
- **Avoid** switching types of lubricant after initial application, and **never** switch more than one NLGI grade. (5)

> 📝 If you aren't sure what grease to use, **Mobilux EP2** (North America/Europe) and **Fuchs Lagermeister EP2 or BF2** (Europe) are all safe choices.
>
> Several aftermarket 3D printing parts distributors offer blunt-tipped syringes loaded with one of these greases.

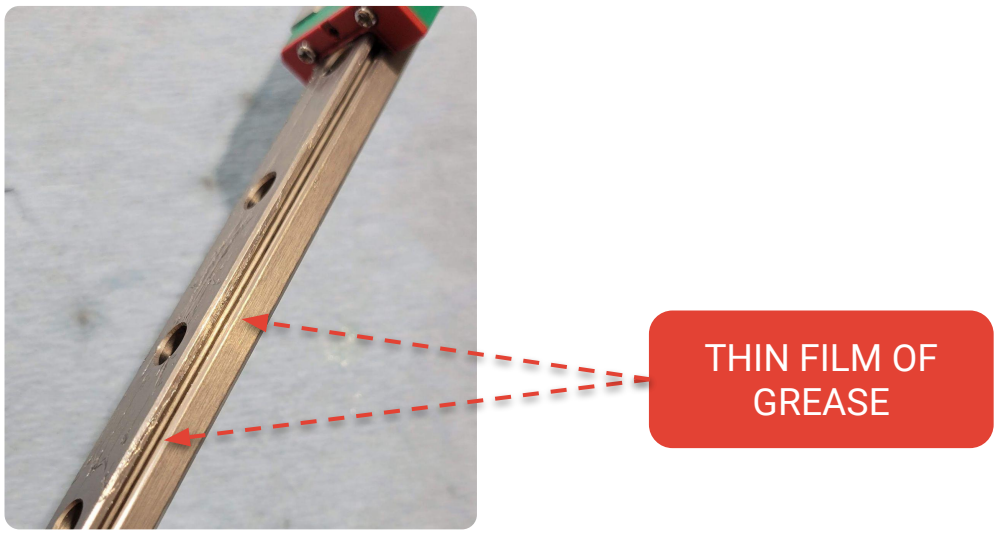
1. HIWIN, Lubricating instructions for linear guideways and ballscrews, pp 24-26.
2. .HIWIN, Lubricating instructions for linear guideways and ballscrews, p. 27
3. Thomson Linear, What should be used to lubricate linear bearings[...]?
4. HIWIN, Lubricating instructions for linear guideways and ballscrews, p. 5
5. HIWIN, Lubricating instructions for linear guideways and ballscrews, p. 6

PACKING VS. BEARING GREASE

Linear rails usually come coated in a **packing grease** to protect the rail. Some distributors clean and prepare ("pack") their carriages with real **bearing grease** before sale. How can you tell if your rails are already lubricated with bearing grease?

PRE-LUBRICATION SIGNS

1. Some grease should be visible, but the **rail should be largely free of grease**.
2. You **may** have a screw hole on the rail that is filled with grease (a sign of the flip & pack method).
3. Run the carriage up and down the rail. There should be a **thin film** of grease left behind in the bearing channel.
4. You should be able to see grease on the underside of the carriage, where the bearings are visible.



CLEANING GREASE: AN INTRODUCTION

To clean our rails, we need lint-free cloths (or shop towels), 91% or better isopropyl alcohol (IPA), and a container to hold the IPA and linear rail carriage. We're going to deep soak it to work out as much lubricant as possible.

⚠️ Linear rail carriages are often **not interchangeable** between rails. Clean your rails **one at a time** to avoid mixing rails and carriages.

OUR EXAMPLE RAIL

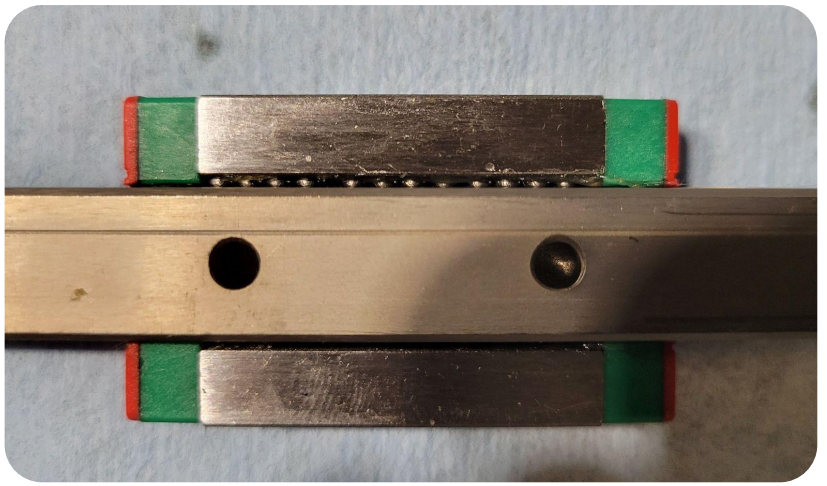
Instead of a new rail coated in packing grease, we used the nearest thing at hand–a several year-old, very cheap, and very dirty rail in need of maintenance.

New rails come with protective caps that are missing from our illustrations. We will call out when to remove these caps.

1. FLIP THE RAIL

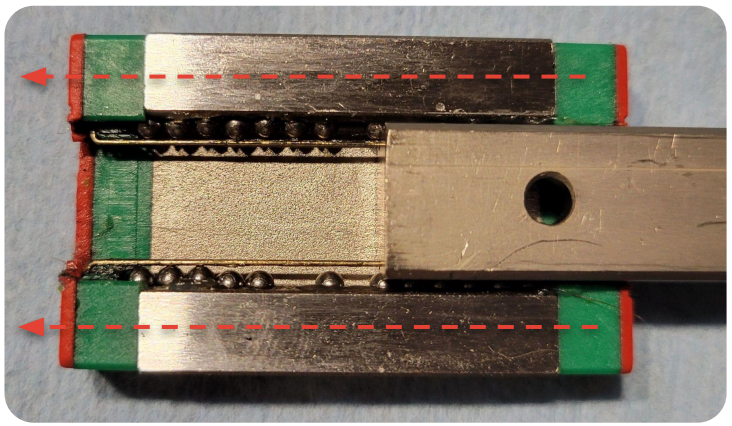
Start by removing **one protective cap** from the rail. Set it aside, but do not lose it.

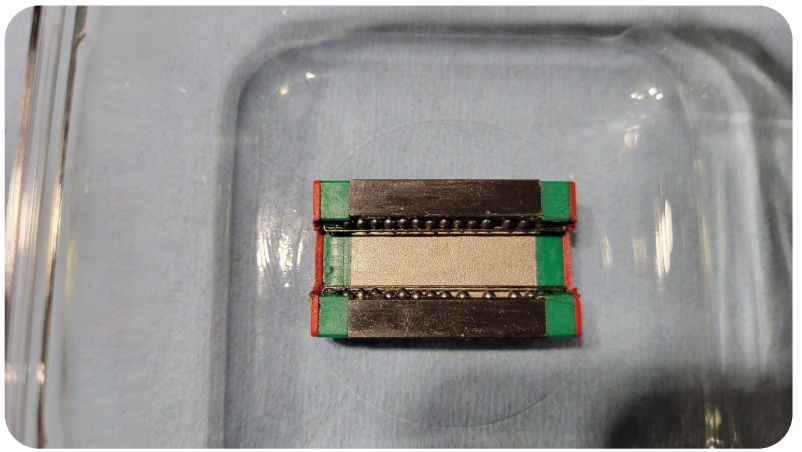
Next, turn the rail over; we want the carriage upside-down.



2. GENTLY REMOVE THE CARRIAGE

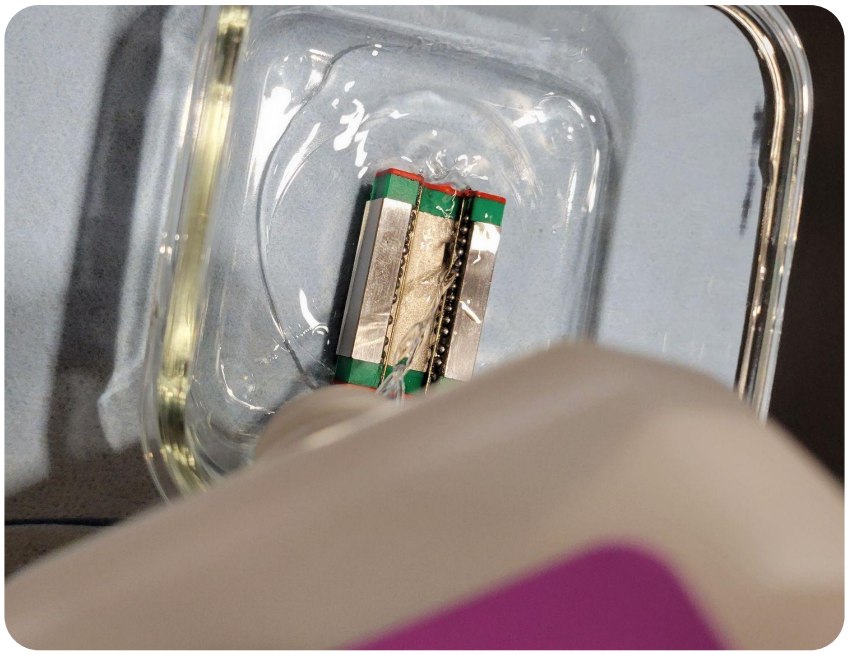
Carefully slide the carriage off of the end of the rail. Move slowly and **do not force** the carriage, as **this can cause bearings to pop out**. Place the carriage in a small container, preferably one made of metal or glass.





3. ADD ISOPROPYL ALCOHOL

Add isopropyl alcohol (IPA) to the container. Use enough to **cover the bearings** in the carriage.



4. LET IT SOAK

We're going to let the IPA soak for at least ten (10) minutes. Put the container in a **well-ventilated area** (preferably outside). We want the IPA to evaporate, so don't put a lid on the container.

Move on to step 5, cleaning the rail, while the carriage is soaking.

5. CLEAN THE RAIL

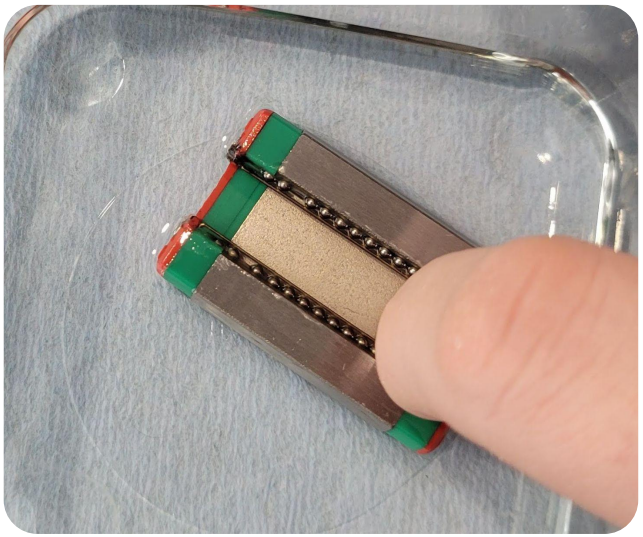
Apply some IPA to a shop towel or lint-free cloth and wipe down the rail. Thoroughly remove any packing grease in the bearing channels on each side.

6. CHECK ON THE CARRIAGE

Let's check on the carriage, which should still be soaking in IPA.

Gently shake the container side to side, then **lightly run a finger** over the bearings to rotate them through the carriage and work out any deep-seated grease.

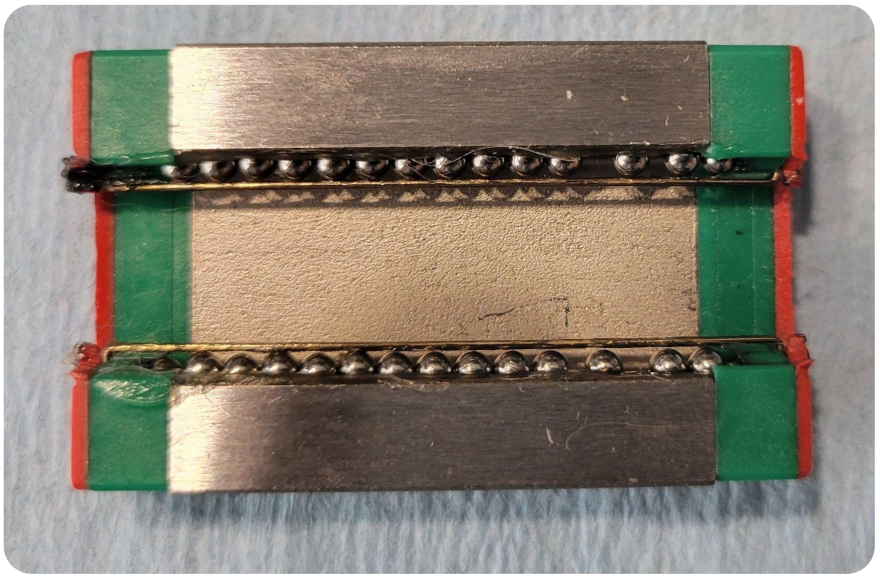
Set the container aside again until it has finished soaking for ten (10) minutes.



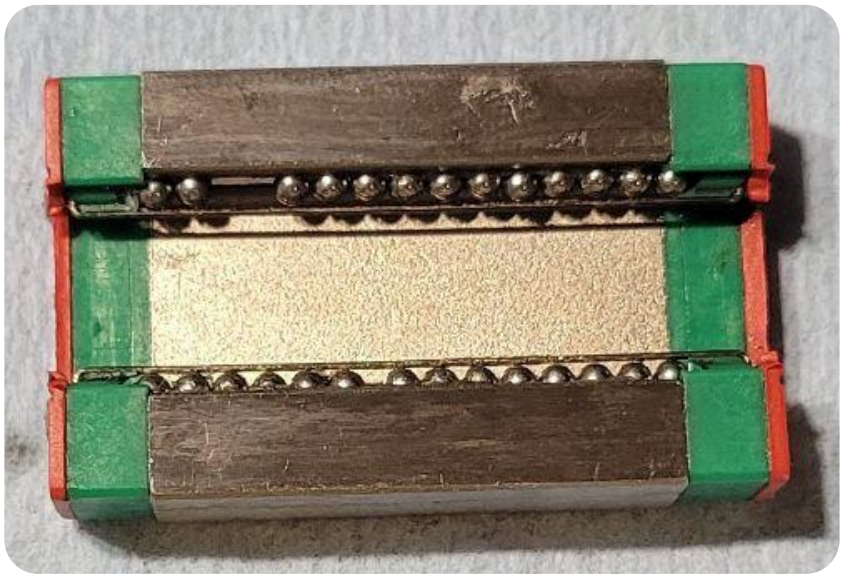
7. DRY THE CARRIAGE

Remove the carriage from the container with IPA and place on a cloth or towel. Allow several more minutes for the remaining IPA to evaporate, if it has not already.

BEFORE CLEANING



AFTER CLEANING



ℹ️ The carriage on the left is very dirty. Lubricated bearings often take on a matte or dull finish; this is nearly gone. There is lubricant outside the carriage, soil built up at the corners of the retaining clip, and hair caught in the bearings.

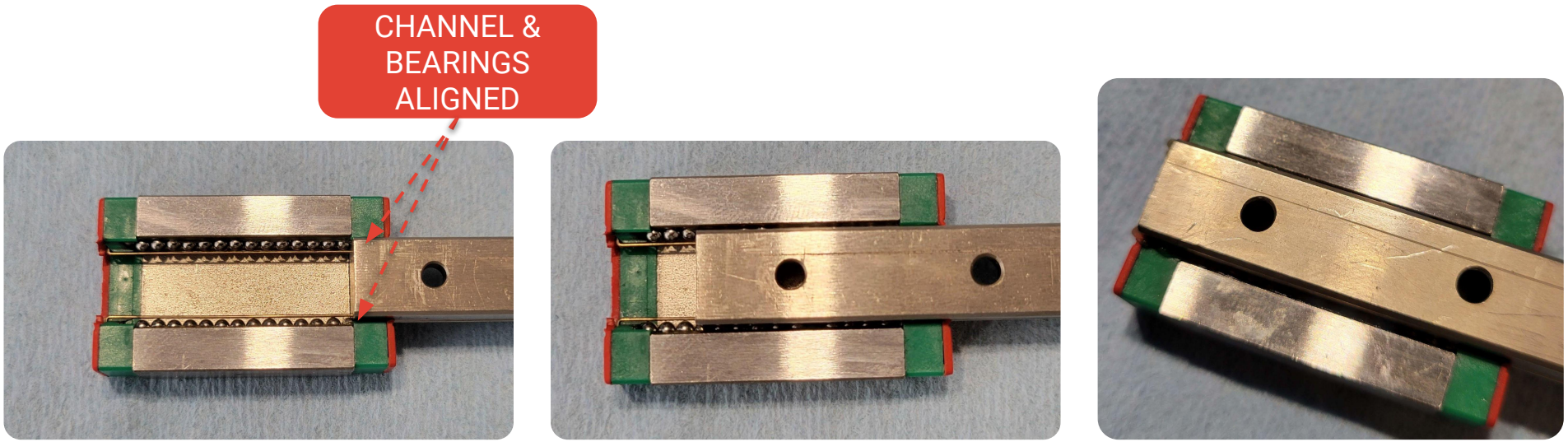
Clean bearings have a bright, chrome finish (right).

8. REASSEMBLE RAIL AND CARRIAGE

Set the carriage **upside down** on a flat surface with the bearings facing upwards. Turn the linear rail **upside down** and align the bearing channels with the with the bearings in the carriage.

Slowly and carefully guide the linear rail onto the carriage. **Do not force the carriage** or you may pop bearings loose!

Lastly, **replace the protective cap** removed in step 1.



CHOOSE AN APPLICATION METHOD

With our rail and carriages clean, we move to lubricating the carriage with grease.

There are two recommended methods of greasing. We will cover both methods; only follow the instructions from one.

- **GREASE PORT APPLICATION**

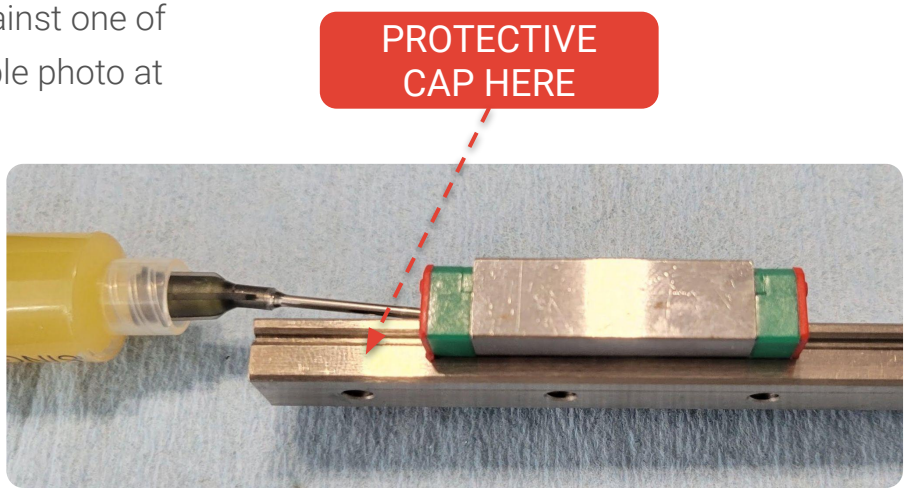
Grease ports are great for applying grease but not all carriages have working ports. This method requires a suitable applicator (normally a blunt-tipped syringe).

- **FLIP & PACK**

This method fills one of your rail's screw holes with grease, but can be done with applicators besides a blunt-tipped syringe.

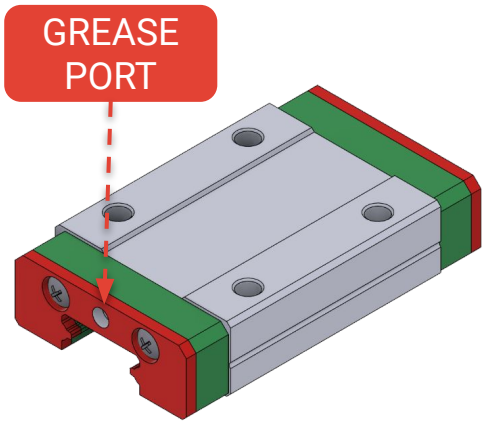
1. MOVE CARRIAGE NEAR THE END

Move the carriage to the end of a rail so that it rests against one of the protective caps. The cap is missing from the example photo at right, but the carriage is positioned correctly.



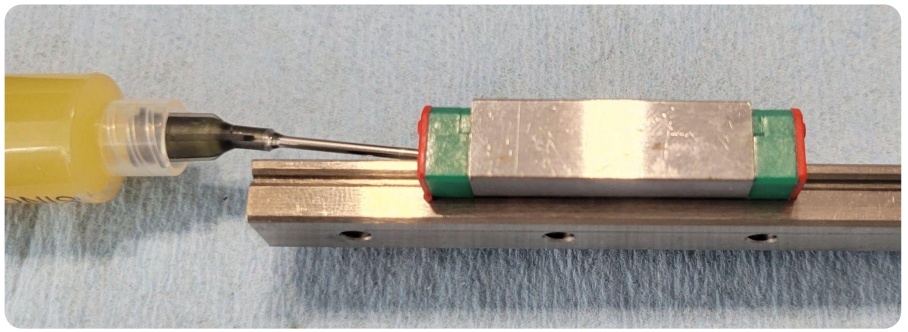
2. PICK A SYRINGE TIP

If your syringe comes with multiple blunt tips, swap for the **largest that will fit** in your carriage's grease port.



3. ADD SOME GREASE

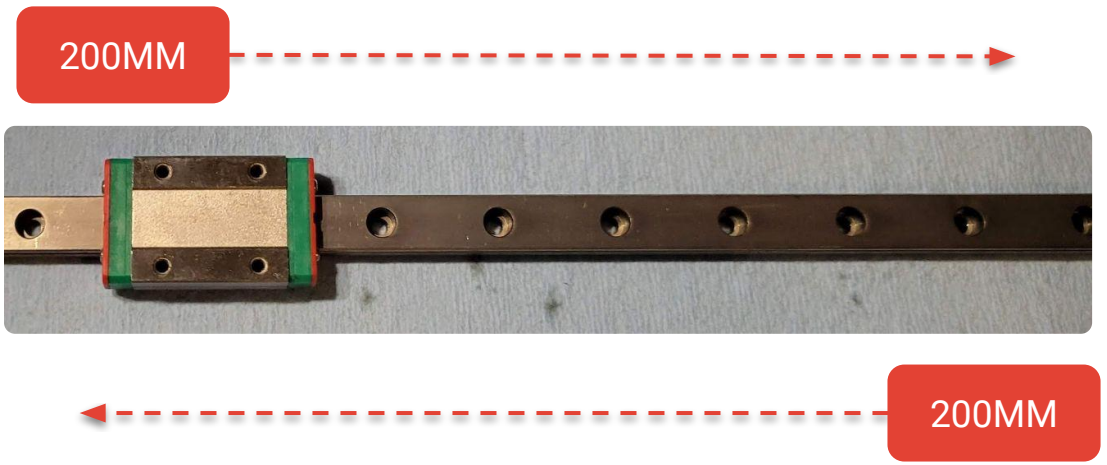
Insert the syringe tip **partway** into grease port. Apply a small amount (less than 0.1mL) of grease to the port.



4. DISTRIBUTE THE GREASE

Slide the carriage 200mm away from the edge and back.

Do this three (3) times.

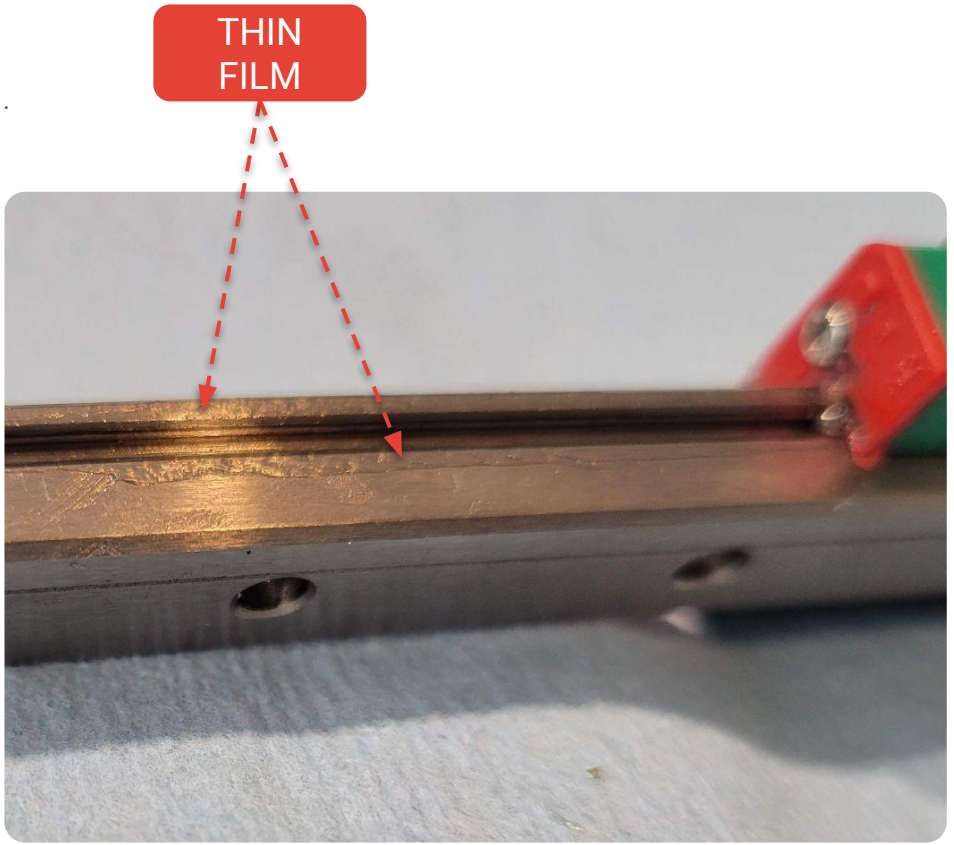


5. REPEAT UNTIL LUBRICATED

Continue applying small amounts of grease (step 3) and distributing it (step 4). You should notice grease appears between the bearings after application.

Stop when both:

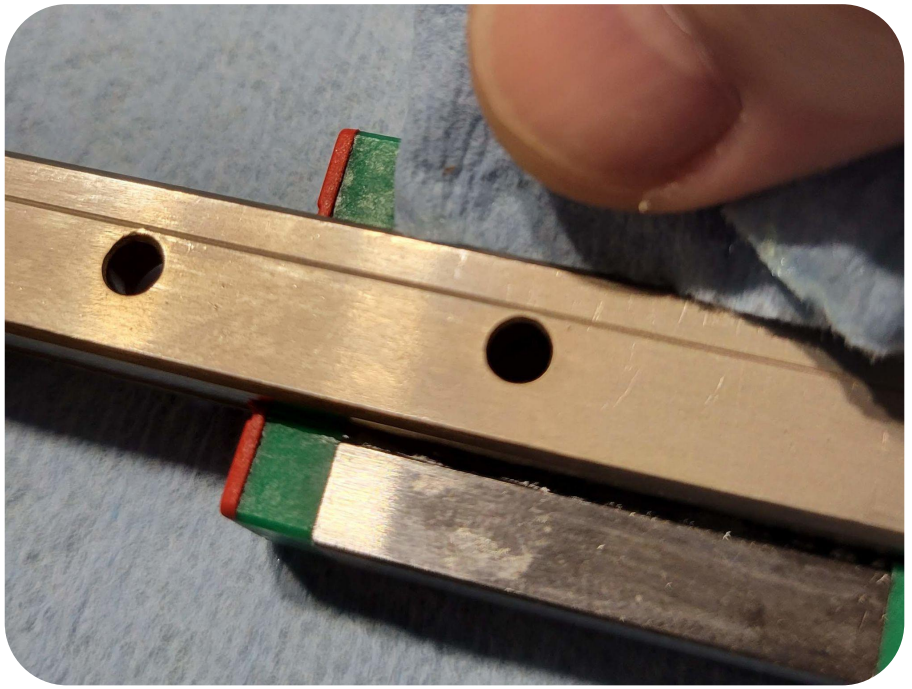
- Grease is well-distributed between the bearings; and
- The carriage begins leaving a thin film in the bearing channel.



6. CHECK AND CLEAN-UP

Take a clean towel or cloth and wipe excess from the rail and outside of the carriage.

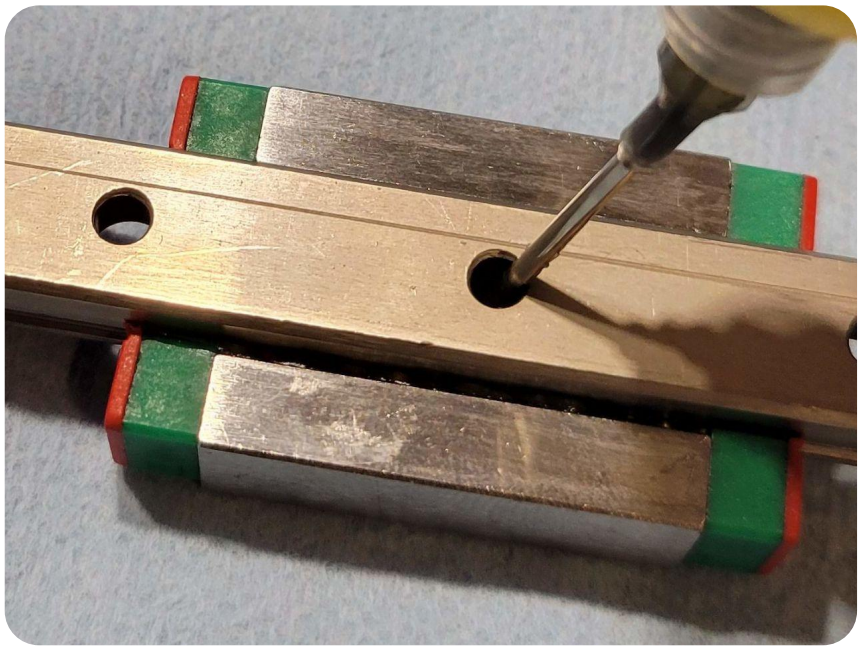
That's it! Skip the Flip & Pack instructions on the following pages and jump to **Z-Lift and Z-Drop Brackets**.



1. FLIP & CENTER THE CARRIAGE

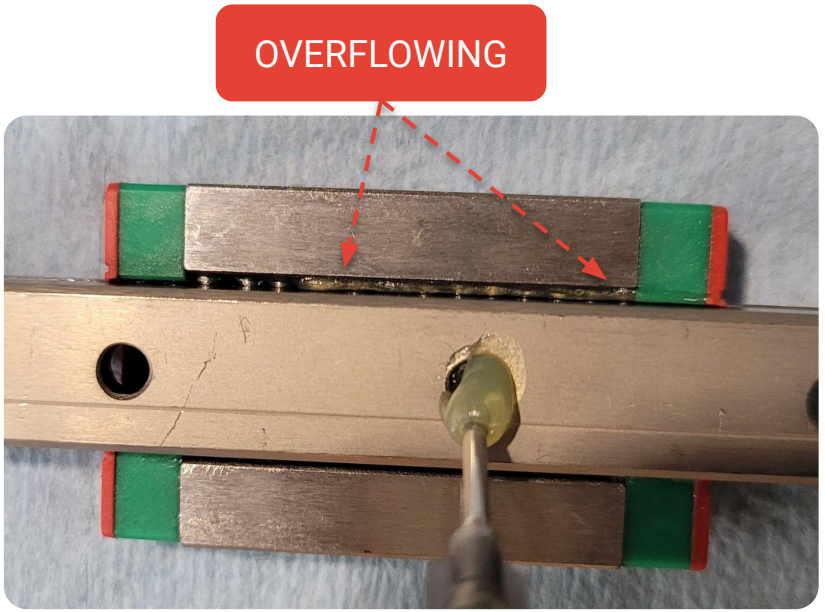
Flip the rail upside down and move the carriage over one of the center screw holes.

Press the grease applicator into the screw hole.



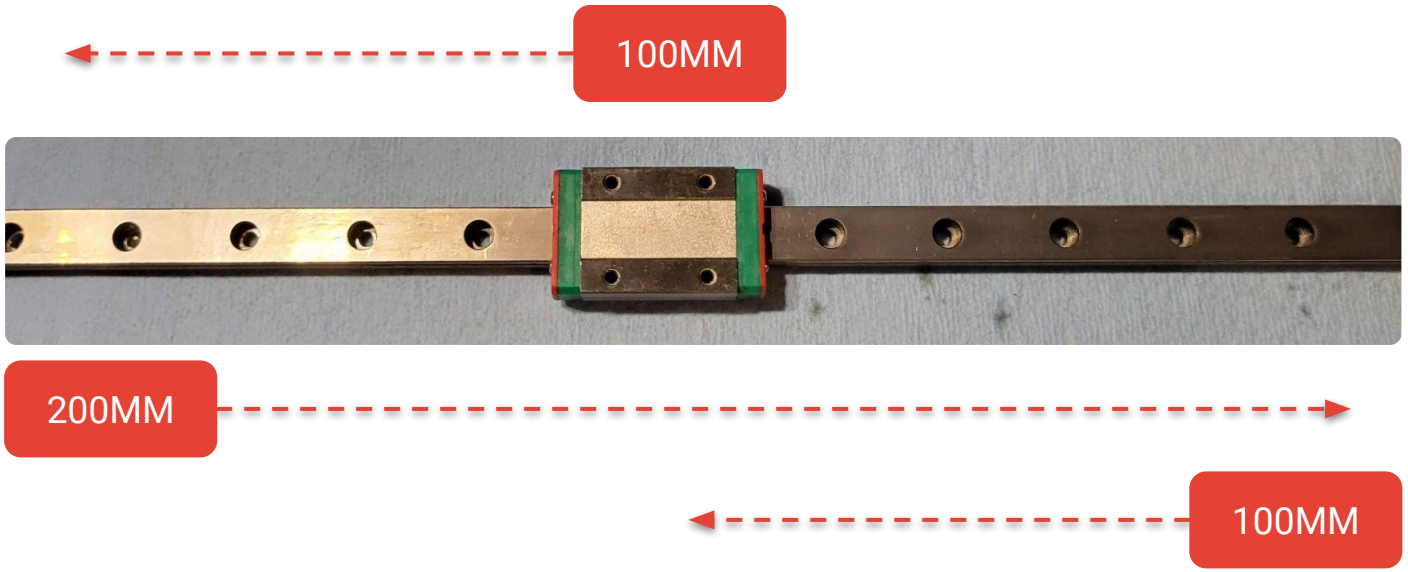
2. PACK THE GREASE

Dispense grease until it overflows **from between the bearings**. Remove the applicator.



3. DISTRIBUTE THE GREASE

Slide the carriage 100mm to the left, 200mm to the right, and back to where it started. **Run the carriage back and forth this way three (3) times.**

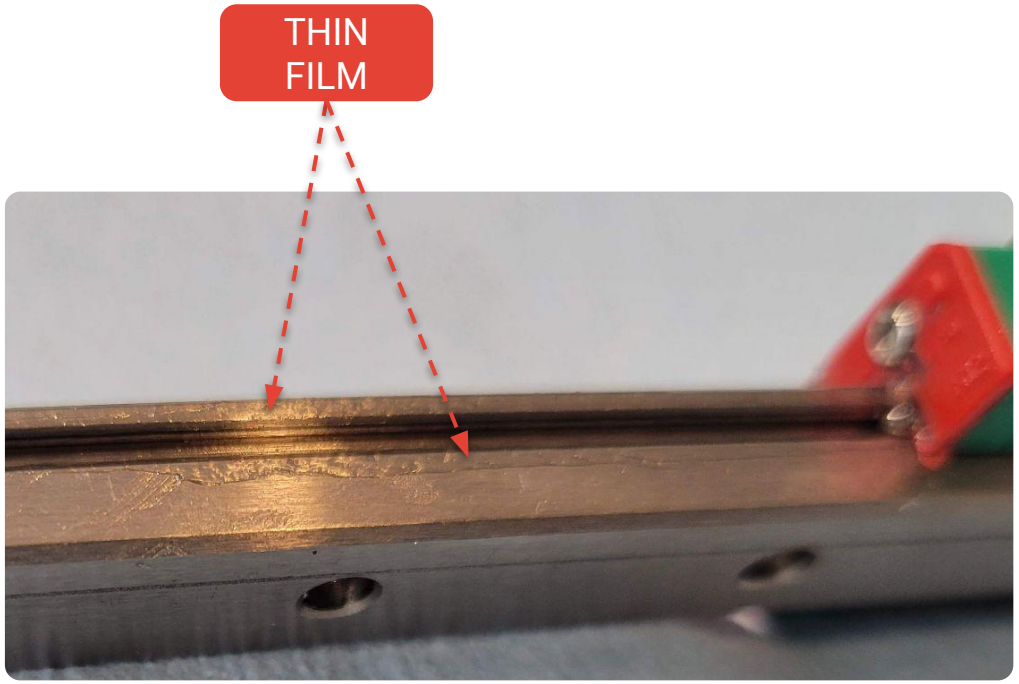


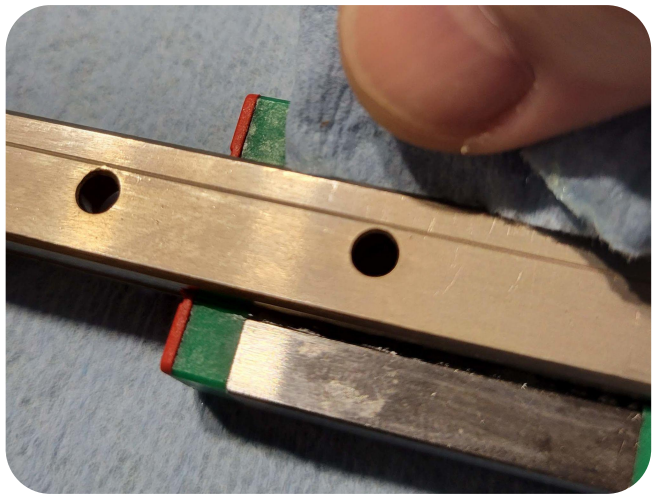
4. CHECK AND CLEAN-UP

With sufficient grease, the carriage trails a **thin film**. If you cannot see a film, repeat steps 2 and 3, using **half as much** as used before.

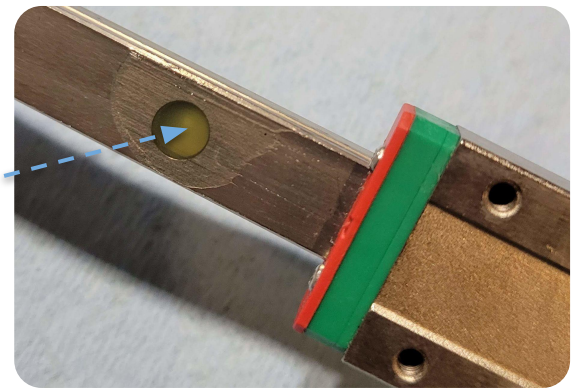
Once the carriage begins trailing some grease, take a clean towel or cloth and wipe excess from the rail and outside of the carriage.

Move on to the **Z-Drop and Z-Lift Brackets** next.





ℹ️ The screw hole used in step 2 is filled with grease. This can be removed.



Z-DROP & Z-LIFT BRACKETS

Z-DROP BRACKETS

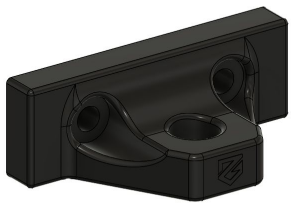
INTRODUCTION

Install Z-Drop Brackets if you are upgrading from an **Ender 5 or Ender 5 Pro** and **have not installed Hydra**. These add extra travel to your Y axis.

If you have a Plus without Hydra, the **Z-Lift Brackets** section is next.

If you have Hydra, move on to **Assembly** instead.

HARDWARE

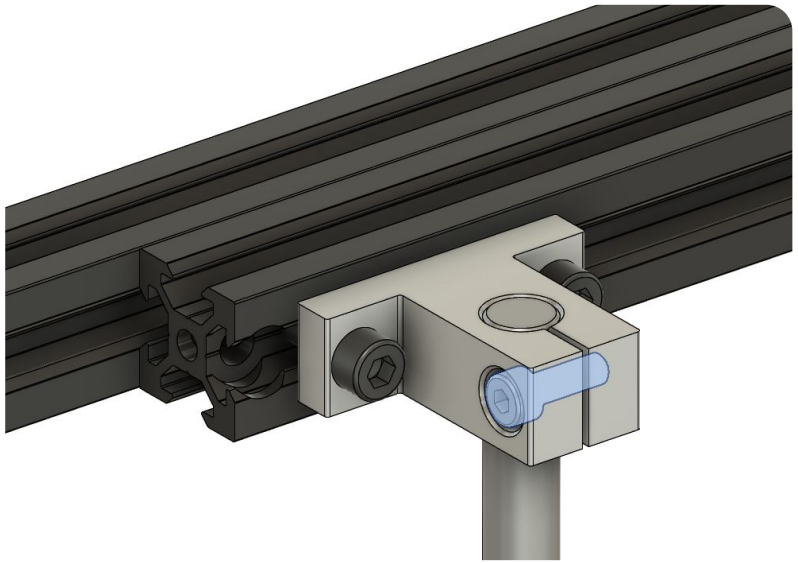


Z-DROP BRACKETS - QTY 2

Z-DROP BRACKETS / LEFT SIDE

1. LOOSEN THE M4X12

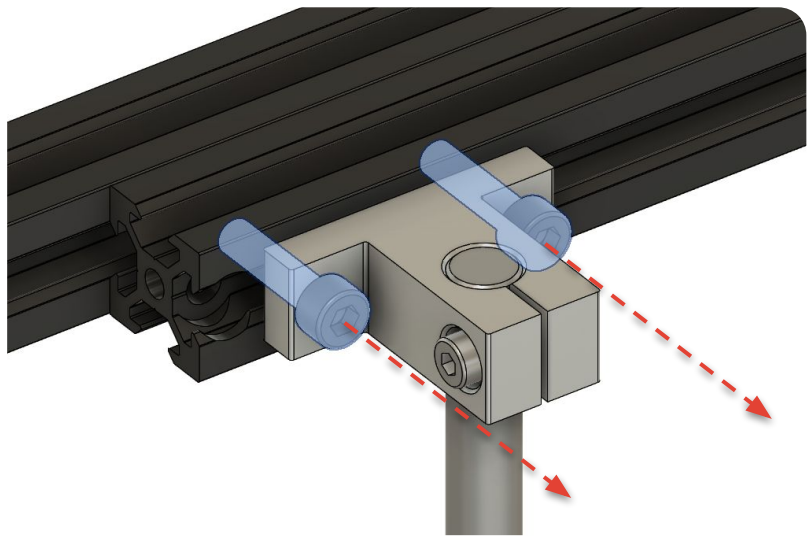
Start with the top left linear rod bracket: loosen the M4x12mm bolt holding the linear rod in place. Do not remove it completely.



⚠️ Reminder: Z-Drop Brackets are **not needed** for the **Ender 5 Plus**. Skip ahead to Z-Lift Brackets if you have a Plus.

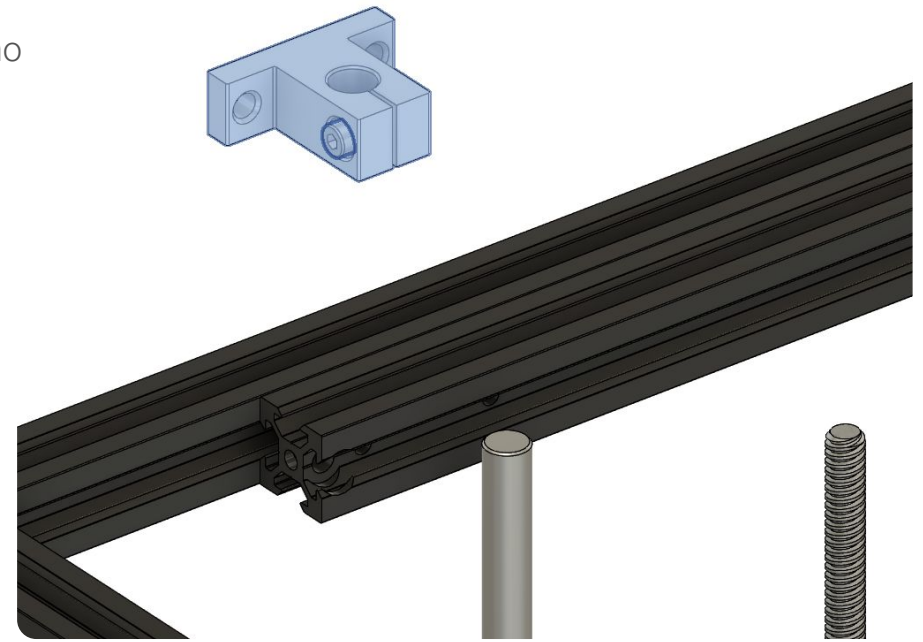
2. REMOVE THE M5X20 BOLTS

Remove the M5x20mm bolts and set them aside; we will need them in a moment.



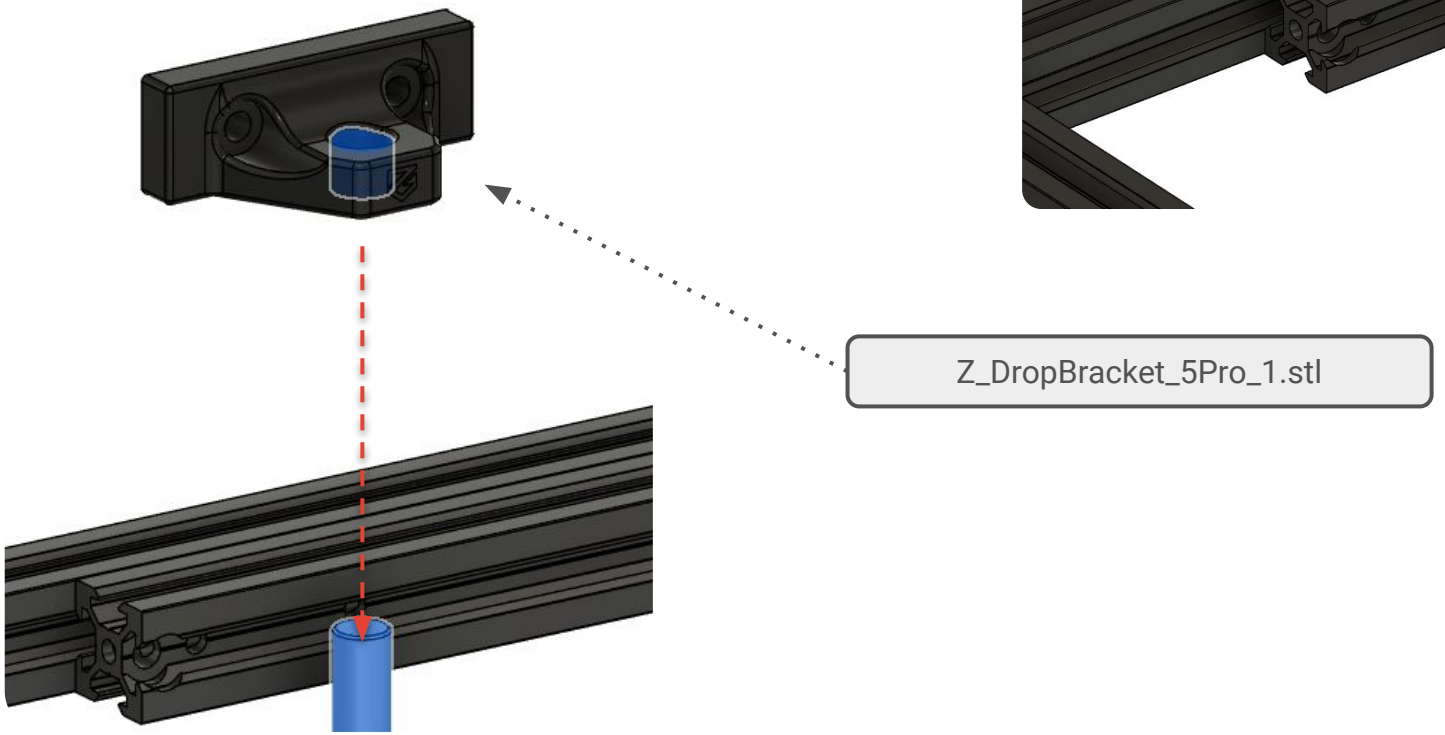
3. REMOVE THE STOCK BRACKET

Remove the stock bracket from the linear rod and set it aside. It is no longer needed.



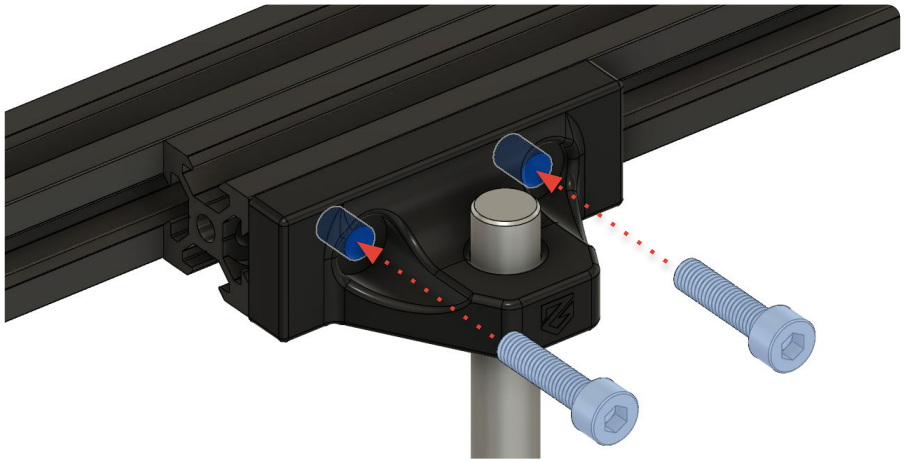
4. INSTALL THE PRINTED BRACKET

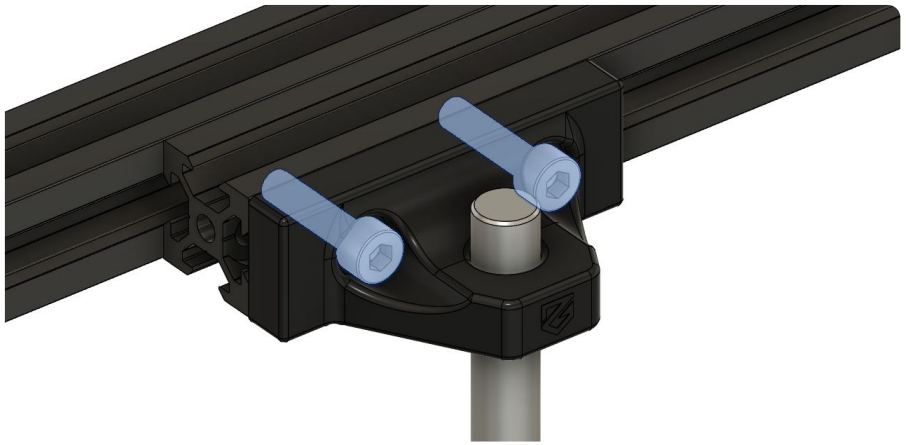
The printed drop bracket should slide onto the linear rod. Note the guide on the back of the bracket that aligns with the rear extrusion.



5. REINSTALL M5X20MM BOLTS

Reinstall the M5x20mm bolts that we set aside earlier.

