BotBuilder

3D Printer Assembly Workshops

Prusa i3 Printer Assembly Guide

Special thanks to Carlos Sanchez and Miguel Sanchez for the graphics.
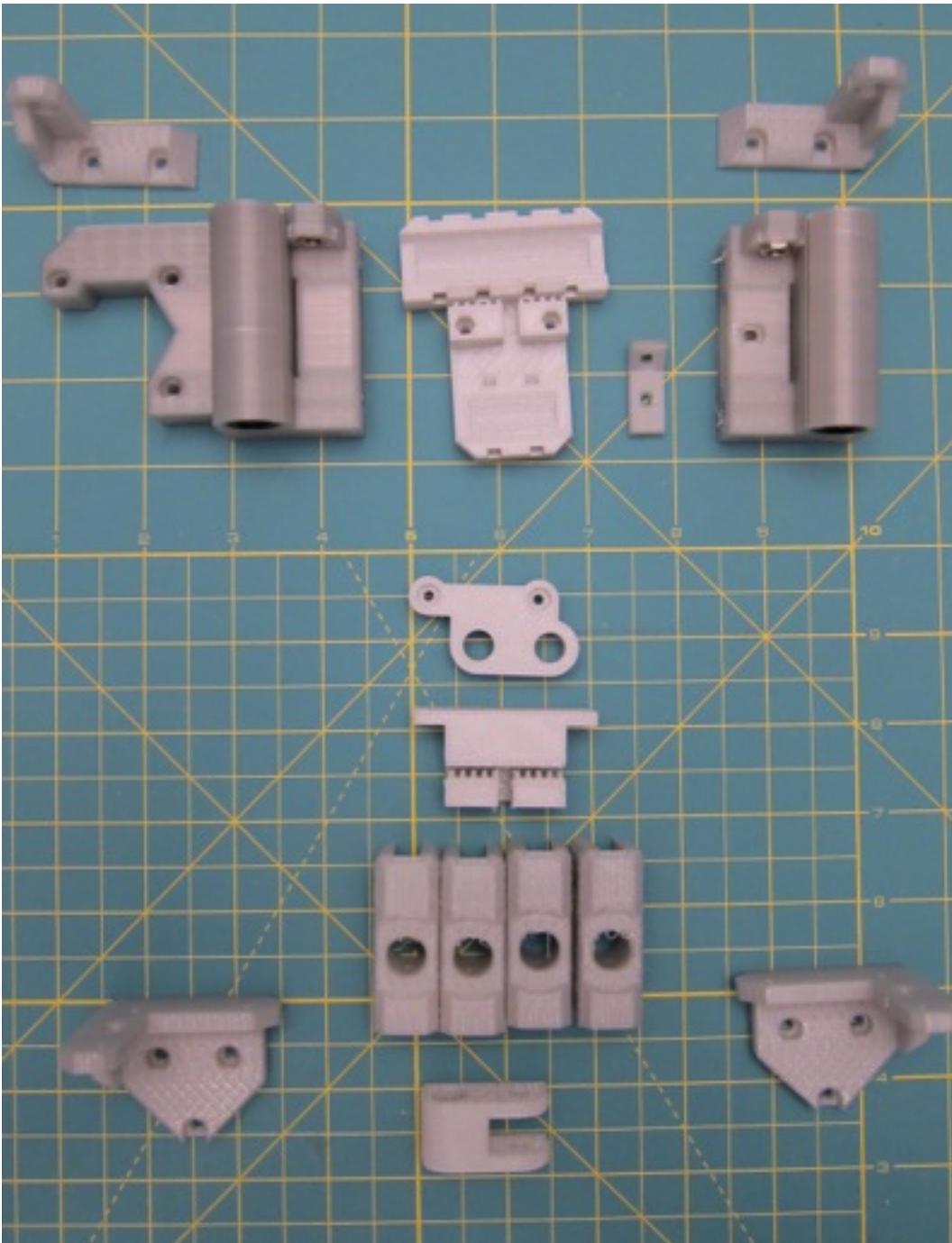
All graphics captured from their great animation: http://www.carlos-sanchez.com/Prusa3/

Step 1: Identify Parts

The main printed parts (in silver) should include what's shown below. The following pages will explain what the pieces are.

There are a few pieces not shown here:

- Belt guides (they're round and almost flat)

- Endstop brackets (which are detailed in the docs when you get to that point)

Step 2: Identify Parts
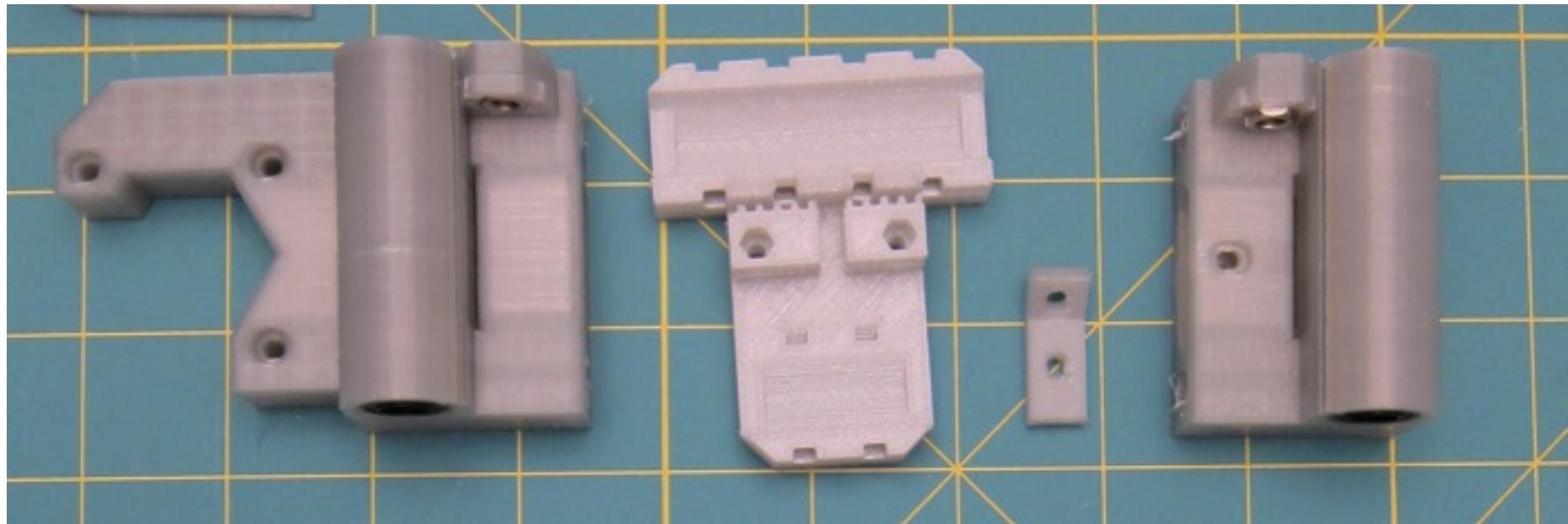
These are the X axis parts - from left to right:
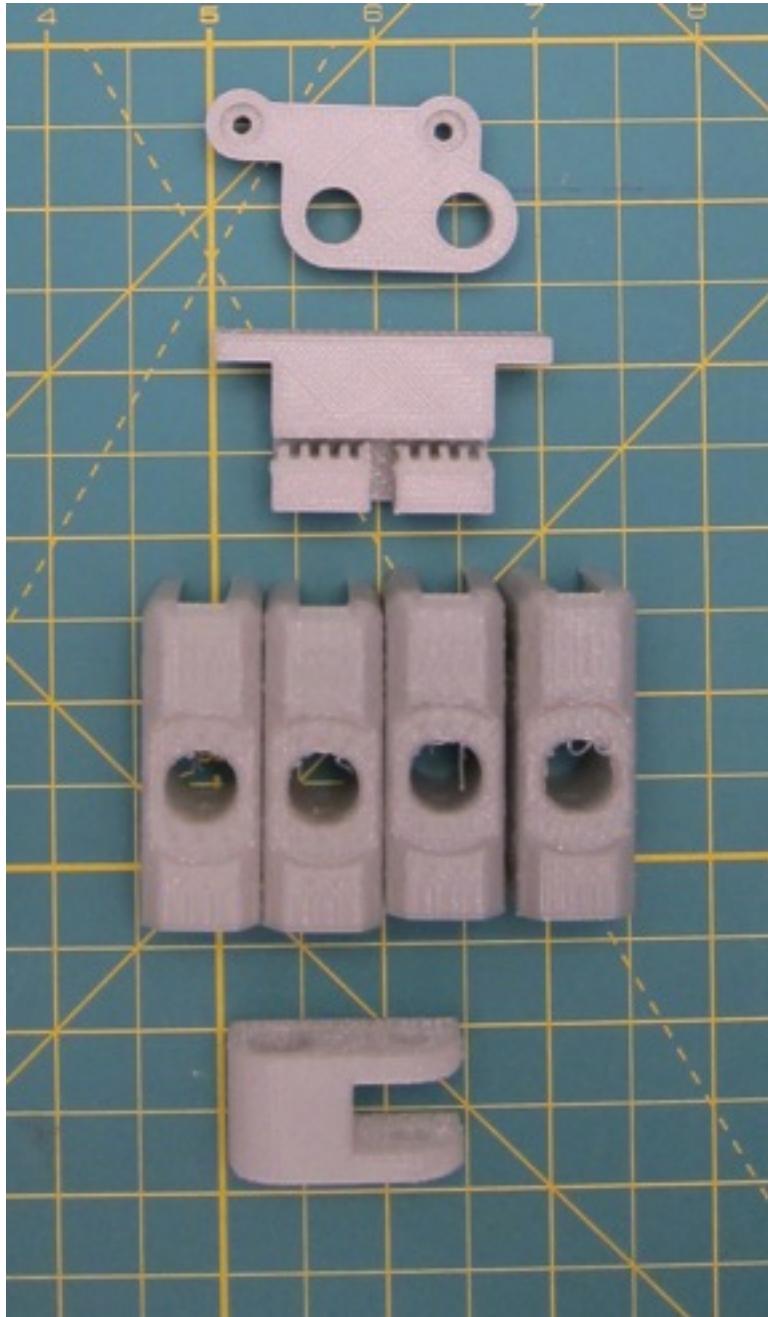
X-axis motor-end
X-axis carriage
Extruder Fan bracket
X-axis idler end

Step 3: Identify Parts
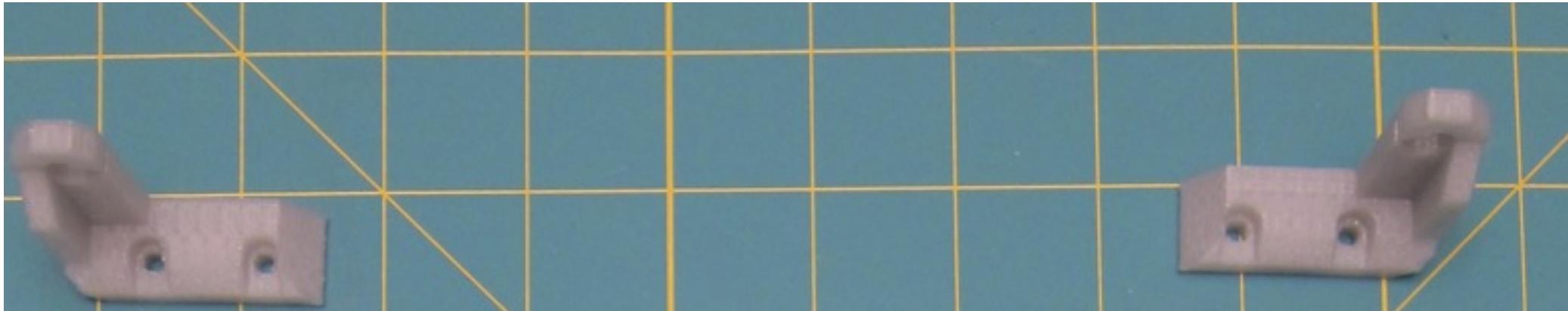
These are the Y axis parts.

From top to bottom:

Y-axis motor bracket
Y-axis belt holder
Y-axis corners
Y-axis idler

Step 4: Identify Parts


These are the Z-axis printed parts.
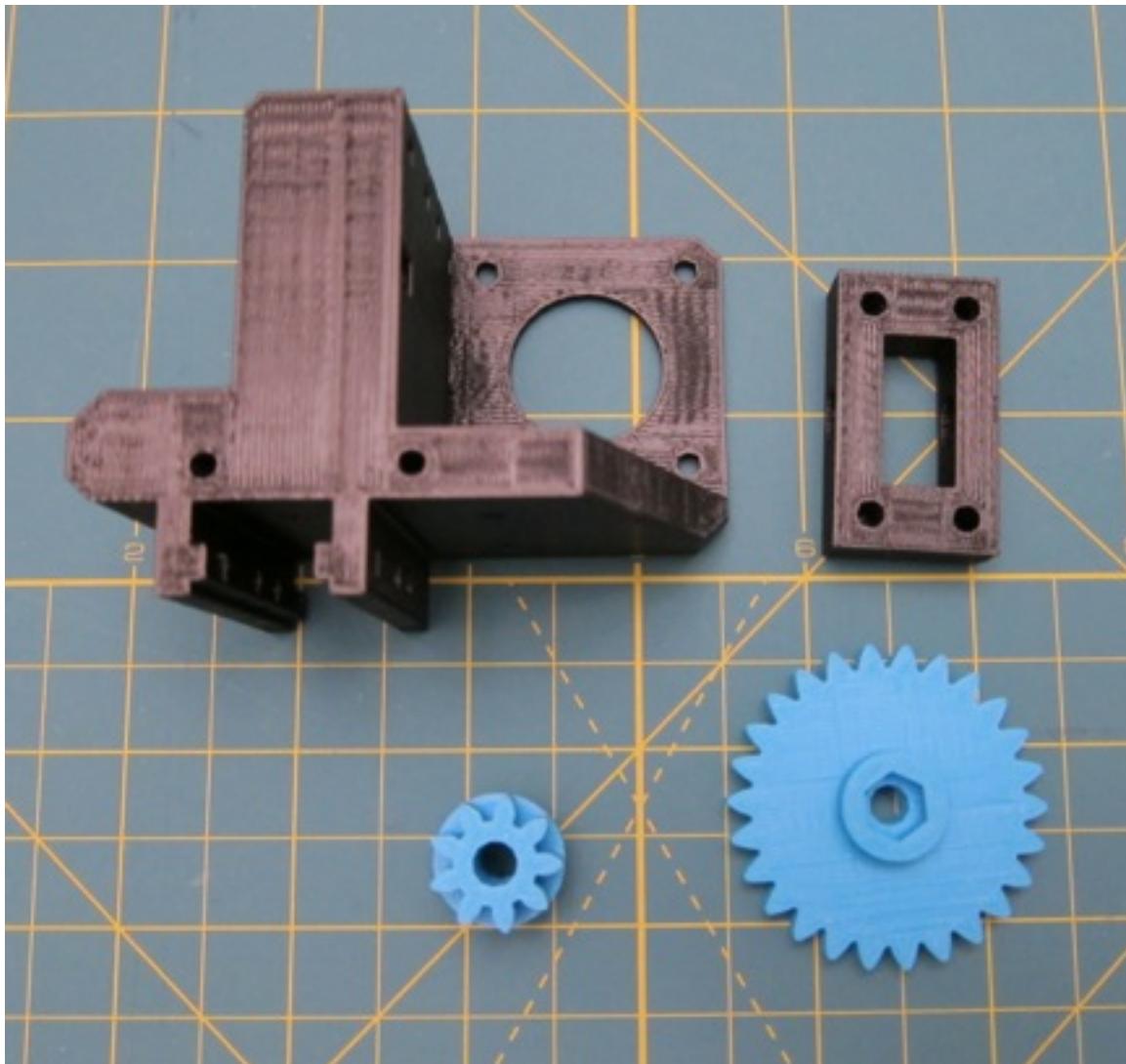
Above:

Z-axis upper brackets

Left:

Z-axis lower brackets

Step 5: Identify Parts

These are the printed extruder parts.

Top row:

- Extruder Body
- Extruder Idler

Bottom row:

- small gear
- big gear

Step 6: Identify Parts

You should have 3 bags of nuts and bolts, bearings and springs, etc.
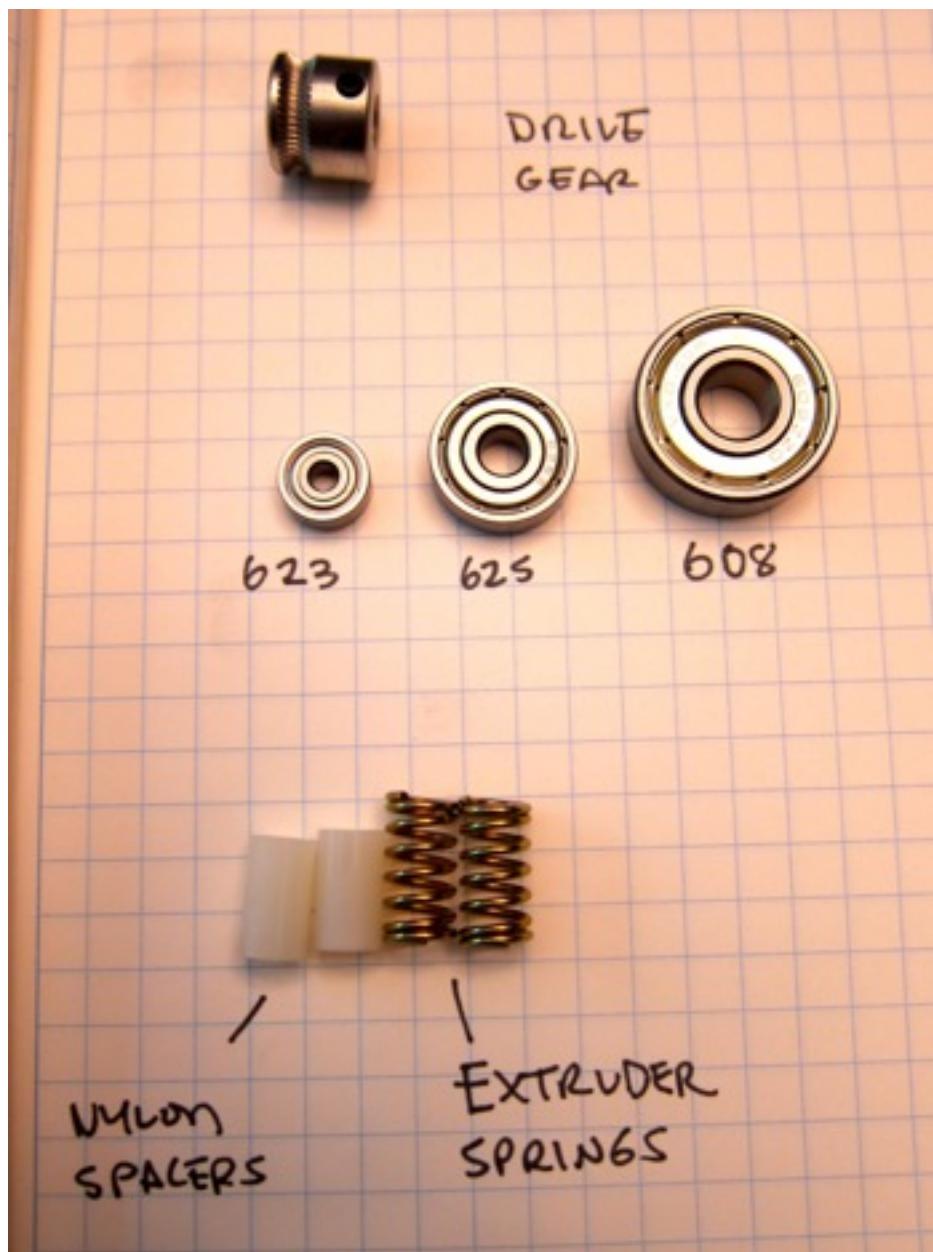
They look like this, only there's 3 of them.

The 'big' bag contains all of your M8 and M10 hardware

The 'small' bag contains all of your M3 / M4 / M5 hardware.

The 'bearings bag' contents are on the following page.

Step 7: Identify Parts

The 'bearings / 3' bag should contain:

2 x 623 bearings

2 x 625 bearings

1 x 608 bearing

1 x drive gear

2 x nylon spacers

2 x extruder springs

6 x LM8UU linear bearings (not shown)

Note: We only show 1 of the bearings on here for clarity.

Step 8: Identify Parts

Everyone should have a bag marked 'Belts' as well.

The bag has 2 belts in it, pre-cut to the right length:

- Y axis: 715mm

- X axis: 900mm

Step 9: Identify Parts

Pulley Bag!

This has:

- 2 GT2 belt pulleys (Y axis and X axis)

- 2 hose couplers for Z-axis threaded rods

- 1 white bag with set screws and allen wrench for the pulleys. The set screws are TINY, be careful when you open the bag.

- 1 8mm smooth x 20mm rod, for extruder idler shaft.

Step 10: Identify Parts

This is the heated bed assembly.

The power wires and thermistor wires have been pre-soldered.

There is also a matched piece of borosilicate glass plate. It'll sit on top of the HBP assembly later on. Keep it safe!

Step 11: Identify Parts

The hot end assembly is as shown.

The thermistor and resistor have been pre-soldered.

The thermistor connection is labeled.   The larger wires are for the hot-end power.

Step 12: Identify Parts

In the bags like this are the extruder fans.

The wires on them are long, and will likely need to be trimmed.

Step 13: Identify Parts

The electronics boxes contain your completed electronics.
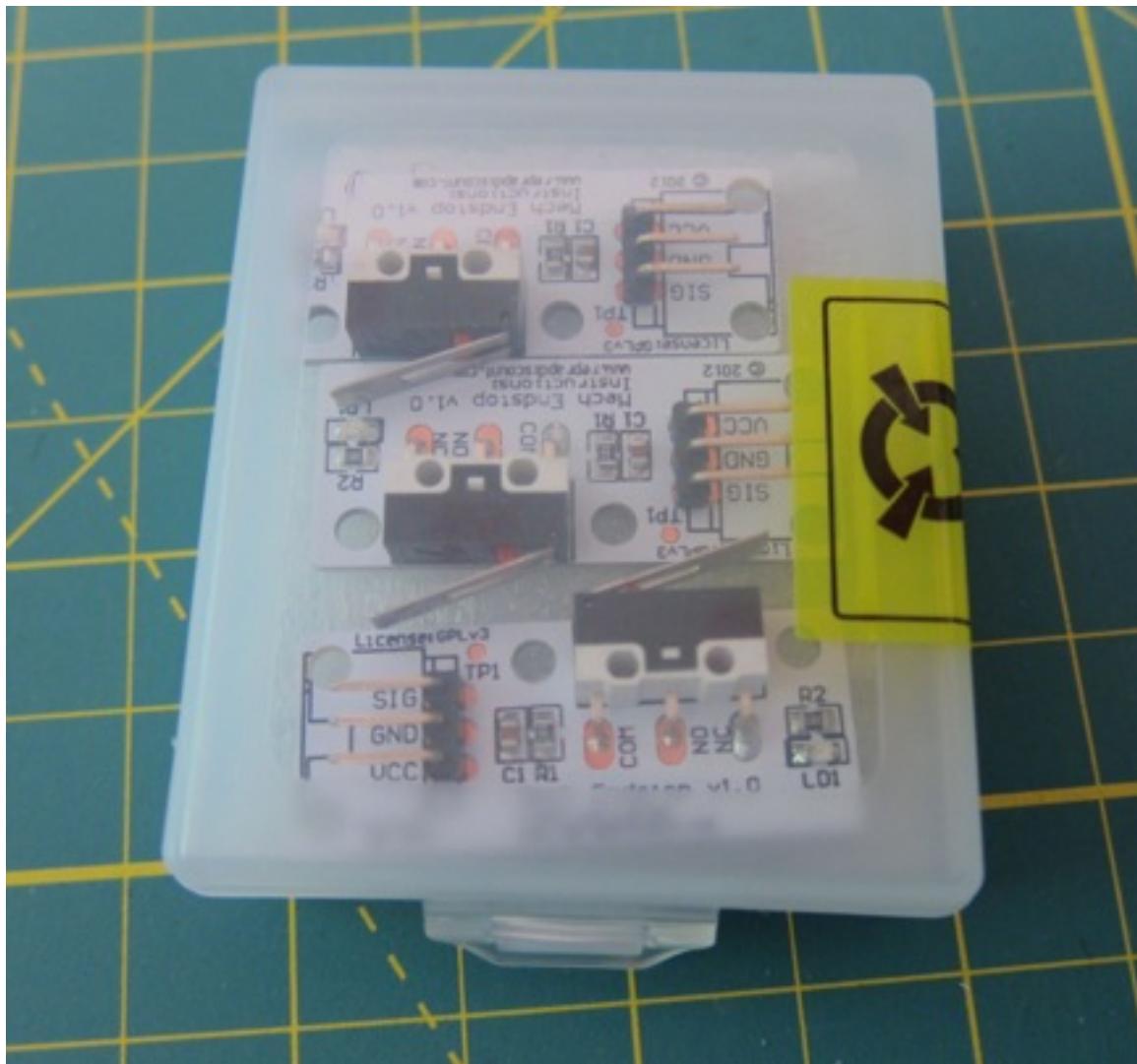
The guts of this consist of an Arduino Mega 2560 and a 'RAMPS 1.4' shield.

The shield is already installed in the Arduino, and the correct configuration for the printers we're building has been loaded on it.

Also in this box is:

- Ceramic screwdriver for adjusting stepper driver voltages

- SDRamps board, for running your electronics off of a MicroSD card.

Step 14: Identify Parts

Each kit has a box with 3 endstop switches in it.
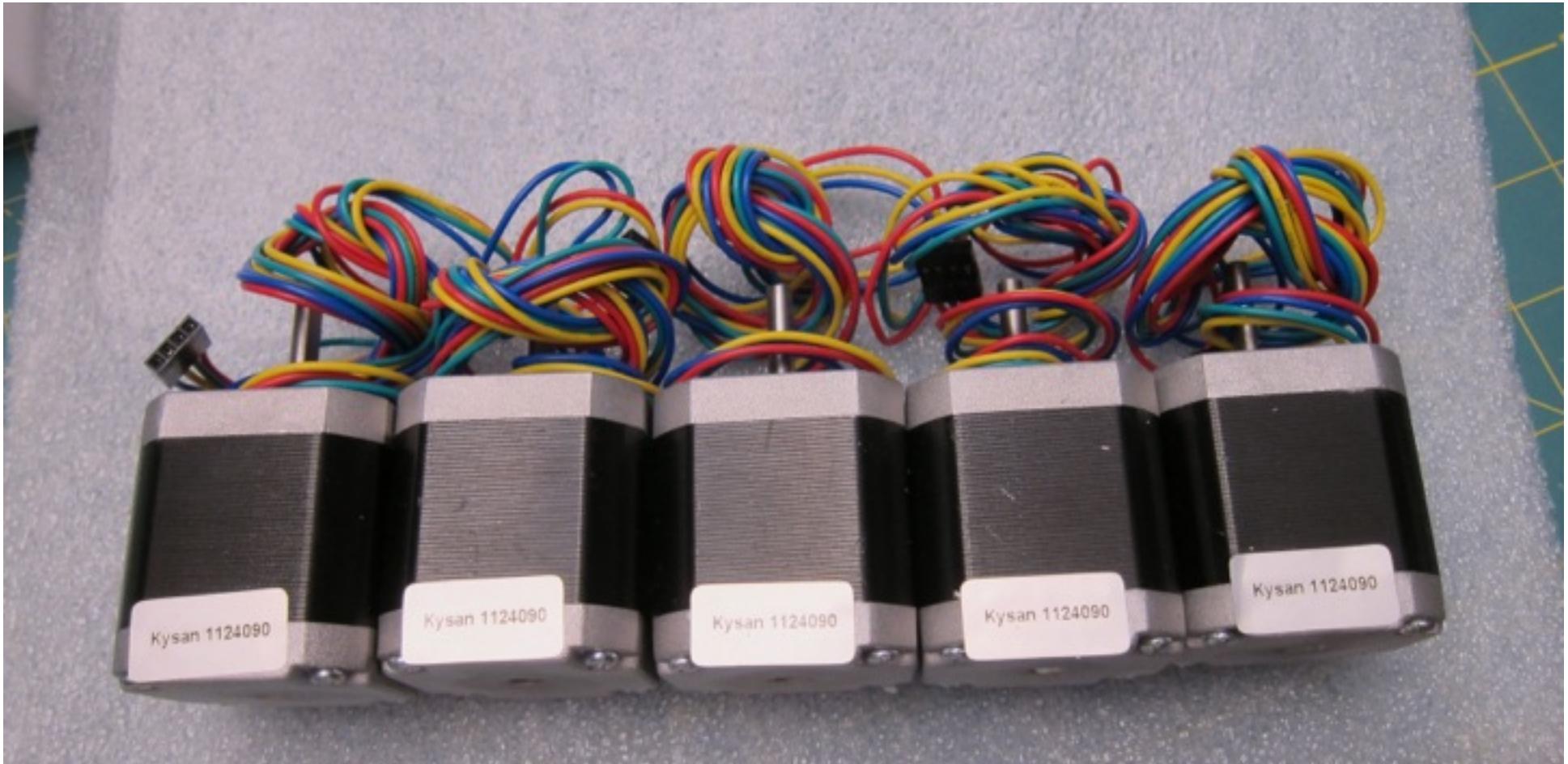
Step 15: Identify Parts

There should be a tied up set of 3 endstop cables in every kit.

They're marked 'endstop' on the end of the cables.

Step 16: Identify Parts

Each kit has a set of 5 stepper motors in it. They're all wrapped up in bubble wrap or foam like in the photo above. You'll need 1 for the Y axis, 1 for the X axis, 1 for the extruder, and 2 for the Z-axis.

Step 17: Identify Parts

The rods are as follows:

Top Row: 8mm threaded 205mm,   8mm smooth (short), 5mm threaded rod - 70mm
Middle Row: 8mm smooth (each pair is labeled)
Bottom Row: 10mm threaded rod, Y-axis
Not shown: 5mm threaded rod x 320mm (one pair)
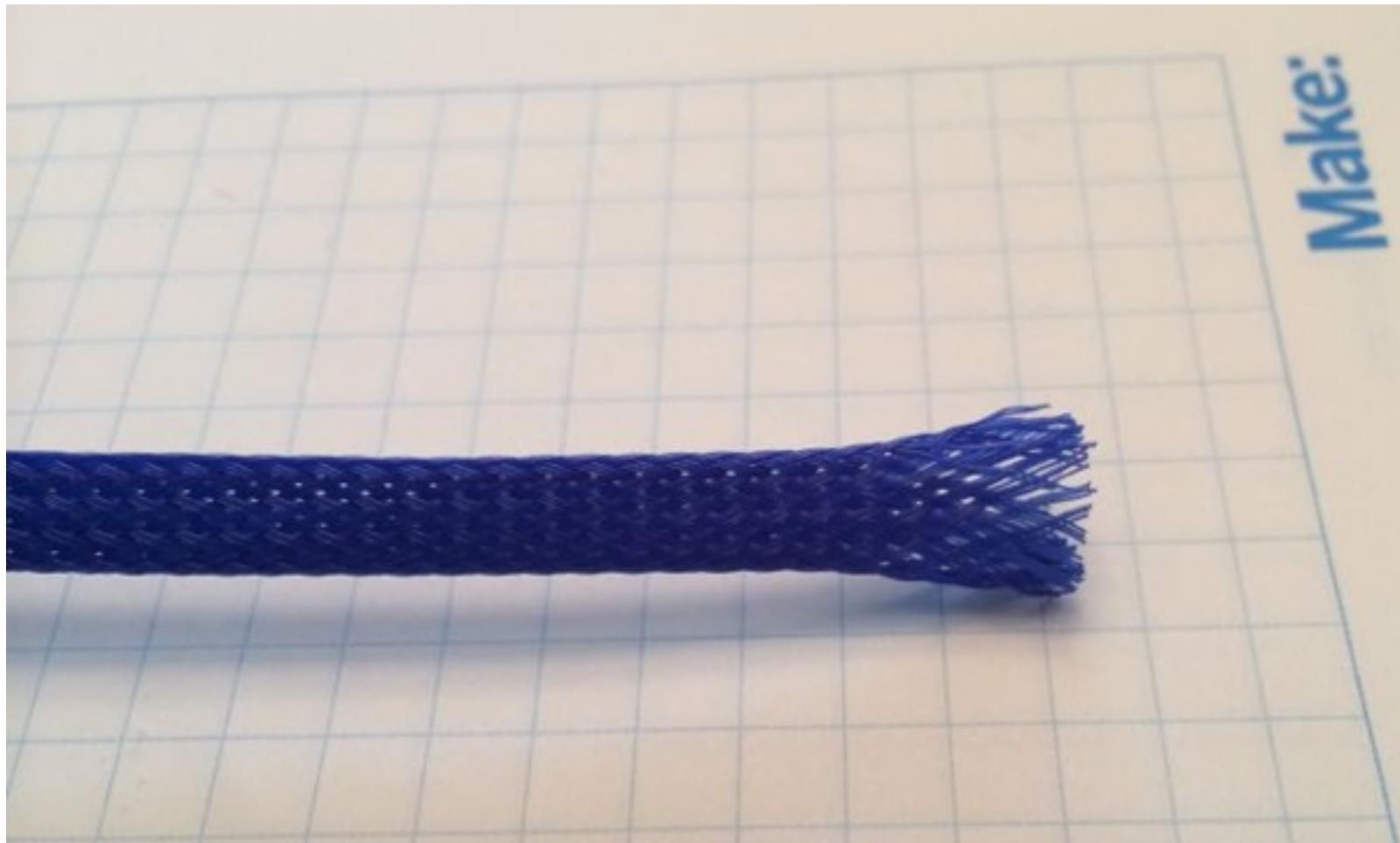
NOTE: The smooth rods may have glue residue from the tape on them. Make sure you clean them before installation.

Step 18: Identify Parts

For the April workshop, every kit has a full set of Allen wrenches, as well as a pair of tweezers. It isn't packed quite like this photo.

Step 19: Identify Parts

New for the April workshop - there are 2 meters of mesh cable wrap in the kits - a larger one and a smaller one for enclosing the cables in.

Step 20: Let's go!

Locate your:

- M10 threaded rods (2)
- 8mm smooth shafts (2)
- Pay attention to the lengths!

2x

M10-370mm

2x

Ø8-340mm

Step 21: Y-Axis Start

Locate your:

- M10 flat washers (4)
- M10 fender washers (4)
- M10 nuts (8)

Thread the nuts and washers on the M10 rods.   The order should be:
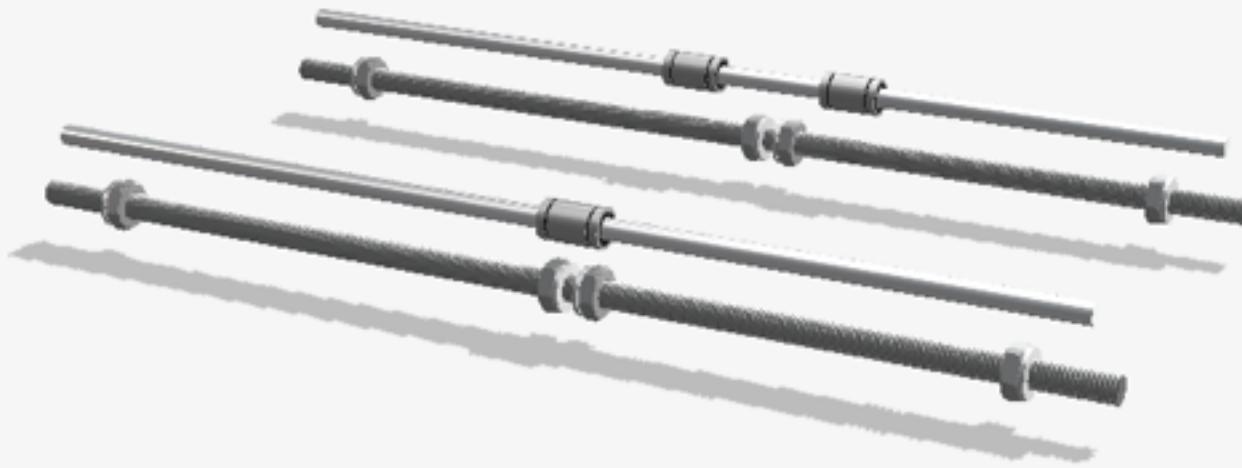
Flat washer > Nut > Nut > Fender Washer > Fender Washer > Nut > Nut > Flat washer

# Step 22: Y-Axis Bearings

Locate your:

- LM8UU Linear Bearings

2 of them go on one of the M8 smooth rods
1 goes on the other. They should slide on smoothly.   Make sure the rods are clean before you slide them on.

Step 23: Y-Axis Corners

Locate your:

- Y-axis corners (4)

These slide onto the end of the M10 rods. Adjust the length so that the smooth rods fit snugly between the Y-corner pieces.

The M8 smooth rods have to snap into place, they can't sit above the slots.

Step 24: Y-Axis Corners

Locate your:
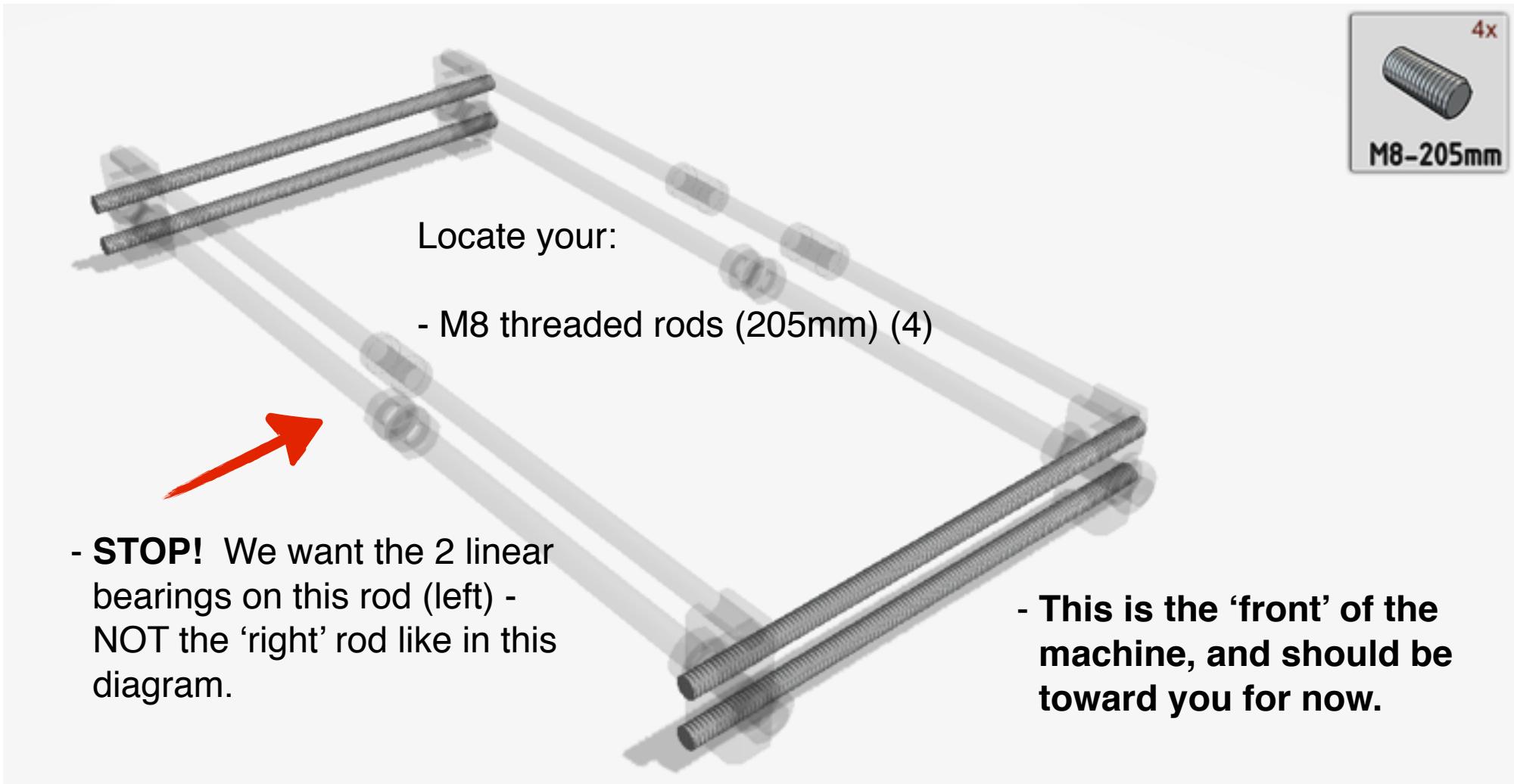
- M10 flat washers (4)
- M10 nuts (4)

Each corner gets a washer and a nut.
Adjust the inner and outer nuts so that the end of the rod is flush with the outside M10 nut.
Do the same on all four corners.
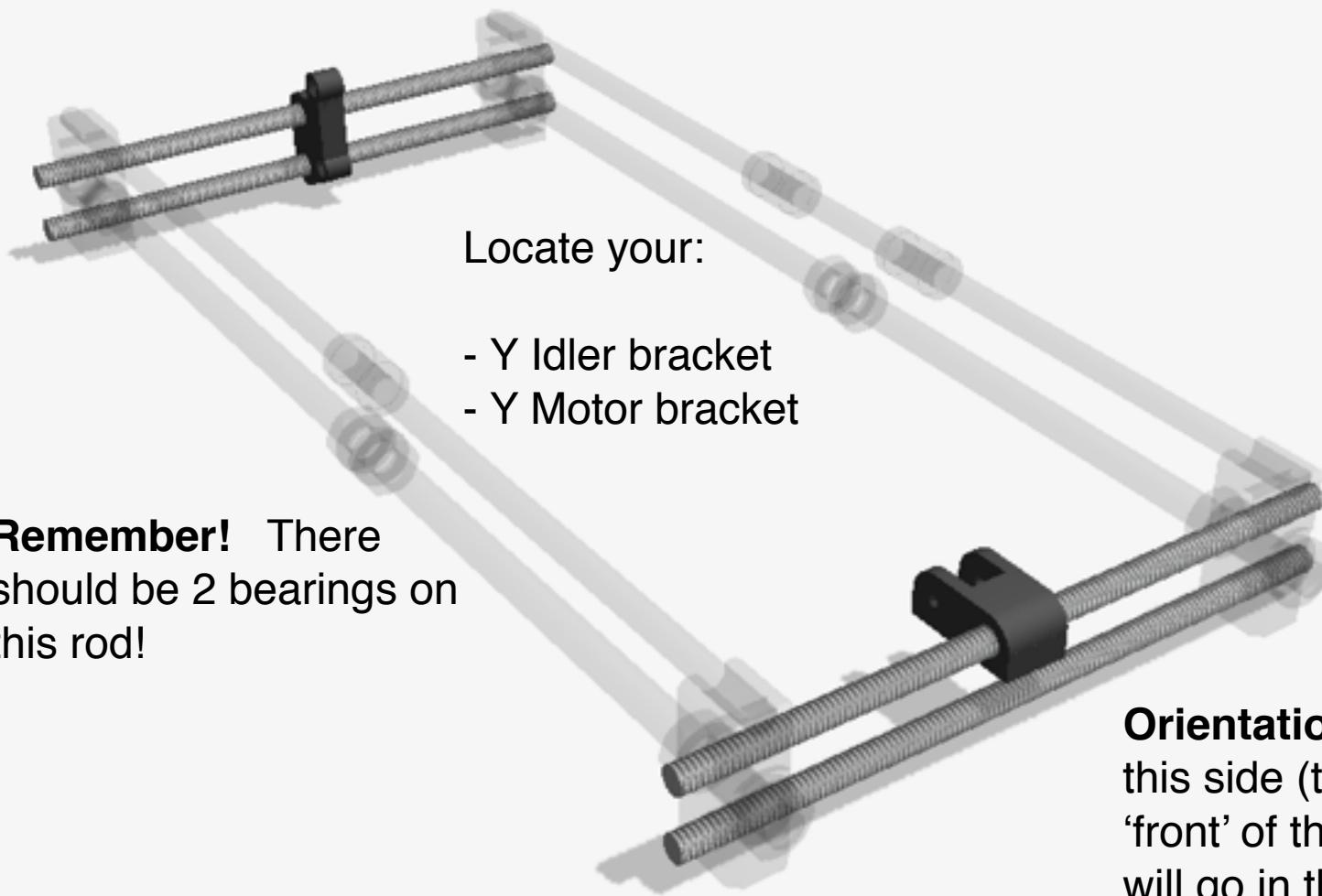
Step 25: Y-Axis Short Rods

4x

M8-205mm

Locate your:

- M8 threaded rods (205mm) (4)

- **STOP!** We want the 2 linear bearings on this rod (left) - NOT the 'right' rod like in this diagram.

