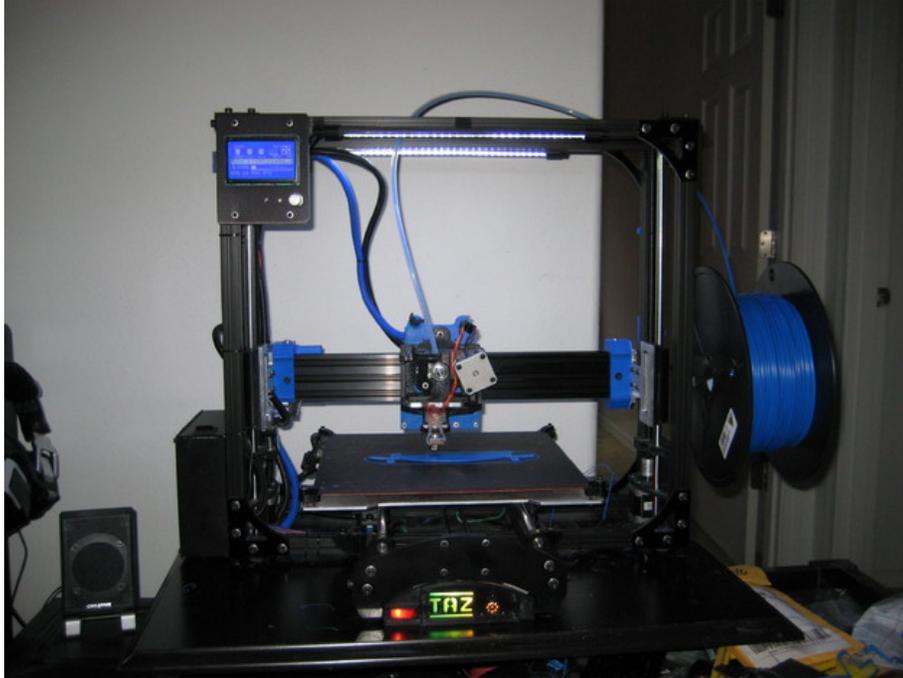# Openbuilds v-slot X axis retrofit

for Lulzbot TAZ 4 or 5 printers

Assembly Instructions and Reference Guide

Revision 1.0

Prepared 6/17/2016

By **Tim Pierce – aka Piercet**

Introduction

The Openbuilds X axis retrofit for the Lulzbot Taz 4 or Taz 5 series printers is designed to improve accuracy and precision of these already very capable printers, and reduce nozzle sag. When properly installed and aligned, most users experience more even print layers, and are able to use larger toolhead designs without middle droop issues associated with rod based designs. This has the effect of eliminating approximately half of the apparent "hump" in the middle of the build plate caused by such droop. When combined with the Openbuilds Y axis retrofit, the two modifications are able to almost entirely eliminate that effect.

This instruction manual is intended to show a step by step, comprehensive assembly process, including what tools and hardware will be required. It assumes that you are proficient in installing heat set inserts (more information: https://www.matterhackers.com/articles/fasteners-for-3d-printing) , using a hacksaw, and operation of basic hand tools. Basic modification alignment tips and tricks are included, however you should not attempt this modification unless you are confident in your ability to modify your printer.

Note: Please be aware that any major printer modification may void your factory warranty. I recommend attempting this modification only after your factory warranty has already expired.

Reference:

The Openbuilds X axis retrofit is an open source project under the Creative Commons : Attribution license. The latest project files are currently maintained here: http://www.thingiverse.com/thing:866604 . The Build thread is available here: https://forum.lulzbot.com/viewtopic.php?f=16&t=2252 Please feel free to ask any questions about this mod, the installation process, etc. there or via the Lulzbot Forum PM system if you like. Technical support is provided on a voluntary basis.

Tools Required:

- o Needle nose pliers
- o M2 hex driver
- o M3 hex driver
- o M4 hex driver (for the low profile M5 bolts)
- o M5 Hex driver
- o Philips head screwdriver (for M6 bolt)
- o Scissors for cutting zip ties and belts
- o Blue Loctite (optional)

Disassembly:

Remove the stock X axis rods, carriage, X motor mount, X idler mount, X motor, X minimum endstop, belt, Idler hardware and the front X carriage guide V notch and associated hardware from your stock Taz. You will reuse much of the mounting hardware and components.

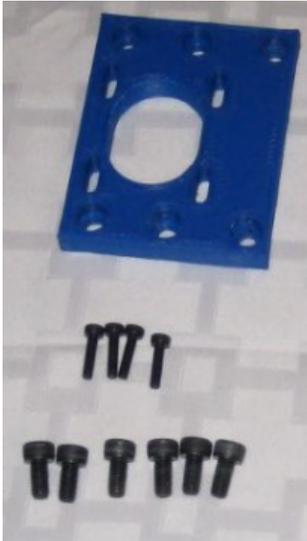# Required hardware Bill of Materials:
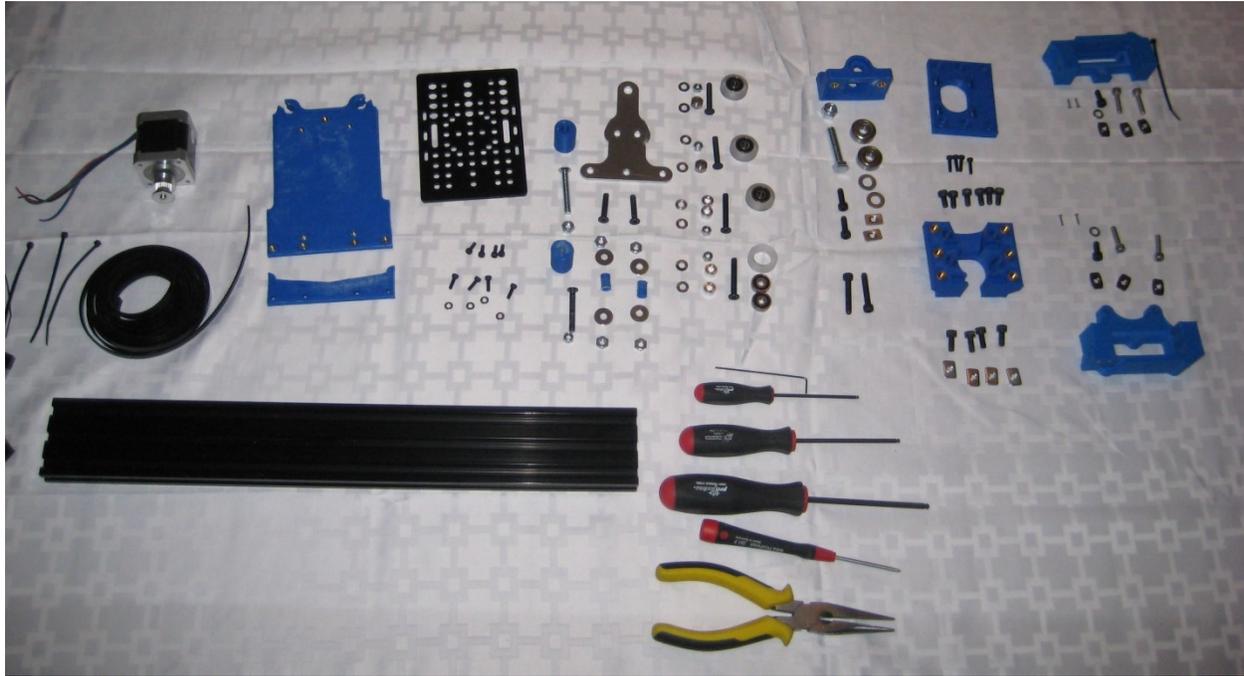
X motor Mount Main block

- o 4x 10mm M5 bolts
- o 6x M5 11mm Long Heat set inserts (http://www.mcmaster.com/#94180a363/=12wc6gg)
- o 4x M5 Tslot nuts

X motor mount lid plate

- o 6x 10mm M5 bolts

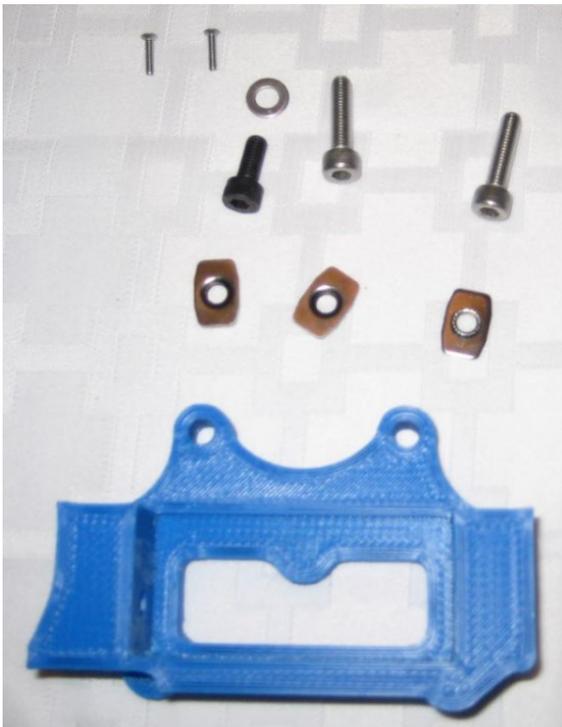Openbuilds X axis for Taz 4/5

o   4x 12mm M3 bolts

Motor mount X end (left)

o   1x 10mm M5 bolt
o   2x 20mm M5 bolt
o   2x 8mm M2 bolt (low profile head preferably)
o   Stock 3 M5 Bolts and washers for Endplate connections (not pictured)
o   3x M5 Tslot nuts
o   3x 6.75mm long M5 Heat set inserts (http://www.mcmaster.com/#94180a361/=12wc6v8)
o   2x M2 heat set inserts (http://www.mcmaster.com/#94180a307/=12wc74i)
o   stock X Minimum endstop (not pictured)
o   One zip tie

Openbuilds X axis for Taz 4/5

Idler X end (Right)

- o 1x 10mm M5 bolt
- o 2x 20mm M5 bolt
- o Stock 3 M5 Bolts and washers for Endplate connections (not pictured)
- o 3x M5 Tslot nuts
- o 3x 6.75mm long M5 Heat set inserts (http://www.mcmaster.com/#94180a361/=12wc6v8)
- o Optional:
- o 2x 8mm M2 bolt (low profile head prefferably)
- o 2x M2 heat set inserts (http://www.mcmaster.com/#94180a307/=12wc74i)
- o One additional X maximum endstop assembly (not pictured
    https://ultimachine.com/collections/electronics/products/microswitch-ss-3gl13pt)

- o

X idler mount

- o Stock Lulzbot idler bearings, washers, Nut and large bolt (non-stock hardware pictured)
- o 2x 6.75mm long M5 Heat set inserts (http://www.mcmaster.com/#94180a361/=12wc6v8)
- o 2x 30mm M5 bolts (the idler adjusters)
- o 2x 10mm M5 bolts
- o 2x M5 Tslot nuts

Openbuilds X axis for Taz 4/5

Main rail

- 1x 60mm x 20mm Openbuilds linear extrusion 500mm long extrusion (64mm removed) http://openbuildspartstore.com/v-slot-linear-rail/

-

X Carriage adaptor plate

- 4x M3 8mm bolts
- 9x M3 heat set inserts (http://www.mcmaster.com/#94180a331/=12wc8o0)
- Stock Lulzbot V notch plastic piece. Stock 4 M3 bolts and washers that hold down that piece (M3 10mm thread plus M3 washers)
- Stock Lulzbot carriage hold down bolt and washer (M3 washer, M3 bolt 10mm thread)
- 4x bearing wheels (http://openbuildspartstore.com/xtreme-solid-v-wheel-kit/)
- 4x spacers (6mm) (http://openbuildspartstore.com/aluminum-spacers/)
- 2x eccentric spacers (6mm) (http://openbuildspartstore.com/eccentric-spacer/)
- 1x Gantry mounting plates. (http://openbuildspartstore.com/v-slot-gantry-plates/)
- 2x 35mm M5 Bolts (Low profile head required http://openbuildspartstore.com/low-profile-screws-m5/).
- 2x 30mm M5 Bolts (Low profile head required http://openbuildspartstore.com/low-profile-screws-m5/).

Openbuilds X axis for Taz 4/5

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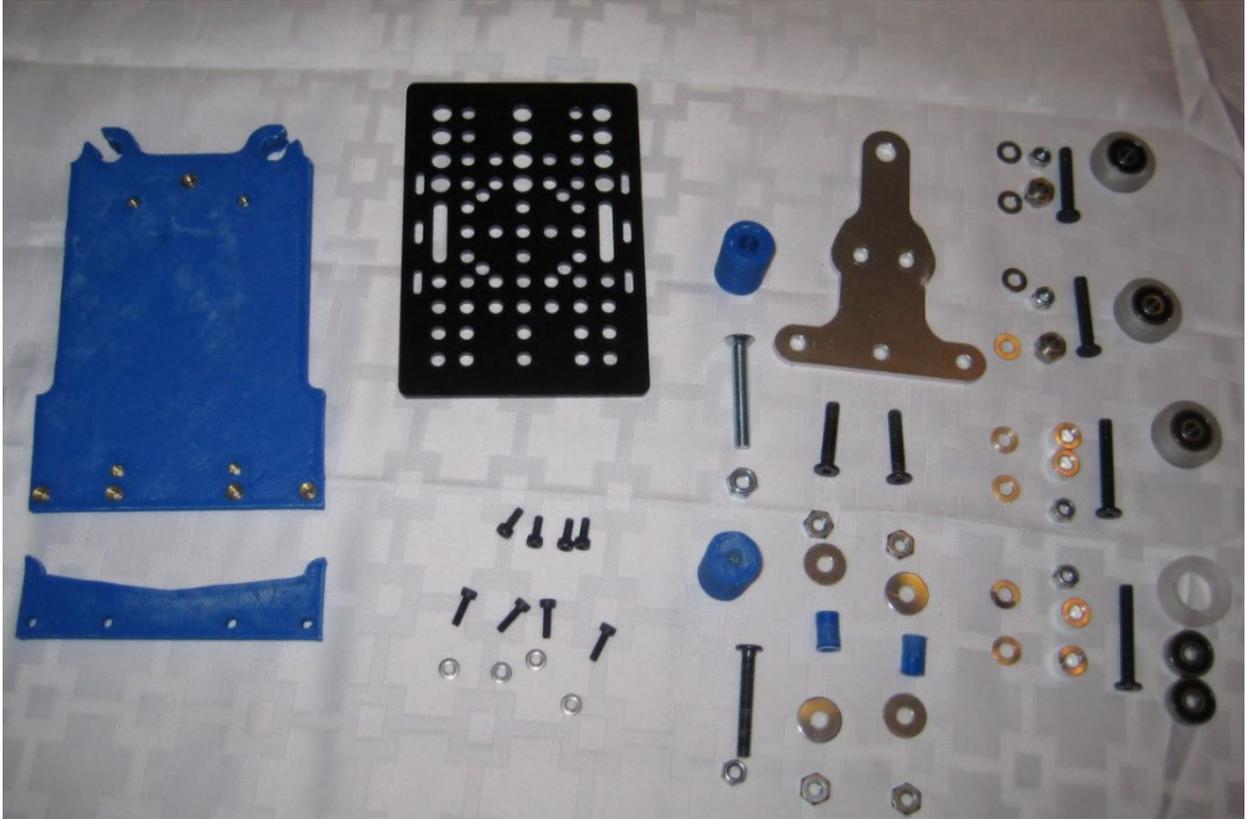
Backplate (metal plate version)

- o 1x 35mm M5 Flat head bolt and Nut (for lower middle Carriage hole - 40mm for printed backplate http://openbuildspartstore.com/low-profile-screws-m5/)
- o 1x 35mm M6 bolt and nut (for upper carriage hole - 40mm for printed backplate)
- o Belt mount posts are made of:
- o 2x 30mm M5 flat head bolt (35mm for printed backplate http://openbuildspartstore.com/low-profile-screws-m5/)
- o 4x M5 nuts
- o 4x M5 large washers (carriage washers)
- o 1x metal backplate
- o Stock Taz belt
- o 4 Zip Ties

Openbuilds X axis for Taz 4/5

Preparation for Installation:

Unless you received this modification in kit form, you will need to print and prepare the following parts:

