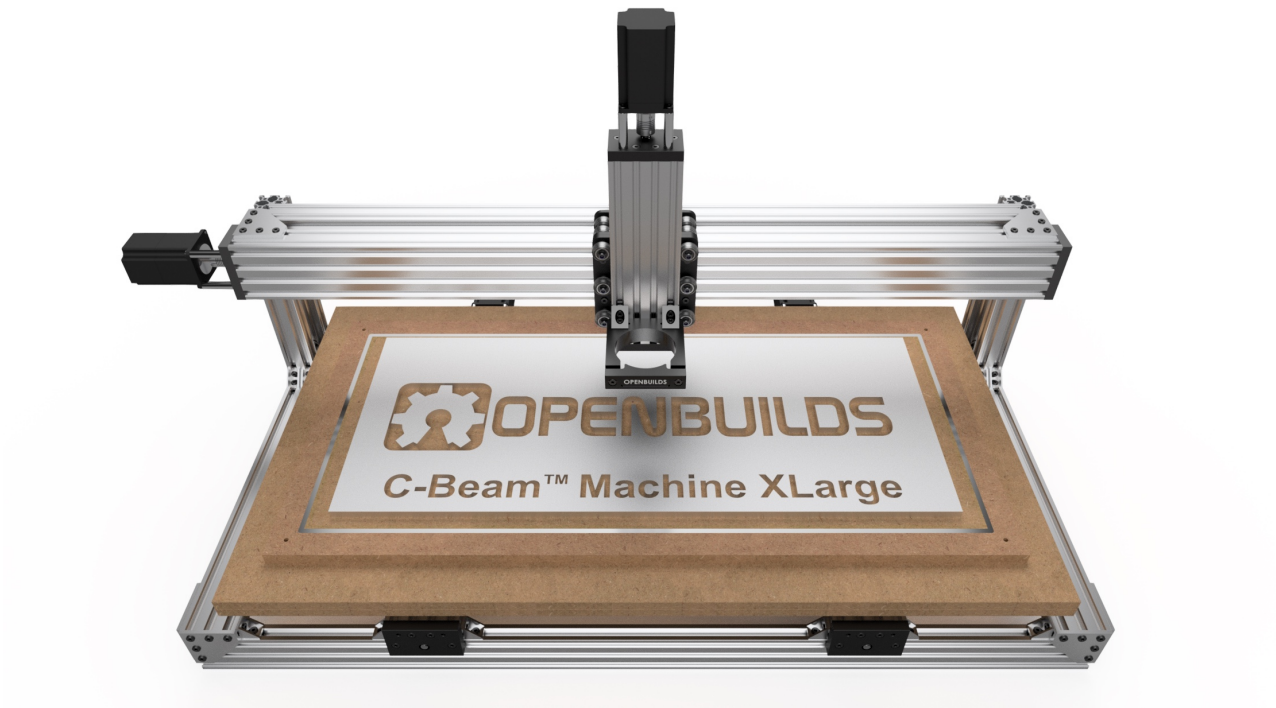
Craig Mills & Mark Carew

C-Beam™ Machine XLarge



Designed with precision and strength in mind, in a sexy double-wide format that is capable of milling Aluminium plate with light cuts. Featuring easy to source off the shelf Openbuilds Parts in an adaptable design; dare I say, reduce its width for a stronger machine. Just add your unique imagination by modifying the design, tossing in some more parts or by making your own plates with this capable Hobby CNC Machine. Part of the fun is adding your individual touch to the build for your own special requirements. Who knows where that might lead you and the brilliant ideas you will come up with!

- 750 mm x 330 mm (29.5” x 13”) X&Y axis cut area.
- Usable cut depth is dependent on how you mount your spindle/router, bit length used and spoil board height. But as a ballpark measurement you are looking at 1 inch (25 mm) material. The Z working height is over 2 inches for deep carving.
- The physical footprint is 1000 mm x 500 mm (with the moving Y table protruding out about 170 mm at full travel, front and back) with the High Torque Steppers sticking out about 140 mm from the frame at the back. Maximum Height (Z-axis fully up) is about 630 mm.
- All the precise Acme Lead Screws are faced away from flying chips to help keep them clean.
- Outside mounted Xtreme Solid V-Wheels™ used throughout for easy on machine adjustment, tuning and strength.
- Doubled up and adjustable Acme Nut blocks on Y and X axes with an Anti-Backlash Nut Block on the Z axis to reduce/remove backlash.
- Strong and accurate C-Beam™ and V-Slot™ Linear Rail with the new heavy duty C-Beam™ Gantry Plate XLarge used for all Actuators.
- Openbuilds Router / Spindle Mount (71 mm inside diameter) designed for the Bosh Colt Router; but with some additional shimming, it is also suitable for the Dewalt 611 Router and the 0.8 kw Chinese Spindles (65 mm diameter).

“Expectations and Limitations”

“It’s hard not to have high expectations, but it is wise to be realistic about the limitations of a hobby CNC”. It will never have the capabilities of a industrial CNC machine, but for the cost of an industrial machine, “Well mortgage the house!” that’s if your lucky enough to own your own or consider reducing your expectations and work within the evident limitations of something a small fraction of the cost, which will get you most of the way there and will teach you heaps in the process. The following is just to give you a basic understanding of some principles and should only be used as a rough guide.

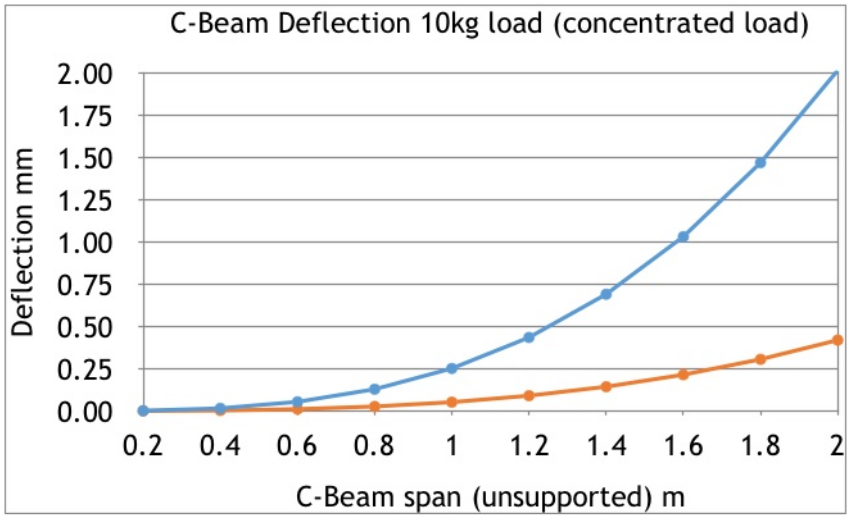


fig 1: Supported beam at both ends with concentrated load in centre. Showing how quickly deflexion increases with increased span. The unsupported X-axis span of C-Beam on the C-Beam Machine XLarge is ~ 0.82 meters. source: http://www.openbuilds.com/projectresources/excel-sheet-to-calculate-deflection.186/

So what are the expectations and limitations? The biggest and most common, is the desire to go as big as possible, with every increase of size adding a non-linear increase in weakness to the machine, through increases in flex of extrusions over longer spans compounded with inaccuracies from the whip from longer drive screws with increased distances from stepper motors among many more things. So if the rigidity of your machine is your priority, the simplest way to reach that goal is to reduce the C-Beam span of your machine.

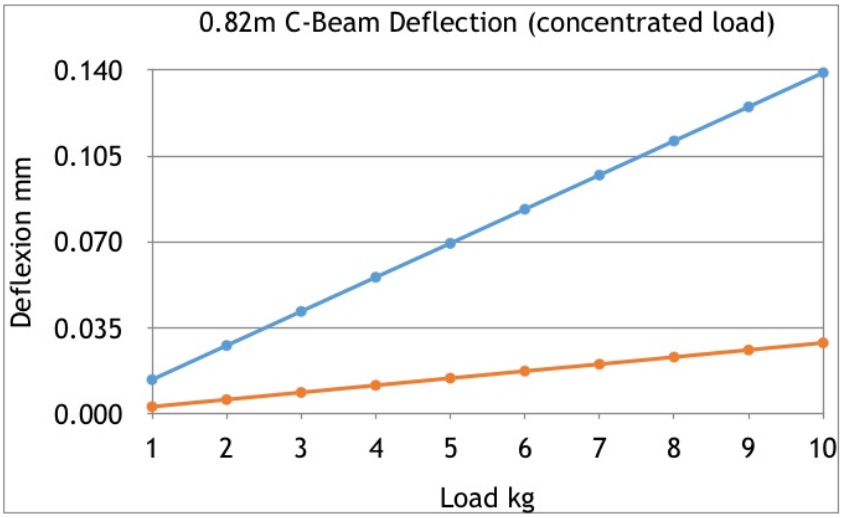
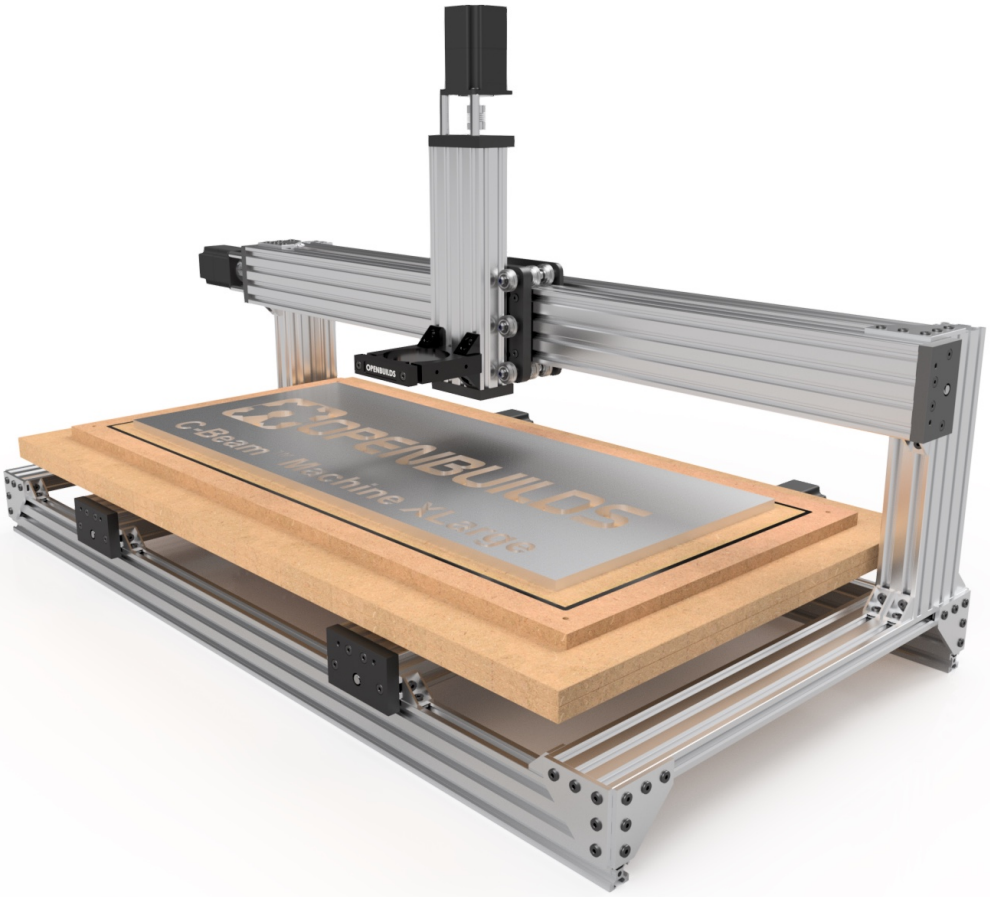


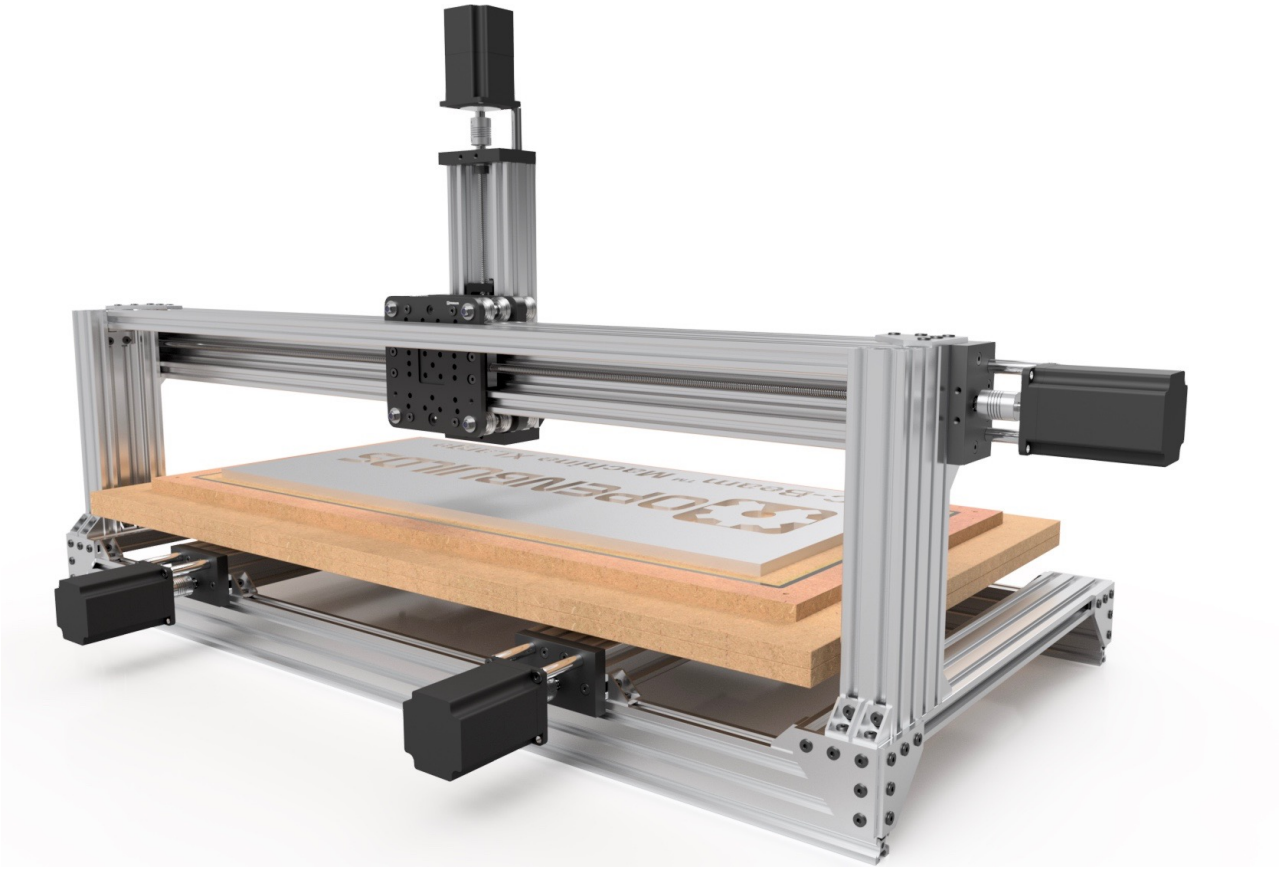
fig 2: The effect of reducing the load on deflexion is linear, halving the load halves the deflection. source:http://www.openbuilds.com/projectresources/excel-sheet-to-calculate-deflection.186/

We can’t just ignore the laws of physics, but we can work within them to get acceptable results, by reducing the loads on the machine by taking it easy, by firstly getting our feeds and speeds just right, starting off with a reduced depth of cut, reducing the material removed with each pass, thus reducing the load on the machine, then slowly increasing the depth of cut to find your machine’s acceptable limitations (sweet spots) with each milling bit size and type, and the material you are using.

It might take longer to cut something out, but you will have better results by getting to know you machines limitations and strengths; just like a valued friend. Learn the basics, acquire more advanced skills from those that have been there before, practice and remember mistakes are just part of the learning curve. Then before you know it, you will be milling like a professional machinist, hopefully making others journeys a little smoother and giving you the knowledge needed to dream up your next improved build.

“Dream it - Build it - Share it”

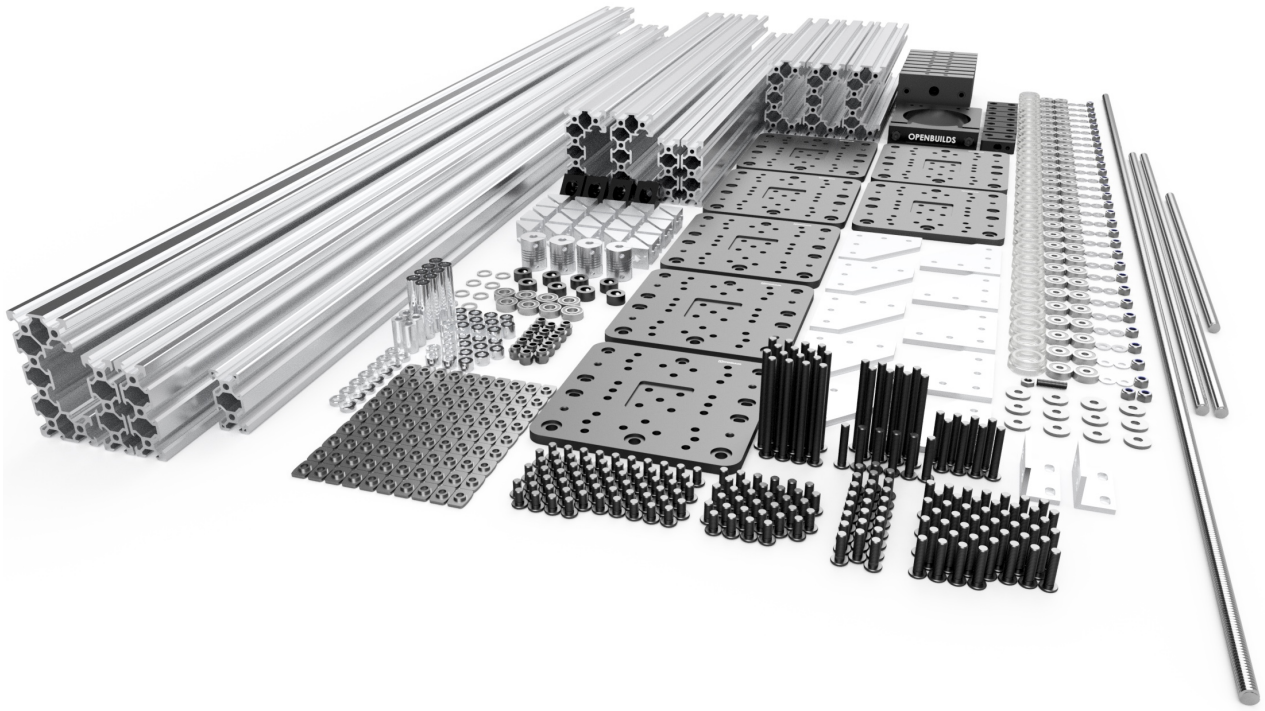




“Putting It All Together”

Like most built things, there are a billion ways to put something together, this is just my take on it, with lots of pictures and just enough words to give you an idea. Have a look and if you find a better way to do it and there will be, please share in the build discussion to help the other builders out there.

To make it easy, I’ve broken it down into bite-sized bits, that make bigger bits..”from little things big things grow”. Just be thankful you’re not in some wacky parallel universe where you just have to blink your eyes and it puts it all together for you… “there definitely wouldn't be any fun or sense of accomplishment in that, would there?”



