July 2025, Release VirtualLab Fusion 2025.1

The New VirtualLab Fusion 2025

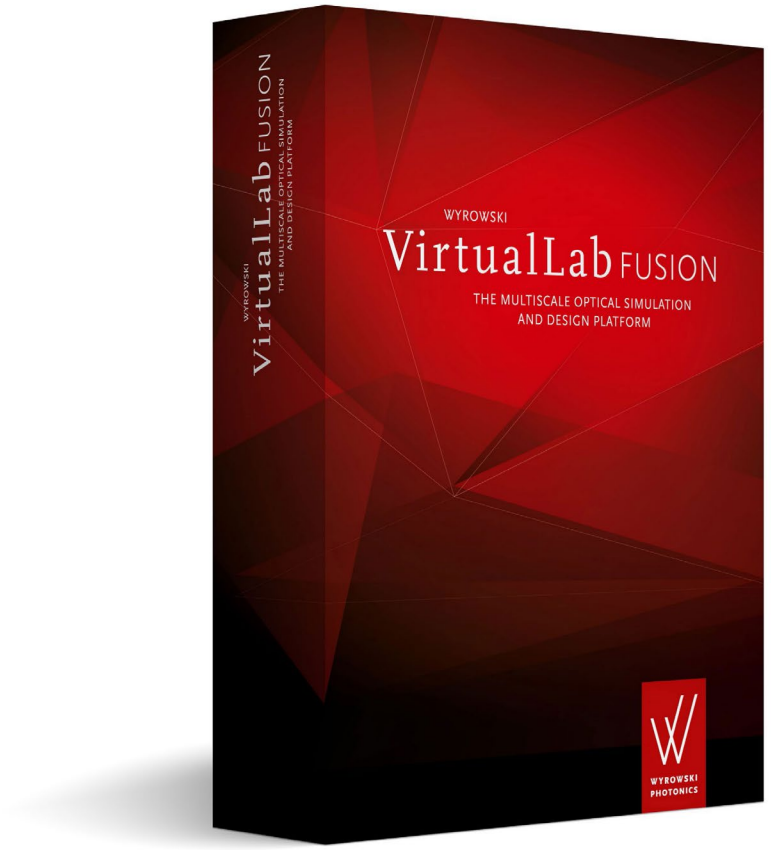
Overview of new features of version 2025.1

General Information

Version	2025.1 (Build 1.176)
Update Service	2nd quarter of 2025 is required.
Install Type	Standalone Installation VirtualLab Fusion 2025.1 is installed in parallel to your existing VirtualLab Fusion installations.

Our Development Focus: From Infrastructure to Solutions

- VirtualLab Fusion's development has always balanced **infrastructure** advancements with **customer-driven solutions**.
- For version 2025.1, we prioritized core improvements like the Plug-In architecture to build a stronger foundation.
- Moving forward, we're shifting more toward solution-oriented features tailored to your real-world challenges.
- If there's a specific problem or application, you'd like us to address, we'd love to hear from you at **support@lighttrans.com**.



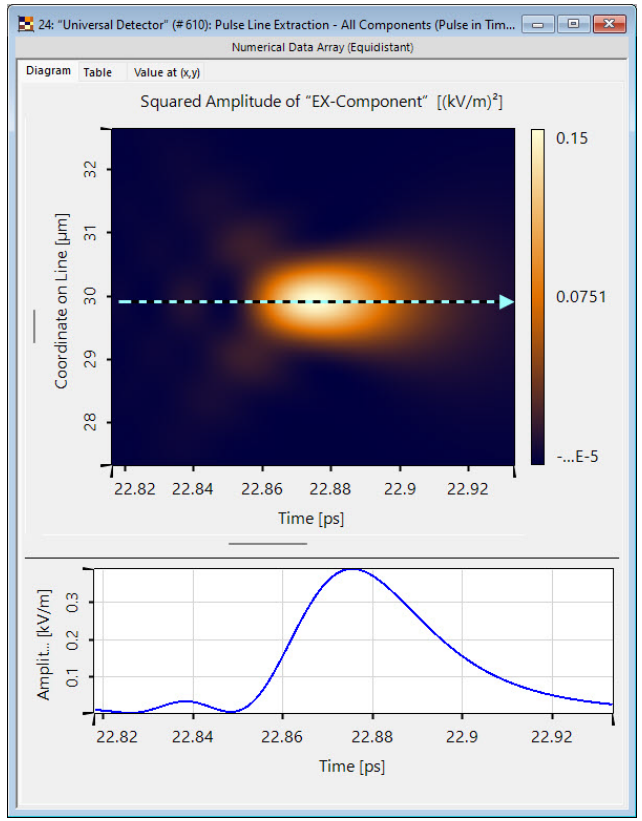
The New VirtualLab Fusion 2025.1

Solutions

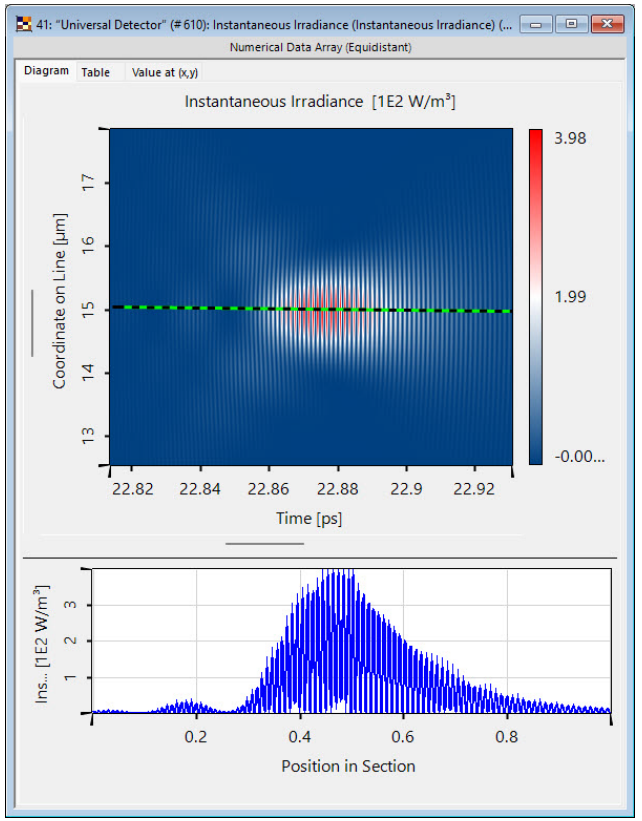
Solution - Ultrashort Pulse Modeling

- Unlock powerful insights into ultrashort pulse behavior with **new detector models** - now supporting precise evaluations of radiometric quantities (instantaneous irradiance, …) and pulse characteristics (pulse duration, …).
- Delivered as modular **detector add-ons**, the new evaluation function can be used inside the Plug-In Detector or enhance results directly from the main window.
- The new **Plug-In Mode Generator** enable effortless integration of spatial, temporal, and even spatio-temporal features right into the source model.

squared amplitude (envelope)



instantaneous irradiance

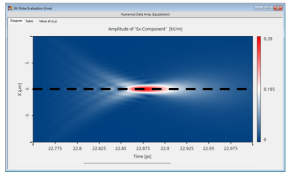


Learn More About: Ultrashort Pulse Modeling

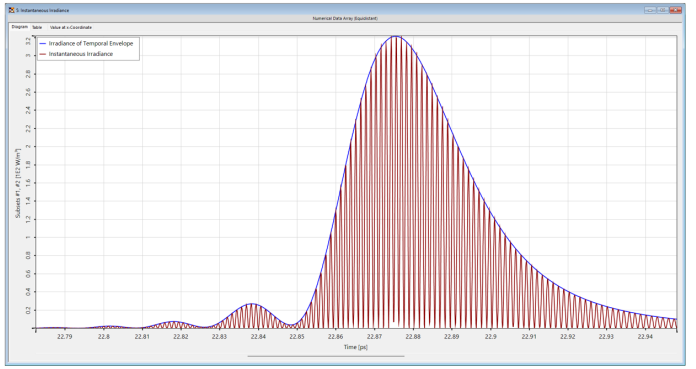
Use Cases

- How to Configure Ultrashort Pulse Simulations in VirtualLab Fusion: A Step-by-Step Guide
- Pulse Focusing with High-NA Lens
- Pulse Broadening in Dispersive Media
- Pulse Front Tilt in SSTF – Setups

Discussion of Instantaneous Irradiance



For the calculation of energy quantities, such as the irradiance, the carrier frequency needs to be considered. Though when the time-dependent phase changes slowly in comparison to the carrier frequency, the envelope of the instantaneous irradiance is the instantaneous irradiance of the temporal envelope of the pulse.



Irradiance (integration over time):

- Real pulse – $6.5e^{-12}\ J/m^2$
- Only Envelope – $1.3e^{-11}\ J/m^2$

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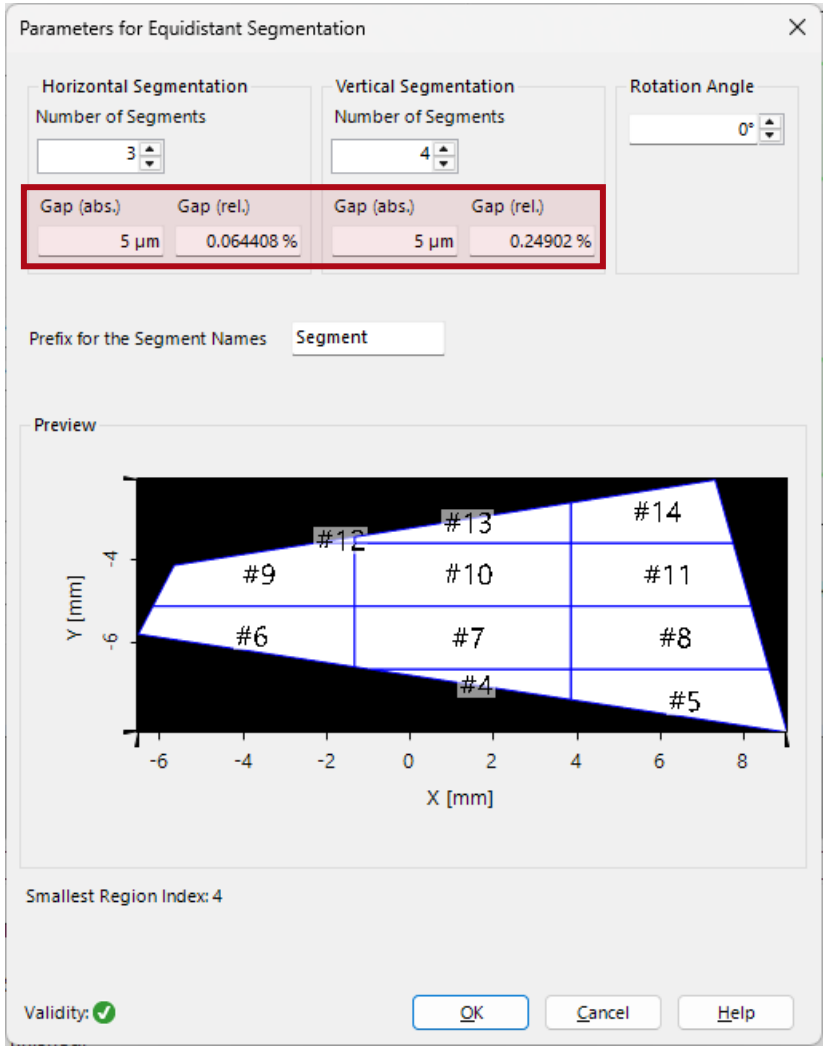
Solution – Analysis of Realistic Fabrication Constraints for Lightguides

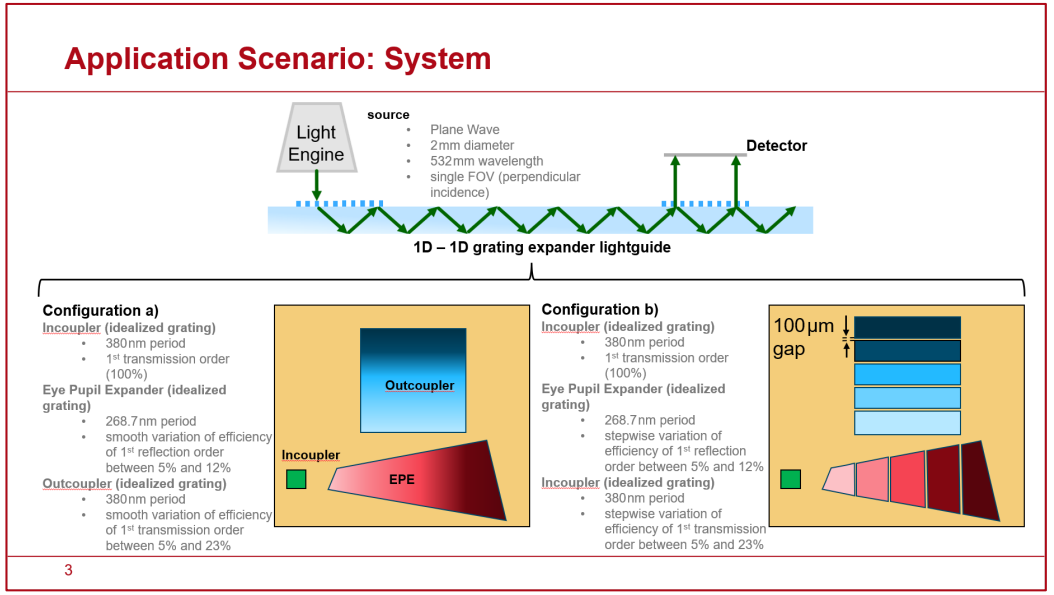
- VirtualLab Fusion introduces advanced capabilities for simulating **diffractive light guides**, a key strength of our platform.
- A notable improvement is the ability to model **gaps within segmented grating** regions, a common fabrication constraint in real-world devices.
- With this tool, engineers and designers can now evaluate the impact of gaps between grating regions on optical performance.
- This enhancement provides deeper insights into device behavior, ensuring more accurate and practical simulation results for diffractive lightguide designs.



Learn More About: Analysis of Diffractive Lightguides

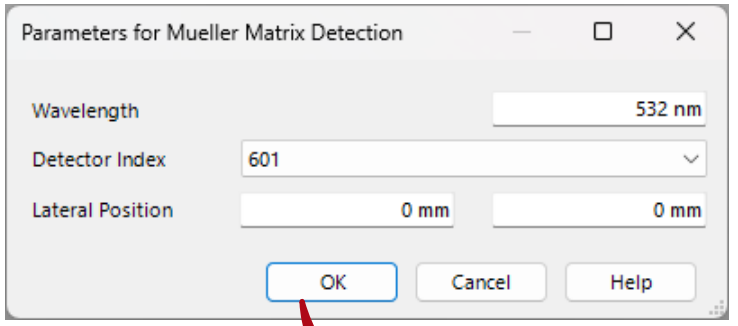
Use Cases

- Lightguide Featuring Segmented Gratings Regions with Intermittent Gaps
- Gridded Segmentation of Grating Regions in Lightguides (Tutorial)
- Grating Analysis and Smoothly Modulated Grating Parameters on Lightguides
- Control of Accuracy-Speed Balance for MTF Analysis in Complex Waveguide Devices for AR-Applications



Solution - Evaluation of Müller Matrices

- VirtualLab Fusion now enables direct evaluation of system polarization properties through automated **Müller** and **Jones matrix** calculation.
- This analyzer tool extracts complete polarization transfer characteristics in a single operation, extending our existing polarization analysis capabilities.
- Engineers can now obtain full polarization response data for components like diffraction gratings or waveplates without manual configuration, streamlining the design of polarization-sensitive systems.



Jones Matrix

1	0
1 + i1	0

[2025-06-27 14:25:05]
Mueller Matrix

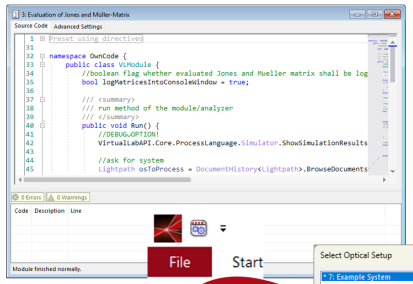
1.5	1.5	0	0
-0.5	-0.5	0	0
1	1	0	0
1	1	0	0

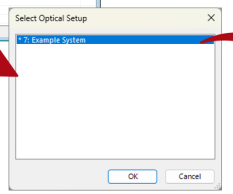
Learn More About: Advanced Polarization Analysis

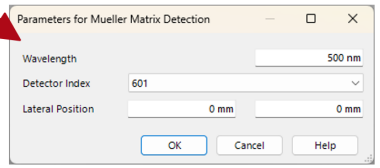
Use Cases

- Evaluation of Jones and Müller Matrices (Tutorial)
- Ellipsometry Analysis via Parameter Variation Analyzer
- Variable Angle Spectroscopic Ellipsometry (VASE) Analysis of a SiO2-Coating

Executing the Module







- Afterwards load the module (which can be found in the data files of this tutorial or under: Evaluation of Jones and Müller Matrices)
- Press Go! in the main ribbon.
- The module will then automatically open new windows where you can specify which additional parameters, such as which system and detector shall be investigated, the wavelength and if an additional lateral shift shall be considered.

