#LaserHack 101

aka Fun with Digital-to-Analog Converters

with Brenden Hierro and Tim Greiser

About Us

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prim8.net

Freelance software engineer and amateur mad scientist.

History

1900: Max Plank $E = hv$

Dr. Theodore Maiman of Hughes Research Laboratories, with the first working laser.

Photo Credit: HRL Laboratories, LLC

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Photo Credit: HRL Laboratories, LLC

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1960: Theodore Mainman develops first working LASER

Dr. Theodore Maiman of Hughes Research Laboratories, with the first working laser.

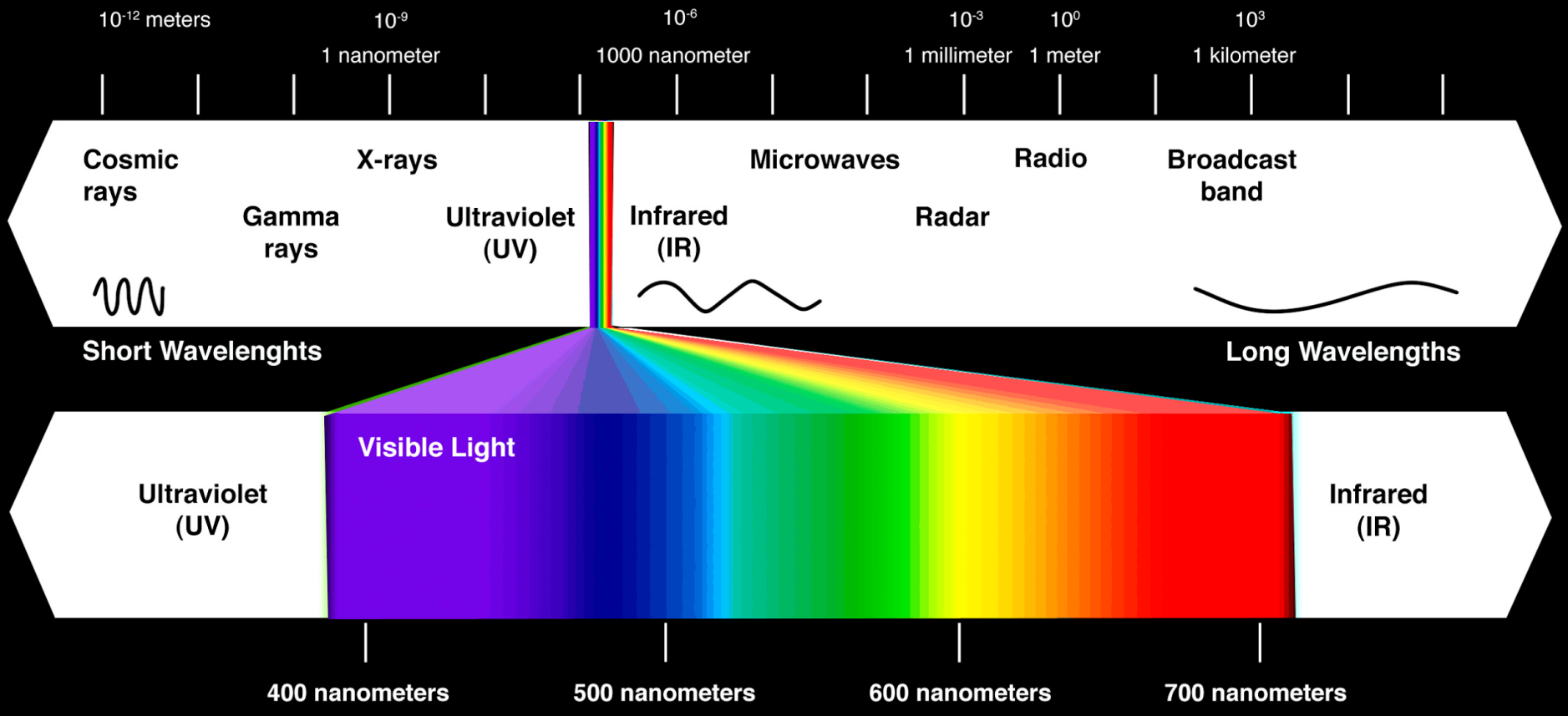
Photo Credit: HRL Laboratories, LLC

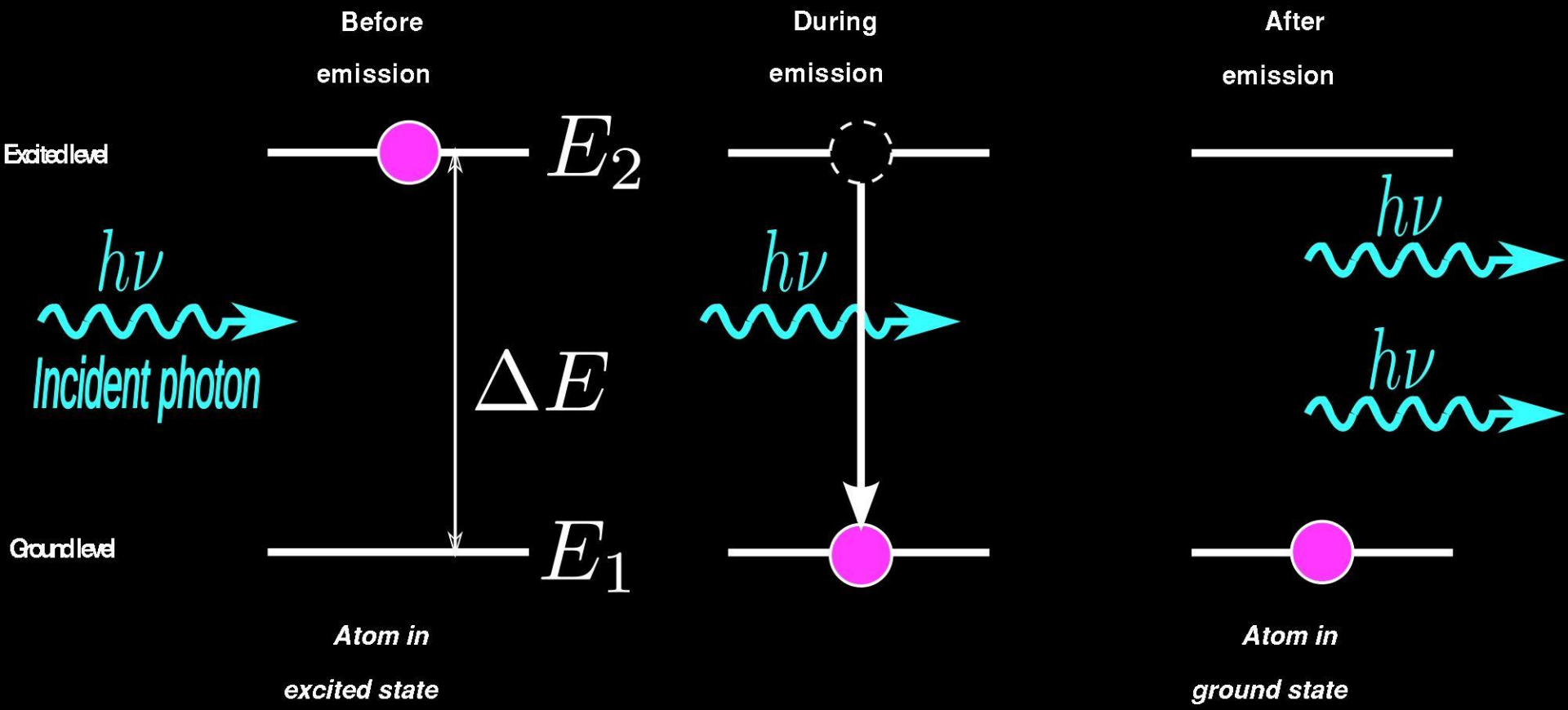
LASER

Light Amplification by Stimulated Emission of Radiation

Physics

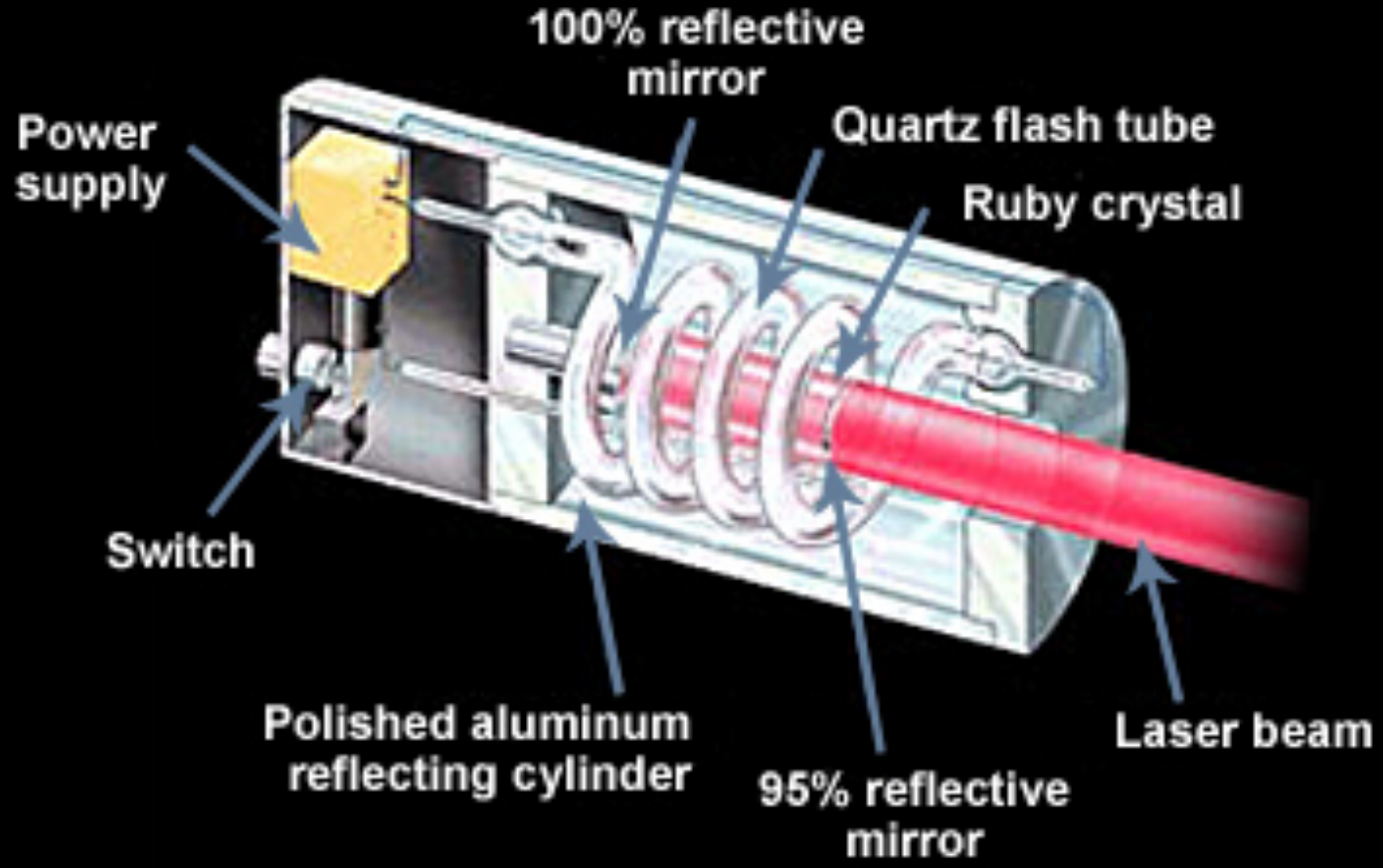
Photo Credit: http://www.immunolight.com/technology/