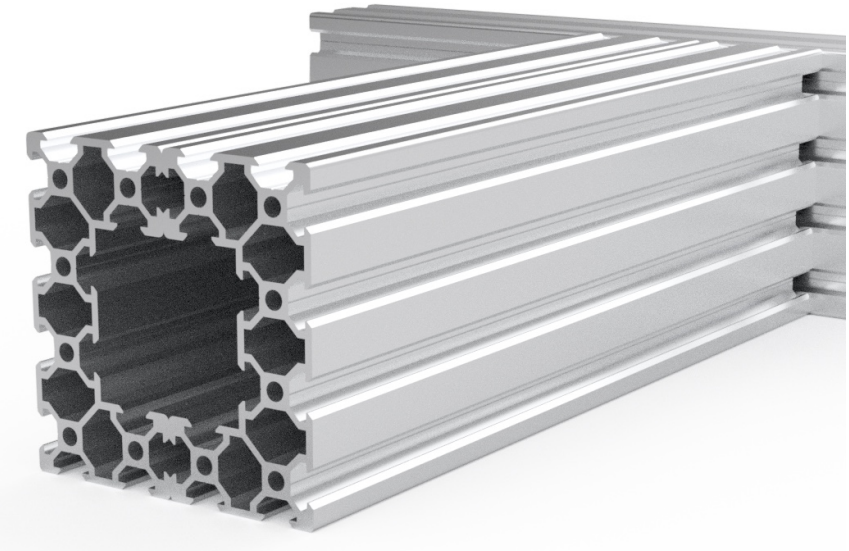
“Turning little of bits awe into something awesome"

"Tools"

- 8mm Open End Wrench (two would be handy)
- 3mm, 2.5mm & 2mm Allen Wrenches
- Square (a little engineer square is perfect)
- M5 0.8 metric Tap (HSS Intermediate) or M5 Drill Tap from the Openbuilds Part Store
- 5mm drill bit
- 10mm drill bit
- Cordless Drill
- Flat Metal File
- Hacksaw 32TDI
- 80 & 120 grit Wet and Dry Sand Paper might be handy
- Measuring "stick"/ tape at least 1meter in length and a short one as well would be handy
- Quick action clamps and a vice would be very handy
- Masking Tape and containers to store the little things that are easily lost
- Some of those little disposable shot glasses, one for WD40 and the other to celebrate
- Marker and scribe (Exacto blade or sharpened nail will do)
- Wood Glue for MDF
- A flat work surface will be your friend!

"Stay Safe, use appropriate safety gear and follow safe work practices"

"Preparation"

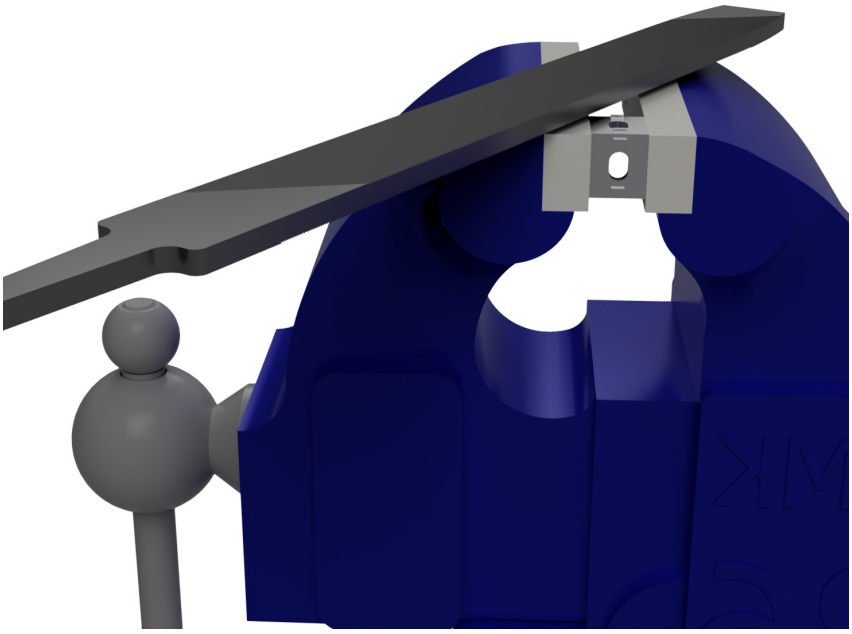


"The 7Ps"

Prior Planning &

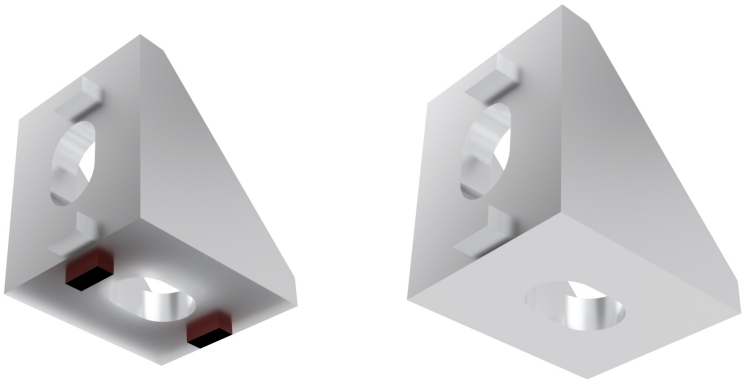
Preparation Prevents Piss

Poor Performance



The Cast Corner Brackets are designed for inline joints like in a picture frame, but can be used in crossing joints with just a little modification to make this kind of joints sit flush and strong like the buttress of a tree.

You will need a flat metal file and ideally a vice to make the job easier. A Benchtop Belt / Disc sander makes the job very easy; just don't manicure your nails to the quick.

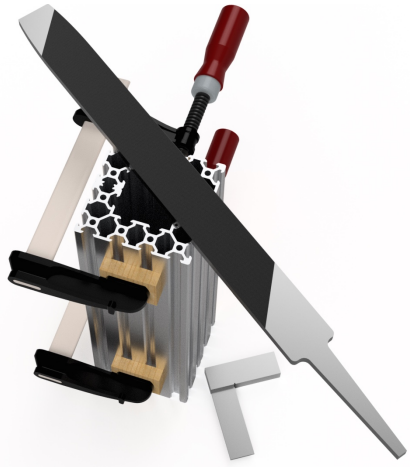


File off those annoying little nubs on one side (highlighted) flush with that side. Prepare eighteen (18) Cast Corner Brackets like this and put aside for the moment. This needs to be done for the crossing joints in the build so these sit nice and flush to make strong neat joins.

While you're at it, practice keeping the file parallel to the face of the Cast Corner Brackets. The Trick is to keep your elbows and or wrists at the same level/plane of your workpiece like they're sliding along imagery rails.

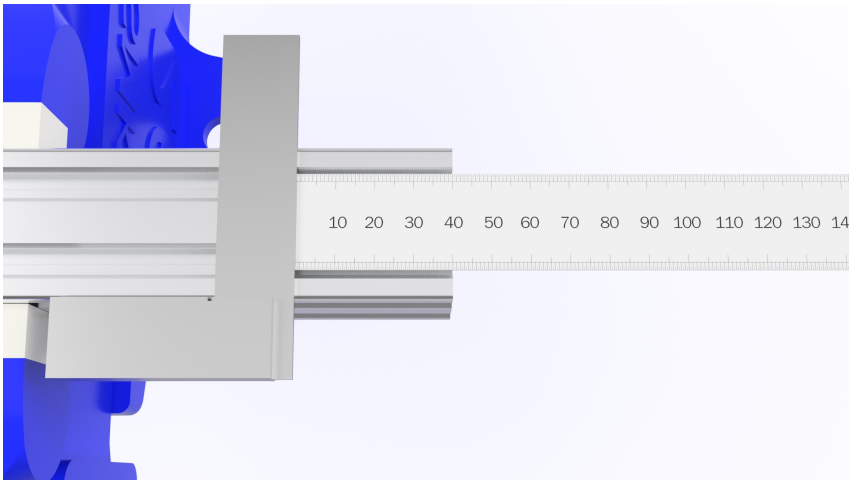
"Be one with the tool and become the machine, Grasshopper"

To make the squaring up of your build easy and ultimately the performance of your machine accurate as possible, you will need to make sure all your extrusions ends are square. Likewise, the 250 mm, 500 mm and 1000 mm lengths of C-Beam and V-Slot need to be the same length. It doesn't matter if they are slightly longer or shorter, just exactly the same length with square ends. The squarer the ends, the easier it will all go together and the better your machine, so spend a little time on this part, it will be worth it in the long run.



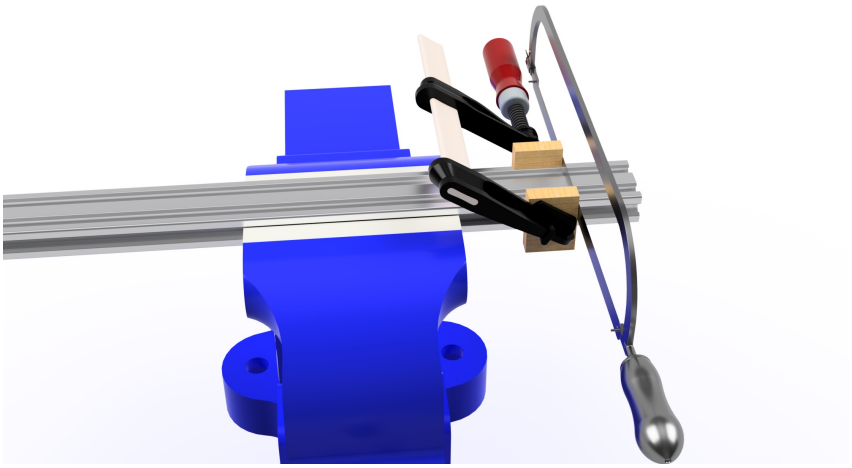
Well, I lie a little, the one 1000 mm 20x40 V-Slot will need to be cut down to 960 mm or just a tad less to make fitting easy. Note that this measure is dependent on the length that the 1000 mm C-Beam ends up; - 40 mm.
In reality, you will only need to make two of the 250 mm C-Beams exactly the same length (Frame uprights) the odd one out will end up being used for the Z axis actuator. So make you job easier and use the closest pair and just make the other one nice and square.

When filing the ends of the extrusions to same length and square, try to vary your angles of approach and check often with a square. Its a slow process but you will get there. Marking the end of the shortest extrusion or low points with a marker pen will give you a strong visual indication when you're gone too far with the filing. Test your work by laying a piece of extrusion on a flat surface and bringing the piece you're working on in at right angles and butting it against the side; there shouldn't be any gaps.
If you have a Mill, trued up Drop Saw or Disc Sander, you should know what to do, to get it close, but finish with a file and square for best results.



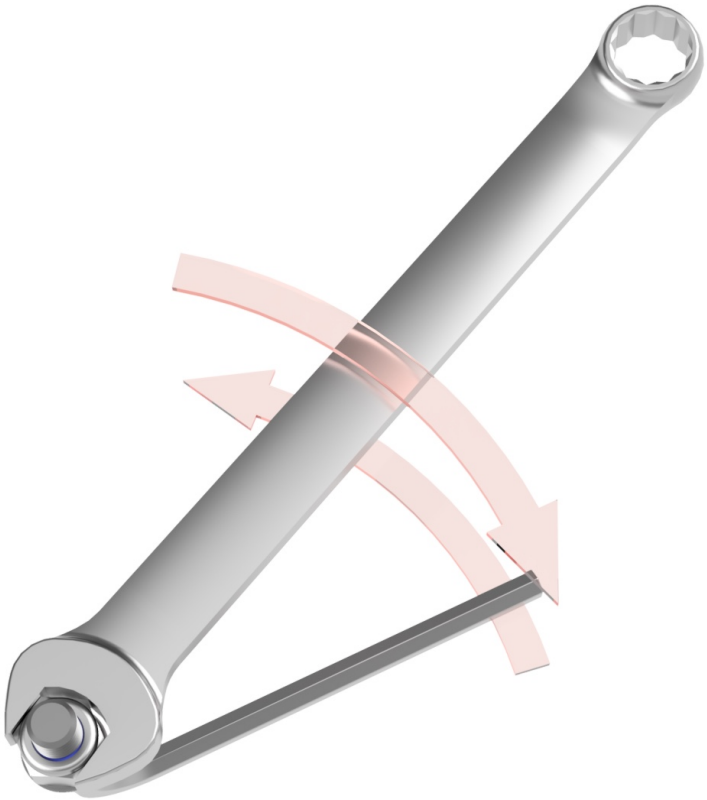
Measure what you ended up with after squaring the 1000 mm lengths of C-Beam and 20x60 V-Slot. Use that measurement and subtract 40 mm if you like sailing close to the wind and having an extremely tight joint or 41mm if you just want things to go together easily. If you make it even just a fraction too long, it's not going to go together.

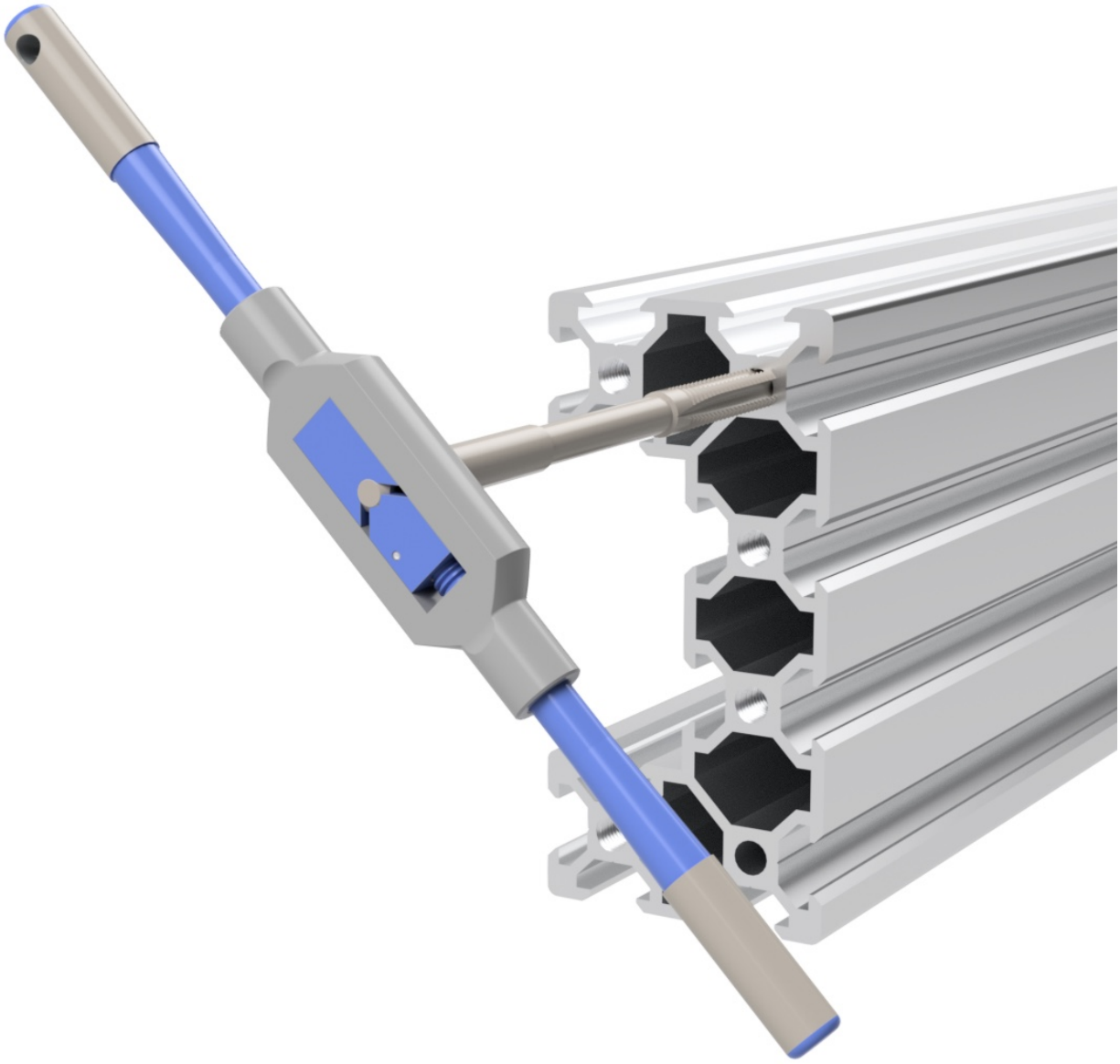
"Measure twice cut once"



Using a square mark this measurement on the 20x40 V-Slots top and side faces. Marking the V-Slot with a dark thick marker then scribing through that mark with a pointy sharp thing will give you a clear line to follow. A couple of blocks clamped along the sidelines can help guide your cut. Take it slowly and let the hacksaw teeth do the cutting.
File the cut end flat and square and you're done.

Note: Only tighten the M5 screws less than a 1/4 turn from snug otherwise you will strip the threads.





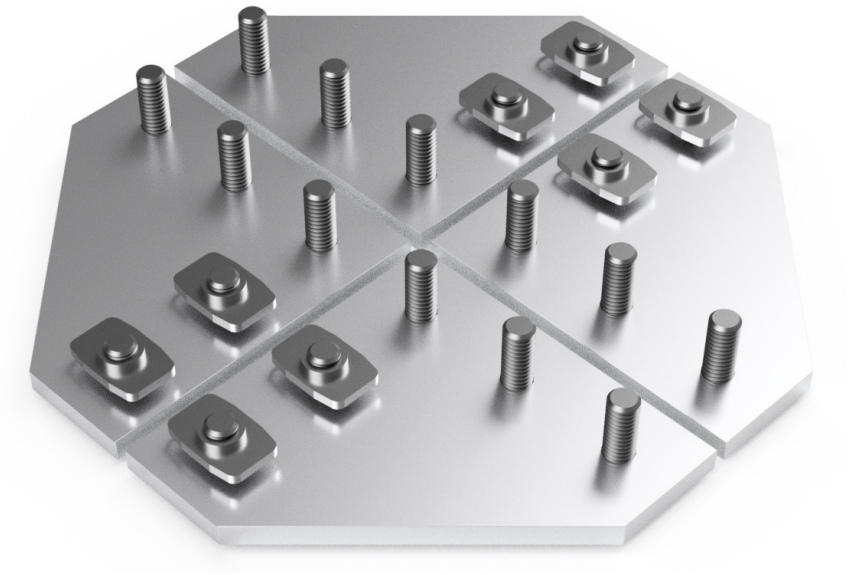
Tap the untapped holes in the ends of two non-Z axis 250mm C-Beams and the four lengths of 20x60 V-Slot. Use Aluminium tapping fluid if you've got it, though WD 40 or Kero will do just fine, just use something. Aluminium is sticky stuff, so try to keep your Tap clean between taps to make the job easier with better results. This is where a shot glass filled with WD 40 comes in handy to dip your tap and a short sharp blow between taps should be enough to clean the Aluminium chips off.

What works for me is to go in as straight as possible, pushing two to three full clockwise turns in then backing it out a turn anti-clockwise to break the chips and repeat until you are at the required depth (~15mm) then go a bit deeper to be safe. The hardest part is getting it started straight, so bevelling the entrance hole a little with a counter sunk bit or an over-sized drill bit helps. Starting it off is kind of like how you start a wood screw… Push and turn a quarter turn at the same time, then repeat until it bites. Sight straight down your tap and extrusion to see if you're going in straight, then adjust if needed. Note: little taps will break in a heartbeat and with little force, so if you're forcing it, you're going in crooked, so back it out and start again and take your time. If you haven't done it before, I suggest practising on the bit of 40x20 V-Slot that you cut off, first. Once you get the hang of it, it is easy as. Another easy option is to use an M5 Drill Tap (available in the Open Builds Part Store) and a cordless drill on low speed, but always lube it up well.

