Fiber Laser Beginner Class

100W MOPA Fiber Laser

**MAKERSMITHS**
INNOVATION FORGE

Laser Training Outline

- Introduction to Fiber Laser Equipment

- Guidelines and Policies

- Laser Safety Review

- Getting to Know the Machine

- Laser Engraving Process

- Introduction to Laser Software: LightBurn

- Tips, Hints, and having FUN

- Hands on Training and Use

Laser Equipment: Purcellville

- We have a 100W MOPA Fiber Laser.
- This is a Galvo laser meaning that it moves the laser with mirrors rather than a gantry like our CO2 lasers.
- Cutting area depends on the lens used
  - 4.3" X 4.3" with the 160mm lens
  - 8.27" X 8.27" with the 290mm lens
  - Use of both lenses will be taught in the intro class and red tool trained people can use either lens.
- Passthrough is achieved by removing the front of the housing and is allowed after taking the fiber laser beginner class.
- Rotary and rotational attachments available and will be taught at a later date.
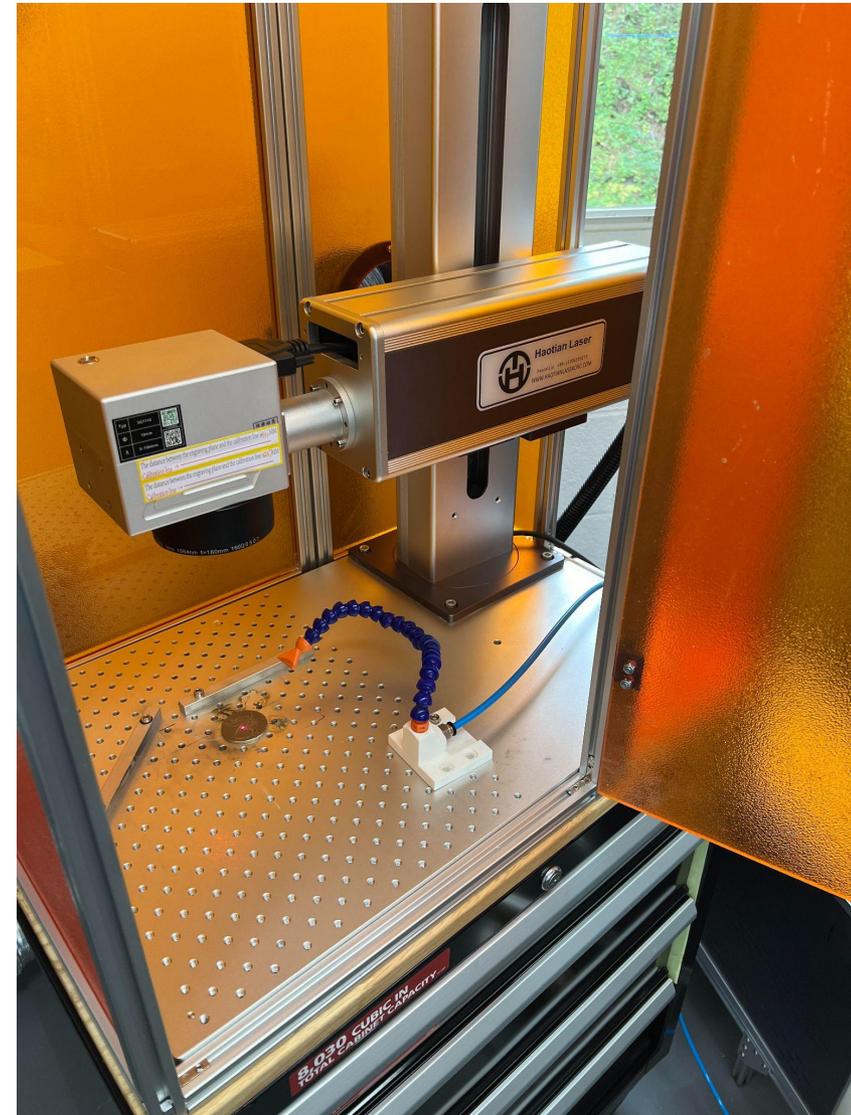
We Have 3 Lasers

- We have one 100W MOPA Fiber Laser in Purcellville
- Cutting area is 4.3" X 4.3" or 8.27" X 8.27" depending on lens used
- Rotary and rotational attachments are available
- Best for engraving metals.
- Certification n the fiber laser is only good for the fiber laser.

- We have one 60 Watt CO2 laser in Purcellville and a 100 Watt CO2 laser in Leesburg.
- Cutting area is 23.6" x 15.7" with max thickness of 6.1" on the 60 watt
- Cutting area is 51.2" x 35.4" with max thickness of 9.1" on the 100 watt
- Both have passthrough, rotary attachments and multiple lenses.
- Best for engraving and cutting organic materials - wood, paper, cardboard, acrylic, leather, fabric, some foams, & some rubbers.
- Certification on one of the two CO2 lasers certifies you for both.

MAKERSMITHS
INNOVATION FORGE

Policies, Safety & Materials

Guidelines and Policies

- **Sign the Makersmiths Waiver Form** - This can be done at the Square terminals in the Leesburg classroom or the Purcellville Green Room
- **All Lasers are Red Tools** – Red tools require safety training on each machine to operate unsupervised for safety and to prevent damage to the machine.
- **Schedule Your Time on the Laser** – Login to Makersmith.org. Go to Members Only Content > Tool Reservations > Fiber Laser Reservations and fill out the reservation form
  - Limits:
    - <= 2 hours per day. You can schedule 4 hours with permission from a laser steward.
    - 8 hours/week if time is open
- **Pay Your Usage Fees** – collected to cover consumables (cleaning supplies, upgrades etc.)
  - Members – $10 per hour
  - Non-Members - Non-Members cannot use the fiber laser
  - Billable time is based on using the machine or schedule on the Google calendar (not cutting time)
  - Payment: Cash Box, Square Terminal, QR Code or on the Tool Reservation Page
- **Record Time in the Log Book** - Keep track of print time /cut time and material cut in the logbook next to the laser computer. This is used to determine maintenance/cleaning routines.

Laser Safety Review

Personal Safety

- **DO NOT look at the laser while it is in operation.** This is even more important when using a fiber laser than a CO2 laser. It can blind you.
- **Wear 1064nm OD6+ safety glasses.** Even with them on, do not look at the laser as it is cutting.
- **Put the laser sign in the door window when running the fiber laser.** This will warn others who may want to come into the classroom.
- **Don't cut or engrave materials that will create fires or produce toxic gases.** A list of these is in this presentation and at wiki.makersmiths.org.
- **The fiber laser DOES NOT shut down if the door is opened.** If you need to shut down in an emergency, press the Emergency Stop button. Do not open the door without turning off the laser.

Device Safety

- **Always be sure the external exhaust fan is in operation** before cutting/engraving.
- **Make sure you have focused the laser optics** to the top of your material with the right height for the right lens you are using.
- **NEVER leave the laser running unattended!** Lightburn will let you pause mid project and start again right where it left off.
- **If material catches fire, DON'T PANIC.** Try blowing it out, remove it from the device, cover fire blanket, and as a last resort use the fire extinguisher.
- **Make sure that the material is supported outside the machine (front and back) if using the passthrough.** There are stand up rollers by the CO2 laser.

MAKERSMITHS
INNOVATION FORGE

Laser Eye Safety

- The fiber laser is more powerful than the CO2 Thunder Lasers we have at Makersmiths.
- As long as you leave the case on and the case door is closed, the chances of the laser bouncing off of your project material, going through the acrylic/aluminum case and hitting your eye is very low.
- However we recommend that you purchase a pair of safety glasses to wear when using the fiber laser.
- These glasses should block the 1064nm wavelength and be rated OD6+ or higher.
- You can find these glasses from many online suppliers.

