

December 2022, Release of VirtualLab Fusion 2023.1

The New VirtualLab Fusion 2023

Overview of new features of version 2023.1

Software Version	2023.1 (Build 1.556)				
Update Service	4 th quarter of 2022 is required; contact your distributor for more information				
Install Type	 Standalone Installation VirtualLab 2023.1 is installed in addition to any other VirtualLab installations on your PC. 				
Release Notes	December 22, 2022				





The New VirtualLab Fusion 2023.1

Major development directions

Major Development Directions of VirtualLab Fusion 2023.1

- VirtualLab Fusion enables physical optics modeling through its amazing fast physical optics technology.
- The development of VirtualLab Fusion never stops. VLF 2023.1* provides:
 - Higher Speed
 - Easier Use
 - More Physics
 - Deeper Transparency
 - Better Control

*Our customers often refer to VirtualLab Fusion as VLF. Thus, in this feature overview we use VLF 2023.1 for VirtualLab Fusion 2023.1.



Higher Speed

Major development directions of VirtualLab Fusion 2023.1

Higher Speed by VirtualLab Fusion 2023.1

- VirtualLab Fusion achieves fast physical optics* system modeling by two key technologies:
 - Connecting specialized modeling techniques per optical component.
 - Applying pointwise modeling techniques wherever possible.
- The algorithms of both technologies are further optimized in VLF 2023.1 and deliver **higher modeling speed**.
- VLF 2023.1 makes better use of multicore processors for parallel computing.
- The new modeling **Profile Editor** and **Profile Editing Tools** enable excellent balancing of accuracy vs. speed.
- The new **Universal Detector** significantly saves modeling steps and time by evaluating multiple detector signals from the electromagnetic field.



Easier Use

Major development directions of VirtualLab Fusion 2023.1

Easier Use of VirtualLab Fusion 2023.1

- Till recently VirtualLab Fusion provided a small button with basic help functions only.
- With VLF 2023.1 we introduce a **comprehensive** help and assistant concept, with content added steadily.
- The new VLF Assistant explains features on demand in a special window inside VLF 2023.1.
- VLF 2023.1 comes with a new modeling **Profile** • Editor and Profile Editing Tools.
- These tools facilitate a smooth getting started with VLF 2023.1 physical optics modeling.
- The **Data Views** in VLF 2023.1 are further unified and received additional features, which make them easier to use.
- The VLF Calculators are helpful tools. VLF • 2023.1 provides more of these helpers.









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More Physics

Major development directions of VirtualLab Fusion 2023.1

More Physics in VirtualLab Fusion 2023.1

- VirtualLab Fusion provides an ever-growing number of physical optics models with emphasis on:
 - Sources with models for light radiation
 - Components with models for light interaction
 - Detectors with models for light evaluation
 - Models for propagation of light from sources to components and to detectors
- VLF 2023.1 introduces a **source power management** to the source models.
- Components come with various new features.
- The new **Universal Detector** means a quantum leap forward in detector modeling with VLF. Missing a detector in VLF? Not anymore!
- VirtualLab Fusion is famous for its seamless control of the inclusion of diffraction in physical optics modeling.* With VLF 2023.1 we make this even better!





Deeper Transparency

Major development directions of VirtualLab Fusion 2023.1

Deeper Transparency of VirtualLab Fusion 2023.1

- The VLF Assistant provides insight into the concepts, the features, the usage, some typical troubleshooting, and further development plans. By that it deepens the transparency of VLF technology.
- The new modeling **Profile Editor** and **Profile Editing Tools** facilitate getting a full and transparent overview of system and modeling parameters.
- The **Process Logging** in VLF 2023.1 provides more and more detailed information about the performance of algorithms, data sampling, process parameters, and cpu time per modeling step. The logging brings great transparency, which is to your benefit.
- New features of the **System Modeling Analyzer** strengthen its functionality and give better insight into the effects of the modeling steps.



P Path	Detectors	Analyzers	Log	ging		1
[10/20/2022 11:07:50]	Propagati	on to Camera Detector	#605			
[10/20/2022 11:07:50]	"Ideal Beam Split	ter" #2 [Output x]				
[10/20/2022 11:07:51]	Conversion from	m non-equidistant data	to equidistant da	ta finishe	d Duration = 00:00:00.8595448	
[10/20/2022 11:07:51]	Fast Fourier Tra	insform (gridded data, ((1539; 1563) sam	pling poir	nts) (Duration = 00:00:00.3511333)	
[10/20/2022 11:07:51]	Pointwise Tra	ansformation Index (PTI)	= 0.0015193 (pc	ointwise Fo	ourier transform used if larger than 1)	
[10/20/2022 11:07:51]	Phase Upgrad	le finished Duration = 0	0:00:00.1156918			
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[10/20/2022 11:07:54]	Inverse Fast For	urier Transform (gridded	d data, (2779; 27	03) sampl	ing points) (Duration = 00:00:01.2304641)	
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[10/20/2022 11:07:55]	Phase Upgrade finished Duration = 00:00:00.0049857					
[10/20/2022 11:07:55]	Conversion from equidistant data to non-equidistant data Duration = 00:00:00.0149589					
[10/20/2022 11:07:55]	"Ideal Beam Split	ter" #2 [Output k]				
[10/20/2022 11:07:55]	Free space pro	pagation in k-domain (D	Duration = 00:00:	00.001807	77)	
[10/20/2022 11:07:55]	"Camera Detecto	or" #605 [Input k]				
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[10/20/2022 11:07:55]	Inverse Fast For	urier Transform (gridded	d data, (609; 761)	sampling	g points) (Duration = 00:00:00.0575992)	
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Better Control

Major development directions of VirtualLab Fusion 2023.1

Better Control of VirtualLab Fusion 2023.1

- The new **Profile Editor** provides full insight and full control of all system and modeling parameters. It functions as your modeling and design control center.
- The editor offers a well-structured access to all relevant parameters and comes with smart features for fast editing.
- To further simplify the work with the Profile Editor, VLF 2023.1 introduces **Profile Editing Tools** to configure modeling parameters in the Profile Editor automatically.
- The new **Expert Modus** of VLF 2023.1 enables a wider range of numerical manipulations of data objects.







