

DUAL-COMB SPECTROSCOPY IN THE OPEN AIR

GREG B RIEKER, *Department of Mechanical Engineering, University of Colorado Boulder, Boulder, CO, USA*; ANDREW KLOSE, SCOTT DIDDAMS, *Time and Frequency Division, National Institute of Standards and Technology, Boulder, CO, USA*; IAN CODDINGTON, FABRIZIO GIORGETTA, LAURA SINCLAIR, ESTHER BAUMANN, GAR-WING TRUONG, GABRIEL YCAS, WILLIAM C SWANN, NATHAN R. NEWBURY, *Quantum Electronics and Photonics Division, National Institute of Standards and Technology, Boulder, CO, USA*.

Dual-comb spectroscopy is arguably the natural successor to FTIR. Based on the interference between two frequency combs, this technique can record broadband spectra with a resolution better than 0.0003 cm^{-1} . Like FTIR, dual-comb spectroscopy measures an entire spectrum simultaneously, allowing for suppression of systematic errors related to temporal dynamics of the sample. Unlike FTIR it records the entire spectrum with virtually no instrument lineshape or error in the frequency axis. The lack of moving parts in dual-comb spectroscopy means that spectra can be recorded in milliseconds to microseconds with the desired signal-to-noise being the only real constrain on the minimum recording time. Finally the high spacial beam quality of the frequency combs allows for increased sensitivity through long interaction paths either in free-space, multi-pass cells or enhancement cavities.

This talk will explore the recent use of dual-comb spectroscopy in the near-infrared to measure atmospheric carbon dioxide, methane and water concentrations over a 2-km outdoor open-air path. Due to many of the strengths just mentioned, precisions of $<1\text{ ppm}$ for CO_2 and $<3\text{ ppb}$ for CH_4 in 5 min are achieved making this system very attractive for carbon monitoring at length scales relevant to carbon transport models.

Additionally this presentation will address recent work on robust, compact, and portable dual-comb spectrometers as well as dual-comb spectroscopy further into the IR.