VECTOR FILES vs RASTER FILES

VECTOR FILES

Made from lines and curves known as paths, rooted in mathematical theory

Can be scaled and edited non-destructively (image quality remains the same)

Ideal for:

cutting/etching lines, shapes, text. all files should be vector unless it's a photo realistic etch.

File Types:

.drw, .pif, .pct, .ps, .eps, .svf, .svg

Illustrator: .ai, .ait, .art

Corel Draw: .cdr, .cdrw, .cdt

Corel: .pat

Digital Line Graph: .dlg, .do

LibreOffice: .odg

Recommended Programs:

Adobe Illustrator, VCarve, Affinity Designer, Sketch (mac only), Inkscape

RASTER FILES

Made from millions of tiny squares, known as pixels

Scaling and editing is a destructive process (image quality degrades with manipulation).

Ideal for:

etching photorealistic images, that's about it.

File Types:

.jpg, .gif, .png, .tiff, .tif

Photoshop: .psd

Procreate: .procreate

Recommended Programs:

Adobe Photoshop, Procreate, Affinity Photo, GIMP

How to Save for Laser Use:

Start with a file between 150-300 dpi

Flatten all necessary layers

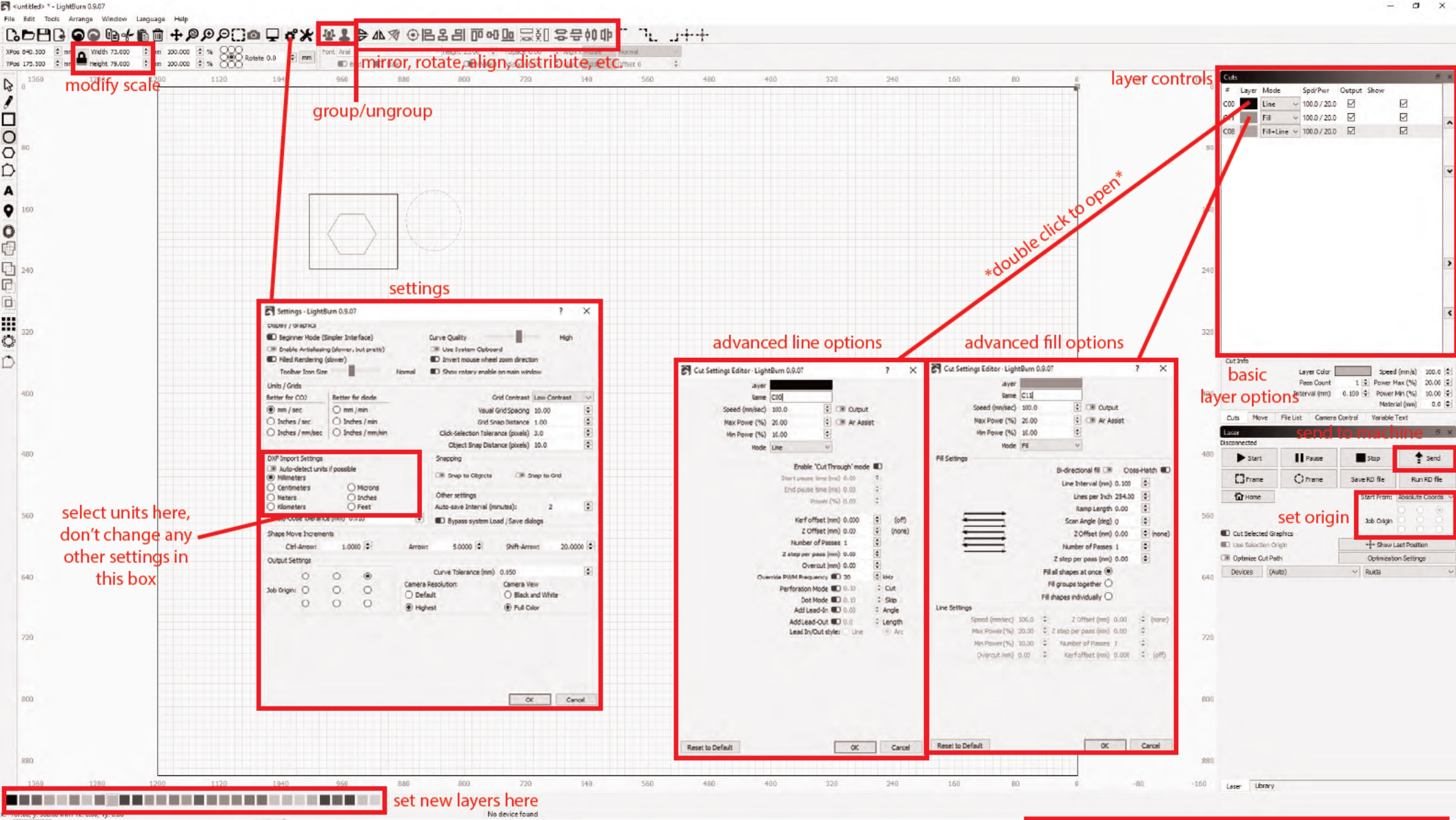
Image ->Mode ->RGB

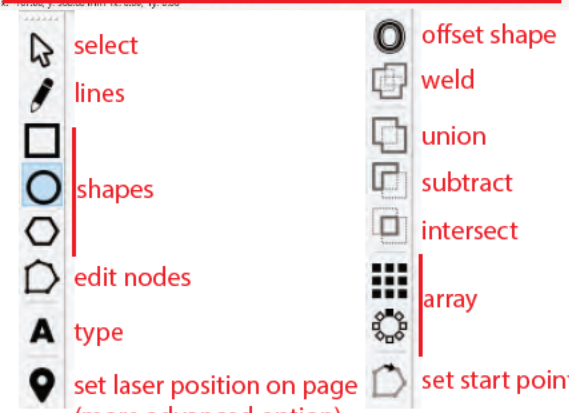
Image ->Mode ->Grayscale(Discard color info)

Image ->Mode ->Bitmap (play with output and method for best results. Stay within 150-300 dpi for output unless you know what you're doing. For method, halftone screen is usually best.

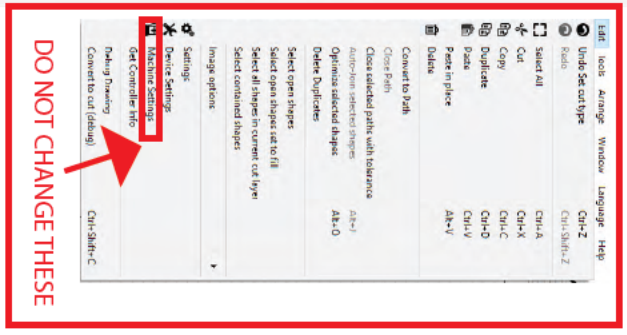
File ->Save as...-> .BMP (1 bit depth)

.eps and .pdf files are containers that can hold vector or raster files


modify scale
mirror, rotate, align, distribute, etc.
group/ungroup
layer controls
double click to open
settings
