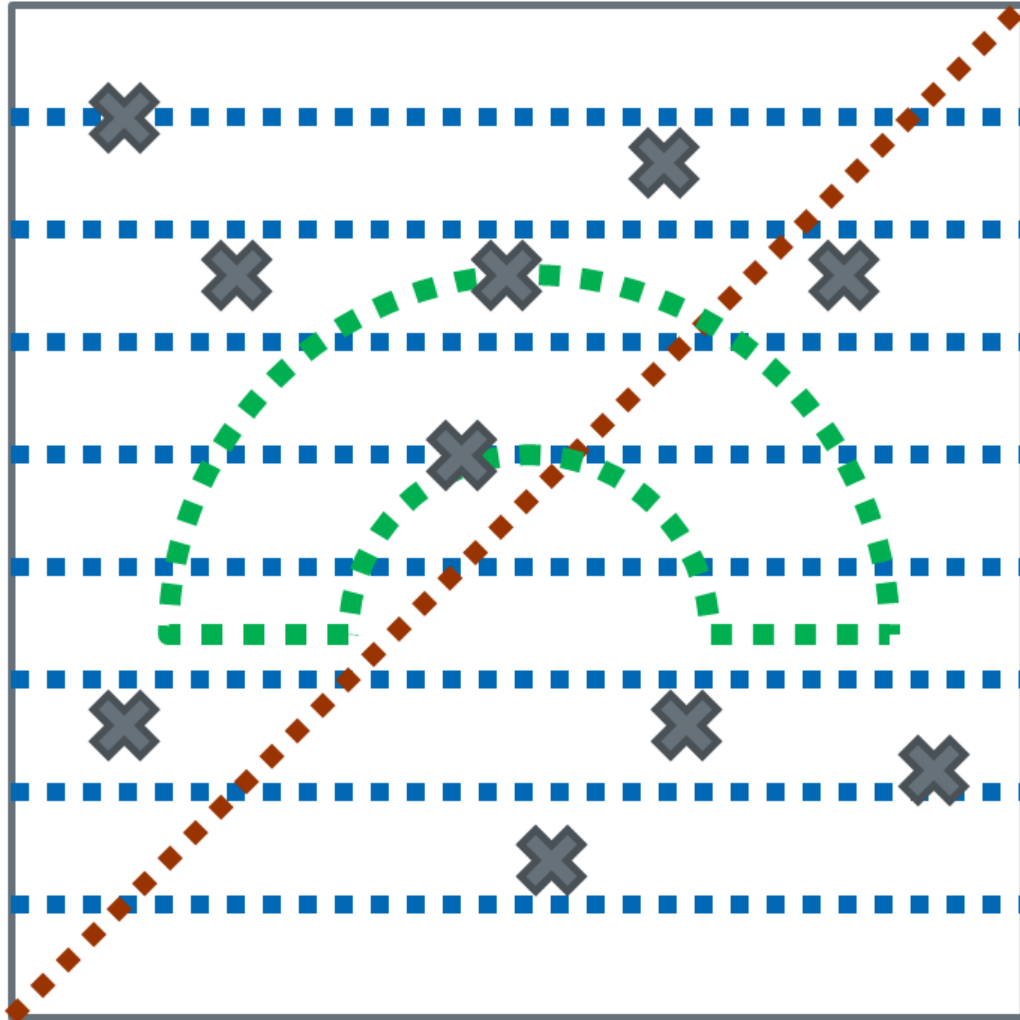


# Usage of the Parameter Run Document

# Abstract



For a given optical system, it is helpful to check its performance by controlling and varying selected parameters. VirtualLab Fusion provides a fully flexible and computationally efficient (via parallelization) Parameter Run, which enables the user specify different manners of parameter variations. As an example, it can be used for the tolerance analysis with respect to any system parameters under investigation. The analysis result can be visualized in different ways, such as single numbers, graphs, or even animations.

