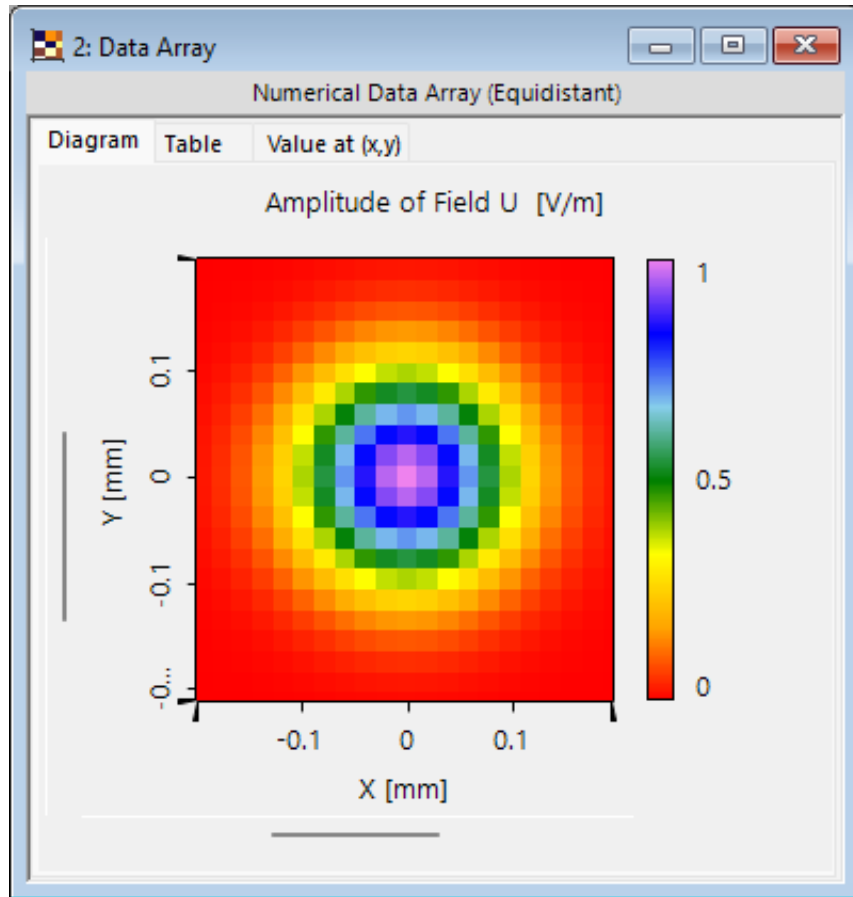


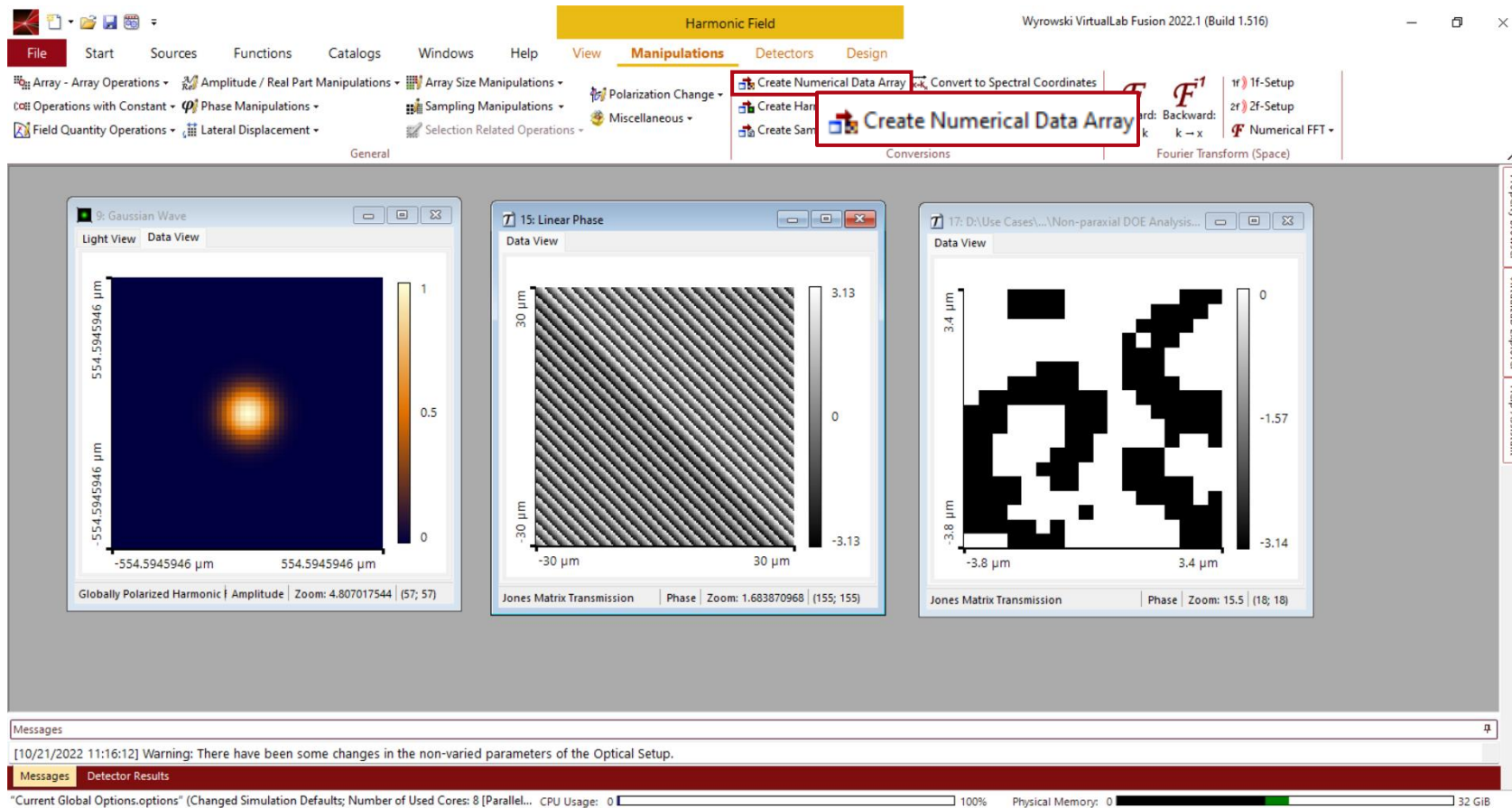
# Introduction to Data Arrays

# Abstract



Data arrays are the most fundamental native data type in VirtualLab Fusion. Being a generic data type, they are among the most flexible when it comes to introducing physical attributes, re-sampling and interpolation. Array computing is made easy thanks to VirtualLab Fusion's user-friendly GUI where users can perform operations without having to write for-loops. In this use case, we would like to introduce the basic tools to generate and configurate Data Arrays. This includes the specific main menu ribbons (views, manipulations and detectors) as well as the settings of the property browser.

# Generation of Data Arrays



*Data Arrays* are the fundamental representation of physical data that most of VirtualLab Fusion's results are based on, be they electromagnetic fields, phase transmission functions or Iterative Fourier Transform Algorithm (IFTA) results. Hence, most of these kind of documents can be transformed into a *Data Array* in one way or another.

In most cases there exists a *Create Numerical Data Array* option in the *Manipulations* tab.