- o 1x - **Taz_Openrail_X_belt_bracket_2_0_a.stl** (Or the metal backplate – as shown in these instructions)
- o 1x - **Taz_Openbuild_X_Carriage_1_2_a.stl**
- o 1x - **Taz_Openbuild_X_top_backplate_spacer.stl**
- o 1x - **Taz_Openbuild_X_bottom_backplate_spacer.stl**
- o 2x - **Taz_Openbuild_X_backplate_belt_post_spacer.stl**
- o 1x - **Taz_OpenRail_Idler_Endcap_2_0_b.stl**
- o 1x - **Taz_OpenRail_Idler_Tensioner_2_0_a.stl**
- o 1x - **Taz_OpenRail_XMotor_Endcap_9_0_a.stl**
- o 1x - **Taz_OpenRail_Xmotor_Mount_lid_2_0_a.stl**
- o 1x - **Taz_Openrail_xmotor_Mount_mainblock_2_0_a4.stl**

Heat set inserts:

Taz_Openrail_xmotor_Mount_mainblock_2_0_a4.stl requires insertion of 6 M5 heat set inserts

Openbuilds X axis for Taz 4/5

Taz_Openbuild_X_Carriage_1_2_a.stl requires 9 M3 heat set inserts, 4 on the back and 5 on the front
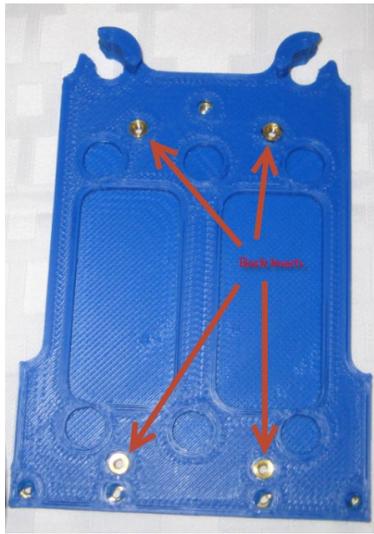
Taz_OpenRail_Idler_Tensioner_2_0_a.stl requires 2 M5 heat set inserts

Taz_OpenRail_Idler_Endcap_2_0_b.stl requires 3 M5 heat set inserts and (optional) 2 M2 inserts

Openbuilds X axis for Taz 4/5

Taz_OpenRail_XMotor_Endcap_9_0_a.stl requires 3 M5 heat set inserts and 2 M2 inserts

(Not pictured 2x m2 inserts go in the small holes similar to the Idler Endcap above)

Rail Preparation:

Measure your 500mm x 60mm x 20mm Openbuilds rail to ensure it is in fact actually 500mm long. If so, remove 64mm using a metal blade hacksaw and a miter box. The openbuilds X axis design allows for approximately +/- 2mm error on this cut.

Please note: If you received this openbuilds X axis modification in Kit form, your rail will already have been cut.

Openbuilds X axis for Taz 4/5

Assembly Instructions:

X Carriage Assembly

Step 1: Locate the 35mm M6 bolt and Nut, the gantry plate, and the **Taz_Openbuild_X_top_backplate_spacer.stl**
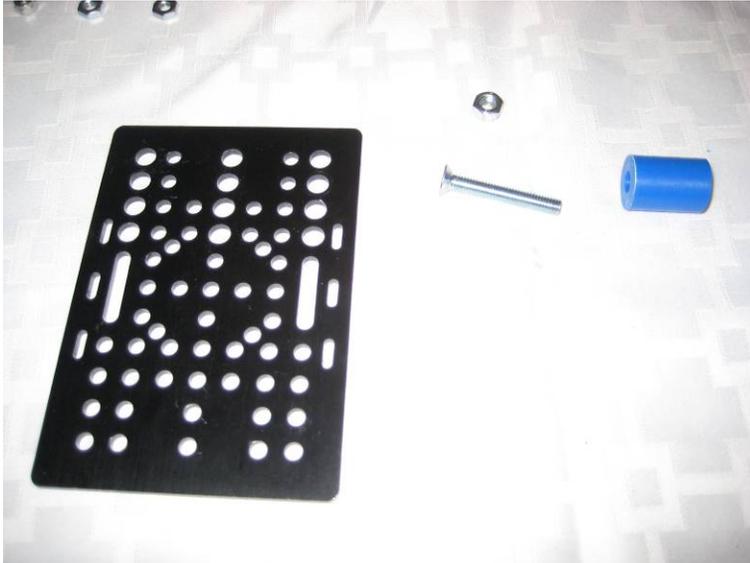
Step 2: Insert the M6 35mm bolt through the second from the top 7.2mm center hole in the gantry plate as shown in the picture, then install the spacer.
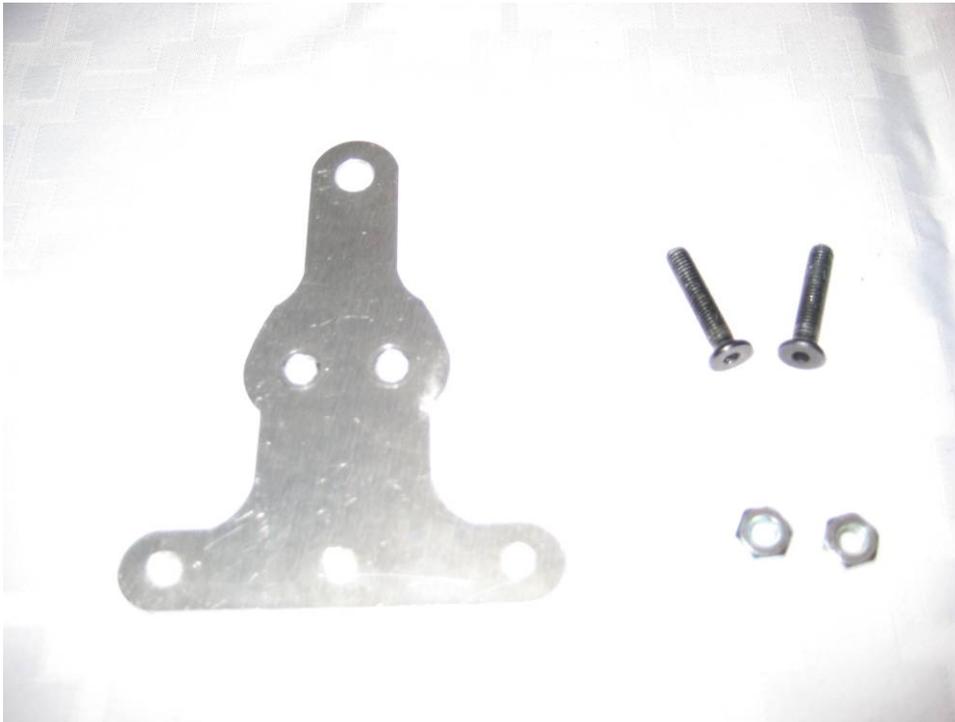
Openbuilds X axis for Taz 4/5
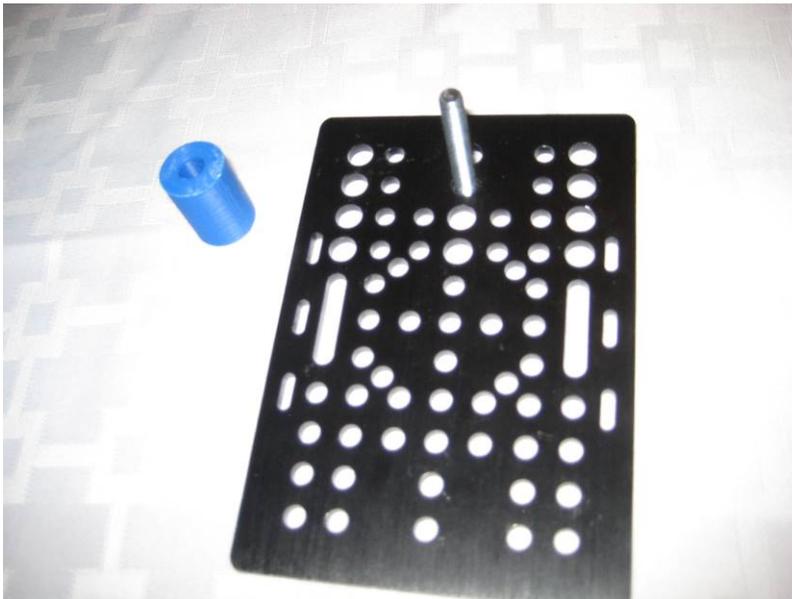
Step 3: Locate the flat head 35mm M5 bolt and nut and the
Taz_Openbuild_X_bottom_backplate_spacer.stl
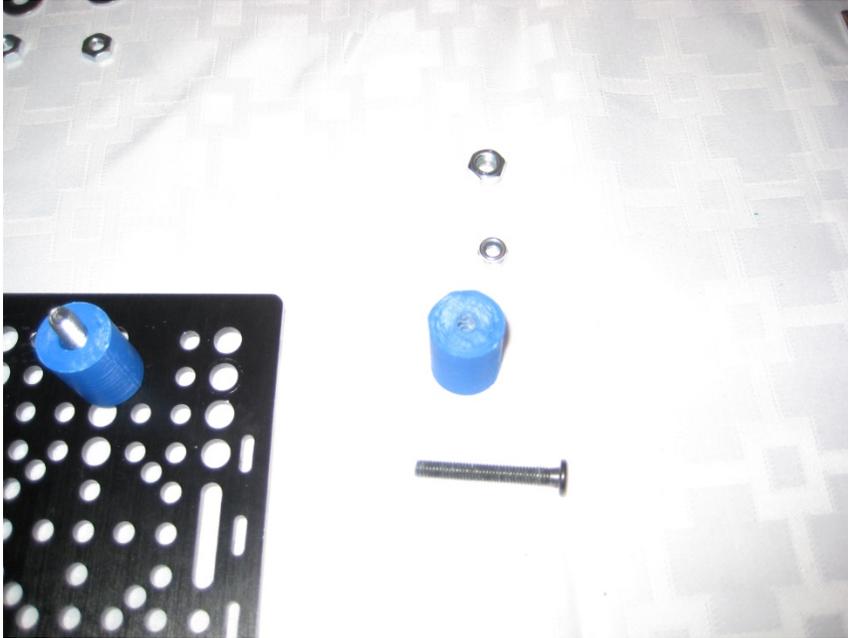
Step 4: insert the 35mm bolt through the second from the bottom 5.2mm hole in the gantry plate and then install the spacer (Not pictured)

Step 5: Locate the backplate, 2 M5 30mm low profile head bolts and 2 nuts

Step 6: Insert the bolts through the back of the backplate, then install the nuts. Tighten the nuts down until they are very tight.
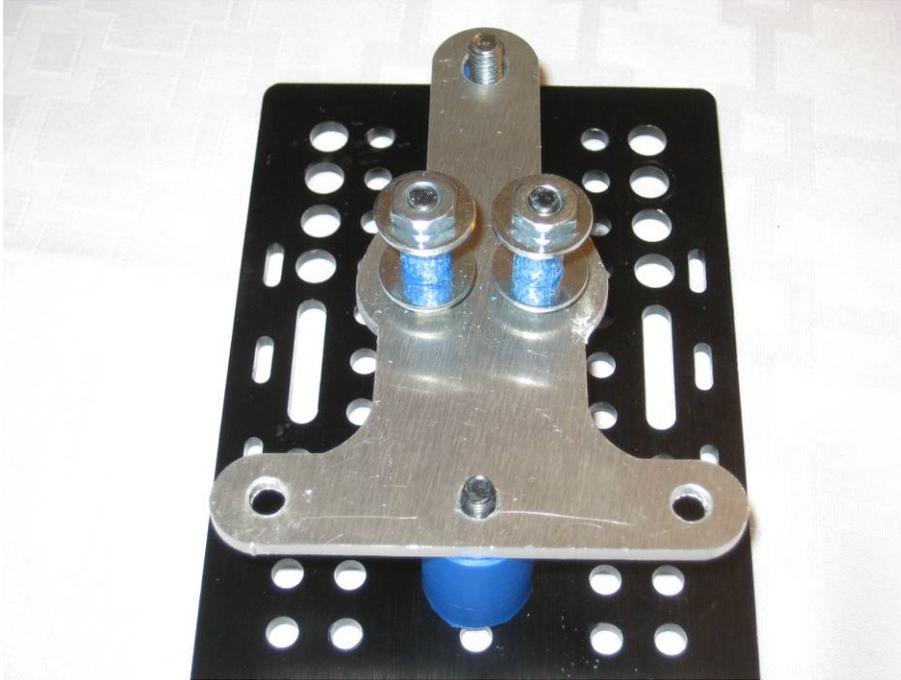
Step 7: Locate 2 M5 washers and 2 **Taz_Openbuild_X_backplate_belt_post_spacer.stl .** Install the washers and then the spacers on the bolts.
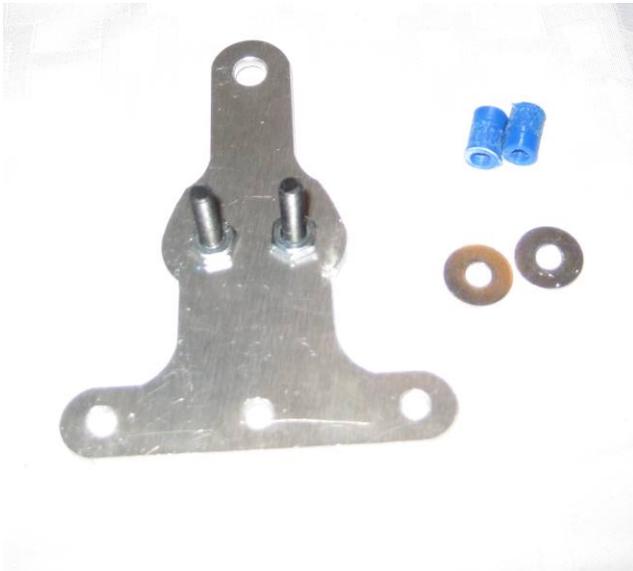
Step 8: Install a second set of 2 washers and 2 nuts on the bolts, tighten. You may optionally apply blue Loctite to the last bolts.
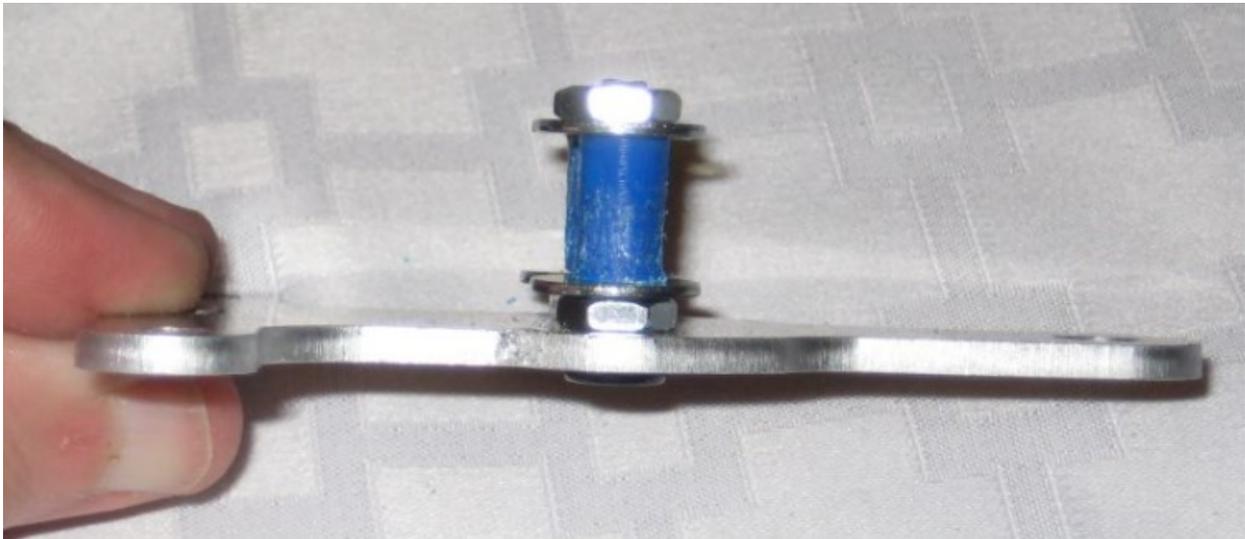
Step 9: Place the assembled backplate on the Gantry plate assembly as shown in the picture:

**Step 10:** Secure the M6 and M6 nuts to lock the backplate in place.

Openbuilds X axis for Taz 4/5

Step 11: Assemble all 4 Openbuilds wheels by installing the two included bearings into the wheels, one per side. They should snap into the housing, and sit flush with the edge of the wheel.