- **This is the 'front' of the machine, and should be toward you for now.**

Do not slide the rods into the Y corner brackets yet!   Just find them.

Step 26: Y-Axis Short Rods

Locate your:

- Y Idler bracket
- Y Motor bracket

- **Remember!** There should be 2 bearings on this rod!
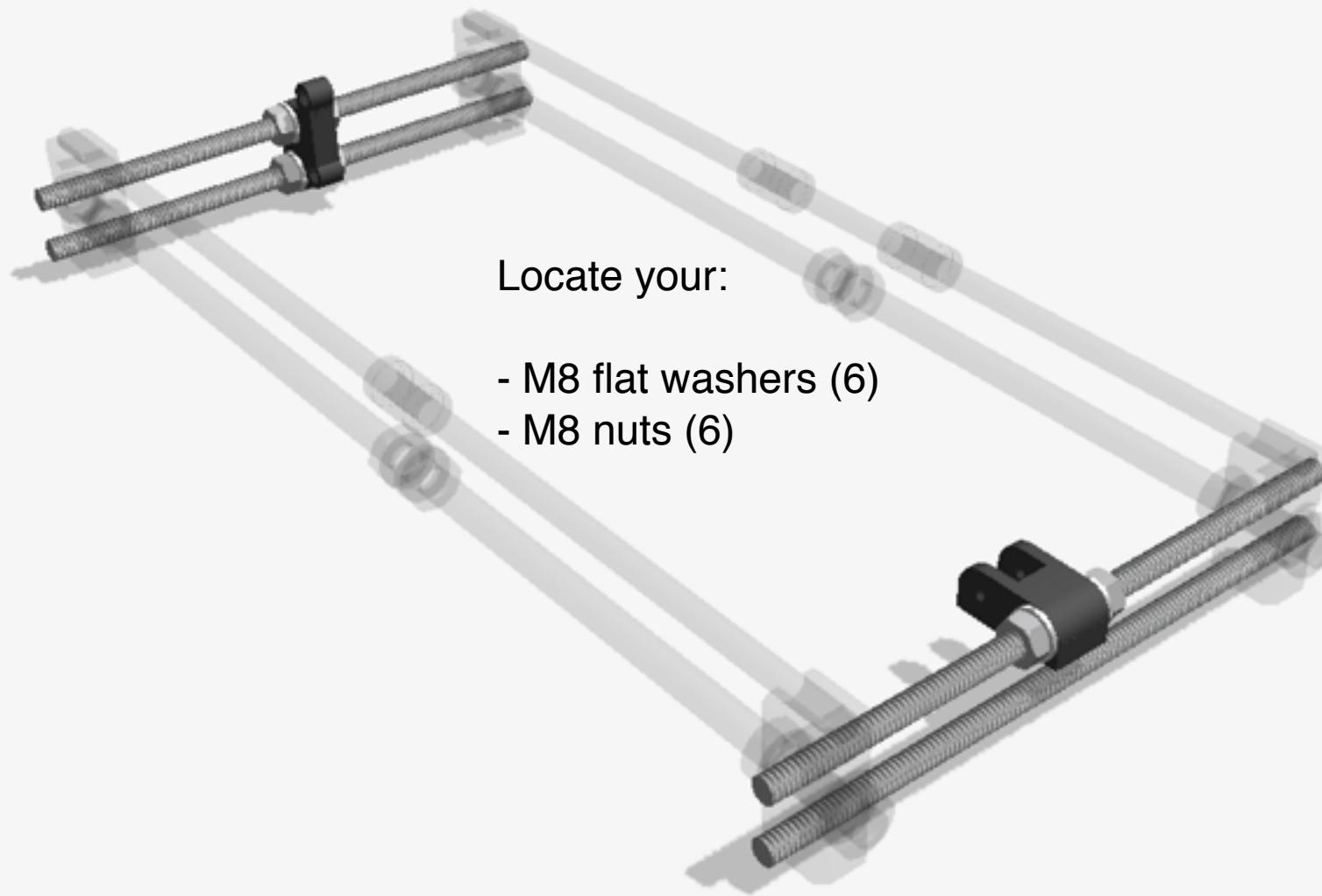
Orientation Note: From now on, this side (the Y idler end) is the 'front' of the printer. The Y motor will go in the 'back.'

Slide one onto the one of the M8 rods

Slide the other onto two others. Use the diagram for orientation.

Step 27: Y-Axis Short Rods

Locate your:
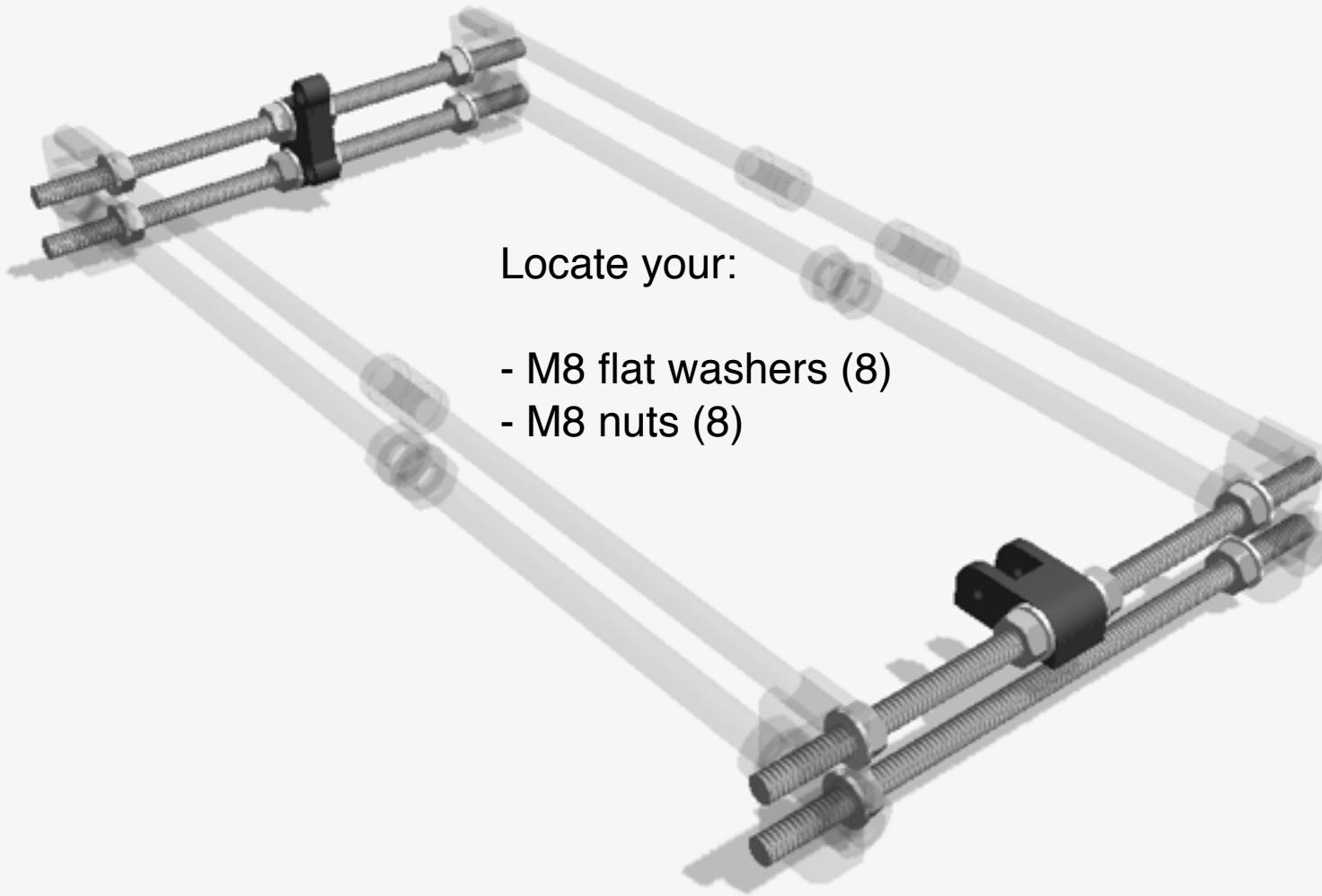
- M8 flat washers (6)
- M8 nuts (6)

6x

M8

6x

M8

Put the idler and motor brackets roughly in the center of their short rods.

On each side of both pieces should be a flat washer and a nut. Do not tighten yet!

Step 28: Y-Axis Short Rods
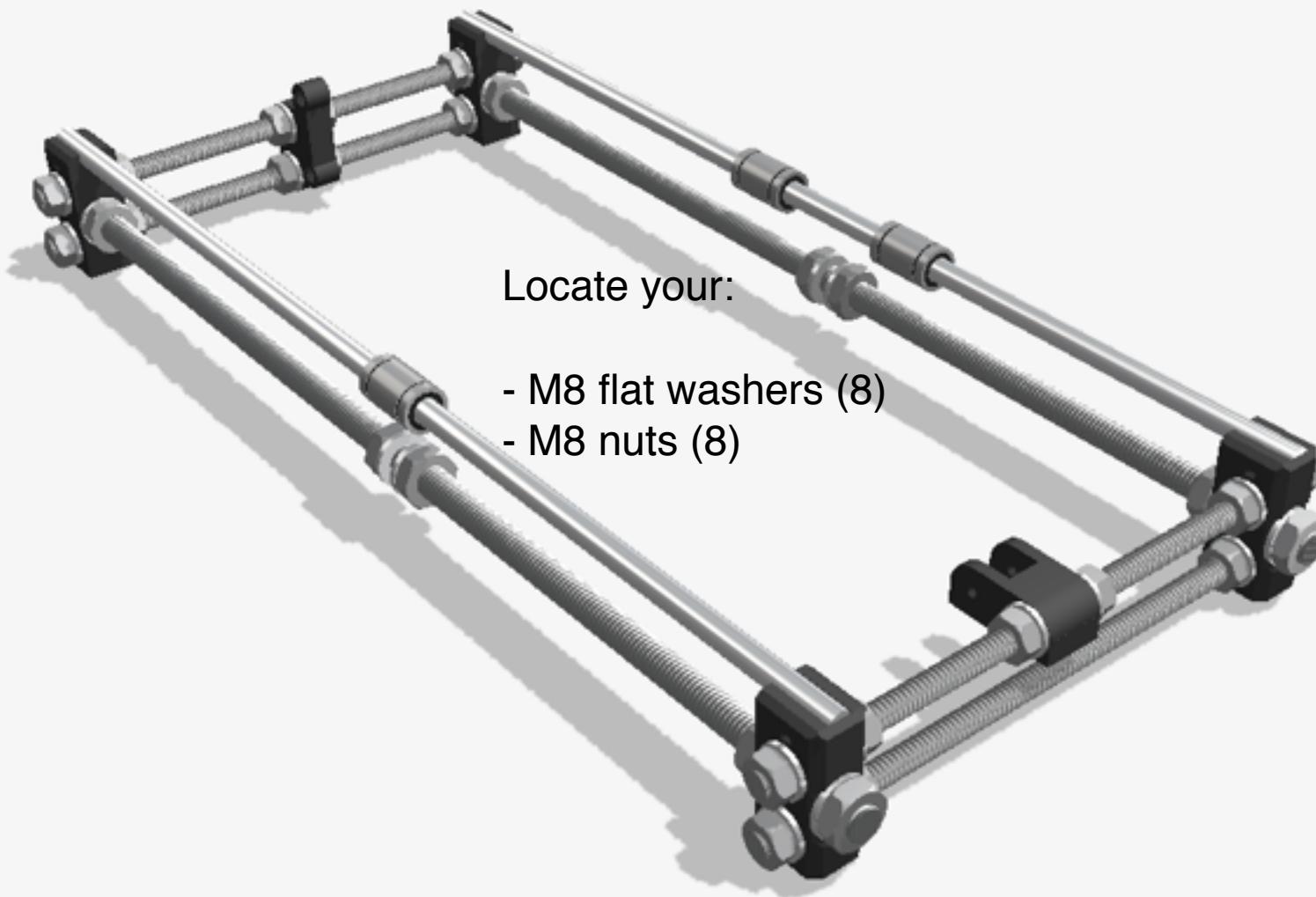
Locate your:

- M8 flat washers (8)
- M8 nuts (8)

Each of the 4 short rods needs a nut and a washer on the end - nut on the inside. Put them approximately 1 inch from the end of the rod.

Use the photo for reference.

Step 29: Y-Axis Short Rods

Locate your:

- M8 flat washers (8)
- M8 nuts (8)

8x
M8

8x
M8
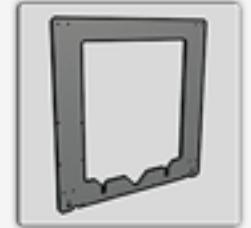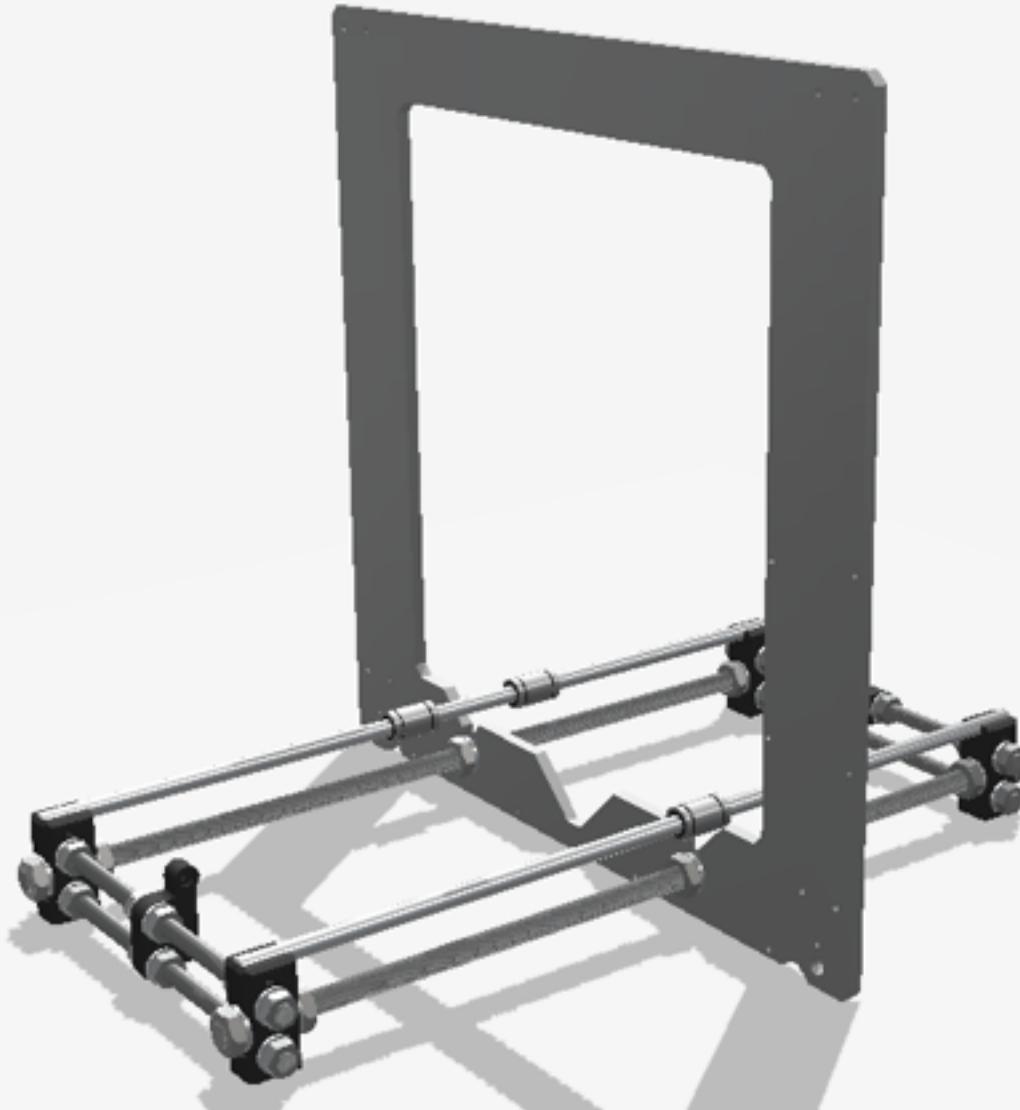
Slide the short rod assemblies into the Y corners as shown.   Each corner will get 2 washers (one on each rod) and 2 nuts (one on each rod)

Again, adjust the inner and outer nuts for each Y-corner so the rod end is flush with the nuts. DO NOT TIGHTEN YET!

Step 30: Main Frame

Locate your:
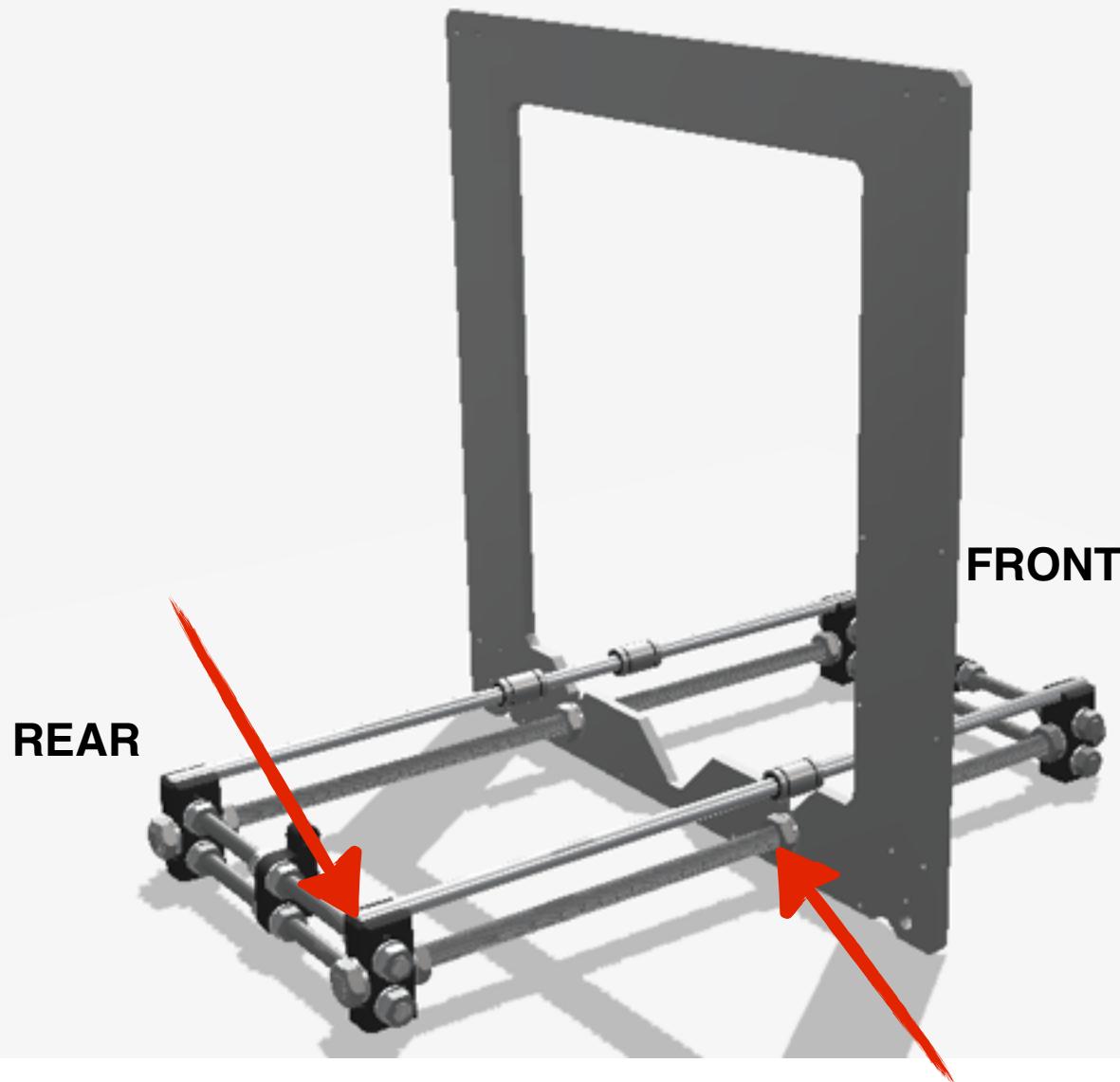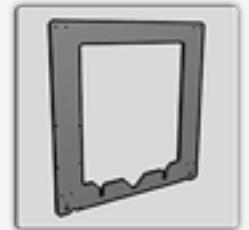
- Main Frame (it's black)

The main frame is held upright by the two large fender washers on the Y-axis threaded M10 rods. Adjust the frame so that it's sticking out 215mm from the front to the plate (i.e. the front (where it says Prusa) should be sticking out a lot further than the back)

Tighten the nuts on the fender washers to hold the frame in place, but know that it may need to be adjusted.

Note! You may have to adjust the width of your short rods for this part to fit right!

# Step 31: Main Frame

REAR

FRONT
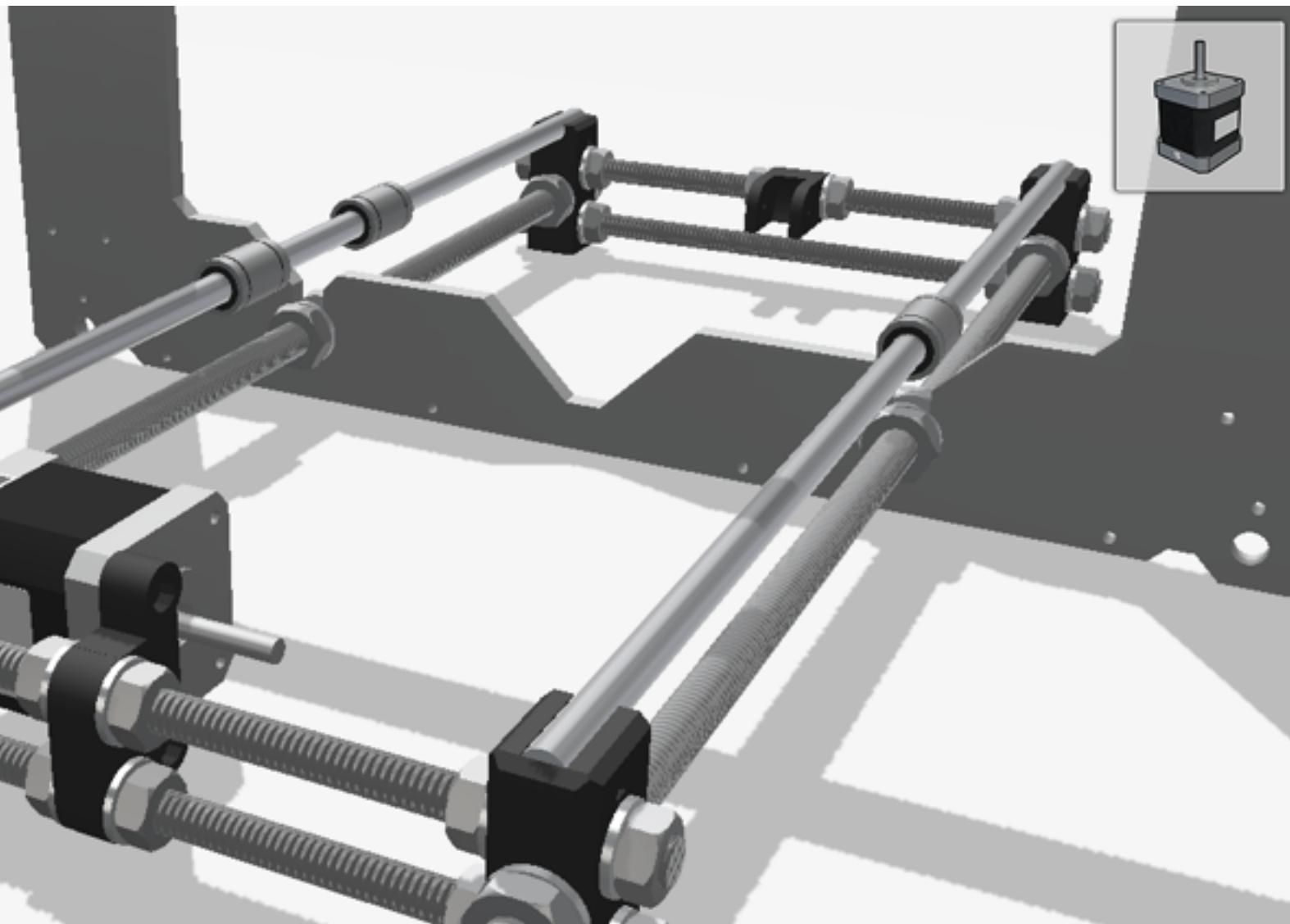
Measure!

From the back of the smooth rods to the back of the main plate should be about 15 cm.

Step 32: Y-Axis Stepper Motor

Locate your:

- Stepper Motor
 (any is fine, they're
  all the same)
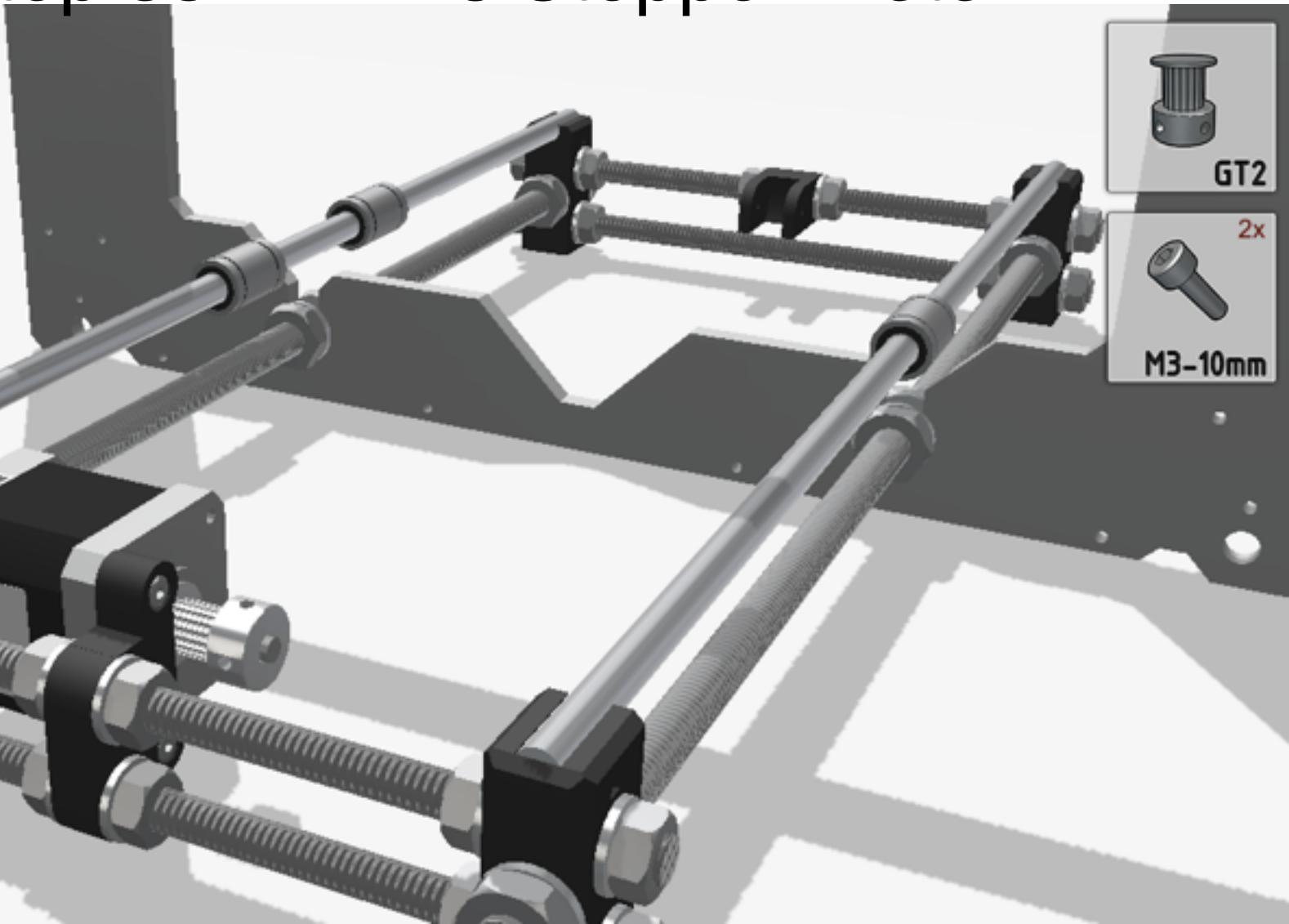
Hold it up to make sure that it aligns with the Y-axis motor mount.

Step 33: Y-Axis Stepper Motor

Locate your:

- M3 x 10mm bolts (2)
- GT2 Belt pulley (1)

GT2

2x

M3-10mm
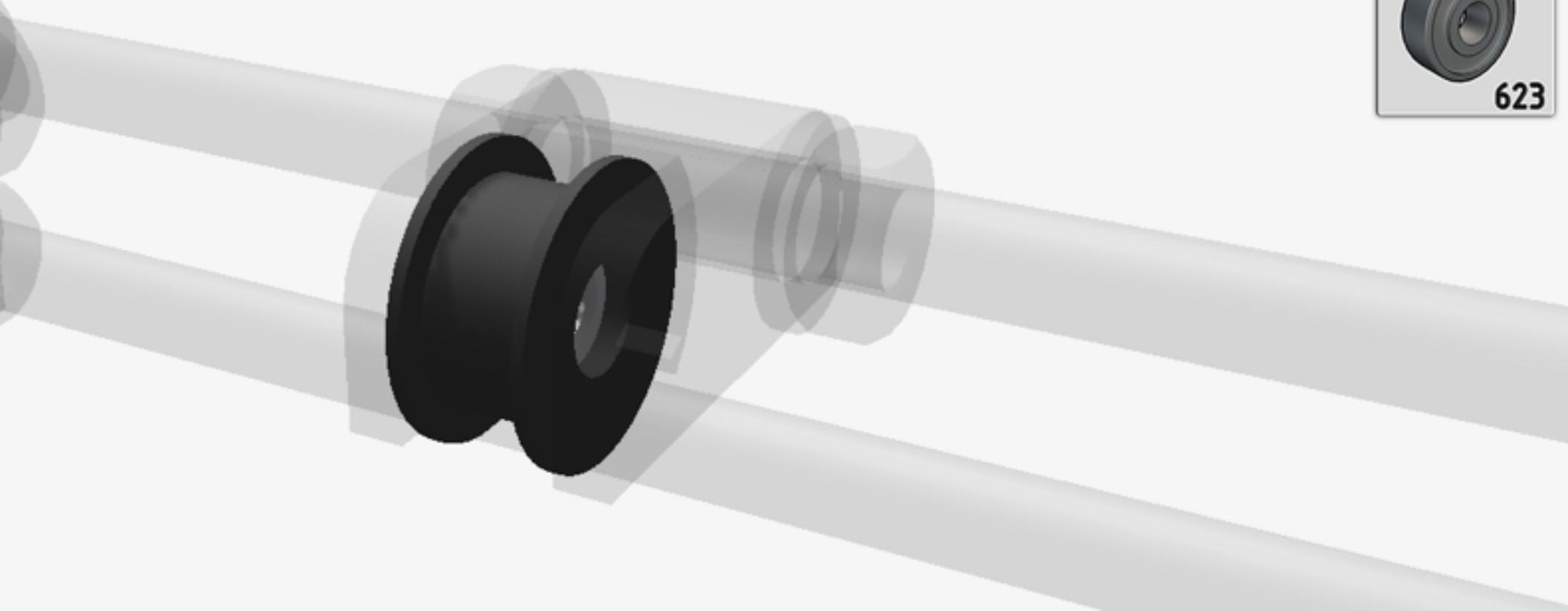
The Y-axis motor bolts to the motor mount with two M3 x 10mm bolts.   Make sure the wires are facing toward the short M8 bars closest to the motor.

The Pulley mounts to the motor shaft with 2 small set screws.   At least one of them should be on the 'flat' of the motor shaft. We'll show it in class.

Step 34: Y-Axis Idler

Locate your:

- Printed belt guides (2)
- 623 Bearing (1)

The printed guides slip onto the bearing, with the flanges facing outward.

Step 35: Y-Axis Idler

Locate your:
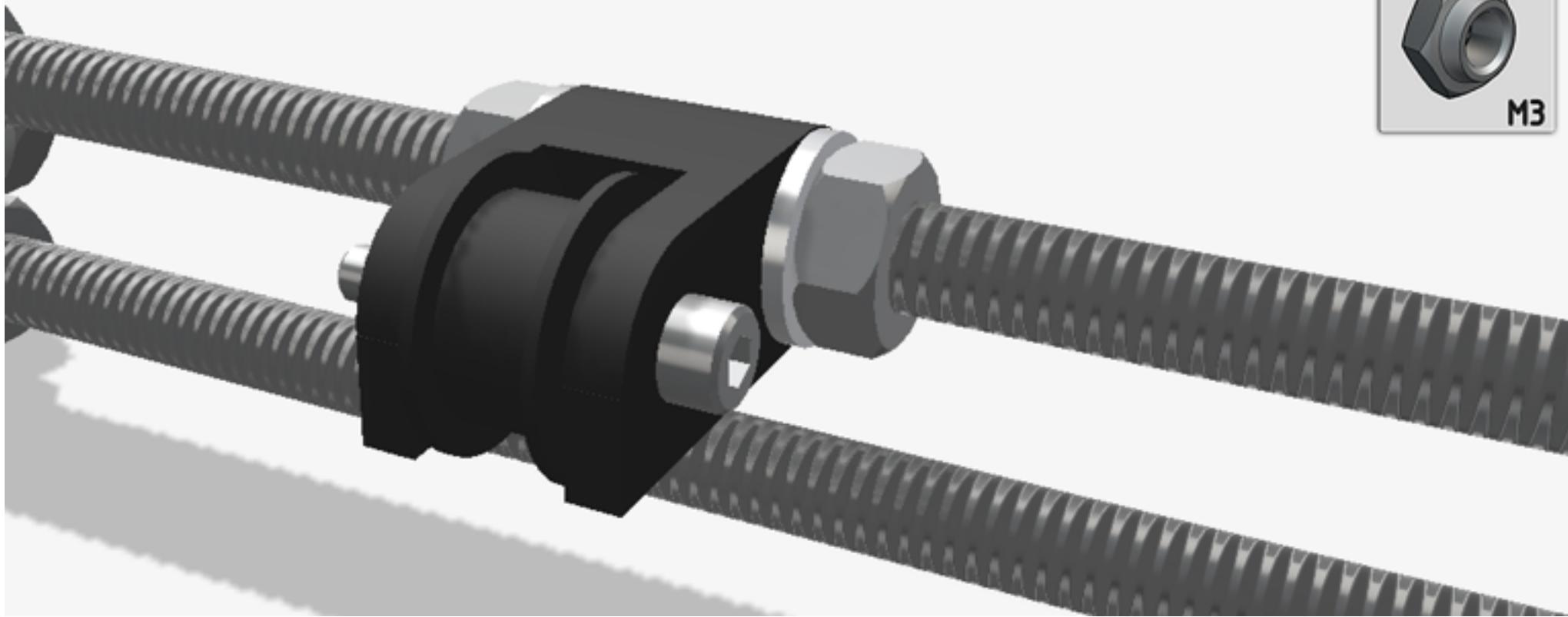
- M3 x 25mm bolt
- M3 nut (nylon)

M3-25mm

M3
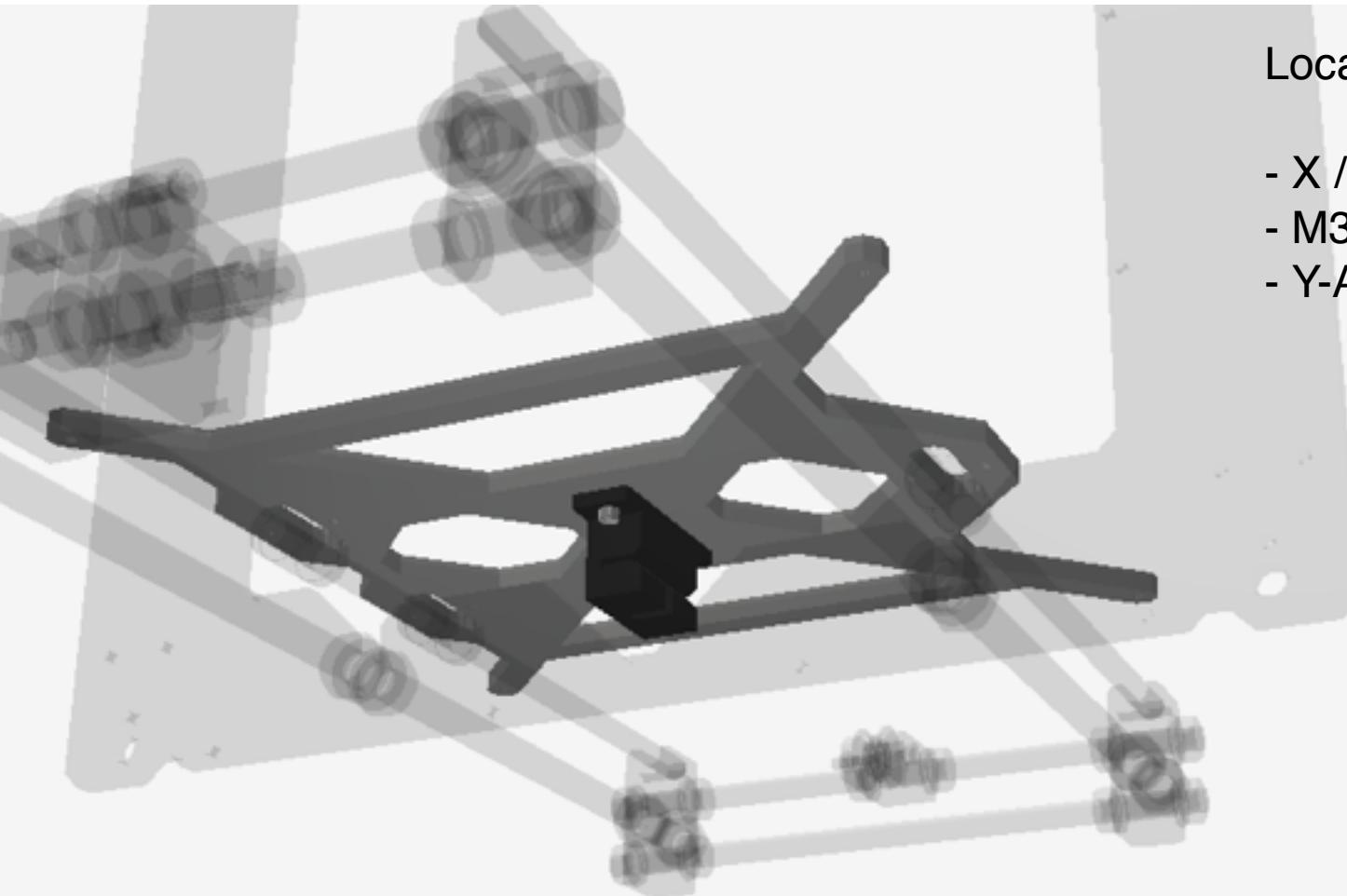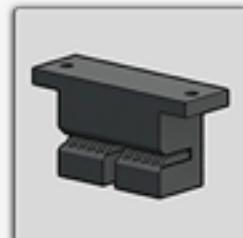
Put the bolt through the idler, the bearing / belt guides, and the idler again.   Secure with an M3 nut. You can tighten this one, but don't go crazy. Make sure the pulley spins freely.

