

LIGHT

and the challenge of prescriptive standards

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what museums do.....

DISPLAY & PRESERVE

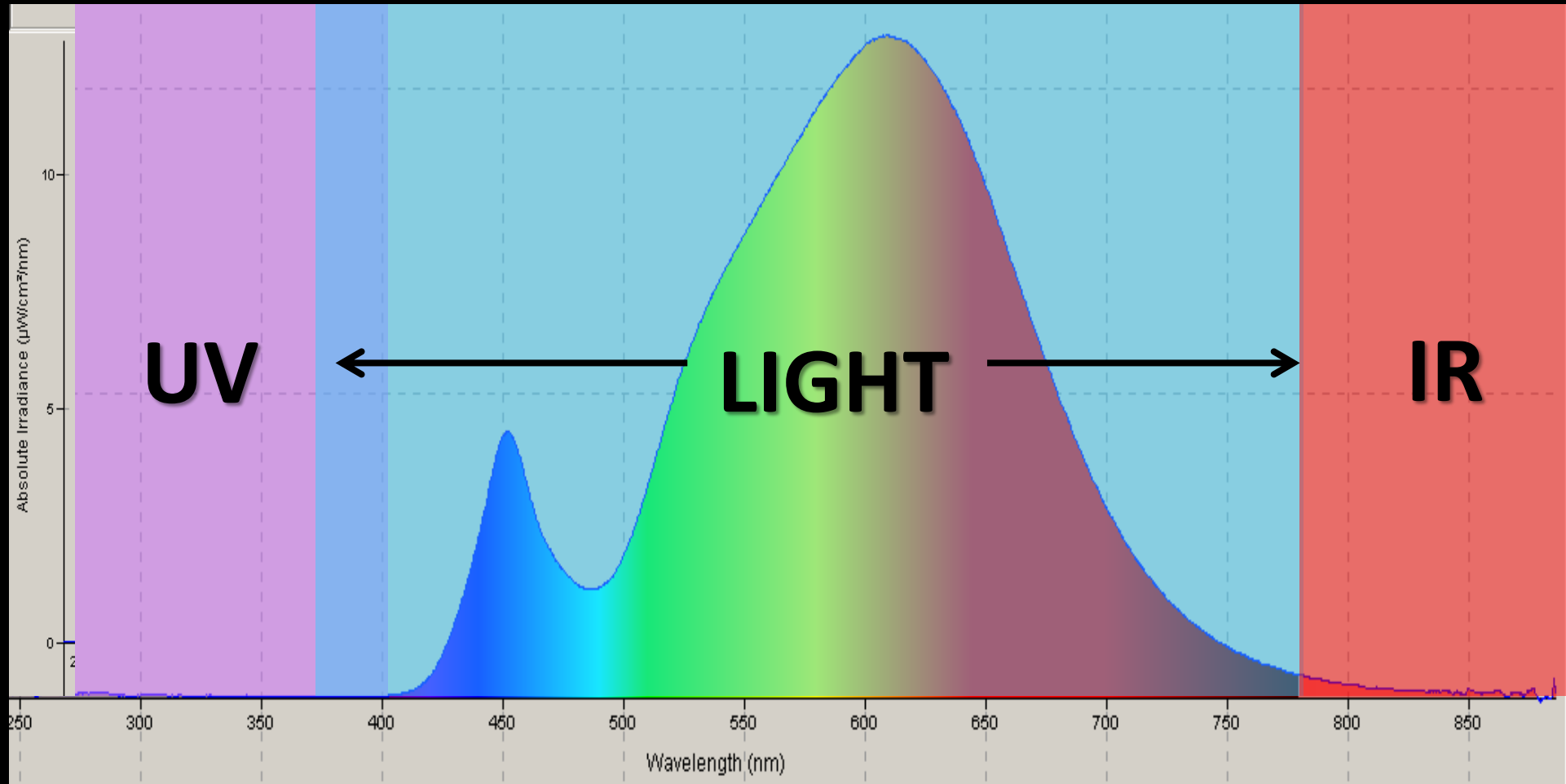
50 Lux

Very light sensitive objects



What is light?