# Data Arrays

The screenshot displays the software's main menu with a yellow banner labeled "Data Array" at the top. A red arrow points to this banner. Below the banner, the "Manipulations" and "View" menus are visible. Two windows are open: "18: Data Array created from '9: Gaussian Wave'" showing a 2D plot of "Amplitude of Field U [V/m]" and "20: Extracted 1D Data Array (18:)" showing a 1D plot of "Amplitude of Field U [V/m]" vs "X [mm]". A Messages window at the bottom shows a warning: "[10/21/2022 11:16:12] Warning: There have been some changes in the non-varied parameters of the Optical Setup."

*Data Arrays* can appear in the form of 2D documents or 1D documents. A banner highlighted in yellow will appear at the top of the main menu to indicate the the currently selected document is a *Data Array*. This is important as, depending on the document class, different *Manipulations* and *View* settings are available.

In this use case we concentrate on 2D *Data Arrays*, but the overall functionality stays the same also in the 1D case. The specific windows will look slightly different as not all tools for 2D *Data Arrays* are useful when working with 1D *Data Arrays*.

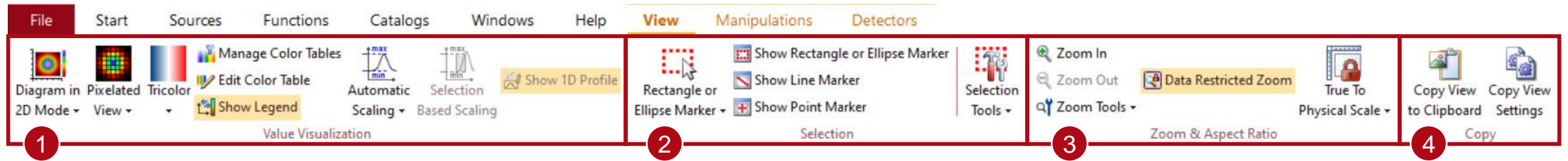
# Data Array Options

The screenshot displays the VirtualLab Fusion software interface. The main menu bar includes File, Start, Sources, Functions, Catalogs, Windows, and Help. A secondary menu bar, highlighted in yellow, contains View, Manipulations, and Detectors. The 'Data Array' menu is currently open, showing options such as Forward:  $x \rightarrow k$ , Backward:  $k \rightarrow x$ , Numerical FFT, Fourier Transform (...), Add Point, Add Cloud, Add Region, Add Polarization, Add Ellipses, and Edit List. The main workspace shows a numerical data array plot titled '45: Data Array created from "44: Gaussian Wav...'. The plot is a 2D heatmap showing the amplitude of field U [V/m] over a square region from -0.5 to 0.5 mm on both X and Y axes. A color scale on the right ranges from 0 (dark blue) to 1 (red). The Property Browser on the right side of the window is open, showing settings for the selected data array. The Property Browser has tabs for View, Object, and Selections. The View tab is active, showing settings for General (Window Size: 400, 420; True To Scale: True; Data Restricted Zoom: True; Zoom Factor: 164.99 px/mm), Colors (Color Table: Tricolor), Data (Auto Scaling of Data: True; Displayed Data Range: [0 V/m; 1 V/m]; Format of Color Scale: Engineering; View Interpolation: Pixelated View), Labels (Font Size of Axis Labels: 12; Font Size of Title: 12), Selection (General) (Selection Mode: Rectangle or Ellipse), Selection (Line) (Display Line Marker: False), Selection (Point) (Display Point Marker: False), and Selection (Region) (Show Rectangle or Ellipse N: False). The Window Size section indicates the size of the document window. The bottom status bar shows CPU Usage: 0%, Physical Memory: 0/32 GIB, and a message bar with 'Current Global Options' (Changed Simulation Defaults; Number of Used Cores: 8).

Whenever a *Data Array* is selected, new options appear in the *Main Menu* and the *Property Browser*.

The three tabs *Views*, *Manipulations* and *Detectors* are only accessible when a *Data Array* is selected.

# View



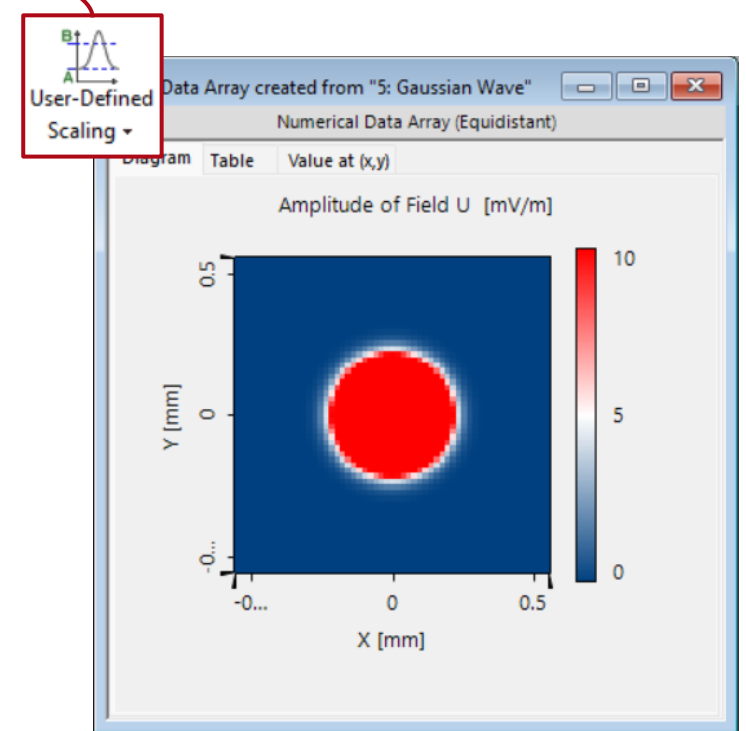
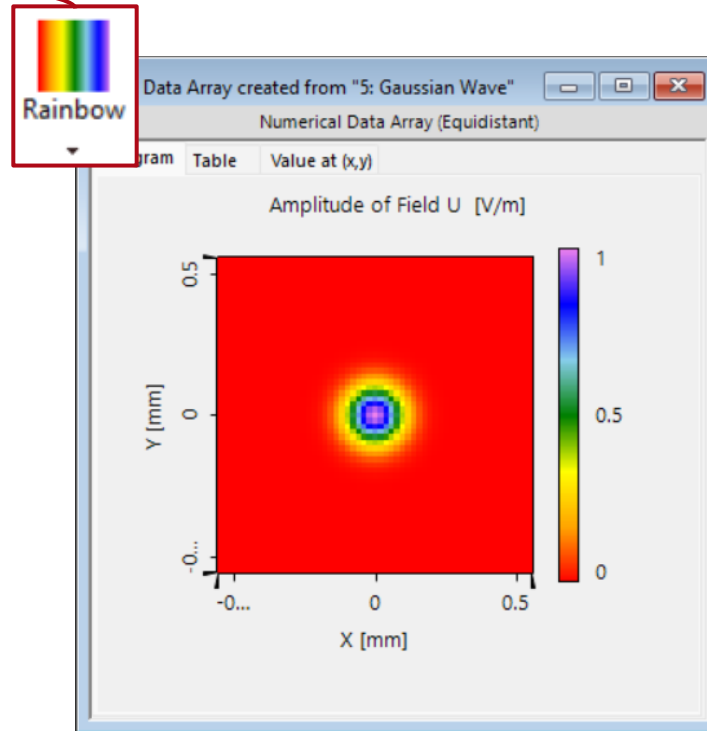
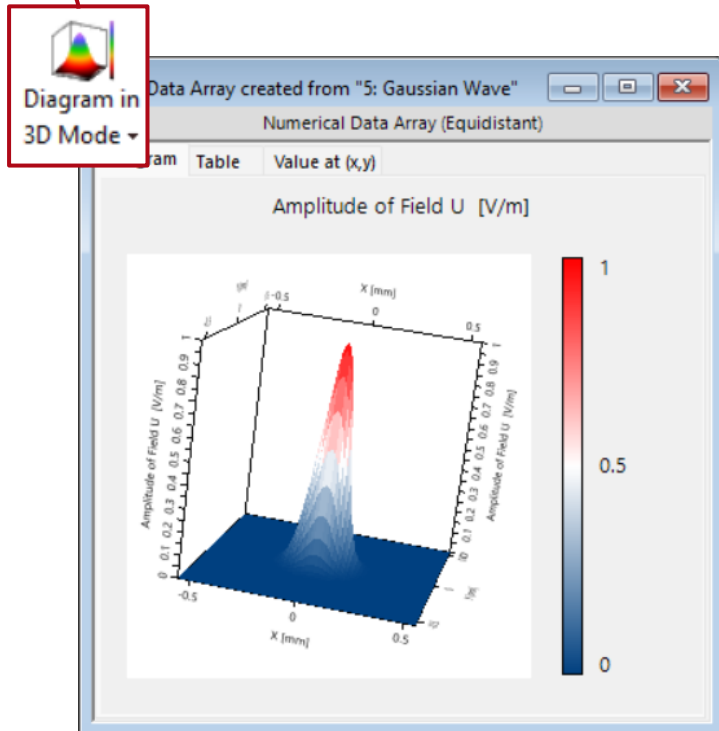
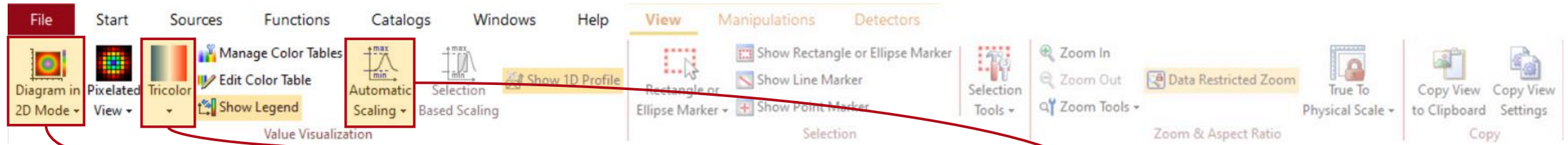
The *View* tab of the main menu allows for various adjustments regarding the visual style of the *Data Array*, including:

