

Supplementary Material

Power estimation of Toptica emitter

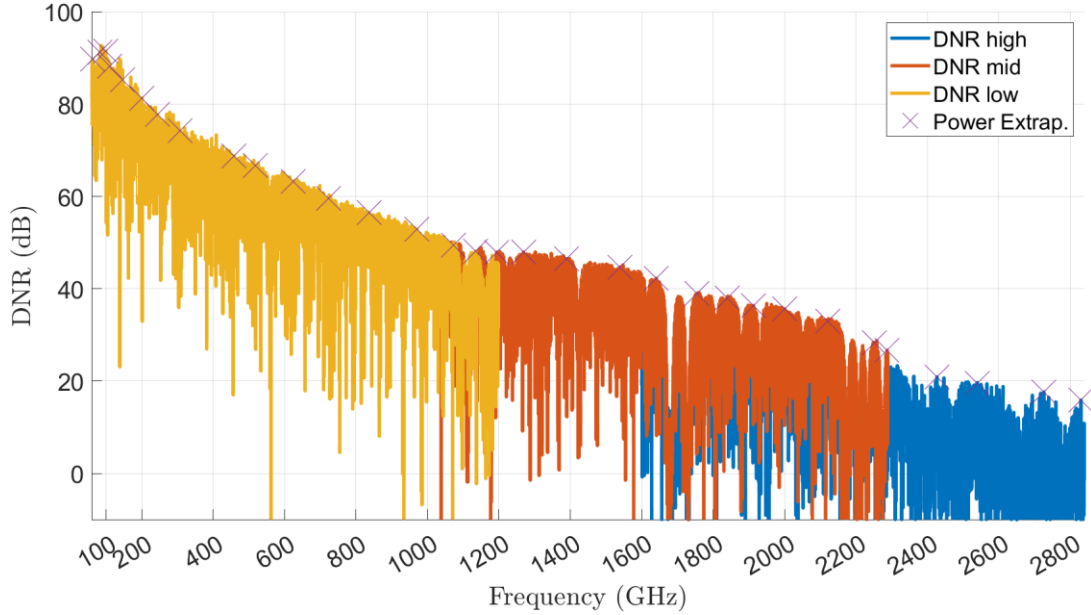


Figure S1: Frequency dependent homodyne Signal-to-Noise Ratio (SNR) for Toptica TeraScan 1550 system for 100 ms integration time. Crosses Figure S 1mark points applied for power extrapolation.

Figure S1 shows frequency-dependent homodyne signal-to-noise ratio (SNR) of the Toptica TeraScan 1550 system for an integration time of 100 ms. The system noise level, $I_{Noise,RMS}$, is determined as the root-mean-square (RMS) value of approximately 1100 independent measurements acquired with the homodyne TeraScan 1550 receiver optically blocked by a metal beam stopper. In unblocked condition, the homodyne system rectifies photocurrent proportional to the incident terahertz electric field ($I_{ph}(\nu) \propto E_{THz}(\nu)$). We calculate homodyne SNR via

$$SNR_{dB}(\nu) = 20 \cdot \log_{10} \frac{I_{ph,RMS}(\nu)}{I_{Noise,RMS}} \quad (1)$$

As shown in Fig. 1, the available terahertz power decreases exponentially with increasing frequency. Owing to this strong decay, reliable power measurements using a PTB-calibrated pyroelectric detector (THz 10 HS, vendor: SLT GmbH, calibrated by Physikalisch-Technische-Bundesanstalt (PTB, Braunschweig, Germany)) were feasible in the frequency range from 100 GHz to 730 GHz, yielding a measured power of 290 nW. Towards higher frequencies, the terahertz power was extrapolated based on the frequency-dependent $SNR_{dB}(\nu)$ determined from the homodyne measurements. For higher frequencies, the available terahertz power was estimated by extrapolation based on the frequency-dependent signal-to-noise ratio $SNR_{dB}(\nu)$ derived from our homodyne photomixer measurements (summarized in Figure S2). The blue markers represent the data points employed for this extrapolation, chosen to avoid the influence of pronounced water vapor absorption lines at ambient pressure and humidity.

