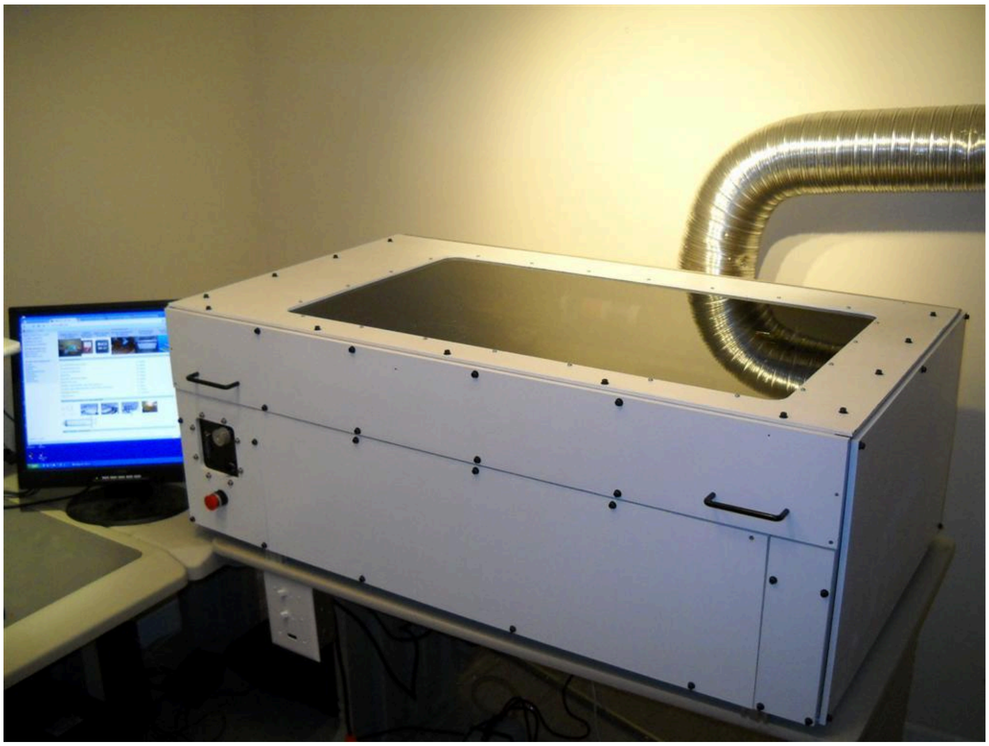
Buildlog.net Laser
Assembly Instructions
(Incomplete)



Introduction
This is a shared Google Doc. If you would like permission to edit it to improve anything, please request permission via email to bdring@buildlog.net. You should probably read through this entire document before starting. It will give a good overview and could save some two steps forward, one step back iterations.

Safety
Lasers are dangerous in many ways. They can kill you with high voltage, they can blind you with the beam. The laser can start fires inside or outside the enclosure. Never operate the machine without laser rated safety glasses and never operate it unattended. The fumes can be toxic when cutting some materials. Bottom Line: You built it, so you are responsible for all aspects of safety.

License

Tools Needed
- Screw Drivers
- Drill or Drill Press
- Allen Wrenches
- Drill Bits
- Taps
    - #4-40
    - #6-32
- Voltage Meter / Continuity Checker

Drawings.
All drawings are located on this page. The assembly drawings represent logical sub assemblies from a design and reference perspective, not an assembly perspective. Most items should be built at the top level following this document.

Schedule
Expect this project to take at least 2-3 months.

Purchasing Parts
This is an open source design so you can get the parts anywhere you like. There are kits for some of the basic parts at buildlog.net. That is only for some of the parts. You must get the rest elsewhere.

Don't buy everything at once. Things may change during your build that might affect what you need to buy. Tubes allegedly also have a shelf life and you don't want that clock started earlier than needed.

