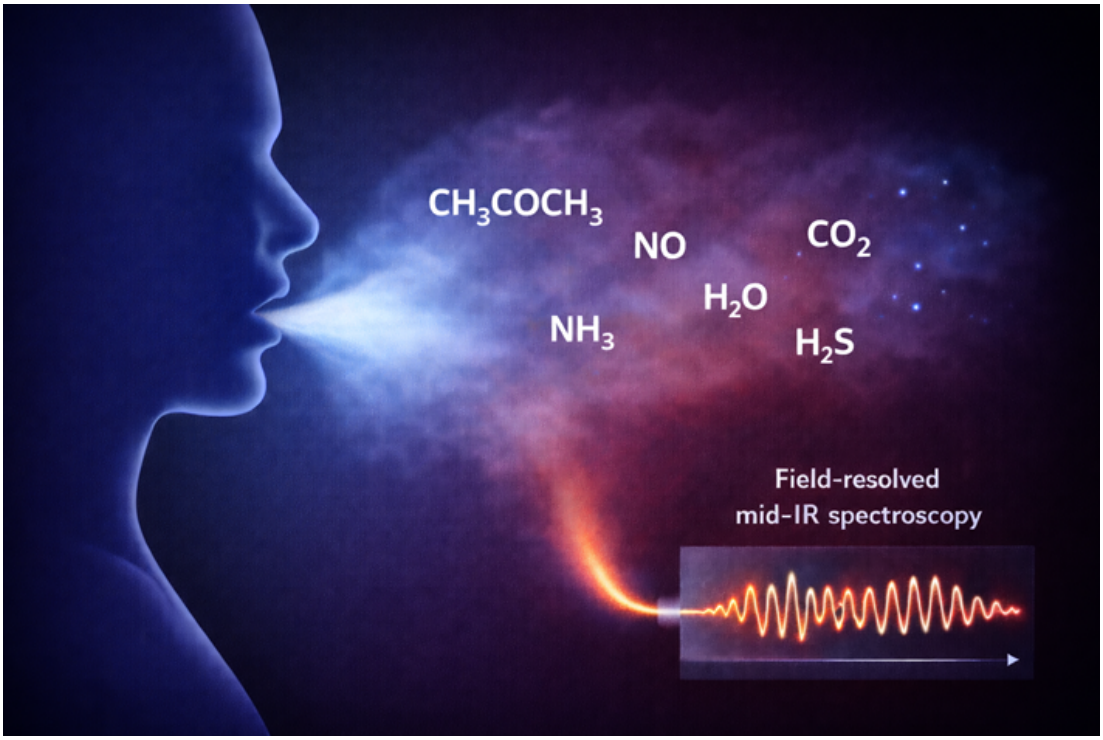
MSc Thesis at the Laboratory of Lightwave Metrology, Prof. Ioachim Pupeza

Analysis of Biological Gases with Field-Resolved Mid-Infrared Spectroscopy



Biological gases, such as exhaled breath or the headspace of microorganism cultures, contain a rich set of volatile organic compounds that reflect metabolic and inflammatory processes in real time. Yet, the molecular complexity in such samples render their quantitative, multivariate analysis an ongoing challenge.

In this project, you will use field-resolved mid-infrared spectroscopy [1], which directly measures the electric field of ultrabroadband pulses and therefore offers linear response over several orders of magnitude, to develop and characterize a platform for the analysis of biological gases. You will work on a prototype system based on a multi-watt Kerr-lens mode-locked femtosecond laser driving ultrabroadband mid-infrared generation, and optimize it for quantitative detection of biologically relevant gas species.

As an MSc student, you will design and automate gas-handling and measurement procedures for test gas mixtures, implement calibration and data-analysis routines for concentration retrieval, and perform systematic sensitivity studies to determine detection limits for gases linked to vital functions and patient status. This work will contribute toward breath-by-breath monitoring of intensive-care patients with high accuracy and robustness, which is one of the main goals pursued at our lab. The project offers hands-on experience with ultrafast laser systems, mid-infrared field-resolved spectroscopy, experimental automation, and advanced data analysis in an international research environment.

[1] I. Pupeza et al., “Field-resolved infrared spectroscopy of biological systems,” Nature 577, 52 (2020)

Contact: Dr. Pierre Kolejak, pierre.kolejak@rptu.de
lightwavelab.de