TM - 30 15
Lighting Passport
יוני 2016

NISKO
ELECTRICITY &
ELECTRONICS LTD

מרצה: מהנדס שחר שרעבי .EE B.Sc
מהנדס החברה – "ניסקו חשמל ואלקטרוניקה"

תוכן המצגת

- חזרה קצרה על מושגי יסוד בתאורה
- CRI, CQS, TM-3015 – מדידת איכות הצבע
- Lighting Passport - למדידת איכות האור

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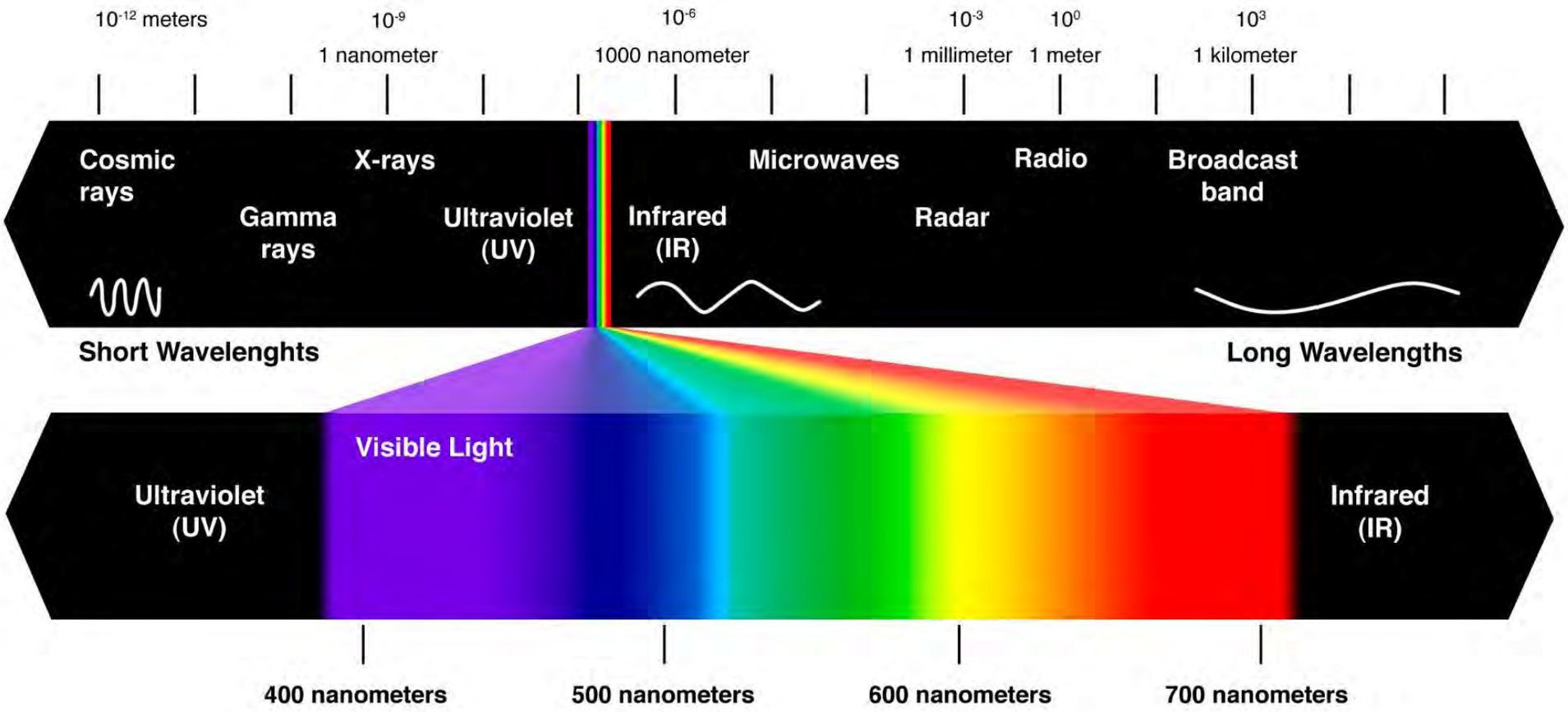
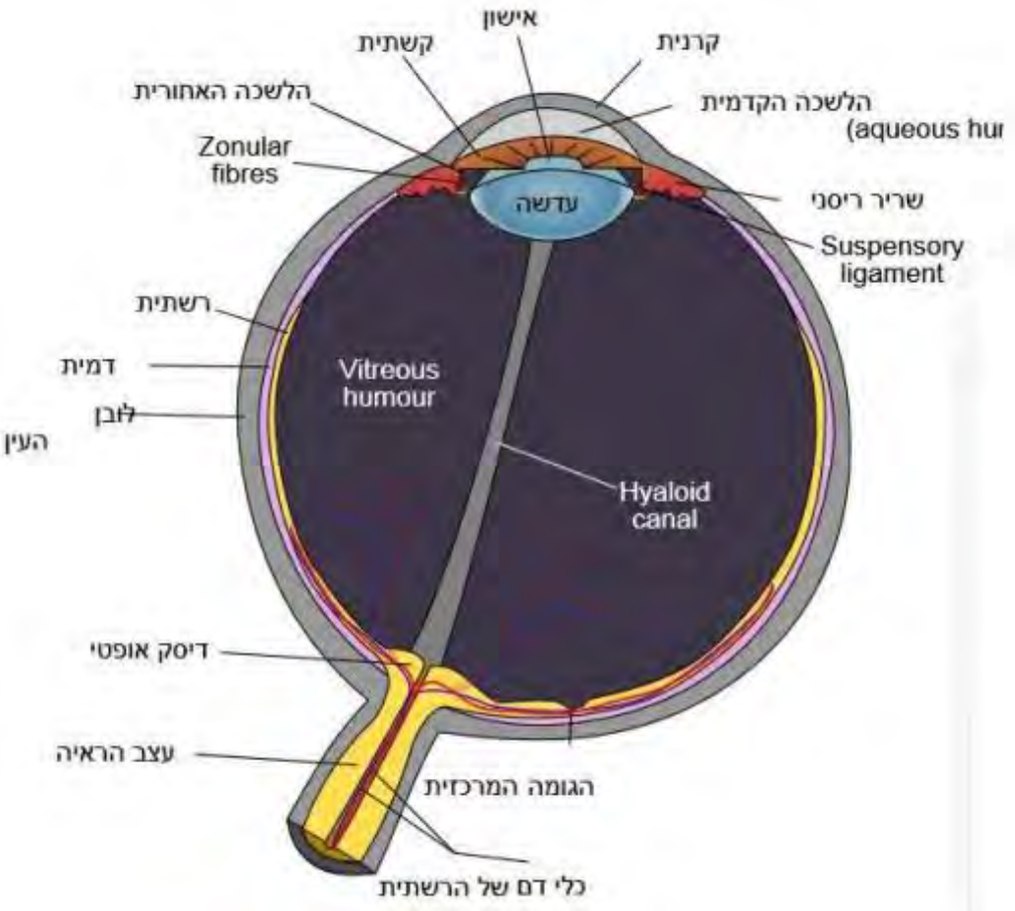
- למדידת איכות האור - Lighting Passport