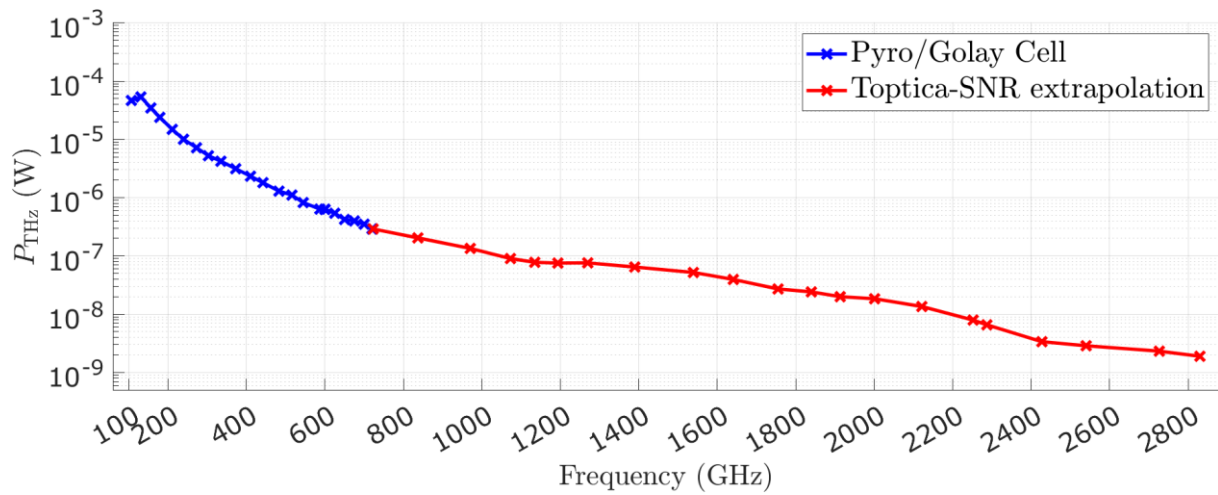


Figure S2: Experimental data points taken with Pyroelectric detector/Golay cell (blue). Final power reference based on photomixer-emitter roll-off extrapolation up to 2.85 THz only including power at the respective frequency due to homodyne mixing process.

Modulation bandwidth of applied thermal emitter

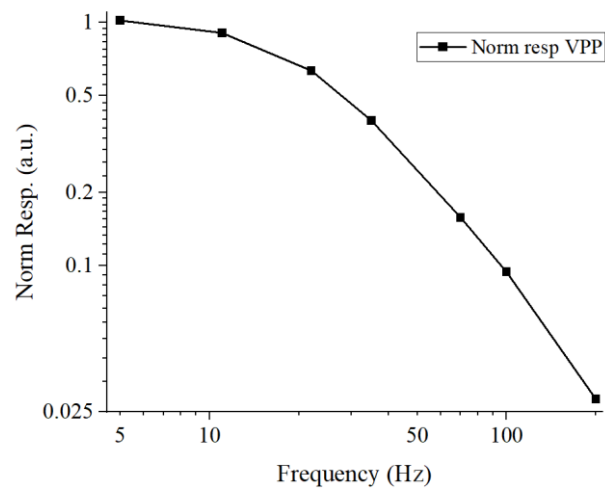


Figure S3: Bode-Plot of the thermal emitter's frequency response while being modulated with 50%-Duty Cycle (square-)pulses at the respective modulation frequency (Thermal emitter: INTX17-0900, vendor: Laser Components GmbH). For comparability reasons, a pyroelectric detector (THz 10 HS vendor: SLT Sensor- und Lasertechnik GmbH, calibrated power-detector (Physikalisch Technische Bundesanstalt (PTB), Germany) was applied for this measurement. At 11 Hz, the modulation depth is around 90 % compared to a mechanical chopper, while only 10 % modulation depth remains at 100 Hz.

