# *Introduction to the CNC Laser*

Dallas Makerspace

# *Introduction to the CNC Laser*

- ◆ CNC = Computer Numeric Control
- ◆ Lasers are good for Cutting (Vectoring) or Engraving (Rastering)
- ◆ Engraving input is a bitmap (picture) file
- ◆ Vector input is from a drawing or CAD pro-gram
- ◆ Maximum size is 13"x13", laserable area is 12.75"x11"
- ◆ Laser power is 40 Watts, by comparison a laser in a DVD burner is 0.1 to 0.4 Watts, can cut up to 1/4" thick plastic/rubber

# Uses for a CNC Laser

Engraving  (Wood, Plastic, Leather, Glass, Stone, Metal – with a coating)

- ◆ Engraving rubber to make rubber stamps
- ◆ Engraving coated blank PCB to make circuitboards
- ◆ Engraving Layered plastic to make signs, awards, trophies, etc.
- ◆ Engraving wood blackens the engraved area making a good contrast
- ◆ Engraving black anodized metal allows great detail at high contrast

# *Uses for a CNC Laser*

Cutting (Wood, Plastic, Rubber, Cork, Cloth, Paper, Cardboard, etc but not metal)

◆ Cutting wood to make a makerbot
◆ Cutting plastic to make robots
◆ Cutting a template to make a solder mask, sand-
　　blasting mask, painting mask
◆ Cutting paper to make pepakura

# *Safety*

- Laser can burn/cut skin and blind. The laser beam is infrared so it is invisible
- The laser is entirely contained in the enclosure so exposure risk is minimal. Only a window on top, but it blocks all laser light and some visible light
- There is a safety interlock that disables the laser when the lid is open, but the laser fire on the button panel always works with the power on so be careful
- Fires WILL occur at times inside the laser. Most of the time these self extinguish as soon as the laser stops, but if it doesn't, use the $CO_2$ duster – if that doesn't work – use the fire extinguisher

# *Startup*

- ◆ Turn on the key for the laser
- ◆ Check for water flow using meter attached to bars near laser
- ◆ Put the part to cut/engrave in the machine and adjust the height control knob until the top of the part is lined up with the white line on the side (focus line)
- ◆ Move the laser head to the top left corner of the area to cut or engrave
- ◆ Start up the exhaust fan

# *Hardware*

- 4 Buttons on panel are Air, Light, Laser Test, Laser Switch
- The big red button is Emergency stop – push to stop, twist to reset
- The small gray knob is laser power control
- The big black one is laser power key switch

# *Hardware*



- Laser tube at the back generates the laser light (power)
- Needs cooling water at all times – tube will crack within 30 seconds without water

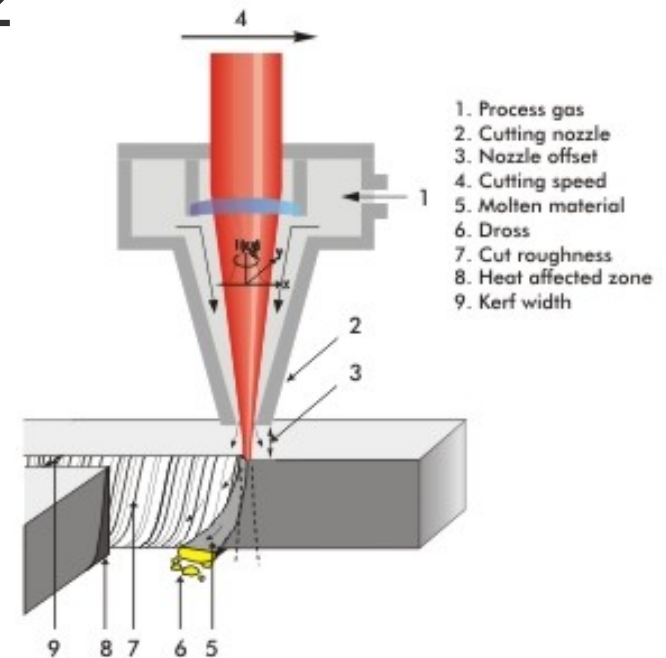- The small box at the lower right is for fume exhaust, fumes can be very stinky and potentially hazardous

