Scenario 317.01: Design and analysis of grating array for reshaping of LED light into a cross pattern

This application scenario demonstrates the design and analysis of an illumination system for the shaping of LED light into a cross light pattern. The shaping is done by a grating cells array.

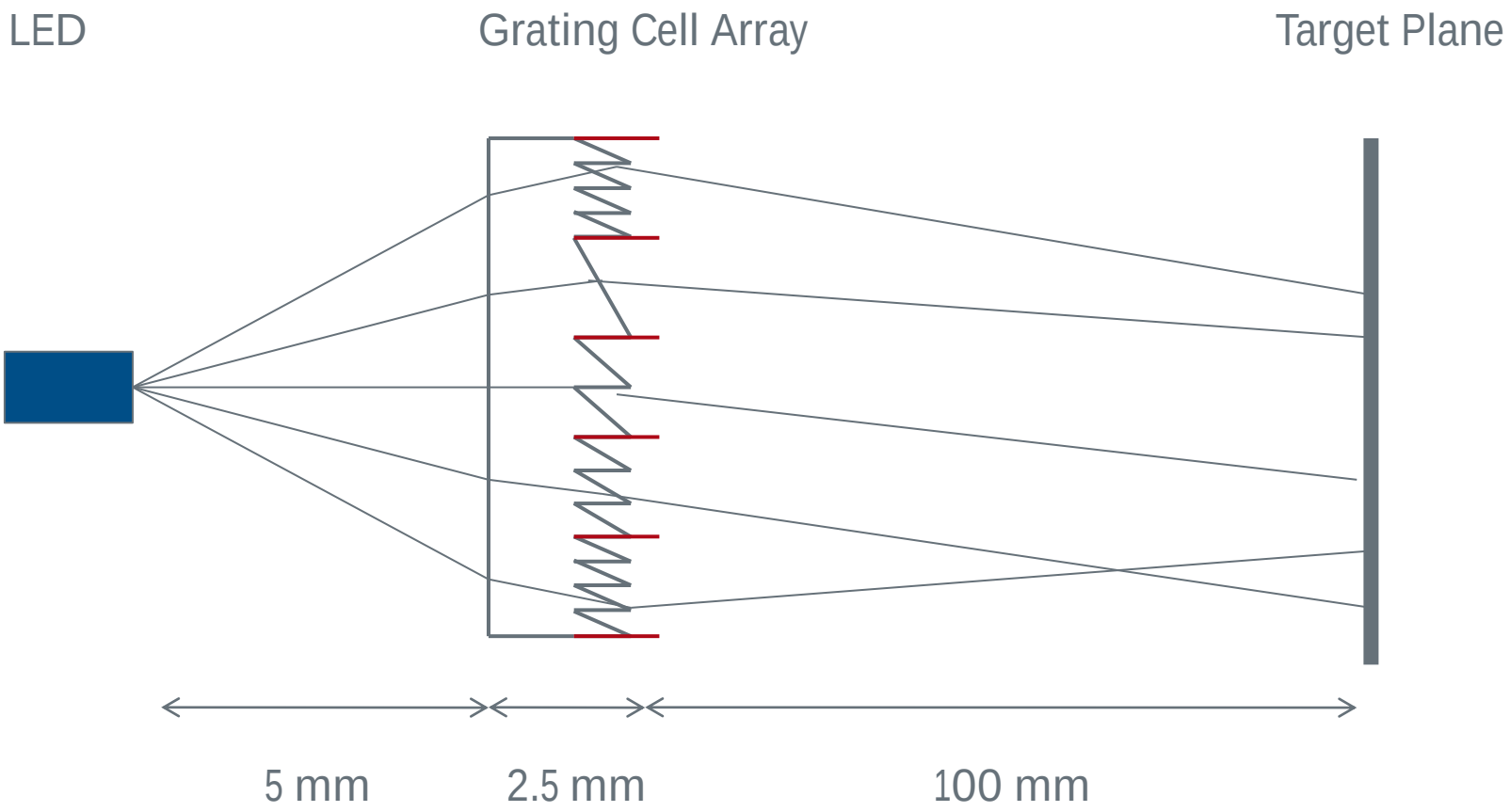
Keywords: grating, arrays, LED, illumination

