

Complete Release Notes VirtualLab™ 4

Version 4.8.1

General Information:

- Update Service: release date is July 2010. Update service including the 2nd quarter 2010 is required.
- Installation: VirtualLab™ 4.8.1 is an update. VirtualLab™ 4.8.1 requires the installation of VirtualLab™ 4.8.

VirtualLab™ 4.8.1 is a service release without additional features. Some computational issues with respect to the Grating Toolbox have been resolved.

Version 4.8

General Information:

- Update Service: The release date is June 2010. Update service including the 2nd quarter 2010 is required.
- Installation: VirtualLab™ 4.8 is a complete installation. Uninstall any previous version of VirtualLab™ 4 first. After that, install VirtualLab™ 4.8.

VirtualLab™ 4.8 provides the following enhancements:

- Grating Simulations
 - General 2-D gratings can be defined now. Using so called stacks, the period of the structure can be defined by a sequences of optical interfaces, including grating, conical, aspherical, sampled and programmable interfaces. Stacks can be added at both sides of a base block. Hereby a great flexibility for the definition of gratings is available. Until now, these interfaces must by separated in z-direction.
 - In VirtualLab™ Advanced multi-core computing is now supported. The core of the FMM now works in parallel and single simulation can be accelerated.
 - In VirtualLab™ Advanced larger periods (about $1900 \cdot \text{wavelength}$ in 2D or $(37 \cdot \text{wavelength})^2$ in 3D) and more orders (about 5800 in 2D and $(75 \cdot 75)$ in 3D) can now be simulated.
 - Field Inside Grating Analyzer now works for non-perpendicular incidence.
 - Near field propagation now considers absorption coefficients.

- The reflection channel of gratings accepts distances greater than zero.
- Active/deactivate of light path linkages is now available in the Grating Toolbox.
- Modeling of Optical Components
 - Pixelation and quantization can be applied to any optical interface. This allows to simulate the interfaces as they appear after certain production processes. For quantized interfaces paraxial geometrical optics propagation or mode (AI)/(All) of geometrical optics propagation should be used.
 - Several scaling factors for optical interfaces have been introduced. This allows in particular to perform tolerance analysis with respect to pixelation errors and quantization errors caused. e.g. by non-exact etching.
- Parameter Run
 - In VirtualLabTM Advanced the parameter run can be accelerated by using multiple cores.
 - Many more structure parameters are available for parameter run now. This applies especially to parameters of optical interfaces in the optical interface sequence and the double interface component.
 - The weight for monochromatic light sources is available in the parameter run.
- Programming
 - The editor for snippets and modules has been improved. Source code highlighting has been added.
 - The trial version allows to load and to simulate applications scenarios that include snippets (programmable components).
- Design of Diffractive Optical Elements
 - The session editors for the design of diffractive optical elements (diffusers, beam splitters) now set the size of the aperture of the DOE automatically.
- Trial Version
 - The trial version does not require administrative rights to be started.
 - The trial version allows to load and to simulate applications scenarios that include programmable components.

- Handling
 - Now the user can extract any material from media or from coatings to be put into the user defined materials catalog.
 - View of materials shows the state of matter.
 - One-dimensional diagrams can detect their minimum and maximum value, respectively.
- Miscellaneous
 - Some of the LZOS glass data have been corrected using the data at LZOS's homepage.
 - The ray tracing analyzer may require some more time to initialize when it is used in "Rotatable" mode.

Version 4.7

VirtualLab™ 4.7 (released March 2010) provides the following enhancements:

- Ray Tracing Analyzer
 - The brightness of rays is adjusted according to their intensity in the input plane (similar to the light view).
 - Rays that are close to an aperture can optionally be shifted (default setting) such that they touch the aperture. Further, rays of small intensity can be disabled via a user-defined threshold.
- Grating Simulations
 - Field Inside Grating Analyzer now works for non-perpendicular incidence.
 - Near Field Propagation now considers absorption coefficients.
 - The reflection channel of gratings accepts distances greater than zero.
- Parameter Run
 - If multiple parameters are varied at the same time, the parameter run now shows the corresponding values in a tooltip.
 - A parameter run set to "Programmable" copies now also the snippet and the global parameters from an already open parameter run.
 - Large parameter runs can be saved to hard disc again (bug in version 4.6).
- Catalogs

