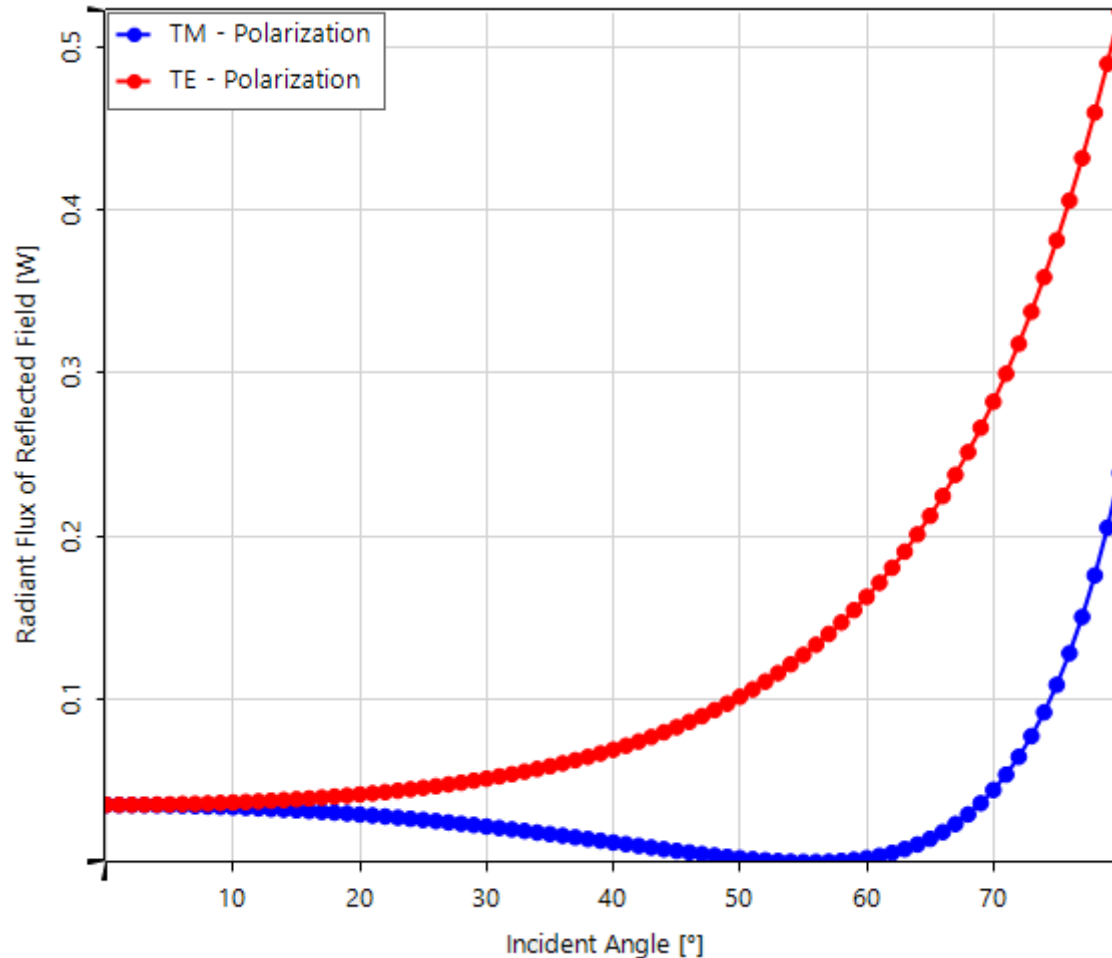


# **Polarization and Angle-Dependent Transmittance and Reflectance at a Plane Interface**

# Abstract

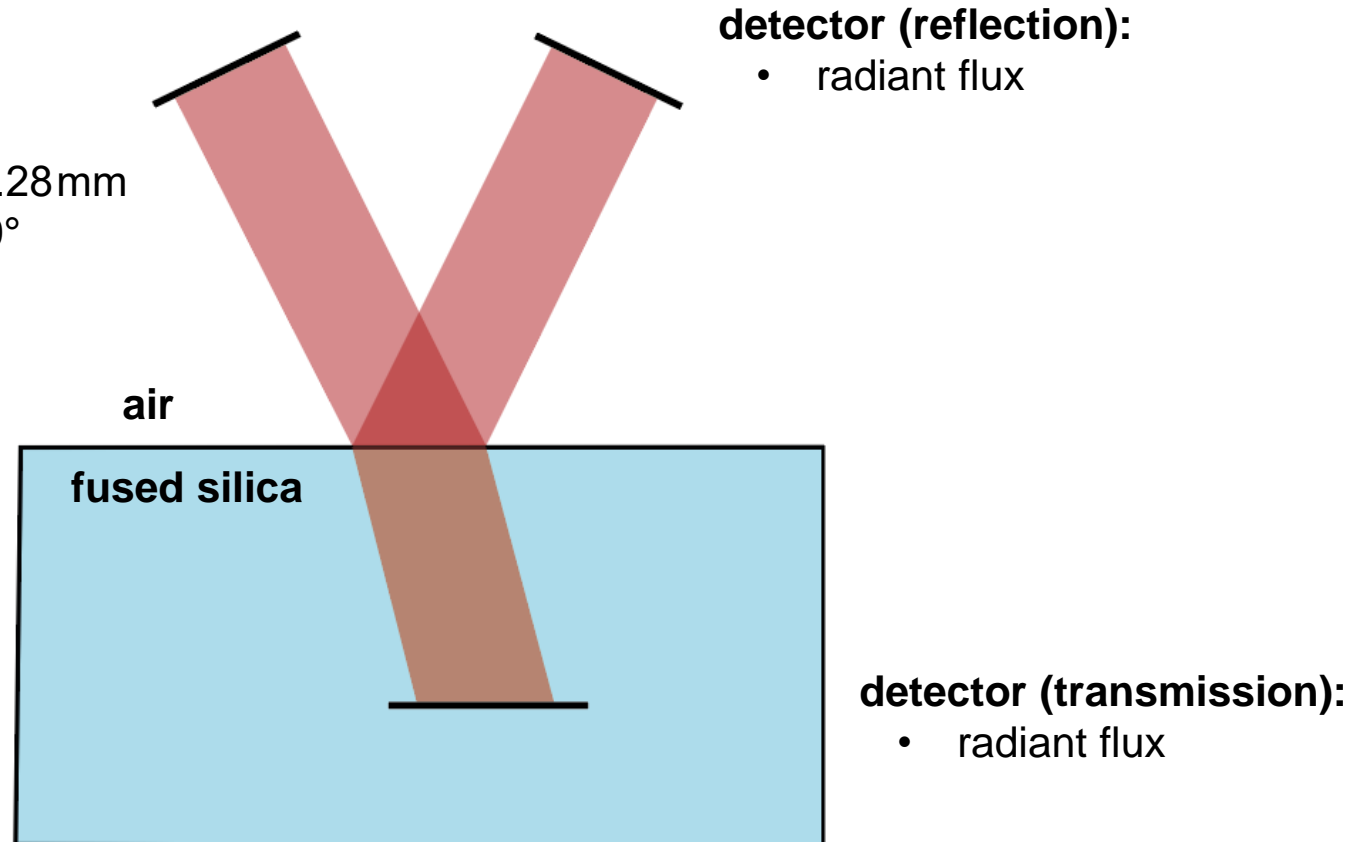


The Fresnel effect, which describes the behavior of transmittance and reflectance of light at an optical transition between two media, was one of the first historical observations to understand the vectorial nature of light. The deduced Fresnel equations enable to calculate the amount of energy being reflected or transmitted at such a material interface, depending on the polarization state and the angle of incidence of the impinging light. As a physical-optics based software, VirtualLab Fusion offers multiple tools to evaluate this, also for modern optics, crucial effect, such as the *Fresnel Effect Calculator* to calculate the Fresnel coefficients directly and the *Universal Detector* that measures the radiant flux of the transmitted and reflected light in an optical system.

# Task Description

## plane wave (input)

- wavelength 532nm
- TE/TM polarization
- diameter 1.28mm×1.28mm
- incident angle: 0°- 80°
- power: 1W



