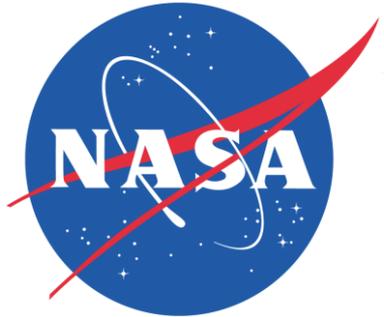


User Training Manual

Laser Cutter



SpaceShop
Ames Research Center
Moffett Field, CA



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National Aeronautics and
Space Administration

SPACESHOP

Laser Cutter Training Manual

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I. Introduction

This document is for the user qualification training of the Laser Cutter located at the Ames SpaceShop facility on the 2nd floor in Building 220. Before a user operates the machine, he/she must have signed the required documentation as described in the “SpaceShop Standard Operating Procedures”. For additional information, please see a SpaceShop staff member.

II. Universal Laser Cutter

The Universal Laser Cutter is a machine that uses a laser beam to complete three different processes: a) to cut completely through a material along a designated path, b) to engrave by vaporizing material to a user controlled depth, c) to mark a material by modifying the material surface.

The specifications of the laser cutter are as follows:

- Table Work Area: 36 x 24 in
- Maximum Part Size: 40.5 x 30 x 12 in
- 150 Watt
- Weight: 400lbs

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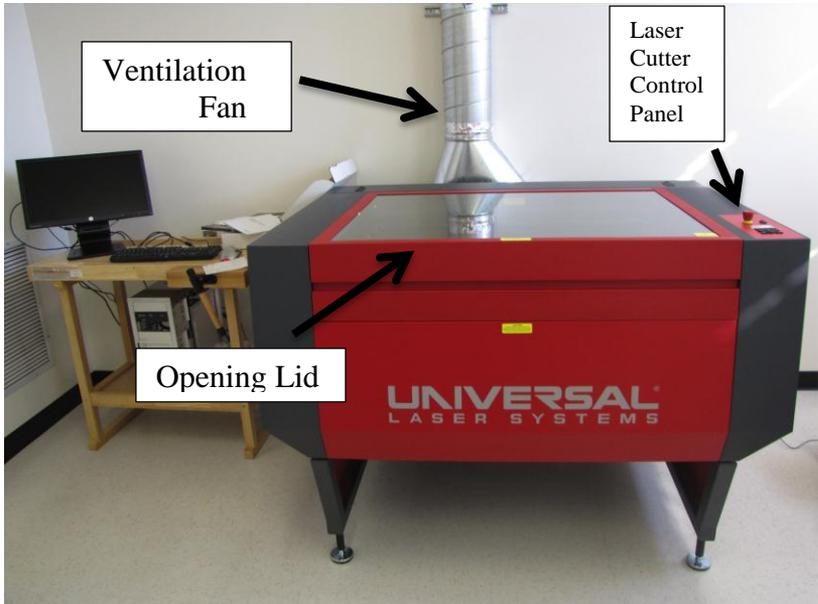


Figure 1: Universal Laser Cutter

III. Safety Precautions

a. Laser Cutter Safety

SHALL...

- You **SHALL** notify SpaceShop staff prior to running any job.
- You **SHALL** wear closed-toe shoes at all times.
- You **SHALL** wear eye protection when working with tools and processes that involve chemicals, metal shards, wood chips or sawdust.
- You **SHALL** clean up your space after every job session, and leave 10-15

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minutes for cleanup prior to shop closure.

- You **SHALL** secure badge and any loose items that might get caught in moving machinery.
- You **SHALL** ensure all tools are in good condition before use.
- You **SHALL** use your sense of sight and sound to keep yourself aware of the operational conditions of the Laser Cutter for safe use.
- You **SHALL** remove all debris from the aluminum tray before starting a job.
- You **SHALL** lift up the machine lid to deactivate the laser when you see a flame or potentially a significant amount of smoke.
- You **SHALL** transfer files with a usb stick to the laser monitor.
- You **SHALL** keep the laser ventilation fan on at all times during a job operation.
- You **SHALL** keep the machine lid closed for 2-3 minutes after the laser has completed its operation, since some materials after laser engraving or cutting, continue emitting fumes for several minutes after processing.
- You **SHALL** make a reservation to use the laser.
- You **SHALL** use common sense and if you are not sure about any step of the laser tutorial, ask for help and a SpaceShop staff member will be more than happy to assist you.

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SHALL NOT...

- You **SHALL NOT** wear or have any loose objects on your body while operating this machine, including badges, jewelry, loose clothing, and loose long hair.
- You **SHALL NOT** leave the machine unattended while it is in operation.
- You **SHALL NOT** work alone while in the SpaceShop.
- You **SHALL NOT** unplug the cables hooked up to the laser monitor, not even to connect your own computer to the laser cutter.

