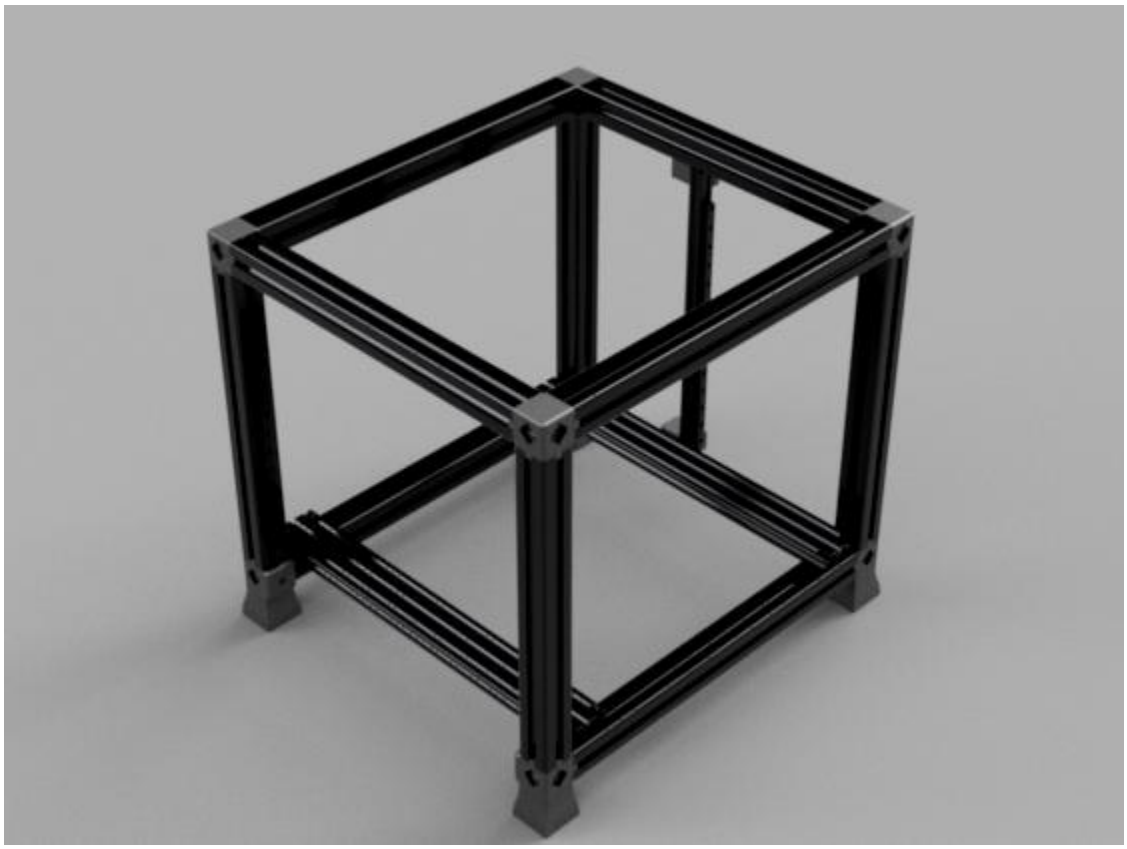
Blackbox CE Mechanical Assembly:

01. Frame



Change Log

Version	Description
1	Initial release for Blackbox Refresh.
1.1	Added steps for M4 Heat Set Insert into bottom of Print_Corner_Bracket_Bottom_CE. Added four M4x6x5mm_Heat_Set_Insert to parts list.
1.2	Added five LinearCarriage_MGN12H_LDO to parts list.
1.3	Added Change Log.
1.4	Added new tools: Print_Y-Axis_Linear_Rail_Installation_Tool_(16.5), Print_Z-Axis_Left_Linear_Rail_Installation_Tool_(10)_CE, and Print_Z-Axis_Right_Linear_Rail_Installation_Tool_(20)_CE. Updated pictures and steps to reflect.
1.5	Added current version column for printed parts. Changed font to match other tables.
1.6	Updated pictures to reflect new Print_Z-Axis_Support_Bracket_Top_CE.
1.7	Added links to STL kits and individual STL files.

Tools

- Hex Wrenches
- Reamers
- Electric Drill
- Metric Tape Measure
- Carpenters Square
- Blue Painters Tape
- Soldering Iron with Heatset Insert Tip Installed

Parts

QTY	Description
4	T-Slot_40x40mm_Nut8_470mm_CE
8	40x40x40_Corner_Bracket
20	ISO7380_M8_25mm_BHHS
2	T-Slot_40x40mm_Nut8_420mm_CE
4	T-Slot_40x40mm_Nut8_395mm_CE
2	T-Slot_20x60mm_Nut6_482mm_CE
8	DIN9021_M4_Fender_Washer
10	Tnut_40Series_M4
9	DIN912_M4_30mm_SHCS
3	LinearRail_MGN12_335mm_LDO
34	Tnut_40Series_M3
34	DIN912_M3_14mm_SHCS
2	LinearRail_MGN12_400mm_LDO
1	T-Slot_20x20mm_Nut6_395mm_CE
6	Tnut_20Series_M4
4	DIN912_M4_16mm_SHCS
4	DIN912_M4_35mm_SHCS
8	Tnut_20Series_M3
8	DIN912_M3_8mm_SHCS
16	M3x4.6x4mm_Heat_Set_Insert
16	DIN912_M3_10mm_SHCS
8	M4x6x5mm_Heat_Set_Insert
4	DIN7991_M4_25mm_FHHS
5	LinearCarriage_MGN12H_LDO

Printed Parts

QTY	Description	Version	Link
1	Frame STL Kit ZIP (includes all models listed below)	1.7	Link
1	Print_Z-Axis_Support_Installation_Tool_(146.311)_CE	3	Link
1	Print_Z-Axis_Support_Bracket_Top_CE	9	Link

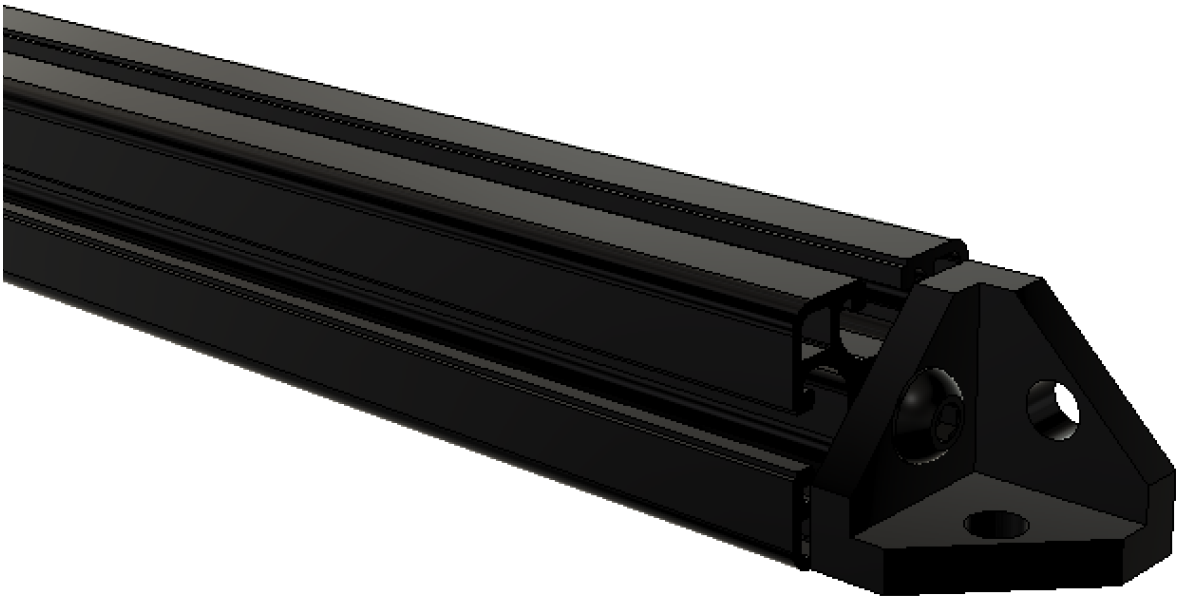
1	Print_Z-Axis_Support_Bracket_Bottom	8	Link
4	Print_Corner_Bracket_Top_CE	16	Link
12	Print_Corner_Bracket_Lock_CE	13	Link
4	Print_Corner_Bracket_Bottom_CE	16	Link
4	Print_Corner_Bracket_Bottom_Lock_CE	11	Link
3	Print_MGN12_Alignment_Block_2020	3	Link
3	Print_MGN12_Alignment_Block_4040	2	Link
1	Print_Y-Axis_Linear_Rail_Installation_Tool_(16.5)	2	Link
1	Print_Z-Axis_Left_Linear_Rail_Installation_Tool_(10)_CE	1	Link
1	Print_Z-Axis_Right_Linear_Rail_Installation_Tool_(20)_CE	3	Link

