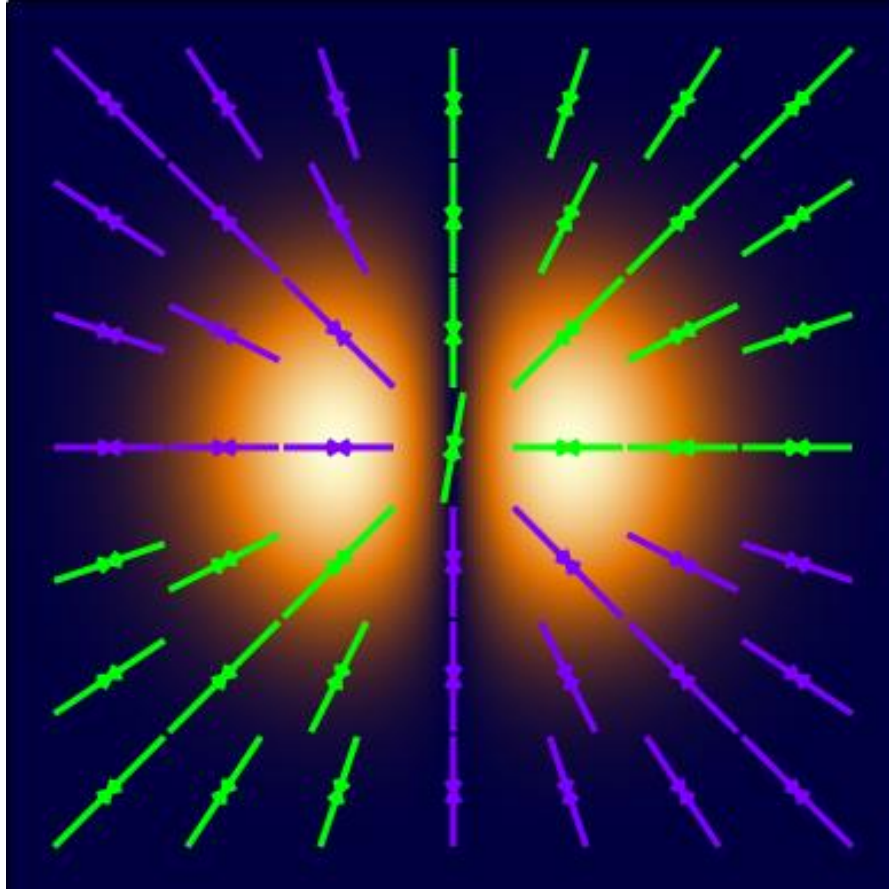


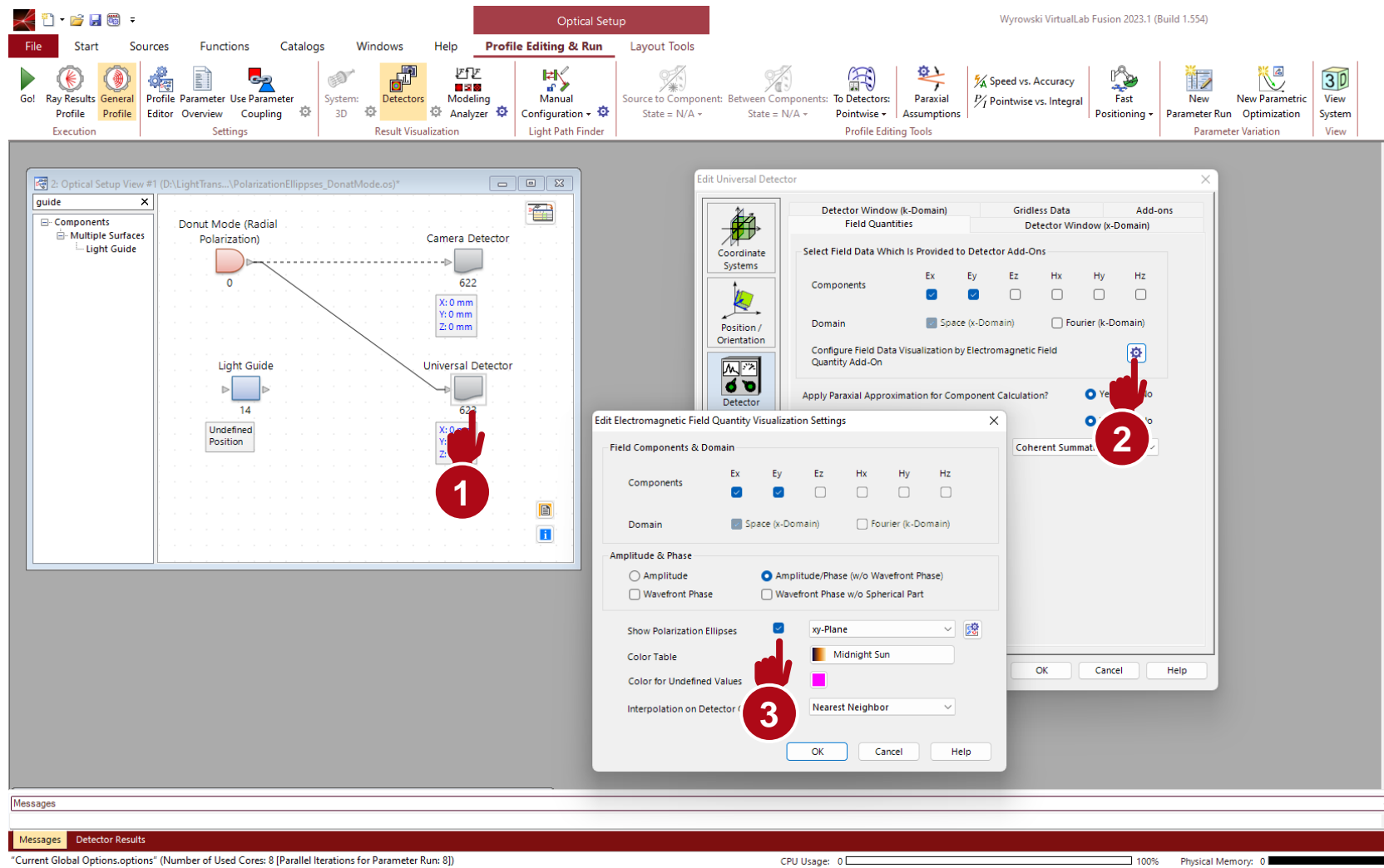
Polarization Ellipses

Abstract



As light is more than just power and flux, the full vectorial representation as electromagnetic wave in VirtualLab Fusion enables to reveal all its characteristics. One parameter that is of high interest in modern applications, is the polarization state at certain locations inside the regarding optical system. In order to visualize the polarization state of a considered complex wave in a depictive way, VirtualLab Fusion utilizes so-called polarization ellipses. This visualization option indicates the strength and type of polarization for waves that comprise at least two field components. Moreover, various options to customize the shown ellipses in color, size, etc. are available.

