VirtualLab Applications, Technology & Workflows

Exploring VirtualLab Fusion

LightTrans International
Speaker: Olga Baladron-Zorita

Links of Interest

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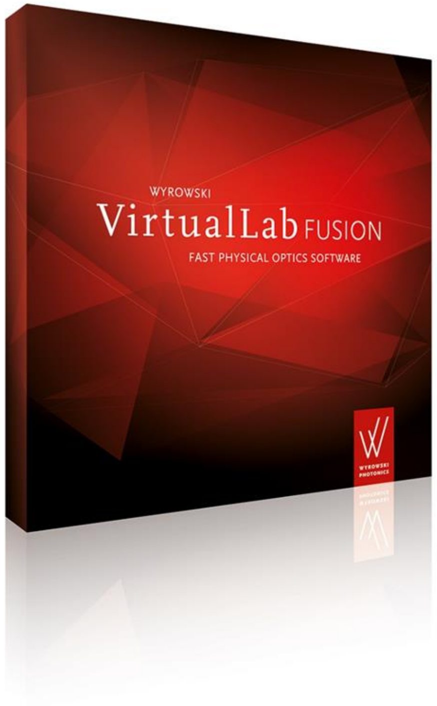
- Want to give VirtualLab Fusion a test drive? Request a trial version: www.LightTrans.com/resources/trial-software
- Interested in purchasing VirtualLab Fusion? Check out our products, licence model and learn more about additional evaluation possibilities: www.LightTrans.com/products-services/virtuallab-fusion/editions-toolboxes