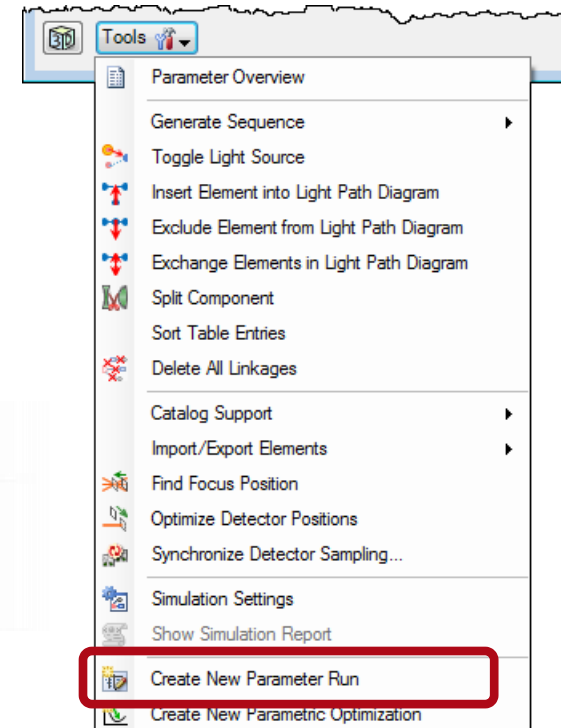
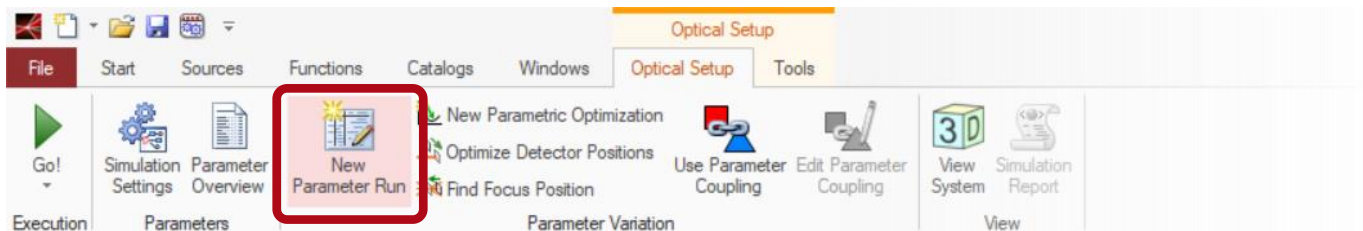
# Parameter Run Document

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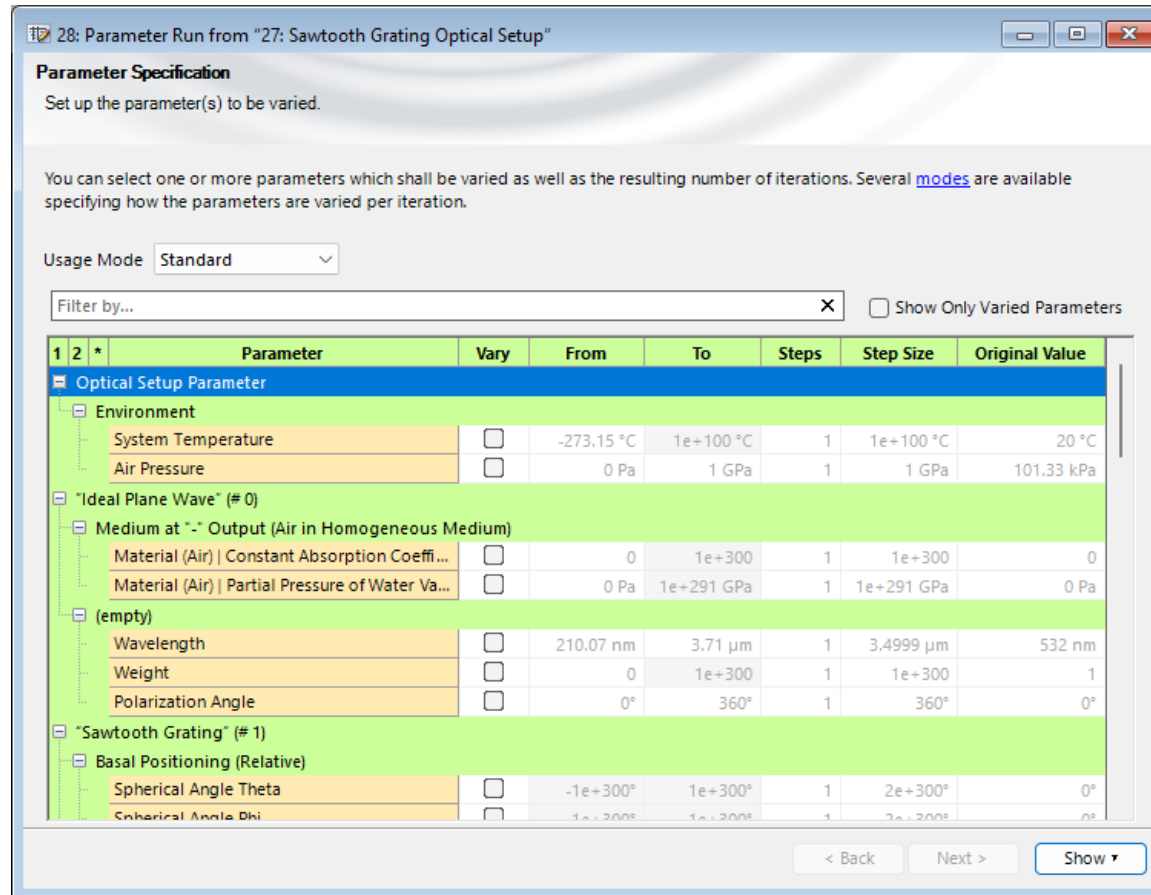
- The Parameter Run document allows the variation of the numerical parameters of an Optical Setup.
- It can be used e. g.
  - to investigate the system's sensitivity for parameter tolerances
  - to optimize parameters
  - to evaluate the changing profile of a beam in the vicinity of a focus
  - ...
- One or multiple parameters can be varied.
- Detector results are recorded within the Parameter Run document.
- A copy of the original Optical Setup is stored in the Parameter Run document.