- 1 Value Visualization:** Determine the *Color Table* of the *Data Array* as well as various scaling options.
- 2 Selection:** This region contains the options regarding the markers and various tools to quickly find certain regions.
- 3 Zoom & Aspect Ratio:** In this region the user finds buttons to zoom into (and out from) the data.
- 4 Copy:** Allows the user to quickly copy view settings from one *Data Array* to another.

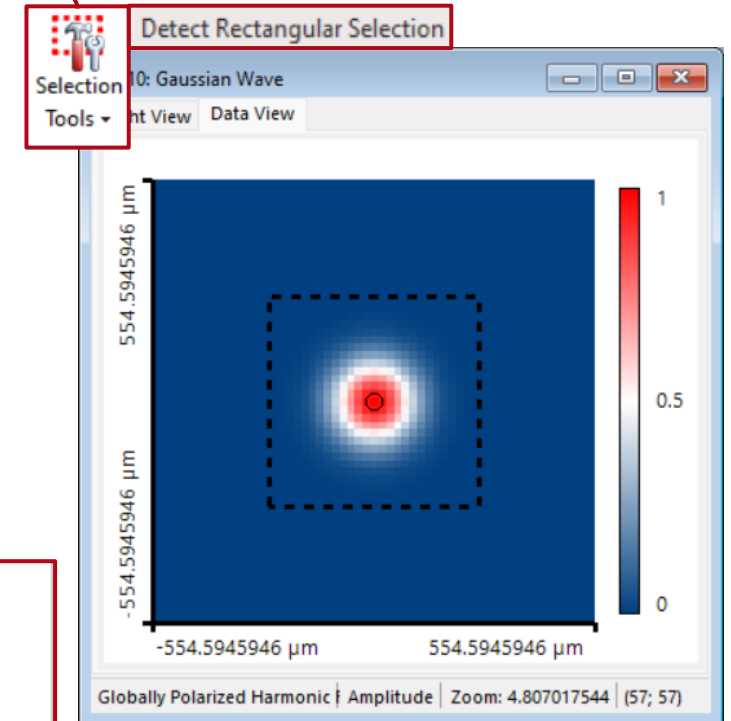
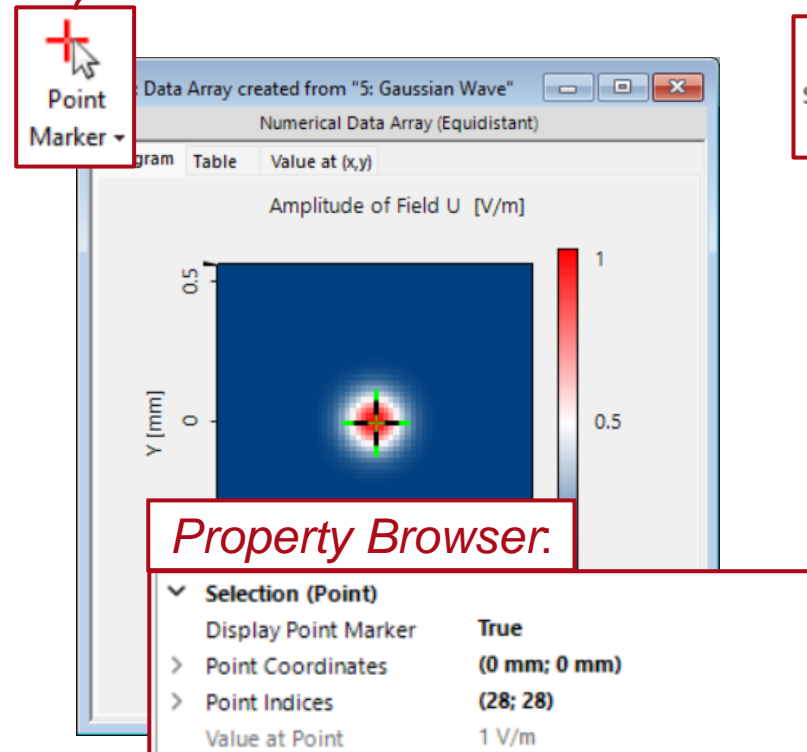
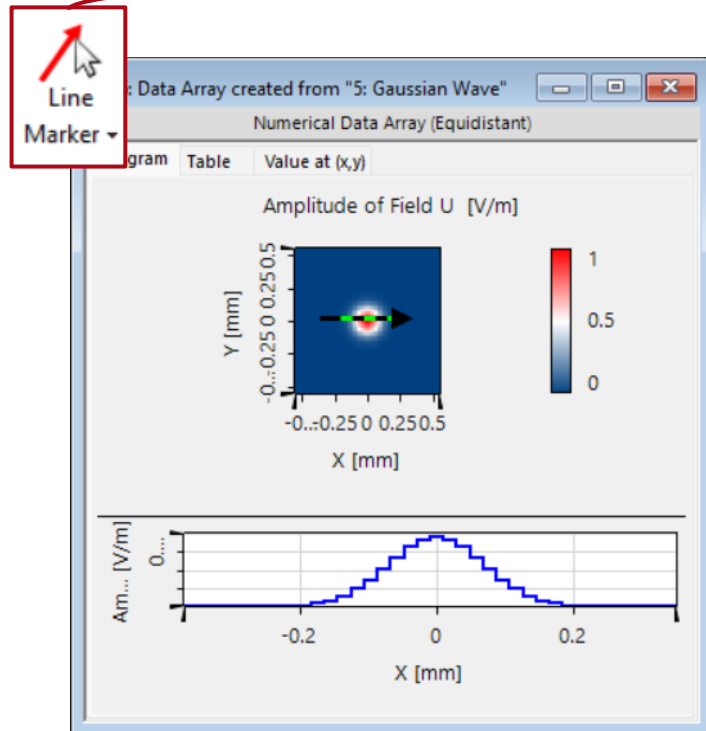
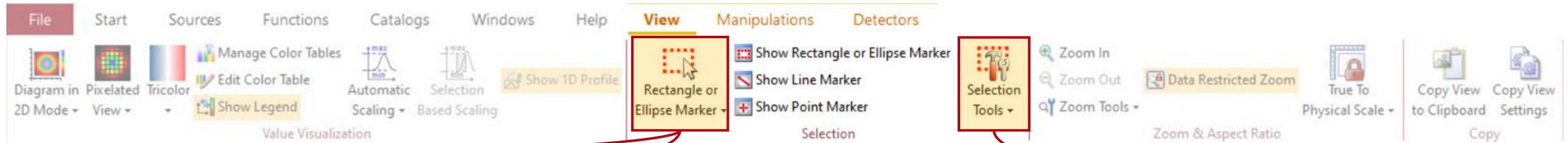
As this use case is only meant to provide a rough overview of the available options, for more information about view settings for *Data Arrays*, please see:

[View Settings for 2D Data Arrays](#)

# Value Visualization

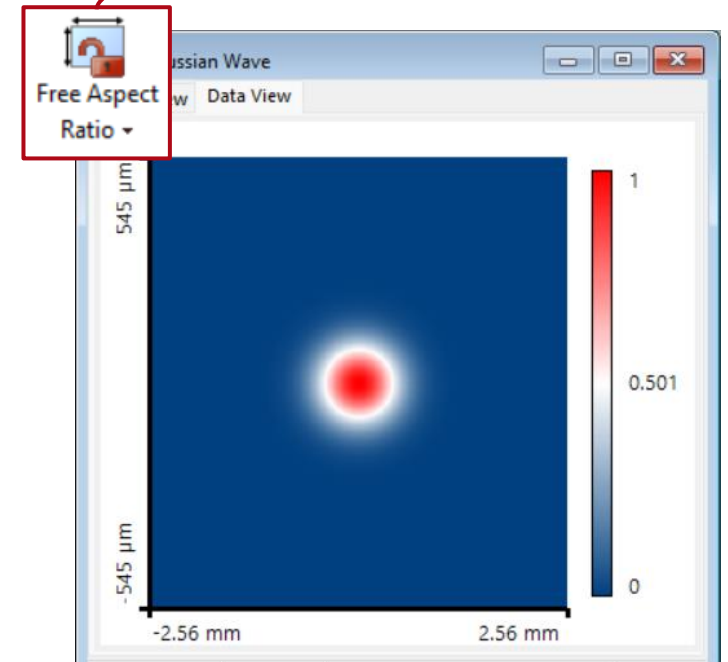
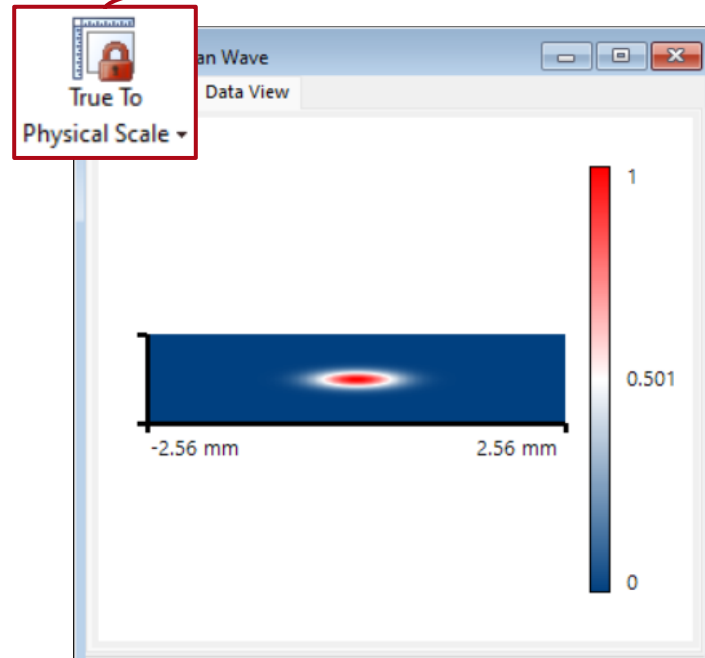
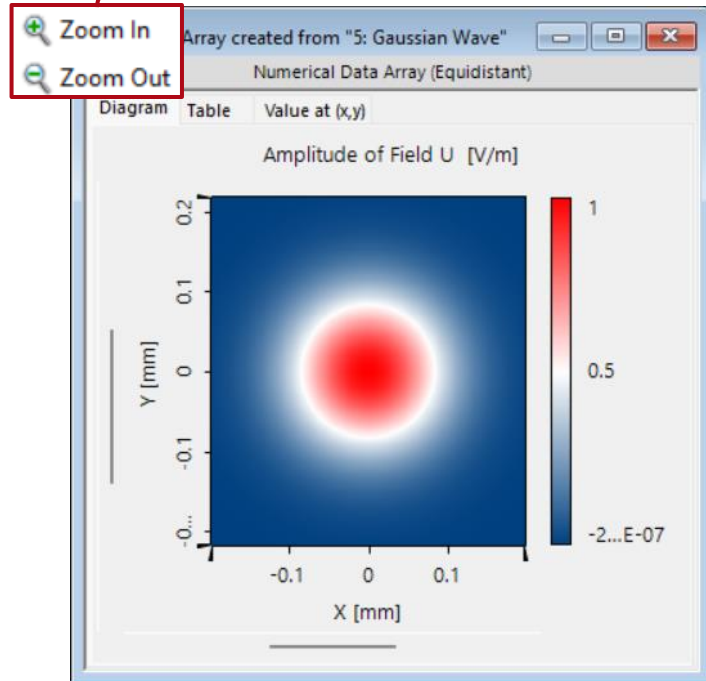
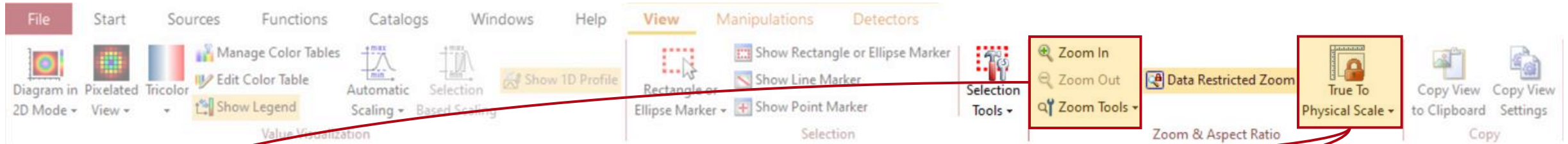