Step 1 – Preparation

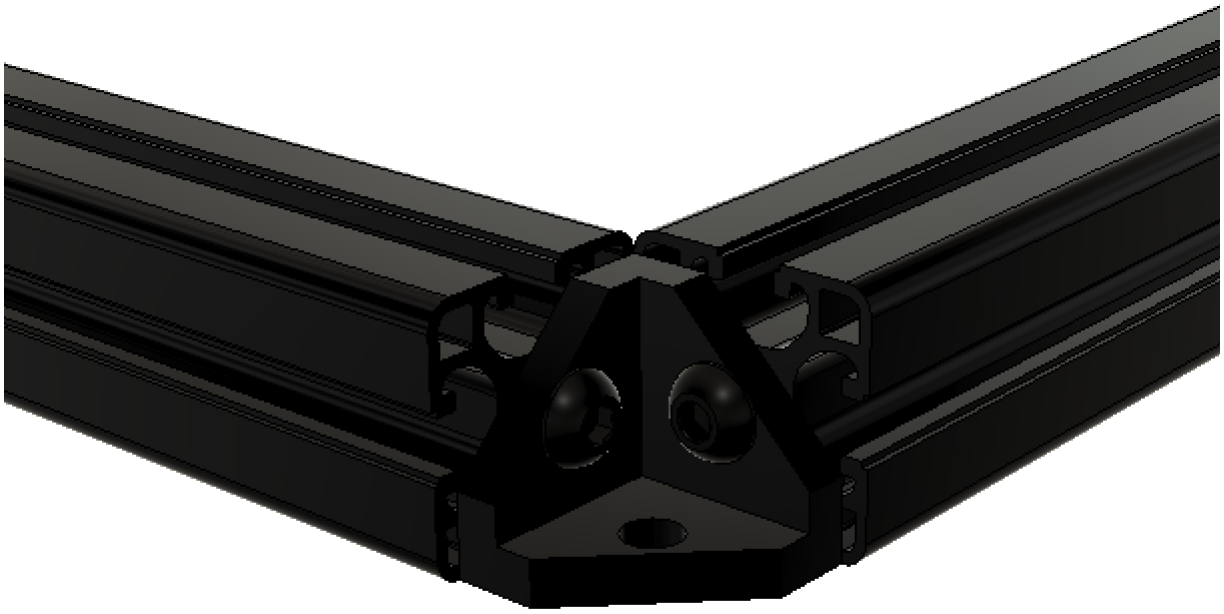
Find a flat surface which will be large enough to hold your frame. The assembled frame dimensions are 570mm x 520mm. Lay out all the 4040 extrusions for identification. There are three lengths: 395mm (x4), 420mm (x2), and 470mm (x4). The 470mm extrusions will define the front (and back) of the machine. The printed parts will take the majority of labor hours (hopefully for your printer) involved in the build. For the frame section, the Support Installation Tool and the Alignment Blocks may be printed in a less expensive material such as PLA. The four Bottom Corner Brackets also incorporate the machine foot and is recommended to print with cubic subdivision infill pattern at 100%. All through holes in the printed parts need to be cleaned with a reamer of the same size. Your MGN12 linear rails come with the MGN12H cartridges pre-installed. These cartridges are matched to the rails and should not be removed. There are over 60 small ball bearings inside of each MGN12H cartridge that can e asily fall out and become lost if the cartridge comes off the rail or even if half or less of the cartridge moves past the end of the rail. It is best to secure the rail in place with blue painters tape to prevent unfortunate accidents. Both M3 and M4 heat set inserts are used in this guide. Most soldering iron installation kits for heat set inserts have a different tip for M3 and M4 inserts. You will need to let the iron cool after installing inserts of one size before switching to the other installation tip to continue with the other size.

Step 2 – Upper Frame

Start with a 4040 extrusion of 470mm. Attach a 4040 corner bracket using a M8x25mm BHHS (If your kit comes with M8x25 FHHS use these instead). Do not fully tighten the screws for now, you will fully tighten the screws a bit later.



Next attach a 4040 extrusion of 420mm to the corner bracket with another M8x25mm BHHS.

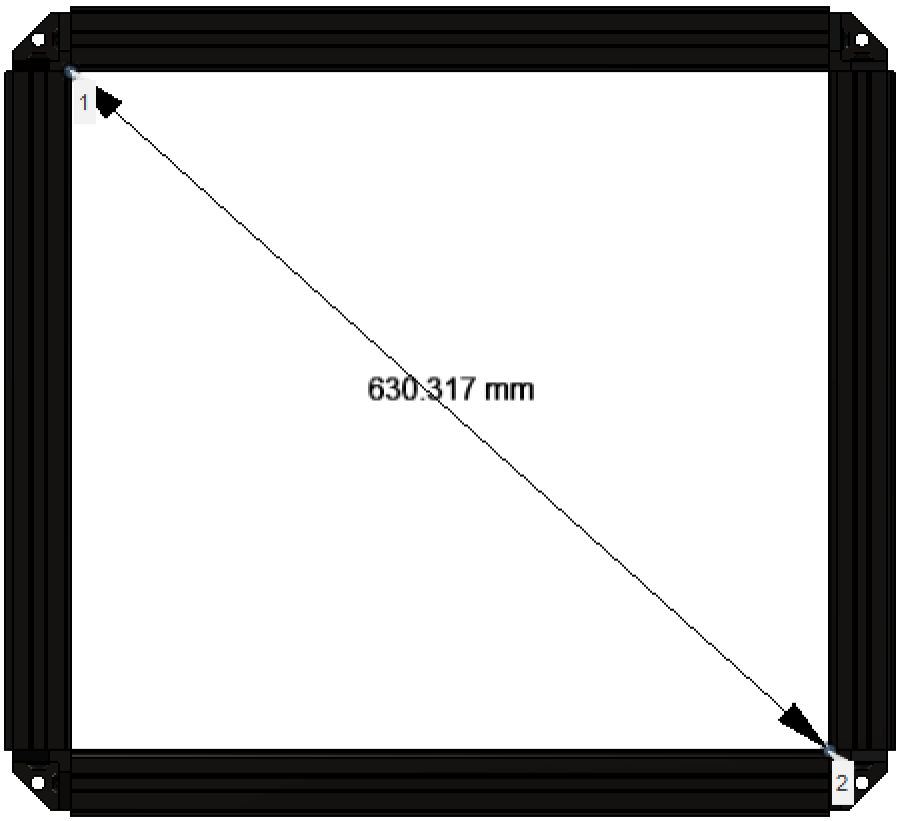


Rotate your frame counterclockwise 90 degrees and mirror your progress with another corner bracket, another 4040 extrusion of 420mm, and two M8x25 BHHS.

Take another 4040 extrusion of 470mm and attach a corner bracket to each end with a M8x25 BHHS.

Take this assembled 420mm extrusion and attach it to the rest of the top frame with two M8x25 BHHS.

Now it is time to press all the parts flat on your build surface and check the corners for square. The distance between opposing inside corners is 630.317mm. (Whatever value you manage to measure needs to be the same when you measure the other two opposing corners). When distance between all opposing inside corners is equal the upper frame is square and you can give all the BHHS the final tightening.



Step 3 – Side Frames

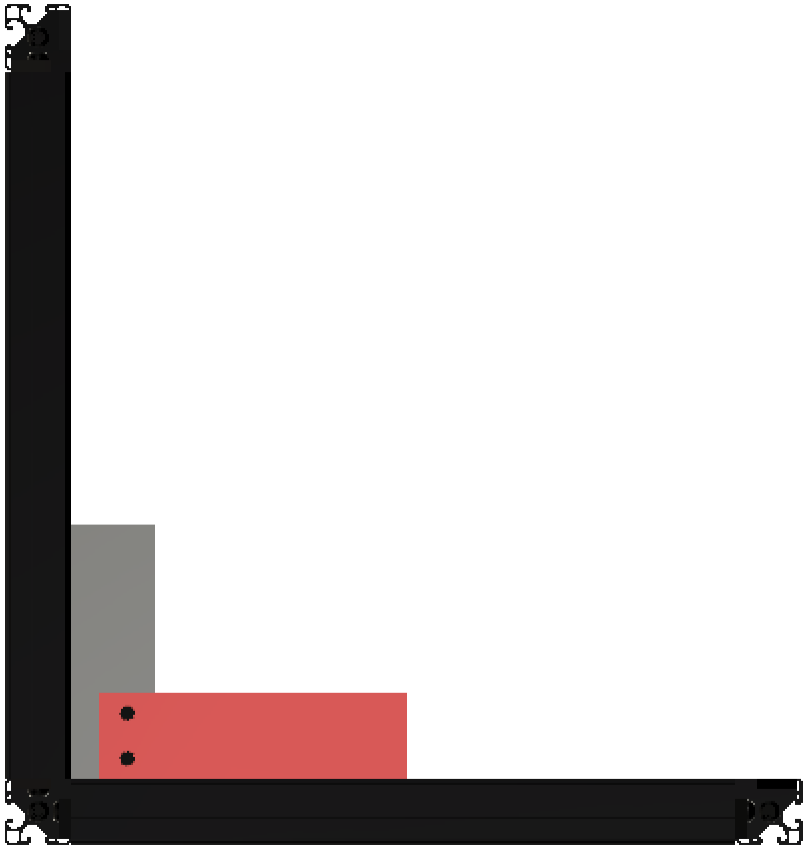
Turn the assembled upper frame onto one of the 420mm frame extrusions. Attach a 4040 extrusion of 395mm to a corner bracket using a M8x25mm BHHS.

Attach another 395mm extrusion to the other lower corner bracket of the upper frame with a M8x25mm BHHS.

