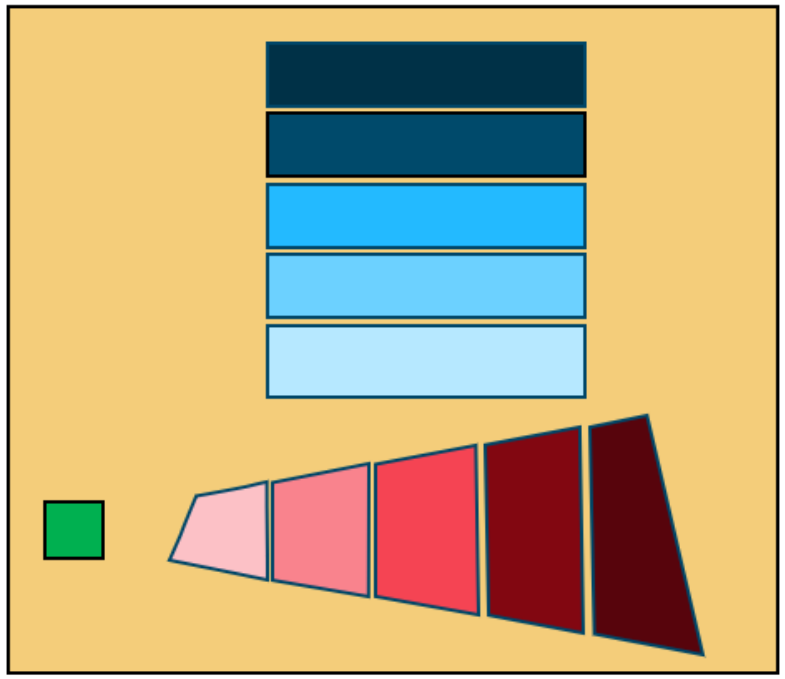
Lightguide Featuring Segmented Gratings Regions with Intermittent Gaps

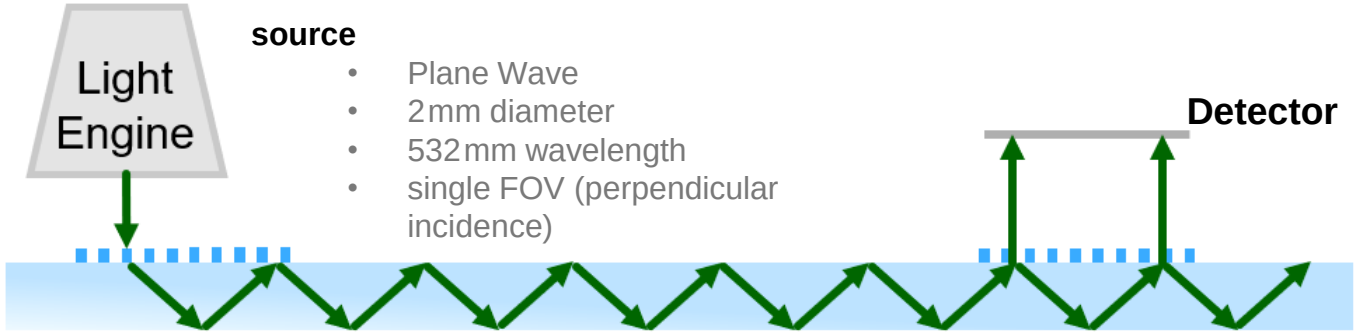
Abstract



VirtualLab Fusion enables the definition of gratings in lightguides either with continuously varying parameters or as segmented structures, where each segment features a constant but different parameter value. This Use Case examines the differences between these two by comparing its resulting irradiance and uniformity, with particular attention to the impact of gaps between segments.

Application Scenario

Application Scenario: System



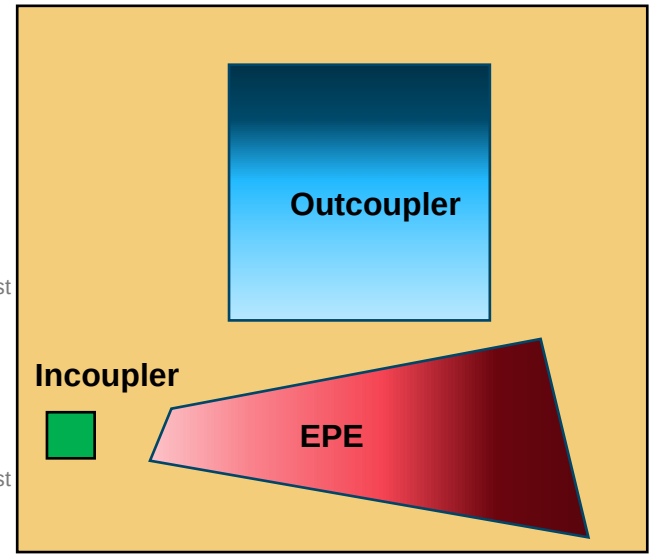
1D – 1D grating expander lightguide

Configuration a)

Incoupler (idealized grating)
- 380nm period
- 1st transmission order (100%)

Eye Pupil Expander (idealized grating)
- 268.7nm period
- smooth variation of efficiency of 1st reflection order between 5% and 12%

Outcoupler (idealized grating)
- 380nm period
- smooth variation of efficiency of 1st transmission order between 5% and 23%

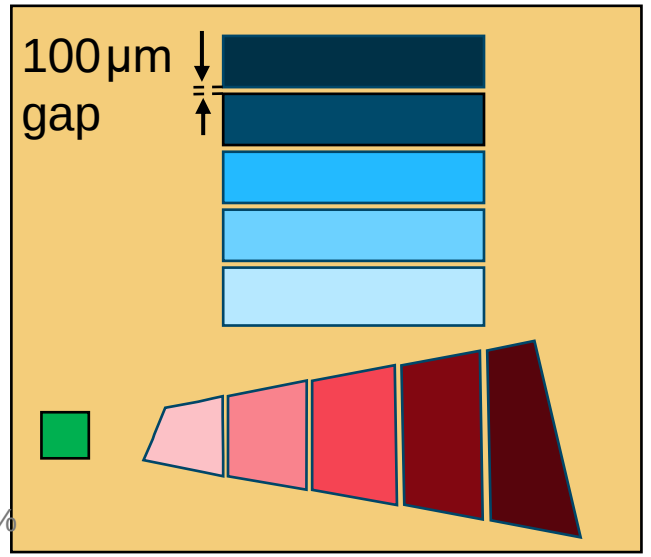


Configuration b)