# Selection



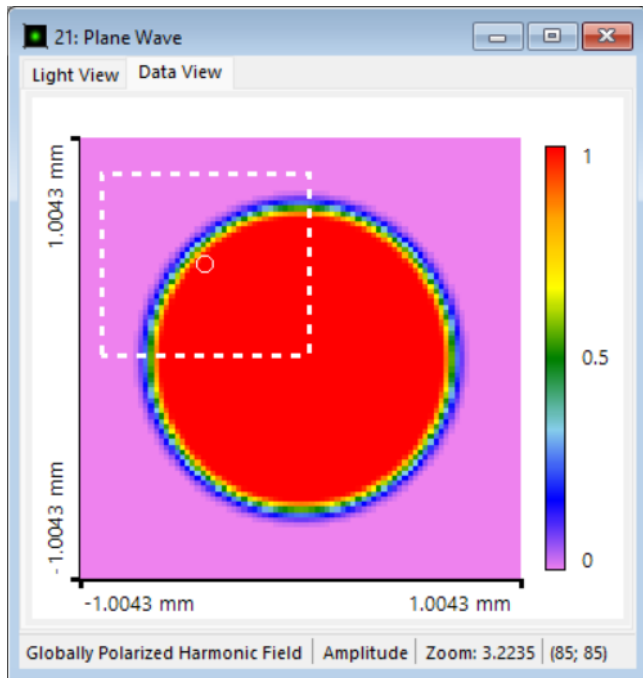
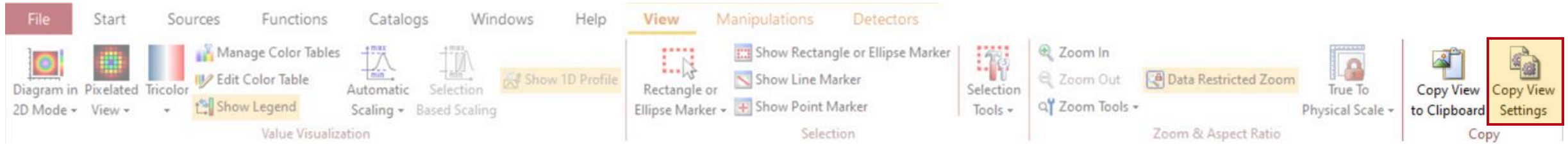


# Zoom & Aspect Ratio

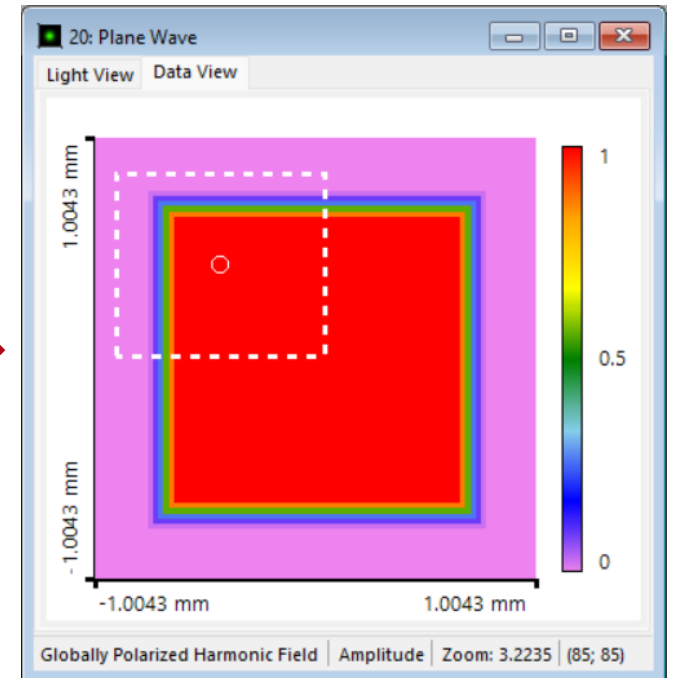
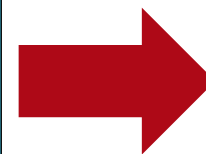
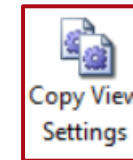
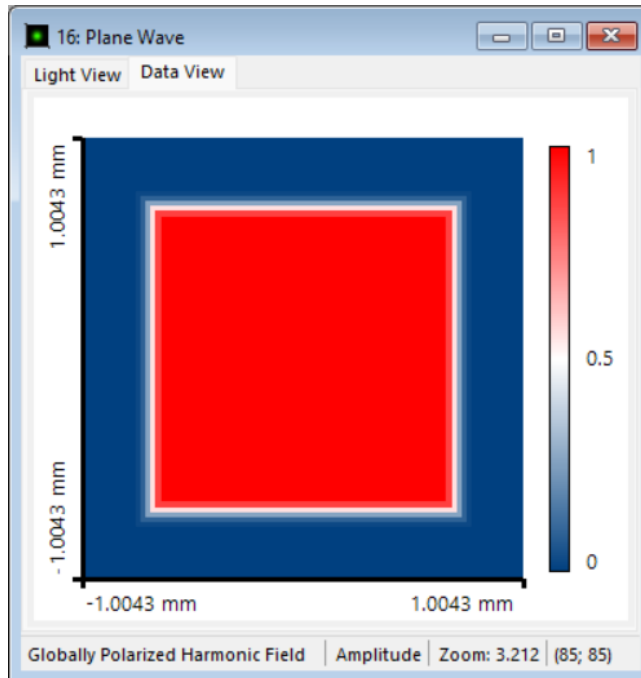


*Note: To demonstrate this feature an asymmetrical Gaussian is shown!*

# Copy



reference



# Manipulations



The *Manipulations* tab of the main menu allows for various adjustments regarding the actual data of the *Data Array*, including:

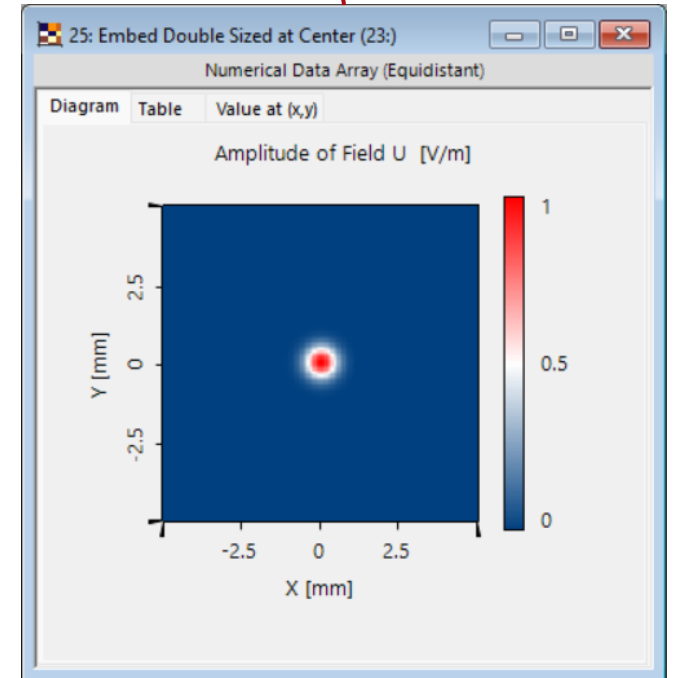
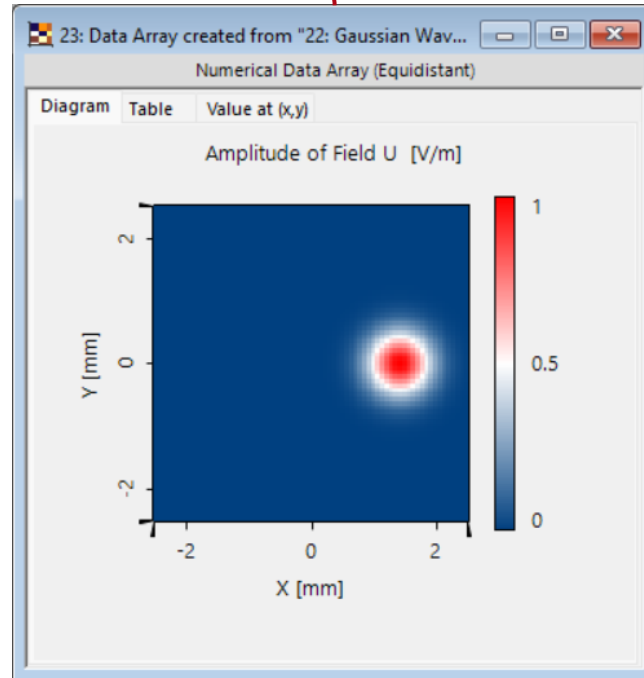
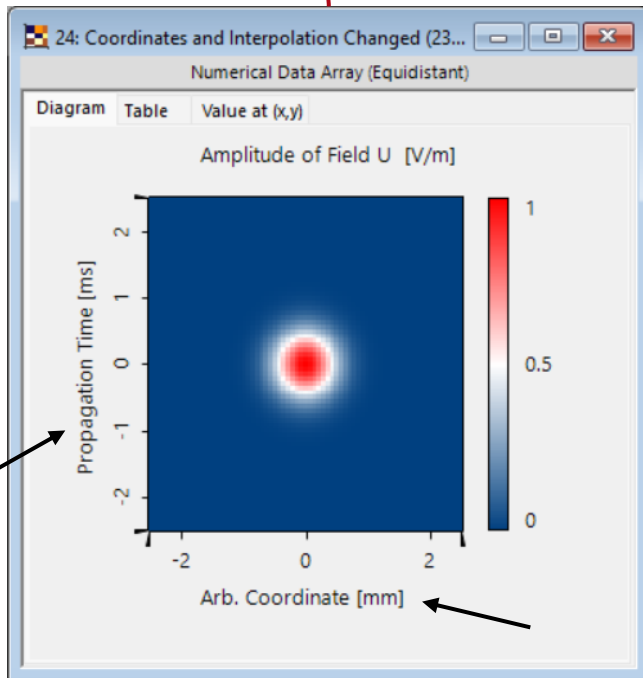
- 1 General:** Lots of different customization options ranging from coordinate transformations over mathematical operations with single values or other arrays, to the sampling manipulations.
- 2 Conversion:** Transform *Data Array* to other objects.
- 3 Fourier Transform (Space):** Apply *Fourier Transform* onto the *Data Array*.
- 4 Graphics Add-ons:** Add additional information onto the *Data Array* as an overlay.

