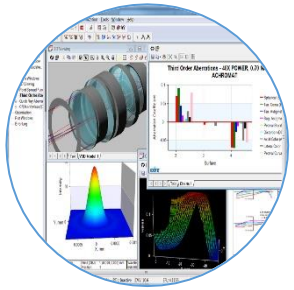
Optical Simulation software for Horticulture Lighting

EPIC meeting, 10th July 2020
by Yan Cornil, CEO

LIGHT TEC ACTIVITIES

Synopsys Optical Simulation Software

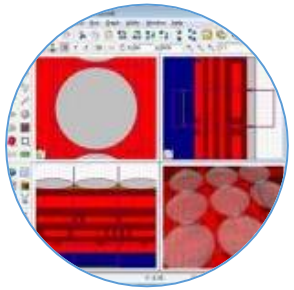


CODE V

Imaging optical design

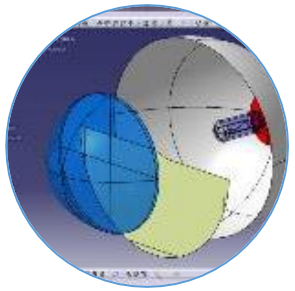
LightTools

Illumination design



RSoft

Micro & nano optics



LucidShape

Automotive Illumination

Optical Scattering Measurement Instruments Services

Measurement Service

Scattering measurement

Measurement Instruments

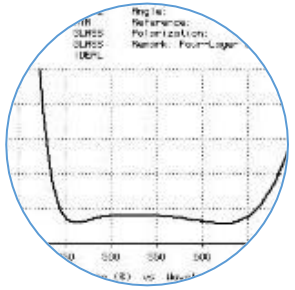
Mini-Diff V2 / Mini-Diff VPro

Reflet 180 S

Engineering & Training

Illumination design &

Imaging optical design



TF calc

Thin films, analysis, optimization

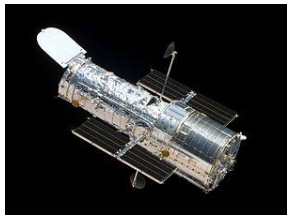
Illumination Design Software: Applications

