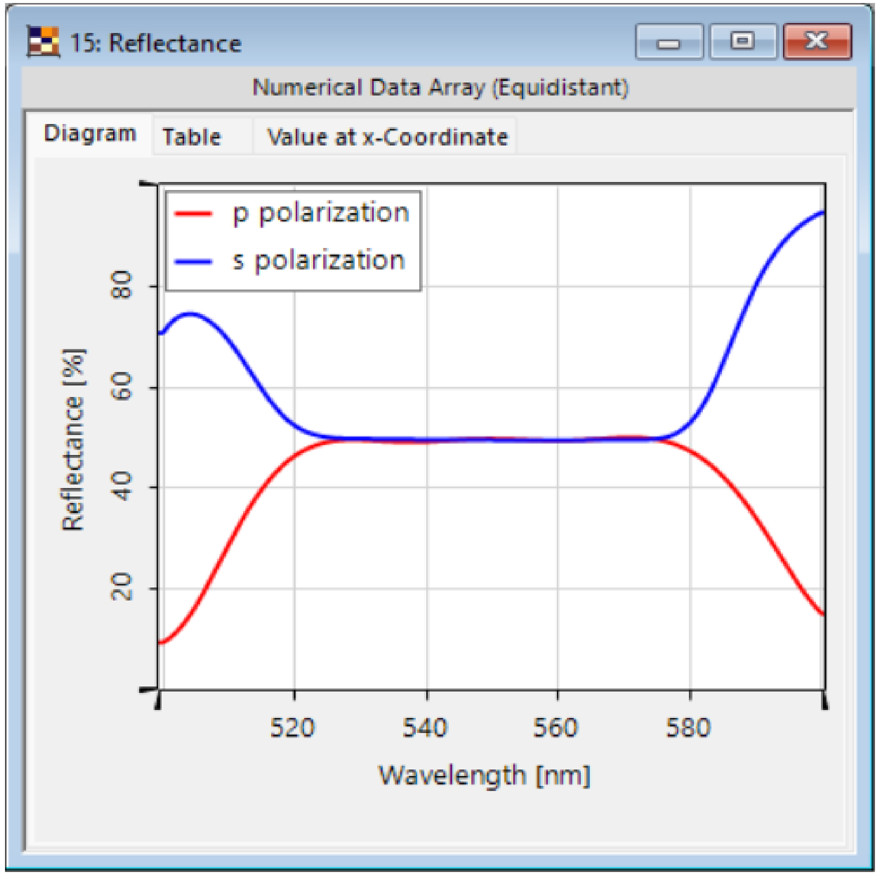
Beam Splitter Cube

Abstract



This use case presents the simulation of optical beam splitters, including both polarizing and non-polarizing types, using VirtualLab Fusion software. An appropriate layer configuration is imported, followed by a wavelength scan to evaluate the performance of the beam splitters.

