

Universal Detector

Abstract



The Universal Detector is the most versatile tool to evaluate and output any information of an electromagnetic field in VirtualLab Fusion. It is capable of providing information in different domains (spatial and spatialfrequency domain) and coordinate systems (coordinate system of the field vs. detector position). Moreover, it enables to further evaluate and export the information of the impinging light to calculate any physical, radiometric or photometric quantity by using very flexible in-built or customized Add-ons.

How to Find the Universal Detector?



The Universal Detector can be found in the tree of components in Light Path Editor, directly, To add it to your system, simply drag & drop it to the desired position.

Universal Detector with Different Modeling Profiles



The available options in the Universal Detector depend on whether Ray Results Profile or General Profile is chosen.

Field Quantities (General Profile)

Detector Windo	Detector Window (k-Domain)		Grid	ess Data		Add-or
Field Quan	tities		De	tector W	indow (x-D	omain)
Select Field Data Wh	ich Is Provided	to Detec	tor Add-O	ns		
Components	Ex	Ey	Ez	Hx	Hy	Hz
components				\Box	\Box	
Domain	Spa	ace (x-Dor	nain)	C Fo	urier (k-Do	omain)
Configure Field Dat Quantity Add-On	a Visualization	by <mark>Electro</mark>	magnetic	Field		¢
Apply Paraxial Appro	ximation for Co	omponent	Calculatio	on?	O Yes	⊖ No
Sum Mutually Cohere	ent Modes?				O Yes	() No
			Cab	rant Cum	matian	
How to Sum Mutually	Correlated Mo	odes?	Con	erent Sun	imation	~

Components:

Determines which components of the electromagnetic field are detected. At least one component must be selected. Note: VirtualLab Fusion uses Ex and Ey for the propagation and calculates other components on demand.

Domain:

The detector can evaluate and output the data in the x-domain (spatial domain) and/or k-domain (spatial-frequency domain).

Apply Paraxial Approximation for Component Calculation:

Determines whether the detector uses a paraxial approximation to calculate additional components of the electromagnetic field. (See: <u>Paraxial Assumptions</u>)

Sum Mutually Correlated Modes?

If this option is activated, correlated modes will be summed before any further evolution or output is performed. It offers

three options for the summation: Coherent Summation

Coherent Summation Incoherent Summation Partially Coherent Summation

Detector Window

12	Detector Window (k-Domain)	Gridless Data	Add-ons
	Field Quantities	Detector Wi	ndow (x-Domain)
Coordinate	Detector Window Centered Around	O Detector Position	Center of Field Mode
A	Lateral Window Position	0 mm ×	0 mm
	Detector Window Size		
Position /	O From Field Data (Per Mode)	O Manual Setting (All Mod	les)
	Size Scaling Factor	1 ×	1
Detector Parameters	Detector Grid Resolution From Field Data (Per Mode) Set Grid Period Grid Points 512 ² (1:1)	Manual Setting (All Mod Set Grid Points 512	les) × 512 €
ropagation			
ə: Opt	tions for Detecto	or Window]
main) are similar on	ly the unite	

The central position and size of the detector window can be defined according to coordinate system and extend of each individual mode or the position of the detector.



Center of Field Mode

Detector Position

The user can also configure, whether the sampling shall be handled individually (per mode) or on a mutual grid. This grid can be either specified by a period (sampling distance) or grid points (number of sampling points).

