Towards a Brighter Future: Laser-based White Lighting

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CHANGING WHAT'S POSSIBLE

MATERIALS RESEARCH LABORATORY

the innovation engine for new materials

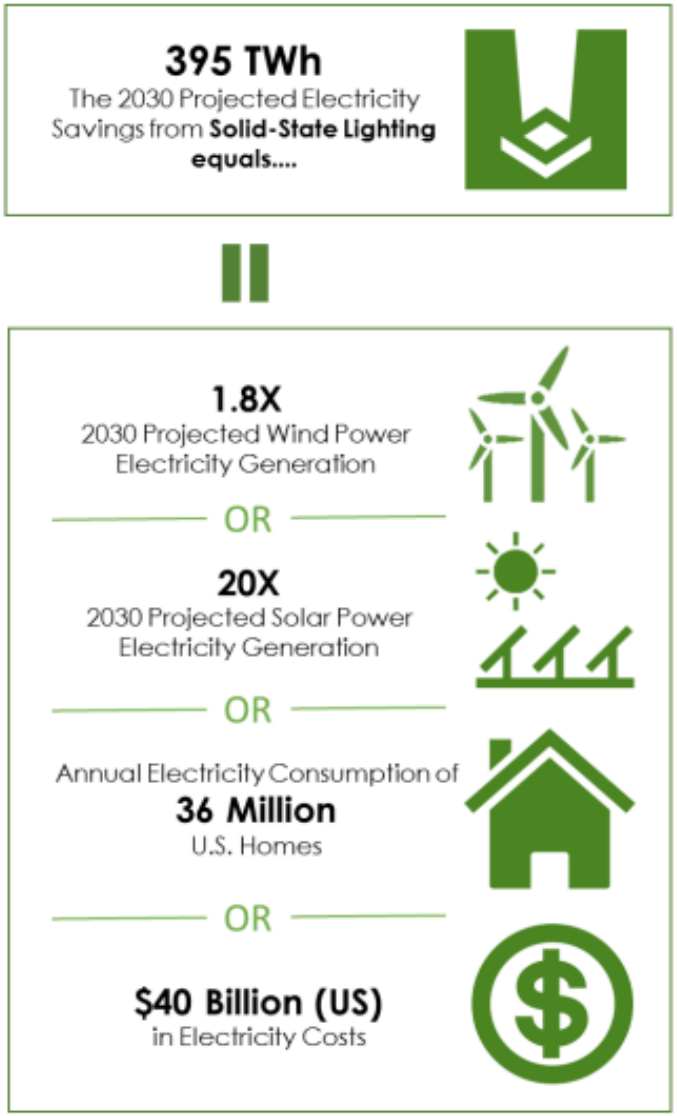
UC Santa Barbara

LEDs and lasers offer huge energy savings

LEDs show the many successes of solid-state lighting; lasers are next!

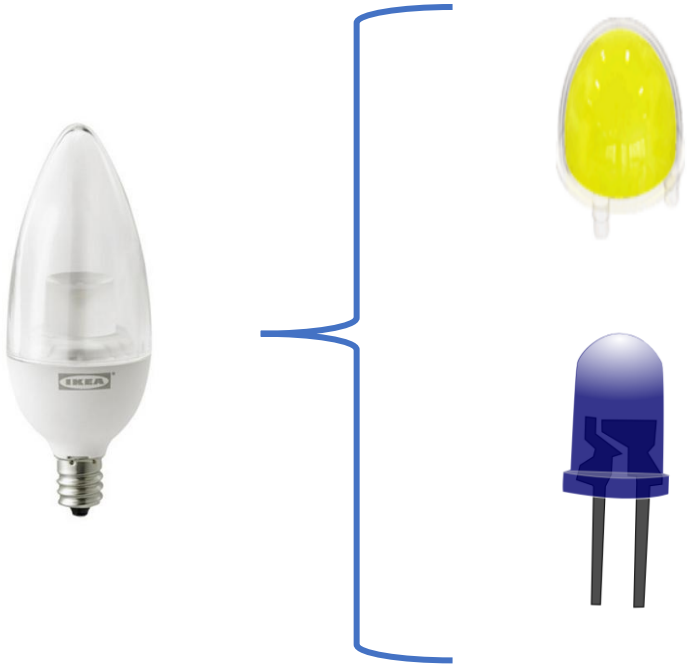
Advanced Research Projects Agency Energy (ARPA-E) is funding UCSB to integrate lasers into white-light sources