Scenario

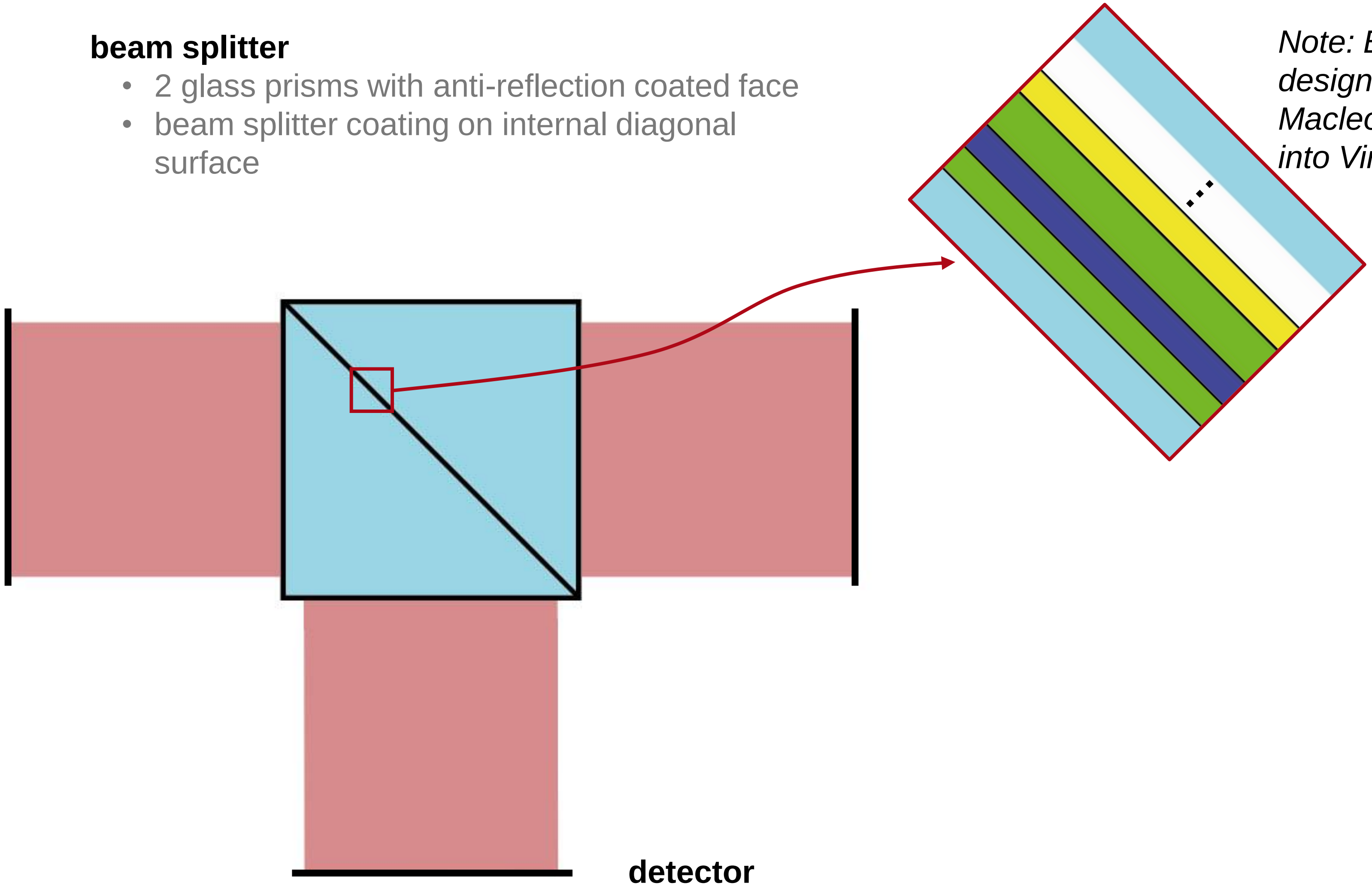
beam splitter

- 2 glass prisms with anti-reflection coated face
- beam splitter coating on internal diagonal surface

Note: Beam Splitter Coating designed by Essential Macleod and then imported into VirtualLab Fusion

input field

- plane wave
- s/p polarization



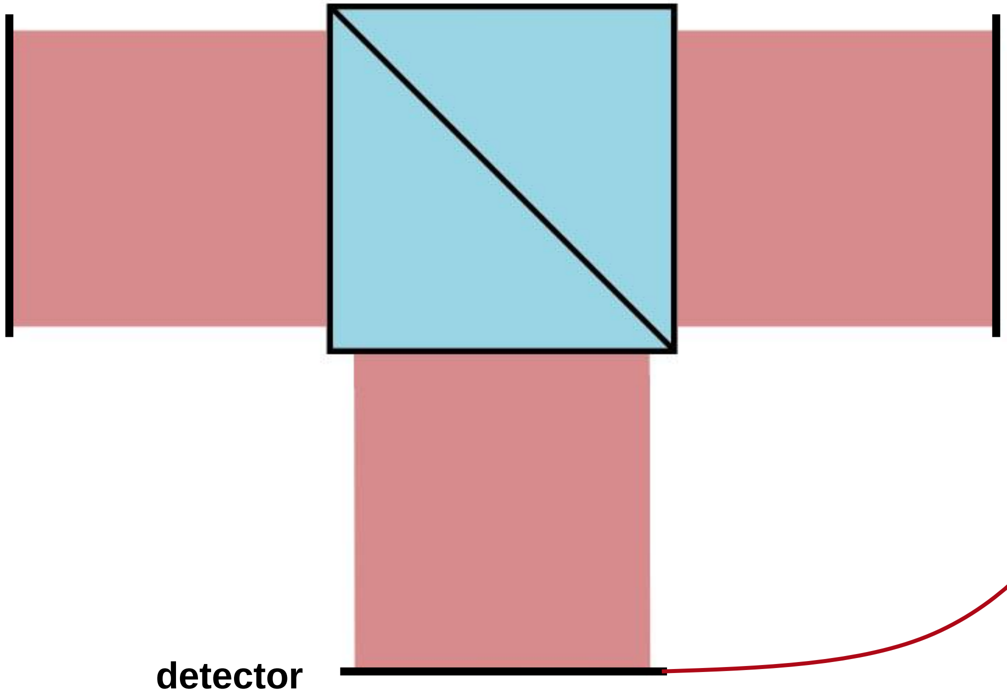
Modeling Task – Non-Polarizing Beamsplitter Cube