How to Visualize the Polarization State of Light – Detector



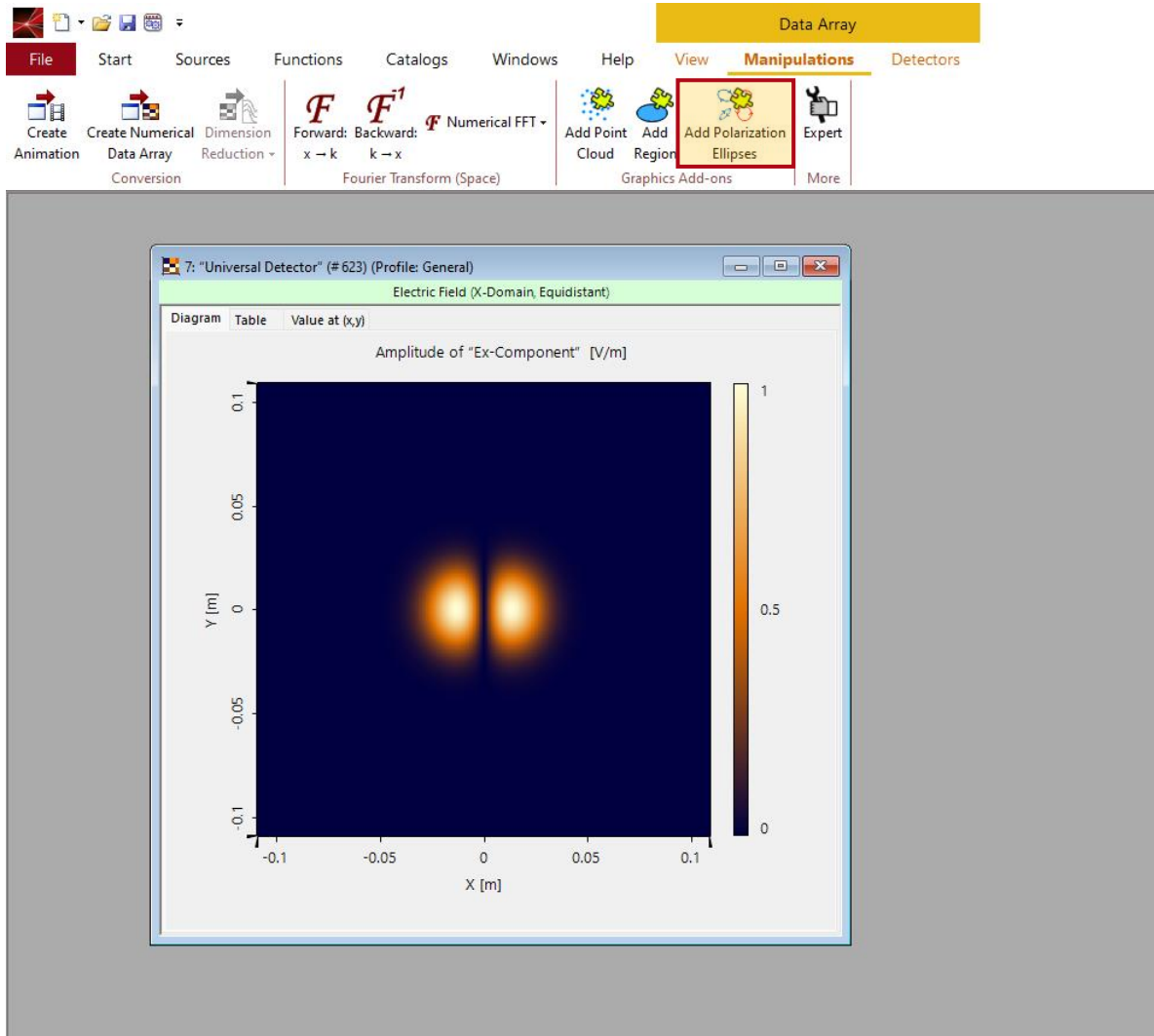
The *Universal Detector* enables to visualize the polarization of light by polarization ellipses. The corresponding option can be found in the settings dialog of the *Electromagnetic Field Quantity Add-on*.

Please note, that for the visualization a field with at least two components is required and detected.

More information for the *Universal Detector* under:

 [Universal Detector](#)

How to Visualize the Polarization State of Light – Data Array



It is also possible to retroactively visualize the polarization state of light, represented as *Data Array*, where at least two field components are stored in subsets.

This can be done by using the *Add Polarization Ellipses* option in the *Graphic Add-ons* section of the *Manipulations* ribbon.

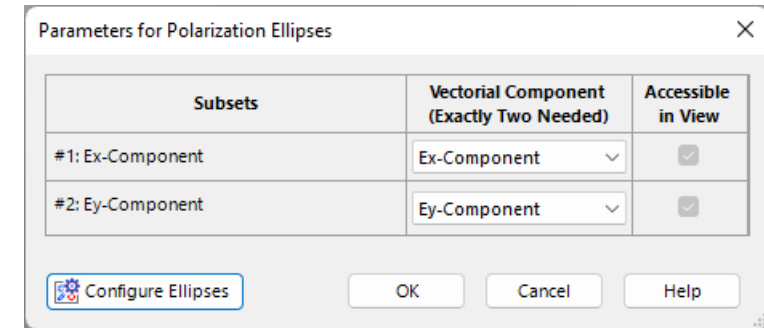
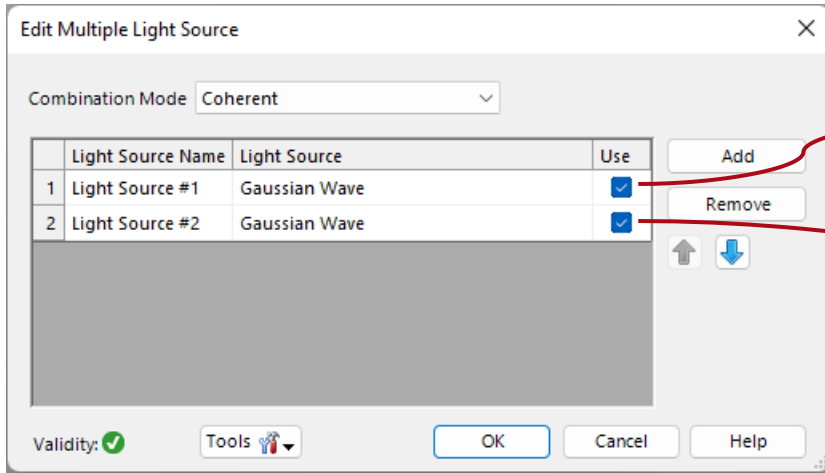


Illustration Example



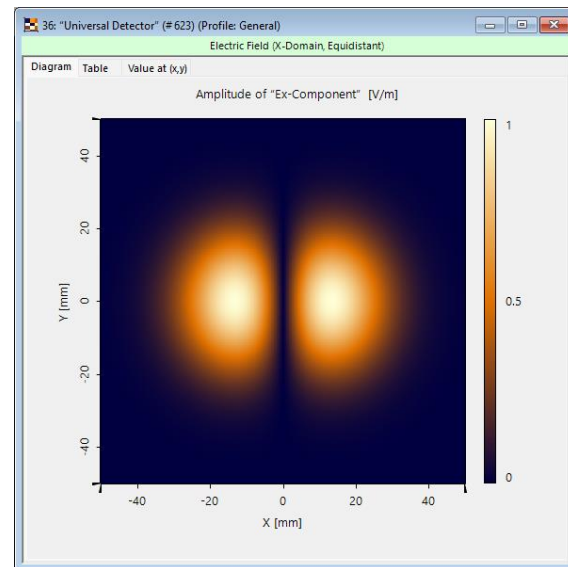
Normalized Jones Vector

$$\begin{pmatrix} J_x \\ J_y \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