"Little bits for the Frame"

Frame Assemblies

• 90 Degree Joining Plate Assembly (A1)

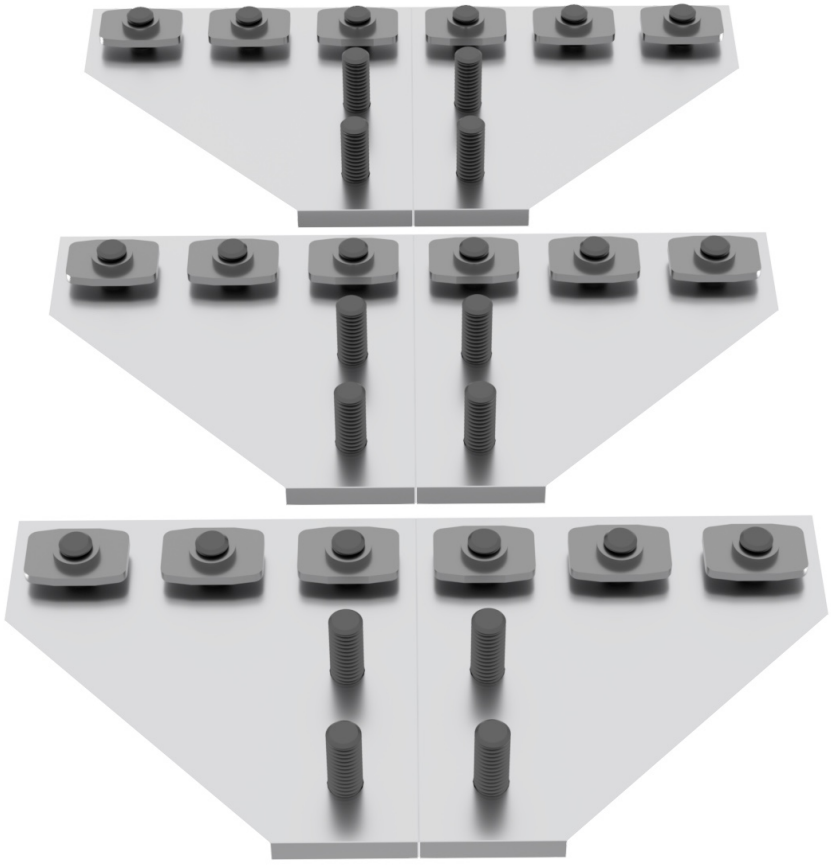


MINI BOM (BOM= Bill of materials)

- (4) 90 Degree Joining Plates
- (8) 10 mm Low Profile Screws M5
- (12) 15 mm Low Profile Screws M5
- (8) Tee Nuts

Makeup two mirrored pairs like in the picture, with the 15 mm screws down one edge, the last two holes get 10 mm screws with Tee Nuts. A trick is to put a bit of tape on the 15 mm screw heads to keep them together or just put them aside till needed. Just get the tee nuts threads started so they are easy to slide into the V-Slot later.

• 90 Degree Joining Plate Assembly (A2)



MINI BOM

- (6) 90 Degree Joining Plates
- (18) 10 mm Low Profile Screws M5
- (12) 15 mm Low Profile Screws M5
- (18) M5 Tee Nuts

Makeup three mirrored pairs, with the 10 mm screws with Tee Nuts down one edge, the last two holes get 15 mm screws.

* A bit of masking tape over the 15 mm screw heads will keep them in place for the moment or just put them aside.

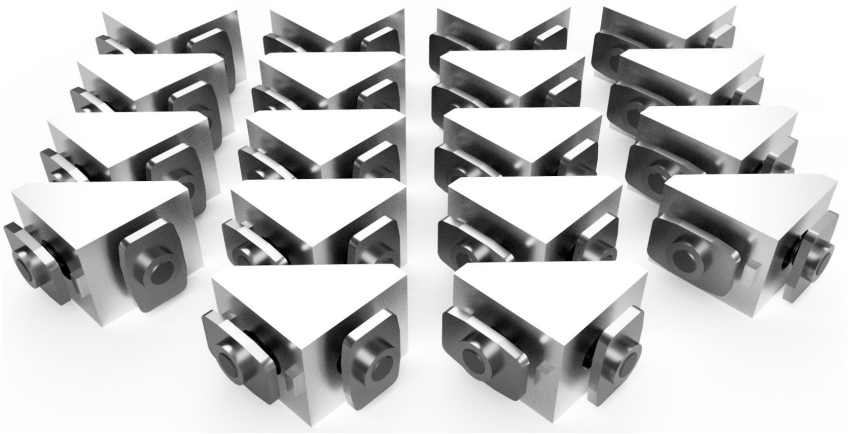
Cast Corner Bracket Assembly (B1)

MINI BOM

- (8) Cast Corner Brackets with nubs intact
- (16) 8 mm Low Profile Screws M5
- (16) Tee Nuts

Just get the Tee Nuts started so they slide into the V-Slot easily. Makeup eight and put aside

Cast Corner Bracket Assembly (B2)

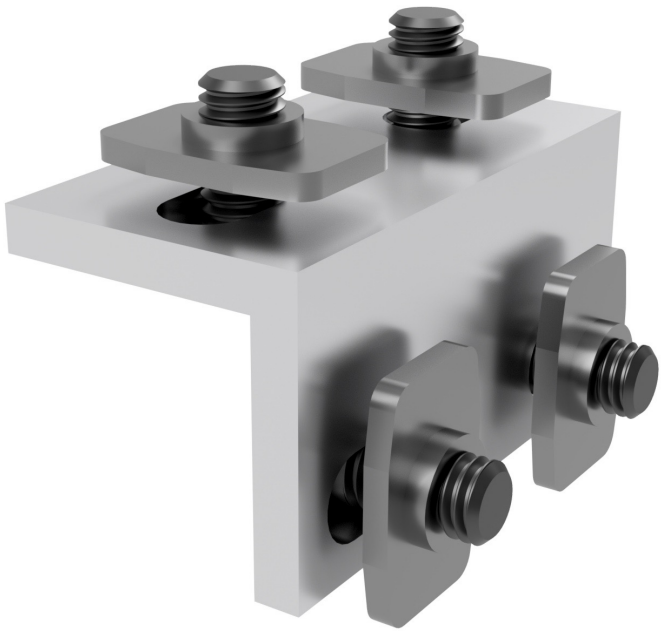


MINI BOM

- (18) Cast Corner Brackets (with nubs filed off on one side)
- (36) 8 mm Low Profile Screws M5
- (36) M5 Tee Nuts

File the two nubs off if you haven't. Makeup eighteen (18) B2 assemblies to put aside. To save some time, leave the Tee Nuts and Screws off the nub side of eight (8) They will be used for the Y-Actuators.

Double L Bracket Assembly (C1)

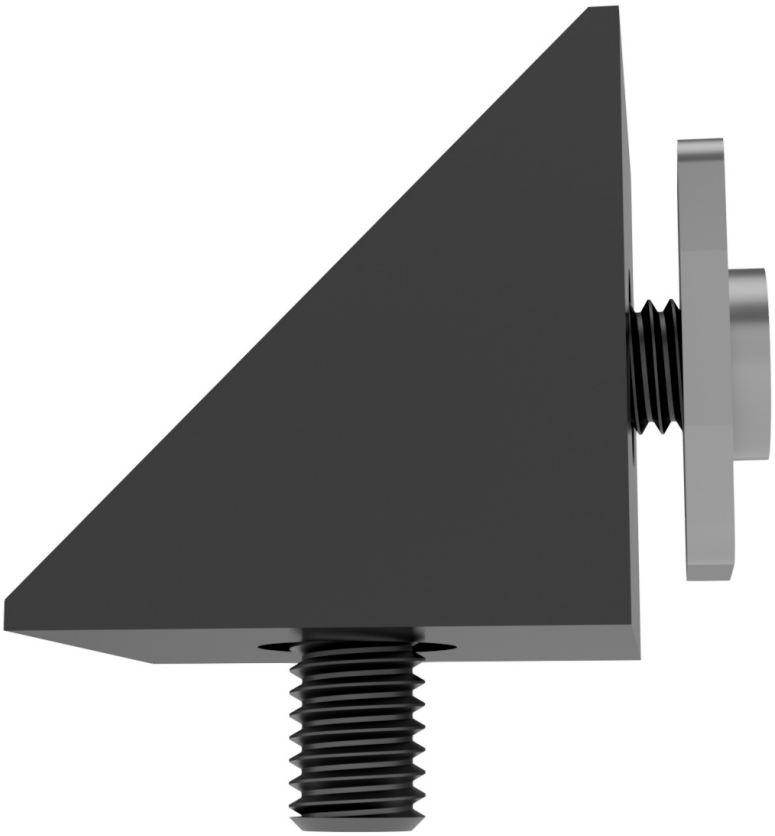


MINI BOM

- (2) Double L Brackets
- (8) 8 mm Low profile Screws
- (8) M5 Tee Nut

Makeup two C1 assemblies and put aside.

Black Angle Corner Assembly (D1)

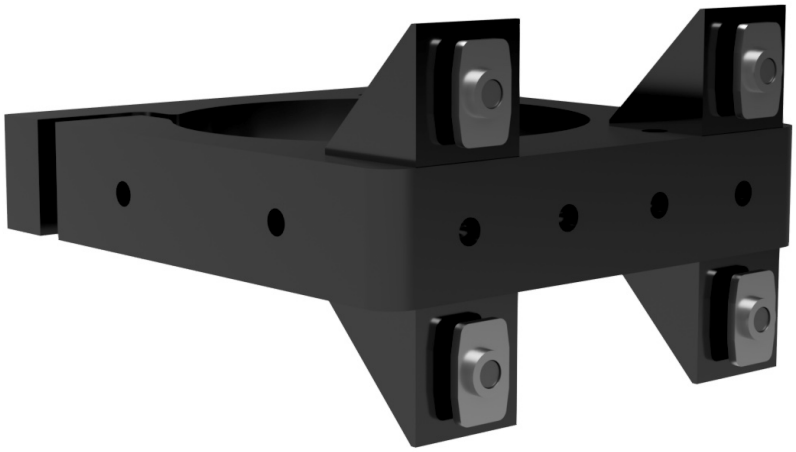


MINI BOM

- (4) Black Angle Corner Connectors
- (4) 10 mm Low Profile Screws M5
- (4) 8 mm Low Profile Screws M5
- (4) M5 Tee Nuts

Make up four D1 assemblies. The 8 mm Screws get the Tee Nuts.

Spindle/Router Mount Assembly



MINI BOM

- (1) Spindle/Router Mount
- (4) D1 assemblies

TOOLS

- 3 mm Allen Wench

Use the 10 mm screws to attach the D1 assemblies to the threaded mount holes on the outside like in the picture.

“Building the Frame”

• Frame Side Assemblies

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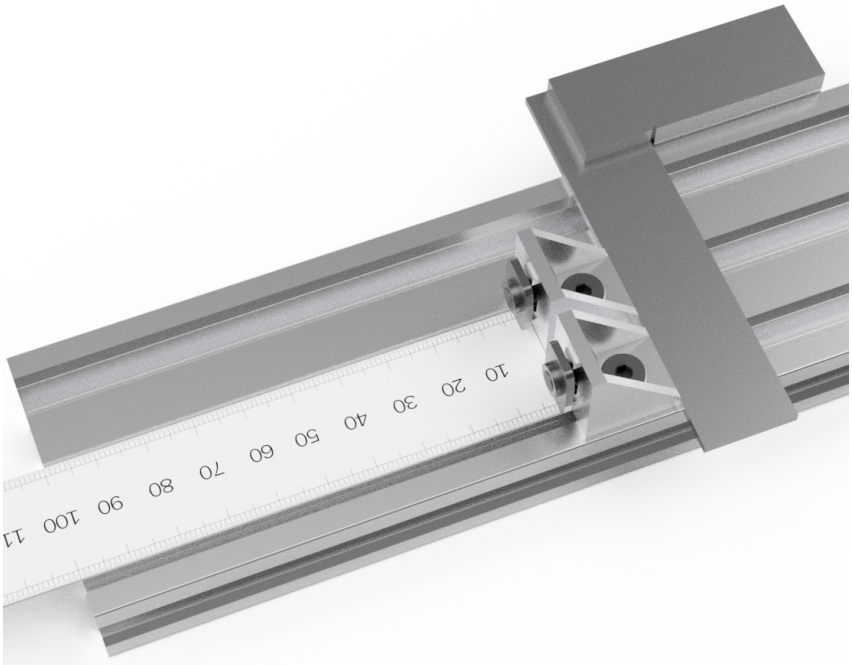
MINI BOM

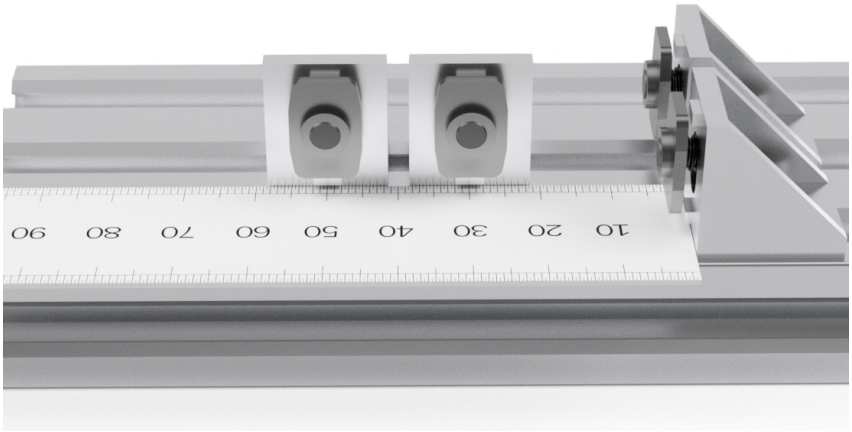
- (2) 500 mm 20x60 V-Slot
- (2) 250 mm C-Beam
- (4) A2 assemblies
- (8) B1 assemblies
- (4) B2 assemblies

TOOLS

- 3 mm Allen Wench
- Square



Slide in two B1 assemblies into the two upper slots in the 500 mm 20x60 V-Slot like in the picture, 100 mm back from the end and snug them up but don’t tighten the tee nuts in the slot, you just need to stop them from slopping about. Square them up and locate them centrally in the slot.



Slide in two B2 assemblies with the filed side down in the middle slot and loosely snug them down and locate as in the picture with their centres* being at 30 mm and 50 mm.

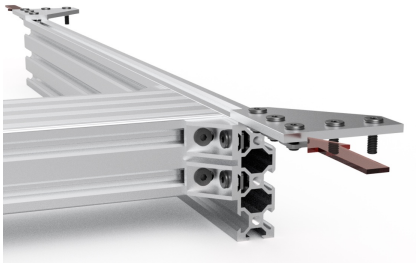
*center (US spelling) centre for the rest of the English-speaking world.

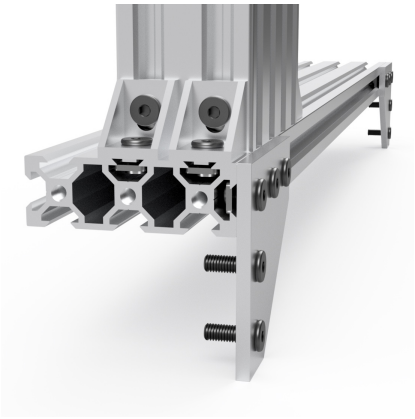
Add two more B1 assemblies, centring them in the slots with their back edge flush and square with the end of the V-Slot. Tighten these two as they will be what the others are referenced from in the join.

Lay it on its side on a flat surface and slide a 250 mm length of C-Beam into the joint, like in the picture. Some wiggling and loosening of Tee-nuts might be needed. Getting all the Tee-nuts pointing in the same direction is the hardest part.

Push down on a flat surface the loosely joined 60x20 V-Slot and C-Beam, then tighten the connectors, checking that the joint is nice and square with connectors centred in their slots.

If you did a good job squaring up the C-Beam there will be no gaps where it buts up tightly with the 60x20 V-Slot.

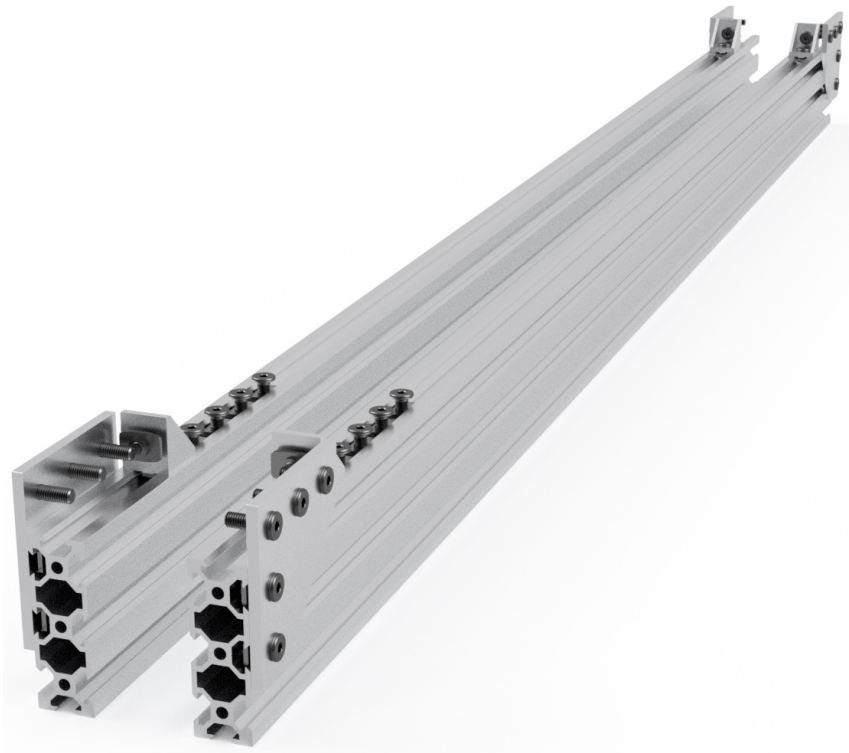




Slide a plate into the side slots, front and back and snug up the Tee-nuts level and square to the ends and top of 60x20 V-Slot

Make up a mirrored copy and your done making the Side Frames.

