

**VirtualLab Applications, Technology & Workflows**

## **Exploring VirtualLab Fusion**

LightTrans International

Speaker: Olga Baladron-Zorita

# Links of Interest

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- LightTrans website: [www.LightTrans.com](http://www.LightTrans.com)
- Our past webinars: [www.LightTrans.com/products-services/learning/webinars](http://www.LightTrans.com/products-services/learning/webinars)
- Find a VirtualLab Fusion distributor in your region: [www.LightTrans.com/company/distributors](http://www.LightTrans.com/company/distributors)
- You have further questions? Drop us a line at [info@LightTrans.com](mailto:info@LightTrans.com)
- Subscribe to our newsletter: [www.LightTrans.com/newsletter](http://www.LightTrans.com/newsletter)
- Connect with us on the following social networks:
  - LinkedIn ([www.linkedin.com/company/lighttrans](http://www.linkedin.com/company/lighttrans))
  - Twitter ([www.twitter.com/LightTrans](http://www.twitter.com/LightTrans))
  - YouTube ([www.youtube.com/LightTransInternational](http://www.youtube.com/LightTransInternational))
- Check out our downloads page to see VirtualLab in action across a broad range of fields of application: [www.LightTrans.com/resources/downloads](http://www.LightTrans.com/resources/downloads)
- Want to give VirtualLab Fusion a test drive? Request a trial version: [www.LightTrans.com/resources/trial-software](http://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](http://www.LightTrans.com/products-services/virtuallab-fusion/editions-toolboxes)

# Who We Are



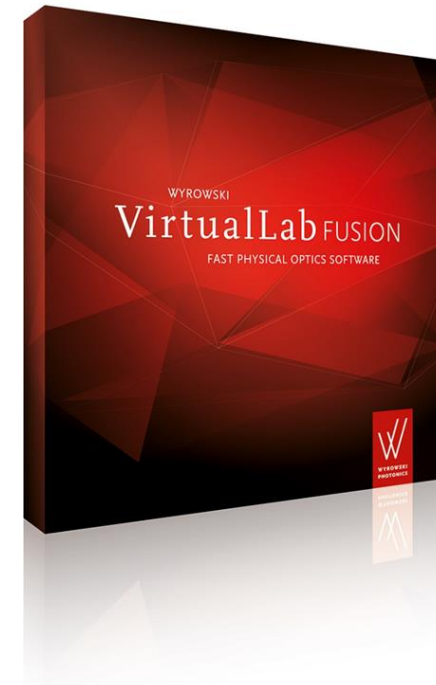
Founded 1999



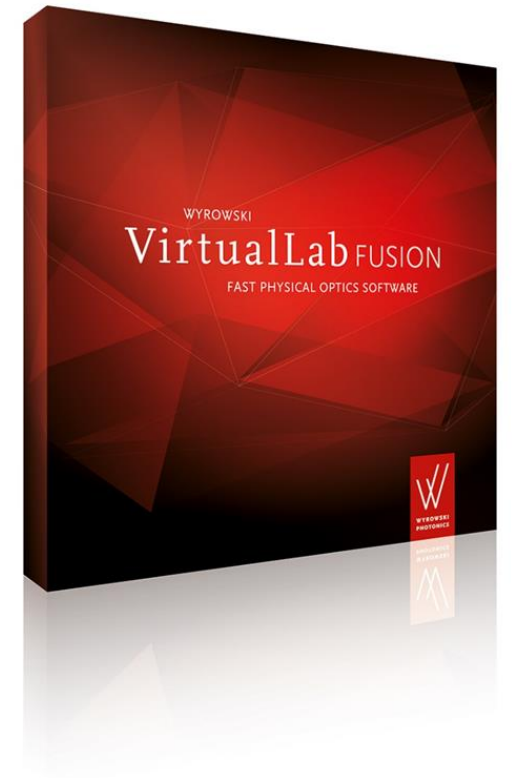
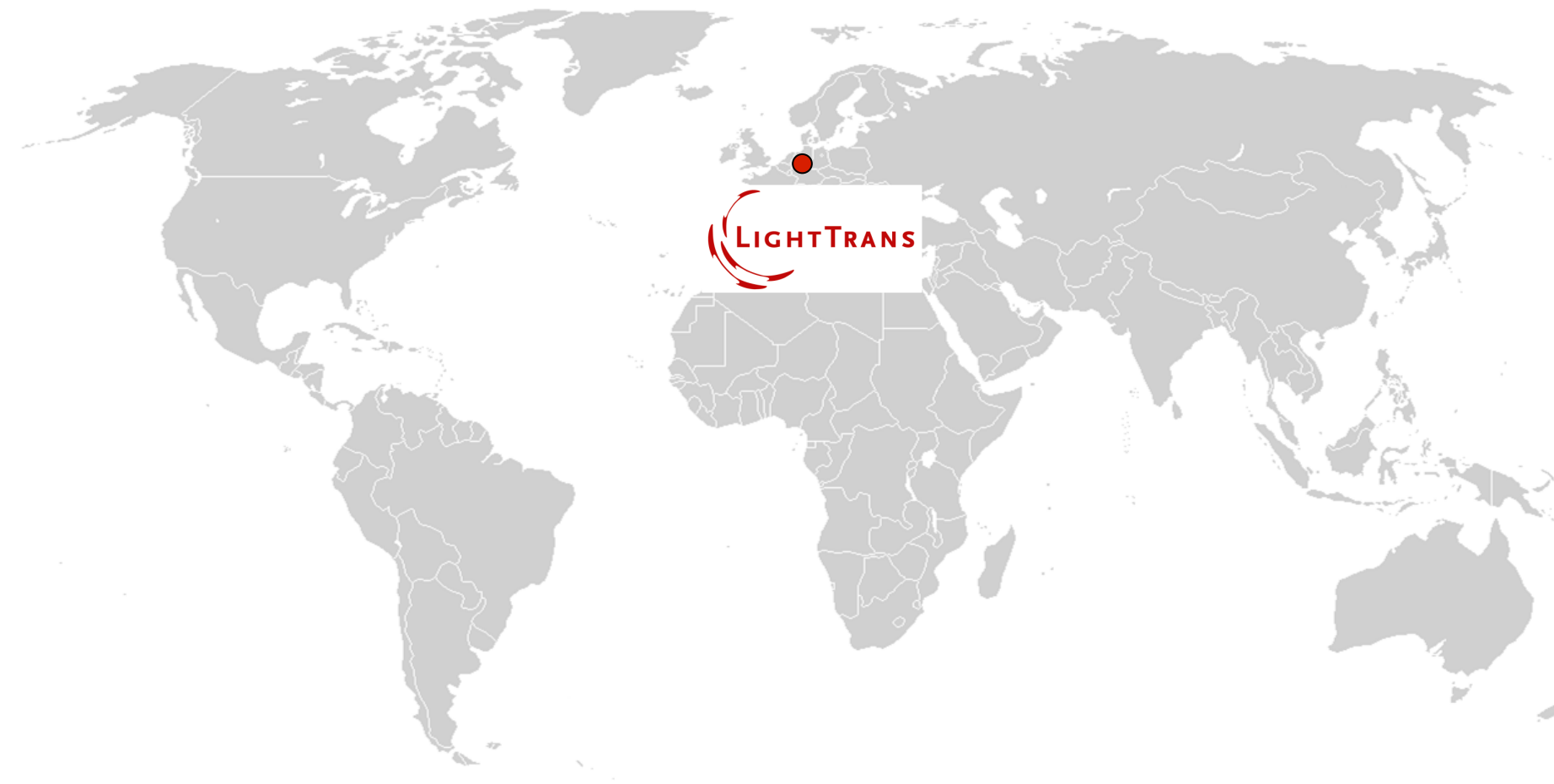
Founded 2014

