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Free Space Optical Communications using Quantum Cascade Lasers

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Mid-Wave Infrared (MIR) free-space optical communications offer multiple advantages, such as improved transmission capacity through the atmosphere and immunity to electromagnetic interference. MIR transmission between 8 and 12-micron provides low visibility, stealth for the communication signal thanks to the random thermal blackbody radiation having a strong background at these wavelengths, hence greatly reducing the probability of adversaries intercepting a MIR laser signal. To achieve this goal quantum cascade lasers (QCL) are unipolar semiconductor lasers operating in the MIR domain from which stimulated emission is obtained via electronic transitions between discrete energy states inside the conduction band. This seminar reports a full unipolar quantum optoelectronics communication system using a 9-micron externally modulated QCL with a Stark modulator. Two different detectors are considered namely an uncooled quantum cascade detector (QCD) and a nitrogen-cooled quantum well infrared photodetector (QWIP). We evaluate the maximum data rate of our link in a back-to-back (B2B) configuration before adding a multi-pass Herriott cell so as to increase the transmission length of the light path up to 31 meters. By using pulse shaping, pre- and post-processing, we reach a record bitrate of 40 Gbps for both 2-level (OOK) and 4-level (PAM-4) modulation scheme for a 31-meter propagation link and a bit error rate (BER) compatible with standard error-correction codes.

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Frédéric Grillot is Full Professor at Télécom Paris (France) and a Research Professor at the University of New-Mexico (USA). His research interests include advanced quantum confined devices such as quantum dots lasers and light-emitters based on intersubband transitions, non-classical light, nonlinear dynamics and optical chaos in semiconductor lasers systems as well as microwave and silicon photonics applications. He has served diligently and successfully Optica in particular as an Associate Editor of Optics Express, now as a Deputy Editor since September 2022. He has published more than 130 journal articles, 3 book chapters, and delivered many invited talks in major international conferences and workshops. Frédéric Grillot is a Fellow Member of the SPIE, Senior Member of Optica and the IEEE Photonics Society. In 2022, he received the IEEE Photonics Society Distinguished Lecturer Award.

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