High-Precision Carbon Isotope Laser Absorption Spectrometer (CILAS)

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The design and performance of a new mid-IR laser absorption spectrometer for the detection of the isotopic ratio of $^{13}C/^{12}C$ in CO_2 will be presented. CILAS design is based upon an optical fiber pumped, single-pass difference frequency generation (DFG) source operating at λ=4.35 μm [1,2]. The DFG source is split into two identical beams by a novel optical divider and each beam is coupled with a 40 cm long, two pass absorption cell. The absorption signals (2-f modulation) are combined and focused onto a thermoelectrically cooled MCT detector using a single off-axis parabolic mirror. A mechanical chopper switches between the two absorption signals / cells. A four gas channel inlet system permits inter-comparison between three different calibration standards and ambient air.

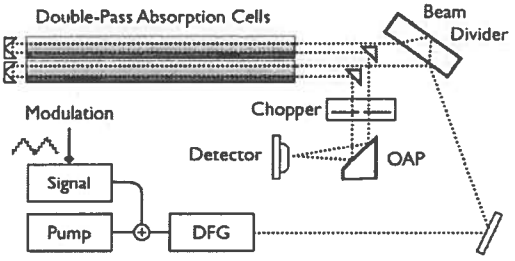

Fig.1: Optical Schematic of CILAS

The CILAS system provides small sampling volumes (40 cm^3), a relative gas temperature stability between the absorption cells of less than 5 mK (3 hours) principally enabling precisions of better than 0.1 ‰, optical stability times in excess of 1000 seconds, and so far a demonstrated spectroscopic precision of 0.3 ‰ sampling ambient air. The current performance is limited by large intensity fluctuations (>10%) caused by a commercial optical fiber amplifier operating at λ=1115 nm seeding the DFG source. By implementing new near-IR pump and signal mixing wavelengths and custom fiber amplifier designs, CILAS can offer a significantly improved spectroscopic performance. In addition to the

optical design, we will discuss the various spectroscopic as well as gas sampling aspects that potentially impact the retrieved precision and accuracy.

[1] M. Erdelyi, D. Richter and F. K. Tittel. *Applied Physics B* **75**, 289-295 (2002).
[2] P. Weibring, D. Richter, A. Fried, J.G. Walega and C. Dyroff. *Applied Physics B* **85**, 207-218 (2006).