Medical

Automotive

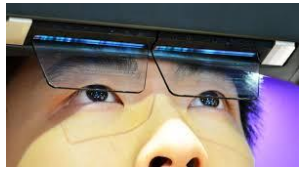
Lighting

LightTools®



Camera

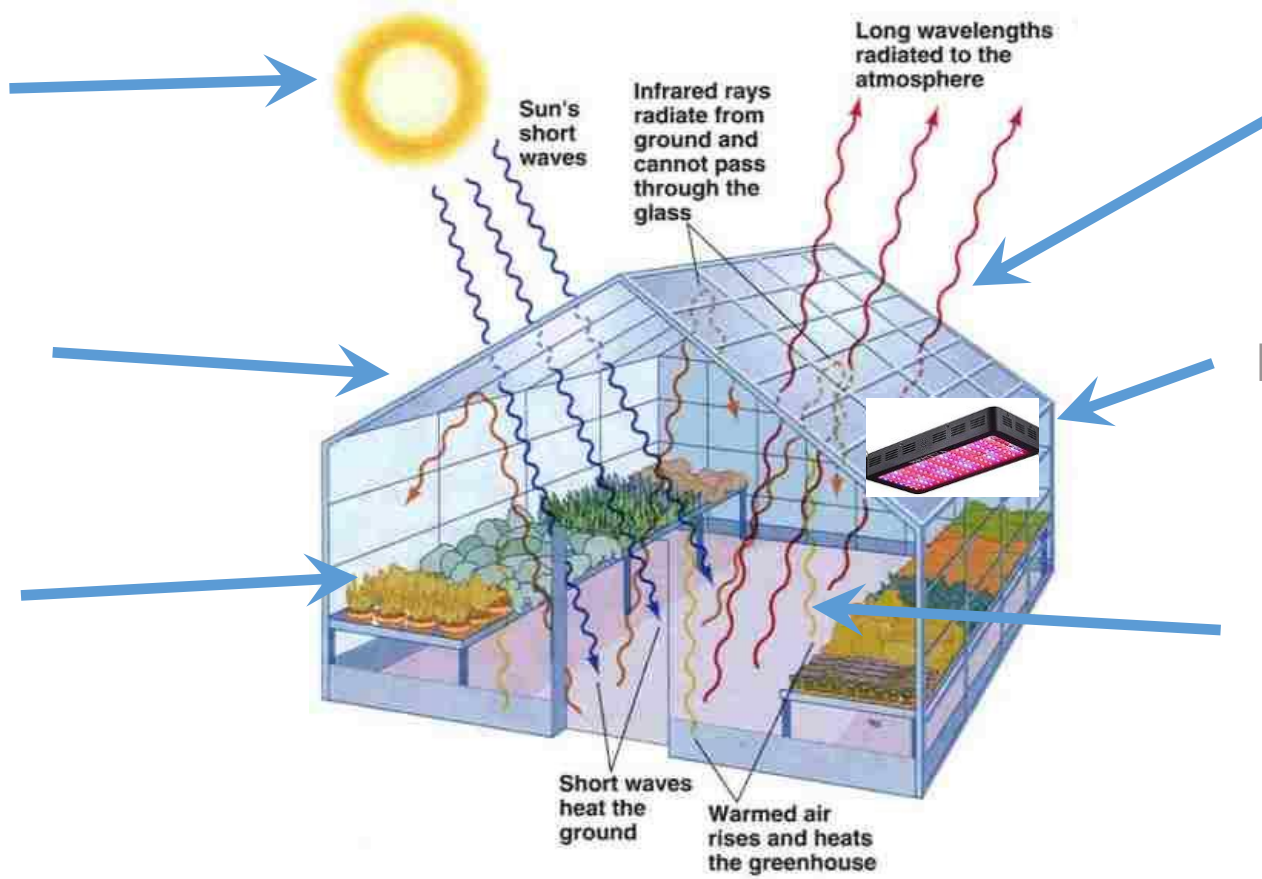
Displays



Type of optical simulation possible

Infrared Exchange

Sun/Sky Light



Glass Roof

Lighting fixtures

Leave effect

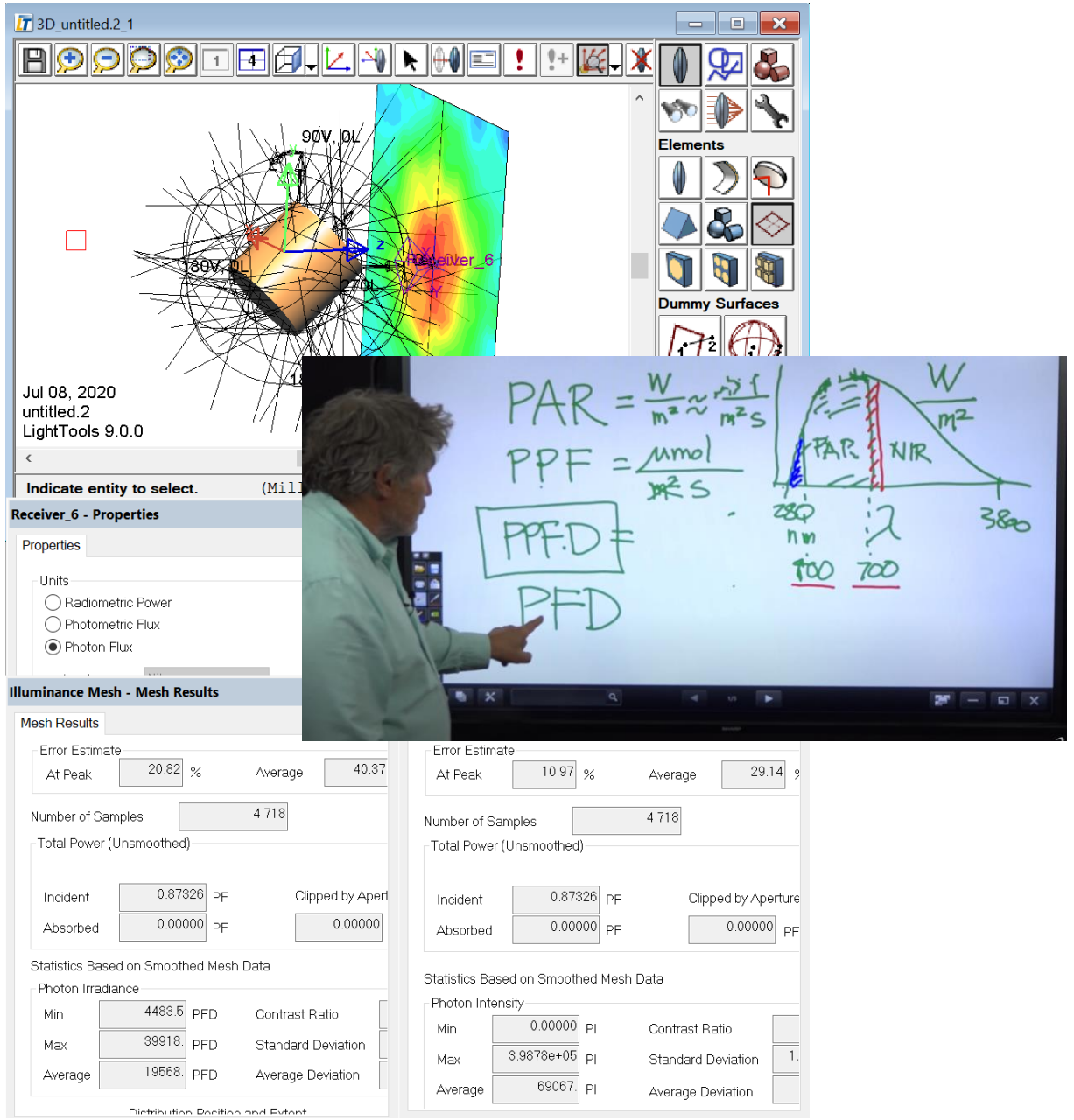
Efficacy

The dedicated Units

are available

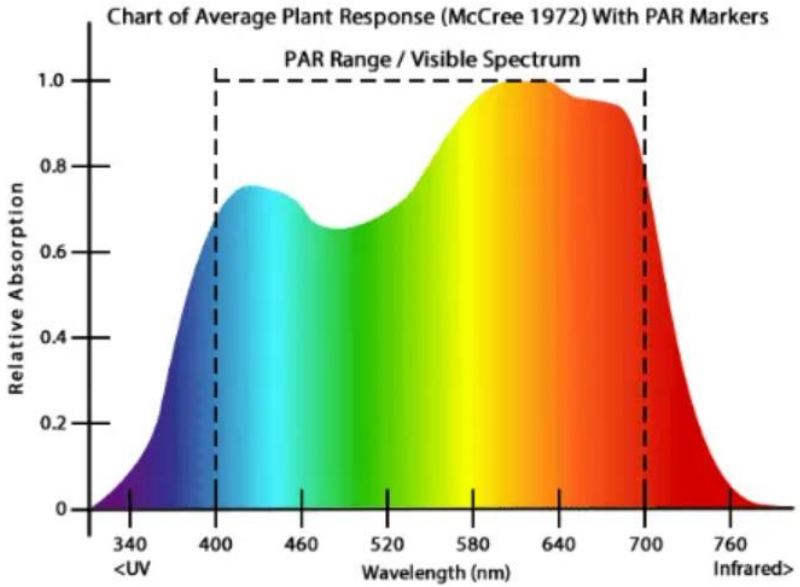
- PAR = Photosynthetically Active Radiation
- Photon Flux - PF is used for the units displayed in the user interface to reduce visual clutter and is calculated in µmol/s
- Photon Intensity – PI is used for the units displayed and is calculated in µmol/s/sr
- Photon Flux Density – PFD is used for the units displayed and is calculated in µmol/s/m2, regardless of the default system units
- *Example ,full sunlight is:*

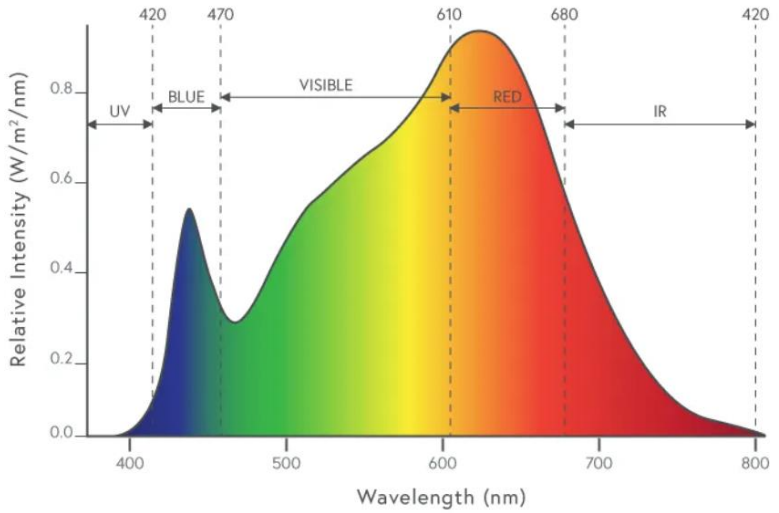
  2000 µmol m^{-2} s^{-1} ←→ 108,000 Lux



Special needs

PAR = Photosynthetically Active Radiation (PAR)





Blue Light

Plant Leaf Growth.
Promoting the synthesis of chlorophyll, cartenoids, chlorophyll A&B, boosting photosynthesis.

Red Light

Plant Blooming & Fruiting.
Promoting the synthesis of chlorophyll A&B. Resulting in fruit and blooming.

Ultraviolet Light

Disinfect the Virus.
Good for germination and sterilization. Prevents plants from being infected.

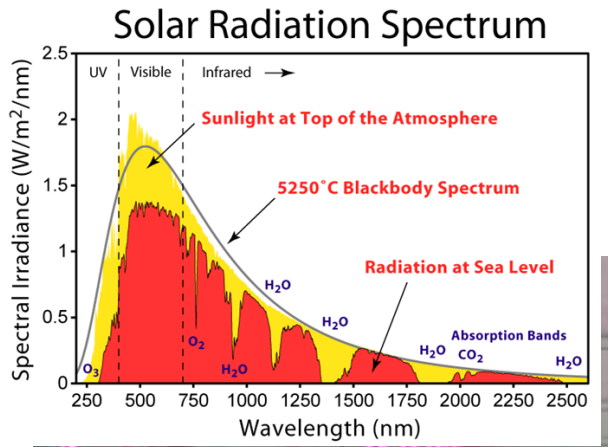
Infra-red Light

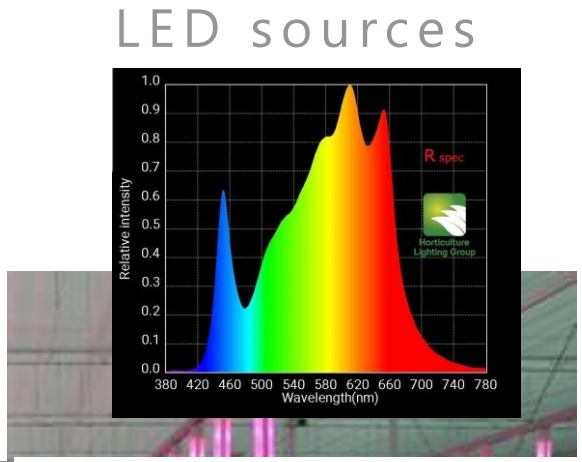
Promoting Cell Division.
Have a certain impact on promotion cell division and good for plant blooming.

