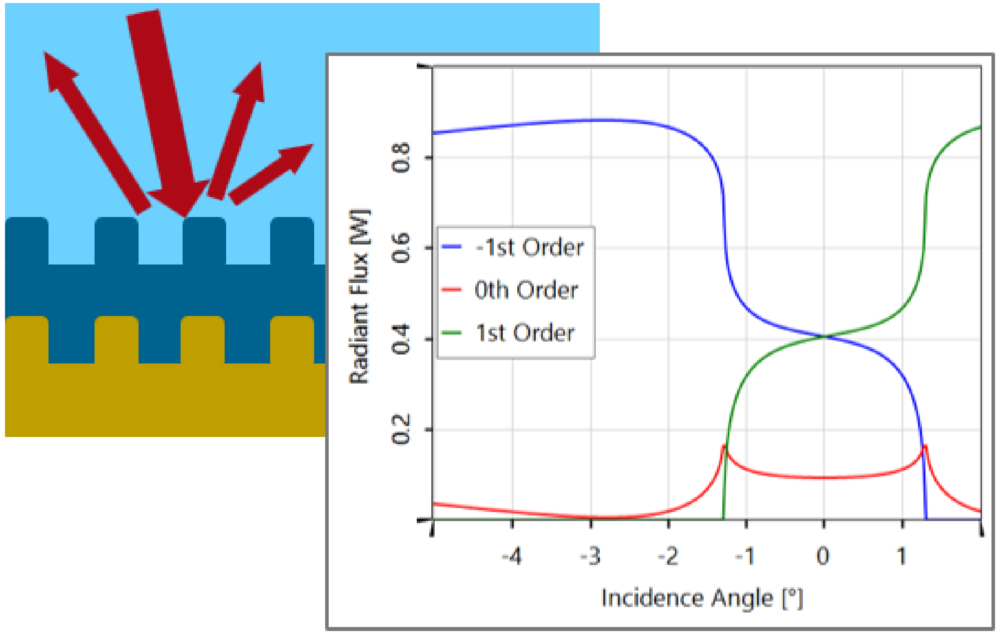
Resonant Grating Coupler

Abstract



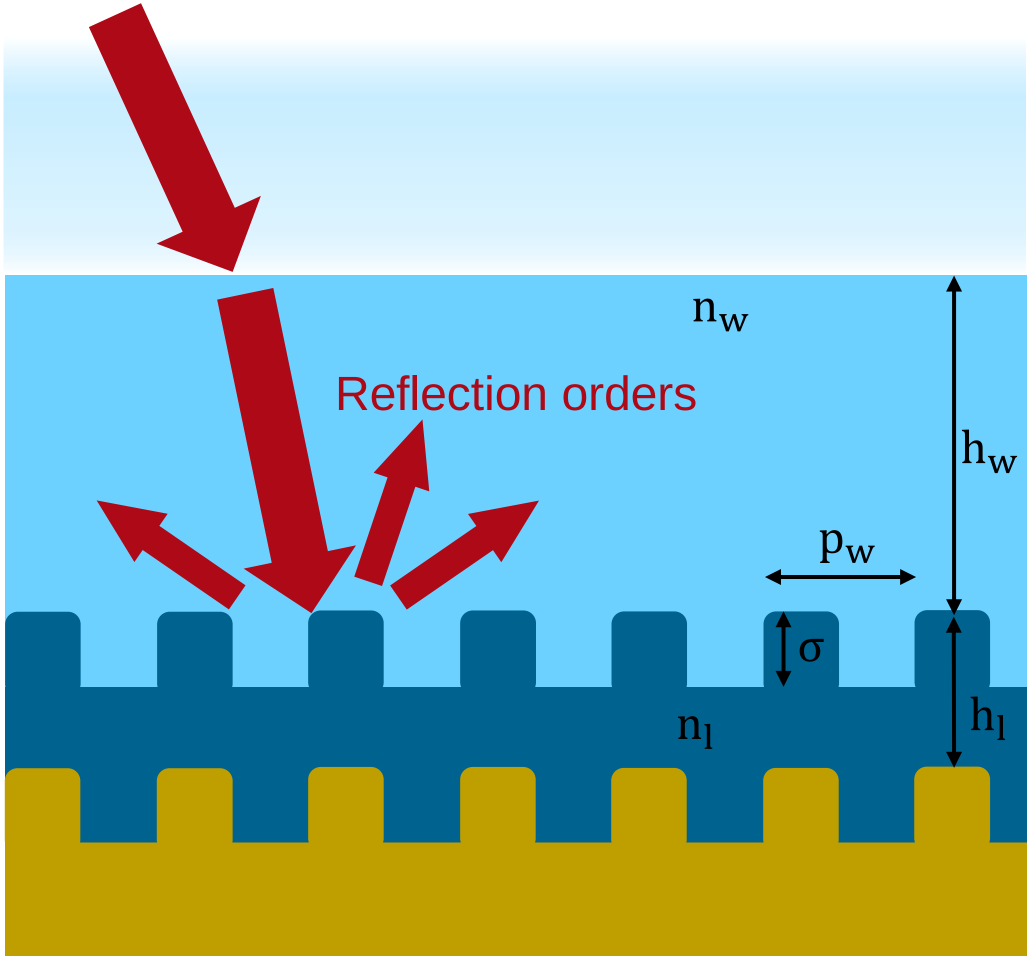
We investigate the properties of the resonant grating coupler proposed by Destouches et al. (2007), with particular emphasis on how the efficiency of different reflective diffraction orders varies with the angle of incidence.

