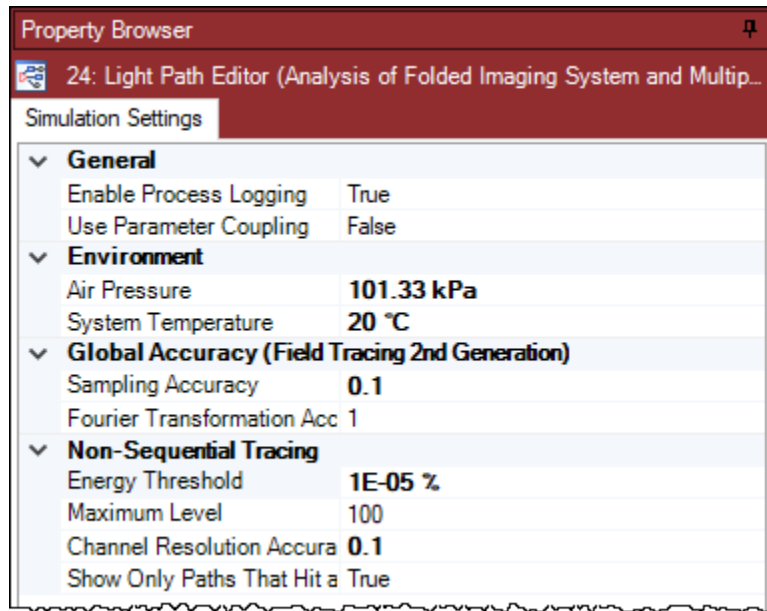


# **Non-Sequential Configuration: How to Use Simulation Settings for Ray and Field Tracing**

# Abstract



VirtualLab Fusion can be used to perform ray tracing as well as field tracing. The control of numerical simulations is typically handled by specification of various numerical parameters. In VirtualLab Fusion this is commonly handled by the specification of accuracy factors. This document explains the usage of the provided accuracy factors to control the ray and field tracing engine within VirtualLab Fusion with the focus on the setting of non-sequential simulation.

# Overview Simulation Settings

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The following simulation settings will be explained in more detail:

## **Global Accuracy (Field Tracing 2nd Generation)**

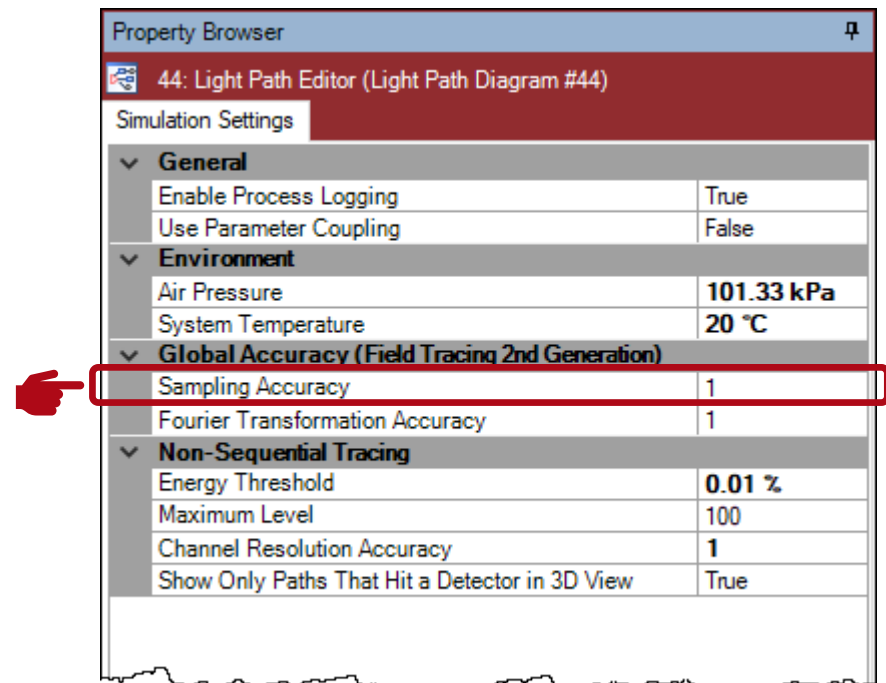
1. Sampling Accuracy
2. Fourier Transform Accuracy

