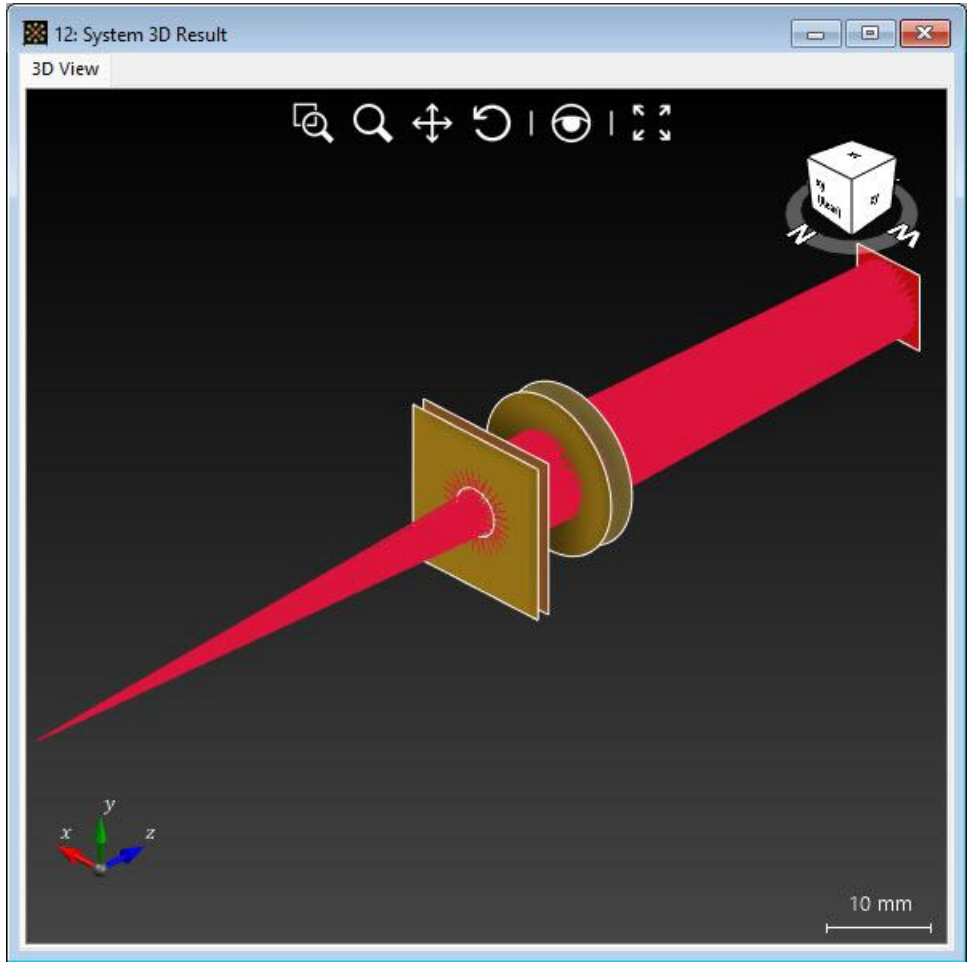
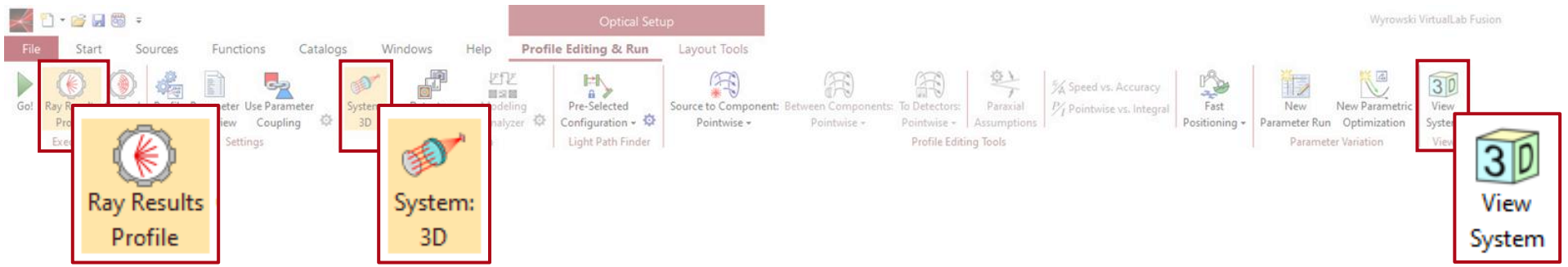
3D Visualization of Optical Systems

Abstract



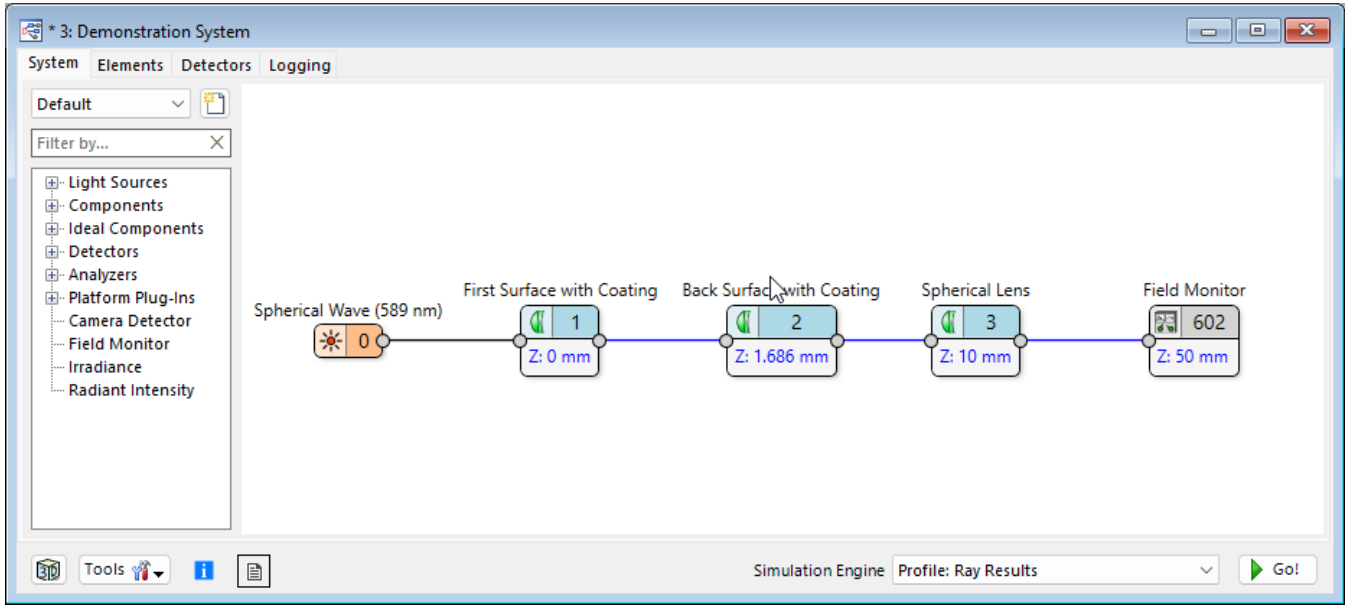
For a fundamental understanding of the properties of an optical system, a visualization of its components together with an indication of the light propagation is immensely helpful. For this purpose, VirtualLab Fusion provides tools which display a three-dimensional visualization of optical systems. These tools can further be used to check the positions of elements and detectors, as well as to get a quick overview of the light propagation inside the system. The applied modeling technique for the 3D view is similar to ray tracing.

How to Generate a System View Document



option #1

option #2



3D views of an optical system can be generated in two different ways:

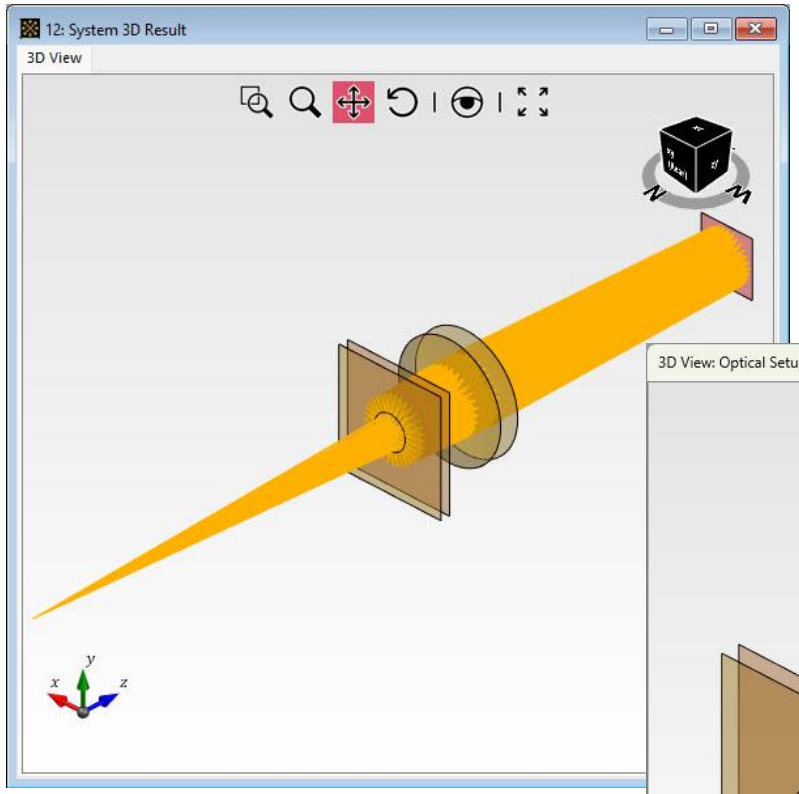
1. Use *Ray Results Profile* and choose *System: 3D* as result, then run the simulation.

2. Click on *View System* (just 3D-display of the components, no light propagation).

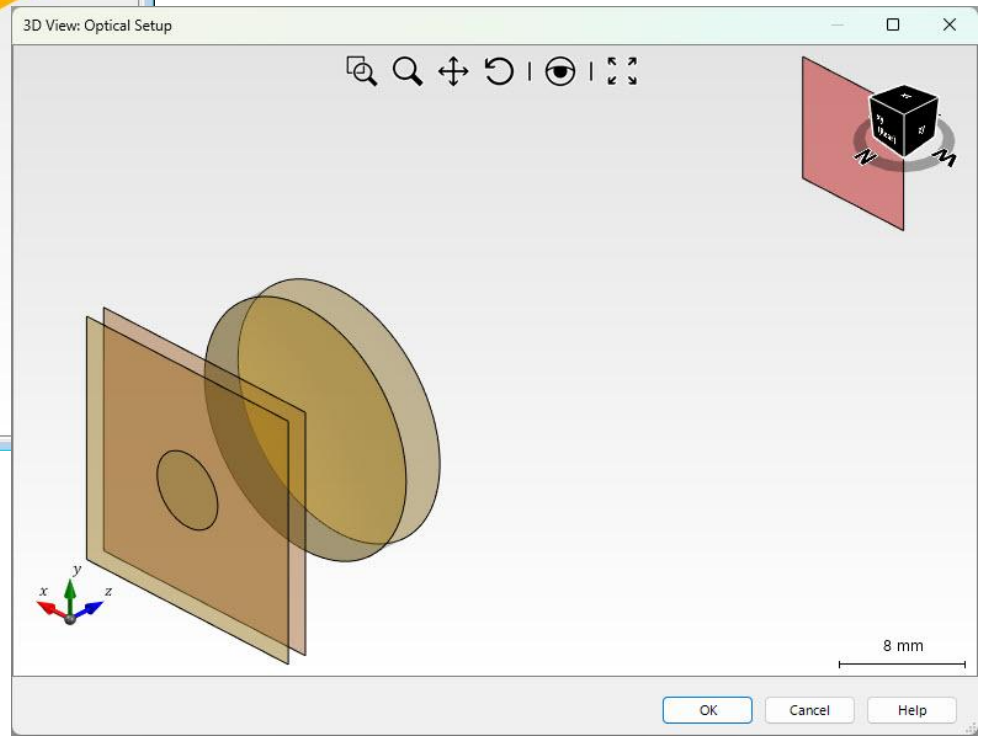
System: 3D (Ray Result Profile) vs. 3D System View

The major difference between the two methods is that the first also provides information about the propagating light by using the *Ray Results Profile*, while in the latter only components and detectors will be displayed.

We will focus on the *System: 3D* view for the rest of the use case.