Laser Safety Review: OK Materials

OK TO LASER List:
- **Metals:** Stainless steel, aluminum, brass, titanium, gold, silver, and tungsten. Care should be taken when engraving Manganese, Chromium, Nickel, Cobalt, Copper, Lead
- **Coated Metals** - powder coated, anodized, or painted metals like tumblers, business cards, dog tags etc.
- **Plastics:** acrylic, lucite, plexiglass (won't cut through clear)
- **Stone:** Brick, granite, and marble
- **Tile:** Can be engraved with a fiber laser

Other materials either should not be, or simply won't cut on a fiber laser. Use the CO_2 laser for wood, leather, and other allowed materials.
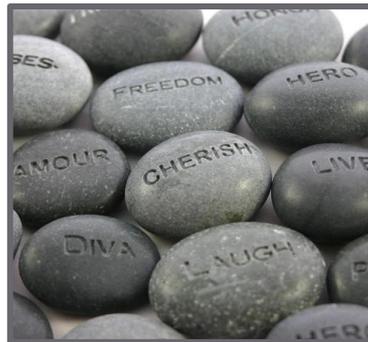
Laser Safety Review: DO NOT LASER

DO NOT LASER List
- Galvanized metals
- Any material that won't cut well or emits gasses
- PVC: produces hydrochloric acid and toxic fumes
- ABS: emits cyanide gas and tends to melt
- Polycarbonate/Lexan: cuts very poorly, discolors, catches fire, may contain chloride which is bad, might look like acrylic but is not the same thing
- Artificial leathers, Pleather: contains PVC and produces toxic gasses when lasercut
- High Density Polyethylene (HDPE): milk bottle plastic, melts and creates fires
- Foams like PolyStyrene or PolyPropylene: they catch fire
- Fiberglass: emits fumes
- Cellulose: combustible
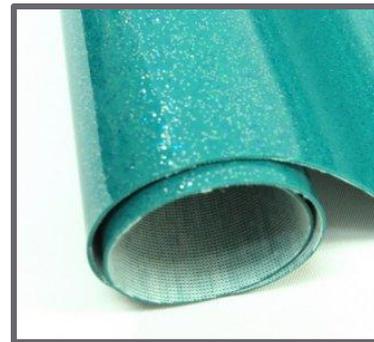
Getting to Know the Fiber Laser

Getting to Know the Machine: Switches & Air

- The main laser case looks like a desktop computer housing.
- The front has buttons that raise and lower the laser and an Emergency Stop button.
- There is a power switch on the back of the case, but turning it on and off should be done from the power strip.

- All of the components of the laser have been plugged into the power strip attached to the side of the cart. Each switch is labeled.
- Turn on/off the laser, exhaust and air assist as needed.
- Leave the Computer and Monitor switches on at all times

- The air assist compressor does not have a tank and should just be turned on and off as you use the laser. There is no adjustment on the main compressor.
- The air extraction is turned on at the powerstrip on the side of the cabinet and can be adjusted by the dial that is inline on the cord.

MAKERSMITHS
INNOVATION FORGE

Getting to Know the Machine: Case

The door on the front fits tightly into the frame of the enclosure so that it stays in place while projects are being engraved.

This machine DOES NOT SHUT OFF if the door is opened. ALWAYS make sure the laser is not firing before opening the door.
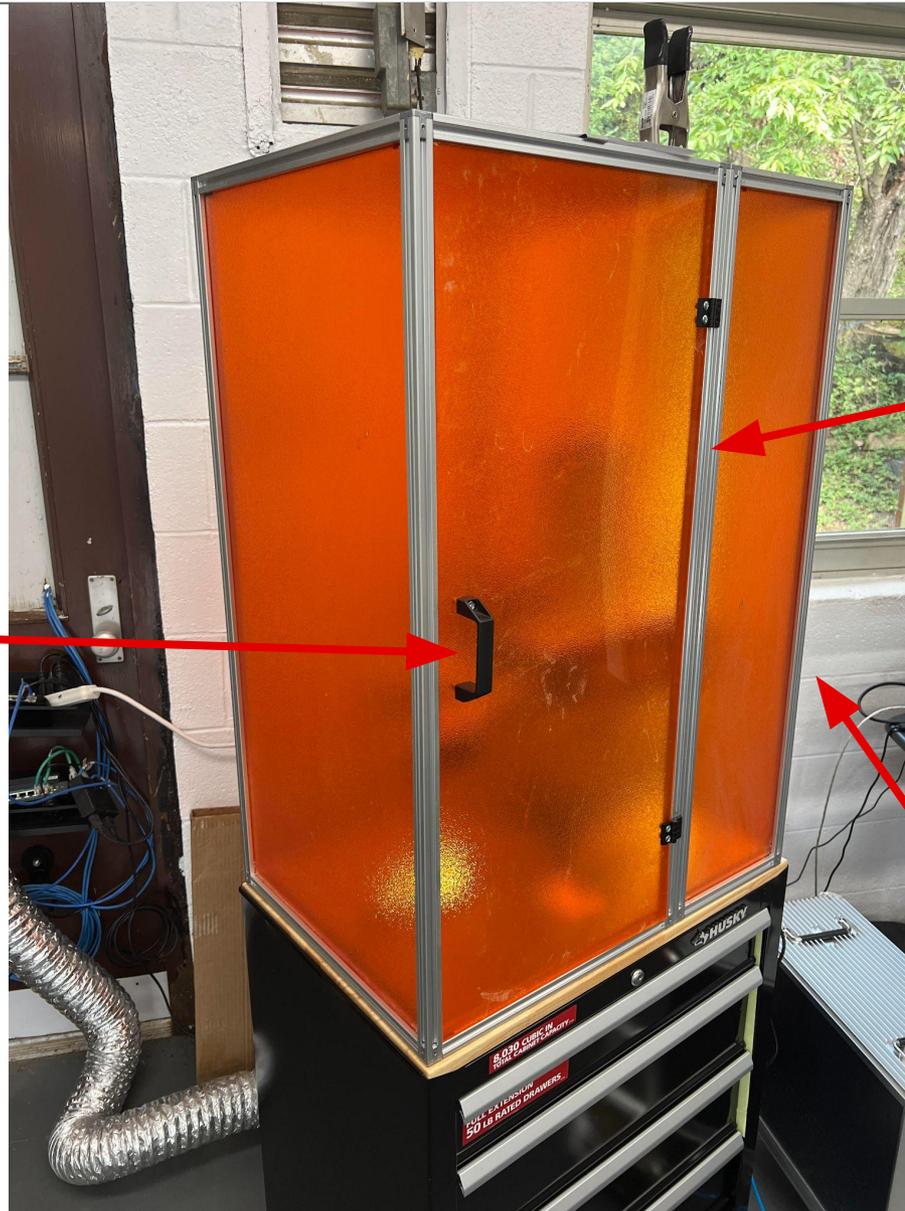
The case is in two parts so that the front half can be taken off to accommodate large parts. There are latches on the front and back to hold both parts of the enclosure tightly together.

The right side and back of the case have holes to accommodate air assist, power to raise and lower the gantry, and the air exhaust. The back section cannot be removed.

