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Silicon to Software™

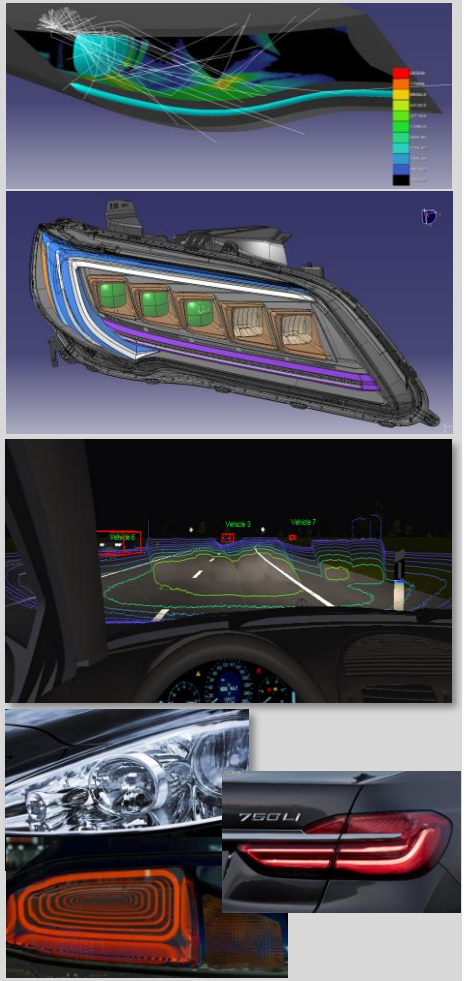
From Light Bulbs to Photonics – Synopsys Optical Simulation Tools in the Automotive Industry

Rainer Födisch

EPIC PHABULOUS Online Workshop:
Freeform Micro-Optics for Automotive Applications

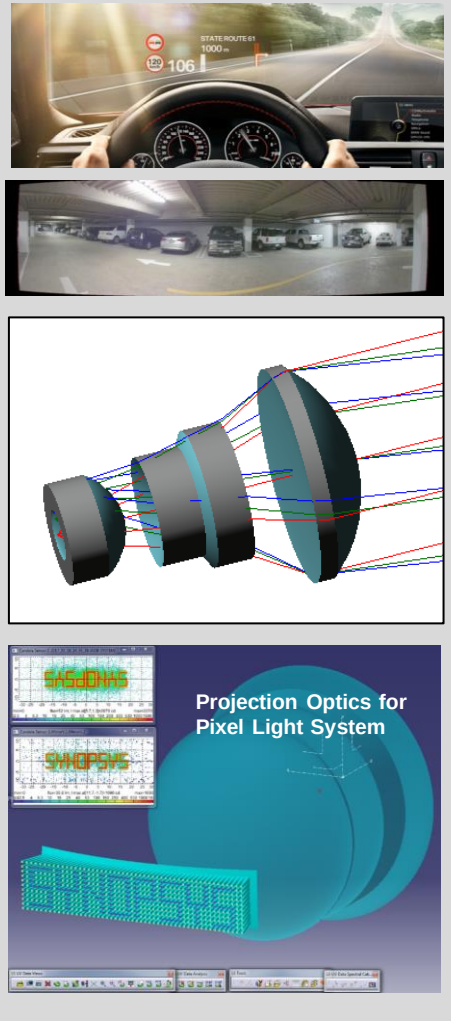
From Light Bulbs to Photonics – Synopsys Optical Simulation Tools in the Automotive Industry