Gridless Data

1 -	Field Quar	ntities	Detector Window	v (x-Domain)
	Detector Windo	w (k-Domain)	Gridless Data	Add-ons
Coordinate Systems	Show Result w/o Inte (If Gridless Data Avai	rpolation for Gridless lable in Detector)	Field Data?	es 🔿 No
14	Show Interpolated	d Result on Equidistant	t Grid Additionally	
Position /	Quantity	O Field Va	lues Only Posit & Wavefro	ions, Directions, ont Phase
Orientation	Unselect Position	s with Associated Ener	gy Smaller Than	0.1 %
10 D	Gridless Sampling	Points	O Manual S	ampling
Parameters	Undinoci orro.			amping
F F ⁻¹				
\mathcal{F} \mathcal{F}^{-1} Free Space Propagation				
\mathcal{F} \mathcal{F}^{-1} Free Space Propagation	ivating Sh	ow Inter	nolated	
Free Space Propagation	ivating Sh	ow Inter	polated	
propagation	ivating Sh It on Equi	ow Inter distant G	polated Grid	
propagation <i>te:</i> Act <i>Resu</i> <i>ddition</i>	ivating Sh It on Equi ally, will o	ow Inter distant G utput bot	polated Grid Sh, the	
te: Act Resu	ivating Sh It on Equi ally, will ou	ow Inter distant G utput bot	polated Grid Srid	

If gridless data is used for the propagation, the detector can visualize this type of data as well. The gridless pattern of the field samples is output either in addition to the gridded information or exclusively. Further, the amount of output information (quantities) can be reduced to just positions and directions (like a ray tracing result). Please note that this will only work for a single mode or of the coherent summation is disabled.





gridless data

Detector Add-Ons – Electromagnetic Field Quantities



Add-ons are versatile tools that allow for an additional calculation of any values based on the impinging field data (either single physical values or 2D arrays). They are organized in tree, for the case the one add-on requires the result of another.

By default, the *Electromagnetic Field Quantities* add-on is preconfigured (cannot be deleted). It outputs any field component in the x- and/or kdomain. Please note, that only field components can be output, which are selected in the *Field Quantities* tab (vice versa, it is not necessary to enable the output of all components). Furthermore, options to output just the amplitude or the wavefront phase additionally are available, as well as display options.

Detector Add-Ons – Custom Add-ons

While all *Add-ons* are calculated, the user can specify which results to display.



- Result will be visualized.
- 😤 R
 - Result will not be visualized.

1 7	Field Quantities	Detector Window	(x-Domain)
	Detector Window (k-Domain)	Gridless Data	Add-ons
ordinate ystems	Data from Universal Detector		¢
	Electromagnetic Field Quantitie	'S	¢
osition / entation	Poynting Vector		\$ \$
	Illuminance		¢ ×
etector ameters	Lateral Extent via Full Width x%	Maximum (FWx%M)	¢ ×
F F-1			
e Space			
nagation			
pagation	New Load Duplicate	• 8	

Each *Add-on* comes with its own set of options. They can be accessed via the 🄯 - button.

In this area detector *Add-ons* can be created, duplicated or loaded from the officially provided database. The Provided database. The Provided database of *Add-ons* via internet from the LightTrans website.

Detector Add-Ons – Hierarchy Tree



By default, the Universal Detector provides all *Add-ons* with the electromagnetic field information based on the field components that are specified in the *Field Quantities* tab. Some *Add-ons* will require just single components, while other necessitate a full set of all 6 components (**E** and **H**). Further, some *Add-ons* require a different physical quantity as input (e.g. the Poynting-Vector). For this purpose, *Add-ons* can be arranged in a tree.

In the example, the *Poynting Vector* add-on is applied on the field data to calculate the Poyntingvector in x-domain. The resulting information can be used to calculate the (spectral) irradiance and moreover processed to calculate the illuminance. In contrast, the *Radiant Flux & Efficiency (Surface)* just requires the full set of field data. Hence, it is positioned at a new branch.