The New VirtualLab Fusion 2023.1

Feature Overview

Higher Modeling Speed

VirtualLab Fusion 2023.1 feature overview

Higher Modeling Speed in VLF 2023.1

- The modeling algorithms in VLF 2023.1 are further optimized and deliver higher modeling speed.
- VLF 2023.1 makes better use of multicore processors for parallel computing.
- At five examples we demonstrate the increase of computational speed which ranges from a factor 1.5 to 3 times faster calculation.
- Dependent on the specific task the increase in speed can be even higher.













Example 1: Modeling of Microlens Arrays



Use Case: Modeling of Microlens Arrays with Different Lens Shapes

Example 2: Waver Inspection System







Simulation Times

VLF 2021.1 (Build 1.180): 19 sec VLF 2023.1 (Build 1.554): **8 sec**

Example 3: Coherence Measurement

Use Case: Coherence Measurement Using Michelson Interferometer and Fourier Transform Spectroscopy





Simulation Times

VLF 2021.1 (Build 1.180): 52 sec VLF 2023.1 (Build 1.554): **25 sec**

Example 4: Grating Stretcher







Simulation Times

VLF 2021.1 (Build 1.180): 74 sec VLF 2023.1 (Build 1.554): **33 sec**

Example 5: Analysis of Collimation System



Use Case: Collimation Testing with Shearing Interferometry

Higher Modeling Speed in VLF 2023.1

- The new **Universal Detector** allows the calculation of any detector signal from the electromagnetic field.
- The field is calculated once in the detector plane and all detector signals are obtained from the same electromagnetic field data.
- This significantly increases the modeling speed by avoiding multiple calculations of field data.
- Figure: In the example the Poynting vector, radiant intensity, luminous intensity, illuminance and irradiance is calculated from the field data.



Profile Editor

VirtualLab Fusion 2023.1 feature overview

Modeling Profiles

- VirtualLab Fusion stores optical systems in .os files. These files include all parameters about the system layout, sources, components, and detectors.
- VLF 2023.1 introduces the concept of Modeling Profiles which are also stored in the .os files.
- The Modeling Profiles allow the configuration and storage of the modeling settings.
- Optical systems come with the General Profile, which enables an unrestricted editing of the modeling settings.
- The additional Ray Results Profile is preconfigured to enable fast access to results known from ray optics.
- The profiles enable a seamless control of the inclusion of diffraction in physical optics modeling.*





Profile Editor

- VLF 2023.1 drastically improves the access to all relevant parameters in an optical system and its modeling (.os file).
- The center for modeling control is the Profile Editor. It gathers parameters from all other places and dialogues and systematically present them in one dialogue.
- The first version of the Profile Editor is released with VLF 2023.1 and combines a parameter overview and an easy parameter access with smart internal editing tools.
- This Profile Editor offers a new and additional user interface for system and modeling configuration. No other dialogues were removed.



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Sources	12.	Object	Category	Parameter	Value		
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				Field Size Factor	1		
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	·			Order X	0		
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	·····			Waist Radius X (1/e^2)	250 µm		
				Waist Radius Y (1/e^2)	250 µm		
			Offset between x- and y-Plane	0 mm			

Profile Editor

- The basic categories of the Profile Editor are:
 - Sources
 - Components & Solvers
 - Visualization & Detectors
 - Other Settings
- The source tab gives access to all source parameters. VLF 2023.1 is still restricted to one major source. But the Multiple Light Source provides already a great way to work with a collection of sources in one system.
- Each system requires some basic settings which can be set in Other Settings.
- **Process Logging** provides deep insight into the modeling and its performance. While initializing a system we recommend normal/detailed logging. For simulation series and optimization, logging should be switched off to save, though small, contribution to cpu time.



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Profile Editor – Components & Solver

- The tab Components & Solver gives access to the categories
 - Parameter Overview
 - Solver & Function
 - Free Space Propagation
 - Channel Configuration
- The Parameter Overview provides an excerpt of the System Parameter Overview per component.
- The Solver & Function tab will give access to all related parameters per component. However, in the first editor version which comes with VLF 2023.1, most of these parameters are not yet gathered from the component dialogues.
- The Channel Configuration tab enables easy configuration of non-sequential modeling per component.





Profile Editor – Free Space Propagation

- The propagation from sources to components and detectors as well as between components constitutes the key technology for connecting the sources with the component solvers and with the detectors.*
- It is controlled by the tab Free Space Propagation for components and Propagation to Detectors for detectors.
- The Profile Editor enables detailed settings of the Fourier transforms in the modeling and by that a seamless control of the inclusion of diffraction in physical optics modeling.*
- VLF 2023.1 provides various **tools** to help with these settings together with technical background information to master this key technology easily.





Profile Editor – Detectors & Visualization

- Results can be visualized by:
 - System 3D illustrations
 - Data views from detectors
 - Data views from Modeling Analyzer
- Since light propagation in 3D systems is illustrated by rays, VLF 2023.1 provides the selection of 3D System visualization in the Ray Results Profile only.
- Detector outputs can be generated in both profiles. In the Ray Results Profile, they are restricted to dot diagrams, direction diagrams, and visualization of wavefront phase/OPL.
- The General Profile enables the selection of the **Modeling Analyzer** also.



Profile Editor – Detectors & Visualization

- The first version of the Profile Editor provides all parameters of the new **Universal Detector**.
- The parameters include the Propagation to Detector settings and by that seamless control of the inclusion of diffraction in the propagation to detectors.
- The Detector Settings allow the selection of field quantities to be evaluated in x- and k- domain, and the specification of the detector windows with respect to size and sampling.
- If the last step in the modeling of propagation to the detector is pointwise, the field values reach the detector in form of gridless data. VLF 2023.1 allows the display of this point cloud with field values or positions only.
- This provides direct access to dot diagrams known from ray optical modeling.