MAKERSMITHS
INNOVATION FORGE

Getting to Know the Machine: Passthrough

If you remove the front half of the case to engrave something larger than the bed, make sure to wear your laser glasses and put a sign up in the door to the room to warn people that the laser is in use.
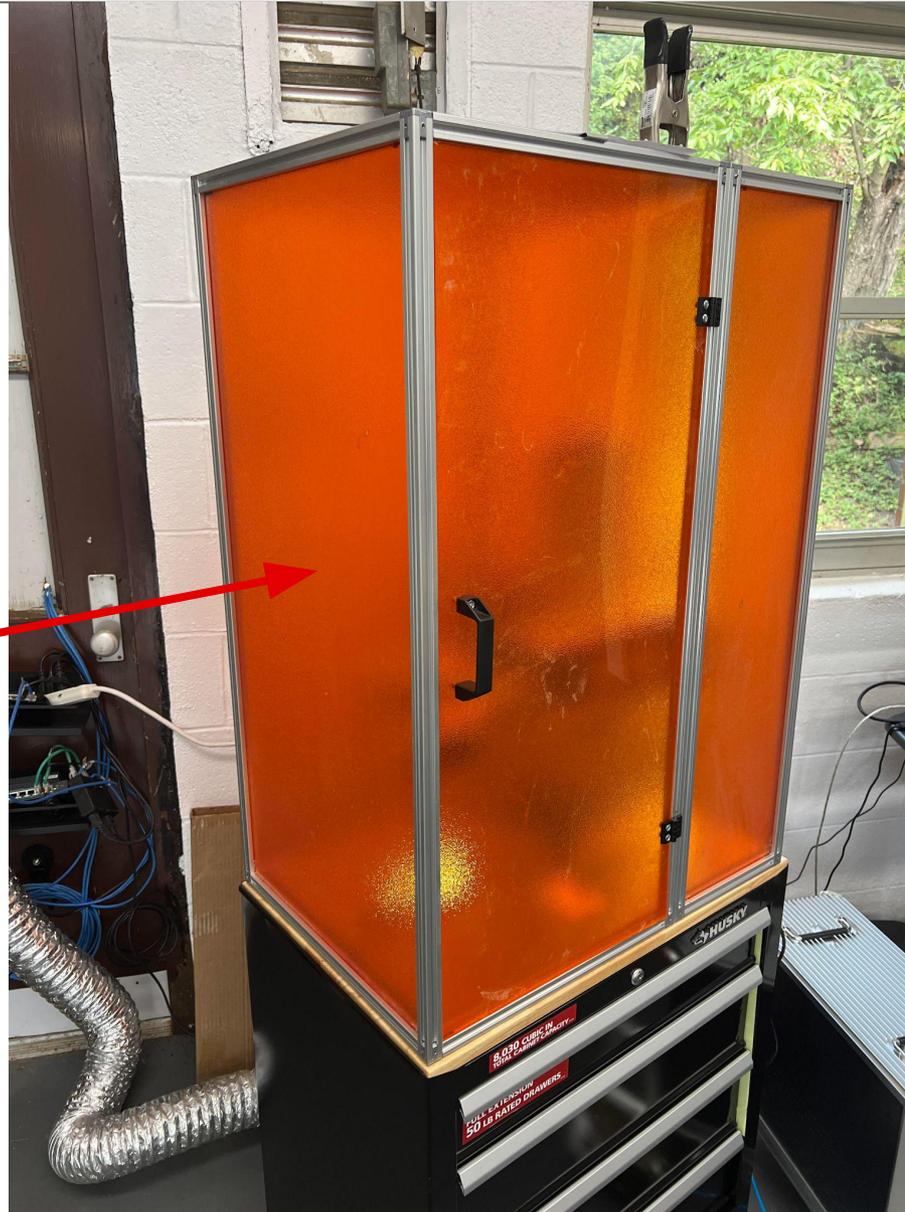
When you are done engraving with the front section removed, replace the front section afterwards.

If your project fits on the bed and you can align your workpiece/art, don't remove the cover unnecessarily.

MAKERSMITHS
INNOVATION FORGE

Getting to Know the Machine: Bed

The bed has M6 holes for fixturing pieces to be screwed to the bed as needed.

The bed is larger than the area it is possible to engrave on.
160mm = 4.3" x 4.3"
290mm = 8.27" x 8.27"

There are a few fixturing pieces available for use. You can make, buy, laser cut or 3D print your own fixturing pieces. If you 3D print, use PLA, not ABS.
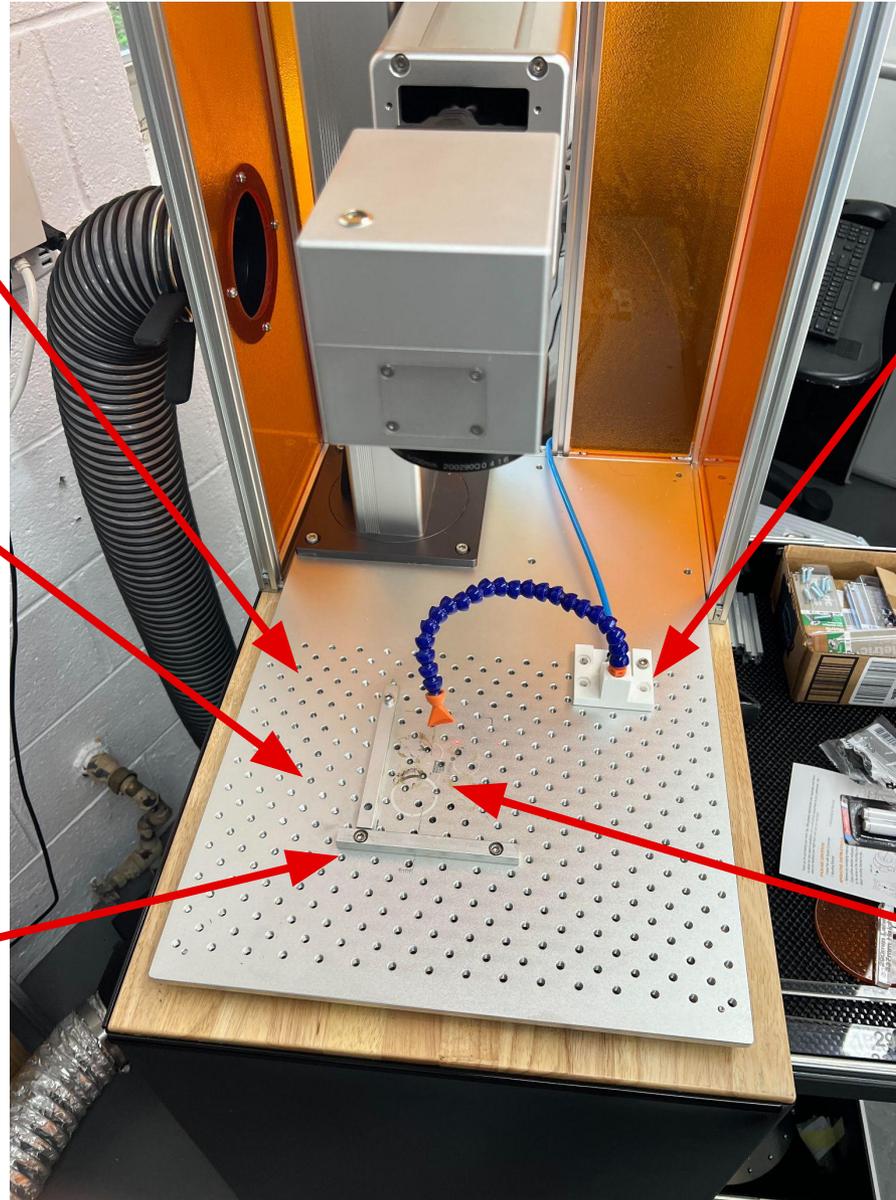
The air assist base can be moved around the bed and kept in place with one or more M6 screws.

If you want to engrave at or over the edges of your project material, place a piece of metal between your project piece and the base as a spoil board. Otherwise you could engrave into the bed.

MAKERSMITHS
INNOVATION FORGE

Getting to Know the Machine: Important Buttons

- The fiber laser has no air or machine control panel. The only hardware buttons are outlined below. All other machine control is done through LightBurn.

- There is an emergency stop button on the front of the case and this is the quickest way to stop the machine in case of a fire, emergency etc.
- You can also stop the machine by pressing "Pause" or "Stop" in LightBurn.
- The up and down arrow buttons raise and lower the laser height more quickly than turning the handle by hand.


MAKERSMITHS
INNOVATION FORGE

Getting to Know the Machine: Lenses

- There are two lenses that you can use on the fiber laser - 160mm and 290mm.
- The 160mm lens will let you engrave in an area of 4.3" x 4.3" and will deliver more power at the same power settings in that area than the 290mm lens.
- The 290mm lens will let you engrave in an area approximately 8.27" x 8.27", but the power applied across the area will be lower even at the same power setting as used with the 160mm lens.
- The lens focal length is written on the side of the lens.
- To remove a lens, grip the bottom of the lens and turn clockwise to loosen the lens. Turn and be careful not to drop the lens. Put the plastic covers on both the top and bottom of the lens, and put it away in the lens box.
- To install the other lens, remove both plastic covers, gently put the small end of the lens into the housing and turn slowly counterclockwise until the threads catch. Do not force the lens into the housing. Hand tighten only. There are no exterior moving parts on the lens that would cause it to loosen over time.
- Each lens is setup as a different Device in LightBurn. I.e. each lens is treated as a separate machine and you need to select the correct one.

