



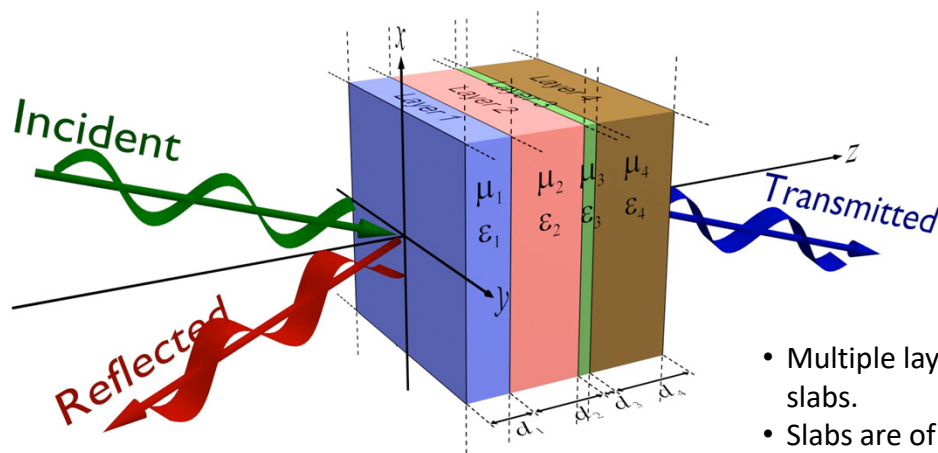
Advanced Computation:
Computational Electromagnetics

One-Dimensional Structures in Electromagnetics



1

One-Dimensional Structures & Simulations



- Multiple layers of homogeneous slabs.
- Slabs are of infinite extent in x and y directions.
- Very fast and efficient simulation.

2

Reducing 3D Problems to 1D



3

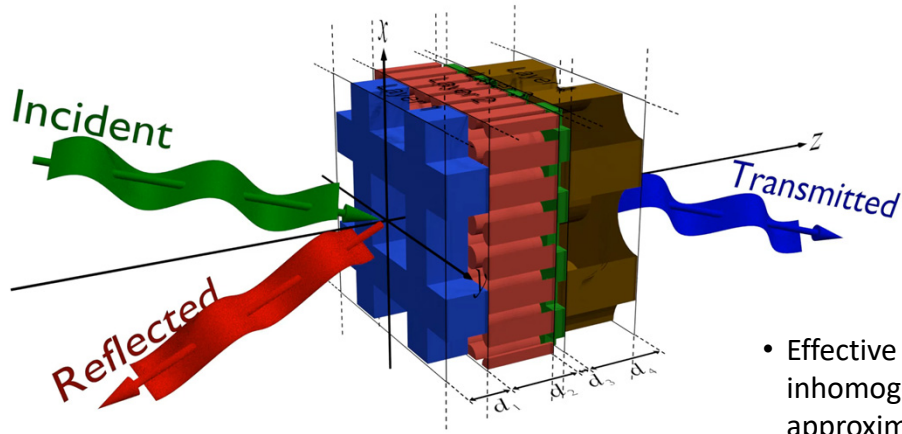
Simulating Thin Film Optical Filters in 1D



If we can ignore the edges of this device, thin film optical filters are just 1D stacks of different dielectrics.

4

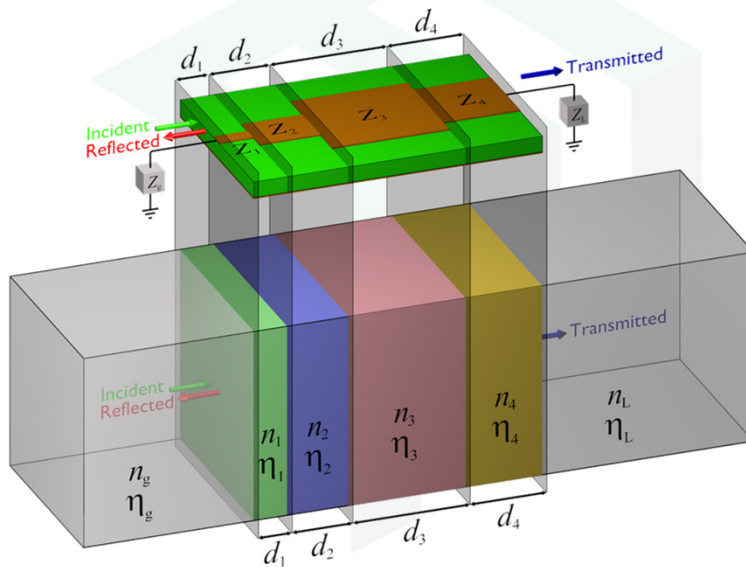
3D → 1D Using Effective Medium Theory



- Effective medium theory allows inhomogeneous layers to be approximated as homogeneous.
- Serves as an excellent preliminary simulation before moving to 3D.