Step 36: Build Plate
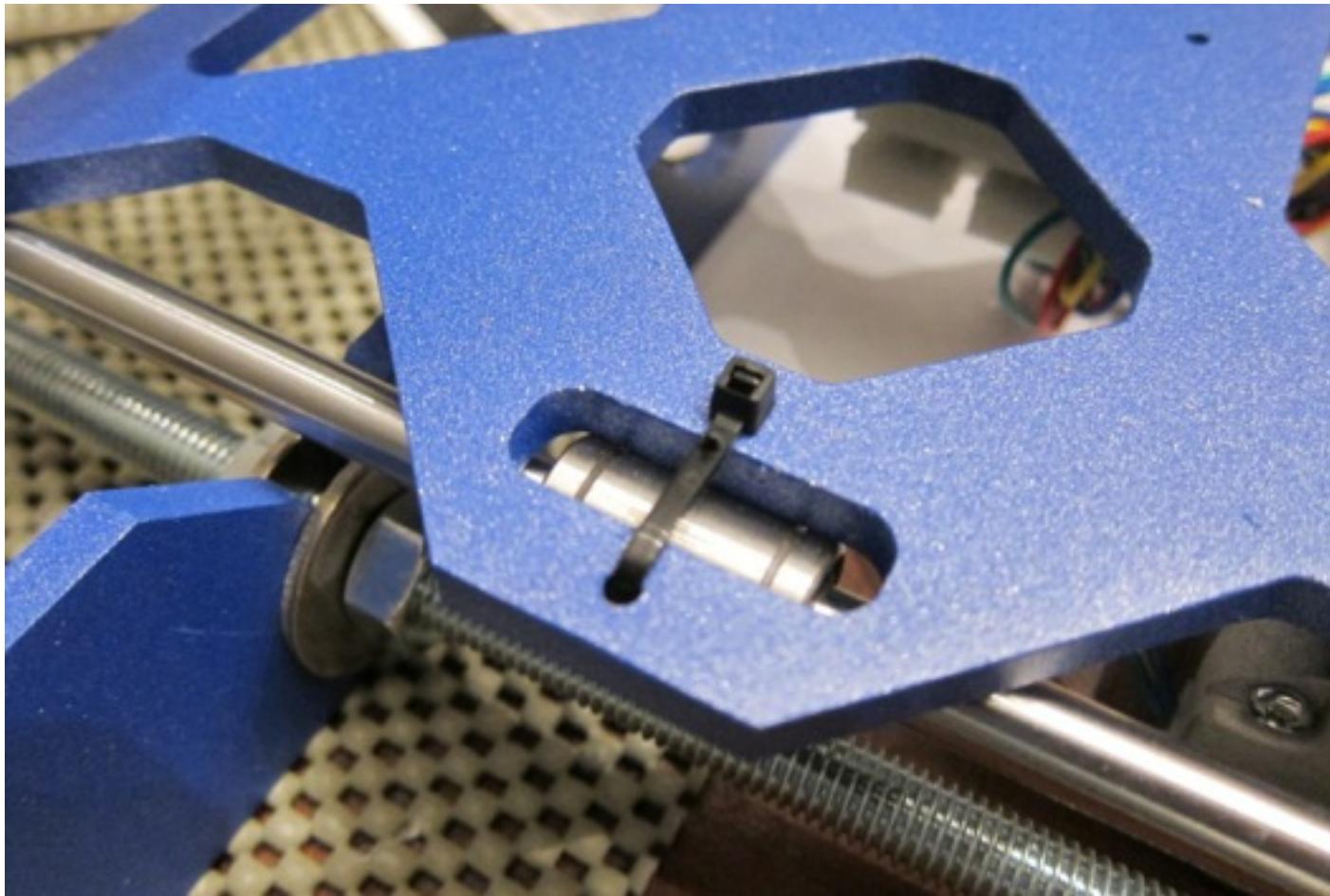
Locate your:

- X / Y plate (1)
- M3 x 10mm bolts (2)
- Y-Axis belt mount

2x

M3-10mm

Mount the belt mount to the underside of the X/Y plate using two of the M3 x 10mm bolts. Take note of the orientation of the plate as well as the mount.

Step 37: Build Plate ZIP TIES
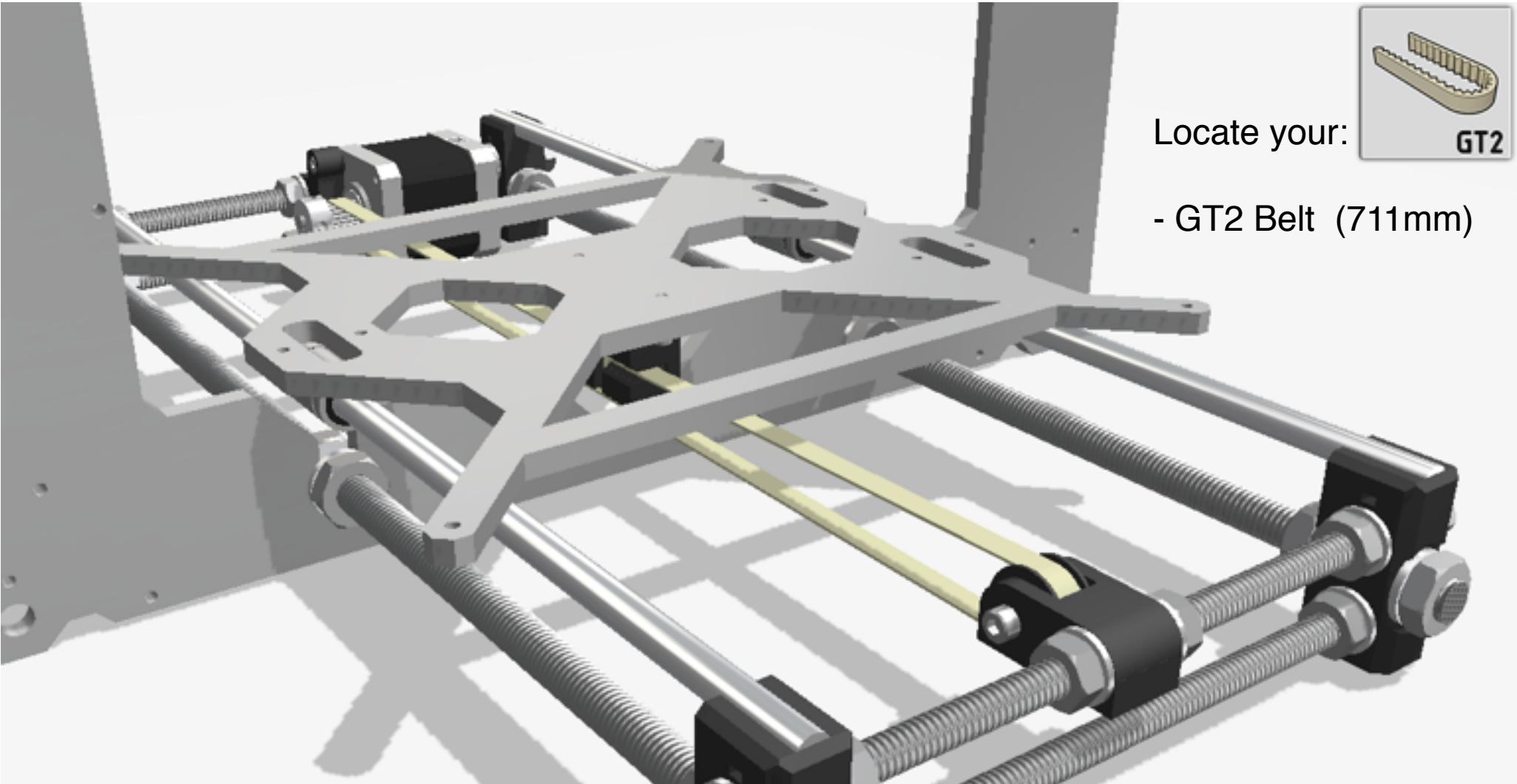
Locate your:

- 4" zip ties (3)

The build platform frame gets zip-tied to the 3 linear bearings.   Each bearing should be centered in the spots cut out for it.   The 'knob' part of the zip ties must be facing upward! These have to be really right.   We can show you tricks to get them tighter.

Note: You may have to loosen / adjust your Y-short rods to get the bearings to line up right with the slots.
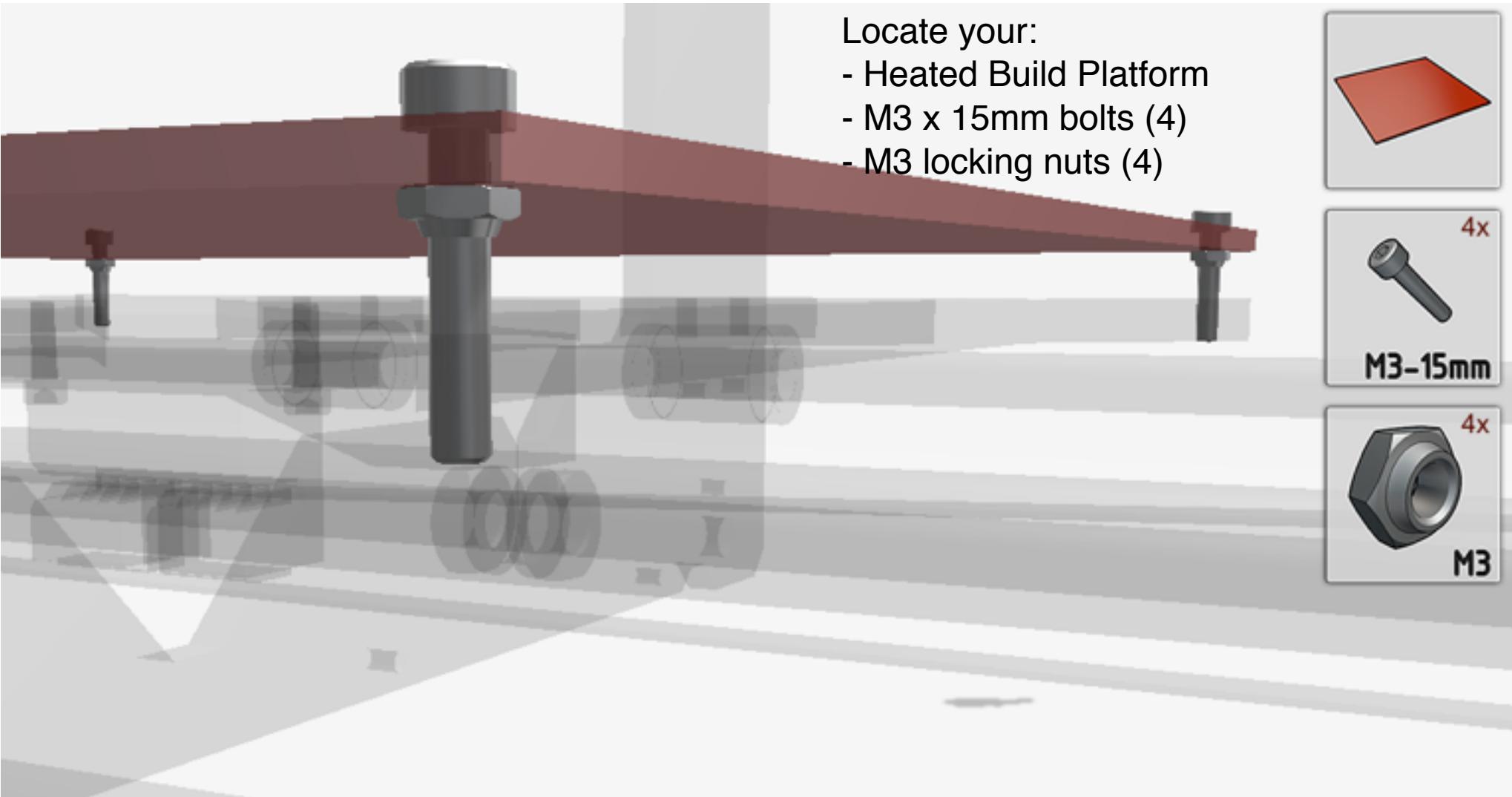
Step 38: Build Plate

GT2

- GT2 Belt (711mm)

Insert the belt into the belt mount on the underside of the platform, wrap the belt around the stepper motor pulley, under the platform, around the Y-idler, and then back to the belt mount.

We'll show you how to align it, tension it, and secure it with Zip ties.

Step 39: Heated Platform

Locate your:
- Heated Build Platform
- M3 x 15mm bolts (4)
- M3 locking nuts (4)

4x

M3-15mm

4x

M3
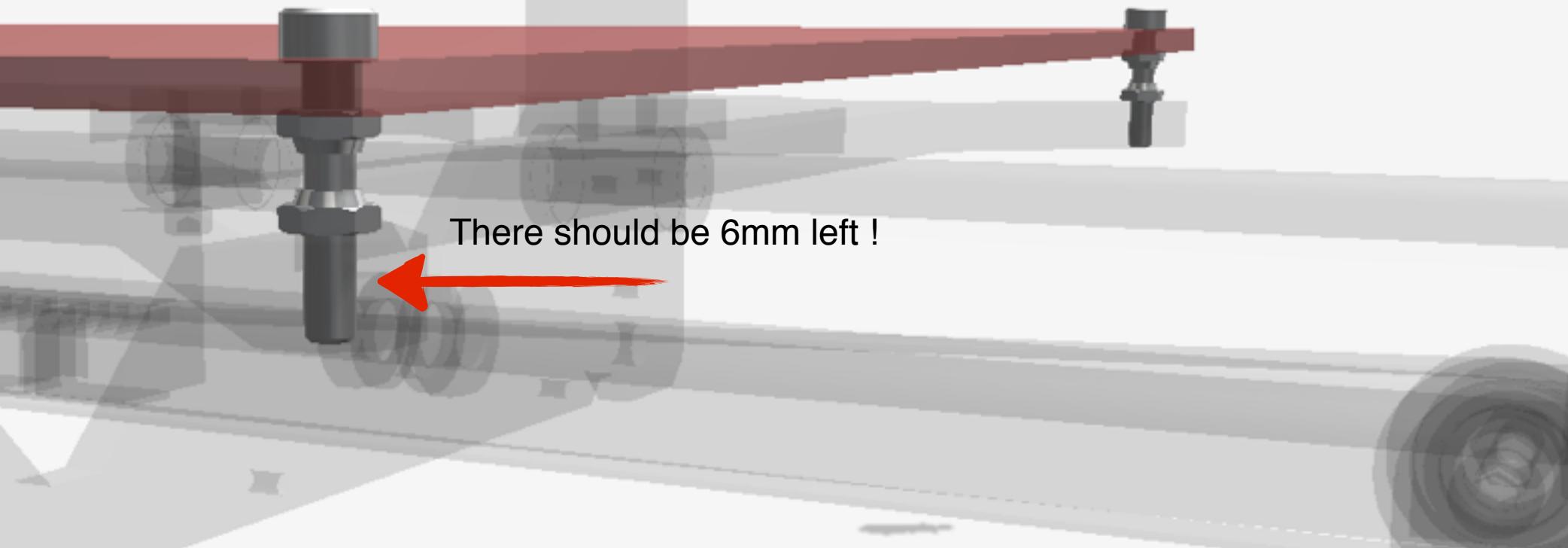
Make sure you get the right side up on the HBP, there is a thermistor taped to the bottom!

Put a single locking M3 nut on each M3 bolt - it should be brought up to just barely touch the red board, don't tighten it down!   Keep the board off for now.

# Step 40: Heated Platform
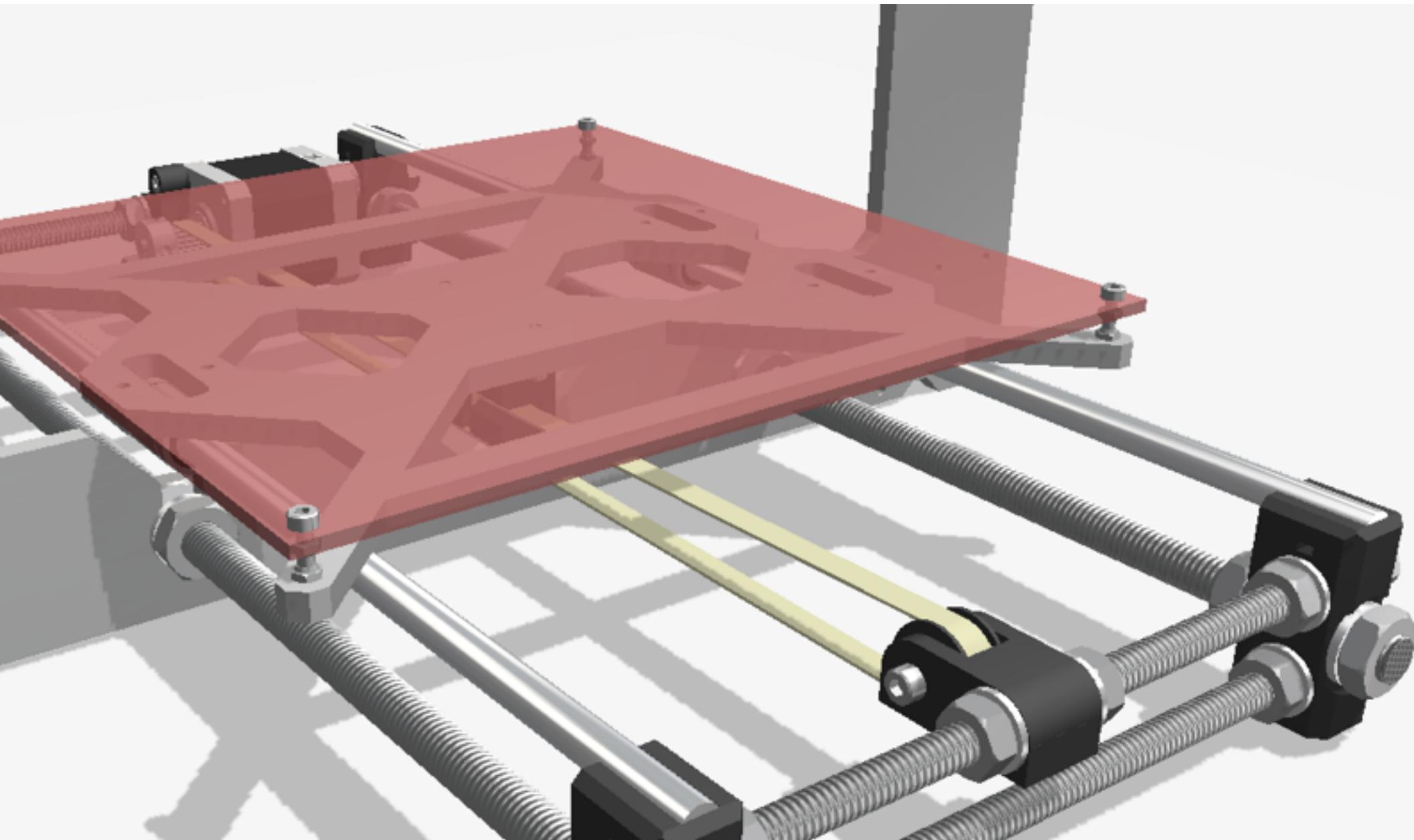
Locate your:

- M3 locking nuts (4)

4x
M3

There should be 6mm left !
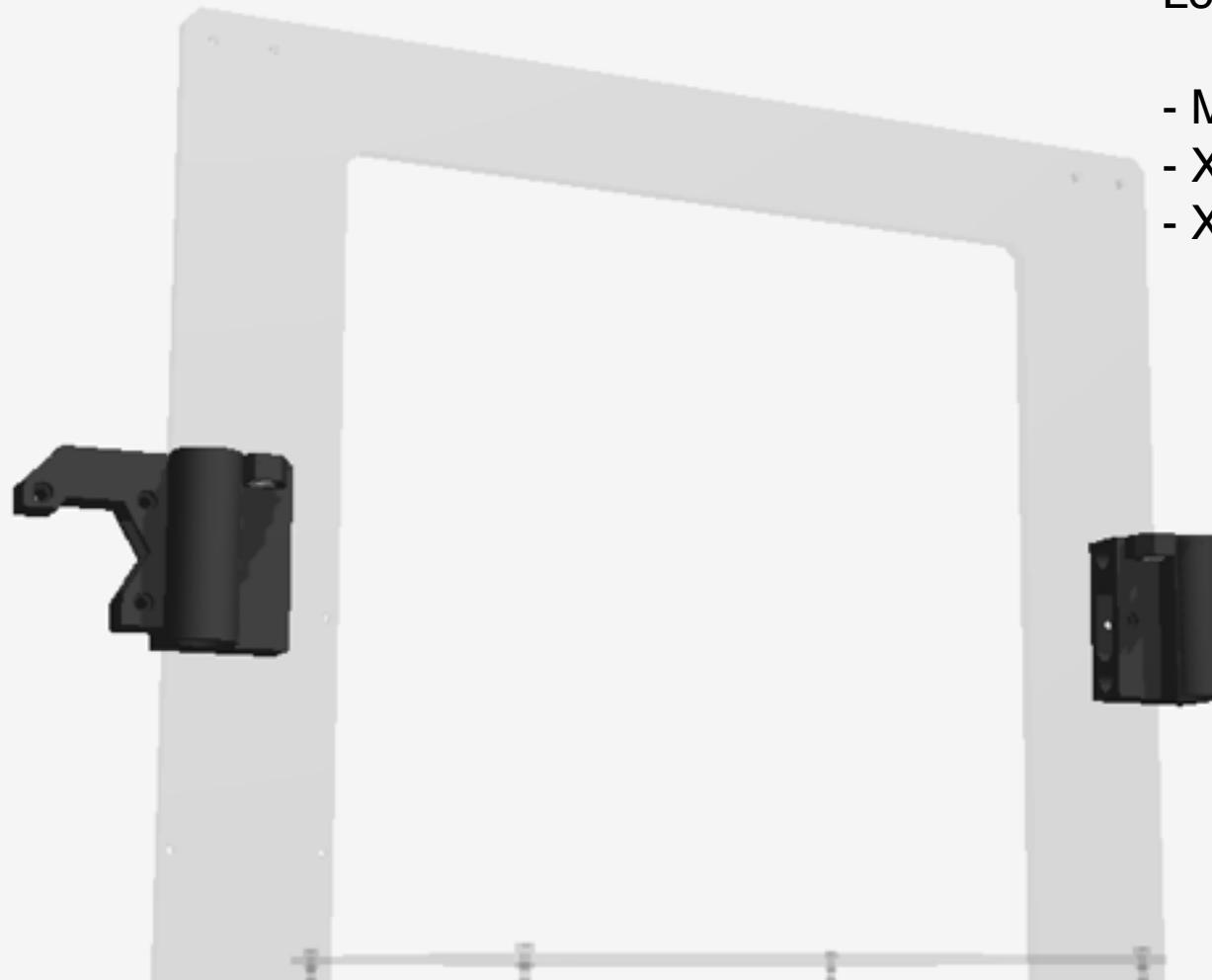
Put another locking nut (keep the orientation right!) on each M3 x 15mm corner bolts.   You want to leave about 6mm of the bolt shaft sticking down past the second nut.

Step 41: Heated Platform

Take the HBP with 4 bolt assemblies and rest it on the X-shaped platform.   The bolts should not stick out past the bottom of the frame.   **NOTE: The wires go out the back (toward the Y-stepper)**

Step 42: X-Axis Start
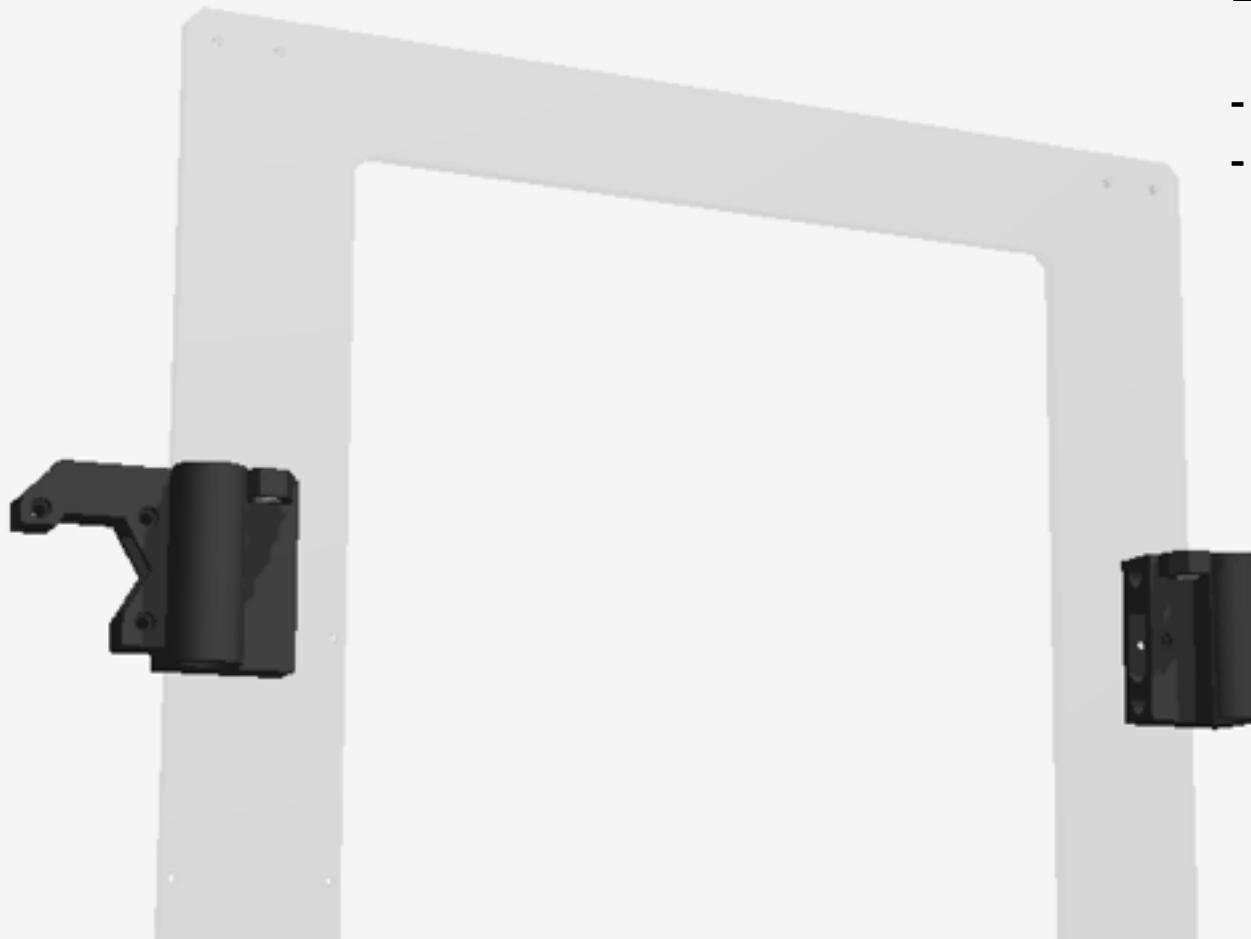
Locate your:

- M5 Nuts (2)
- X-Axis Motor End
- X-Axis Idler End

The M5 nuts have been pressed into your X-motor and X-idler ends for you!

Step 43: X-Axis Bearings
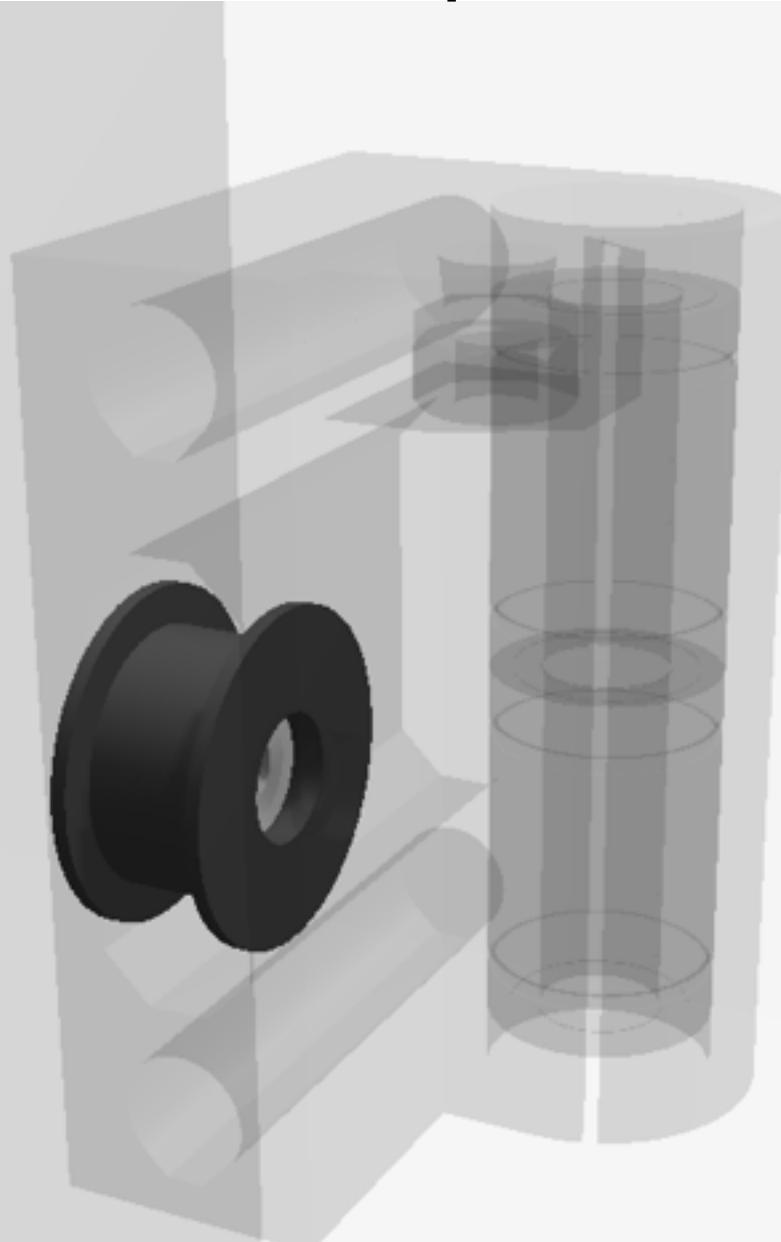
Locate your:

- LM8UU Linear Bearings
- (4 of them)

4x

LM8UU

These bearings have been pressed in for you, as it required special tools.

Step 44: X-Axis Idler
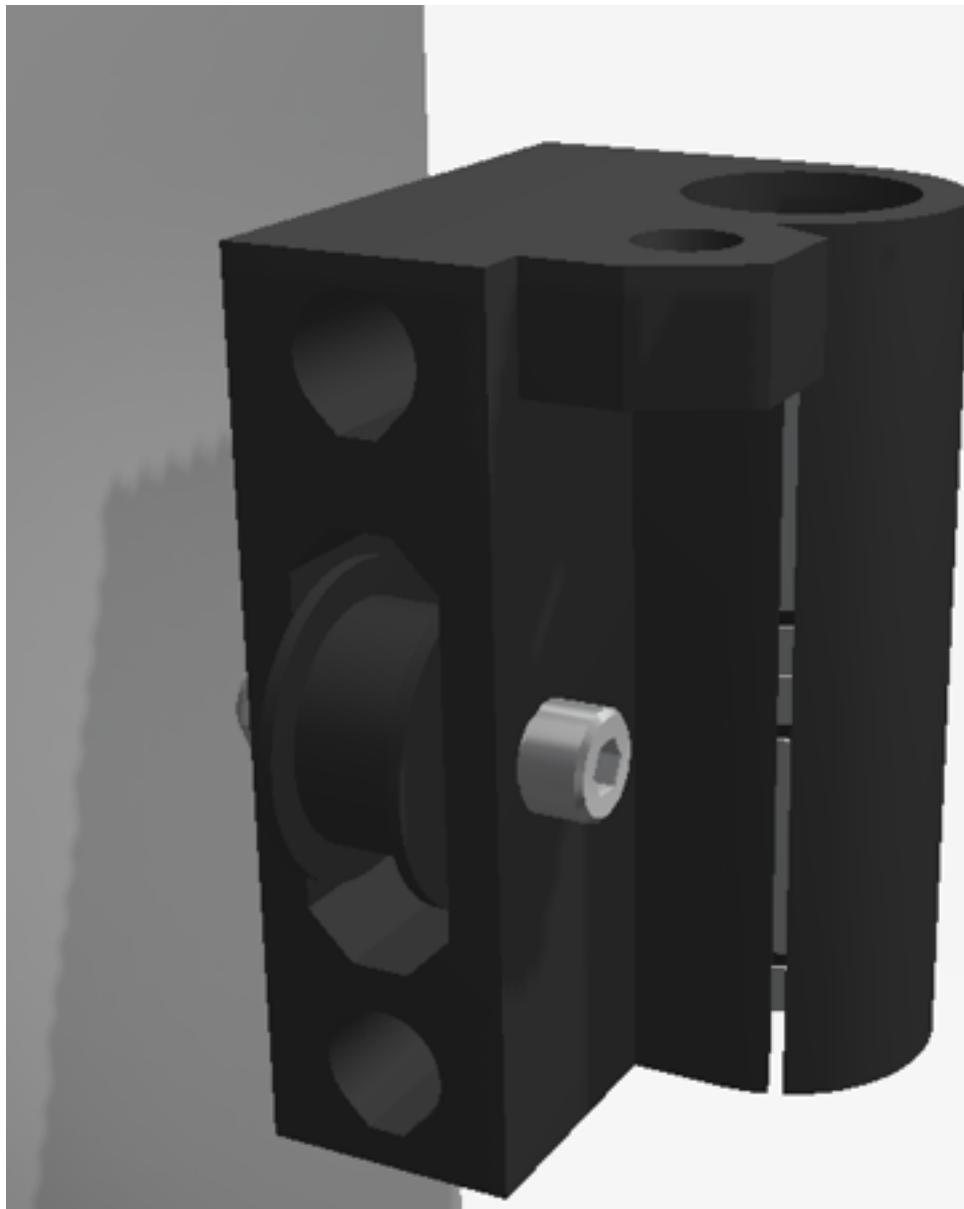
Locate your:

- 623ZZ bearings
- Printed belt guides (2)

The belt guides press onto the bearing, with the flange sides facing out (like in the image above)

Step 45: X-Axis Idler

Locate your:

- M3x18mm bolt
- M3 locking nut
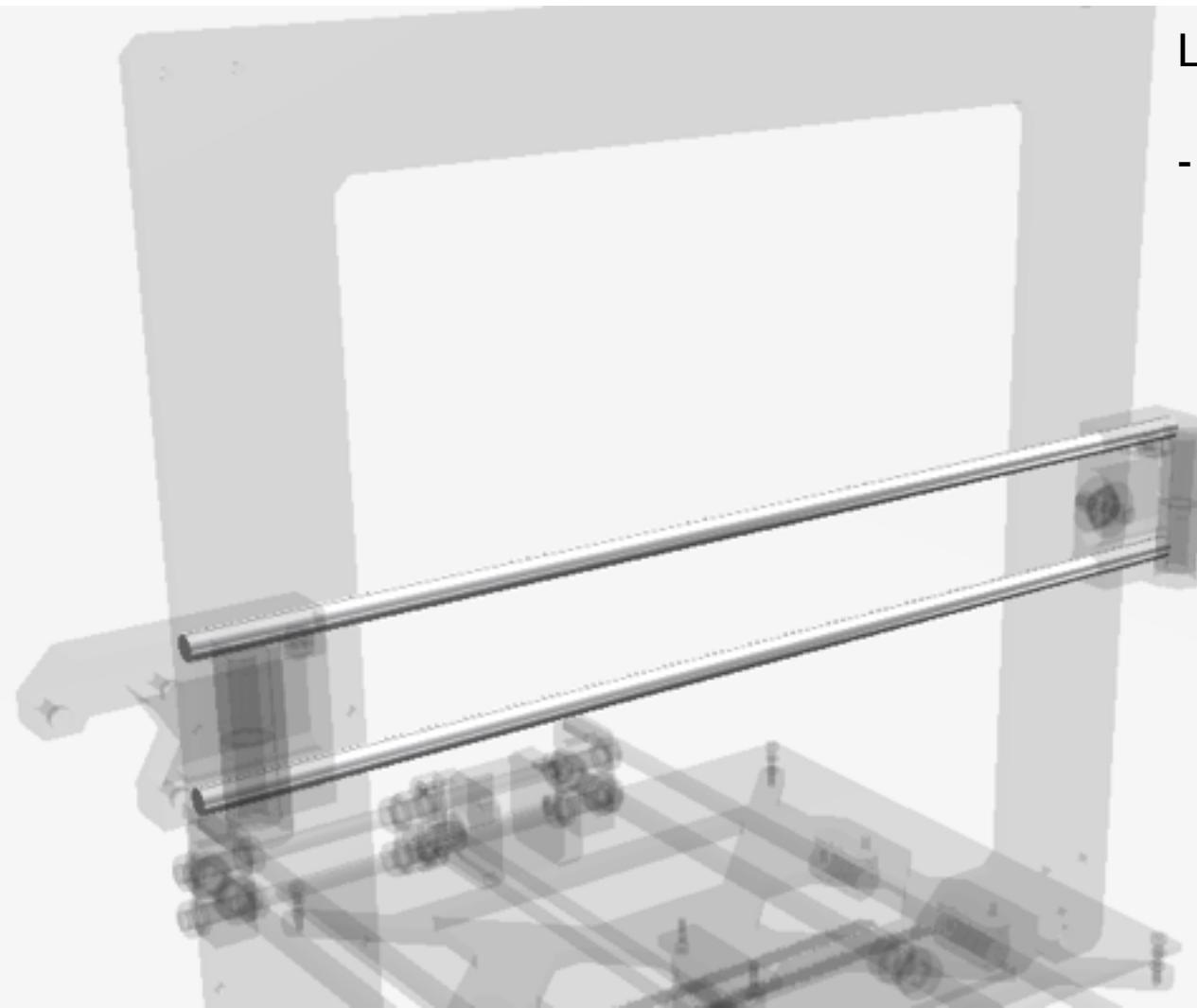
(Yes, the photo to the right is wrong)

M3-20mm

M3

Put the bolt through the idler from front to back, through the assembled bearing with flanges. The nut goes on the back. Make sure the pulley spins freely.