IV. Step-by-Step Tutorial

Tools Required

- Universal Laser Cutter
- Computer with CorelDraw, Adobe Illustrator or Inkscape(FREE)
- Computer with Universal Control Panel(UCP) Software
- 2 x 3.5 inch, 0.0195 inch thick anodized aluminum
- Paper & Pencil
- Tape measure
- Clean Hands

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- Calipers
- Height Gauge for either the 2.0 or HPDFO lens
- Flat Bed Tray or Rotary Attachment
- HPDFO Lens Kit or 2.0 Lens Kit

Getting Started

- **SPECIFY** to a SpaceShop Staff member, if you will use the **2.0 Lens kit** or the **HPDFO Lens kit**, **AND** if you will need the **FLAT BED TRAY** or the **ROTARY** attachment.

2.0 Lens Kit- standard lens kit ideal for cutting or minimal low resolution etching. Like the HPDFO Lens, it will say 2.0 on the Lens Kit Panel.



Figure 2: 2.0 Lens Kit

HPDFO Lens Kit- High Power Density Focusing Optics (HPDFO) uses a method to expand the laser beam within the focusing carriage. This expansion allows engraving to create sharper high resolution images and also for direct marking on some metals.



Figure 3: HPDFO Lens Kit

Flat Bed Tray- Ideal for cutting or etching flat materials.

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Figure 4: FlatBed Tray

Rotary Attachment- Ideal for etching objects with curved surfaces especially those with a symmetric cross-section such as cylinders or cones.

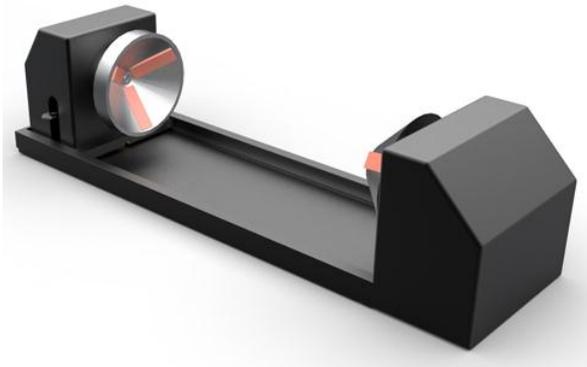


Figure 5: Rotary Attachment

- Ask a SpaceShop Staff Member to clean the lens **BEFORE YOU PROCEED ANY FURTHER.**

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- Once you are checked off on cleaning the lens, you may clean it here-on-after for all other jobs. **CLEAN THE LENS BEFORE AND AFTER EVERY JOB.**
 - A job depends on how long the laser is on, and also depends on the material you are cutting.
 - If you have to make many cuts at once, divide the cutting area so that the laser is only on for less than 2-3 minutes at a time. Let the laser cool off for a couple minutes and turn it back on to continue cutting and repeat these steps.
 - If you are not sure, ask a SpaceShop Staff member.

Preparing To Cut

1. Check the Appendix of this tutorial to make sure your material is on the **APPROVED LIST OF MATERIALS** or ask a SpaceShop Staff member if the material is not listed.
2. Note the thickness of your material with a set of calipers, and check the Appendix for speed and power settings. If your material is not listed, notify a SpaceShop staff member. **YOU NEED TO VERIFY YOUR POWER AND SPEED SETTING WITH A SPACESHOP STAFF MEMBER** before you proceed to the next step.
3. Make sure everything is **CLEAN** inside and outside the laser cutter. If you notice anything odd, ask a SpaceShop Staff member right away, or the shop

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will assume an issue was caused by you as opposed to the person who used the machine before you.

4. Bed is fragile, so carefully place your items on the tray. **IF THERE IS SMALL DEBRIS, VACUUM HONEYCOMB GRID** (Figure 6).
 - a. If the grid has **large leftover parts** on the honeycomb from a previous session, then **remove those parts with your fingers**. The grid is resting on the table, and therefore any movement of the grid may misalign the rulers to those in the software interface.