LucidShape and LucidShape Catia V5 / 3D Experience Based for Automotive Lighting

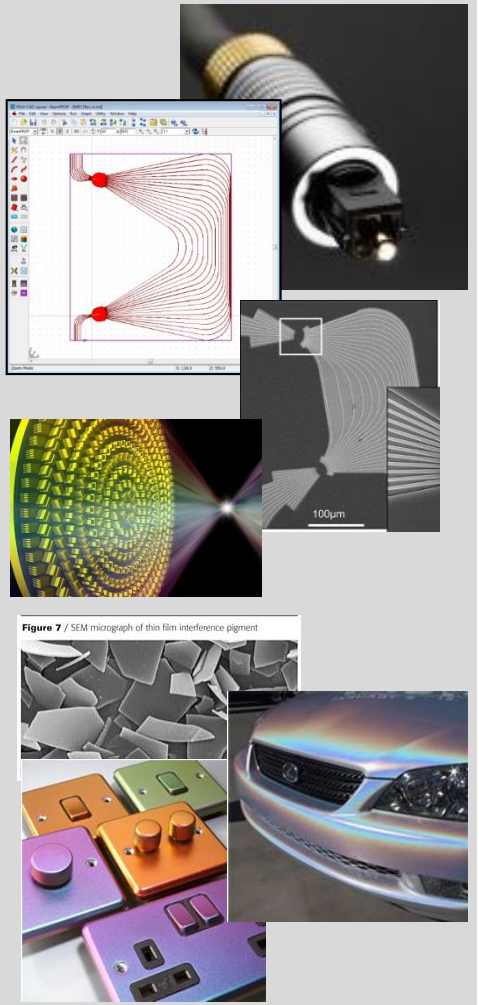


LightTools for Interior Lighting and Sensor and LIDAR

CODE V for Automotive Imaging Optics

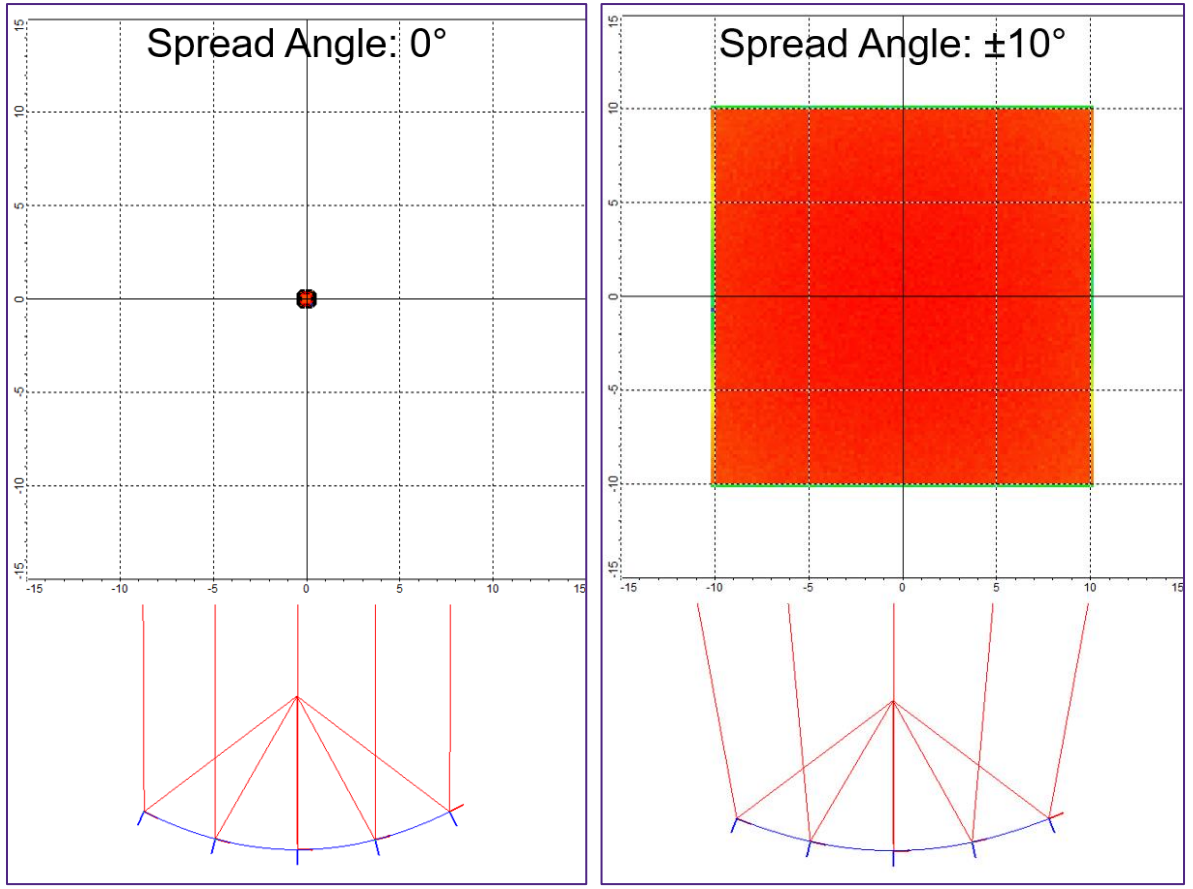


RSoft Design Tools Photonic Devices & Optical Communications



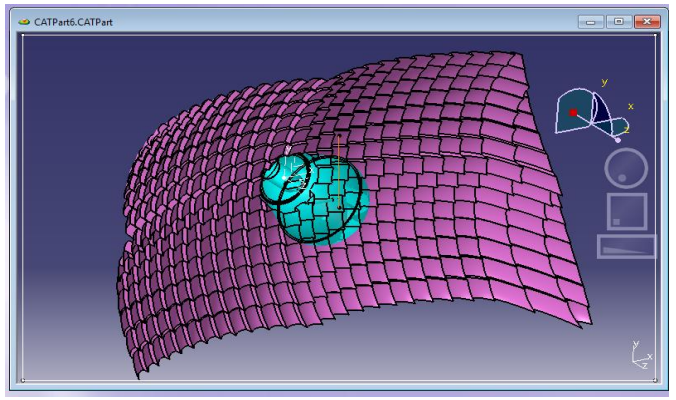
Concept: Functional Geometry (FunGeo)

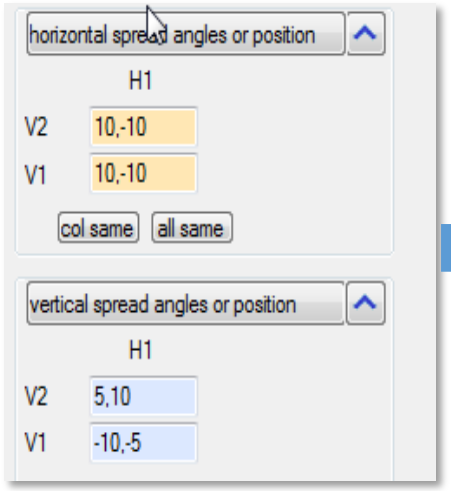
- LucidShape Functional Geometry uses algorithms that automatically calculate and construct optical geometries based on user-defined intensity and illuminance distributions.
- Gives you the freedom to focus on overall design objectives rather than on the creation of sophisticated freeform surfaces.

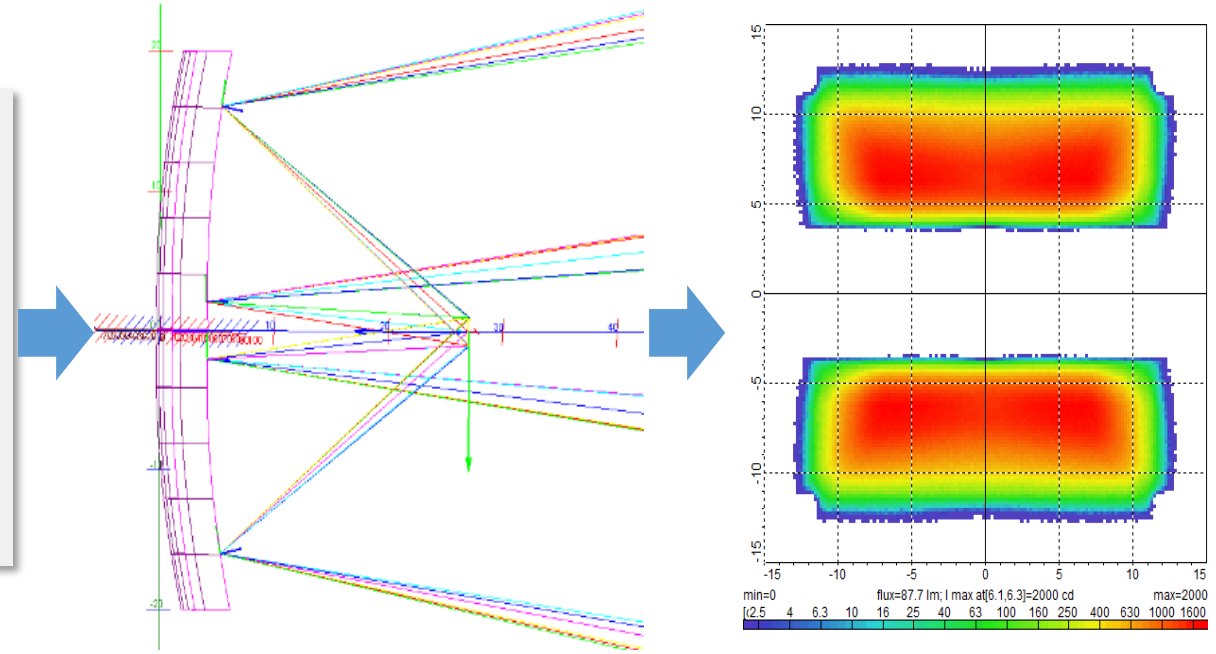


FunGeo

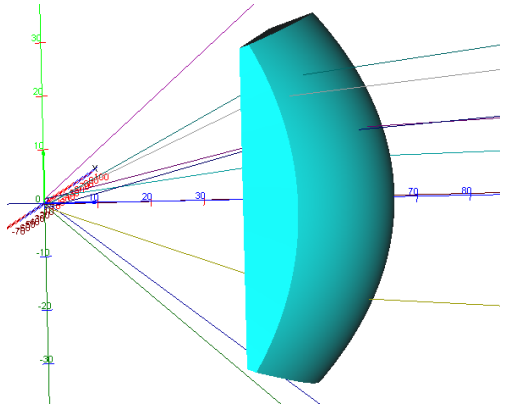
- Design by function:
  - The engineer can directly control the light output.
  - LucidShape will create the optical surfaces.
  - Used in all advanced surface design tools of LucidShape.
- 2 facets with different light spreads:
  - Upper facet from 5 to 10°.
  - Lower facet from -5 to -10°.