Required Toolboxes: Lighting Toolbox

Related Tutorials: Tutorial 96.01

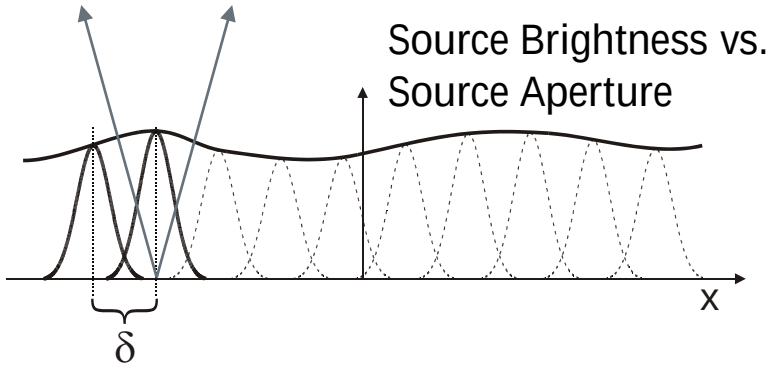
LightTrans

Modeling Task



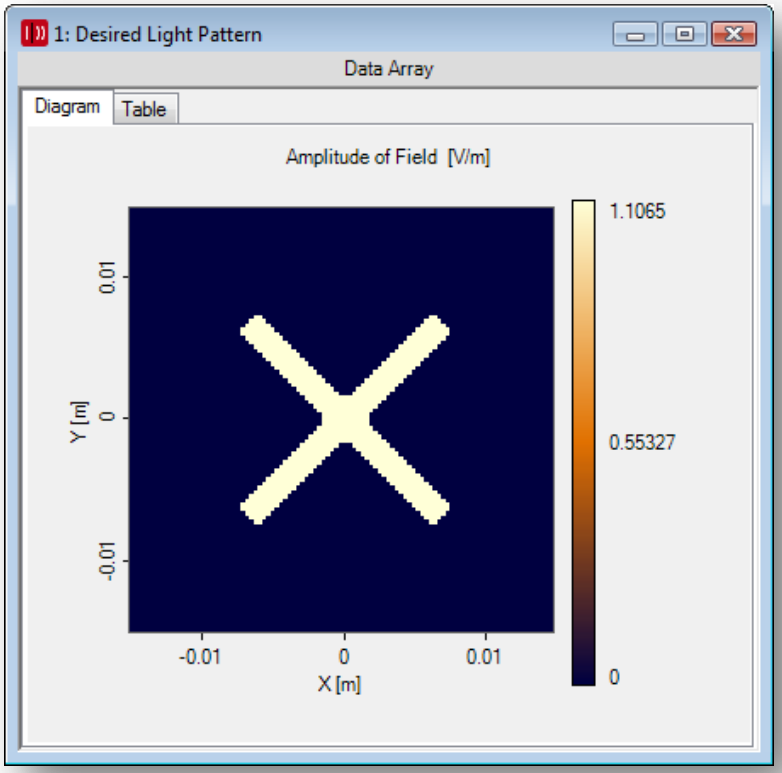
Modeling Task

Far field of source determined by lateral mode shape



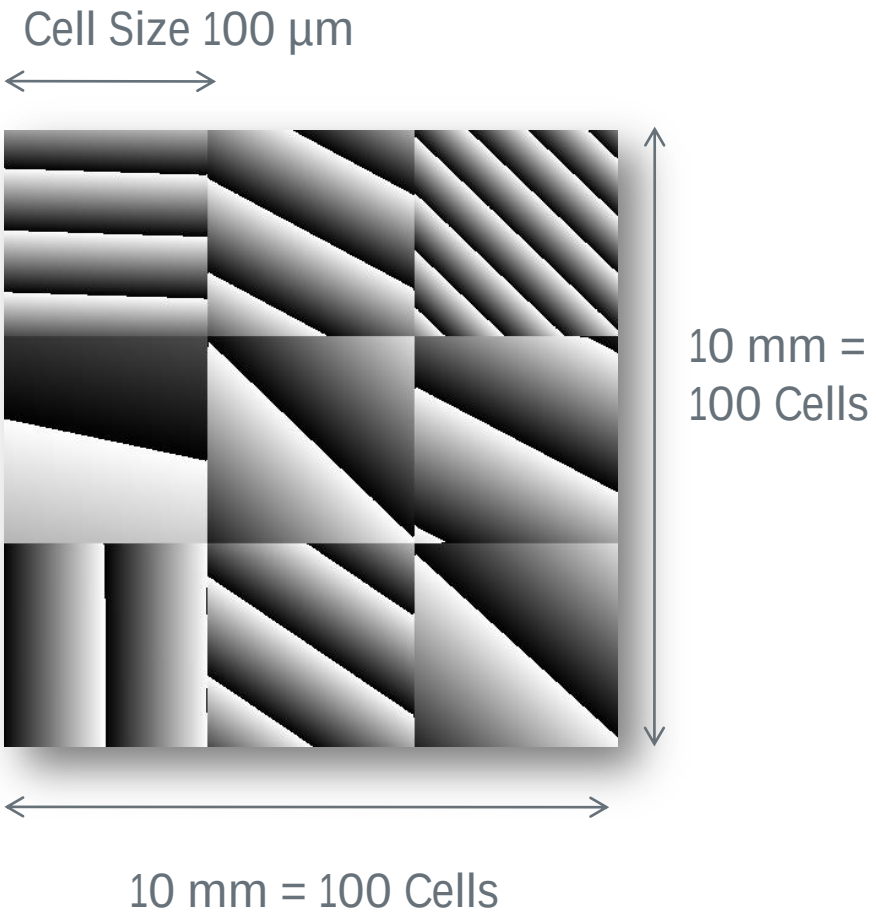
- Quasi homogeneous partial coherent source model:
  - Light describe by set of modes.