Who We Are

General Distributor of the
Fast Physical Optics Software
VirtualLab Fusion

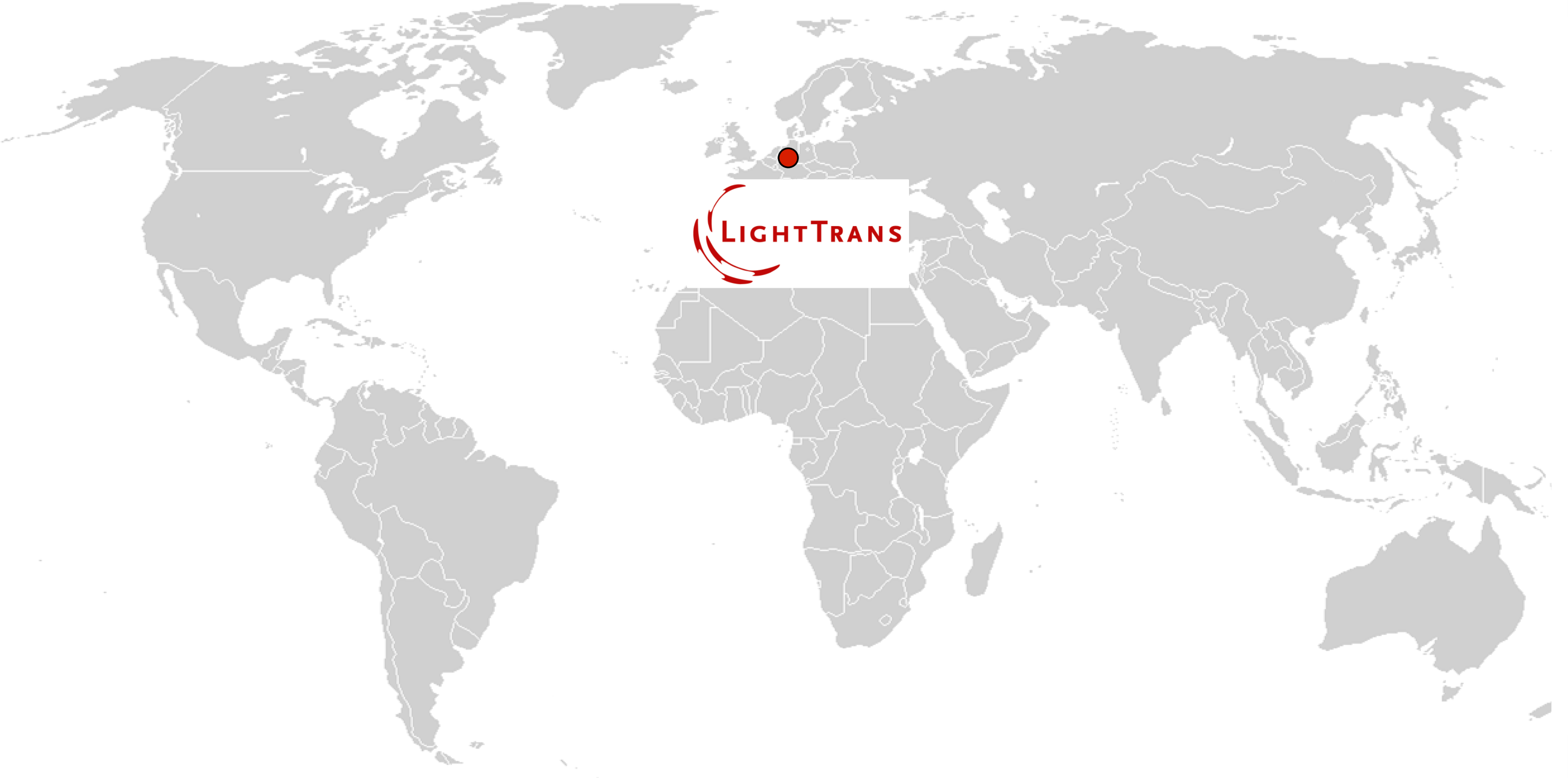
Founded 1999

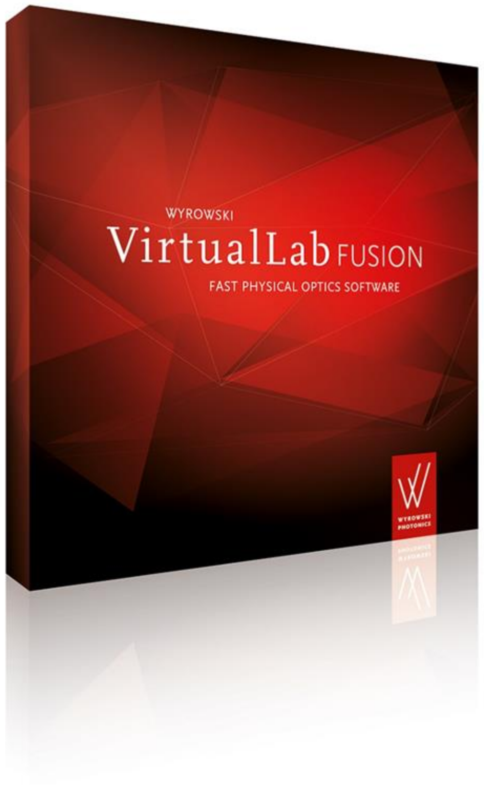


Developer of the
Fast Physical Optics Software
VirtualLab Fusion

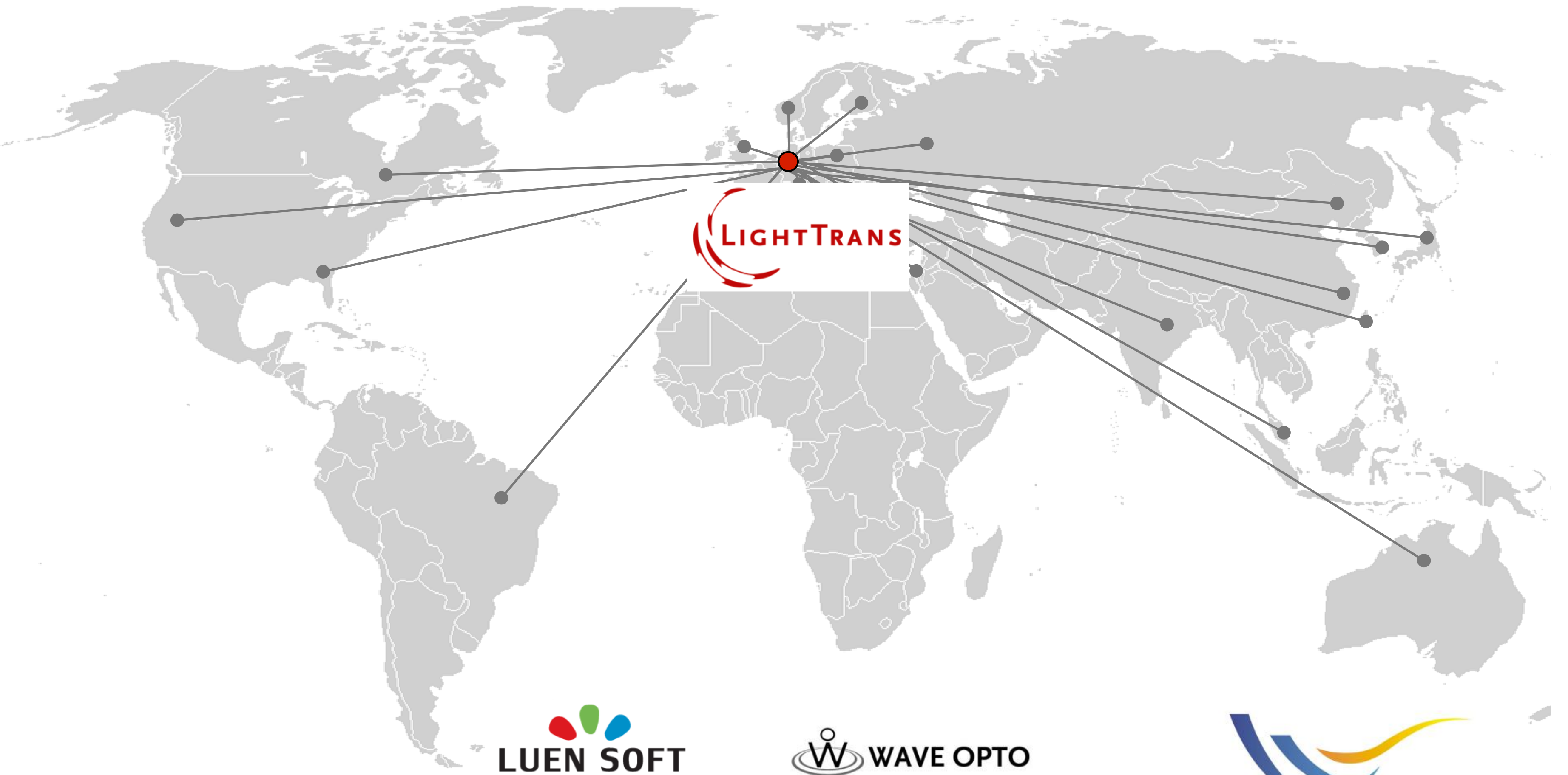
Founded 2014

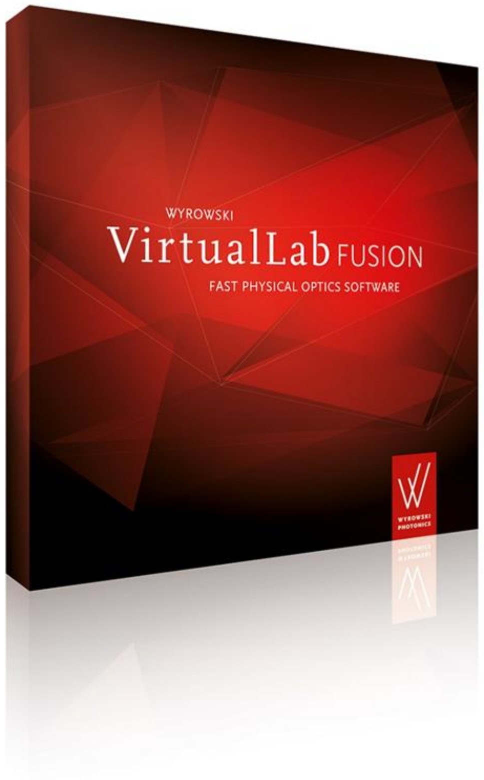
Fast Physical Optics Modeling and Design Software