beam splitter

- 2 glass **(n=1.51854)** prisms with anti-reflection coated face
- beam splitter coating on internal diagonal surface: **multilayer system containing titanium oxide (TiO_2), magnesium fluoride (MgF_2), aluminum oxide (Al_2O_3)**

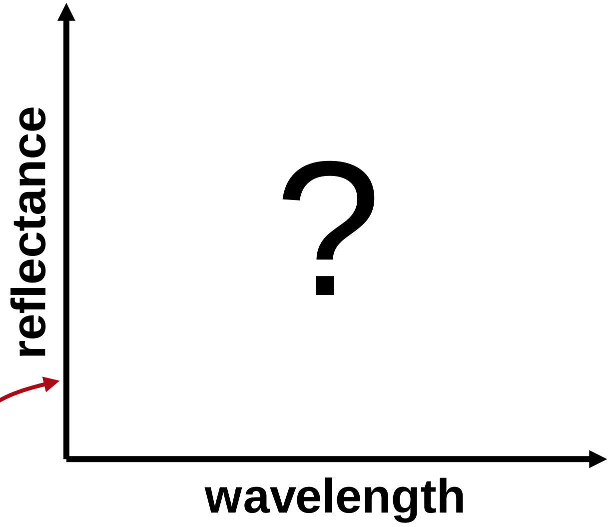
input field

- plane wave
- s/p polarization
- **wavelength 500 - 600 nm**



detector

- efficiency

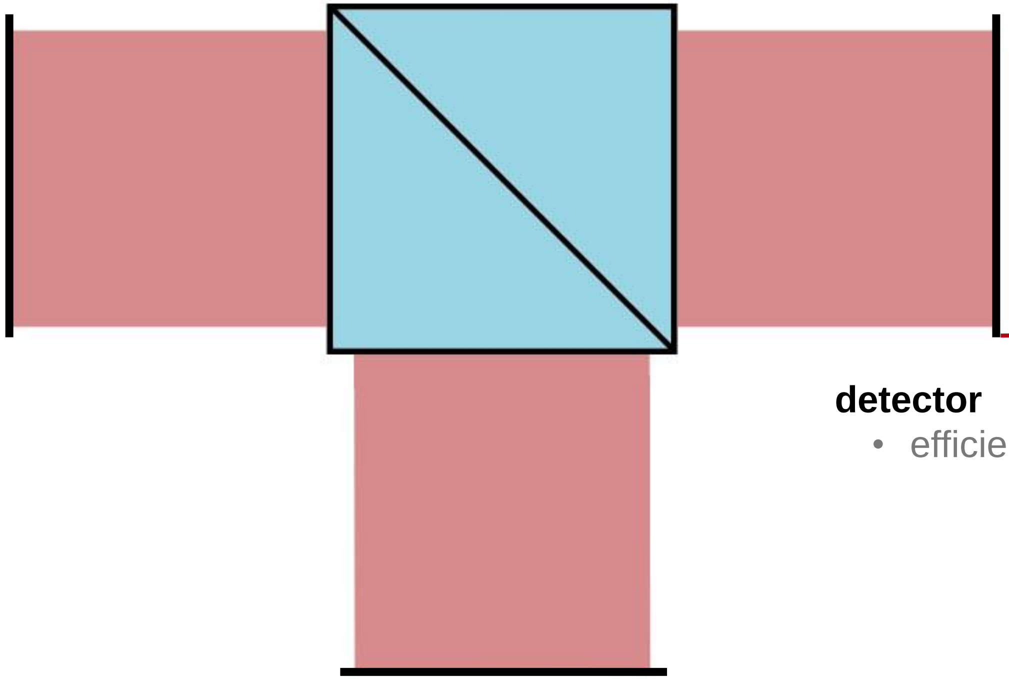


task: measure reflectance with respect to wavelength for s- and p-polarized light

