Blackbox CE Mechanical Assembly:

04. XY-Axis Motion

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Change Log

Version	Description
1	Initial release for Blackbox Refresh.

Tools

Description
Aluminum to Steel Epoxy
Disposable Toothpick
Electric Drill
Hand Tap Wrench
Hex Wrenches
M3x0.5 Tap
M5x0.5 Tap (Note: Not standard pitch)
Medium Strength Thread Locker (Blue Locktite)
Reamers
Small Hand Vise or Small Arbor Press
Soldering Iron with Heatset Insert Tip Installed
Tweezers

Parts

QTY	Description
1	4MM_E-Clip
2	Bearing_Flanged_5x10x4mm
2	BlackStop
2	CNC_Belt_Clamp_Left
1	CNC_ToolChangeLock
1	CNC_X-Plate_Kelvin_External_Cooler_V2
2	DIN912_M3_6mm_SHCS
9	DIN912_M3_8mm_SHCS
2	DIN912_M3_10mm_SHCS
2	DIN912_M3_25mm_SHCS
2	DIN912_M3_30mm_SHCS
5	DIN912_M3_35mm_SHCS

8	DIN912_M3_40mm_SHCS
6	DIN912_M3_45mm_SHCS
8	DIN912_M3_50mm_SHCS
4	DIN912_M4_10mm_SHCS
4	DIN912_M4_20mm_SHCS
3	DIN912_M4_25mm_SHCS
1	DIN912_M4_30mm_SHCS
4	DIN912_M4_35mm_SHCS
1	DIN916_M3_4mm_Set_Screw
16	DIN916_M3_5mm_Set_Screw
4	DIN916_M4_4mm_Set_Screw
1	DIN985_M3_Nylon_Lock_Washer
8	DIN7991_M3_6mm_FHHS
8	GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore
2	GT2_20t_Pulley_9mm_Belt_5mm_Bore
2	GT2_894t_Belt_9x1788mm_(1.52mm)
2	GT2_Smooth_Idler_Pulley_9mm_Belt_5mm_Bore
3	ISO7380_M3_8mm_BHHS
1	ISO7380_M3_45mm_BHHS
2	ISO7380_M4_30mm_BHHS
1	LinearCarriage_MGN12H_LDO
1	LinearRail_MGN12_375mm_LDO
1	Linear_Shaft_2x6mm
5	Linear_Shaft_3x8mm
2	Linear_Shaft_5x30mm
4	Linear_Shaft_5x35mm
4	Linear_Shaft_5x50mm
1	Nema17_25mm
2	Nema17_47mm
18	M3_4.6x4mm_Heat_Set_Insert
2	M5_Magnet_Set_Screw
1	SLS_ExtruderDrive_ModifiedSetScrew
2	Steel_Bearing_Ball_8mm_G10
4	T-Lock_Shim
8	Tnut_20Series_M3
6	Tnut_20Series_M4
12	Tnut_40Series_M4
1	T-Slot_10x20mm_Nut6_488mm_CE

Printed Parts

QTY	Description	Material	Ver	Link
1	XY-Axis Motion STL Kit (includes all models listed below)		1	Link
1	Print_Bearing_Flanged_Pocket_5x10x4mm	PC-PBT	3	Link
1	Print_BeltClamp_Right_Front	PC-FR	10	Link
1	Print_BeltClamp_Right_Rear	PC-FR	11	Link

0	Print_ExtruderDrive_ModifiedSetScrew	Igus iglide® I180-BL-PF	3	Link
0	Print_MGN12_Alignment_Block_2020	PC-FR	4	Link
1	Print_T-LockShimPocket	PC-PBT	4	Link
1	Print_X_Bracket_V2_Part_1	PC-FR	24	Link
1	Print_X_Bracket_V2_Part_2	PC-FR	5	Link
1	Print_X-Axis_Linear_Rail_Installation_Tool_(56.50)_CE	PC-FR	3	Link
1	Print_XY_Belt_Tensioning_Tool_Front_CE	PC-FR	2	Link
1	Print_XY_Belt_Tensioning_Tool_Rear_CE	PC-FR	4	Link
2	Print_XY_Belt_Tightening_Tool_(1.52mm)	PC-FR	12	Link
1	Print_XY-Axis_Belt_Corner_Bracket_Front_Bottom	PC-PBT	9	Link
1	Print_XY-Axis_Belt_Corner_Bracket_Front_Top	PC-PBT	14	Link
1	Print_XY-Axis_Belt_Corner_Bracket_Rear_Bottom	PC-PBT	16	Link
1	Print_XY-Axis_Belt_Corner_Bracket_Rear_Top	PC-PBT	11	Link
2	Print_XY-Axis_Belt_Tensioner_Linear_Shaft_Instal_Tool_(6.05)	PC-FR	5	Link
1	Print_XY-Axis_BlackStop_Mount	PC-FR	7	Link
2	Print_XY-Axis_Corner_Bracket_Linear_Shaft_Install_Tool_(1.8)	PC-FR	2	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part01	PC-FR	10	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part02_CE	PC-FR	7	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part03	PC-FR	1	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part04_CE	PC-FR	3	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part05	PC-PBT	13	Link
1	Print_XY-Axis_Motor_Bracket_Front_Part06	PC-PBT	4	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part01	PC-FR	17	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part02_CE	PC-FR	11	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part03	PC-FR	5	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part04_CE	PC-FR	9	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part05	PC-PBT	28	Link
1	Print_XY-Axis_Motor_Bracket_Rear_Part06	PC-PBT	5	Link
1	Print_XY-Axis_Motor_Installation_Tool_(4.75)	PC-FR	3	Link
1	Print_XY-Axis_Motor_Pre_Tensioner_Tool_(8.5)	PC-FR	3	Link
1	Print_Y-Axis_Bracket_Front_Bottom_(1.52mm)	PC-PBT	42	Link
1	Print_Y-Axis_Bracket_Front_Top_(1.52mm)	PC-PBT	34	Link
1	Print_Y-Axis_Bracket_Rear_Bottom_(1.52mm)	PC-PBT	22	Link
1	Print_Y-Axis_Bracket_Rear_Top_(1.52mm)	PC-PBT	25	Link
2	Print_Y-Axis_Bracket_Linear_Shaft_Installation_Tool_(1.2)	PC-FR	2	Link

Step 1 – Preparation

For the XY-Axis Motion section, the Installation Tools and the Alignment Jigs may be printed in a less expensive material such as PLA. Your kit comes with a SLS printed SLS_ExtruderDrive_ModifiedSetScrew. The model Print_ExtruderDrive_ModifiedSetScrew is provided if you need to print your own extruder drive gear in the future. If you do choose to print an extruder drive gear, it must be printed with a 0.02 nozzle and with specialized bearing filament such as igus iglide® I180-BL-PF. You will be securing your MGN12 Cartridges installed to the Y-Axis linear rails of the frame to the X-Gantry. This will also involve

the installation of the remaining linear rail for the X-Gantry. In both instances, the MGN12 cartridge can easily slide off the end of the linear rail and become damaged. It is recommended to keep blue painters tape wrapped around each MGN-12 cartridge to prevent unnecessary movement. It is best to lay out all the required hardware identified in each step. The profiles of the 2010 and 2020 extrusions are somewhat delicate. Do not overtighten any hardware going into a roll-in nut installed to a 2010 or 2020 extrusion to prevent deformation. The lengths of hardware are not substitutable, and a shorter length will prevent proper hold strength while a longer length will deform the 2010 or 2020 profile. You must request or acquire the proper hardware specified in the guide. Hardware going through printed parts can be substituted only with adjustments made to the associated printed part.

Step 2 – Kelvin X-Carriage Plate

Locate the CNC_X-Plate_Kelvin_External_Cooler_V2 and five pieces of Linear_Shaft_3x8mm. Mix your Aluminum to Steel epoxy according to the manufacturer's instructions. Using a disposable toothpick, place some epoxy into the machined pockets of the X-Plate where the 3x8mm shafts are to be placed. It is not necessary to use excessive epoxy and too much can interfere with the kinematics of the FDM tool. It is best to place a bead of approximately 2mm at each inside corner where the 3x8mm shaft will rest. Using tweezers, insert five 3x8mm linear shafts into the areas of the machined pockets where the epoxy was applied. Center each liner shaft in its pocket using the tweezers. It is best to not rotate the linear shafts after they encounter the epoxy. Only parts of the linear shaft that meet the X-Plate should be in contact the epoxy.

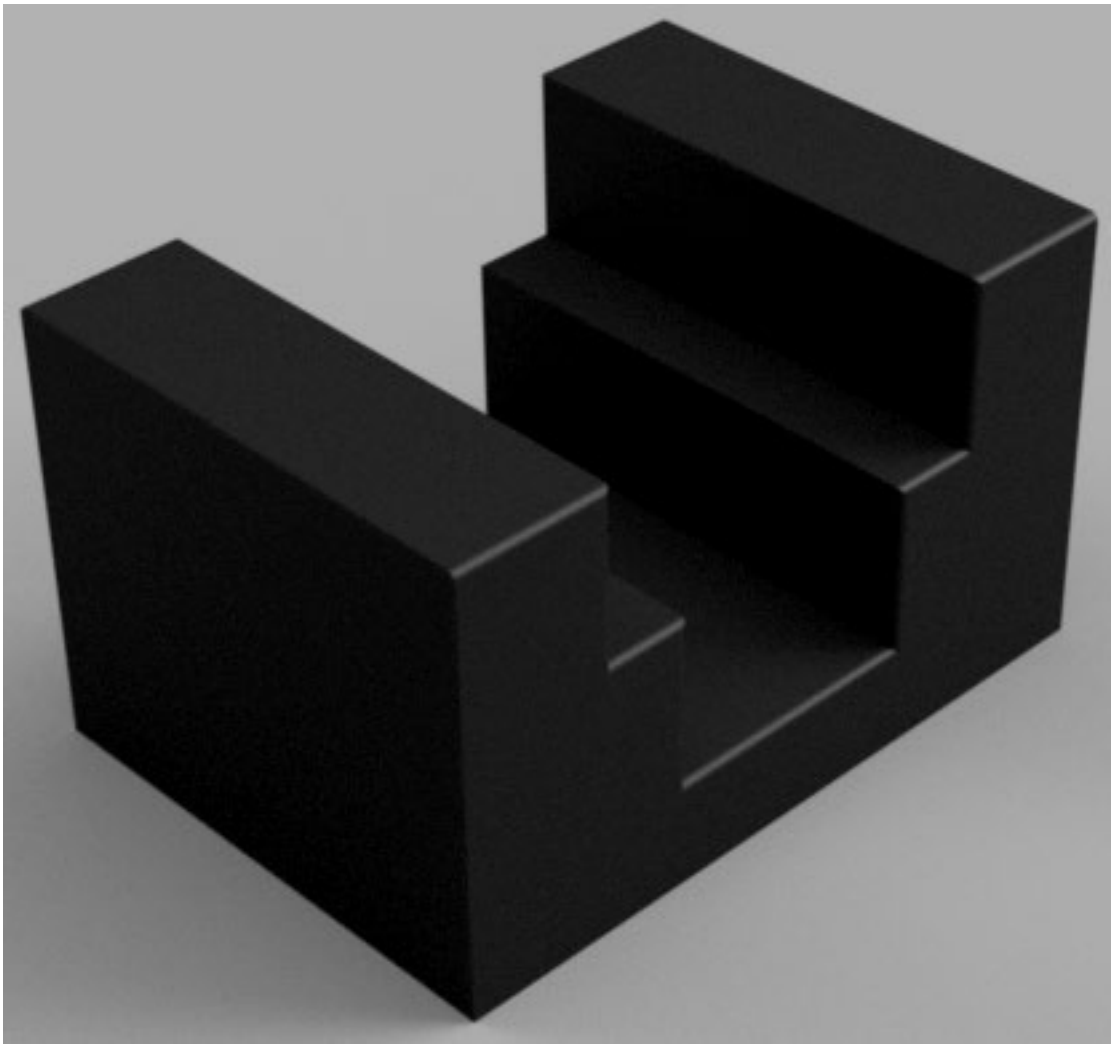
To ensure proper positioning while the epoxy dries, place a Steel_Bearing_Ball_8mm_G10 onto each set of kinematic points and then place a heavy object such as a book or a board on top of the bearing balls until the epoxy is fully cured. NOTE: We are not intending to epoxy the bearing balls to the 3x8mm linear shafts.

After the epoxy is fully cured, remove the bearing balls (these are not needed again until assembling the FDM tools). It is likely that excessive epoxy may be removed after curing if necessary. Refer to the manufacturer's instructions for further details.

Step 3 – X-Axis Gantry

Locate the 2010 extrusion with a length of 488mm and remove the blue painters tape if installed in the preparation section. Be careful not to let the MGN12H carriage slide to the end or off the rail as you move it around during installation. Install eight Tnut_20Series_M3 into the 2010 extrusion as shown. The exact positions will be realized as the MGN12 rail is secured.

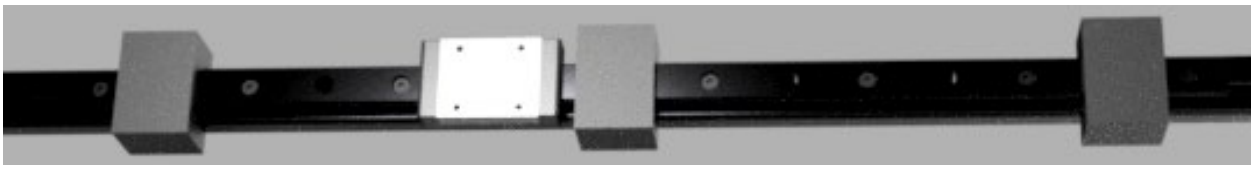
Locate the three Print_MGN12_Alignment_Block_2020 used in the frame build step.



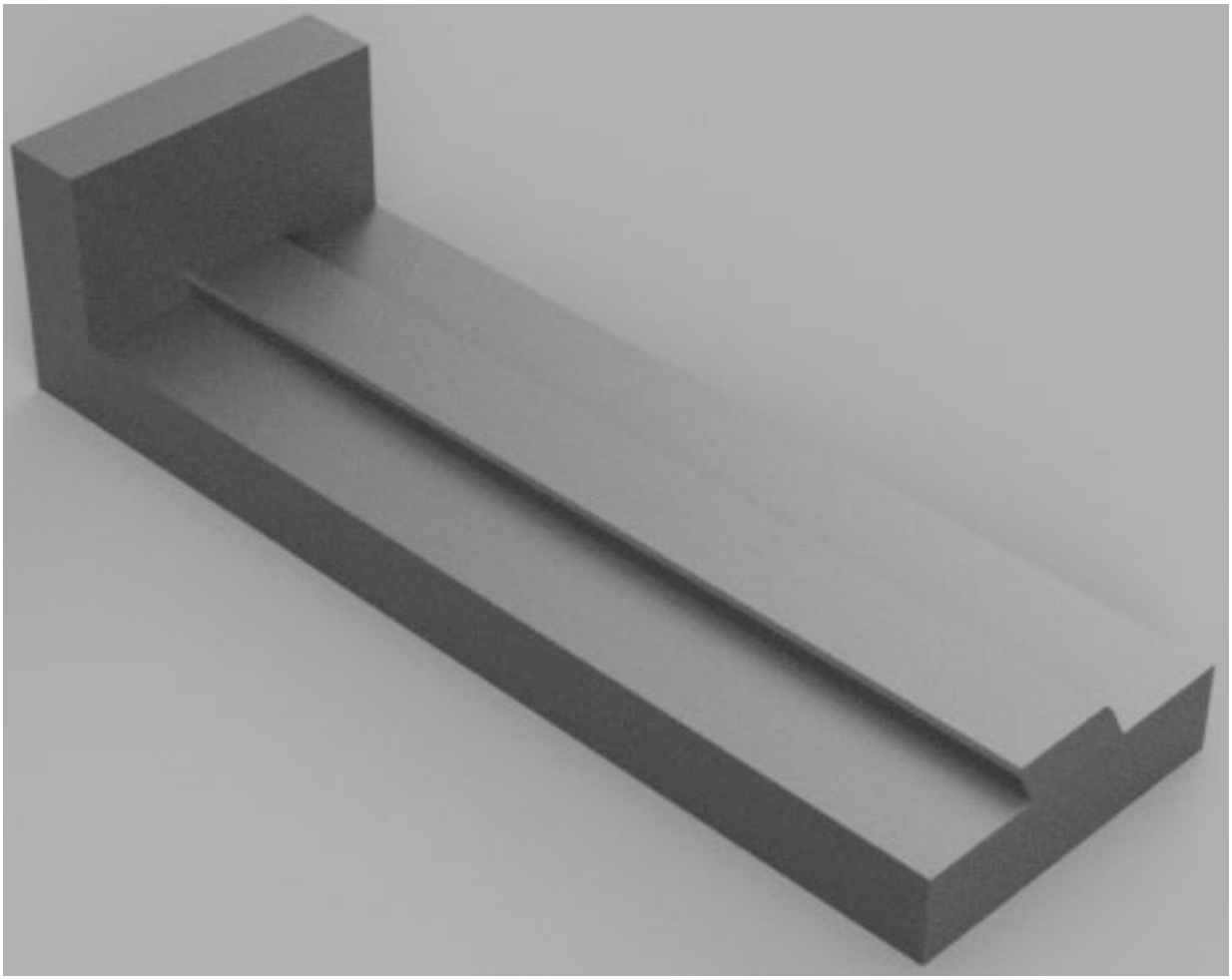
Place the remaining linear rail of 488mm on top of the 2010 extrusion and secure it with the three printed 2020 MGN12 Alignment Blocks.

Laid out this way, all the holes used to secure the MGN12 rail to the 488mm 2010 extrusion are accessible. It is likely that your Tnut_20Series_M3 are not aligned with the proper holes at first. It is easiest to correct this by moving the MGN12 rail left or right until the hole through one of the ends of the MGN12 rail matches up with the threads of the corresponding Tnut_20Series_M3. Once aligned, loosely screw an M3x8 SHCS through the MGN12 rail into the Tnut_20Series_M3. Refer to the picture below with all screws attached to verify you are using the correct hole pattern. After you have loosely attached the first M3x8 SHCS, move the MGN12 rail again until the next prescribed hole lines up with its

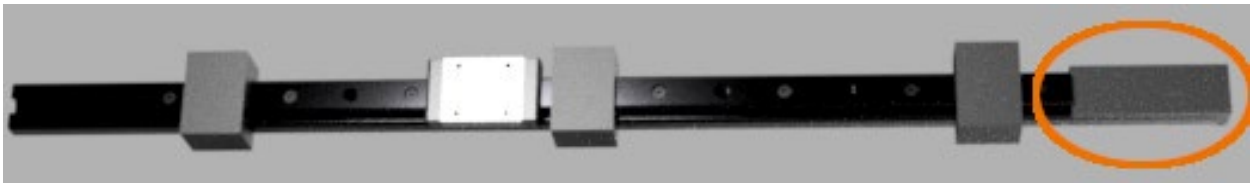
corresponding Tnut_20Series_M3. Repeat this until all eight screws are loosely attached. You will likely need to slide the MGN12H cartridge out of the way to facilitate access to some of the holes.



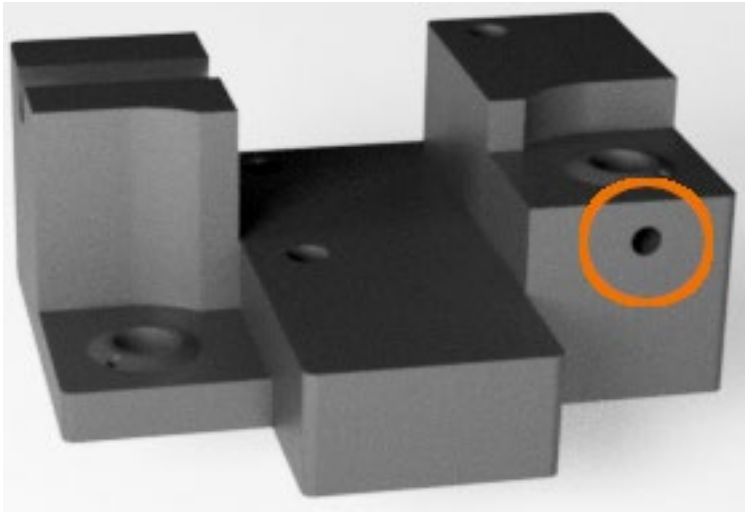
Now that all the M3x8 SHCS are loosely screwed into their proper holes, locate the Print_X-Axis_Linear_Rail_Installation_Tool_(56.50)_CE.



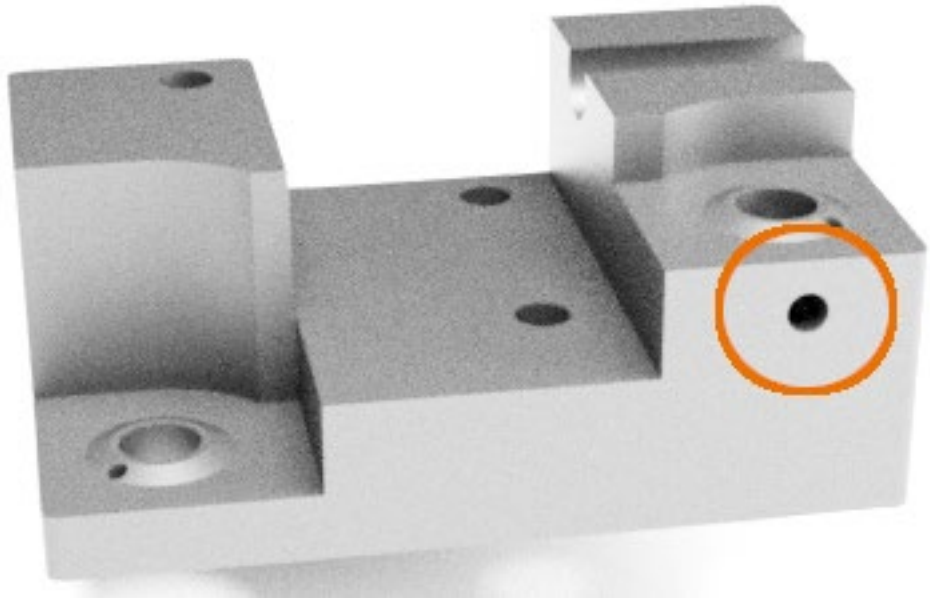
Install the printed alignment tool into the Slot 6 of the 2010 extrusion. Slide the MGN12 rail so the bottom of the rail is flush to the printed Installation Tool and the printed Installation tool is flush to the end of the 2010 extrusion.



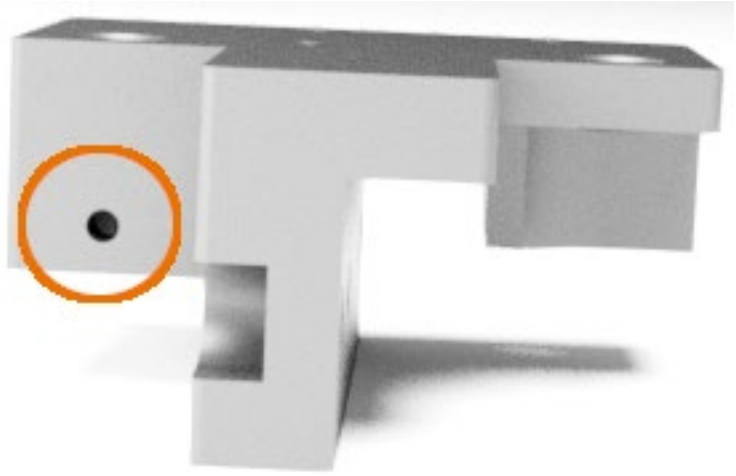
Tighten all the M3x8mm SHCS. Remember not to overtighten these screws to prevent damage to the slot profile in the 2010 extrusion. The 2010 slot profile may also be damaged if the 2020 alignment blocks are not used to hold the MGN12 rail in place as the screws are tightened. Apply some blue painters tape to the MGN12H cartridge to keep it from moving as you continue to assemble the X-Gantry. Remove the 2020 MGN12 alignment blocks and the printed Linear Rail Installation Tool. Set this assembly aside. Locate the Print_Y-Axis_Bracket_Rear_Bottom_(1.52mm) and tap the specified hole below with M3 threads.



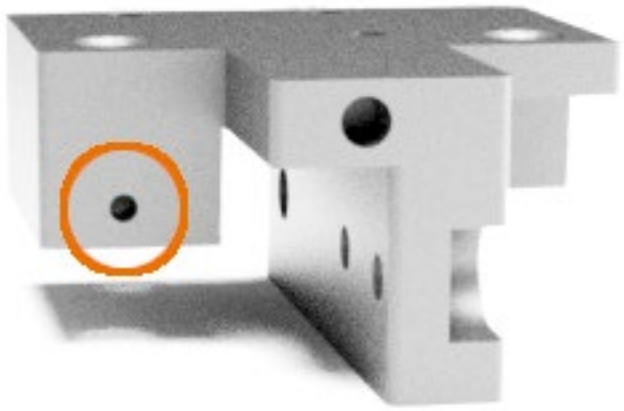
Now locate the Print_Y-Axis_Bracket_Front_Bottom_(1.52mm) and tap the specified hole below with M3 threads.



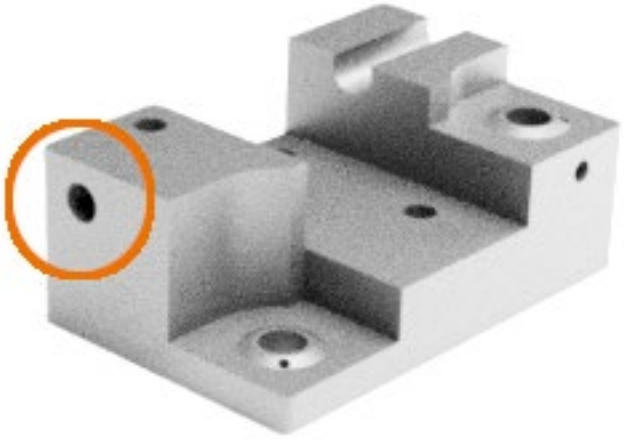
Now locate the Print_Y-Axis_Bracket_Rear_Top_(1.52mm) and tap the specified hole below with M3 threads.



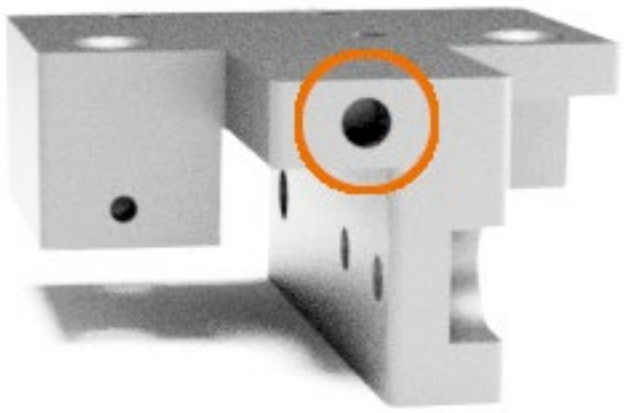
Now locate the Print_Y-Axis_Bracket_Front_Top_(1.52mm) and tap the specified hole below with M3 threads.



Return to the Print_Y-Axis_Bracket_Front_Bottom_(1.52mm) and tap the specified hole below with M5x0.5 threads.

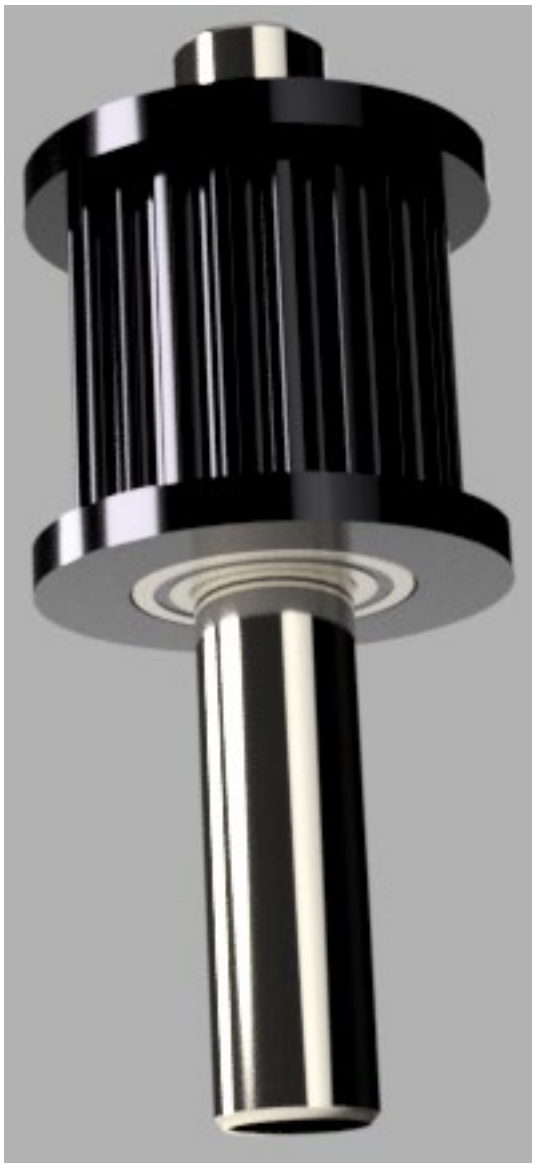


Return to the Print_Y-Axis_Bracket_Front_Top_(1.52mm) and tap the specified hole below with M5x0.5 threads.

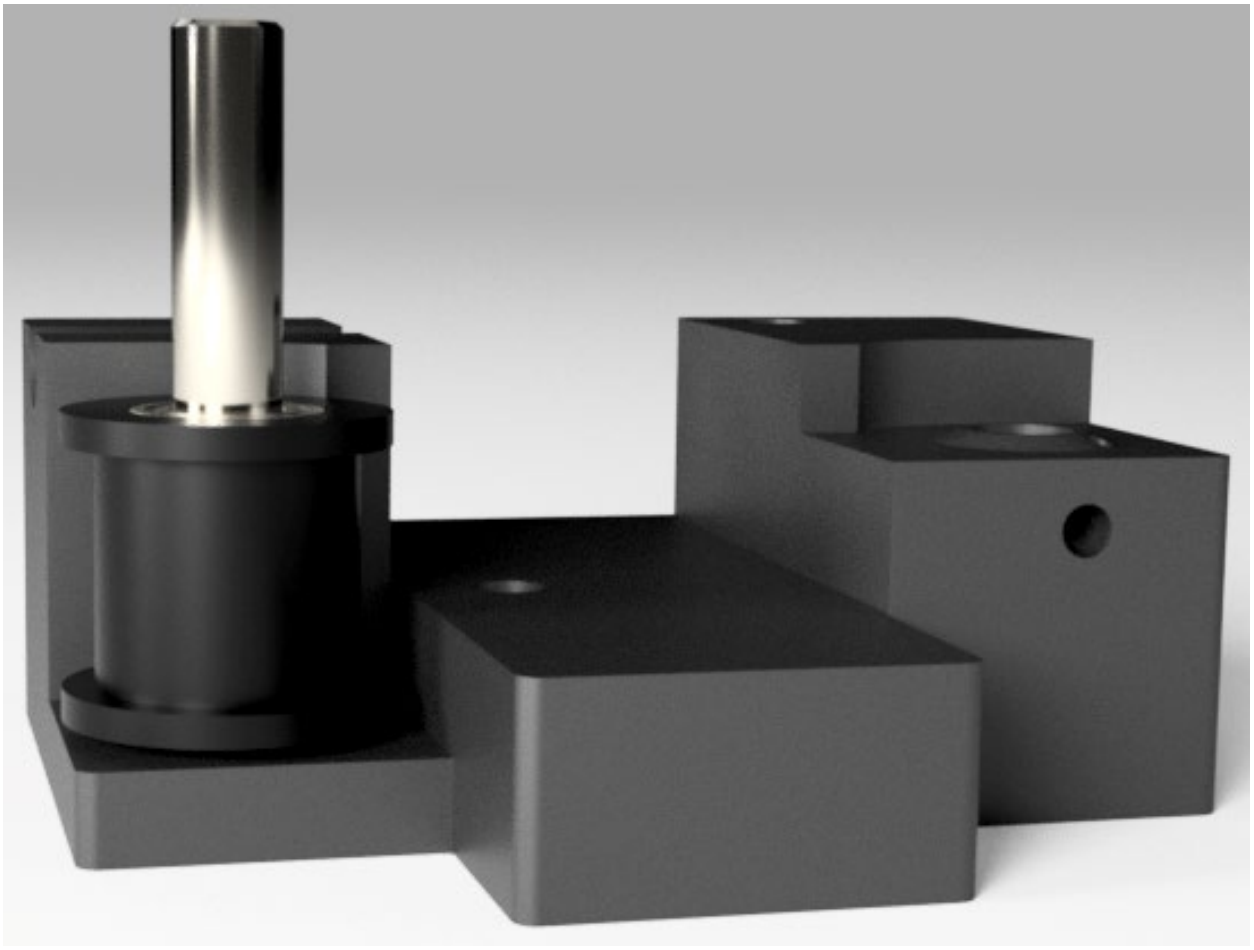


Gather four Linear_Shaft_5x35mm, two GT2_Smooth_Idler_Pulley_9mm_Belt_5mm_Bore, and two GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore. Slide a GT2_Smooth_Idler_Pulley_9mm_Belt_5mm_Bore onto one of the linear shafts. If the pulley seems too difficult to install, first try to install the pulley from the other end of the linear shaft. If the resistance is still too great, put the linear shaft in your electric drill chuck and pinch a small piece of fine grain sandpaper (2000 or higher) around the end of the linear shaft while you operate the drill for a few seconds. It is not necessary to sand both ends of the shaft. The pulley should slide onto the shaft with some resistance, but not excessive force. Do not hammer, pound, or hit your pulleys to install them onto the linear shafts. Each idler pulley contains two very small bearings. Any impact, or even excessive force from pressing with cause flat spots on the bearing balls. This type of bearing damage will cause the bearing to experience resistance during use that results in heat buildup of the bearing, shortening the bearing life, and vibration that can travel through the belts and ultimately into the surface finish of your printing part.

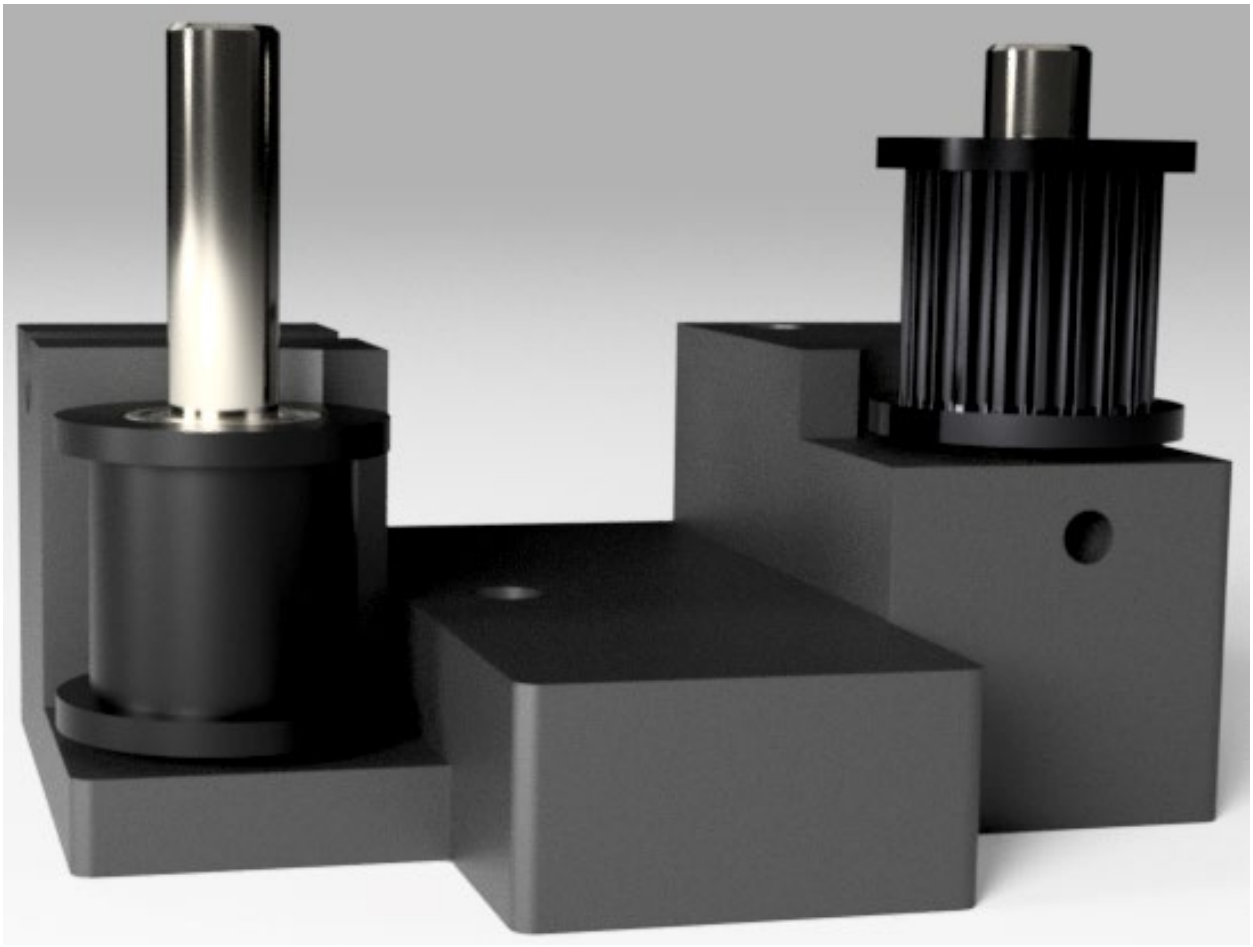
Repeat this for the other GT2_Smooth_Idler_Pulley_9mm_Belt_5mm_Bore and then for both of the GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore.



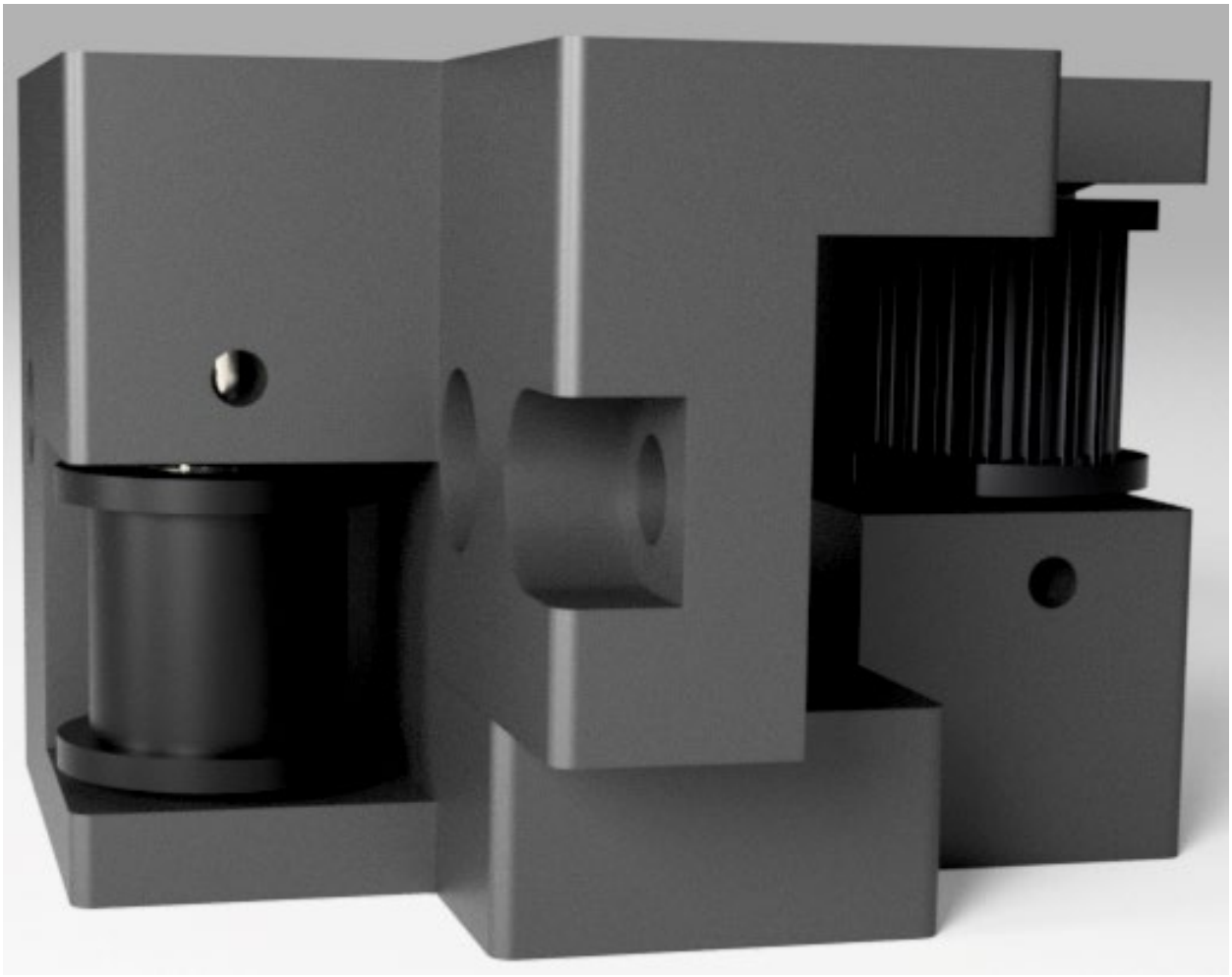
Install one of the assembled smooth idler pulleys into Print_Y-Axis_Bracket_Rear_Bottom_(1.52mm) as shown below.



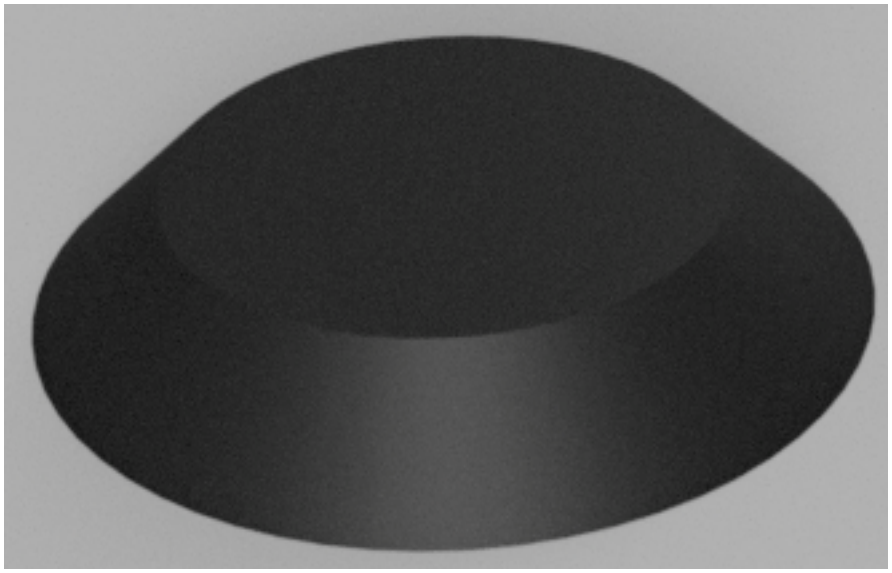
Install one of the toothed pulley assemblies into the other hole as shown below.



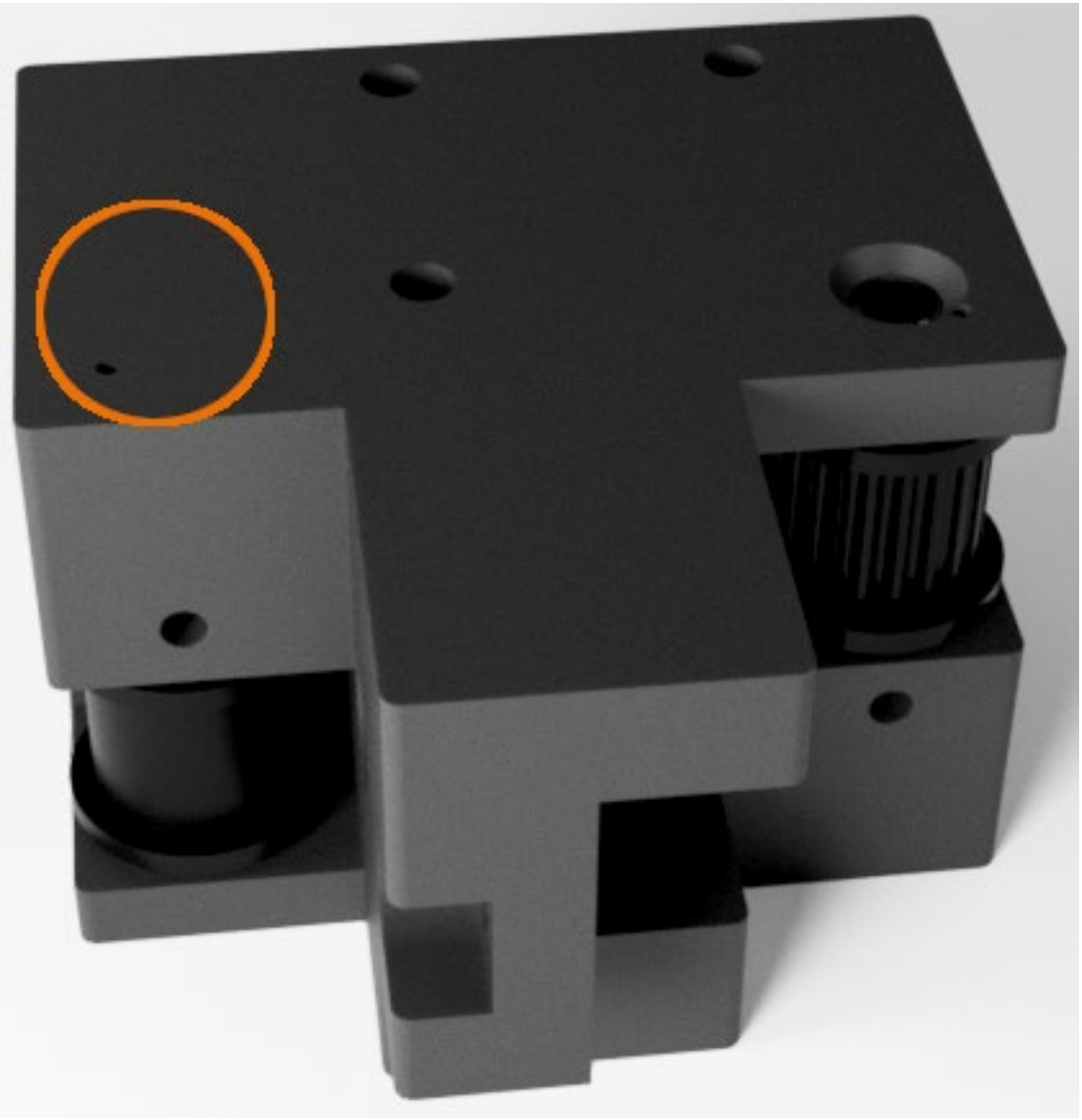
Press the Print_Y-Axis_Bracket_Rear_Top_(1.52mm) onto the assembly as shown below.



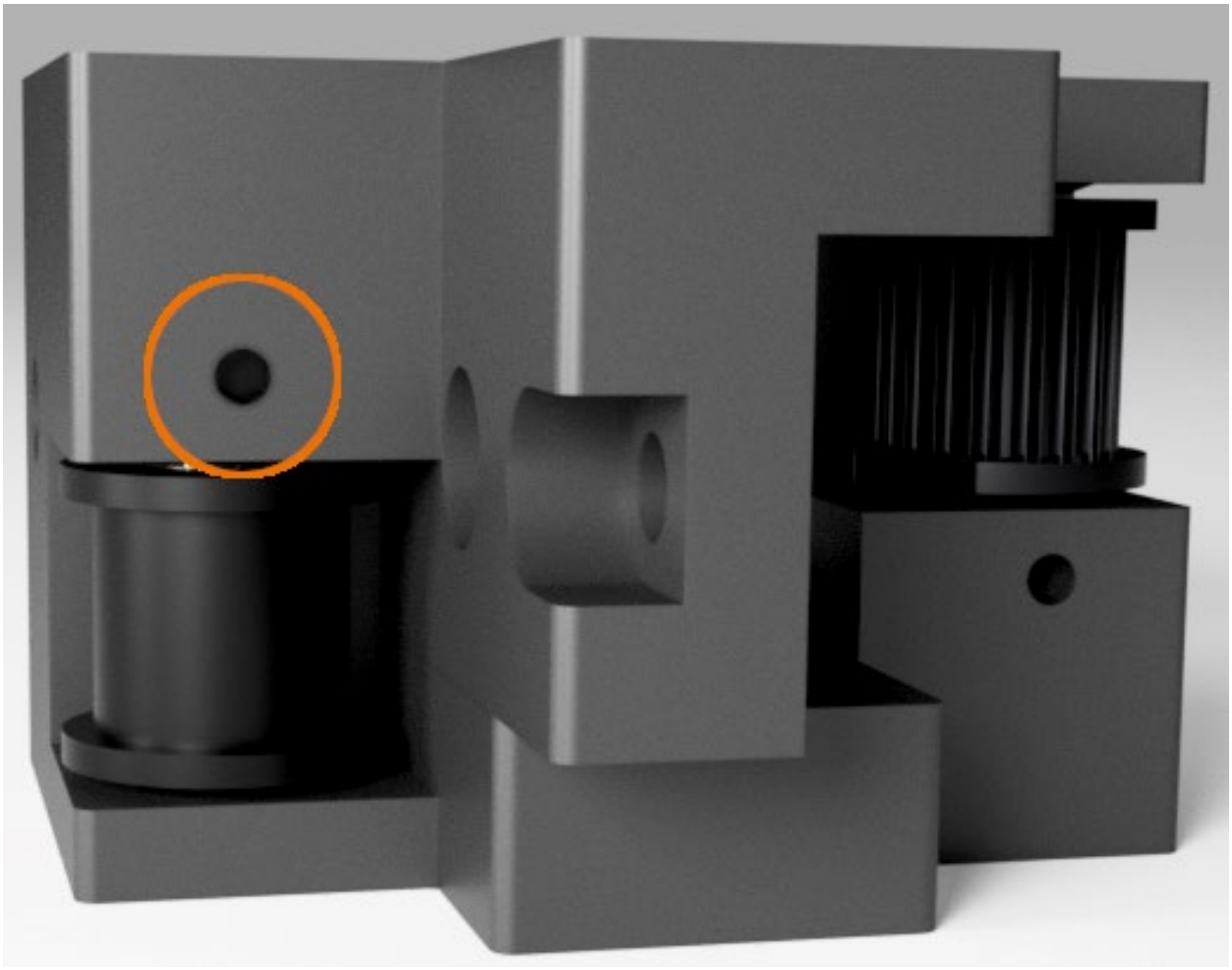
Locate the two Print_Y-Axis_Bracket_Linear_Shaft_Installation_Tool_(1.2).



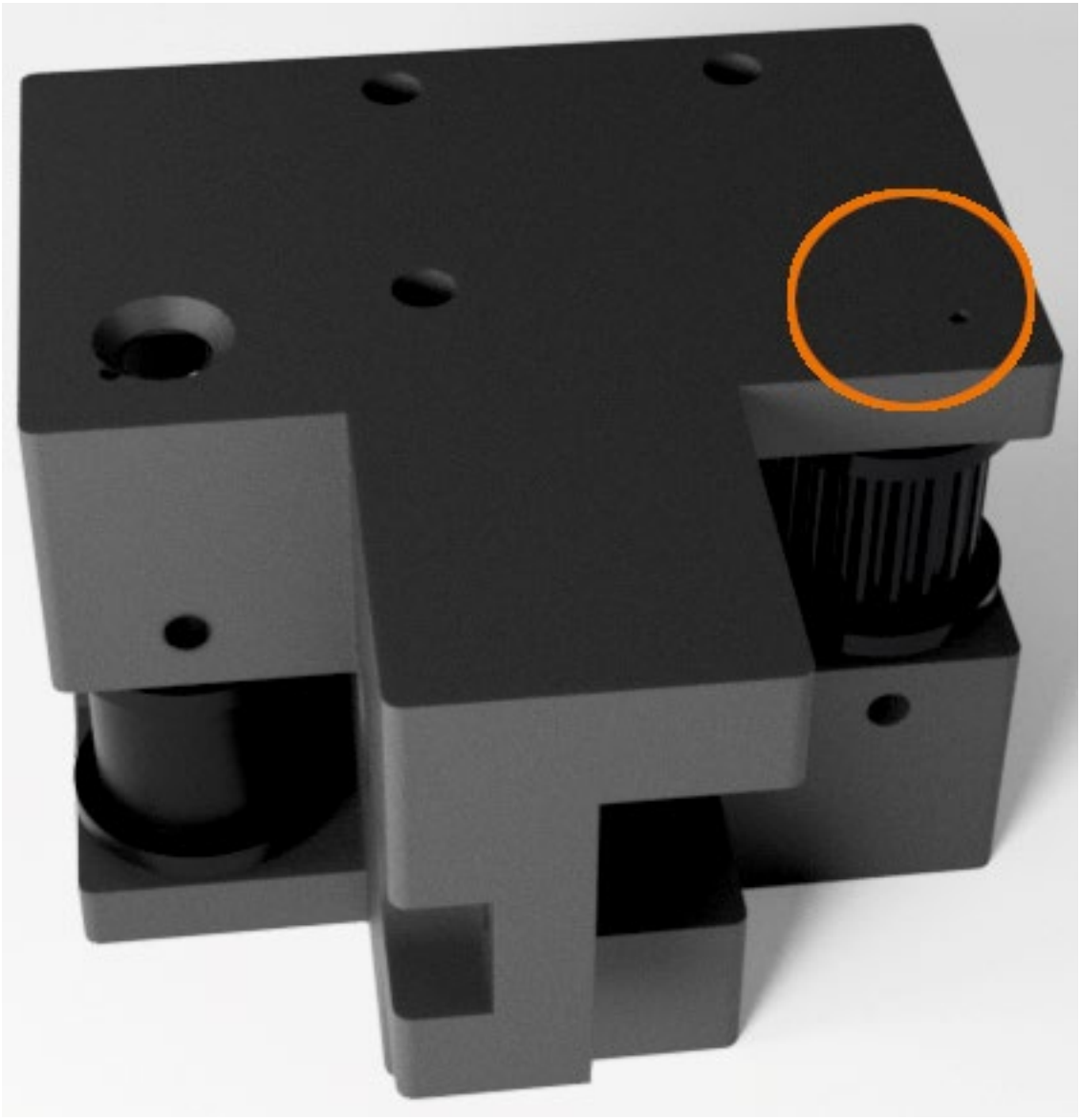
Place one tool in the linear shaft recess of the top bracket assembly as shown below.