## **Non-Sequential Field/Ray Tracing**

3. Energy Threshold
4. Maximum Level
5. Channel Resolution Accuracy
6. Show Only Paths That Hit a Detector in 3D View

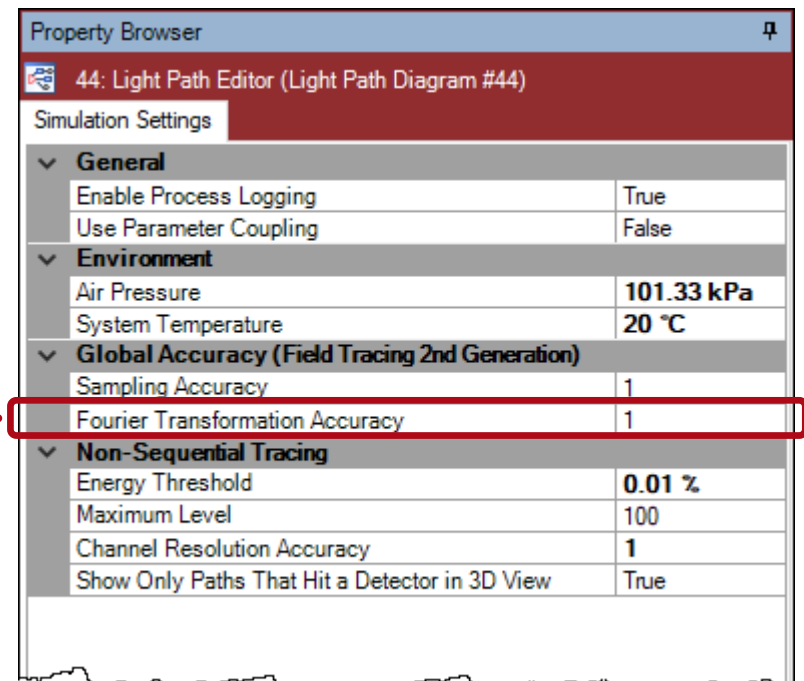
# 1. Sampling Accuracy

- The *Sampling Accuracy* is a parameter to manipulate the accuracy of the field information during its tracing.
- If unexpected artefacts in the intensity occur, this might be overcome by increasing the sampling accuracy factor.