# *Hardware*

- Controller for the laser in designed and made in USA, but laser is Chinese made
- Laser tube is a consumable – will last around 1000 hours and cost about $300 to replace
- The lens costs $250 to replace but should last the life of the machine if properly cared for
- Gray power dial 20 mA = full power = 40 Watts, 10 mA = half power = 20 Watts, etc.
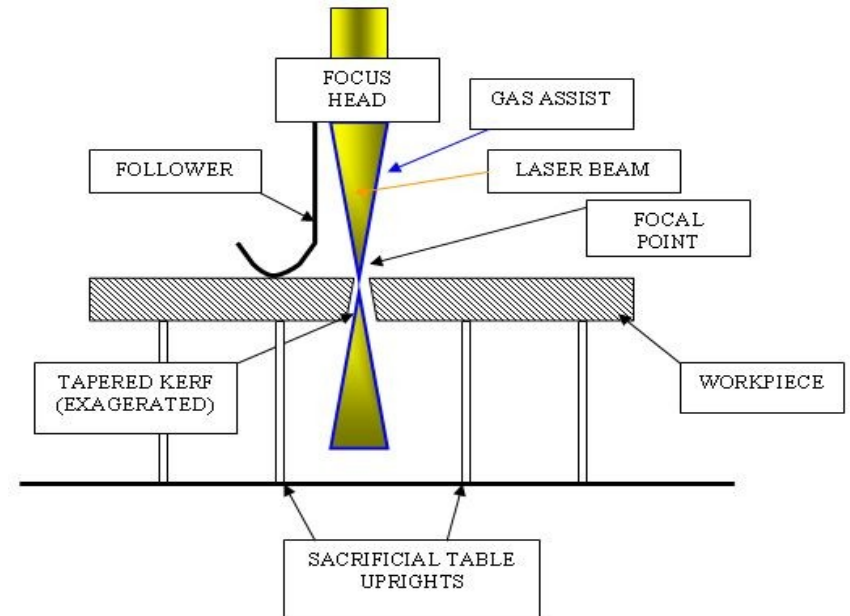- Smallest machine movement is 0.001"

# *Optics*

- This machine uses "flying" optics – just means the mirrors/lens moves and not the laser itself
- The beam bounces off of 3 mirrors before passing through the lens made from ZnSe
- Normal glass is opaque to $CO_2$ laser light so it won't work for lenses
- The lens this machine has is about 2" focal length lens (the point of focus is 2" below the lens)





1. Process gas
2. Cutting nozzle
3. Nozzle offset
4. Cutting speed
5. Molten material
6. Dross
7. Cut roughness
8. Heat affected zone
9. Kerf width

# *Optics*

- Shorter focal length lenses like this one are better for making a smaller "spot" - this one can get 0.005" diameter spots
- Shorter lenses are better for rastering because they have a small spot but the depth they are in focus is also small
- Longer focal length better for cutting due to tapered kerf effect

FOCUS HEAD

GAS ASSIST

FOLLOWER

LASER BEAM

FOCAL POINT

TAPERED KERF (EXAGERATED)

WORKPIECE

SACRIFICIAL TABLE UPRIGHTS

# *Software*

- The software runs under Windows XP, Vista, 7 and shows up as a printer and a stand alone program (RetinaEngrave)
- Can "print" to the laser from any Windows program
- Before you print, you need to start RetinaRaster
- All windows program will work with raster mode but only some (vector based) will work with vector mode, i.e. AutoCAD, Inkscape, Adobe Illustrator, Corel Draw, etc.

# *Vector Mode*

◆ Jog buttons in upper right move the laser head around
◆ Unlock, unlocks the head allowing you to move it by hand
◆ Can apply different speeds/power levels to different colored vectors in the same file (good for marking and cutting in the same file)
◆ File..Open can open .PLT (HPGL files) or .XPS files

# Vector Mode

◆ The lines in the program you are using must be 0.005" wide or less to be considered as "vectors". In Corel Draw these are called hairline

◆ Programs that are good for Vectoring are Inkscape (free), DraftSight (free autocad clone), Adobe Ilustrator, Corel Draw, etc.

◆ Layer colors can be Black, Red, Green, Blue, Magenta, Yellow or Cyan. Colors that are not these colors will be approximated to their closest neighbors

