# Write Field Optimization for Photonic Neuromorphic and AI Systems

M. Lipkin(1, 2), J. Kaur(1), G. Vydrevich(1, 2), M. Möller(1), J. Bolten(1), R. Thomas(1), S. Suckow(1), M. C. Lemme(1,2)

(1) AMO GmbH, Otto-Blumenthal-Str. 25, Aachen 52074, Germany
(2) Chair of Electronic Devices, RWTH Aachen University, Otto-Blumenthal-Str. 25, Aachen 52074, Germany

Large-scale silicon photonic circuits (PICs) are emerging as a promising platform for energy-efficient information processing, neuromorphic computing, and photonic AI hardware [1]. Such architectures rely on long optical paths and accurate phase control, making them highly sensitive to fabrication induced phase errors and optical propagation losses. Electron-beam lithography (EBL) is widely employed for the fabrication of PICs due to its high resolution and direct-write capability. To pattern large circuit layouts, EBL divides the design into adjacent write fields. While smaller write fields increase the number of stitching boundaries in between the write fields, larger write fields reduce their density but increase local lithographic deviations at their boundaries [2]. The resulting trade-off between stitching density and stitching magnitude has remained largely unexplored. To investigate this effect, silicon waveguides were fabricated with write field sizes ranging from 80 µm to 480 µm and characterized using the nondestructive cutback method. Propagation losses were found to increase systematically with write field size. The smallest write fields exhibited the lowest losses per unit length, despite introducing the largest number of write field boundaries. Across two nominally identical fabricated wafers, propagation losses increased from approximately 0.6 dB/cm for 80 µm write fields to about 1.0 dB/cm for 480 µm write fields at 1550 nm optical wavelength. These results indicate that the magnitude of local lithographic deviations dominates over the density of stitching boundaries. The presented findings provide practical design guidelines for reducing losses in phase-sensitive silicon photonic circuits relevant to neuromorphic PICs.

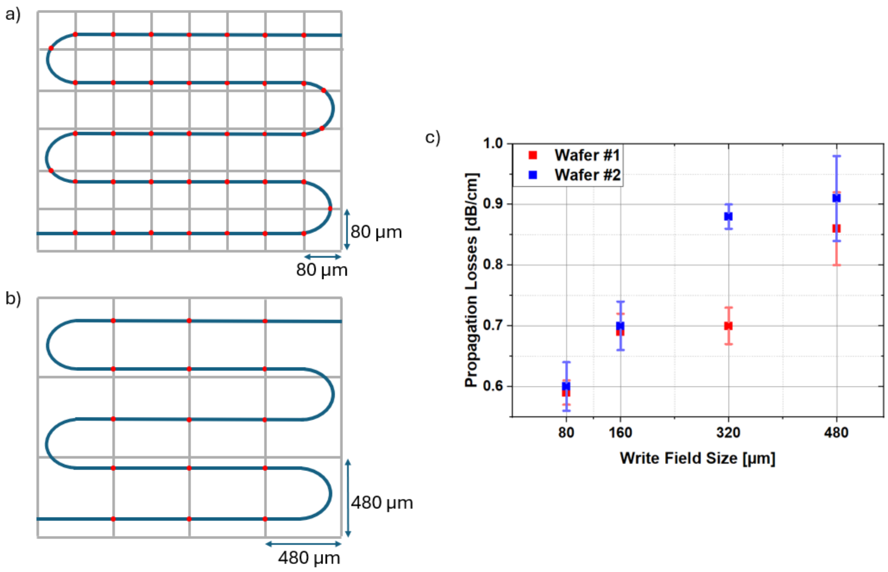


Figure 1: Comparison of waveguide layouts written using 80 µm × 80 µm (a) and 480 µm × 480 µm (b) electron-beam write fields. Red markers denote crossings between the optical waveguides and write-field boundaries. (c) Measured propagation losses as a function of write field size for two nominally identical wafers.

[1] R. Li et al., Adv. Mater., 37, 2312825, 2025.

[2] A.L. Bogdanov et al., J. Vac. Sci. Technol. B, 30, 031606, 2012