General Distributor of the  
Fast Physical Optics Software  
**VirtualLab Fusion**

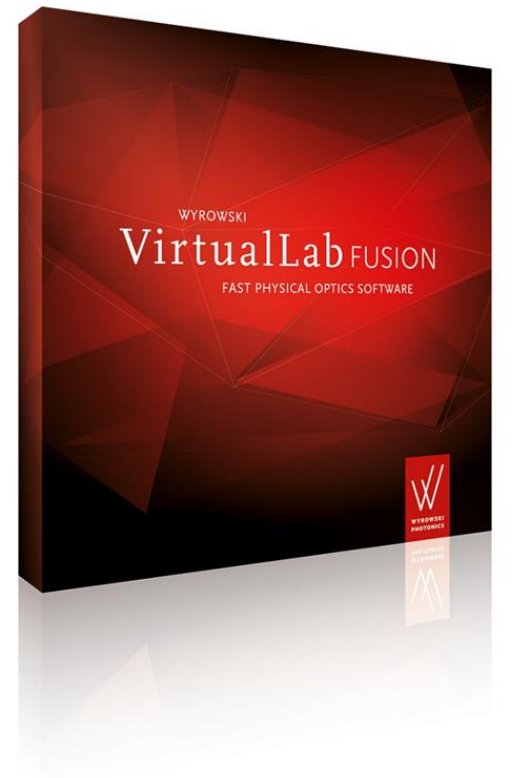
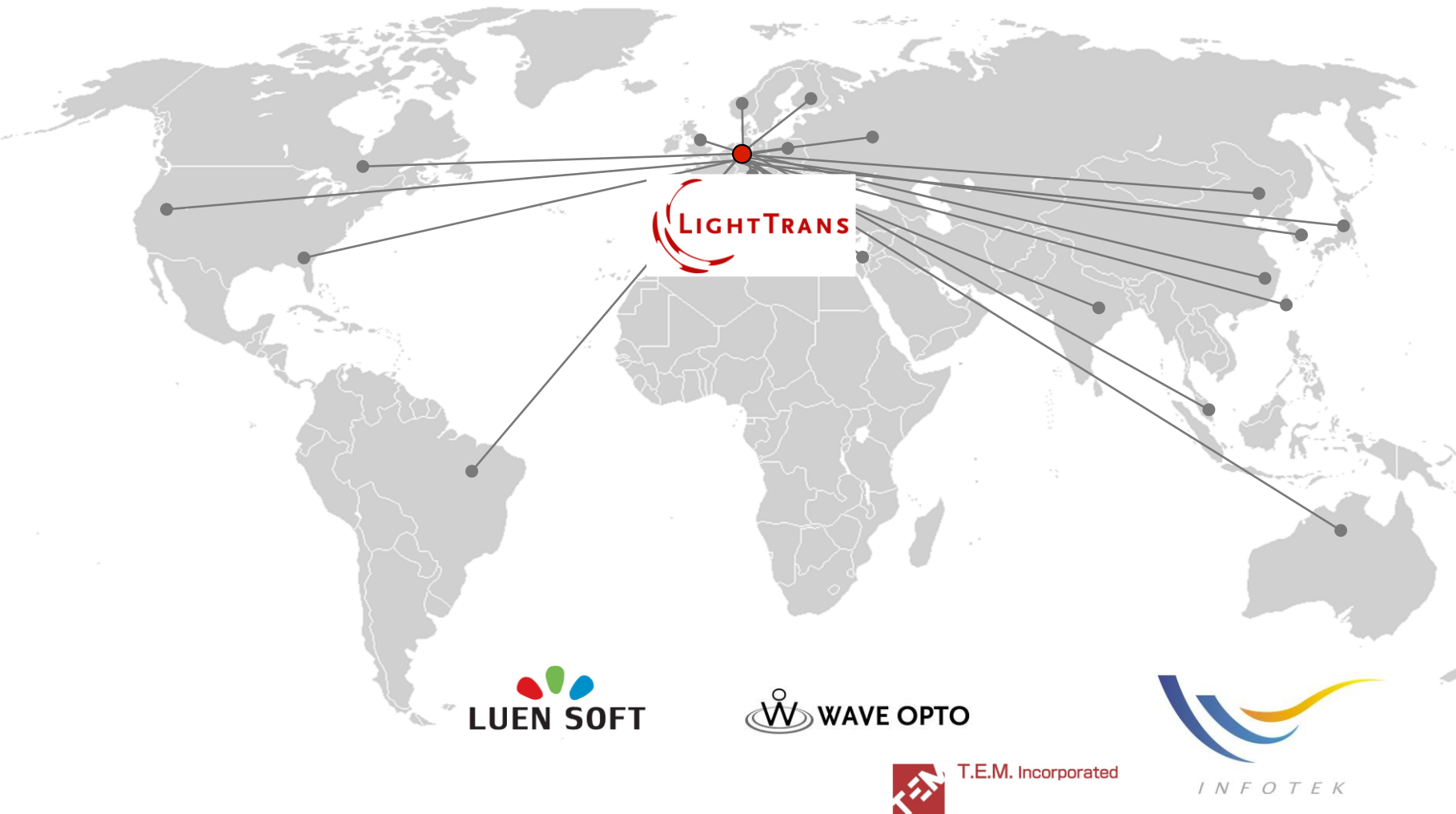
Developer of the  
Fast Physical Optics Software  
**VirtualLab Fusion**



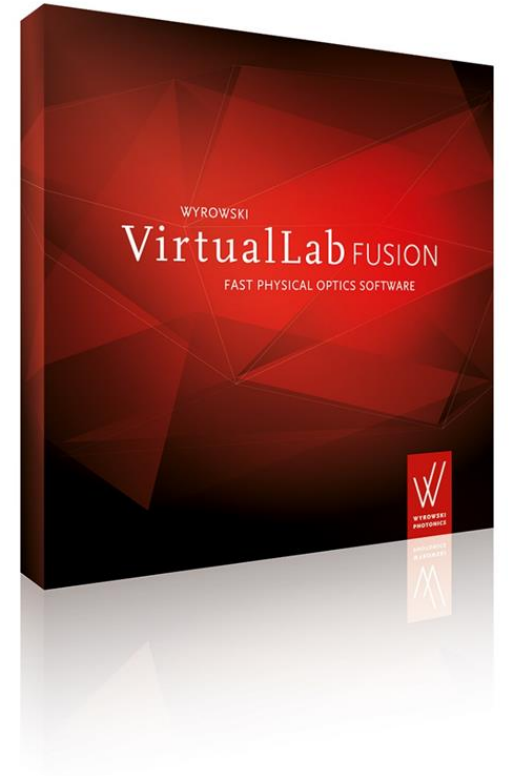
# Fast Physical Optics Modeling and Design Software