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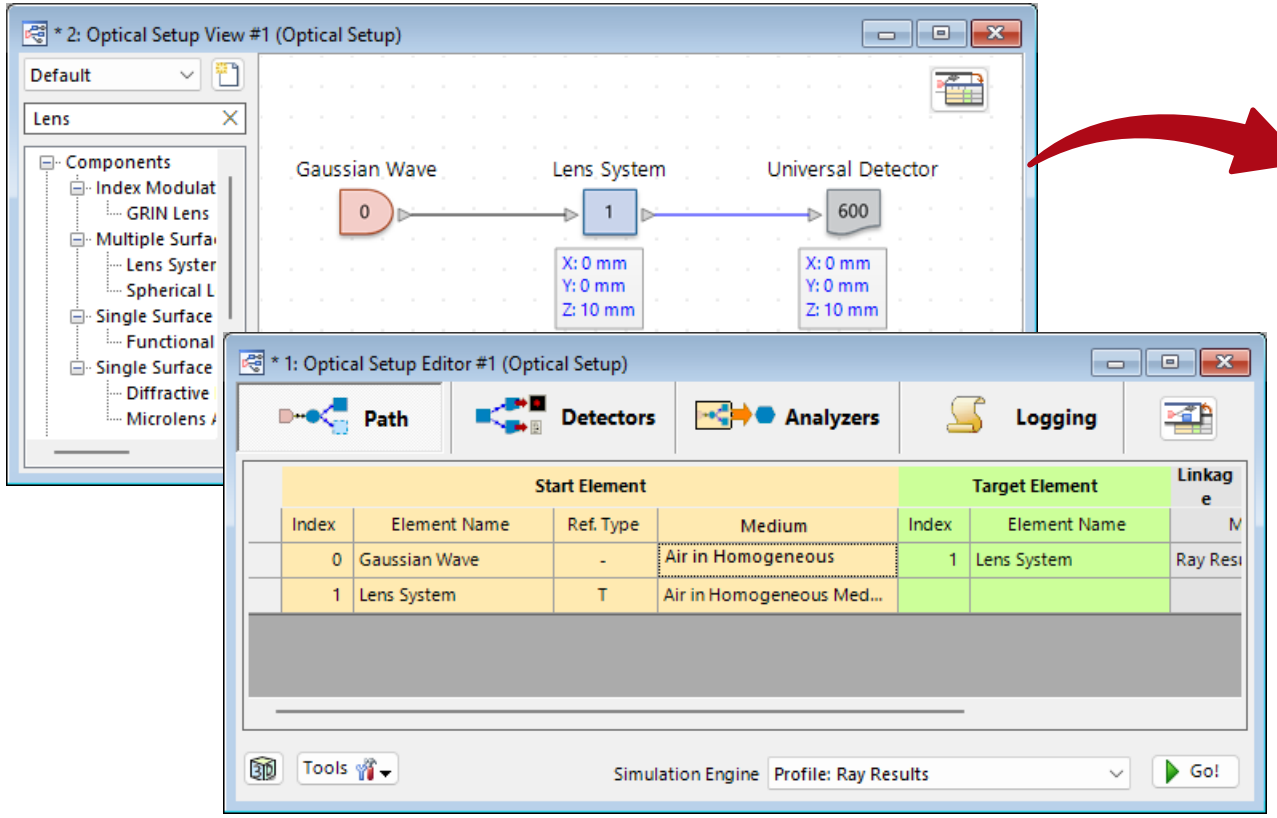
The All-New VirtualLab Fusion 2025.1

Feature Overview

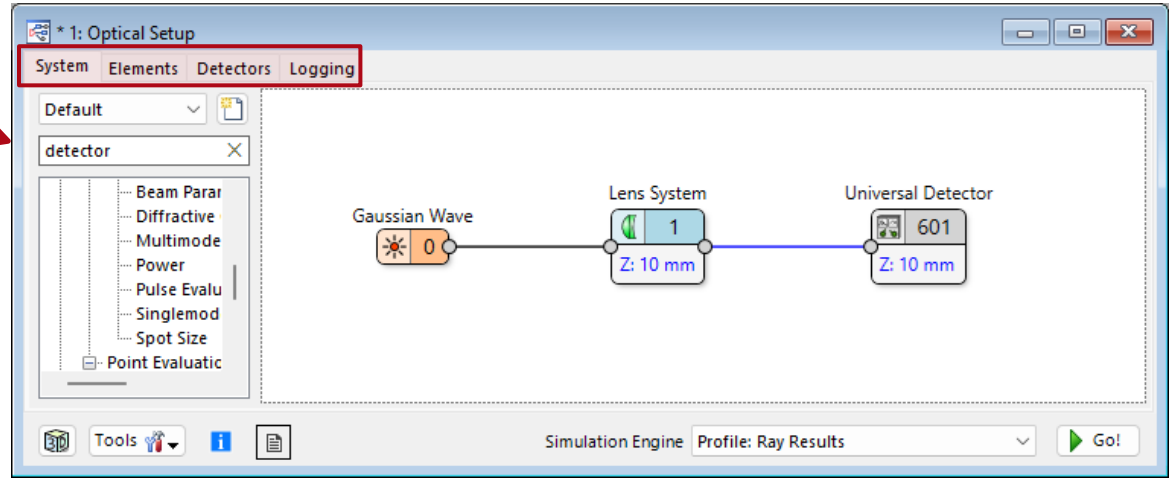
New Optical Setup Document

Redesigned Optical Setup View: All Parameters, One Place

2024.1



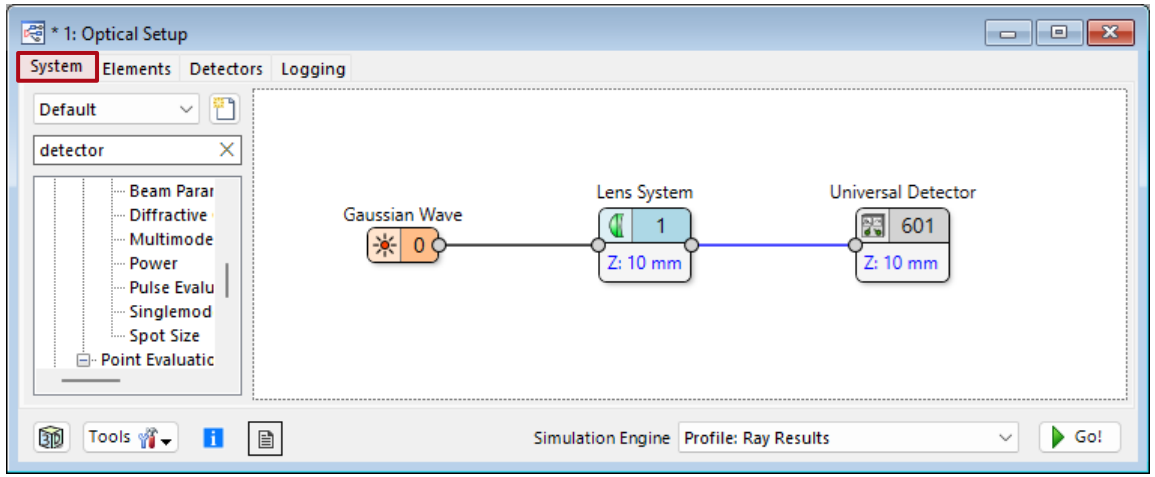
2025.1

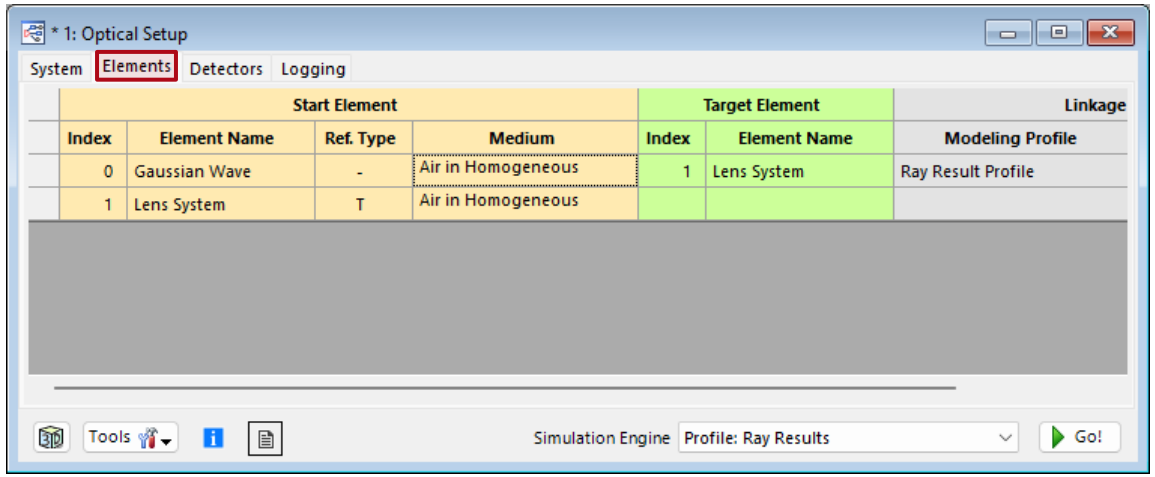


- The **Optical Setup View** has been completely reengineered to present all system information in a **unified document** interface.
- This redesign consolidates previously distributed data into a single comprehensive view, streamlining workflow and analysis.

Redesigned Optical Setup View: All Parameters, One Place

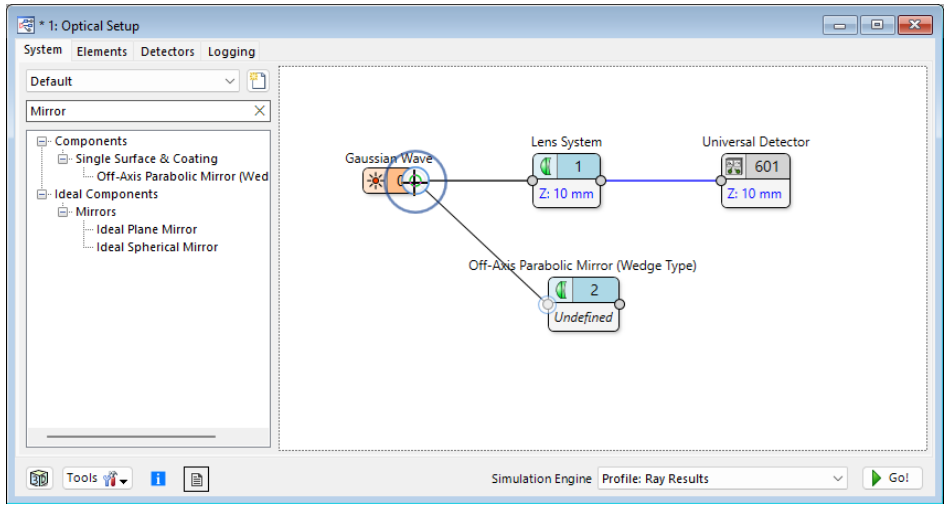
- The new document format provides:
  - **Unified** presentation of all optical system parameters
  - **Intuitive** document-style organization
  - Enhanced accessibility of setup details
- The new implementation eliminates view switching while maintaining full technical depth, significantly improving user efficiency during optical system configuration and review.
- The redesigned interface delivers the comprehensive data in an **elegant, streamlined layout** – combining full functionality with a cleaner, more focused workspace.

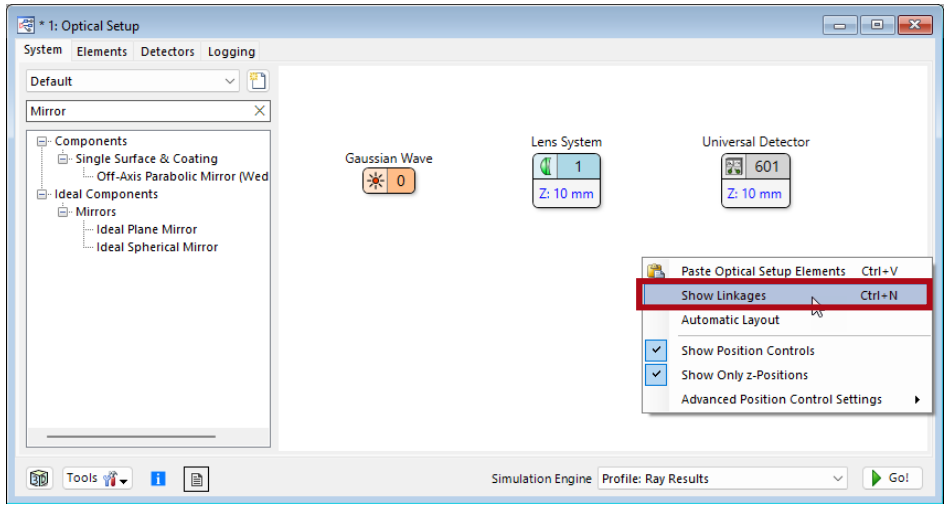




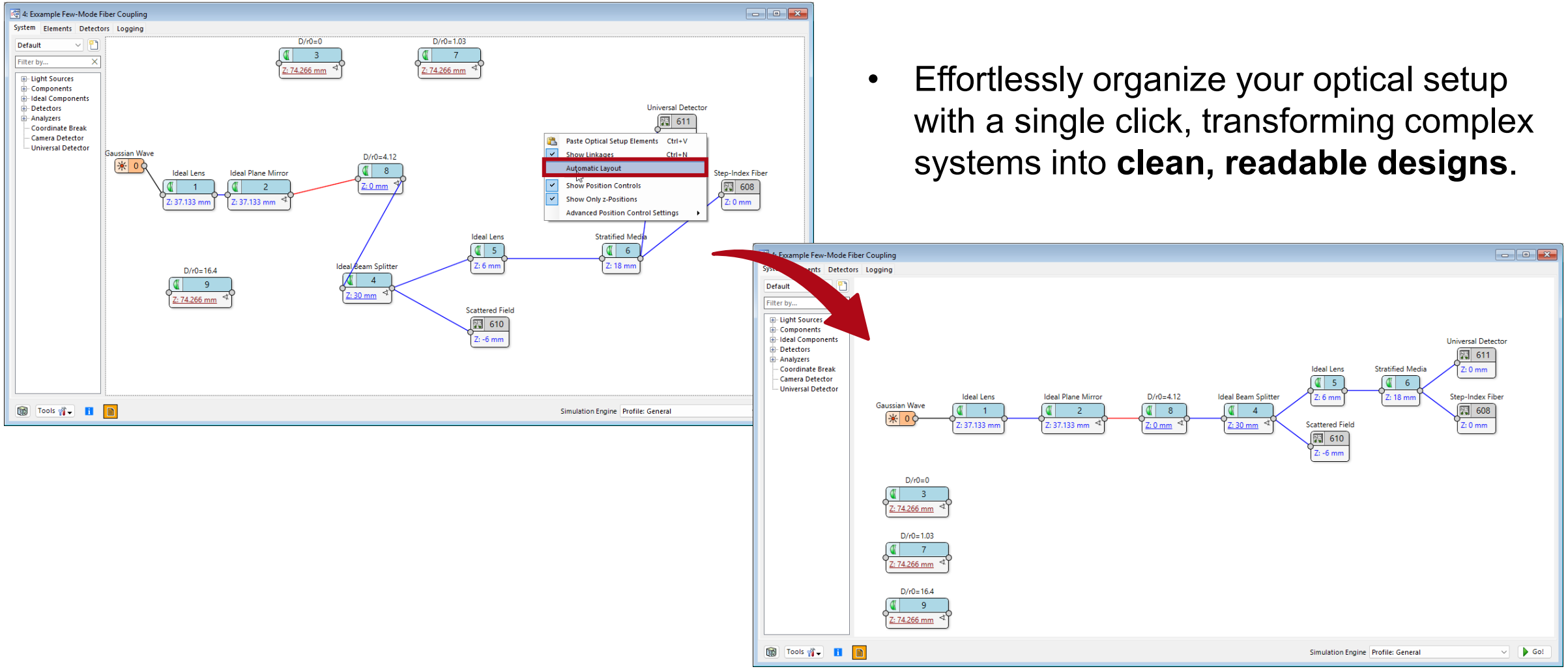
Redesigned Optical Setup View: Enhanced Usability & Navigation

- The redesigned Optical Setup View now includes intuitive alignment tools and workflow optimizations:
  - **Smart Snap-Lines**
    Guides ensure perfect note alignment, with optional visibility toggle via right-click.
  - **Streamlined Shortcuts**
    - Change linkage types (*T/R/0/1*) with Shift + Double Click
    - Reset zoom to default via Ctrl + 0





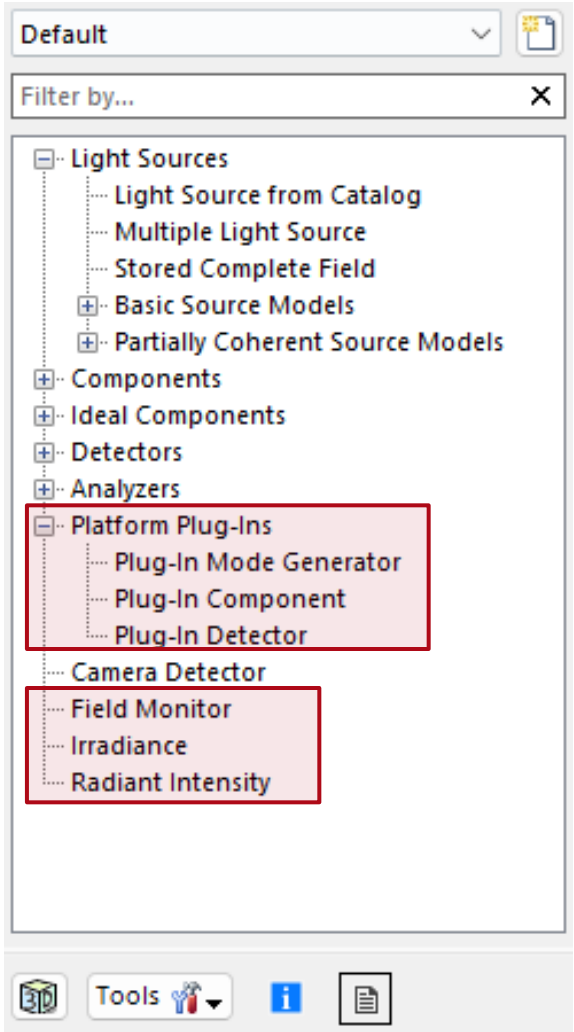
Redesigned Optical Setup View: Automatic Layouts



- Effortlessly organize your optical setup with a single click, transforming complex systems into **clean, readable designs**.

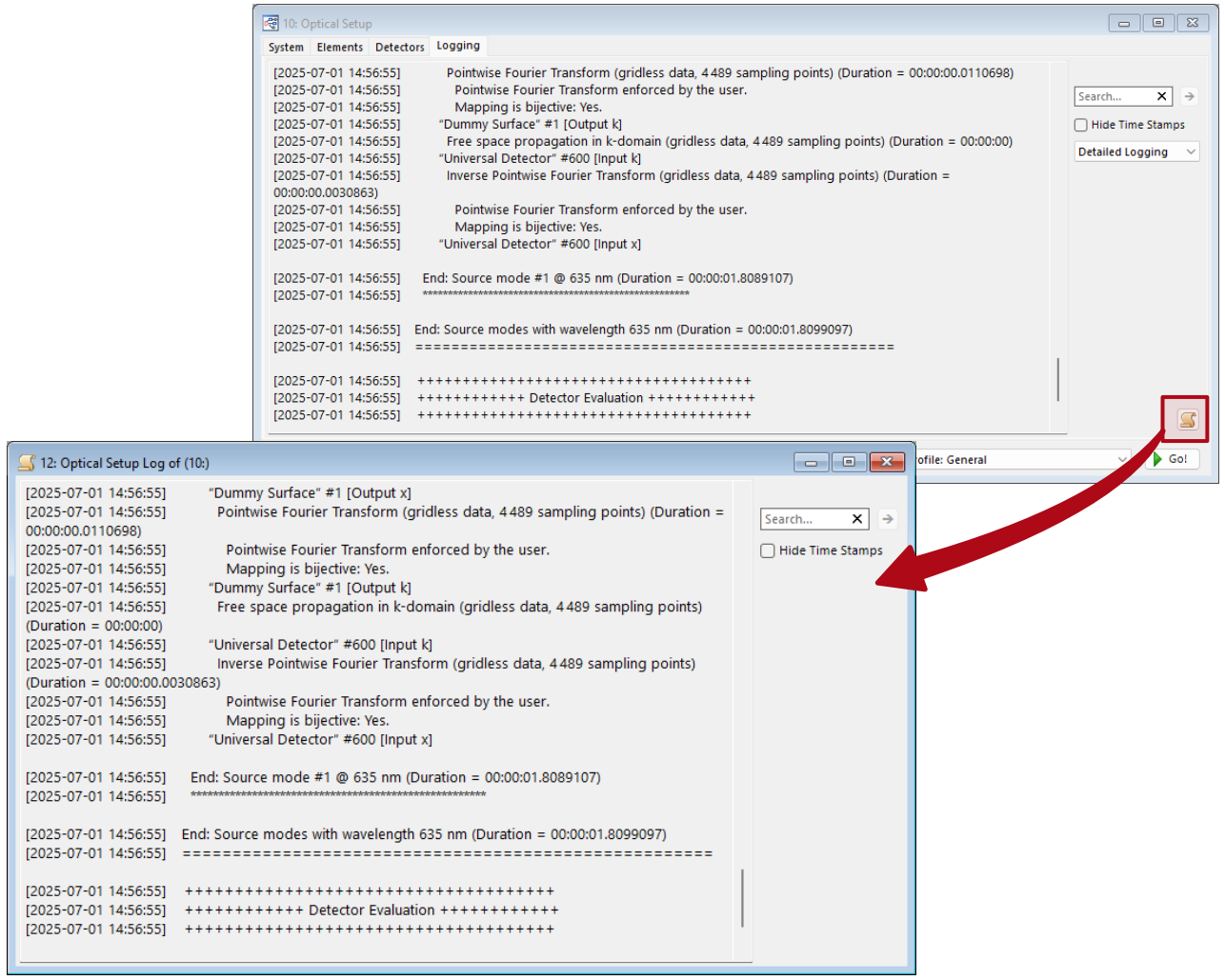
Optical Setup View: New Default Tree

- The standard optical setup tree in VirtualLab Fusion has been reorganized to improve workflow clarity:
  - **New Dedicated Section Platform Plug-Ins**
    - Plug-In Mode Generator
    - Plug-In Component
    - Plug-In Detector
  - **Added Root-Level Entries:**
    - Field Monitor: direct x/k-domain field extraction
    - Radiometric Detectors: Irradiance & Radiant Intensity calculations



