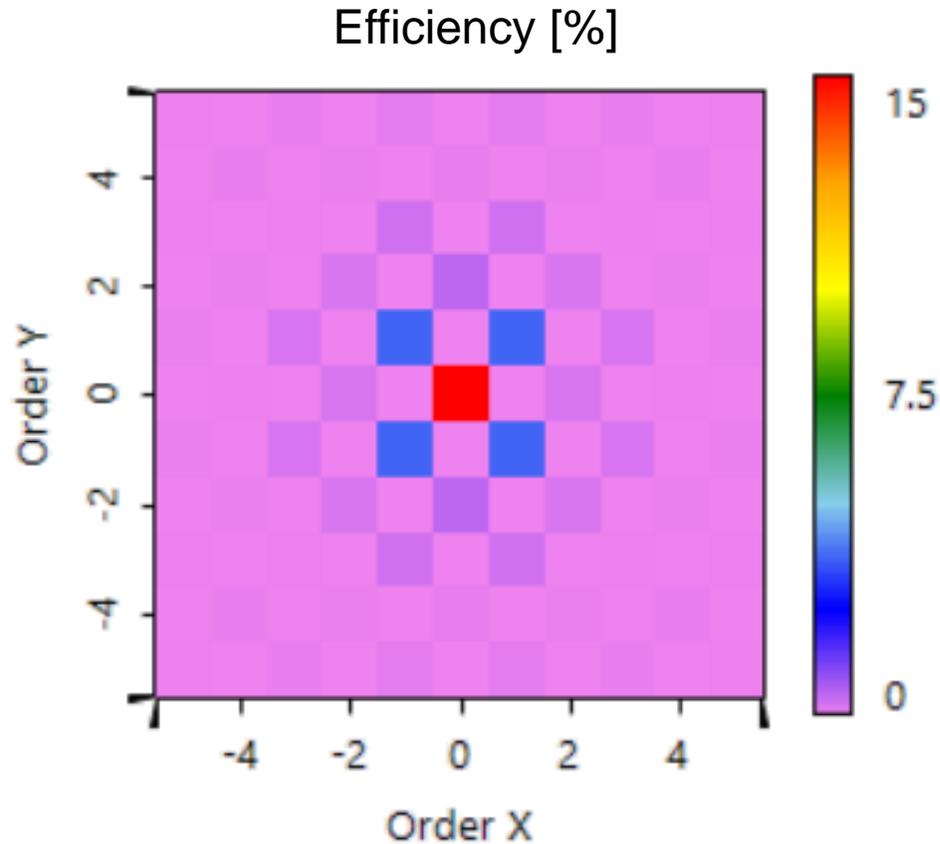


# Programmable Grating Analyzer

# Abstract



For different grating applications, one may like to access the grating diffraction properties in different manners. Besides the standard Grating Order Analyzer, VirtualLab Fusion provides a fully customizable analyzer. In this example, we show how to access the complete grating diffraction information, to display them, and to use it for further analysis or optimization. We use a pillar grating for illustration and show how to access the result of interest via Parameter Run.

# Programming Task

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Source Code Editor
Source Code Global Parameters Snippet Help Advanced Settings
Main Function
1 DetectorResultObject[] detectorResults = new DetectorResult
2
3 //Get the efficiency into a ComplexField
4 ComplexField Efficiency_cf = TransmissionResults.ConvertEf
5
6 //Calculate the Starting Order Index
7 SamplingParameters SP = new SamplingParameters(Efficiency_
8 VectorD FirstOrderIndexXY = CoordinateTransformations.Poin
9 //Display
10 DataArray2D Efficiency = new DataArray2D(new ComplexFieldA
11 new PhysicalProperty[] {PhysicalProperty.Percentage},
12 new string[] {"Efficiency"},
13 1.0,
14 FirstOrderIndexXY.X,
15 PhysicalProperty.NoUnit,
16 "Order X",
17 1.0,
18 FirstOrderIndexXY.Y,
19 PhysicalProperty.NoUnit,
20 "Order Y");
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```

# Initialization

Programmable Grating Analyzer can be found in the left panel of Optical Setup in *Grating Toolbox*.

