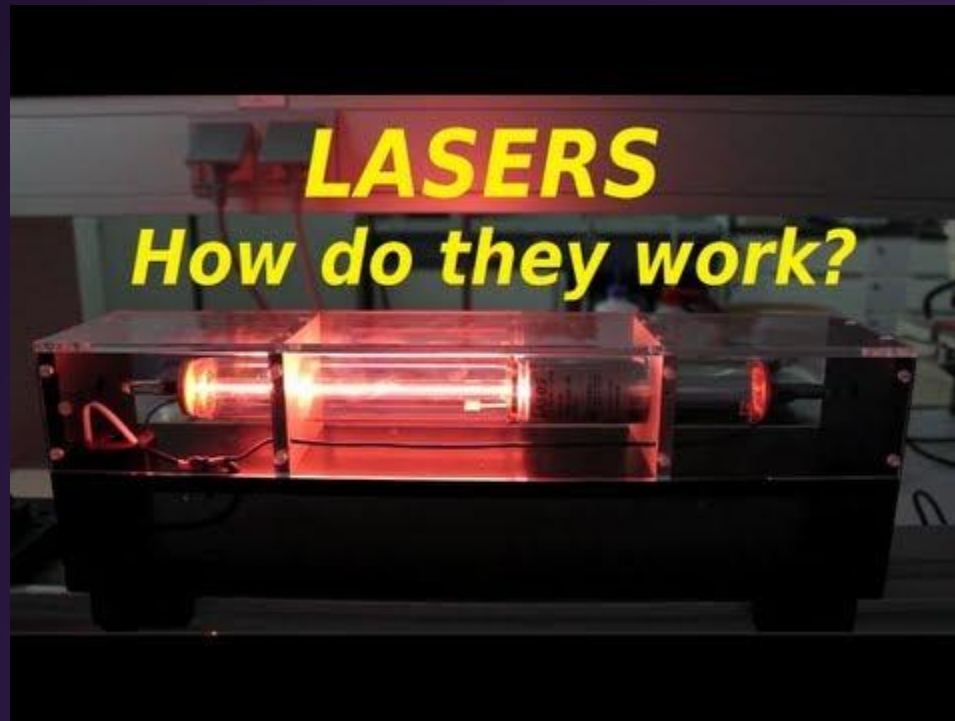


Laser Cutter: CAD to CAM, Operation, Safety & Work Practices

Version 2021

Laser Cutters: How Do They Work

— Enter Neil deGrasse Tyson

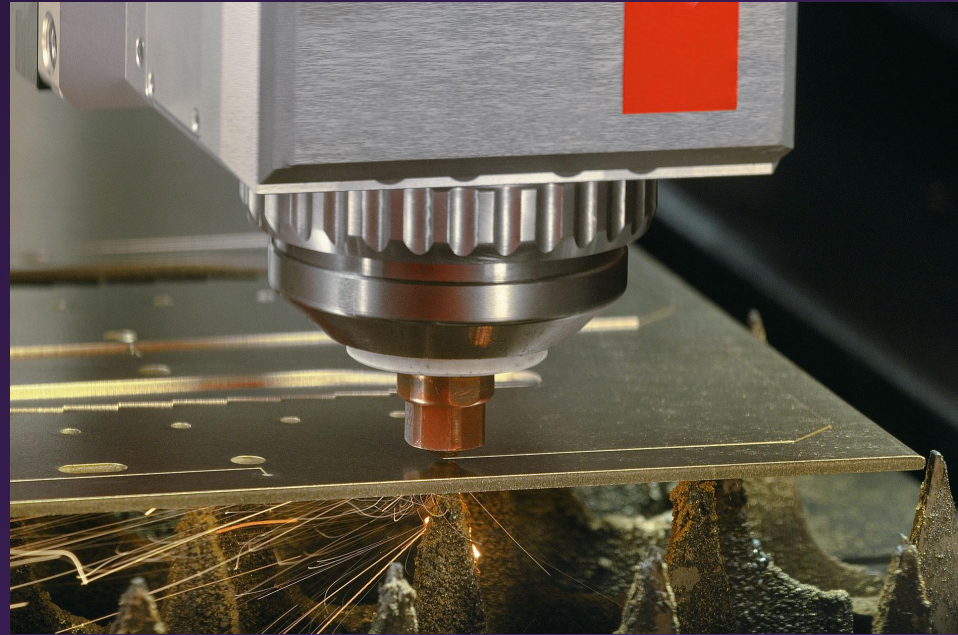


Light Amplified by the Stimulated Emission of Radiation