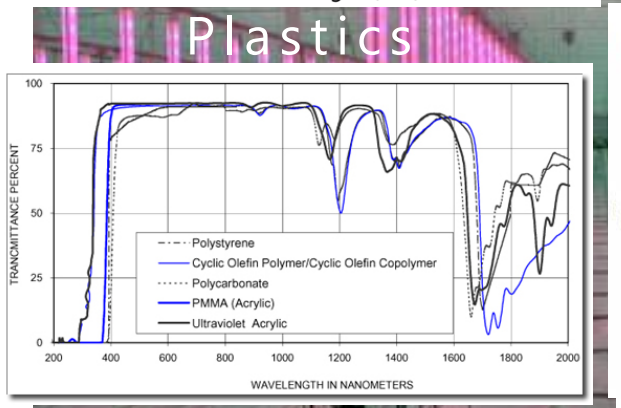
G2V

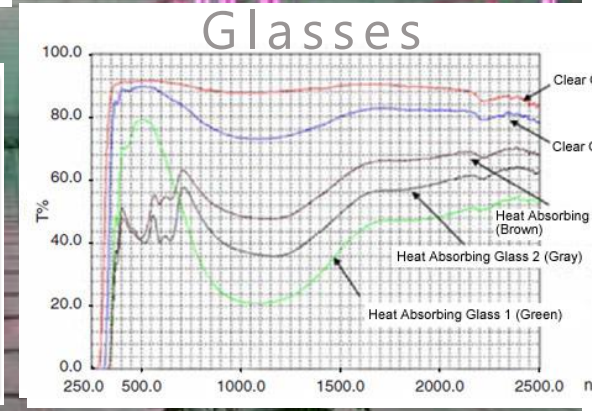
Defining each spectrum

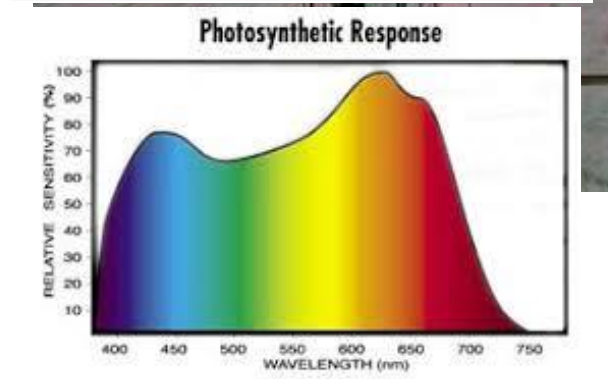
- Sun Light
  - User Defined
  - Spectrum Libraries
  - Importing data (Meteonorm, etc)
- Led/Lamp
  - User Defined
  - Spectrum Libraries
- Glass/Plastic transmission
  - User Defined
  - Spectrum Libraries
- Plant absorption
  - User Defined

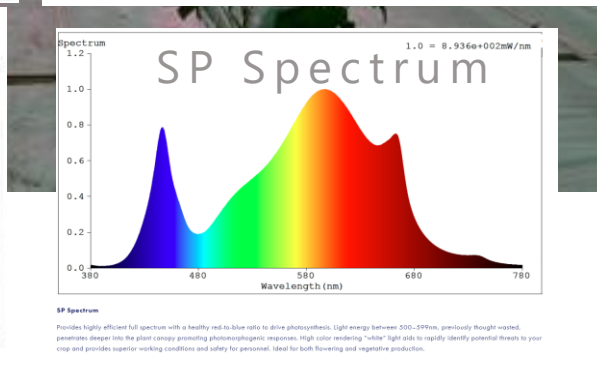






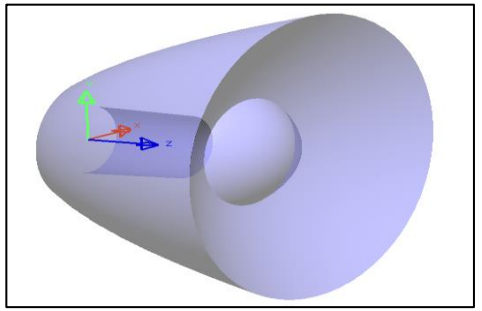


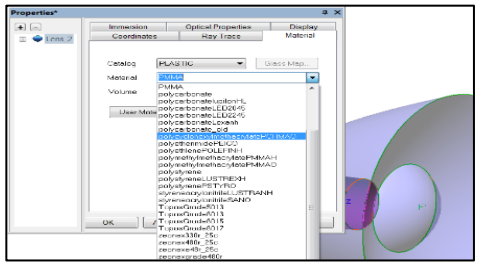


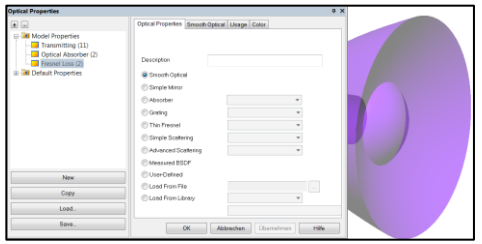


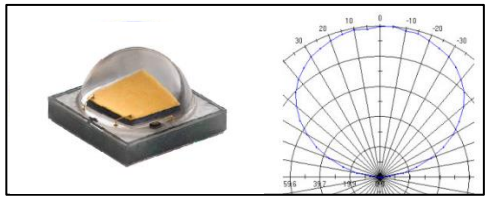
Analysis work flow

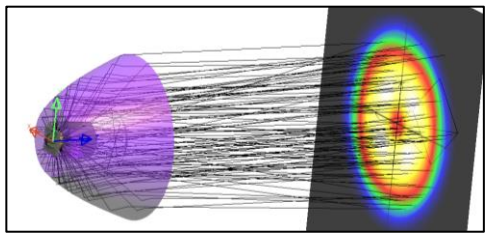
- **Create** the model geometry – native or imported from a CAD package (or combination)
- **Define** the materials
- **Define** the optical properties of the model surfaces
- **Define** the source spectrum, power and apodization
- **Define** the receivers for analysis



