



Human Centric Lighting - Optimizing Lighting for Student Learning & Beyond

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ipRGC

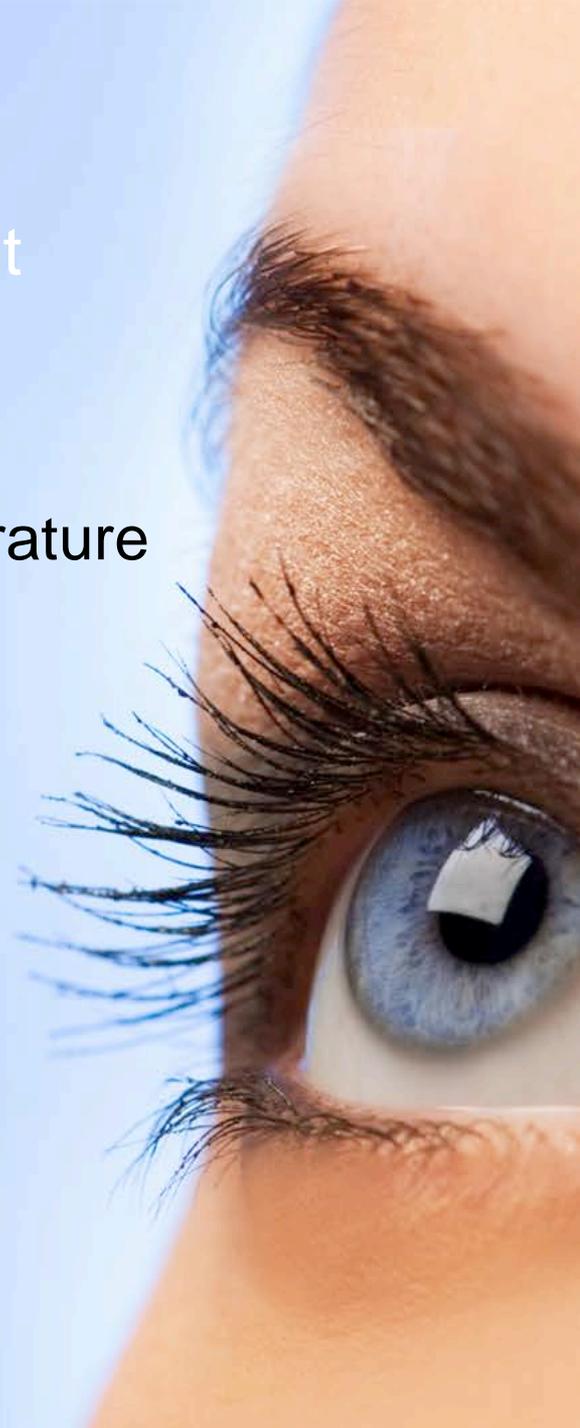
Non Visual Effects of Light

- Constricts the Pupil Size
- Suppresses Pineal Melatonin Production
- Increases heart rate and core body temperature
- Stimulates Cortisol & Serotonin production
- Acts as a Neurophysiological Stimulant
 - Improves Reaction time
 - Reduces Lapses of Attention
 - Improves Alertness