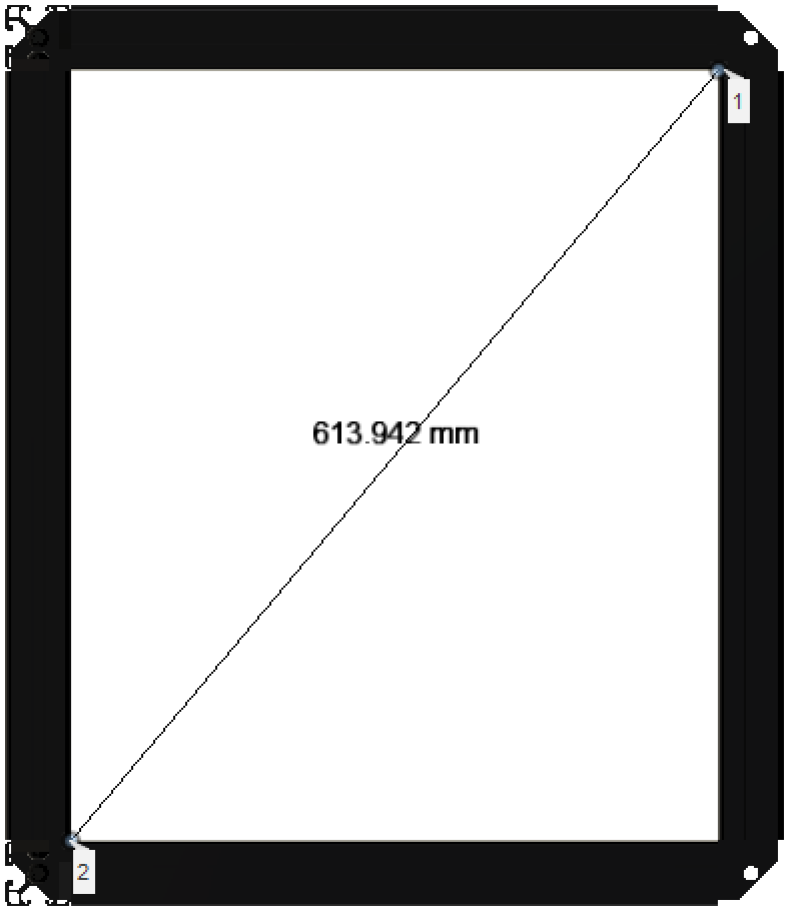
Take another 4040 extrusion of 470mm and attach a corner bracket to each end with a M8x25 BHHS.

Attach this assembled 470mm extrusion to the bottom of the two 395mm extrusions using two M8x25 BHHS.

Using a carpenters square, check that the angle between the side frame and the upper frame is 90 degrees.



And check that the distance between opposing inside corners of side frame is 613.942mm. (Whatever value you manage to measure needs to be the same when you measure the other two opposing corners). Give these screws for the side frame a final tighten.

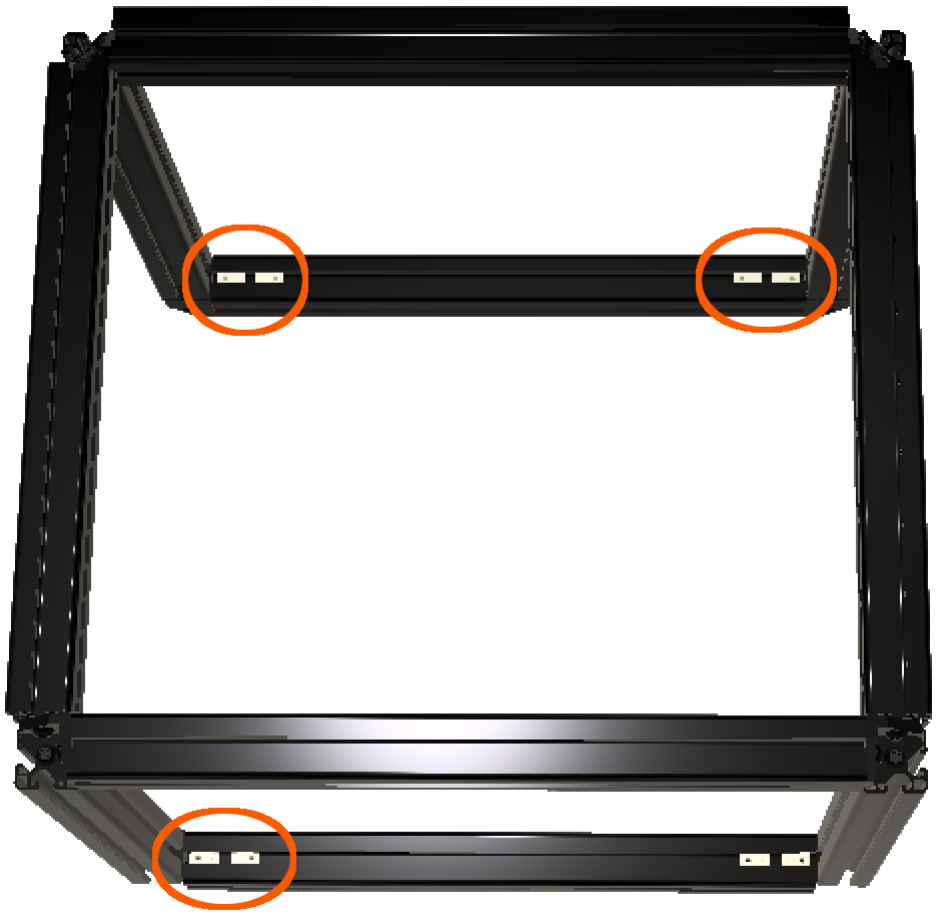


Now build the remaining side in a similar fashion using the remaining 470mm extrusion, two corner brackets and four M8x25mm BHHS. Be certain to check for square and equal distances as stated above. When finished, tighten all screws to final torque.

Step 4 – Bottom Frame

Now turn the partially completed frame upright with one of the side openings facing you. This will become the front side. We are now going to attach the two 2060 extrusions to the side frames. (If your 2060 extrusions have three holes on each end, we are going to only use the outer two holes. Future 2060 extrusions will only come with two drilled holes per end). Place two M4 Slot 8 roll-in nuts in the top slot of the lower extrusion near a corner.

Repeat the insertion of the M4 Slot 8 roll-in nuts for the other three corners.



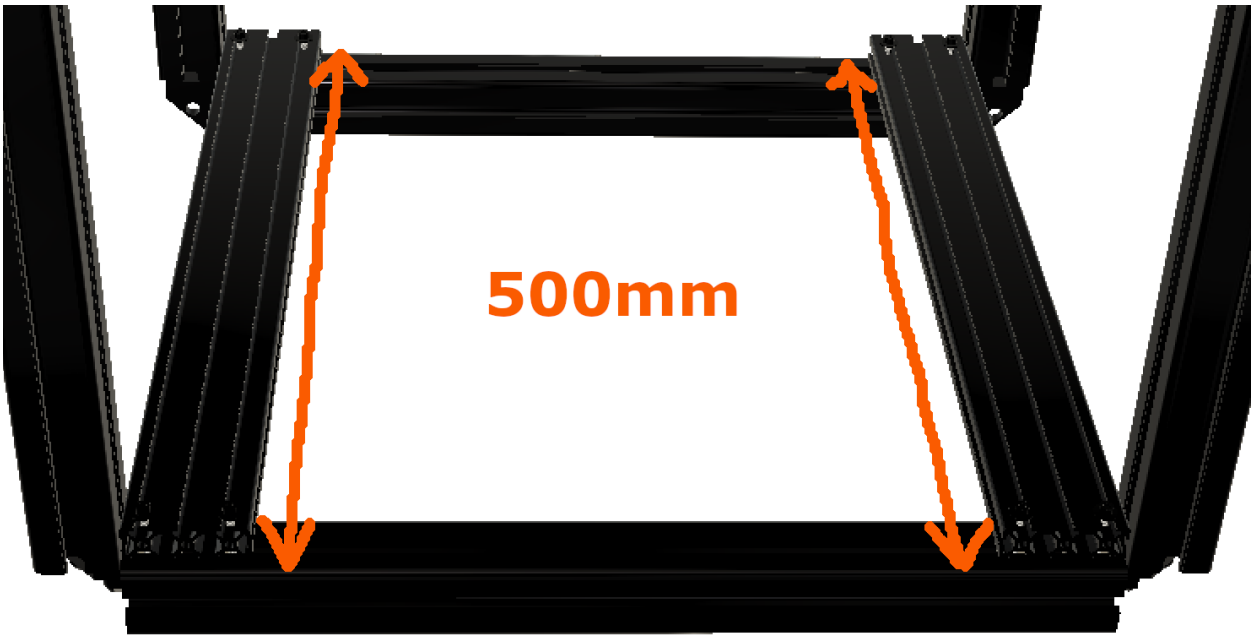
Place one 2060 extrusion on top of the two lower 470mm 4040 extrusions.

Verify the holes for the roll-in nuts are centered in the holes drilled through the 2060 extrusion. Repeat for other end.

Insert a M4x30mm SHCS through a M4 fender washer and insert through one of the holes of the 2060 extrusion then fasten to the M4 Slot 8 roll-in nut. Repeat for the three other holes of the 2060 extrusion. Check that the 2060 extrusion is flush against the two 395mm 4040 extrusions.

Repeat this process for the other side with the remaining 2060 extrusion, 4 M4x30 SHCS, and 4 M4 fender washers.

Now to verify frame is square, measure the distance between the outer faces of the lower 470mm 4040 extrusions. The distance should be 500mm at each end. Adjust if necessary while keeping the 2060 extrusions flush with the vertical 395mm 4040 extrusions. Tighten all the M4 screws of the 2060 extrusions. Note: The 2060 extrusions have a light profile and cannot handle over-tightening. Any excessive tightening into a roll-in nut will cause the nut to deform the extrusion it is housed in.



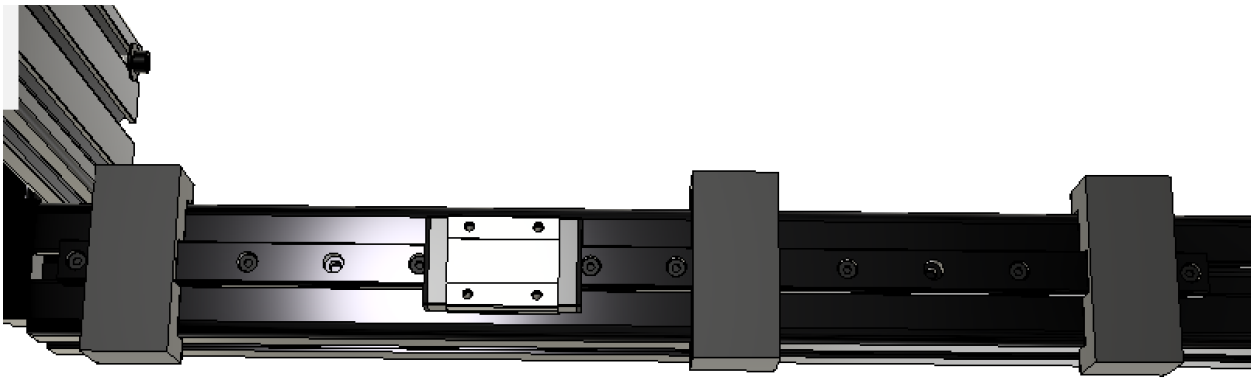
Step 5 – Linear Rails

Look at your frame and choose one of the sides with the 470mm extrusions to be the front and orient this side facing you. For the rest of the guide, printed parts and assembly contexts will use the nomenclature of front, back, left, and right. Multiple parts which attach to the same side will be designated as top and bottom. Lay the frame down onto its front face. Locate one of the 335mm MGN12 rails 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. Insert eight M3 Slot 8 roll-in nuts into the left front 395mm 4040 extrusion as shown. The exact positions will be realized as the MGN12 rail is secured.