5

3D → 1D Using Circuit-Wave Equivalence



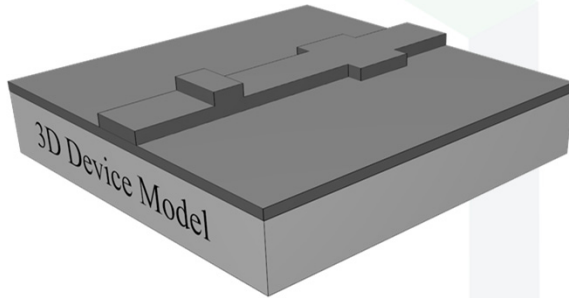
$$n_i = \sqrt{\mu_{r,i} \epsilon_{r,i}}$$

$$Z_i = \eta_i = \sqrt{\frac{\mu_i}{\epsilon_i}}$$

6

Simulating Optical Waveguide Circuits in 1D

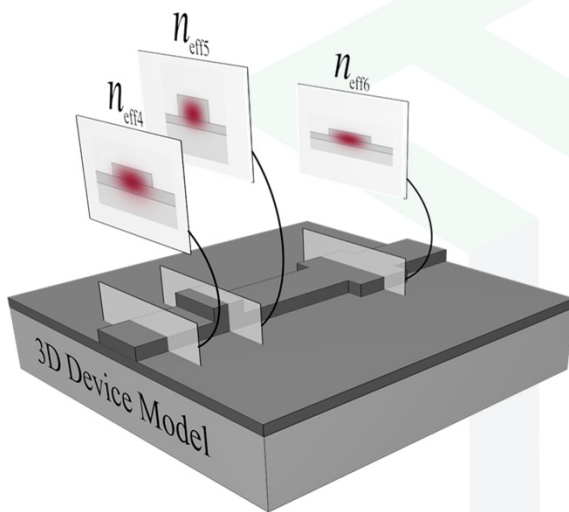
Start with a 3D device.



7

Simulating Optical Waveguide Circuits in 1D

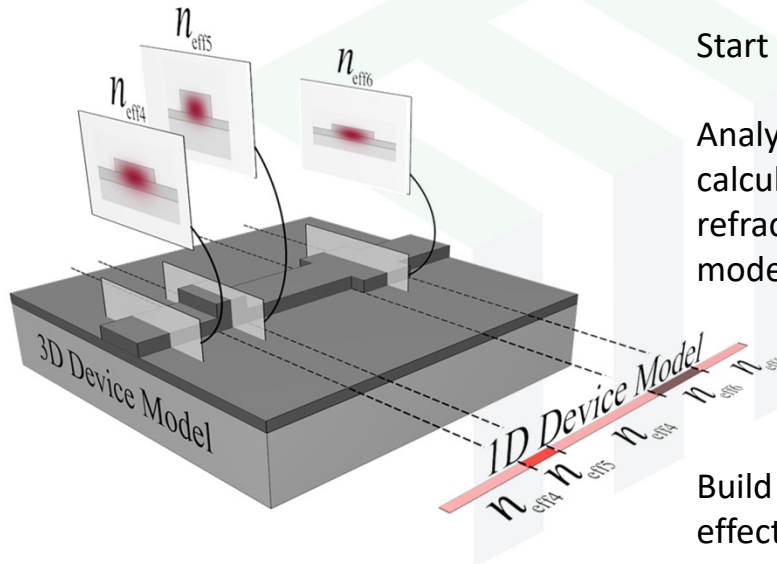
Start with a 3D device.



Analyze the cross sections to calculate the effective refractive index of the guided mode in each unique segment.

8

Simulating Optical Waveguide Circuits in 1D



Start with a 3D device.

Analyze the cross sections to calculate the effective refractive index of the guided mode in each unique segment.

Build a 1D model using the effective refractive indices.