

Optimizing Sleep and Circadian Health in Hospital Shiftworkers via a Novel Multi-Component Lighting Intervention: Need, Feasibility and Future Plans

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Actigraphy



Actigraphy

DAY

NIGHT

Noon

Midnight

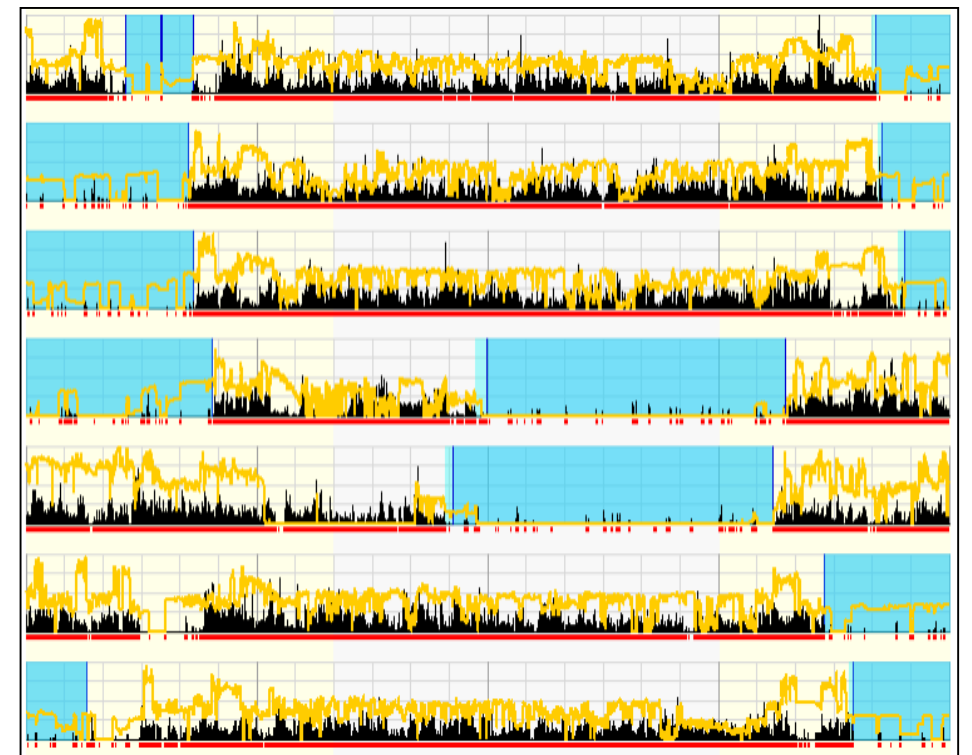
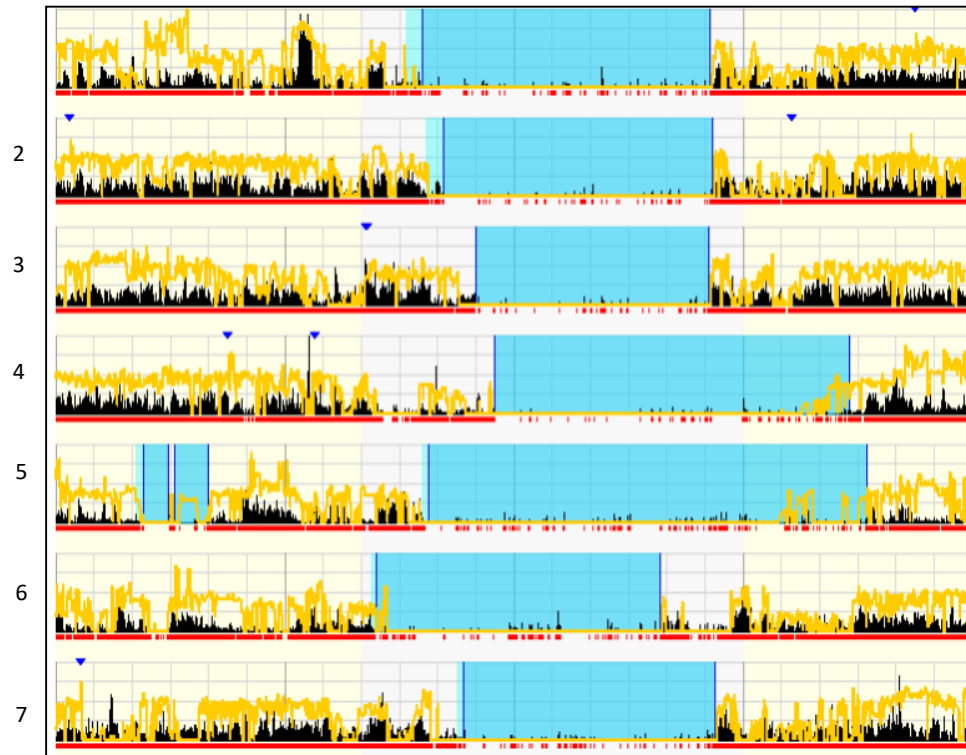
Noon