advanced line options
advanced fill options
basic layer options
send to machine
set origin
select units here, don't change any other settings in this box
set new layers here


select
lines
shapes
edit nodes
type
set laser position on page (more advanced option)

offset shape
weld
union
subtract
intersect
array
set start point


DO NOT CHANGE THESE

FILE PREPARATION:

LIGHTBURN

1. Open LightBurn.
2. IMPORT your file. Only OPEN a file if it was previously generated and saved in LightBurn.
3. Make any necessary adjustments to size, orientation, etc. if needed. Sometimes the file may import at the wrong size depending on what units it was saved in (inches or mm). The final gcode sent to the machine is always in mm, so working in mm is usually preferable to keep things simple.
4. Set any separate layers as necessary by assigning different colors to different layers. This is done by clicking on the colored boxes at the bottom of the screen while having a selection in the work panel.
5. Set Line/Fill/Fill+Line as needed in the layers tab (in older versions of LightBurn these are called Cut/Scan/Scan+Cut).Set all power and speed settings appropriately according to the chart on the wall. DO NOT set the power above 85, as this will degrade the laser tube faster.
6. Set the Job Origin in LightBurn (located under the layers tab and the power/speed tab).
7. Double check all relevent settings, including Scale, Orientation, Speed, Power, Job Origin, etc.
8. SEND the file to the machine. The machine must be powered on and booted first. Name the file something unique to help insure there are no accidental file over-writes on the machine end.

