

An Overview of NSF Smart Lighting Engineering Research Center

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John Wen

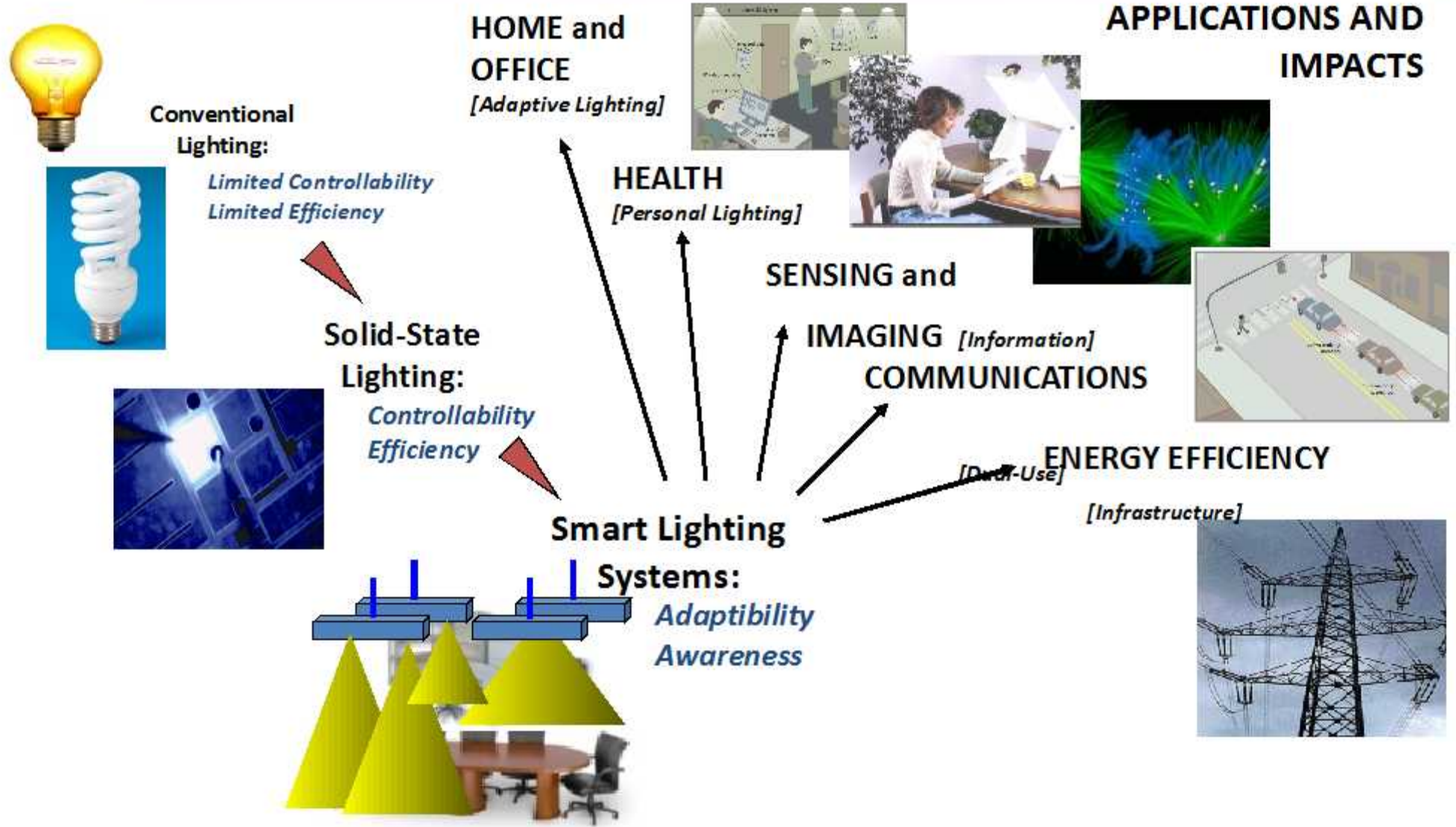
Interim Director, Smart Lighting Center

Director, Center for Automation Technologies & Systems (CATS)