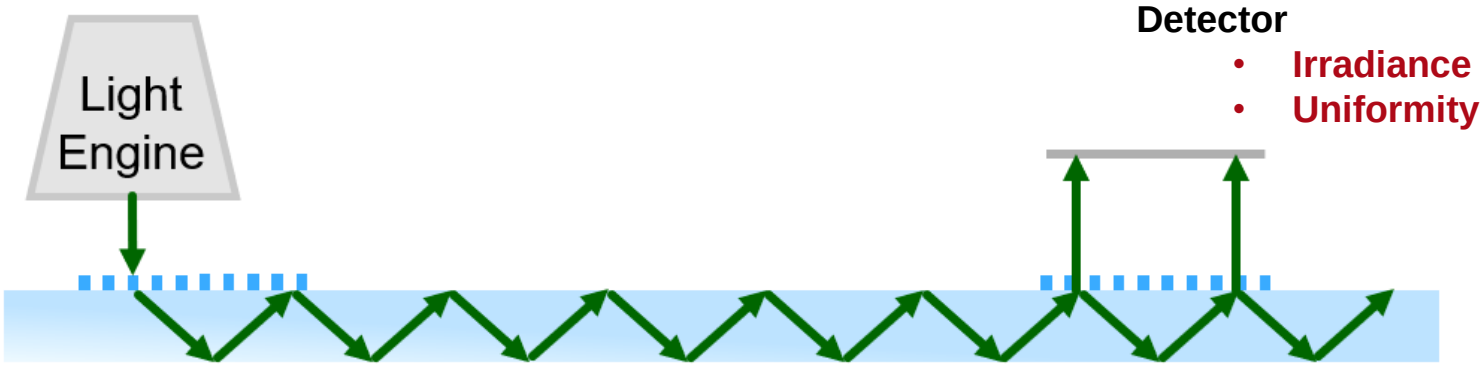
Incoupler (idealized grating)
- 380nm period
- 1st transmission order (100%)

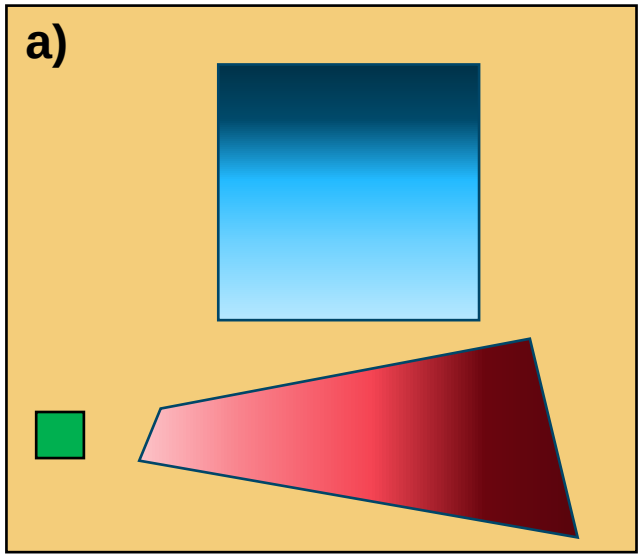
Eye Pupil Expander (idealized grating)
- 268.7nm period
- stepwise variation of efficiency of 1st reflection order between 5% and 12%

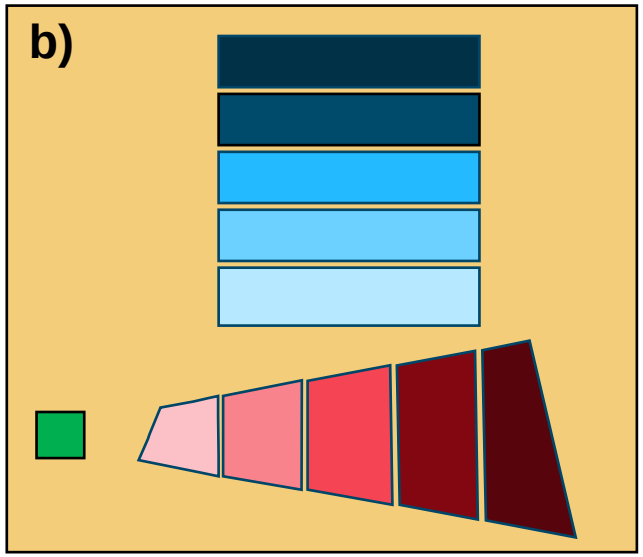
Incoupler (idealized grating)
- 380nm period
- stepwise variation of efficiency of 1st transmission order between 5% and 23%



Application Scenario: Task



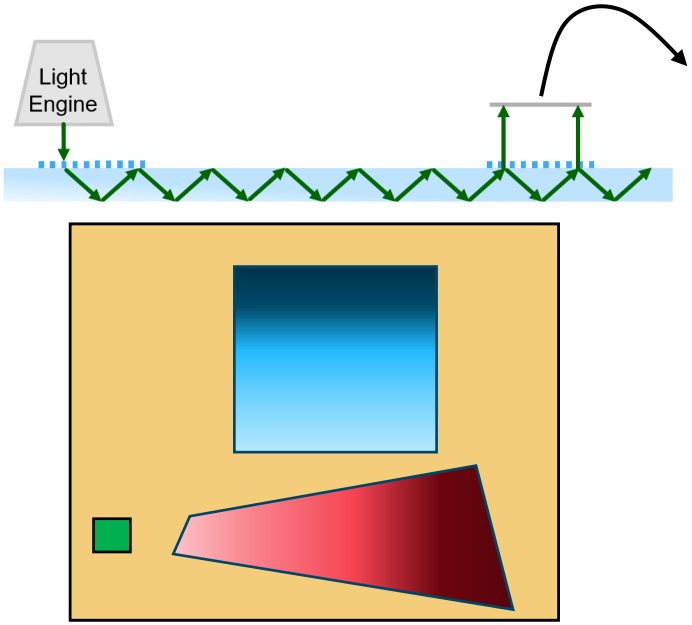


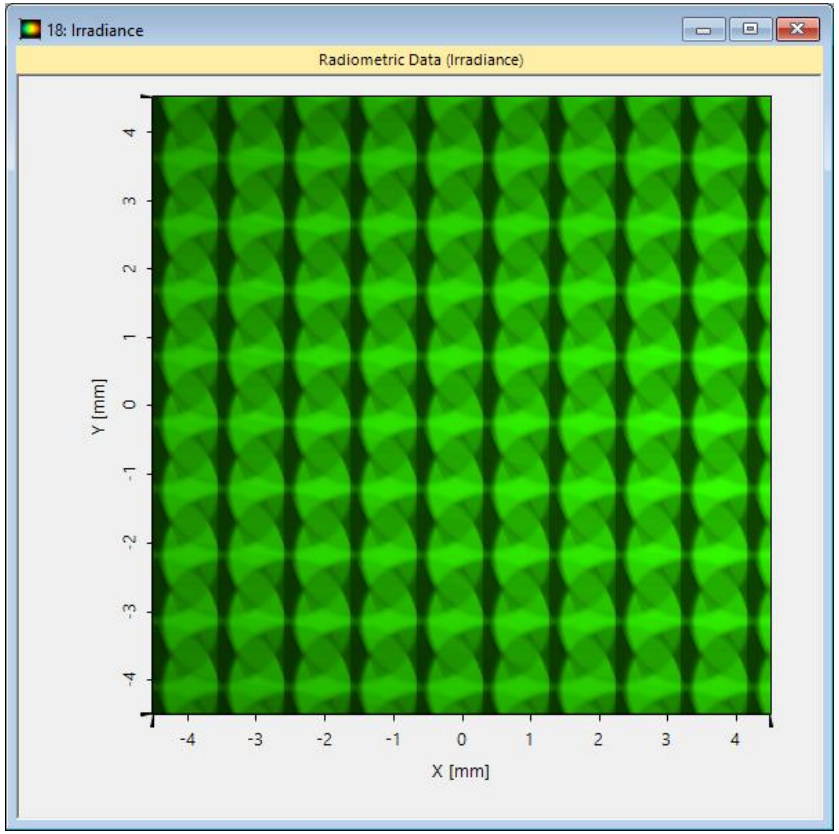


Task: Calculate irradiance and uniformity for the two configurations.