Fast Physical Optics Modeling and Design Software





LUEN SOFT

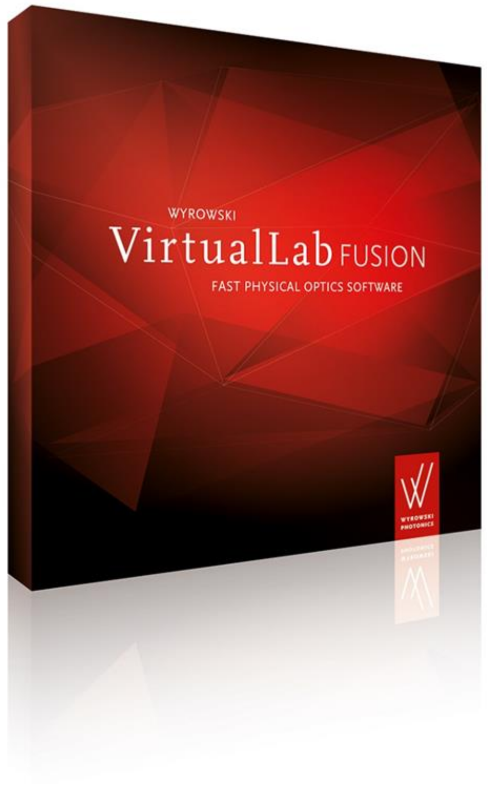
WAVE OPTO

T.E.M. Incorporated

INFOTEK

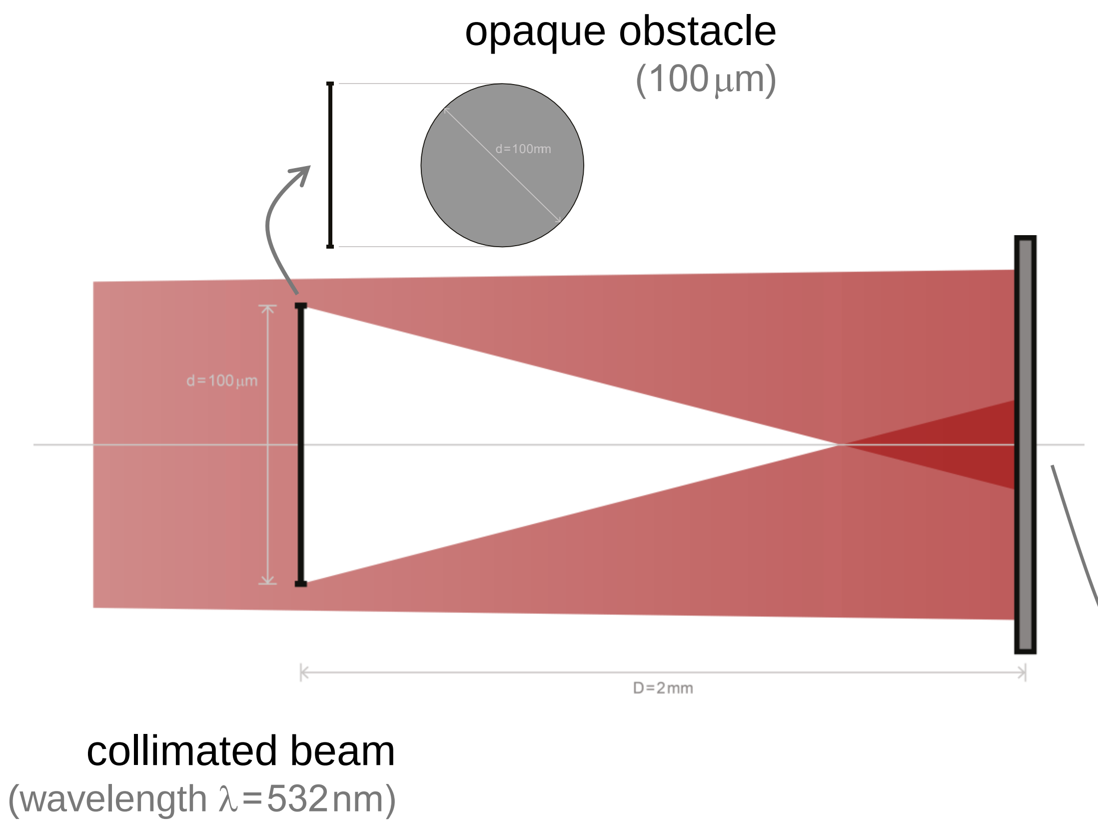
VirtualLab Fusion

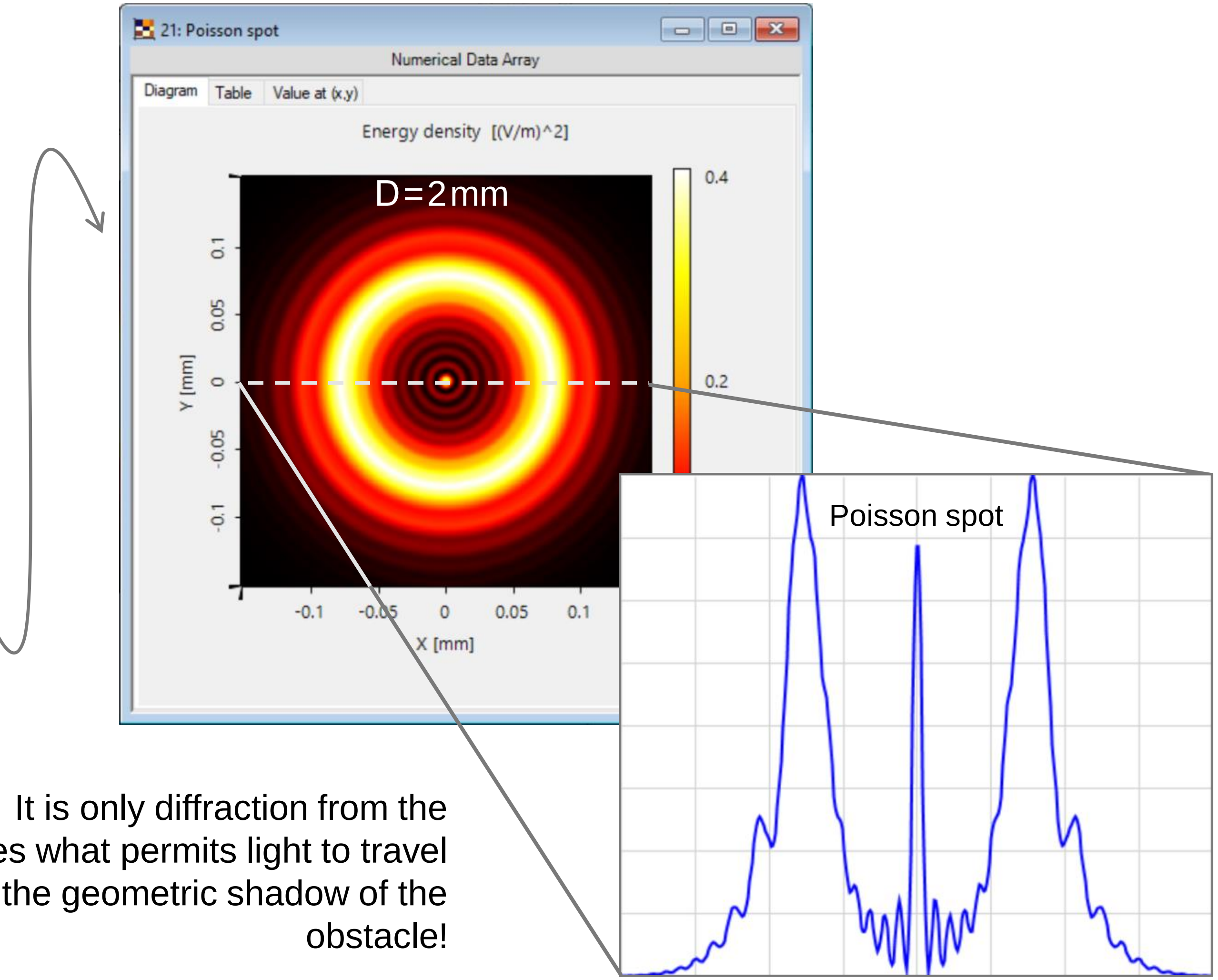
Connecting Field Solvers!