Properties of Light Affecting Circadian Photoreception

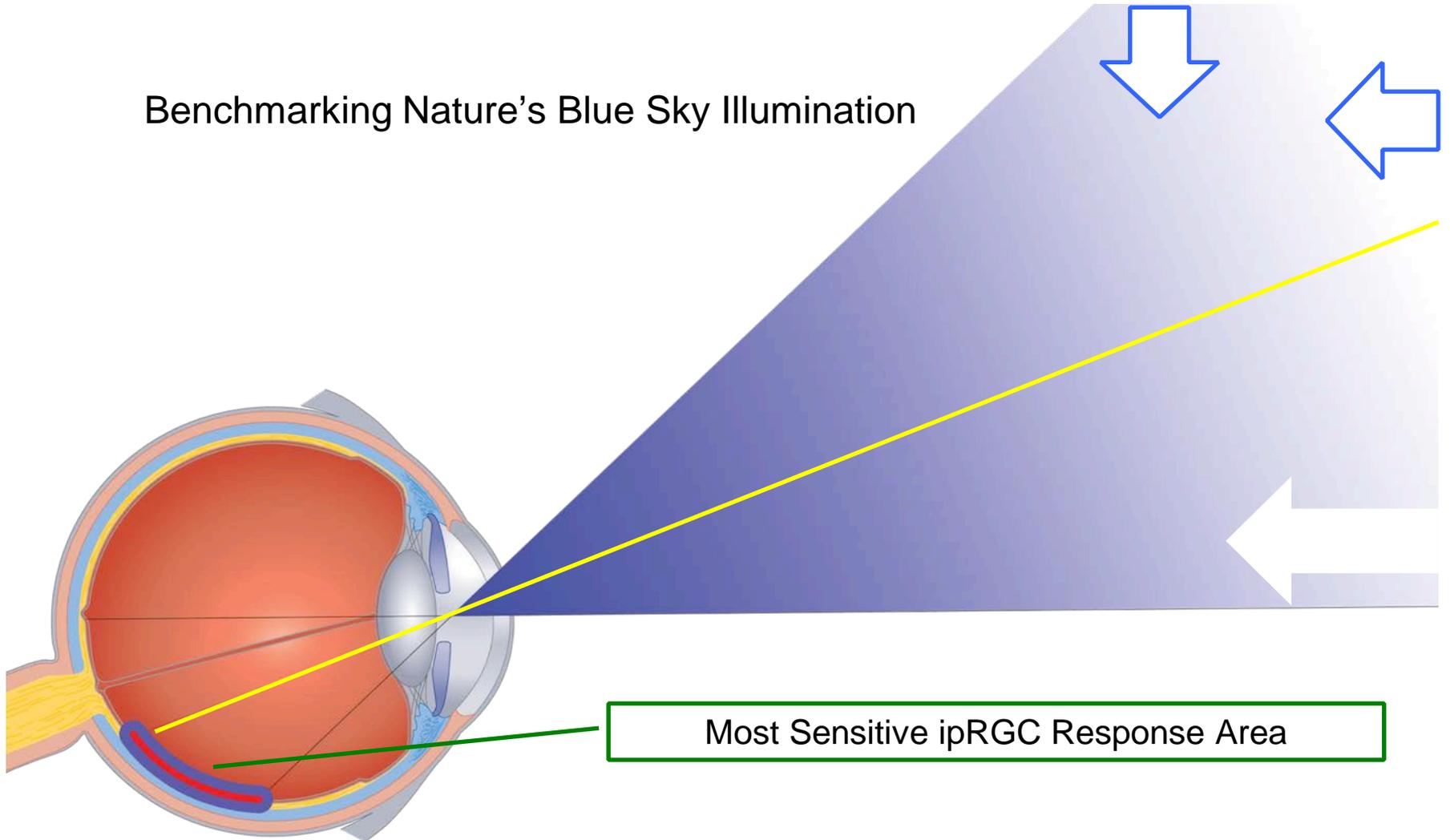
Wavelength, Timing, Intensity, Pattern, Light History

Most Sensitive to 460~490 nm Spectrum



Optimizing HCL Implementation

Benchmarking Nature's Blue Sky Illumination



Space Age Lighting Configuration



Low Intensity 2700K
(<100 lux, 90 cd at the Eye)

High Intensity 6500K
(3200 lux, 420 cd at the Eye)

4500K White Light (239 lux, 210
cd at the Eye)

Sleep

4500K

11PM

12:30PM

8:30AM

10AM

Seattle



Seoul



PLANLEDTM

Sleepless in Seattle for a Reason

Caffeine with
Half Life of 5 Hours



VS

Light Caffeine without
Withdrawal Process



226 Cloudy Days a Year, 155 Days of Rain, 81 Partly Cloudy Days, 58 Sunny Days



Dying in the Dark

	<i>Daylight Area</i>	<i>Enclosed Area</i>
<i>Mortality Rate for Woman</i>	14%	22%
<i>Mortality Rate for Man</i>	4.5%	9.4%
<i>Length of Stay for Woman</i>	2.3 Days	3.3 Days
<i>Length of Stay for Man</i>	2.3 Days	2.4 Days

- 628 patients admitted to the Cardiac Intensive Care Unit with first attack of myocardial infarction(MI) retrospectively compared for fatal outcomes and for length of stay in the CICU.

