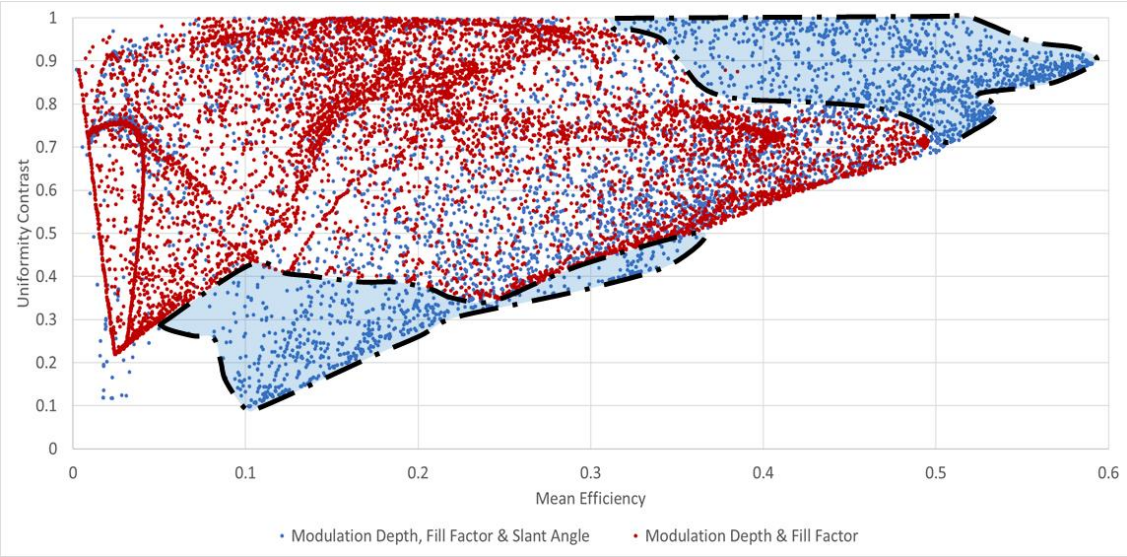
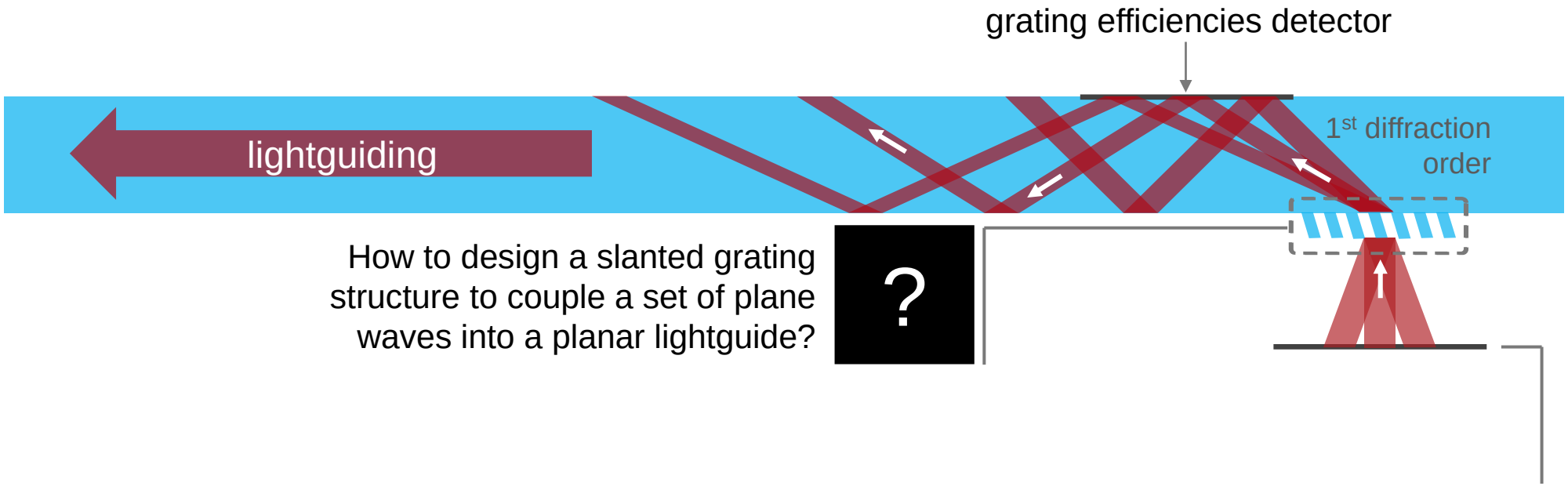
Optimization of Slanted Grating for Lightguide Coupling over Desired FOV

Abstract



Slanted gratings are known for their capability to concentrate diffracted light into a specific order. Therefore, they are often used for coupling light into lightguides. In VirtualLab Fusion, it is not only possible to analyze slanted gratings rigorously, but also possible to perform the design. In addition, by using VirtualLab together with the software optiSLang from Dynardo, it further enables the optimization of grating structure for coupling light within a desired field of view (FOV).