Noon

Midnight

Noon

Day 1

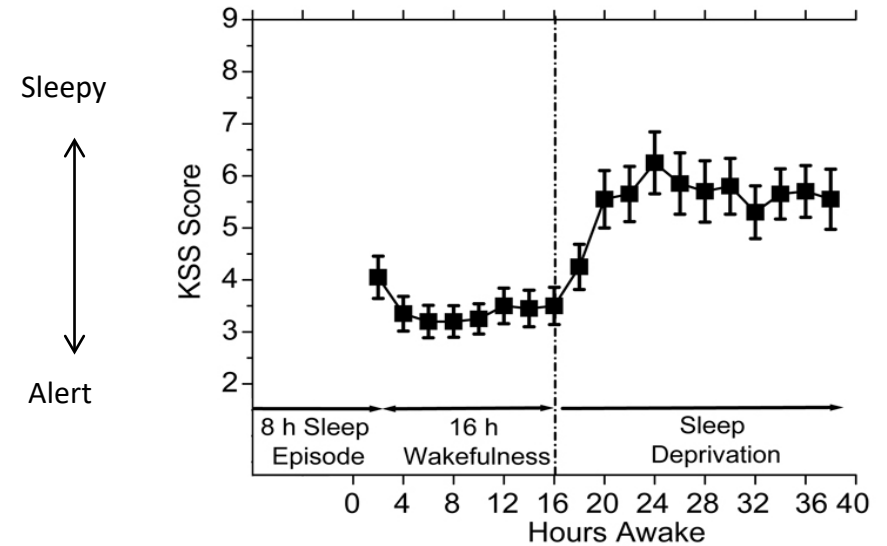


Alertness

Subjective Measures:

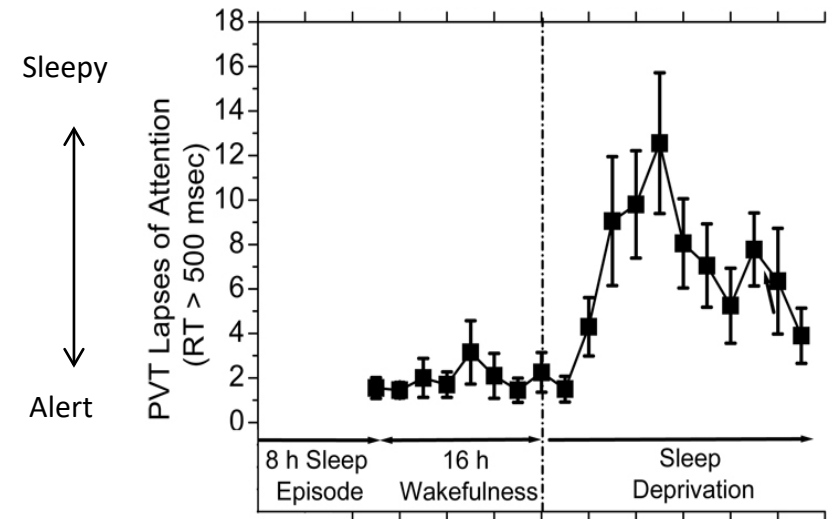
Karolinska Sleepiness Scale (KSS):

On a scale from 1 to 9, how sleepy do you feel?



Objective Measures:

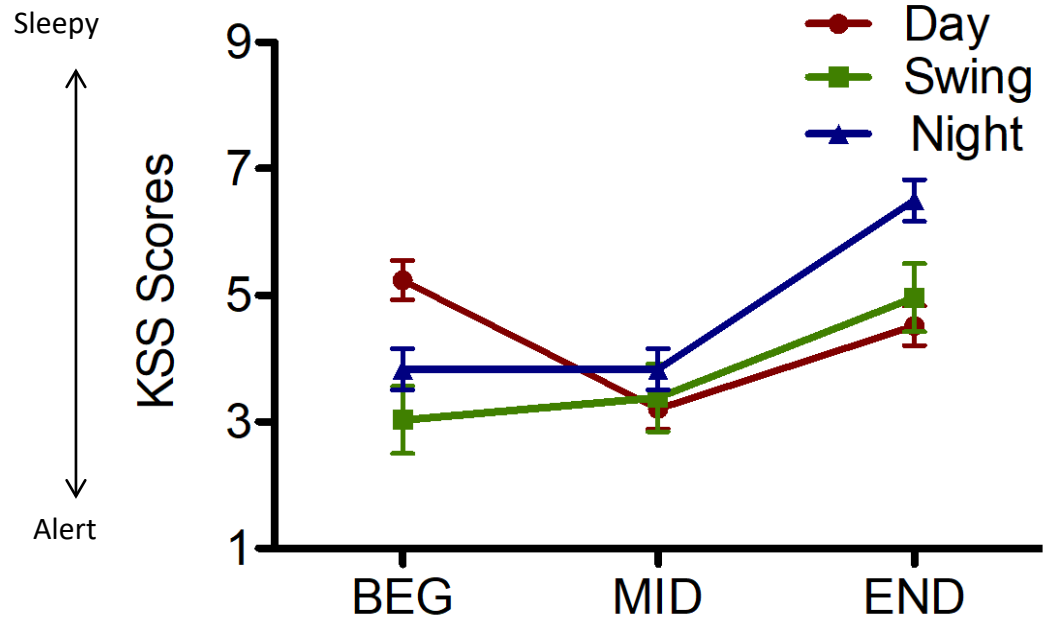
Psychomotor Vigilance Task (PVT)



