Tesselmax.EM

Electromagnetic Simulator for Integrated Optics

Introduction

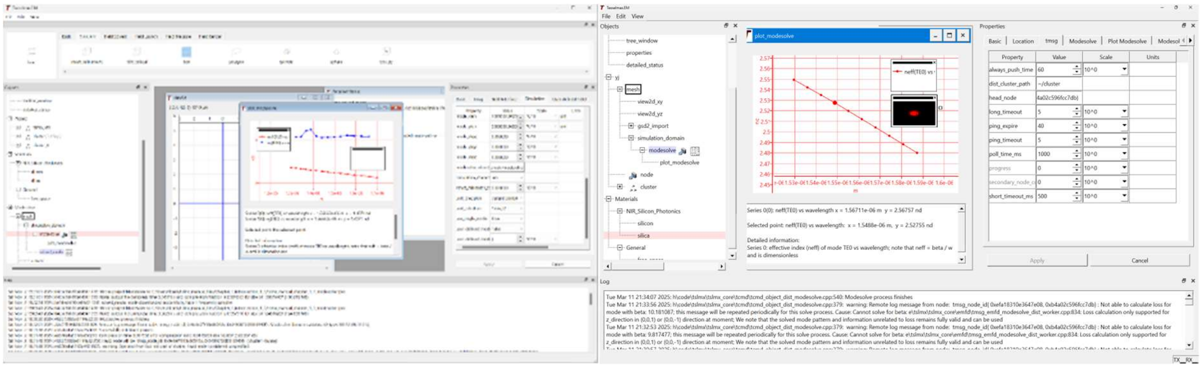
Tesselmax.EM is a design tool that allows the simulation and analysis of integrated optical devices, especially silicon photonics devices. Waveguide mode patterns, dispersion profiles, and component performance can all be modeled in 3D. Designed to seamlessly perform computations in the cloud using the latest AI-optimized hardware, Tesselmax.EM will let you quickly reach closure on your design challenges for even the largest problem domains. With the incredible memory bank size now available in multi-GPU AI optimized machines, problem domains even as large as 50 x 50 x 1000 μm can be simulated with FDTD, providing a way to address challenges such as fiber component design that previously could not be handled with FDTD at all. And with the incredible speed these machines provide, large simulations such as 3d grating couplers can be run in minutes, where previously hours were required.

Applications

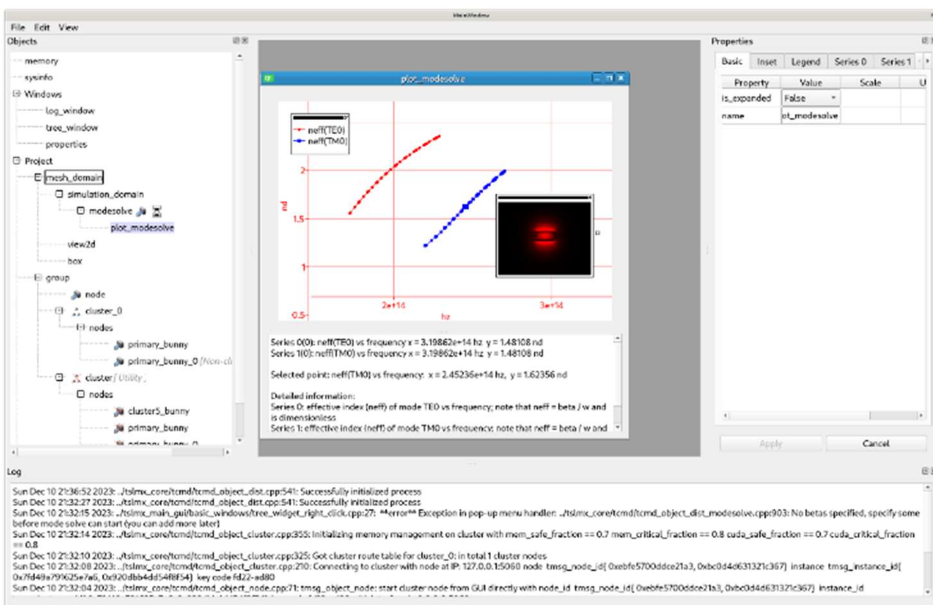
- Silicon photonics waveguide design including silicon and silicon nitride waveguides
- Edge couplers and grating couplers for free space or fiber coupling
- Y-junctions, mode converters, and other on-chip photonic component design
- Design of optical portion of silicon photonics modulators and detectors
- Fiber optical component designs and microlenses
- Photolithography simulations
- Photonic meta-materials