COMMON TIPS AND TRICKS

1. When engraving (Fill), try to align the bulk of the engraving paths along the short axis (y). This will cut down on job time.
2. If a file is not importing from a thumb drive, try saving it to the desktop and then import from there. Please delete it from the desktop when you're finished.
3. If the Fill parts of a file look weird or it is not engraving correctly, double check that all your paths are closed.
4. Sometimes the settings get set to very specific ones which may not be ideal for your job. Double-click on the layer and hit "Reset to Default" in the lower left corner of this panel, then set all your settings accordingly to make sure this doesn't happen.
5. Always make sure that Air Assist is turned on in the layer settings. This helps prevent flare-ups, as well as allowing the material to vaporize properly instead of burning.
6. Using either Perforation Mode or Dot Mode in Line settings can help minimize burning on very thin or light materials (fabric, leather, paper, etc.).
7. The machines use 2.5" Focal Length lenses by default. Changing the lens can help either get better engraving resolution or cut through thicker material. Please ask on Slack if you are thinking of changing the lens, we're happy to help you pick the right lens for the job!

MACHINE PREPARATION:

1. Insert RFID card into reader. If the machine does not turn on promptly, make sure you inserted your card all the way into the reader in one quick motion. If that still doesn't turn the machine on, let us know on the #steward_lasercutter channel in Slack (the reader may need to be reset).
2. The machine will calibrate to its' home position (x0, y0) and then reset to the last known origin point. ONLY interrupt this process if the machine is making a loud sound and appears to be trying to move past the laser bed. If this happens, #steward_lasercutter.
3. Make sure that while the machine is booting, the chiller turns on (located under the central table) and that you hear the fan start up (located behind the laser machine). The chiller front panel readout should be below 24C, if the temperature is above that threshold please let the chiller run for up to 5 minutes until the temperature drops under 24C. Running above 24C can cause damage to the laser tube. Please do not leave the machine turned on at idle (no laser firing) for longer than 10 minutes, this can cause condensation in the tube and damage the tube.
4. Place your material in the bed. On the green laser, swap the slat bed for the honeycomb bed (located between the machine and the wall on the right side) if you are working with leather, fabric, paper, or other lightweight and/or flammable materials. *When engraving, please try to align the majority of the engraving area with the shorter (y) axis. This will decrease overall job time.
5. Using the directional buttons on the front machine panel, place the laser head over the material surface. Adjust the focal offset (distance from laser head to material surface) if necessary to make sure the laser head does not collide with anything below it.
6. Set focal offset.

    6a. (Orange Laser) Turn locking screw clockwise to loosen focal lens enclosure. Using a focal offset gauge, set the focal lens enclosure in relation to the material surface. If there are no gauges, or you are having trouble getting the focus right, please refer to the paper test. Once the focal offset is set, tighten the locking screw counter-clockwise to lock the focal lens enclosure in place.

    6b. (Green Laser) Place aluminum billet underneath the z-height sensor. Adjust the z-height if necessary by pressing "Z/U" on the front panel, then using the RIGHT/LEFT arrow keys. Once the billet is in place, make sure you are still in the Z-adjustment window, then hit "auto focus" at the bottom of the menu. The Z offset should auto-calibrate. If the aluminum billet is missing, or you are having trouble getting the focus right, please refer to the paper test.
7. Hit the "File" button on the machine panel (after sending your file over) and choose your file. Hit Enter.
8. Use the arrow keys to move the laser head to the relevant job origin as was set in the software. Hit the "Origin" button.
9. Hit the "Frame" button to check the job outline and ensure it fits on your material.
10. Hit START. Watch the job to make sure it works without problem, and wear your safety glasses!