• Front & Back Frame Assemblies

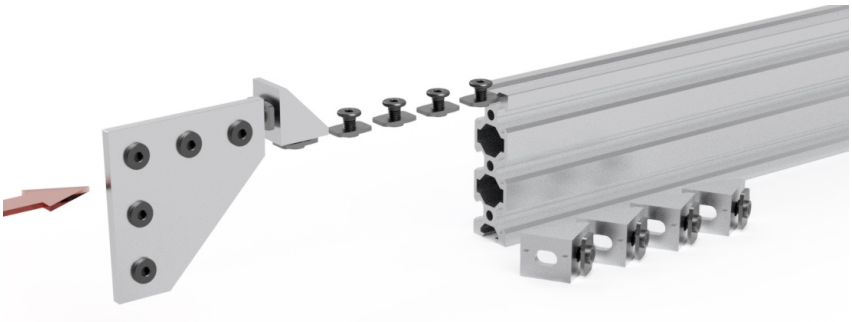


MINI BOM

- (2) 1000 mm 20x60 V-Sot
- (4) A1 assemblies
- (12) B2 assemblies

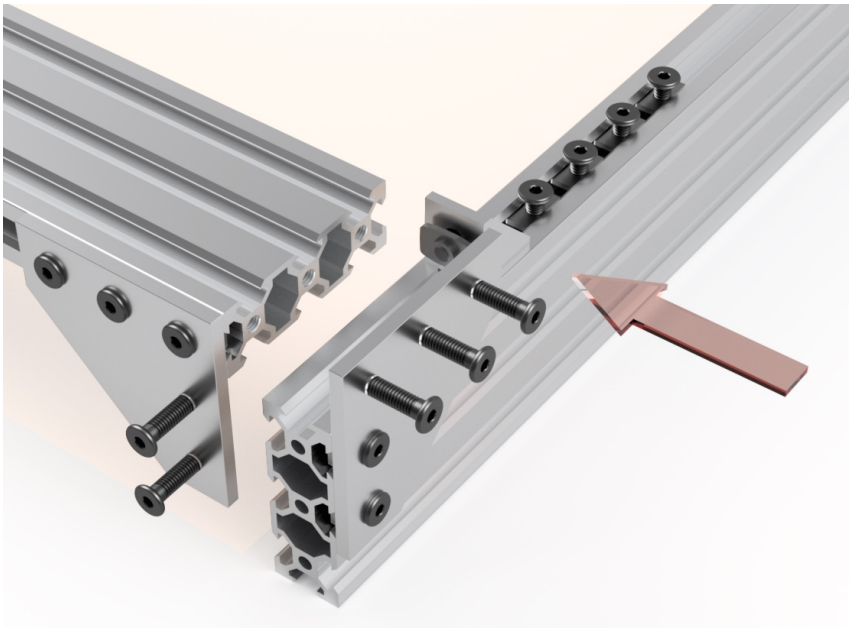
Makeup pair of Front/Back Frame Assemblies.

Remove the screws and tee nuts from nub side of four B2s and slide them into the top slot, followed by one intact B2 (nub side down) and another at the other end. Then slide in A2 plates.

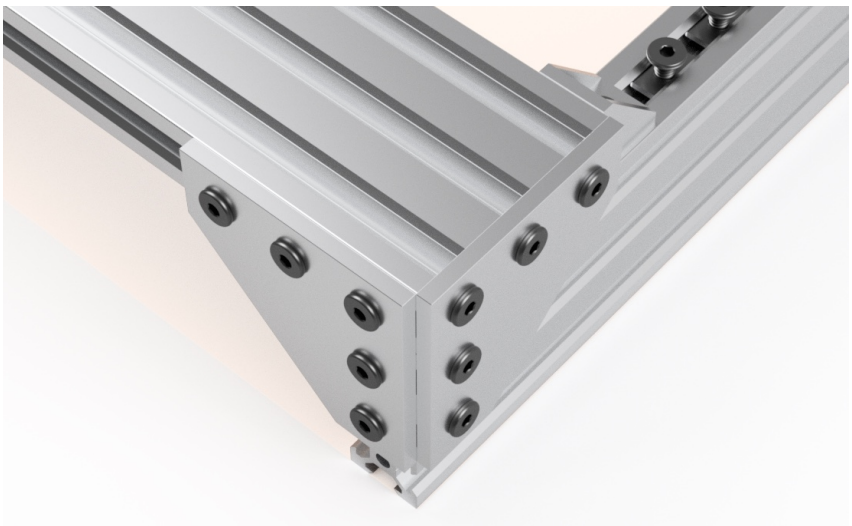


Makeup a mirrored pair and put the cast corners aside for attaching to the Y-Actuators later.

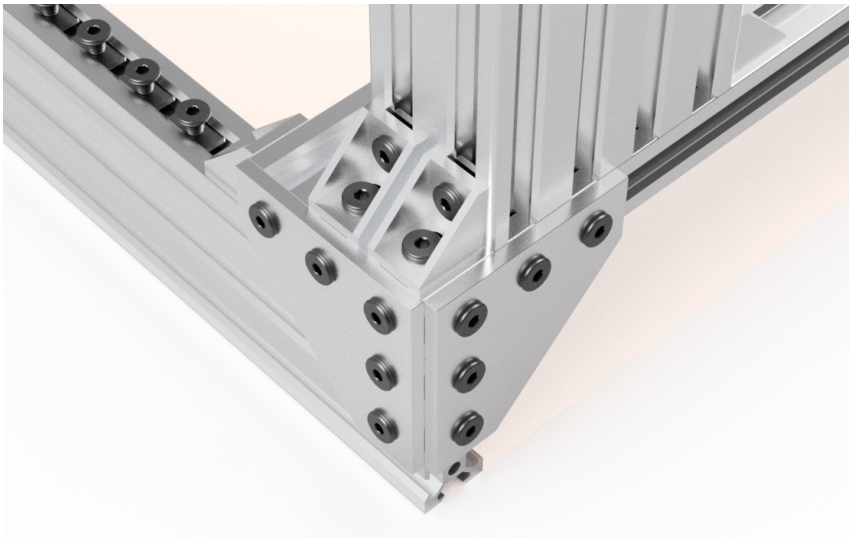
Joining the Frame Base



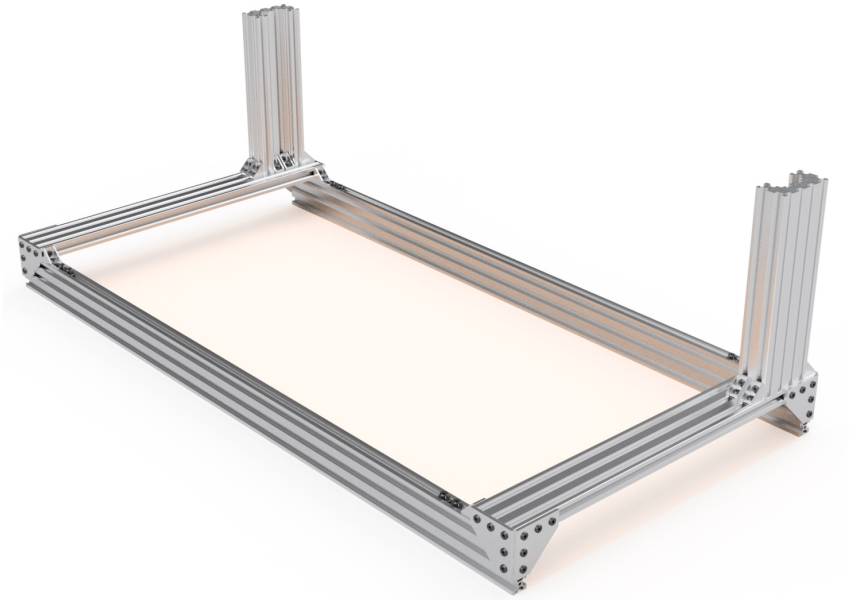
Remove the tape holding the 15 mm screws in place on the plates. Then introduce the corner joint together like in the picture.
Now join the four corners of the base frame using the 15 mm screws through the corner plates into the tapped holes you spent all that time getting right.



For a tight joint, tighten the 15 mm screws into the tapped holes first, followed by the tee nuts on the plate finishing with Cast Corner Bracket Tee-nuts. Check for squareness as you go.

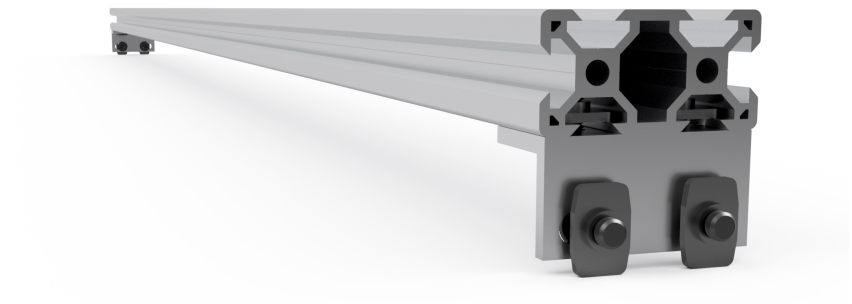


Use the same tightening order as the front corners.



You will end up with something looking like this.

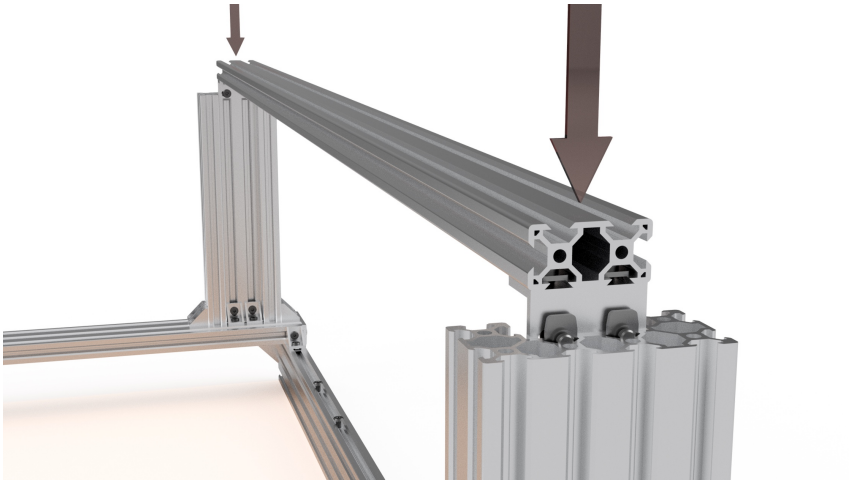
X-Axis Frame Brace



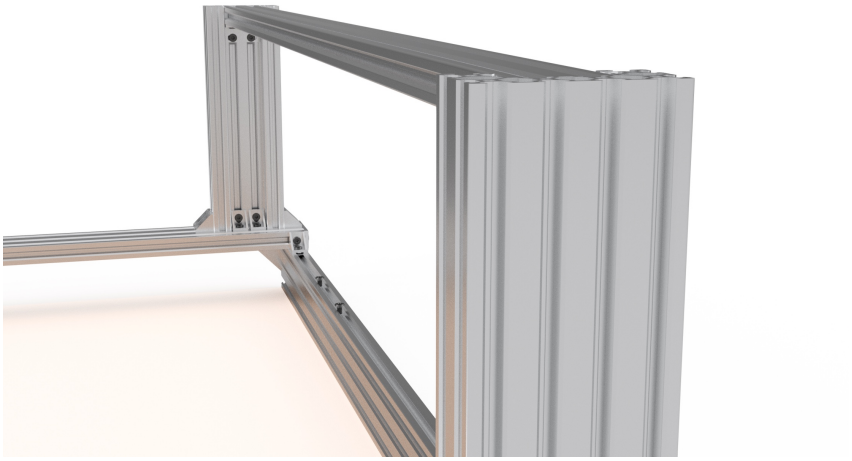
MINI BOM

- (1) ~960 mm 20x40 V-Slot
- (2) C1 Assemblies

Introduce the C1 Double L Bracket Assemblies into the V-Slot like in the picture and tighten them flush, square and centred to the outside ends of the V-Slot.



Introduce the X-Axis Frame Brace into the inside slots of the Side Frame Uprights and slide down till flush. Snug up the Tee-nuts with the brace flush with the top of C-Beam.



If the 20x40 is a bit tight going into the mouth of the C-Beam, either lubricate the joint a little or sneak the 20x40 down to the freezer for a bit of a snooze and grab an icy pole “frozen ice on a stick” while you’re there. While waiting for the 20x40 to reduce in size in the chill, smooth off the sharp edges of the C-Beam mouth with some sandpaper and a little flat stick.

“Basic Structure Complete”

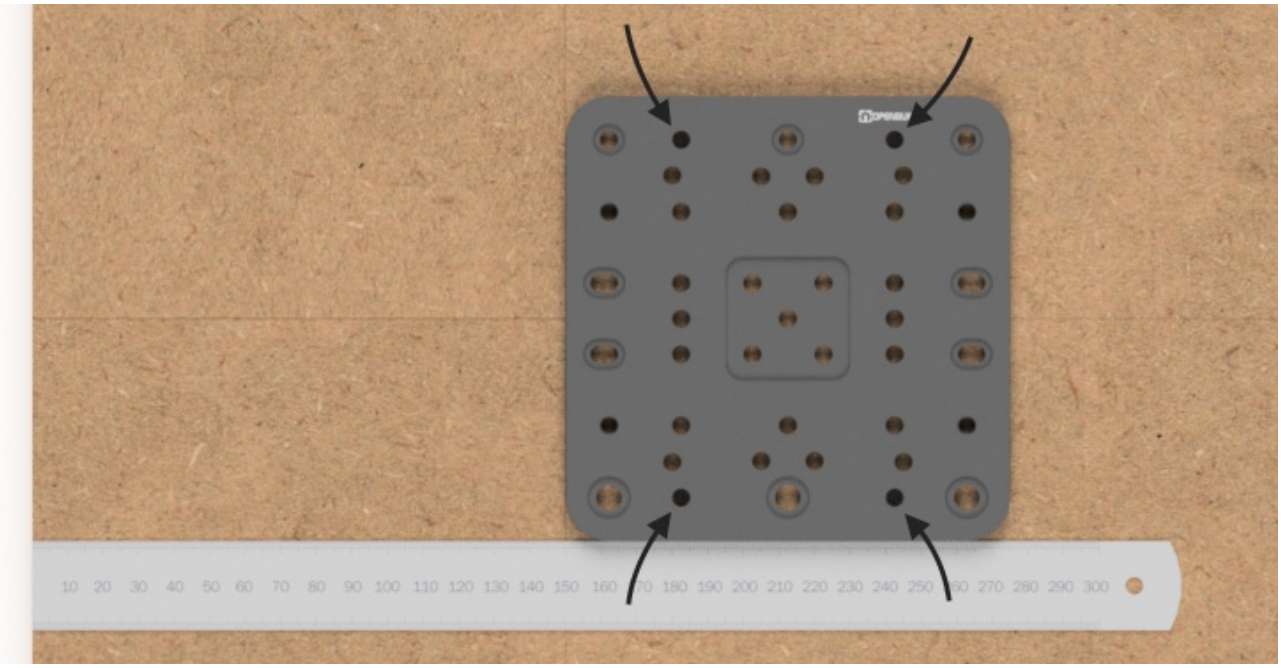
Well done, things are starting to look cool now that you've got the basic frame or backbone together before you go any further, you need to make up the Y-Axis Table, Spoil-board, the wheels and gantry assemblies, but before you move on check for squareness and tighten all those screws. Don't tighten them too much or you will strip the threads, less than a quarter of a turn is all that is needed on these little screws; if your worried that they will come loss, use some Locktite on the threads.

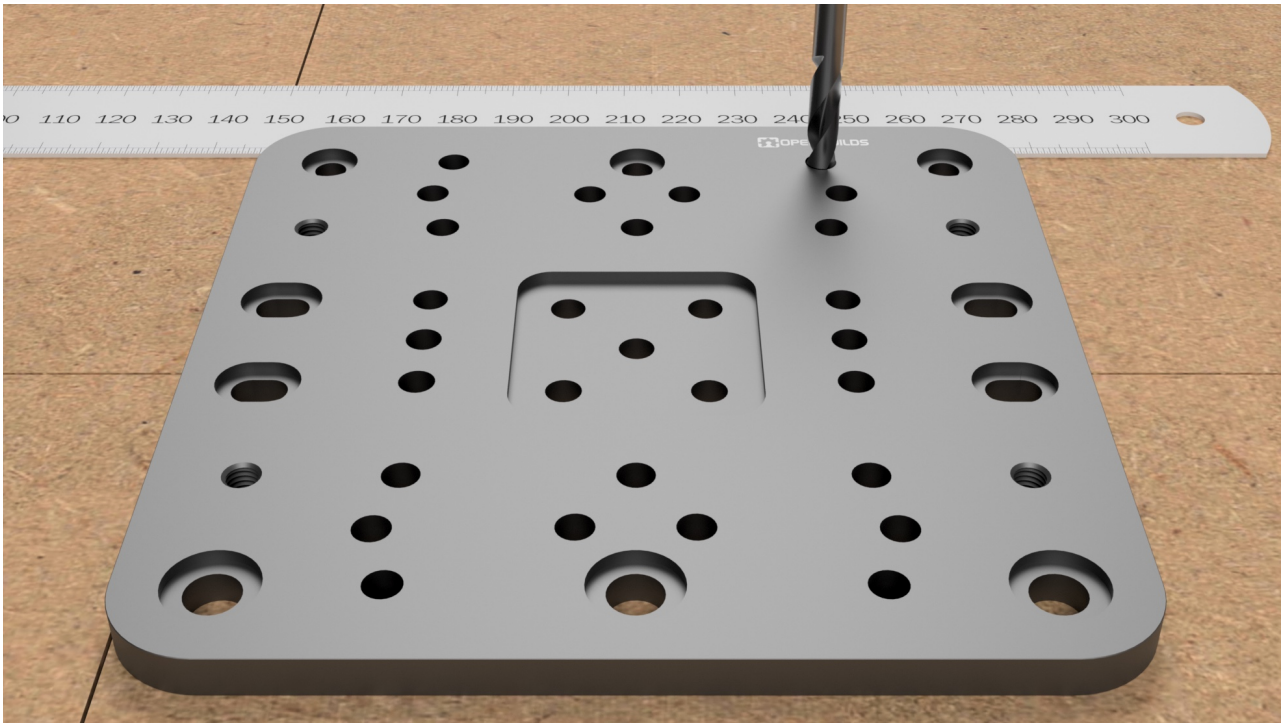
If you don't have a square, one of the plates will do in a pinch. Note: Diagonal measurements from frame corners should be the same if square. That is if the sides of the rectangle are the same lengths.

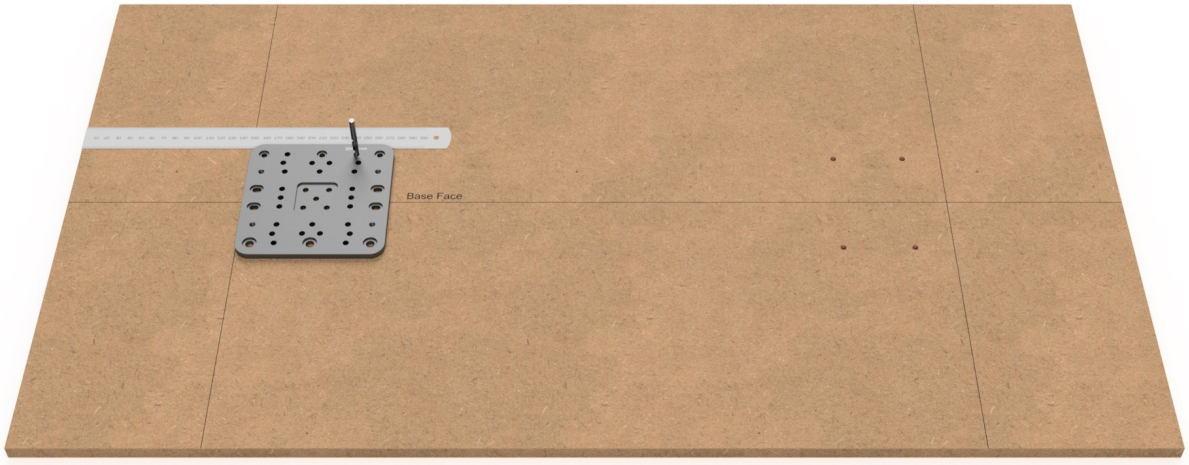
"Making the Y-Axis Table"

The table is the direct connection between the Y-Axis Actuators and your workpiece and in this set up moves your workpiece backwards and forward under your Spindle/Router. It can be made of a variety of materials but in this example, we will use MDF (Medium Density Fibreboard) 900 mm x 500 mm x 1/2" doubled up and screwed and glued for strength. MDF is readily available, relatively cheap, easy to work, consistent in thickness and fairly stable when sealed. Please feel free to change how this is made to suit your work needs and how you want to securely attach your work pieces.