Application of B05 detector for imaging of a 2.5 THz QCL-focal plane

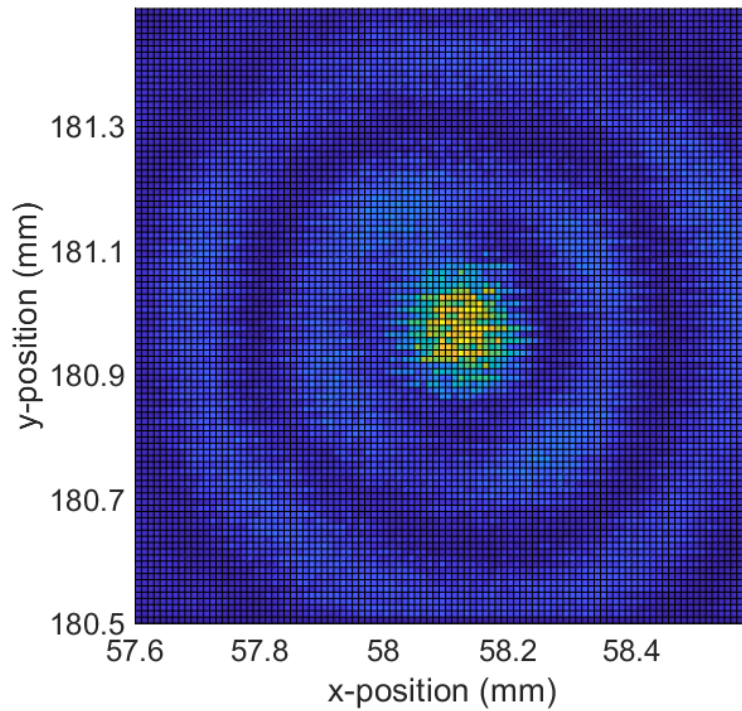


Figure 4: Data generated using B05 detector (without Si-lens) to scan across a $1 \times 1 \text{ mm}^2$ section of a 2.5 THz-QCL's focal plane operated in 1 kHz pulsed mode (stepsize in x and y direction $10 \mu\text{m}$). The integration time was chosen with 50 ms.

Standing wave in cw-system

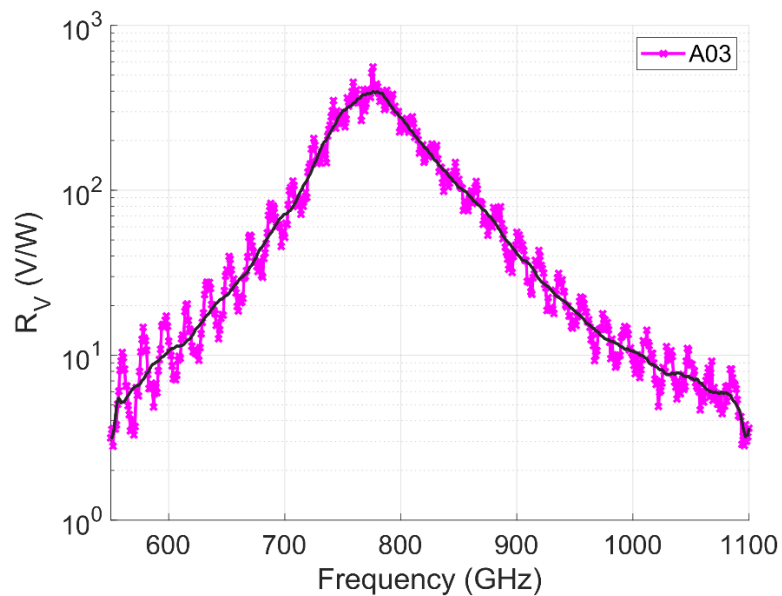


Figure 5: Zoomed-in raw data for A03 detector indicating the strong standing wave contributions within the cw-system.