Optimization Task

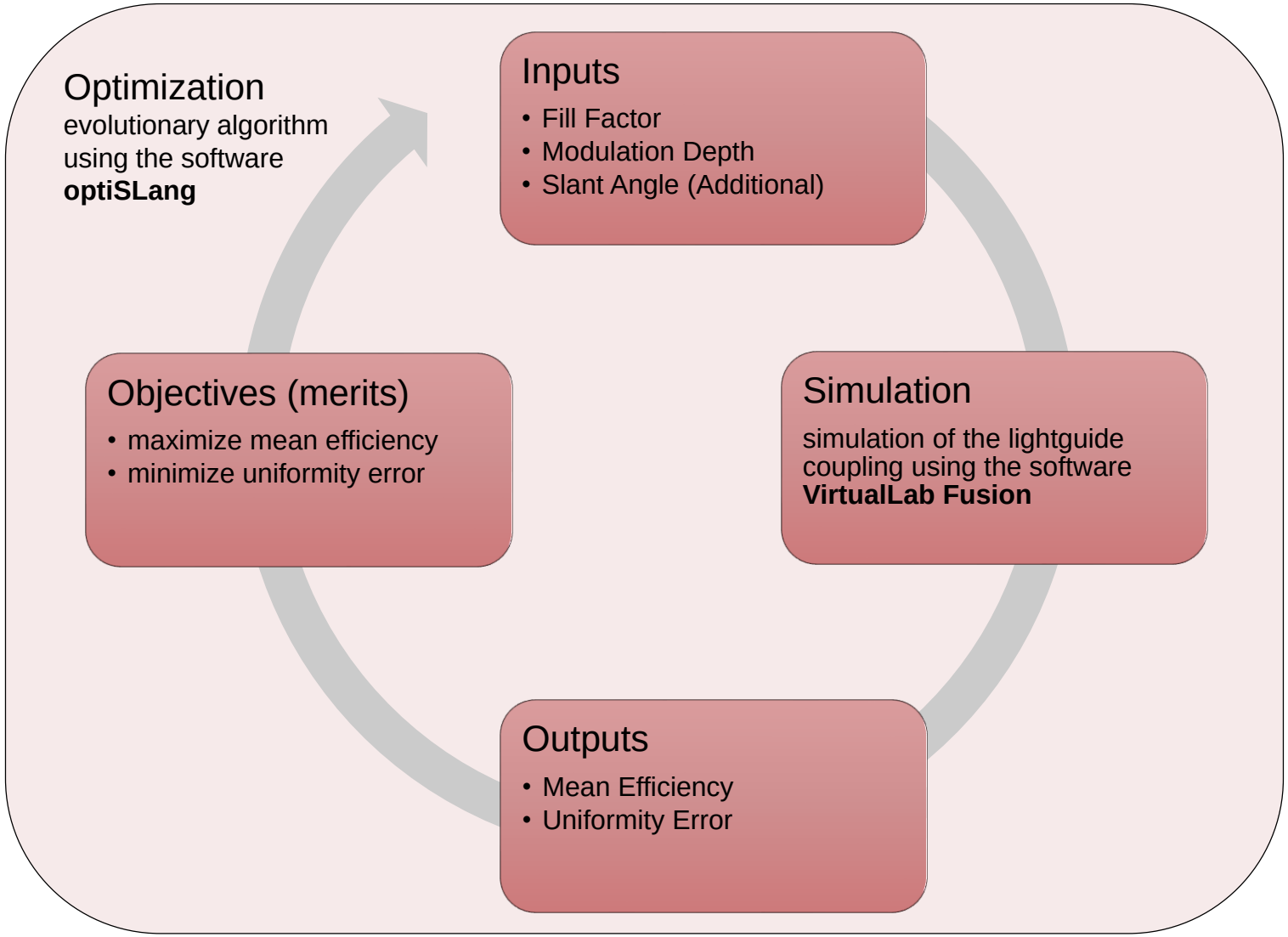


set of plane waves

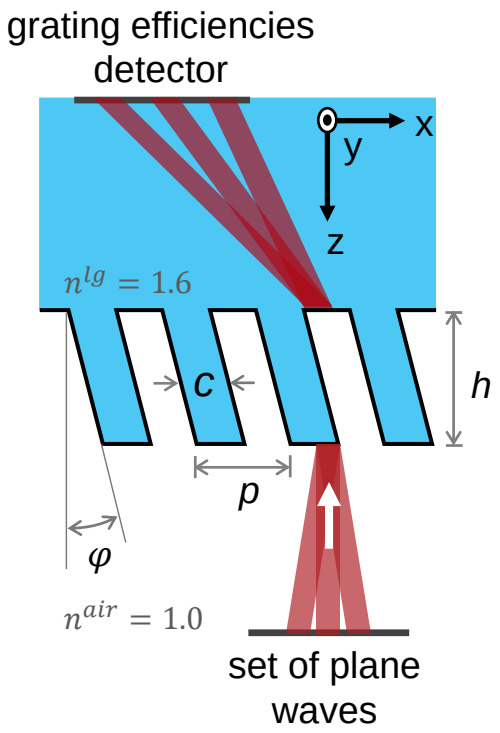
- field of view (-30..30, -15..15)°
- wavelength 532 nm
- linearly polarized along x-axis

Optimization Workflow

- the following optimization workflow is applied to design a slanted grating for efficient lightguide coupling:
  1. Define the inputs and their ranges, start with a reference input combination
  2. Perform the optimization with several simulations
  3. calculate the corresponding outputs
  4. Evaluation of the defined objectives
  5. Next iteration with new inputs
- the optimization algorithm stops after certain iterations and/ or when no more improvement of the objectives can be achieved



