Title: High power laser-driven Terahertz sources

Abstract: Terahertz Time Domain Spectroscopy (THz-TDS) has become a ubiquitous tool in many scientific fields and is also increasingly deployed in industrial settings. While these systems become more and more mature, efficient, and lab-based THz generation methods combining broad bandwidth and high dynamic range (e.g., as provided by high THz average power and correspondingly high repetition rate) remain rare. Most industrial THz-TDS systems make use of semiconductor-based photoconductive emitters and receivers. These systems offer record-high dynamic range operation at very high repetition rates of hundreds of MHz, and the corresponding emitters provide high conversion efficiencies with low power excitation, driven by compact ultrafast fiber-lasers. For applications where strong-fields are desired, the most commonly used technique is optical rectification in nonlinear crystals, for instance zinc telluride (ZnTe), gallium phosphide (GaP), lithium niobate (LiNbO3) or organic crystals (e.g., BNA, DAST, DSTMS). Whereas all these techniques have seen continuous performance progress in the last few years driven by different application fields, their average power has mostly remained low. A promising route is simply to increase the average power of the driving lasers using state-of-the-art, high-average power ultrafast Yb-gain based lasers providing multi-100-W to kilowatt average-power levels as excitation sources, which are increasingly available both in laboratory setting and commercially. This new excitation regime for THz generation in various schemes has become an active area of research in the last few years, and current results have allowed to reach power levels in the THz domain in the multi-ten to multi-hundred milliwatts in different repetition rate regions – which was previously restricted to accelerator facility-type THz sources. This progress opens the door to a multiplicity of new and old research areas to be re-visited. In this presentation, we review recent progress in the generation of high-average power THz-TDS. We will present the state-of-the-art of high-power ultrafast laser sources with potential for driving THz sources, current technological challenges in scaling THz average power, and applications areas that could potentially benefit from these novel lab-based sources.

Short CV: Clara Saraceno is a full professor at the Ruhr University Bochum, Germany. She was born in 1983 in Argentina. In 2007 she completed a Diploma in Engineering and an MSc at the Institut d'Optique Graduate School, Paris France. She first worked as an engineering trainee at Coherent Inc. Santa Clara, California, until 2008. She then completed a PhD in Physics at ETH Zürich in 2012 where she carried out research on high-power ultrafast disk lasers. From 2013-2014, she worked as a Postdoctoral Fellow at the University of Neuchatel and ETH Zürich, Switzerland, where she worked on high-flux XUV generation via high harmonics generation. In 2016, she received a Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation and became Associate Professor of Photonics and Ultrafast Science in the Electrical Engineering Faculty at the Ruhr University Bochum, Germany, followed by a full professorship in the same university since 2020.

Prof. Saraceno's research interests are in the development of high-power ultrafast laser systems and their application in driving secondary sources via nonlinear optics. One of her current main research areas is THz technology and spectroscopy, where her group aims to achieve high average power level broadband THz radiation.

She has received a number of prizes and awards including the ETH Medal for Outstanding PhD thesis (2013), the European Physical Society Quantum Electronics and Optics Division PhD prize in applied aspects (2013), the Sofja Kovalevskaja Award of the Alexander von Humboldt (2016), an ERC Starting Grant (2018) and the SPIE Harold E. Edgerton Award for High-speed Optics (2024). She was elected Fellow of Optica (formerly the Optical Society) in the 2022 class.