

Logging in VirtualLab Fusion

| 🗟 2: Optical System | | | |
|--------------------------------|--|---|--------------------|
| System Elements Detectors | Logging | | |
| [2025-07-03 15:52:57] | "USP 4436383" #1 (Surface #6) modeling | | Search X → |
| [2025-07-03 15:52:57] | Surface #5 of "USP 4436383" #1 [Output x] | | Searchin X 7 |
| [2025-07-03 15:52:57] | Pointwise Fourier Transform (gridless data, 1027 | | Hide Time Stamps |
| sampling points) (Duration | n = 00:00:00) | | |
| [2025-07-03 15:52:57] user. | Pointwise Fourier Transform enforced by the | | Detailed Logging 🗸 |
| [2025-07-03 15:52:57] | Mapping is bijective: Yes. | | |
| [2025-07-03 15:52:57] | Surface #5 of "USP 4436383" #1 [Output k] | | |
| [2025-07-03 15:52:57] | Free space propagation in k-domain (gridless | | |
| data, 1027 sampling point | s) (Duration = 00:00:00) | | |
| [2025-07-03 15:52:57] | Surface #6 of "USP 4436383" #1 [Input k] | | |
| [2025-07-03 15:52:57] | Inverse Pointwise Fourier Transform (gridless | | |
| data, 1 027 sampling point | is) (Duration = 00:00:00) | | |
| [2025-07-03 15:52:57] user. | Pointwise Fourier Transform enforced by the | | |
| [2025-07-03 15:52:57] | Mapping is bijective: Yes. | 1 | |
| [2025-07-03 15:52:57] | Surface #6 of "USP 4436383" #1 [Input x] | 1 | |
| [2025-07-03 15:52:57] | B-Operator Surface #6 (+/+) ["USP 4436383" #1] | | |
| (Duration = 00:00:00) | | | |
| [2025-07-03 15:52:57] | Surface #6 of "USP 4436383" #1 [Output x] | | 2 |
| 🔞 Tools 🎢 🖬 📗 | Simulation Engine Profile: General | | ✓ ► Go! |

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

| ystem Elements Detec | tors Logging | |
|--|--|-----------------------------------|
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Simulation by Profile: General is started. | Search X |
| [2025-07-03 15:52:53] | | Hide Time Stamps Detailed Logging |
| | +++++++++ Source Modes Processing ++++++++++++++++++++++++++++++++++++ | |
| [2025-07-03 15:52:53] | | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Start: Source modes with wavelength 488 nm | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] 00:00:00.0354741) [2025-07-02 15:52:53] | "USP 4436383" #1 (Surface #1) modeling B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | |

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

| ystem Elements Detector | s Logging | |
|---------------------------|---|------------------|
| [2025-07-03 15:52:53] | B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | |
| 00:00:00.0354741) | | Pointwise X |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | |
| | | Hide Time Stamps |
| [2025-07-03 15:52:53] | "USP 4436383" #1 (Surface #2) modeling | Detailed Logging |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | Detailed Logging |
| [2025-07-03 15:52:53] | Pointwise Fourier Transform (gridless data, 1027 sampling points) | |
| (Duration = 00:00:00.0613 | 3588) | |
| [2025-07-03 15:52:53] | Pointwise Fourier Transform enforced by the user. | |
| [2025-07-03 15:52:53] | Mapping is bijective: No. | |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output k] | |
| [2025-07-03 15:52:53] | Free space propagation in k-domain (gridless data, 1027 sampling | |
| points) (Duration = 00:00 | :00.0166020) | |
| [2025-07-03 15:52:53] | Surface #2 of "USP 4436383" #1 [Input k] | |
| [2025-07-03 15:52:53] | Inverse Pointwise Fourier Transform (gridless data, 1027 sampling | |
| points) (Duration = 00:00 | :00.0053585) | |
| [2025-07-03 15:52:53] | Pointwise Fourier Transform enforced by the user. | |
| [2025-07-03 15:52:53] | Mapping is bijective: Yes. | |
| [2025-07-03 15:52:53] | Surface #2 of "USP 4436383" #1 [Input x] | |
| [2025-07-03 15:52:53] | B-Operator Surface #2 (+/+) ["USP 4436383" #1] (Duration = | () (|
| 00-00-00 00545651 | | |
| 🗊 Tools 🎢 🔒 🚺 | Simulation Engine Profile: General | ✓ ► Go! |