# Fast Physical Optics Modeling and Design Software

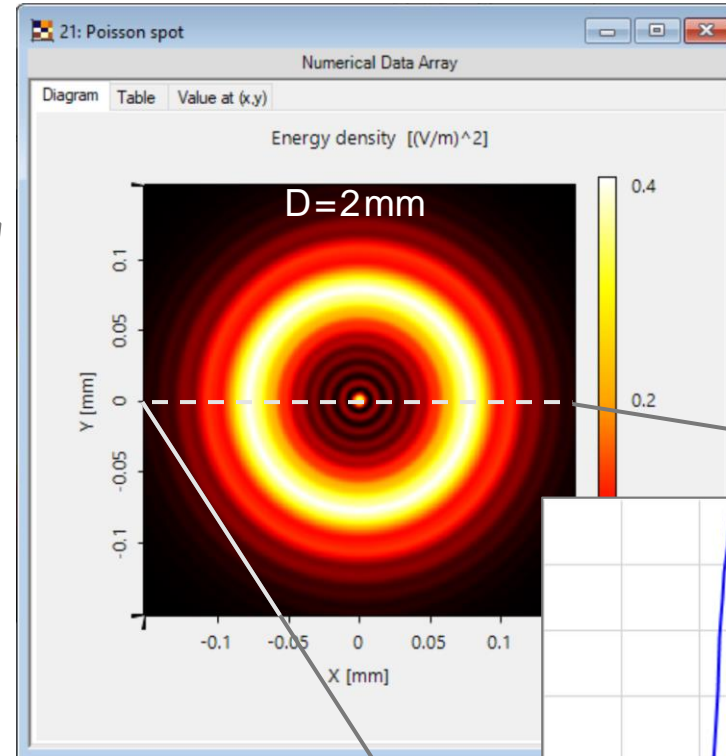
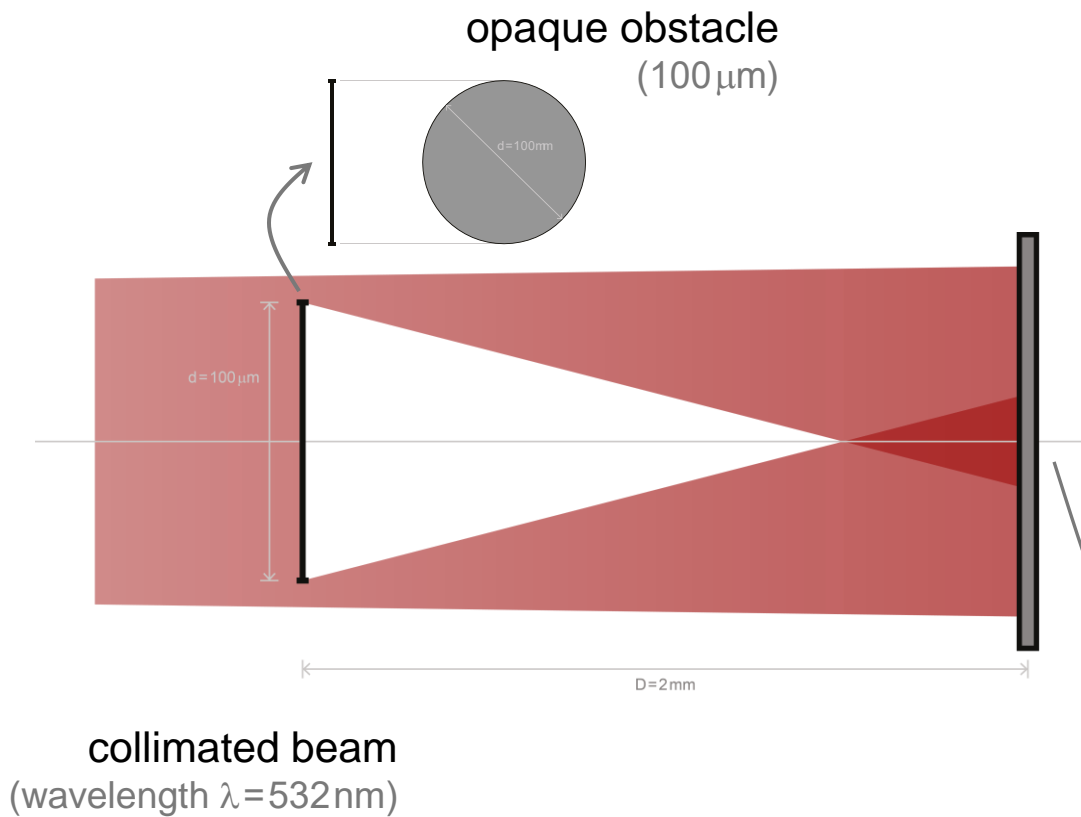


Connecting Field Solvers!