Simulation Results and Configuration of the Merit Function

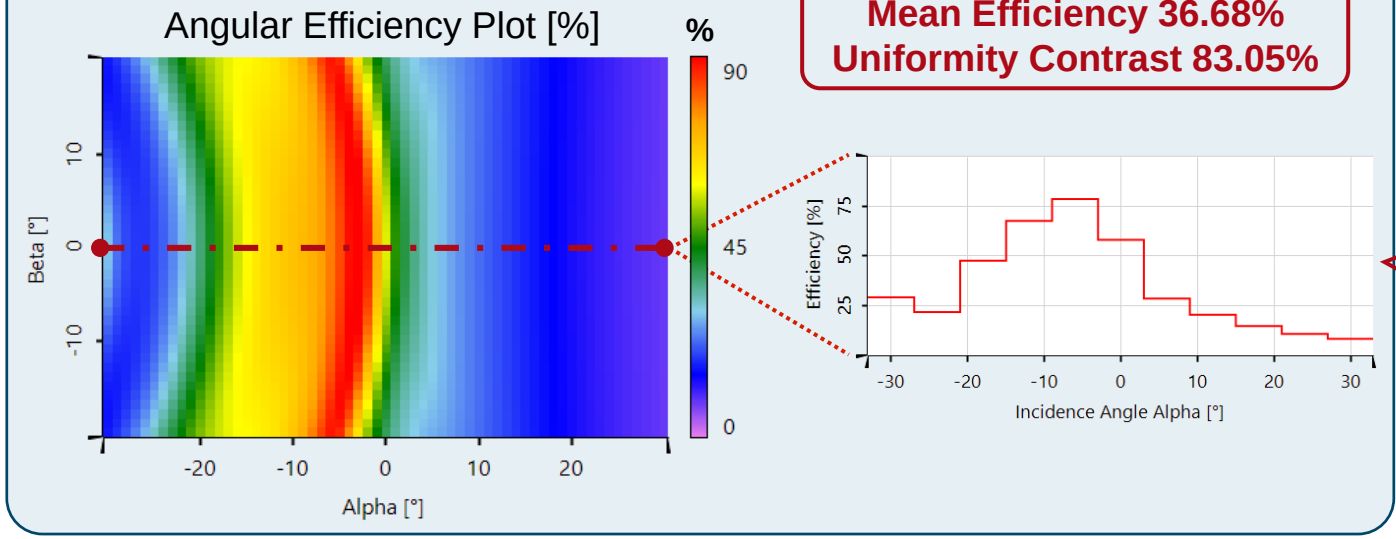


- variation of the **fill factor** *c/p* with the slit width *c* and the period *p*
  - ➢ **0.1% to 99.9%**
- variation of the **modulation depth** *h*
  - ➢ **50 nm to 1500 nm**
- <u>additionally</u>: variation of the **slant angle**
  - ➢ **0° to 50°**

Initial Configuration of Grating	
fill factor	50.00%
modulation depth	400.00 nm
slant Angle	40.00°
period	354 nm
operating order	1st transmitted