Professor, Electrical, Computer, & Systems Engineering

Rensselaer Polytechnic Institute

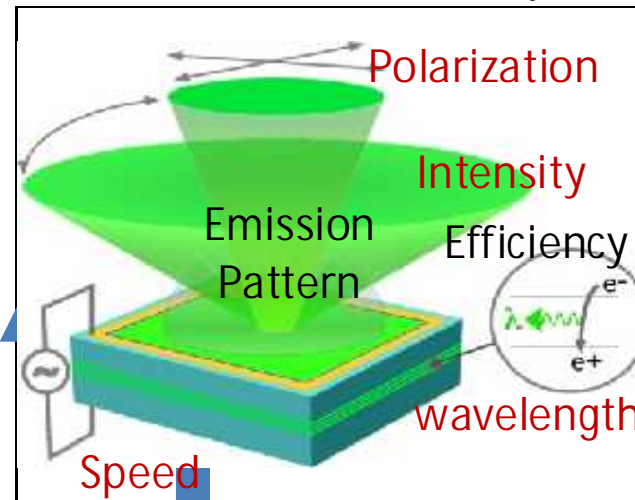
November 18, 2009



- Founded in 2008 by NSF ERC grant, additional NYS support: NYSTAR and NYSERDA.
- Interdisciplinary, inter-institution teams of > 30 investigators
- Core Partners: RPI (lead), BU, UNM; Outreach universities: Howard, Morgan State, RHIT

Smart Lighting Systems

Tunable Device Properties



Systems Level Observables

- Light field distribution
- Energy usage
- Communication BW
- Cell health & image quality
- Human health indicators

**Adaptive
Feedback**

Core Systems Technologies:

Control

Communications

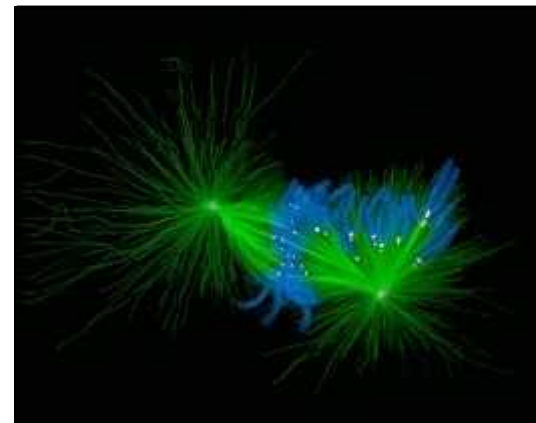
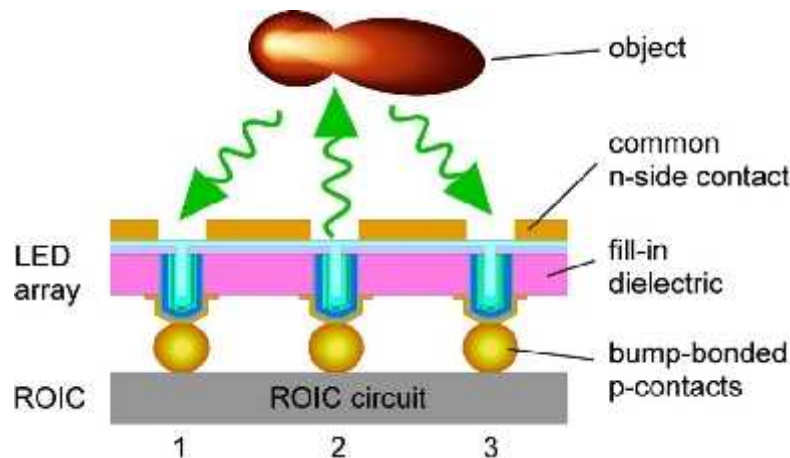
Image Processing

ERC Research Programs in Smart Lighting



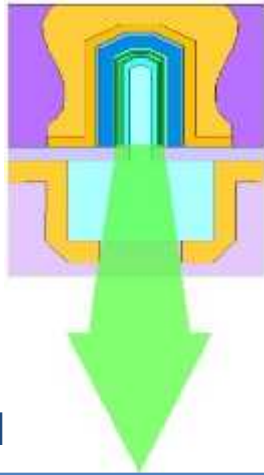
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Applications