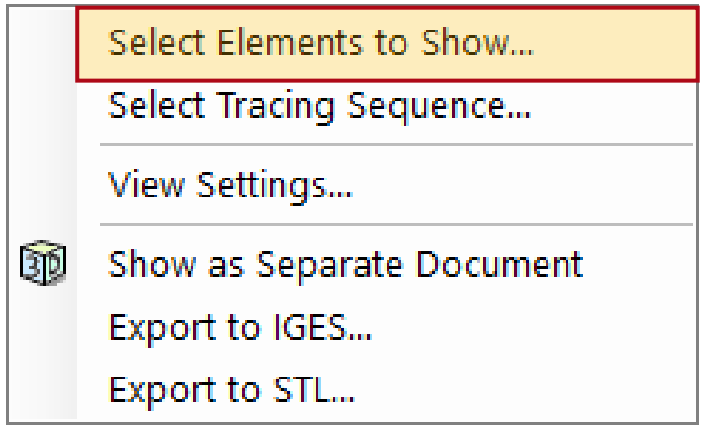


System: 3D view for *Ray Results Profile*

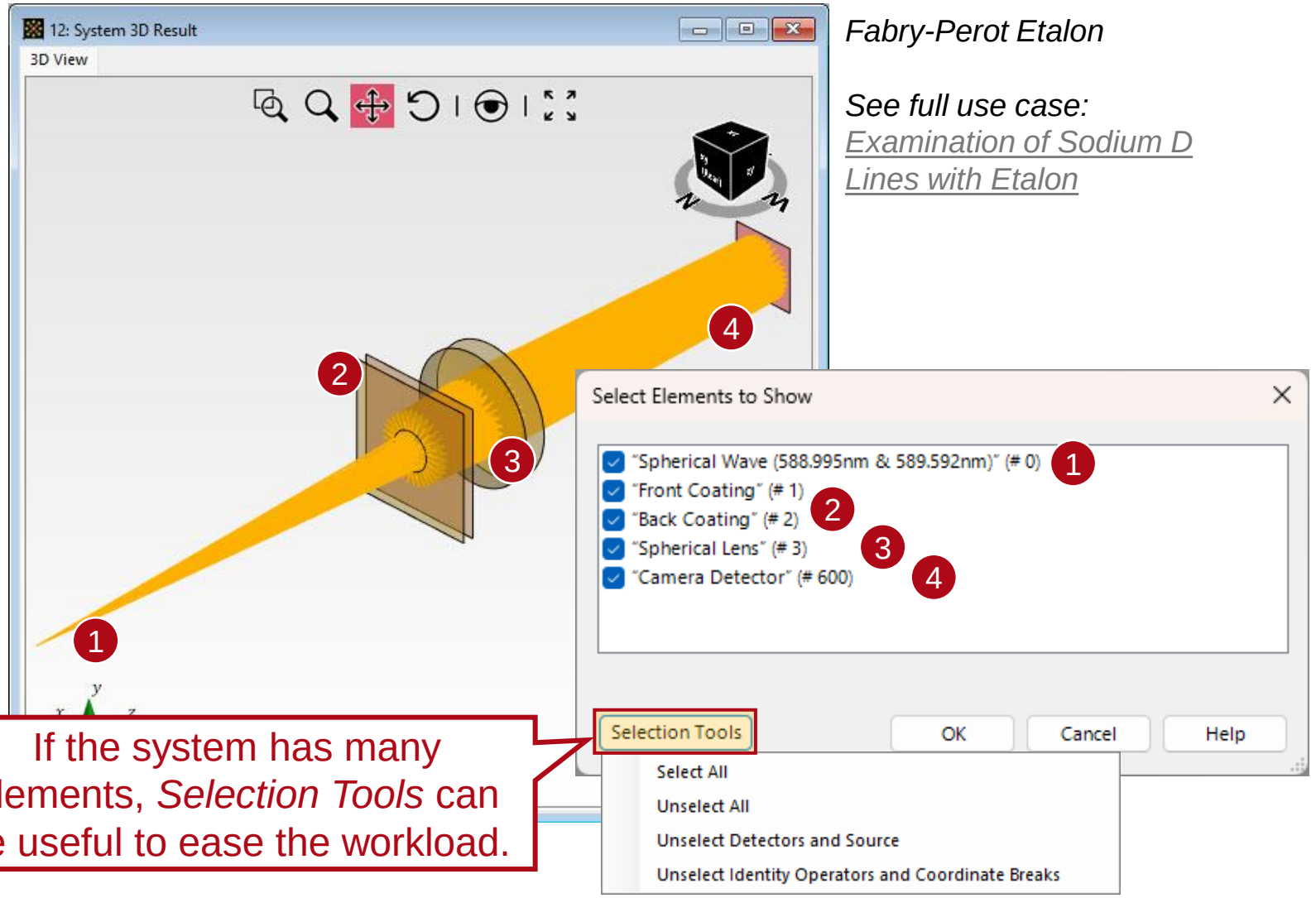


3D System View: system visualization without depiction of light

Options – Select Elements to Show



A menu providing detailed options is available by right-clicking on the document window. The first option "*Select Elements to Show*" allows the configuration of the elements of the system which are shown in the document (by default all elements are shown).

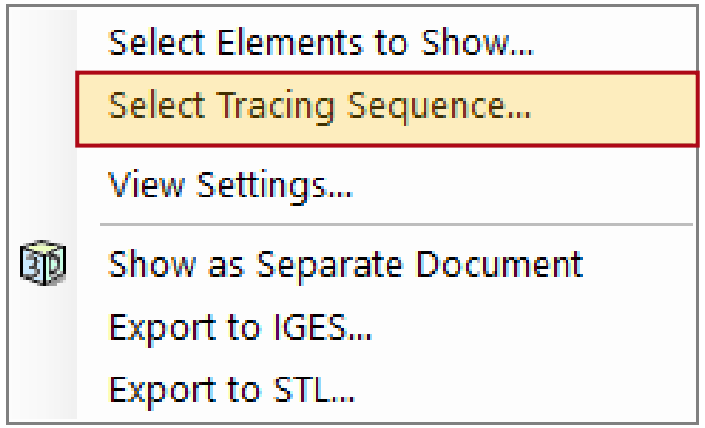


If the system has many elements, *Selection Tools* can be useful to ease the workload.

Fabry-Perot Etalon

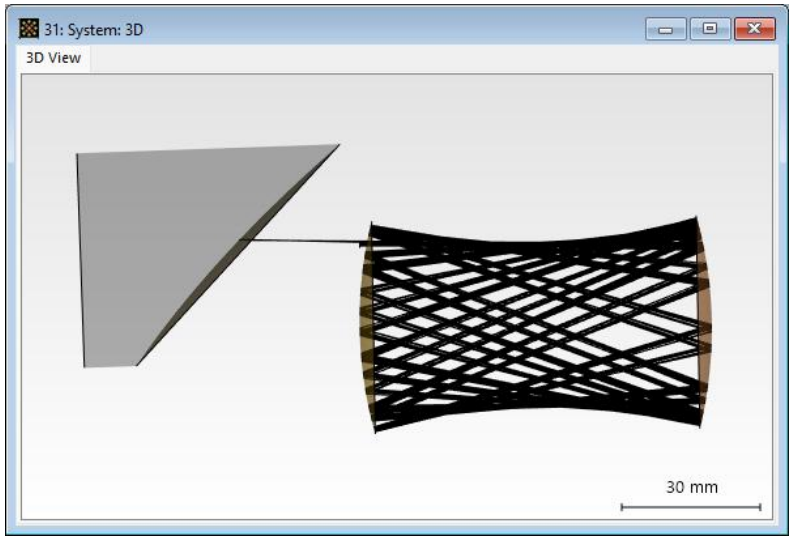
See full use case:
Examination of Sodium D Lines with Etalon

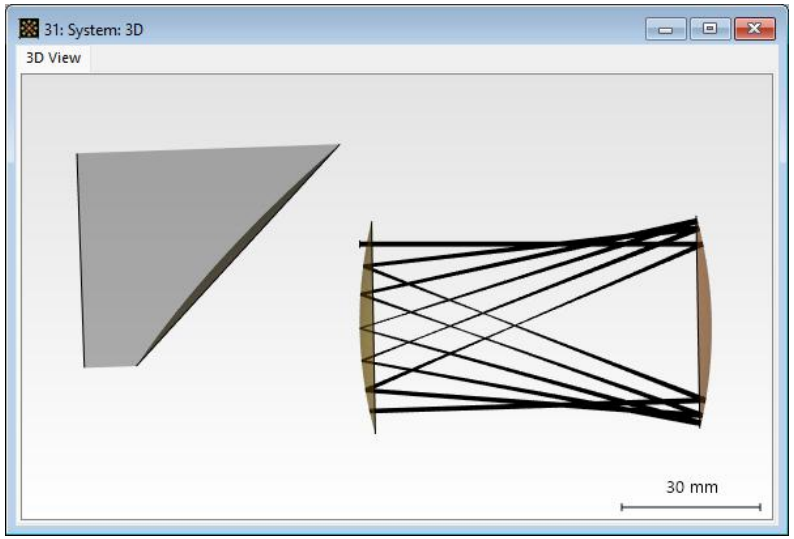
Options – Select Tracing Sequence

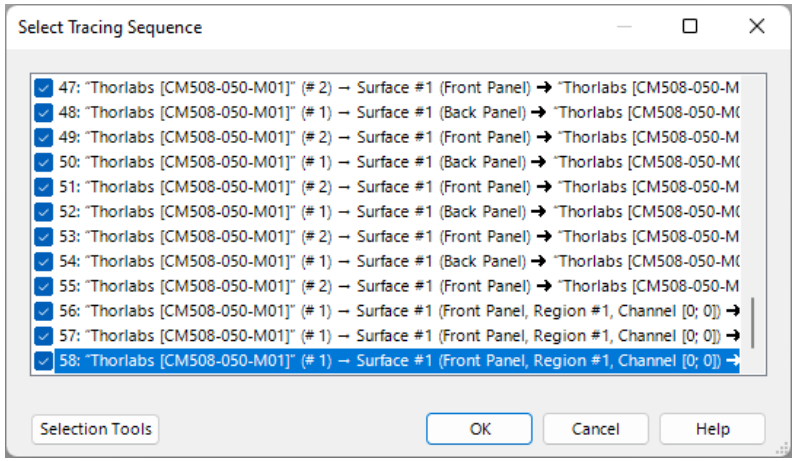


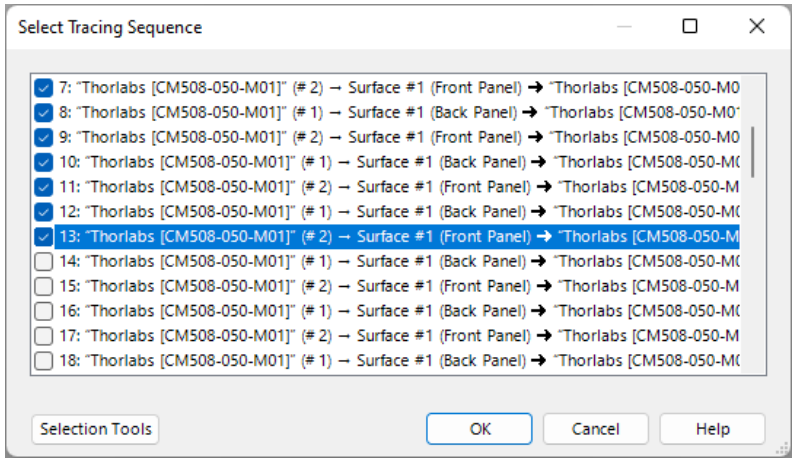
In case of non-sequential propagation (manual channel configuration) many light paths can be available in the system. The *Select Tracing Sequence* option lets users include or exclude specific propagation steps, with the view updating in real time.

