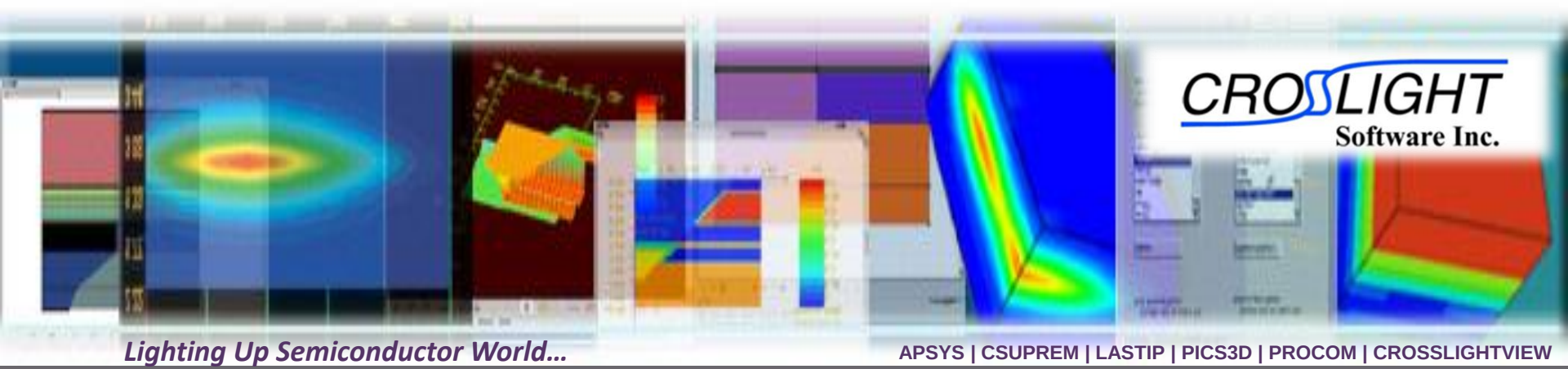


Raytracing Simulation of Phosphor Coated LED

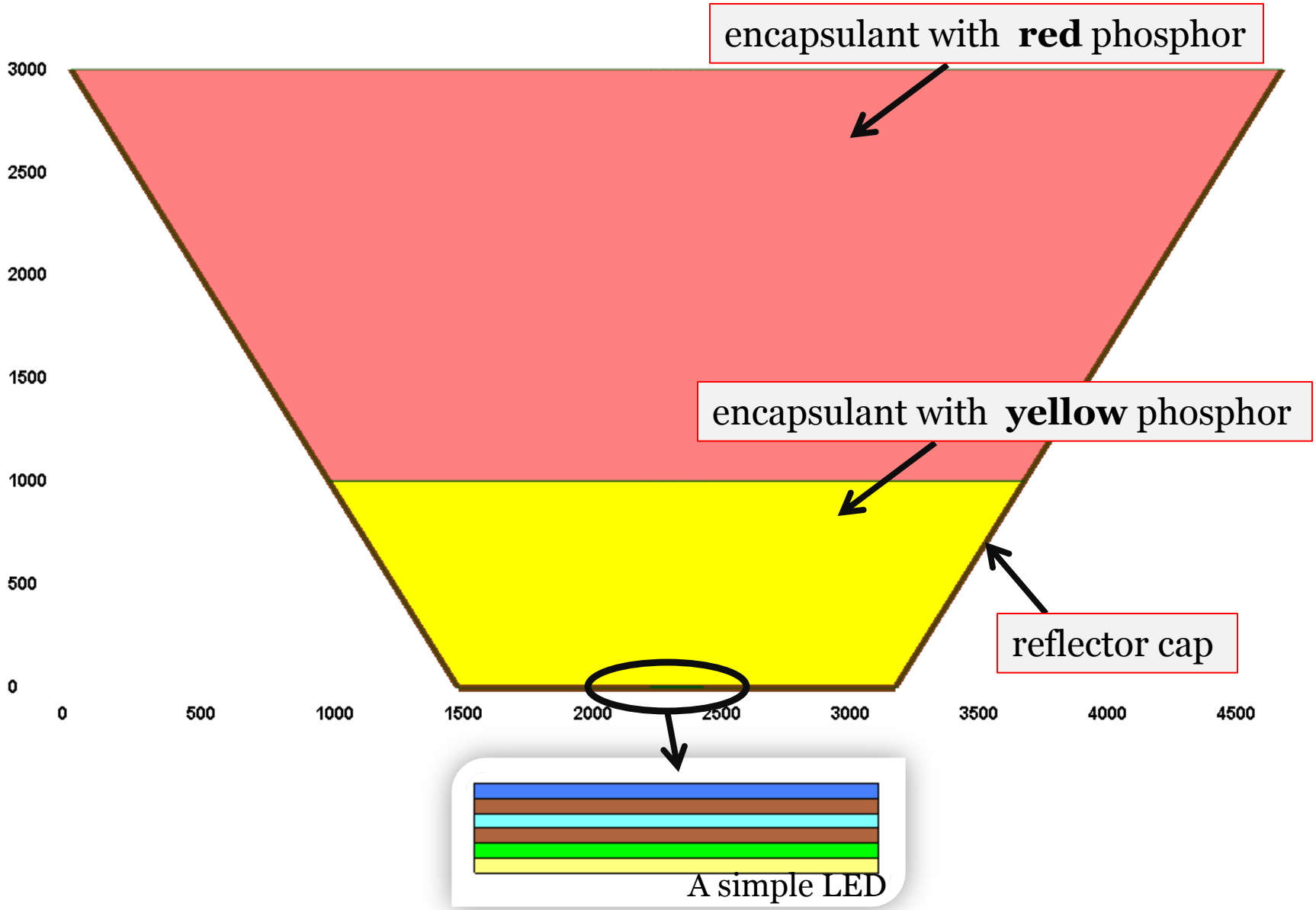
© 2011 - Crosslight Software Inc.