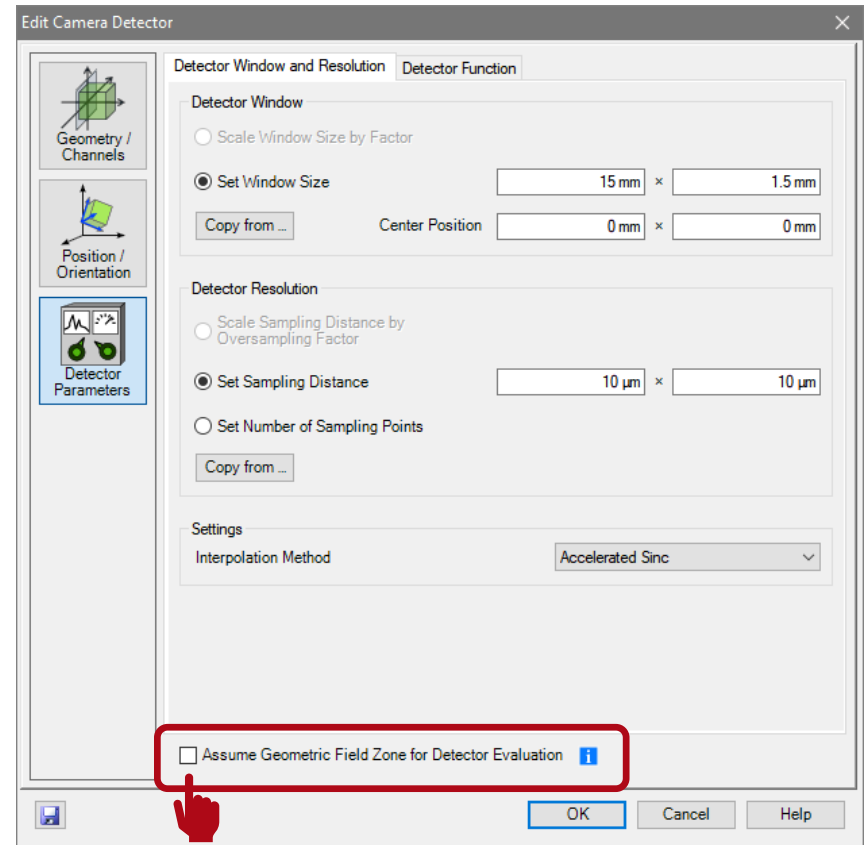
## 2. Fourier Transformation Accuracy

- In VirtualLab Fusion there are several Fourier transform algorithms implemented.
- These are selected automatically depending on whether the field is located in its diffractive or geometric zone.
- A small *Fourier Transformation Accuracy* (e.g. 0.01) forces the global use of the geometric Fourier transform, which is typically much faster than the diffractive one.



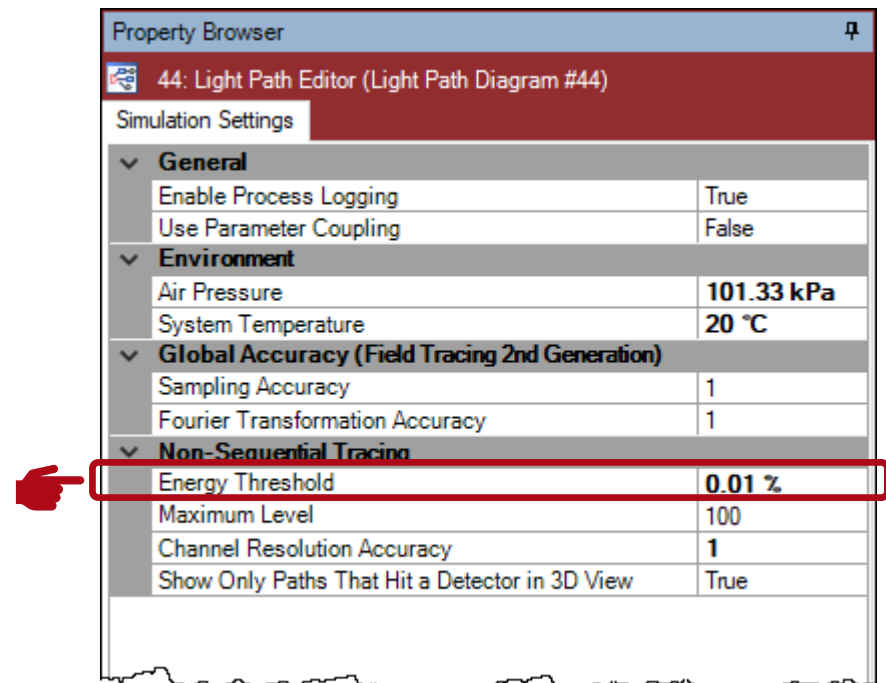
## 2. Fourier Transformation Accuracy

- Additionally, each detector has the option to individually force the use of the geometric Fourier transform.
- This can be selected by activating the check box *Assume Geometric Field Zone for Detector Evaluation* under the *Detector Parameters* tab, in the edit dialog of the corresponding detector.



