Res-Q-Trace: A Mobile CEAS-Based Demonstrator for Multiple-Component Trace Gas Detection in the MIR

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Laser spectrometers based on quantum cascade lasers (QCLs) operating in the mid-infrared are an exciting prospect for trace gas sensing as they enable access to strong fundamental vibrational bands of many compounds with absorption cross sections that are typically two orders of magnitude larger than in the near-infrared. A further increase in sensitivity can be achieved by combining QCLs with cavity-enhanced techniques based on optical cavities. The importance of sensitive trace gas detection is manifold. Not only during the development, optimization and control of technological processes and for the monitoring of pollutant emissions, but also in medical breath analysis and for the detection of drugs and explosives a sensitive detection of trace gases down to part per billion (ppb) and part per trillion (ppt) levels is needed. For example exhaled human breath contains a few atmospheric molecules in relatively high concentrations such as H_2O, CO_2, N_2, O_2, several volatile organic compounds (VOCs) at part per million (ppm) or sub-ppm levels, and about four hundred major VOCs at ppb or ppt levels. The application of laser spectroscopic techniques promises the potential for small, portable, reliable and selective sensor systems which are sensitive enough for the online and in situ detection of trace gases. In order to proof and validate this concept, we will present a mobile demonstrator system comprising of four QCLs and CEAS measurement cells, two off-axis variants and two optical feedback variants respectively. The measurement cells are connected on the vacuum side, so that multi-component detection in one gas sample could be realized. Exemplarily species relevant not only for breath analysis but also for the detection of explosives were selected and will be presented with achieved sensitivities in the range of ppb and below: NO, N_2O, CH_4, C_2H_4, C_2H_6 and C_3H_6O.
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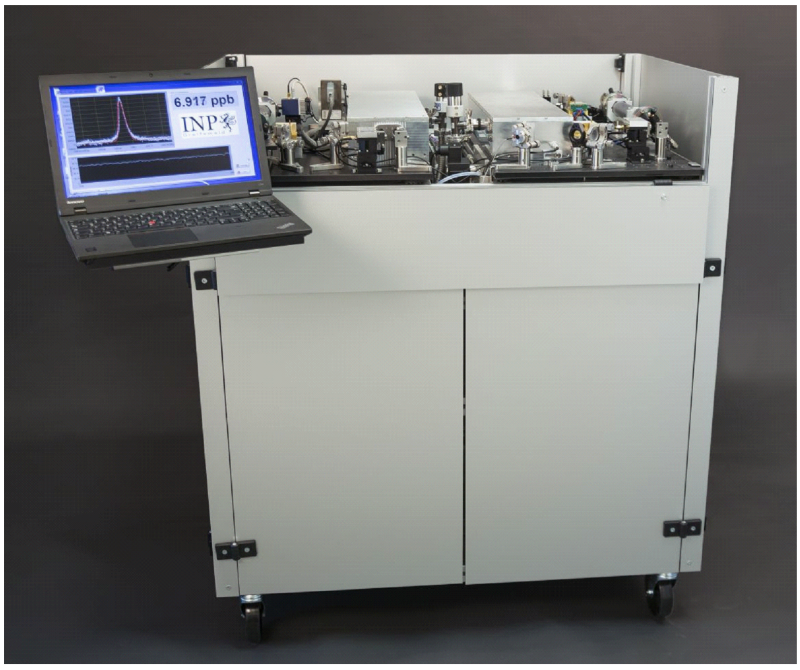

Demonstrator system RES-Q-Trace