- Fresnel and cylindrical Fresnel interfaces, several types of grating interfaces and the combined interface are now available as templates in the interface catalog.
- For Standard Air, the Edlén formula is now used to describe the dispersion, it replaces sampled data.
- Programming
 - Consistence Check of Snippets within the Source Code Editor shows detailed information about the line where the snippet definition is invalid and the error message.
 - Improved handling for import and export of arrays within global parameters of snippets.
- Handling
 - The handling of homogeneous media is now consistent in the dialogs, e.g. dialog of the Optical Interface Sequence.
 - The selected element in the light path view are used as initial configuration for the LPD tools.
 - Multiple selection is enabled for the import of light path elements.
 - Multiple selection is enabled for the import of old materials and coatings in the catalog.
 - Interfaces with asphere or polynomial coefficients as well as the GRIN medium now use millimeters instead of meters as base unit. That is, the usage of catalog values is simplified.
 - The virtual screen now allows to show the polarization, including polarization ellipses.
 - In diagrams you can now calculate the minimum position, maximum position and the FWHM
 - Most tables now allow to copy their entries to the clipboard using the context menu. Certain tables also support pasting from the clipboard (for Aspherical Interface, Cylindrical Interface, Fresnel Interface, Cylindrical Fresnel Interface, Polynomial Interface, GRIN Medium, Zernike Seidel Aberrations).
 - Plane Waves Field View now allows to copy all items to the Windows clipboard.

Version 4.6.1

VirtualLab™ 4.6.1 (released February 2010) is a service release without additional features. The behavior of the dialog of aspherical interfaces has been improved.

Version 4.6

VirtualLab™ 4.6 (released January 2010) provides the following enhancements:

- Introduction of 3-D grating simulations
 - The electromagnetic analysis of 3-D index-modulated gratings has been enabled. In version 4.6, the index-modulation can be described by a pillar-type medium that can be used to simulate, e.g., artificial media.

Version 4.5.1

VirtualLab™ 4.5.1 (released December 2009) is a service release without additional features. The performance of programmable interfaces has been improved.

Version 4.5

VirtualLab™ 4.5 (released December 2009) provides the following enhancements

- Partially coherent light simulation
 - Partially coherent light of quasi homogeneous sources can be modelled by sets of harmonic fields (modes). In order to model light distributions with customized coherence function customized modes are required. A Programmable Mode Planar Source has been added that allows the specification of a customized mode by a small code snippet.
 - Planar sources are used in VirtualLab™ for the simulation of partially coherent light. Version 4.5 allows to define a customized global polarization for every planar source.
- Modeling of optical components with index modulation
 - LightTrans adds the modeling of index modulated optical components. These components consist of two freeform surfaces and an index modulated medium in between and can be realized using the new Double Interface Component.
 - The Double Interface Component allows for example the simulation of GRIN lenses, customized index modulated components and defects inside the substrate of optical components.
 - The Programmable Medium allows the specification of a three dimensional index modulation by a code snippet.
 - The XY-Index Modulated Plate is replaced by the Double Interface Component. When loading old light path documents with an XY-Index Modulated Plate, the conversion is done automatically.

- Diffractive and refractive freeform surfaces
 - A Polynomial, a Sampled and a Programmable interface have been added in order to model diffractive and refractive freeform surfaces. The interfaces can be used in the Double Interface, Single Optical Interface and the Optical Interface Sequence Components.
 - The Sampled Interface allows the specification of customized freeform surfaces by discrete height data points while the Programmable Interface enables the specification by a code snippet.
 - The component Aspherical Interface Sequence has been renamed to Optical Interface Sequence.
- Modeling of diffractive and micro structured optical elements
 - Diffractive and micro structured optical elements, as for example diffractive optical elements, phase plates, micro lens arrays, diffractive lenses, Fresnel lenses, hybrid lenses, can be modelled by the Double Interface Component.
 - The modeling of the surface profiles can be done using the new programmable and sampled interfaces.
- Ultra Short Pulse Simulation:
 - As part of the starter toolbox we introduce the simulation of ultra short pulses in version 4.5.
 - Generation of pulses using Gaussian pulse spectrum, propagation of pulses and an optical path length analyzer for sampling reduction are included.
 - The Fourier transformation between temporal and frequency domain is provided for pulses.
 - The Optical Path Length analyzer can be used to evaluate the optical path length between the active source and a user-defined element of the light path diagram. It can also be specified whether the absolute phase shall be calculated. Three different linear phase fits can be investigated.
- Analysis of Laser Resonators:
 - The eigenmode analyzer is provided for computing eigenmodes (both fundamental and higher modes) and eigenvalues of resonator setups. Fox-Li and Arnoldi algorithms are available.
 - The resonator session editor allows to import resonator systems from LASCAD.
 - A stored mirror function can be used to simulate micro-structured mirrors as part of the resonator. Customized apertures are available using stored functions.