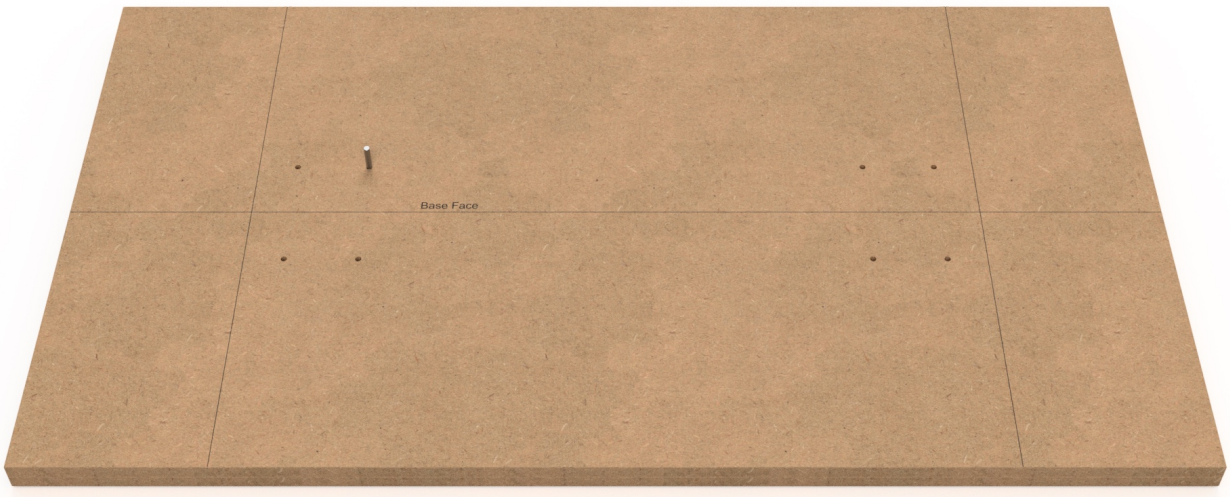
The simplest way to mark out the fastening holes to your Y-Gantry plates is to mark a centre line and two more parallel lines 150 mm in from each side. Use these to locate one of the gantry plates which you will use as a template and drill guide using the unthreaded holes arrowed below. Drill straight down with a 5 mm drill bit using the arrowed holes as a guide.

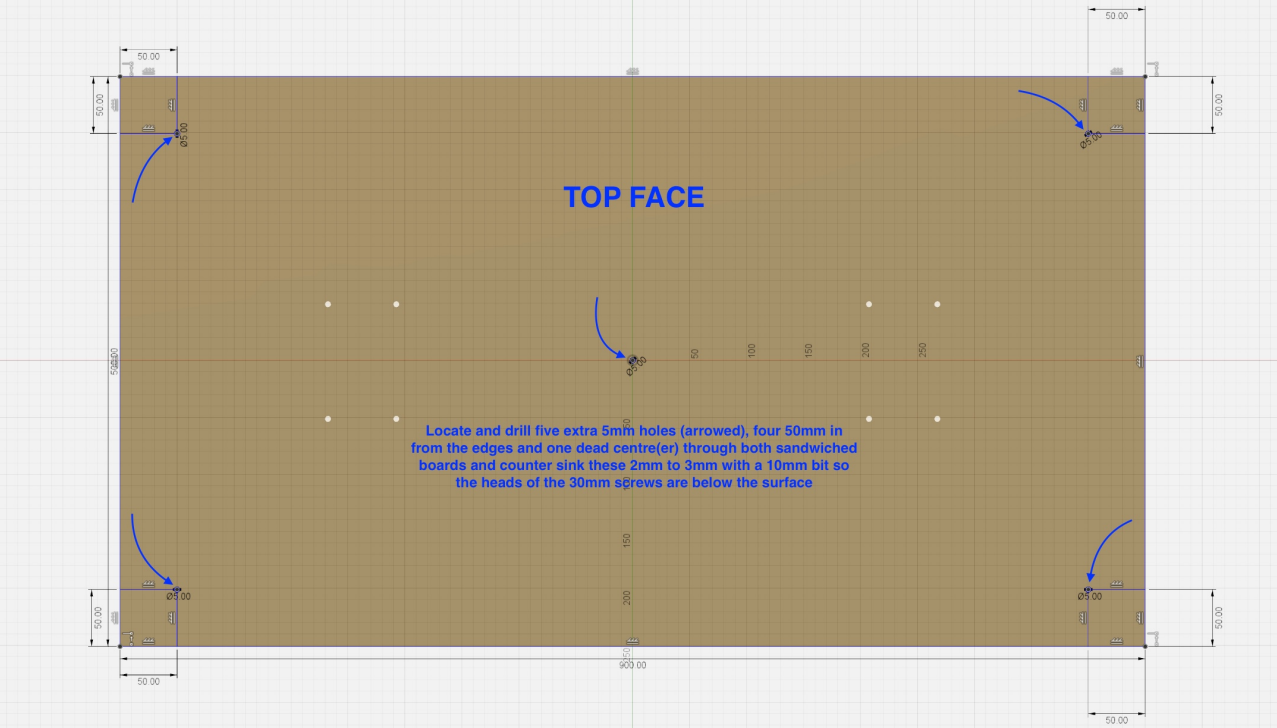




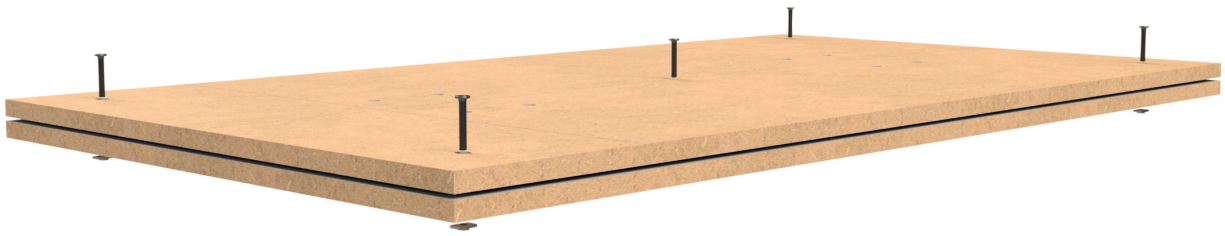


Using a plate as a template, drill through the panel. This board side will be the base face. I did both at the same time, using a straight edge along the top edge of both plates to keep them parallel, then clamped them in place with a 3-foot length of 2”x1” and two quick action clamps. Just make sure everything is where it should be before you commit. Place the drilled panel on the second panel, aligning the edges flush and use it as a template to drill right through the second panel.



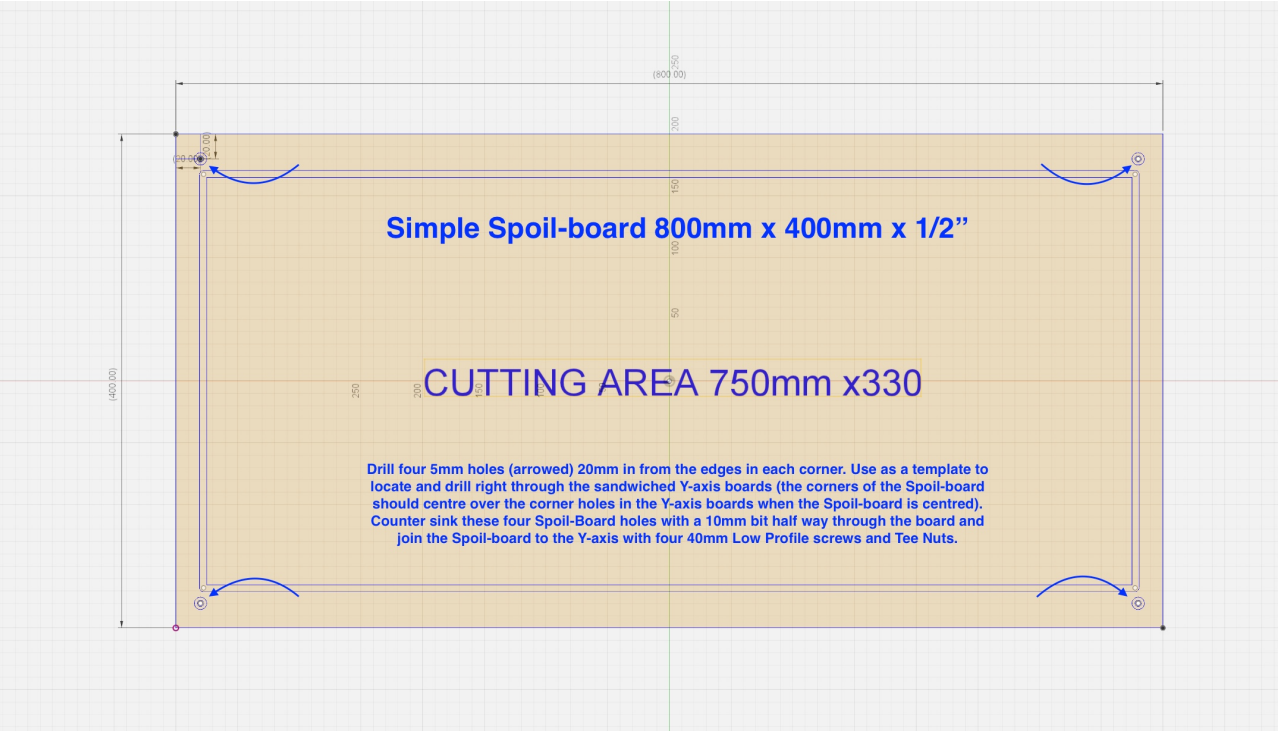


Keeping the two boards together, flip the two boards over so you can work on the top face. Dropping in some 30 mm Low Profile Screws to keep the boards aligned, helps. Mark out five more holes, one dead centre by drawing diagonal lines from corners and four with their drill centres 50 mm in from each edge on the corners. Using a 5 mm drill bit, drill these right through both boards. Then using a 10 mm bit, countersink the thirteen holes on the top face down 2 mm to 5 mm, so the heads of the Low Profile Screw sit just below the surface of the top face.

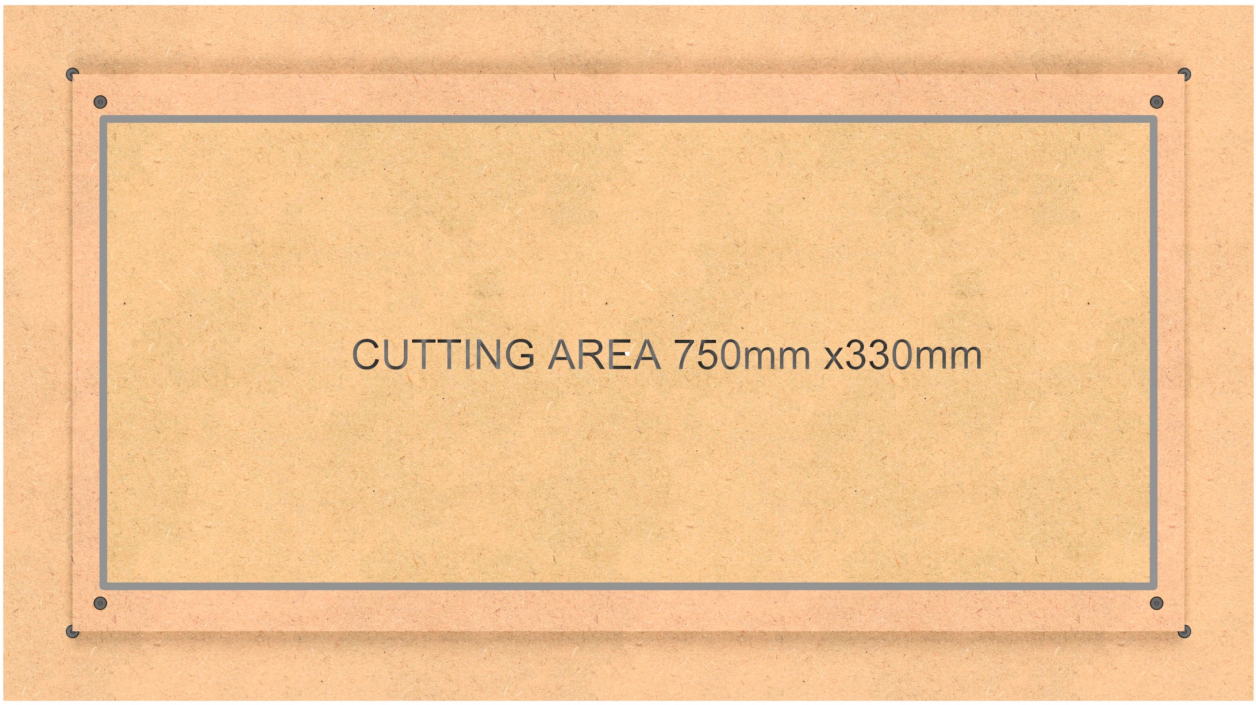


Spread a thin coat of glue between the two boards and clamp together with five 30 mm Low Profile Screws and Tee Nuts.

You will end up with sandwiched board something like this.



Make up your Spoil-board using an 800 mm x 400 mm x 1/2” sheet of MDF. Mark four drill centre points, 20 mm in from the edges on each corner. Drill these holes with a 5 mm Drill Bit, right through the Spoil-board. Countersink these hole with a 10 mm Drill Bit half way through the Spoil-board, so the Screw heads are out of harms way.

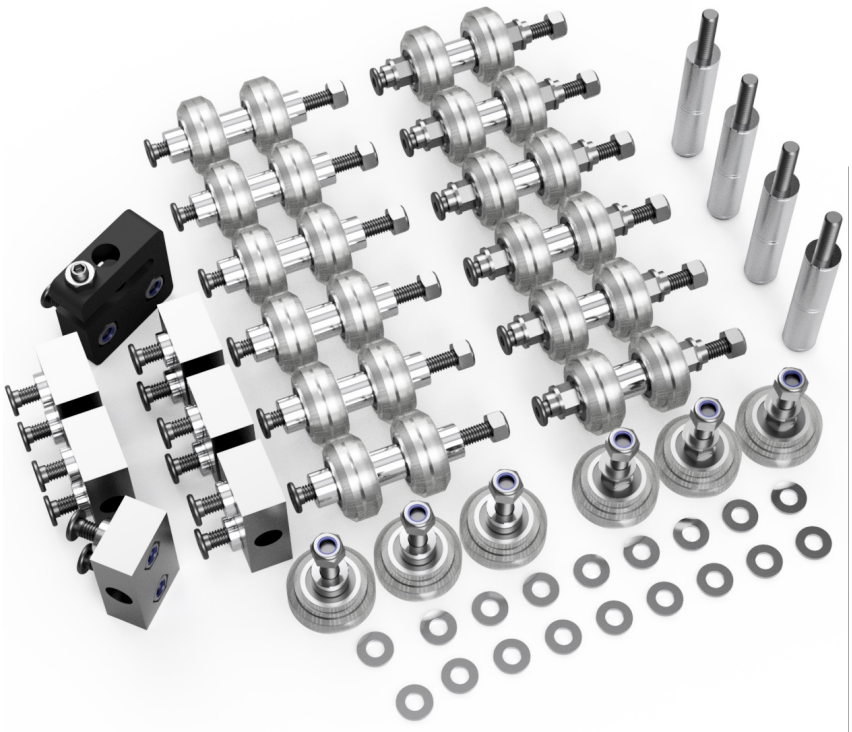


Centre the Spoil-Board to the Y-Axis Table, using the Y-axis Table corner screws as a reference. Then using the Spoil-board corner holes as a template, drill right through the Y-Axis Table with a 5 mm Drill Bit.

The Spoil-board will be attached to the Y-Axis Table with four 40 mm Low Profile Screws and Tee Nuts, without glue, so it can be removed when too scarred (spoiled) and replaced with a new fresh one. Don't attach it just yet, it will be attached after the Y-Axis Actuators are attached to the Y-Axis Table.

If you want your Y-Axis Table to last this is a good time to give it a coat of paint to seal it. I used a couple of coats of external marine grade satin Polyurethane, using a small paint roller.

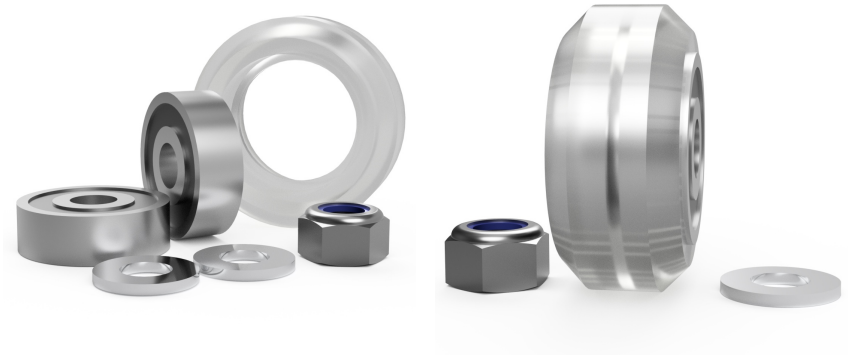
“Wheels, Nut Blocks and Spacers”



MINI BOM

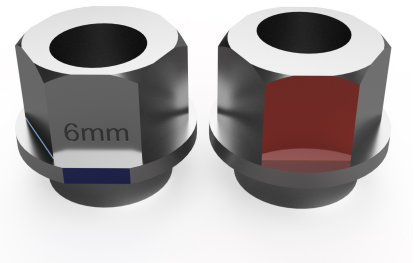
- (30) Wheel Kits
- (14) 3 mm Aluminium Spacers
- (15) 6 mm Aluminium Spacers
- (12) 9 mm Aluminium Spacers
- (8) 20 mm Aluminium Spacers
- (15) 6 mm Eccentric Spacers
- (12) 20 mm Screws
- (6) 25 mm Screws
- (16) 60 mm Screws
- (6) Acme Nut Blocks
- (1) Anti-Backlash Nut Block

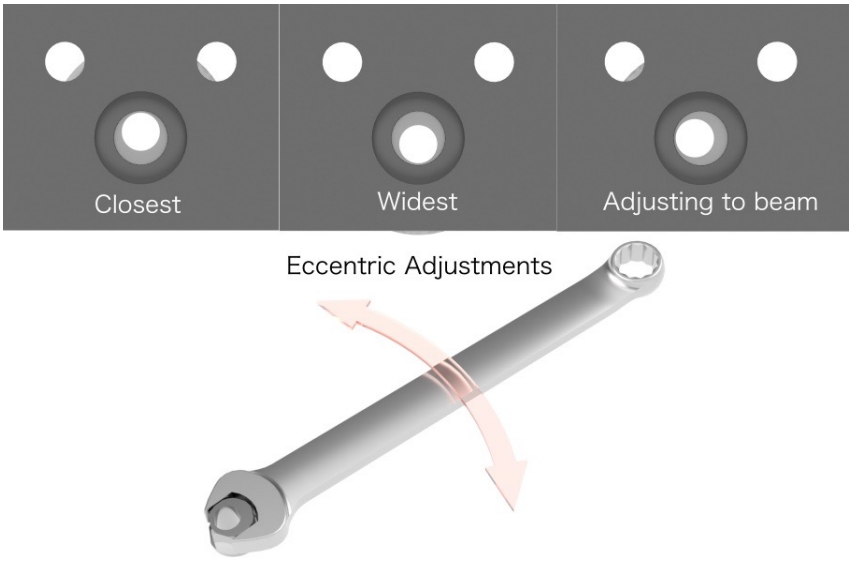
“There will be thirty (30) spare precision shims from the Wheel Kits after building your wheels. Twelve (12) of these will be used for the Spacer Assemblies further down. Lucky you! You will have eighteen spare precision shims at the end of your build”



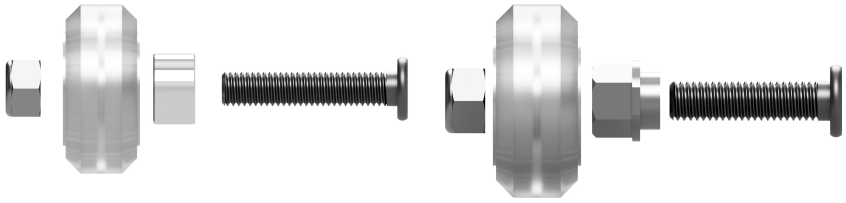
Build up your thirty (30) **Wheel Assemblies** from the Wheel kits.

