

Universal Lasers Systems

MICA Digital Fabrication Studios *with Ryan McKibbin*

Model PLS 6.75

LASER - Light Amplification by Stimulated Emission of Radiation

This manual is intended to be supplemental to the instruction you received through coursework. If you are completely lost, there are video tutorials available on the server to help get you started drawing in Rhino for laser cutting. Please watch them in the computer lab with headphones, or download the entire folder to a thumb drive and watch them at home. They are located here:

```
\\picasso\Courses\_Student Resources\dFab\Resources\VideoTutorials
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This is a server address, not available from the world wide web, but locally on MICA's network. Check out the [dFab Resources](#) page for instructions on how to access the server.

1 Key Concepts

1.1 Safety

No personal protective equipment (PPE) is required for standard operation of the lasers, however, laser radiation is dangerous. Never bypass or remove any of the safety systems on the machine. Students must report malfunction to the tech on duty or Studio manager. All maintenance is performed or approved by the Digital Fabrication Studios Manager.

- **Unsupervised operation of the system is not permitted.**
- Follow all CAUTION and SAFETY labeling.
- Don't stare directly at the laser, it is very bright and can damage your eye sight
- **PVC must never be cut on our lasers.** Before processing materials, verify that no harmful gases or fumes will be generated.

1.2 Power, Speed and PPI Explained

Power - A percentage (%) of the total machine power (watts). Increase the power and you will increase how deep you cut.

Speed - A percentage (%) of the total machine speed. Decrease speed to increase how deep you cut. For Vector (following your lines) processes, this value should not be above 15% to 20%. For Raster (zig zag over a jpeg for example) this value should be 100% unless you need to cut deeper and are already at 100% power.

Collectively the Power and Speed are referred to as "Power Settings." To reduce your power settings you could increase speed or decrease power. To increase power settings you could increase power, or decrease speed.

PPI- Pulses Per Inch. A value between 0 and 1000. The laser is actually making a series of very small holes when it "cuts". These are approximately 0.005" in diameter. One inch divided by 0.005" is 200, so the minimum setting for this parameter is usually 200ppi. Some materials burn more than others, for wood

sometimes we'll go down to 160ppi (assuming a diameter of 0.00625") to reduce burning. For Acrylic sheet we set this to 1000ppi for a better edge finish.

1.3 Cutting Modes Explained

Rast – Stands for Raster and will be processed first. An engraving mode where the machine will vary the power based on the value of each pixel. The speed will remain constant, however the machine must be able to move past your image to account for acceleration and deceleration in the zig zag motion. The Power% that is user set is the upper limit of the power setting. In this mode, the relationship between Image Size (dpi in Photoshop) and Pulses Per Inch (PPI in ULS settings) is important. They must be the same or multiples of one another. **Speed should be set as high as possible (100%) and power should be varied to get the quality of cut you desire.**

Vect – Stands for Vector and will be processed after all raster layers are complete. This mode may be used to cut through material (cut) or cut only partially through material (engrave, sometimes referred to as etch). The machine will follow the centerline of your vector based lines, power settings will be determined by the layer color. Because the machine must follow the lines you drew, it will need to accelerate and decelerate. It is capable of slightly varying the power to avoid burning at sharp corners like on a rectangle, however only to a certain extent. **Speed Settings should not exceed 15% in most cutting conditions and power should be varied to get the quality of cut you desire. When testing in settings, once power hits 100% reduce speed to achieve the cut.**

Rast/Vect – Stands for Raster then Vector. This mode will allow for both raster and vector geometry on one layer, they will be processed with the same settings, Raster will be processed first, then Vector.

Skip – Will allow that color to be skipped. We generally use black as layout and therefore generally skip that layer.

1.4 Focus

The laser beam width will vary slightly depending on your material, but it is theoretically 0.005" wide. The cut produced should be very thin. If you are using the settings on the sheet or settings you have used before but they are not working, first think focus. This is demonstrated in person with the class or workshop.