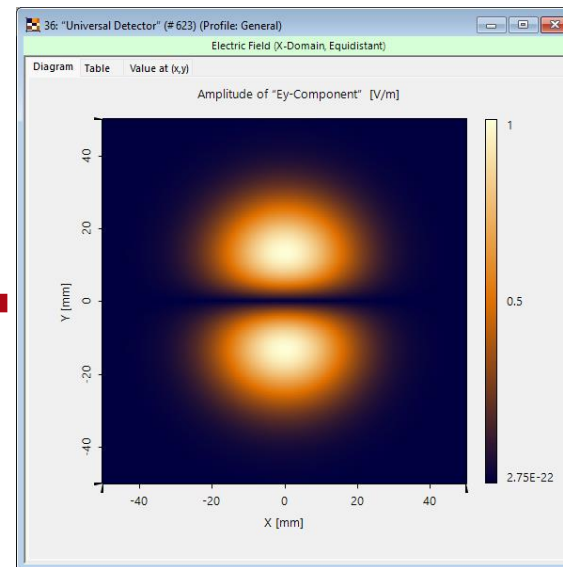
Normalized Jones Vector

$$\begin{pmatrix} J_x \\ J_y \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

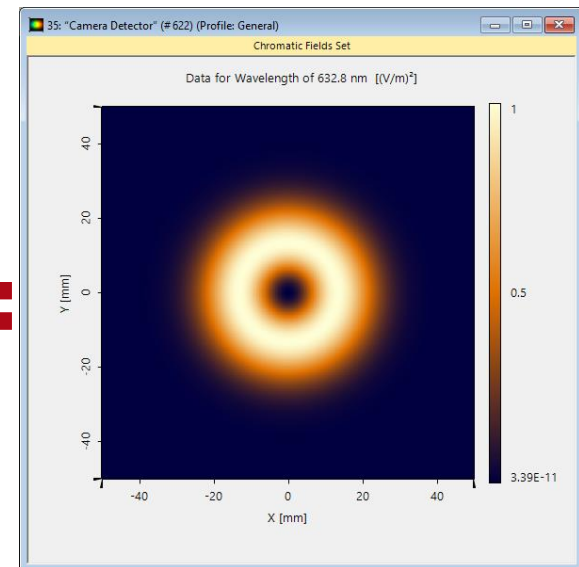
For the demonstration of the available features of this tool, a donut mode is used, that consists of two Hermite gaussian (1,0) modes (one is linearly polarized in x and the other in y-direction).



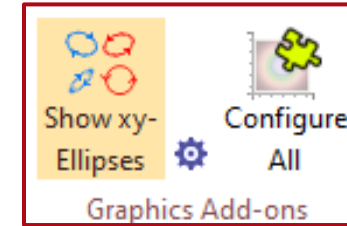
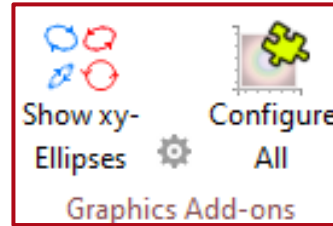
+



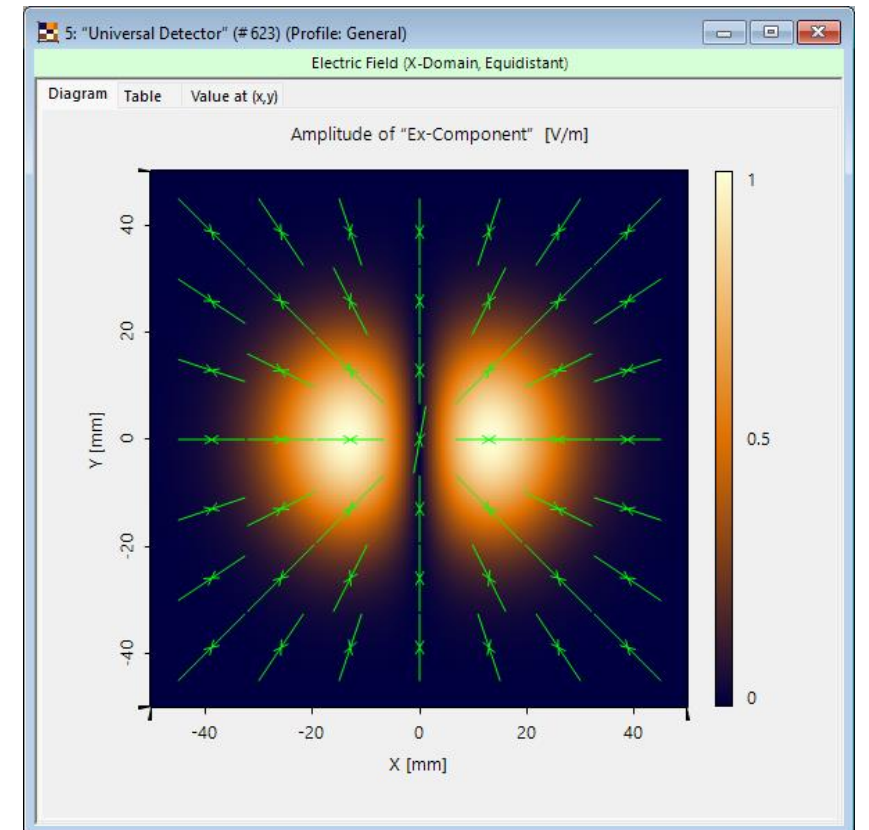
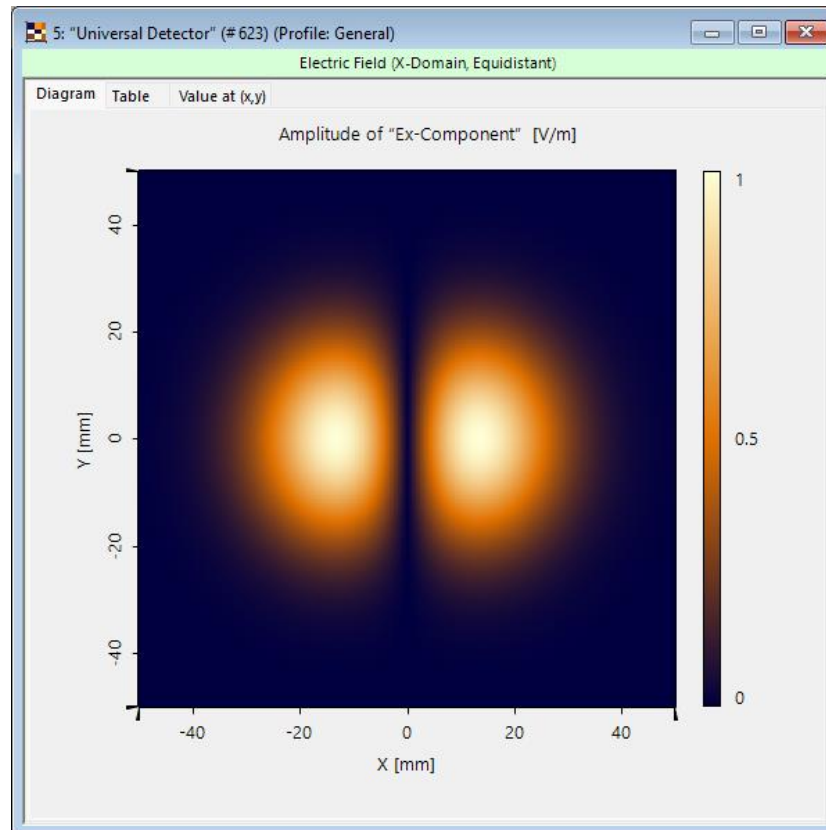
=



