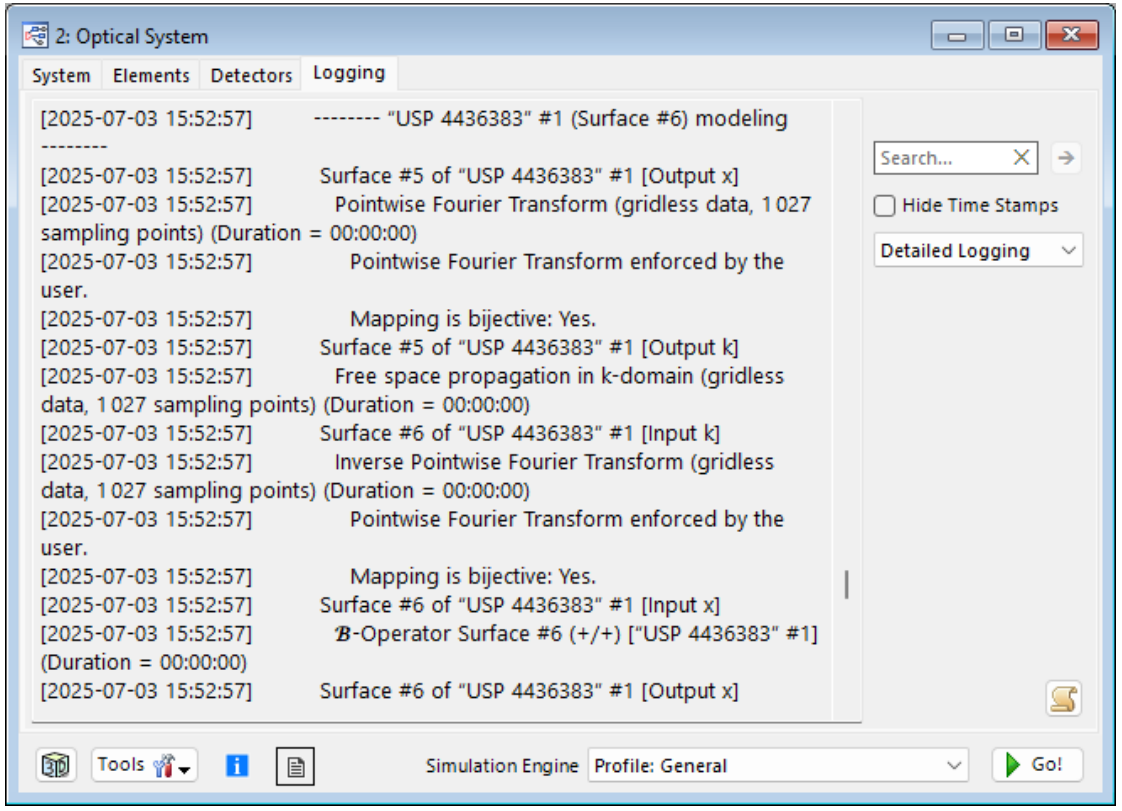
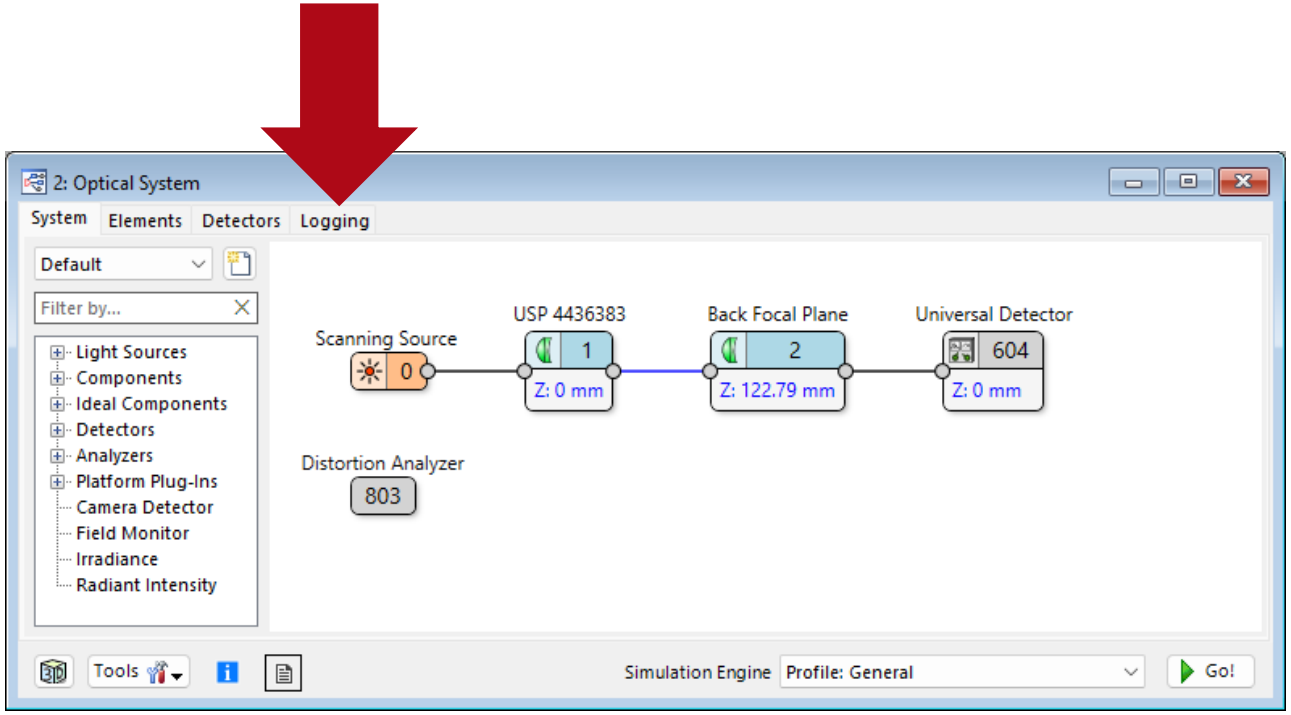
Logging in VirtualLab Fusion