◆ Typical layer uses are 1 layer for marking, another for cutting

◆ Can also use layers to cut small parts first and large outlines last

# *Raster Mode*

- ◆ Same jog controls
- ◆ Can open BMP files that are 1 bit (black/white) to get maxim-
   um control and resolution
- ◆ Invert used for inverting image like engraving on black mater-
   ials
- ◆ Trim whitespace used for removing extra white space
   around image – this moves the image however
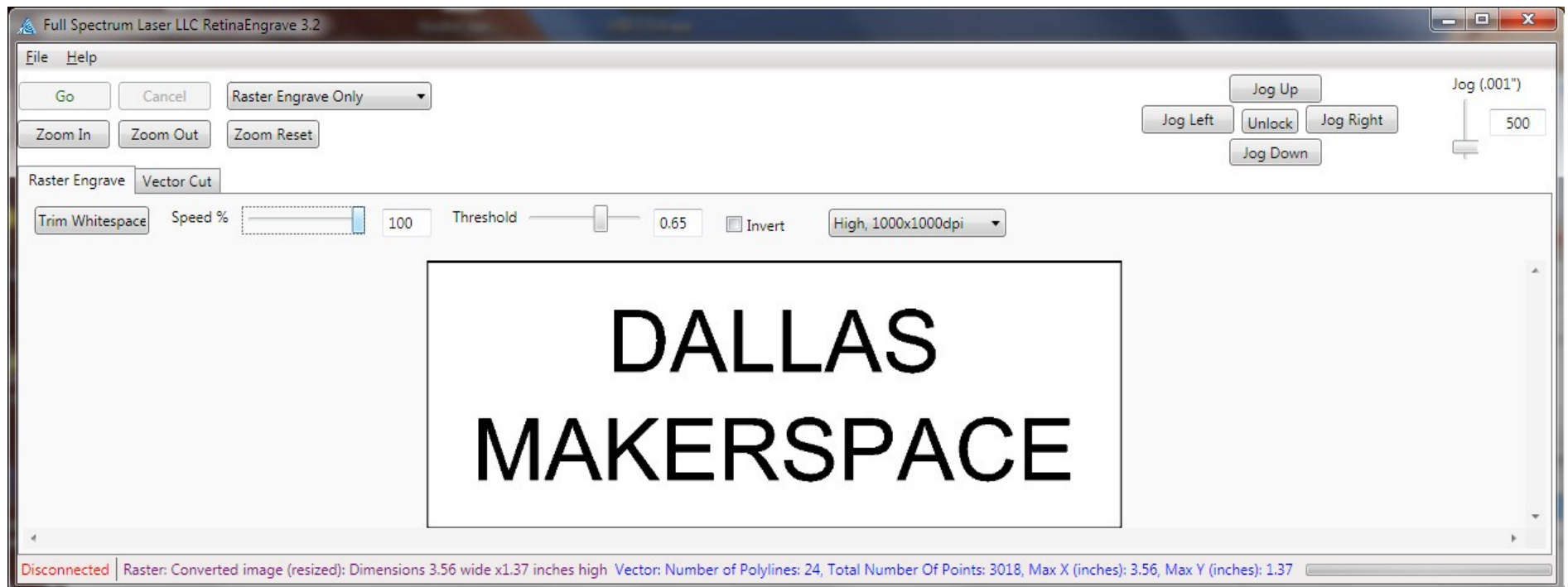
# *Shutdown*

- Turn off exhaust fan
- Turn off key switch for laser
- Turn off PC
- Check for fires ;)

# *Vector vs Raster*

◆ Raster is slower than vectoring, much slower
◆ Raster works for any software and more ma-
terials
◆ Raster is typically used for engraving or
marking
◆ Vector is usually used for cutting but can be
used for engraving lines at high speed and
low power
◆ Vector can have several different
speeds/power settings in one file (that may
change with new software)

# Do's and Don'ts

## Do

1) Check for water flow on startup
2) Make sure exhaust fan is running
3) Check for fires and put them out ;)

## Don't

1) Ever leave the laser unattended (see fires above)
2) Turn off the "Air" button. That needs to be on to protect the lens
3) Turn power on higher than 20 mA (it shortens the laser tube's life
4) Laser on Vinyl, PVC, Sintra (will produce corrosive and toxic gases)
5) Cut metals (it won't work)
6) Bump or touch the mirrors or lenses (will put the machine out of alignment or damage optics)

# *Troubleshooting/Tips*

◆ FOCUS FOCUS FOCUS! Focusing the laser is just as important if not more important than on a camera. I found this to be the #1 mistake of the people using the laser so far.

◆ If it doesn't work at first ask and/or try again, it can take trial and error to get it right

◆ Flame ups can be a sign you are using too much power or going too slow – Use just enough power to get the job done. Using too much power will result in back side burning, scorching, melting, etc.

◆ Sometimes it can take multiple passes to cut cleanly with thick materials

◆ Some materials come with a protective plastic or paper cover, usually its better to cut with paper on and raster with plastic off, but it can be trial and error here too

# *Troubleshooting/Tips*

- Sometimes it may help to add a protective cover to the material to avoid soot and redeposit of vapors to the material. Blue painter's tape works well
- Importing files usually results in broken vectors which can cause problems with cutting smoothly/cleanly. Use Corel Draw and export as PLT – load into RetinaVector using File..Open
- If starting vectors from scratch use Inkscape (for art oriented) or DraftSight (for technical oriented) both are free as in beer
- Visit sites like Ponoko, Thingiverse for ideas/sample files
- Visit Full Spectrum Engineering for laser help in forums

# *Troubleshooting/Tips*

- The laser software was just released 3 months ago and is updated frequently. You will probably run into some bugs. As of this writing we are at v3.3
- New features are added often
- Use a small dot in the upper left corner to line up a vector and raster on the same job (like engraving a luggage tag and then cutting it out)

# *Summary*

- If all else fails – call Glenn
- Like anything else – practice makes perfect

# *References*

- Full Spectrum Engineering (laser supplier support forum)
- Laser Tutorial Videos from Full Spectrum Engineering
- Ponoko (free online designs, files)
- Thingiverse (free online designs, files)
- Buildlog.net (DIY CNC lasers)
- Adafuit laser info

# *Glossary*

◆Laser = Light Amplification by Stimulated Emission of Radiation
◆Kerf = Cutting diameter (think the width of a drill bit)
◆CNC = Computer Numeric Control
◆ZnSe = Zinc Selenide
◆$CO_2$ = Carbon Dioxide
◆CAD = Computer Aided Design
◆PCB = Printed Circuit Board