SAFETY AND MAINTENANCE

SAFETY:

1. Remove any FLAMMABLE materials from the laser cutter, including small cut-out bits from previous jobs.
2. Certain materials are dangerous to cut or engrave. Please refer to the safety sheet for a full list.
3. Be aware when cutting acrylic that any fumes not properly ventilated are toxic to anyone in the room.
4. Store cleaning acetone away from the lasers as it is flammable.
5. NEVER leave the machine unattended while it is running.
6. FIRE! Small flashes of flame are normal, any continuous flame can damage the machine. If there is a continuous flame, either the power is too high or the speed is too low. Pressing the PAUSE button should stop any small flames, if it doesn't try the following:

    Place the fire blanket over the material,
    Use the fire extinguisher if the fire is out of control. This is for emergencies only and will likely ruin the electronics.
    Evacuate the building if a fire is out of control. Call 911 and do not re enter.

MAINTENANCE:

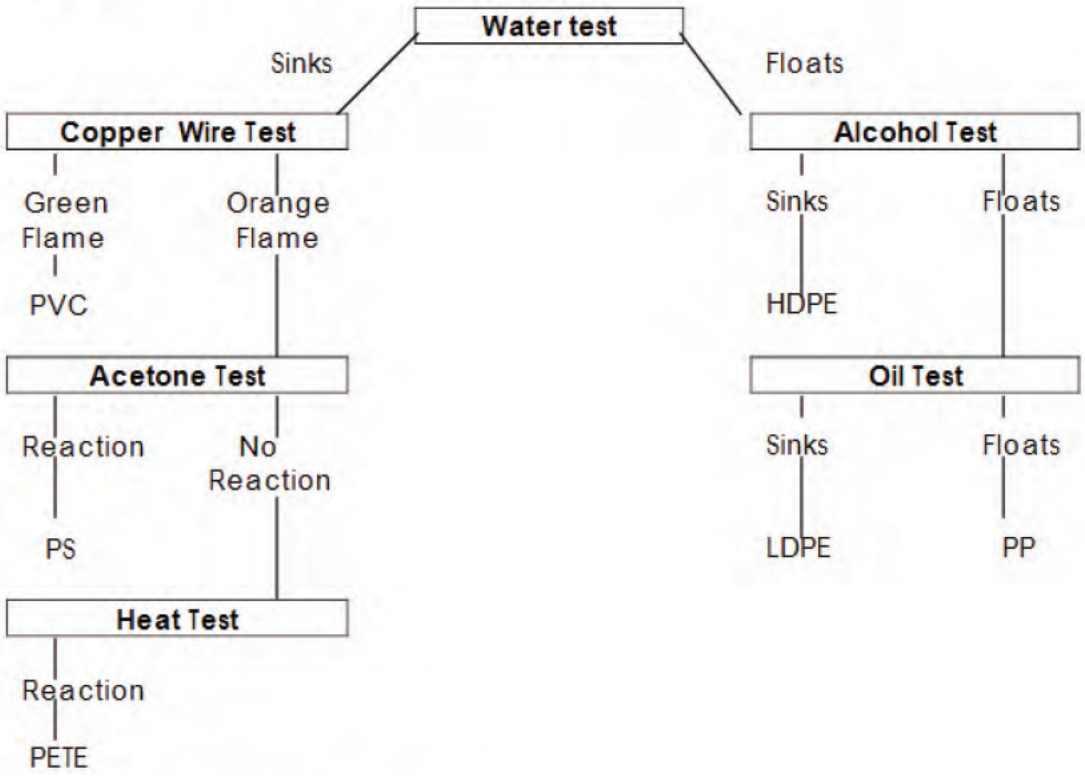
1. Clean the lenses and mirrors with acetone and a microfiber cloth if you notice they are dirty. Refer to the Lens Cleaning Procedure to properly clean the lens.
2. If you notice any sparking or arcing in the rear of the machine, stop it immediately. Use Slack to notify us if this happens and do not try to resolve it yourself as this is a HIGH VOLTAGE machine.
3. If the Green Laser makes a grinding sound while adjusting the z-axis, try adjusting the axis in small up and down increments until it moves freely again. Silicon spray may be applied to the threaded rods under the laser bed to help with this. Please do not lower the z-axis all the way down, as it will likely seize up if you do this and need to be manually reset.
4. The mirrors and lenses on both machines need to be periodically re aligned. If you think they are getting out of alignment (cuts not going through material, a wide kerf on cuts or etches, etc.) please ask an expert user to align the lenses.
5. The water chillers will need to be topped off every 6 months. If you notice a chiller running at or above 24C, please turn the machine off immediately and let us know.
6. If the focal lens or z-axis sensor are changed, the calibration of the z-axis will need to be re done. Only expert users should recalibrate these settings.
7. Only use the version of Lightburn on the two laser computers to send any files to the machines. Sending files from an improperly set up version of Lightburn can corrupt the machine settings, in which case they will need to be rebuilt.