Getting to Know the Machine: Air Assist
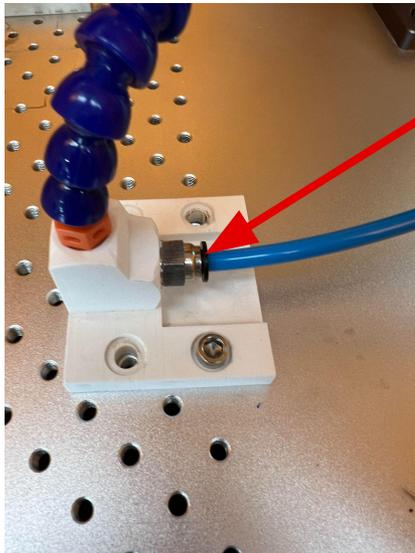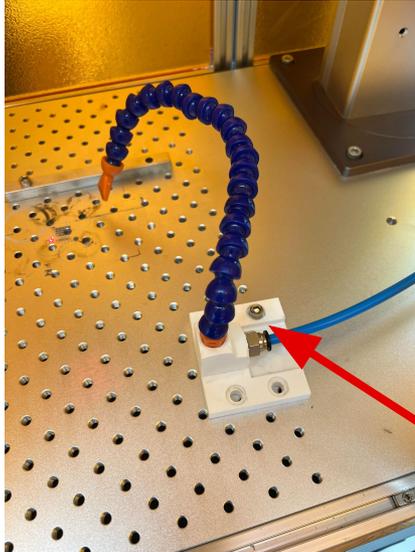
- The air assist helps to keep engraving dust clear of the laser when you are running more than one pass.
- You can move the air assist around on the table by moving the base and adjusting the end to where it needs to be used.
- The air assist hose can be removed from the base by pressing in on the black ring on the air hose and gently pulling out the air hose.
- The air hose can be replaced by pushing the air hose back into the housing until you hear a "click" noise.
- Air assist is turned on by turning on the switch on the powerstrip attached to the side of the cart.
- Unless you have some extremely thin material, the air assist is not powerful enough to move your workpiece.

Setting Up to Laser Cut/Engrave

# Laser Setup: Focusing the Laser

There are two heights of laser focusing tools, and multiple different sizes of each.

- If using the 160mm lens, use a height gauge labelled "160mm Lens. 198mm height"
- If using the 290mm lens, use a height gauge labelled "290mm Lens. 337mm height"

Put the bottom of the gauge on top of your workpiece, and adjust the height so that the bottom of the lens housing touches the top of the gauge. Do not touch the glass of the lens.

You can move your workpiece to make it easier to adjust the height of the lens, then move your workpiece into the right position for engraving later.

You raise and lower the height with the buttons on the front of the case, or by turning the handle on top of the gantry. The buttons should be used for fast moves and turning the handle should be used for fine adjustment.
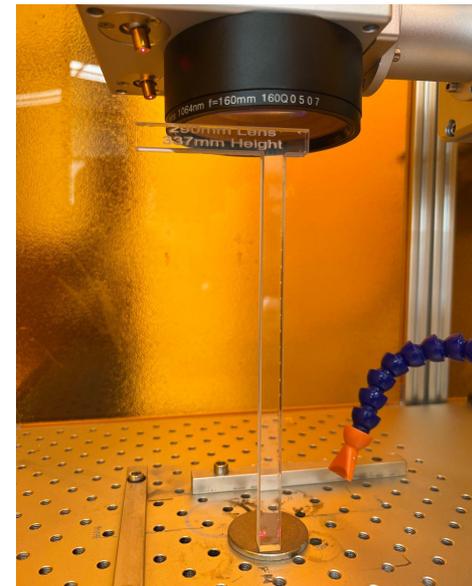
Laser Setup: Alignment

If you will be engraving over the edges of your project piece, put a piece of metal underneath to avoid marking the bed.

Unlike our CO2 lasers, you cannot change the start origin point on a galvo laser. The origin is always the center of the work area.

To align your workpiece to the engraving/cutting area, you will use the "Frame" function in LightBurn to line your workpiece up to the frame and/or adjust your artwork to align with your workpiece.
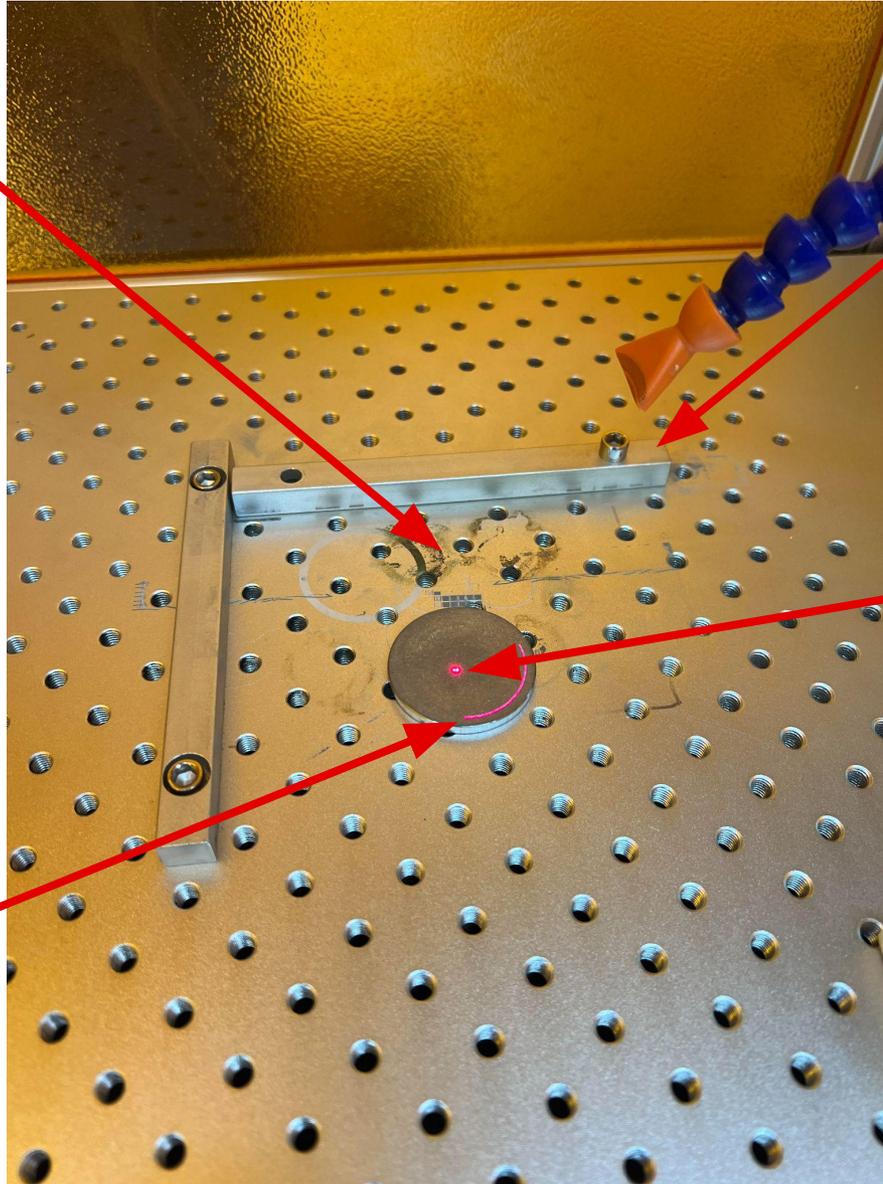
You can use the the fixture pieces (existing with the machine or your own) for a repeatable method to engrave in the same place on each workpiece.

As of the date of these slides, the center point marker IS NOT aligned correctly. Use the "Frame" function to align your workpiece.

The engraveable areas are as follows:
160mm lens = 4.3" x 4.3"
290mm lens = 8.27" x 8.27"

MAKERSMITHS
INNOVATION FORGE

Getting to Know LightBurn

Laser Software - LightBurn

LightBurn Software
- In Lightburn you can preview, edit or create artwork. It also controls the fiber laser.
- We have a limited number of Makersmiths licenses available. There is one for each computer attached to a laser, and one for the Leesburg Classroom.
- You can download a 30 day trial and/or purchase your own copy. If purchasing you will need to buy the Lightburn DSP License Key for the CO2 lasers or a Galvo License Key for the fiber laser. The fiber laser/galvo license will also work for the CO2 lasers, but not vice versa.

Design Software
- If you want to design outside of Lightburn, you can use a vector drawing program such as CorelDraw, Adobe Illustrator, Canva, Inkscape, Fusion 360 or any software that will export vector graphics in the file types shown later in these slides.