- The parameter run can be used to perform tolerance analysis of the resonator.
- Outcoupling modes can be computed and simulated in exterior optical systems.
- Propagation:
 - The split step propagation (based on paraxial beam propagation methods) has been introduced for the simulation of index modulated media.
 - The paraxial geometrical optics operator has been added and is available in the double interface component and in the laser resonator toolbox. Other components in the starter toolbox will follow in forthcoming releases. It is a performance-optimized version of modes (AI, AII) provided by the geometrical optics operator.
- Catalogs:
 - VirtualLab implements a new concept for working with catalogs. The existing catalogs for materials and coatings are adapted. There are new catalogs for optical interfaces and optical media. More information can be found in the manual.
 - Coating handling is now full part of the VirtualLab catalog management. Additionally, it is now easier to create high reflection coatings with replicated layer sequences via automatic replication.
 - Materials do know their state of matter now.
 - The substrate is determined automatically if a coating is added to an optical interface.
- Improvements Related to Design:
 - The structure design provides the option to generate a light path diagram holding a Double Interface Component that contains the structure of the DOE.
- Improvements Related to Grating Simulations:
 - The Grating Efficiency Analyzer now shows also summed efficiencies and the absorption.
 - The new Field Inside Grating Analyzer allows to calculate the field inside a grating.
 - In the Holographic Volume Grating component the user enters the vacuum wavelength now instead of the medium wavelength of the interfering plane waves. Both vacuum and medium wavelength are shown.

- TE and TM polarization for ideal plane wave light source work correctly now.
- Parameter Run:
 - The programmable Parameter Run enables the user to specify the progression of the selected parameters by a self programmed snippet. So not only a linear progression can be evaluated.
 - Zernike Fringe coefficients can be varied in the Parameter Run now.
- New and updated Light Path Elements and their features:
 - For Stored Lateral Field source, only globally polarized fields are admissible as lateral fields, the polarization is defined in the dialog, i.e. the polarization of the imported field is ignored.
 - New reference points are available for Single Optical Interface, Optical Interface Sequence and Spherical Lens: maximum extension of component defines the two new points.
 - In the customized propagation mode that is available e.g for the double interface component, it is now possible to define different propagation operators for different regions of a component.
 - The entries in the Optical Interface Sequence Component table can now be set up with a comment per interface.
 - An Ideal spherical Mirror has been introduced.
 - Now the Ideal Mirrors allow to define the reflectance.
 - Field Size and Sampling Manipulator accepts now "1" as sampling point for one directions which means that a 2-D field is converted to 1-D.
 - The fiber coupling efficiency detector allows to specify either the NA of the fiber or the diameter of the fiber mode.
 - The ray tracing analyzer has been added to visualize ray propagation through sequences of optical interfaces.
- Calculators:
 - Direction converter (calculator) can handle different media now.
 - Fresnel Effects Calculator can give diagram output with wavelength and angular dependency now.
- Programming:
 - The source code editor used to edit VirtualLabTM snippets allows to check their consistency directly.