# Fresnel Effects Calculator

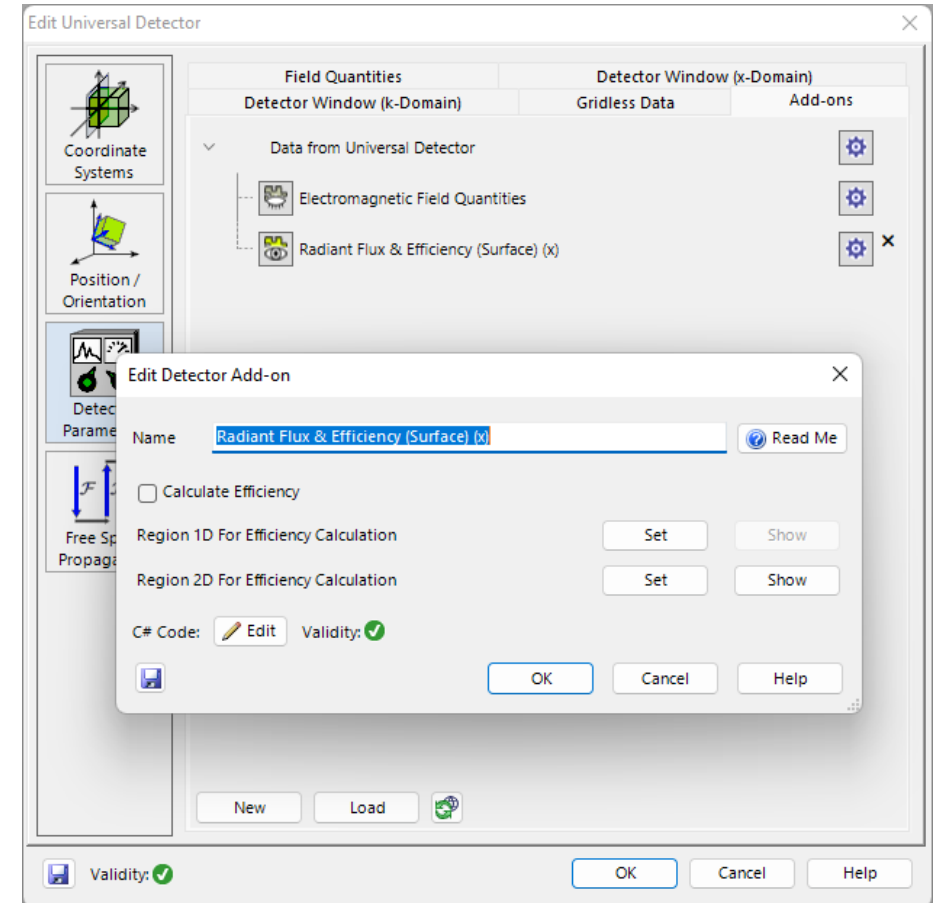
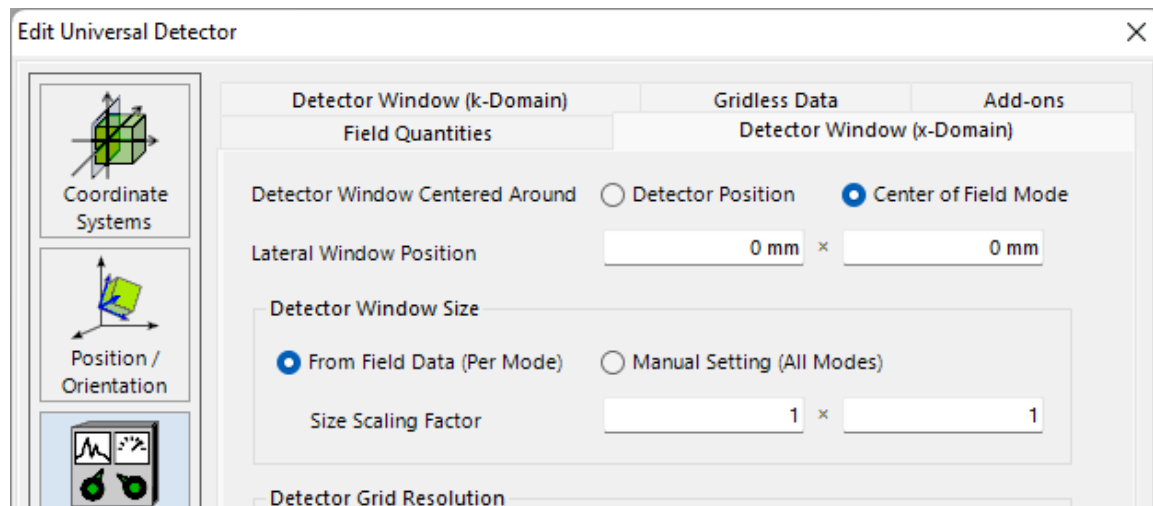
In order to assess the transmittance and reflectance upon an interface of two optical media, VirtualLab Fusion provides the *Fresnel Effect Calculator* found in the *Calculators* section of *Start* ribbon.

This calculator is based on the Fresnel equations and visualizes the curves of transmittance and reflectance over wavelength or angle of incidence. The material transition can be defined by materials provided in the catalog or by manually entered indices of refraction. Moreover, a coating, which can comprise multiple layers, can be added to the interface.

The screenshot displays the VirtualLab Fusion software interface. The top ribbon includes 'File', 'Start', 'Sources', and 'Functions'. The 'Start' ribbon is active, with the 'Calculators' section highlighted. Below the ribbon, the 'Fresnel Effects Calculator' window is open. The window is divided into several sections: 'First Material' (Name: Air, State of Matter: Gas or Vacuum), 'Second Material' (Name: Fused\_Silica, State of Matter: Solid), and 'Coating' (Name: No Coating). A 'Diagram' tab shows a schematic of light incident on an interface between two materials. A graph on the right plots 'Reflectance [%]' against 'Incidence Angle  $\alpha$  (for  $\lambda=532$  nm) [°]'. The graph shows two curves: 'TE Polarization' (blue) and 'TM Polarization' (green). The TE curve starts at 0% at 0 degrees and increases to approximately 50% at 80 degrees. The TM curve starts at 0% at 0 degrees and increases to approximately 25% at 80 degrees. The interface also includes a 'Parameters' section with 'Incidence Angle' set to 0°, 'Wavelength' set to 532 nm, and 'Polarization' set to 'TE and TM'. A 'Validity' indicator shows a green checkmark.