Abstract



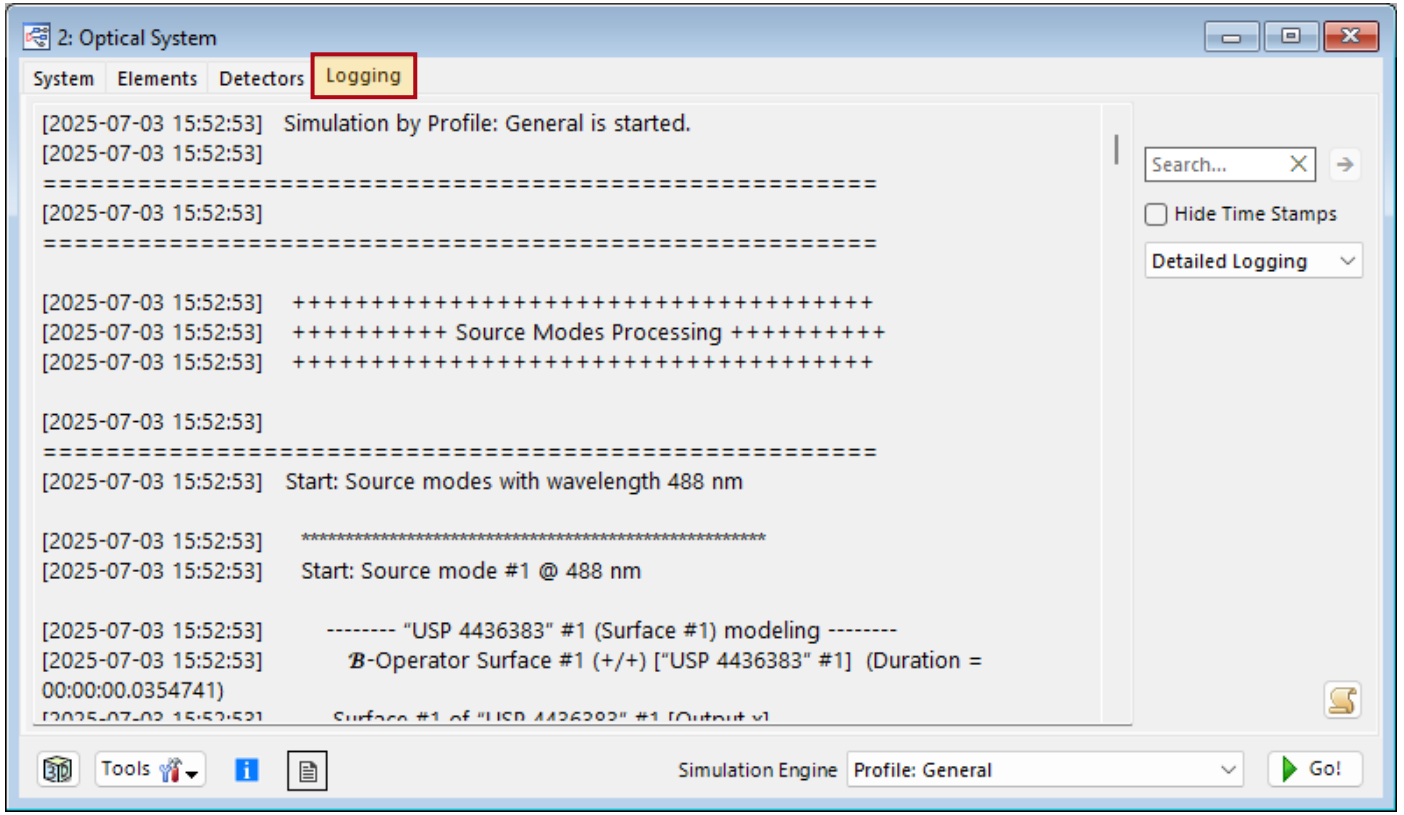
The ability to log results provides indispensable information as a simulation progresses, tracking not only the time duration of all simulation steps, but also which Fourier transforms are used for the internal propagation operators. In this use case, we will introduce the extensive logging capabilities of VirtualLabs Fusion.

Where to find the Logging



Each *Optical Setup* in VirtualLab Fusion has tabs attached that provides additional functionality for setting up or analyzing the system, such as logging.

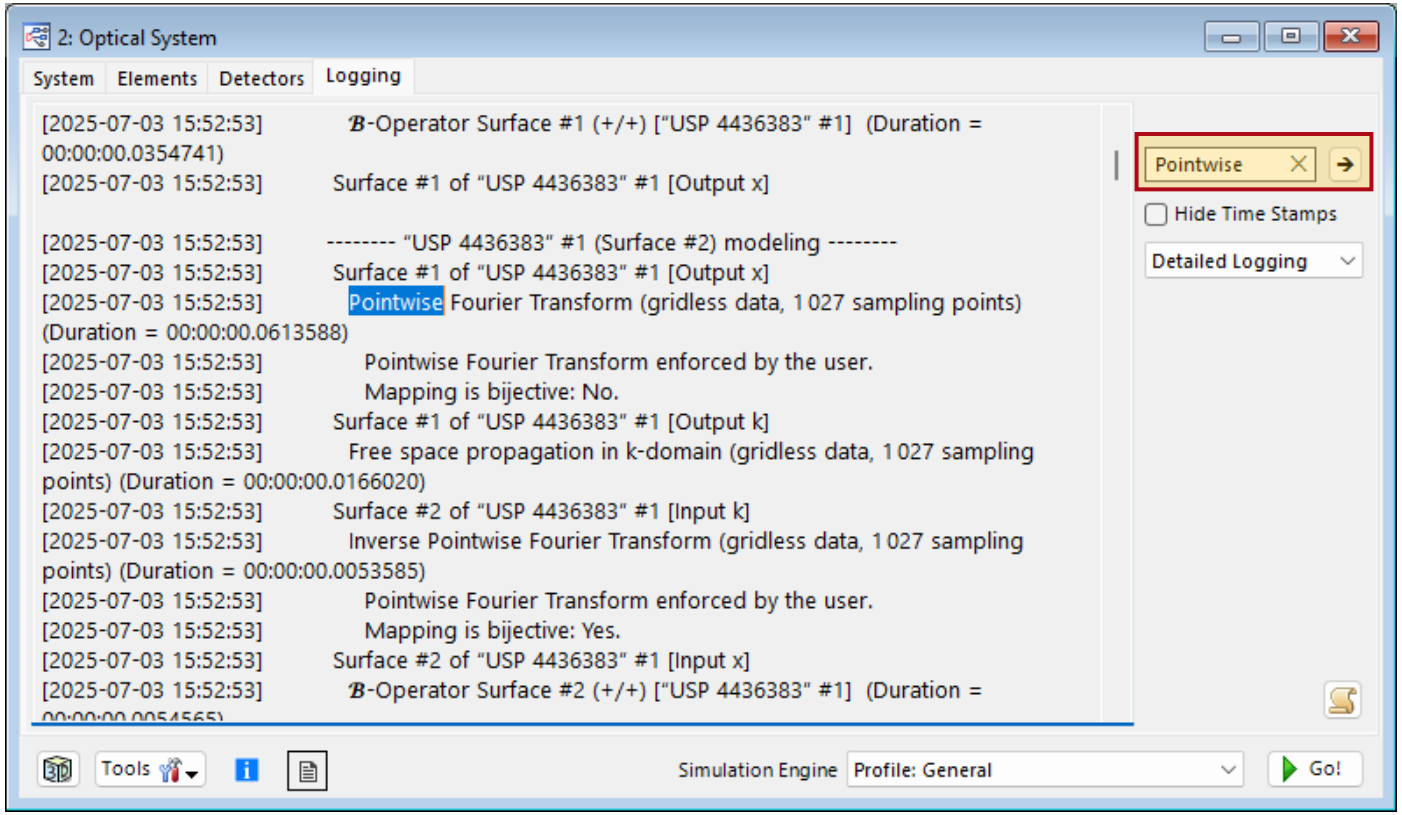
Logging in VirtualLab Fusion



Logging can be found in the *Logging* tab and provides detailed information about each propagation step VirtualLab Fusion takes, important information that is included:

- Used Fourier transforms
- Sample points
- Timestamp per step

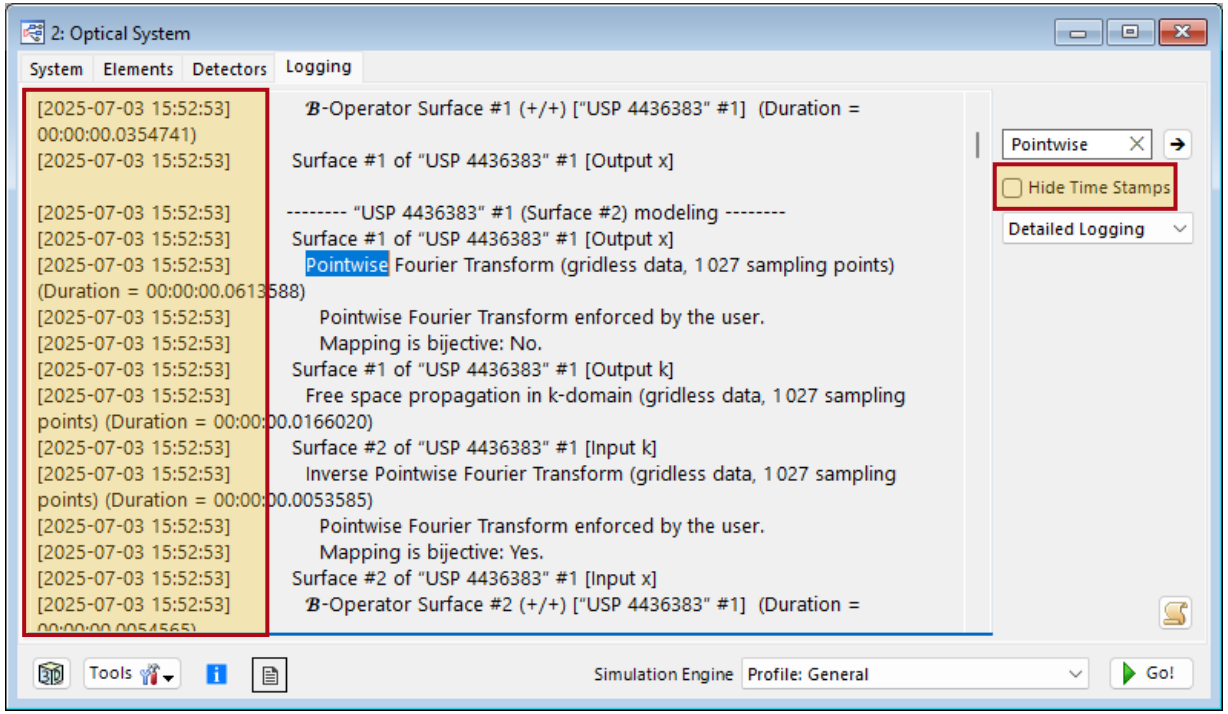
Search Function

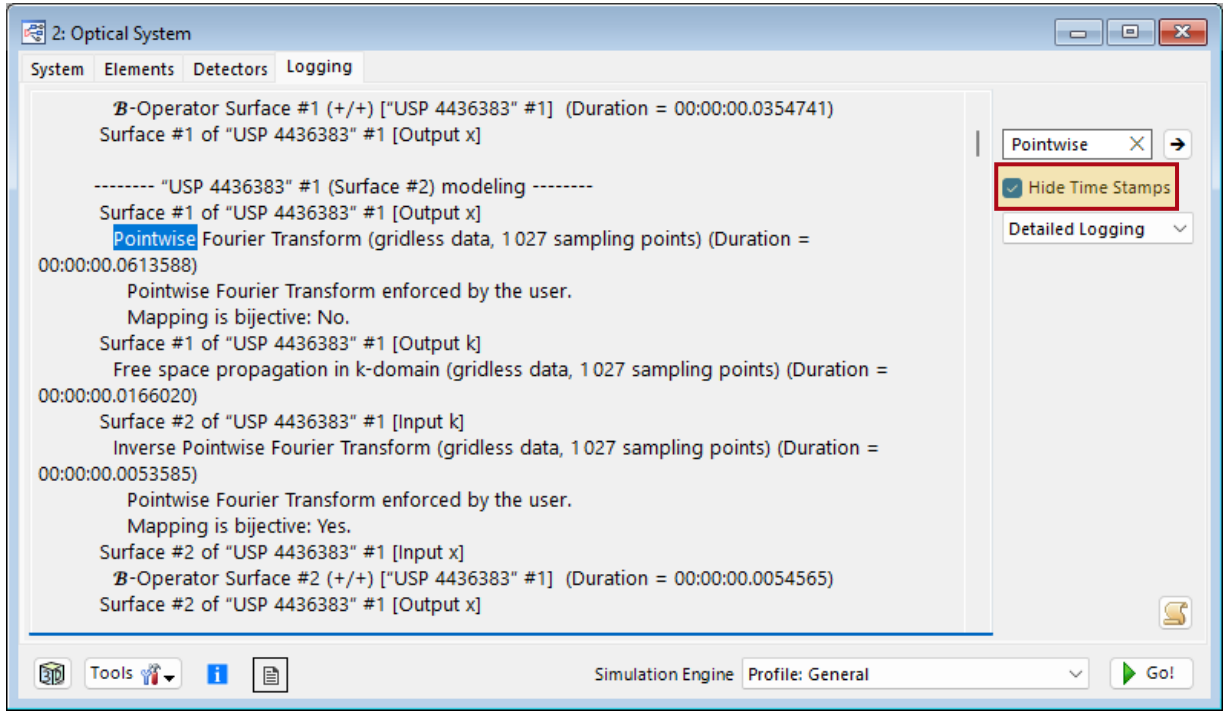


To let the user quickly orientate himself, VirtualLab Fusion provides a search functionality on the top right corner of the *Logging* tab.

