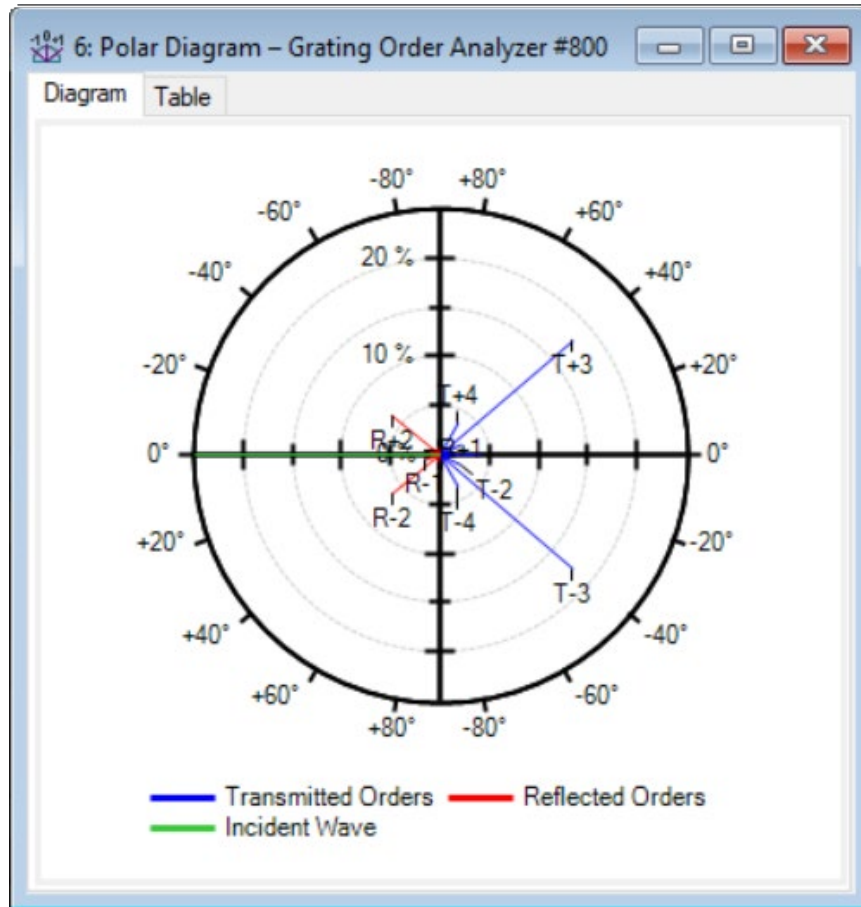


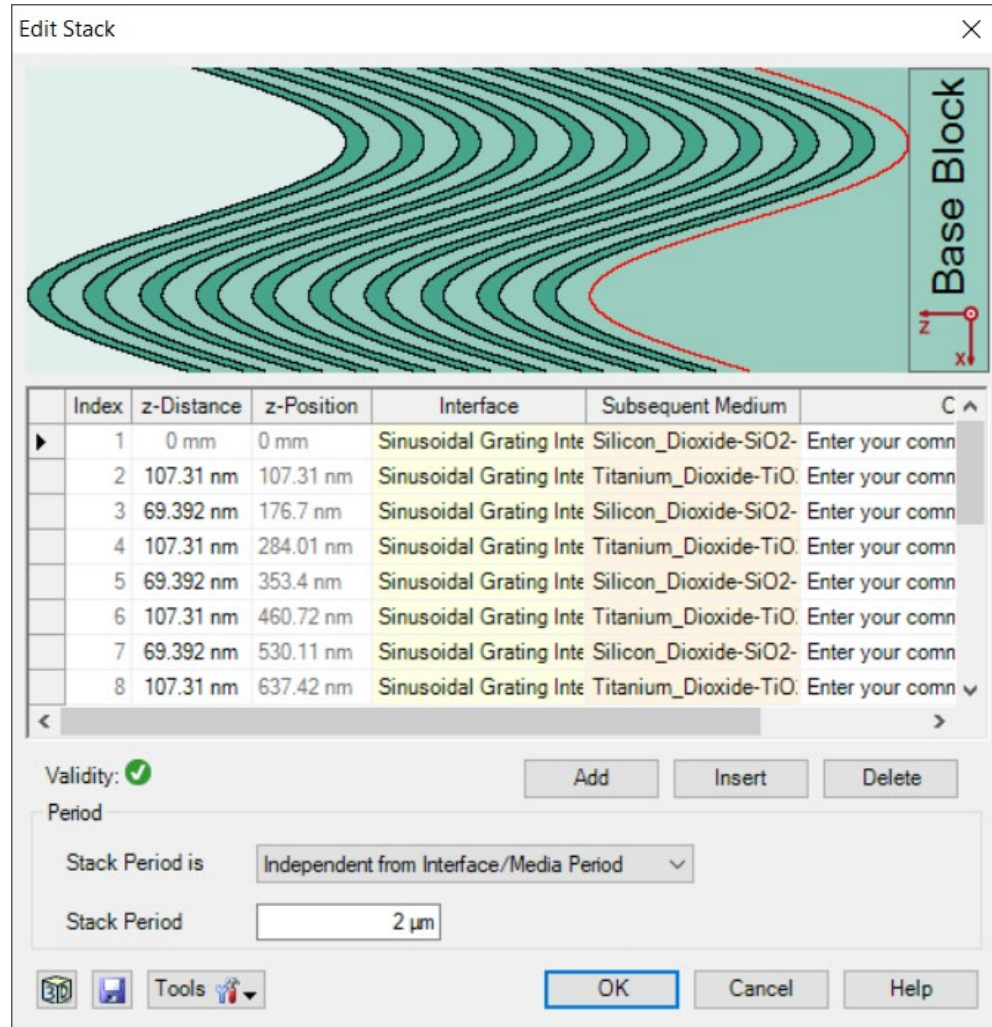
Grating Order Analyzer

Abstract



The analysis of the diffraction efficiencies of gratings is the typical modeling task for gratings. The efficiencies follow from the Rayleigh coefficients. Both quantities are given for each of the diffraction orders of a grating. VirtualLab Fusion enables the calculation of efficiencies and Rayleigh coefficients by the fully vectorial Fourier modal method (FMM, also known as RCWA). With the help of the Grating Order Analyzer, one can display the efficiencies and Rayleigh coefficients of the distinct orders in various ways.