I develop optical models to screen lasers for color and brightness



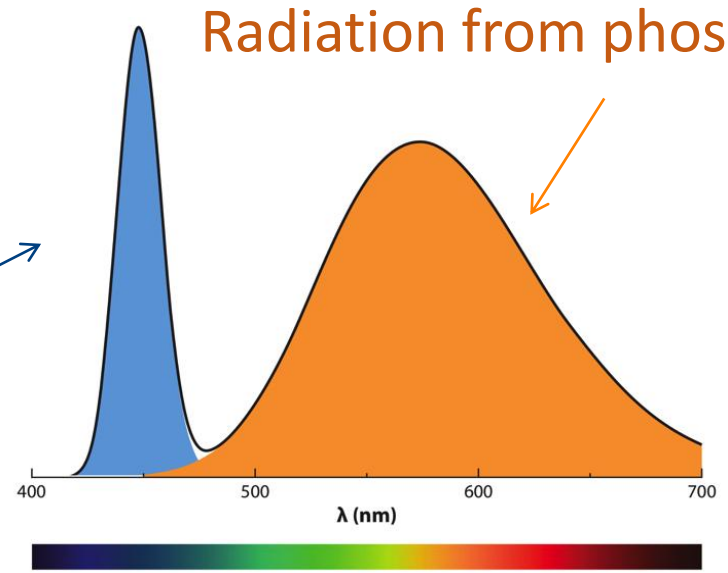
Solid state lighting projection by DOE, May 2015

