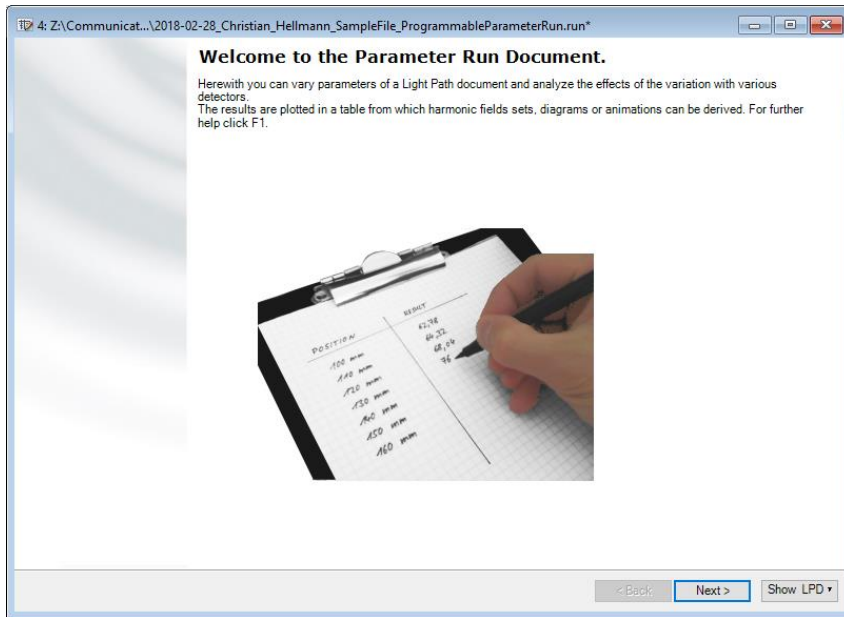


# **Application of the Programmable Mode of a Parameter Run**

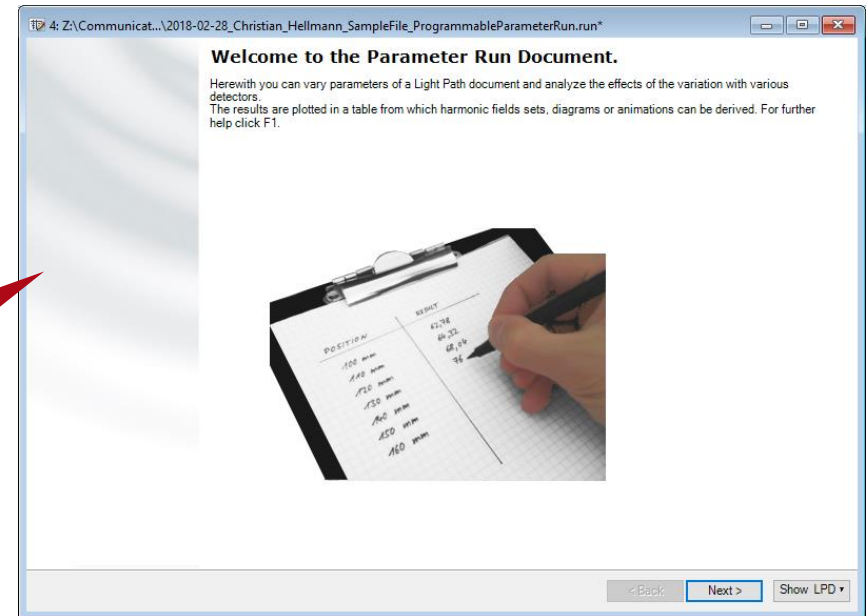
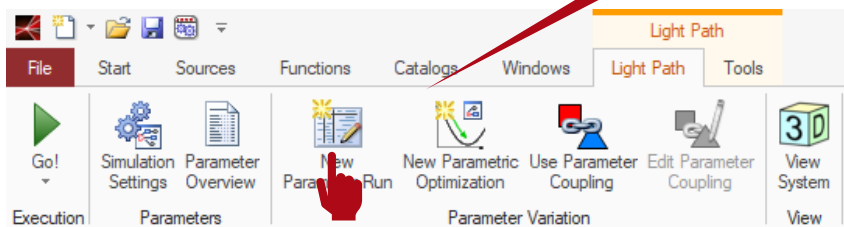
# Abstract



Systematical variations of parameters are substantial for detailed investigations of complex optical systems. VirtualLab Fusion enables the variation of parameters by the so-called parameter run feature. By using the parameter run, such variations can be configured arbitrarily, depending on the demands of the task of analysis. Further, the special programmable mode allows a free configuration in order to provide fully customizable parameter variations. In an example, the application of this programmable mode is presented.

# Initialization of a Parameter Run

- Variations of parameters can be done by using the parameter run feature.