1.5 Air Assist

Our machines are equipped with Air Assist. This feature, called "Flow" in the "Manual Control" Settings, must be on to prevent damage to the expensive mirrors and lenses. Air assist delivers compressed clean and dry air to enclosures around all the optics. If it is accidentally forgotten, the expensive optics will be damaged almost immediately.

2 File Setup

2.1 Limitations in Scale

The laser cutters are able to process sheets that are up to 32 inches wide and 18 inches tall. It is advisable to cut your material just smaller than that size so that it lays flat on the bed. When breaking down a larger sheet, consider dividing the overall length and height by 2 or 3 so that all sheets are the same size, provided your parts will fit on that size sheet. This will speed up your process and minimize waste.

The thickness that can be processed depends on material. Starting out, use materials 1/8" and under, the power settings are far more forgiving at that thickness. The machines are capable of cutting up to about 1/4" plywood (though the edge will be quite burned) and about 3/8" Plexiglas. There is no real limit to how thin you can cut

Remember that we are using amplified light to essentially burn a bunch of tiny holes along a line through your material. Wood products with more glue such as flight grade plywood, MDF and HDF (Masonite) tend to burn more than those products that contain less glue such as 3 ply plywood, or solid wood.

2.2 Layers

This machine uses layer color to identify power and speed. You will set power settings based on material and testing in a later step. RGB values are listed next to the color, they must be exact