Assessing Light, UV, and IR





Blue LED

+

Phosphor

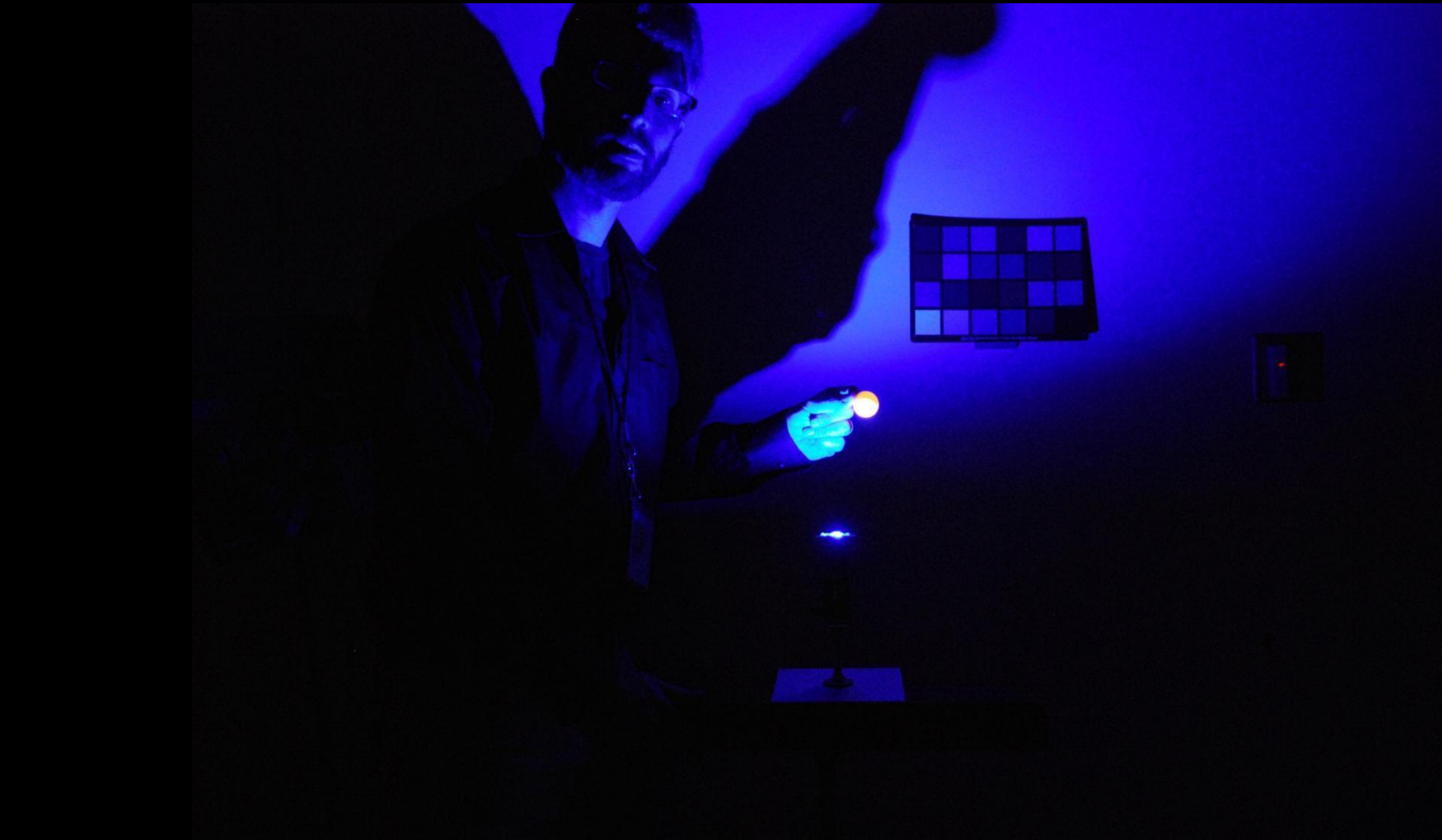


SMASHED OPEN BULB
SHOWING LEDs



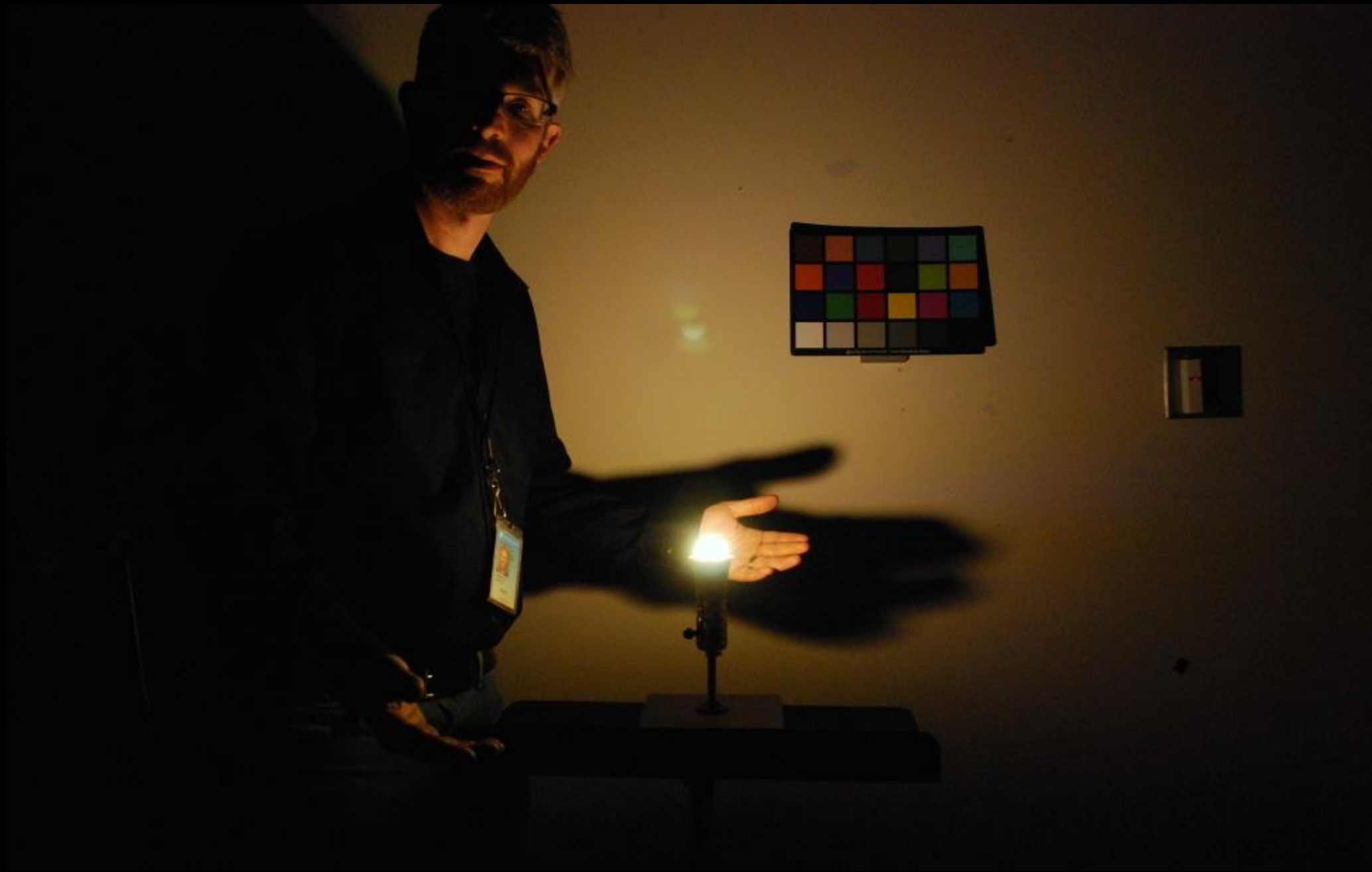
REMOTE PHOSPHOR
DISK SITS OVER LEDs