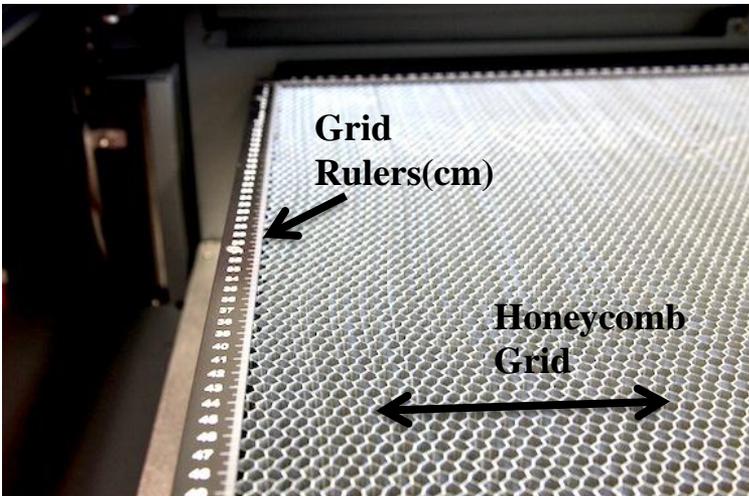


Figure 6: Vector Grid or HoneyComb Grid

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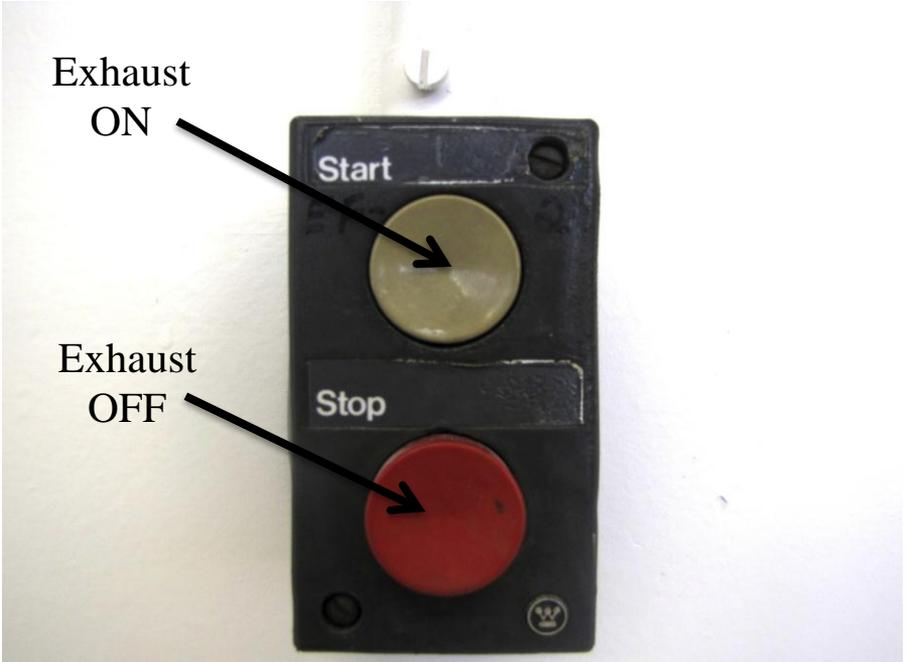


Figure 7: Buttons to Turn On and OFF Ventilation

5. **TURN ON** the exhaust fan at this time (Figure 7).

NOTE: This switch is located near the entry door. Make sure to leave the exhaust fan **ON** for the **entire** duration of the job.

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Figure 8: Honeycomb Trays

6. Clean the **HONEYCOMB TRAYS** for excess material, by opening the laser door on the front of the machine, pulling towards you gently and removing both trays out of the laser to discard extraneous material (Figure 8).
 - a. **Extraneous material left over in the honeycomb trays may ignite during laser cutting!**

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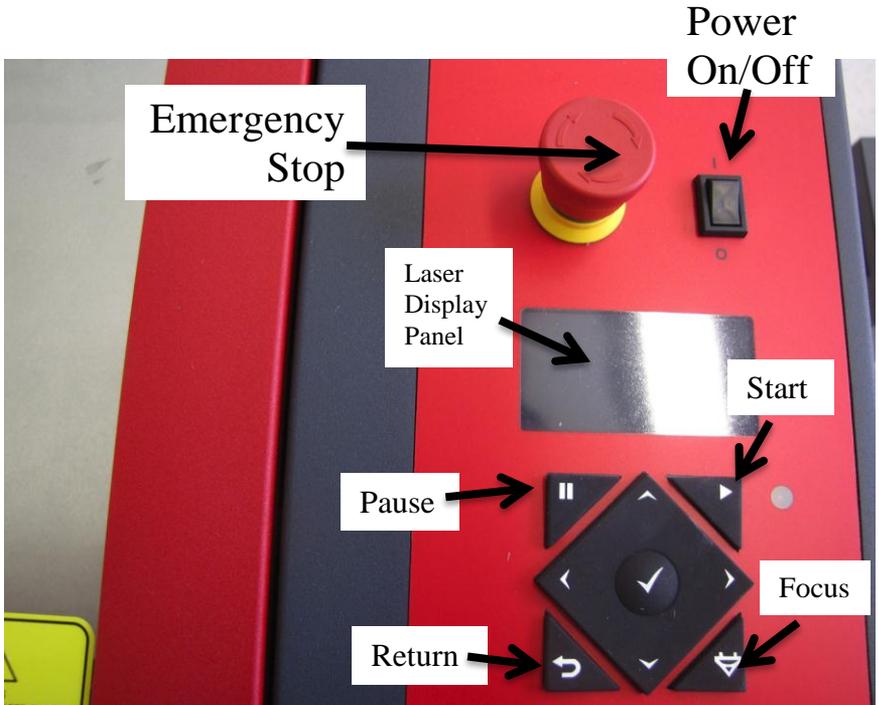


Figure 9: Laser Cutter Switches

7. **POWER ON** the laser with the **ON/OFF** switch (Figure 9).
8. Open the machine cover **GENTLY**. **DO NOT LET IT SLAM** as it opens (Figure 1,10).