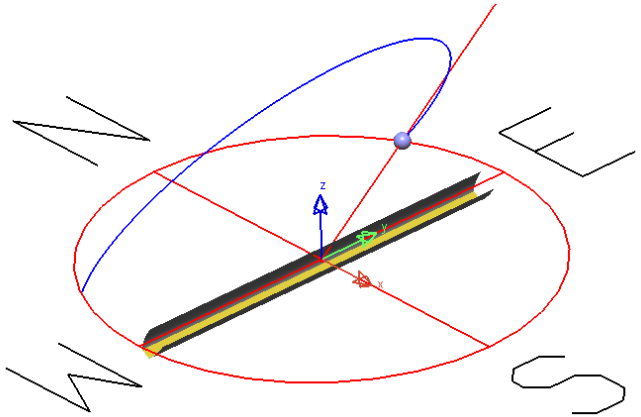


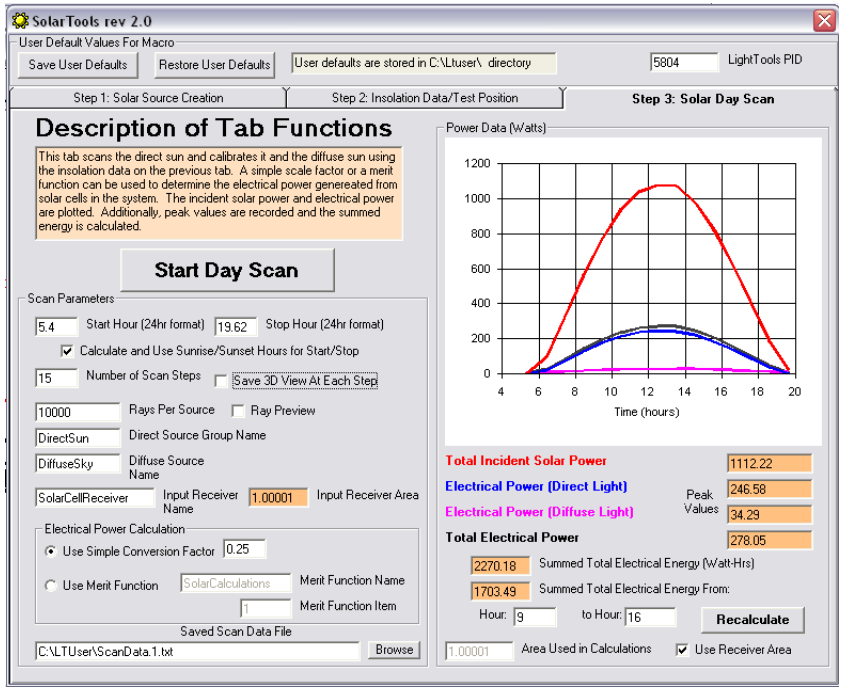


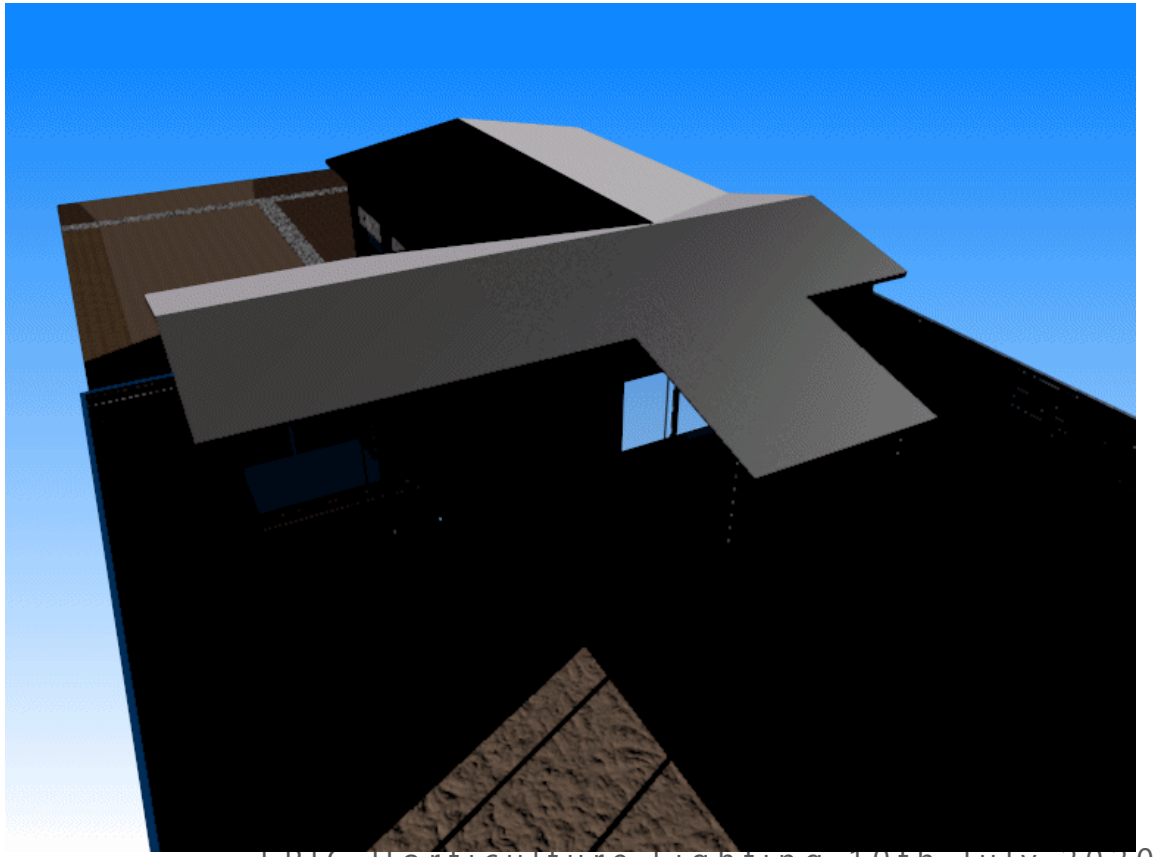




Day Light Simulation

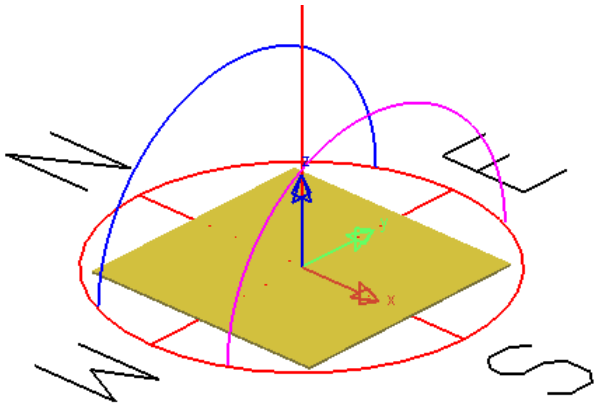


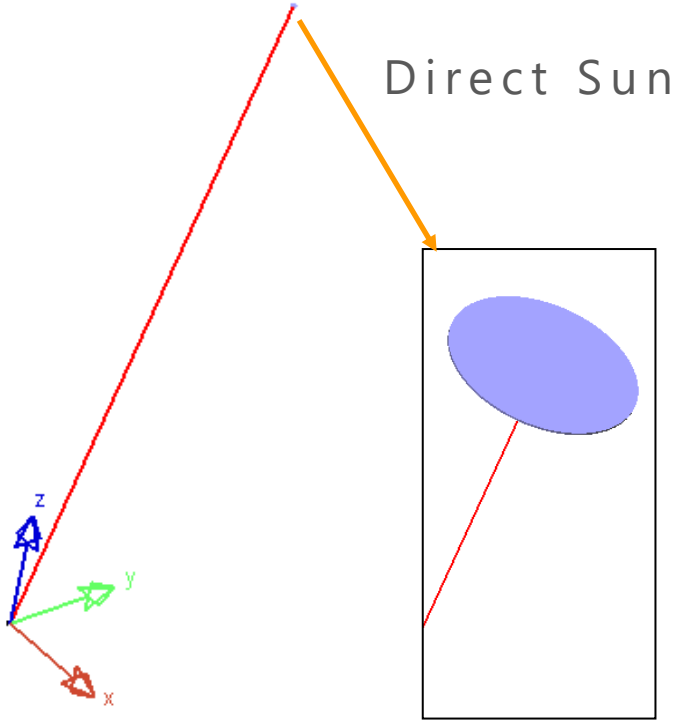




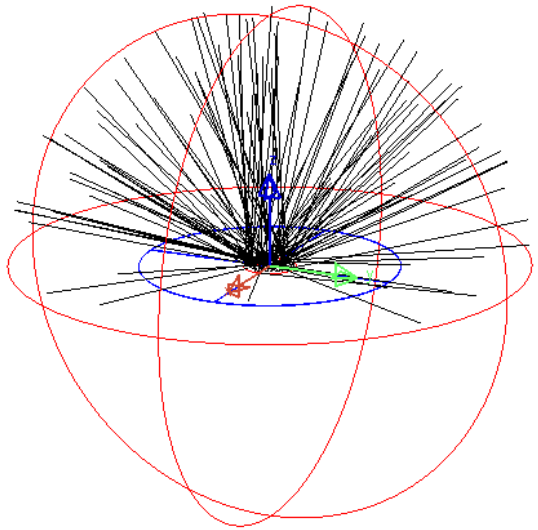
Direct Sun and Diffused Sky

Green House Area



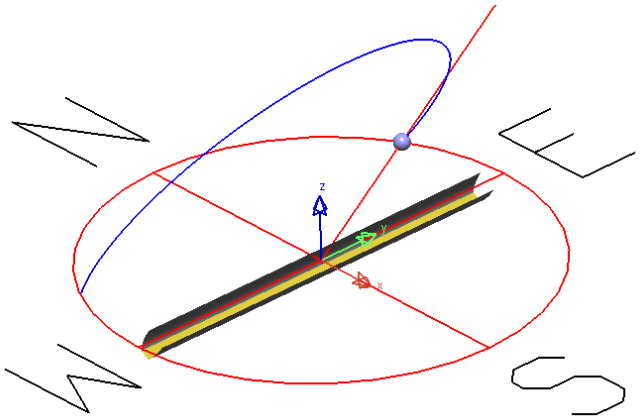


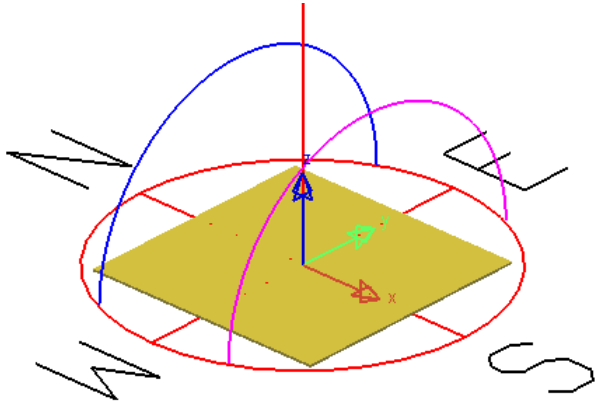
Diffused Sky

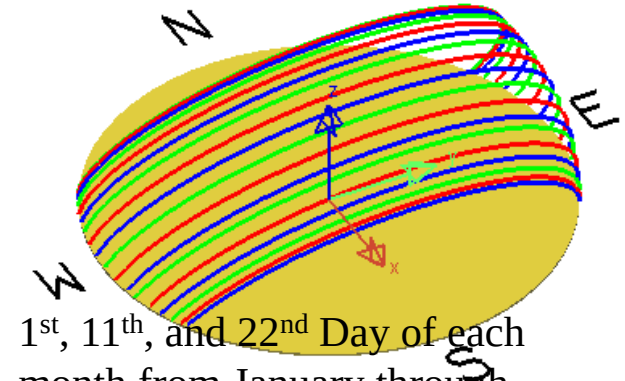


Solar Day path