Learn More About Profile Editor

Videos

- Modeling Profile Editor
- Parameter Overview
- Source Position & Size
- Source Power Management
- <u>Component Solvers</u>

Use Cases

- Profile Editor
- <u>Configuring Your Simulation in</u> <u>VirtualLab Fusion</u>
- <u>Free Space Propagation</u>
 <u>Settings</u>



Profile Editing Tools

VirtualLab Fusion 2023.1 feature overview

Profile Editing Tools: Control Inclusion of Diffraction



New in VLF 2023.1

Pro	ofile Editing & Run	Layout Tools						3
∠ _4 ing ,∠er ⊀	Pre-Selected	Source to Component: Pointwise +	Between Components: Pointwise +	To Detectors: Automatic +	Paraxial Assumptions	$\frac{5}{4}$ Speed vs. Accuracy $\frac{P}{1}$ Pointwise vs. Integral	Fast Positioning +	Pi
	Light Path Finder			Profile Editi	ng Tools			

- The seamless control of the inclusion of diffraction in physical optics modeling constitutes one of the key technologies in VirtualLab Fusion.*
- Before VLF 2023.1, this control was simplified by the introduction of modeling levels. With VLF 2023.1, this concept is further developed and becomes more transparent.
- The new tool allows selecting pointwise propagation and by that diffraction is neglected independent of the magnitude of diffraction.
- In the automatic propagation mode of operation VLF 2023.1 evaluates the magnitude of diffraction for each propagation step.
- If the magnitude of diffraction is smaller than a preselected threshold, VLF 2023.1 switches from integral to pointwise propagation.

Profile Editing Tools - Paraxial Assumptions



- The development of diffraction effects by propagation of paraxial light can be very slowly.
- That means, the diffraction-induced divergence of the paraxial beam is small.
- In VLF 2023.1 small diffraction effects of paraxial beams can be neglected to further accelerate the modeling or for other reasons.
- VirtualLab Fusion applies vectorial physical optics in all modeling steps.
- By that the results show vectorial effects when they occur.
- It is well known, that for paraxial light, vectorial effects are predominantly confined to the transversal field components.
- VLF 2023.1 enables the active restriction to vectorial effects of the transversal field components to further accelerate simulations.

Profile Editing Tools - Speed vs. Accuracy





- VLF 2023.1 provides a tool for a compact and direct control of balancing modeling speed and modeling accuracy.
- The sampling of field data has a significant effect on modeling speed and accuracy. The tool provides access to control equidistant and gridless sampling of field data.
- The pointwise Fourier transform (PFT) algorithm uses significantly less sampling points than the FFT and is therefore often much faster.
 Enforcing the PFT comes at the cost of less accuracy in inclusion of diffraction effects.
- The use of automatic sampling algorithms sometimes leads to oversampling and by that too high PC memory demand. VLF 2023.1 allows a general limitation of sampling. This comes together with a **new calculator for PC memory evaluation**.
Profile Editing Tools – Pointwise vs. Integral Propagation



- Because of the importance of field propagation in homogeneous media, e.g., air, VLF 2023.1 provides a new tool for its control.
- This tool allows a detailed selection of different propagation methods:
 - Pointwise: diffraction *neglected* independent of magnitude of diffraction
 - Integral: diffraction *included* independent of magnitude of diffraction
 - Automatic Selection: diffraction *included* dependent on the magnitude of diffraction.
- These selections can be independently done for propagation from and to sources, components, and detectors.
- An even more detailed access to these settings is provided on the propagation tabs in the Profile Editor.

Learn More About Profile Editing Tools

Videos

- Propagation from Source to Component
- Propagation Between and Inside Components
- Propagation to Detectors
- Optional Paraxial Assumptions
 in Modeling
- Balance Modeling Speed vs.
 <u>Accuracy</u>
- Pointwise vs. Integral
 Operations

Use Cases

- Profile Editor
- Paraxial Assumptions Tool
- Speed vs Accuracy Tool
- Free Space Propagation
 Settings



Universal Detector

VirtualLab Fusion 2023.1 feature overview

The Detector Revolution



- Light is fully described by electromagnetic fields. Physical optics modeling provides electromagnetic fields and by that unrestricted access to all light quantities.
- Before VLF 2023.1 fields had to be propagated to any selected detector. With VLF 2023.1 we change that drastically by fully exploiting the power of physical optics.
- Any detector function can be applied to light which is propagated to the new Universal Detector.
- This is done by add-ons in the detector which enables an ever-growing number of detector functions, e.g., spot size, aberrations, M², radiometry and photometry quantities.
- And the best of it: any missing detector function can be delivered quickly on customer request without a new software release.

Universal Detector – Field Quantities and Their Visualization



- The Field Quantity settings allow the selection of the field quantities which are needed for further processing by detector add-ons.
- The field visualization can be configured in the Field Quantity Add-on.
- It enables the selection of the field components to be visualized.
- For the selection of amplitude and phase VLF 2023.1 offers the extra feature to show the wavefront phase without the spherical part and by that the aberrations only.
- The Universal Detector enables the display of polarization ellipses as **Graphics Add-ons**.

Universal Detector: Add-ons With Release of VLF 2023.1



- With the release VLF 2023.1 comes with detector add-ons for
 - Extent measurements for any lateral signal, e.g., beam size
 - Radiometry
 - Photometry
 - Region indication in detector outputs
- More detector add-ons are provided steadily and independent of further releases.
- If you miss a detector, send a mail to support@lighttrans.com.
- LightTrans' support team will contact you and make sure that you will get the missing detector soon.

Preconfigured Universal Detectors



Author: Christian Hellmann Version: 1.0 Last Modified: Friday, December 16, 2022									
nput: gridded electromagr	etic field data (1d/2d: electric field components in k-domain, i.e., Ex, Ey, Ez).								
Function: calculates the rad	ant intensity per wavelength of input data.								
Dutput: radiant intensities i	Radiometric Data View window.								
Radiometric Data View: Rad vavelength, and (2) addition option provides human eye .earn more about radiomet	ometric data is provided (1) as spectral quantities, i.e., per wavelength and integrated over all modes with the same ally integrated over the wavelengths. The view can show the results in false color or real color in both cases. The real color color perception.								
Radiometric Data View: Rad	ometric data is provided (1) as spectral quantities. i.e., per wavelength and integrated over all modes with the same								
wavelength, and (2) addition	ally integrated over the wavelengths. The view can show the results in false color or real color in both cases. The real color								
option provides human eye	color perception.								
.earn more about radiomet	ic detectors <u>here</u> .								
PARAMETER	DESCRIPTION								
Radiometric Data View: Rad	ometric data is provided (1) as spectral quantities, i.e., per wavelength and integrated over all modes with the same								
wavelength, and (2) addition	ally integrated over the wavelengths. The view can show the results in false color or real color in both cases. The real color								
option provides human eye	color perception,								
e.earn more about radiomet	ic detectors <u>here</u> .								
PARAMETER	DESCRIPTION								
Oversampling Factor	Select factor to obtain the detector result on a finer (>1) or coarser (<1) grid compared to the grid of the input data.								