As this use case is only meant to provide a rough overview of the available options, for more information about manipulating *Data Arrays*, please see:

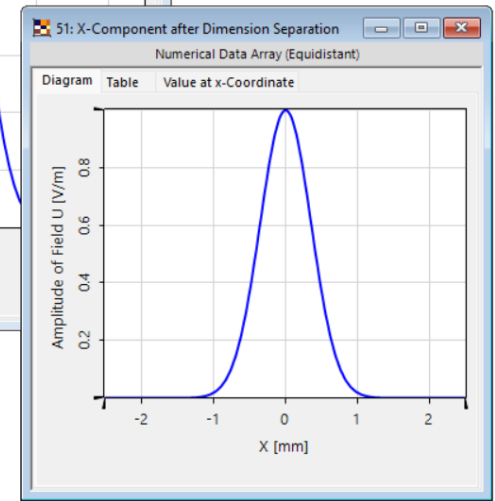
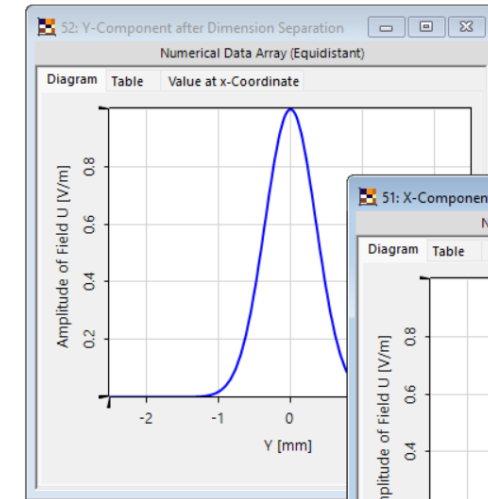
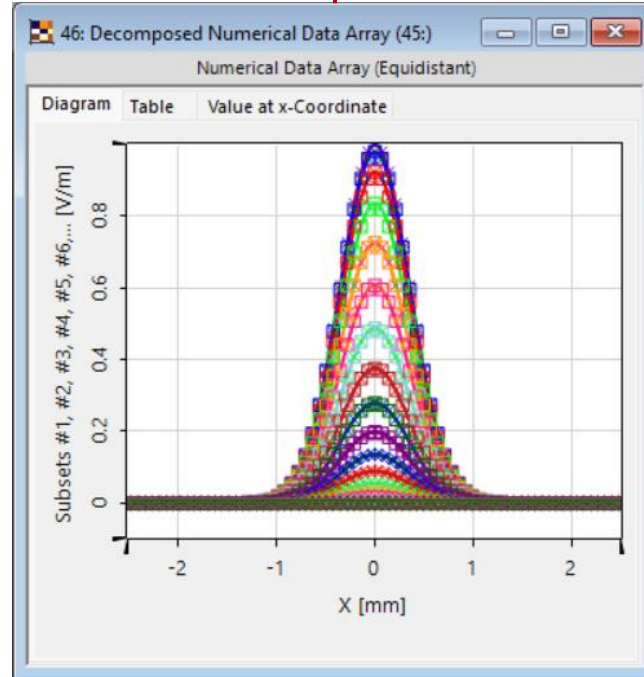
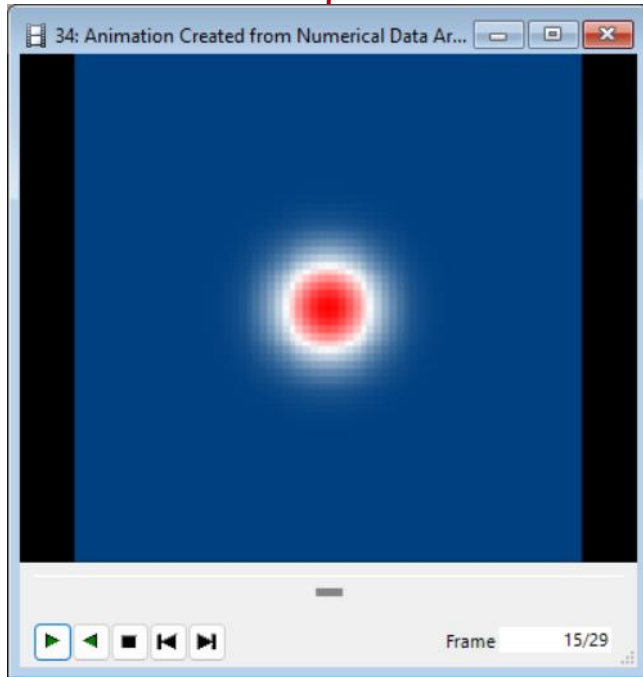
[!\[\]\(a03a7eb2f4046e1d3c76772003e549ea\_img.jpg\) General Manipulation Tools for Data Arrays](#)

[!\[\]\(cbe2492b119e39e02a1dab2af4a4b296\_img.jpg\) Graphics Add-on](#)