BLUE LEDS

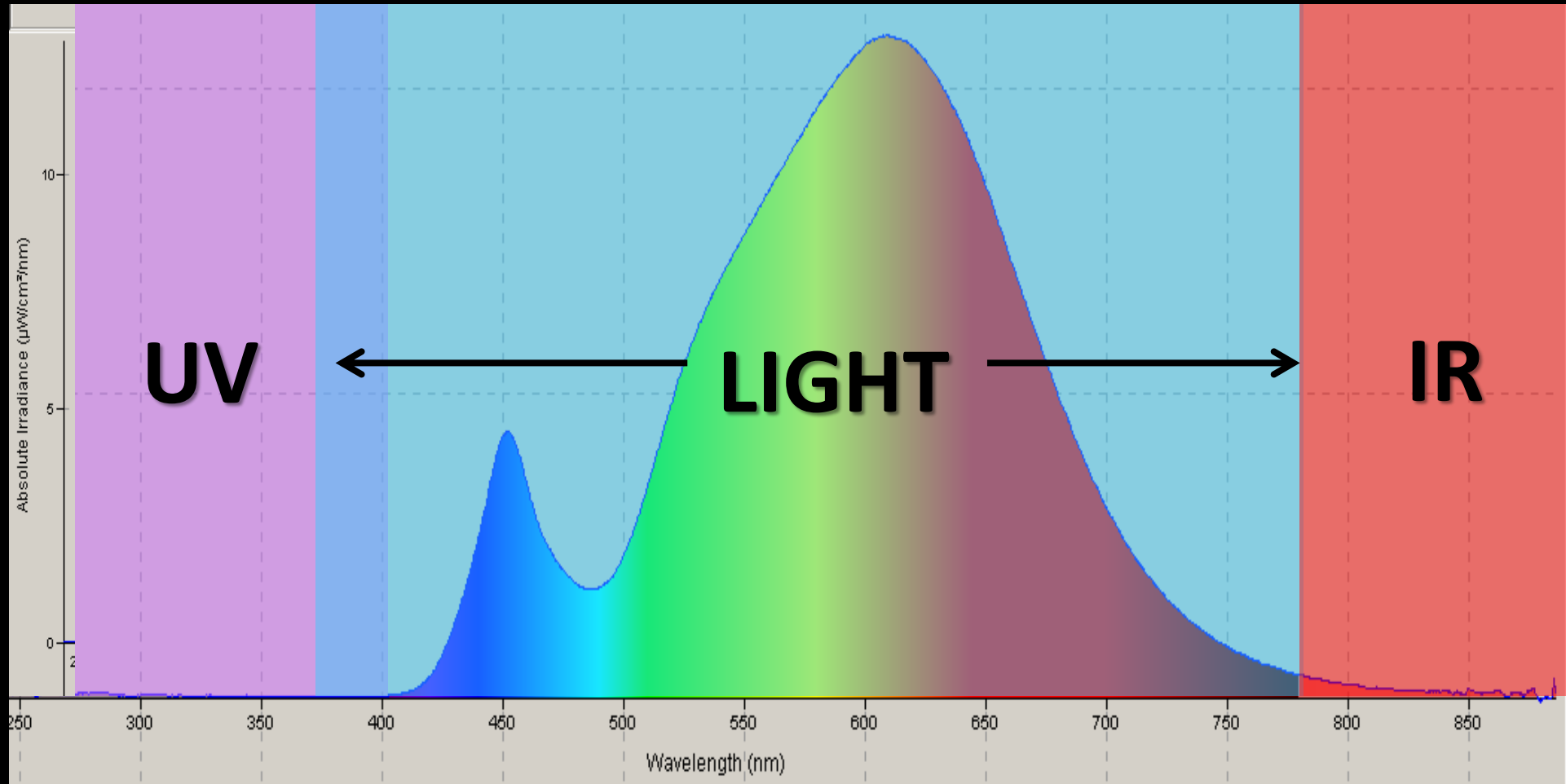




BLUE LEDS + **Remote Phosphor**



Assessing Light, UV, and IR



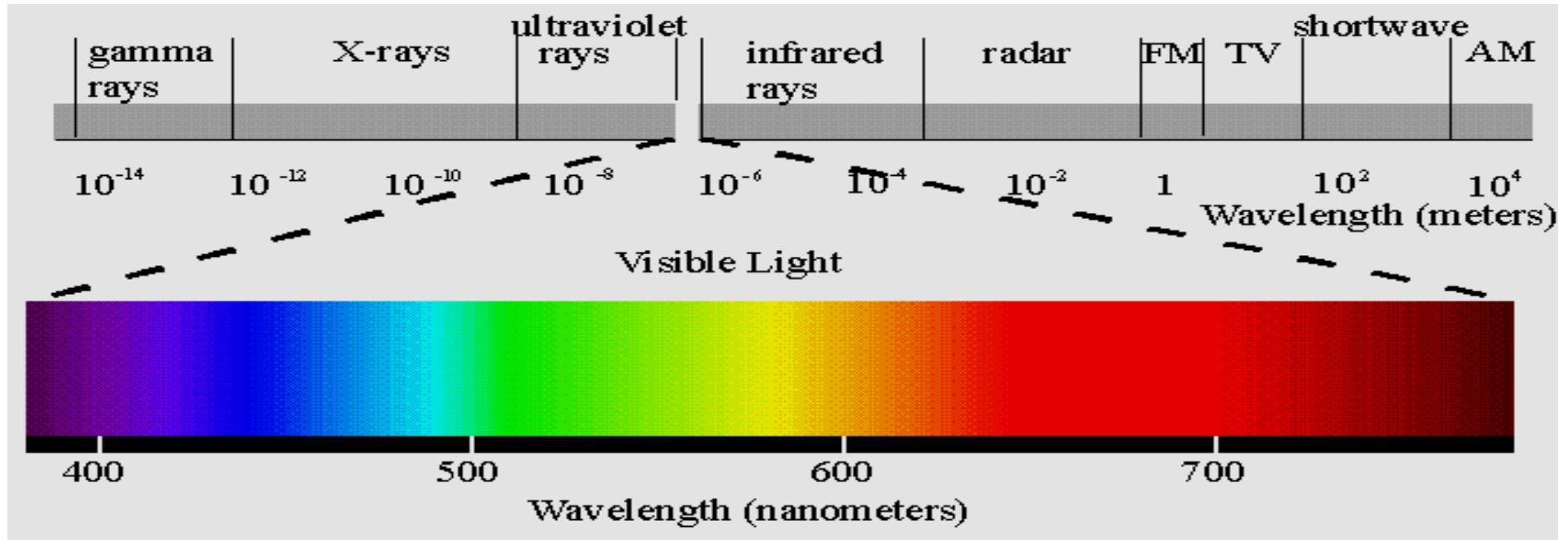
Optical energy assessments.....