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Figure 10: Laser Cover Open

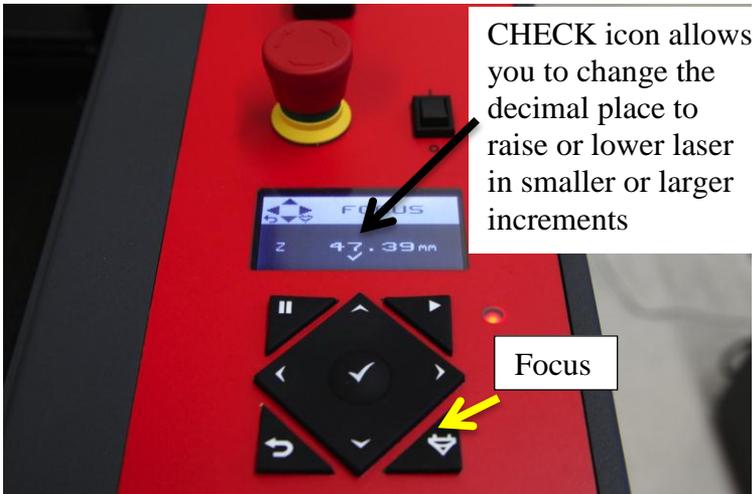


Figure 11: Focus Icon

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9. There are two methods to **FOCUS** the laser to your specific material. Before you complete the next set of steps, make sure nothing is blocking the laser carriage since it will move across the table.
 - a. Automatic Focus- Click and hold on the **FOCUS** button. The laser carriage will move to the center of the table and alter the Z-axis until it focuses.
 - b. Manual Focus – Click on the **FOCUS** button and scroll to Z. Click enter to go to the Z-axis adjuster (Figure 11)
10. To manually focus the laser to the material you have chosen, make sure to **LIFT UP** the machine's **LID** for the following steps (Figure 10). **REMOVE YOUR BADGE TO AVOID SCRATCHING OR HITTING THE TABLE AND LASER.**
11. **CLICK** once on the lower right hand **FOCUS** icon (Figure 9,11).

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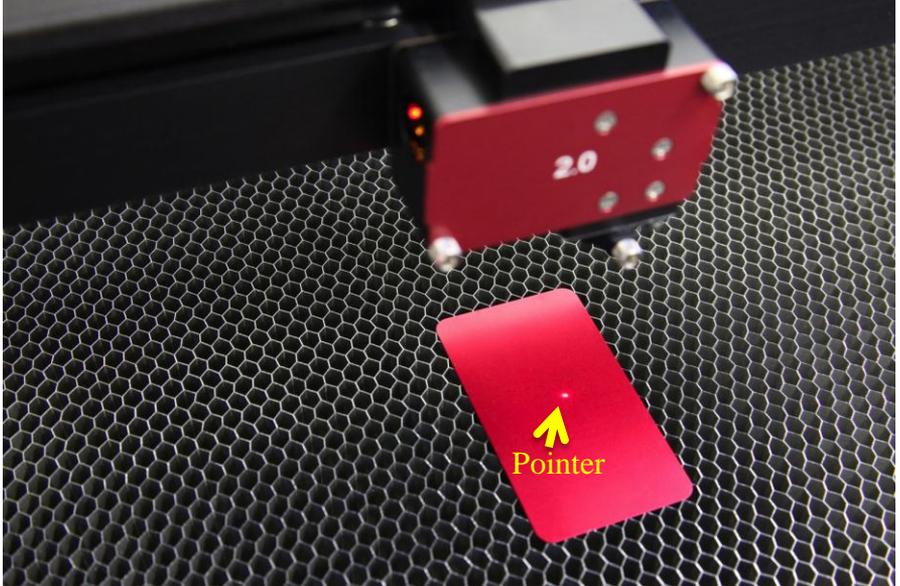


Figure 12: Red Pointer during Manual Focus

12. The laser has now moved to the **CENTER** of the **HONEYCOMB GRID** (Figure 8,12).
13. Place your **MATERIAL** under the focus carriage and notice the **RED POINTER DOT** in Figure 12. You will only be able to see the dot on your material if the machine cover is **OPEN** (Figure 9,10).

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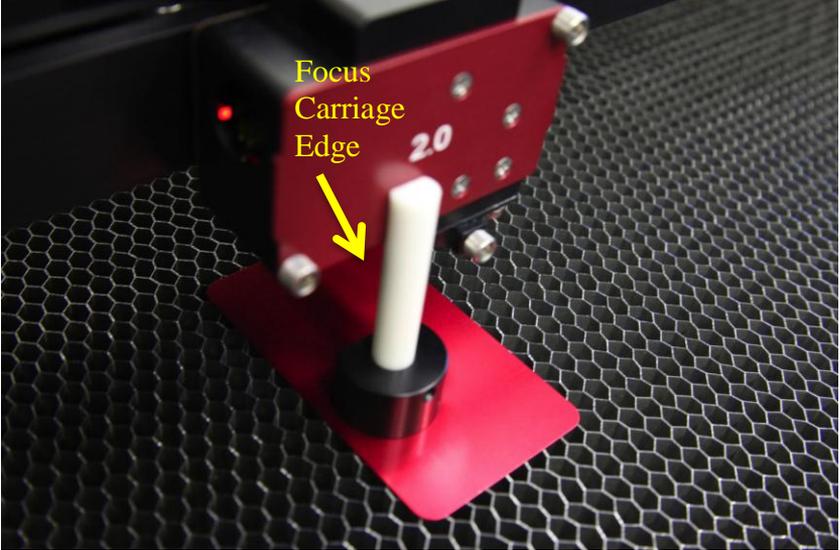


Figure 13: Manual Focus Tool is used to manually set the focus to the height of your material