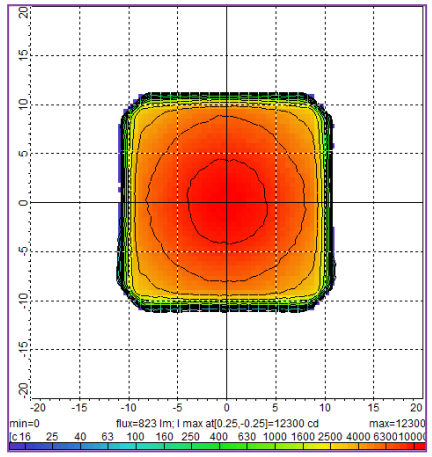


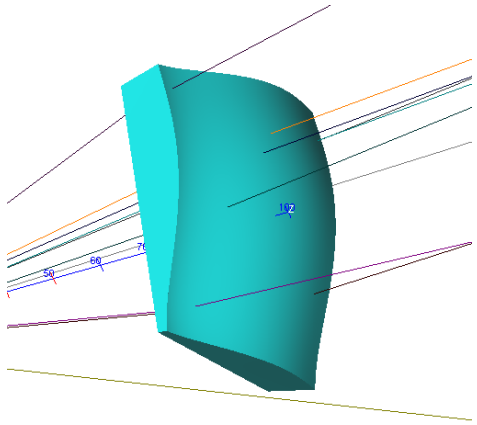


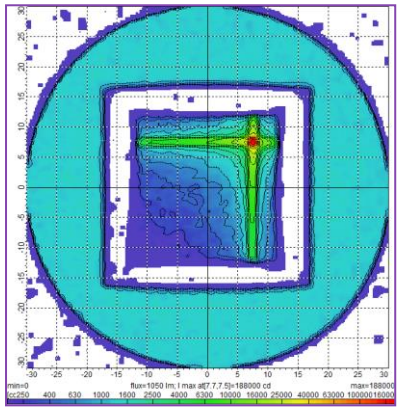


LucidShape Freeform optical elements

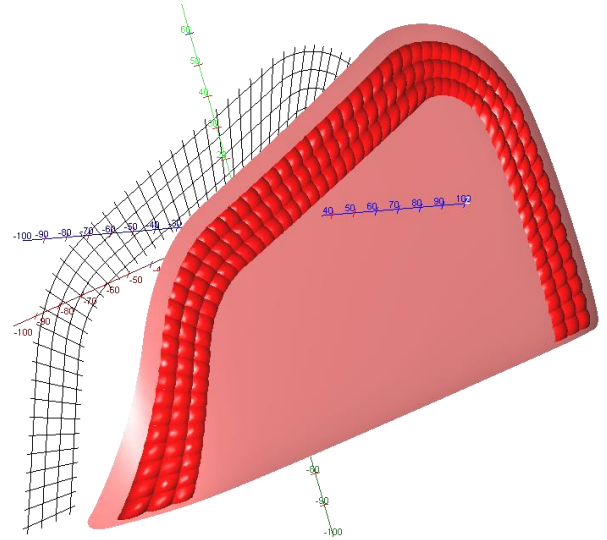






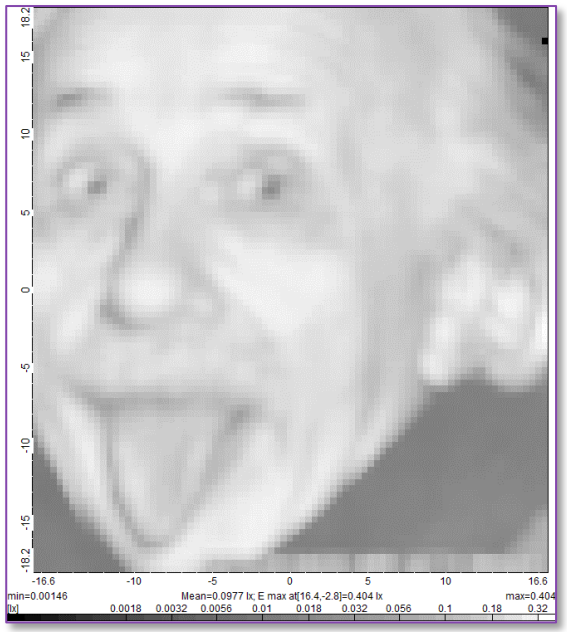


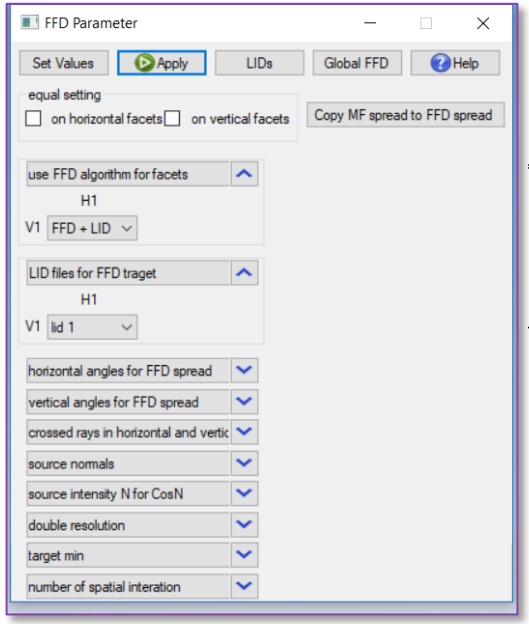
- Grid based on curves: You can customize the shapes and sizes of your facets as you desire.
- Can be useful for styling purposes.

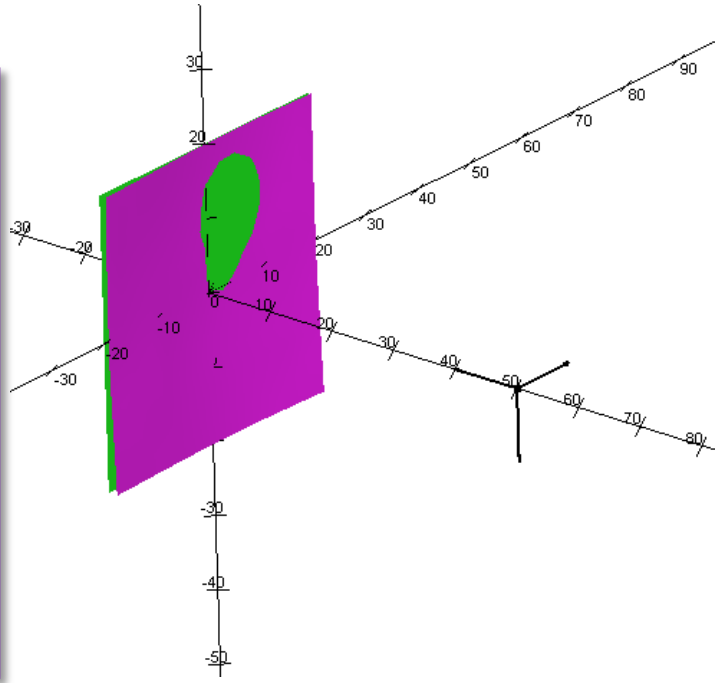


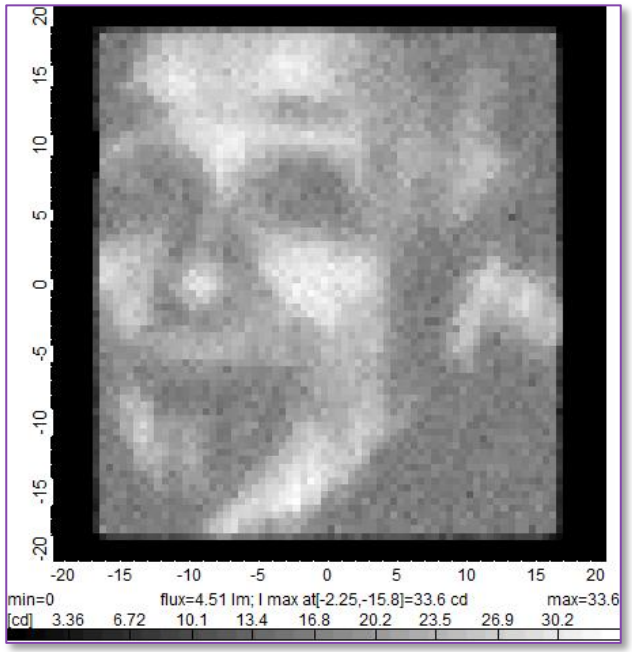
MacroFocal Freeform Design Capabilities

- Freeform Design capabilities: You can load a grayscale image as a target, and the shape of the reflector will be adapted to produce the desired light distribution.