Configuring Detectors to Extract 1D Field Cross-Section

Observation of the Poisson spot

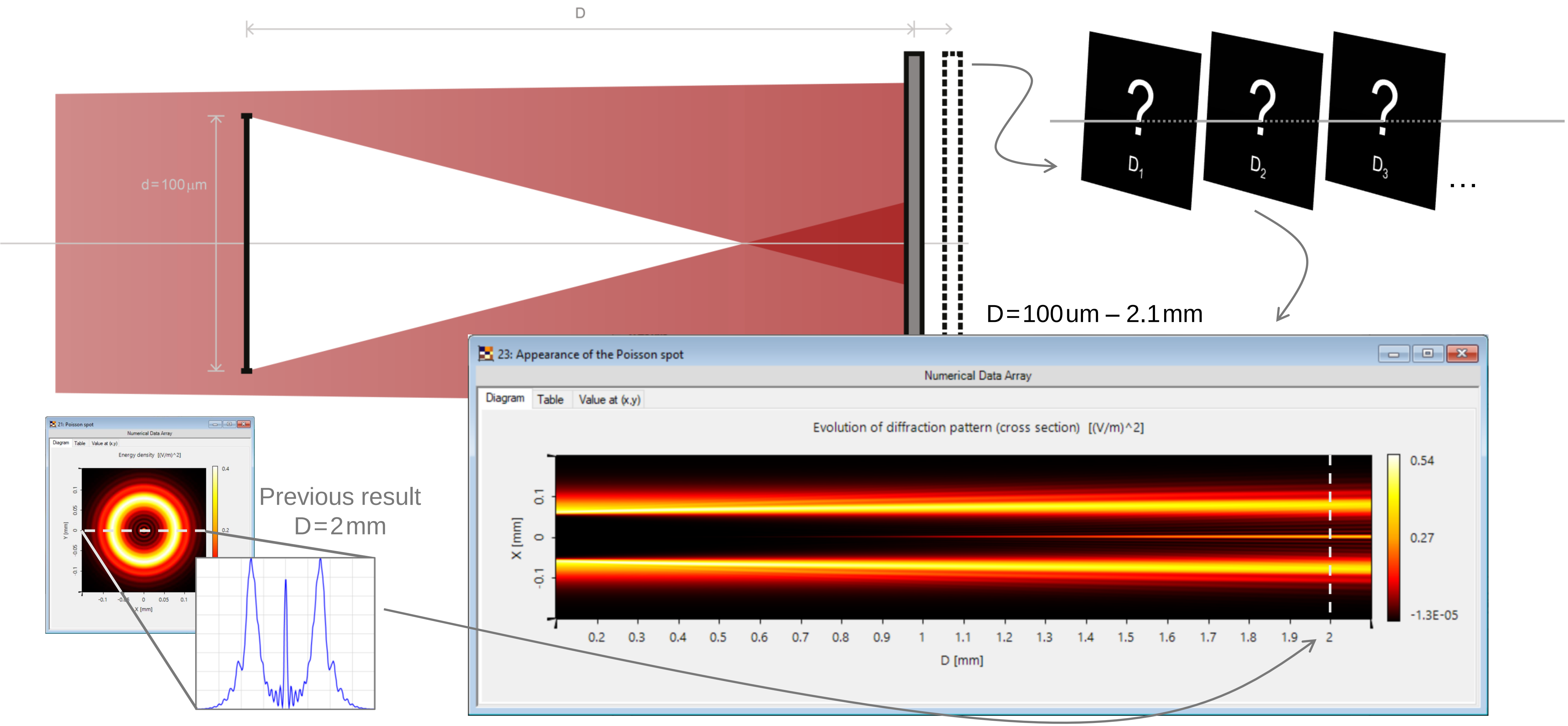




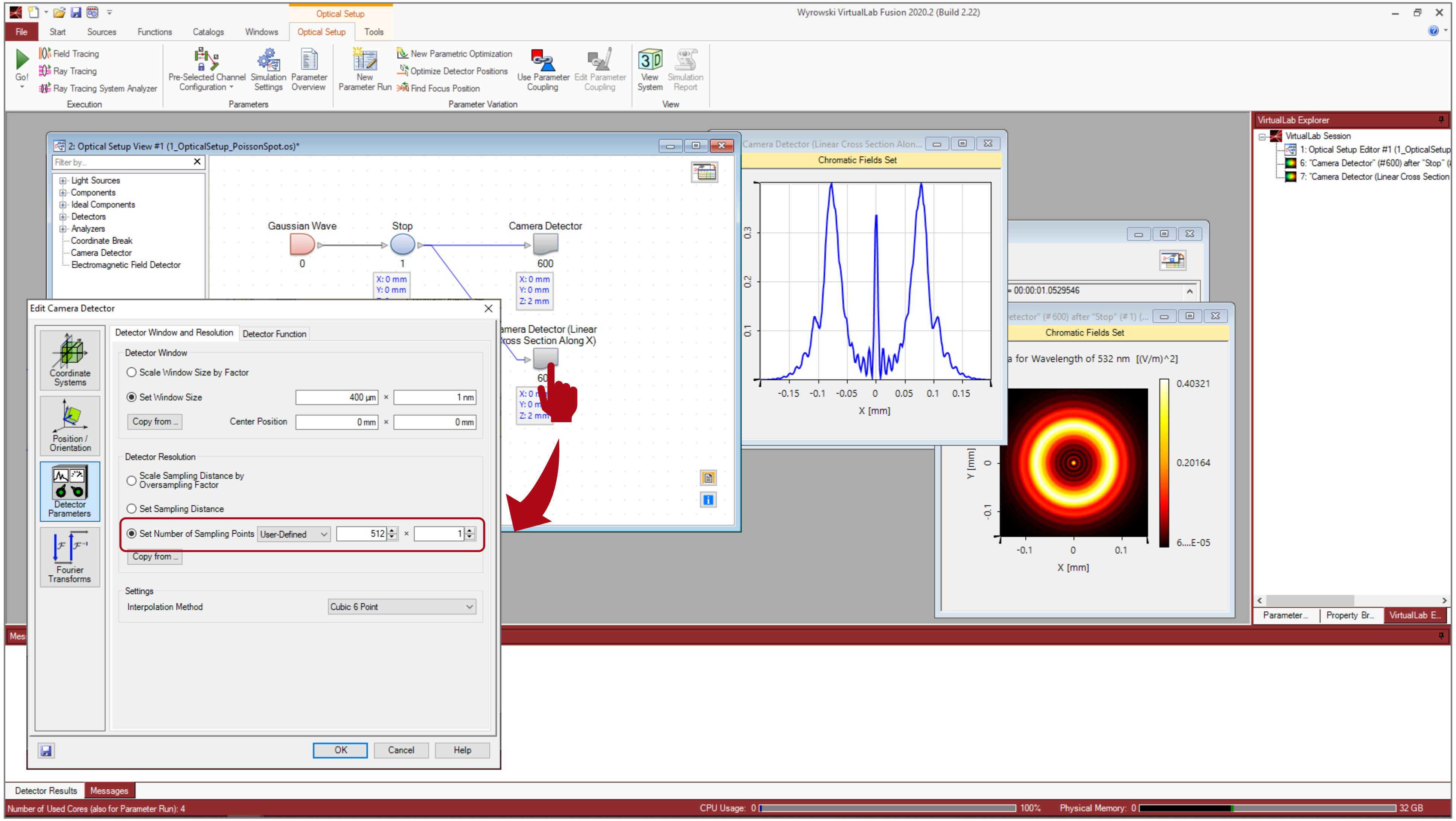
It is only diffraction from the edges what permits light to travel to the geometric shadow of the obstacle!

see the full Application Use Case: *"Observation of the Poisson Spot"*

Evolution of Diffraction Pattern and Appearance of the Spot



Configuring Detector for 1D Cross-Section



Visualization of Time Dependence of Electromagnetic Fields

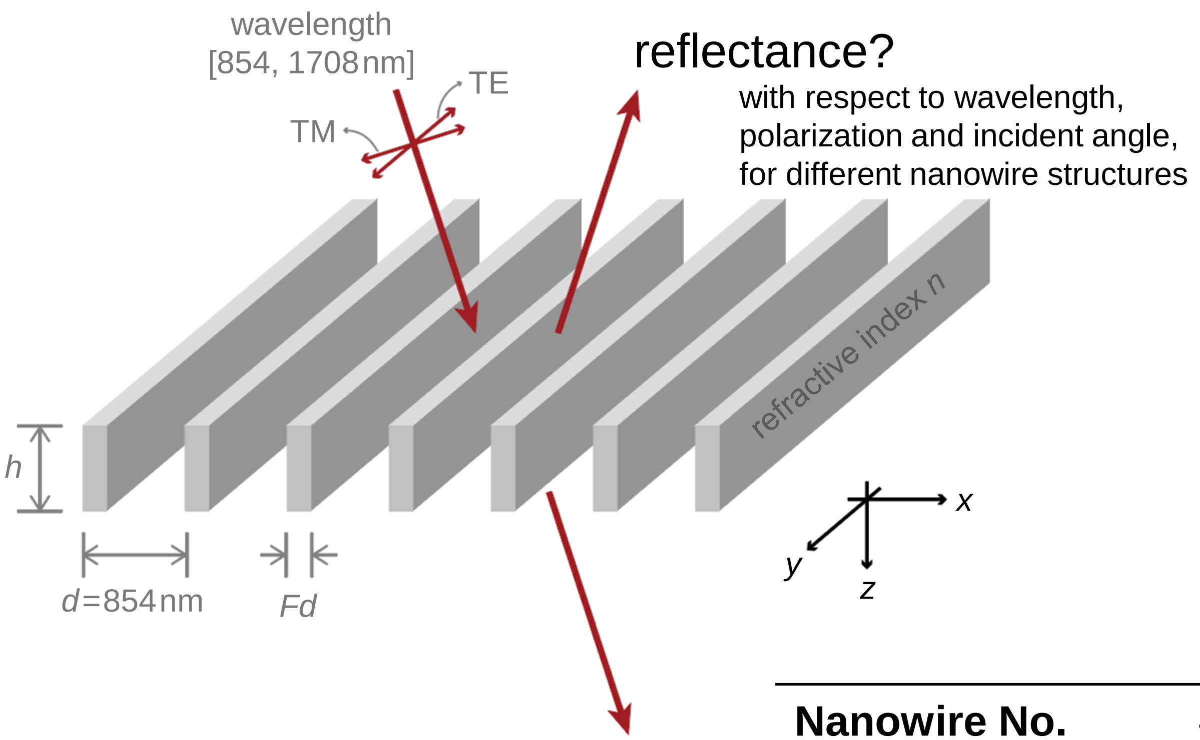
Visualization of Time Dependence of EM Fields

- In VirtualLab Fusion we model light as an **electromagnetic field**: a six-dimensional vector field which follows Maxwell's equations.