Step 12: Locate 2 wheel assemblies, 2 30mm M5 low profile head bolts, 2 Eccentric spacers, 4 openbuilds wheel washers, and 2 M5 lock nuts.

Openbuilds X axis for Taz 4/5
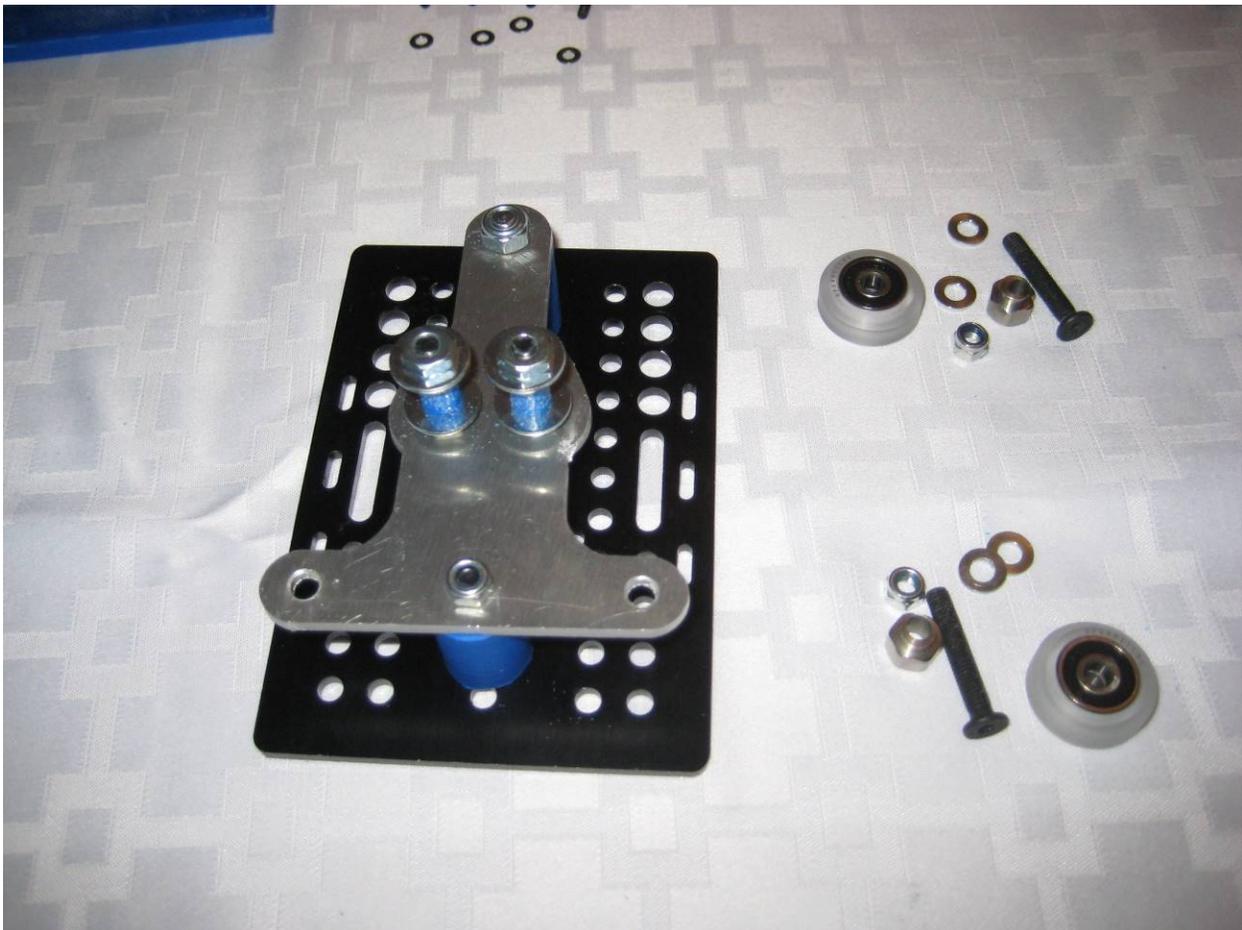
Step 13: Insert the M5 bolts through the gantry plate in the two outer 2.2mm holes, one row down from the top (as shown in the picture). Insert the Eccentric spacers so that the smaller section sockets into the 7.2mm hole surrounding the bolt.
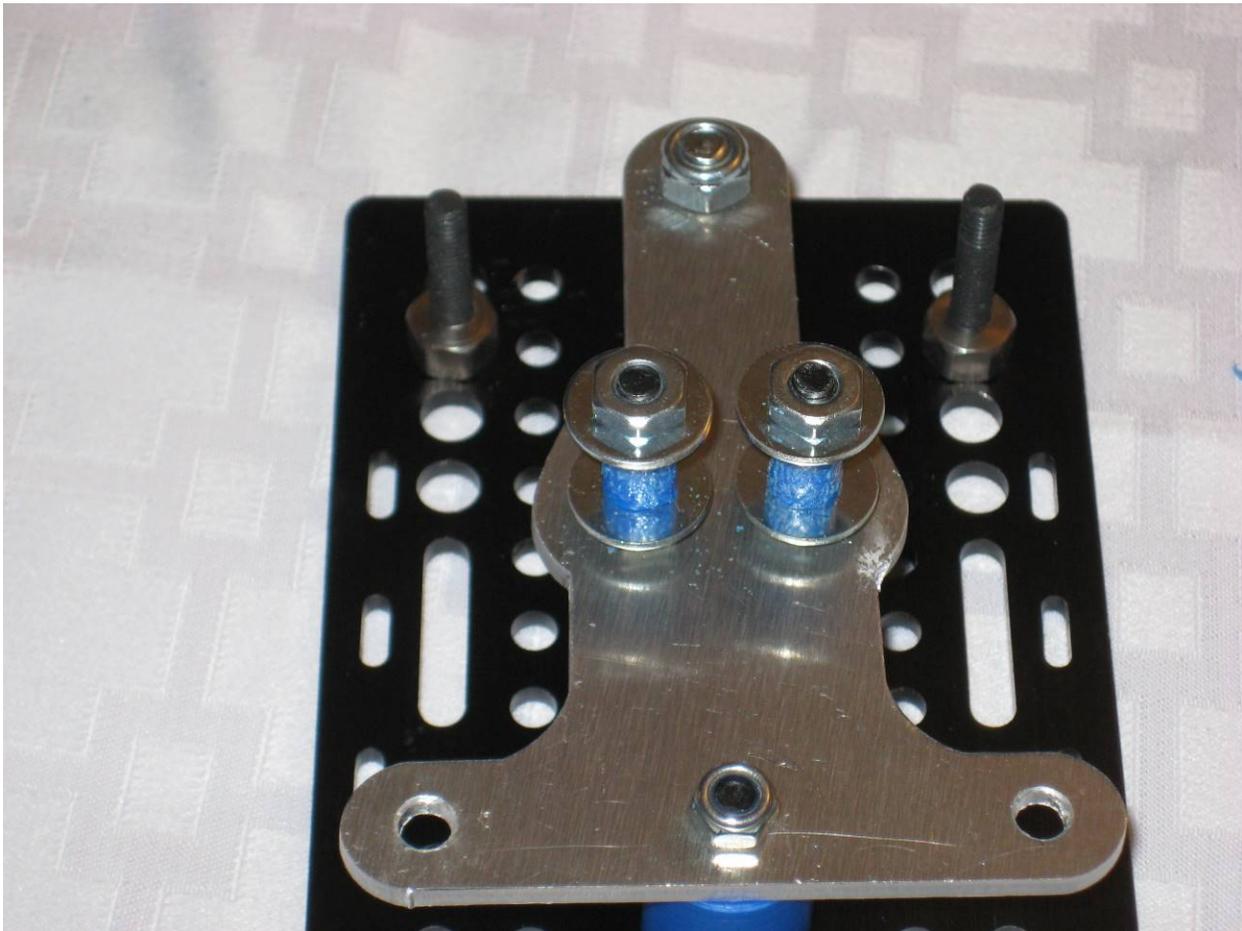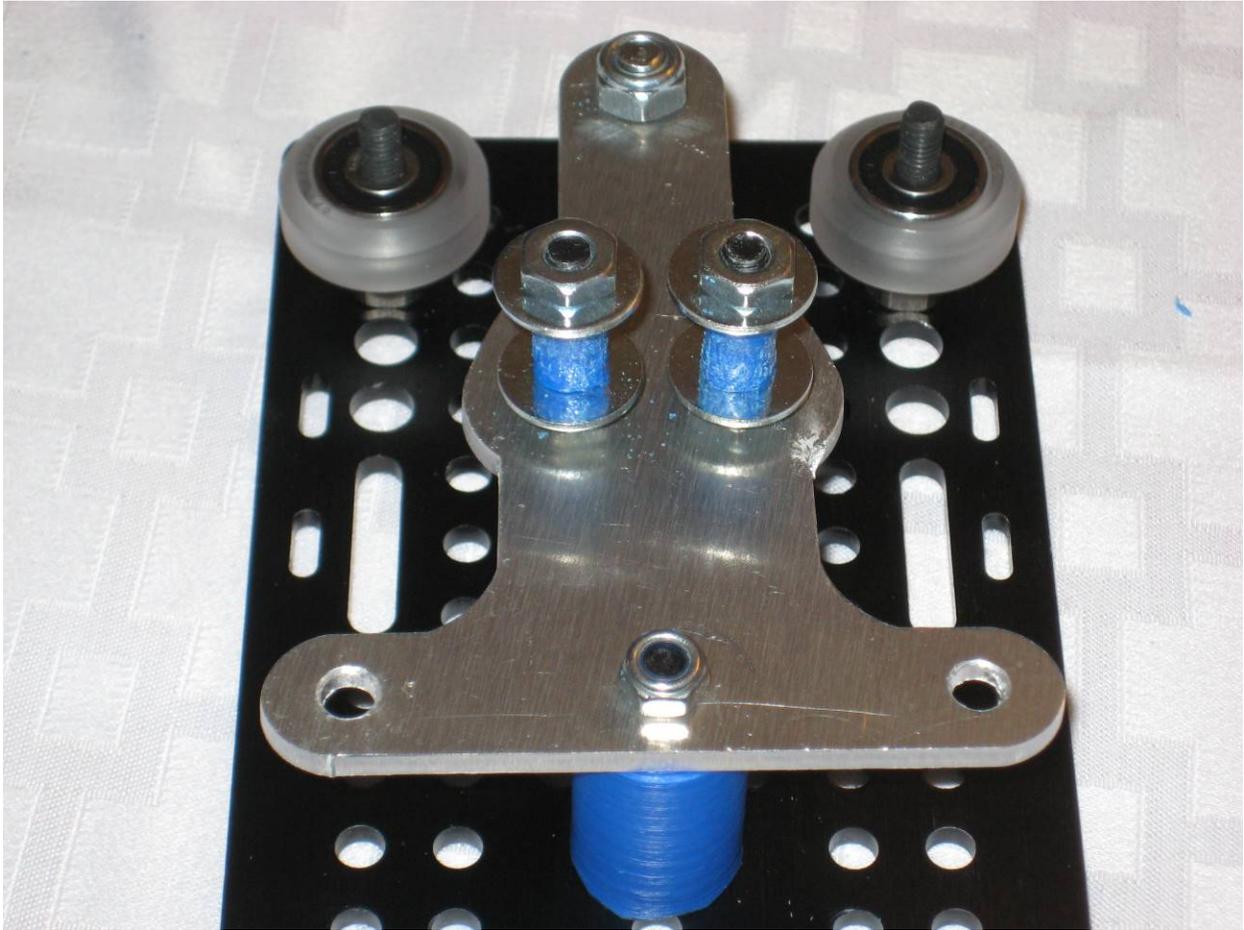

The eccentric spacers have a mark on them that indicates where the narrowest point of the offset is located. Set this mark to the top of the gantry plate for now. There are several models of eccentric spacer, yours may have a Line notch instead of an imprint.
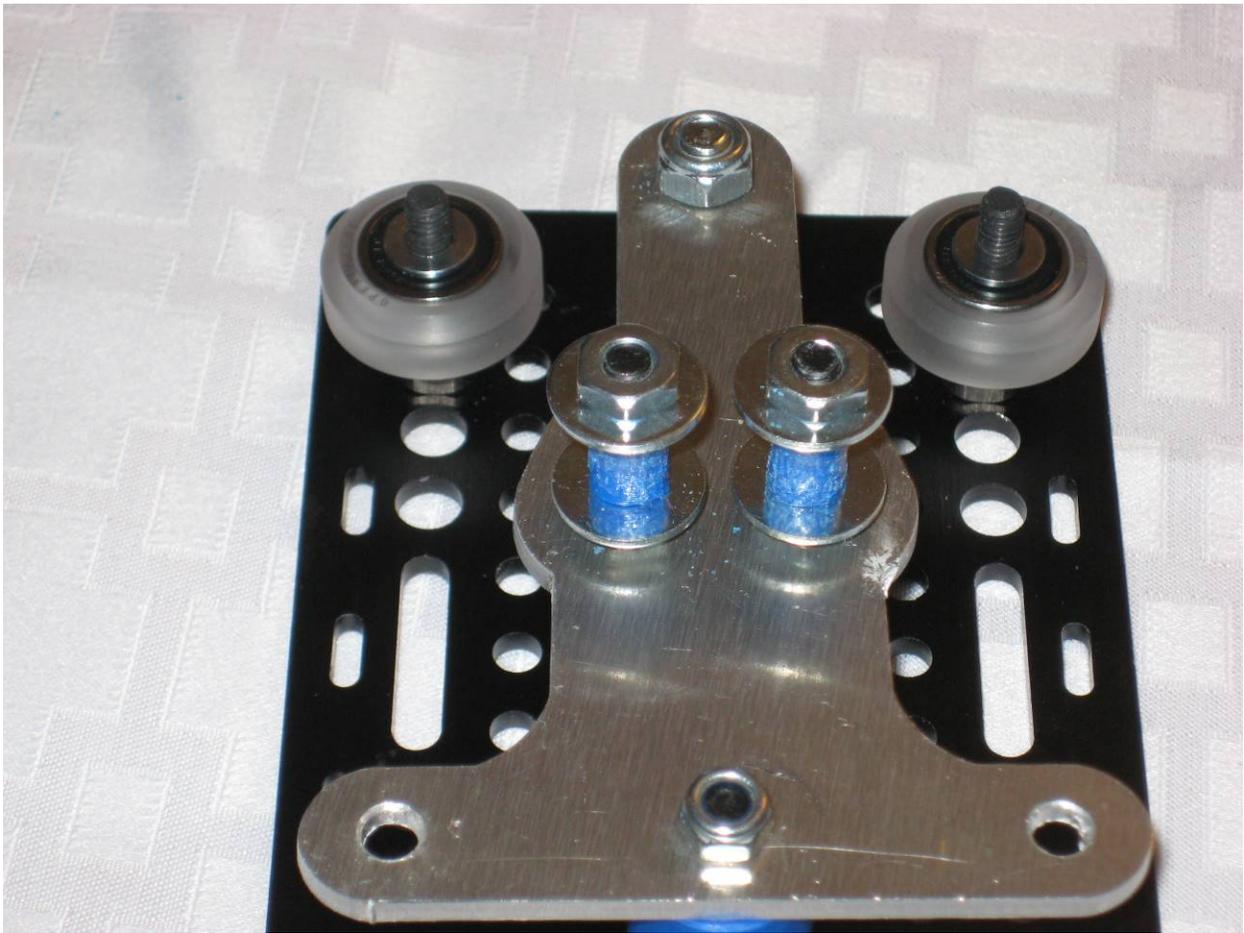
Openbuilds X axis for Taz 4/5