# Universal Detector & Detector Add-ons

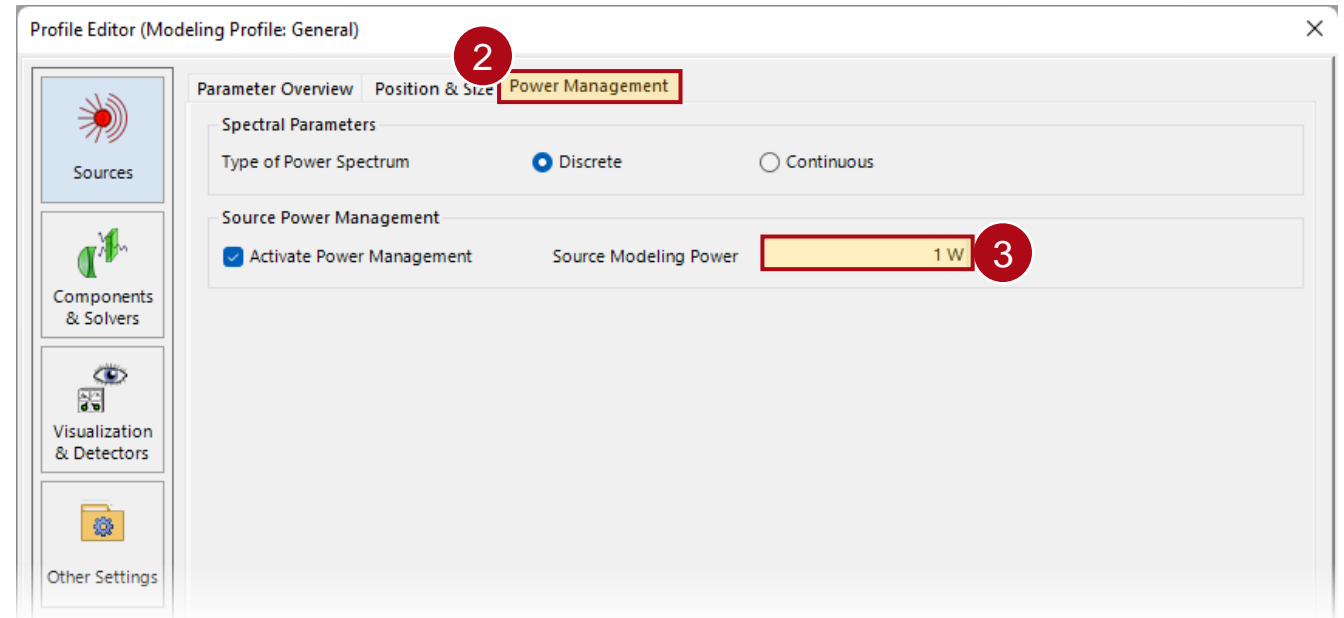
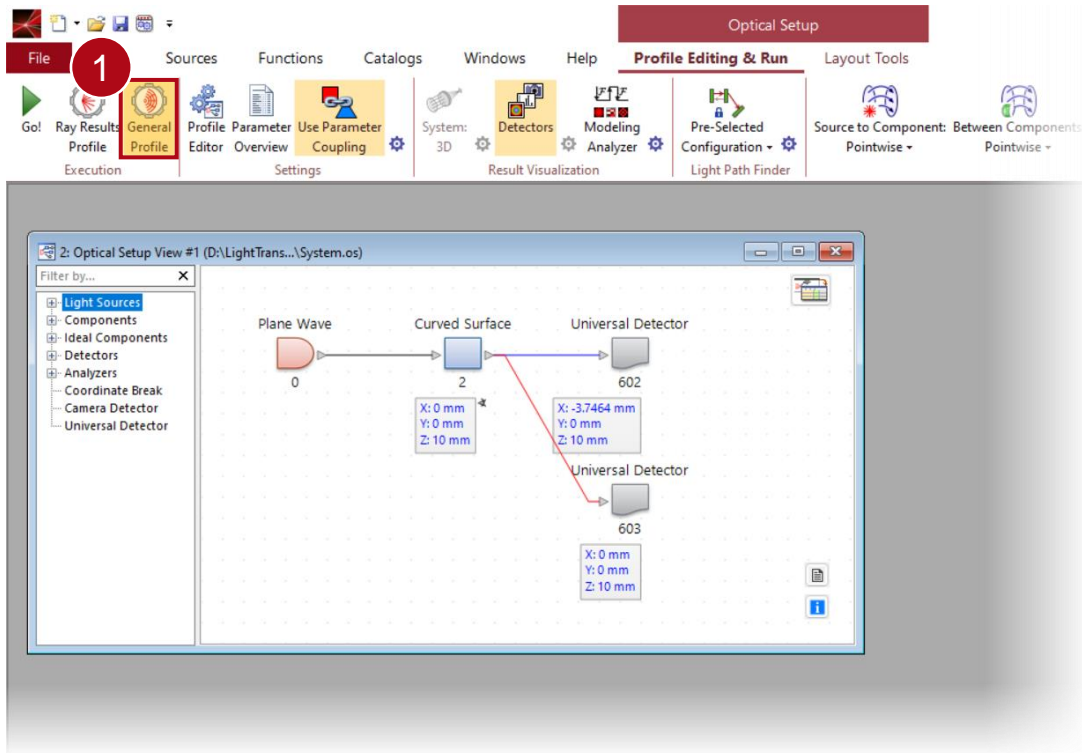
The *Universal Detector* allows to evaluate the impinging field and to calculate various physical quantities by using so-called *Add-ons*. One of the provided *Add-ons* enables to assess the radiant flux in space domain. The detectors size and position can also be specified manually or set to center around the impinging field. For more information, see: [Universal Detector](#)