- Users can configure the universal detector by selecting and combining add-ons.
- This concept provides an amazing flexibility to obtain the detectors which you need.
- As examples preconfigured universal detectors are added in the catalog:
 - Irradiance
 - Intensity
 - Radiant intensity
 - Radiometry
 - Photometry
 - Beam/Spot size (electromagnetic field)
 - Beam/Spot size (irradiance)
 - Region detection for AR light guide glasses
 - System efficiency

Post-Processing: Application of Detector Add-Ons



• The application of detector add-ons must not be done in the universal detector already but can be performed in a postprocessing as well.

	Apply Detector Add-on New Add-on Luminous Energy Density ✓ Edit Validity: ✓	×
ddOn ergy Density.addOn ergy.addOn x & Efficience (Solid Angle).addOn x & Efficience (Solid Angle).addOn	Integration Type1	Sooppet Help - O X Luminous Energy Density Author: Christian Hellmann
ight Guide.addOn	As Separate Window Wave Front Data (Optional) Set Remove	Version: 1.0 Last Modified: Thursday. December 1, 2022 Input: radiant energy density data from <i>Radiant Energy Density Add-on</i> . Function: calculates luminous energy density. Output: luminous energy density in data view window. Photometric quantiles: Photometric quanties follow from integration of radiometric quantiles over the wavelengths, e.g., Illuminance follows from the integration over irradiance data. The integration is done with the weight of the luminosity function. This add-on enables the selection of the photopic and the soctopic luminosity function.
	Medium to Use Detector In Air in Homogeneous Medium	Learn more about photometric detectors here. PARAMETER DESCRIPTION Integration Type Select the luminosity function:
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Universal Detector – Usage of Graphics Add-ons

📔 Add Region Information from Light Guide.addOn



Amplitude of "Ex-Component" [V/m]

- The Universal Detector add-on concept offers more flexibility to provide detector results.
- The detector add-ons can be combined with graphics add-ons.
- The display of the polarization ellipses in a detector result is an example of this new technique.
- With VLF 2023.1 this concept is further extended and applied to the indication of regions as well.
- The figure shows the example of the three grating regions of an AR glass layout together with the field inside the light guide.
- The green region indicates the outcoupling grating.

Universal Detector – Window Specifications

dit Universal Detector				×	
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00	Detector Grid Resolution				
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- The new Universal Detector enables an independent specification of the detector window in x- and k-domain.
- Often physical optics modeling leads to a set of correlated and uncorrelated field modes in the detector plane.
- VLF 2023.1 allows the display of all modes in the same window and coordinate system or alternatively in windows with the center of the individual modes.
- If field values reach the detector by a pointwise operation, gridless data is obtained.
- VLF 2023.1 allows the display of the field values, the phase values, the local directions, and the data positions at the gridless positions with and without lateral interpolation.

Multimode Fiber Coupling Efficiency Detector

\/I E 20	121·	Edit Multimode Fiber	Coupling Efficiency Detector			×	_
		Coordinate Systems Position / Orientation Detector Parameters Fourier Transforms	Detector Window and Resolution Parameters Fiber Length Core Diameter If G R I N Fiber Gradient Constant Maximum Radial Order Core Material: "Non-Dispersive Cladding Material: "Non-Dispersive	Detector F Material (n= rsive Material	1.4 💕 Load (n 💕 Load	500 mm 10 µm 0.00343 3 \$ 1 \$ Edit Q View ✓ Edit Q View	
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- The Multimode Fiber Coupling Efficiency Detector comes in a new version in VLF 2023.1.
- It provides a more user-friendly interface and an easier use.

New Ellipsometry Analyzer



- VLF 2023.1 provides a new analyzer for ellipsometry evaluations of systems.
- It enables a full analysis of ellipsometry quantities like phase difference and Mueller Matrix.

New Feature @ Field Inside Analyzer







SS: Rectangular Grating Numerical Data Array Diagram Table Value at 0,x) Amplitude of "Ex" [V/m] 0.287 0.287 0.144 0.144 0.144 0.144

Backward Propagati

Forward Propagating

- The Field Inside Analyzer for the analysis of gratings with the Fourier Modal Method (FMM) shows the electromagnetic field inside the grating.
- VLF2023.1 allows the separate or superimposed investigation of forward and backward propagated fields inside the grating.

Learn More About Universal Detectors

Videos

- General Modeling Profile
- Source Power Management
- Polarization Ellipses in Data
 <u>Array Views</u>
- <u>Visualize Positions in View</u>
 <u>Windows</u>

Use Cases

- Universal Detector
- <u>Fresnel Curves on a Plane</u> <u>Surface</u>
- Add Point Cloud to Data Array



Help Center

VirtualLab Fusion 2023.1 feature overview

Comprehensive Help and Assistant Concept

Before		-	- 8	×	
	0	User Interface		F1	
		Content			
		Index			
		Programming Refe	rence		
	-	Diagnosis & Clean	up		
	æ	Mail Support Infor	mation	n	
	ß	First Steps			
	ß	What's New?			
	1	Tips and Tricks			
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VLF 2023.1:

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File	Start	Sour	ces	Functions	Cat	alogs	Windows	Help							
Table of Contents	Index Prog Ref	ramming ference	User Interface	Assistant	Gratings	Fiber Coupling +	11 Interferometry	Microscopy	Virtual and Mixed Reality +	Show Sample Files	Diagnosis & Cleanup	Mail Support Information	News	First Steps	About VirtualLab Fusion 않 License Information 딸 Update Information
	User's M	anual		Assistant			Fo	ocus Topics			Comn	nunication Cer	nter	Tips & Tricks	License

- VLF 2023.1 raises the help and assistant workflow to a new level.
- A new ribbon leads to the comprehensive help center.
- It gives access to the User's Manual, which provides all information about the meaning of objects and parameters of the user interface in VLF.
- Then we have the additional categories:
 - License information
 - Tips & Tricks
 - Communication Center
 - Focus Topics
 - Assistant

Communication Center



- VLF users appreciate the direct help through our support team.
- VLF 2023.1 facilitates the direct contact with the LightTrans team via the communication center.
- By clicking on *Mail Support Information* an email is generated, which includes all important information for the team to get to the core of your request fast.
- The ribbon News enables us to provide you with information of new developments, innovations, and other issues around VirtualLab Fusion in a timely manner.
- In short: VLF 2023.1 provides a more direct communication line between you and us.