Current lighting: LED and phosphor combo



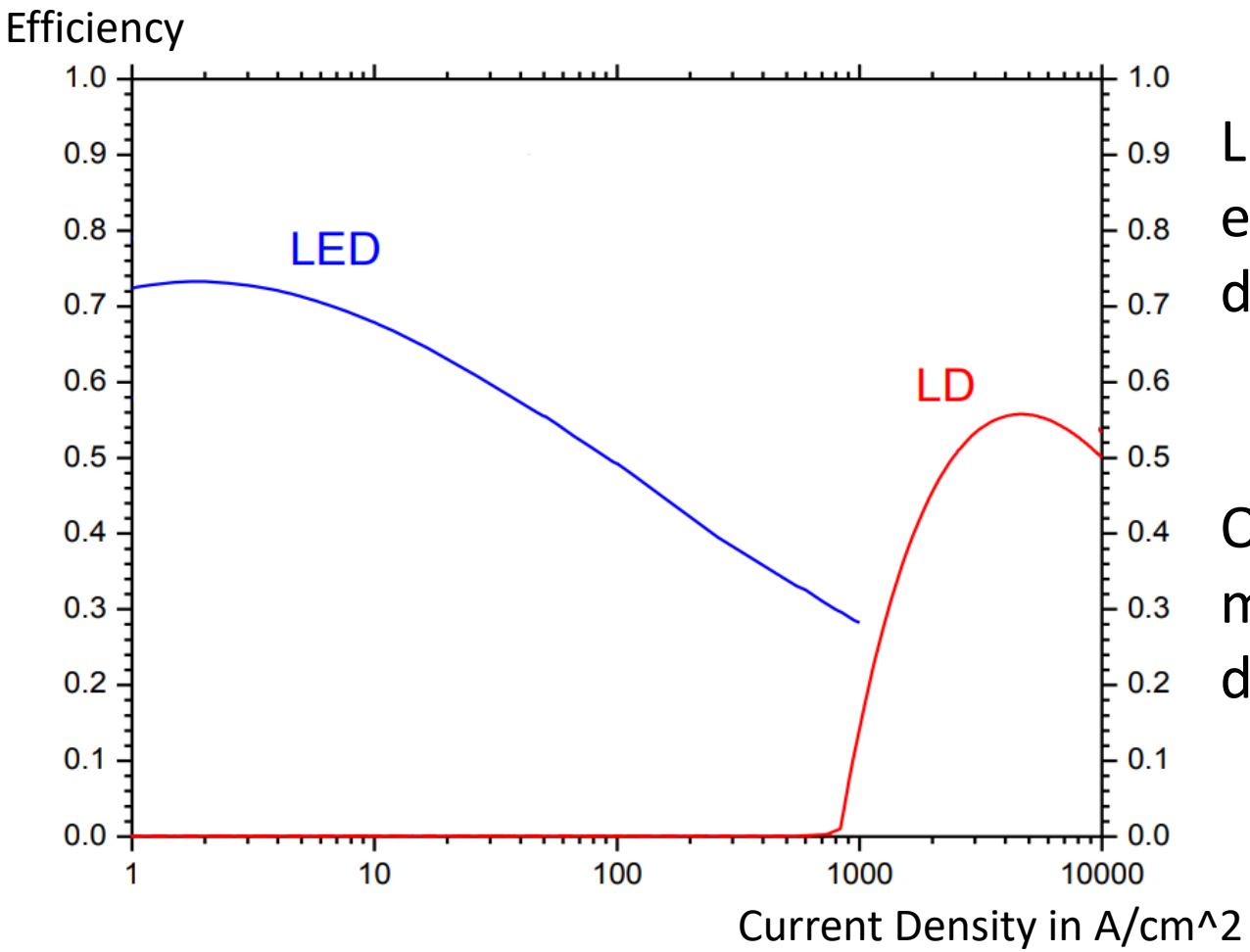
Phosphor converts color of LED emission to cover visible spectrum