Kathleen M Beauchemin PhD, Peter Hays MB FRCPC
Journal of Royal Society of Medicine Volume 91, 1998

Effect of Bright Light and Melatonin on Cognitive and Noncognitive Function in Elderly Residents of Group Care Facilities

<i>Cognitive Deterioration</i>	5% Reduction
<i>Depressive Symptoms</i>	19% Reduction
<i>Progressive Functional Limitation</i>	53% Reduction
<i>Sleep Duration</i>	27 Minutes Increase

Riemersma-van der Lek et al
JAMA, June 11, 2008—Vol 299, No.

22

Lighting for School Applications



[Renton SD](#)

Adolescent Development & Sleep: The Perfect Storm

PRE-ADOLESCENCE

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SLEEP TIMING

Circadian
Phase
Delay

Slowed Rise
of Sleep
Pressure

BIOREGULATORY PRESSURE -> DELAY
PSYCHOSOCIAL PRESSURE -> DELAY

Bedtime
Autonomy

Academic
Pressure

Screen Time
& Social
Networking

SOCIETAL PRESSURE <-EARLY RISE

School
Start Time

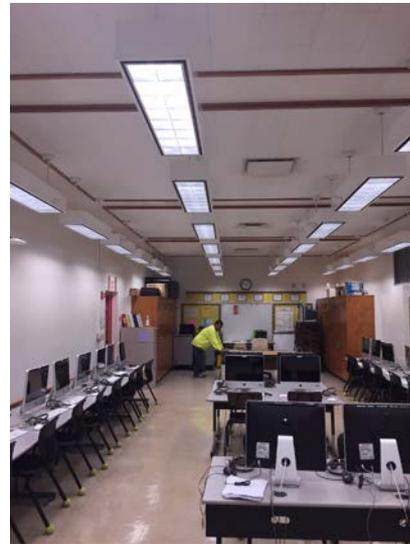
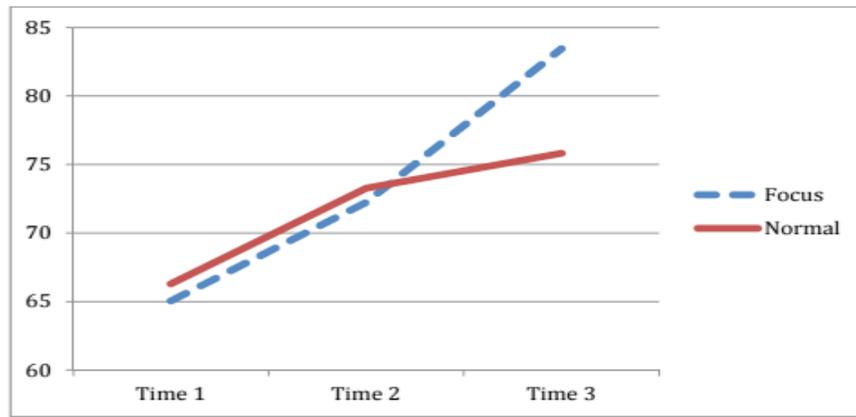
LATE TO BED, EARLY TO RISE =>
SHORT SLEEP

Oral Reading Fluency – Dr. Michael Mott

- Blue enriched white light increased Oral Reading Fluency (Reading Comprehension)
- Electrical Lighting is found to increase test scores and is key to create an effective learning environment
- An estimated 85% of children spend time indoors according to a recent study
- Next to daylight, artificial light is reported to support students visual, cognitive and behavioral skills