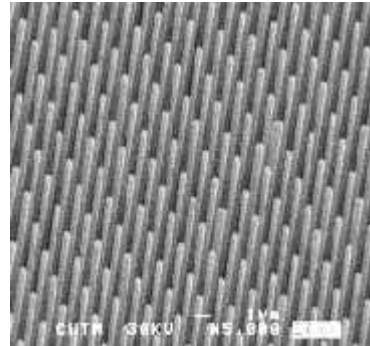
Research Projects: Materials and Device

Coaxial nanoLEDs:
 revolutionary efficiency, outcoupling, polarization performance



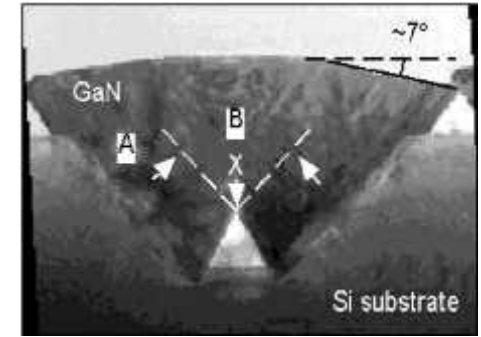
Steve Hersee, UNM

Nano-patterning
 for photonic crystals



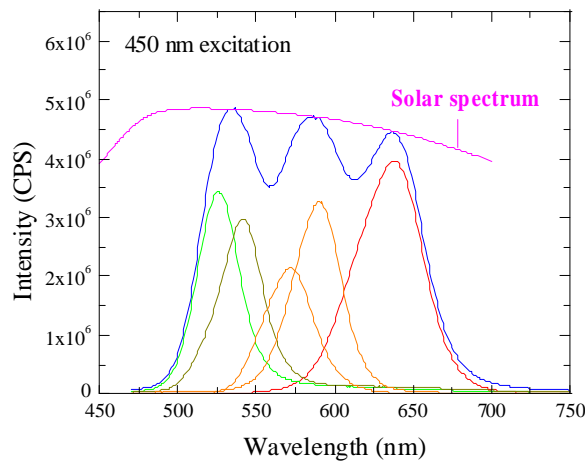
Shawn Lin, RPI

Cubic GaN
 for high p-doping



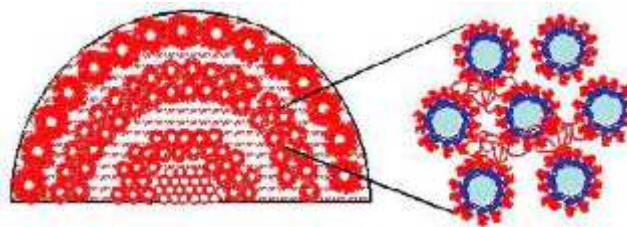
Steve Brueck, UNM

Hi-speed nano-phosphors
 for "daylight" quality white-light



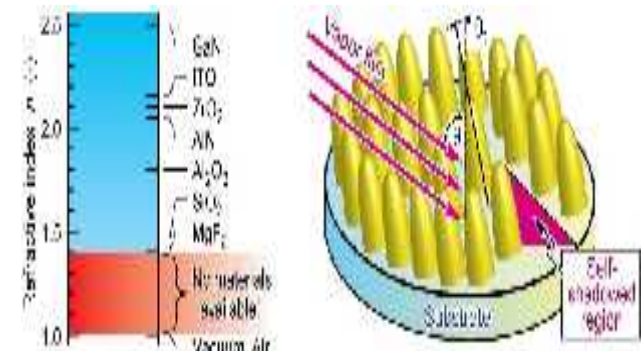
Marek Osinski, UNM

High-index, loaded epoxy
 for high output coupling efficiency and phosphor incorporation