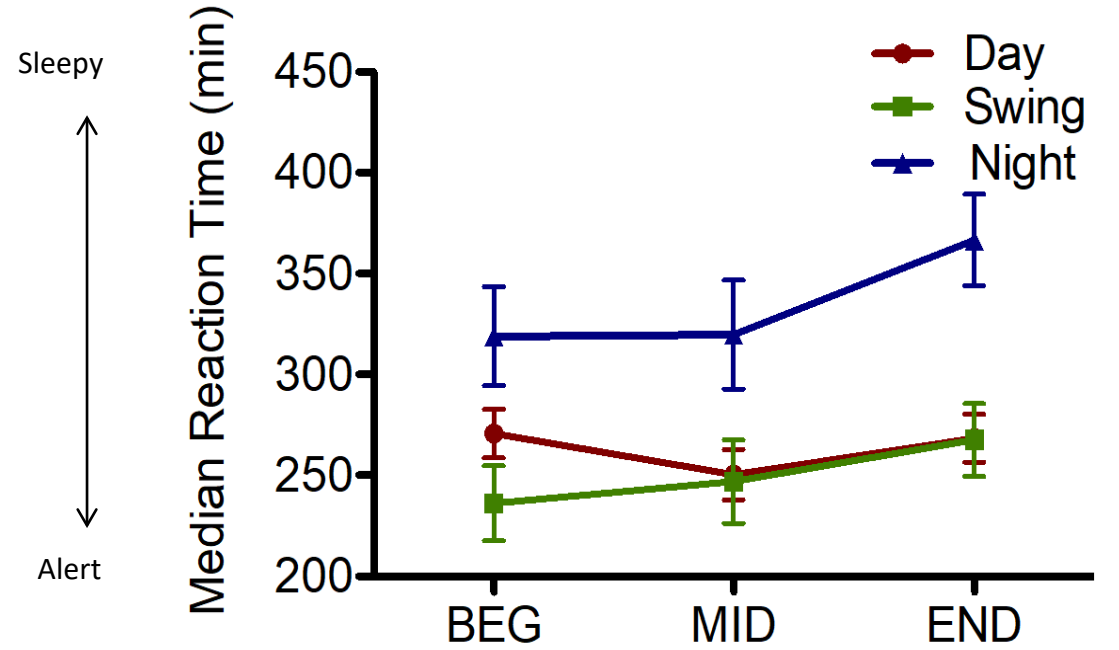
Van Dongen et al. *Sleep* (2003)

Alertness

SUBJECTIVE



OBJECTIVE



Approach

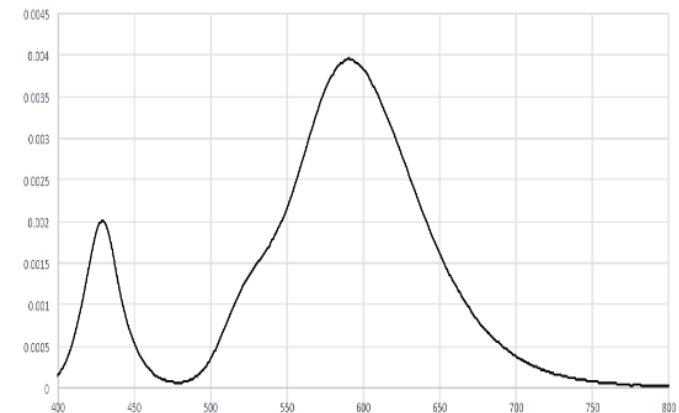
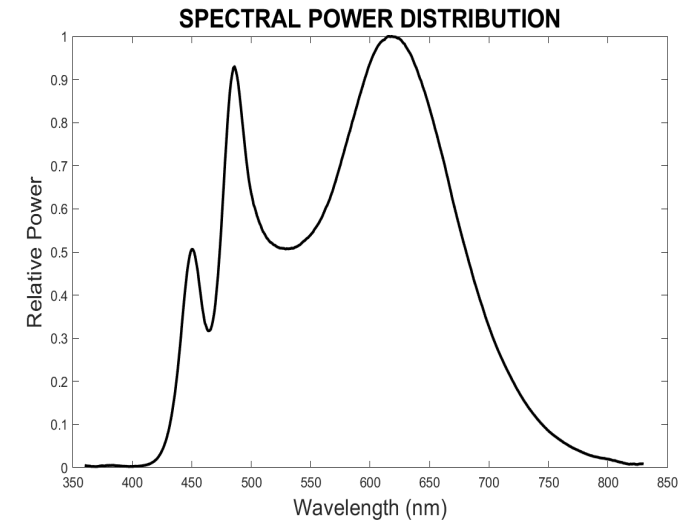
Combines two evidence-based lighting interventions that address two different responses:

Circadian Phase Resetting, architectural

- maximize input during desired day
- minimize input just before and during desired bedtime

Acute Alerting, individual

- light for alerting ONLY
- only when KSS ≥ 6 and/or increased reaction time on PVT (*need based**)



Efficacy vs Effectiveness

- trade-offs between projects with more predictable results versus more innovative research, including projects involving more real-world samples that could result in greater public health impact

Implementation Science

- Developing generalizable knowledge that can be widely applied beyond the individual system under study
- Requires trans-disciplinary research teams
 - lighting industry partner (BIOS) and Pacific Northwest National Lab
 - hospital study site collaborators (Scientific Director, Director of Facilities, Director of Nursing, Nightshift Council Staff, Nurse Researchers and Nightshift Staff)

Impediments to Uptake of Evidence-Based Practice

- Lack of knowledge, skills and resources
- Misalignment of research evidence with operational priorities
- Competing demands



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

Tunable LED Lighting in Realistic Settings: Effects on Energy Use and Human Response

Bob Davis, Ph.D., FIES

Senior Staff Lighting Scientist / Engineer

Pacific Northwest National Laboratory

January 31, 2019

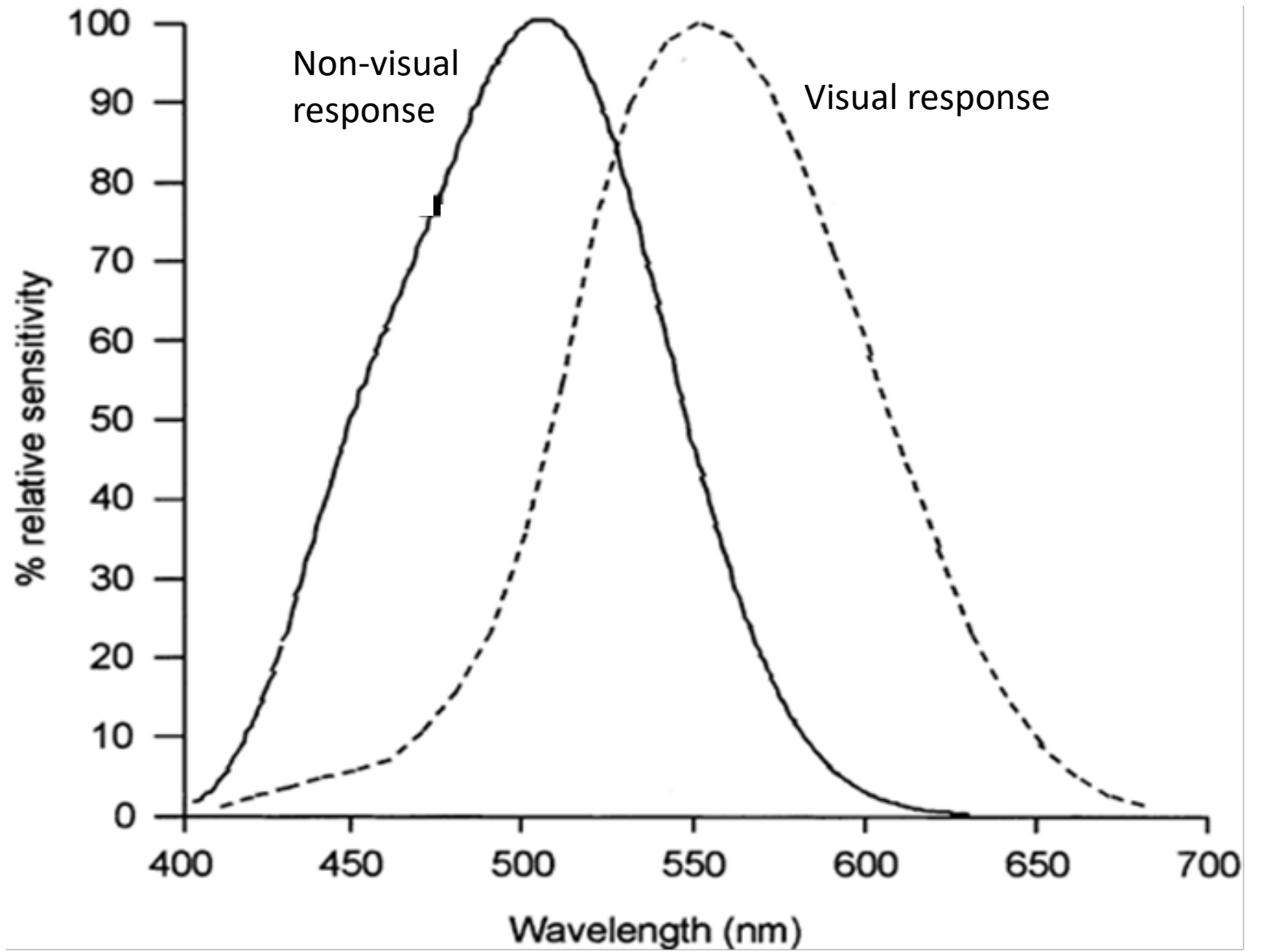
INTENSITY



DURATION



SPECTRUM





acc

**SENIOR
SERVICES**







7:00 AM – 2:00 PM

2:00 PM – 6:00 PM

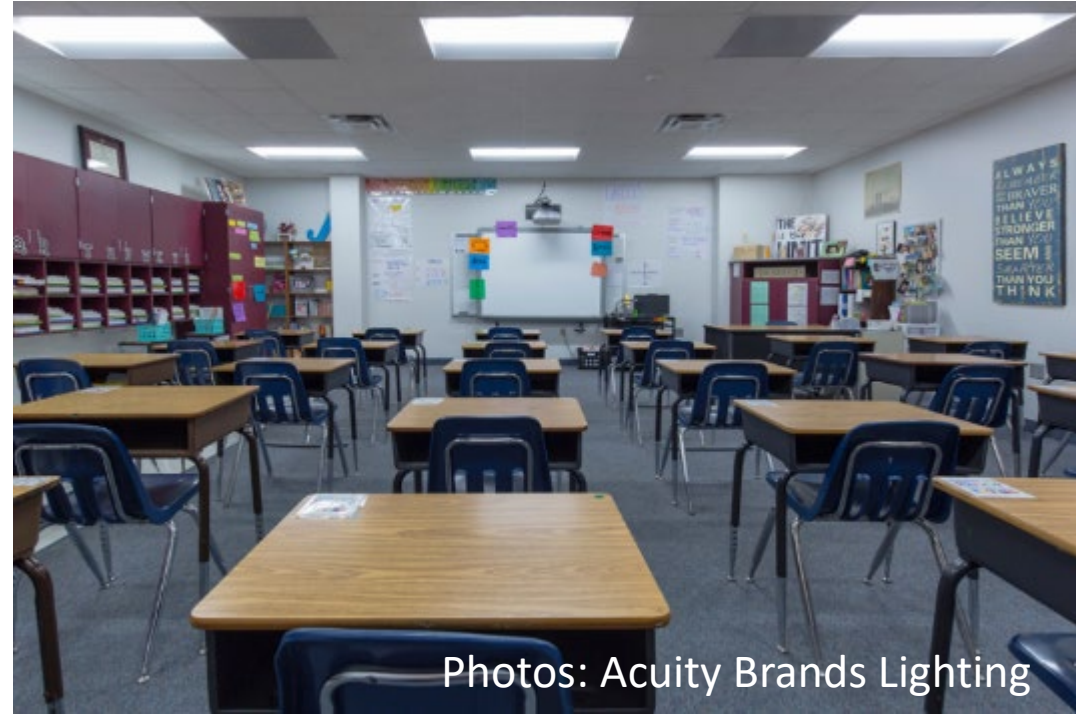
6:00 PM – 7:00 AM

ACC Care Center Outcomes

- 68% energy savings in corridors
- Residents are sleeping through the night
 - Sleeping in their beds
 - Reduction in psychotropic and sleep medications
- 41% reduction in behaviors
 - Yelling, Agitation, Crying
- Residents “hanging out” in Cherry Lane
- Now implementing throughout facility