  - Modes have identical far field intensity but have different positions and different wavelength.
  - Modes are modeled as spherical waves in this example.
- LED parameters:
  - Wavelength 532 nm
  - Source plane diameter: 0.1 x 0.1 mm

Modeling Task



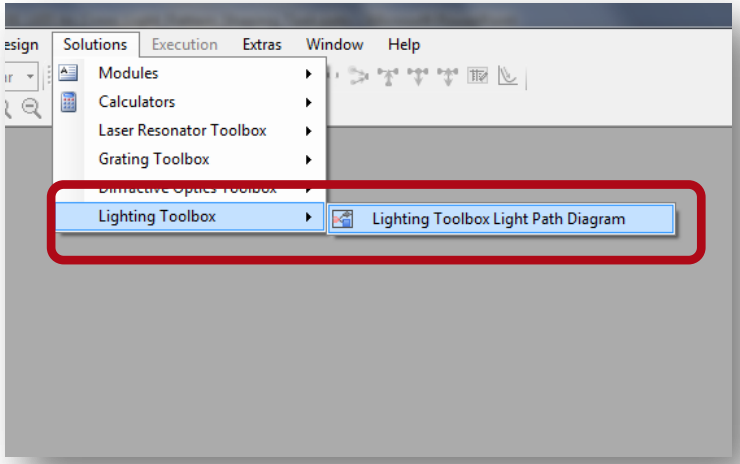
- Desire light distribution stored in “Scenario_317.01_LED_to_Cross_Light_Pattern_Shaping_01.bmp”.
- Pattern diameter: 30 x 30 mm