Content

- Structural Configuration
- Primary and secondary (re-emission) raytracing settings
- Results

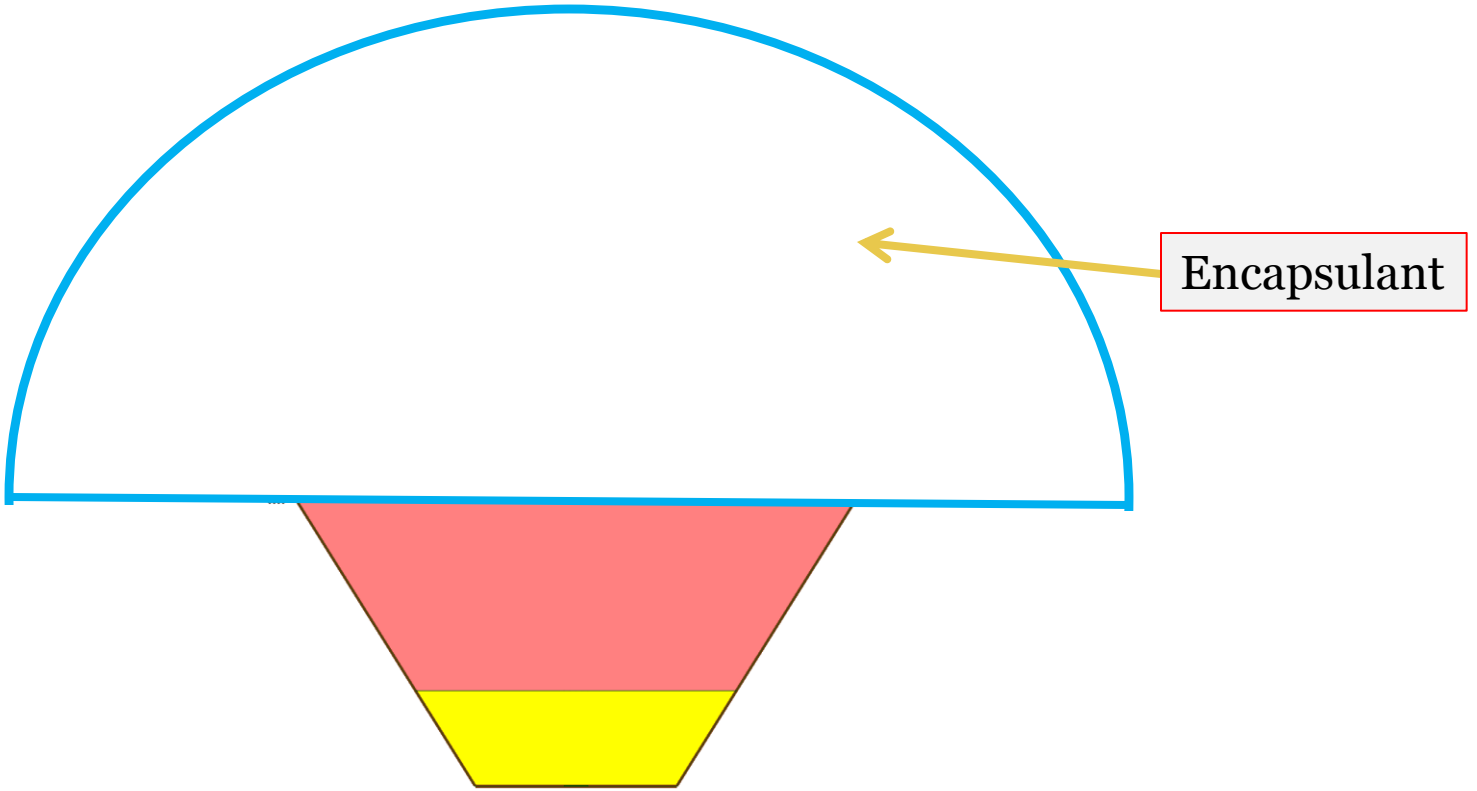
© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Structural Configuration



© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Structural Configuration



© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Simulation Procedures

1) Start an LED emission ray trace at a single wavelength in blue. Record absorbed power density profile in phosphor material.

2) Convert the absorbed power density profile to re-emission power density profile.

3) Perform re-emission ray trace for all wavelengths in the emission spectrum of the phosphor material.

4) Set a different LED blue emission wavelength and repeat 1) to 3).

5) Sum up all the blue emission and red/yellow re-emission data and obtain the final emission spectrum of the phosphor coated LED.

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

LED Emission Source in Blue

- Ray trace program puts some emission source points on LED quantum-well plane according to APSYS LED simulation.
- Spectrum of blue emission comes from APSYS simulation. Alternatively, it can be taken from experimental measurement.

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Re-Emission Source

- First, profile of absorbed power density is recorded in the encapsulant with phosphor.
- Next, the power density profile is converted to a re-emission source according to the quantum efficiency (QE) spectrum of the phosphor.
- Phosphor QE & re-emission spectrum are obtained from experimental measurements.

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Ray Trace Settings

Index(n,k) for LED emission ray trace

Material	Refractive Index,*n*	Absorption[/mm]
Encapsulant	1.5	0
Encapsulant+ yellow phosphor	1.65	6
Encapsulant +red phosphor	1.65	3
InGaN	2.42	8
GaN	2.42	8

Index spectrum is also supported by ray trace program.
Here, we set fixed index for simplicity.

