

# As Accurate as Needed, as Fast as Possible: New VirtualLab Fusion 2023.2!

Speaker: Olga Baladron-Zorita, Senior Optical Engineer at LightTrans International GmbH

### **Links of Interest**

- LightTrans website: <u>www.LightTrans.com</u>
- Our past webinars: <u>www.LightTrans.com/products-</u> services/learning/webinars
- Find a VirtualLab Fusion distributor in your region: <u>www.LightTrans.com/company/distributors</u>
- You have further questions? Drop us a line at info@LightTrans.com, for technical questions support@lighttrans.com
- Subscribe to our newsletter: <u>www.LightTrans.com/newsletter</u>
- Connect with us on the following social networks:
  - LinkedIn (www.linkedin.com/company/lighttrans)
  - Twitter (<u>www.twitter.com/LightTrans</u>)
  - YouTube (<u>www.youtube.com/LightTransInternational</u>)

- Check out our downloads page to see VirtualLab in action across a broad range of fields of application: <u>www.LightTrans.com/resources/downloads</u>
- Want to give VirtualLab Fusion a test drive? Request a trial version: <u>www.LightTrans.com/resources/trial-software</u>
- Interested in purchasing VirtualLab Fusion? Check out our products, licence model and learn more about additional evaluation possibilities: <u>https://www.lighttrans.com/products-services/virtuallabfusion/virtuallab-fusion-packages.html</u>
- New! VirtualLab Fusion 2023.2: <u>https://www.lighttrans.com/products-services/virtuallab-fusion-release-2023-2.html</u>

### Who We Are







### **Control of the accuracy-speed balance...**

... through pool of interoperable modeling techniques on a single platform

**New License Model** 

### **New License Model: VirtualLab Fusion + Packages**

	New VirtualI ab Eusion Product Family		
C	Dur product policy has undergone a complete change. We now differentiate between the optical mo is the platform, and additional packages, which can be combined to suit your needs.	deling and design software VirtualLab Fusion	
S yı a	itarting with a single licence of VirtualLab Fusion, there is no longer a distinction between Basic or / our personal VirtualLab Fusion platform to enhance its functionalities. All packages work seamless Ind user-friendly interface.	Advanced. You can add different packages to ly together, facilitated by a common, intuitive	
X	Which package do you need to start your solution?		
C	Our sales team help you to find the right combination of packages for your personal applications an	d requirements: sales (at) lighttrans.com.	
ŀ	Packages		
L	A quick overview and initial understanding of our packages		
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F	Packages		
Α	A quick overview and initial understanding of our packages.		
	Grating Package	~	
	Diffractive Optics Package	$\checkmark$	
	Flat Lens Package	~	
	Light Shaping Package	~	
	AR VR XR Package	$\checkmark$	

### **Distributed Computing**

New Package!

# **New Distributed Computing Package**



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# How to Start Distributed Computing in VLF?



When the *Distributed Computing Package* is available, a new tab will appear on the right side of the main menu.

Activate *Distributed Computing* by clicking *Start Server*.

### **Adding Clients**



You can distribute the individual elementary simulation tasks among the different machines in your network, with multiple *Clients* per machine.

# Diffraction in White-Light Interferometer: Simulation with Distributed Computing

### **Simulation Task**



### **Elementary Simulation Task**



### **Collection of Elementary Tasks: Variation of Wavelength**



### **Collection of Elementary Tasks: Variation of Wavelength**



## **Distributed Computing**

Computation time of complex tasks that require many individual simulations (such as parameter sweeps etc.) can be drastically reduced by using *Distributed Computing*. In this case, the individual simulations can be distributed to different workstations, each with several clients.

More information under:

Usage of Distributed Computing



### **Collection Simulation Using Distributed Computing**



### **Overview Simulation Times**



simulation result

	simulation ti	me
elementary simulation	7s	
collection of elementary simulations (500) on one machine	57 min	(100%)
collection of elementary simulations (500) via distributed computing (24 clients)	3min 50s	(7%)

### 93% lower calculation time!!!

# Analysis of AR Device Using Test Image: Simulation with Distributed Computing

### **Elementary Simulation Task**

### source (Plane Wave):

- wavelength: 532nm
- on-axis propagation ( $\alpha$ , $\beta$  = 0°)
- polarization: E<sub>x</sub>





- period: 380nm
- width of grating ridge: 190nm
- height: 100nm
- grating orientation: 0°

2 expander (EPE):



- period: 268.7 nm
- width of grating ridge: 198–215nm
- height: 50nm
- grating orientation: 45°

<b>dete</b> effici	<b>ctor result :</b> ency within eyebox	
	Efficiency	0.79652 %
	simulation tim	e: 8s
•	outoouplar	
3	outcoupier:	
bi	nary grating	
•	period: 380nm	

- width of grating ridge: 200–301 nm
- height: 124 nm
- grating orientation: 90°

### **Collection of Elementary Tasks: FOV**



### **Collection Simulation Using Distributed Computing**



### **Overview Simulation Times**



simulation result

elementary simulation	8s	
collection of elementary simulations (10201) on one machine	31h 10min	(100%)
collection of elementary simulations (10201) via distributed computing (35 clients)	1h 5min	(3%)

### 96% lower calculation time!!!

simulation time

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### **Parameter Variation Analyzer**

New Analyzer!