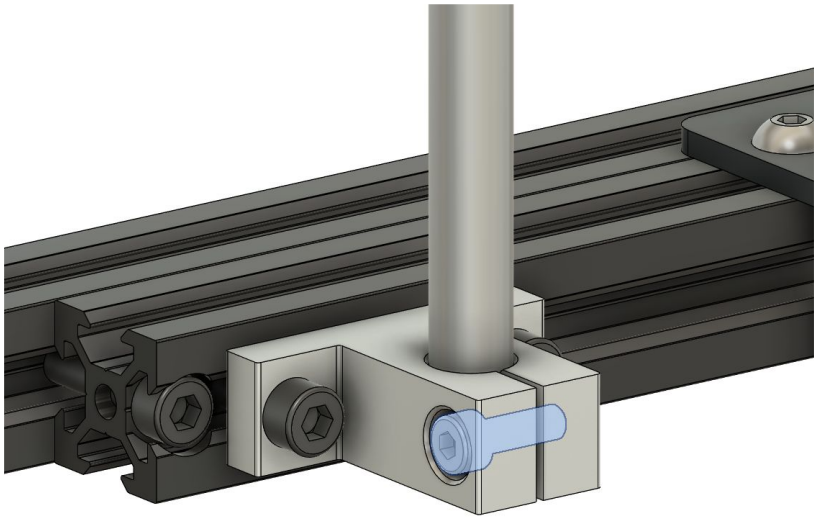




6. LOOSEN THE LOWER M4X12

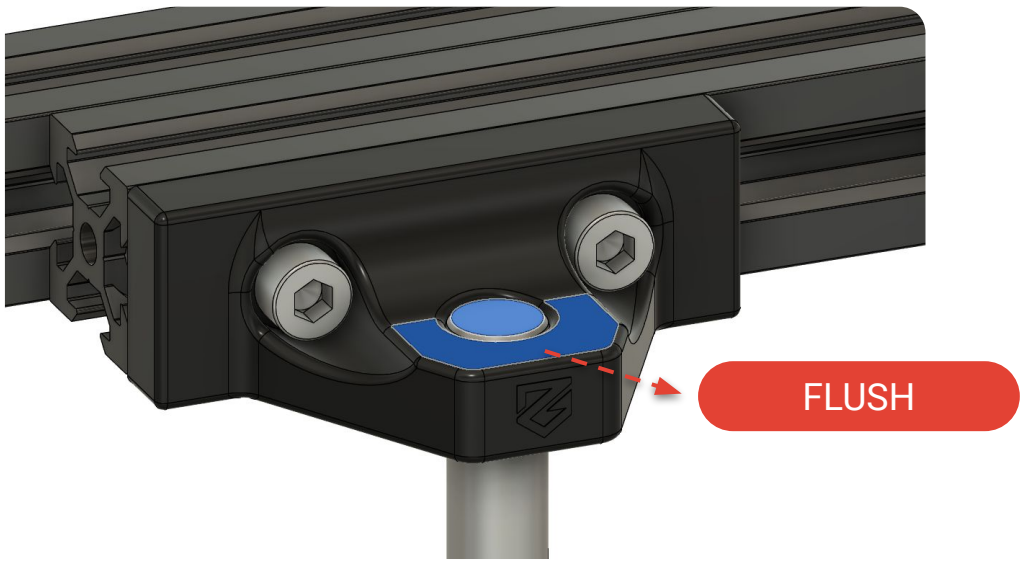
Next we need to lower the linear rod.

Loosen the **M4x12mm** bolt on the **lower bracket** enough to allow the linear rod to move. Do not remove the bolt completely.



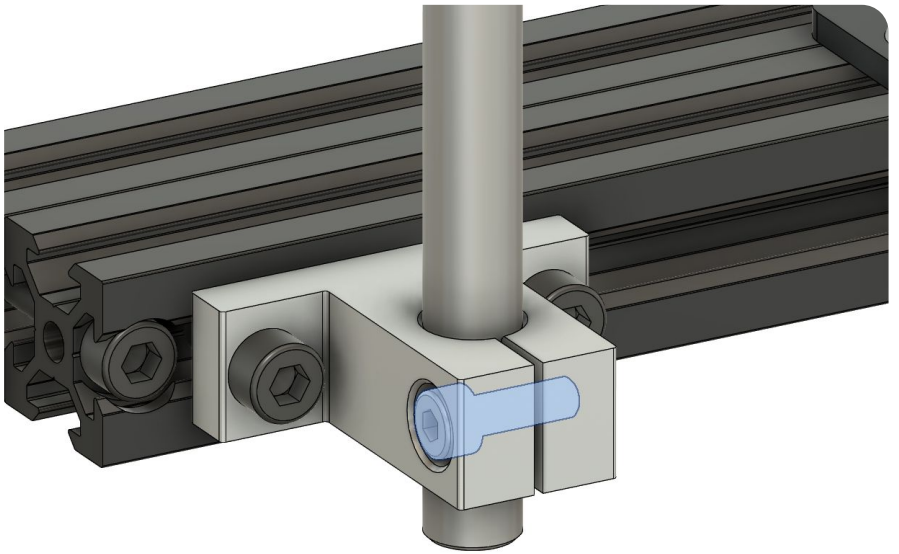
7. LOWER THE LINEAR ROD

Lower the rod until it is level with the top surface of the printed bracket (about 10mm). If the rod remains tightly fitted it may need some force to move; this is normal.



8. TIGHTEN M4X12

Tighten the M4x12mm bolt to hold the linear rod in position.



9. REPEAT

Follow the same steps with the right linear rod to install the second Z-Drop bracket.

Z LIFT BRACKETS / HARDWARE

ABOUT Z-LIFT BRACKETS

If you're upgrading from an **Ender 5 Plus** and **have not installed Hydra**, this component is **required**.

These are shims that sit under the bed extrusions, raising the bed by 10mm. Full illustrations are not available for these yet, although we still provide instructions.

⚠️ Z-Lift Brackets are used with the Ender 5 Plus **only**.

Skip ahead if you have an Ender 5/Ender 5 Pro (or Hydra).

HARDWARE

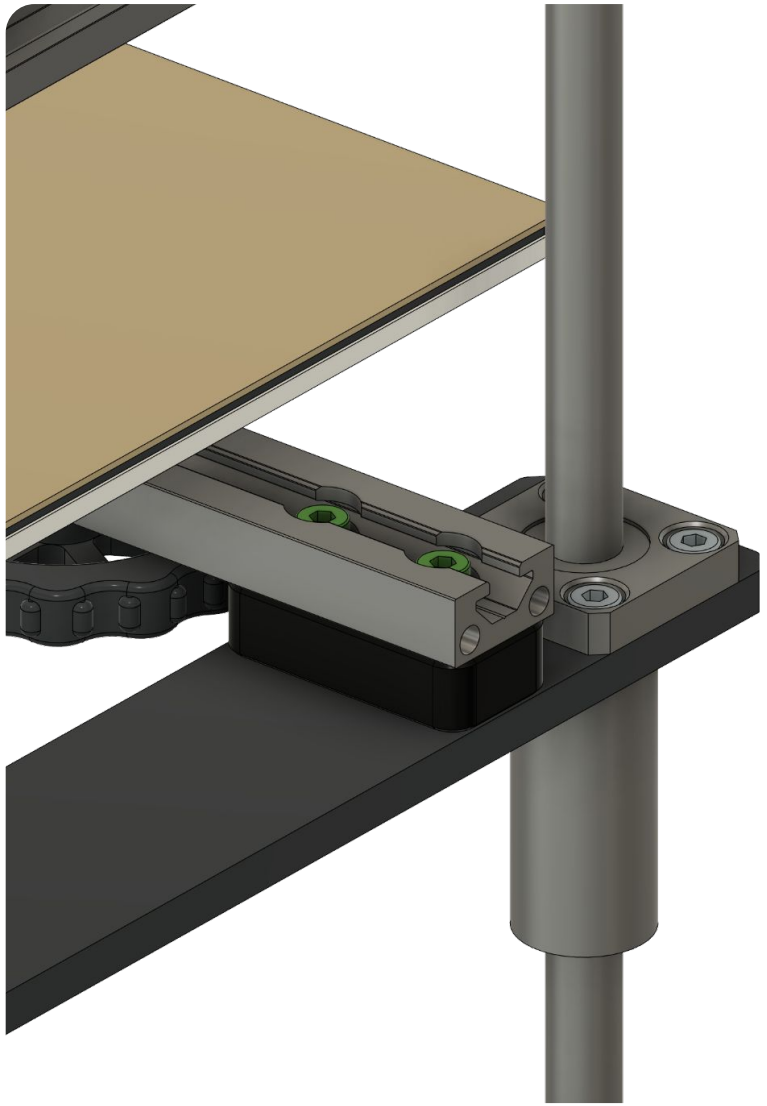
Z-LIFT BRACKETS - QTY 4

M4X20 SHCS - QTY 8

Z LIFT BRACKETS / STEPS

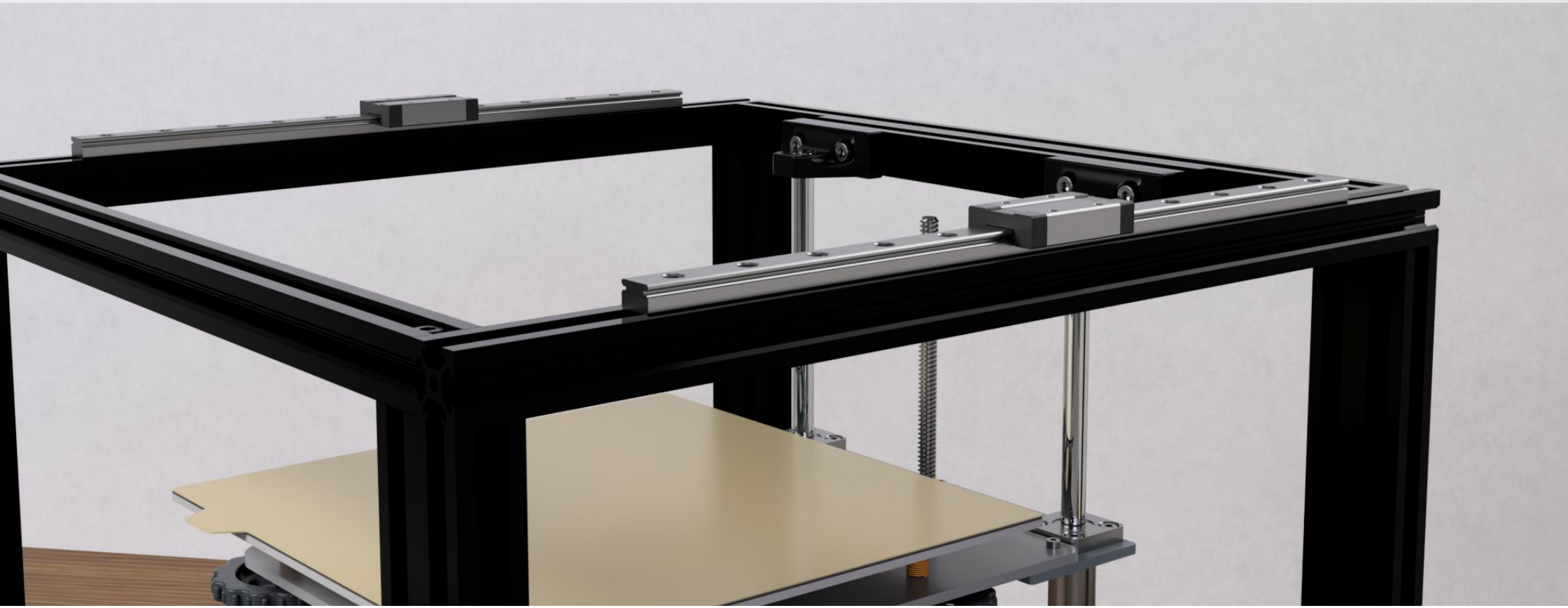
INSTALL STEPS

1. There are two (2) M4x8mm bolts by each linear rod, holding the Z axis crossbar extrusions in place. **Remove all eight (8) of these bolts.**
2. Carefully lift the bed assembly and slide a bracket underneath one crossbar, **directly under** the screw holes.
3. Install and **finger tighten** an M4x20mm screw through the crossbar and shim.
4. Lift another crossbar and install a screw. Continue until **all four** (4) brackets are installed and secured with one (1) screw each.
5. Install and finger tighten the second M4x20mm bolt at each crossbar end.
6. The crossbars should be flush with the outside of the Z joints; the lift brackets should not stick out. Adjust their alignment as needed.
7. **Fully tighten** all eight (8) M4x20mm bolts.



PART 3: ASSEMBLY

Y AXIS
LINEAR RAILS

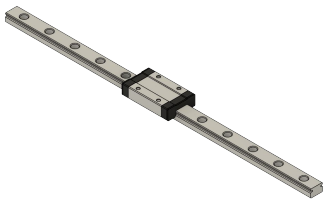


Y AXIS / HARDWARE

INTRODUCTION

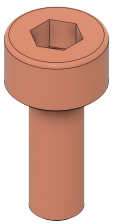
With any necessary Z axis adjustments out of the way, we can start on the CoreXY kinematics. Our first step is installing the Y axis linear rails.

HARDWARE



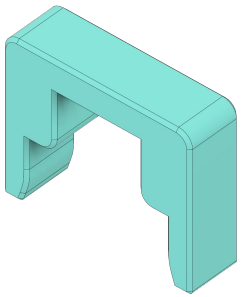
MGN12H LINEAR RAIL - QTY 2

Ender 5: 330mm (standard) or 300mm
Ender 5 Plus: 450mm

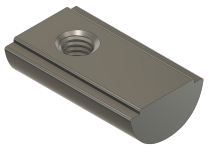


M3X8MM SHCS

300mm rails: Qty 12
330mm rails: Qty 14
450mm rails: Qty 18



RAIL ALIGNMENT TOOL - QTY 2



M3 ROLL-IN T-NUT

300mm rails: Qty 12
330mm rails: Qty 14
450mm rails: Qty 18

1. PREP BOLTS AND T-NUTS

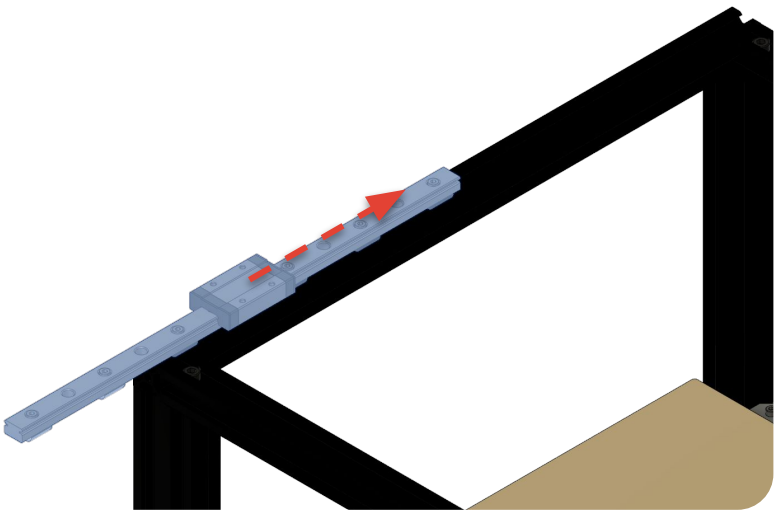
This step requires six (6) bolts and t-nuts for 300mm linear rails, seven (7) for 330mm, and nine (9) of each for 450mm rails.

Install M3x8mm bolts and M3 t-nuts to the first linear rail, alternating holes as you go. Leave about 2mm of space between the t-nuts and bottom of the linear rail.

Do not completely remove the protective caps; instead move them to unused screw holes.

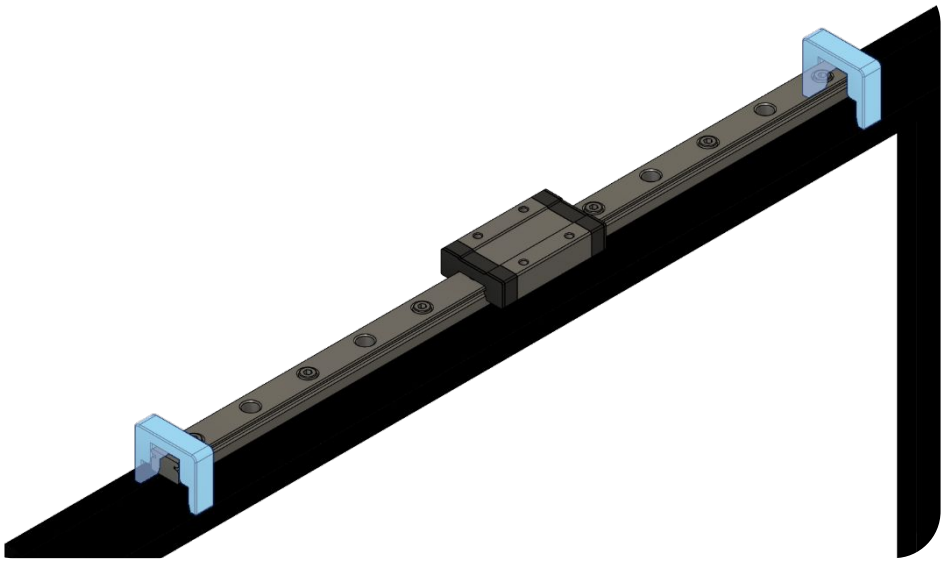
2. ADD RAIL TO EXTRUSION

Slide the loaded rail onto the frame's **top left** 2020 extrusion. Guide the t-nuts into the extrusion channel and tighten or loosen the screws as needed to raise or lower each t-nut.



3. POSITION THE RAIL

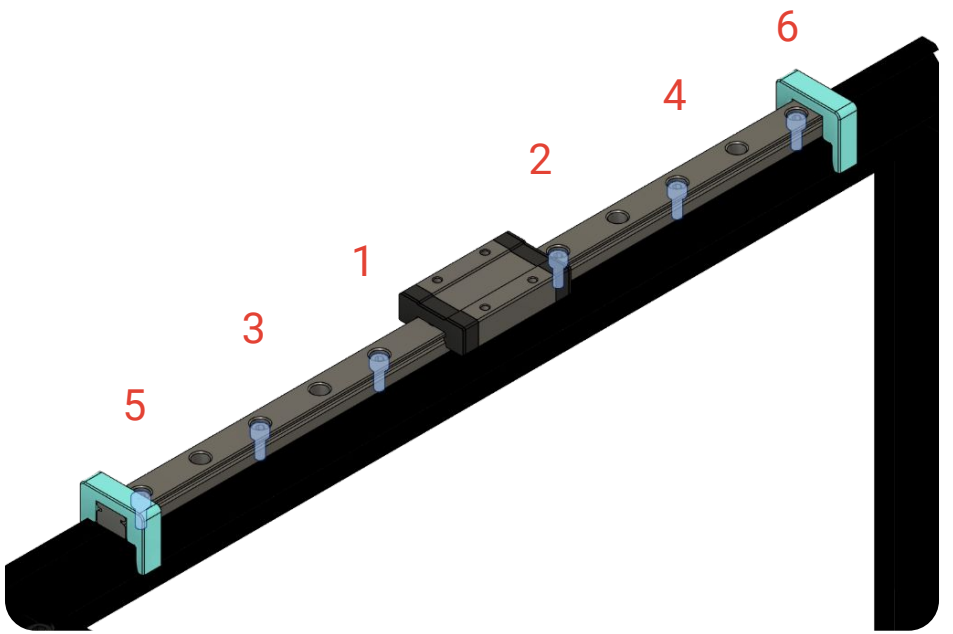
Center the linear rail on the extrusion, then align it to the center. Use printed alignment tools for this.



4. TIGHTEN BOLTS

Start with the inner two (2) M3x8mm bolts and tighten them **just enough to hold the rail** in place. Work outwards in the pattern seen at right.

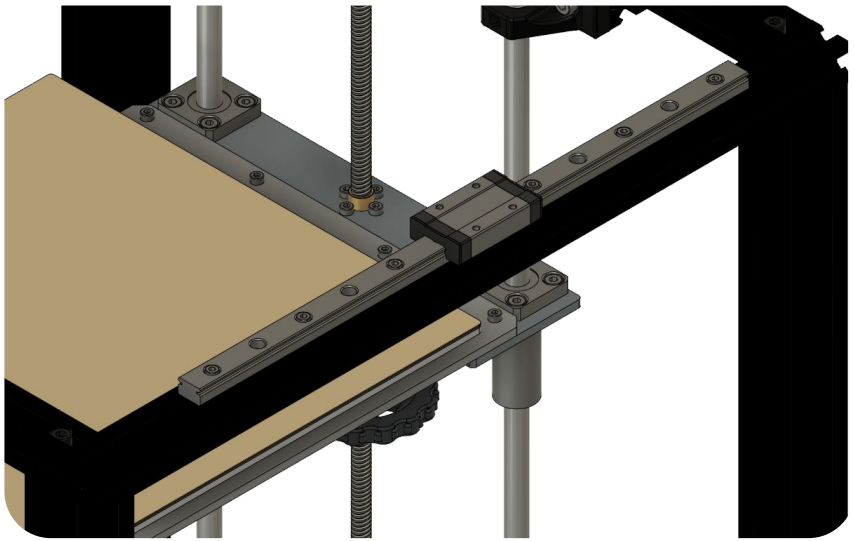
Finally, **fully tighten** all of the bolts in the same pattern and remove the alignment tools. Keep the alignment tools close; we'll need them again for the next rail.



5. PREP AND INSTALL RIGHT SIDE

Prepare another linear rail with M3x8mm bolts and t-nuts, in the same manner as the previous rail.

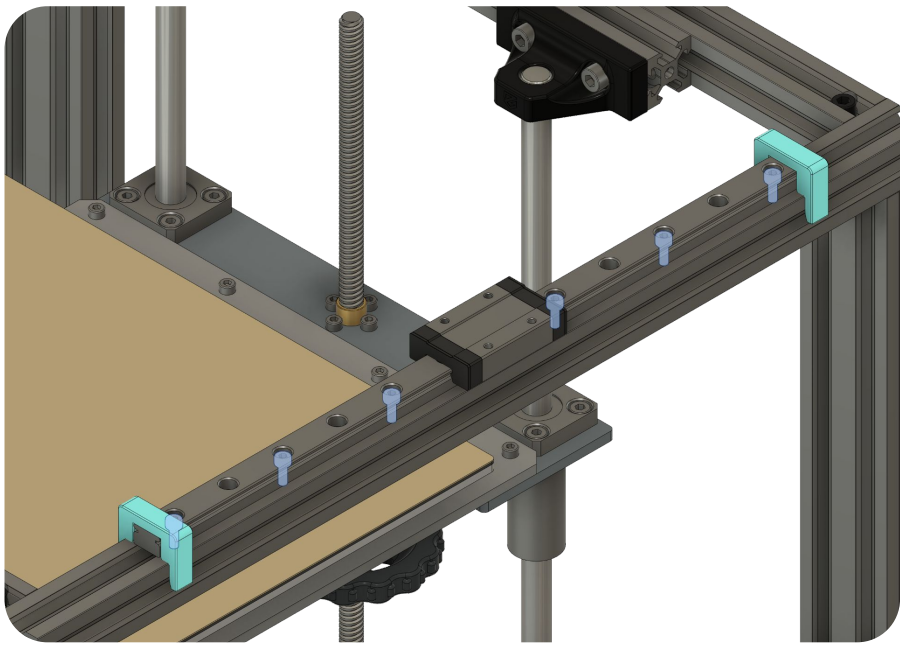
Install the remaining linear rail and M3 hardware on the frame's **top right** 2020 extrusion.



6. CENTER AND TIGHTEN

Use your printed alignment tools to center the rail, then **finger tighten** the M3x8mm bolts. As before, **start in the center** and work outwards.

Do not fully tighten the screws; we will come back to this in a later stage of assembly.



STEPPER PULLEYS

STEPPER PULLEYS / HARDWARE

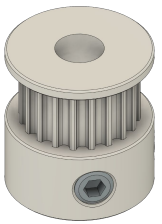
INTRODUCTION

This is the first of three sections that covers building and installing stepper towers. Stepper pulley alignment is **critical** to your printer's proper function, so we have printed tools to help.

HARDWARE

NEMA17 STEPPERS - QTY 2

These are typically 2A or 2.5A steppers.

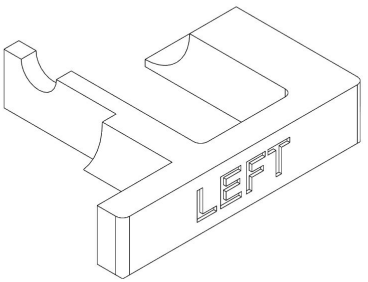


GT2 20T PULLEY, 5MM ID - QTY 2

These should come with grub screws pre-installed.

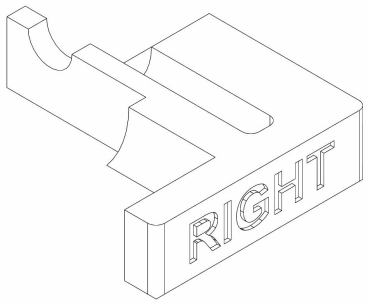
BLUE THREADLOCKER

Strongly recommended.



LEFT PULLEY ALIGNMENT TOOL

"left_pulley_alignment_tool.stl"
Download here.



RIGHT PULLEY ALIGNMENT TOOL

"right_pulley_alignment_tool.stl"
Download here.

STEPPER PULLEYS / LEFT

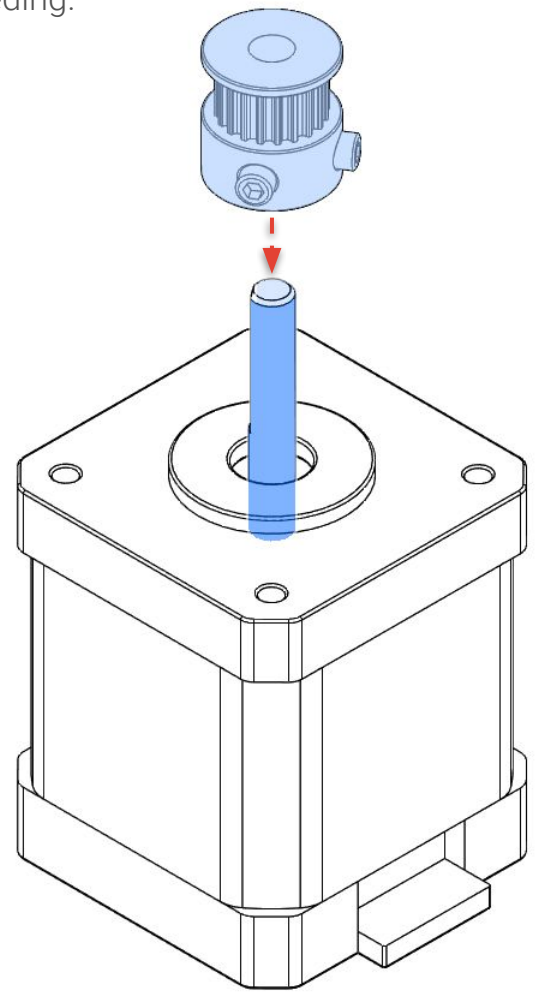
1. LOOSEN GRUB SCREWS

Loosen the grub screws, but be **careful not to lose them**.

If you have threadlocker, **apply it to the grub screw threads** before proceeding.

2. INSTALL PULLEY

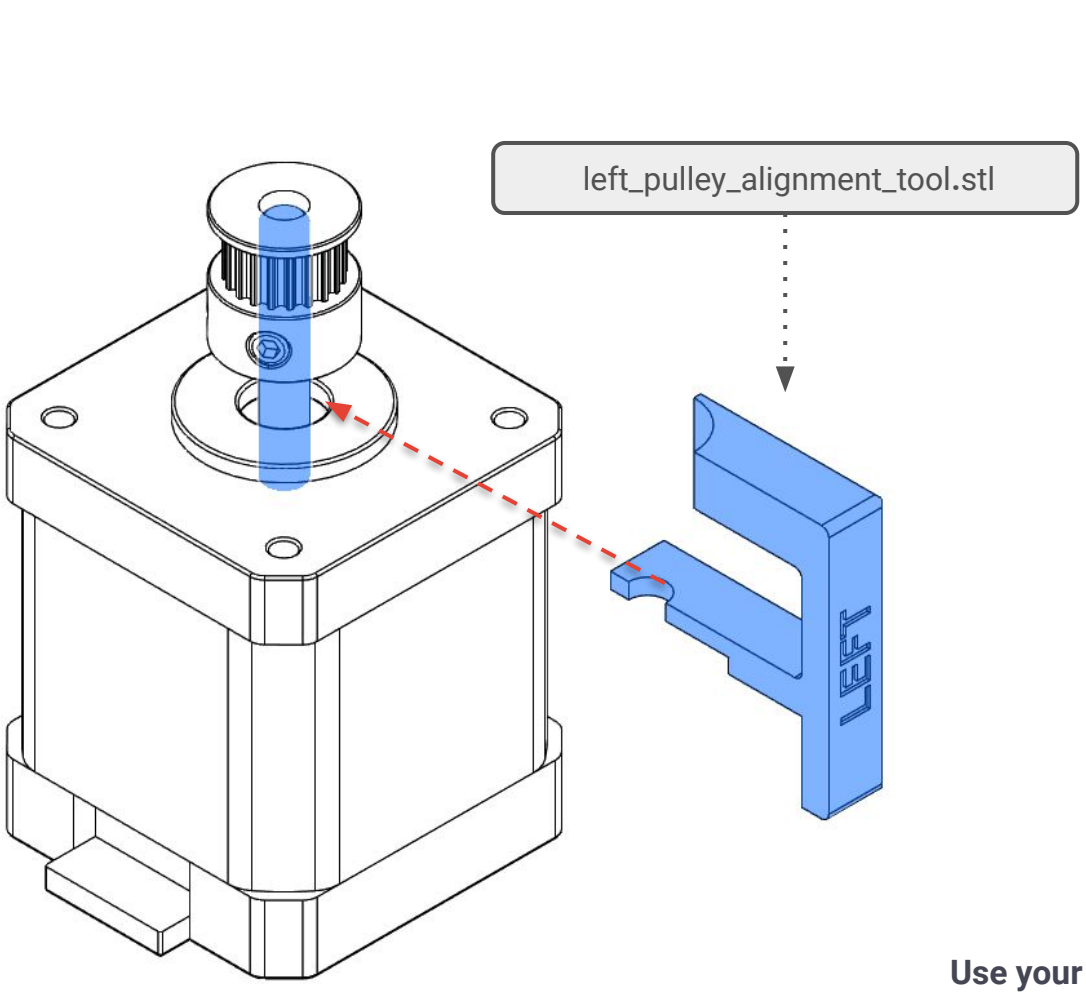
Place the 20-tooth pulley onto the stepper shaft, ensuring that the **thin flange is facing up**, as shown in the image.

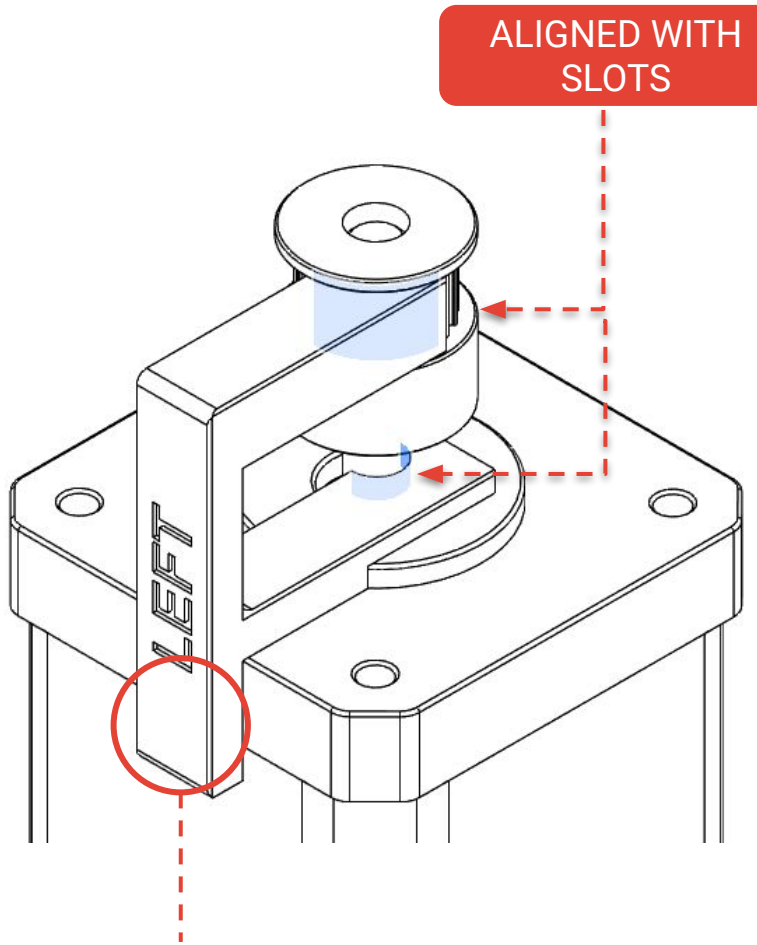


YOUTUBE VIDEO - LEFT SCAN QR OR CLICK HERE

3. LEFT PULLEY ALIGNMENT TOOL

Grab the printed helper tool labeled "LEFT." This part has slots that align with both the stepper motor shaft and the stepper pulley.

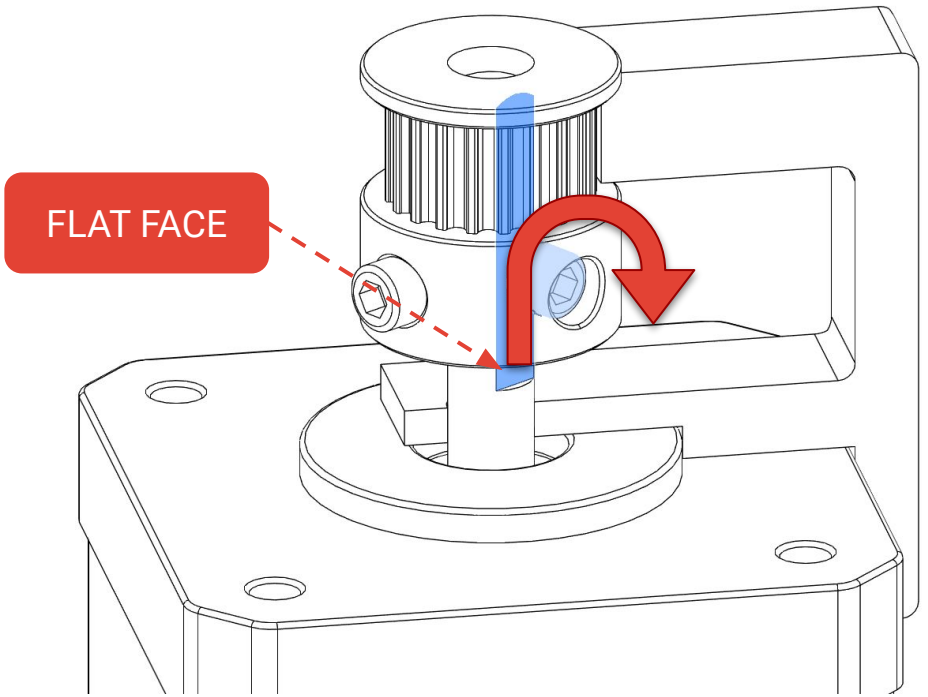


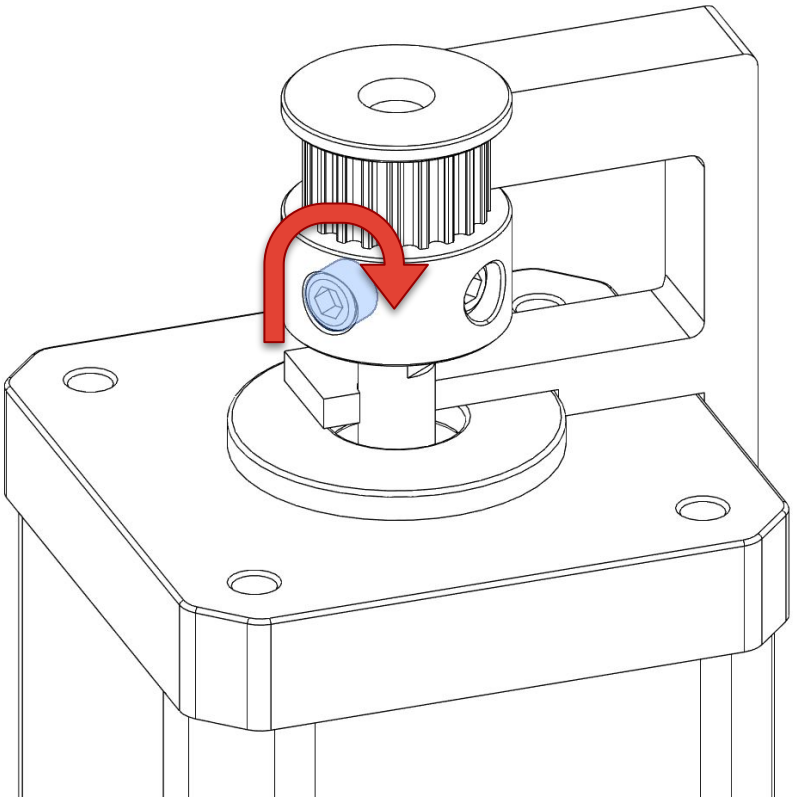


Use your finger or thumb to keep the tool in place.

4. TIGHTEN THE GRUB SCREWS

Rotate the pulley so that one grub screw **aligns with the flat face** on the stepper motor shaft. Tighten both of the grub screws, but be **careful not to overtighten**, as the heads strip easily.





STEPPER PULLEYS / RIGHT

1. PREPARE GRUB SCREWS

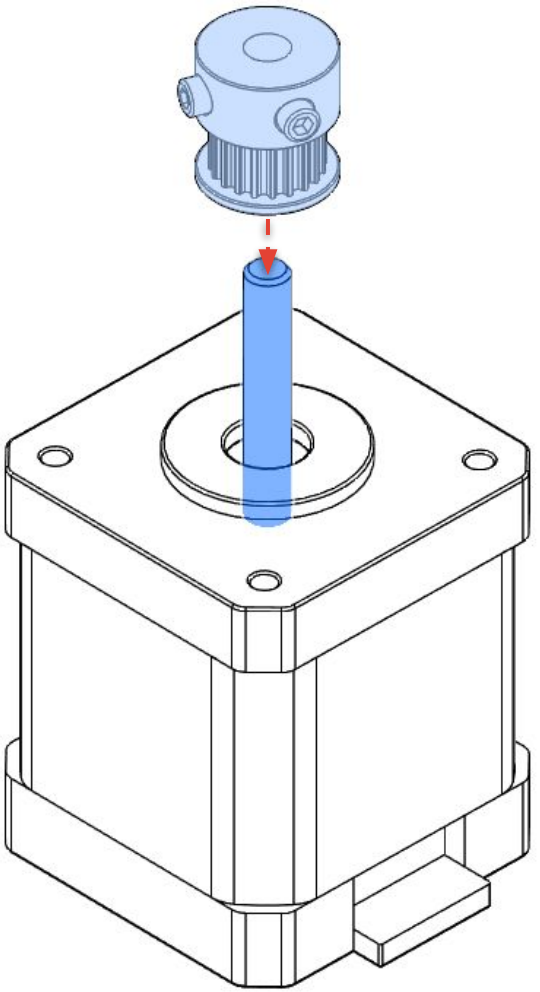
Loosen the grub screws, but be **careful not to lose them**.

If you have threadlocker, **apply it to the grub screw threads** before proceeding.

2. INSTALL PULLEY

Place the 20-tooth pulley onto the stepper shaft, ensuring that the **thin flange is facing down**, as shown in the image.

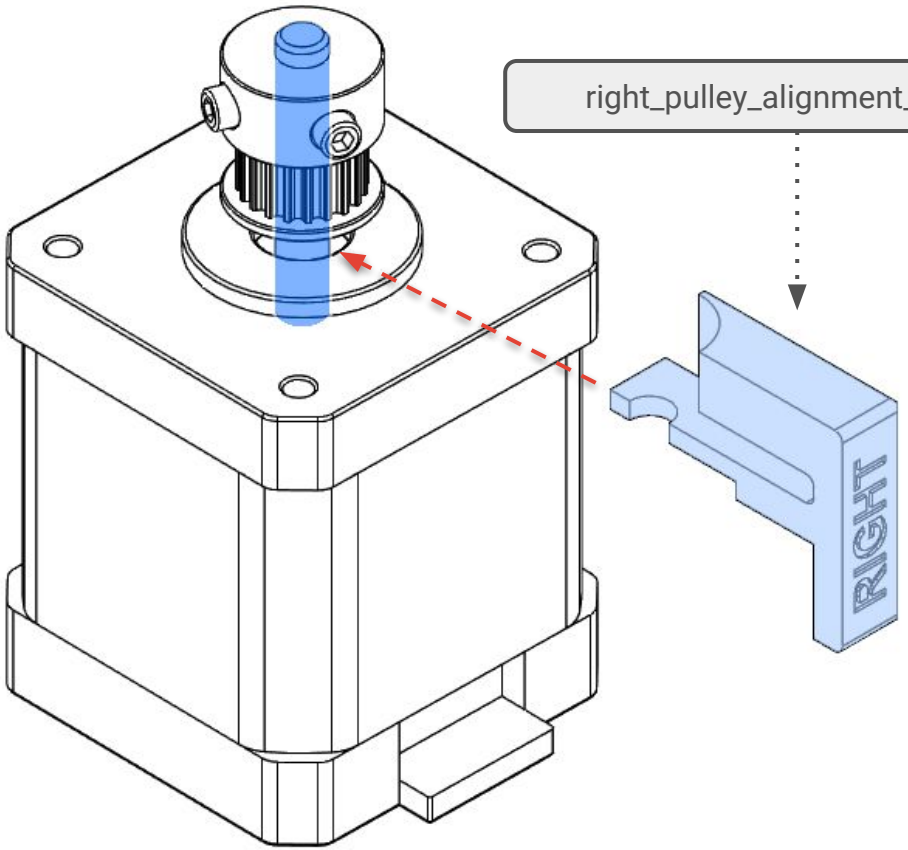
Note that this differs from the left stepper!

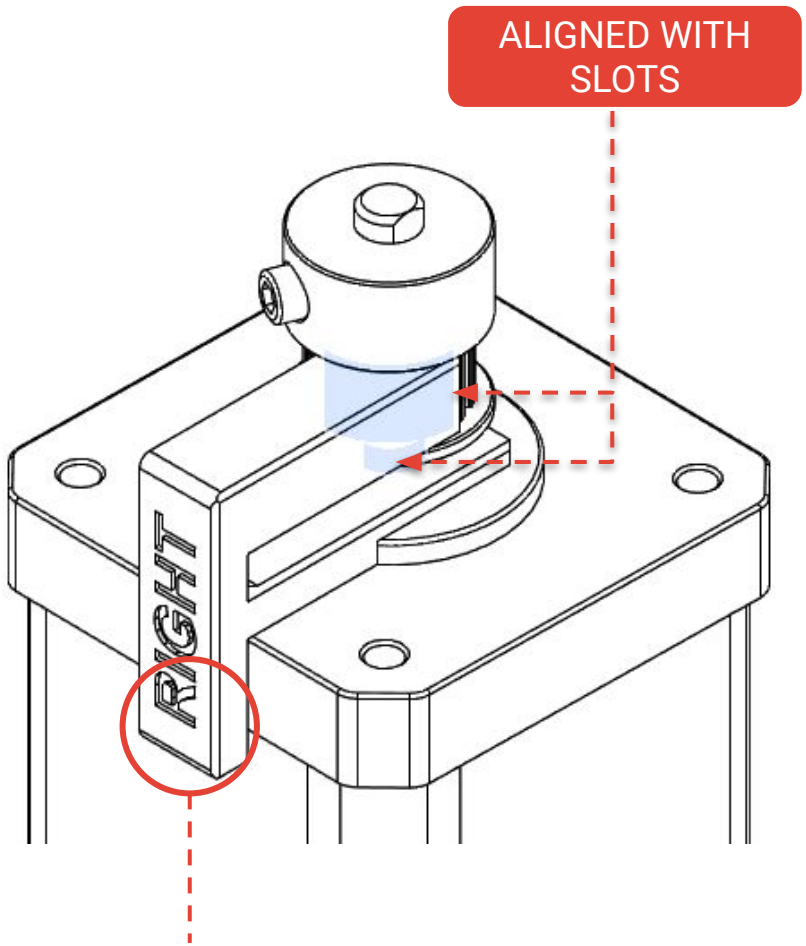


YOUTUBE VIDEO - RIGHT SCAN QR OR CLICK HERE

3. RIGHT PRINTED ALIGNMENT TOOL

Grab the printed helper tool labeled "RIGHT." This part has slots that align with both the stepper motor shaft and the stepper pulley.

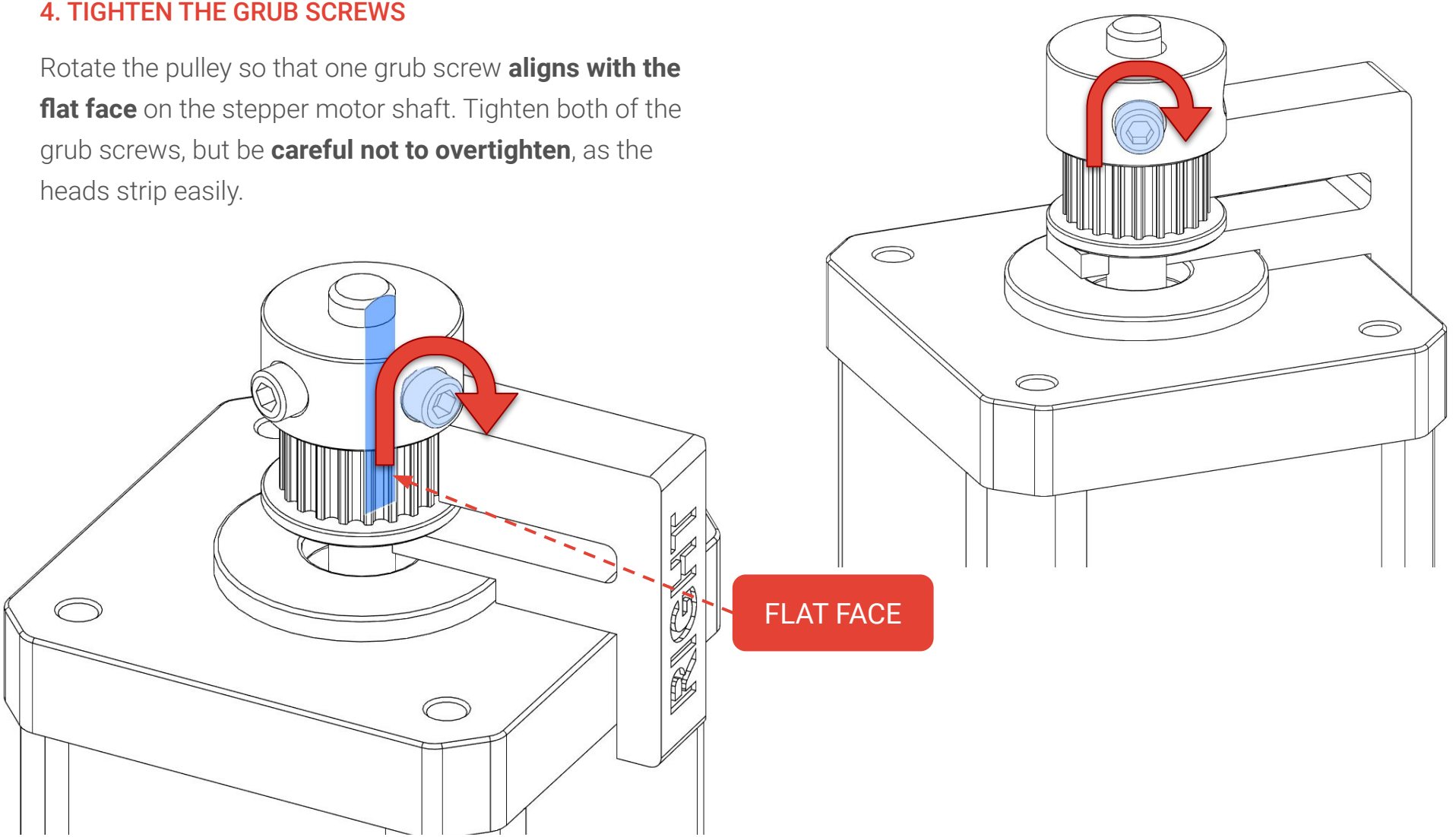




Use your finger or thumb to keep the tool in place.

4. TIGHTEN THE GRUB SCREWS

Rotate the pulley so that one grub screw **aligns with the flat face** on the stepper motor shaft. Tighten both of the grub screws, but be **careful not to overtighten**, as the heads strip easily.



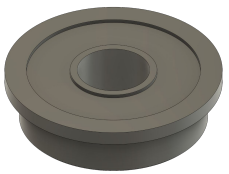
STEPPER TOWERS ASSEMBLY

INTRODUCTION

Next, we'll build our stepper towers, the heart of our CoreXY motion system. In the process, we'll also build our first flange stacks.

We have a **YouTube** video demonstrating this part of the assembly process, if you would prefer.

HARDWARE



F695 BEARING - QTY 12

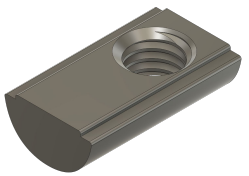
5x30 DOWEL PIN - QTY 4

These were sanded for fit in the prep section.

5x1MM SHIM - QTY 16

M3x20MM SHCS - QTY 6

M5X50MM SHCS - QTY 4



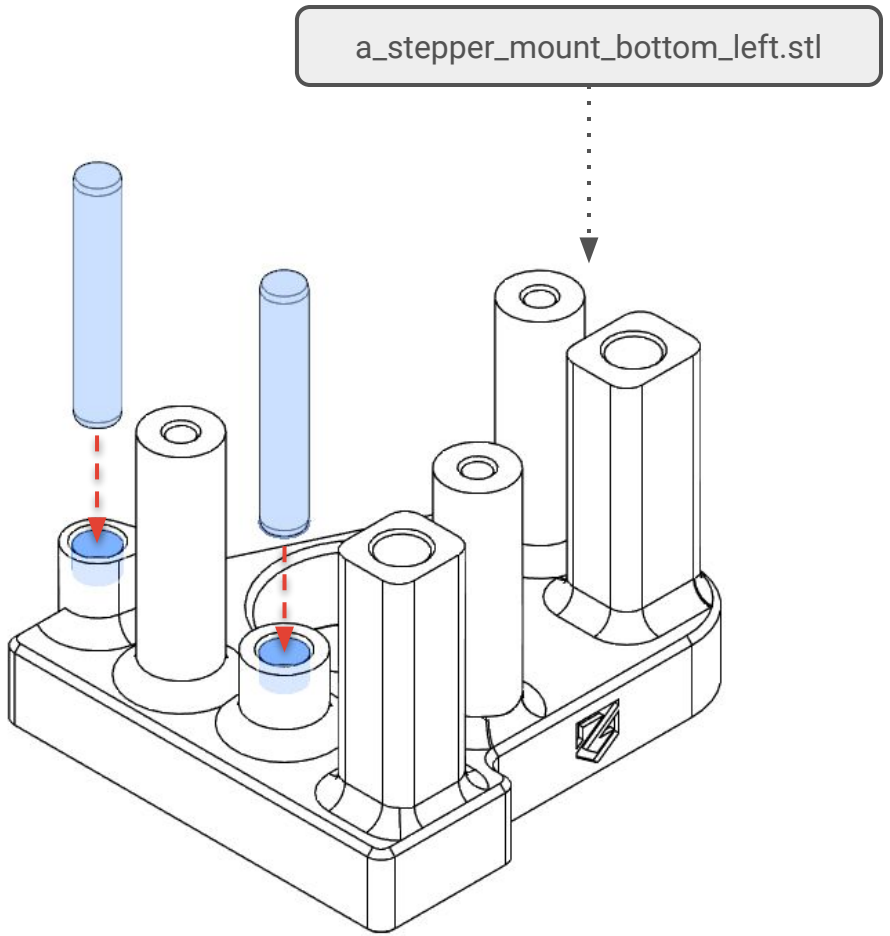
M5 ROLL-IN T-NUTS - QTY 4

Drop in t-nuts are not recommended.

1. INSERTING DOWEL PINS

Insert an M5x30mm dowel pin in each of the two holes shown right.

📝 Dowel pins may fit loosely in the pin holes. Installation of the top plate and belt tension will keep them secure.

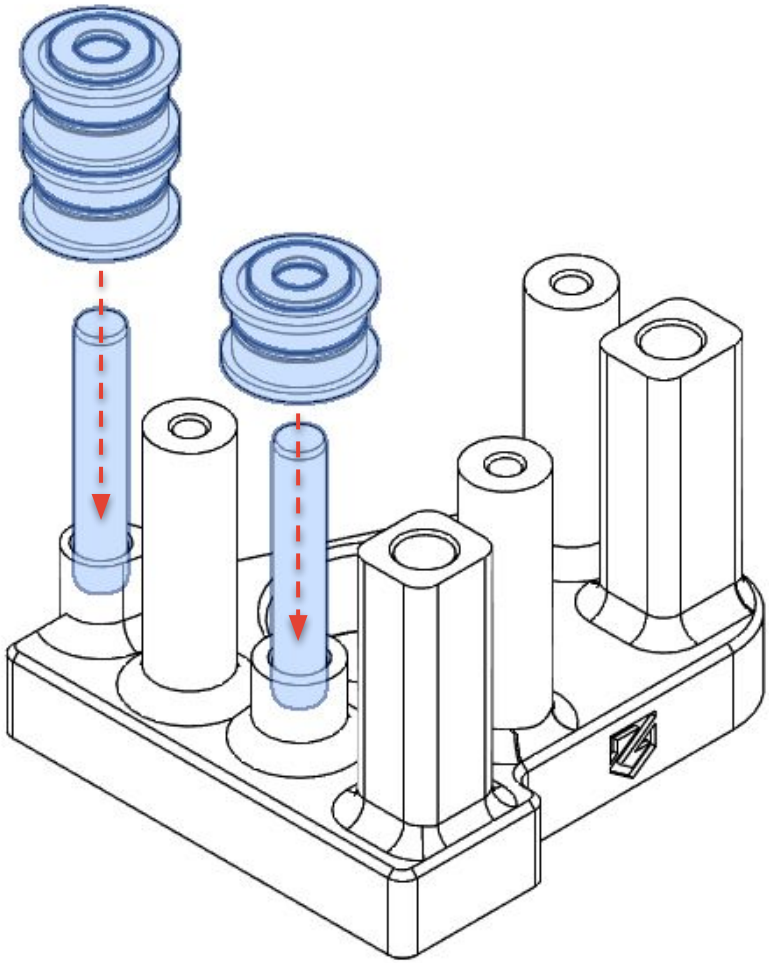


ℹ️ The stepper towers were updated in Version 1.1.6. The left stepper illustrations are outdated, but the visual differences will not affect assembly.