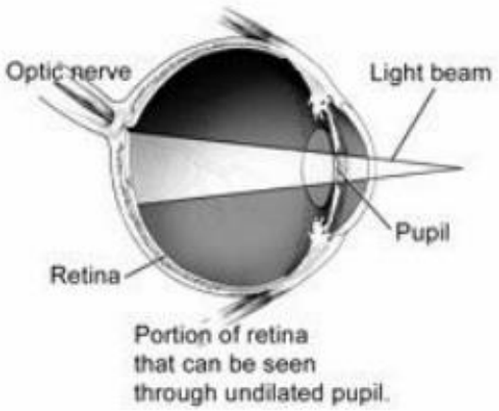
מושגי יסוד - ספקטרום

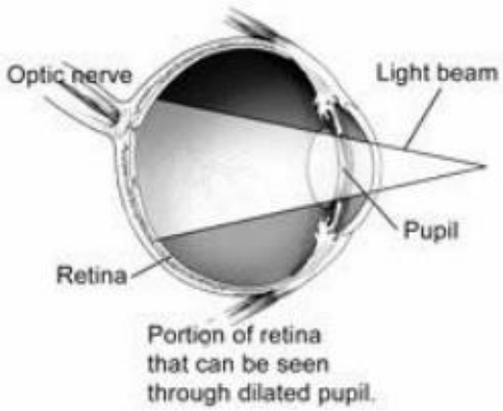


מושגי יסוד - רגישות העין ליום ולילה

- בחושך – האישון גדל
- באור – האישון קטן

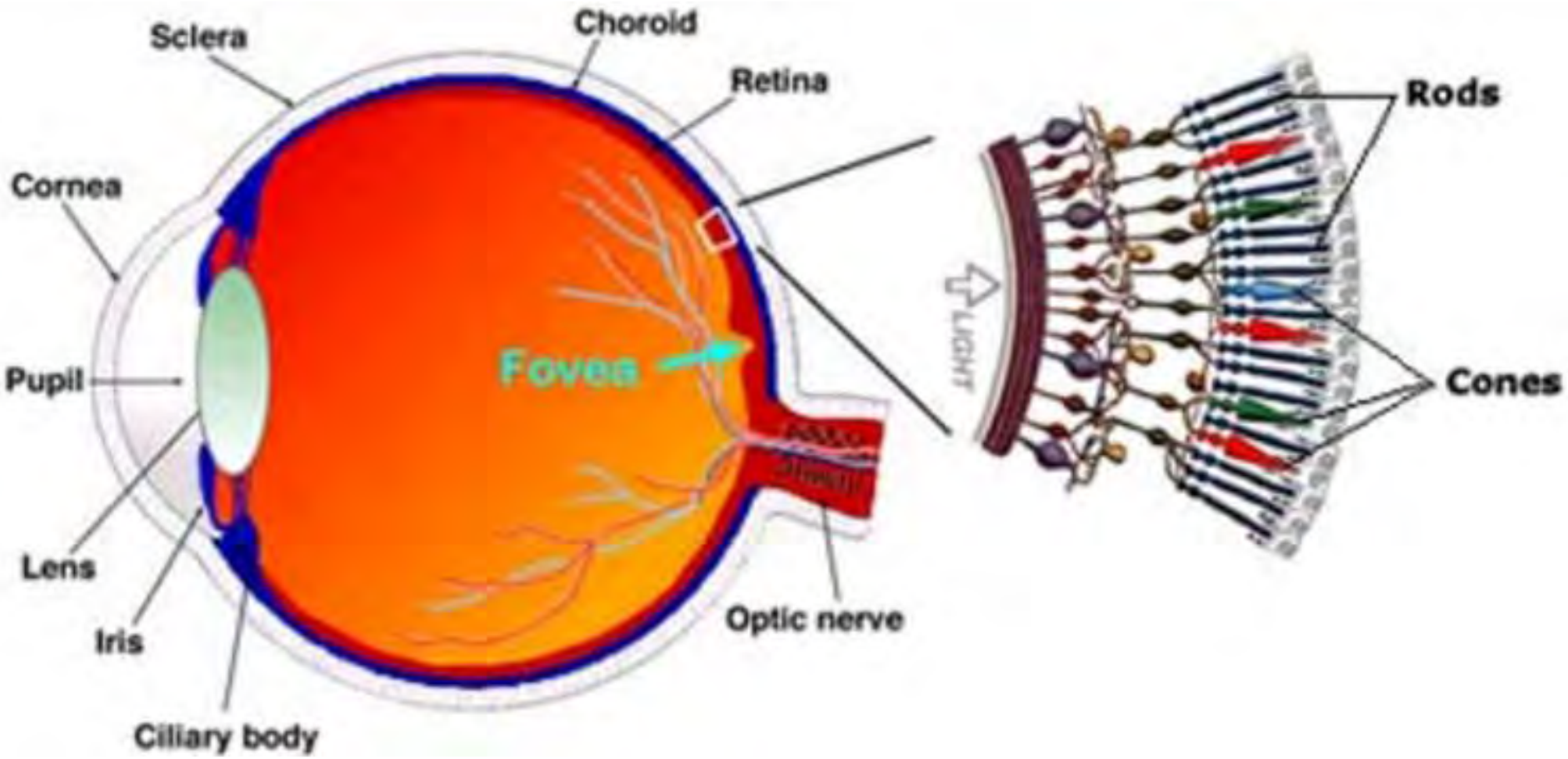






מושגי יסוד – מבנה העין

- מבנה העין האנושית:
  - חרוטים – כ- 6 מיליון
  - מקלונים – כ- 120 מיליון



מושגי יסוד

Φ – Luminous flux

Lumen (lm) **שטף אור**

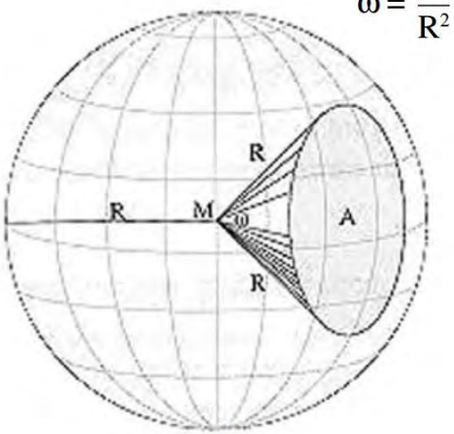
I - Luminous intensity