# Selection of Parameters and Range of Variation

- On the second page, the mode of the parameter run has to be chosen.
- In the table below, the desired parameter for variation can be selected, as well as the corresponding range and number of variation steps.
- In this example, the period and the height of a rectangular grating are varied.

4: Z:\Communicat...\2018-02-28\_Christian\_Hellmann\_SampleFile\_ProgrammableParameterRun.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 number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

Usage Mode: Programmable

Filter by...  Show Only Varied Parameters

1	2	Object	Category	Parameter	Vary	From	To	Steps	Original Value
		Rectangular Grating #1	Stack #1 (Rectangular Grating)	Interface #1 (Rectangular Grating Interface)   Grating Period	<input checked="" type="checkbox"/>	500 nm	2 $\mu$ m	10	1 $\mu$ m
				Interface #1 (Rectangular Grating Interface)   Modulation Depth	<input checked="" type="checkbox"/>	800 nm	900 nm	10	500 nm

< Back    Next >    Show LPD ▾

# Customization of the Parameter Run

- Next, the variation of the chosen parameters can be configured with the help of basic C# code.
- For instance, the period is varied linearly, whereas the height is set randomized.

The screenshot displays a Source Code Editor window with the following C# code:

```
1 double[,] parameters = new double[NumberOfParameters,NumberOfIterations];
2
3 double minPeriod = MinimumValues[0];           //extract minimum period
4 double maxPeriod = MaximumValues[0];           //extract maximum period
5 double minModulationDepth = MinimumValues[1];  //extract minimum modulation depth
6 double maxModulationDepth = MaximumValues[1];  //extract maximum modulation depth
7
8
9 //calculate step width for period for linear scan
10 double stepWidthPeriod = (maxPeriod - minPeriod) / (NumberOfIterations - 1);
11 //generate random number generate to generate random distributed modulation height
12 Random randGenerator = new Random(0);         //we use fixed seed of 0 to generate reproducible results
13 //calculate range for modulation depth
14 double rangeModulationDepth = maxModulationDepth - minModulationDepth;
15
16 //loop over all iterations
17 for(int runIterations = 0; runIterations < NumberOfIterations; runIterations++){
18     //calculate period value of current iteration
19     parameters[0, runIterations] = minPeriod + (runIterations * stepWidthPeriod);
20     //calculate random modulation depth value of current iteration
21     parameters[1, runIterations] = minModulationDepth + (randGenerator.NextDouble() * rangeModulationDepth);
22 }
23
24 //return generated parameter array
25 return parameters;
```

Overlaid on the editor is a dialog box titled "Parameter Specification" with the following content:

4: Z:\Communicat...\2018-02-28\_Christian\_Hellmann\_SampleFile\_Pro

**Parameter Specification**

Set up a snippet which generates a two dimensional array, which is used as

Definition

Edit

Validity: ✓

Parameters list:

- NumberOfParameters [int]
- NumberOfIterations [int]
- MinimumValues [double[]]
- MaximumValues [double[]]

A red arrow points from the "Edit" button in the dialog box to the first line of code in the editor.

# Customization of the Parameter Run

- On the next page, the configured iterations of the parameter run are exhibited.

4: Z:\Communicat...\2018-02-28\_Christian\_Hellmann\_SampleFile\_ProgrammableParameterRun.run\*

### Parameter Visualization

Preview of used parameter sets per iteration

The table below shows the parameters which will be used in each iteration of the Parameter Run.  
It is also checked whether all parameters are valid. If invalid parameters are present, please check the set up snippet.