- We mostly work with **complex-valued fields** – well-known mathematical trick to swap trigonometric functions for complex exponentials, which are easier to handle!

- To explore the time dependence of the fields, we must retrieve the real part.

Modeling Task



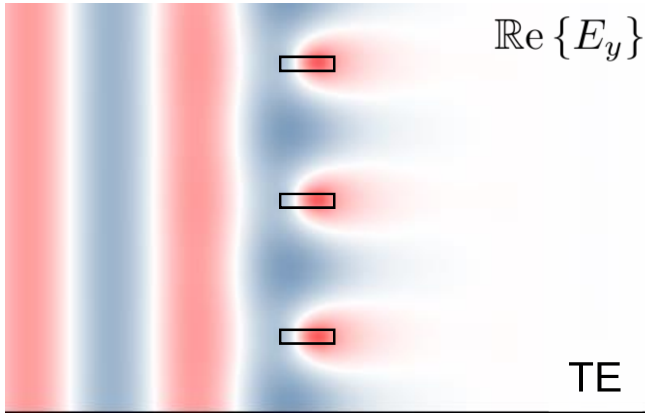
Nanowire No.	#1	#2	#3
refractive index *n*	10	7.07	3.16
height *h*	269 nm	270 nm	292 nm
filling factor *F*	0.01	0.02	0.1

Parameters are taken from reference paper: J. W. Yoon *et al*., Opt. Express **23**, 28849-28856 (2015).

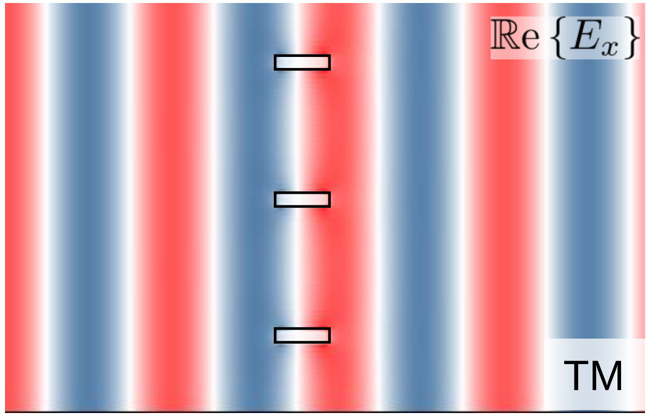
see the full Application Use Case:
"Ultra-Sparse Dielectric Nano-Wire Grid Polarizers"

Visualization of Field Inside Grating

Fourier modal method (FMM) simulation in VirtualLab Fusion @1045 nm

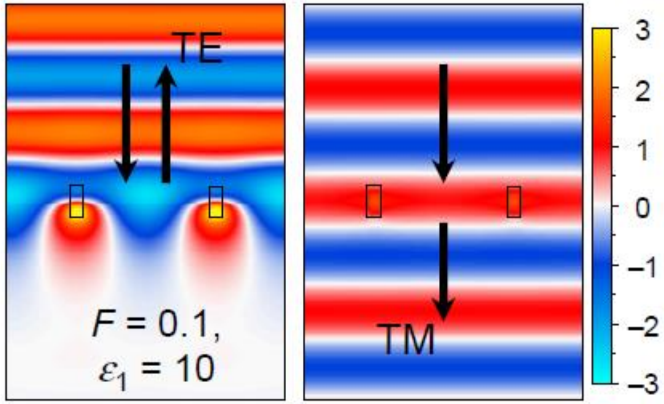


[animation]



[animation]