example: Herriott Cell – See full use case: Modeling of a Herriott Cell

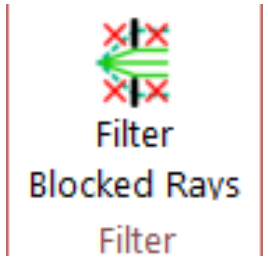






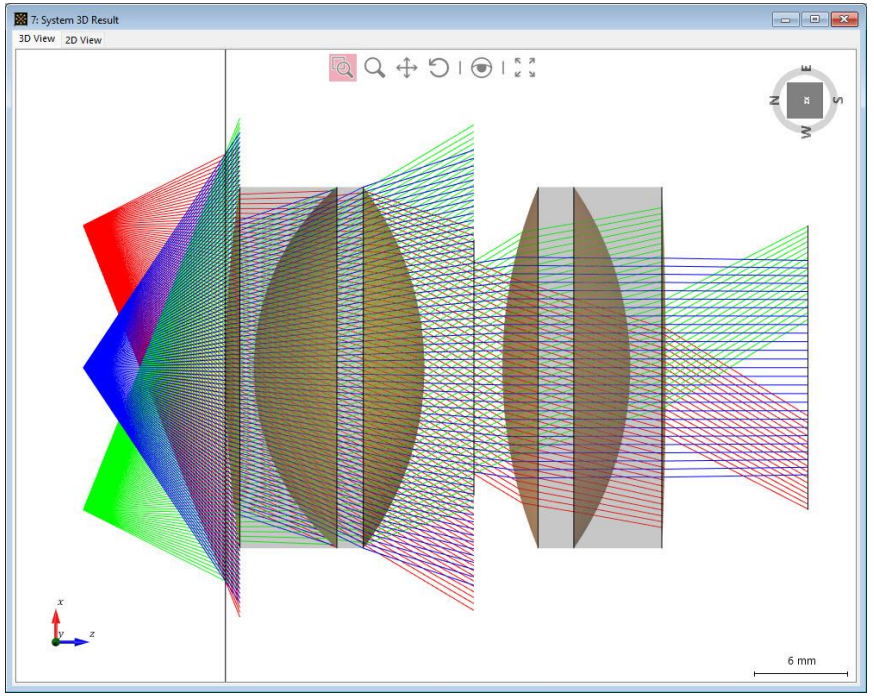


Options – Filter Blocked Rays

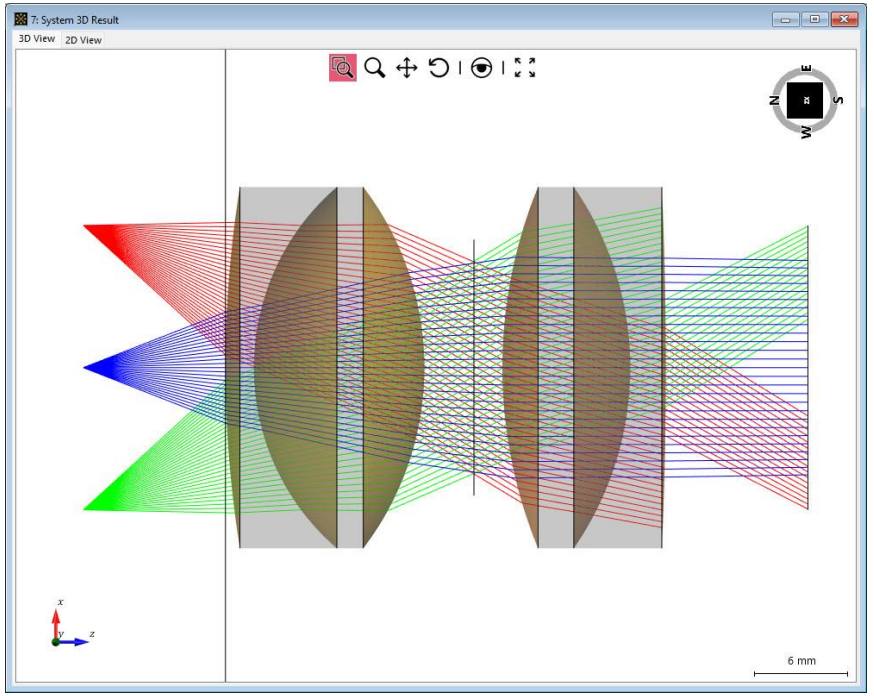


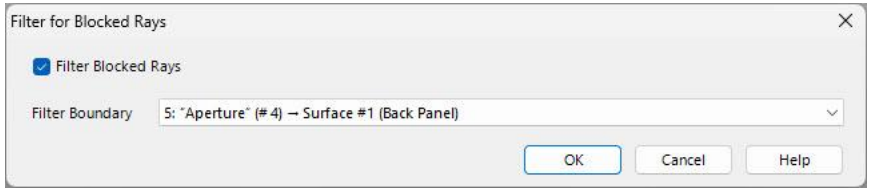
For the sake of clarity, it is possible to filter out all rays that do not pass through a certain aperture in the sequence.

no filter

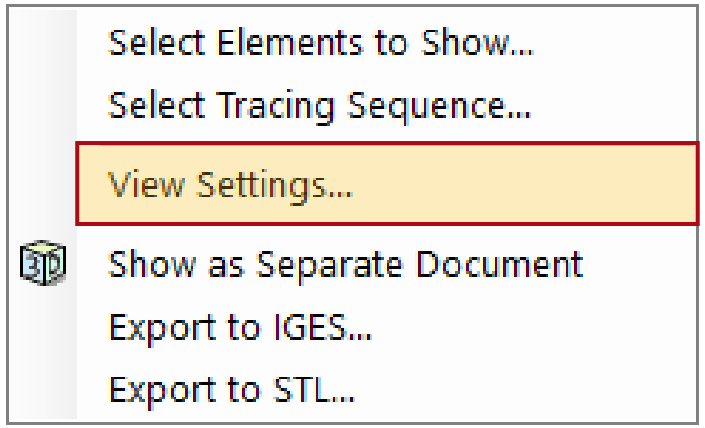


with filter

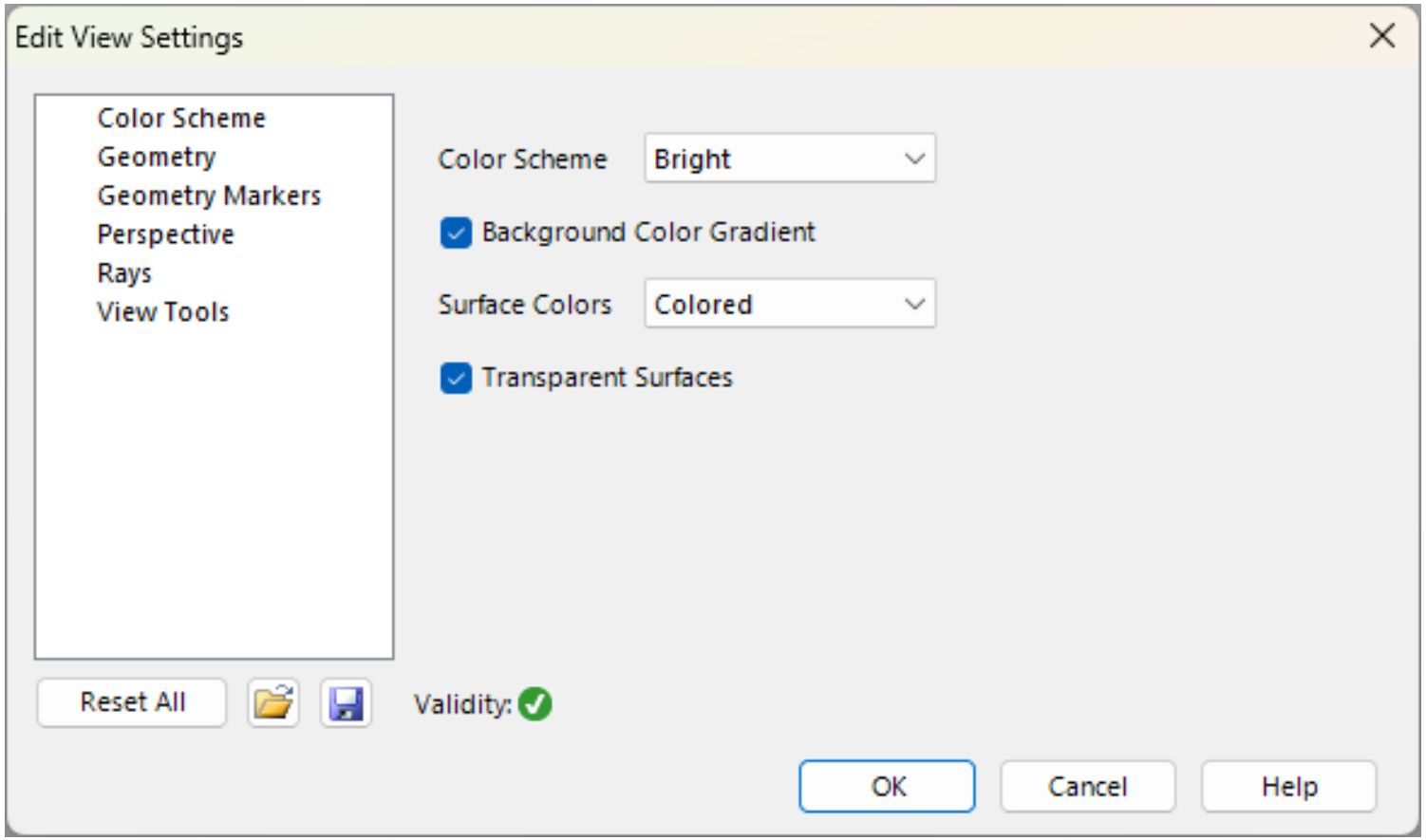




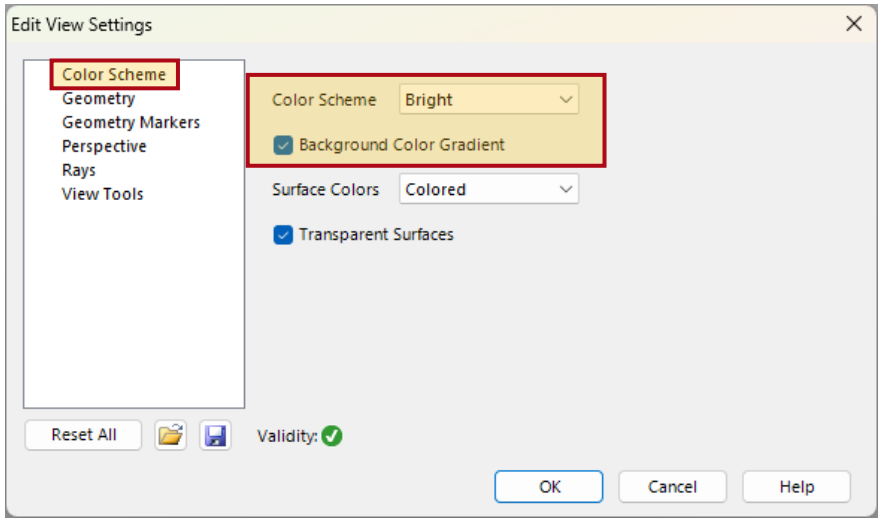
Options – View Settings

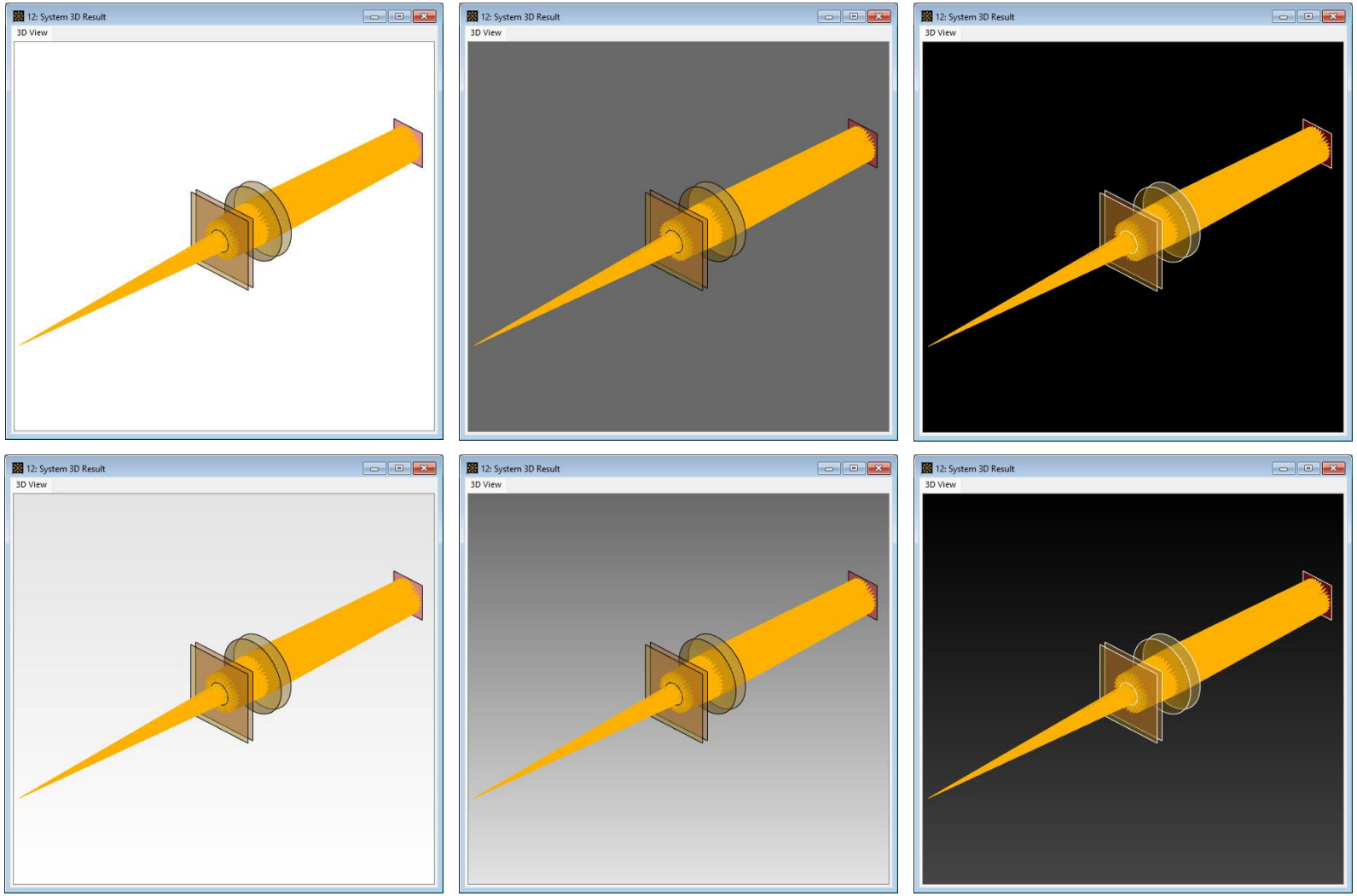


View Settings will open another menu with various options to customize the 3D view, like *Color Scheme*, *View Tools* or depiction style of rays, etc.