- Light
- Material Damage
- Circadian Response
- Optical Safety

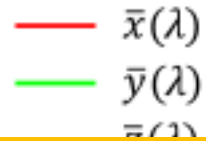
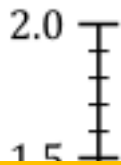


Assessment Criteria

1. Action spectra
2. Quantity of action spectra
3. Duration of exposure

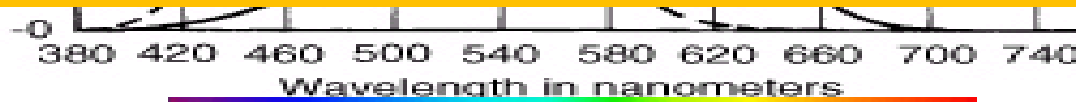


**ACTION
SPECTRA**



**CIE 1931 Standard
Colorimetric Observer**

ACTION SPECTRA



SOURCE: IES

QUANTITY

METRIC	UNIT	USE
Luminous Flux	<ul style="list-style-type: none">• Lumen	Quantify potential light spread in all directions
Illuminance	<ul style="list-style-type: none">• Lux = lumens/ meter²• Footcandles= lumens/foot²	Quantify light striking surface
Luminance	<ul style="list-style-type: none">• Candella/ Meter² (cd²)	Quantify light directed toward eye



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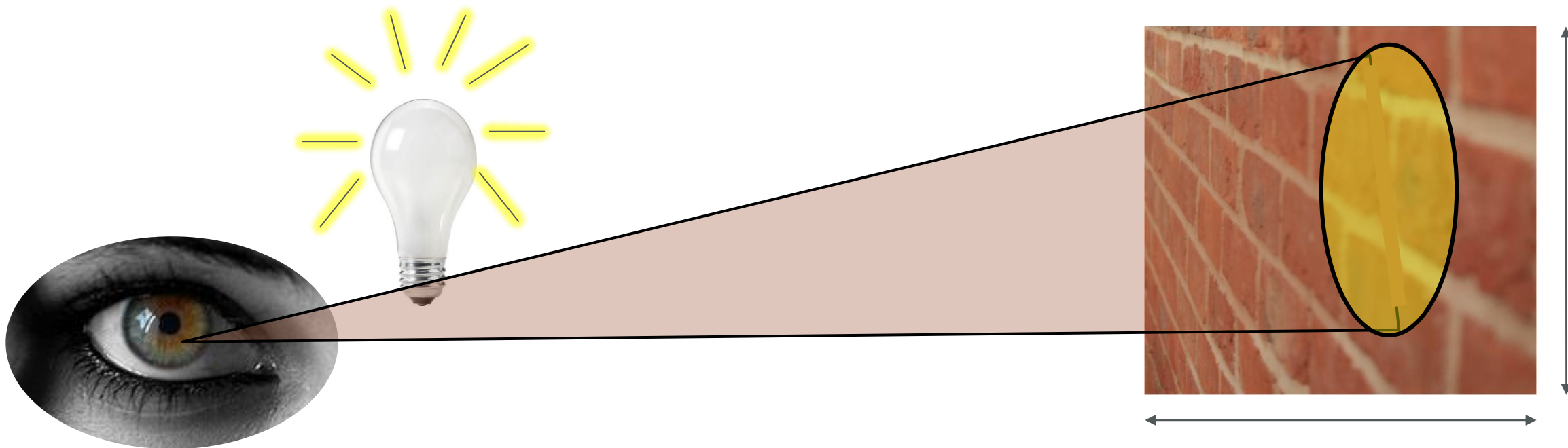
METRIC	UNIT	USE
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10.76 LUX = 1 FOOTCANDLE



METRIC	UNIT	USE
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DURATION

Additional Criteria that Effect Visibility

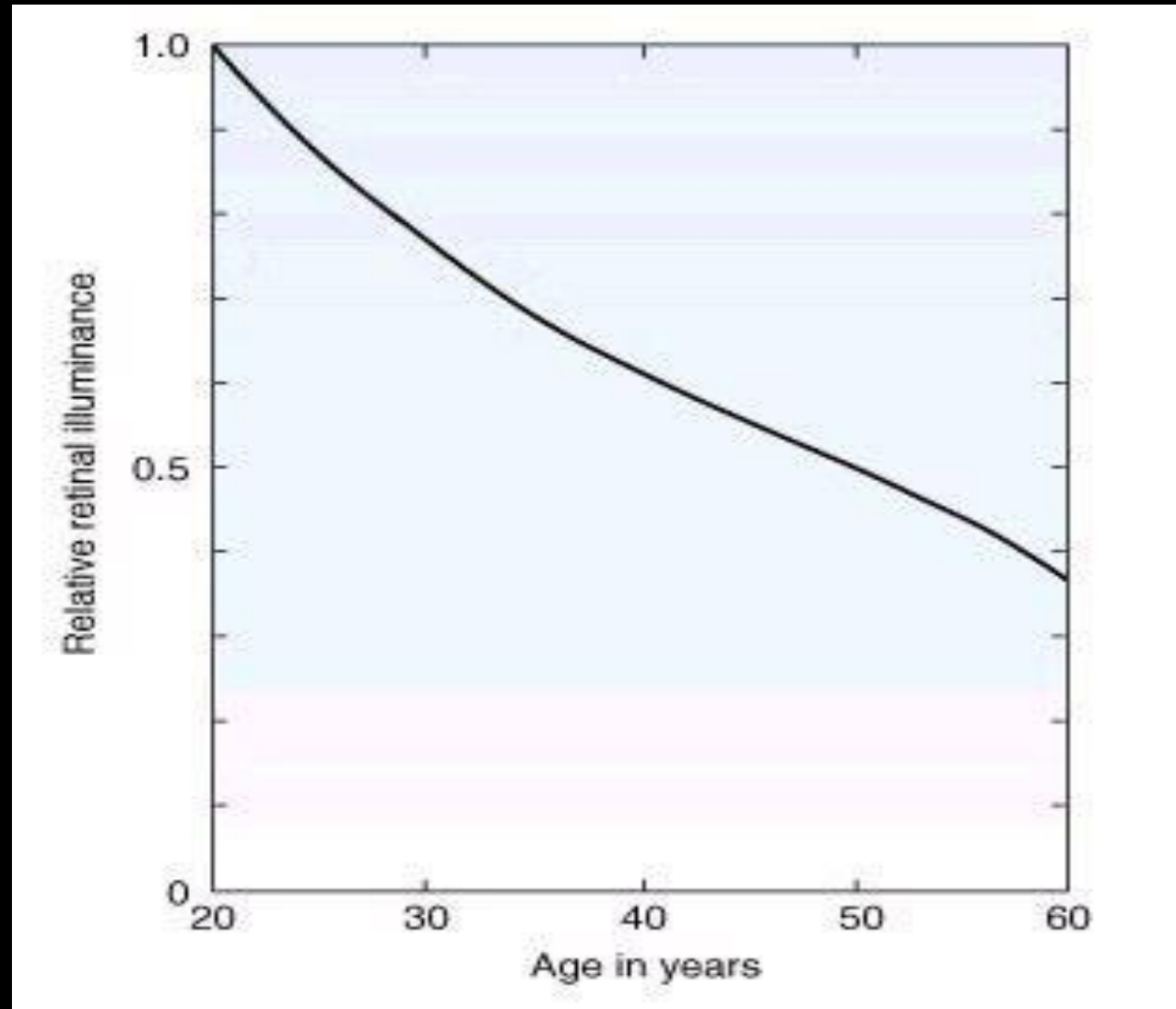
1. Reflectance of surfaces
2. Contrast between surfaces
3. Age of Viewer