to be varied

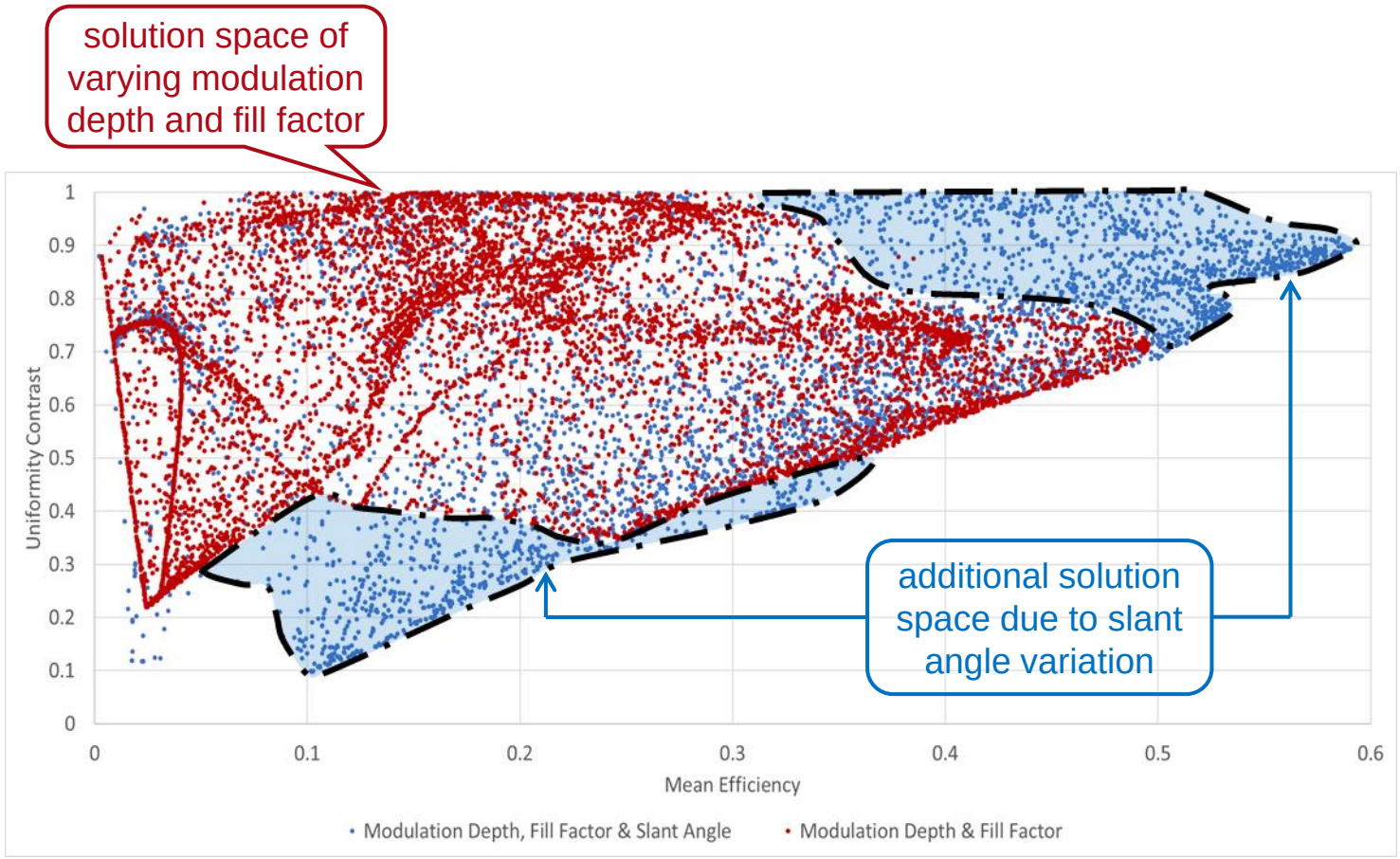
Grating Efficiencies Detector Result



Mean Efficiency 36.68%
Uniformity Contrast 83.05%

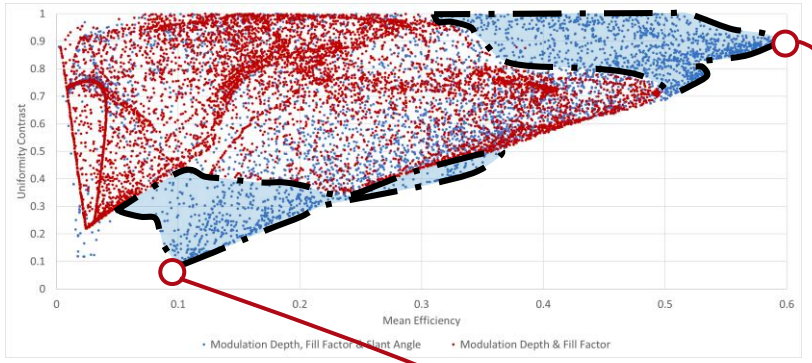
a roughly sampled evaluation of the incidence angles along the period is sufficient for the optimization

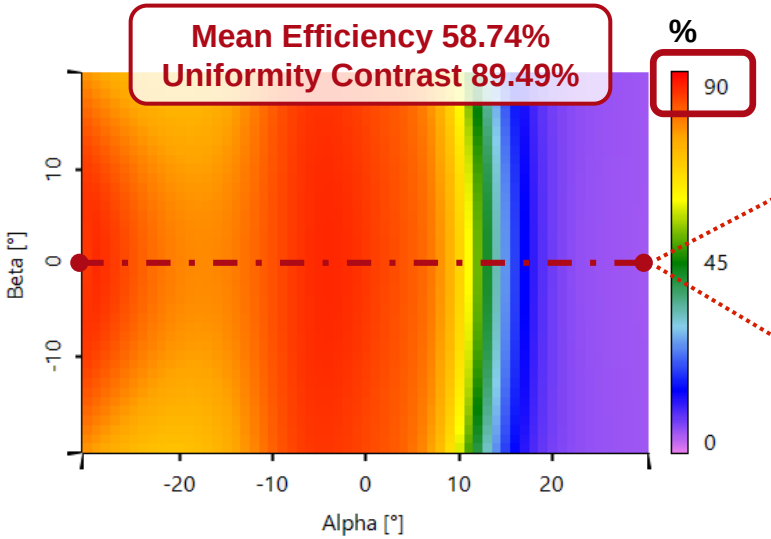
Optimization Result of optiSLang



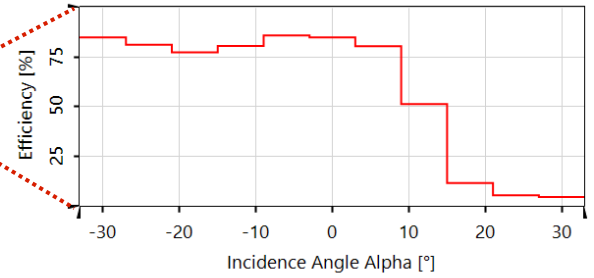
- an evolutionary optimization algorithm is applied using the optimization software optiSLang
- the additional freedom of the slant angle provides additional solutions

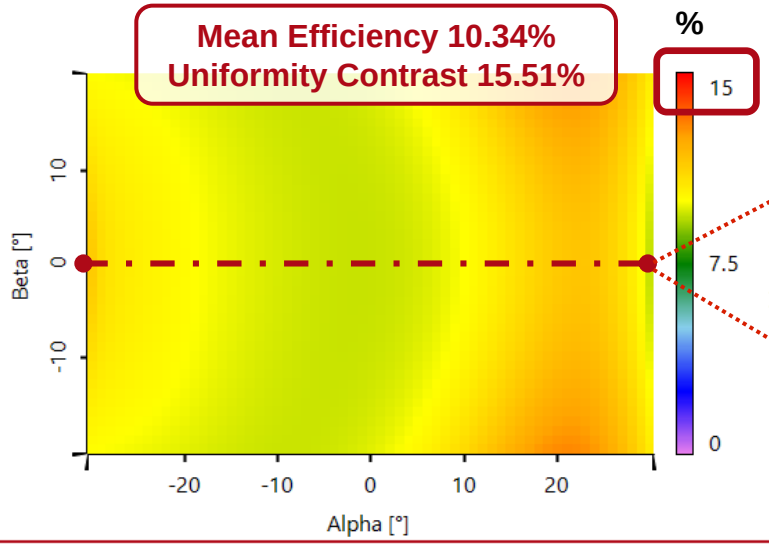
Analysis of Coupling Efficiency for Optimization Results