CO₂ Lasers - use carbon dioxide gas as medium for lasing. Higher power needs, limited materials, lower cost.

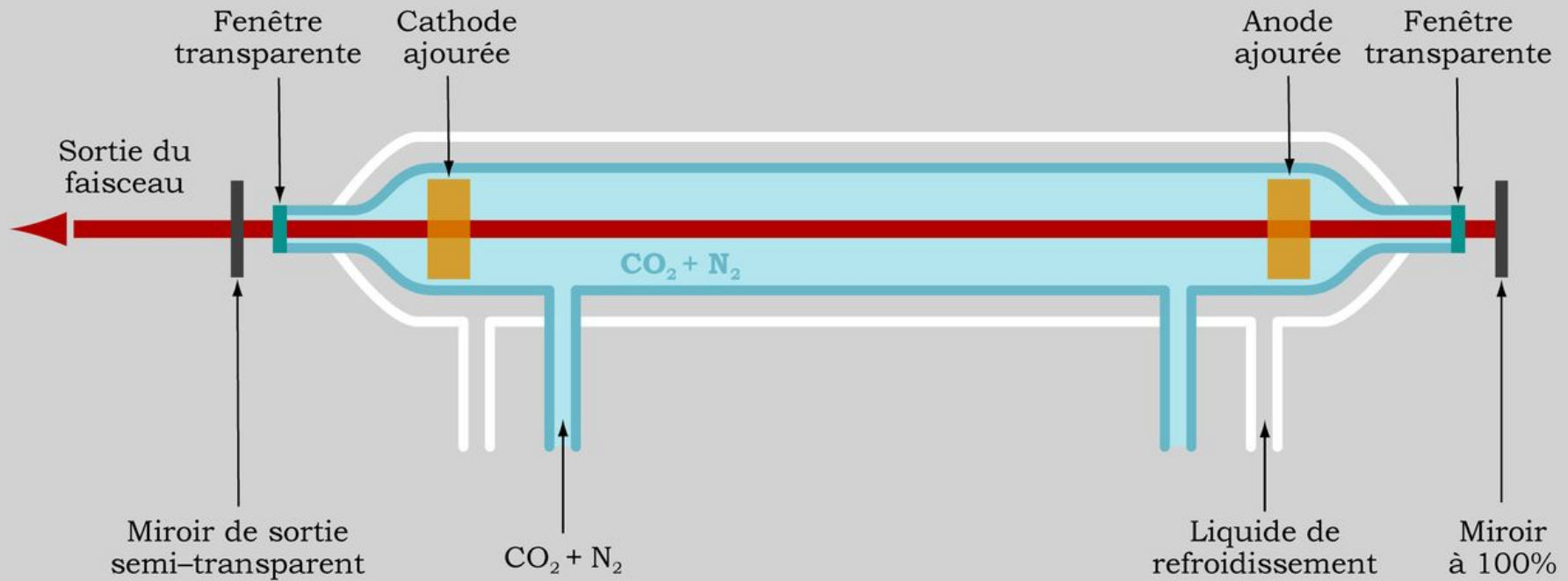
Fiber Laser - newer technology, uses optical fibers for lasing. Lower power, can cut metal, higher cost.

cost:

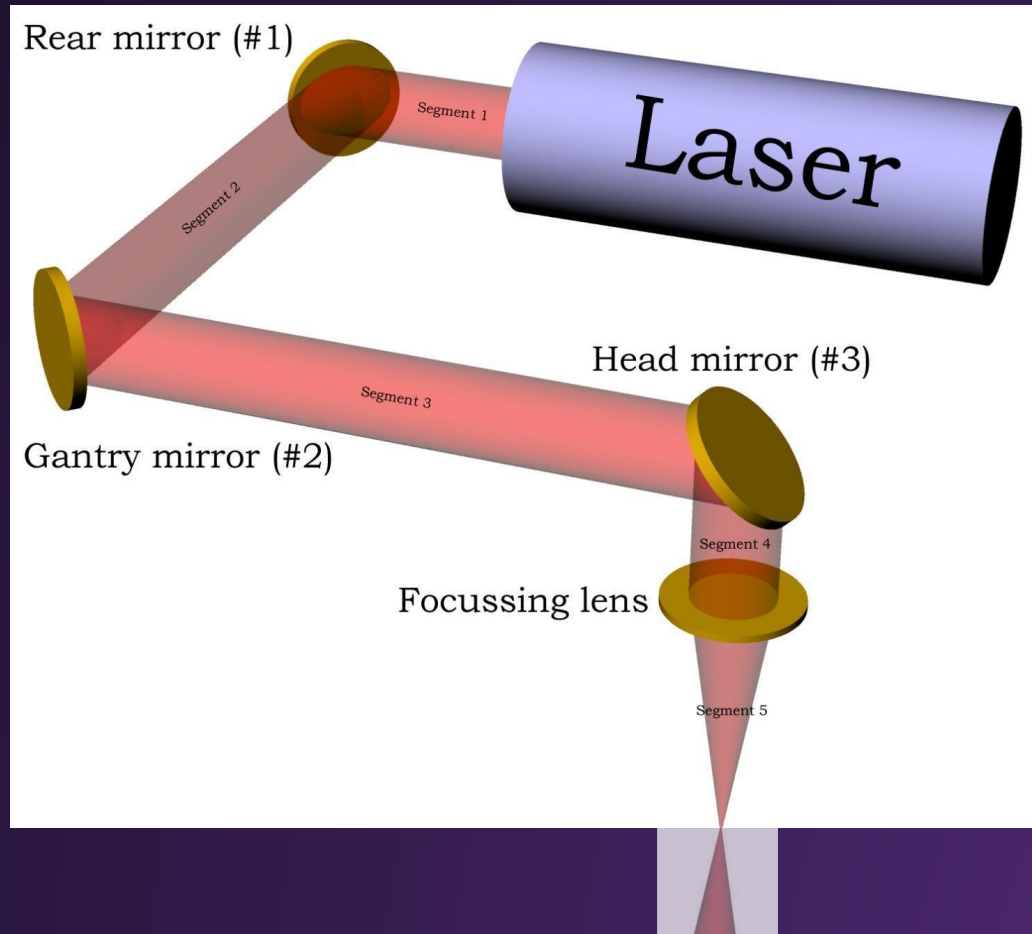


source: wikipedia

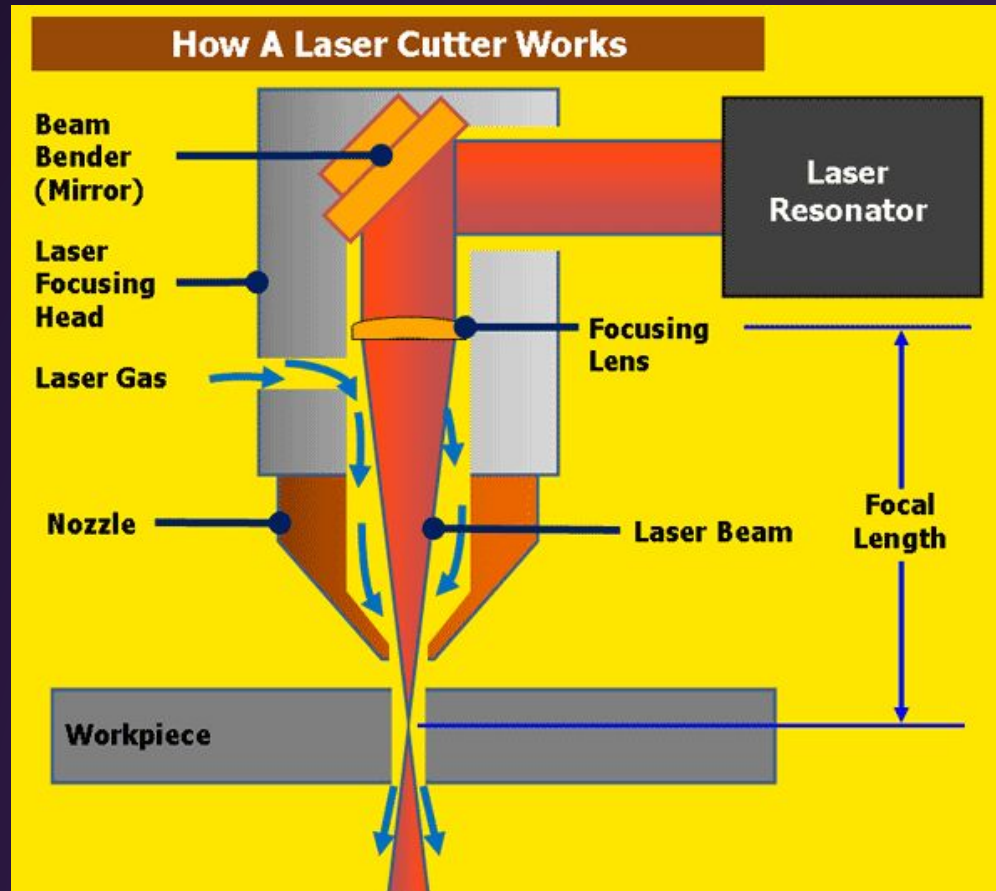
CO₂ Lasers in Action



The Mechanics



The Laser Head



— Common Operations

Cutting

- Laser beam passes all the way through material
- Multiple passes are sometimes needed
- Vector graphic input

Scanning (Engraving)

- Laser Beam only scores the surface of the material
- Can either "FILL" an enclosed vector or do Raster Graphic
- Depth of scoring is dependent on:
 - Material,
 - Beam power,
 - Speed,
 - Number of passes

Laser Safety

Personal Safety

- Light

- Laser produces sharp, bright light.
- Don't stare at light
- Wear protective glasses.
- Never operate machine with lid open

- Smoke

- Some materials produce harmful off-gases (chlorine, cyanide)
- Make sure air filtration & exhaust is working

Personal Safety, Pt. 2

- Noise

- Use hearing protection for periods of long exposure
- Check decibel meter to measure current levels (90+)

- Pinching

- Only one operator at a time
- No loose clothing

Laser Cutter Safety

- Don't override safety switches
- Be careful when raising/lowering the bed to focus
- Check for flammable material leftover from previous users
- Always operate with chiller, air assist, and air scrubber running.

Laser Safety, Pt. 2: **FIRE**

- Lasers cut by burning the material
- Fire will happen (Don't Panic!)
 - Blow it out
 - Pull it out and stamp it out
 - Last resort: fire extinguisher
 - Can crack and destroy mirrors
 -



Always supervise a machine under operation.



CAD to CAM

CAD – Computer Aided Design

CAD – Software used to aid the creation, modification, analysis and optimization of an object's design.

Can develop projects in 2D or 3D space, as needed.

CAD – Computer Aided Design

Parametric Modeling –

incorporates the relationship between geometries. Tries to capture the “design intent”.

Direct Modeling – Models without needing to modify the original sketch.

— Common CAD Software & Packages

Common programs:

- OpenSCAD - Uses a programming language to develop objects
- OnSHAPE (web based/free)
- Fusion360 (free hobbyist version, limited CAM capacities)
- SolidWorks



— CAD to CAM

Computer Aided Manufacturing - the use of software and machinery that aids in the manufacturing process.