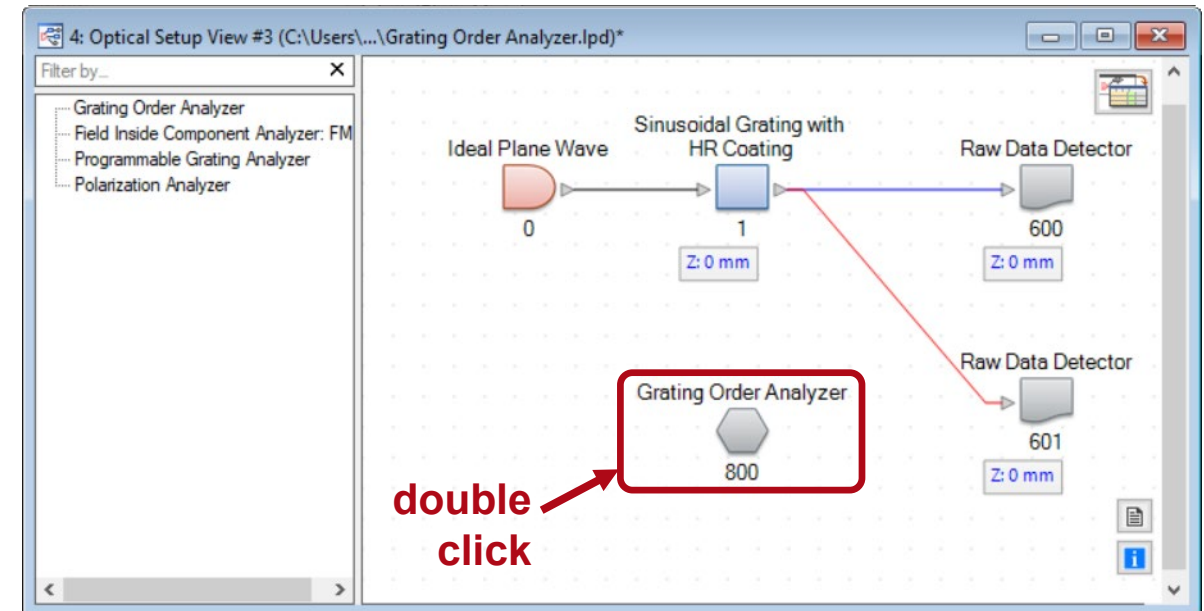
Grating Specification



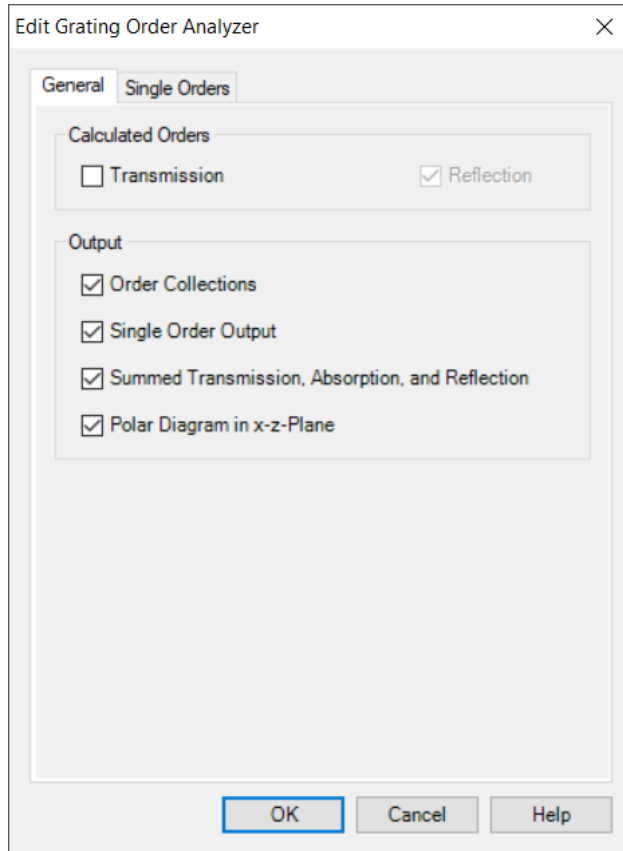
- For the demonstration of the Grating Order Analyzer for 1D gratings we use a sinusoidal grating with HR coating.
- The grating parameters can be specified within the stack that can be accessed in the edit dialog of the grating component.

Grating Order Analyzer Settings

- After the grating structure has been defined you can configure the Grating Order Analyzer.
- Various output options can be specified.
- This is done through the edit dialog of the analyzer which is opened by double clicking it element in the optical setup view.

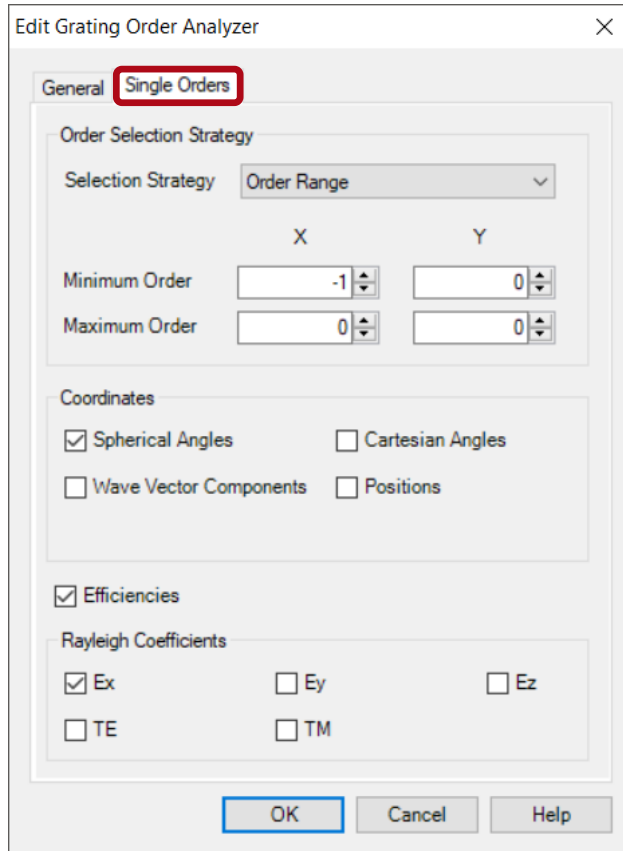


General Settings



- In the General tab, you can select whether transmission and/or reflection shall be analyzed.
- In addition you can specify whether you would like to evaluate the summed transmission, absorption and reflection values, and whether you would like to show a polar diagram.

Single Orders Settings



- In the Single Orders tab you can select whether information for single orders shall be logged.
- This option is very helpful if you would like to use the parameter run or the parametric optimization of VirtualLab Fusion to analyze and optimize the grating for specific orders.

Single Orders Settings

Edit Grating Order Analyzer

General

Single Orders

Order Selection Strategy

Selection Strategy

Order Range

X

Y

Minimum Order

-1

0

Maximum Order

0

0

Coordinates

☒ Spherical Angles

☐ Cartesian Angles

☐ Wave Vector Components

☐ Positions

☒ Efficiencies

Rayleigh Coefficients

☒ Ex

☐ Ey

☐ Ez

☐ TE

☐ TM

OK

Cancel

Help

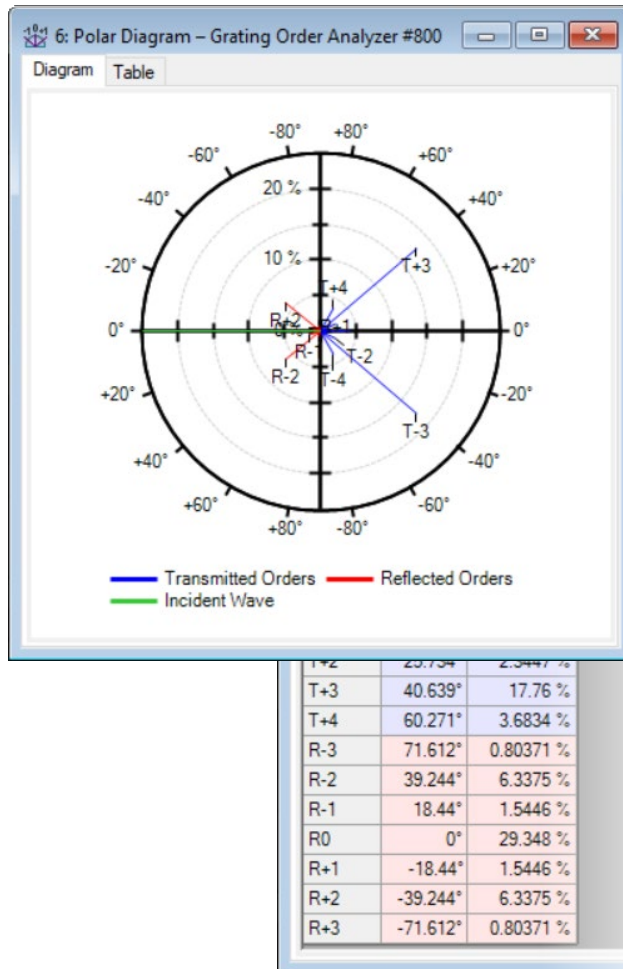
Parameter	Description
Order Selection Strategy	The user can define which order shall be evaluated. The user can define whether to analyze All orders, analyze only those orders which have an efficiency Above a Given Threshold or calculate only orders in a manually defined Order Range . Depending on the selection strategy the user has to define additional parameters.
Coordinates	Logging of the coordinates of the orders is also supported. The user can specify whether to show the coordinates in Spherical Angles , Cartesian Angles , Wave Vector Components or Positions . For the Position calculation a z-distance between the grating and the screen has to be specified.
Efficiencies	The user can select whether efficiencies shall be logged.
Rayleigh Coefficients	In addition it is possible to log the Rayleigh coefficients. The user can select to show the coefficient E_x , E_y , E_z , TE or TM .