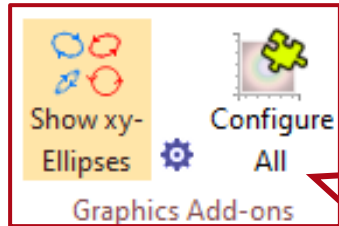
Polarization Ellipses Graphic Add-on



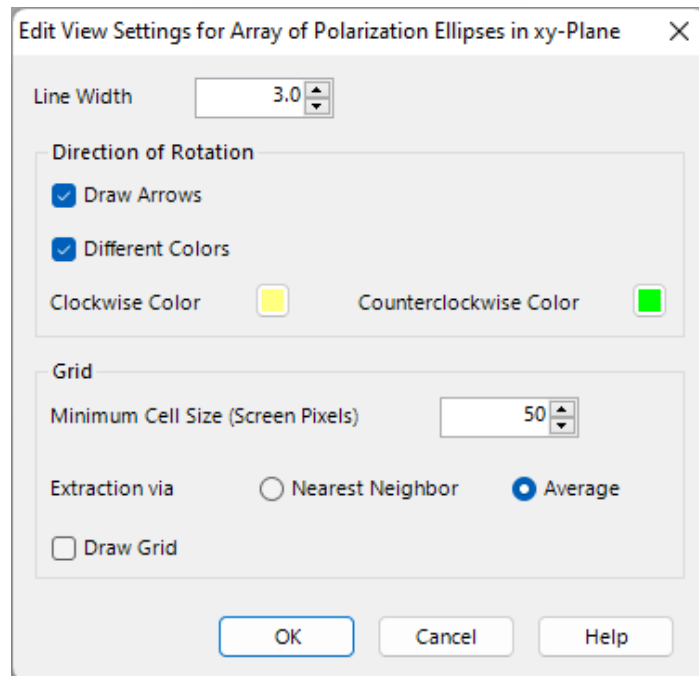
The Jones vector generated by this source is radially symmetric around the origin. This can be shown in the field data directly by using the function *Show xy-Ellipses* found in the *Graphics Add-ons* section of the *View* ribbon.



Visualization Options – Polarization Ellipses



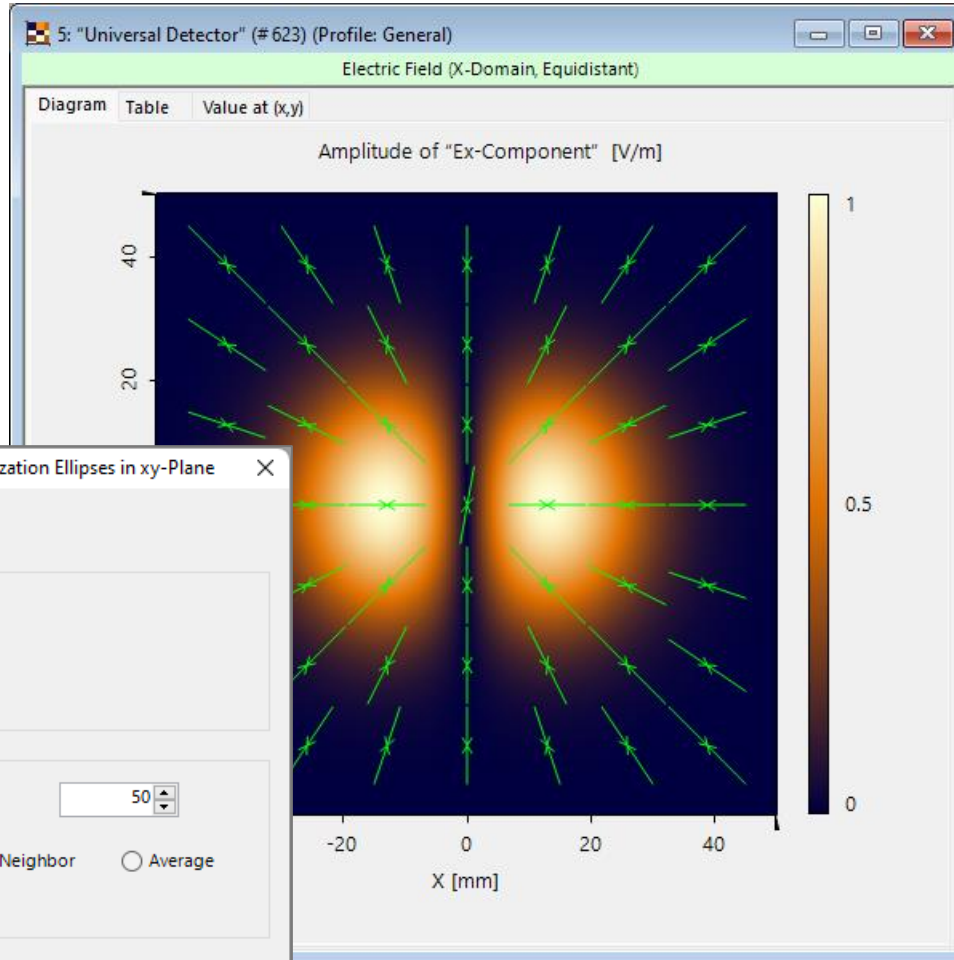
The visualization options for the polarization ellipses can be accessed from the main menu by clicking on the small blue cog wheel or by clicking on *Configure All*.



The *Graphic Add-on* can be customized in various ways, including changing the thickness and color of the lines. It is also possible to add small arrows and use two different colors to visually distinct clockwise and counterclockwise orientation.

Finally, the *Minimum Cell Size (Screen Pixels)* parameter determines how many detector pixels shall be grouped together for the visualization of a single polarization ellipse, as in most cases it is too confusing to display one ellipse per sampling point. For visual impressions of the options, please have a look on the following pages.

