Nitrogen Laser

By Leslie Wright

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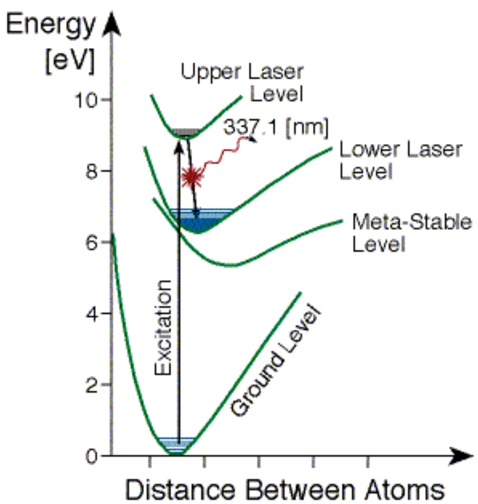
The molecular nitrogen laser at 337.1nm was first demonstrated in 1963, and has been commercially available since 1972. They rarely show up in laboratories though, as they have been largely surpassed by Excimer lasers and third or fourth harmonic light from neodymium lasers, that have higher powers and `cleaner` beams than nitrogen lasers.

The nitrogen laser is however an excellent choice for the amateur or poorly funded lab to build, and, with a little care in its construction, and improvement of the original design ("the amateur scientist" scientific american 1974) can be quite a performer!

The active medium, is as its name suggests, nitrogen gas, at pressures between 20 torr and 1 atmosphere. Most commercial designs are flowing gas, but occasionally sealed tubes show up (with reduced repetition rates).

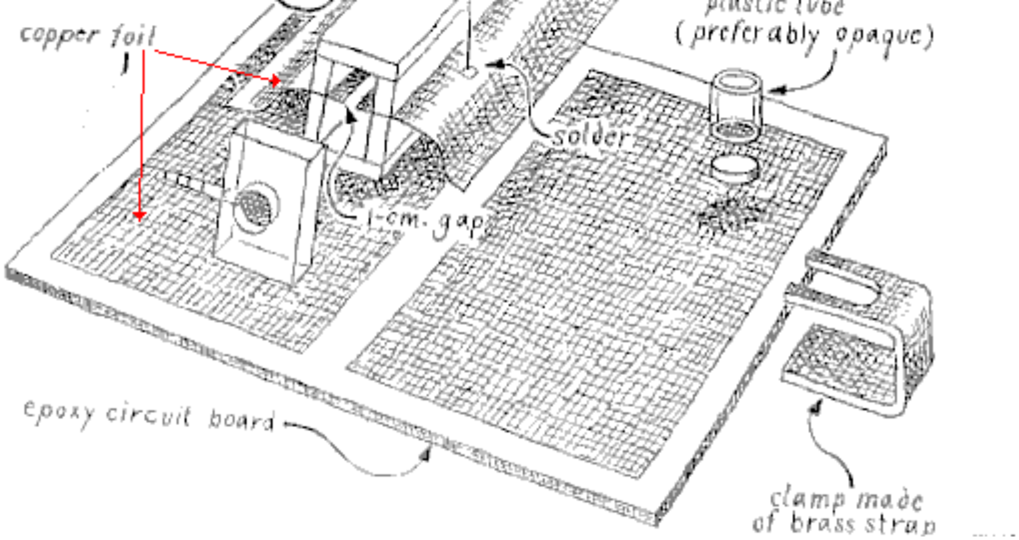
A fast high voltage discharge populates the upper laser level, an excited state with a 40ns lifetime, which emits at 337.1nm when it drops to the lower laser level as shown in the diagram below:



The transition is vibronic, making the emission fairly broadband by laser standards.
The lower laser level has a 10μs decay time, much longer than the upper level, and drops to a metastable state with a lifetime of many seconds. This would make lasing impossible except that the fast electric discharge very efficiently populates the upper level.

These features combine to give N_2lasers extraordinarily high gains, 50 dB/m or more are typical. Virtually all nitrogen lasers can operate in superradiant mode without cavity mirrors, and the lasing medium is relatively tolerant of impurities. The use of a high reflector and 4% reflecting output coupler will more than double the output, and considerably reduce the divergence.