reference results from the literature



Nanowire No.	#1	#2	#3
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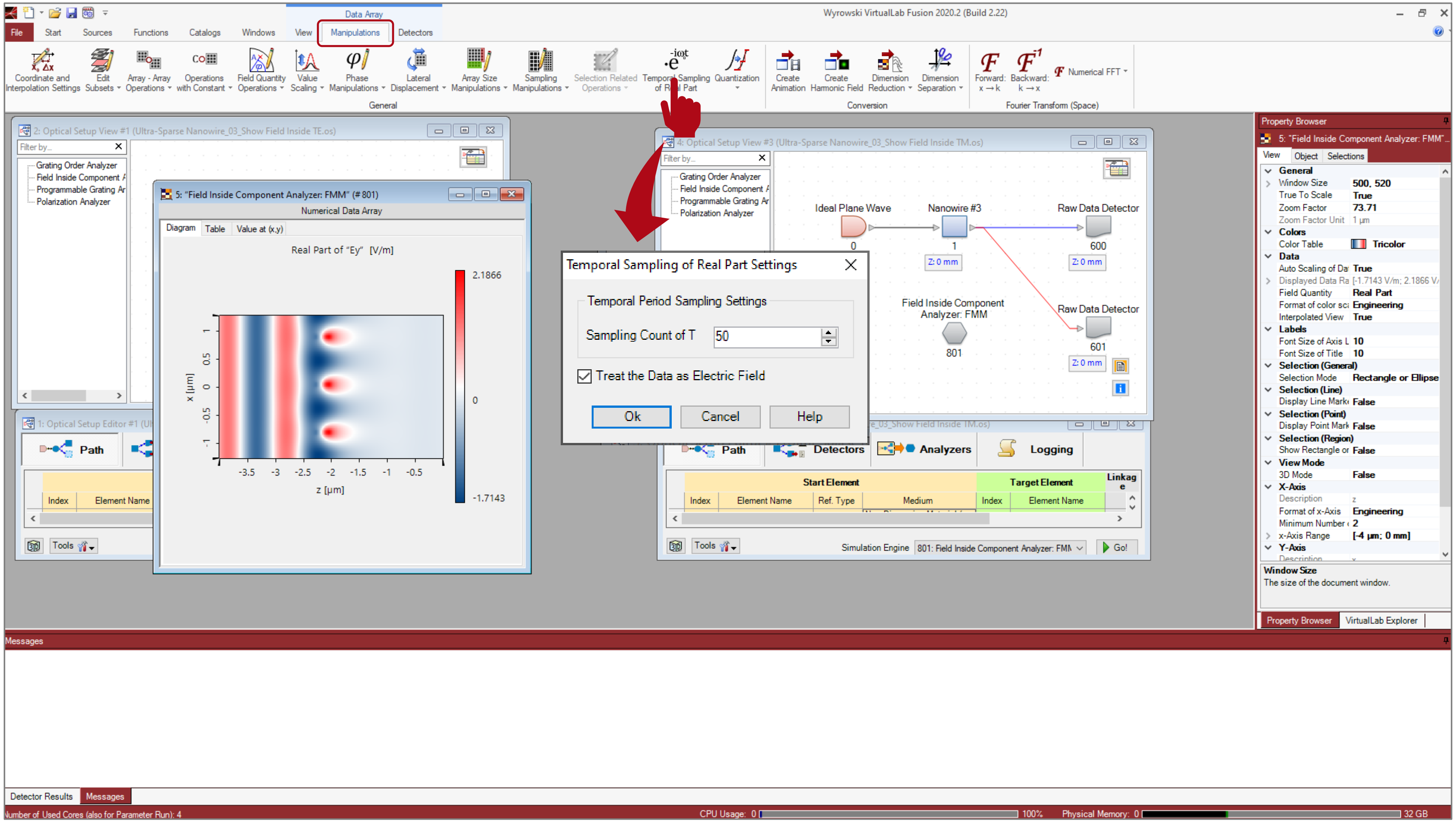
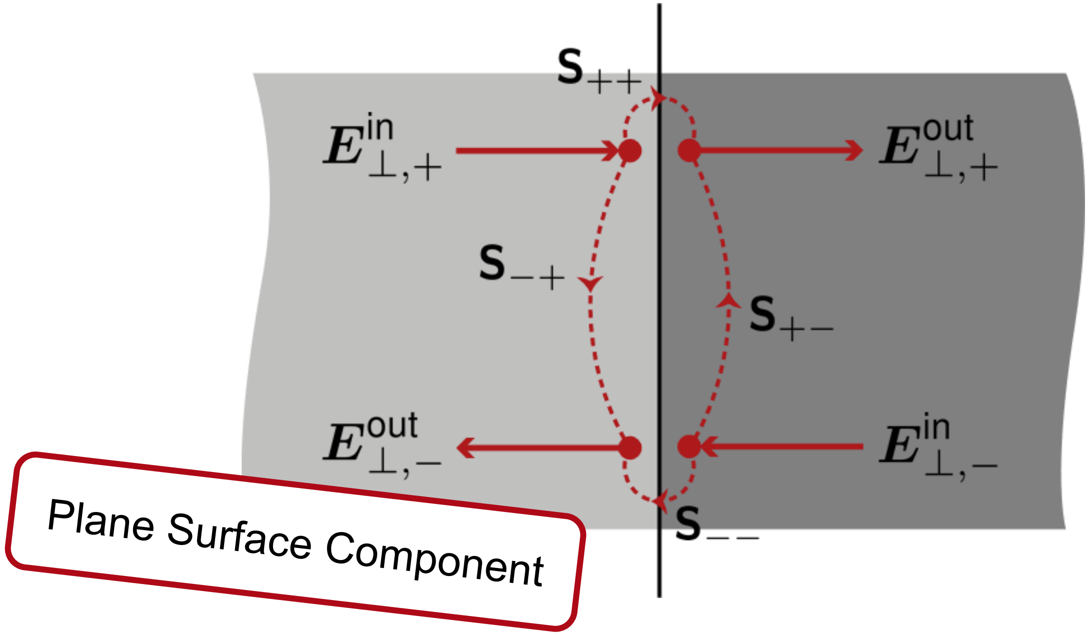
Visualization of Time Dependence of EM Fields



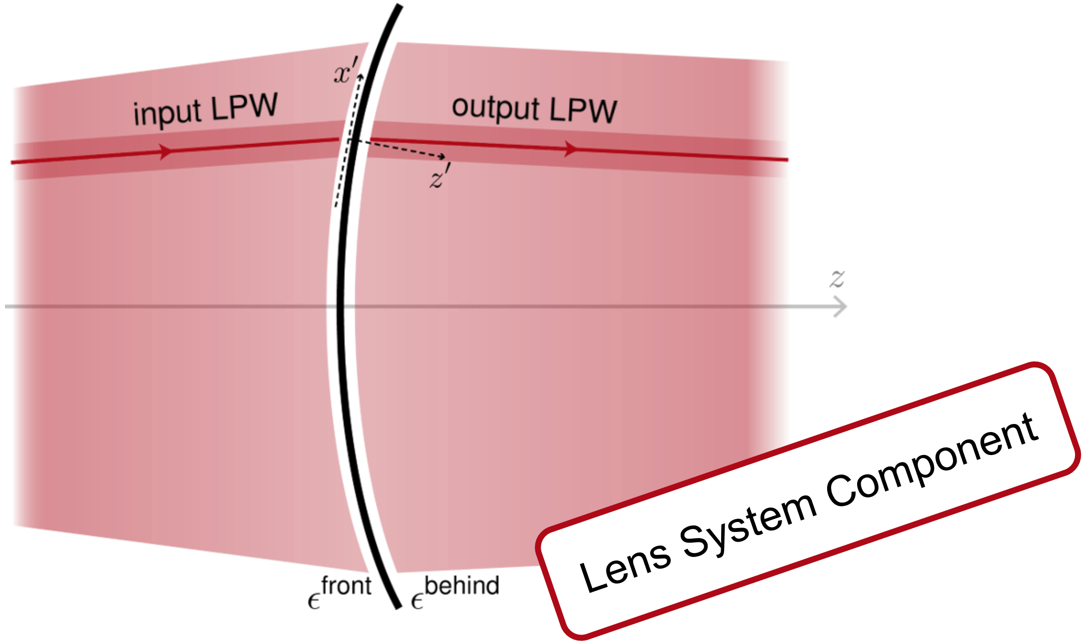
Plane Surfaces in your Optical System

Field Solvers for Plane Surfaces

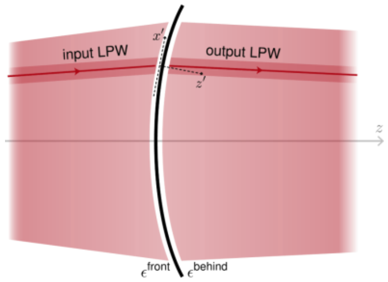
- Assuming infinitely extended ideal plane surface ➔ Fresnel Matrix
- Solver in **k domain**



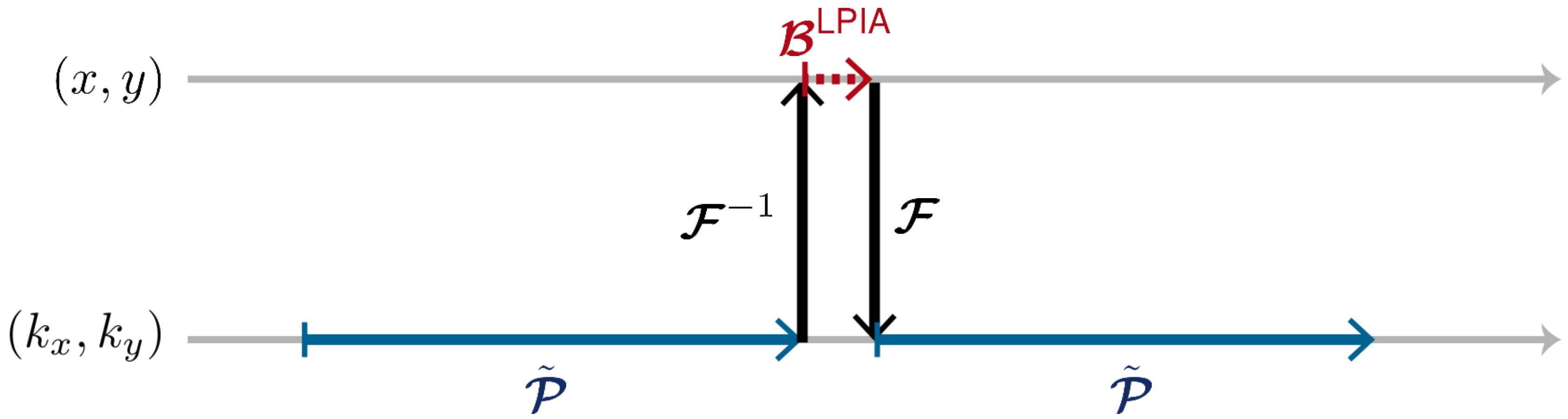
- As a curved surface without curvature ➔ Local Plane Interface Approximation
- Solver in **x domain**