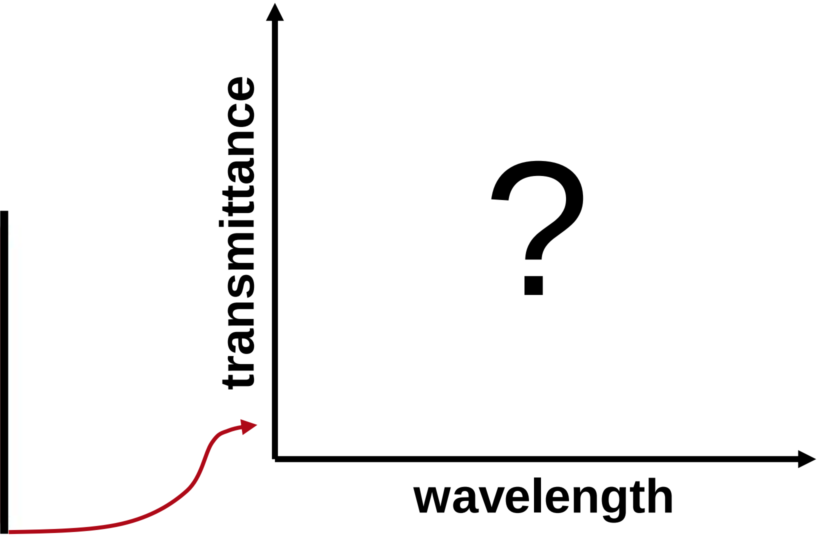
Modeling Task – Polarizing Beamsplitter Cube

beam splitter
- 2 glass **(n=1.62889)** prisms with anti-reflection coated face
- beam splitter coating on internal diagonal surface: **multilayer system containing alternating layers of silicon dioxide (SiO2) and tantalum pentoxide (Ta2O5)**