Modesolver

Tesselmax.EM features a modesolver, capable of solving for continuous or discretely symmetric waveguides.

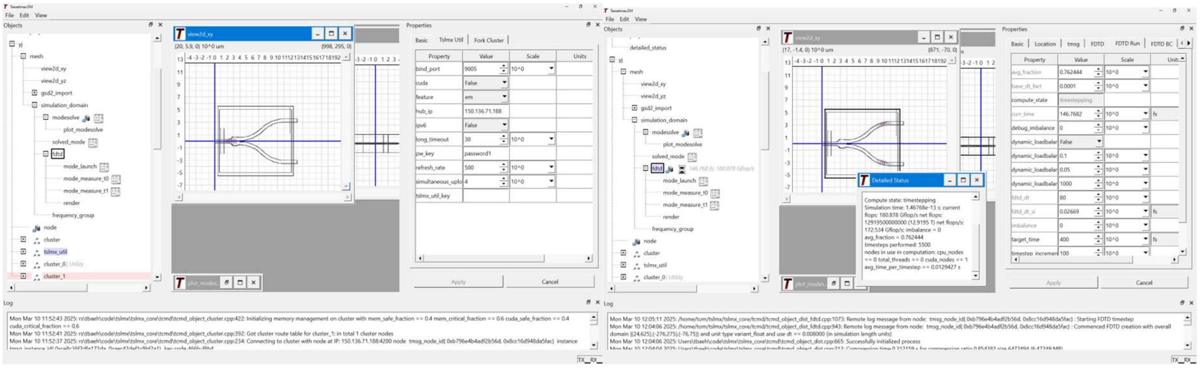


An arbitrary waveguide geometry can be specified in the CAD system, after which the modes can be solved. Material loss can be converted into propagation loss, even in cases of very low-loss materials where the waveguide loss might be on the order of 1 dB/km. The effective index, group index, and dispersion is available. Material dispersion can be included in the modesolve.

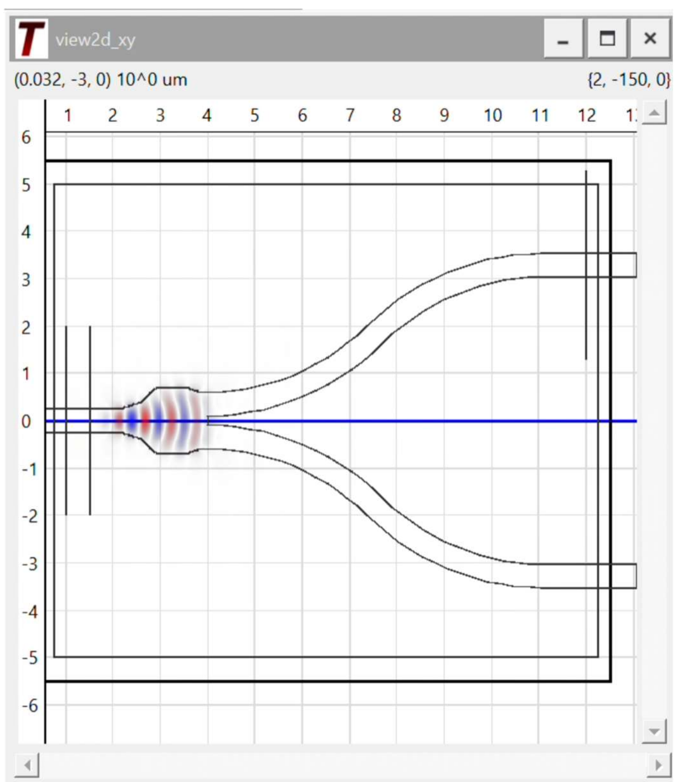


Finite-Difference Time Domain (FDTD)