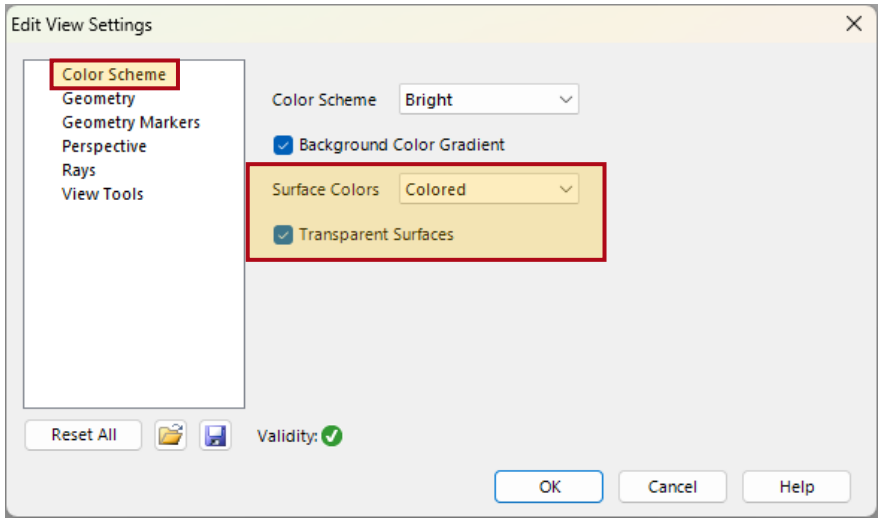
Color Schemes – Background Color



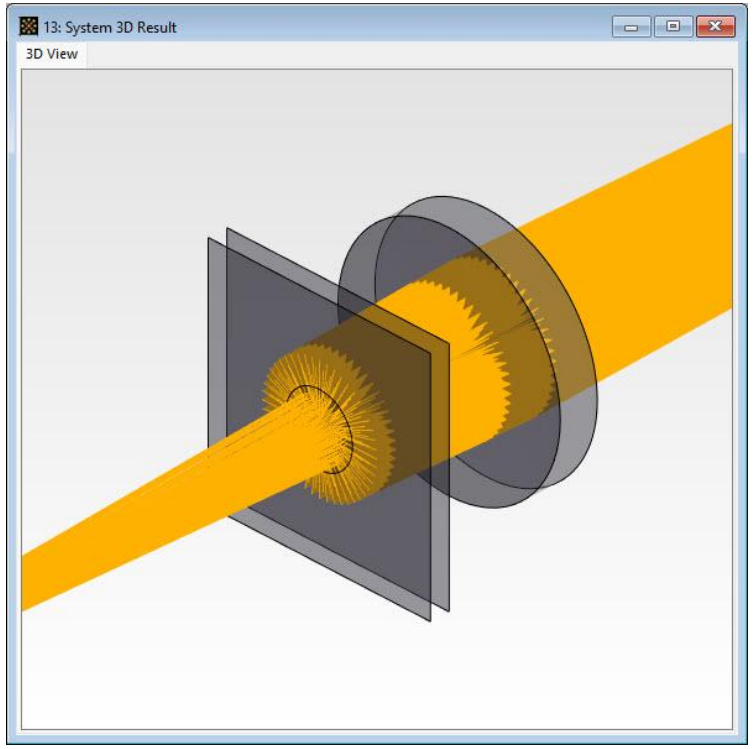


Available color schemes are *Bright*, *Medium* and *Dark*. Furthermore, the user can decide whether to include a *Background Color Gradient* or not.

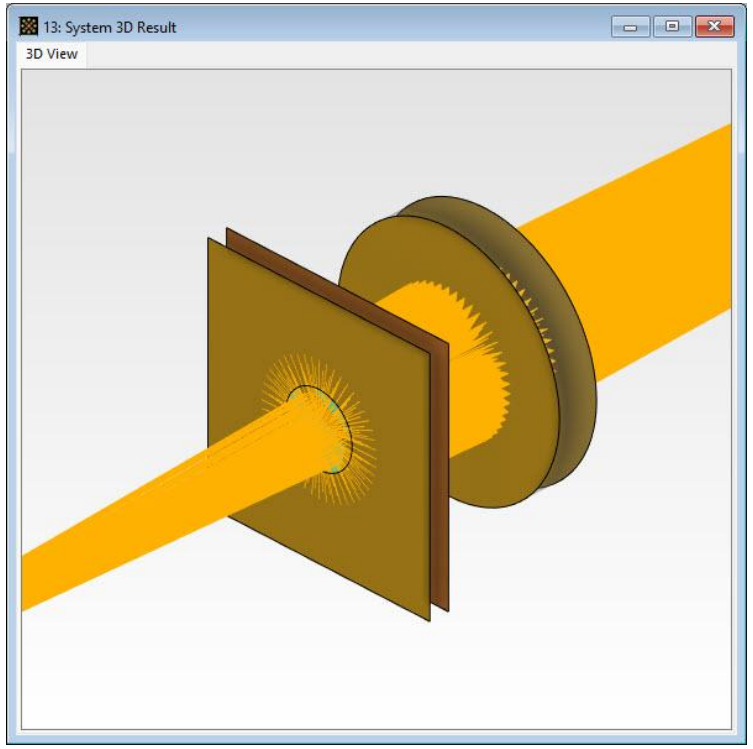
Color Schemes – Components



The surfaces of the components can be depicted either *Colored* (green for sources, yellow for components and red for detectors) or *Uncolored*. It is also possible to display them with transparency.

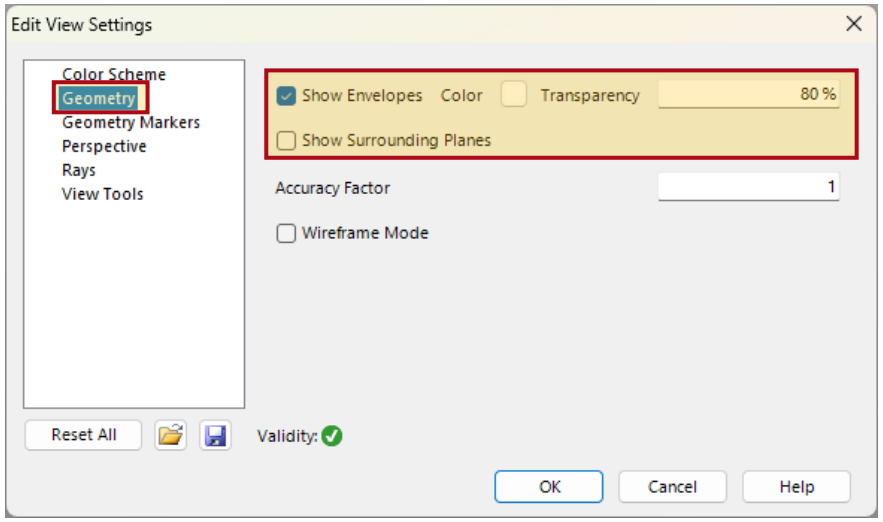


Uncolored surfaces



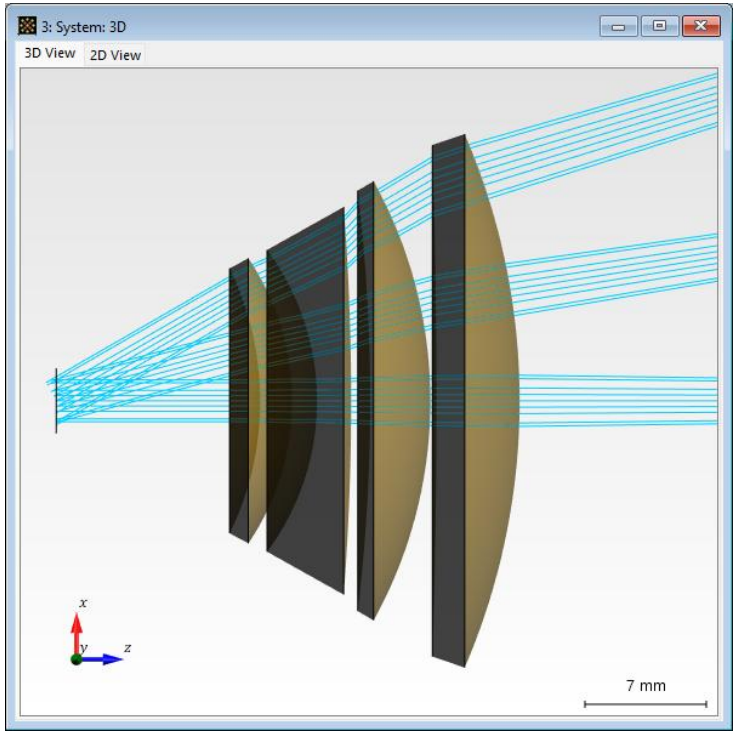
non-transparent surfaces

Geometry – Envelopes

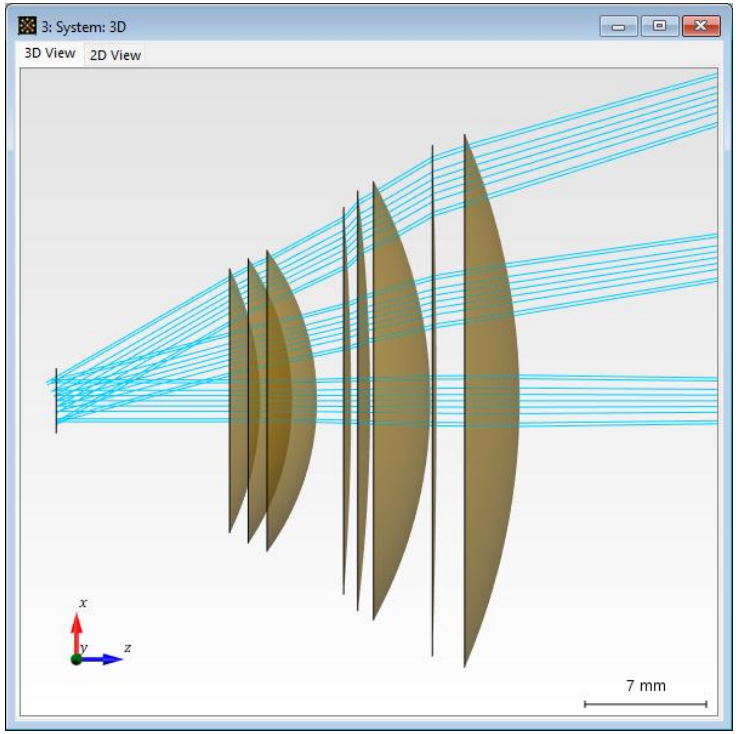


The *Geometry* tab covers the customization of the depiction of system components, such as lens systems. It is possible to show or hide envelopes of the lenses. The envelopes can also be shown with a certain transparency.

with envelopes

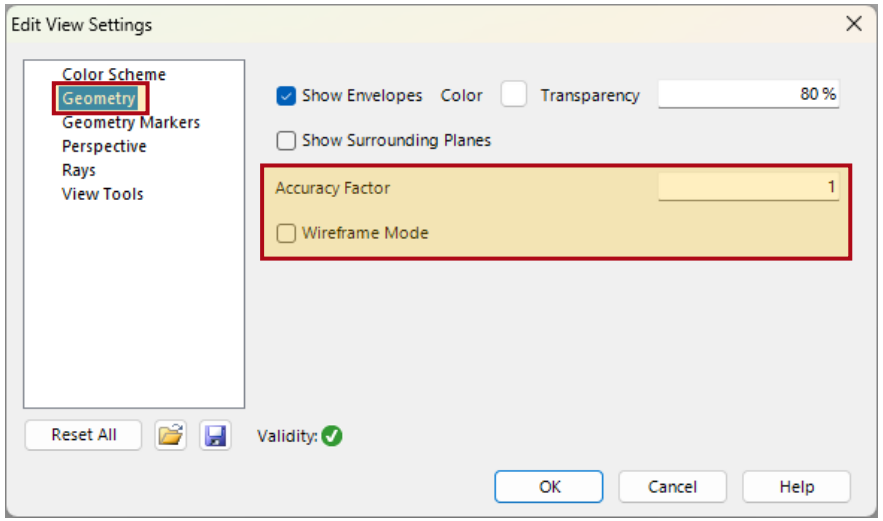


without envelopes

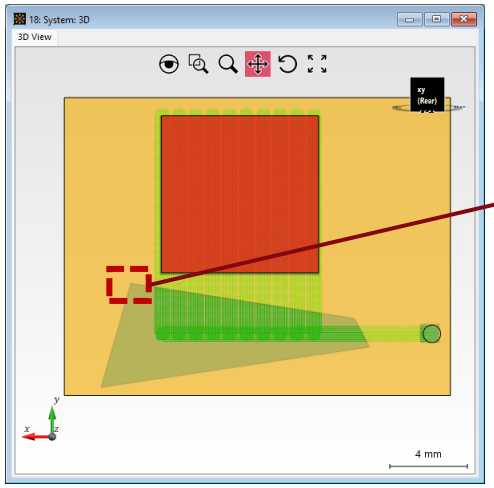


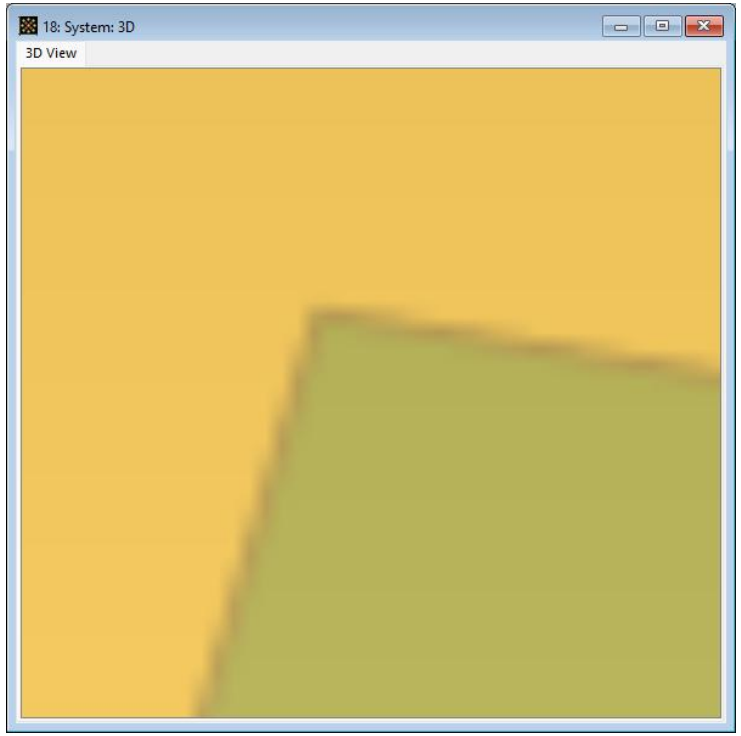
F-Theta Lens - See full use case: Performance Evaluation of an F-Theta Scanning Lens