Focus Topics



- *Focus Topics* provides the user with a collection of selected use cases.
- Focus Topics provides the user with a collection of selected use cases.
- LightTrans can update this collection independent of the release. That provides us with a dynamic way to inform you about hot topics evolving in the market.
- Clicking on a use case example opens the *Assistant* window in VLF 2023.1 to give you basic information and links to a full use case description.
- You also have the option to open the use case VLF file together with the Assistant window and running it yourselves.

VirtualLab Fusion Assistant



- VLF 2023.1 introduces the new VirtualLab Fusion Assistant.
- You may access it via the Assistant button in the Help Menu or via Assistant buttons in an ever-increasing number of dialogues.
- While the Help button in dialogues provides access to the User's manual, the Assistant button opens the new Assistant window.
- There, the Assistant offers useful information on the theory and the usage of related software features.
- The content of the Assistant is dynamically updated also between software releases.

VirtualLab Fusion Assistant



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- In VLF2023.1 we considerably strengthen the Tool Tips concept.
- Most important ribbons have now a Tool Tip with an additional link to an Assistant entry on the function of the ribbon.
- Because of the software technique which is used for the Tool Tip implementation in VLF, the Tool Tip behavior is as follows:
 - Each time you move the mouse pointer over a ribbon triggers the Tool Tip to be visible for a time duration, which can be adjusted in Global Options | Main Window.
 - The Tool Tips are not displayed, if you select 0 seconds in *Display Duration of Tool Tips.*

Customized Programming

× "	- 凒	🖵 🧱 🔻			
File	Sta	art Sour	ces	Functions	Catalo
Table of Contents	Index	Programming Reference	User Interface	Assistant	Gratings.
	Use	er's Manual		Assistant	



- More experienced users massively benefit from the programming features which come with VirtualLab Fusion.
- The snippet help document can now include a picture to help visualizing of what the snippet is about.
- The Programming Reference provides all relevant information to get the maximum out of VLF 2023.1.
- The following methods have been added:
 - Acos and Asin in VL_Math (both for complex numbers)
 - Centroid and CreateDetectorResult in VL_Detectors
 - ExtractSummedSquaredAmplitudes in VL_Fields
 - CalculateBitmapFromDataArray2D and ClaculateBitmapFromChormaticFieldsSet2D in VL_Files
- More parameters are added to their corresponding programmable items:
 - Complete data of the varied parameters to Programmable Parameter Run

Data Views

VirtualLab Fusion 2023.1 feature overview

Selected Data Views in VirtualLab Fusion 2023.1



Selected Data Views in VirtualLab Fusion 2023.1



- Optical simulations most often generate 2d or 1d result data. VLF 2023.1 applies data view windows to provide the results to the user.
- **System 3D**: used to illustrate the coordinate mapping of pointwise physical optics modeling, which provides the results known from ray optics.
- **Data Array**: the universal visualization tool for 2d and 3d gridded and gridless data.
- Set of Data Arrays: In modeling we often deal with multiple modes and wavelengths. Then, several data arrays are combined in a set of data arrays.
- **Radiometric Data**: Energy quantities, e.g., irradiance, can be visualized according to the human eye color perception by the concepts of colorimetry.

System 3D View: New Dialogue and Configuration Options



- VLF 2023.1 provides a new dialogue to control the System 3D view.
- It simplifies the use of the 3D System view and adds new configuration features.
- The use of color tables to customize the appearance of different modes is available in the new dialogue.

Cancel

Help

Data Array View: Smoothing of Pixelated Data



- The speed of detector evaluation is the higher the smaller the selected number of pixels in the detector.
- However, then complex data is typically undersampled and leads to artifacts in the interpolated data.
- In VLF 2023.1 we add an option to obtain a smoother visualization of data without demanding more sampling points for complex interpolation.

Example 1: Field data with nearest neighbor interpolation setting, i.e., pixelated view only. The new option allows a smoothing without changing the interpolation via Manipulations.

Data Array View: Smoothing of Pixelated Data



- Complex data is typically undersampled and leads to artifacts in the interpolated data.
- In VLF 2023.1 we add an option to obtain a smoother visualization of data without demanding more sampling points for complex interpolation.

Example 2: Complex field data with cubic interpolation setting, which enables the interpolated view. Because of a random phase the complex interpolation leads to speckles. The new option allows a smoothing of the real-valued amplitude only.

Data Array View: Polar Diagrams



10	peny	browser			÷			
8	1: C	\Users\\	DA_Polardiagra	m.da				
Vie	w	Object	Selections					
~	Gen	eral						
>	Win	dow Size		756, 446				
	Show Polar Diagram			False	\sim			
	Data Restricted Zoom			True				
	Tran	sposed V	/iew	False				
	Zoom Factor			612.55				
	Zoom Factor Unit		Unit	1 px / [1 rad]				
~	Data							
	Viev	v Interpol	ation	Interpolated View				
×	Lab	els						



/ie	W Object Selections	
~	General	
>	Window Size	756, 446
	Show Polar Diagram	True 🗸
	Orientation of Half Circle.	Тор
~	Azimuthal Axis	
	Description	Alpha
	Number of Grid Lines/Quadrant	2
	Orientation of Angular Labels	Horizontal
	Show Angles in Radian	False
~	Data	
	View Interpolation	Interpolated View

- One-dimensional (1d) data may be generated by detectors directly or are obtained by extracting 1d lines from 2d data.
- VLF 2023.1 adds the option of polar diagram views for all cases, in which the 1d data depends on an angle.
- Switch between a Cartesian and a polar diagram visualization via the Property Browser.
- This new feature can be directly applied to the new angle dependent radiometric and photometric detector add-ons!