Radiant Flux (Surface)

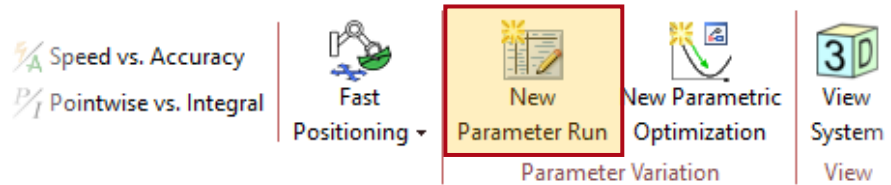
1000 mW

# Power Management



In VirtualLab Fusion any source can be configured with a desired emitting power (*Source Modeling Power*). Physically, the power of the source is defined as the flux of light through the aperture of the source (measured directly behind the source). The corresponding amplitude of the electromagnetic field emitted by the source will be adjusted accordingly.

# Parameter Run



The *Parameter Run* feature can be used to show the dependence of the result on certain parameters of the system. In this use case, the radiant flux of the transmitted and reflected wave depending is measured as function of angle of incidence (measured with respect to the interface normal).

More information about the *Parameter run* under:

[Usage of the Parameter Run Document](#)

**Parameter Specification**  
Set up the parameter(s) to be varied.

Usage Mode: Standard

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original Val
					Oversampling Factor	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1
			"Plane Wave" (# 0)		Input Field Size X	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1
			"Curved Surface"								

**Results**  
Start the parameter run and analyze its results

Go!

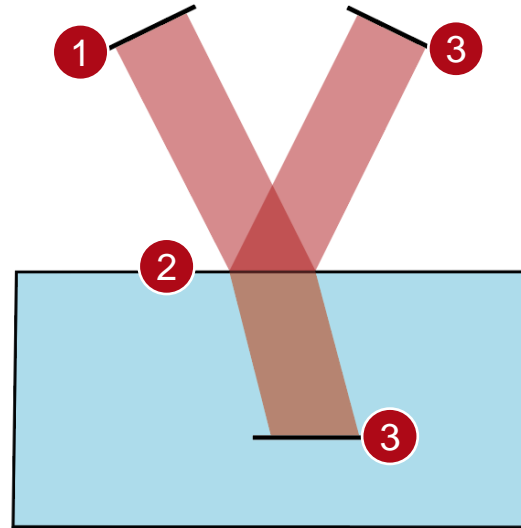
Use Already Calculated Results for Next Run

Detector	Subdetector	Combined Output	Iteration Step			
			9	10	11	12
Varied Parameters	Rotation # 1 (about Y-Axis),...	Data Array	8°	9°	10°	11°
"Universal Detector" (# 602...	Radiant Flux (Surface)	Data Array	965.88 mW	966.13 mW	966.41 mW	966.72 mW
"Universal Detector" (# 603...	Radiant Flux (Surface)	Data Array	34.117 mW	33.868 mW	33.589 mW	33.28 mW