# **Defining the Parameter Variation**



After adding the analyzer to the optical system, the parameter sweep, and the evaluation of the results must be defined. By clicking Configure Parameter Variation you get access to an in-built Parameter Run document, where parameter variation can be configured.

> X

> > 0 Pa

1.6

OK

For a detailed introduction on how to operate the *Parameter Run* document, please see:

Usage of the Parameter Run Document

### **Evaluation of the Results**



**Robustness Optimization of Slanted Grating with Parameter Variation Analyzer** 

## **Simulation Task**

### plane wave

- wavelength: 532nm
- linearly polarized along x-axis

### slanted grating

- operation order: +1<sup>st</sup> (transmission)
- fill factor: 49%, 49.5%, 50%, 50.5%, 51%
- medium in front: air
- medium behind: n=1.6



To perform a robustness analysis, efficiencies from 5 different fill factors between 49% and 51% will be combined in two merit functions: uniformity contrast & mean efficiency.

### optimization parameters

- grating height: varied between 4µm and 6µm
- period: varied between  $8\mu m$  and  $12\mu m$

(\*) figures slightly exaggerated for illustration purposes

# **Grating Order Analyzer**



The *Grating Order Analyzer* can be used to investigate the order efficiencies of any given grating. Find more information under:

Grating Order Analyzer

	rs		General Single Orders	
Order Selection Stra	itegy		Output for Evaluated Direct	tions
Selection Strategy	Order Range	~]	Order Collections	Transmission
	x	Y	Single Order Output	C Reflection
Minimum Order	1 🜩	0 🜩		🗌 Incident Wav
Maximum Order	1 🐳	0 🜩		
			General Output	
Coordinates			Summed Transmission	Absorption, and Reflection
Spherical Angles	Cartesia	an Angles	🗌 Polar Diagram (Angle o	t Only)
Wave Vector Co	mponents 🗌 Positior	ns		
Efficiencies				
Rayleigh Coefficien	ts			
	🗌 Ey	🗌 Ez		
Ex				

resulting efficiency in the Detector Results tab: Efficiency T[+1; 0] 11.997 %

### **Parameter Variation Analyzer**



Since results of different grating parameter have to be taken into account, the *Parameter Variation Analyzer* is used to calculate the according merits. With this tool the efficiencies of the grating with different fill factors will be calculated and the resulting mean efficiency and uniformity contrast automatically determined. For more information, see:

Parameter Variation Analyzer

### merit functions:

mean efficiency (to be maximized):  $\eta_{\text{mean}} = \frac{\sum_{i}^{n} \eta_{i}}{n}$ uniformity contrast (to be minimized):  $u = \frac{\eta_{\text{max}} - \eta_{\text{min}}}{\eta_{\text{max}} + \eta_{\text{min}}}$ 

With  $\eta_i$  being the 1<sup>st</sup> order transmission efficiency for an individual fill factor.

## **Parametric Optimization**



Now, the grating can be optimized by using the inbuild *Parametric Optimization*. An efficiency of 100% (to maximize this value) und uniformity contrast of 0% (to minimize this value) are used as target values for the merit function.

_	Constraint Host		Constraint Name	1	1	Use W	/eight	Constraint Ty	e Value 1	Value 2	Start Value	Contribution	T
nera	al Gratino" (# 1)	Stack #1 (Incouple	Grating (Slanted))	Medi	um #1		1	Range	8 µn	n 12 µm	10 µm	0 %	2
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ame	eter Variation Analyzer" (# 80	01) (Result) mean efficiency					1	Target Value	100 9	6	16.028 %	63.382 %	2
		uniformity contras	t	_			1	Target Value	0 9	6	63.826 %	36.618 %	
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	Start or stop the optimization												
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### More information under: Introduction to the Parametric Optimization Document

# **Optimization Result**

### initial design:

- mean efficiency: 16.03%
- uniformity contrast: 63.83%







### optimized design:

- mean efficiency: 7.14%
- uniformity contrast: 16.241%

Eventually, the optimization results in a trade-off between the mean efficiency and the uniformity contrast. With the chosen weights, some efficiency is sacrificed for a lower uniformity contrast. By adjusting the weights, the result can be influenced towards better efficiency or uniformity.

# Field Inside Component: FMM

Now 3D!

# Sampling of the Output Data: 1D-Periodic Gratings (Lamellar)



For *1D-Periodic (Lamellar)* gratings, the analyzer generates a 2D cross-sectional image with the parameters specified in the *Sampling* section of the dialog.



# Sampling of the Output Data: 2D-Periodic Gratings



When the analyzed grating is set to 2*D*-Periodic, the Field Inside Component Analyzer: FMM, will instead generate a series of quadratic cross-sections through the structure, with the sampling parameter in z-direction dictating the number of cuts performed.

### 11 fields



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### **3D System View**

Measure Distances!

### **Measure Distances in 3D View!**

In order to improve the usability, there are a few additional features that we would like to highlight.



Use the *Magnifying Glass* in the *Tool Bar* to zoom into details without changing the actual system view.

The *Line Measuring Tool* allows for an easy analysis of the distances and sizes of the various components.

### ... And So Much More!

Release Notes 2023.2