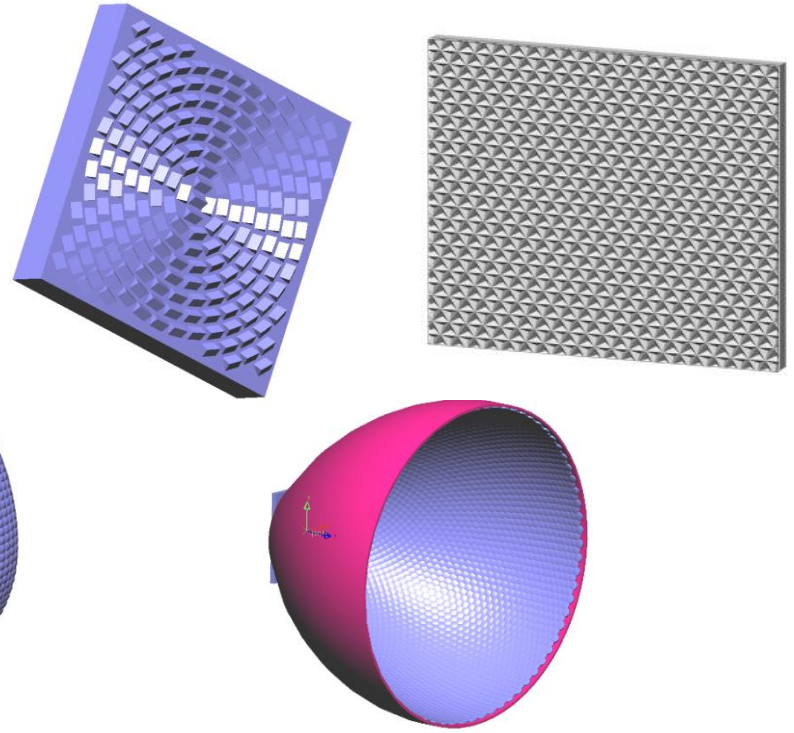


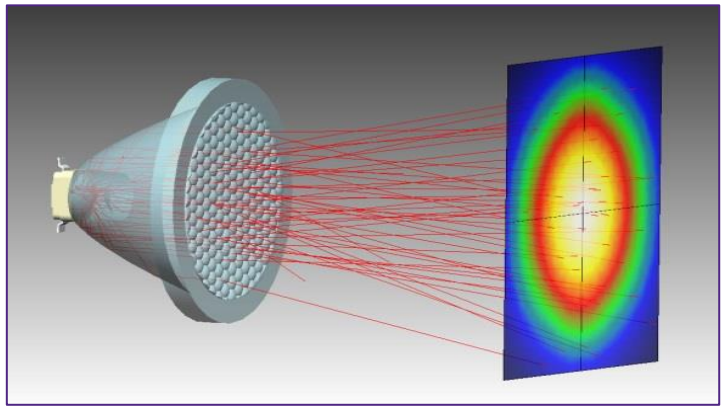


3D Mini & Micro Textures on any Surface Shape

- Define arbitrary numbers of identical or similar structures on flat and freeform surfaces
- Perfect for:
  - Backlight light extraction
  - LED color shift mixing
  - Controlled angular spread
  - Light pipe light extraction
  - Fly's eye condensers
- Predefined shapes

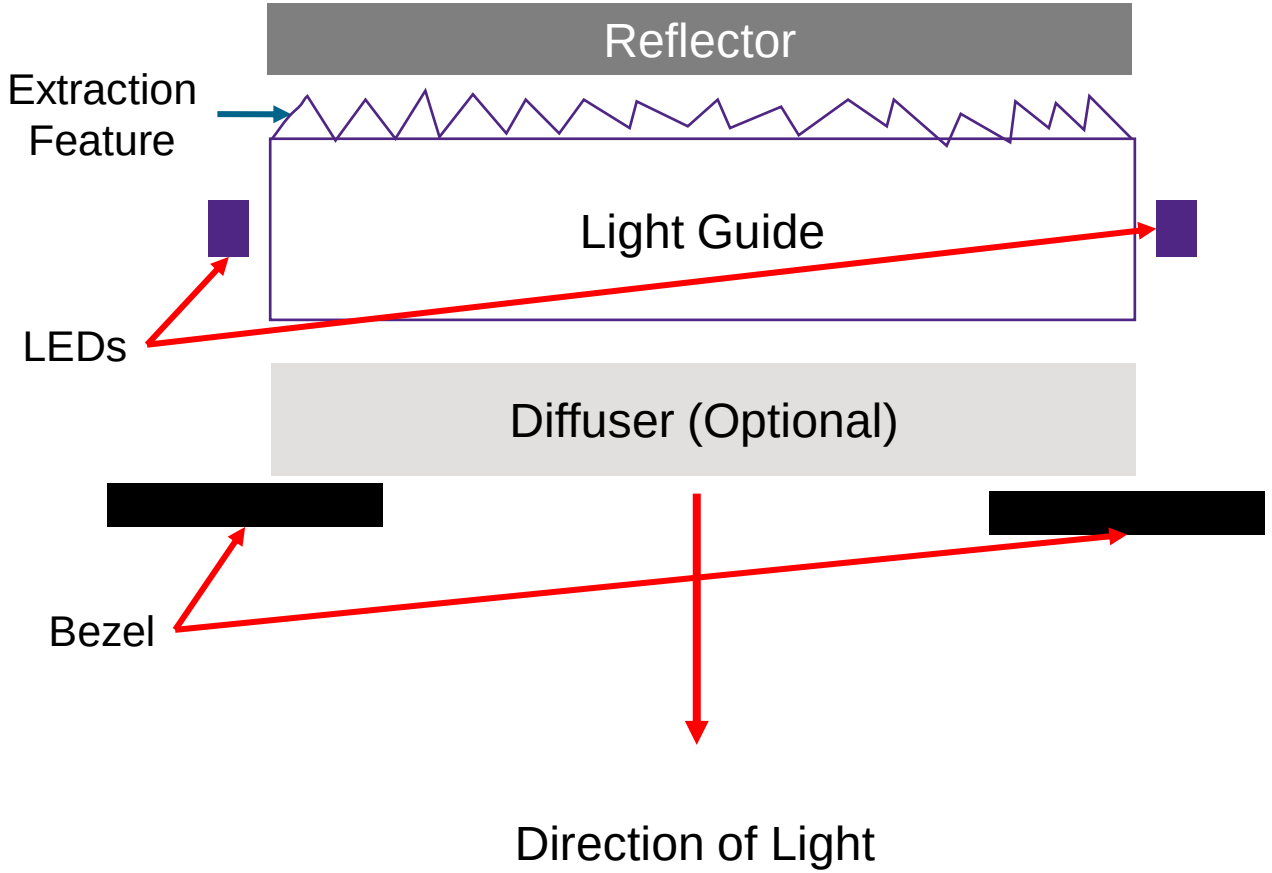
  Spherical, prismatic, cylindrical, etc.
- Customer structure, e.g., imported from CAD
- Structures vary across surface by:
  - Size, orientation, density, shape, etc.