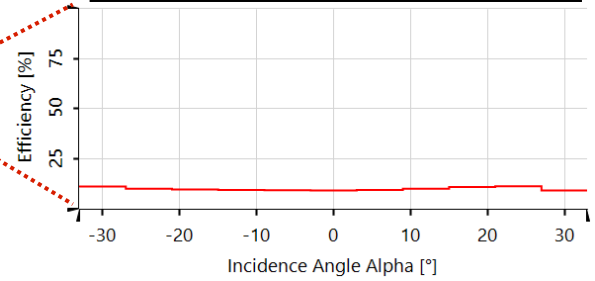


fill factor	70.82%
modulation depth	381.91 nm
slant Angle	24.58°



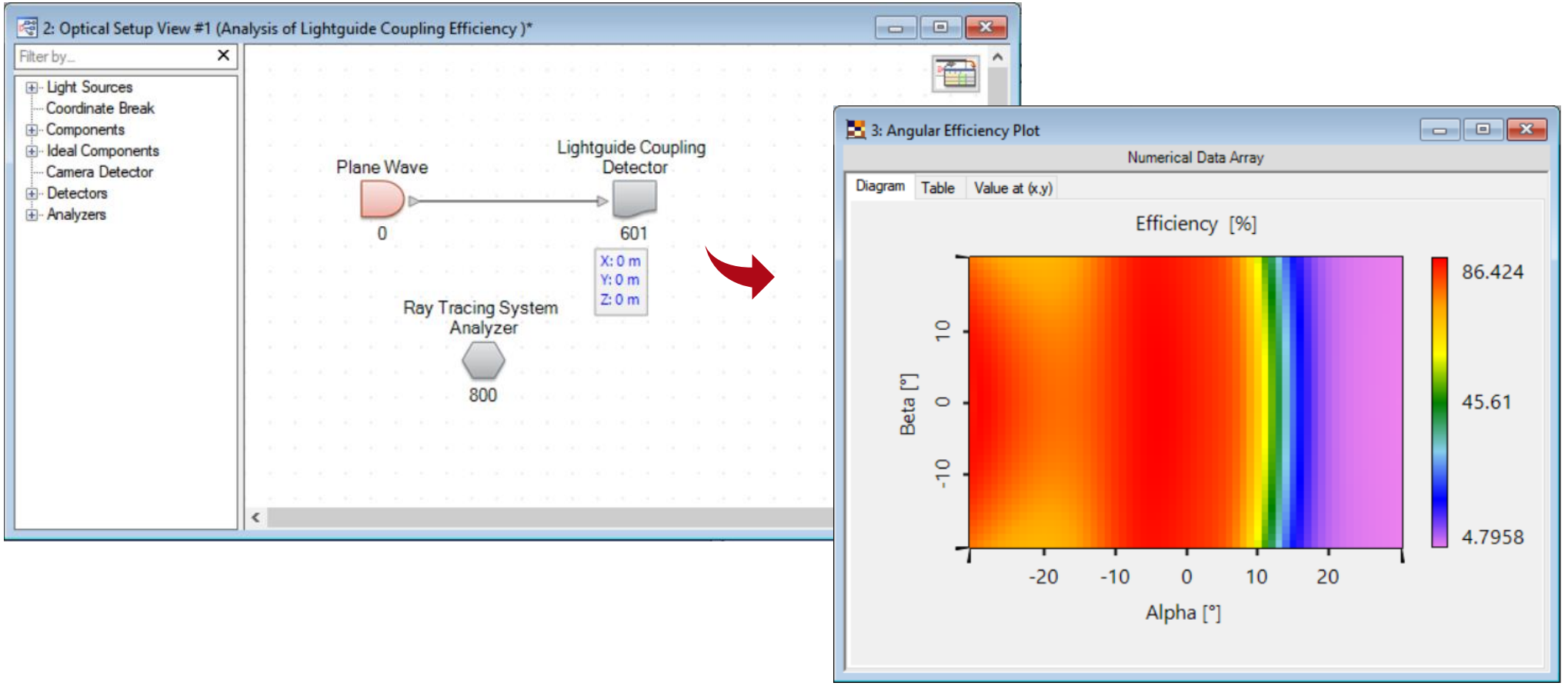


fill factor	90.00%
modulation depth	189.64 nm
slant Angle	14.57°



- an appropriate solution can be selected according specific constraints
- either uniformity contrast or mean efficiency might be prioritized