Shop standard layers are below.

Vector Cutting - Blue (0,0,255)

Vector Etching - Red (255,0,0)

Raster Engraving - Cyan (0,255,255)

Additional layers are available if needed

Green (0,255,0)

Magenta (255,0,255)

Yellow (255,255,0)

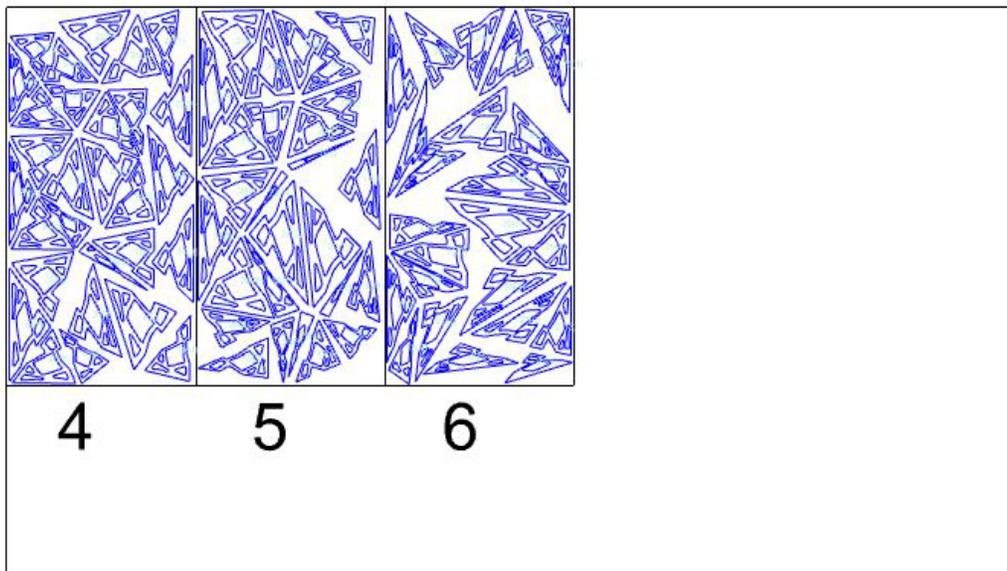
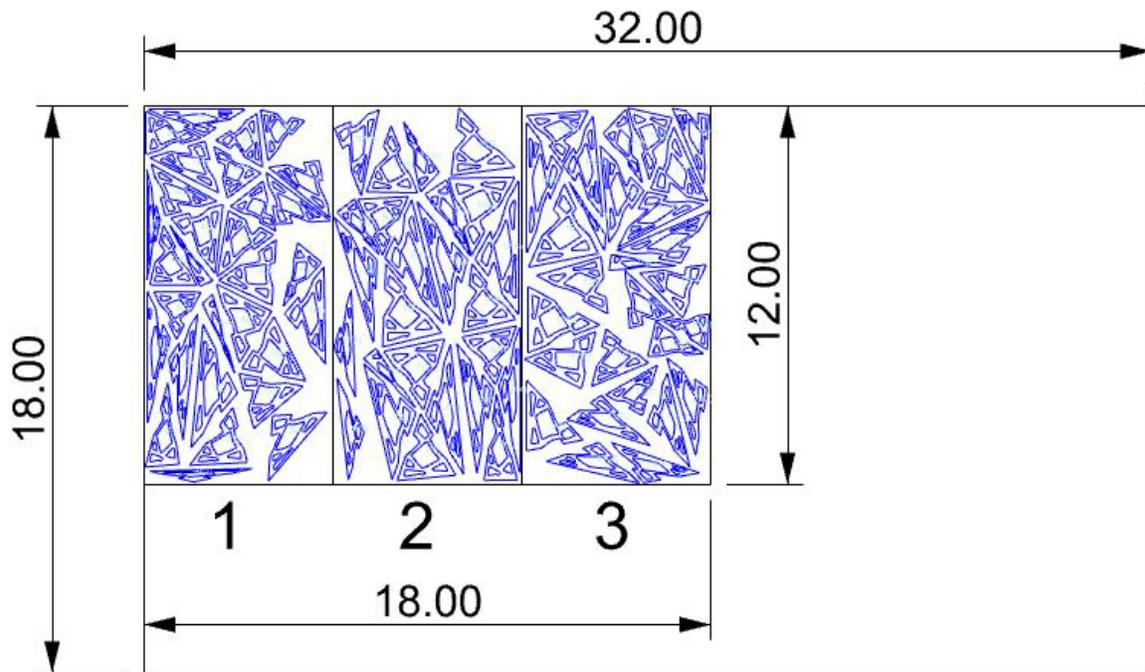
Orange (255,102,0)

Black – Automatic Layer (Can be confusing, only use for raster engraving color images)

2.3 Layout

It's possible, and advisable to cut multiple sheets of material from the same file. Setup for each sheet is identical, to cut different sheets, you will move the print window around in the file. Hint for the future: this is very similar to setting a work zero on CNC! Let's set up one sheet.

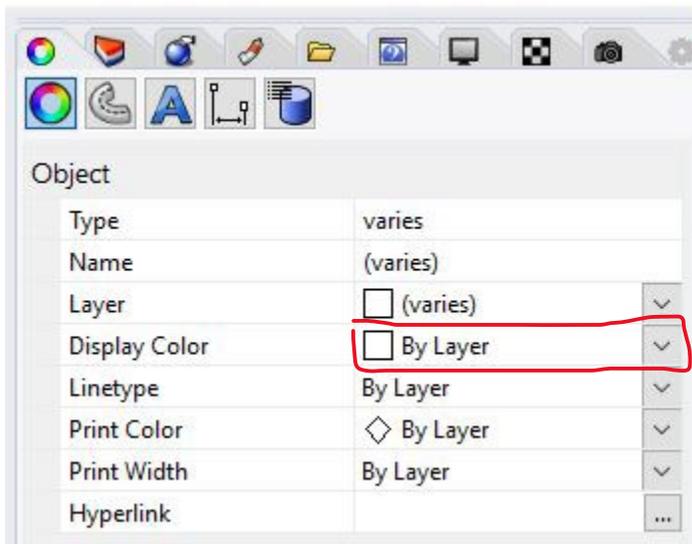
First, nest your parts, orienting them such that you will maximize use of your material. Parts can be close together, about 0.020" apart at minimum. **With rectangular parts, be careful not to have overlapping lines, these can cause a fire.** In the example I want to make a model before cutting full scale on CNC and I've left in that numbering on the black layer. This will cut from 6 sheets at full scale, but I'll be able to make the model from just two cuts, each from an 18 inch by 12 inch piece of plywood.



In the above example, the black layer is used for layout, it will be “skipped” in a later step. I drew an 18”x32” rectangle to represent the size of the machine, then drew a rectangle that represented the size of our sheet, in this case 18”x12”. I’m planning on putting the sheet in the top left hand side of the machine when I cut.