Figure 1

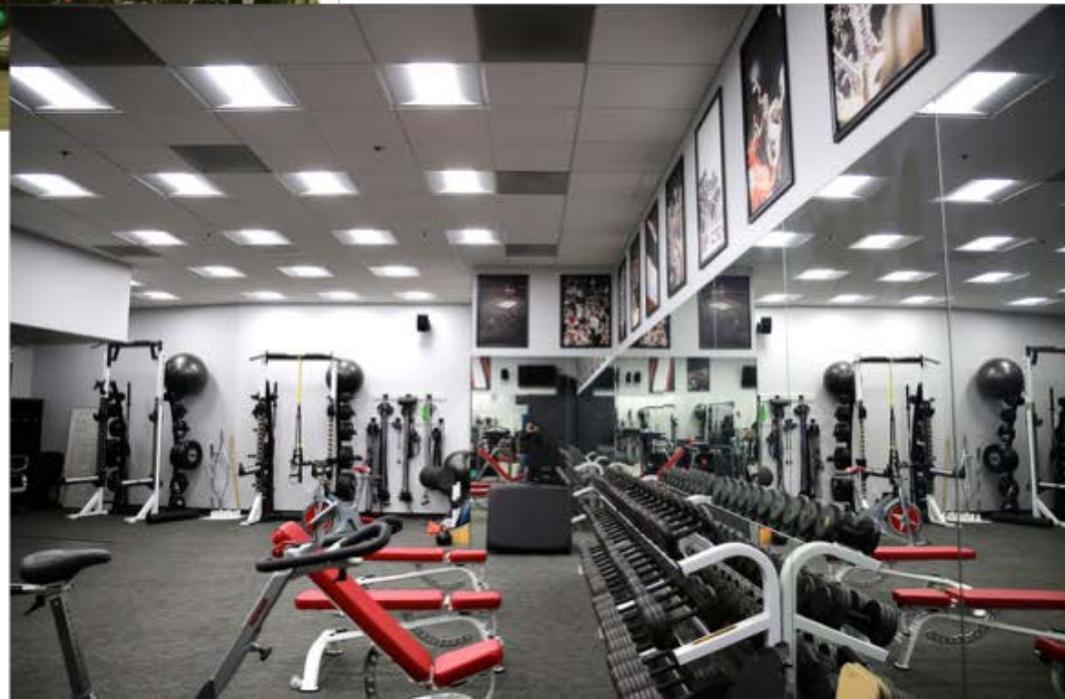
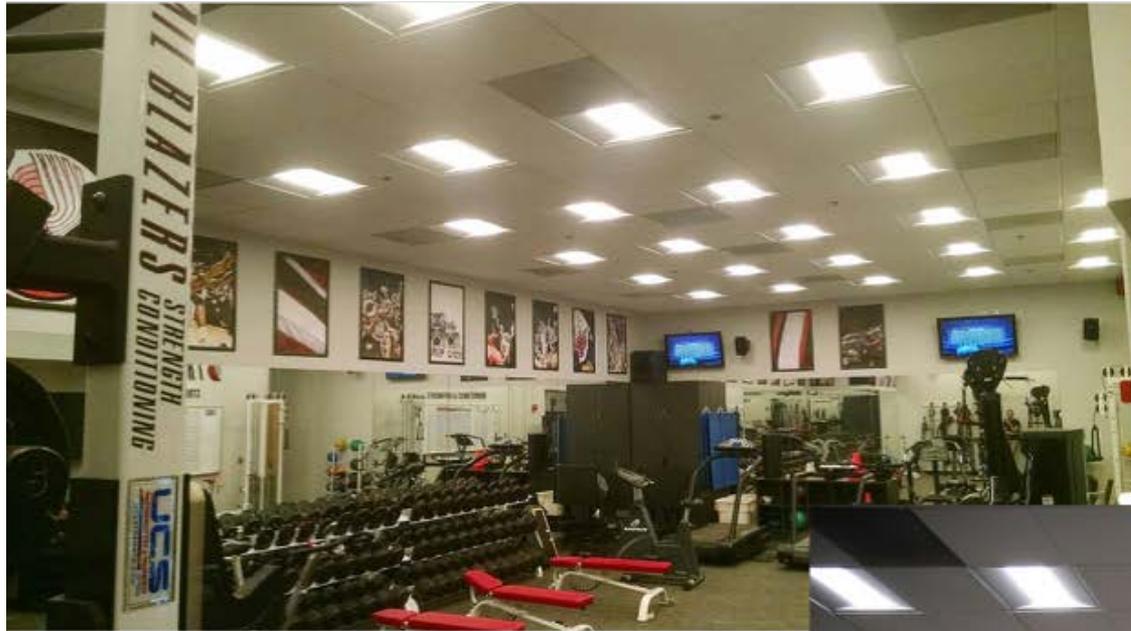
Means for Oral Reading Fluency Scores by Lighting Condition by Time



Illuminating the Effects of Dynamic Lighting on Student Learning

- Imperceptible 100 Hz flicker from fluorescent lighting can impair visual and cognitive performance
- *Blue Enriched White Light* can improve vision, concentration, motivation levels, reading speed/accuracy & attentiveness.
- **As Mood Lights have shown effectiveness in treating SAD & non seasonal mood disorders, blue enriched white lights can prepare students to be in a better mood, which is correlated to sharpness and cognitive abilities**
- Spectral Composition (SPD) & Color Temperature have been found to greatly influence student gains in reading.