Create Output from Selection

< Back    Next >    Show ▾

# Summary – Components...

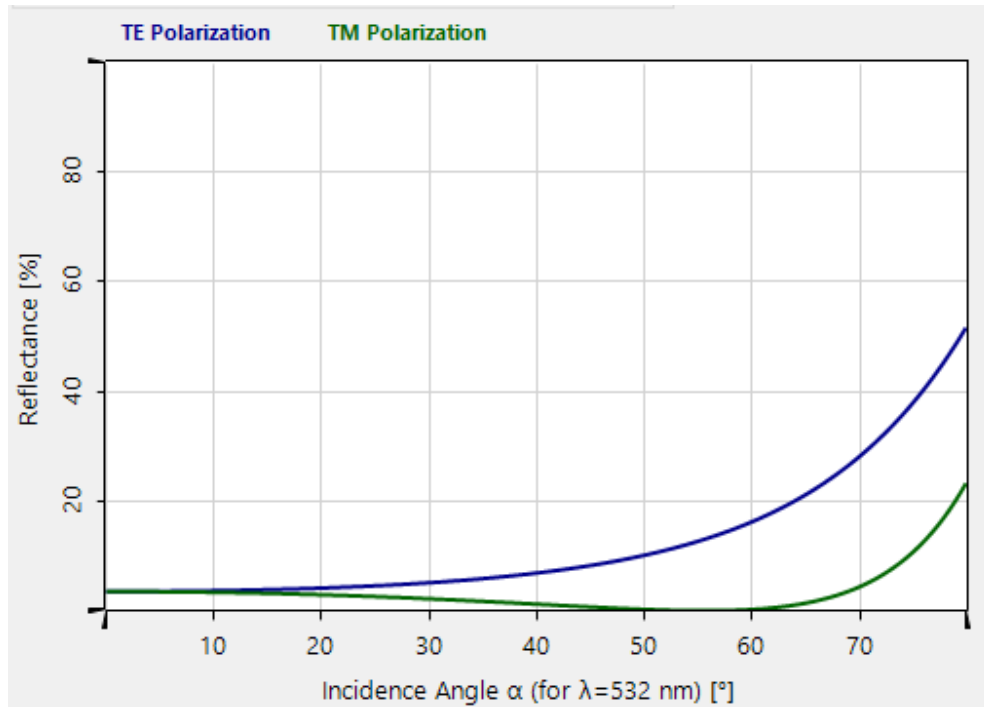


... of Optical System	... in VirtualLab Fusion	Model/Solver/Detected Magnitude
1. source	<i>Plane Wave</i>	truncated Ideal Plane Wave
2. surface	<i>Curved Surface Component</i>	Local Plane Interface Approximation (LPIA)
3. detector	<i>Universal Detector with Radiant Flux (Surface) Add-on</i>	Radiant Flux

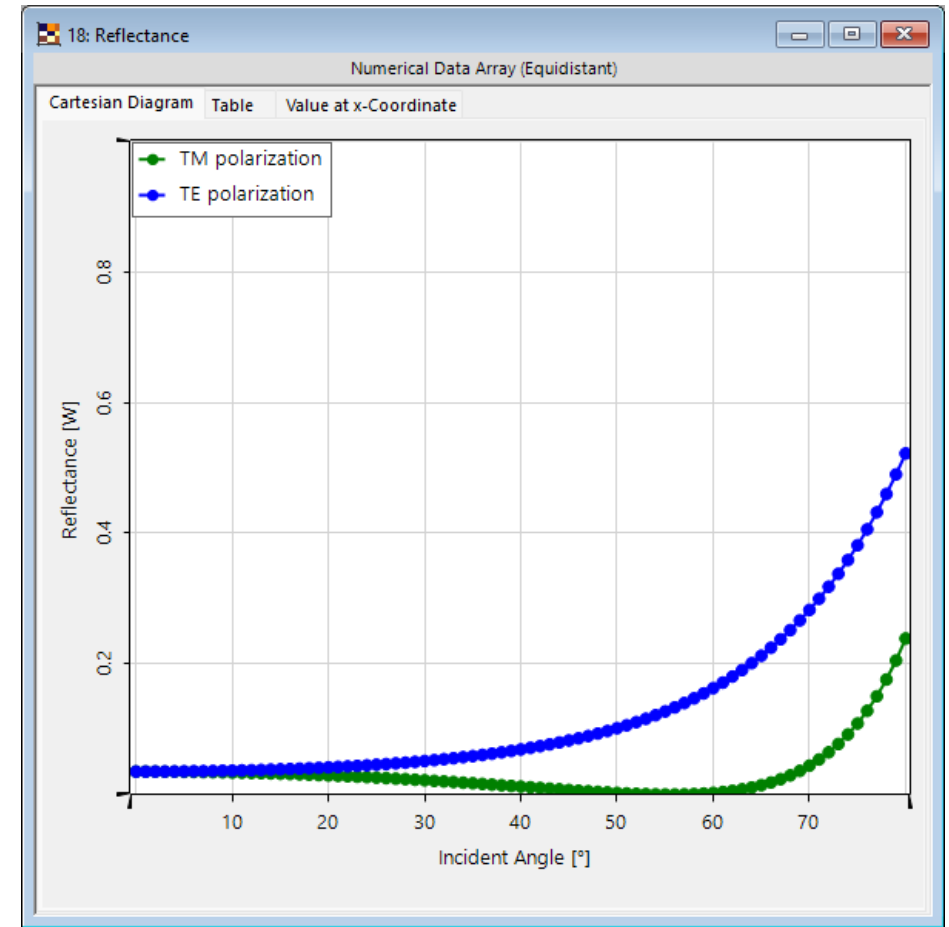


# Result: Reflectance for TE and TM polarized light

Now, the results of the reflectance determined by the Fresnel equation and the measured reflectance obtained by evaluation of the radiant flux are compared. The results show a perfect agreement, as well as exhibiting the expected dependencies.