2.4 Object Properties

You may notice when you are setting layers that the color of the object does not change when you change its layer. If you worked in any other software, or if you set a display color in Grasshopper, you may need to adjust the Object Properties. Go ahead and window select all objects, or type in `Se1A11`.

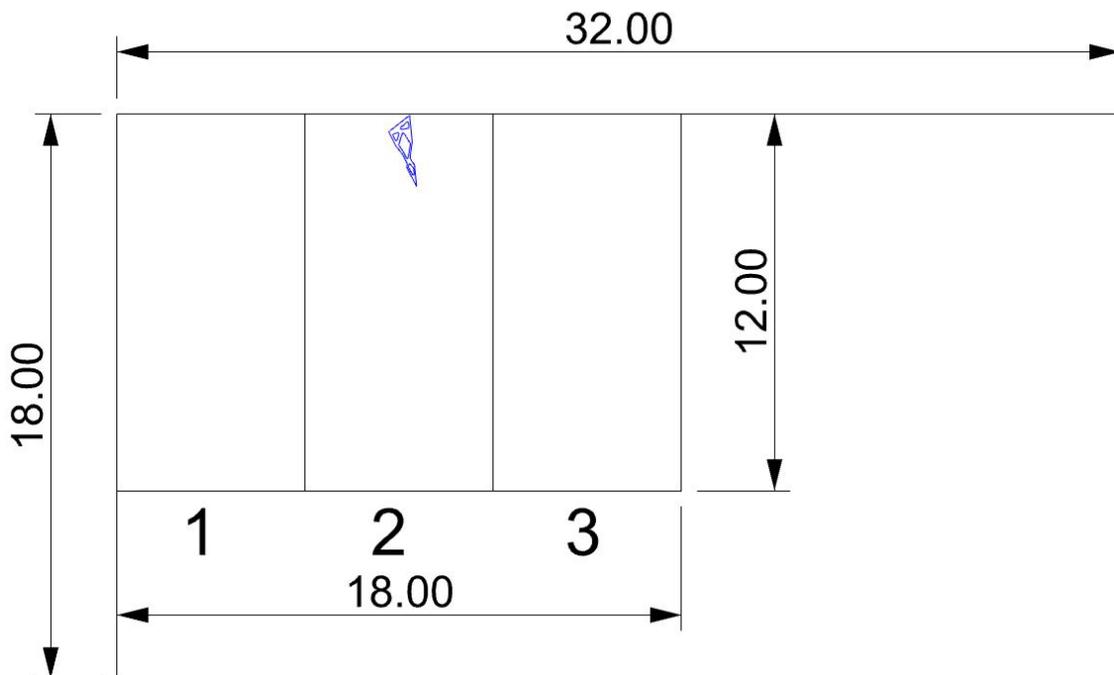


On the Properties Panel (usually on the right hand side, multicolor ring icon) check that Display Color, Linetype, Print Color and Print Width are set to “By Layer.”

Set your object properties as displayed to the left.

The properties panel will not look as it does in the example if you do not have any geometry selected.