14. Place the **MANUAL FOCUS TOOL** on your material. The flat side will rest against the **FOCUS CARRIAGE** (Figure 9).

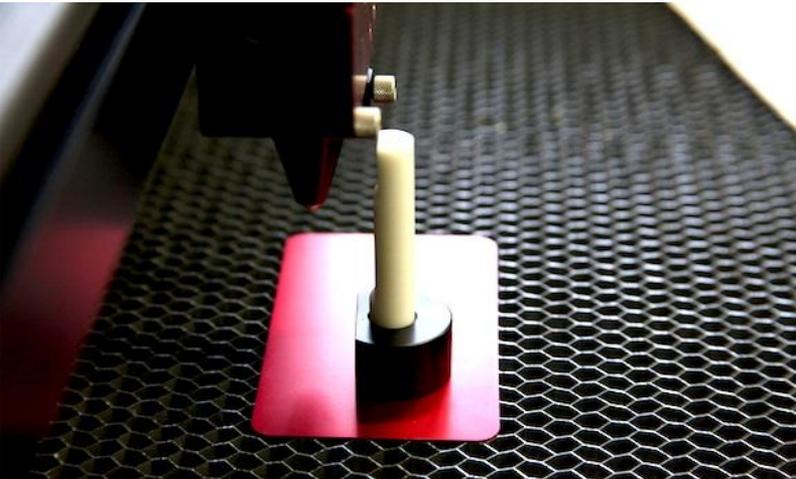


Figure 14: Manual Focus Tool Zoomed In

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15. Manual focus tool is now flush against the **FOCUS CARRIAGE**. The bed needs to move up, to get the lowest point of the indent on the manual focus tool, aligned with the bottom edge of the focus carriage (Figure 13).
16. Press the **UP** and **DOWN** arrows on the **LASER PANEL** in order to **RAISE** and **LOWER** the **LASER BED** until the **BOTTOM EDGE** of the **LASER OPTICS CARRIAGE** is **FLUSH** with the **BOTTOM EDGE OF THE MANUAL FOCUS TOOL INDENT** (Figure 13,14).

Note: If you need to make smaller adjustments to move the bed up or down, you can do this by **CLICKING** on the **CHECK** mark **ICON** in Figure 10, the digital **CHECK** on the **DISPLAY PANEL** will move under the decimal place you wish to change. This allows one to make larger or smaller adjustments at a time.

17. **CLICK** the **RETURN ARROW** on the **SIDE PANEL** to set **FOCUS**.

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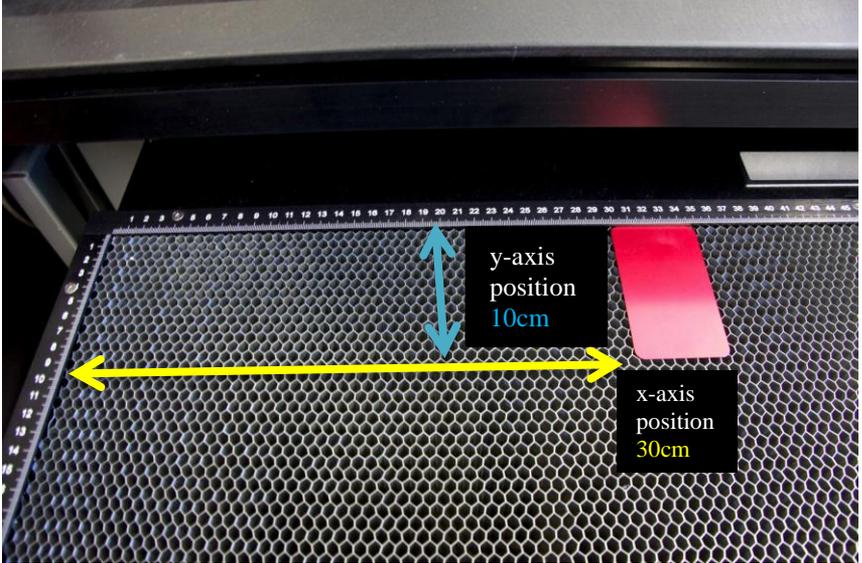


Figure 12: Placement of Material and Measurements

18. **POSITION MATERIAL** to be cut or etched, with both edges against the rulers (Figure 12). **NOTE DIMENSIONS** and **POSITION OF MATERIAL** along the rulers on the bed.

NOTE: In the case of etching a small area whereby the laser will travel short distances rapidly in the x-direction, place the materials somewhere along the center of the vector grid to reduce vibration and prevent the carriage from hitting the end of its x-axis rapidly as it pulses.

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19. Click on the **CoreDRAW** icon (Figure 13).