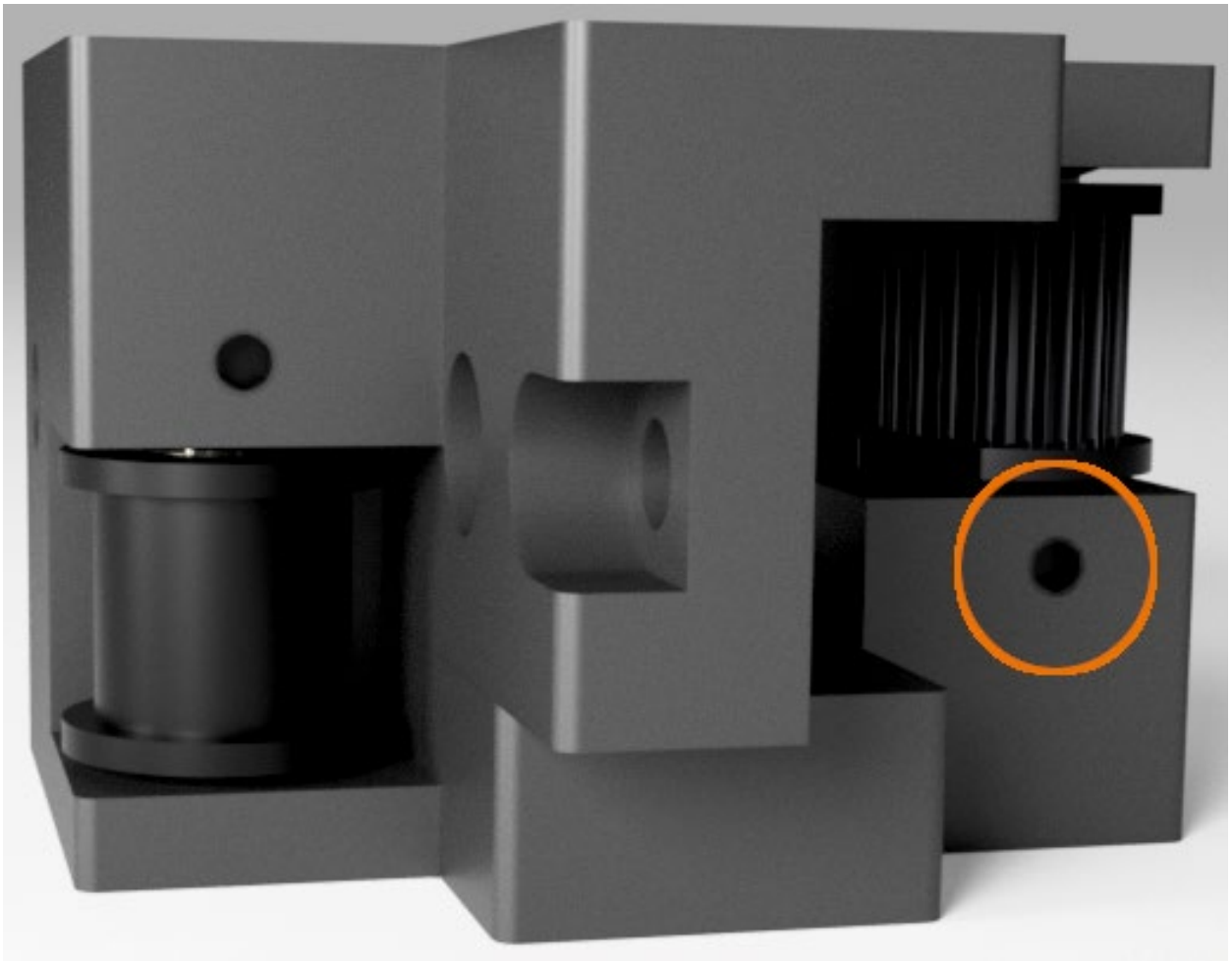
Place the other tool into the recess on the bottom of the bracket assembly and then use your hand vise to clamp the two halves of the bracket assembly together setting the shaft in the proper centered position. Install a DIN916_M3_5mm_Set_Screw into the tapped hole as shown below.



Remove the hand vise and the linear rail installation tools. Move the linear installation tools to the corresponding positions of the other linear rail in the bracket assembly.

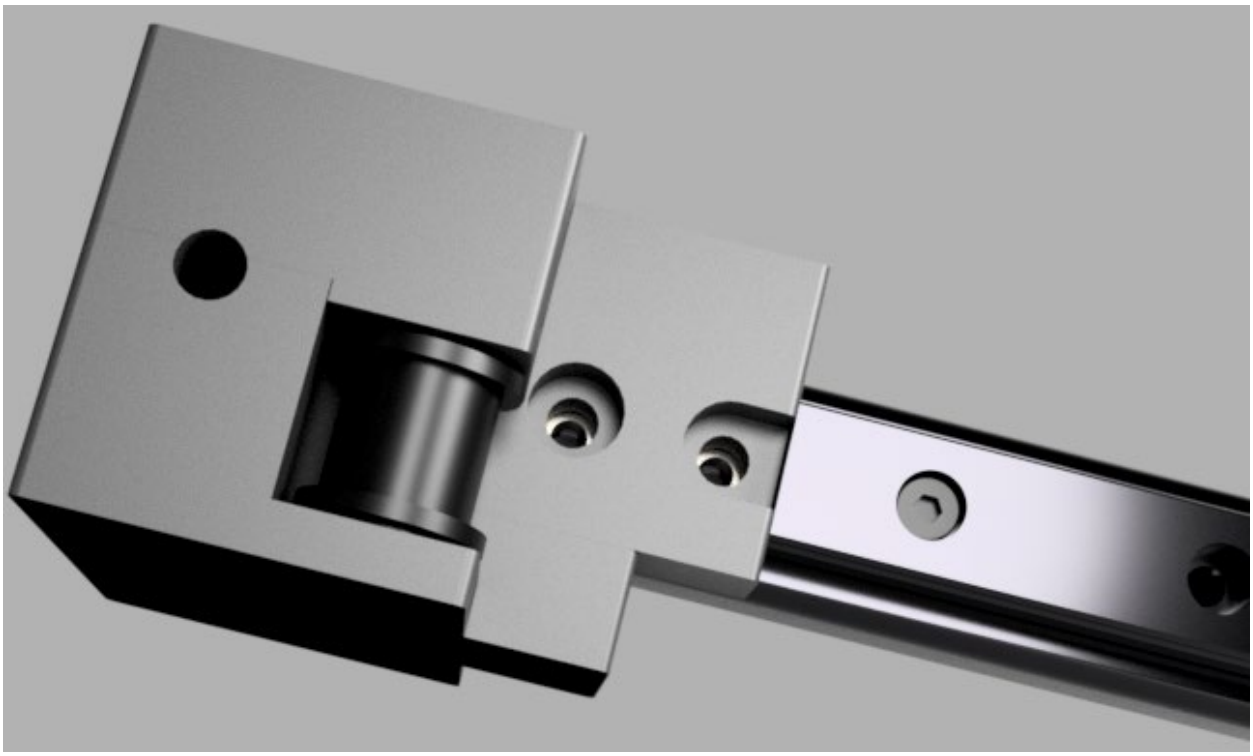


Again, use your hand vise to press the two halves of the bracket assembly together and set the centered position of this linear shaft. Install another DIN916_M3_5mm_Set_Screw into the tapped hole as shown below.

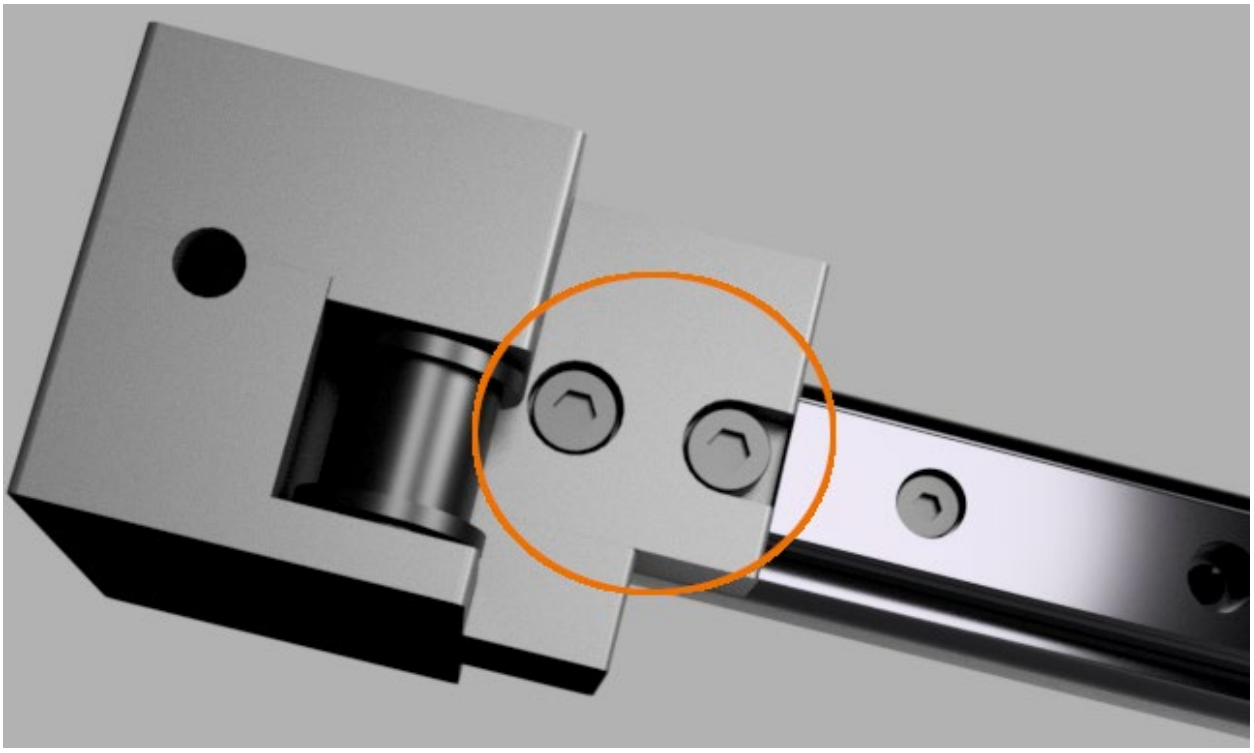


Remove the hand vise and the linear rail installation tools. Install three Tnut_20Series_M4 into the X-Axis linear rail assembly as shown below.

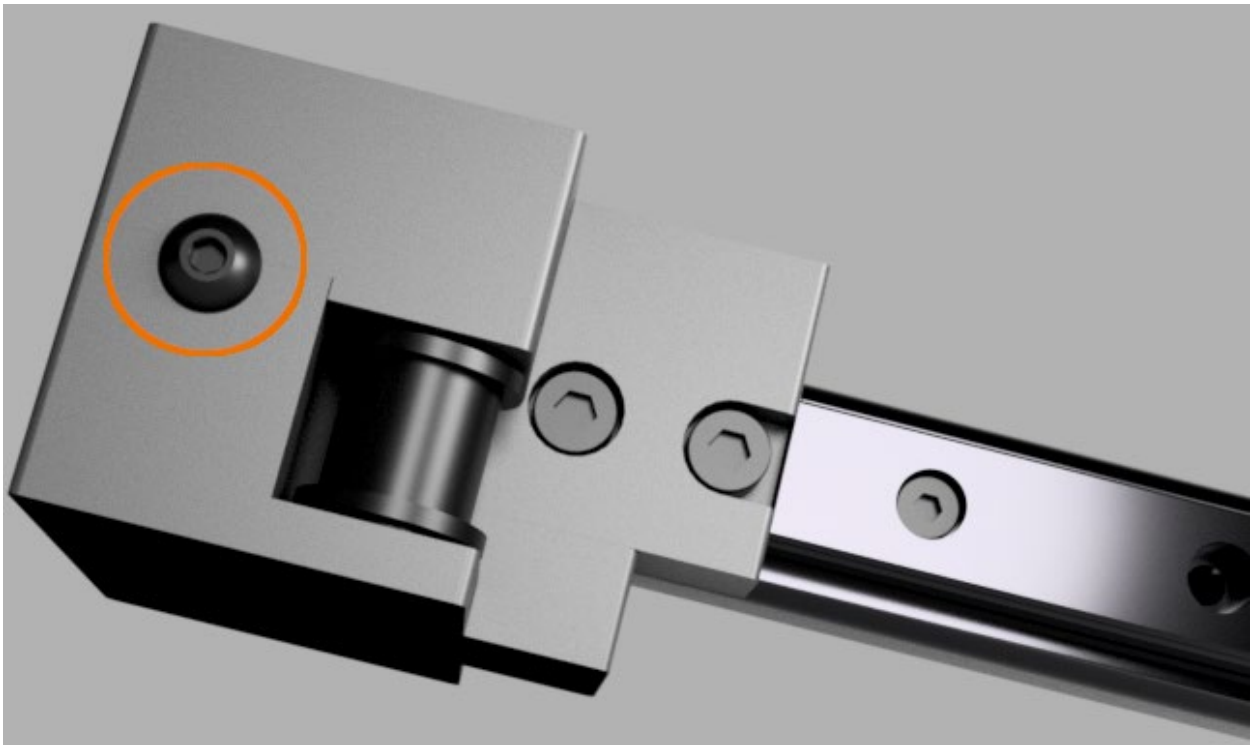
Slide the assembled Y-Axis Bracket Rear onto the X-Axis linear rail assembly and line the holes in the roll-in nuts to the holes in the printed assembly.



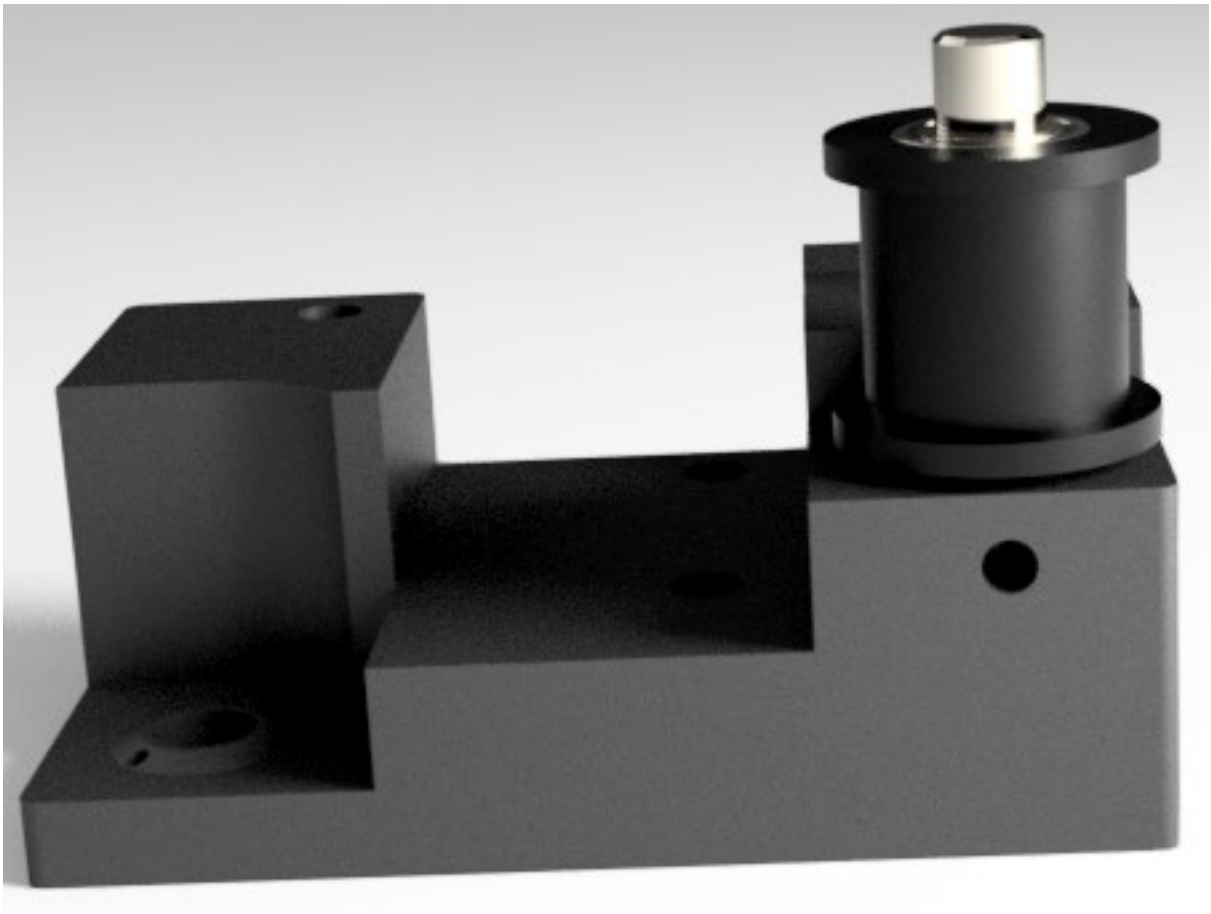
Install two DIN912_M4_10mm_SHCS into the locations shown below and fully tighten.



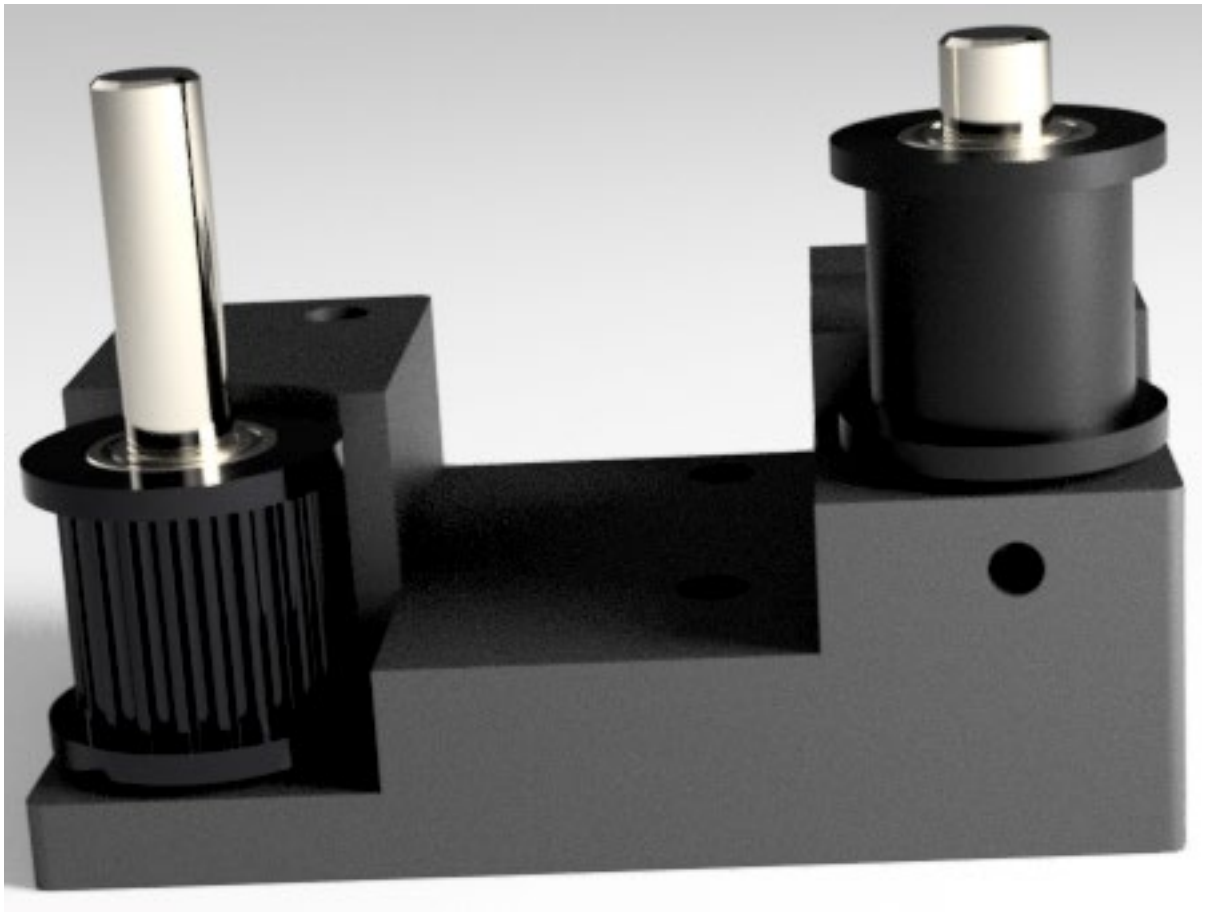
Install a ISO7380_M4_30mm_BHHS into the location shown below and fully tighten.



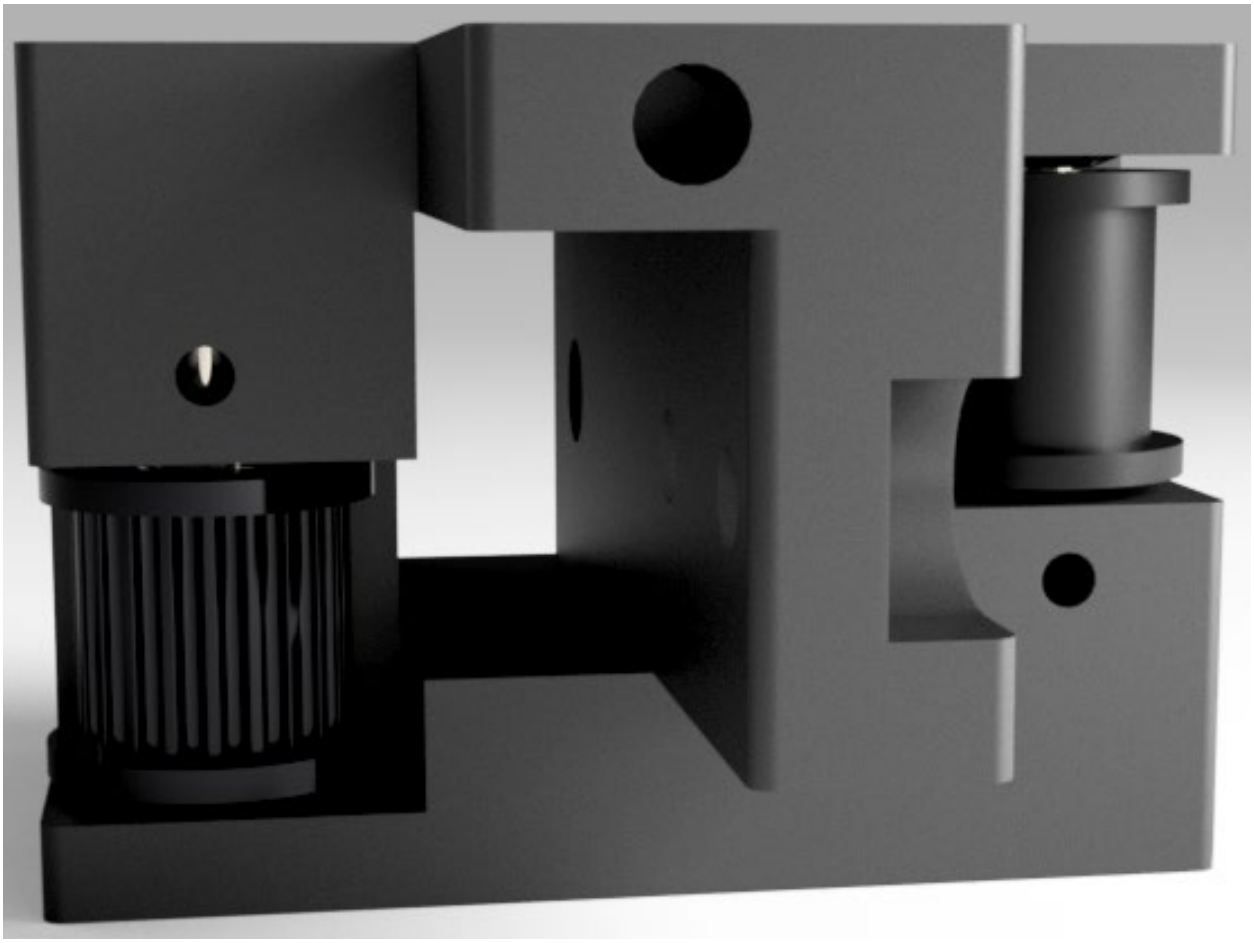
Install one of the assembled smooth idler pulleys into Print_Y-Axis_Bracket_Front_Bottom_(1.52mm) as shown below.



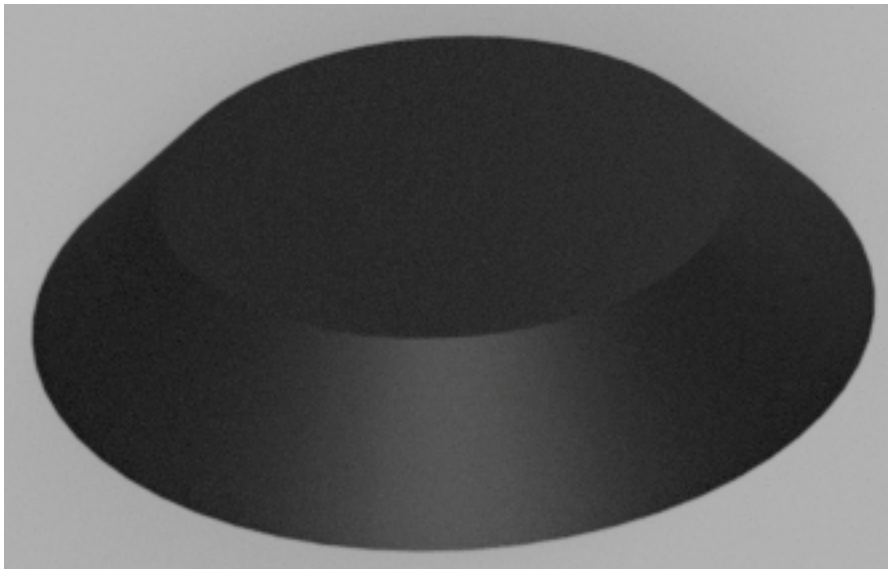
Install one of the toothed pulley assemblies into the other hole as shown below.



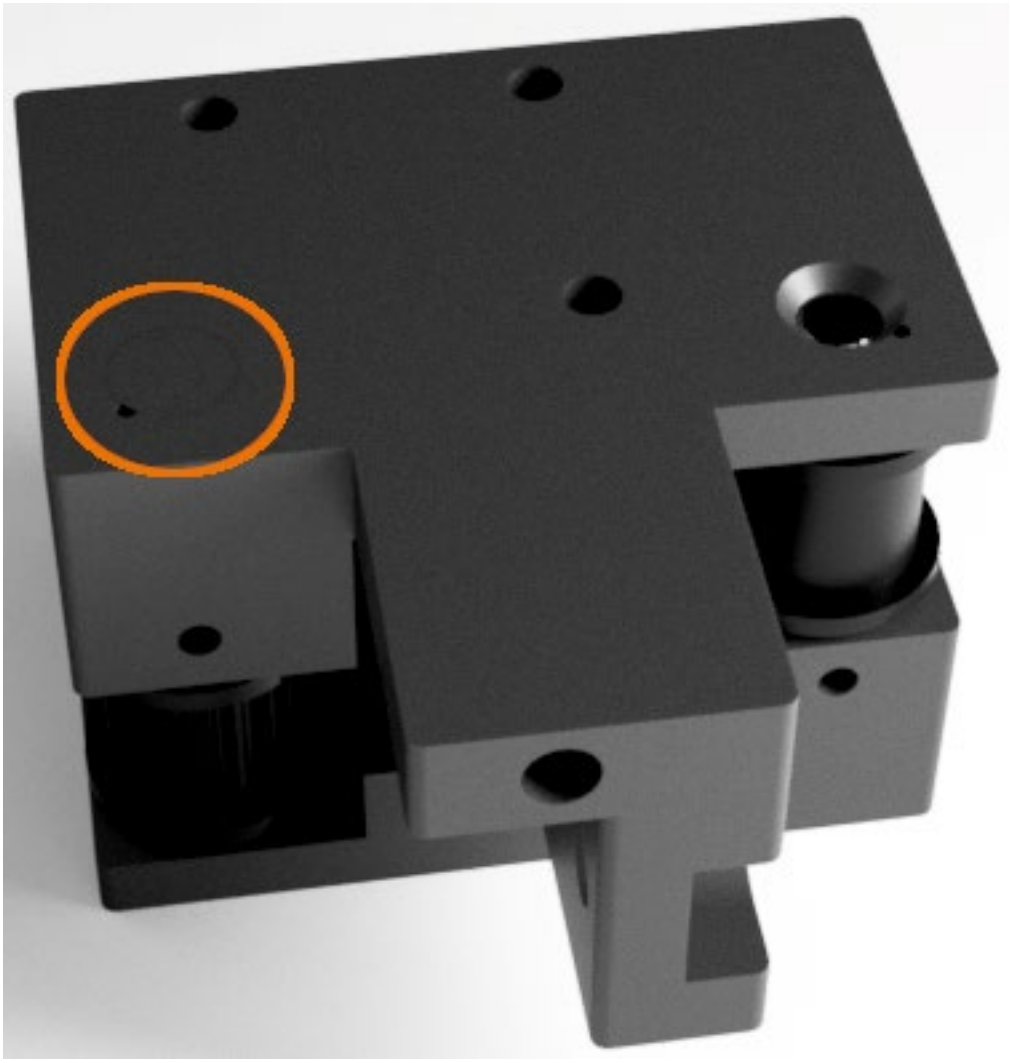
Press the Print_Y-Axis_Bracket_Front_Top_(1.52mm) onto the assembly as shown below.



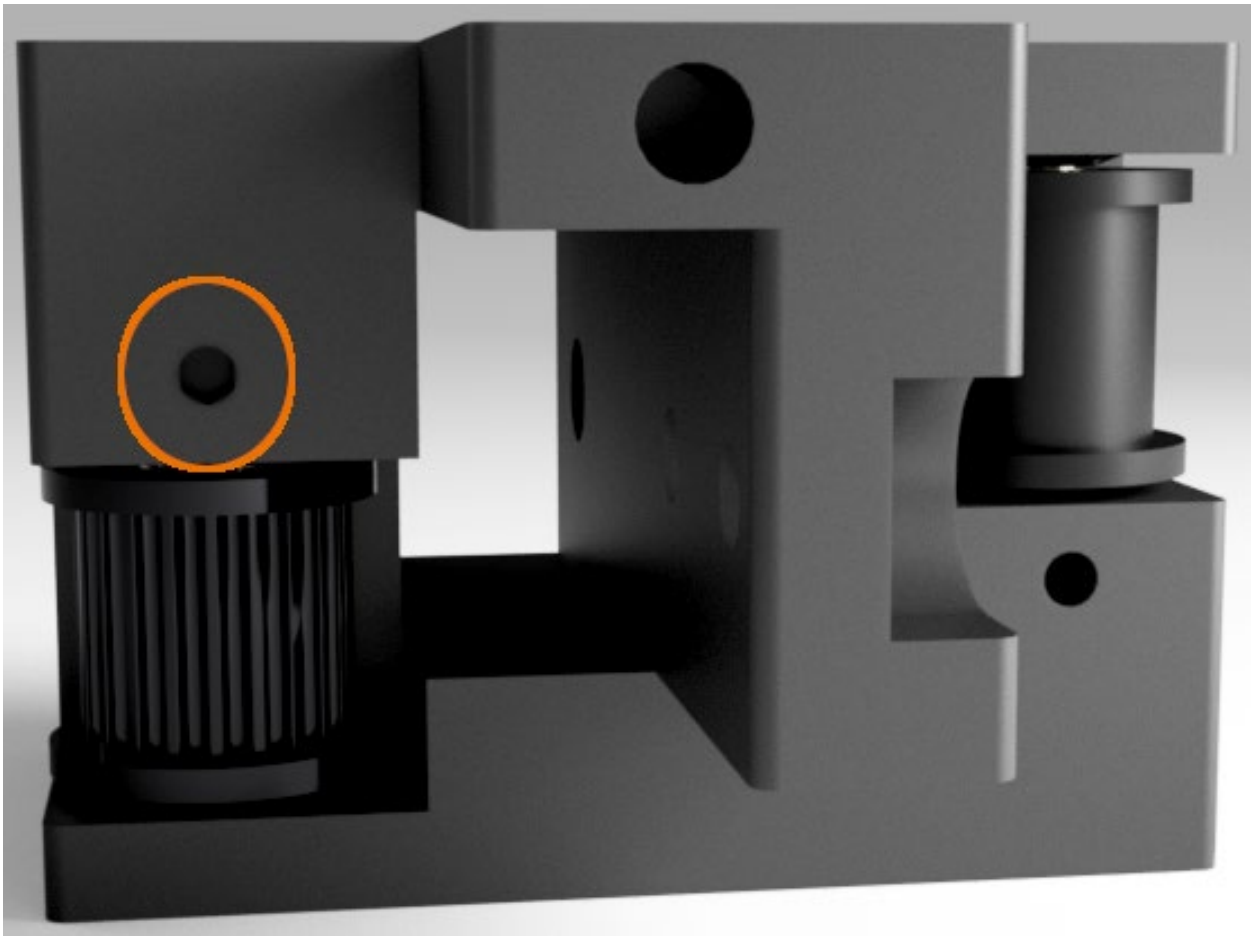
Locate the two Print_Y-Axis_Bracket_Linear_Shaft_Installation_Tool_(1.2).



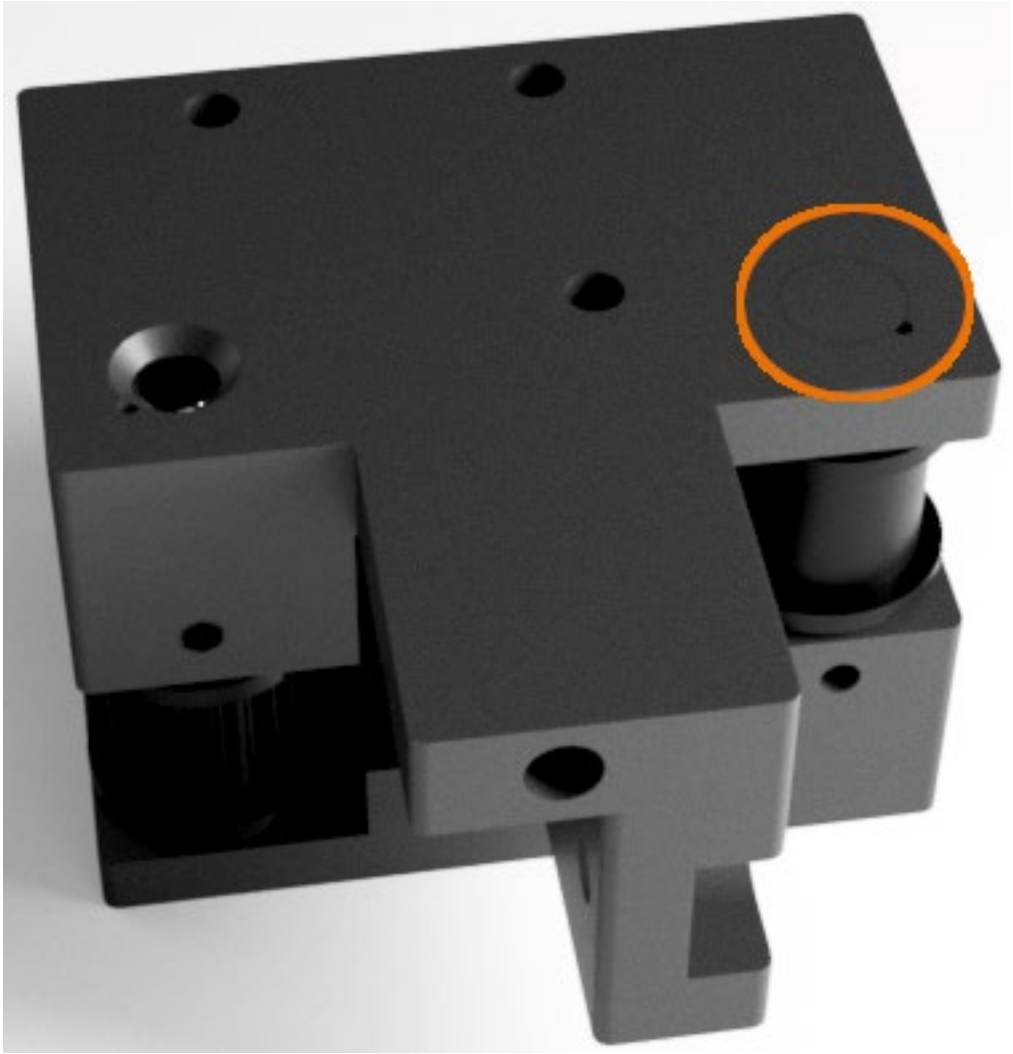
Place one tool in the linear shaft recess of the top bracket assembly as shown below.



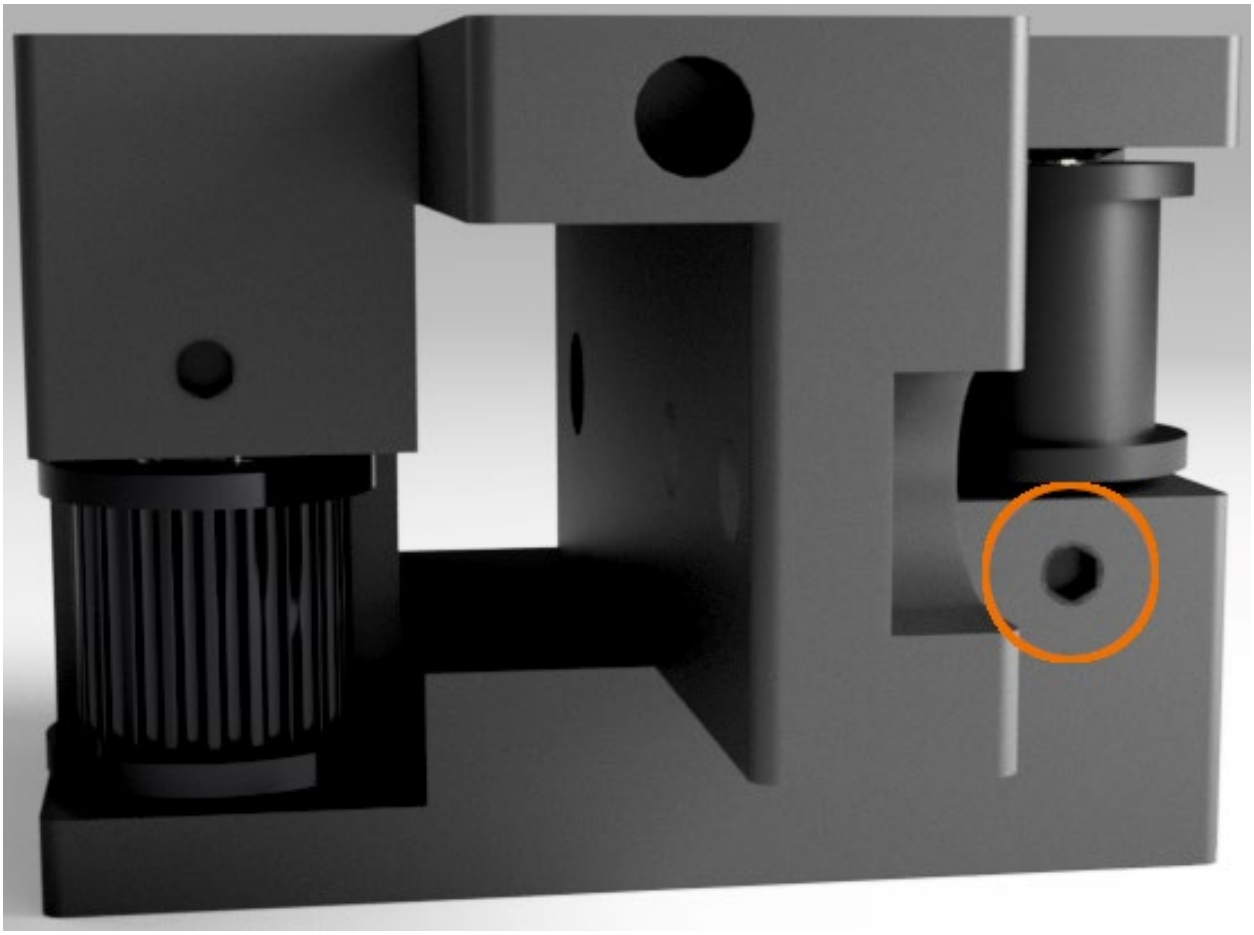
Place the other tool into the recess on the bottom of the bracket assembly and then use your hand vise to clamp the two halves of the bracket assembly together setting the shaft in the proper centered position. Install a DIN916_M3_5mm_Set_Screw into the tapped hole as shown below.



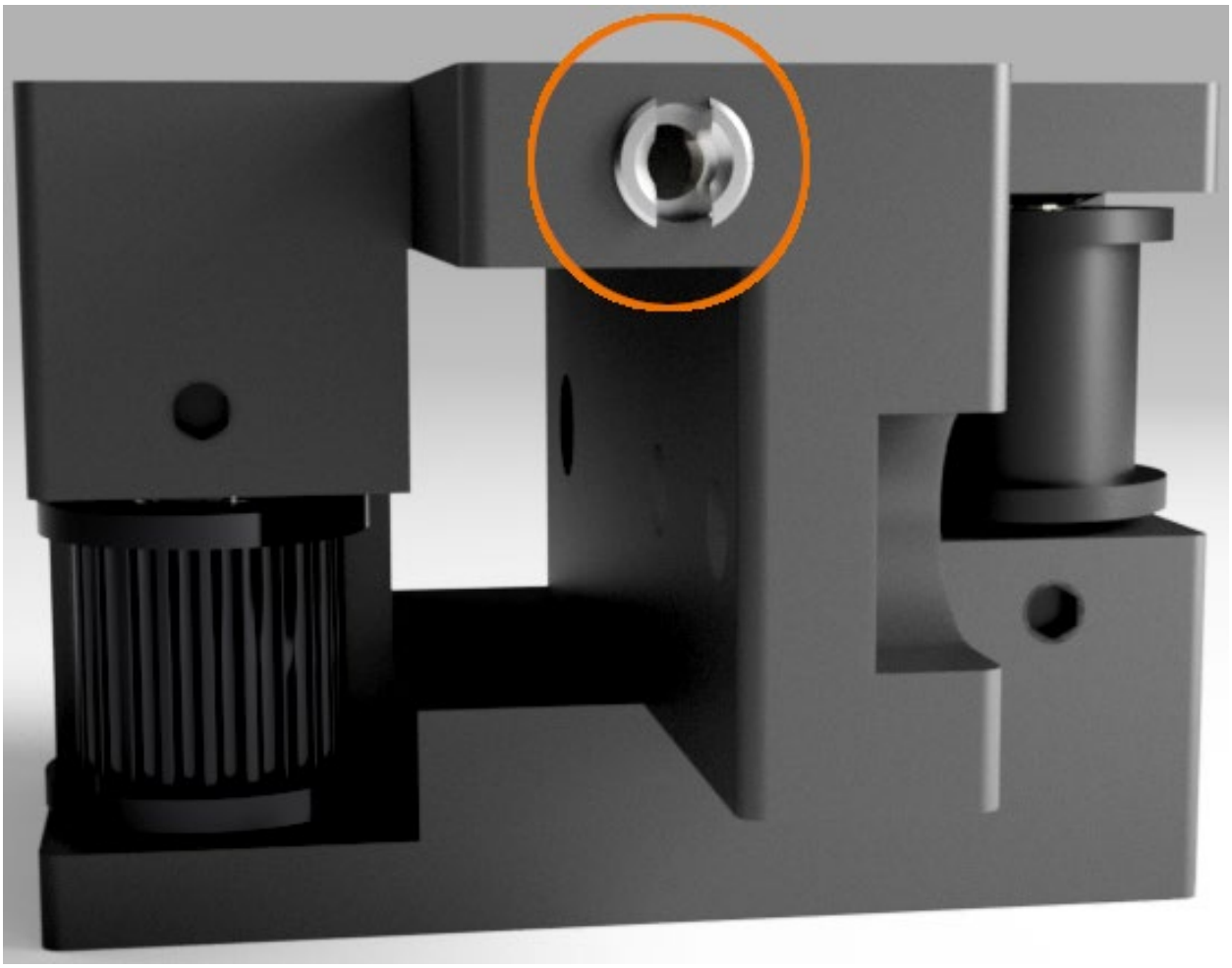
Remove the hand vise and the linear rail installation tools. Move the linear installation tools to the corresponding positions of the other linear rail in the bracket assembly.



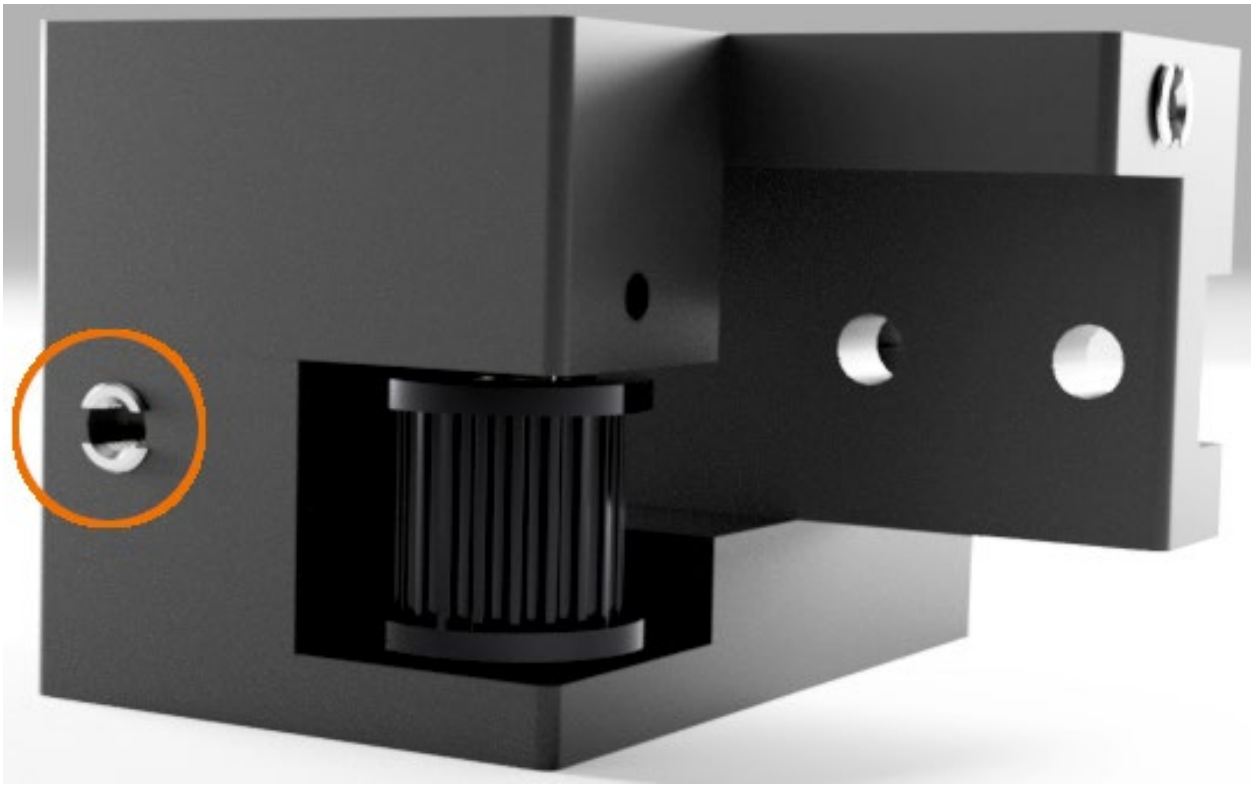
Again, use your hand vise to press the two halves of the bracket assembly together and set the centered position of this linear shaft. Install another DIN916_M3_5mm_Set_Screw into the tapped hole as shown below.



Remove the hand vise and the linear rail installation tools. Install a M5_Magnet_Set_Screw into the location designated below.

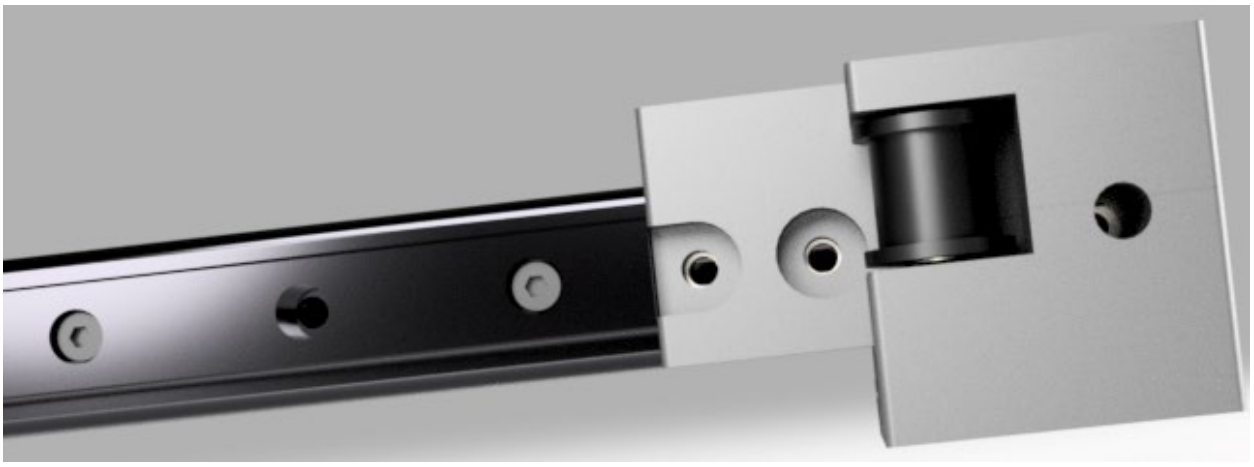


Install another M5_Magnet_Set_Screw into the location designated below.

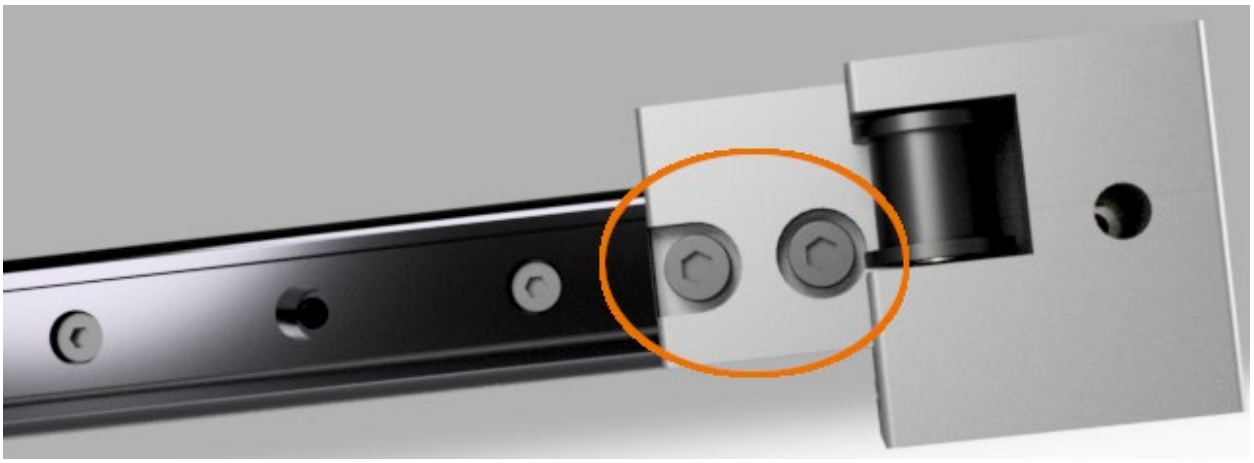


Install three Tnut_20Series_M4 into the X-Axis linear rail assembly as shown below.

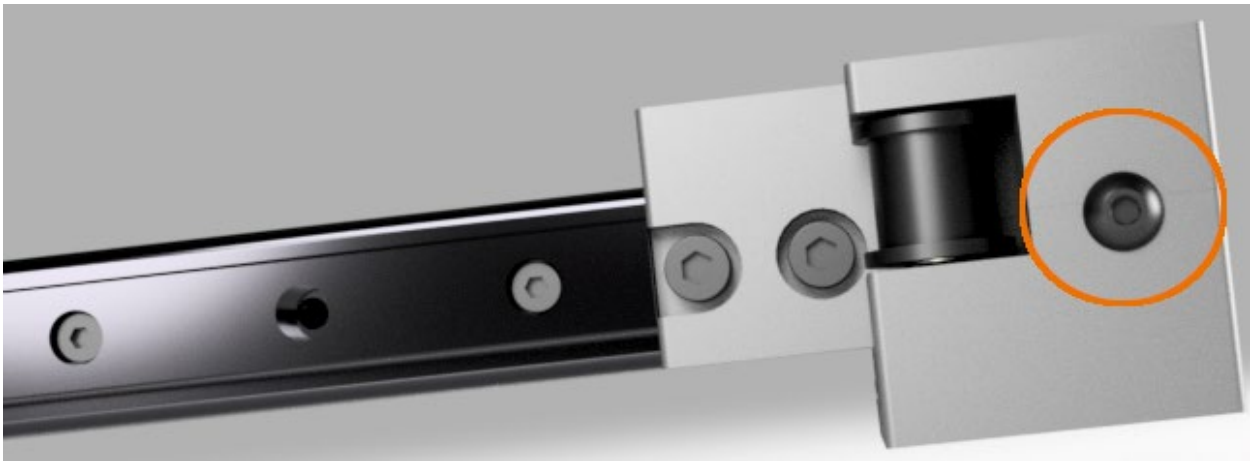
Slide the assembled Y-Axis Bracket Front onto the X-Axis linear rail assembly and line the holes in the roll-in nuts with the holes in the printed assembly.



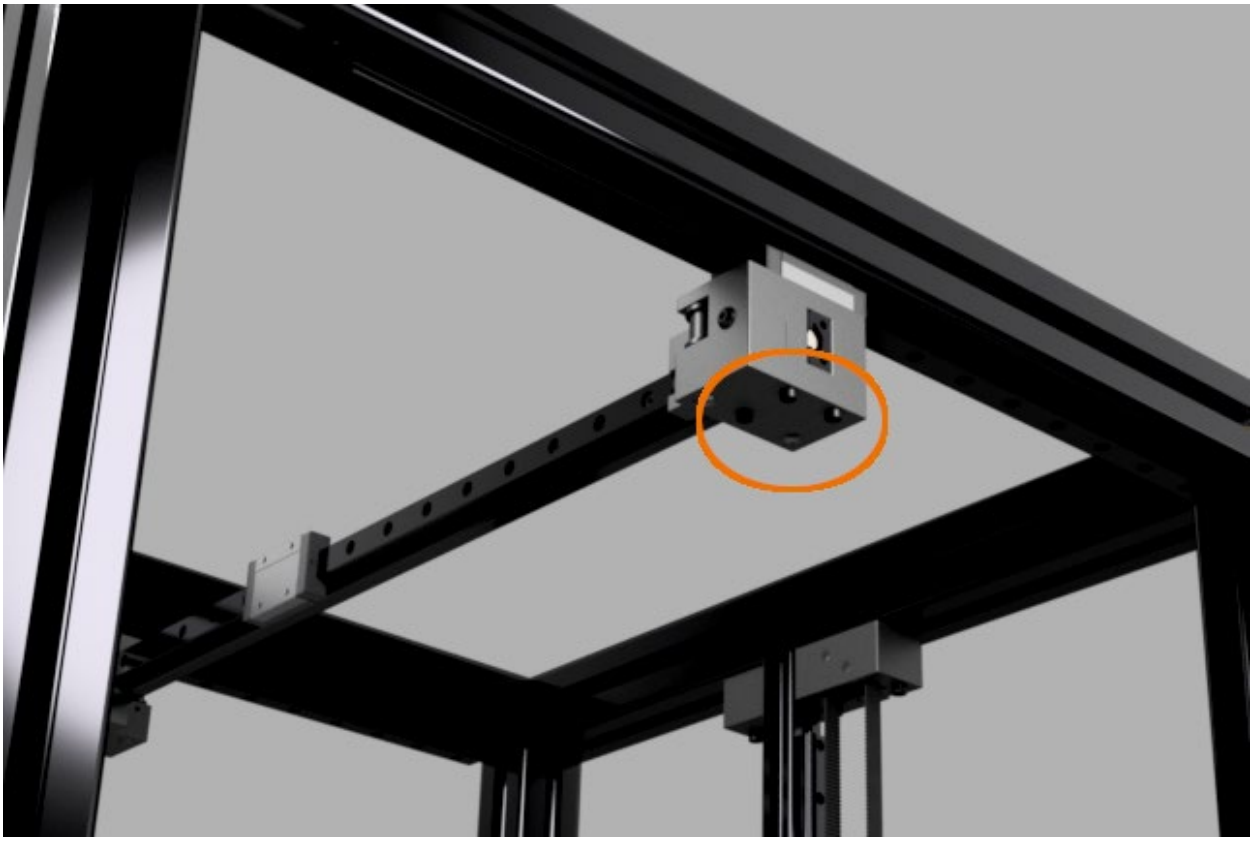
Install two DIN912_M4_10mm_SHCS into the locations shown below and fully tighten.



