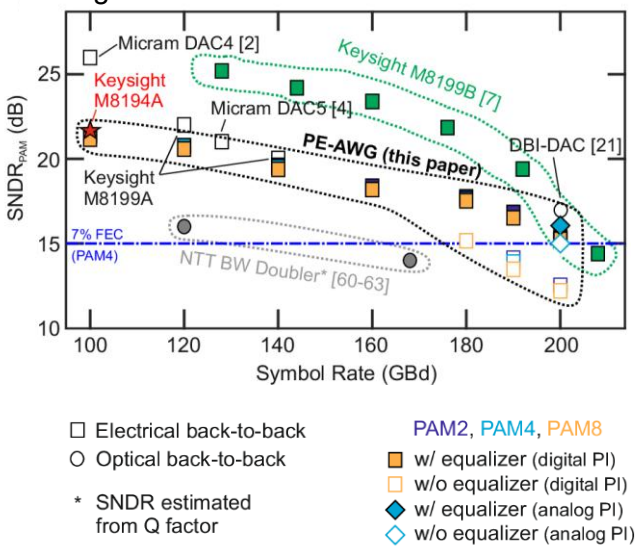
Bachelor / Master Thesis:

Photonic-electronic arbitrary-waveform generator (PE-AWG) using a single-photodiode down-converter

Karlsruhe Institute of Technology

Photonic-electronic signal processing is a highly promising approach to overcome the bandwidth scaling bottleneck of conventional electronic systems. In this approach, software-defined waveforms are first generated in the optical domain, where the extremely high optical carrier frequency enables the generation of ultra-broadband signals. By subsequently performing opto-electronic down-conversion, electrical signals with significantly larger bandwidth and potentially improved signal quality can be obtained. Previous demonstrations (see Fig. 1) have employed an optical local oscillator (LO) together with a balanced photodetector to down-convert the generated optical signal. To ensure coherent conversion, an active phase stabilization scheme is typically required. In this project, we explore the possibility of simplifying the architecture by using a single photodiode.

Fig. 1



SNDR$_{PAM}$ levels achieved for generating PAM waveforms at various symbol rates with the PE-AWG and with several other waveform generators, comprising both commercially available AWGs as well as other research-type waveform generators.

Source: C. Füllner et al., "Photonic-electronic arbitrary-waveform generation using quadrature multiplexing and active optical-phase stabilization," Nature Communications 16, 8318 (2025)

Your tasks:

- Simulate the system and analyze its performance
- Investigate the theoretical limits of the achievable signal quality
- Develop and implement a suitable system calibration method
- Perform experimental characterization and verification of the system

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