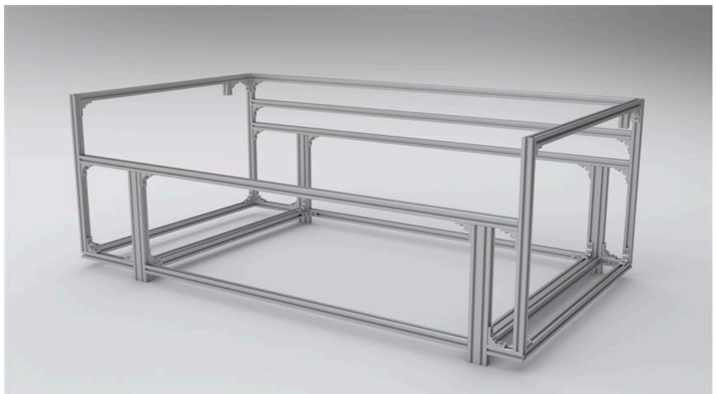
When buying Misumi parts get extra brackets and t-nuts. You will probably use more than you think and the bracket and nuts come in handy when mounting electronics, etc.

- Stepper Motor Driver. A food quality smooth running driver with microstepping to get you to at least 1000 steps/inch (see motor setup for formula). Anything over 1,000 is not really going add anything. At really high resolutions, some parallel ports are not fast enough to give you the speed

you need. 24V, 1.5 amp should be sufficient.
- Stepper Driver Power Supply. 24V, 150W should be more than enough.
- Laser Tube (40W recommended for this project)
- Laser Tube Power Supply
- Water pump
- Exhaust Blower.

Assembly

Frame



The frame is actually a good place to start. It is fun to build and goes quickly. Your project will appear to show a lot of initial progress.

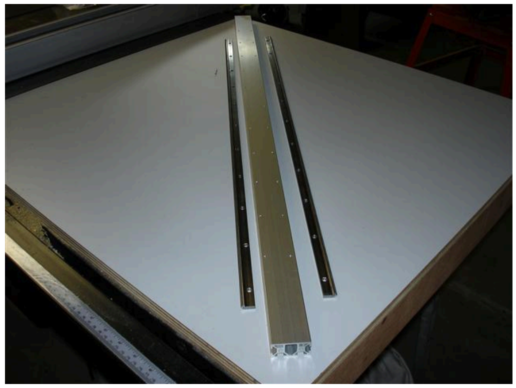
Most of the frame can be assembled using the basic inexpensive t-nuts. You should use these wherever you can. You will forget to install some so you should buy some post assembly nuts. These can be installed into the slot without access to the ends. Get about 20-30 of these. You should also get of of the nuts that have a a spring loaded ball or set screw that keeps them in place on vertical grooves. These are very handy

I find it easiest to install the brackets firmly onto one piece first. Put a screw and nut loosely on the other leg of the bracket them slide it onto the next extrusion.

The frame will be a little tricky at first to keep straight, but as more parts are added it gets more stable. Don’t worry about making the first few connections perfect.

After it is all done use a large carpenters square and tape measure to make sure it is all correct and square. You might have to go around a few times to get it all square.

V Rail Assembly.



While not too hard, this is probably the most difficult fabrication task on the build. I suggest drilling the v rails first. If you have any “walking” of the drill bit, you can compensate for it on the extrusions. I used transfer punches to mark my extrusions using the holes in the v rails, but measuring will work just as well.

Both sides of the channel on the back of the v rail should contact the extrusion. If it does not try enlarging any holes on the v rail that might be causing the problem.

Lightly tighten all screws than firmly push the v rail against the extrusion before the final tighten.

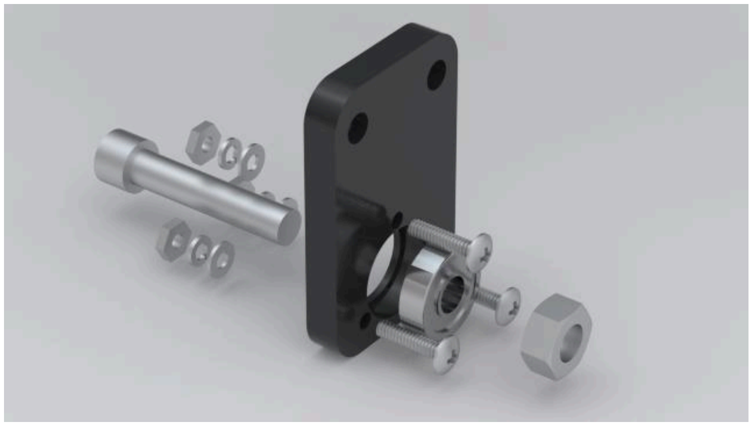
Acrylic Preparation.

The acrylic parts will have a dusty machined edge if they are cut with a router. This can be cleaned up a lot by unwrapping them and rubbing the edge with a dish towel while running under cold water. They can also be flame polished if you want a better edge (YouTube Search Flame Polishing). Be careful, the edge can be sharp sometimes. Don’t run any fingers along the edge with any pressure.