Install a ISO7380_M4_30mm_BHHS into the location shown below and fully tighten.



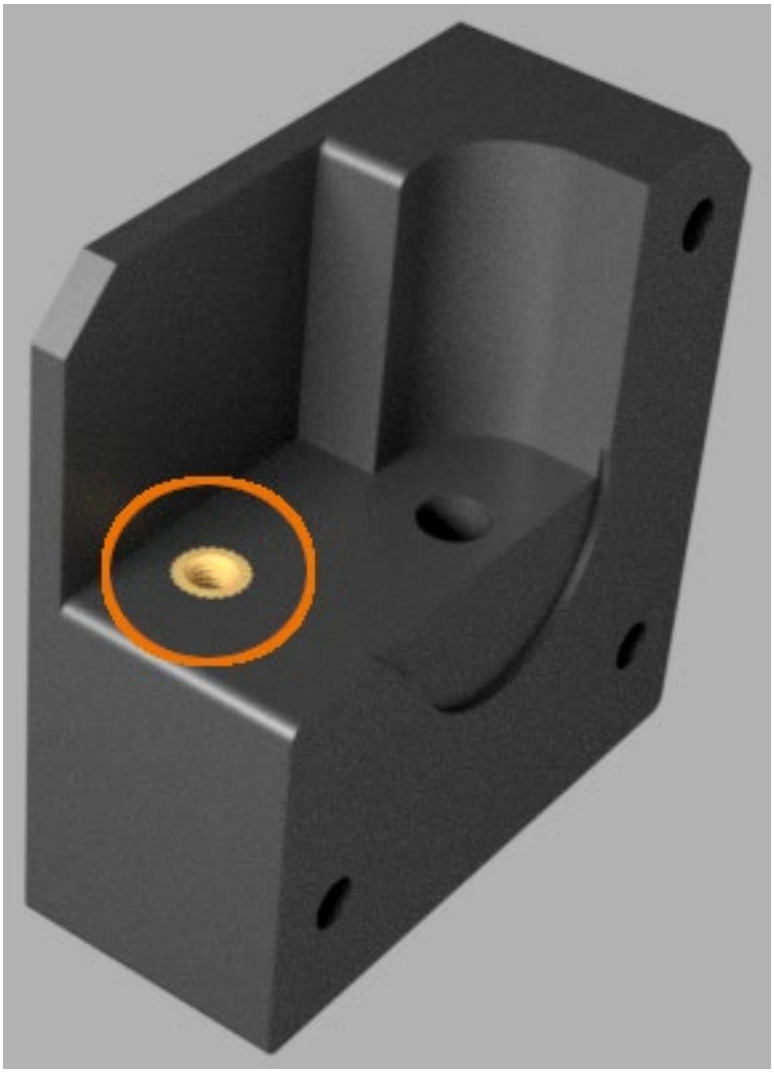
Position the assembled X-Gantry inside of the machine frame with the linear rail facing the left side of the machine. Remove the blue painters tape from the MGN-12 linear rail cartridge of the front Y-Axis rail (if previously installed) and line it up to the front Y-Axis bracket of the X-Gantry. Secure the bracket to the gantry with three DIN912_M3_40mm_SHCS.



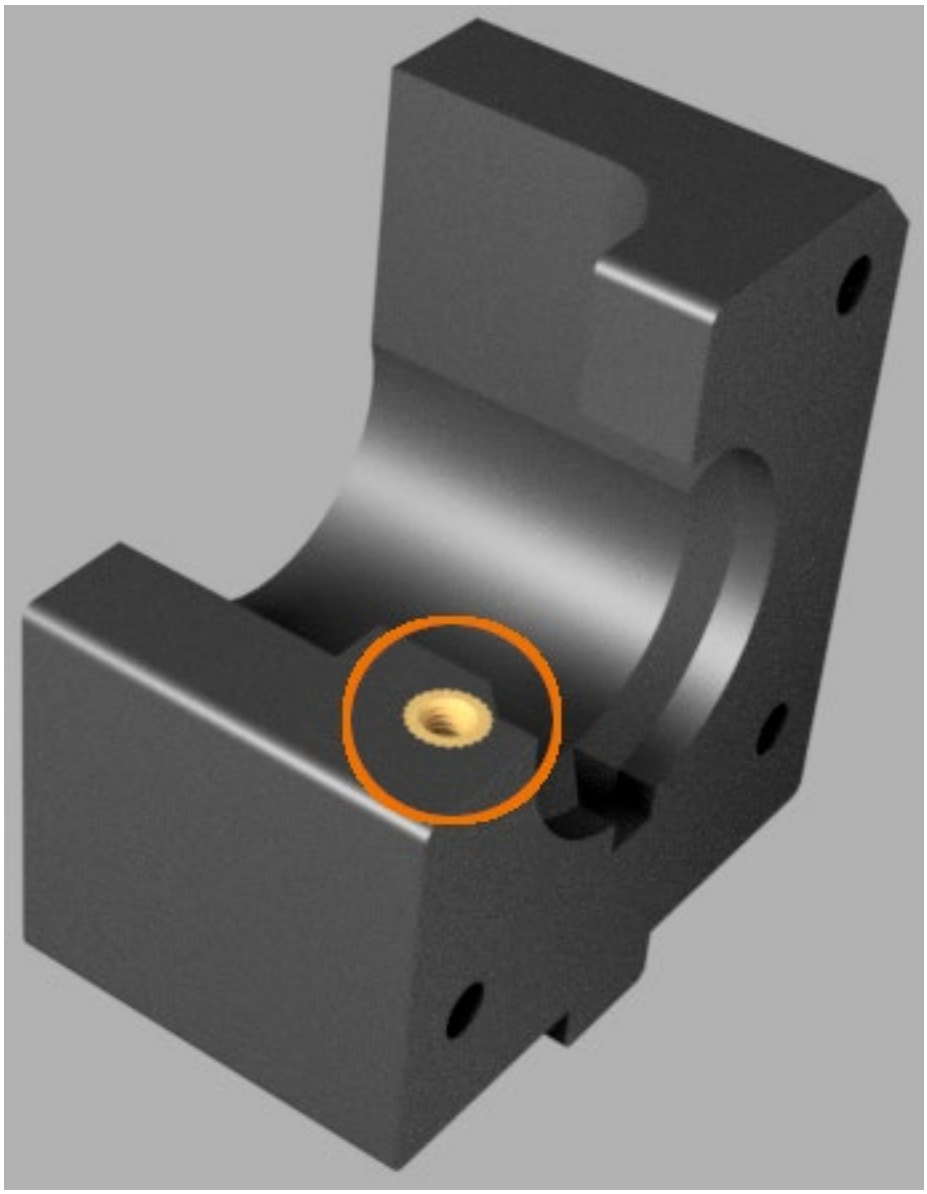
Remove the blue painters tape from the MGN-12 linear rail cartridge of the rear Y-Axis rail (if previously installed) and line it up to the rear Y-Axis bracket of the X-Gantry. Secure the bracket to the gantry with three DIN912_M3_40mm_SHCS.

Step 4 – XY-Axis Motors

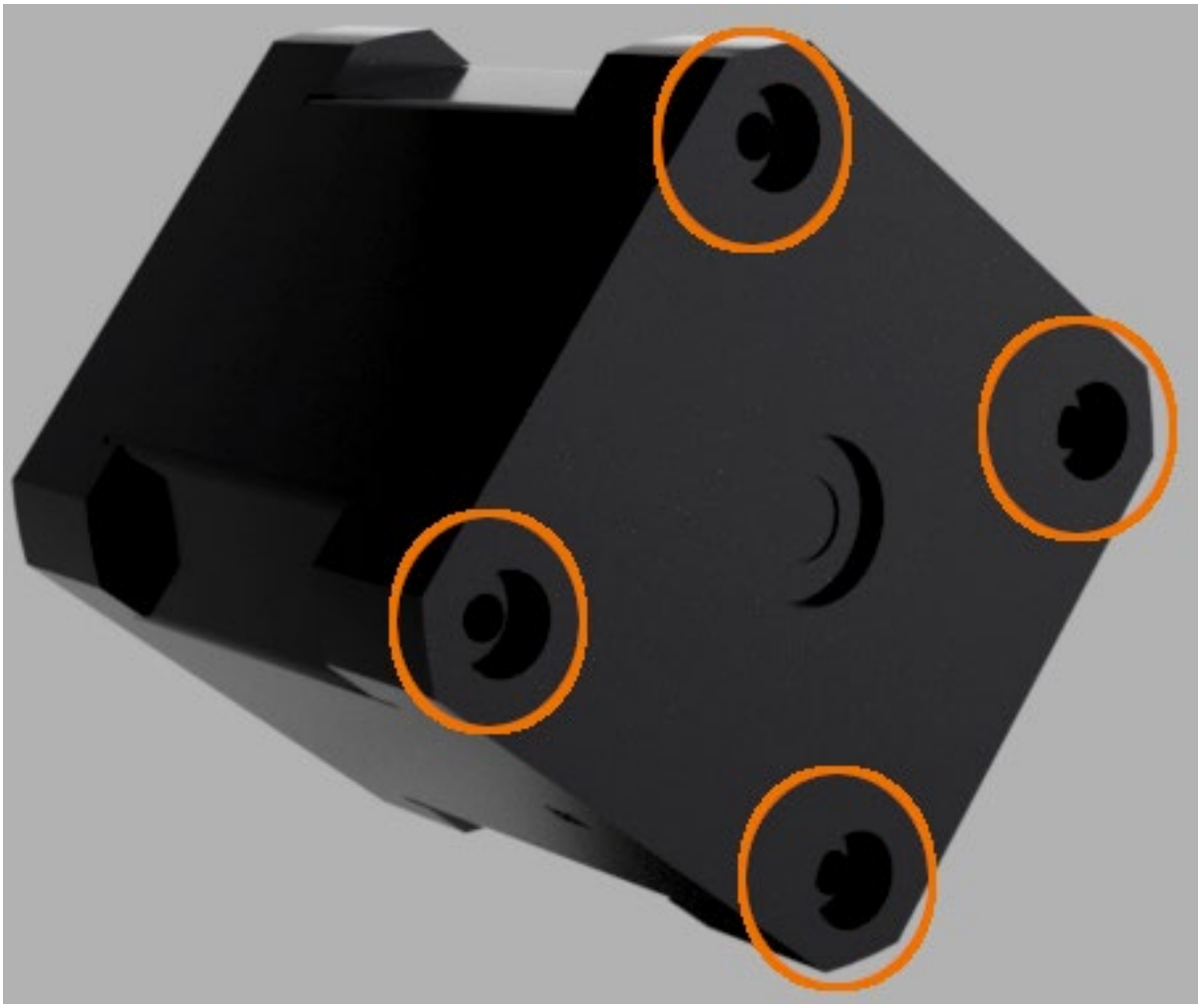
Locate Print_XY-Axis_Motor_Bracket_Front_Part01 and install a M3_4.6x4mm_Heat_Set_Insert into the location shown below.



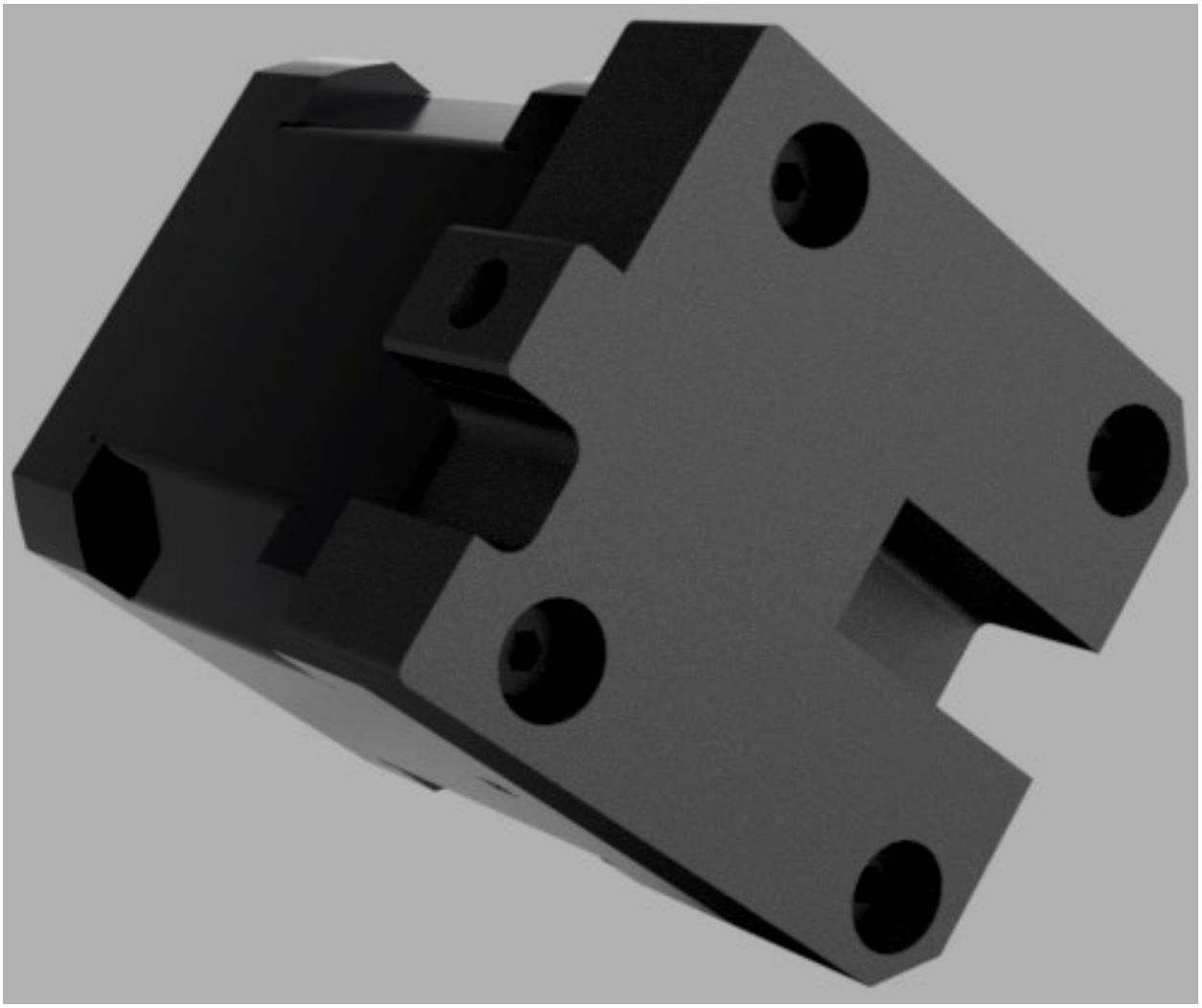
Locate Print_XY-Axis_Motor_Bracket_Front_Part02_CE and install a M3_4.6x4mm_Heat_Set_Insert into the location shown below.



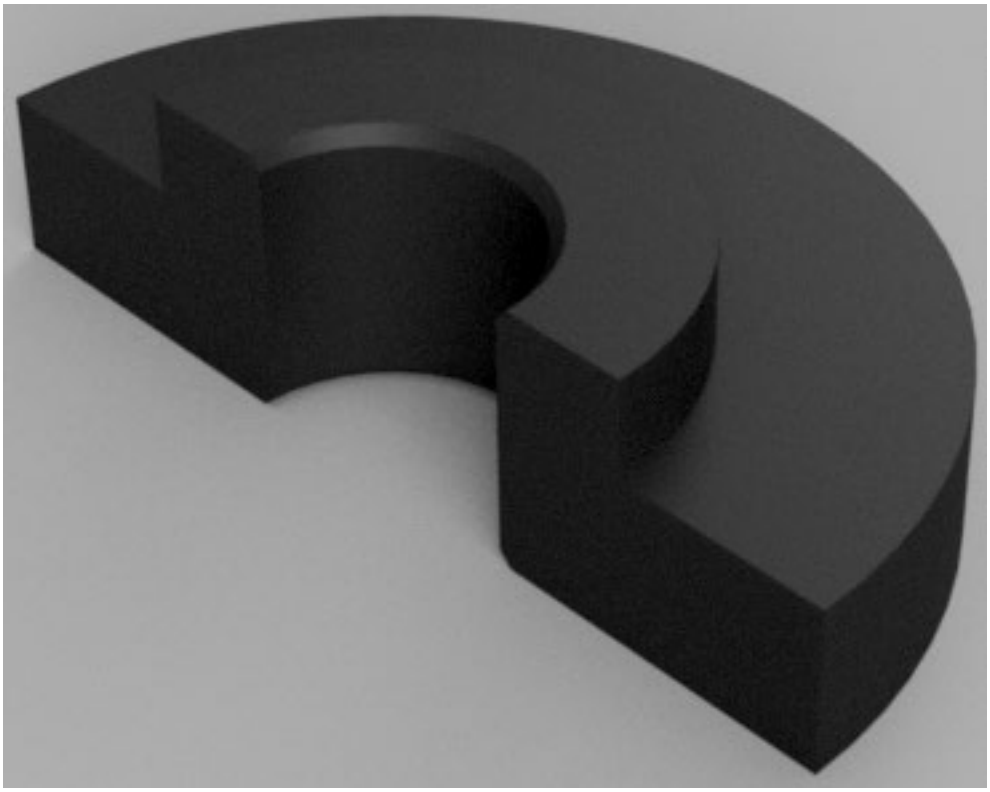
Locate one of the Nema17_47mm motors and remove the four factory installed screws from the bottom of motor. These screws will not be reused.



Place Print_XY-Axis_Motor_Bracket_Front_Part04_CE onto the bottom of the motor and secure with four DIN912_M3_50mm_SHCS as shown. NOTE: Orient the motor with the electrical connector facing down.



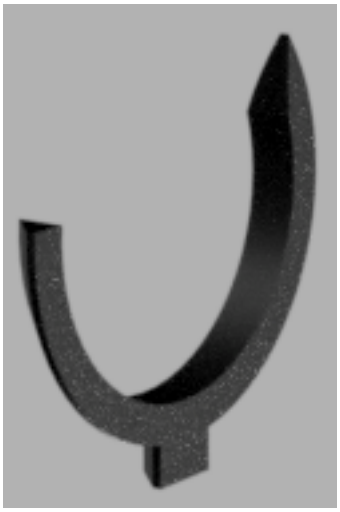
Locate the Print_XY-Axis_Motor_Installation_Tool_(4.75).



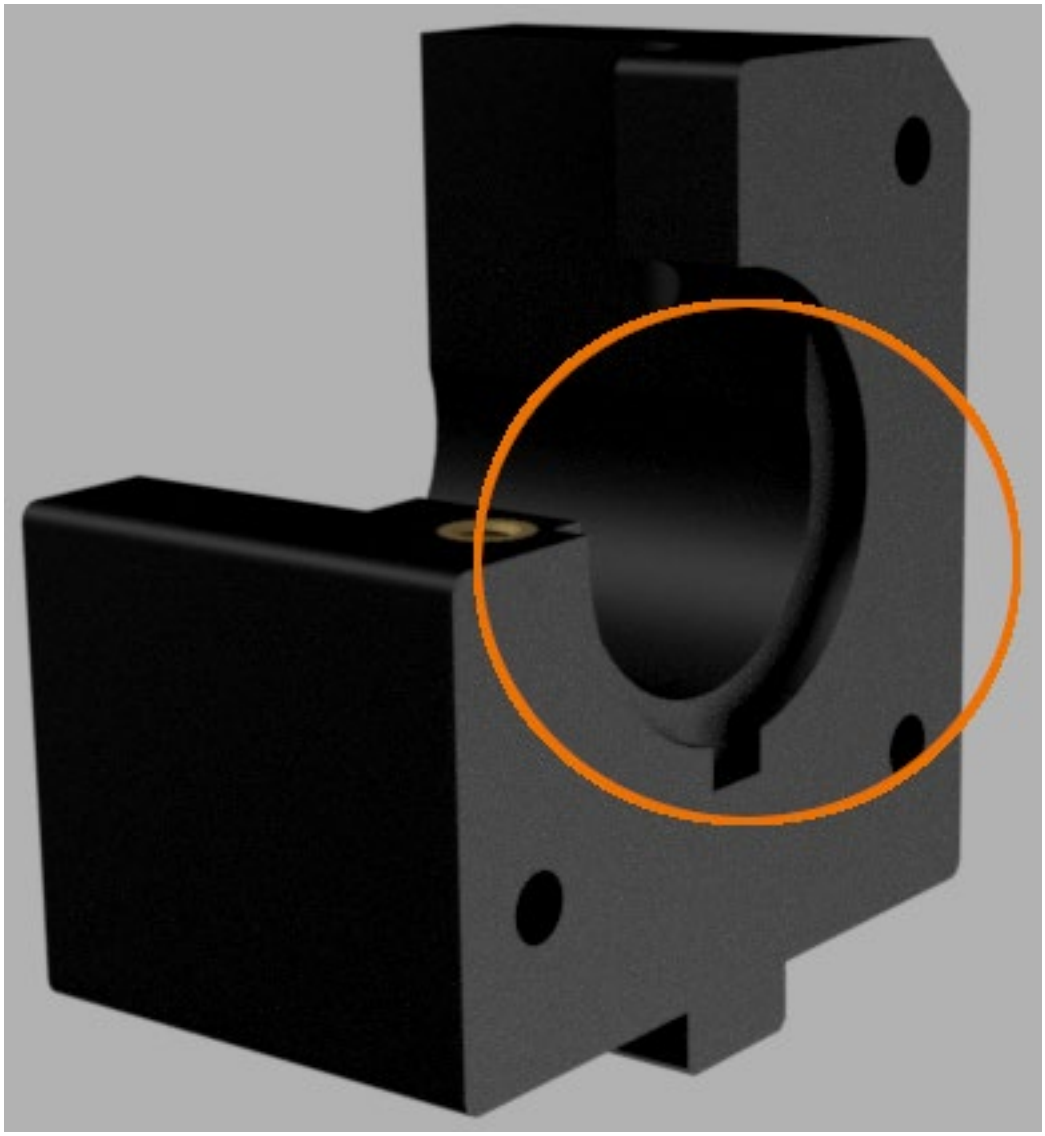
Snap the printed installation tool onto the shaft of the NEMA 17 motor and slide it flush to the base of the motor.

Slide a GT2_20t_Pulley_9mm_Belt_5mm_Bore onto the NEMA 17 motor shaft. Align one of the set screw holes with the flat of the motor shaft. Coat two M4x4mm set screws with medium strength thread locker. Secure the 20t pulley to the NEMA 17 motor shaft with the two M4x4mm set screws securely. Start by securing the set screw facing the flat of the motor shaft. As this screw tightens, wiggle the 20t pulley to assure the flat end of the set screw mates flush with the flat of the NEMA 17 motor shaft. Keep the hub of the 20t pulley tight with the printed Installation Tool to set the proper pulley height. Tighten both M4x4mm set screws completely.

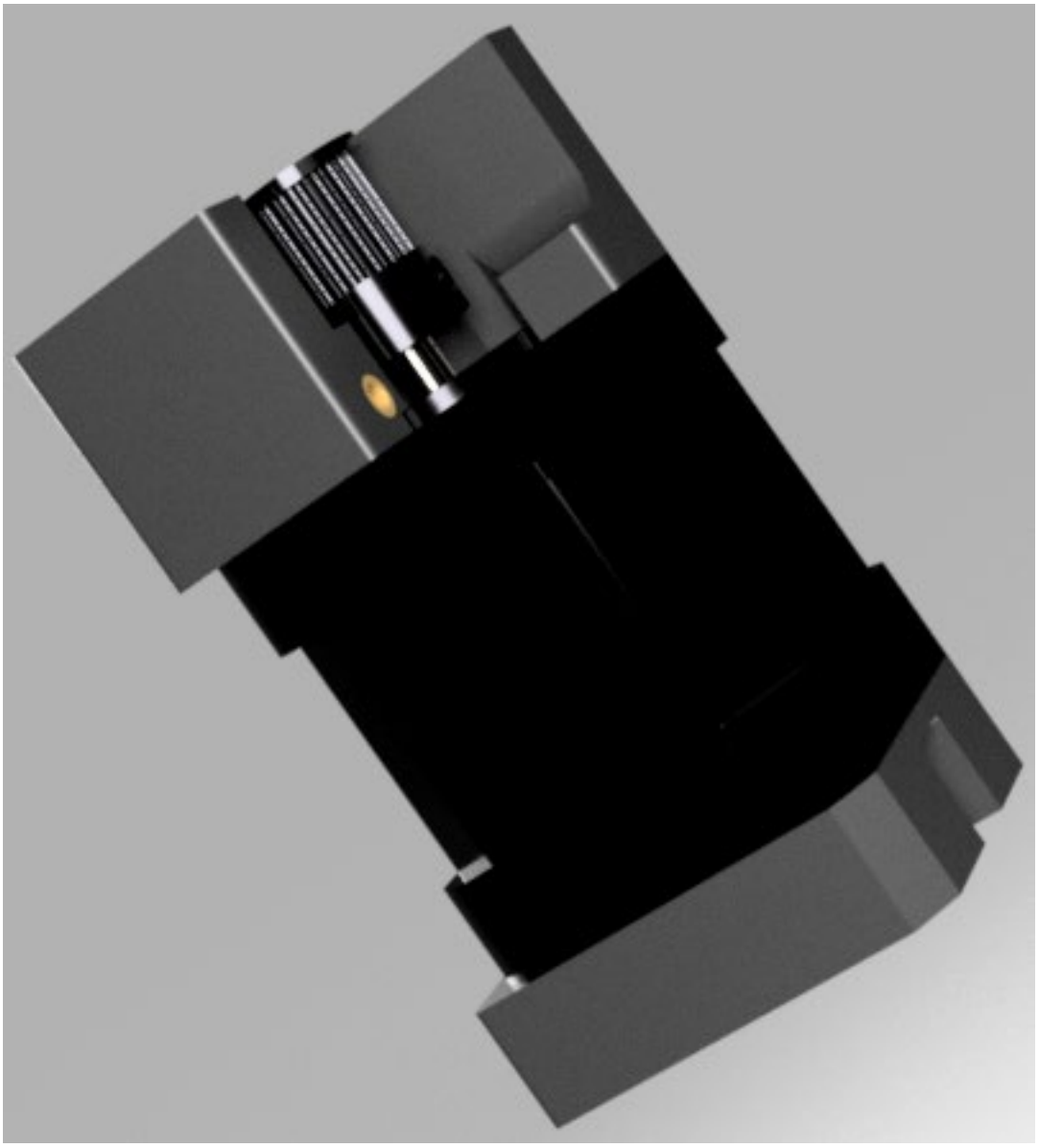
Remove the printed installation tool. Locate a Print_XY-Axis_Motor_Bracket_Front_Part03.



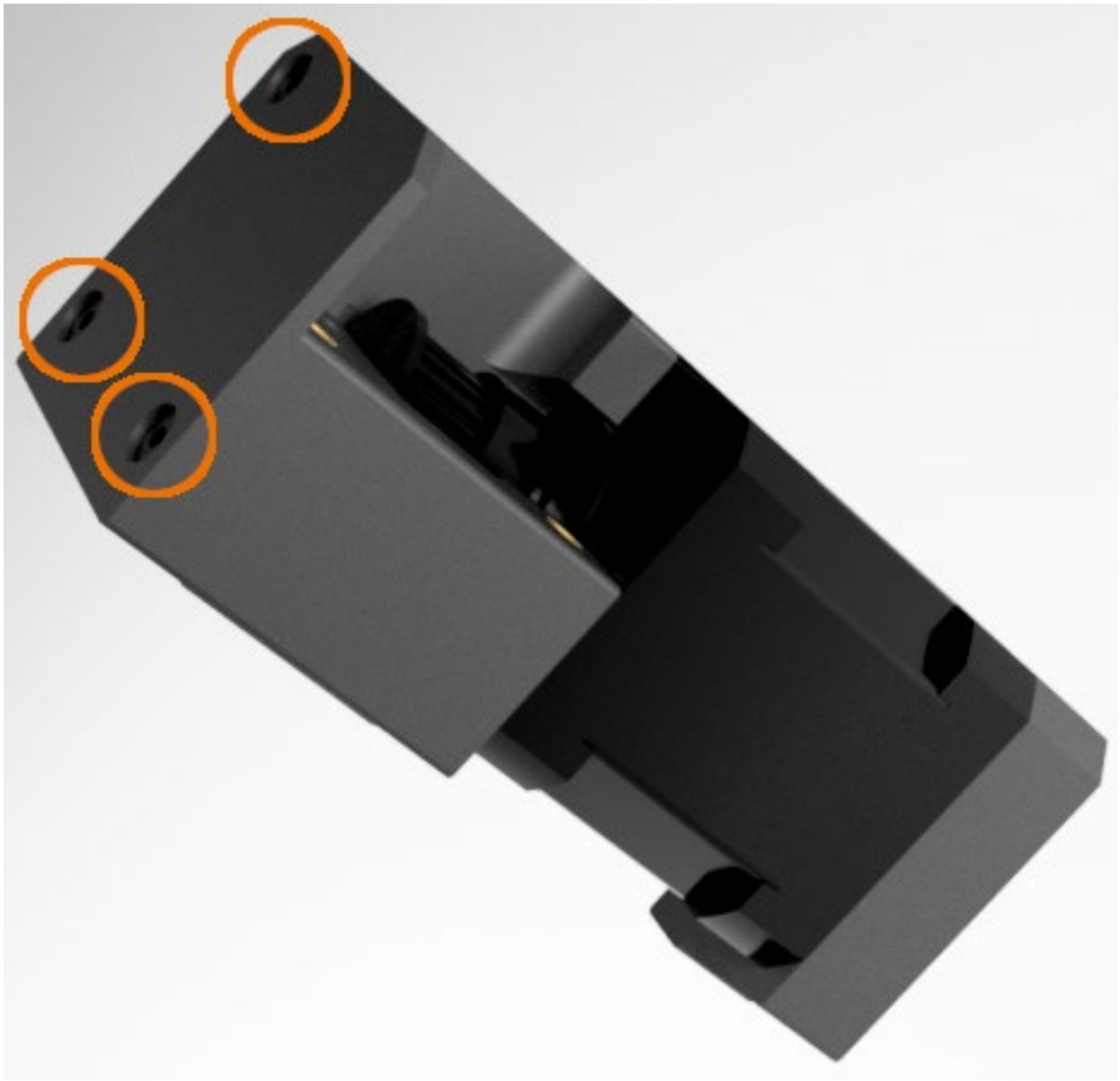
Snap this printed part into Print_XY-Axis_Motor_Bracket_Front_Part02_CE as shown below.



Orient this printed assembly onto the NEMA 17 motor assembly being careful to keep the printed parts together.



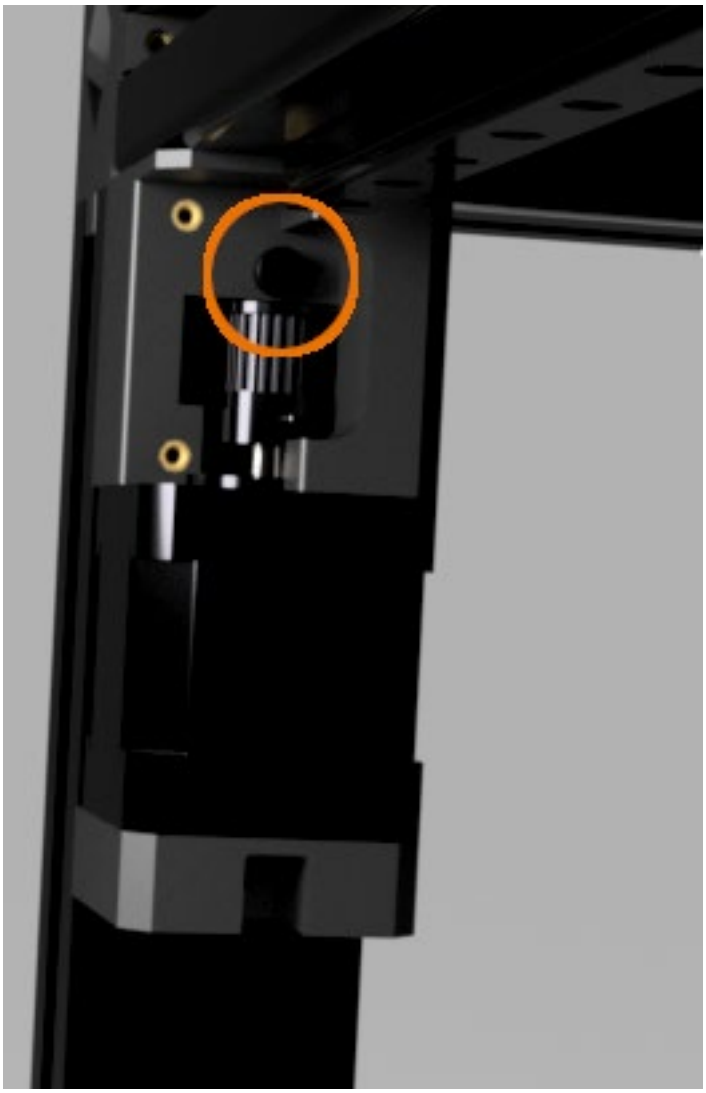
Place Print_XY-Axis_Motor_Bracket_Front_Part01 onto the NEMA 17 motor assembly as shown and secure the printed parts to the motor with three DIN912_M3_45mm_SHCS fully tightening.



Place two Tnut_40Series_M4 into the front left extrusion of the frame as shown below.

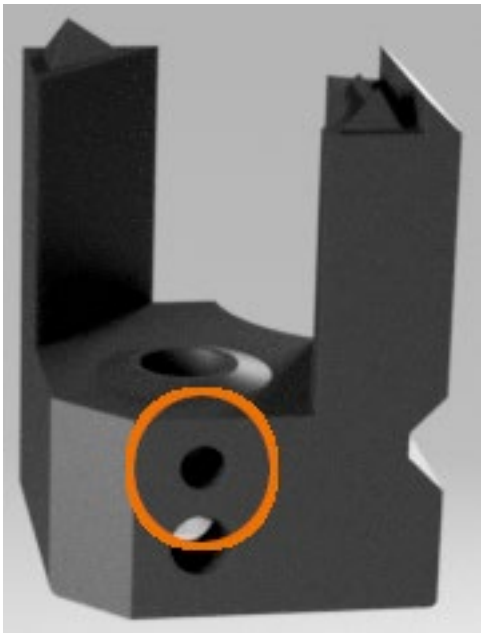
Place the assembled front XY motor onto the extrusion with the tabs at the back of the motor lining up with the roll-in nuts installed in the previous step. The top of the motor should be flush with the top extrusion.

Secure the top of the motor assembly to the frame with a DIN912_M4_35mm_SHCS as shown below.

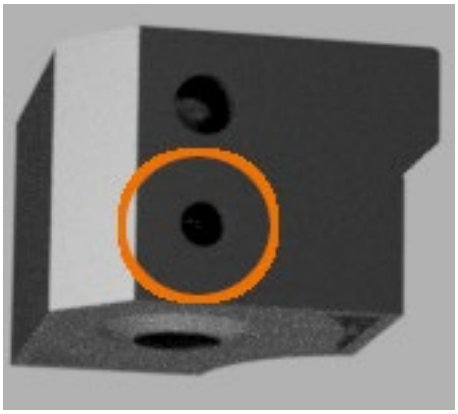


Secure the top of the motor assembly to the frame with another DIN912_M4_35mm_SHCS as shown below.

Locate Print_XY-Axis_Motor_Bracket_Front_Part05 and tap M3 threads into the specified hole below.

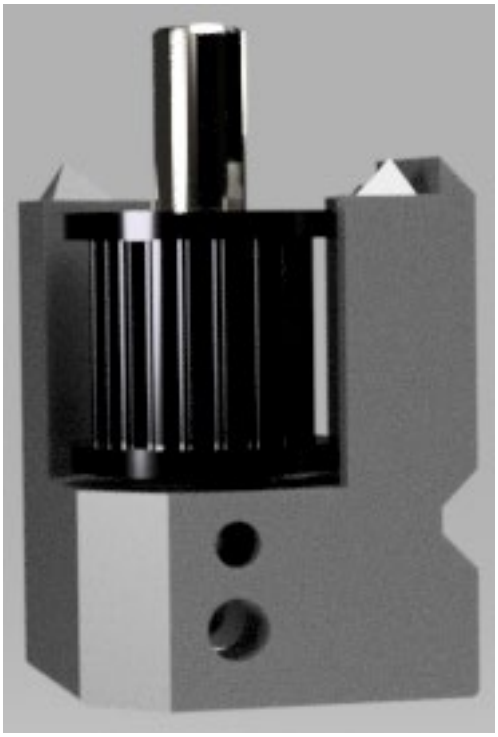


Locate Print_XY-Axis_Motor_Bracket_Front_Part06 and tap M3 threads into the specified hole below.

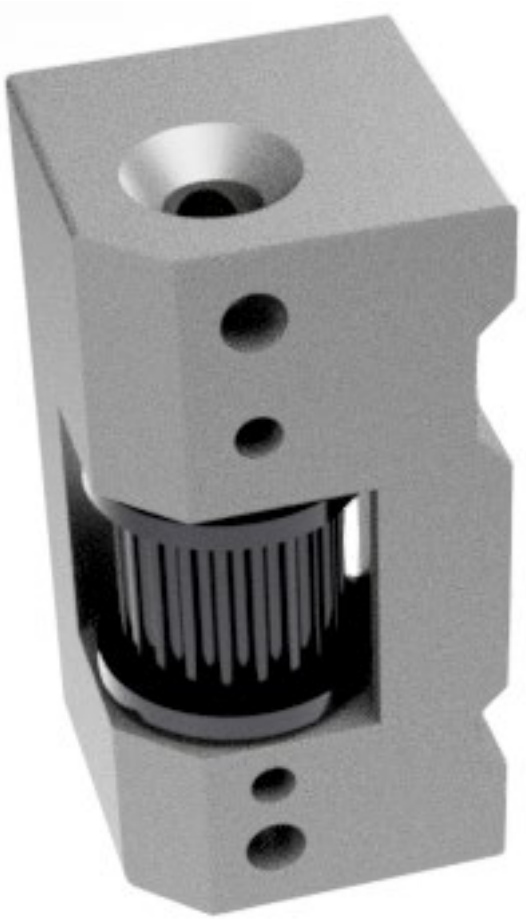


Gather two Linear_Shaft_5x30mm and two GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore. Slide a GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore onto one of the linear shafts. If the pulley seems too difficult to install, first try to install the pulley from the other end of the linear shaft. If the resistance is still too great, put the linear shaft in your electric drill chuck and pinch a small piece of fine grain sandpaper (2000 or higher) around the end of the linear shaft while you operate the drill for a few seconds. It is not necessary to sand both ends of the shaft. The pulley should slide onto the shaft with some resistance, but not excessive force. Do not hammer, pound, or hit your pulleys to install them onto the linear shafts. Each idler pulley contains two very small bearings. Any impact, or even excessive force from pressing with cause flat spots on the bearing balls. This type of bearing damage will cause the bearing to experience resistance during use that results in heat buildup of the bearing, shortening the bearing life, and vibration that can travel through the belts and ultimately into the surface finish of your printing part.

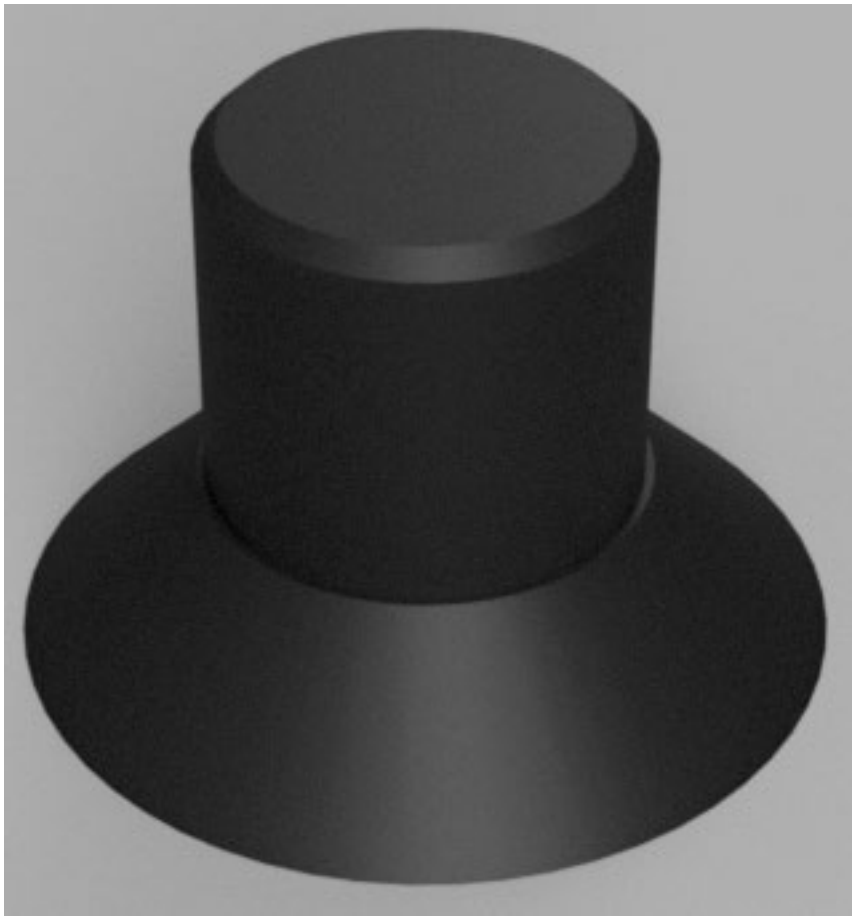
Repeat this for the GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore. Install one of the assembled idler pulleys into Print_XY-Axis_Motor_Bracket_Front_Part05 as shown below.



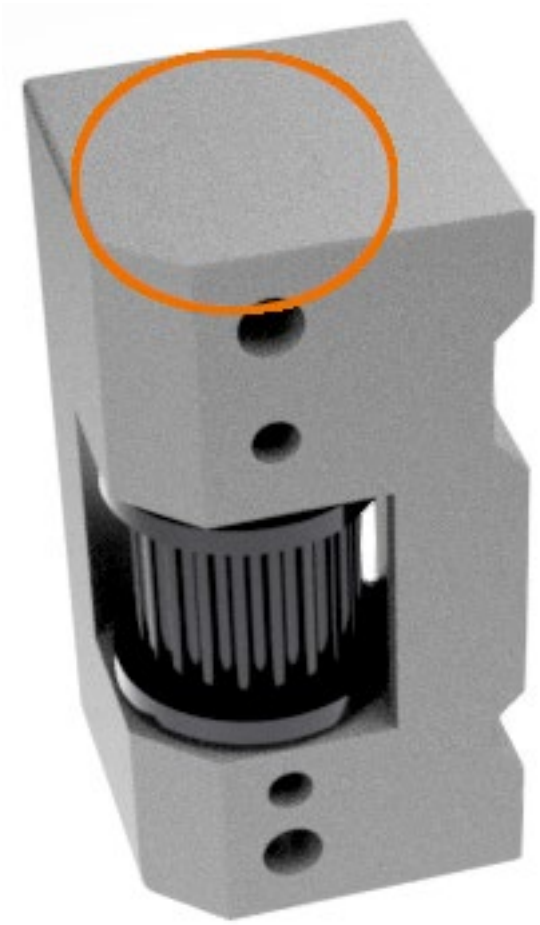
Press Print_XY-Axis_Motor_Bracket_Front_Part06 on to the tensioner assembly as shown below.



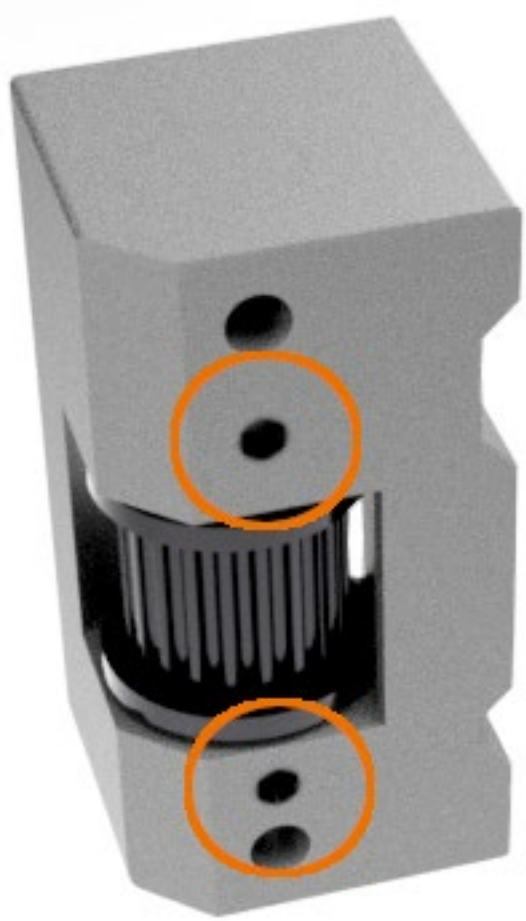
Locate two Print_XY-Axis_Belt_Tensioner_Linear_Shaft_Instal_Tool_(6.15).



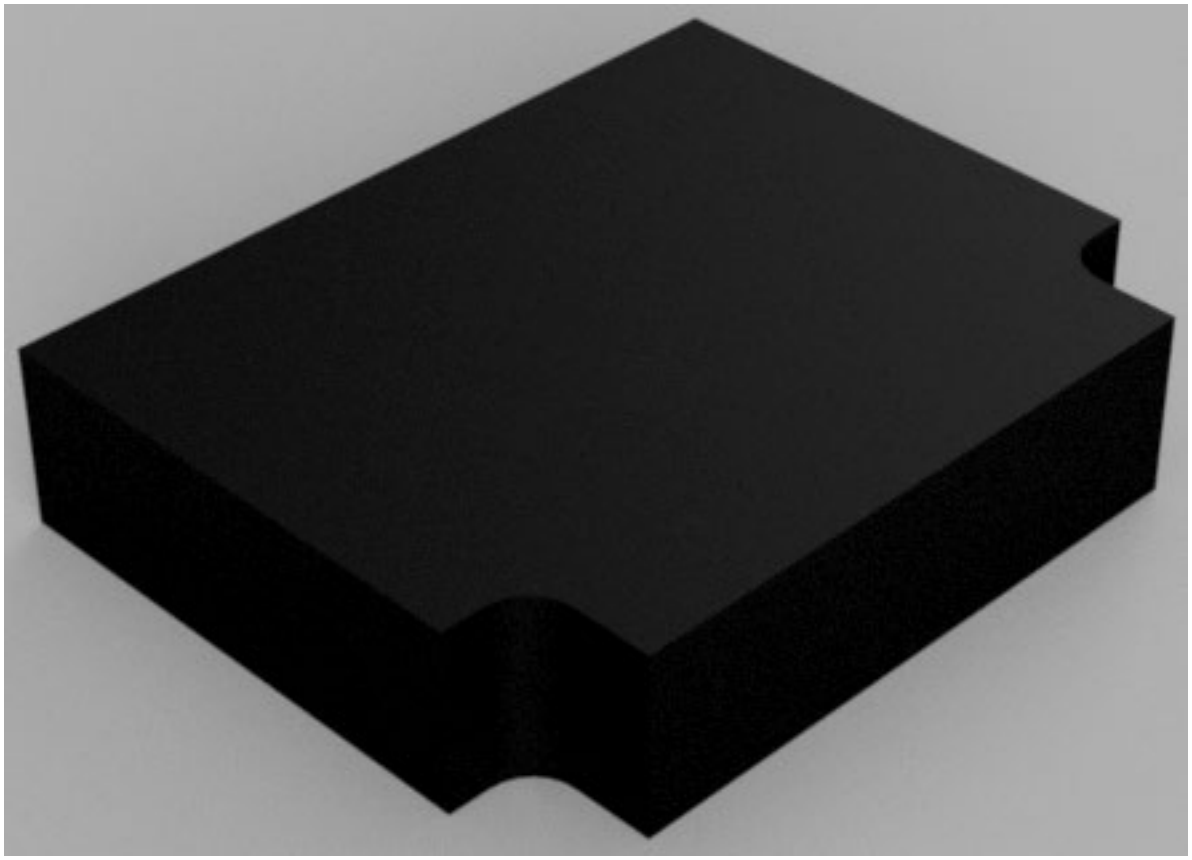
Press one printed installation tool into the top and bottom of the tensioner assembly.



Using your hand vise, compress the two halves of the belt tensioner assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.

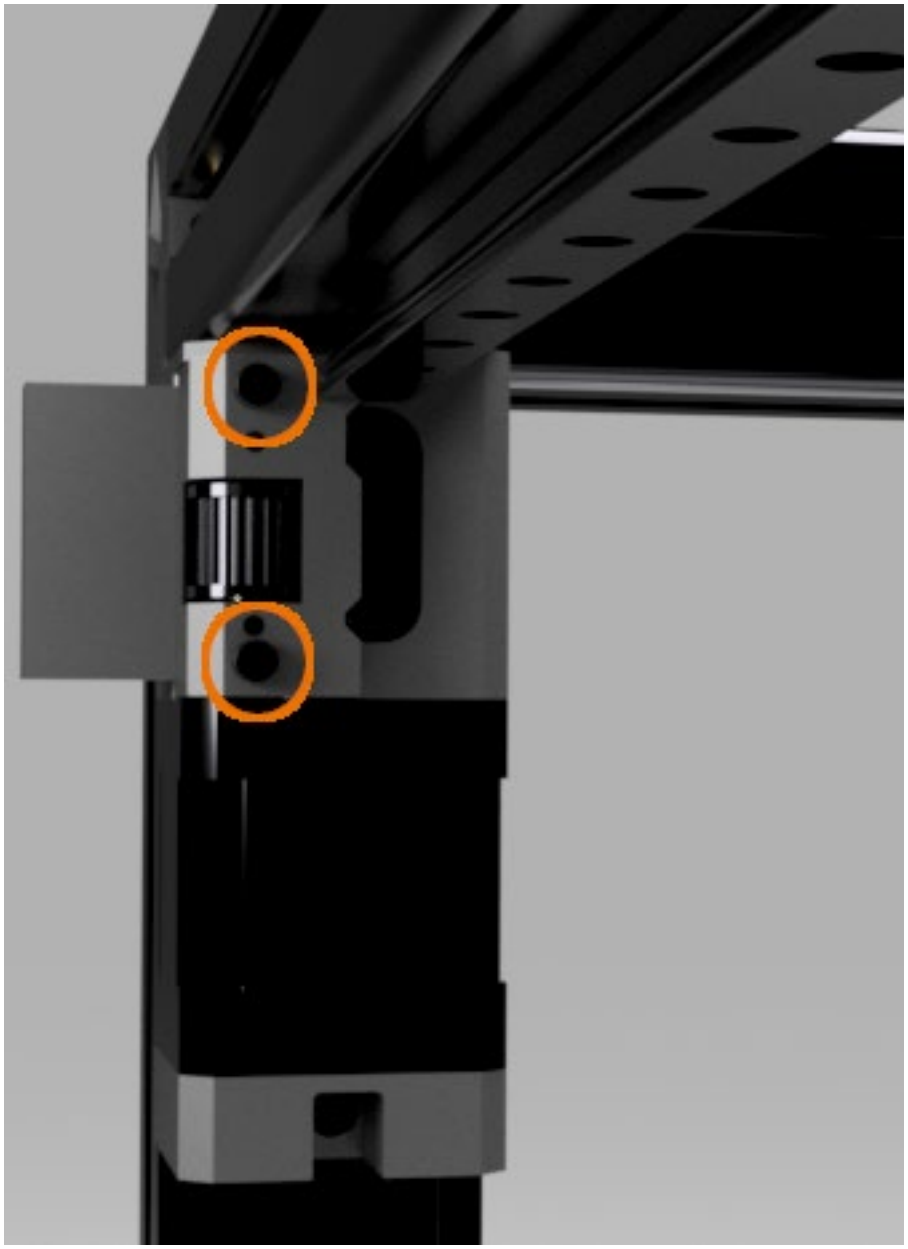


Remove the printed installation tools and the hand vise. Locate Print_XY-Axis_Motor_Pre_Tensioner_Tool_(8.5).

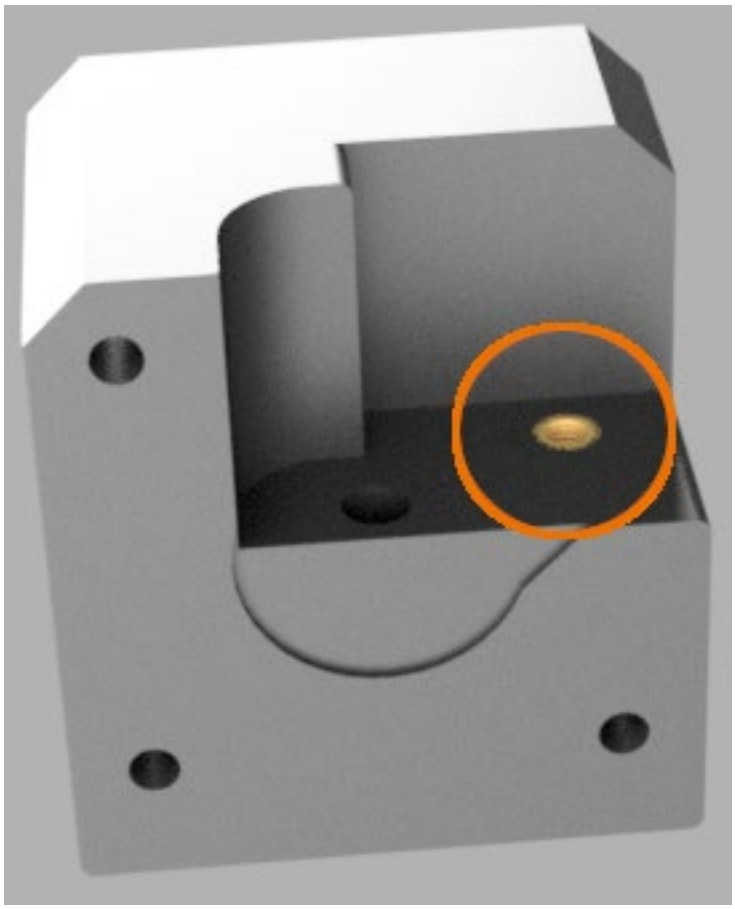


You will use the tool to set the pre-tension gap of the XY-Axis belt tensioners. The tool slips between the motor housing and the tensioner part. This is the position of where you will hold the tool during the pre-tensioning process.