# New Parameter Run

- To generate a new Parameter Run an open and activated Optical Setup window is required.
- A new Parameter Run document can be generated via
  - ribbon
  - Optical Setup Tools
  - shortcut Ctrl + P

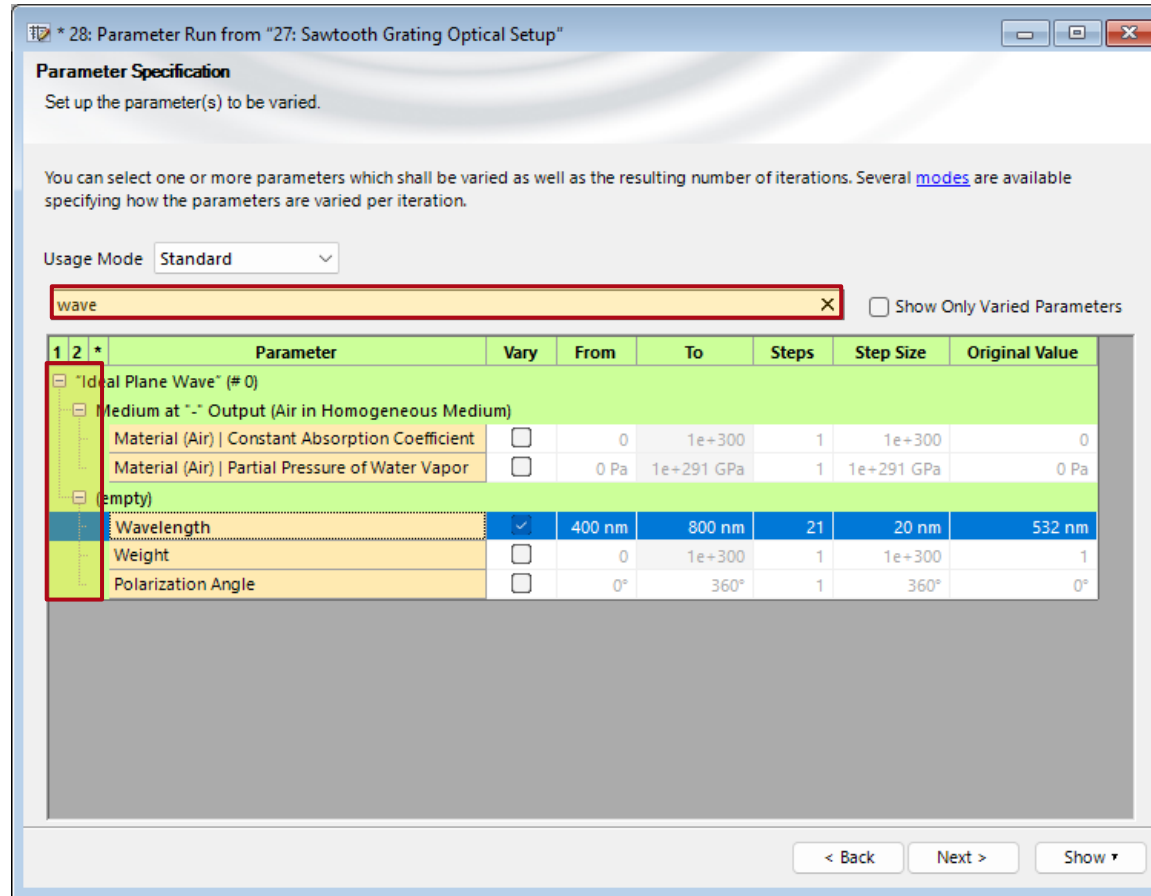


# Parameter Specification Page



- This page allows you to select the parameters that should be varied.