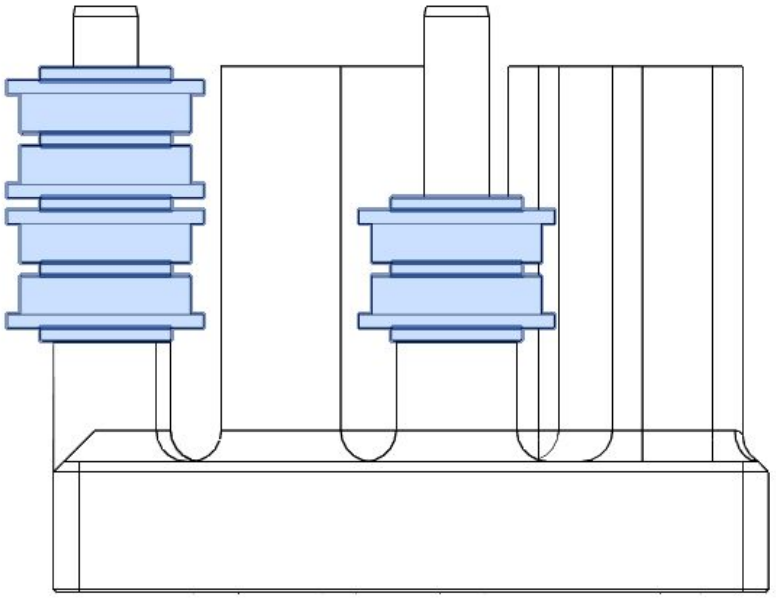
2. FLANGE STACKS

Build a **double flange stack** on the **rear pin** and a **single flange stack** on the **front pin**.

Remember to alternate bearings and shims! Refer to **Concepts: Flange Stacks** for reference.

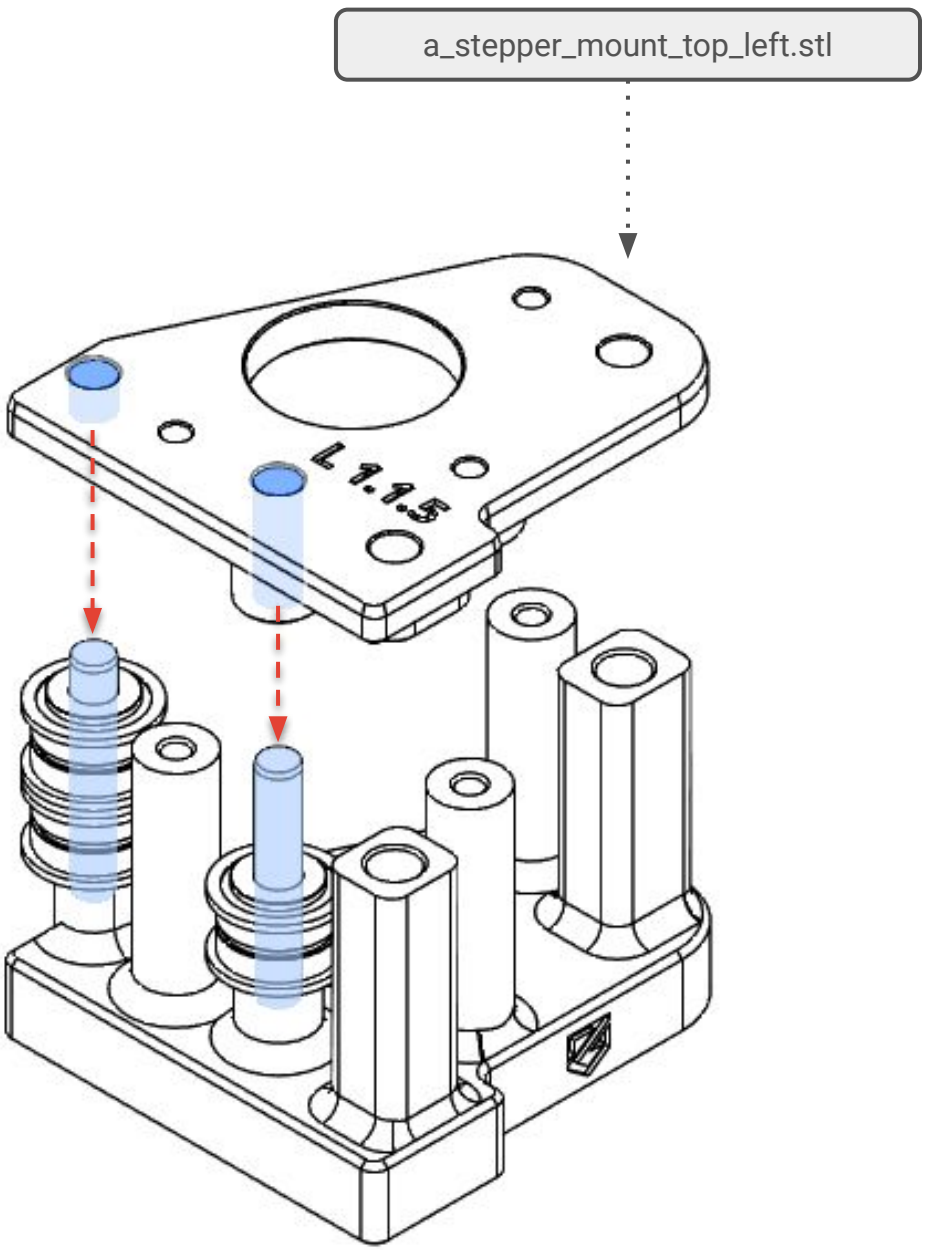


SHOULD LOOK LIKE (SIDE VIEW)

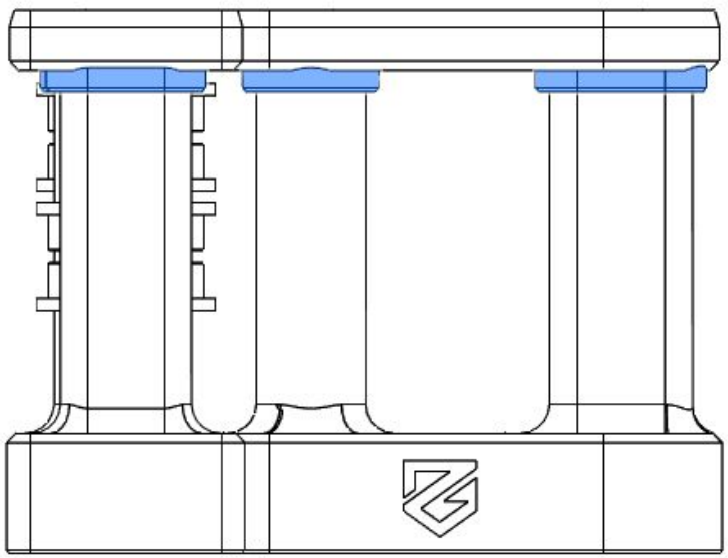


3. CAPPING IT OFF

Close off the assembly with the left top. The guides highlighted bottom left will help align the top. You may need to wiggle the dowel pins to get them to fit.

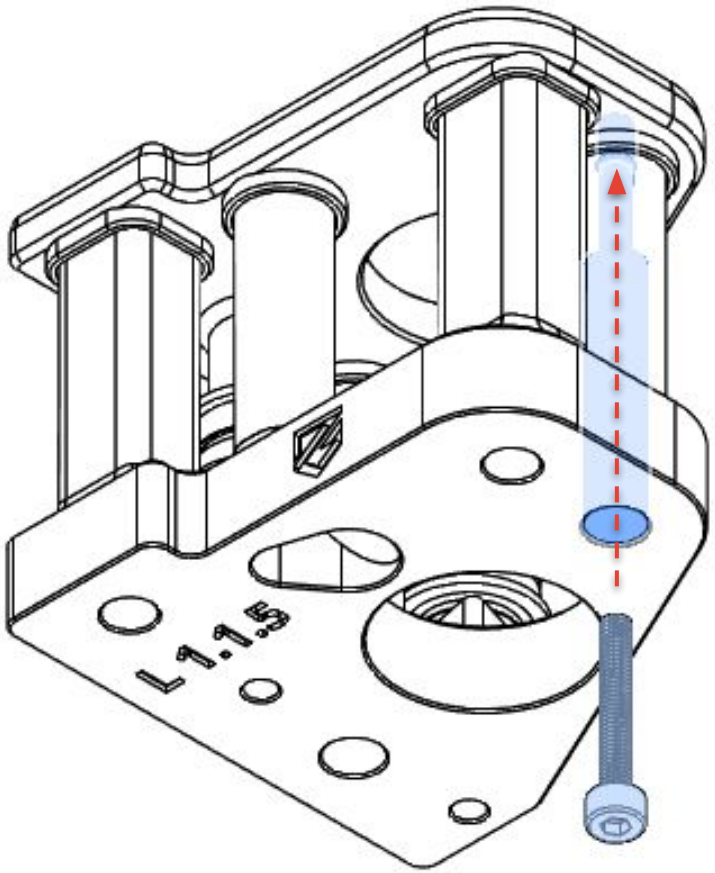


SHOULD LOOK LIKE

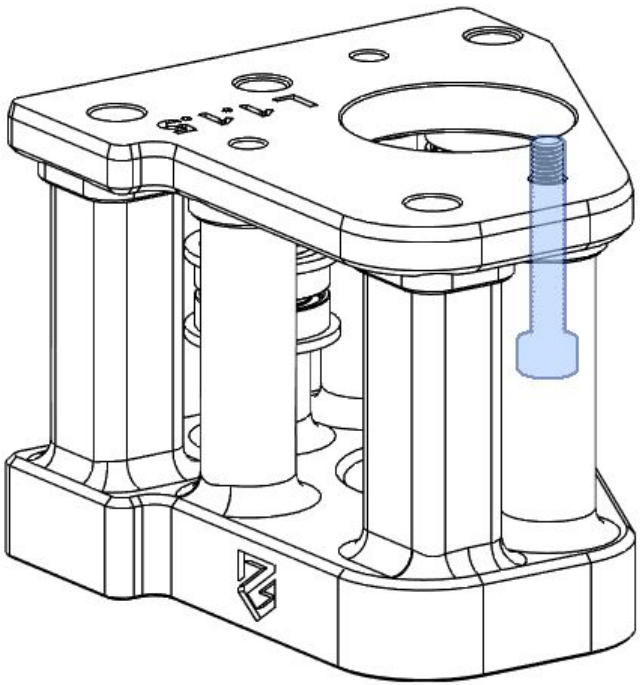


4. PRE-INSTALL M3X20

Install one M3x20 bolt. This will help you align the stepper in the following step.

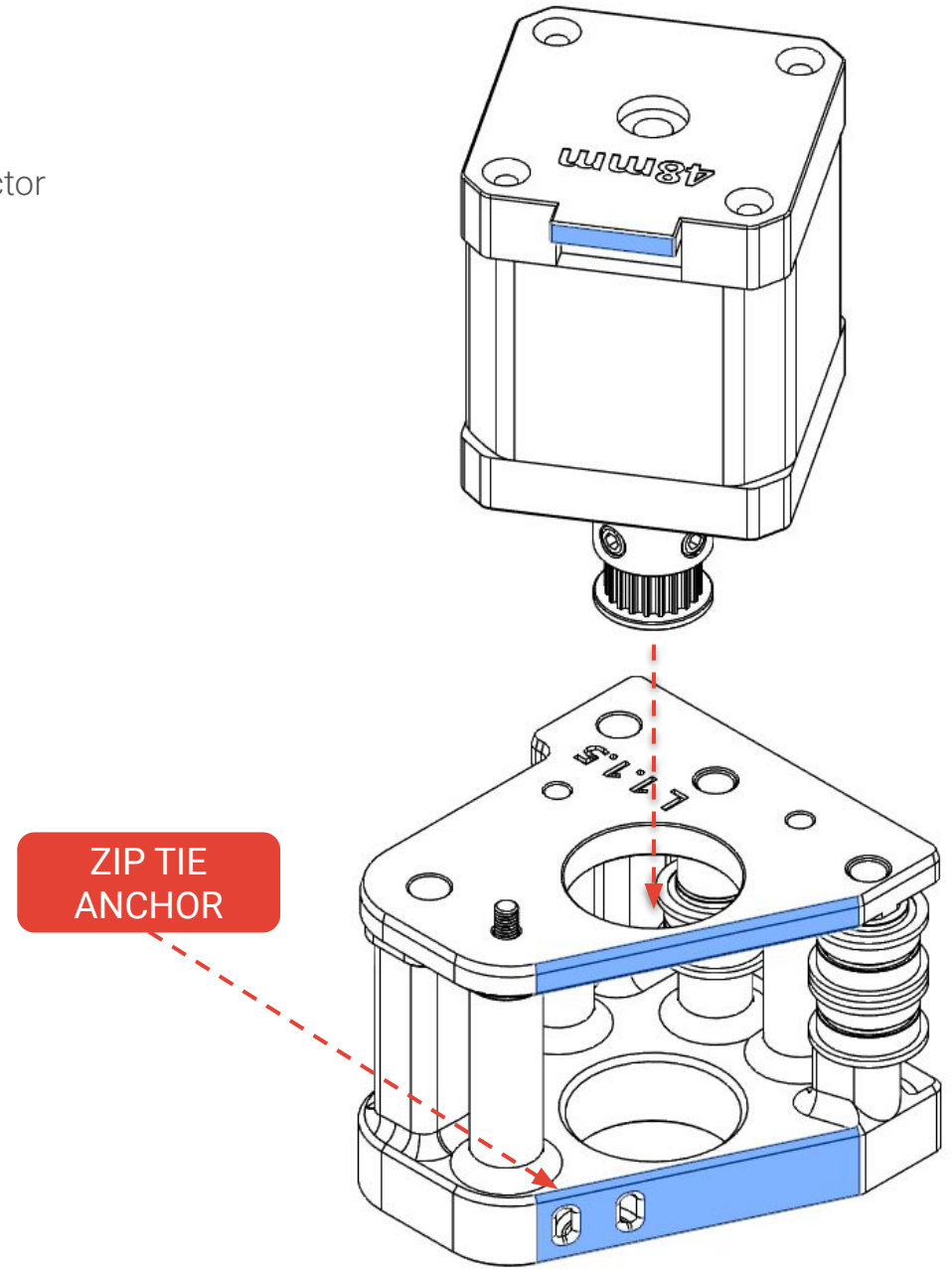


SHOULD LOOK LIKE



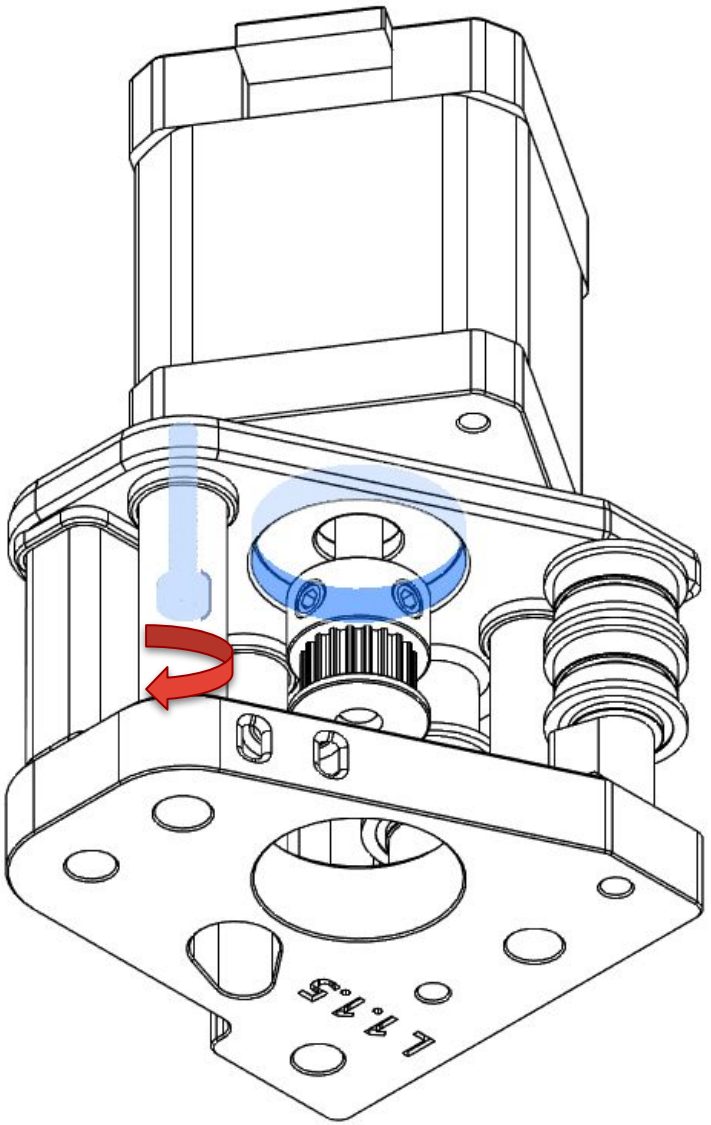
5. INSTALLING THE STEPPER MOTOR

Lower the NEMA 17 motor with the cable connector aligned with the face with a zip tie anchor.



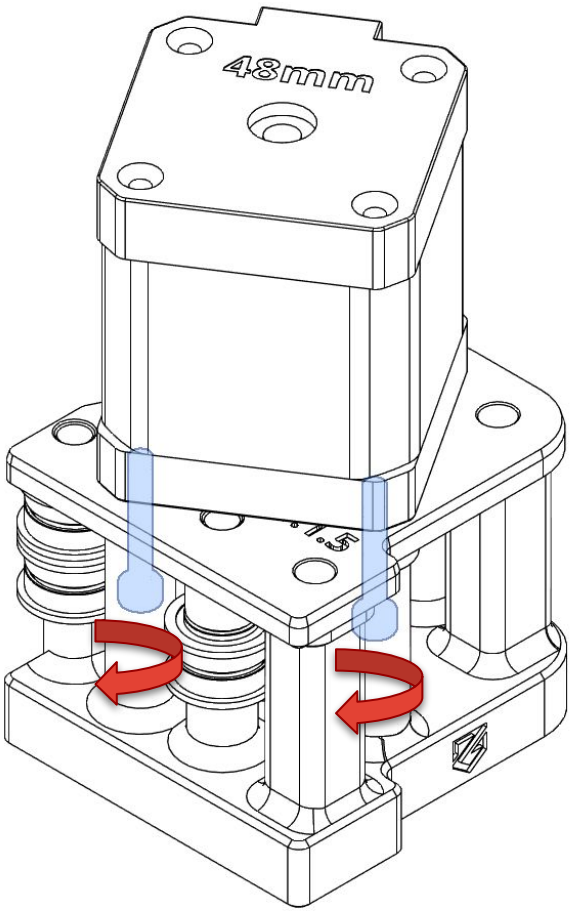
6. FINGER TIGHTEN THE M3X20

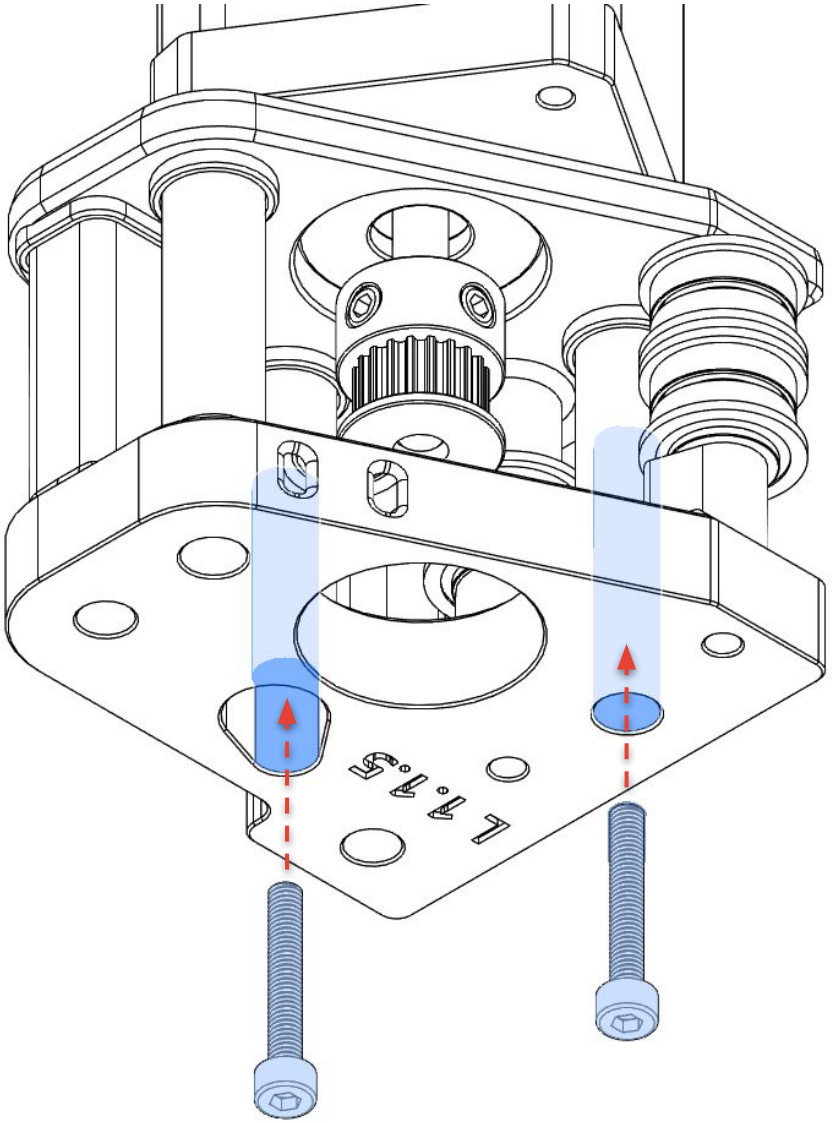
Once the stepper motor is lowered, **finger tighten the M3x20 bolt**. This bolt will help align the stepper over the other bolt holes. The stepper should be centered on the highlighted ring in the middle of the illustration.



7. TIGHTENING THE BOLTS

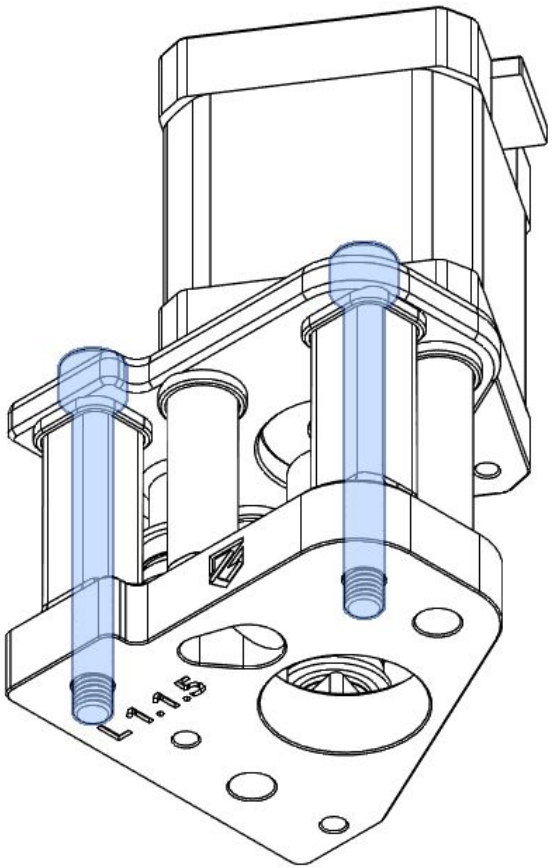
Insert the final two (2) M3x20mm bolts and tighten all of them. Be **careful not to overtighten**, as they are aligned with the layer stacking. After completing this step, all three (3) M3x20mm bolts should be secure.

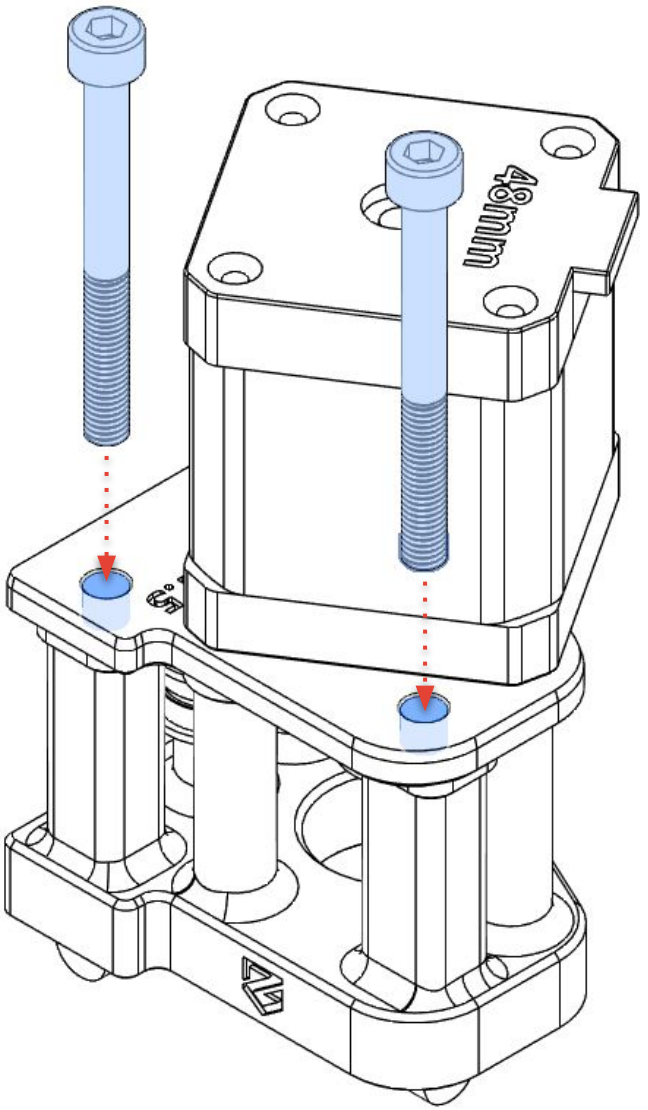




8. ADDING THE FINAL BOLTS

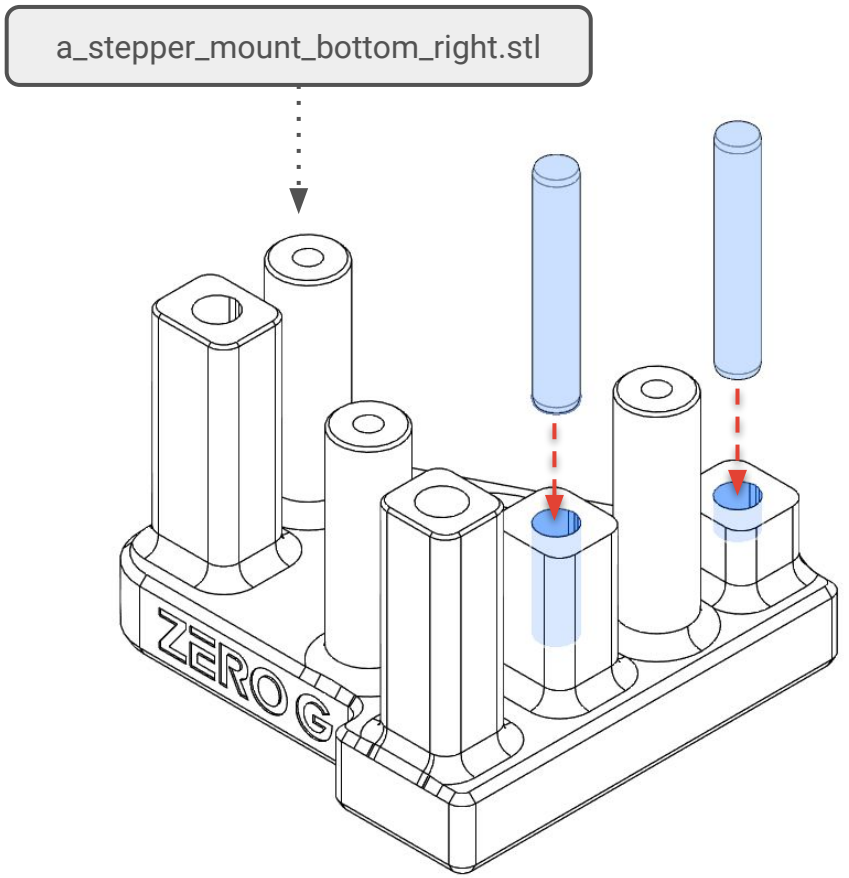
Now, insert the **M5x50mm bolts**. In a later step, these bolts will be secured to the frame with t-nuts.





1. INSERTING DOWEL PINS

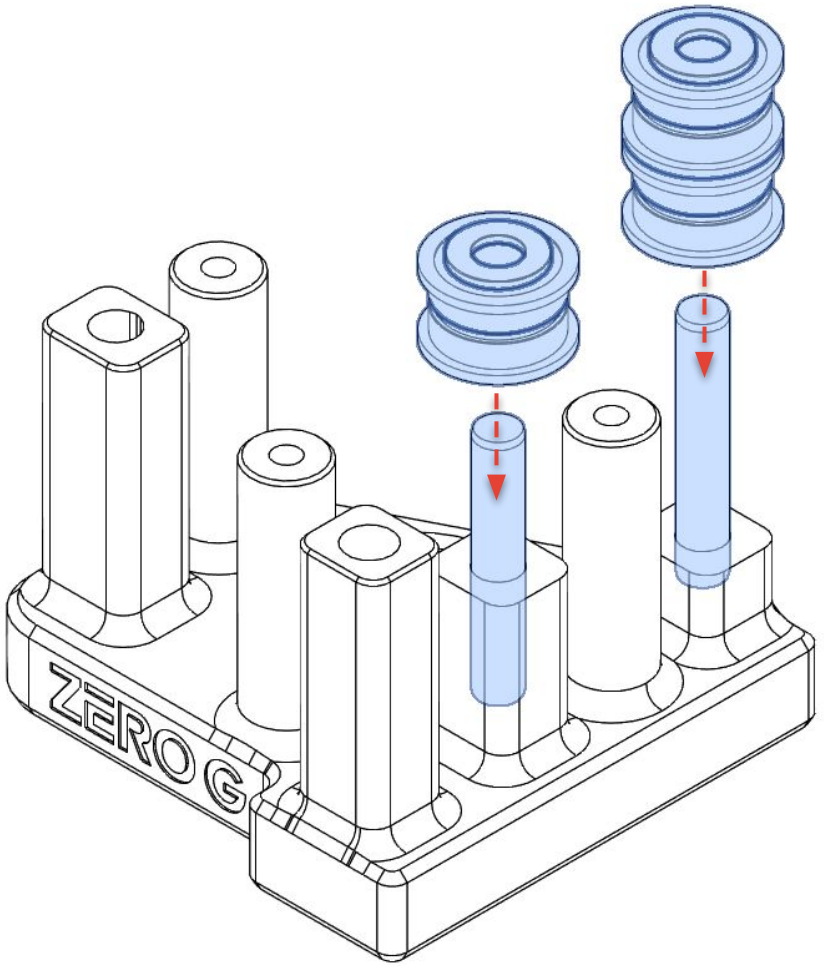
Insert a 5x30mm dowel pin in each of the two holes shown right.



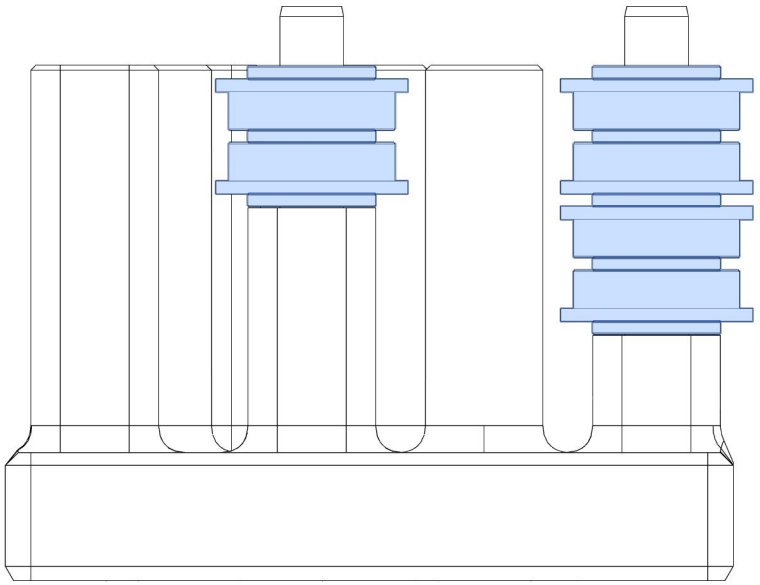
📝 Dowel pins may fit loosely in these holes; however, belt tension and the top plate installation in a later step will keep them securely in place.

2. LOWERING FLANGE STACKS

Like the left tower, build a **double flange stack** on the **rear pin** and a **single flange stack** on the **front pin**.

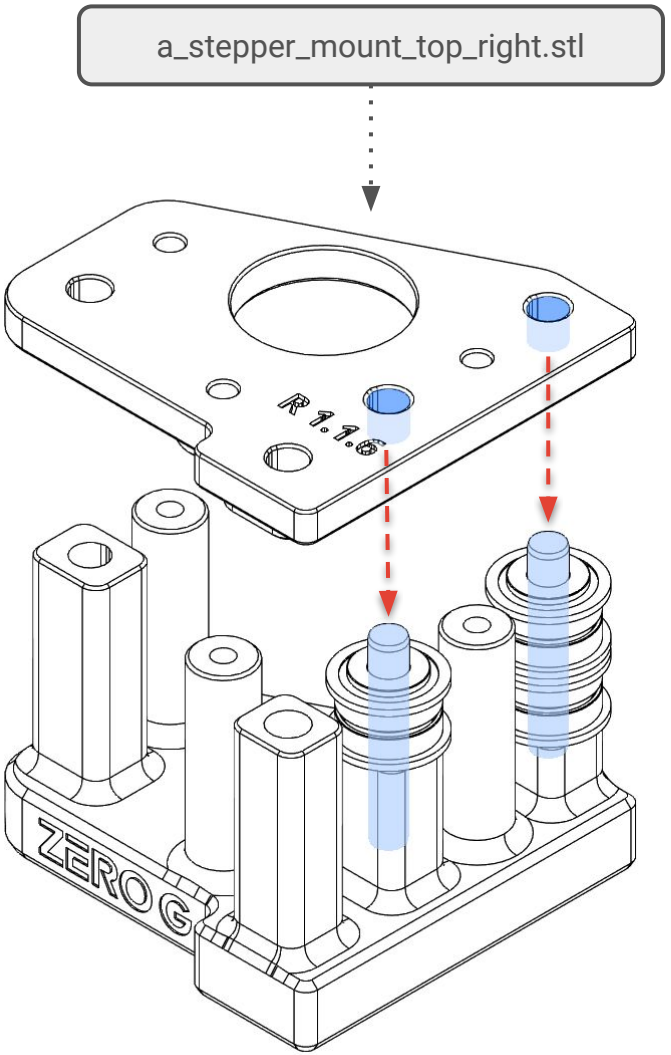


SHOULD LOOK LIKE (SIDE VIEW)

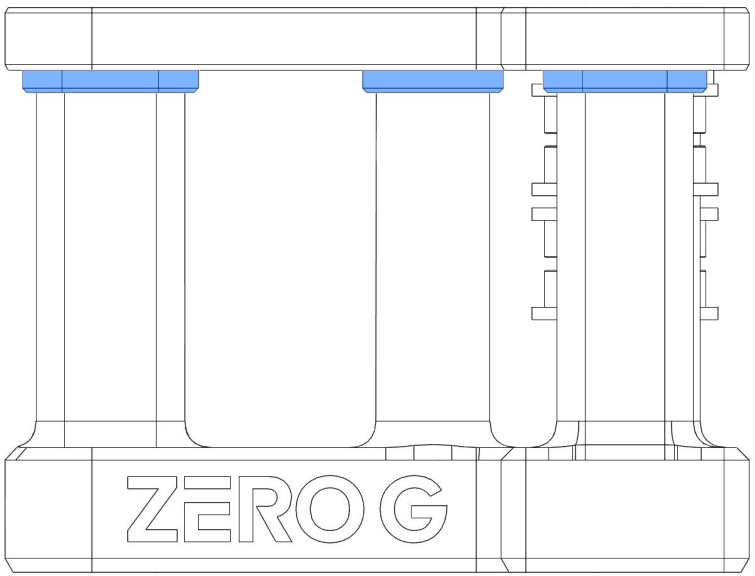


3. CAPPING IT OFF

Close off the assembly with the right top. The guides highlighted at bottom left will help aid installation. You may need to wiggle the dowel pins to align them with the top.

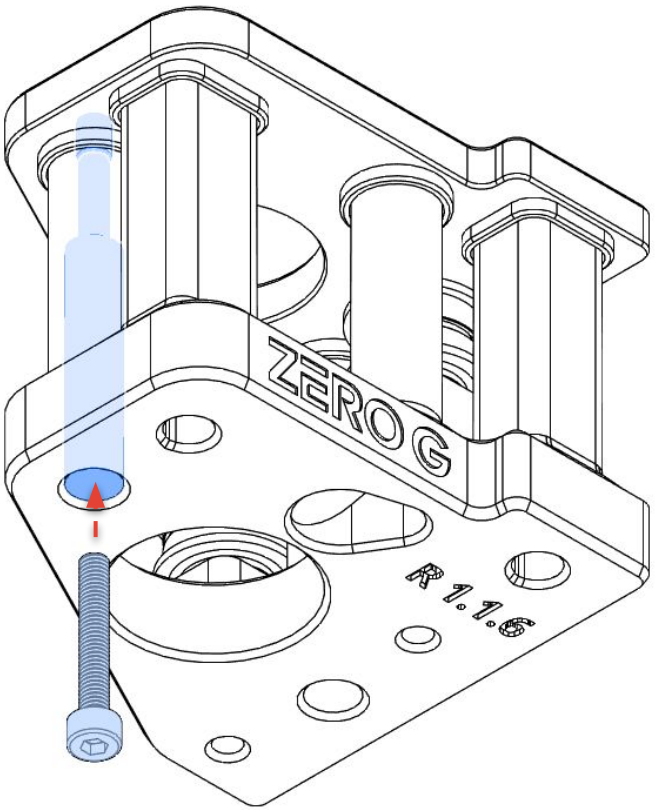


SHOULD LOOK LIKE

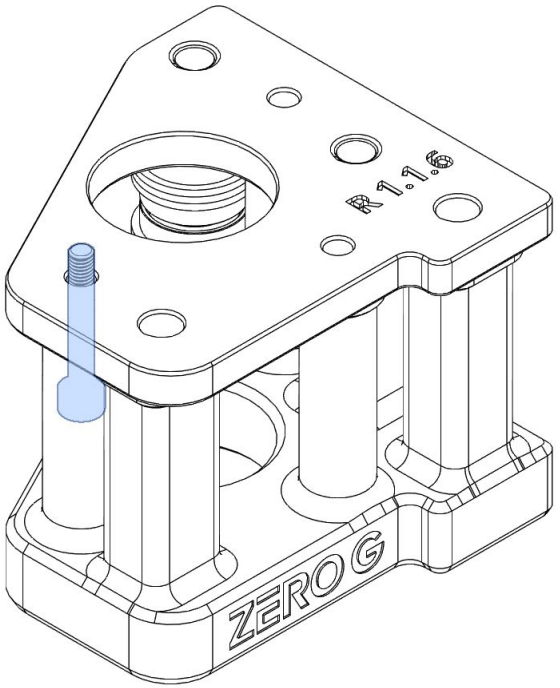


4. PRE-INSTALL AN M3x20

Install one M3x20mm bolt. This will help you align the stepper in a moment..

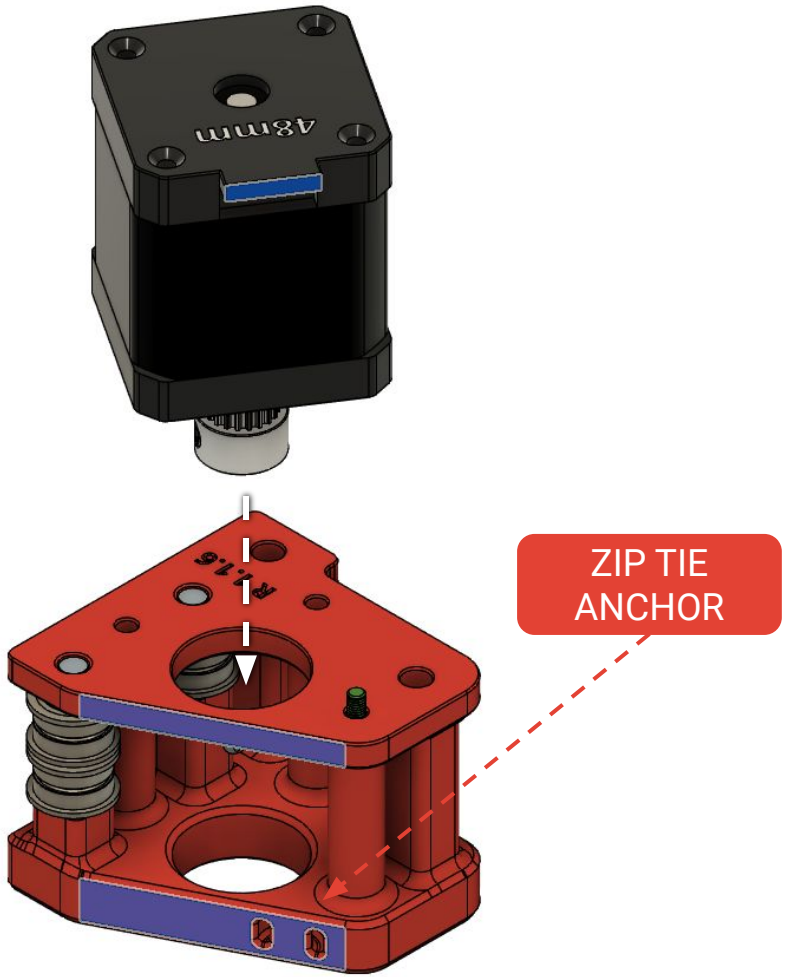


SHOULD LOOK LIKE



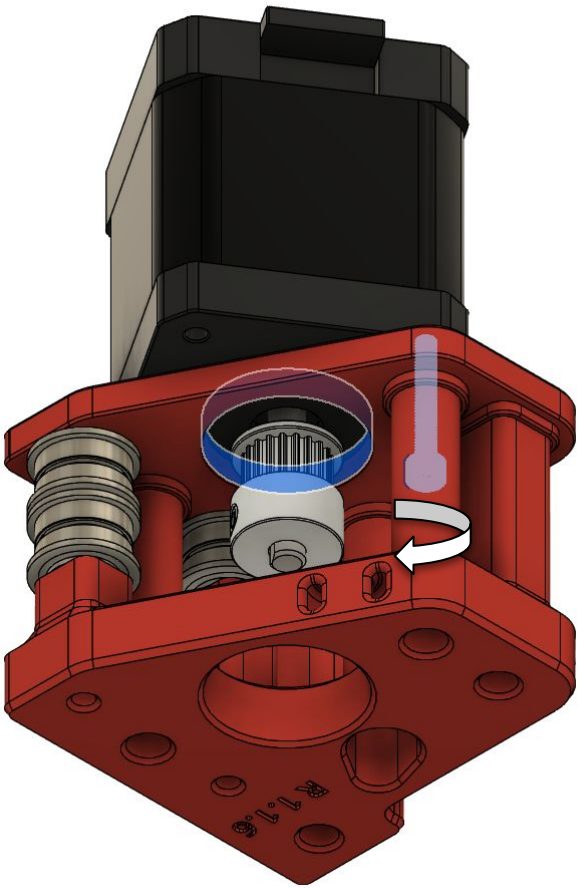
5. INSTALL THE STEPPER MOTOR

Lower the Nema 17 motor with the connector pointed towards the face with a zip tie anchor.



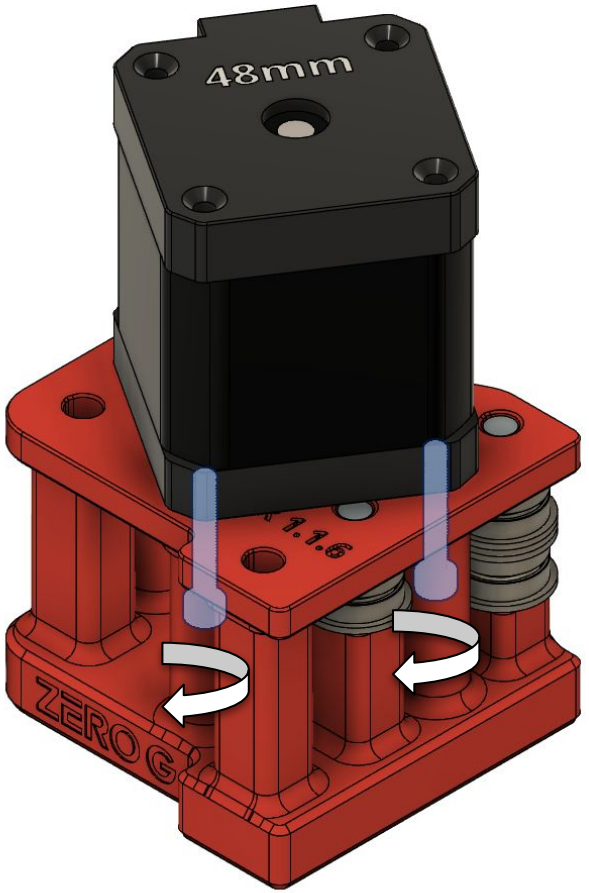
6. TIGHTEN THE M3X20

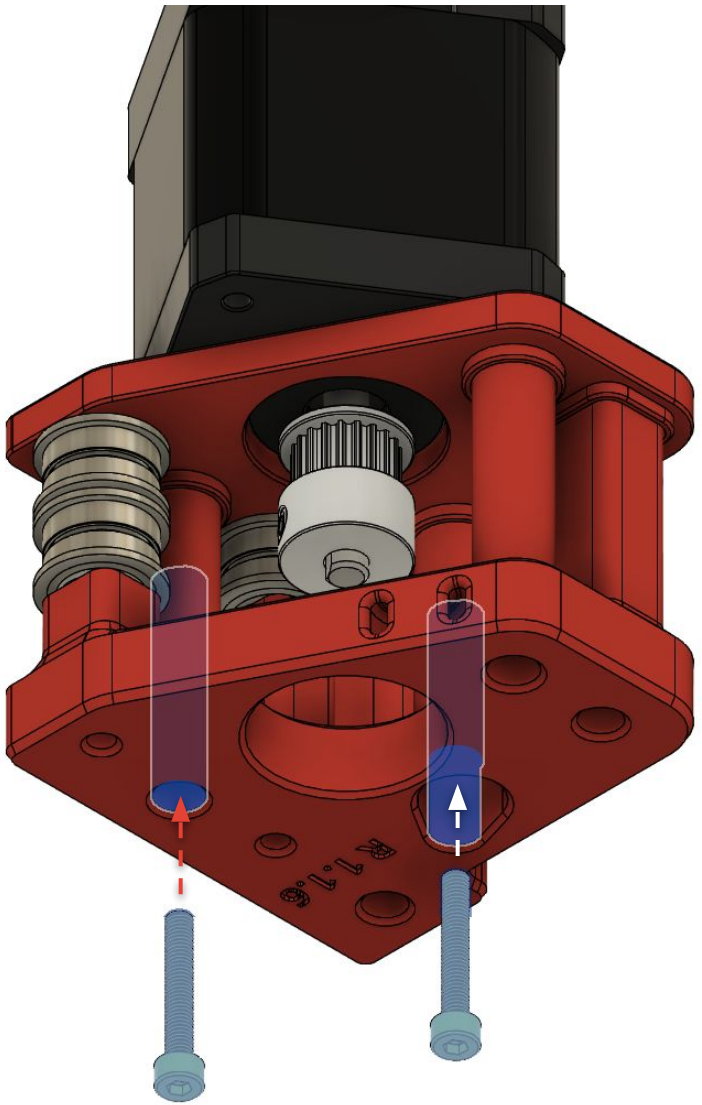
Finger tighten the M3x20mm bolt that we just installed. This bolt will help align the others.



7. TIGHTENING THE BOLTS

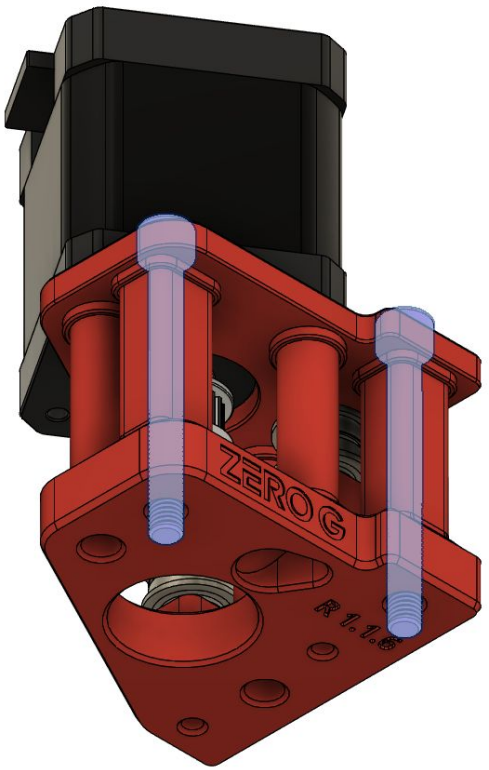
Install the final M3x20mm bolts and tighten all three (3). Be **careful not to overtighten!** Overtightening can affect layer stacking and cause belt alignment issues.

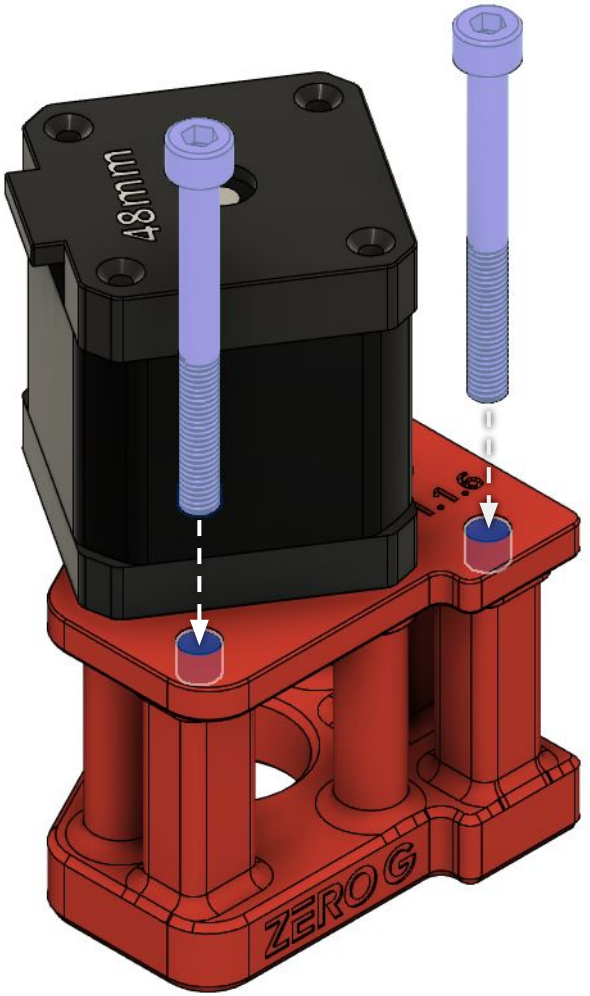




8. ADDING THE 50MM BOLTS

Finally, drop in the two (2) M5 x 50mm bolts.



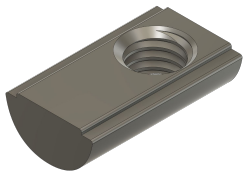


STEPPER TOWERS INSTALL

INTRODUCTION

It's time to install our stepper towers! We only need a few t-nuts for this section.