Step 46: X-Axis Rods
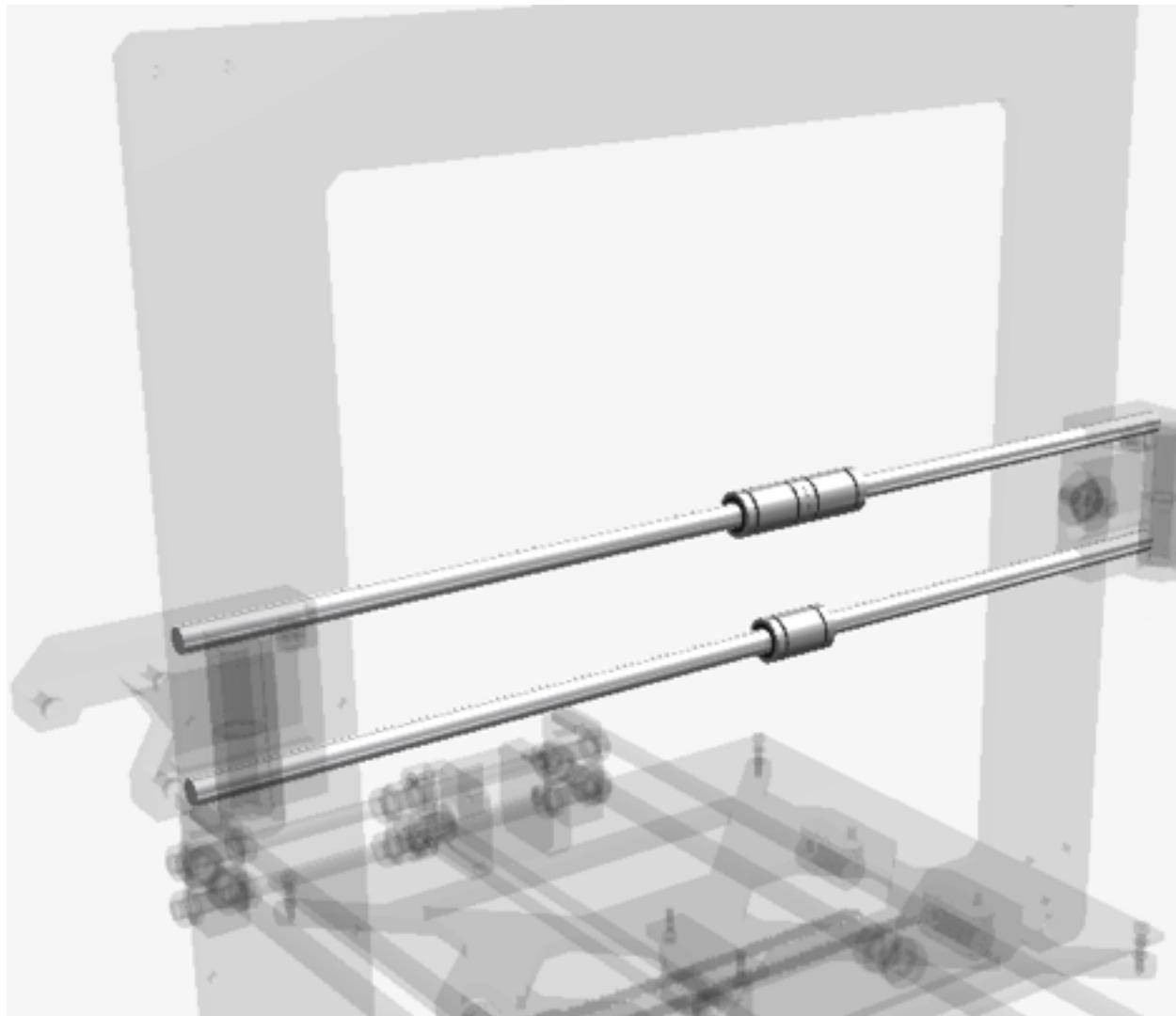
Locate your:

- M8 smooth rods (the long ones in your kit) - 2

2x

Ø8-370mm

Don't press them into anything yet!

Step 47: X-Axis Rods


3x

LM8UU

Locate your:
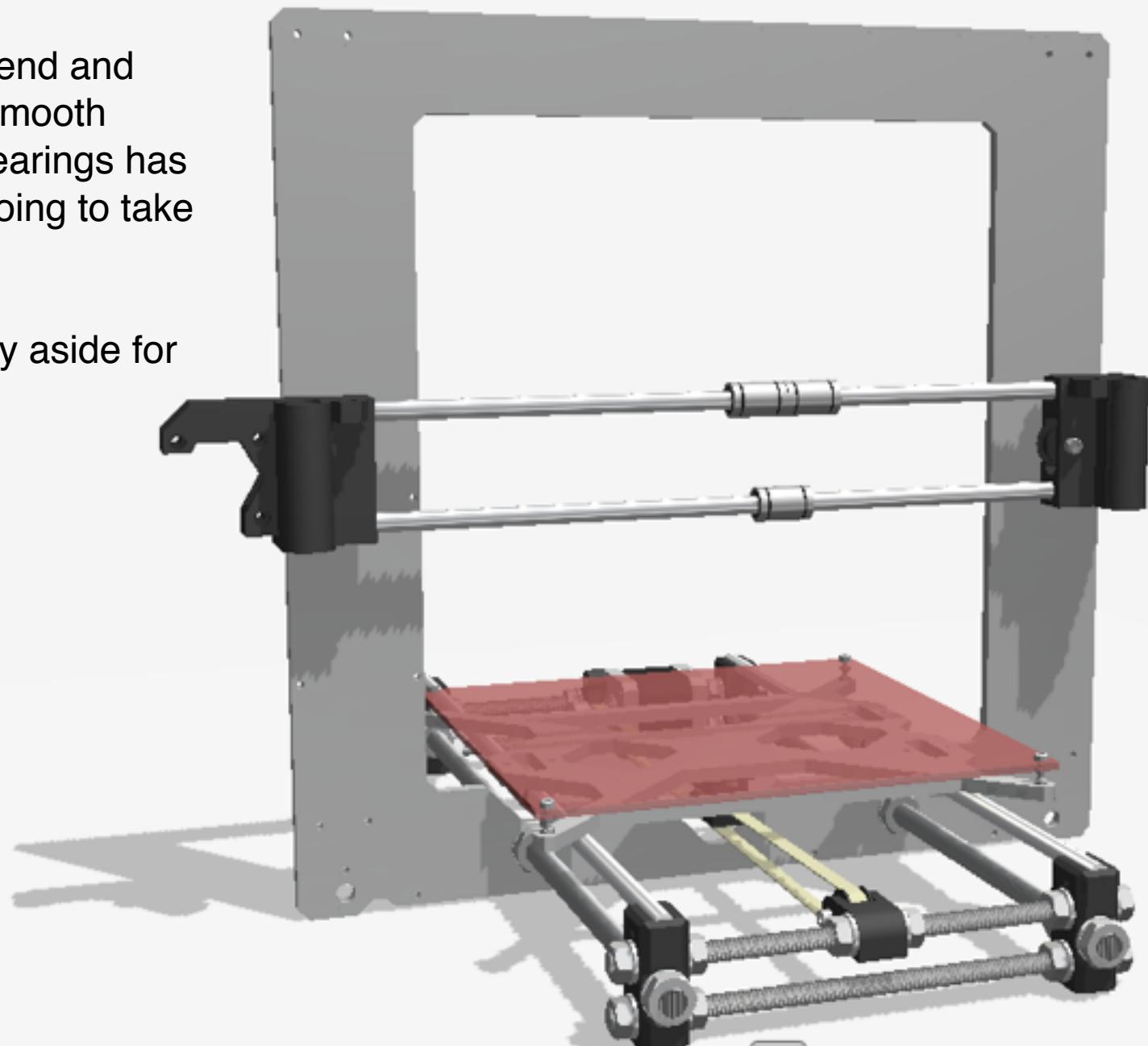
- LM8UU linear bearings (3)

Slide 2 bearings onto one rod, and one onto the other.   Take care putting them on the rods.
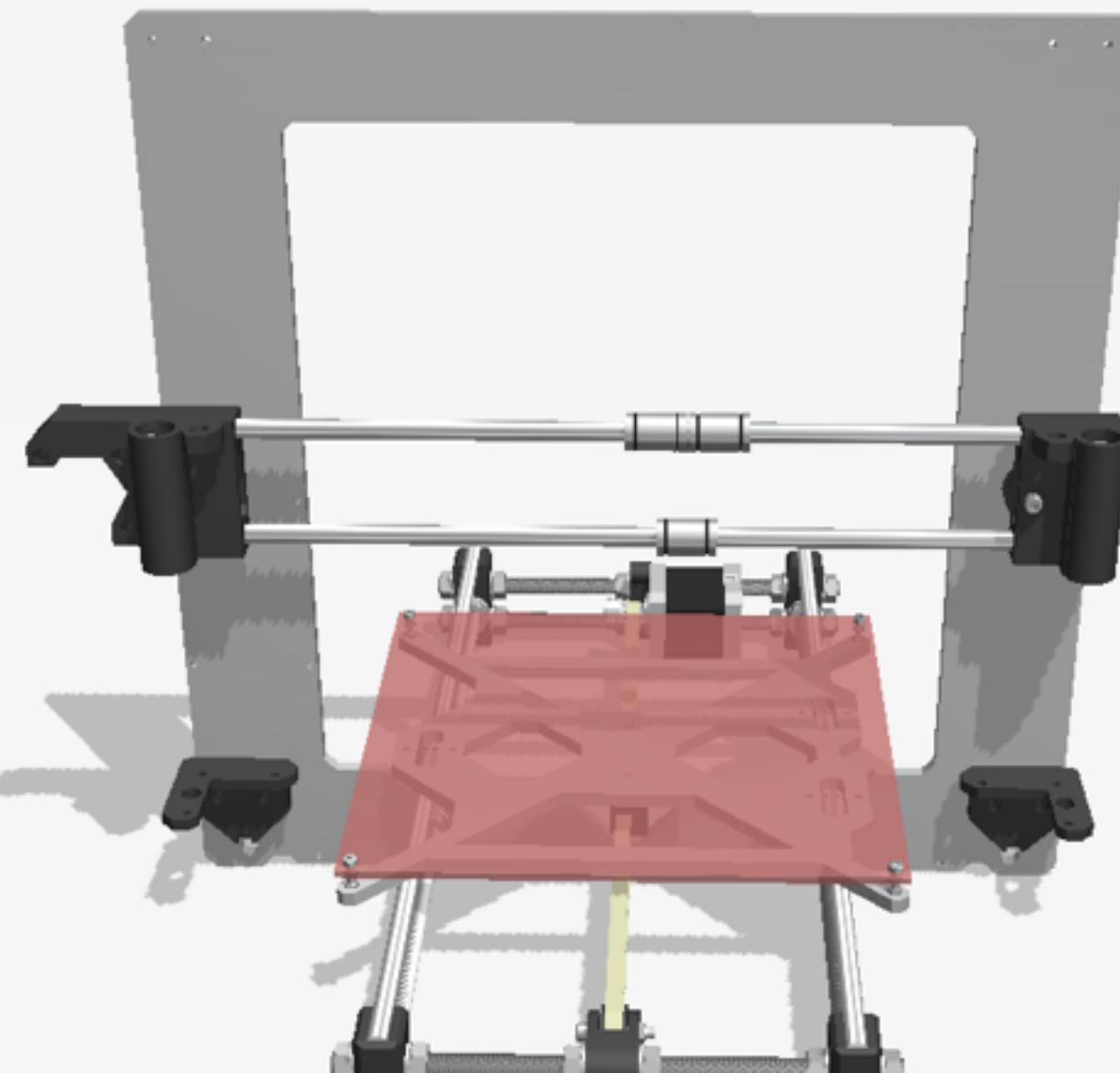
Step 48: X-Axis Rods

Slide the X-axis motor-end and the idler-end onto the smooth rods. The rod with 2 bearings has to go on top. This is going to take some force.

Put the X-axis assembly aside for a few minutes.

Step 49: Z-Axis Start
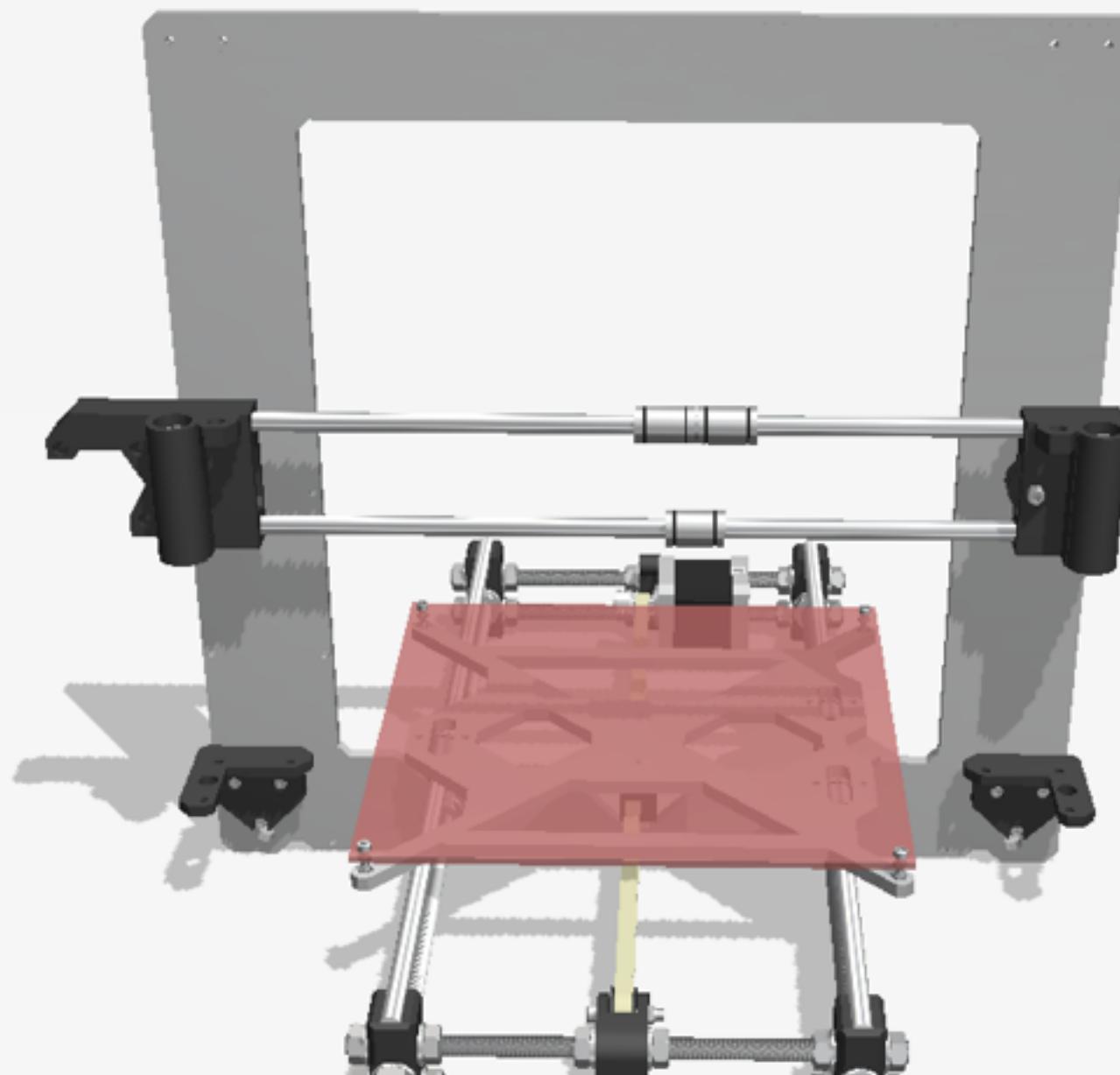
Locate your:

- Z-axis bottom mounts

Type to enter text

Step 50: Z-Axis Bottom Mounts


6x

M3-10mm
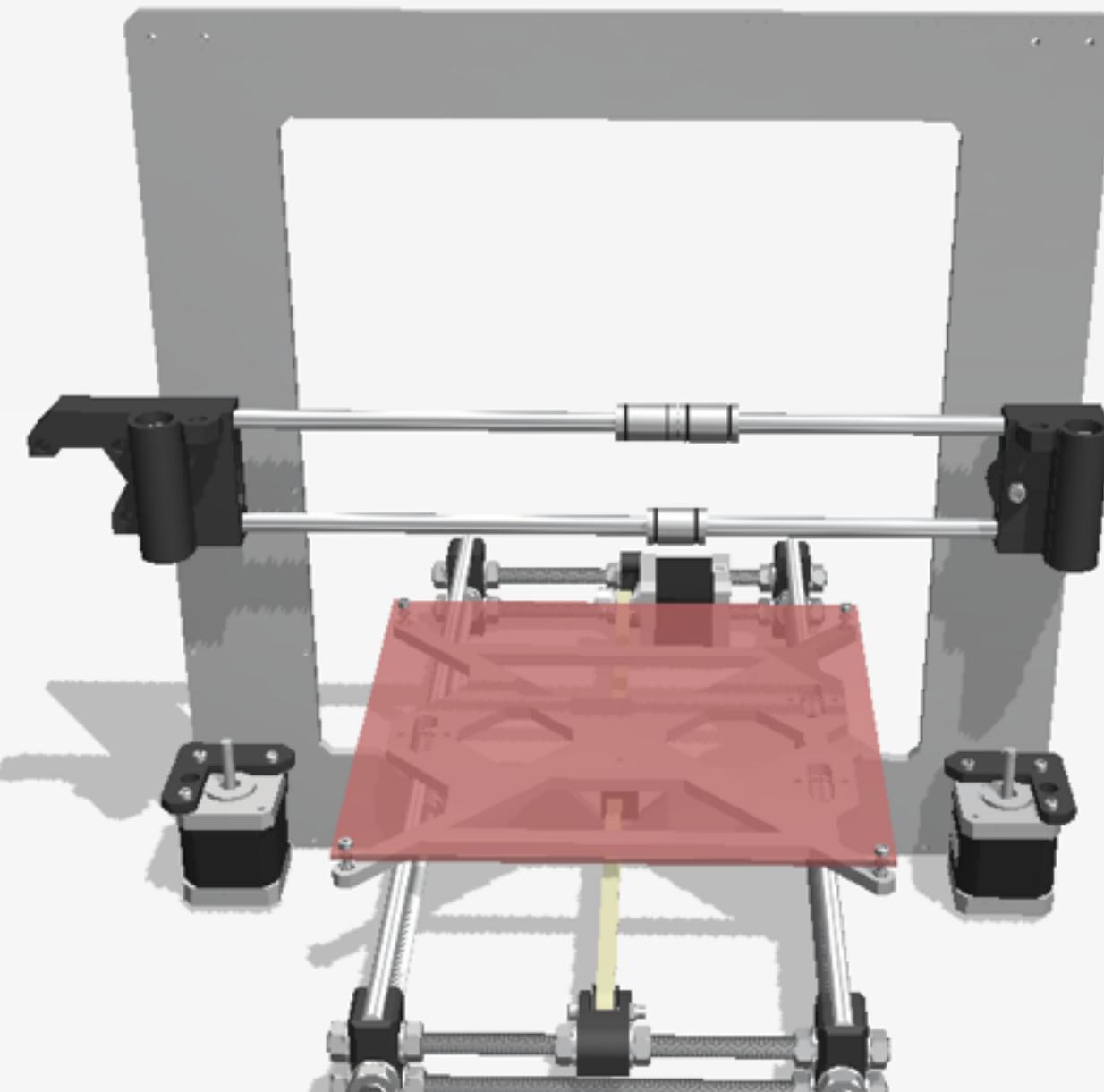
Locate your:

- M3 x 10mm bolts (6)

The lower mounts bolt to the black Prusa frame with M3 bolts. The frame is tapped, no nuts are needed.

Step 51: Z-Axis Bottom Mounts
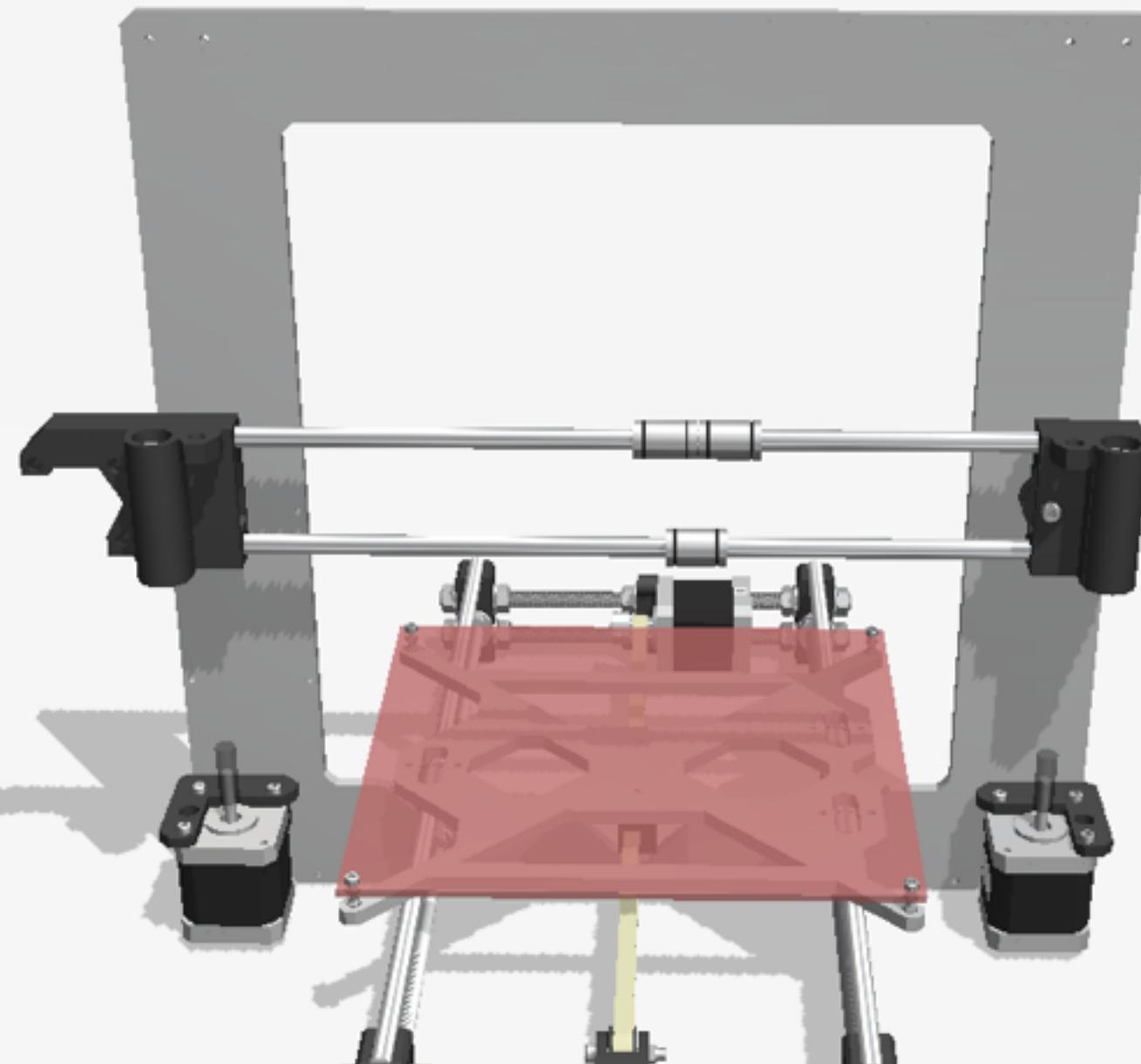
Locate your:

- Stepper Motors (2)
- M3 x 10mm bolts (6)

The Z-axis stepper motors mount to the plastic bottom mounts with M3x10mm bolts. Make sure the wiring for each motor points inward, toward the center of the machine.

Step 52: Z-Axis Bottom Mounts
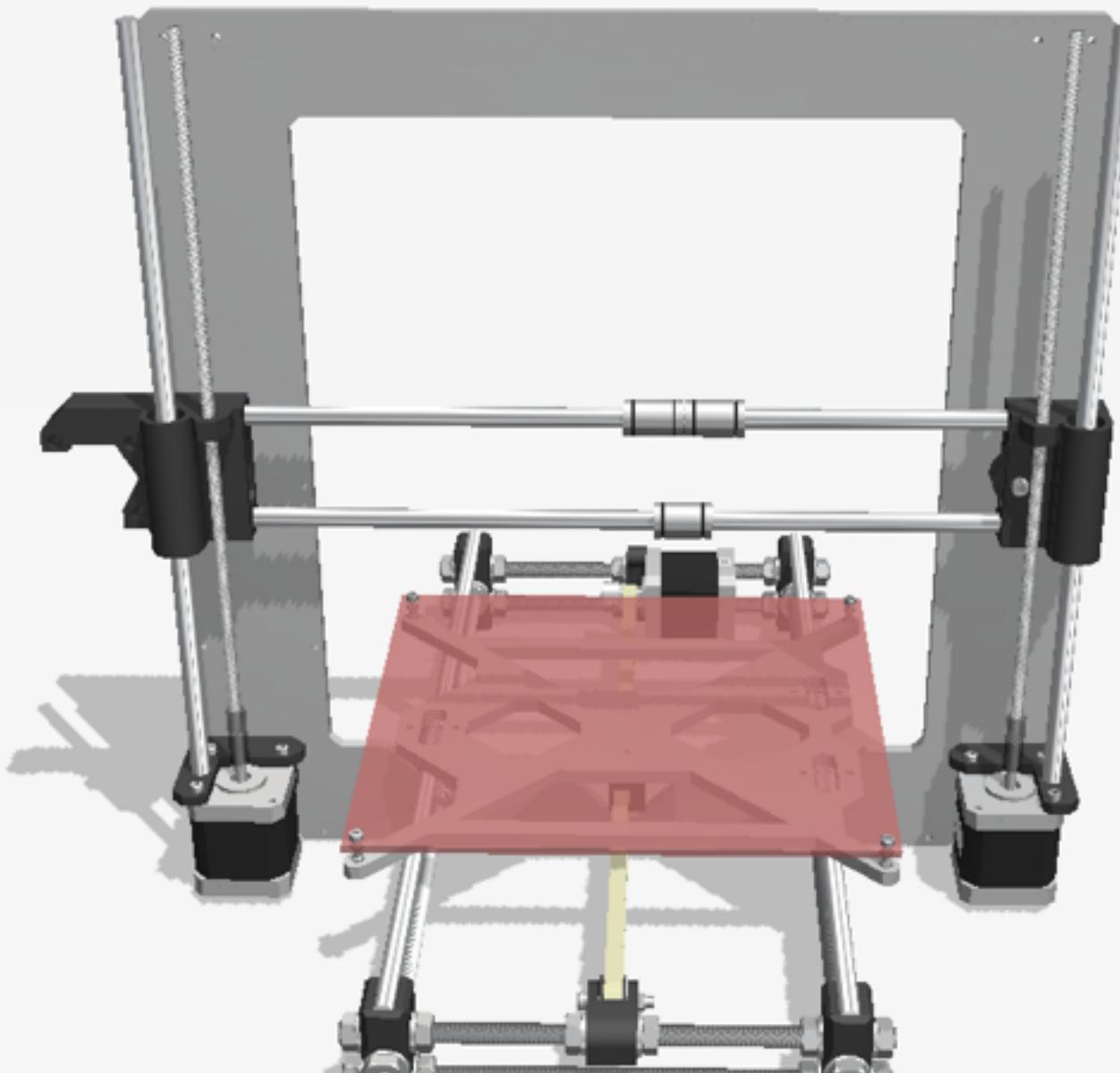
Locate your:

- Z-Axis coupler tubes
  (Clear tubes) - 2

These tubes slide onto the motor shafts.

Step 53: Z-Axis Bottom Mounts

2x
Ø8-320mm

2x
M5-300mm

Locate your:

- M5 threaded rods (2)
- M8 smooth rod (2)

The M5 rods get threaded down into the plastic tubes, and the X-axis assembly gets lowered onto the smooth rods and threaded rods.   You'll need to turn the 5mm threaded shafts to lower the assembly a bit. TRY to keep it level.

Step 54: Z-Axis Bottom Mounts

Locate your:

6" zip ties (8)
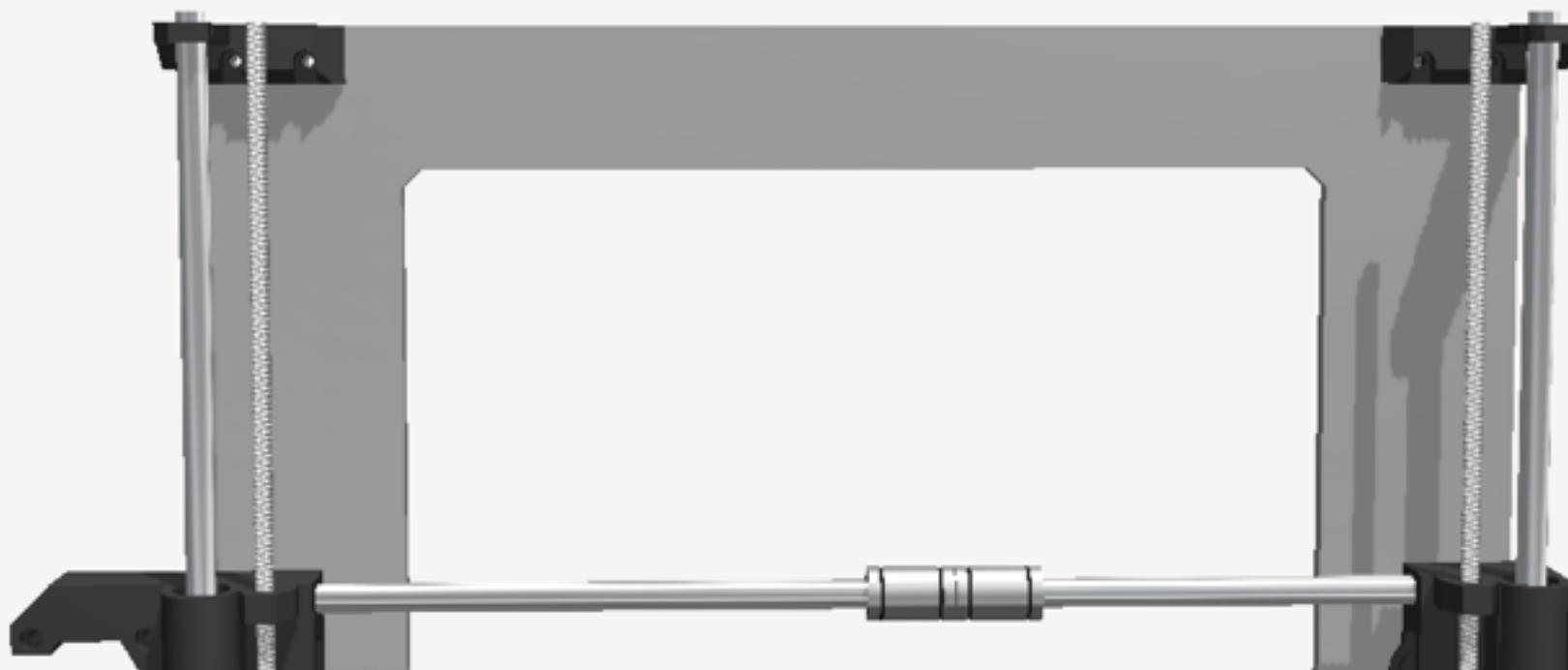
These get zipped around the hose coupler, about 1cm apart.   Make them tight!

You should do 4 on each hose - 2 top and 2 bottom.

Step 55: Z-Axis Top Mounts

Locate your:

- Z-axis top mounts
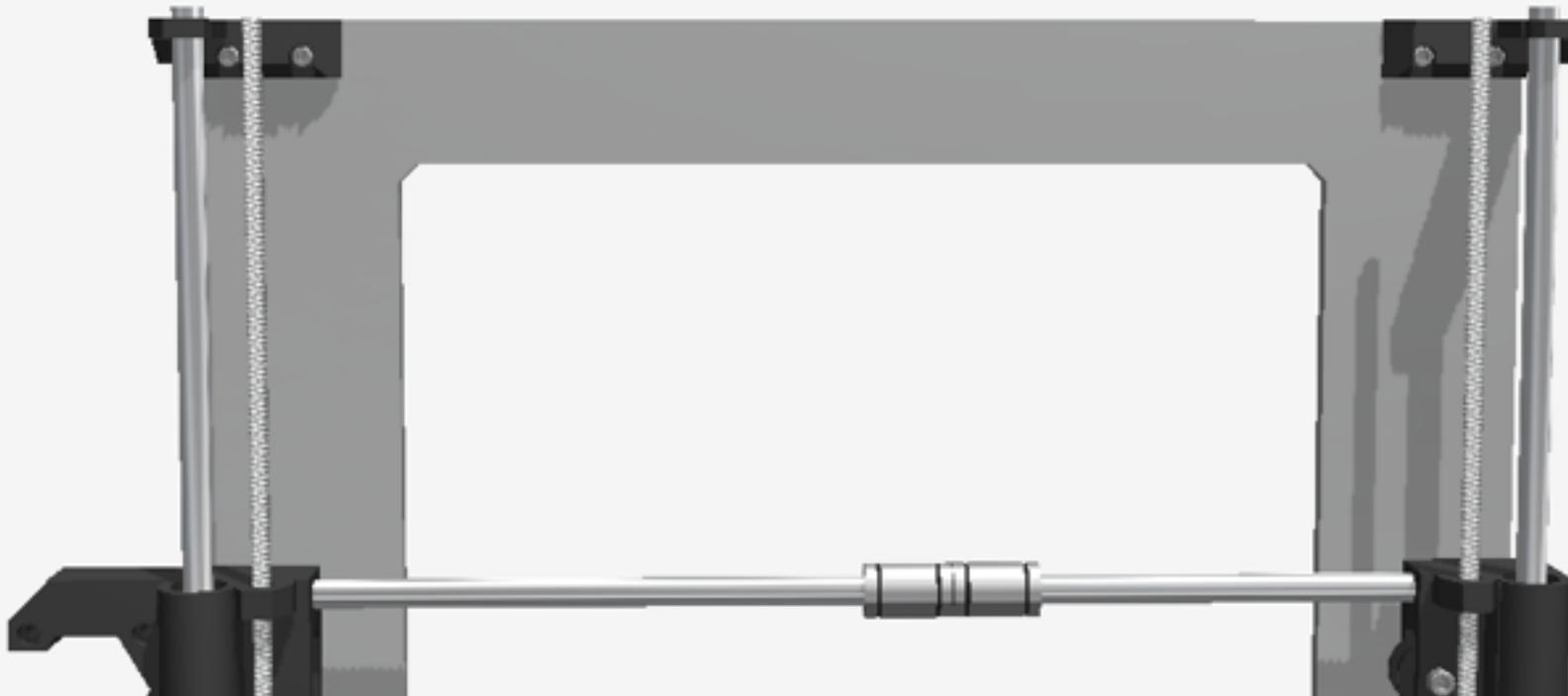
Type to enter text

Step 56: Z-Axis Top Mounts

Locate your:

Type to enter text

- M3x10mm bolts (4)

4x

M3–10mm
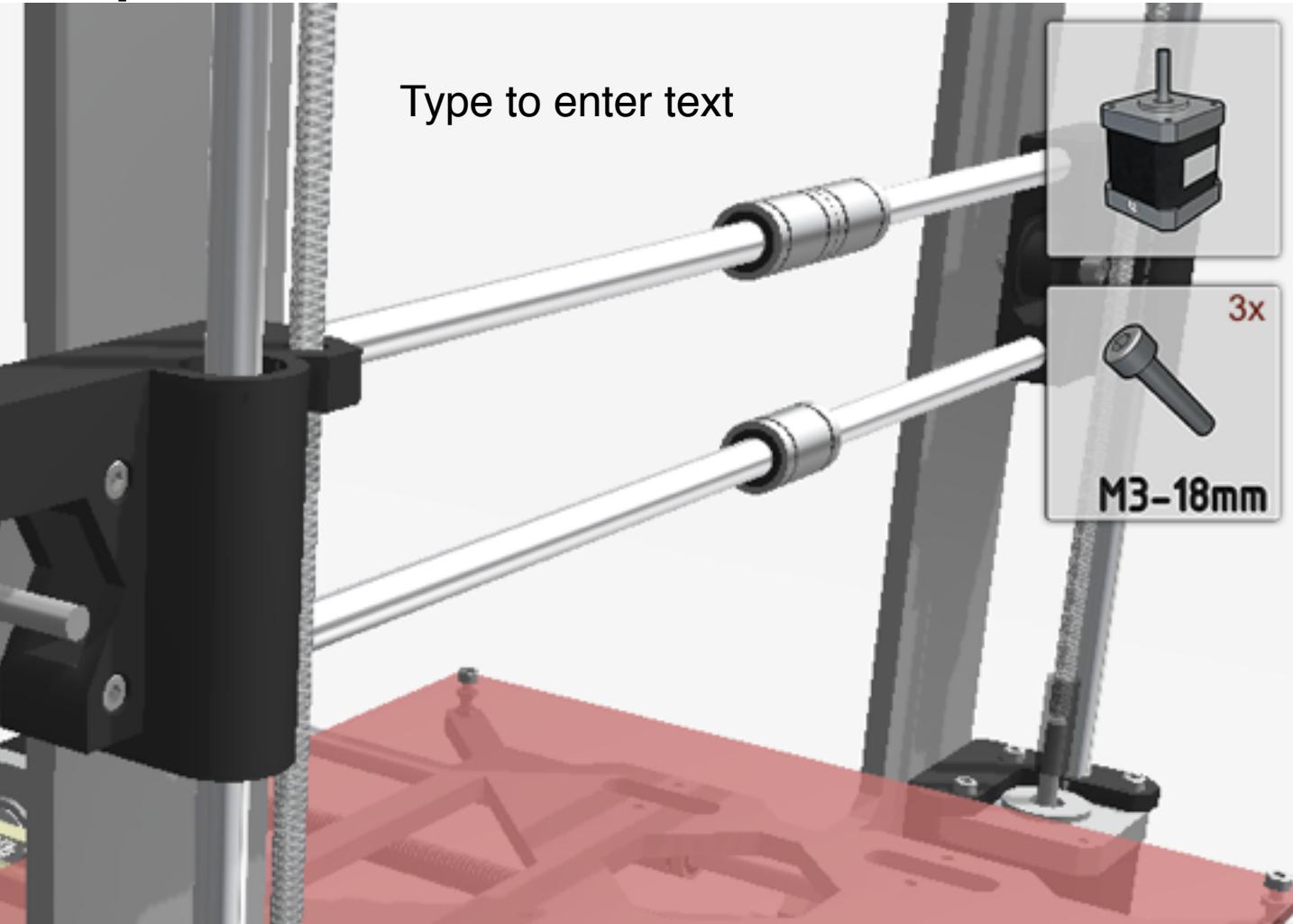
The Z-axis top mounts get bolted to the frame with M3 x 10mm bolts - 2 on each side. You'll need to slide these mounts over the Z-axis smooth rods.

Step 57: X-Axis Start

Locate your:

- Stepper Motor (1)
- M3 x 18mm bolts (3)

Type to enter text

3x

M3–18mm
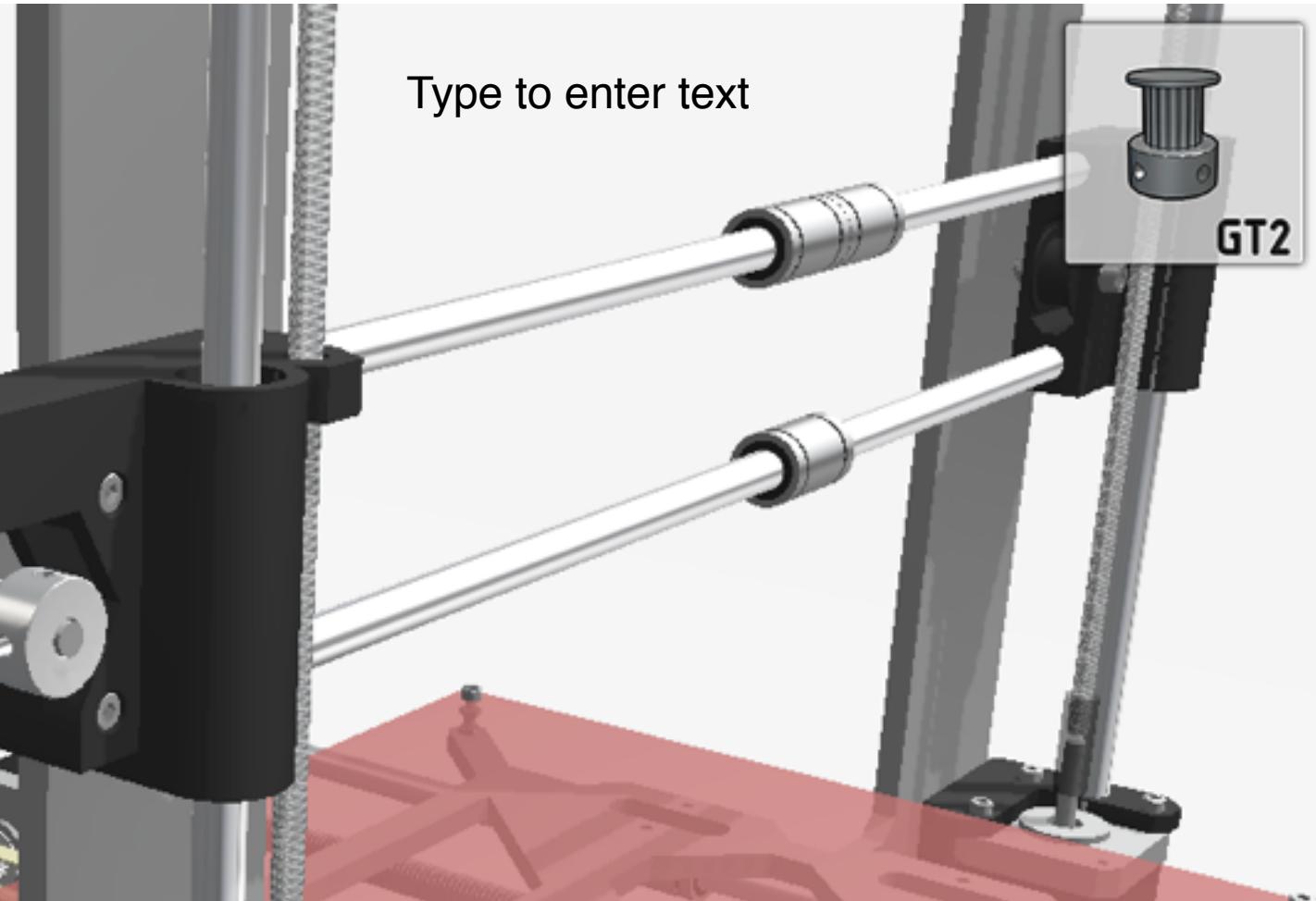
Mount one of the stepper motors to the X-end-motor piece - it uses three of the M3 x 18mm bolts. The wires on the stepper motor should point downward.