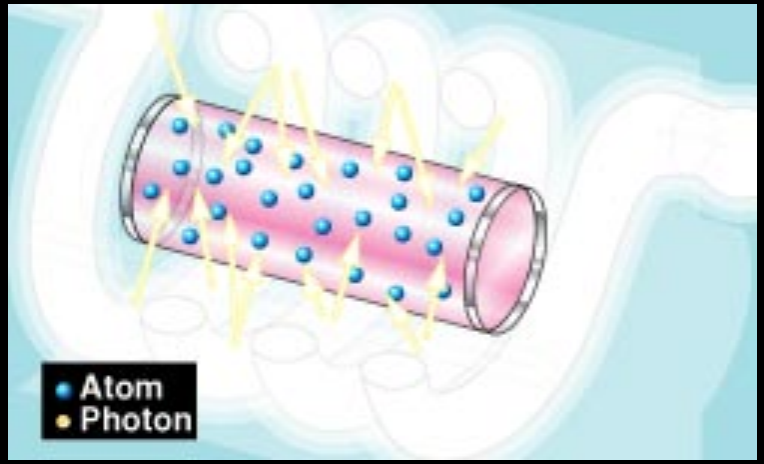




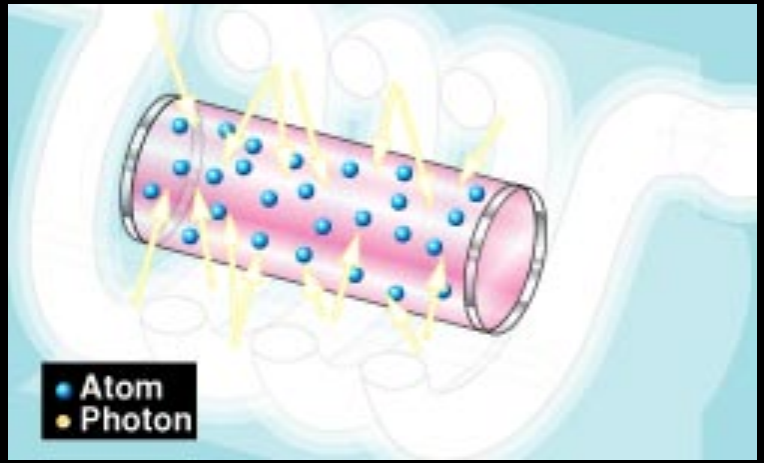
$$E_2 - E_1 = \Delta E = h\nu$$

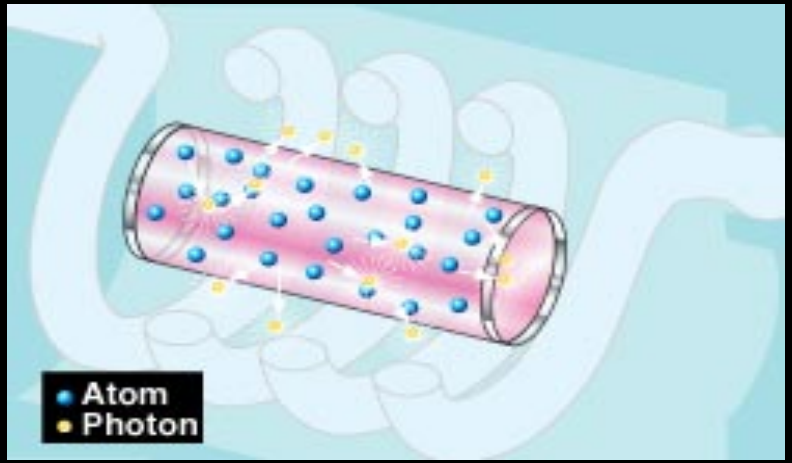
Components of the first ruby laser





Reference: http://laserfest.org/lasers/index.cfm





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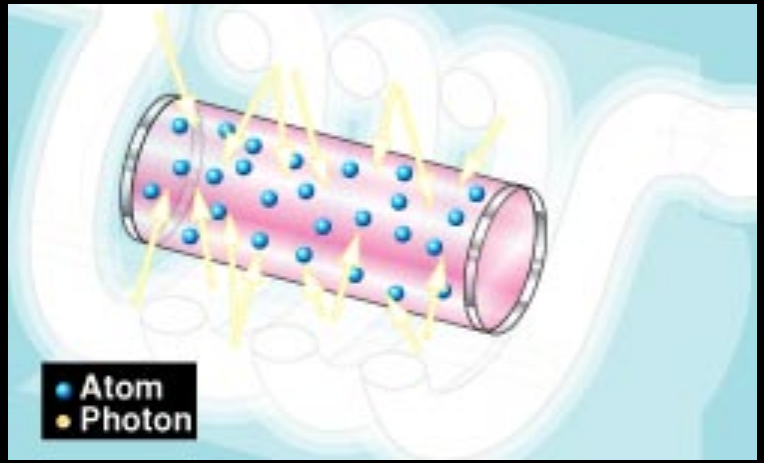