Step 14: Install 1 washer on each bolt

Openbuilds X axis for Taz 4/5
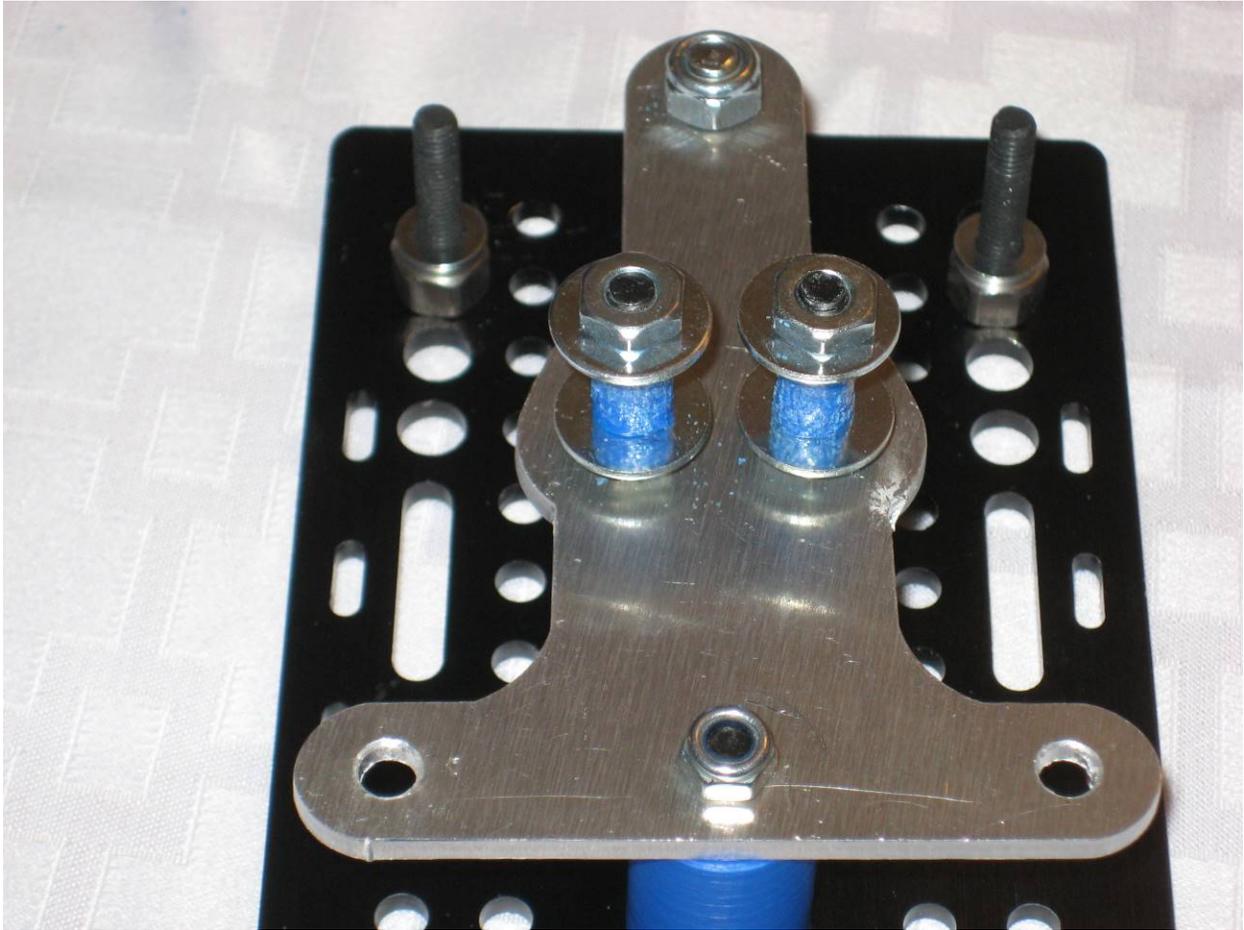
Step 15: Install the wheel assemblies on each bolt

Openbuilds X axis for Taz 4/5

Step 16: Install another set of washers above the wheel

Openbuilds X axis for Taz 4/5

Step 17: Install the locknuts. Tighten them until the wheel has no wobble or play on the bolt, but still moves freely. If the wheel seems difficult to turn or has drag, back the nut off a small amount until it turns freely again.
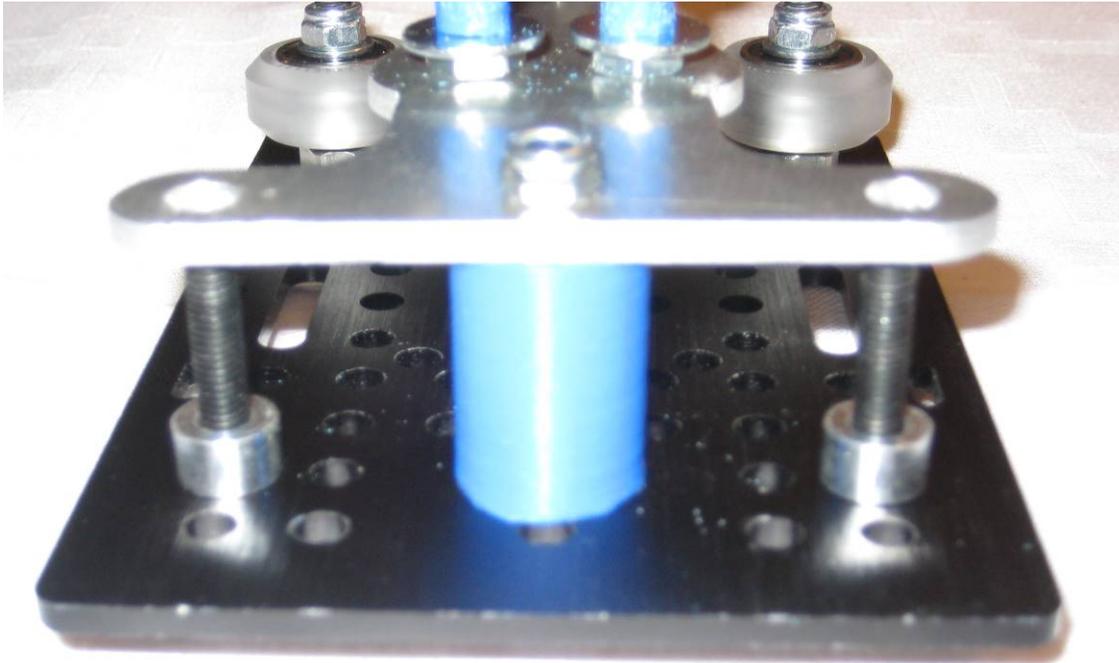

Side view

Openbuilds X axis for Taz 4/5
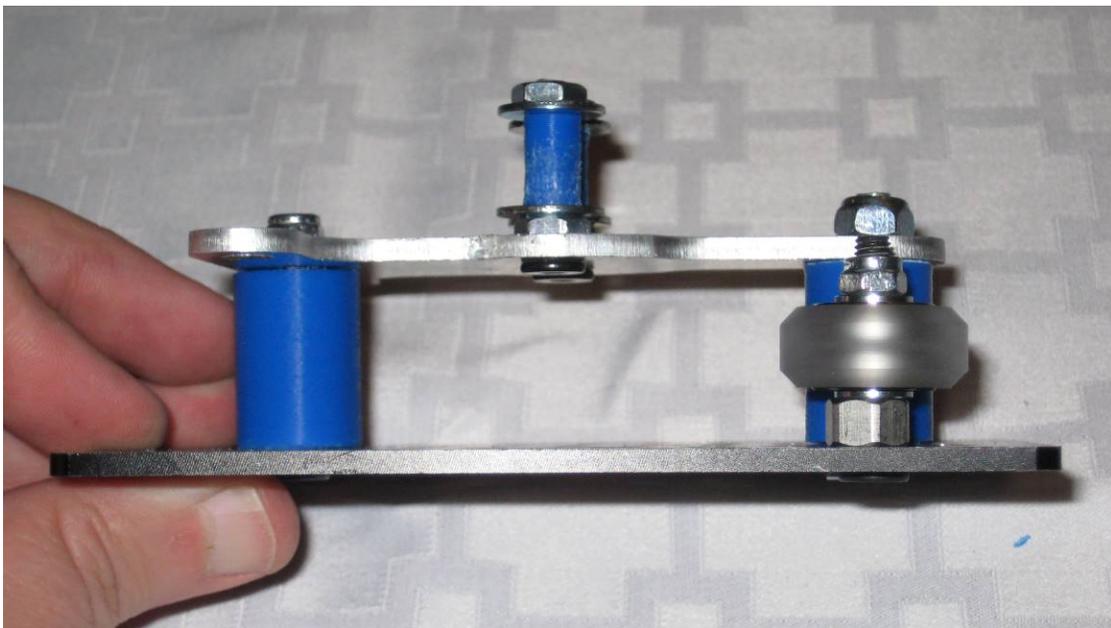
The front showing bolt placement. The M6 bolt is at the top

**Step 18:** Locate 2 35mm M5 low profile head bolts and insert them through the gantry plate part way.

Openbuilds X axis for Taz 4/5

Step 19: Slip one of the 6mm non eccentric spacers over each bolt

Step 20: Slip a washer over each bolt

Openbuilds X axis for Taz 4/5
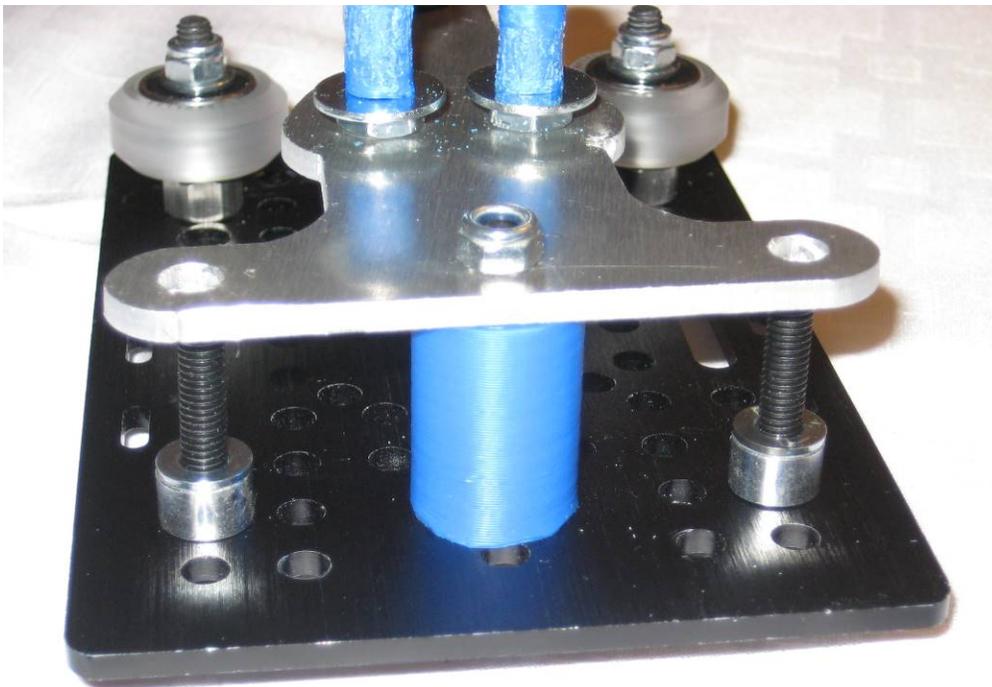
Step 21: Slip another washer, the other spacer over each bolt, extend the bolt through the backplate, then add the M5 lock nut. Yes, I skipped a couple of pictures. Sorry.
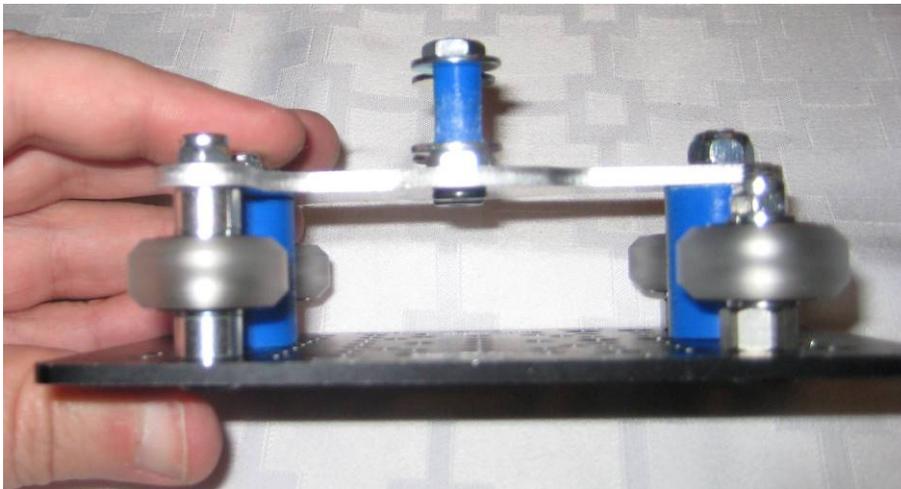
Step 22: Locate the **Taz_Openbuild_X_Carriage_1_2_a.stl plate,** the stock Taz 4/5 Carriage guide, and the stock 4 m3 10mm bolts and washers

Step 23: Install the carriage guide to the adaptor plate, ensure that the notch slopes down towards the plate so that it mirrors the stock configuration