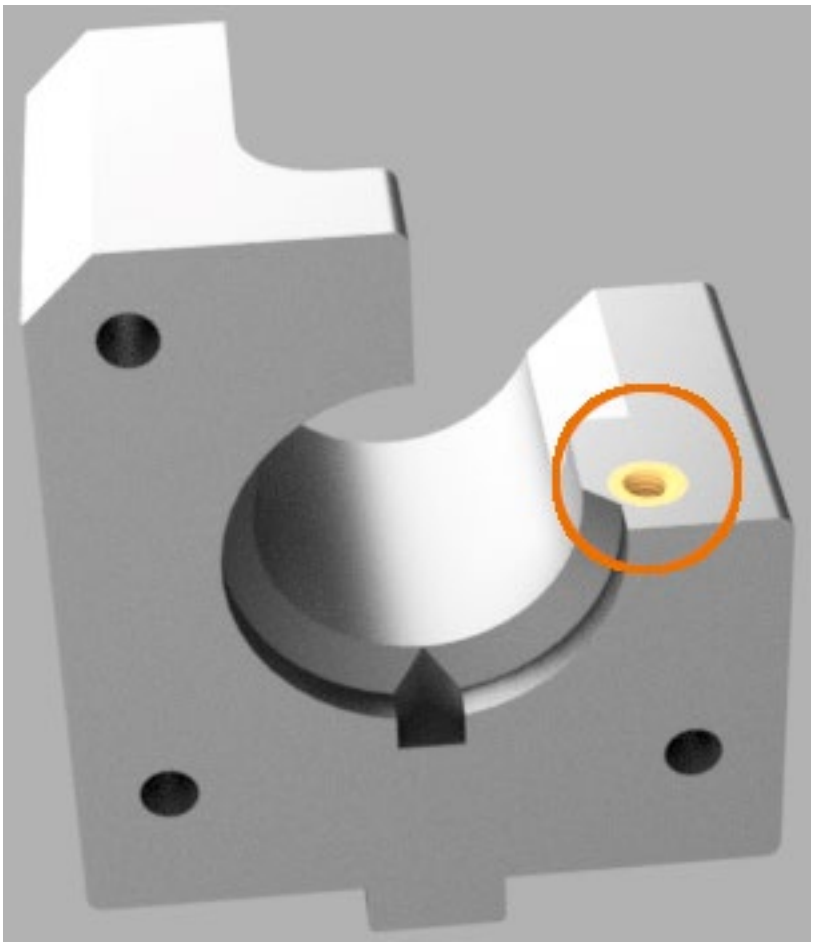
Place the tensioner assembly onto the motor housing and secure it to the housing with two DIN912_M3_35mm_SHCS. Tighten the screws equally until the pre-tensioning tool has some drag when moved. It is more important to try and keep the tensioner parallel to the motor housing than to have the position exact. The final position of the tensioner will occur later during the belt tensioning process.



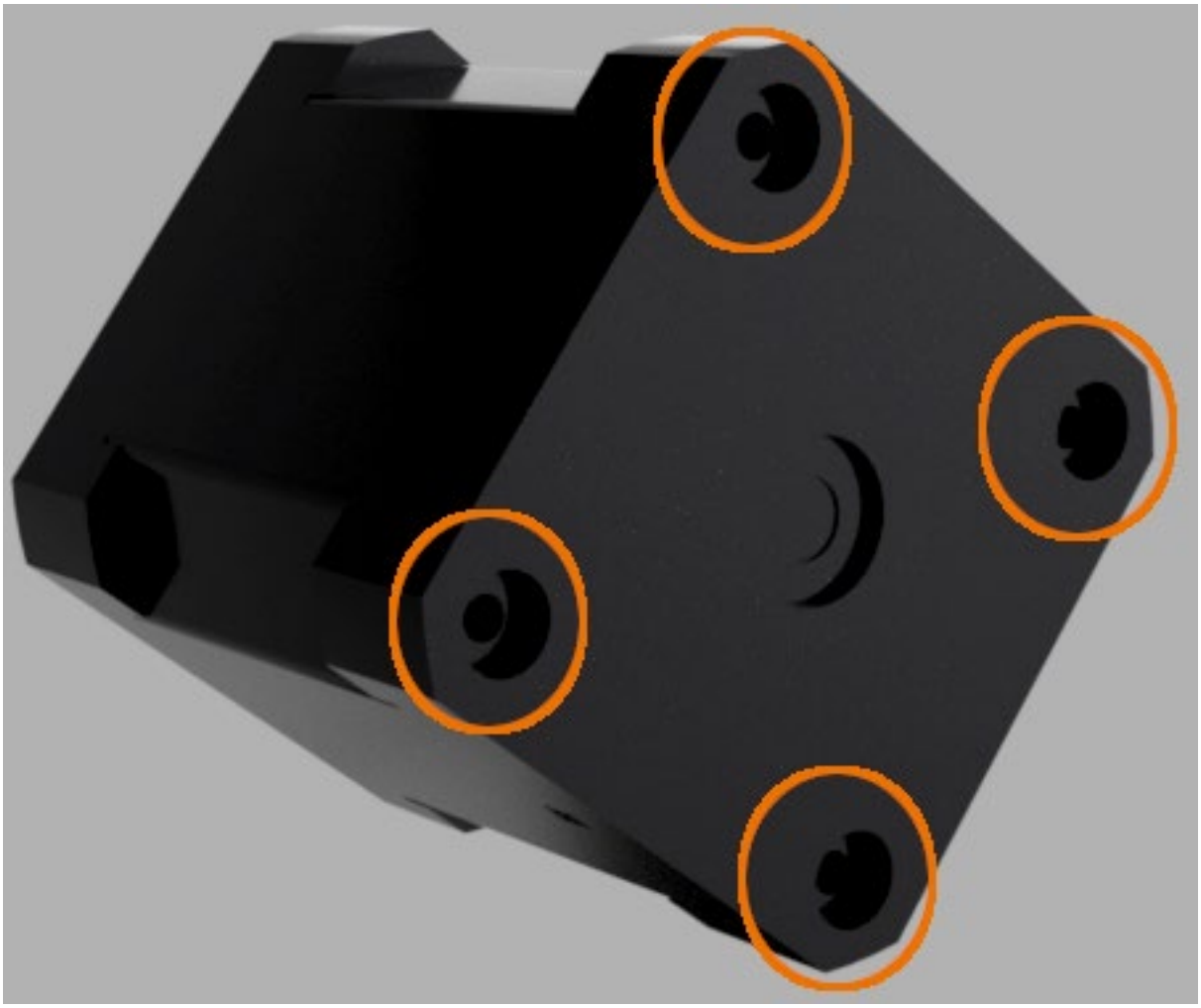
Remove the printed pre-tensioning tool. Locate Print_XY-Axis_Motor_Bracket_Rear_Part01 and install a M3_4.6x4mm_Heat_Set_Insert in the position shown below.



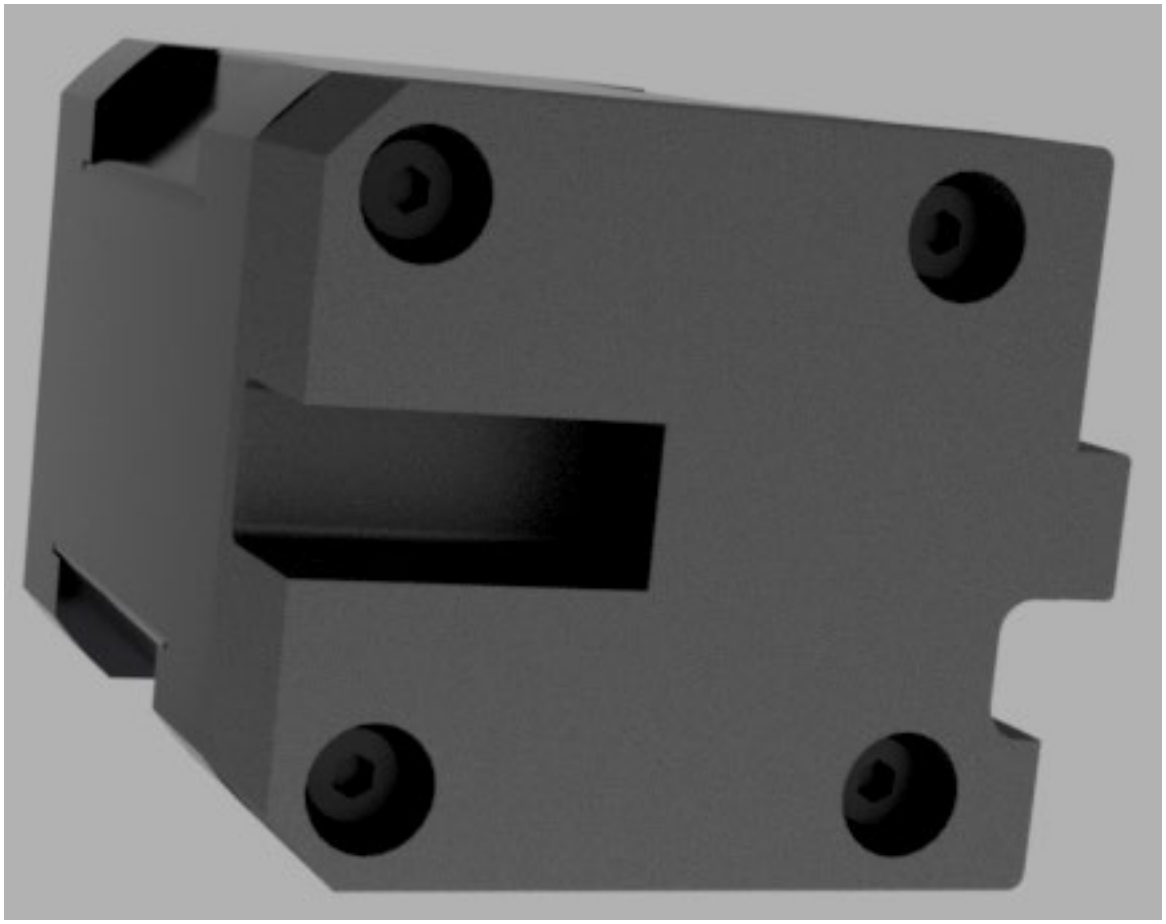
Locate Print_XY-Axis_Motor_Bracket_Rear_Part02_CE and install a M3_4.6x4mm_Heat_Set_Insert in the position shown below.



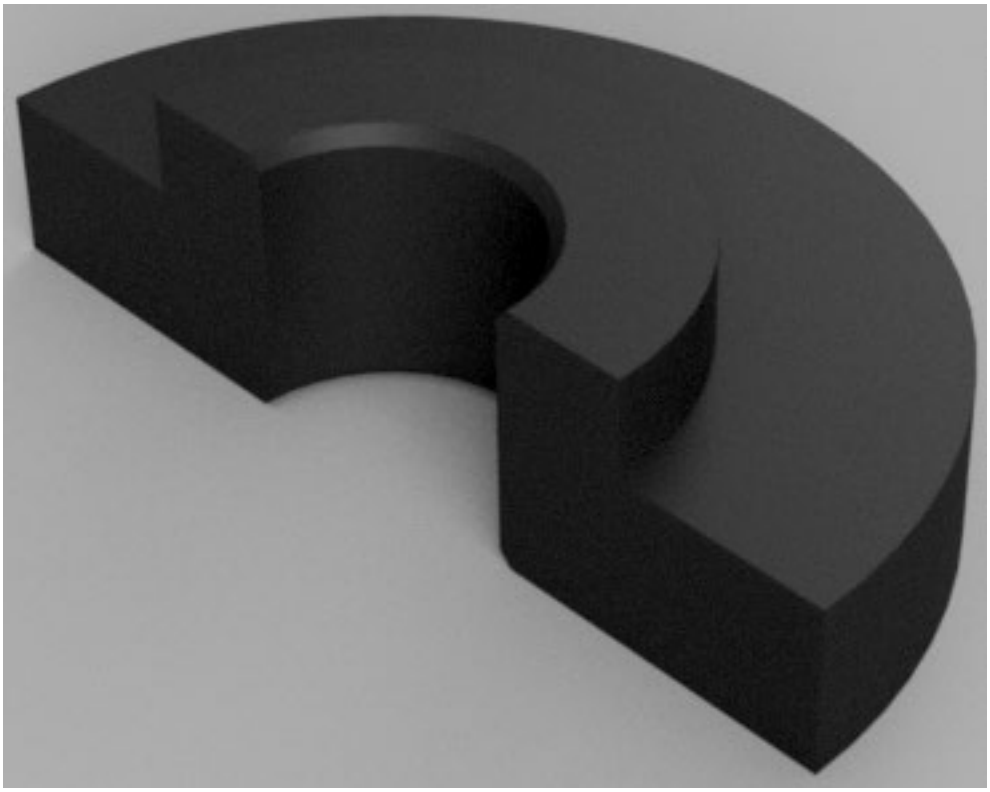
Locate one of the Nema17_47mm motors and remove the four factory installed screws from the bottom of motor. These screws will not be reused.



Place Print_XY-Axis_Motor_Bracket_Rear_Part04_CE onto the bottom of the motor and secure with four DIN912_M3_50mm_SHCS as shown. NOTE: Orient the motor with the electrical connector facing down.



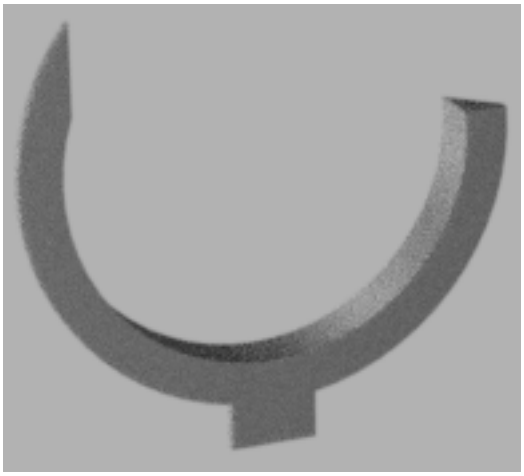
Locate the Print_XY-Axis_Motor_Installation_Tool_(4.75).



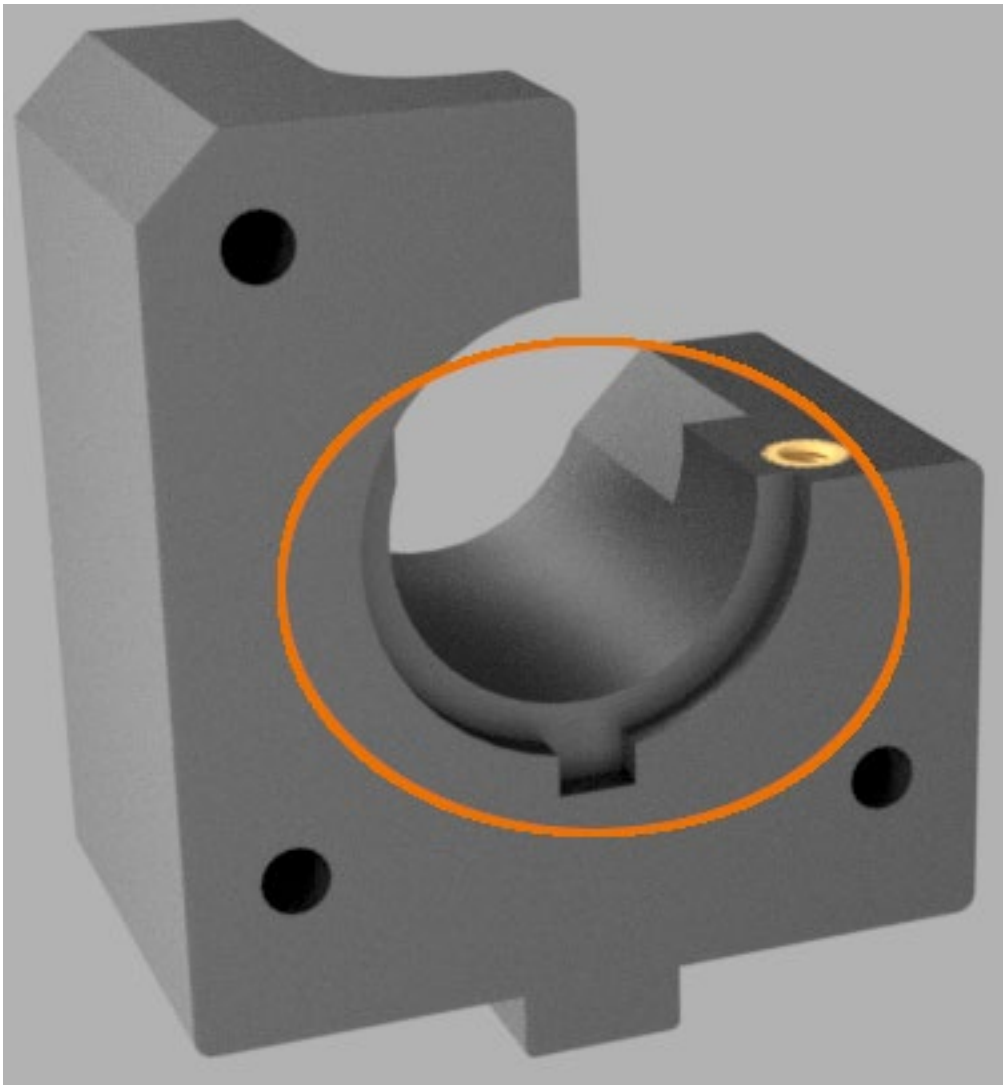
Snap the printed installation tool onto the shaft of the NEMA 17 motor and slide it flush to the base of the motor.

Slide a GT2_20t_Pulley_9mm_Belt_5mm_Bore onto the NEMA 17 motor shaft. Align one of the set screw holes with the flat of the motor shaft. Coat two M4x4mm set screws with medium strength thread locker. Secure the 20t pulley to the NEMA 17 motor shaft with the two M4x4mm set screws securely. Start by securing the set screw facing the flat of the motor shaft. As this screw tightens, wiggle the 20t pulley to assure the flat end of the set screw mates flush with the flat of the NEMA 17 motor shaft. Keep the hub of the 20t pulley tight with the printed Installation Tool to set the proper pulley height. Tighten both M4x4mm set screws completely.

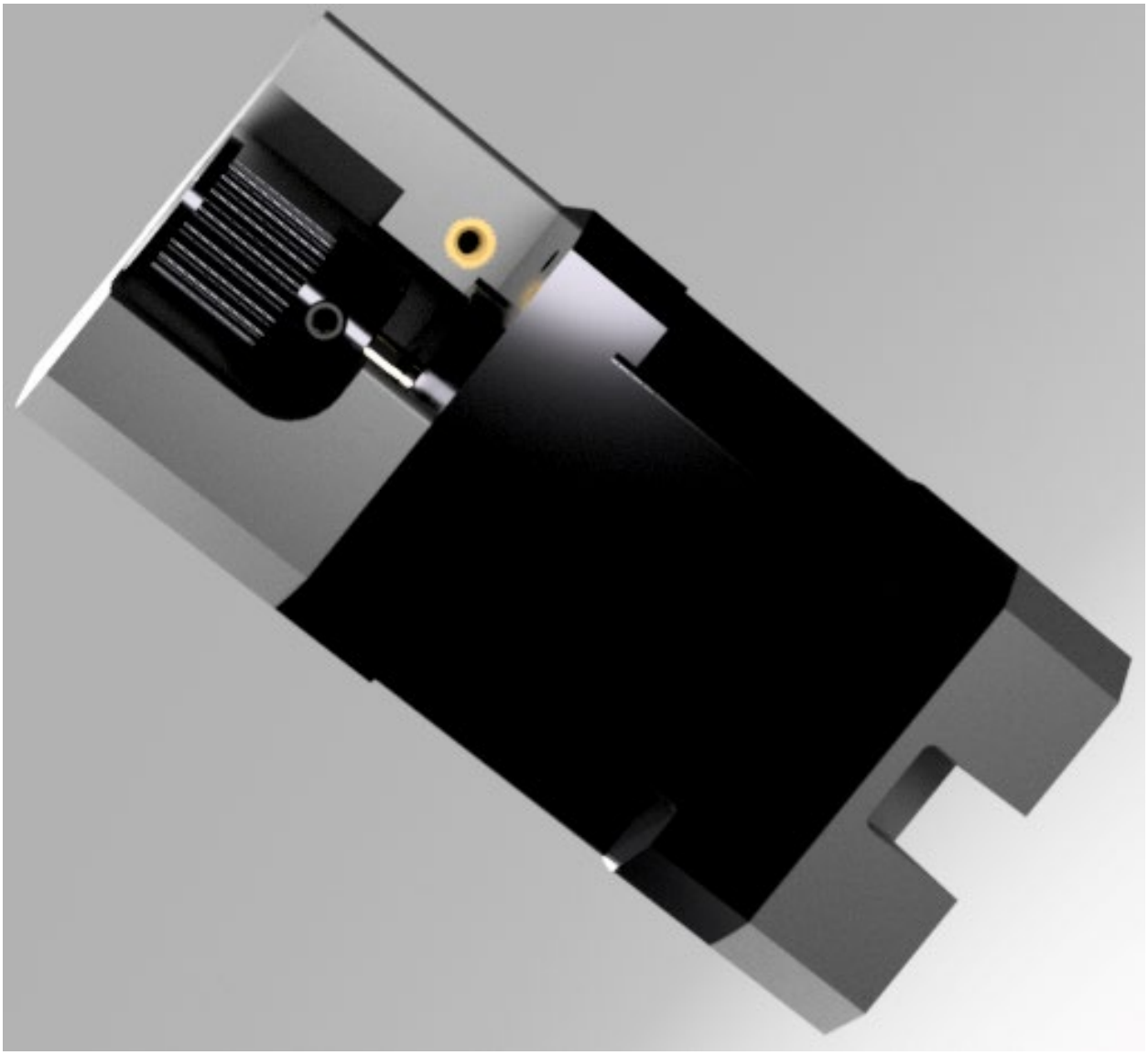
Remove the printed installation tool. Locate a Print_XY-Axis_Motor_Bracket_Rear_Part03.



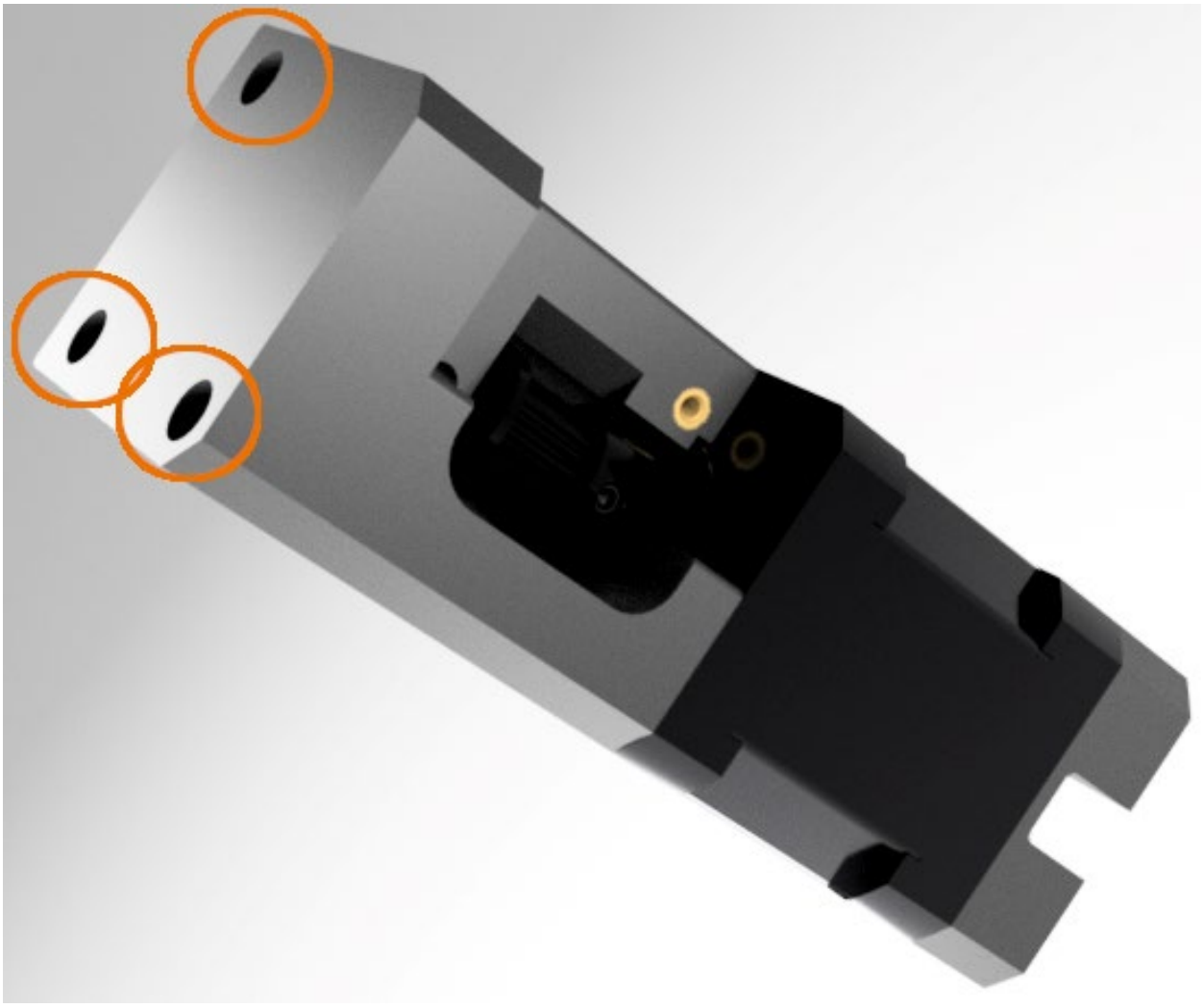
Snap this printed part into Print_XY-Axis_Motor_Bracket_Rear_Part02_CE as shown below.



Orient this printed assembly onto the NEMA 17 motor assembly being careful to keep the printed parts together.



Place Print_XY-Axis_Motor_Bracket_Rear_Part01 onto the NEMA 17 motor assembly as shown and secure the printed parts to the motor with three DIN912_M3_45mm_SHCS fully tightening.

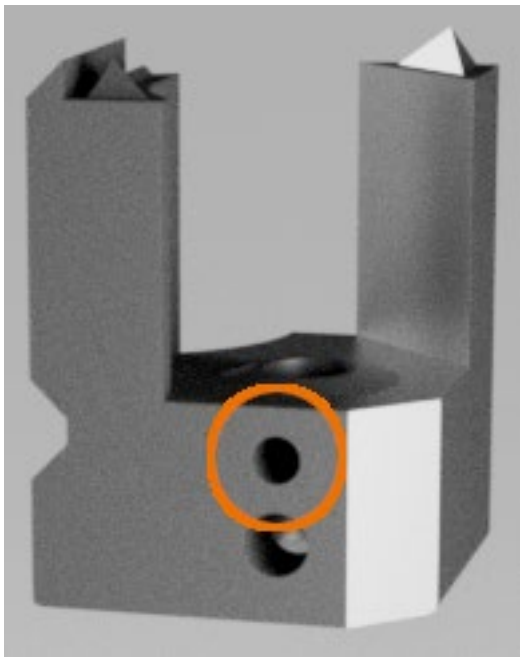


Place two Tnut_40Series_M4 into the rear left extrusion of the frame as shown below.

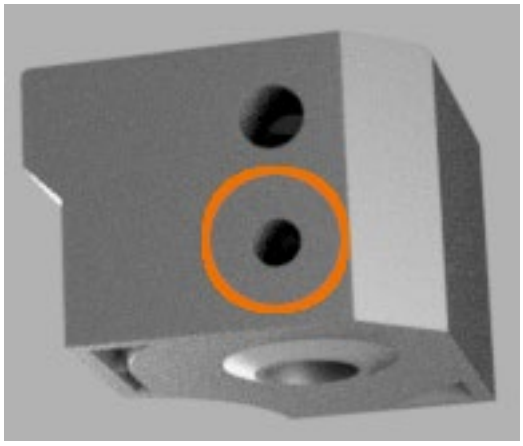
Place the assembled rear XY motor onto the extrusion with the tabs at the back of the motor lining up with the roll-in nuts installed in the previous step. The top of the motor should be flush with the top extrusion.

Secure the motor assembly to the frame with two DIN912_M4_35mm_SHCS as shown below

Locate Print_XY-Axis_Motor_Bracket_Front_Part05 and tap M3 threads into the specified hole below.

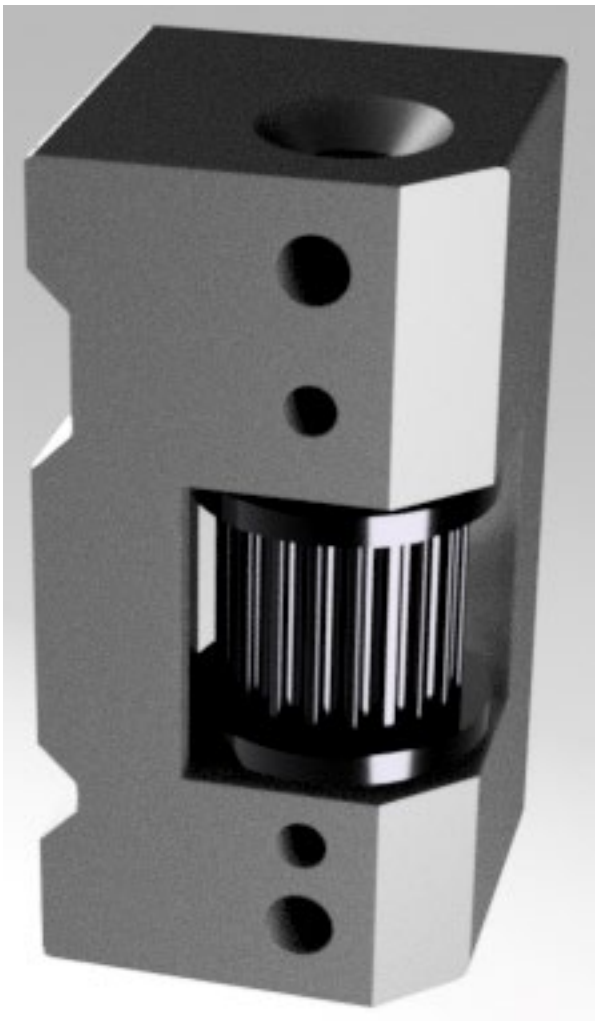


Locate Print_XY-Axis_Motor_Bracket_Rear_Part06 and tap M3 threads into the specified hole below.

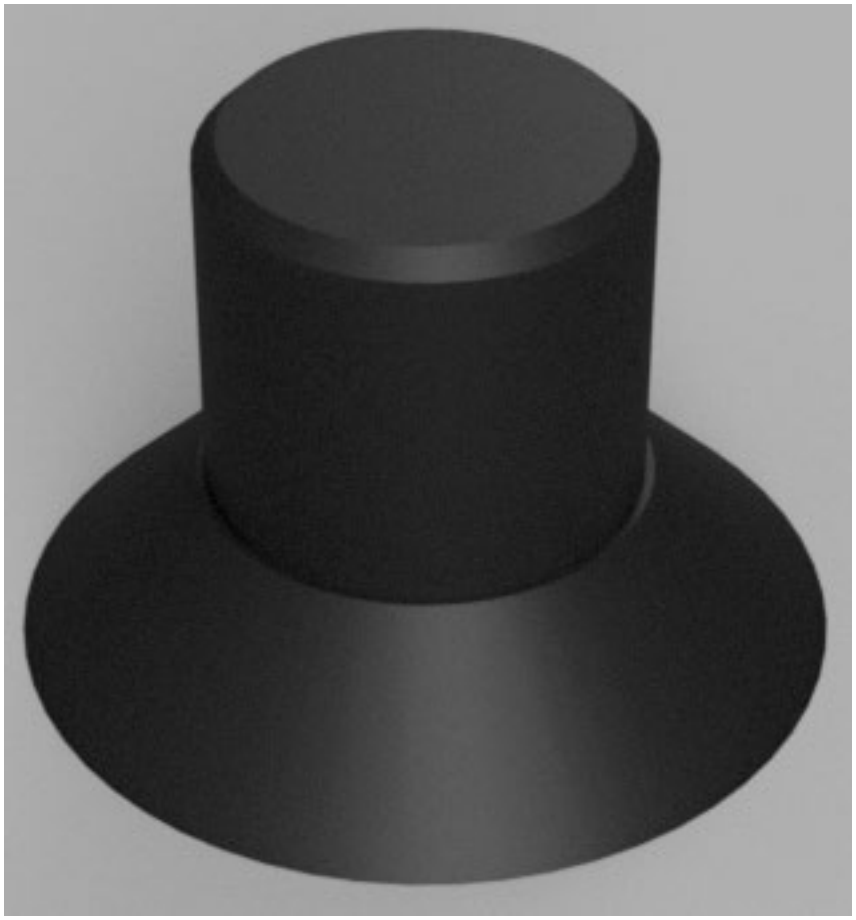


Install the remaining assembled idler pulley into Print_XY-Axis_Motor_Bracket_Rear_Part05 as shown below.

Press Print_XY-Axis_Motor_Bracket_Rear_Part06 on to the tensioner assembly as shown below.

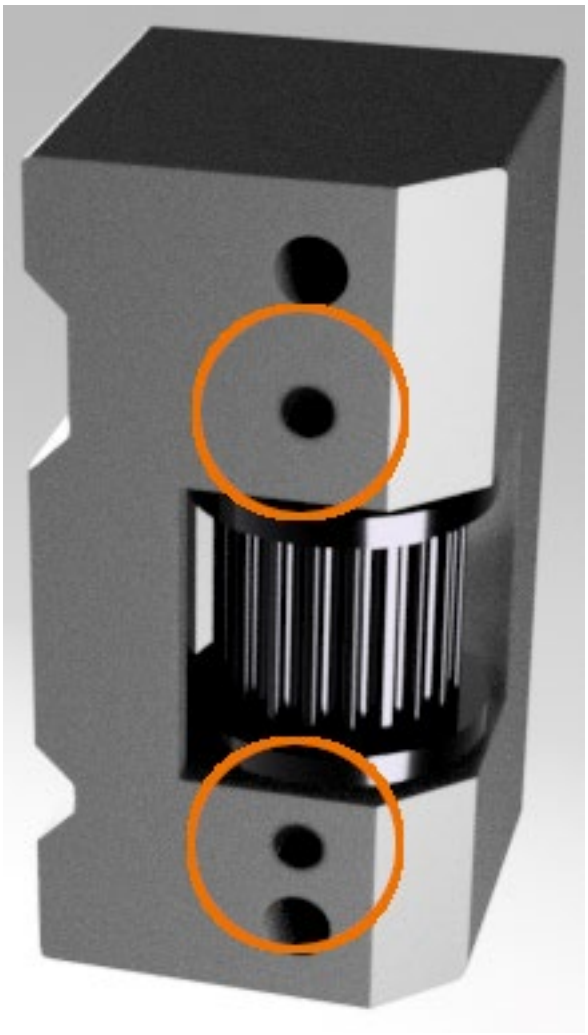


Locate two Print_XY-Axis_Belt_Tensioner_Linear_Shaft_Instal_Tool_(6.15).

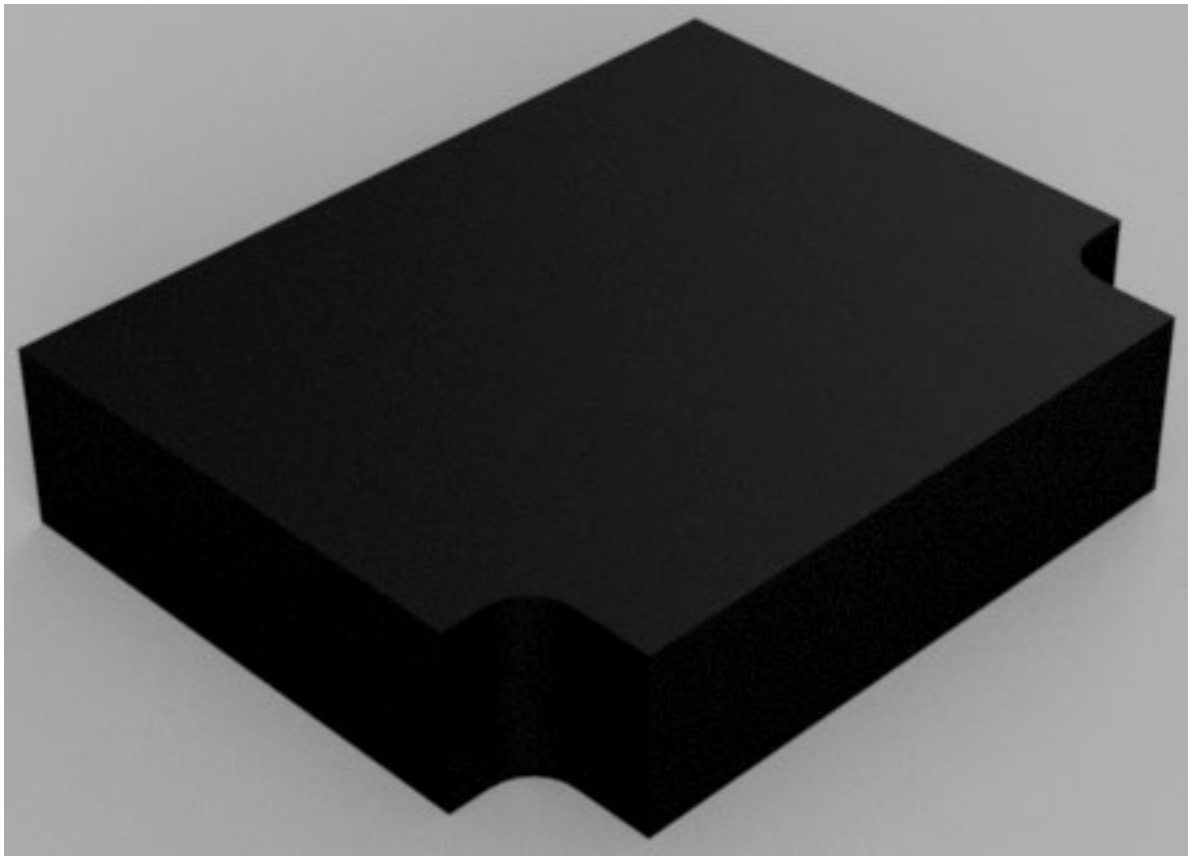


Press one printed installation tool into the top and bottom of the tensioner assembly.

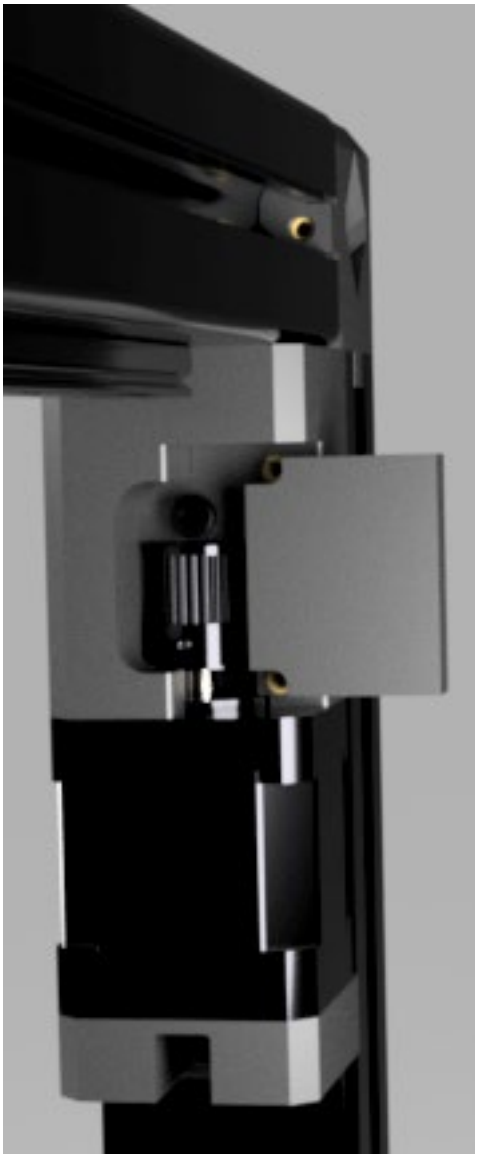
Using your hand vise, compress the two halves of the belt tensioner assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.



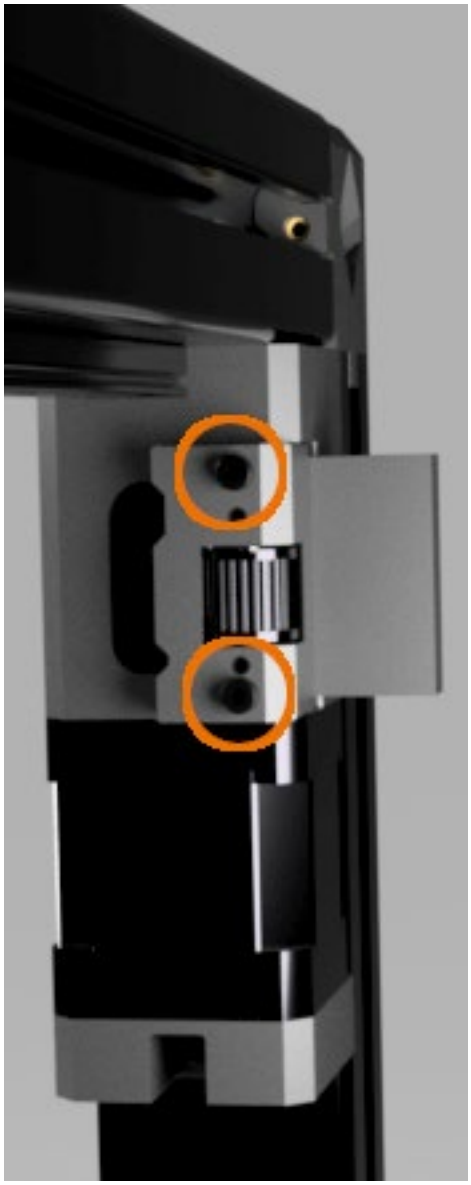
Remove the printed installation tools and the hand vise. Locate Print_XY-Axis_Motor_Pre_Tensioner_Tool_(8.5).



You will use the tool to set the pre-tension gap of the XY-Axis belt tensioners. The tool slips between the motor housing and the tensioner part. This is the position of where you will hold the tool during the pre-tensioning process.



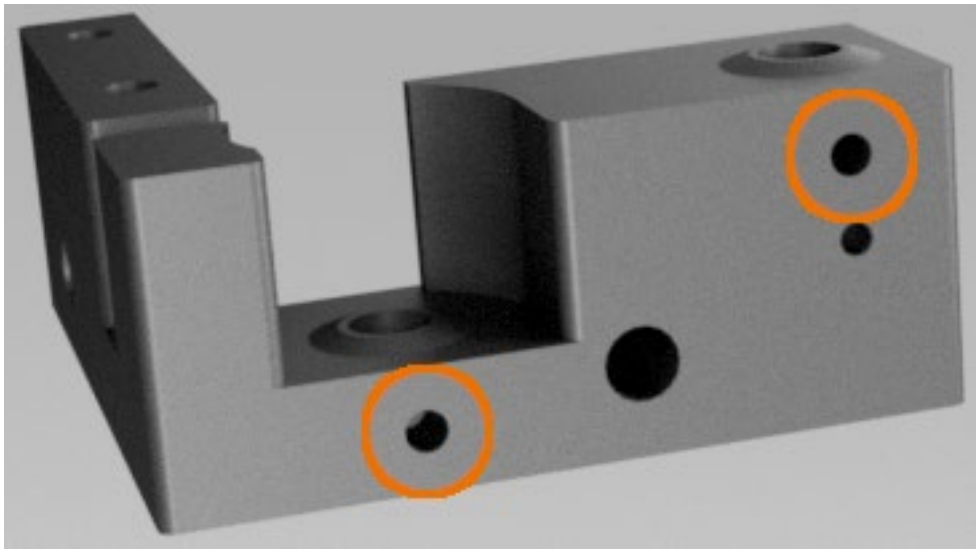
Place the tensioner assembly onto the motor housing and secure it to the housing with two DIN912_M3_35mm_SHCS. Tighten the screws equally until the pre-tensioning tool has some drag when moved. It is more important to try and keep the tensioner parallel to the motor housing than to have the position exact. The final position of the tensioner will occur later during the belt tensioning process.



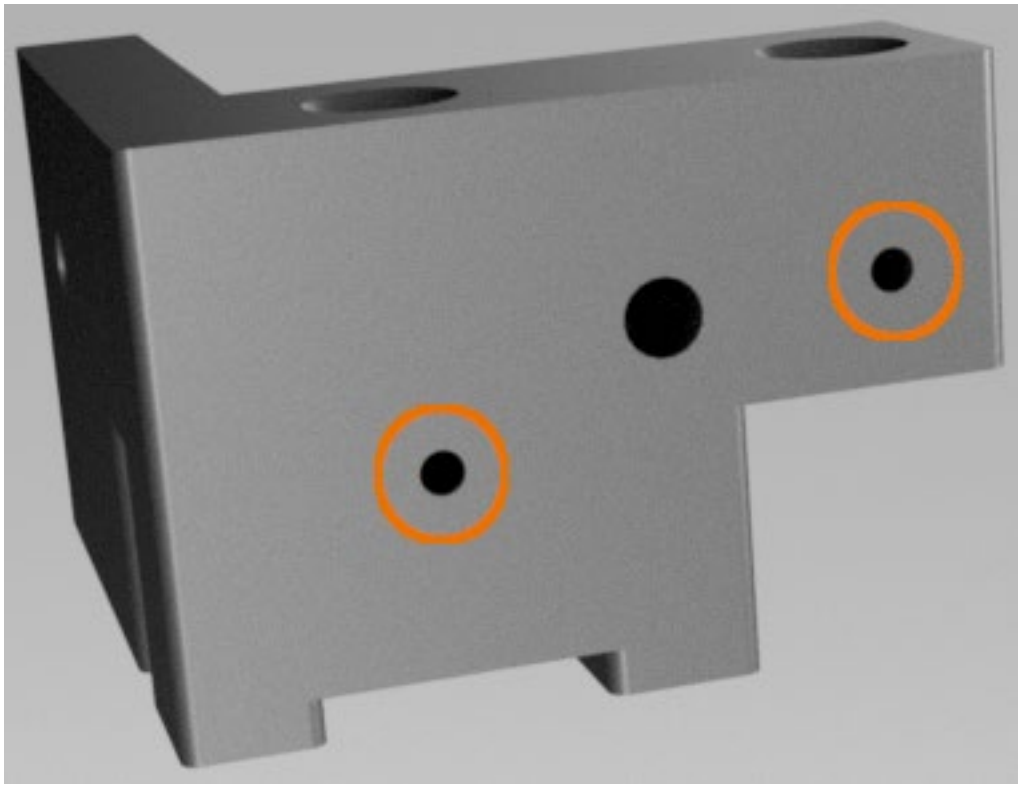
Remove the printed pre-tensioning tool.

Step 5 – XY-Axis Idler Corner Brackets

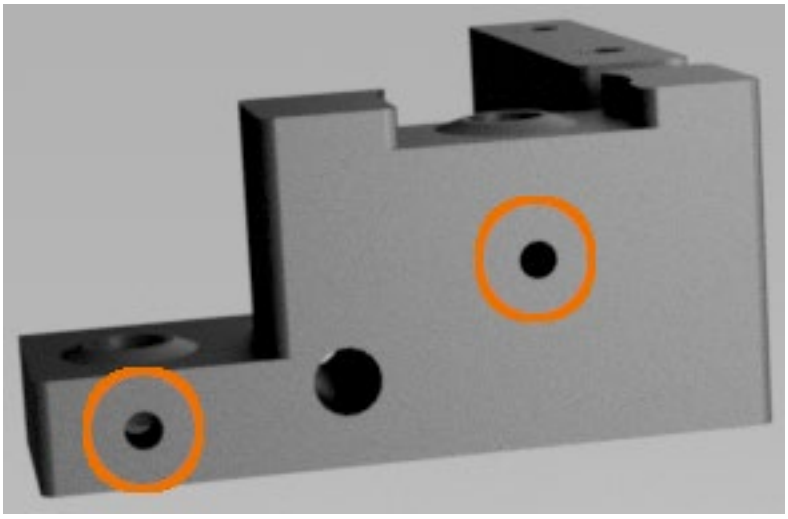
Locate Print_XY-Axis_Belt_Corner_Bracket_Front_Bottom and tap M3 threads into the two hole locations shown below.



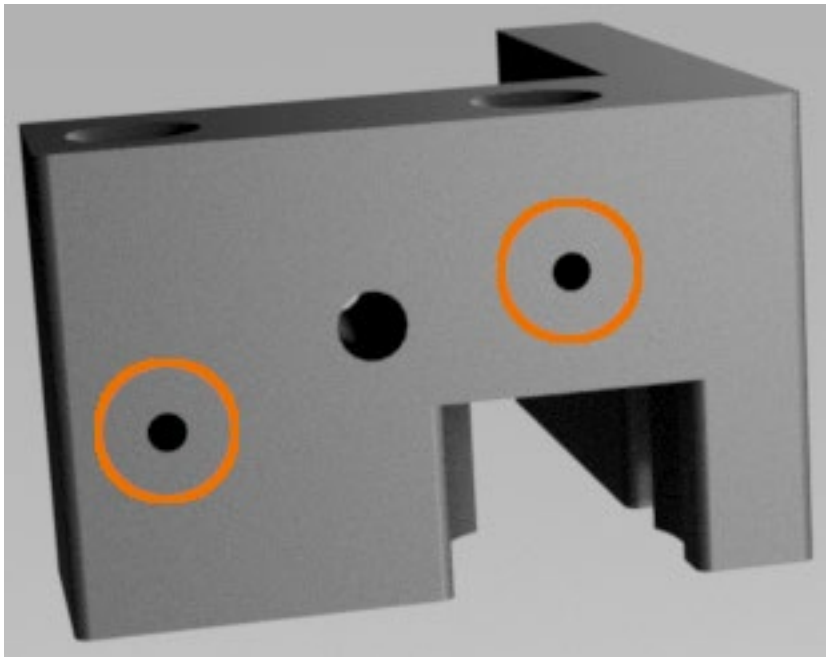
Locate Print_XY-Axis_Belt_Corner_Bracket_Front_Top and tap M3 threads into the two hole locations shown below.



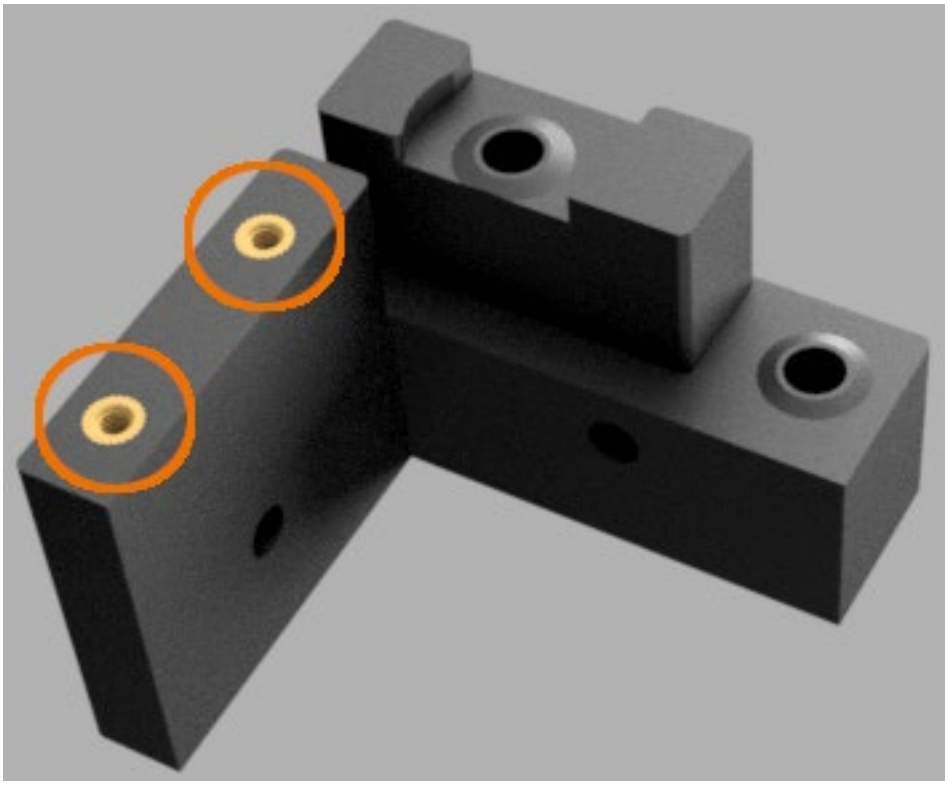
Locate Print_XY-Axis_Belt_Corner_Bracket_Rear_Bottom and tap M3 threads into the two hole locations shown below.



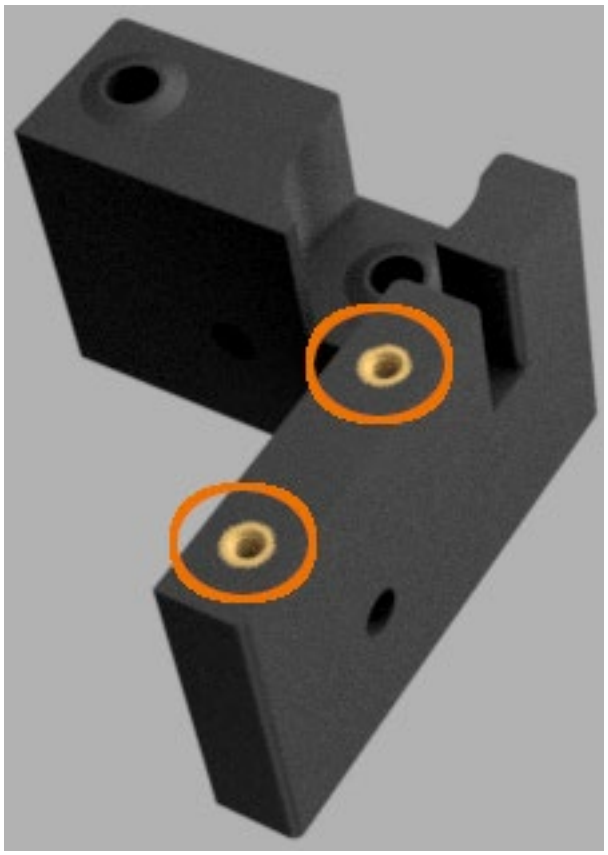
Locate Print_XY-Axis_Belt_Corner_Bracket_Rear_Top and tap M3 threads into the two hole locations shown below.