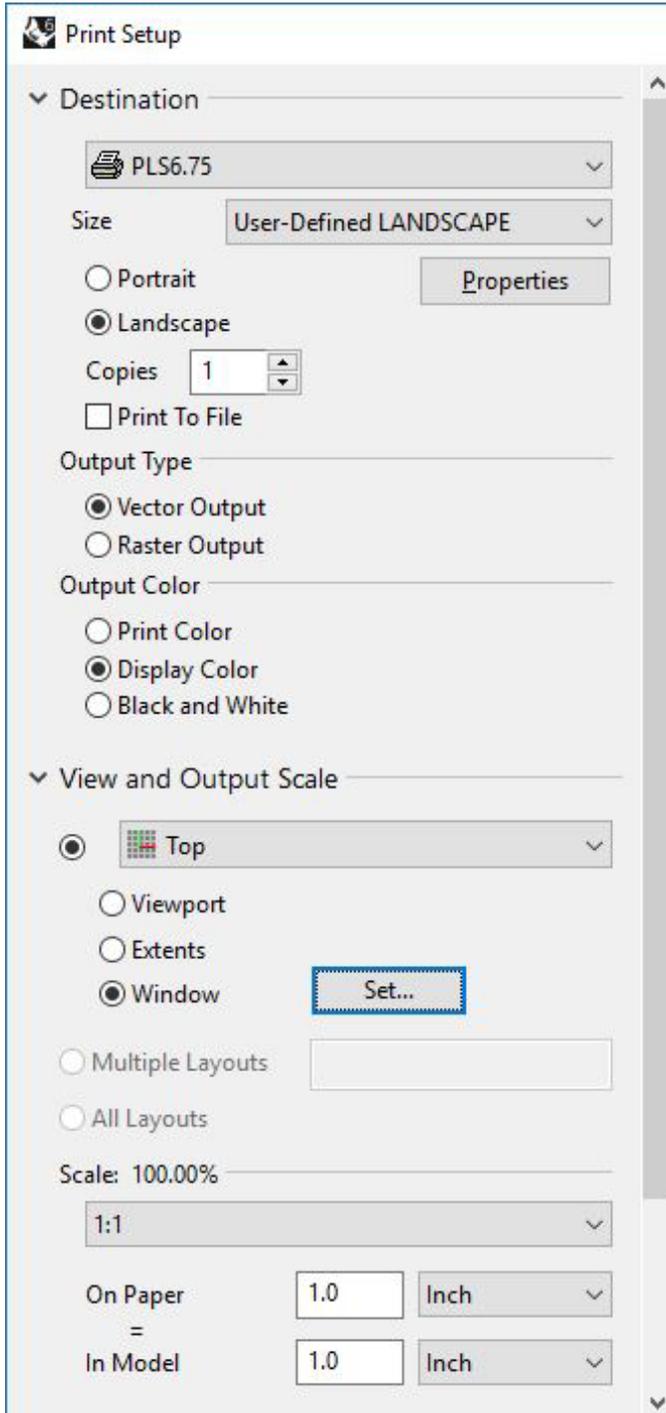
2.5 Set up for the Test Cut



3 Print Setup – ULS Printer Driver

We will now setup the printer. These are the **steps after typing in print in Rhino**

3.1 Rhino Destination and Scale



You will first be presented with Rhino's print dialogue.

Set the **Destination to PLS 6.75**

Set the scale to 1:1. This will ensure that you are cutting at the size you drew your part.

Change the view to Window or use the **Set...** button next to window to set the window.

Careful! **Only the middle handle is used to move the print window** around on the canvas. If you use any of the exterior handles on the print window it will re-size your print window and you will need to set the scale back to 1:1.

If **Object Snaps are getting in your way**, **hold down Alt** and you will not snap to them as you are setting the window.

It's also possible to set the window using the move command from the command line option. This will function just like the move command in Rhino as if the print window were a rectangle that you want to move. First choose the point to move from, then choose the point to move too.

Once Rhino is showing the geometry that you want to cut to the right of the print setup settings, it's time to set up **power settings by clicking the Properties** button, third from the top in the image to the left.

3.2 Properties

Go to the **Manual Control** tab and notice that if you click on any column in the row, the entire row will become selected. To select multiple rows, shift is not needed. To unselect a row click in any column, on that row again.

Next notice the **Power Speed, PPI and Z-Axis** fields, as well as the **Mode**, and the large round **Set** button.

3.2.1 Starting Settings – Zero all Settings

Select all rows and do the following:

Change the **Mode** to skip **Z-Axis** to Off, **Flow** to Air, and **Flow Rate** to 100%

Change **Power** to 0%, **Speed** to 100%, **PPI** to 180

Once the changes have been made choose the large round **Set** button on the right-hand side of the screen.

Your screen should now look like below.