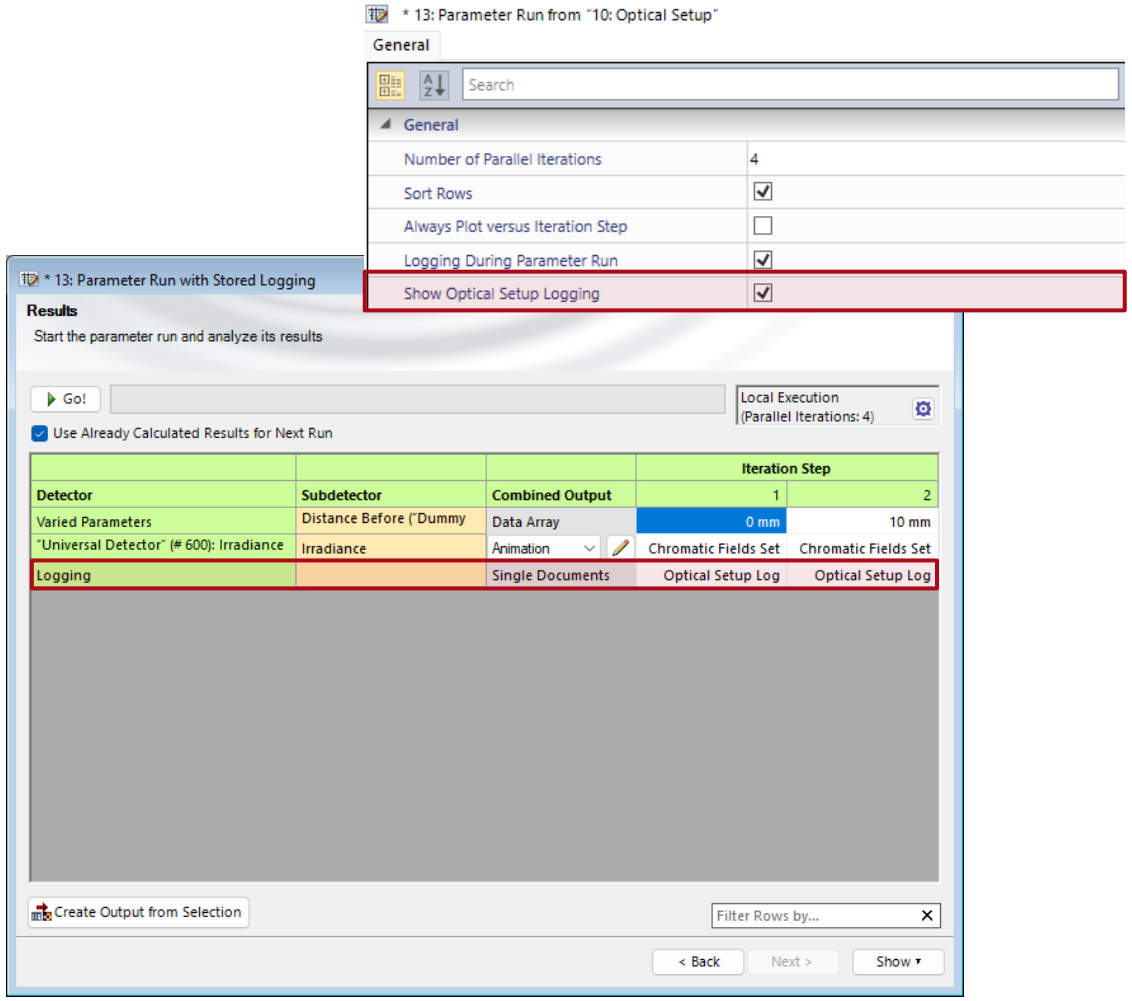
Optical Setup View: Extract Process Logging Information

- VirtualLab Fusion now offers improved access to simulation process logs, enabling deeper insights:
  - **Post-Simulation Extraction**
    Logs can be smoothly exported after calculations complete
  - **Flexible Comparison**
    Easily cross-reference results across multiple simulations
  - **Integrated Access**
    Logs remain available within the Optical Setup View



Parameter Run Logging Enhancement

- VirtualLab Fusion now offers per-iteration process logging for Parameter Runs:
  - **New Feature:**
    - Log entries are stored directly in the Parameter Run result table
    - Enabled via checkbox in the property browser
  - **Key Benefits:**
    - Track evolution of simulations across iterations
    - Correlate parameters with intermediate results
    - Debug complex optimizations more effectively

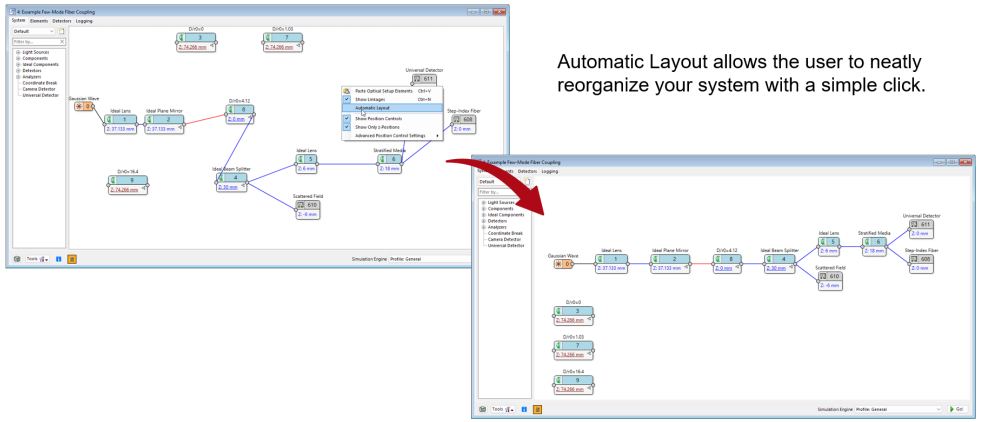


Learn More About: Optical Setup Configuration

Use Cases

- Introduction to the Optical Setup
- Configuring Your Simulation in VirtualLab Fusion
- Profile Editor
- Logging in VirtualLab Fusion (Tutorial)

Automatic Layouts

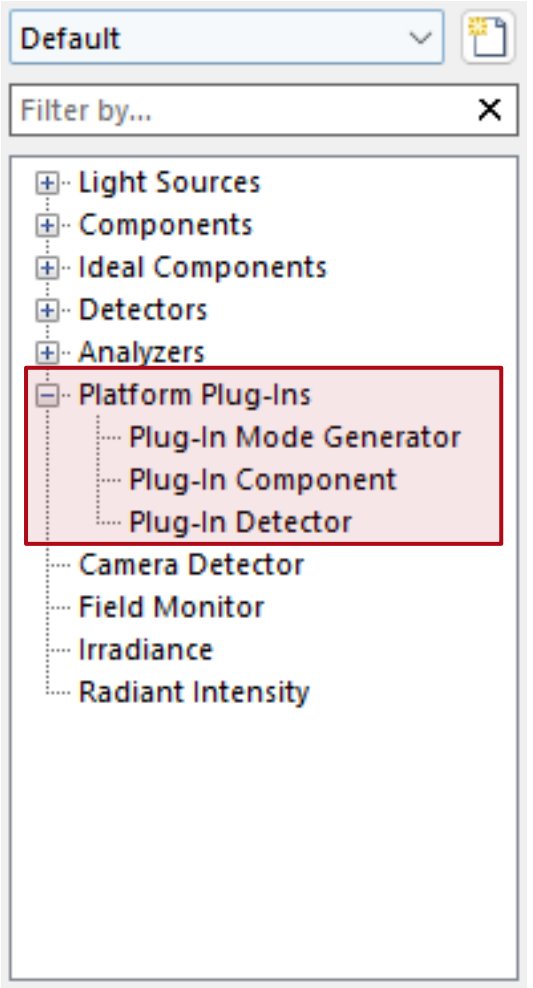


Automatic Layout allows the user to neatly reorganize your system with a simple click.

Opening the VirtualLab Fusion Modeling Platform by Plug-In Mode Generators, Components & Detectors

Extendable Simulation Platform

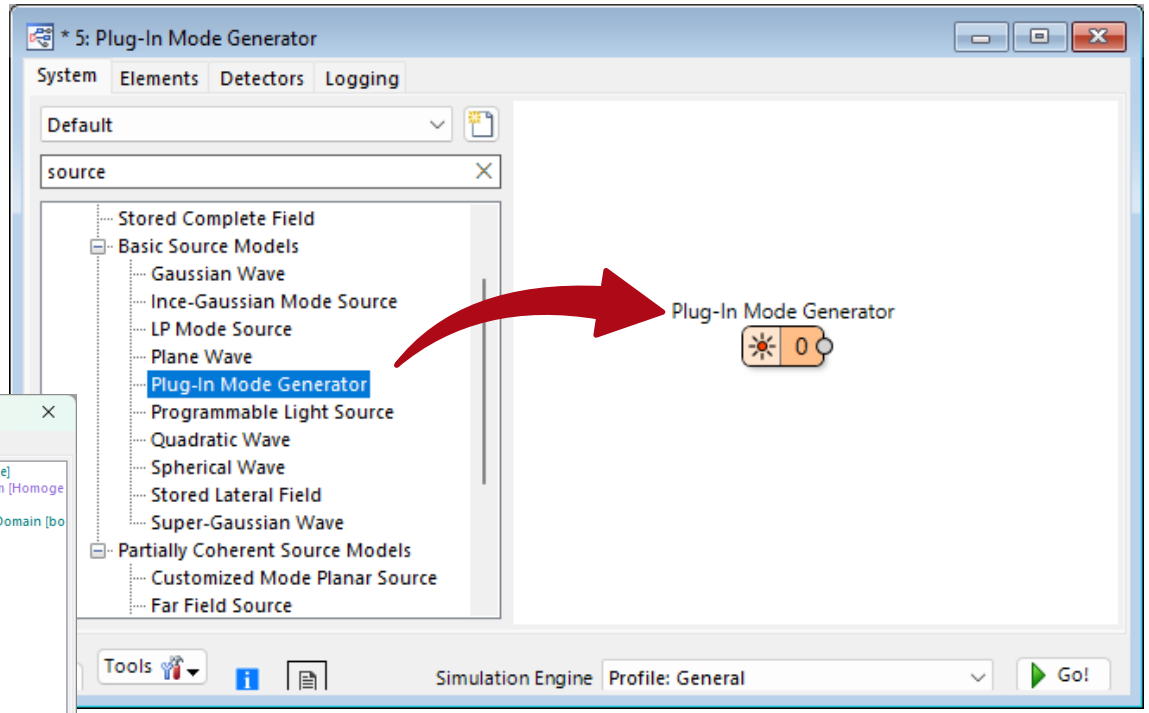
- VirtualLab Fusion 2025.1 introduces open Plug-In interfaces for:
  - **Mode Generators**
  - **Components**
  - **Detectors**
- This enables the following key benefits:
  - ✓ **For Users**:
    Unlimited flexibility to implement proprietary simulation elements
  - ✓ **For Us**:
    Rapid solution delivery without full release cycles
- This symbiosis accelerates innovation while maintaining platform stability.

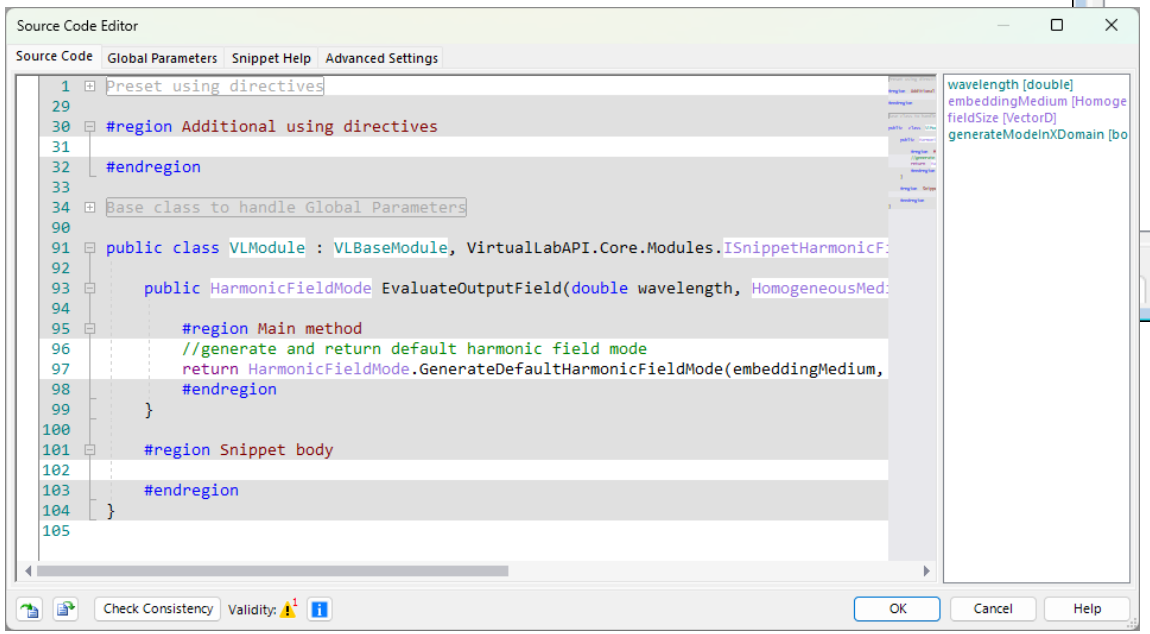


Plug-In Mode Generator

Plug-In Mode Generator

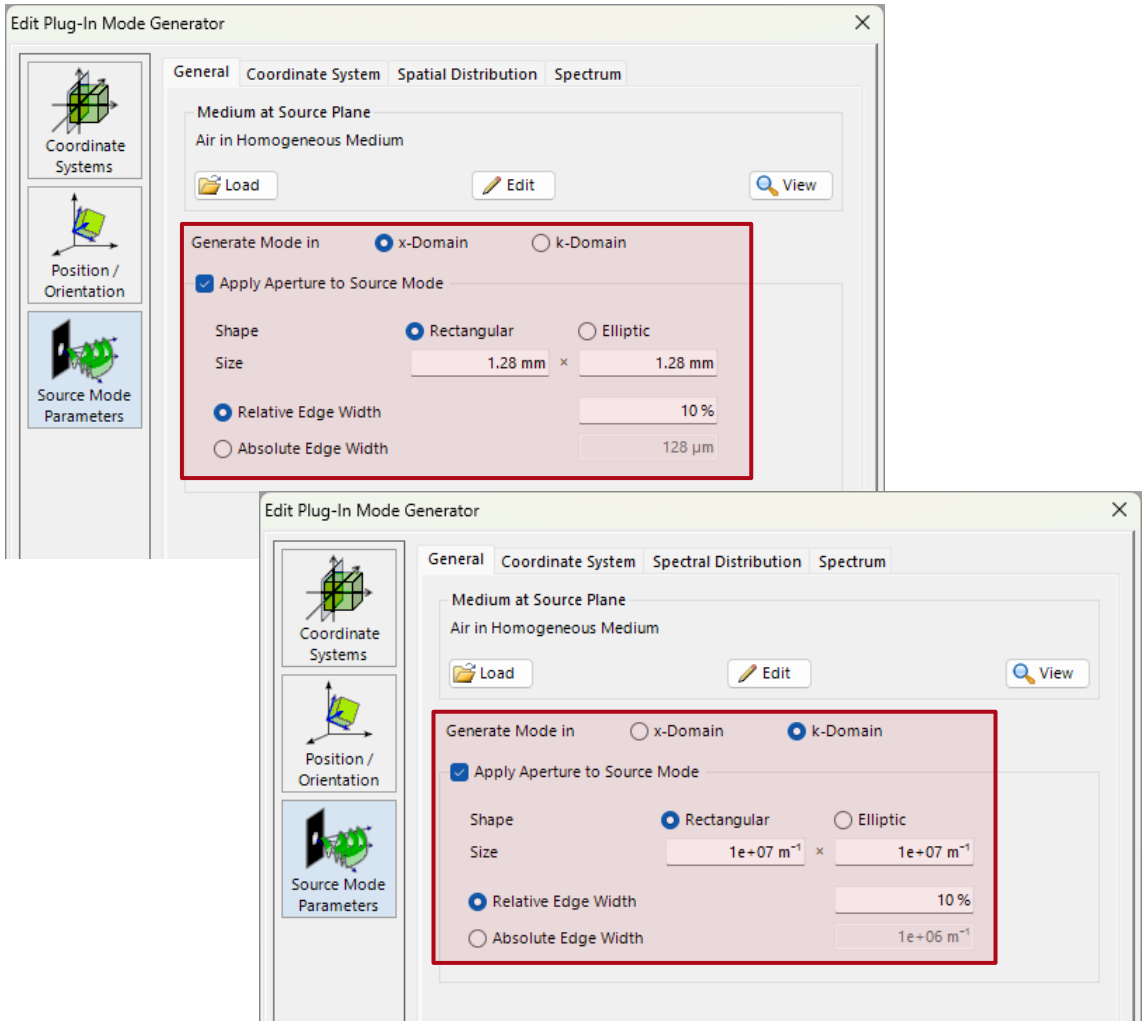
- The Plug-In Mode Generator can be used to define any **arbitrary lateral field distribution** depending on your needs.
- Define any beam profile needed for your application.





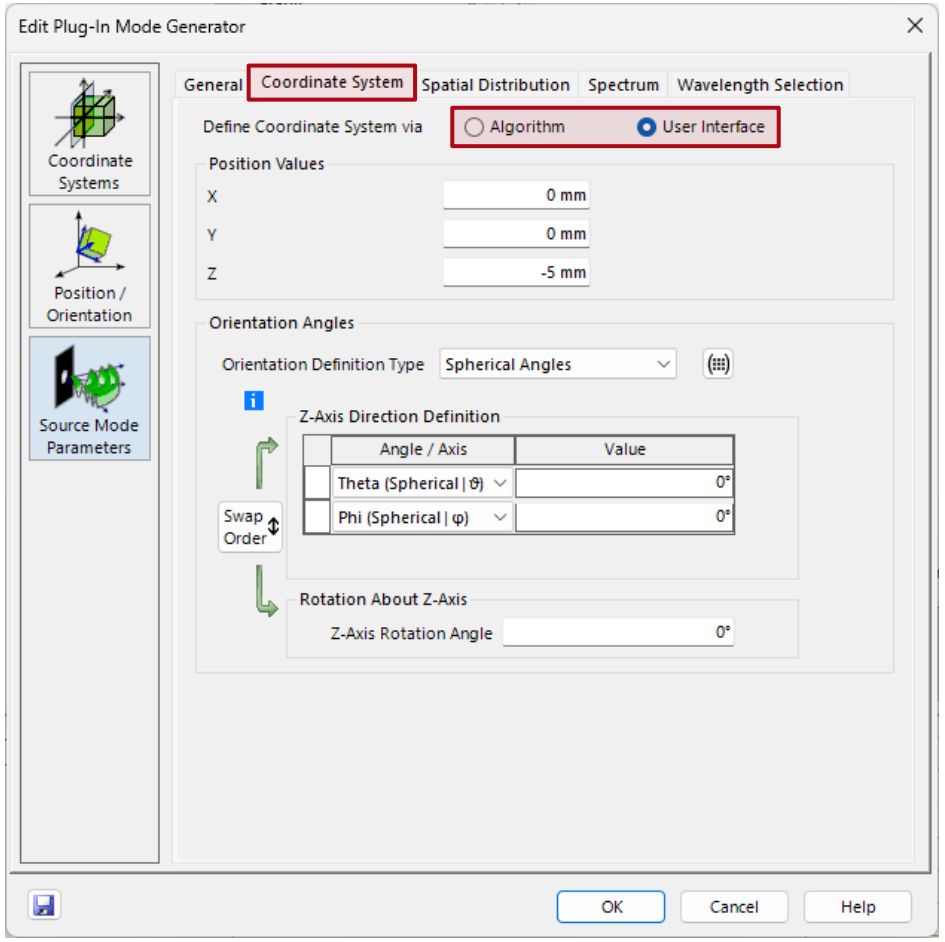
Plug-In Mode Generator – Specification in x- and k-Domain

- The Plug-In Mode Generator empowers users to define custom lateral fields in either **x- or k-domain** through intuitive C# scripting, combining the flexibility of a high-level language with physics-ready results.
- Optionally, a **smooth aperture** can be defined using VirtualLab Fusion's standard user interface and applied to the generated mode.