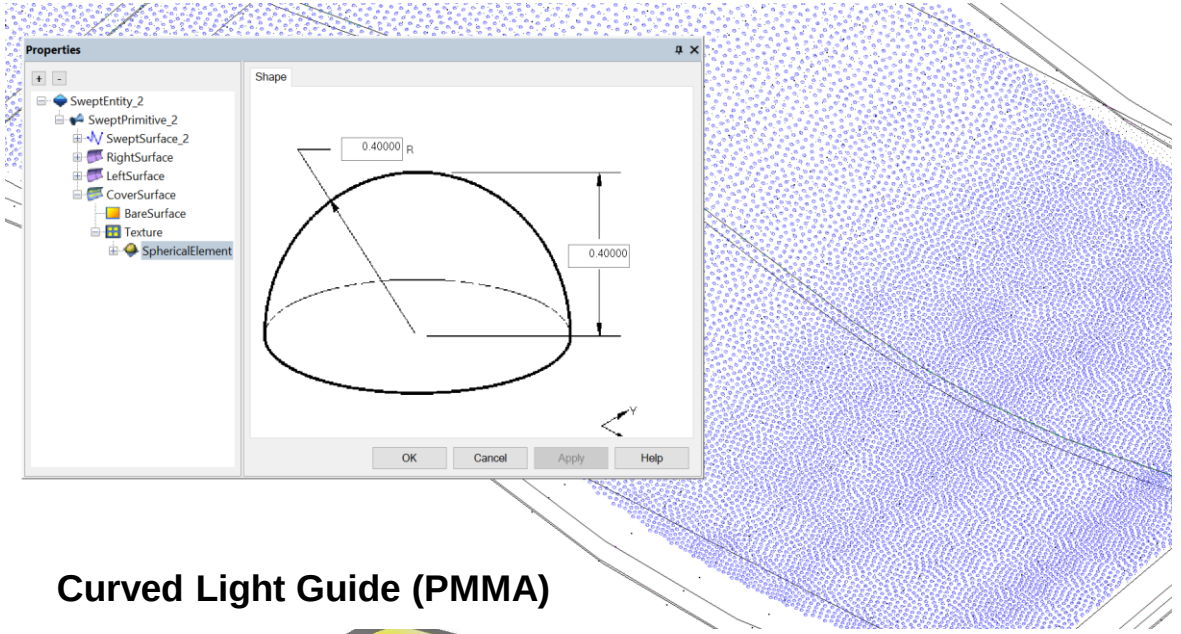
Anatomy of a Back light and area lighting system

- Similar to a backlight unit from an LCD display, without the LCD
- Components include:
  - Edge-lit light guide with extraction features
  - Reflector
    - Specular or diffuse for recycling light that leaves the light guide in the wrong direction
  - LEDs
  - Bezel
    - For hiding the electronics from an observer
  - Diffuser (Optional)
    - Scattering sheet or bulk diffuser to further spatially mix the light leaving the light guide

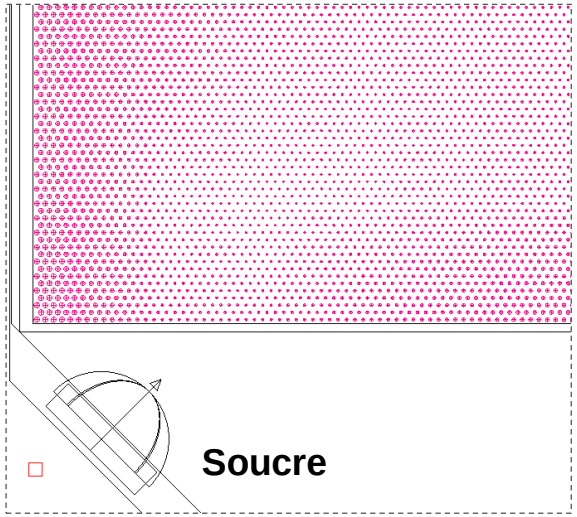


LightTools Texture Optimization for Area Illumination

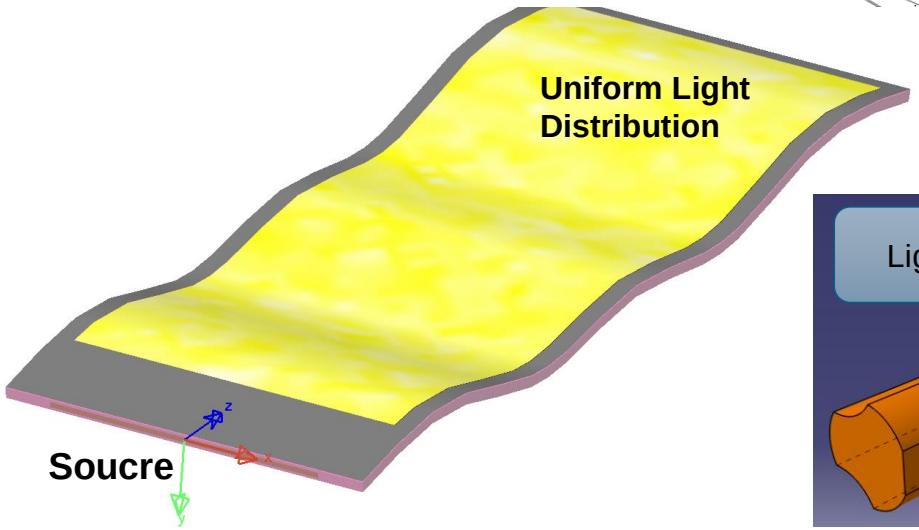
- Fast simulation for both printed 2D patterns and 3D textures
- Logos, decorative light elements, display backlight
- Optimization for uniform output using specialized Backlight Pattern Optimizer tool
- Example with 27.000 spherical texture elements (Radius = 0.4 mm)
- Optimization time about 10 min

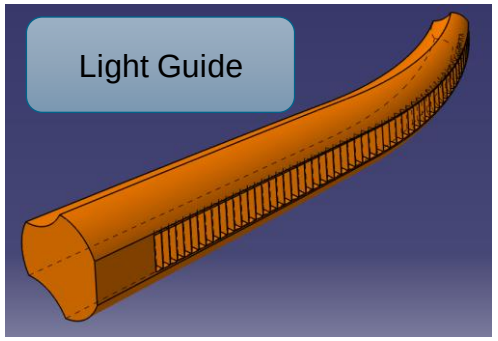


Curved Light Guide (PMMA)