Outputs in Detector Tab

Detector Results				
	Date/Time	Detector	Sub - Detector	Result
12	03/24/2019 09:11:50	Grating Order Analyzer #800	Overall Reflection Efficiency	46.719 %
11			Overall Transmission Efficiency	53.281 %
10			Overall Reflection and Transmission Efficiency	100 %
9			Absorption	0 %
8	03/24/2019 09:11:50	Grating Order Analyzer #800 (Results for Individual Orders)	Spherical Angle Theta R[-1; 0]	18.44°
7			Spherical Angle Phi R[-1; 0]	0°
6			Efficiency R[-1; 0]	1.5446 %
5			Rayleigh coefficient Ex R[-1; 0]	$121.05 \cdot \exp(-1.695 \cdot i)$ mV/m
4			Spherical Angle Theta R[0; 0]	0°
3			Spherical Angle Phi R[0; 0]	0°
2			Efficiency R[0; 0]	29.348 %
1			Rayleigh coefficient Ex R[0; 0]	$541.74 \cdot \exp(-0.11644 \cdot i)$ mV/m
Messages Detector Results				

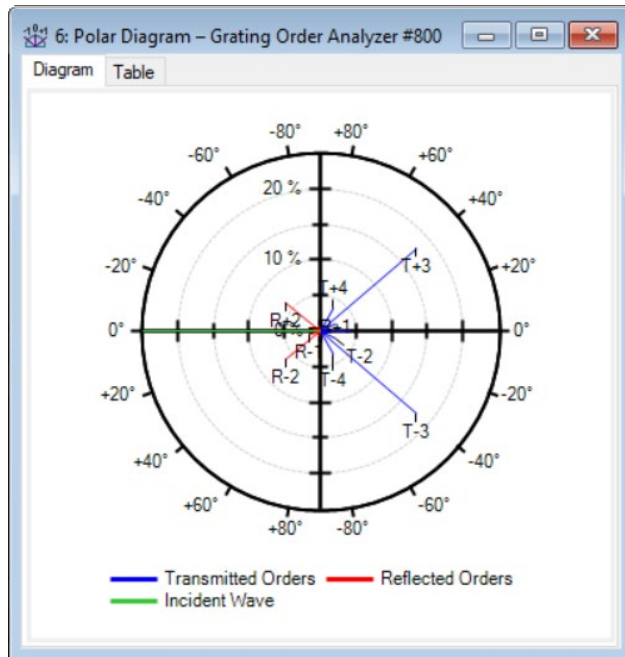
- If the Grating Order Analyzer is processed within the Optical Setup, the single order output values are logged into the detector results tab.
- These values are also available in the parameter run and the parametric optimization.

Outputs in Polar Diagram



- The polar diagram output of the Grating Order Analyzer plots the efficiencies of both the reflected and the transmitted orders versus the angles in the x-z-plane.
- It also provides a table of all angles and efficiencies of the displayed orders.

Polar Diagram Settings



- You can zoom into the polar diagram with the mouse wheel, the Property Browser and the ribbon.
- You can configure which orders are shown by right-clicking on the diagram.

Select Diffraction Orders to Show

Type of Orders to Show

☒ Incident Wave ☒ Transmitted Orders ☒ Reflected Orders

Minimum Angle Maximum Angle

☐ Use Stride

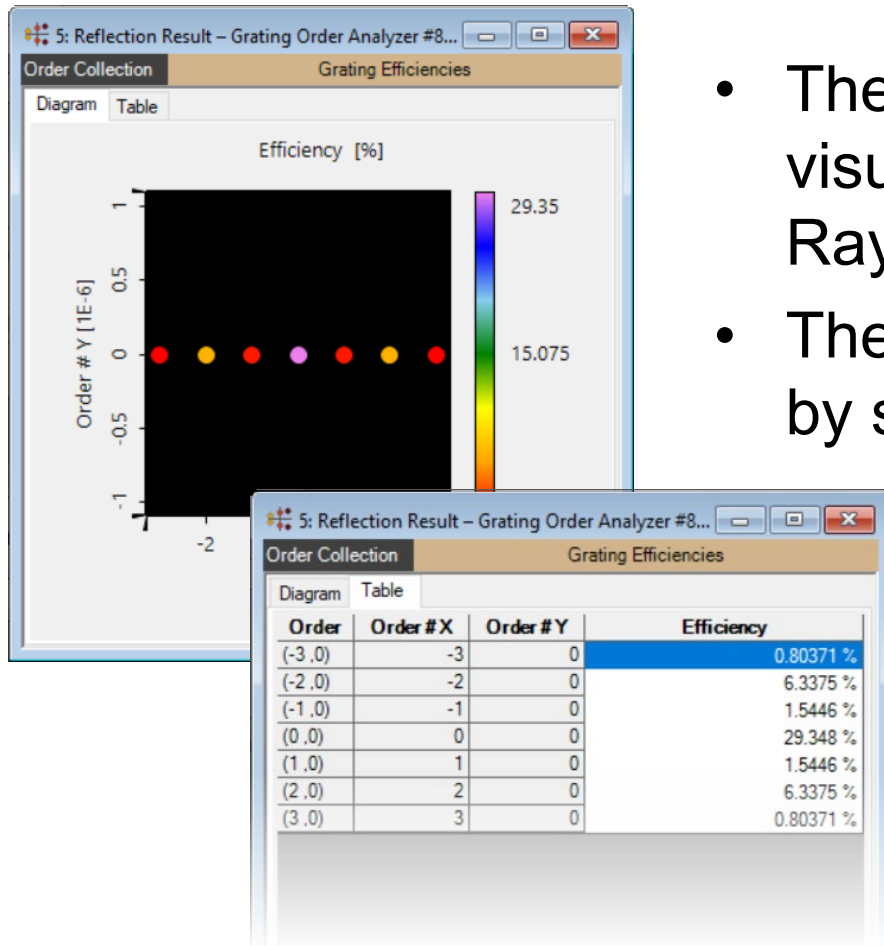
Order	Angle	Efficiency
<input checked="" type="checkbox"/> I	0°	100 %
<input checked="" type="checkbox"/> T-4	-60.27°	3.683 %
<input checked="" type="checkbox"/> T-3	-40.64°	17.76 %
<input checked="" type="checkbox"/> T-2	-25.73°	2.345 %
<input checked="" type="checkbox"/> T-1	-12.54°	0.8165 %
<input checked="" type="checkbox"/> T0	0°	4.072 %
<input checked="" type="checkbox"/> T+1	12.54°	0.8165 %
<input checked="" type="checkbox"/> T+2	25.73°	2.345 %