Tesselmax.EM provides the classic Finite-Difference Time Domain (FDTD) algorithm for structure design. Pulses can be sent through a structure, launched either by a Gaussian source, or from a solved mode, and using frequency-domain filtering, the coupling coefficients between photonic ports can be measured. Continuous-wave (CW) sources can also be used.

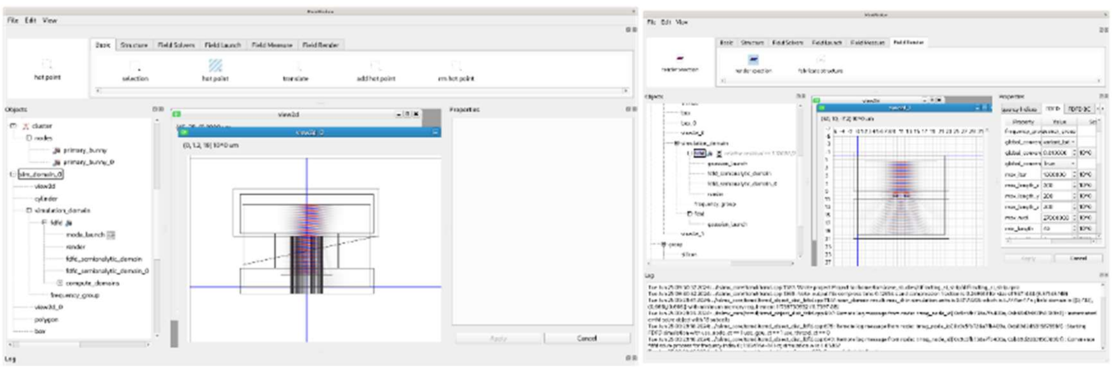


A number of tools are available for rendering simulations as they progress, interrogating fields, or calculating metrics such as power flow through a surface. An extensive collection of boundary conditions is available including Mur, PML, periodic and mirror. Boundary conditions can be mixed as well, and in the case of PML, tuned to provide optimal performance for a given situation.



Finite-Difference Frequency Domain (FDFD)

Tesselmax features the new Finite-Difference Frequency Domain (FDFD) algorithm. This enables a single frequency to be solved for over even FDTD sized domains or beyond. For the free space portions of the simulation, semianalytic solves can be used to speed up the solution with a high degree of accuracy in the boundary conditions.



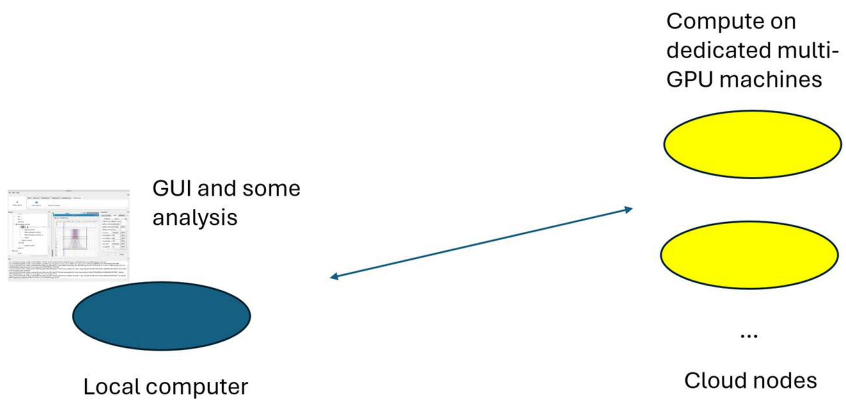
The steady state pattern obtained can be useful in allowing a more detailed analysis of the structure and help in inverse design efforts. At the moment the FDFD solver is in pre-alpha state and will only run effectively on small domains on a few GPUs or CPUs. In the long run, we expect the FDFD solver to scale to clusters of multiple 8 GPU machines or beyond, enabling problem domains beyond even what FDTD can handle.