NEVER CUT THESE MATERIALS

Material	DANGER!	Cause/Consequence
PVC (Poly Vinyl Chloride)/vinyl/pleather /artifical leather	Emits chlorine gas when cut!	Don't ever cut this material as it will ruin the optics, cause the metal of the machine to corrode as chlorine is released and ruins the motion control system. It will also ruin human lungs.
ABS	Melts/ Cyanide	ABS does not cut well in a laser cutter. It tends to melt rather than vaporize, and has a higher chance of catching on fire and leaving behind melted gooey deposits on the vector cutting grid. It also does not engrave well (again, tends to melt). Cutting ABS plastic emits hydrogen cyanide, which is unsafe at any concentration.
HDPE/ milk bottle plastic	Catches fire and melts	It melts. It gets gooey. It catches fire. Don't use it.
Polystyrene Foam	Catches Fire	It catches fire quickly, burns rapidly, it melts, and only thin pieces cut. This is the #1 material that causes laser fires!!!
PolyPropylene Foam	Catches Fire	Like PolyStyrene, it melts, catches fire, and the melted drops continue to burn and turn into rock-hard drips and pebbles.
Epoxy	Burns/ Smokes/ Cyanide	Epoxy is an aliphatic resin, strongly cross-linked carbon chains. A CO2 laser can't cut it, and the resulting burned mess creates toxic fumes (like cyanide!). Items coated in Epoxy, or cast Epoxy resins must not be used in the laser cutter. (see Fiberglass)
Fiberglass	Emits fumes	It's a mix of two materials that cant' be cut. Glass (etch, no cut) and epoxy resin (fumes)
Coated Carbon Fiber	Emits noxious fumes	A mix of two materials. Thin carbon fiber mat can be cut, with some fraying - but not when coated.
Any foodstuff (such as meat, seaweed 'nori' sheets, cookie dough, bread, tortillas...)	The laser is not designed to cut food, and people cut things that create poisonous/noxious s ubstances such as wood smoke and acrylic smoke.	

Material with Sticky Glue Backing	Coats lens, cracks lens	There are many normally laserable items such as thin wood laminates that you can purchase that become un-cuttable when the manufacturer adds a layer of peel-off glue on the bottom to attach them to surfaces. Examples include cork tiles, thin wood laminate, acrylic tiles, and paper stickers. Never cut these materials in the l aser cutter if they have this backing. The glue will vaporize forming a coating on the lens that will coat it, cloud it, heat it, and then potentially crack the lens. The glue residue is worse than resin, and can't be removed without risking damage to the lens ... requiring a lens replacement.
Thick (>1mm) Polycarbonate/Lexan	Cuts very poorly, discolors, catches fire	Polycarbonate is often found as flat, s heet material. The window of the laser c utter is made of Polycarbonate because polycarbonate strongly absorbs infrared radiation! This is the frequency of light t he laser cutter uses to cut materials, so it is very ineffective at cutting polycarbonate. Polycarbonate is a poor choice for laser cutting. It creates long stringy clouds of soot that float up, ruin the optics and mess up the machine.

WARNING: Because many plastics are dangerous to cut or etch, it is important to know what kind you are planning to use. Below is a flow chart for determining which material a plastic is. (If you know the specific material you are planning to use and are unsure of whether it is safe or not, find the Material Safety Data Sheet (MSDS) and confirm it does not contain chlorine or anything else dangerous).