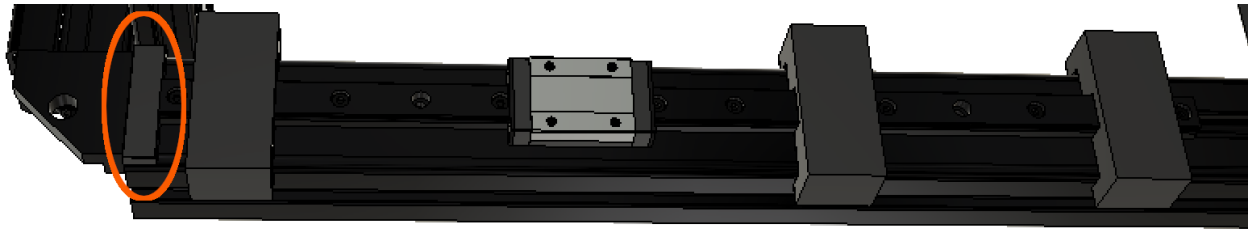
Place the MGN12 rail assembly onto the 395mm 4040 extrusion and secure it with three printed 4040 MGN12 Alignment Blocks.

Laid out this way, all the holes used to secure the MGN12 rail to the 395mm 4040 extrusion are accessible. It is likely that your M3 Slot 8 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the MGN12 rail up or down (left and right by aspect of picture) until the hole through one of the ends of the MGN12 rail matches up with the threads of the corresponding M3 Slot 8 roll-in nut. One aligned, loosely screw an M3x14 SHCS through the MGN12 rail into the M3 Slot 8 roll-in nut. 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 M3x14 SHCS, move the MGN12 rail again until the

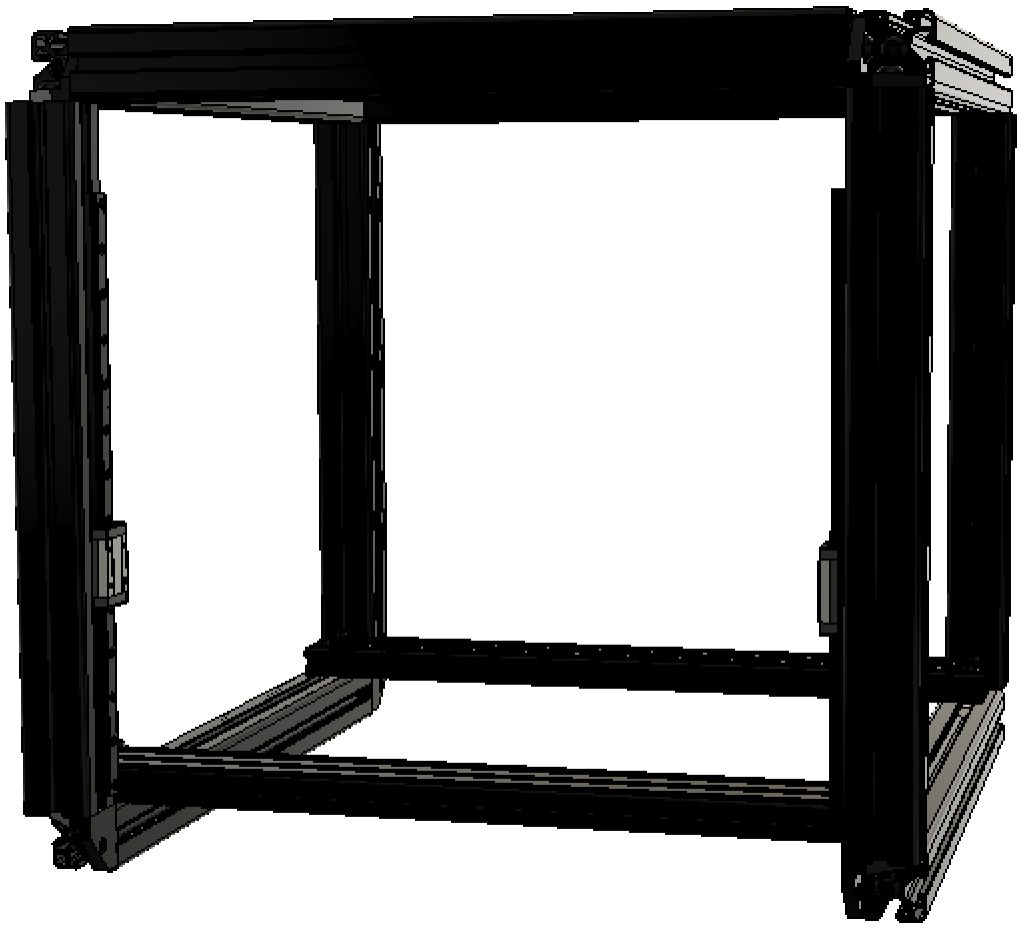
next prescribed hole lines up with its corresponding M3 Slot 8 roll-in nut. Repeat this until all eight screws are loosely attached. You will likely need to slide the MGN12H cartridge out of the way to facilitate access to some of the holes.



Now that all the M3x14 SHCS are loosely screwed into their proper holes, install the Print_Z-Axis_Left_Linear_Rail_Installation_Tool_(10)_CE into the Slot 8 of the 4040 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 4040 Corner Bracket.

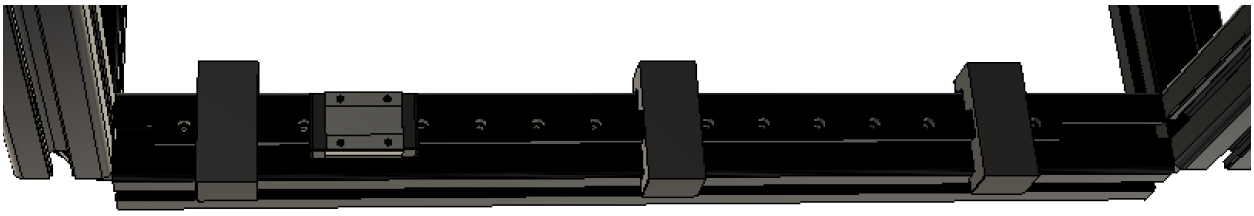


Tighten all the M3x14mm SHCS. Remember not to overtighten these screws to prevent damage to the slot profile in the 4040 extrusion. The 4040 slot profile may also be damage d if the 4040 alignment blocks are not used to hold the MGN12 rail in place as the screws are tightened. Apply some blue painters tape to the MGN12H cartridge to keep it from moving as you continue to assemble the frame. Remove the 4040 MGN12 alignment blocks and the printed Linear Rail Installation Tool. Rotate the frame 180 degrees so the rear side is facing your work surface. Repeat all above steps to secure another 335mm MGN12 assembly to the other 395mm extrusion. Rotate your frame upright. The installed MGN12 rails should appear on the left side of your machine as depicted below.



Rotate the frame so the top is facing work surface and front side facing you. Locate one of the 400mm MGN12 rails 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. Insert nine M3 Slot 8 roll-in nuts into the bottom face of the front 470mm 4040 extrusion as shown. The exact positions will be realized as the MGN12 rail is secured.

Place the MGN12 rail assembly onto the 470mm 4040 extrusion and secure it with three printed 4040 MGN12 Alignment Blocks.



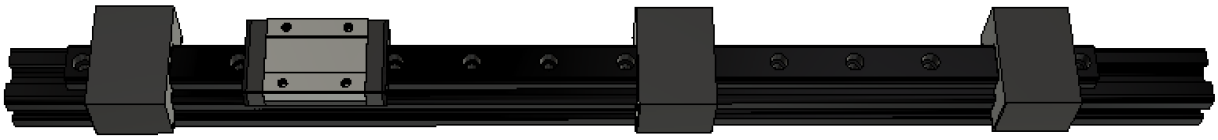
Laid out this way, all the holes used to secure the MGN12 rail to the 470mm 4040 extrusion are accessible. It is likely that your M3 Slot 8 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the MGN12 rail left and right until the hole through one of the ends of the MGN12 rail matches up with the threads of the corresponding M3 Slot 8 roll-in nut. One aligned, loosely screw an M3x14 SHCS through the MGN12 rail into the M3 Slot 8 roll-in nut. 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 M3x14 SHCS, move the MGN12 rail again until the next prescribed hole lines up with its corresponding M3 Slot 8 roll-in nut. Repeat this until all nine 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 M3x14 SHCS are loosely screwed into their proper holes, install Print_Y-Axis_Linear_Rail_Installation_Tool_(16.5) onto the 395mm 4040 extrusion. Slide the MGN12 rail so the right end (left end for perspective of picture) of the rail is flush to the printed installation tool and the printed installation tool is flush to the right 395mm 4040 extrusion.

