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litz, F. Lackner and W. E. Ernst
, *Austria*

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CONDENSED MATTER

(COND)

COND SESSION I 14:00-15:30 TUESDAY, SEP 11 **HS P2**

COND-1 TALK 14:00-14:15 TUESDAY, SEP 11 HS P2

QWIPs and QCDs for RF

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Optical frequency combs were initially developed in the near infrared region, based on fundamentally mode-locked lasers. Nowadays, large efforts are being made to bring frequency comb technology into the mid-infrared spectral region with a similar degree of maturity. Typical Fabry-Perot QCLs have cavity lengths between 2 and 6 mm resulting in a repetition frequency around 10 GHz. One needs therefore detectors with a bandwidth larger than the repetition frequency to investigate the locking mechanism of the QCLs. In 2006 it was shown that photovoltaic quantum cascade detectors (QCD) show a comparatively flat frequency response up to 4 GHz limited only by the circuit used to contact the detector [1]. With this principle, it was already demonstrated that mid-IR detectors based on intersubband transitions can cover up to 30 GHz of bandwidth [2].

We demonstrate the connection of the QWIP to commercial available RF connectors with a coplanar waveguide. By calculating the gap width of the CPW as function of the center conductor while trying to maintain the characteristic impedance of 50 Ohm, it is possible to suppress reflections due to impedance mismatches. We examined the frequency response of the QWIP by injecting an AM radiofrequency signal into the microwave CPW and sweeping the carrier frequency . The measurement of the rectified signal reveals a cut-off frequency around 10 GHz. Furthermore, we show that it is possible to measure the RF beatnote created by the beating of the Fabry-Pérot modes of a 4 mm long interband cascade laser with an SNR exceeding 15 dB using our RF QWIP at 80 K . We report on a single-period QCD with a room-temperature quantum efficiency of 40 percent and a responsivity of 0.86 A/W [3]. The frequency cut-off around 500 MHz is high enough to cover the highest frequency of the multiheterodyne beatings.

[1] Hofstetter D., Graf M., Aellen T., Faist J., Hvozdara L., & Blaser S. (2006). 23 GHz operation of a room temperature photovoltaic quantum cascade detector at 5.35 μm. *Applied physics letters*, **89**(6), 061119.

[2] Liu H. C., Li J., Buchanan M., & Wasilewski Z. R. (1996). High-frequency quantum-well infrared photodetectors measured by microwave-rectification technique. *IEEE journal of quantum electronics*, **32**(6), 1024-1028

[3] Schwarz,B, Reininger P., Harrer A., MacFarland D., Detz H., Andrews A.M., Schrenk W. and Strasser G. (2017). High-frequency quantum-well infrared photodetectors measured by microwave-rectification technique. *Applied Physics Letter*, **111** (6) 1024-1028