LED converts electricity to light



N. C. George, K. A. Denault, R. Seshadri, *Annu. Rev. Mater. Res.*, **2013**, *43*, 481.

Laser advantage at high output powers

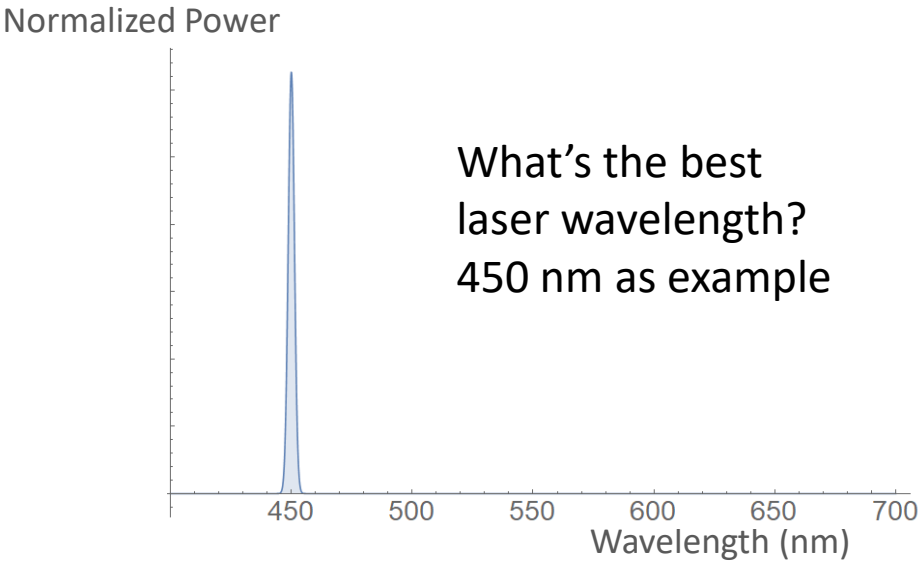


LEDs suffer from efficiency droop; lasers dominate high powers

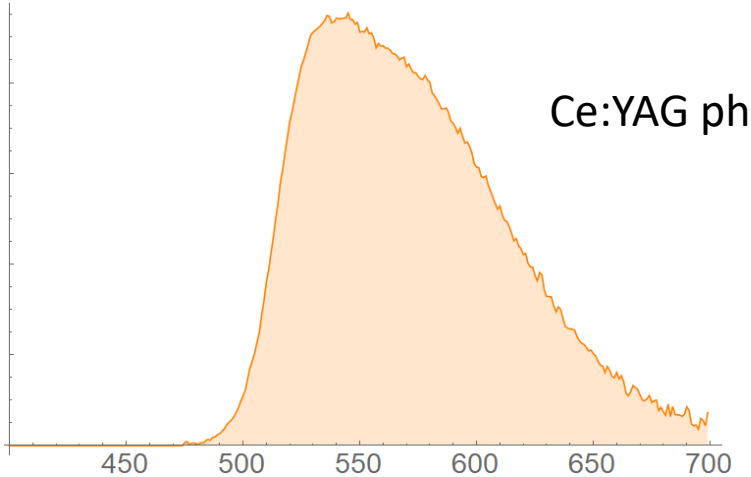
Opens up whole new markets of high-power devices!

Adapted from Joachim Piprek's *Comparative analysis of efficiency limitations* NUSOD 2016 conference paper