Configuration – Change Line Thickness



Edit View Settings for Array of Polarization Ellipses in xy-Plane

Line Width

Direction of Rotation

- Draw Arrows
- Different Colors
- Ellipse Color

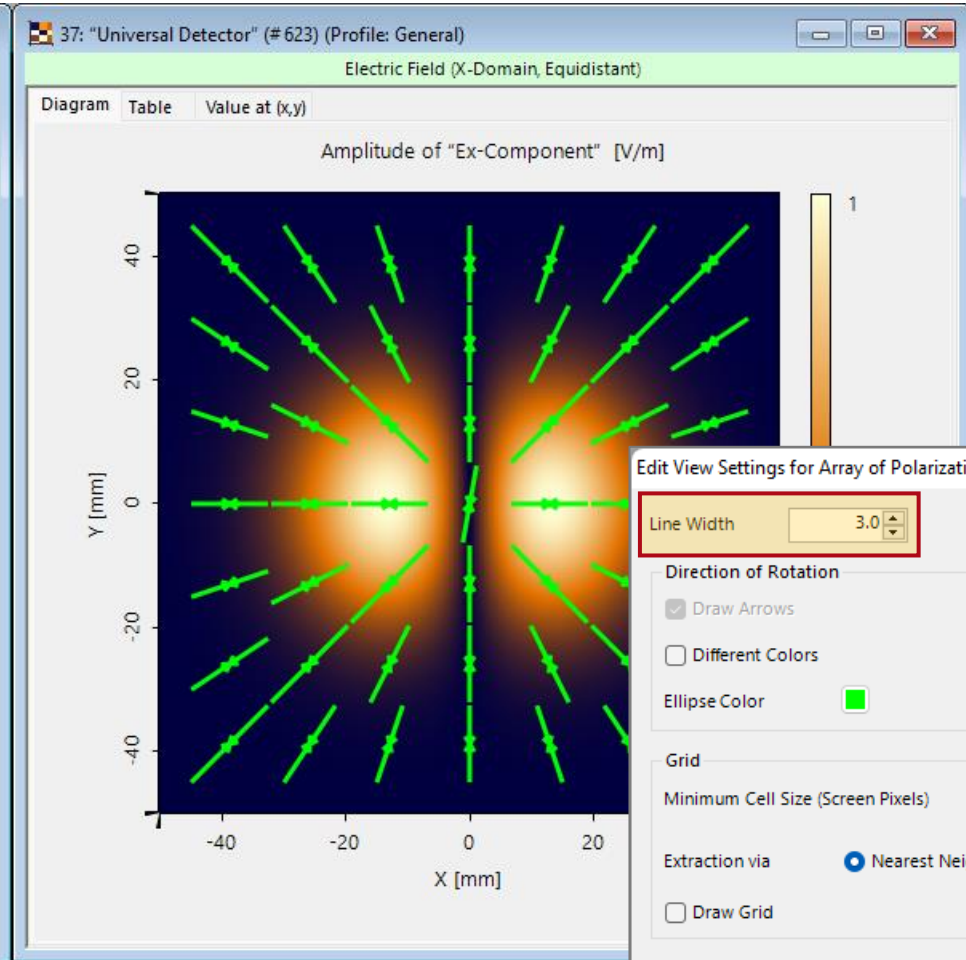
Grid

Minimum Cell Size (Screen Pixels)

Extraction via Nearest Neighbor Average

Draw Grid

OK Cancel Help



Edit View Settings for Array of Polarization Ellipses in xy-Plane

Line Width

Direction of Rotation

- Draw Arrows
- Different Colors
- Ellipse Color

Grid

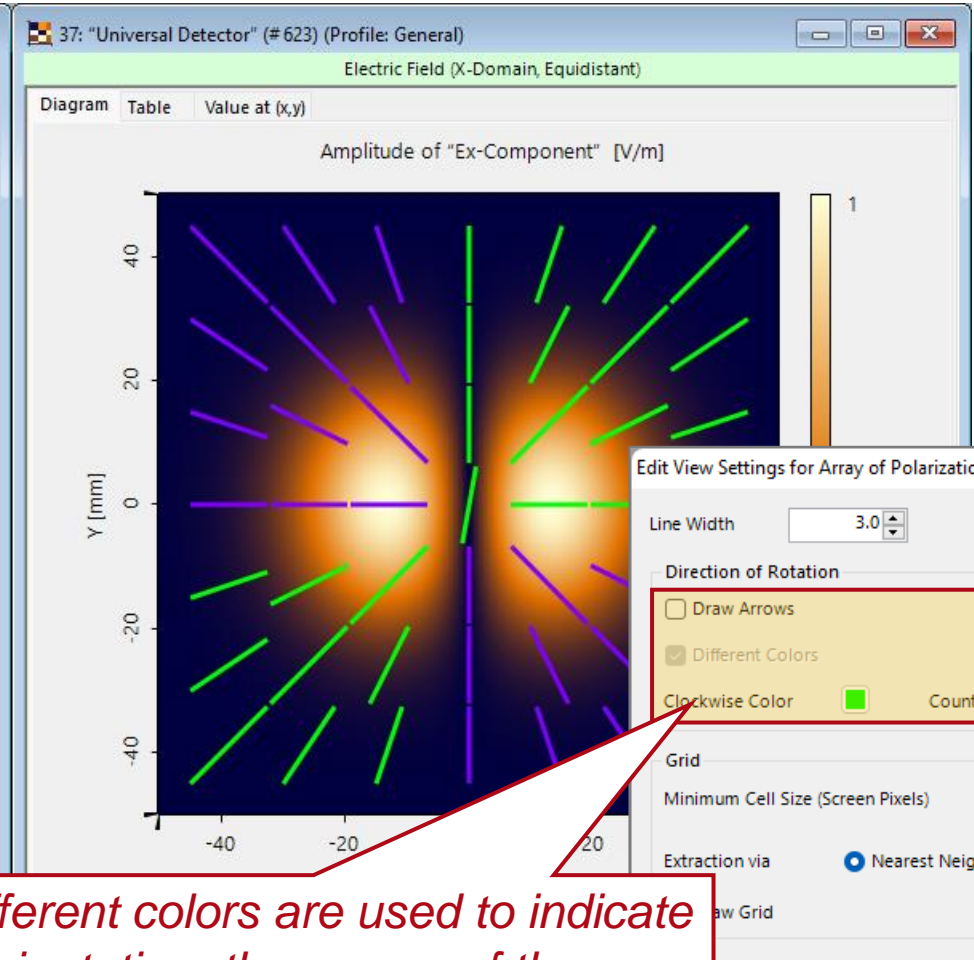
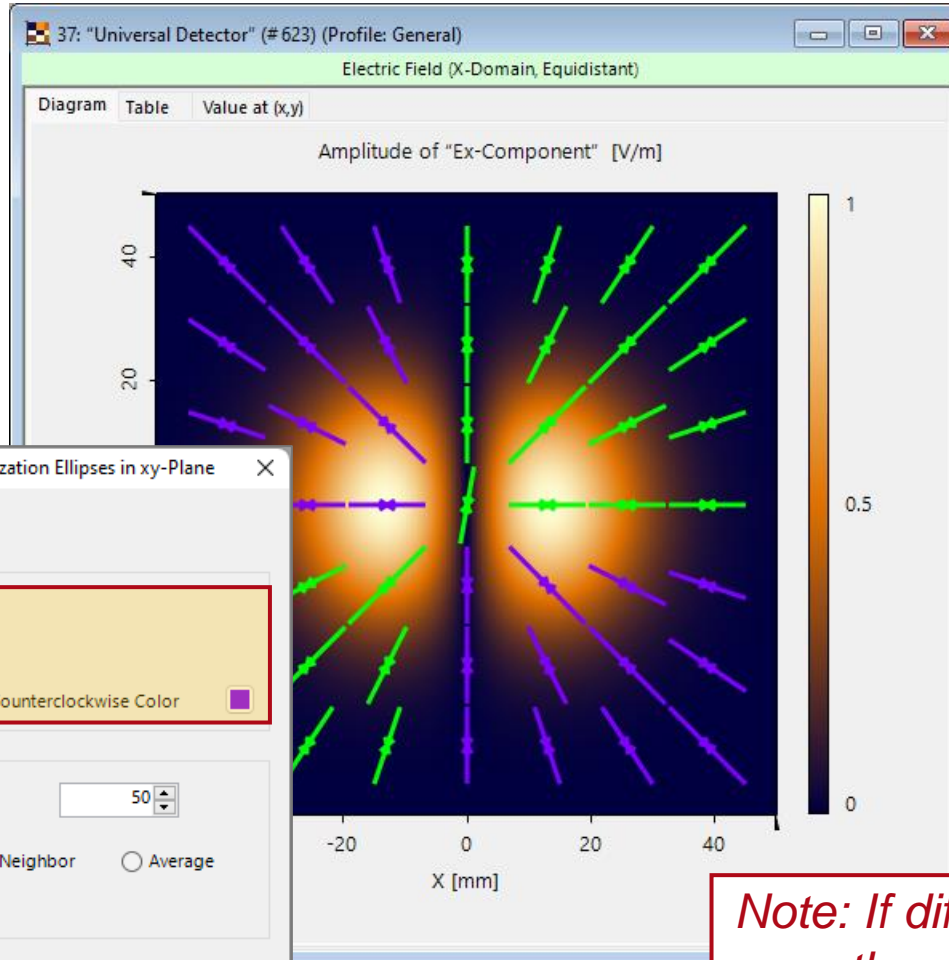
Minimum Cell Size (Screen Pixels)

