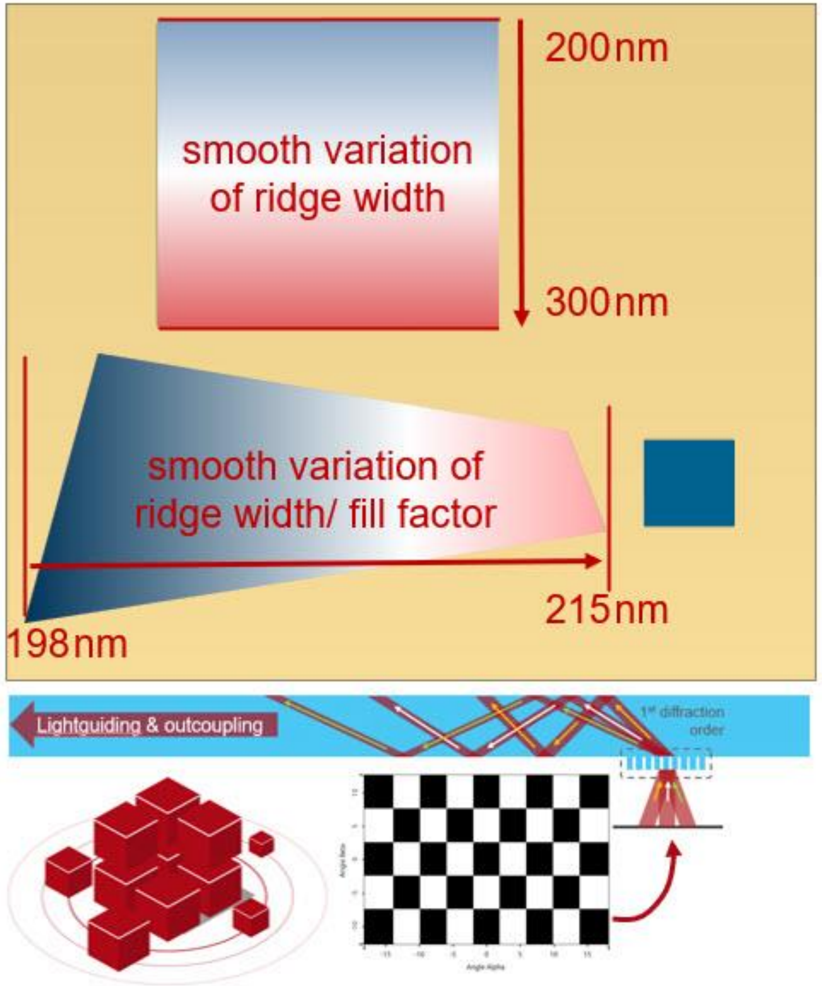
Simulation of a Test Image in an AR Waveguide Using Distributed Computing

