Cristina Benea-Chelmus
Hybrid Photonics Laboratory (HYLAB), EPFL, Switzerland

Millimeterwave integrated photonic circuits

Integrated electro-optic modulators are essential building blocks in terabit-per-second communication, tunable frequency combs, high-end instrumentation, optical computers, and distributed quantum networks. Many of these applications now demand operation at extended millimeterwave and terahertz frequencies. However, achieving power-efficient terahertz-speed modulators, or electro-optic frequency combs with frequency spacings of 100s of gigahertz, is extremely challenging due to increased losses in the integrated photonic circuits, coaxial cables, terahertz probes, and their interfaces. Here, we demonstrate that wireless signal delivery is effective at these extended frequencies and eliminates the need for fragile and costly terahertz probes and cables. Our design features an on-chip terahertz antenna that couples signals from free space to an on-chip transmission line [1]. The antenna mimics an on-chip terahertz signal generator with tailored impedance. We achieve spectrally flat electro-optic modulators with efficiencies. Taking advantage of the large bandwidths of our modulators, we demonstrate coherent mmWave detectors with 6~GHz electronic bandwidth and frequency-agile electro-optic frequency combs [2] with adjustable line spacings of 123~GHz and 308~GHz, spanning 2 THz, paving the way for high-data rate 6G communications and femtosecond pulse generators with 100s of GHz repetition rates.

References

[1] Y. Lampert et al. https://arxiv.org/abs/2406.15651
[2] A. Gaier et al. https://arxiv.org/abs/2505.04585