Several of the acrylic pieces need some tapping. The drawing shows which items these are. There is a little dimple at the point to drill which makes it easier. I use a little Dawn dish soap watered down about 50% as a lubricant. Do not use any oils unless they are specifically designed for use with acrylic. Be sure to clean your tap after using soap or they will probably rust quickly.

The back side of the Z lift motor plate needs to be counter sunk. It has two patterns, one for NEMA 17 and one for NEMA 23. You only need to countersink the one you will use. Use one of the screws to determine when the depth is correct.

Idler Brackets

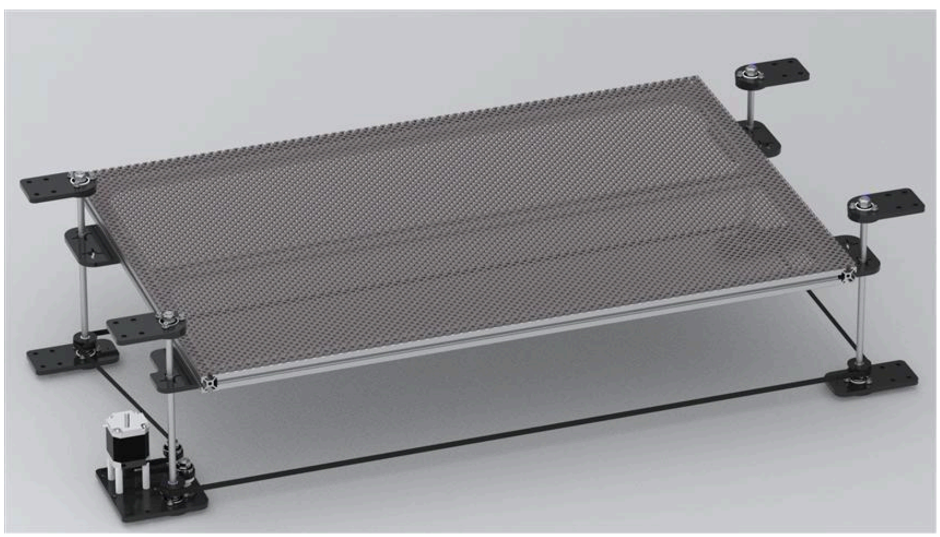


Make two idler brackets per this drawing.

Y Axis Rails

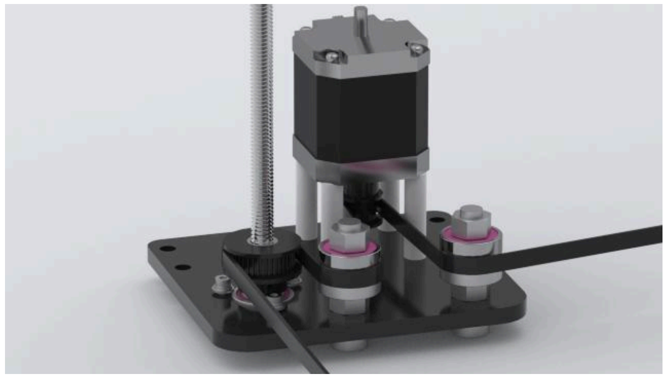
Build these and install into frame. Be sure to slip in (2) t nuts to each of the bottom side slots that will be used to mount the Z lift assembly. It is very important that the rails are parallel. The trick I uses was to temporarily remove the long upper rear extrusion from the frame. I tightened two of the Misumi brackets at the correct inside distance and pushed the y axis rails until they contacted the brackets. I double checked it a few times and tightened everything up. You can always readjust later when the gantry is installed.

Z Lift Assembly



The assembly drawing describes the location of all the parts, but you will not build it outside the frame on it's own.

Mount (8) of the 8x22x7 bearings into the upper and lower plates. Assemble (4) 8x22x7 bearings onto the motor plate on the 5/16 bolts to act as belt guides around the motor pulley. Mount the remaining (2) 8x22x7 bearings to the z axis idler.



Loosely attach the pulley to the motor, close to the body of the motor (helps when installing the belt). The exact height will be set later. Attach the stepper motor to the plate using the spacers.

Firmly attach a pulley to each threaded shaft. There is a dimension on the drawing to show how far the shaft protrudes past the pulley.

