

INVERSE-DESIGNED PHOTONIC BUILDING BLOCKS FOR SCALABLE CLASSICAL AND QUANTUM OPTICAL SYSTEMS

Student scientific and professional competition **2026**

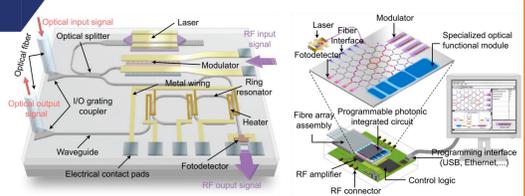
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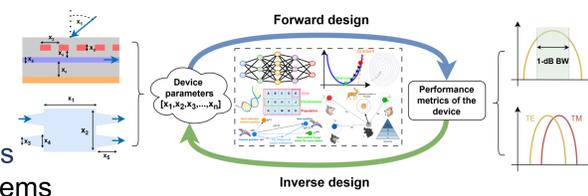
Integrated photonics

- Ultra-compact circuits
- Low-cost manufacturing
- Compatibility with CMOS
- Integration with electronics
- Wide application range



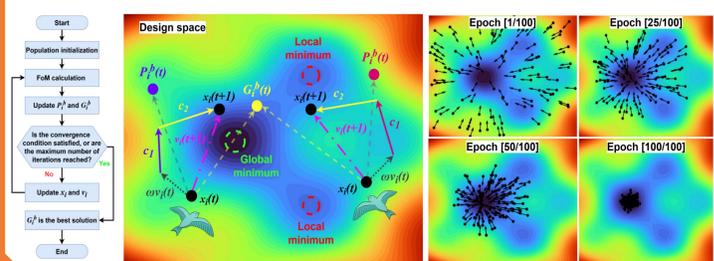
Inverse design

- Reduced computational overhead
- Accelerated development cycles
- High degree of design automation
- Efficient exploration of design spaces
- Scalability to high-dimensional problems



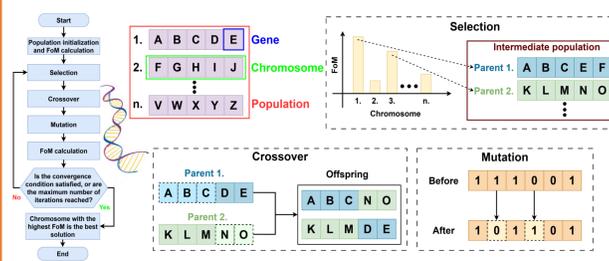
Particle Swarm Optimization (PSO)

- Swarm-based algorithm where particles update solutions using individual and global best information



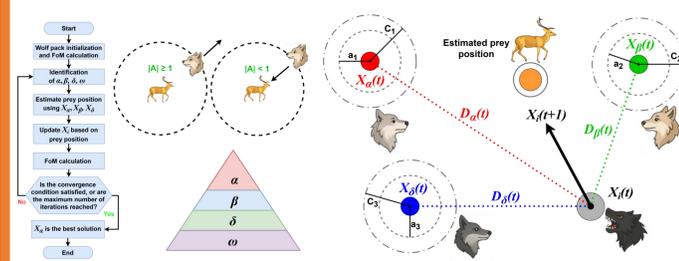
Genetic Algorithm (GA)

- Evolutionary algorithm based on natural evolution and genetic operators such as selection, crossover, and mutation