Openbuilds X axis for Taz 4/5

Step 24: Flip the adaptor plate over, locate the 4 8mm M3 screws, and position the X carriage gantry plate and back plate assembly so that the bolt heads line up with the recessed cirles
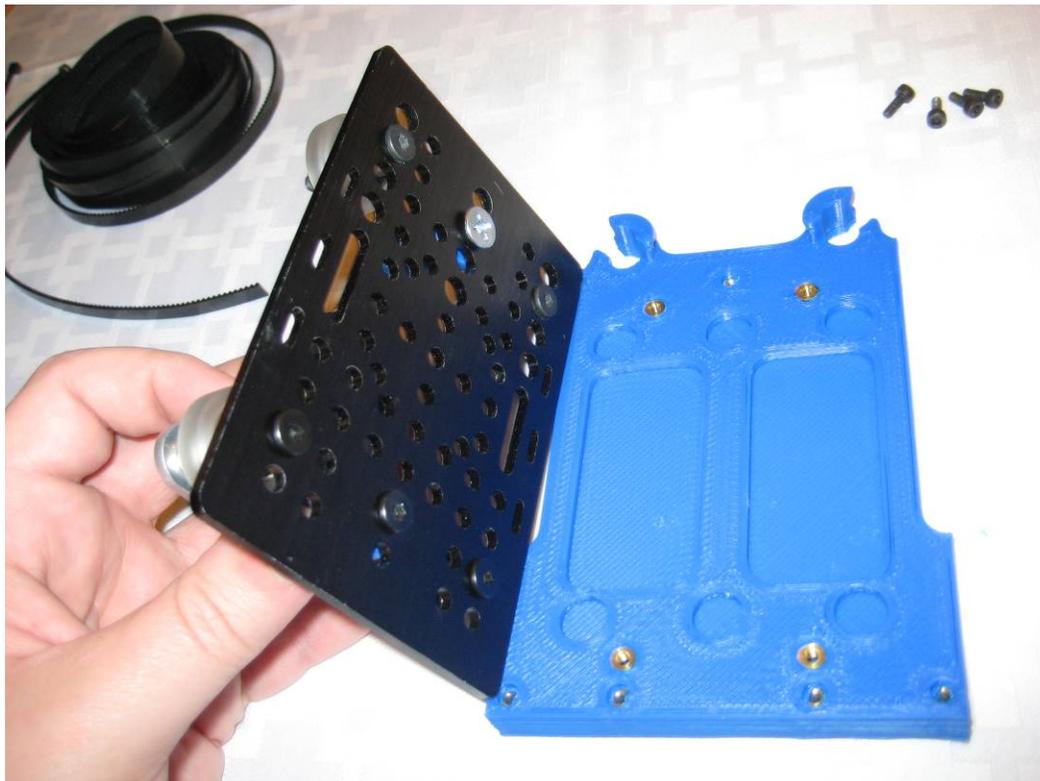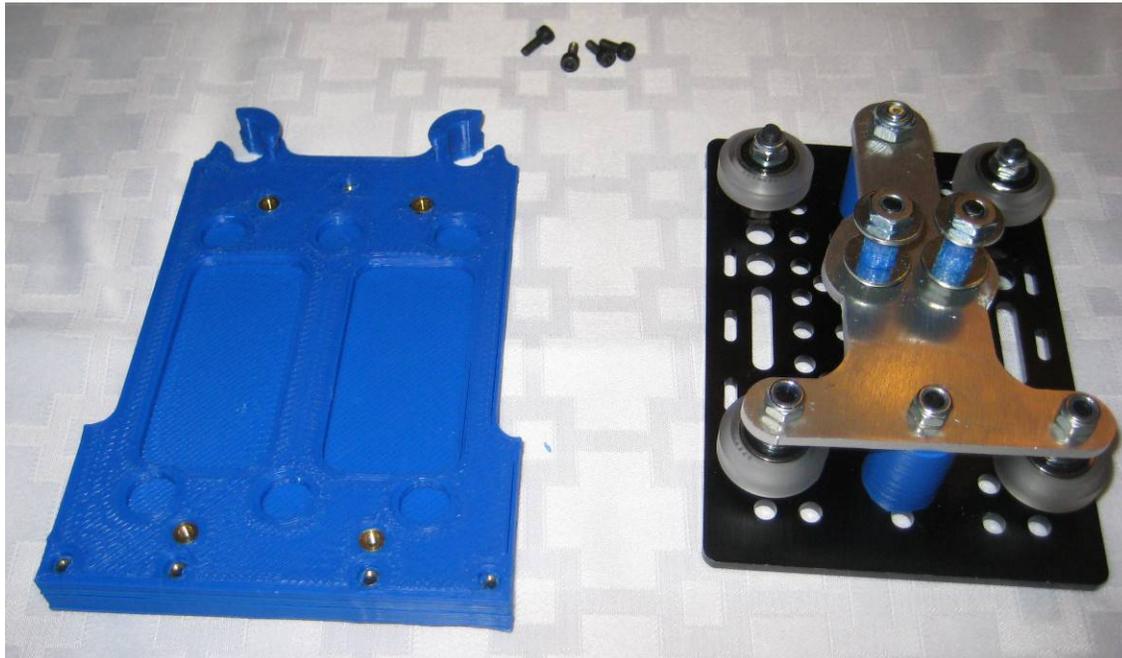
Step 25: Install the 4 M3 8mm bolts into the holes that line up with the exposed heat set inserts. The adaptor plate should be lined up with the gantry plate, square, and centered on those holes. The bolts should be tight enough to prevent movement or slippage later.
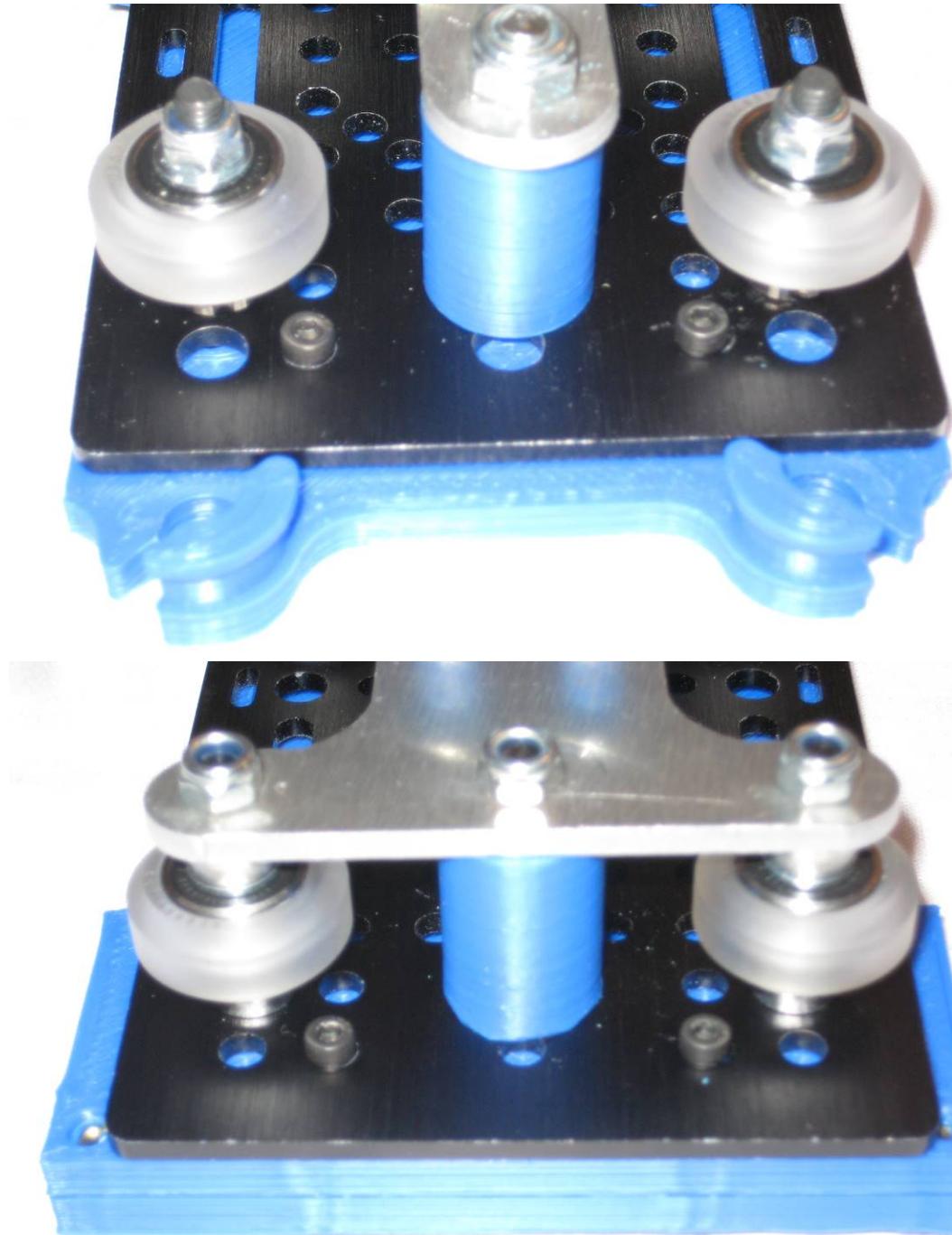
side view of the completed X carriage Assembly

Openbuilds X axis for Taz 4/5

Step 26: Place the X carriage assembly on the Openbuilds V rail. At this point it should be loose and somewhat wobbly.
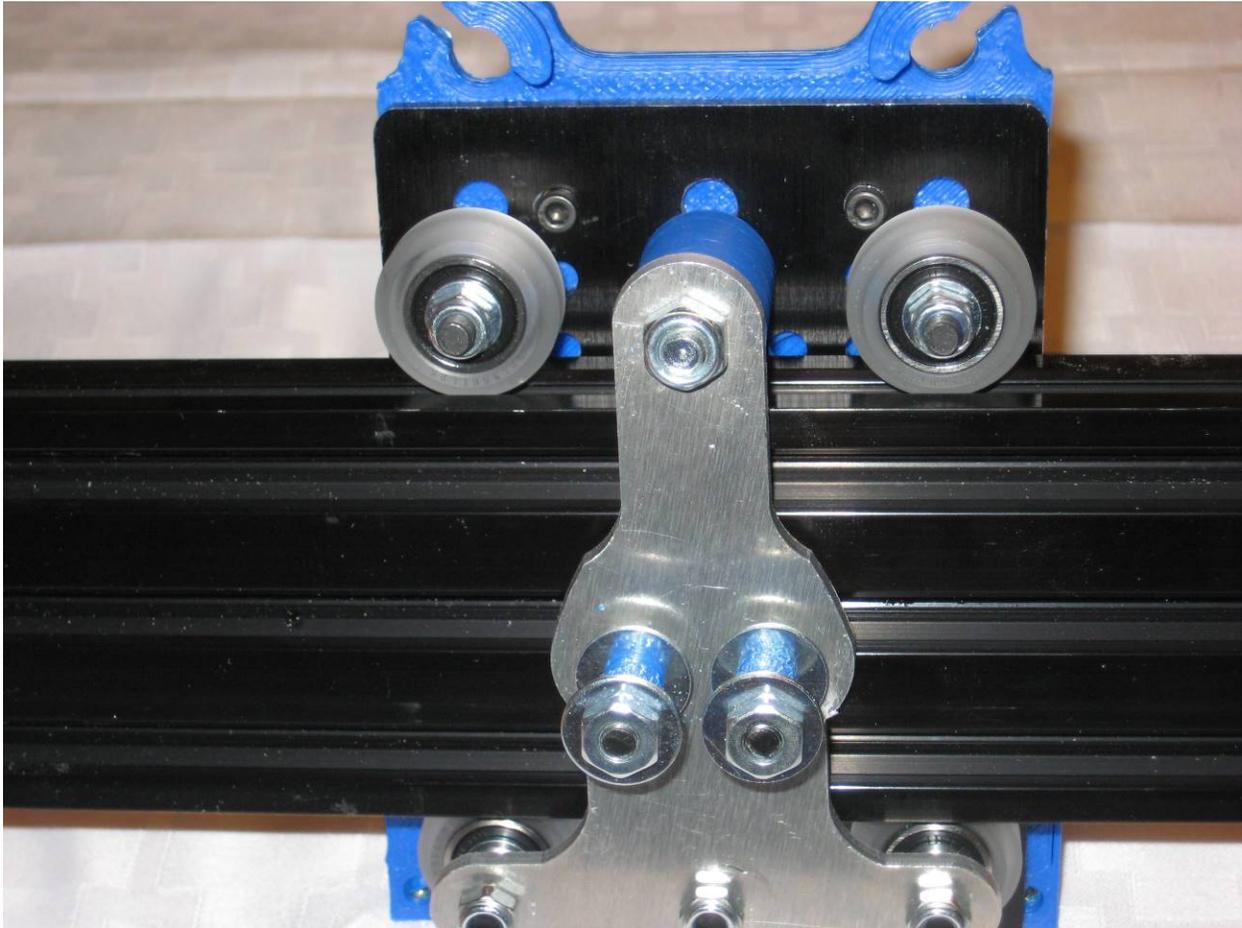
Step 27: Using your needle nose pliers, turn the eccentric spacers until the wheels tighten up on the rail. There should be zero play or wobble of the carriage when both are adjusted, but the carriage should roll freely if you tilt the rail. If it feels too tight, back the eccentric spacers off. In production the spacers can move slightly over time, but I find that adjustment is only required on average of once every 6 months or so, and even then is minor. Adjustment can be carried out with the carriage mounted to the Taz later.

Openbuilds X axis for Taz 4/5

Idler Assembly

Step 28: Locate the **Taz_OpenRail_Idler_Tensioner_2_0_a.stl**, Stock Taz Idler hardware, and two 10mm M5 bolts, and T-nuts. **Note:** your stock Taz Idler bolt will look significantly different than this bolt.

Step 29: Reinstall the stock Taz idler hardware, with the bolt head at the bottom of the idler block, followed by a washer, 2 608zz bearings, another washer, and then the Nut on the outside of the assembly as shown in the picture below.

Openbuilds X axis for Taz 4/5

Step 30: Insert the M5 bolts through the assembly, and pre install the T-nuts. Set this assembly aside for now.

Openbuilds X axis for Taz 4/5

Idler Endcap Assembly

Step 31: locate the **Taz_OpenRail_Idler_Endcap_2_0_b.stl**, One 10mm M5 bolt and washer, 2 20mm M5 bolts, 3 M5 Tslot nuts, and Optionally 2x 8mm M2 bolts and a Z maximum endstop assembly

Step 32: Insert the 20mm M5 bolts through the top and bottom of the Idler endcap, and the 10mm M5 bolt and washer through the front. Preinstall the M5 Tslot nuts on those bolts. Optionally, install the X maximum Endstop with the 8mm long M2 bolts. Set aside, along with the 2 32mm long M5 bolts and the

Openbuilds X axis for Taz 4/5

Idler block for later.

Openbuilds X axis for Taz 4/5

X Motor Mount Lid

Step 33: Locate the stock Taz 4/5 X axis motor, **Taz_OpenRail_Xmotor_Mount_lid_2_0_a.stl** 4 12mm long M3 bolts and 6 10mm M5 bolts

Openbuilds X axis for Taz 4/5
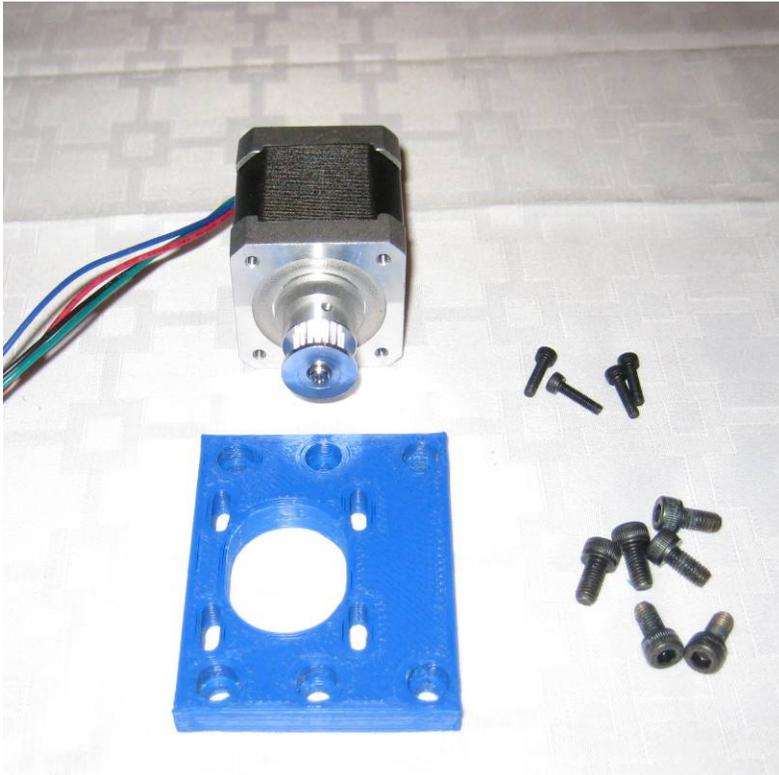
Step 34: Install the motor using the 4 M3 bolts. It is adjustable later. Preinstall the 6 M5 bolts so they are flush with the recessed sockets. Set the completed assembly aside for later. **Note:** You can use a vibration damper here if you like, however the design of the mount already serves that purpose so there is no real gain to doing so at this location.
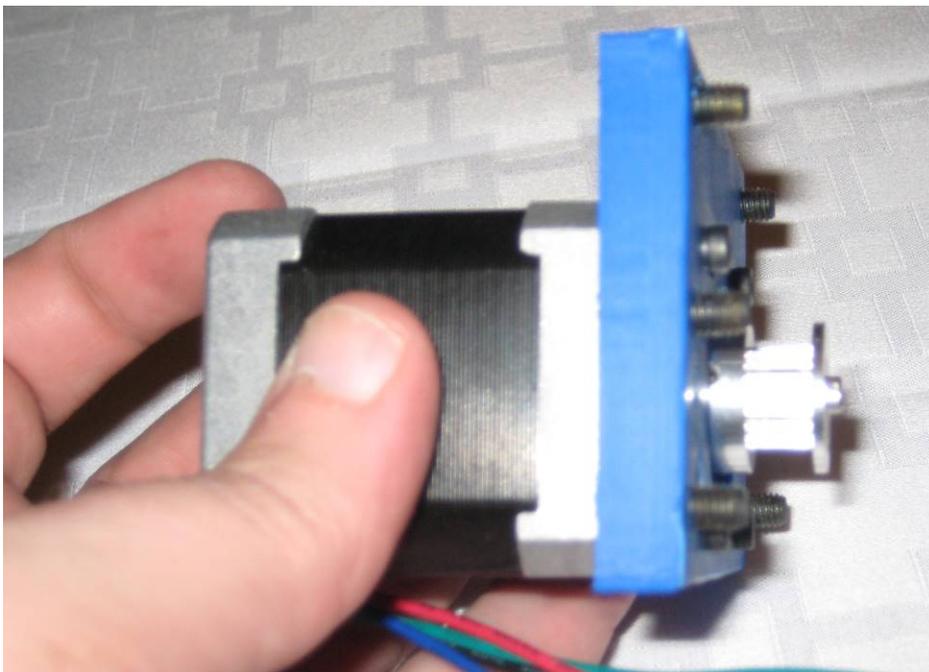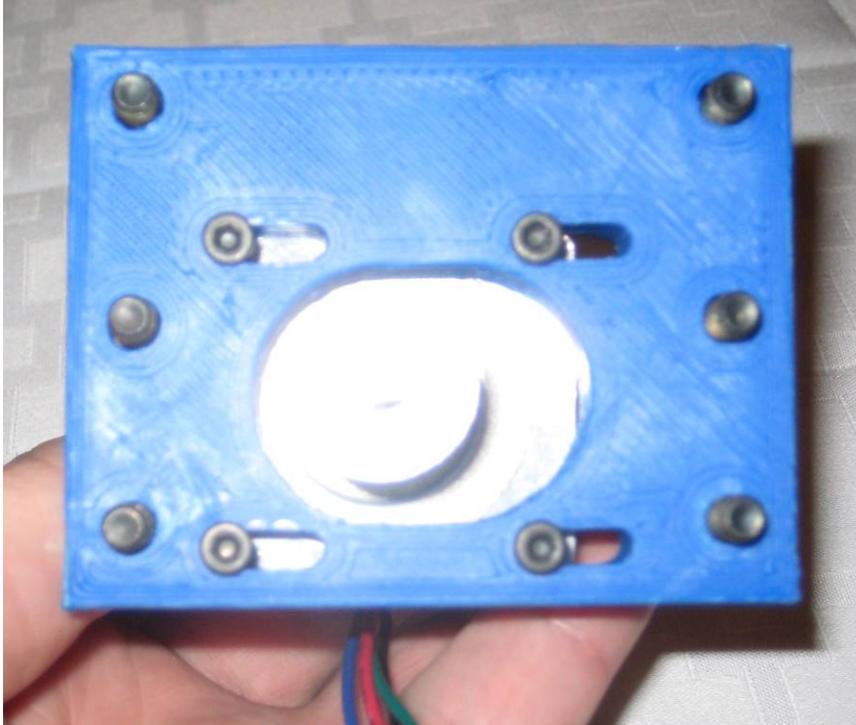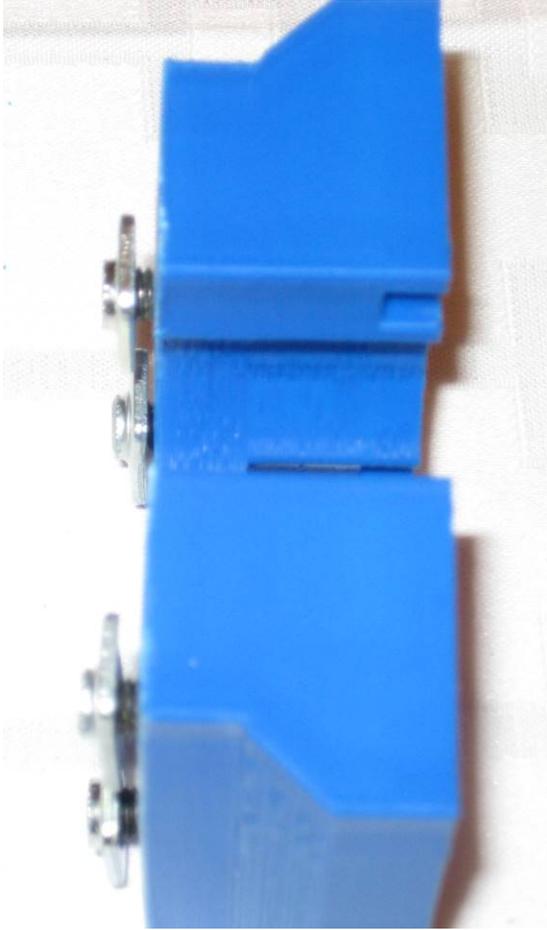
Yes, I do have goofy looking thumbs.