HARDWARE

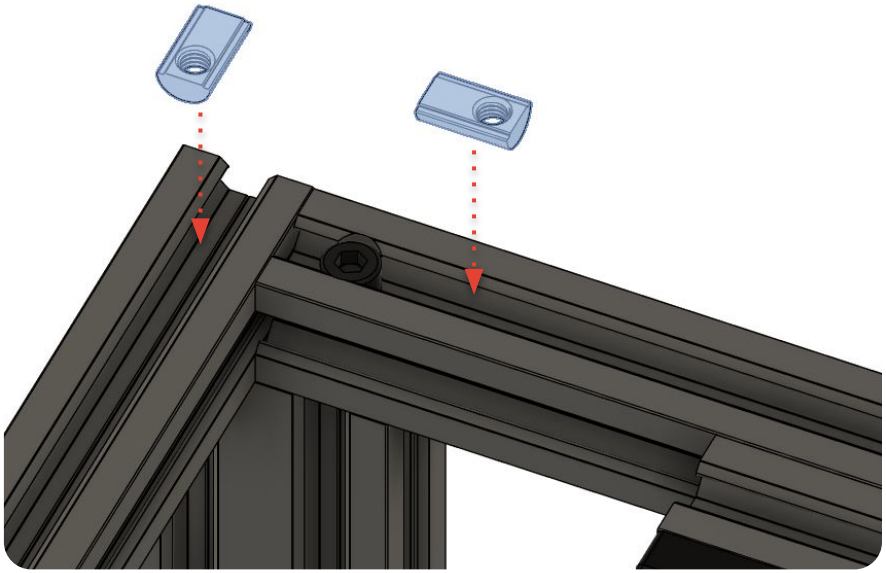


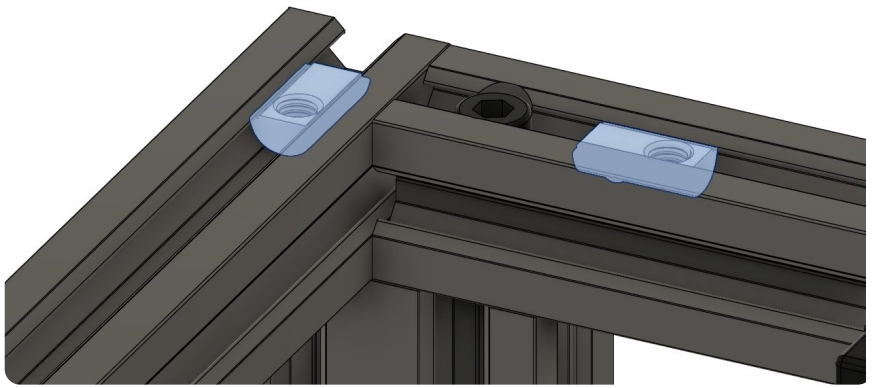
M5 ROLL-IN T-NUT - QTY 4

1. LEFT REAR

Install two (2) t-nuts in the **left rear** of the frame, facing the direction shown in the image. Consider using a small Allen wrench to position the t-nuts.

The t-nuts only need to be roughly positioned for now; we will align them in a later step.

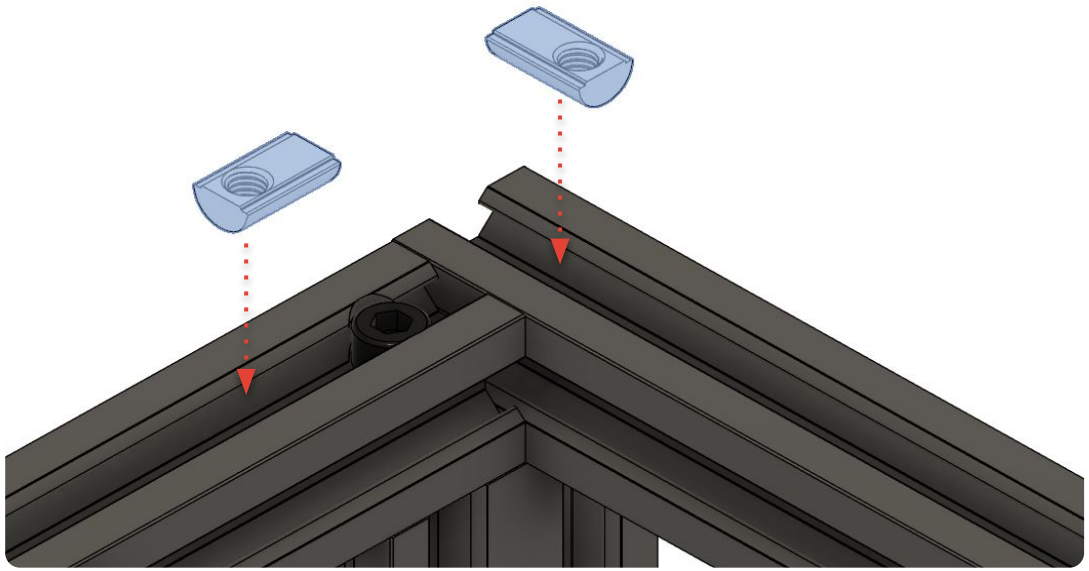


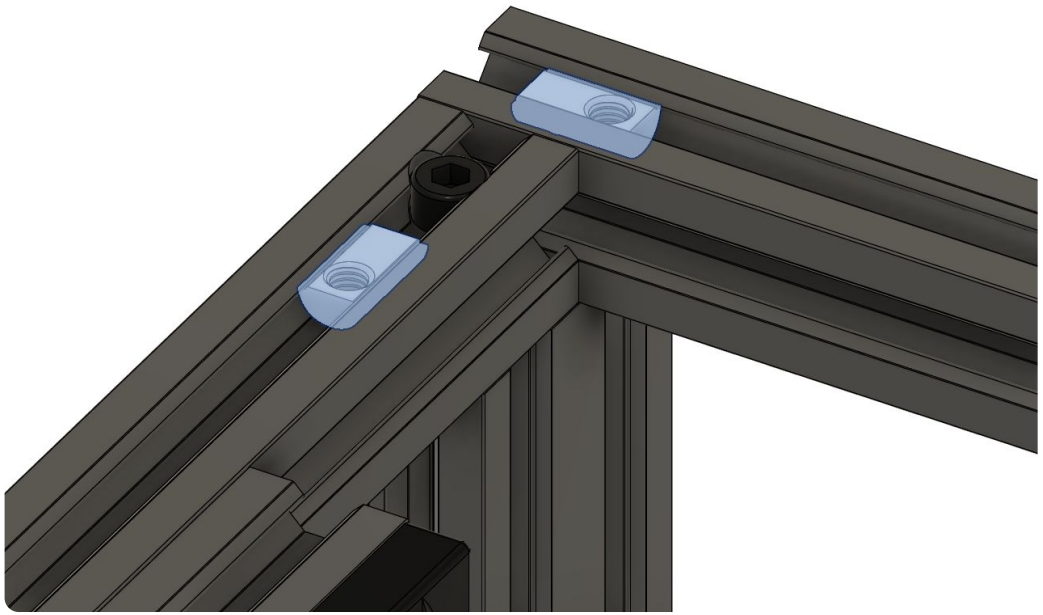


2. RIGHT BACK

Install two (2) t-nuts in the **right rear corner**, mirroring the ones we just installed.

As before, make sure that the t-nuts face the direction shown in the images.

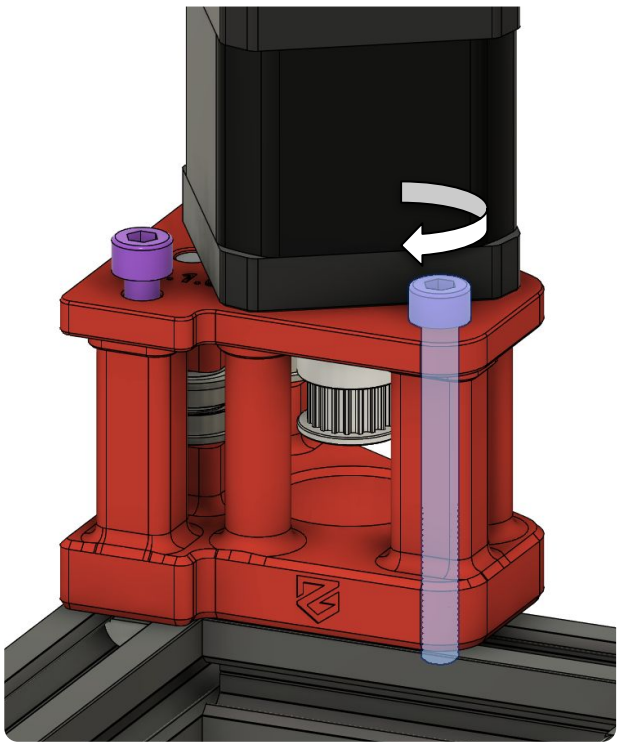


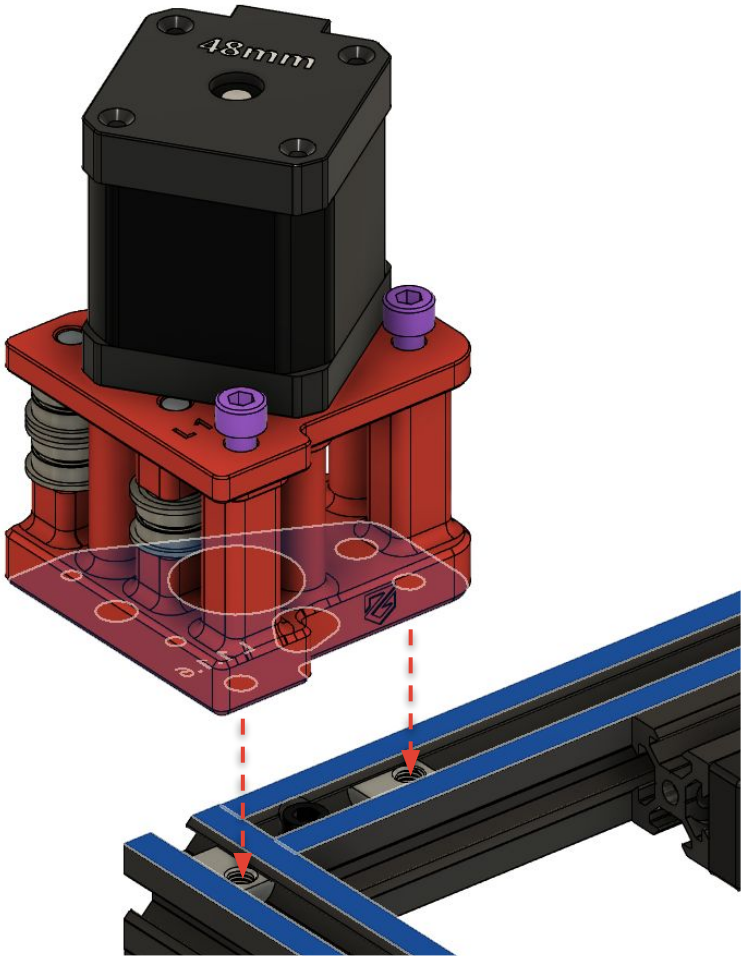


1. LOWER THE LEFT ASSEMBLY

We will now install the assembled left stepper tower onto the frame. Begin by lowering the assembly with the bolts aligned with the pre-positioned t-nuts.

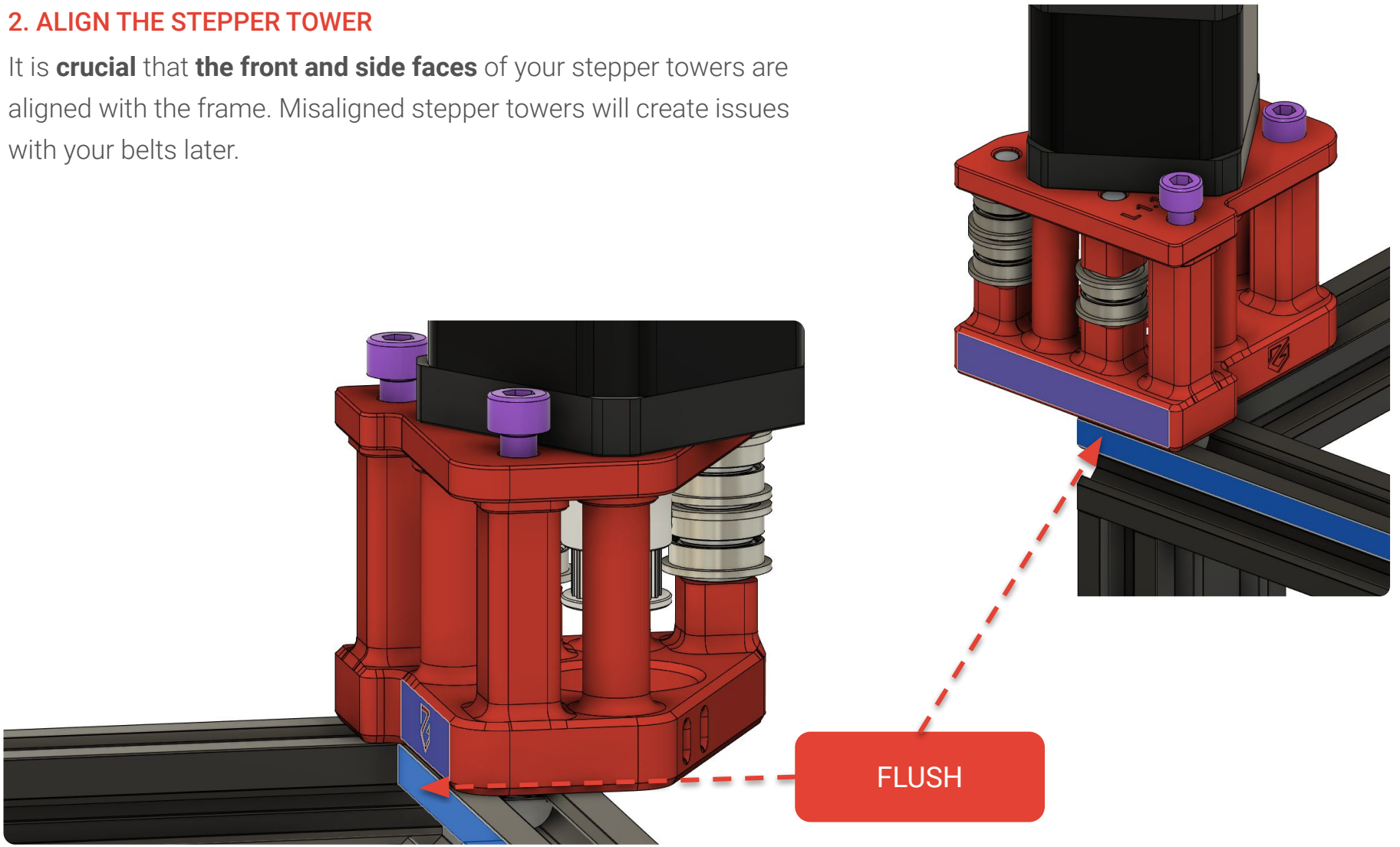
Next, **finger tighten** the right bolt. This will “capture” a t-nut and help to align the tower.





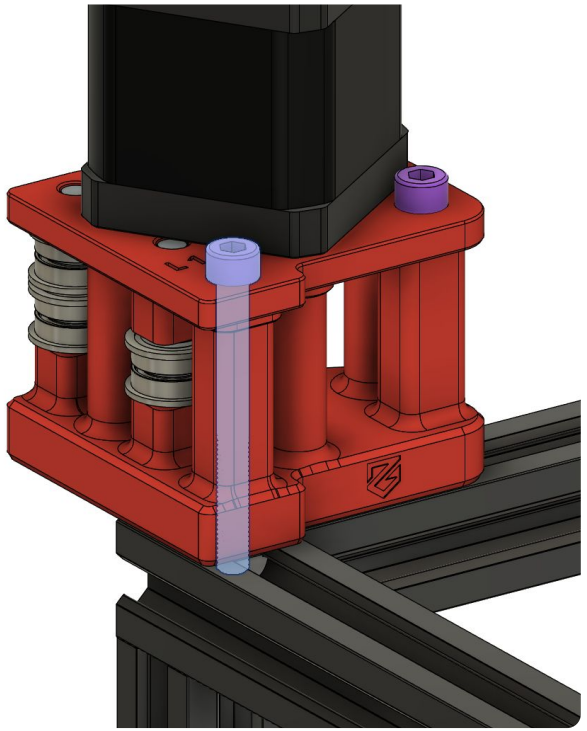
2. ALIGN THE STEPPER TOWER

It is **crucial** that **the front and side faces** of your stepper towers are aligned with the frame. Misaligned stepper towers will create issues with your belts later.



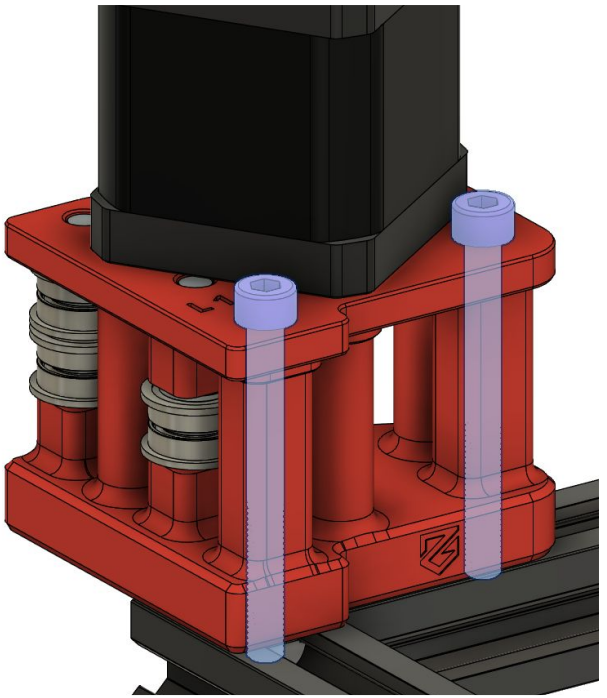
3. LEFT M5X50

Finger tighten the M5x50mm bolt on the left.



4. DOUBLE CHECK FACES AND TIGHTEN

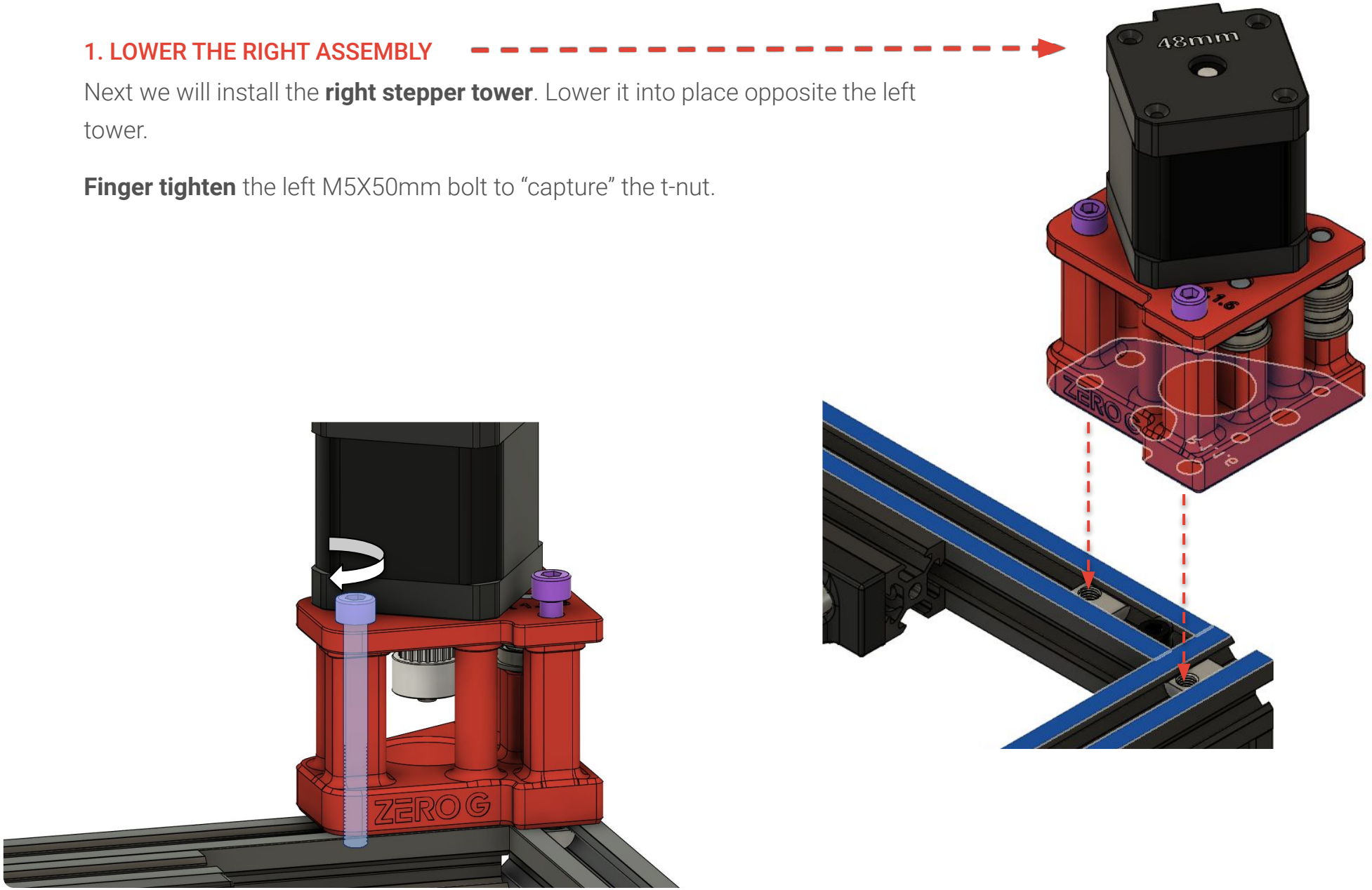
Check the front and left faces to ensure they are **aligned and flush** with the extrusion, then **fully tighten** both M5x50mm bolts.



1. LOWER THE RIGHT ASSEMBLY

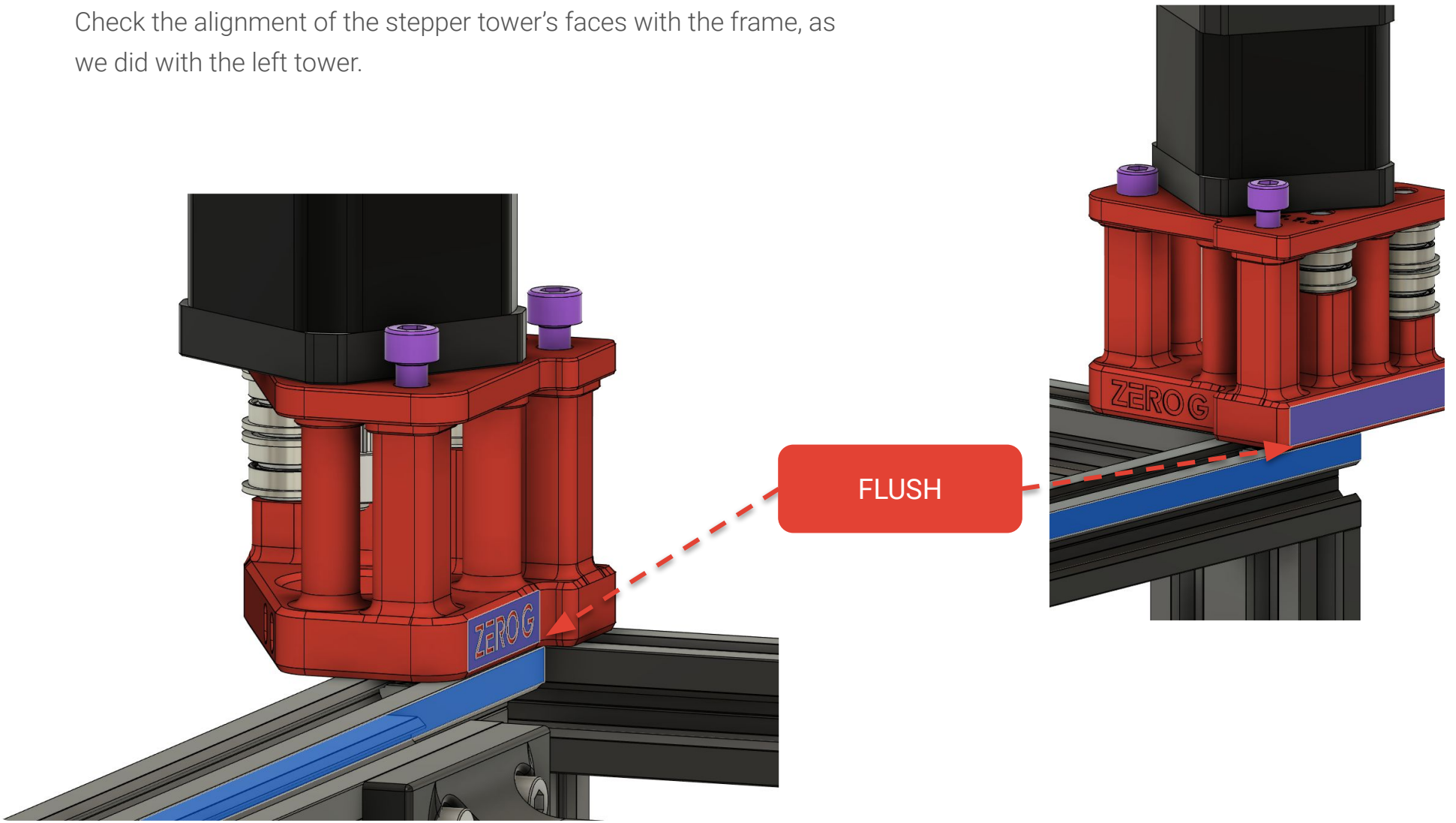
Next we will install the **right stepper tower**. Lower it into place opposite the left tower.

Finger tighten the left M5X50mm bolt to “capture” the t-nut.



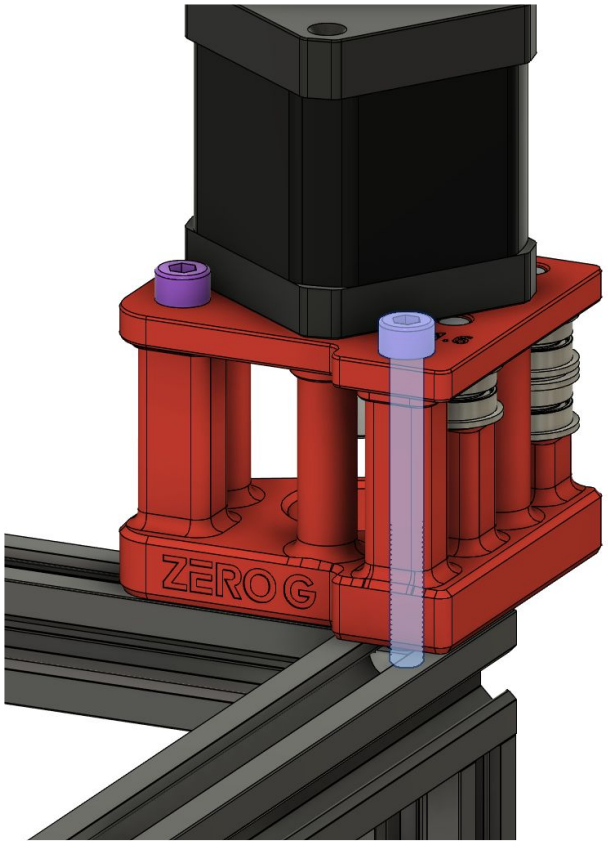
2. ALIGN THE FACES

Check the alignment of the stepper tower's faces with the frame, as we did with the left tower.



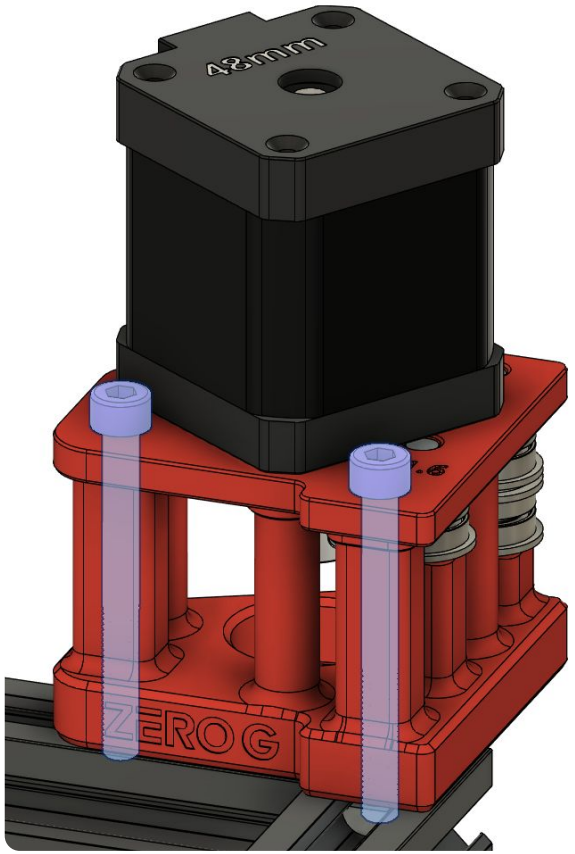
3. RIGHT M5X50

Finger tighten the M5x50mm bolt on the right.

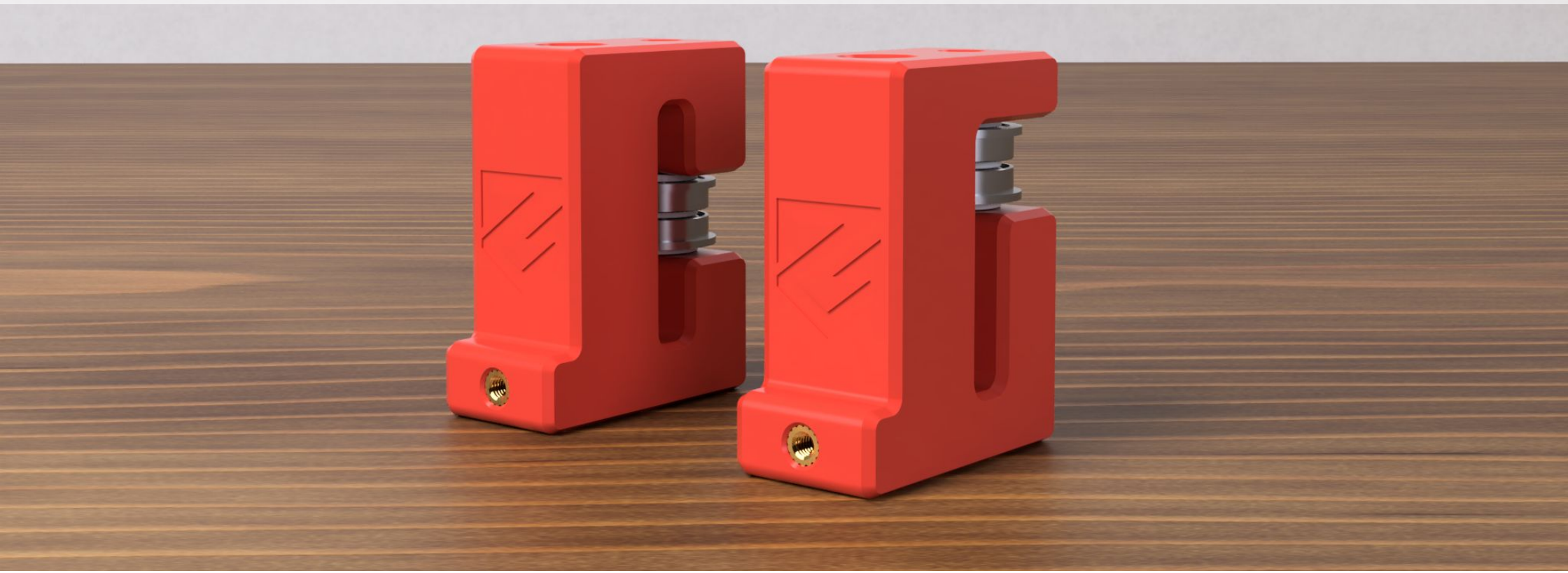


4. DOUBLE CHECK FACES AND TIGHTEN

Check the front and left faces to ensure they are **aligned and flush** with the extrusion, then **fully tighten** both M5x50mm bolts.



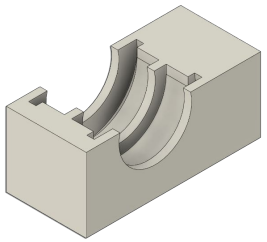
TENSION TOWERS ASSEMBLY



INTRODUCTION

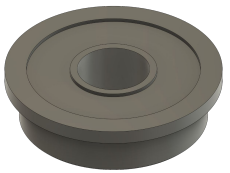
Tension towers allow us to adjust the tension on our belts. They require a little assembly before installation.

HARDWARE

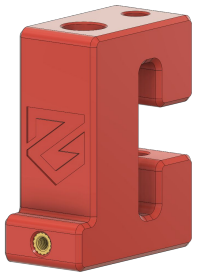


FRONT TOWER TOOL

“front_tower_tool.stl” or (if using brass shims)
“front_tower_tool_brass.stl”



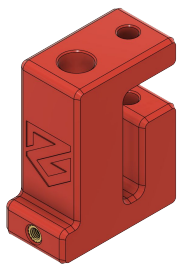
F695 BEARING - QTY 4



LEFT TENSION TOWER

“a_front_tower_left.stl”

5MM x 1MM SHIM - QTY 6



RIGHT TENSION TOWER

“a_front_tower_right.stl”

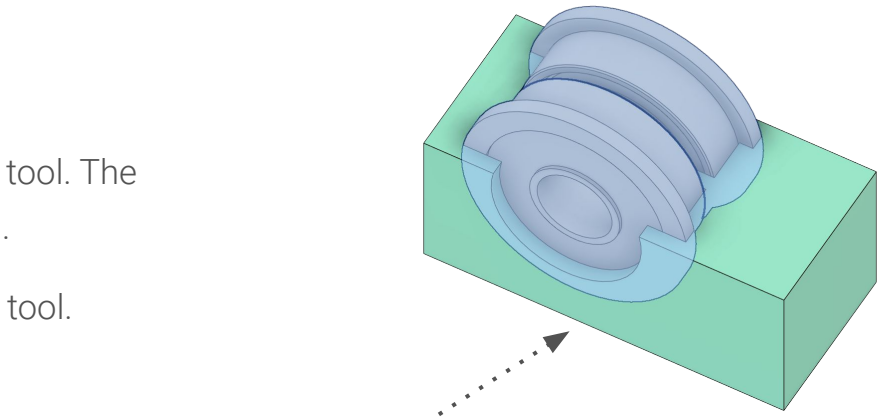
5X30MM DOWEL - QTY 2

These should be sanded for fit.

1. INSERT F695 BEARINGS

First, we will build a flange stack in our printed helper tool. The bearings and shims will be a tight fit; this is by design.

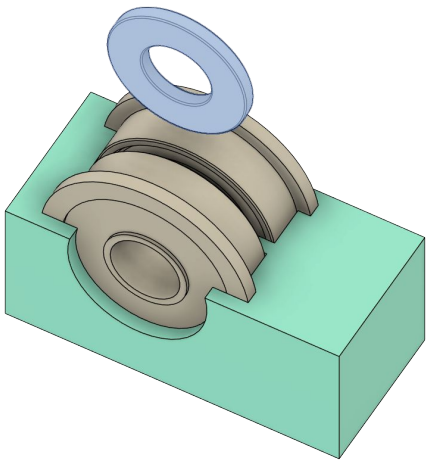
Start by putting two (2) F695 bearings into the helper tool.



front_tower_tool.stl

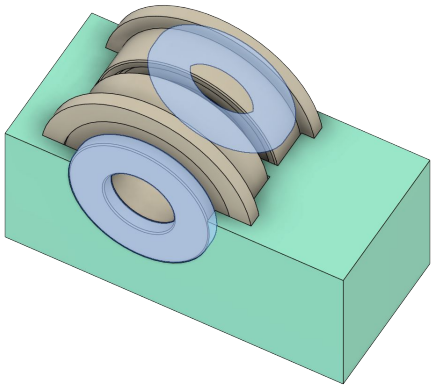
2. ADD CENTER SHIM

Insert a shim in between the two bearings.



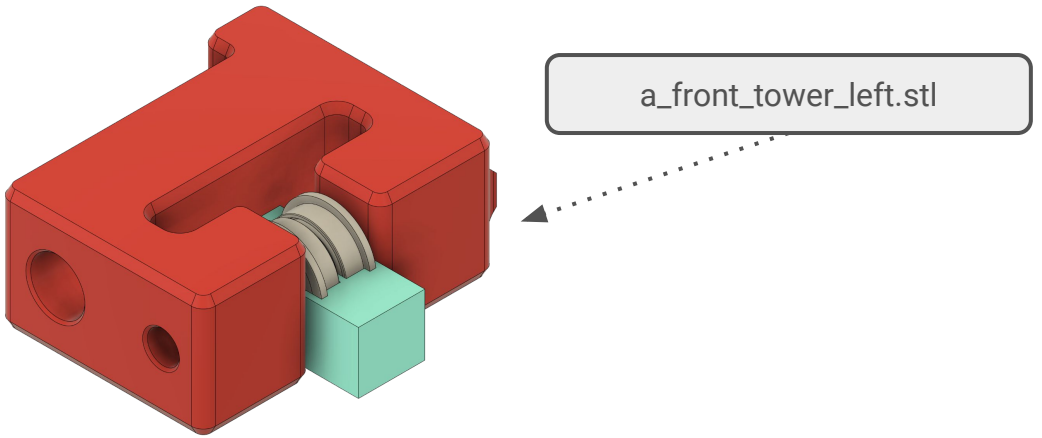
3. ADD THE OUTSIDE SHIMS

Add two shims outside the bearings to complete the stack.



4. ADD TENSIONER TO STACK

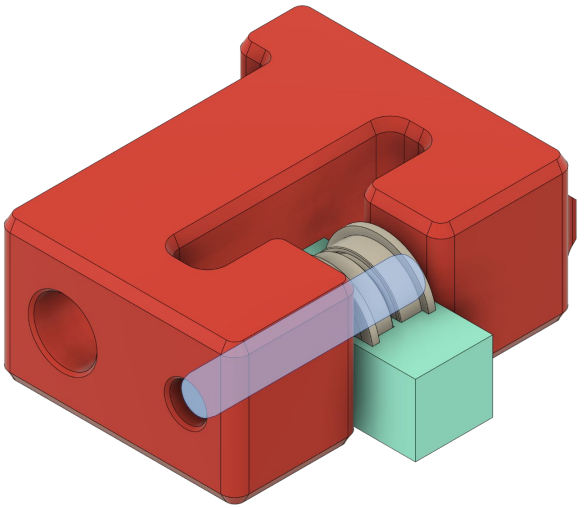
Place the left tensioner over the prepared flange stack, as pictured.



5. INSERT PIN

Slide a 5x30mm dowel pin into the tension tower. It should not require much wiggling and may slide in freely.

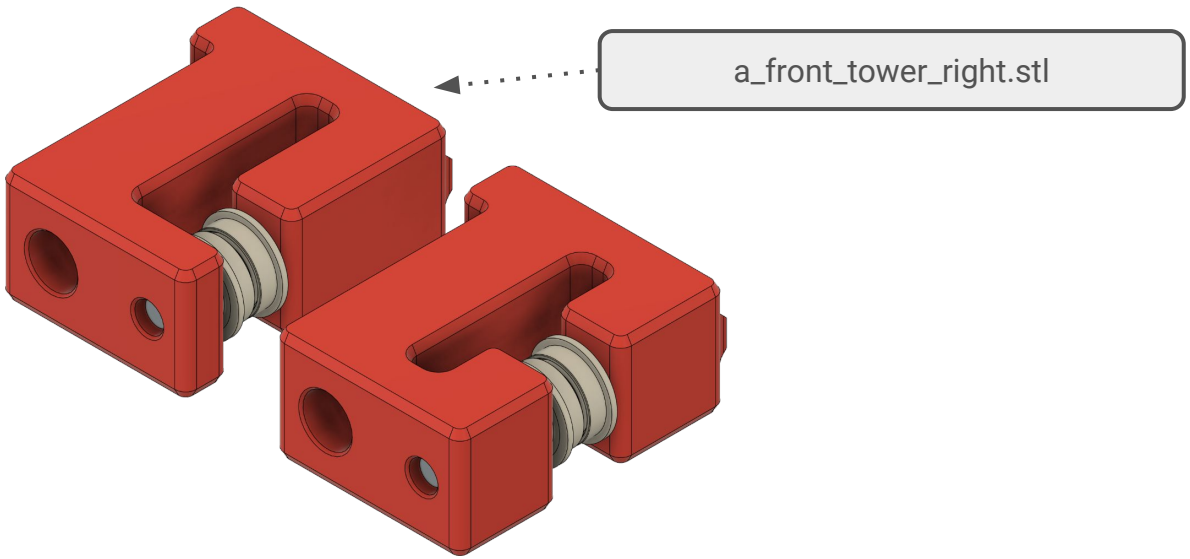
Use an allen wrench to push the pin below the surface, if necessary.



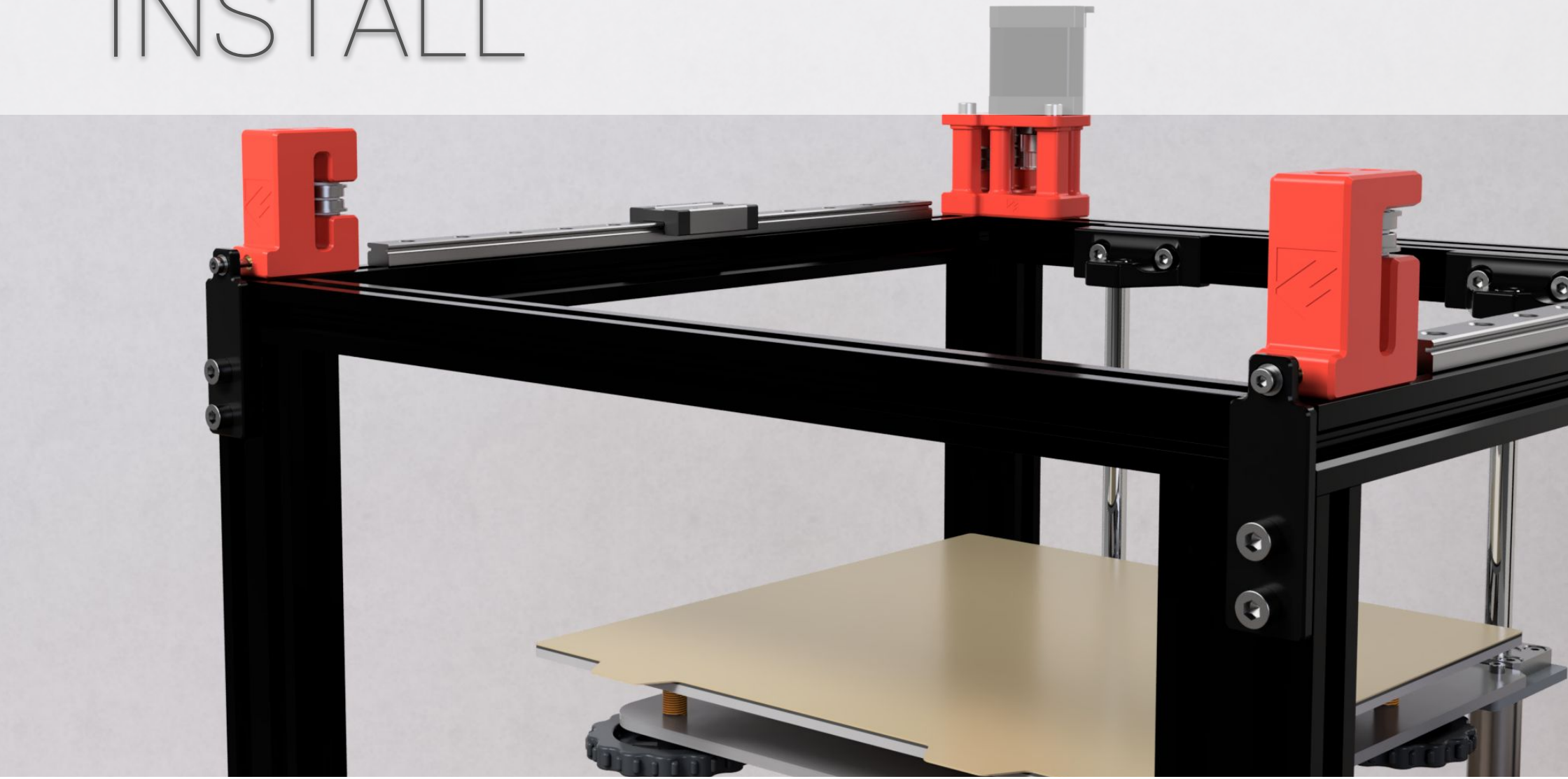
6. REPEAT WITH THE RIGHT TOWER

Take the **right tower** and **repeat the process** of building a flange stack and inserting a pin.

Both towers are ready!



TENSION TOWERS INSTALL



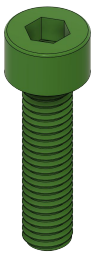
INTRODUCTION

With assembly out of the way, we can install the tension towers and tension plates.

HARDWARE

M3X16 SHCS - QTY 2

M3 WASHER - QTY 2

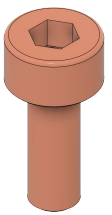


M5X20MM SHCS - QTY 2

TENSION PLATE - QTY 2

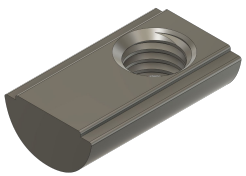
“Front_tension_plate_t-nut_1.stl”
“front_tension_plate_t-nut_2.stl”

If you have tapped ends, substitute with the tapped tension plates.



M5X8MM SHCS - QTY 4

You will only need two (2) M5 x 8mm SHCS if using tapped ends.



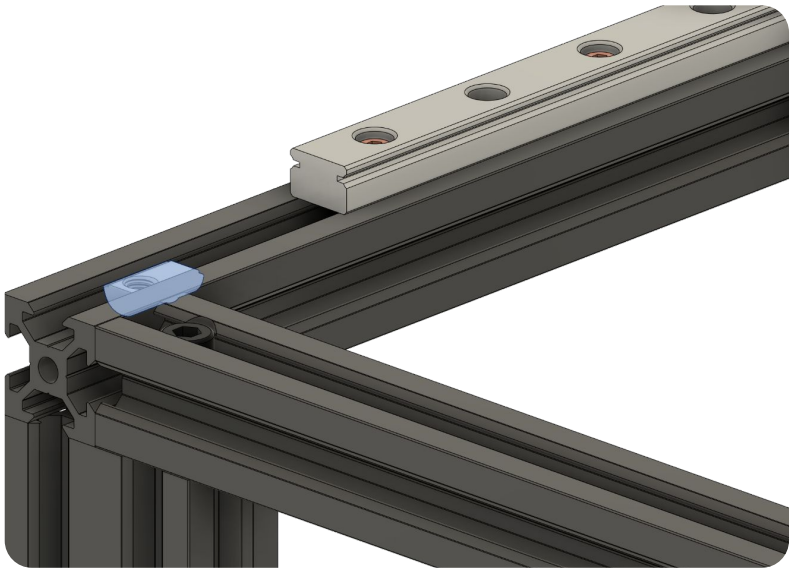
M5 ROLL-IN T-NUT - QTY 6

Only two (2) needed if using tapped ends.

1. INSERT TOP T-NUT

Insert an M5 t-nut in the **top left** extrusion in front of the linear rail.

The t-nut's screw hole should be about **20 - 25mm** from the front of the frame. Orientation of the nut does not matter.



2. INSERT FRONT T-NUTS

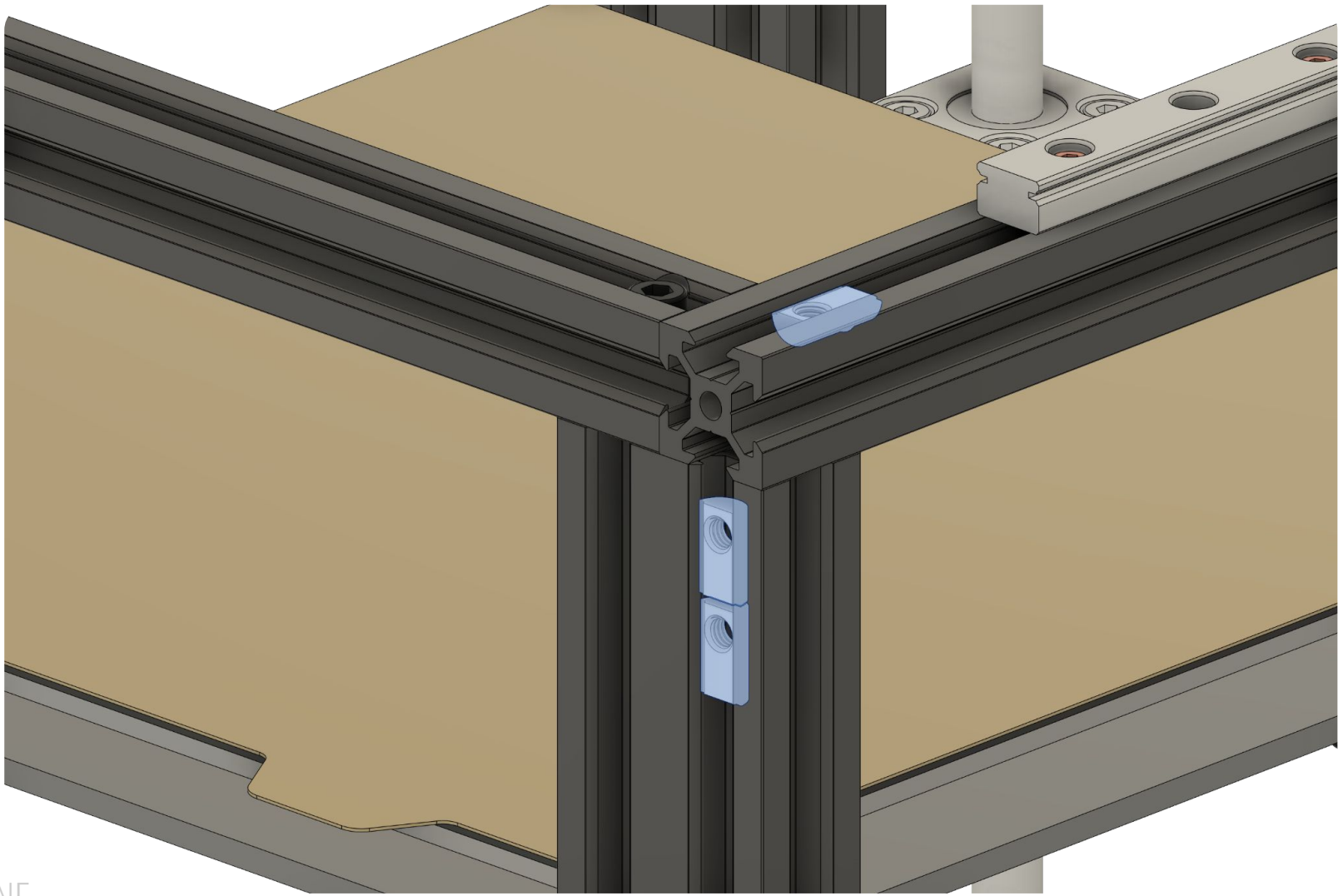
Insert two (2) t-nuts in the front extrusion.

Orientation of the nuts **does matter**, so they should look as pictured with the holes on top.

ℹ️ Visit our Discord if you want to tap your extrusion end and use the tapped tension plate.

3. REPEAT ON THE RIGHT SIDE

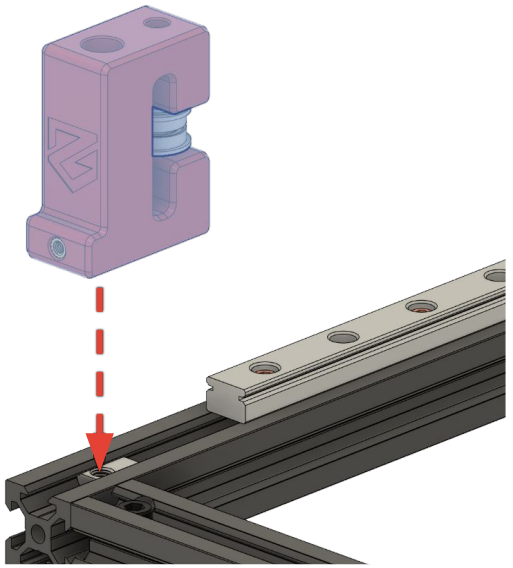
Repeat the previous page's steps for the **right side** of the frame, using three (3) more M5 t-nuts.



1. POSITION LEFT TOWER

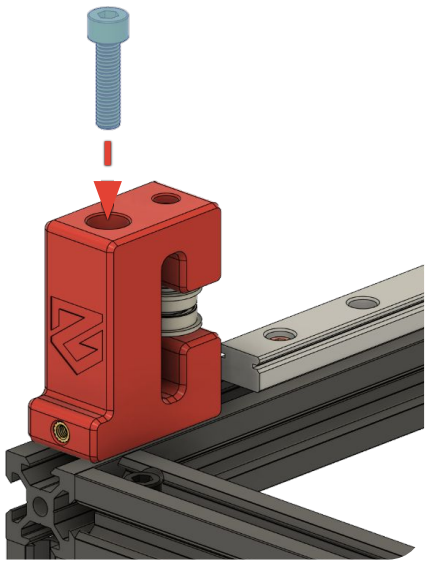
Let's install those tension towers now.

