K 2: Laser Technology and Applications (joint session Q/K)

Time: Monday 11:00–12:30 Location: HS V

K 2.1 Mon 11:00 HS V

Simulation of Optically Induced Electrical Picosecond Pulses on Coplanar Waveguides Using PySpice — •Sophie-Luise Hachmeister and Heiko Füser — Physikalisch Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

The generation and characterization of optically induced electrical picosecond pulses is vital for the calibration of high-frequency electrical devices. Coplanar waveguides (CPWs) are commonly employed as platform for the generation, propagation and utilization of these pulses. While experimental techniques have been extensively explored, a notable gap persists in accurately simulating the pulse propagation characteristics. This work aims to address this shortcoming by developing a simulation framework utilizing PySpice, an open-source circuit simulation library in Python. The proposed model simulates the generation and propagation of picosecond pulses on CPWs, incorporating optical input parameters, the electrical properties of the CPW, and the characteristics of connected devices. To validate the framework, the simulation results are benchmarked against experimental measurements. Initial findings demonstrate a strong correlation between simulated and observed pulse dynamics, underscoring the model*s capacity to replicate the physical behavior effectively. By bridging the gap between experimental observations and computational simulations, this work offers a powerful tool detailing on high-frequency signal generation and enhances the understanding of optically induced electrical pulses. Future research will expand on these findings by exploring novel experimental setups and adapting the simulation model accordingly.

K 2.2 Mon 11:15 HS V

Generation of high power cw UV radiation using elliptical focusing enhancement cavities — •Jens Gumm, Denise Schwarz, and Thomas Walther — TU Darmstadt

Long term cw laser operation with high output power in the UV spectral range is of great interest in many scientific and commercial applications.
Generation of cw-UV light is often realized by resonant second harmonic generation employing β-Barium Borate (BBO) as the nonlinear optical medium. A known parasitic effect in BBO is the degradation of the crystal due to two-photon absorption.
We theoretically showed that elliptical focusing can lead to higher conversion compared to the spherical optimum and significantly decreases the peak intensity in the nonlinear crystal. Experimentally, we demonstrated UV powers in excess of 2.4W with a fundamental power of 14W.

K 2.3 Mon 11:30 HS V

Transportable Pulsed UV Laser System for Bunched Beam Laser Cooling — •Benedikt Langfeld[1,2], Tamina Grunwitz[1], and Thomas Walther[1,2] — [1]TU Darmstadt, Institut für Angewandte Physik — [2]HFHF Campus Darmstadt

Laser cooling of bunched relativistic ion beams has been shown (e.g. at GSI Helmholtzzentrum) to be a powerful technique to generate ion beams with small emittances and narrow longitudinal velocity distributions. For highly relativistic (large γ-factors) and intense heavy-ion beams, laser cooling will be very efficient and cooling times of the order of seconds are expected. For these reasons, laser cooling will be the only available cooling method at the planned heavy-ion synchrotron SIS100 at FAIR.

In this talk, we discuss the principle of bunched beam laser cooling using multiple laser beams. We will give an overview of one of the laser systems that will be used at the SIS100, namely the tunable high repetition rate (1-10 MHz) pulsed UV laser system - with a continuously adjustable pulse duration between 50 and 735 ps and a high average UV power of up to 4 W. Employing a walk-off compensation design with two BBO crystals, the laser frequency can be tuned over a range of 3.4 THz in the UV.

K 2.4 Mon 11:45 HS V

Integrated Quantum Dot Comb Laser for Three-dimentional Imaging — •Marjan Shojaei, Stephan Amann, and Nathalie Picque — Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Berlin, Germany

Holography is a powerful technique for lensless three-dimensional imaging. It is an interferometric imaging technique that allows to measure phase and amplitude simultaneously. In digital holography, the image acquisition is done with a digital camera sensor, and a computer performs the process of image reconstruction. By using a frequency comb, we do not get a single image as would be the case with a continuous-wave laser, but there are multiple images corresponding to the individual comb lines. This allows to reconstruct the phase over a large unambiguous distance with high accuracy. Here, we assess the potential of quantum dot comb lasers for applications in miniaturized three-dimensional imaging systems. Our quantum-dot comb laser spans over 5nm around the central wavelength of 1310nm with a flat-top spectral distribution and a line spacing of 80 GHz. Due to its large line spacing and turn-key operation, quantum dot lasers are promising comb sources for an application in miniaturized three-dimensional imaging systems and could allow to measure the phase profile of macroscopic objects with interferometric precision.

K 2.5 Mon 12:00 HS V

THz frequency combs for traceable 6G channel characterization — •Adam Kuchnia, David Humphreys, Nora Meyne, and Heiko Füser — Physikalisch Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

Traceable characterization of communication systems operating in the 6G frequency range is currently limited by the availability of measurement equipment traced back to primary SI standards. A solution is provided via photoconductive antennas (PCAs) in combination with THz frequency combs, utilized to directly down-convert free-space THz RF signals to baseband. Traceability is ensured by referencing the THz frequency comb to an atomic clock. Within this work, the PCA antenna performance within the 6G frequency range is investigated. CST-Microwave-Studio-based simulations are performed to analyze existing designs and to suggest optimized structures. Channel characterization is realized by measurement of free-space THz RF signals and analyzing amplitude and phase dependency over a wide frequency range. A comparison to the expected antenna behavior is provided. This approach opens new possibilities for THz measurement, including traceable detection of CW and RF-modulated waveforms and channel sounding.

K 2.6 Mon 12:15 HS V

How to generate XUV frequency combs with only 10 W? — •Muhammad Thariq[1,2], Johannes Weitenberg[1,3], Francesco Canella[4,5], Gianluca Galzerano[5], Theodor W. Hänsch[1,2], Thomas Udem[1,2], and Akira Ozawa[1] — [1]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany — [2]Fakultät für Physik, Ludwig-Maximilians-Universität München, 80799 Munich, Germany — [3]Fraunhofer-Institut für Lasertechnik ILT, 52074 Aachen, Germany — [4]Dipartimento di Fisica, Politecnico di Milano, 20133 Milan, Italy — [5]Istituto di Fotonica e Nanotecnologie - Consiglio Nazionale delle Richerce, 20133 Milan, Italy

The extreme ultraviolet (XUV) frequency comb (FC) is a vital tool for extending optical frequency metrology into the unexplored wavelength range below 200 nm. However, generating XUV FCs via high harmonic generation (HHG) often demands very high peak intensities. This typically requires an enhancement resonator, where a circulating average power of 10 kW leads to heating and damage issues.

In this work, we propose using a low repetition rate FC to drive single-pass HHG. By reducing the repetition rate by three orders of magnitude with an AOM-based pulse picker while maintaining a high peak power and a frequency comb structure, the average power is decreased proportionally. We have generated high harmonics from a 40 kHz-repetition rate FC with a peak power of 140 MW and pulse width of 35 fs. The results demonstrate the feasibility of generating XUV FCs with average powers below 10 W, making them more accessible to researchers across disciplines.