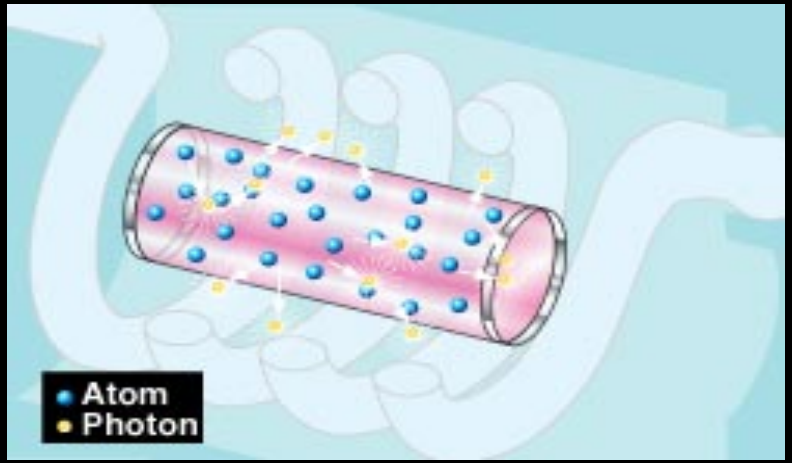

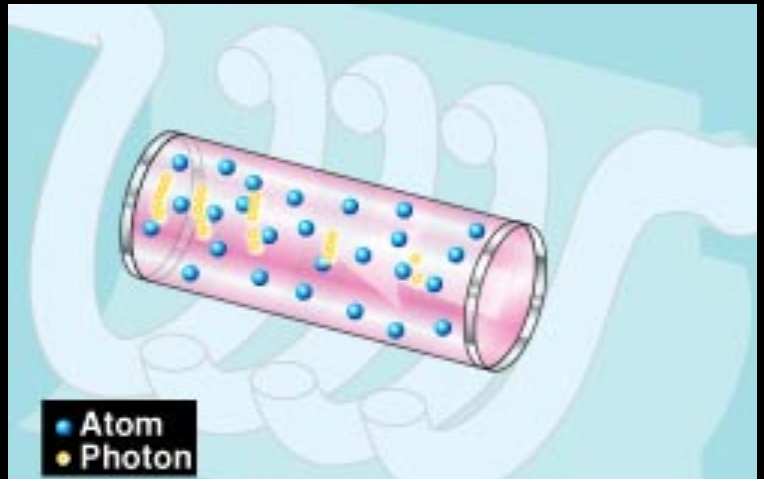

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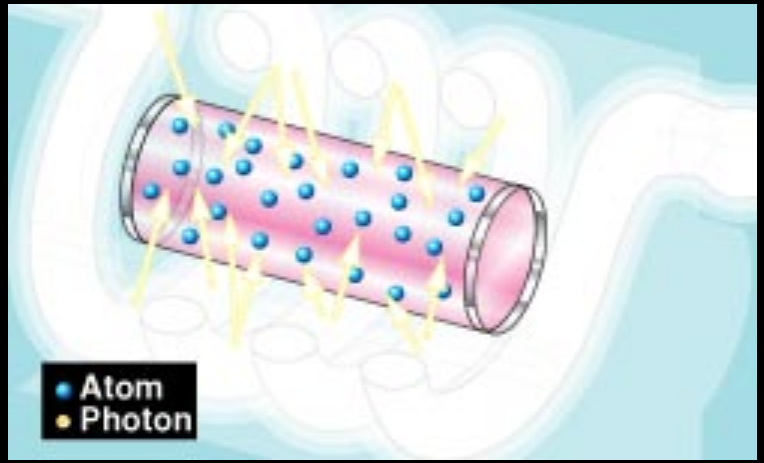

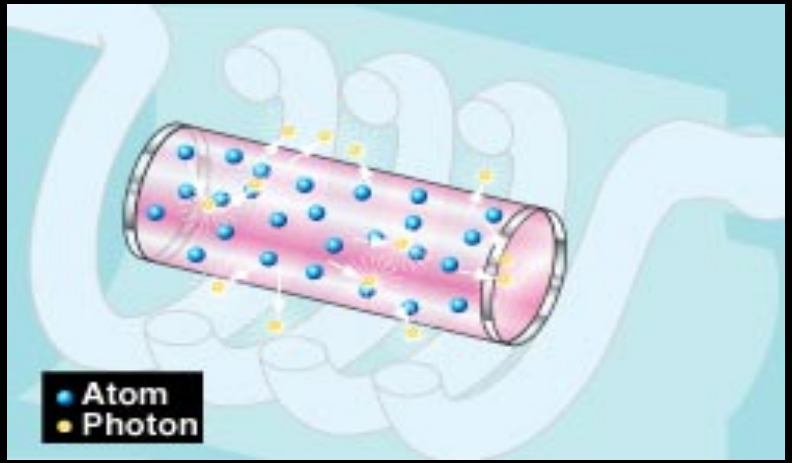

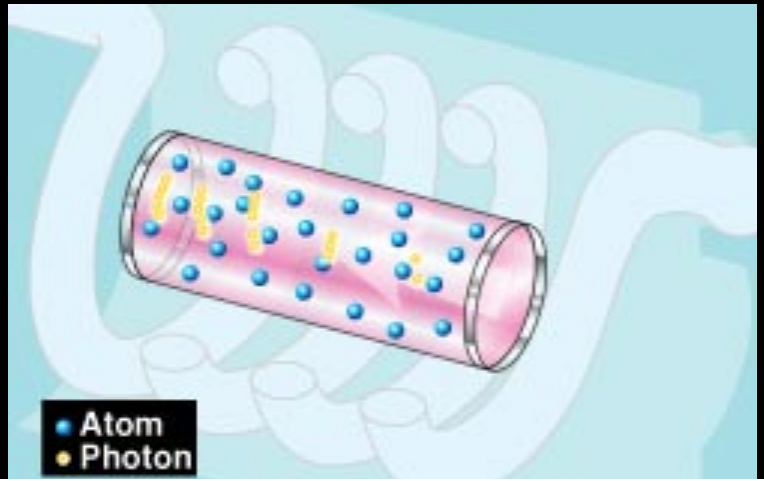

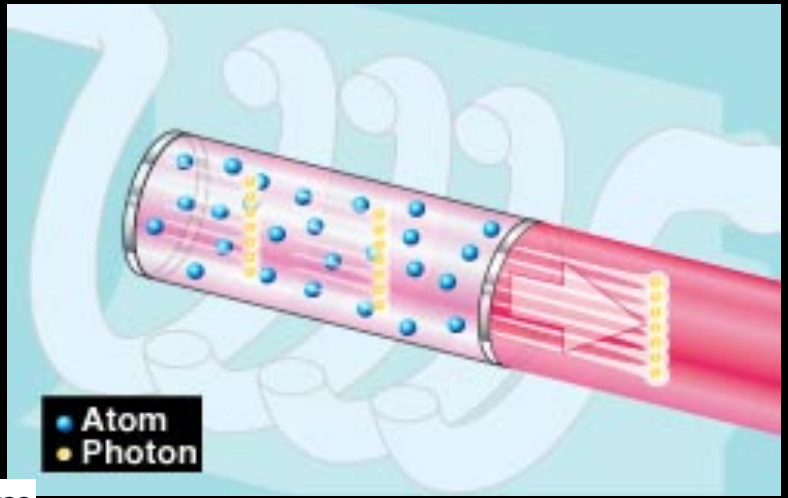

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Applications

- Laser Cutting
- Laser Welding
- Laser Drilling
- Optical Communications
- Guidance Systems
- Barcode Readers
- Holography
- 3D Scanners
- Military Weaponry
- LiDAR
- Heat Treatment
- Photochemistry
- Laser Cooling
- Nuclear Fusion
- Targeting Systems
- Dental Procedures
- Optical Tweezers
- Remote Sensing
- Spectroscopy
- Eye Surgery
- Laser Scalpel
- Etc...