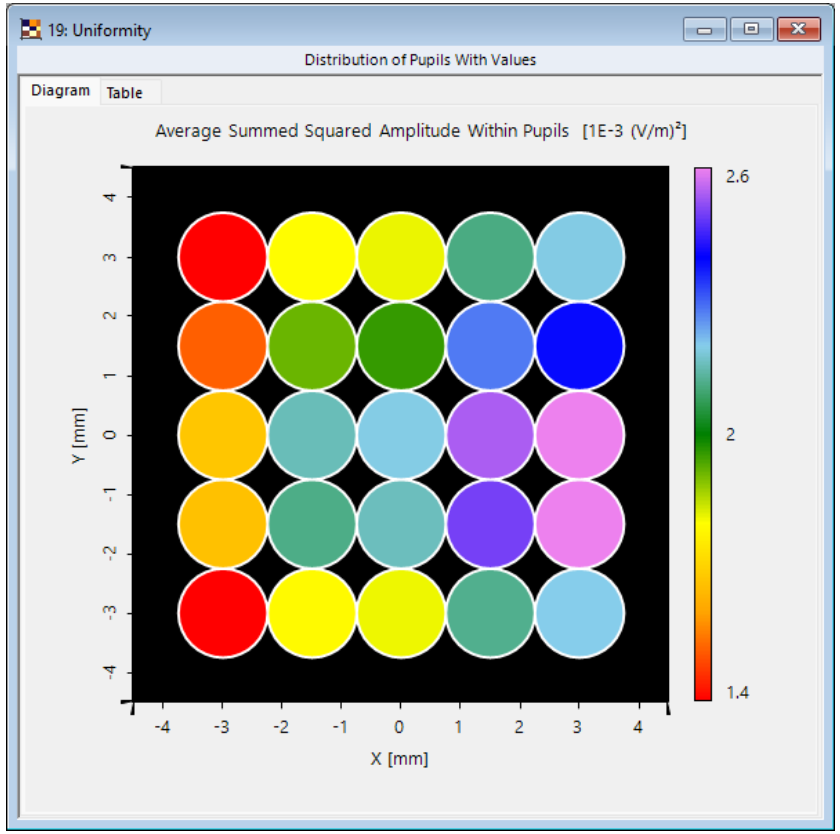
Simulation Results

Config. A: Irradiance & Uniformity Error behind Outcoupler





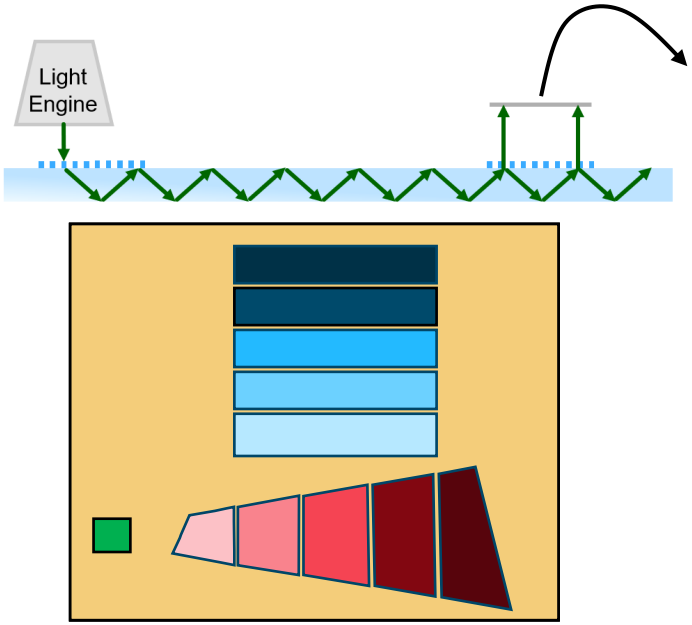
Irradiance (real color)