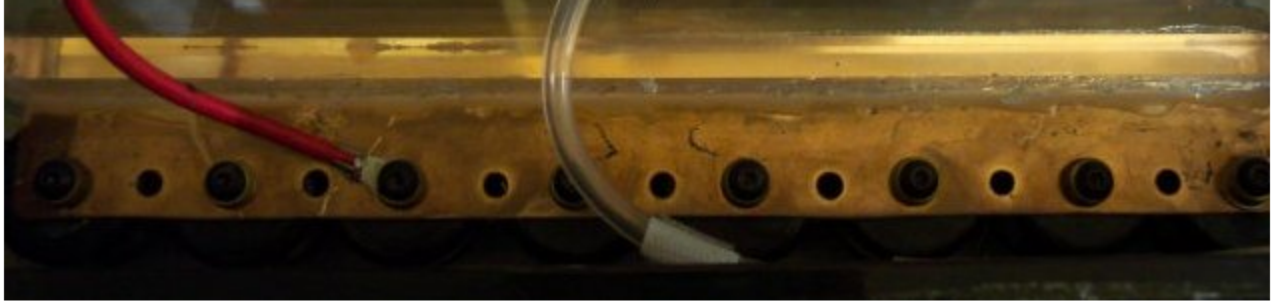
My design is similar to the Scientific american design pictured here:



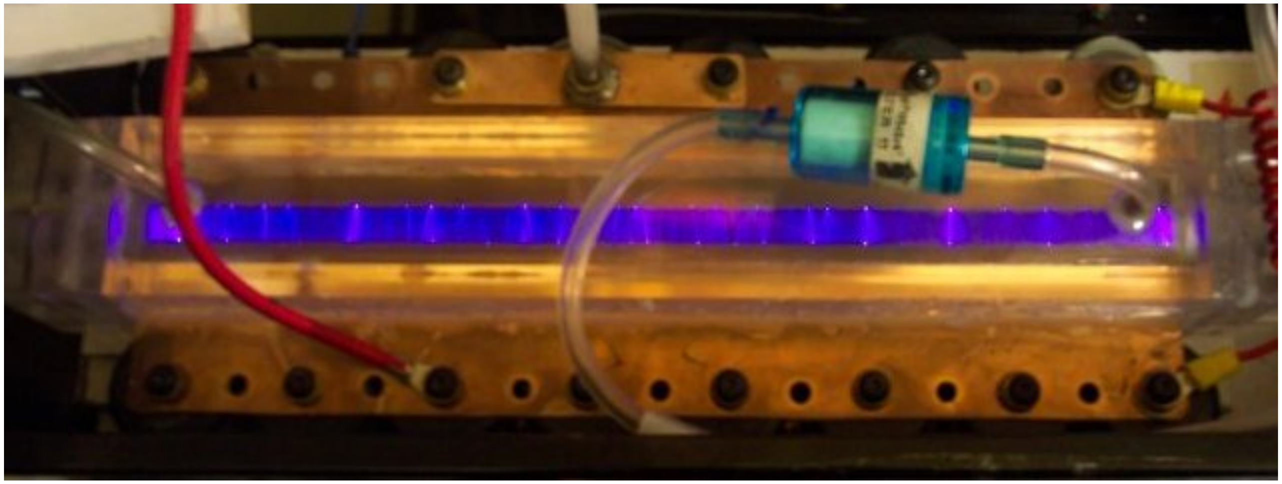
With the following modifications:

1) the epoxy circuit board capacitors were replaced with high voltage doorknob capacitors, this reduces the width of the laser to 10cm, whilst at the same time providing gre
2) copper foil electrodes replaced with 1mm thick copper sheet, for rigidity.
3) the new design incorporates a built in HR mirror on an adjustable mount. There is no OC, but the exit window is high quality fused silica.
4) the power supply is a far beefier version of the somewhat feeble sci-am design, and is capable of easily running the laser in excess of 100pps!
5) the nitrogen gas is flowing at a somewhat higher rate then the sci-am design, allowing higher average power to be extracted.