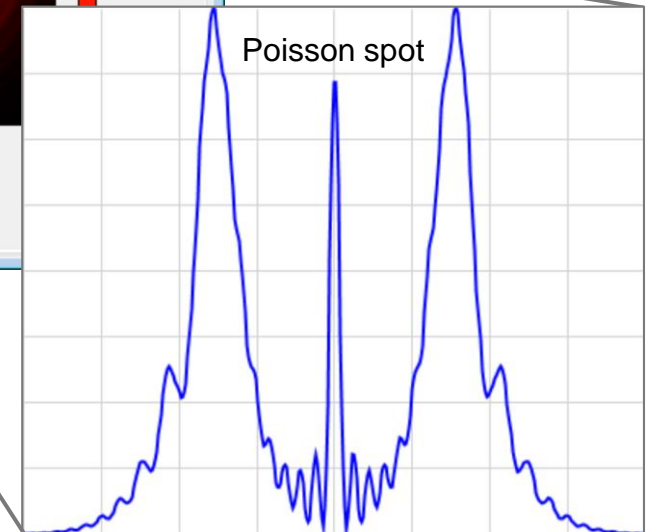


# **Configuring Detectors to Extract 1D Field Cross-Section**

# Observation of the Poisson spot



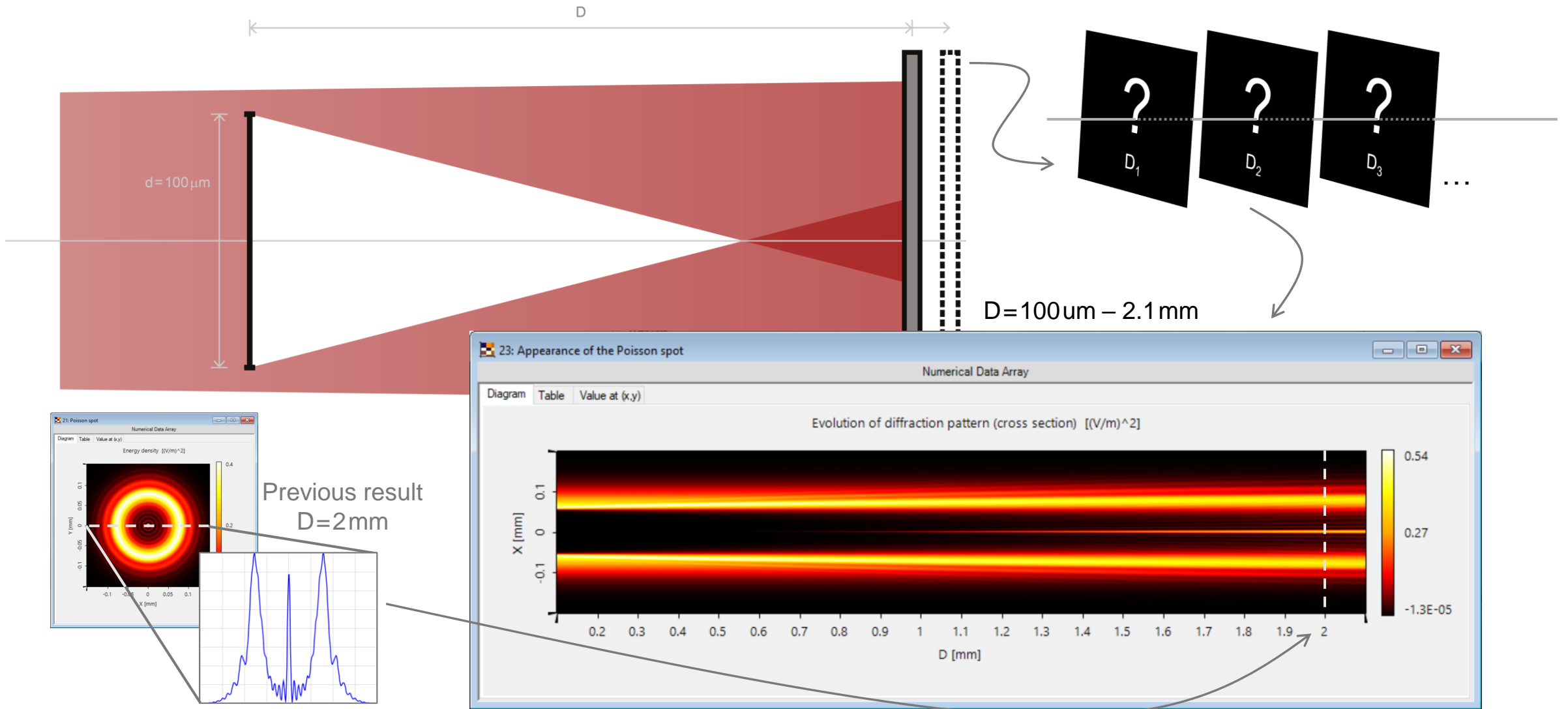
It is only diffraction from the edges what permits light to travel to the geometric shadow of the obstacle!



 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

The screenshot displays the WyoVirtLab Fusion 2020.2 (Build 2.22) interface. The main workspace shows an optical setup with a Gaussian Wave (0), a Stop (1), and a Camera Detector (600). The Camera Detector is configured for a linear cross-section along the X-axis. The 'Edit Camera Detector' dialog box is open, showing the following settings:

- Detector Window and Resolution:  Set Window Size (400  $\mu\text{m}$  x 1 nm),  Scale Window Size by Factor,  Copy from...
- Detector Resolution:  Set Number of Sampling Points (User-Defined, 512 x 1),  Scale Sampling Distance by Oversampling Factor,  Set Sampling Distance,  Copy from...
- Settings: Interpolation Method (Cubic 6 Point)

The 'Chromatic Fields Set' plot shows the intensity profile along the X-axis (mm) for a wavelength of 532 nm. The plot shows a central peak at 0 mm and two side peaks at approximately -0.05 mm and 0.05 mm. The Y-axis represents intensity, ranging from 0 to 0.3. A color map of the intensity profile is also shown, with a color scale from 6...E-05 to 0.40321.

The 'VirtualLab Explorer' panel on the right shows the simulation tree with the following components:

- 1: Optical Setup Editor #1 (1\_OpticalSetup\_PoissonSpot.os)
- 6: Camera Detector (#600) after "Stop" (#1)
- 7: Camera Detector (Linear Cross Section)

The status bar at the bottom shows the following information:

- Detector Results | Messages
- Number of Used Cores (also for Parameter Run): 4
- CPU Usage: 0%
- Physical Memory: 0%
- 32 GB

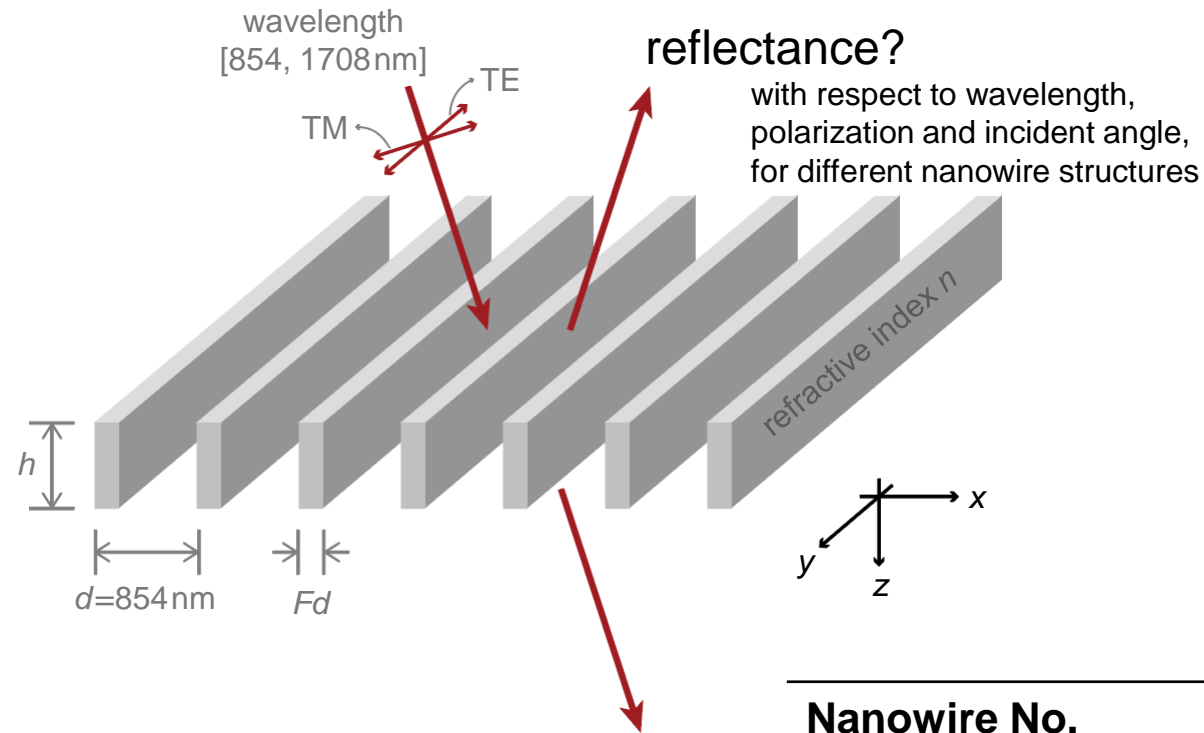
# Visualization of Time Dependence of Electromagnetic Fields