Tighten all the M3x14mm SHCS. Remember not to overtighten these screws to prevent damage to the slot profile in the 4040 extrusion. The 4040 slot profile may also be damaged if the 4040 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 frame. Remove the 4040 MGN12 alignment blocks and the printed Installation Tool. Rotate the frame 180 degrees so the top side is facing your work surface and the rear side is facing you. Repeat all above steps to secure another 400mm MGN12 assembly to the other 470mm extrusion. Rotate your frame upright. The installed MGN12 rails should appear on the underside of the top frame as depicted below.

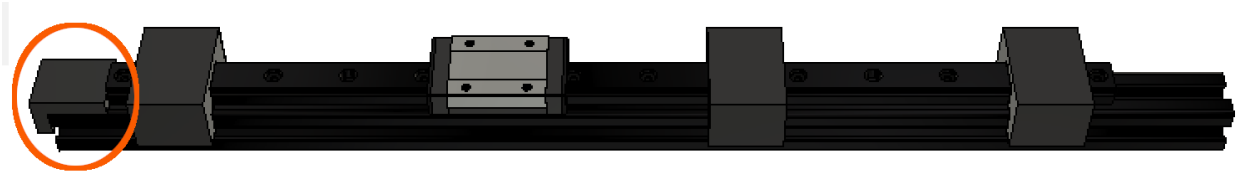
Move the frame aside and place the 2020 extrusion of 395mm in front of you. Locate the remaining 335mm MGN12 rail and remove the blue painters tape if installed in the preparation section. Be careful not to let the MGN12H carriage slide to the end or off the rail as you move it around during installation. Insert eight M3 Slot 6 roll-in nuts into the 395mm 2020 extrusion as shown. The exact positions will be realized as the MGN12 rail is secured.

Place the MGN12 rail assembly onto the 395mm 2020 extrusion and secure it with three printed 2020 MGN12 Alignment Blocks.



Laid out this way, all the holes used to secure the MGN12 rail to the 395mm 2020 extrusion are accessible. It is likely that your M3 Slot 6 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the MGN12 rail up or down (left and right by aspect of picture) until the hole through one of the ends of the MGN12 rail matches up with the threads of the corresponding M3 Slot 6 roll-in nut. Once aligned, loosely screw an M3x8 SHCS through the MGN12 rail into the M3 Slot 6 roll-in nut. 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 M3 Slot 6 roll-in nut. 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, install Print_Z-Axis_Right_Linear_Rail_Installation_Tool_(20)_CE into the Slot 6 of the 2020 extrusion. Hold the printed Installation Tool flush to the bottom of the 2020 extrusion then slide the MGN12 rail so the bottom end (left end for perspective of picture) of the rail is flush to the printed Installation Tool.



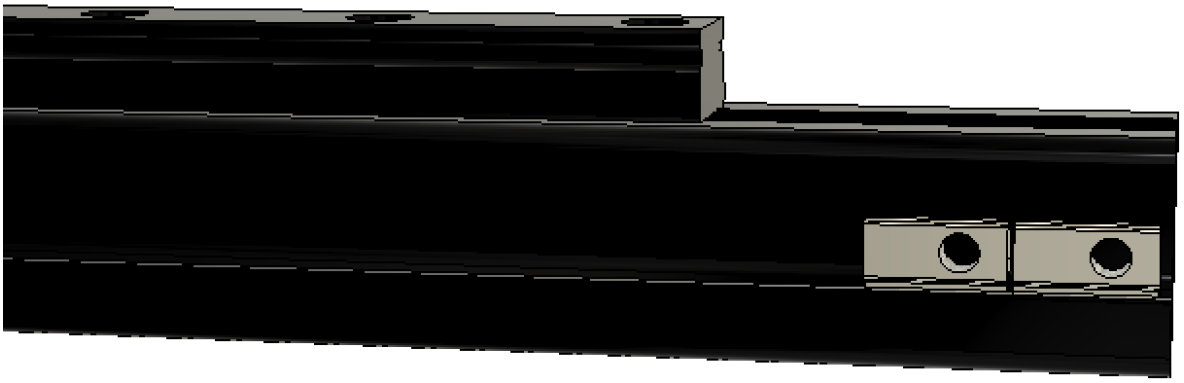
Tighten all the M3x8mm SHCS. Remember not to overtighten these screws to prevent damage to the slot profile in the 2020 extrusion. The 2020 slot profile may also be damaged if the 2020 alignment blocks are not used to hold the MGN12 rail in place as the screws are tightened. Apply some blue painters tape to the MGN12H cartridge to keep it from moving as you continue to assemble the frame. Remove the 2020 MGN12 alignment blocks and the printed Installation Tool.

Step 6 – Z-Axis Support

Insert two M4 Slot 6 roll-in nuts into the 395mm 2020 extrusion as shown. The exact positions will be realized later.

Place the printed part Z-Axis_Support_Bracket_Bottom as shown. It is likely that your M4 Slot 6 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the printed part up or down until the hole through one of the ends of the printed part matches up with the threads of the corresponding M4 Slot 6 roll-in nut. One aligned, loosely screw an M4x16 SHCS through the printed part into the M4 Slot 6 roll-in nut. After you have loosely attached the first M4x16 SHCS, move the printed part again until the other hole lines up with its corresponding M4 Slot 6 roll-in nut. Stand the extrusion up and slide the printed part until it is flush with the bottom of the 395mm 2020 extrusion. Tighten all the M4x16 SHCS.

Insert two M4 Slot 6 roll-in nuts into the other end of the 395mm 2020 extrusion as shown. The exact positions will be realized later.



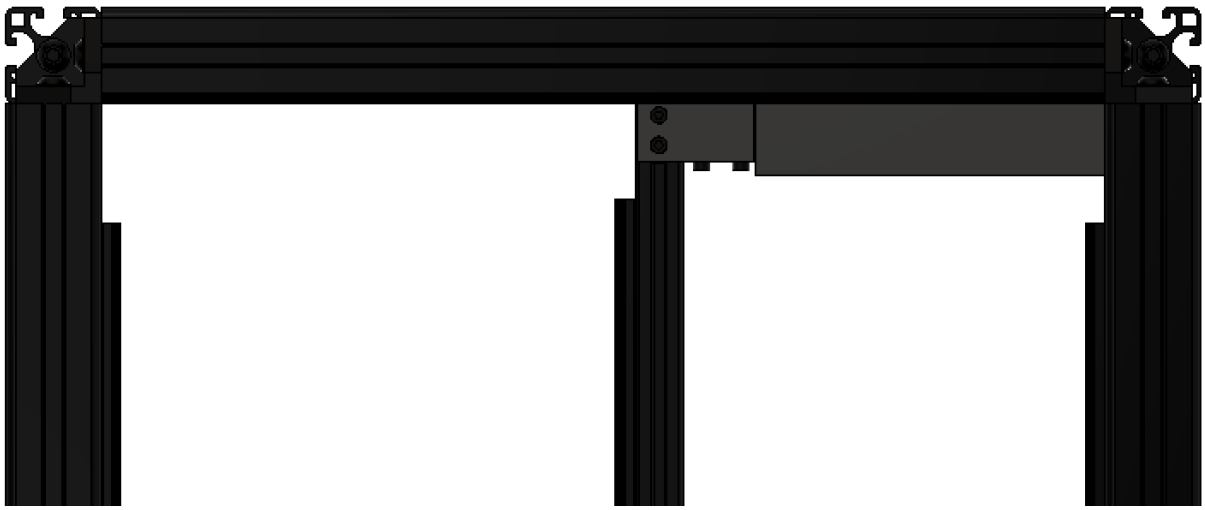
Place the printed part Z-Axis_Support_Bracket_Top as shown. It is likely that your M4 Slot 6 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the printed part up or down until the hole through one of the ends of the printed part matches up with the threads of the corresponding M4 Slot 6 roll-in nut. One aligned, loosely screw an M4x16 SHCS through the printed part into the M4 Slot 6 roll-in nut. After you have loosely attached the first M4x16 SHCS, move the printed part again until the other hole lines up with its corresponding M4 Slot 6 roll-in nut. Stand the extrusion up and slide the printed part until it is flush with the top of the 395mm 2020 extrusion. Tighten all the M4x16 SHCS.

The Z-Axis Support Assembly should appear as depicted below.

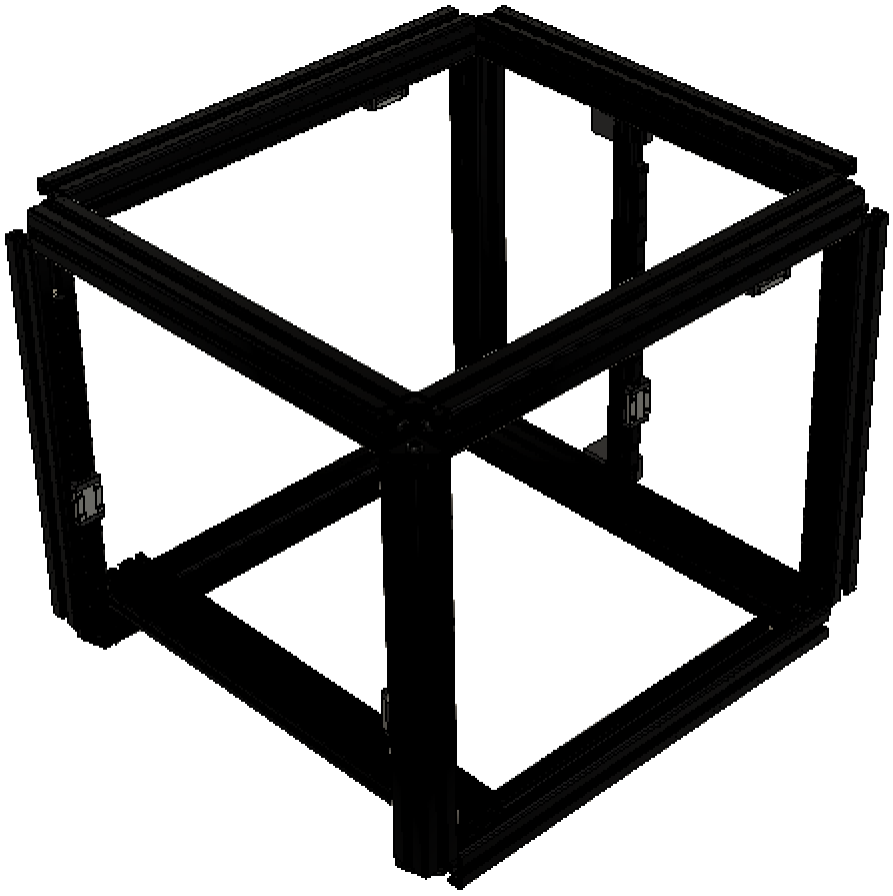
Collect your assembled frame and orient it with the right side facing you. Insert two M4 Slot 8 roll-in nuts into the bottom side of the 420mm 4040 extrusion as shown below. The exact positions will be realized later.