Data Array View: Find and Mark Points by Index



~	Selection (Point)		\mathbf{v}	Selection (Point)	
	Display Point Marker	True		Display Point Marker	True
	Wavelength	532 nm		Wavelength	532 nm
	Is Central Point	False		Is Central Point	False
	Point Index	550	_ [Point Index	550
~	Selection (Point) Properties		~	Selection (Point) Properties	
	Position	(521.17 μm; 78.554 μm; 0 mm)		Position	(-18.098 µm; 6.6918 µm; 0 mm)
	Direction	(-0.053847; -0.0071756; 0.99852)		Direction	(-0.053847; -0.0071756; 0.9985)
	Wavefront Phase	-1.1834E+05 rad		Wavefront Phase	-27.695 rad

- For pointwise operations it is interesting to follow the mapping of selected points.
- Hence, VLF 2023.1 enables the visual indication of a selected point index in the data view.
- In a typical workflow the user checks the index of the point of interest in a data view close to the source. Then, VLF 2023.1 allows the visual indication of the same index point in all other views of the same system modeling.

Export to Overview Bitmap



- The flexible illustration of data is essential for a fast result documentation.
- VLF 2023.1 introduces a new feature to enable the convenient layout of arrays of result figures.
- The workflow uses the generation of a bitmap sequence from a set of data arrays, from which then the Overview Image is composed.

Data Array View: More New Features





• VLF 2023.1 enables the selection of the color to illustrate undefined values in a view.

• VLF2023.1 provides the value of the position and the data at the mouse position.

More Options in Data Views by Graphics Add-ons







- In addition to the visualization of the data about the light itself, e.g., amplitude, phase, and irradiance, other information should be added to the data view.
- VLF 2023.1 introduces the concept of graphics add-ons, which enable to add such additional information to data array views.
- This concept can be universally applied to include a growing number of geometric objects into a data view.

Graphics Add-ons: Polarization Ellipses



- VLF 2023.1 applies the new graphics-add on concept to optionally add polarization ellipses to the field data output of the universal detector.
- Once added to the data view, the ellipses can be configured via the View ribbon.
- Graphics add-ons provide a great variety of configuration options

Graphics Add-ons: Add Point Cloud



- The seamless transition between physical and geometrical optics modeling concepts in VirtualLab Fusion enables the generation of different types of results by using different modeling configurations.
- VLF2023.1 applies the graphics add-on concept to enable the combination of different results.

-

33,578

Electric Field (X-Domain Equidistant)

Amplitude of "Ex-Component" IV/m

-0.08 -0.06 -0.04

X [mm]

-0.02



Regions in VirtualLab Fusion



- Regions are used in VirtualLab Fusion, e.g., for some time to define signal windows in diffractive optics designs.
- In VLF 2023.1 we start to apply the region concept in many more scenarios.
- Regions define 1d and 2d domains in which specific operations should be performed, e.g., a detector should be evaluated, or a grating should be defined.
- We steadily extent the usability of the region concept. VLF 2023.1 adds the periodical extension of regions.
Graphics Add-ons: Add Region





ippet Heip	- 0 X				
Lateral Extent via St	andard Deviation				
Author: Christian Hellmann /ersion: 1.0 .ast Modified: Thursday, Dece	mber 15, 2022				
nput data: any gridded or grid Function: determines lateral ex Dutput: calculated lateral exter	lless data, e.g., complex field data and output data (1d,2d) from other add-ons. tent of data using the standard deviation from expected value. tt values; data view window with indicated extension (optional).				
The detector provides the exter	nt measure per subset of the input data array.				
earn more about the lateral ex	tent detectors <u>here</u> .				
PARAMETER	ETER DESCRIPTION				
Quantity for Measurement	Select on which quantity of complex valued input data the detector function should be applied. The following options are available (the options have no effect for real valued input data): • 0 - Real Part • 1 - Imaginary Part				
	 2 - Amplitude 3 - Squared Amplitude 				
Lift Data To Positive Values	2 - Amplitude 3 - Squared Amplitude Checked: data is lifted to positive values before the application of the lateral extent measurement. Unchecked: no change of data				
Lift Data To Positive Values Indicate Detected Extent in Output	2 - Amplitude 3 - Squared Amplitude Checked: data is lifted to positive values before the application of the lateral extent measurement. Unchecked: no change of data. Checked: provides data view window with extent indicated by graphics add-on. Unchecked: No data view window.				

- Regions define geometric objects, which can be included in data arrays by graphics add-ons.
- VLF 2023.1 enables this concept in a direct way via the Manipulation ribbon.

 The concept can be also used in add-ons of the universal detector, e.g., to indicate the measured extent of a function.

Light Guide Toolbox: New View Features



- The VirtualLab Fusion Light Guide Toolbox provides a power workflow for the design of light guides for AR/VR.
- We steadily improve the tools for the design.
- VLF 2023.1 adds new features to some specialized views:
 - Visualization of the regions in detectors behind light guides (see <u>here</u>).
 - Direct visualization of the uniformity in the exit pupil.
 - Improved and interactive preview of the grating regions layout in a light guide for faster access and control of regions and grating parameters.

Learn More About VirtualLab Fusion Views

Videos

- Optical System
- Data Arrays
- Positions, Directions & Wavefront Phase
- Interpolation and Smoothing
- Graphics Add-ons
- Polarization Ellipses in Data
 <u>Array Views</u>
- <u>Visualize Positions in View</u>
 <u>Windows</u>
- <u>Visualize Region Boundaries in</u> <u>View Windows</u>

Use Cases

- <u>3D Visualization of the Optical</u>
 <u>Setup</u>
- Universal Detector
- <u>View Settings for 2D Data</u>
 <u>Arrays</u>
- Graphics Add-on
- Add Region to Data Array
- Add Point Cloud to Data Array



Source Power Management

Source Power Management

Profile Editor (Modeling Profile: General)	×
Parameter Overview Pos Sources Spectral Parameters Type of Power Spectrum Source Power Manager Components Activate Power Manager Solvers Source Power Manager	ition & Size Power Management
Visualization & Detectors Other Settings	The power management and various detector add-ons perform an integral over the wavelengths. For discrete spectra, the integral becomes a sum. For continuous spectra, the integral is implemented with a trapezoid rule.
Olobal Settings	OK Cancel Help

- With the introduction of radiometric and photometric detector add-ons in VLF 2023.1, the need for a source power management became pressing.
- Thus, VLF 2023.1 provides a source power management. The user have access to it via the Profile Editor in Sources.
- Activating the power management and specifying the source power leads VLF 2023.1 to perform
 - an evaluation of the source power for the given specifications in the source,
 - and a subsequent scaling of the amplitude of all field modes in the source before propagating the modes through the system to produce the specified source power for modeling.