input field
- plane wave
- s/p polarization
- **wavelength 400 - 700 nm**

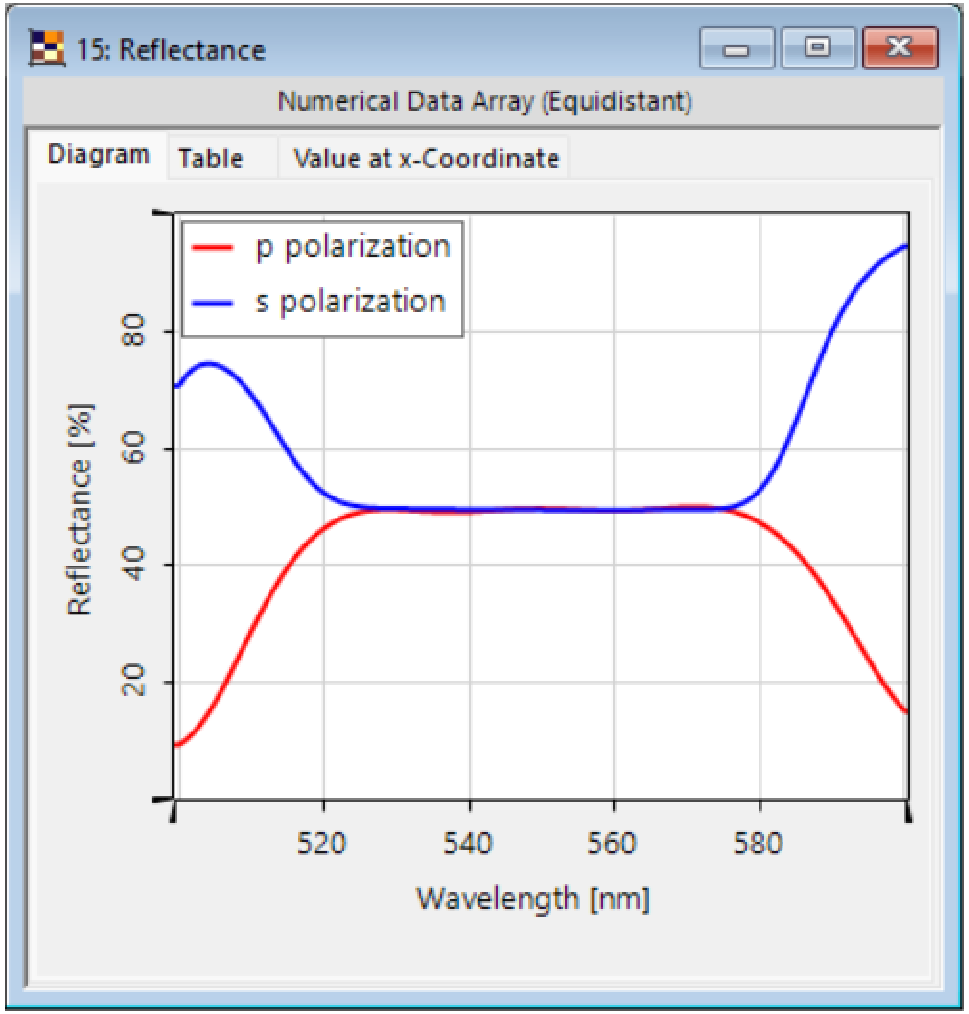


detector
- efficiency



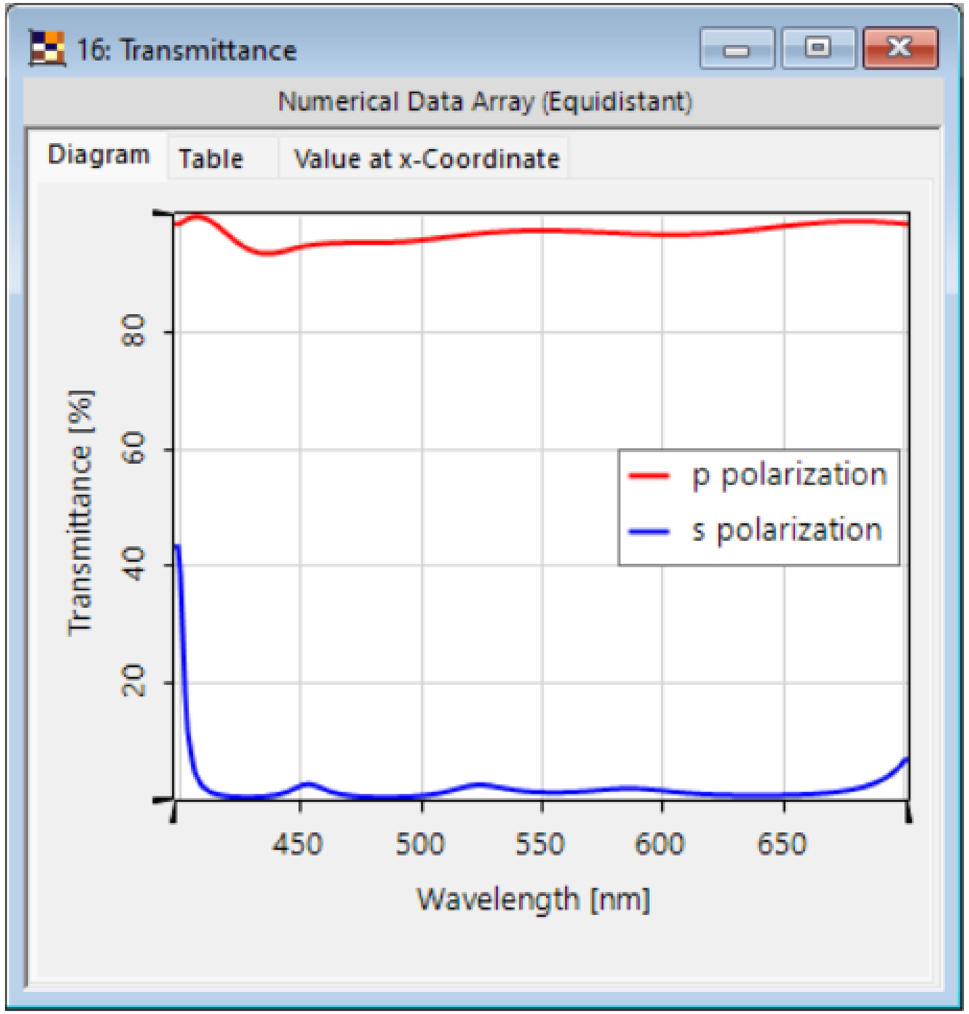
task: measure transmittance with respect to wavelength for s- and p-polarized light

Reflectance of Non-Polarizing Beamsplitter Cube



The reflectance diagram indicates that the non-polarizing beamsplitter cube splits the incident beam independently of polarization within the operating wavelength range of approximately 525 nm to 575 nm.