For the water, alcohol (isopropyl), and oil tests, you are simply determining if a very small piece of the material sinks or floats in the given substance.

The copper wire test: Obtain a piece of copper wire about 5cm long. Handle the wire with pliers, etc. as you will be applying heat to it. Heat one end of the wire in an open flame until is is red hot and the flame no longer has a green color to it. Touch the hot end of the wire to the material and get a small amount of material melted off onto the wire. Place the material over the open flame. If the flame turns green in color, the material contains chlorine and should not be used.

Acetone test: Find a small container and fill it high enough with acetone to immerse a very small material sample in the acetone. Let the material sit in the acetone for roughly 20 seconds and remove it. If the sample is soft and sticky, and the outer layer can be scraped with your fingernail, discard the sample and do not laser cut the material.

Heat test: Submerge a small sample of the material in boiling water for approximately 30 seconds, then remove it. If it is soft and sticky and can be scraped with your fingernail, discard it and do not laser cut the material.

Materials which can be etched (but not cut)

Glass
Ceramic Tile
Anodized Aluminum
Painted/coated metals
Stone, marble, granite, soapstone, onyx

Marking:

Cermark is the brand name of a marking compound containing molybdenum that costs between $50-$100 for a 12oz spray can. It can be sprayed onto stainless steel, brass, aluminum, copper, nickel, glass, or light colored stone/tile before etching to leave behind a permanent dark black mark. A cheaper alternative to Cermark is Dry Moly Lube, which containts molybdenum sulfate which breaks down to molybdenum, but does not leave a mark as consistently dark and uniform as Cermark.

LENS CLEANING AND REPLACEMENT

* The procedure detailed here is for the Hurricane (Green) Laser. Steps for the Orange Laser are very similar, any differences will be noted in the specific step.*

1. 

Bring the head assembly to a convenient spot to work on it, and turn the machine off. Unscrew the set screw holding the conical tip of the head in place. *On the Orange Laser, there is no set screw. Loosen the locking ring (see next step), then turn the loosened tube while holding the conical tip to unscrew the tip.* Let this part hang free for now.

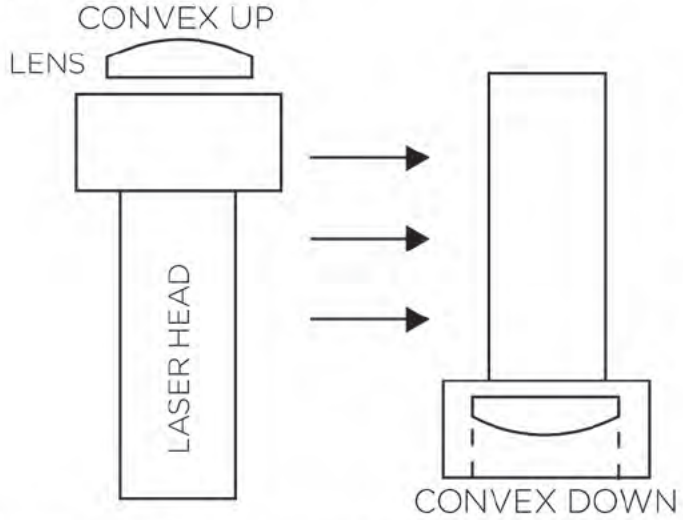
2. Loosen the locking ring by turning counter-clockwise. On the Green Laser, you may need a set of channel locks to help turn it, it tends to hold pretty tight. Once this is loosened and the conical tip is no longer attached, the laser head may be removed. On the Green Laser, you may need to twist it with the channel locks to get it started. Let the z-axis sensor hang free on the Orange Laser once the head is removed. The removed laser head will look like this --->

3. With the laser head removed, flip it over and you will see a silver locking ring holding the lens in place. There are two notches in this ring for loosening and tightening it, the right sized chisel or a flat head screwdriver can help get it going: Be very careful at this stage not to scratch or chip the lens, and also not to damage the notches on the locking ring. Once the ring is loosened enough, it can be removed by hand to help avoid scratching the lens. On the Orange Laser, the locking ring is recessed further down into the head, but all other steps are the same for removing it. Before you remove the actual lens, please grad this black and red tool box, located under the table between the two lasers:

Also grab the acetone while you are at it, this will be used to clean the lens.

