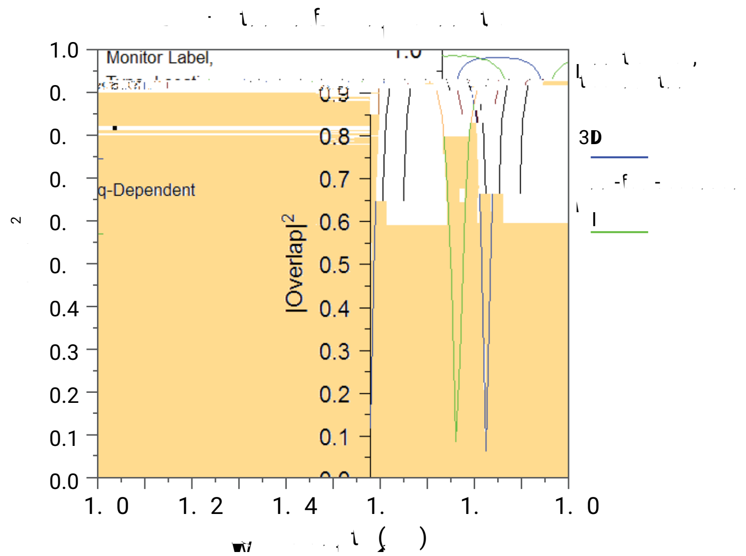
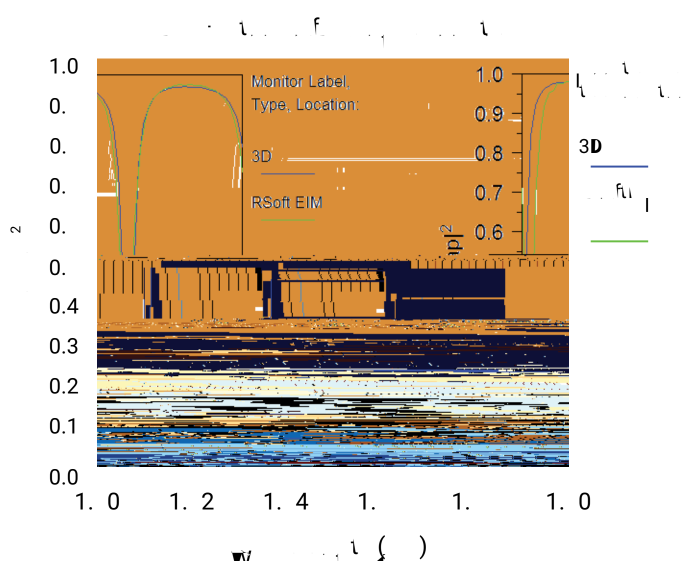
The Effective Index Method (EIM) can be used in Synopsys RSoft™ photonic design software to greatly reduce the computation time and memory requirements of a simulation by converting a 3D structure into an approximate 2D structure [1]. This is also called an approximate 2.5D structure. Once a 3D structure has been reduced into a 2.5D structure using EIM, the propagation can be performed using one of numerous algorithms suitable for computational photonics, such as Finite Difference Time Domain (FDTD), Beam Propagation Method (BPM), Eigenmode Expansion (EME) and Rigorous Coupled Wave Analysis (RCWA). Most of the RSoft passive device modeling tools [2], including BeamPROP™, FullWAVE™, ModePROP™ and DiffractMOD™, all support EIM.

This white paper illustrates the performance and accuracy benefits of the EIM approach for two SOI-based structures: a ring resonator example and a 1x2 MMI example.

When applying EIM to a time-domain technique such as FDTD, which can calculate the response over a broad frequency range in a single simulation, it is critical to include frequency dependence in the EIM method. If this is not done, it can lead to incorrect results as shown in Figure 2, which compares the through port response for an SOI-based ring resonator obtained through full 3D FDTD simulations versus the results from an EIM simulation not accounting for the frequency dependence. As can be seen, the Free Spectral Range (FSR) can differ substantially for the two cases: ~33 nm predicted by EIM versus ~26 nm predicted by a full 3D simulation.



However, when the frequency dependence is correctly accounted for in the EIM method, as is done in FullWAVE, the EIM results are in much closer agreement with the full 3D results. This is demonstrated in Figure 3, where the FSR predicted by EIM including frequency dependence is ~25.8 nm, which is very close to the ~26 nm predicted by the full 3D simulation. Moreover, the EIM simulation is ~300x faster than the full 3D simulation for this example.



Multimode interference (MMI) devices have been utilized within photonic integrated optical circuits requiring power splitters, Mach Zehnder interferometers, and optical switches. MMIs can be fabricated on a wide range of material platforms including on CMOS compatible, SOI-based platforms for silicon photonic applications. Based on the number of ports and the nature of the self-imaging phenomena utilized by MMIs is such that these devices can be long. For example, increasing the number of ports by a factor of two