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

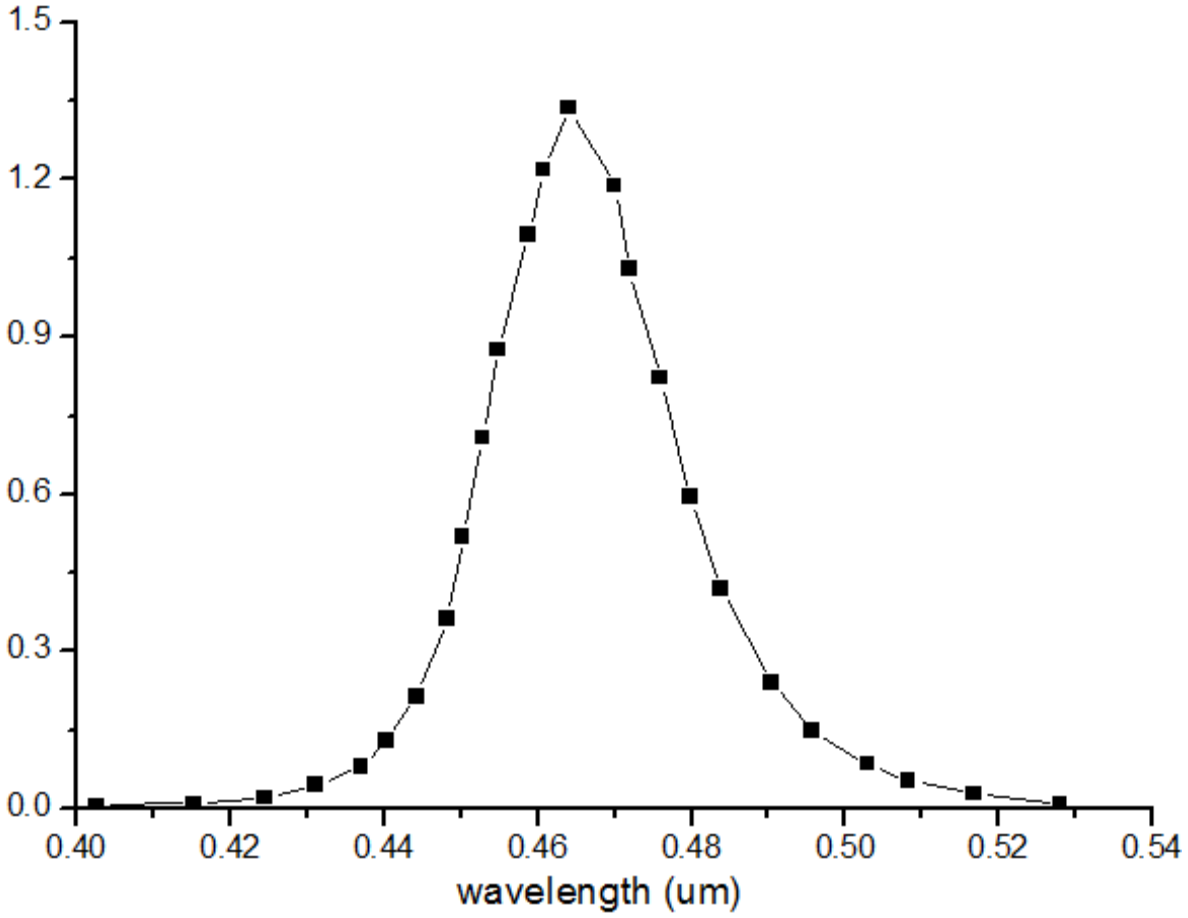
Ray Trace Settings

Index(n,k) for re-emission ray trace

Material	Refractive Index,*n*	Absorption[/mm]
Encapsulant	1.5	0
Encapsulant+yellow phosphor	1.65	0
Encapsulant+red phosphor	1.65	0
InGaN	2.42	0
GaN	2.42	0