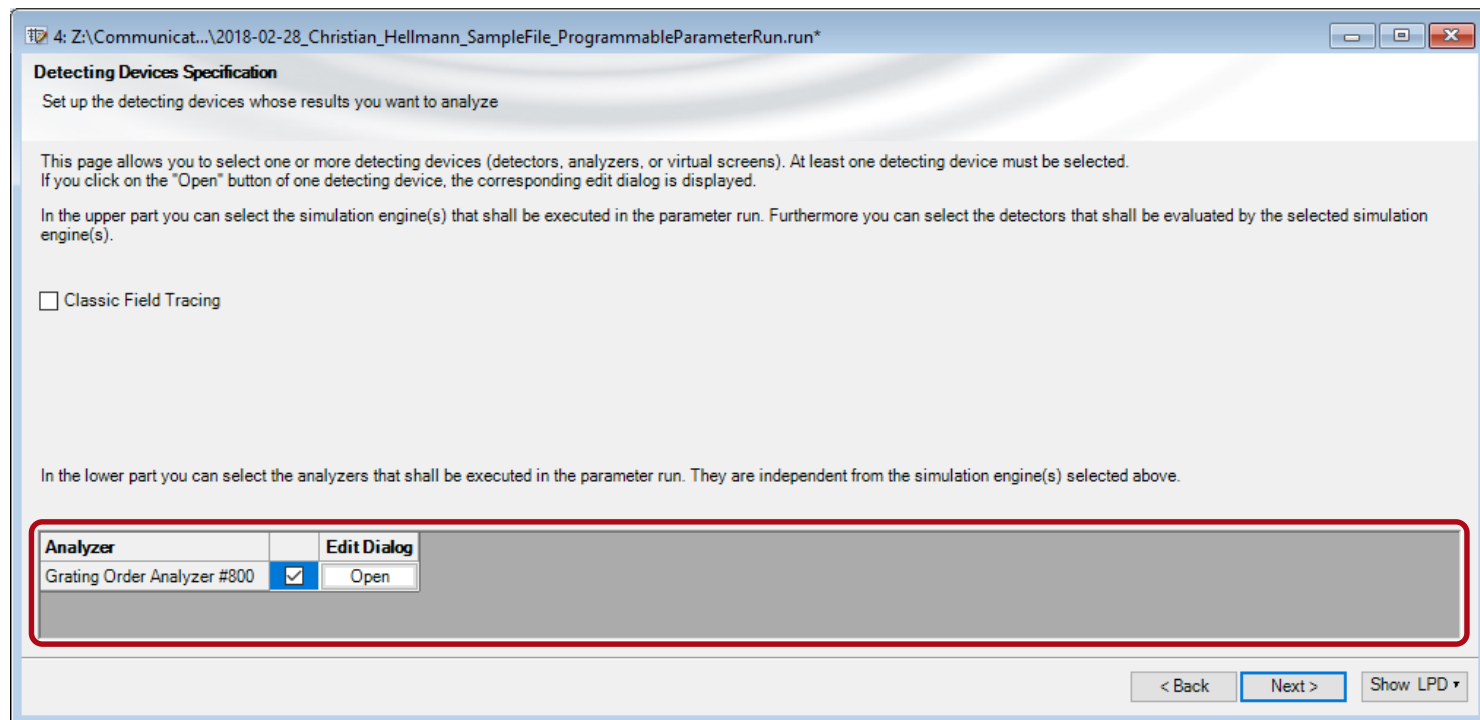
	Iteration Step	1	2	3	4	5
0	Grating Period (Rectangular Grating #1   Stack #1 (Rectangular Grating)   Interface #1 (Rectangular Grating Interface))	500 nm	666.67 nm	833.33 nm	1 μm	1.1667 μm
1	Modulation Depth (Rectangular Grating #1   Stack #1 (Rectangular Grating)   Interface #1 (Rectangular Grating Interface))	872.62 nm	881.73 nm	876.8 nm	855.82 nm	820.6 nm

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< Back Next > Show LPD ▾

# Set up of the Parameter Run

- Next, as for all modes of the Parameter Run, the desired simulation engine and/or analyzer has to be selected.
- In this example, just the *Grating Order Analyzer* is used.




# Set up of the Parameter Run









- Then click Go to start the calculation.
- After the calculation has finished, all results are presented in the table below.

4: Z:\Communicat...\2018-02-28\_Christian\_Hellmann\_SampleFile\_ProgrammableParameterRun.run\*

**Results**  
Start the parameter run and analyze its results



Use Cached Results for Next Run

Detector	Subdetector	Combined Output	Iteration Step					
			5	6	7	8	9	10
Varied Parameters	Grating Period (Rectangul...	Data Array 	1.1667 $\mu\text{m}$	1.3333 $\mu\text{m}$	1.5 $\mu\text{m}$	1.6667 $\mu\text{m}$	1.8333 $\mu\text{m}$	2 $\mu\text{m}$
	Modulation Depth (Rectan...	Data Array 	820.6 nm	855.89 nm	890.6 nm	844.22 nm	897.75 nm	827.37 nm
Grating Order Analyzer #8...	Transmission Result	Animation 	Order Collection	Order Collection	Order Collection	Order Collection	Order Collection	Order Collection
Grating Order Analyzer #800 (Results for Individual Orders)	Efficiency T[-2; 0]	Data Array 	16.173 %	20.515 %	23.578 %	10.542 %	9.6119 %	6.4215 %
	Efficiency T[-1; 0]	Data Array 	26.882 %	22.539 %	14.363 %	22.402 %	16.389 %	23.567 %
	Efficiency T[0; 0]	Data Array 	7.6773 %	9.9875 %	22.302 %	15.989 %	26.275 %	16.085 %
	Efficiency T[+1; 0]	Data Array 	26.882 %	22.539 %	14.363 %	22.402 %	16.389 %	23.567 %
	Efficiency T[+2; 0]	Data Array 	16.173 %	20.515 %	23.578 %	10.542 %	9.6119 %	6.4215 %

< Back   Next >   Show LPD ▾



# Document Information

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title	Application of the Programmable Mode of a Parameter Run
version	1.0
VL version used for simulations	7.0.3.4
category	Feature Use Case

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