GLOSS



Additional Criteria that Effect Visibility

1. Reflectance of surfaces
2. Contrast between surfaces
3. Age of Viewer



***The Decline in Retinal Illuminance with Age
(Source: IES)***

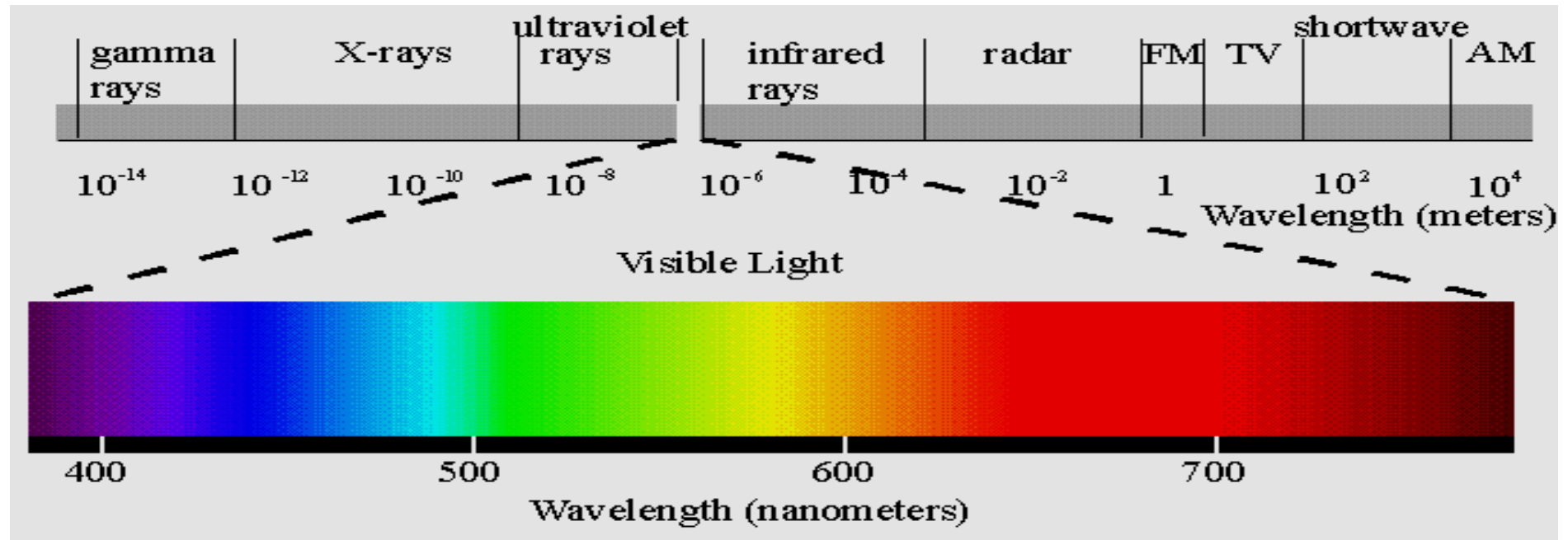
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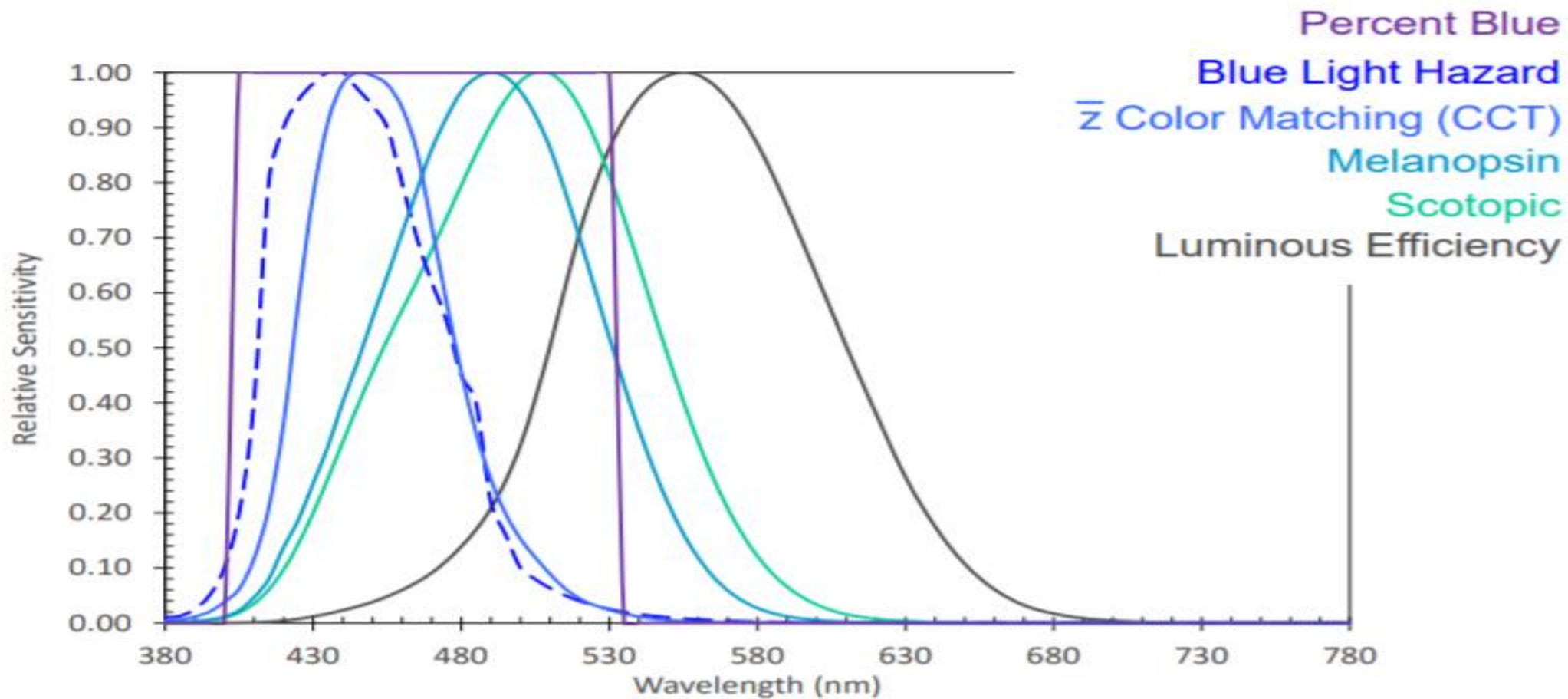