# Visualization of Time Dependence of EM Fields

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- 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



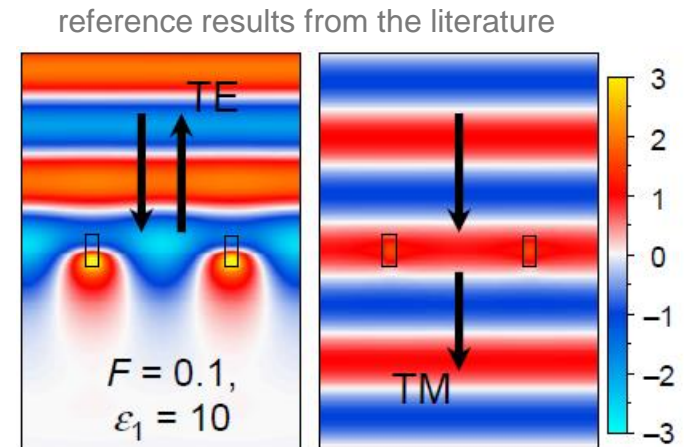
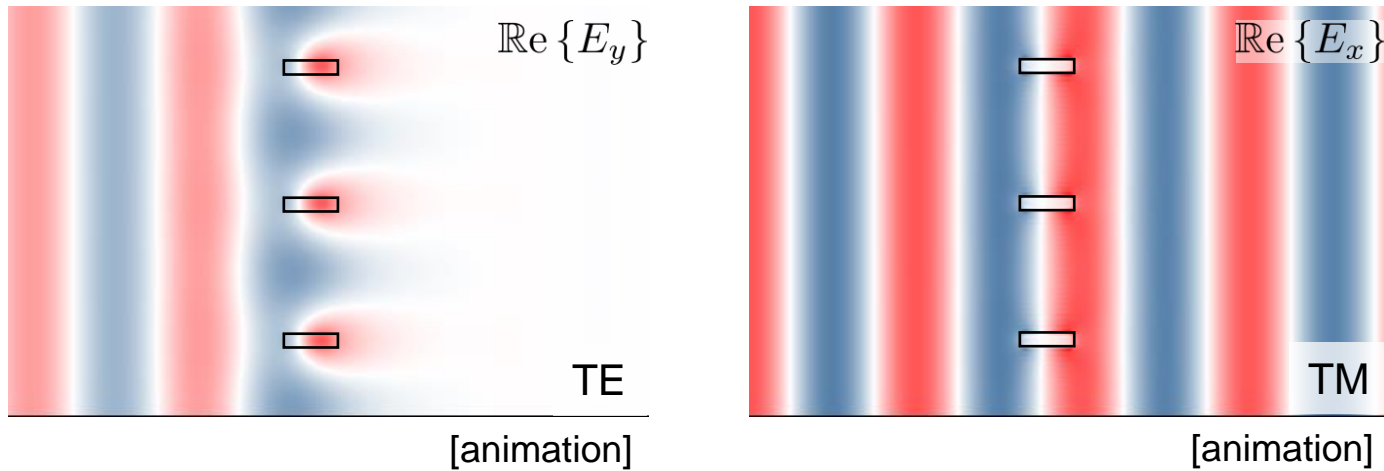
Nanowire No.	#1	#2	#3
refractive index $n$	10	7.07	3.16
height $h$	269nm	270nm	292nm
filling factor $F$	0.01	0.02	0.1

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 @1045nm



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

# Visualization of Time Dependence of EM Fields

The screenshot displays the Wyrowski VirtualLab Fusion 2020.2 (Build 2.22) interface. The main workspace shows a simulation setup for an ultra-sparse nanowire. The setup includes an Ideal Plane Wave (0) incident on a Nanowire #3 (1) at a height of Z 0 mm. The field is analyzed by a Field Inside Component Analyzer: FMM (801). Two Raw Data Detectors (600 and 601) are positioned to capture the field data. A red arrow points to the 'Temporal Sampling of Real Part' settings dialog box, which is open over the simulation. The dialog box shows the following settings:

- Temporal Period Sampling Settings
- Sampling Count of T: 50
- Treat the Data as Electric Field

The 'Field Inside Component Analyzer: FMM' (#801) window displays a numerical data array plot of the Real Part of  $E_y$  [V/m]. The plot shows the field distribution in the x-z plane, with x ranging from -1 to 1  $\mu\text{m}$  and z ranging from -3.5 to -0.5  $\mu\text{m}$ . The color scale ranges from -1.7143 to 2.1866 V/m. The plot shows a series of vertical red and blue bands, indicating the time dependence of the field.

The Property Browser on the right shows the settings for the 'Field Inside Component Analyzer: FMM' (#801):

- General: Window Size 500, 520; True To Scale True; Zoom Factor 73.71; Zoom Factor Unit 1  $\mu\text{m}$
- Colors: Color Table Tricolor
- Data: Auto Scaling of Data True; Displayed Data Range [-1.7143 V/m; 2.1866 V/m]; Field Quantity Real Part; Format of color scale Engineering; Interpolated View True
- Labels: Font Size of Axis L 10; Font Size of Title 10
- Selection (General): Selection Mode Rectangle or Ellipse
- Selection (Line): Display Line Mark False
- Selection (Point): Display Point Mark False
- Selection (Region): Show Rectangle or False
- View Mode: 3D Mode False
- X-Axis: Description z; Format of x-Axis Engineering; Minimum Number of 2; x-Axis Range [-4  $\mu\text{m}$ ; 0 mm]
- Y-Axis: Description x

The bottom status bar shows the following information:

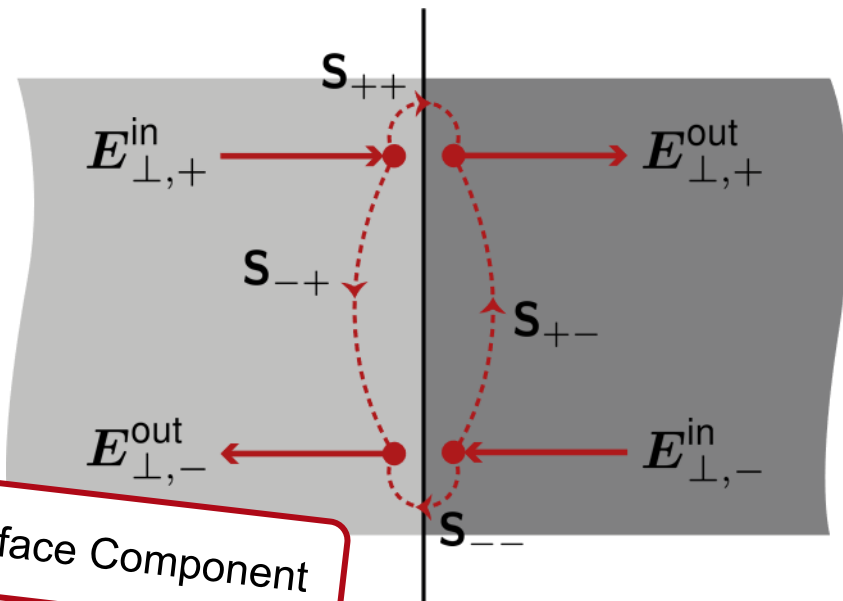
- Detector Results: Messages
- Number of Used Cores (also for Parameter Run): 4
- CPU Usage: 0%
- Physical Memory: 0%
- 32 GB