- The parameter range and the number of steps can be specified.
- Four different Usage Modes (Standard, Programmable, Scanning, Random) will be Explained later.

# Parameter Specification Page



You can

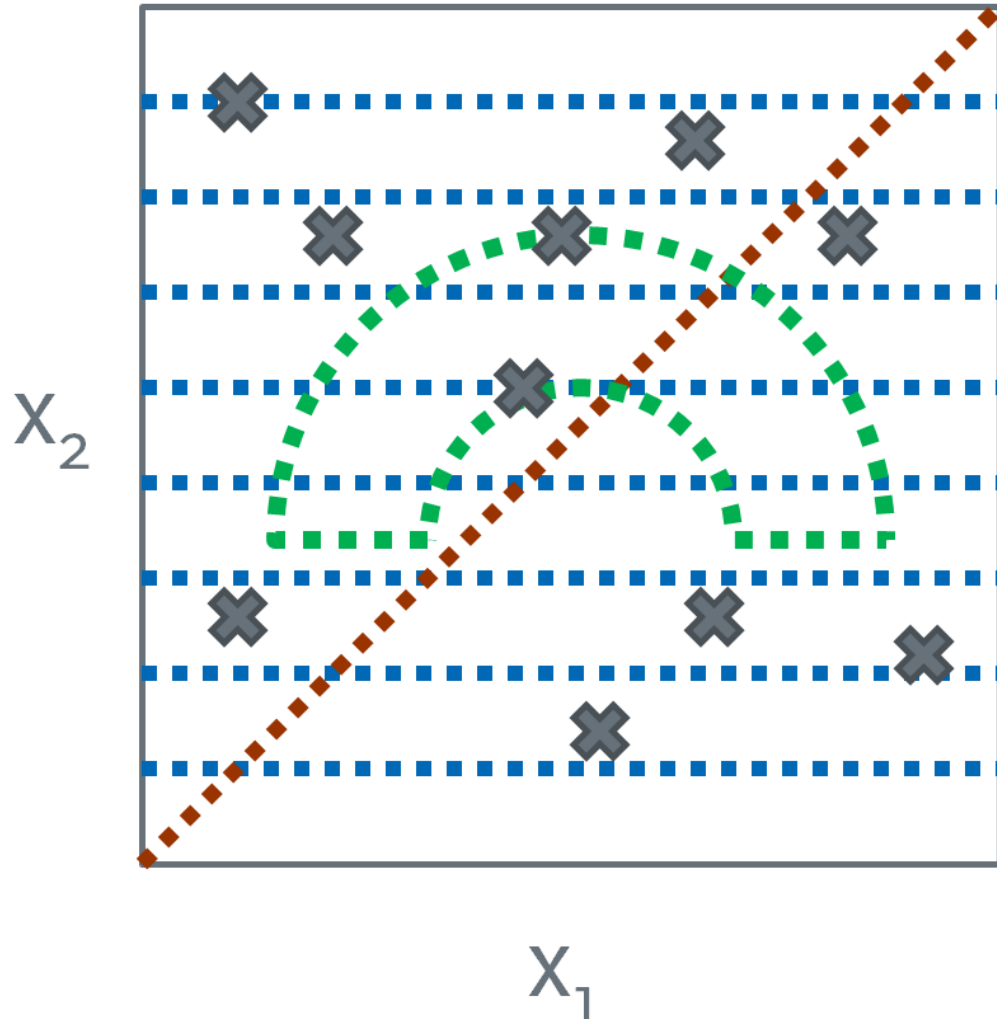
- filter for specific parameters
- show only the ones that are already set for variation
- fold/unfold the parameter list for a clearer representation by using the first three columns