Assessment Criteria

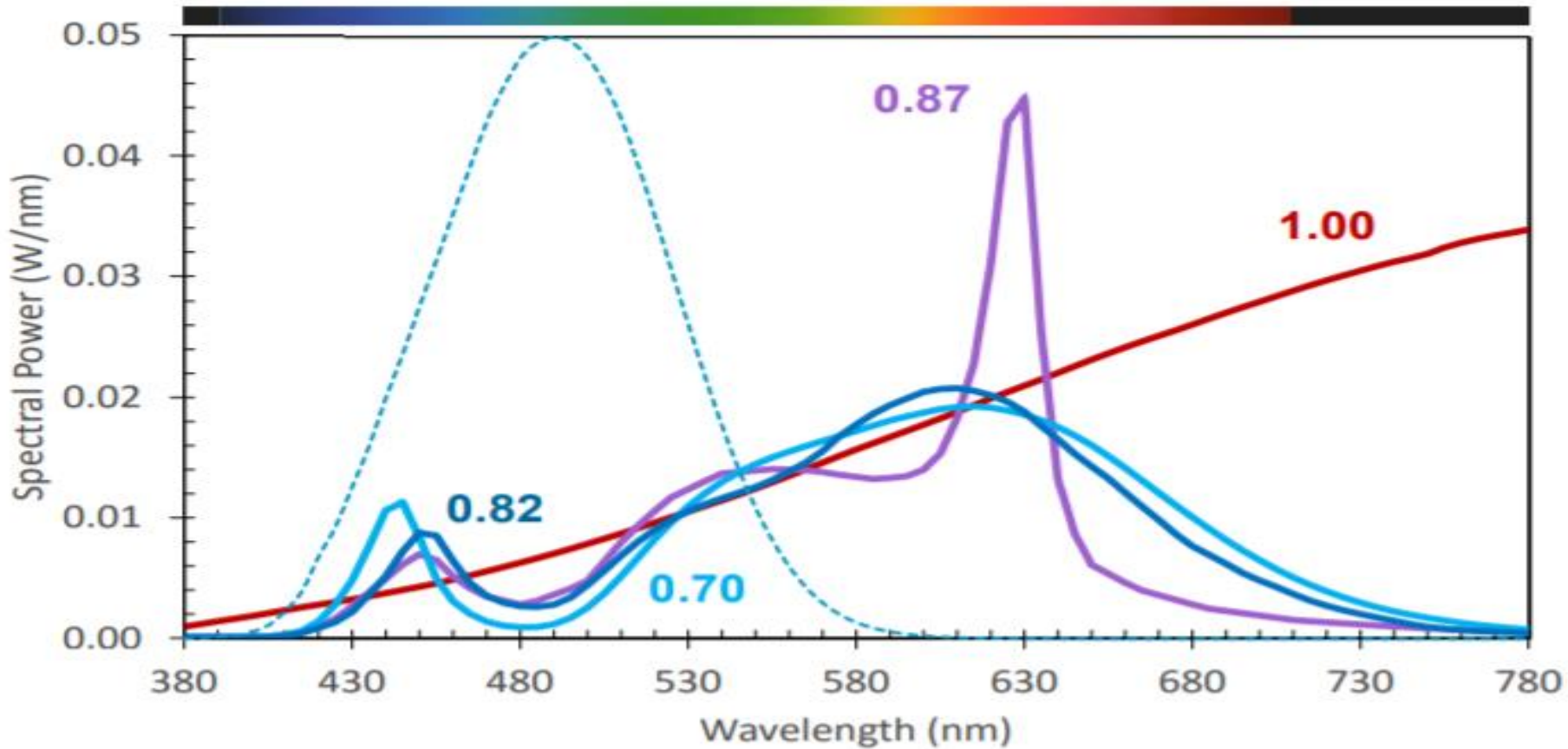
1. Action spectra
2. Quantity of action spectra
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BLUE LIGHT HAZARD AND ipRGC RESPONSE



Comparing Spectral Power Distributions



Melanoptic Response

47 (Values shown are relative M/P ratio)

Compare with numbers!

Row	Light source	Luminous Flux (lm)	CCT (K)	% Blue*	Relative Scotopic Potential	Relative Melanopic Potential**	Relative BLH Potential
A	PC White LED	1000	2700	17% - 20%	0.80 - 0.99	0.70 - 0.99	0.79 - 1.05
B	PC White LED	1000	3000	18% - 25%	0.85 - 1.08	0.77 - 1.10	0.67 - 1.35
C	PC White LED	1000	3500	22% - 27%	0.92 - 1.24	0.86 - 1.31	1.21 - 1.70
D	PC White LED	1000	4000	27% - 32%	0.95 - 1.20	0.86 - 1.25	1.38 - 1.94
E	PC White LED	1000	4500	31% - 35%	1.06 - 1.29	1.01 - 1.40	1.77 - 2.11
F	PC White LED	1000	5000	34% - 39%	1.17 - 1.31	1.17 - 1.38	1.91 - 2.46
G	PC White LED	1000	5700	39% - 43%	1.25 - 1.50	1.27 - 1.66	2.22 - 2.74
H	PC White LED	1000	6500	43% - 48%	1.48 - 1.79	1.61 - 2.15	2.52 - 2.84
I	Narrowband Amber LED	1000	1606	0%	0.16	0.04	0.02
J	Low Pressure Sodium	1000	1718	0%	0.16	0.04	0.01
K	PC Amber LED	1000	1872	1%	0.32	0.15	0.06
L	High Pressure Sodium	1000	1959	9%	0.40	0.32	0.36
M	High Pressure Sodium	1000	2041	10%	0.45	0.37	0.42
N	Mercury Vapor	1000	6924	36%	1.05	0.91	2.58
O	Mercury Vapor	1000	4037	35%	0.96	0.92	3.36
P	Metal Halide	1000	3145	24%	0.98	0.94	1.28
Q	Metal Halide	1000	4002	33%	1.14	1.16	2.15
R	Metal Halide	1000	4041	35%	1.28	1.38	2.14
S	Moonlight***	1000	4681	29%	1.50	1.68	2.26
T	Incandescent	1000	2812	11%	1.00	1.00	1.00
U	Halogen	1000	2934	13%	1.03	1.03	1.03
V	F32T8/830 Fluorescent	1000	2940	20%	0.91	0.84	1.08
W	F32T8/835 Fluorescent	1000	3480	26%	1.07	1.05	1.50
X	F32T8/841 Fluorescent	1000	3969	30%	1.17	1.17	1.68