Select All Select None

View

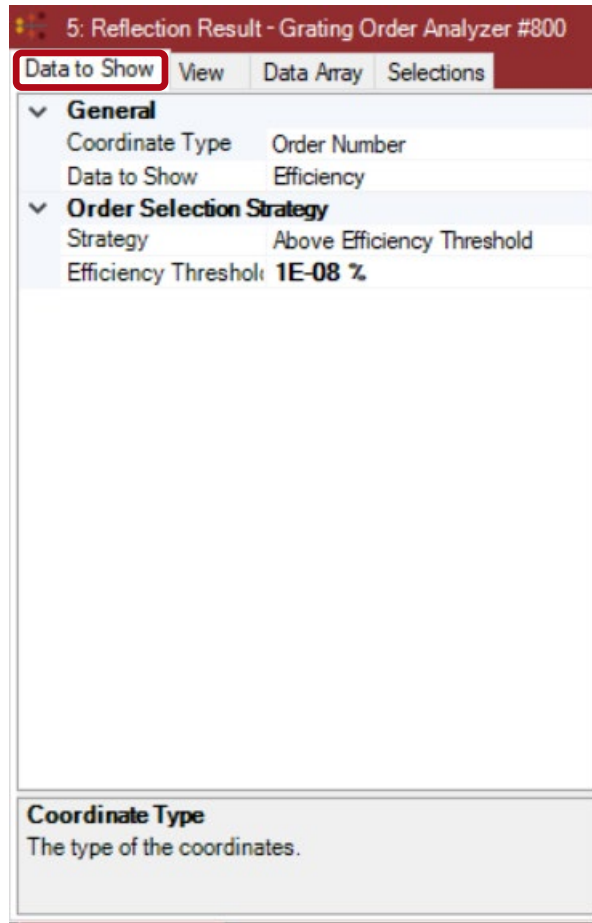
General	
Window Size	400, 420
y-Axis	
Maximum	25 %
Minimum	0 %

Outputs in Order Collection



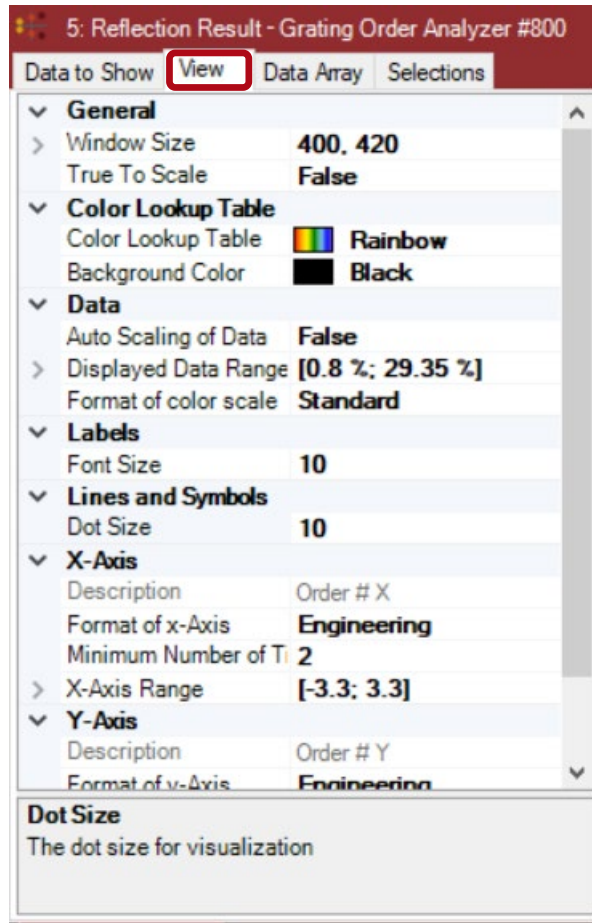
- The Grating Order Collection object is used to visualize the calculated grating efficiencies or the Rayleigh coefficients over different coordinates.
- The user can configure the data that shall be shown by setting diverse options via the property browser.

Order Collection Settings



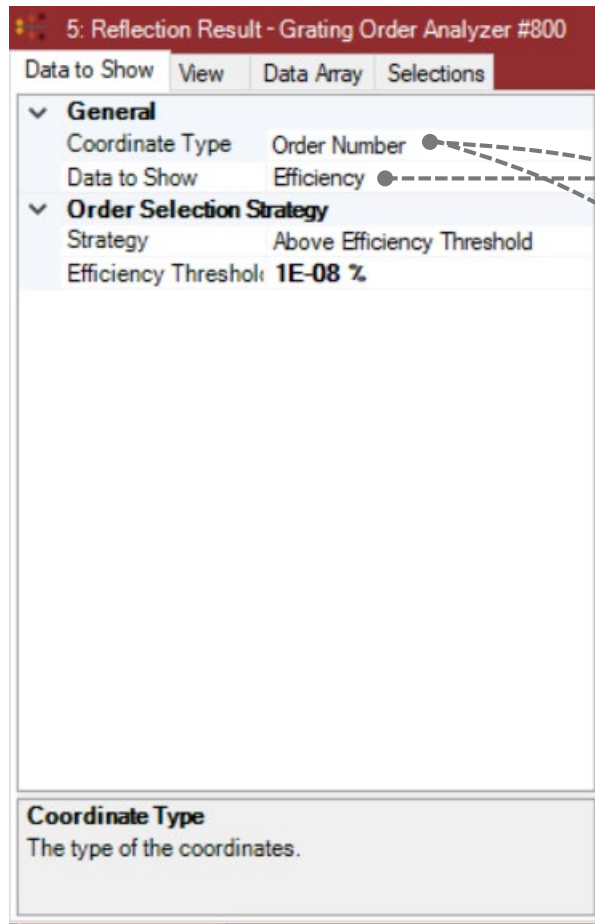
Option	Description
Coordinate Type	This property can be used to define the coordinates over which the data shall be visualized. Currently the order collection supports the visualization over Cartesian Angles , Spherical Angles , Wave Number Vectors and Positions .
Data to Show	It is possible to select the different data values that should be shown. The user can select to display the efficiency or the Rayleigh coefficient over the selected coordinate type. For Rayleigh coefficients E_x , E_y , E_z , TM and TE are supported.
Order Selection Strategy	The user can define which order shall be displayed. The user can define whether to show All , show only orders which have an efficiency Above a Given Threshold or show only orders for a manually defined Order Range . Depending on the selection strategy the user has to define additional parameters.