Modeling Task



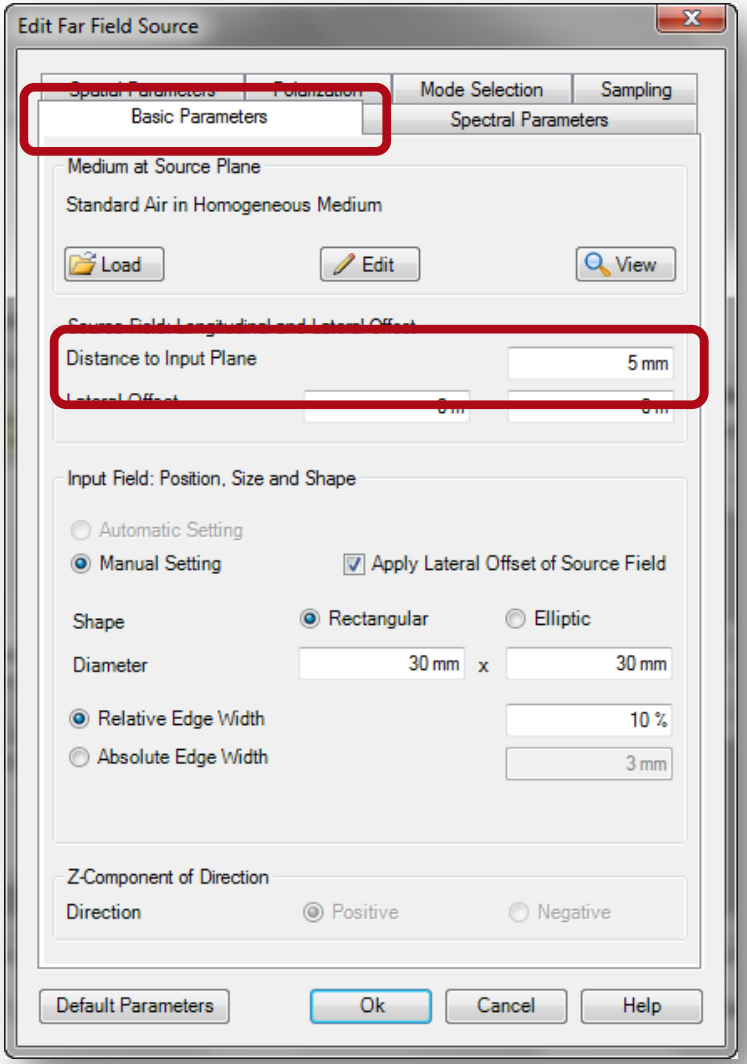
- Grating cell array consists of 100 x 100 cells.
- Cell size:
  100 x 100 µm
- Array diameter:
  10 x 10 mm

Design Steps



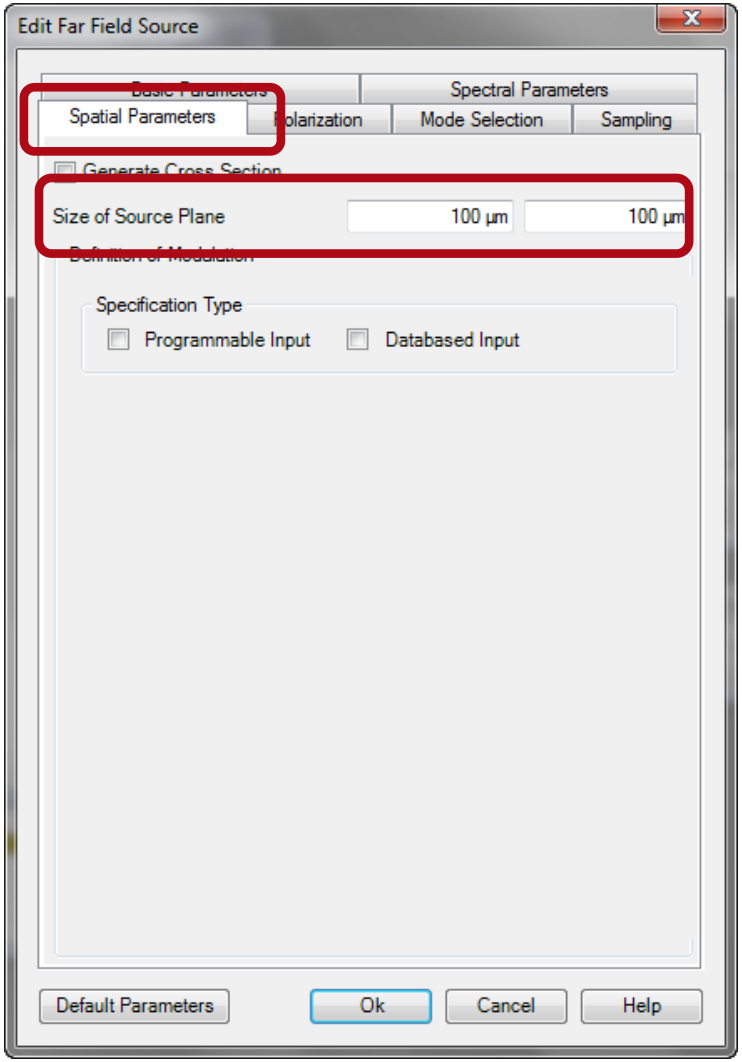
- For the simulation of this illumination system a specific light path diagram must be generated. It contains already the required setup.
- Only the distances and light source parameters must be set.