Figure 13: CoreDRAW Icon

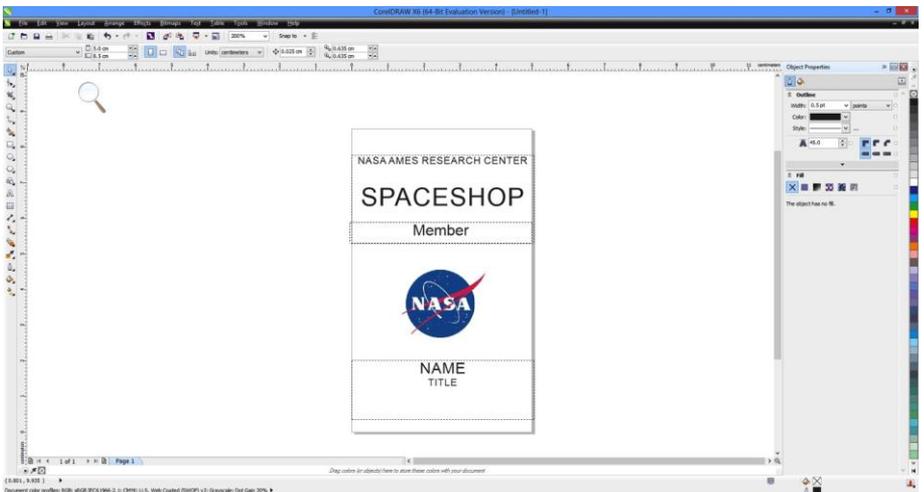


Figure 14: Design File in CoreDRAW

20. **OPEN** your design file in **CoreDRAW** (Figure 14).

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- **NOTE:** The file in Figure 17 features a combination of vectors for the words, and a raster image of the NASA logo.
 - A **VECTOR** drawing is made up of straight or curved paths with control points that you can select to modify the paths. The vectors in this file are in black, because we desire to etch the surface.
 - A design file may also have a **RASTER IMAGE (or bitmap)**, a rectangular grid of pixels used to etch a material. Your design file may also have a combination of both vectors and raster images. Make sure to set your vectors to Hairline else you will receive an error when it comes time to perform the cutting.

21. In the File menu, click on **PRINT** and the print window will pop-up. We are not ready to print yet (Figure 15).

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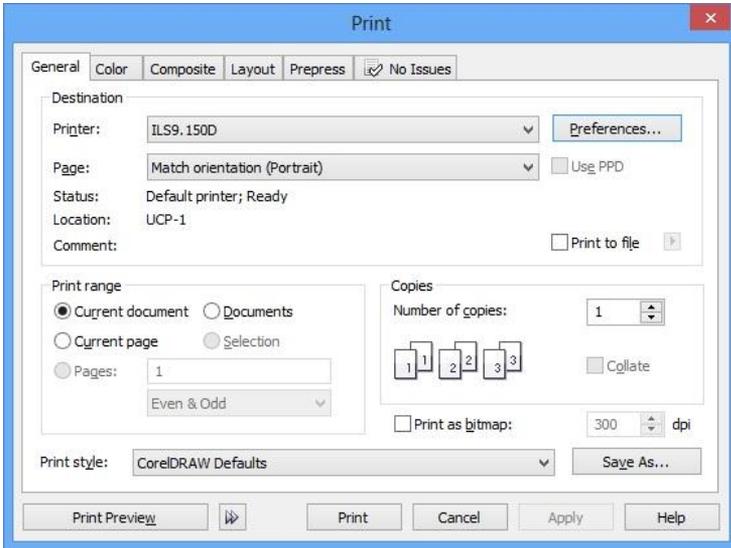


Figure 15: Print Dialog Box

22. Under **PRINT RANGE**, make sure you have the box selected for the option you need (Figure 15).

- **Note:** If you have **CURRENT DOCUMENT** selected, then the laser will do everything that is within your bounding box.
 - It is always better to **SELECT** the items in CorelDRAW you want to laser cut, and then verify under **PRINT RANGE**, that the **SELECTION** box is checked.

23. Make sure the correct **PRINTER** is selected ILS9.150D. Click on the **PREFERENCES** box to enter the **LASER SETTINGS** window.

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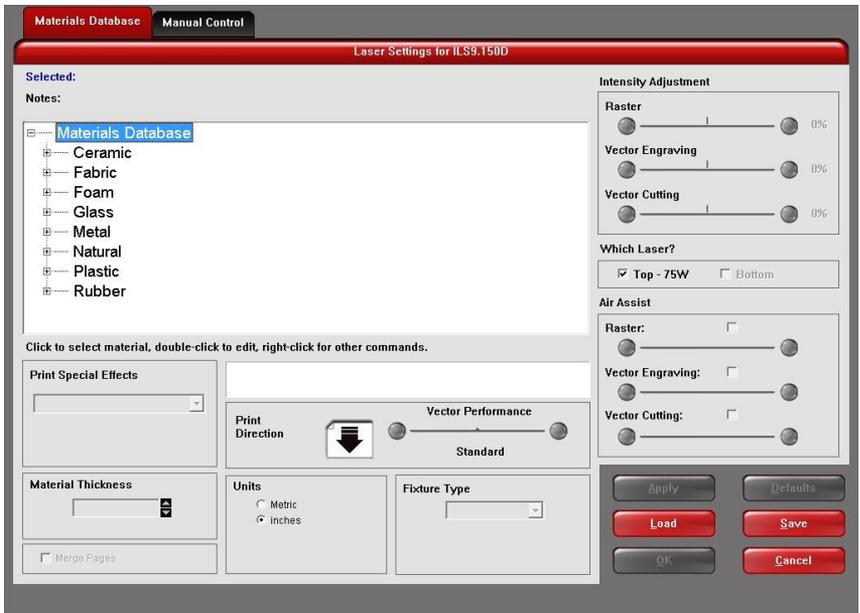


Figure 16: Materials Database Selection

24. Select desired material from the **MATERIALS DATABASE TAB** (Figure 16).

25. Set the **FIXTURE TYPE** to **NONE** (Figure 16).

26. Measure the thickness of the material with digital calipers for accuracy. Enter this into the **MATERIAL THICKNESS** field (Figure 16).