Step 58: X-Axis

Locate your:

- Metal GT2 pulley

Type to enter text

GT2
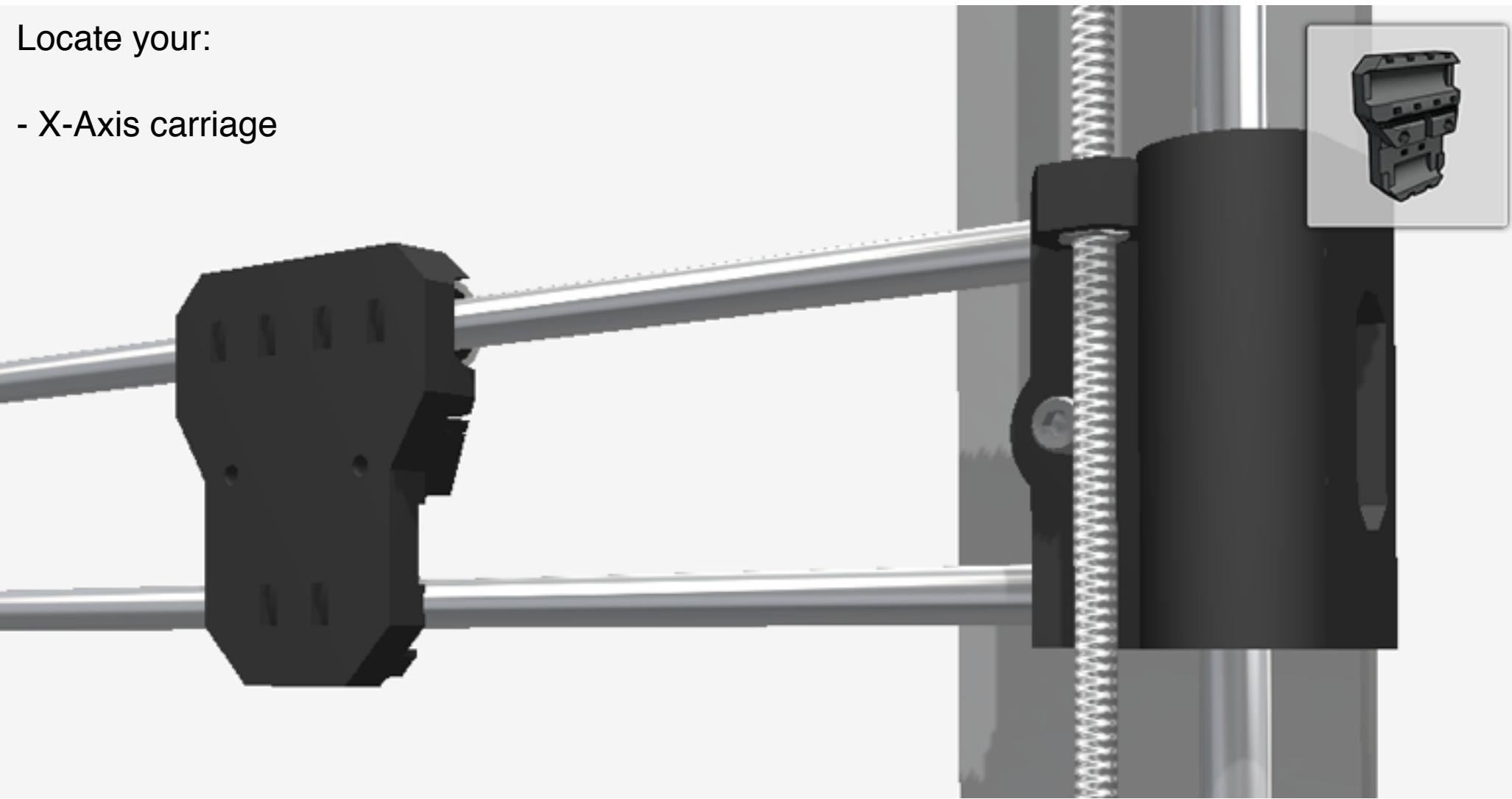
Mount the pulley to the stepper motor.   Make sure at least one of the set screws is on the flats of the motor shaft.   Try to align the geared part of the pulley with the gap in the x-motor-end piece, so we can thread the belt through.

Step 59: X-Axis

Locate your:

- X-Axis carriage
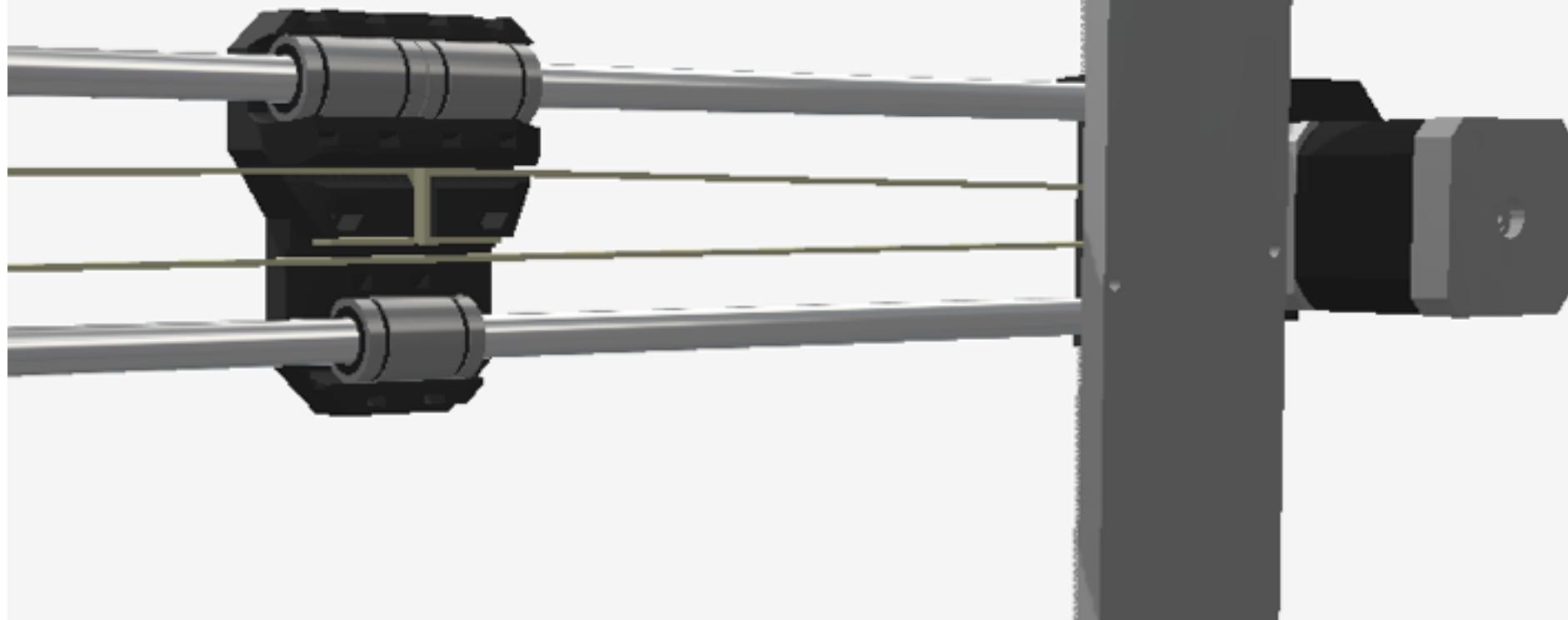
The carriage gets mounted to the three LM8UU bearings with zip ties.   Make sure that the 'knob' part of the zip-ties faces back (i.e. the bearing side, not the flat side).

Step 60: X-Axis Belt

Locate your:

- X-Axis GT2 Belt
 (900mm)
- 4" Zip ties (2)

GT2
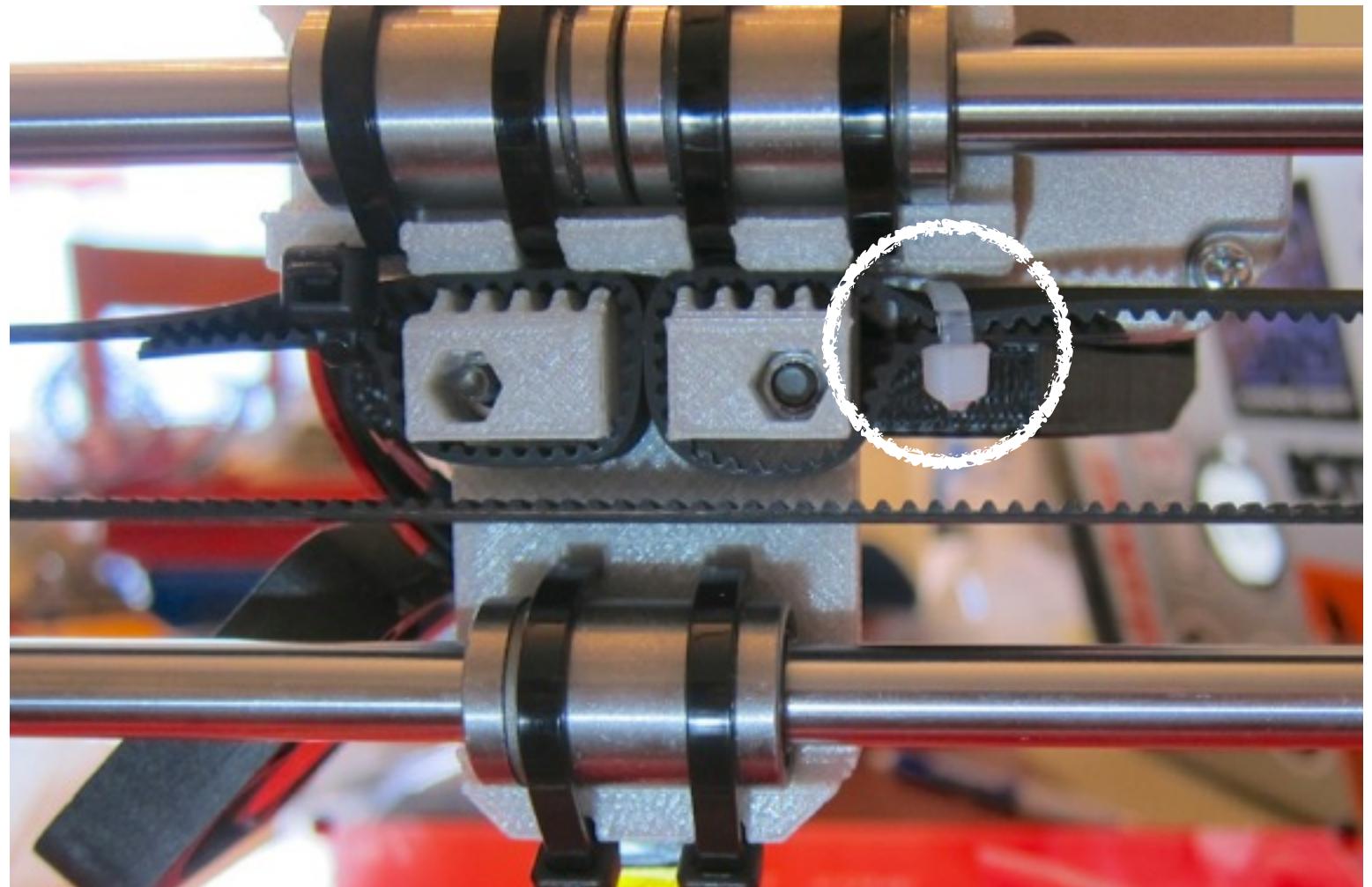
The belt gets installed in the X-carriage via press fit, and then looped around the motor shaft, under the carriage, around the X-idler bearing assembly, and then back to the X-carriage.

It needs to be tight, you'll probably need to pull on it with pliers. We can show you how.

Step 61: X-Axis Belt

Locate your:

- 4" Zip ties (2)
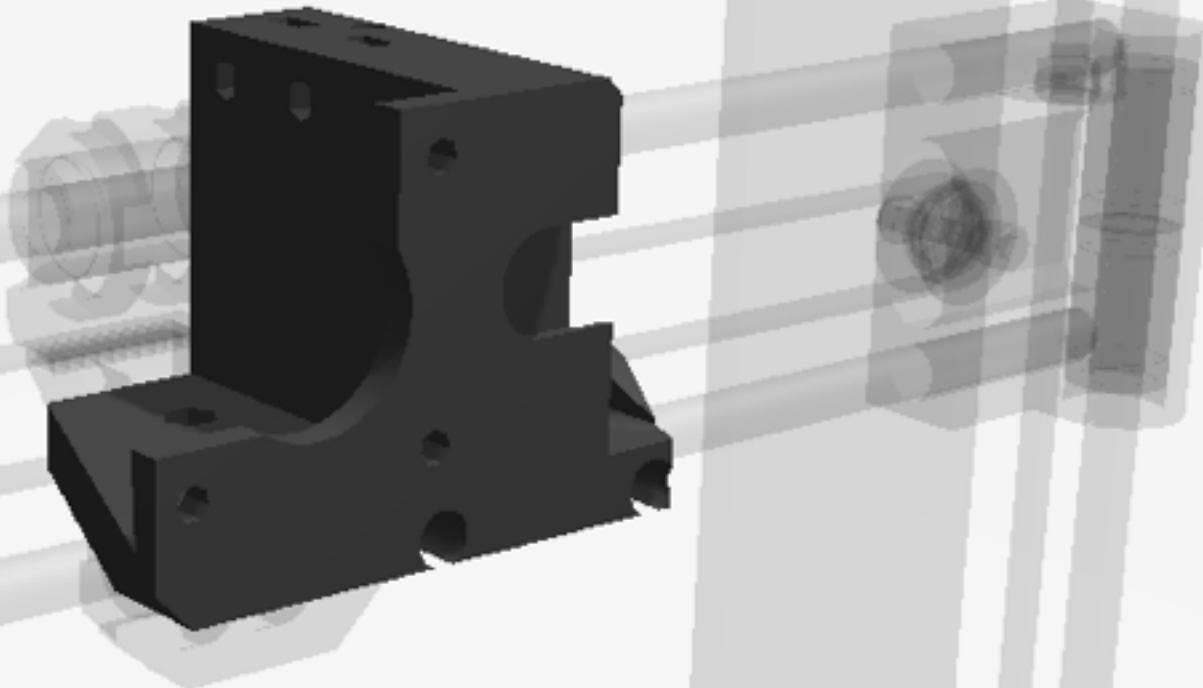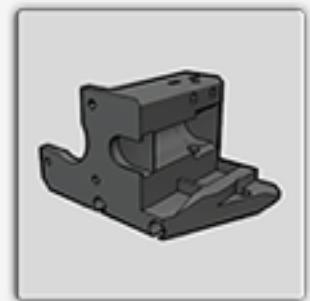
The loose ends of the belt should be zip tied UP to the upper part of the belt.

NOTE: Take note of the white zip tie! The knob has to be facing down like this for clearance later. It's circled.

Step 62: Extruder Main Block

Locate your:

- Extruder Main Block
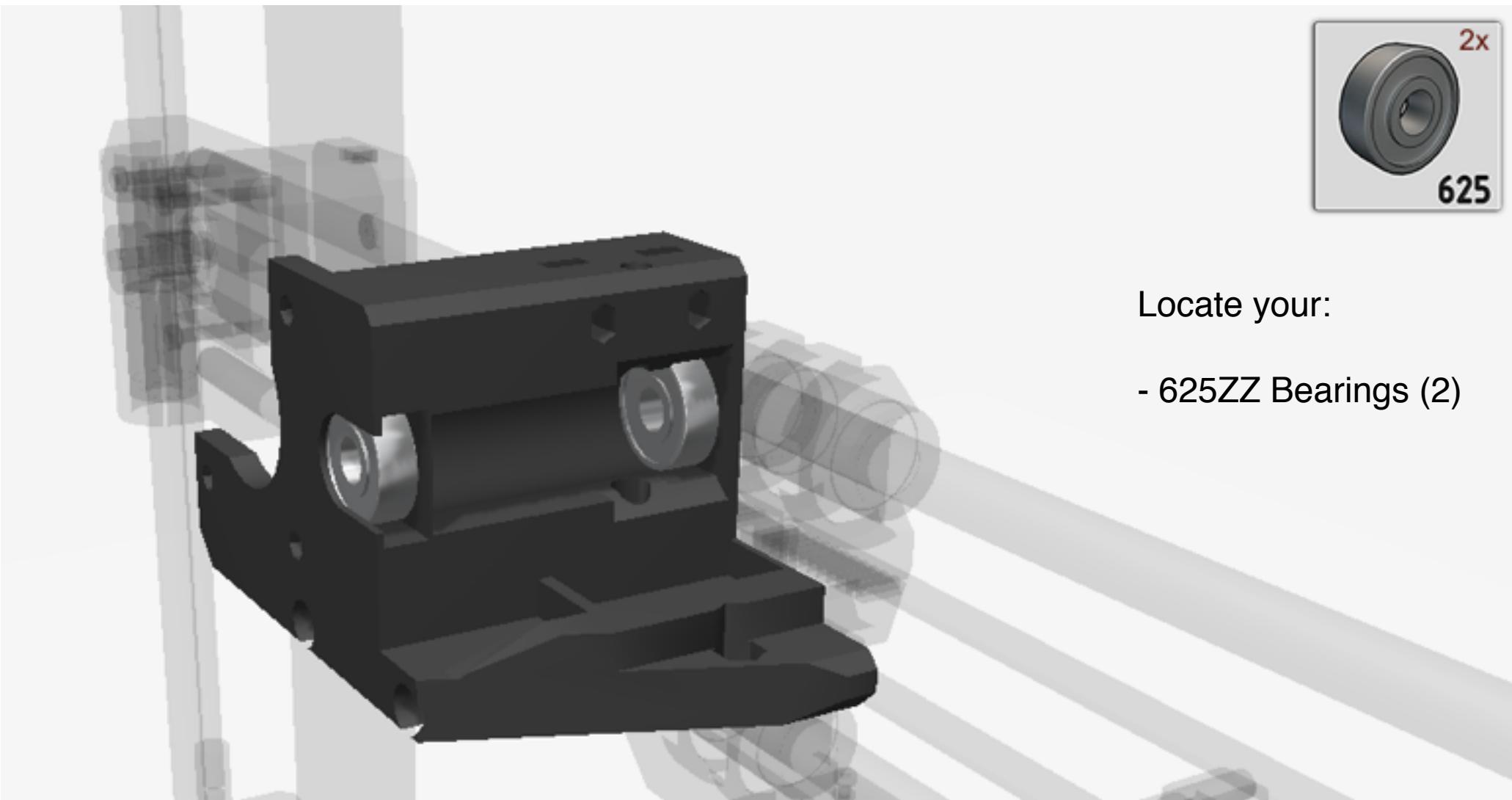
Note: Ours looks slightly different from this, don't panic!   Don't Mount it yet.

Step 63: Extruder Bearings


2x

625
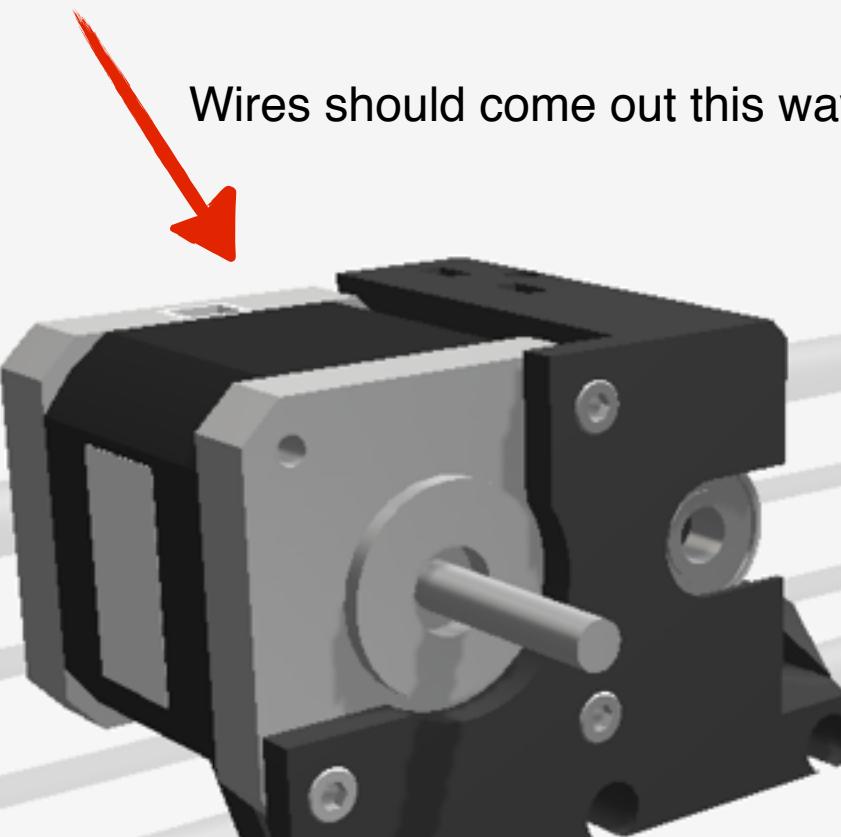
Locate your:

- 625ZZ Bearings (2)
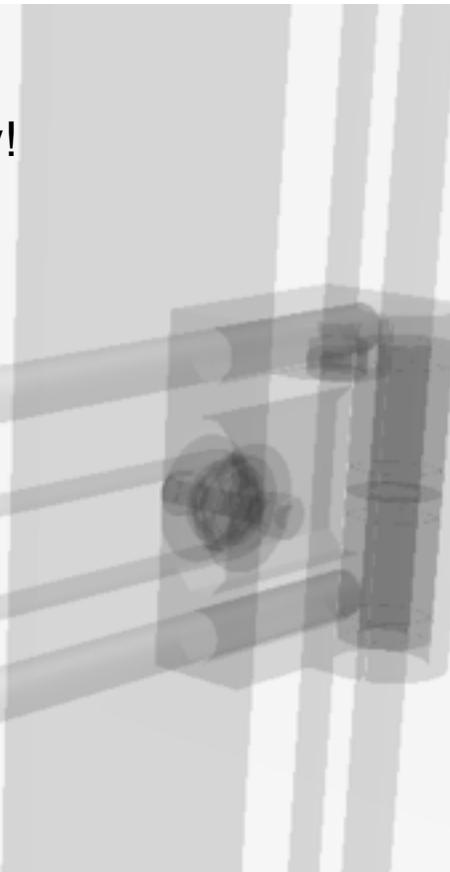
These get pressed into the front and back of the Extruder body - they'll only fit in one place.

Step 64: Extruder Motor

Wires should come out this way!

3x

M3-10mm
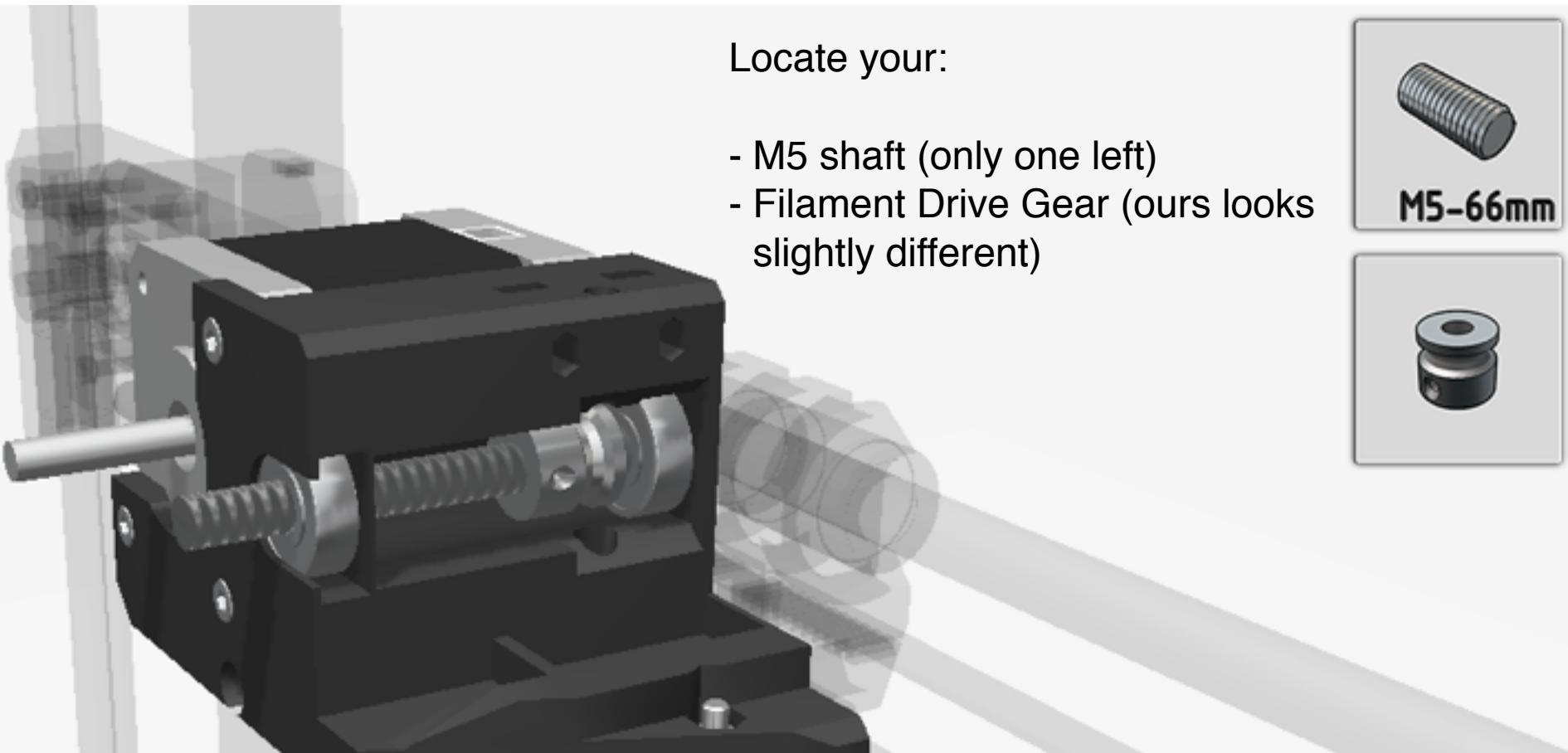
Locate your:

- Stepper Motor
- M3 x 8mm bolts (4)

Our extruder is slightly different - use 4 of the M3 x 8mm.

The motor bolts to the piece as shown with the 8mm bolts. Make sure the wires are exiting the top of the motor (see arrow)

Step 65: Extruder Drive Shaft
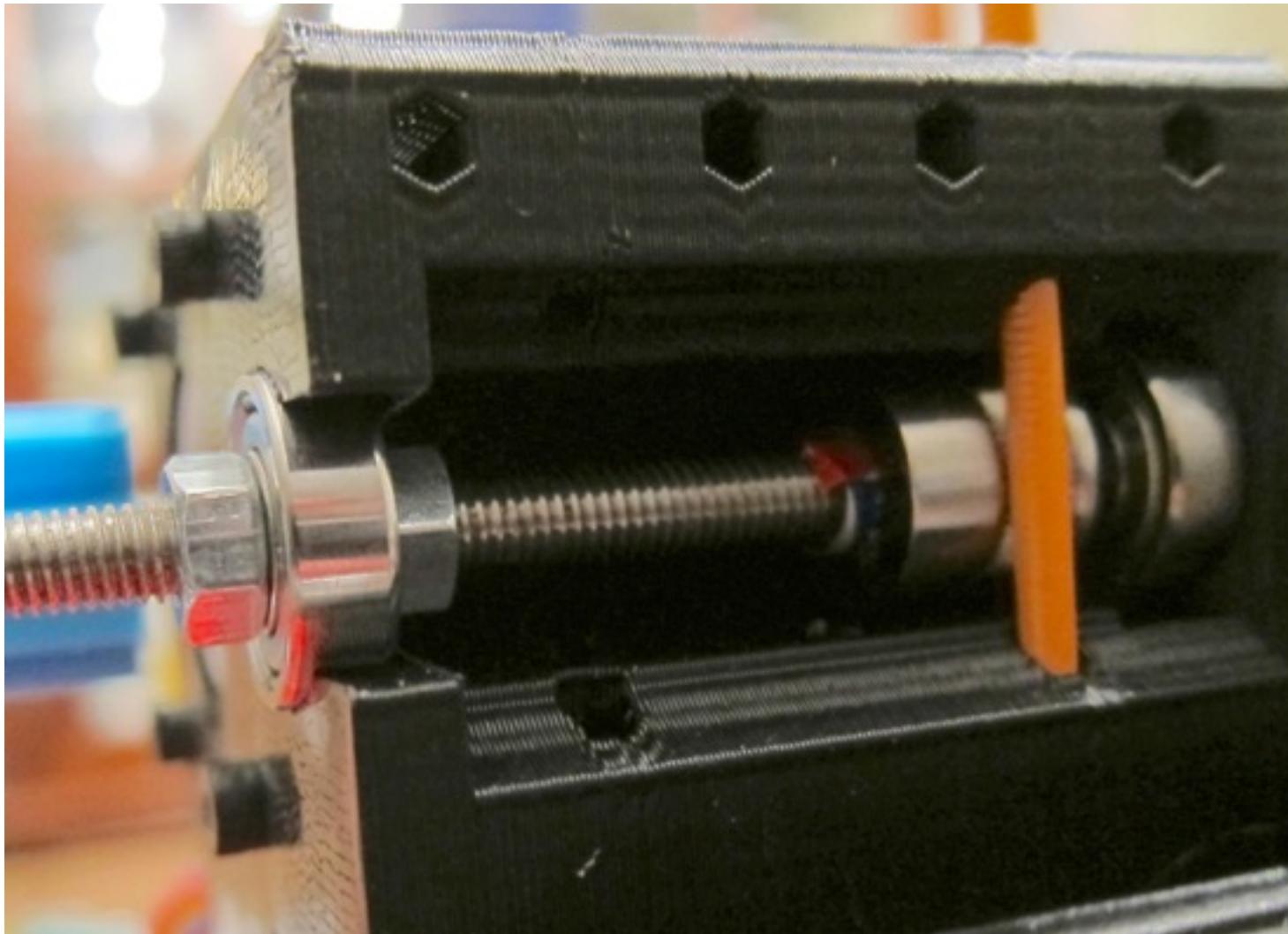
Locate your:

- M5 shaft (only one left)
- Filament Drive Gear (ours looks slightly different)

M5-66mm

NOTE: Before proceeding, read below and look at the next page! It'll help.

The shaft goes through the first bearing, and then needs to have the filament drive pulley mounted to it. Slide it over loosely, and push the shaft into the rear bearing.   Once the shaft is pressed into place, align the valley of the pulley with the filament feed hole directly below it. We need the hole to be directly in the center of the toothed valley in the drive gear. Once it's centered, tighten (but don't go crazy) the set screw on the drive pulley.

# Step 66: Extruder Drive Shaft
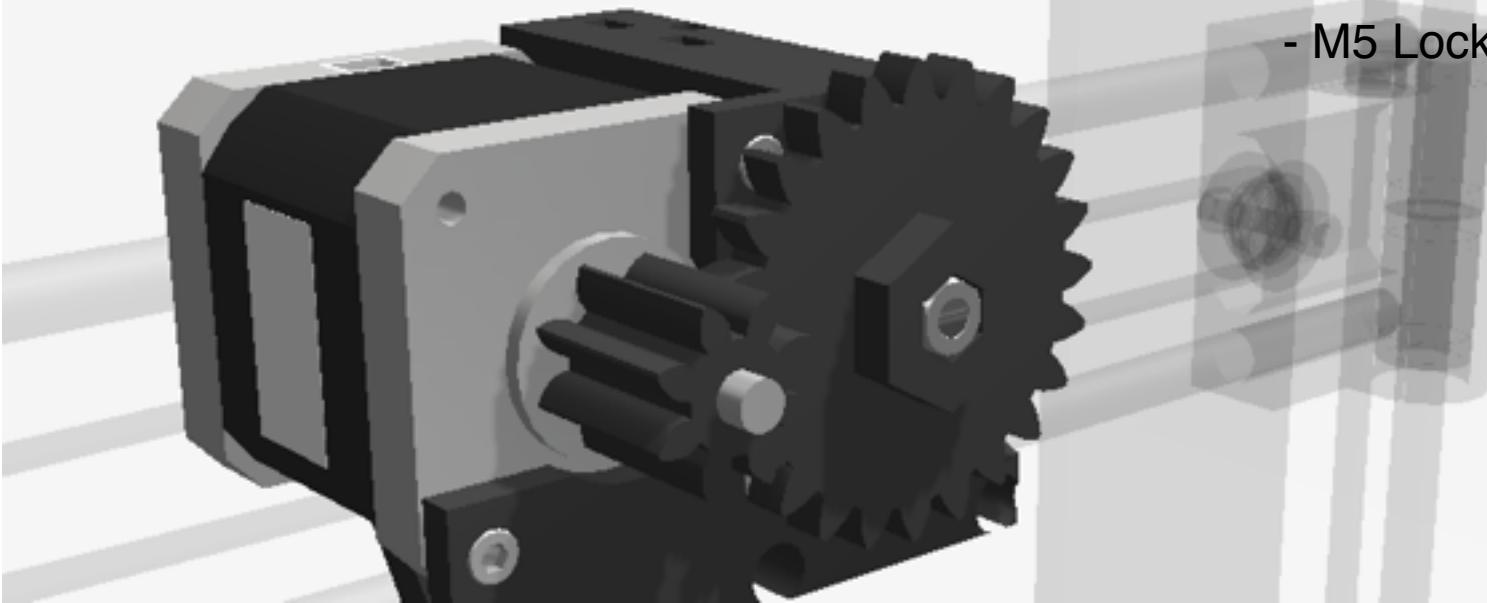
We want it to be: M5 Nut -> Bearing -> M5 Nut > Drive Gear -> Bearing

The outermost nuts need to be tightened against each other.

Step 67: Extruder Drive Gears

Locate your:

- Printed extruder gears:
- Large
- Small
- M5 Lock Nut

M5

The drive gear we're using needs to have an M3 nut pushed into the slot, and then the gear is pressed onto the extruder shaft.   Our small gear doesn't look like what's in the the diagram.

You'll need an M3 x 8mm bolt to hold the small gear to the shaft. Make sure the bolt lines up with the flat on the shaft.

The large gear gets bolted onto the end of the driveshaft with an M5 nylon nut.

Step 68: Extruder Idler

Locate your:

- Printed extruder idler block
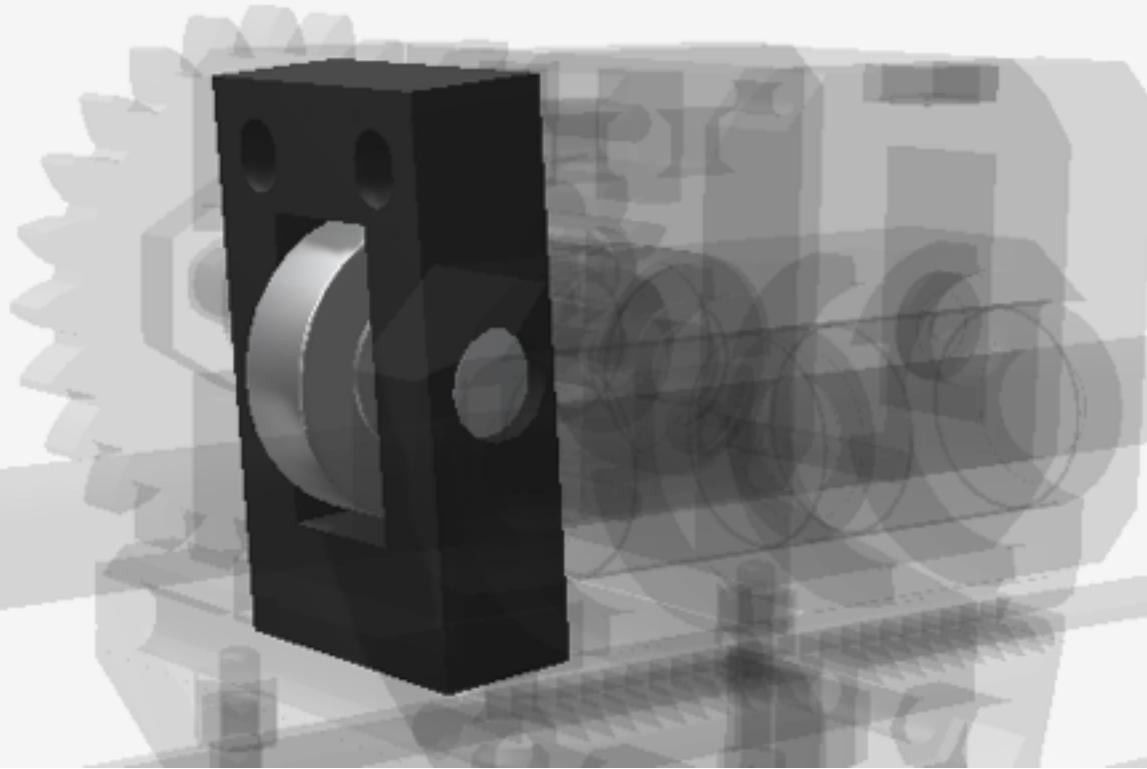

Got it? Next step!

Step 69: Extruder Idler
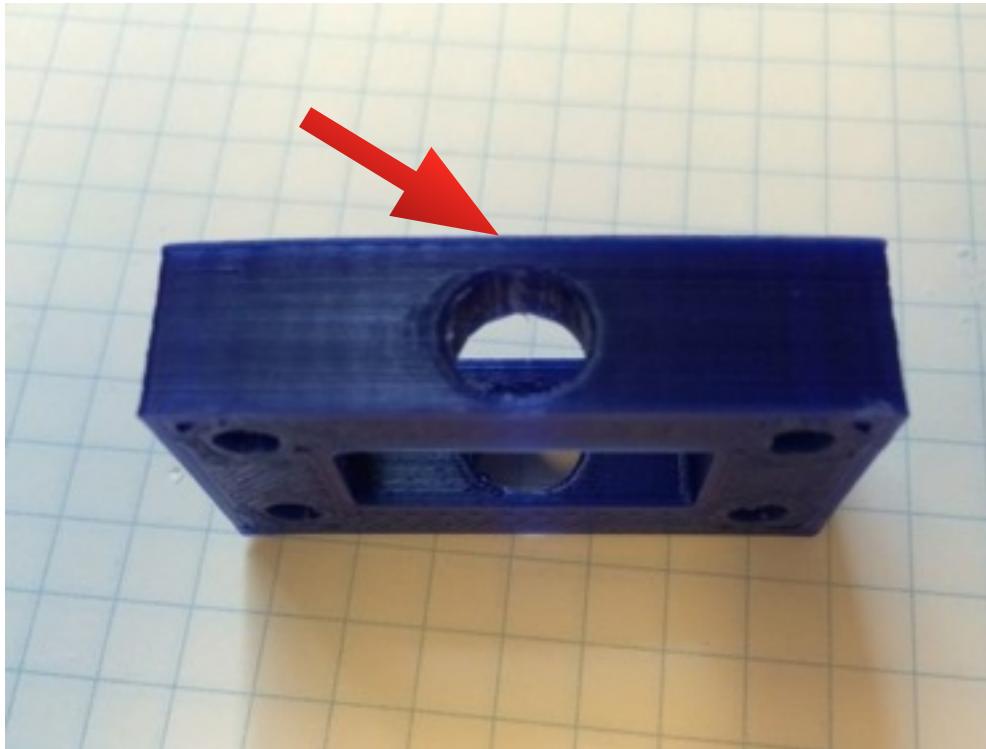
Locate your:

- 608 bearing
- 8mm smooth rod (short)

608

The smooth rod acts as the axle for the bearing, and should be pressed into the idler block with the bearing on the shaft.