Popping a bearing in on either side of the polycarbonate wheel, with one precision shim between the two bearings.

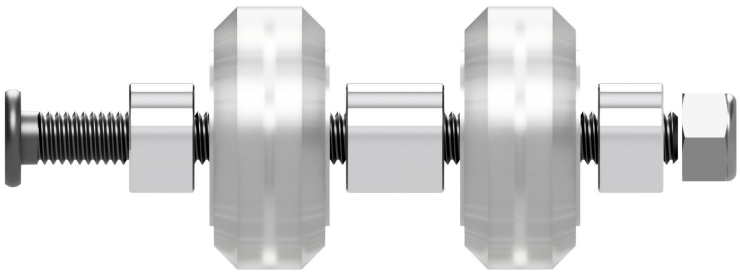




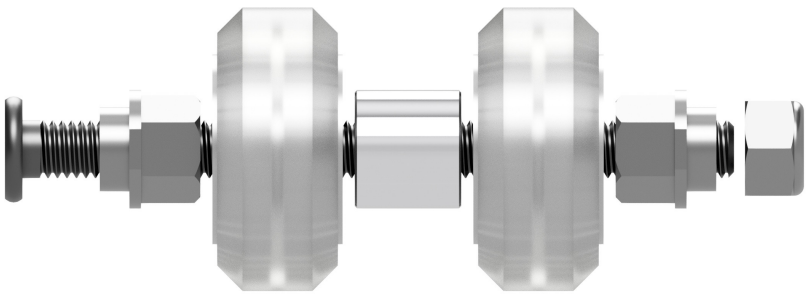
While you've got all the eccentrics in the one place, have a look for the 6 mm stamp on the thinnest part. If the 6 mm stamp is hard to see, you can mark that side with a marker pen, so it is easier to see for adjustment later on. Getting on in age and not having the eagle eyes of when I was a pup; I found that marking the opposite flat side with a different colour also helped as this mark will come into view to the outside when adjusted to the beam and to the outside when closest or at the maximum tightest adjustment.



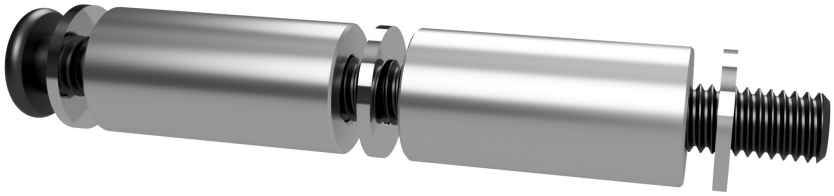
Makeup three (3) **Single Std Wheel Assemblies**, using 25 mm Screw, 6 mm spacer, Wheel Assembly, Nylon Nut. Make up three (3) **Single ECC Wheel Assemblies**, by using a 6 mm Eccentric Spacer instead of the Aluminium Spacer.



Makeup six (6) **Double Std Wheel Assemblies**, using a 60 mm Screw, 6 mm Spacer, Wheel Assembly, 9 mm Spacer, Wheel Assembly, 6 mm spacer, hold it together for now with a Nylon Nut.



Makeup six (6) **Double ECC Wheel Assemblies**, using a 60 mm Screw, 6 mm Eccentric Spacer, Wheel Assembly, 9 mm Spacer, Wheel Assembly, 6 mm Eccentric Spacer, hold it together for now with a Nylon nut.

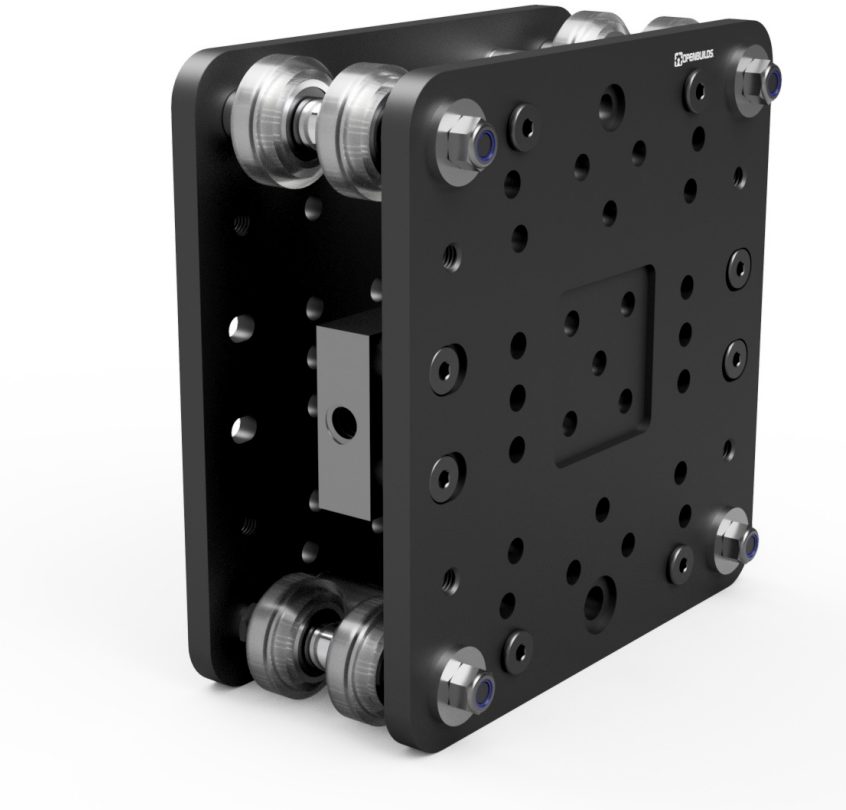


Makeup four (4) **Spacer Assemblies** using a 60 mm screw, 1 mm precision shim, 20 mm spacer, 1 mm precision shim, 20 mm spacer, 1 mm precision shim.

Put together six (6) Nut Block Assemblies, using two (20) 20 mm screws, two (2) 3 mm Spacers, two (2) Nylon Nuts and one (1) Nut Block.

Put together one (1) Anti-Backlash Nut Block Assembly using two (2) 20 mm screws, two (2) 3 mm Spacers, two (2) Nylon Nuts and one Anti-Backlash Nut Block kit.

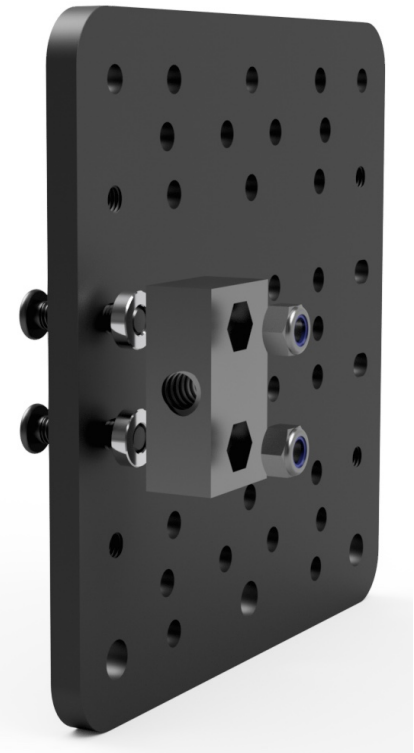
“X-Gantry Assembly”



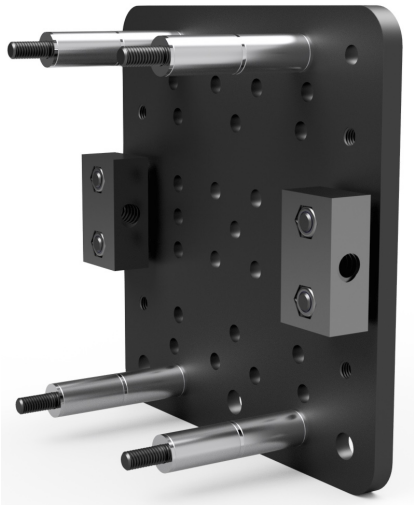
MINI BOM

- (2) XLarge Gantry Plates
- (2) Double Wheel Std Assemblies
- (2) Double Wheel ECC Assemblies
- (4) Spacer Assemblies
- (2) Nut Block Assemblies
- (4) Slot Washers

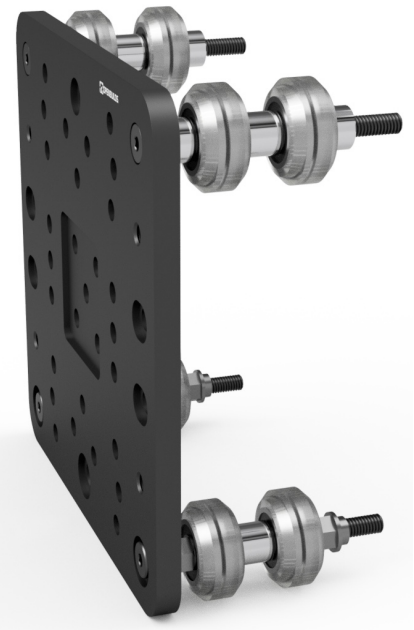
We will jump straight into the deep end and do the most complicated Gantry first, so you will find out it’s not as difficult as it looks, just a little fiddly.



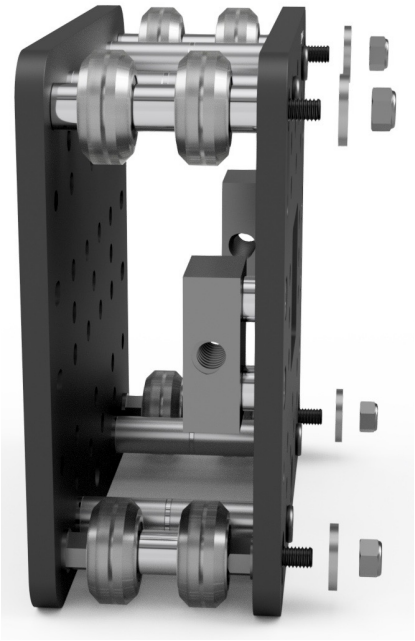
Attach a pair of Acme Nut blocks to one plate with 20 mm Screws, 3 mm spacers and Nylon Nuts and snug up the screws and bring them to the out side of the slots for the moment.



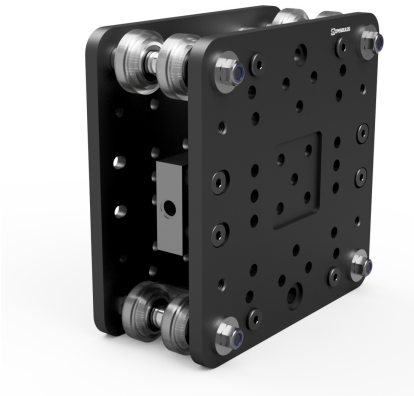
Add four 60 mm Screws through plate, Shim / 20 mm Spacer / Shim / 20 mm Spacer / Shim. A bit of Tape on the screw heads will hold them in place for now.



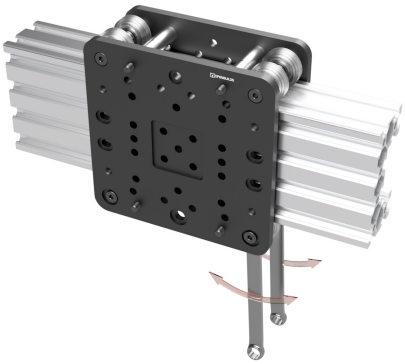
On the other plate introduce the Double Std Wheel Assemblies to the two outside **small holes** on the corners. Add the Double ECC Assemblies to the **large holes** on the outside corners.

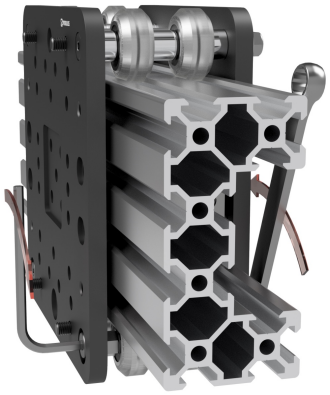


Introduce the two sides together, add the four Slot Washers then the Nylon Nuts and snug them up for now. The 60mm screws with the spacers will be used to join the X gantry to the Z gantry later on, so leave them taped in place for now.



Sit back for a moment and admire the coolest paperweight on the block. Or more like the building blocks of the awesome linear motion system you've just made.



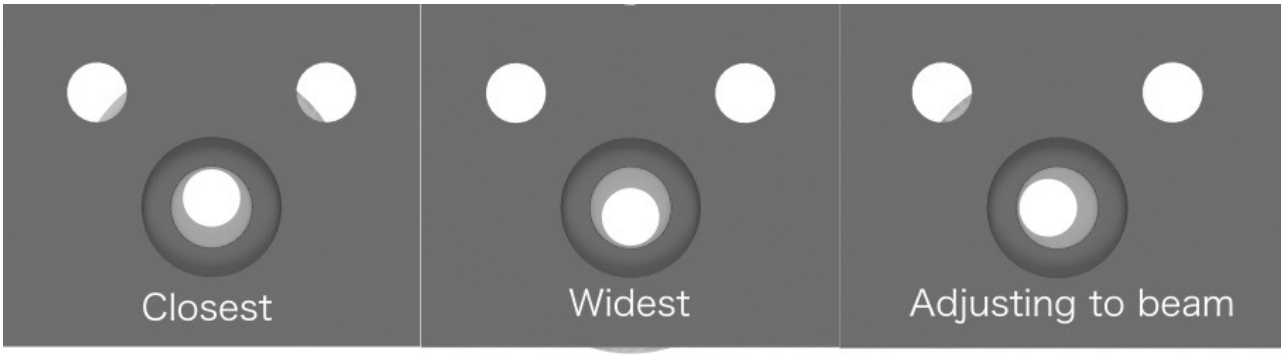


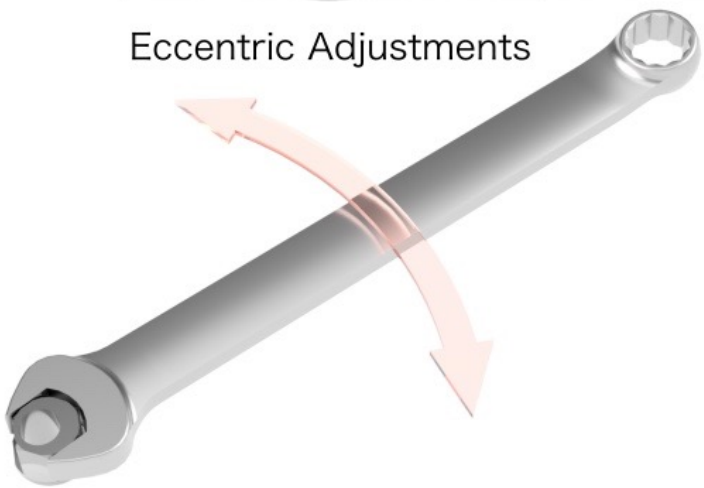
Adjust the four eccentrics to their closest position, this bringing the bottom wheels above the base of the plates. Push down both plates on a flat surface, then tighten firmly the wheels assemblies with the standard spacers at the top.

Readjust the eccentrics to their widest position. Introduce a section of C-Beam then adjust them back towards the closed position until there is no play between the wheels and beam.

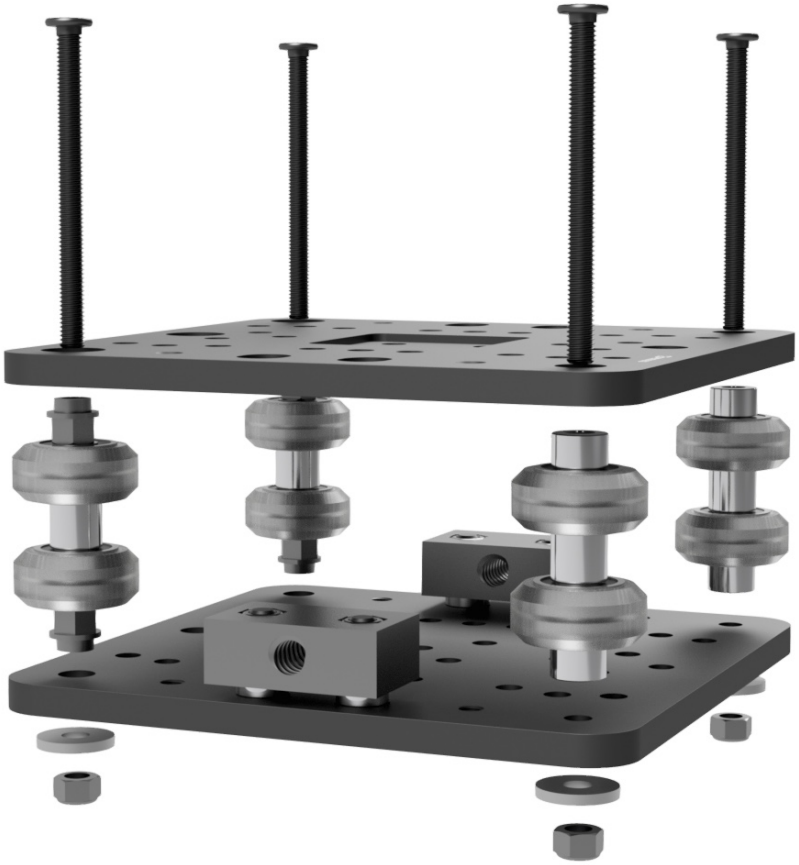
Make sure you adjust the pairs of eccentrics to exactly the same position. This is where a pair of wenches and the marks on the eccentrics, makes adjusting easier.

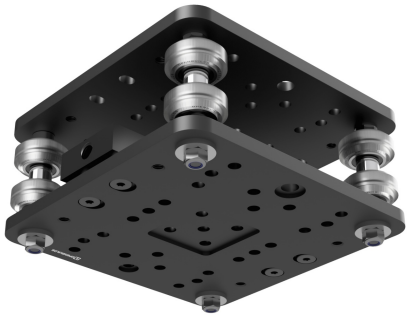
When the wheels are tight to the beam with just a bit of slip of the wheels and no binding, tighten the double wheel eccentric assembly. The wheels on the mouth side of the C-Beam will slip more than the ones on the backside when adjusted to the same position, so try to get the best compromise, with both in the same position. Retest for no play, no binding, with just a little slip on all wheels. Readjust as needed.

