

# QEPAS Module for a Mach-Zehnder modulated OPO

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Due to its extremely high detection sensitivity the concept of quartz-enhanced photoacoustic spectroscopy (QEPAS) became increasingly popular. QEPAS utilizes a quartz tuning fork as acoustic detector, thus, replacing the microphone. The high sensitivity of this approach is owed to the fact that the tuning fork represents an active band-pass filter amplifying only acoustic signals of a very narrow frequency band [1].

We applied the QEPAS concept in combination with an optical parametric oscillator (OPO). This radiation source is widely tunable in the mid-infrared spectral range and, therefore, particularly suited for the analysis of complex gas mixtures [2]. The OPO modulation which must be kept stable within the narrow frequency band of the tuning fork is realized with an electro-optical Mach-Zehnder modulator (MZM) [3].

In order to perfectly combine the advantages of QEPAS and Mach-Zehnder modulated OPO we designed a new acoustic detection module (ADM). It employs a conventional quartz tuning fork with a resonance frequency of 32 768 kHz. The respective off-beam micro resonator is specifically designed for the tuning fork and the beam dimensions. The ADM is modular, mechanically highly customizable and consists of 3D printed components. Figure 1 shows the schematic experimental setup.

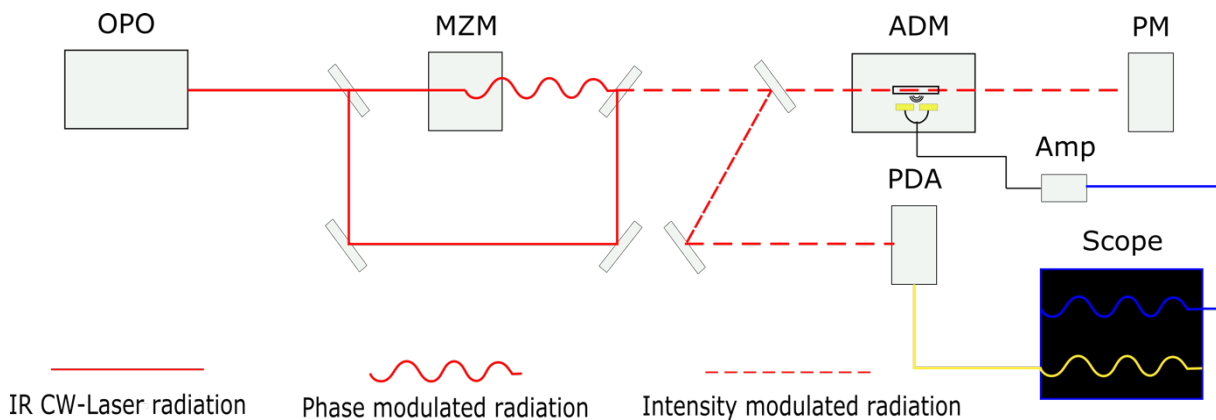


Fig 1. Schematic experimental setup (OPO: Optical parametric oscillator, MZM: Mach-Zehnder modulator, ADM: Acoustic detection module, PM: Power meter, PDA: Amplified photodetector, Amp: Amplifier).

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[2] Y. Saalberg, and M. Wolff. *Sensors* **18**, 1562 (2018).

[3] H. Bruhns, Y. Saalberg, and M. Wolff. *Sensors & Transducers* **188**, 40 (2015).