Openbuilds X axis for Taz 4/5

X Motor Mount Main Block

Step 35: Locate **Taz_Openrail_xmotor_Mount_mainblock_2_0_a4.stl ,** 4 M5 10mm bolts, and 4 M5 Tslot nuts. Insert the M5 bolts through the holes in the top of the main block, press them down all the way, then preinstall the m5 Tslot nuts.

Openbuilds X axis for Taz 4/5
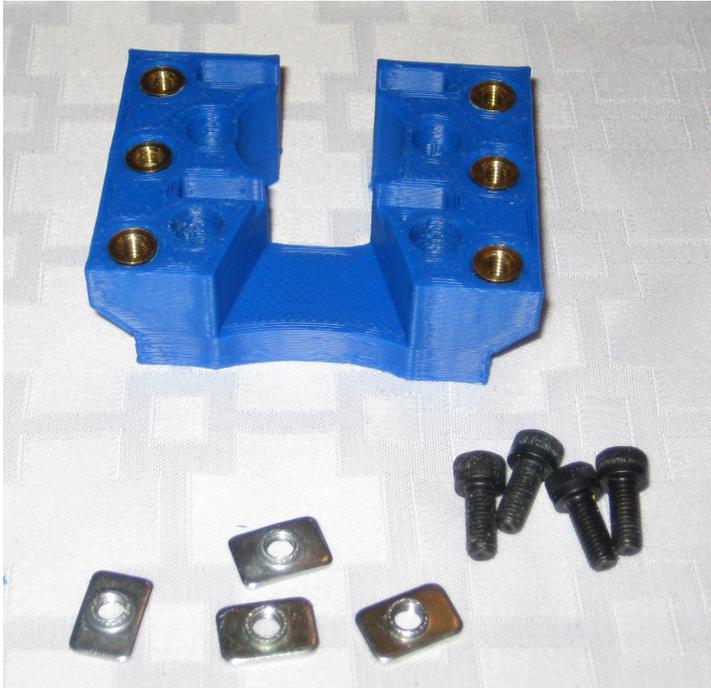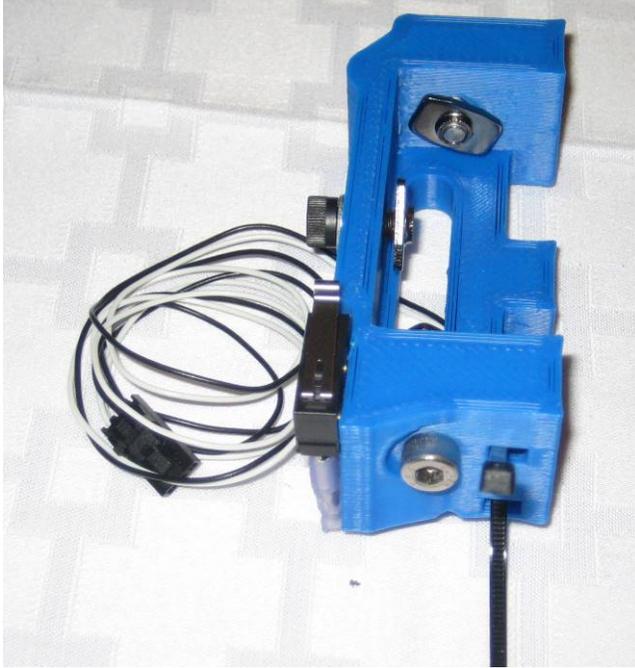
X Motor Endcap

Step 36: Locate **Taz_OpenRail_XMotor_Endcap_9_0_a.stl,** The stock Taz X minimum endstop, 2 20mm M5 bolts, 1 10mm M5 bolt, 1 M5 washer, 3 M5 Tslot nuts, 2 M2 8mm bolts and a Zip Tie.

Openbuilds X axis for Taz 4/5

Step 37: Install the X minimum Endstop using the M2 bolts.

Openbuilds X axis for Taz 4/5

Step 38: Insert the 20mm M5 bolts through the top and bottom of the Idler endcap, and the 10mm M5 bolt and washer through the front. Preinstall the M5 Tslot nuts on those bolts. Also preinstall the X cable retention zip tie at this time
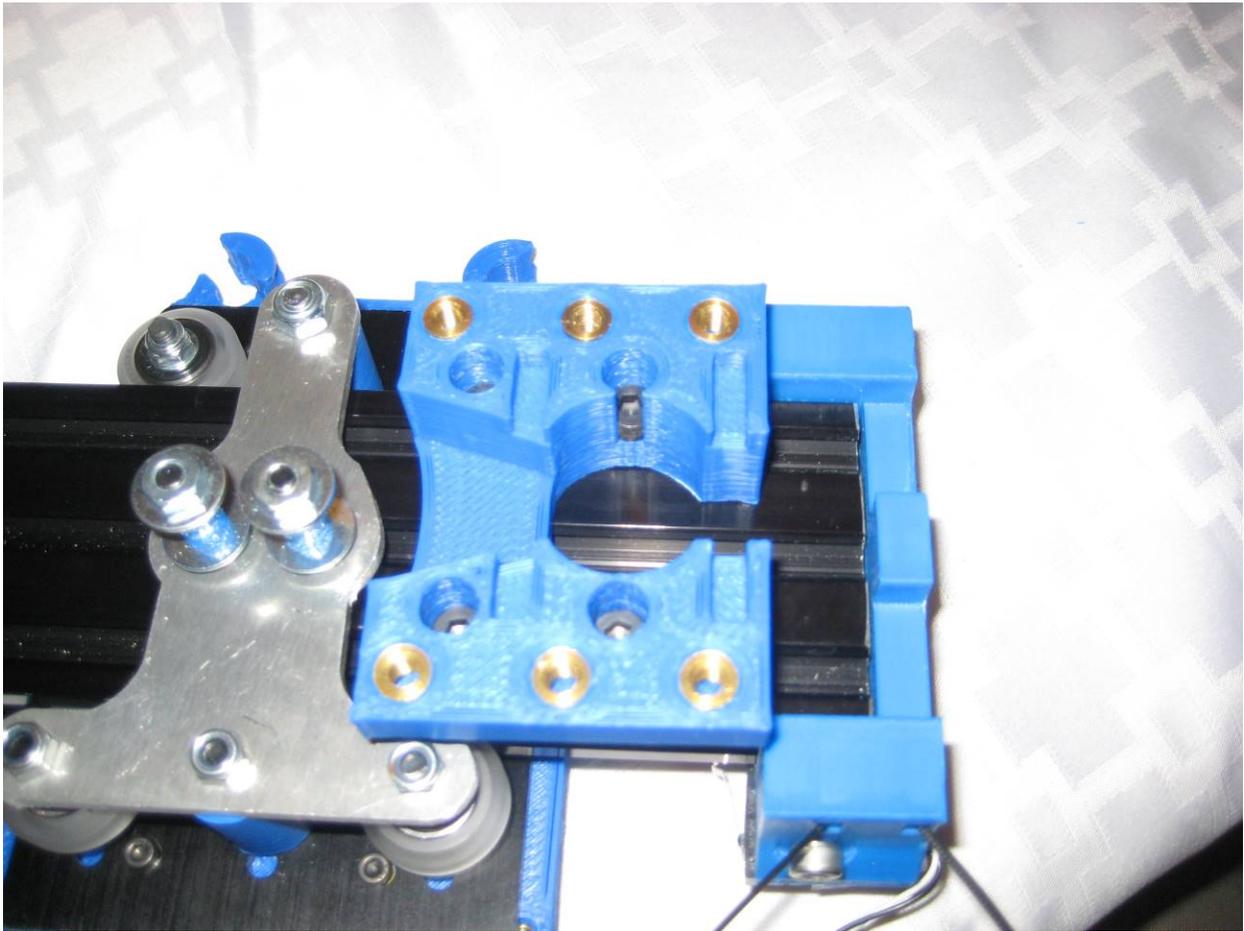
Openbuilds X axis for Taz 4/5

Final Assembly:

Step 39: Slide the main motor block assembly onto the right side of the openbuilds rail as shown, but do not tighten it down yet.

Openbuilds X axis for Taz 4/5
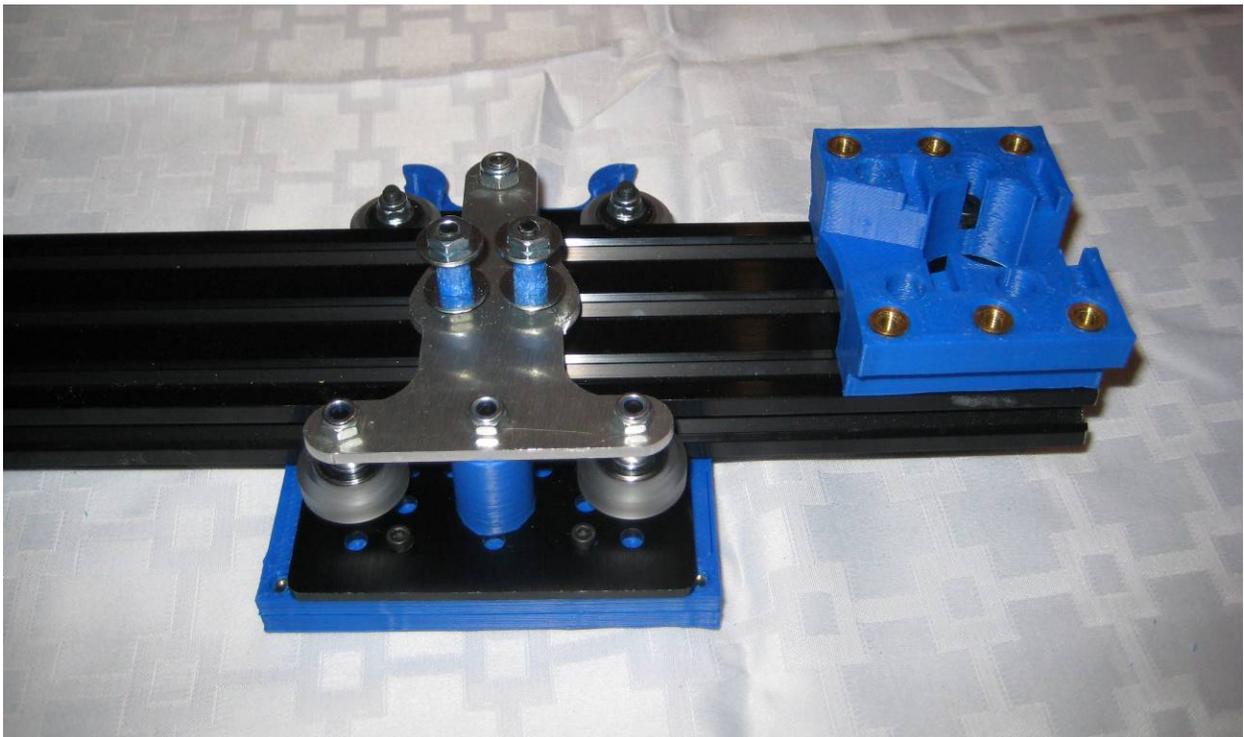
Step 40: Install the X motor endcap as shown. Ensure that there is no gap between the end of the rail and the inside of the endcap.