# **Plane Surfaces in your Optical System**



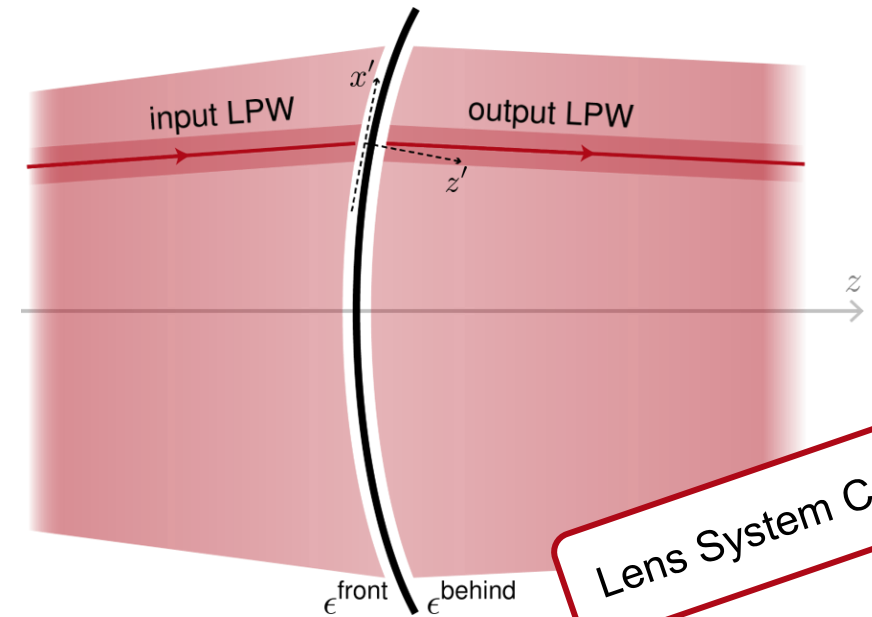
# Field Solvers for Plane Surfaces

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



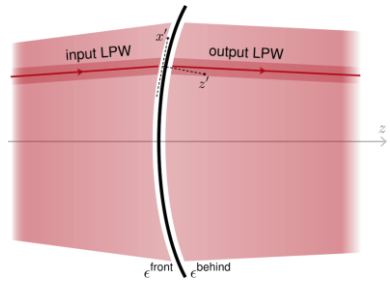
Plane Surface Component

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

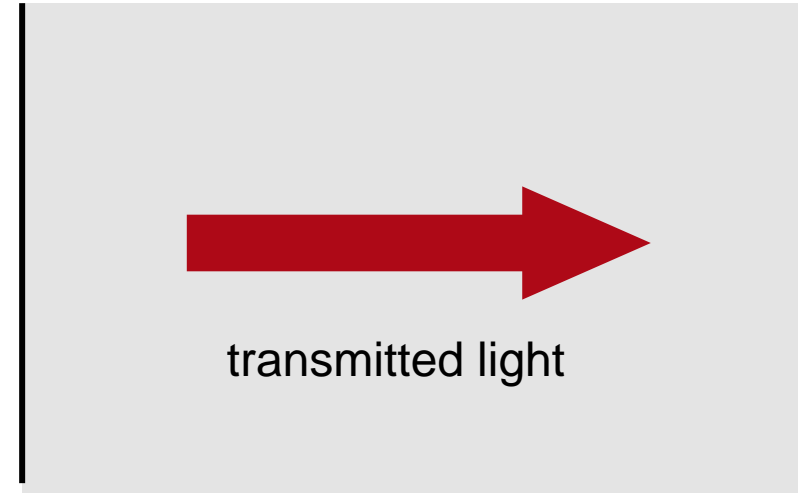


Lens System Component

# Field Solvers for Plane Surfaces: Modeling Sequence

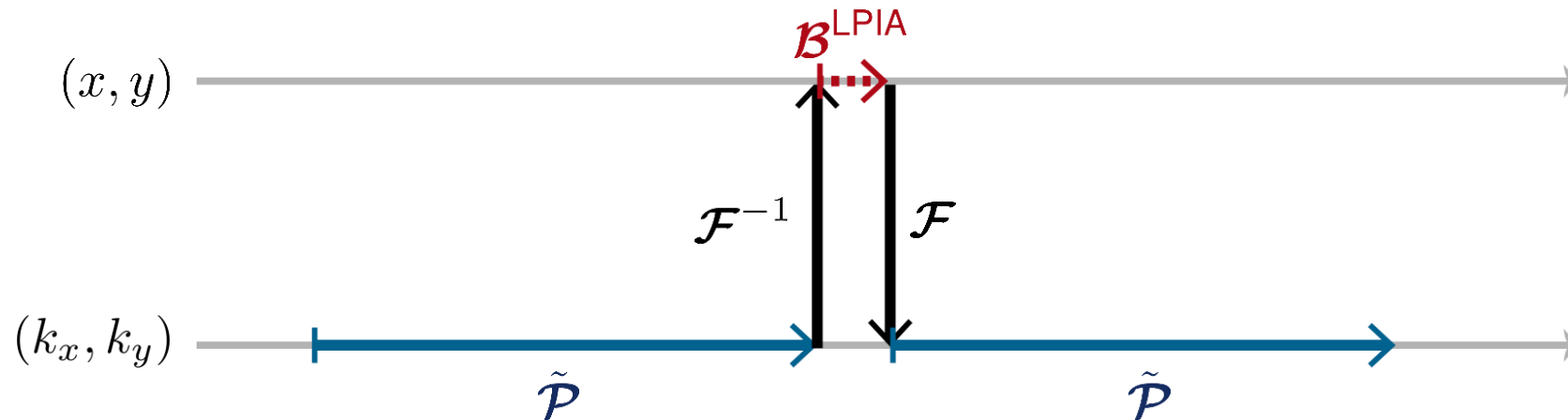


incoming light

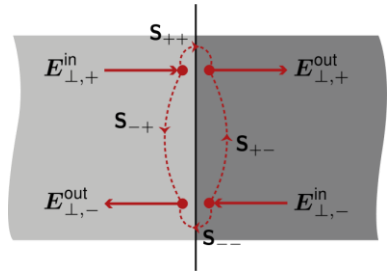


transmitted light

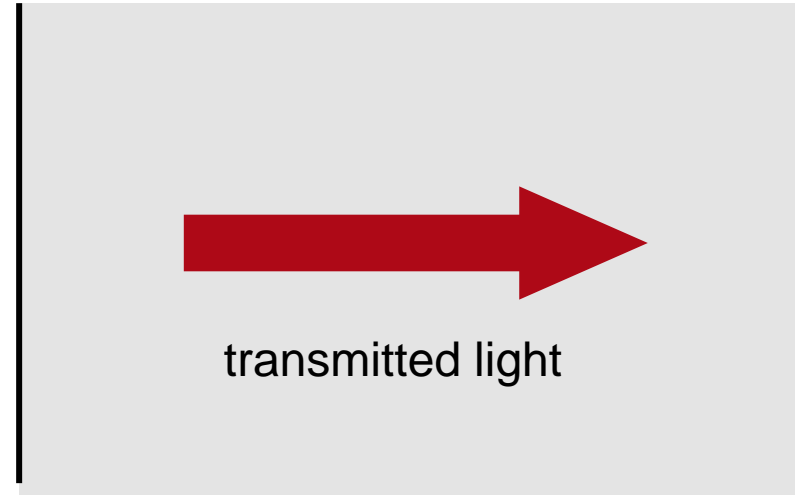
Plane Surface in Lens System



# Field Solvers for Plane Surfaces: Modeling Sequence

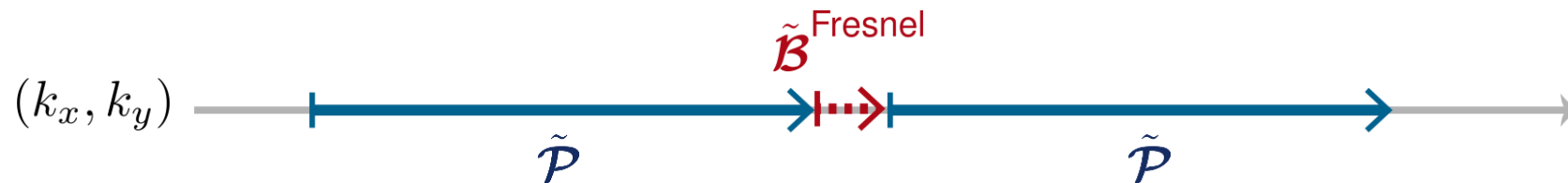


incoming light

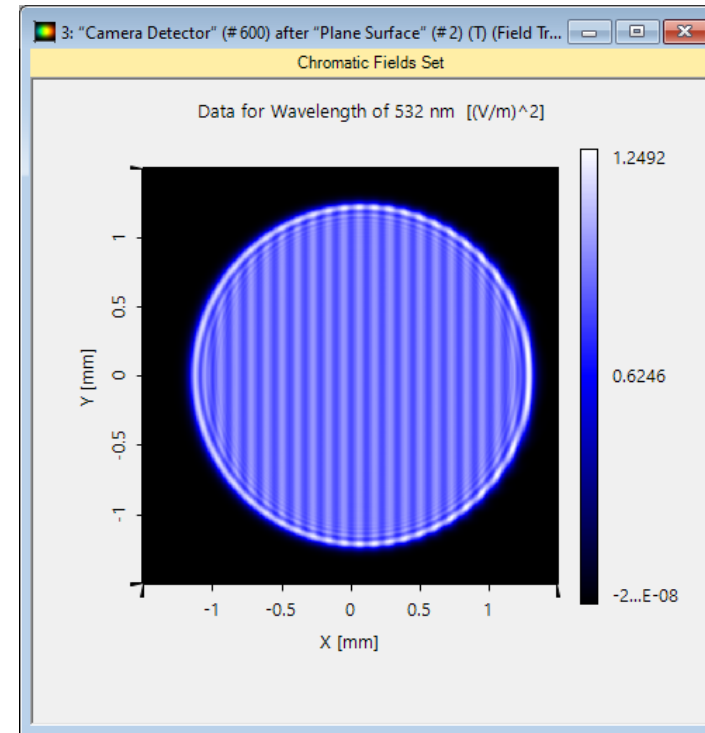
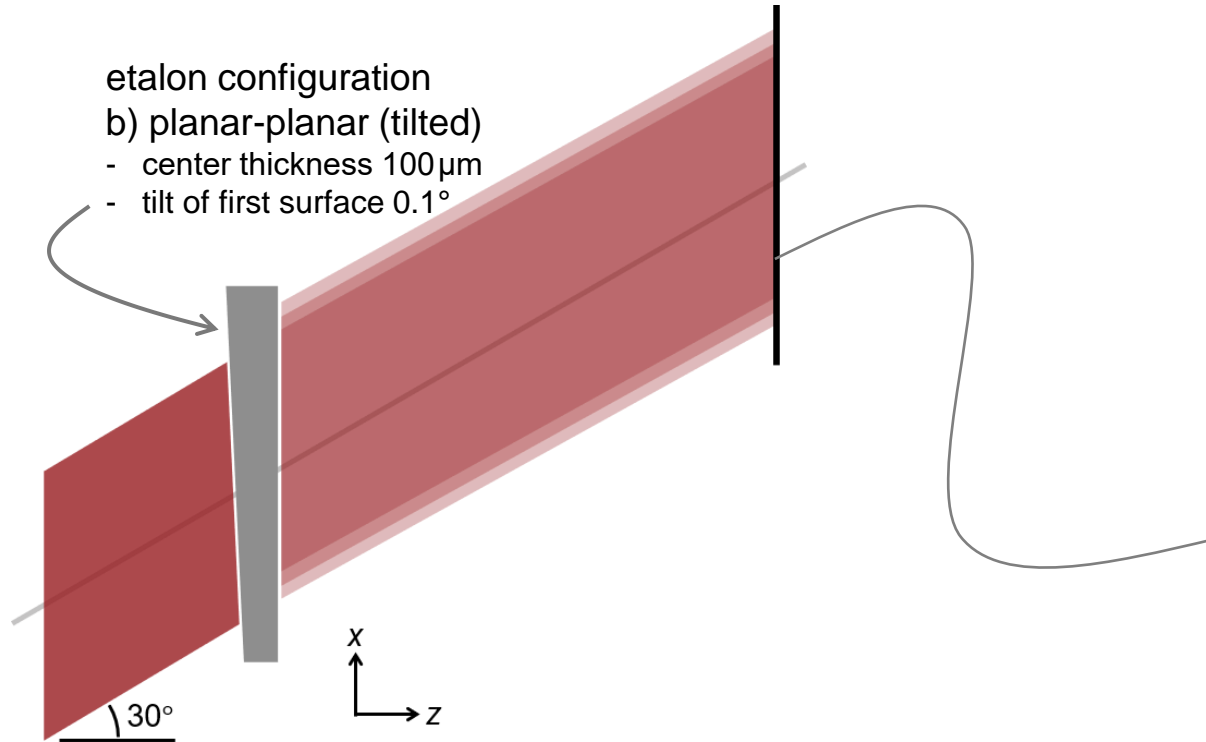