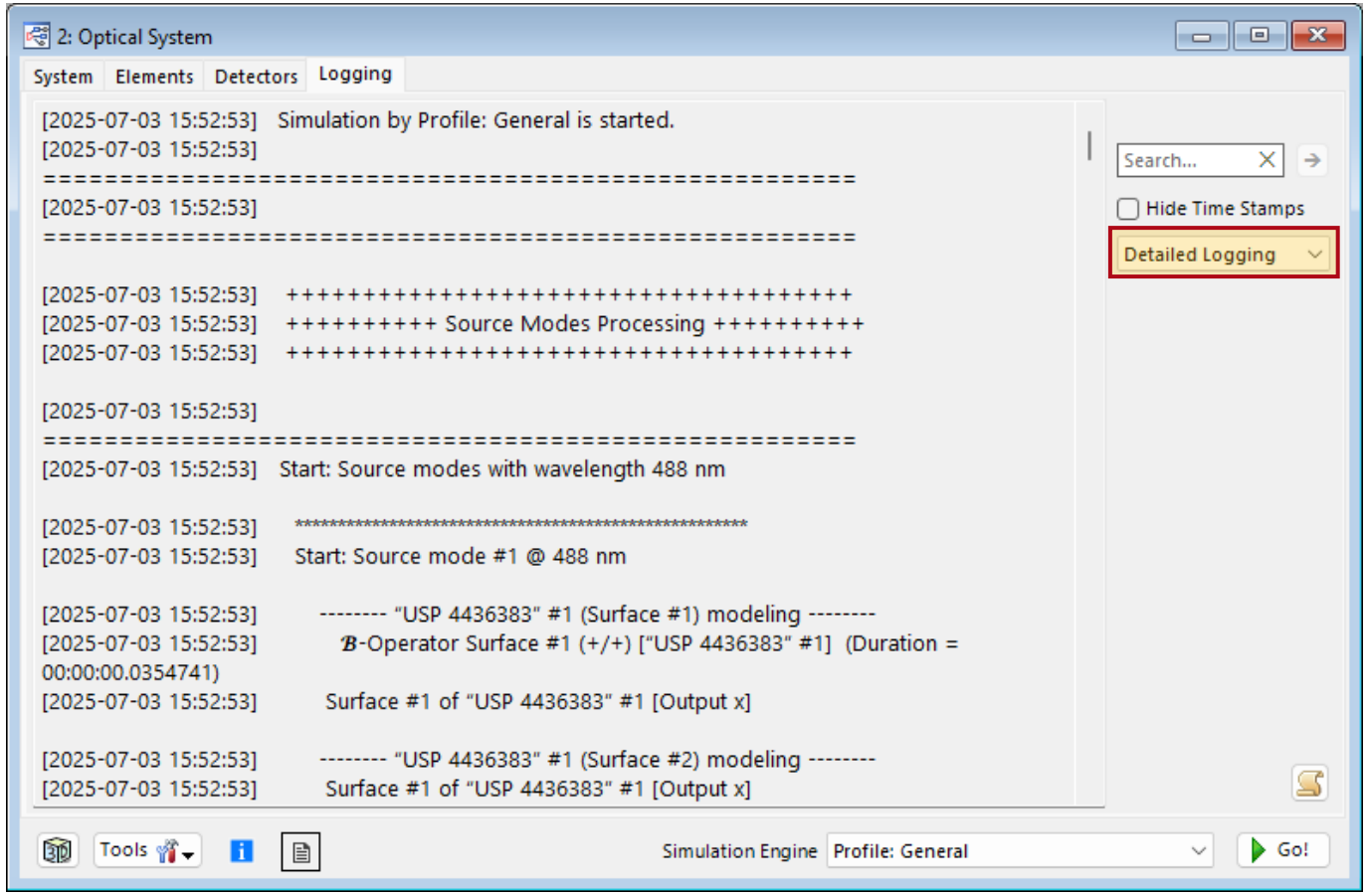
Hide Time Stamps

If unnecessary, the time stamp information on the left side can be hidden.

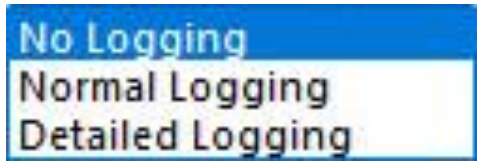




Level of Details

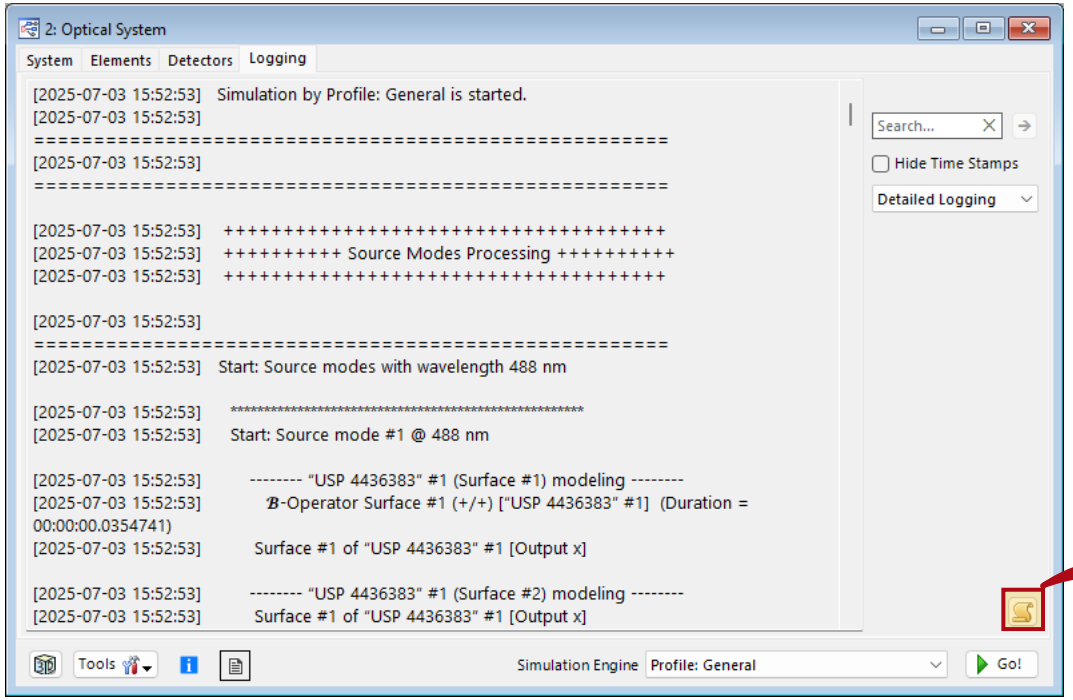


Logging can be output in three different levels:

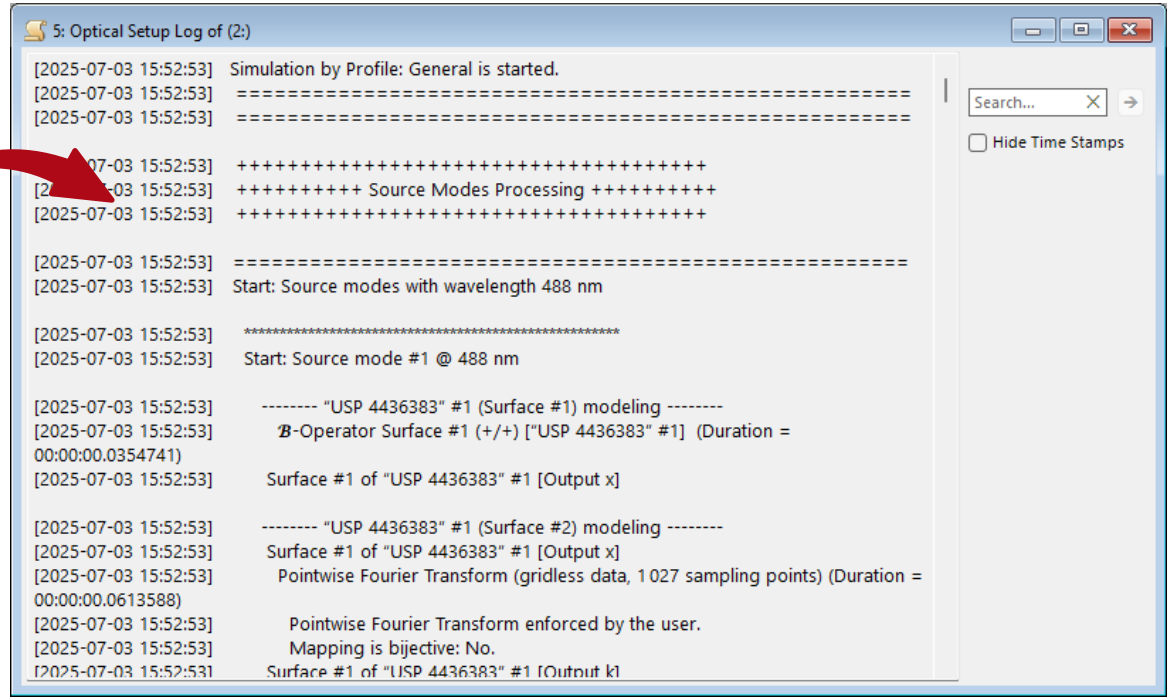


No Logging here means, of course, that there is no logging. *Normal logging* captures only the most important information, such as the Fourier transforms and sample points used, while *Detailed Logging* includes additional information about why a particular solver was used. More information about this is shown in the following example.