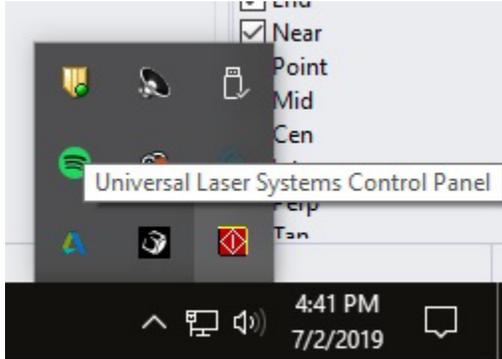
Color	Mode	Power	Speed	PPI	Z-Axis	Flow
Blue	Skip	0.0%	100%	180	0.120"	100%
Red	Skip	0.0%	100%	180	0.120"	100%
Green	Skip	0.0%	100%	180	0.120"	100%
Black	Skip	0.0%	100%	180	0.120"	100%
Yellow	Skip	0.0%	100%	180	0.120"	100%
Magenta	Skip	0.0%	100%	180	0.120"	100%
Cyan	Skip	0.0%	100%	180	0.120"	100%
Orange	Skip	0.0%	100%	180	0.120"	100%

3.2.2 Test Cut Settings

The process is simple, and only takes a few moments. **It's important to work up to the power setting that just barely cuts through.** Set your power settings using [the chart on the clipboard](#) and the steps outlined above in **“Properties”**. This chart is used as a starting reference for dialing in your settings. Always run a test cut, especially if you are cutting a big file or making many cuts that are close together. **Refer to the “Key Concepts” section above to understand power, speed, PPI, Focus and Air Assist.**

Each time you cut, even if you have cut that material before, run a quick cut to be sure that your settings are right. Always start with settings that are too low and increase them until you get the desired result. This will save you time and much needed \$krilla.

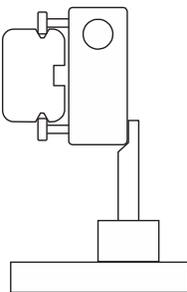
Once your settings have been entered, and you pressed the **Set button**, choose **OK**, then **Print**. This will queue the job, it will not actually run yet. To double check, choose the red icon from the system tray on the bottom right hand corner of the screen shown below. By pressing this button, you will open up a preview of the job.



If everything was set properly, you will only see the geometry you intend to cut. If you see anything else, now is your chance to correct that before starting the cut. Large jobs may take a moment to show up here. If you are doing raster work, this can take upward of a minute.

3.3 Focus on Your Part

The next step is to load your material and double check that the machine is focused by raising or lowering the cutting table using the keypad on the machine. You can either use the “focus” button or the X Y manual travel motions to move the cutting carriage out over your material. Remove the focusing tool from the left side of the machine and place it on top of your material below the focus tool such that the upper flat face of the tool is flush with the front face of the carriage. Raise the bed in Z increments of 0.01” until the tool deflects due to the angled face of the tool contacting the bottom edge of the carriage. Back off one click (-0.01” in Z) and you’re focused!



Material *should* be flat, but it isn't always perfect. Pick an average height spot on warped material to focus to, it may require a little more power to cut through.

Don't forget to put the focus tool away as soon as you finish focusing on your sheet.

3.4 Print Your Test

If you're ready, walk over to the machine and press the green play button. Stay with the machine while it cuts. Because you took the time to test your settings, it's not likely that a fire will start. If one does, there is a wool fire blanket in the laser room that can be used to put out the fire. A successful test cut is one that just barely cuts through the material. If you cut through on your first try, reduce power settings and try again. If it does not cut through slightly increase the power settings until it just barely cuts.

3.5 To Stop the Job

Press Pause, the red button next to the green play button on the machine. You will be able to resume the job by pressing this button again. If you press play the job will start at the beginning.

3.6 Print your File

After testing, show all your geometry in Rhino and print with the tested settings.

3.7 Clean Up

When you are done, remove your material and scraps from the machine. Wait to take Plexiglas or any materials that will create fumes for a few minutes after the cut finishes. If you were using a high power setting or if the machines were running for a long period of time, you may hear a fan running to cool the laser. Wait to turn off the machines until after that fan turns off on its own.