Application Scenario

Application Scenario: System

Input field

- Plane Wave
- Wavelength $\lambda = 850\,\mathrm{nm}$
- Linearly polarized
- Variable incidence angle



Air

Waveguide

- Refractive index $n_w = 1.568$
- height $h_w = 50\,\mu\mathrm{m}$

High index layer

- Refractive index $n_l = 1.9$
- Height $h_l = 175\,\mathrm{nm}$
- Period $p_l = 550\,\mathrm{nm}$
- Modulation depth $\sigma = 165\,\mathrm{nm}$
- Rounded edges: $90\,\mathrm{nm}$

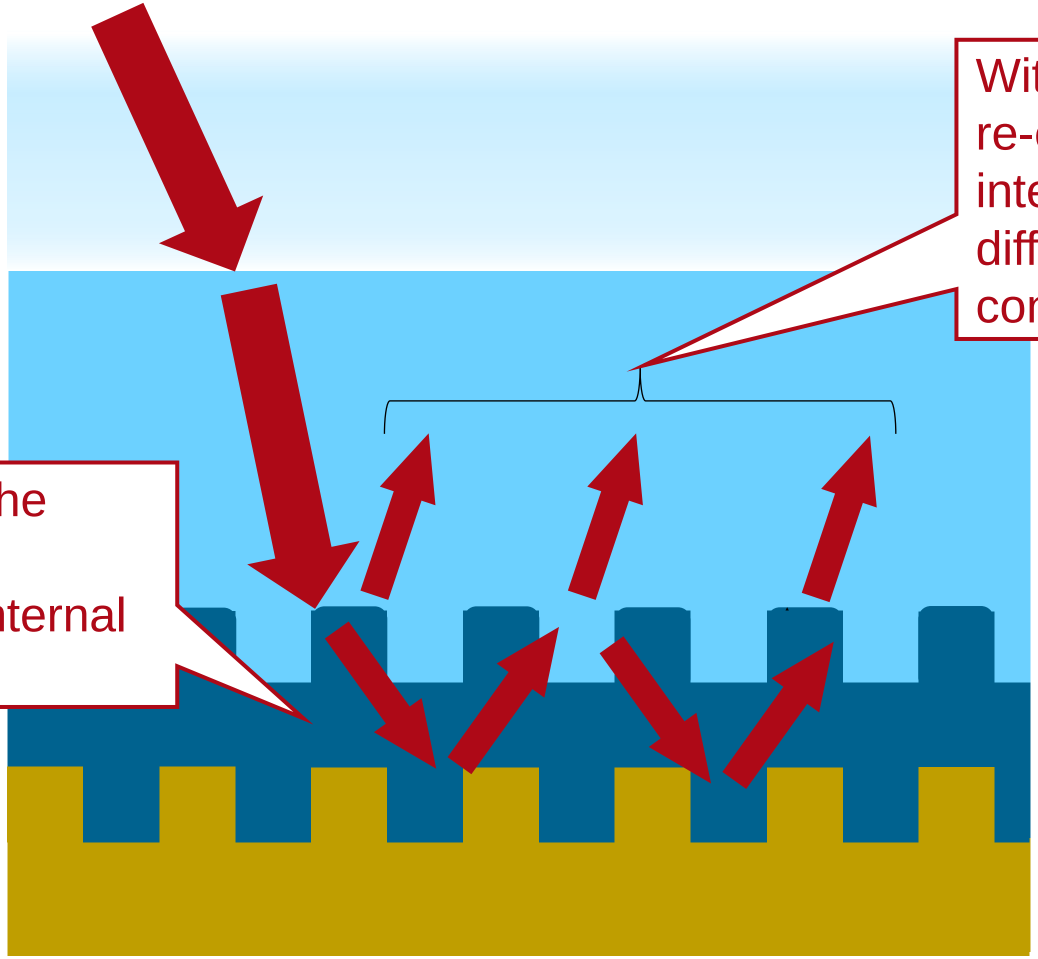
Substrate

- Material: Gold

System parameters are derived from the following paper:

Destouches, et. al. Efficient and tolerant resonant grating coupler for multimode optical interconnections. Optics Express. 15. (2007).

Application Scenario: System



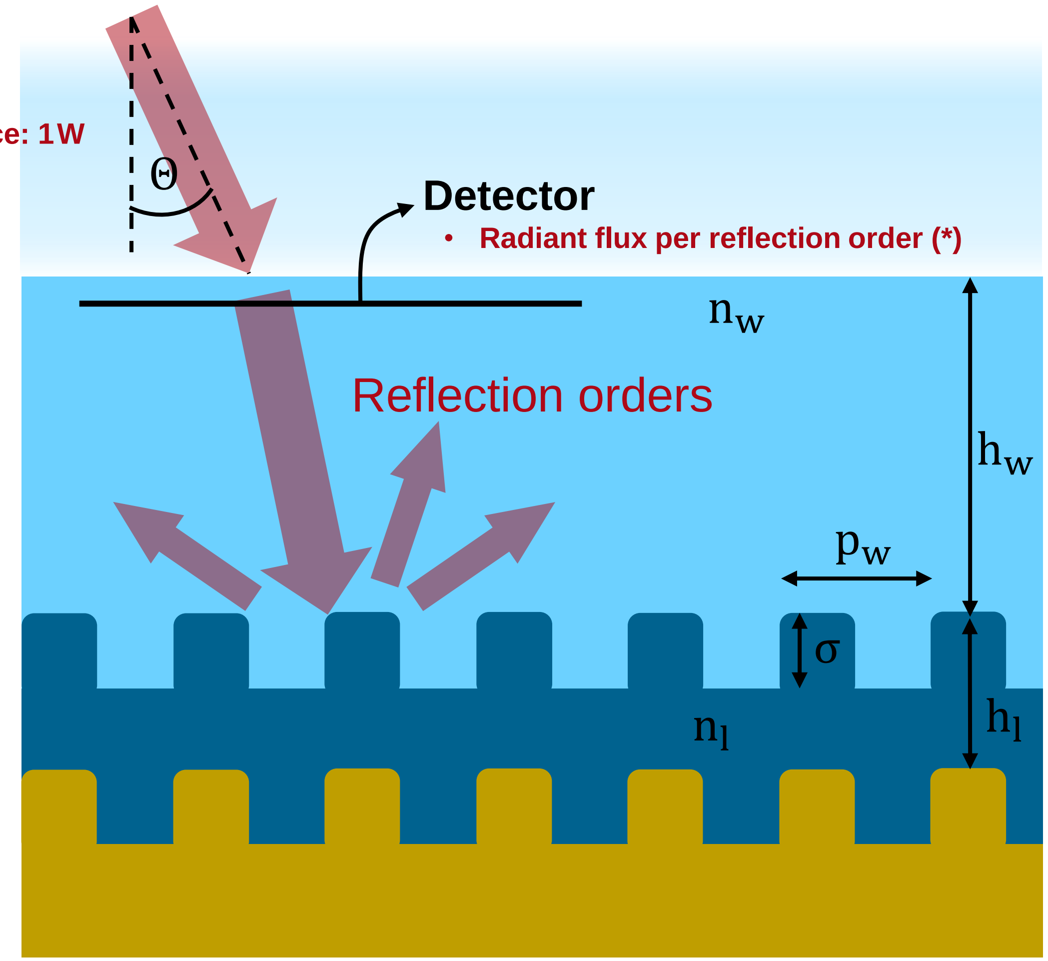
Incident light enters the high-index layer and undergoes multiple internal reflections.

With each round trip, part of the light re-enters the waveguide. The resulting interference can suppress specific diffraction orders under suitable conditions.