Linda Schadler,
 Richard Siegel, RPI

Adjustable index porous dielectrics
 for reflective and anti-reflective coatings



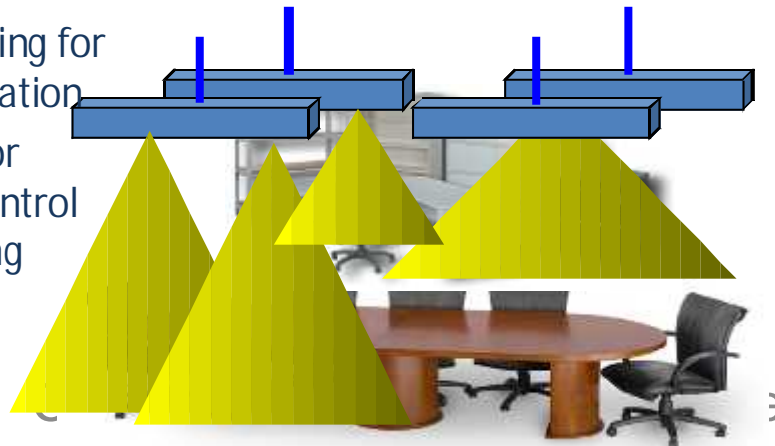
Joel Plawsky,
 William Gill, RPI

Smart Lighting Systems and Applications

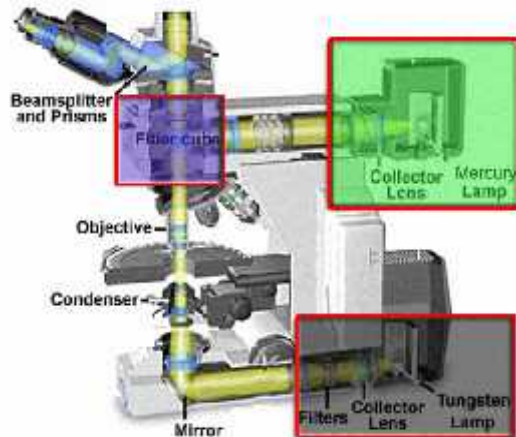
Goal: Estimation & control of distributed light field

- Adaptive sampling for light field estimation
- Distributed color temperature control while minimizing energy usage

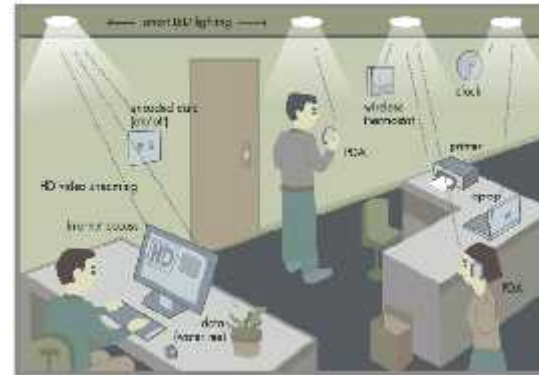
Distributed Adaptive Lighting and Display



Biosensors and Bioimaging



Communications and Dual-Use



Lighting and Health



Goal: High BW, mobility

- BW density > 1Mb/s/m² at 3m
- Handoff latency < 1s at 1m/s



Prototype Board

Adaptive Illumination for Live Cell Imaging

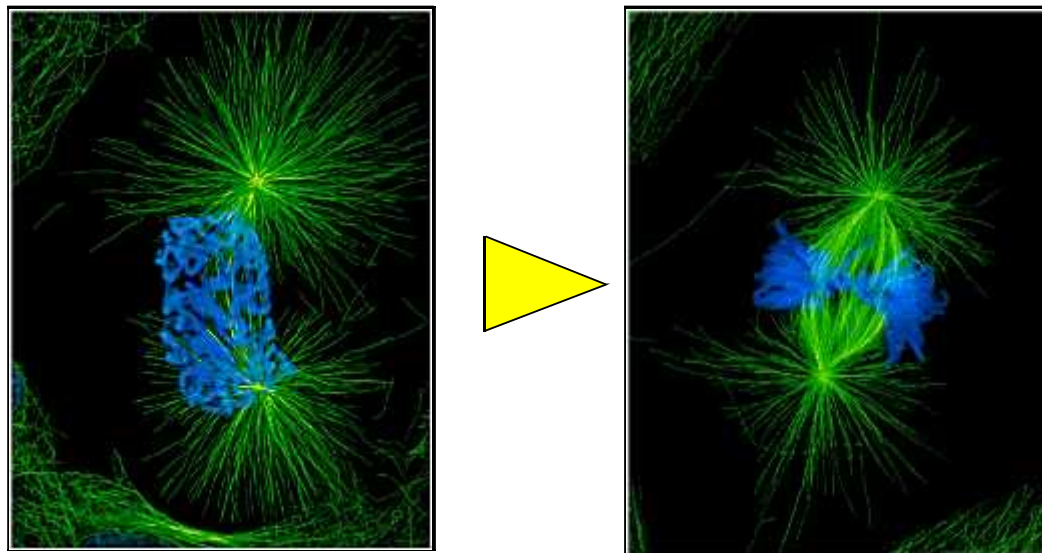
Visualization of genetically-encoded fluorescent proteins (e.g., GFP) is extremely important in studies of genes

