1. Introduction

This document serves as a general guide on how to approach and successfully calibrate a Picarro cavity ring-down spectrometer (CRDS). The steps described herein can be used on isotopic and/or concentration analyzers that measure CO_2, CO, CH_4, H_2O, C_2H_2, C_2H_4, C_2H_6, CH_2O, O_2 and N_2O. Additional analyzers may require special or extra steps to calibrate properly. If you are unsure if this document applies to your analyzer, please consult with Picarro support (support@picarro.com), your Picarro sales representative and Application Scientist.

2. Basic principles of CRDS

Picarro analyzers measure gas molecules and/or isotopologues based on the principle of laser light absorption. This light, tuned to a wavelength that corresponds to the vibrational mode and frequency of the target molecule and/or isotopologue, enters an empty cavity where it reflects between three high-reflectivity mirrors (Figure 1). When the cavity is brought into resonance, the intensity of the light increases due to constructive interference. Once a threshold in light intensity is reached, the laser source is turned off and since the mirrors are only 99.999% reflective, light slowly bleeds out of the cavity and into the photodetector where its intensity is measured. The exponential decay time of the intensity of the light is expressed as the ring-down time. When sample gas is introduced into the cavity, the light intensity drops more rapidly is due to the absorption of light by the target molecule and/or isotopologue – an additional loss mechanism which leads to a faster decay time. The software then converts measurements of absorption at several wavelengths into an optical spectrum. A non-linear curve-fitting algorithm of this optical spectrum is used to quantify the strength of the key absorption peaks, which are then used to calculate species concentration and isotopic abundance.

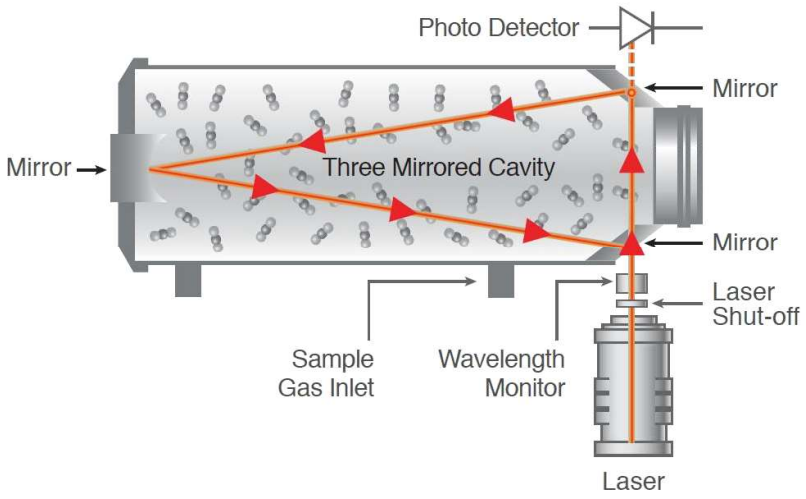

Figure 1 – Schematic drawing of a Picarro cavity and key optical components. The unique cavity design leads to an effective optical path length of over 20 km.2.1 Calculation of an Isotopic Ratio