European Semiconductor Laser Workshop

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Programme and Abstracts

Sponsors

applied sciences

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1) Institut FEMTO-ST, Université Bourgogne Franche-Comté CNRS UMR 6174, Besançon, France
2) Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

14:15 - 14:30 **Weight Adjustable Photonic Synapse by Non-Linear Gain in a Vertical Cavity Semiconductor Optical Amplifier**

Juan A. Alanis, Joshua Robertson, Matěj Hejda, and Antonio Hurtado
Institute of Photonics, Dept. of Physics, University of Strathclyde, Glasgow, UK

14:30 - 14:45 **Oxide-Confined vs. Buried Tunnel Junction VCSELs**

A. Gullino[,1], S. Pecora[1], A. Tibaldi[1,2], F. Bertazzi[1,2], M. Goano[1,2], P. Debernardi[2]*
1) Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
2) CNR-IEIIT, Corso Duca degli Abruzzi 24, 10129 Torino, Italy

14:45 - 15:00 **1.5 GHz VECSEL-based Laser System for Ultrafast Multicontrast Nonlinear Imaging**

Thibault A.G Bondaz[1,2], R. Jason Jones[1], Jerome V. Moloney[1] and John G. McInerney[2]*
1) Wyant College of Optical Sciences, University of Arizona, 85721 Tucson, USA
2) Department of Physics and Tyndall Institute, University College Cork, Cork, Ireland

15:00 - 15:15 **Break (15min)**

Session III - Frequency Combs & Semiconductor Laser Applications
Chaired by Prof. Mariangela Gioannini

15:15 - 15:45 **Frequency-modulated combs in quantum cascade lasers: origins and opportunities (Invited talk)**

Prof.David Burghoff
University of Notre Dame, USA

15:45 - 16:00 **Measuring the Linewidth Enhancement Factor during Frequency Comb Operation**

Nikola Opačak[1,], Florian Pilat[1], Dmitry Kazakov[1,2], Sandro Dal Cin[1], Georg Ramer[3], Bernhard Lendl[3], Federico Capasso[2], Gottfried Strasser[1] and Benedikt Schwarz[1,2]*
1) Institute of Solid State Electronics, TU Wien, Gusshausstrasse 25-25a, 1040 Vienna, Austria
2) John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts
3) Institute of Chemical Technologies and Analytics, TU Wien, Getreidemarkt 9/164, A 1060 Vienna, Austria

16:00 - 16:15 **Gain-switched Optical Frequency Combs with comb spacing down to 5 MHz**

Measuring the Linewidth Enhancement Factor during Frequency Comb Operation

Nikola Opačak[1*], Florian Pilat[1], Dmitry Kazakov[1, 2], Sandro Dal Cin[1], Georg Ramer[3], Bernhard Lendl[3], Federico Capasso[2], Gottfried Strasser[1] and Benedikt Schwarz[1, 2]

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Abstract: The linewidth enhancement factor (LEF) is known as an important property of semiconductor lasers. Recently, it is gaining more interest due to its key role in frequency comb operation. However, as of yet existing techniques to measure the LEF are limited to sub-threshold bias or single-mode operation. Here, we introduce a novel and universally applicable method to directly obtain the spectrally resolved LEF of a running laser frequency comb. The technique utilizes a phase-sensitive single shot measurement scheme. We derive a theoretical model, which is investigated by extensive Maxwell-Bloch simulations and demonstrated in an experiment on a quantum cascade laser.

1. Introduction

Semiconductor frequency comb lasers are compact, electrically pumped sources of coherent light that find application in areas such as high-precision spectroscopy for medical and chemical sensing. The linewidth enhancement factor (LEF) is well-established in the theoretical description of such lasers and plays a key role in understanding dynamic processes like laser linewidth broadening, modulation response and comb dynamics and even soliton formation [1,2]. Therefore, the knowledge of its value is of utmost importance. Previously experimental investigation was limited to measurements below the lasing threshold or single-mode operation.

2. Model description, experimental setup

Here we present a novel modulation technique which enables the measurement of the LEF of an arbitrary, running laser source [3]. In the case of a frequency comb we can infer the LEF over the whole laser spectrum in a single-shot measurement. This is enabled by a phase-sensitive measurement scheme called "Shifted Wave Interference Fourier Transform Spectroscopy" (SWIFTS) [4] and the modulation of the driving current. This modulation leads to small sidebands at each of the comb modes. A sketch of the experimental setup can be seen in Fig. 1a. An RF-optimized quantum well infrared photodetector (QWIP) is used to record the beatings of the laser modes with their modulation sidebands. The theoretical model is investigated vastly using numerical simulations of a spatio-temporal model based on Maxwell-Bloch formalism [5]. Then the method is demonstrated experimentally on a quantum cascade laser frequency comb.

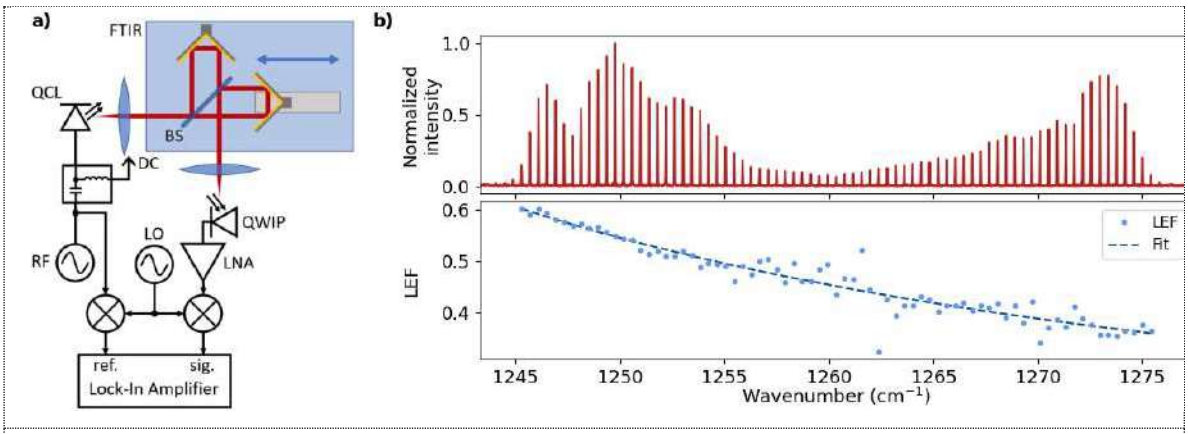

Figure 1: a) Experimental Setup, b) Laser comb spectrum (top), Spectrally-resolved LEF with fit (bottom)