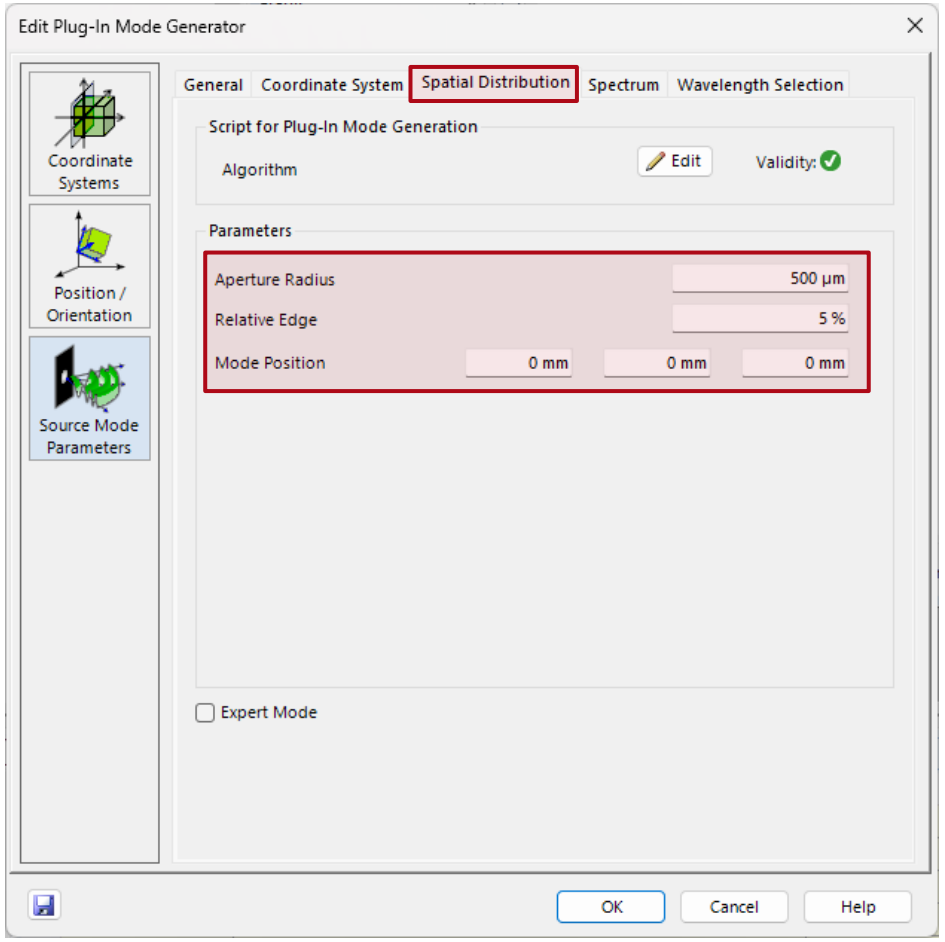
Plug-In Mode Generator – Coordinate System

- The Plug-In Mode Generator supports **user-defined coordinates** for generated modes, specified either:
  - **Graphically** via VirtualLab Fusion's UI, *or*
  - **Programmatically** within the C# script
- This relative coordinate system (referenced to the system coordinate system) enables precise placement and orientation of source modes at any position.



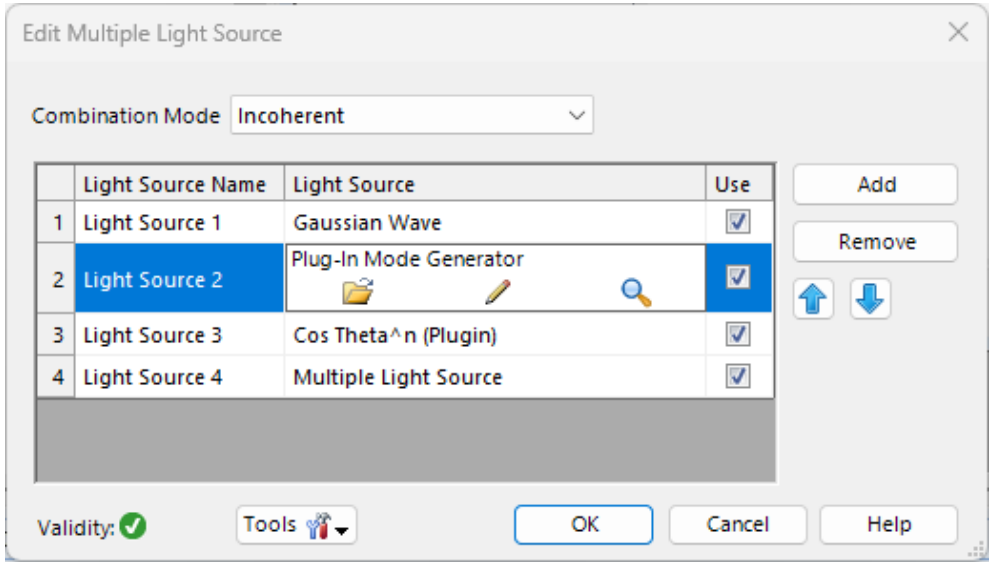
Plug-In Mode Generator – Definition of Harmonic Field Mode

- The Plug-In Mode Generator uses a C# script to define the lateral field distribution by specifying a `HarmonicFieldMode` object.
- The users can specify:
  - Arbitrary complex-valued distributions for both E_x and E_y fields
  - **Wavefront properties**, including phase and phase gradient, for complete source characterization
- The parameters of the C# script are accessible within:
  - Standard UI input/dialog
  - Parameter overview table/tree
  - Parameter Run



Plug-In Mode Generator – Usage with Multiple Light Source

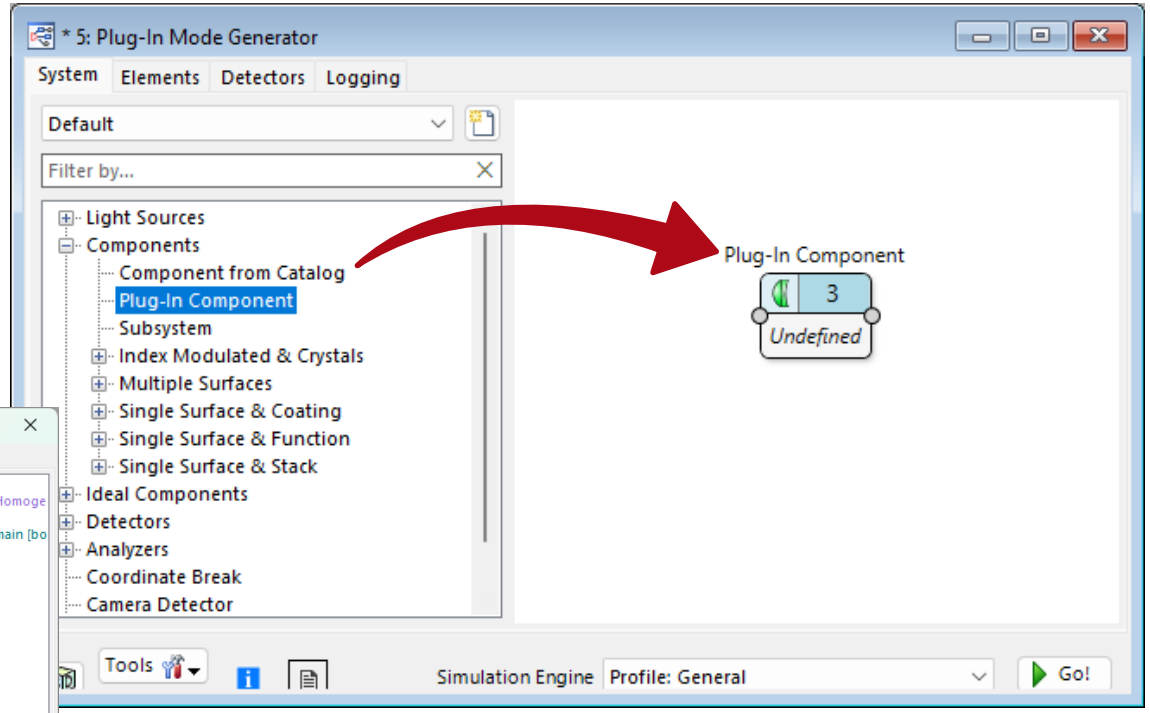
- VirtualLab Fusion's **Multiple Light Source** has been fully reimplemented to unlock:
  - Unrestricted access to all light sources in the catalog
  - Seamless integration of custom sources via the Plug-In Mode Generator
  - Nested configurations (e.g., Multiple Light Sources within others)
- This enables straightforward multimode source definition, where each source mode can be via Plug-In Mode Generator or any standard source from catalog.

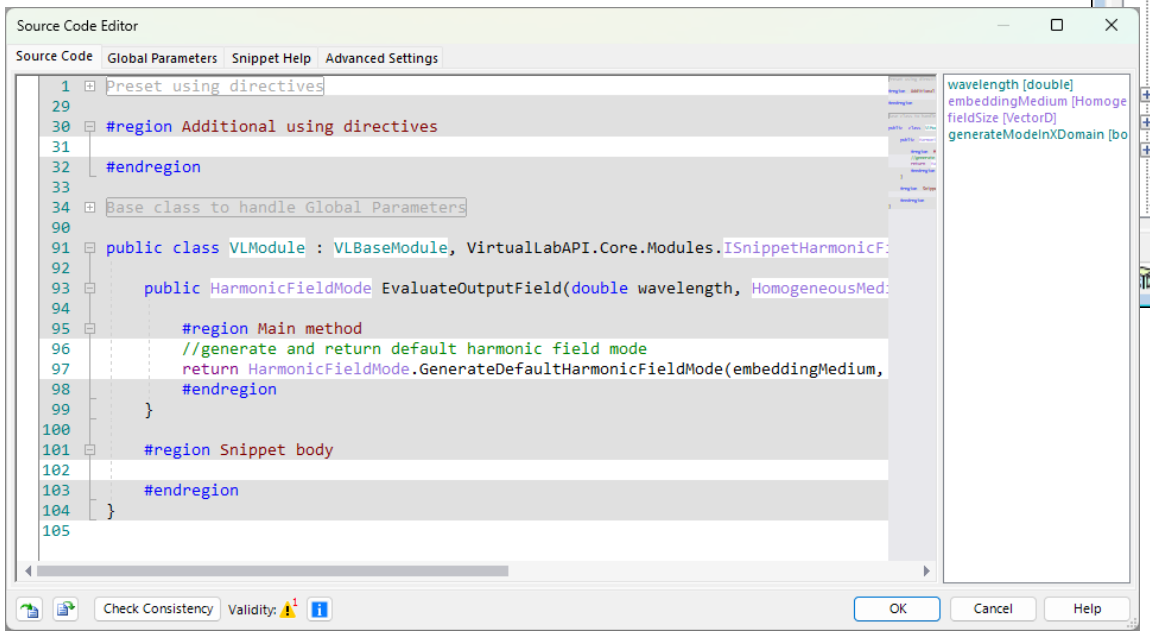


Plug-In Mode Component

Plug-In Component

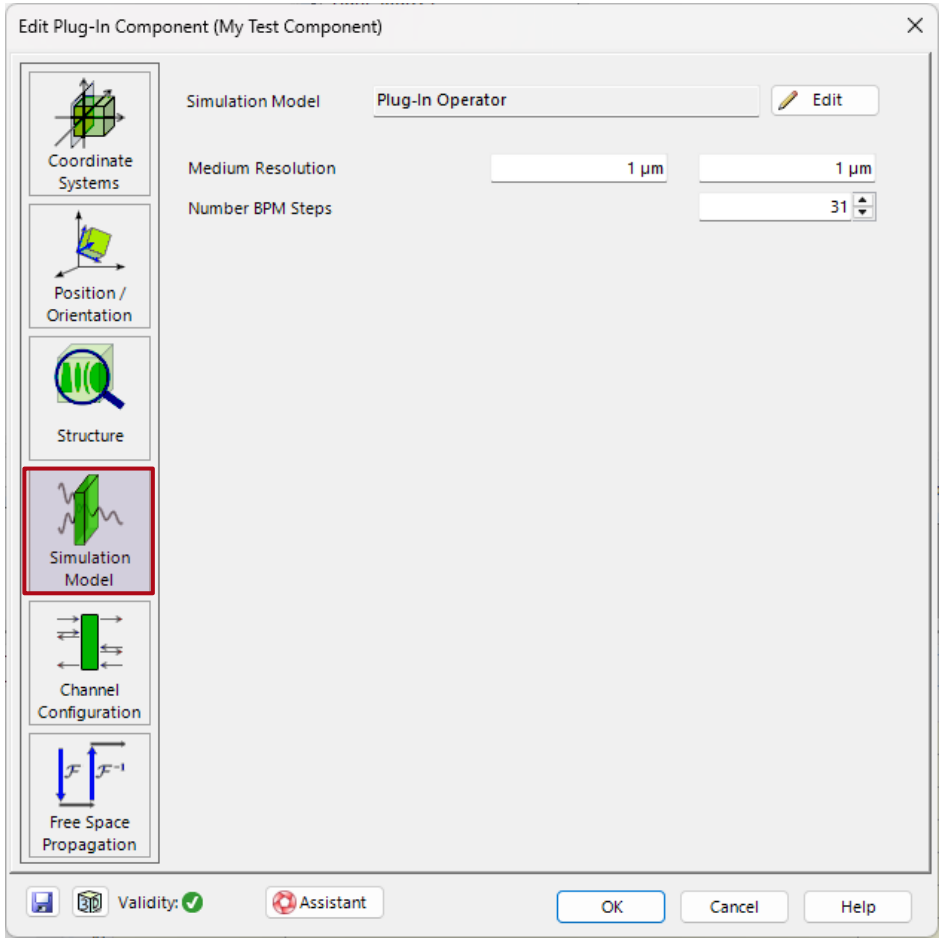
- The Plug-In Component enables **custom simulation models** beyond VirtualLab's built-in options.
- Seamlessly integrate proprietary methods into your simulations.





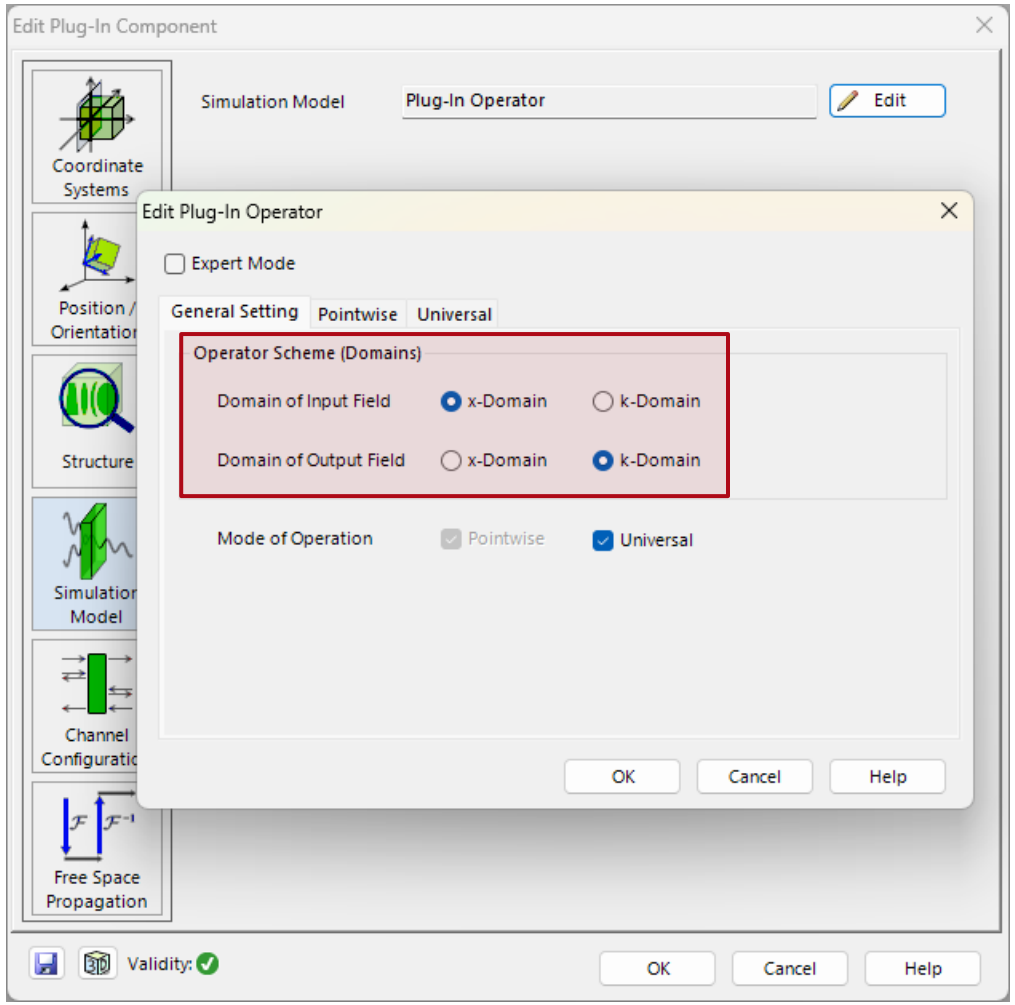
Plug-In Component – Configuration of Simulation Model

- The simulation model is defined through **C# scripts** in the dedicated GUI section.
- The parameters of the C# script are accessible within:
  - Standard UI input/dialog
  - Parameter overview table/tree
  - Parameter Run



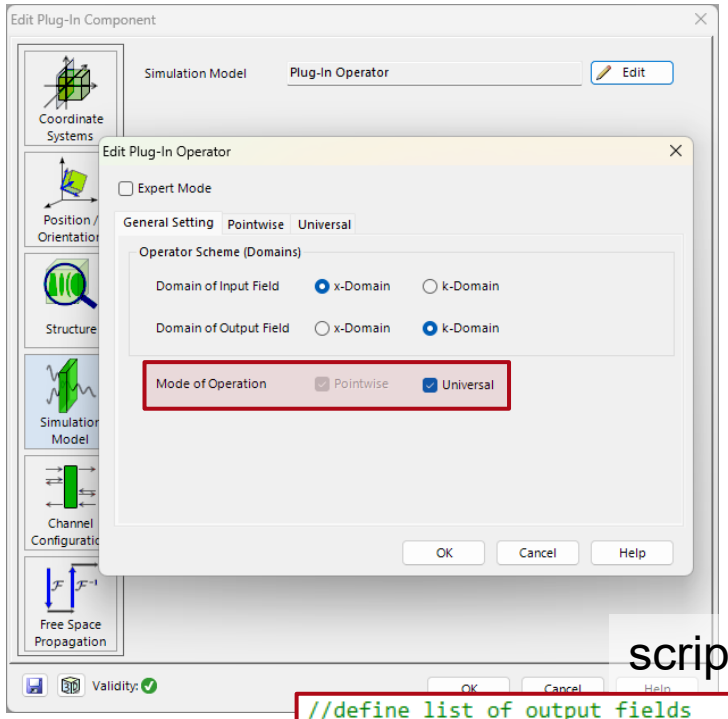
Plug-In Component – Domain Selection

- Every simulation model within in VirtualLab Fusion requires explicit input and output domain specification.
- The unique flexibility of the Plug-In Component allows an independent selection for input/output:
  - **x-domain**
  - **k-domain**