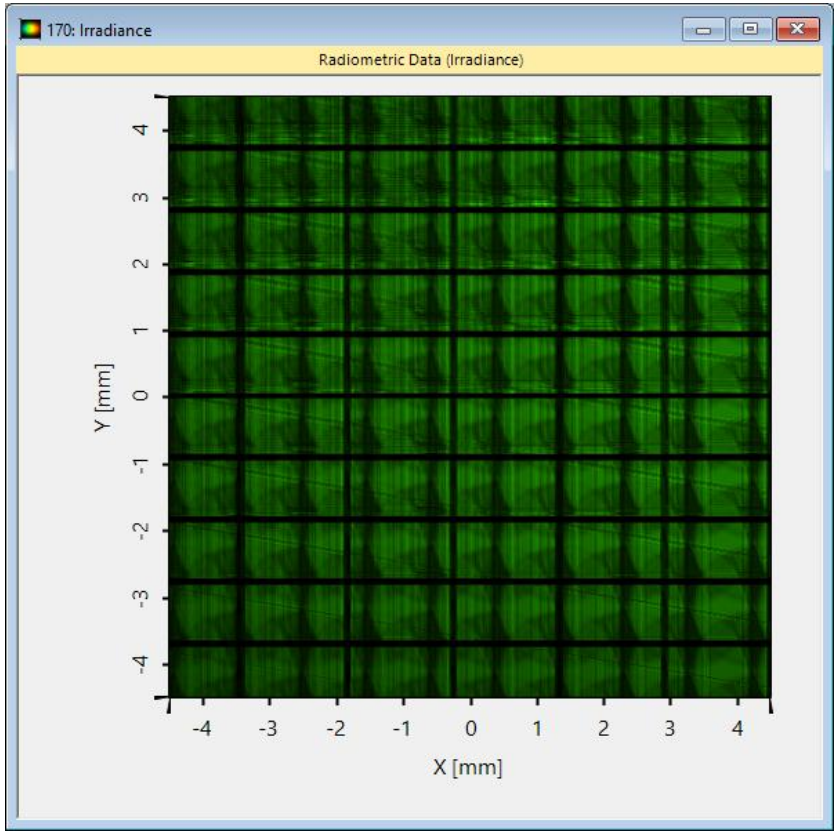


Average energy density per pupil

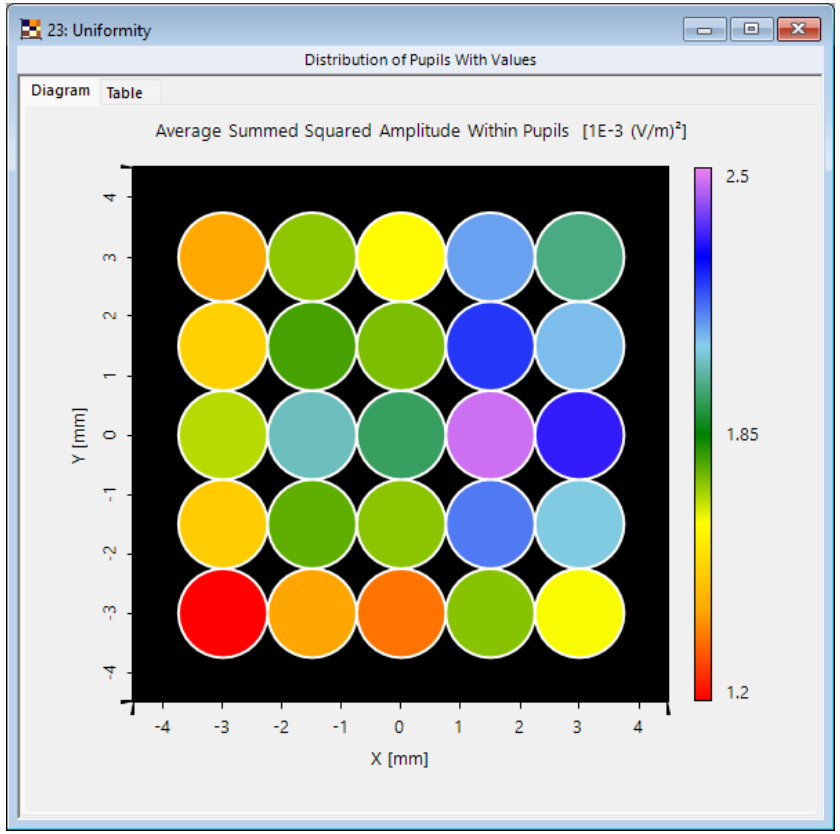
Uniformity error: 31.126%
Arithmetic mean: 2039.8 mV/mm²

Config. B: Irradiance & Uniformity Error behind Outcoupler





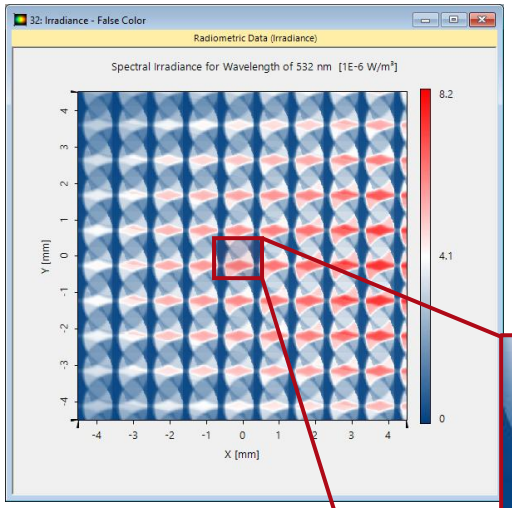
Irradiance (real color)



Average energy density per pupil

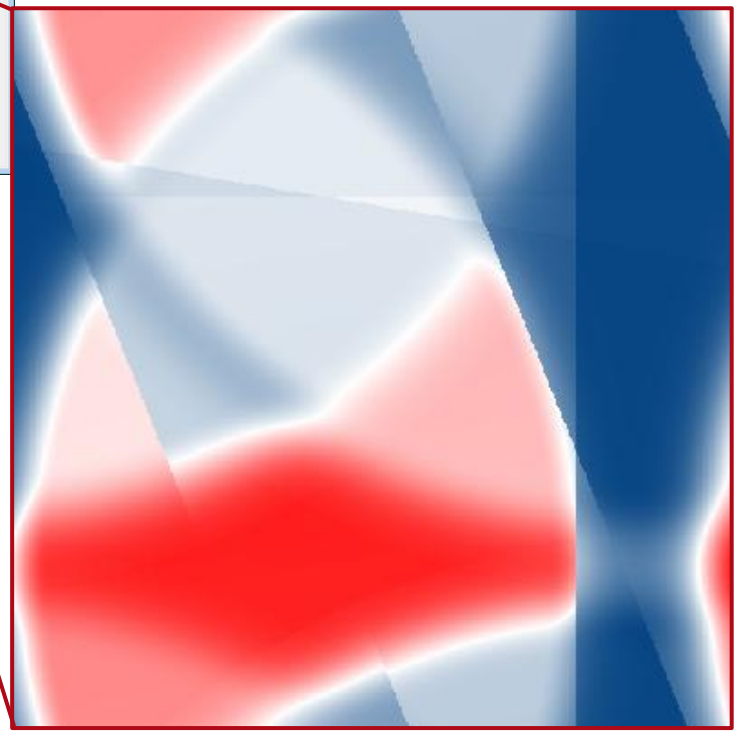
Uniformity error: 35.148%
Arithmetic mean: 1809.8 mV/mm²