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

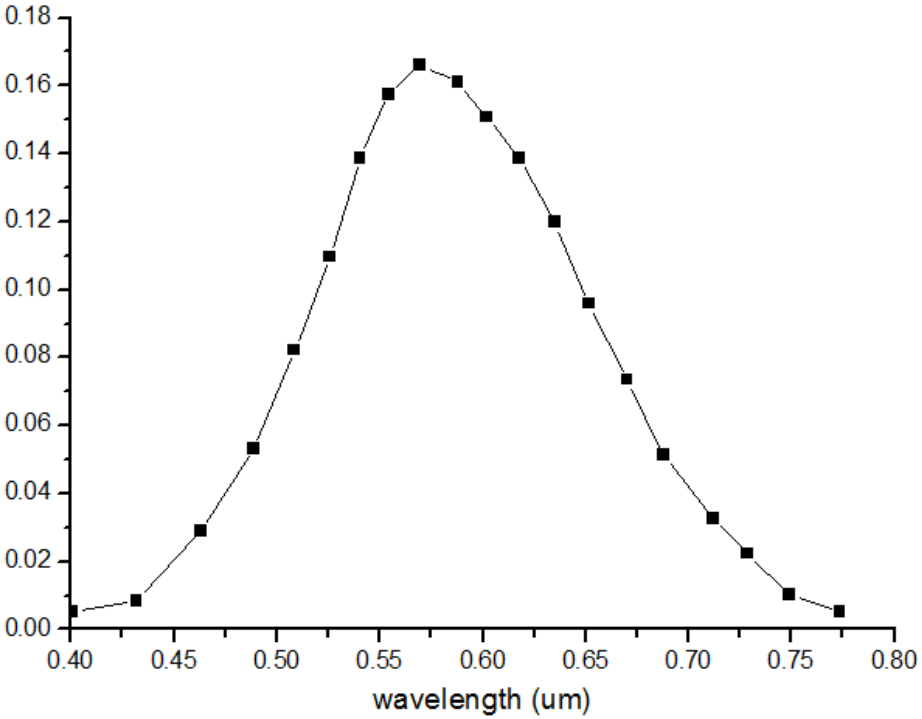
Ray Trace Settings

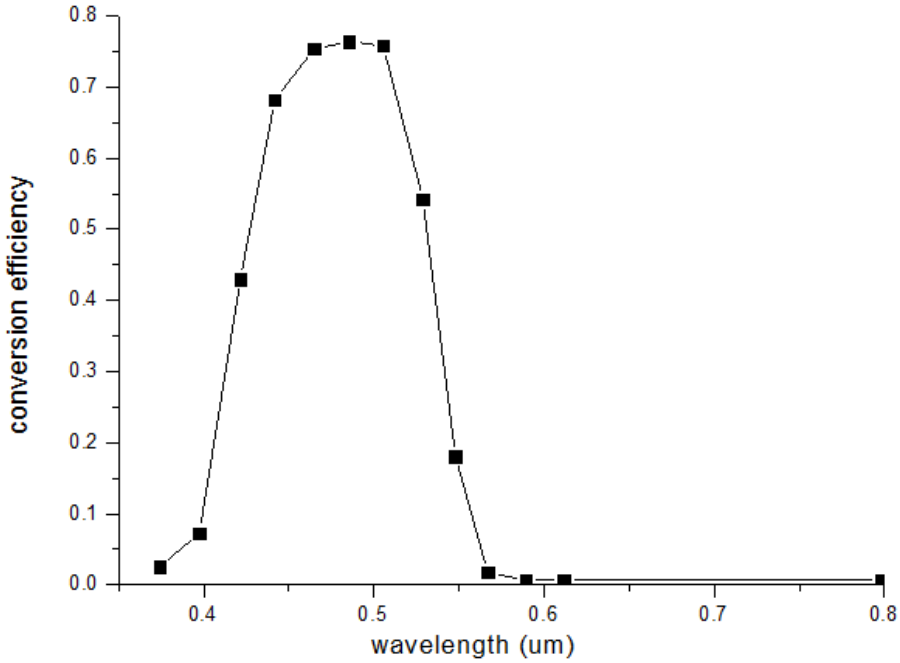


LED emission spectrum

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Ray Trace Settings

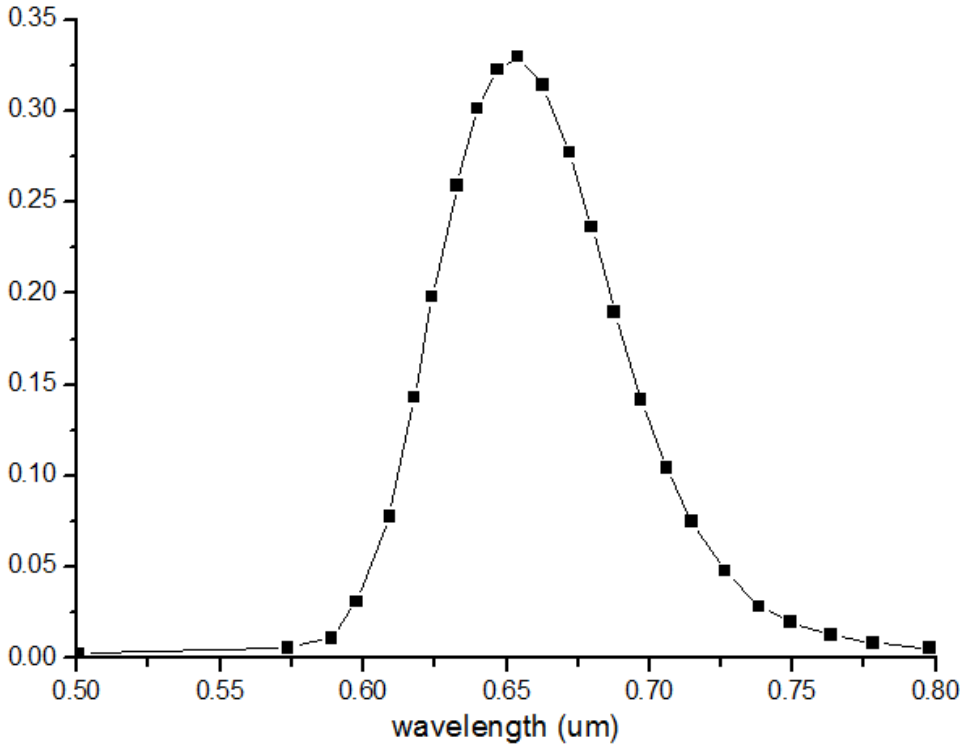


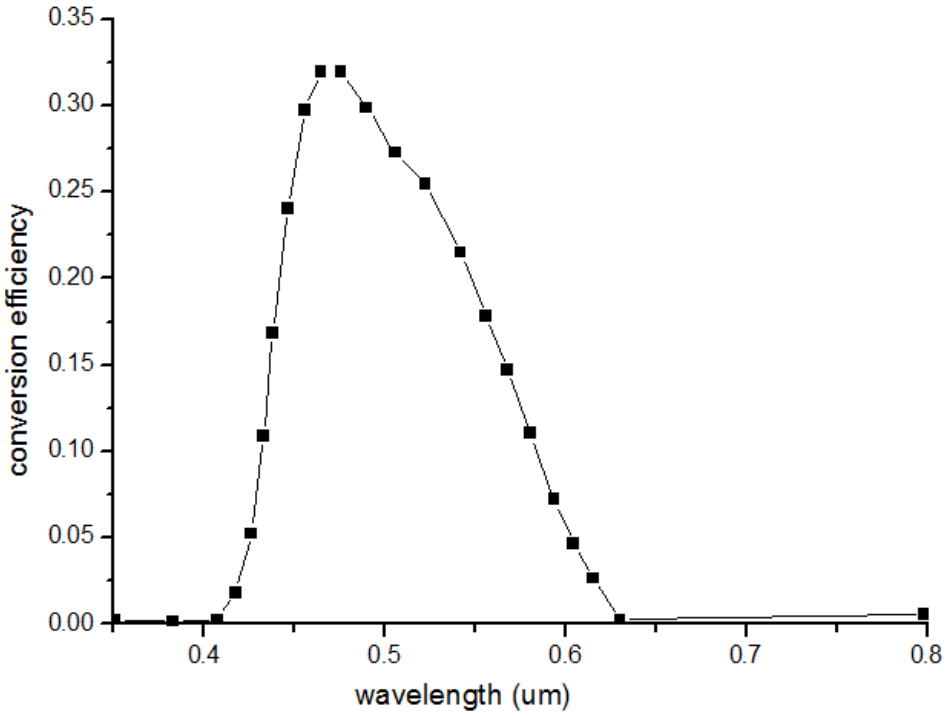


Emission spectrum and Conversion efficiency of **yellow** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Ray Trace Settings