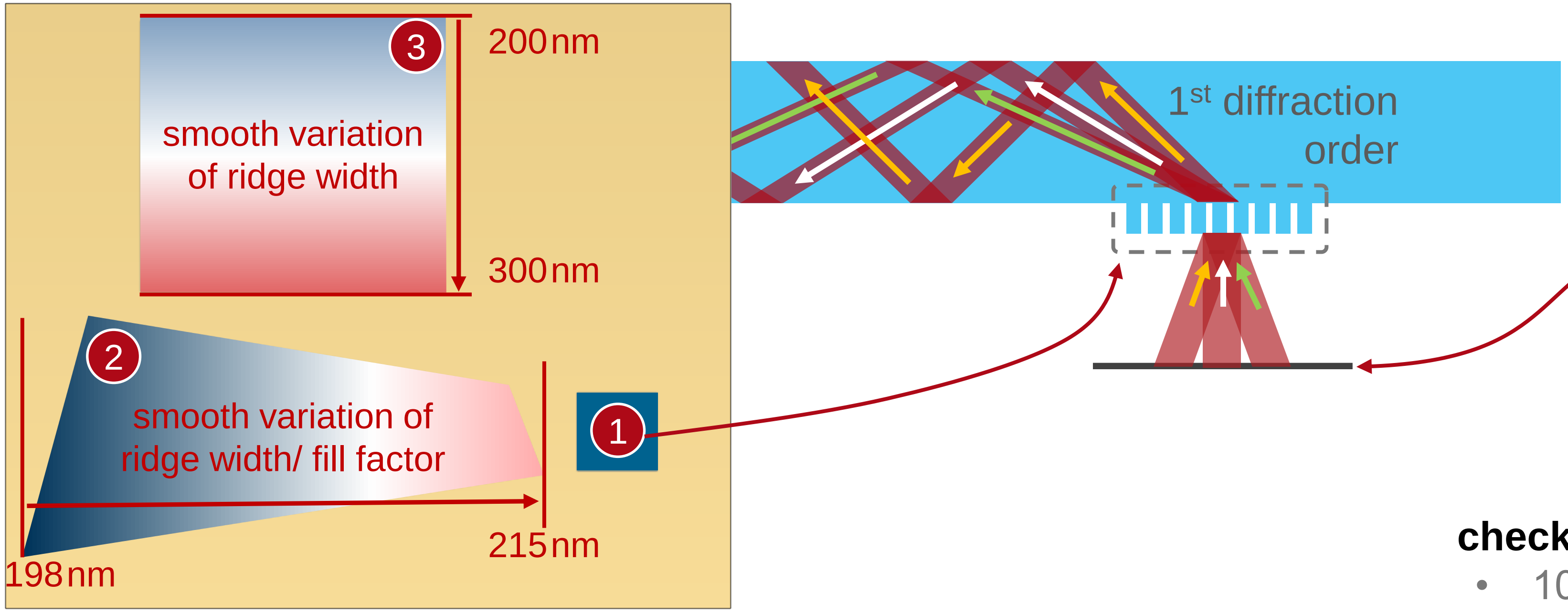
Abstract

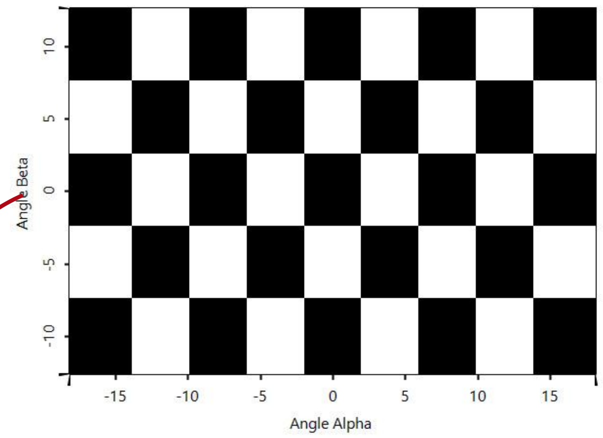


Modeling waveguide combiners for augmented and mixed reality (AR, MR) applications is notoriously challenging due to the complexity of the optical configurations and the multiple source modes representing the field of view (FOV), among others. Hence, detailed analyses, e.g. of the optical performance of the angular characteristics, can be quite time consuming as many source modes and field angles must be considered. In this Use Case, we use a checkerboard test image with 101 by 101 sampling points (i.e. angles) to investigate the angular performance of a waveguide, leading to 10201 individual elementary simulations.

By using a network of five multi-core PCs providing 41 clients, the simulation time is reduced to about 4 hour (compared to ~43 hours previously).

Simulation Task





checkerboard test image

- 101 × 101 different angles (36° × 24°) varying parameter

➔ in total 10201 elementary simulation tasks

lightguide with continuously varied grating parameters:

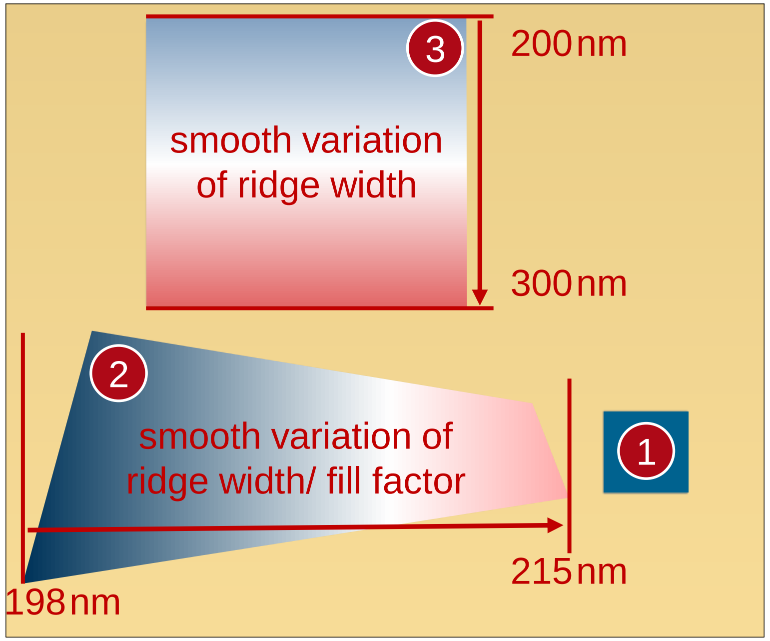
incoupler 1
- period: 380 nm
- width of grating ridge: 190 nm
- height: 100 nm
- grating orientation: 0°

expander (EPE) 2
- period: 268.7 nm
- width of grating ridge: 198–215 nm
- height: 50 nm
- grating orientation: 45°

outcoupler 3
- period: 380 nm
- width of grating ridge: 200–300 nm
- height: 124 nm
- grating orientation: 90°

Elementary Simulation Task

source:
- plane wave
- wavelength: 532 nm
- on-axis propagation (α,β = 0°)
- polarization: E_x



detector result :
radiant flux within eyebox

Radiant Flux (Surface)	0.67864 pW

simulation time: ~12 s

incoupler: 1

- period: 380 nm
- width of grating ridge: 190 nm
- height: 100 nm
- grating orientation: 0°

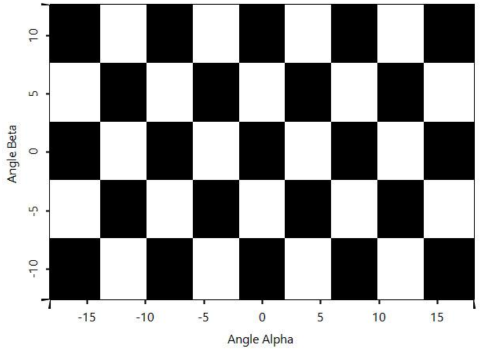
expander (EPE): 2

- period: 268.7 nm
- width of grating ridge: 198–215 nm
- height: 50 nm
- grating orientation: 45°

outcoupler: 3

- period: 380 nm
- width of grating ridge: 200–300 nm
- height: 124 nm
- grating orientation: 90°

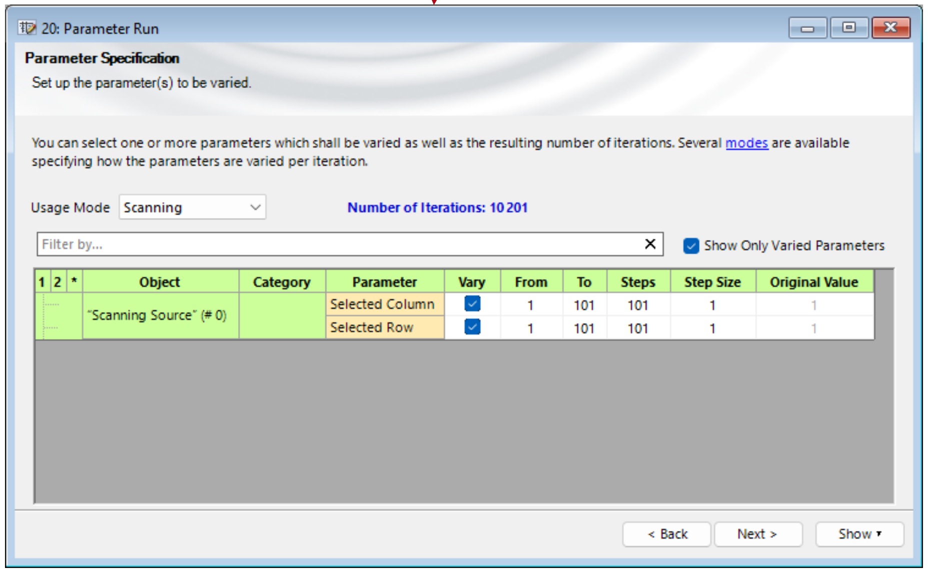
Collection of Elementary Tasks: Angles of Incidence of FOV