# Basic Parameters

The image shows a Source Code Editor window with a code snippet and a Global Parameters dialog box. The code snippet is as follows:

```
1 DetectorResultObject[] detector
2
3
4 /******
5 ***** INSERT YOUR CODE HERE *****
6 *****
7
8 detectorResults[0]
9 return detectorResults
```

The Global Parameters dialog box is open, showing the following settings:

- Standard Usings: using System; using System.Collections.Generic; using System.Drawing; using System.IO; using VirtualLab.Programming; using VirtualLabAPI.Core.BasicFunctions; using VirtualLabAPI.Core.Common; using VirtualLabAPI.Core.DataVisualization; using VirtualLabAPI.Core.FieldRepresentations; using VirtualLabAPI.Core.Functions; using VirtualLabAPI.Core.GeometryDescription;
- Additional Usings: using VirtualLabAPI.Core.RigorousAnalysis;

Annotations in the image:

- A red box highlights the parameters: TransmissionResults [RigorousSimulationResult2D], ReflectionResults [RigorousSimulationResult2D], and AssociatedSystem [Lightpath]. An arrow points to this box with the text: "order information can be accessed from the two global parameters".
- A red box highlights the "Additional Usings" field in the dialog, containing "using VirtualLabAPI.Core.RigorousAnalysis;". An arrow points to this box with the text: "additional using must be included here".

# Efficiency of a Specified Order

C# Code: get the efficiency of a specified order and display of it

```
DetectorResultObject[] detectorResults = new DetectorResultObject[1];

//Get the efficiency of Order (1,1)
OrderInfo Order_11 = TransmissionResults.GetOrder(1, 1);
double Efficiency_11 = Order_11.

```

- Efficiency public double Efficiency
- Equals
- GetHashCode
- GetType
- OrderNumber
- RayleighCoefficients
- ToString

```
//display of efficiency of specific order
detectorResults[0] = new DetectorResultObject(new PhysicalValue(Efficiency_11, //order efficiency [double]
    PhysicalProperty.Percentage, //property of efficiency[PhysicalProperty]
    "Efficiency of Order (1,1)", //title of the display[string]
    "Programmable Grating Analyzer"); //name of this analyzer[string]

return detectorResults;
```

well guidance of C# code.

Simulation Engine 802: Programmable Grating Analyzer

Go!



Detector Results				
	Date/Time	Detector	Sub - Detector	Result
1	12/19/2018 14:32:58	Programmable Grating Analyzer	Value #1: Efficiency of Order (1,1)	3.7191 %

Messages | Detector Results

# Efficiencies of All Grating Orders

C# Code: get the efficiency matrix

```
//Get all efficiencies  
ComplexField Efficiency_cf = TransmissionResults.ConvertEfficienciesToComplexField();//Convert efficiency into a 2D matrix
```

C# Code: formulate the display matrix with setting the physical properties of x-/y- axis and efficiency

```
//Calculate the index of order (OrderX_min, OrderY_min)  
SamplingParameters SP = new SamplingParameters(Efficiency_cf.SamplingPoints, //order numbers  
                                               new VectorD(1, 1)); // order index is integer, so sampling distance is 1 along both x and y direction  
VectorD FirstOrderIndexXY = CoordinateTransformations.PointFromPixelToPhysicalCoordinates(new Vector(0, 0), SP); //(OrderX_min, OrderY_min)  
  
//2D order efficiencies matrix  
DataArray2D Efficiency = new DataArray2D(new ComplexFieldArray(Efficiency_cf), //efficiency matrix  
    new PhysicalProperty[]{PhysicalProperty.Percentage}, // unit of efficiency is percentage  
    new string[]{"Efficiency"}, // "title of the data array"  
    1.0, //sampling distance of order index is 1 along x direction  
    FirstOrderIndexXY.X, //OrderX_min  
    PhysicalProperty.NoUnit, //index has no unit  
    "Order X", //label of x-axis  
    1.0, //sampling distance of order index is 1 along y direction  
    FirstOrderIndexXY.Y, //OrderY_min  
    PhysicalProperty.NoUnit, //index has no unit  
    "Order Y"); //label of y-axis
```