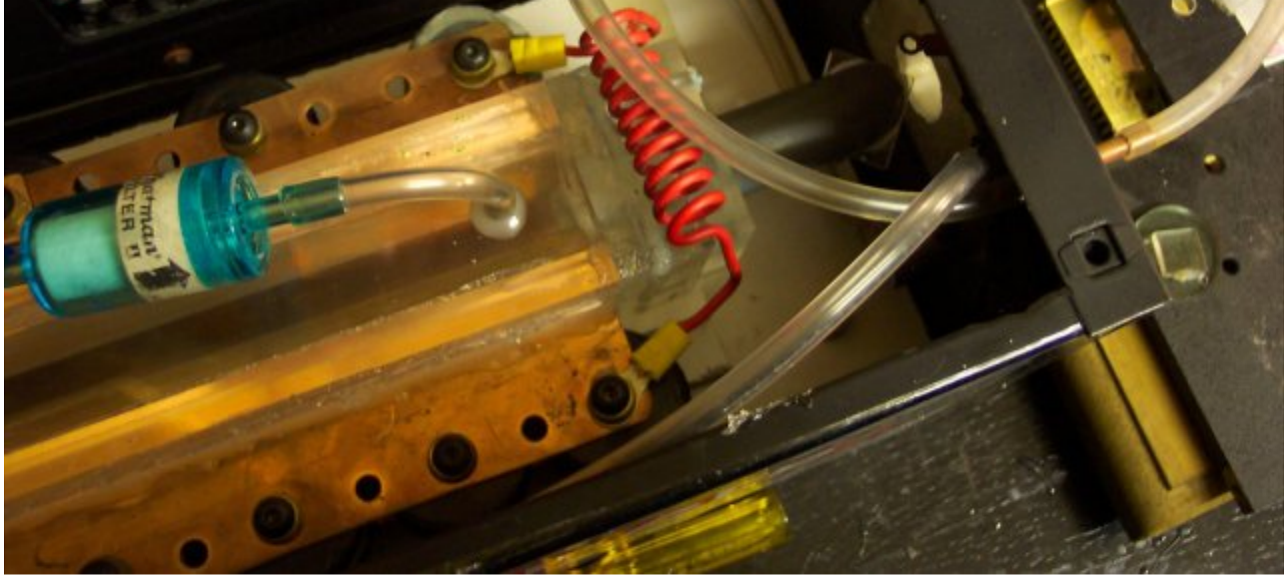
Here is a top view of the cavity, the large blue object is an air filter connected to the N_2inlet there is a similar one on the outlet to the pumps. The doorknob capacitors are m
bolts on the copper plates, the EHT is provided by the red cable.
The spark gap is partly visible (the small copper plate top middle).