Scanning for a position on earth, one day of the year , for each hour

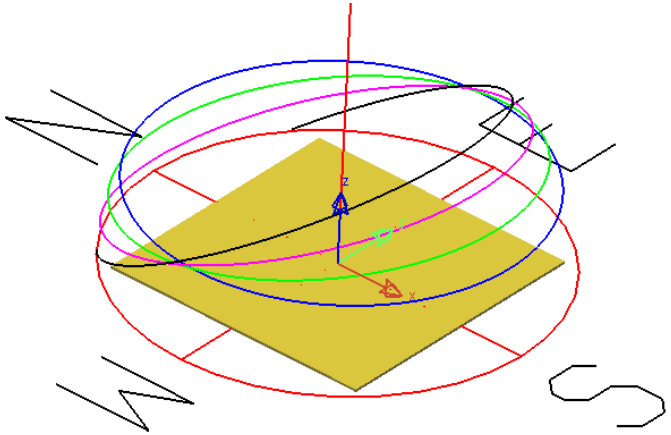






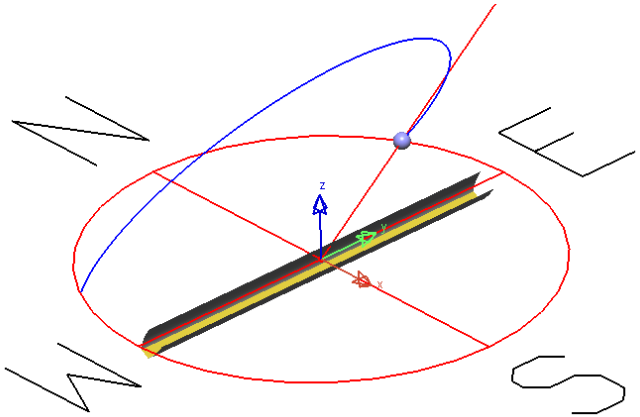
1st, 11th, and 22nd Day of each month from January through June, with alternating colors

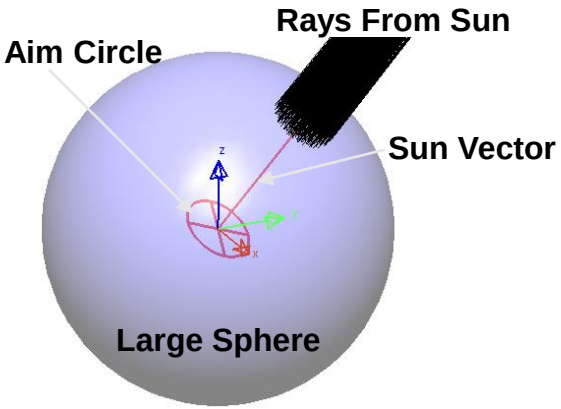
(Phoenix, AZ, latitude: 33.4°)



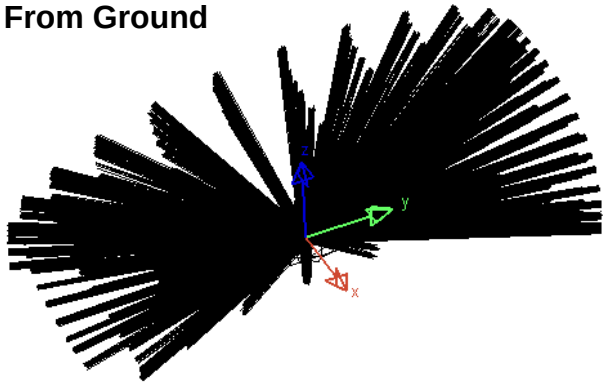
Collection with scan

Possibility to create an « annual source » representing one source for all year/ date/hour