Extraction via Nearest Neighbor Average

Draw Grid

OK Cancel Help

Configuration – Different Colors for Orientation



Edit View Settings for Array of Polarization Ellipses in xy-Plane

Line Width

Direction of Rotation

- Draw Arrows
- Different Colors

Clockwise Color Counterclockwise Color

Grid

Minimum Cell Size (Screen Pixels)

Extraction via Nearest Neighbor Average

Draw Grid

OK Cancel Help

Edit View Settings for Array of Polarization Ellipses in xy-Plane

Line Width

Direction of Rotation

- Draw Arrows
- Different Colors

Clockwise Color Counterclockwise Color

Grid

Minimum Cell Size (Screen Pixels)

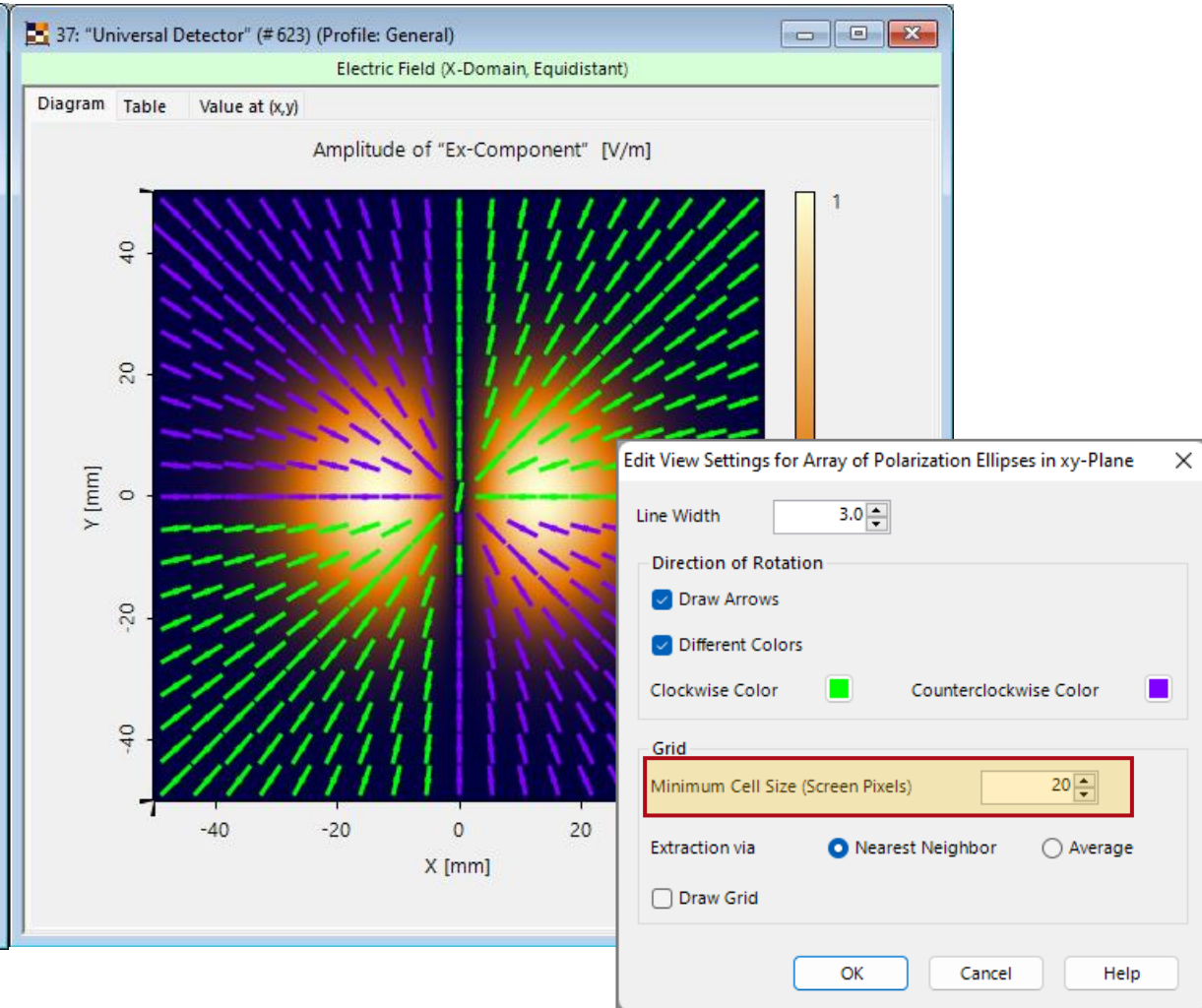
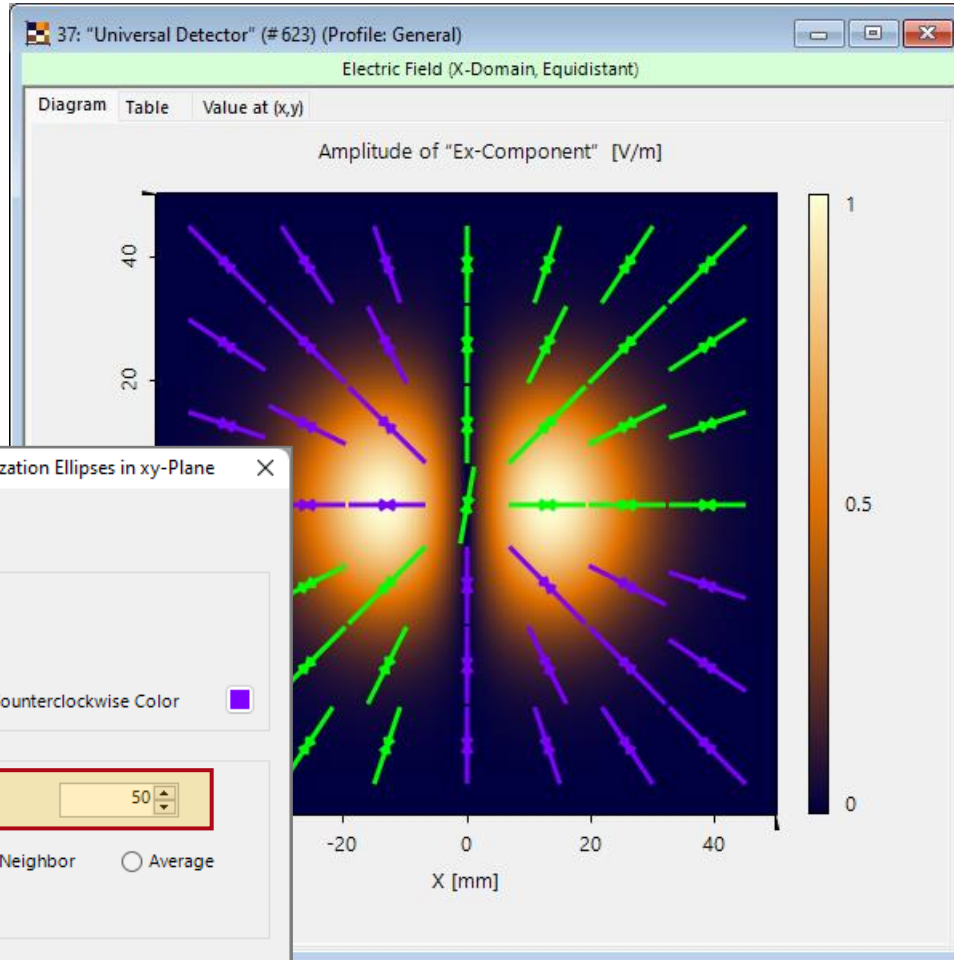
Extraction via Nearest Neighbor Average