27. Select **APPLY**.

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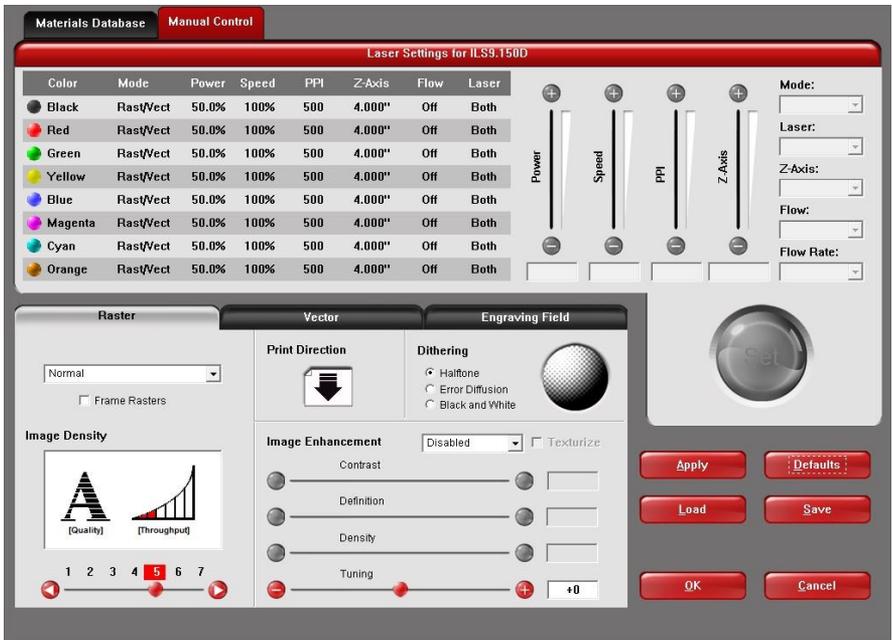


Figure 17: Manual Control Tab

28. **CLICK** on the **MANUAL CONTROL** tab (Figure 17).

NOTE: Once you have chosen a material from the previous step, the colors will automatically update in the **MANUAL CONTROL** box. The preferred settings for each row is automatically updated given the material selection. As a test, go back into the **MATERIALS DATABASE** to change your material selection and return to the **MANUAL CONTROL TAB**. You will notice the settings change both for recommended **POWER** and **SPEED**.

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29. Note that once a material has been selected, and a thickness has been applied, the power settings indicate how deep the laser will cut the material (Figure 18).

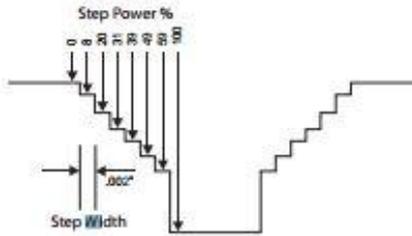


Figure 18: Power cut settings

30. Click on the Black Color in the first row, and under FLOW RATE, make sure all **AIR ASSISTS ARE ON**.
31. Click the green **SET** button to apply the setting.
32. Now select **OK**.
33. Select **PRINT** in the Print dialog window (Figure 15).
- **NOTE:** Potential error's that may show up at this point include: "No Data" error if you have not set your vectors to hairline, or "Air Cone Error" if the compressor is off.

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Figure 19: Laser Display Panel

34. Make note of your **FILENAME**, in this case the title is: **UNTITLED-1** (Figure 19). This **FILENAME** should **MATCH** the filename in whatever program you are using, or the most recent file you have sent to the laser.

- **Note:** Every time you send a new job, the laser panel will update the name of your print job. Always make sure your print job matches the most recent job you sent, to prevent any errors.
 - Imagine etching you **IPHONE** case only to find out that you hit GO on the wrong file with power settings that have now cut through instead of etched your **IPHONE** cover.

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Figure 20: Universal Control Panel (UCP)

35. Now launch the **UNIVERSAL CONTROL PANEL (UCP)** icon on your desktop, or in the lower right hand corner of your computer screen. **RED ICON** labeled UCP (Figure 20).