Application Scenario: Task

Input field

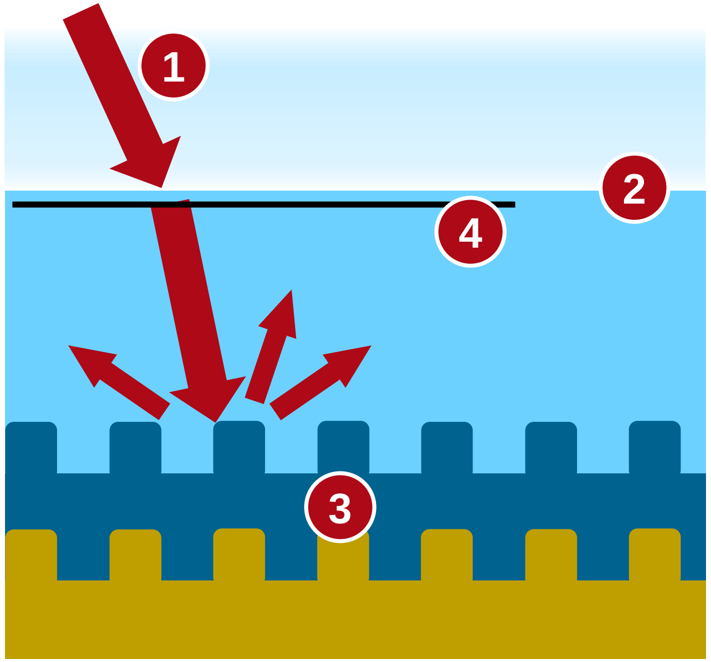
- Incidence angle Θ
- Radiant flux of source: 1W



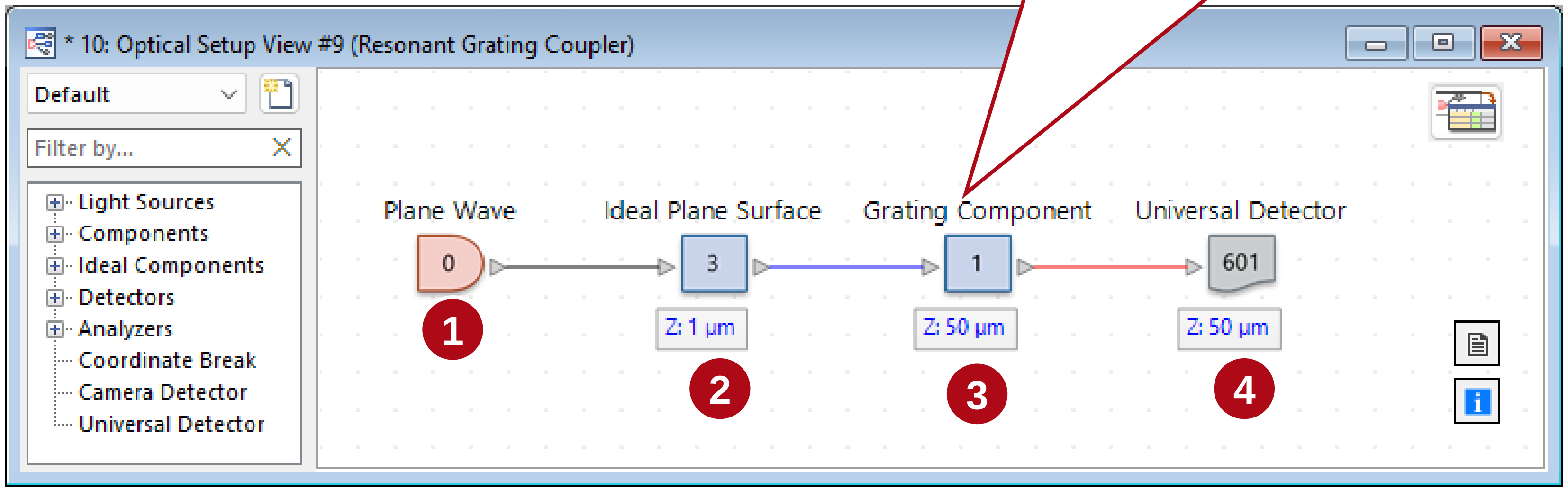
Task: Vary the incidence angle between -5° and 2° and investigate efficiency of the -1st, 0th and 1st reflected diffraction orders.

(*) Note: In this system, all reflection orders are superimposed. By definition, a radiant flux detector measures the total combined field. However, to enable comparison with the reference, we isolate individual reflection orders by propagating them separately, thereby preventing superposition.