Draw Grid

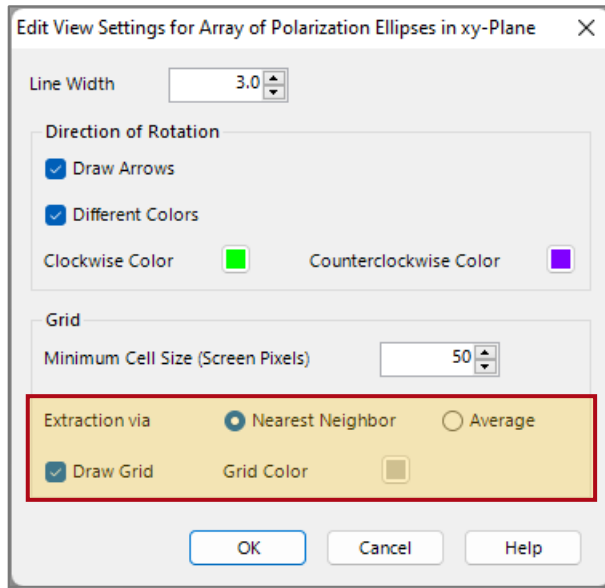
OK Cancel Help

Note: If different colors are used to indicate the orientation, the arrows of the polarization ellipses can be deactivated.