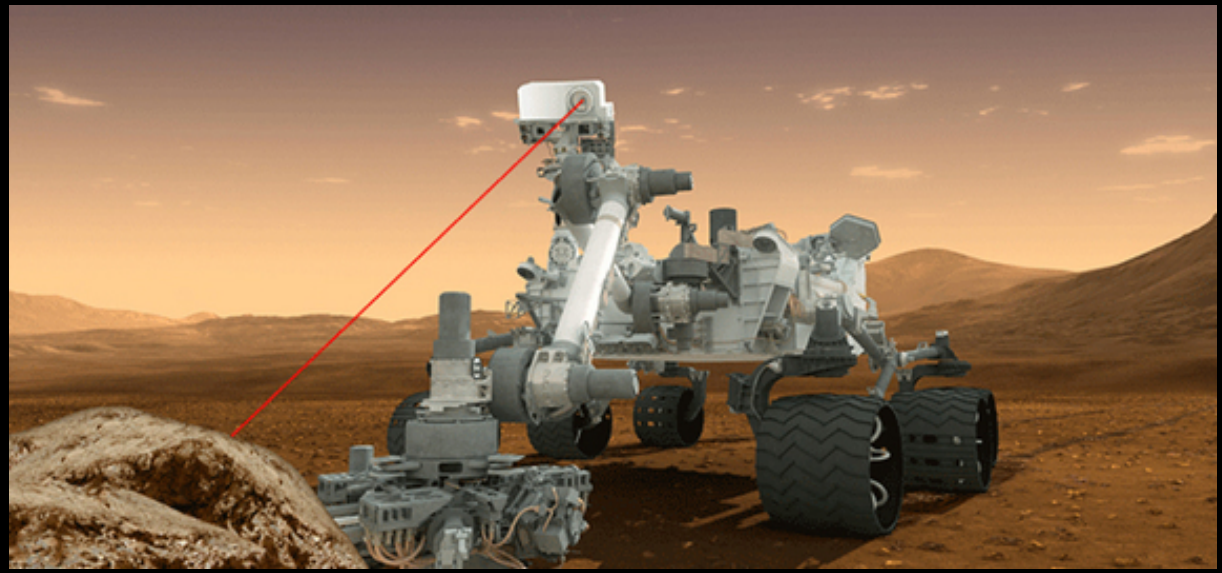
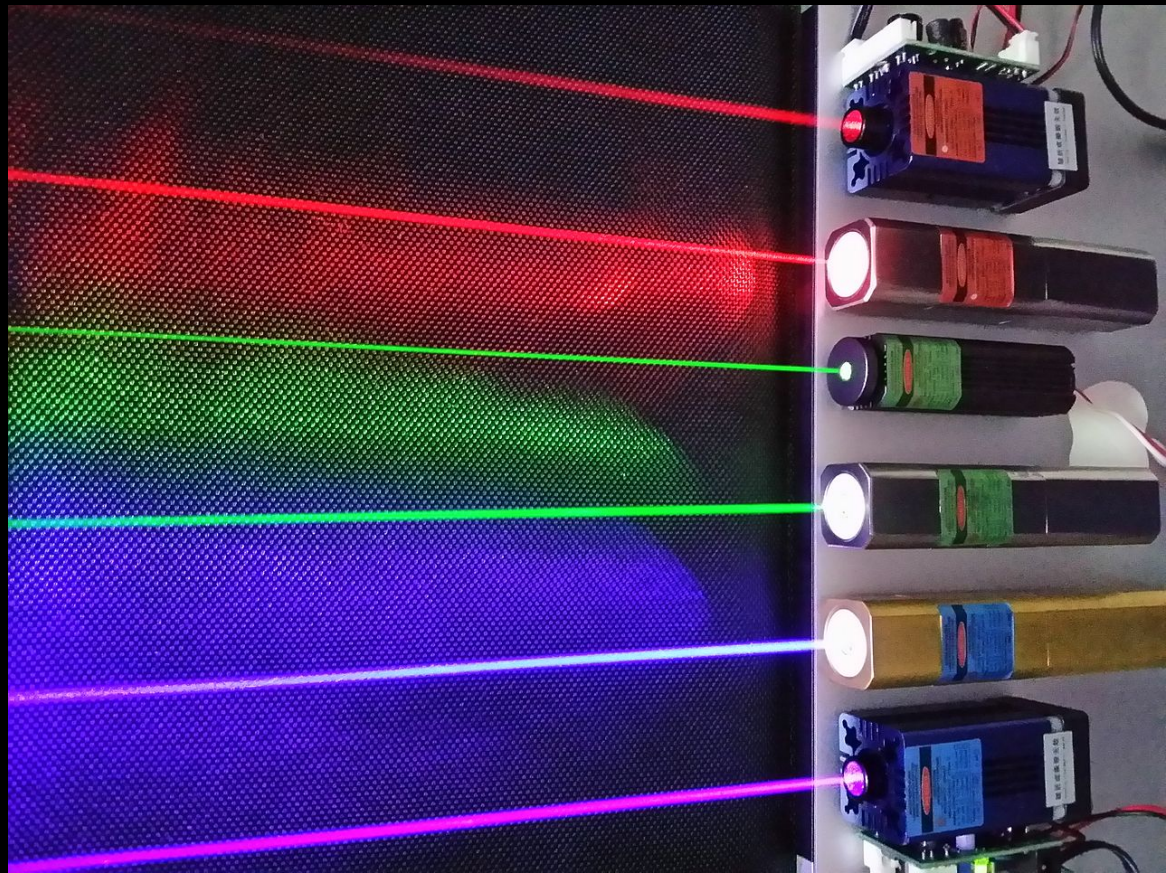


Photo Credit: NASA

Laser Projector Hardware

The LASER

- Diode (RGB)
- Gas
  - He-Ne (red)
  - Argon (red)
- Solid State
  - YAG (infrared)
- Power outputs
  - 5mW - 5,000mW