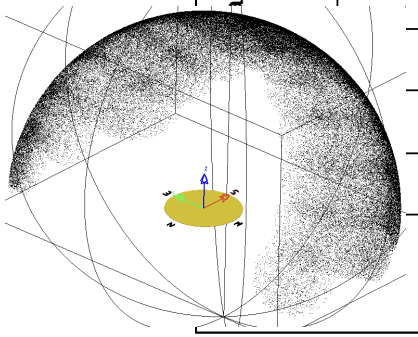




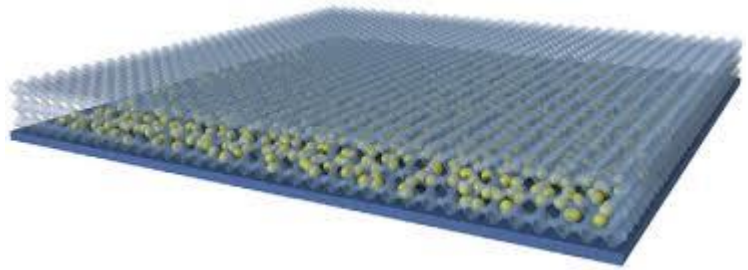
Hourly Ray Bundles From Each Sun Position in Time Band Far From Ground



Sample of ray Intersections from time band source on hemisphere closer to test geometry



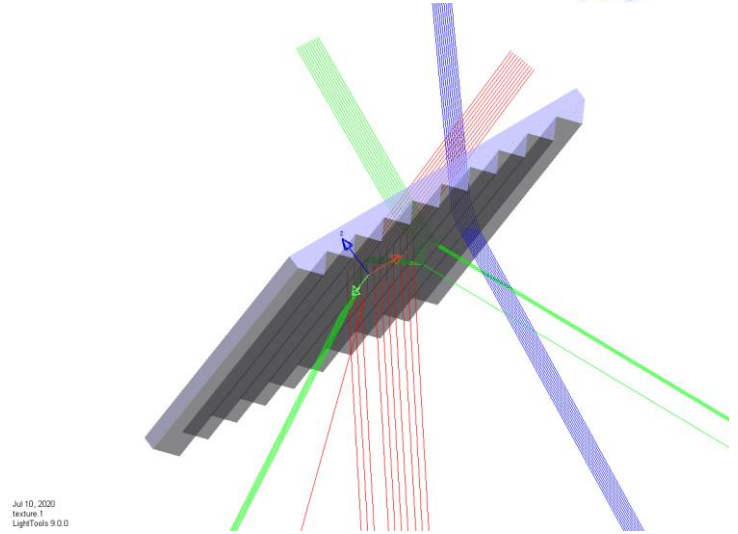
Designing the roof windows



Possibility to set up

- any textures shapes,
- And any layout

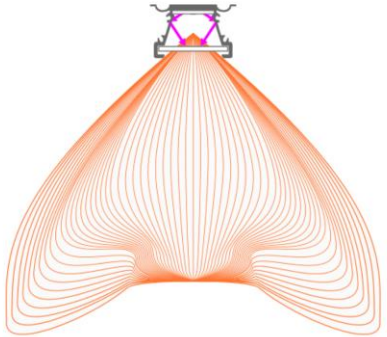
Optimisation possible

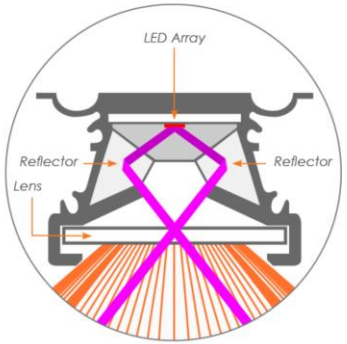


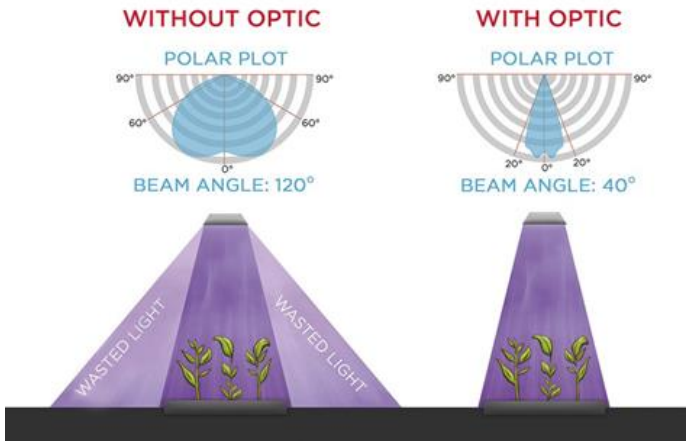
Designing lighting fixtures

Several solutions

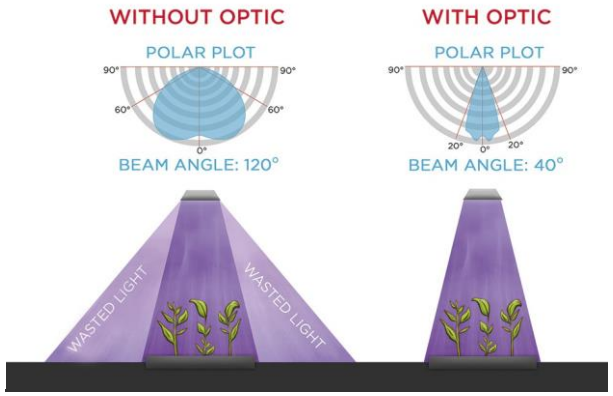
- Leds module directly from vendors
- Reflectors
- Lenses







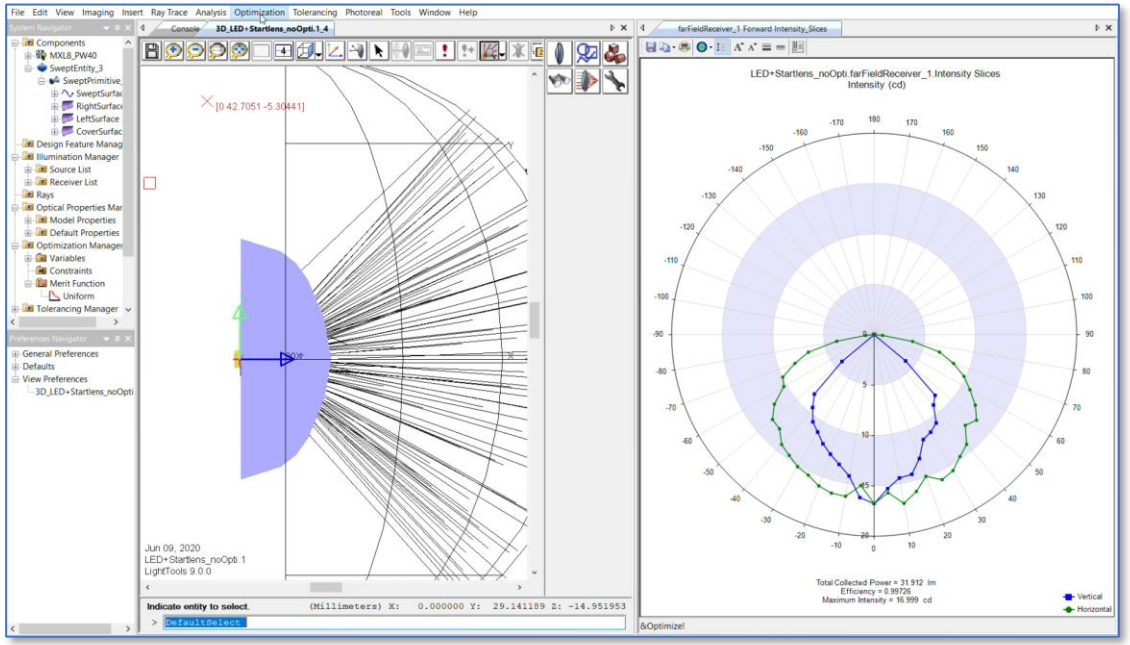
Optimisation of the lighting system with lenses