Extract Logging Information



Logs can be smoothly exported after calculations complete, to provide easy cross-references.



Example: F-Theta

Example: F-Theta Lens

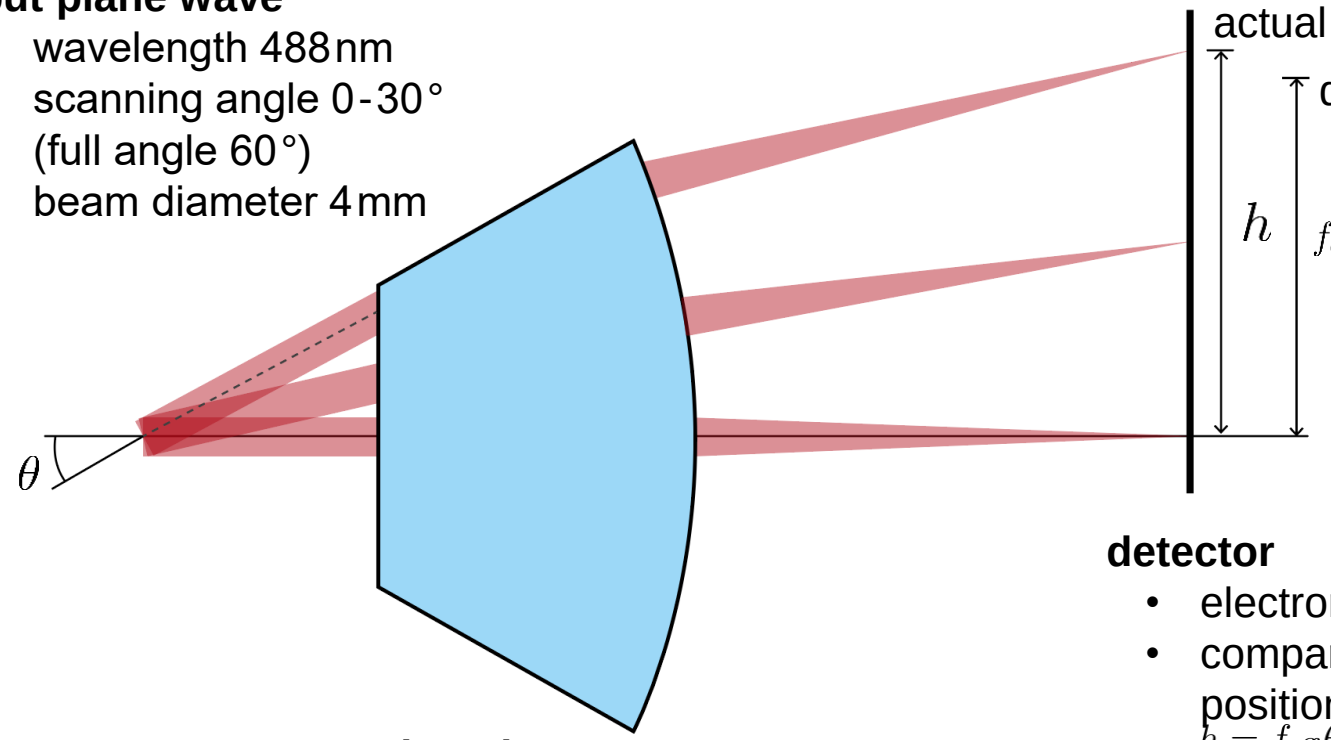
To demonstrate the logging feature, we would like to show a F-Theta lens which is analyzed by a scanning source.

The corresponding Use Case can be found under:

Performance Evaluation of an F-Theta Lens

input plane wave

- wavelength 488 nm
- scanning angle 0 - 30° (full angle 60°)
- beam diameter 4 mm



F-Theta lens

- effective focal length $f_{\text{eff}} = 100.18\,\text{mm}$
- from patent USP 4436383

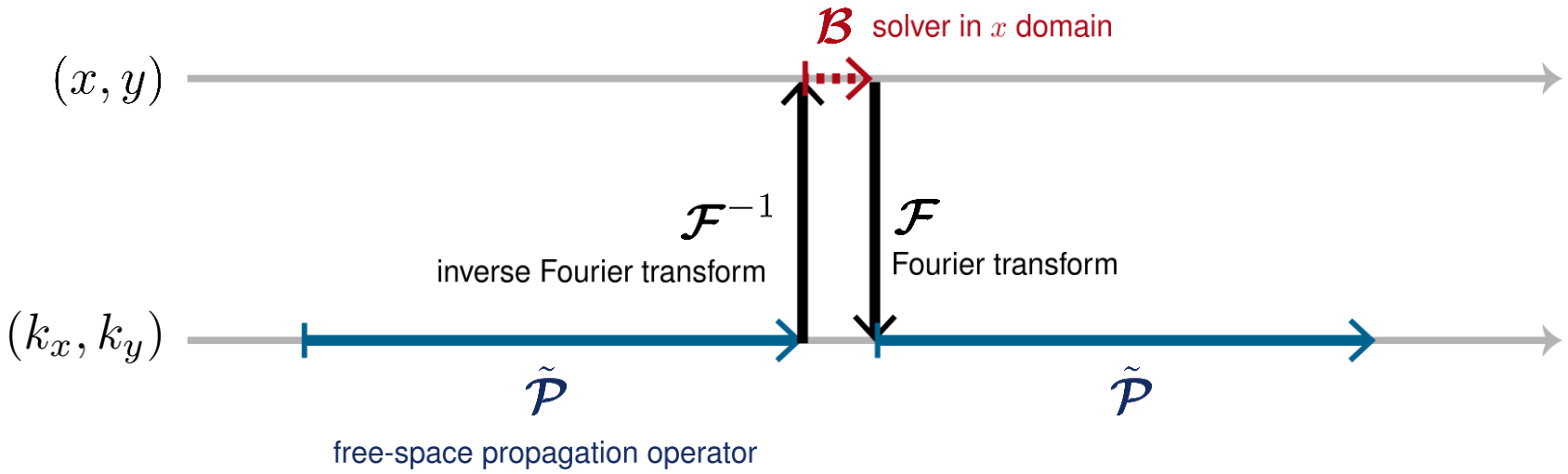
detector

- electromagnetic field
- comparison of the focal spot position with the ideal case $h = f_{\text{eff}}\theta$