Limitation: photodamage to cells, photobleaching to fluorophores

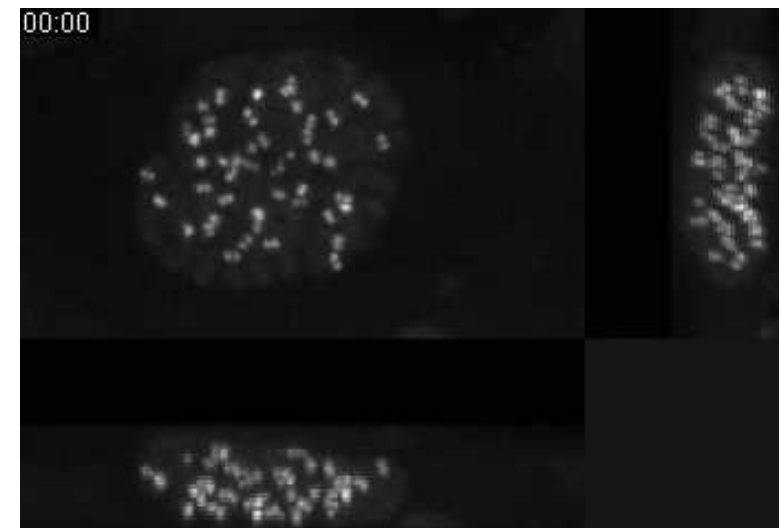
Nonlinear response of cells to light: dosage threshold for cell damage

Adaptive LED illumination control: Vision based illumination control in 3D live cell imaging – kinetochore localization and tracking, adaptive z-sampling, optimal illumination for long term imaging

Adaptive illumination and automated analysis of kinetochore motion in cell mitosis



Alexey Khodjakov, Wadsworth



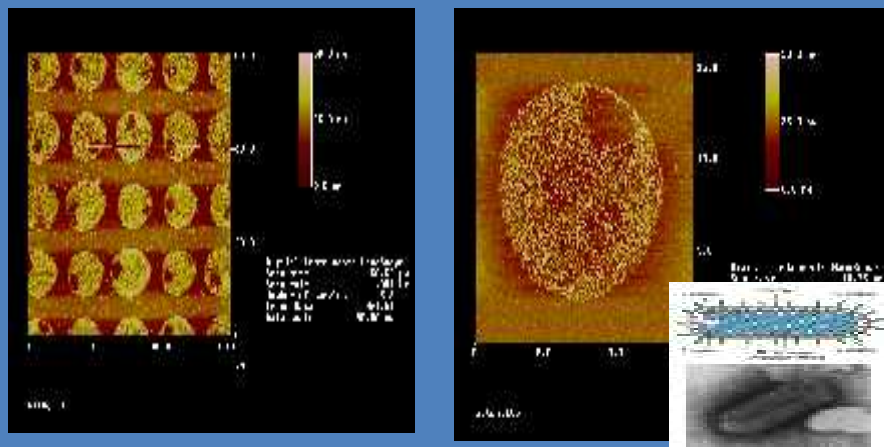
LED-Enabled Label-Free Biosensors

Inexpensive, label-free, field-deployable immunoassay for detection of pathogens would improve disease diagnosis and treatment worldwide.

