A Doppler broadening thermometry is implemented using a laser-locked cavity ring-down spectrometer\(^a\)\(^b\) combined with a temperature-stabilized sample cell. The temperature fluctuation of the gas sample cell is kept below 1 mK for hours. The probing laser is frequency locked at a longitudinal mode of a Fabry-Pérot interferometer made of ultra-low-expansion glass, and the spectral scan is implemented by scanning the sideband produced by an electro-optic modulator. As a result, a kHz precision has been maintained during the measurement of the spectrum of 10 GHz wide. A ro-vibrational line of $\text{C}_2\text{H}_2$ is measured at sample pressures of a few Pa. Using a pair of mirrors with a reflectivity of 0.99997 at 787 nm, we are able to detect absorption line profiles with a signal-to-noise ratio of $10^5$. Fitting of the recorded spectra allows us to determine the Doppler width with a statistical uncertainty of 10 ppm. Further improvements on the experimental reproducibility and investigations on the collision effects will probably lead to an optical determination of the Boltzmann constant with an uncertainty of a few ppm.