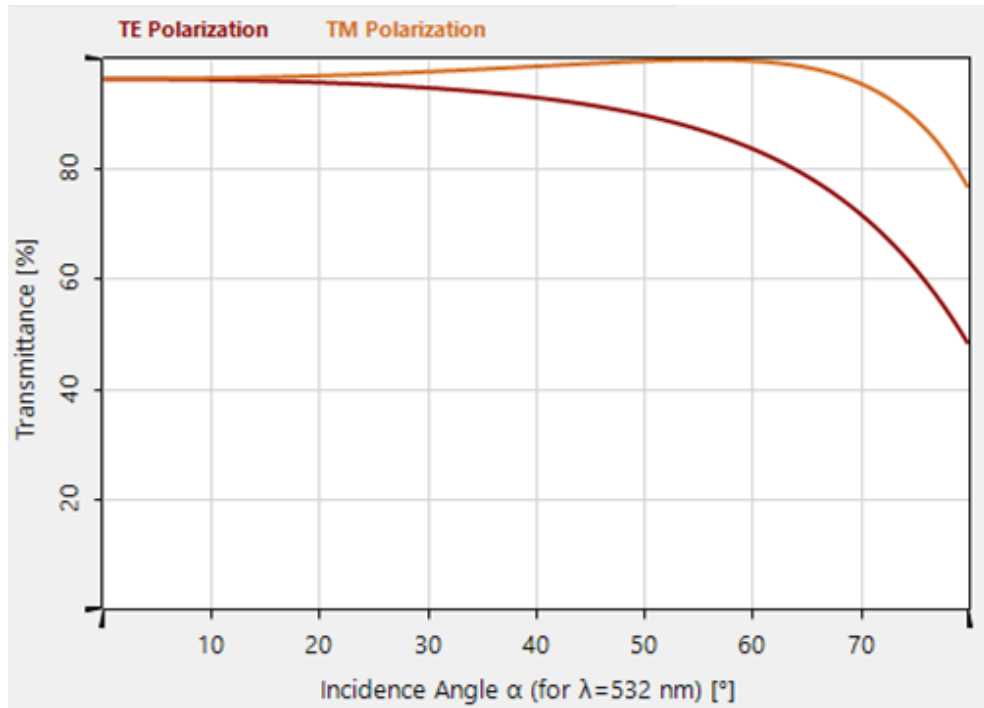
result of the calculator



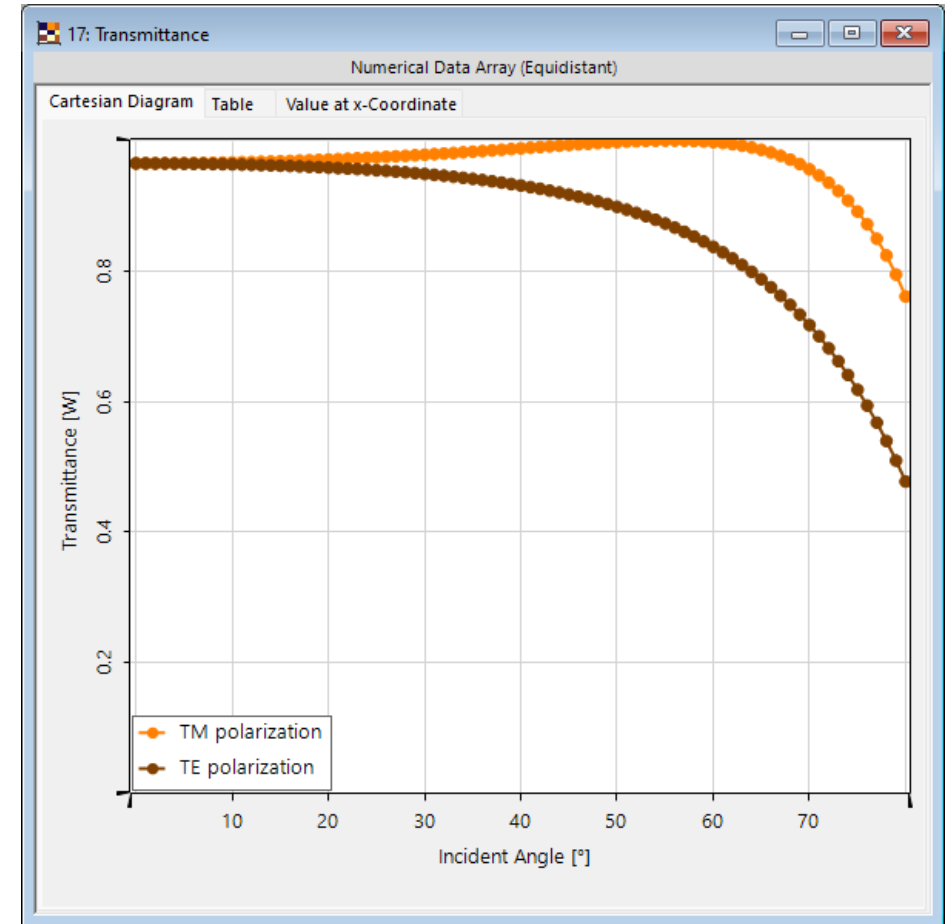
measured reflectance by radiant flux evaluation

# Result: Transmittance for TE and TM polarized light

Here, the results of the transmittance stated by the Fresnel equation and the measured values obtained by evaluation of the radiant flux are compared. Again, the results are identical, and show the expected characteristics.