Terms for the Laser Cutter:

- **Toolpaths** - The line of travel for tool head
- **Water-tight** - All polygons/geometries have no gaps in the loop

The Code

Text file ANY CNC can read

G0 – Rapid Travel

G1 – Travel while

Working

F – Feed

X; Y; Z – Co-ordinates in Space

M4/M5 – Tool On/Off

Sample Code:

```
; GCODE Generated by cam.openbuilds.com on 2021-03-16
G21 ; mm-mode
G54; Work Coordinates
G21; mm-mode
G90; Absolute Positioning
M4; Dynamic Power Laser On
```

```
; Pass 0
; Operation 0: Laser: Vector (path outside)
; Laser Spot Diameter: 0.1
```

```
G0 Z10; move to z-safe height
G0 F1000 X100.0000 Y-0.0500
```

```
G0 Z0
G1 F300 Z-0.1000
G1 F1000 X0.0000 Y-0.0500 Z-0.1000 S1000
G1 F1000 X-0.0500 Y0.0000 Z-0.1000 S1000
G1 F1000 X-0.0500 Y100.0000 Z-0.1000 S1000
G1 F1000 X0.0000 Y100.0500 Z-0.1000 S1000
G1 F1000 X100.0000 Y100.0500 Z-0.1000 S1000
G1 F1000 X100.0500 Y100.0000 Z-0.1000 S1000
G1 F1000 X100.0500 Y0.0000 Z-0.1000 S1000
G1 F1000 X100.0000 Y-0.0500 Z-0.1000 S1000
; retracting back to z-safe
G0 Z10
```

```
M5; Laser Off
```

Work Processes (Putting It All Together)