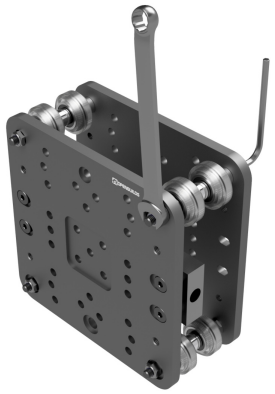


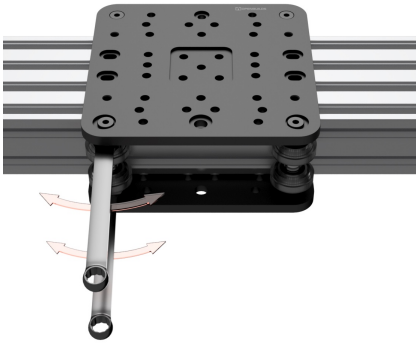


“Y-Gantry Assembly”









MINI BOM

- (4) XLarge Gantry Plates
- (4) Double Wheel Std Assemblies
- (4) Double Wheel Ecc Assemblies
- (4) Nut Block Assemblies
- (8) Slot Washers

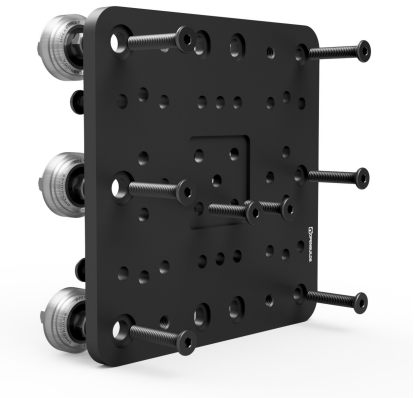
The Y-Gantry assemblies and adjustment are pretty much the same as the X-Gantry assembly without the extra spacers. Makeup two (2) exactly the same. Please use your newly gained Ninja skills to work it out.

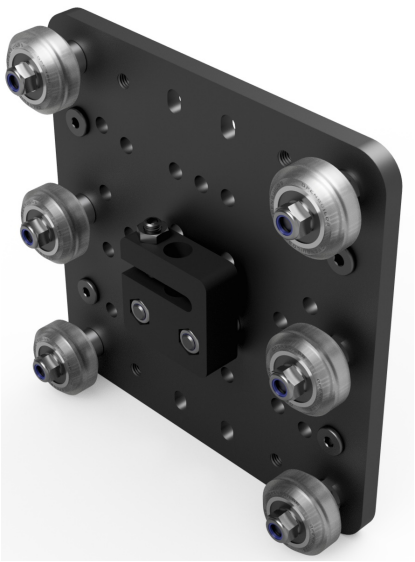
“Z-Gantry Assembly”

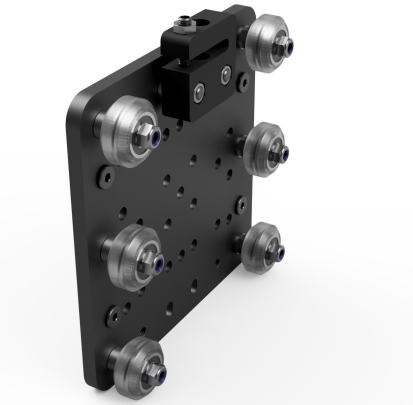
MINI BOM

- (1) XLarge Gantry Plate
- (3) Single Std Assemblies
- (3) Single ECC Assemblies
- (1) Anti-Backlash Assemblies
- (4) 10 mm Screws

You should have refined your ninja skills to put these gantries together by now, the only difference with this one is it uses single wheel assemblies instead of doubles and we are using the Anti-Backlash Nut Block. Have a think about which side you want the eccentrics (are you a lefty or righty?) and where the nut block ends up on your machine for ease of adjustment. A little hack is to attach the nut block on the two slots at the top for easy on machine adjustment, which I did on my build, but I will leave that decision up to you.







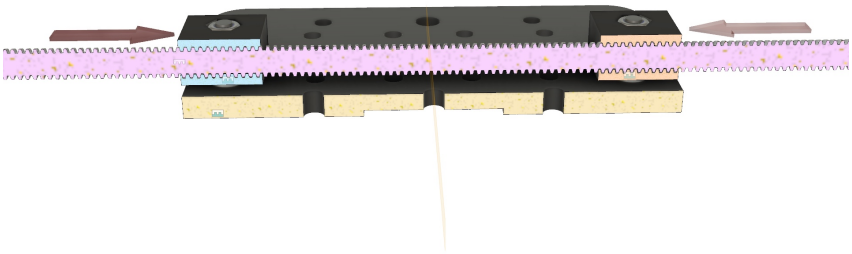
Don’t forget those four 10mm screws located in the unthreaded holes between the wheels. Tape them in place so you don’t lose them, they will join the Z to the X gantry later on.

“Acme Lead Screws & Nut Blocks”

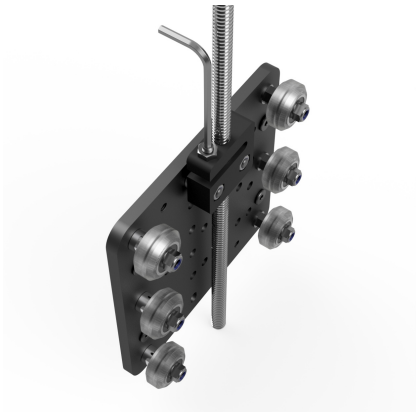
Just a little bit of information about the stainless steel 8mm Acme Lead Screws that are used to translate motor revolution into linear motion.

Tr8*8-2p (4 starts) equates to 8mm of movement for each full rotation.

While the lead screws are out of the machine, give them a little love by cleaning any gunk off, filing or sanding off any shape edges from the starts of the threads and hand threading them through the nut blocks to clear any milling waste. A little dry lube will result in a nice smooth movement, which is a good thing.

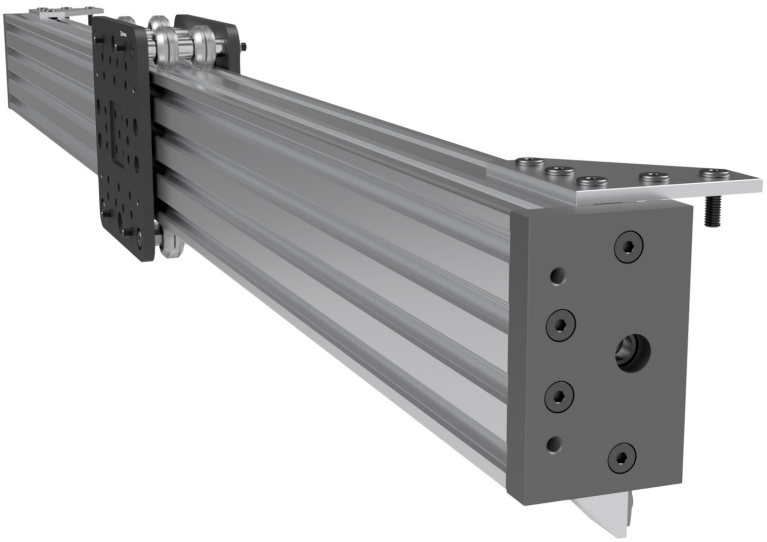


Lead Screw Backlash on the X and Y actuators can be reduced by pushing the nut blocks together and tightening them enough to hold them firmly in place in the adjustment slots, without crushing and deforming them.



Adjust the Anti-Backlash Nut Block on the Z with the grub screw, locking it in place with the lock nut. What you’re aiming for is no up and down play in the thread with free and smooth rotational movement.

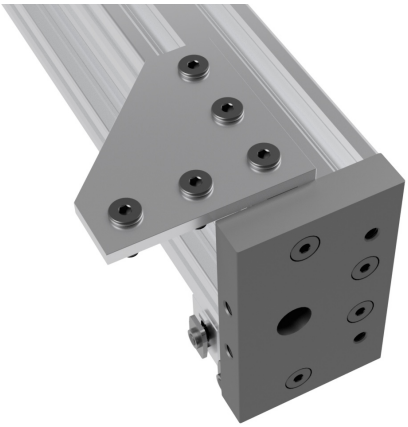
“X-Axis Actuator Assembly”



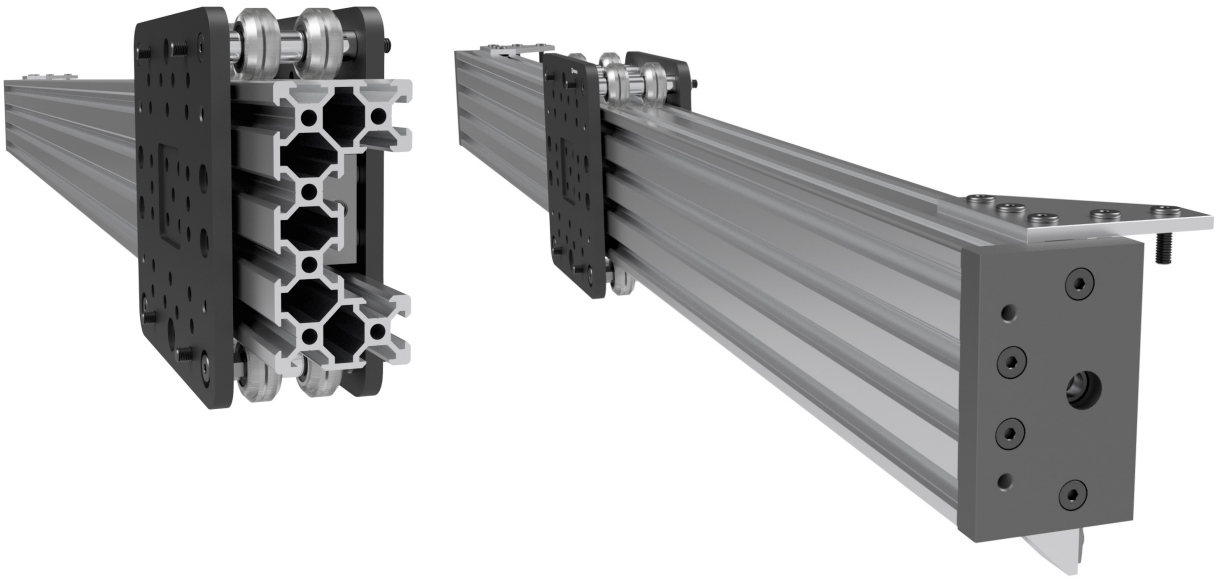
MINI BOM

- (1) 1000 mm C-Beam
- (2) B2
- (2) A2
- (2) C-Beam End Plates
- (8) 20 mm Screws
- (2) Ball Bearing 8x16x5
- (2) 8 mm shims
- (2) 8 mm Lock Collars
- (1) 1000 mm Lead Screw
- (1) 1/4” x 8 mm Flexible Coupling

Slide in one B2 into bottom slot of C-Beam (filed side), ~ 1.5 mm in from the edge and then snug it up in place. Slide in an A2 into the top slot and snug it up flush with outside edge, square and centred.

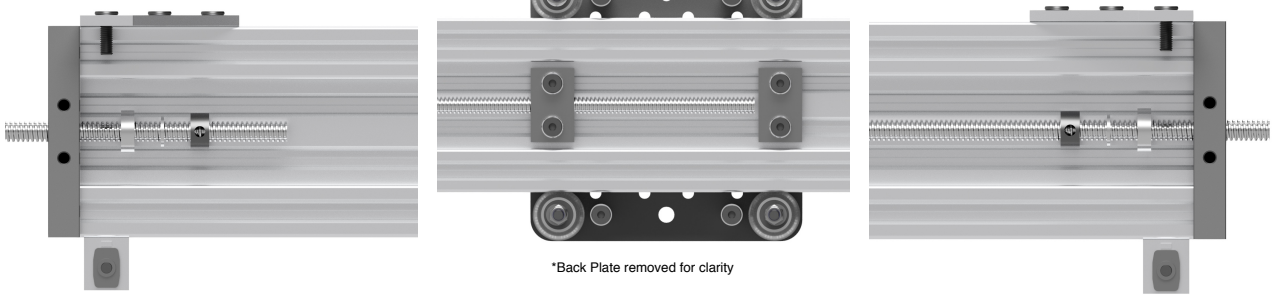


Attach a C-Beam End Plate using four (4) 20 mm screws and tighten. You should end up with something looking like this



Turn the beam around and slide on your X Gantry with the eccentrics to the bottom.

Now mirror what you did on the first end. Have a bit of a think about which side you want to have your stepper motor. Having it close to your controller and power supply makes sense.

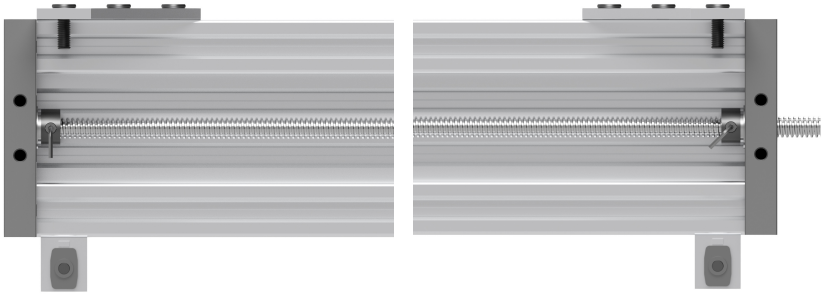


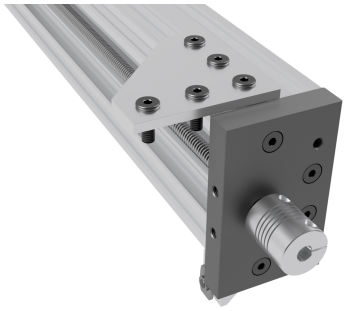
*Back Plate removed for clarity

Introduce the Acme Lead screw, threading it through the C-Beam End Plate > 688Z 8x16x5 Bearing > 8 mm Shim > 8 mm Lock Collar, then continue to the first Acme Nut Block.
Note: Round side of 8 mm Shim should face bearing on ends of Lead Screw.

Start screwing it through the first Nut Block then up to the second. Loosen the second Nut Block Mounting Screws so you don't cross thread the Lead Screw, aiming to keep it to the outside of the slots.

Continue to other end and thread through the Lock Collar > Shim > Bearing > End Plate.



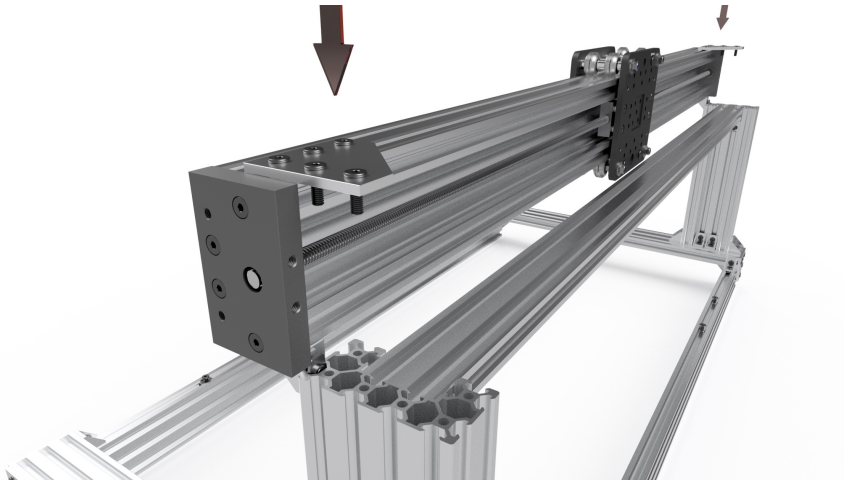


Bring the Lead Screw end Flush with the outside of the End Plate, push the bearing into the pocket in the End Plate and tighten the Lock Collars grub screw firmly while pinching it all together. The grub screw needs to fit between the Acme threads not the top of the thread so rotate the Acme till it does. Do not over tighten the lock collar or it will strip out the grub screw. *A hack is to file a flat on the Acme under the Lock Collar and to add a couple turns of Teflon tape between the Bearing and Acme to reduce slop between the Bearing and Acme.*

Back to the other end. Back off the C-Beam End Plate screws, 1/2 turn from snug. Pinch the lock Collar and end of Lead screw together, pushing the bearing into the End Plate and tighten the Lock Collars Set Screw loosely between the Acme thread, rotate the collar like a nut until snug, then tighten the grub screw firmly. Retighten the End Plate screws, this putting a little pretension on the bearings.

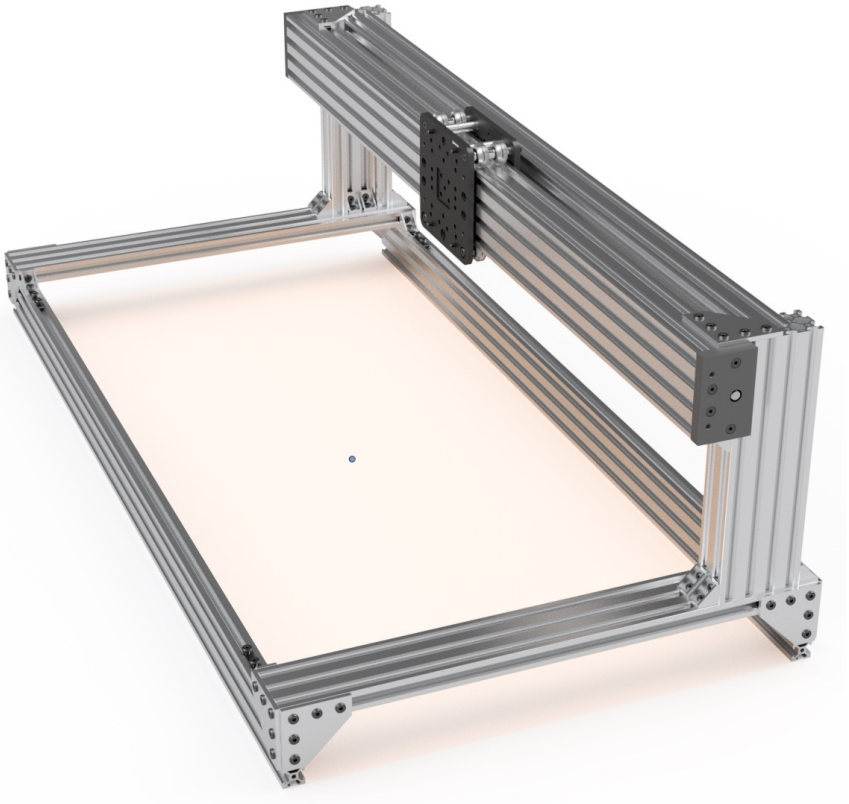
Attach Flex Coupling at least 1mm away from the end plate, so it doesn't scrape. Tightening the larger set screw first, using a 2.5 mm Allen key, to close the gap and then the little grub screw to lock it in place with a 2 mm key. Just be careful not to strip these little screws and the little grub screw sits between the Acme thread. This is the side that your Stepper Motor will attach to. Adjust the Acme Nut Blocks while it is off the frame and easy to do. You just completed your first actuator.

"Being the longest Actuator this Acme Lead Screw is the most prone to whiplash, so adjusting it just right with just a little pretension and not too much is what you are aiming for. What worked for me was to move the X Gantry to one end and over tension, the opposite end, bowing out the Acme Lead Screw a little; then slowly loosen the Lock Collar Grub Screw until the Acme Lead Screw straightens, then retighten the Grub Screw again." This will only work if you've filed a dead flat area on the Acme Lead Screw where the grub screw tightens down to. Take your time to get it right while it's off the machine and easy to do. If you don't want to file the Acme use the Collar like a nut with its grub screw between the Acme thread but not tightened"



Introduce the X-Actuator Assembly into the front slots of the C-Beam Frame uprights. The overhangs of the C-Beam End Plates will be a tight fit if the 40x40 is exactly 40 mm shorter then X actuator C-Beam, making a strong precise join. If it is tight you can loosen the C-Beam End Plate Screws a little, just remember to retighten them when it is in place.