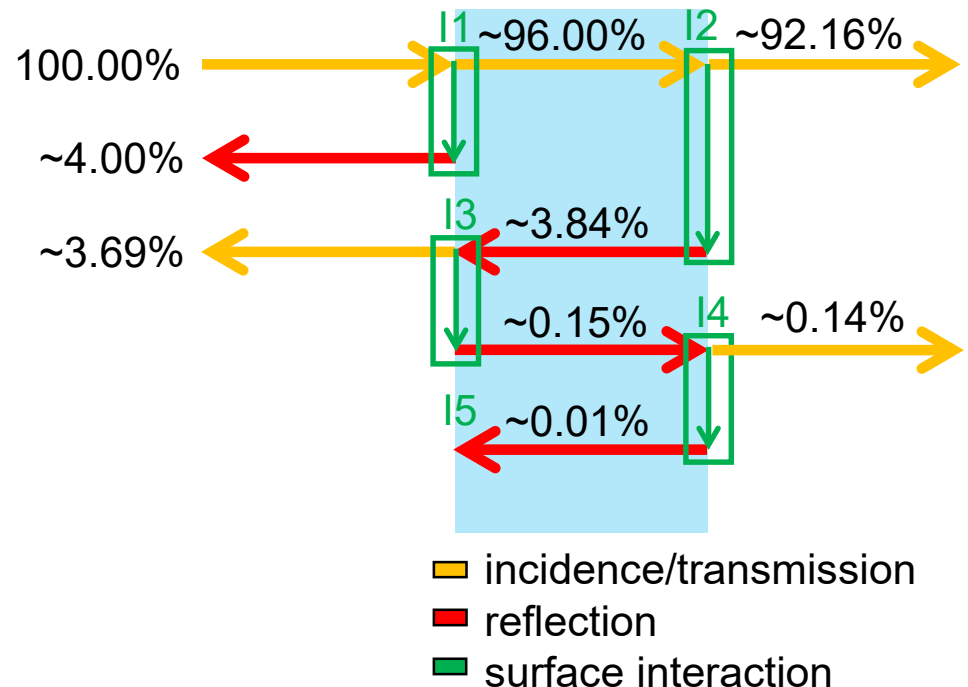
### 3. Energy Threshold (Non-sequential Ray/Field Tracing)

- The *Energy Threshold* is a stop criterion for the non-sequential tracing engine.
- If the energy of the light for each non-sequential path falls below the energy threshold, the tracing of the light along the path is not processed further.



### 3. Energy Threshold: Scenario Illustration

- Exemplary illustration of light energies transmitted and reflected when encountering a glass plate.
- Often not many reflections are required until the remaining energies reaches negligible levels.
- In case of total reflections, of course, many interactions should be considered.

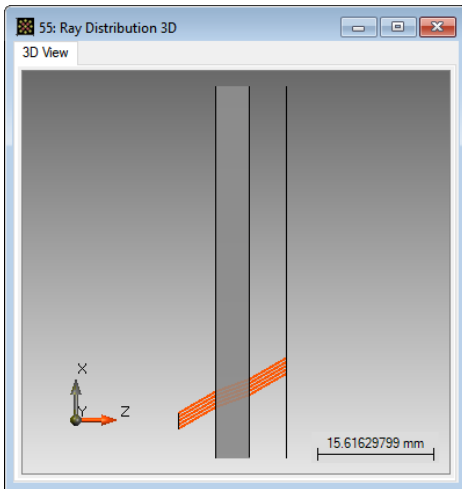




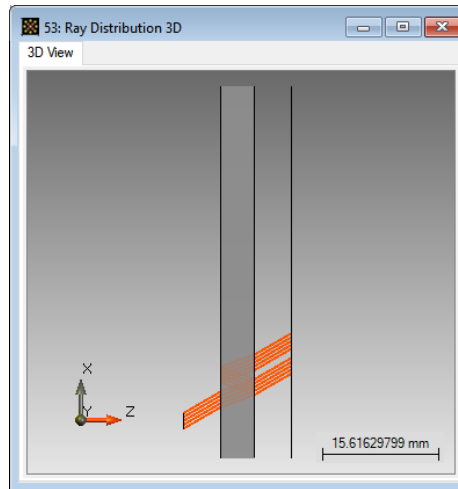
### 3. Energy Threshold (Non-sequential Ray/Field Tracing)