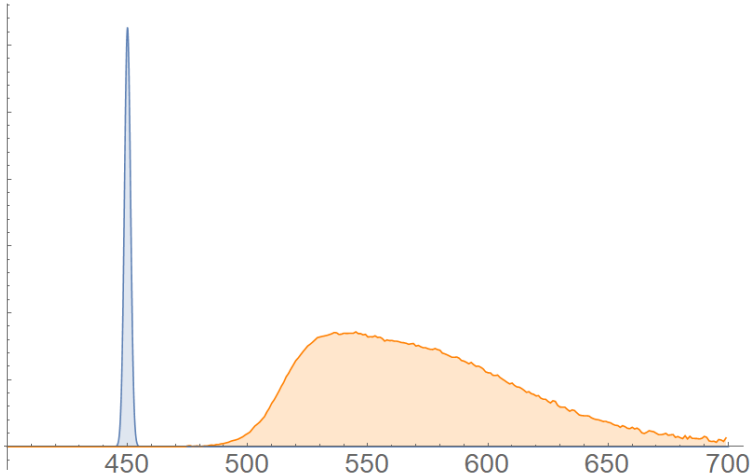
Laser and phosphor spectra



What's the best laser wavelength?
450 nm as example

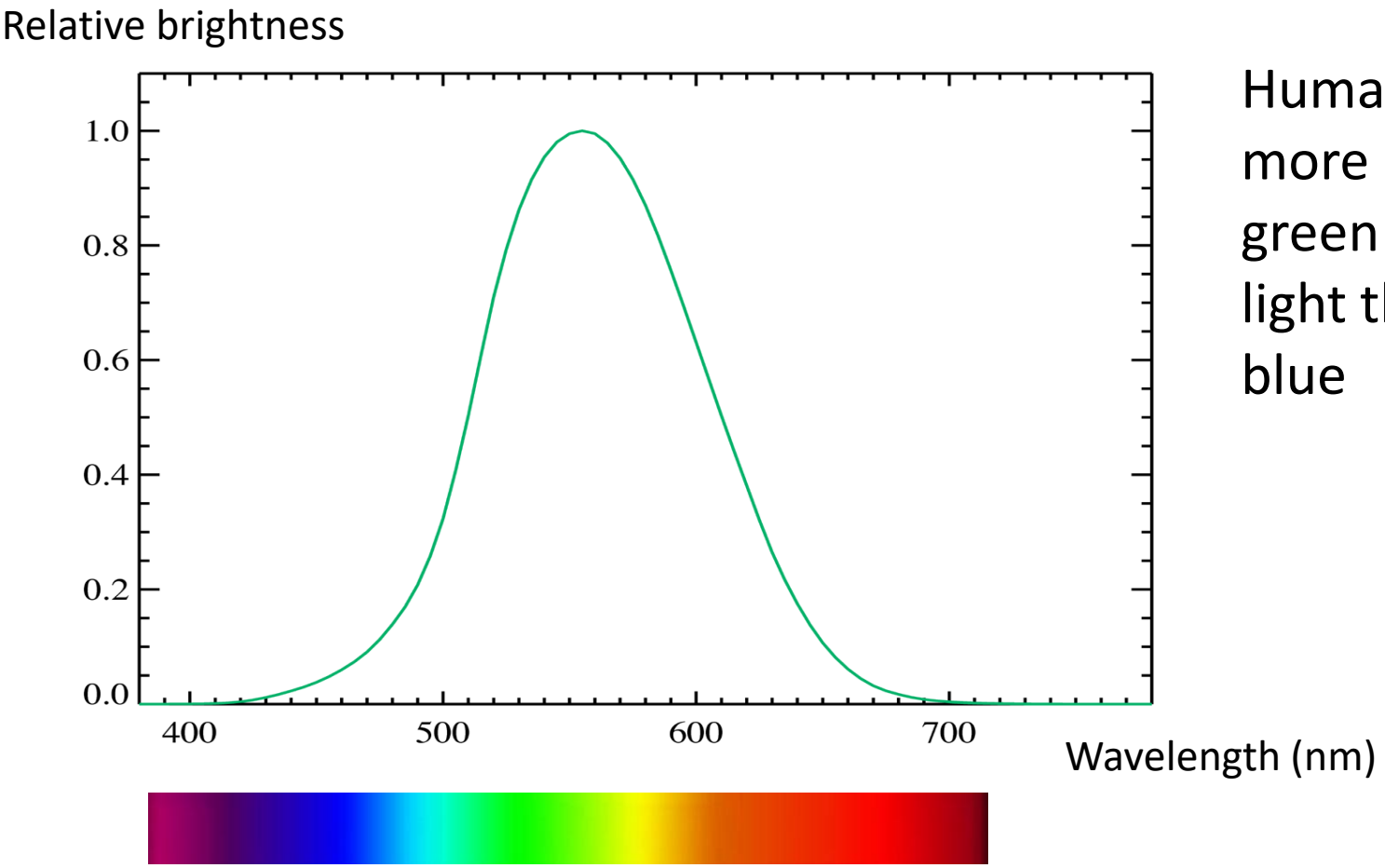


Ce:YAG phosphor



I parametrize final spectrum by how much laser light the phosphor absorbs