Loosen the 40x20 Double L Brackets a little and screw in the four 15 mm screws of the top plates into the C-Beam Frame uprights, then square everything up and retighten again, making sure the C-Beam End Plates butt up tightly with the C-Beam Frame uprights.



Looking good :), go on and have a play with the movement of the X. Just be a little careful not to run the wheels up hard against the top plates or you will damage them. One of the first mods you might consider is to replace those top plates with a 120 mm x 40 mm x ~4 mm plate, so you can gain about 40 mm of extra X travel, reduce the risk of damaging your wheels and give that top joint a nice finished look ;)

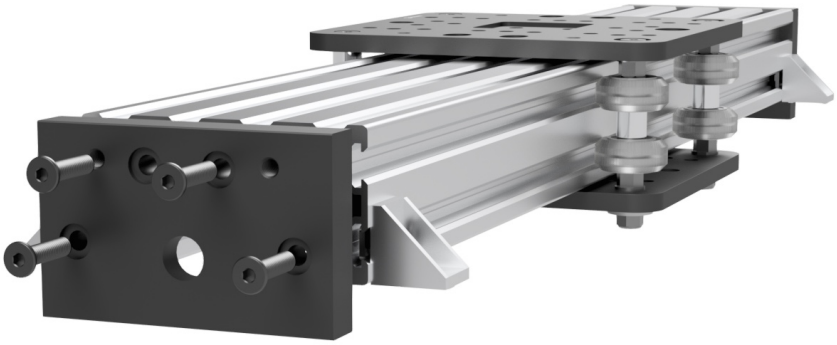
“Y-Axis Actuators”

MINI BOM

- (2) 500 mm C-Beams
- (8) B2 assemblies with the 8 mm screw and Tee Nut removed (these should be in the top slot of the front and back frame)
- (2) Y-Gantry Assemblies
- (1) Y-Axis Table Assembly
- (16) 20 mm Low Profile M5 Screws
- (8) 30 mm Low Profile M5 Screws
- (4) C-Beam End Mounts

Add two B2s to the bottom side slots of 500 mm C-Beam and snug up the Tee Nuts about 1.5 mm in from the edge. Introduce a Y-Gantry Assembly, then add two more B2s on the other end and snug up 1.5 mm in from that end.

You will end up with something like this.

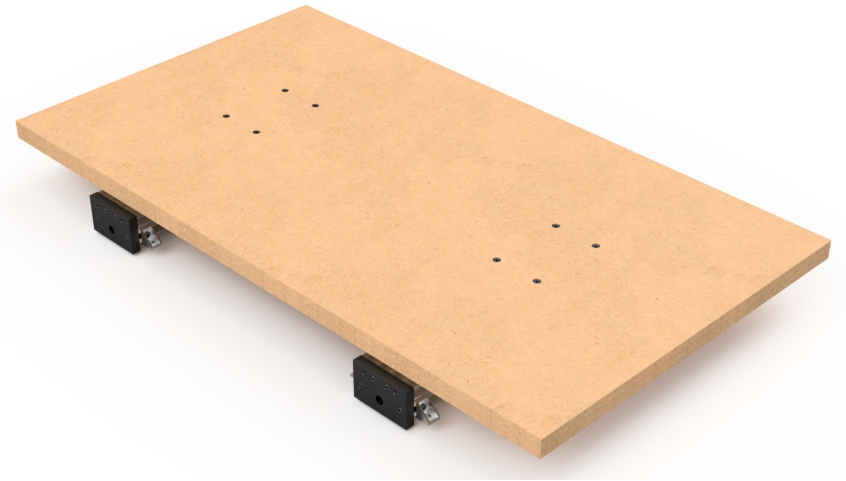


Attach the C-Beam End Plates with the 20 mm screws.

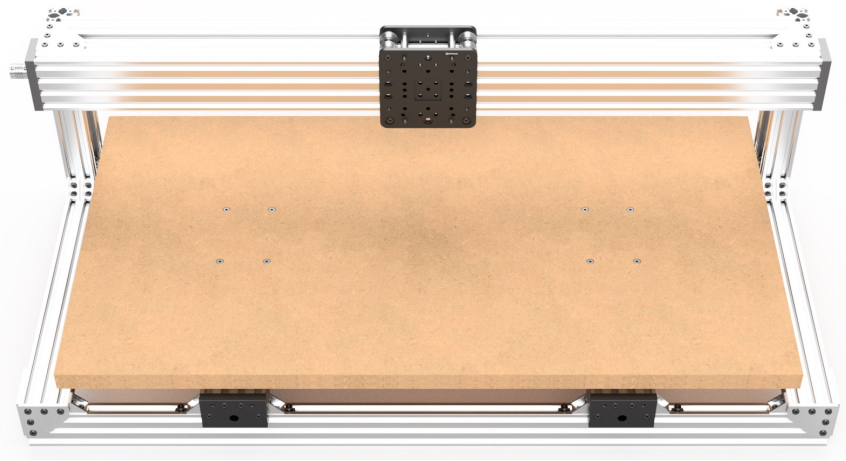
Make up two. Things are always more fun with company!

Attach the Y-Axis Table with the eight(8) 30 mm screws. Making sure the eccentric side of the Y-gantries is pointing towards the middle.

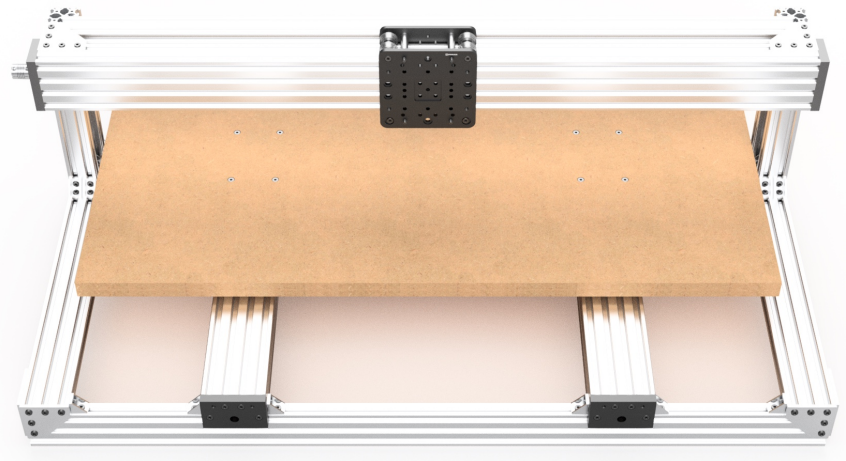
“ It’s a bit tricky lining up the screws to the plates. I found that standing the table on its edge with just one screw poking through, I was able to move the gantry into place to locate the screw and get it started. Once you get the first one started, the others are easy to locate.”



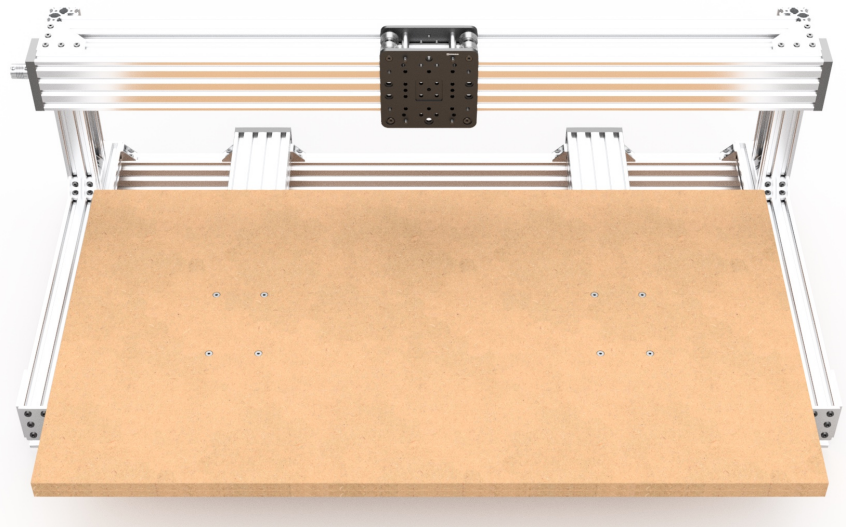
You will end up with something looking like this. We will call it the Y-Axis Table Assembly for now.
Leave the screws just snug for now.



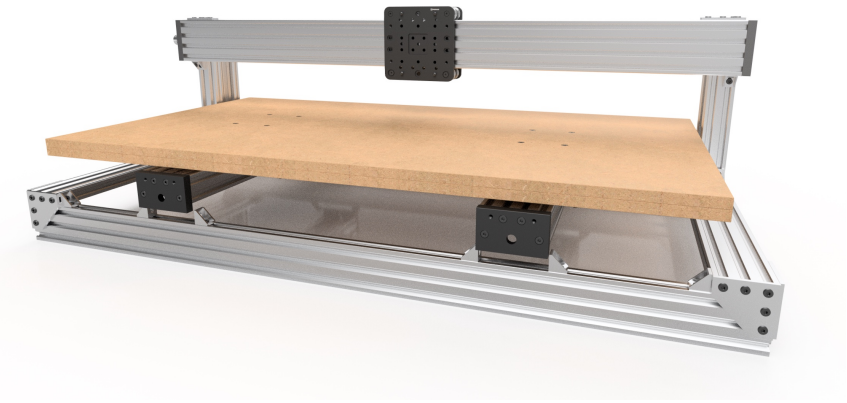
Introduce the Y-Axis Table Assembly to the frame, hooking the C-Beam end plates over the front and back of the frame.
Make sure the Tee-Nuts are out of the way. Centre the table (there should be about 10 mm space between the Table and the Frame Uprights) and attach the Tee Nuts to the Cast Corner Bracket and loosely snug up.



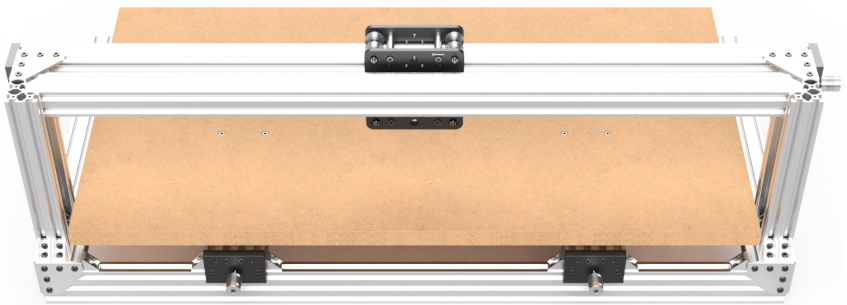
Slide the table back and forward to locate the table to the frame making sure the gap between the frame uprights and the table are equal (~ 10 mm each side). The measurements between the front and back of the Y-actuators and the side frame need to be equal.
When satisfied, tighten the Tee Nuts.



Well, that's it folks you're just made a "Slider Chair" (patent pending;)… No just kidding, this thing is much more exciting than a chair.



On the bad news front, you will have to undo eight screws, now that the Y-Axis Table has been located to the frame, to add and adjust the Acme Lead Screws to the Y-actuators easily. Just make sure the 8 mm screws and Tee-Nuts holding the Cast Corner Bracket stay fully tightened to the frame and only undo the ones on the Y-actuators.
Once removed, flip it on its back to make it easier to work on and add and adjust the Acme Lead Screw like you did one the X-actuator.



When you are satisfied the Lead Screws are adjusted the same both sides. move them to the same position on the table and reattach to the frame.

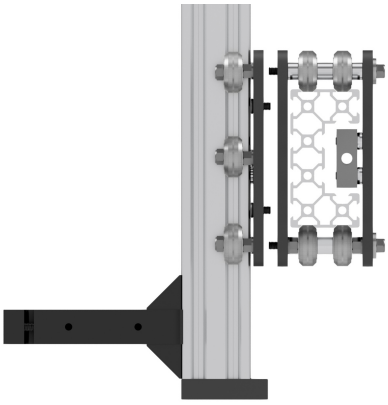
"Z-Axis Actuators"

The pile of bits and pieces is getting pretty small now and the pile of empty bags is getting large as the end of the build is near. So hopefully your worked out the routine, so I won't slow you down with a Mini BOM (just use what's left) and I will just show you.

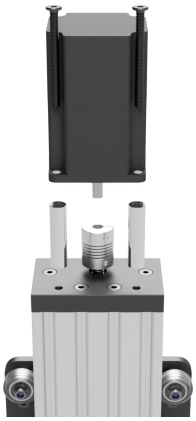
What needed to assemble the Z-Axis Actuator should be pretty straight forward by now.

Just slide in and attach the Router/ Spindle Assembly flush with the bottom of the C-Beam, add the Z-Gantry Assembly then attach the C-Beam End Plates with 20mm screws.

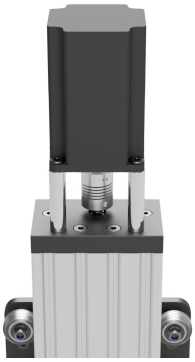
It will look something like this, ready to add the lead screw like you did with the X and Y Actuators.



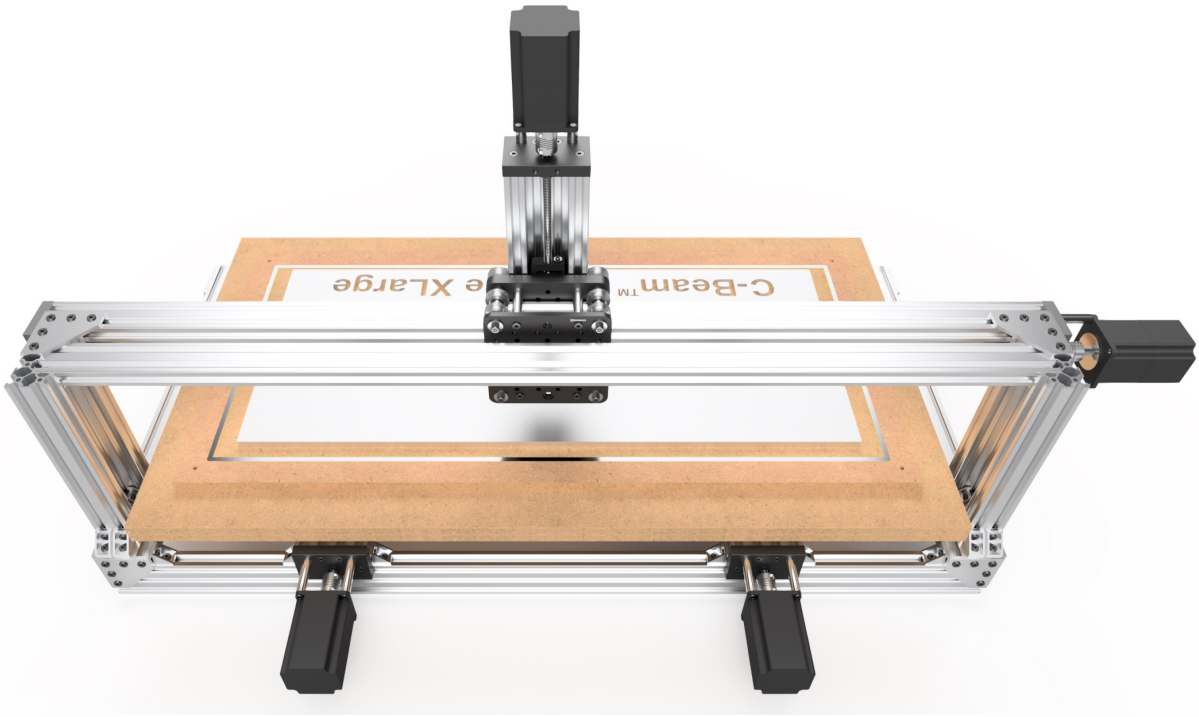
Join the Z to the X with the four 60mm spacer screws of the X and the four 10mm Screws of the Z and tighten, to make one.



Add your Stepper Motors using 55mm Screws with the 40mm Spacers between and tighten them, then tighten the grub screws of the Flexible Coupler up nice and tight, being careful not strip the threads.



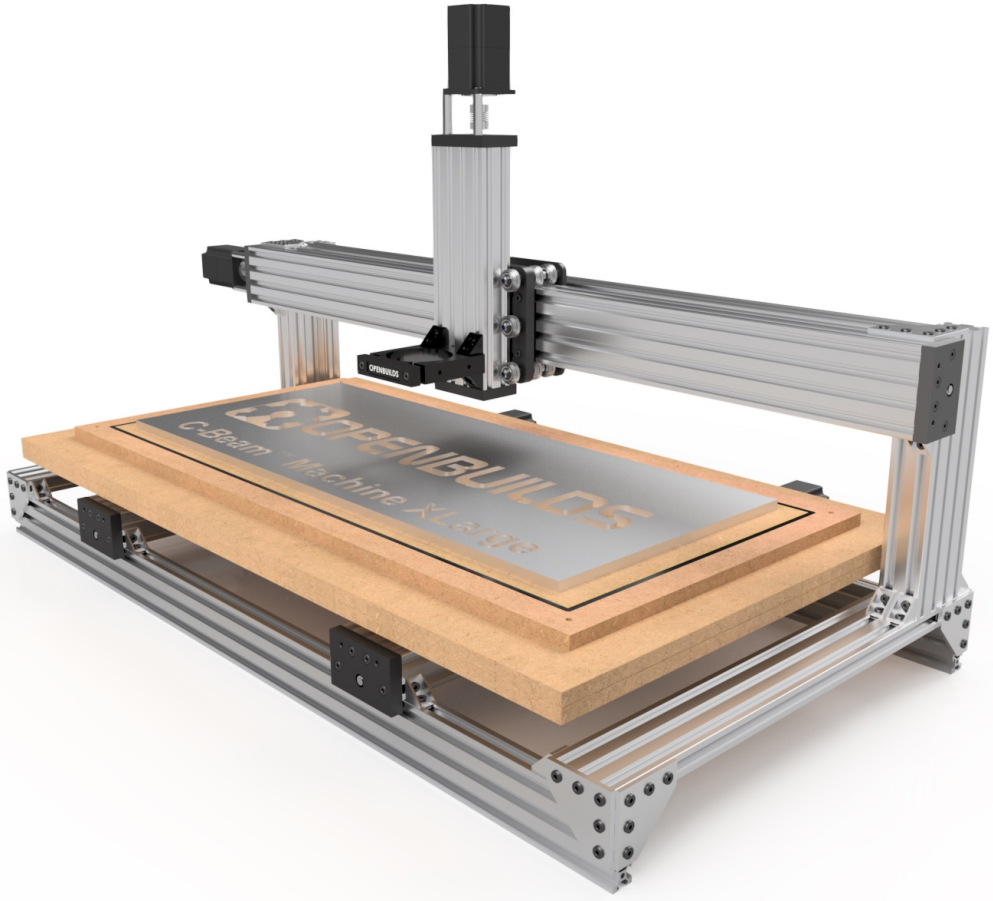
Repeat for all the other Actuators, attach the Spoil-board and the mechanical side of the build is done. Woo Hoo. Congratulations…where did you put that clean shot glass? Just needs wiring and brains now. :)



Hoping this was of some help to someone ;)

“The End”

“or is it the beginning?”



A big thank you to all that made this possible and a real thing, from the “Newbies to the Master Builders” from this awesome Openbuilds community, without you, all this couldn’t have happened and I feel privileged to be a small part of it all.

Dream on, Build on, Share on!

Thank you

Moag