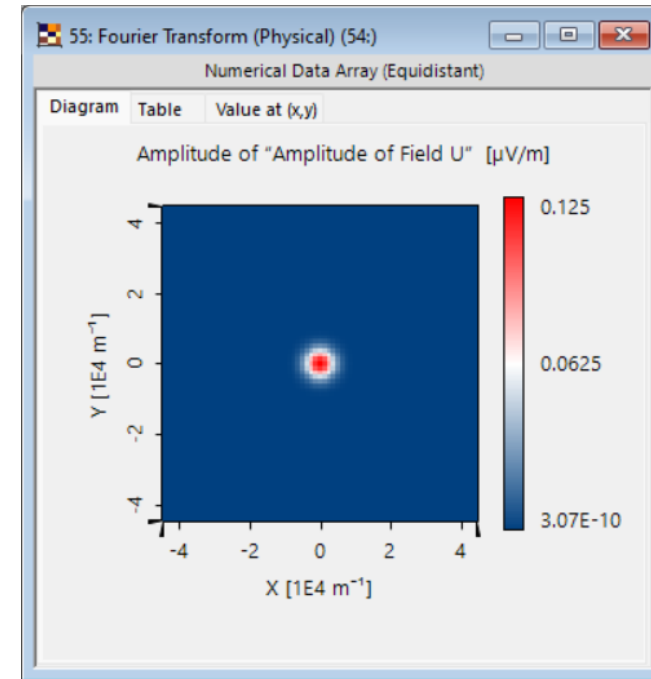
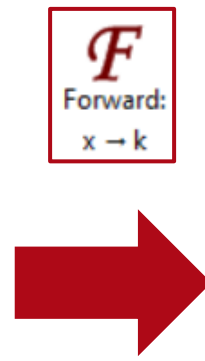
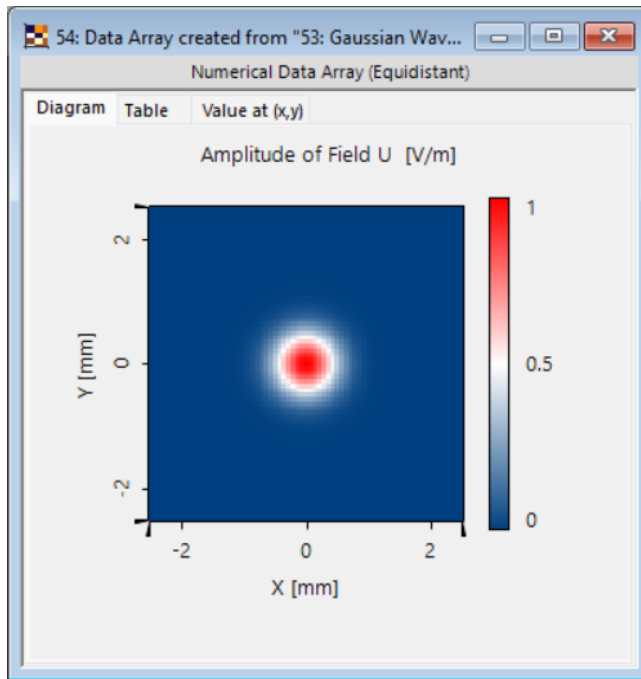
# General



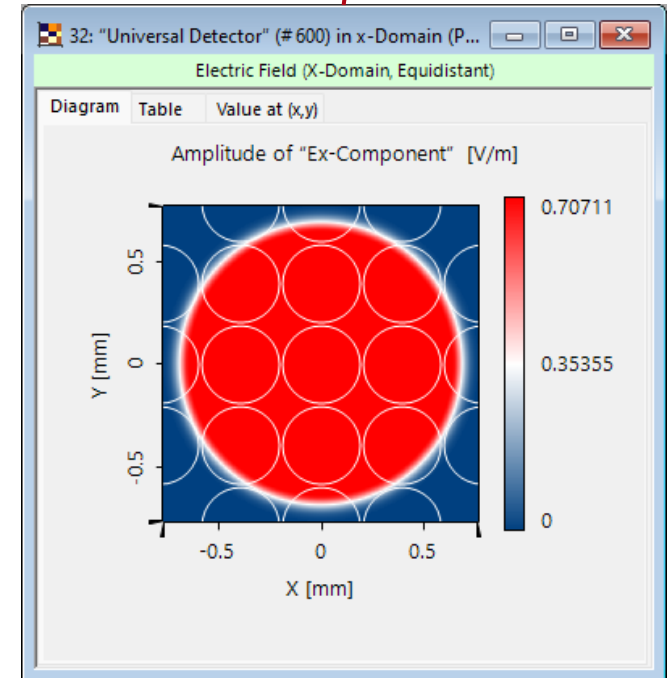
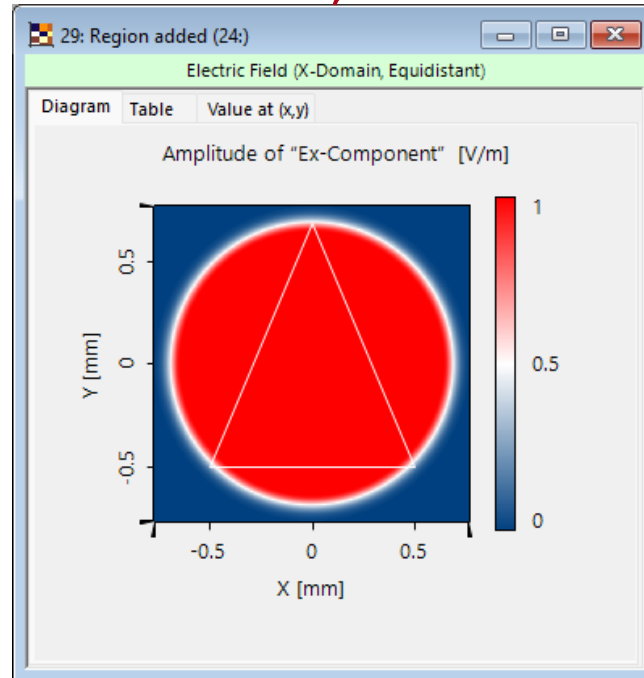
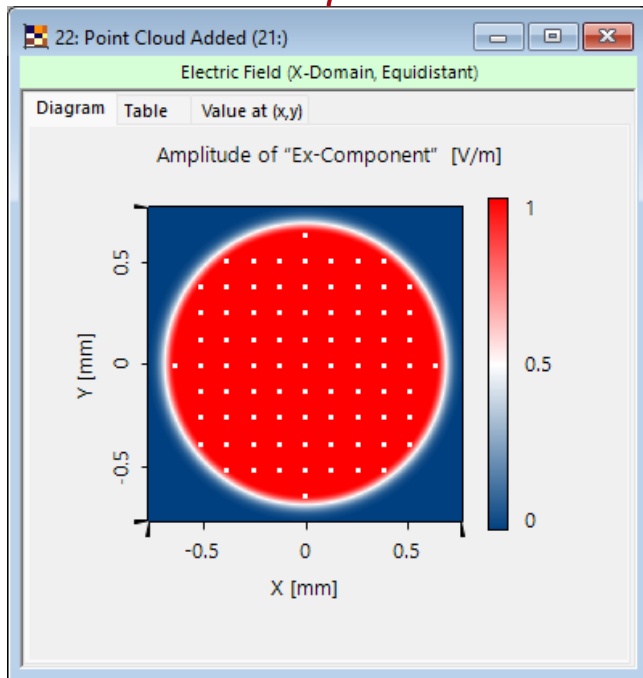
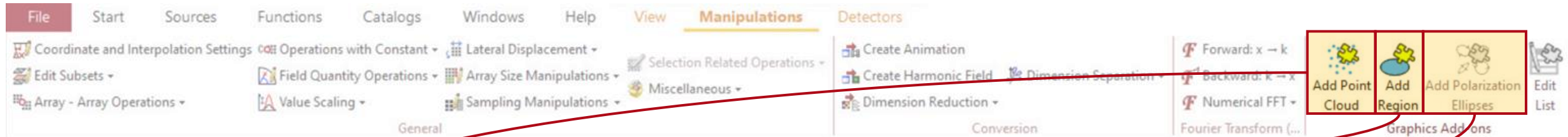
# Conversion



