29: Back-Reflections and HeNe Lasers

Back-reflections of a laser's output directly back to it is inherently destabilizing for most lasers, and in some cases even potentially destructive. Many factors determine what effects back-reflections will have including the type of laser, and optics between the laser cavity (inside the laser or external) and the source of the reflections.

HeNe lasers are particularly sensitive to back-reflections, though no damage is ever likely to occur. However, the instantaneous polarization state and amplitude of the longitudinal modes will be affected. These effects may not be noticeable for common HeNe lasers without using fancy instruments since they occur at nanosecond time scales. For these lasers, average output power from the laser will not be affected but for random-polarized HeNe lasers, the intensity of any portion of the beam passed through optics that affect polarization may fluctuate dramatically.

Suffice it so say that one should avoid back-reflections to HeNe lasers, but especially for stabilized HeNes. Even the reflection from a piece of fresh transparent tape in the beam may cause the laser to lose lock. What happens is that when a mode swaps polarization, the controller will attempt to relock but that may require several seconds or longer. Some lasers may indicate their unhappiness by flashing the READY or LOCK indicators, or in the case of the Spectra-Physics 117A and Melles Griot 05-STP-901, making clicking noises. :)

The best way avoid such instabilities is to arrange the setup so that there are no back-reflections. ;-) The HP/Agilent interferometer configurations used for metrology applications shown in Most Common Hewlett Packard/Agilent Interferometers are nearly perfect. With their high quality Polarizing Beam-Splitters (PBSs), there are virtually no back-reflections directly to the laser. The next best solution where this is unavoidable is to add an optical isolator at the output of the laser. A Faraday isolator is best but very expensive. For a beam with a single linear polarization, adding a PBS cube and Quarter Wave Plate (QWP) will redirect any reflections downstream that have not had a polarization change off to the side. In many applications, this is sufficient. But in some cases, two Faraday isolators in series are needed to fully tame the HeNe beast. ;-)