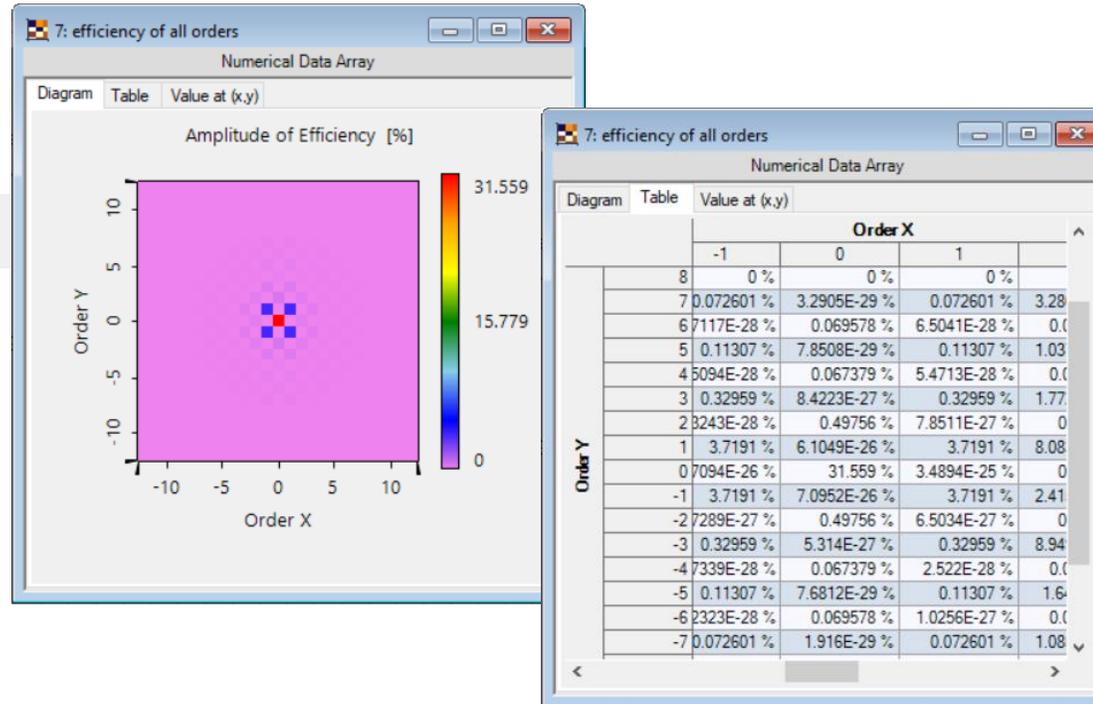
# Efficiencies of All Grating Orders

C# Code: display the efficiency matrix

```
//Display the efficiency data array 2D  
detectorResults[1] = new DetectorResultObject(Efficiency, "Grating Order Efficiency", "Programmable Grating Analyzer");
```

Simulation Engine 802: Programmable Grating Analyzer

Efficiencies are displayed  
as a 2D matrix/graph.



# Parameter Run – Varing Wavelength

varing wavelength from 300 nm to 700 nm for 11 steps

Parameter Specification

Set up the parameter(s) to be varied.

You can select one or more parameters which shall be varied as well as the resulting number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