Order Collection Settings

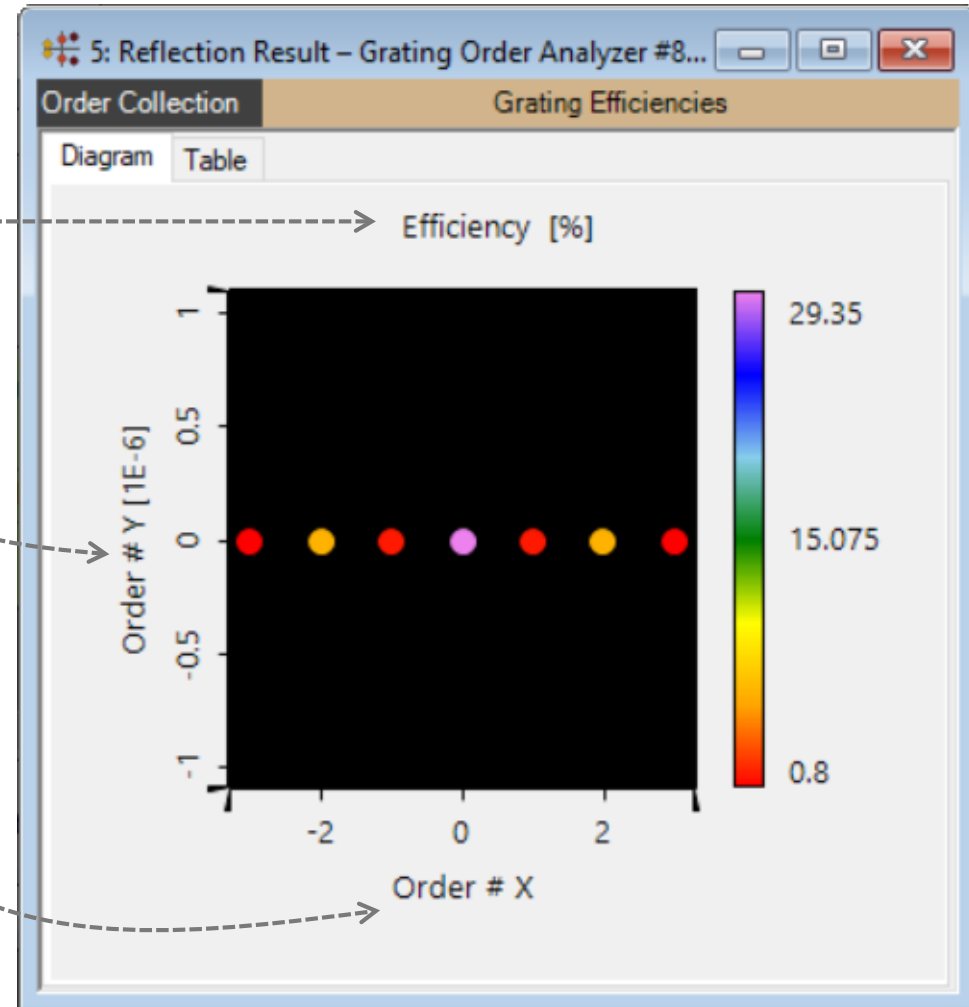


- In the View tab of the property browser, the user can set up additional view parameters.
- Most important for the customization of the view are the color settings.
- The user can select the background color for the view as well as the color lookup table that shall be used to define the colors for the displayed data values.