Warm White to Cool White Tunable CCT Technology



Greatest Platform to Change the World

- 150+ Teams
- MLB, MLS, NBA, NHL, NLL, USTA, WNBA
- First Publication of Lighting Playbook for Sports Teams



Lighting for Increasing Winning Percentage

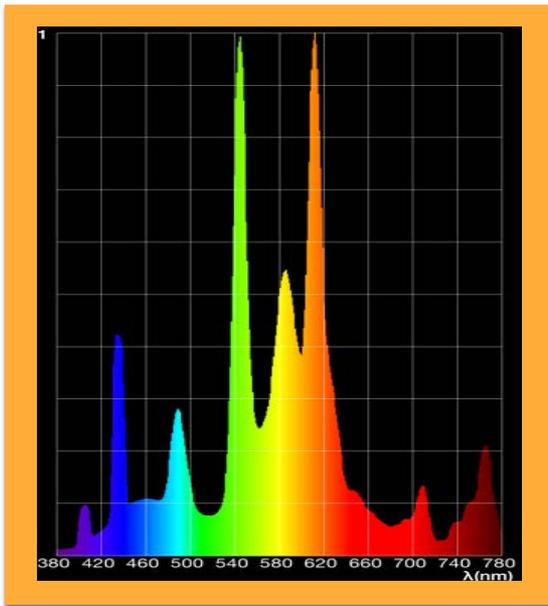
<i>Region</i>	<i>West Coast</i>	<i>East Coast</i>
<i>Winning %</i>	<i>63.5%</i>	<i>36.5%</i>
<i>Winning Points</i>	<i>14.7</i>	<i>9.0</i>
<i>Home Win %</i>	<i>59.3%</i>	<i>56.5%</i>
<i>MNF Home Win%</i>	<i>71% vs EC</i>	<i>43.8% vs WC</i>
<i>MNF Home Win %</i>	<i>58.1% vs Non-EC</i>	<i>67.5% vs Non-WC</i>

Because of the circadian rhythm, which they(EC) can't control, their bodies are past their natural performance peaks before the first quarter ends.

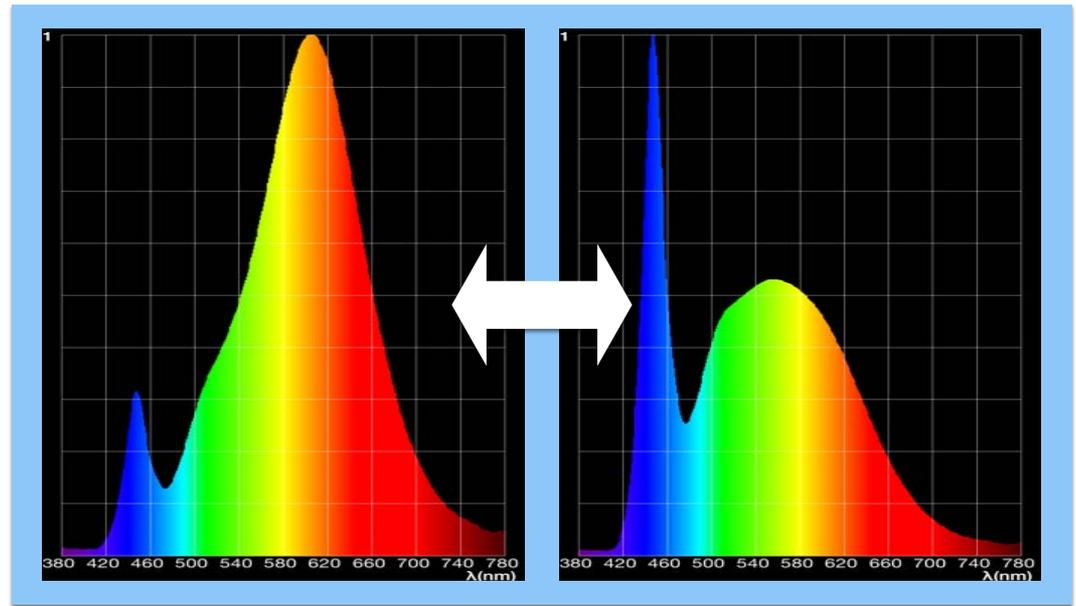


Before & After (Clubhouse)