Peek into VirtualLab Fusion

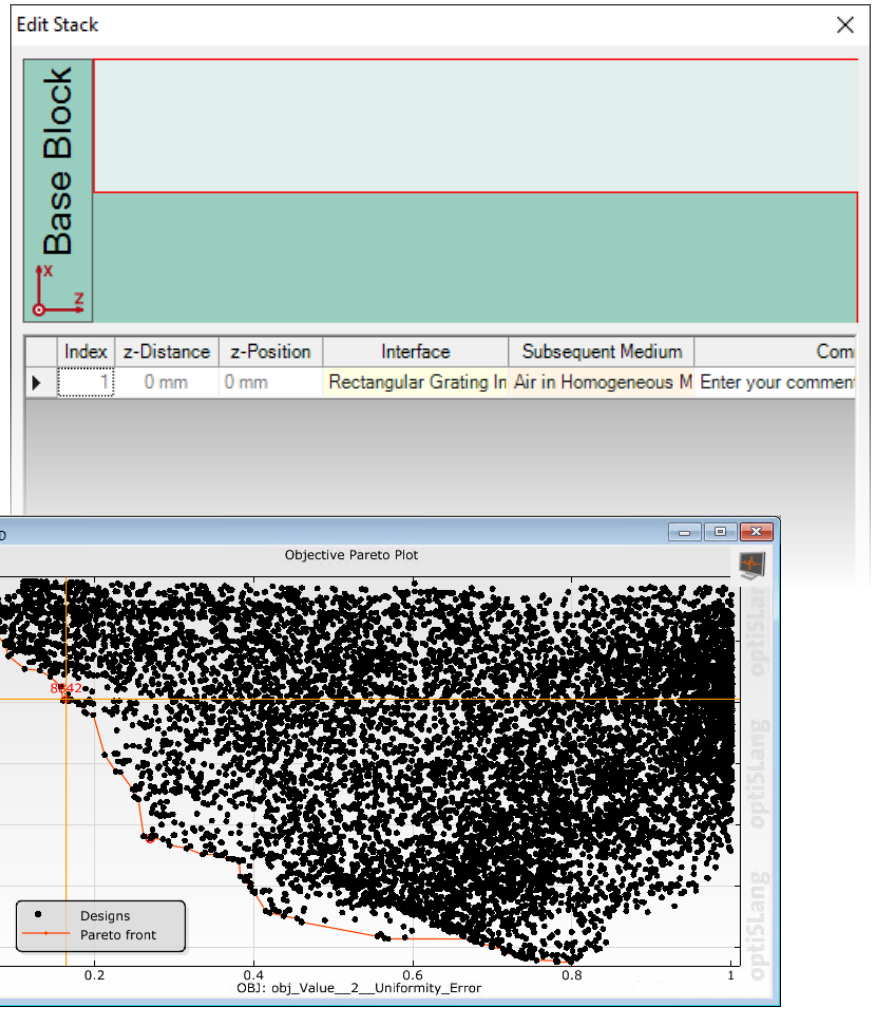


Detector Results

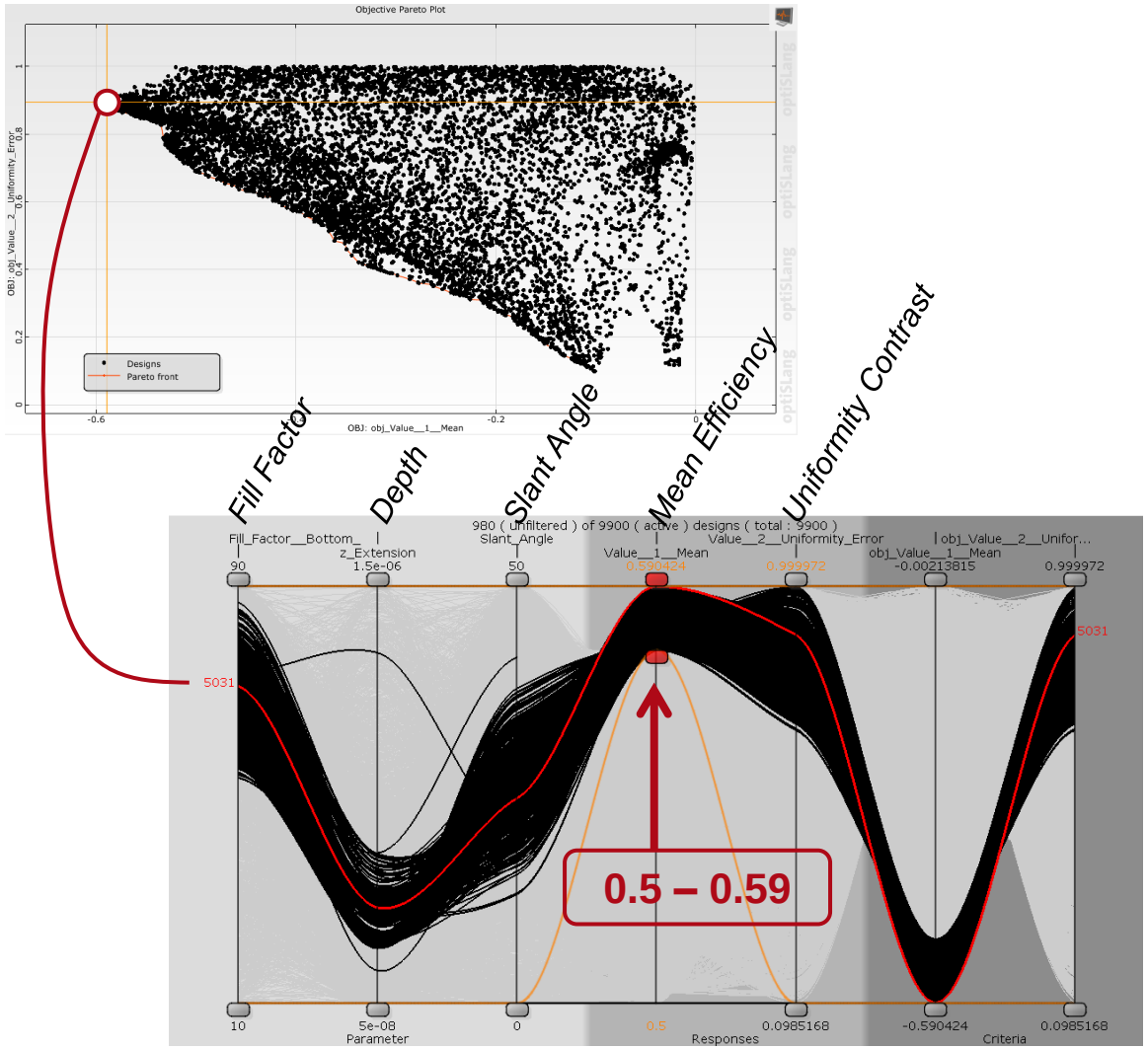
	Date/Time	Detector	Sub - Detector	Result
2	12/07/2018 07:34:24	Lightguide Coupling Detector #601 after Plane Wave #0 (-) (Field Tracing 2nd Generation)	Mean	58.739 %
1			Uniformity Error	89.485 %