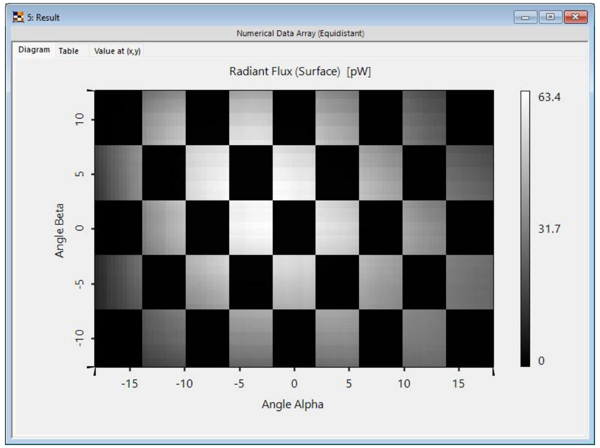


varying parameter:

101×101 different angles (36°×24°)

➔10201 elementary simulation tasks





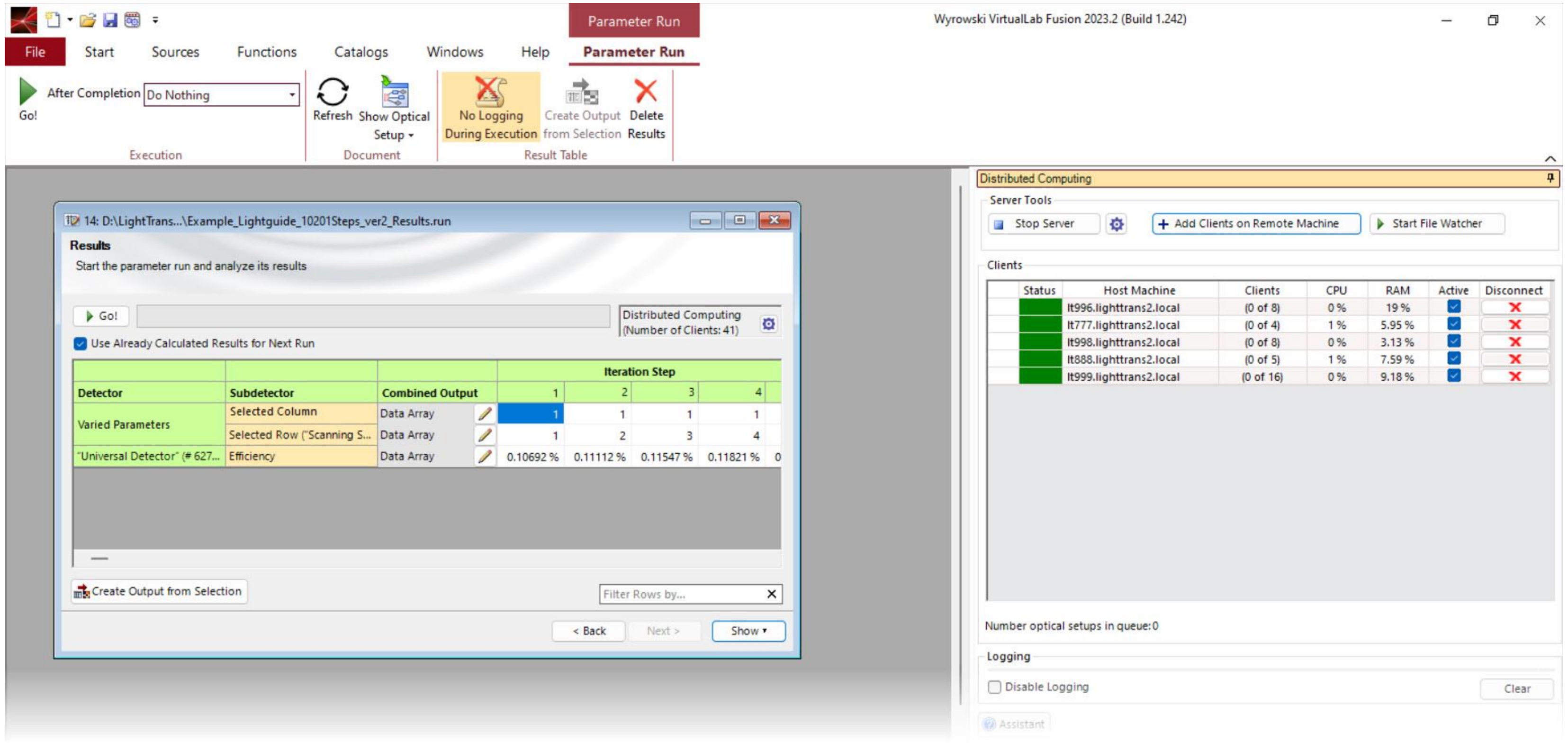
simulation time (10201 simulations): ~43h