Openbuilds X axis for Taz 4/5

Step 41: Slide the X motor main block over so it is flush with the outer edge of the X motor endcap. And tighten all of the bolts.
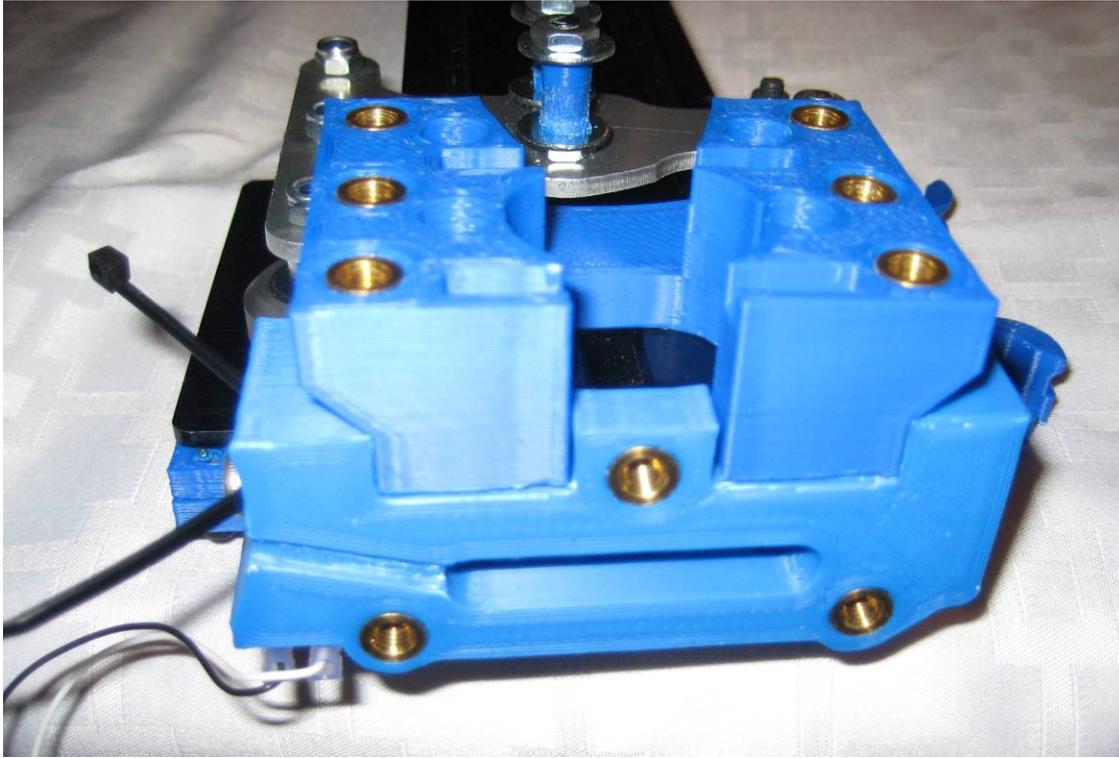
Step 42: Check for clearance of the X carriage on both sides, and alignment with the endstop.
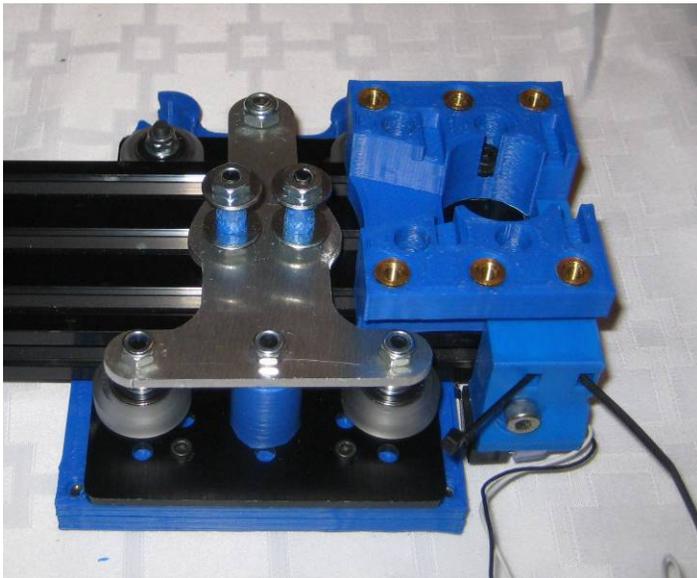
Step 43: Loosely slide the X idler block onto the openbuilds rail, do not tighten it at this time.


Step 44: loosely install the Idler endcap onto the rail. You will want an approximate 5mm gap between the end of the rail and the inner wall of the endcap as shown below. This will allow for adjustment when the rail is installed on your Taz and is by design. You will tighten the bolts later once you install the rail into your Taz

Openbuilds X axis for Taz 4/5
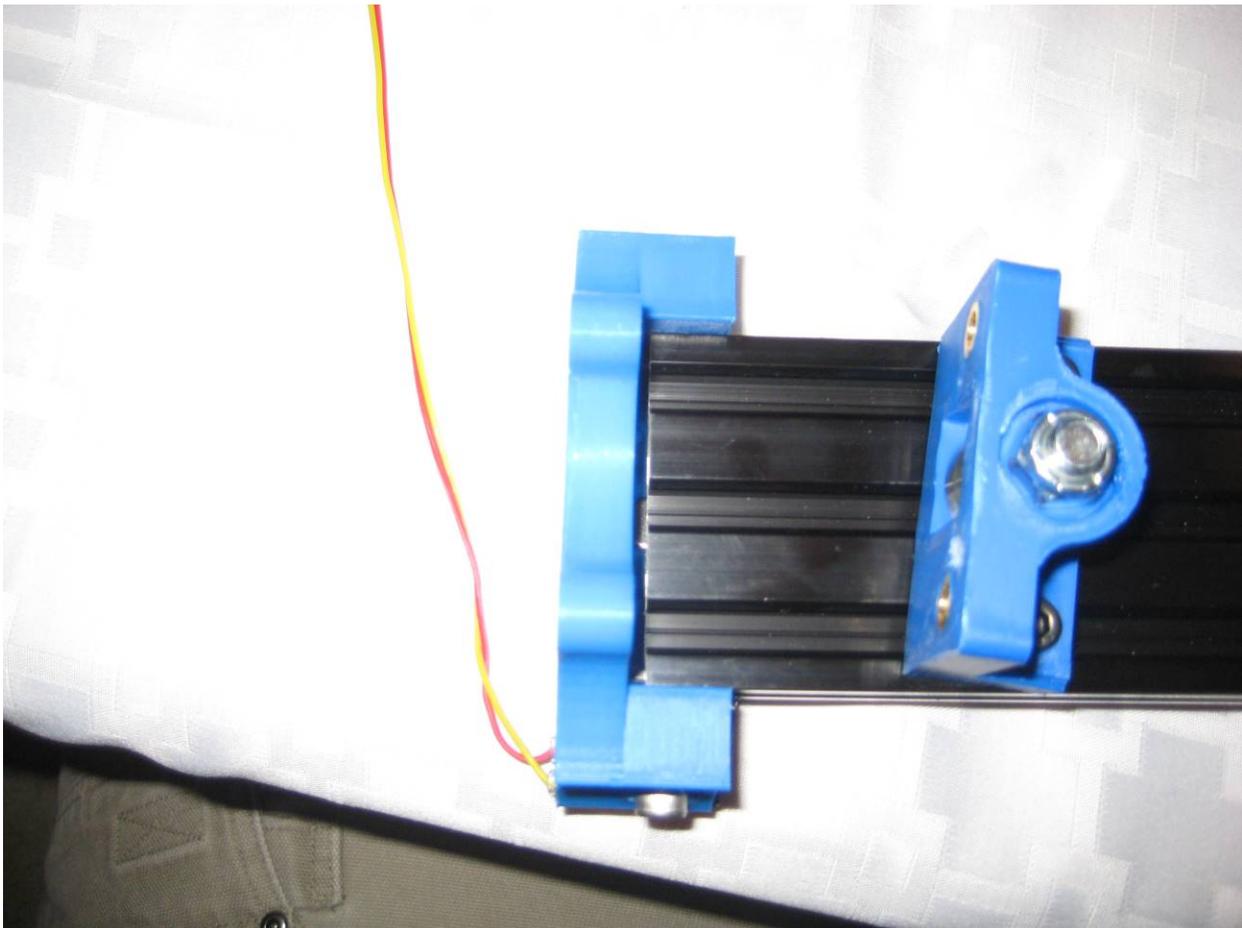
Step 45: Install the M5 32mm long bolts through the idler endcap and into the idler block. Tighten them until they bottom out, then back them each off 4 turns. These bolts will allow you to adjust the belt tension on your X axis belt.
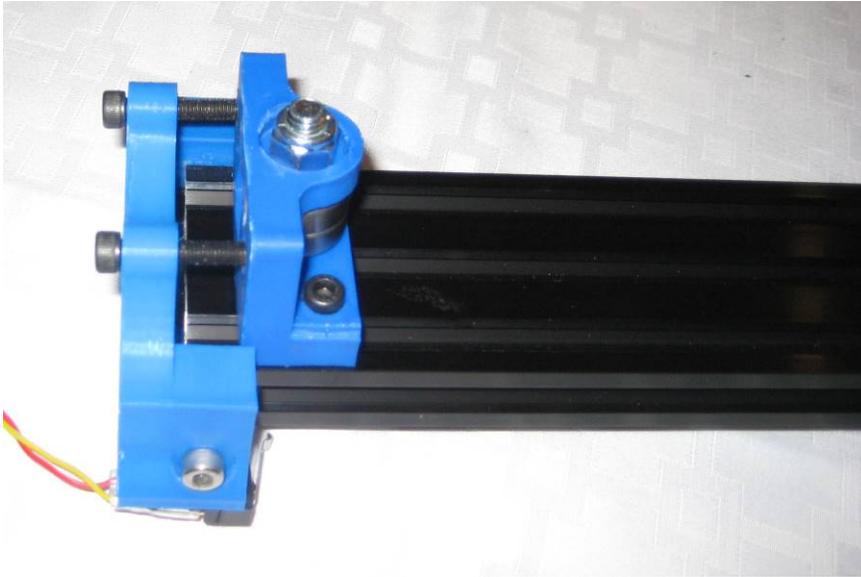
Step 46: (Optional) If you installed the X maximum endstop, route the endstop cable through the Openbuilds rail as shown and out the other side, where it will join the X minimum endstop cable path.

Openbuilds X axis for Taz 4/5
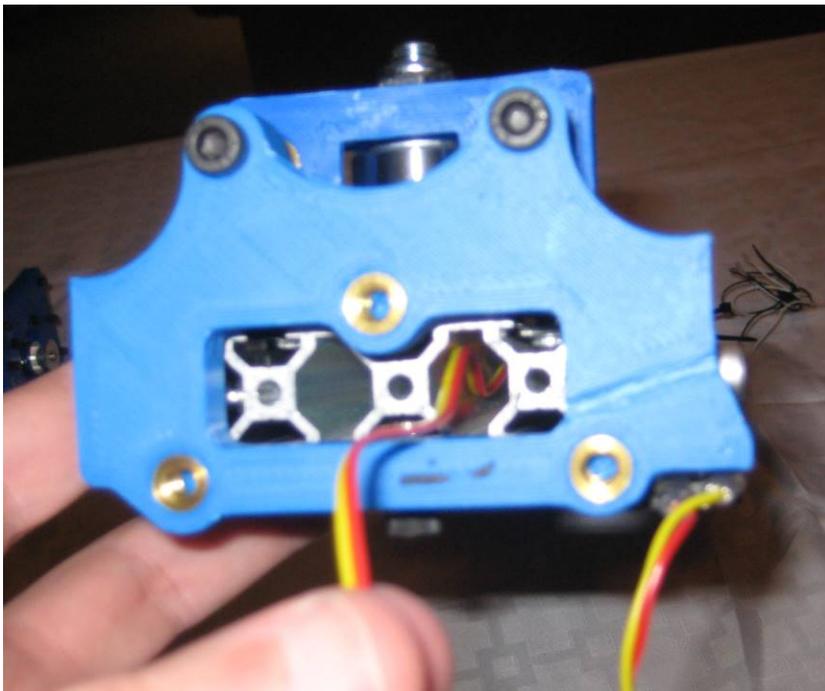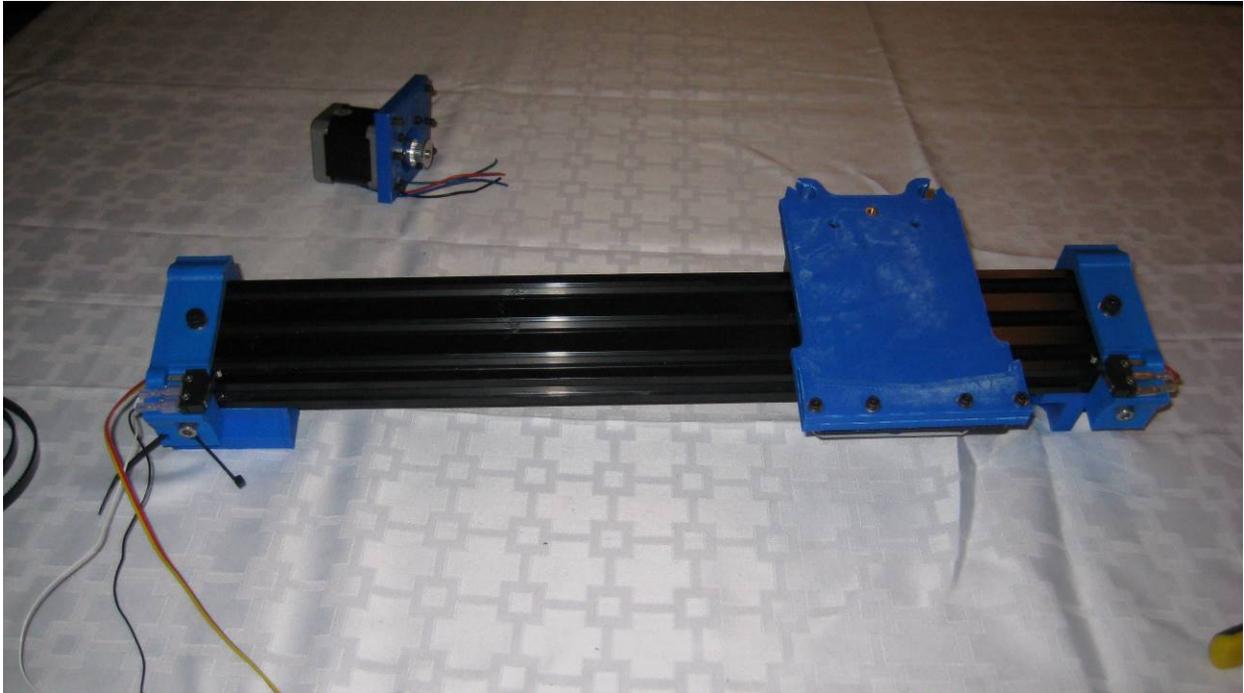
**Step 47:** Using the stock Taz belt and 2 Zipties, attach one end of the belt to one of the posts using the teeth of the belt to lock onto itself**.**

Note: The belt should pass UNDER the posts, not over it as shown in this picture. Otherwise your X axis will be backwards.

Openbuilds X axis for Taz 4/5

Step 48: Attach the motor mount lid to the main block, with the belt around the motor pulley. Adjust the motor position as needed using the M3 screws until you get a smooth belt path that isn't blocked.

Openbuilds X axis for Taz 4/5

Usually the motor wants to be towards the bottom of the lid.

Openbuilds X axis for Taz 4/5
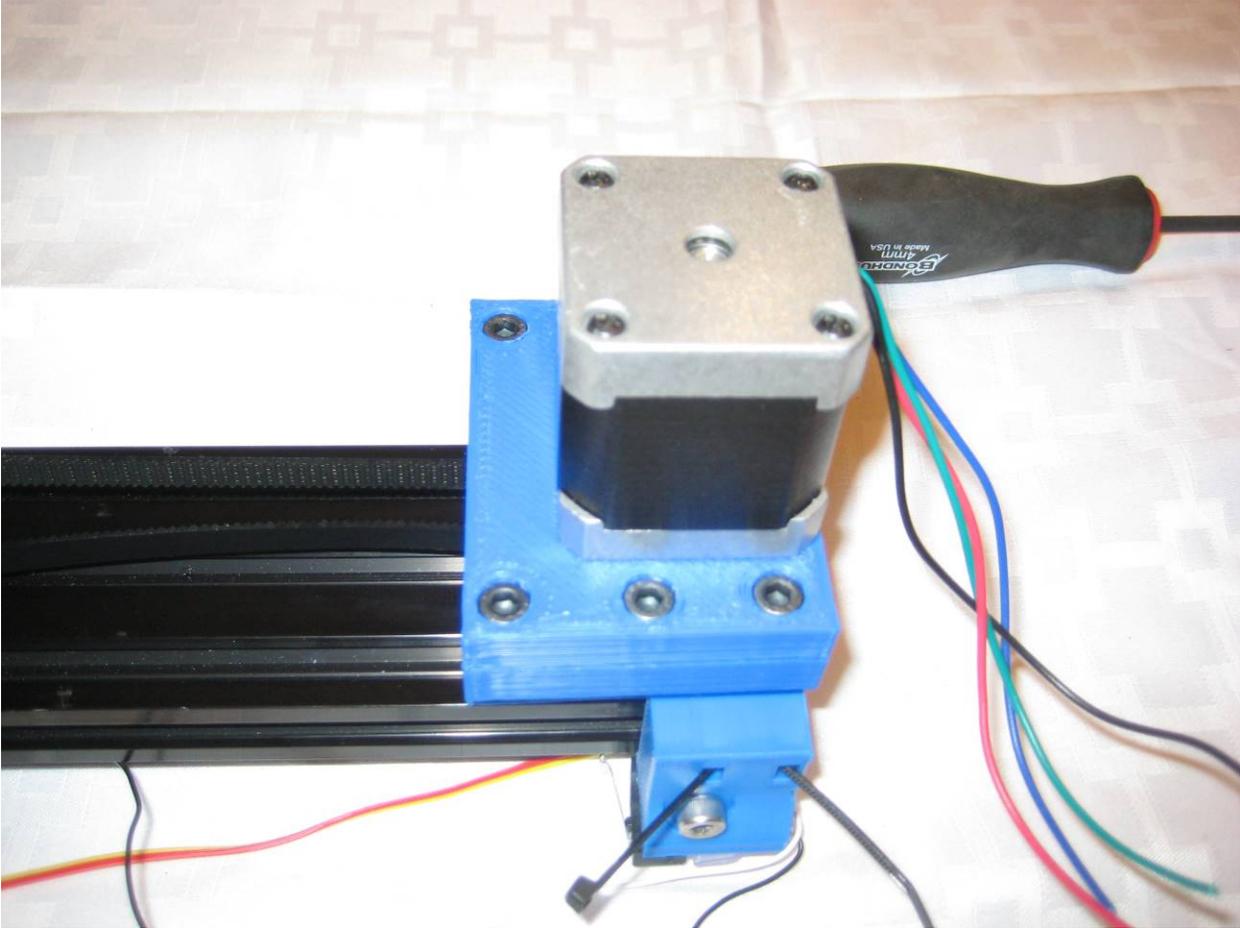
Step 48: Attach the other side of the belt to the posts. Trim any remaining excess belt or zip tie ends. You will tension the belt later once the assembly is bolted to the Taz.