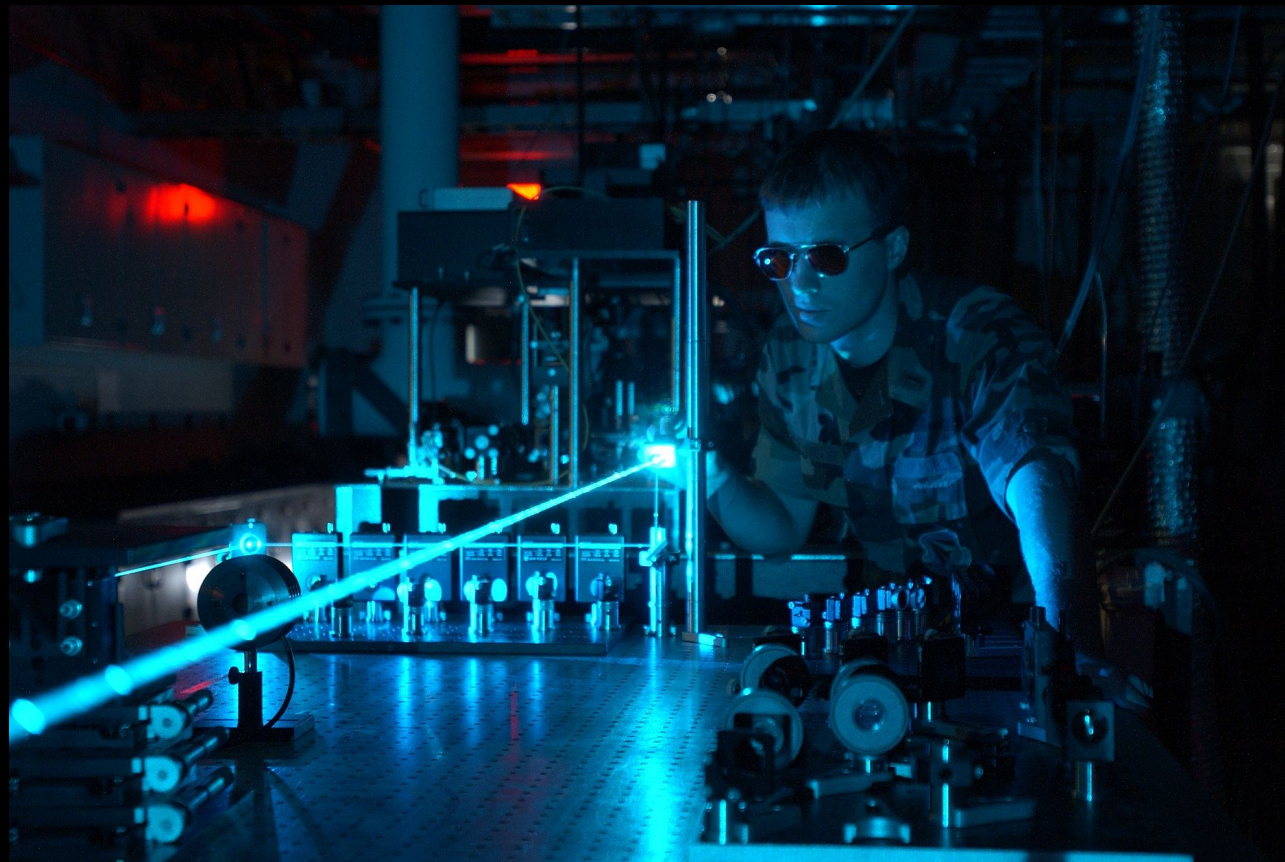
Laser Projector Hardware

Beam Table

Mounts hold:

- Mirrors
- Galvos
- Actuators
- Fiber Feeds
- Optical Elements

Can be moved around and easily repositioned.



Laser Projector Hardware

Galvanometers (Scanners)

- Used to create laser graphics
- Gets electrical signals from DAC
- 15-50 kpps (kilo-points per second)

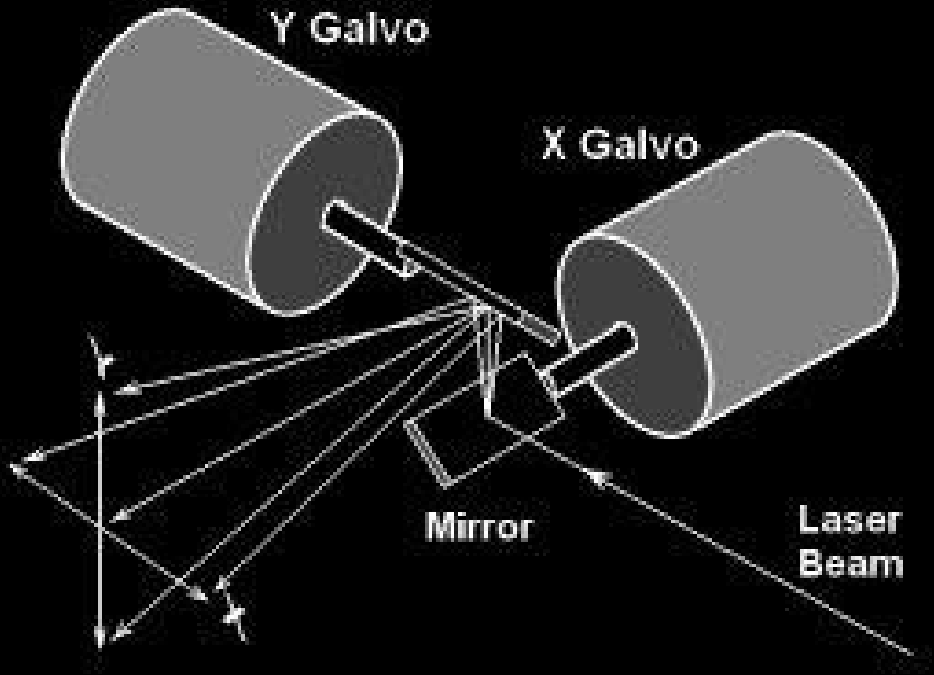


Photo Credit: **Electronic Lives Mfg.**

Laser Projector Hardware

DAC (Digital Analog Converter)

- Recommended: Ether Dream
- Others: lumax, easylase
- DIY: OpenLase sound card hack

Control Signals

Electronic oscillators

Fun to listen to!

On an oscilloscope, you can visualize the waveform.