simulation result:

radiant flux over FOV angles*

Note: 21×21 directions are stored in the look-up tables of the gratings with continuously variated parameters.

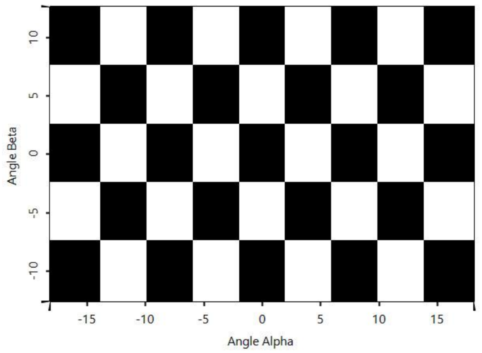
Using Distributed Computing



A *Parameter Run* is used to vary the angle of the current FOV mode, which allows the various iterations to be distributed to computers in the network. In order to enable *Distributed Computing*, simply navigate to the corresponding tab and configure the number of computers and clients available. Then start the simulation as usual, the transfer of data to the clients and the collection of the results is done automatically (in the same way as for a locally performed parameter sweep).

For a more in-depth tutorial on how to set up distributed computing, please see:
[Usage of Distributed Computing]

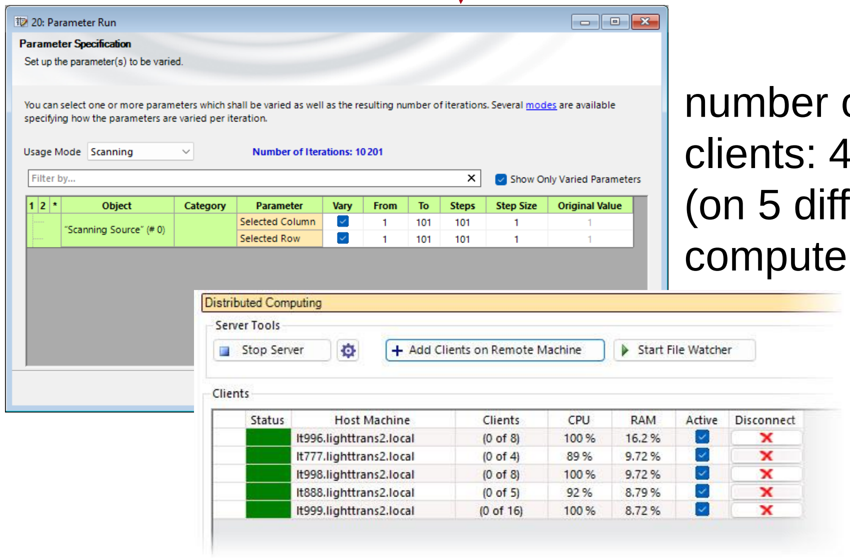
Simulation by Using Distributed Computing