transmitted light

Plane Surface Component

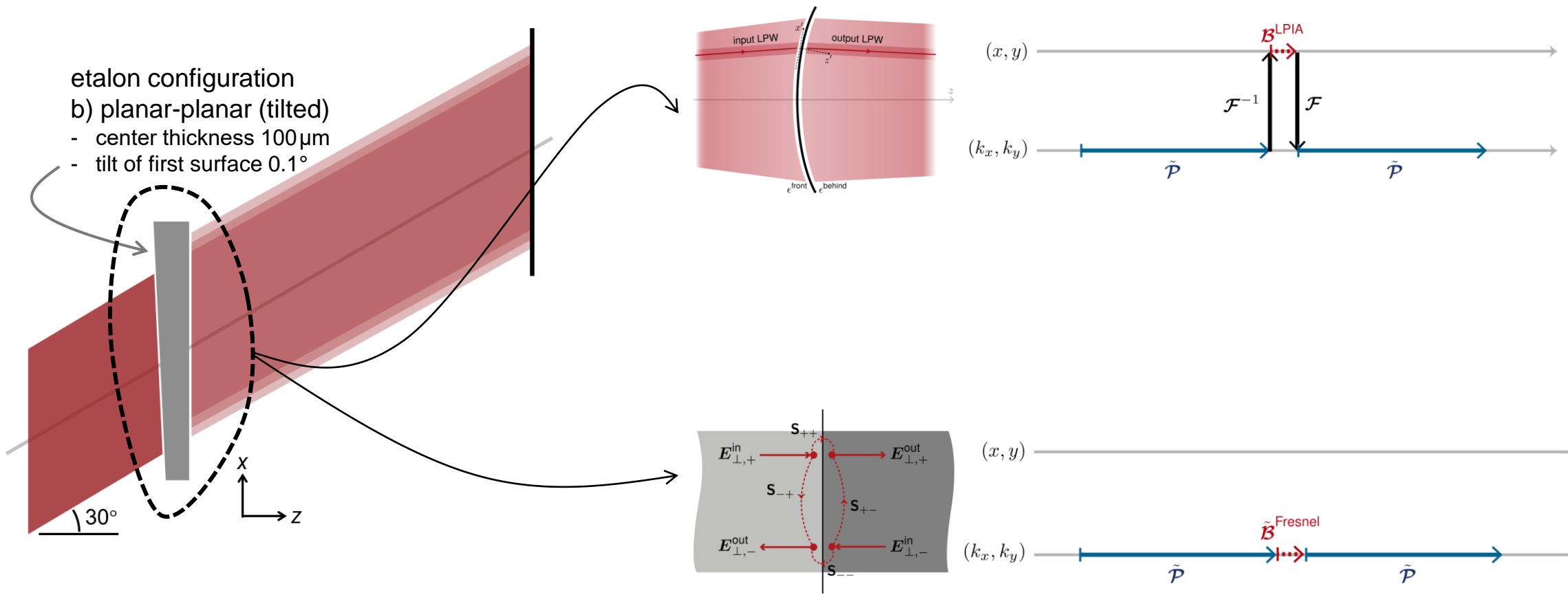


# Modeling an Etalon with Plane Interfaces...

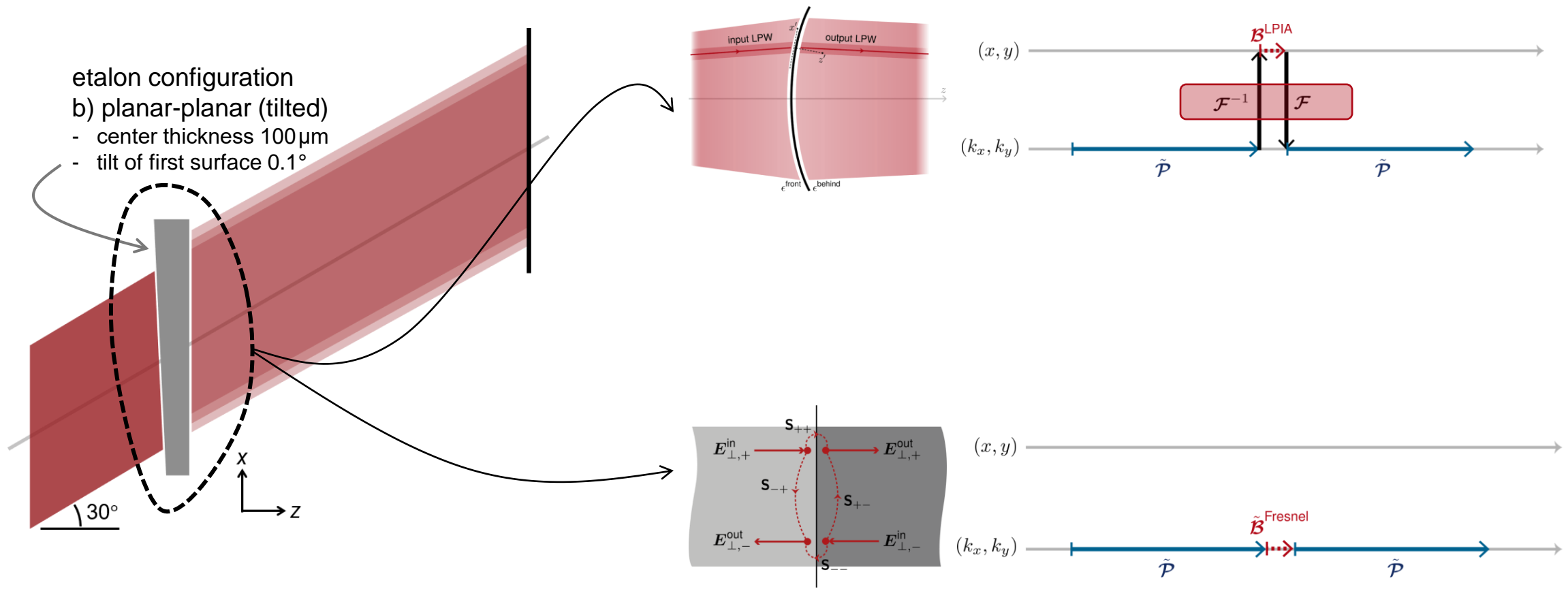


 [see the full Application Use Case:  
"Modeling of Etalon with Planar or Curved Surfaces"](#)

# ... Two Ways



# ... Two Ways



# Conclusions

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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

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- 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](#))