Design Steps



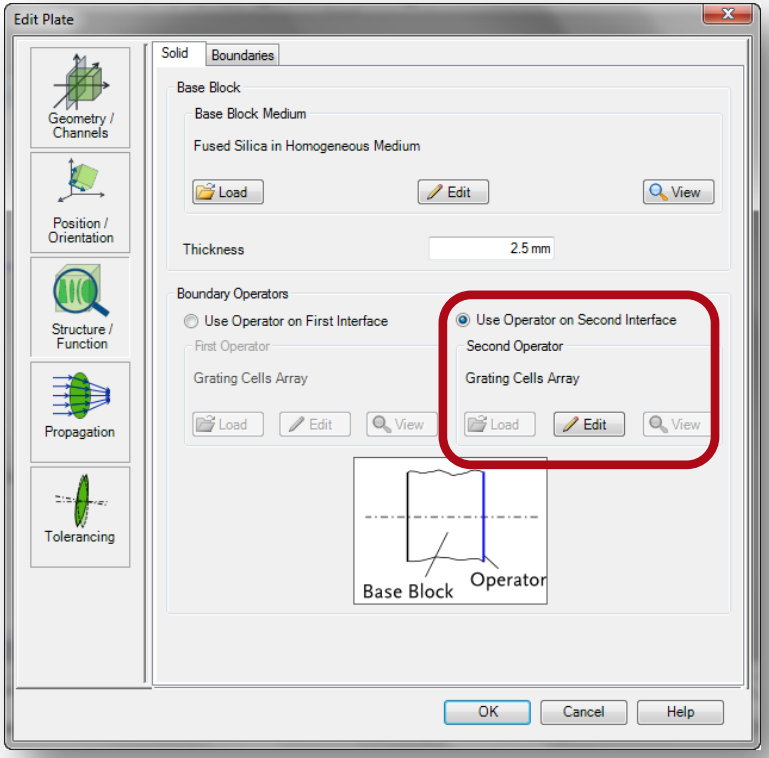
- All distances and source parameters must be entered in the light path diagram.
- The distance between source and grating cell array is entered on the Basic Parameters page (see left image).

Design Steps



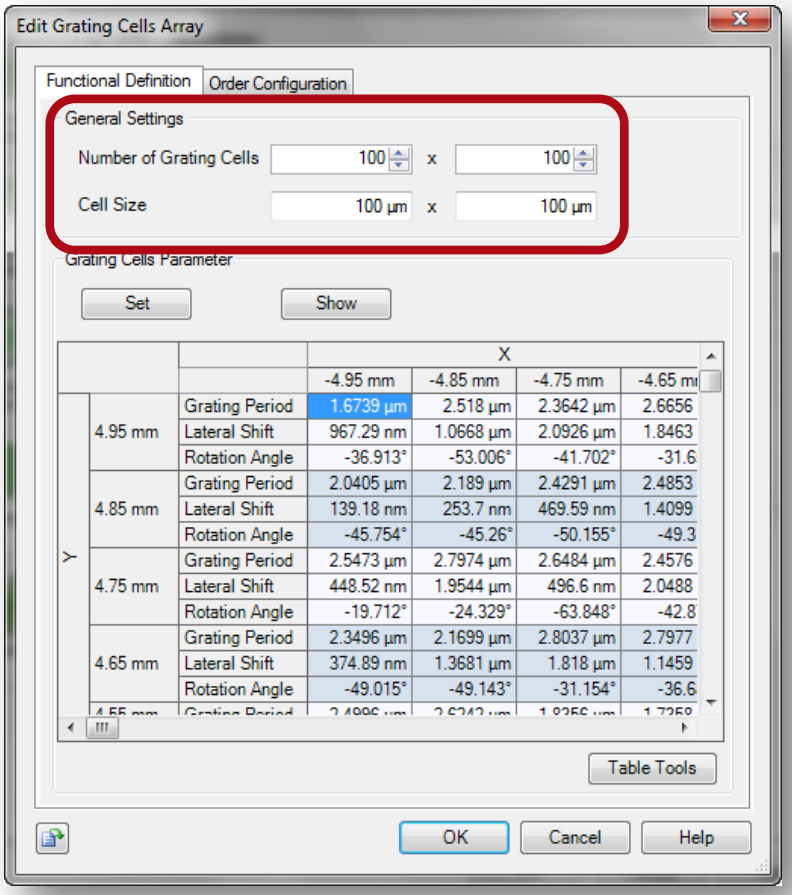
- The source plane diameter must be set on the Spatial Parameters page.

