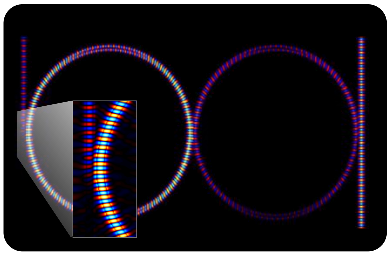
MT-FIMMPROP

Optical Propagation for <u>Multi Topology</u> Waveguide Devices

Simulate **entire** PIC components, and circuits in a layout environment

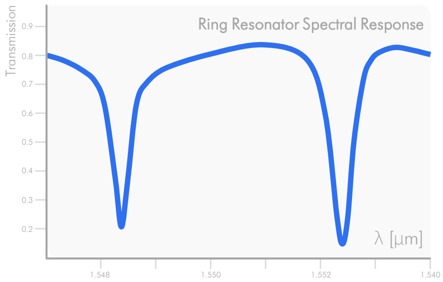
600 um long arm MZI Intensity view.
Less than 10% of canvas is actually simulated.

Add to your FIMMPROP licence | Photon Design



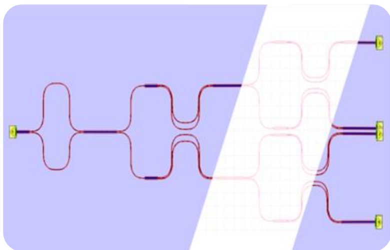
Component Design

The market's longest developed EigenMode Expansion (EME) engine for *<u>3D</u> simulations of waveguide components*.



Circuit Simulation

Combine components to find the response of an *entire* passive waveguide device including *wavelength scans*.



Layout Tool

Create your full device in a layout environment and export to GDS-II with one button.

3 Tools in a <u>Single Environment</u>

- No more switching back and forth between simulation and layout tools.
- Master just one tool instead of three - minimise errors and cut costs.
- Utilise Photon Design's famous EME engine – continuously improving since 1998.
- No compromise to simulation speed in the new environment.

Start your 30 day trial today

Photon Design

Photon Design have been serving the photonics community for over **30 Years** with market leading software for designing passive components, active components, and entire PICs. All of our tools are under continuous development driven by the feedback of our users and their cutting edge research.

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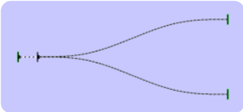
How is MT-FIMMPROP 3 tools in one?

Until now, to design an entire passive PIC device, three tools would be needed:

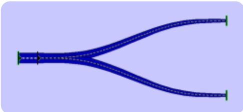
- A Component Simulator - describe coupling regions and devices.
- A Circuit Simulator - connect these simulations together.
- A Layout Tool - describe the geometry of the full device or circuit.

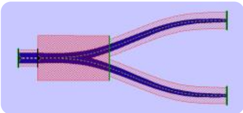
Multi Topology FIMMPROP collects <u>all</u> of these functionalities into <u>one environment</u>.

How it Works



Create an arbitrary path which can be defined by a function including a spline or *Euler bends* as used in this example.





Add an etch mask to define the width and etch depths of your waveguide's ridge in your epitaxy structure. Masks can *also* be expressed as a function to create ***arbitrary tapers***. Waveguides can include tilted sidewalls and corner rounding to match fabricated devices.

Add computational regions to assign areas to be simulated. This includes the conformal *path region* (following the waveguide's shape) or *span regions*, where coupling between waveguides is simulated.

Each computational region is its own simulation utilising FIMMPROP's EigenMode Expansion (EME) engine with <u>no compromise to performance</u>. MT-FIMMPROP then natively combines these rigorous composite simulations to create a scattering matrix of inputs to outputs for the entire photonic integrated circuit.

EME vs FDTD

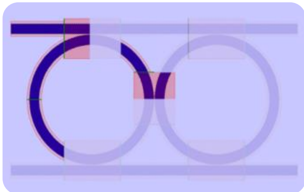
MT-FIMMPROP uses the *EigenMode Expansion (EME)* method that Photon Design have pioneered since 1998.

Rigorous – EME is a rigorous solution to Maxwell's equations. For the devices that it can be applied to, ***there is no reason results should disagree with a correctly formatted FDTD simulation.***

Fast – Simulations along straight/ constant curvature waveguides are calculated *near instantly regardless of length* in most cases as they require only a single mode list.
For EME, the simulation time increases the more unique cross sections in the device compared to FDTD which scales with simulation volume.

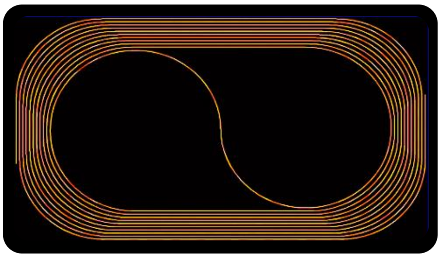
Efficient – Reuse results from previous simulations where parts of the device are unchanged for *fast iterative design and parameter sweeps*.

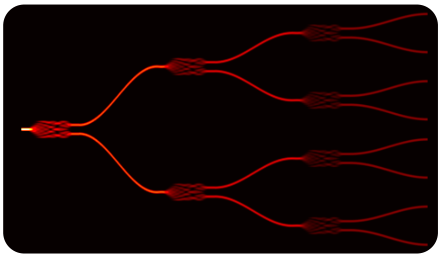
Recycle – *Reduce simulation time* by re-using the result of composite parts of your device which are duplicated multiple times. By exploiting symmetric simulations, periodic components, and repeated entire structures, this can lead to a 10 times or even 100 times simulation speed increase for large scale circuits.
This is <u>not</u> possible in FDTD.

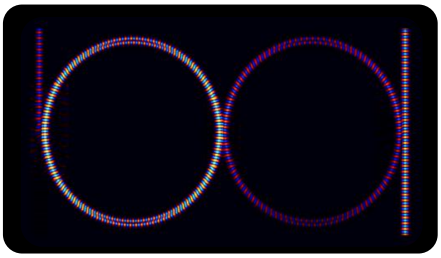


In this double ring resonator, faded regions show areas of the device where simulation results can be reused. Only the non-faded regions are simulated meaning the simulation can be run ~5 times faster.

Applications



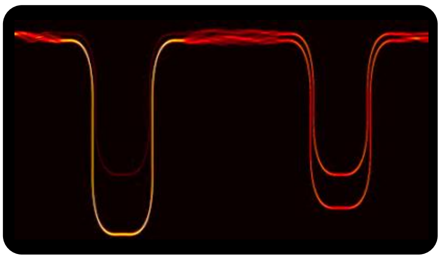




Delay Line – *Made from only constant curvature sections and straight sections, this delay line example can simulate centimetres of optical path length in seconds.*

Cascaded MMIs – *Large efficiency gains are made by recycling simulation results, reducing 7 MMIs and 14 unique bends down to a just a single MMI and just 3 unique bends.*

Ring Resonators – *A wavelength sweep using the native FIMMPROP scanner can highlight the resonant wavelengths with the rings (seen overleaf).*



Long Arm MZI – *Built using Euler bends to minimise losses, this design from Cherchi et al, varies the power output of its two MMI arms based on the wavelength of the input. The device spans 600 um while still simulating on a standard desktop in seconds.*

*Devices such as these can be built, simulated, and optimised by connecting a script (**Python, MATLAB**) to MT-FIMMPROP for integration with your current design flow.*

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

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