Learn More About Source Power Management

Videos

- General Modeling Profile
- Source Power Management

- Use Cases
- <u>Universal Detector</u>
- <u>Fresnel Curves on a Plane</u> <u>Surface</u>



Components

New Features of Components in VirtualLab Fusion

- VirtualLab Fusion combines sources, components and detectors to configure optical systems.
- Components are constructed by surfaces, stacks on surfaces, and media in between surfaces.
- Media can describe any spatial refractive index modulation, including jumps in the modulation of the index.
- The wavelength dependency of the refractive index is described in the materials.
- Components come with a specific solver for modeling.
- VLF 2023.1 provides some new features for components.



www.lighttrans.com

New Features of Components in VirtualLab Fusion I

efractive Index	bsorption Addition	al Information	Temperatur	e Data
Define Abcorntio	n hv		remperatar	
Denne Absorptio				
Sampled	Absorption Coeffici	ent 🗸	Ν	
 Constant 	Absorption Coeffici	ent	13	
O Programmable	Internal Transmittar	ice		
Data				
Wavelength	Absorption Coefficie	ent		Set Data Array
300 nm	119.83	m ⁻¹		Set Data Array
310 nm	55.452	m ⁻¹		Show Data Array
320 nm	26.157	m ⁻¹		999
334 nm	9.9385	m ⁻¹		📝 Add Datum
350 nm	3.3353	m ⁻¹		Data Cat
365 nm	1.1772	m ⁻¹		New Data Set
370 nm	0.93075	m ⁻¹		
380 nm	0.68585	m ⁻¹		
390 nm	0.44244	m ⁻¹		
400 nm	0.32129	m ⁻¹		
405 nm	0.28098	m ⁻¹		
420 nm	0.28098	m ⁻¹	U	lpper Limit
436 nm	0.32129	m ⁻¹		2.675 um
460 nm	0.28098	m ⁻¹		
The Sampled Ab	sorption Data are	Non Equ	idistant	
so the Interpo	lation Method used is	Linear Ir	terpolation	
Domain of Defini	tion			
Vacuum Waveler	ngth Range		300 nm t	ο 2.675 μn

Absorption can now also be defined using sampled data representing Absorption Indices and Internal Transmittance.



The proper sampling of the field behind a microstructure component is crucial. VLF 2023.1 gives direct access to this sampling.

New Features of Components in VirtualLab Fusion II



The new General Aperture with Soft Edge combines the creation of general 2d regions with the concept of soft edges to ensure correct sampling of fields passing through such apertures. Surfaces Catalog X $\odot \oslash \bigcirc \leftrightarrow \circlearrowright$ Definition Type LightTrans Defined Filter by. JRear) - Aspherical Surfaces Axicon Surfaces - Lens Arrays Polygonal Pyramid Surface Sine Period Varied by Exponential Sine Period Varied by Linear Functio Sine Period Varied by Random Func Sine Period Varied by Sine Function Rotational Symmetric Programmed Surf - Special Asphere Formula Surfaces - x-Modulated Surfaces • × **Polygonal Pyramid** Author: Wyrowski Photonics Gmbl Version: 1 Last Modified: Friday, July 29, 2022 The snippet allows to define a pyramid with a polygonal base 🗊 / 🗙 Tools 🍟 🚽 Show Preview Apex Polygonal Base PARAMETER DESCRIPTION Polygonal Base Base of the pyramid. Has to be a convex polygon The apex of the pyramid. Its (x,y) coordinates have to lie within Polygonal Base. Apex Automatic Center If activated, the polygonal base will be centered automatically to the origin of the surface coordinate system Close

A new pyramid surface, defined by polygonal region as base, is added in VLF 2023.1

New Features of Components in VirtualLab Fusion III



Edit Volume Grating Medium Basic Parameters Scaling Periodization Holographic Material Q Name Vacuum ~ / 🞽 Catalog Material Gas or Vacuum State of Matter Interferogram Index Modulation O Holographic Material Directions are defined in Vacuum Representation of Direction Cartesian Angles λ (Medium) No. Weight α α (Quant.) β β (Quant.) Dir. λ (Vacuum -500 nn 500 nm 1 2° 2.866° 0° 0° ➡ 500 nm 500 nm Append Edit Delete Edit Plane Wave × Limit Period x-Directi 10 (defines k space discre Structure Period x-Direction: 10 µm; Structure Peri Wavelength 500 nr Weight Structure Period z-Direction 399.75 µm Direction 0 Cartesian Angles Alpha 0° 0 Beta Positive z-Direction OK Cancel Help

New media in VLF 2023.1:

- Slanted Grating with rounded edges
- Medium to shift and rotate another medium

More options to configure the volume grating medium.

New Features of Components in VirtualLab Fusion IV



More types of Zemax OpticStudio® Lens Files can be imported.

The following parameters are now available for Parameter Extraction in Parameter Run and Optimization:

- **Materials**: Parameter of the dispersion formulas
- Crystal Plate Component: Orientation
- Pillar Medium (z-Independent): constant refractive index
- Light sources: Jones vector
- Microstructure Component: Accuracy Factor
- **Periodic Aperture**: Aperture settings