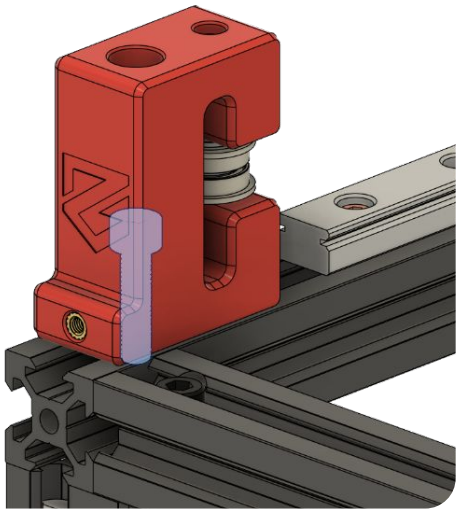
Lower the left tower, aligning the M5 t-nut's screw hole with the matching hole on the tension tower.



2. INSERT M5X20 SHCS

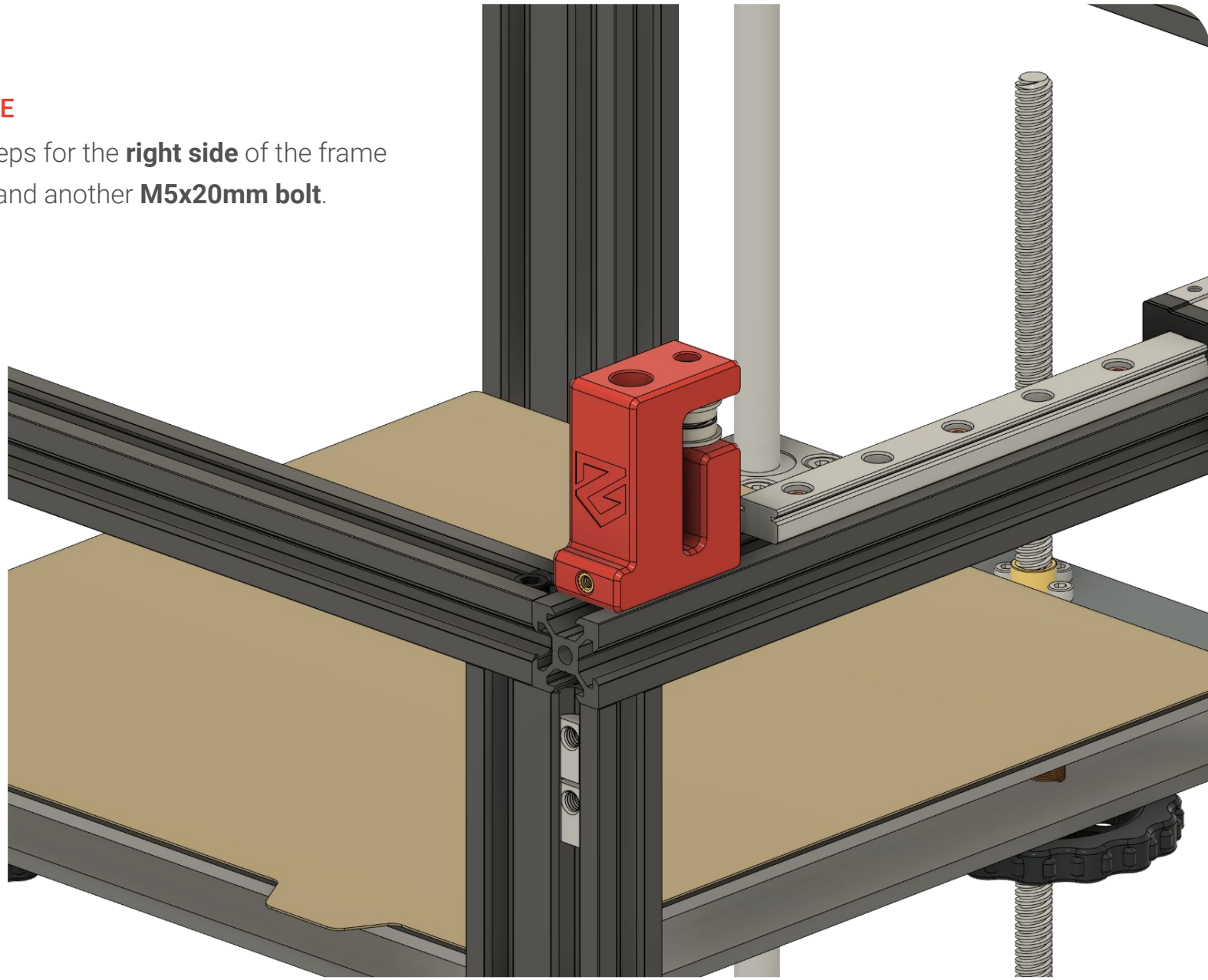
Insert an **M5x20mm SHCS** into the large hole at the top of the tensioner. **Partially tighten** this bolt into the pre-installed t-nut. We will finish tightening it in a later step.





3. REPEAT ON THE RIGHT SIDE

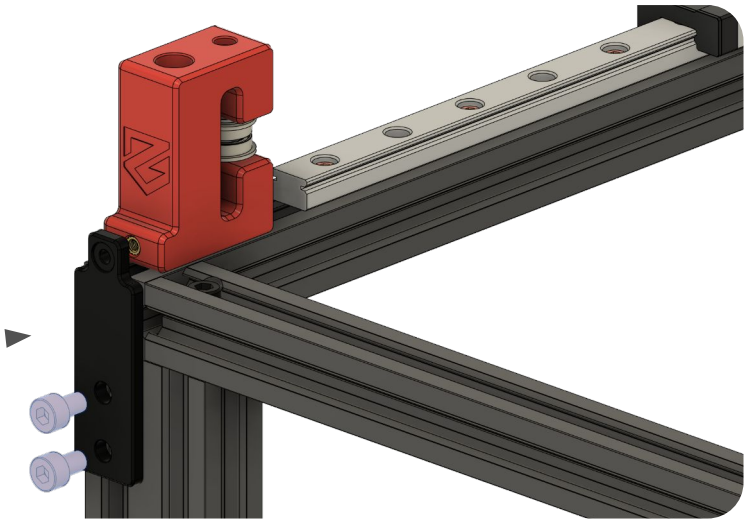
Repeat the previous page's steps for the **right side** of the frame and with **right tension tower** and another **M5x20mm bolt**.



1. LEFT TENSION PLATE

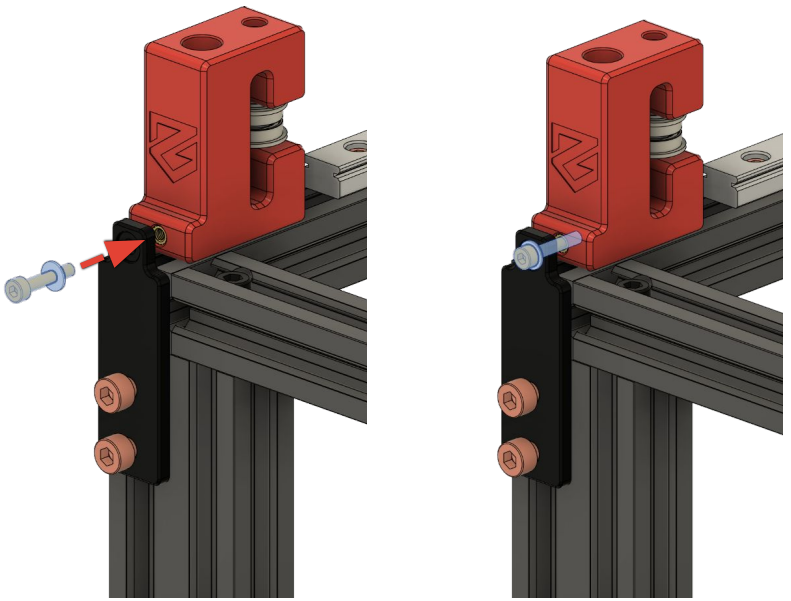
Set a tension plate against the front of the frame as pictured at right. **Finger tighten** two (2) M3x8mm bolts into the pre-installed t-nuts.

front_tension_plate_t-nut_1.stl



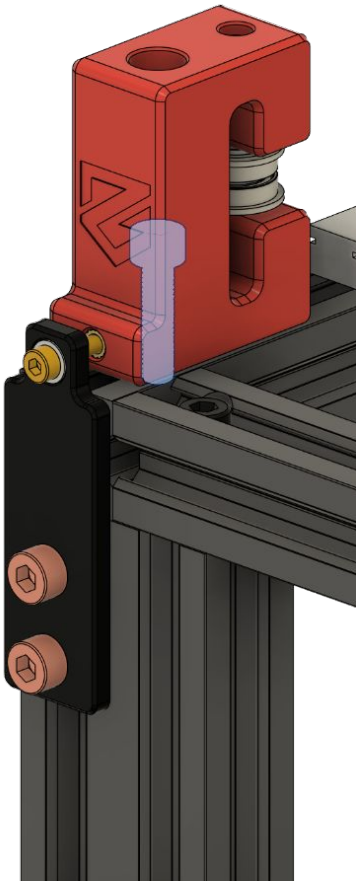
2. INSTALL TENSION ADJUSTMENT BOLT

Slide a washer and M3x16mm bolt through the top hole of the tension plate. Thread the bolt into the heat set insert **four turns only**, then stop and push the M3x16mm bolt flush against the tensioner plate.



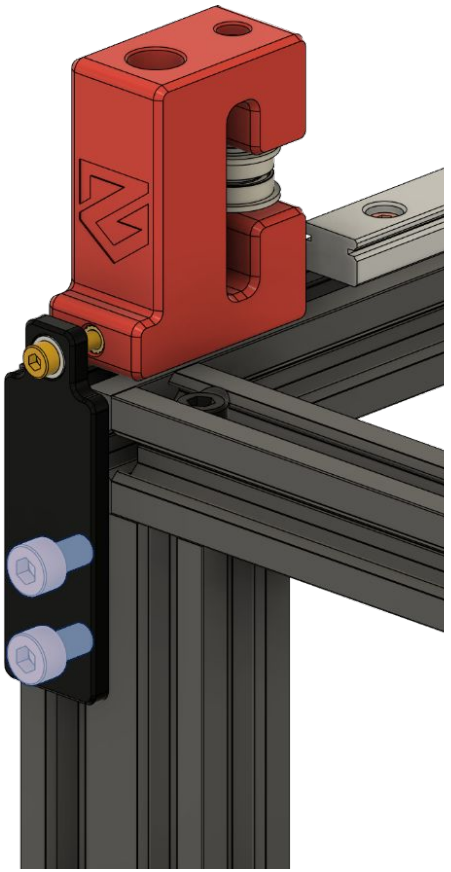
3. TIGHTEN THE 20MM BOLT

Fully tighten the M5x20mm bolt, securing the tension tower to the frame.



4. TIGHTEN 8MM BOLTS

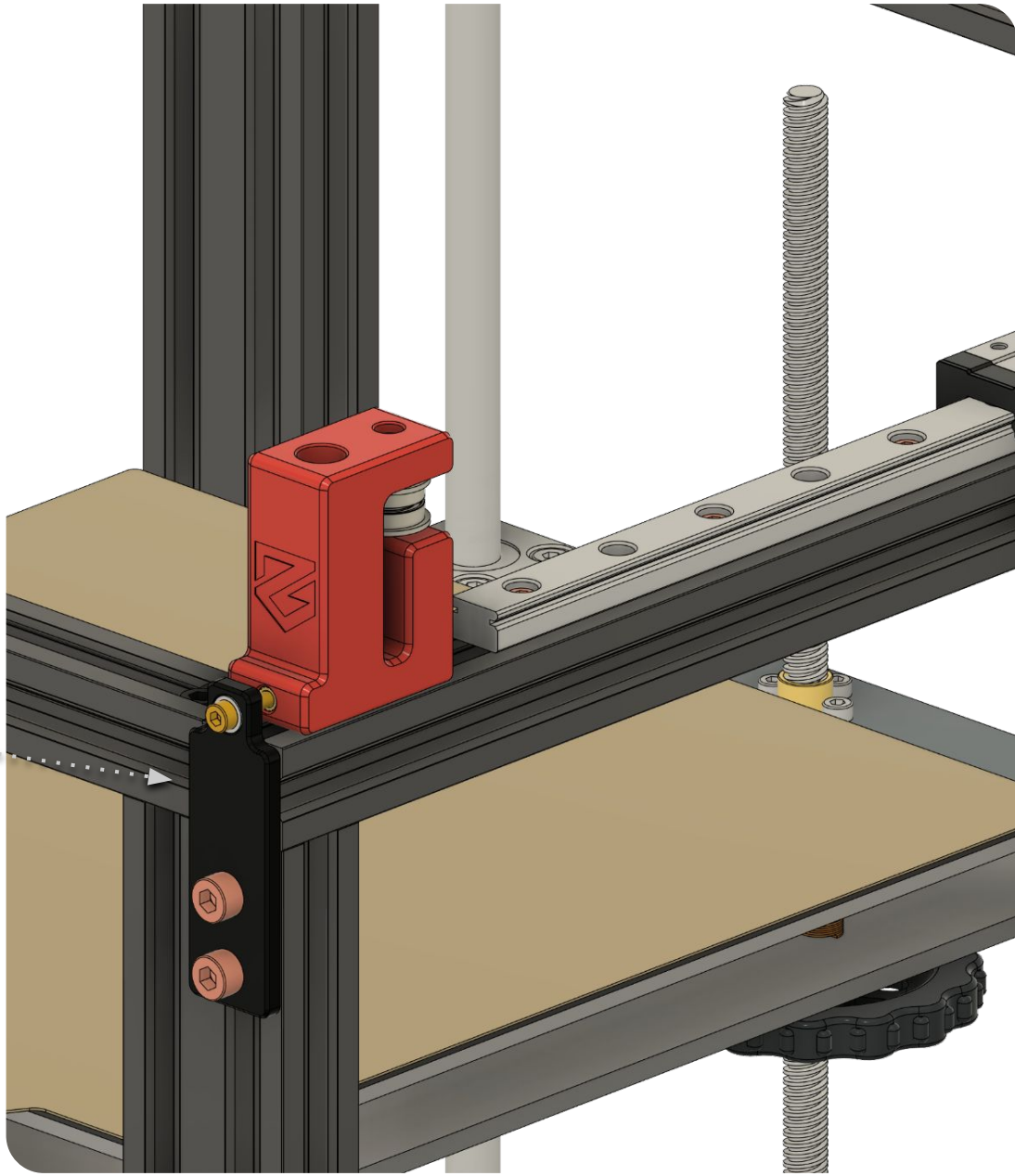
Adjust the height of the tension plate, if needed, to ensure the M3 tensioning screw is straight, then **fully tighten** the M5x8mm bolts holding the tension plate in place.



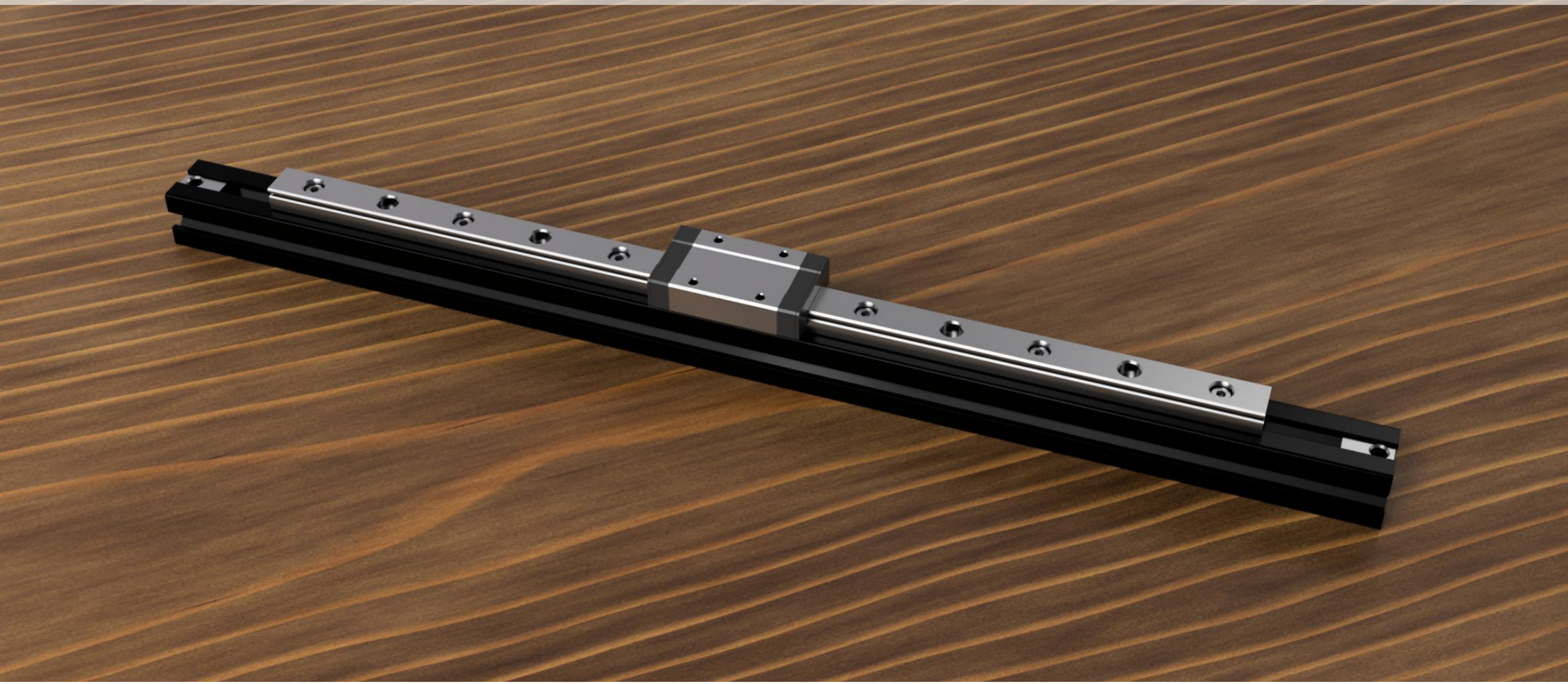
5. REPEAT ON THE RIGHT SIDE

Repeat the previous four steps for the **right side** of the frame and the **right tension tower**. Be sure to thread the M3 tension adjustment screw **four turns only**.

front_tension_plate_t-nut_2.stl



X AXIS LINEAR RAIL

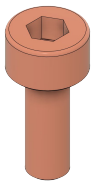


X AXIS / LINEAR RAIL / HARDWARE

INTRODUCTION

It's time to assemble our X axis linear rail.

HARDWARE

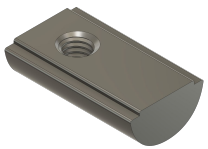


M3X8MM SHCS

300mm rails: Qty 6
330mm rails: Qty 7
450mm rails: Qty 9

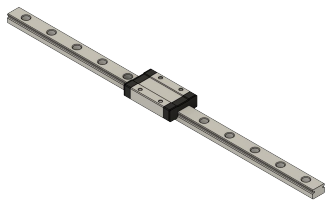
2020 EXTRUSION - QTY 1

Ender 5: 370mm
Ender 5 Plus: 500mm



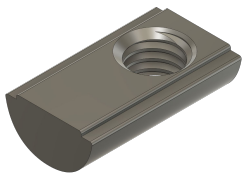
M3 ROLL-IN T-NUT

300mm rails: Qty 6
330mm rails: Qty 7
450mm rails: Qty 9

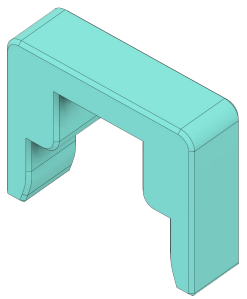


MGN12H LINEAR RAIL - QTY 1

Ender 5: 330mm (standard) or 300mm
Ender 5 Plus: 450mm



M5 ROLL-IN T-NUT - QTY 4

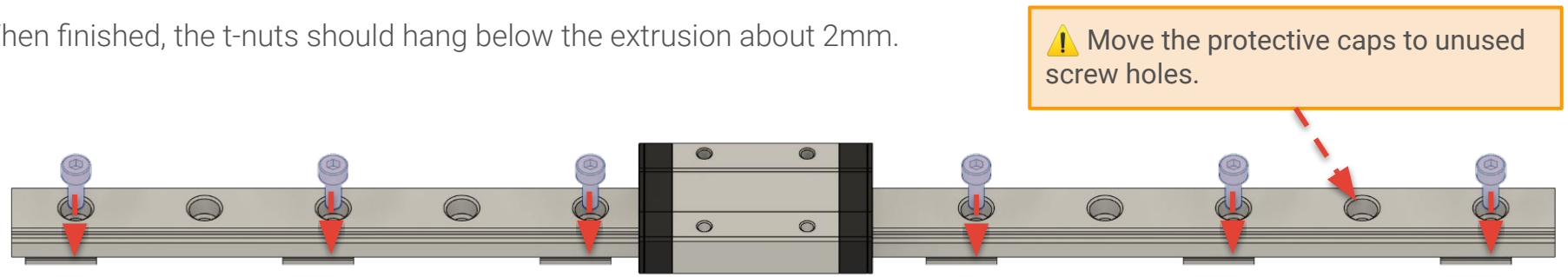


RAIL ALIGNMENT TOOL - QTY 2

1. PREP BOLTS AND T-NUTS

Install M3x8 bolts and M3 t-nuts to the linear rail, alternating holes as you go. This requires six (6) bolts and nuts each for 300mm rails, seven (7) each for 330mm rails, and nine (9) for 450mm rails.

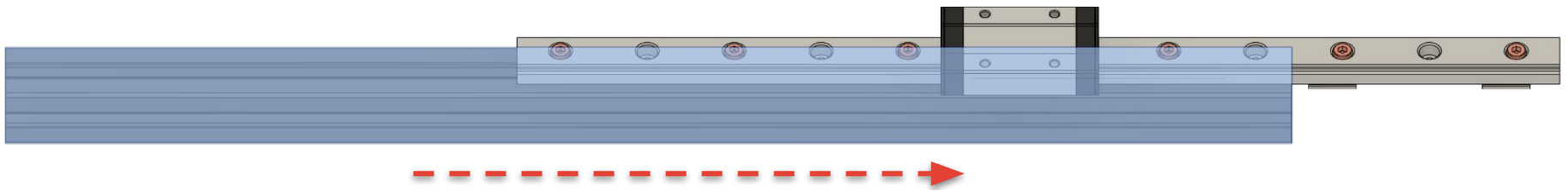
When finished, the t-nuts should hang below the extrusion about 2mm.



2. ADD RAIL TO EXTRUSION

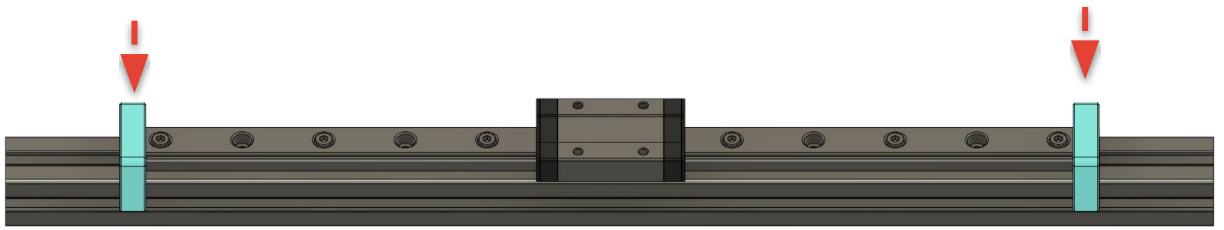
Slide the loaded rail onto the 2020 extrusion, one t-nut at a time.

Guide the t-nuts into the extrusion channel. Loosen or tighten the M3 bolts to adjust the height of each t-nut, as needed.



3. CENTER AND ALIGN THE RAIL

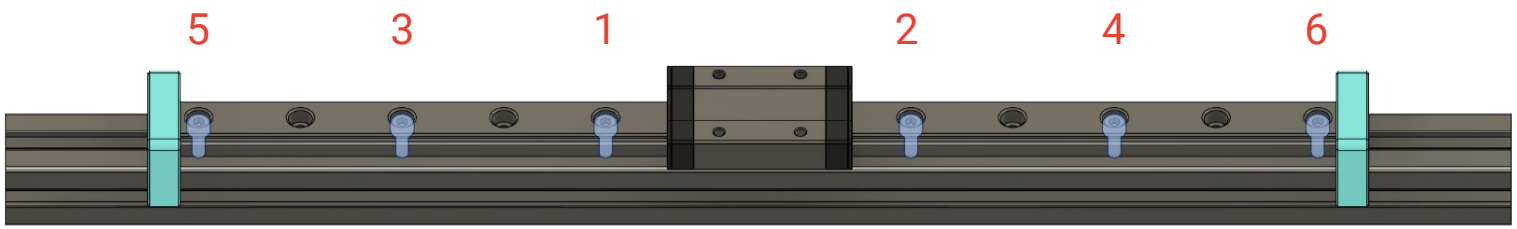
Center the rail on the extrusion, then add rail alignment tools at each end of the rail.



4. TIGHTEN BOLTS

Finger tighten the M3x8mm bolts in the pattern below, then **fully tighten** them in the same pattern.

Finally, remove the alignment tools.

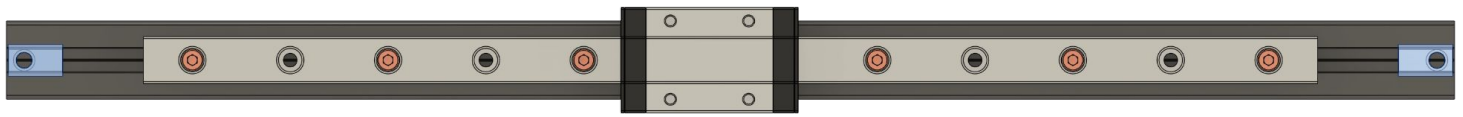


5. ADD M5 T-NUTS

Using two (2) M5 t-nuts, slide one (1) on each side of the linear rail. Note the orientation of the nut and location of the holes, **about 5 mm** from the edge.

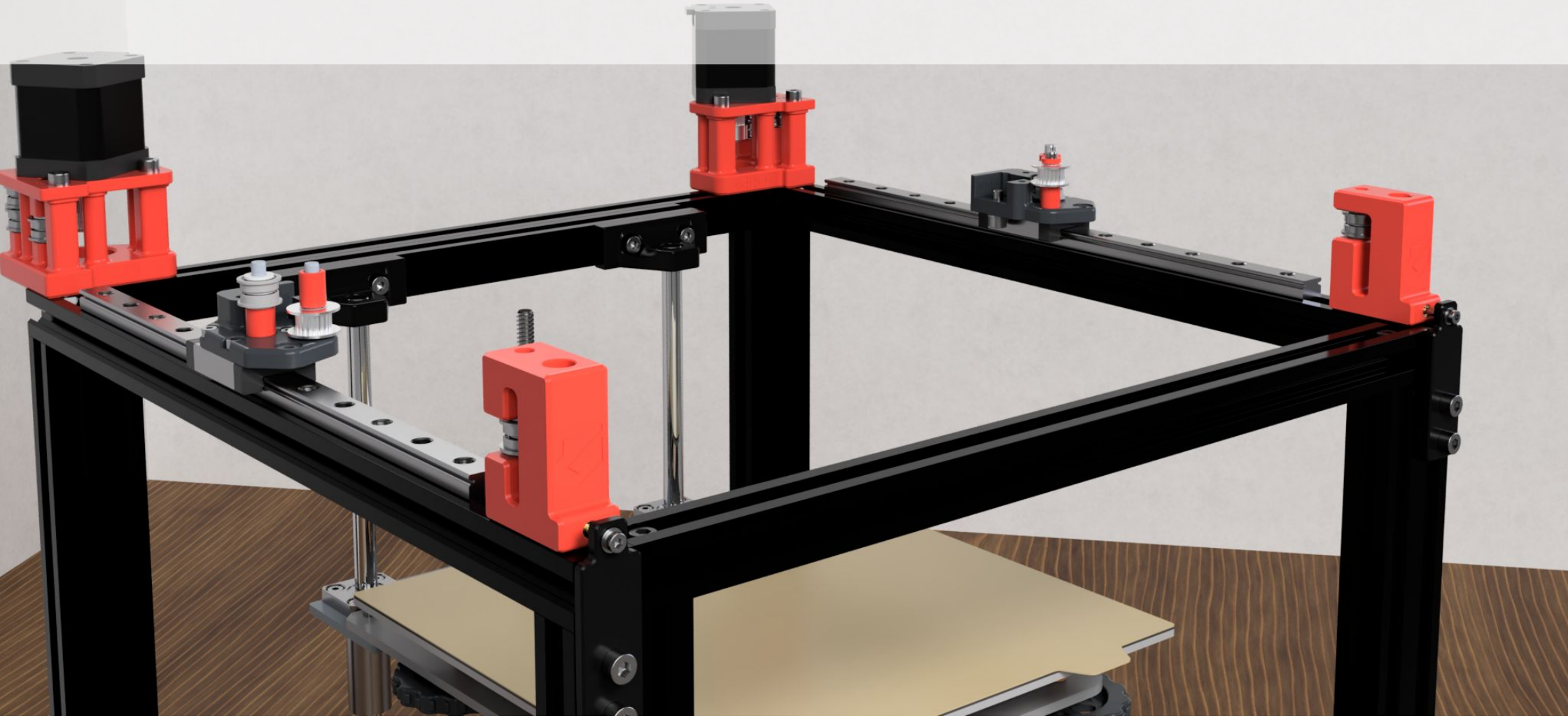
Slide the remaining two (2) t-nuts into the bottom side of the extrusion. The holes should be **about 10 mm** from the edge. Again, orientation of the nut is important.

TOP



BOTTOM

BOTTOM X JOINTS

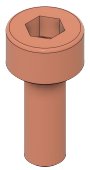


X AXIS / X JOINTS / BOTTOM / HARDWARE

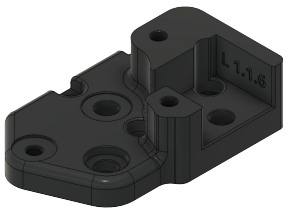
INTRODUCTION

In the next few sections, we will install the final flange stacks and complete our motion system. Let's get to it!

HARDWARE

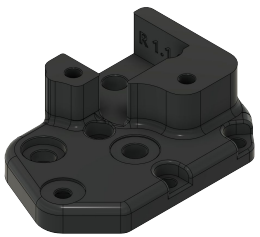


M3x8MM SHCS - QTY 8



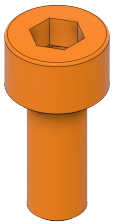
LEFT BOTTOM X JOINT

"XJoint_left_bottom.stl"



RIGHT BOTTOM X JOINT

"XJoint_right_bottom.stl"



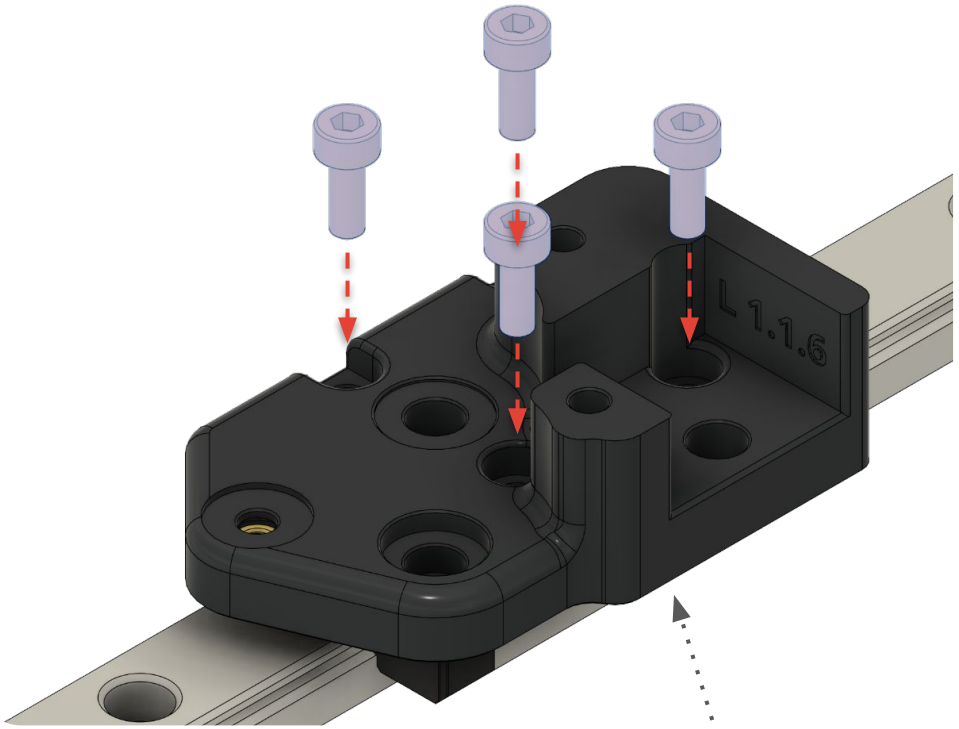
M5X12MM SHCS - QTY 2

If you have the lightweight aluminum gantry, substitute M5x10.

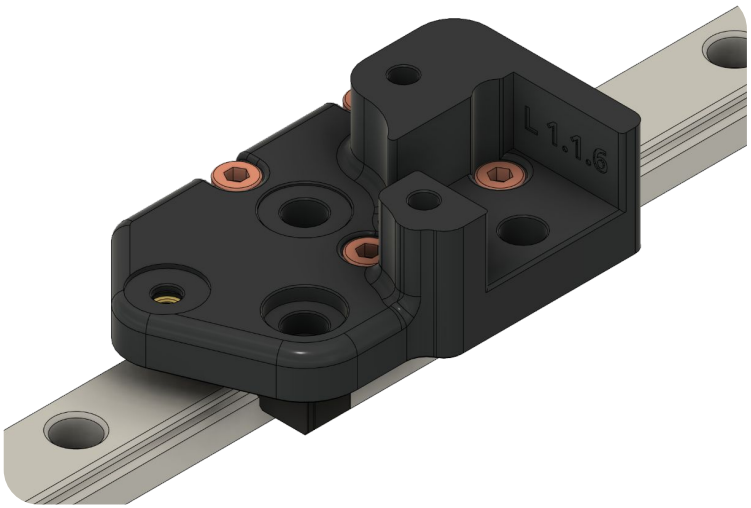
5MM x 1MM SHIM - QTY 2

1. LEFT BOTTOM X JOINT

Place the printed left bottom X joint on the left Y axis MGN12H carriage.
Secure with **four (4) M3x8mm** bolts.



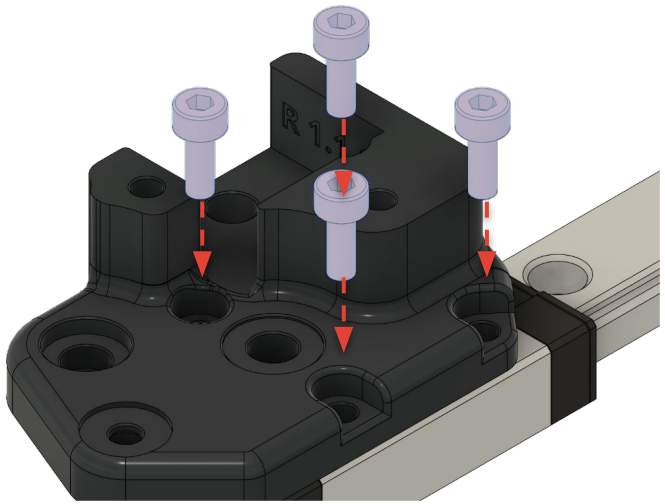
SHOULD LOOK LIKE



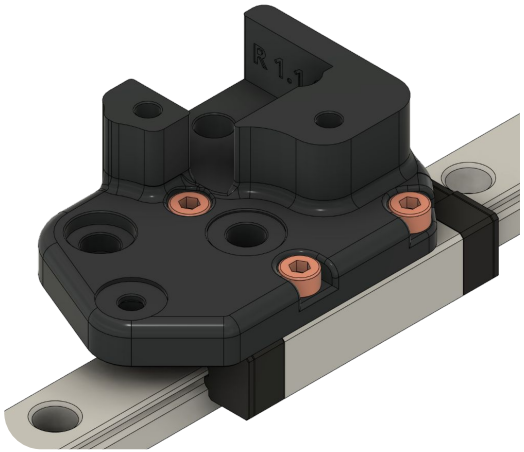
2. RIGHT BOTTOM X JOINT

Use the same procedure as above to install the **right** bottom X joint on the **right** Y axis carriage.

XJoint_right_bottom.stl



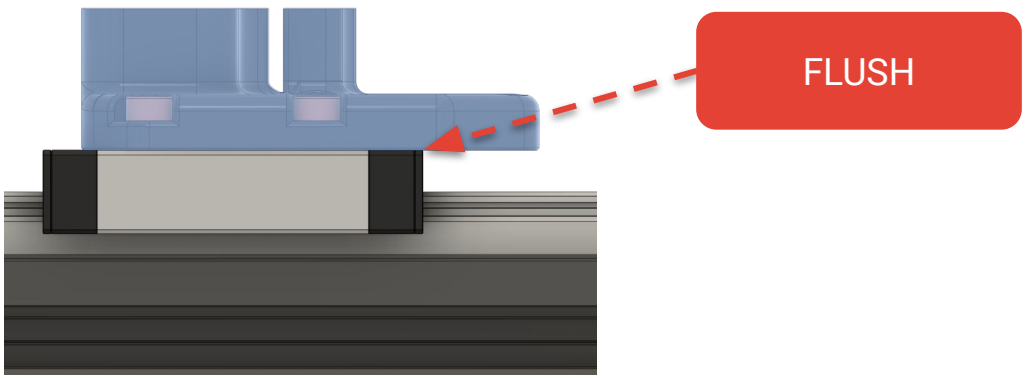
SHOULD LOOK LIKE



3. INSPECT FOR GAPS

Inspect the installed joints for gaps between the printed joint and MGN12H carriage. These are caused by protruding heat set inserts.

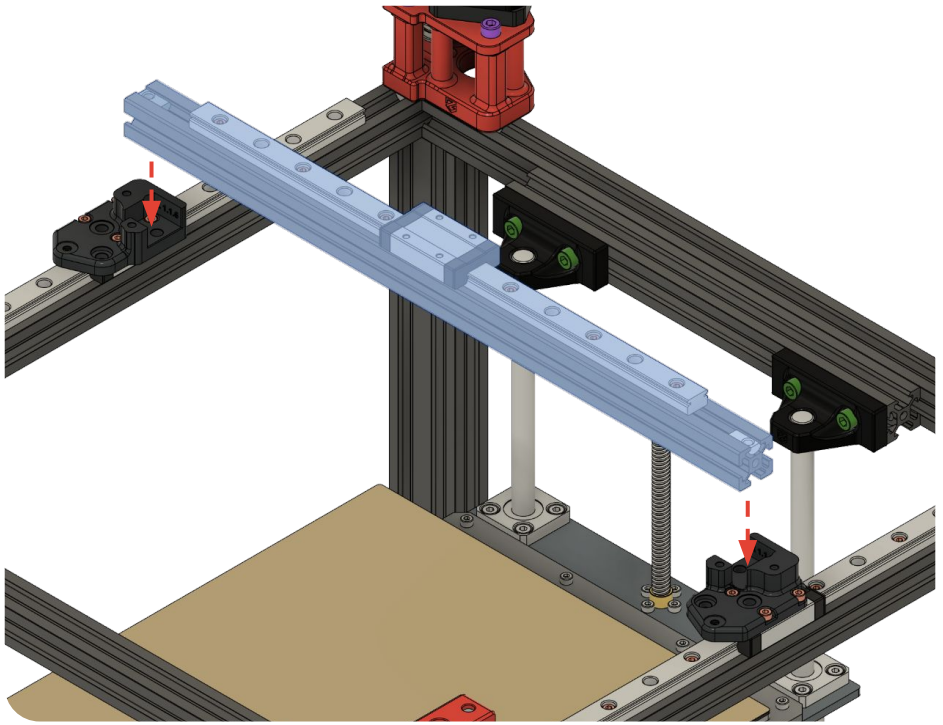
If any gaps are found, remove the joint and fix the inserts, then reinstall.



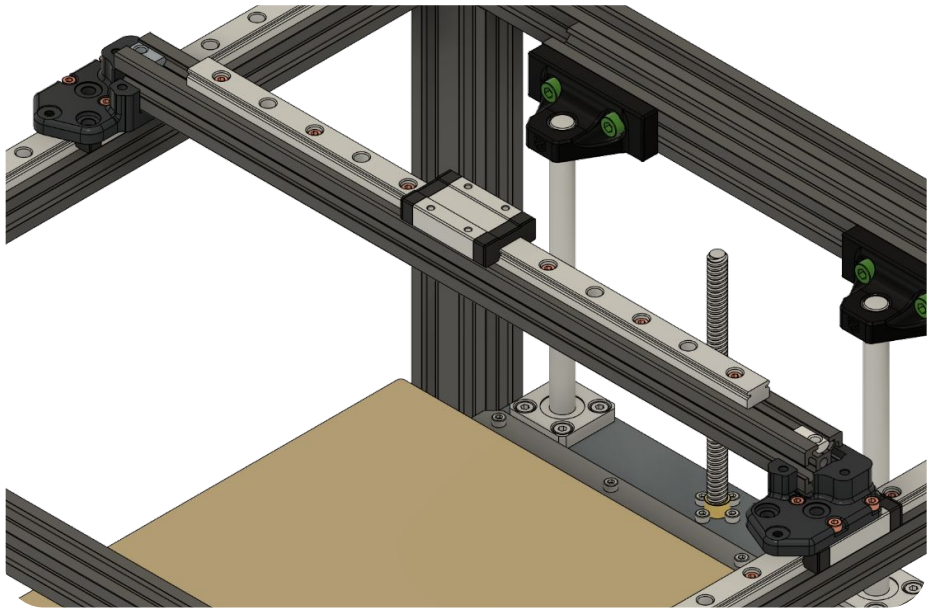
4. X AXIS EXTRUSION

Take the X axis extrusion and seat it in the X joints. The X axis linear rail should face upwards, as pictured.

The joints allow for extrusions that are several millimeters shorter or longer than specified.

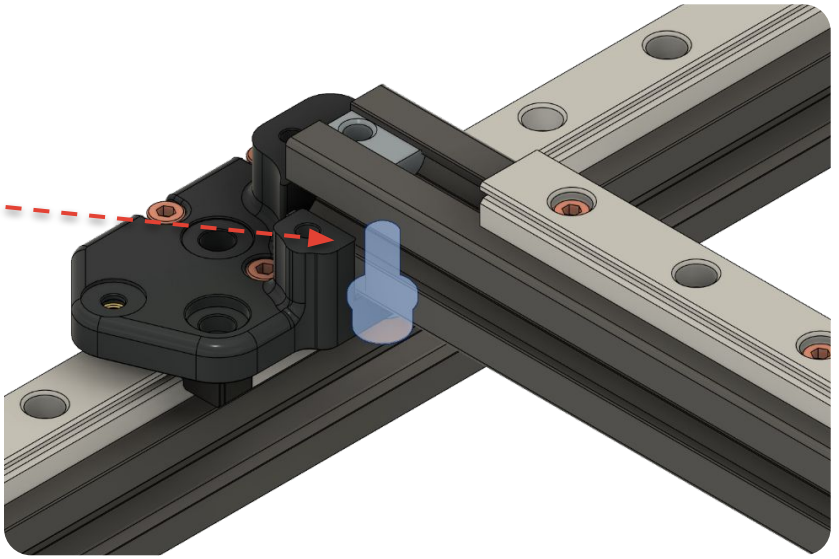


SHOULD LOOK LIKE

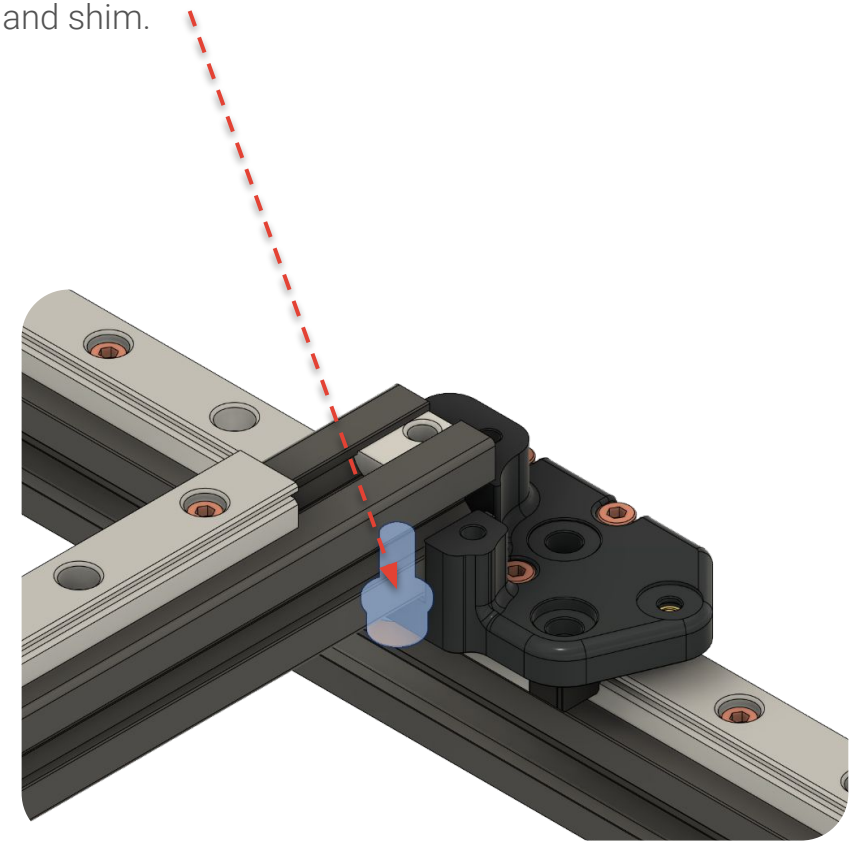


5. INSTALL M5x12 BOLTS

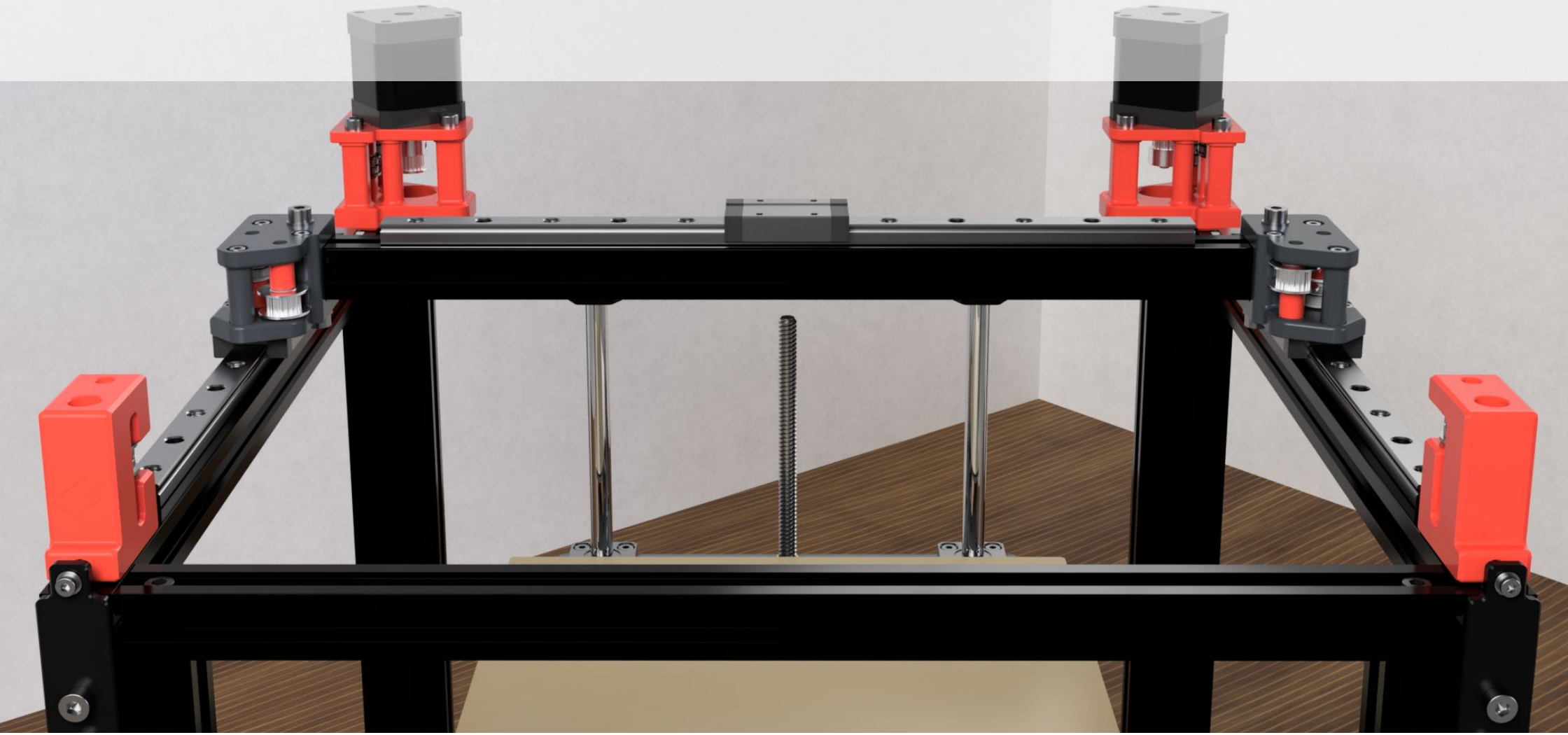
Put an M5x1mm shim on an M5x12mm bolt. Install it under the left X joint, but **finger tighten** only.



Repeat this step on the right side with the remaining M5x12 bolt and shim.

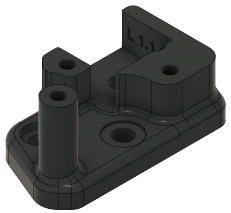


TOP X JOINTS



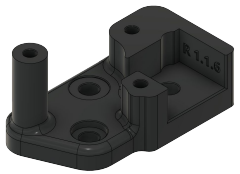
INTRODUCTION

With the X axis extrusion and linear rail in place, we can install flange stacks and cap off our X joints.



LEFT TOP X JOINT

"XJoint_left_top.stl"

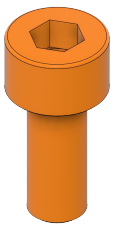


RIGHT TOP X JOINT

"XJoint_right_top.stl"

M3 WASHER - QTY 6

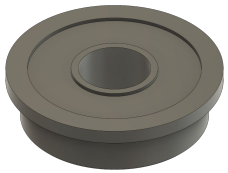
M3X30MM SHCS - QTY 6



M5X12MM SHCS - QTY 2

If you have the lightweight aluminum gantry, substitute M5x10.

M5X1MM SHIM - QTY 8



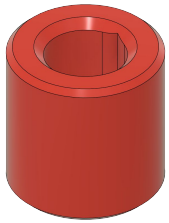
F695 BEARING - QTY 4

SHORT AND TALL TOOTHED IDLER SPACERS - QTY 2

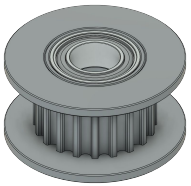
These are the spacers we measured for your toothed idlers.

5X30MM DOWEL - QTY 4

These should already be sanded for fit.



FLANGE STACK SPACER - QTY 2

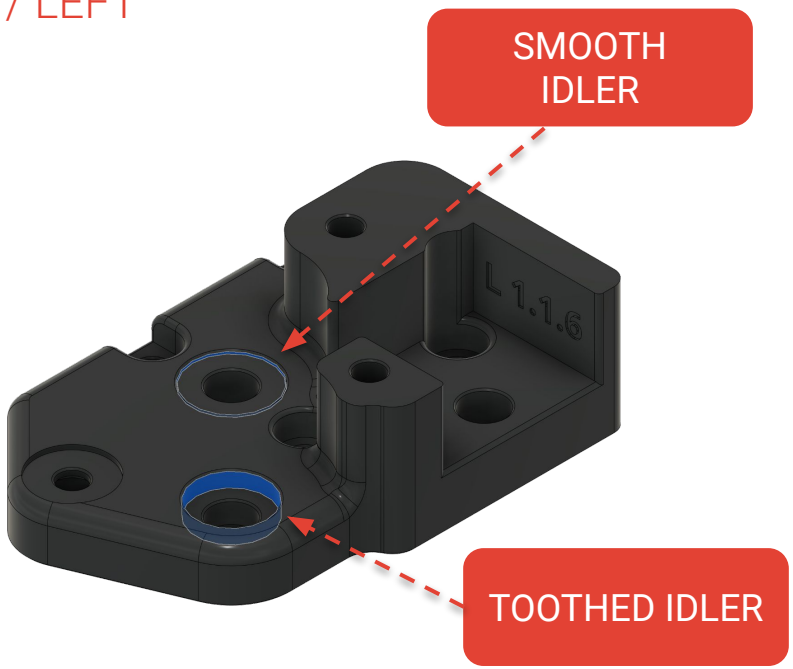


GT2 20T TOOTHED IDLER - QTY 2

ℹ️ Versions prior to 1.1.6 both short and tall flange stack spacers.