The eye response function: color picks brightness

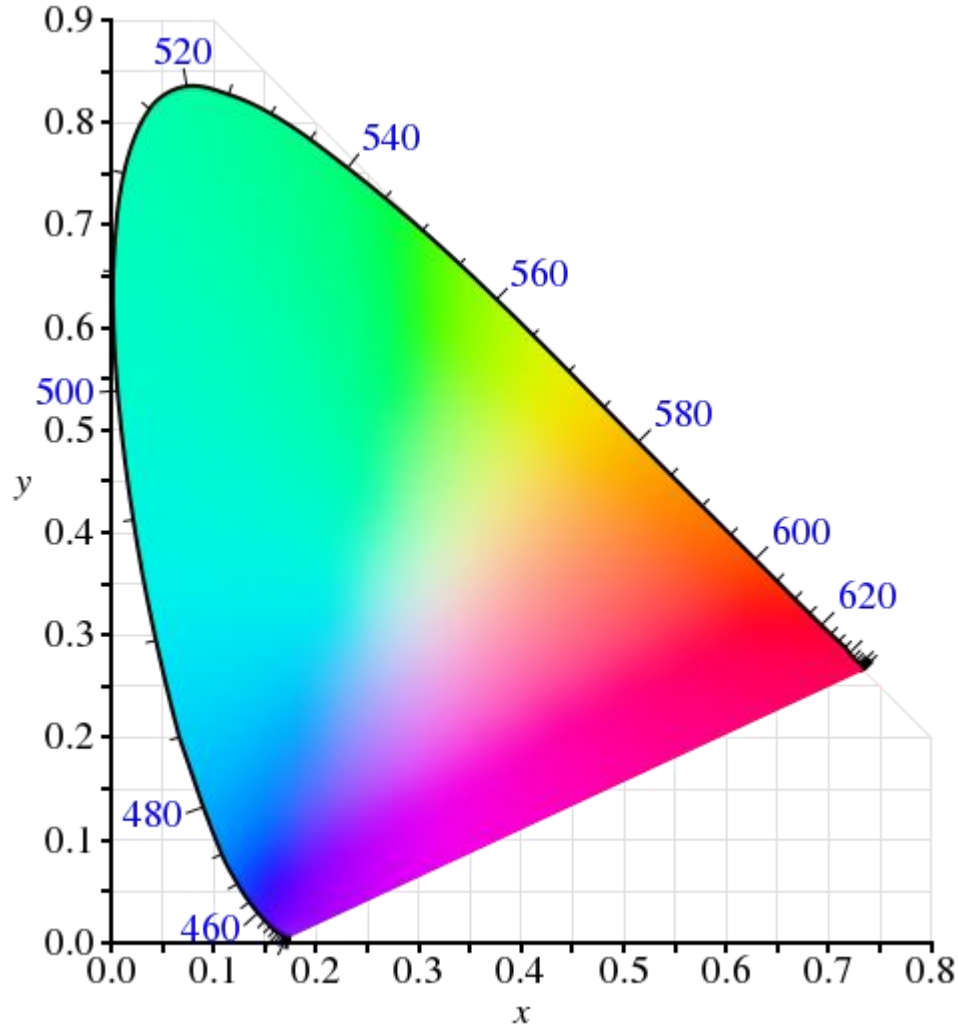


Human eye is more sensitive to green and yellow light than red or blue

Balancing color and brightness

CIE diagram maps wavelengths to color

A mix of two colors falls on the line between the two