Plug-In Component – Domain Selection

- All simulation models require selecting either **pointwise** or **universal** operation mode.
- Pointwise operators process field data at discrete positions, while universal operators handle complete field transformations.
- The selected mode determines which C# script interface must be implemented to define the operator's algorithm.



script in pointwise mode

```
//define list of output fields
List<PointwiseOperator> outputModes = new List<PointwiseOperator>();
//add default pointwise operator to return list
outputModes.Add(new PointwiseOperator());
//return generated list
return outputModes;
```

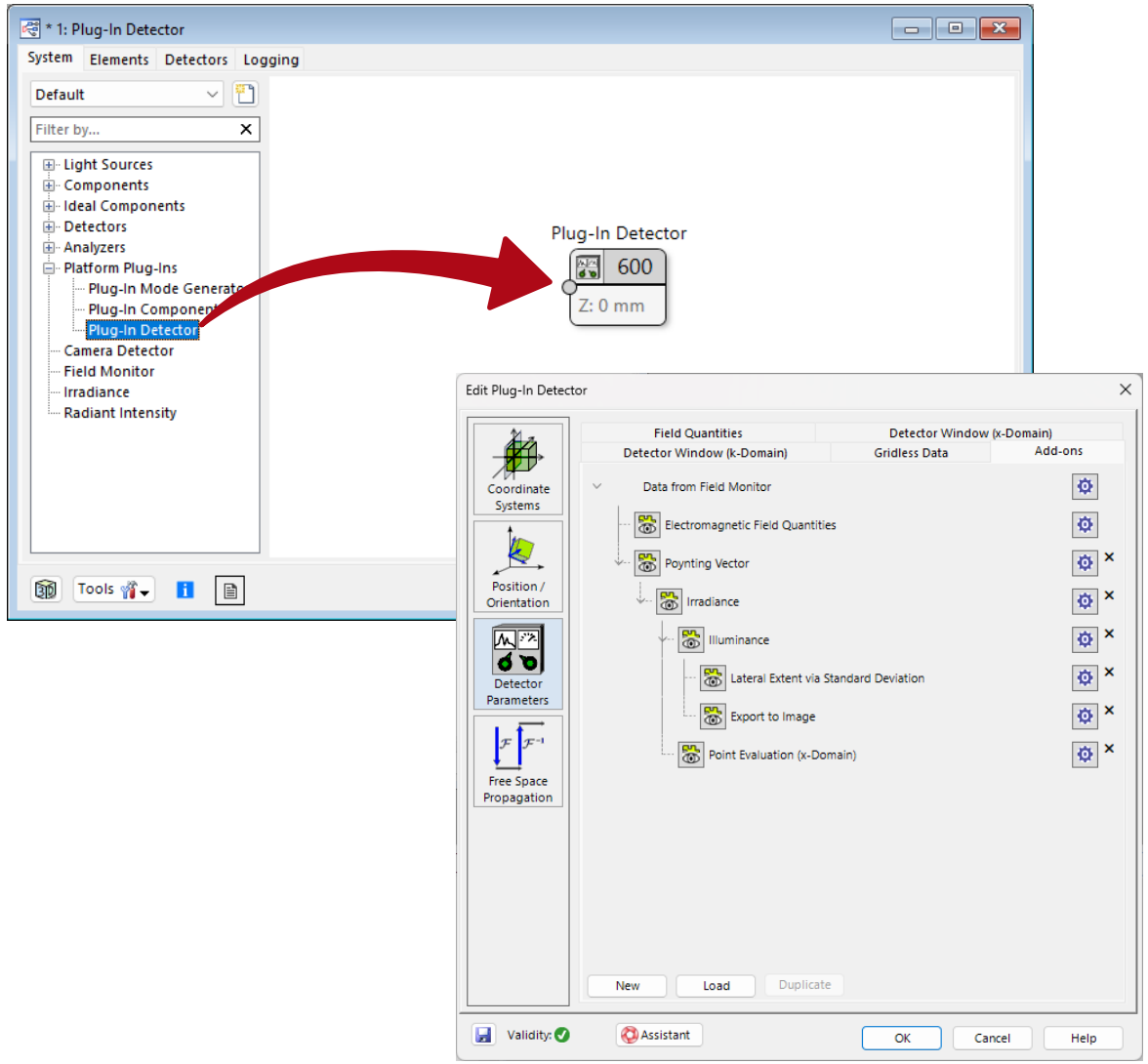
script in universal mode

```
//define list of output fields
List<PointwiseOperator> outputModes = new List<PointwiseOperator>();
//add default pointwise operator to return list
outputModes.Add(new PointwiseOperator());
//return generated list
return outputModes;
```

Plug-In Detector

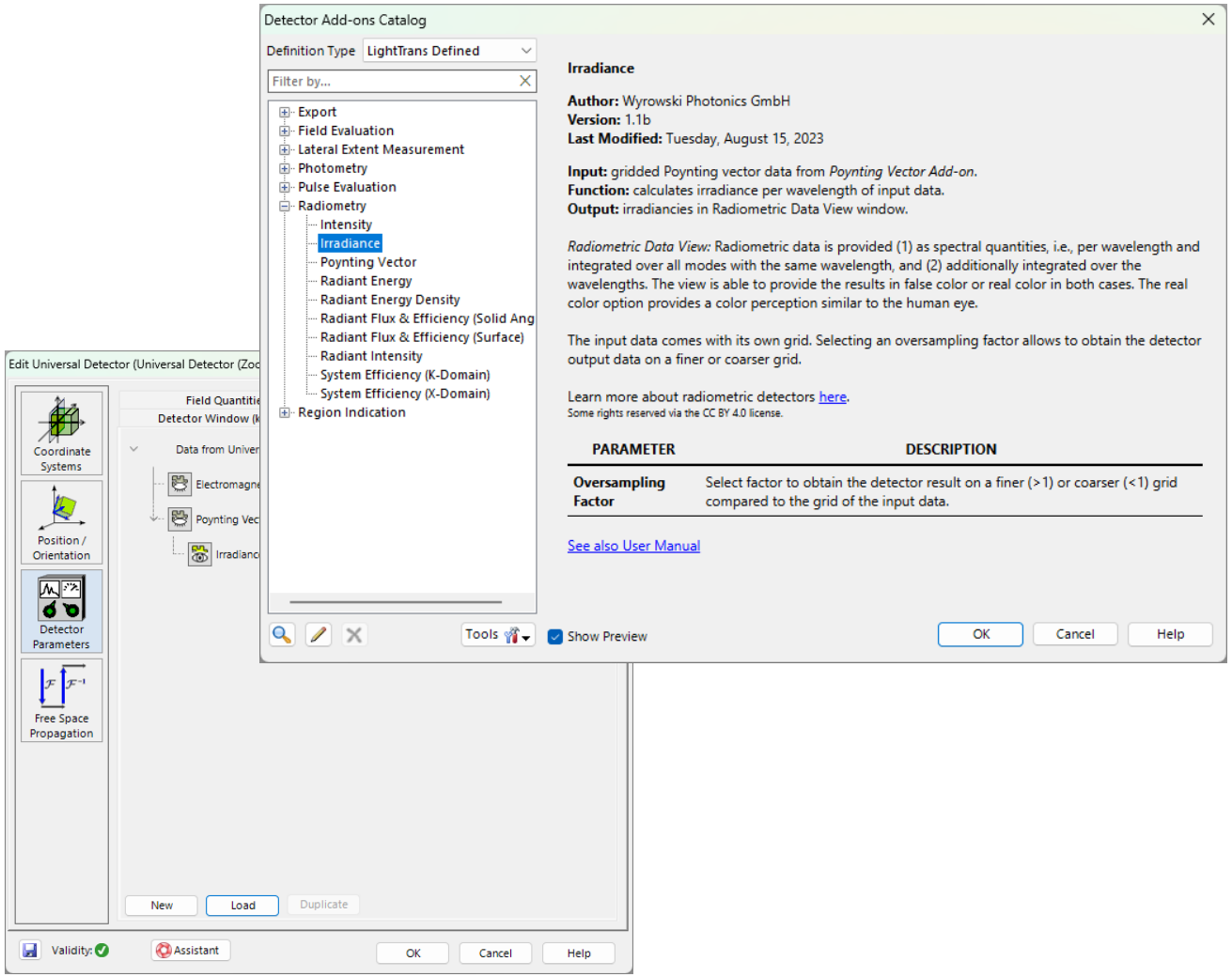
Plug-In Detector

- In VirtualLab Fusion 2025.1, we've renamed the Universal Detector to **Plug-In Detector** to:
  - Align with our Plug-In Component and Plug-In Mode Generator naming
  - Provide clearer intuition about its customizable nature
- This change maintains all existing functionality while improving conceptual consistency across the platform.



Plug-In Detector – Catalog Access for Detector Add-Ons

- VirtualLab Fusion 2025.1 now integrates Plug-In Detector add-ons into the **standard catalog system**, enabling:
  - Seamless handling of both built-in and custom detector add-ons
  - Centralized access through VirtualLab's existing catalog interface
  - Automatic updates via the online update mechanism
- This integration provides a consistent workflow for all detector types while maintaining full extensibility.

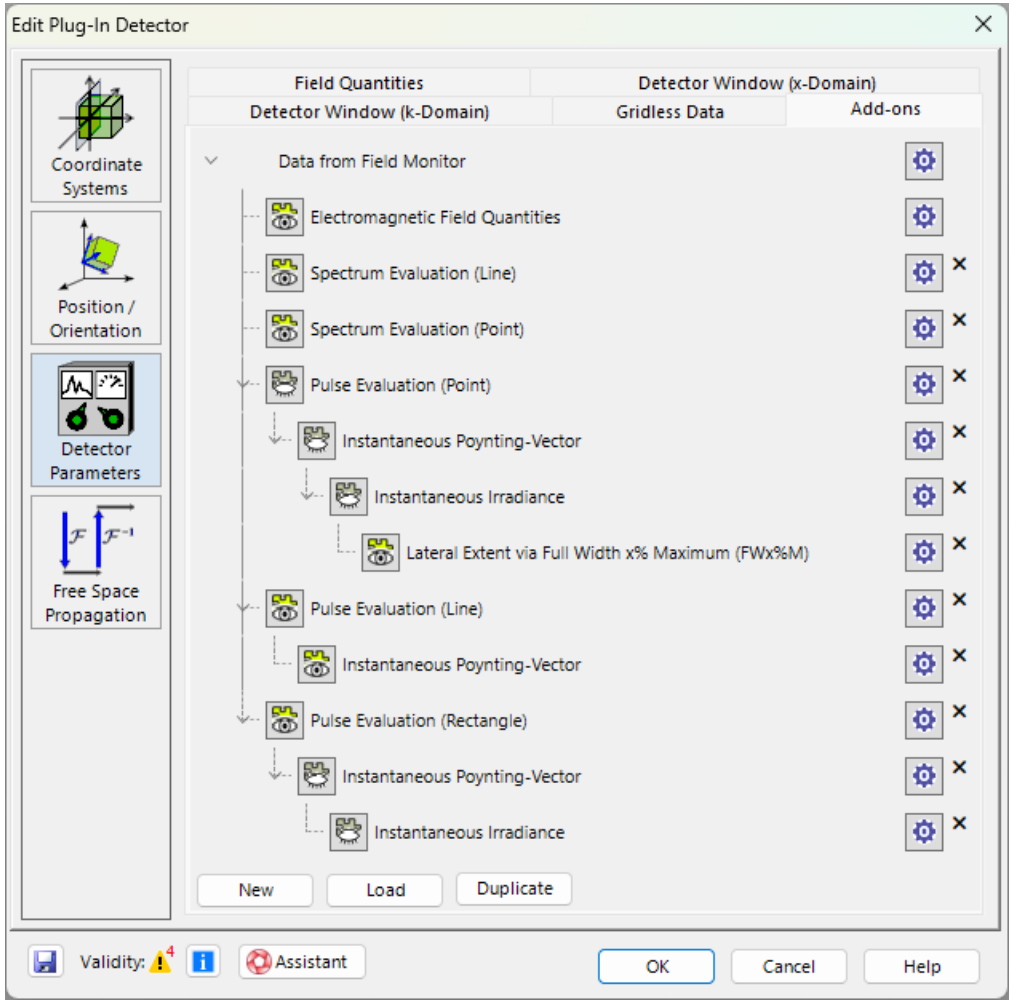


Plug-In Detector – New Add-ons for Pulse Evaluation

- VirtualLab Fusion 2025.1 introduces specialized detector add-ons for comprehensive pulse characterization, including:
  - **Instantaneous Poynting Vector** analysis
  - **Instantaneous Irradiance** measurement
  - **Pulse Energy** calculation
- All pulse evaluation tools are available in the detector add-on catalog, providing:

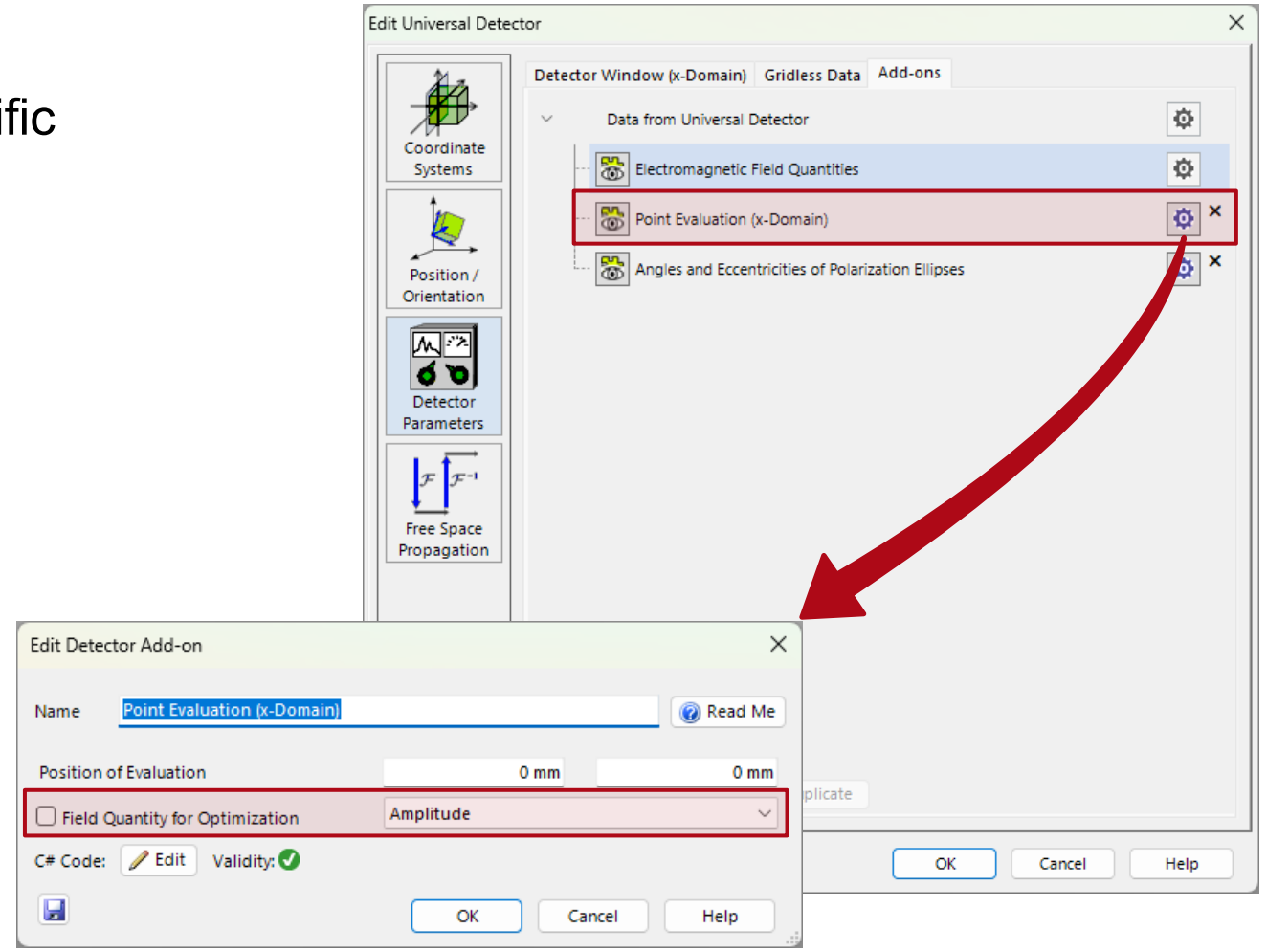
✓ One-click access to key temporal metrics

✓ Seamless integration with existing pulse simulations



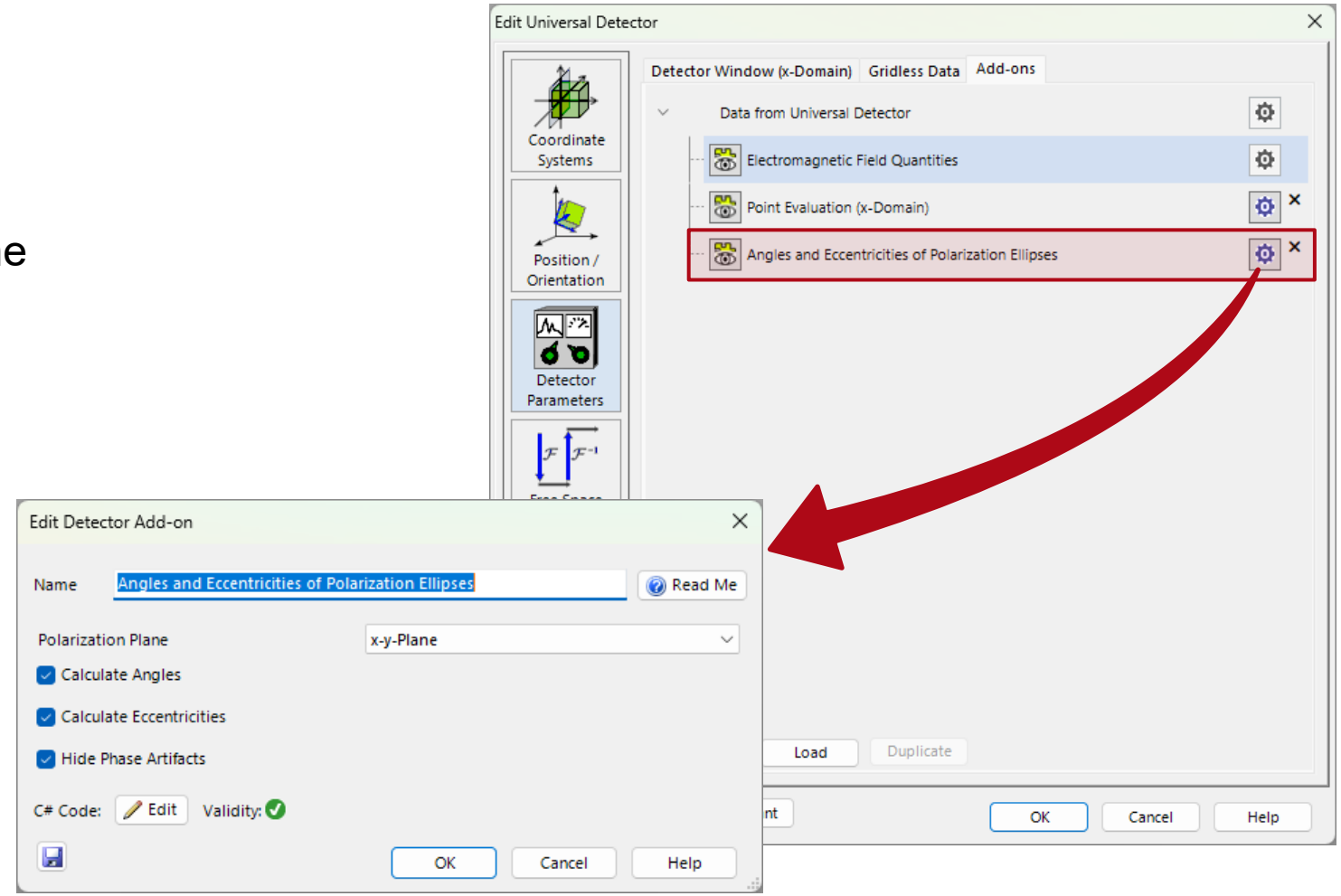
Plug-In Detector – New Add-ons for Point Evaluation