# Usage Modes

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- **Standard Mode:**  
Linear variation of all selected parameters between minimum and maximum value.
- **Programmable Mode:**  
Customized parameter values per variation step. A table with the parameter values per variation step is filled by a snippet.
- **Scanning Mode:**  
Scan of parameter space – all possible parameter combinations are simulated.
- **Random Mode:**  
Random variation of parameters between minimum and maximum value. Sometimes also called Monte-Carlo-Simulation. A seed can be used for reproducible results.

# Usage Modes



- Illustration of the different usage modes for the parameter run. A two-dimensional parameter space defined by two parameters  $X_1$  and  $X_2$  is shown.
- **Red:** Resulting parameter sets for the standard mode.
- **Green:** Example how the parameter sets can be generated by a snippet in the programmable mode.
- **Blue:** Resulting parameter sets for the scanning mode.
- **Grey:** Some randomly generated parameter sets.



# Detecting Devices Specification Page

**Specification of Detecting Devices**  
This page allows you to select one or more detecting devices (detectors, analyzers, and the 3D system view). At least one detecting device must be selected.

Detector		Edit Dialog
"Universal Detector" (# 600)	<input checked="" type="checkbox"/>	Open
"Universal Detector" (# 601)	<input checked="" type="checkbox"/>	Open

Analyzer		Edit Dialog
"Grating Order Analyzer" (# 800)	<input checked="" type="checkbox"/>	Open

Validity:

< Back   Next >   Show ▾

- This page allows to select which simulation engines, detectors, screens and analyzers are evaluated.
- The detecting devices can be configured after clicking Open to get to the edit dialog.

# Results Page

Starts and stops the parameter variation.

Results

Start the parameter run and analyze its results

Local Execution (Parallel Iterations: 8)

Use Already Calculated Results for Next Run

Detector	Subdetector	Combined Output	Iteration Step			
			18	19	20	21
Varied Parameters	Wavelength ("Ideal Plane	Data Array	740 nm	760 nm	780 nm	800 nm
"Grating Order Analyzer" (# 800)...	Efficiency R[0; 0]	Data Array	99619 %	0.00091778 %	0.00025977 %	0.0010451 %
	Efficiency R[+1; 0]	Data Array	7528 %	0.0033005 %	0.0041585 %	0.0061311 %
"Universal Detector" (# 600)...		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array
"Universal Detector" (# 601)...		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array

Simulation results: Double click on a document to view it in a separate window.

In the Property Browser you can change the formatting of the shown physical values (number of digits) so that you can better export them to e.g. spreadsheet programs via copy & paste.

Property Browser

\* 32: Parameter Run from "27: Sawtooth Grating Optic..."

General

Number of Parallel... 8

Sort Rows

Always Plot versus...

Logging During...

Automatic Saving

After Parameter Run... Do Nothing

Automatic Saving

Format of Numbers

Number of Digits 5

Format of Complex... Amplitude / Phase

# Optical Setups within Parameter Run

Wyrowski VirtualLab Fusion 2024.1 (Build 1.134)

Parameter Run

File Start Sources Functions Catalogs Windows Help Parameter Run

Execution: After Completion (Do Nothing) Go!

Document: Refresh Show Optical Setup

Result Table: Logging During Execution Create Output from Selection Delete Results

\* 32: Parameter Run from "27: Sawtooth Grating Optical Setup"

Results

Start the parameter run and analyze its results

Go! Local Execution (Parallel Iterations: 8)

Use Already Calculated Results for Next Run

Detector	Subdetector	Combined Output	Iteration Step			
			18	19	20	21
Varied Parameters	Wavelength (Ideal Plane)	Data Array	740 nm	760 nm	780 nm	800 nm
"Grating Order Analyzer" (# 800...)	Efficiency R[0; 0]	Data Array	19619 %	0.00091778 %	0.00025977 %	0.0010451 %
"Universal Detector" (# 600...)	Efficiency R[+1; 0]	Data Array	17528 %	0.0033005 %	0.0041585 %	0.0061311 %
"Universal Detector" (# 601...)		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array
"Universal Detector" (# 601...)		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array

Create Output from Selection Filter Rows by...