- An example of the impact of the energy threshold is shown below.
- For the purposes of this example, a plane wave with an incidence angle of  $30^\circ$  is propagated through an etalon.
- The smaller the energy threshold, the more paths are traced.

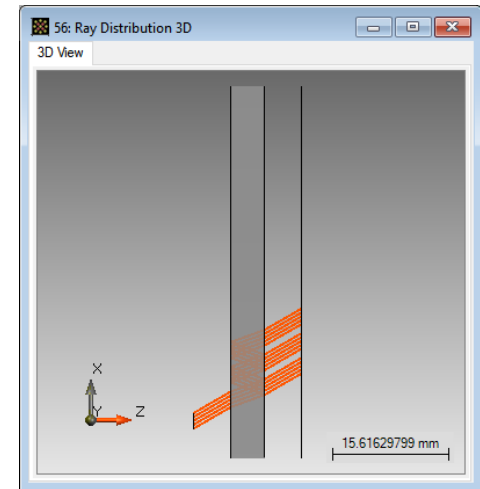
energy threshold  
1 %



energy threshold  
0.01 %

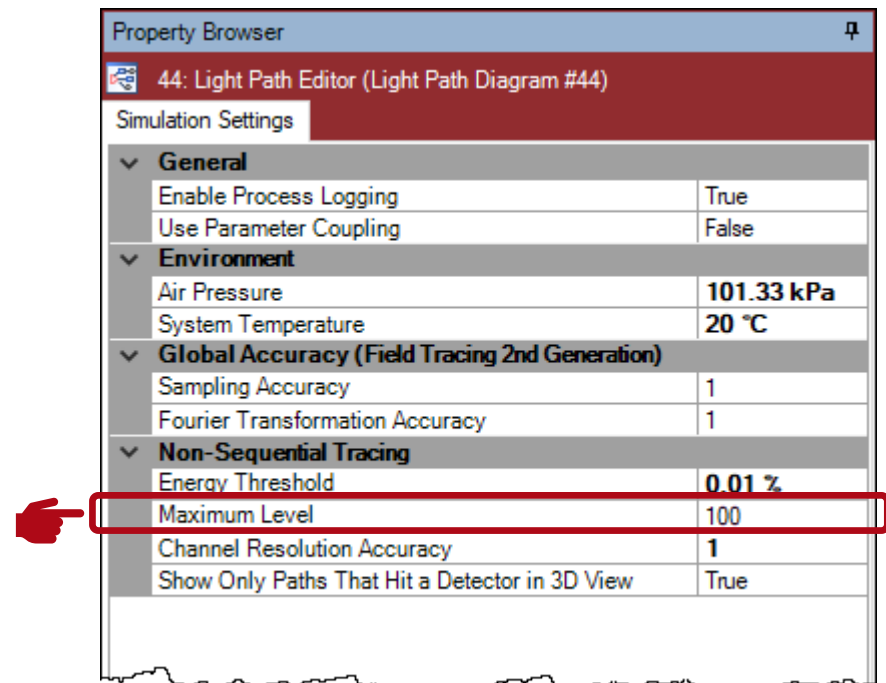


energy threshold  
0.0001 %



## 4. Maximum Level (Non-sequential Ray/Field Tracing)

- The *Maximum Level* is a stop criterion for the non-sequential tracing engine.
- This parameter limits directly the number of detected surface transitions/interactions for each non-sequential path.



