MT-FIMMPROP *layout and simulation in one environment*

NEW!

Multi-Topology (MT) FIMMPROP is an innovative new design environment from Photon Design.

Combining the roles of layout and simulation, MT-FIMMPROP does away with the frustrating need to shuttle between two design environments.

Interested in giving MT-FIMMPROP a try? Please get in touch to find out more!

Key benefits

- ☑ A flexible **layout editor** that allows you to construct arbitrary photonic circuits via masks and lithographic processes.
- ☑ **Computational regions** specifying any subset of the PIC that needs to be simulated - greatly improving the speed and efficiency of calculations.
- ☑ Featuring FIMMPROP's market leading **eigenmode expansion engine** (EME method), allowing you to simulate the optical performance of an entire PIC without the compromises of traditional multi-tool approaches.
- ☑ No more swapping back and forth between layout and schematic environments - everything can be done in the unified environment.
- ☑ Single environment shortens designer's learning curve over traditional approach.
- ☑ Simulation of full PIC in a physical layout allows effects such as cross-talk to be readily accounted for.
- ☑ **Field visualisation**. The field profile of either the entire device or individual output ports of the device can be observed directly in the layout view.
- ☑ A **scanner interface** is provided for easily scanning over up to two design parameters.
- ☑ An extensive **command-line interface** that supports Python and MATLAB scripting.
- ☑ Other physical effects such as heating, wafer stresses, wafer scale variations, can be naturally included in the environment and coupled to the optical circuit simulation (future version).
- ☑ One click export to **GDSII** for mask manufacture.

☑ Ring Resonators

Large ring resonators provide an example where significant efficiency gains are to be had by using computational regions that conform to the waveguides in the device. In the double ring resonator example shown in Figure 1, where the radius of each ring is 30μm, it is only the red hashed computational regions that are included in the simulation. As such, we avoid having to unnecessarily include the large areas in the centre of the rings in the computation.

Moreover, using computational regions that conform to the waveguides means that the number of modes required in each computational region is **minimised**.

This double ring resonator also takes advantage of MT-FIMMPROP's ability to **re-use s-matrices** of repeated components to improve efficiency. The bus-ring coupling region is modelled as a building block, whose s-matrix only has to be calculated once and can then be re-used wherever the building block is referenced.

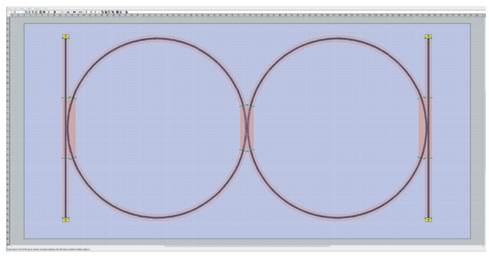

Figure 1: Two 30μm-radius ring resonators in series.

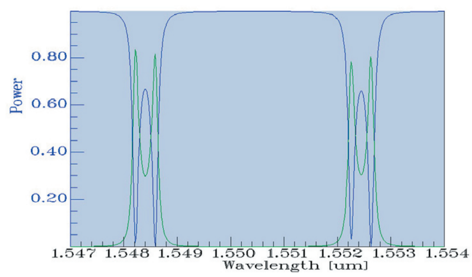

Figure 2: Transmission and coupling vs wavelength for the two-ring resonator depicted in Figure 1.

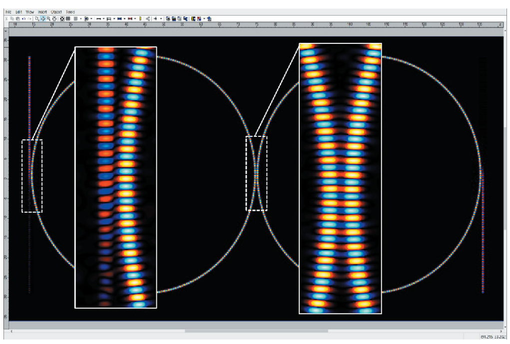

Figure 3: Plot of Hy for the two-ring resonator depicted in Figure 1 on injecting the fundamental mode into the port at the top left of the device at a wavelength of 1.55262 μm. Insets show enlargements of the bus-ring and ring-ring coupling regions.

Scanning over the wavelength using the built-in scanner interface, we can look at the transmission from the port at the top left of the device to the port at the bottom left and the coupling from the port at the top left to the port at the bottom right (Figure 2).

Based on these results, taking a wavelength of 1.55262 μm we can plot the Hy field for the whole device on injecting mode 1 into the port at the top left of the device as shown in Figure 3.

MT-FIMMPROP

☑ Mach-Zehnder Interferometer

Long-arm Mach-Zehnder Interferometers (MZIs) are another example of the sort of structures that can now be modeled using MT-FIMMPROP.