Return to Print_XY-Axis_Belt_Corner_Bracket_Front_Top and install two M3_4.6x4mm_Heat_Set_Insert into the locations shown below.



Return to Print_XY-Axis_Belt_Corner_Bracket_Rear_Top and install two M3_4.6x4mm_Heat_Set_Insert into the locations shown below.



Locate four Linear_Shaft_5x50mm and four GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore. Slide a GT2_20t_Idler_Pulley_9mm_Belt_5mm_Bore onto one of the linear shafts. If the pulley seems too difficult to install, first try to install the pulley from the other end of the linear shaft. If the resistance is still too great, put the linear shaft in your electric drill chuck and pinch a small piece of fine grain sandpaper (2000 or higher) around the end of the linear shaft while you operate the drill for a few seconds. It is not necessary to sand both ends of the shaft. The pulley should slide onto the shaft with some resistance, but not excessive force. Do not hammer, pound, or hit your pulleys to install them onto the linear shafts. Each idler pulley contains two very small bearings. Any impact, or even excessive force from pressing with cause flat spots on the bearing balls. This type of bearing damage will cause the bearing to experience resistance during use that results in heat buildup of the bearing, shortening the bearing life, and vibration that can travel through the belts and ultimately into the surface finish of your printing part. The pulley should approximate the location shown below on two of the shafts.

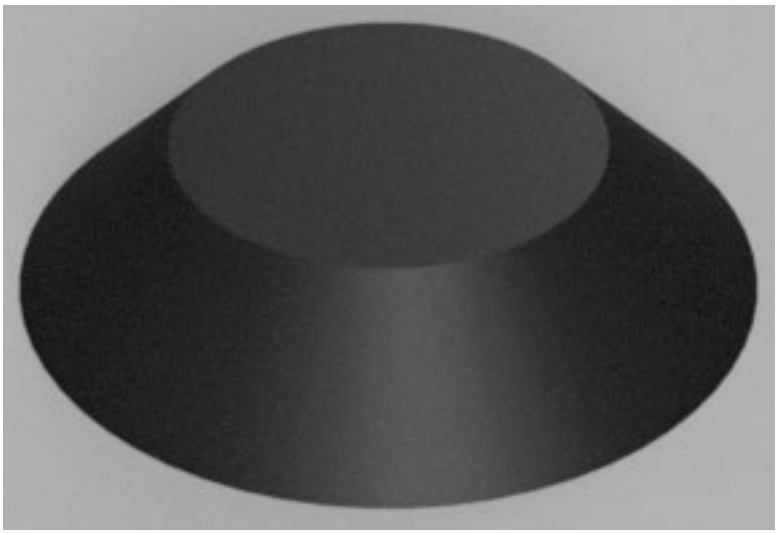
The other two idler pulleys should approximate the position shown below on their linear shafts.

Return to the Print_XY-Axis_Belt_Corner_Bracket_Front_Bottom and install one of the idler pulley assemblies as shown below.

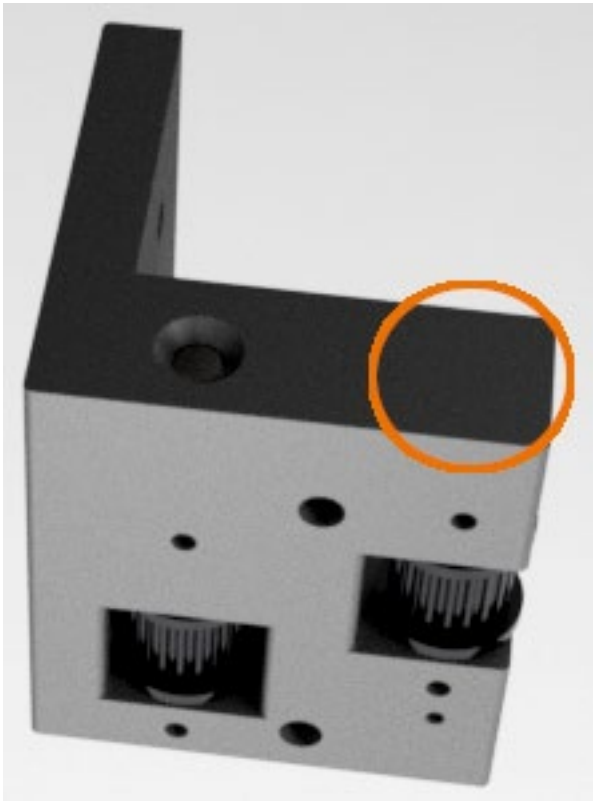
Install another idler pulley assembly into the other position of the printed part as shown.

Press the Print_XY-Axis_Belt_Corner_Bracket_Front_Top onto the corner bracket assembly.

Locate the two Print_XY-Axis_Corner_Bracket_Linear_Shaft_Install_Tool.



Press one printed installation tool into the top and bottom of the corner bracket assembly covering the idler pulley assembly shown below.

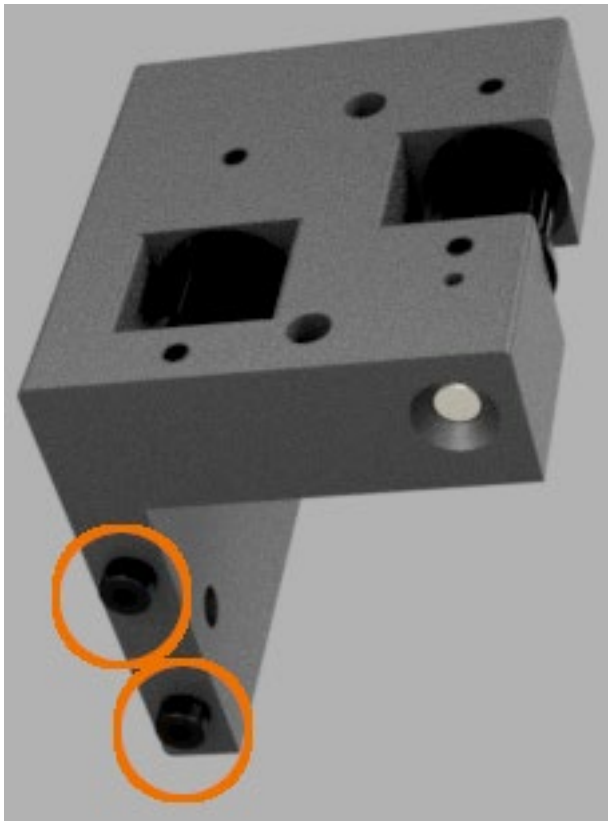


Using your hand vise, compress the two halves of the corner bracket assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.

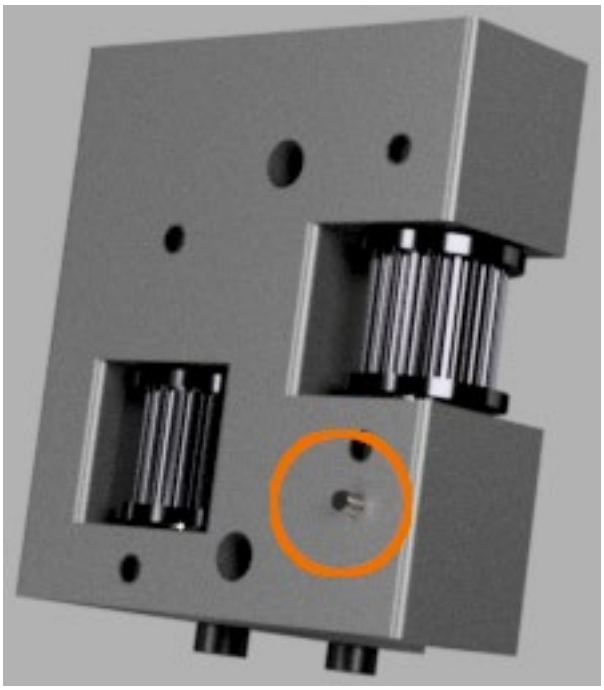
Remove the hand vise and the printed installation tools. Press one printed installation tool into the top and bottom of the corner bracket assembly covering the idler pulley assembly shown below.

Using your hand vise, compress the two halves of the corner bracket assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.

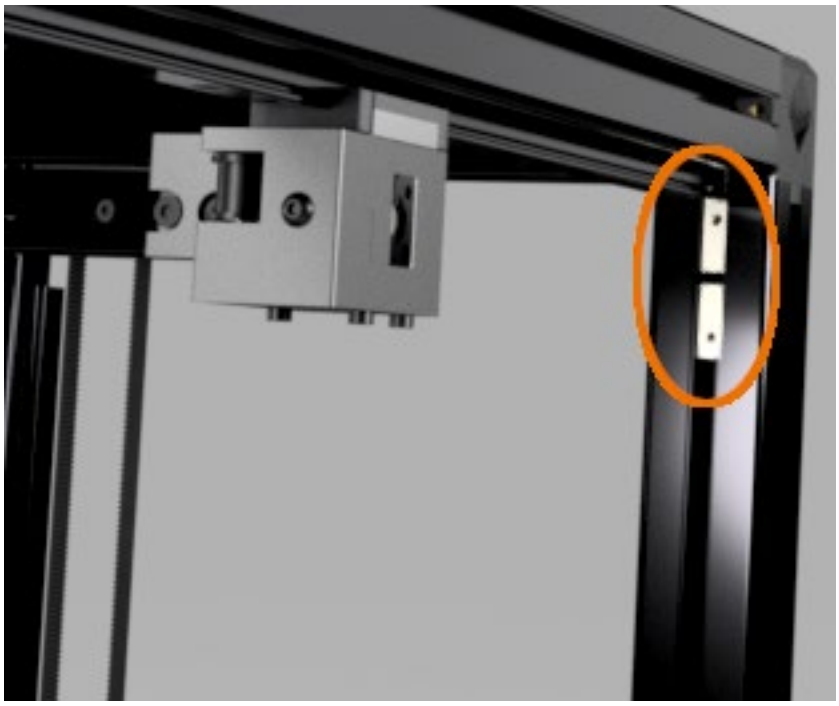
With the hand vise still clamping the corner bracket assembly together, install two DIN912_M3_25mm_SHCS in the locations below and fully tighten.



Remove the hand vise and the printed installation tools. Locate the Linear_Shaft_2x6mm. Press the linear shaft into the location shown below until fully seated.

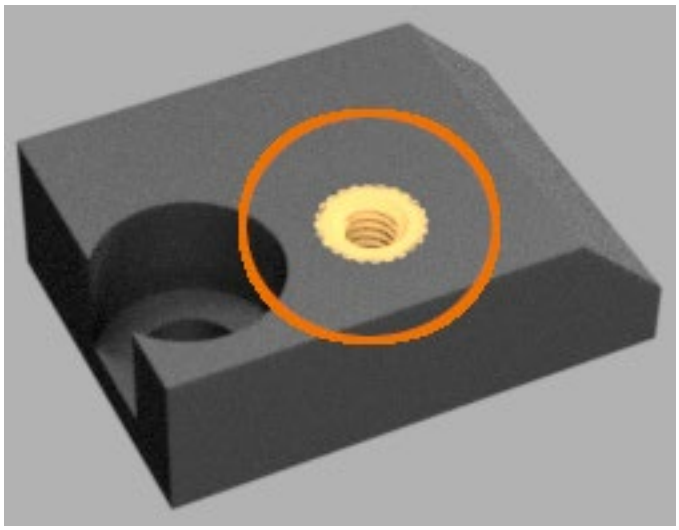


Install two Tnut_40Series_M4 into the top of the front right extrusion as shown.

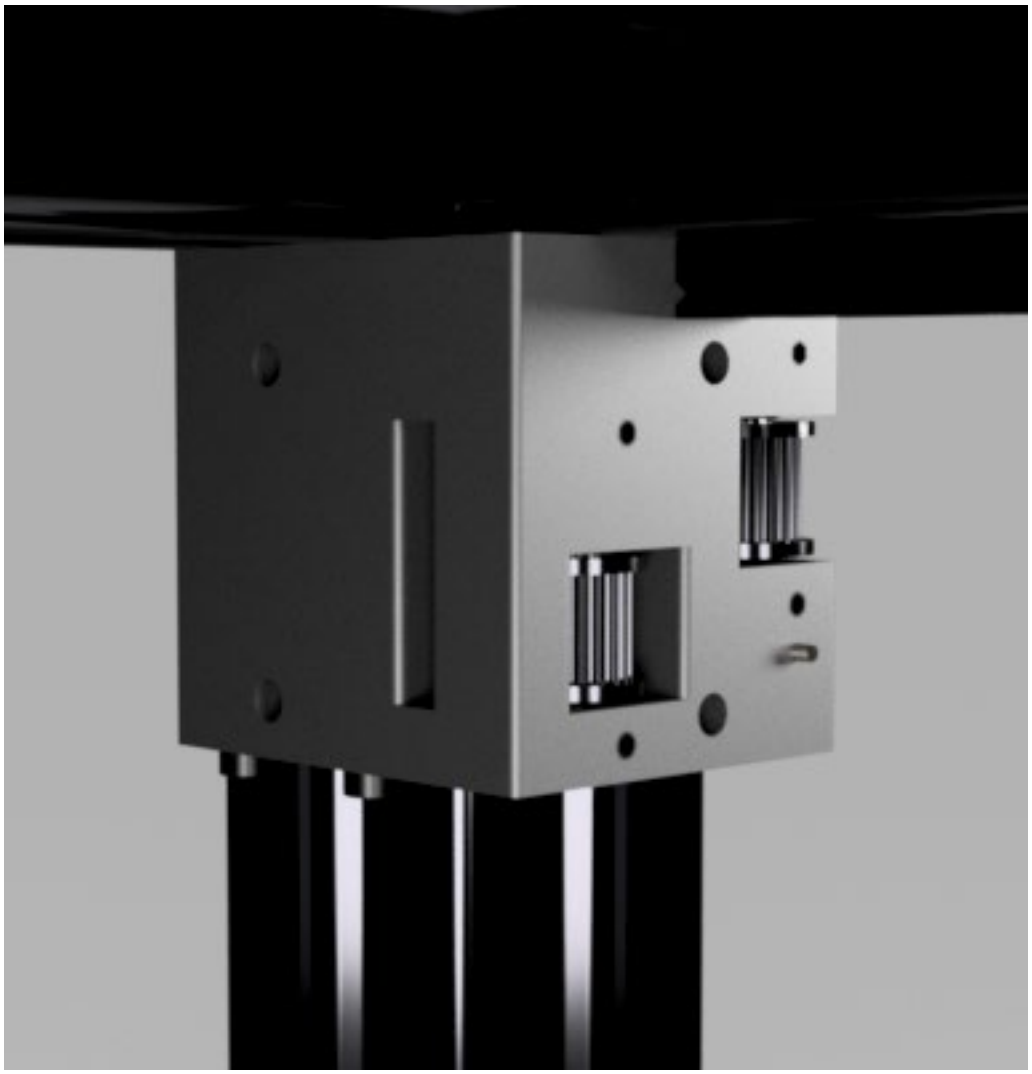


Install an additional two Tnut_40Series_M4 into the other inside corner of same extrusion.

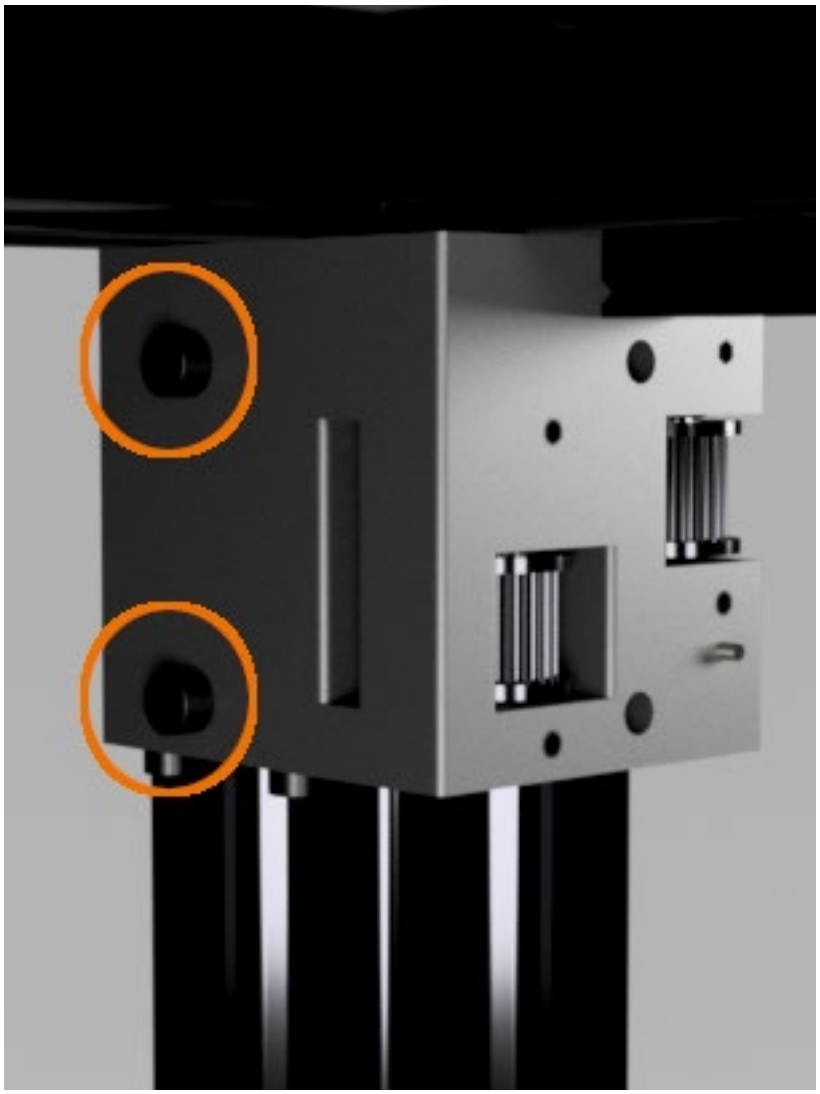
Locate Print_XY-Axis_BlackStop_Mount and install a M3_4.6x4mm_Heat_Set_Insert into the location shown below.



Place the front corner bracket on the inside corner of the front right extrusion and line up all the roll-in nuts with their corresponding through holes in the bracket.

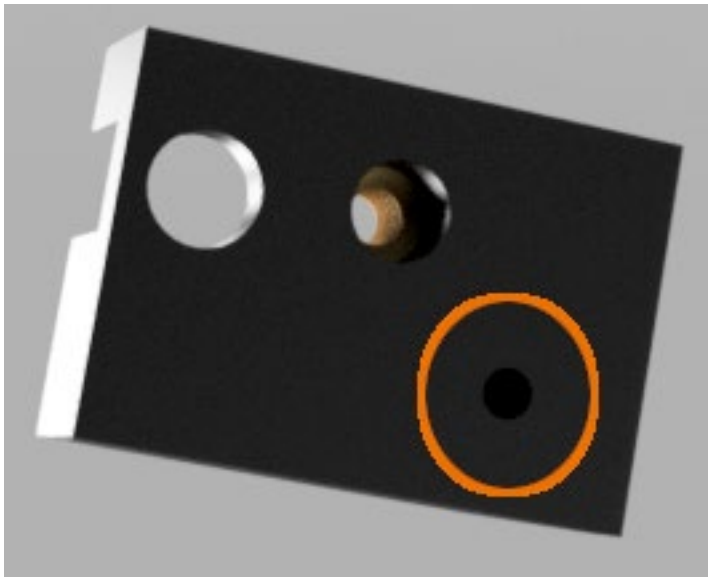


Install two DIN912_M4_20mm_SHCS into the locations shown below and fully tighten.

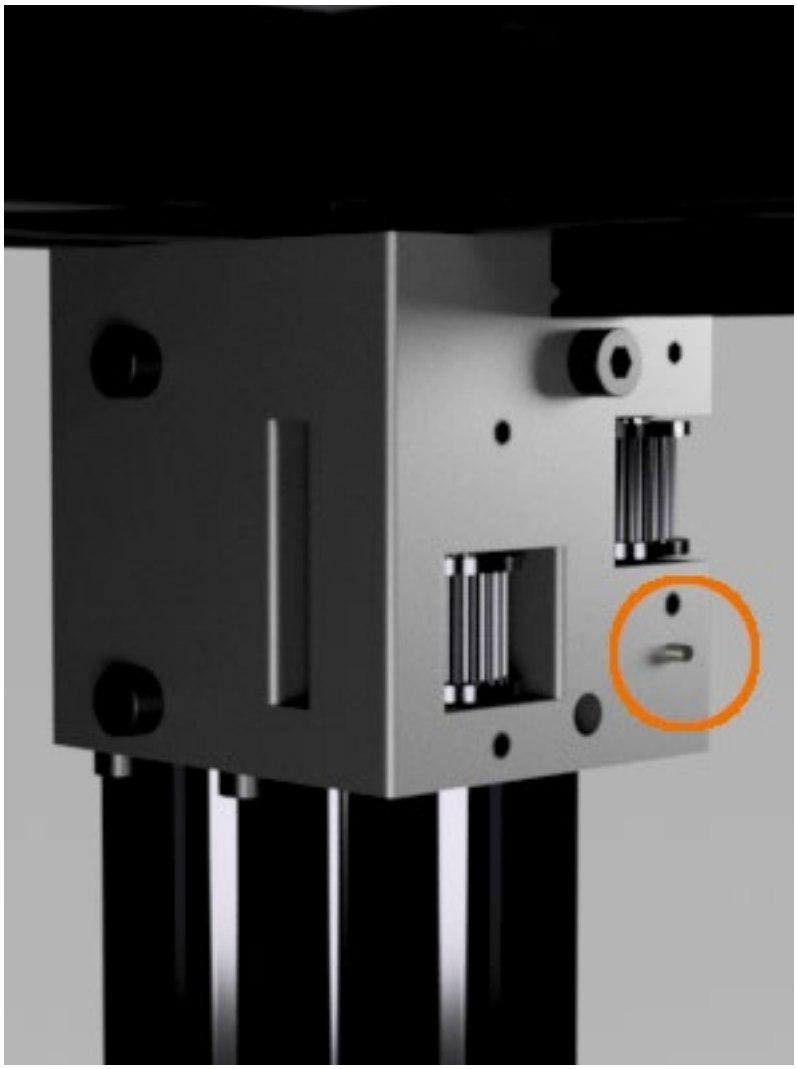


Install a DIN912_M4_25mm_SHCS into the location shown below and fully tighten.

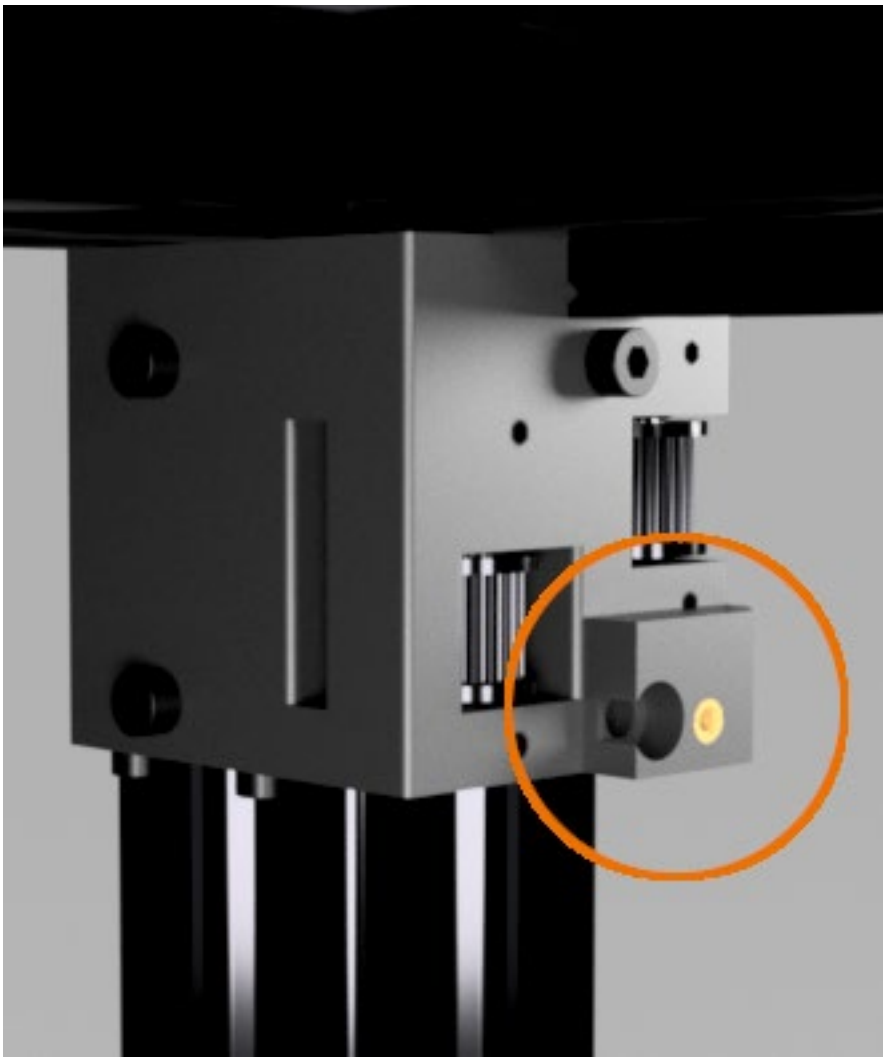
Note the index hole location on the back of Print_XY-Axis_BlackStop_Mount.



This index hole will fit onto the pin of the corner bracket assembly.

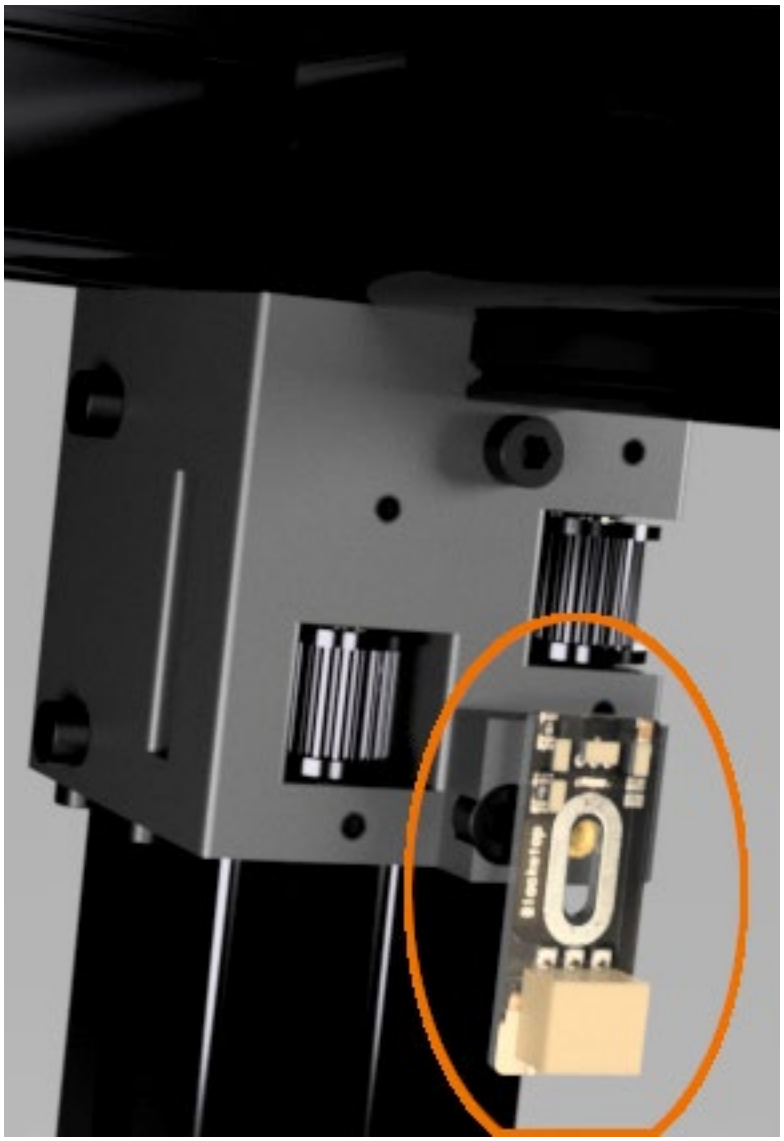


Install the printed part on the corner bracket as shown.

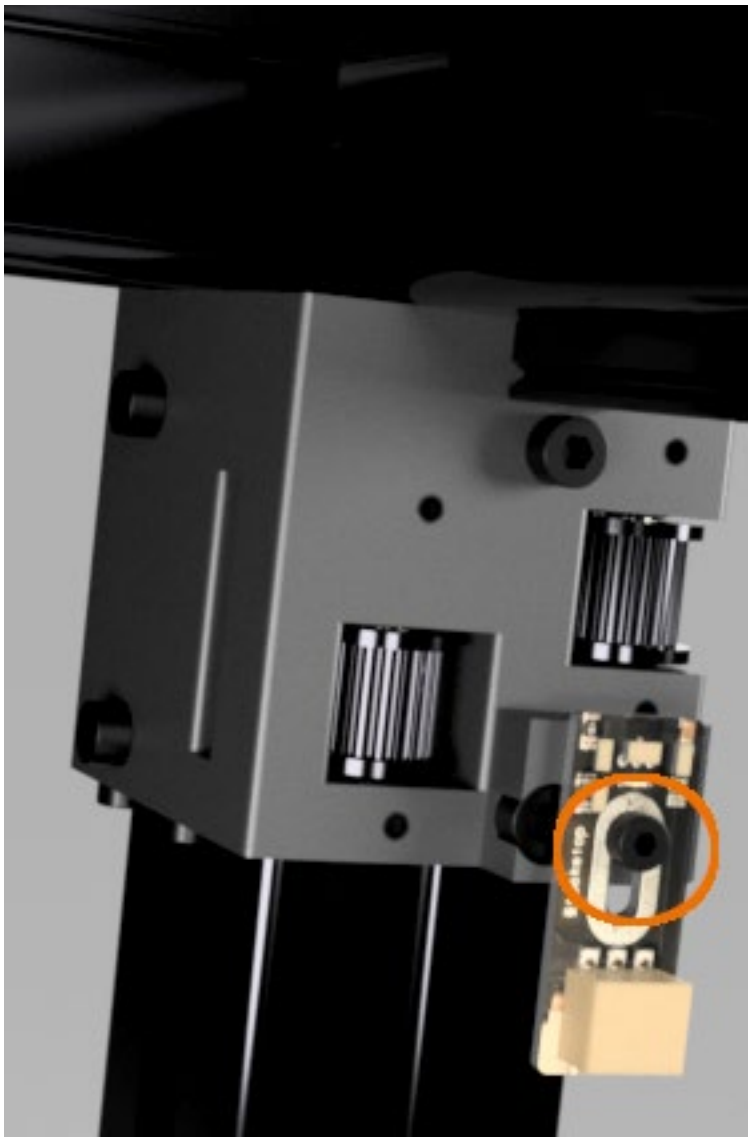


Install a DIN912_M4_30mm_SHCS into the location shown below and fully tighten.

Locate a BlackStop and orient it on the corner bracket assembly as shown.



Install a DIN912_M3_8mm_SHCS to secure the BlackStop as shown.

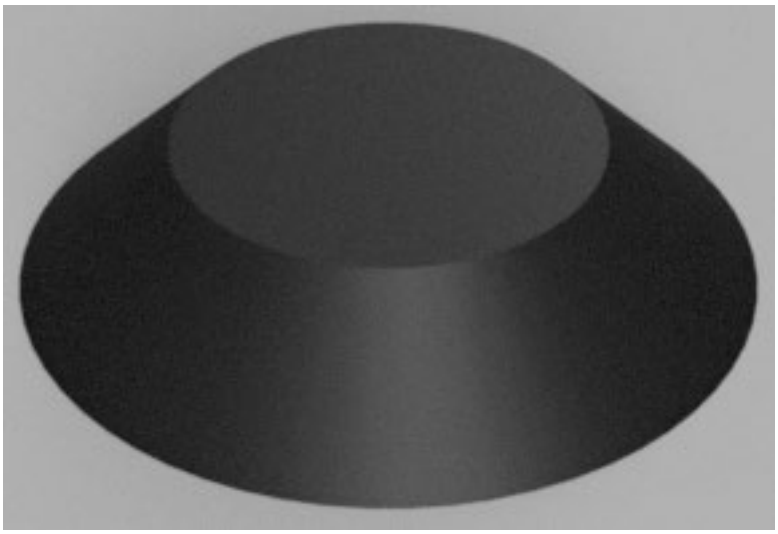


Return to Print_XY-Axis_Belt_Corner_Bracket_Rear_Bottom and install one of the idler pulley assemblies as shown below.

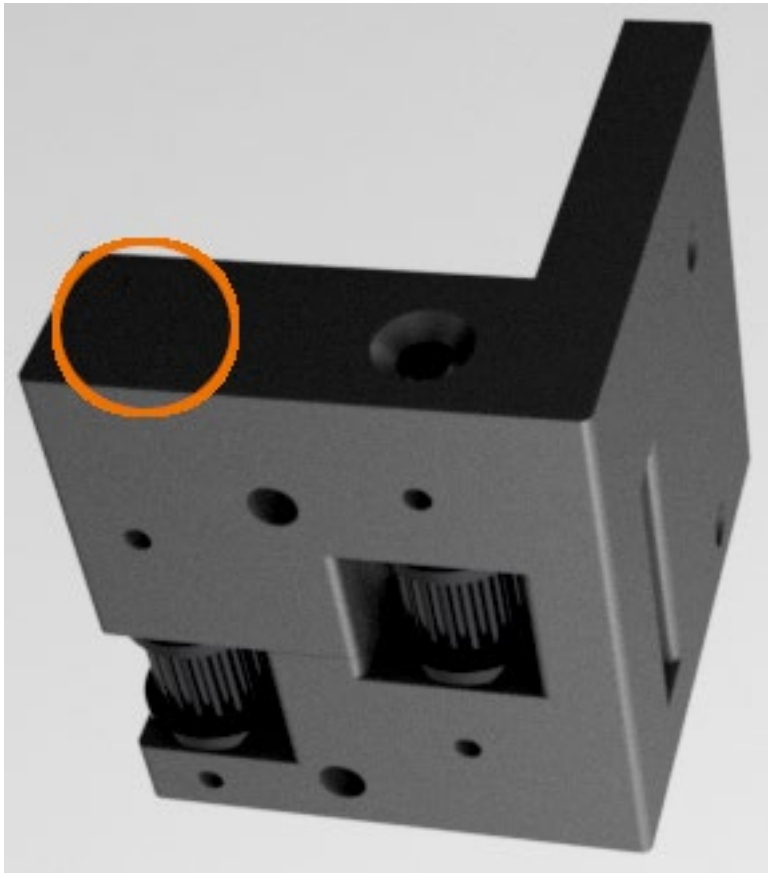
Install the remaining idler pulley assembly into the other position of the printed part as shown.

Press the Print_XY-Axis_Belt_Corner_Bracket_Rear_Top onto the corner bracket assembly.

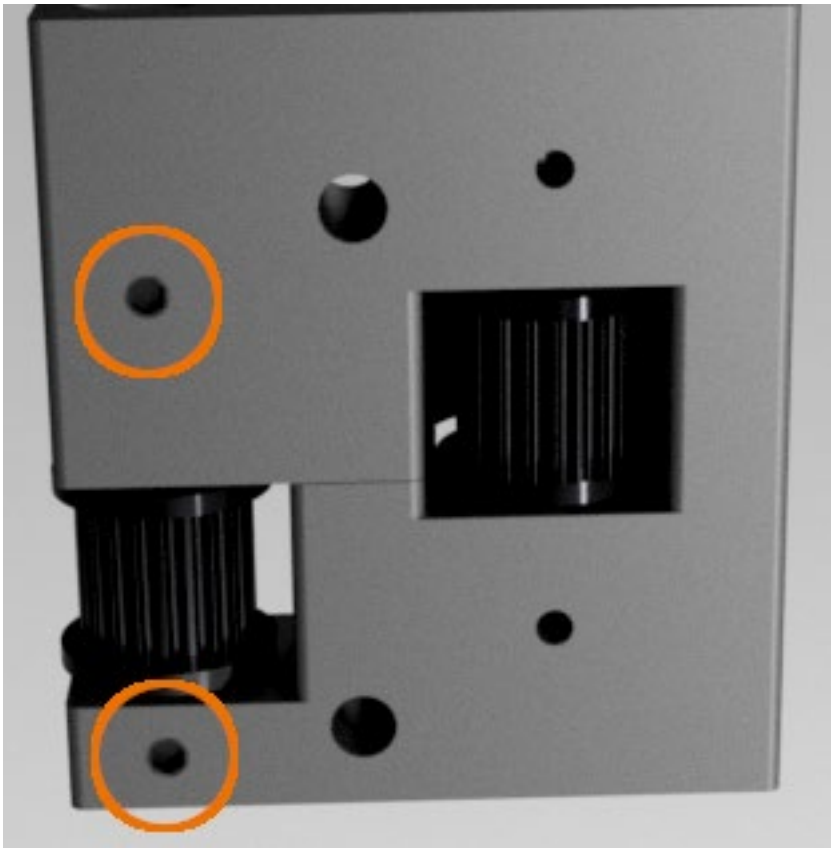
Locate the two Print_XY-Axis_Corner_Bracket_Linear_Shaft_Install_Tool used earlier.



Press one printed installation tool into the top and bottom of the corner bracket assembly covering the idler pulley assembly shown below.

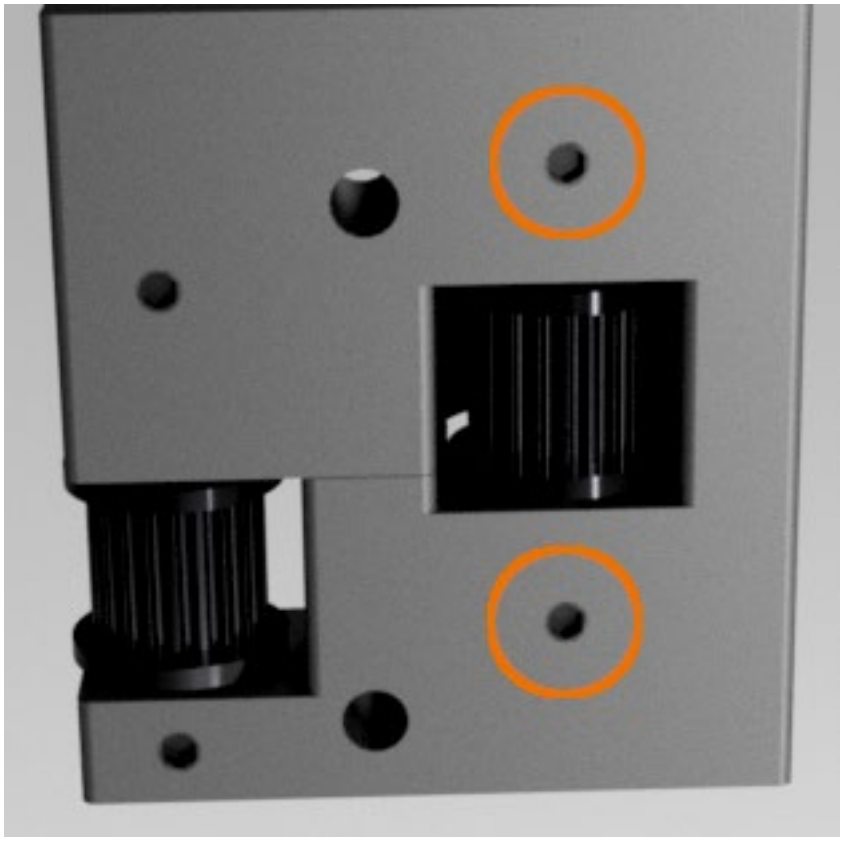


Using your hand vise, compress the two halves of the corner bracket assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.

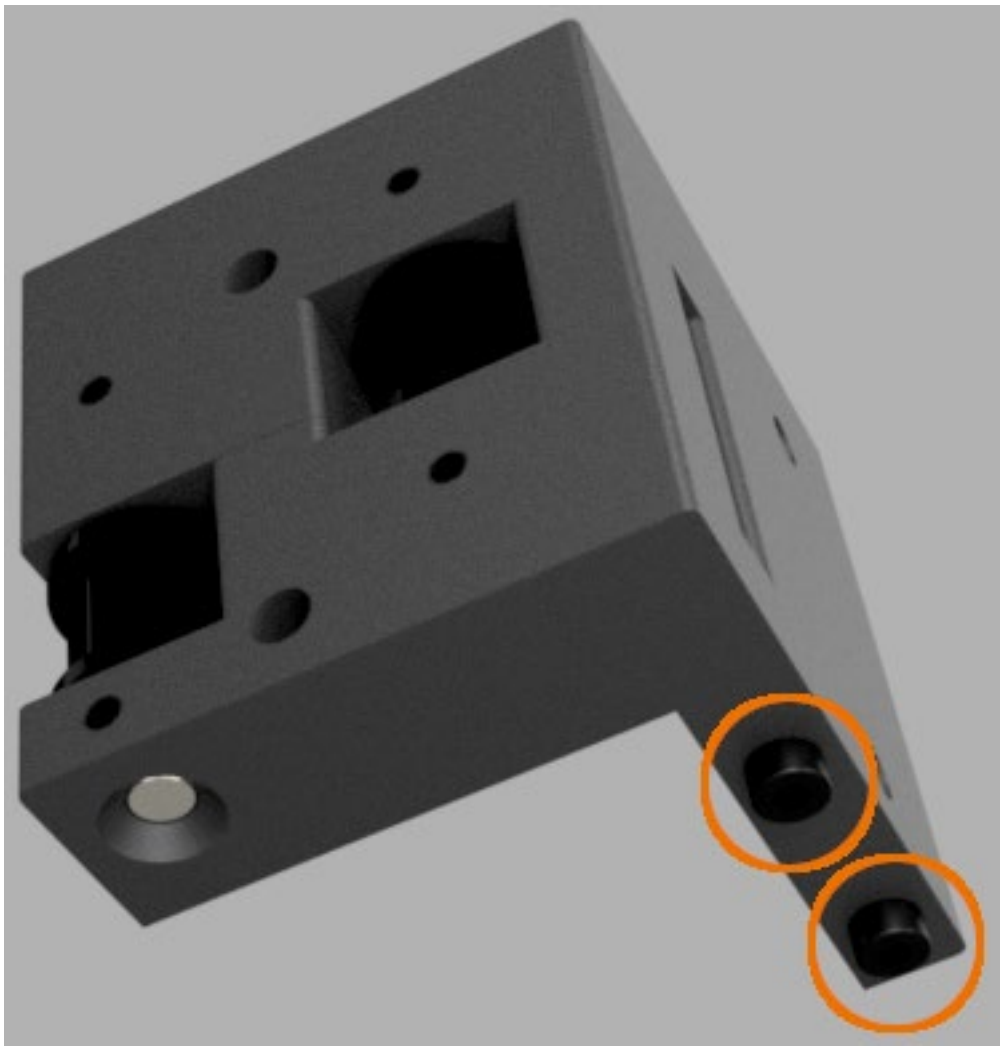


Remove the hand vise and the printed installation tools. Press one printed installation tool into the top and bottom of the corner bracket assembly covering the idler pulley assembly shown below.

Using your hand vise, compress the two halves of the corner bracket assembly setting the position of the linear shaft. Install two DIN916_M3_5mm_Set_Screw into the locations shown below and fully tighten.



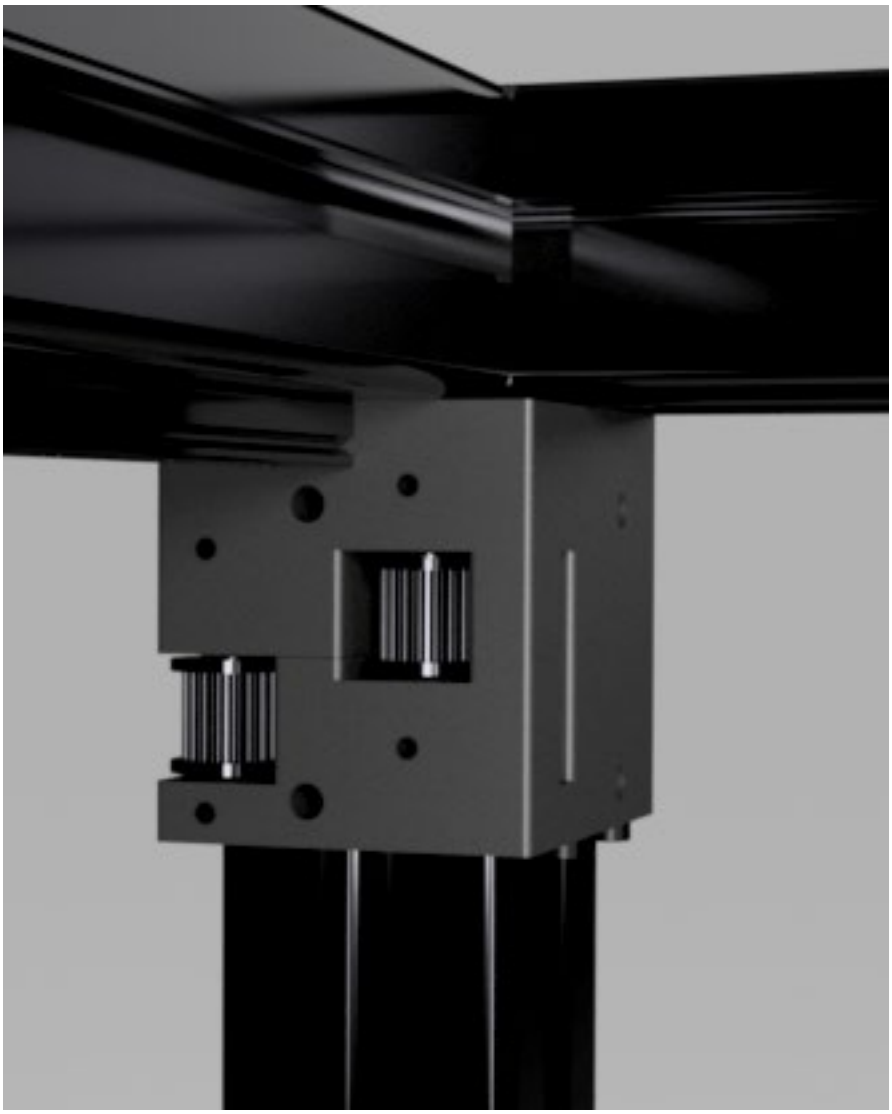
With the hand vise still clamping the corner bracket assembly together, install two DIN912_M3_25mm_SHCS in the locations below and fully tighten.



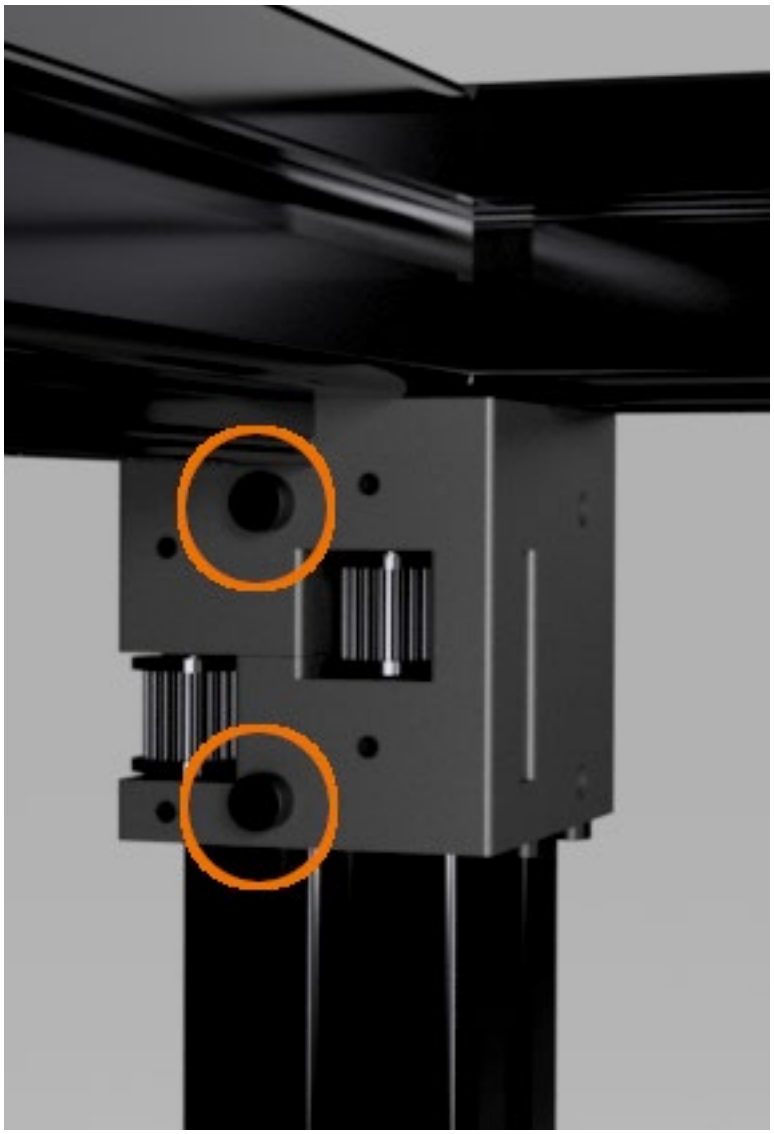
Remove the hand vise and the printed installation tools. Install two Tnut_40Series_M4 into the top of the rear right extrusion as shown.

Install an additional two Tnut_40Series_M4 into the other inside corner of same extrusion.

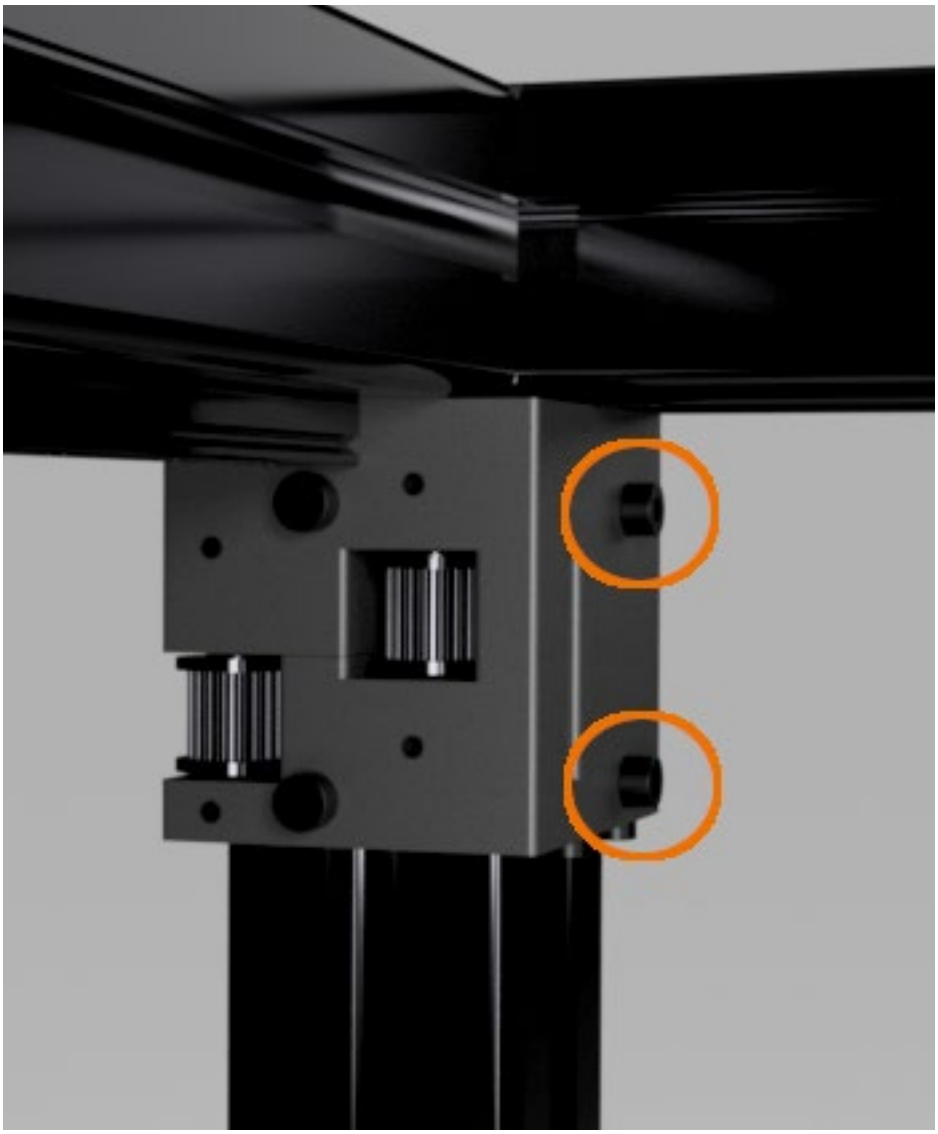
Place the rear corner bracket on the inside corner of the rear right extrusion and line up all the roll-in nuts with their corresponding through holes in the bracket.



Install two DIN912_M4_25mm_SHCS into the locations shown below and fully tighten.



Install two DIN912_M4_20mm_SHCS into the locations shown below and fully tighten.