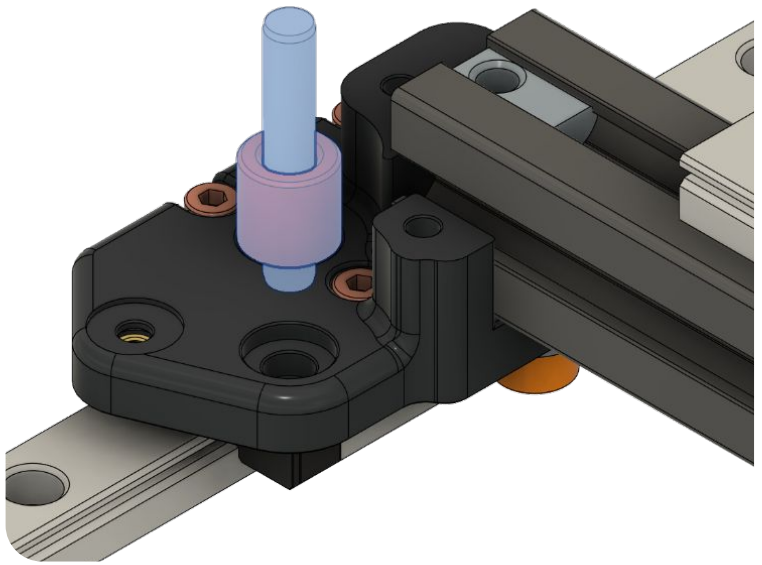
TOOTHED AND SMOOTH IDLERS

Let's finish the X joints, starting with the left X joint. Notice that the holes around the pins are different sizes; the smooth and toothed idler spacers are **different diameters**. This is to help avoid accidentally using the wrong spacer.



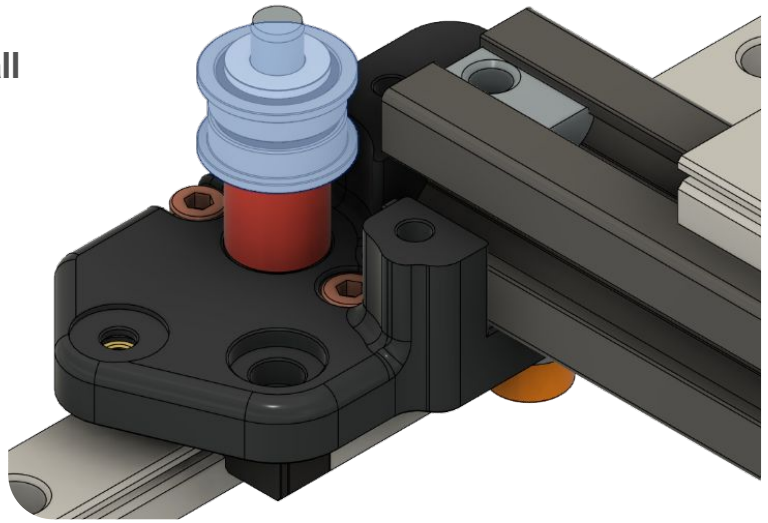
1. SMOOTH IDLER: PIN AND SPACER

Put a 5x30mm dowel pin in the **rear** hole, then add the **smooth idler spacer**. This is the widest spacer.



2. ADD THE FLANGE STACK

Next build a **single flange stack** on top of the spacer. Don't forget **all three shims**!



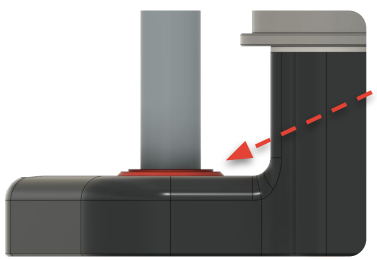
ℹ️ Versions 1.1.5 and earlier used a second, short spacer with the smooth idler assembly.

With version 1.1.6, this spacer is built-in to the X joint and no longer needed.

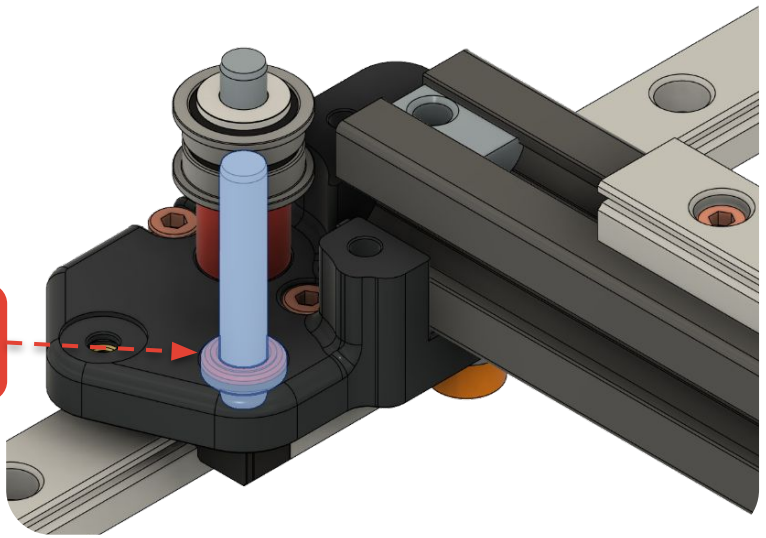
3. TOOTHED IDLER PIN

Add a second 5x30mm dowel pin to the **front hole**.

Slip a **short toothed idler spacer** over the dowel with the small lip **facing upward**.

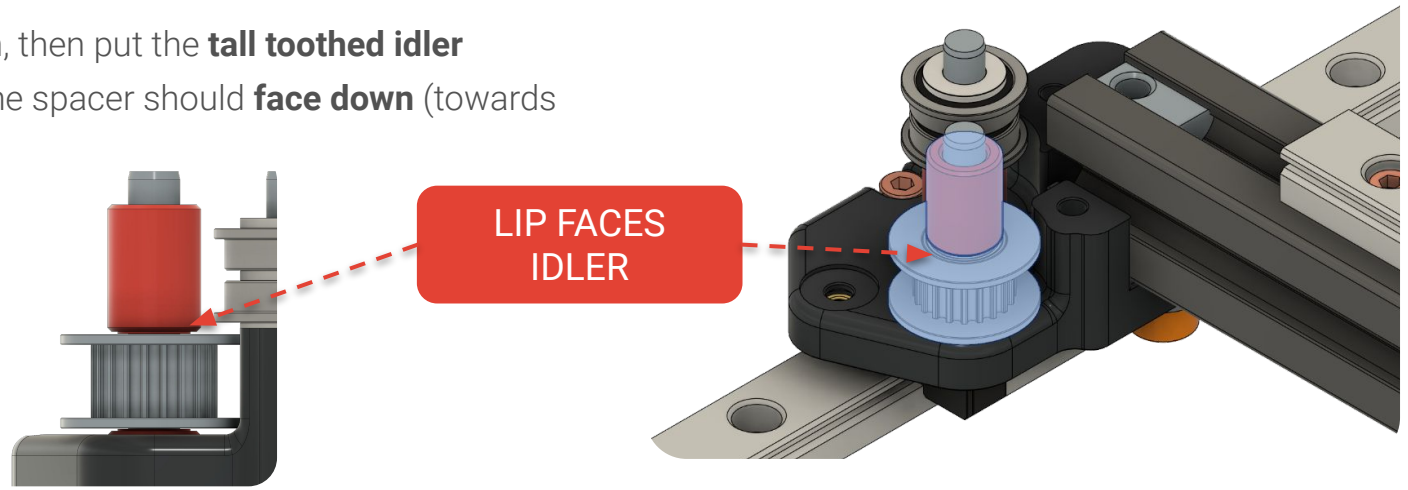


LIP FACES UPWARD



4. TOOTHED IDLER

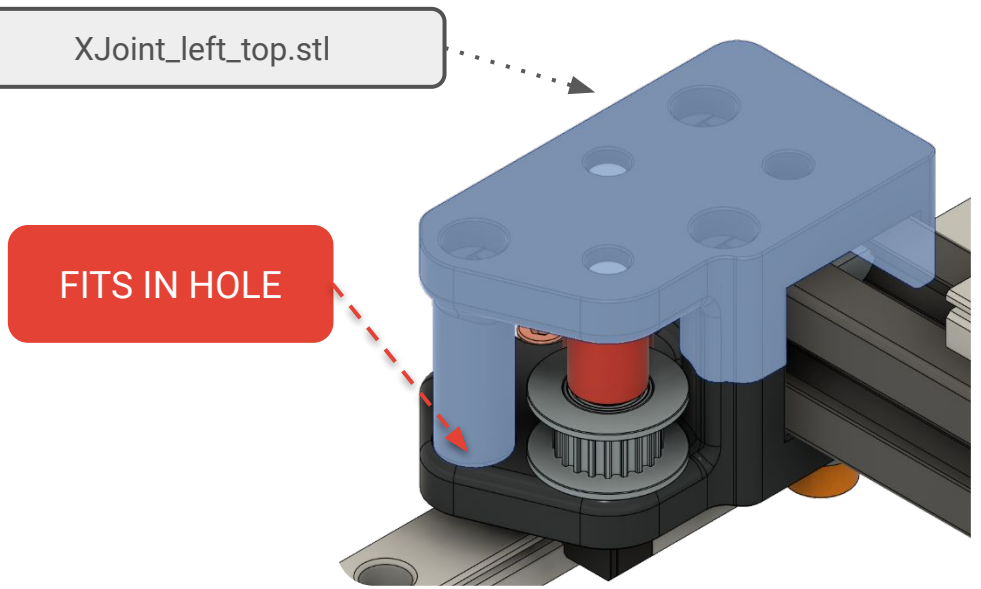
Add a **toothed idler** to the pin, then put the **tall toothed idler spacer** on. The small lip on the spacer should **face down** (towards the idler).



5. FIT THE TOP

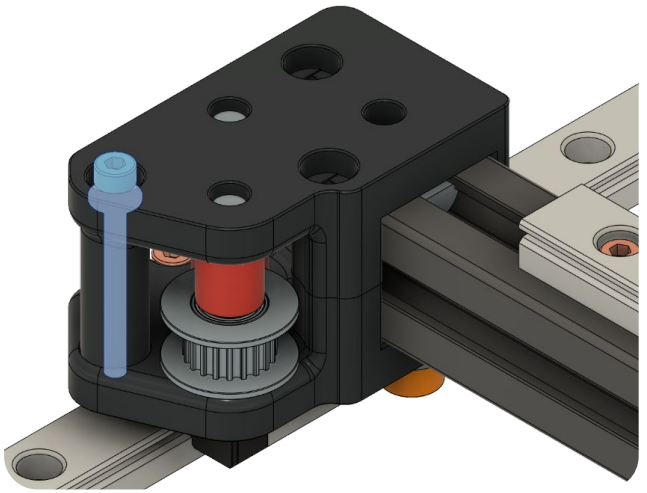
Put the **top left X joint** over the pins and X axis extrusion. You may need to nudge the dowel pins upright with a small Allen wrench before the top will fit in place.

The front pillar of the printed top should fit into the matching depression in the printed bottom.



6. FRONT M3X30 BOLT AND WASHER

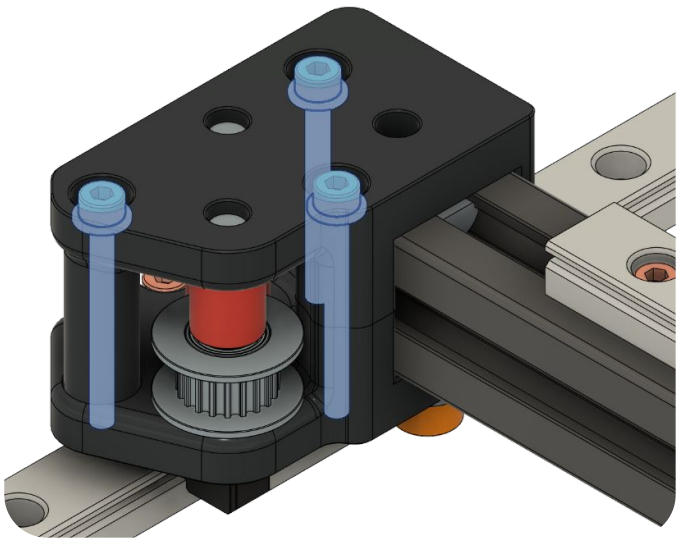
Put an **M3 washer on an M3x30mm bolt** and insert it into the X joint's **front pillar**. Do not completely tighten yet.



7. MORE BOLTS AND WASHERS

Add the remaining two (2) M3 bolts and washers and **fully tighten** all three (3).

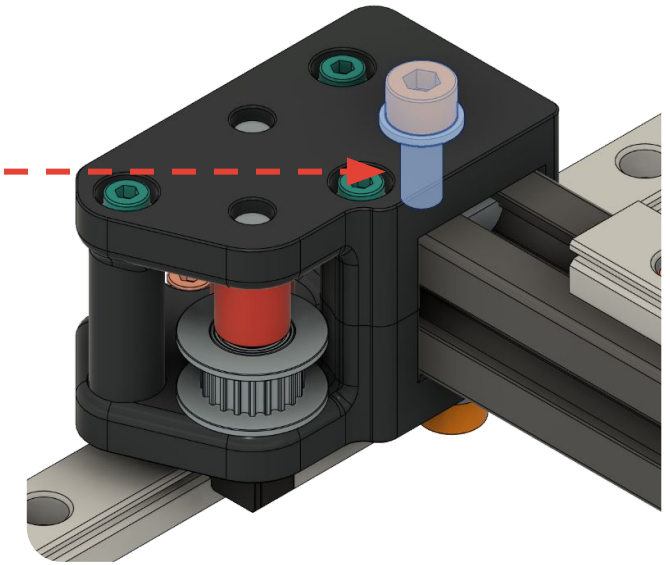
> 📝 Over-extrusion on the printed parts can cause a small gap between the top and bottom parts. This is a cosmetic issue only.

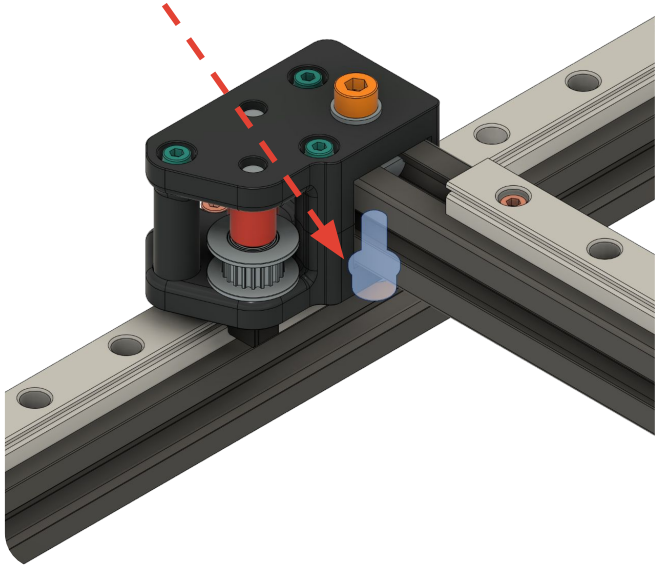


8. M5x12 BOLTS AND SHIMS

To secure the extrusion, install an **M5x12mm bolt with a shim** and **fully tighten**.

Also **fully tighten** the M5x12mm bolt on the **bottom** of the X joint.



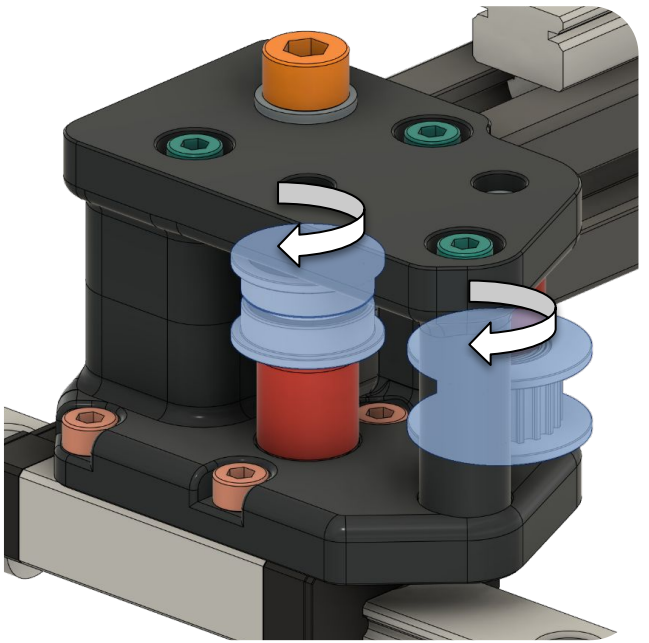


9. INSPECT BEARINGS

Spin the smooth and toothed idlers and inspect their motion. The bearings should spin evenly and smoothly.

Binding of the bearings (resistance to turning) can be caused by over-tightening the M3x30 bolts or incorrect toothed idler spacer orientation.

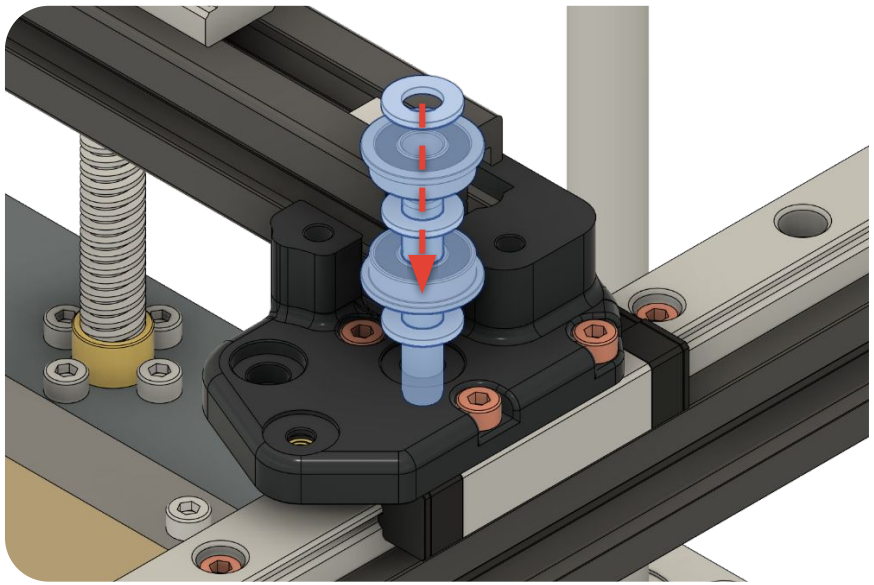
Some vertical play in the bearings is normal. **Large (over 0.2mm) gaps** in the idlers are often caused by incorrect spacer sizes for the toothed idlers and missing shims for the smooth idlers.



1. PIN AND FLANGE STACK

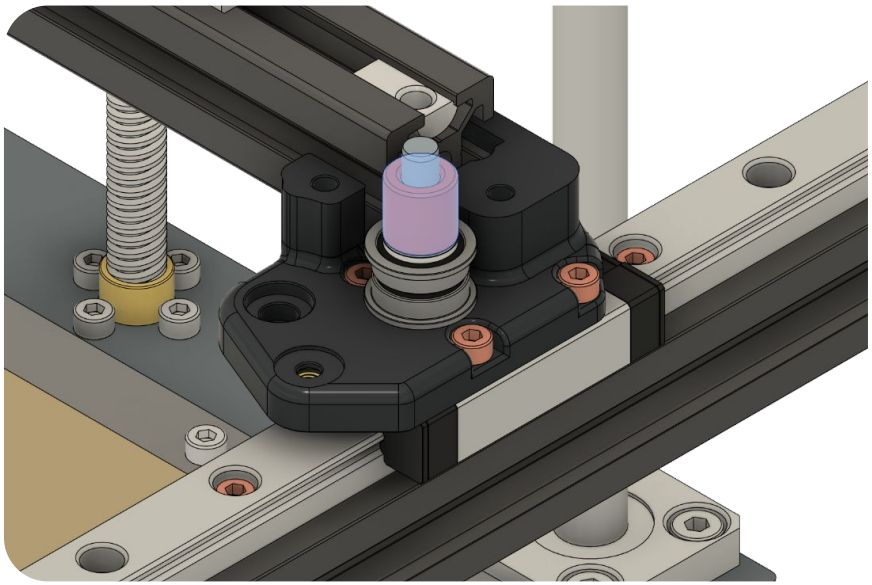
We're shifting over to the right side now. Install a 5x30mm dowel pin in the **right X joint's rear pin hole**, then **build a flange stack** on the pin.

⚠️ The right idlers and spacers are upside-down compared to the left side.



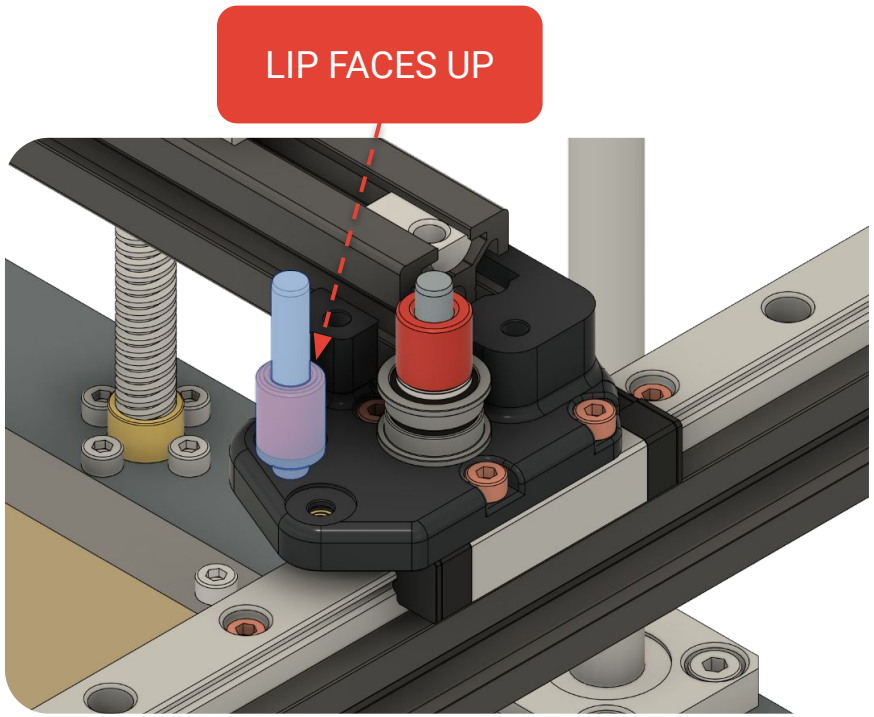
2. ADD A SPACER

Top the pin with a **smooth idler spacer**.



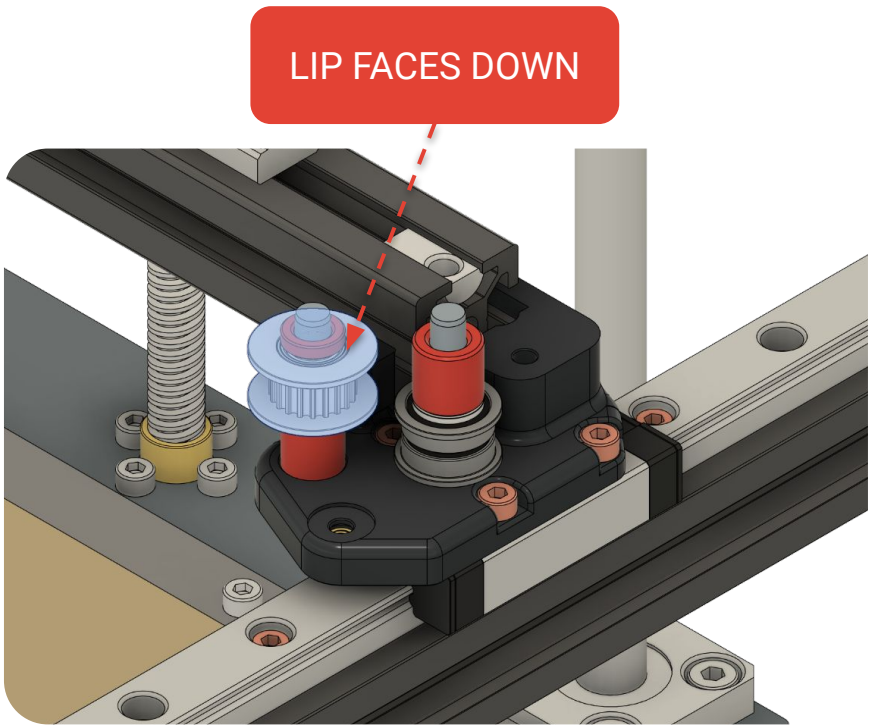
3. FRONT PIN AND TALL SPACER

Next, install a dowel pin in the front pin hole, along with the **tall toothed idler spacer**. The spacer's lip should face upwards.



4. TOOTHED IDLER AND SHORT SPACER

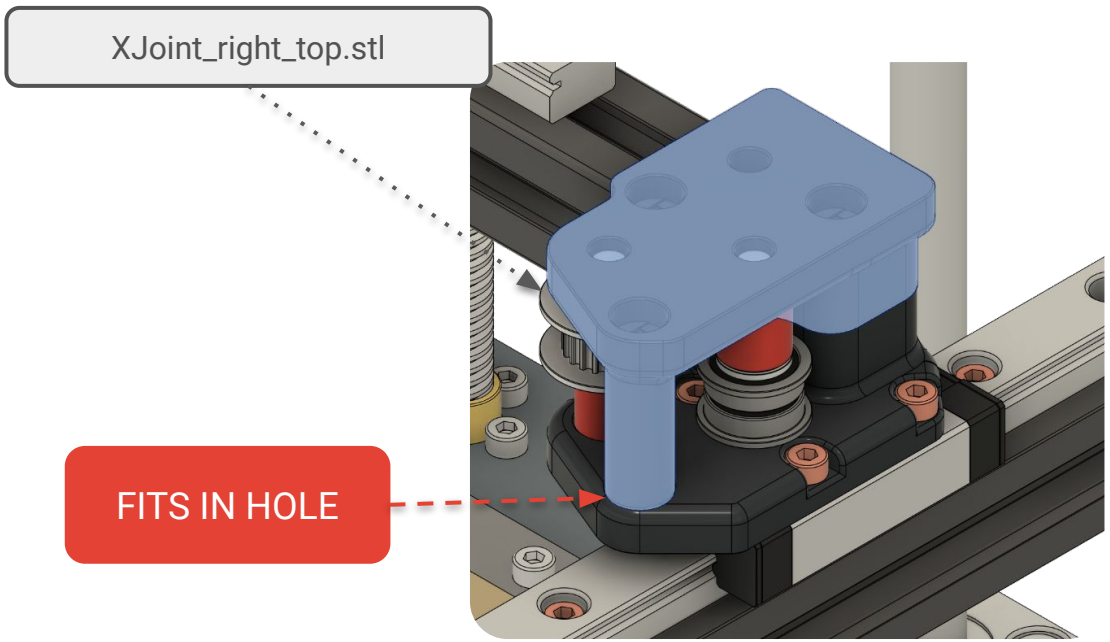
Add the remaining **toothed idler**, then the **short toothed idler spacer**. The short spacer lip should face the down, towards the idler.



5. INSTALL TOP

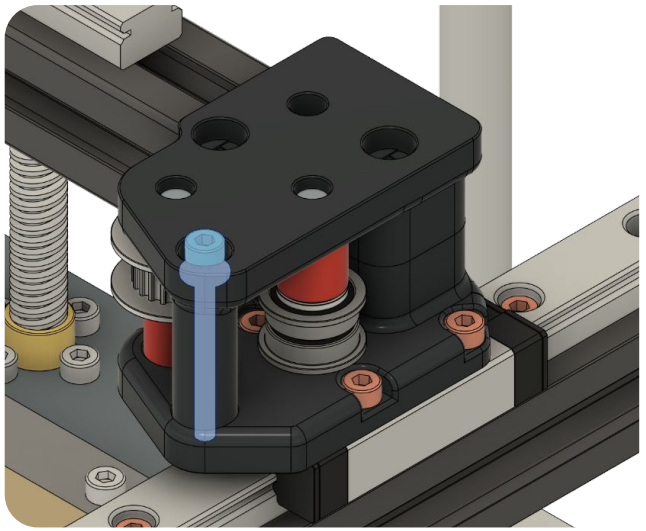
Put the **top right X joint** over the pins and X axis extrusion. You may need to adjust the dowel pins to get the top to fit.

As before, check that the front pillar sits in the matching depression in the bottom.



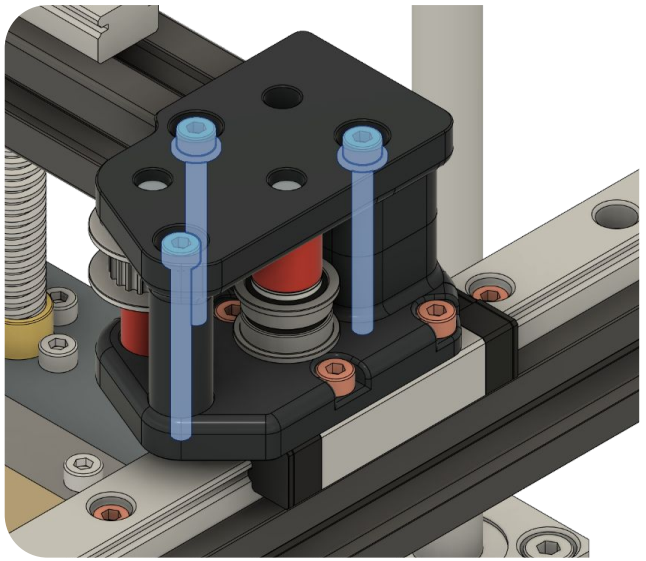
6. FRONT M3X30 BOLT AND WASHER

Put an **M3 washer on an M3x30mm bolt** and insert it into the X joint's **front pillar**. Finger tighten the bolt.



7. MORE BOLTS AND WASHERS

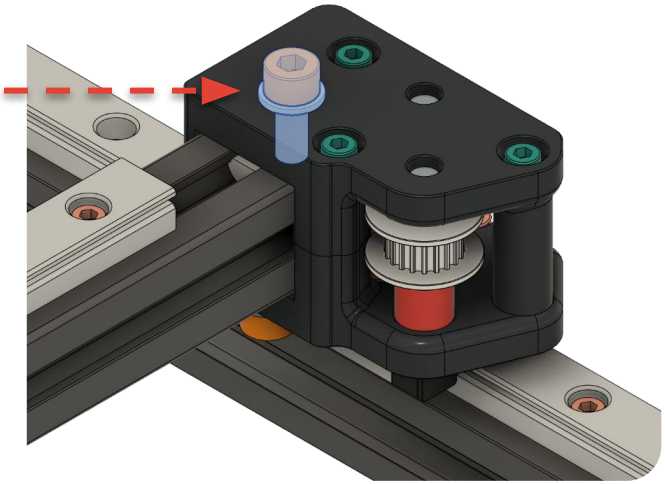
Add the remaining two (2) M3 bolts and washers and **fully tighten** all three (3) bolts.

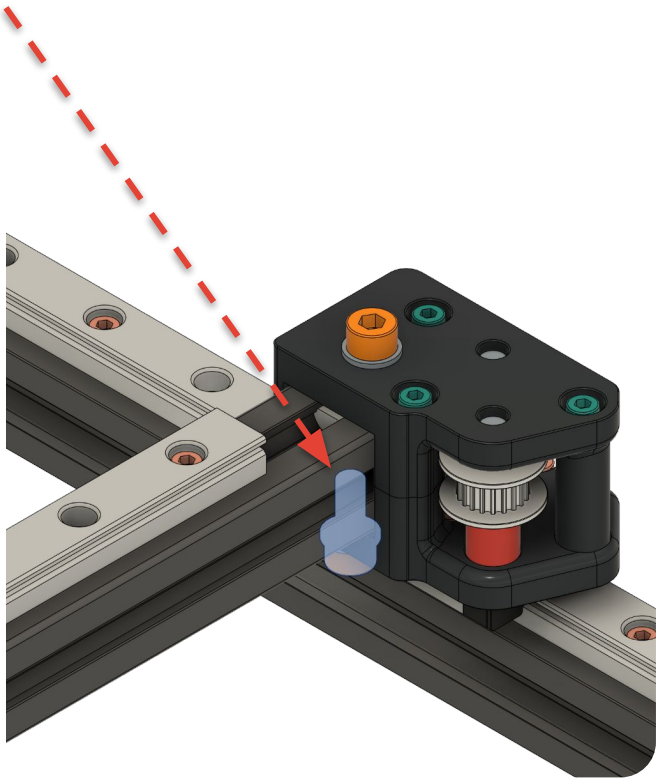


8. M5x12 BOLTS AND SHIMS

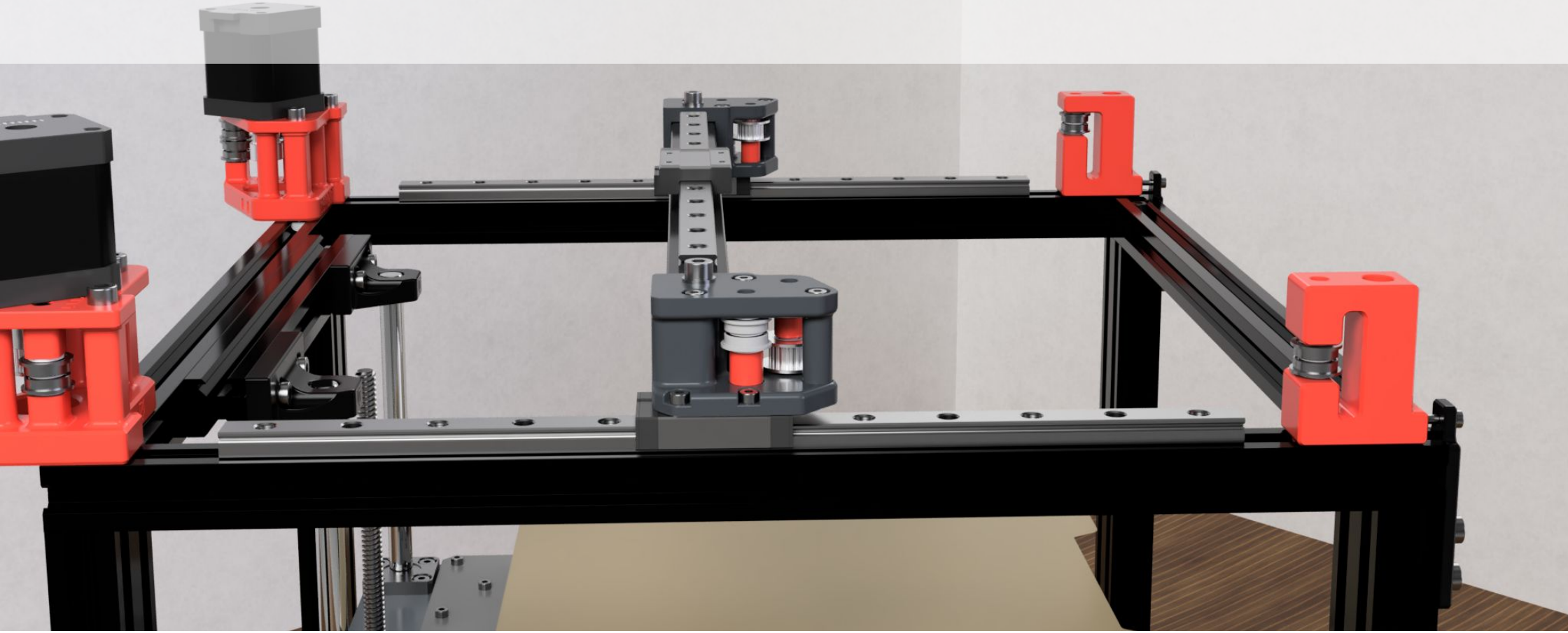
To secure the extrusion, install an **M5x12mm bolt with a shim** and **fully tighten**.

Also **fully tighten** the M5x12mm bolt on the **bottom** of the X joint.





Y AXIS ALIGNMENT



Y AXIS ALIGNMENT

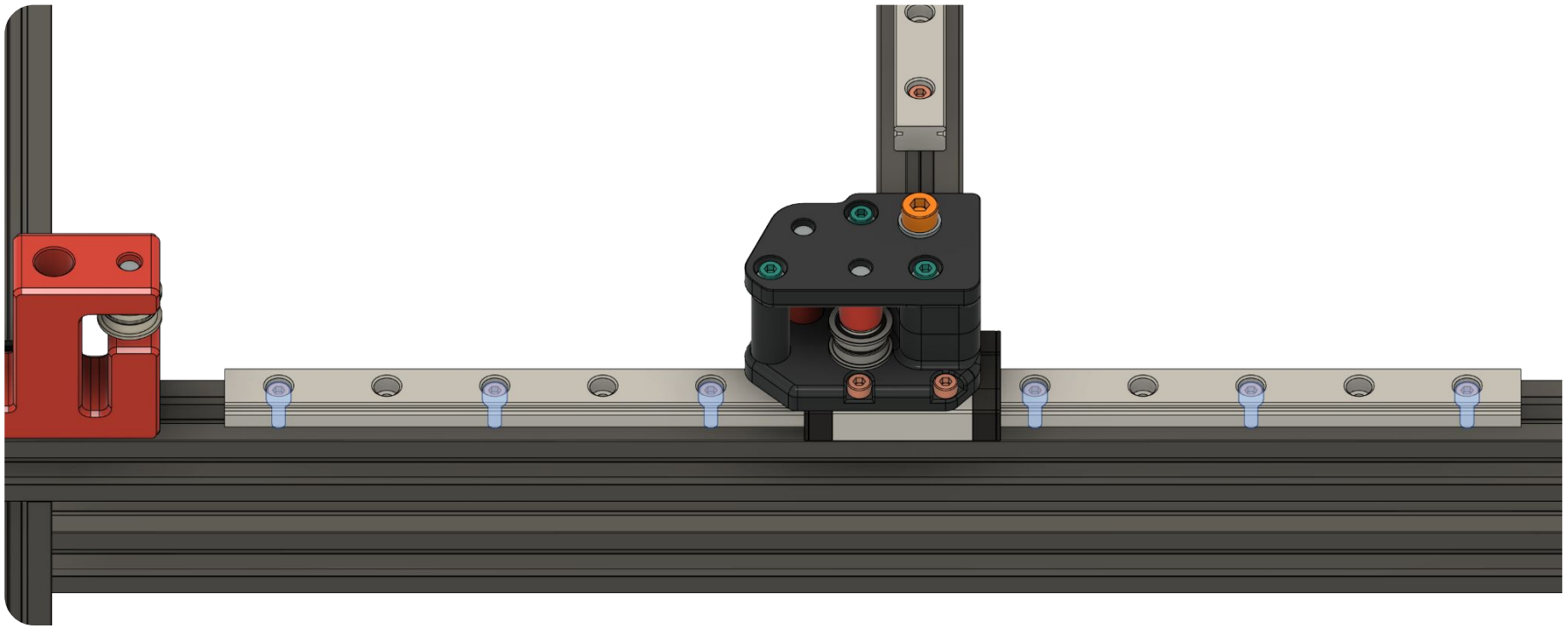
INTRODUCTION

Our Y axis linear rails are centered on the top left and right extrusions, but those extrusions may not be perfectly parallel. We're going to adjust our rail alignment to account for this.

No additional hardware is needed for this section.

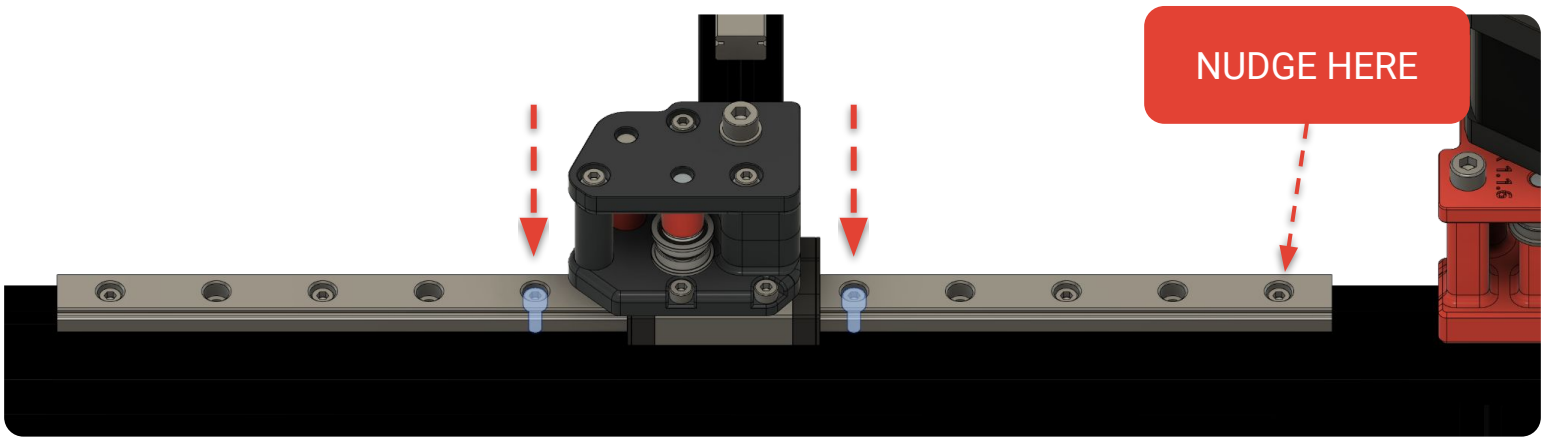
1. LOOSEN THE RIGHT RAIL

Loosen **all** of the M3x8mm bolts on your **right linear rail**, enough that the rail can be moved. Do **not** remove the bolts.



2. CENTER AND ANCHOR THE RAIL

Center the carriage. Tighten the screws on either side of the right carriage just enough to **lightly hold the rail** in place, but not enough to keep the ends from being nudged side-to-side with gentle pressure.

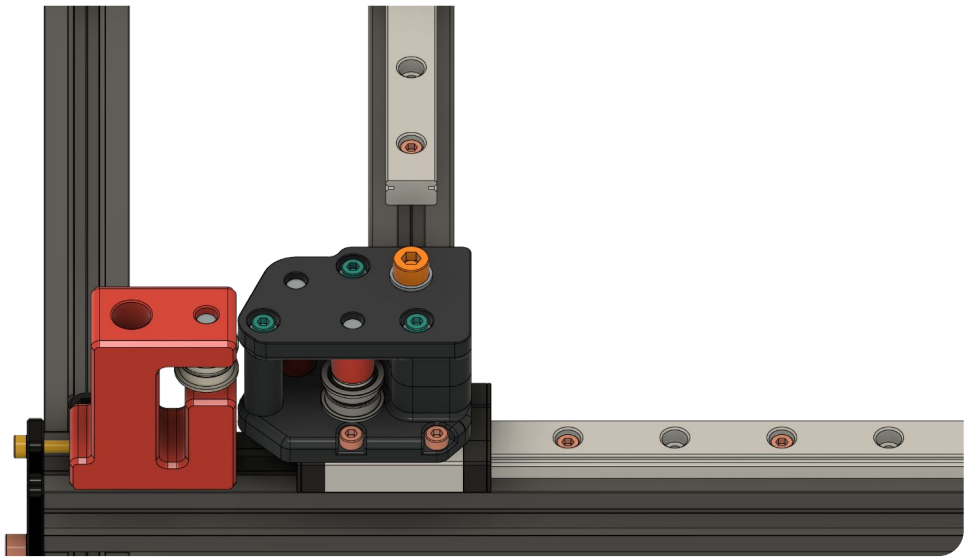


3. HOLD THE X CARRIAGE

Grab your MGN12H carriage on the **X axis linear rail** and **center it**. Now **close your fist** around the X axis extrusion. We want the X carriage stationary for the next steps.

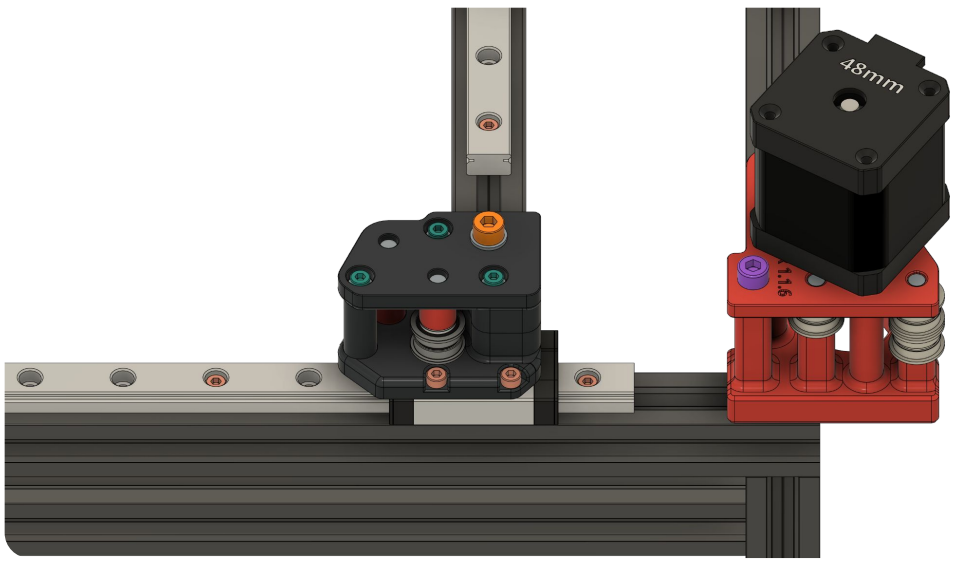
3. BRING IT FORWARD

Pull the X axis forward **near** the end of the rail or until you bump into the tension towers. If you have a **300mm Y axis**, **be careful** not to run off the end of the rail!



4. MOVE TO THE BACK

Push the Y axis **close** to the **rear end** of the rail. If you have a **300mm Y axis**, **be careful** not to travel beyond the end of the rail.

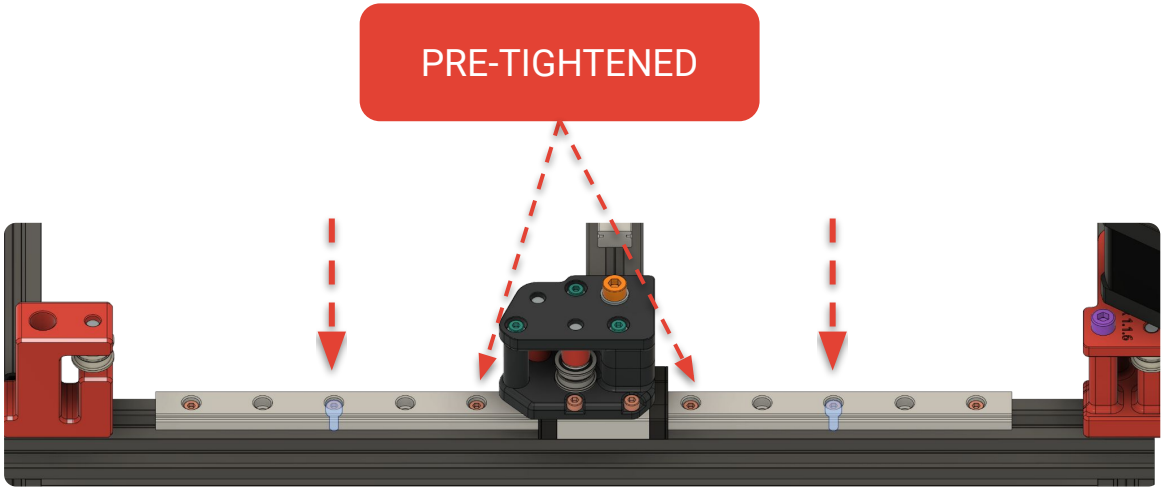


6. RE-CENTER AND SECURE THE RAIL

Re-center the X gantry and let go of the carriage.

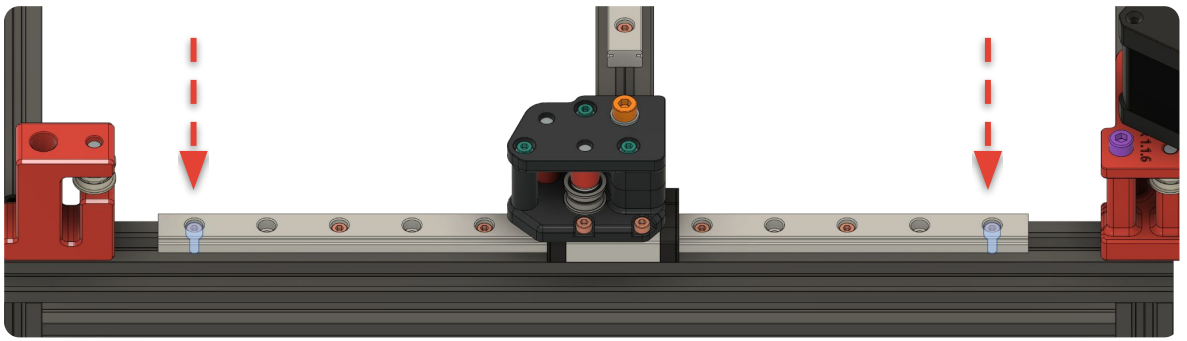
Find the two bolts closest to the center of the rail that are not tightened. Secure them **as tightly as the center screws**, or just enough to hold the rail in place.

Continue this procedure until only the outer two screws remain untightened.



7. LOCK DOWN THE OUTSIDE

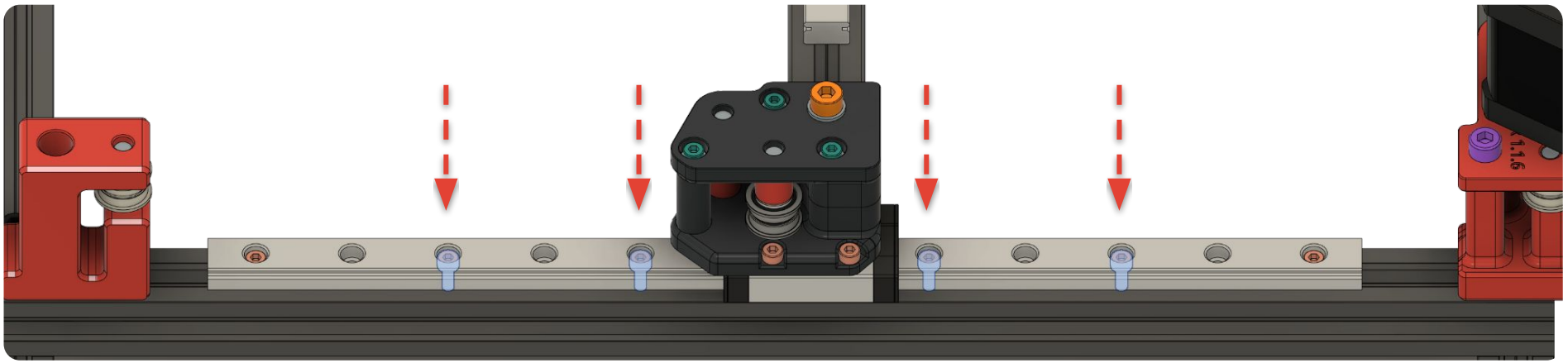
Next, **fully tighten** the outside two screws.