Application Scenario Goes to VirtualLab Fusion

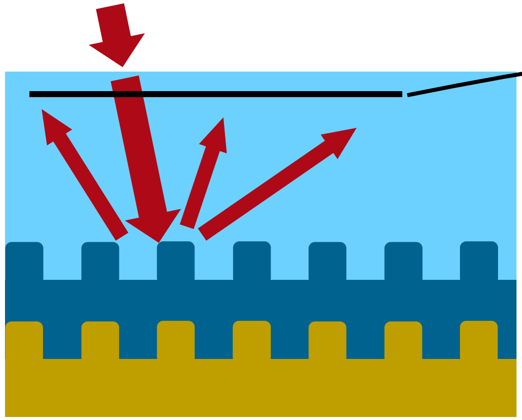


Both grating interfaces—the one between the waveguide and the high-index layer, and the one between the high-index layer and the substrate—are modeled within a single *Grating Component*.

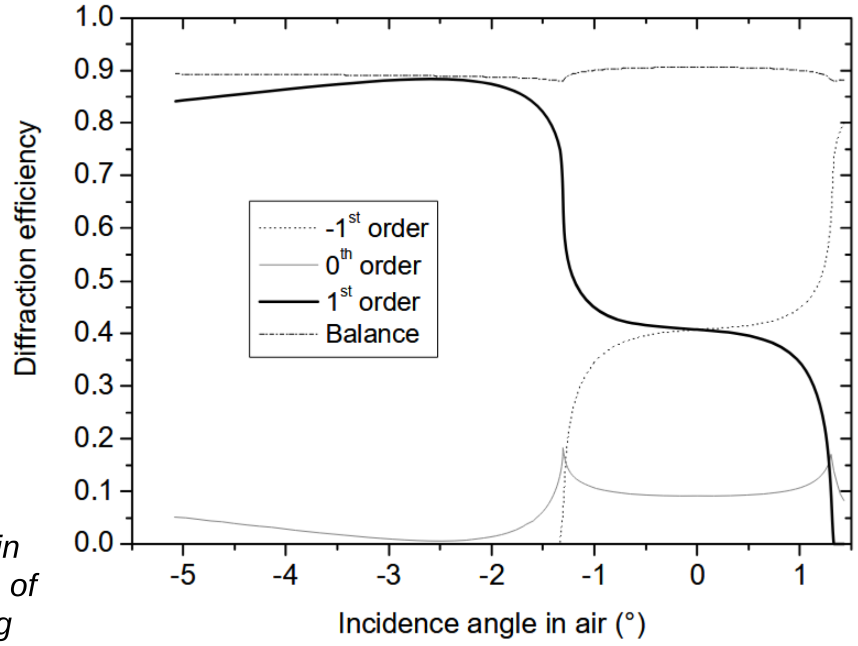


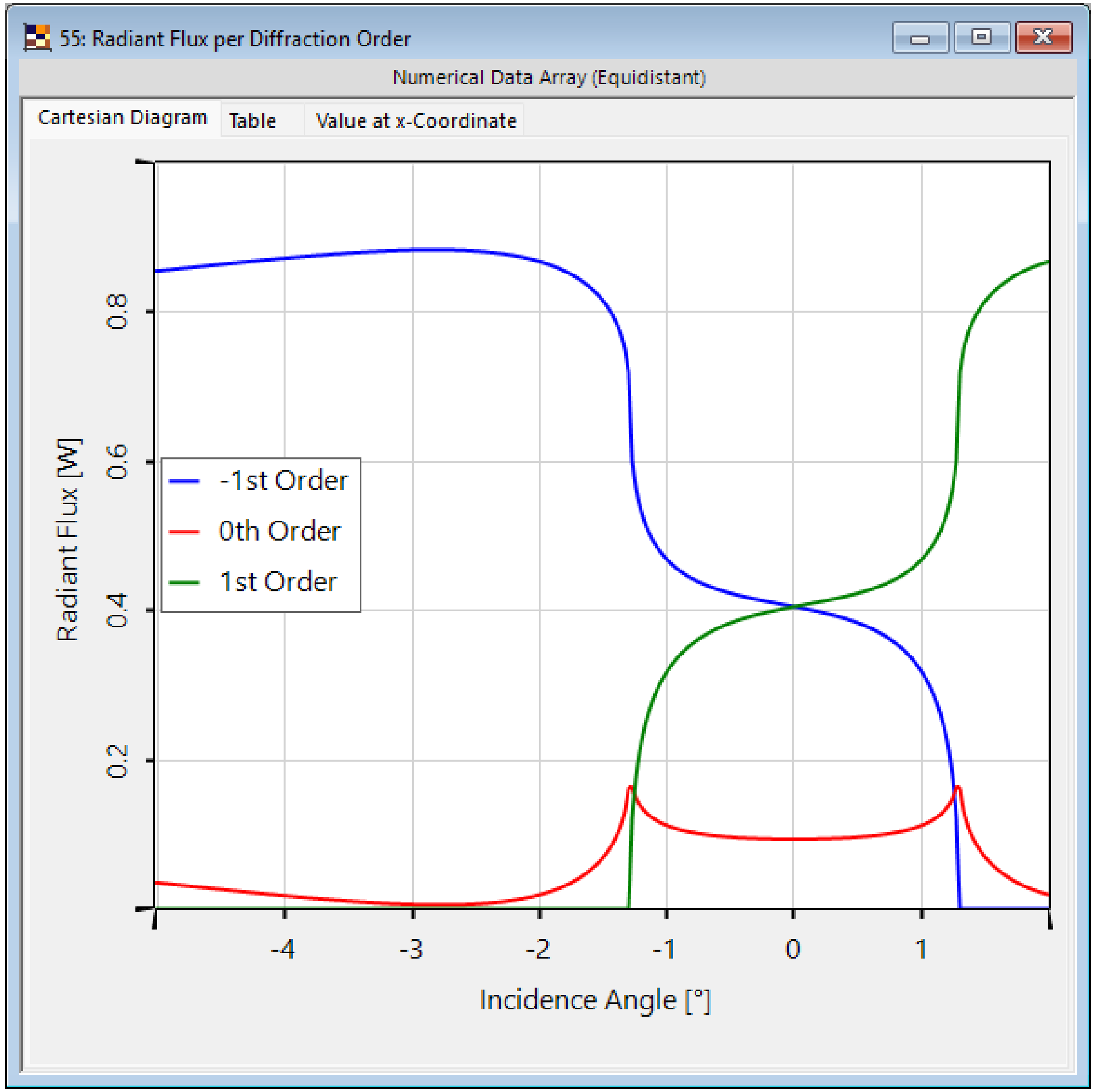
Simulation Results

Radiant Flux per Diffraction Order