Design Steps



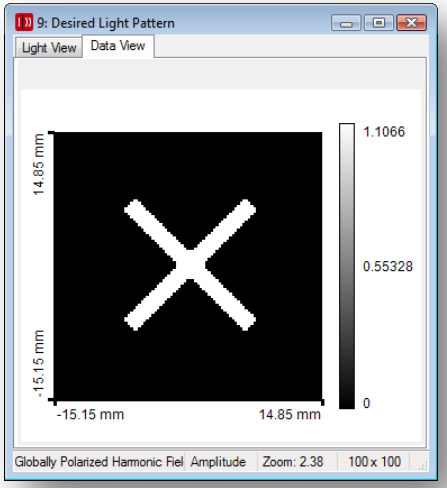
- The grating cell array is on the second surface of the light shaper component
- Click the Edit button of the grating cell array in order to configure the cell size and the number of cells.

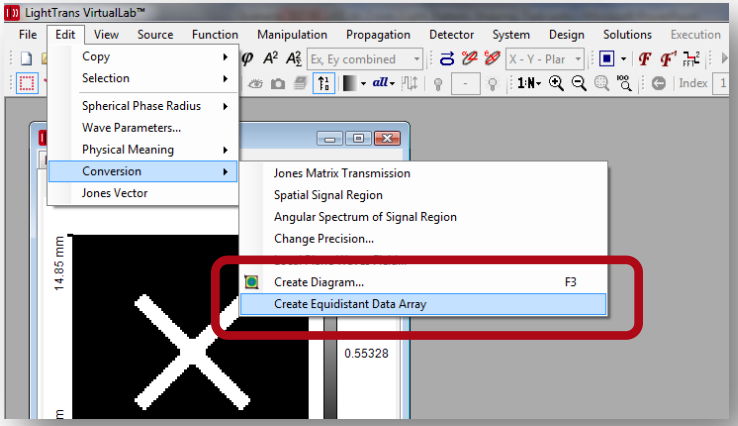
Design Steps



- Number of cells: 100 x 100
- Cell size: 100 x 100 µm
- Configured light path diagram is stored in “Scenario_317.01_LED_to_Cross_Light_Pattern_Shaping_02.lpd”.