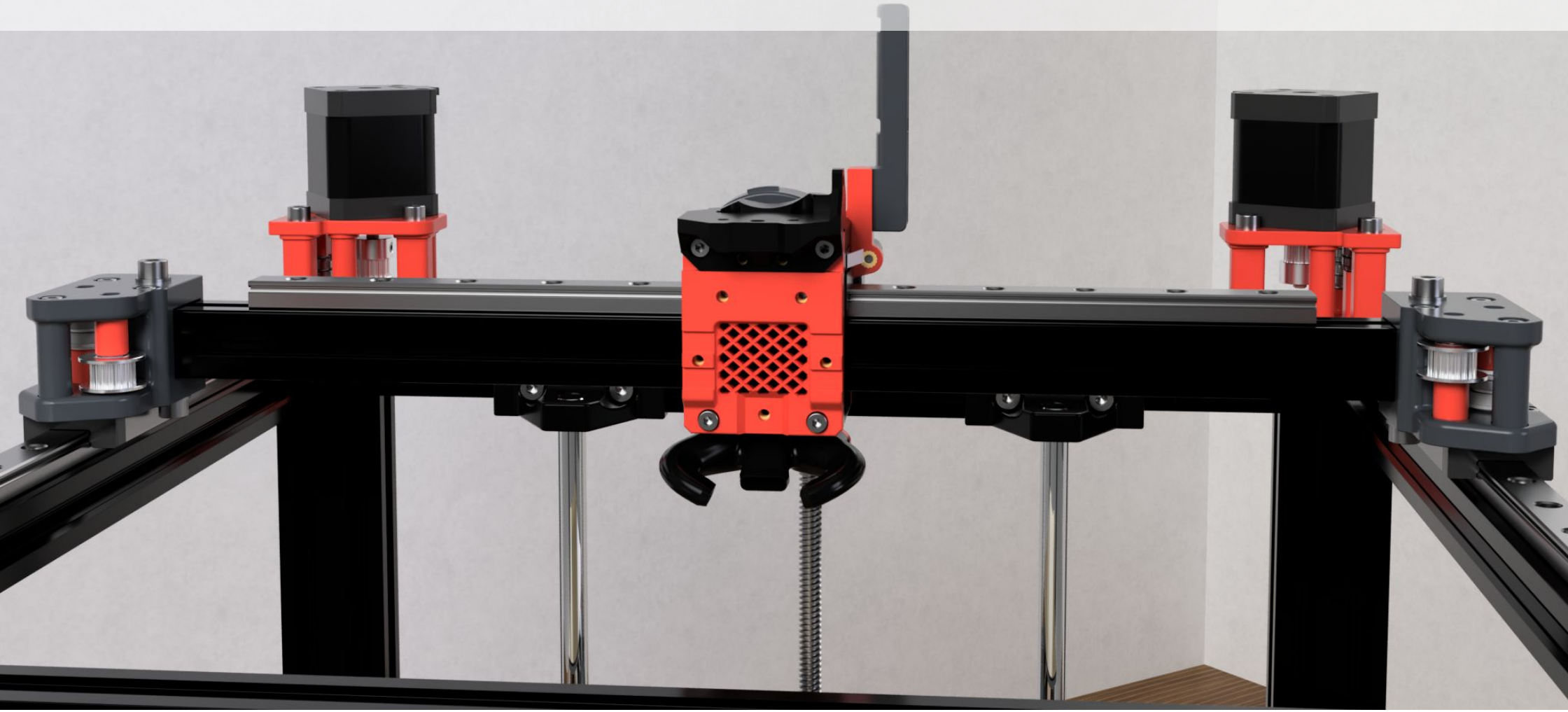
8. LOCK IT ALL DOWN

Finally, **fully tighten all** of the interior screws (order does not matter).

That's it; our Y axis rails are aligned!



TOOLHEAD



TOOLHEAD / INTERMISSION

We're almost ready to install our belts, but first we need a toolhead!

CHOOSE A TOOLHEAD

Mercury One.1 supports multiple toolheads; the stock supported version is based on EVA 2.4. This is the toolhead you may have downloaded through our Configurator, and the one that our illustrations use.

You'll need to assemble your toolhead of choice until the belts are ready for installation. Once that's done, we'll pick up from there!

> 📝 Your toolhead should include a mechanism to trigger the X axis endstop, often called a stop block.

ZEROG TOOLHEADS

EVA 2.4

Docs pending

CNC Vz-Printhead

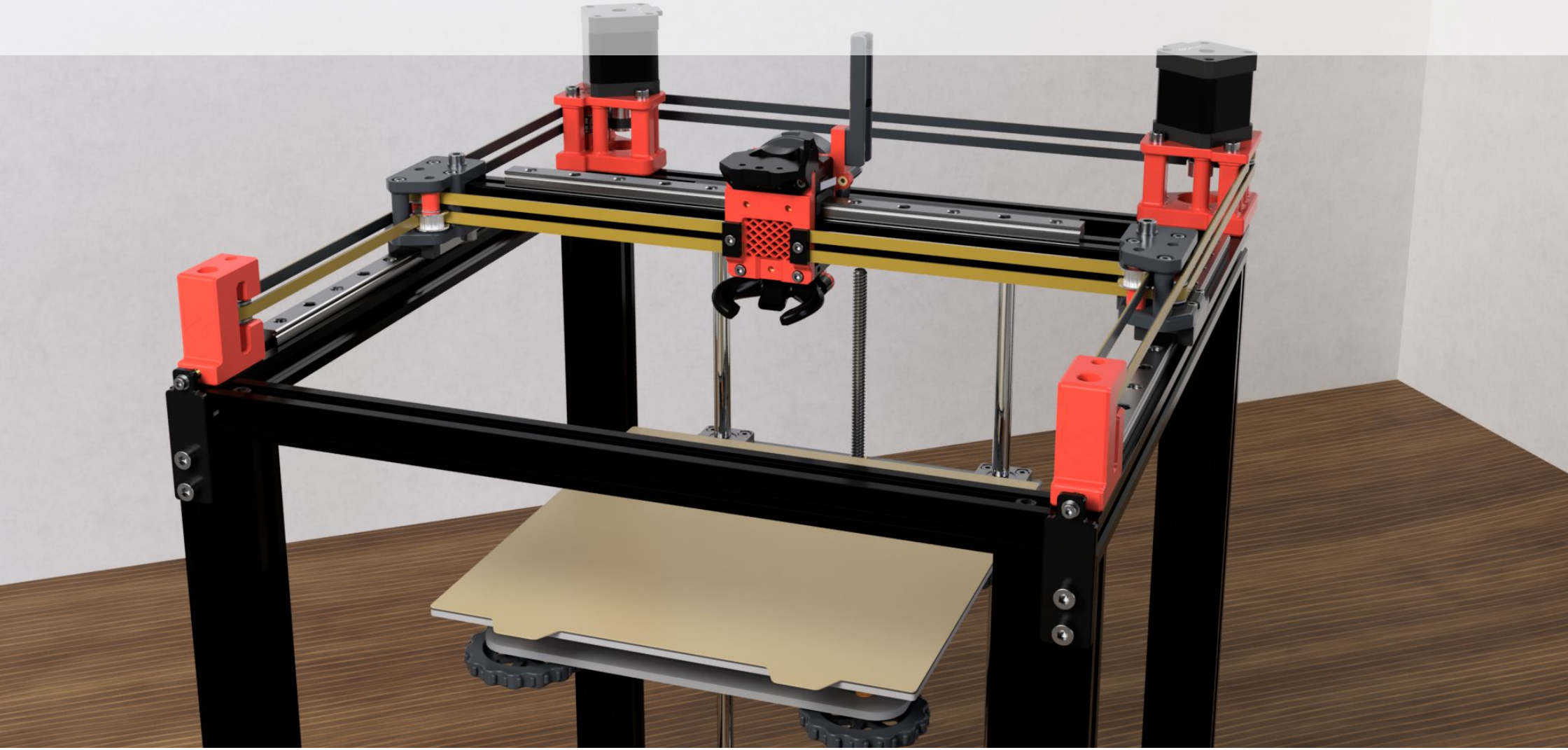
Link is to store page; docs pending

COMMUNITY TOOLHEADS

EVA 3 (E34M1)

Docs & Assembly Guide

BELTS



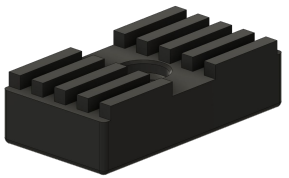
INTRODUCTION

We're ready to install our printer's belts. This section **can be tricky** for new users. The first two pages are reference graphics for how each belt is routed.

HARDWARE

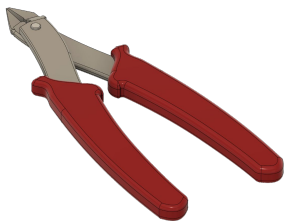
GT2 6MM BELTS

Ender 5/Ender 5 Pro: 4M
Ender 5 Plus: 6M



BELT GRABBERS - QTY 2

These are part of your toolhead. For illustrative purposes, we will use EVA 2.4's belt grabbers.



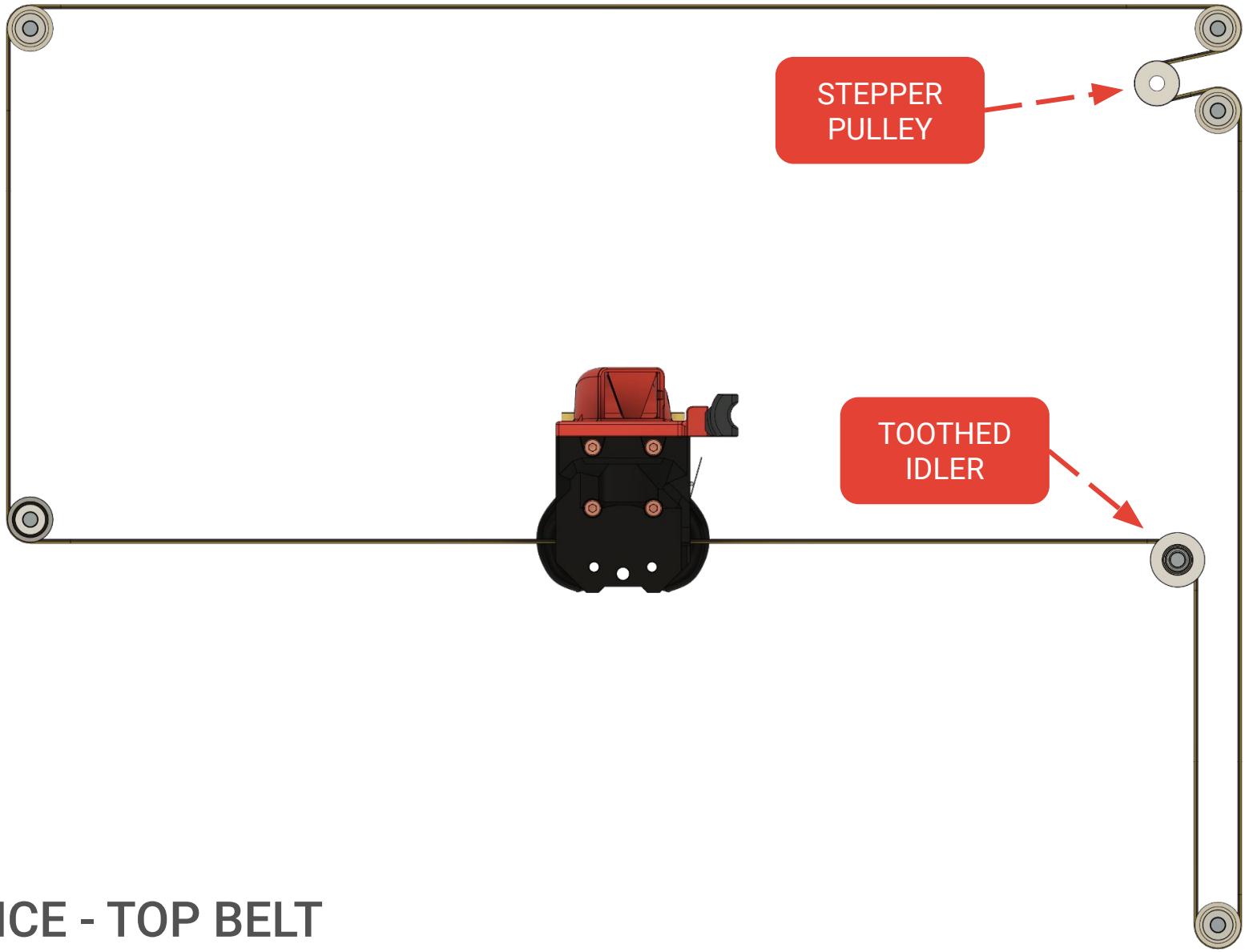
FLUSH CUTTERS

Scissors will also work.

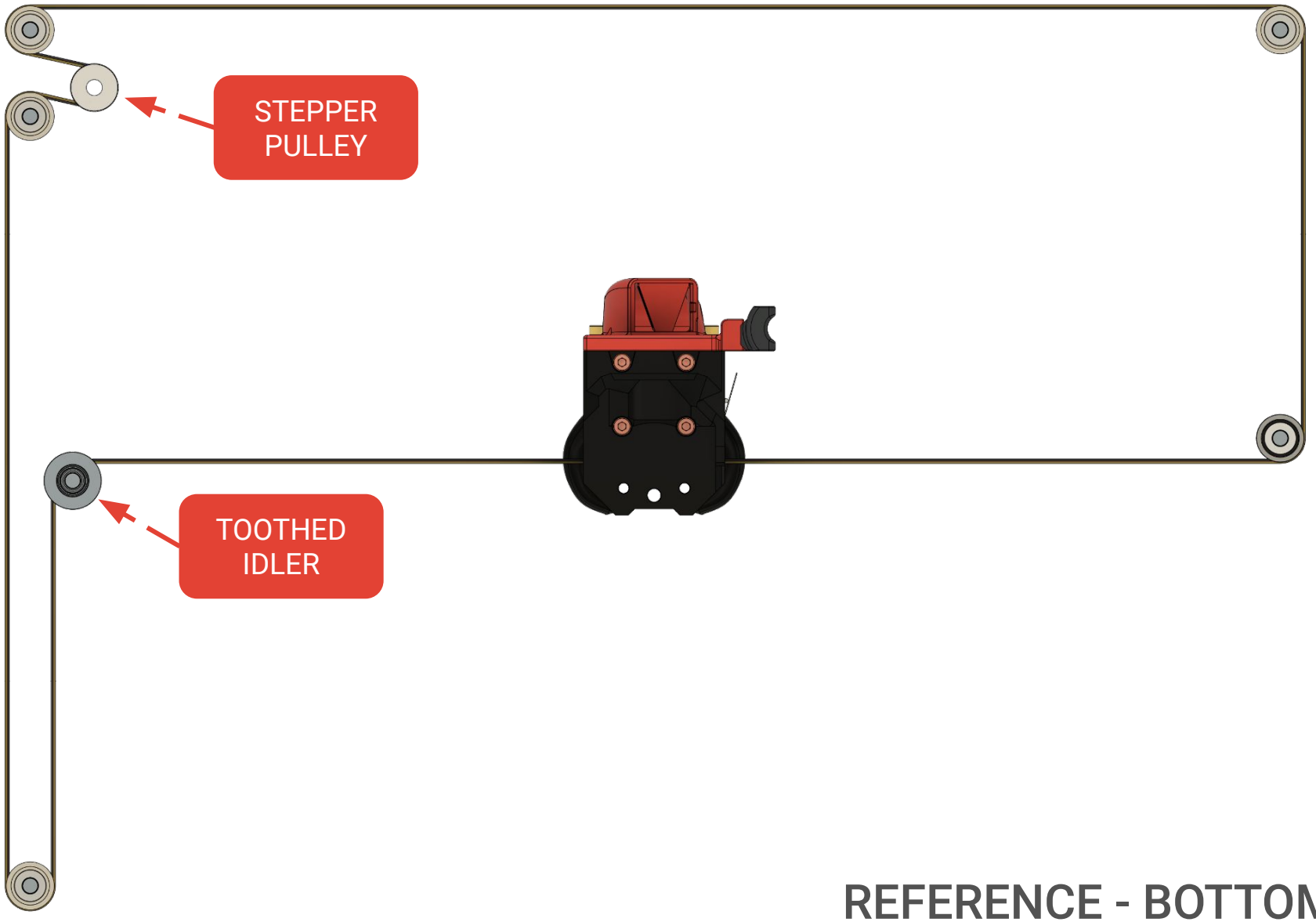
GANTRY SQUARING TOOL (OPTIONAL)

This is a popular user mod that holds the gantry square while working on the belts. You can get it here.

Note that this tool does not work with the lightweight gantry or a relocated front crossbar.



REFERENCE - TOP BELT



REFERENCE - BOTTOM BELT

1. CUT BELT IN TWO

We need two, **identical** lengths of belt.

If your belt is one long piece, fold your it in half and use flush cutters to cut the belt through the midway point.

2. TRIM TO EQUAL LENGTHS

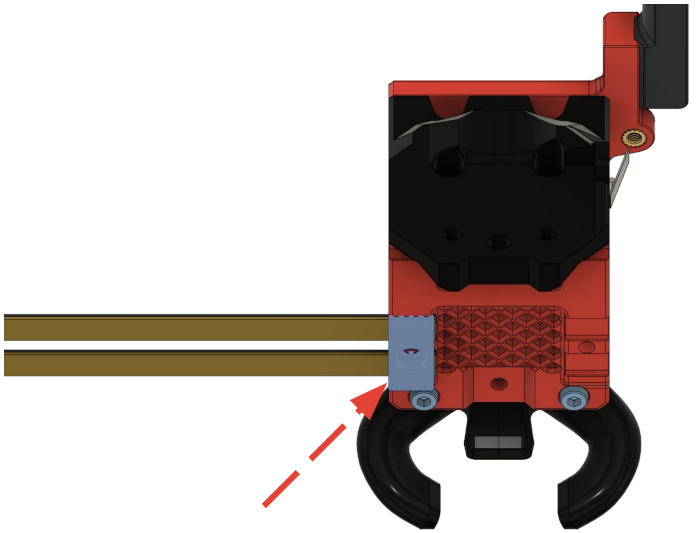
Compare the cut lengths of belt, then trim the long belt to the **same length** as the short belt. This will be important for tuning later.

> 📝 For the Ender 5 Pro, the both lengths of belt should both be **no less than** 1.8m long. This is enough for most toolheads with room to spare.
>
> We don't have a minimum recommended length for the Ender 5 Plus, so aim for half (3 m) of the recommended 6 m of belt.

3. SET BELTS AND GRABBER

Put the end of one belt in the **top left** belt catch with the **ribs facing out** and the end of another belt in the **bottom left** belt catch, again with the ribs facing out.

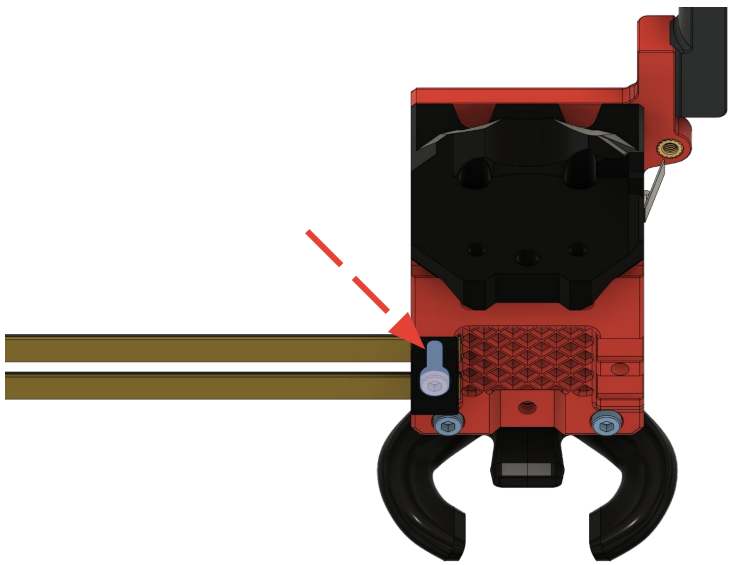
Press a **belt grabber** over the two belts, aligned with the insert hole of the belt catch.



4. ALIGN BELTS AND TIGHTEN GRABBER

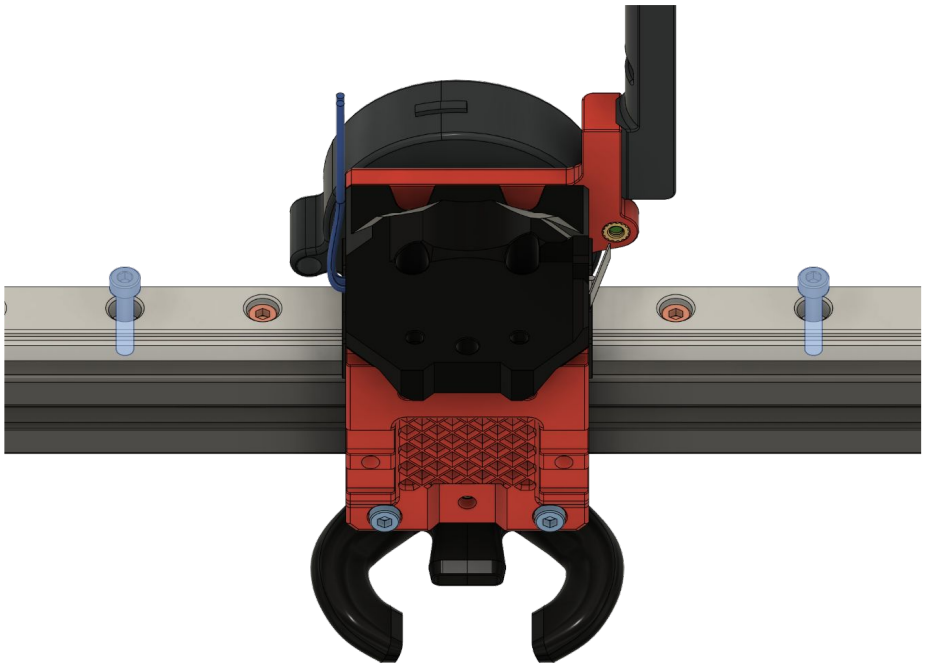
Insert an **M3x8mm bolt**, and **finger tighten** it.

Align the ends of the belts with the belt grabber, then **fully tighten** the M3x8mm bolt.



5. KEEP THE TOOLHEAD IN PLACE

Threading the belts will tug on the toolhead quite a bit. If you are not using a gantry squaring tool, consider temporarily putting long M3 screws through free screw holes on either side of the X axis linear rail carriage.



6. FEED THE BELT

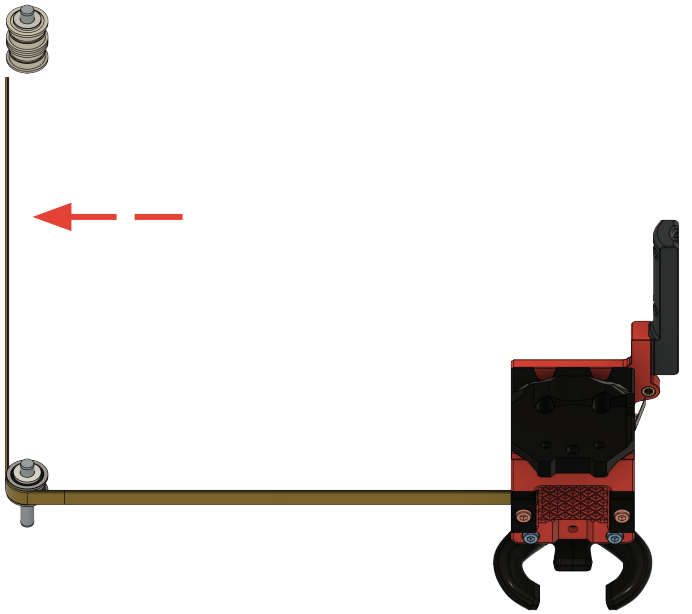
Pinch the **top belt** between one thumb and forefinger where the belt attaches at the toolhead. Feed the belt through your fingers until you reach the end, ensuring you have **no tangles**.

When you're ready, we'll start routing the top belt next.

1. TO THE X JOINT

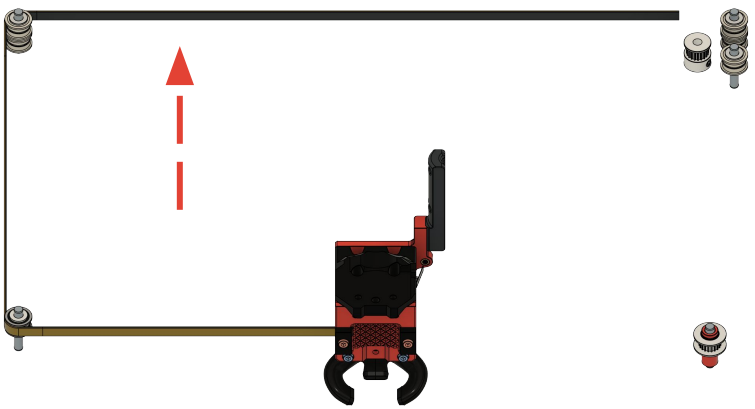
Take the end of the **top** belt and run it around the **smooth idler** of the **left X joint**. The smooth side of the belt should contact the bearings, not the ribs.

The belt may fall loose as we continue, but we'll fix it shortly.



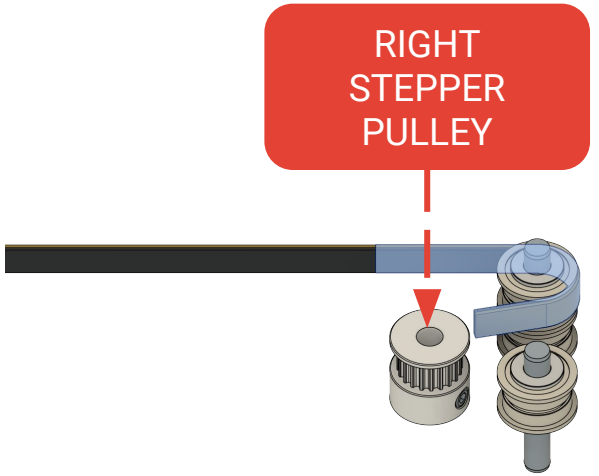
2. AROUND THE LEFT STEPPER TOWER

The **left stepper tower** has one top-level smooth idler, and several bottom-level idlers. Take the end of the belt and pass it around the **top idler**.



📝 Pull the end of the belt fully through each turn so there is no remaining slack.

ℹ️ Top Belt Reference



3. INTO THE RIGHT STEPPER TOWER

Feed the **smooth side** of the belt around the **double flange stack** of the **right stepper tower**.

Note that the belt goes **into** the tower, not past it. We're going to wrap it around the pulley.

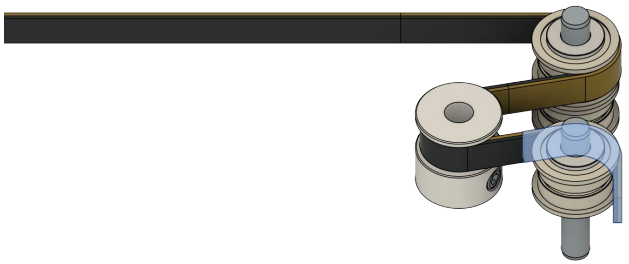
4. ENGAGE THE PULLEY

Feed the **ribbed side** of the belt around the stepper pulley.

This area is hard to reach; an Allen wrench can help pull the belt through tight spaces.

5. BACK OUT THE SINGLE STACK

Feed the belt back out the **single flange stack** and pull it tight.

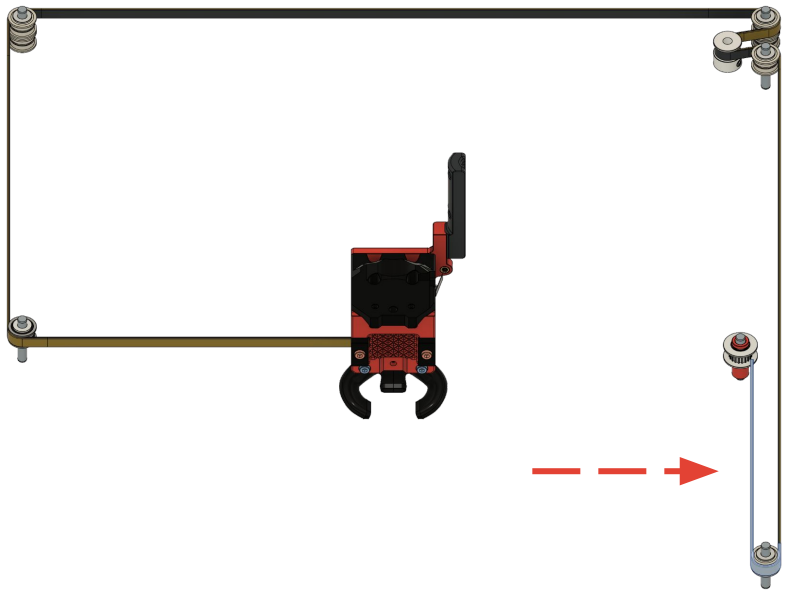


📝At this point, it's a good idea to check our belt's path through the idlers, fixing any places the belts have slipped free.

ℹ️ Top Belt Reference

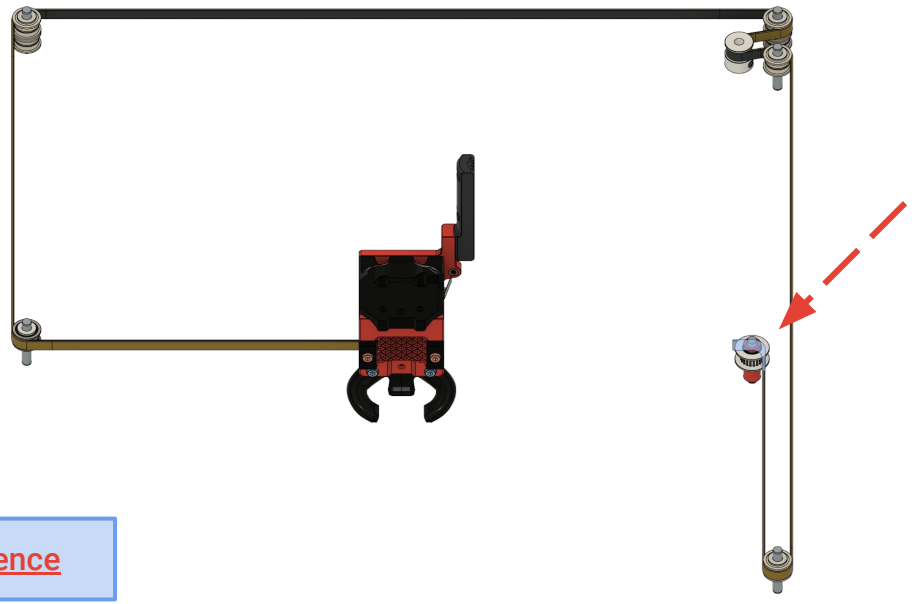
6. THREAD THE TENSIONER

Run the smooth side of the belt around the **right tension tower**.



7. TOOTHED IDLER

Thread the belt through the **toothed idler's teeth** and feed it towards the toolhead. This area in the X joint is a tight fit, so you may need to use an Allen wrench to guide the belt.

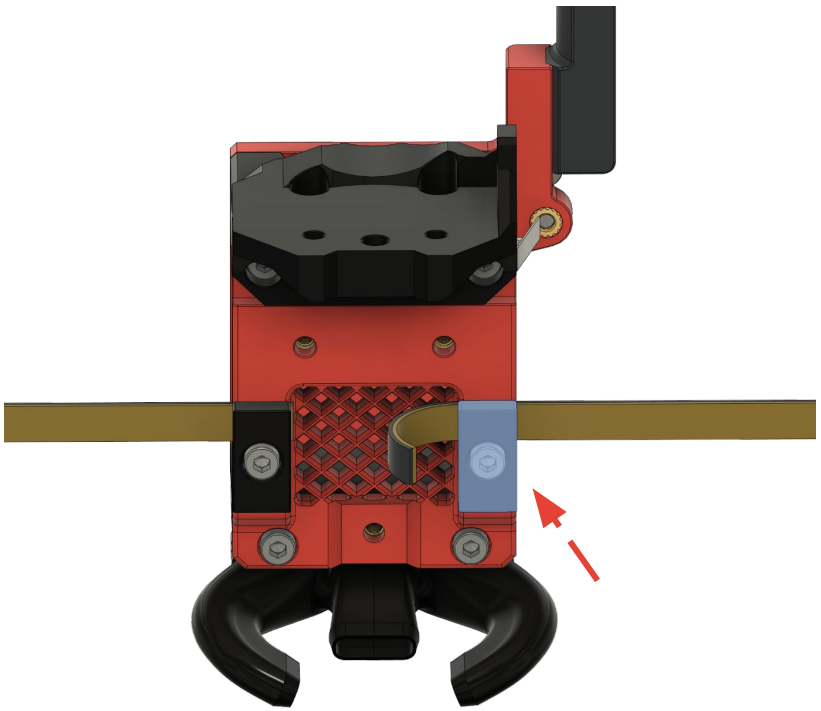


Top Belt Reference

8. SECURE TO TOOLHEAD

Pull the belt tight to the toolhead. You should have at least some extra belt; we'll trim that later.

Use your remaining belt grabber and an M3x8mm screw to secure the top belt.



9. CHECK YOUR WORK

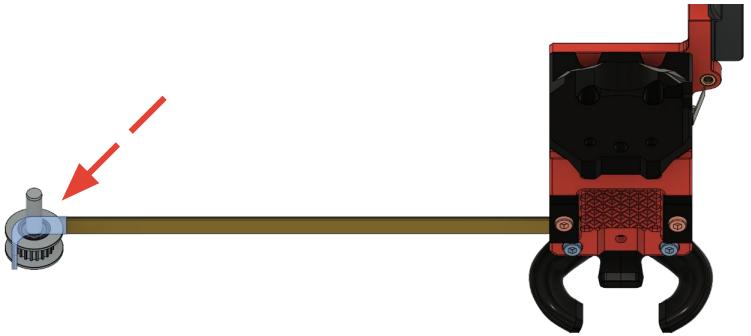
Verify that your belt is **free of twists** and engages the **stepper pulley and every top-level idler**. Refer to the Top Belt Reference when making adjustments, if needed.

Top Belt Reference

1. TOOTHED IDLER

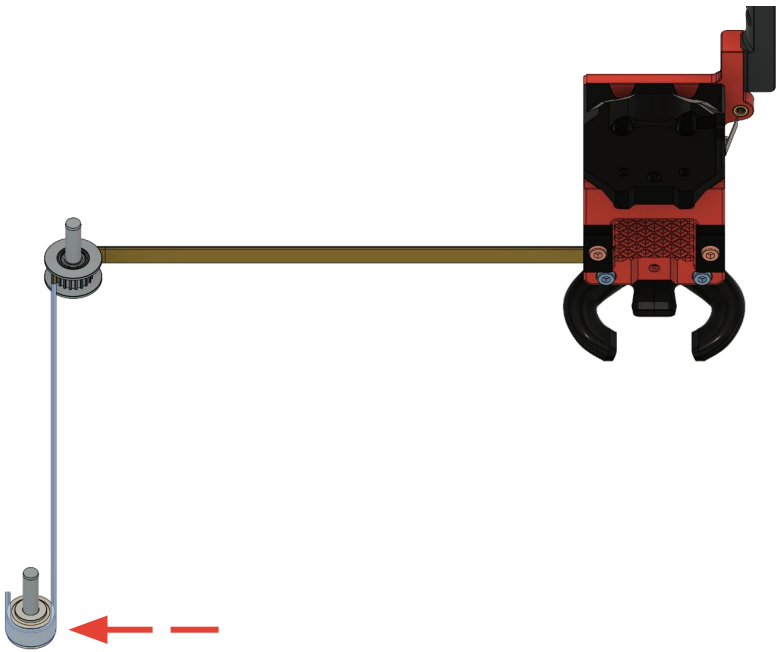
Next we will install the bottom belt. The steps for installing the bottom belt are **reversed from the top belt**.

We start by looping the belt around the **toothed idler**. After it passes through the idler, pull the belt **forward**.



2. THREAD THE TENSIONER

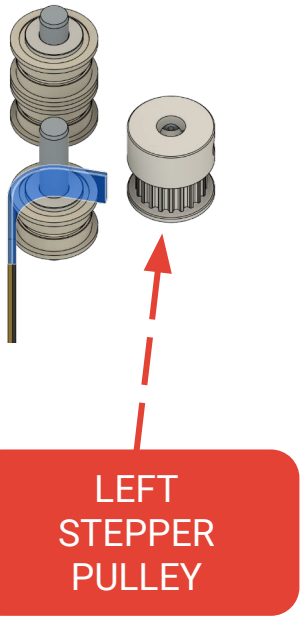
Loop the belt around the **left tensioner's** smooth idler.



ℹ️ Bottom Belt Reference

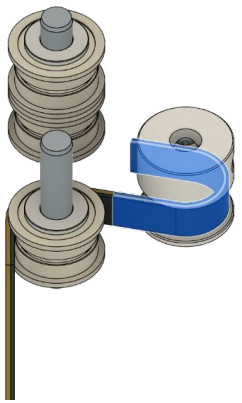
3. AROUND THE SINGLE STACK

Feed the **smooth side** of the belt around the **lower front idler** of the **left stepper tower**.



4. ENGAGE THE PULLEY

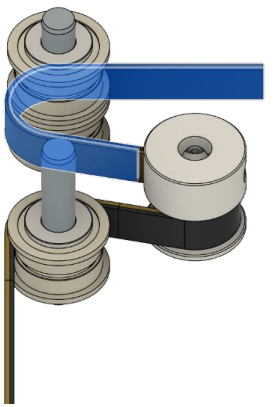
Feed the **ribbed side** of the belt around the stepper pulley, using an Allen wrench to help, if needed.



5. BACK OUT THE DOUBLE STACK

Feed the belt back out the **lower rear idler** and pull it tight.

Check your progress up to this point, fixing any parts of the belt that have slipped.

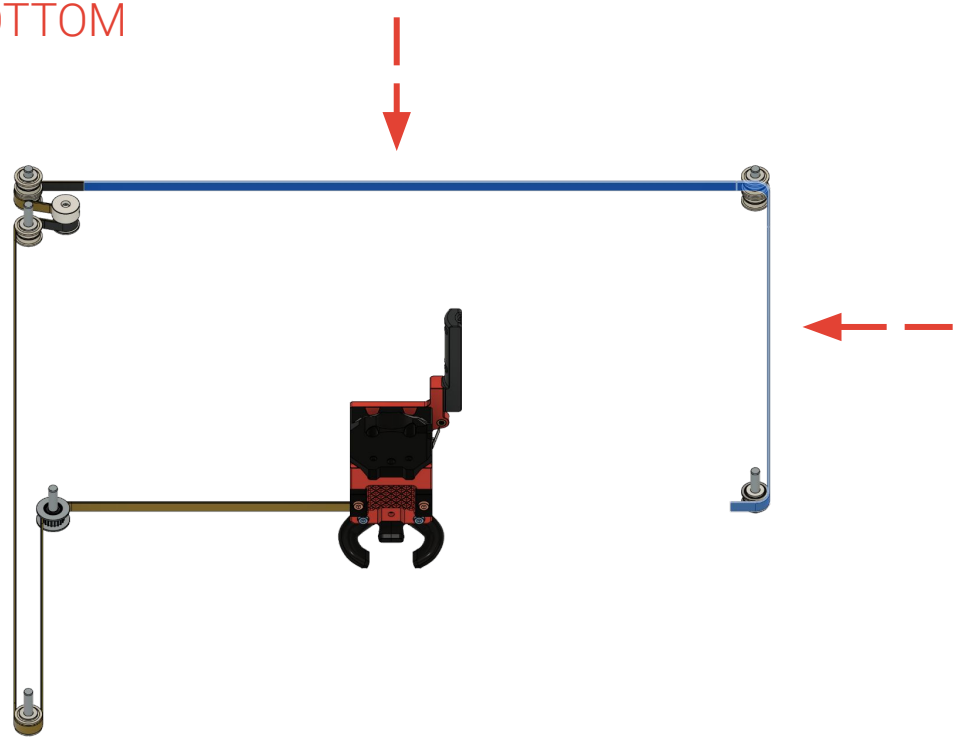


ℹ️ Bottom Belt Reference

6. FINAL IDLERS

Route the belt across the back and around the **lower idler** of the **right stepper tower**.

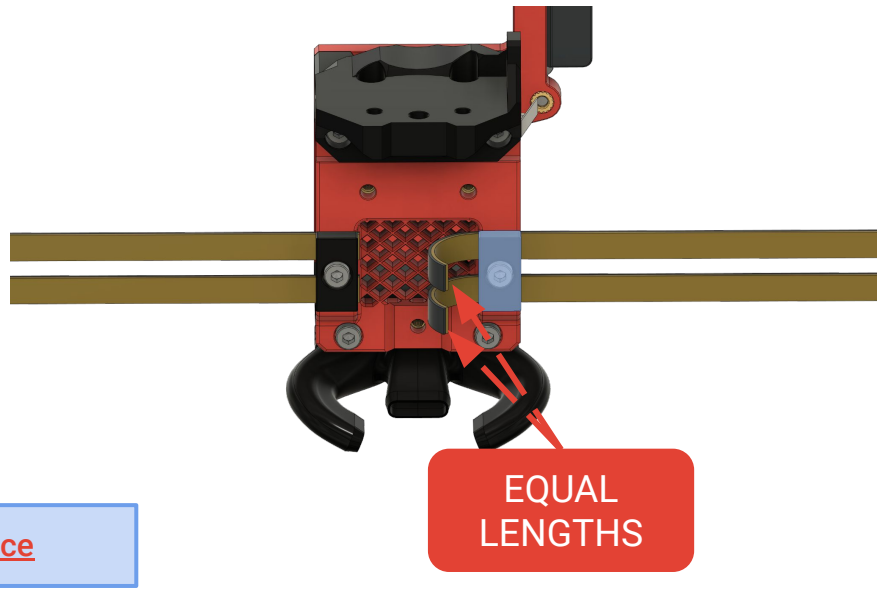
Continue threading the belt through the **right X joint's smooth idler**.



7. SECURE THE BOTTOM BELT

Pull the belt to the toolhead, then loosen the **right belt grabber** enough to slip in the bottom belt.

Tighten the belt grabber just enough to hold the belts in place for now.

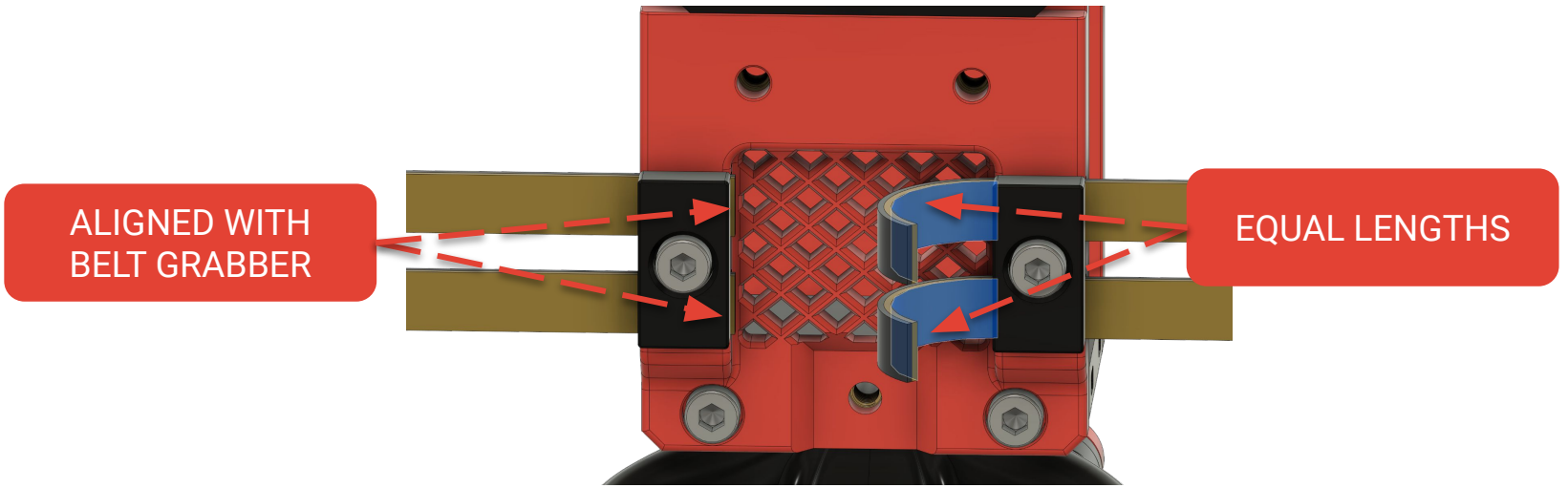


ℹ️ Bottom Belt Reference

1. ADJUST BELTS

It's time to do some testing and tuning of our motion system. This is significantly easier if both belts are equal length. To ensure this, the extra lengths of belt on the right side should be equal.

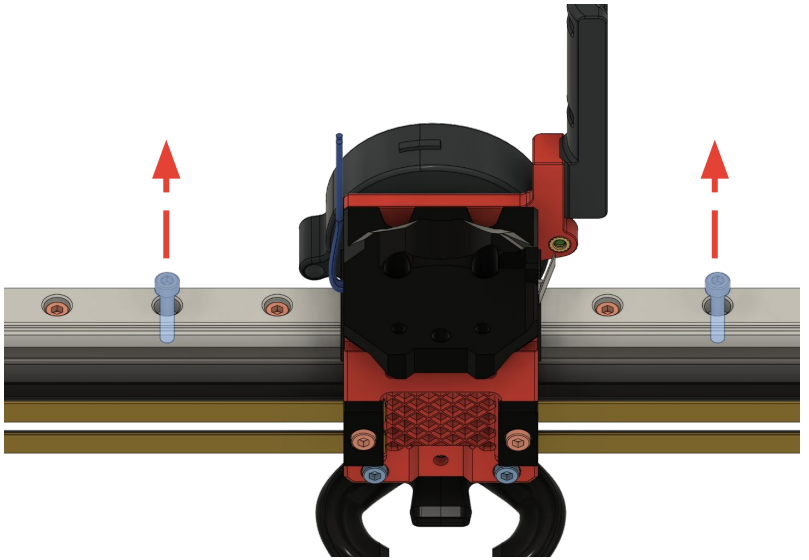
If necessary, loosen the grabber and adjust the excess until they are equal. Finally, **fully tighten** the right belt grabber.



2. REMOVE OBSTRUCTIONS AND CAPS

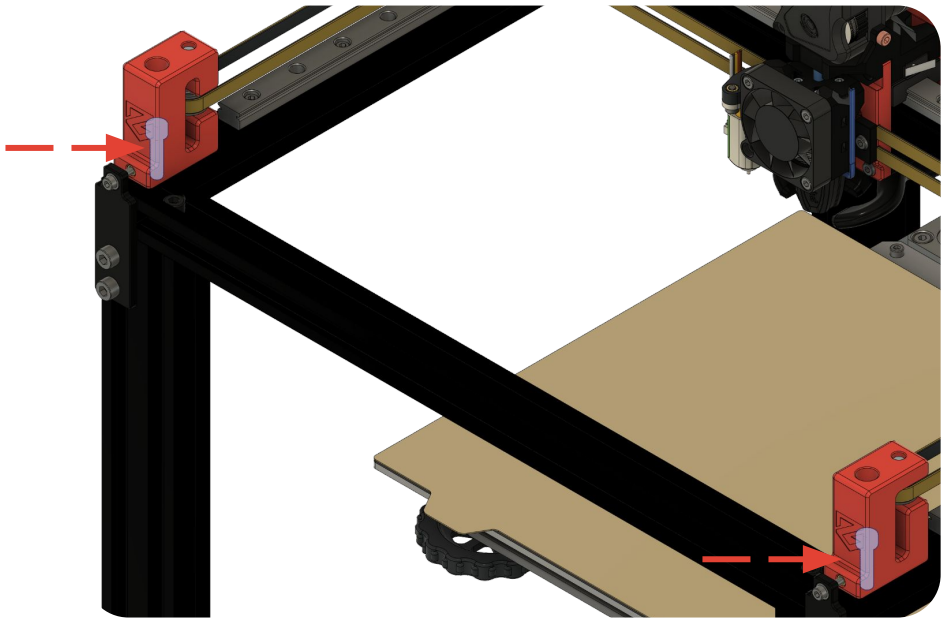
Remove the protective caps on the end of all three (3) linear rails.

If you have a gantry squaring tool or M3 screws keeping the toolhead in place, remove them as well.



3. LOOSEN TENSIONER BOLTS

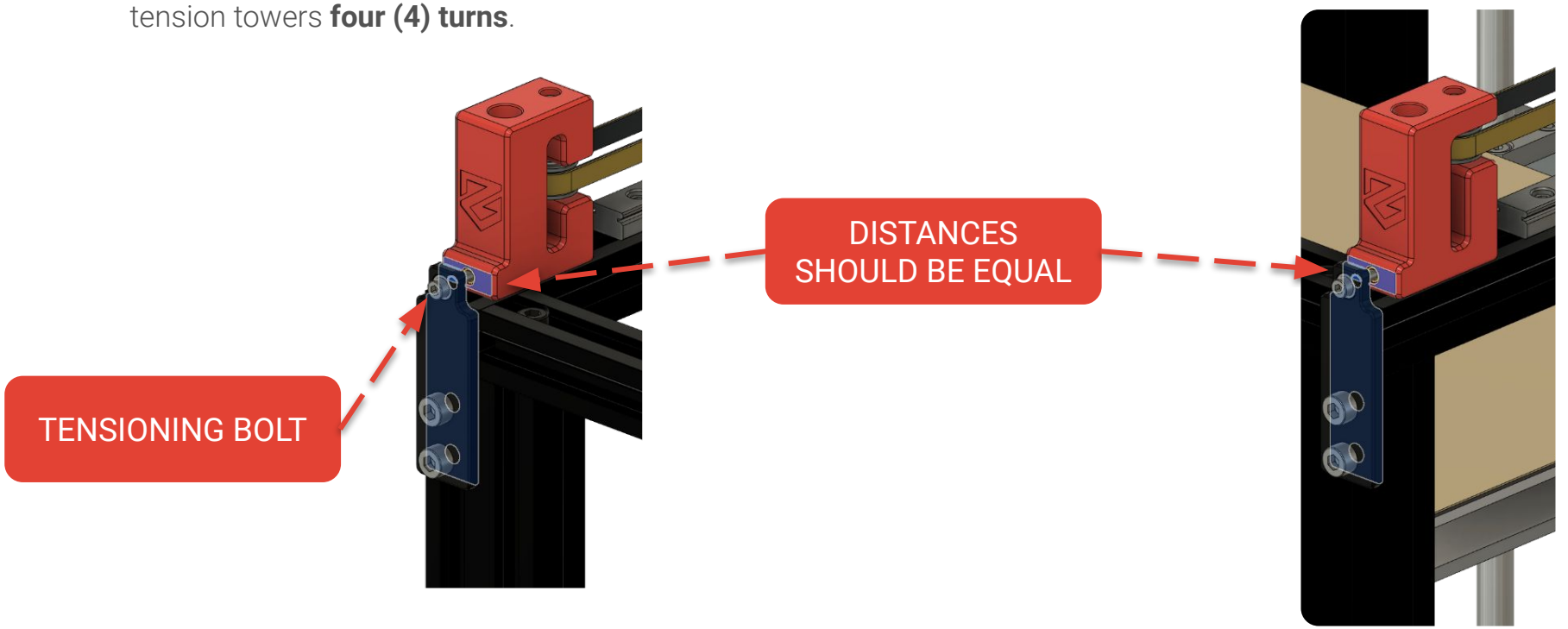
Loosen the M5x20mm bolts on both tensioners **just enough** that the tensioners can be moved.



4. ADJUST TENSION TOWER POSITIONS

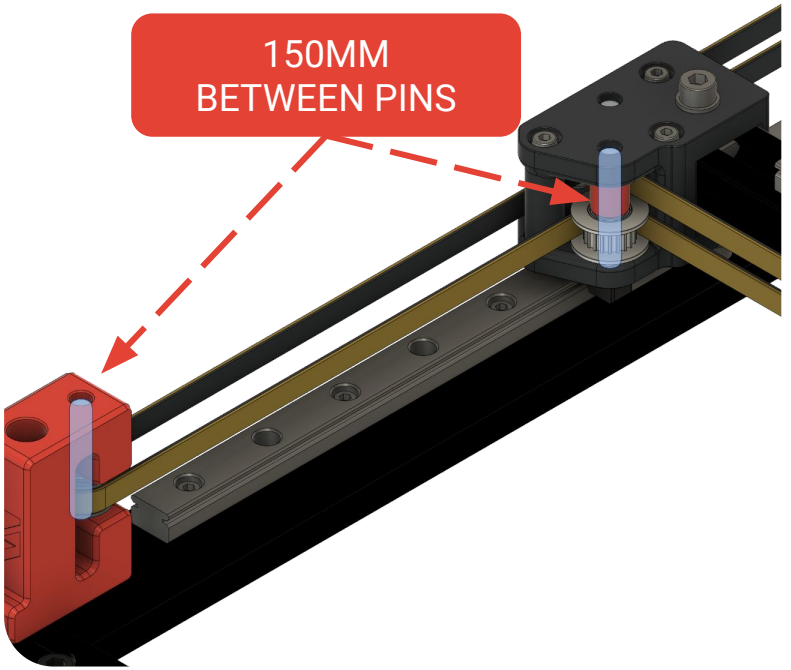
Now that the belts are pulling on the tension towers and the M5x20 bolts are loose, the tension screws can be used to adjust tension.

If both tensioners are not the same distance from the tension plate, “reset” both tensioners by unscrewing the M3 tensioning bolts completely, then threading them back into the tension towers **four (4) turns**.



5. MOVE GANTRY 150MM OUT

Move your X axis gantry so that the **left toothed idler pin** is 150mm away from the **left tensioner pin**.



6. ELIMINATE AMBIENT NOISE

Muffle or turn off as many sources of ambient noise as possible: fans, music, open doors or windows, and so on.

