

## A DECADE-SPANNING HIGH-RESOLUTION ASYNCHRONOUS OPTICAL SAMPLING BASED TERAHERTZ TIME-DOMAIN SPECTROMETER

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High-resolution ASynchronous Optical Sampling (ASOPS) is a technique that substantially improves the combined frequency resolution and bandwidth of ASOPS based TeraHertz Time-Domain Spectroscopy (THz-TDS) systems. We employ two mode-locked femtosecond Ti:Sapphire oscillators with repetition frequencies of 80 MHz operating at a fixed repetition frequency offset of 100 Hz. This offset lock is maintained by a Phase-Locked Loop (PLL) operating at the 60th harmonic of the repetition rate of the Ti:Sapphire oscillators. Their respective time delay is scanned across 12.5 ns requiring a scan time of 10 ms, supporting a time delay resolution of up to 15.6 fs. ASOPS-THz-TDS enables high-resolution spectroscopy that is impossible for a THz-TDS system employing a mechanical delay stage. We measure a timing jitter of 1.36 fs for the system using an air-gap etalon and an optical cross-correlator. We report a Root-Mean-Square deviation of 20.7 MHz and a mean deviation of 14.4 MHz for water absorption lines from 0.5 to 2.7. High-resolution ASOPS-THz-TDS enables high resolution spectroscopy of both gas-phase and condensed-phase samples across a decade of THz bandwidth.