From reference:





Note: Minor differences between the curves are expected due to unknown rounded edge parameters in the reference and their use of the C-method for simulating the grating structure.

Workflow Steps

Basic Workflow Steps

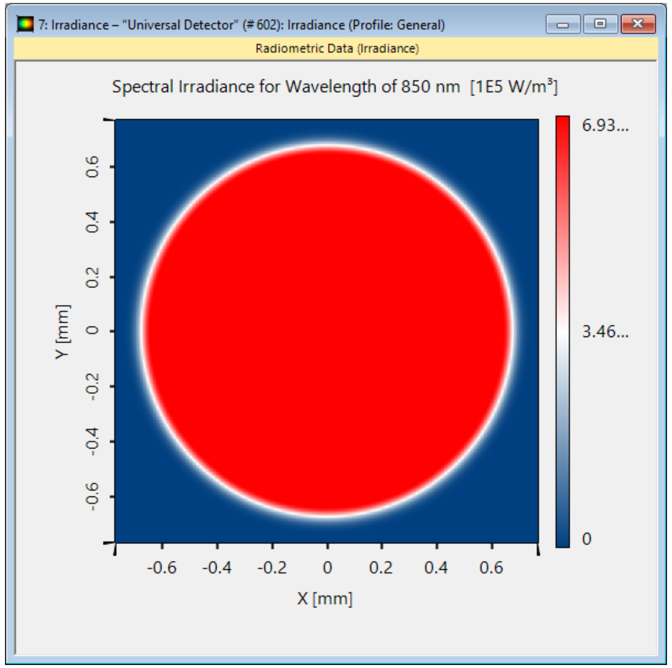
Source selection

System setup

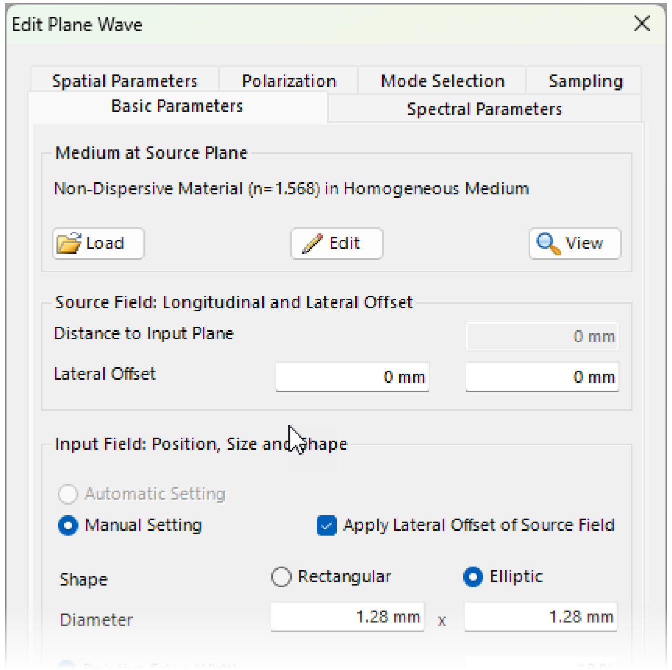
Detector selection

Getting it done in VirtualLab Fusion:

- Plane Wave source



Irradiance of source



Source settings

Basic Workflow Steps

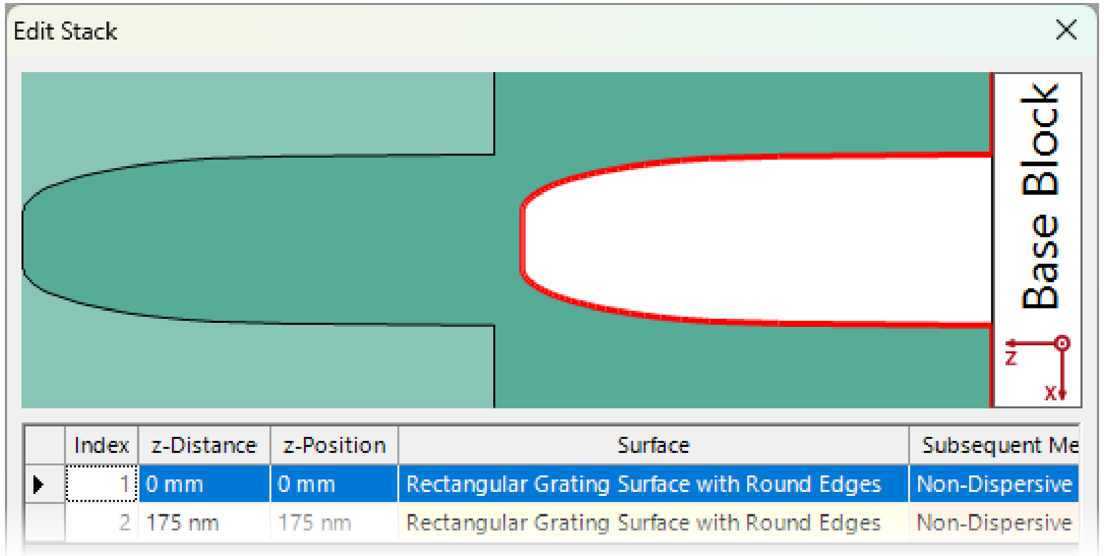
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Configure grating by using interfaces
- Save grating as stack and include structure into optical system by Grating Component
- Add Ideal Plane Surface for air-waveguide medium transition



Grating stack with rounded edges

Basic Workflow Steps

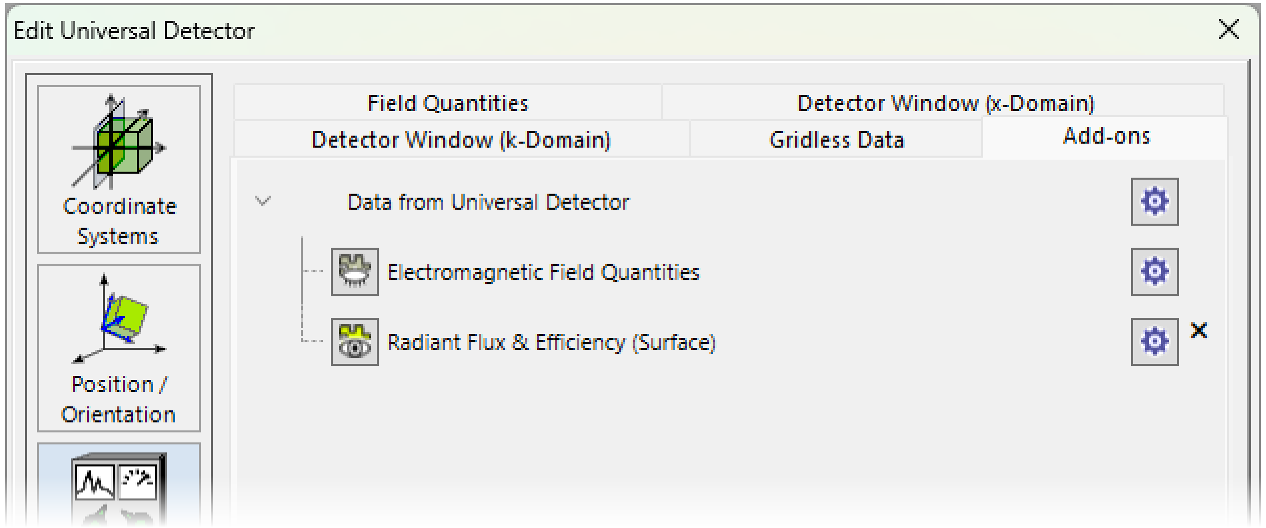
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Radiant Flux Detector