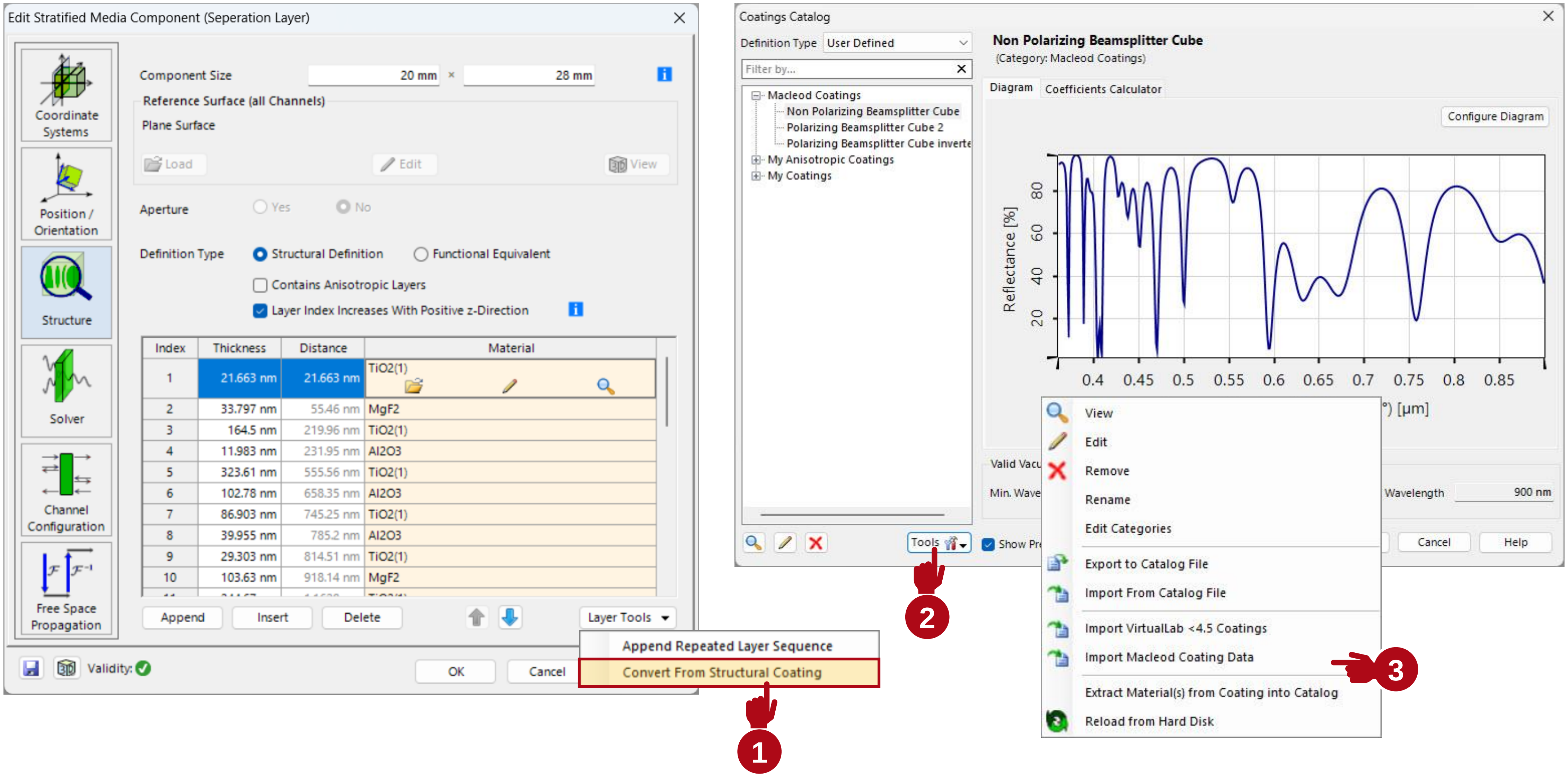
Transmittance of Polarizing Beamsplitter Cube



In contrast, the polarizing beam splitter cube only transmits the p-polarized component of the incident light within its operational wavelength range (approximately 420 nm to 650 nm).