Geometry – Accuracy Factor

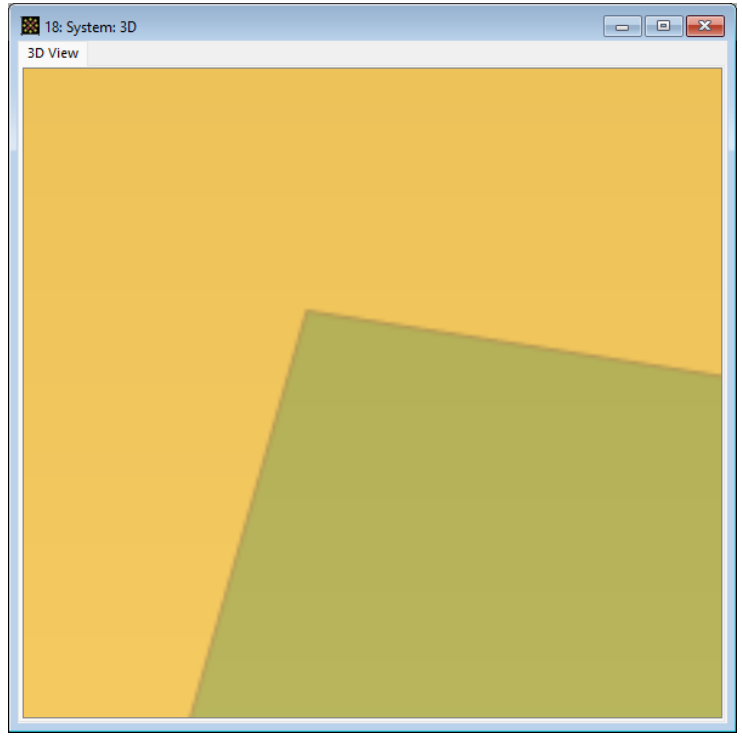


The *Accuracy Factor* controls the sampling of the 3D visualization. An increased *Accuracy Factor* might be helpful for the detailed depiction of structured surfaces or crisp visualization of region borders. However, note that very high values can increase rendering time.



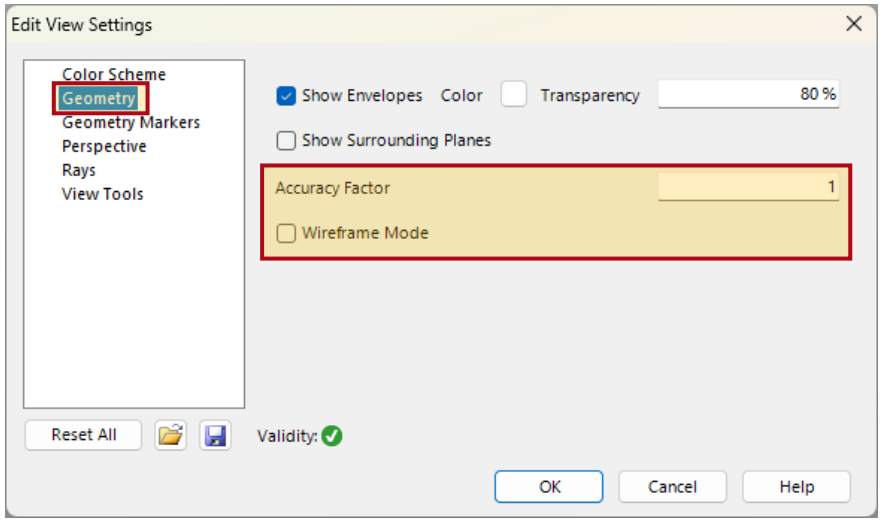


Accuracy Factor: 1

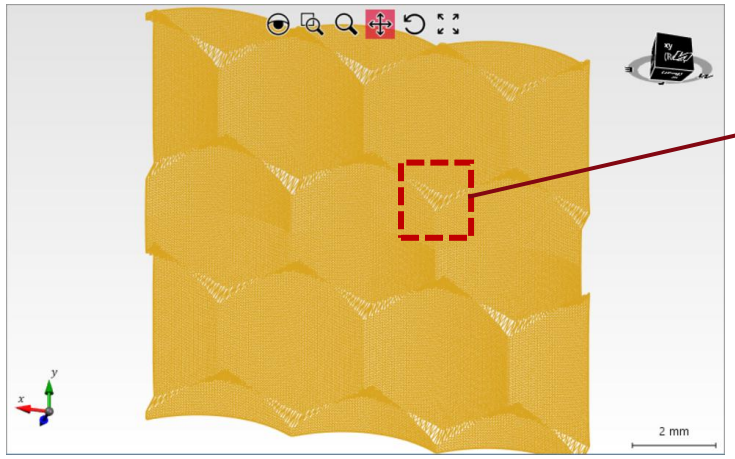


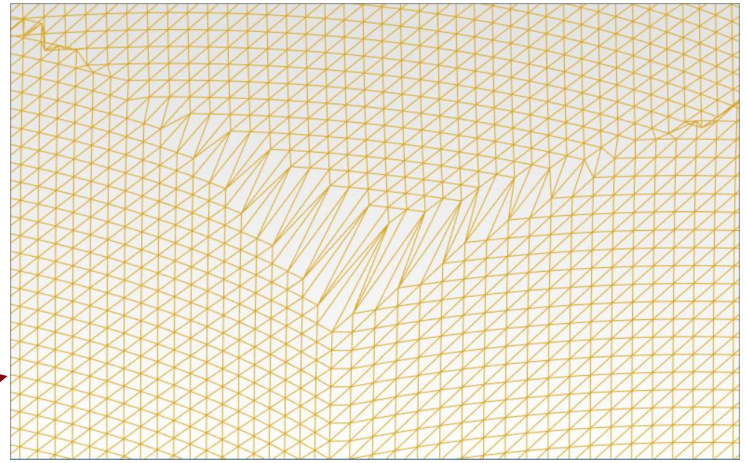
Accuracy Factor: 5

Geometry – Wireframe Mode

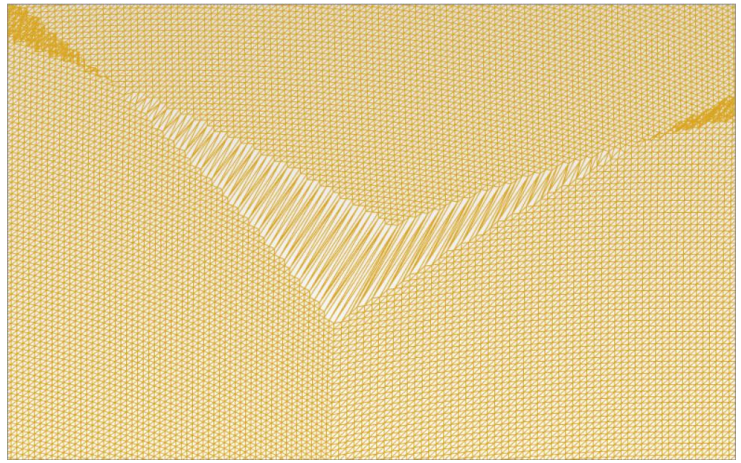


Activating the *Wireframe Mode* will display all surfaces in the system through their mesh. The *Accuracy Factor* will retain the same function in this mode.