Insert two M4 Slot 6 roll-in nuts into the right side of the 482mm 2060 extrusion as shown below. The exact positions will be realized later.

Place the assembled Y-Axis Support onto the frame as shown. It is likely that your M4 Slot 8 roll-in nuts and M4 Slot 6 roll-in nuts are not aligned with the proper holes at first. It is easiest to correct this by moving the top of the assembly from front to back (left and right by aspect of picture) until the hole through one of the ends of the printed part matches up with the threads of the corresponding M4 Slot 8 roll-in nut. Once aligned, loosely screw an M4x35 SHCS through the upper printed part into the M4 Slot 8 roll-in nut. After you have loosely attached the first M4x35 SHCS, move the top of the assembly again until the other hole lines up with its corresponding M4 Slot 8 roll-in nut. Loosely install the other M4x35 SHCS. Now move the bottom of the assembly from front to back (left and right by aspect of picture) until the hole through one of the ends of the printed part matches up with the threads of the corresponding M4 Slot 6 roll-in nut. Once aligned, loosely screw an M4x35 SHCS through the lower printed part into the M4 Slot 6 roll-in nut. After you have loosely attached the first M4x35 SHCS, move the bottom of the assembly again until the other hole lines up with its corresponding M4 Slot 6 roll-in nut. Loosely install the other M4x35 SHCS. Place the printed tool Z-Axis Support Installation onto the rear 395mm 4040 extrusion. The tab on the printed tool goes into the 8mm slot of the 4040 extrusion. Slide the top of the Z-Axis support assembly until it is flush with the tool. Tighten all the top M4x35mm SHCS.

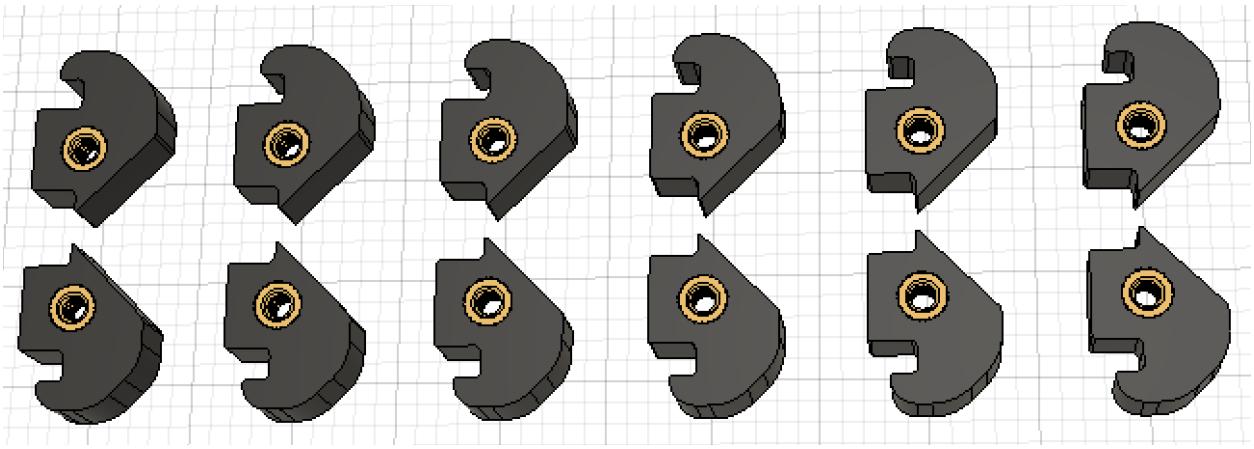


Move the printed tool to bottom of the rear 395mm 4040 extrusion. Again, the tab on the printed tool goes into the 8mm slot of the 4040 extrusion. Slide the bottom of the Z-Axis support assembly until it is flush with the tool. The tool does not line up as well as it does when used at the top of the assembly. Be certain to keep the end of the tool with the tab flush and perpendicular with the 395mm 4040 extrusion to ensure proper distance is achieved. Tighten all the bottom M4x35mm SHCS. Remove the tool. Your assembled frame should resemble the picture below.

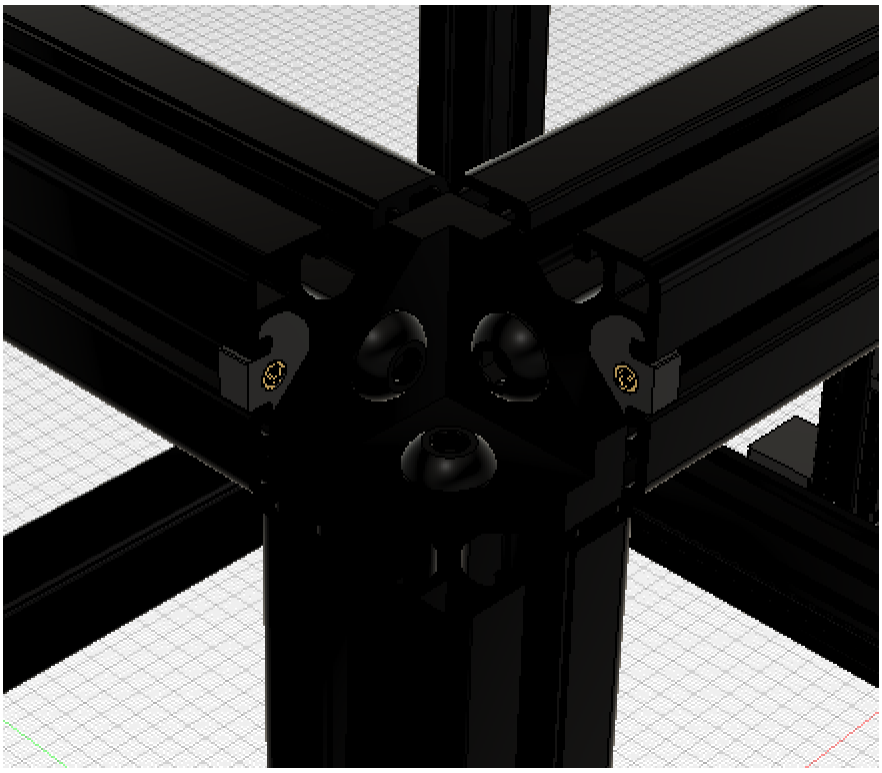


Step 7 – Corner Brackets

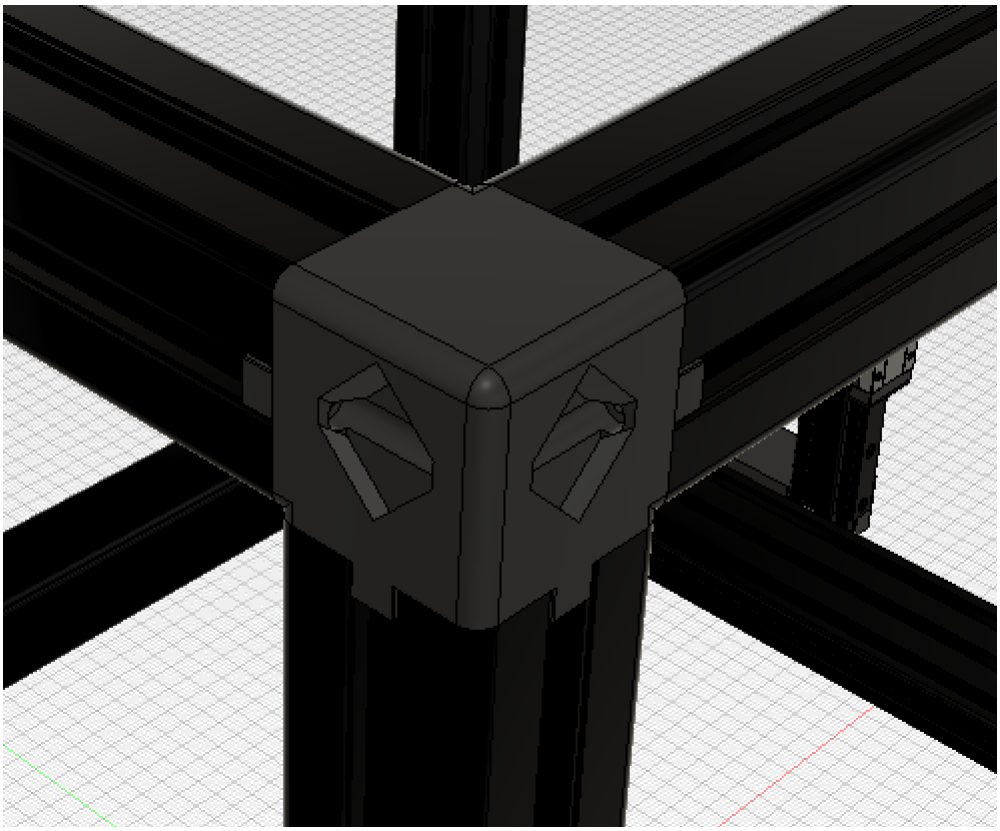
Move the frame aside. Locate the 12 printed Corner Bracket Lock parts. An M3 heat set insert will be installed flush into one side of six of these, and the other side of the other six. When completed, your inserts should resemble the below picture.