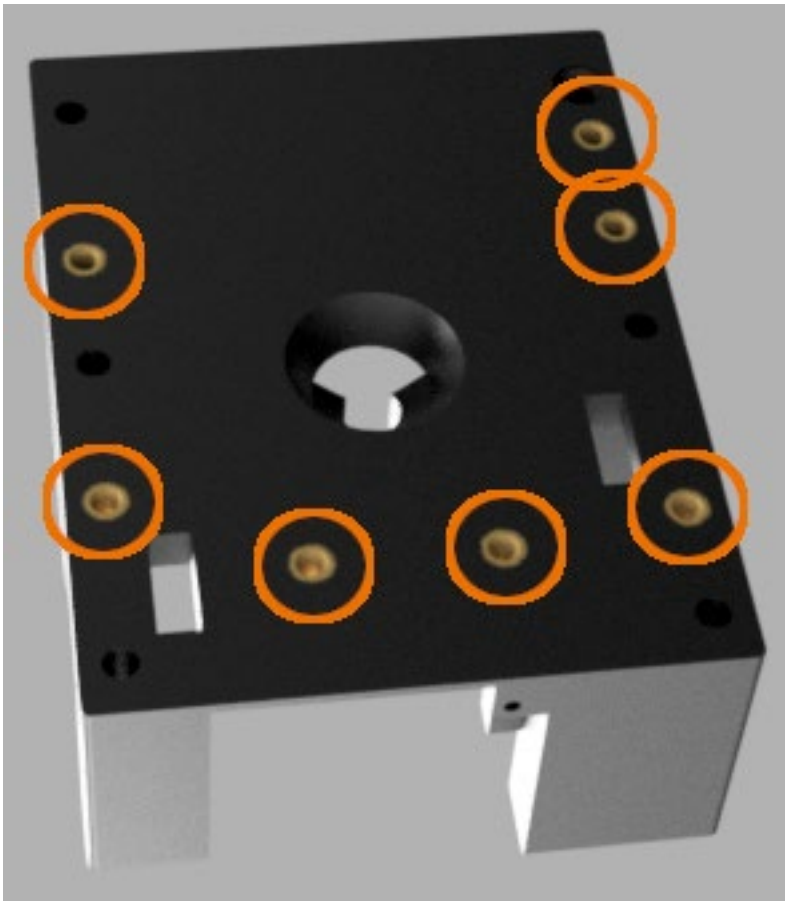


Step 6 – Tool Changer and XY-Axis Belts

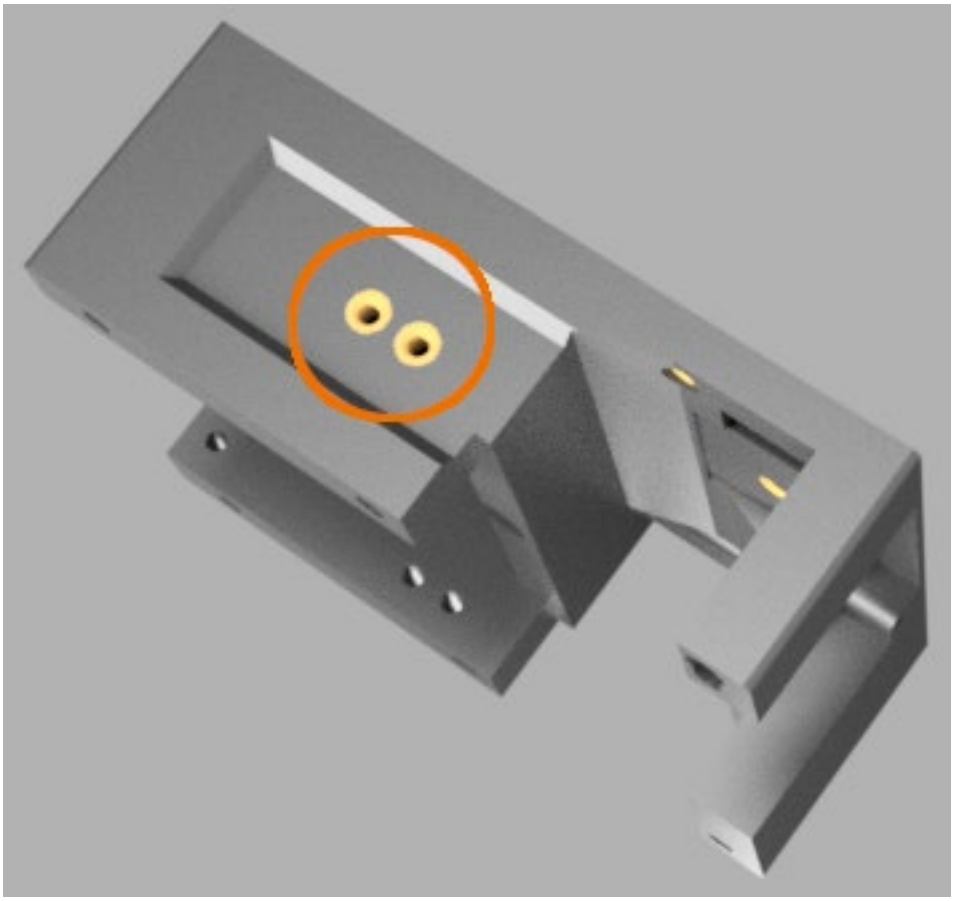
Line the mounting holes of CNC_X-Plate_Kelvin_External_Cooler_V2 with the MGN-12 cartridge of the X-Axis and secure with four DIN7991_M3_6mm_FHHS as shown.

Locate the Nema17_25mm and install onto the X-Plate with wiring connector facing up. Secure with four DIN7991_M3_6mm_FHHS as shown below.

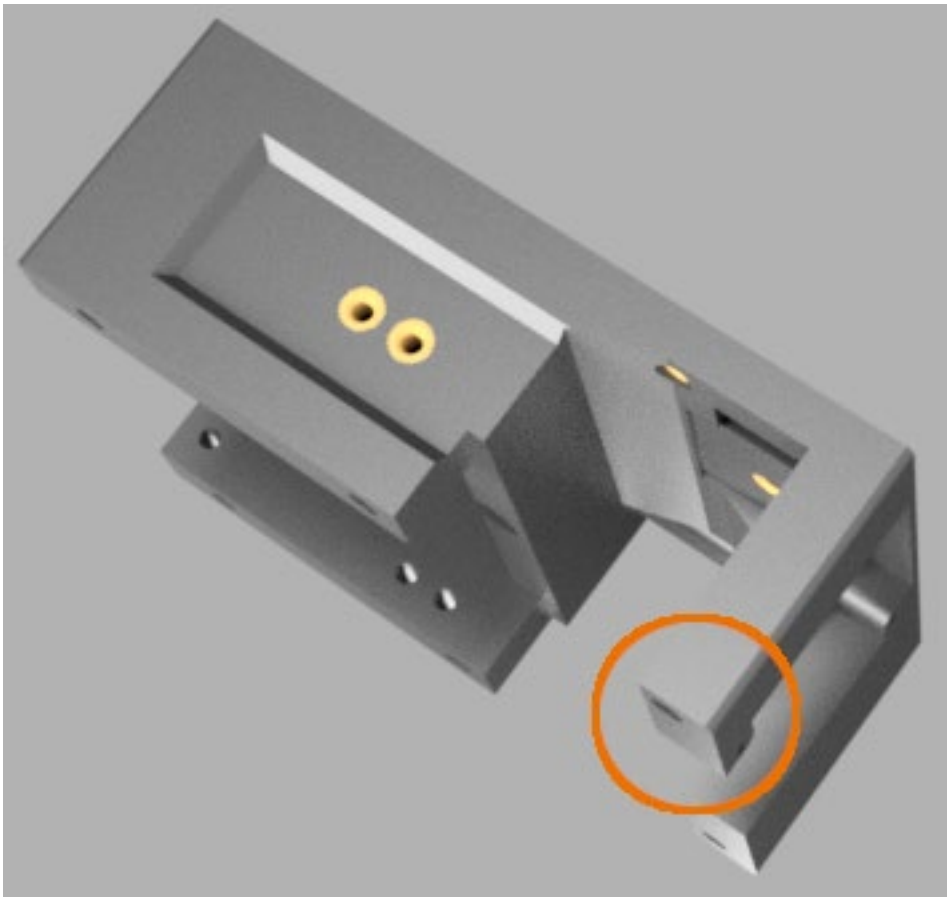
Locate Print_X_Bracket_V2_Part_1 and install seven M3_4.6x4mm_Heat_Set_Insert into the locations shown below.



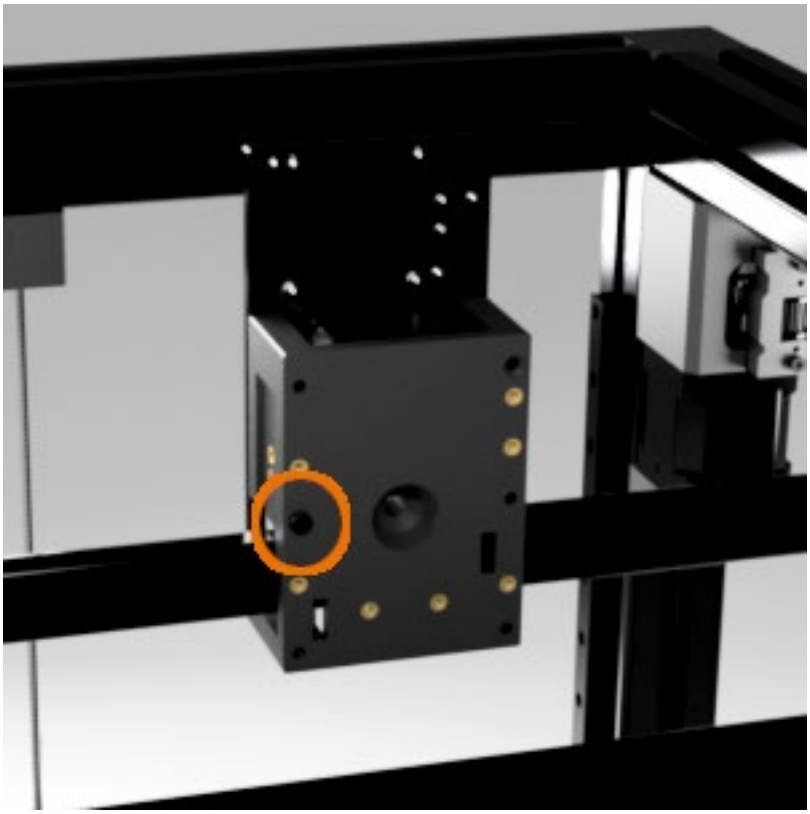
Rotate the printed part and install two M3_4.6x4mm_Heat_Set_Insert into the locations shown below.



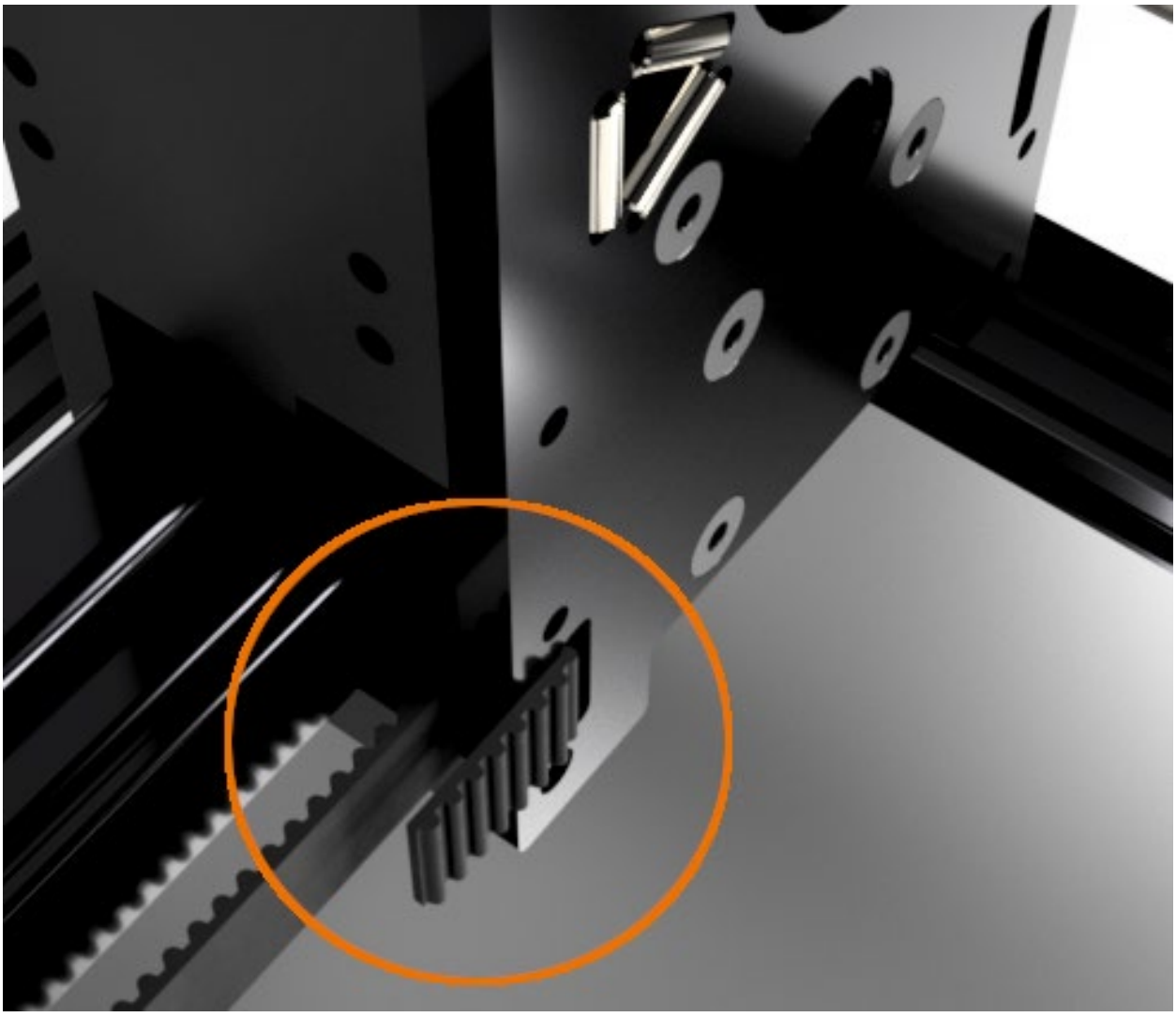
Snap Print_X_Bracket_V2_Part_2 into part one as shown below.



Line up the X-Bracket assembly to the back of the X-Plate and loosely secure with a DIN912_M3_35mm_SHCS as shown below.

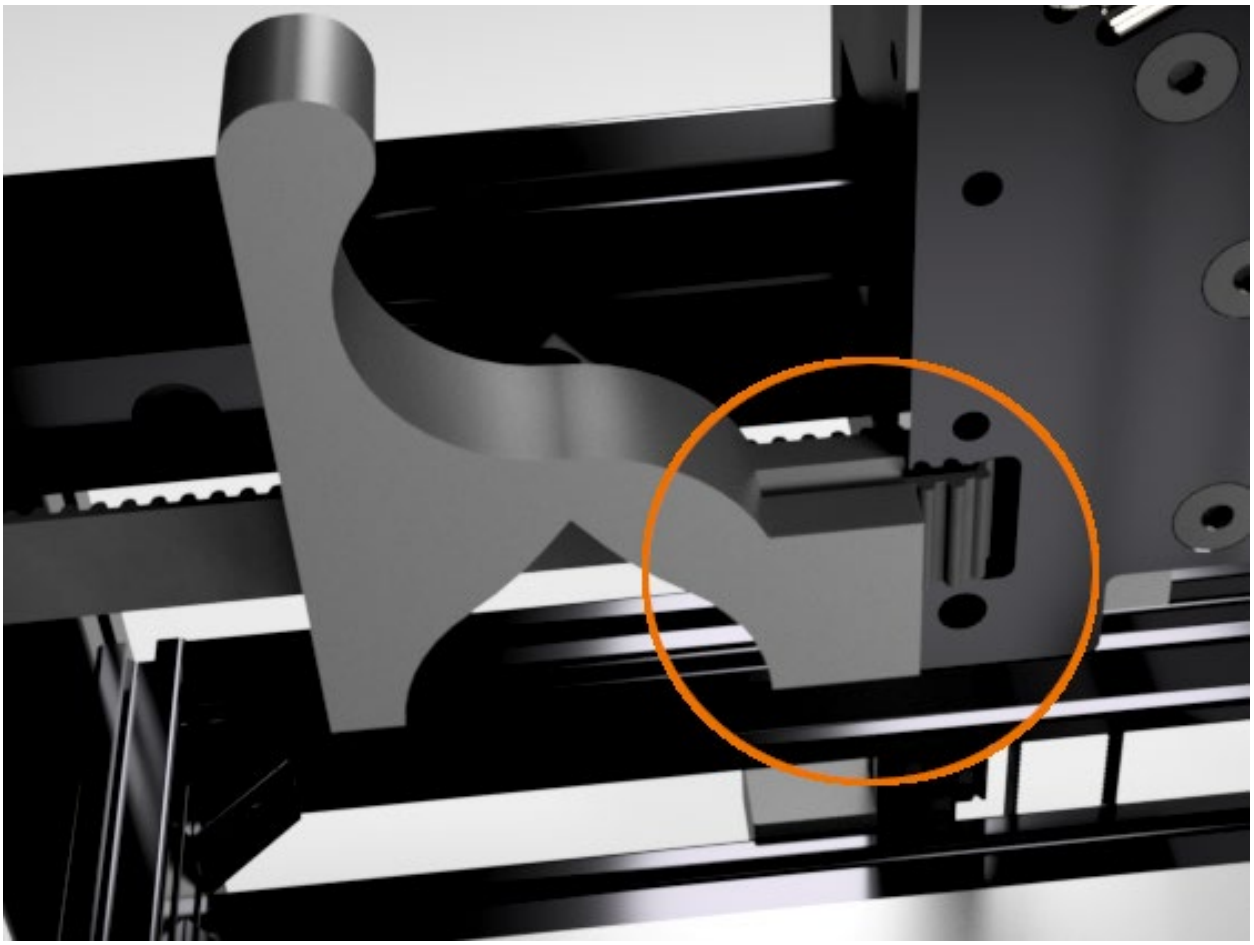


Install one end of GT2_894t_Belt_9x1788mm_(1.52mm) through the back of the X-Plate with belt teeth oriented as shown below.

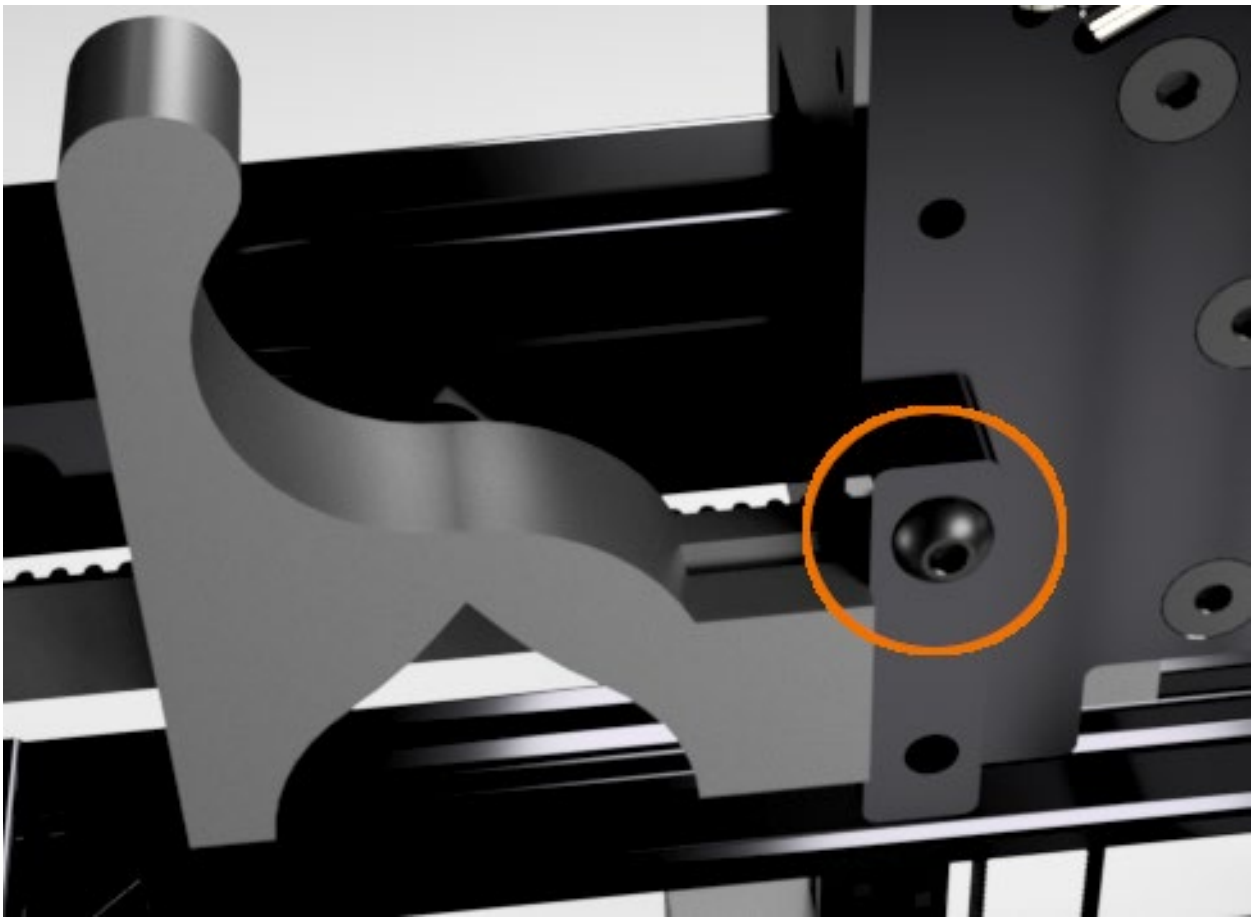


Locate one Print_XY_Belt_Tightening_Tool_(1.52mm).

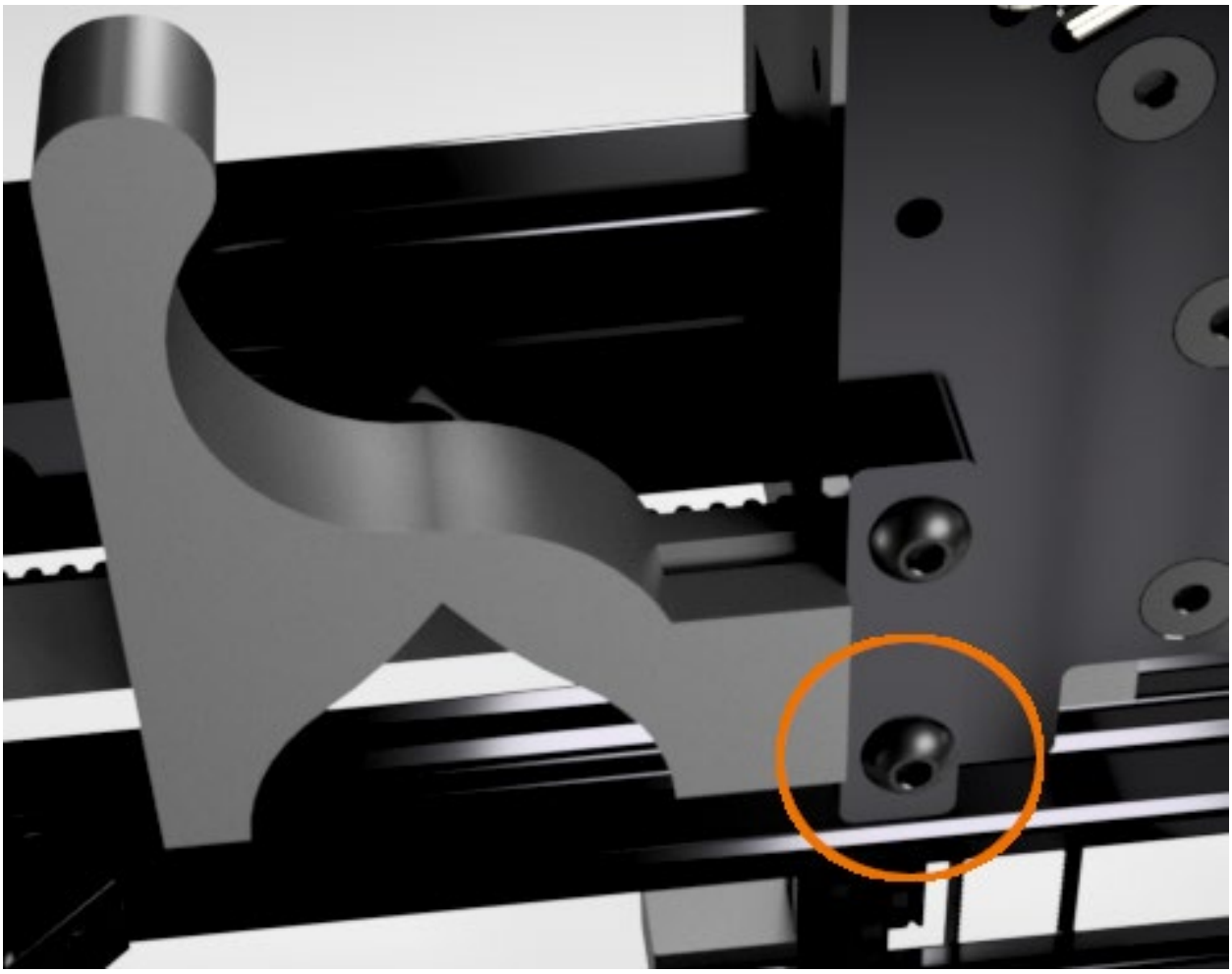
Attach the tool to the end of the belt as shown.



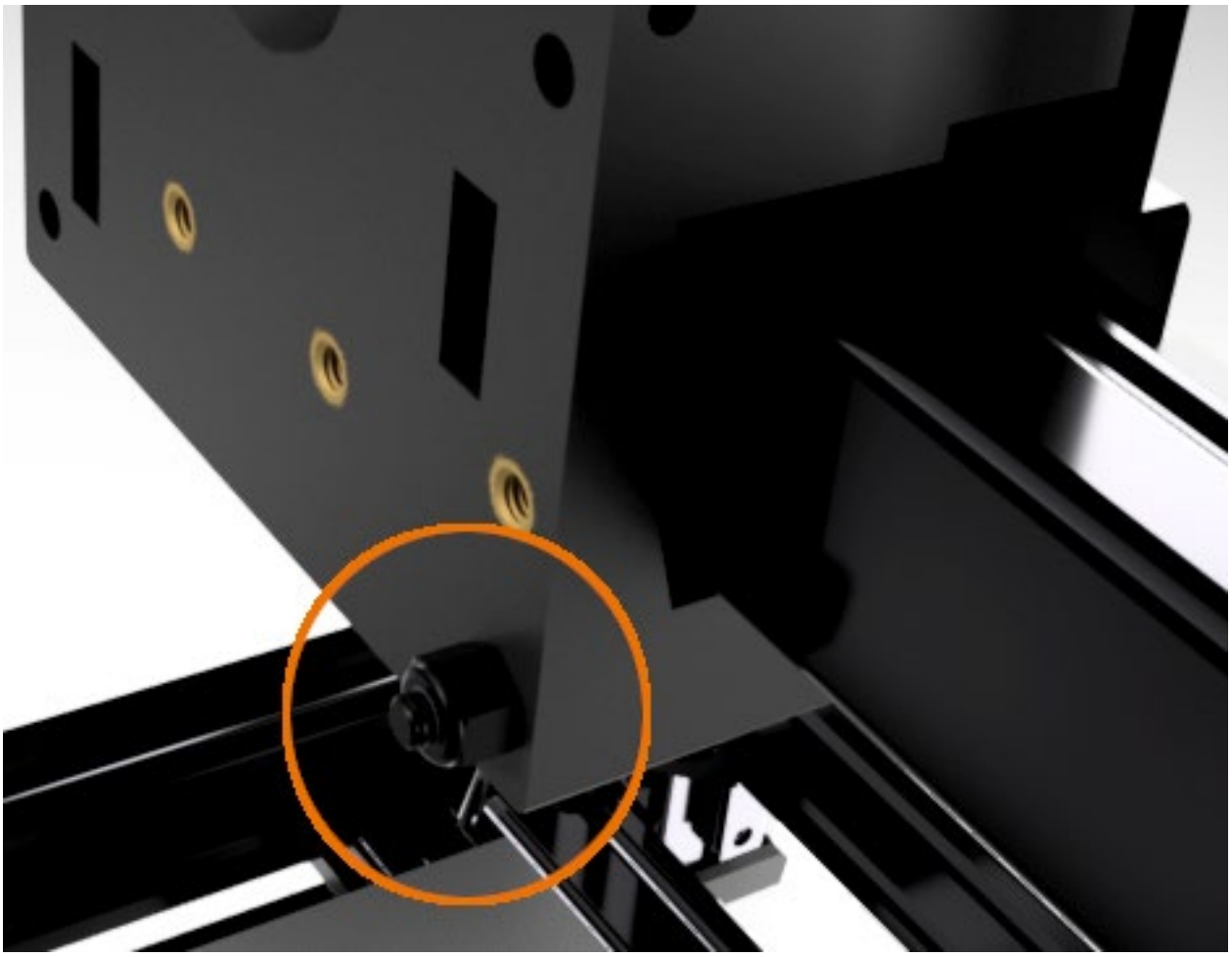
Locate CNC_Belt_Clamp_Left and loosely secure with ISO7380_M3_8mm_BHHS as shown. NOTE: The Belt Clamp is oriented to keep the outside edge of clamp flush to the outside edge of X-Plate.



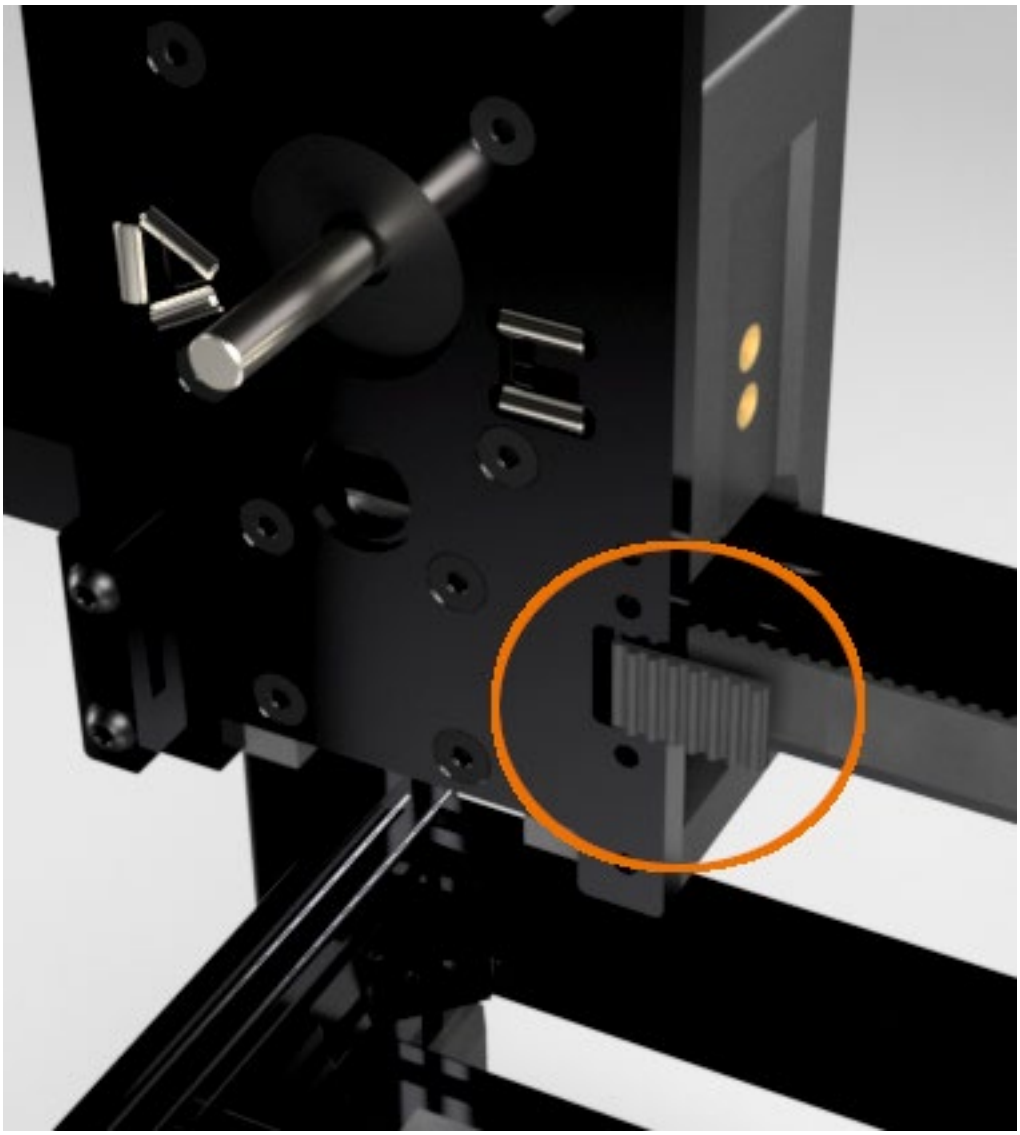
Insert a ISO7380_M3_45mm_BHHS fully into the location shown below.



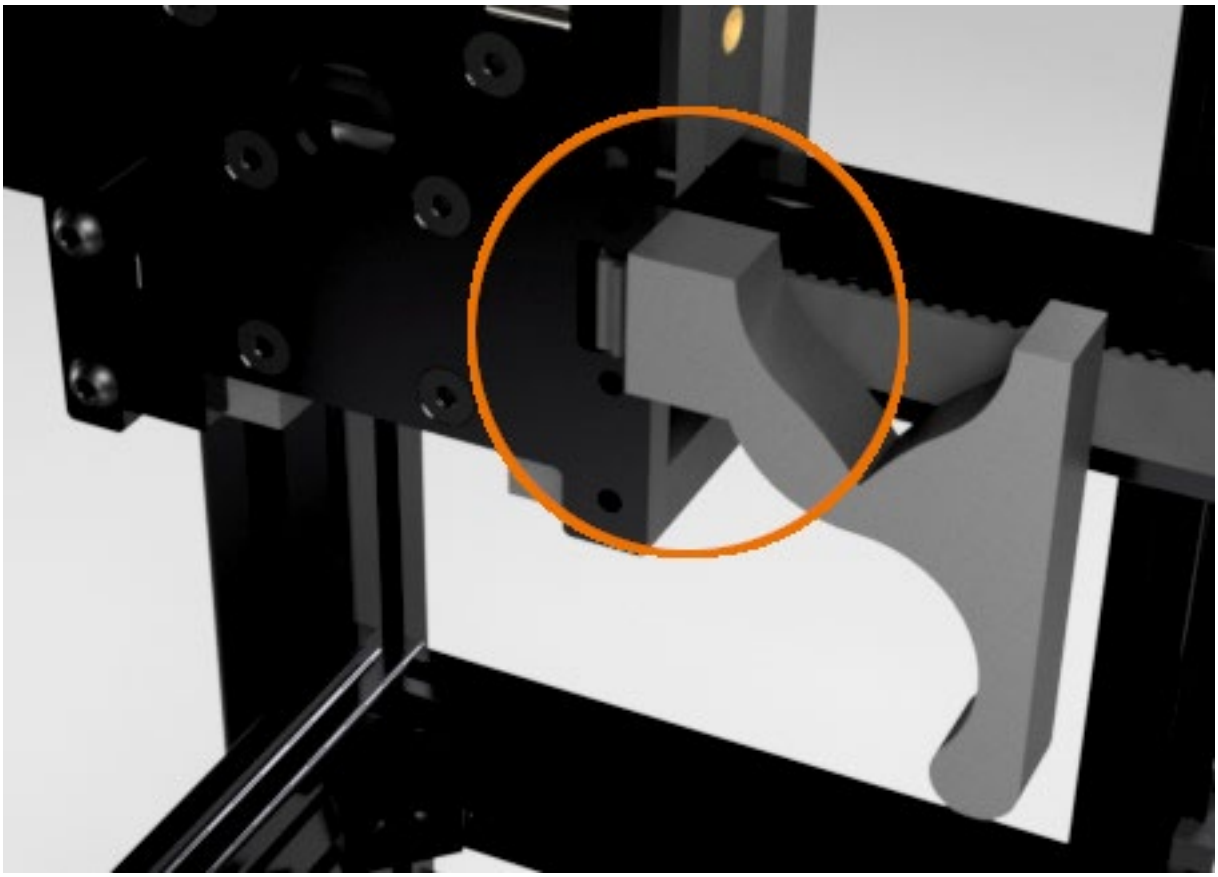
Loosely install a DIN985_M3_Nylon_Lock_Washer onto the M3x45 screw as shown.



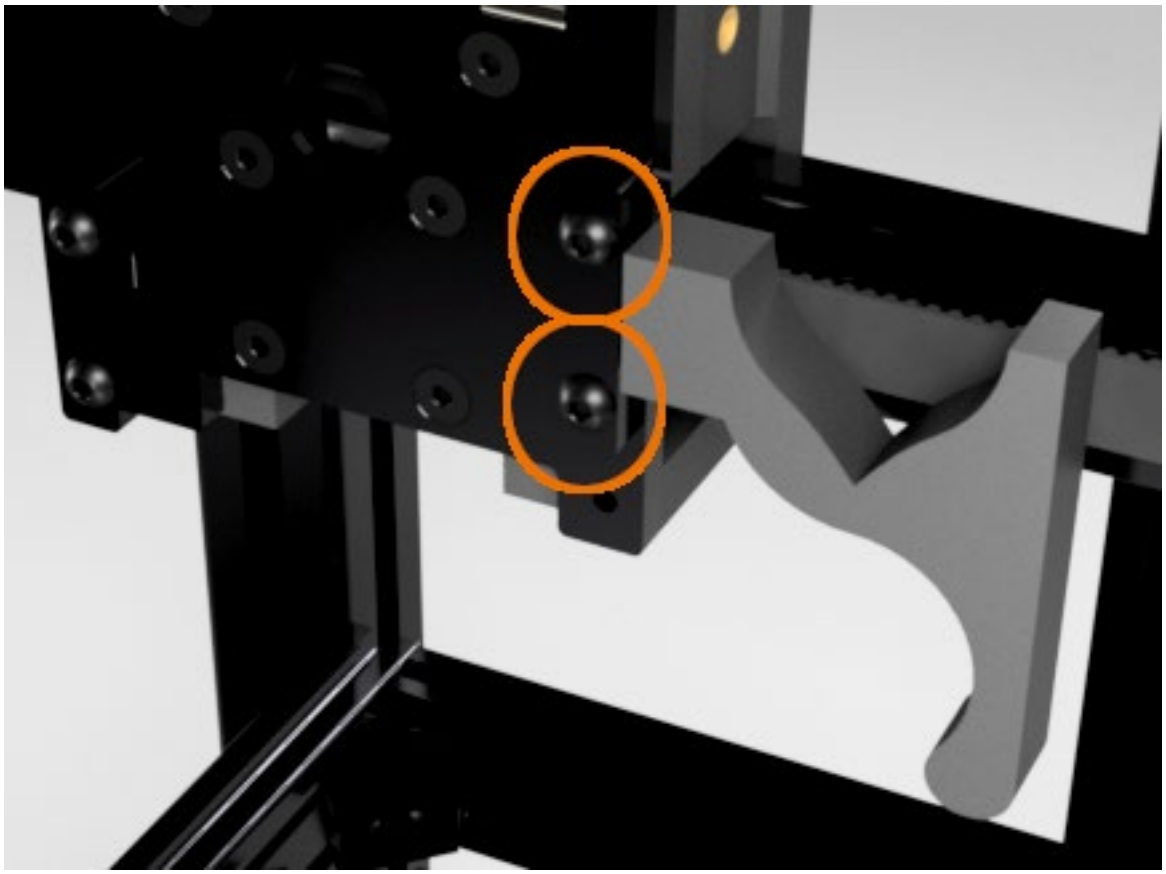
Pull the XY belt to bring the printed tool snug to the body of X-Plate. Keep tension on the XY belt while checking the printed X bracket is aligned with the X-Plate. Fully tighten both BHHS going through the belt clamp. You may need to hold the lock nut captive in order to fully tighten the M3x45 BHHS. Also fully tighten the M3x35 SHCS installed previously. Remove the printed belt tightening tool. Locate the remaining GT2_894t_Belt_9x1788mm_(1.52mm) and insert through the back of the X-Plate as shown.



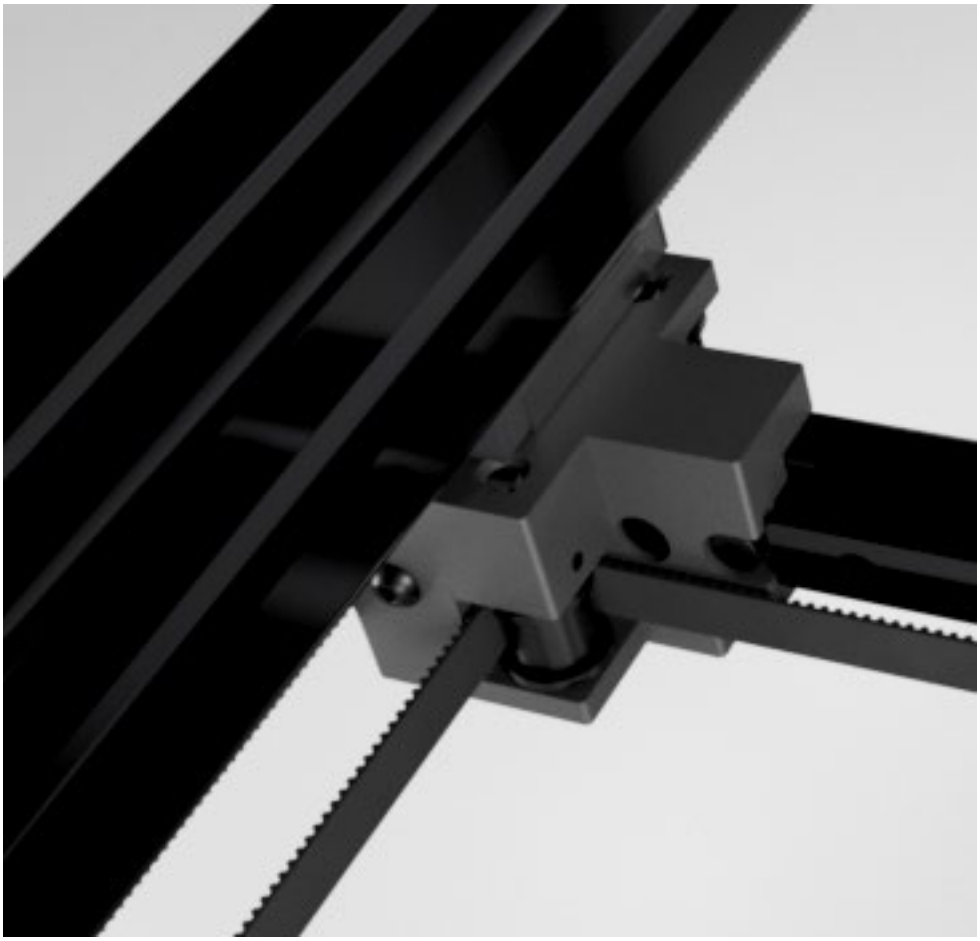
Attach the Print_XY_Belt_Tightening_Tool_(1.52mm) to the end of the XY belt as shown. Note: The printed tool is inverted when installed on this side of the X-Plate.



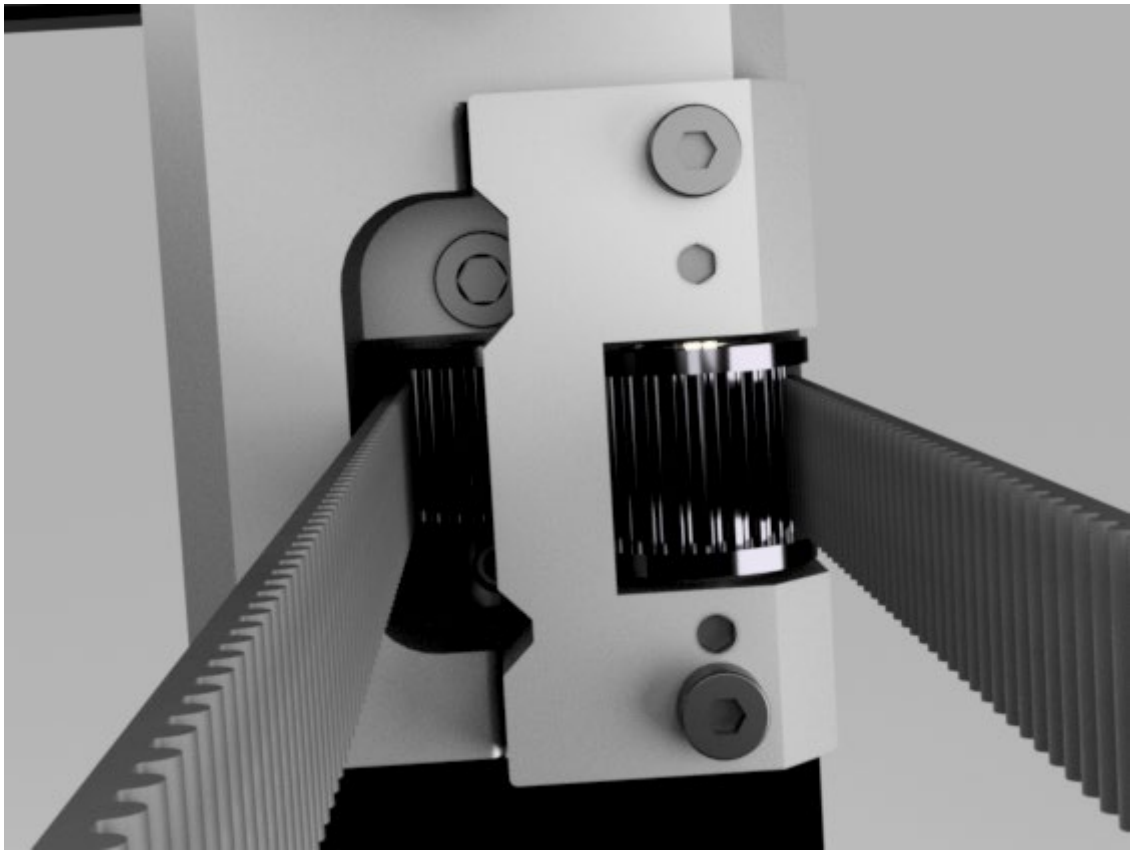
Locate the remaining CNC_Belt_Clamp_Left and loosely attach to the X-Plate with two ISO7380_M3_8mm_BHHS as shown.



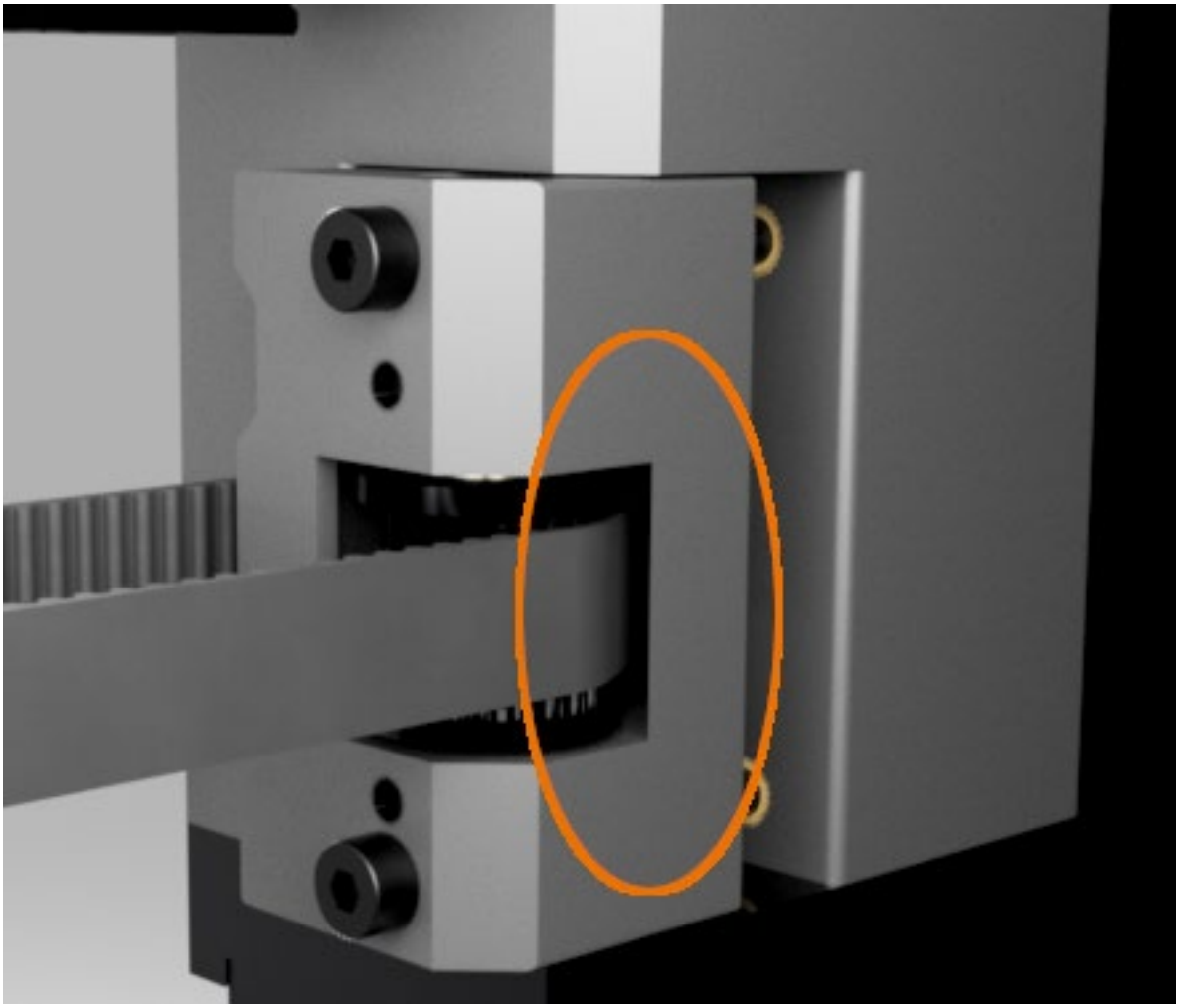
Pull the XY belt to bring the printed tool snug to the body of X-Plate. Keep tension on the XY belt and fully tighten both BHHS going through the belt clamp. Remove the printed belt tightening tool. Take time to verify that the X-carriage freely slides along the linear rail. Any binding or “rough spots” felt during the movement from one end of the X-Axis to the other could indicate problems in the MGN-12 cartridge. Check the movement of the entire X-Gantry on the Y-Axis by moving the gantry from one end of machine to the other. The Y bracket assemblies should glide along the linear rails freely. Return to the first XY belt attached to the rear side of the X-Plate. Route the loose end of the belt through the Rear Y-Axis Bracket assembly. The smooth side of the XY belt goes around the smooth pulley in the Y bracket as shown.



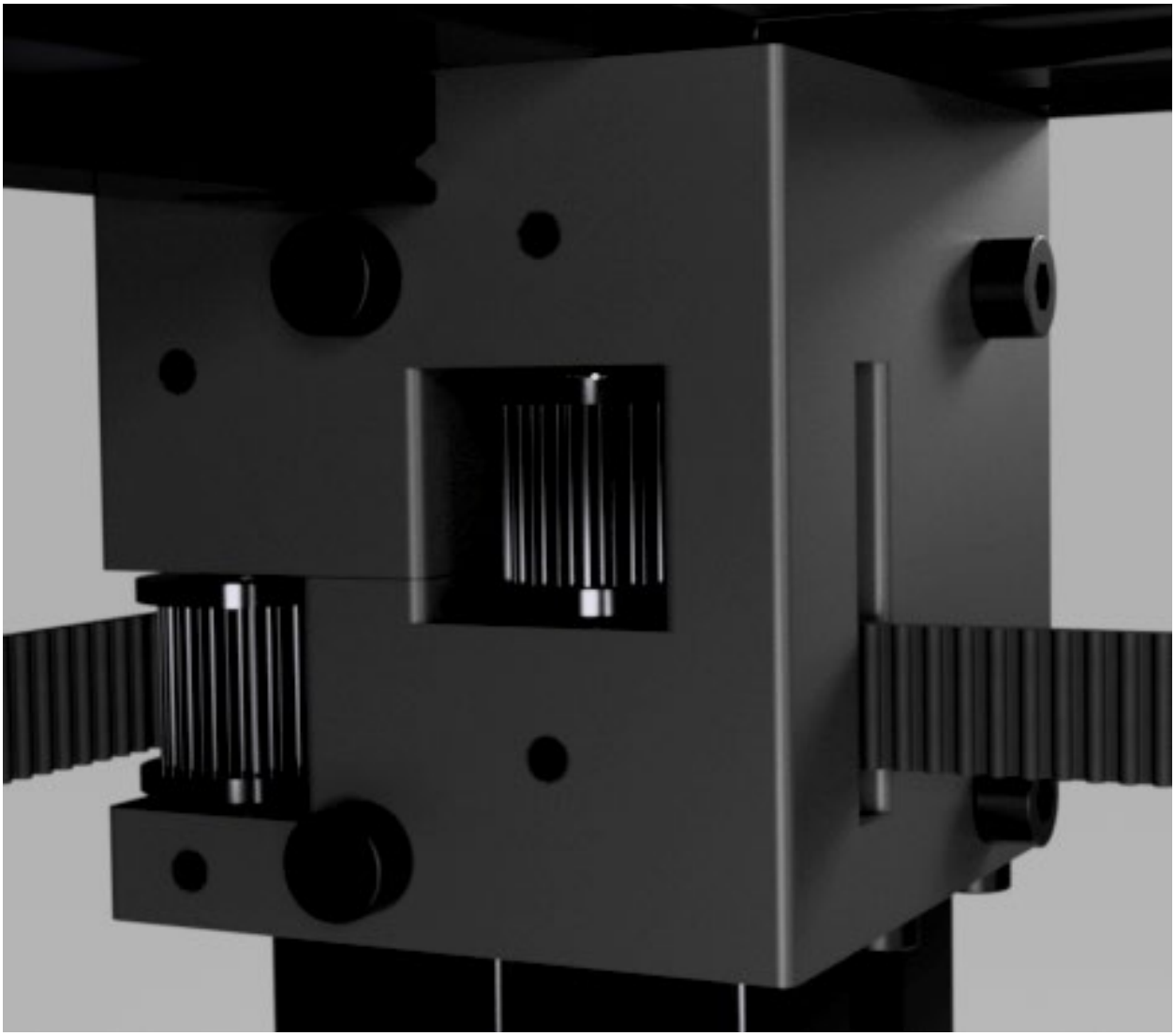
Now route the loose end of this XY belt through the rear XY motor assembly. The toothed face of the belt faces the toothed pulleys. Start by feeding the belt around the motor pulley and having the belt exit the motor assembly through the tensioner idler.



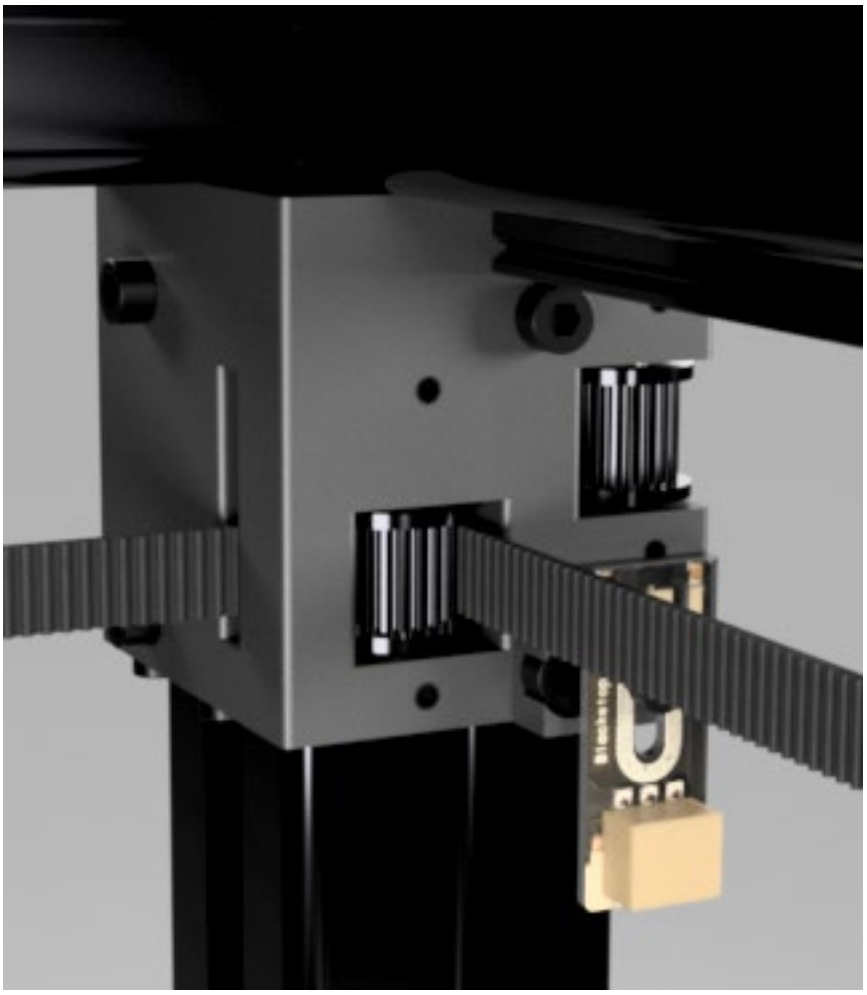
The toothed belt should only come in contact with the toothed pulleys. It should not rub or touch any other part of the machine. Verify that belt is going through tensioner housing and not around the tensioner housing.