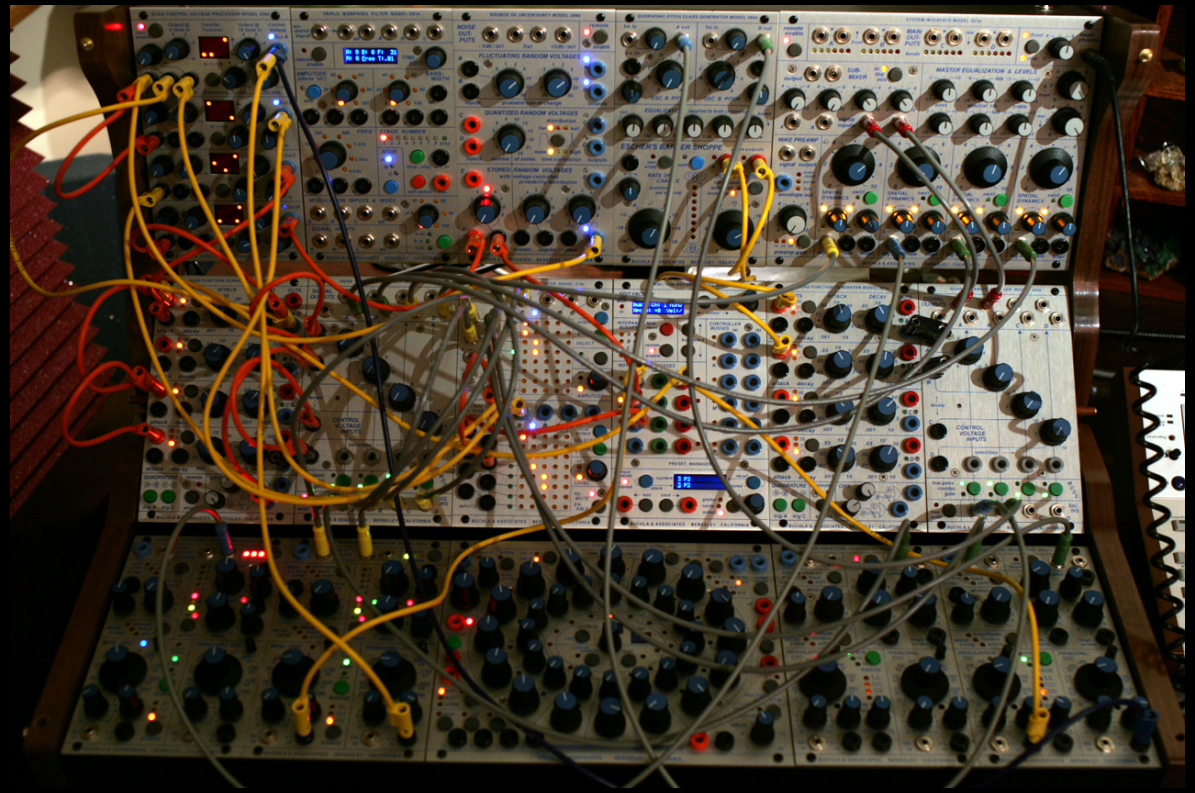


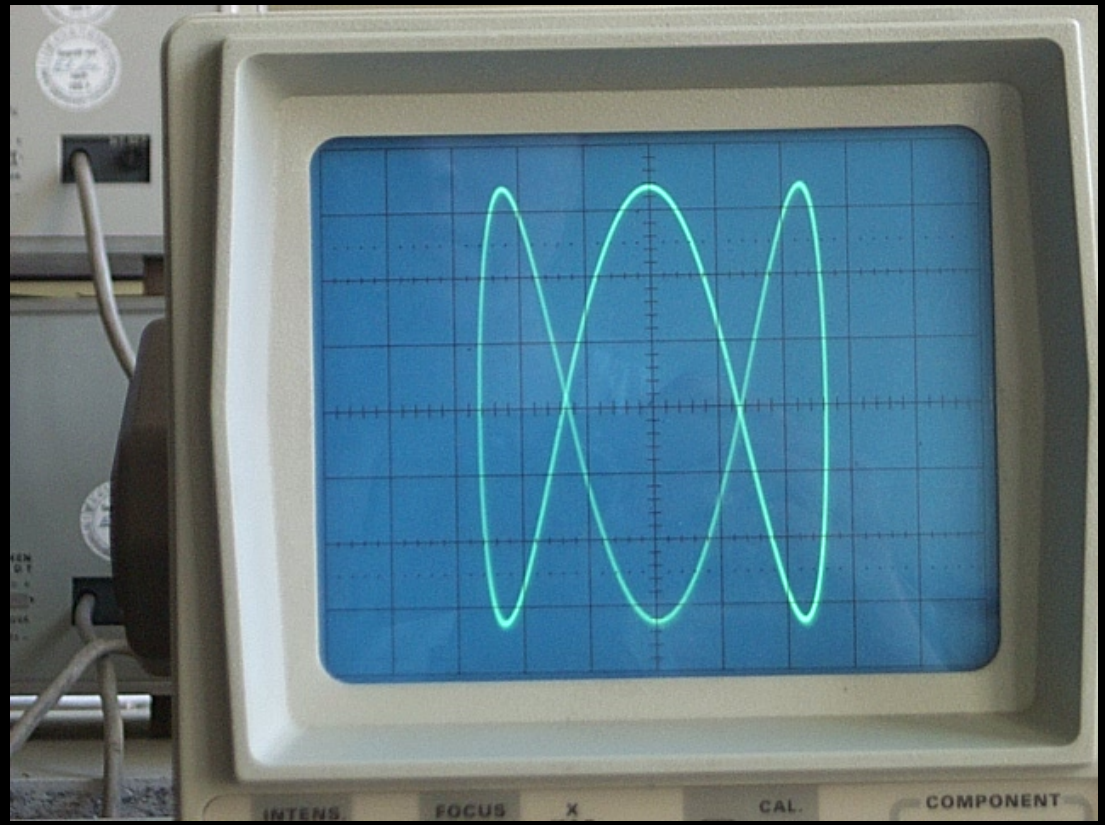
Photo credit: Michael Tiemann at Wikipedia

Control Signals

Use a sereo signal - left for horizontal deflection, right for vertical.

Sound becomes images, or more precisely, frequencies are assigned points on a cartesian grid.