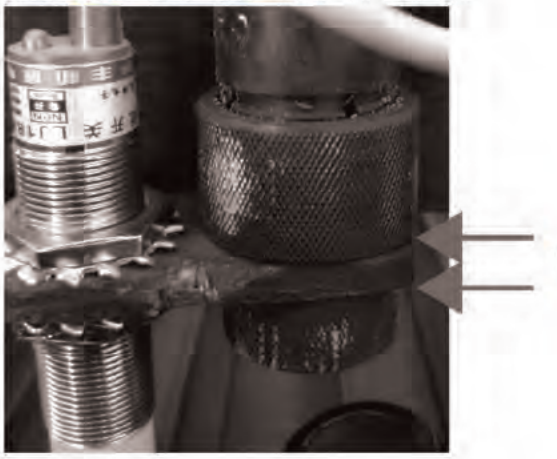
4. In the toolbox's lower portion, you will find a lens case like the one below. This should have an extra microfiber cloth in it. Let the lens fall out of the laser head onto the microfiber cloth.

Wrap the cloth around the lens, and get it wet with some acetone. Use gentle scrubbing motions to clean the lens with the cloth. Be careful not to get any oils from your fingers onto the two main surfaces of the lens, as they can cause a hot spot when the laser fires and crack the lens. Holding the lens by the edges with your bare hands is fine, but never touch the two main surfaces with bare hands. Once the lens is clean, it should be inserted into the laser head so that the convex side of the lens is facing down when it is all reassembled. So place the lens in convex side UP, reinsert the locking ring and tighten it being very careful not to scratch or get finger oil on the lens, then flip the laser head back over so the convex side of the lens is now facing DOWN:



Be sure to tighten the locking ring all the way. If it is loose, or gets loose over time, it will rattle around as the gantries move and produce a very inconsistent focal point.

5. Congrats! The hard part is over. Please remember to put the microfiber cloth back in the lens case, then put the lens case in the tool box and store it all under the table between the lasers. Also please put the acetone away (if there is no acetone or it's running low it would be much appreciated if you either make a note of it, or run over to Kroeger's to pick some up). Now follow the instructions on the previous page in reverse to reassemble the head assembly. On the Orange Laser, one of the focal depth gauges can be used to make sure it is in focus before tightening the black locking ring. On the Green Laser, make sure there is minimal-to-no spacing between the locking ring, head, and the piece the holds the z-axis sensor. This will ensure the right focal depth on the Green Laser. Be careful not to over-tighten the locking rings, as they can get cross-threaded, and remember to reinsert the set screw on the Green Laser!



PAPER TEST

If the aluminum billet and/or focal gauges are missing, using the paper test is the next easiest way to set the focal offset for both machines.

1. Find a piece of paper and place it on the surface of your material (or the surface of another equally thick piece of material if you don't want to mark up your material's surface).
2. With the laser head over the paper, hit the "Pulse" or "Laser" button on the front panel. DO NOT hold either of these buttons down, a quick press is all you need. On the Green Laser, the machine lid will need to be closed before pressing the button.
3. The laser should have briefly fired, creating a hole in the paper. The goal of the paper test is to get this hole as small as possible.

3a. On the Orange Laser, manually move the focal offset by moving the focal lens enclosure up or down in small increments. "Pulse" the laser at every increment to see if the hole is getting larger or smaller when compared to the previous hole made. When the hole is as small as you can get it the laser should be extremely close to being in true focus. A small (within .5mm) deviation from true focus in either direction is fine, it will not noticably impact your results.

3b. On the Green Laser, us the "Z" button and then the UP/DOWN ARROW KEYS to incrementally move the bed up and down. The machine lid must be closed, and you must be on the main screen (not the Z axis control screen) for the "Laser" button to fire the beam. Press the "Laser" button at every increment to see if the hole is getting larger or smaller when compared to the previous hole made. When the hole is as small as you can get it the laser should be extremely close to being in true focus. A small (within .5mm) deviation from true focus in either direction is fine, it will not noticably impact your results.