< Back Next > Show

Property Browser

\* 32: Parameter Run from "27: Sawtooth Grating Optic..."

General

Number of Paralle... 8

Sort Rows

Always Plot versus...

Logging During...

Automatic Saving

After Parameter Run... Do Nothing

Automatic Saving

Format of Numbers

Number of Digits 5

Format of Complex... Amplitude / Phase

Property Br... VirtualLab... Assistant Distributed...

Detector Results Messages

Displays the optical setup:

- initial
- from any iteration

Show Initial Optical Setup  
Show Optical Setup for Certain Iteration Step...

# Logging of Parameter Run Results

The screenshot displays the VirtualLab Fusion interface. The main window shows a 'Parameter Run' document titled '\* 32: Parameter Run from "27: Sawtooth Grating Optical Setup"'. The 'Results' section is active, showing a table of data for various parameters across iteration steps 18, 19, 20, and 21. A red box highlights the 'Logging During Execution' button in the 'Parameter Run' ribbon. The 'Property Browser' on the right shows the 'Logging During...' checkbox checked. A tooltip is visible over the 'Show' button in the results window.

Detector	Subdetector	Combined Output	Iteration Step
Varied Parameters	Wavelength [Ideal Plane]	Data Array	18 19 20 21
			740 nm 760 nm 780 nm 800 nm
"Grating Order Analyzer" (# 800)...	Efficiency R[0; 0]	Data Array	0.9619 % 0.00091778 % 0.00025977 % 0.0010451 %
"Universal Detector" (# 600)...	Efficiency R[+ 1; 0]	Data Array	0.7528 % 0.0033005 % 0.0041585 % 0.0061311 %
"Universal Detector" (# 601)...		1D Data Array	1D Data Array 1D Data Array 1D Data Array

- For time critical simulations especially for Parameter Runs with many iterations, the simulation time can be reduced by **deactivating the logging**.
- Thus the results are only shown after all iterations are finished.
- In order to see the results of a running Parameter Run document that have been produced so far, you can duplicate the document via the Windows ribbon; then VirtualLab creates a Parameter Run document of the current status with all already calculated results.

# Display of Parameter Run Results

The screenshot displays the 'Parameter Run' window in Wyrowski VirtualLab Fusion 2024.1. The main window shows a table of results for a parameter run from '27: Sawtooth Grating Optical Setup'. The table has columns for 'Detector', 'Subdetector', 'Combined Output', and 'Iteration Step' (18, 19, 20, 21). The results are organized into sections: 'Varied Parameters', 'Grating Order Analyzer', and 'Universal Detector'. A 'Delete Results' button is highlighted with a red box and a '1' in a red circle. The 'Property Browser' on the right shows settings for the parameter run, with 'Sort Rows' and 'Format of Complex...' highlighted by red boxes and '2' and '3' in red circles respectively. A tooltip is visible at the bottom of the results window.

Detector	Subdetector	Combined Output	18	19	20	21
Varied Parameters	Wavelength [Ideal Plane]	Data Array	740 nm	760 nm	780 nm	800 nm
Grating Order Analyzer (# 800...)	Efficiency R[0; 0]	Data Array	9619 %	0.00091778 %	0.00025977 %	0.0010451 %
	Efficiency R[+ 1; 0]	Data Array	7528 %	0.0033005 %	0.0041585 %	0.0061311 %
Universal Detector (# 600...)		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array
		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array

1. It is possible to delete the results in order to save a smaller Parameter Run document (e.g. for email sending). (Sometimes the saving or opening of a Parameter Run document with many and/or huge results takes longer than the simulation of all iterations.)
2. The user can select different orders for the display of the results.
3. There are different options to display complex numbers.

# Saving (& Shutdown) after Parameter Run Completion?

Allows you to save the results after the simulation has finished and then shut down your computer.