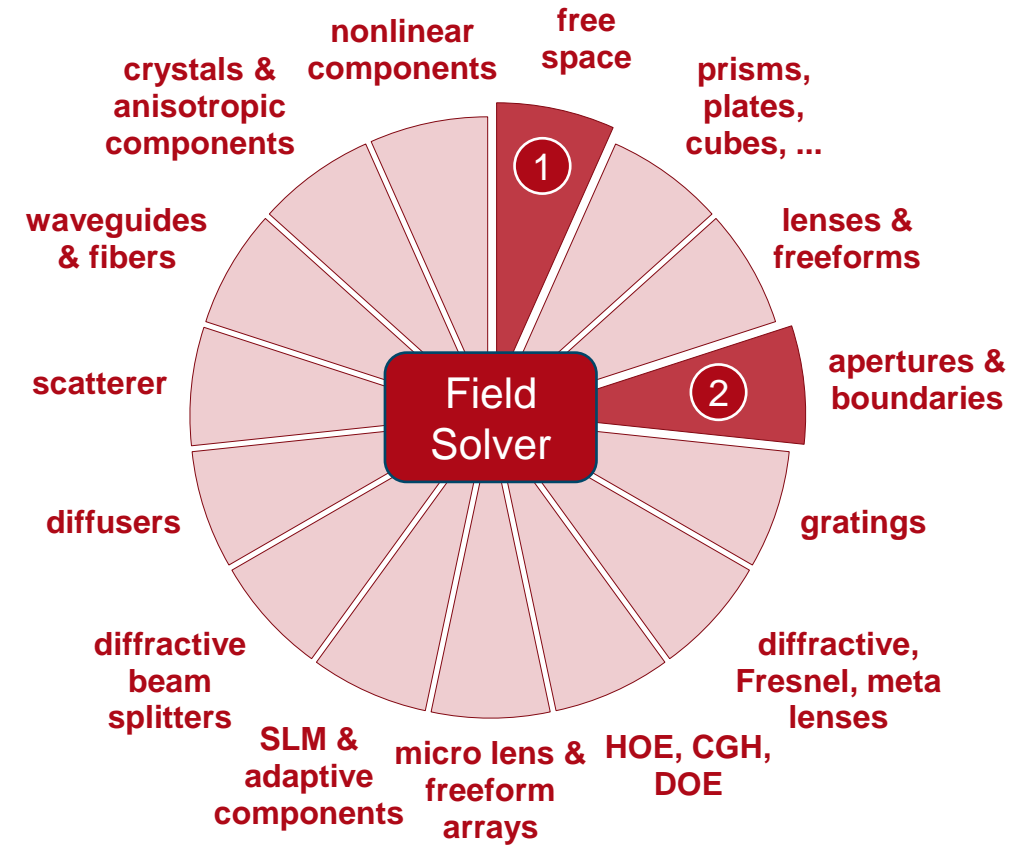
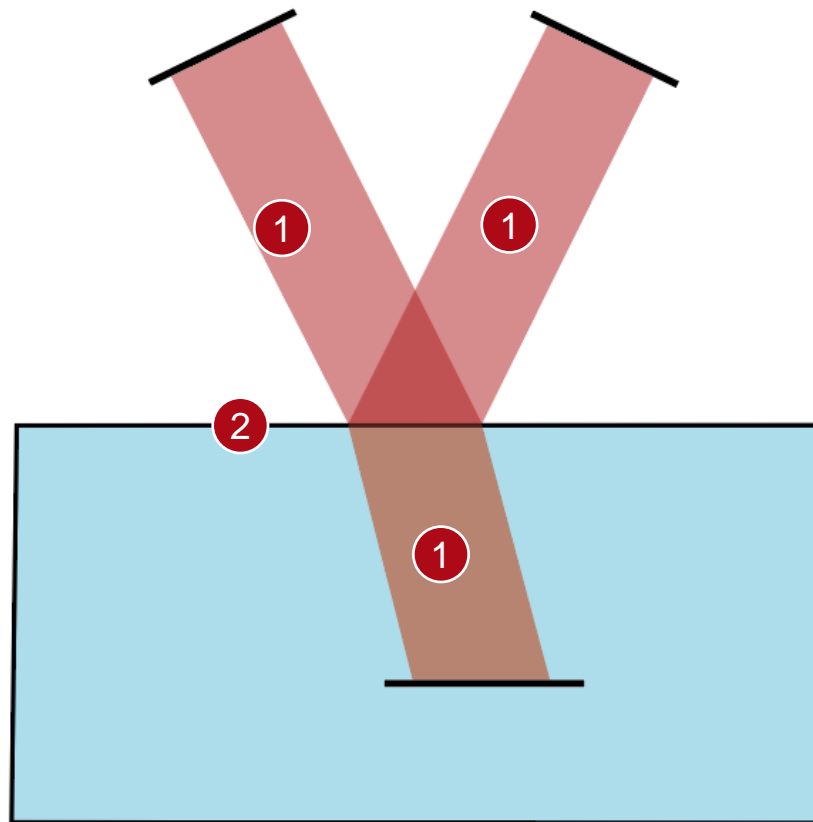


result of the calculator



measured transmittance by radiant flux evaluation

# VirtualLab Fusion Technologies



# Document Information

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title	Polarization and Angle-Dependent Transmittance and Reflectance at a Plane Interface
document code	MISC.0097
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software version	2022.1 (Build 1.554)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>• <a href="#">Universal Detector</a></li><li>• <a href="#">Usage of the Parameter Run Document</a></li></ul>