Advanced Features to Make Simulations Easier

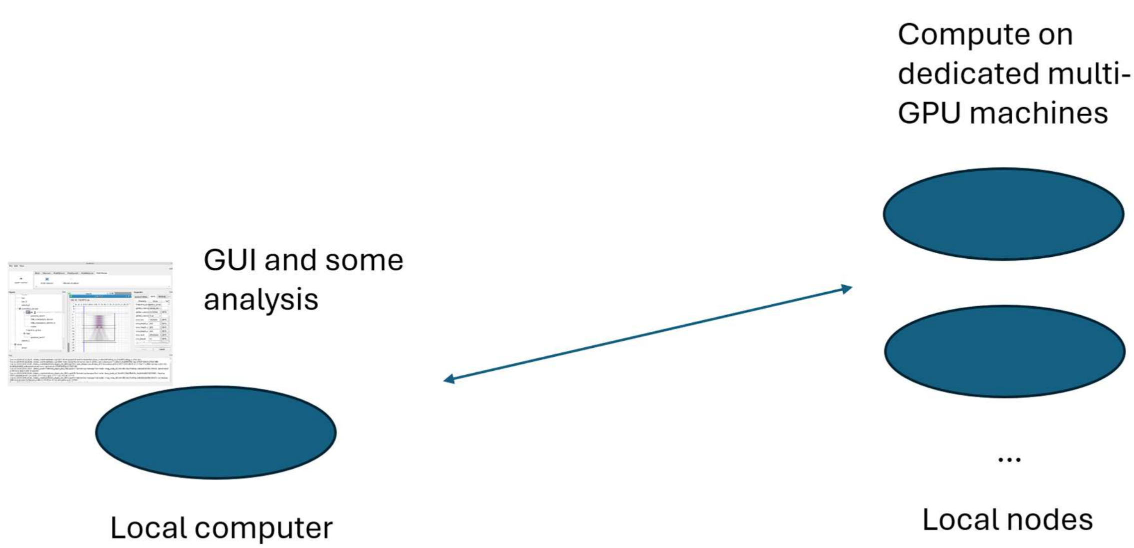
Tesselmax.EM uses a number of advanced features to make simulation problems easier. These include a field capture / relaunch tool, which allows a field pattern to be measured in one simulation, and then re-launched in another simulation, even if the field pattern is not a guided mode. In this manner, multiple simulation domains can be stitched together. It is even possible to reverse the propagation direction of the captured field. A sophisticated mode matching object is also available to find the optimal location and angle of photonics modes that may be coupling into free space. And for situations where the structure is difficult to define with discrete objects, it is possible to use Python code to define the structure mathematically – so things like graded index waveguides can be easily simulated.

Computation Model – Use CPU or GPU locally or in the Cloud

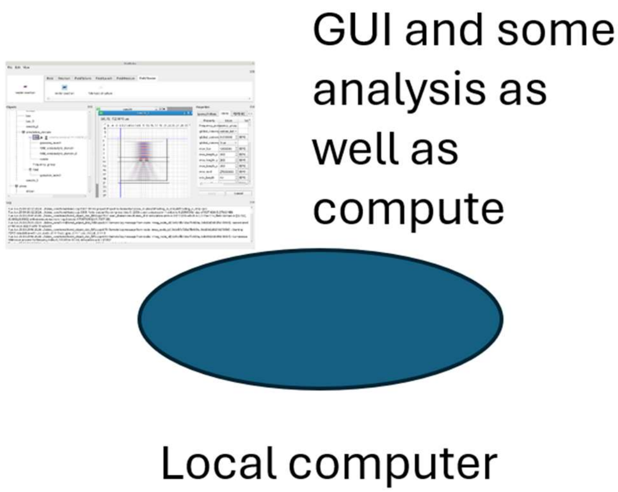
Tesselmax has been designed to be maximally flexible in terms of support for computation models for modesolving, FDTD and FDFD. Specifically, you can run the software in a number of configurations as shown below.