Step 70: Extruder Idler
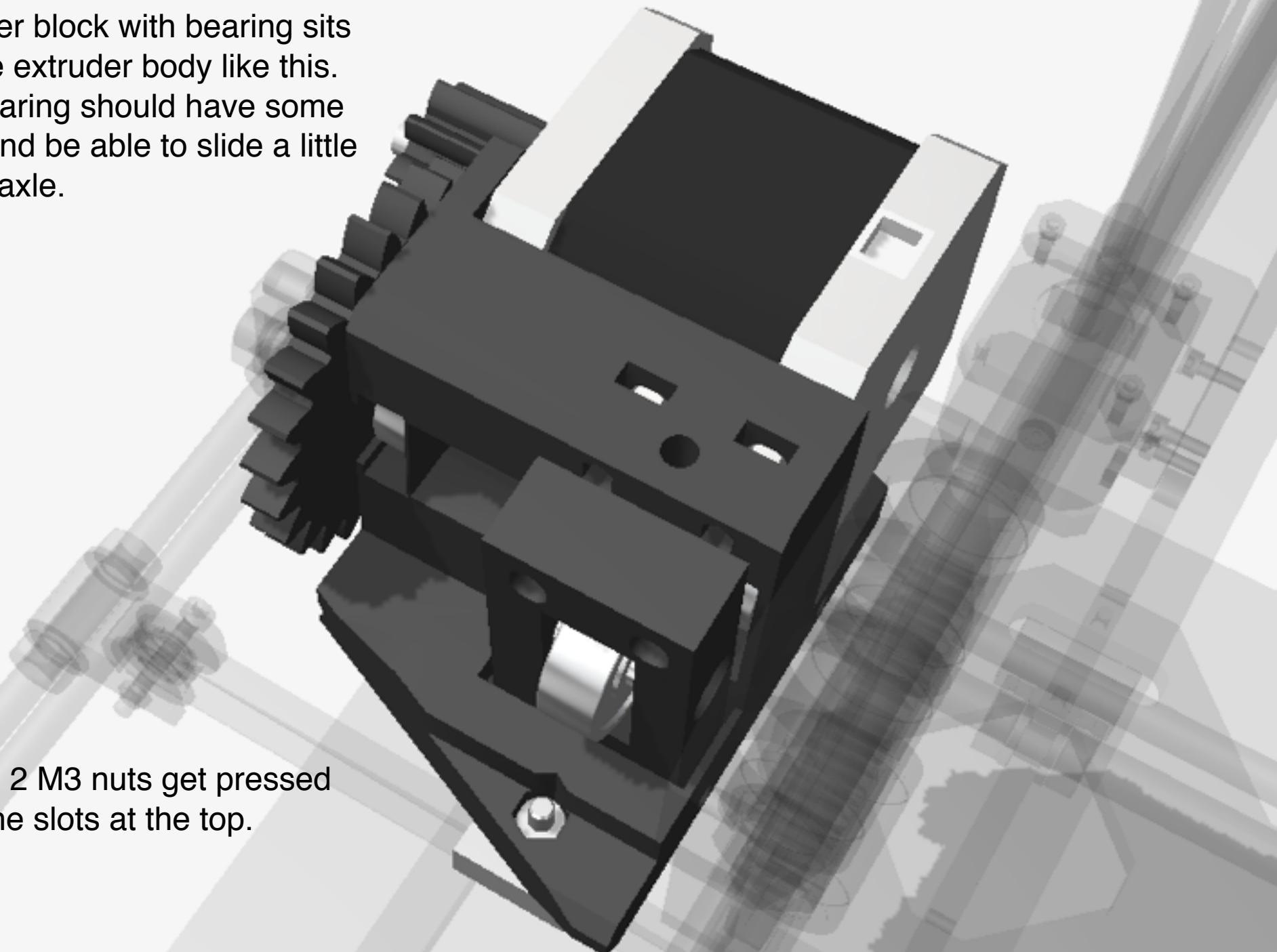
Note:

The idler block hole is not centered! One side of the hole has more material next to the hole versus the other side.

When installing it in the next steps, the 'fat' side of the block goes on the outside, away from the stepper motor.
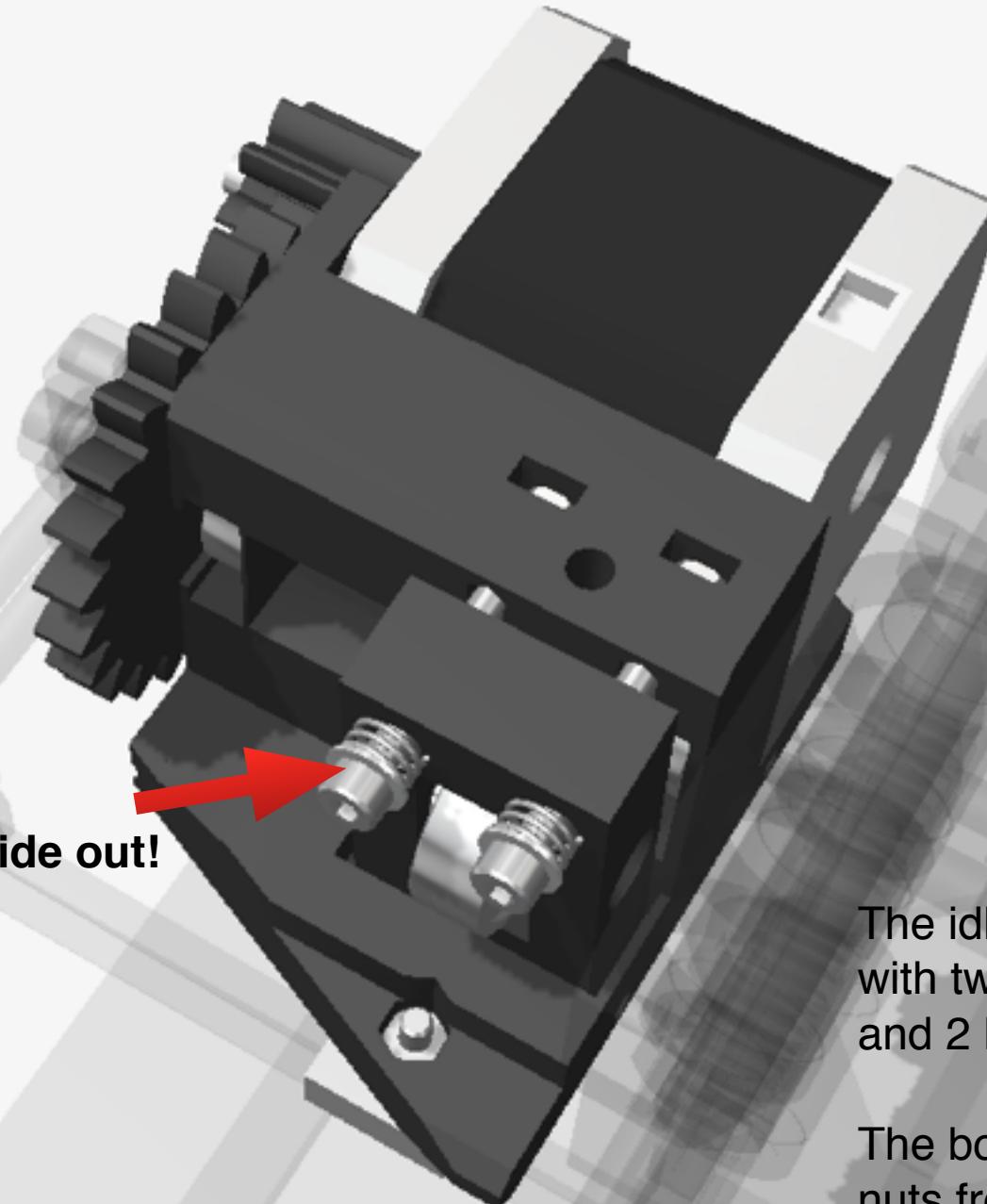
Step 71: Extruder Idler

The idler block with bearing sits into the extruder body like this. The bearing should have some 'float' and be able to slide a little on the axle.

Also - 2 M3 nuts get pressed into the slots at the top.

Step 72: Extruder Idler

Fat side out!

2x M3

2x

2x M3-40mm

The idler block is fastened at the top with two M3 x 40m bolts, 2 springs, and 2 M3 washers.

The bolts should screw into the M3 nuts from the previous step.

Step 73: Hotend Mounting
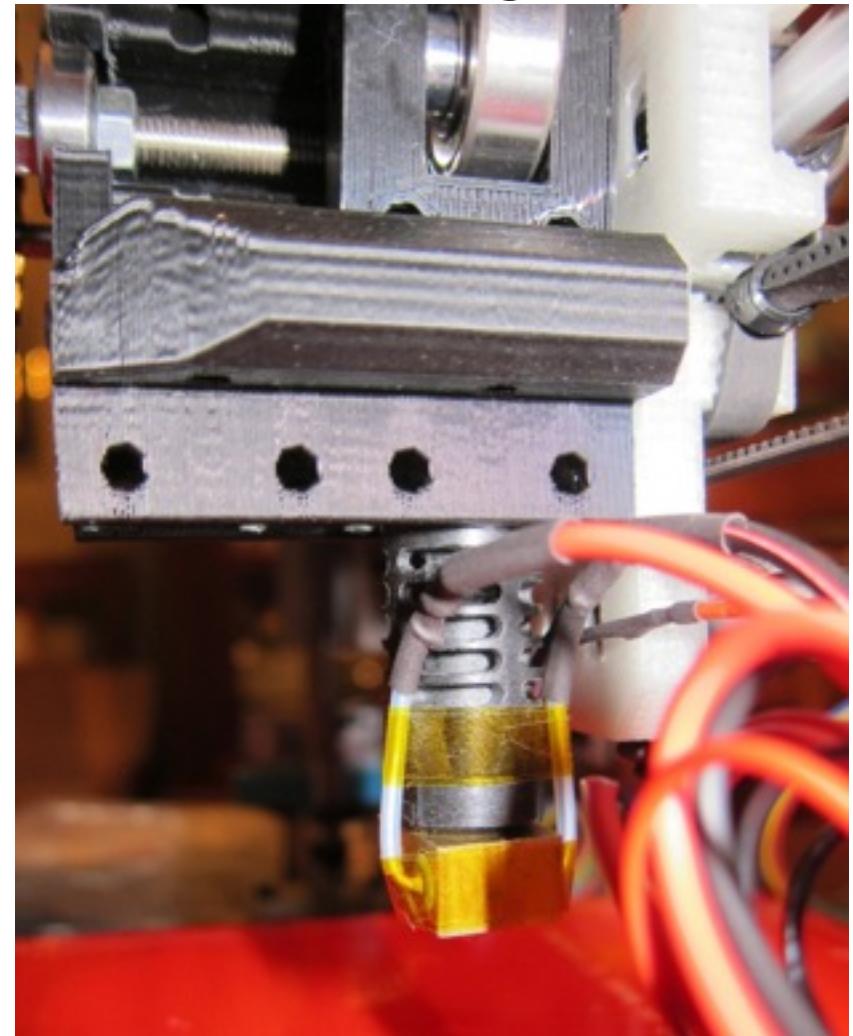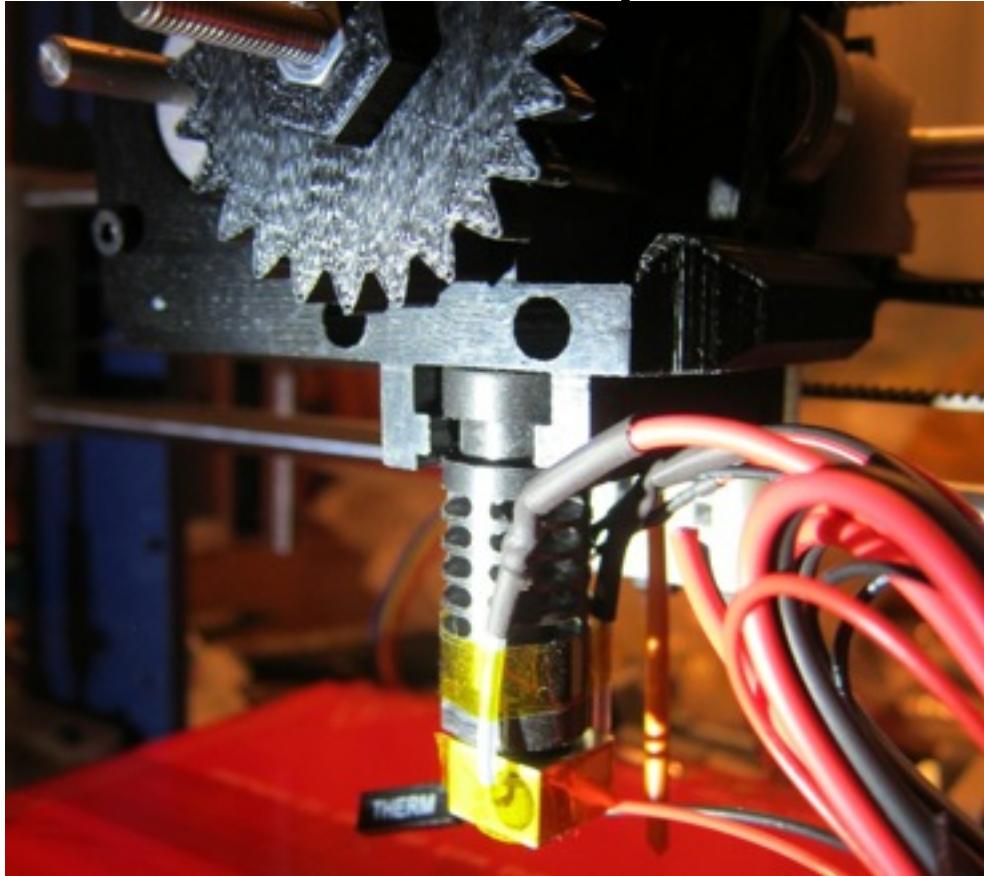
Locate Your:
- Hotend Assembly (1)

- The hot-end assembly is a heater barrel, a heater block, a resistor and a thermistor.

- The soldering has been done ahead of time, there are 2 sets of wires coming from the assembly.

# Step 74: Hotend Mounting
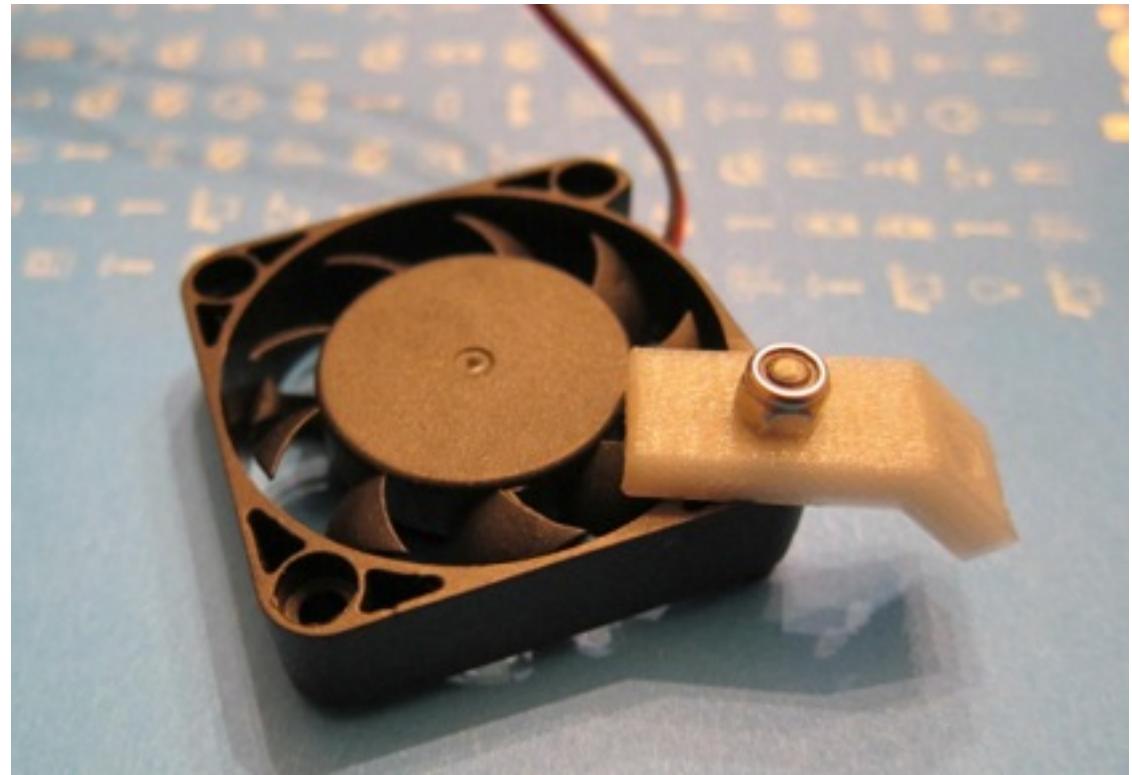
Locate Your:
- M3 x 30mm bolts (2)
- M3 nuts (2)

- The assembly slides into the track on the bottom of the extruder body. Keep the wires going to your right (away from the stepper motor) - you may have to flex them slightly to clear the extruder chassis.   The hotend should slide to the rear position, between the two bolt holes.   Secure with two 30mm bolts and nuts.

Step 75: HOTEND FAN

Locate Your:
- M3 x 18mm bolt (1)
- M3 x 16mm bolt (1)
- M3 locking nut (2)
- Fan Mount
- Fan
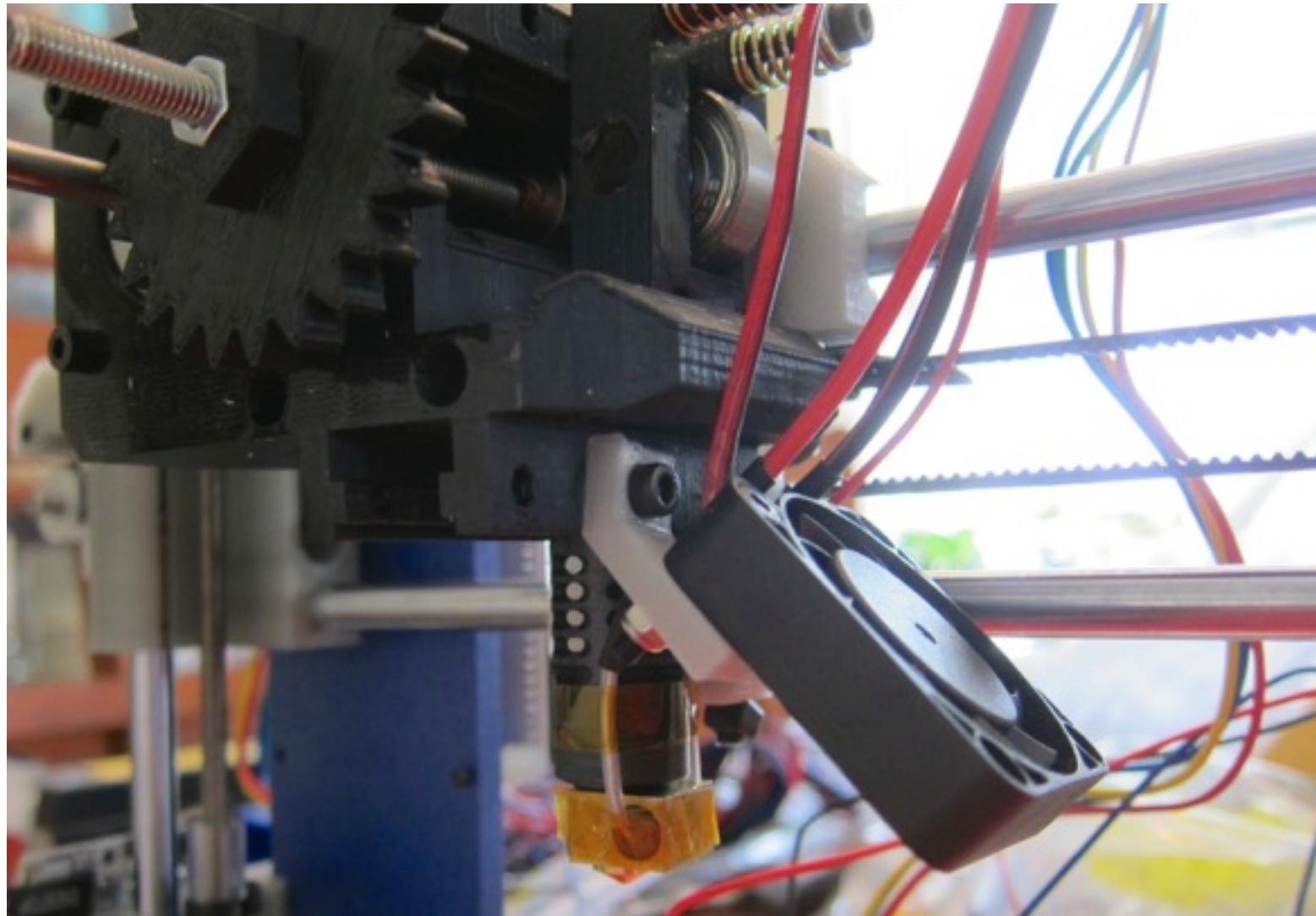
- Type to enter text

The fan bolts to the bracket with an M3 x 18mm bolt.   The fan bolts to the long side of the fan bracket.

NOTE: The sticker on the fan should be facing up in this photo.   Make sure you get it right!

# Step 76: HOTEND FAN
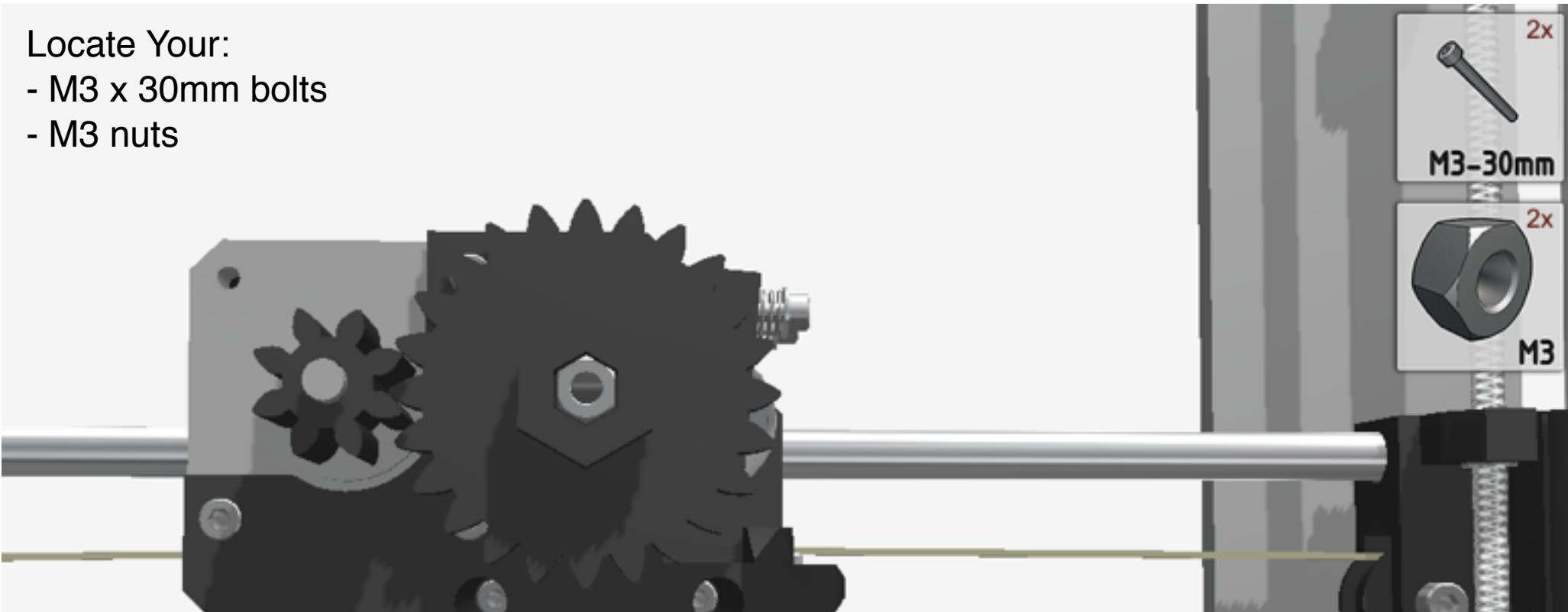
The fan bracket bolts to the Extruder body using an M3 x 16mm bolt, and a locking nut.   See photo for mount details.

Step 77: Extruder Mounting
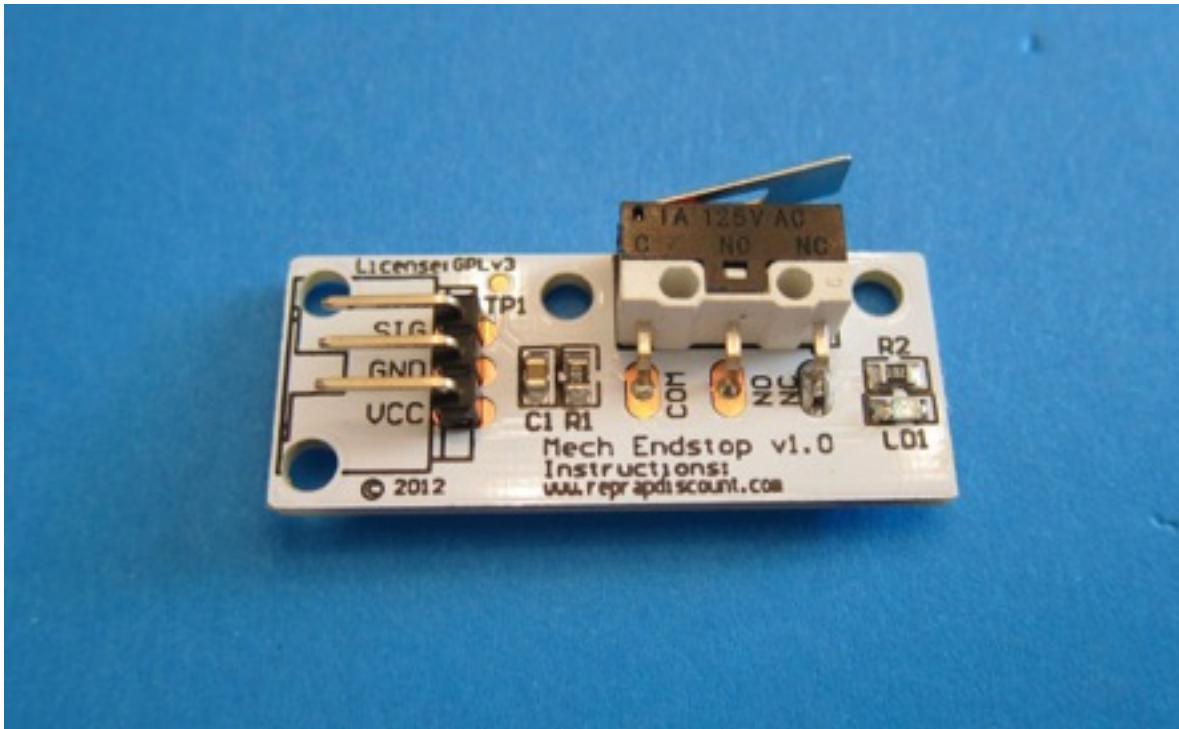
Locate Your:
- M3 x 30mm bolts
- M3 nuts

2x

M3-30mm

2x

M3

- The completed extruder will now bolt to the X-carriage piece using 2 of the M3 x 30mm bolts, and two of the M3 nuts that press into the X-carriage.

Type to enter text
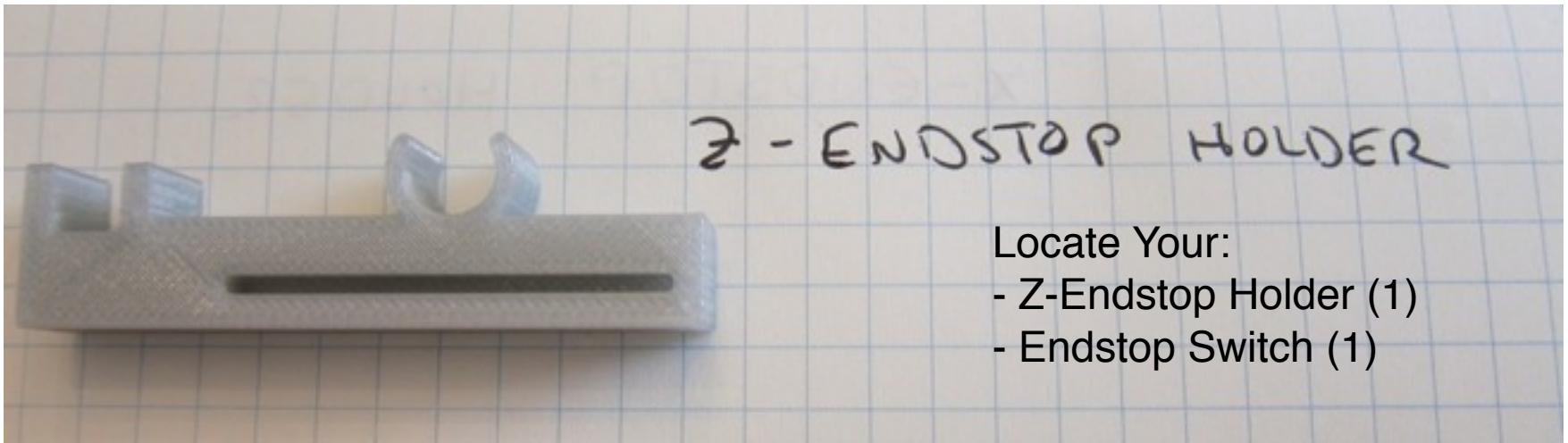
Step 78: Endstop Switches

Locate Your:
- Endstop Switches (3)
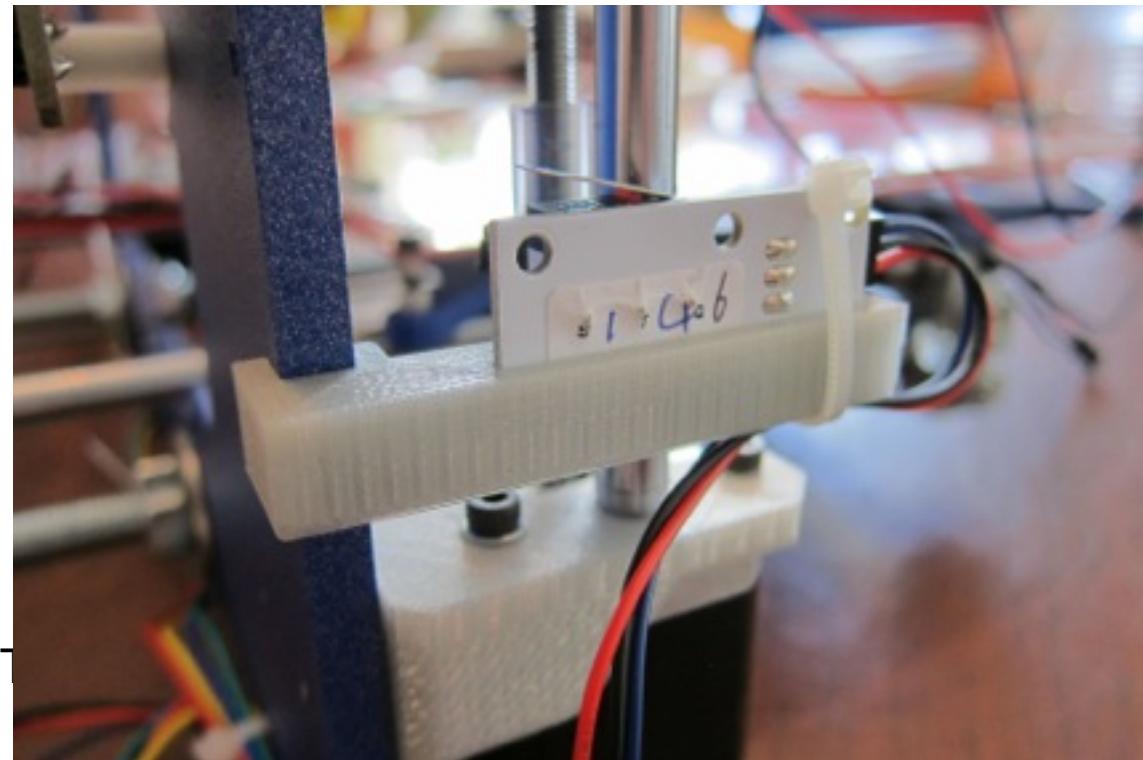
- These will press-fit into the printed holders on the next few steps. Be careful pressing them in.

Type to enter text

Step 79: Z-Endstop

Z-ENDSTOP HOLDER

Locate Your:
- Z-Endstop Holder (1)
- Endstop Switch (1)

- The switch side needs to face toward the circular and square clips.
- The endstop-holder gets snapped onto the black frame and the Z-axis smooth rod on the left side of the machine.
- You should zip tie a loop in the wires as shown.
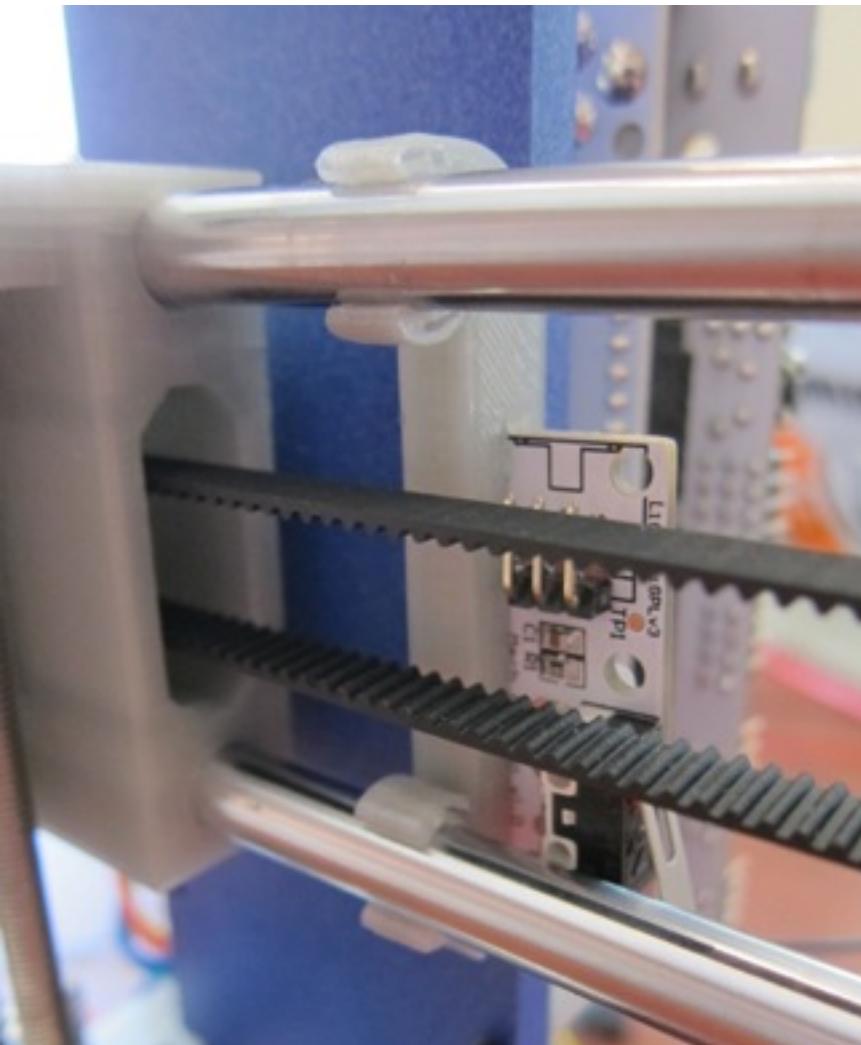
Note: Put this a few inches above the z-stepper motors for now, we'll adjust it downward later.

Step 80: X-Endstop
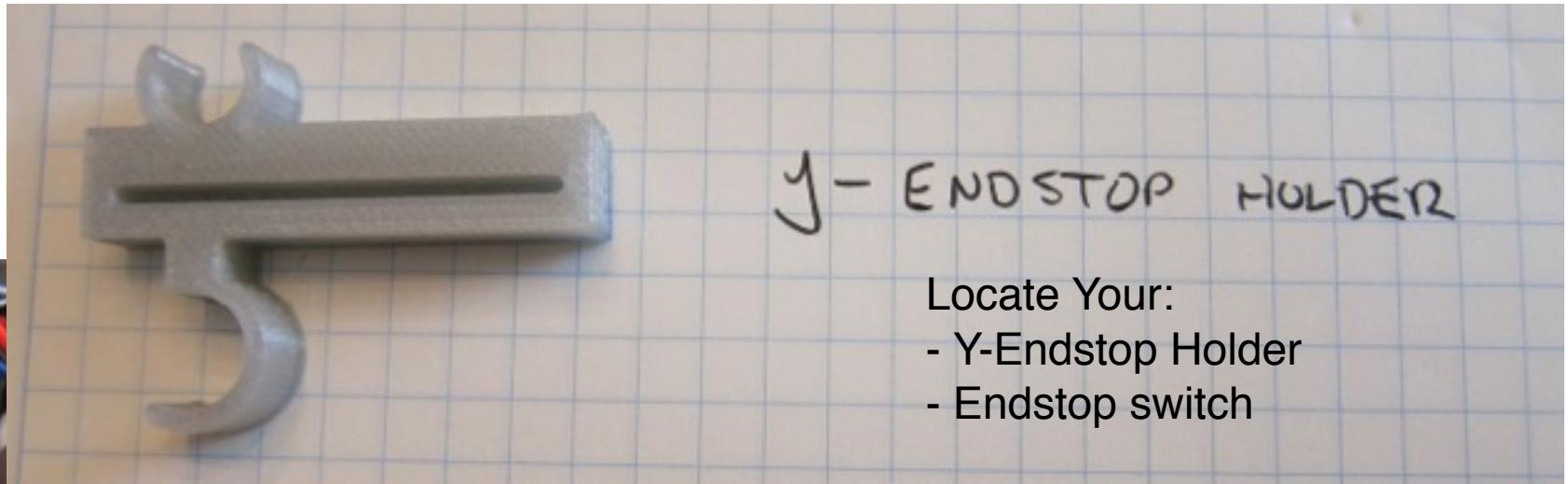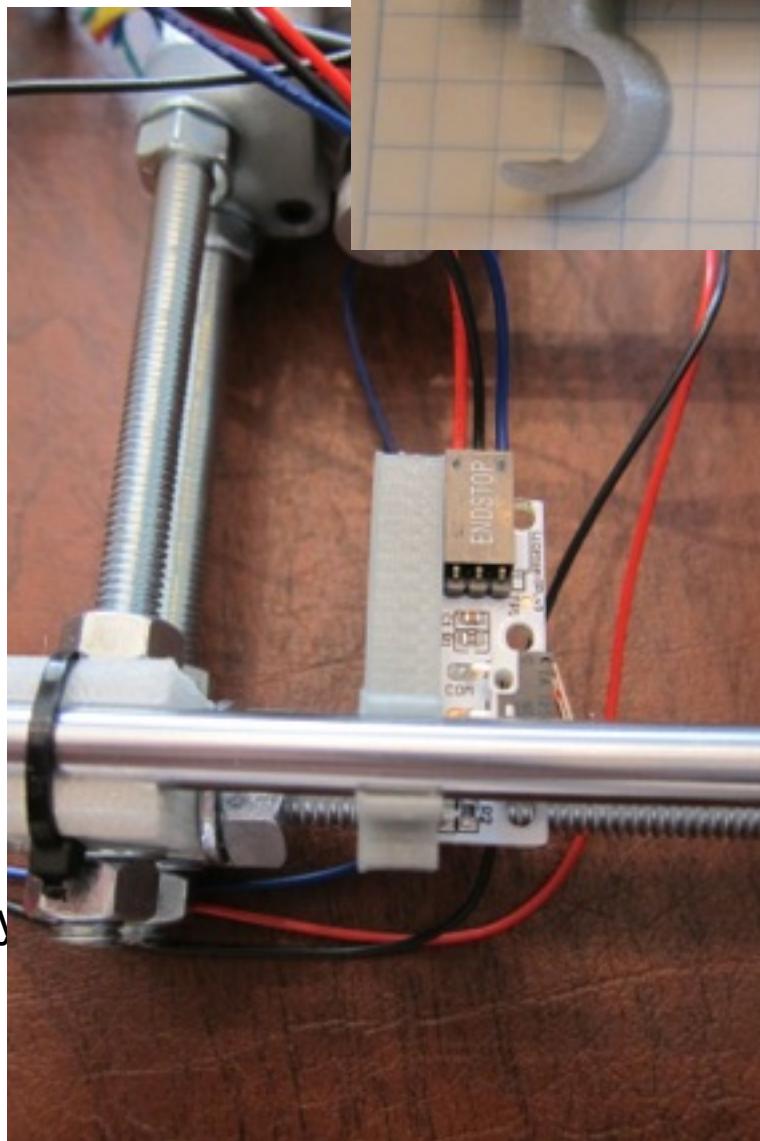
Locate Your:
- X-Endstop Holder
- Endstop Switch

X-ENDSTOP   HOLDER

- The endstop switch needs to face the round clips on this part.
- The assembled switch and holder clips to the BACK side of the X-axis smooth rods, on the left-hand side.   See photo.