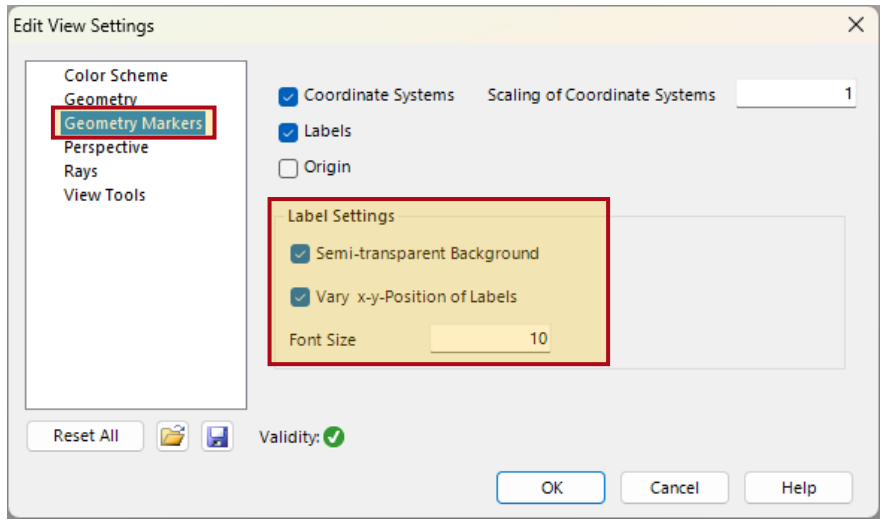


Accuracy Factor: 1

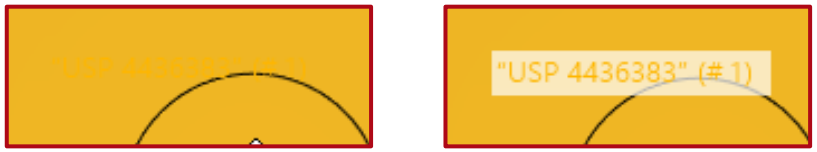


Accuracy Factor: 3

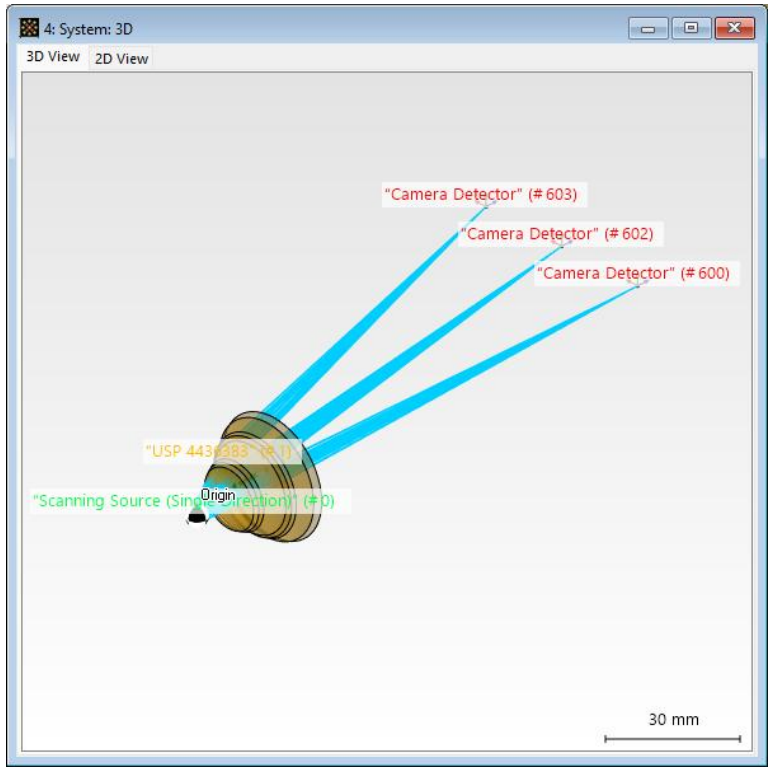
Geometry Markers

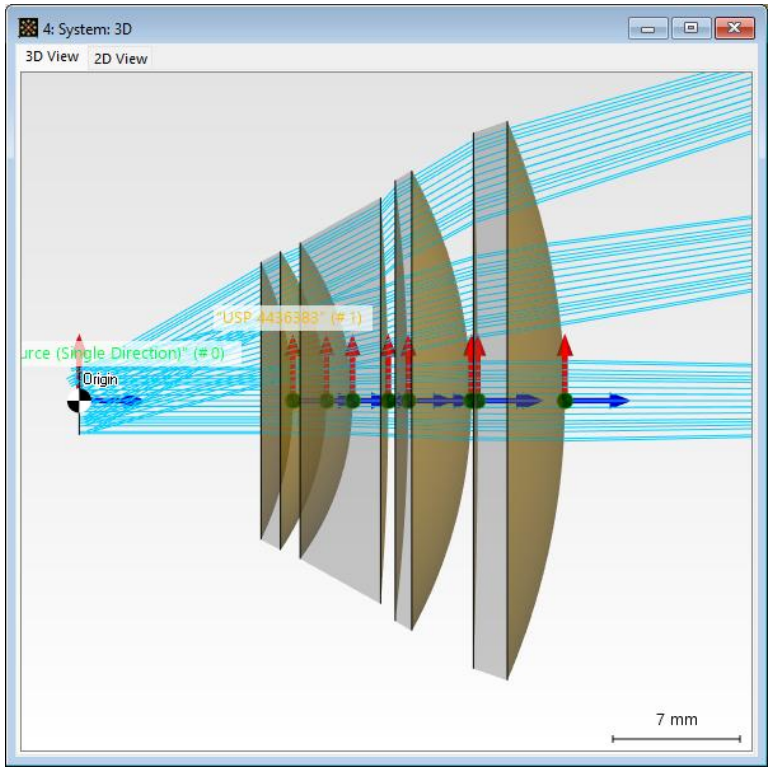


Semi-transparent Background on & off



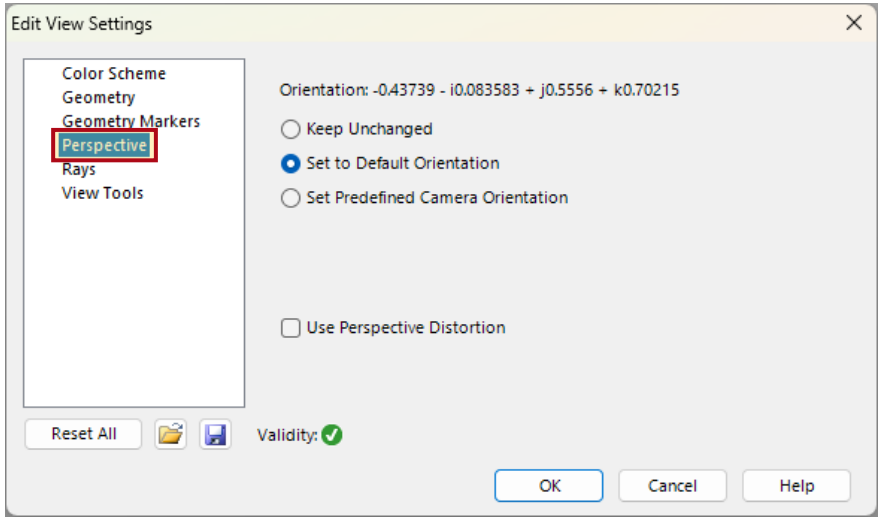
Vary x-y-Position of Labels on & off



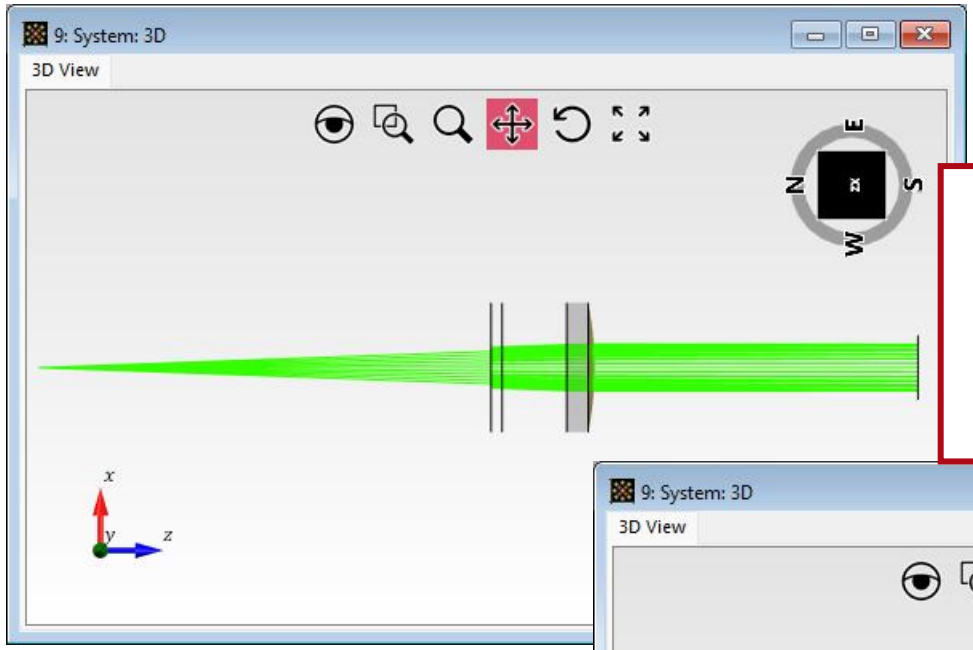


In the *Geometry Markers* panel the display of *Coordinate Systems*, as well as the *Labels* of the elements, can be enabled. In the visualization it is also possible to include the *Origin*, meaning the origin of the global coordinate system (source).

Perspective

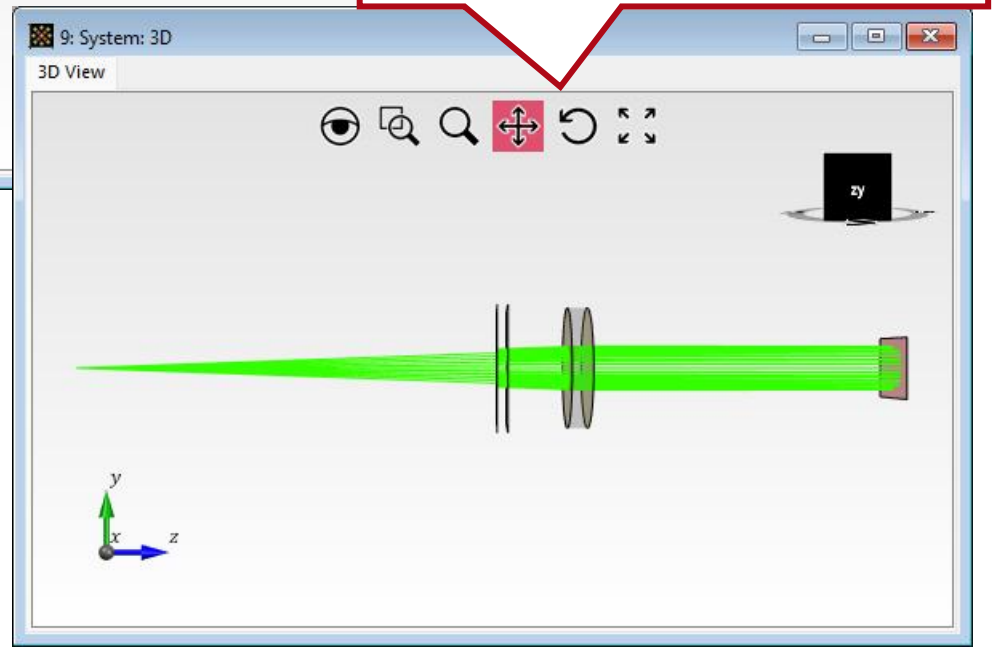


The *Perspective* sub-menu provides options to fix the camera orientation to a desired plane. The current camera orientation is highlighted in the top right corner of the document if the tool *View Cube* is active. Through the control *Use Perspective Distortion,* it is possible to highlight certain planes in the optical setup.



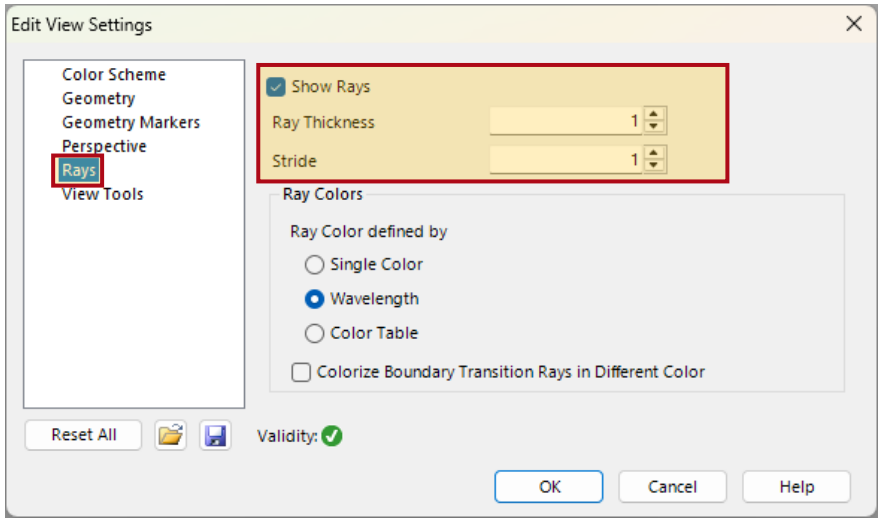
without *Use Perspective Distortion*

Note: While a pre-defined camera orientation will adjust the view to the specified plane, the user can still rotate the view by using the rotation tool.



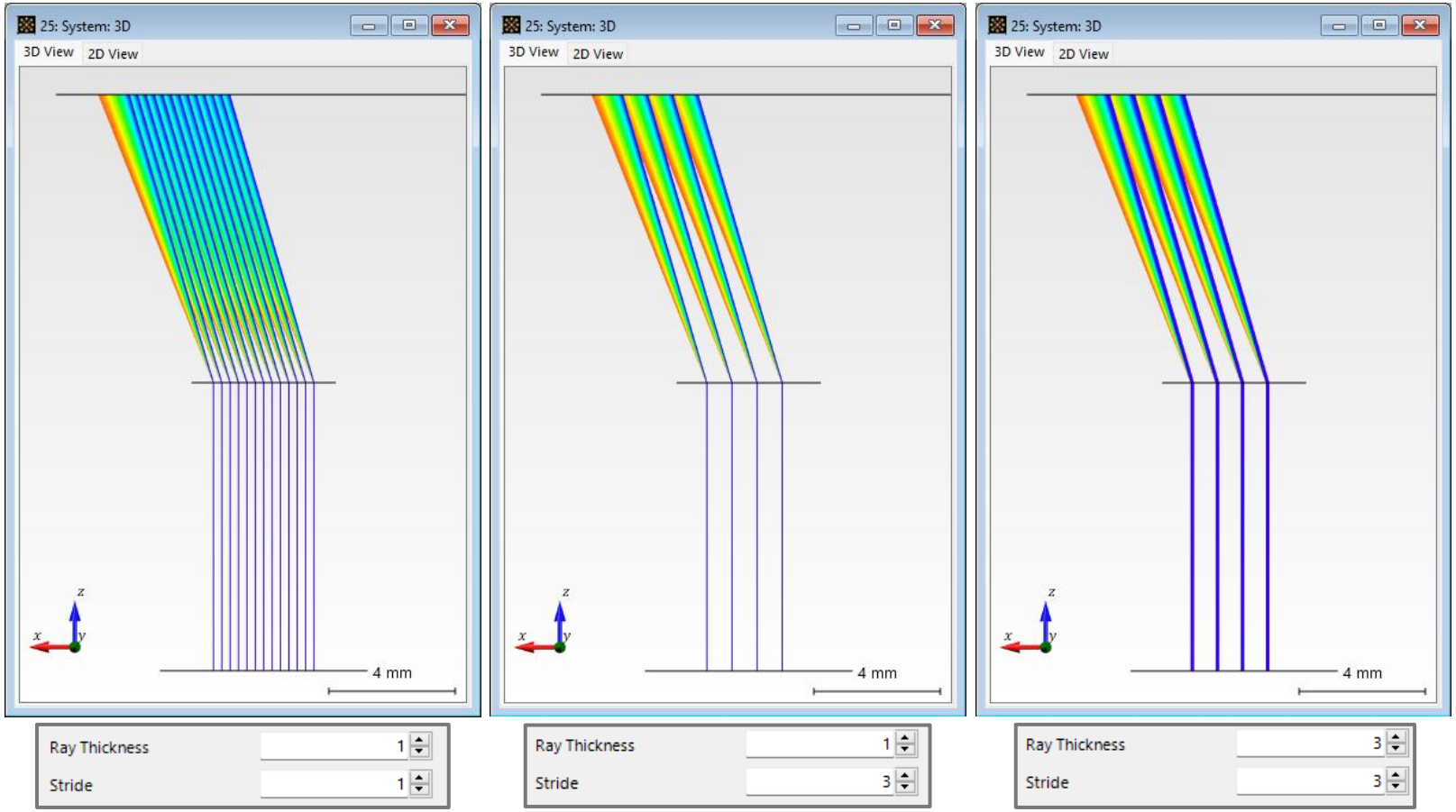
with *Use Perspective Distortion*

Ray Visualization



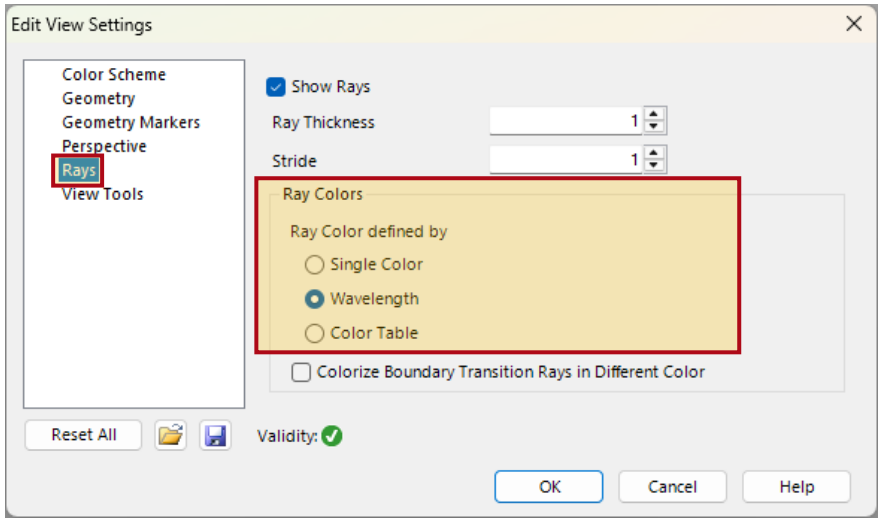
The depiction of rays, including their thickness and gap, can be set in the *Rays* tab of the menu.