Install the motor bracket and right front lower shaft bracket into the frame. The exact location is not critical, but it is probably best to keep the threaded shafts on a common center. The assembly drawing gives a suggested location.

Install the rear lower brackets into the frame loosely (just loose enough so they can still slide) and a little further forward than they would normally go so the belt can be installed loosely. Install all of the threaded shafts into the bearings. Put a 5/16 washer on top of each bearing first to act as a spacer. The shafts will be very loose and floppy at this point. Install the belt tensioner loosely.

Install the belt. The belt just needs to be threaded onto all the parts and not tensioned. It will get trapped by the next step, so it needs to be done now.

Thread on the 5/16 t nuts with the points facing upwards. Thread them down about 1/2 the way. Keep them roughly even with each other. Place the table lift plates on the shaft. The one over the motor is different so it clears the motor. Again, these will be all floppy and loose until the table is installed.

Install the upper bearing plates by sliding them over the shafts and attaching them to the lower side of the Y axis frame parts. Adjust the front two bearing plates so the shafts are as close to vertical as possible. Measure off several reference points on the frame in X and Y directions to insure they are vertical.

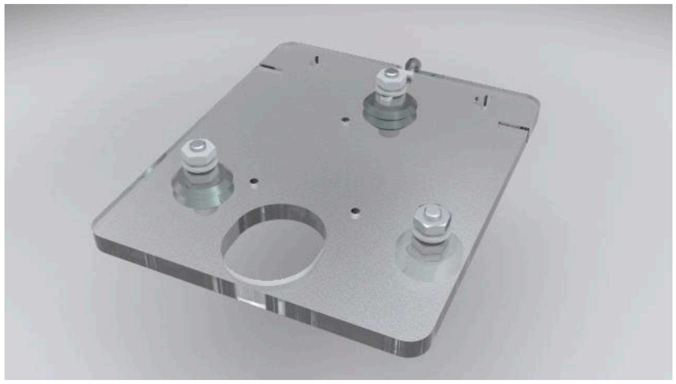
Adjust the pulley on the motor until it is in line with the other pulleys vertically.

Install the upper rear bearing plates similar to the previous steps. Now, slide the rear threaded rod assemblies back to tension the belt. Once the belt is tight and the rear threaded rods are perfectly vertical, you are done with this step. The table will be installed later

Z Lift Table

Gantry Assembly

The gantry v rail should have been made already in the v rail assembly step.



Build the laser car per the drawing, but do not install the lens assembly. The v wheels have a 3/16" (0.1875) diameter hole and the screws are #10 (0.189) diameter. This means they need to be sanded down a small amount. The easiest way is to put them in a drill press and sand them while spinning. It usually takes about 10 seconds per screw. Use a v wheel to check before removing from the drill. I also use a flat file sometimes which goes a little quicker. Do the screws for all 9 wheels.

Tighten the two fixed position v wheels fully. Tighten the v wheel in the slot so it is snug, but can still move with minimal rocking. Slide the wheel as close to the edge as possible.

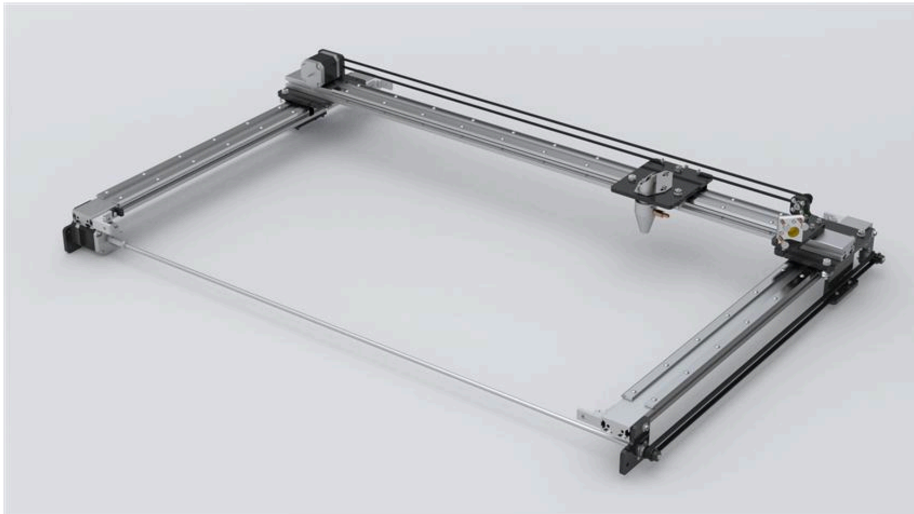
Install the laser car onto the v rail assembly. Make sure the front is facing the correct way. The v rail is not symmetrical. There is a dimension on the drawing to help orient the assembly. Use the rear tensioning screw to push the back v wheel onto the r rail. Once the wheel contacts the rail and there is no play in the carriage, tighten the bolt through the v wheel. This may tighten the wheel more against the rail if it was loose and at a small angle. If it gets too tight, loosen and readjust. I like just enough tension that the carriage will stay in place when the assembly is held vertically, but still rolls with a light touch.