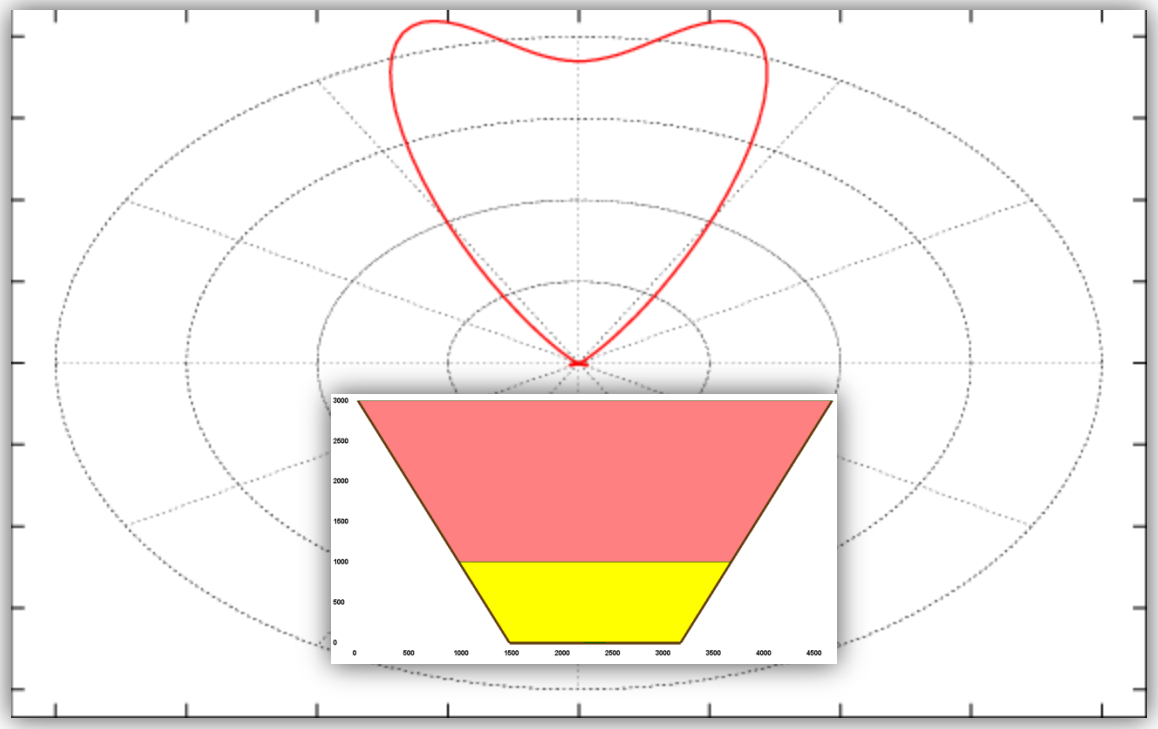




Emission spectrum and conversion efficiency of **red** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