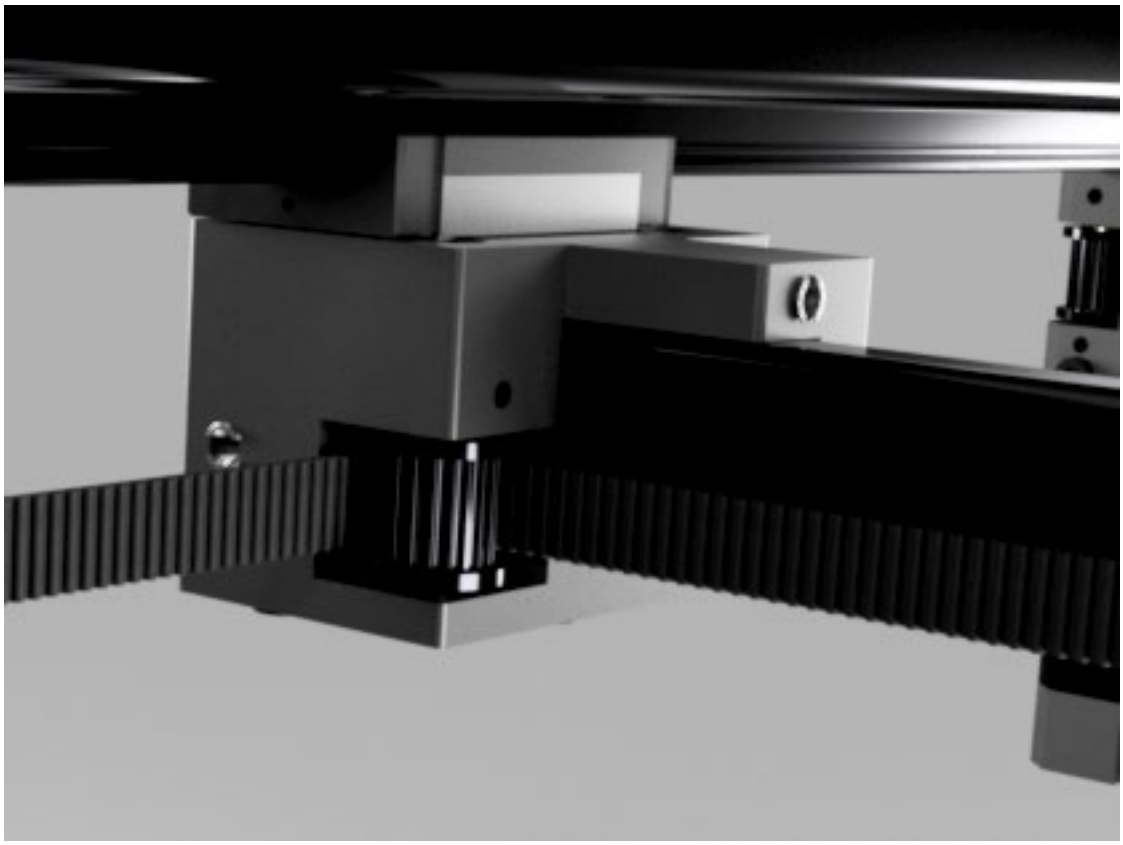
Route the loose end of the XY belt through the rear XY corner bracket around the lower pulley and through the slot towards the front. Again, the toothed face of the belt is to mate with the toothed pulley profile.



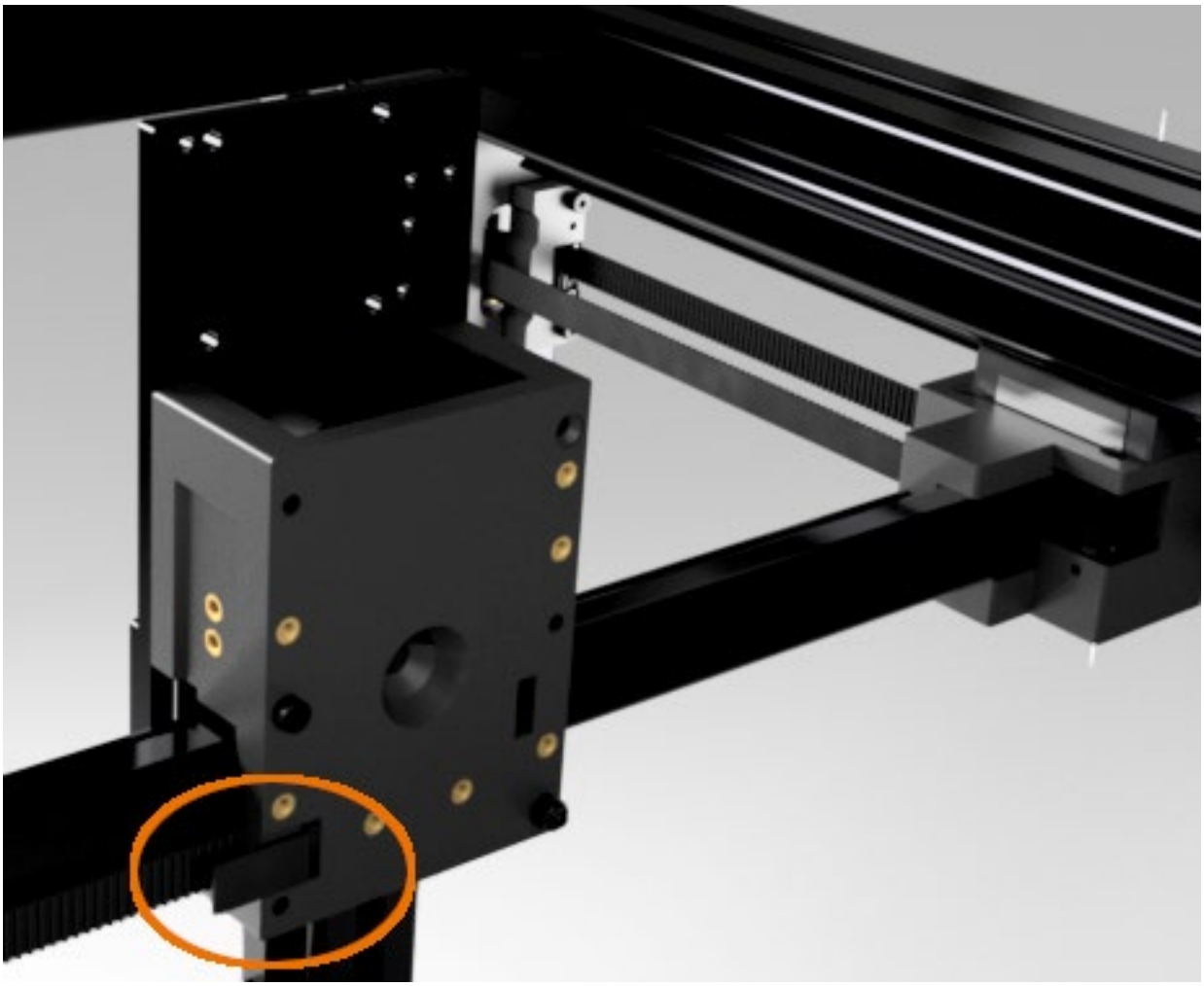
Continue to route the loose end of the XY belt through the front XY corner bracket slot then around the lower pulley and out toward the left.



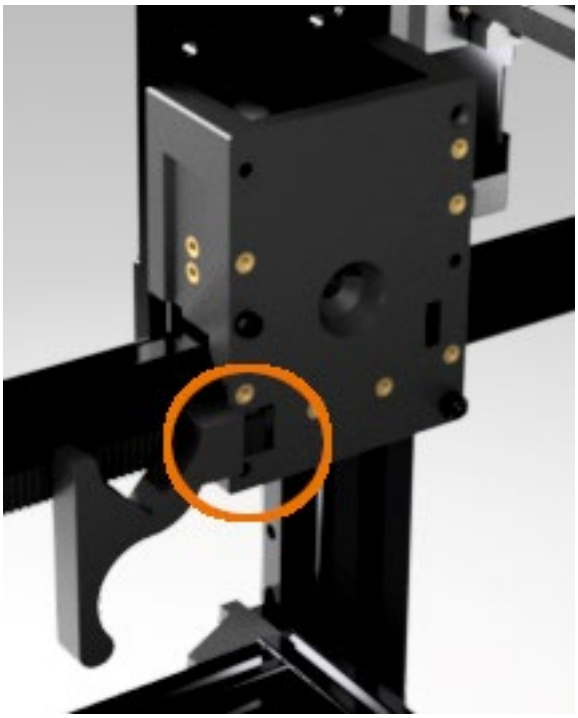
Route the loose end of the XY belt through the front Y-Axis bracket around the toothed pulley and toward the X-Plate.



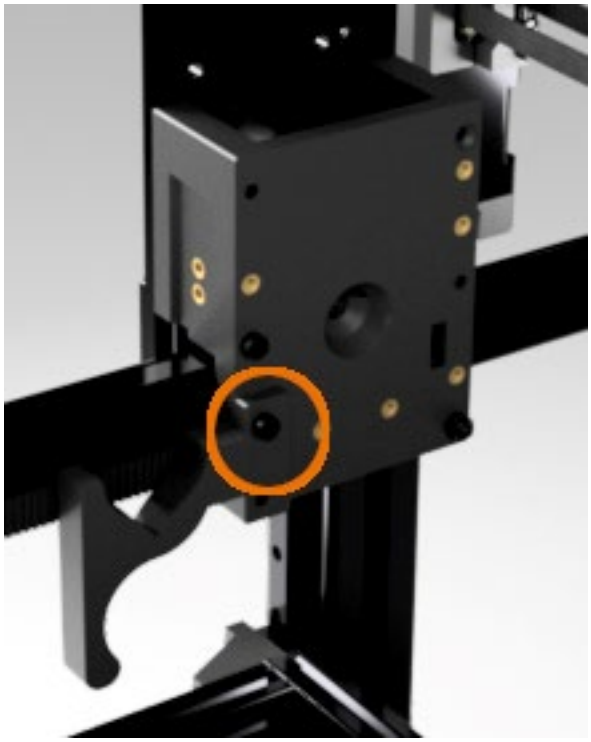
Route the loose end of the belt through left front slot on the printed X-Bracket as shown.



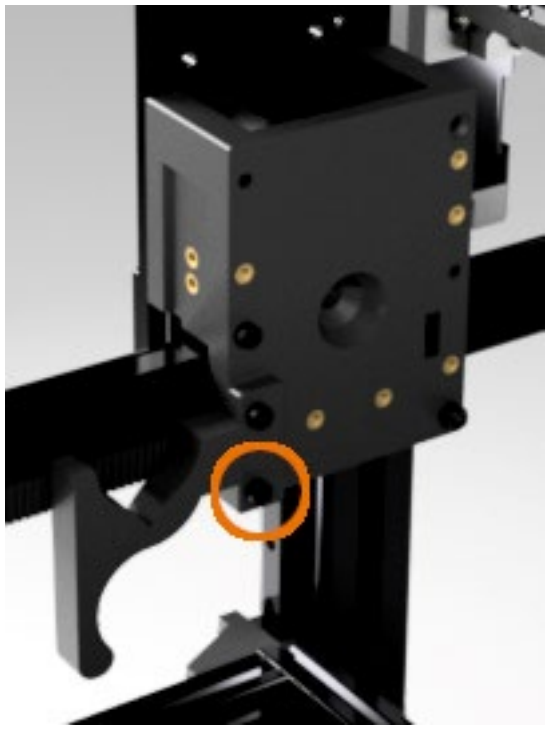
Attach a Print_XY_Belt_Tightening_Tool_(1.52mm) to the end of XY belt.



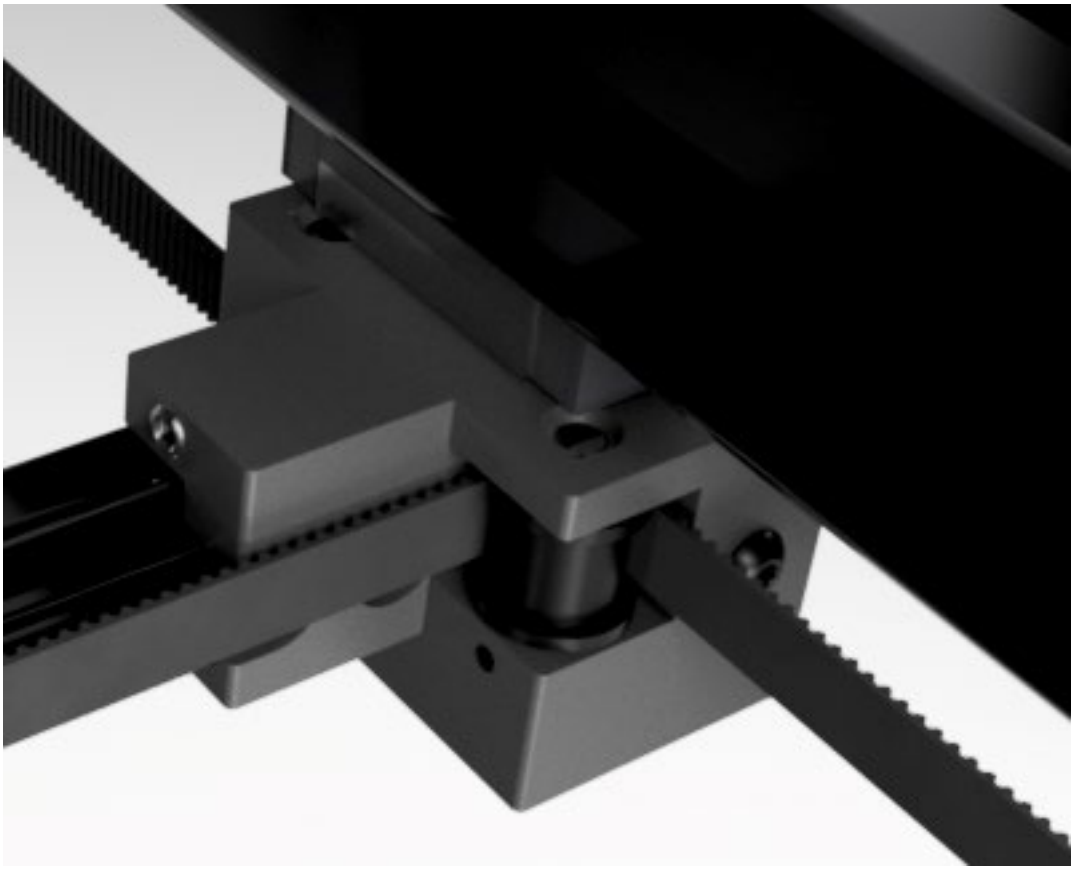
Locate Print_BeltClamp_Right_Front and loosely secure with a DIN912_M3_10mm_SHCS. Note: Orient this printed part so the edge of the printed clamp is flush with the front edge of the X-Bracket.



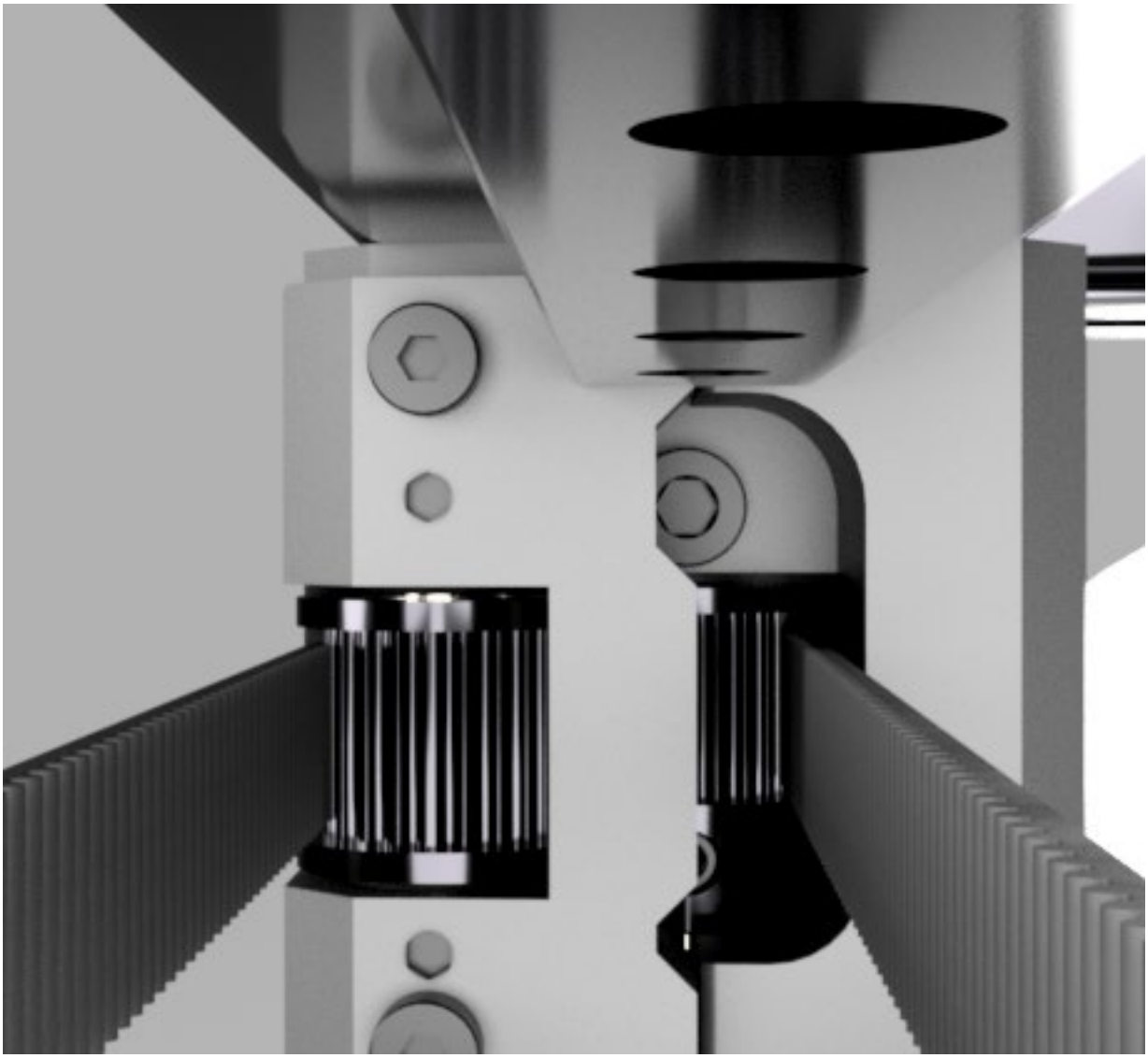
Loosely secure the other end of the printed clamp with a DIN912_M3_40mm_SHCS.



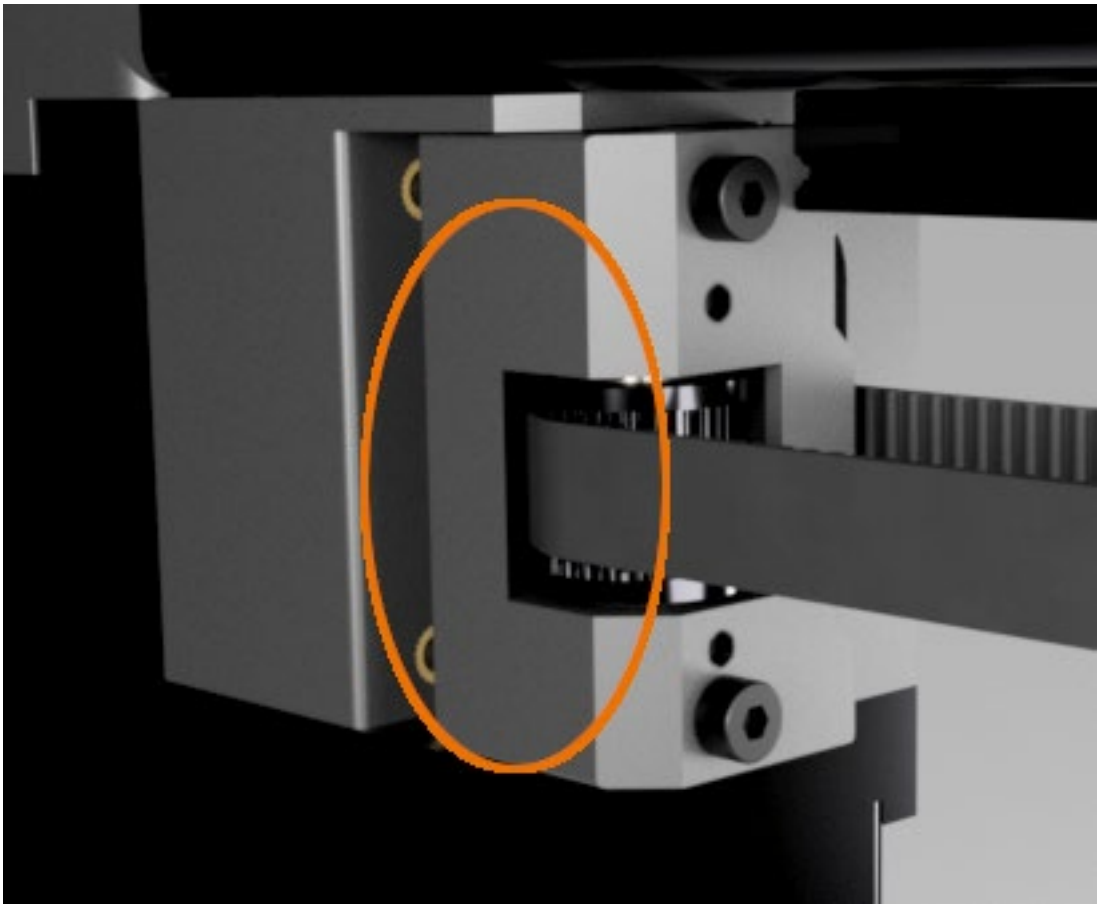
You will now remove excess slack in the installed belt. This step is not to achieve the final belt tension. Pull on the printed belt puller tool to remove slack from the belt. If the X-axis gantry begins to move, then the tension is too tight. Only pull until just before movement on the X-axis gantry is observed. Hold this position while fully tightening the two M3 screws going through the printed front belt clamp. Remove the printed tool. Route the loose end of the other XY belt through the smooth pulley of the front Y-axis bracket. The smooth side of the XY belt goes around the smooth pulley in the Y bracket as shown.



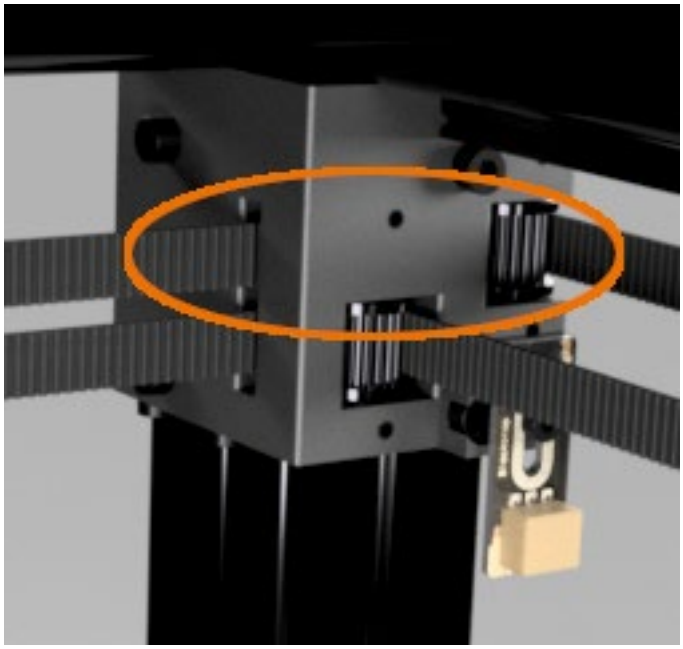
Now route the loose end of this XY belt through the front XY motor assembly. The toothed face of the belt faces the toothed pulleys. Start by feeding the belt around the motor pulley and having the belt exit the motor assembly through the tensioner idler.



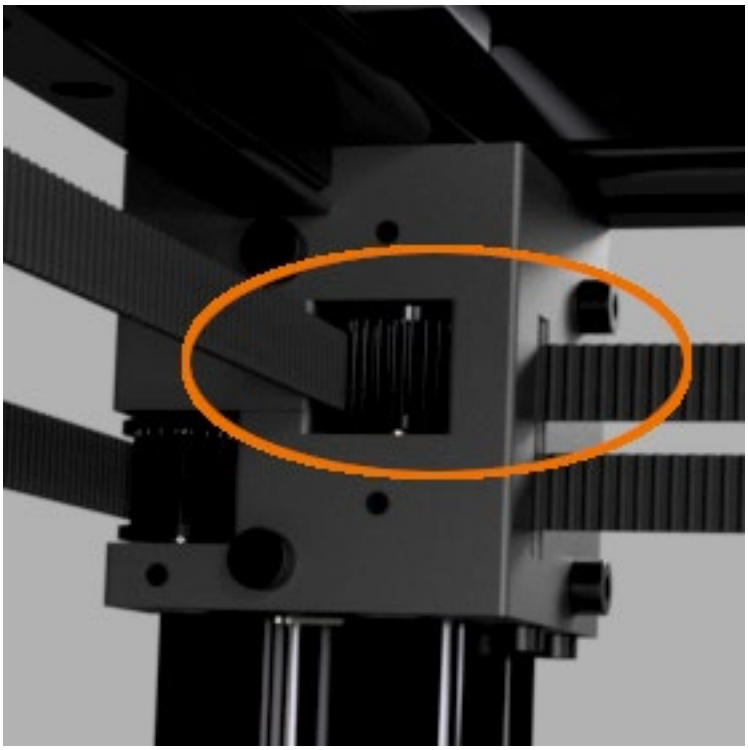
The toothed belt should only come in contact with the toothed pulleys. It should not rub or touch any other part of the machine. Verify that belt is going through tensioner housing and not around the tensioner housing.



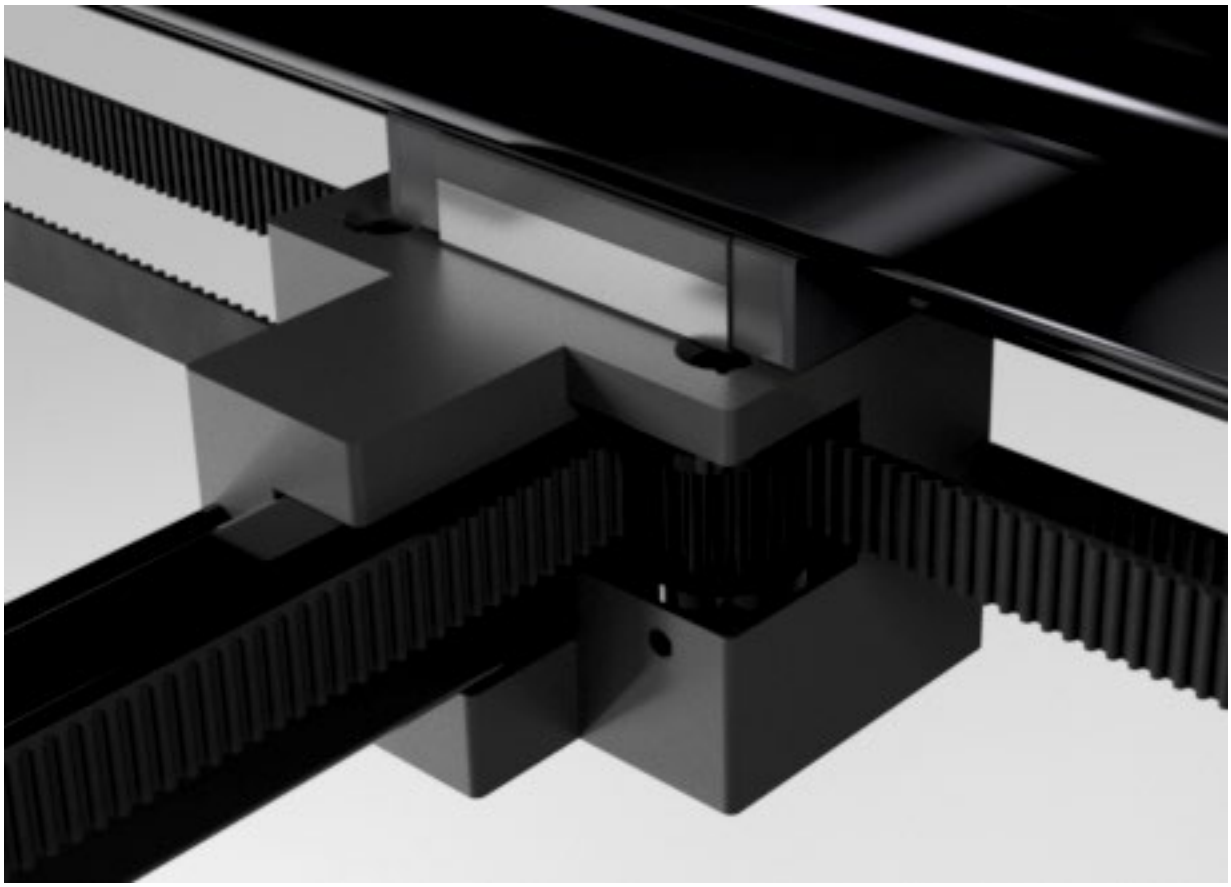
Route the loose end of the XY belt through the front XY corner bracket around the upper pulley and through the slot towards the rear. Again, the toothed face of the belt is to mate with the toothed pulley profile.



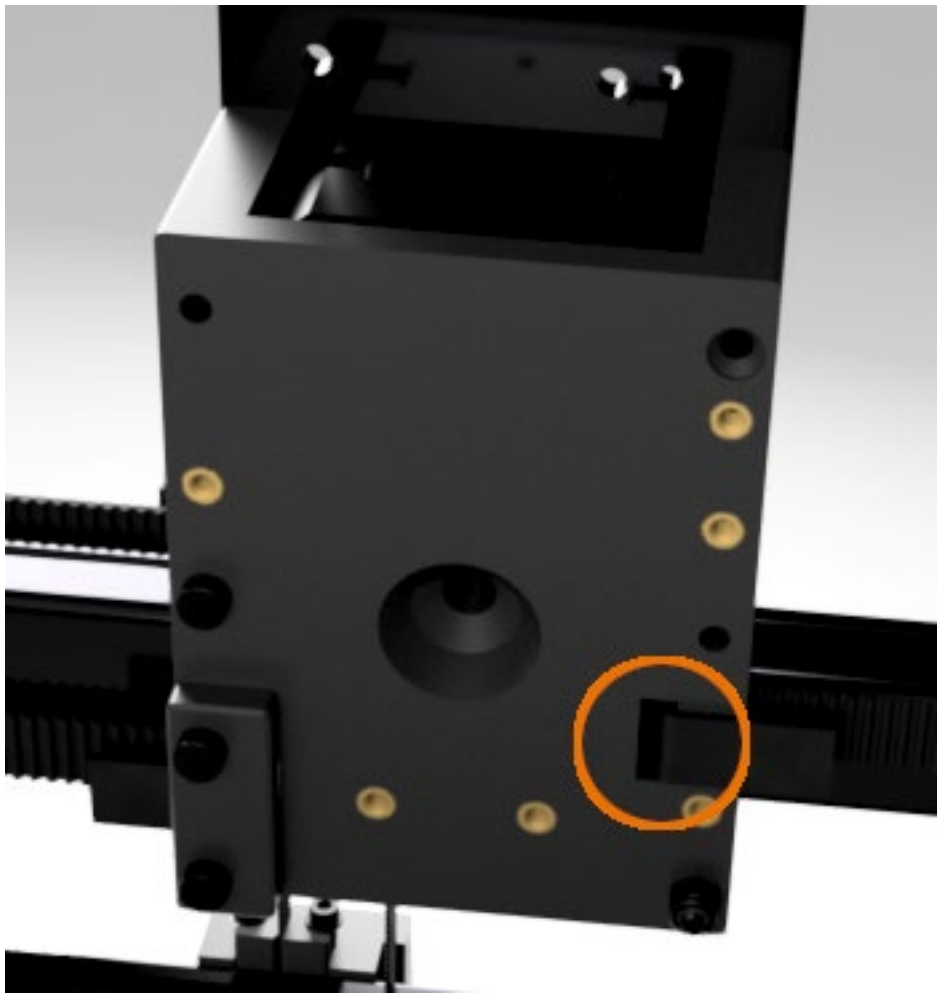
Continue to route the loose end of the XY belt through the rear XY corner bracket slot then around the upper pulley and out toward the left.



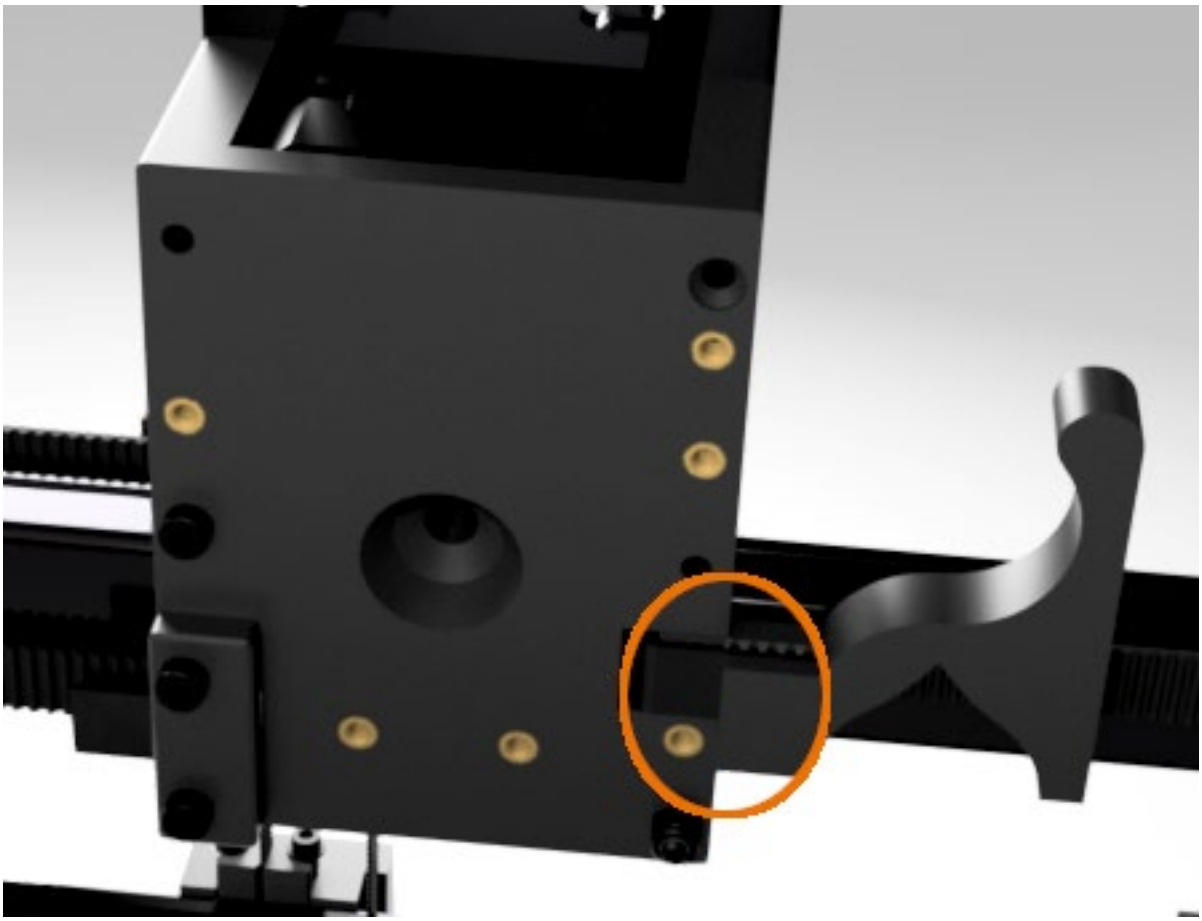
Route the loose end of the XY belt through the rear Y-Axis bracket around the toothed pulley and toward the X-Plate.



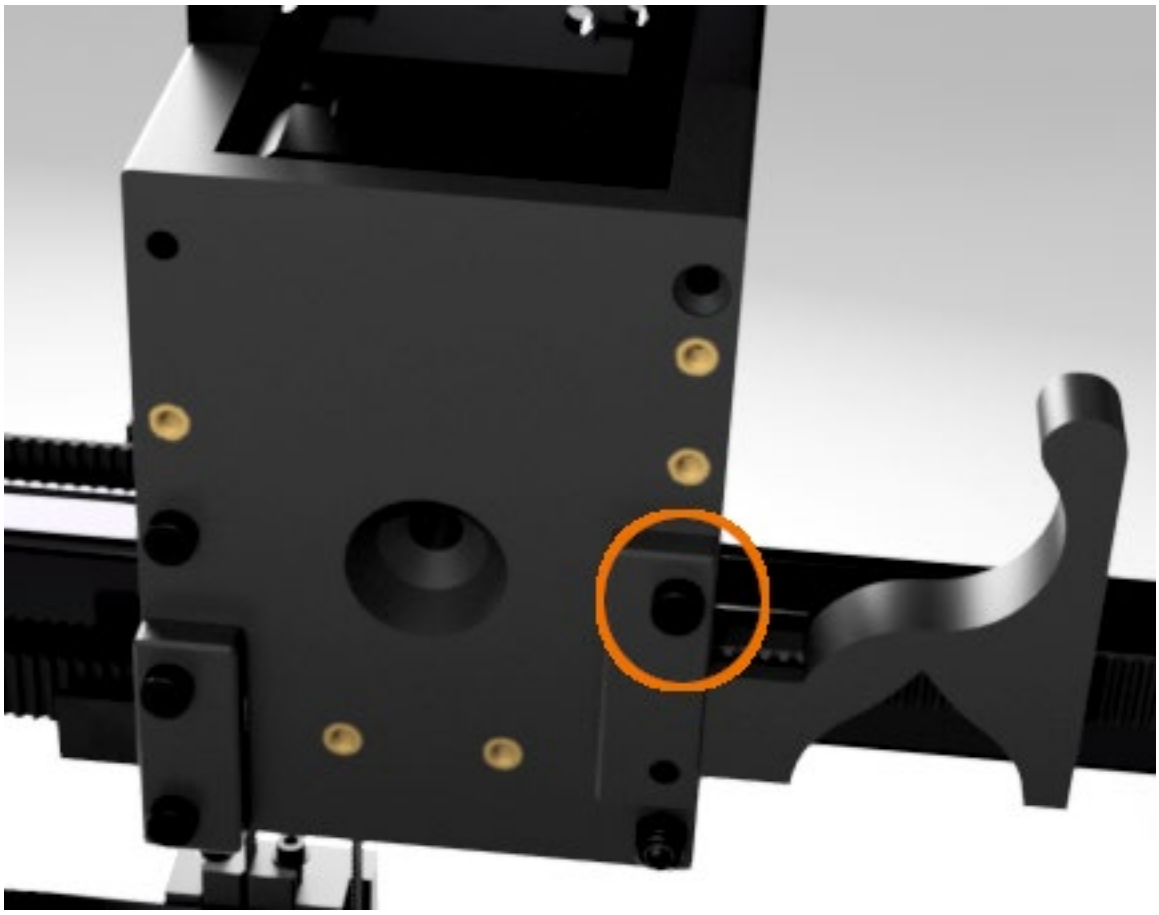
Route the loose end of the belt through left rear slot on the printed X-Bracket as shown.



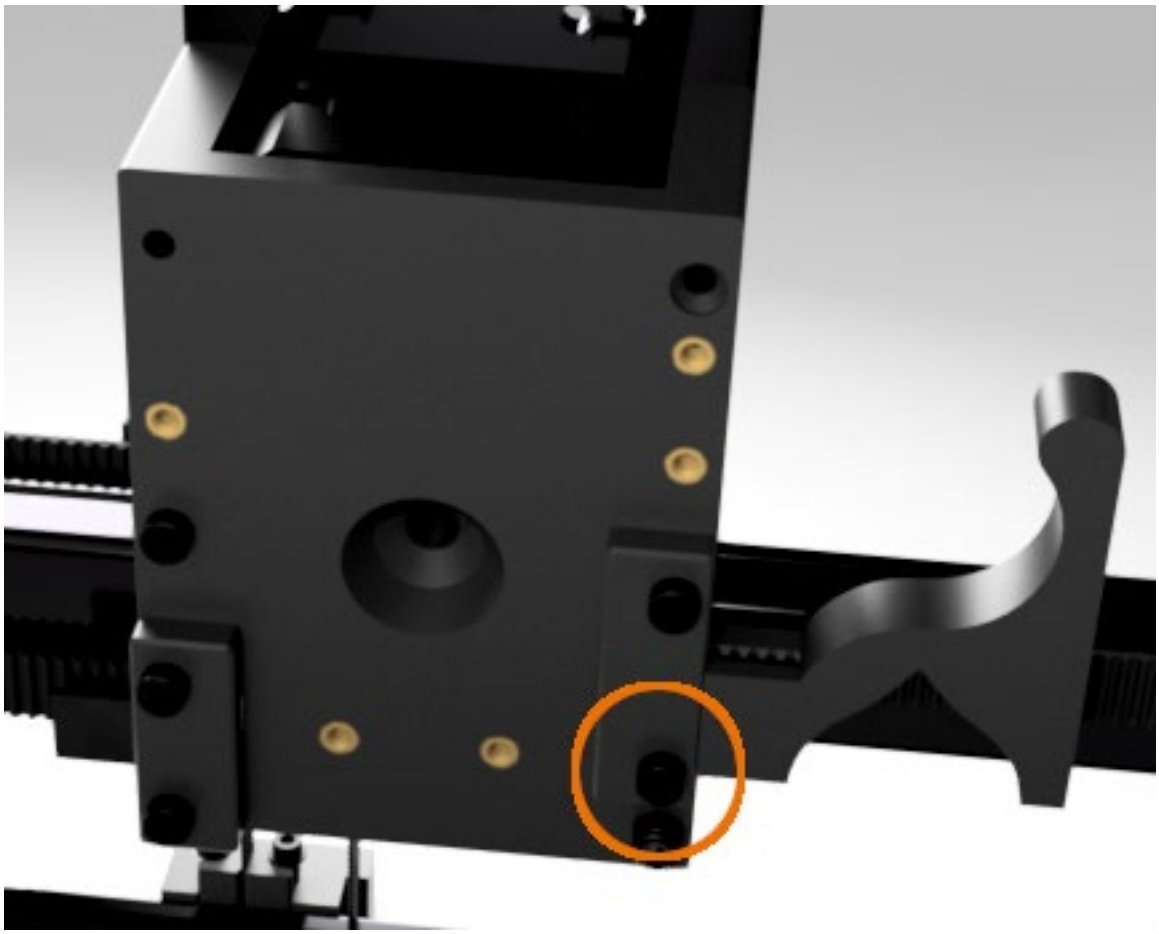
Attach a Print_XY_Belt_Tightening_Tool_(1.52mm) to the end of XY belt.



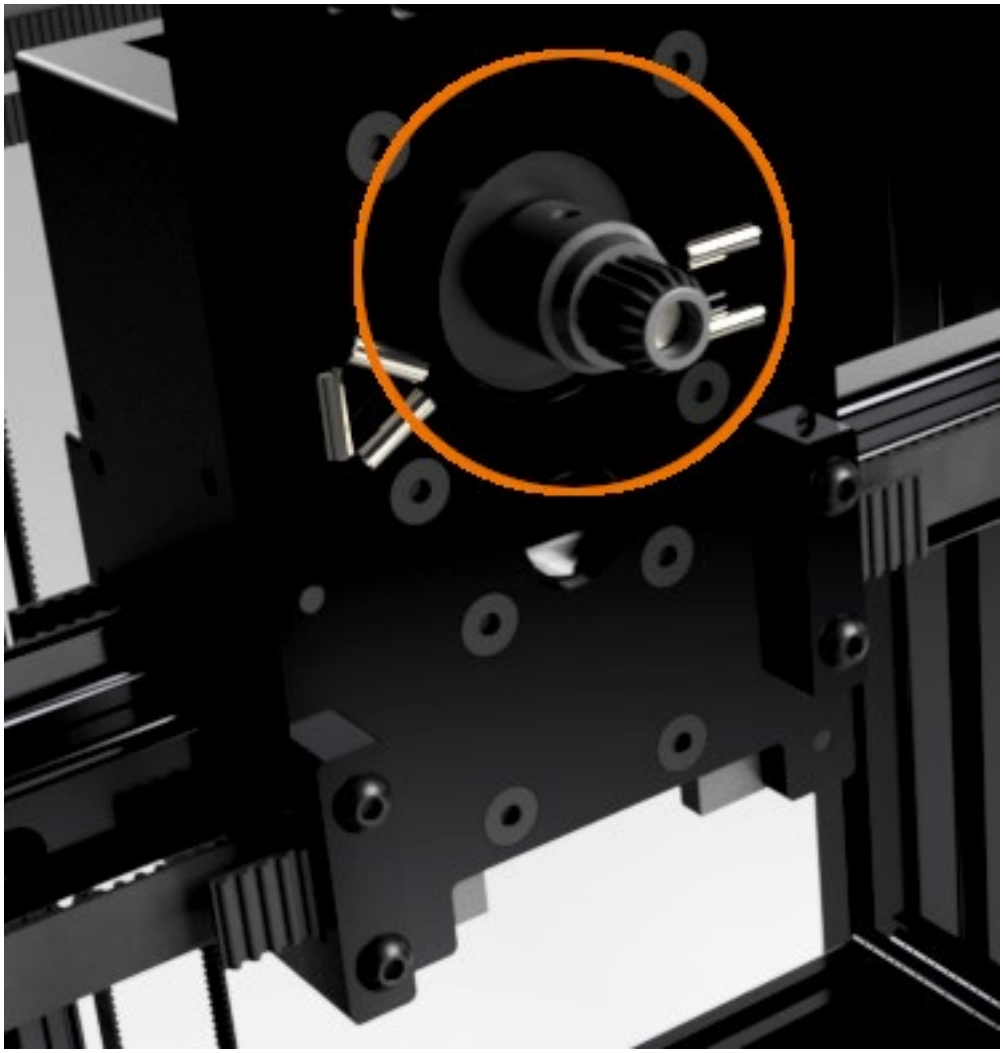
Locate Print_BeltClamp_Right_Rear and loosely secure with a DIN912_M3_40mm_SHCS. Note: Orient this printed part so the edge of the printed clamp is flush with the rear edge of the X-Bracket.



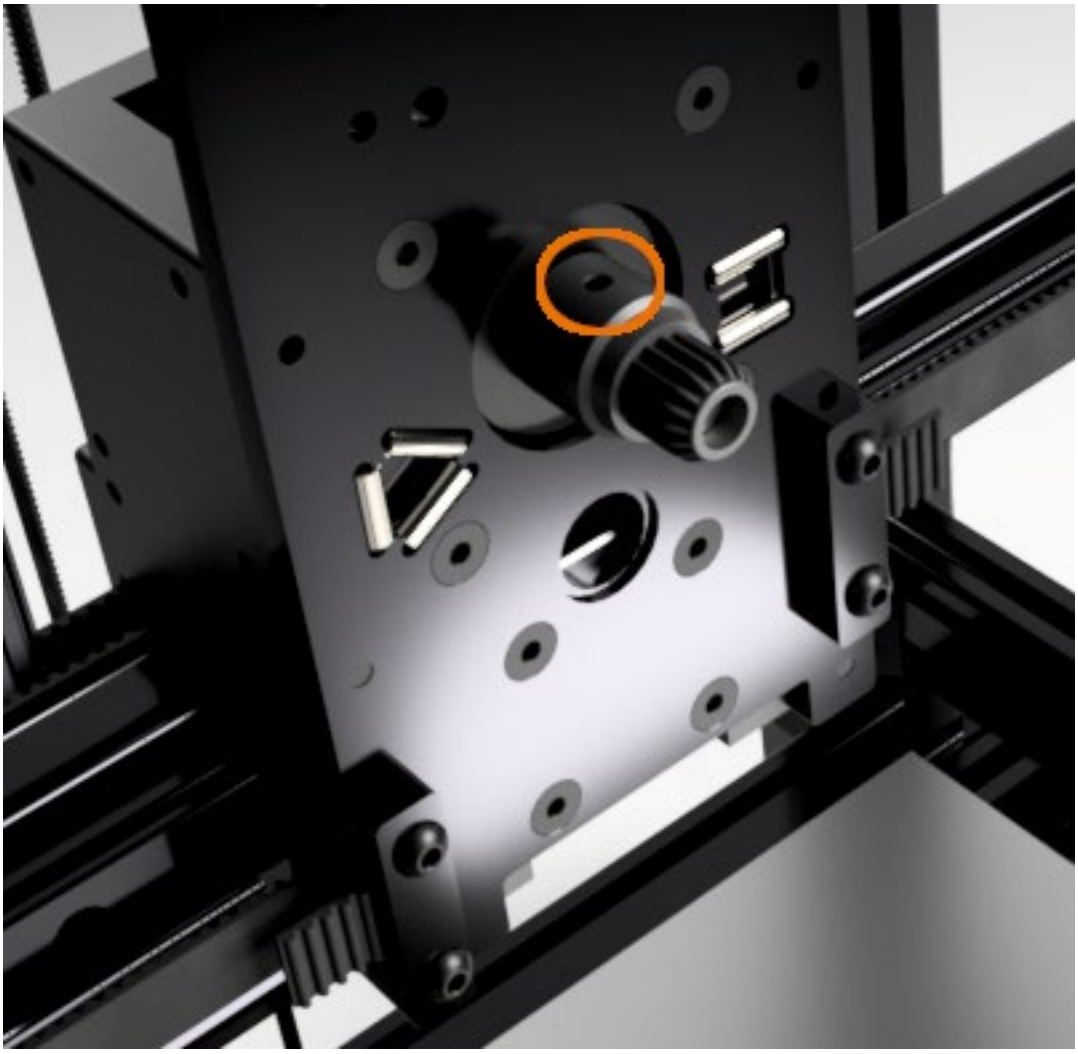
Loosely secure the other end of the printed clamp with a DIN912_M3_10mm_SHCS.



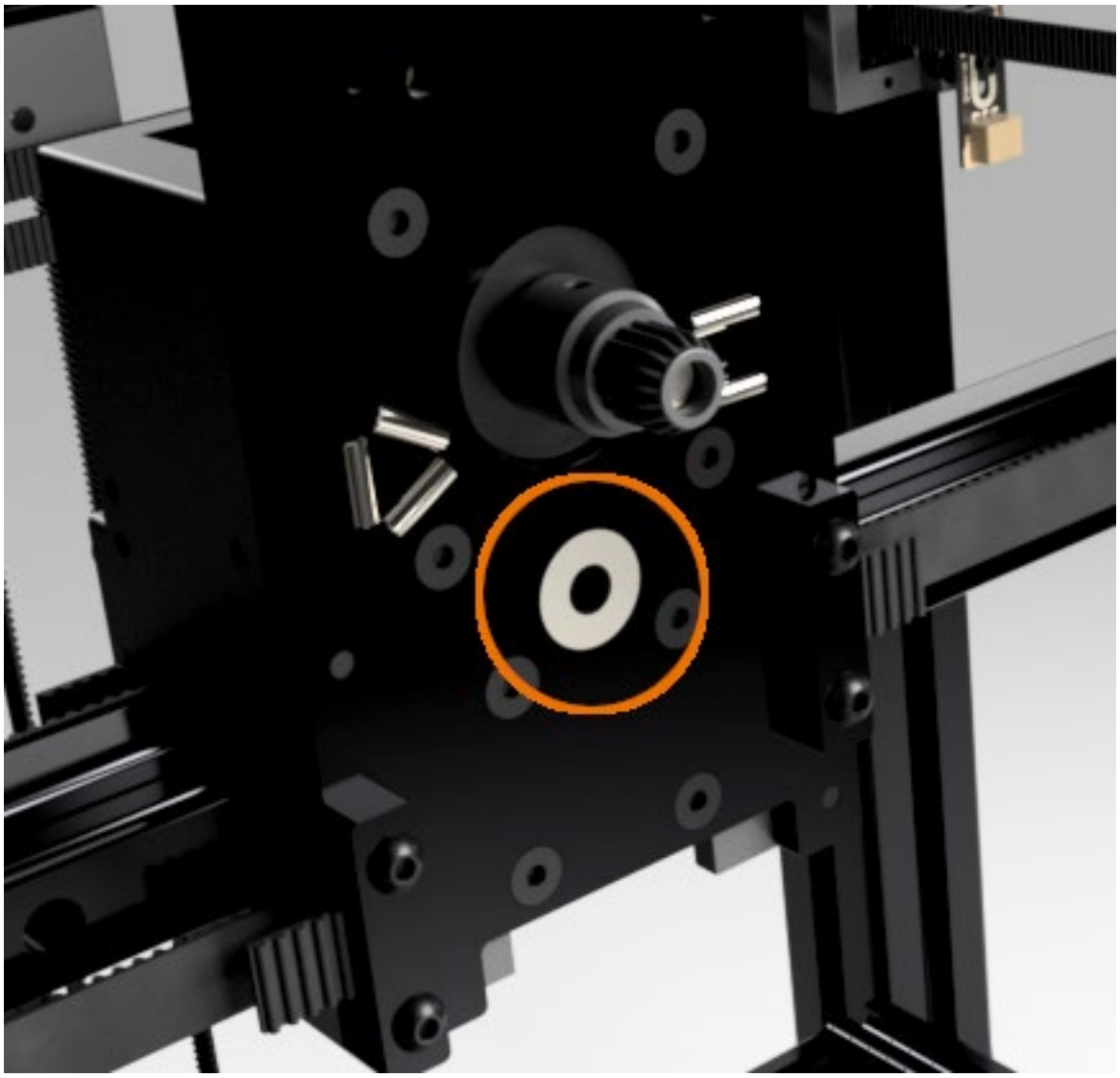
You will now remove excess slack in the installed belt. This step is not to achieve the final belt tension. Pull on the printed belt puller tool to remove slack from the belt. If the X-axis gantry begins to move, then the tension is too tight. Only pull until just before movement on the X-axis gantry is observed. Hold this position while fully tightening the two M3 screws going through the printed rear belt clamp. Remove the printed tool. Locate SLS_ExtruderDrive_ModifiedSetScrew and slide this gear onto the shaft of the extruder NEMA 17 motor. Align the set screw hole of the gear with the flat of the motor shaft.