Detector Add-Ons Read Me – Documents

Edit Dete	ector Add-on			>
Name	Radiant Flux & Efficiency (Surface)			🔞 Read Me
	ulate Efficiency			
Region	1D for Efficiency Calculation		Set	Show
Region	2D for Efficiency Calculation		Set	Show
C# Code	: 📝 Edit Validity: 🖉			
		ОК	Cancel	Help

Every *Add-on* from the official database comes with a read-me document, explaining its functionality and stating the input and output parameters.

nippet Help	- 0	×
Radiant Flux & Effi	ciency (Surface)	í
Author: Christian Hellmann Version: 1.0 Last Modified: Monday, Dece	mber 19, 2022	
Input: gridded electromagnet Function: calculates (1) the to total radiant flux through a sp (2) and (1). Output: radiant fluxes and eff	ic field data (1d/2d; all six components in x-domain). tal radiant flux of the input data through the detector plane, and additionally (2) (optional) the ecified region in the detector plane together with the efficiency, i.e., the ratio of the fluxes in iciency in Detector Results.	e
Learn more about radiometric Some rights reserved via the CC BY 4.0 I	detectors <u>here</u> . icense.	
PARAMETER	DESCRIPTION	
Calculate Efficiency	<i>Checked:</i> (additional) calculation of flux through region of detector plane and corresponding efficiency. <i>Unchecked:</i> flux calculation through entire detector plane only.	
Region 1D for Efficiency Calculation	Specify 1d region (1d input data only) in the detector plane for partial flux and efficiency calculation.	

Close

Release 2023.2 – Overview of Add-Ons

The official database categorizes the available detector add-ons into subcategories. With the release of version 2023.2 the following add-ons are available:

Lateral Extent Measurements:

- Lateral Extent via Full Width x% Maximum (FWx%M)
- Lateral Extent via Minimum Rectangle (FWxM)
- Lateral Extent via Standard Deviation
- Lateral Extent via Sum of Squares Percentage

Export:

- Export to CSV
- Export to Image
- Export to Raw Data

Photometry:

- Illuminance
- Luminous Energy Density
- Luminous Energy
- Luminous Flux & Efficiency (Solid Angle)
- Luminous Flux & Efficiency (Surface)
- Luminous Intensity

Region Indication:

 Add Region Information from Light Guide

Radiometry:

- Intensity
- Irradiance
- Poynting-Vector
- Radiant Energy Density
- Radiant Energy
- Radiant Flux & Efficiency (Solid Angle)
- Radiant Flux & Efficiency (Surface)
- System Efficiency (x-Domain)
- System Efficiency (k-Domain)

Detector Add-Ons – Programmable Snippets



Any Add-on is based on a programmable snippet that allows for a maximum of flexibility. A more in-depth introduction for programmable tools in VirtualLab Fusion can be found under: How to Work with the Programmable Detector

X

Help

Post-Processing: Application of Detector Add-ons

				A	pply Detector Add-o	on	×
📈 🛅 🕶 🔛 🐻 📼			Data Arra	ay	New Add-on	New Detector Add-on	
File Start Sources	Functions Catalogs	Windows Help V	iew Manipulation	s Det	/ Edit Validity:	0	
Apply Detector Add-on + Add-on Apply Detector Add-on Update Predefined Add-ons	$\overline{\mathcal{A}} = \overline{\overline{\mathcal{G}}}$ $\overline{\mathcal{G}}$ $\operatorname{Max}_{x,f_x}$ ta Point Complex Maximum verage Histogram (Position and Va	Min _{x,fx} Minimum (Position Full alue) and Value) Half Selected Detectors	Width at Maximum	म्रा AunAu niformity Error	No global p	arameters defined / necessary i	n this <mark>snippet.</mark>
☆ Favorites							🔞 Read Me
Mean Efficiency				-	Wave Front Data (O	ptional)	
Poynting Vector					Set	Remove	Show
Pulse Extraction					Medium to Use Det Air in Homogeneous	ector In : Medium	
Under <i>Detectors/Ap</i> predefined or custor further post-process	oply Detector Add- mized Detector Ad s the results.	<i>on</i> the user can dd-ons to a Data	apply any <i>Array</i> to		Eoad	OK Cance	Q View

Clicking on the button will add a *Detector Add-on* to the favorites list, allowing easier access.

Document Information

title	Universal Detector
document code	SWF.0014
document version	1.2
software edition	VirtualLab Fusion Basic
software version	2023.2 (Build 1.242)
category	Feature Use Case
further reading	