Optimized Pattern Placement

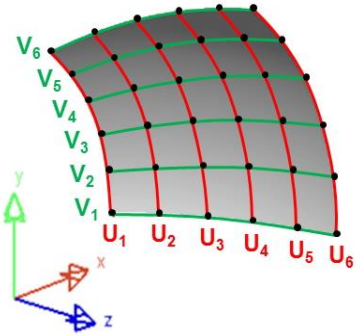


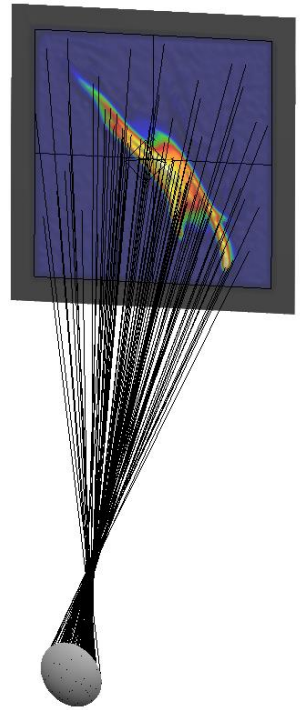


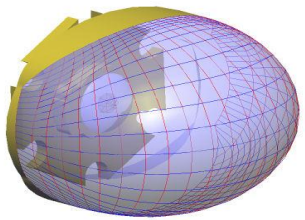
LightTools Freeform Design Feature

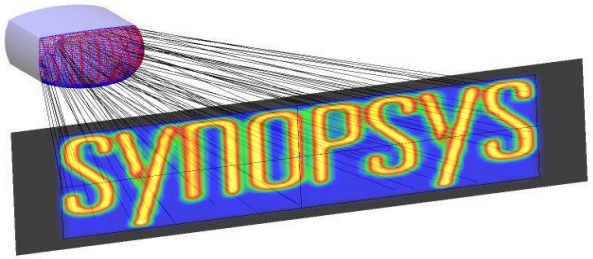
- Useful for designing non-faceted freeform reflective and refractive surfaces
- Most suitable for systems with sources that are small relative to the size of the optic (e.g., LEDs, small halogen sources, arc lamp)
- Target distributions can be simple or complex
- Illuminance and intensity targets

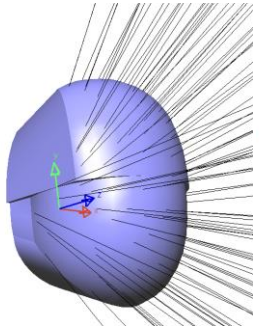
Interpolated 3D Surface

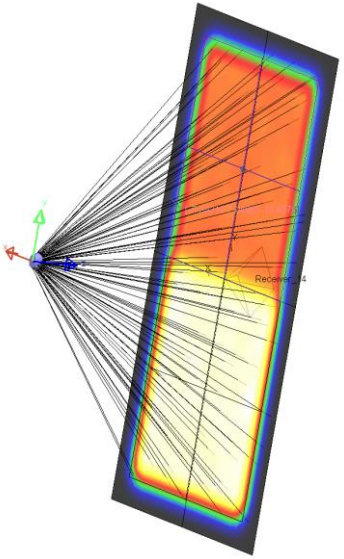




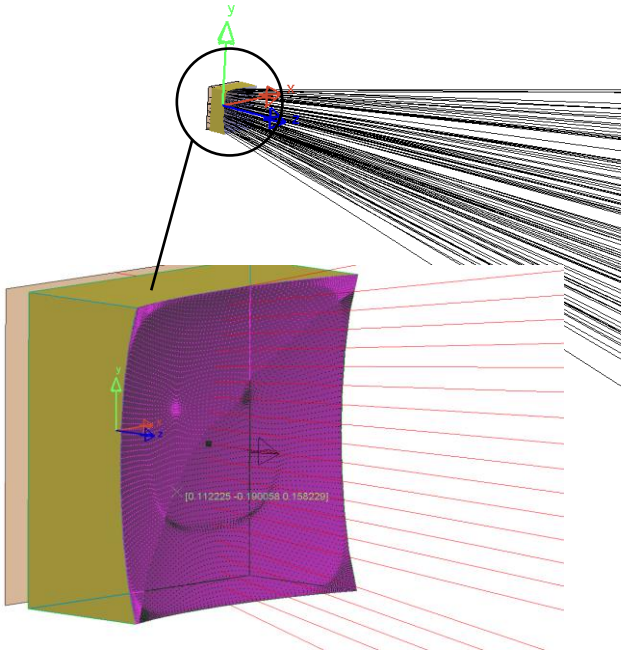






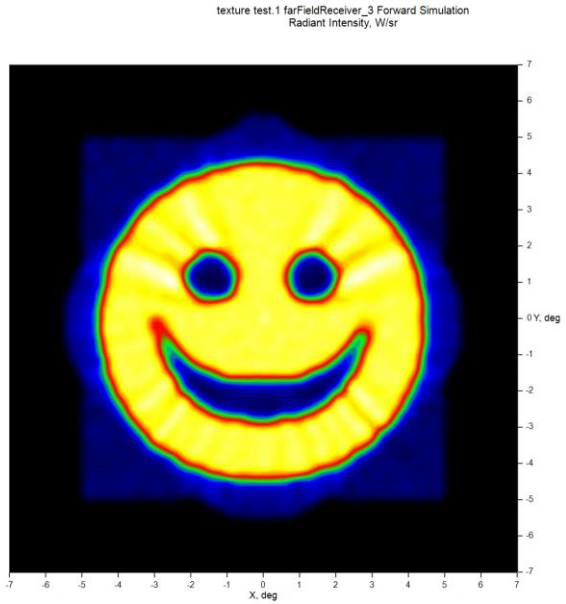


LightTools Freeform Lens Arrays

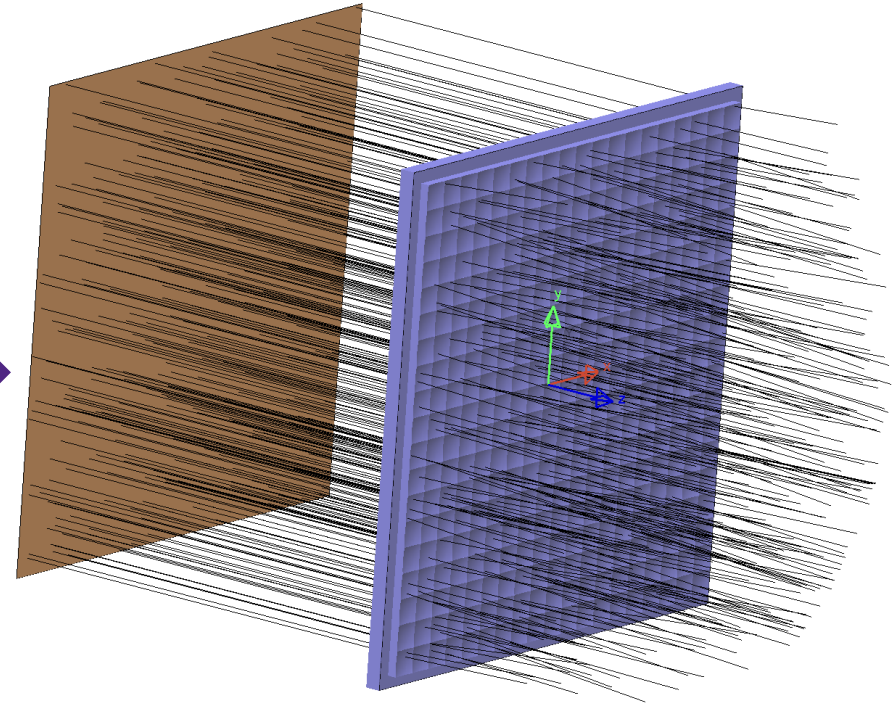


1 x 1 mm Freeform Lens

(Lens dimensions down to 5-10 µm possible)