- The **point evaluation** add-on enables targeted analysis at specific locations, allowing you to:
  - Select exact evaluation points in your simulation
  - Choose which field quantities to measure
  - Apply to any detector generating sampled data



Plug-In Detector – Add-ons for Polarization Ellipse Information

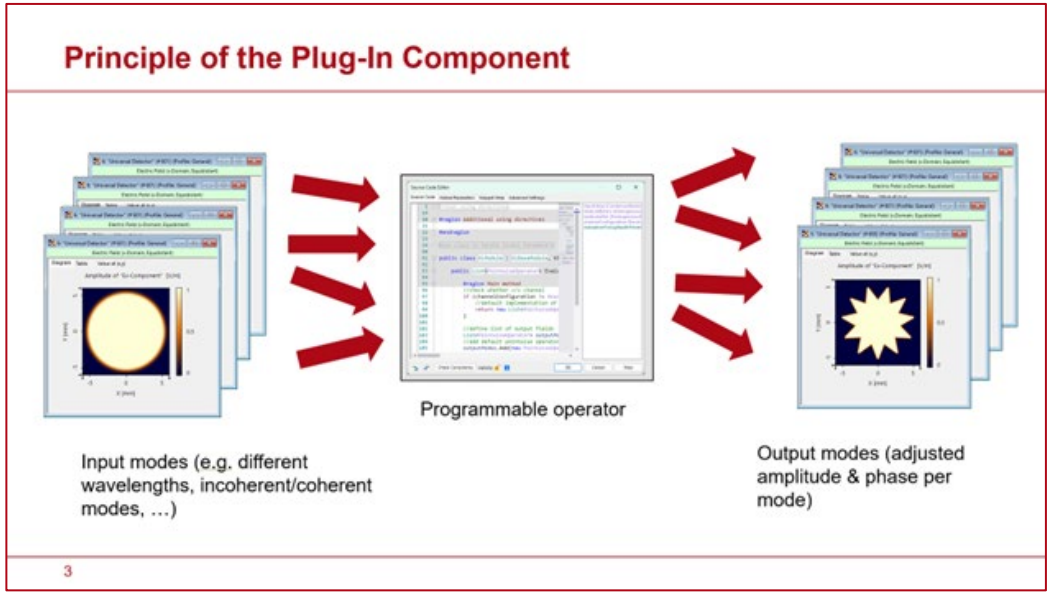
- The new **polarization ellipse** detector add-on extracts and displays:
  - Rotation angle (orientation of the major axis)
  - Ellipse eccentricity (degree of circular/linear polarization)



Learn More About: Plug-Ins in VirtualLab Fusion

Use Cases

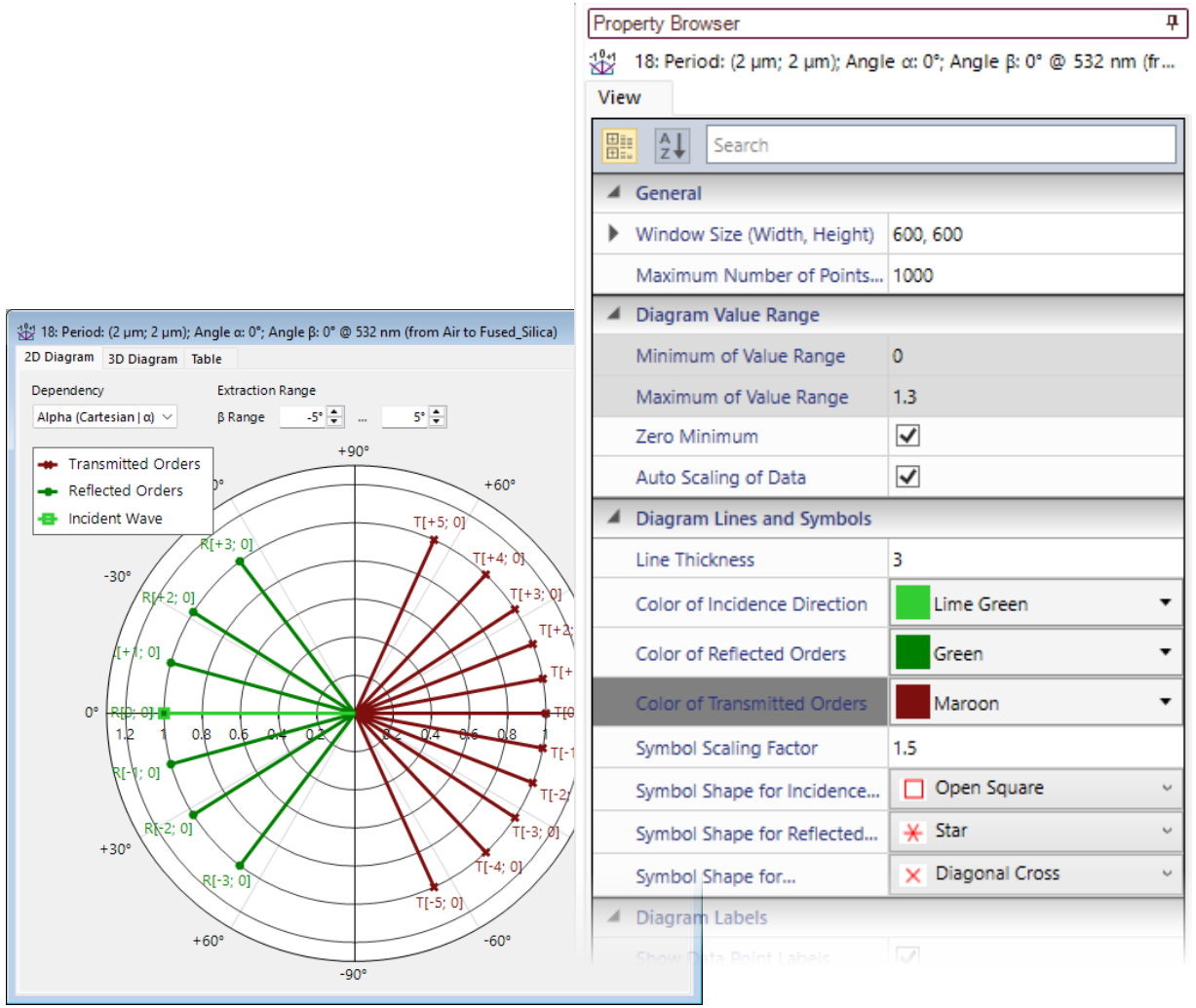
- Plug-In Mode Generator (Tutorial)
- Plug-In Component (Tutorial)
- Plug-in Detector (Tutorial)
- Programming Detector Add-ons in VirtualLab Fusion
- How to Configure Ultrashort Pulse Simulations in VirtualLab Fusion: A Step-by-Step Guide
- Pulse Focusing with High-NA Lens



Views & Data Visualization

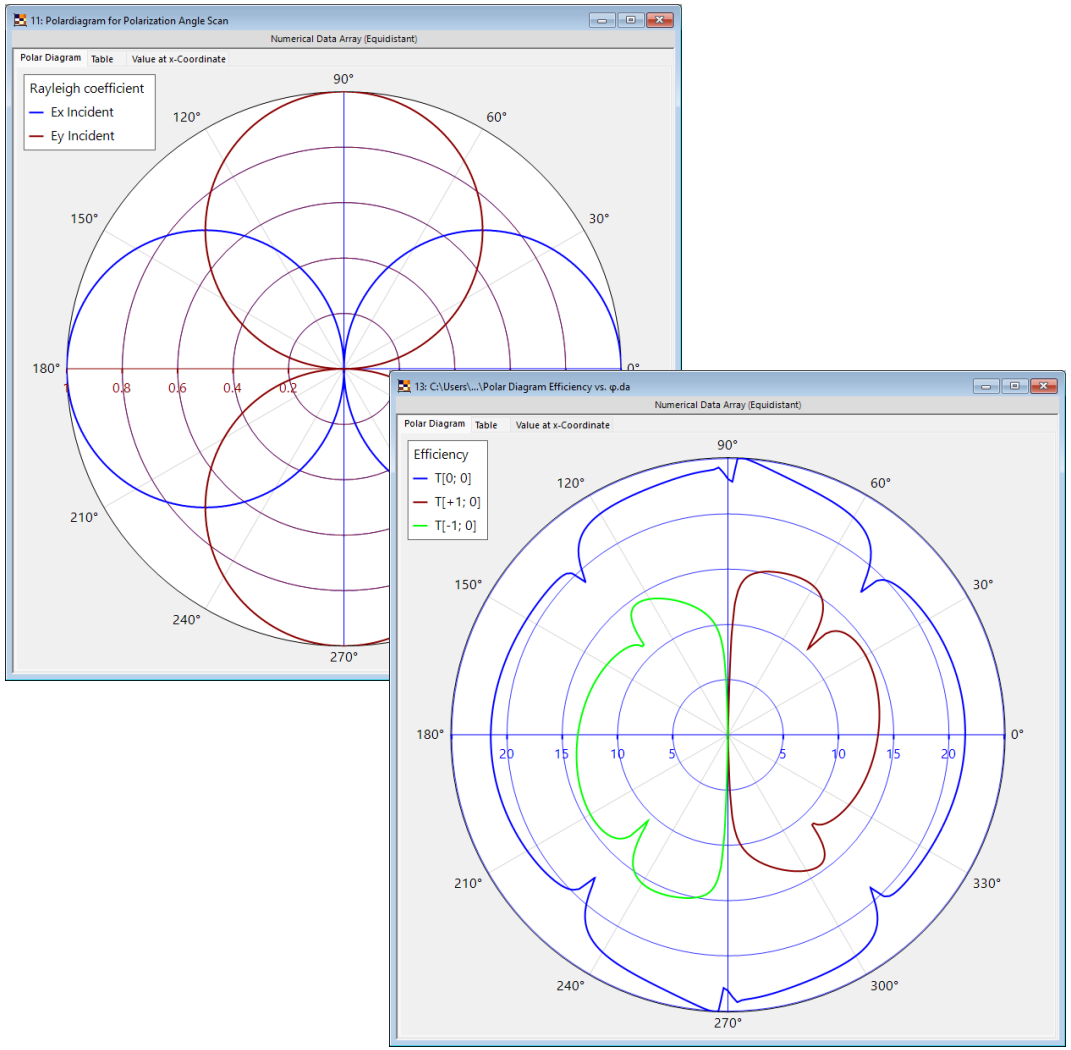
Redesigned Diffraction Order Diagram

- The Diffraction Order Diagram has been comprehensively upgraded for enhanced usability:
  - **New Customization Features**
    - Full control over colors, symbols, and styling via the Property Browser
    - Persistent order labels for immediate identification
  - **Performance Improvements**
    - Optimized rendering for systems with numerous orders
    - Smoother interaction during parameter adjustments



Full-Circle Polar Diagrams

- VirtualLab Fusion's **polar diagram view** now seamlessly handles 0°–360° data ranges, automatically displaying the full 2π circle when appropriate.
- This enhancement delivers more intuitive visualizations for complete angular datasets.
- Key Features:
  - Automatic detection of >180° ranges triggers full-circle display
  - Perfect for Parameter Run results covering all angles
  - Maintains all existing polar plot customization options



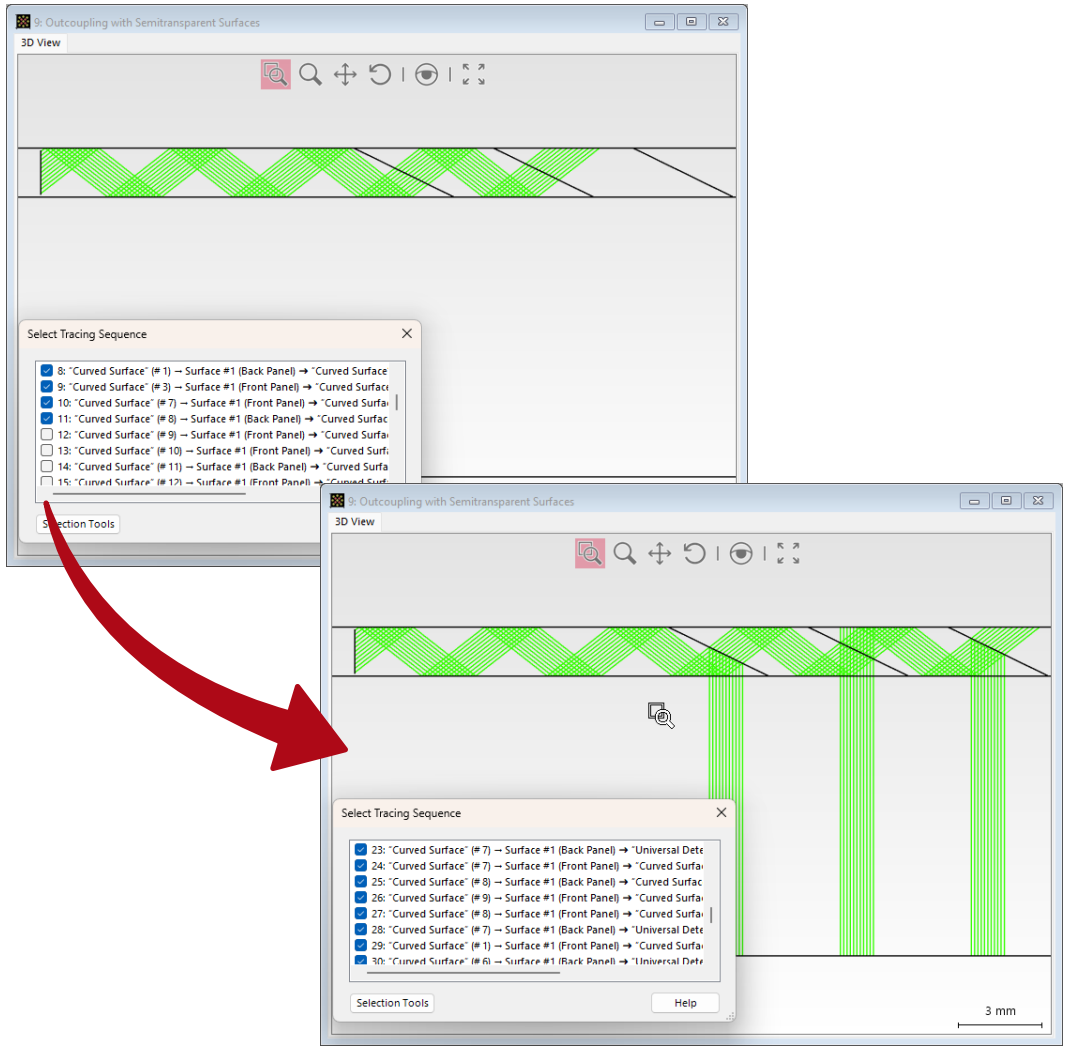
Live 3D System View Updates

- The enhanced 3D System View now provides **real-time visualization** as you:
  - Activate/deactivate optical surfaces
  - Enable/disable tracing sequences
- Key Benefits:

✓ Instant feedback on system configuration changes

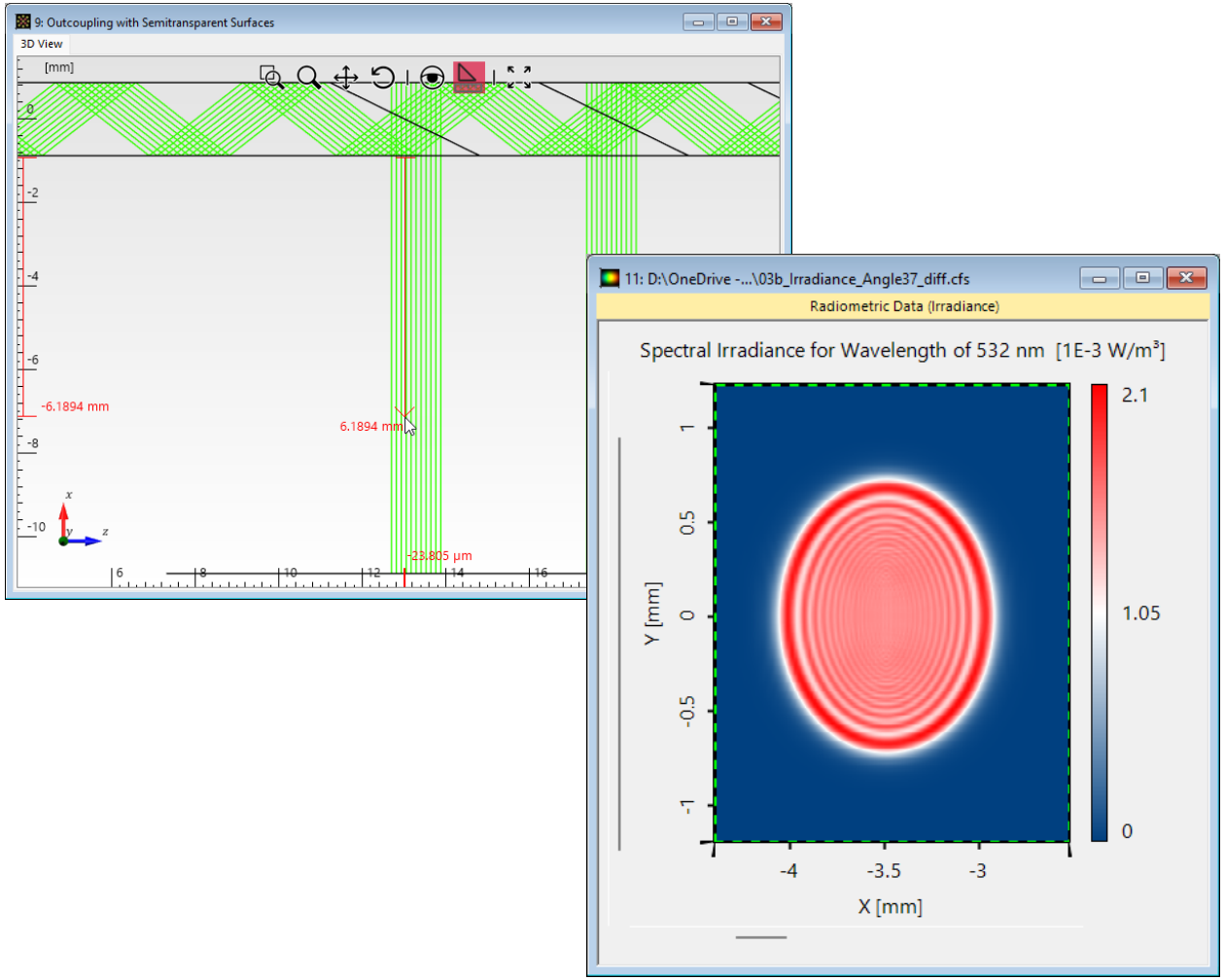
✓ Clearer troubleshooting of ray paths and element roles

✓ Interactive exploration of sequence dependencies



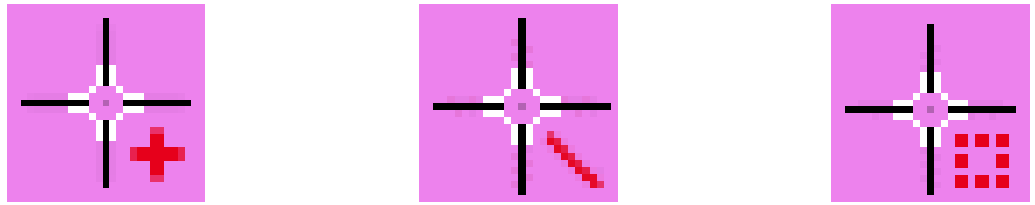
New View Configuration Shortcuts

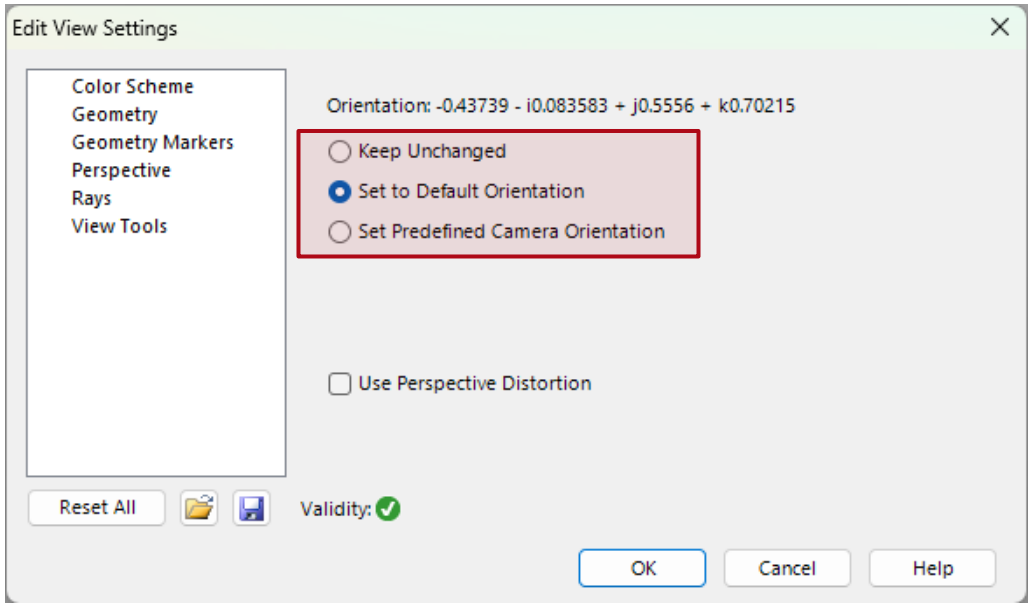
- To accelerate workflow navigation, we've introduced:
  - **3D View Enhancements**
    Hold Ctrl while measuring to snap to perfect horizontal/vertical alignment.
  - **Data Array View Optimizations**
    Ctrl + Double Click instantly sets markers to visible data ranges.



