Institute of Applied Physics
Friedrich-Schiller-Universität Jena

Finding the refractive index profile of optical waveguides using machine learning

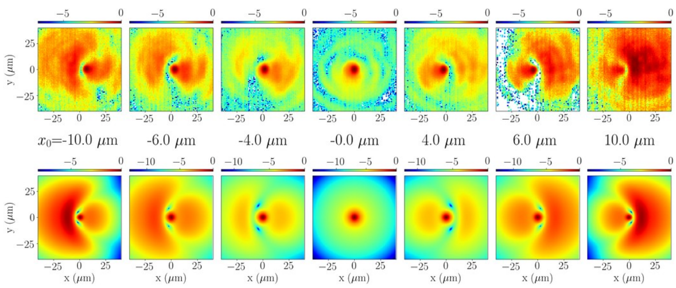
Theme / Problem definition:

Dielectric optical waveguides are one of the pillar in modern optics. Although their theoretical description is well established, from the experimental side is very complicated to get an accurate measurement of the refractive index profile in the case of graded index (GRIN) structures. The most accurate measurements require a geometry requiring the phase matching, thus permitting the accurate measurement of the propagation constant. Direct measurement of the guided modes are often inaccurate due to the intrinsic sensitivity to noise of algorithm based upon the inversion of the Helmholtz equation.

Tasks / Aim:

We are looking for a motivated and self-driven candidate who will work in the area of physically informed machine learning (PINN). The aim of the project is to realize and train a neural network capable of finding the refractive index of the waveguide once the intensity profile at the output of the waveguide is provided.

- Design and training of a PINN taking the fundamental mode and providing the refractive index of the corresponding waveguide.
- Adding artificial noise to the PINN.
- Generalization to the case of a multi-modal waveguide.
- Application to the real case of laser-written waveguides.
- Preliminary knowledge of machine learning is not required, but it could strongly help.
- Knowledge in Python is desirable.



Output field measured (top row) and computed (bottom row) intensity profile at the output of a short laser-written waveguides in silicon. Each panel corresponds to a different shift of the input beam.

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Literature:

- *White, J.M., and Heidrich, P.F., 1976. Optical waveguide refractive index profiles determined from measurement of mode indices: a simple analysis. Applied Optics, 15(1), pp. 151-155*
- *Alberucci, A., Alasgarzade, N., Chambonneau, M., Blothe, M., Kämmer, H., Matthäaus, G., Jisha, C.P., and Nolte, S. 2020. In-depth optical characterization of femtosecond-written waveguides in silicon. Physical Review Applied, 15(10), p. 024078.*
- *Alberucci, A., Jisha, C.P., and Nolte, S., 2019. Determining the waveguide profile using the overlap integral. The European Conference on Lasers and Electro-Optics, paper cj_p_73.*