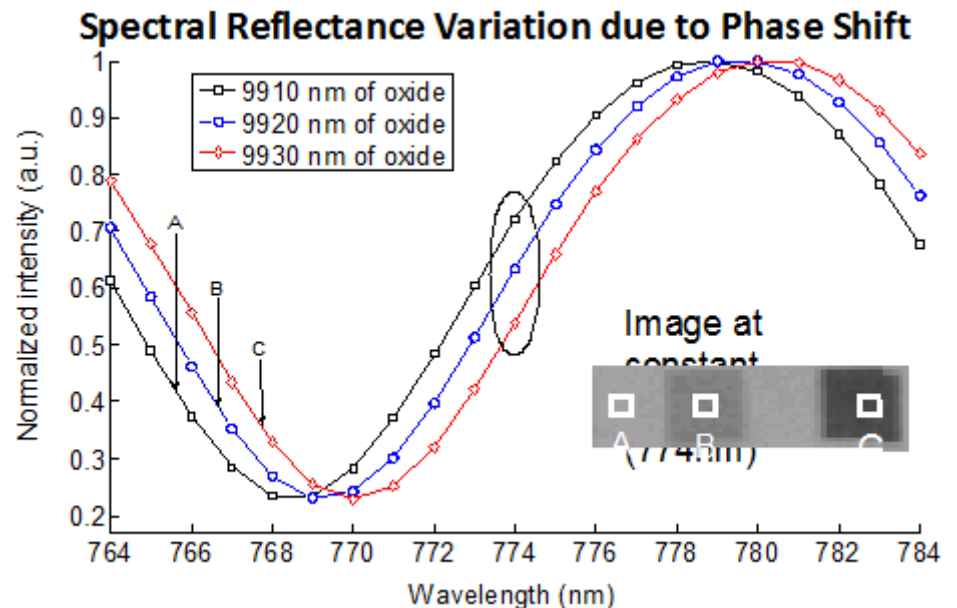
LED-enabled biosensing technologies:

- Plasmonic biosensor: Surface plasmon excited by LED array; resonance shift due to biomolecules
- Spectral reflectance biosensor: Reflectivity affected by surface height variation due to presence of biomolecules
- Autofluorescence biosensor: Bacterial autofluorescence sensor with UV LED excitation

Virus Capture and Detection with Plasmonic Sensor



Hatice Altug, BU



Mike Ruane and Selim Ünlü, BU

Light System for Personal Health

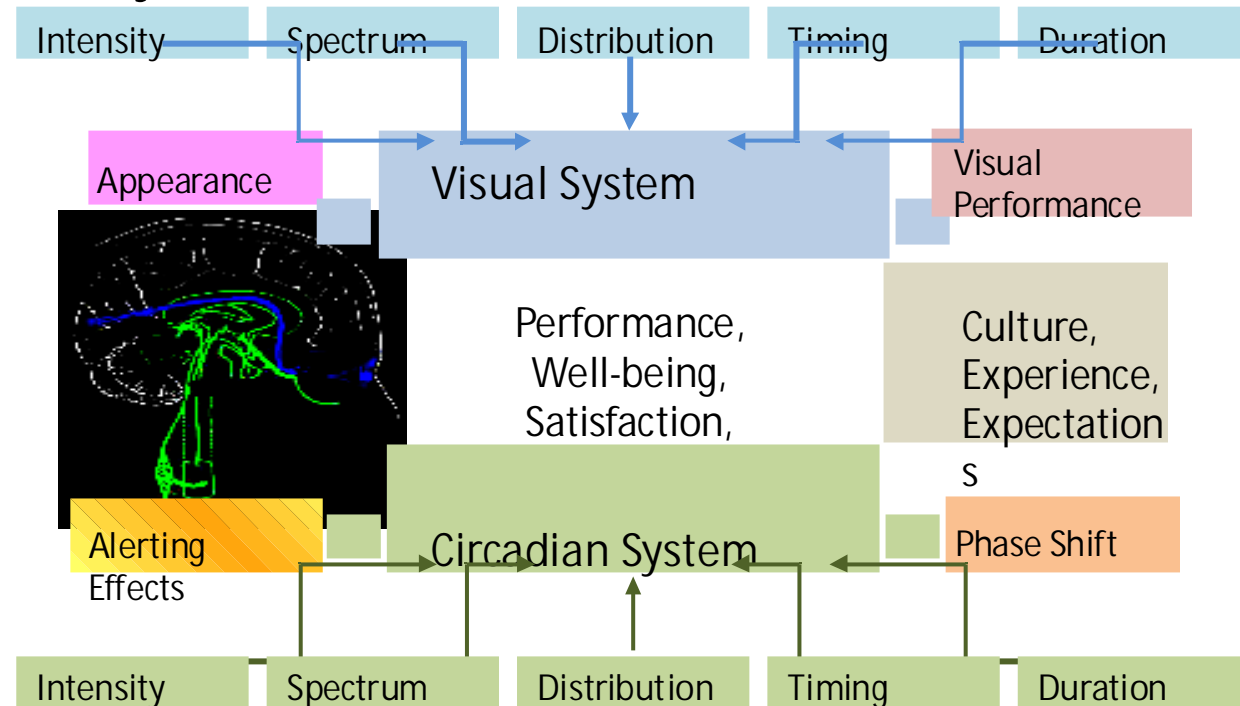
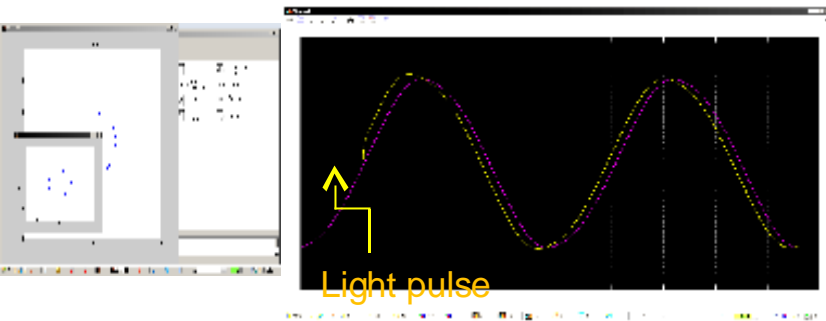
Direct effect of light on circadian rhythm through non-visual receptors