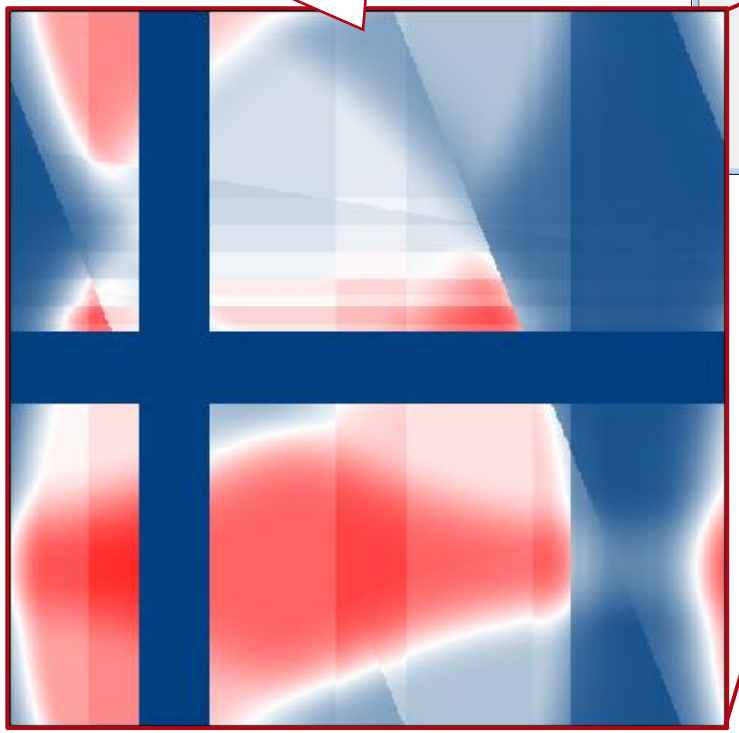
Comparison

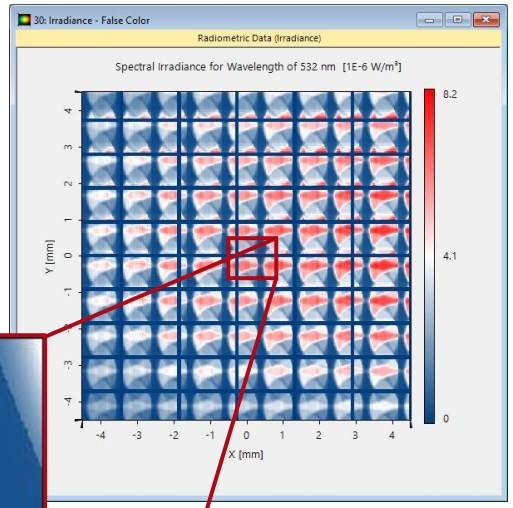


Irradiance of configuration a) (false color)

The introduction of gaps between grating regions will lead to additional boundary interactions visible in the outcoupled field.

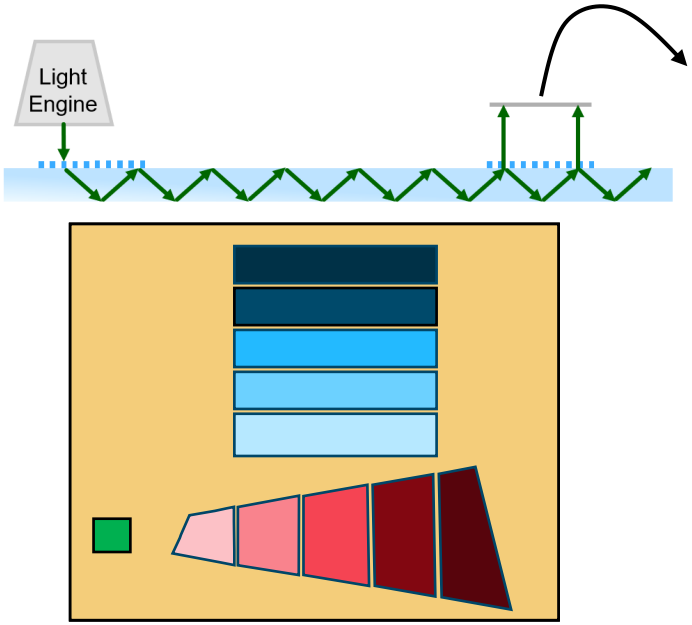


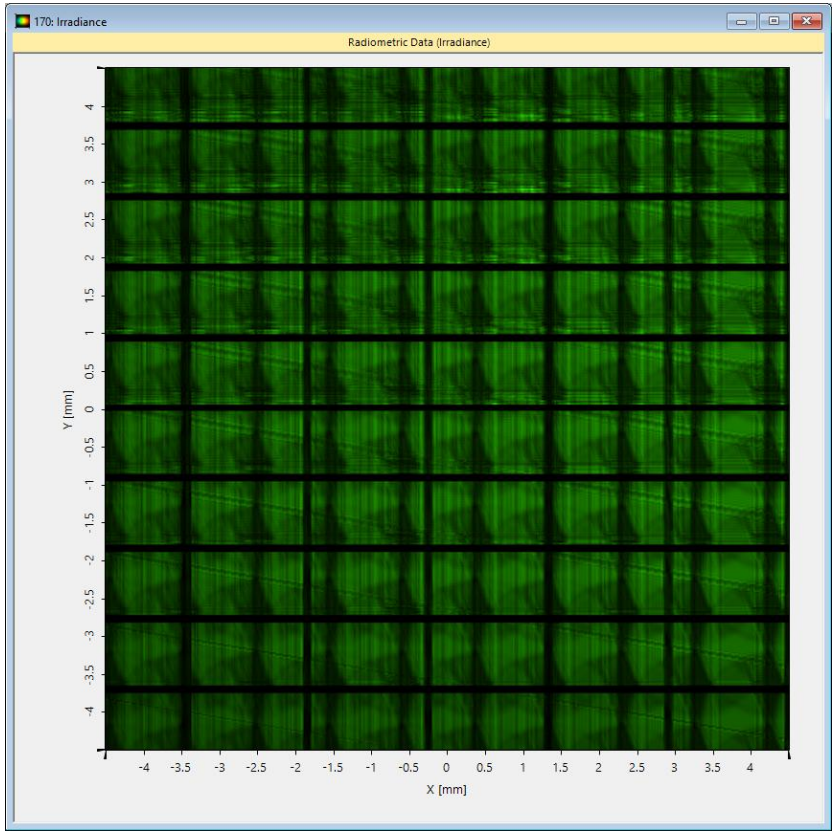




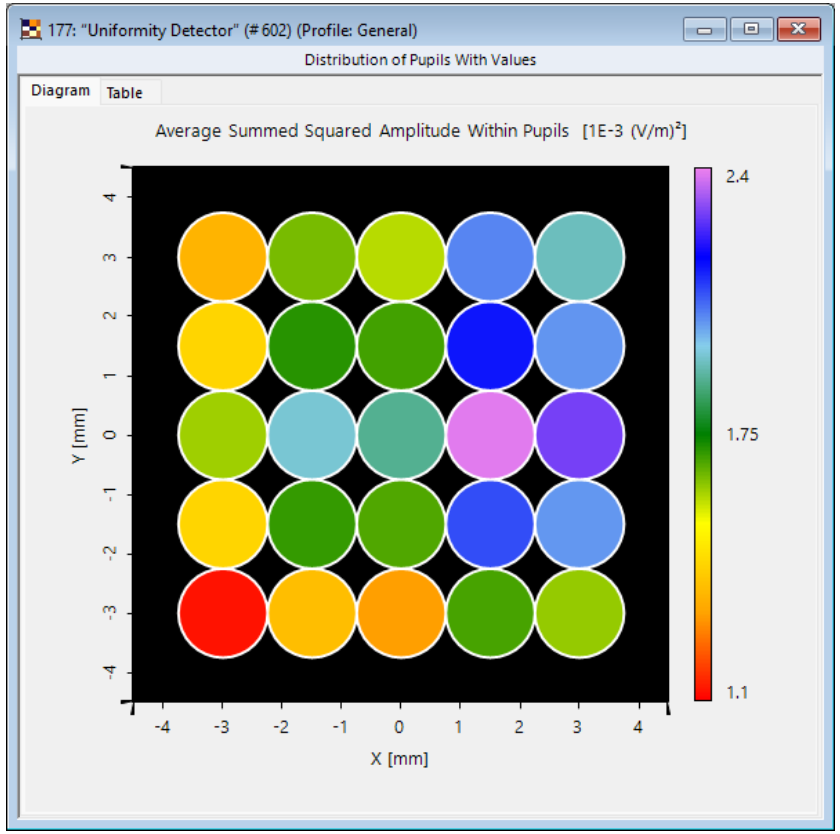
Irradiance of configuration b) (false color)