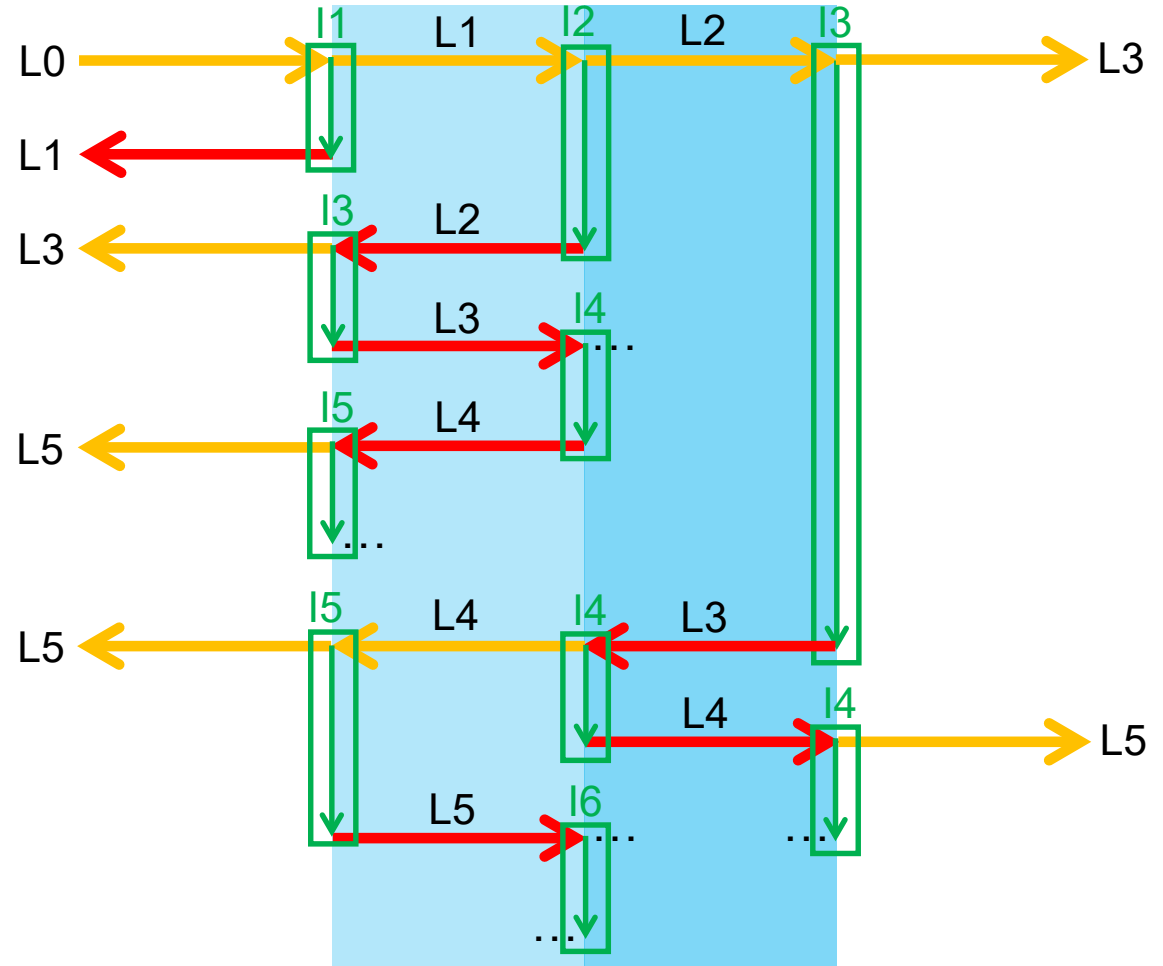
# 4. Maximum Level: Transition/Interaction

For non-sequential propagations VirtualLab keeps track of the different light paths/channels:

- Adjacent figure illustrates the level numbering used during the non-sequential simulation process.
- The level is increased with each surface interaction.