Example of Customized Order Collection Settings

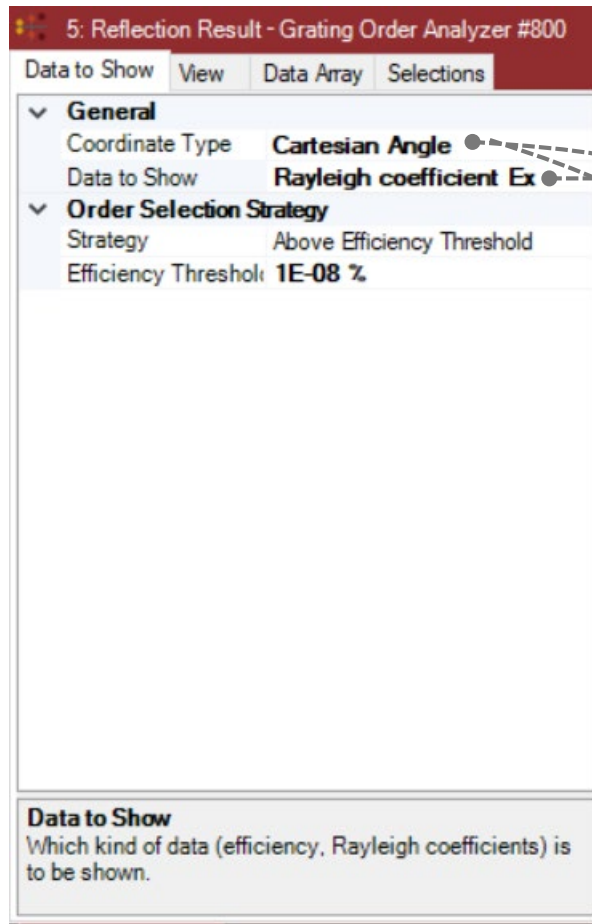


settings

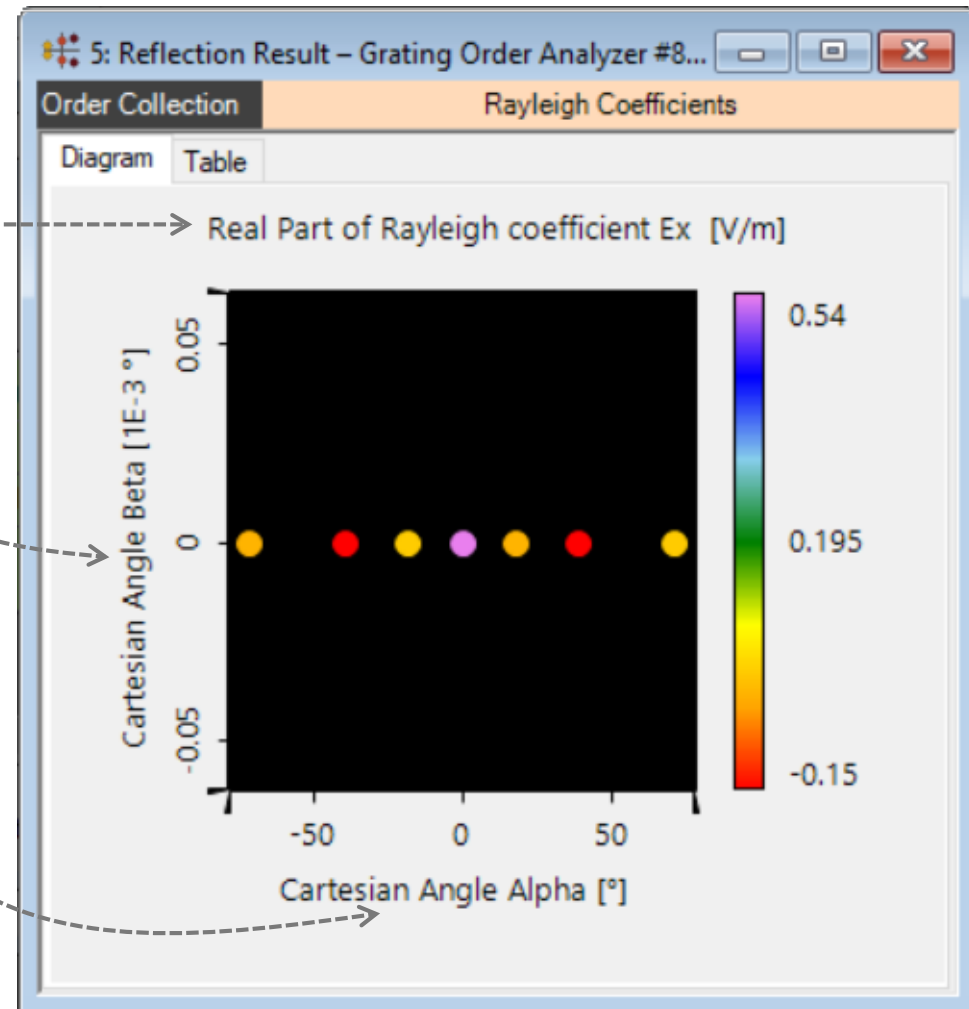


result

Example of Customized Order Collection Settings

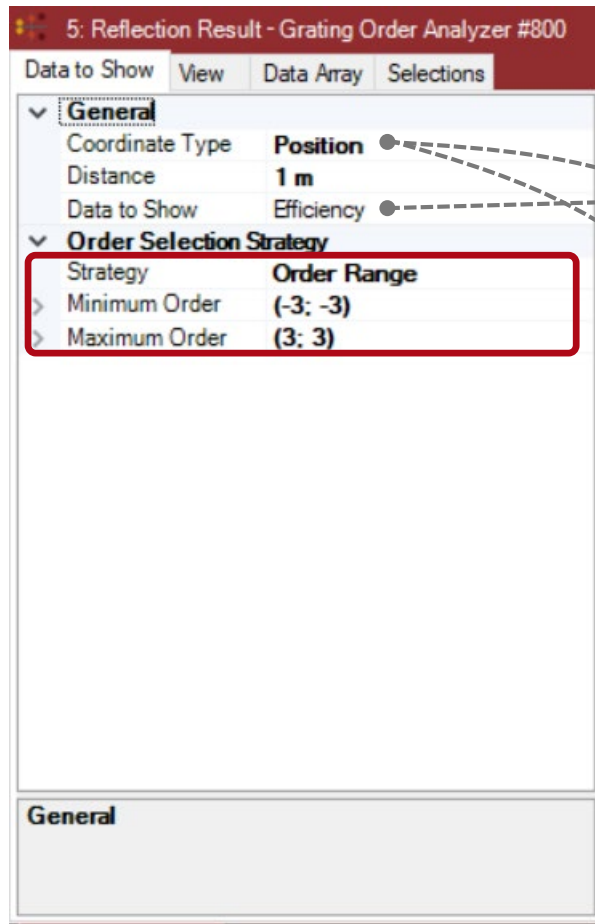


settings

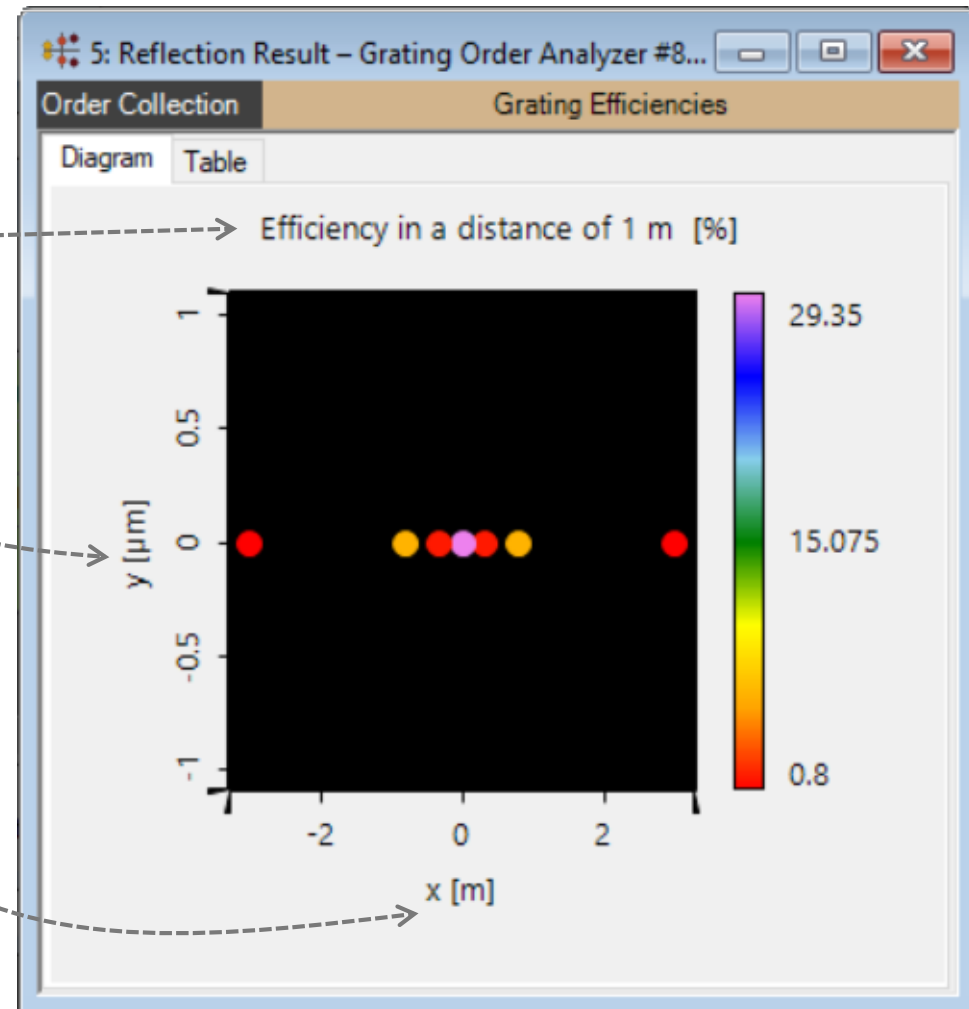


result

Example of Customized Order Collection Settings

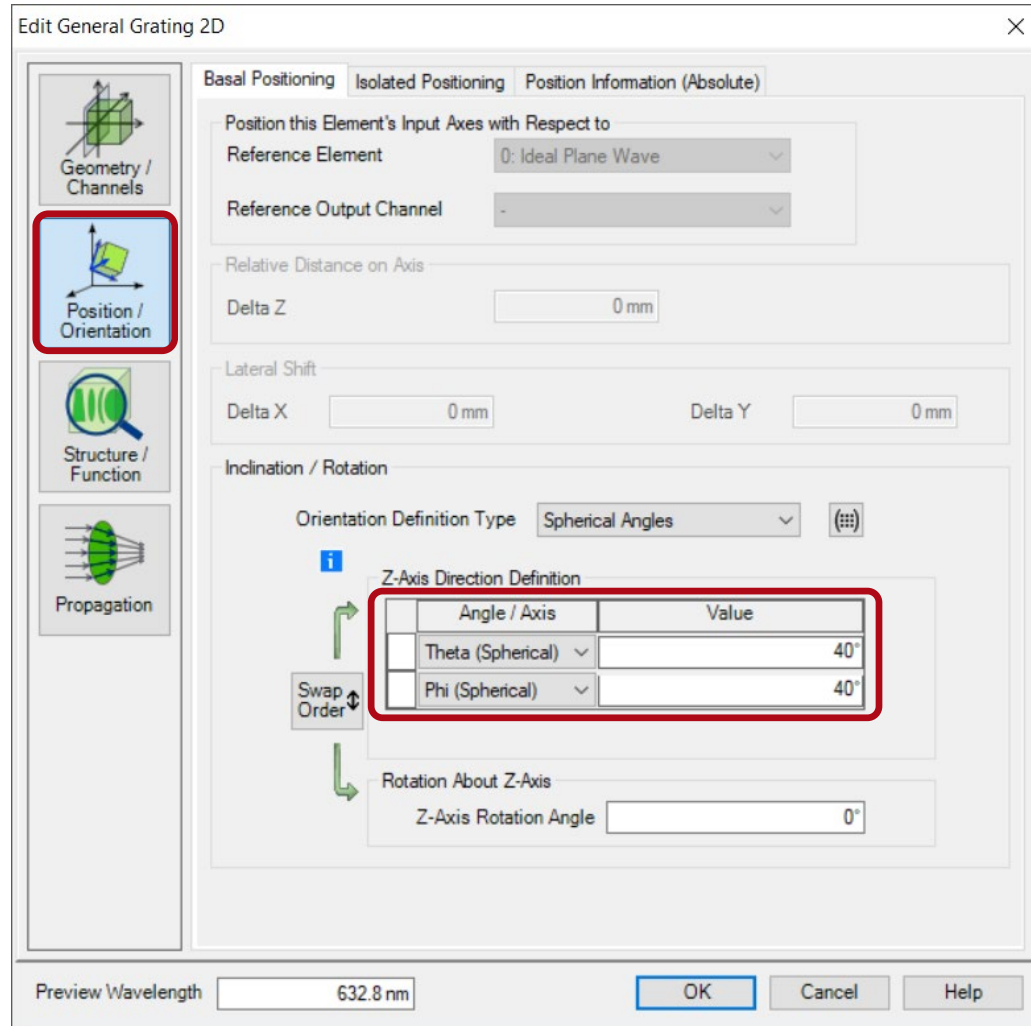


settings