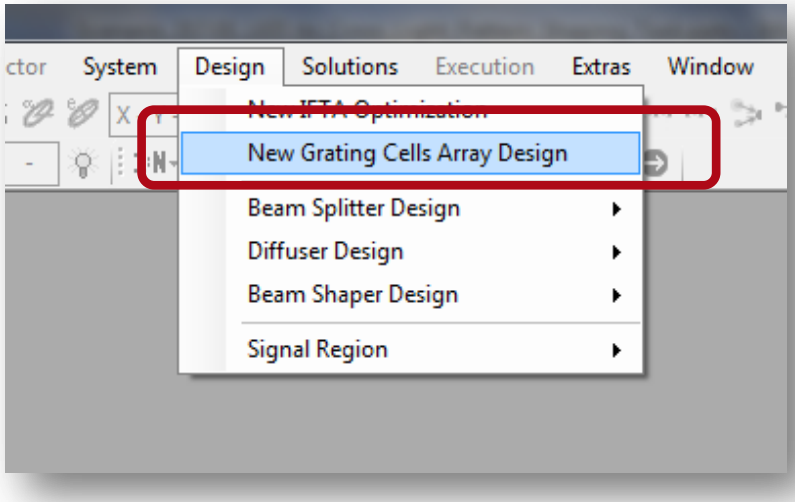
Design Steps





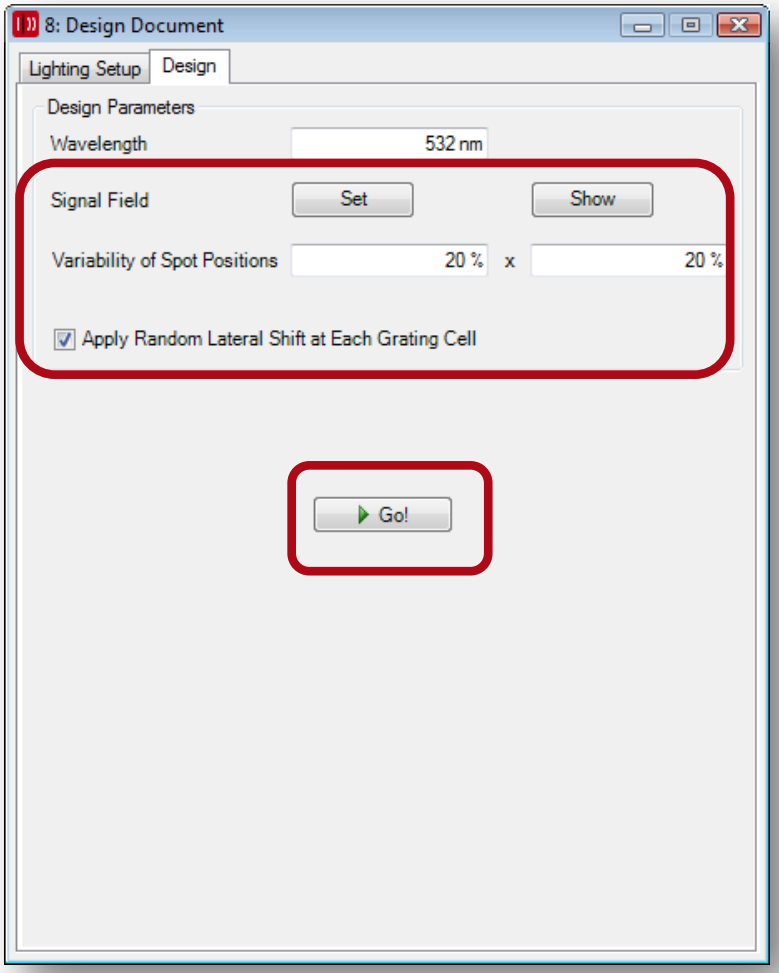
- The File→Import function can be used to import the desired light distribution from the “Scenario_317.01_LED_to_Cross_Light_Pattern_Shaping_01.bmp” bitmap file.
- The result of the import is a harmonic field.
- The array size must be set to 30 x 30 mm after the import with the help of the property browser.
- This harmonic field must be converted into a Data Array (see left lower image).

Design Steps



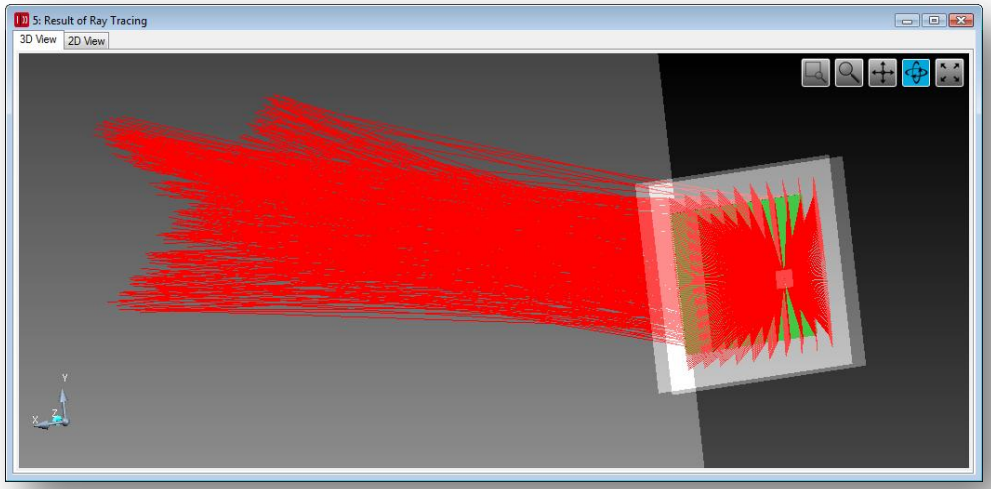
- A new grating cells array design document must be generated.
- It requires an active Lighting Toolbox light path diagram.

