Optical beatnote detection of a portable THz QCL comb by direct microwave mixing onto an Hot-electron bolometer

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Frequency combs based on quantum cascade lasers [1] have gained attention as efficient, compact on-chip sources in the Mid-IR and THz regions. THz comb devices, thanks to their broadband double-metal waveguides, can provide wide coherent bandwidths covering more than 1 THz [2,3]. The full potential of frequency combs can be exploited by coupling them to high performance fast detectors capable of high frequency detection (>15 GHz) [4] in a dual comb scheme [1] or in SWIFT spectroscopy [5], where the THz signal is demodulated at the repetition rate (i.e. intermodal spacing) of the comb by measuring the optical beatnote.
Hot Electron Bolometers are extremely sensitive detectors and they are vastly employed in astronomical observations to map THz lines with a very high spectral resolution [6]. At the same time, such devices feature an intrinsically wide electrical bandwidth, making them appealing for applications in the THz range where the quest for high-speed detectors has been boosted by renewed interest in the field of ultrafast THz physics and frequency comb technology.
We present optical beatnote detection from a narrow, planarized THz QCL comb [7] operating at 80 K in a small nitrogen-cooled dewar. The 21.6 GHz comb beatnote is detected by downconversion, directly mixing free-space signals from the QCL and a microwave synthesizer onto an NbN HEB optimized for RF frequencies and downconverting it to a >3 GHz bandwidth. In Fig.1the RF signal at 840 MHz measured from the bolometer results from the mixing of the carrier wave at 20.8 GHz and the optical beatnote of the QCL that is then equal to 21.640 GHz. The setup constitutes a very convenient platform for the study of QCL-based optical frequency combs and a building block for compact, portable frequency comb fast spectrometers.

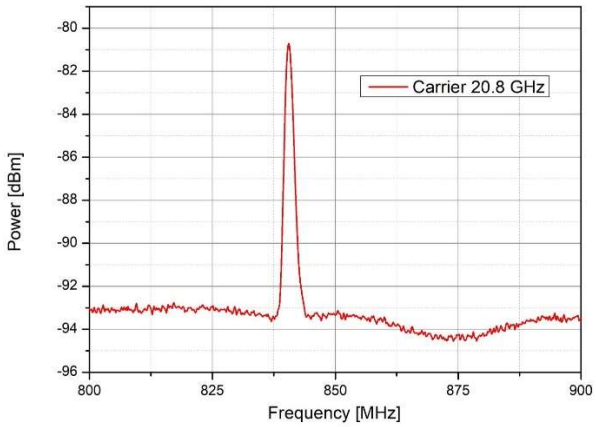

Figure 1. The RF signal measured from the bolometer results from the mixing of the carrier wave at 20.8 GHz and the optical beatnote of the QCL

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