Process Logging

Extended Process Logging

	· ·		
	System Free Space Propagation	Light Path Finder	
)	General		
s	Process Logging Level	Detailed V None	
	Environment	Normal Detailed	
·	Air Pressure	101.33 kPa	
ente	Sustem Temperature	20 %	
rs	system remperature		
tion			
ors			
ings			
. 1	28: Optical Setup Editor #28 (P	ocess Logging)*	
-	Path 📢	Detectors Analyzers Logging	
	[10/20/2022 11:07:50] -	Propagation to Camera Detector #605	
	[10/20/2022 11:07:50]	deal Beam Splitter" #2 [Output x]	
	[10/20/2022 11:07:51]	Conversion from non-equidistant data to equidistant data finished	d Duration = 00:00:00.8595448
	[10/20/2022 11:07:51]	Fast Fourier Transform (gridded data, (1539; 1563) sampling poin	ts) (Duration = 00:00:00.3511333)
	[10/20/2022 11:07:51]	Phase Upgrade finished Duration = 00:00:00.1156918	uner transform used in larger than 1)
	[10/20/2022 11:07:51]	Conversion from equidistant data to non-equidistant data Duration	on = 00:00:00.2124700
	[10/20/2022 11:07:51]	deal Beam Splitter" #2 [Output k]	
	[10/20/2022 11:07:51]	Free space propagation in k-domain (Duration = 00:00:00.014959	9)
	[10/20/2022 11:07:51]	Conversion from non-equidistant data to equidistant data finished	Duration = 00:00:00.9380307
	[10/20/2022 11:07:54]	inverse rast rouner mansform (gridded data, (2779, 2703) sampli	ing points) (Duration = 00.00.01.2304641)
	[10/20/2022 11:07:54]	Pointwise Transformation Index (PTI) = 1E-05 (pointwise Fourier	r transform used if larger than 1)
	[10/20/2022 11:07:55]	[amera Detector" #605 [Input x]	
	[10/20/2022 11:07:55] -	Propagation to Camera Detector #605	
	[10/20/2022 11:07:55]	deal Beam Splitter" #2 [Output x]	
	[10/20/2022 11:07:55]	Conversion from non-equidistant data to equidistant data finished	d Duration = 00:00:00.0687826
	[10/20/2022 11:07:55]	Fast Fourier Transform (gridded data (161-289) sampling points)	(Duration = 00:00:00.0151626)
	[10/20/2022 11:07:55]	Pointwise Transformation Index (PTI) = 1E-05 (pointwise Fourier	r transform used if larger than 1)
	[10/20/2022 11:07:55]	Conversion from equidistant data to non-equidistant data. Durati	on = 00:00:00 0140580
	[10/20/2022 11:07:55]	deal Ream Splitter" #2 [Output k]	011 - 00.00.00.0149389
	[10/20/2022 11:07:55]	Free space propagation in k-domain (Duration = 00:00:00.001807	(7)
	[10/20/2022 11:07:55]	Camera Detector" #605 [Input k]	10
	[10/20/2022 11:07:55]	Conversion from non-equidistant data to equidistant data finished	d Duration = 00:00:00.1096427
	[10/20/2022 11:07:55]	Inverse Fast Fourier Transform (gridded data, (609; 761) sampling	points) (Duration = 00:00:00.0575992)
	[10/20/2022 11:07:55]	Pointwise Transformation Index (PTI) = 1E-05 (pointwise Fourier	r transform used if larger than 1)
	[10/20/2022 11:07:55]	Jamera Detector #605 [input x]	

- Process logging delivers transparency in optical modeling and design.
- The more modeling steps are included in the logging the more modeling characteristics and behavior can be understood.
- VLF 2023.1 adds more operations in the logging, e.g., data conversions which can be sometimes time consuming.
- The automatic selection of the pointwise Fourier transform algorithm constitute a key technology in VirtualLab Fusion.
- We introduce with VLF 2023.1 a new criterion, the Pointwise Transformation Index (PTI) to judge the switching point between FFT and PFT algorithms. The logging provides the PTI values to provide maximum flexibility.

System Modeling Analyzer

System Modeling Analyzer

Ray Results General Profile Profile Editor Overview Execution Se	r Use Parameter Coupling Ø ttings Result Visualiz	Modeling Analyzer O Ation	nanual iguration → ✿ ht Path Finder	Source to Com Pointwise	ponent: Betwee • Po	Components:	To Detectors: Pa Pointwise - Assu Profile Editing Too	araxial mptions Martine Ma	curacj . Integ
		4 4							
	Edit Modeling Analyzer	V						×	
								~	
	Detector Window Field Quantit	(k-Domain) ties		Gridless	; Data tor Windo	w (x-Dom	Add-ons		
	- Select Field Data Whi	ch is Provided	to Detect	or Add-O	ns				
	Select Held Bata Hill	Ev	Ev	F7	Hy	Hv	Hz		
	Components		2						
	Domain	🗹 Spa	ice (x-Dor	nain)	🗸 Fo	urier (k-Do	omain)		
	Configure Field Data Quantity Add-On	Configure Field Data Visualization by Electromagnetic Field Quantity Add-On			Ø				

- Besides the process logging, the System Modeling Analyzer provides deep insight into the modeling steps by generating a set of data arrays with all modeling results per step.
- In VLF 2023.1 the Universal Detector is used to provide the fields per step. That gives access to the fields in x- and k domain.
- Dependent on the modeling settings in the profile the Modeling Analyzer now also provides gridless field data without interpolation on demand.

Expert Modus

Manipulations of Data Arrays in Expert Modus



VLF 2023.1.1:



- With VLF 2023.1 we change our concept of the availability of ribbons.
- Dependent of the type of data in a data array view selected ribbons are available. That helps to reduce the number of ribbons to the most important ones for the special type of data.
- However, it also limits the manipulations which are available for the data type.
- In VLF 2023.1 we give this restriction up to offer our users the maximum flexibility for data manipulations.
- To this end VLF 2023.1 offers the Expert Modus which provides all available manipulations independent of the data type.

VLF Calculators

The Small Helpers: New Calculators





📋 11: Memory Cal	culator	- • ×			
Sampling Points	5362 🜩	× 1421 +			
Precision	Double Precision V				
	O Real-Valued	Complex-Valued			
	O Globally Polarized	Locally Polarized			
	Such a field requires 243.82 MB of memory.				
Validity: 🕑	C	Close Help			

- Our customers appreciate the Calculators in VirtualLab Fusion.
- We add new calculators with most major releases.
- VLF 2023.1 adds a new feature to the Spherical Lens Calculator for lens design with the lens maker's formula.
- Then VLF 2023.1 adds a Memory Calculator to give a fast understanding of the usage of memory in your PC dependent of the data type and the number of sampling points.

VirtualLab Fusion 2023.1 – The Feature Firework

- VirtualLab Fusion 2023.1 provides amazing new features for:
 - Higher Speed
 - ➤ Easier Use
 - More Physics
 - Deeper Transparency
 - Better Control
- Do not miss the webinar series on VLF 2023.1!

Register Now!