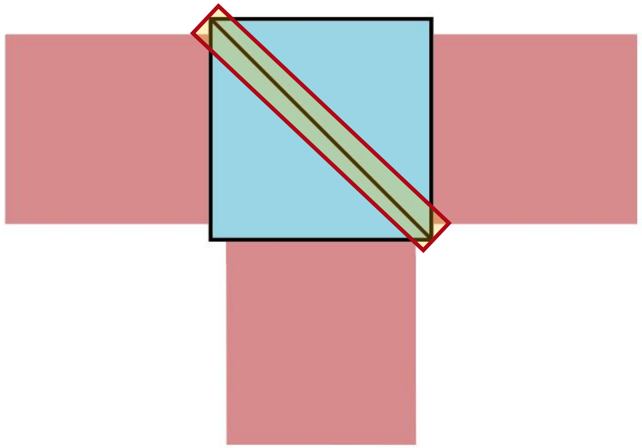
Workflows

Import Coatings into VirtualLab Fusion



System and Modeling Parameter

Connected Modeling Techniques: Separation Layer

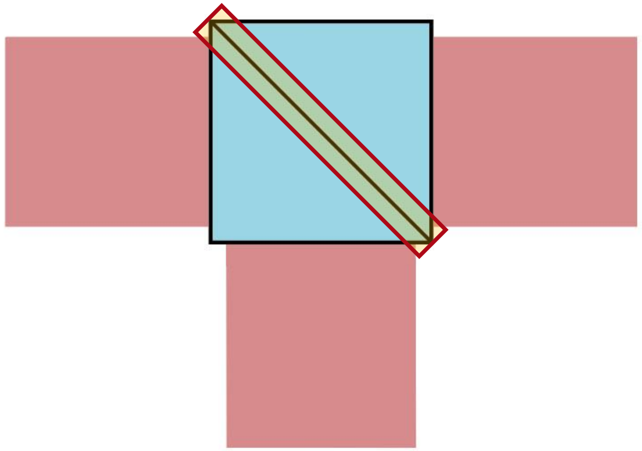


Available modeling techniques for interaction with surfaces:

Methods	Preconditions	Accuracy	Speed	Comments
Functional Approach	-	Low	Very High	No Fresnel Losses
S-matrix	Planar surface	High	High	Rigorous model; includes evanescent waves; k-domain
Local Planar Interface Approximation	Surface not in focal region of beam	High	High	Local application of S-matrix; LPIA; x-domain

The rigorous S-matrix/Layer Matrix algorithm is developed precisely for an x,y-invariant layered structure, such as coatings.