Disruption of circadian linked to major health problems

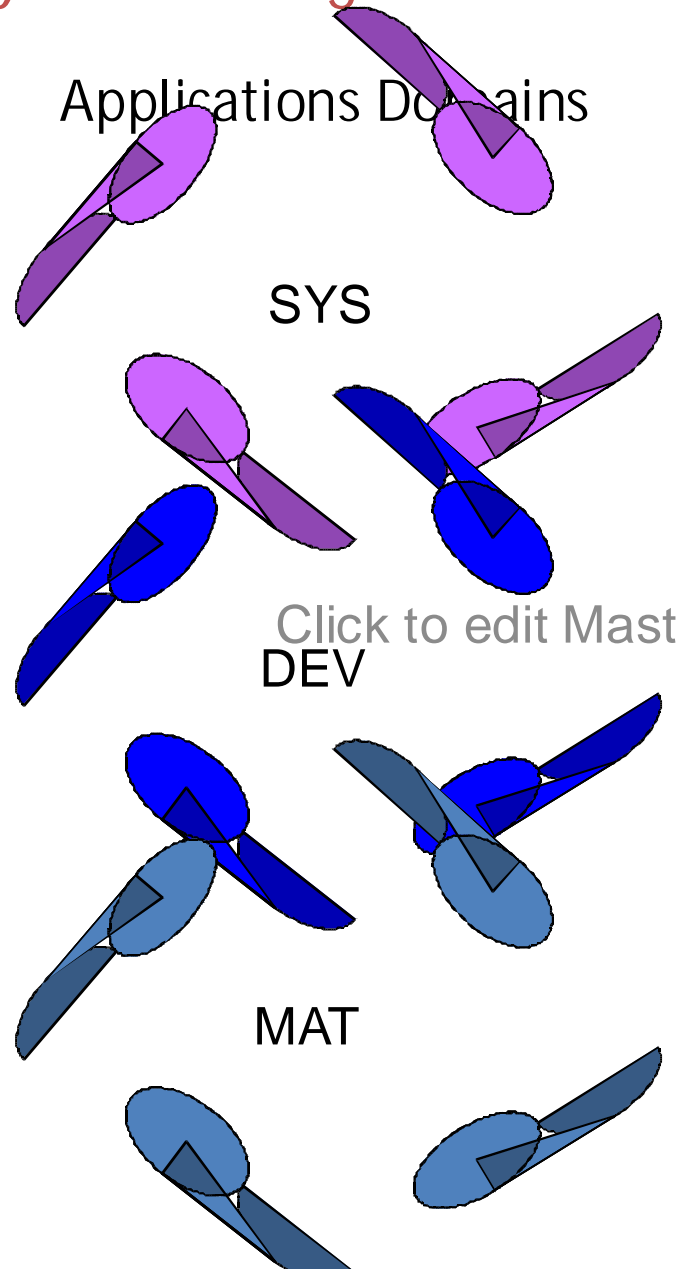
Personal Light System:

- Circadian rhythm estimator based on entrainment model and daysimeter data

- Optimized lighting control with daysimeter feedback for entrainment



Systems Integration



Integration Testbed Program