example: ideal transmission grating – 1st order



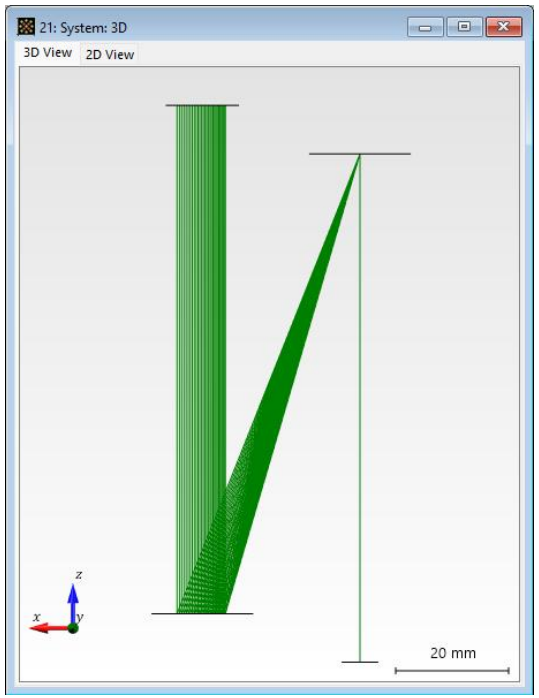
only available for *System: 3D (Ray Result Profile)*

Ray Visualization for Multiple Wavelengths

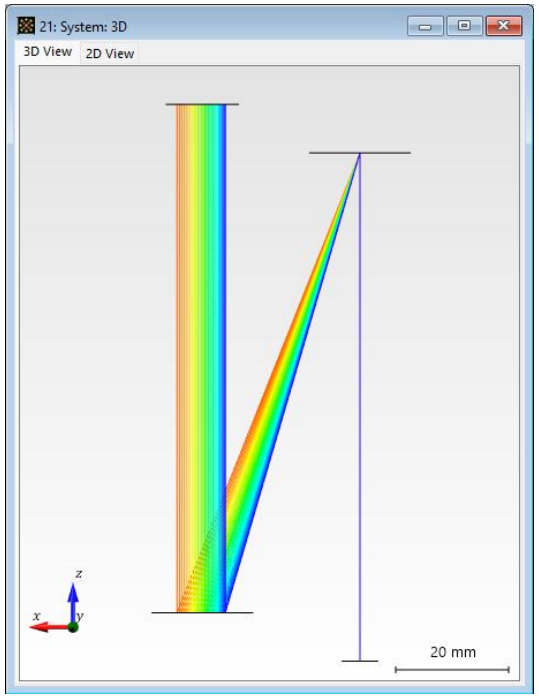


For optical systems with multi-wavelength or multi-mode sources, it is also possible to depict the rays according to their wavelength or mode using the real color of the wavelength or a color table.

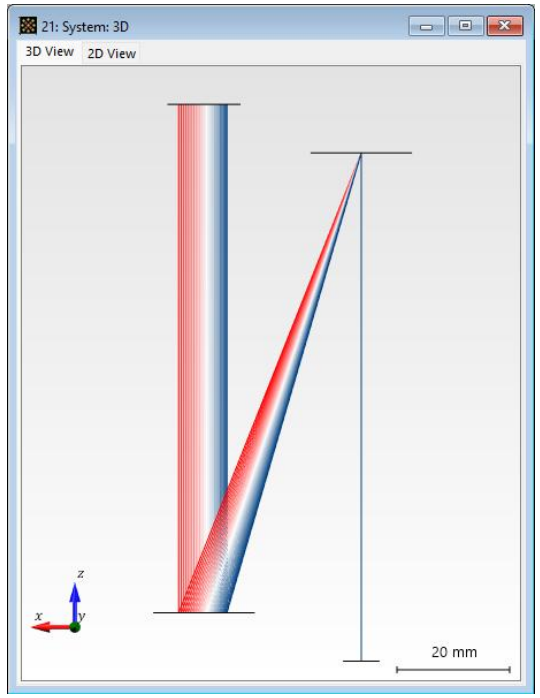
example: ideal reflection grating doublet – 1st order



Single Color



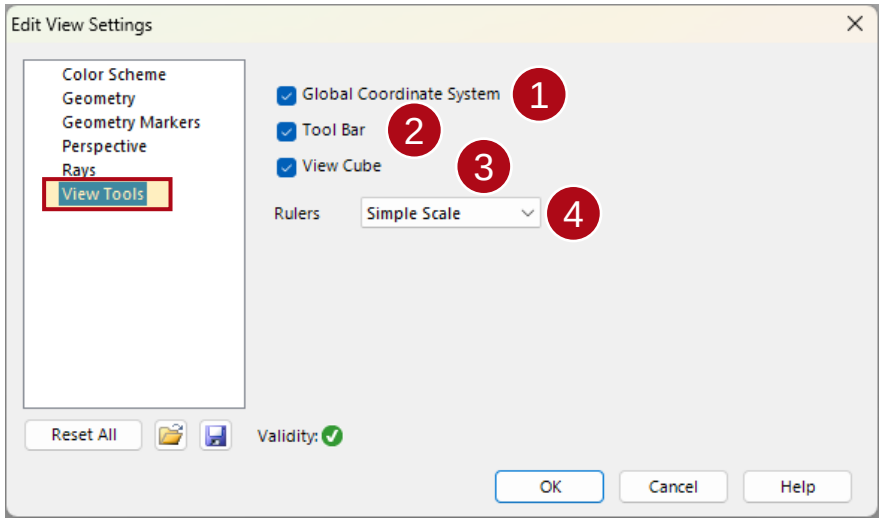
Wavelength



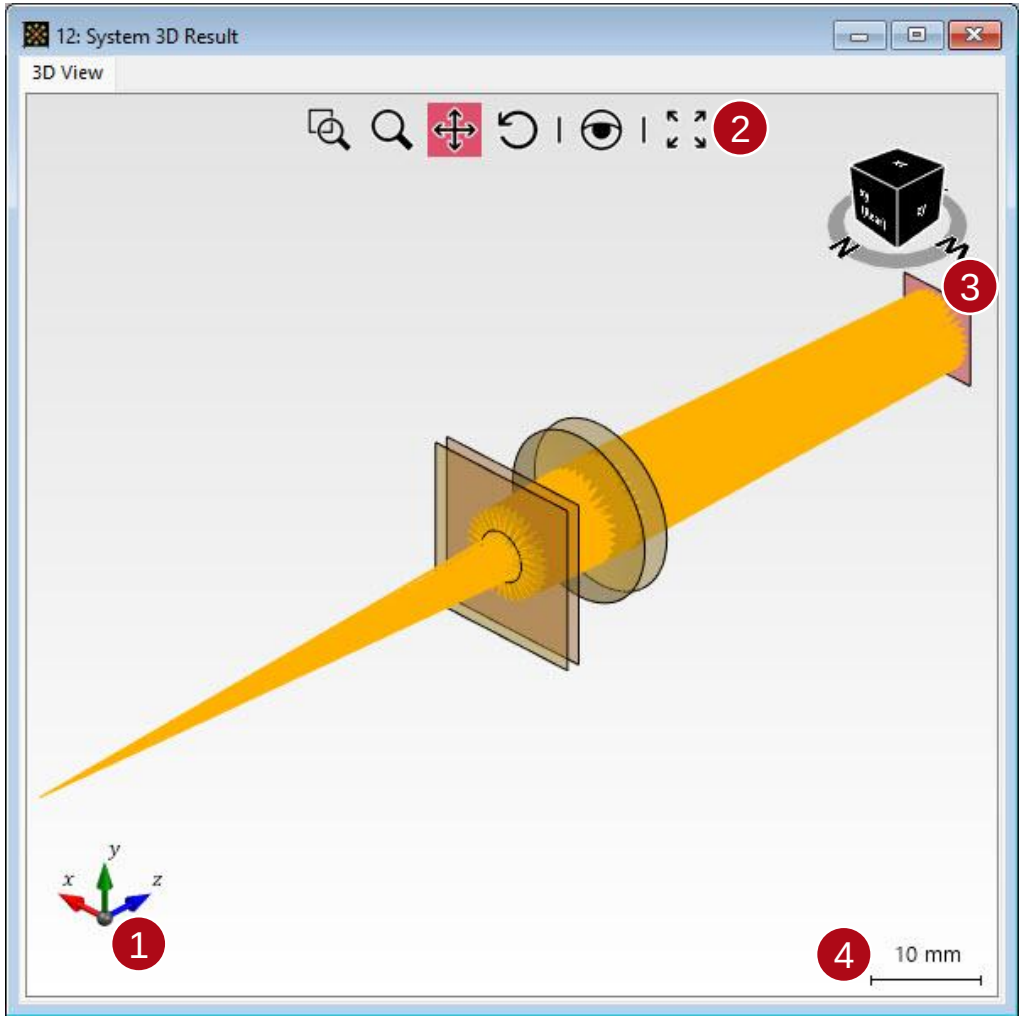
Color Table

only available for *System: 3D (Ray Result Profile)*

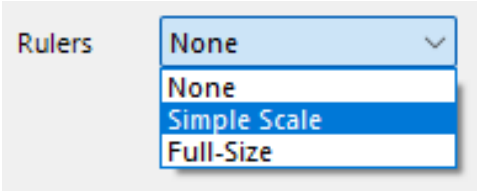
View Tools



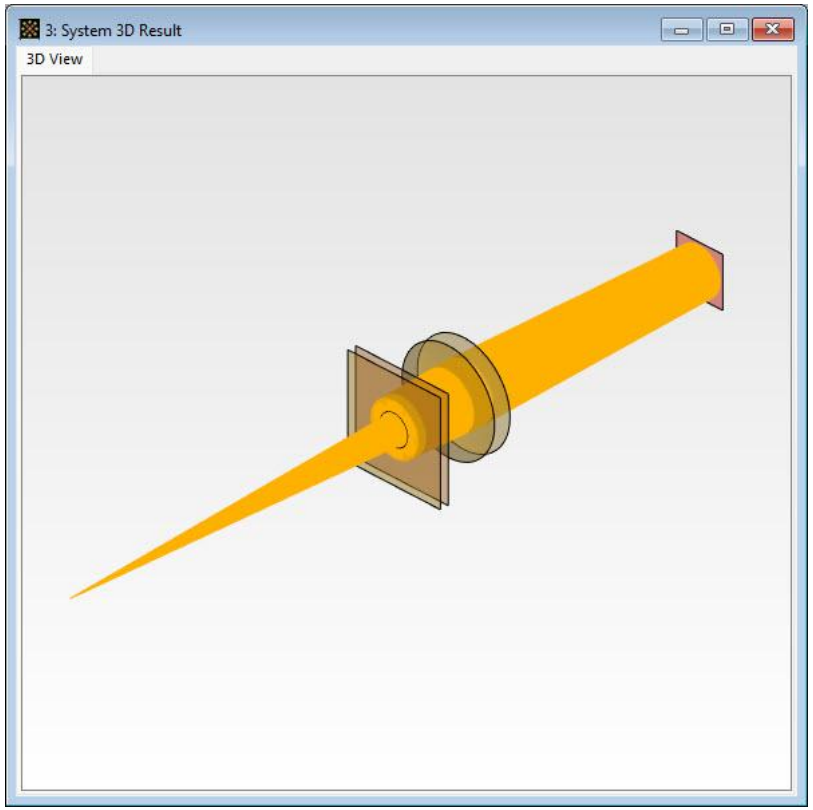
The panel *View Tools* provides helpful options to display or omit information in the document window, such as the *Global Coordinate System* (1), the *Tool Bar* (2), the *View Cube* (3) and the *Ruler* (4).