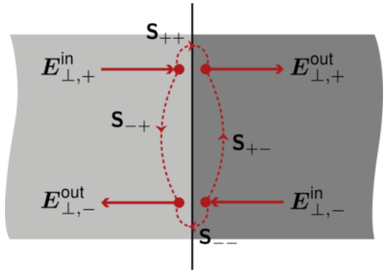
Field Solvers for Plane Surfaces: Modeling Sequence



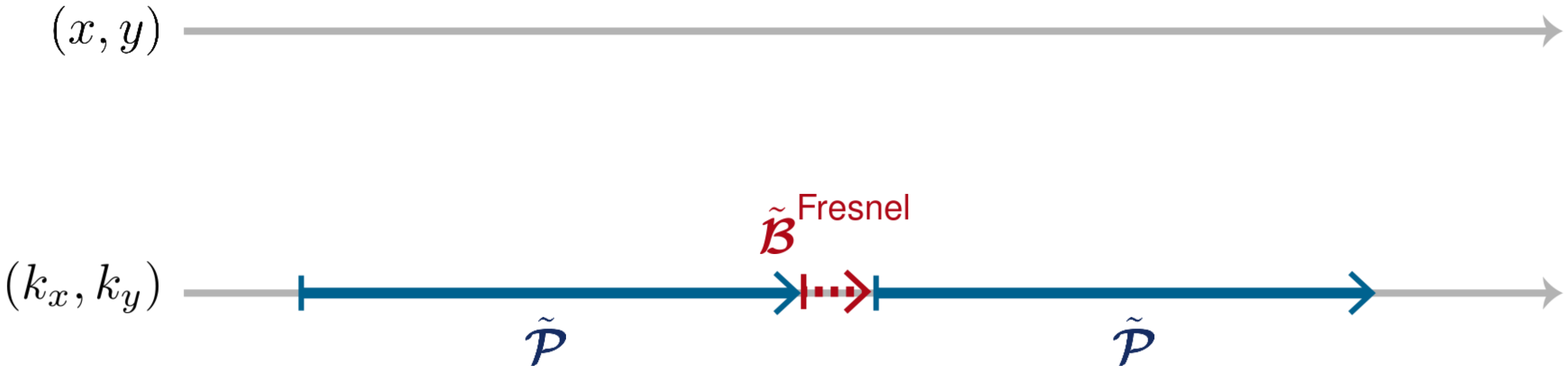
Plane Surface in Lens System



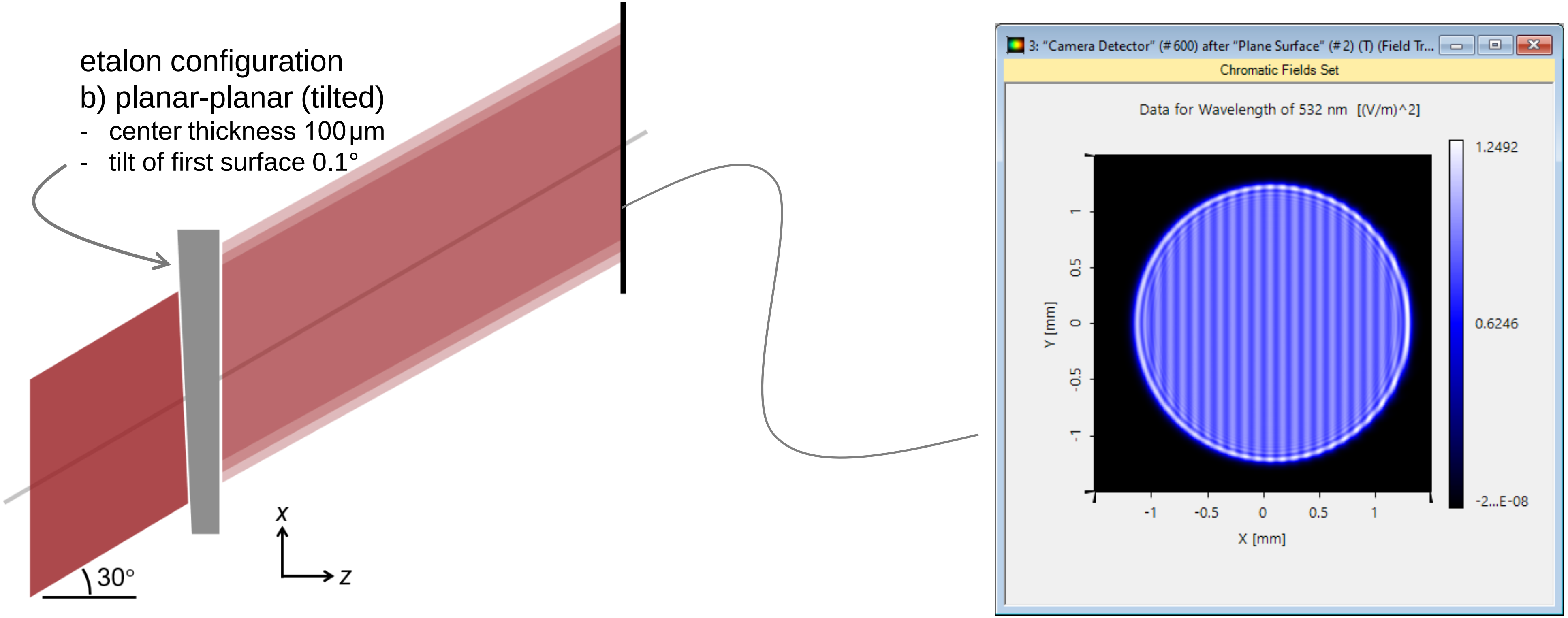
Field Solvers for Plane Surfaces: Modeling Sequence