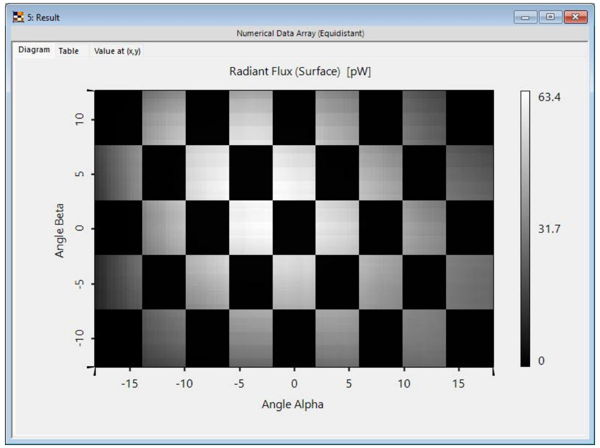
varying parameter:

101×101 different angles (36°×24°)

➔10201 elementary simulation tasks



number of clients: 41 (on 5 different computers)



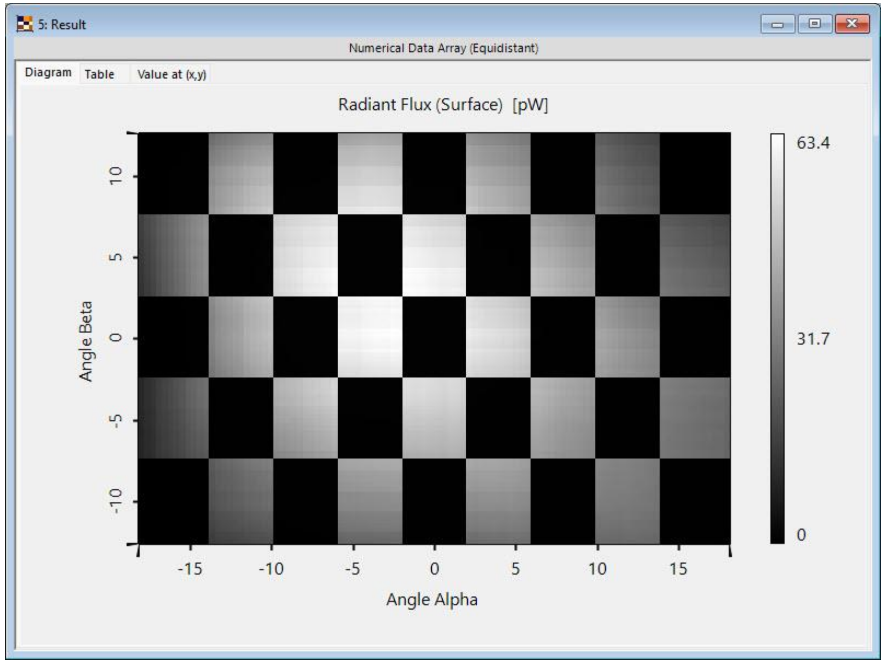
simulation time (10201 simulations): 4 h 10 min

simulation result:

radiant flux over FOV angles

Comparison of Simulation Times

simulation result



	simulation time
elementary simulation	~12s
collection of elementary simulations (10201) on one computer	~43h (100%)
collection of elementary simulations (10201) via distributed computing (41 clients on 5 computers)	**4h 10min (9%)**

→ Distributed Computing reduces the simulation time by 91%!*

**Note: As the elementary simulation only takes a few seconds, the reduction in simulation time is limited due to the network overhead.*

Document Information

title	Simulation of a Test Image in an AR Waveguide Using Distributed Computing
document code	DC.0003
document version	1.1
required packages	• Grating Package • Lightguide Package • Distributed Computing Package
software version	2023.2 (1.242)
category	Application Use Case
further reading	• Usage of Distributed Computing • Optimization of Lightguide with Continuously Modulated Grating Regions • Coherence Measurement in Michelson Interferometer –Analysis by using Distributed Computing in VirtualLab Fusion