3500K FL



2700K~6500K Beetle System





Clubhouse & Training Environment



<http://www.king5.com/story/tech/science/environment/2014/09/26/company-brightens-offices-and-moods/16296317/>

<http://planled.com/?portfolio=mariners-project-introduction>

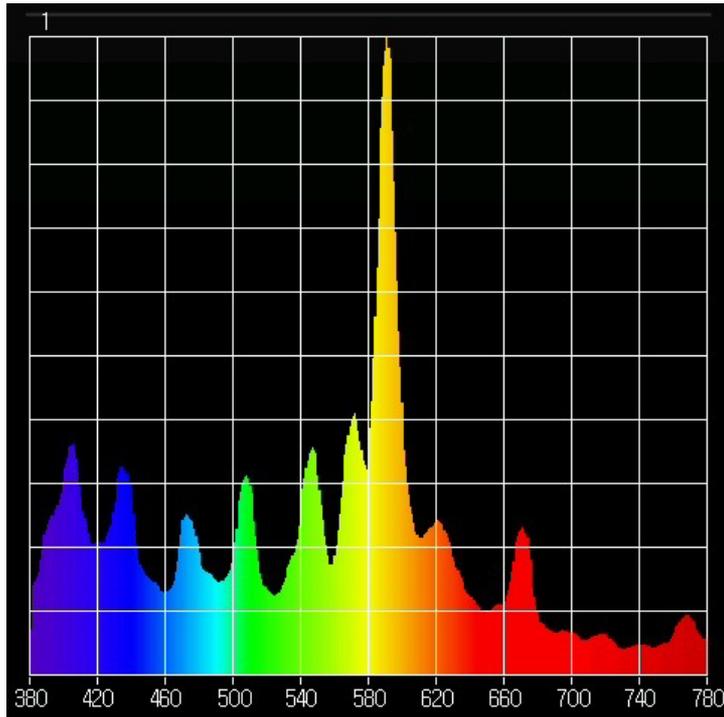


[Mariners Project Q&A](#)

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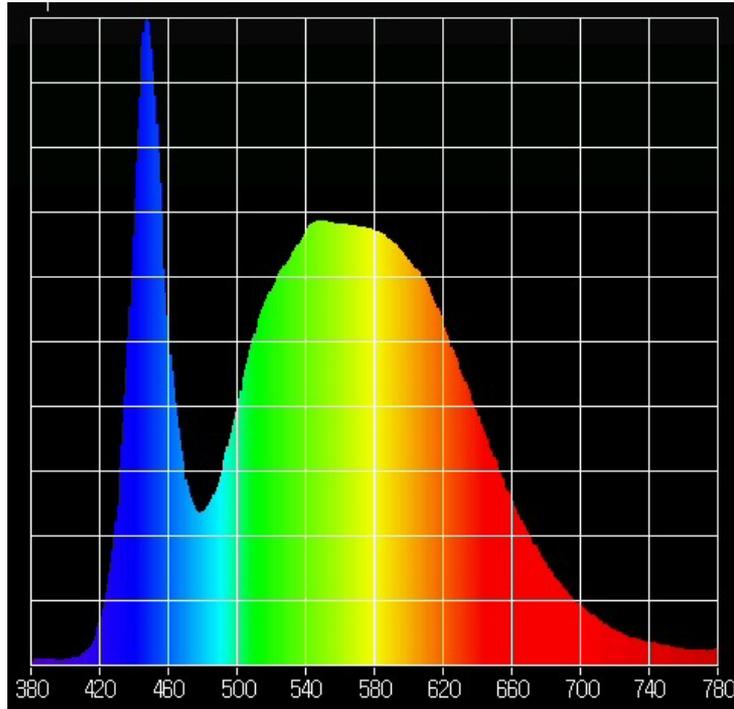


Metal Halide



Light Level	20~30% Below League Guideline (Most of the Stadiums)
CRI <small>True to Life Color Rendering</small>	63 - Faded Vision / Difficult to Deliver True Colors for Broadcasting
R9	-113 (Negative R9 Provides Poor 'Red' Rendering)
Flickering	Magnetic Ballast Creates Flickering
Color Temperature	3500 - 3800K (Close to Sunset/Sunrise - Relaxes the Players)
Uniformity	With Quick Depreciation Creates Less Uniform Distribution
Noise	Loud Buzzing Noise
Glare	Difficult to Control Omni-Directional Light Source
Control	No Control - 15 Minute Restrike Time
Measurement Taken with MK-350 on January 7th at Safeco Field with No Ambient Light at 7PM	