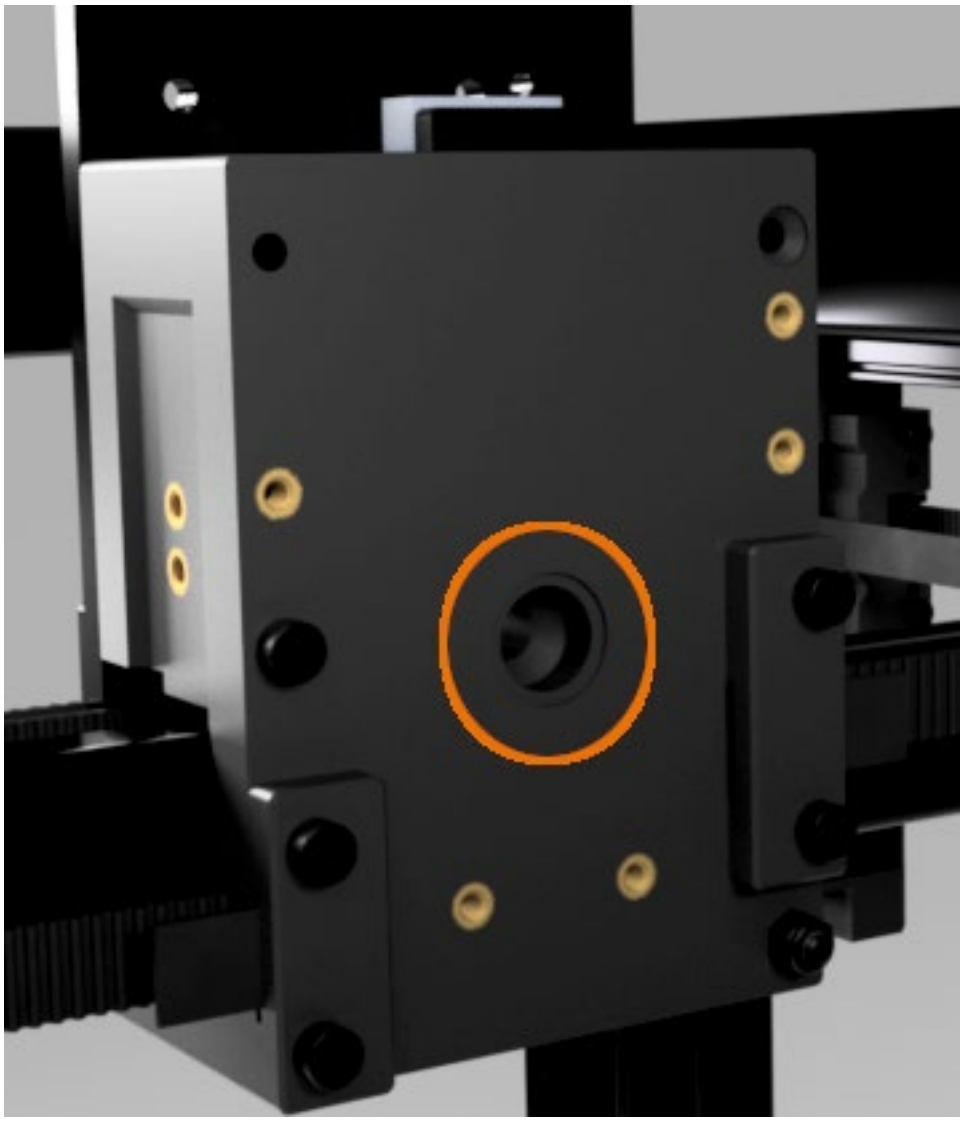
Secure the extruder drive gear to the shaft with a DIN916_M3_4mm_Set_Screw. As this screw tightens, wiggle the extruder gear to assure the flat end of the set screw mates flush with the flat of the NEMA 17 motor shaft. Keep the hub of the extruder gear slightly above the face of the motor to prevent the gear from rubbing against the motor while turning. Tighten the M3x4mm set screw completely.



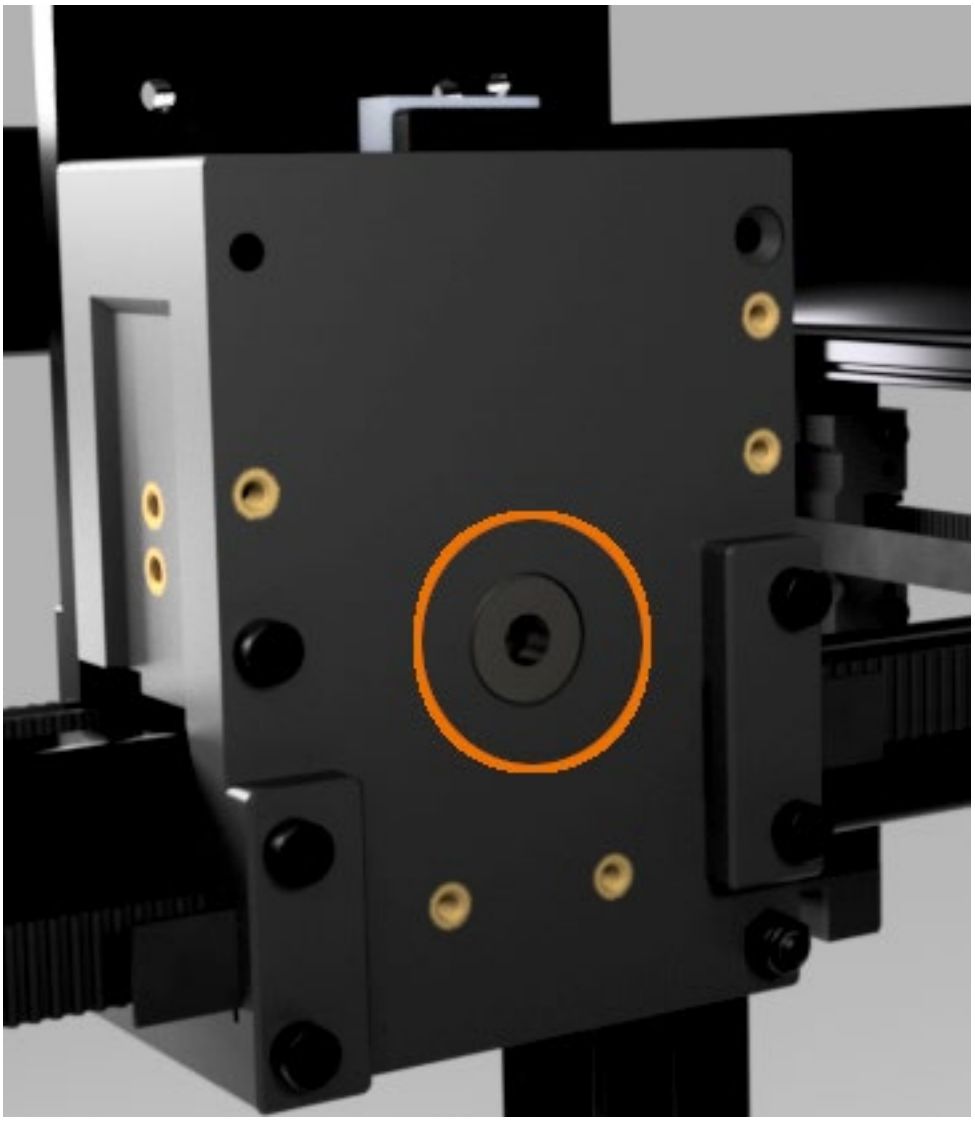
Locate a Bearing_Flanged_5x10x4mm and snap into the X-Plate as shown.



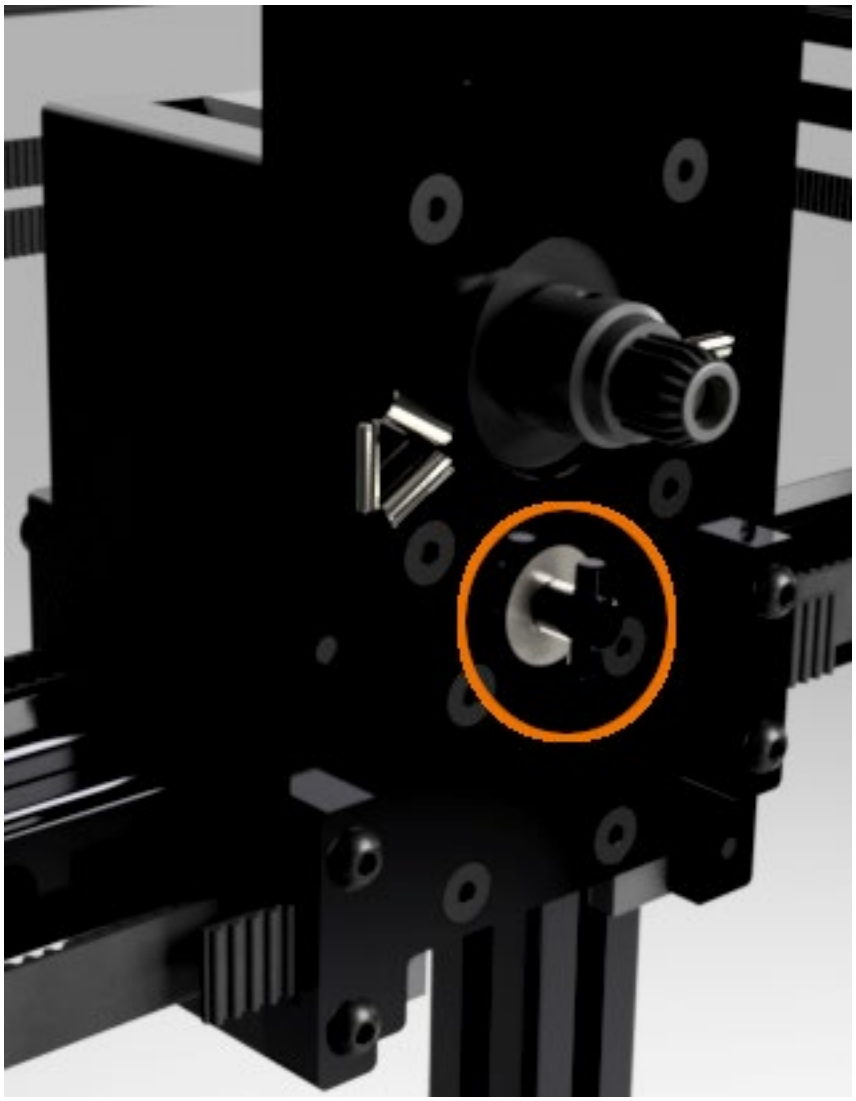
Locate Print_Bearing_Flanged_Pocket_5x10x4mm and snap into back of X-Bracket as shown.



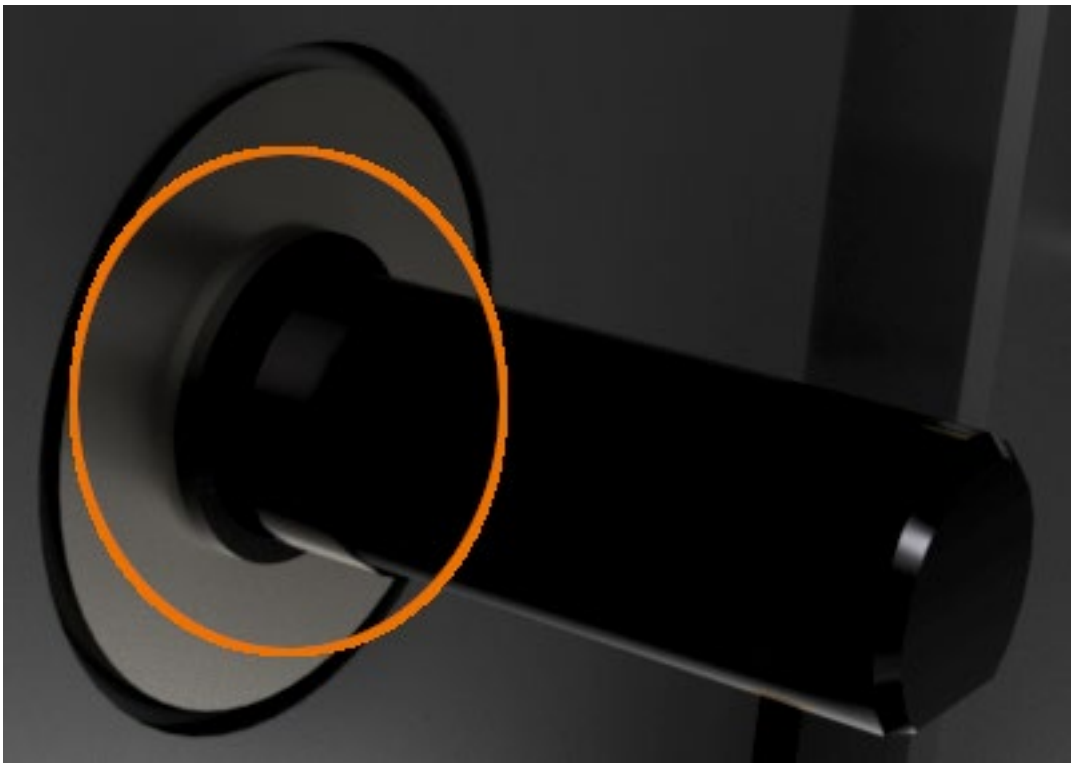
Locate another Bearing_Flanged_5x10x4mm and snap into the printed part as shown.



Locate the CNC_ToolChangeLock and slide through the two flanged bearings starting from the one in the X-Plate.

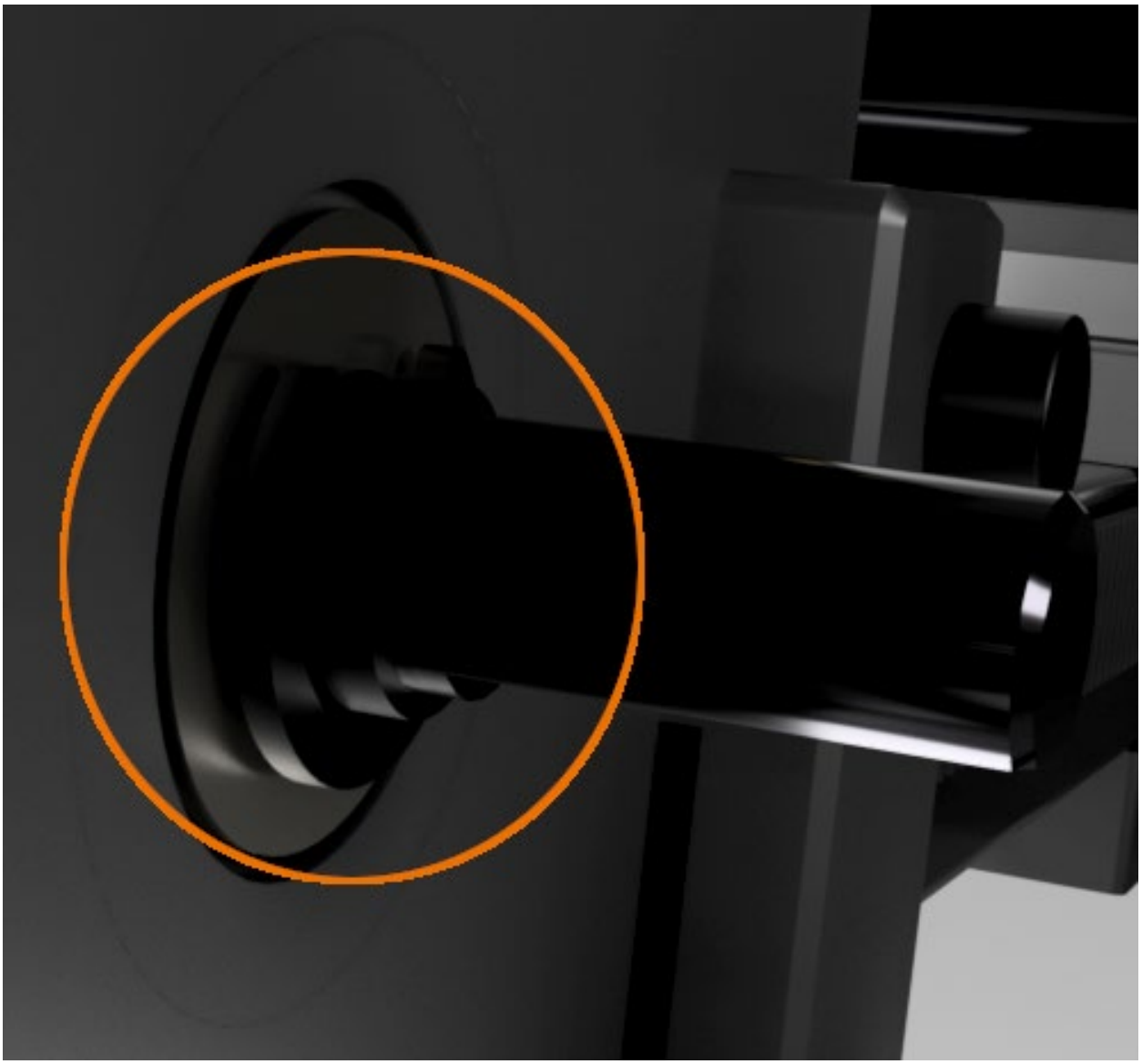


Locate a T-Lock_Shim. These parts are extremely small, be careful not to lose them during installation. Slide one shim onto the end of the T-Lock shaft. Be certain to push the shim past the groove.

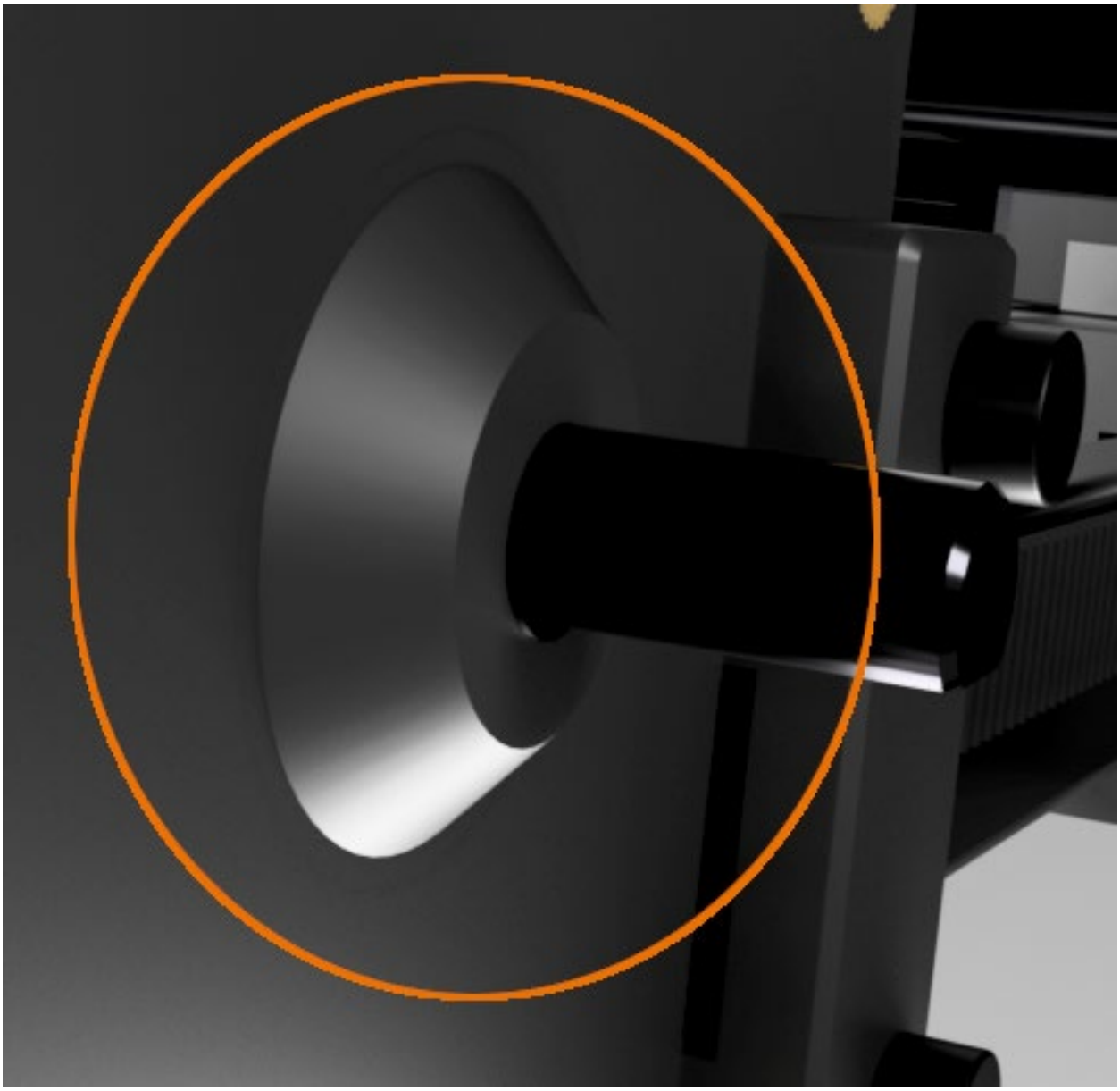


Locate 4MM_E-Clip and snap it into the groove of the end of the T-Lock.

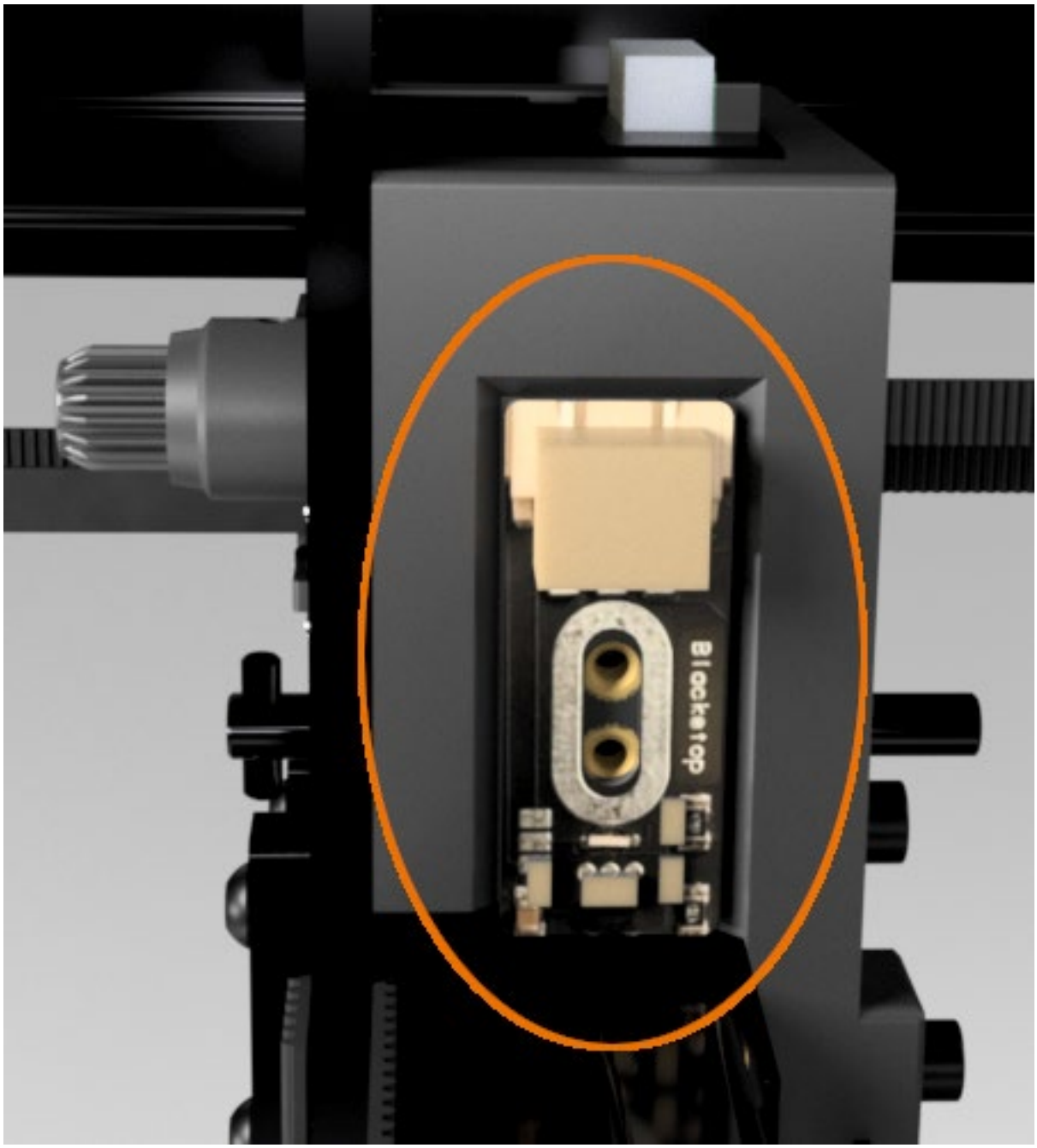
Slide three more T-Lock_Shim onto the end of the T-lock and slide them all the way to the E-Clip.



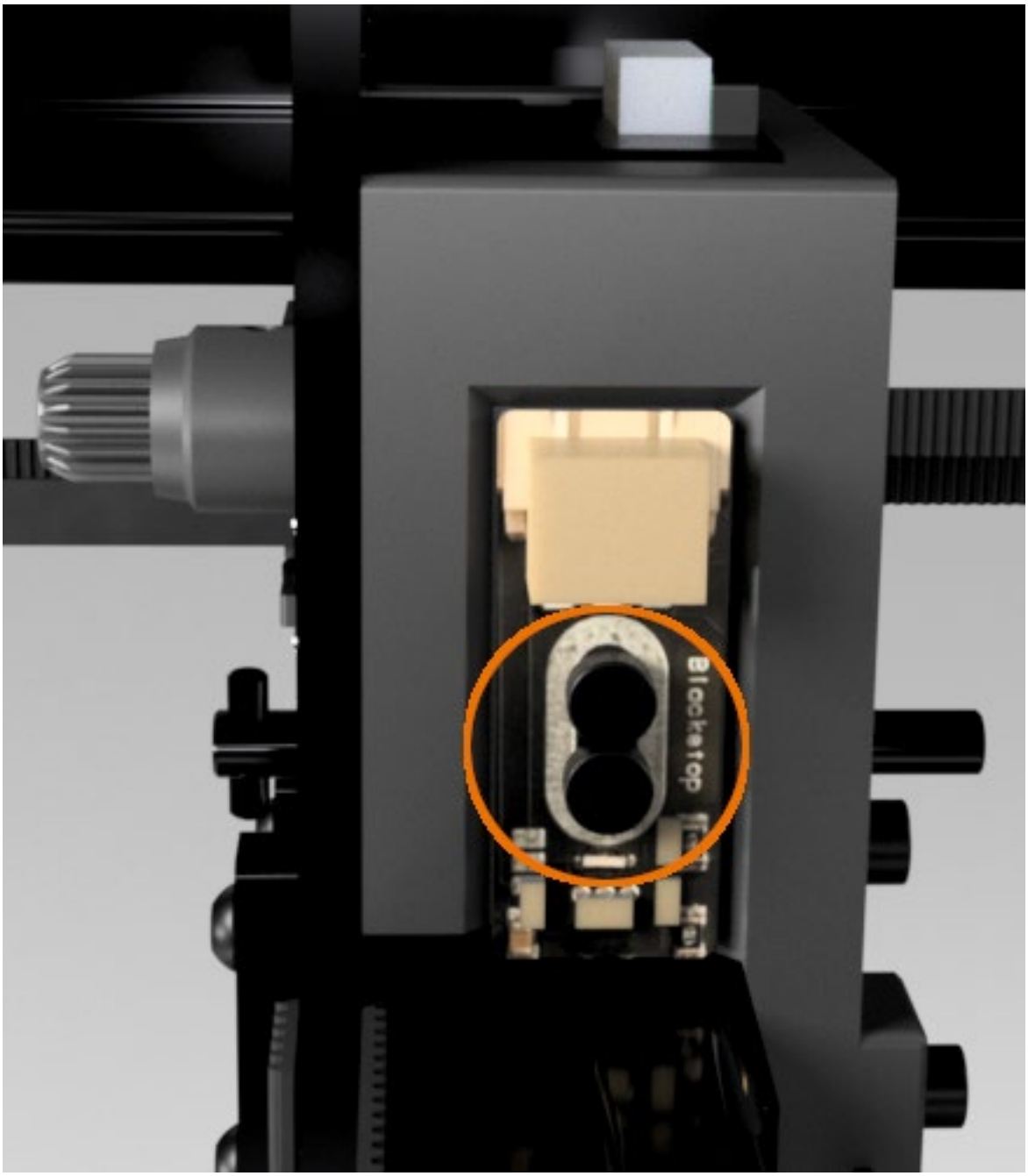
Locate Print_T-LockShimPocket and slide it over the end of T-Lock and press it flush to the back of the X-Bracket.



Locate a BlackStop and place on the front of the X-Bracket as shown.

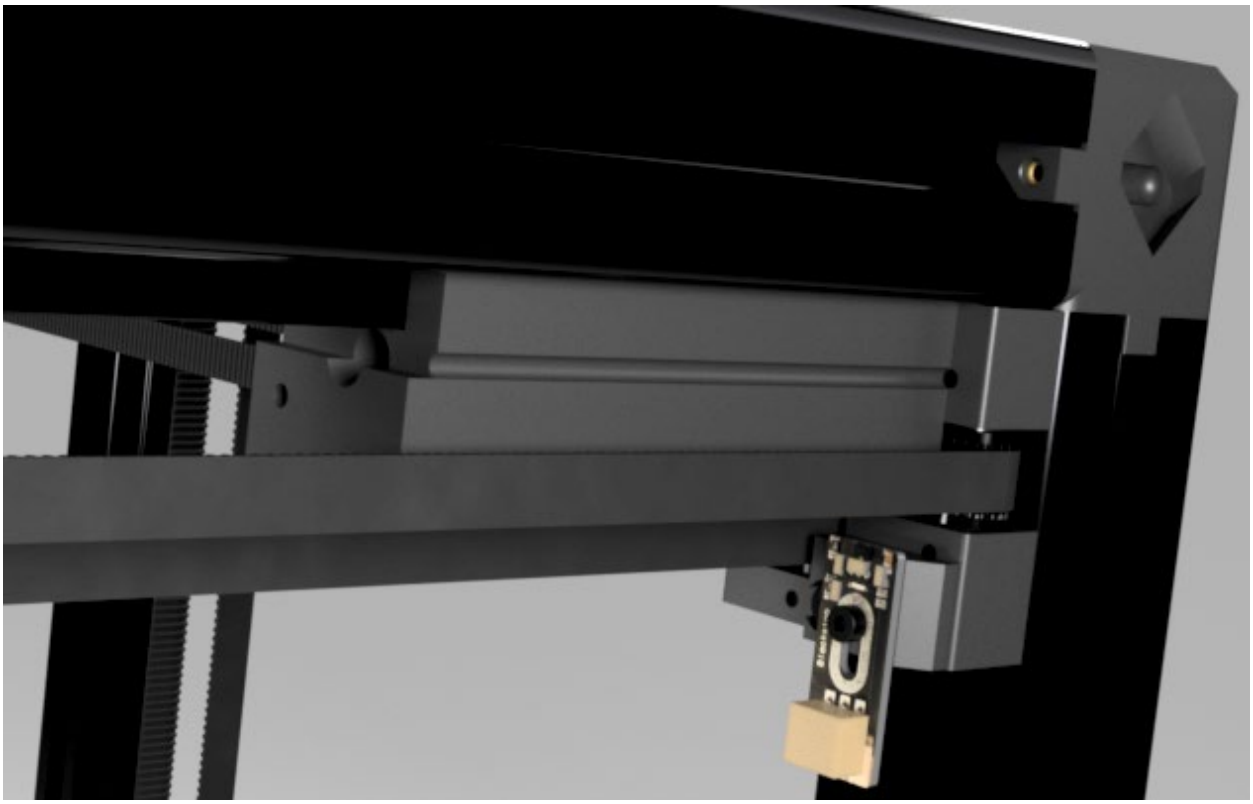


Secure the BlackStop to the X-Bracket with two DIN912_M3_6mm_SHCS.

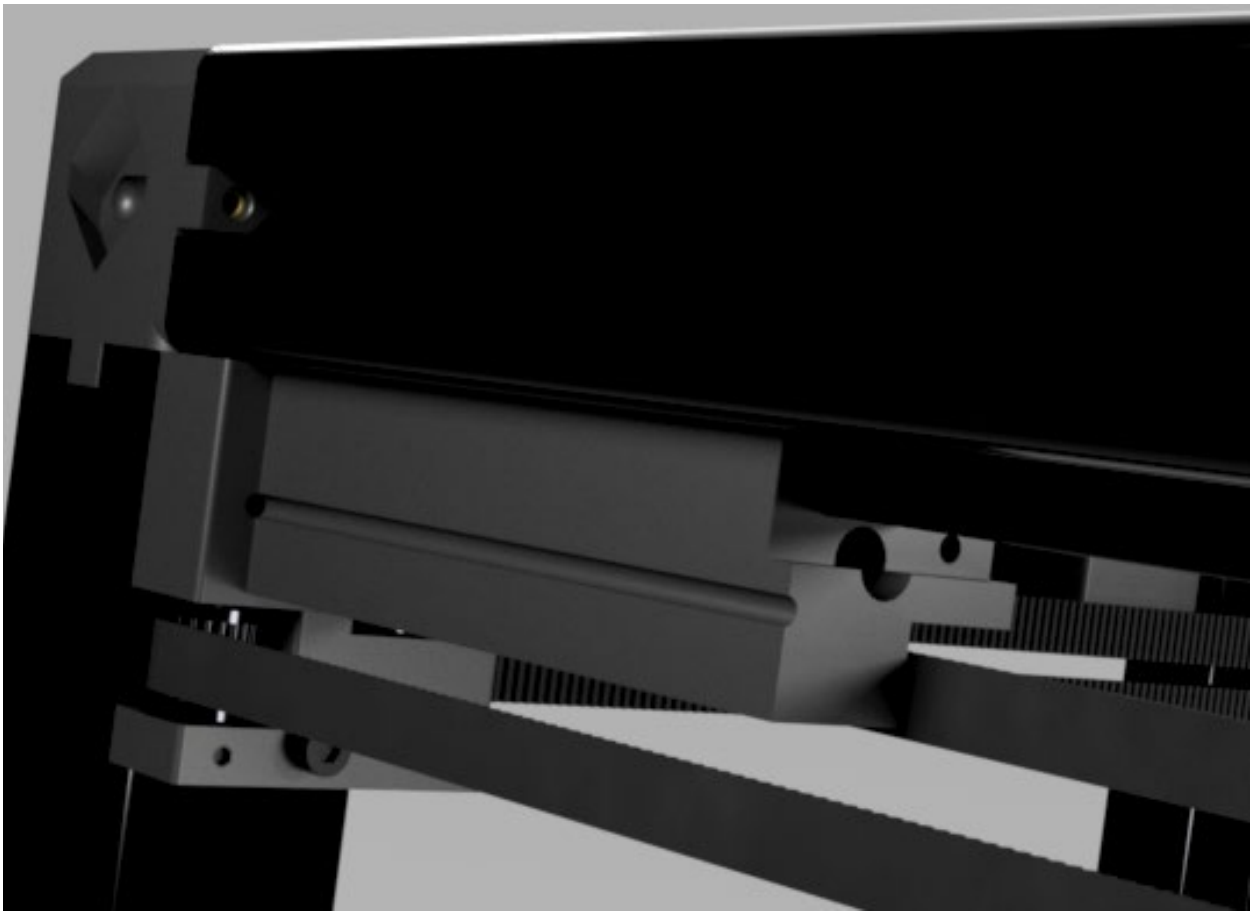


Step 7 – XY Belt Tensioning

Stepper motors will produce electrical current when turned by hand. It is always best to manually move components attached to stepper motors via belts with the motor harness disconnected from associated electronics. If you are unable or unwilling to disconnect the motors from their controllers, be certain to move components slowly. The faster the motor turns, the more electricity will be generated and could possibly even damage motor controller components. Move the X-carriage slowly toward the left end of the machine until the Y-Axis brackets are resting against the XY-belt tensioners. Locate Print_XY_Belt_Tensioning_Tool_Front_CE and install into the location shown below. The clearance between this tool and the belts is tight. It will be easier to mount the tool to the Y-Axis linear rail in the center of travel where the belts have more slack then slide it toward the Front XY-Corner Bracket assembly until flush.

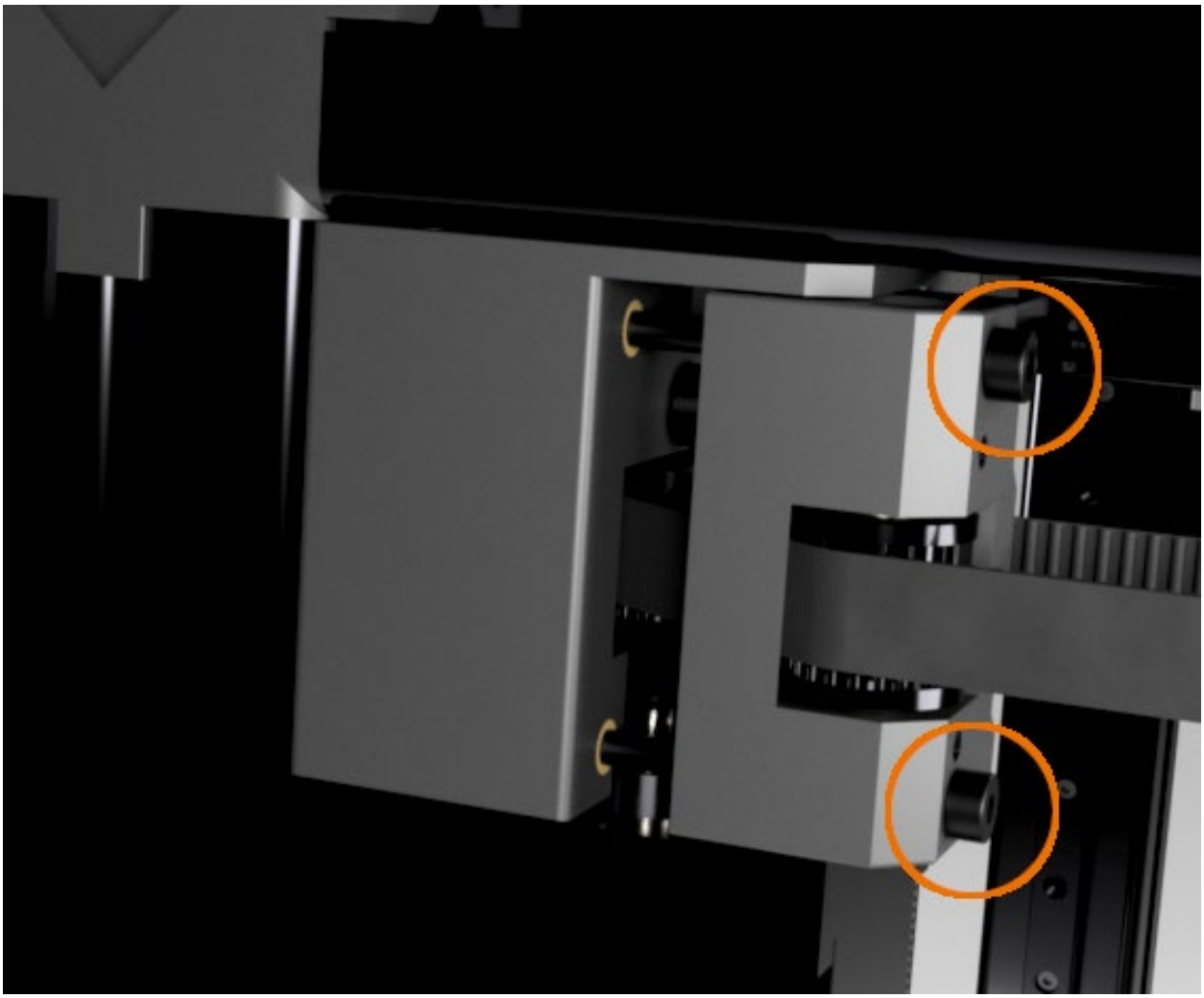


Locate Print_XY_Belt_Tensioning_Tool_Rear_CE and place on machine in location shown below using similar procedure.

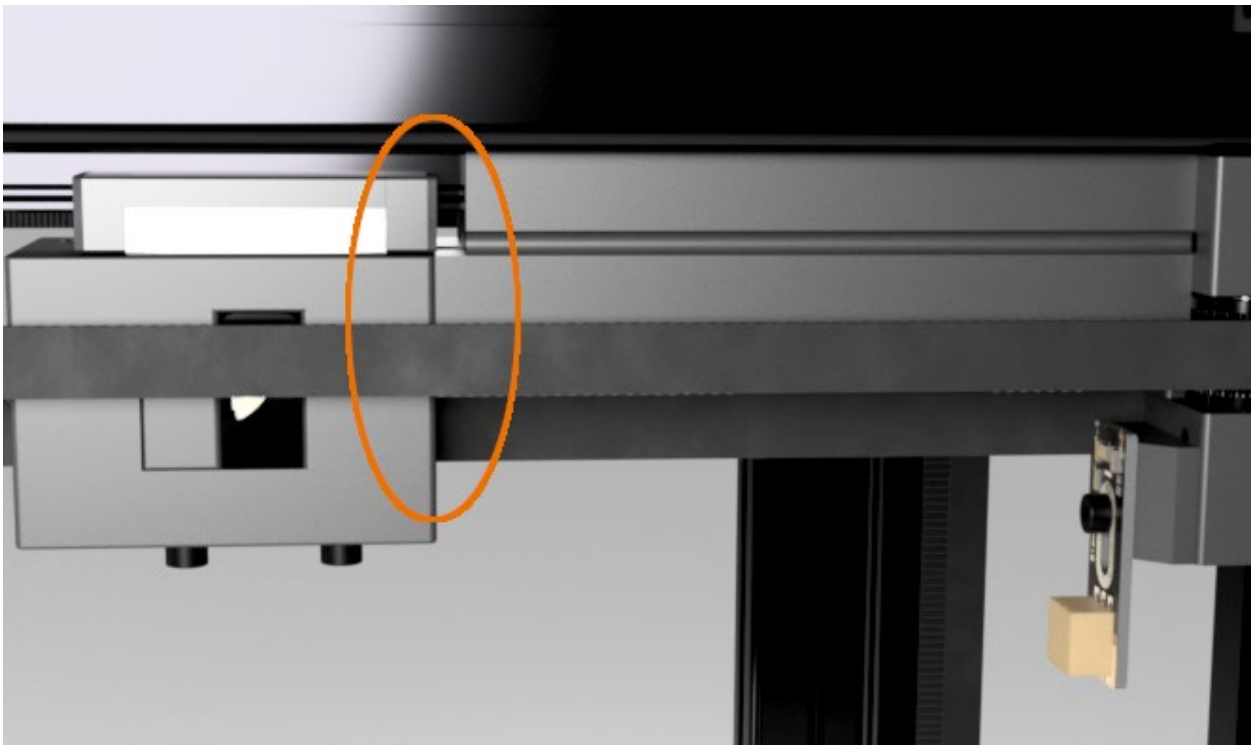


Now slowly move the X-Gantry until both Y-Axis brackets are flush to the tensioning tools.

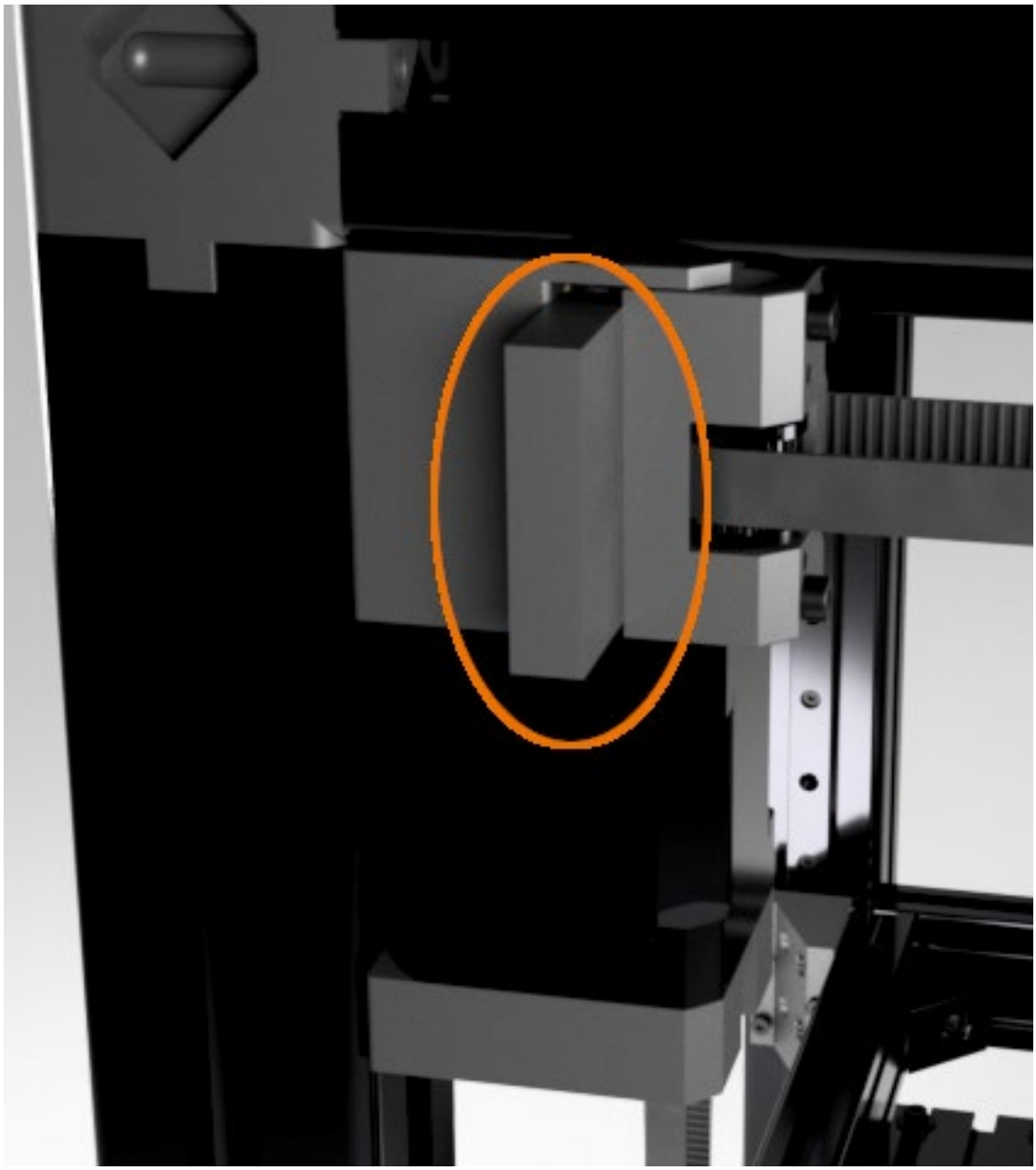
The goal is to tighten the tension in each of the XY belts as to prevent skipped steps during operation. Contrary to popular belief, excessively tight belts are not better. Excessive belt tension adds to vibration in the X-Gantry that leads to surface defects on the print. In the tuning guide, input shaping calibration will reveal if the belts are too tight. We will begin by equally tightening the screws on one of the XY belt tensioners.



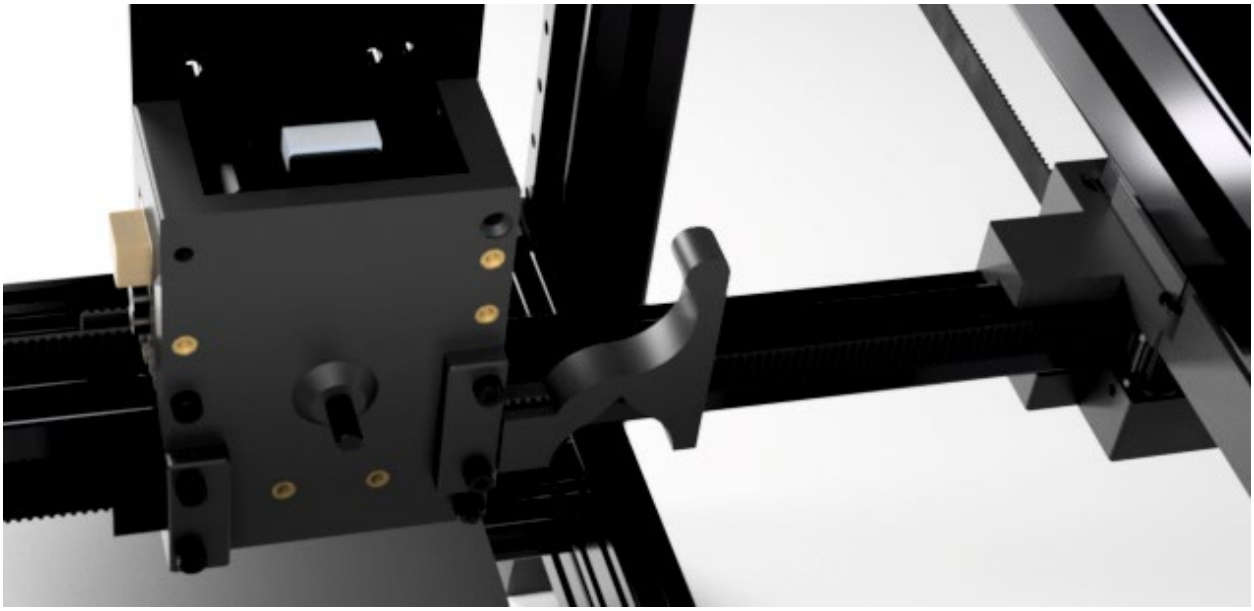
It is important to turn each screw in the tensioner block equal amounts to keep the tensioner block and pulley parallel to each other. When the desired tension in this belt is achieved, you will notice that one of the Y-Axis brackets will have moved away from the tensioning tool. Move to the XY belt tensioner on the other side of the machine and began to turn the screws on that tensioning block in equal amounts. As this tensioner block is tightened. The other Y-axis bracket will begin to move away from the tensioning tool. Move the X-Gantry until one or both of the Y-axis brackets are flush to the tensioning tools. If both Y-axis brackets are not flush, continue tightening the screws of the appropriate XY belt tensioner in equal amounts to bring the Y-axis bracket which is flush out from the belt tensioning tool. Repeat the process of moving the X-gantry to check if both Y-axis brackets are flush to the tensioning tools then adjusting an XY belt tensioner to bring the flush side out a bit. Both Y-axis brackets should appear flush to the tensioning screws as displayed below.



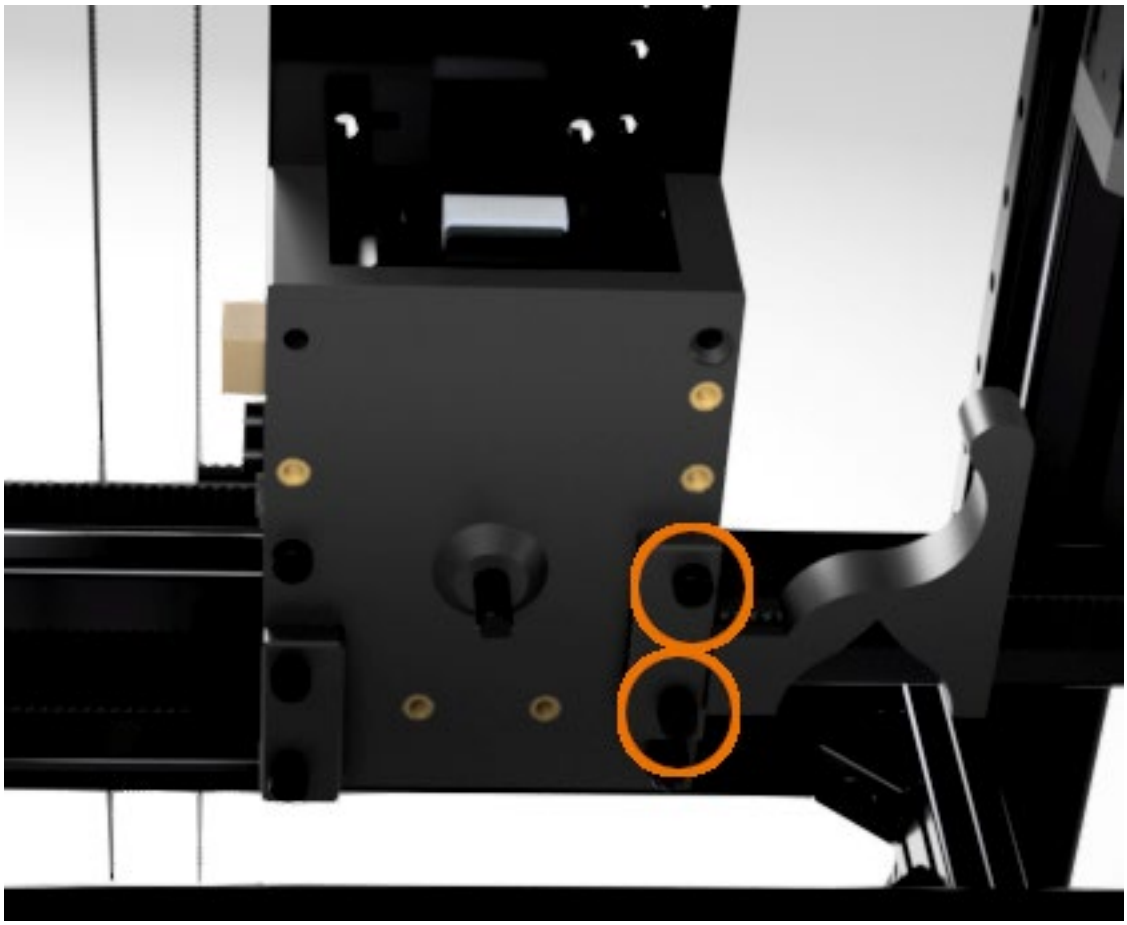
When both Y-axis brackets are flush to the belt tensioning tools, verify that both belts have the desired tension, slowly move the X-gantry toward the left end of the machine until it is flush with the XY motors, remove the printed belt tensioning tools, and reconnect motor harness wires if removed. If one belt appears to be too loose, then continue the tensioning procedure above until both Y-axis brackets stay flush to the tensioning tools, and both XY belts have the desired tension. If you find that you run out of adjustment and one or both XY belts are still too loose, then you will need to remove more slack from one or both XY belts. To accomplish this, loosen both tensioning block screws on one XY belt tensioner until the pre-tensioner tool fits in between the tensioning block and the motor housing.



This is a good time to verify that the tensioner block is parallel to the motor housing. Adjust the screws to keep the tensioner flush to the pre-tensioning tool. Attach a belt puller tool to end of the XY belt you are adjusting. We will only remove slack from the printed side of the X-Carriage assembly by loosening the printed belt clamps. Be certain to attach the belt puller to the proper belt end.



Loosen the two screws in the printed belt clamp and pull the belt with the belt pulling tool. Each tooth pulled past the edge of the printed belt clamp will gain 2mm of adjustment for the XY belt tensioner. Exposing four and a half teeth will restore the full range of the XY tensioner (8.5mm). When you have finished removing the extra slack from the XY belt, fully tighten the two screws in the printed belt clamp and remove the printed belt pulling tool.



Proceed to properly set the XY belt tension of both belts.

Congratulations! You have completed all the steps for the assembly of the XY-Axis Motion System.

Optional Step 8 – Support Blackbox

Blackbox is an Open Source project created from thousands of hours of work. The developers have released all this technology to you with no expectations of profits or compensation. If you are enjoying this project and wish to contribute to future development, please visit the Support Blackbox page on our website.