Conf B: Irradiance & Uniformity Error after Lightguide





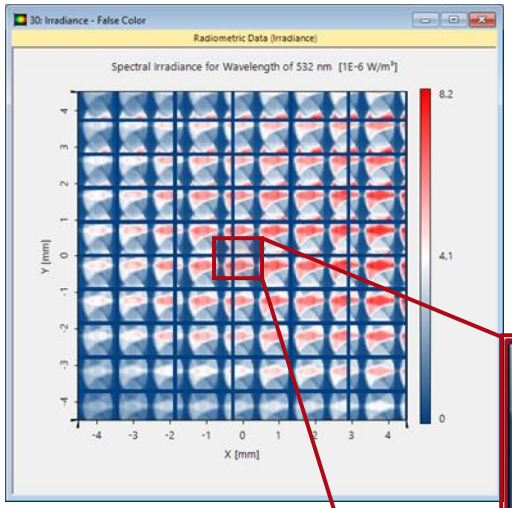
Irradiance (real color)



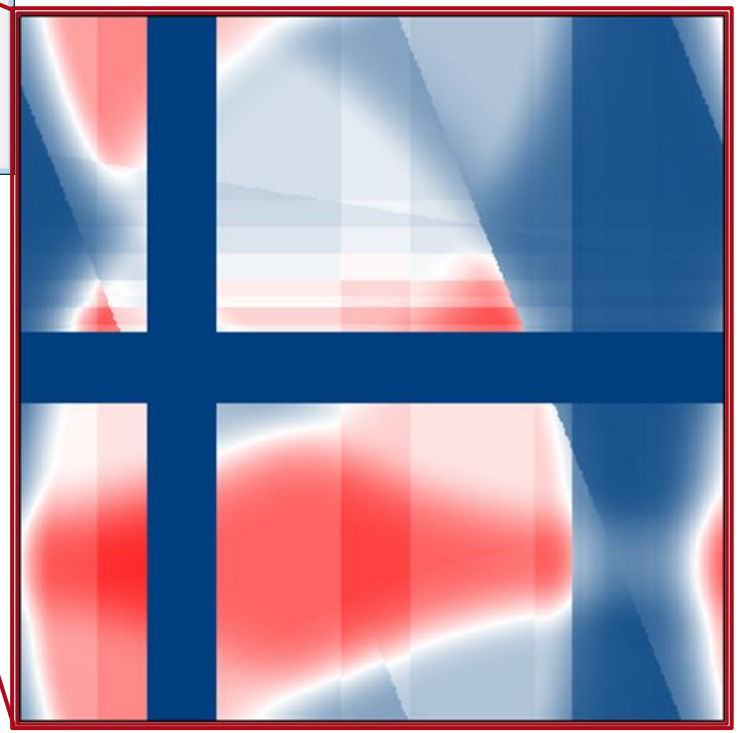
Average energy density per pupil

Uniformity error: 35.985%
Arithmetic mean: 1752 mV/mm²

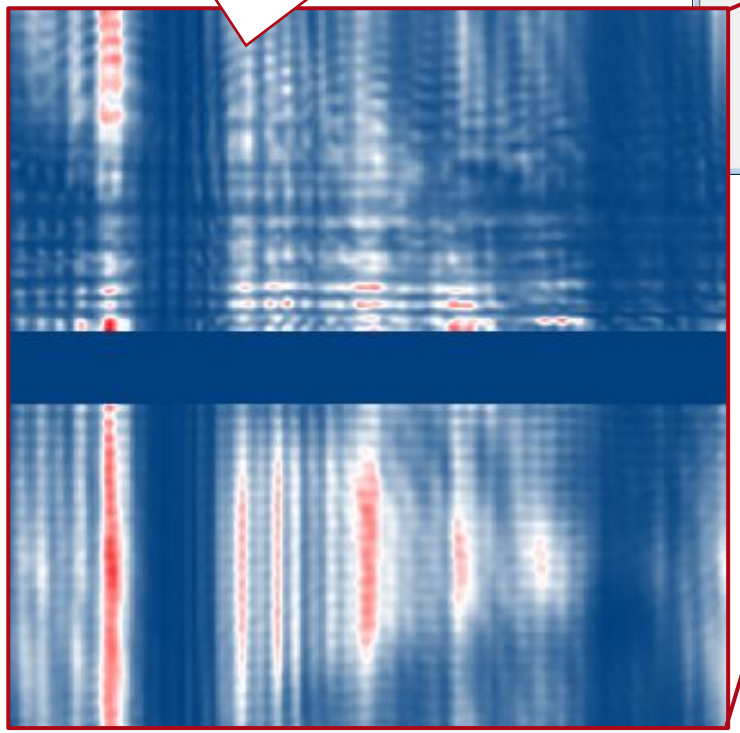
Comparison

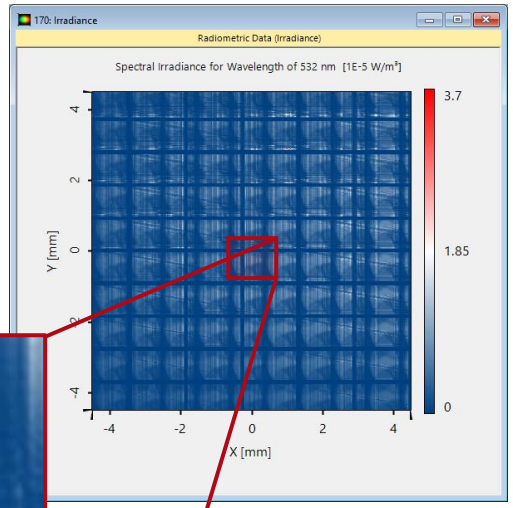


Irradiance without inclusion of diffraction effects



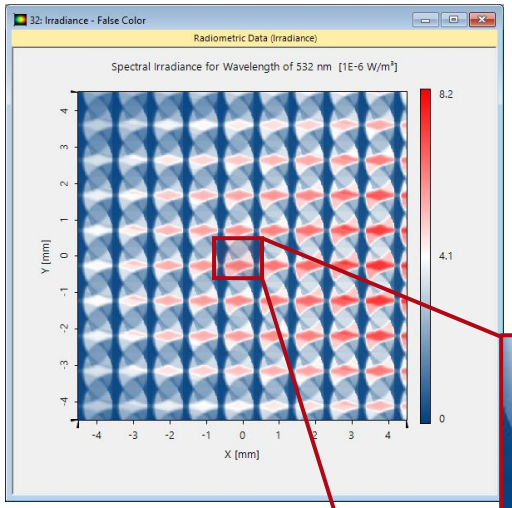
While the uniformity merit function will not show too much effects due to the averaging, locally diffraction effects matter a lot.