7. STRUM THE LEFT BELT SPAN

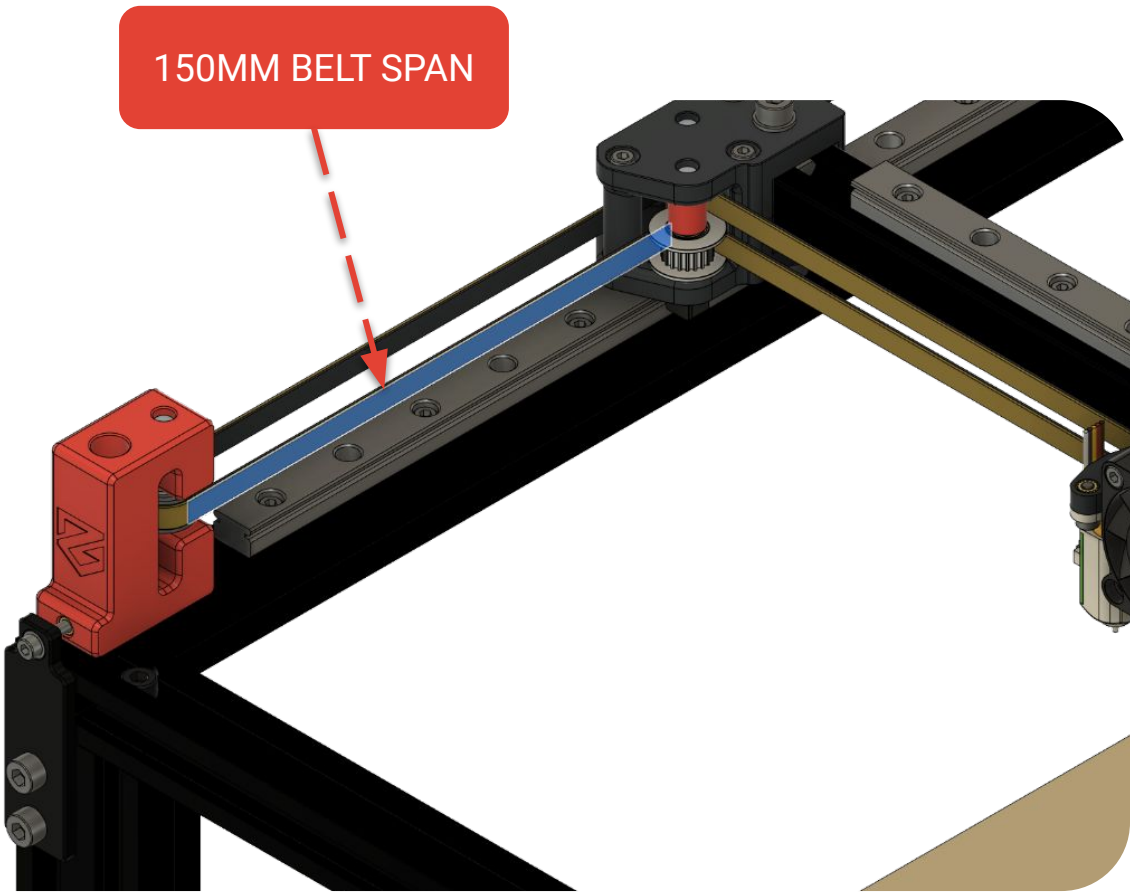
Hold your phone or tablet near the left tension tower with the spectrum analysis app open.

Strum (like a guitar string) the **center** of the belt span between the tensioner and toothed idler (see right).

Note the strongest, lowest frequency response in your app.

8. STRUM THE RIGHT BELT SPAN

Strum and note the frequency of the **upper belt** using the same span (between tension tower and toothed idler) by the **right tension tower.**



9. ADJUST TENSION

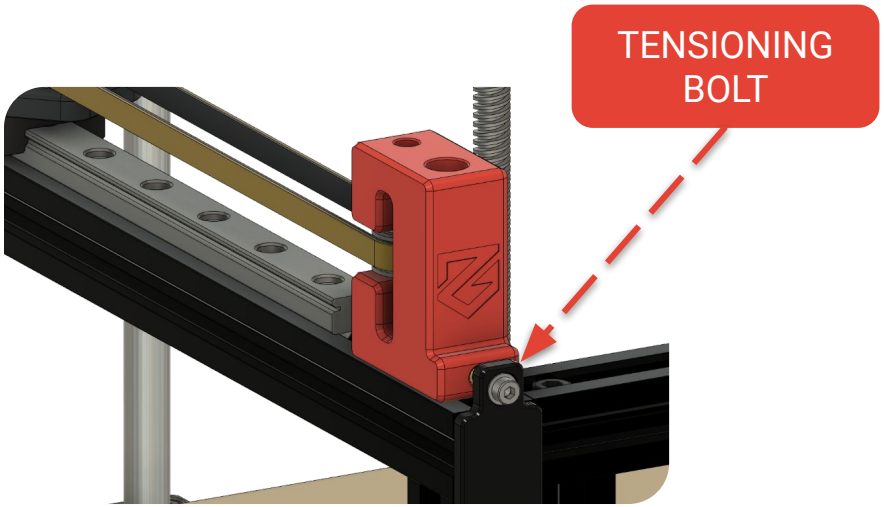
Adjust the tension bolts on both belts, one at a time. Turn **clockwise** to **increase** the belt tension, counter-clockwise to decrease it.

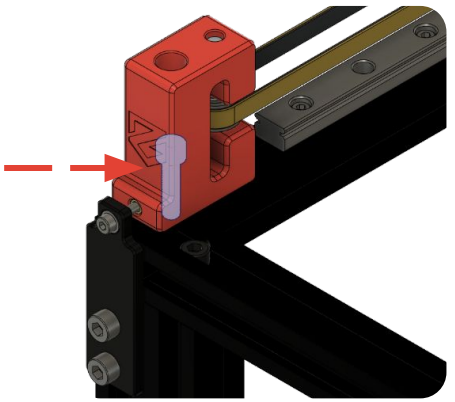
Adjust each bolt **no more** than one quarter (¼) of a turn at a time.

10. DIAL IT IN

After adjusting **both** tension towers, retest the belt tension (steps 7 and 8) and adjust (step 9) until the belts are closely tensioned between **110Hz and 120Hz**.

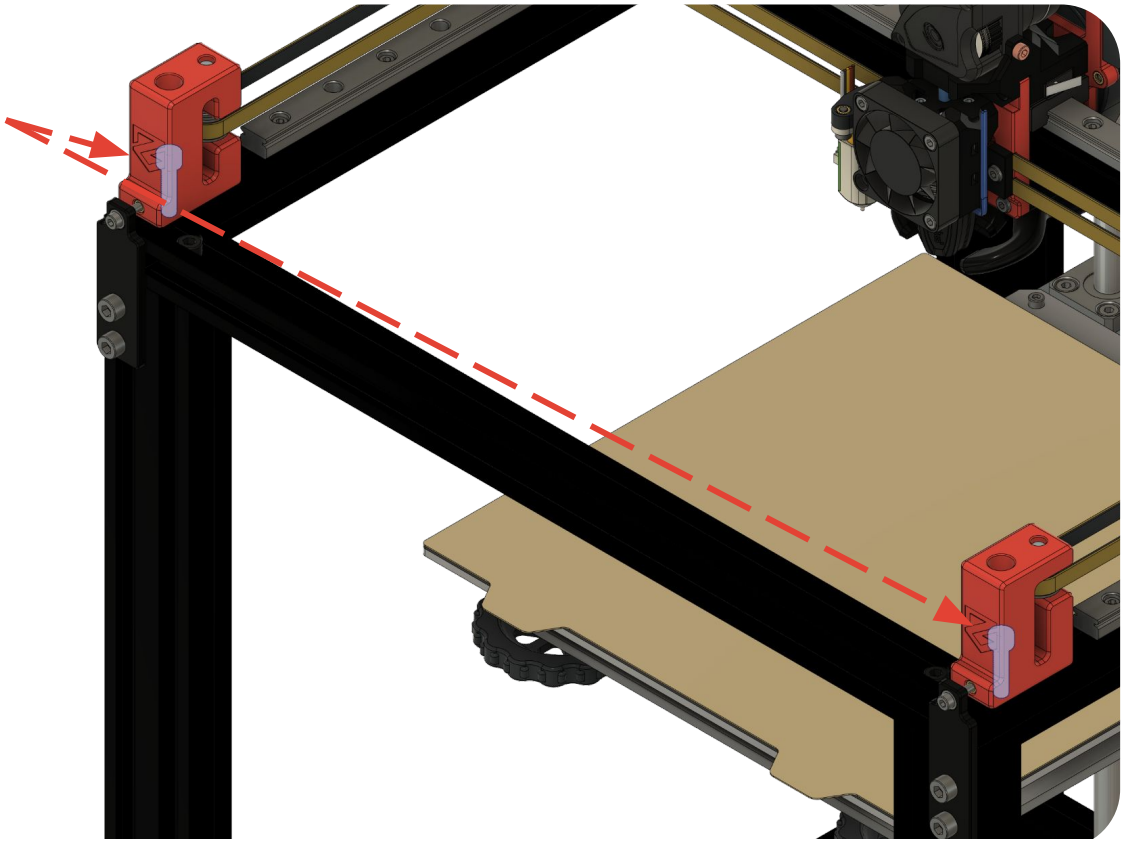
📝 Skip back to the Concept: CoreXY section for general tips on tensioning.



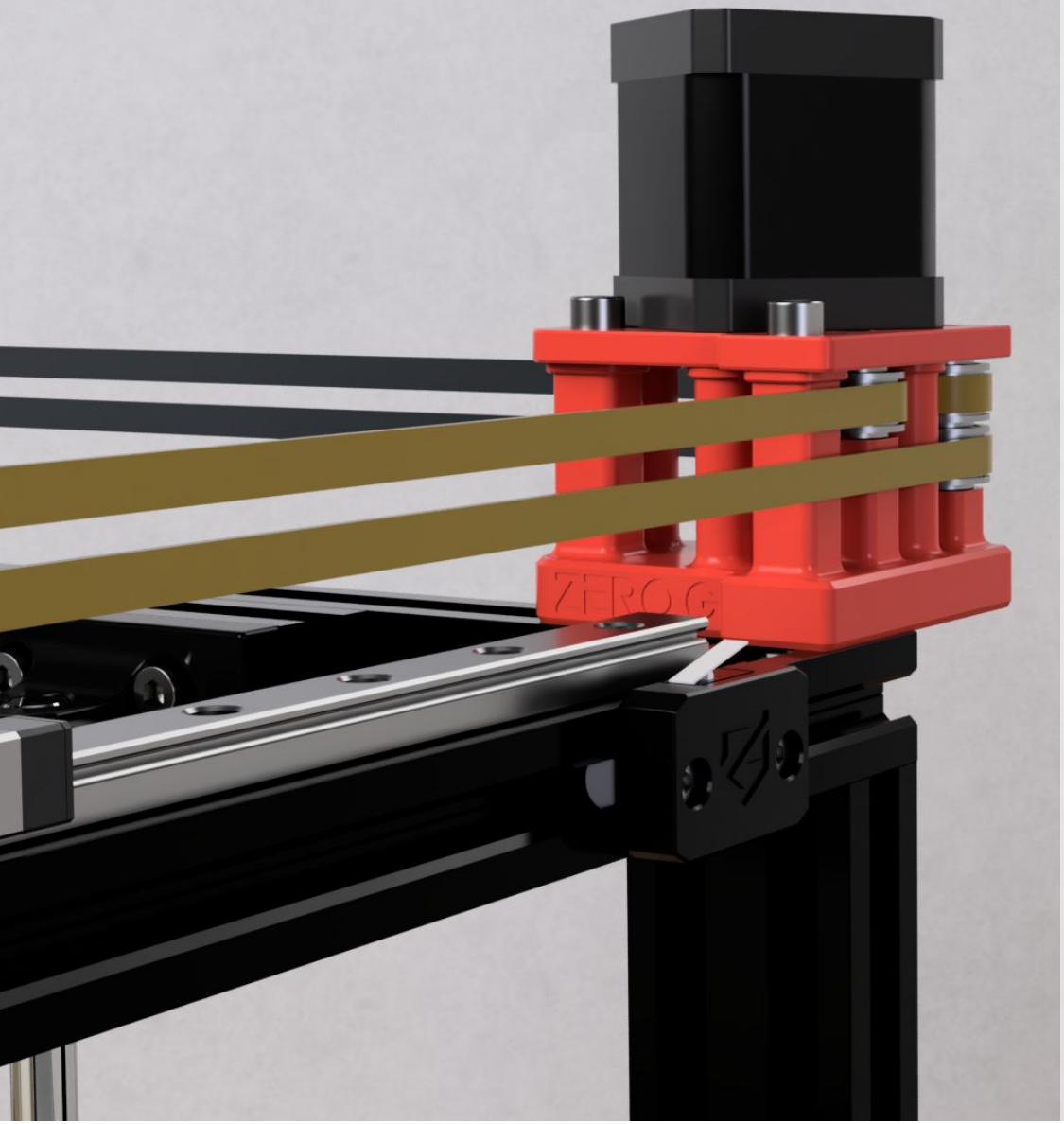


11. LOCK DOWN THE TOWERS

Fully tighten the M5x20mm bolts in each tension tower



📝 The tension plates are not needed during normal operation. After completing setup and testing, consider loosening the tensioning bolts to avoid warping the tension plate.



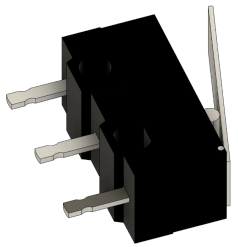
Y AXIS ENDSTOP

Y ENDSTOP / HARDWARE

INTRODUCTION

One of the final parts of installation is our Y endstop. We will first solder the wiring to our microswitch, then assemble and install the endstop.

HARDWARE

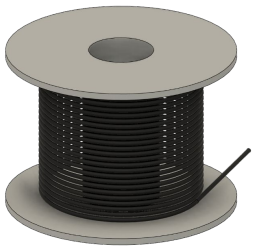


MICROSWITCH - QTY 1

The Omron D2F-L is the gold standard for accuracy, but you can also use a microswitch cut from a Creality endstop.

Y ENDSTOP MOUNT

“y_endstop.stl”



24 AWG/0.5MM STRANDED WIRE

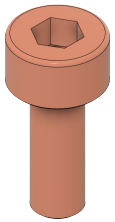
You will need enough for two (2) of wires to reach your MCU board.

Terminating the wire with a connector (typically JST XH) is beyond the scope of this document.

ELECTRICAL PLIERS

This is to strip your wire ends.

Y ENDSTOP / HARDWARE (CONT'D)



M3X8MM SHCS - QTY 2

SOLDERING IRON

M3 ROLL-IN T-NUTS - QTY 2

SOLDER

3:1 HEATSHRINK TUBE, 2MM ID

1.5-3mm ID should work. You will need no more than 50mm of tubing.

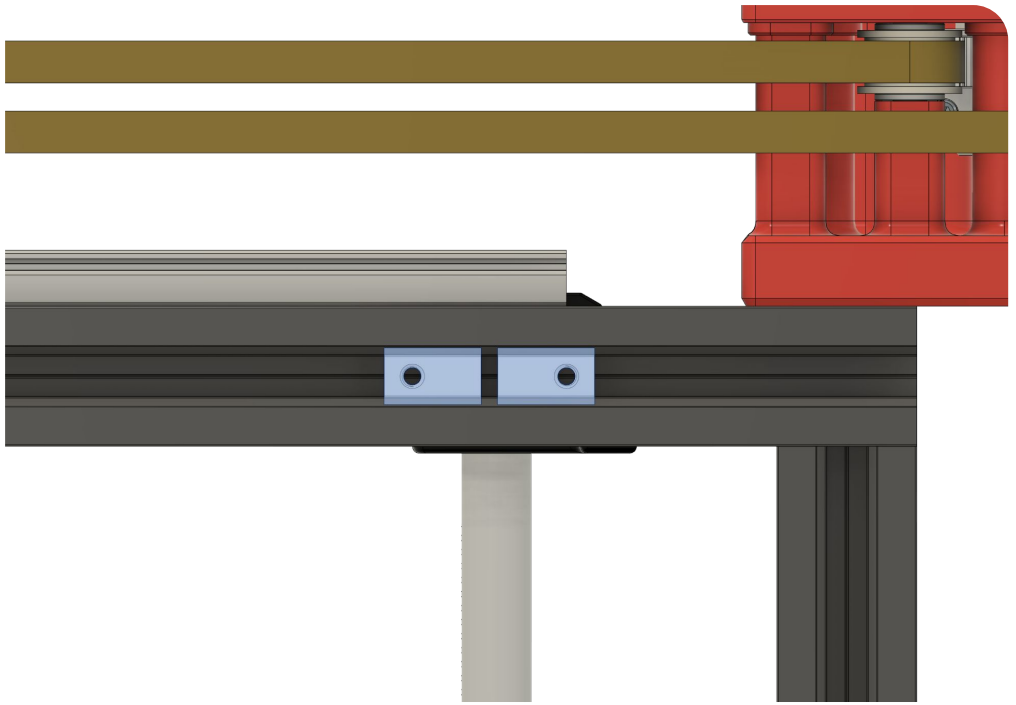
SUPERGLUE

This is an **optional** addition to give the endstop a more secure installation.

Y ENDSTOP / STEPS

1. INSTALL T-NUTS

Seat the two (2) M3 roll-in t-nuts in the orientation pictured.

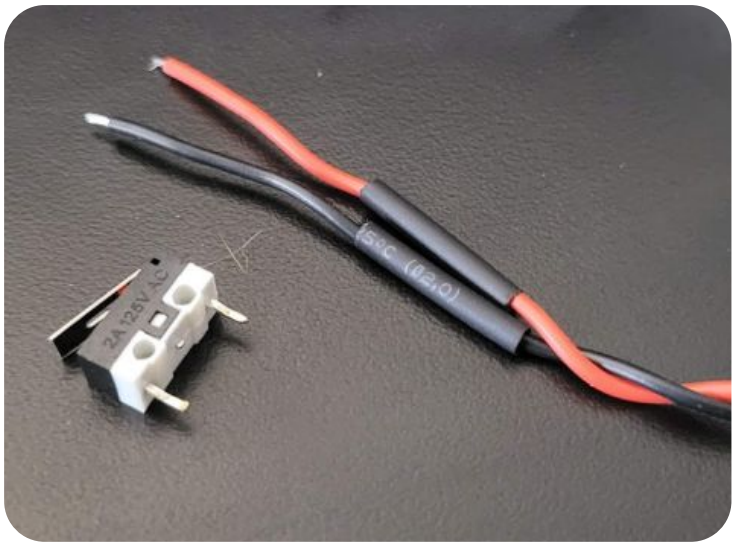


ℹ️ It is also possible to install the Y endstop on the inside of the frame. This requires removing one of the factory corner brackets. We have omitted illustrating this configuration for sake of space.

2. PREPARE THE MICROSWITCH WIRES

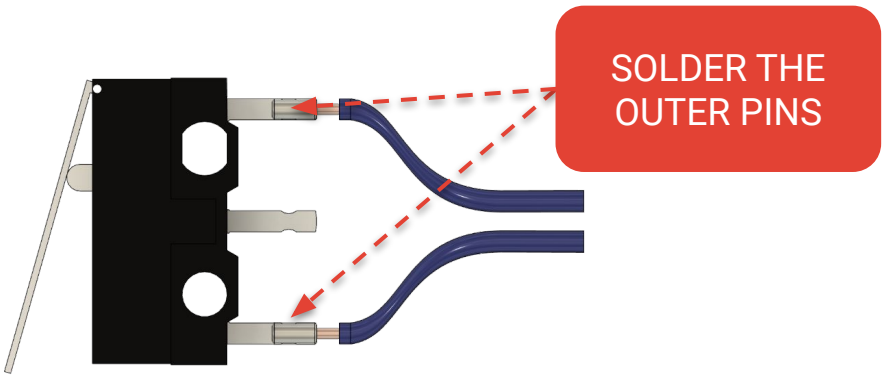
Measure (twice) and cut the pair of wires for the Y endstop. Strip several millimeters on one end of the wire pair.

Slide a short (10-20mm) piece of heat shrink onto each of the wires.



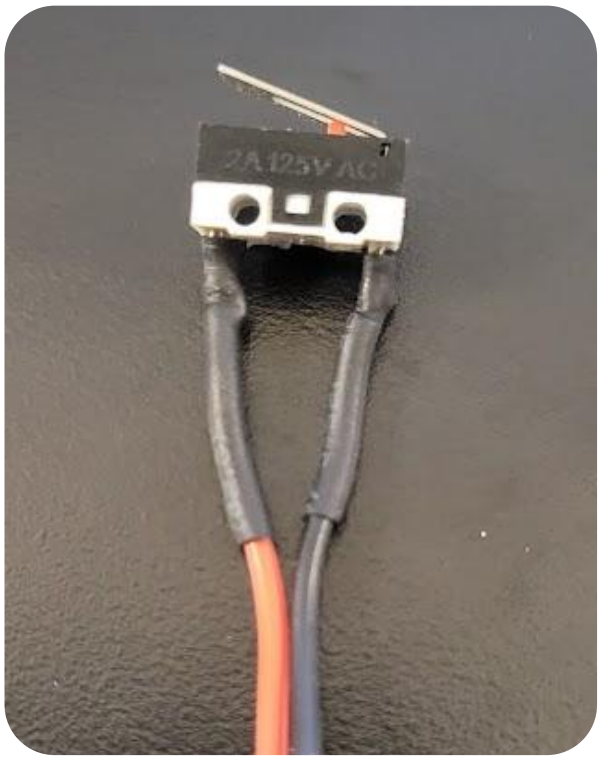
3. SOLDER THE MICROSWITCH

Solder a wire to each of the microswitch's **outer pins**. Polarity does not matter.



4. COVER WITH HEATSHRINK

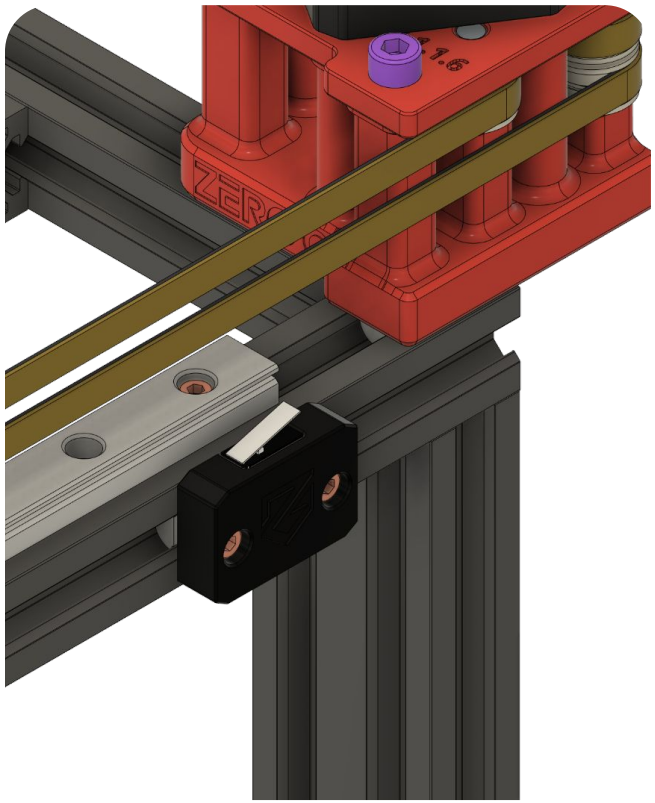
Slide heatshrink tubing over the soldered joints, then shrink the tubing in place.



5. DETERMINE LEVER DIRECTION

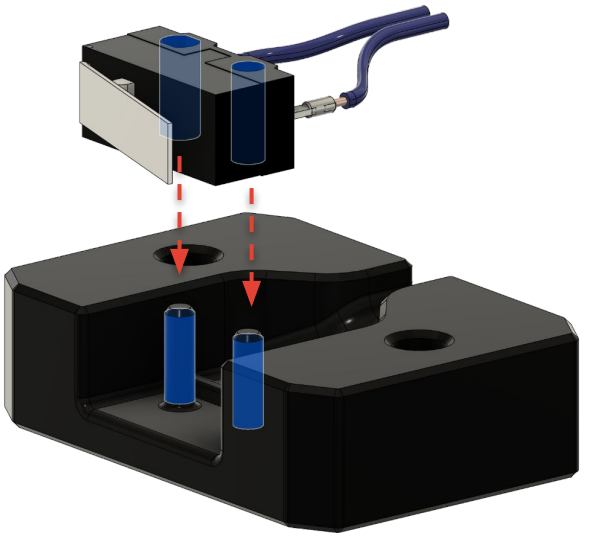
Take note of the direction of the lever in the illustration. If installed backwards, the linear rail carriage will not trigger the switch and may damage it.

If you are installing your Y endstop on the **inside** of the frame, **invert** the lever direction for the next step!



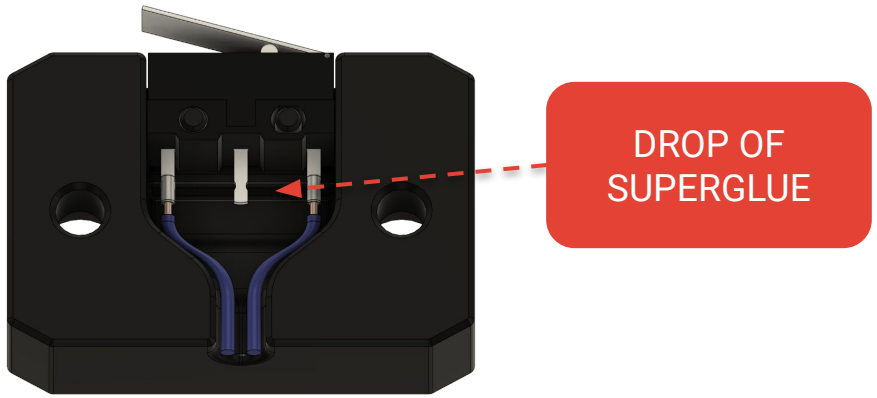
6. INSTALL THE MICROSWITCH

Push the microswitch through the pins on the Y endstop mount–be careful, they are **fragile**!



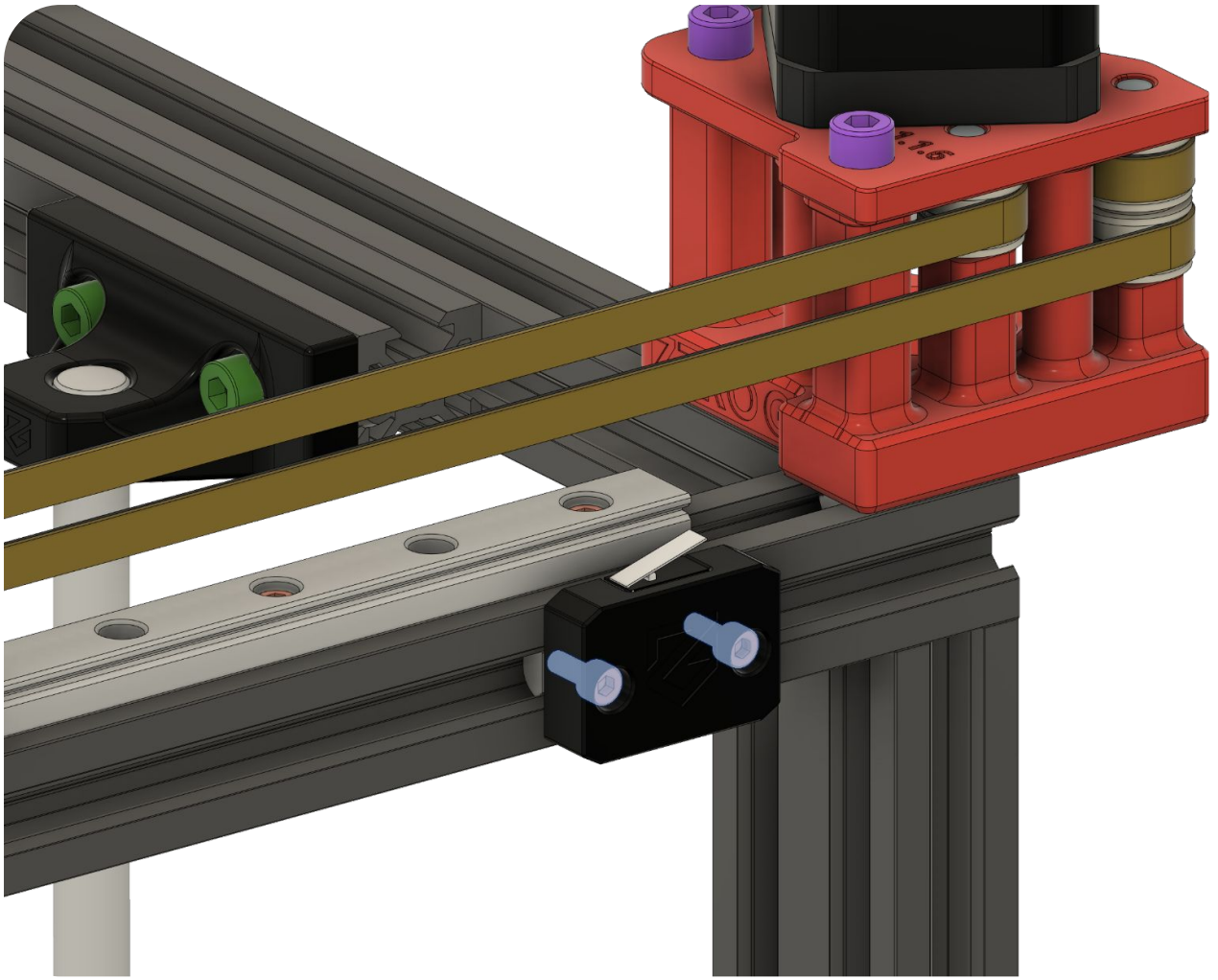
⚠ Invert the direction of the lever if you are installing your endstop on the inside of the frame!

Friction will hold the microswitch in place, but a **drop of superglue** is also a good idea.

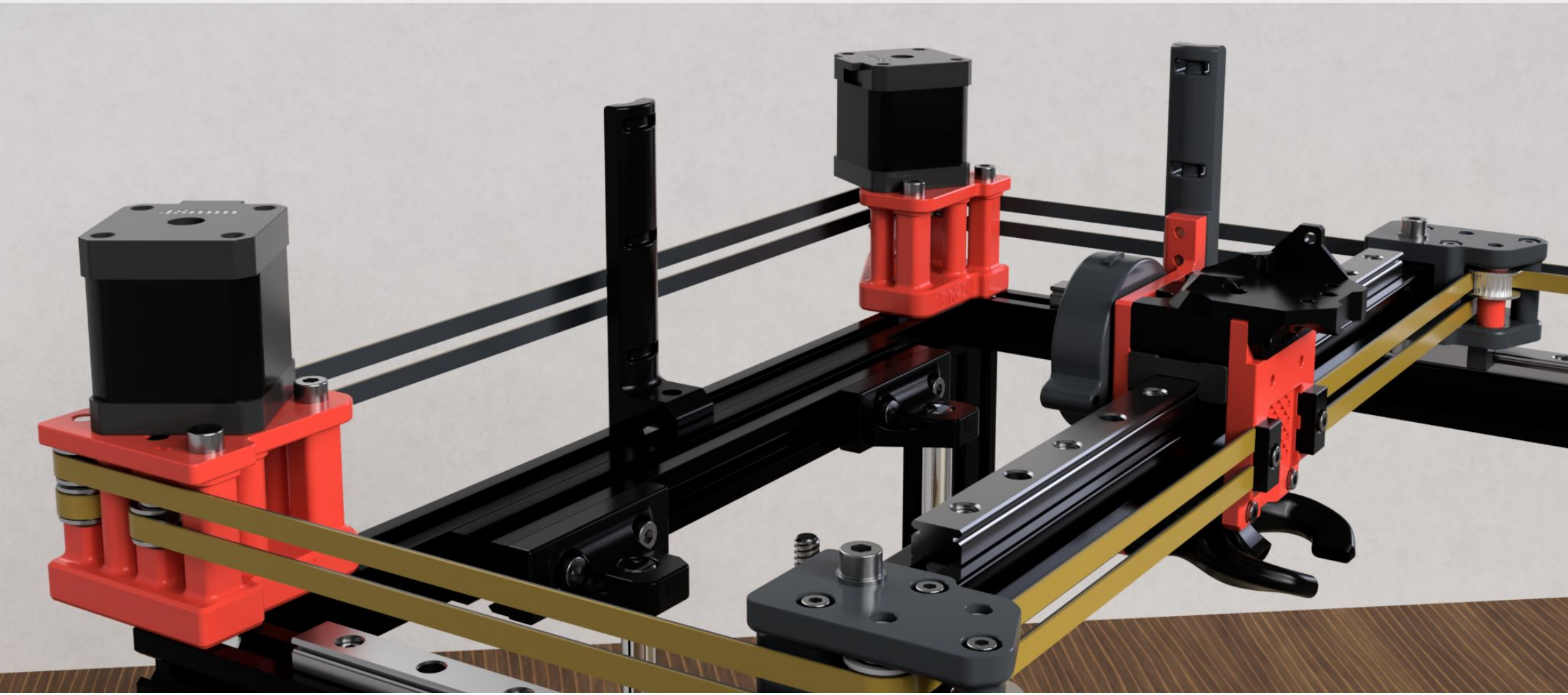


7. INSTALL THE Y ENDSTOP

Finally, install your endstop with two (2) M3x8mm bolts.



REAR CABLE ARM



REAR CABLE ARM / HARDWARE

INTRODUCTION

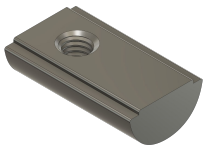
The rear cable arm guides the wiring for our toolhead and the PTFE tube for our filament.

This section is pretty simple, so we saved it for last. ❤️

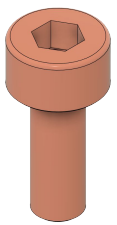
HARDWARE

REAR CABLE ARM

"RearSplitloomArm_V1-1-0.stl"



M3 ROLL-IN T-NUT - QTY 2

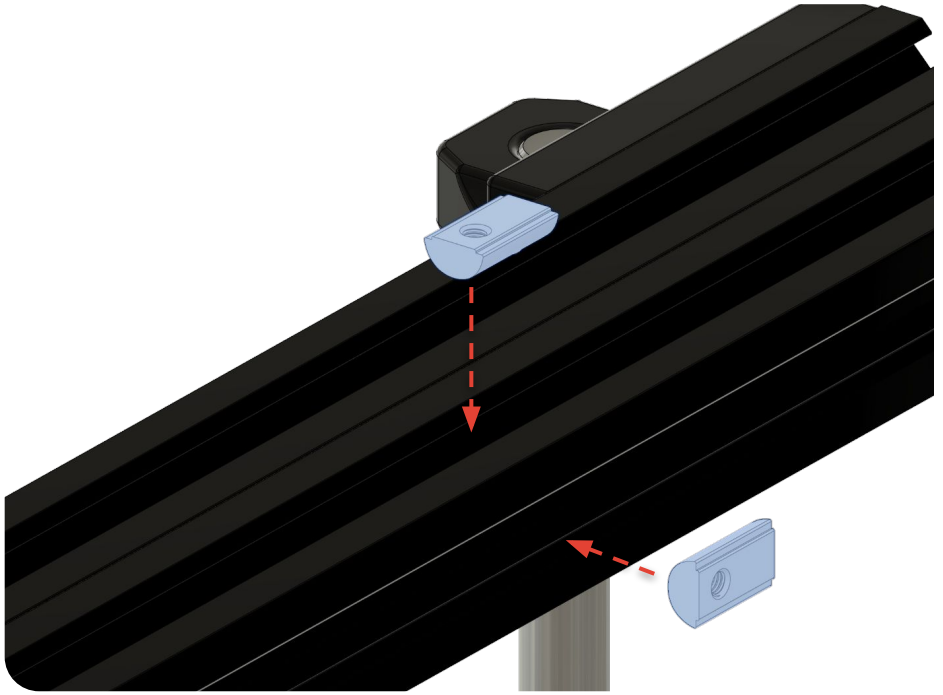


M3X8MM SHCS - QTY 2

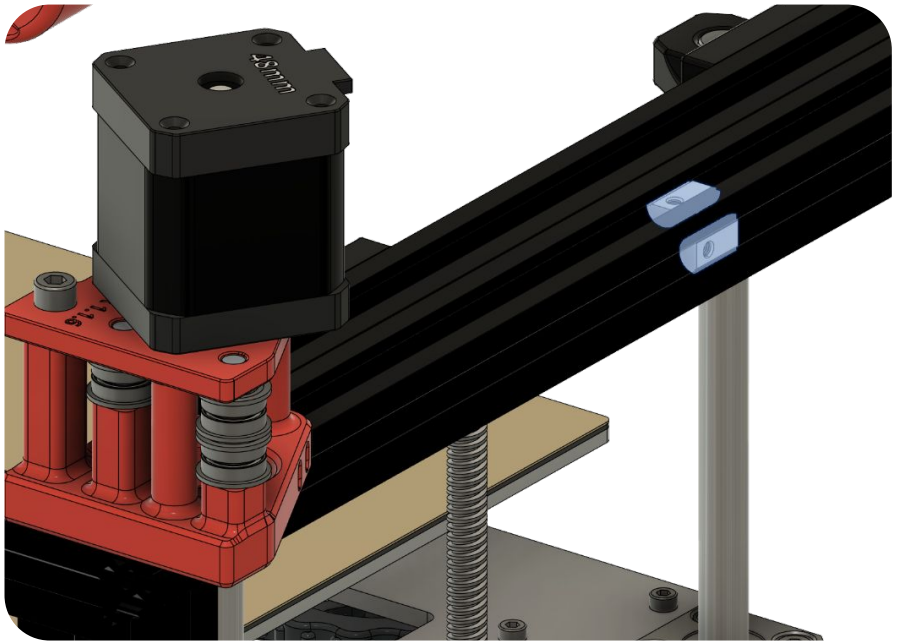
1. INSTALL T-NUTS

Pick a location along the top rear extrusion for your cable arm.

Install one (1) t-nut in the top channel and another in the rear channel. The t-nuts' screw holes should be aligned (see below).



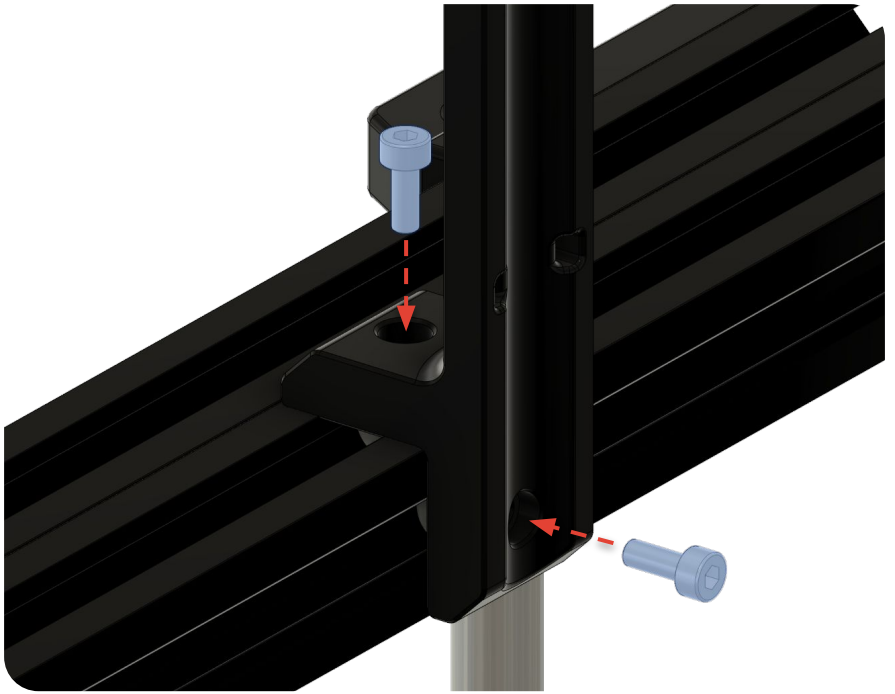
SHOULD LOOK LIKE



2. INSTALL THE CABLE ARM

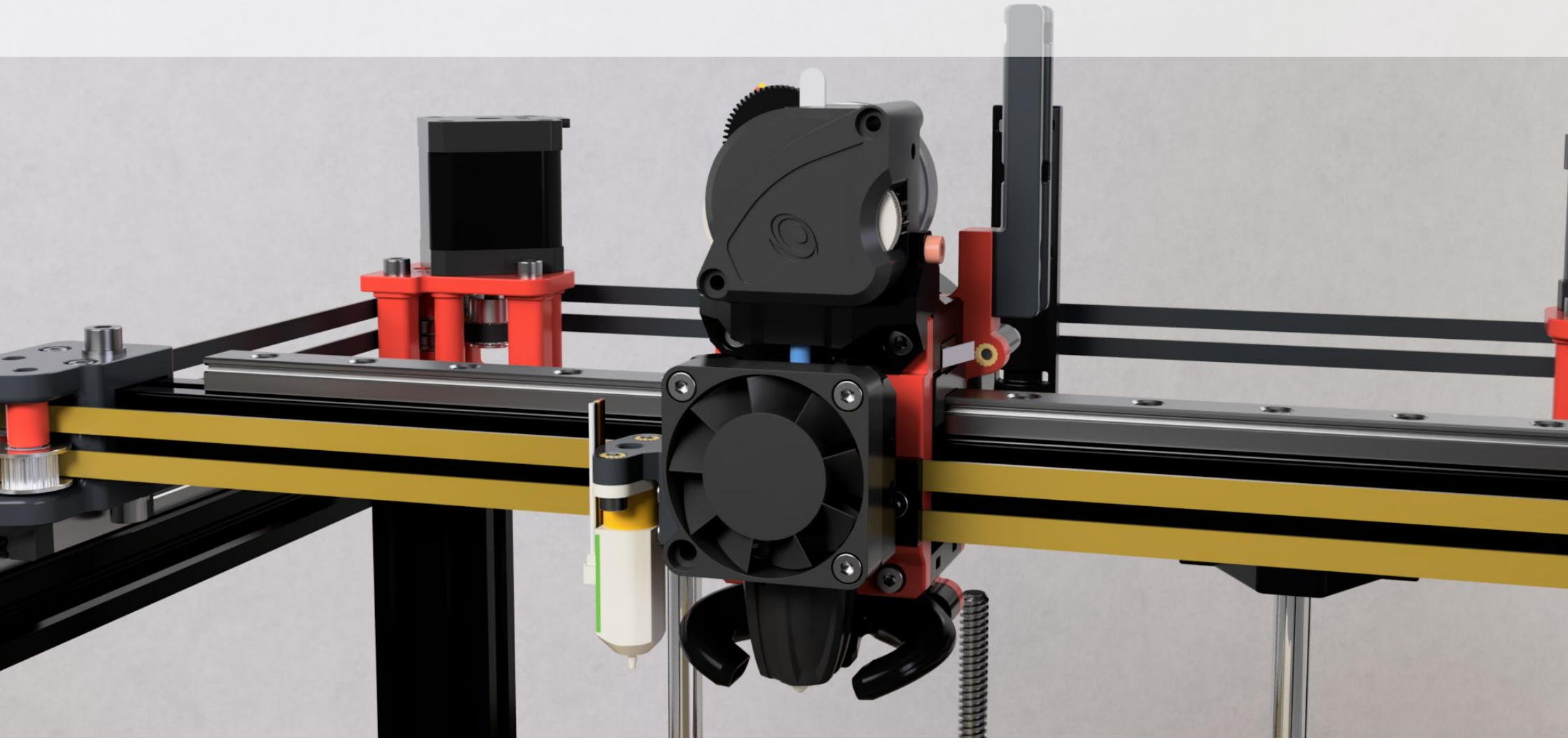
Position the rear cable arm: line up the cable arm's screw holes with the screw holes in the installed t-nuts.

Now install the two (2) M3x8mm bolts to secure the arm.



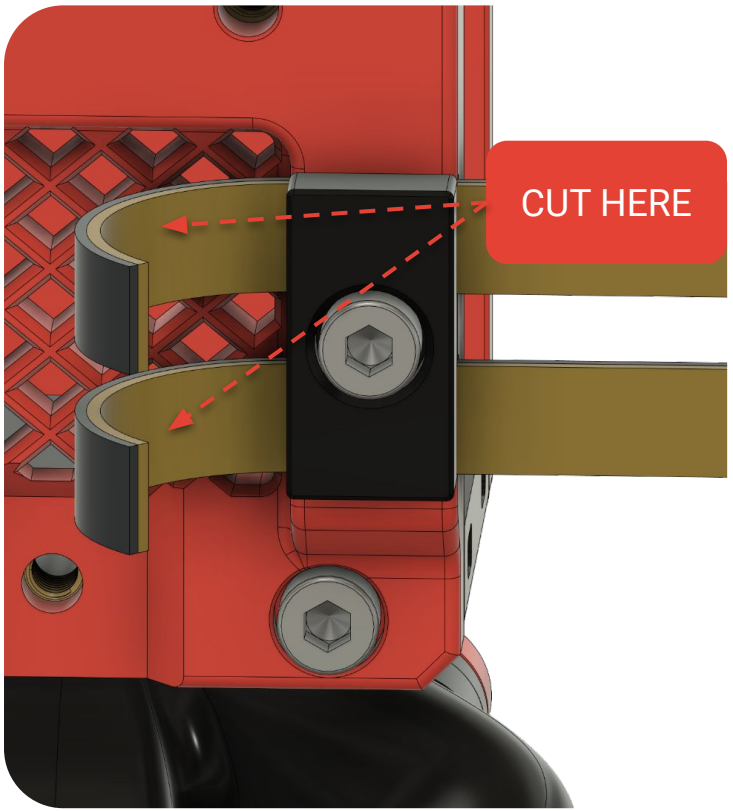
SHOULD LOOK LIKE

FINAL STEPS



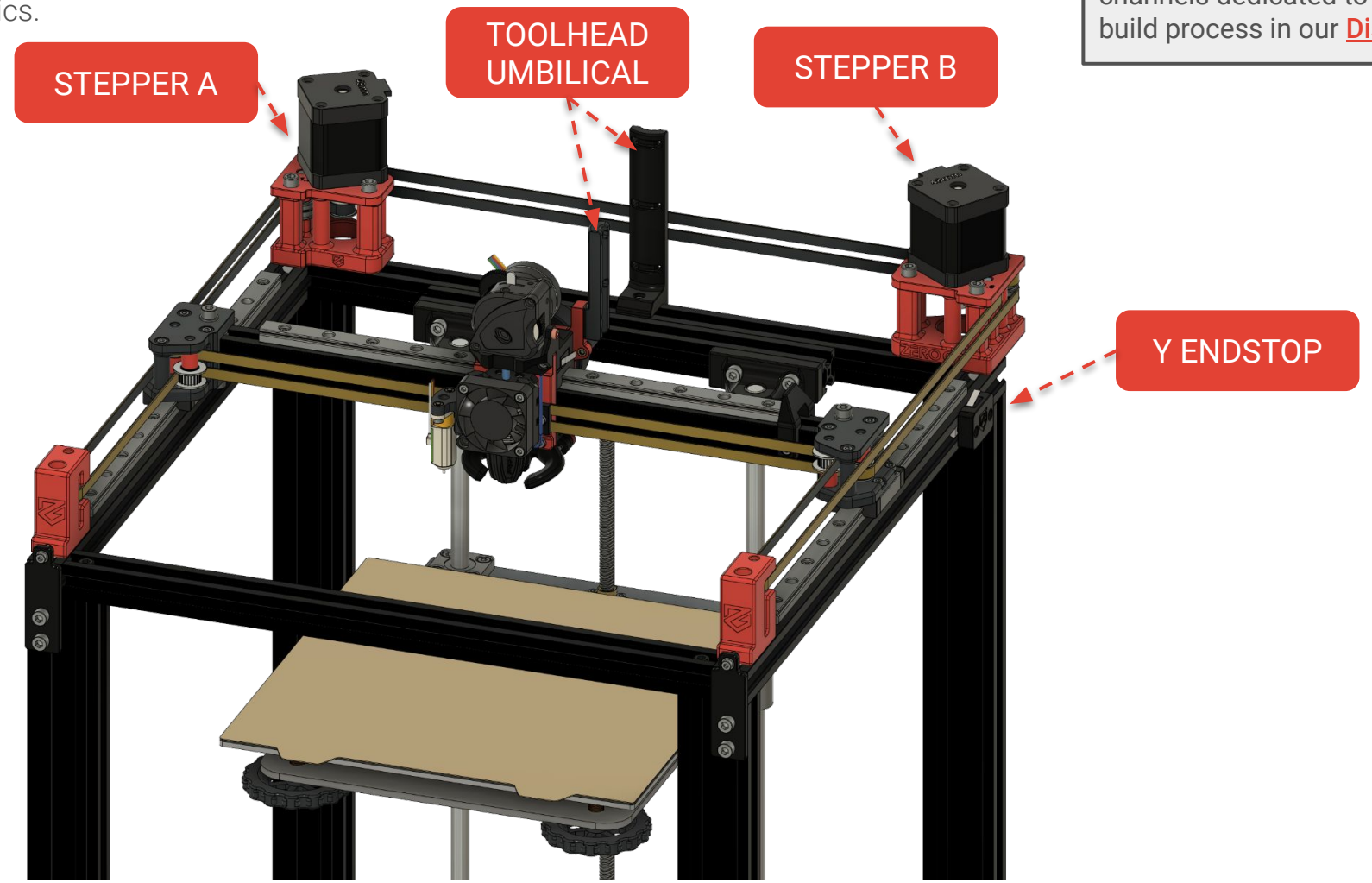
1. TRIM BELTS

Trim the excess from both belts until only three (3) to six (6) excess belt ribs stick out from the right belt grabber (6-12mm of belt).



2. WIRING

You'll need to wire your steppers, Y endstop, toolhead umbilical, any any other electronics.



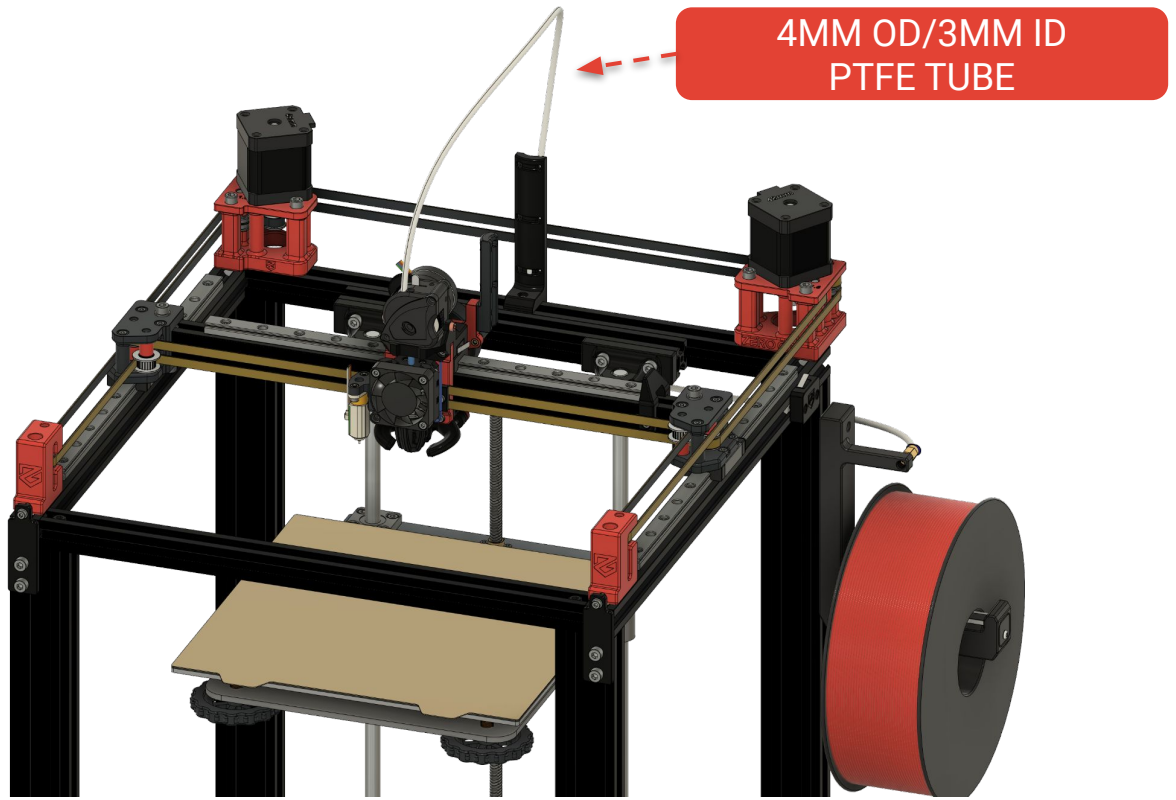
📝If you need help with wiring, we have several channels dedicated to the build process in our Discord.

3. SPOOL HOLDER

The simplest option is to re-use the stock Ender 5 spool holder.

4. PTFE TUBE

Run a 4mm OD/3mm ID PTFE tube from the extruder to at least the rear cable arm, or on to your preferred spool holder.



📝 This installation guide ends here, but our support does not:

- Join our Discord for help with next steps and troubleshooting.
- Visit docs.zerog.one for Klipper and tuning tools, as well as additional resources.

LIFTOFF