Enhanced Data Array View & 3D View Settings

- **Data Array Views**
  - New contextual cursor icons now visually indicate the active interaction mode (point, line or rectangular marker selection).
- **3D View Settings**
  - Added support for resetting to default camera orientation directly from the view settings dialog.

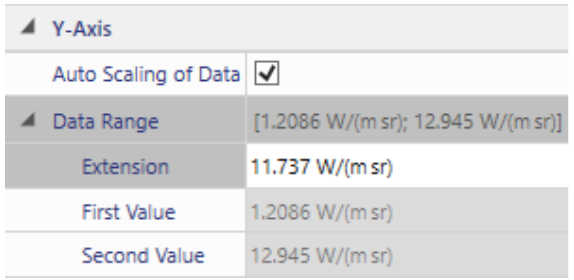




Improved Property Browser Interface

- As one of VirtualLab's central control panels, the **property browser** now features:
  - **Streamlined Layout** - Improved organization of editable and read-only parameters
  - **Optimized Visual Design** - New color scheme for better parameter identification
  - **Consistent Read-Only Display** - Unified presentation of non-editable values
- These refinements accelerate workflows while maintaining the browser's comprehensive functionality.

2024.1



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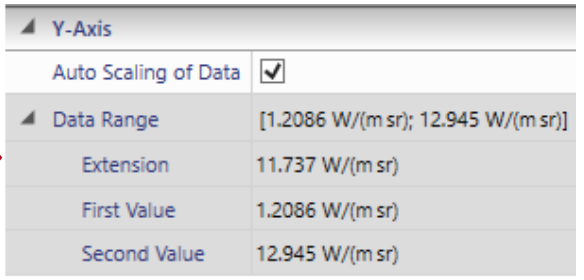


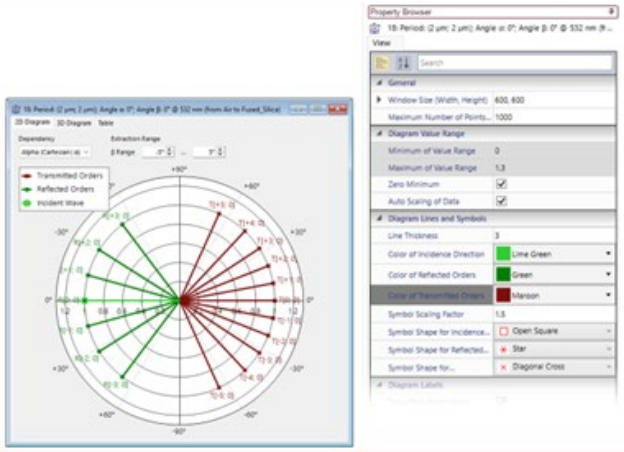
Learn More About: Views in VirtualLab Fusion

Use Cases

- Diffraction Angle Calculator
- 3D Visualization of the Optical System
- Introduction to Data Arrays
- View Settings for 2D Data Arrays
- Creating 1D-Diagrams in VirtualLab Fusion
- Working with the Property Browser

Options for the Diffraction Order Diagram

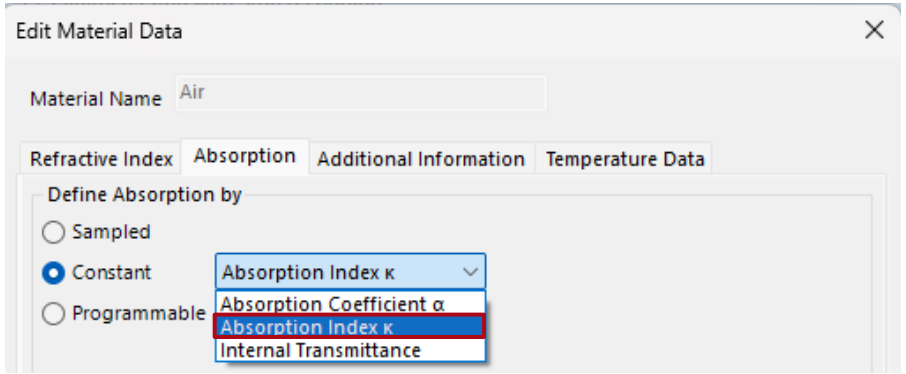
The Diffraction Order Diagram can be customized (colors, symbols, legend) via the Property Browser.

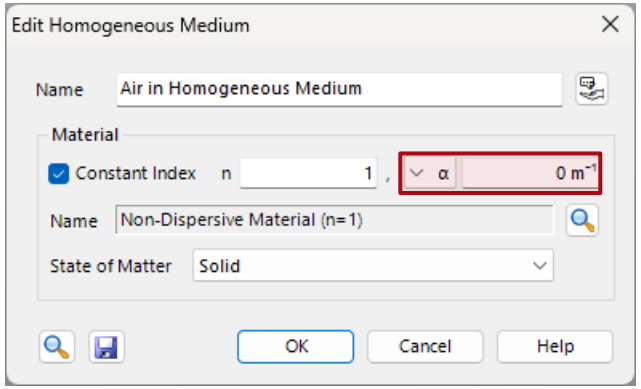


System Building Blocks

Improved Material and Homogeneous Media Configuration

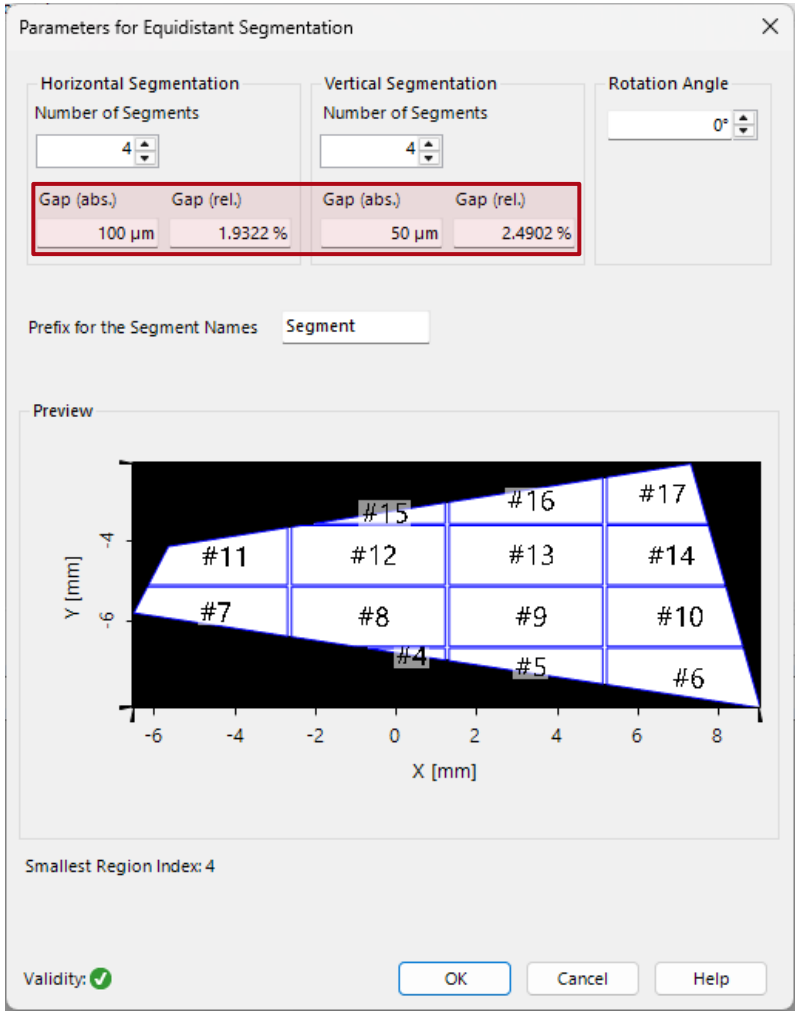
- VirtualLab Fusion now supports absorption properties for both materials and homogeneous media:
  - **Materials** can include the absorption index (κ) for complete optical constant definition
  - **Homogeneous media** maintain their constant-n behavior while adding optional absorption
- These updates enable more realistic modeling while preserving simplicity.





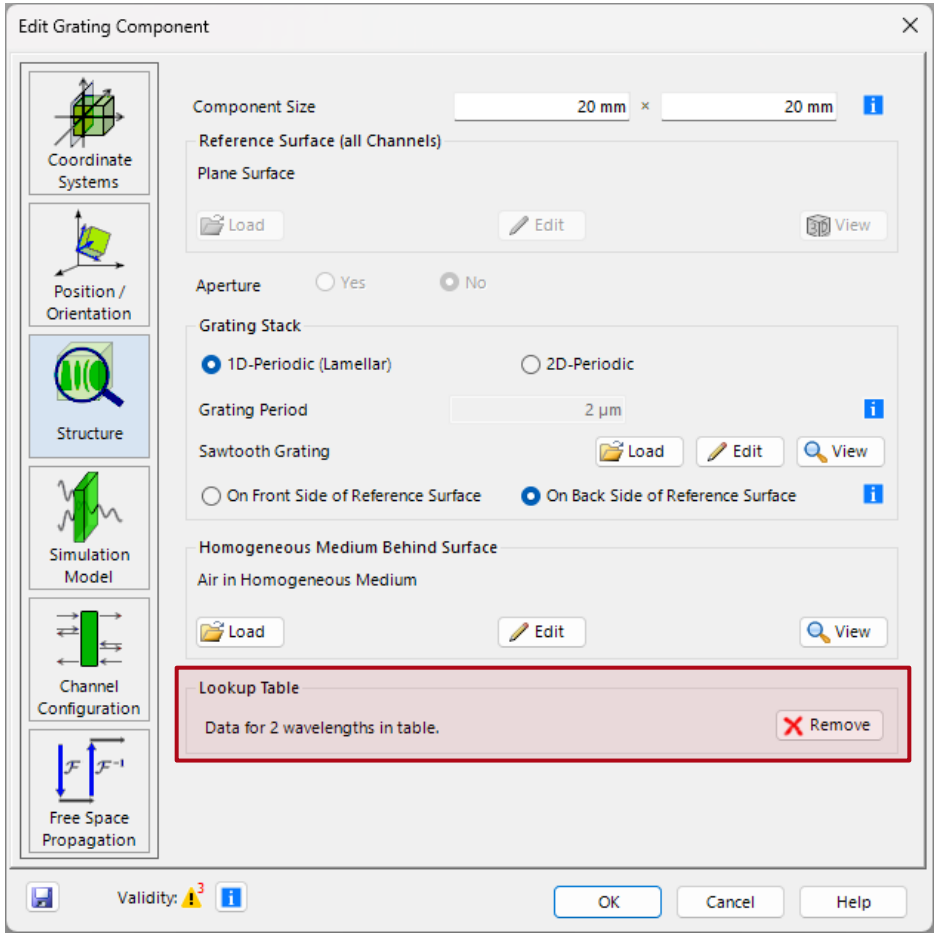
Enhanced Region Segmentation Options

- VirtualLab Fusion already lets you segment regions into arbitrary smaller areas, including convenient conversion from modulated to segmented regions with constant grating properties.
- Now in version 2025.1, we've added a key enhancement to the **segmentation** tool: the ability to introduce **gaps** between segmented regions, which enables:
  - Model manufacturing tolerances and physical separations.
  - Better represent real-world fabrication constraints.



Enhanced Lookup Table Handling for Gratings

- We've made working with grating **lookup tables** more transparent and flexible.
- Now you can:
  - Peek inside stored results to understand what's cached
  - Clean up selectively by removing lookup tables when you need fresh calculations

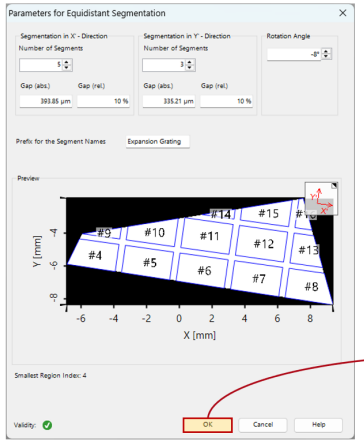


Learn More About: System Building Blocks

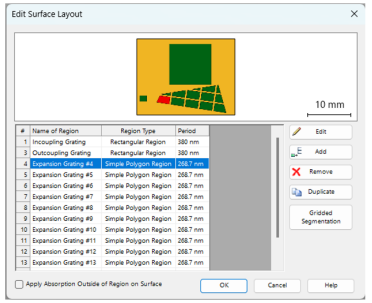
Use Cases

- Lightguide Featuring Segmented Gratings Regions with Intermittent Gaps
- Gridded Segmentation of Grating Regions in Lightguides (Tutorial)
- Grating Component for General Optical Systems

Segmentation of the Functional Grating



The shape of the gridded segmentation can be adjusted by modifying the *Number of Segments*, the *Gap* between them, and the *Rotation Angle*. Additionally, users can customize the segment name as needed.

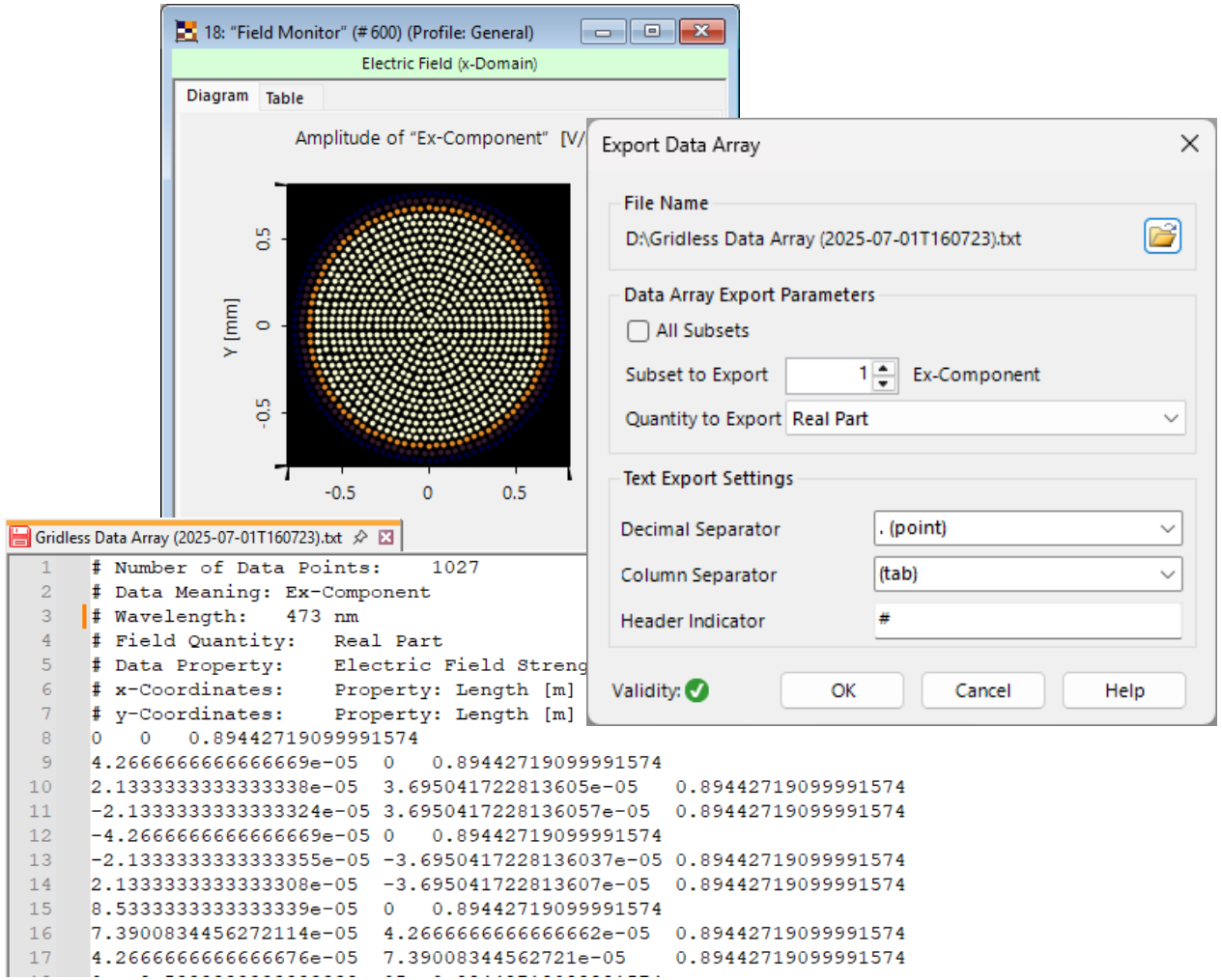


5

Import/Export

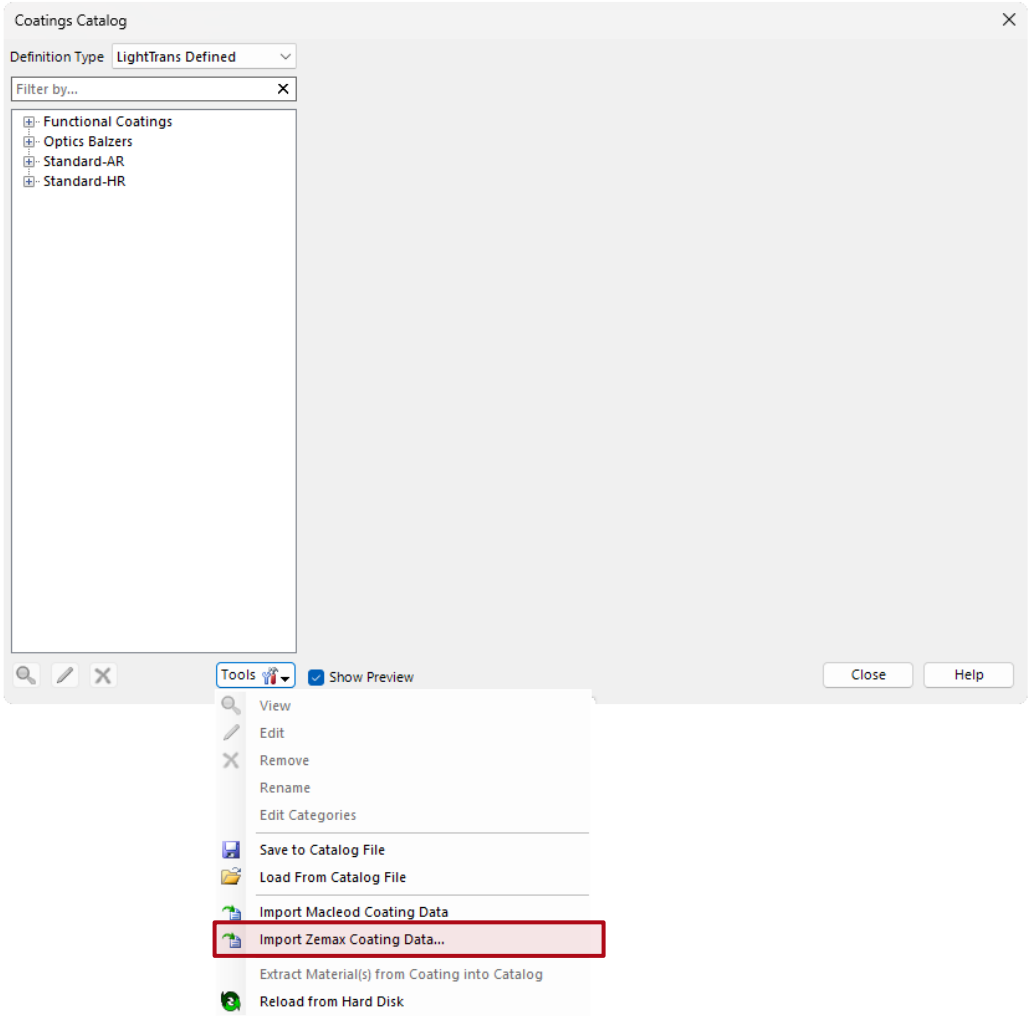
Export of Gridless Data

- VirtualLab Fusion extends its **export** capabilities to include **gridless point cloud data**, complementing the existing equidistant data export functionality.
- The new exporter handles gridless results with the same flexibility you expect:
  - Select specific quantities for export
  - Choose subset ranges when needed
  - Customize file formatting with different separators



