

Thoughts for EERE SSL LED Roundtable

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Traditional lighting isn't the target anymore, SSL is its own target

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|--|----------------------------|
| 1. Ultra-high source (light production) efficiency: | Lasers |
| 2. Ultra-high system (light usage) efficiency: | Luminaire on a chip |

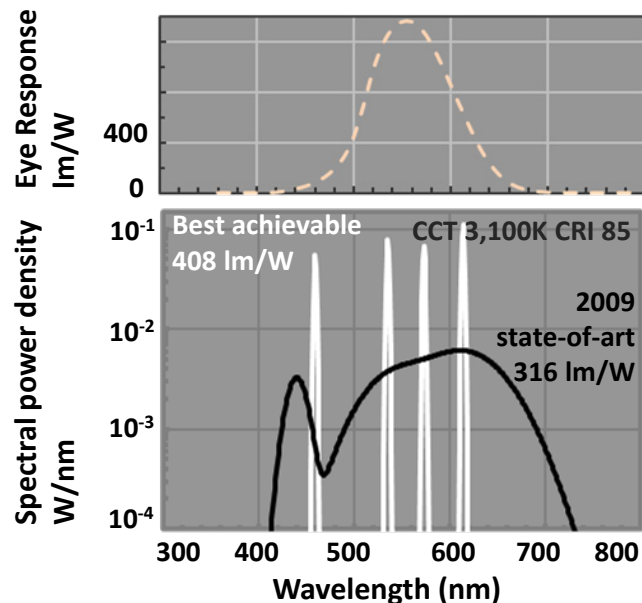
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Lasers are beneficial in many ways

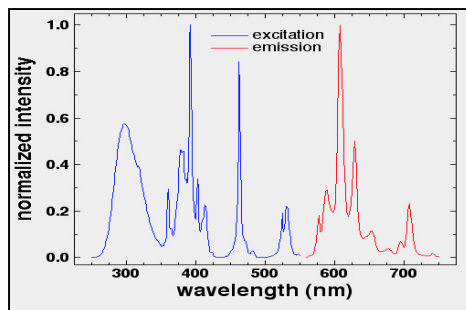
1 Narrow linewidths

give the highest luminous efficacies of radiation



Adapted from JM Phillips, et al "ME Coltrin and JY Tsao, Appendix 1 (Technology Perspective) of "Basic Research Needs for SSL" Basic Energy Sciences Workshop Report (2006).

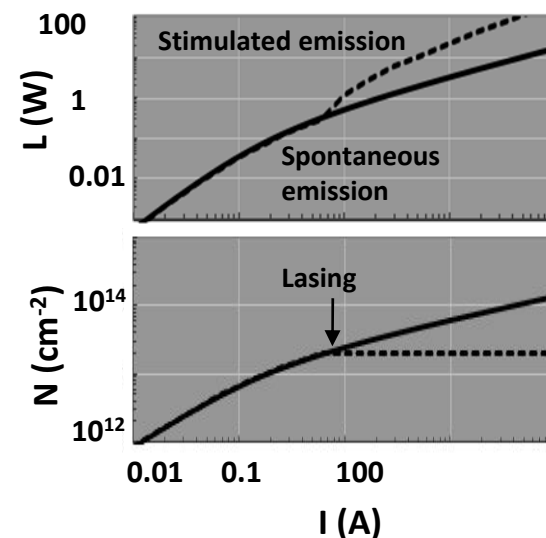
are well-matched to next-generation narrow-linewidth red phosphors



Excitation and emission spectra of $\text{KGdTa}_2\text{O}_7:\text{Eu}^{3+}$ pyrochlore phosphor, courtesy of Lauren Rohwer, May Nyman, Jim Martin, Sandia National Labs.

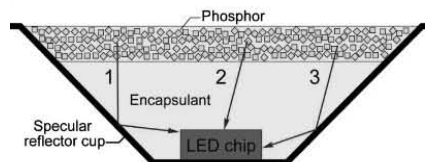
2 Stimulated emission

enables high power at low carrier densities



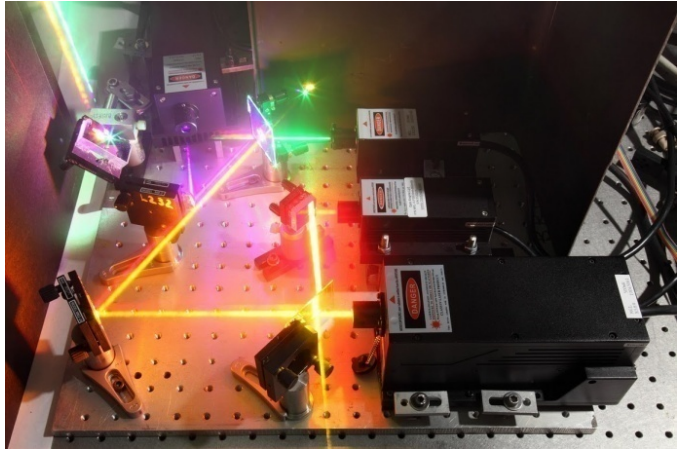
3 Directionality

enables expanded system architectures



JK Kim, H Luo, EF Schubert, J Cho, C Sone, Y Park, "Strongly enhanced phosphor efficiency in GaInN white light-emitting diodes using remote phosphor configuration and diffuse reflector cup," Jap J Appl Phys 44, L649 (2005)

Human factors study of narrow-band RYGB illumination



Experiment in the works

- Collaboration between
 - Sandia (Jon Wierer, Jeff Tsao)
 - UNM (Sasha Neumann, Steve Brueck)
 - NIST (Wendy Davis, Yoshi Ohno)
- RYGB lasers at 636, 589, 532, 457 nm
- Side-by-side comparison (same CCT, Duv, lux) between
 - RYGB lasers
 - Incandescent
 - Warm/neutral/cool white PC-LEDs

Preliminary result

- RYGB lasers give excellent color rendering

Bring luminaire functionality to the chip



Theatre luminaire (expensive)

- Rotates, tilts, focuses, changes chromaticity, digitally controlled
- Hemispherical array gives the ultimate control over the illumination of a scene, but can only afford a few

Microsystem luminaire (inexpensive)

- Same functionality as theatre luminaire, but fractionated and ubiquitous
- Opportunity for much higher efficiency and productivity of light use