Operation of a THz quantum-cascade laser in a compact mechanical cryocooler

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***Abstract*—A major challenge for heterodyne receivers operating above approximately 2 THz is the local oscillator, which has to be a compact source requiring little electrical input power and providing sufficient output power not only for a single mixer but for an array of mixers. THz quantum-cascade lasers (QCLs) have the potential to comply with these requirements. The laser itself is only a few mm long, and the cooling system which is necessary for operation of the QCL determines the mass and power budget. So far, the smallest QCL-based THz source weighs approximately 15 kg [1].**

We report on the development of a compact, easy-to-use source, which combines a QCL operating in a very compact, low-input-power linear Stirling cooler (model AIM SL400). The cooler has been optimized for this application. The QCL is based on a bound-to-continuum design similar to the one reported in Ref. [2]. Special care has been taken to achieve a good thermal coupling between the QCL and the cold finger of the cryostat. The cryocooler with the QCL weighs less than 4 kg. The QCL operates on a single mode at 2.5 THz, and its output power is approximately 0.15 mW. With an appropriate optical beam shaping, the emission profile of the laser becomes a fundamental Gaussian one. We will present the performance of this THz source and discuss perspectives for improvements and applications.

[1] H. Richter, M. Greiner-Bär, S. G. Pavlov, A. D. Semenov, M. Wienold, L. Schrottke, M. Giehler, R. Hey, H. T. Grahn, and H.-W. Hübers, Opt. Express 18, 10177–10187 (2010).

[2] S. Barbieri, J. Alton, H. E. Beere, J. Fowler, E. H. Linfield, and D. A. Ritchie, Appl. Phys. Lett. 85, 1674 (2004).