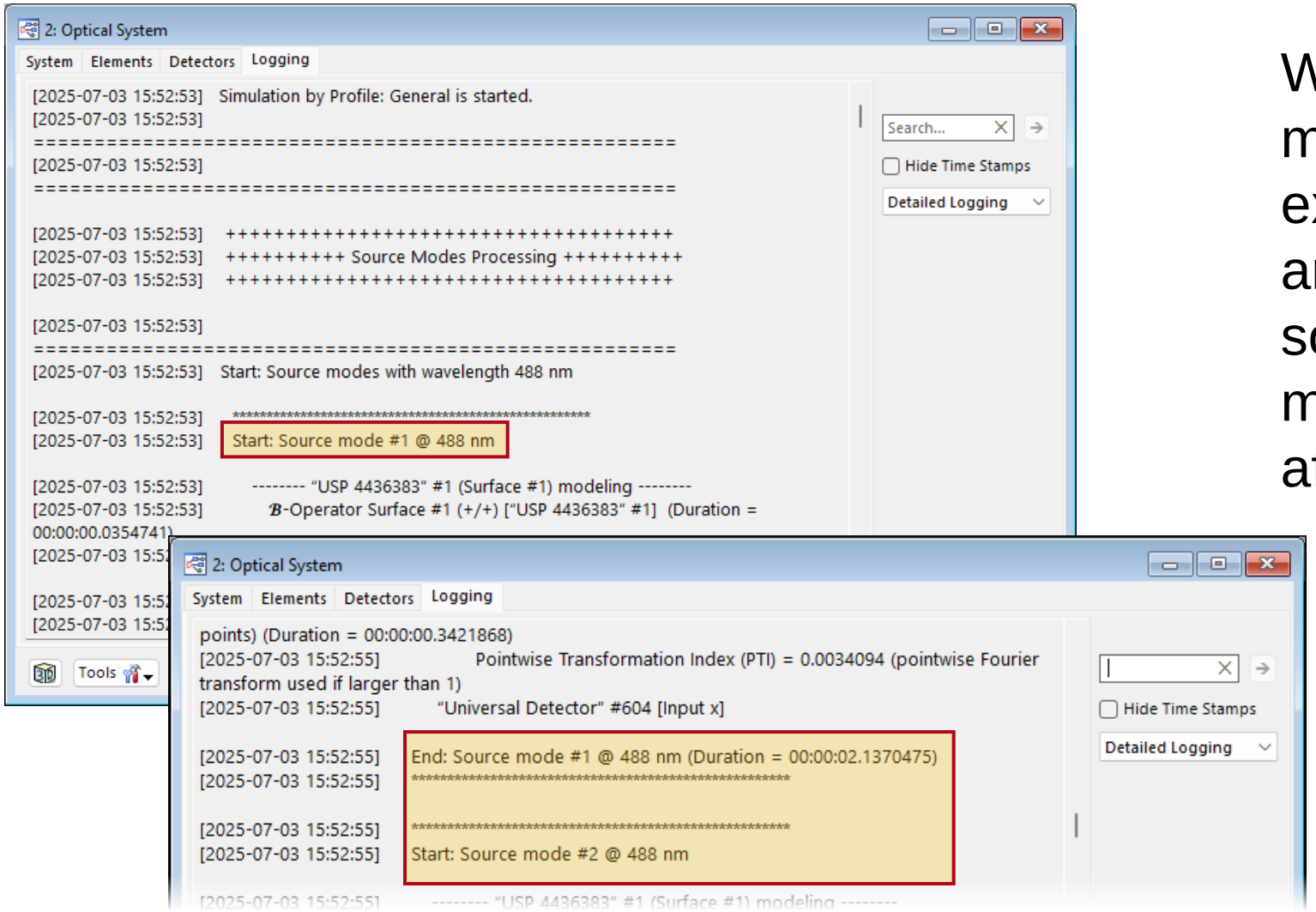
Domain of Application of the Solvers

To understand the information that the logging is providing, we first need to discuss how a standard propagation step is handled in VirtualLab Fusion. Free-space propagation operators are commonly defined in k-domain, while many solvers of actual components (such as lenses, apertures, etc) are defined in x-domain.

Hence, the common strategy is to use an inverse Fourier transform to transform the input into x-domain, then apply the component solver, back transform it into k-domain afterwards and finally apply the free-space propagation operator to propagate it to the next surface/component.