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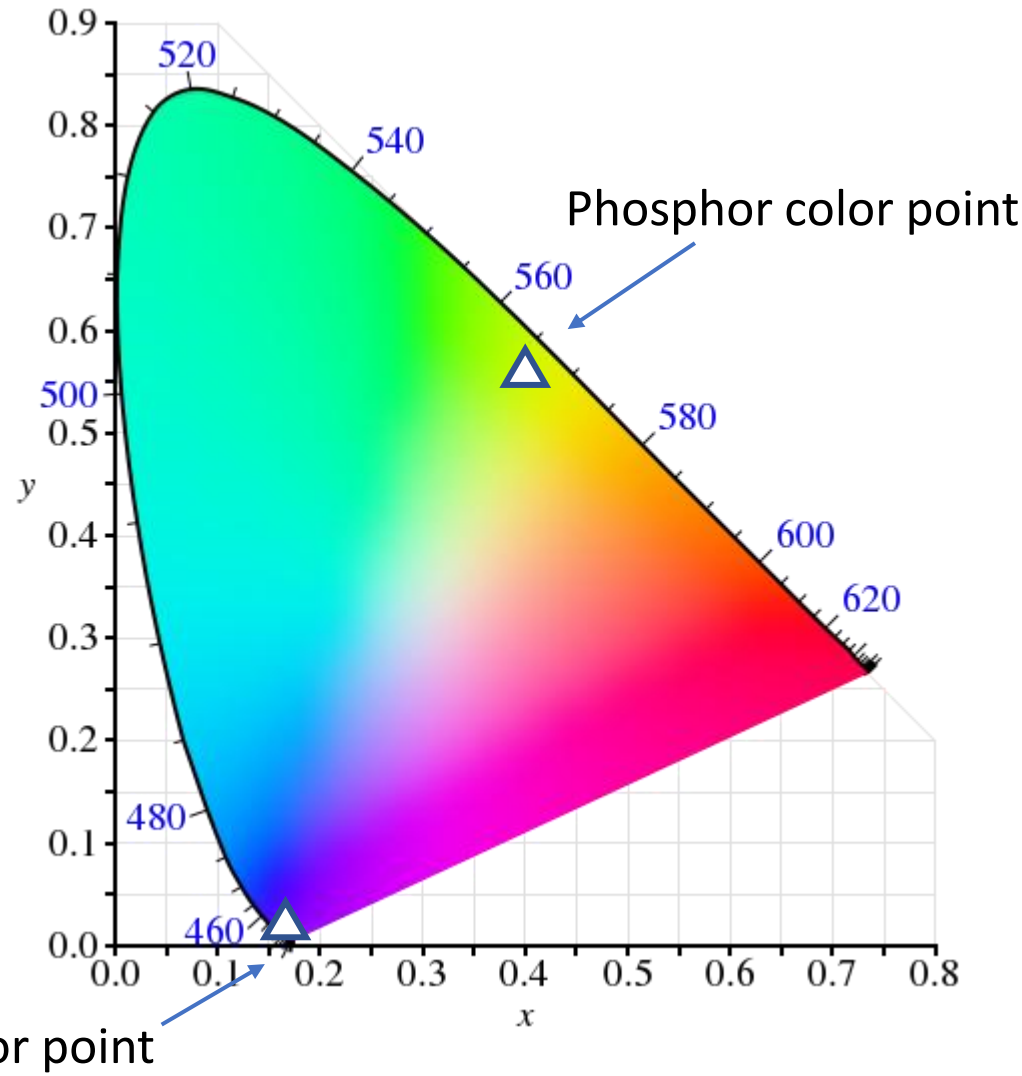
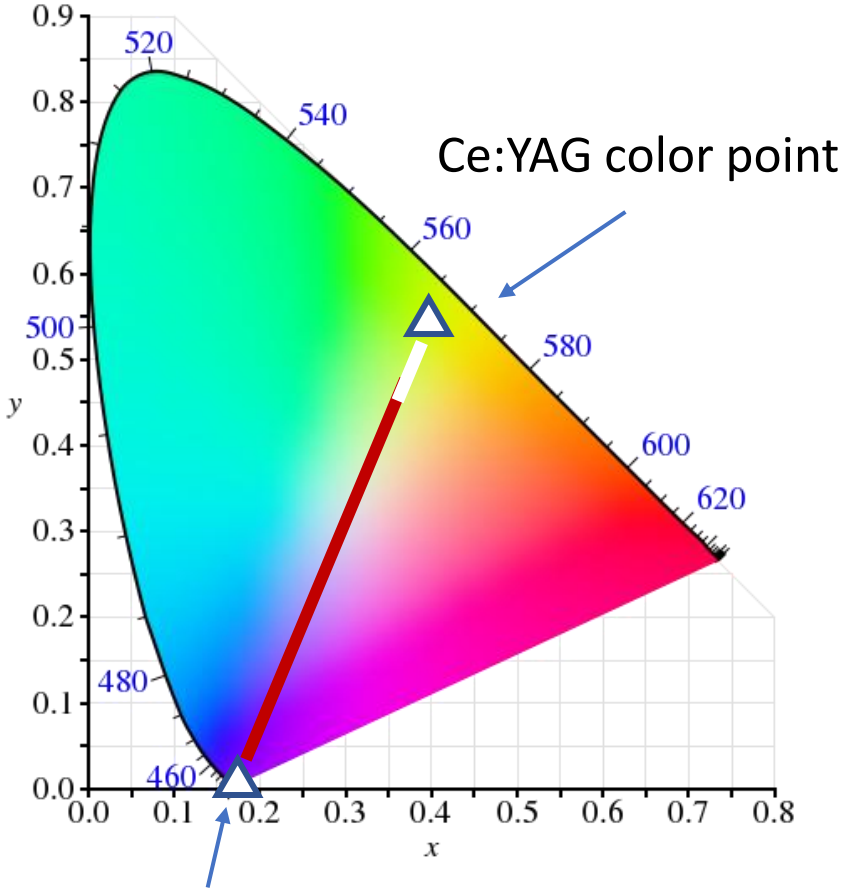
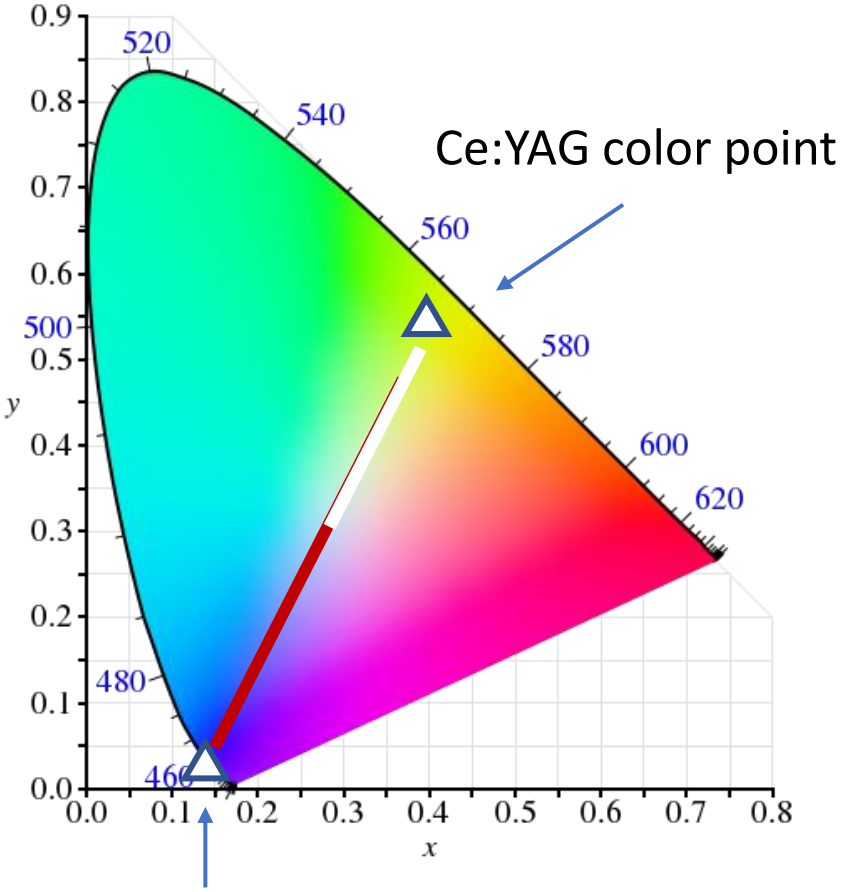


Shaping the direction of laser research

Model shows 450nm laser better at reaching color and brightness goals





Current successes and future goals

Successfully described laser pumps in terms of their color and brightness capabilities

Developed foundation for screening phosphors and pumps with ability to grow

Want to take on new color rendering metrics and keep pushing at frontier of lighting!