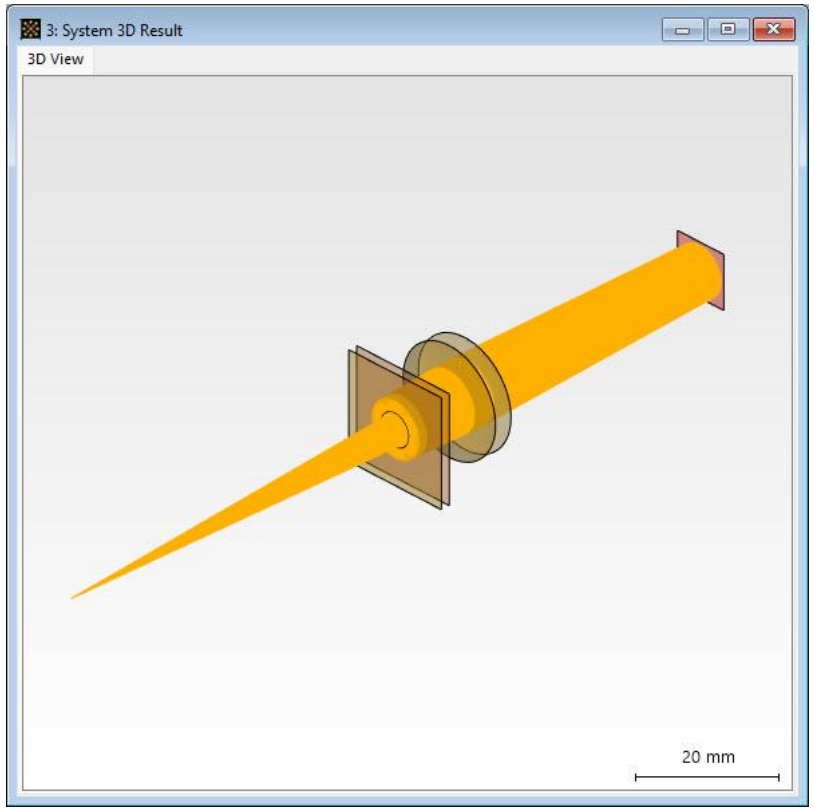
View Tools – Ruler



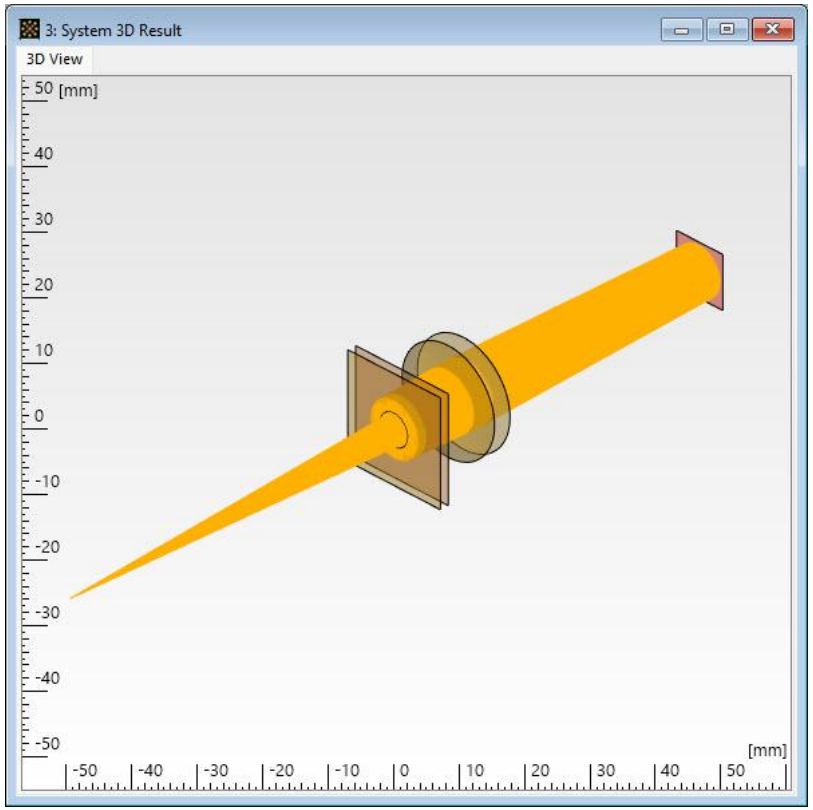
The different options for the *Ruler* include a simple and a full-size version. It is also possible to turn it off completely.



None



Simple Scale

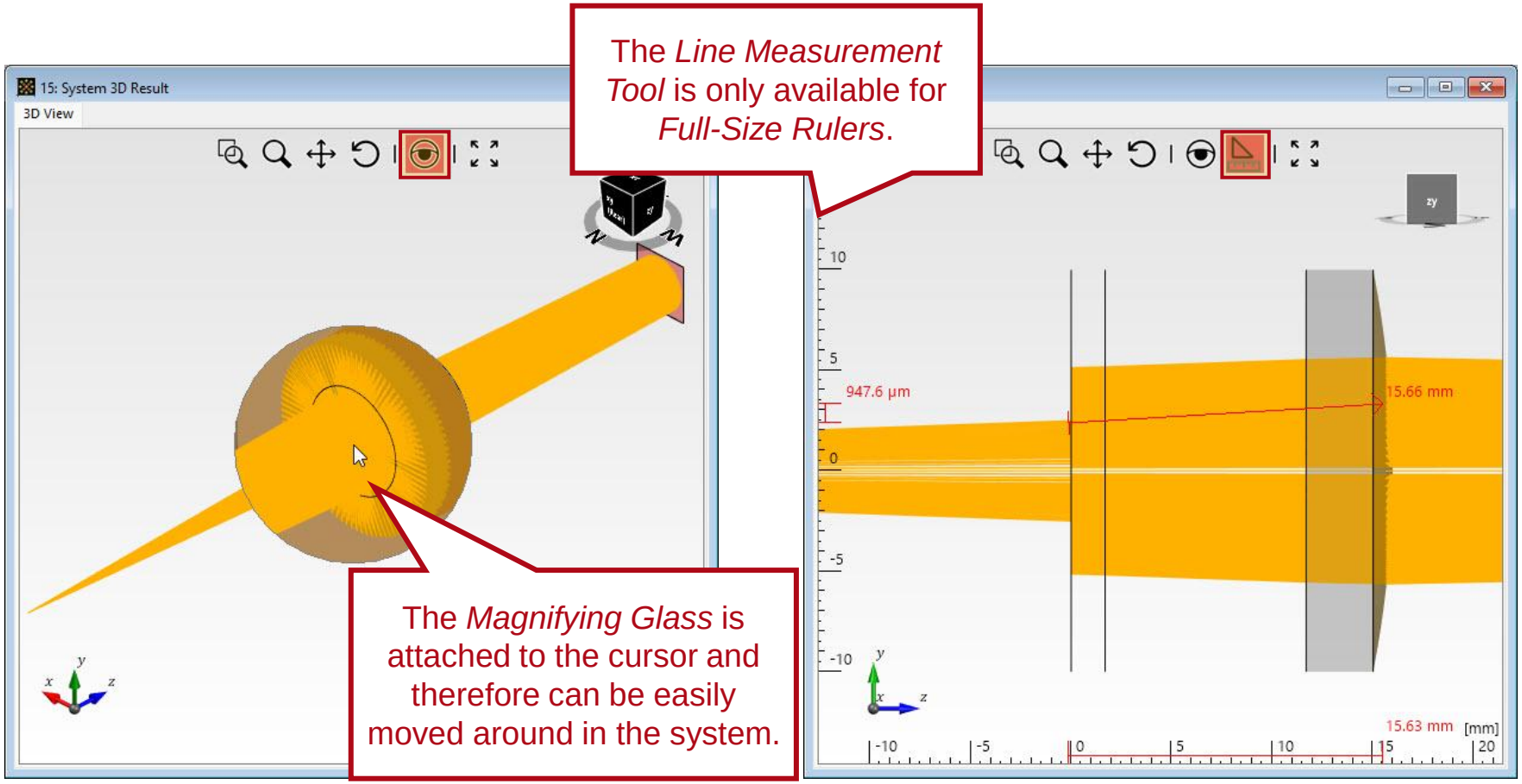


Full-Size

Tips for Positioning

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

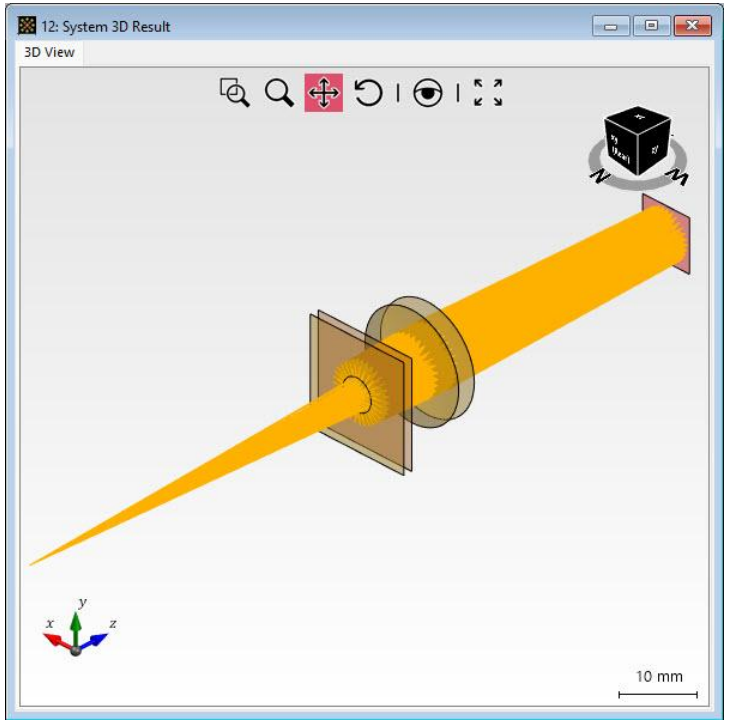
- Hold Ctrl while measuring to snap to perfect horizontal/ vertical alignment.
- Ctrl + Double Click instantly sets markers to visible data ranges.

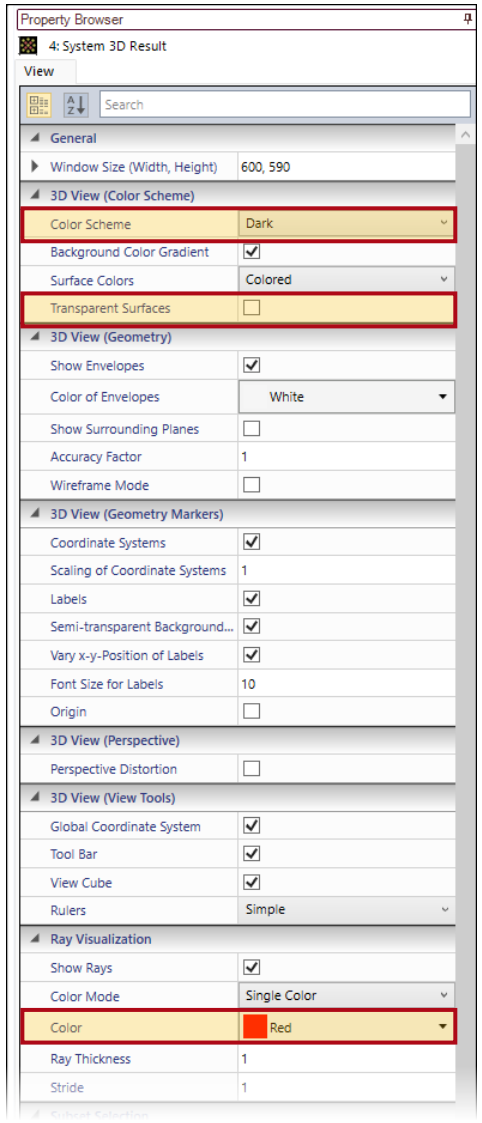


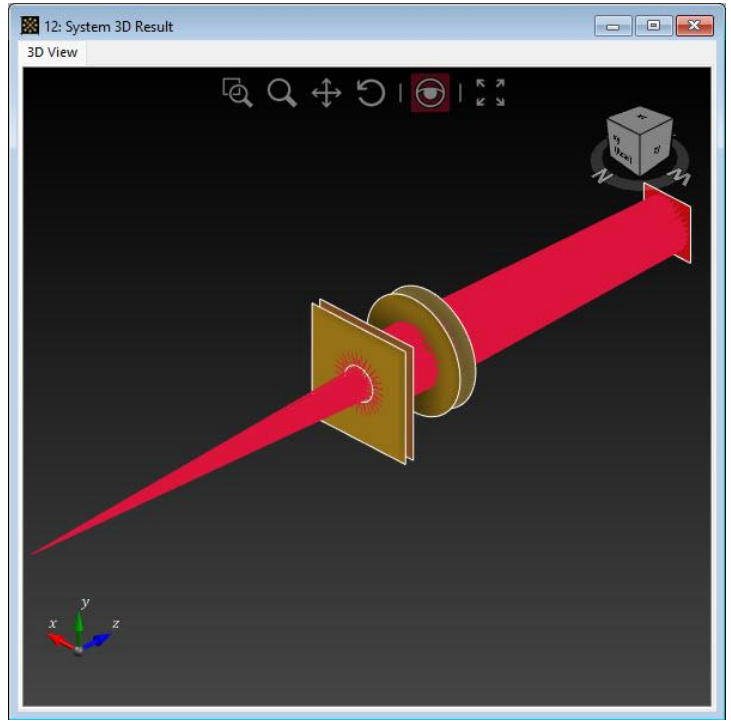
Use the *Magnifying Glass* in the *Tool Bar* to zoom into details without changing the actual system view.

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

Tips for Fast Access

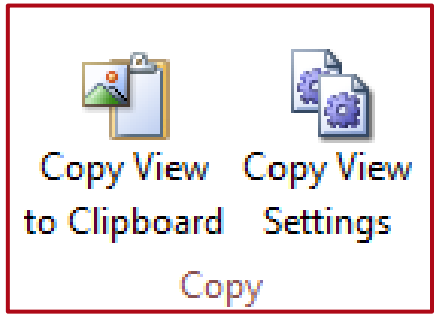






Most options can be quickly accessed via the *Property Browser*.

In the *View* ribbon, you will also find tools to quickly copy settings from one document to another.



Document Information

Title	3D Visualization of Optical Systems
Document code	TUT.0333
Publication date	08.07.2025
Required packages	-
Software version	2025.1 (Build 1.172)*
Category	Tutorial
Further reading	• Configuring Your Simulation in VirtualLab Fusion • Performance Evaluation of an F-Theta Scanning Lens • Examination of Sodium D Lines with Etalon

* *The files attached to this document require the specific version or later.*