The preferred method is to run the GUI on a local machine, while the compute process runs on cloud machines with multi-GPUs, such as the Nvidia DGX-A100 box with 8 GPUs and capable of supporting FDTD domains of 500 GB or more.



If you prefer to run your simulations locally, no problem. You can use a local cluster too. Any remote node or set of nodes, whether they are in the cloud or not, can be “assimilated” and controlled by a GUI with a single command. No need to install a virtual machine or extensive set of support programs, or to edit complex configuration files. Our software will run on a reference Linux, Windows or Mac system without any additional libraries installed. Both x86 and Arm64 are supported.



Finally, if you prefer to run your compute process on your local computer within the GUI, you can do so. No GPU is required – though if you have a local GPU on your desktop or laptop, that will speed computations greatly.

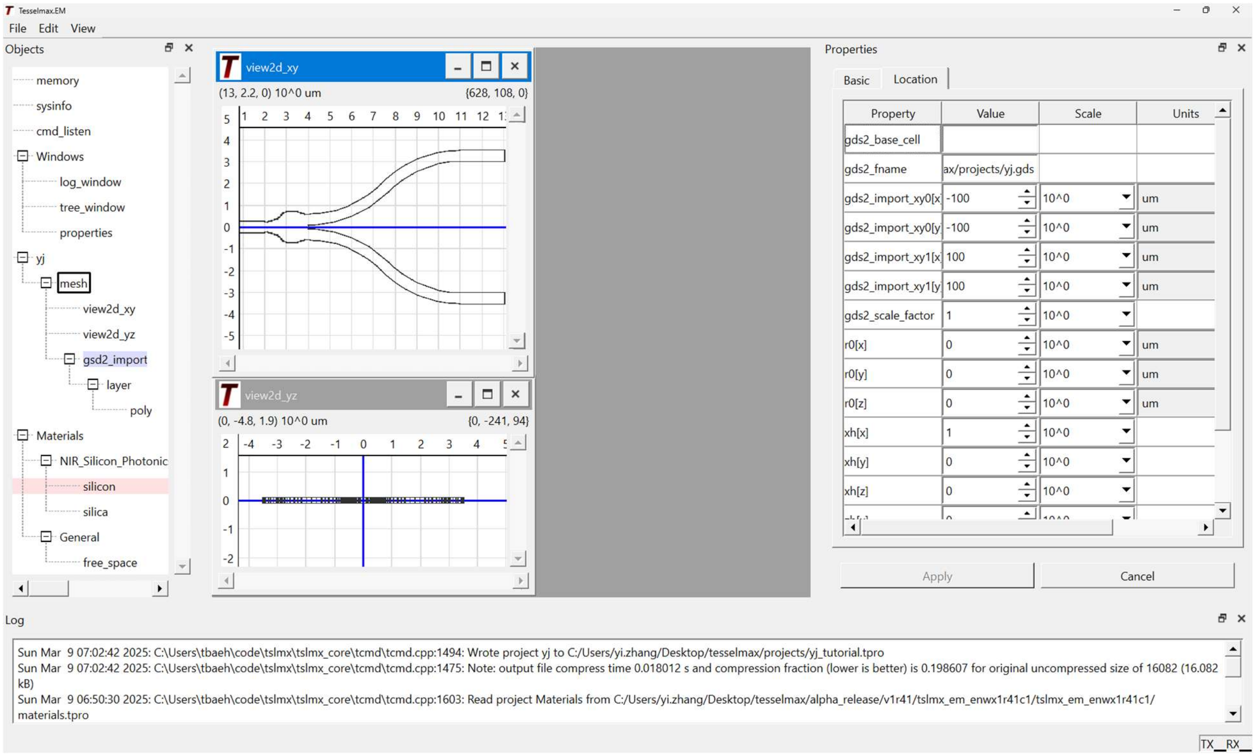
At the moment only Nvidia GPUs are supported.