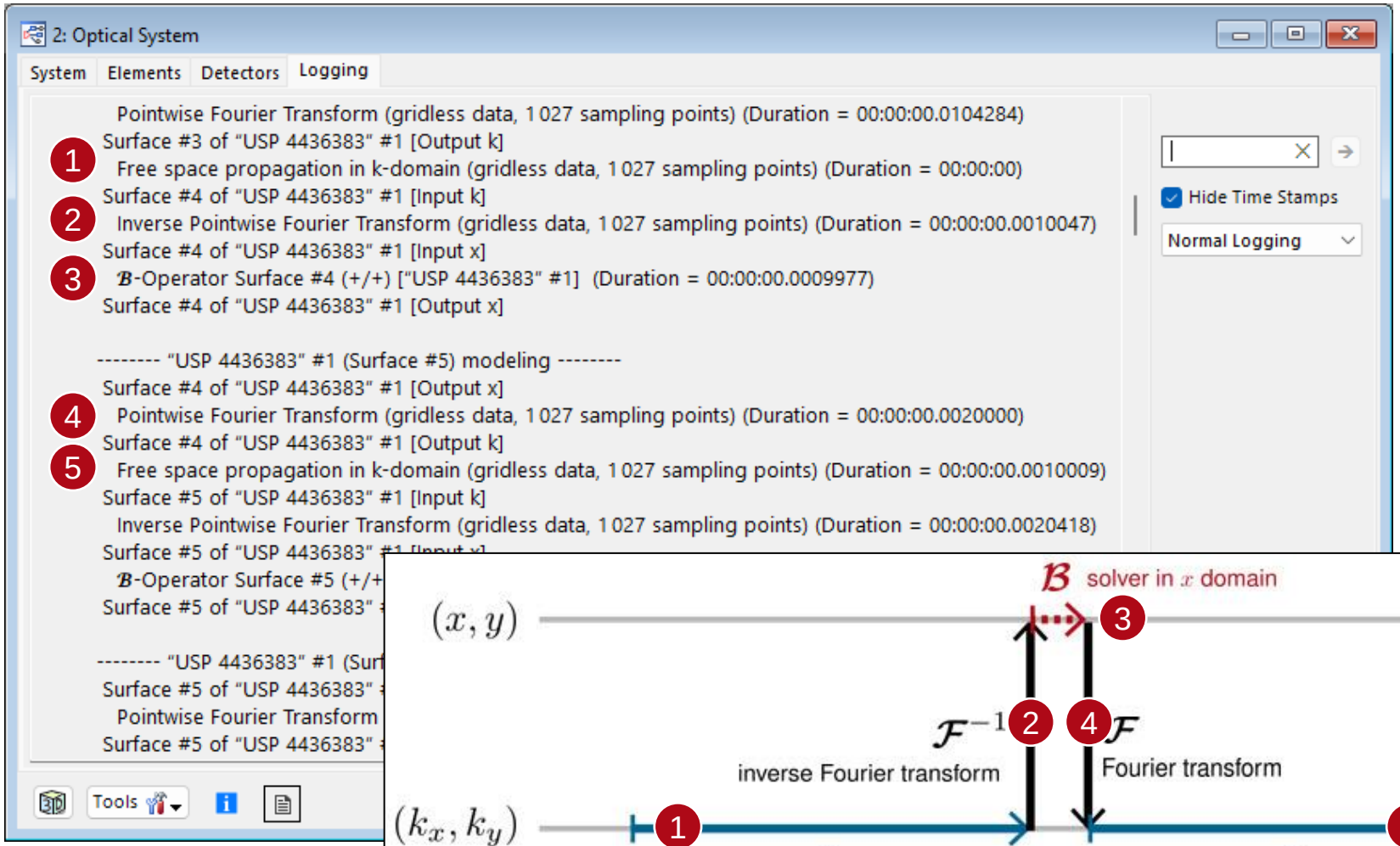


Source Modes



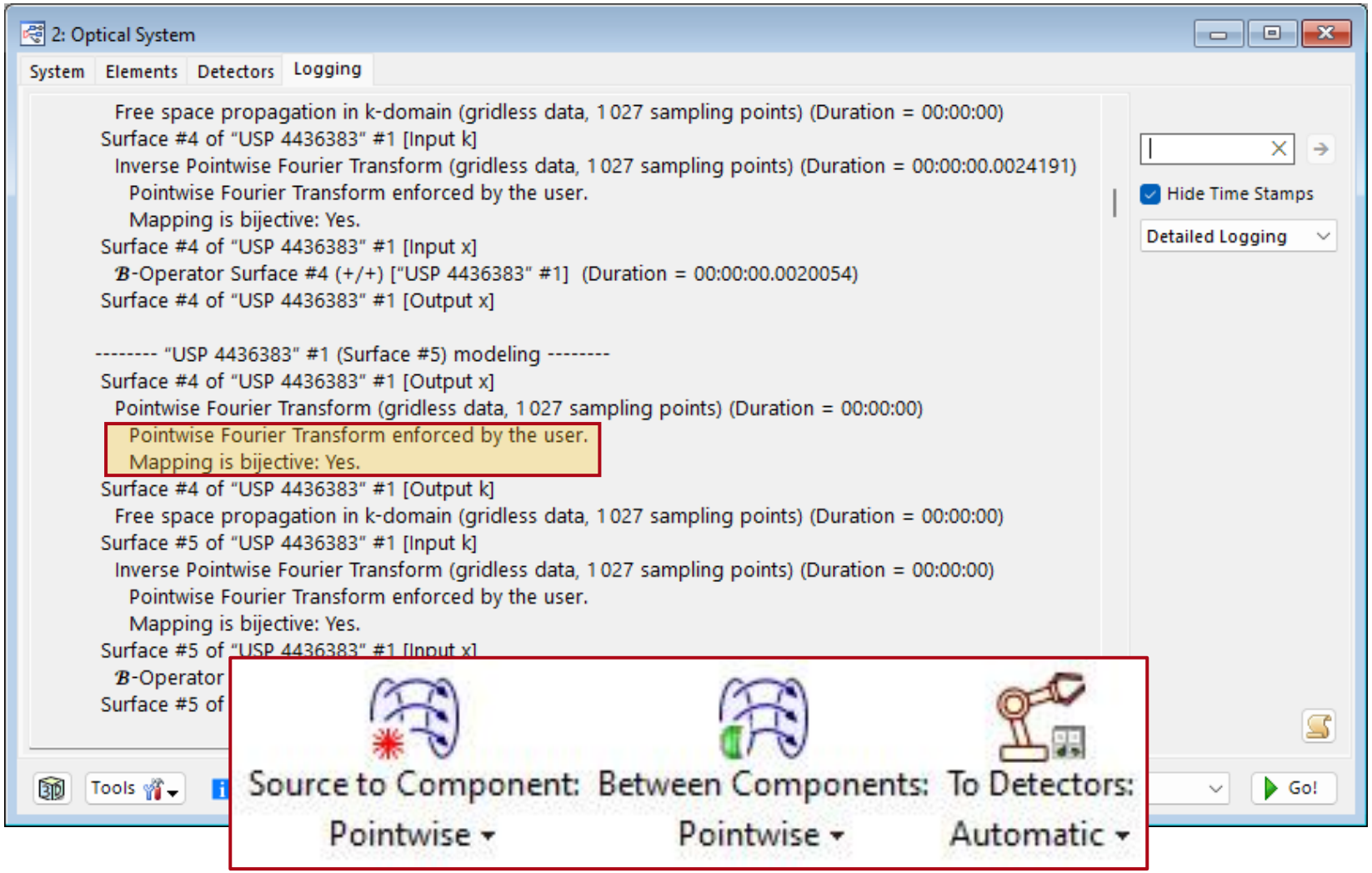
When using a source with multiple modes (in our example the different incident angles from the scanning source), the individual source modes will be propagated one after the other.

Propagations – Normal Logging



Normal Logging will track which Fourier transform is used as each propagation step as well as its according sampling parameters. The time duration of all operators is also given out.

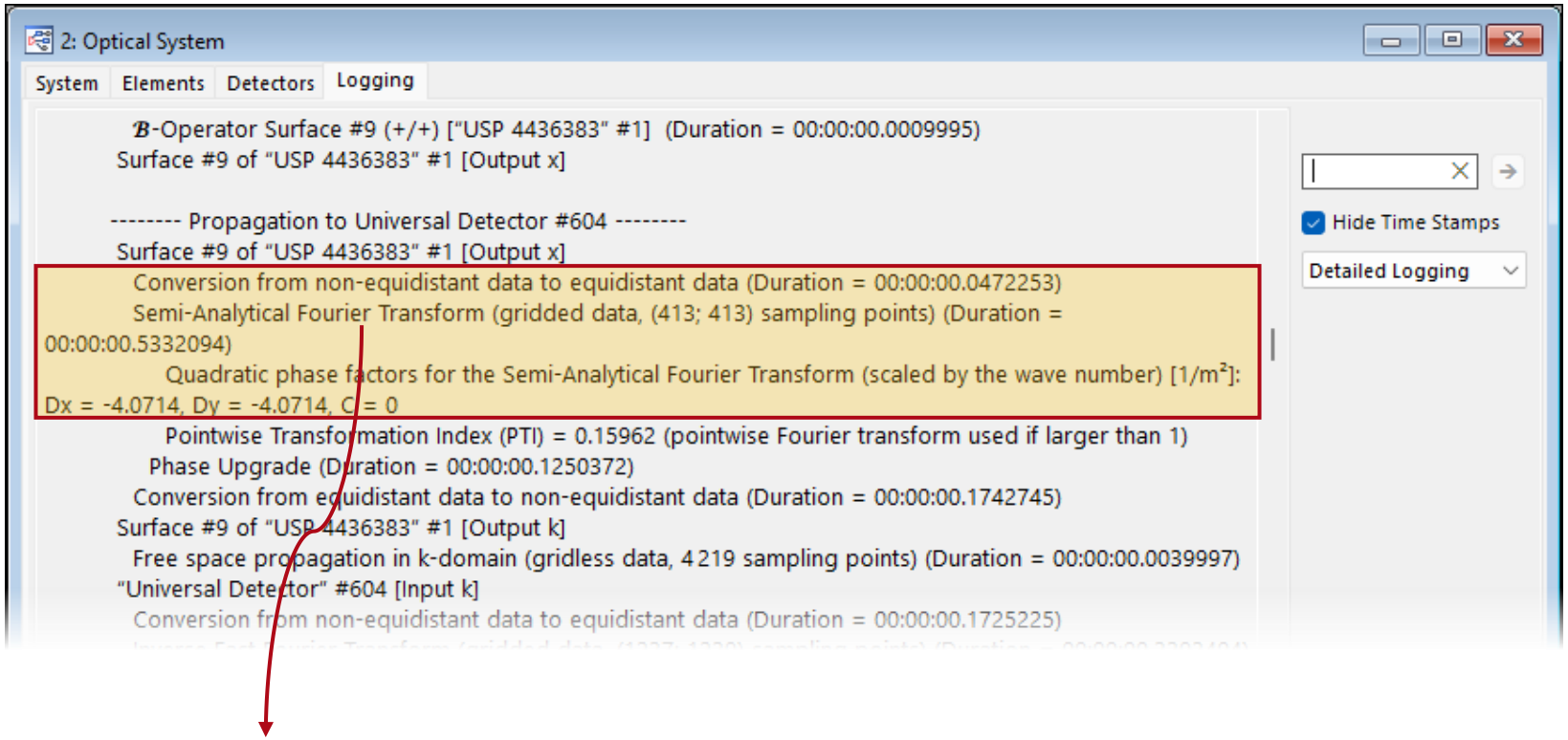
Propagations – Detailed Logging



Detailed Logging will include additional information, such as if a *Pointwise Fourier Transform* was enforced by the user or due to exceeding sampling limits.

