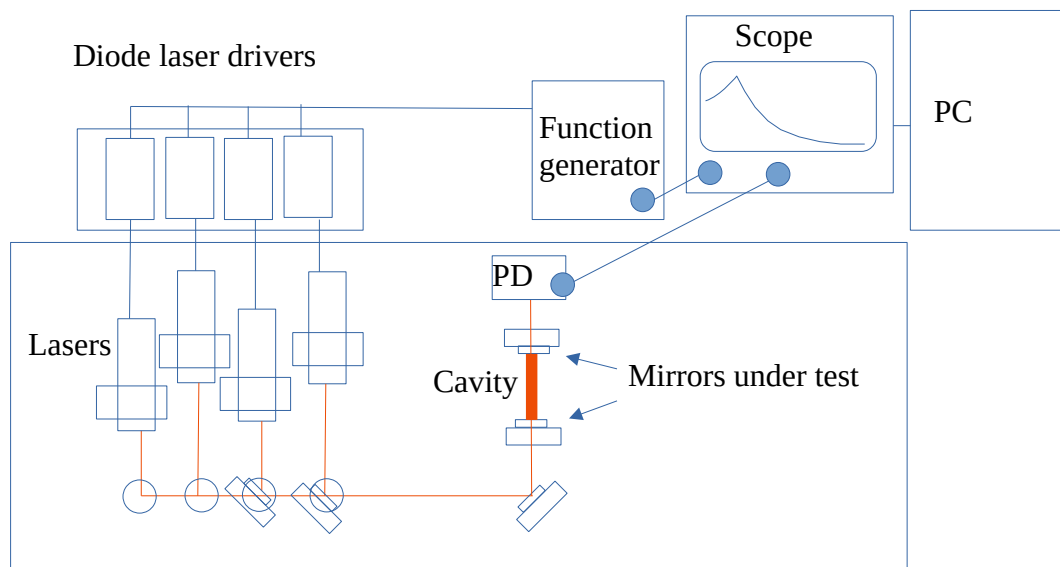


Ringdown measurement system for low-loss mirrors

Ringdown measurements are for measuring small losses for highly reflective mirrors. Such mirrors are generally used in laser cavities, where very low losses are needed for good performance. Mirrors are usually measured in pairs, but a single mirror can also be measured by using a second mirror that has previously been measured.

The hardware

Below is a typical ringdown system, shown schematically.



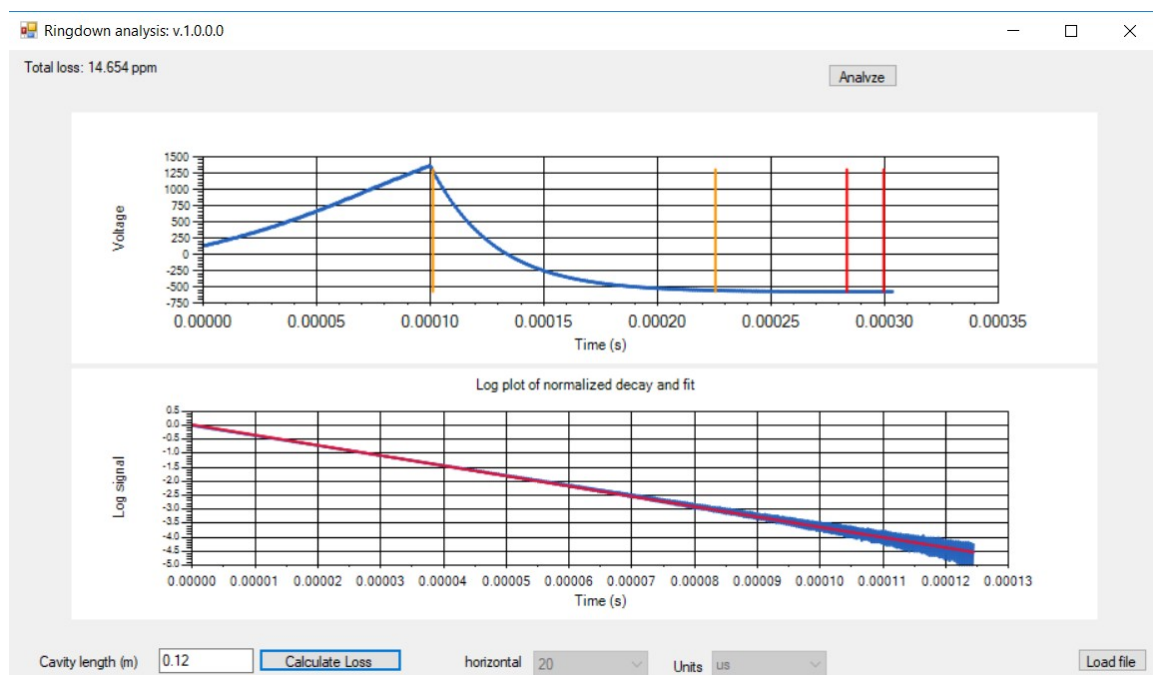
There are many variations for setting up a ringdown system, mostly determined by the lasers and wavelengths that are needed. The version shown here uses diode lasers, with fast electronic switching, which is low in cost and easy to use. Some beam shaping lenses are not shown here.

The mirrors under test form an optical build-up cavity. A laser for a particular wavelength is selected. While the laser is on, intensity builds up in the cavity. When the signal reaches a threshold, the laser is turned off suddenly. Light continues to emerge from the cavity, decaying exponentially, as the accumulated light escapes. The decay time of this “ringdown” signal is related in a simple way to the reflectivity of the mirrors,

R. The transmission, T , is also measured, and mirror loss is then $1-R-T$, usually expressed in parts-per-million (PPM).

For most laser wavelengths that are commonly used, a fairly fast photodiode (PD) detector is used. In some situations, a photomultiplier or an avalanche photodiode detector might be better.

The software



The Software is in two parts. A desktop application, reads the scope data, and does the fitting to obtain the decay time. A screenshot is shown above. Although the functional form of the decay is simple, it pays to be somewhat careful to use appropriate weights in the fitting procedure. The data and the fitted curve are then made available to a spreadsheet (usually Excel or Libre Office), where a certificate is generated. The formatting of the certificate can be modified and enhanced with pretty fonts, colors and logos. Then the certificate can be printed or archived, and provided to the customer.

Training

Ringdown measurements are direct and easy to understand, and measurements are normally quick and easy, but hands-on training is very helpful for working with optical

cavity alignment. Some training will make all the difference. Some extra training should be included for folks who are less comfortable with oscilloscopes and function generators. After one or two persons are comfortable with the system, they can train others as needed. The skills learned are applicable to many other optical measurements.