Scale to 8 GPUs or beyond

We have tested Tesselmax.EM on 8 GPU machines for FDTD. It's not presently possible to scale FDTD beyond 8 GPUs for a single simulation in most cases – though with 8 GPUs, even large simulations such as 3d grating couplers may require a runtime of only a few minutes. But it's possible to use multiple such 8 GPU machines in a single GUI instance in parallel, enabling inverse design to be supported.

CAD System

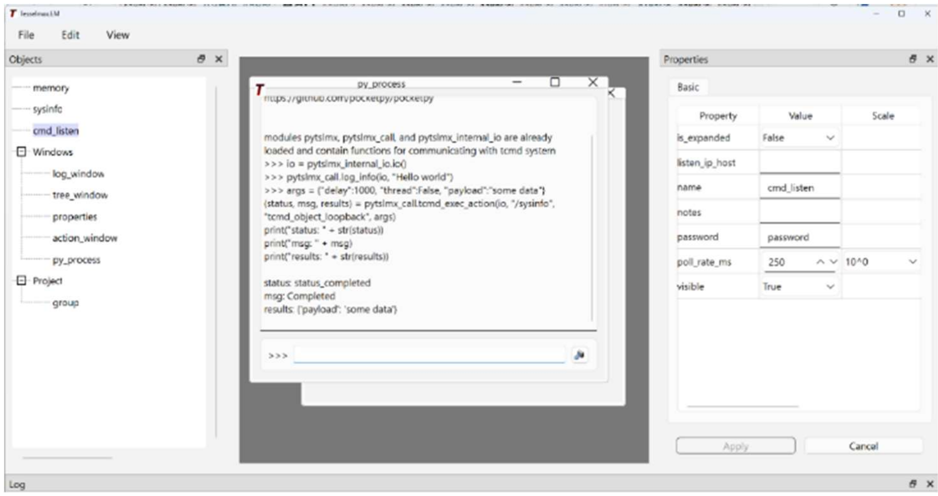
Tesselmax.EM features a full 3d CAD system, capable of dealing with some of the most complex structure definition problems within integrated optics.



GDS2 files can be imported and converted into structures with a few clicks. Multiple clusters can be controlled and simulations launched and results obtained all from within the GUI. Adaptive meshing can be used to focus on a specific region in a specific dimension with increased accuracy. Structural materials can have frequency dependance, loss, or can be perfect conductors. Anisotropy is also supported, as well as left-handed materials.

Python Interface

Nearly every action that can be performed in the GUI can also be performed with Python.



You can use the built-in Python interface, or use an external Python process that connects to the GUI via TCP socket, enabling maximal flexibility in how you control the simulation. This will be especially important for things like inverse design.

Alpha Release Completely Free – Starting March 2025

Tesselmax is pleased to release the free alpha version of Tesselmax.EM as of March 27 2025. The alpha version features a fully functional modesolver and FDTD implementation with no known major issues or bugs. The FDFD implementation can be used for smaller domains but is known to have scaling issues on multi-GPU machines, and is thus not recommended for most design studies; FDTD will be a better choice.

Priced for Affordability – Starting September 2025

After the free alpha period is over, the full commercial license for 1 GUI instance and 8 GPU/CPU instances will be $2k/year. This is enough to run a simulation on a DGX-A100 box, one of the latest and most powerful computers used for AI calculations. For users who want to use multiple such boxes, we will offer a commercial supercomputing license at $10k/year with 2 GUI instances and up to 64 GPU/CPU instances – enough to drive 8 DGX-A100 AI machines, each with 8 GPUs, in parallel – providing the computational horsepower for inverse design or other computationally expensive efforts. An academic version at $50/year for the GUI and 2 GPU/CPU nodes will be available.

Available Now!

After registering for a free account on www.tesselmax.com you can immediately download binaries for all supported platforms, which include Mac, Windows and Linux x86 and Arm64.