Configuration – Minimum Cell Size

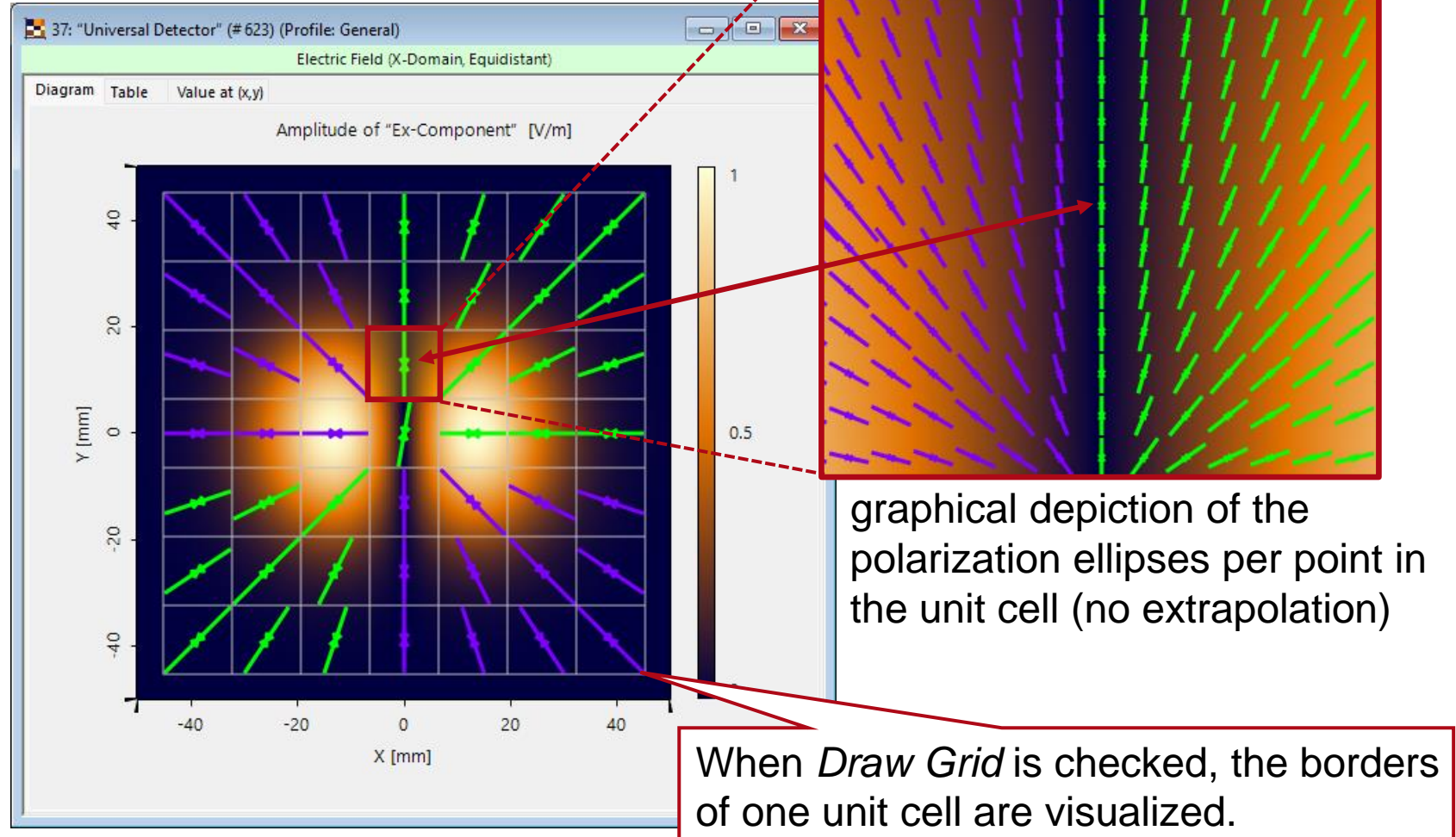


Extrapolation Info – Nearest Neighbor

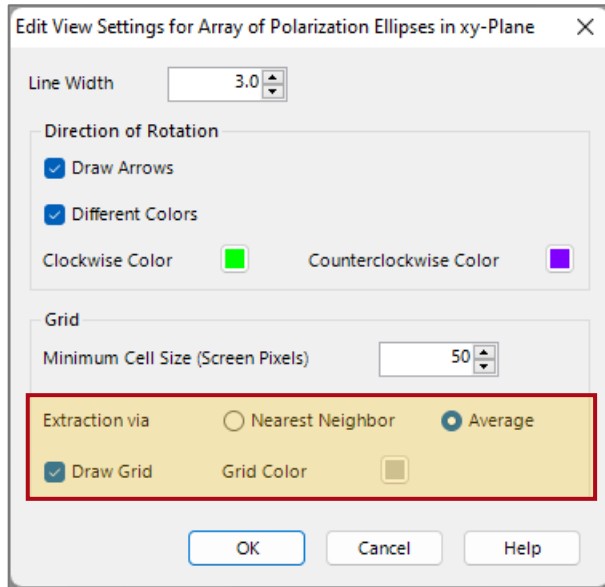


There are two options to extrapolate the polarization ellipses from a unit cell. If the option *Nearest Neighbor* is chosen, only the polarization ellipse that belongs to the point closest to the center of the unit cell will be shown.

extrapolated ellipses

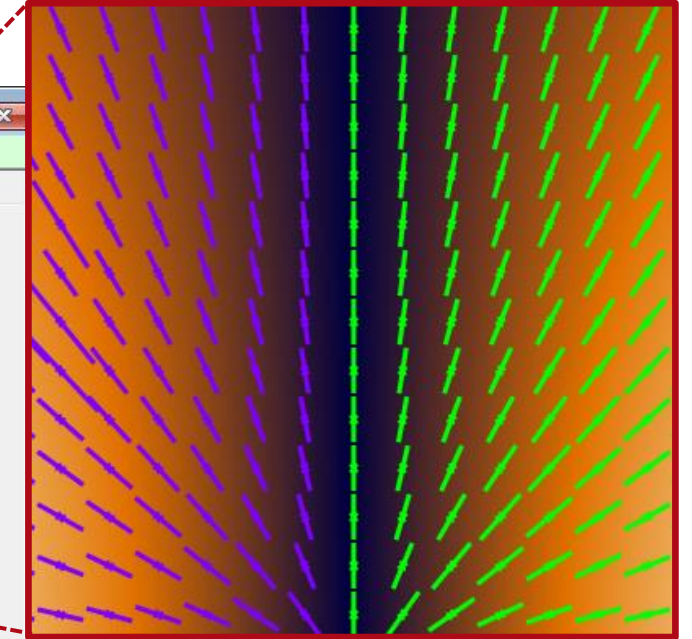
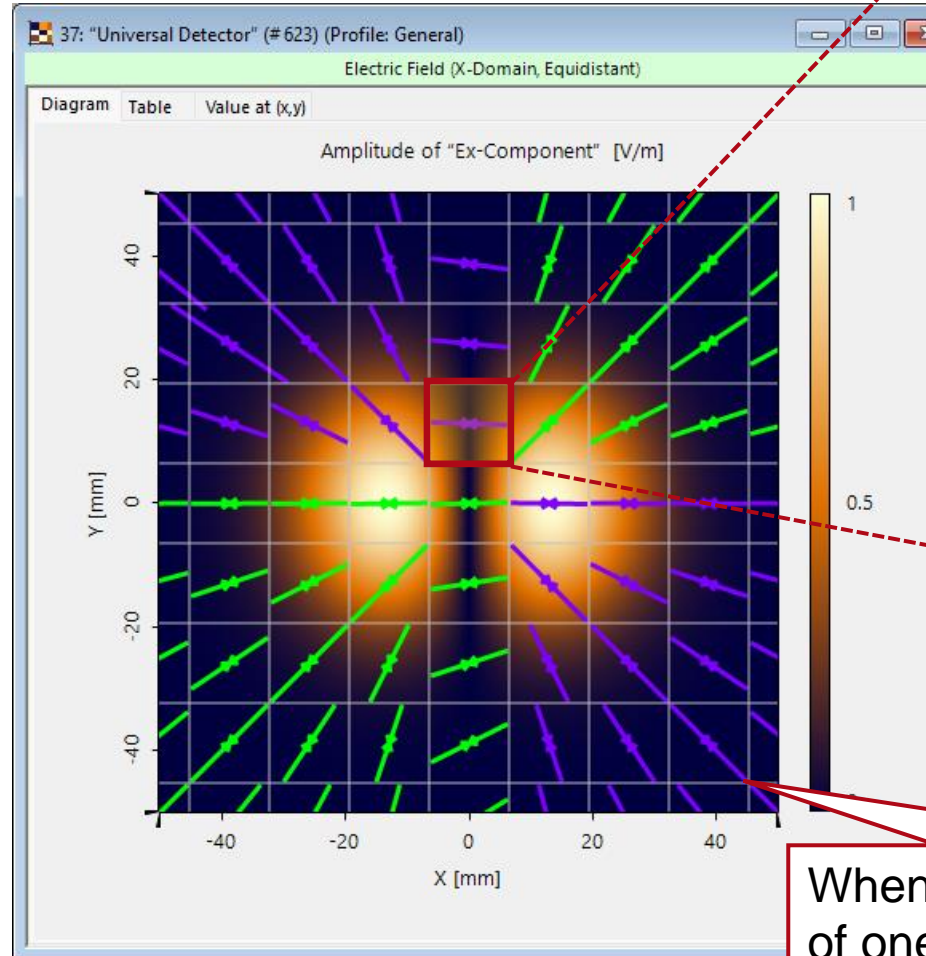


Extrapolation Info – Average



If *Average* is chosen instead, the Jones vectors of all points inside the unit cell will be averaged. This value then will be used to visualize the polarization ellipse of the entire unit cell.

extrapolated ellipses



graphical depiction of the polarization ellipses per point in the unit cell (no extrapolation)

When *Draw Grid* is checked, the borders of one unit cell are visualized.

Document Information

title	Polarization Ellipses
document code	SWF.0033
document version	1.1
software edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.556)
category	Feature Use Case
further reading	<ul style="list-style-type: none">• <u>Add Point Cloud Overlay to Data Array</u>• <u>Add Region Overlay to Data Array</u>• <u>Graphics Add-on</u>• <u>Universal Detector</u>