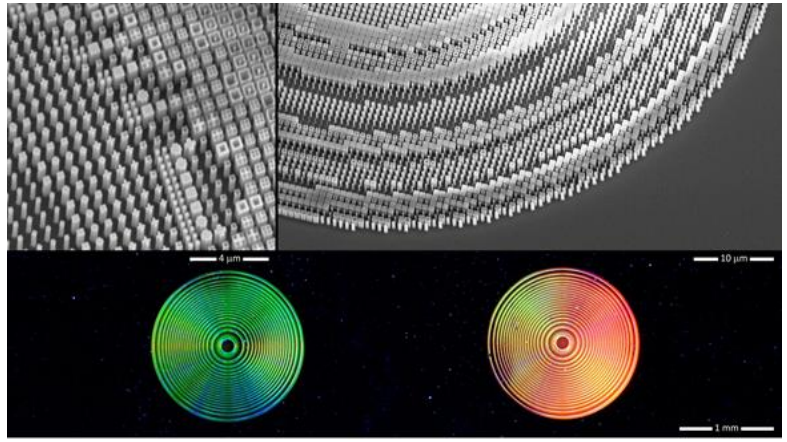
Intensity distribution



20 x 20 mm Lens Array with 400 single lens elements

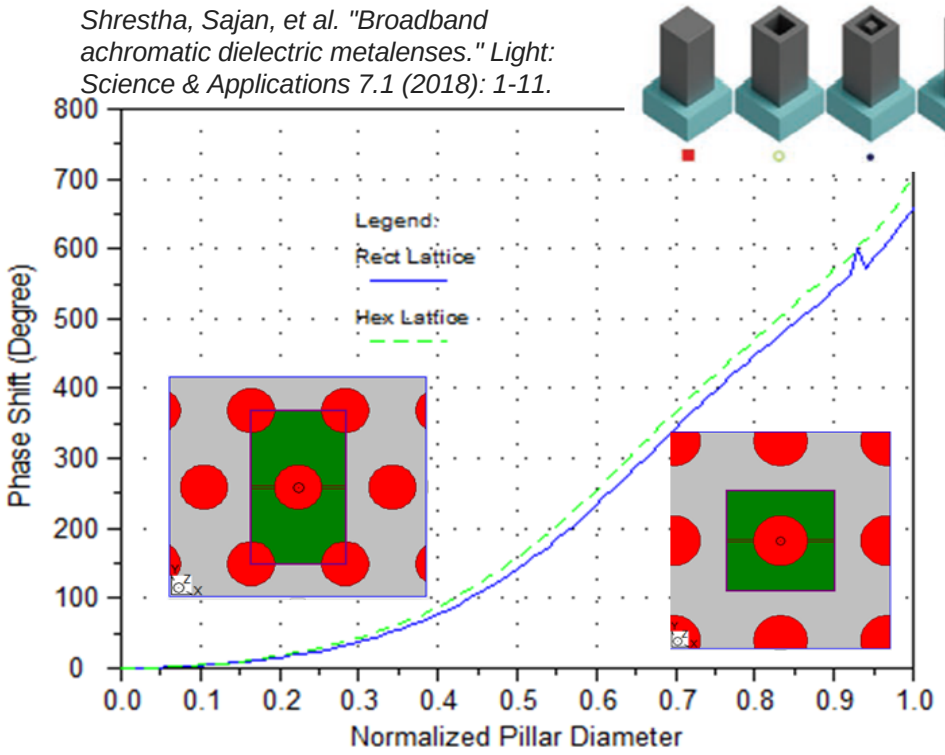
Meta surfaces design and simulation

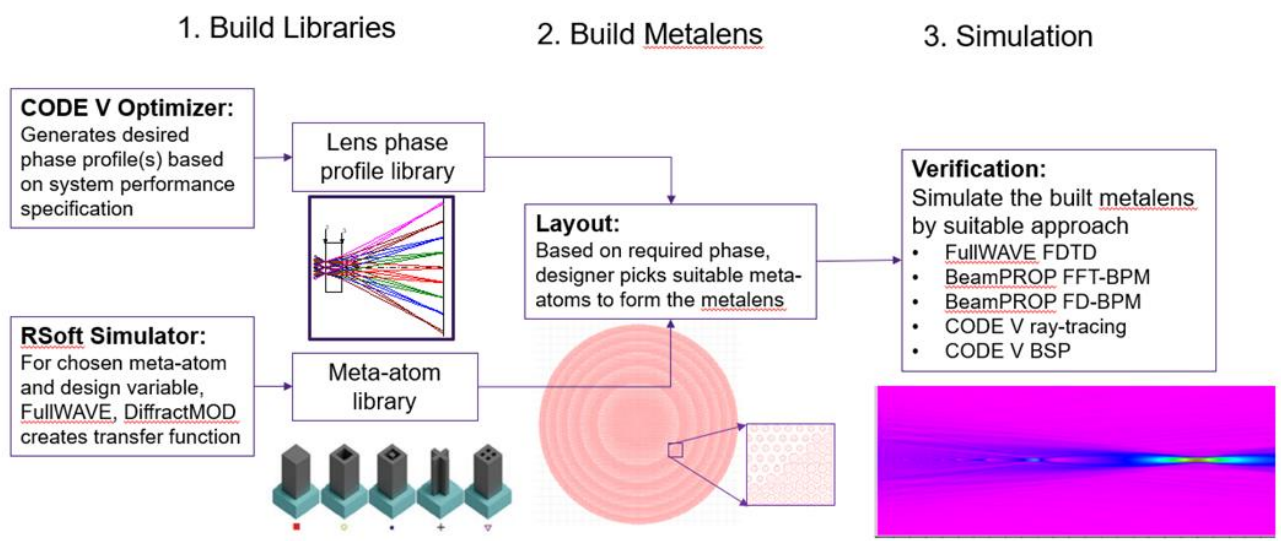
https://phys.org/news/2018-10-revolutionary-ultra-thin-meta-lens-enables-full-color.html



DiffractMOD RCWA is part of design flow for MetaSurface design. This algorithm is perfectly suitable for generation of phase shift induced by meta-atoms and it would be typically ~30X faster than FDTD

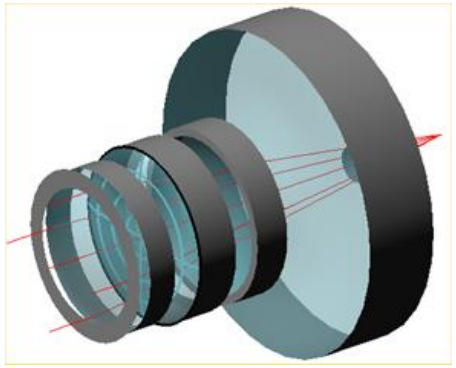
Shrestha, Sajan, et al. "Broadband achromatic dielectric metalenses." Light: Science & Applications 7.1 (2018): 1-11.