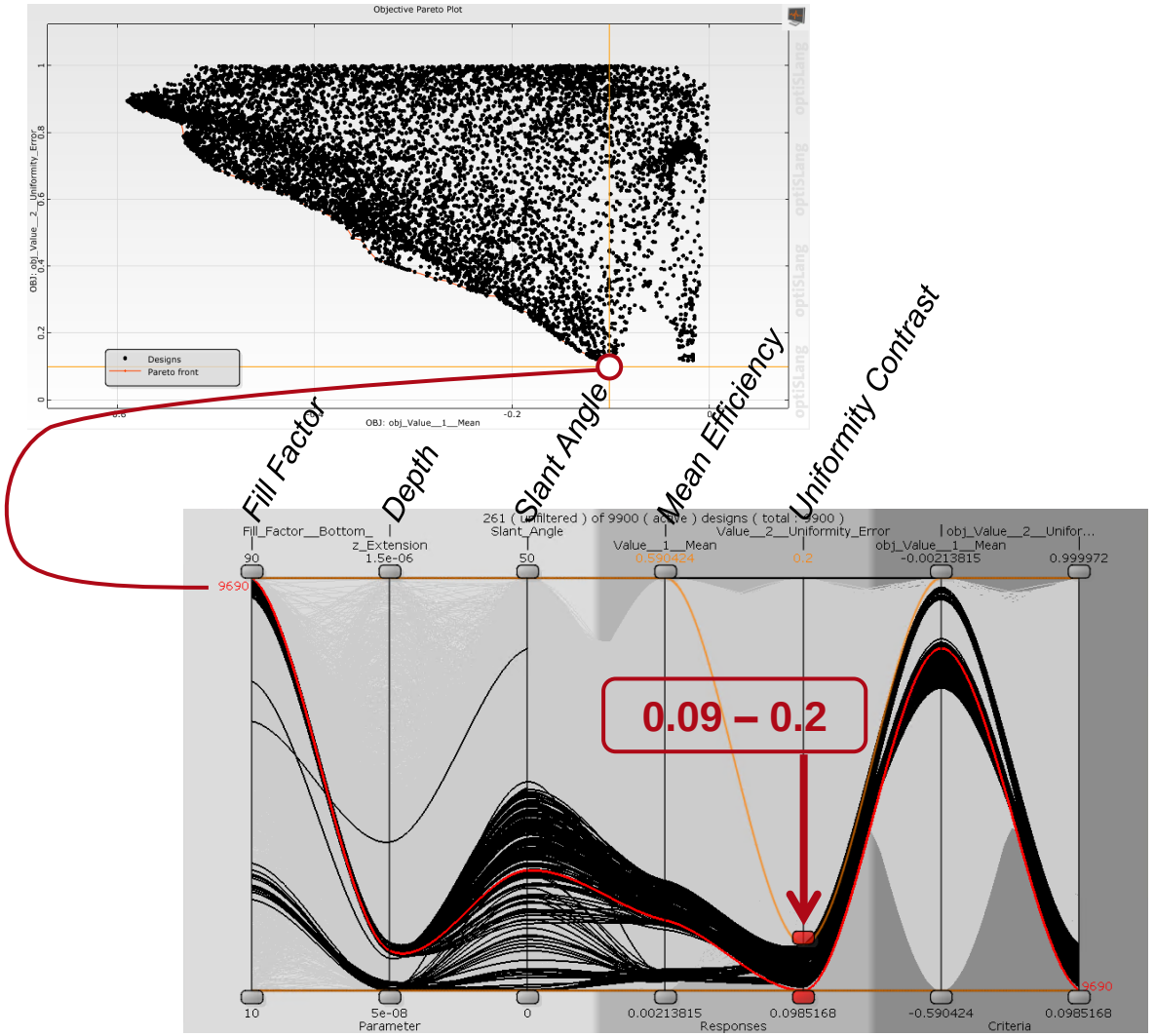
Workflow in VirtualLab Fusion

- Configuration of grating structure
  - Configuration of Grating Structures by Using Special Media [Use Case]
  - Advanced Configuration of Slanted Gratings [Use Case]
- Evaluation of coupling efficiency
  - Customized Detector for Lightguide Coupling Grating Evaluation [Use Case]
- Optimization of grating structure
  - Grating Optimization in VirtualLab Fusion Using optiSLang [Use Case]