MAKERSMITHS
INNOVATION FORGE

LightBurn: Opening/Importing Your File

To get the most of out of a laser cutter, your files will primarily be vector files. The laser uses the vector pathways as a guide when cutting. Raster files can also be used, but are not as vector files. You can find more info here: Raster vs Vector Files

Most Commonly Used Vector Drawing Programs:
- Adobe Illustrator: Subscription based, around $50 a month, with discounts for students. We have a license available at each location.
- CorelDraw: One time cost. We have a license available at each location.
- InkScape: Free, with some small limitations relative to the paid options. A copy can be found on most of our computers.
- Fusion360: Free "Hobbyist" version, sketches can be exported as .DXF files for import to Lightburn. Useful for very precise drawing.
- Others: Other vector/CAD drawing programs are available, but may take some more work to get the file ready.
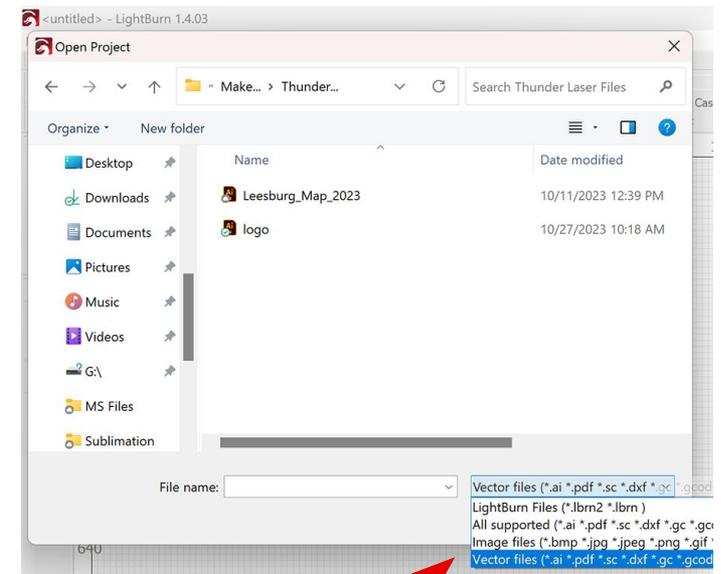

Open LightBurn and go to File > Open and choose your file. You may not see it right away, since LightBurn defaults to its own file format. To get to your file go down to the bottom right corner, next to the "File name" bar and click the extension box to see other file options.

LightBurn: File Types

LightBurn can accept many file types!

We have tested many of them, and most open perfectly fine with the exception of .svg's. When imported, the object in the .svg file can be smaller than the original design. Always double check that ANY file you import is the correct size!
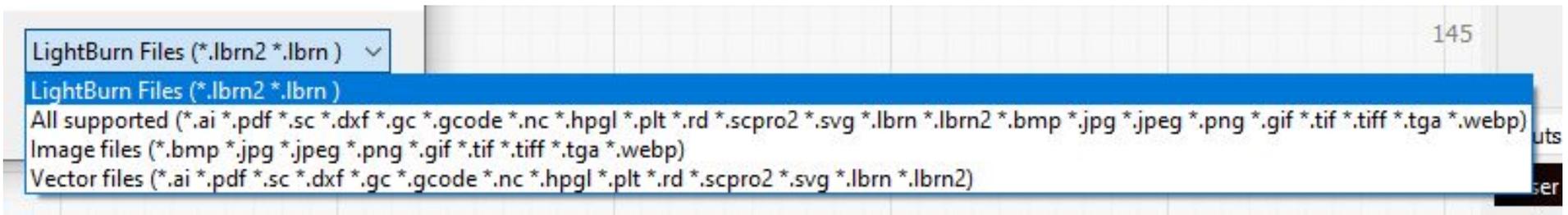
With past laser cutters, you were required to have specified line weights and colors.
LightBurn does not require that! It just needs vector lines, or fills and you get to choose what each line does before you begin cutting/engraving. You can also import raster files for photo engraving.

If you know ahead of time that you want all of the lines to cut with the same power/mms, then group them together. Same with your fill lines. This will save you time later on.

If you use Inkscape, make each type of cut you want to do a different color in your drawing and LightBurn will import them as separate layers/cut profiles and assign them the closest color. This can save time.

LightBurn: File Setup

Let's get to know this screen…

Preview Button: see the lasers path and time

Order of Operations

Layer Power, Speed, Pass Count, Interval, Q-Pulse and Frequency Settings

Start Job

Boundaries Check

Layer Color Options (you get to choose!)

Laser Controls Tab

Materials Library Tab

No origin selection when using galvo

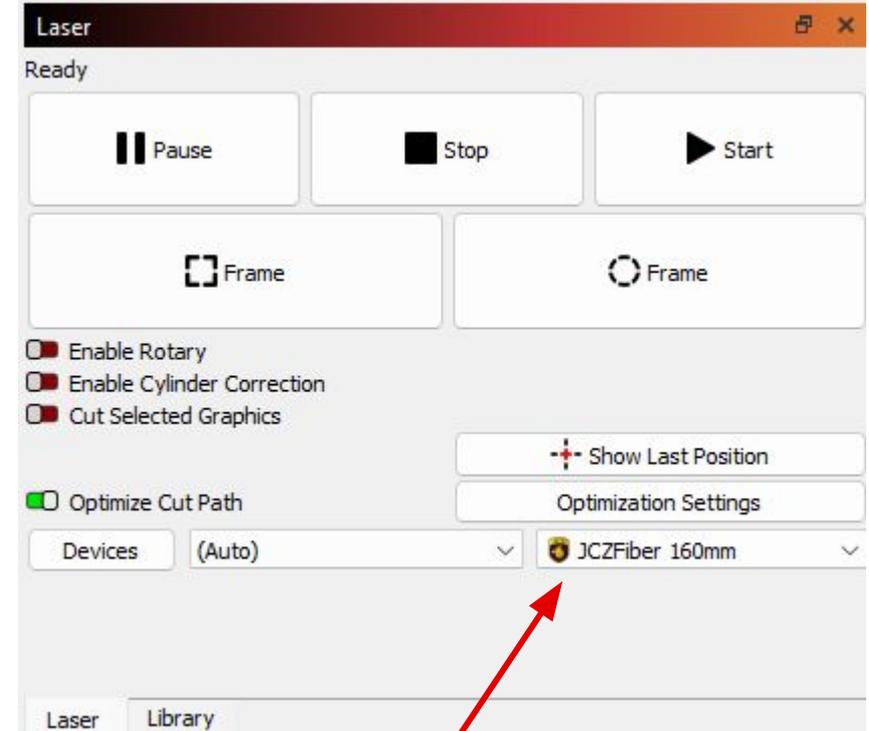# LightBurn: CO2 vs Fiber Laser Differences
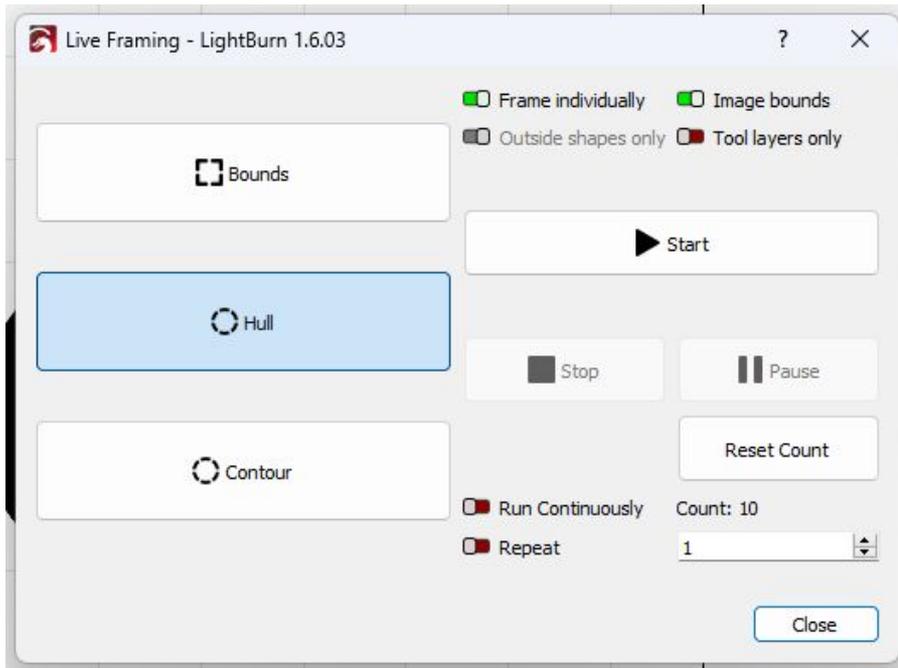
Let's get to know this screen…
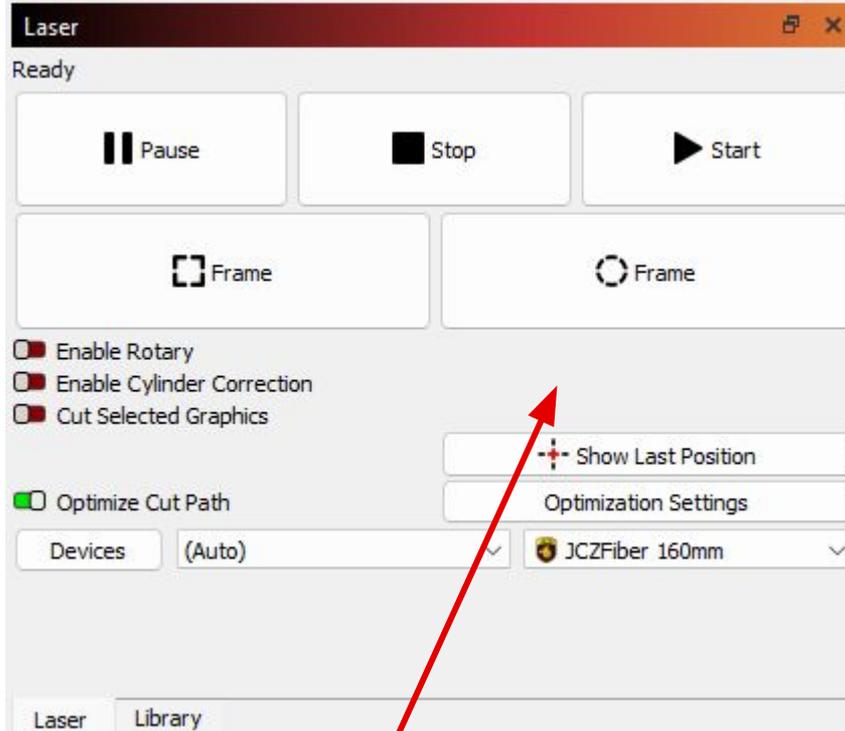
There is no option to change the origin point. The origin point is always the middle focus point of the laser.

