Quantum-Cascade Laser emission at 3.5 THz from dual diagonal feedhorns

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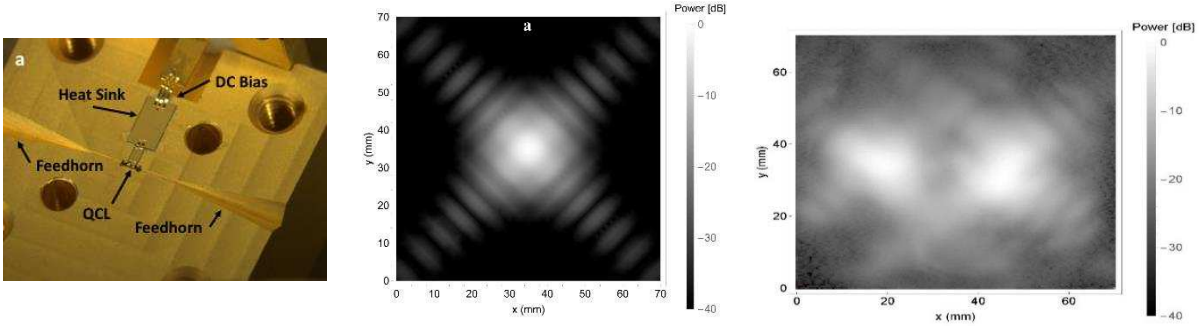
The LOCUS satellite (Linking Observations of Climate, the Upper Atmosphere and Space weather) is a proposed mission to explore and observe key gas species within the upper atmosphere using a novel terahertz-frequency (THz) heterodyne spectrometer, in which the emission spectra are simultaneously recorded in four channels in the 0.8–4.7-THz band [1]. THz quantum-cascade lasers (QCLs) will be exploited as local oscillators for the first time in space because they are powerful, yet compact THz sources, providing > 1-mW continuous-wave output at key LOCUS frequencies (3.5 and 4.7 THz). Furthermore, they have been integrated successfully into precision-micro-machined waveguide blocks and operated in space-qualified Stirling-cycle cryo-coolers (~60 K) [2]. A key development challenge will be stabilising the emission frequency of the QCL by locking it to a stable reference oscillator.

In this paper, we present a new QCL dual-feedhorn integration technique, which advances this goal by enabling access to radiation emitted from both facets of the QCL simultaneously. In this configuration, the THz emission may be coupled simultaneously to a mixer and to a stabilisation subsystem. Figure 1(a) shows the integration of a 3.5-THz QCL into a precision micro-machined channel in a copper block. A second, symmetrical copper block is placed on top of this to form a rectangular waveguide around the QCL, with a diagonal feedhorn at either end. Figure 1(b) shows the simulated far-field beam pattern for a single feedhorn at 3.5-THz, in which the maximum collected power is represented in the bright central area. Figure 1(c) shows the experimental results for the dual-feedhorn waveguide block, in which the radiation from each horn is reflected onto the same plane, and measured using a raster-scanned Golay-cell detector. Good agreement with the simulated single-feedhorn emission has been observed, with similar beam width and side-lobe content.

In conclusion, the integration of a 3.5-THz QCL into a dual-feedhorn waveguide block has been demonstrated. This opens the way towards simultaneous integration of the QCL with a frequency stabilisation system and a supra-THz mixer.



(a) (b) (c)

Figure 1 (a) QCL mounted within a dual-feedhorn waveguide block (b) Simulated beam-profile for the emission from a single feedhorn, (b) QCL emission beam-pattern obtained experimentally from dual-feedhorn waveguide block.

References

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[2] A. Valavanis et al., 'Mechanically robust waveguide-integration and beam shaping of terahertz quantum cascade lasers', Electron. Lett., vol. 51, no. 12, pp. 919–921, Jun. 2015.