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

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

| ኛ 2: Optical System | | | 🚭 2: Optical System | |
|---|---|---|---|---|
| System Elements Detectors | s Logging | | System Elements Detectors Logging | |
| [2025-07-03 15:52:53] 00:00:00.0354741) [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Pointwise Fourier Transform enforced by the user. Mapping is bijective: No. Surface #1 of "USP 4436383" #1 [Output k] Free space propagation in k-domain (gridless data, 1 027 sampling 00.0166020) Surface #2 of "USP 4436383" #1 [Input k] Inverse Pointwise Fourier Transform (gridless data, 1 027 sampling | Pointwise X → Hide Time Stamps Detailed Logging ∨ | B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = 00:00:00.0354741) Surface #1 of "USP 4436383" #1 [Output x] "USP 4436383" #1 (Surface #2) modeling Surface #1 of "USP 4436383" #1 [Output x] Pointwise Fourier Transform (gridless data, 1027 sampling points) (Duration = 00:00:00.0613588) Pointwise Fourier Transform enforced by the user. Mapping is bijective: No. Surface #1 of "USP 4436383" #1 [Output k] Free space propagation in k-domain (gridless data, 1027 sampling points) (Duration = 00:00:00.0166020) Surface #2 of "USP 4436383" #1 [Input k] Inverse Pointwise Fourier Transform (gridless data, 1027 sampling points) (Duration = 00:00:00.053585) | Pointwise ➤ ✓ Hide Time Stamps Detailed Logging |
| points) (Duration = 00:00: [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Pointwise Fourier Transform enforced by the user. Mapping is bijective: Yes. Surface #2 of "USP 4436383" #1 [Input x] B-Operator Surface #2 (+/+) ["USP 4436383" #1] (Duration = | Go! | Pointwise Fourier Transform enforced by the user. Mapping is bijective: Yes. Surface #2 of "USP 4436383" #1 [Input x] B-Operator Surface #2 (+/+) ["USP 4436383" #1] (Duration = 00:00:00.0054565) Surface #2 of "USP 4436383" #1 [Output x] Image: Tools Image: To | ✓ G o! |

Level of Details

| 🥰 2: Optical System | | | |
|--|--|---|----------------------|
| System Elements Detect | tors Logging | | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Simulation by Profile: General is started. | I | |
| | | | Search X → |
| [2025-07-03 15:52:53] | | | Hide Time Stamps |
| | | | Detailed Logging 🛛 🗸 |
| [2025-07-03 15:52:53] | +++++++++++++++++++++++++++++++++++++++ | | |
| [2025-07-03 15:52:53] | ++++++++ Source Modes Processing +++++++++ | | |
| [2025-07-03 15:52:53] | +++++++++++++++++++++++++++++++++++++++ | | |
| [2025-07-03 15:52:53] | | | |
| [2025-07-03 15:52:53] | Start: Source modes with wavelength 488 nm | | |
| [2025-07-03 15:52:53] | ******* | | |
| [2025-07-03 15:52:53] | Start: Source mode #1 @ 488 nm | | |
| [2025-07-03 15:52:53] | "USP 4436383" #1 (Surface #1) modeling | | |
| [2025-07-03 15:52:53] | B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | | |
| 00:00:00.0354741) | | | |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | | |
| [2025-07-03 15:52:53] | "USP 4436383" #1 (Surface #2) modeling | | _ |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | | 2 |
| Tools 資 🖬 | Simulation Engine Profile: General | | ✓ Go! |

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

>

| 🖁 2: Optical System System Elements Detect | ors Logging | | |
|---|--|--|----------------|
| [2025-07-03 15:52:53] | Simulation by Profile: General is started. | | Search X |
| [2025-07-03 15:52:53] | | | Hide Time Stam |
| [2025-07-03 15:52:53] | ++++++++++++++++++++++++++++++++++++++ | | |
| [2025-07-03 15:52:53] ==================================== | Start: Source modes with wavelength 488 nm | | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] | ************* | | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] 00:00:00.0354741) | "USP 4436383" #1 (Surface #1) modeling <i>B</i> -Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | | |
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] "USP 4436383" #1 (Surface #2) modeling Surface #1 of "USP 4436383" #1 [Output x] | | |
| 🗑 Tools 🎢 🗸 🚺 | Simulation Engine Profile: General | | |