Carrollton-Farmers Branch Schools

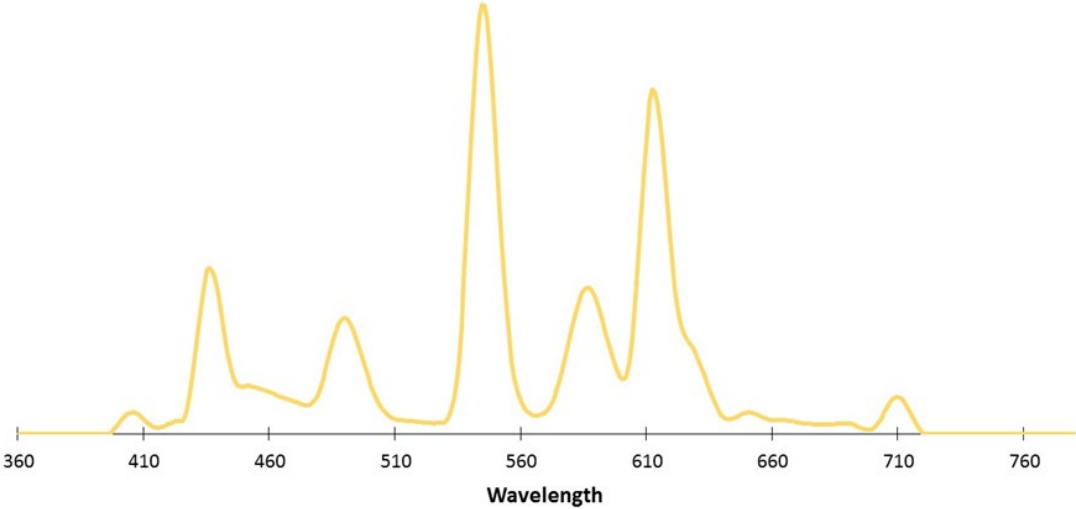




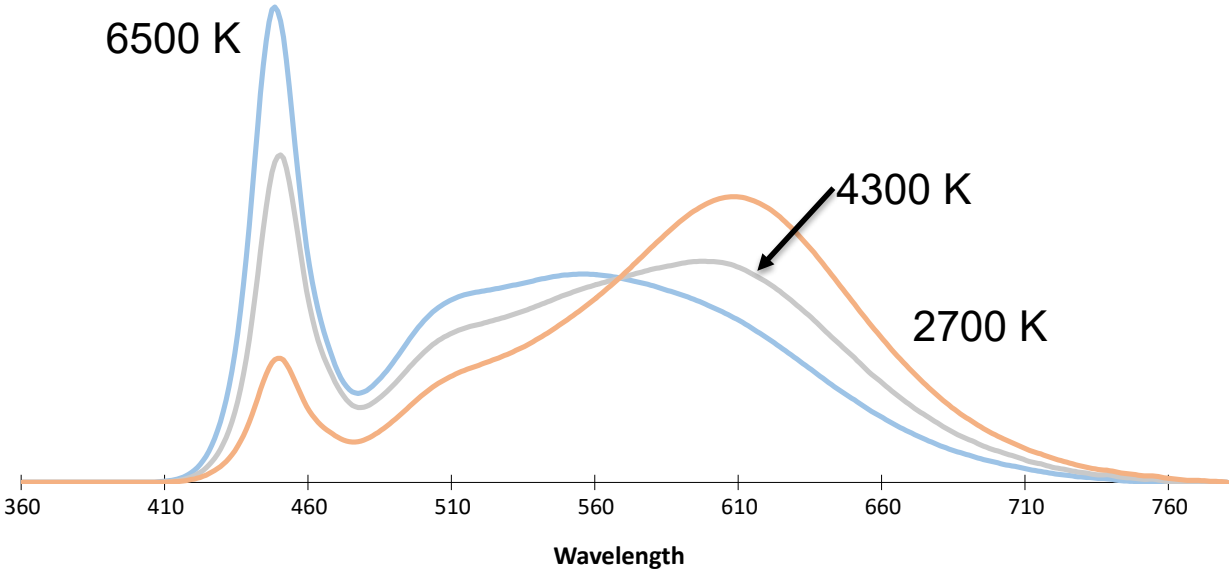
- 58% energy savings based on power reduction
 - Deeper savings due to controls / dimming
- Lighting used by teachers to provide behavioral cues
- One teacher credits the lighting with “keeping me from retiring”