Import of Coatings from Zemax Systems

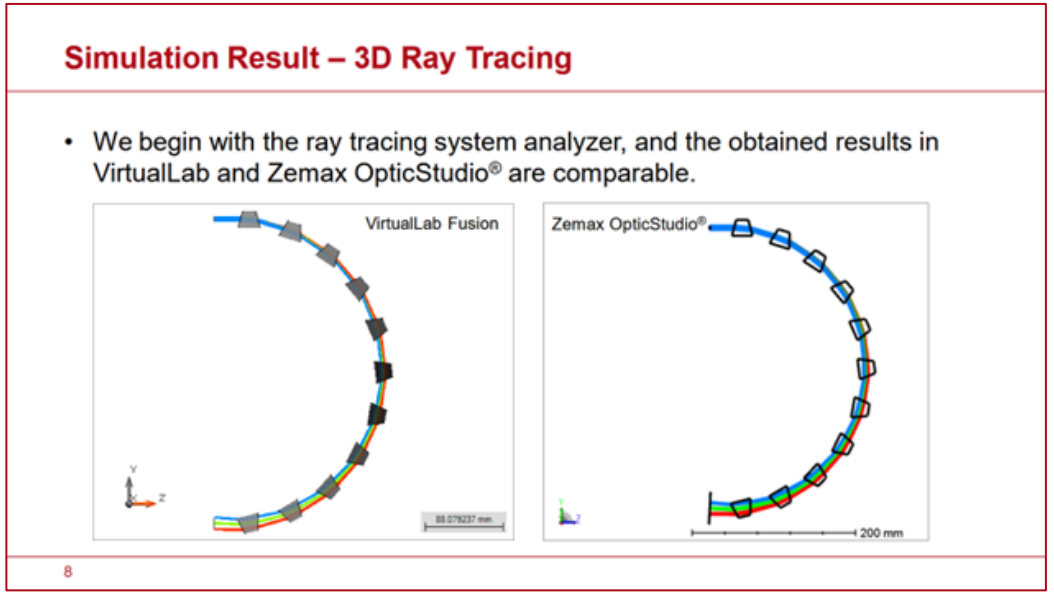
- VirtualLab Fusion 2025.1 introduces automatic **coating import** from Zemax lens systems, plus a dedicated tool for direct catalog integration.
- This enable the following key features:
  - **System Import:**
    Coatings transfer automatically with imported Zemax designs
  - **Catalog Tool:**
    Add coatings manually from Zemax files to your user catalog
  - **Full Support:**
    Handles real, ideal, and encrypted coatings



Learn More About: Import / Export

Use Cases

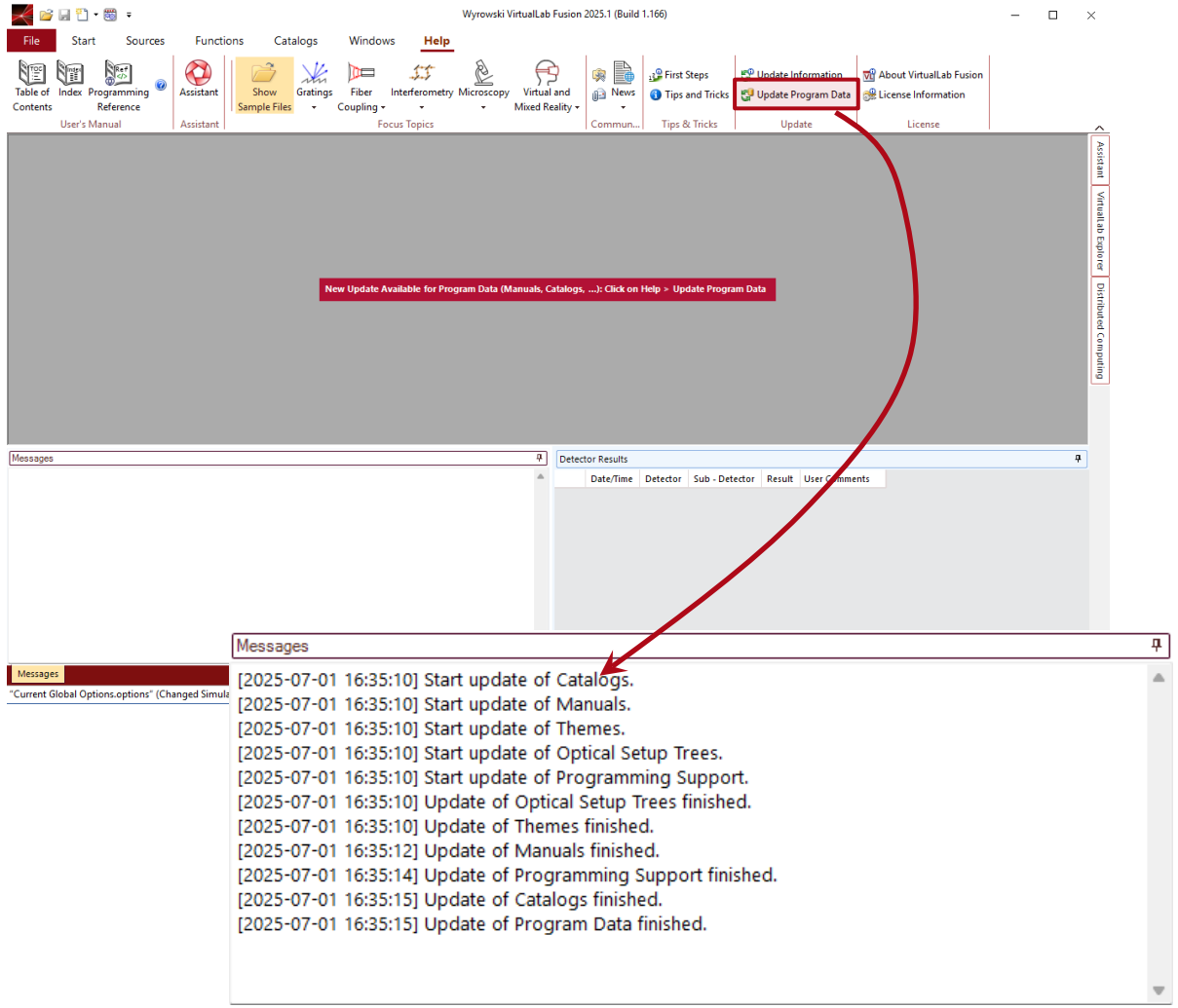
- Import Optical Systems from Zemax OpticStudio
- Import Text Files into VirtualLab Fusion
- Automatic Export of Simulation Results via Add-on



Usability

Enhanced Program Data Synchronization

- VirtualLab Fusion's **automatic update** system has been upgraded for simpler maintenance and better user control.
- Key Improvements:
  - **Standard User Access**: New local directory requires no admin rights.
  - **Proactive Notifications**: Get alerted at startup when updates are available.
  - **One-Click Sync**: Maintain catalogs, manuals and more with minimal effort.

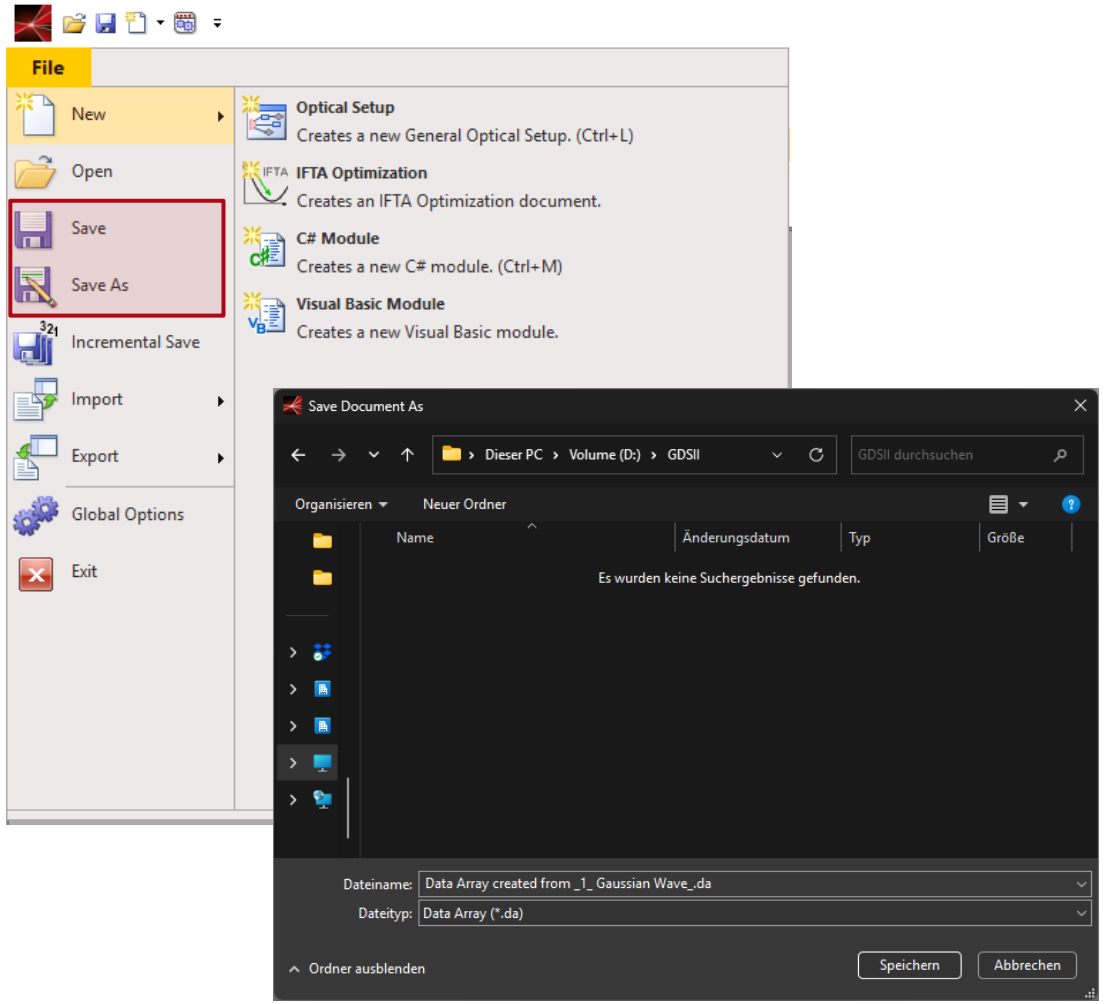


Transition to XML File Format

- VirtualLab Fusion now uses exclusively **XML-based file** storage, completing our migration from the legacy binary format.
- This results in:
  - New Default: All files now save only in our optimized XML format
  - Backward Compatibility: Existing binary files can still be opened
  - Conversion Recommended: Users should update older files to XML format
- This change prepares for:

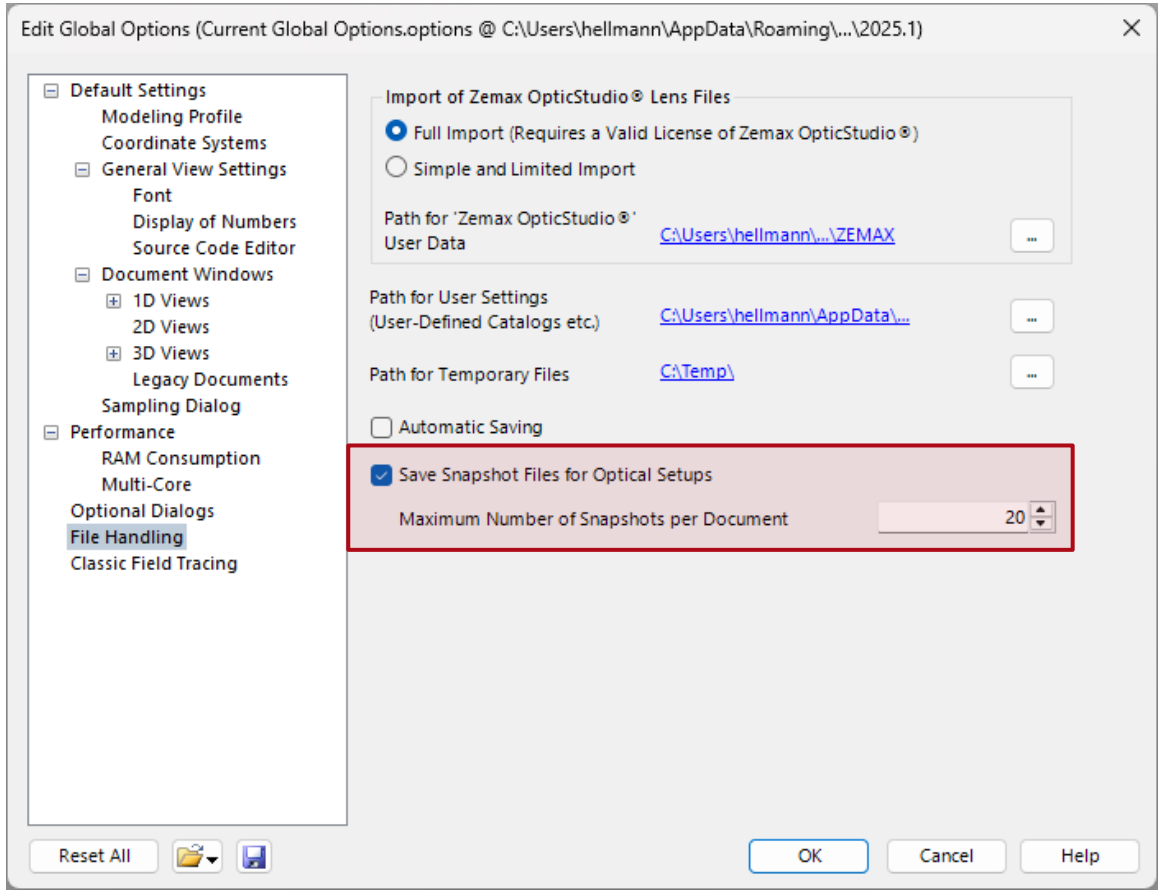
  ✓ **.NET 8.0+ compatibility**

  ✓ **Better long-term file stability**



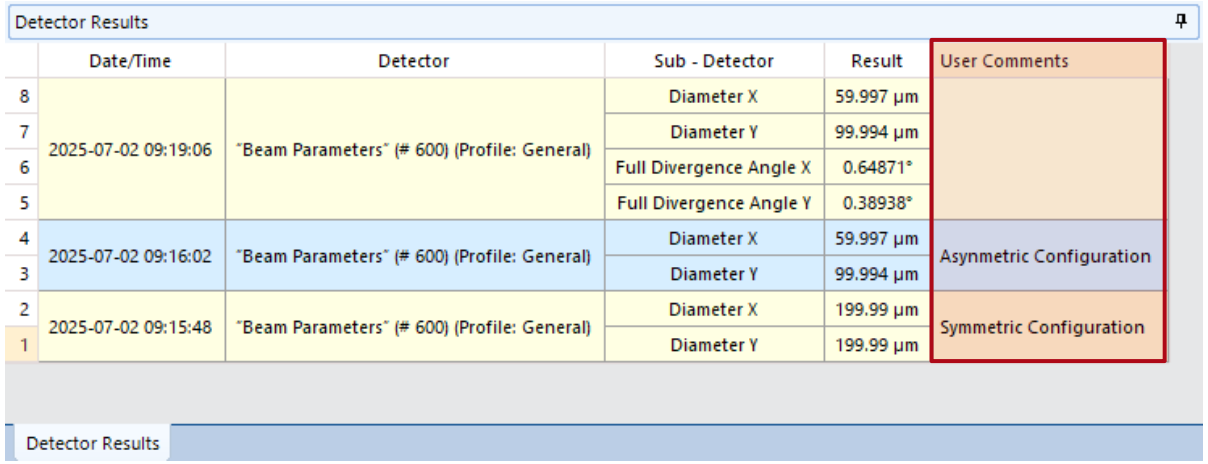
Advanced Option for Snapshot Management

- VirtualLab Fusion 2025.1 adds new control over optical setup snapshots
- What's New:
  - Set a **maximum snapshot count** for any optical setup as global option within VirtualLab Fusion.
  - When limit is reached, the system automatically replaces the oldest snapshots with new ones.
  - Snapshot generation works with change-triggered captures.



Enhanced Table Edit Options

- We’ve enhanced how you work with detector results across VirtualLab Fusion. The detector result tables now support **custom user comments**, making it easier to track and compare simulation outcomes by adding meaningful notes directly to your results.
- For all physical value inputs within tables (e.g. in Parameter Runs) we’ve standardized on a **unified entry control**. This brings consistent behavior and validation wherever numerical values are entered.



VirtualLab Fusion 2025.1 Release Highlights

- **Core Capability Upgrade**
  - New Plug-In architecture
  - Optimized workflow controls
  - Enhanced data visualization
- **Enabling Advanced Solutions**
  - Pulse modeling and analysis
  - Advanced polarization studies
  - and more…
- **Experience faster, more flexible optical simulations.**