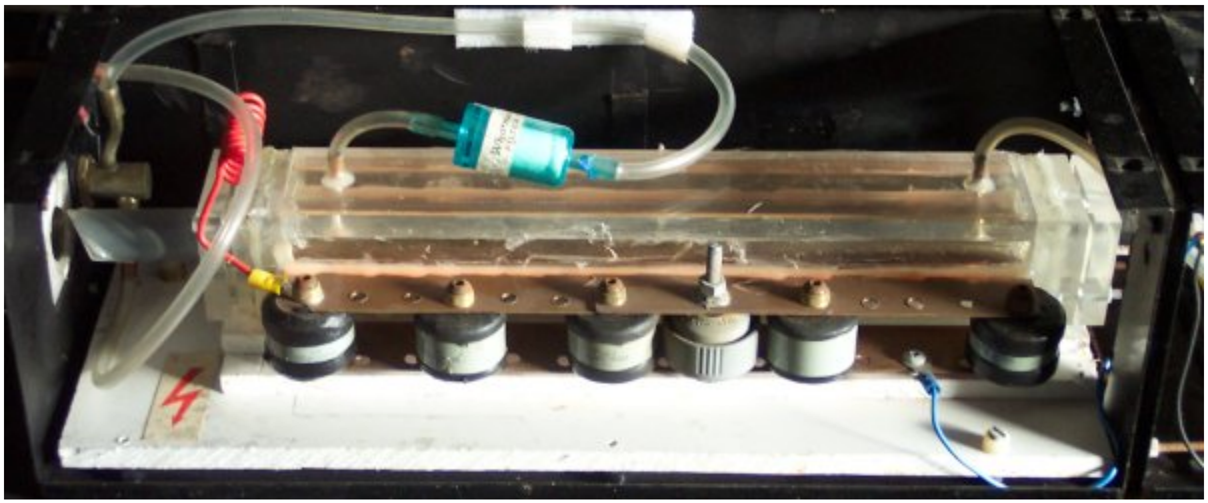


This is a picture of the cavity firing, the rear mirror mount is visible on the left, and the inductor is visible on the right.



This is a view of the output end, the quartz window is mounted at an angle on the end of the grey tube.

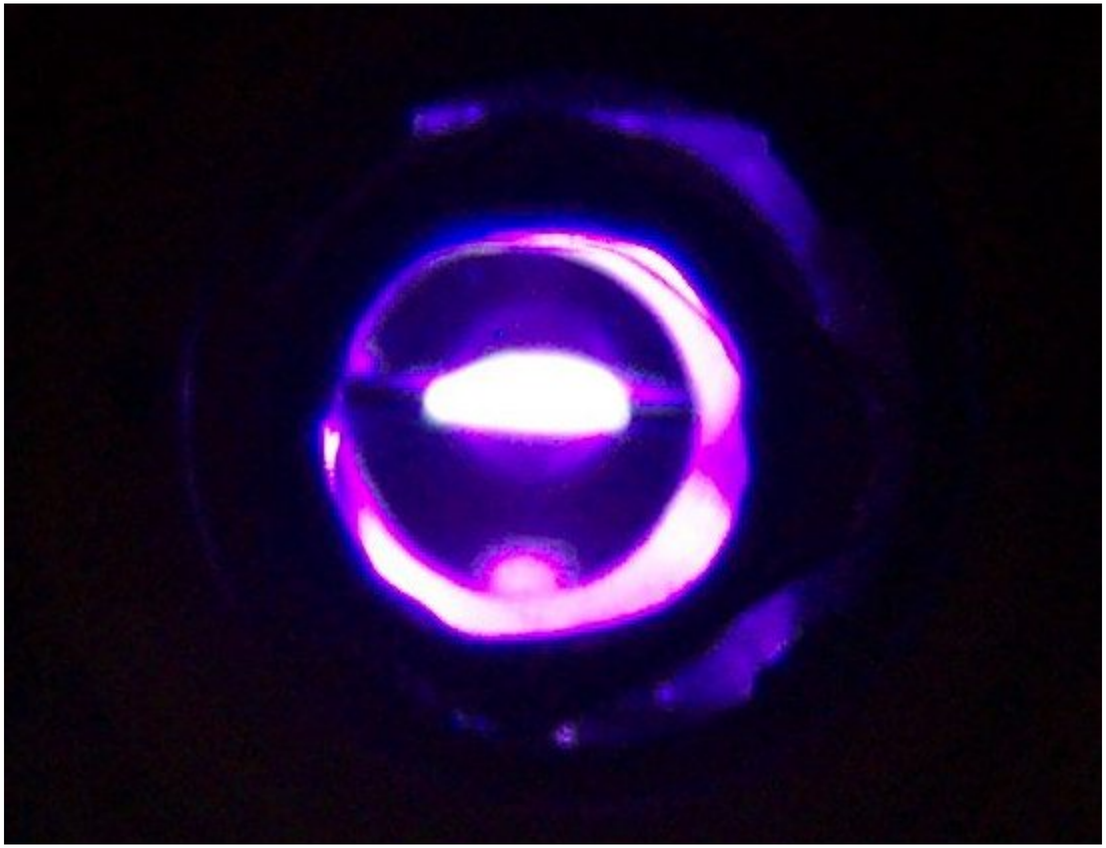




This is a side view of the entire cavity. The grey thing in the middle, is the spark gap, the others are capacitors. The black ends on the capacitors, is self-amalgamating tape
corona and flashover. The odd spacing of the capacitors on the spark-gap side of the cavity, is deliberate, and was found by experiment to work the best. The Capacitors on

