

# Digital Signal Processing in Mid-Infrared Spectroscopy

Amandeep Chhabra<sup>1</sup>, Alexandra Tsekeri<sup>1</sup>, Paul Corrigan<sup>1</sup>, Reuven Huntley<sup>1</sup> and Maung Lwin<sup>1</sup>

<sup>1</sup>Mirthe Foundation, City College of New York, New York, 10031, USA

email: achhabr00@ccny.cuny.edu

Open-path Fourier Transform Infrared Spectroscopy (FTIR) is a mid-infrared technique used in remote sensing to measure the concentration of trace gases by infrared absorption. Data processing applications provided with commercial FTIR have limited features and lack of flexibility for customization, e.g.: user defined background algorithms, concentration calculations. An efficient application is required to precisely compute the concentration of gas from a measured absorbance spectrum. We developed a Matlab program to analyze data obtained from an open-path FTIR. HITRAN 2000 was used as reference database to implement a classical least squares method to calculate the concentrations of ozone, ammonia, water vapor and carbon dioxide via Beer's law.

We installed the FTIR on campus at CCNY and monitored outdoor concentrations with our own Matlab program. The FTIR produces an interferogram (Figure 1) that contains the absorbance information, so a second program was developed to retrieve the true spectrum by Fourier transformation. This program reduced the errors introduced in the fast Fourier transform of the interferogram to absorbance spectrum by including correct apodization, a smoothing curve to enhance resolution, and phase correction, to combat sampling, electronic and optical effects (Figure 2) [1]. This program was also used to test the accuracy of the commercial software provided by the FTIR manufacturer (MIDAC). From test bed trials performed at CCNY, our program was found to be as equally efficient as the commercial software, but provides added flexibility for future customization, such as micro window analysis, for single species detection and alternative background characterization.

These results from the test bed trials at the City College of New York will be used to investigate the retrieval algorithm and to compare it with an open path Quantum Cascade Laser spectroscopy system currently under development. To do this we designed an optical setup for a Herriot type multi-pass cell that included a QCL aligned with a ZnSe Lens and HeNe laser with three reflectors which ensures proper coupling of the QCL into the gas cell.

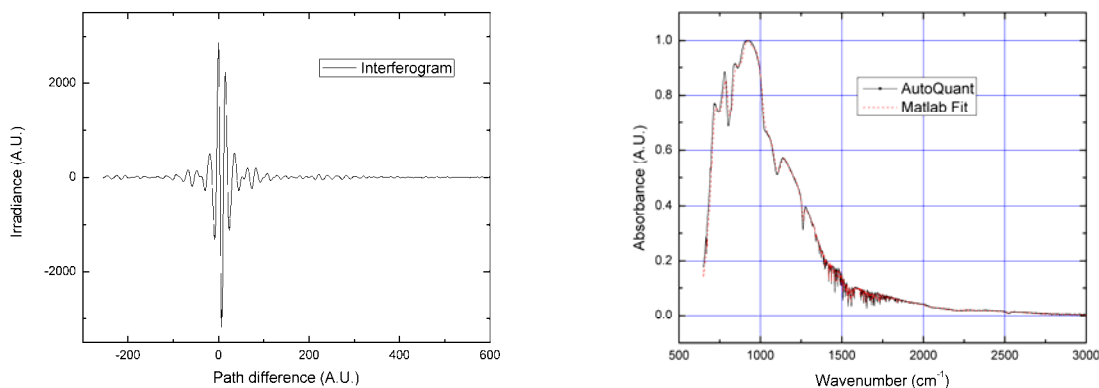


Fig 1 (left): the interferogram obtained from FTIR system. Fig. 2 (right): Mertz Phase Corrected Single Beam Spectrum transformed from the interferogram using our customized Matlab algorithm and the commercial AutoQuant Pro software

[1] P. R. Griffiths, J. A.de Haseth, *Fourier Transform Infrared Spectrometry*, Wiley, New York, 1986