# Beam patterns of distributed feedback surface-plasmon THz quantum cascade lasers

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*Abstract*— **The beam patterns are known to be crucial for coupling the radiation to a mixer. Here we report the first beam pattern measurements of 3.4 THz DFB surface plasmon QCLs.**

*Index Terms*— **Beam pattern, THz DFB QCL, and Surface plasmon QCL,**

THz quantum cascade lasers (QCLs) become the choice of solid-state local oscillators (LO) beyond 2 THz because of their frequency coverage, compactness, high power efficiency, and narrow linewidth. They have been successfully demonstrated as LO in laboratory's tests using a wideband black body source (a hot/cold load)[1]. Until now only QCLs based on Fabry-Perot cavity have been investigated as LO, including their beam patterns. However, to perform a heterodyne spectroscopic measurement, QCLs with a stable single–mode emission at a precisely designed wavelength are desirable. For this purpose, distributed feedback (DFB) QCLs are required.

Here we report the first beam pattern measurements of [3.4] THz DFB surface plasmon QCLs. The beam patterns are known to be crucial for coupling the radiation to a mixer.

The QCLs used are developed by University of Neuchâtel [2]. The active region is based on a bound-to-continuum design, while the DFB structure is based on strongly coupled surface grating fabricated with wet etching and metal coverage. Two QCLs with a ridge width of 100 μm or 200 μm have been studied and both lase in single-mode at 3.4 THz. To measure the far-field beam patterns, we use a similar setup as for the metal-metal waveguide QCLs 3] but with a reduced surface area of the pyroelectric detector to improve the angular resolution. We found that the beams follow nearly the diffraction limit, if measured with a poor angular resolution and a coarse scanning. However, we observed the interference patterns, characterized by a strong modulation in the intensity with a (intensity) minimum in the pointing direction of the laser, if measured with a relatively high angular resolution and a fine scanning. We also notice that the interference patterns behave in a very much different way as in metal-metal waveguide QCLs[3,4] suggesting a different physical origin.

We will also demonstrate an experimental approach to eliminate the interference effect.

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