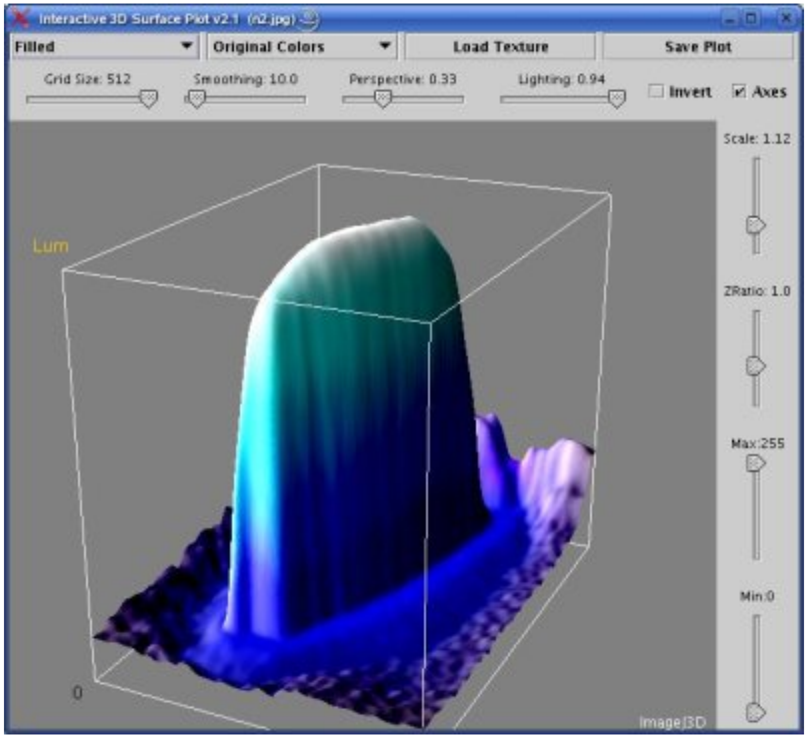
This is a view of the PSU section. To the left the rear mirror mount of the laser cavity is accessible.
The cockroft walton mutiplier is located next to it, which is fed by a car ignition coil.
The power suppply is a simple ignition coil based EHT supply. 50v DC is switched through the coil at high frequency (the coils resonant frequency) by a pair of 2N3055 `s in simple 555 timer circuit.
The entire circuit is capable of generating 30kV at a generous current and is almost indestructible!
Pulse repetition rate of the laser is adjusted by varying the frequency of the driver, around the coils resonant point.

This is a view down the bore whan the laser fires!

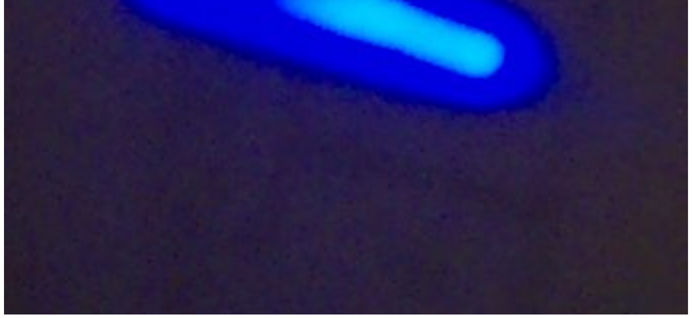


This is what the beam looks like on white paper when run with oxygen free nitrogen.