— Common File Types

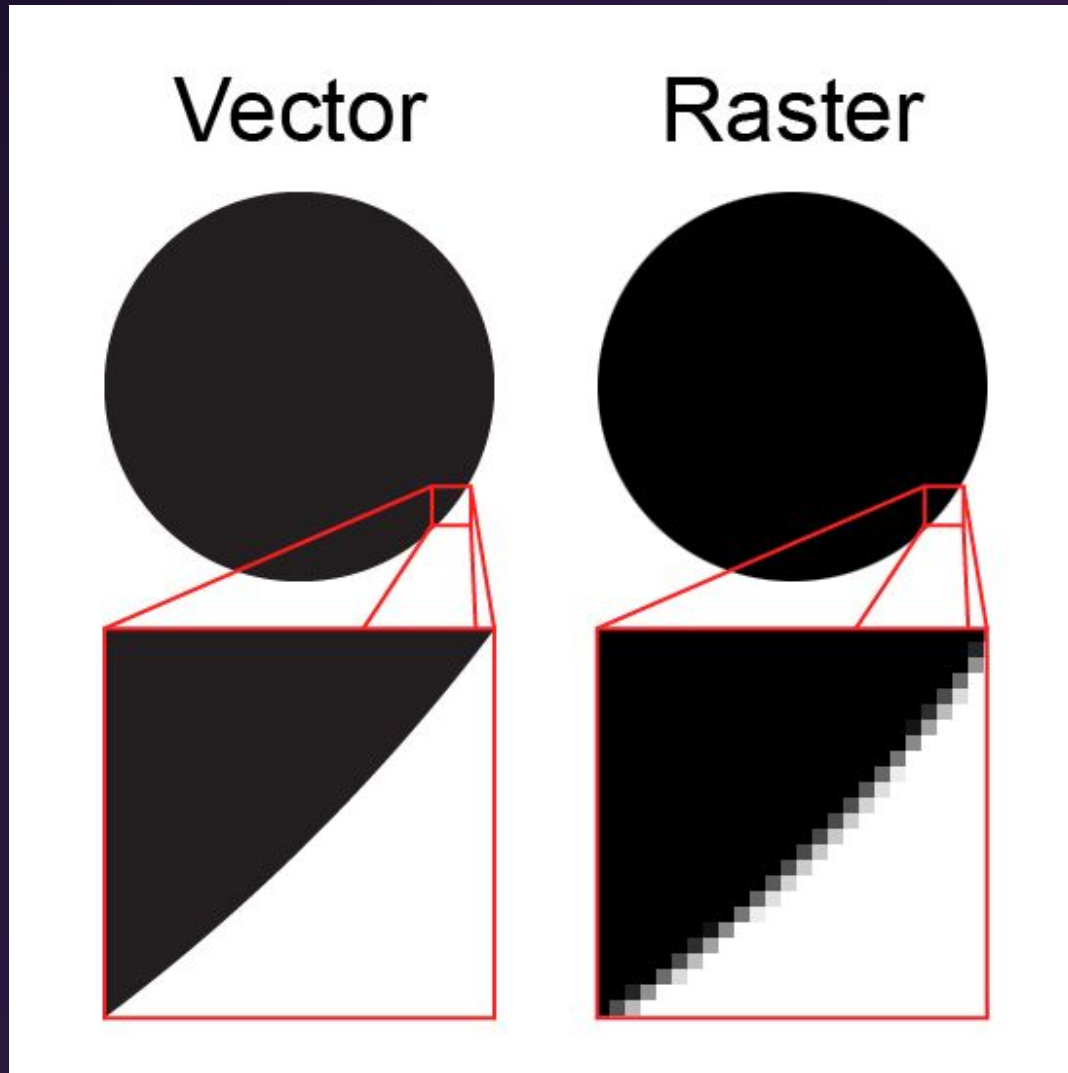
The Great Trio: DXF, DWG and SVG

DXF: 2D line data without units, often exported from a 2D sketch

DWG: 2D line data without units, often exported from a technical drawing

SVG: Scalable Vector Drawing from a graphic design program, often needs a little processing to make compatible with laser cutter

Vector vs. Raster/Bitmap examples



Vector vs. Raster/Bitmap

Vector

- Artwork/design defined by math
- Can be scaled up or down without degradation
- Common programs:
 - Corel Draw (on computer)
 - Inkscape (Free)
 - Adobe Illustrator

Raster/Bitmap

- Pixel based images
- Lose detail when sized up
- Common programs:
 - GIMP
 - Adobe Photoshop
 - MS Paint

*We're most concerned with 1-bit monochrome bitmaps, where individual pixels are either black or white.

Dithering can be applied to give the impression of continuous-tone images.

Laser Cutters As Tools

- It is a Computer Numerical Controlled (CNC) machine
- It is a tool that requires experience and craftsmanship to master
- Each job is unique and may require adjustments:
 - **Characteristics of the specific material**
 - Variations in thickness
 - Variations in construction
 - **The current conditions affect performance**
 - Cleanliness of mirrors and lens
 - Aging of the tube
 - Bed alignment
 - Mirror alignment

Basic Operational Checklist:

1. Move gantry/tool head to back right corner of machine
2. Place workpiece
3. Move gantry to workpiece
4. Adjust focal length/z-height
5. Origin the machine
6. Run test/run work

Approved Materials/Substrates

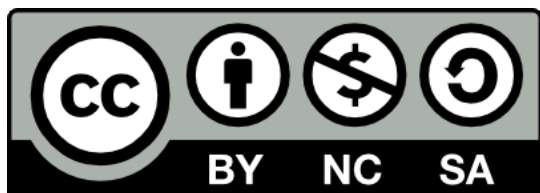
- Cuts:
acrylic, plywood, wood,
cardboard, paper, fabric,
leather, rubber
- Engraves:
Metal with coating, ceramic
tile glaze, wood, plywood,
leather, stone, acrylic,
rubber, glass

Banned Materials

- Material No-Nos:
 - Metal (Reflective Laser, doesn't work)
 - Vinyl / PVC (chlorine gas)
 - ABS (Cyanide gas)
 - Lexan/Polycarbonate (Noxious gas, Cuts poorly and gums up the laser cutter)
 - It can't cut other materials that emit poisonous gasses or respond poorly to heat.

After The Cut...

- Check out the product before moving the material:
 - Test to see if cuts and engravings are of expected depth.
 - If both are too light, run it again.
 - If engraving is OK but the cut didn't go deep enough, deselect engraving layers, adjust power and speed for cuts, upload and run again.
- Clean up any material left on the bed.
- Save your file for later cuts or power references



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