Each lens is set up as a different device. You must change the Device to match the lens focal length you are using. There are only two choices and they are labeled with the focal length.

LightBurn: CO2 vs Fiber Laser Differences

The Live Framing screen will always come up after you press start. There are three framing options. You will hit Start again on this screen when you are ready to start. You can make your engravings Run Continuously, or Repeat X number of times.
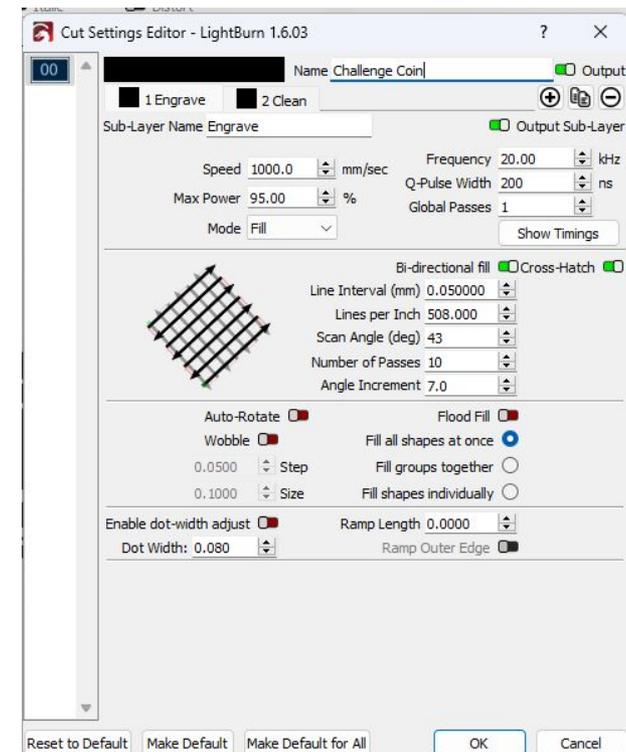
For anything more than removing a coating on metal, you will most likely run more than one type of engraving pass. You can do this with multiple layers, or you can set up sub-layers within a single main layer and run each at different settings and number of passes. Example: run 10 deep engrave passes followed by one cleanup pass, and repeat that over and over.

LightBurn: Origin

- When using a galvo laser, there is only one origin point - that is the center of the lens's cutting area.
- The origin section of LightBurn is hidden when using a galvo laser.
- To align your workpiece, press "Frame" to see where your workpiece will be engraved.
- From here, you can move your workpiece so that it is in the correct position, or you can move your art around on the canvas in LightBurn until it lines up with your workpiece. It is often a combination of these two that will be quickest to align your workpiece.
- If you plan to make multiples of one project, it would be helpful to create a jig, then align your artwork to match it.
- Unfortunately "Print and Cut" doesn't work on the galvo laser.
- LightBurn Information on Framing with a Galvo Laser

LightBurn: Layer Settings

- The ratios of Speed, Power, Frequency, Interval, Passes and Q-Pulse can make a substantial difference in the quality your engraving as well as how long it takes you to complete.
- **Power** is the intensity/power of each laser pulse/fire.
- **Speed** is how fast the mirrors/laser moves
- **Frequency** is how many pulses the laser fires per second. The more pulses, the smoother the image, but the lower the power per pulse.
- **Interval** is how many lines per inch/mm are engraved when using Fill mode.
- **Q-Pulse** - is the pulse width and it interacts with frequency to create color engraving on stainless steel and titanium.
- There are no simple recommended base settings with the fiber laser, though we will develop some and provide material tests over time.
- TEST TEST TEST. Always test your material with different fill and line settings before doing your final project.
- Once you find the settings that work for your material, save that information (Google sheet, notebook, OneNote etc.) so you can use those settings again in the future.
- Remember that the different lenses will require different settings. More power at the same speed will be delivered with the 160mm than the 290mm lens. Settings that worked on one will not necessarily give the same result on the other.
- You can choose the order in which the laser cuts and engraves by pressing the arrows on the far right of the "Cuts / Layers" window.
- You can also use sub-layers to do different types of engraving passes.
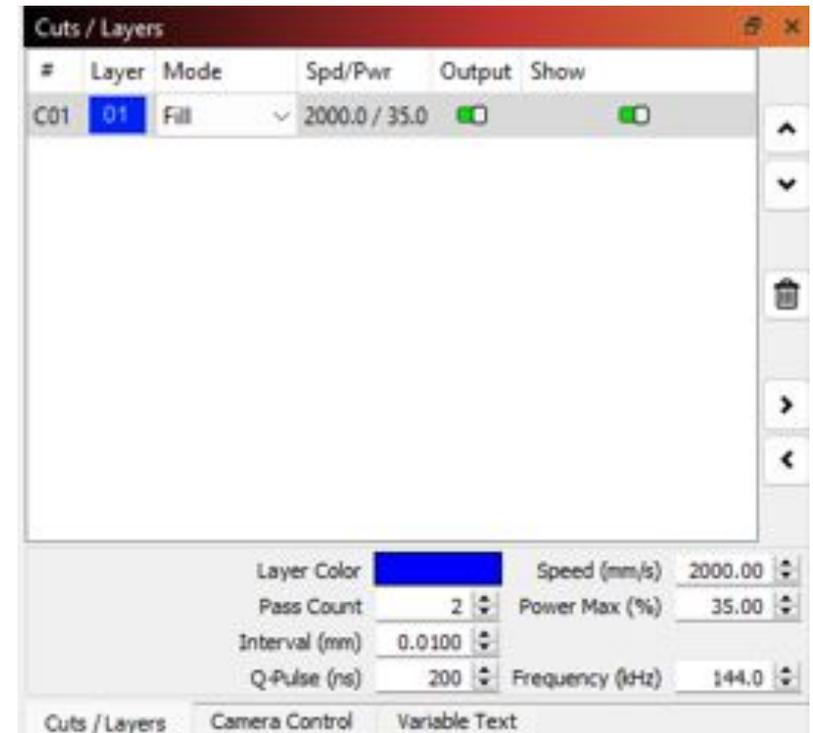
LightBurn: Layer Settings