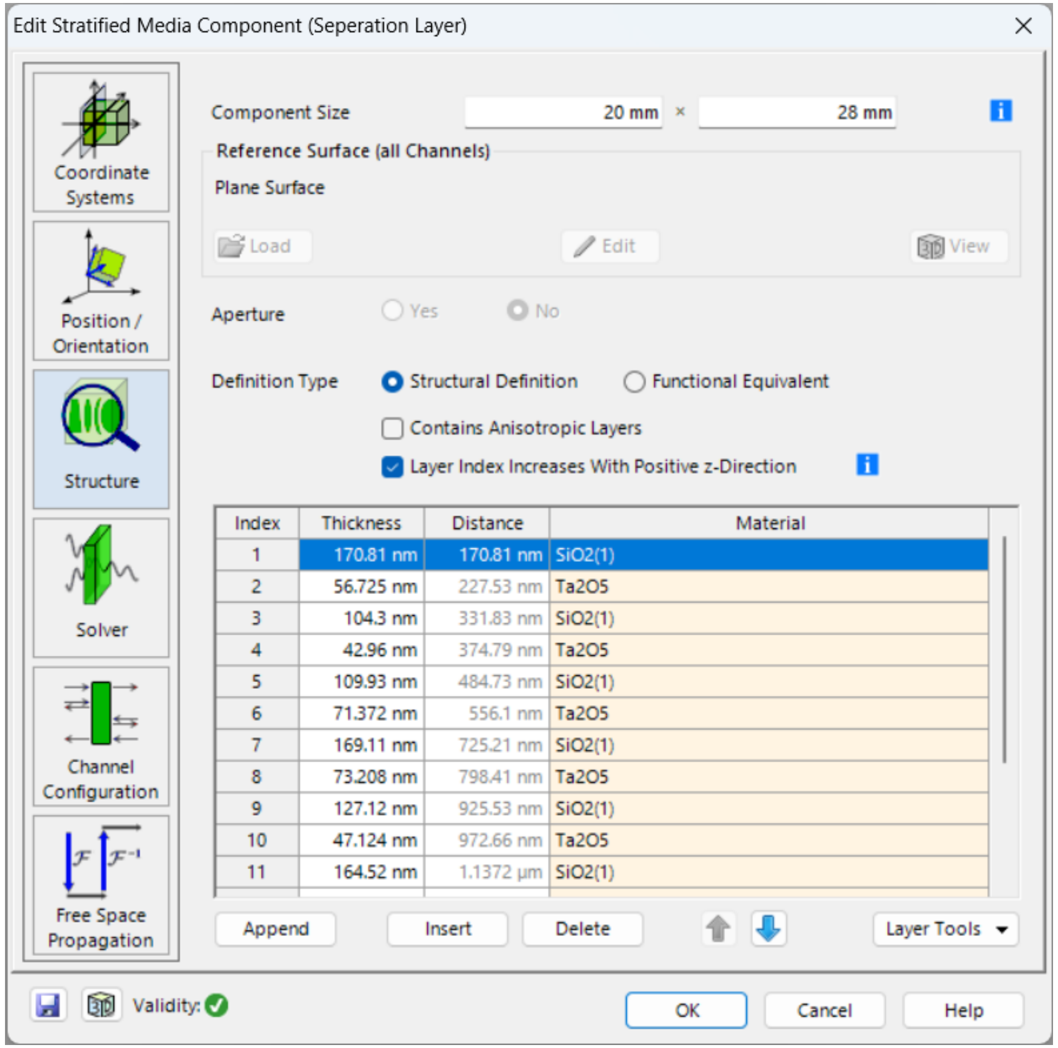
Stratified Media Component



The coating itself was designed by Essential Macleod and then imported into VirtualLab Fusion using the *Stratified Media Component*.

More information about the *Stratified Media Component* and how to import coatings under:

[Stratified Media Component]



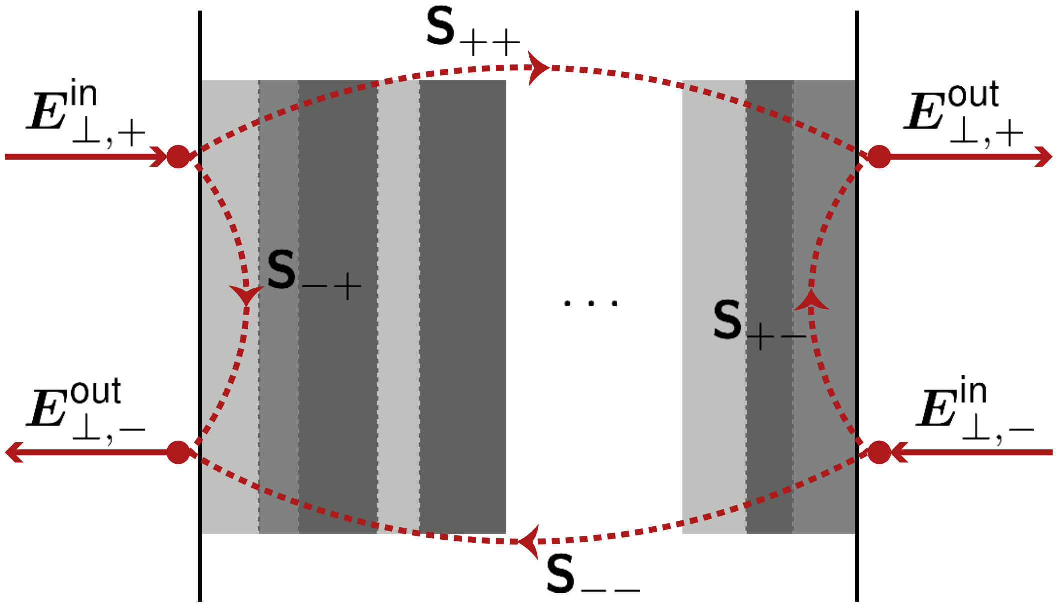
Layer Matrix Solver

The *Stratified Media Component* uses the layer matrix electromagnetic field solver. This solver works in the spatial frequency domain (**k-domain**). It consists of

1. an eigenmode solver for each homogeneous layer and
2. an S-matrix for matching the boundary conditions at all the interfaces.

The eigenmode solver computes the field solution in the k domain for the homogeneous medium in each layer. The S-matrix algorithm calculates the response of the whole layer system by matching the boundary conditions in a recursive manner.

This is a method well-known for its unconditional numerical stability since, unlike the traditional transfer matrix, it avoids the exponentially growing functions in the calculation steps.



For further information:

[Layer Matrix [S-Matrix]]

Document Information

title	Beam Splitter Cube
document code	IFO.0023
document version	1.0
required packages	-
software version	2024.1 (Build 2.30)
category	Application Use Case
further reading	• Stratified Media Component • Channel Setting for Non-Sequential Tracing • Laser-Based Michelson Interferometer and Interference Fringe Exploration • Mach-Zehnder Interferometer