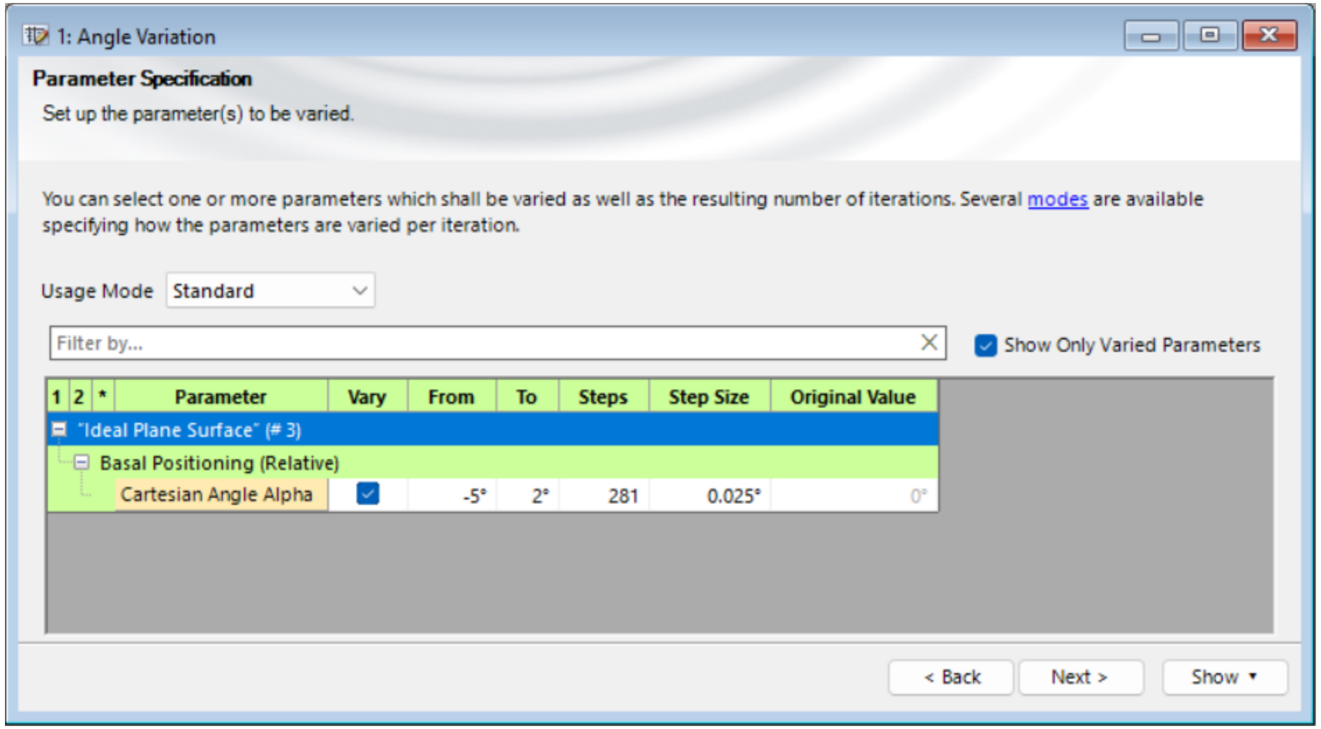
Detector add-on selection

Specific Workflow Steps Related to Use Case

Perform parameter sweep

Getting it done in VirtualLab Fusion:

- Parameter Run document



Parameter Run document

Document Information

Title	Resonant Grating Coupler
Document code	USC.0456
Publication date	04.06.2025
Required packages	-
Software version	2024.1 (Build 2.74)*
Category	Use Case
Further reading	- Grating Component in Optical Setup - Imaging of Grating Patterns Positioned on Each Side of a Wafer - Optimization of Grating Incoupler for Lightguides/Waveguides

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