Note: The belt is still upside down in this picture. It should pass UNDER the posts, not over it as shown in this picture. Otherwise your X axis will be backwards
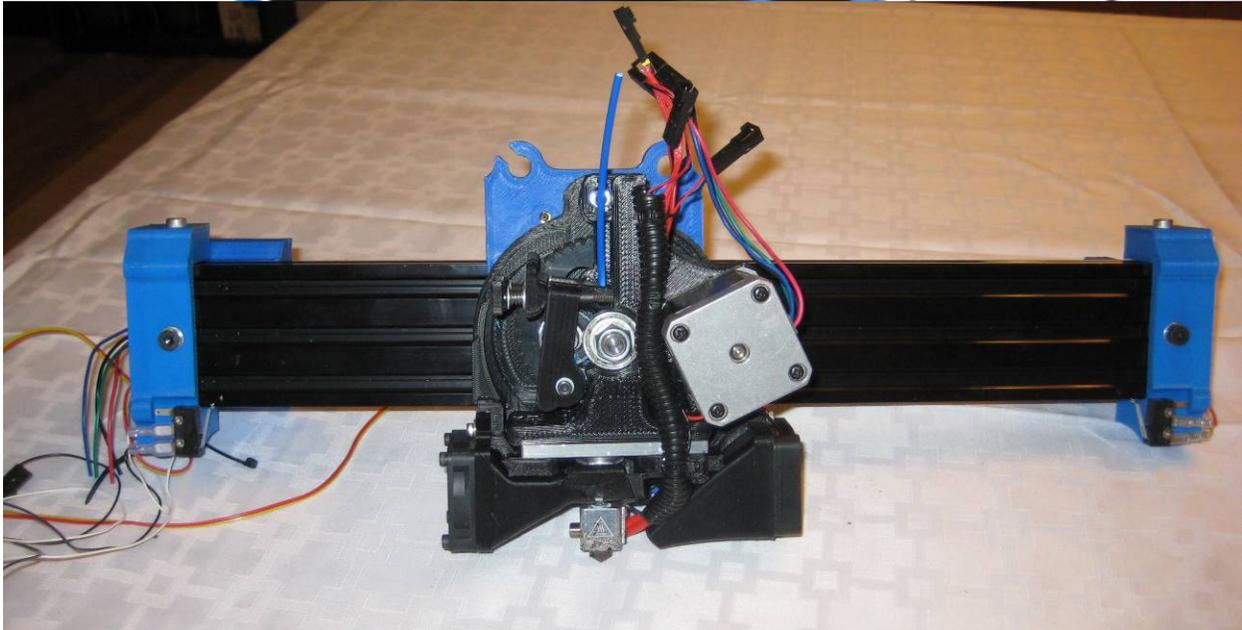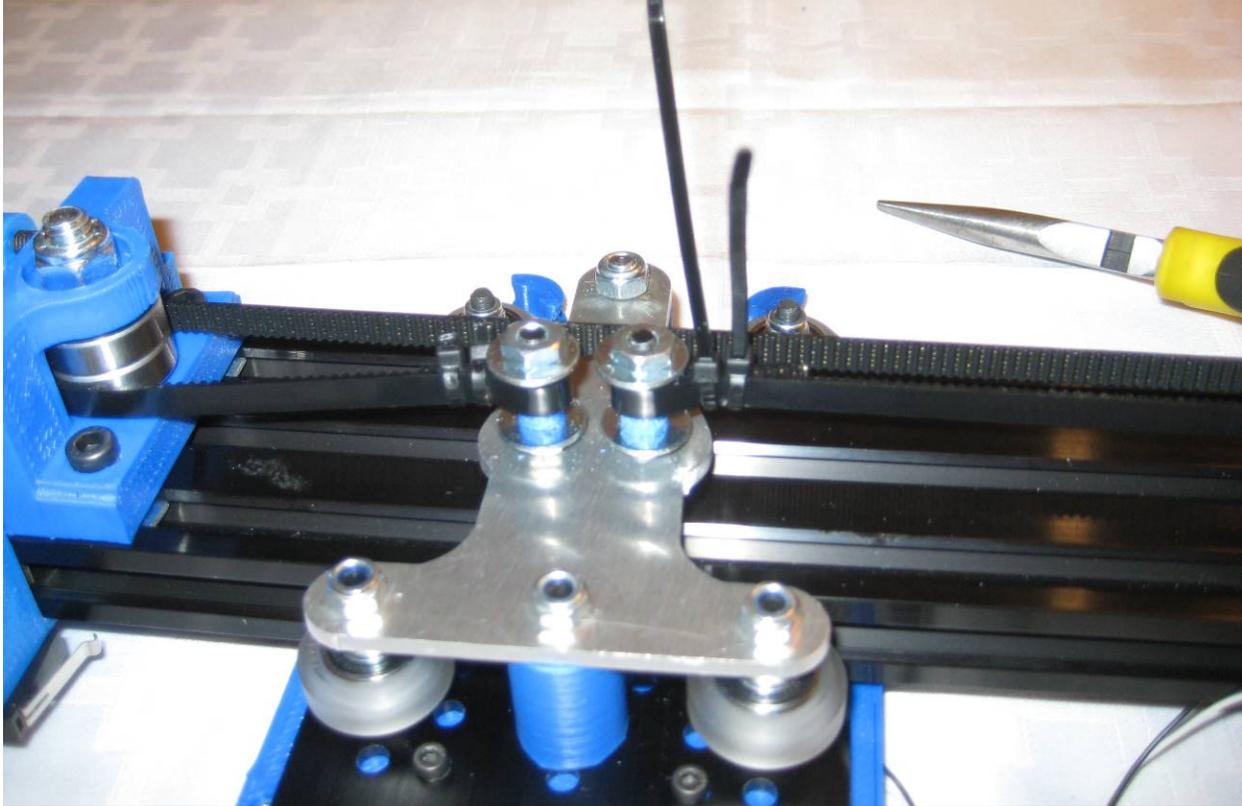
The Completed open builds assembly, with a toolhead mounted.

Openbuilds X axis for Taz 4/5

Step 49: Using the stock M5 bolts and washers, bolt the endcaps to the stock metal Taz X endplates. Use a square to check that the plates are at exactly 90 degrees to the rail, and then tighten the Idler Endcap bolts. Route the X cables through the Zip tie, tighten it, and trim any excess ziptie.

Openbuilds X axis for Taz 4/5
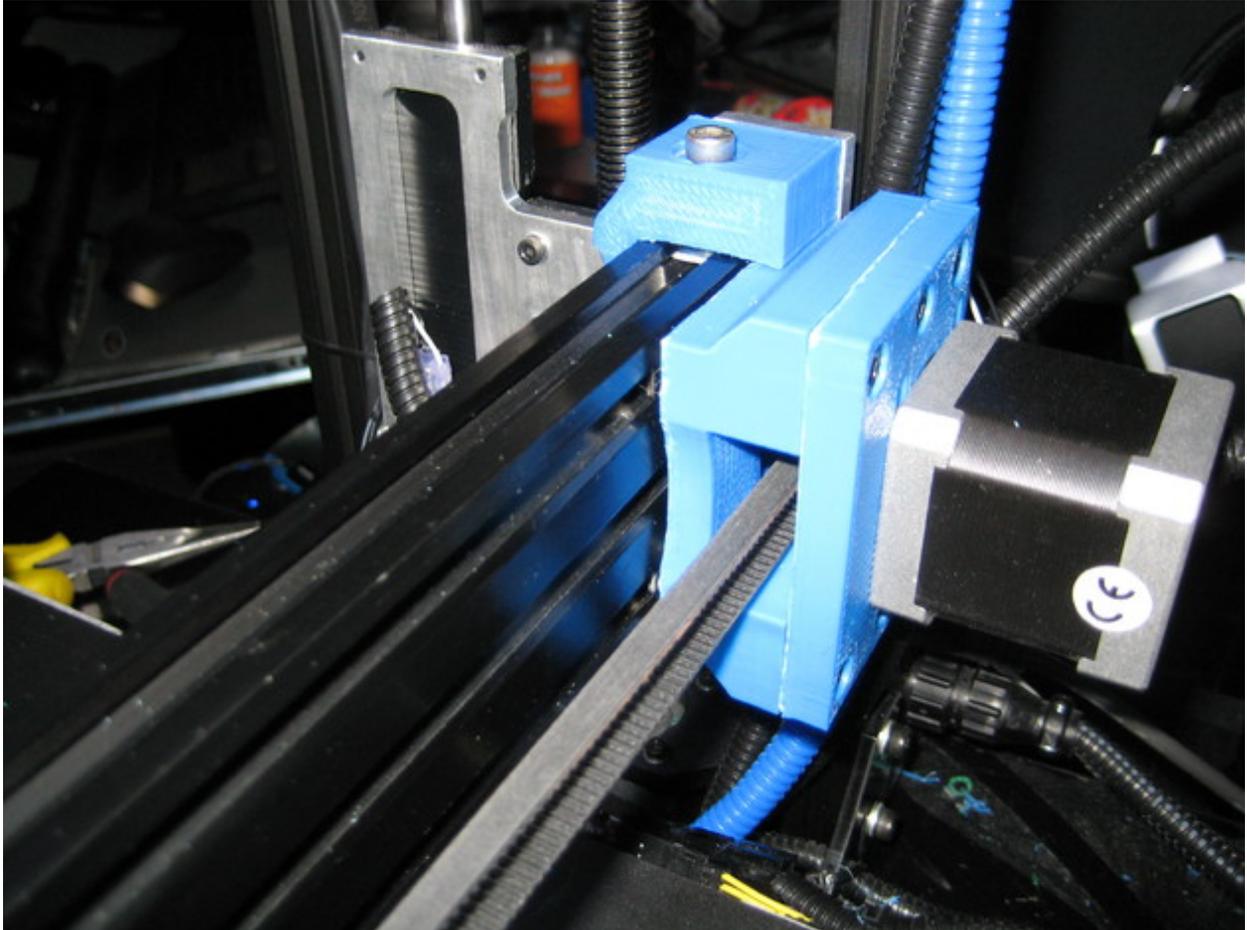
Step 50: tighten the idler tension bolts until the belt makes a tone when plucked top and bottom. Once the idler is in place, tighten the rail side bolts to ensure it doesn't move. Use zip ties to secure the extruder wire harness cable(s).
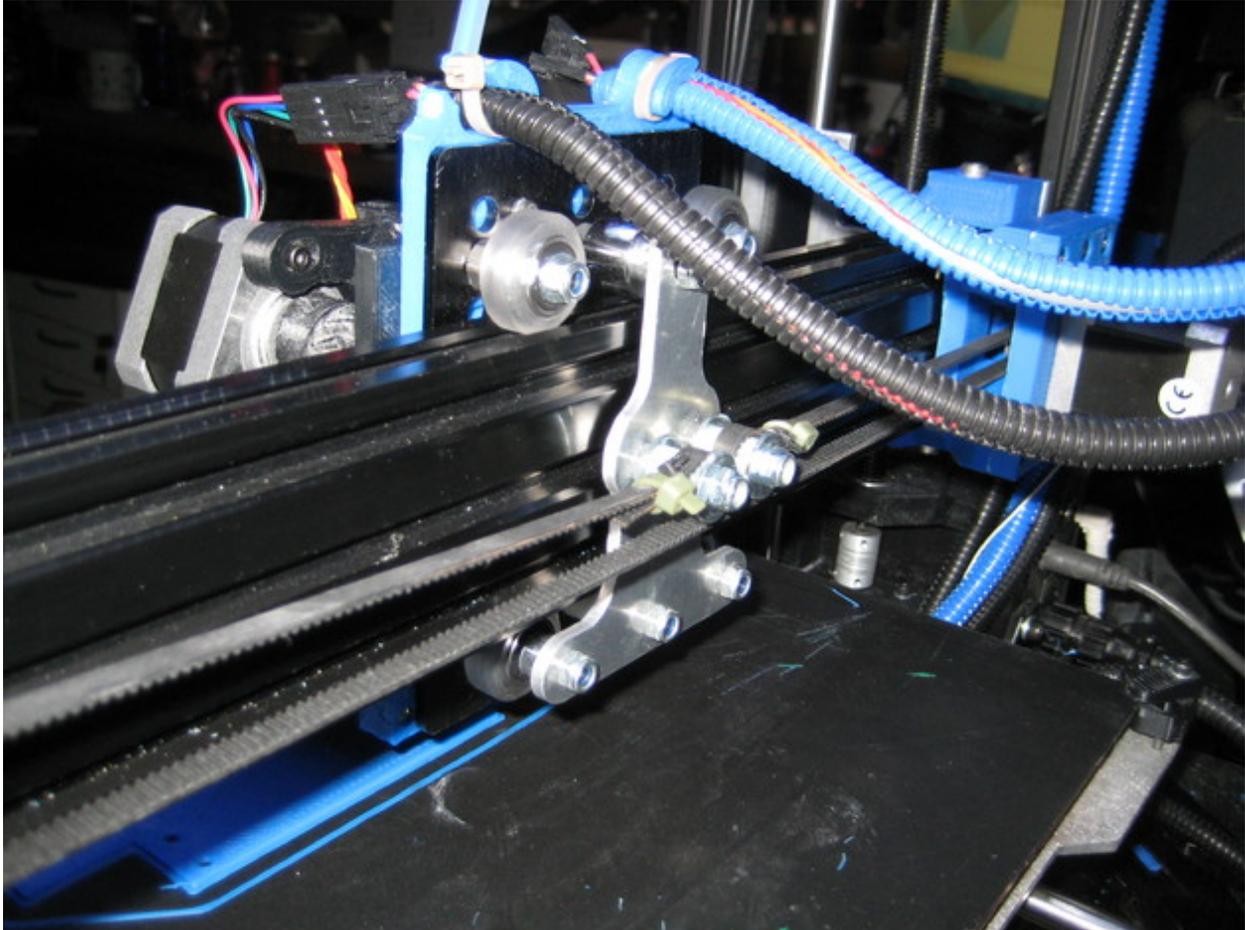
Congratulations! You now have a fully operational Openbuilds V-slot X axis! Enjoy!

Openbuilds X axis for Taz 4/5

Troubleshooting:

If the X axis binds when moving up or down in Z after this installation:

- o You either have the X idler endcap in or out too far on the rail, or the X endplates themselves are out of alignment. Loosen the X idler endcap bolts and move the Z axis up and down. If that resolves the problem, re-tighten the bolts and see if it still moves freely.
- o If the X endplates are out of alignment, you can re-allign them by moving the Z axis to Z home, measuring the distance from the bottom of the Z leadscrew nut to the top of the Z bearing on the X motor side. Use a caliper to transfer that distance to the X idler side. To adjust the Z motor, power off the machine, disconnect that motor from the Rambo board, then manually turn the leadscrew until the measurement matches. Then reinstall the motor wire harness and turn your machine back on. The binding should be gone.
- o In rare cases, improperly installed heat set inserts can cause the end Xplate to not be flush with the endcap and cause binding. Ensure that your heat set inserts are flush with the surface of the plastic.

If the X axis goes the wrong way or fails to home:

- o Make sure the belt is installed correctly

If the toolhead looks crooked.

- o Make sure the X carriage adapter plate is installed parallel to the X gantry plate, and adjust as needed.

If the endstop worked before and now it doesn't

- o Ensure the endstop is still attached to the Rambo board in the appropriate socket. Electrical fault issues are outside the scope of this document.

Openbuilds X axis for Taz 4/5

Notes:

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Openbuilds X axis for Taz 4/5