Plane Surface Component

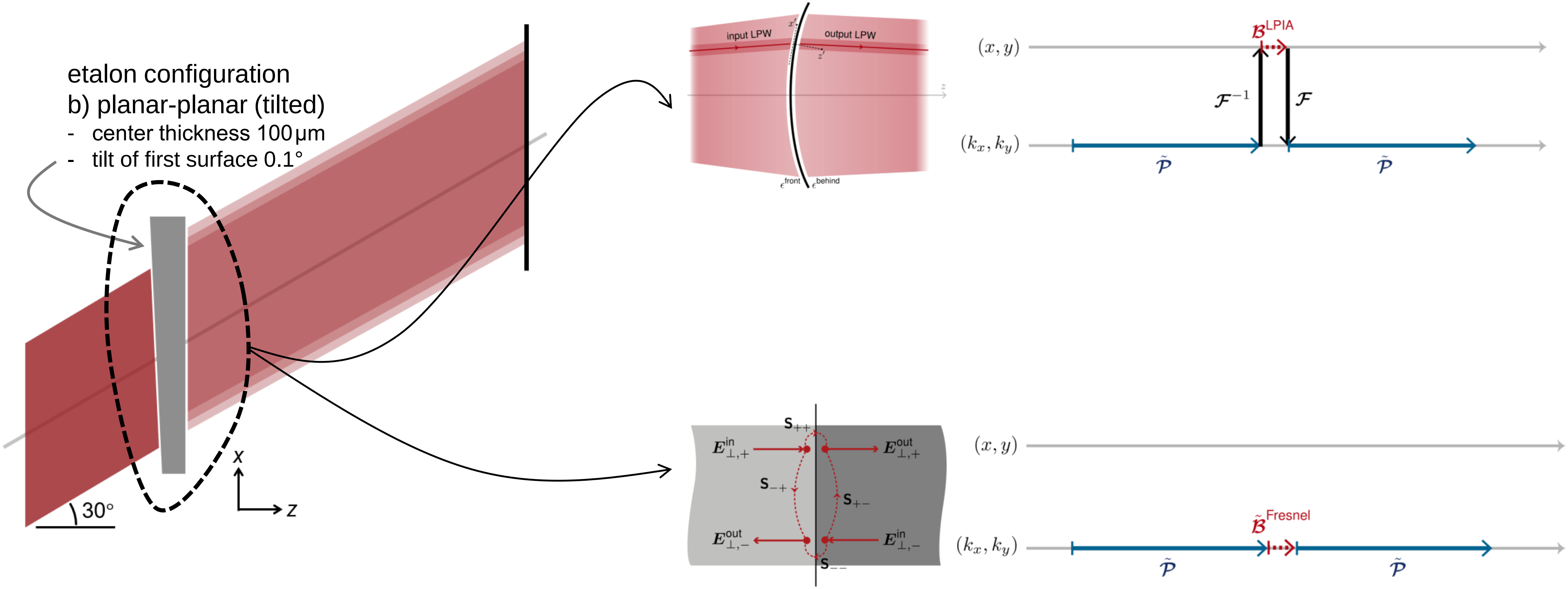


Modeling an Etalon with Plane Interfaces…



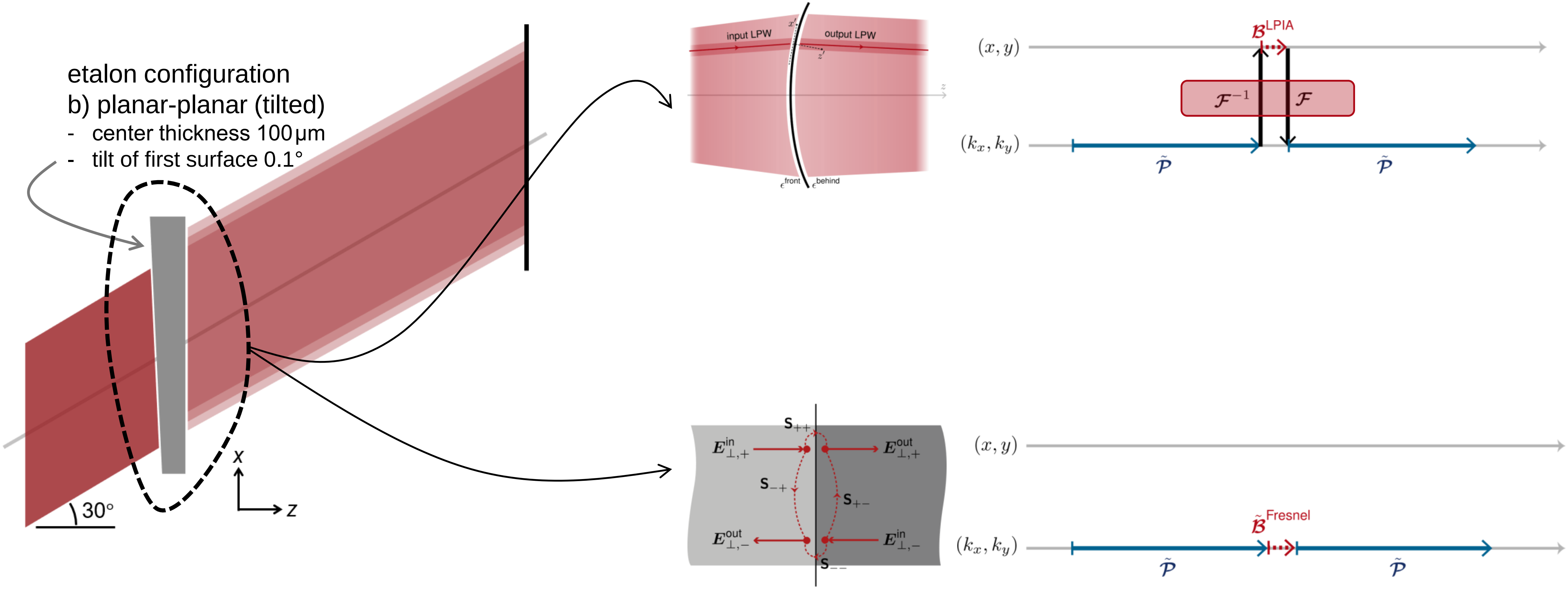
[see the full Application Use Case:
“Modeling of Etalon with Planar or Curved Surfaces”]

… Two Ways



etalon configuration
b) planar-planar (tilted)
- center thickness 100 µm
- tilt of first surface 0.1°
30°
x
z
input LPW
output LPW
ϵ^{front}
ϵ^{behind}
(x, y)
(k_x, k_y)
$\mathcal{B}^{LPIA}$
$\mathcal{F}^{-1}$
$\mathcal{F}$
$\tilde{\mathcal{P}}$
$\tilde{\mathcal{P}}$
S_{++}
S_{-+}
S_{+-}
S_{--}
$E^{in}_{\perp,+}$
$E^{out}_{\perp,+}$
$E^{out}_{\perp,-}$
$E^{in}_{\perp,-}$
(x, y)
(k_x, k_y)
$\tilde{\mathcal{B}}^{Fresnel}$
$\tilde{\mathcal{P}}$
$\tilde{\mathcal{P}}$

… Two Ways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b) planar-planar (tilted)
- center thickness 100 µm
- tilt of first surface 0.1°
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input LPW
output LPW
ϵ^{front}
ϵ^{behind}
(x, y)
(k_x, k_y)
$\mathcal{B}^{LPIA}$
$\mathcal{F}^{-1}$
$\mathcal{F}$
$\tilde{\mathcal{P}}$
$\tilde{\mathcal{P}}$
S_{++}
S_{-+}
S_{+-}
S_{--}
$E^{in}_{\perp,+}$
$E^{out}_{\perp,+}$
$E^{out}_{\perp,-}$
$E^{in}_{\perp,-}$
(x, y)
(k_x, k_y)
$\tilde{\mathcal{B}}^{Fresnel}$
$\tilde{\mathcal{P}}$
$\tilde{\mathcal{P}}$

Conclusions

Two possible solvers for plane interfaces in an optical system: the Fresnel Matrix and the Local Plane Interface Approximation (LPIA). Which one is more appropriate for your system depends on the circumstances:

Fresnel Matrix

- Assumes ideal plane surface
- Works in spatial-frequency (k) domain
- Reduces the number of Fourier transforms to be calculated ➔ potential numerical gain
- Assumes infinite surface

LPIA

- Solver for curved surfaces (plane surface = zero curvature)
- Works in spatial (x) domain
- Requires computation of more Fourier transforms
- Includes finite size of surface

Related Use Cases

- Observation of the Poisson Spot (link)
- Ultra-Sparse Dielectric Nano-Wire Grid Polarizers (link)
- Modeling of Etalon with Planar or Curved Surfaces (link)
- Channel Configuration for Surfaces and Grating Regions (link)
- Fourier Transform Settings – Discussion at Examples (link)
- Automatic Selection of Fourier Transforms in Free-Space Propagation (link)