- Handling:
 - VirtualLab™ checks whether the document needs to be saved before closing the document. This is implemented for modules, design problems, spreadsheets, light path diagrams and parameter runs.
 - After closing a session editor the user can specify whether all subsequent documents, generated by the session editor, shall be closed or not.
 - Detector results are logged in an extra table on the bottom of the VirtualLab™ main window. This leads to a more well-arranged overview of all detector results produced by VirtualLab™.
 - The menu item "Windows - Close All but Current" all windows except the current one can be closed.
 - Zoom into diagrams is possible via mouse wheel and toolbar now.
 - Windows can be arranged in different ways (cascade, tile horizontally, tile vertically, arrange icons)
 - The axes of data series diagrams can be adjusted via the property browser now.
 - Files with extension .csv can now be imported directly.
- Tools:
 - Data Field Diagrams can now be replicated periodically.
 - The Light Path Diagram Tools (Toolbar) are available also if the Light Path View is the active document window. The toolbar of VirtualLab™ provides a standard button to start or stop an active Light Path Diagram (window as well as editor) and an active VirtualLab™ Module.
 - The Field Evaluation Tools provide methods to evaluate harmonic fields. By extraction of a point or a line profile, VirtualLab™ provides a diagram where the field quantity is selectable.

Version 4.2.1

VirtualLab™ 4.2.1 (released May 2009) is a service release without additional features.

Version 4.2

VirtualLab™ 4.2 (released May 2009) provides the following enhancements

- New Light Path Elements:

- Evanescent Field Filter. The filter eliminates the evanescent part of the field. Only propagating plane waves remain in the spectrum of plane waves representation of the field.
- Polarization Detector. This detector shows the E_Rho and E_Phi component of fields. This is available in the light path only.
- General Jones Matrix - please do not use - is being removed in version 4.2.1.
- Enhancements for Spheres and Aspheres
 - Collins integral by ABCD matrix propagation has been added for the spherical lens, single interfaces and sequence of interfaces within the AIS. This is restricted to plane and conical interfaces.
 - A 3D view of the interface sequence has been added. It shows the interfaces of these components in a real 3D view. Some edit functions are available directly from the view window.
 - ZEMAX import: image and object surface are imported as 2 additional interfaces of the AIS. If the ZEMAX file contains DISZ INFINITY as distance, then the distance is replaced by 1m and a warning is given.
- Grating Toolbox
 - It is now possible to specify the number of diffraction orders used for FMM calculations directly. Previously, only the number of evanescent orders could be set (customer request).
 - A programmable grating component is available. This allows you to program snippets which give the refractive index at a certain lateral position. Global Materials can be used to consider dispersion effects.
- Other enhancements:
 - Harmonic fields and field sets are defined in some medium. In the main window all fields are generated in vacuum. Fields that are generated by a virtual screen in a light path diagram may be defined in another medium which is now handled correctly in the main window, e.g. during interpolation and handling of the spherical phase in the view.
 - For Data Series Diagrams it is now possible to zoom in and out via the toolbar.
 - Results of the Parameter Run which represent harmonic fields can now be swapped on hard disc.
 - The Color Detector (available in the spreadsheet) has been removed and is replaced by Virtual Screen.

- The automatic sampling has been improved for spherical and ideal lenses, quadratic and spherical waves and the lateral shift component. In particular the estimates take into account the lateral offset in connection with a spherical phase radius and are more robust for non-paraxial problems.
- For the reflection channel of lenses, AIS and single interfaces the spherical phase radius of the field is now computed correctly. Further, the estimate of the phase radius has been improved for non-paraxial fields.
- Transmission Design Document does simulate the energy conservation for 2f-setups and 1d-fields in a correct way.

Version 4.1

VirtualLab™ 4.1 (released February 2009) provides the following enhancements

- New Light Path Elements:
 - Programmable Light Source: The Programmable Light Source enables the user to program the lateral mode used in the VirtualLab™ light source concept. The required program is a C# snippet that defines the lateral mode as a point-wise complex value. The user can introduce global parameters that can be varied in the Parameter Run.
 - Programmable Transmission: The Programmable Transmission element can be used in the Light Path Diagram to specify a user-defined point-wise complex function. The use of this Light Path Element is completely embedded in the VirtualLab™ framework.
- Propagation:
 - Improved field size estimates for SPW, Fresnel and Far Field Operator have been introduced resulting in more robust automatic mode especially for non-paraxial fields.
 - The deviation threshold used within the Automatic Propagation Operator can now be set in the dialog and in the Globals Options.
- Light Path:
 - New Light Path Tool: The Light Path Tool "Convert to Starter Tool Box LPD" enables the user to convert the given LPD which was generated by a session editor, into a Light Path Diagram where all modification can be done. This tool is only available for Light Path Diagrams generated by the Diffractive Optics Toolbox, the Starter Toolbox is required.