In the figure below MT-FIMMPROP is used to model an interleaver design proposed by Cherchi et al. that is based on cascaded MZIs and multimode interferometers (MMIs) as power splitters.

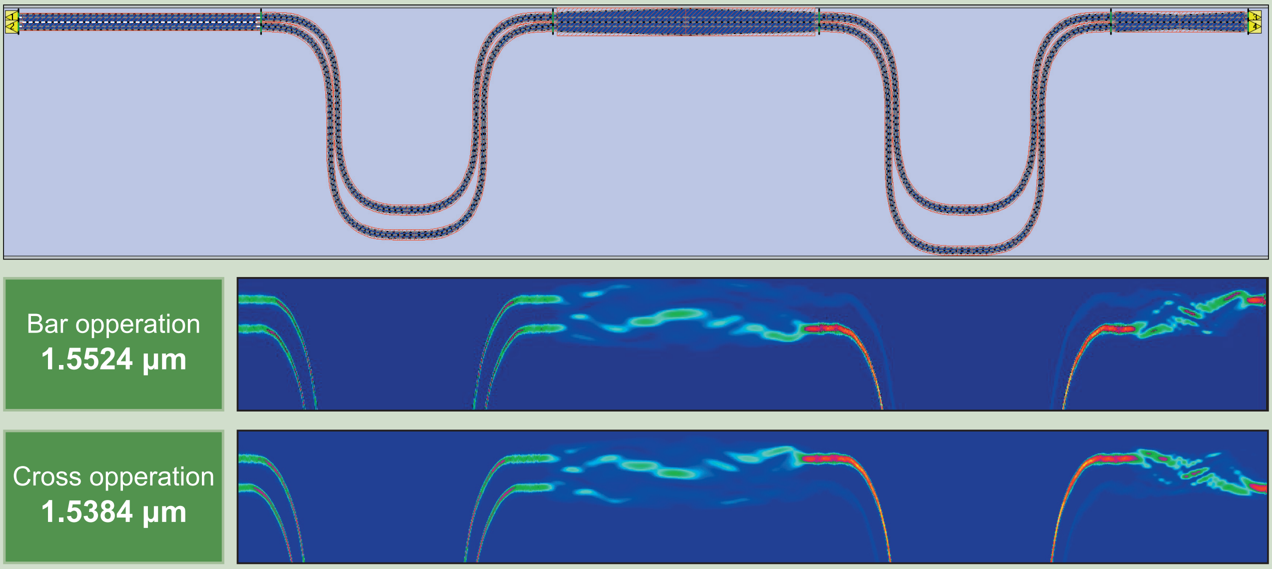

Figure 4: Top: Schematic of a cascaded MZI interleaver with MMI power splitters. **Middle:** The field through the device at 1.5524 µm. **Bottom:** The field through the device at 1.5324 µm.

Using the built-in scanner, we can obtain the response of the device shown to the right. We see that the design has a flat-top response, improving on the sinusoidal response of a simple MZI design.

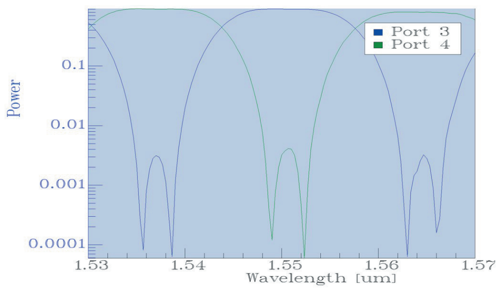

Figure 5: Flat-top response of the cascaded MZI interleaver.

M. Cherchi et al, *Flat-top interleavers based on single MMIs,* (2020) [*https://arxiv.org/abs/2002.07521*]

Eigenmode Expansion Method (EME)

MT-FIMMPROP engine is based on the **EME method**, inheriting all the advantages associated with that method:

- ☑ **Rigorous**: The EME method provides a rigorous solution to Maxwell's equations and MT-FIMMPROP has a selection of fully vectorial mode solvers.
- ☑ **Bi-directional**: The EME method is bi-directional, allowing internal reflections to be taken into account.
- ☑ **Wide Angle Capacity**: Provided sufficient modes are included it is possible to model wide angle problems.
- ☑ **Fast**: The EME method is semi-analytical and allows propagation along the length of a waveguide to be calculated accurately and near-instantaneously once the modes of the waveguide have been found. This means that scans over design parameters that only affect the lengths of waveguides can be performed very quickly.
- ☑ **Efficient**: Once the s-matrix of a circuit has been calculated we can obtain the output for any desired input. In addition, if a certain component appears multiple times within a circuit then its s-matrix only has to be calculated once and can then be re-used.

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