Build and install the motor and idler wheel using the dimensions on the drawing. Be sure the pulleys are aligned. Measure a piece of MXL belt. You want about 3/4" of belt to stick through slots on the laser lens car. Clamp one side of the belt then pull the other end tight and clamp. It only need the belt to be slightly tight. Final tensioning is done by sliding the motor or idler on the extrusion.

At this point, if you are adventurous, you can temporarily hook up a motor to a stepper driver and test it using EMC, Mach3, etc. It is fun to see your first controlled movement.

Assemble the rest of the gantry per the drawing. Install the outside v wheels loosely and slide the out as far as they will go. Do not install the laser mirror. Note: The mirror typically installs a little low. This allows you to shim it up to the exact height of the mirror on the car. I use one or two #4 washers between the mirror mounting parts to do this. The end plates with the v wheels need to slide a little in the next step so they should not be fully tightened.

XY Assembly



The trick to this step is to get the gantry installed so that runs smoothly with no play on the y axis rails and it is mount as close to 90 degrees to the y axes as possible. I used a large carpenters square to get it close to 90 degrees. The 2 Y belts will hold the final angle firmly. Once the laser is running you can draw 90 degree corners and check them. The belts will be adjusted to get the final angle adjustment.

The adjustable v wheels should be spread out as far as possible so the wheels can get over the v rail. The two wheel plates should also be mounted loosely to the gantry so they can move a little, but tight enough that they won't slide around on their own. I have always done it alone, but help from a friend might make this easier.

Place the gantry over the Y axis rails. Squeeze the two wheel plates together so the gantry is now riding on the two outer wheel of each plate. Now use the wheel tensioners to bring the inner wheels to contact the inner v rails. Just get them a little snug. Now you need to make sure the gantry is square with the Y axis. Once it looks pretty good tighten everything down. You may need to recheck a few times to make sure the tightening is not taking it out of square.

Motor Testing.

Connect the motor to the stepper driver. Make sure you make a strong connection. Losing the connection while running will destroy most stepper drivers.

Connect your driver power supply.

Determine your resolution. Use the formula below to calculate it. It will work for Metric or English units if you are consistent.

$$\frac{motor\ steps}{rev} \cdot \frac{driver\ microsteps}{step} \cdot \frac{rev}{pulley\ teeth} \cdot \frac{belt\ teeth}{inch} = microsteps/inc$$

Example

$$\frac{400\,motor\ steps}{rev} \cdot \frac{4\,microsteps}{step} \cdot \frac{rev}{20\,pulley\ teeth} \cdot \frac{12.5\,belt\ teeth}{inch} = 1000\,micros$$

Connect the stepper driver to some sort of step source. I primarily use Mach3, but EMC2 is a good, free Linux alternative. If you are using parallel port control, **be sure to use a good quality cable** where all pins are connected and go straight through. Some cables do not use all pins or cross over between pins. This had caused many people a lot of frustration. Use the speed and acceleration setup screens of the program to dial in a nice max speed and acceleration. Start slowly and work your way up.

Some stepper drivers have tuning capability. If so, do that to all motors now.

You need to determine what current to set for the motors. The published value for motors may not always work for your application. It has to do with operating voltage, the duty cycle the stepper driver uses and cooling factors. This design does not add much conductive cooling to a the motors so I would suggest starting at about 1.0amp current and adjust from there. The motors can run quite hot, but if they are hot enough to burn you that is too hot. I would limit them to about 75deg C.

Tube Installation.

Cooling.

Tube Testing

Mirror Alignment

...don't forget about the final mirror. This must be perfectly square with the beam or the beam will exit at a slight angle and not make vertical cuts on your material. The mirror can be rotated on the mounting plate to adjust this.

Skins