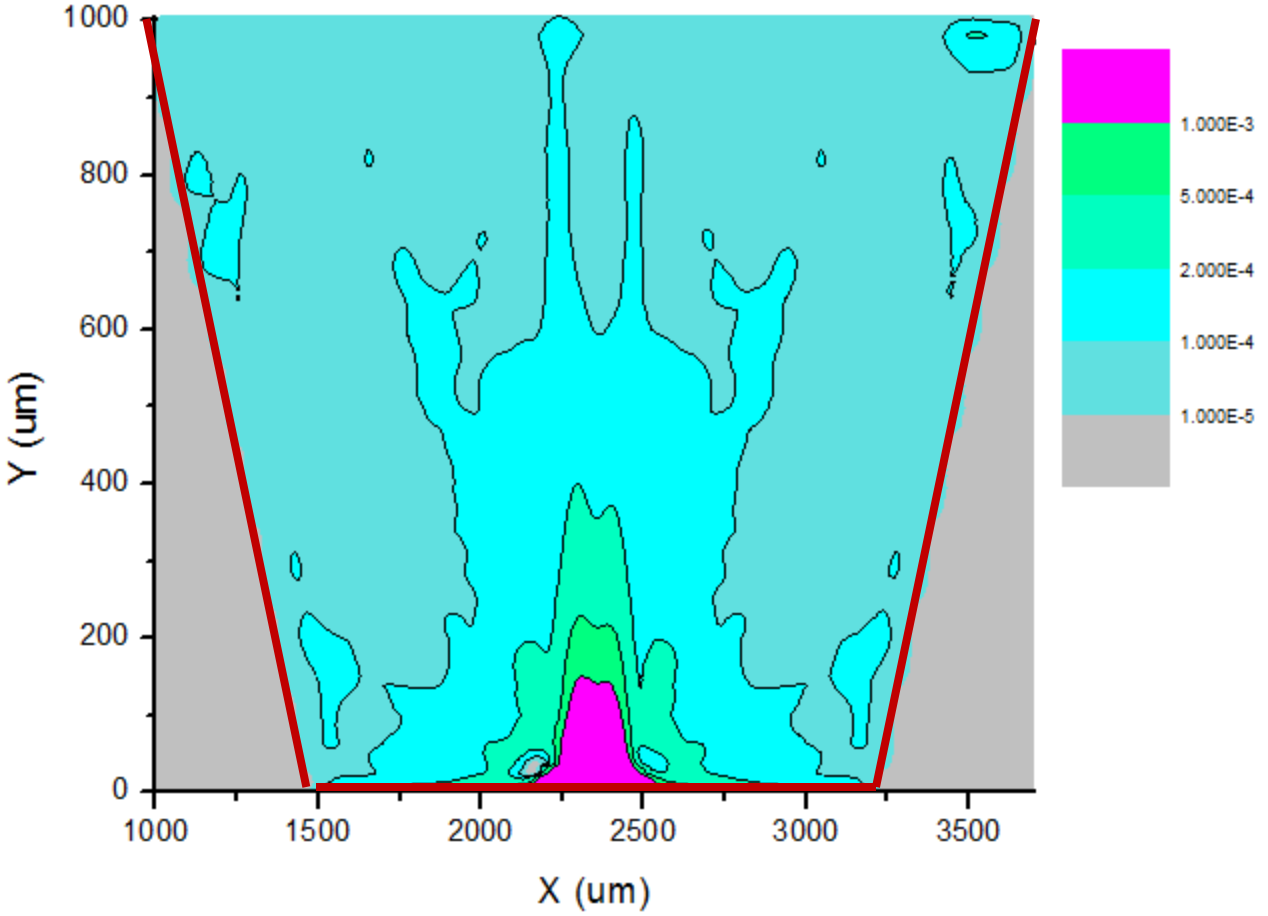
Results



Angular distribution of transmitted power after LED emission ray trace

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

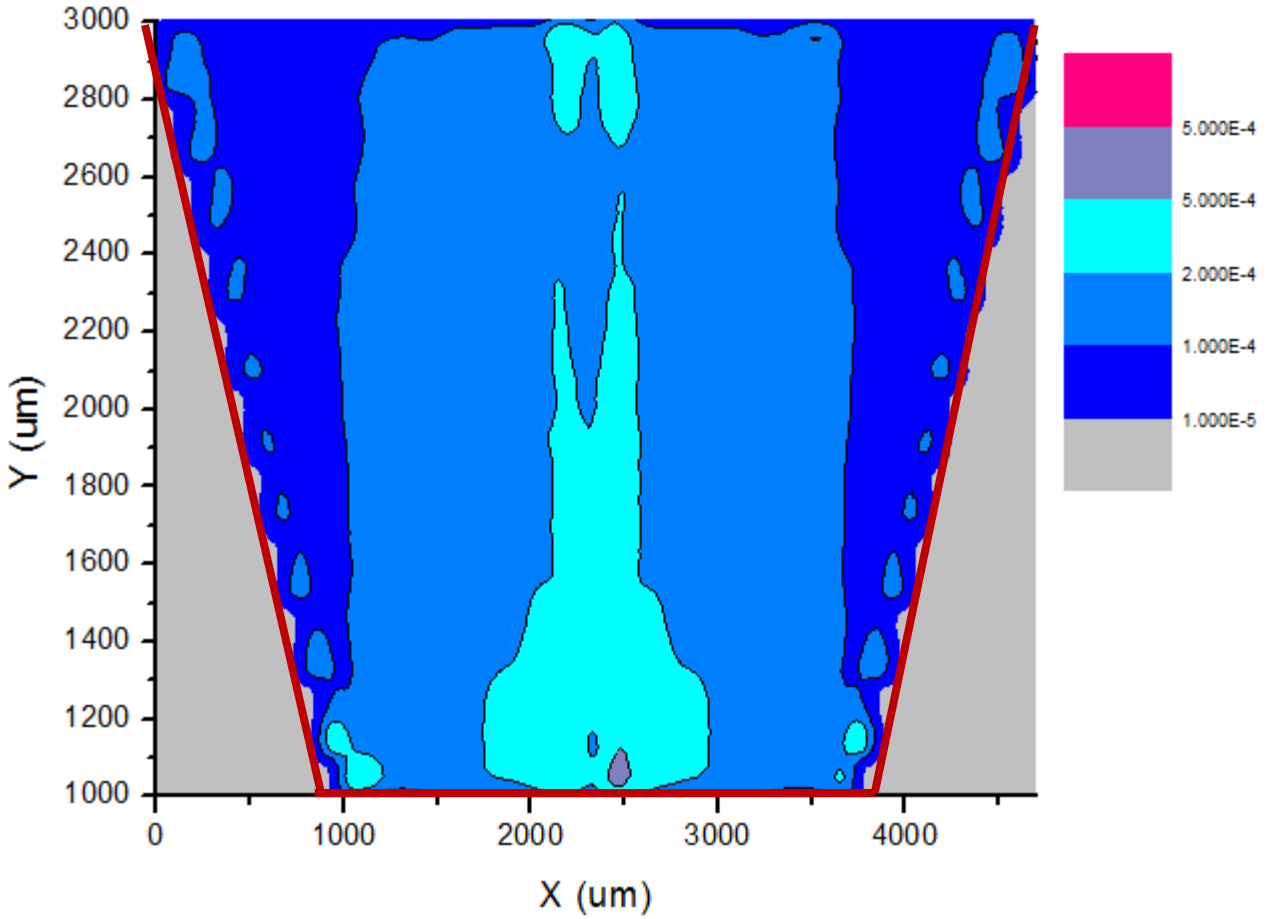
Results



A profile of absorbed power density in **yellow** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