In our case the *Pointwise Fourier Transform* was enforced by the *Profile Editing Tools*.

Propagations – Detailed Logging



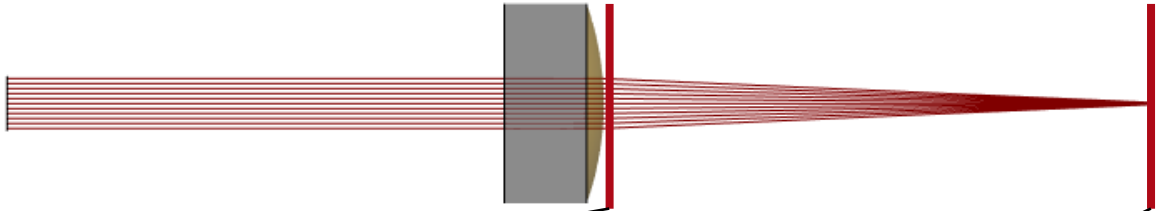
In case VirtualLab Fusion decides on a Fourier transform by itself, the *Pointwise Transformation Index (PTI)* is indicated (pointwise Fourier transforms are used when this index is larger then 1).

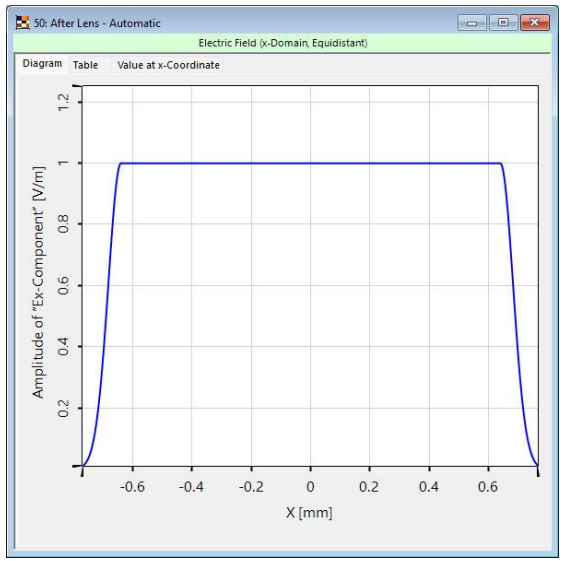
For semi-analytical Fourier transforms the numerical parameter are also part of the output. For more information on the different types of Fourier transforms used in VirtualLab Fusion, please see:

Fourier Transforms in VirtualLab Fusion

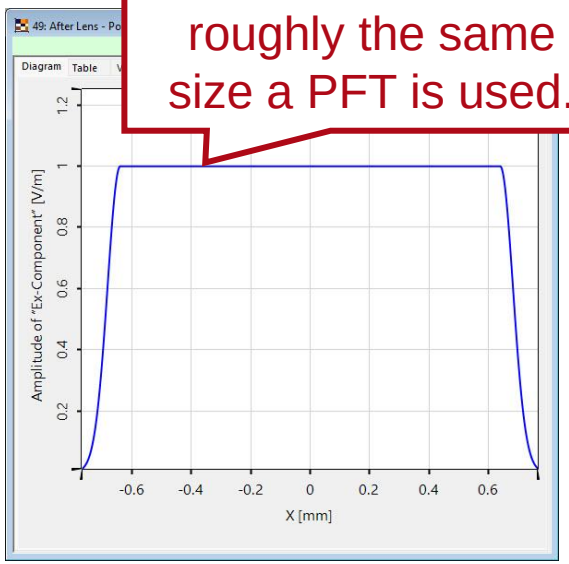
Pointwise Transformation Index

The Pointwise Transformation Index (PTI) is the deciding factor on which Fourier transform is used. It is calculated by performing automatic and pointwise Fourier transforms of 1D cuts of the field and comparing their sizes. The corresponding bandwidths will be multiplied with a scaling factor to calculate the PTI.



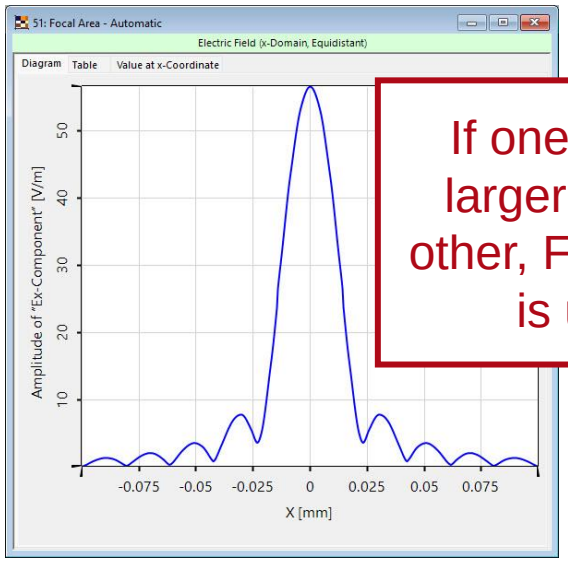


automatic

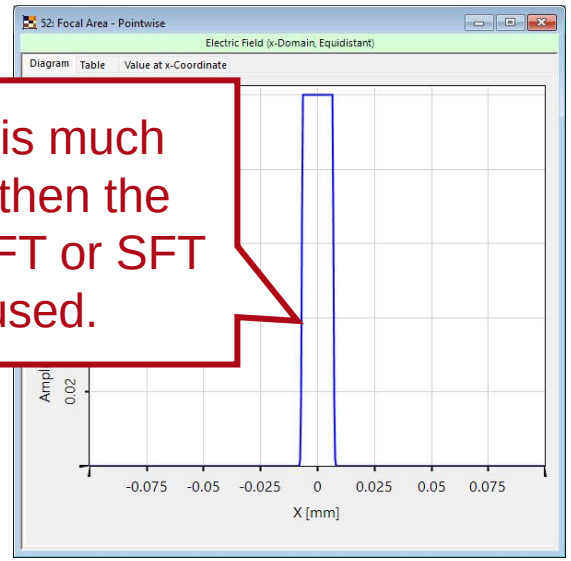


pointwise

If the two cuts are roughly the same size a PFT is used.



automatic



pointwise

If one is much larger then the other, FFT or SFT is used.

Document Information

Title	Logging in VirtualLab Fusion
Document code	TUT.0462
Publication date	08.07.2025
Required packages	-
Software version	2025.1 (Build 1.172)
Tutorial	Use Case
Further reading	