Step 81: Y-Endstop

J - ENDSTOP HOLDER

Locate Your:
- Y-Endstop Holder
- Endstop switch

- The endstop switch slides into the holder and faces up in the photo above - the switch gear and electronics should face the small round clip, not the longer one.
- This assembled part clips between the Y-axis smooth and threaded rod in the rear corner. See our demo machine or the photo for details.
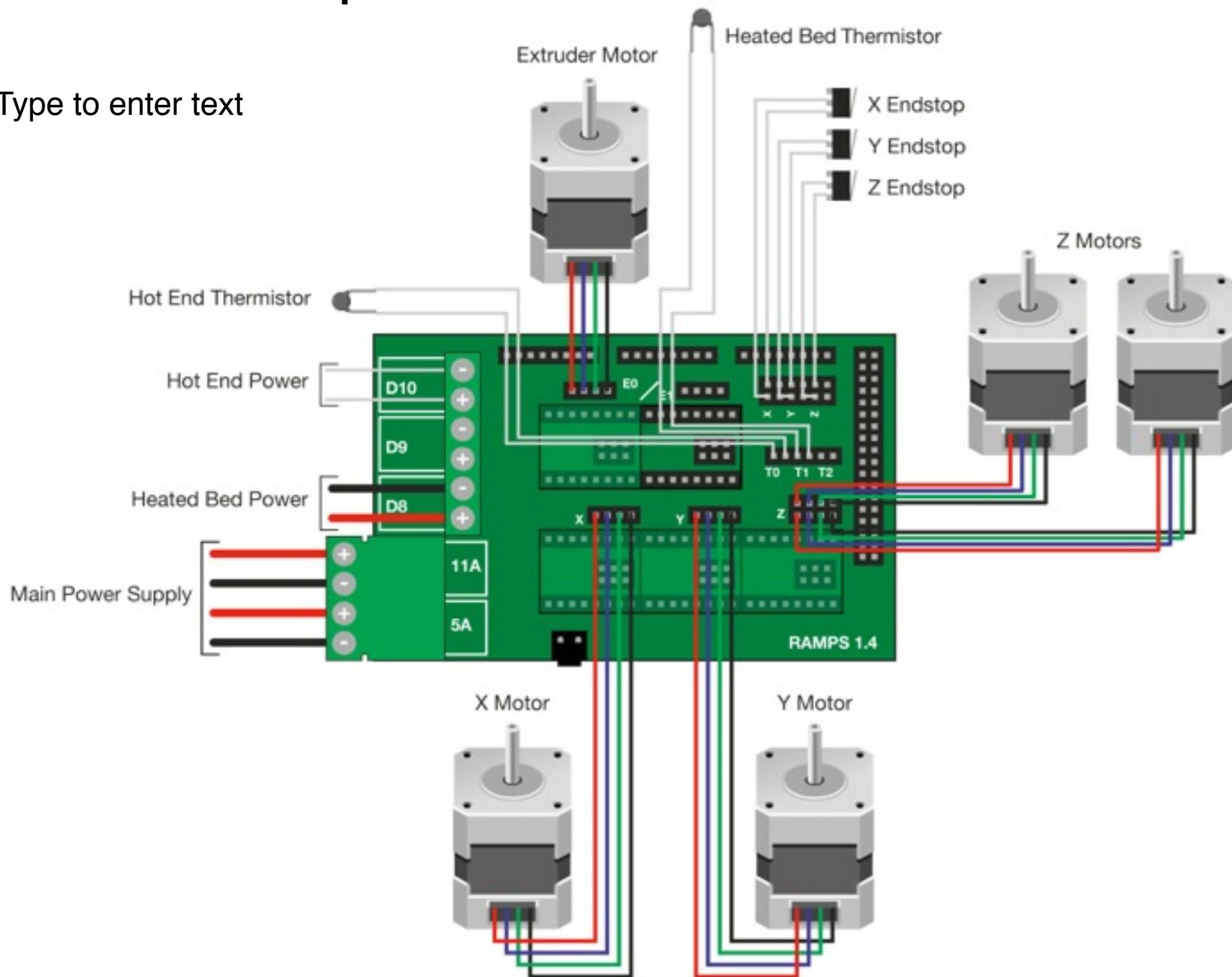
Step 82: Congratulate Yourself

- Locate Your:
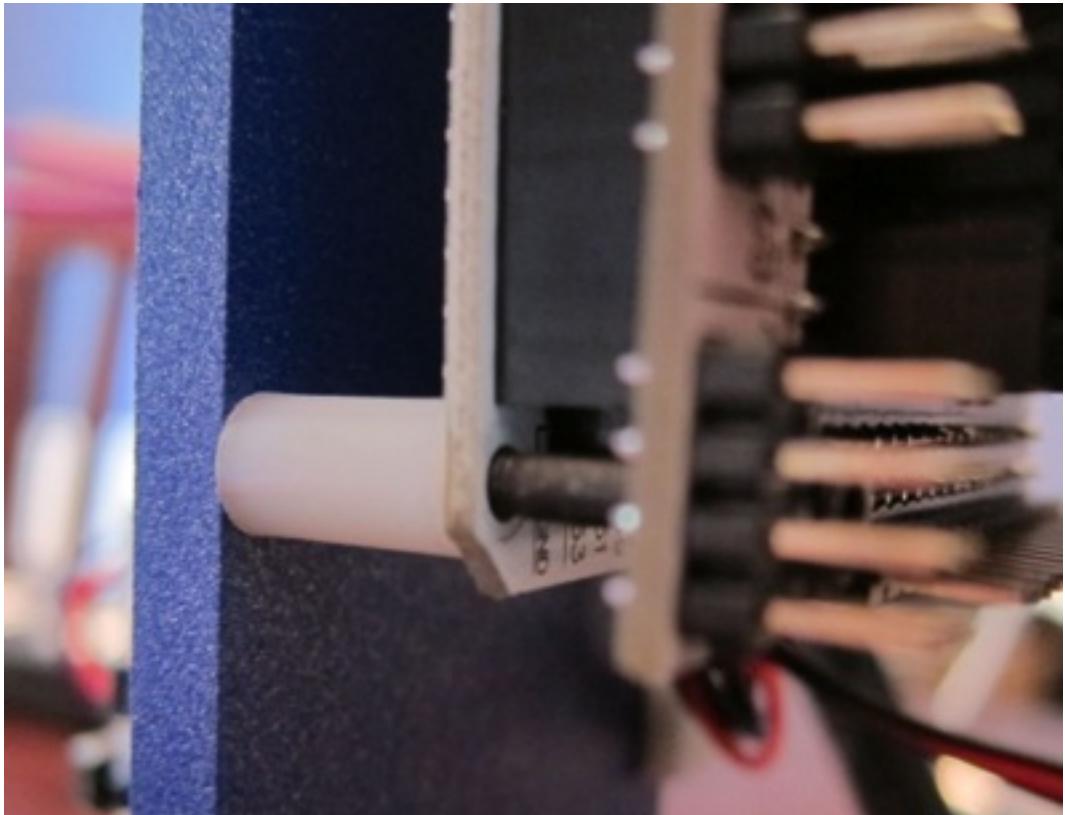
Recently completed mechanical printer! All of the main build is now done, just time for wiring!

Step 83: Electronics Overview

Type to enter text

Step 84: Mount RAMPS to Frame

We mount the RAMPS assembly to the frame with 2 M3x30mm bolts and 2 of the white nylon spacers.

For now just use one bolt in each diagonal corner, as shown.   Don't go crazy on the bolts.

The power terminals and USB port are going to face UP.

Step 85: PSU Wiring
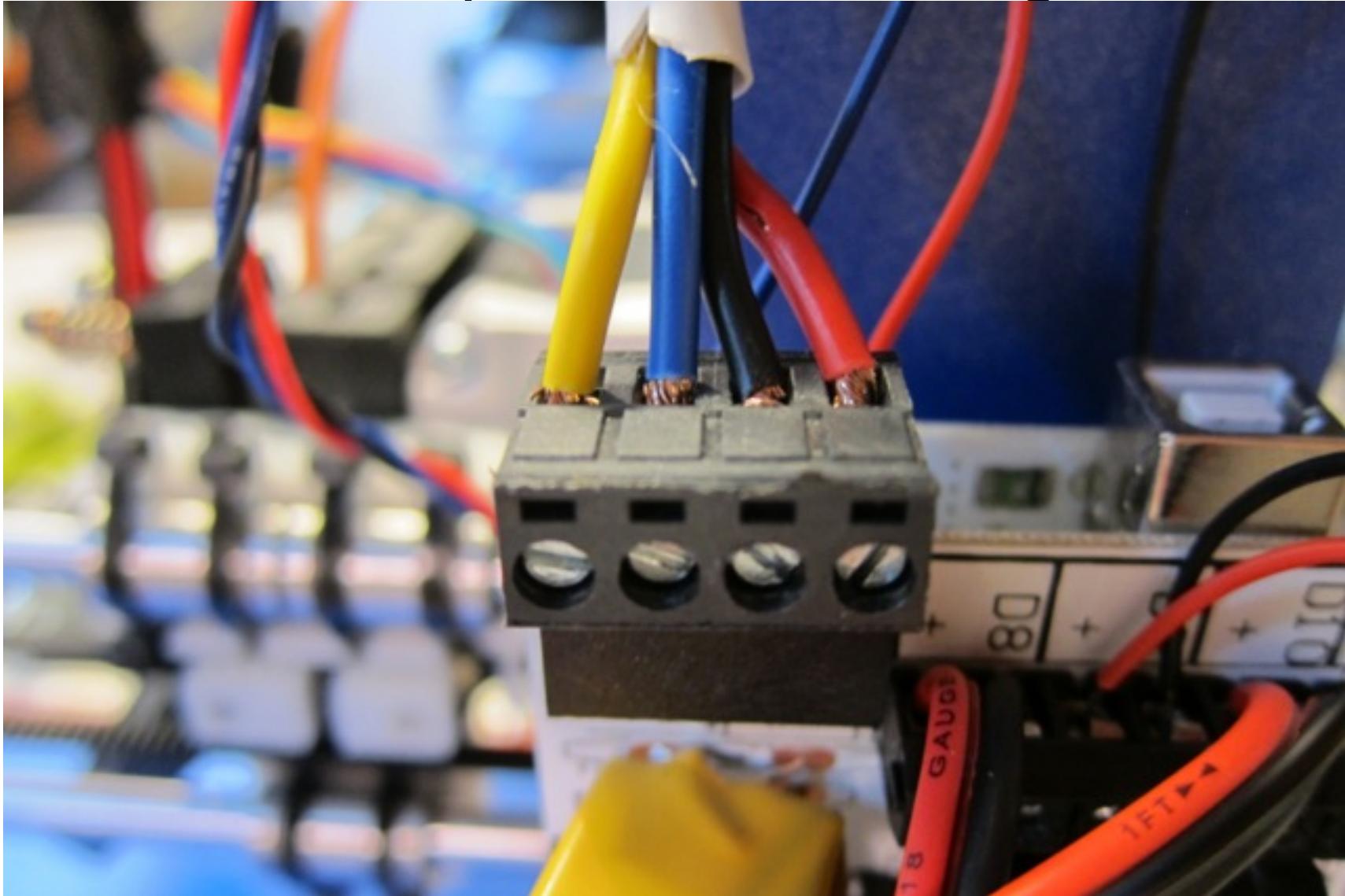
The power supply gets 2 sets of wires - 3 from the black power cord, and a 4 conductor wire (white sheath) that goes to the RAMPS.   Wire them in like shown.

(in case this is b&w - white 4 conductor cable: red, blue, yellow, black   -   and black 3 conductor cable: green, white, black)

If your power supply looks different, let us know and we can help. This happens sometimes due to running production changes.
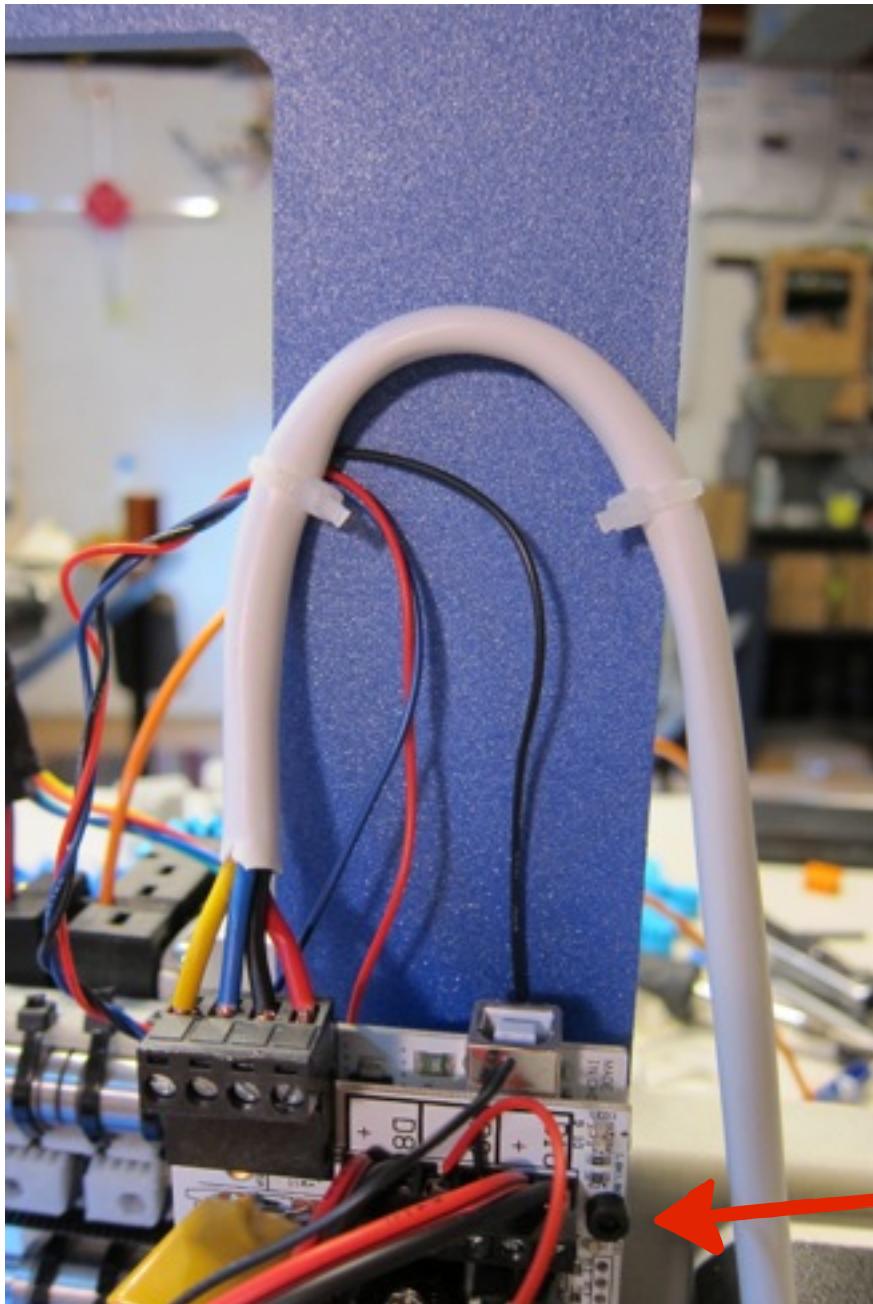
Step 86: PSU Wiring

On the RAMPS board, there are 4 screw terminals on the top edge. Wire them up as shown - and tighten down the terminals. Make sure that no copper from any wires are touching.

The colors (left to right) are: yellow, blue, black, and red)

Step 87: PSU Wiring

To make sure the power cabling doesn't put stress on the RAMPS power plugs, I zip tie it like this to the holes in the frame.   This way if the power wire gets tugged it won't mess anything up.

You need to use the small zip ties to get through the frame holes.

Note: Make sure you zip tie the wire to the back of the frame, not the side.

Tip! If you unbolt one of the screws on the arduino, you can put the white cable behind it, to keep it neater.
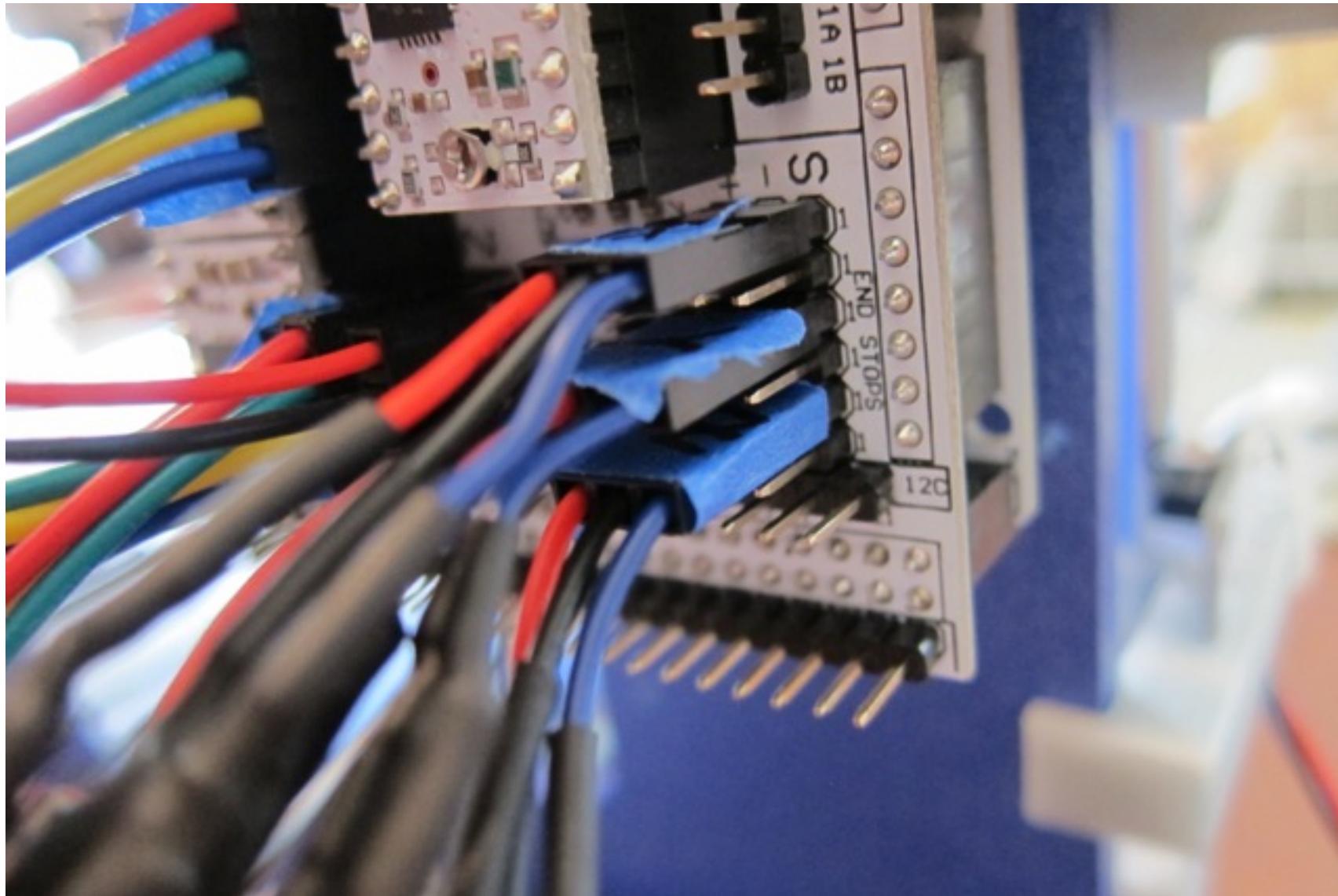
Step 88: Wiring Mesh Note!

If you're going to use the blue mesh sheath for the wiring, make sure you slip it over the wires before connecting them to the RAMPS.

You may want to slip one over the main bundle of wires going from the extruder (extruder power, fan power, thermistor) to the RAMPS as well as from the HBP (HBP power + thermistor) to the RAMPS.

Tape the ends with electrical tape.

Step 89: Endstop Wiring

All three endstops get wired to the RAMPS board similarly.

They go
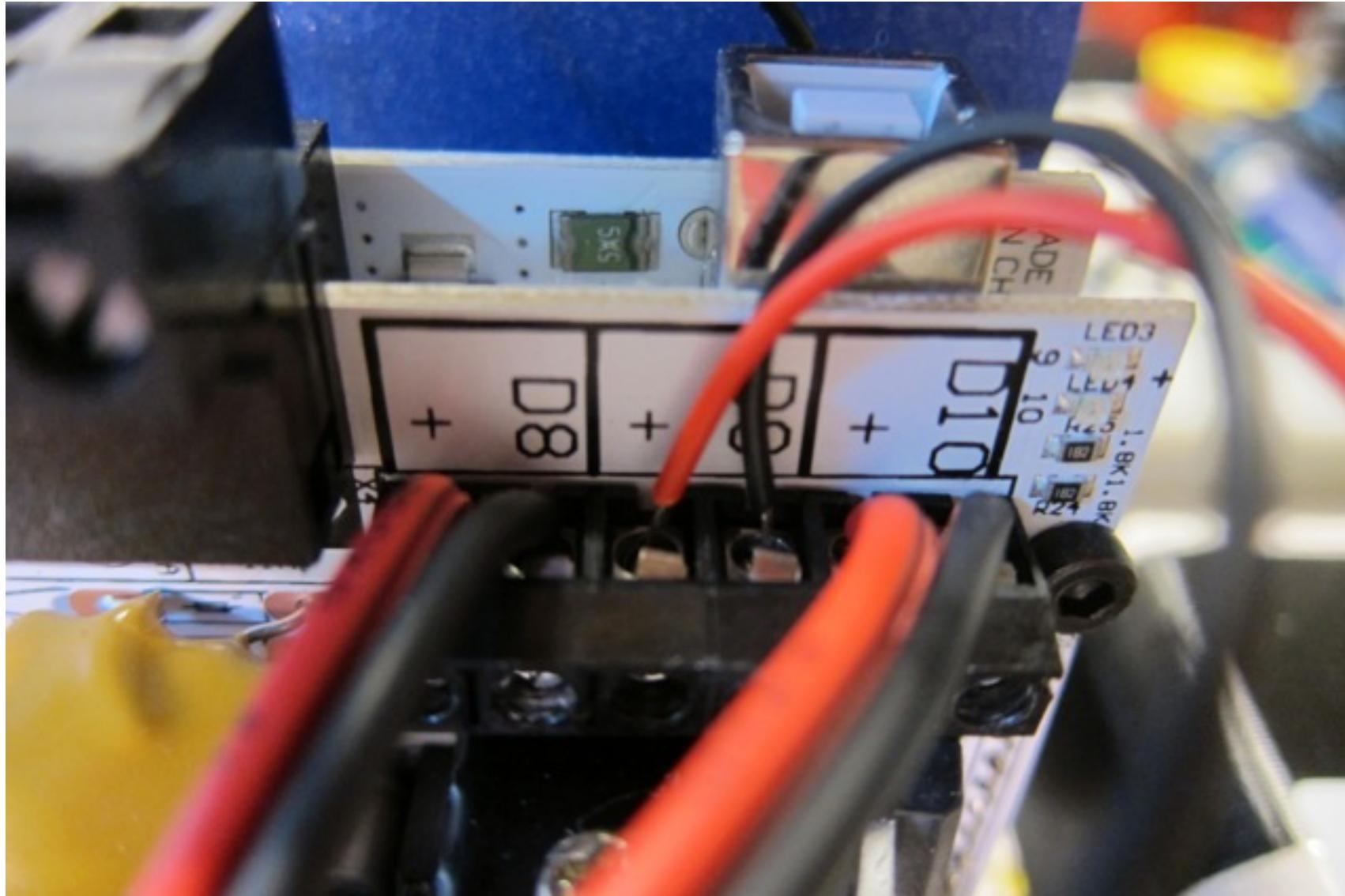
X
Y
Z

From top to bottom.
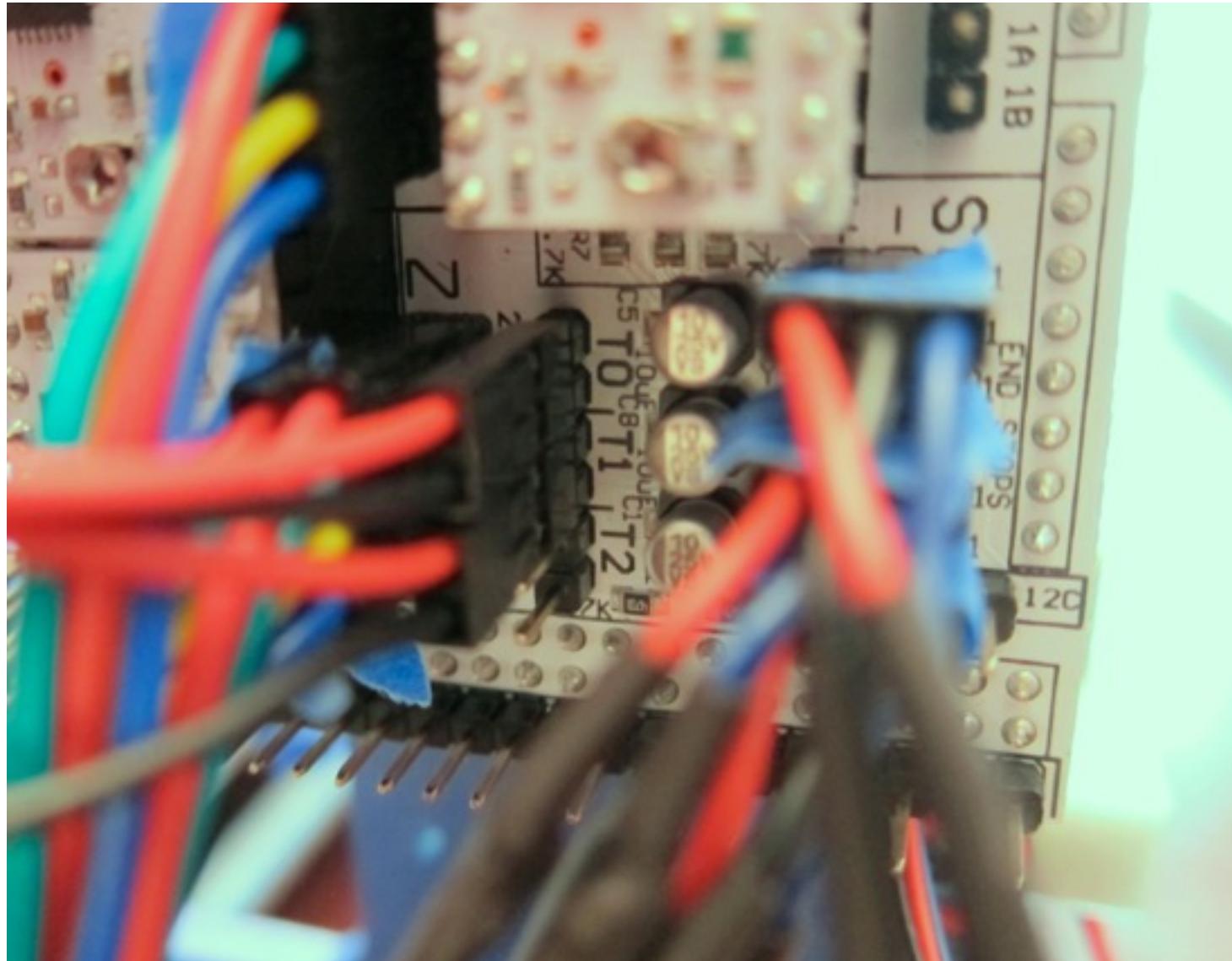
Plug in all of the endstop cables on the right hand / lower corner of the board.   Red cables go to the left.   **NOTE:** We're plugging into the 1st, 3rd, and 5th plugs - like the photo.

Step 90: Heated Bed Wiring
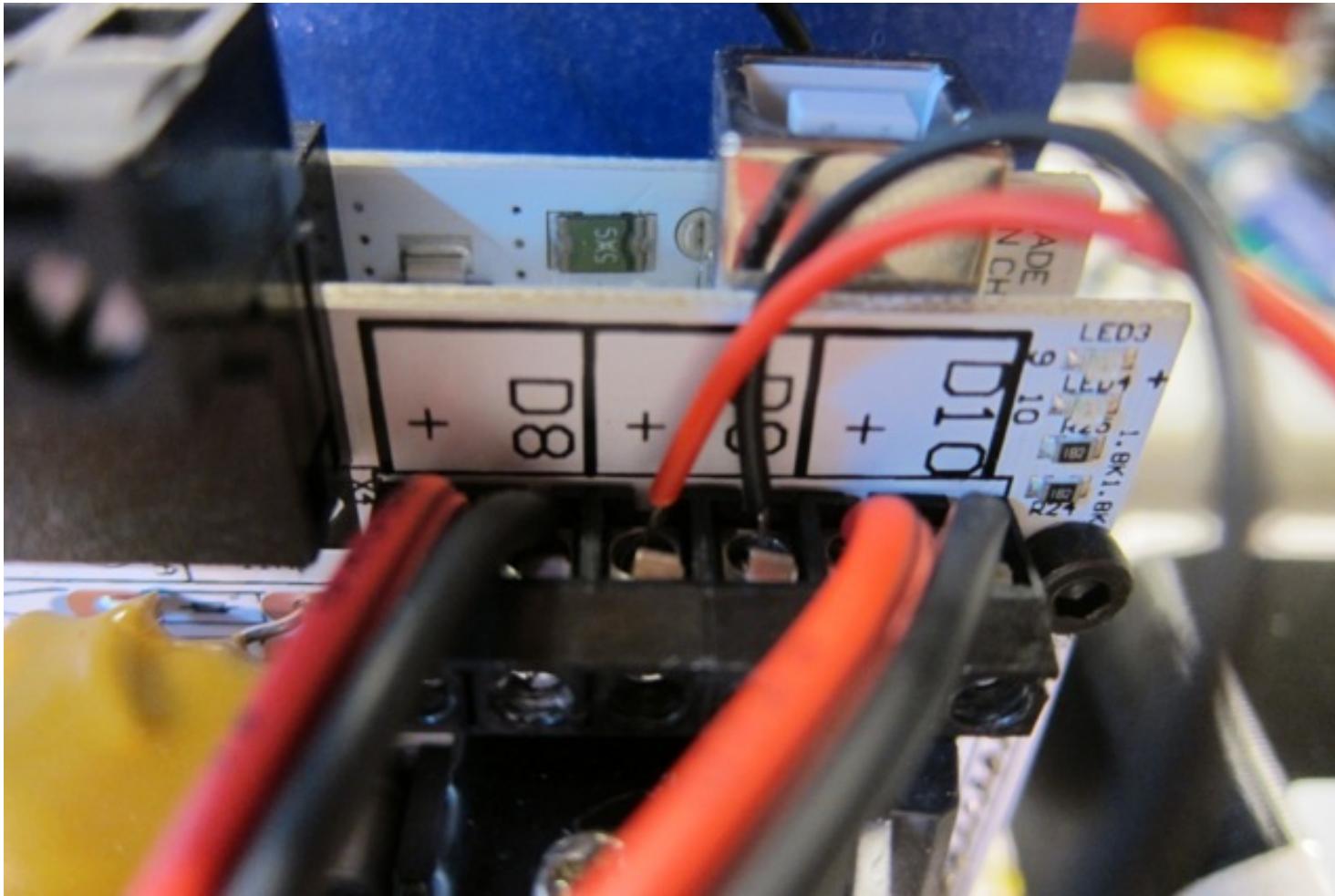
The two large wires from the heated bed get plugged into D8 on the Ramps board. Make sure the red goes into the + spot.

Step 91: Heated Bed Wiring
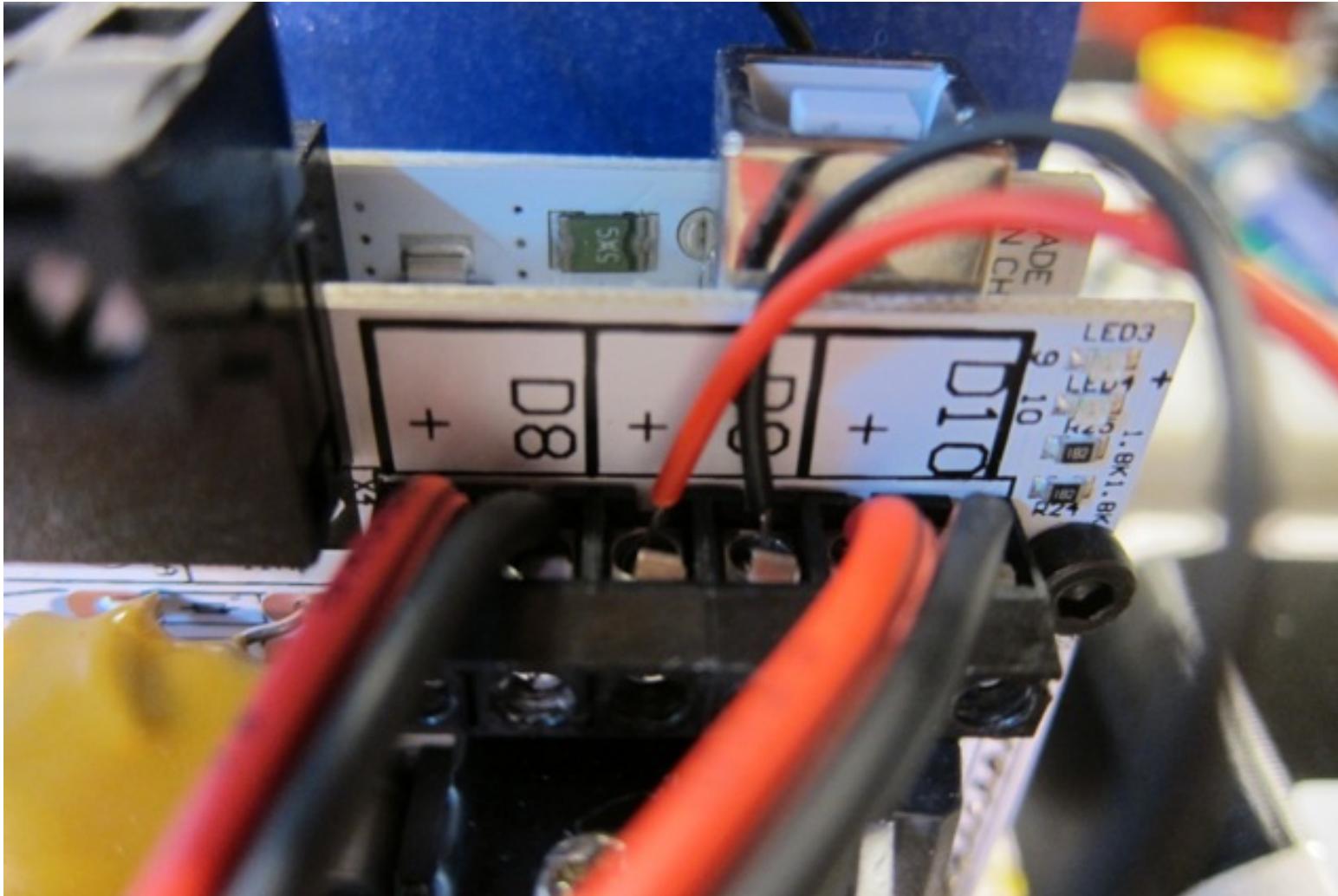
The heated bed thermistor wire goes to T1 - red wire goes up!

Step 92: HotEnd Wiring

- The wiring from the hotend needs to loop up over the top of the frame and then down to the RAMPS board
- The wires labeled 'Therm' go to T0 on the RAMPS board. Direction is not important, it'll work either way.
- The power wires get screwed into the terminals labelled D10. These are not directional, but to be neat it's good to keep them in the same order as the wires in D8.
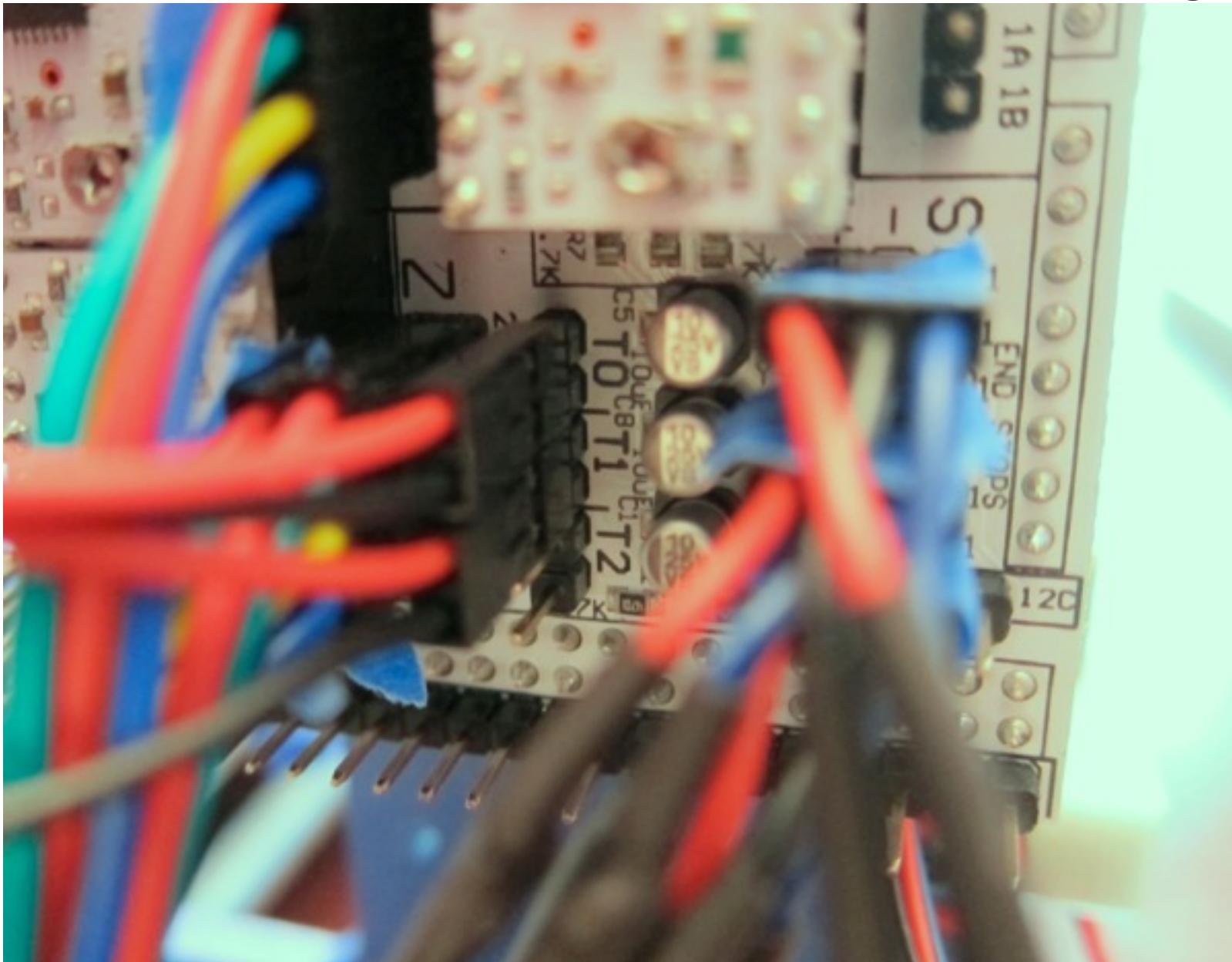
Step 93: Extruder Fan Wiring

The extruder fan power wires (small wires) follow the same path as the hot-end wires.
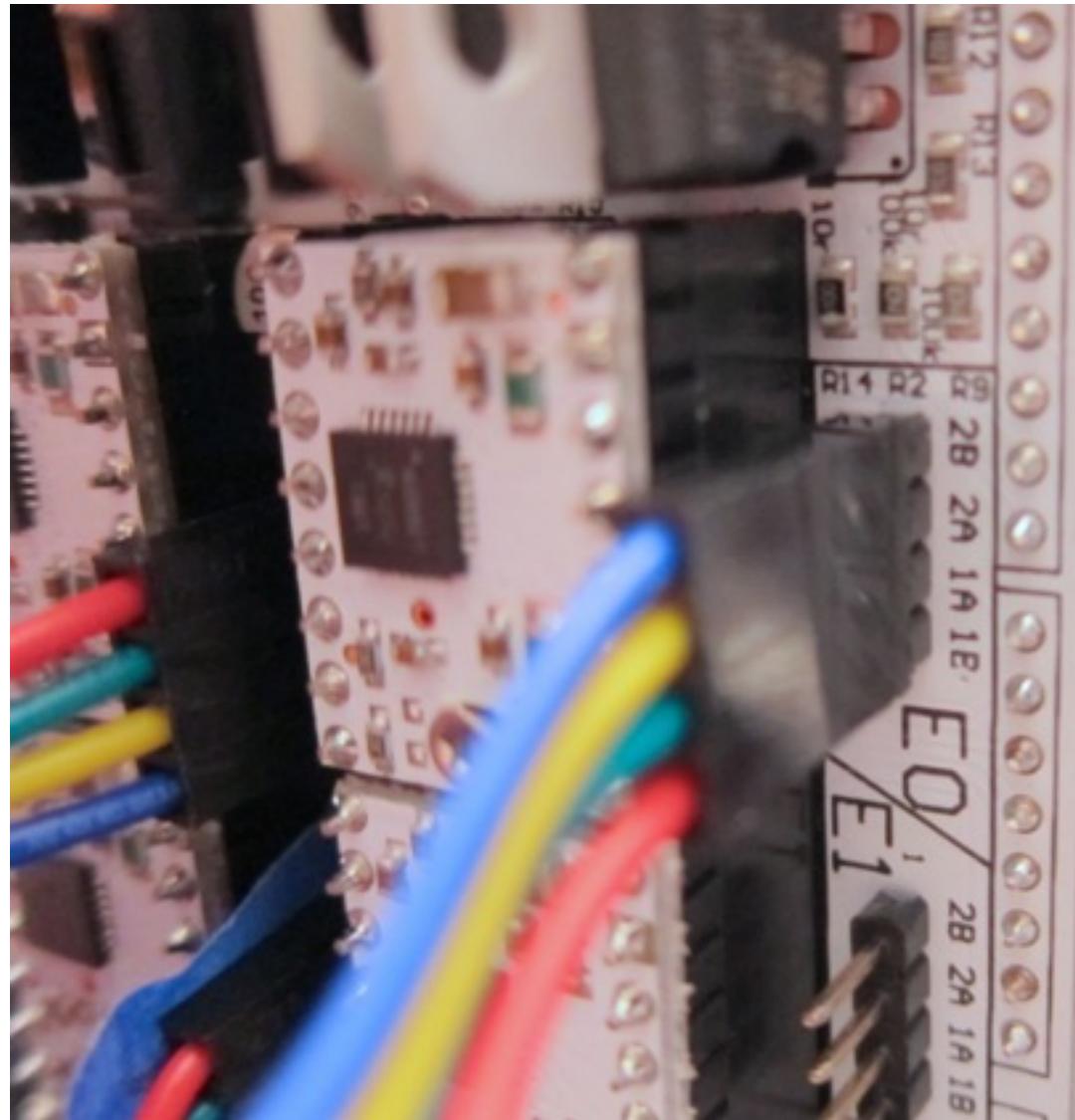
They get plugged into D9 - keep the black and red oriented the same as D8 and D10.