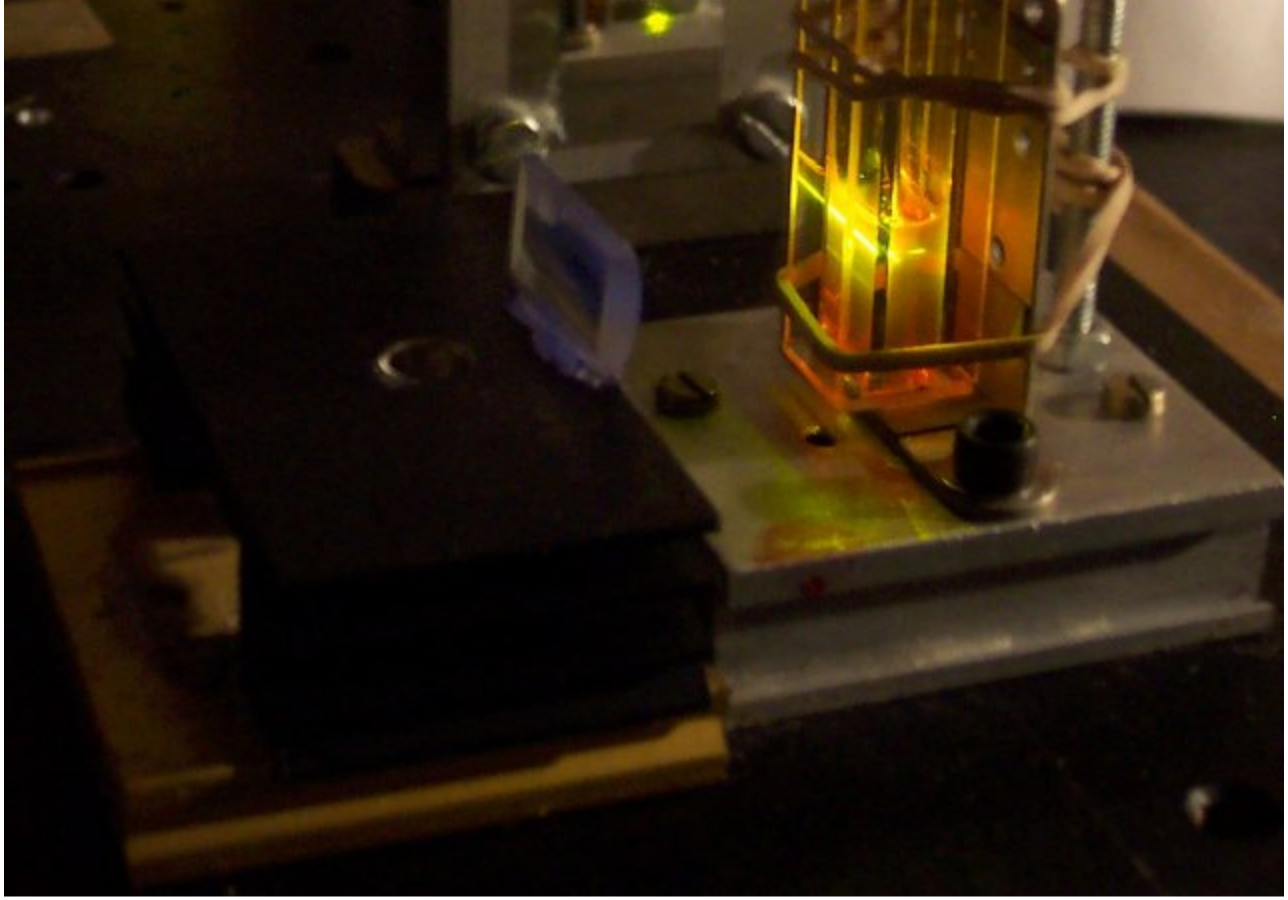
And a beam profile:



As you can see from the beam shots, and the above profile, the beam is very rectangular, due to the transverse nature of the discharge. Although is is quite ugly, it is well su
shown at the bottom of the page.
This is the beam on the same paper target, except the cavity is using AIR as the lasant!



Pumping a small cuvette containing Rhodamine 6G in Methanol. A cylinder lens is used to focus the beam into a line on the dye cell. The dye Laser is also capable of lasing



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