# Fourier Transform

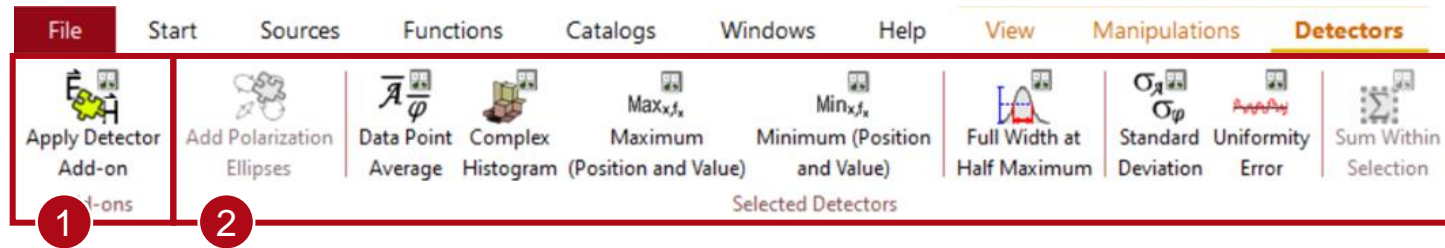


# Graphics Add-On



More information under: [Graphics Add-Ons](#)

# Detectors



The *Detectors* tab of the main menu offers several post-processing options for the *Data Array*, including:

- 1 *Add-ons*: *Detector Add-ons* calculate various physical quantities from the given data. See more information under: [Universal Detector](#).
- 2 *Selected Detectors*: This section incorporates different post-processing options of the given *Data Array*; depending on the detector, the result will either be displayed as an additional window or in the *Detector Result* tab at the bottom of the VirtualLab window.



# Property Browser – View Tab

In the *Property Browser*, the most important information about the selected *Data Array* is summarized. It consists of three tabs: *View*, *Object*, *Selections*.

The *View* tab contains all parameters that determine the overall look of the window (like size, scaling, axis, etc.) as well as the visualization of the actual data (color table, markers, smoothing, ....). Therefore, many of its parameters can also be found in the *View* tab of the main menu.

It can be used to drastically change the overall look of the results VirtualLab Fusion provides. For a deep dive on how to modify *Data Arrays* to fit certain visual requirements, please have a look on: [How to Format VirtualLab Fusion Results](#).

# Property Browser – Object & Markers

Property Browser

4: Data Array created from "3: Gaussian Wave"

View Object Selections

- Dimensions**
  - Array Size X 1.0897 mm
  - Array Size Y 1.0897 mm
  - Coordinate Boundaries : [-554.59  $\mu\text{m}$ ; 554.59  $\mu\text{m}$ ]
  - Coordinate Boundaries ' [-554.59  $\mu\text{m}$ ; 554.59  $\mu\text{m}$ ]
  - Coordinate Extent X 1.1092 mm
  - Coordinate Extent Y 1.1092 mm
  - No of Data Subsets 1
- Interpretation**
  - Subset Meaning Amplitude of Field U
  - Subset Property Electric Field Strength
  - X Coordinate Meaning X
  - X Coordinate Property Length
  - Y Coordinate Meaning Y
  - Y Coordinate Property Length
- Sampling**
  - Equidistant in X True
  - Equidistant in Y True
  - No of Data Points (57; 57)
  - First X Coordinate -544.86  $\mu\text{m}$
  - First Y Coordinate -544.86  $\mu\text{m}$
  - Sampling Distance X 19.459  $\mu\text{m}$
  - Sampling Distance Y 19.459  $\mu\text{m}$
- Miscellaneous**
  - Complex or Real Real-valued data.
  - Extrapolation Method Constant Value

**Equidistant in X**  
Is the data array equidistantly sampled in x-direction?

The *Object* tab incorporates numerical parameters like sampling points, physical units and coordinate settings. Unlike the *View* tab, this parameters cannot be changed inside the *Property Browser*.

The *Selections* tab summarizes parameters from any given marker, such as start- and end-point.

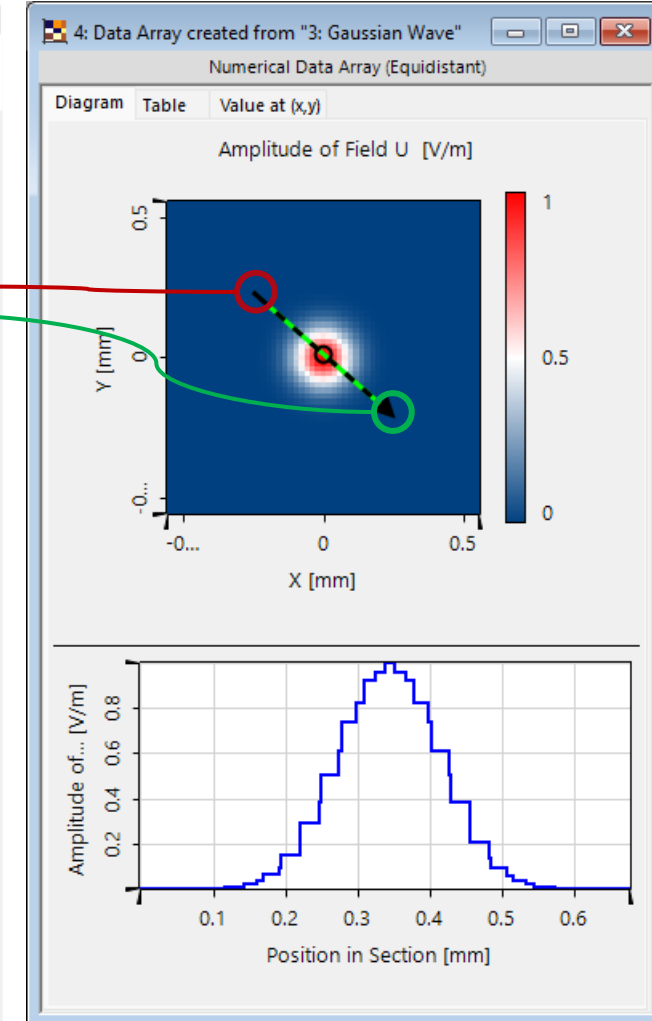
Property Browser

4: Data Array created from "3: Gaussian Wave"

View Object Selections

- Selection (General)**
  - Coordinate Snapping Se True
  - Selection Mode Line
- Selection (Line)**
  - Display Line Marker True
  - Start Coordinates (-252.97  $\mu\text{m}$ ; 233.51  $\mu\text{m}$ )
  - End Coordinates (252.97  $\mu\text{m}$ ; -214.05  $\mu\text{m}$ )
  - Length 675.5  $\mu\text{m}$
  - Start Indices (15; 40)
  - End Indices (41; 17)
- Selection (Point)**
  - Display Point Marker False
- Selection (Region)**
  - Show Rectangle or Ellips False

**Show Rectangle or Ellipse Marker**  
Visibility of the rectangular or elliptic selection marker.



# Document Information

title	Introduction to Data Arrays
document code	SWF.0023
document version	1.1
software edition	VirtualLab Fusion Basic
software version	2023.2 (Build 1.242)
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>• <a href="#"><u>View Settings for 2D Data Arrays</u></a></li><li>• <a href="#"><u>General Manipulation Tools for Data Arrays</u></a></li><li>• <a href="#"><u>Graphics Add-ons</u></a></li><li>• <a href="#"><u>Universal Detector</u></a></li></ul>