Step 94: Hot End Thermistor Wiring

The hot-end thermistor gets plugged in to T0 on the RAMPS board, red wire up.

Step 95: Extruder Stepper Wiring
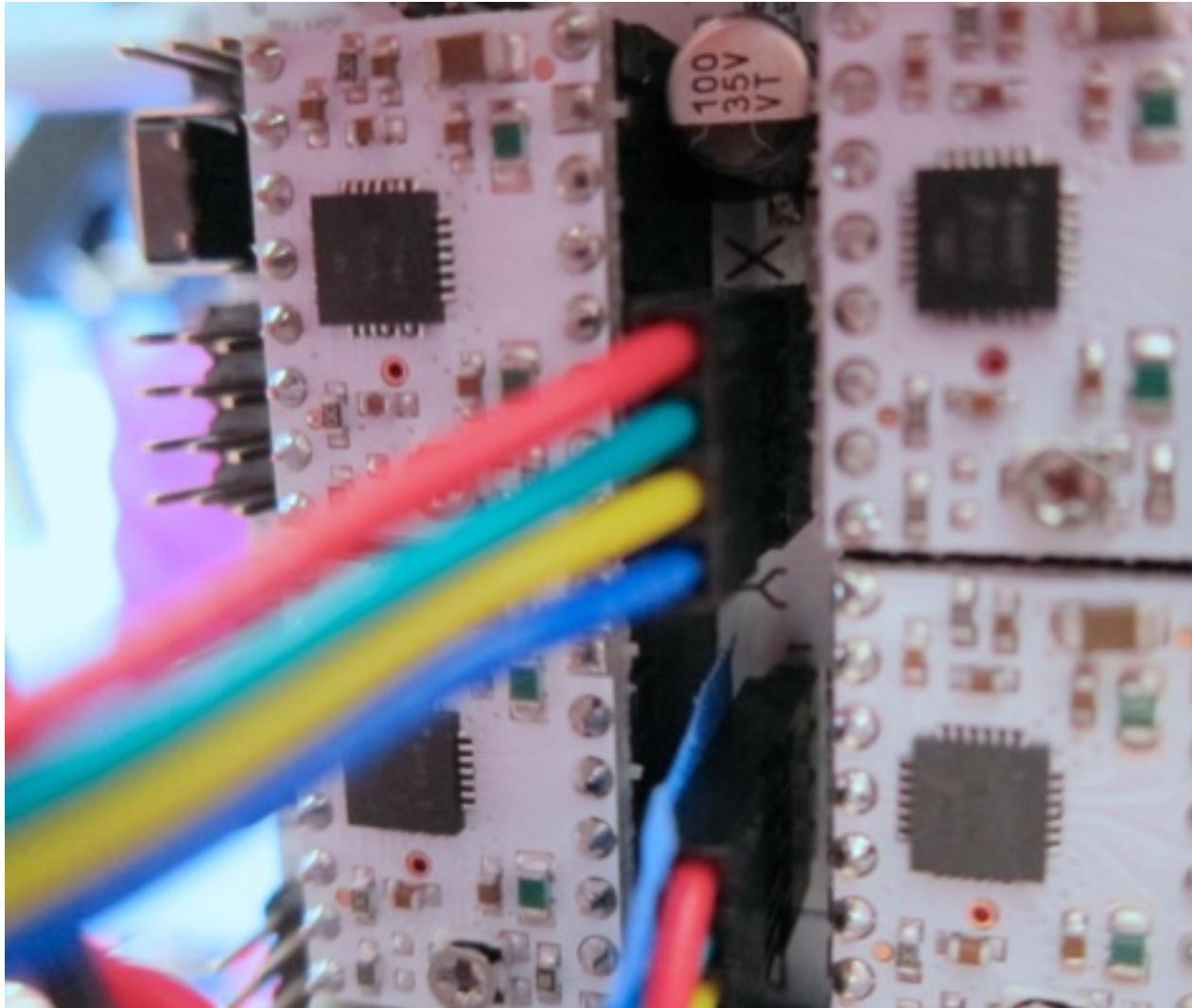
- Extruder stepper wires go with the loop up and over the frame (along with hotend power and hotend fan) and plug into E0 on the RAMPS.

The blue wire goes up!
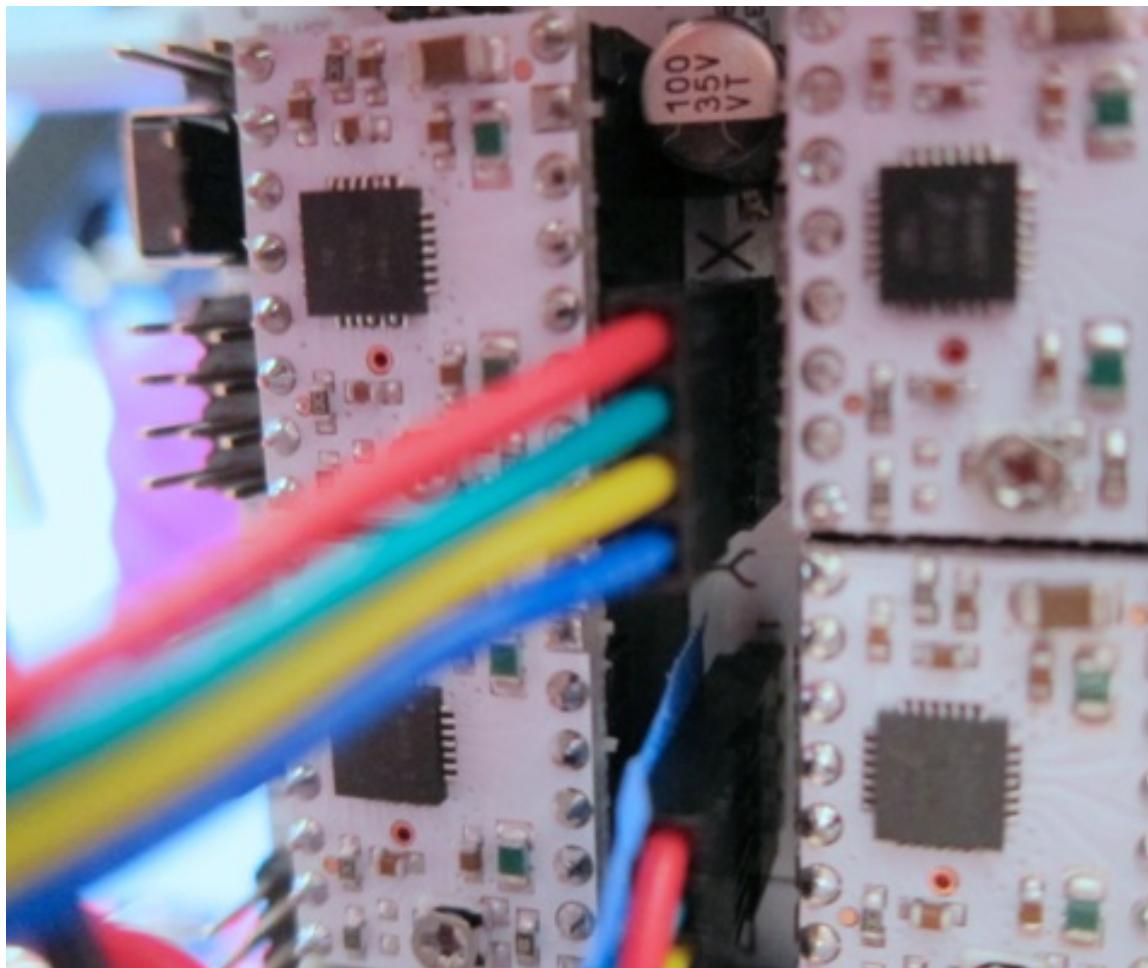
(We need to spin the extruder backwards because of how it's geared)

Step 96: X Stepper Wiring

- The X-axis stepper motor comes with the correct connector already on the end of the motor cables.
- The X-stepper wire goes to the X spot on the RAMPS board. The RED wire goes toward the main power terminals on the board (i.e. UP!)   Look at the diagram !
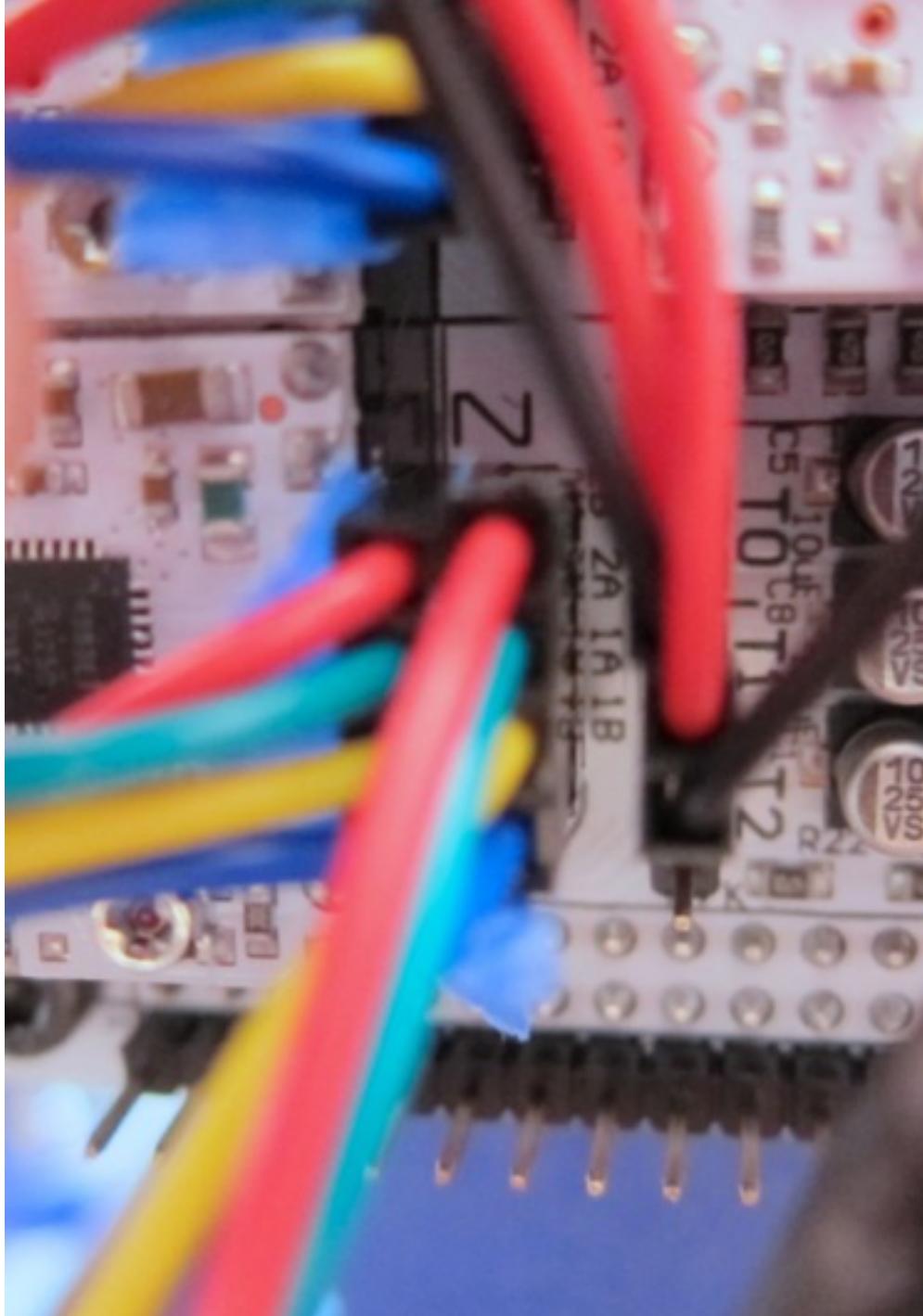
Step 97: Y Stepper Wiring

- The wiring from the Y stepper motor needs to go to the RAMPS board. It's probably best to zip tie this to the frame pieces that lead it closer to the RAMPS, or wrap it with cable wrap. Look at the PSU wiring detail photo.
- The Y stepper motor wire goes to the Y spot on the RAMPS board.   The red lead goes toward the main power terminals on the board.
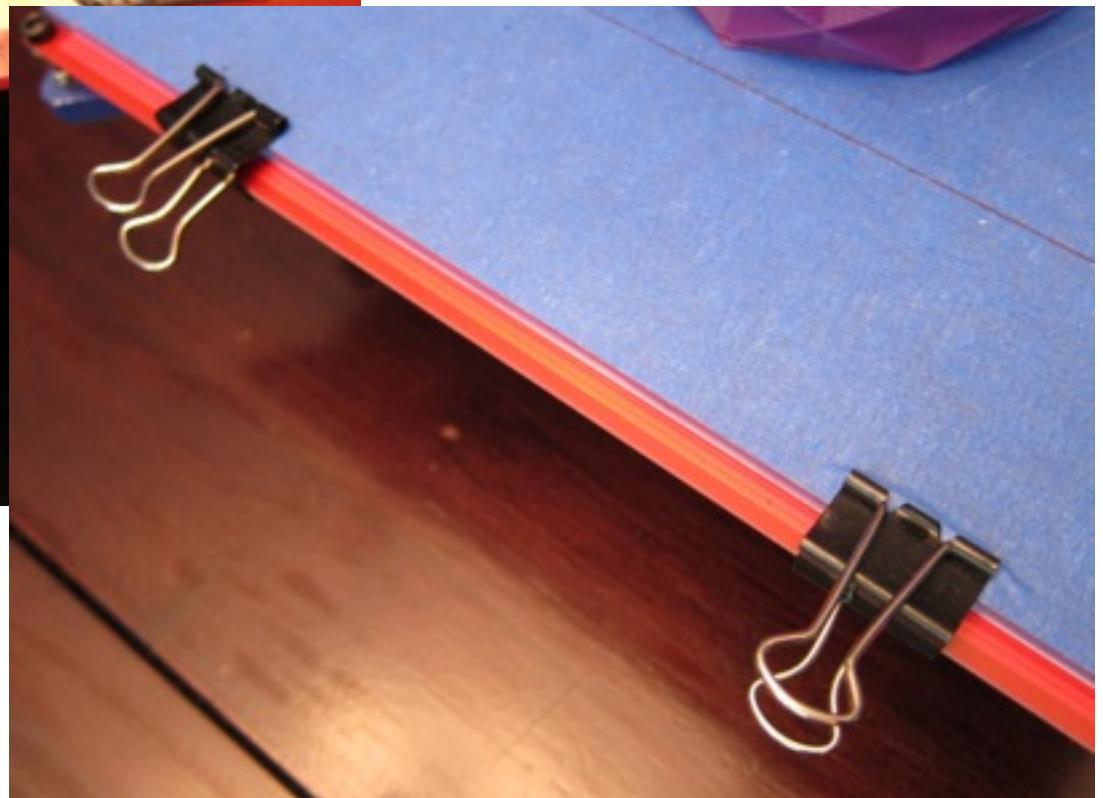
The Y stepper plug is directly below the X!

Step 98: Z Stepper Wiring
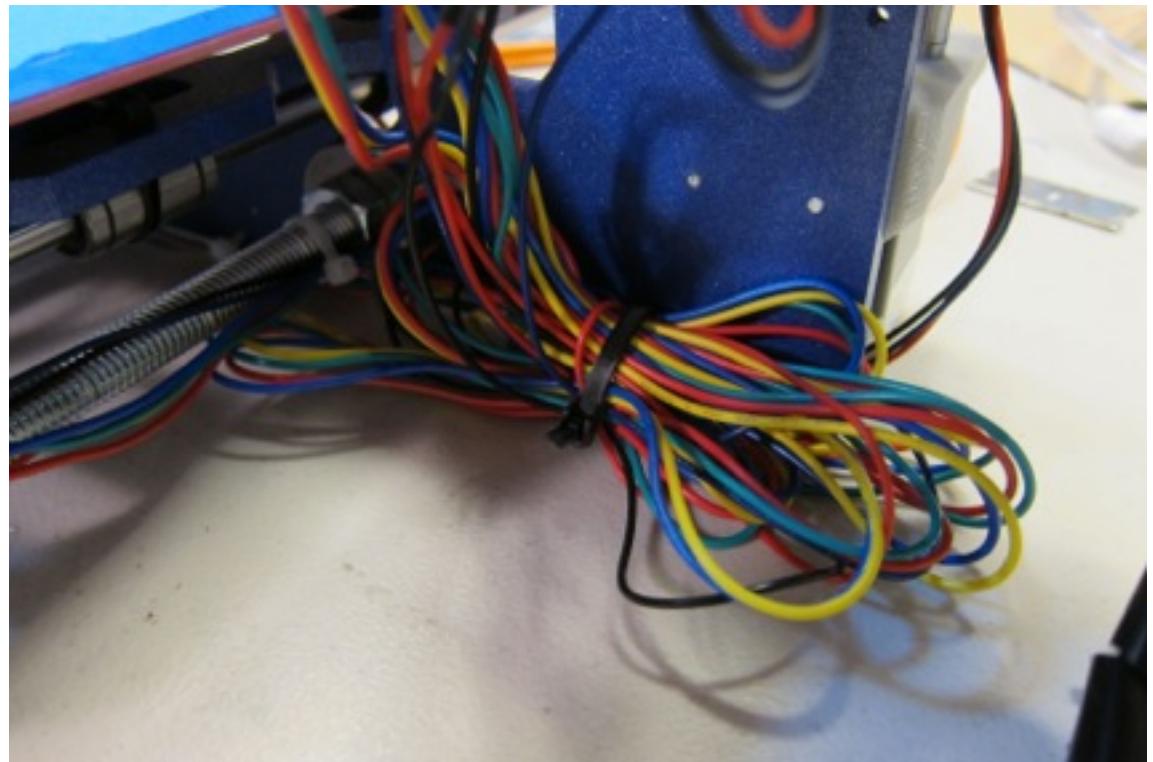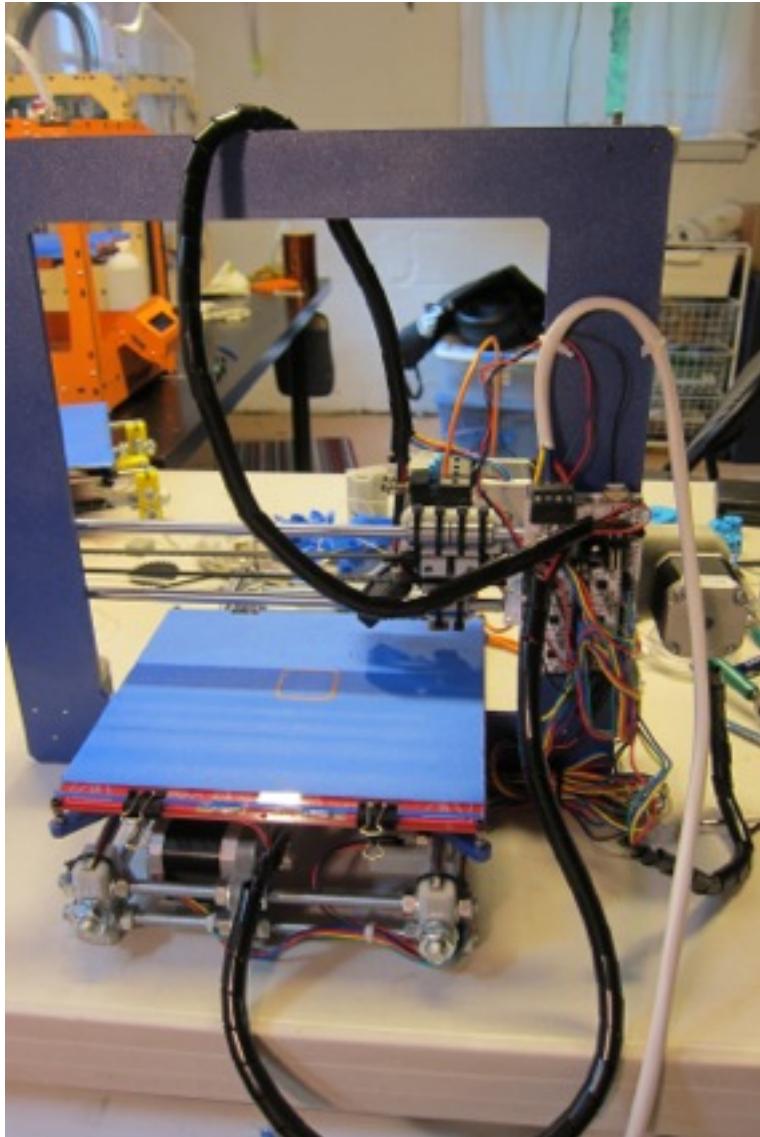
- The Z-axis is different because there are 2 stepper motors, and the wiring for the one needs to come along under the frame to get to the RAMPS board. There are holes in the bottom of the frame to zip-tie it to.

- Each Z-motor plug gets plugged into the Z-motor spots on the RAMPS, with the Red lead pointing toward the main power terminals.   - RED wires up.

Step 99: HBP Glass

NOTE: We should test your Z-endstop before you mount the glass.   The glass should only go on once you're getting ready to print. This step shows you how to do it, but don't actually install it until after at least step 100!

Step 100: Wiring Cleanup

For the extra length of the stepper wires it's easiest just to bundle them up and zip tie them out of the way.

For the wires to the hot-end, HBP, and X-stepper, I like to put black spiral wrap around the wires, and zip-tie the ends.

NOTE: For the Hot-end, the HBP, and the Z-axis stepper, make sure that you leave enough wire for the parts to move! We don't want to move the axes and have it pull wires out.

Step 101: USB Stick Contents

Name	▲	Date Modified
▶ 📁 Arduino		Sep 8, 2013, 12:26 PM
▶ 📁 Firmware		Sep 8, 2013, 12:21 PM
▶ 📁 Manuals		Yesterday, 10:07 PM
▶ 📁 Pronterface		Yesterday, 10:21 PM
▶ 📁 Slic3r		Sep 15, 2013, 4:24 PM
▶ 📁 STL Files		Yesterday, 10:08 PM

On the included USB stick are a number of directories:

Arduino - contains the Arduino software, required if you need to edit the firmware later.

Firmware - contains a pre-configured version of the Marlin firmware that's installed onto the Arduino Mega we use in class

Manuals - PDF version of this manual and a few other useful ones.

Pronterface - Windows / Mac / Linux software for controlling the printer.

**Slic3r** - Program for converting 3d STL models to GCODE that the printer understands
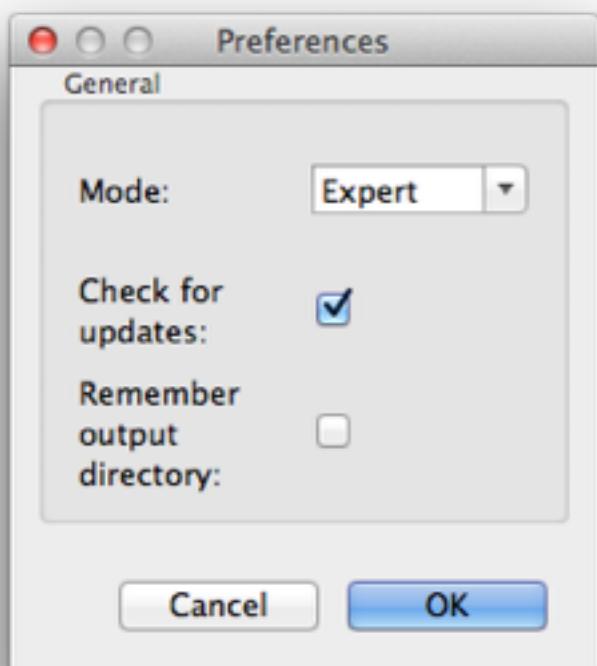
STL Files - Sample files to print, as well as the files for all of the plastic parts on the printer.

Step 102: Software Config

You'll need to install both Pronterface / Printrun and Slic3r - the various OS versions will be in the corresponding directories on the USB stick.   Shout if you need help installing it, but it should be easy.

Once Slic3r is installed, you'll need to do a few things:

Go in the preferences and enable 'Expert' mode - On a Mac it looks like this:

We've included a pre-configured file for Slic3r as well that needs to be loaded.   You should be able to do:

File -> Load Config in Slic3r and then select:

config.ini

from the Slic3r folder on your USB stick.   This will get you a very basic working profile for these machines.

Step 103: Wiring Check!

If you're in our class, now's the time to find an instructor to double-check your wiring before proceeding.

If you're building a printer using these directions, it's a good idea anyway.   Double-check that things are wired as shown to keep things from blowing up, and to help insure that they work right the first try.

Danger! Make sure that the various wires you screwed into terminal blocks are all completely in their blocks, and that no uncovered copper wire is showing - and that it's not touching the similar part of another wire.   You may have to trim some wires to get the length of the uncovered part correct.   Pay special attention to this on the wires going to / from the heated bed, the hotend, and to / from RAMPS and the Power Supply.

Step 104: Connecting!

Note: If you're using one of our kits and running Windows on your laptop, you'll need to install the Taurino driver for Windows before your PC will recognize the board.   You can get the driver from here:

http://reprap.org/wiki/File:RRD_RUMBA_TAURINO_DriverSetup.zip

Once you've got Printrun installed, you'll need to connect to the printer.   Find the USB cable from your kit and connect it to the USB plug on your RAMPS board as well as your PC.   You'll need to pick your port and baud rate. The rate configured on all of our boards is 250,000.

In the 'Manuals' folder of your USB stick is a file called: Slic3rBasics.pdf

This goes over some of the basics of connecting to your printer as well as using Printrun.

There is also another file called: Slic3rInDepth.pdf that goes over much more detail about using Slic3r and the various settings in it that are too in-depth to cover in a two day class.

Step 105: Motion and Endstop Tests

This step assumes that you've got Printrun installed and talking to your printer.   The next step is to test your endstop switches.

Looking at the printer from the front (with the "Prusa" facing you) the endstop switches should be in the following positions:

Z - left hand side of frame
Y - Left rod, farthest from you (i.e. back of machine)
X - left-hand side of X smooth rods
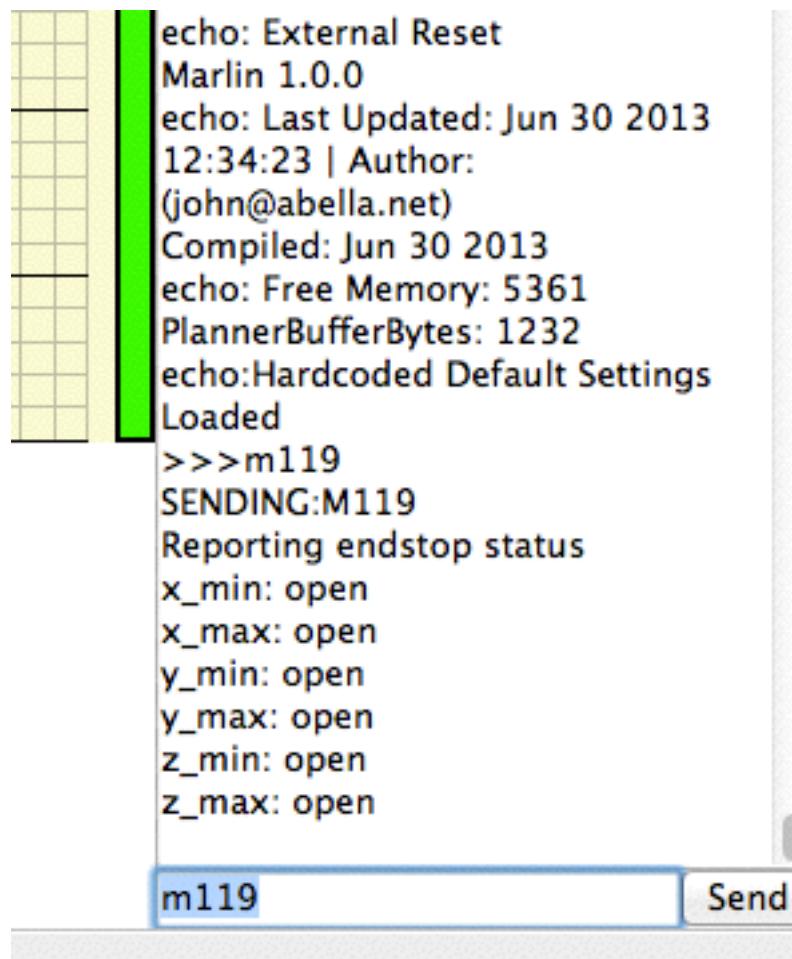
All of our endstops are minimums, not maximums! You'll see this more in a few steps.

Step 106: Endstop Tests

Connect to the printer in Printrun. look like this.

If you're using our electronics, the messages should look like this.

```
echo: External Reset
Marlin 1.0.0
echo: Last Updated: Jun 30 2013
12:34:23 | Author:
(john@abella.net)
Compiled: Jun 30 2013
echo: Free Memory: 5361
PlannerBufferBytes: 1232
echo:Hardcoded Default Settings
Loaded
>>>m119
SENDING:M119
Reporting endstop status
x_min: open
x_max: open
y_min: open
y_max: open
z_min: open
z_max: open
```

```
m119                          Send
```
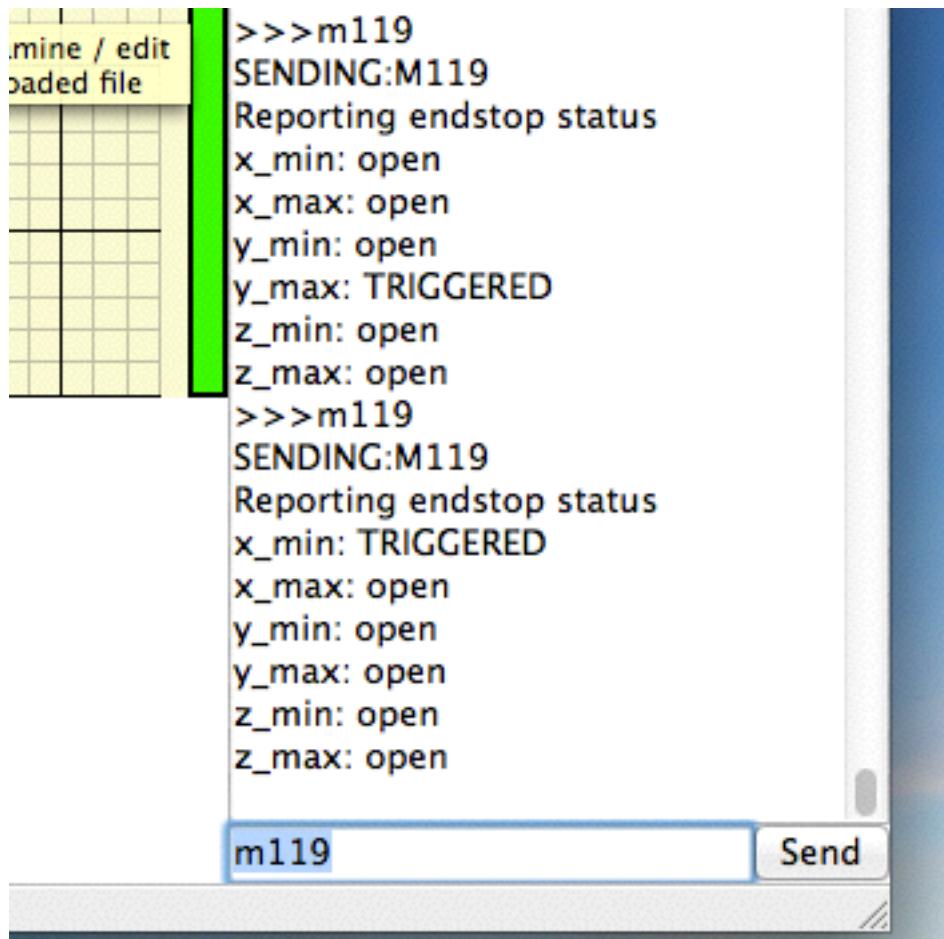
On the lower right hand side, type in M119 and hit 'send.' The board should respond with something like shown here.

This means that **none** of the endstops are currently triggered. This is good.

Step 107: Endstop Tests - X-axis

Now reach over and put your finger on the switch for the X axis endstop. Hit 'send' again in Printrun, and see what happens!

```
>>>m119
SENDING:M119
Reporting endstop status
x_min: open
x_max: open
y_min: open
y_max: TRIGGERED
z_min: open
z_max: open
>>>m119
SENDING:M119
Reporting endstop status
x_min: TRIGGERED
x_max: open
y_min: open
y_max: open
z_min: open
z_max: open
```

m119   Send
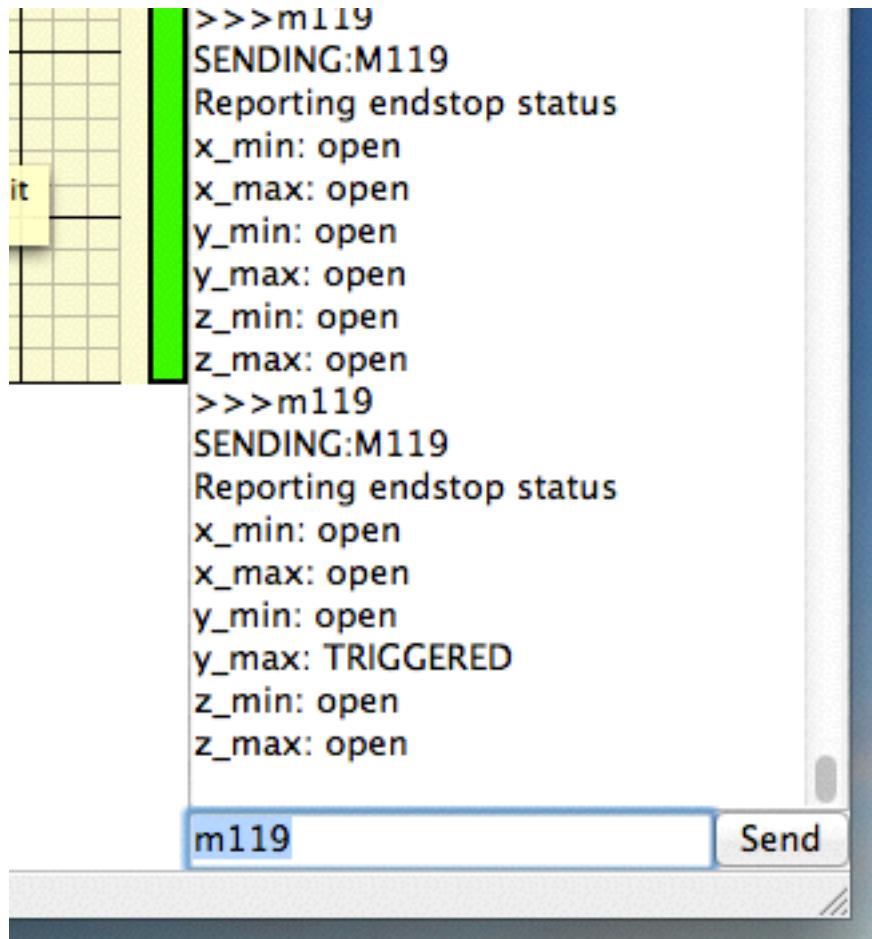
It should look like this. Your x_min: endstop should say 'TRIGGERED'

If it does, proceed! If it doesn't, check your wiring. The most common problem is that you push on the x endstop switch and it shows up as something else when you do the M119 command.

Note: If your Taurino / RAMPS reboots when you press on an endstop switch, your wiring is reversed. Power off, remove USB cable, and reverse the endstop wire connection.

Step 108: Endstop Tests - Y-Axis

Now reach over and put your finger on the switch for the Y axis endstop. Hit 'send' again in Printrun, and see what happens!

```
>>>m119
SENDING:M119
Reporting endstop status
x_min: open
x_max: open
y_min: open
y_max: open
z_min: open
z_max: open
>>>m119
SENDING:M119
Reporting endstop status
x_min: open
x_max: open
y_min: open
y_max: TRIGGERED
z_min: open
z_max: open
```

```
m119                          Send
```

Whoops! It should NOT look like this! This is fairly common in class, it means that you plugged your Y-axis endstop switch into the wrong spot on your RAMPS board. Power off, remove USB cable, and move it to the right spot. Once it says y_min: TRIGGERED you're ready to proceed.

Note: If your Taurino / RAMPS reboots when you press on an endstop switch, your wiring is reversed. Power off, remove USB cable, and reverse the endstop wire connection.

Step 109: Endstop Tests - Z-Axis

Now reach over and put your finger on the switch for the Z axis endstop.   Hit 'send' again in Printrun, and see what happens!

```
Reporting endstop status
x_min: TRIGGERED
x_max: open
y_min: open
y_max: open
z_min: open
z_max: open
>>>m119
SENDING:M119
Reporting endstop status
x_min: open
x_max: open
y_min: open
y_max: open
z_min: TRIGGERED
z_max: open
```

ne / edit
led file

m119   Send

It should look like this.   Your z_min: endstop should say 'TRIGGERED'

If it does, proceed!   If it doesn't, check your wiring.   The most common problem is that you push on the z endstop switch and it shows up as something else when you do the M119 command.

Note: If your Taurino / RAMPS reboots when you press on an endstop switch, your wiring is reversed.   Power off,

Step 110: Homing Tests

Before doing any homing tests, slide each axis to the end in each direction. Be on the lookout for wires that may be too short / tight, and ensure that each carriage can hit the endstop switch without an issue. This is where the specifically placed zip ties on the X-carriage matter! You should hear each switch 'click' when you engage them manually like this.

 If your x-axis endstop worked correctly, you should now be able to hit the homing button for the x-axis in printrun. This will move the x carriage over to the endstop switch and then stop moving.

 Now do the y-axis. Make sure you have enough slack in the cables before testing it! Also verify that the bearing engages the endstop switch!

 Now do the z-axis. If you followed the steps earlier, your z-axis should NOT have glass on it yet, and your z-axis endstop holder should be a few inches too high to ensure that the hot end doesn't impact the bed.

 Once all three have been tested, you can hit the 'home all' button and it will home all three axes.

Step 111: Setting Z-Height

Warning! If you don't do this step carefully, you might break your HBP glass. Take it slow, and be careful. If you haven't put it on the bed yet, now's the time.

Once you're confident that all of your axes will home correctly, it's time to set the z-height.

Move the z-endstop holder down a little bit, and hit the Home Z button. You want the spacing between the nozzle and the bed to be about 75% of your first layer height - in our case, it needs to be about the thickness of a sheet of paper. You're going to do this in multiple steps! Lower it, home it, check distance. Repeat! Small steps…

Once you get close, the amount you need to adjust it get REALLY small. Take your time here.

The right height will be about the thickness of a sheet of paper. If you can move a paper between the nozzle and the blue tape on your bed but it drags slightly, that's usually a good start.

Coming Soon:

- Hotend testing
- Heated Bed Testing
- First Extrusion
- First Print!
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