Photo credit: Oliver Kurmis at Wikipedia

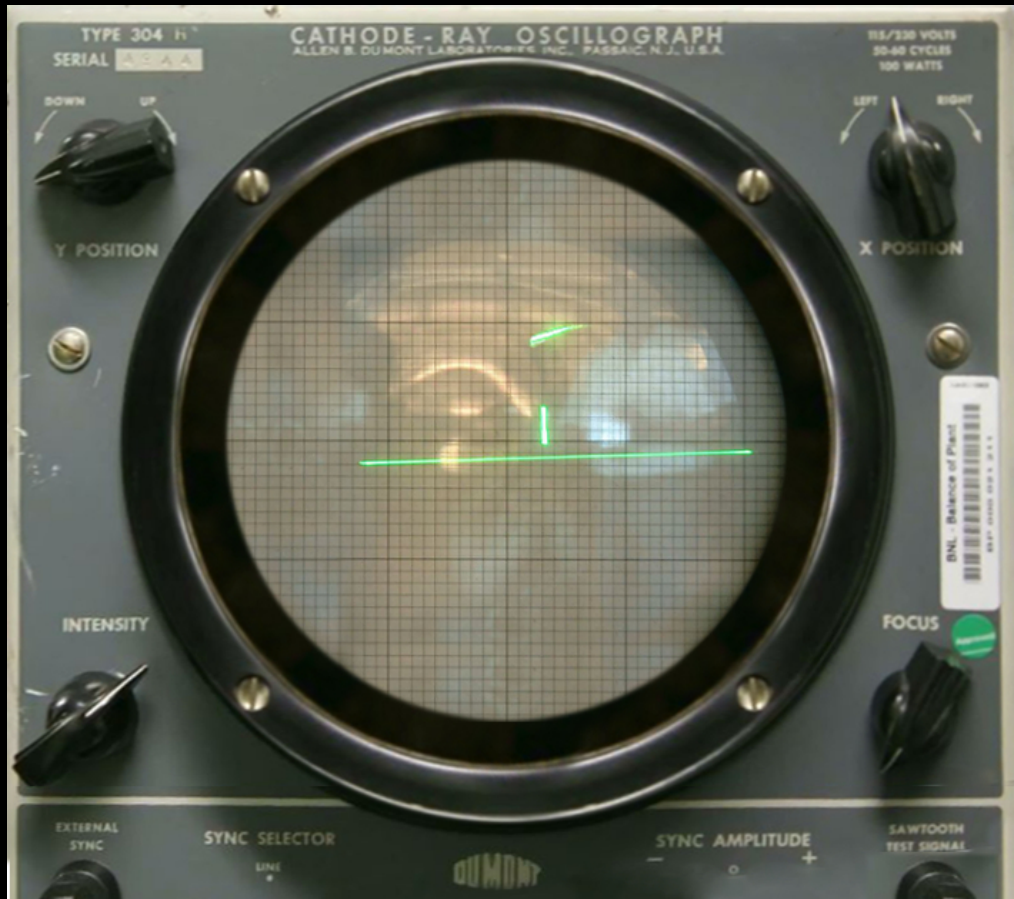


Control Signals

Enterprising hackers long ago figured out how to generate specific control signals in order to play games on oscilloscopes.

Tennis for Two

Photo credit: Brookhaven National Laboratory



Control Signals

We can use the same techniques to craft custom control signals to move the laser galvos.

Photo credit: leatflower via Wikipedia

Software

TouchDesigner - Windows

Direct generation of control signals. Built in EtherDream support.

Cons: difficult to optimize signals

Software

python - osx / linux

Uses Jacob Potter's dac.py lib

https://github.com/j4cbo/j4cDAC/blob/master/tools/tester/dac.py

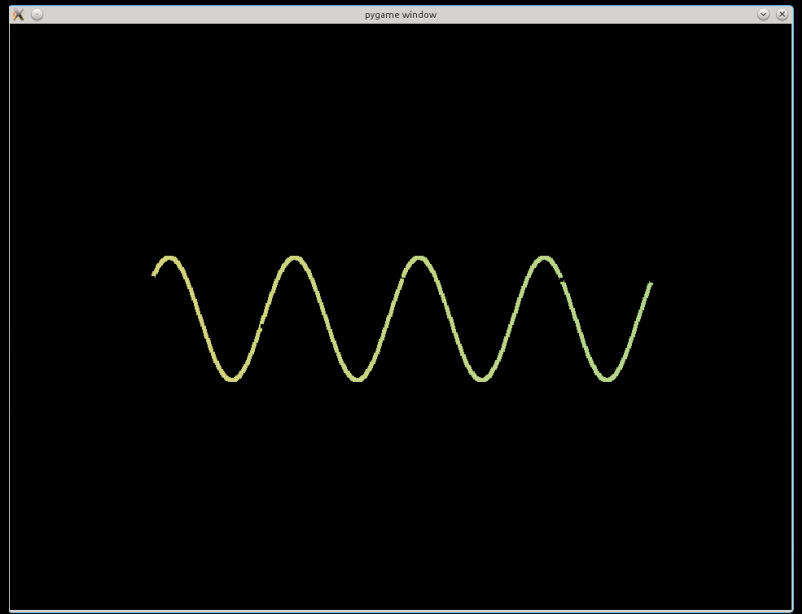
Renders a point stream using generators. Point stream is a tuple with coordinates and colors:

(x, y, R, G, B)

Software

Python ILDA emulator

https://github.com/lightengine/lightstream



Visualize your ILDA test signals on the computer before sending them to the laser.

Software

openFrameworks - osx/linux

ofxIlda / ofxEtherdream

Optimized blanking routines and uniform resampling of polygons.

Software

Etherdream Driver - windows

https://github.com/j4cbo/j4cDAC/tree/master/driver

C driver code is also available.

Software

Lumax - vvvv

http://vvvv.org/documentation/lumax-(devices)

DIY Sound Card DAC - openlase C/Python

https://github.com/marcan/openlase

Reference

Ether-dream Codebase
Jacob Potter aka p4cbo
https://github.com/j4cbo/j4cDAC

Accurate and Efficient Drawing Method for Laser Projection
Purkhet Abderyim, Osama Halabi, Tadahiro Fujimoto, Norishige Chiba
http://www.art-science.org/journal/v7n4/v7n4pp155/artsci-v7n4pp155.pdf

Reference

ofxIlda Overview Document

Memo Aken

https://github.com/memo/ofxIlda/wiki

Etherdream Emulator - Lightstream

Brandon Thomas (eschelon)

https://github.com/lightengine/lightstream

also - many other libraries at https://github.com/echelon

Laser Super Hexagons

/tmp/lab

https://github.com/tmplab