

⑧ Effects of Temperature, Pressure, and Gas-Fill

Aside from the effects on the physical dimensions of the tube, the center of the NGC depends on the gas temperature and pressure, and ambient/tube temperature affects the internal pressure directly as well as from changes to the tube structure.

Cause	Sensitivity	Comments
Helium Pressure	+22 MHz/Torr	Pressure of He decreases with use
Neon Pressure	-25 MHz/Torr	Pressure of Ne decreases with use
Neon Isotopic Ratio	+10 MHz/% of ^{22}Ne	Ratio of ^{22}Ne : ^{20}Ne Decreases with use
Temperature	+280 kHz/ $^{\circ}\text{C}$	Affected by specific lock point

Under normal conditions, the changes in internal pressure are likely to be much less than 1 Torr and temperature itself has only a small affect on the gain center. The major one is gas fill ratio of ^{22}Ne : ^{20}Ne . This is of course determined at the time of manufacture (and may not be that accurate), but will also decline slightly with use as ^{22}Ne will be trapped at a slightly a higher rate than ^{20}Ne .

Another (and perhaps even more important) effect of the isotope ratio is that it impacts the effective width of the NGC. For common (non-stabilized) HeNe lasers, using a 1:1 isotope mix is beneficial as it allows a higher number of longitudinal modes to oscillate resulting in higher power. But for stabilized HeNe lasers, it may be desirable to minimize the NGC width to reduce uncertainty in the optical frequency when locked. And for axial Zeeman stabilized HeNe lasers, it may both increase available power (since the lasing modes are close together) and increase the magnetic field at which rogue modes appear.

One way to assure that the tube itself runs at a relatively fixed known temperature is to warm it up to a set-point temperature rather than using an indirect method like the rate of mode sweep to determine when to lock. And then to fine tune that after awhile to give everything time to reach thermal equilibrium. Once locked in this manner, the temperature of the tube will remain relatively constant. To improve it even further, at least two companies (Lab for Science and MicroG) put the tube (with its heater wrap) in a temperature-controlled housing. Most do not.

More on this may be found in the chapter: [Commercial Stabilized HeNe Lasers](#).