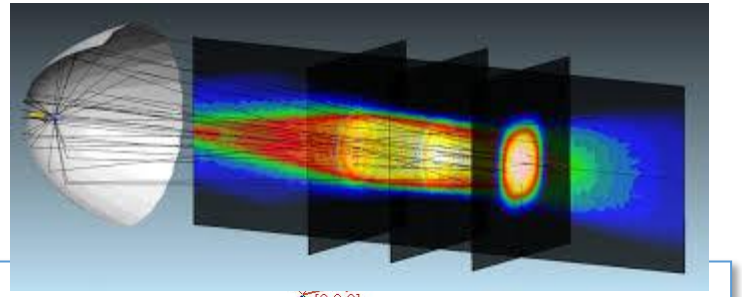
Optimisation of the lens shape:

Optimisation targets :

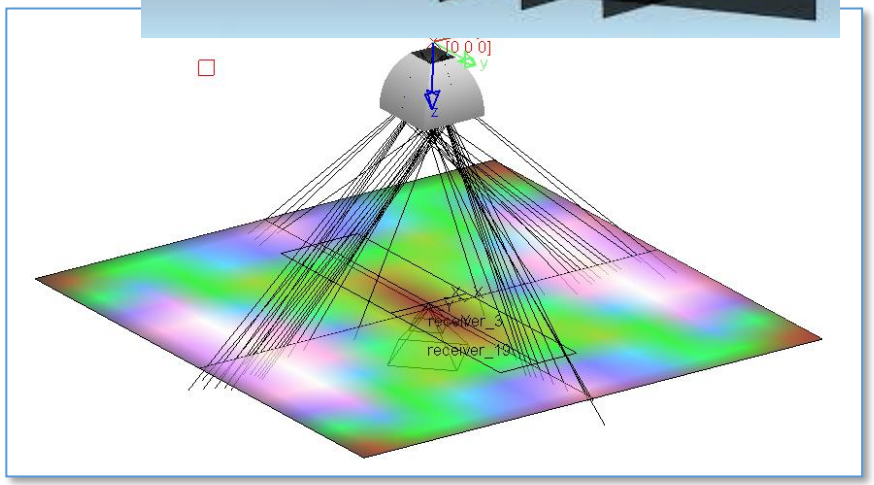
- Photon Flux
- Photon Flux Density
- Efficacy



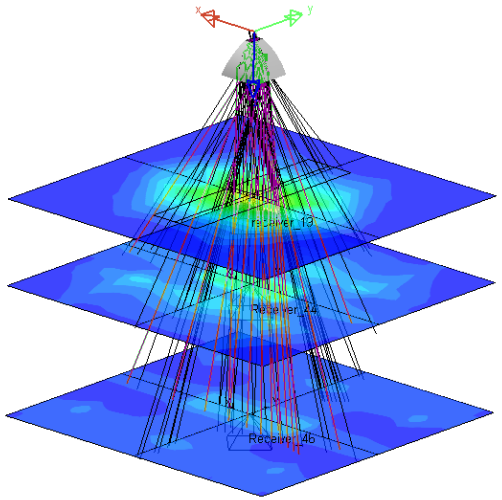
Optimisation of the lighting system with reflector