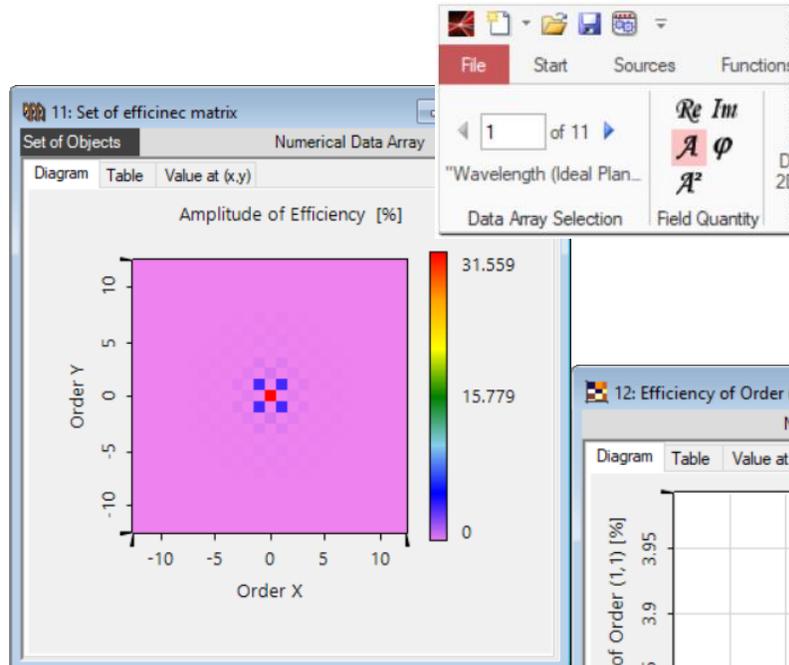
Usage Mode: Standard

wave

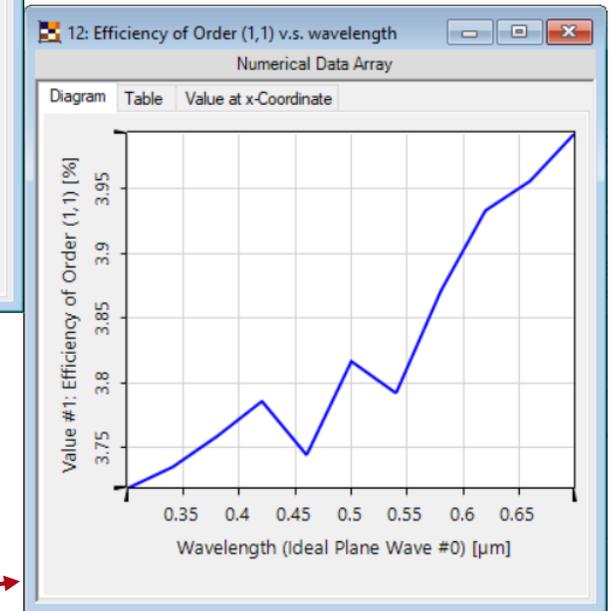
1	2	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original
		Ideal Plane Wave #0	Medium at "..." Cha...	Material (Air) I...	<input type="checkbox"/>	0	1E+300	1	1E+300	0
				Wavelength	<input checked="" type="checkbox"/>	300 nm	700 nm	11	40 nm	300 n
				Weight	<input type="checkbox"/>	0	1E+300	1	1E+300	1
				Polarization An...	<input type="checkbox"/>	0°	360°	1	360°	0°

Use Cached Results for Next Run

		Iteration Step			
Detector	Subdetector	Combined Output	8	9	10
Varied Parameters	Wavelength (Ideal Plane W...	Data Array	580 nm	620 nm	660 nm
Grating Order Efficiency	Programmable Grating An...	2D Data Ara	ata Array	2D Data Array	2D Data Array
Programmable Grating An...	Value #1: Efficiency of Ord...	Data Array	3.8711 %	3.9334 %	3.9562 %



11 layers of 2D data matrix/graph



efficiency (1,1) v.s. wavelength

# Peek into VirtualLab

Source Code Editor

```
8 detectorResults[0] = new DetectorResultObject(new PhysicalValue(Efficiency.  
9 PhysicalPr  
10 "Efficiency:  
11 "Programmable Grating Analyzer"  
12  
13  
14 //Get all efficiencies  
15 ComplexField Efficiency_cf = TransmissionResults.ConvertEfficienciesToComp.  
16  
17 //Calculate the index of order (OrderX_min, OrderY_min)  
18 SamplingParameters SP = new SamplingParameters(Efficiency_cf, new Vec  
19 new Vec  
20 VectorD FirstOrderIndexXY = CoordinateTransformation  
21  
22 //2D order efficiencies matrix  
23 DataArray2D Efficiency = new DataArray2D(new ComplexField[] {  
24 new PhysicalProperty[] {PhysicalProperty.PercentEfficiency, //title of the dat  
25 new string[] {"Efficiency"}, //sampling distance  
26 1.0, //OrderX_min  
27 FirstOrderIndexXY.X, //index has no unit  
28 PhysicalProperty.NoUnit,  
--
```

7: efficiency of all orders  
Numerical Data Array  
Diagram Table Value at (x,y)  
Amplitude of Efficiency [%]  
Order Y  
Order X

8: D:\OneDrive\...\Parogrammable Grating Analyzer\_Parameter Run.run  
Parameter Specification  
Set up the parameter(s) to be varied.  
You can select one or more parameters which shall be varied as well as the resulting are available specifying how the parameters are varied per iteration.  
Usage Mode Standard

1	2	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original
		Ideal Plane Wave #0	Medium at "-" Cha...	Material (Air) [...]	<input type="checkbox"/>	0	1E+300	1	1E+300	0
				Wavelength	<input checked="" type="checkbox"/>	300 nm	700 nm	11	40 nm	300
				Weight	<input type="checkbox"/>	0	1E+300	1	1E+300	1
				Polarization An...	<input type="checkbox"/>	0°	360°	1	360°	0°

Parameter Run to scanning values of wavelength

C# code in the Programmable Grating Analyzer

# Document Information

title	Programmable Grating Analyzer
document code	CZT.0109
version	1.0
toolbox(es)	Grating Toolbox
VL version used for simulations	7.6.1.18
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#">Customized Detector for Lightguide Coupling Grating Evaluation</a></li><li>- <a href="#">Source Code Editor</a></li></ul>