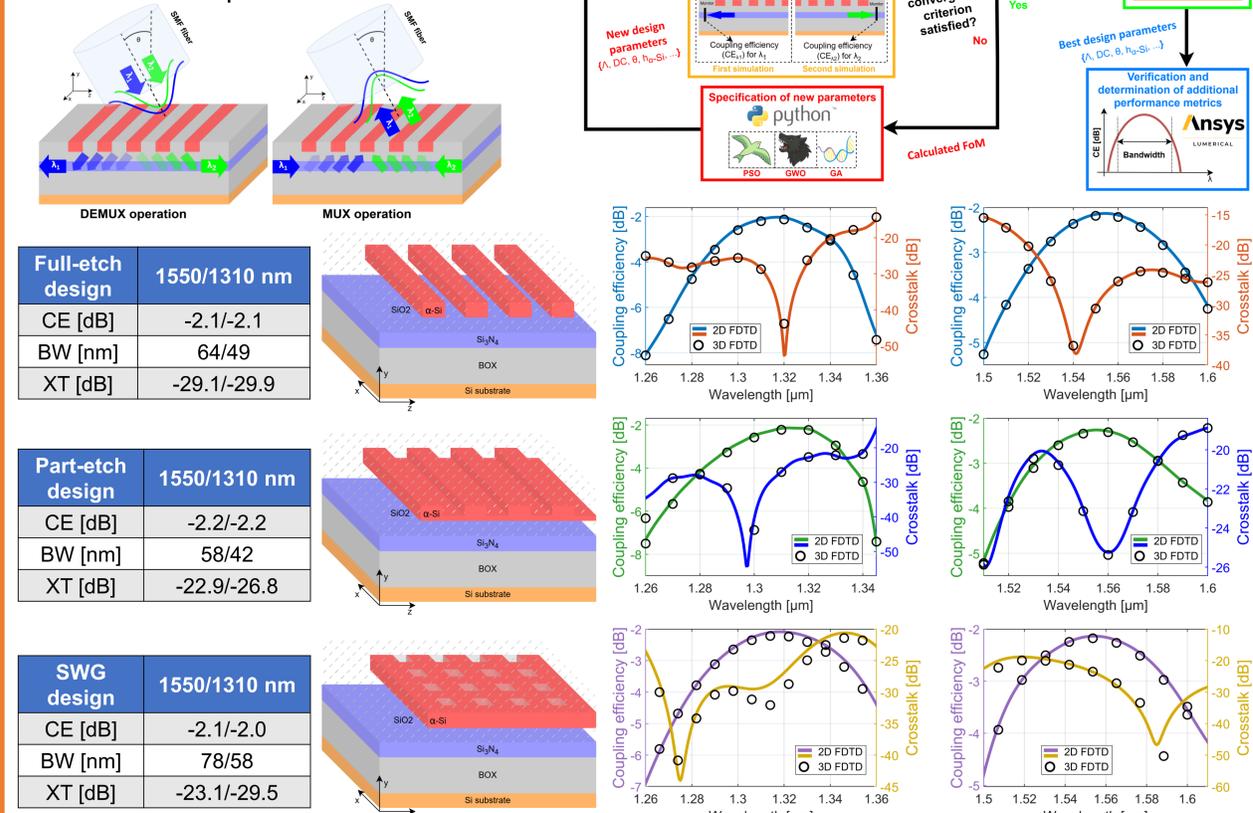
Gray Wolf Optimization (GWO)

- Population-based algorithm inspired by grey wolves' hunting strategy and leadership hierarchy



