

TOPIC OF A COMPETITION PROMOTING STUDENT ENGAGEMENT IN SCIENTIFIC ACTIVITIES

Topic: Photonic Integrated Circuits for Next-Gen Optical Communication
Goal: To investigate how integrated photonics can enhance high-speed, energy-efficient data transmission in the age of AI and cloud computing.
Short description (max. 2000 characters): The exponential growth of data traffic driven by AI and cloud services requires new solutions for faster and more energy-efficient communications. Photonic integrated circuits (PICs) are at the forefront of this effort. Students will begin by conducting a literature review of silicon photonics and indium phosphide technologies, identifying bottlenecks in modulators, detectors, and coupling structures. They will then design and simulate a simple waveguide-based link using open-source tools such as MEEP (FDTD) or MPB to study confinement and propagation loss. Using Python/Octave, students will create a system-level link budget to estimate achievable data rates and energy/bit trade-offs. The final stage involves comparing integration strategies (pluggable optics vs. co-packaged optics) and making recommendations for future data centers. Tools and Materials: MEEP (FDTD), MPB, Python/Octave, literature (Nature, IEEE, OSA). Desired Background: Fundamentals of Photonics/Optical Communications, Semiconductor Devices, Introductory Programming (Python/Octave). <i>Suitable for a third or fourth -year Bachelor or Master student.</i> References: - Shekhar, S., et al. (2024). Roadmapping the next generation of silicon photonics. Nature Communications. doi:10.1038/s41467-024-44750-0 - Zhou, X., et al. (2024). Silicon photonics for high-speed communications and photonic signal processing. Nature Communications Engineering. doi:10.1038/s44310-024-00024-7
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