* Percent blue calculated according to LSPDD: Light Spectral Power Distribution Database,

<http://galileo.graphyics.cegepsherbrooke.qc.ca/app/en/home>

** Melanopic content calculated according to CIE Irradiance Toolbox, http://files.cie.co.at/784_TN003_Toolbox.xls, 2015

*** Measurement by Telelum. Moonlight does not have a constant CCT.

PC – Phosphor Converted LED

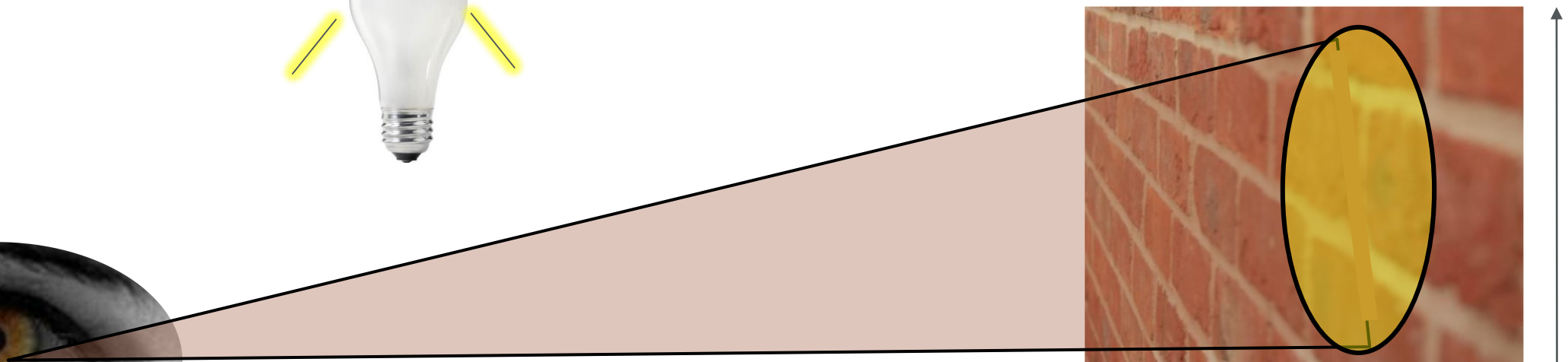
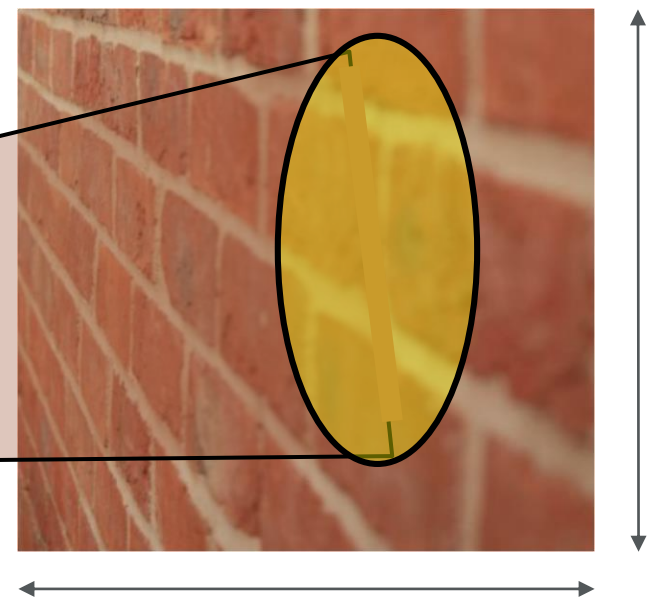
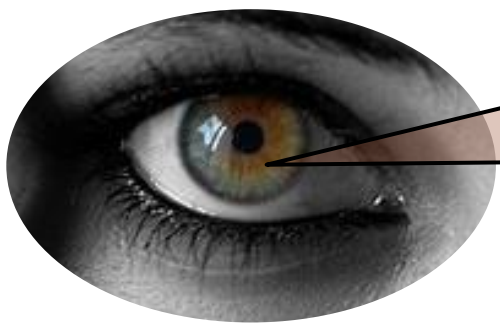