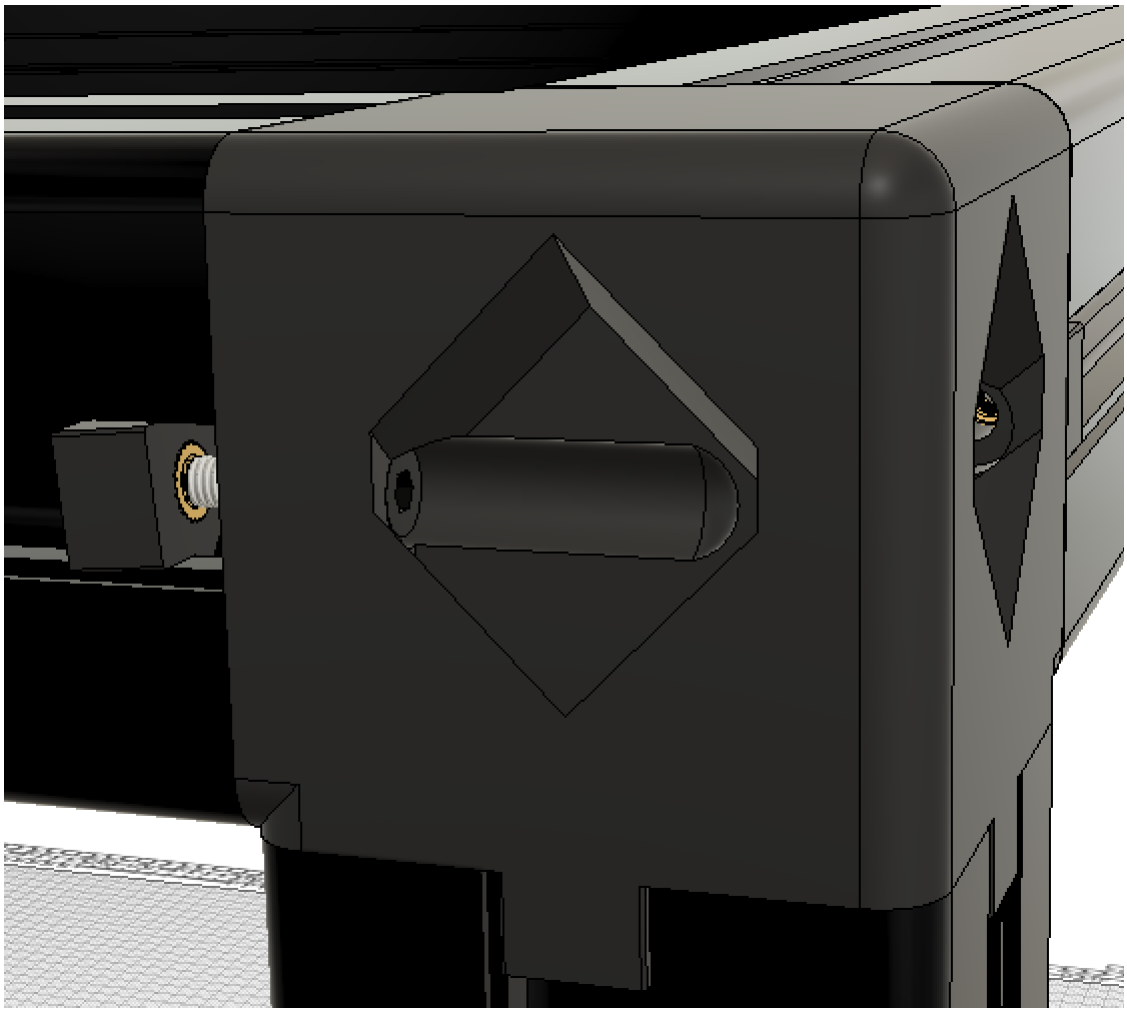
Orient your frame to face an upper corner. Install one of each type of printed Corner Bracket Lock into the 4040 extrusions as shown below.



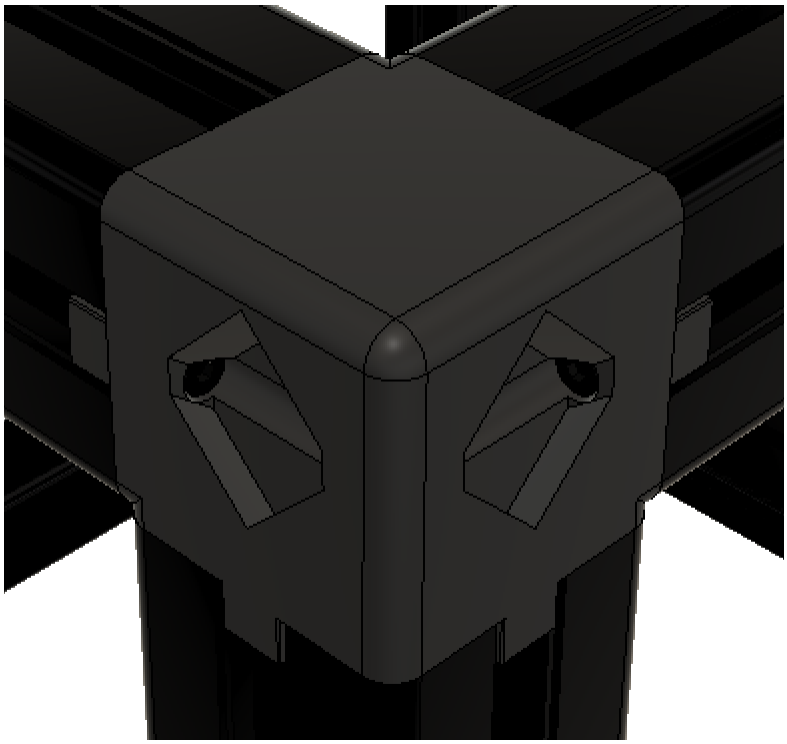
Insert a printed Corner Bracket Top as shown.



Insert an M3x10mm SHCS into the recessed hole of the printed Corner Bracket Top, then push the screw in by hand with enough force to move the printed Corner Bracket Lock until the screw is fully seated.



Using the angled end of your M3 hex wrench, tighten the M3x10 SHCS while pressing on the printed Corner Bracket Lock until the M3x10 SHCS pulls the printed Corner Bracket Lock flush to the printed Corner Bracket Top and is tight. Repeat the process with another M3x10 SHCS on the other face of the printed Corner Bracket Top.

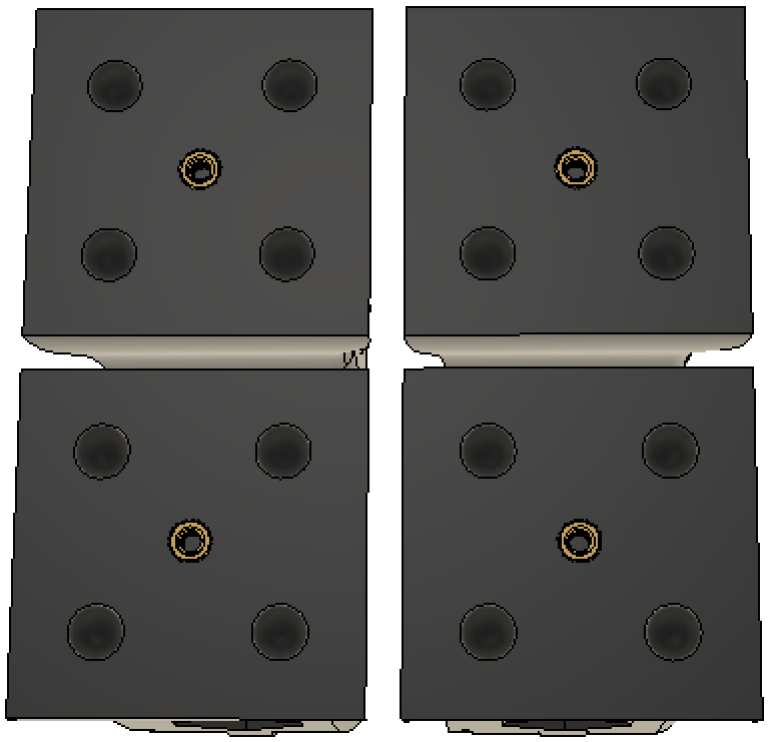


Repeat the above step for the other three top frame corners. With the top corner brackets installed turn your assembled frame upside down and orient the bottom front right corner toward you. The lower brackets use the same parts, however, they are assembled differently per orientation. The front right and rear left corner brackets are assembled the same way. This is true about the front left and rear right corner brackets. We will start by collecting the four printed Corner Bracket Bottom Lock. We will insert an M3 heat set insert into the outer hole of each lock.

Locate the four printed Corner Bracket Bottom parts and insert an M4 heat set insert into the center hole of one side for two of them and the other side for the other two. The result should resemble the picture below.