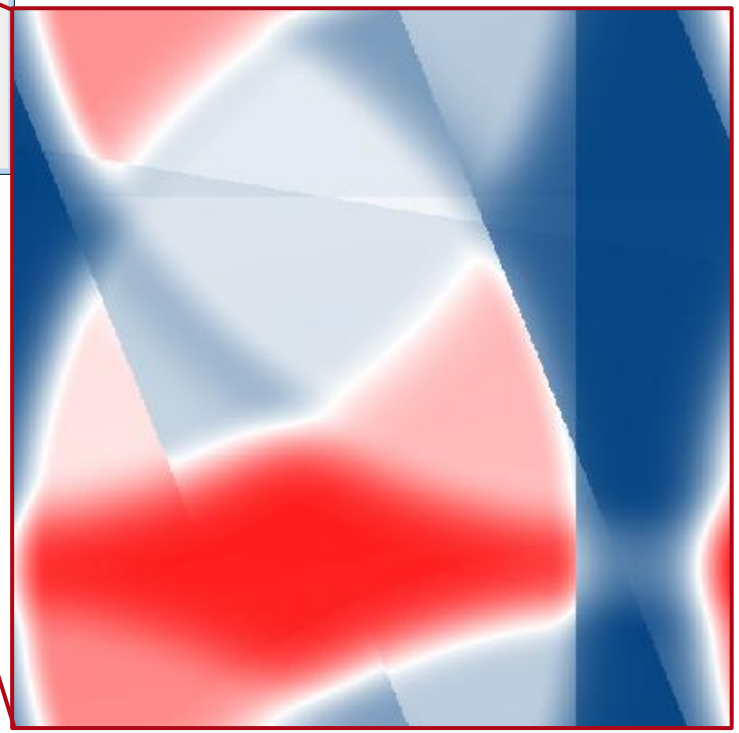


Irradiance with inclusion of diffraction effects

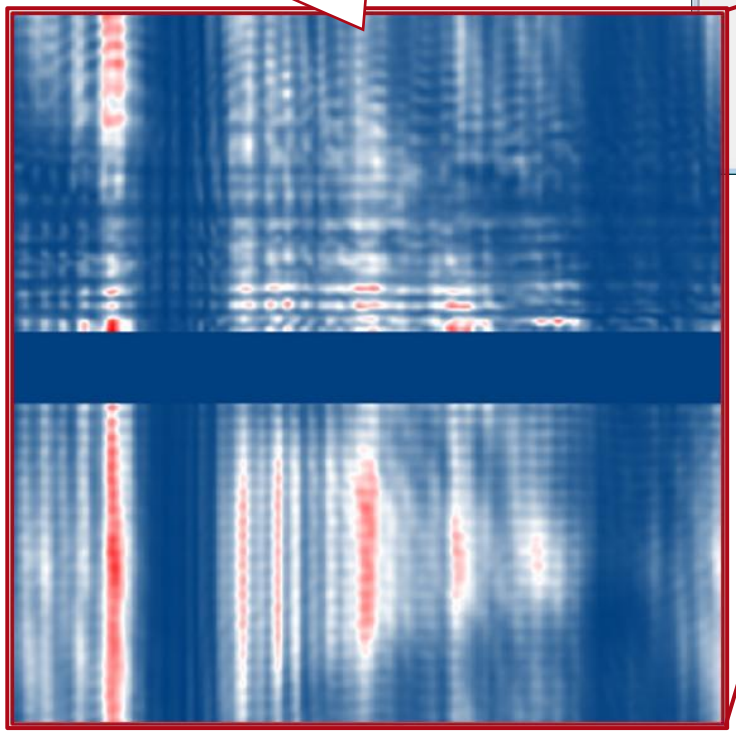
Comparison

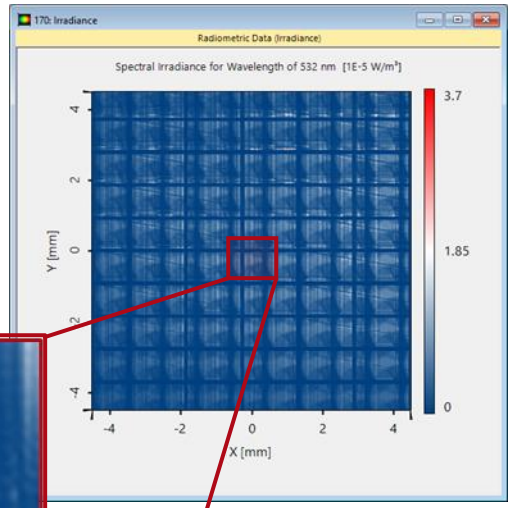


Irradiance of configuration a) (false color)



The introduction of gaps between grating regions will lead to additional boundary interactions visible in the outcoupled field.





Irradiance of configuration b) (false color)

Workflow Steps

Basic Workflow Steps

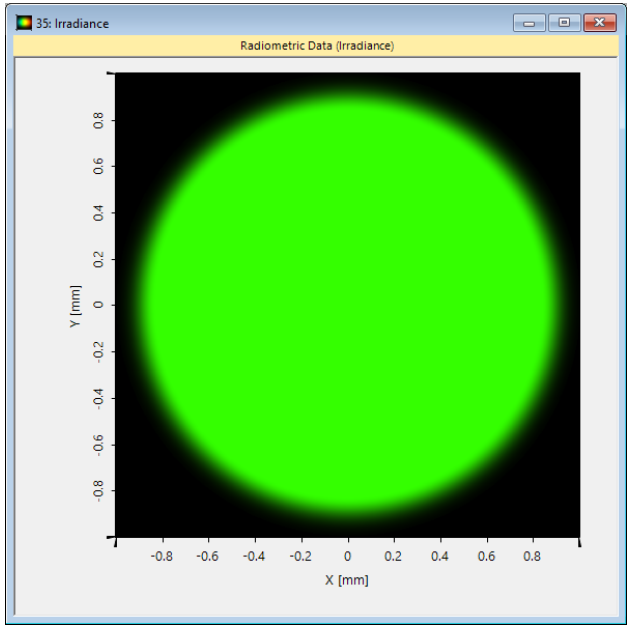
Source selection

System setup

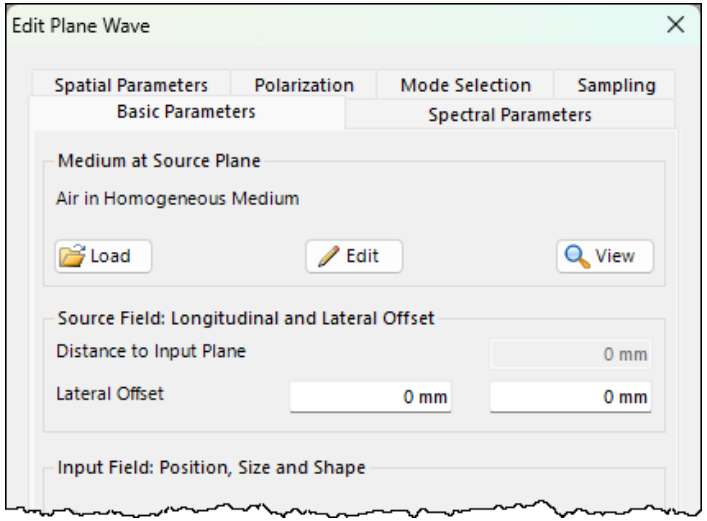
Detector selection

Getting it done in VirtualLab Fusion:

- Plane Wave



Irradiance of source



Source settings

Basic Workflow Steps

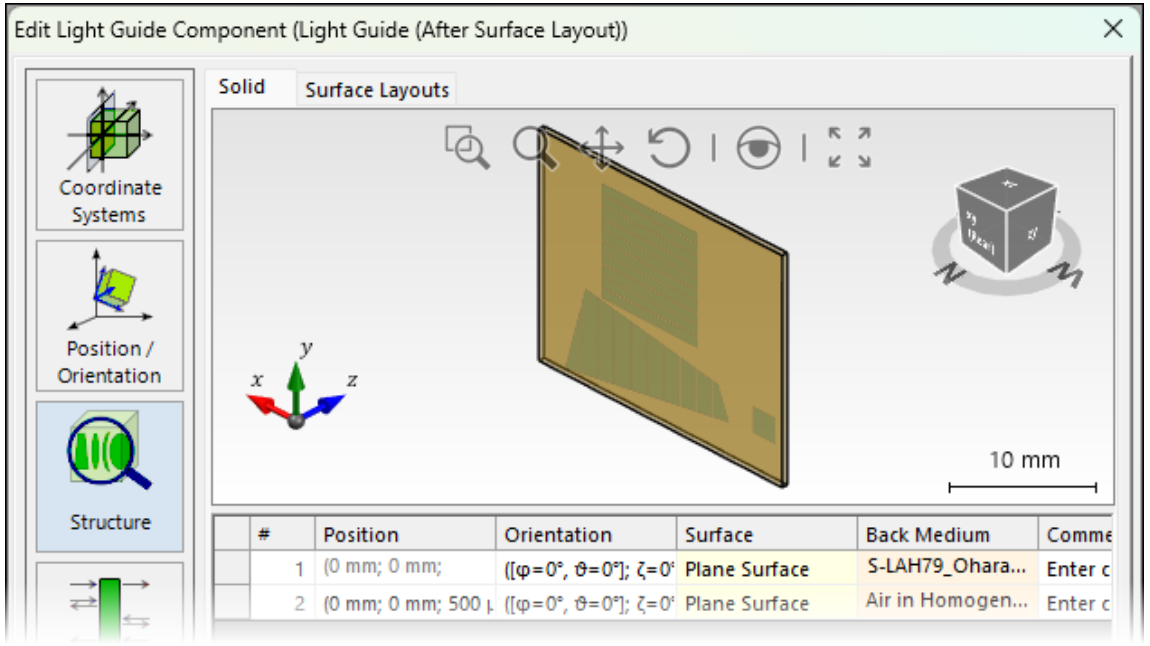
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Lightguide construction by Light Guide Component
- Channel configuration for surfaces and grating regions
- Segmentation of the Grating Regions



Basic Workflow Steps

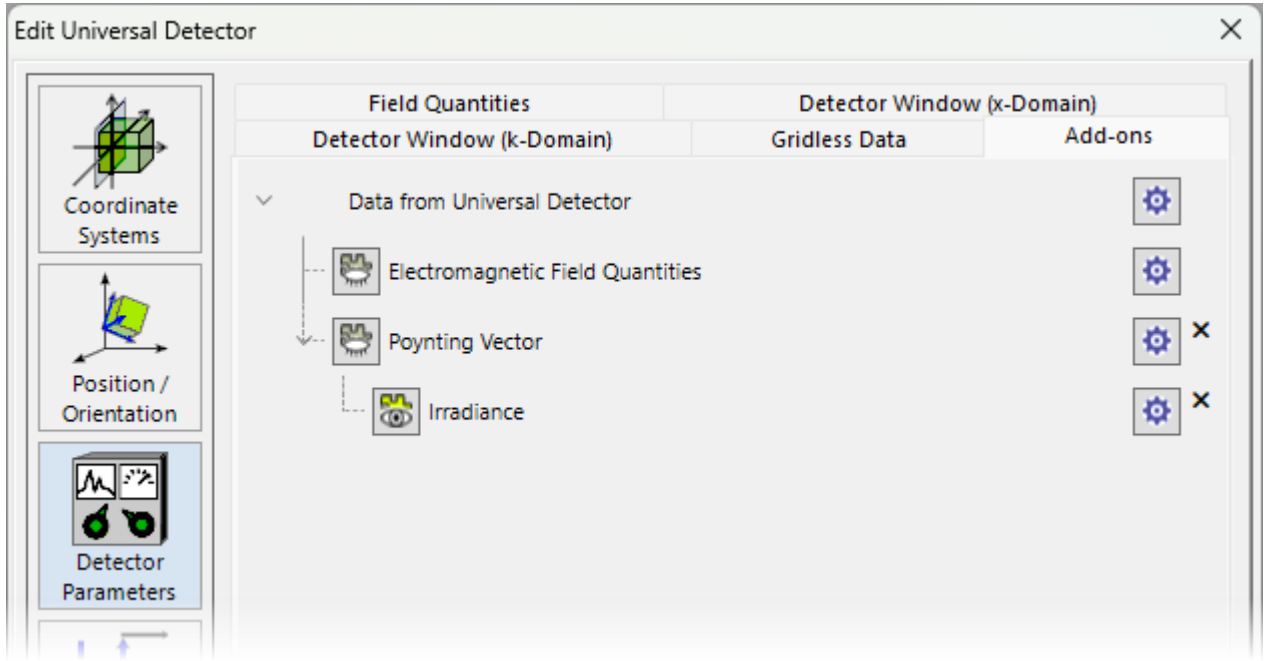
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Universal Detector
- Uniformity Detector



Detector add-on selection

Document Information

Title	Simulation of a Lightguide with Segmented Grating Regions including Gaps
Document code	USC.0461
Publication date	08.07.2025
Required packages	-
Software version	2025.1 (Build 1.172)*
Category	Use Case
Further reading	- Gridded Segmentation of Grating Regions - Grating Analysis and Smoothly Modulated Grating Parameters on Lightguides

* *The files attached to this document require the specific version or later.*

Conf B: Irradiance & Uniformity Error after Lightguide