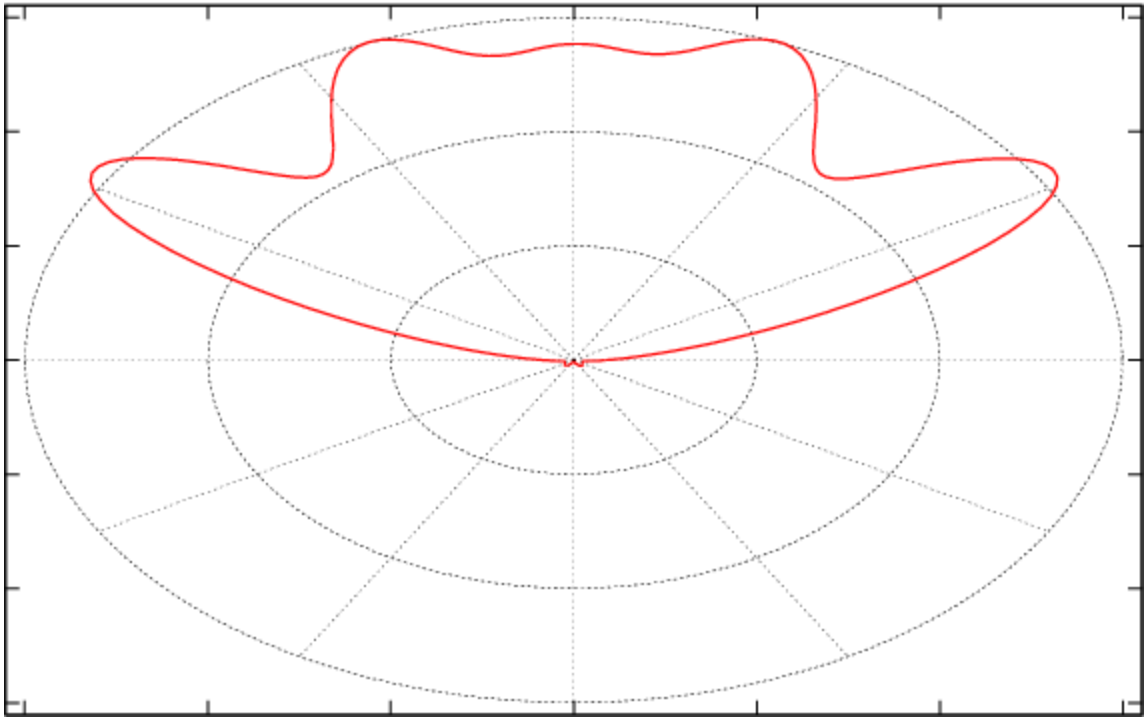
Results



A profile of absorbed power density in **red** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

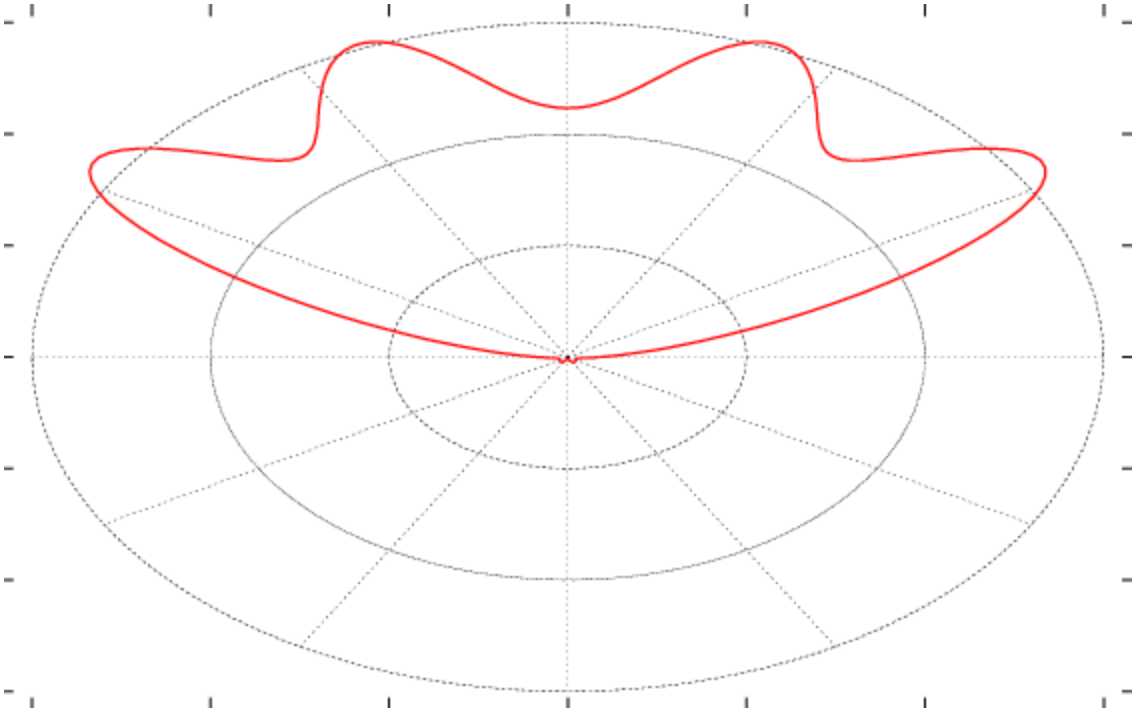
Results



A spatial distribution of transmitted power after re-emission ray trace for **yellow** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