- Most YouTube videos showing deep metal engraving suggest doing a number of engraving passes followed by a cleanup pass.
- Most recommend "Bi-directional fill" and "Cross-Hatch" with a Scan angle that is greater than 0.
- The "Angle Increment" will adjust the angle of the engraving between passes.
- There are many other settings worth researching if you want to optimize for quality and/or efficiency.
- Make sure to click the "Show Timings" button to make sure that the global timing settings have not been overridden by the specific layer settings that someone before you changed.
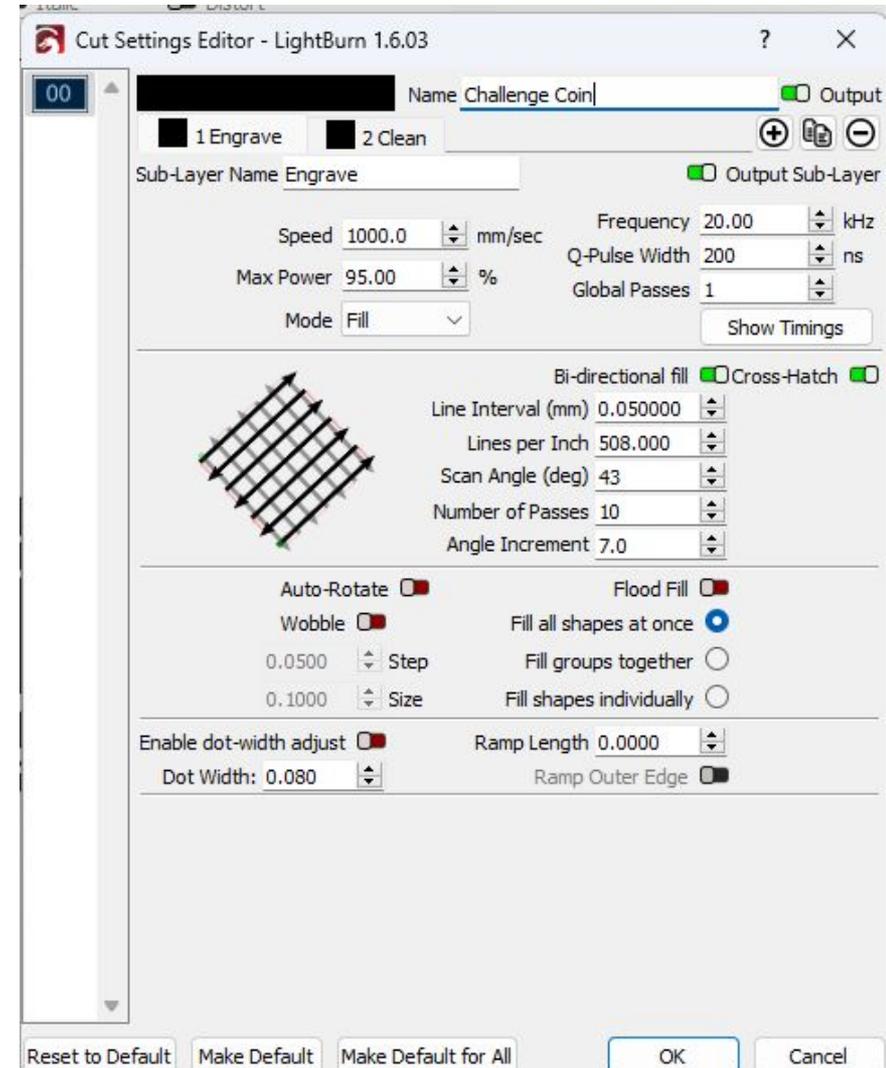
LightBurn: Other Tips & Tricks

- There is no "Air Assist" option because the fiber laser does not have automatic air assist. You can turn on air assist manually at the switch attached to the cabinet.
- The fiber laser top engraving speed is 4000mm/s. With no large moving parts, you can engrave at high speeds.
- The "Preview" button at the top of the screen is useful to find out how long your project will take as well as make sure your cut/fill/layer settings are correct before you get started.
- If you want to change between metric and imperial, you can do so by clicking on the button here.
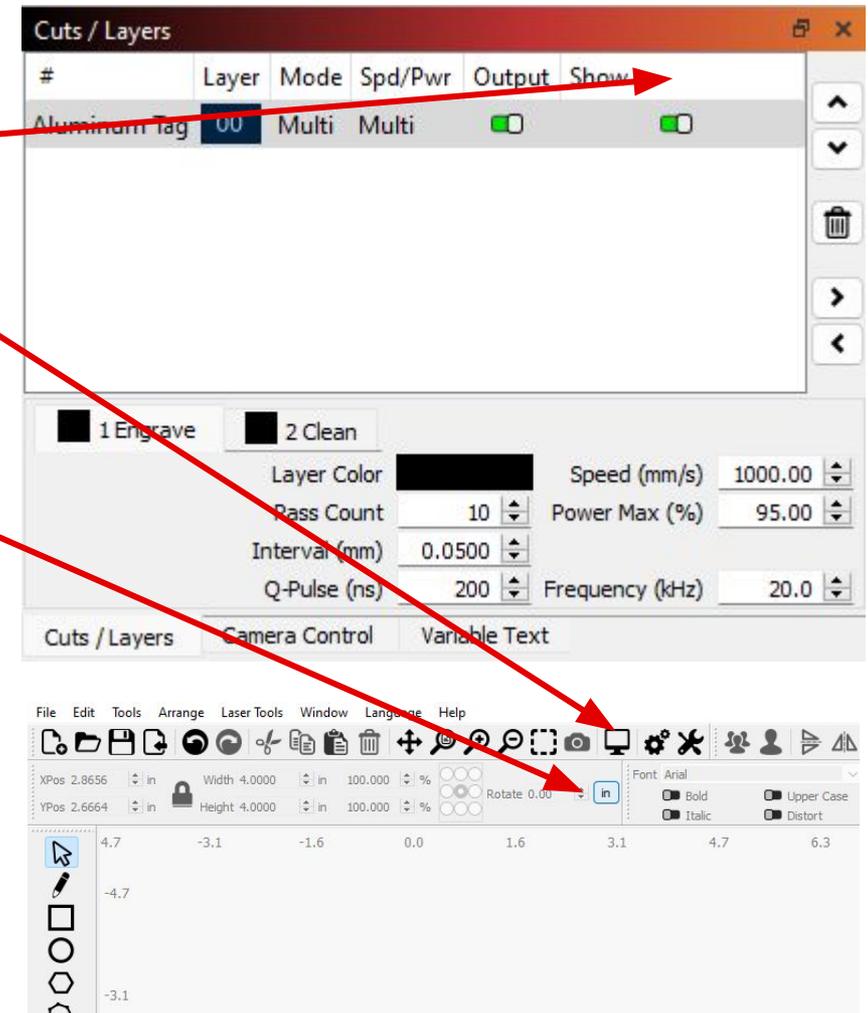
LightBurn: Material Test Cards

Any recommended settings you find online or are developed at Makersmiths are only starting points and not necessarily the best settings. You should do a test on your material before starting your full project. This will allow you to see what the engraving will look like with different setting combinations.

LightBurn has made it super simple to make one with different settings for your material. The widget can be found in the top left menu > Laser Tools > Material Test.