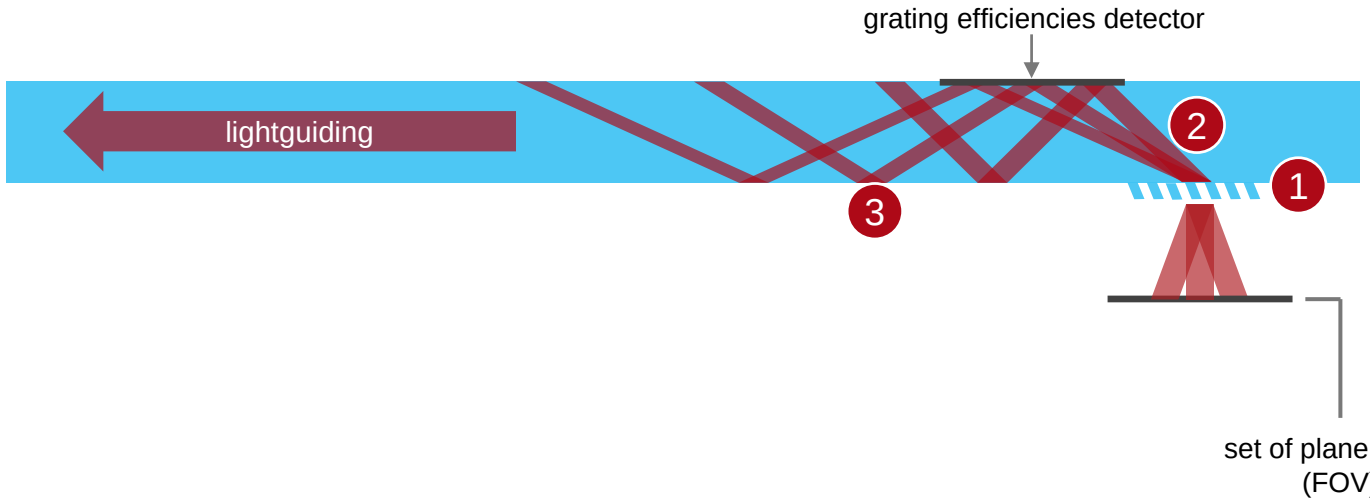


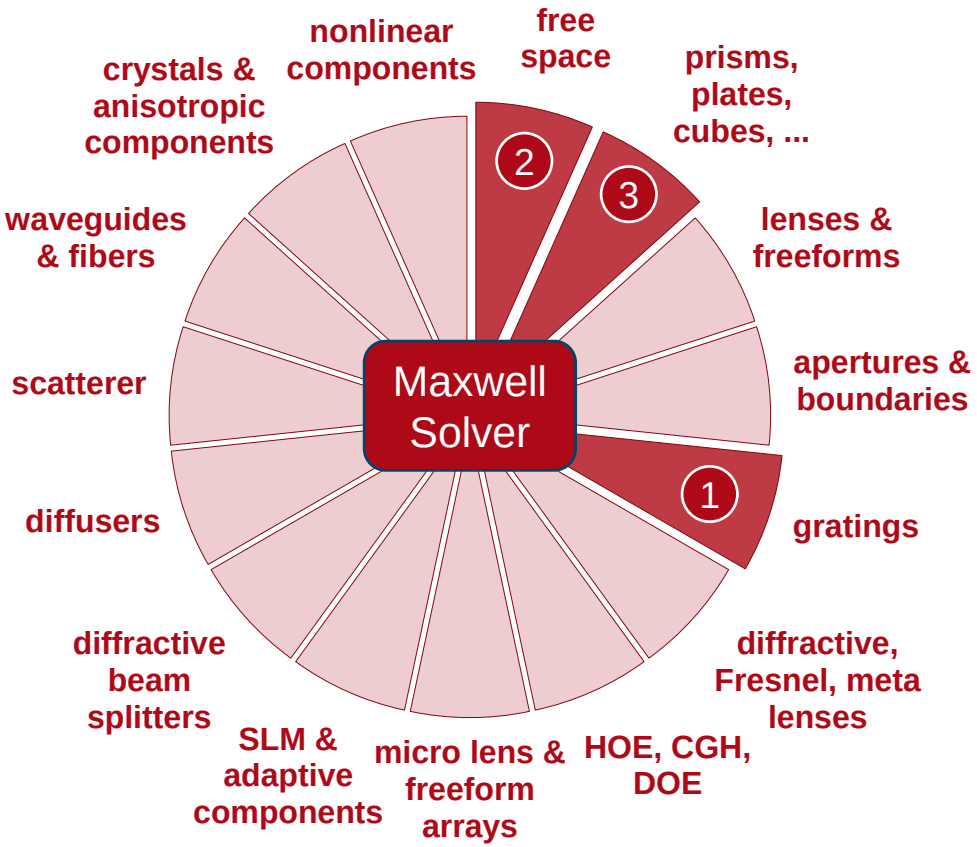
Peek into optiSLang





VirtualLab Fusion Technologies





Document Information

title	Optimization of Slanted Grating for Lightguide Coupling over Desired FOV
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VL version used for simulations	7.4.0.49
category	Application Use Case
further reading	– Analysis of Slanted Gratings for Lightguide Coupling – Optimization of Binary Grating for Lightguide Coupling over Desired FOV – RDO-Journal Article: *“Innovation in Optics and Photonics – VirtualLab and OptiSLang”*