The screenshot displays the Lumerical software interface during a parameter run. The main window shows the 'Parameter Run' dialog with the 'After Completion' dropdown menu set to 'Do Nothing'. A red box highlights this dropdown, and a red arrow points from the text on the right to it. Below the dialog, a 'Results' window is open, showing a table of simulation results. The table has columns for 'Detector', 'Subdetector', 'Combined Output', and 'Iteration Step' (18, 19, 20, 21). The results include data for 'Varied Parameters' (Wavelength) and 'Efficiency R' for different detectors. A tooltip is visible over the 'Show' button, indicating options to 'Show Initial Optical Setup' or 'Show Optical Setup for Certain Iteration Step...'. On the right side, the 'Property Browser' is open, showing the 'Automatic Saving' section with the 'After Parameter Run...' dropdown also set to 'Do Nothing', which is also highlighted with a red box and a red arrow from the text on the right.

Detector	Subdetector	Combined Output	Iteration Step			
			18	19	20	21
Varied Parameters	Wavelength [Ideal Plane]	Data Array	740 nm	760 nm	780 nm	800 nm
"Grating Order Analyzer" (# 800...)	Efficiency R[0; 0]	Data Array	9619 %	0.00091778 %	0.00025977 %	0.0010451 %
"Universal Detector" (# 600...)	Efficiency R[+ 1; 0]	Data Array	7528 %	0.0033005 %	0.0041585 %	0.0061311 %
"Universal Detector" (# 601...)		1D Data Array	1D Data Array	1D Data Array	1D Data Array	1D Data Array

# Results Page – Combined Outputs

The results for each (sub-)detector can be combined into a Data Array, Animation, Harmonic Fields Set or Ray Distribution. Which combined outputs are available depends on the type and dimensionality of the original documents.

Create the combined output – or stop the creation if it takes too long. Clicking/Double clicking on a cell in the Detector or Subdetector column is a shortcut to selecting the whole row and start the output creation with the current combined output.

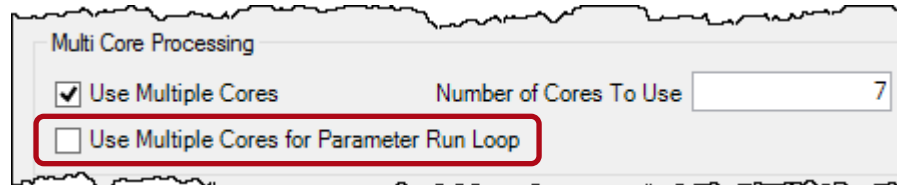
Detector	Subdetector	Combined Output	18	19	20	21
Varied Parameters	Wavelength ("Ideal Plane	Data Array	740 nm	760 nm	780 nm	800 nm
"Grating Order Analyzer" (# 800)...	Efficiency R[0; 0]	Data Array	9619 %	0.00091778 %	0.00025977 %	0.0010451 %
	Efficiency R[+1; 0]	Data Array	7528 %	0.0033005 %	0.0041585 %	0.0061311 %
"Universal Detector" (# 600...		1D Data Array	ta Array	1D Data Array	1D Data Array	1D Data Array
"Universal Detector" (# 601...		1D Data Array	ta Array	1D Data Array	1D Data Array	1D Data Array

- Select the results to combine.
- Clicking on a cell in the Detector or Subdetector column selects the whole row.

- Choose the desired combined output.
- Several combined outputs can be configured by clicking on the pencil icon.

# Parallelization & Amount of Data

- The execution of the different iterations of a Parameter Run simulation is very well parallelized. Thus it represents a very efficient method to simulate many different settings very fast.
- But in case already one simulation is extremely memory consuming, parallel executions are out of the question. They would not be possible or slow down the whole process if VirtualLab may swap such large data on hard disc instead of keeping it in the RAM.
- Then the parallelization should be switched off for Parameter Run Loop.
- VirtualLab will still do parallel computations, as parallelization is also used within single system simulations.





# Document Information

title	Usage of the Parameter Run Document
document code	MISC.0071
document version	2.1
required packages	-
software version	2024.1 (Build 1.132)
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#"><u>Programming a Scanning Parameter Run</u></a></li><li>- <a href="#"><u>Application of the Programmable Mode of a Parameter Run</u></a></li><li>- <a href="#"><u>Tolerance Analysis of a Fiber-Coupling Setup</u></a></li></ul>