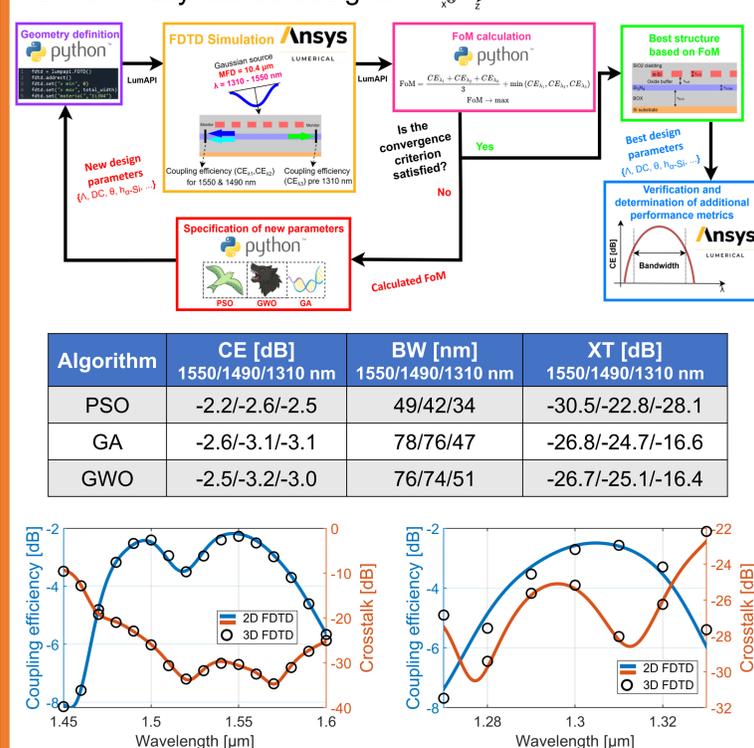
Dual-band grating couplers

- Target wavelengths: 1550 & 1310 nm
- Hybrid platform (Si₃N₄ + α-Si)
- MUX/DEMUX operation



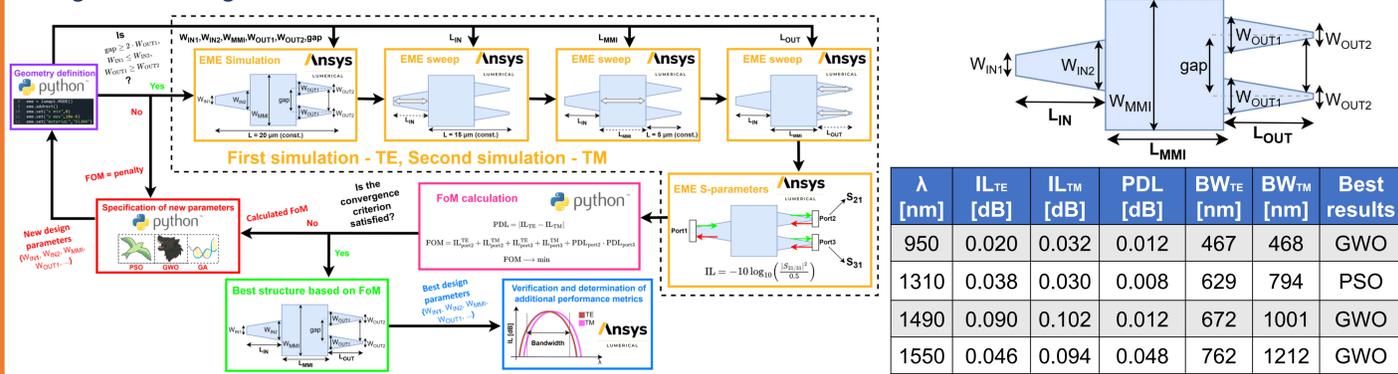
Triple-band grating couplers

- Target wavelengths: 1550 & 1490 & 1310 nm
- Hybrid platform (Si₃N₄ + α-Si)
- MUX/DEMUX operation
- Uniform fully-etched designs



Polarization independent MMI 1 × 2 power splitters

- Standard Si₃N₄ platform
- Target wavelengths: 1550/1490/1310/950 nm



Future work

Neural network exploration

Scalability and adaptation

Publishing results

Device fabrication

Supervisor: Ing. Daniel Benedikovič, PhD.

References:
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 [2] M. Abd Elaziz, et al., "Cooperative meta-heuristic algorithms for global optimization problems", Expert Systems with Applications, 2021
 [3] S. Miao, et al., "Inverse Design for Silicon Photonics: From Iterative Optimization Algorithms to Deep Neural Networks", Applied Sciences, 2021
 [4] A. Petrovič, et al., "Inverse-designed grating couplers for hybrid silicon nitride photonics using metaheuristic methods", Journal of the Optical Society of America B, 2025
 [5] A. Petrovič, et al., "Metaheuristic optimization of hybrid silicon nitride grating couplers", Proceedings of SPIE, 2025

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