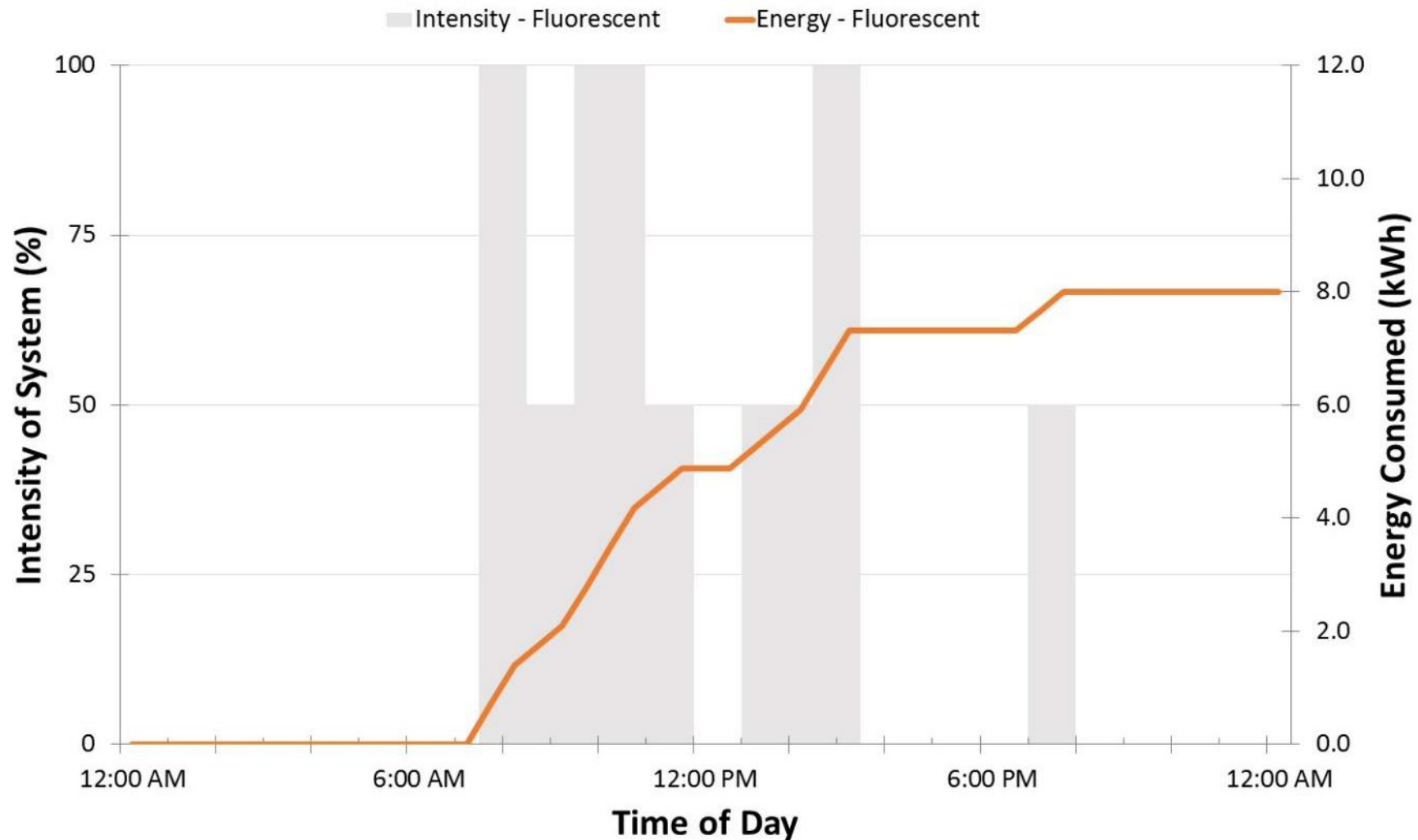
Fluorescent – 3800 K



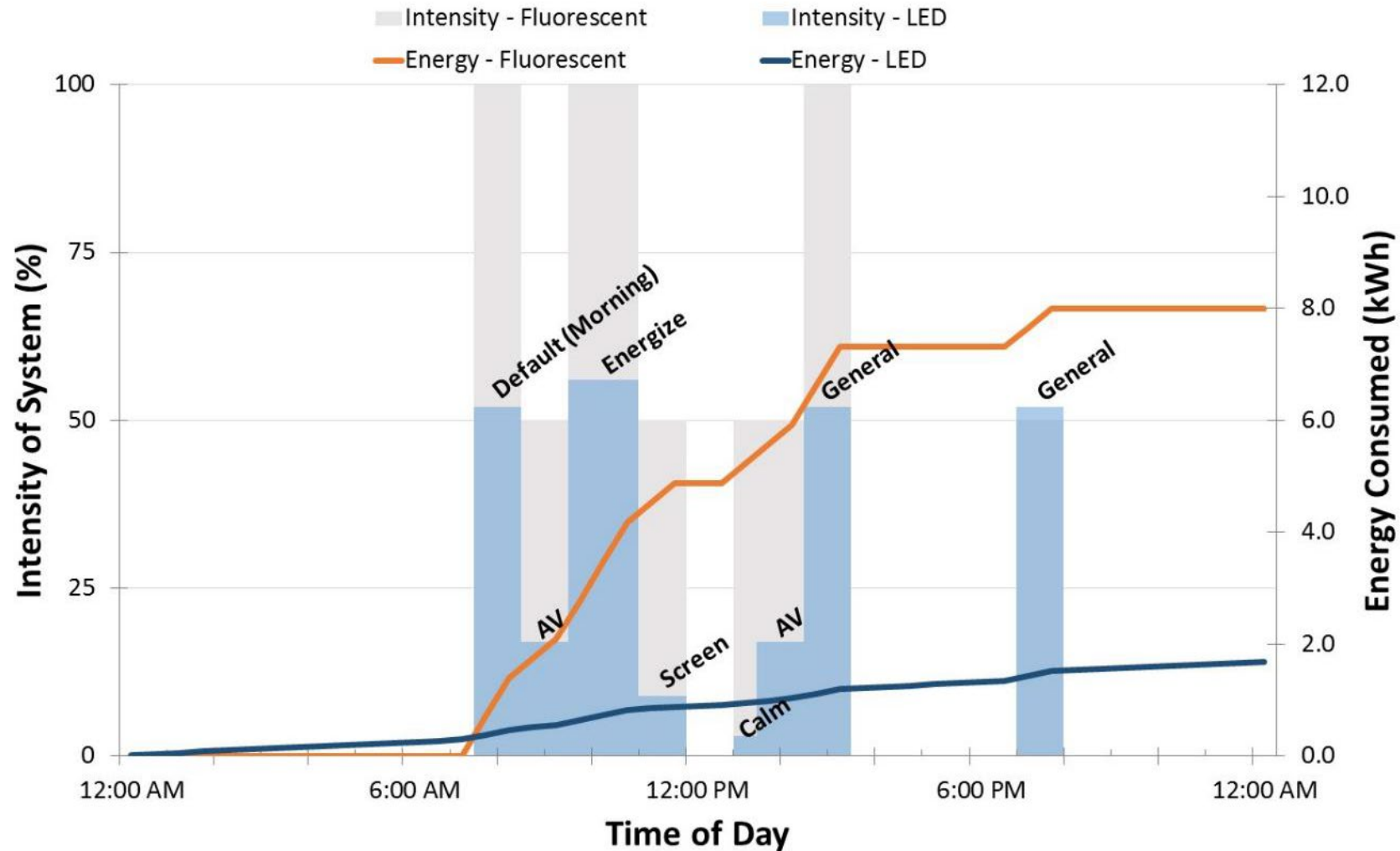
Tunable LED System



Energy use for lighting during a typical day



Energy use for lighting during a typical day



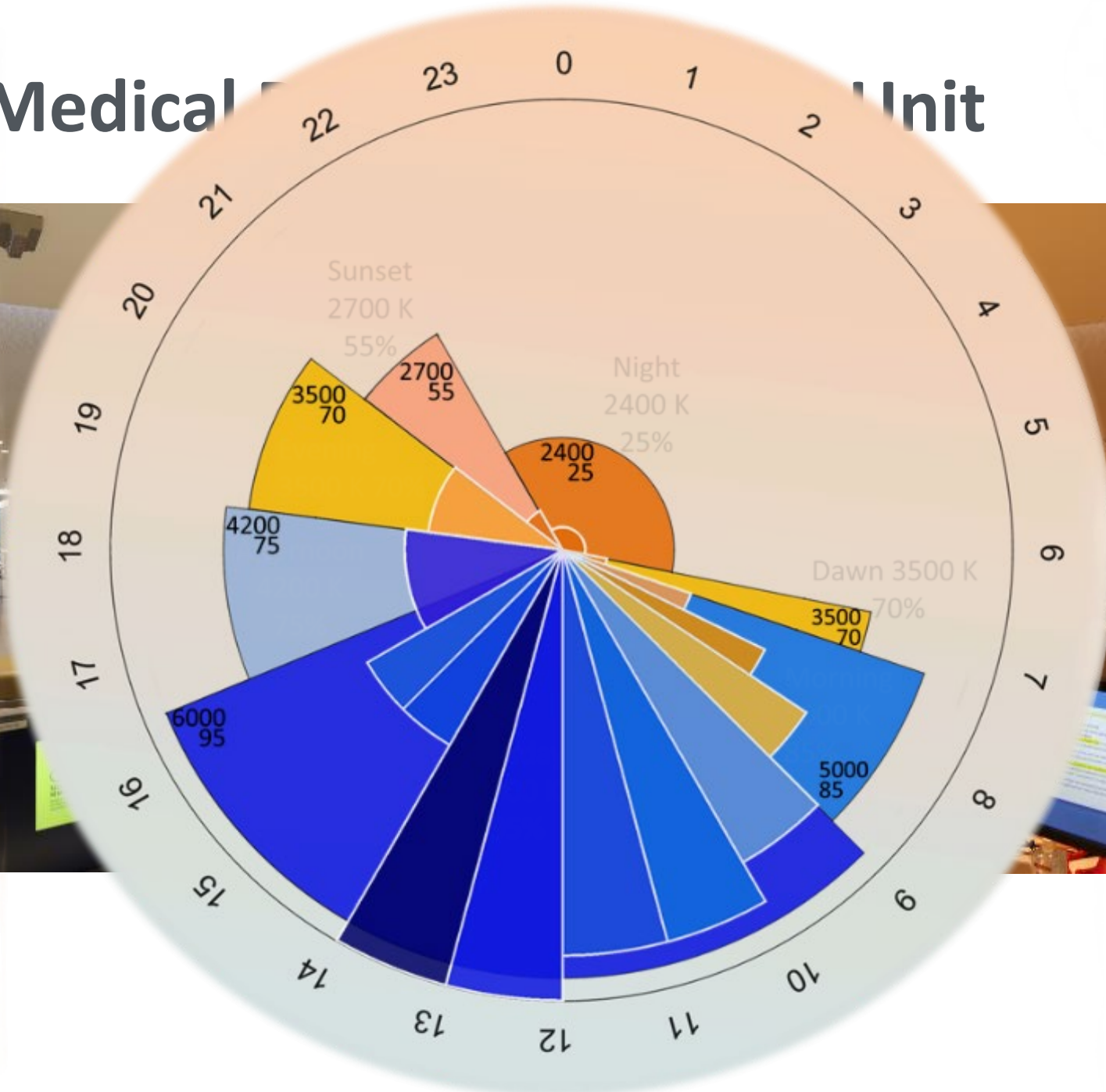
Classroom Outcomes in GATEWAY Pilot Studies

- 45-60% energy savings based on power reduction
 - Deeper savings due to controls / dimming (>70%)
- Color consistency between fixtures & over dimming was very good
- Lighting used by teachers to provide behavioral cues
 - Increased student engagement; improved the learning environment
 - FCUSD included two classrooms with ASD students
 - Provides visual cues for desired student behaviors
 - Allows for “future proofing” to adapt to emerging science on alertness



Swedish Medical Center

Unit



Swedish BHU Outcomes

- Versus “circadian” non-tunable base case: 41% savings
- Versus recommended light level base case: 18% increase
 - 6 hours of circadian light = 74% of lighting energy
- Manual controls resulted in greater energy savings
- Variable lighting supported the biophilic design goals
- Changes in spectrum and intensity served as a cue
 - Nurses no longer need to pester patients about going to bed