BLUE LEDS



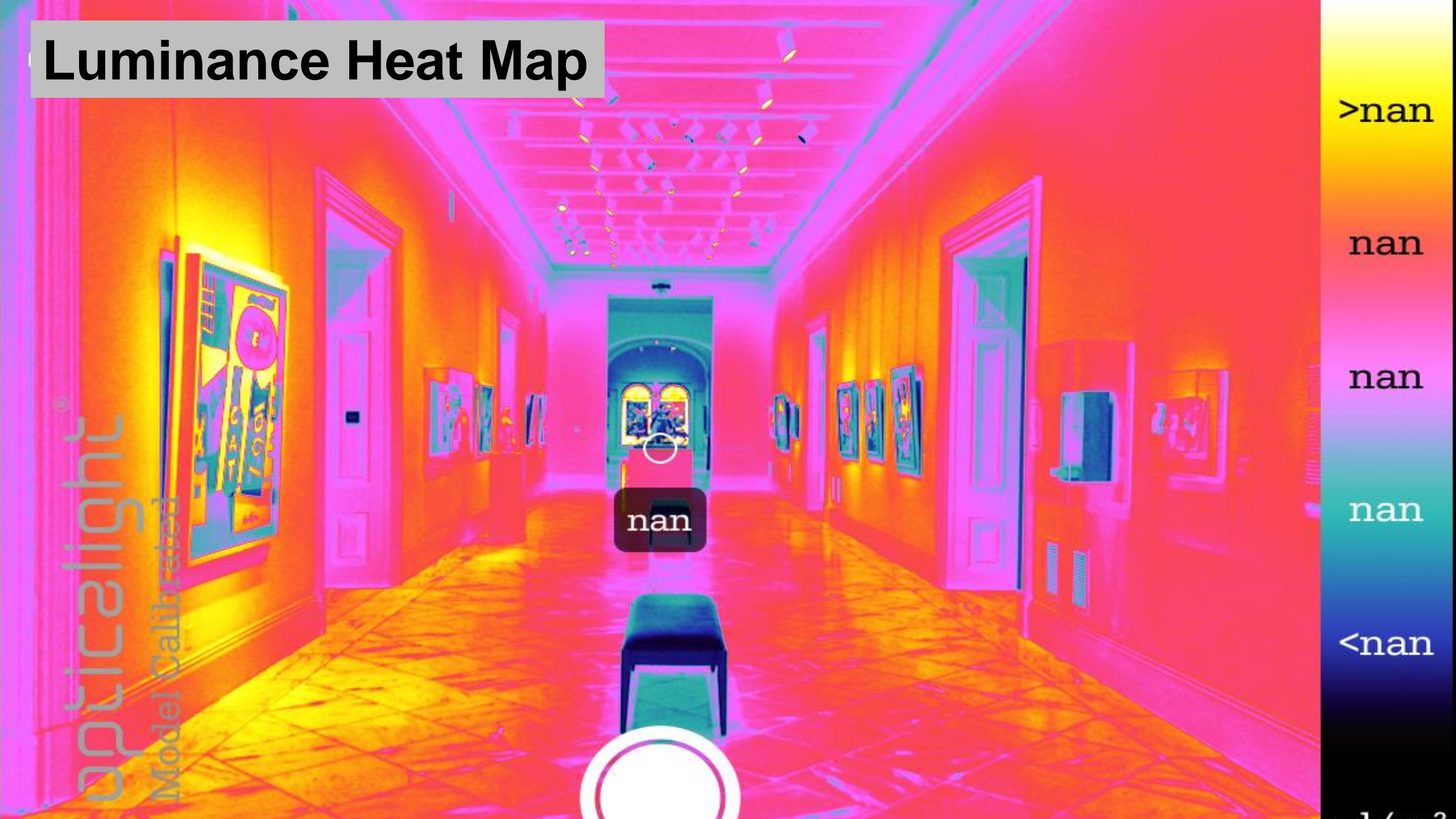
LUMINANCE BASED DESIGN



REAL
WORLD
EXAMPLES



Luminance Heat Map



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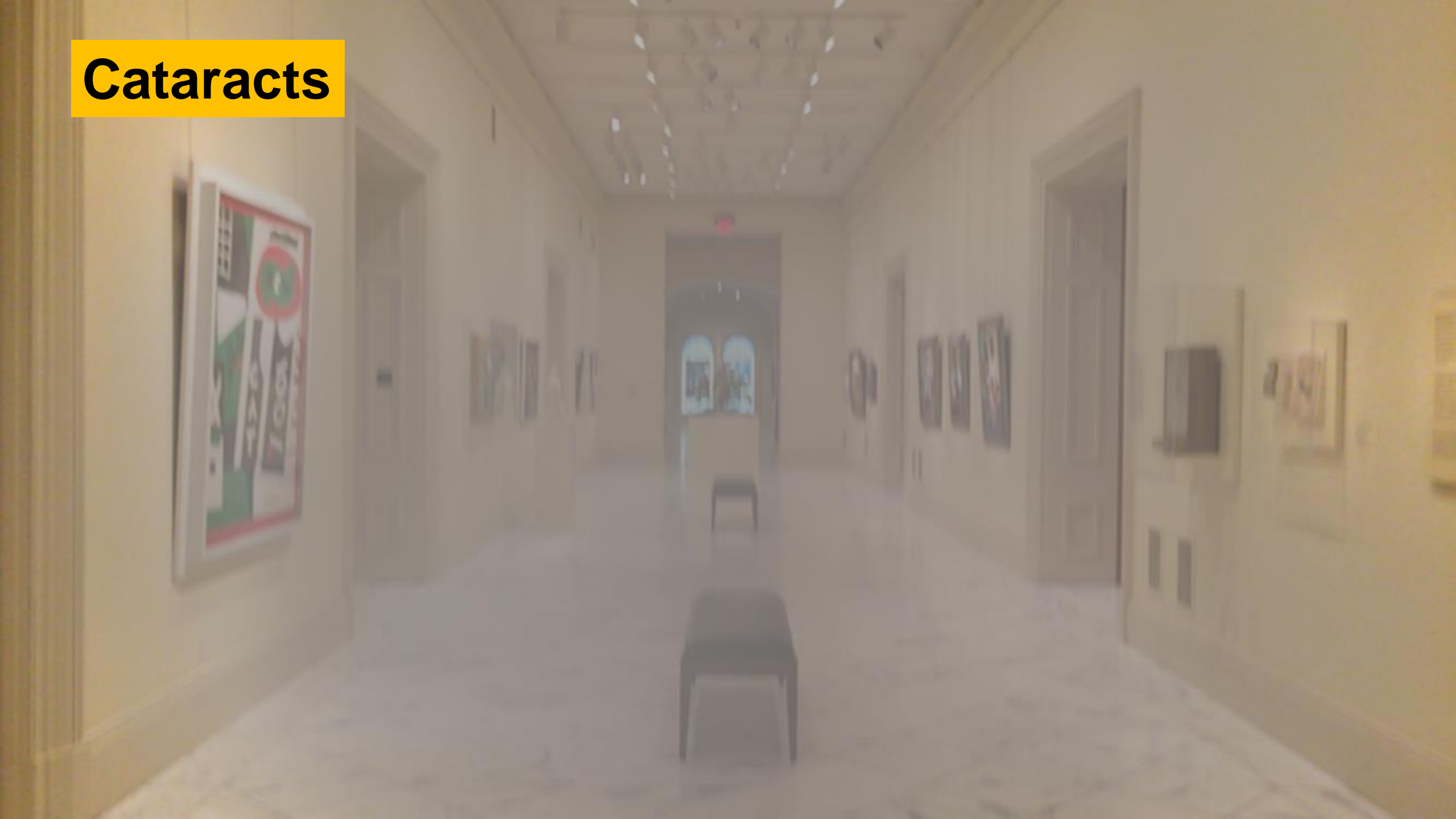
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opticalight®
Model Calibrated



Cataracts



Retinis Pigmentosa



Glaucoma



Macular Degeneration





**HOW MUCH LIGHT DO PEOPLE REALLY NEED TO
SAFELY NAVIGATE THE BUILT ENVIRONMENT?**

THOMAS
WILFRED

LUMIA

AND THE
ART OF LIGHT

Lumia, Thomas Wilfred and the Art of Light was supported by the
Organizer, the Alice and John Hagan Endowment, under the terms of the
Paintings and Sculpture of the Yale University Art Gallery and was
made possible by the Terra Foundation for American Art. Additional
support was provided by Mary Jo and John Shook, and the
Friedlander, the David Bernard Foundation, the Yale University
and Publication Fund, and the Friends of the Museum of Art
Exhibition and Publication Fund.

The presentation of the Smithsonian American Art Museum in
collaboration with the United States House and Congress and
Congressional funding for the exhibition was provided by:

Elizabeth Brown Custard Endowment
James F. Zinke Family Endowment
Kahn Design Foundation

TERRA























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