L# ... level of regarded light propagation

I# ... surface interaction



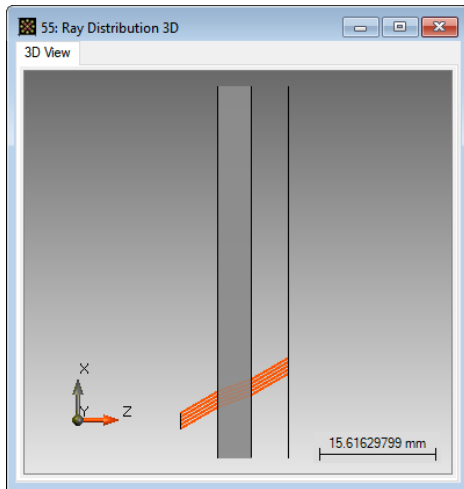
▬ incidence/transmission  
▬ reflection

The default value of regarded levels is 100.

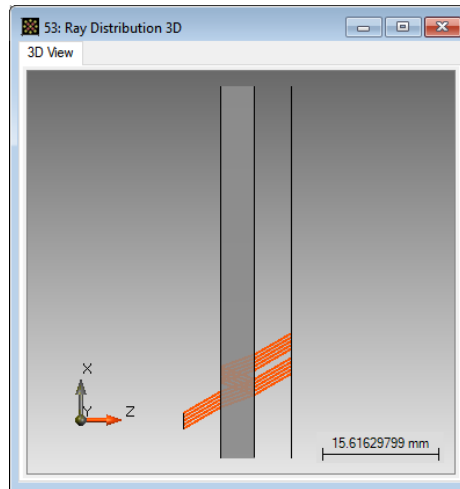
## 4. Maximum Level (Non-sequential Ray/Field Tracing)

- An example of the impact of the maximum level is shown below.
- For the purposes of this example, a plane wave with an incidence angle of  $30^\circ$  is propagated through an etalon.
- The higher the maximum level, the more paths are traced.