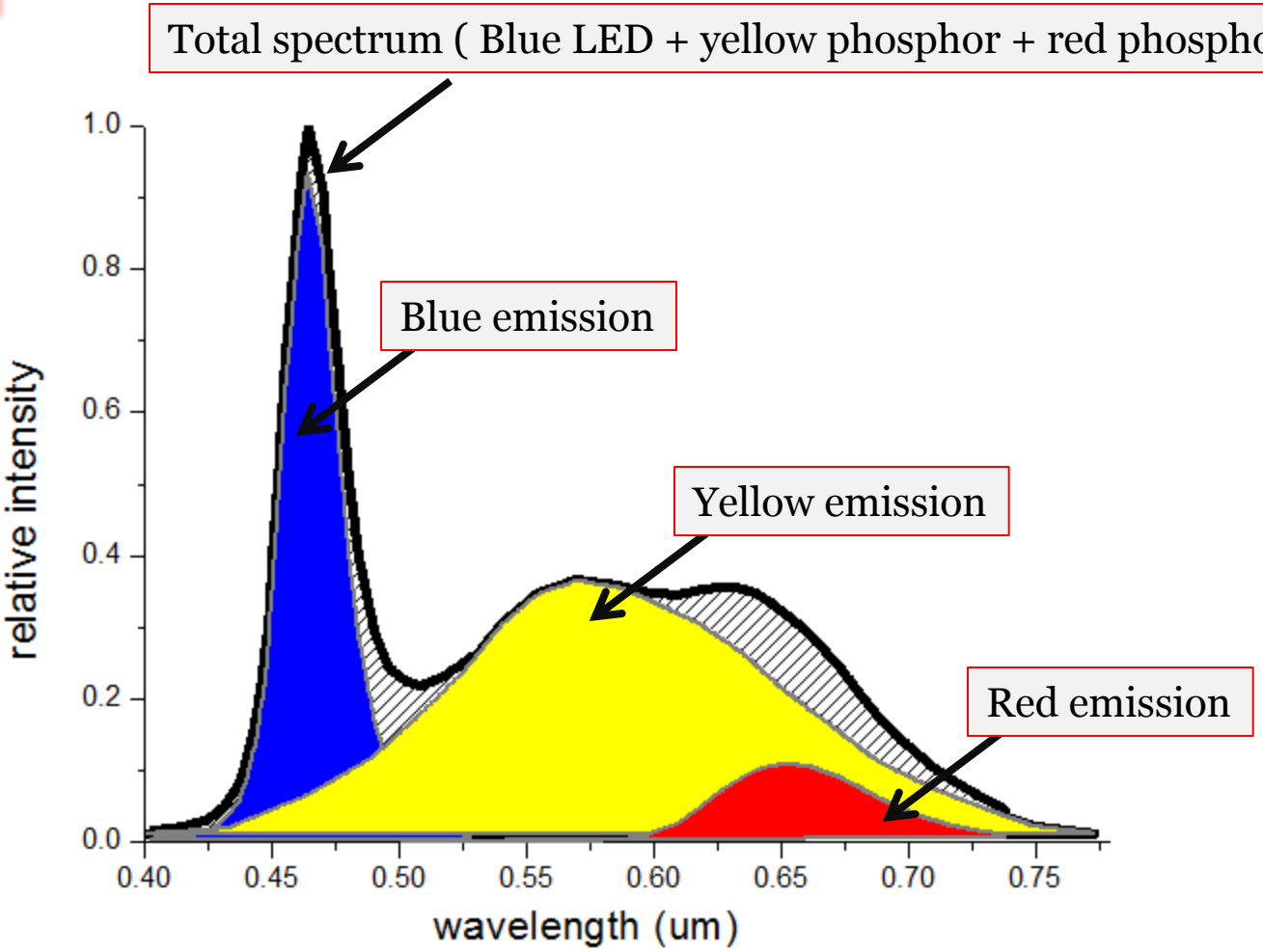
Results



A spatial distribution of transmitted power after re-emission ray trace for **red** phosphor

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Results



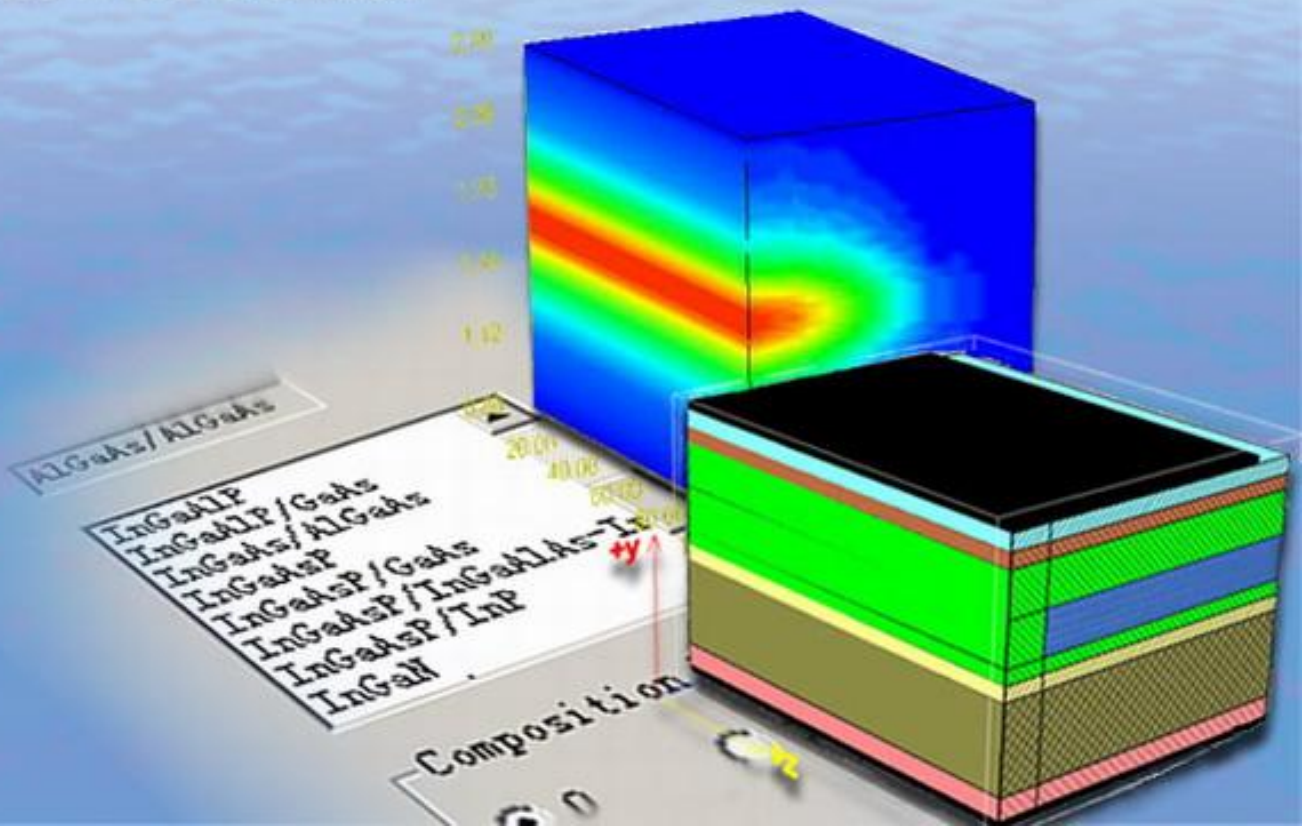
Total transmitted light power spectra

© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com

Creators of Award Winning Software

CROSSLIGHT

Software Inc.



© 2010 Crosslight Software, Inc., Burnaby, BC, Canada www.crosslight.com