Design Steps



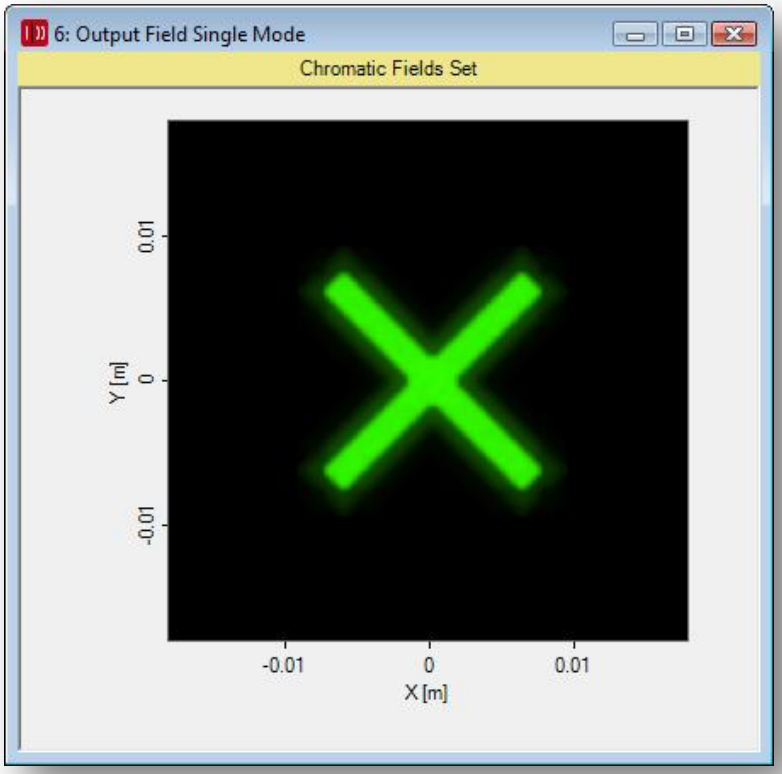
- Use the Signal Field Set button to set the data array containing the desired light pattern.
- A single grating cell will deflect light to one data point of the data array.
- Variability of Spots Position option and Apply Random Lateral Shift at Each Grating Cell option introduces a random shift of all spots in the target plane. This reduces pixel effects.
- The design document is stored in "Scenario_317.01_LED_to_Cross_Light_Pattern_Shaping_03.gcd"
- Click Go button to run design.

Optimization Result



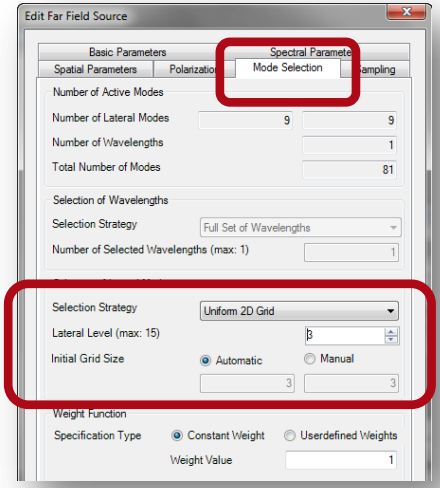
- The optimized light path diagram is stored in the file “Scenario_317.01_LED_to_Cross_Light_Pattern_Shaping_04.lpd”
- A ray tracing analysis is possible by selecting Ray Tracing instead of Field Tracing in the light path diagram.
- Ray tracing does not include diffraction and interference effects.

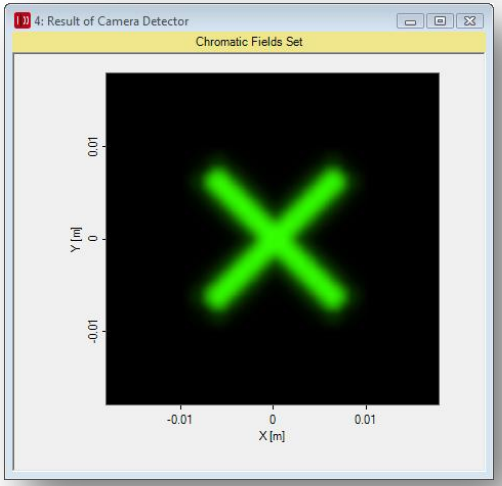
Optimization Result



- Diffraction, interference and partial coherence effects can be include in the simulation by selecting Field Tracing in the light path diagram.
- The standard setting of the light source uses just an on-axis mode for the simulation of the LED light.
- The camera detector shows an incoherent superposition of all spots generated by the grating cells.

Optimization Result





- In order to model the extension of the LED chip several modes must be used.
- The number of lateral modes can be controlled on the Mode Selection page of the light source by the Lateral Level feature.
- The output field for 5 by 5 modes is shown in the left lower image.

Conclusions

- VirtualLab™ can model illumination systems using micro structured grating cells arrays for light deflection.
- Design and analysis of grating cells arrays can be done including diffraction, interference and partial coherence effects.
- Grating cells arrays can be used to reshape and homogenize LED light.