Before Optimization

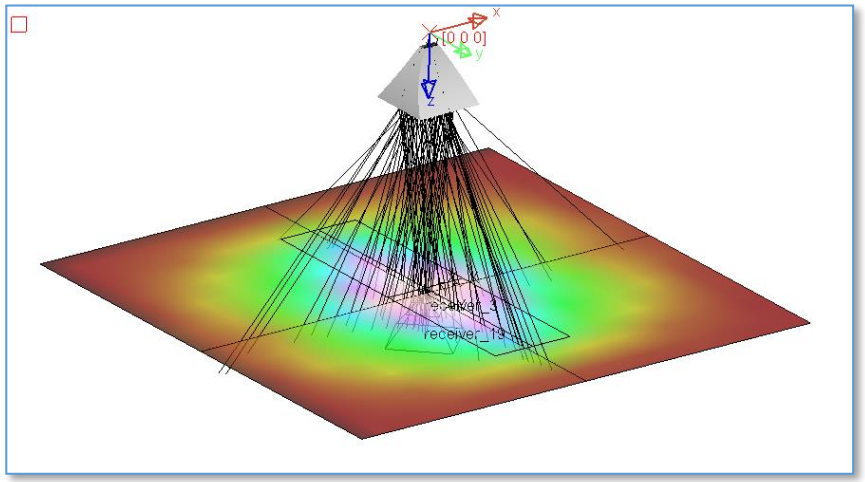


With Light Distribution in one plane or one volume



Jul 08, 2020
RectangularBeziers_Start hortoculture.1
LightTools 9.0.0

After Optimization



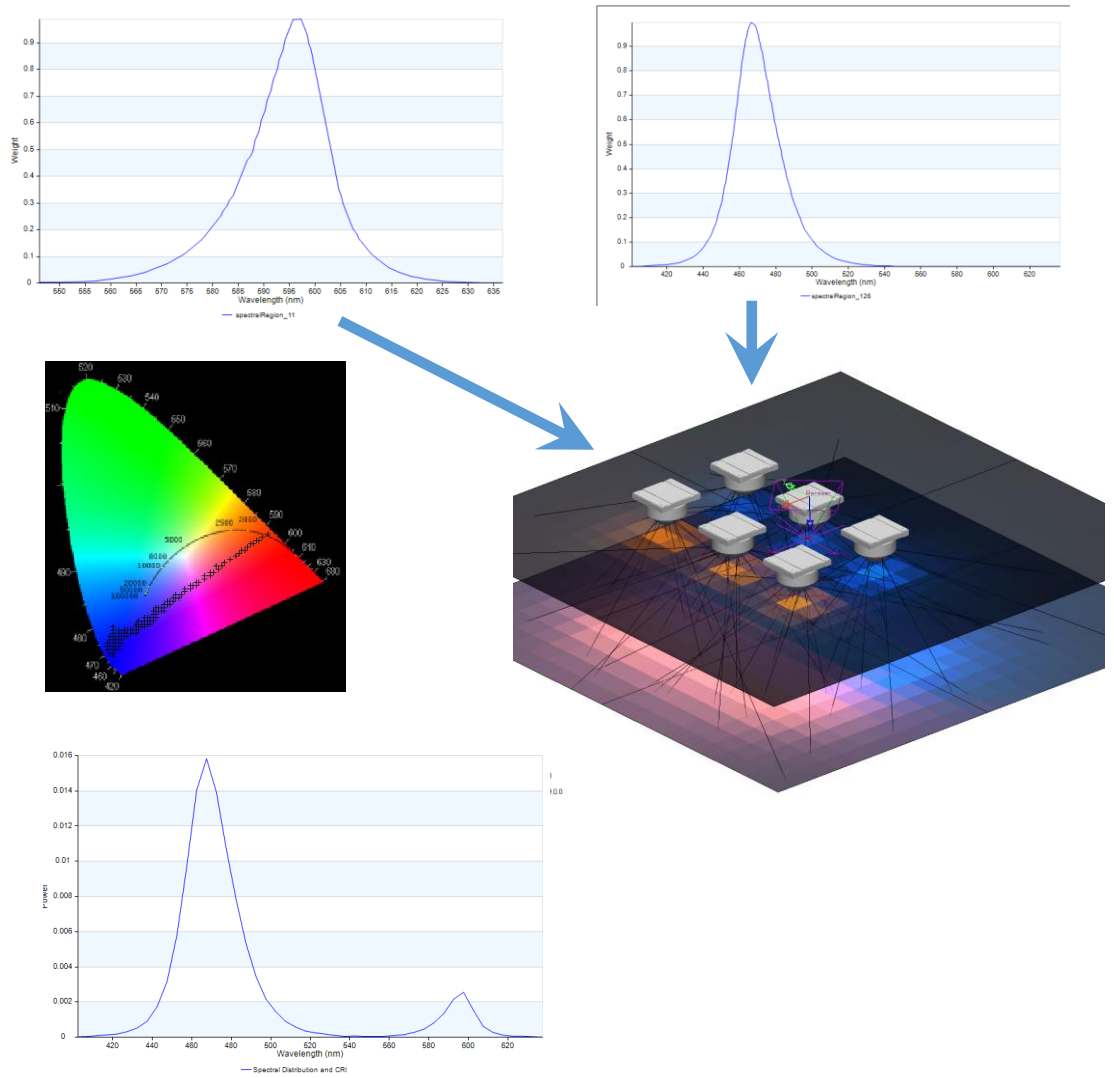
Wavelength Analysis

Spectral consideration:

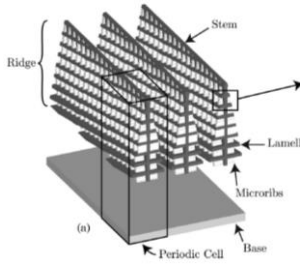
Source

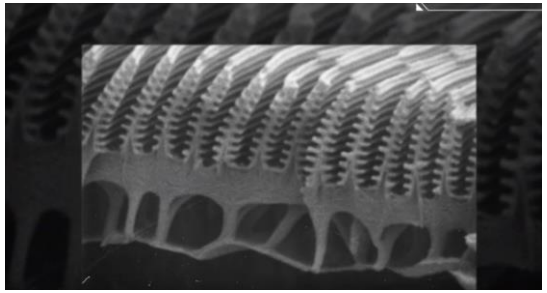
Material (transmissive, reflective)

Spectral distribution in any plane

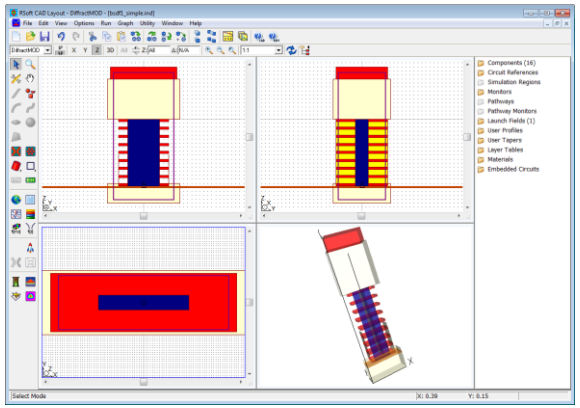


Microstructure RSOFT



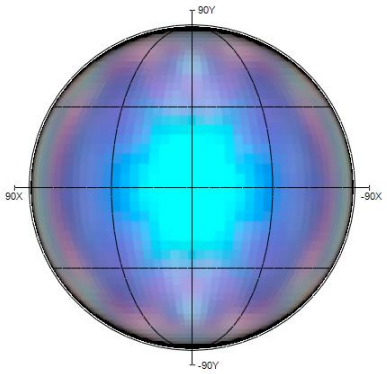


Interaction between light and plants



The iridescent color of the Morpho butterfly is not due to pigments or dye.

It is the result of a complicated nano-patterned photonic structure on the butterfly wing. Rigorous photonic design tools were needed to accurately model the structure



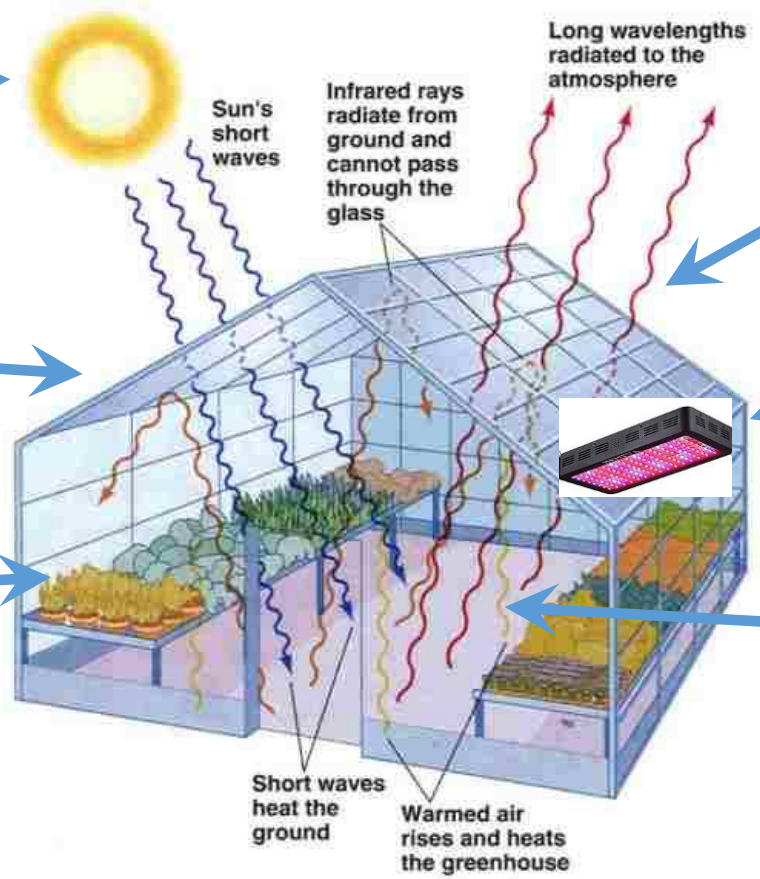
Conclusion: we can do the job !

Infrared Exchange

Sun/Sky Light

Glass Roof

Leave effect



Lighting fixtures

Efficacy


THANK YOU

What we are looking for

- **More customers for our software !**
- **Partnership with material vendor**
  - Plastic
  - Glasses
- **Partnership with research laboratories**
  - Interaction light/plants
- **We can offer optical engineering tasks if needed**

More information

There is a popular misconception that plants utilize only the blue and red wavelengths. As seen in the above figure outlining the McCree curve, **the type of light that plants use also includes green and yellow radiation**.

The most abundant plant pigment involved in photosynthesis, chlorophyll, is most efficient at absorbing blue and red light. Therefore, most of the green light is not absorbed and is reflected by plants, giving leaves their characteristic green-colour. However, plants have other pigments called accessory pigments that include carotenes and xanthophylls. These **accessory pigments are able to absorb green light**.

Also, plants have physical responses to different types of light. **Photomorphogenesis are structural changes that take place in response to changes in the environment, such as variations in light exposure**. Below are some examples of the changes that can be induced by modulating the type of light that plants receive:

400 nm – 520 nm Blue Light can inhibit development if not combined with other types of light and can promote leaf thickness. Also chlorophyll absorbs wavelengths in this range.

500 nm – 600 nm Green Light penetrates deep and is absorbed more deeply into lower parts of the canopy.

630 nm – 660 nm Red Light influences germination, seed formation and plant flowering.

720 nm – 740 nm Infrared Light can promote early flowering, also enters more deeply into lower parts of the canopy.