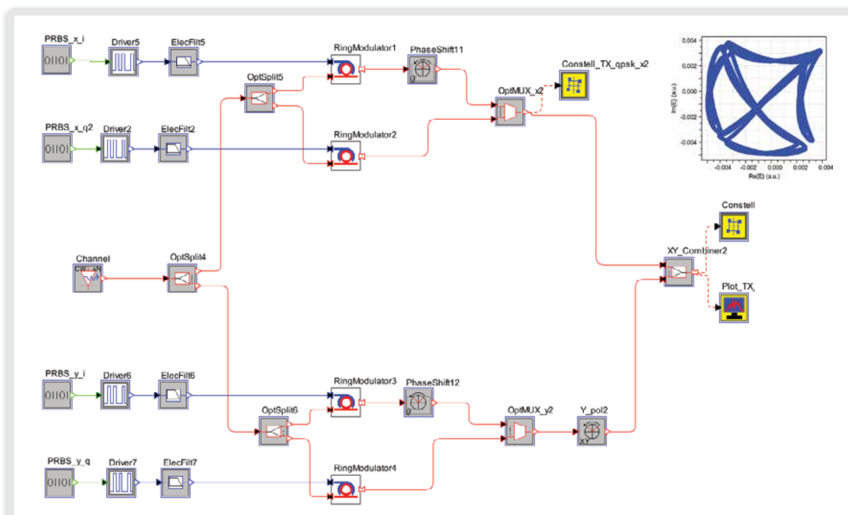
Application Case Study

RSoft OptSim Circuit

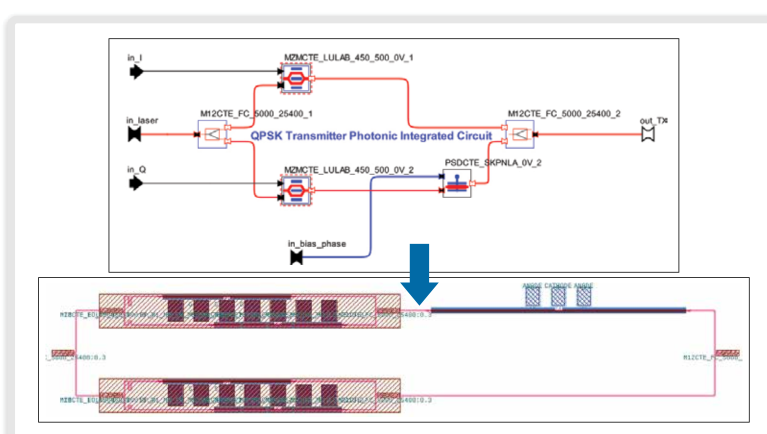
Design Automation of Next-Generation Photonic Integrated Circuits (PICs)

Features At-a-Glance

- Extends OptSim's system modeling capabilities to include single- and multi-stage bidirectional PICs
- Comes with foundry process design kits (PDKs), including IMEC
- Provides mask layout via Luceda Photonics' IPKISS
- Models travelling-wave Mach-Zehnder modulators, silicon photonic ring resonators and modulators
- Models multipath interference (MPI) from network and PIC elements
- Includes library of PIC elements such as bidirectional waveguides, bidirectional couplers and connectors, light sources, modulators and photo diodes
- Supports co-simulation with MATLAB, reusable user-defined components and compound components
- Provides an intuitive GUI and options for exporting data
- Comes with powerful options for data visualization, plotting and management of project resources



Synopsys' OptSim™ Circuit tool provides an ideal platform for modeling optical systems and PICs that operate with coupling and feedback of different optical and electrical signal paths. The graphical user interface (GUI) included with our award-winning OptSim tool offers a more natural user experience to test and optimize performance of PICs at the system level.



Schematic to mask layout

OptSim Circuit Simulation of Travelling-Wave Mach-Zehnder Modulator (TW-MZM) and Impact of Silicon Photonic Foundry Process Variations

This OptSim Circuit application case study illustrates the simulation of a travelling-wave Mach-Zehnder modulator-based transmitter PIC, as well as analysis of its performance due to wafer-to-wafer (WFW) and run-to-run (RTR) variations in the multi-project wafer (MPW) runs[1]. One of the bottlenecks in current high-speed fiber-optic systems is lack of efficient modulators that can support data rates of 40 Gbps and above. To achieve wider bandwidths, travelling-wave electrodes are required in the MZM design. For efficiency, speed and power consumption reasons, these electrodes require impedance and velocity matching, as well as low loss.