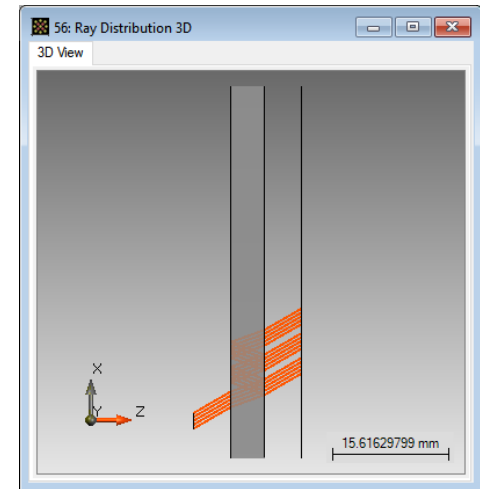
maximum level  
2



maximum level  
4

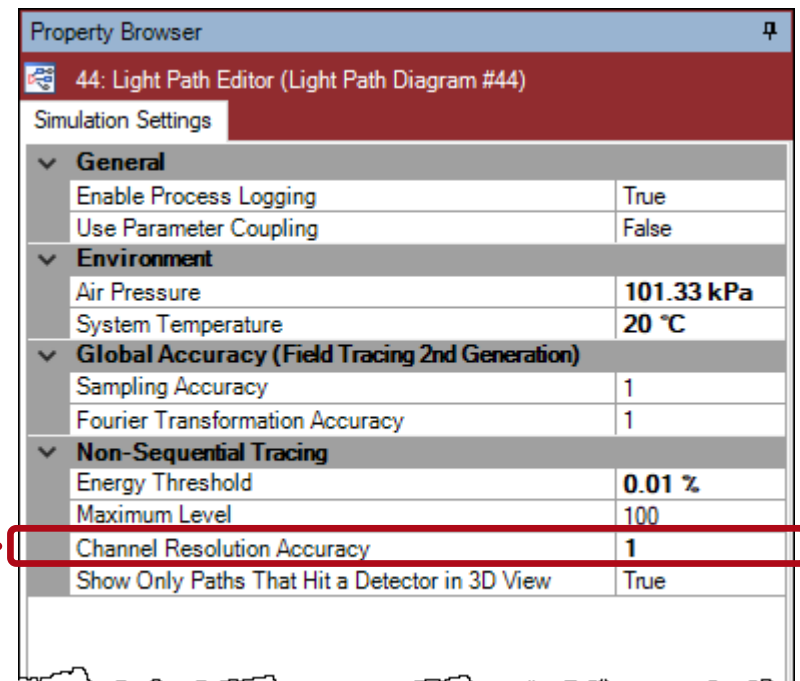


maximum level  
6



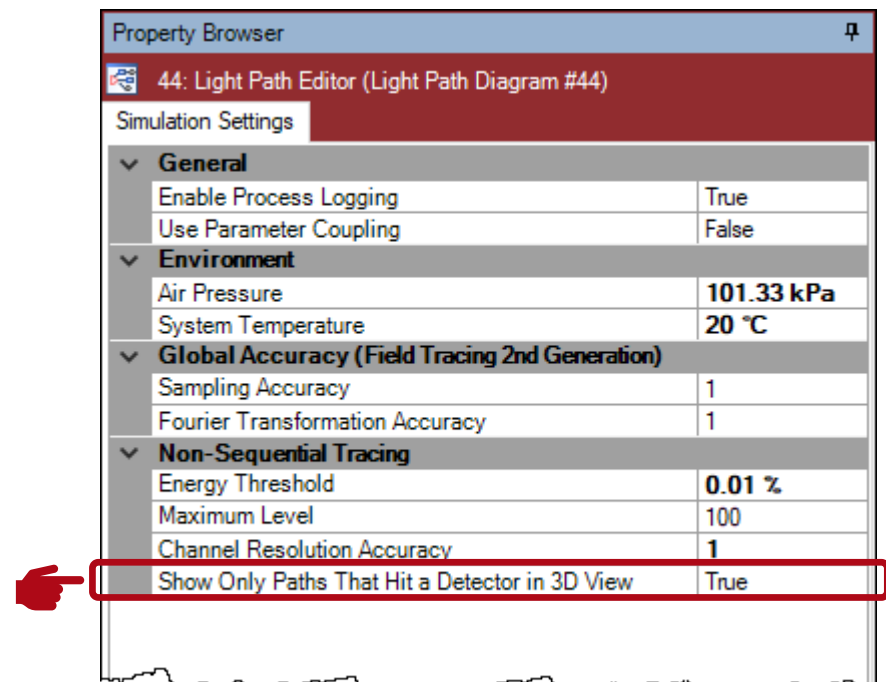
## 5. Path Detection (Non-sequential Ray/Field Tracing)

- VirtualLab Fusion uses a two-step procedure to trace the fields non-sequentially.
- In the 1<sup>st</sup> step VirtualLab Fusion searches which light paths exist. In the 2<sup>nd</sup> step the fields are propagated along these found paths.
- The search for light paths means **identifying which in- & outgoing channels exist for any aperture / grating region.**
- This is done with a certain **Channel Resolution Accuracy**, which is by default 1.



## 6. Path Visualization (Non-sequential Ray/Field Tracing)

- The *Show Only Paths That Hit a Detector in 3D View* parameter controls the visualization of all traced non-sequential paths.
- For stray light visualization it also might be interesting to see the light paths which do not hit the specified detectors.



# Document Information

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title	How to Use Simulation Settings for Ray and Field Tracing
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VL version used for simulations	7.0.3.4
category	Feature Use Case

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