- In the Light Path View, we have introduced a comment (editable) and the name of the Light Path Element can be changed by the user (customer request).
- Improvements for the Parameter Run:
 - It is now possible to start parameter runs with negative steps (customer request).
 - Now it is possible to create animations for the Parameter Run outputs, using the Light Views of selected single Harmonic Fields.
 - The Parameter Run can now show data series diagrams in the result table. This effects mainly the grating efficiency analyzer.
 - Other enhancements:
 - Grating Transmissions can work chromatically now.
 - The detectors Fiber Coupling Efficiency and Diffractive Optics Merit Function can be configured to evaluate their merit function relatively to the initial input field of the Light Path Diagram.
 - New Accelerated Sinc interpolation operator. It is used for field-field or field-transmission operations. Its accuracy is comparable to Sinc interpolation but it avoids out of memory errors that occur for Sinc-FFT interpolation in case of operations between large and small (aperture) fields or transmissions.
 - The Field Size and Sampling Component has been changed. Now it is a one step operation using the Accelerated Sinc interpolation.
 - Copy to Clipboard is now possible for the Light View of Harmonic Fields Sets (customer request).
 - The Scaling Factor has been removed from the dialog of spheres and aspheres.
 - VirtualLab™ now applies Windows Visual Styles resulting in an improved GUI design.
 - The power spectra used in source dialogs (list of wavelengths) now use double precision (previously number of view-digits was used).
 - For spherical lens, single aspherical interface and AIS the reflection channel is now handled correctly (previously wrong assignment of propagation direction).

Version 4.0.2

VirtualLab™ 4.0.2 (released January 2009) provides the following enhancements:

- New Ideal Component:

- Phase Shift. A Phase Shift adds a phase difference to E_x and E_y .
- New Detectors:
 - Two Point Contrast Detector: By the help of the new Two Point Contrast detector in the Light Path Diagram, the contrast of a specified field quantity in two location can be measured. The user have to specify the field quantity he likes to evaluate and the two location where this field quantity shall be measured.
 - Value Monitoring Detector: The new Value Monitoring detector is available in the Light Path Diagram and allows the user to access the field quantities like amplitude and phase on a user defined location of the incoming field.
 - Power Detector: The Power Detector was added to the elements of the Light Path Diagram. This detector can be used for evaluating the power in a specified region of the field which is used as input of the detector. (customer request)
 - Angular Spectrum Visualizer: works similar to the Virtual Screen but shows the angular spectrum.
- Improvements for the Parameter Run:
 - It is now possible to vary more than one parameter at the same time (all with the same number of steps). Negative step sizes are not yet allowed.
 - You can now select whether the Parameter Run gives Harmonic Fields Sets or animations – diagrams as combined output for Harmonic Fields.
 - It is now possible to save the results of the Parameter Run.
 - The results of the Parameter Run are now shown in a more convenient order.
- Enhancements of the Virtual Screen:
 - If a Virtual Screen shows the Data View, it is now possible to set the view size. Furthermore setting the selection within the Virtual Screen now works correctly.
 - The Virtual Screen can now show Summed Squared Amplitudes and polarization.
 - Other enhancements:
 - The Multi Mode Gaussian Source now considers constant Rayleigh length for the higher order modes (constant waist was used before which is physically less meaningful).

- General surface gratings are now always adapted to the specified modulation depth period - it is no longer necessary to first select *Rescale Modulation Depth* or *Rescale Period*.
- The 1d-mode selection for the Grid Gaussian source now works correctly.
- For a New Material, the Cauchy Formula can now be entered correctly.
- Stored Transmission can be applied to 1d,2d fields independent of the dimension of the stored transmission. By definition, a 1d-stored transmission is constant in the missing dimension.

Version 4.0.1

VirtualLab™ 4.0.1 (released December 2008) provides the following enhancements:

- Further improvement of the Geometrical Optics Operator especially of the handling of channels along apertures.
- Improved performance for the Automatic Propagation Operator.
- Parameter run can now handle multiple used detectors.
- Improved sampling estimate for SPW propagation.
- Improved automatic sampling for Zernike Seidel Aberration.
- Generate Spreadsheet is now available as AIS Tool (customer request).
- The dialog of the Coating Analyzer now works correctly.
- The dialog of the Ideal Plane Mirror now works correctly.
- Single aspherical interfaces consider their relative distance within the light path now correctly.