Figure 1 shows the OptSim Circuit topology of the TW-MZM using IMEC foundry PDK elements for the photonic components, and transmission line elements for the RF electrodes. A back-to-back receiver is used to estimate the performance of the transmitter chip. The travelling wave nature of the modulator makes it sensitive to reflections due to impedance mismatch in the travelling wave electrodes. This application case study focuses on the performance impairments due to the impedance mismatches as a result of WTW and RTR variations at the foundry. Figure 2 shows the effect of the impedance between the electrode and the load on the modulator's extinction ratio as measured from the optical eye at the modulator. The extinction ratio varies from as low as 1 dB to as high as 8 dB. Figure 3 shows the impact in terms of back-to-back bit-error-rate (BER).

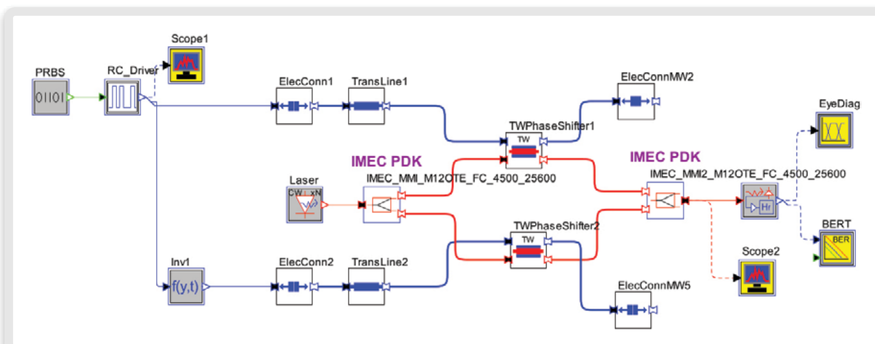


Figure 1. OptSim Circuit topology of TW-MZM

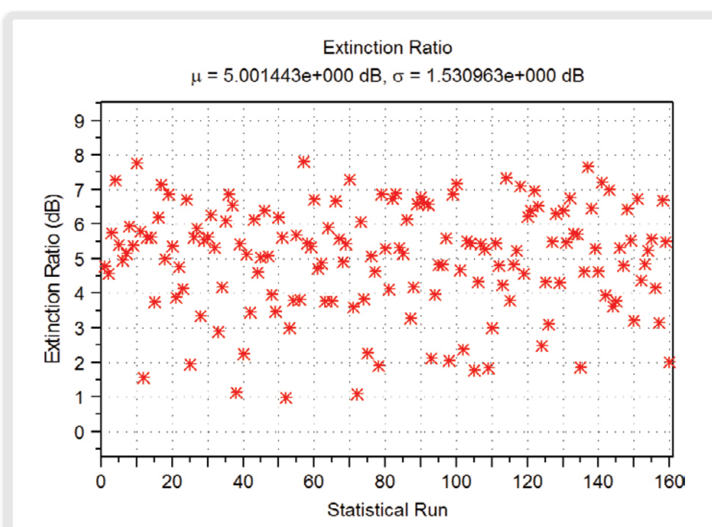


Figure 2. Distribution of extinction ratio

[1] J. Patel, E. Ghillino, C. Xu, D. Herrmann, and E. Heller, "Silicon photonic foundry processes and travelling-wave Mach-Zehnder modulators," Novus Light Technologies Today, Nov. 2015, http://www.novuslight.com/silicon-photonic-foundry-processes-and-traveling-wave-mach-zehnder-modulators_N4838.html

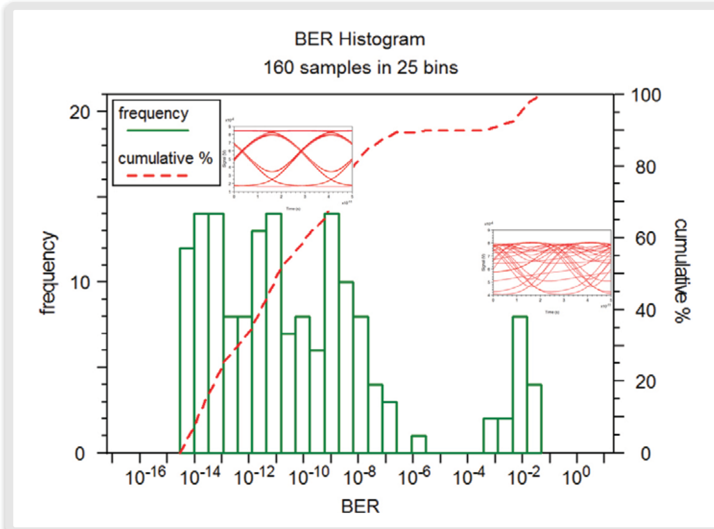


Figure 3. Distribution of back-to-back BER

As this case study demonstrates, it is important to take into account tolerances in the fabrication process, since it not only helps photonic foundries estimate the yield, but also helps system and chip designers understand the performance bounds.

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