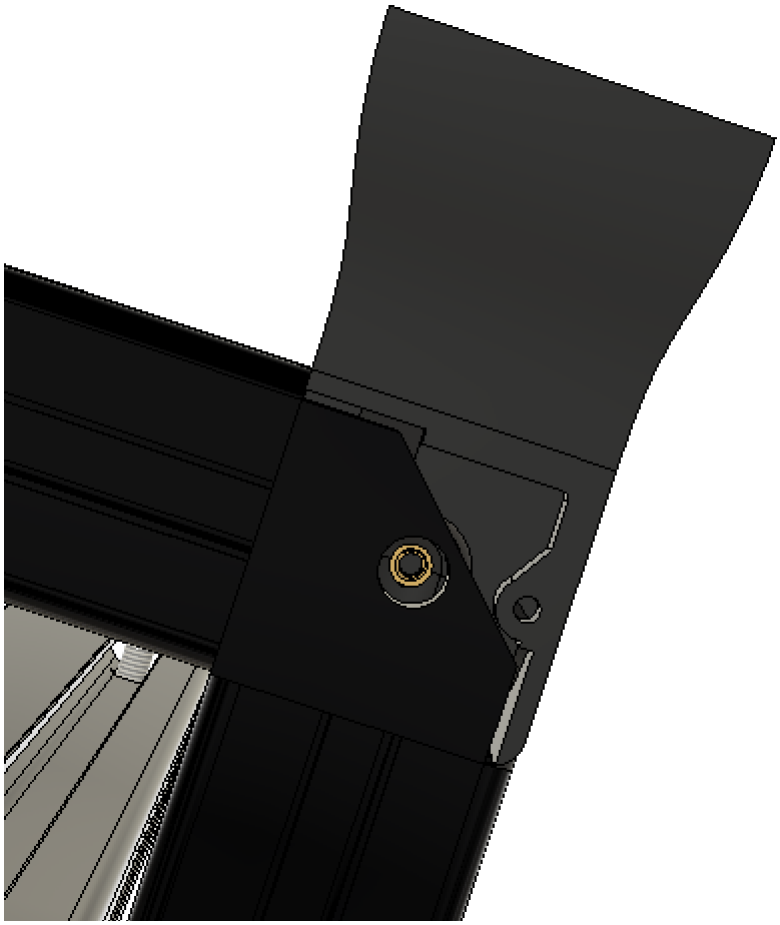
The two printed brackets to the left will attach to the Rear Left and the Front Right. The two printed brackets to the right will attach to the Front Left and Rear Right.

Turn all of the printed Corner Bracket Bottom parts over and insert an M4 heat set insert into the center hole.

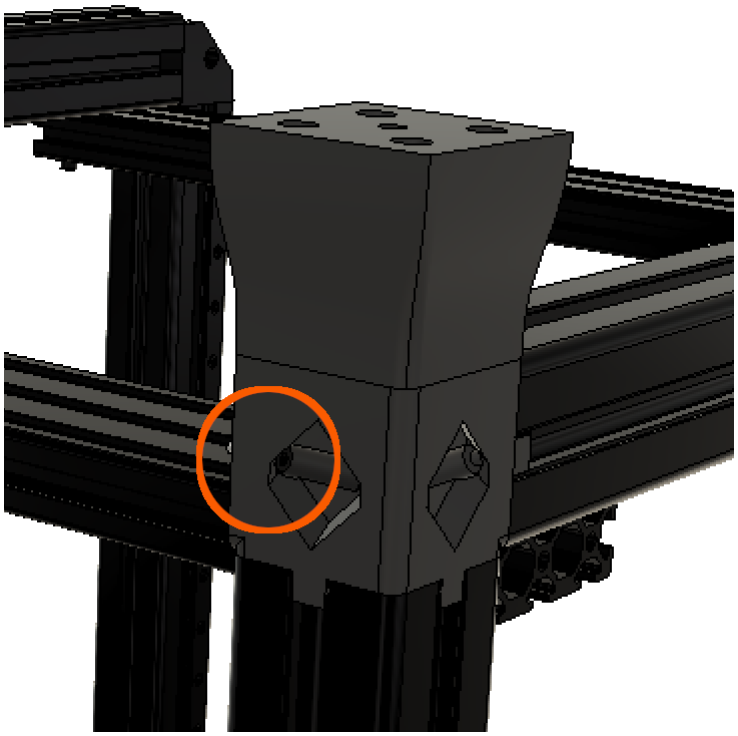


Place the appropriate Corner Bracket Lock into the 4040 extrusion as shown.

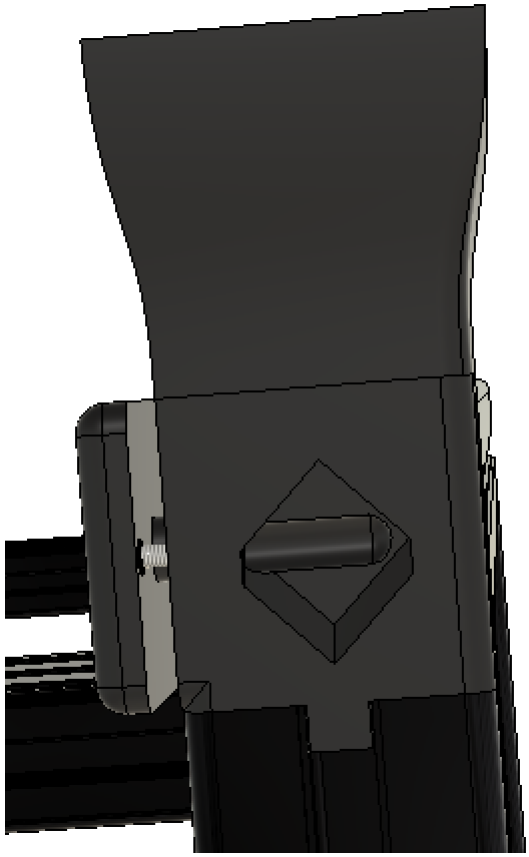
Insert the printed Corner Bracket Bottom which has an M4 insert which will show through the open hole in the Aluminum Corner Bracket.



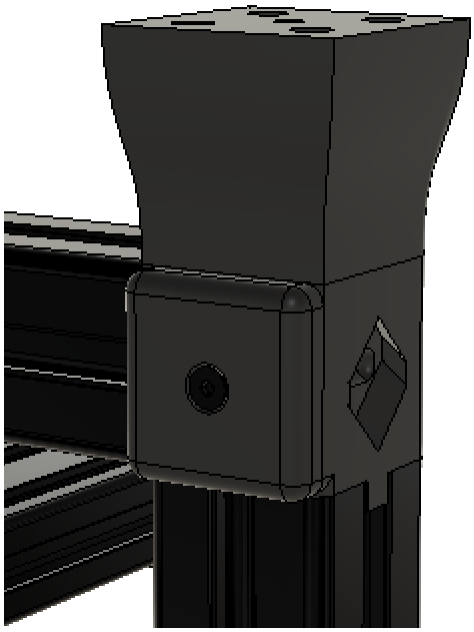
Place an M3x10 SHCS fully into the recessed pocket of the Corner Bracket Bottom.



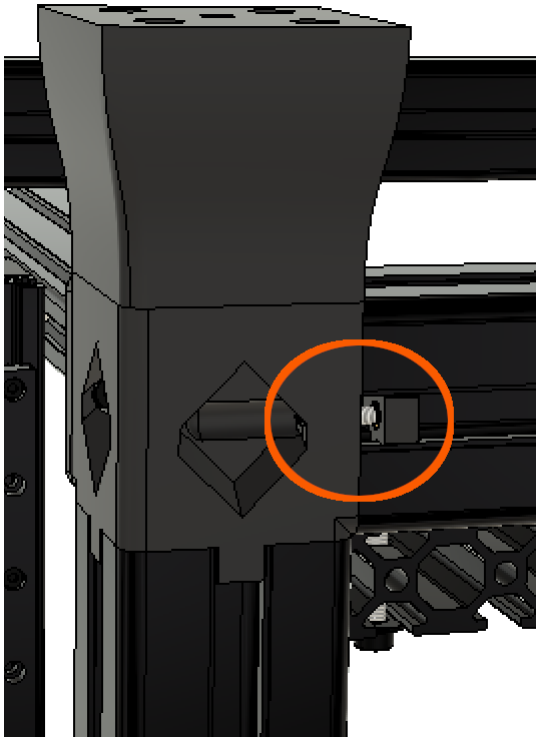
Line up the M3 heat set insert in one of the printed Corner Bracket Bottom Lock parts with the M3x10 SHCS you just installed into the printed Corner Bracket Bottom. Using the angled end of your hex wrench, tighten the M3x10 SHCS allowing the screw to pull the printed Corner Bracket Bottom Lock flush to the printed Corner Bracket Bottom. Be certain the keyed post on the printed Corner Bracket Bottom Lock is properly aligned so it goes through the Aluminum Corner Bracket.



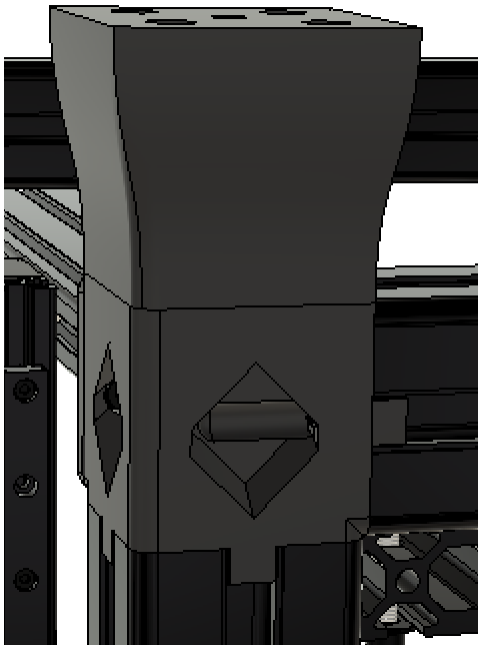
When the printed Corner Bracket Bottom Lock is flush and tight to the printed Corner Bracket Bottom, install an M4x25 FHHS through the center of the printed Corner Bracket Bottom Lock and into the printed Corner Bracket Bottom, then fully tighten.



Insert an M3x10 SHCS in the recessed hole of the printed Corner Bracket Bottom on the opposite face. Fully press the screw in by hand moving the printed Corner Bracket Lock.



Put pressure on the printed Corner Bracket Lock as you tighten the M3x10 SHCS with the angled end of a hex wrench. As you tighten the M3x10 SHCS the printed Corner Bracket Lock will move toward the printed Corner Bracket Bottom. Continue to tighten until these printed parts are flush and tight.



Repeat these steps for the following three bottom corners of the fame. Congratulations! Your basic frame is now complete and assembled.