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

| 写 5: Optical Setup Log of | f (2:) | | |
|---|---|--|------------|
| [2025-07-03 15:52:53] [2025-07-03 15:52:53] [2025-07-03 15:52:53] | | | Search X → |
| 07-03 15:52:531 | +++++++++++++++++++++++++++++++++++++++ | | |
| | ++++++++ Source Modes Processing +++++++++ | | |
| | +++++++++++++++++++++++++++++++++++++++ | | |
| [2025-07-03 15:52:53] | | | |
| [2025-07-03 15:52:53] | Start: Source modes with wavelength 488 nm | | |
| [2025-07-03 15:52:53] | ****** | | |
| [2025-07-03 15:52:53] | Start: Source mode #1 @ 488 nm | | |
| [2025-07-03 15:52:53] | "USP 4436383" #1 (Surface #1) modeling | | |
| [2025-07-03 15:52:53] 00:00:00.0354741) | B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | | |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | | |
| [2025-07-03 15:52:53] | "USP 4436383" #1 (Surface #2) modeling | | |
| [2025-07-03 15:52:53] | Surface #1 of "USP 4436383" #1 [Output x] | | |
| [2025-07-03 15:52:53] | Pointwise Fourier Transform (gridless data, 1027 sampling points) (Duration = | | |
| 00:00:00.0613588) | | | |
| [2025-07-03 15:52:53] | Pointwise Fourier Transform enforced by the user. | | |
| [2025-07-03 15:52:53] | Mapping is bijective: No. | | |
| 12025-07-03 15:52:531 | Surface #1 of "USP 4436383" #1 (Output k) | | |

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



4436383

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 xdomain, 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

| 🗟 2: Optical System | | | |
|--|--|------------------------|--------------------|
| System Elements | Detectors Logging | | |
| [2025-07-03 15:52 =================================== | 2:53] | Search × → | |
| [2025-07-03 15:52 [2025-07-03 15:52 [2025-07-03 15:52 [2025-07-03 15:52 ========== | 2:53] Start: Source modes with wavelength 488 nm | Detailed Logging 🛛 🗸 | |
| [2025-07-03 15:52 [2025-07-03 15:52 00:00:00.0354741 [2025-07-03 15:52 | 2:53] B-Operator Surface #1 (+/+) ["USP 4436383" #1] (Duration = | | |
| | 경 2: Optical System | | |
| [2025-07-03 15:5: [2025-07-03 15:5: | SystemElementsDetectorsLoggingpoints)(Duration = 00:00:00.3421868)[2025-07-03 15:52:55]Pointwise Transformation Index (PTI) = 0.0034transform used if larger than 1)[2025-07-03 15:52:55]"Universal Detector" #604 [Input x] | 094 (pointwise Fourier | │ X → |
| | [2025-07-03 15:52:55] End: Source mode #1 @ 488 nm (Duration = 00:00:02 [2025-07-03 15:52:55] ************************************ | .1370475) | Detailed Logging ~ |
| | [2025-07-03 15:52:55] Start: Source mode #2 @ 488 nm [2025-07-03 15:52:55] | | |

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

| 2: Optical System | |
|---|------------------|
| stem Elements Detectors Logging | |
| B-Operator Surface #9 (+/+) ["USP 4436383" #1] (Duration = 00:00:00.0009995) Surface #9 of "USP 4436383" #1 [Output x] | × - |
| Propagation to Universal Detector #604 | Hide Time Stamps |
| Surface #9 of "USP 4436383" #1 [Output x] | |
| Conversion from non-equidistant data to equidistant data (Duration = 00:00:00.0472253) | Detailed Logging |
| Semi-Analytical Fourier Transform (gridded data, (413; 413) sampling points) (Duration = | |
| 0:00:00.5332094) | |
| Quadratic phase factors for the Semi-Analytical Fourier Transform (scaled by the wave number) [1/m ²]: | |
| 0x = -4.0714, Dy = -4.0714, C = 0 | |
| Pointwise Transformation Index (PTI) = 0.15962 (pointwise Fourier transform used if larger than 1) | |
| Phase Upgrade (Duration = 00:00:00.1250372) | |
| Conversion from equidistant data to non-equidistant data (Duration = 00:00:00.1742745) | |
| Surface #9 of "USP 4436383" #1 [Output k] | |
| Free space propagation in k-domain (gridless data, 4219 sampling points) (Duration = 00:00:00.0039997) | |
| "Universal Detector" #604 [Input k] | |
| Conversion from non-equidistant data to equidistant data (Duration = 00:00:00.1725225) | |

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



| 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 | |