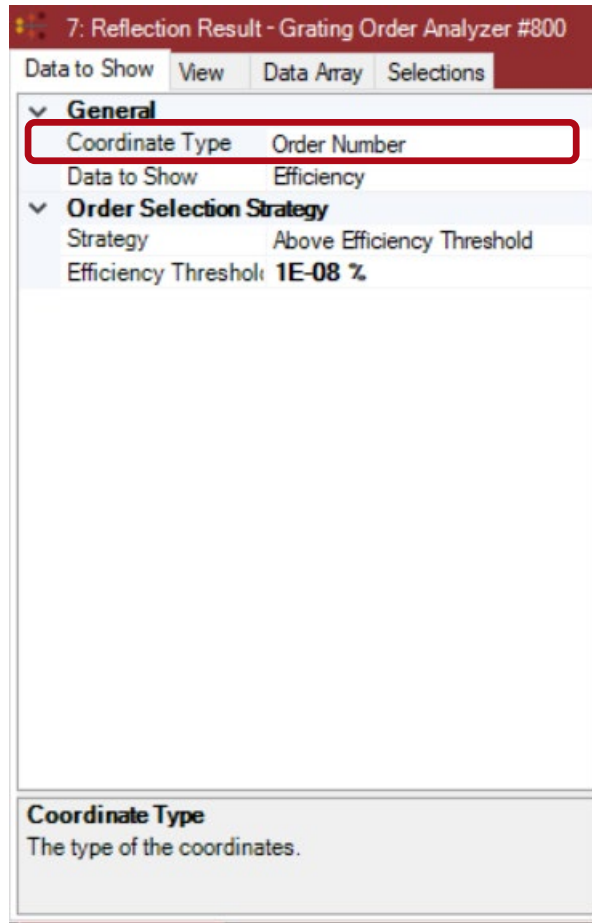
result

Visualization of Conical Diffraction

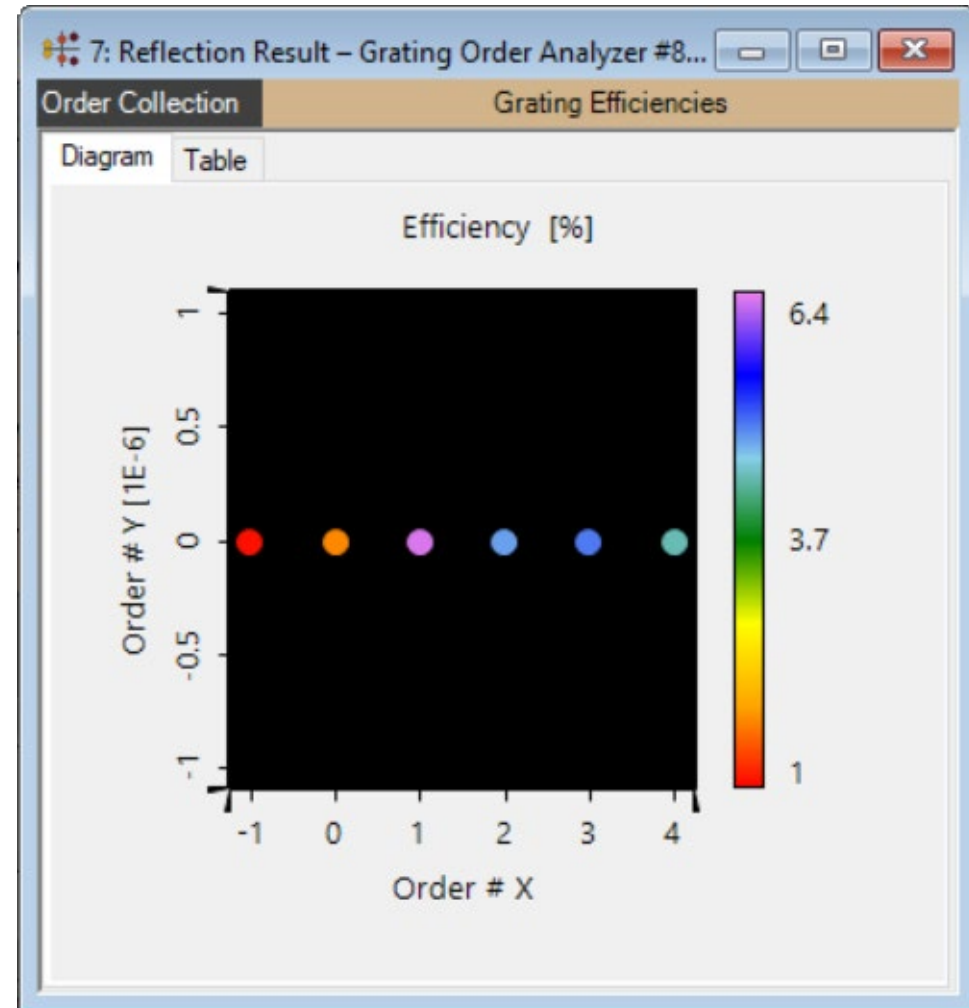


- Within the positions and orientation definition of the grating the user can define an arbitrary orientation.
- This is done in the Position / Orientation tab within the edit dialog of the grating.
- For this use case we use $\Theta = 40^\circ$ and $\Phi = 40^\circ$.