Additionally version 4.0.1 provides several minor improvement and fixes of bugs.

Version 4.0.0

The new version 4.0 of VirtualLab™ (released November 2008) provides you with a new optics modeling and design software package, which combines the matured technology of versions 3.x with lots of powerful and user-friendly new features. Some of them are:

- The most amazing new feature is our Light Path Diagram. Instead of using spread sheets to configure an optical system, you specify the light path through an optical system using a flow chart concept. Of course the former spread sheet concept is still supported. Thus, you gain an

extremely user-friendly concept without losing what you have worked with before. It's your decision, what you prefer. But we expect you will like the new way that we provide you. It is fast and easy to use and it will save you time and money in your work.

- With the Light Path Diagram we have introduced ideal and real components in VirtualLab™. Each component is combined with the modeling techniques suitable for it. And we will add more techniques in 2009. That gives you the flexibility, which our concept promises.
- We have added new propagation techniques. There is a fascinating geometrical optics technique for propagation in free space and through lens systems that is similar to ray tracing software, but we do it in combination with an electromagnetic field representation. Therefore, we combine the power of geometrical optics and access to all parameters of a light field. The technique is equipped, as typical in VirtualLab™, with an automatic sampling feature. You can concentrate on optics instead of numerics. And if you have a better idea than we have at LightTrans, then you can switch over to a manual control and adjust sampling in a way you think is optimal to your problem.
- Absolutely innovative is our new Automatic Propagation Operator for free space. It compares for you the accuracy of geometrical optics, paraxial Fresnel technique, far field approximation with the rigorous spectrum of plane wave method. The technique which fulfills the accuracy criterion and has the minimum numerical effort is automatically selected. That is a great benefit for you to save time of tests and comparisons. In particular, it helps you to decide if your modeling should be paraxial or non-paraxial.
- We understand, that you as a user needs to know what your software is doing. Thus, we added a full logging of what VirtualLab™ is doing for you. You can get the information directly or export it as a complete protocol as an xml document. That is our way to provide transparency to your modeling with VirtualLab™. Our protocols give you a vast amount of modeling information.
- VirtualLab™ offers now a Parameter Run Document, which allows you to specify and run a series of virtual experiments. It will be the basic starting block for upcoming optimization and tolerancing features in VirtualLab™.
- Also in source modeling we added some important new features. With VirtualLab™ 4.0, you have a multimode laser source as well as a customized partially coherent planar source model. A combined source allows generation of locally polarized light, like an azimuthally polarized donut mode.

- We have improved our color representation. Moreover, now you may switch between a photon counting detection and your visual perception of polychromatic light.
- For the analysis of gratings we added the rigorous Fourier Modal Method (FMM). We combined it with the structure definition of surface and holographic volume gratings. That allows you to analyze diffraction efficiencies, near fields and Rayleigh coefficients. And you can do all that in the framework of your VirtualLab™ platform.
- We added various wizards, our new Session Editors, to simplify specifying your modeling and design task. In particular you will benefit from that in diffractive optics. We used our outstanding skills in that area to provide you with easy-to-use ways to design beam splitters, diffusers and laser beam shapers.
- We know, that you often do not need all of the power of VirtualLab™ for solving your modeling and design tasks and making strides in optics innovation. Just some tools may be enough for you. Thus, we offer our technology in toolboxes. VirtualLab™ 4 comes with several toolboxes including Starter, Diffractive Optics and Grating Toolbox along with other toolboxes such as Beam Shaping and Laser Resonator that are under current development. That gives you the choice to concentrate on what you need.

We could give you many more examples of innovative features of VirtualLab™ 4 but maybe it is more important for you to know, that we, the team at LightTrans, are continuously working on serving you better in technical and user-friendly features. Being a customer of VirtualLab™ gives you access to an amazing development in optics software technology. But we also know that something is always missing. Thus, we ask you to send us your ideas and demands for the future development of VirtualLab™.