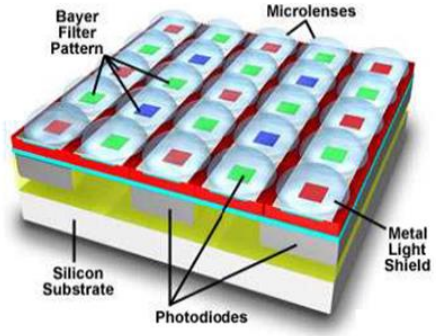


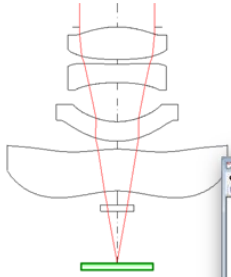


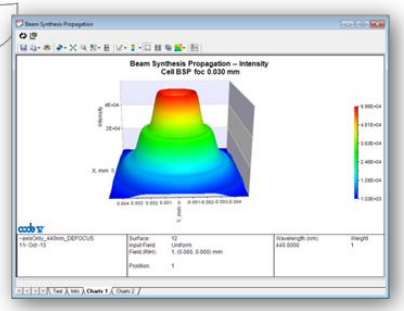
Combined tools for more challenging designs

Cell phone camera: CODE V - RSoft

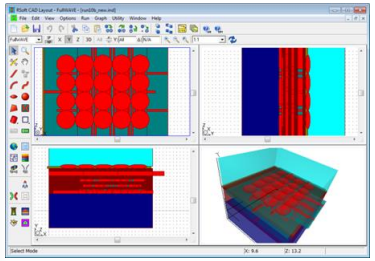




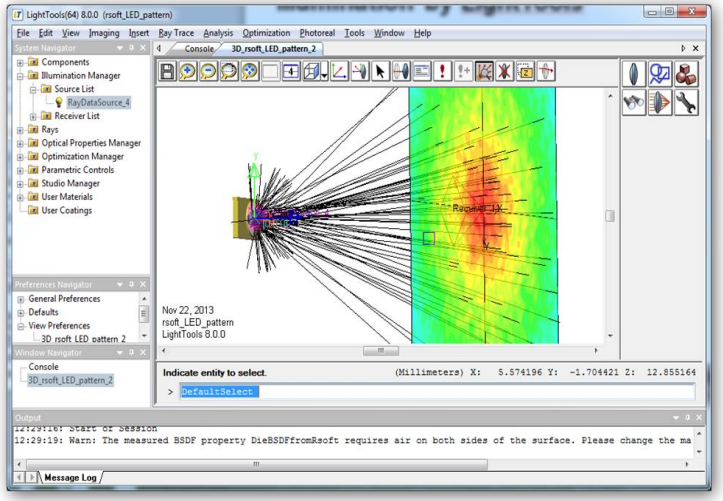




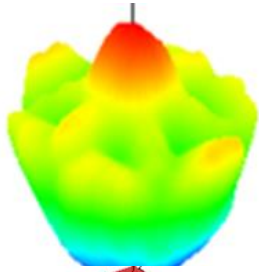
FullWAVE FDTD



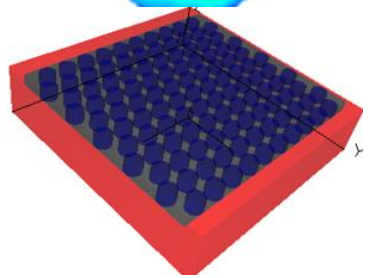
Illumination: Arbitrary Intensity Distributions with LEDs

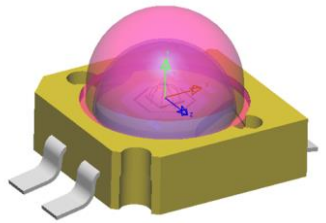


Source



BSDF

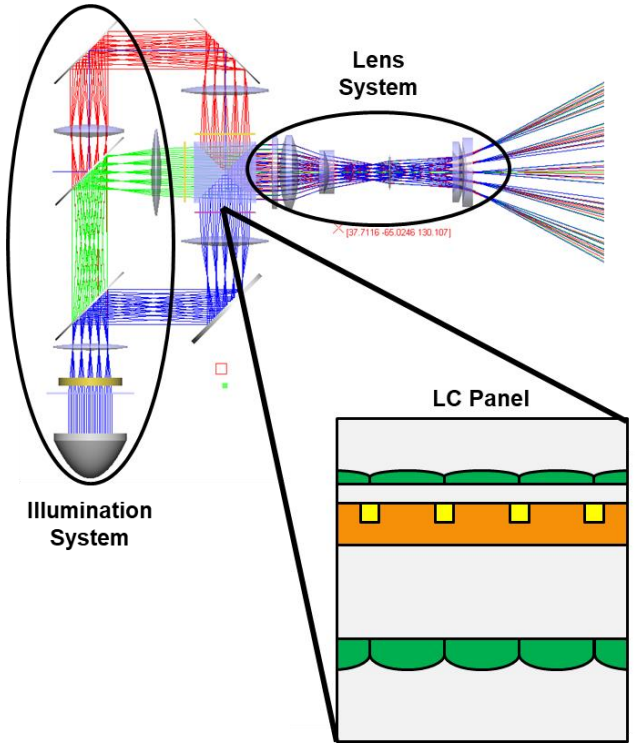


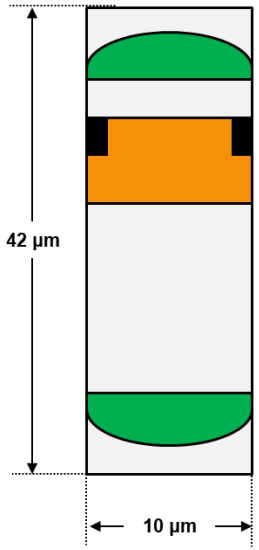


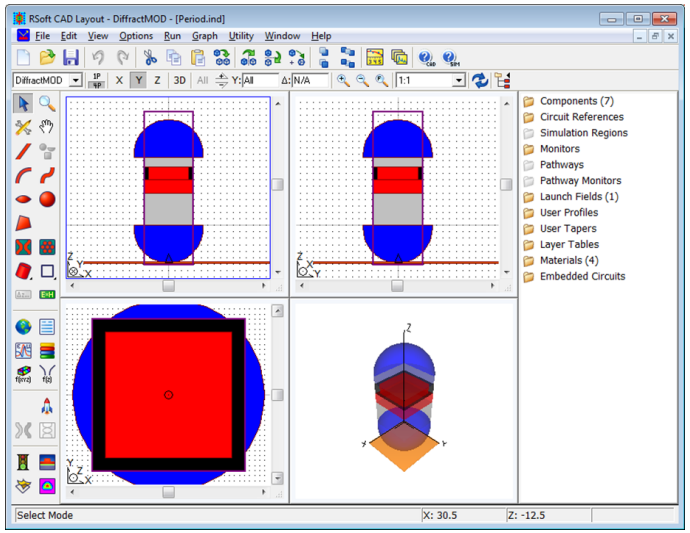
Combined tools for more challenging designs : examples

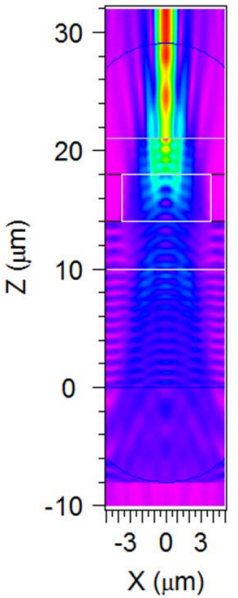
Projector Design using LightTools and RSoft DiffractMod

MLA on Liquide Cristal Panel

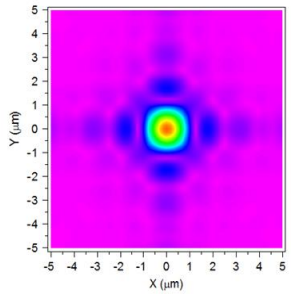








Near field



Far Field