Efficiencies vs. Diffraction Order Number

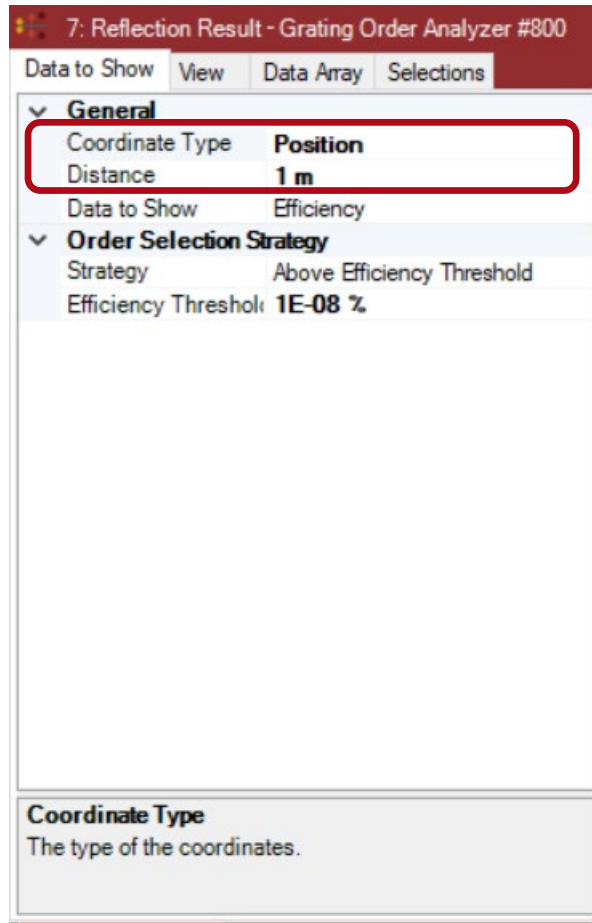


settings

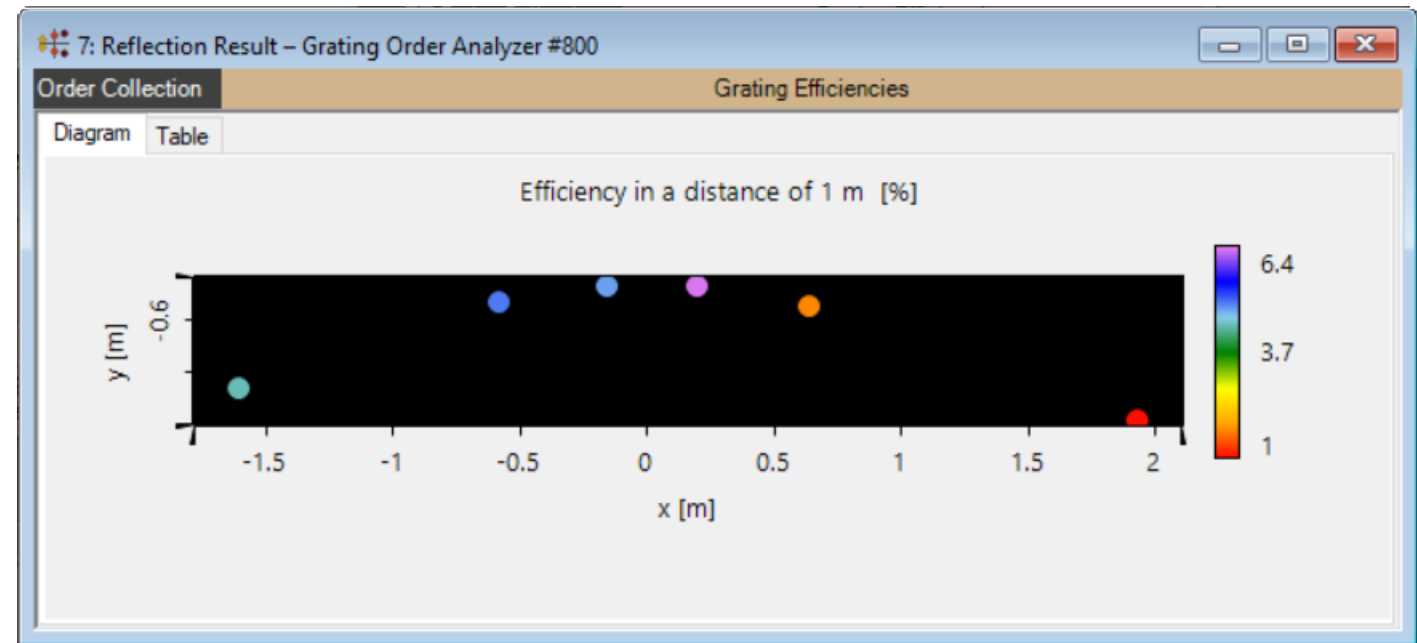


result

Efficiencies vs. Diffraction Order Position

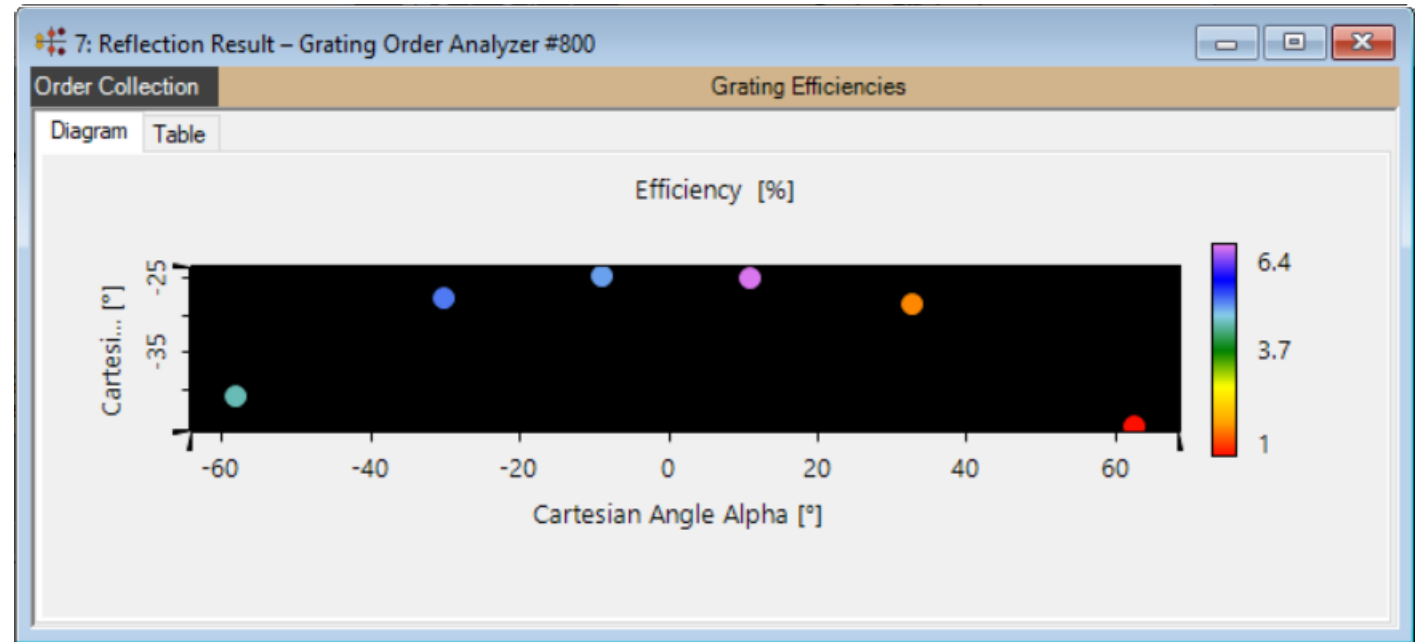
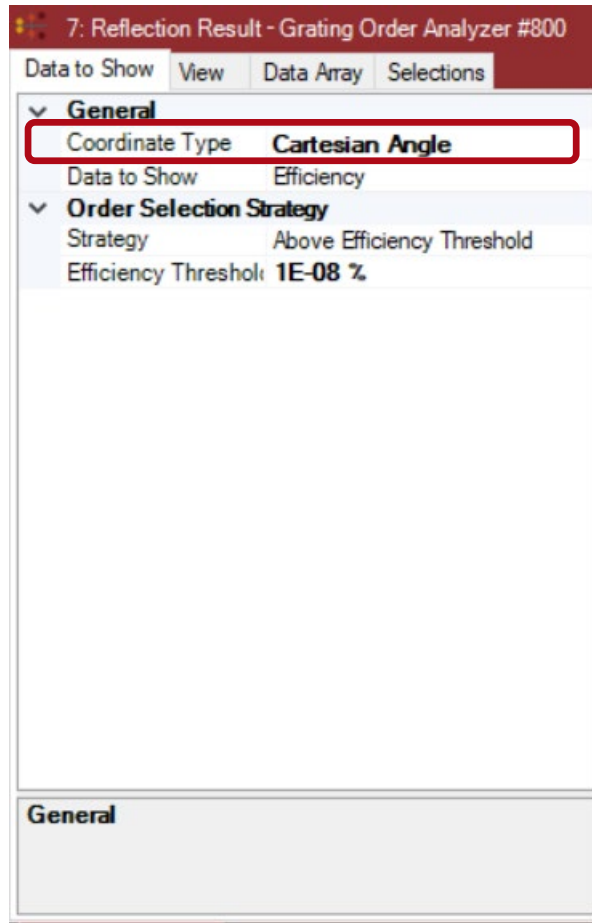


settings



result

Efficiencies vs. Diffraction Order Cartesian Angle



Document Information

title	Grating Order Analyzer
document code	GRT.0002
version	1.1
toolbox(es)	Grating Toolbox
VL version used for simulations	7.4.0.49
category	Feature Use Case
further reading	<ul style="list-style-type: none">- Analysis of Blazed Grating by Fourier Modal Method- Optimization of Lightguide Coupling Grating for Single Incidence Direction