LightBurn tutorial: https://docs.lightburnsoftware.com/Tools/MaterialTest.html or other YouTube videos.
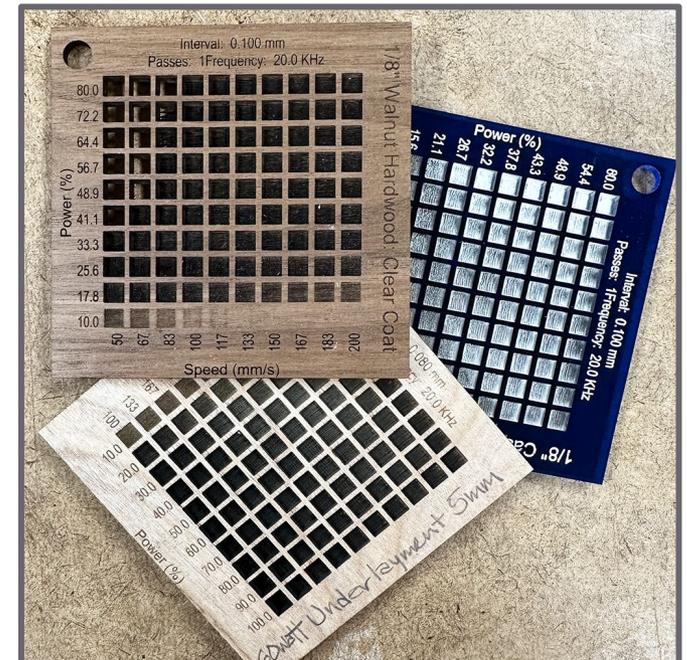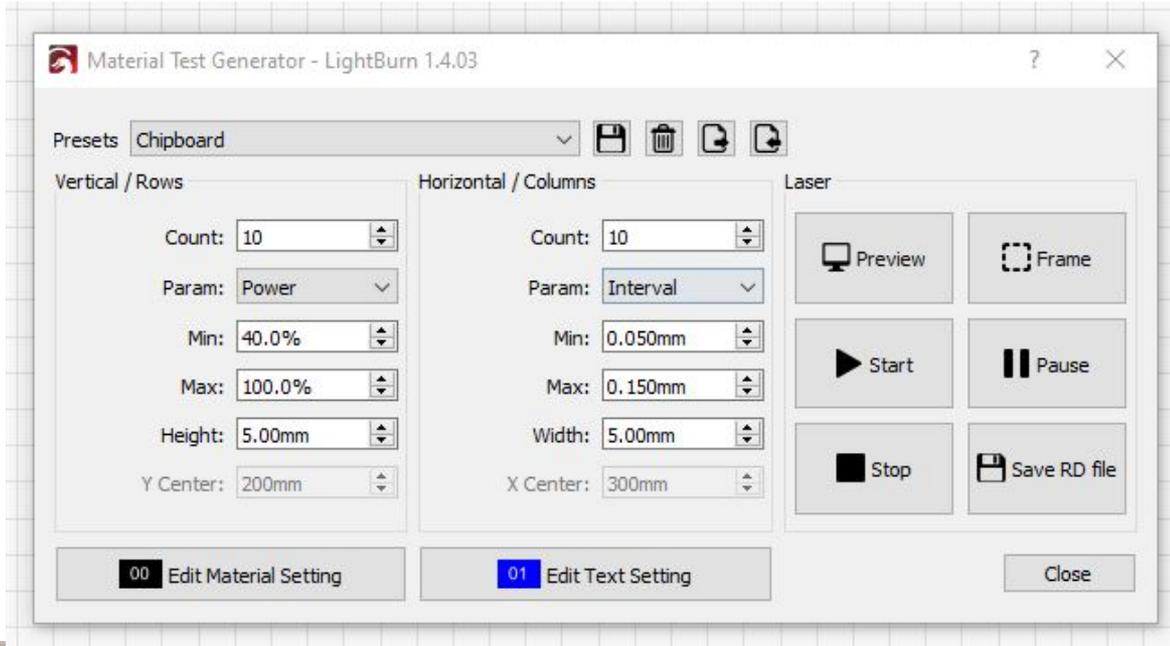
Pre-Start Checklist

- ❏ Turn on the computer and monitor if they are not already on.
- ❏ Turn on the "Laser" switch on the power strip
- ❏ Check that the correct lens you want to use is installed. Swap if necessary.
- ❏ Open LightBurn.
- ❏ Go to File - Preferences- Import Prefs. Load the Default Preferences file from the Desktop folder based on whether you will be importing SVGs from Inkscape or Illustrator.
- ❏ Select the Device (bottom right in LightBurn) relative to the lens you have installed - the 160mm or 290mm.
- ❏ Import/open/create your art as appropriate. Check or set all speed/power/passes/interval/frequency and Q-Pulse layer settings for each layer.
- ❏ Place your workpiece on the bed. Place the correct acrylic focus tool on top of your material. Using the buttons on the front of the laser and/or the dial, adjust the height of the laser for the lens you are using.
- ❏ Place the air assist on the bed and secure it to the bed with at least one screw. Adjust the nozzle as needed.
- ❏ Open the "Camera" application on the computer. Place the webcam on the bed and align so that you can see your workpiece on the monitor.
- ❏ In LightBurn, press the "Frame" button which will show a red outline of the area to be engraved. Move your workpiece, or move your artwork until correctly aligned. If you move your artwork, you will have to go in and out of the "Frame" menu until everything is aligned. Make sure that no wires and the air assist won't be hit by the laser when engraving.
- ❏ When you are happy that your workpiece is aligned correctly, turn on the Air Assist and Air Extraction on the power strip.
- ❏ Close the enclosure door, put your glasses on, warn anyone else in the room that you are starting the fiber laser, close the exterior door, and put the the sign in the window.
- ❏ At this point you should still have the Frame menu open. If not, click Frame again to open the Frame menu. When you are ready to start the engraving, press Start.

During the Project

❏ Keep your laser glasses on at all times, even if the enclosure is closed, while engraving.
❏ Stay with the laser while engraving.
❏ If someone walks in the room unexpectedly, press "Pause" in LightBurn, especially if you have removed the front half of the enclosure. Pressing Pause will allow you to restart at exactly the same position.
❏ You can watch your project through the webcam.

MAKERSMITHS
INNOVATION FORGE

Post-Cut Checklist

- Wait 10-15 seconds for the laser bed to exhaust before opening the door.
- Retrieve object(s) from laser bed.
- Turn off Air Extraction and Air Assist on the power strip.
- If you are done engraving, save your file and close LightBurn and the Camera app.
- Turn off the "Laser" switch on the power strip.
- Replace the front of the enclosure cover if you removed it. Clip the front and back halves together.
- Wipe off the bed with a paper towel.
- Put away any auxiliary parts, alignment jigs, etc.
- Leave the computer and monitor on.

MAKERSMITHS
INNOVATION FORGE

Additional Resources & Advanced Classes

Fiber Laser Useful Links

- Book your fiber laser time: https://makersmiths.org/LaserReservations
- Some fiber laser settings: https://www.omglaser.com/laser-settings/
- Metal blanks:
    - https://www.jpplus.com/engraving/blanks/shapes/metal
    - https://swissbui.com/
    - Etsy
    - Amazon
- LightBurn for Galvo Crash Course:
  https://youtube.com/playlist?list=PLoBR3k35202Yjc1yMfPZsY8EDh_pmcaa2&si=ALTo-ycuzaUfLfva
- Laser MOPA Color: https://youtu.be/-mtg-pmoiOA?si=ANzvetWHZm4_46BE
- Personalized Coins (with some good settings):
  https://youtu.be/uDh832exroA?si=P2ZleoP1xxC1kXP9

Cleaning/Polishing Metal

- Metal doesn't usually come out of the fiber laser engraving process ready to use. Some cleaning and polishing is required.
- There are many ways to do this including by hand, using a rotary tool (Dremel), and using a polishing/buffing wheel on a grinder.
- Cleaning and polishing your engraved metal can be done with scouring pads, scouring pads on a Dremel shaft, sandpaper, wire wheels, cloth wheels with polishing compound of different grits on a Dremel or on a grinder, and many other options.
- A 50 pc buffing/polishing set for a Dremel can be as low as $7.
    - https://a.co/d/3goq07V
- A 145pc of Dremel polishing pads is $7
    - https://a.co/d/eZe7oJw
- A set of 6 polishing compound bars is $10
    - https://a.co/d/5phnxri

Tips, Hints, & Have Fun (cont)

Where to buy Acrylic

- Canal Plastic (closest to us) https://www.canalplastic.com/collections/acrylic-sheets
- Johnson Plastics   https://www.jpplus.com/engraving/sheet/laser/plastic
- Tap Plastics (furthest, longer shipping)
  https://www.tapplastics.com/product/plastics/cut_to_size_plastic
- Inventables (great place to buy small sheets of ⅛" wood too. Just double check it is laser safe)
  https://www.inventables.com/categories/materials

General Laser Links:

- Computer Creationz: https://www.youtube.com/channel/UCB3-k4fmkVqTTjAhb0Cdd_g
- LightBurn Official YouTube Channel: https://www.youtube.com/@lightburnsoftware7189
- The Louisiana Hobby Guy: https://www.youtube.com/@TheLouisianaHobbyGuy
- 10 Tips and Tricks for Laser Engraving and Cutting
  http://www.instructables.com/id/10-Tips-and-Tricks-for-Laser-Engraving-and-Cutting/?ALLSTEPS
- Material Safety and your Laser
  http://support.epiloglaser.com/article/8205/30188/material-safety-and-your-laser
- How to test if a material is safe to laser cut!
  https://www.reddit.com/r/glowforge/comments/3no1vj/how_to_test_if_a_material_is_safe_to_laser_cut/
- Visit the Engravers forum at: http://www.sawmillcreek.org/
- Laser Engraving Tips: http://www.inoplas.com/techtips/laserengrave.asp

Some of the above are more geared towards CO2 than Galvo lasers.

MAKERSMITHS
INNOVATION FORGE

Advanced Classes

We have a rotary attachment and a rotary base for engraving many of the same item which will be taught in a later class.