Photonics and Ultrafast Laser Science

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Integrated photonics for next-generation terahertz and millimeter wave classical and quantum applications

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ABSTRACT

Integrated photonic platforms have seen tremendous progress over the last years, benefitting applications spanning the entire electro-magnetic spectrum [1]. Yet, terahertz science and technology have leveraged surprisingly little of the design flexibility and miniaturization capabilities offered by integrated photonic circuits [2]. While photoconducting emitters have been integrated within terahertz transmission lines for on-chip spectroscopy [3,4,5], the optical beams remained free-space, complicating signal delivery and read-out, leading to cross-talk and ultimately impacting the signal-to-noise ratio and maximal bandwidth. This slow progress complicates research in materials and fundamental sciences where miniaturization would enhance light-matter interaction through increased vacuum fields, or enable sensing within sub-wavelength volumes compatible with low-dimensional materials.

In this talk, I will discuss our recent efforts in generating, controlling, and detecting millimeterwave and terahertz radiation within a single photonic chip realized in thin film lithium niobate [6,7, 8]. I will show that the platform supports generation and detection of terahertz transients beyond 3 THz, alongside with increased capabilities in routing, filtering and cavity-control that benefit both classical [9, 10] and quantum applications.

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ABOUT THE SPEAKER

Cristina Benea-Chelmus is a Tenure Track Assistant Professor in Engineering at EPFL since January 2022.

She leads the Hybrid Photonics Laboratory which develops hybrid electronic-photonic chips for both applied and fundamental sciences. Her research interfaces millimeterwave and terahertz signals with optical ones, aiming to provide innovative solutions for high-capacity communications, millimeterwave quantum circuits, chip-based sensing and time-domain ranging technologies.

Prior to her appointment, she was a Postdoctoral scientist at Harvard, leading efforts on tunable metasurfaces, supported by the Hans-Eggenberger Foundation and the Swiss National Science Foundation. She received her Ph.D. in 2018 from ETH Zurich on quantum metrology of vacuum field fluctuations, for which she received multiple recognitions, and studied at KIT, Germany until 2013.