LED Technology



Light Level	Meet League Guideline (20% Additional Visual from Blue Spectrum)
CRI <small>True to Life Color Rendering</small>	80 - Realistic Color Rendering for Broadcast Cameras
R9	+5 (Positive R9 - Better Red Rendering)
Flickering	Non Flicker Technology - Ready for 640 FPS UHD Slow Motion
Color Temperature	5000K (More Alertness & Better Reaction Time for Players - Dr. Lockley, Harvard University)
Uniformity	Long Life(30+ Years) with Optically Controlled Uniformity
Noise	No Noise
Glare	Less glare for players, fans & also dark sky initiative
Control	Instant On / Fully Dimmable
Measurement Taken at Planled Experience Center on January 8th with MK-350.	

UHD/USM Broadcasting

New Broadcasting Standard

Glare Rating, Vertical Uniformity, Improved CRI

Flicker Free System Up to 960 FPS+



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RGB Façade Lighting Applications

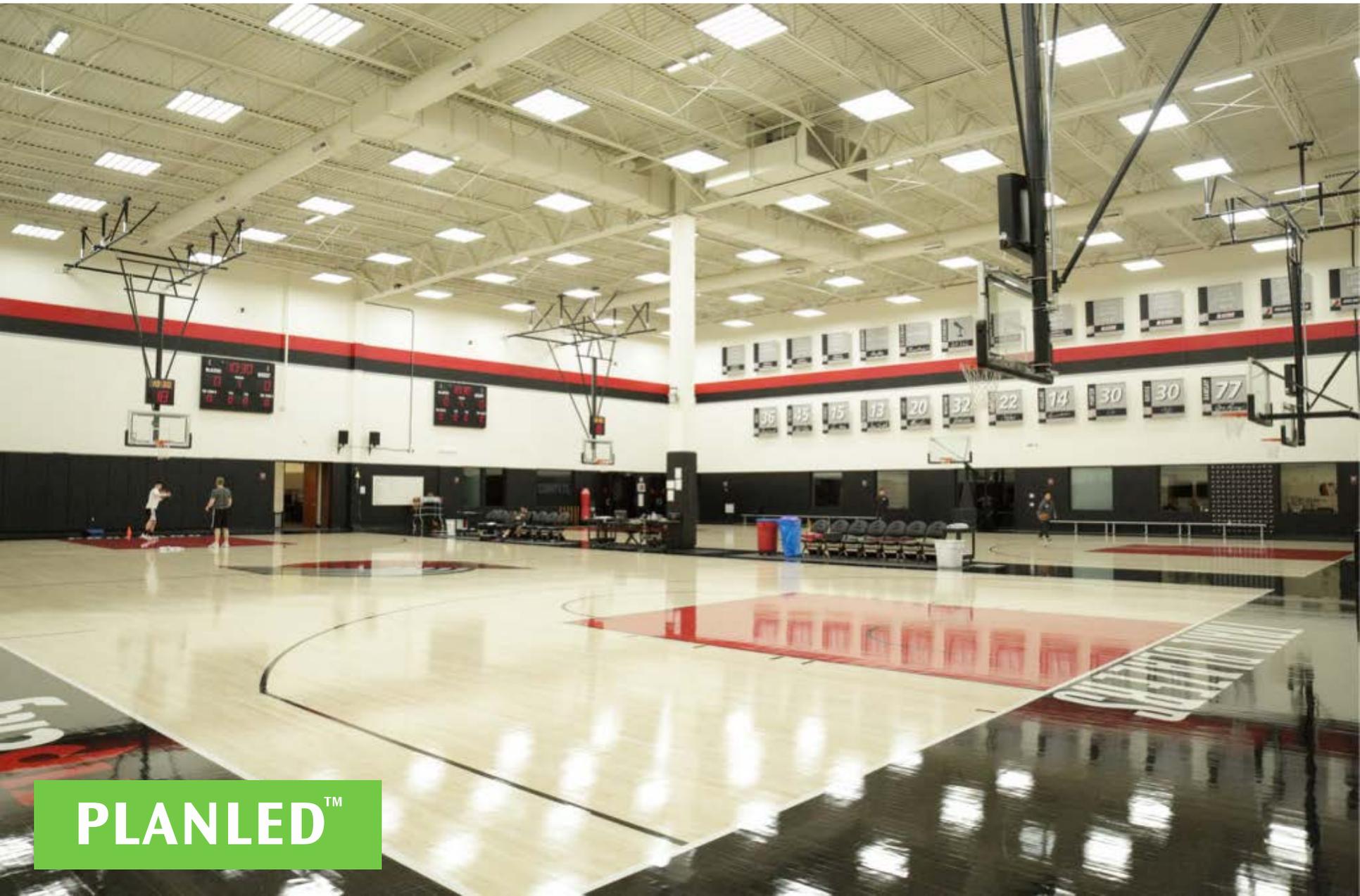


New Paradigm of Indoor Sports Lighting



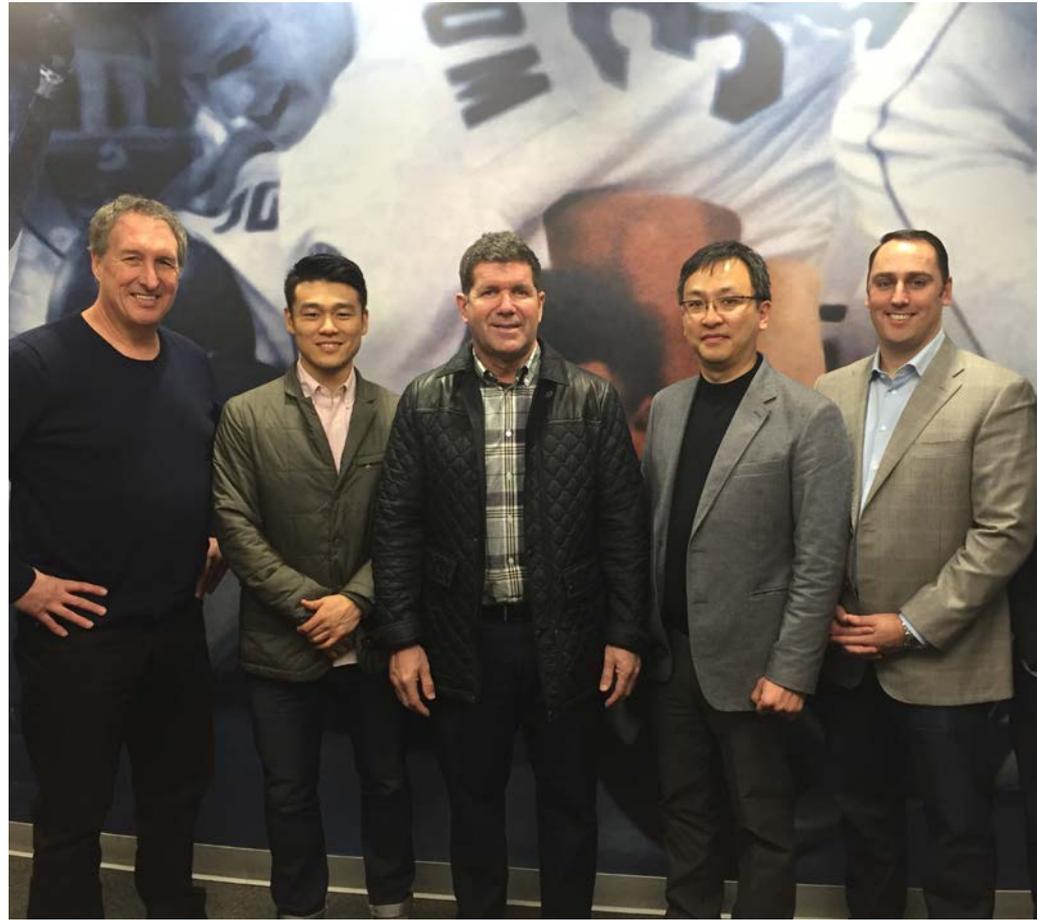
PLANLED™

New Paradigm of Indoor Sports Lighting



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Lighting for Humans, Not for Buildings!



PLANLED™

Let's Change the World Together



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<http://HumanCentricLighting.org>