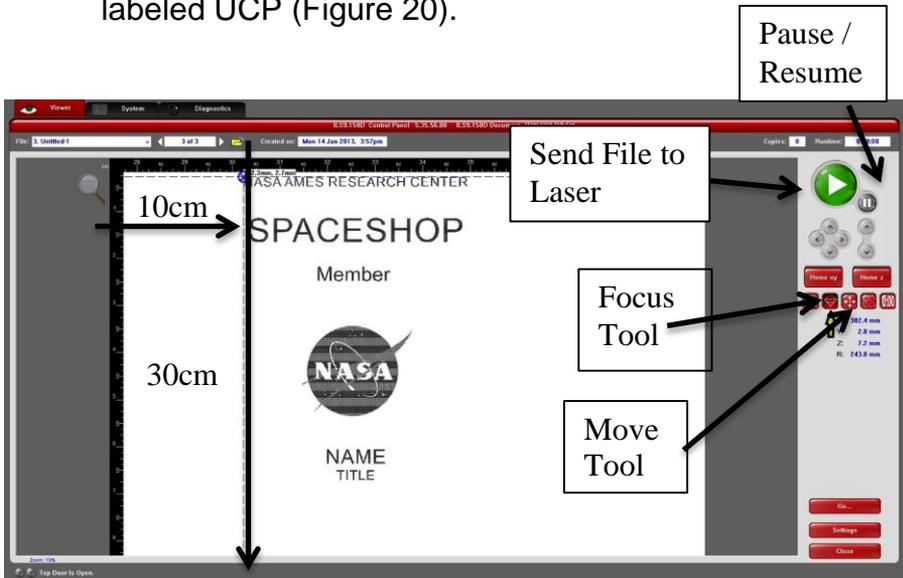


Figure 21: Universal Control Panel

36. Go back to the **VIEWER TAB** and first use the **MOVE** icon next to the **FOCUS** icon, to select your image and move this image across the white space

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to the area where your material physically resides on the **HONEYCOMB GRID** (Figure 12).

NOTE: In our scenario, the material leftmost edge was placed at the 30cm mark. Move you image to that point in virtual space and check if the red pointer is directly on the left edge.

37. **CLICK** on the top left most point of the **VECTOR** box (Figure 22). Note the **DISTANCE** and where the **POINTER** is on the physical material resting on the **VECTOR GRID**. Now **CLICK** on the bottom right most point of the image. You are making sure your bounding box aligns within the bounding box of the physical material, and constantly comparing where the red pointer lands. This is achieved through **TRIAL AND ERROR**.
38. When you are satisfied with the position of the **RED POINTER**, then **CLICK** the **GREEN PLAY ICON** to begin laser processing run (Figure 21).
39. Pressing **PAUSE** will halt the print midway through a run. The **PAUSE** icon will turn into a standard **RESUME** icon.
 - a. Pressing **Resume** will allow the job to continue the run from where it was paused
 - b. Pressing the **GREEN PLAY** button will restart the run from the beginning
 - **Note:** Note that if early on in a run, you notice the power settings are not resulting in

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satisfactory etching/cutting, **PAUSE** allows for the changing of power settings for the same run as well.

40. STAY WITHIN FLOOR'S BOUNDING BOX FOR DURATION OF CUT

- a. Avoiding fires requires being attentive and aware to the cutting process at all times.
- b. **If you see a fire, open the lid and consult a SpaceShop Staff Member.**



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Figure 20: Final Etched Piece

41. Once the laser system has completed processing the material, the focus carriage will move to the home position in the upper right hand corner of the processing field.
42. Before opening the top door, wait a few seconds to allow any remaining fumes that are left from laser processing to evacuate the exhaust system.
43. Congratulations! You have successfully completed the Laser Cutter Training!

To learn more advanced techniques, please consult a SpaceShop staff member for more information.

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APPENDIX A

MATERIAL DATABASE LIST

MATERIAL	ENGRAVE/ETCH	CUT
<u>CARDBOARD</u>		
MATTE BOARD	YES	YES
PAPER	YES	YES
PRESSBOARD	YES	YES
CORK	YES	YES
<u>CLOTH</u>		
CLOTH OF NATURAL FIBERS	YES	YES
LEATHER	YES	YES
CERAMIC CLOTH	YES	YES
POLYESTER	YES	YES
<u>WOOD</u>		
BALSA	YES	YES
CARDBOARD	YES	YES
<u>FOAMCORE(only top layer)</u>	<u>NO</u>	<u>NO</u>
MDF(Medium Density Fiber Board)	YES	YES
PAPER	YES	YES
<u>PLASTIC</u>		
ABS(Acrylonitrile Butadiene Styrene)	YES	YES
ACRYLIC	YES	YES

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POLYMETHYL METHACRYLATE	YES	YES
PMMA	YES	YES
LUCITE	YES	YES
PLEXIGLASS	YES	YES
DELTRIN(Acetal)	YES	YES
MELAMINE	YES	YES
MYLAR	YES	YES
CORIAN	YES	YES
RUBBER	YES	YES
Perforated Plastic	YES	YES
PETG	YES	YES
<u>OTHER</u>		
PVC	NO	NO
PVA	NO	NO
GLASS	YES	NO
CERAMIC	YES	NO
TILE	YES	NO
OTHER VINYL's	NO	NO
POLYSTYRENE	NO	NO
POLYPROPELENE	NO	NO
FIBERGLASS	NO	NO
MARBLE	YES	NO
PLEATHER/ARTIFICIAL LEATHER	NO	NO
SINTRA, KYDEX	NO	NO
COATED METALS	YES	NO
ANODIZED ALUMINUM	YES	NO
PAINTED METALS	YES	NO
GALVANIZED METALS	NO	NO
MIRRORED SURFACES	NO	NO
LEXAN	NO	NO

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