Candela (cd) **- עוצמת האור**

$$I = \frac{\Phi}{\omega}$$

היחס בין שטף האור לזווית המרחבית שדרכו הוא עובר

$$\omega = \frac{A}{R^2}$$



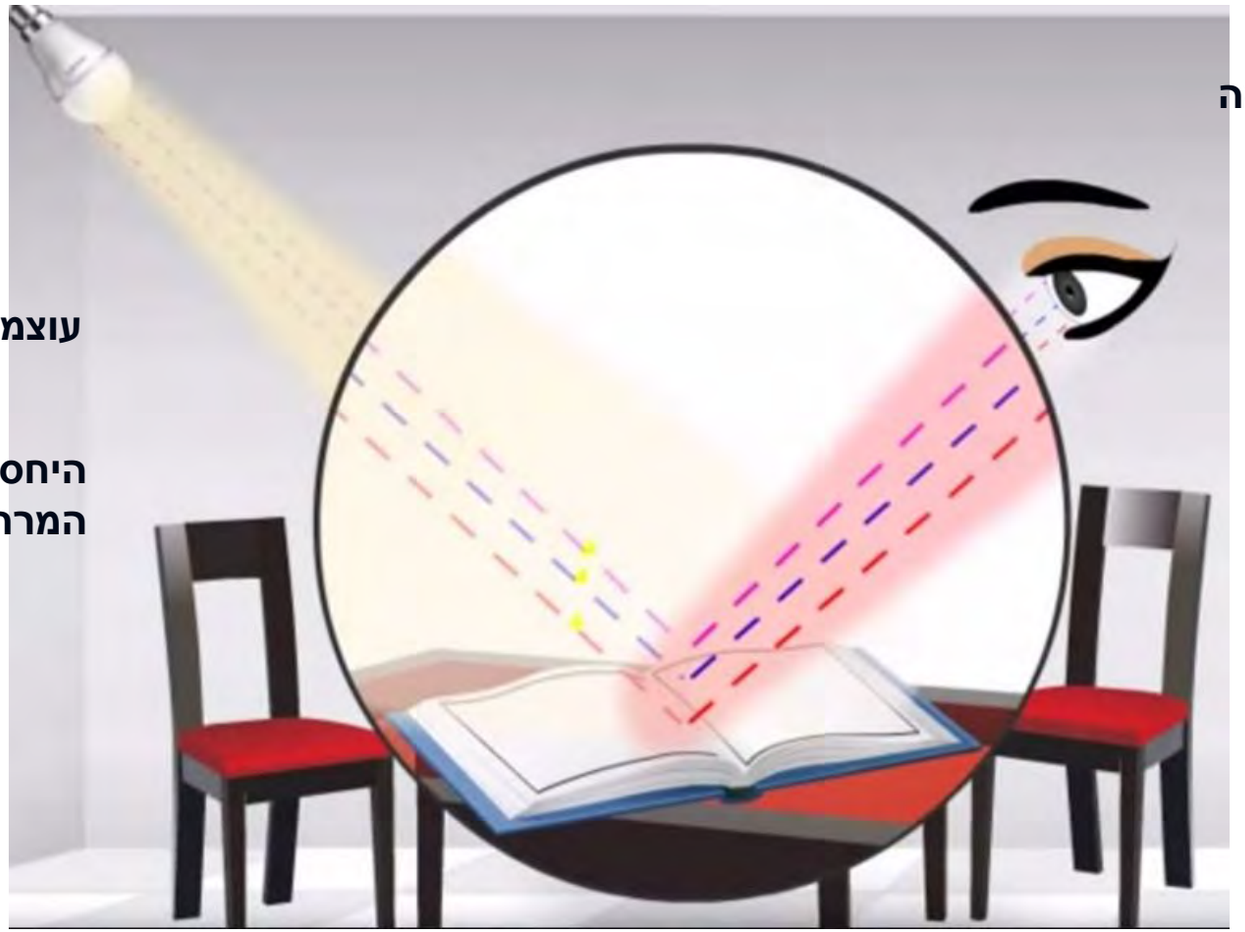
זווית מרחבית

L – Luminance

$$L = \frac{I\ (cd)}{A(m^2)}$$

בהיקות פוטומטרית

ביחס לשטח שהעין רואה



E – Illuminance

$$E = \frac{\Phi\ (lm)}{A(m^2)}$$

Lux (lx) **– עוצמת הארה**

שטף האור ליחידת שטח

מושגי יסוד - CCT

- CCT - Correlated color temperature
- קרינת גוף שחור

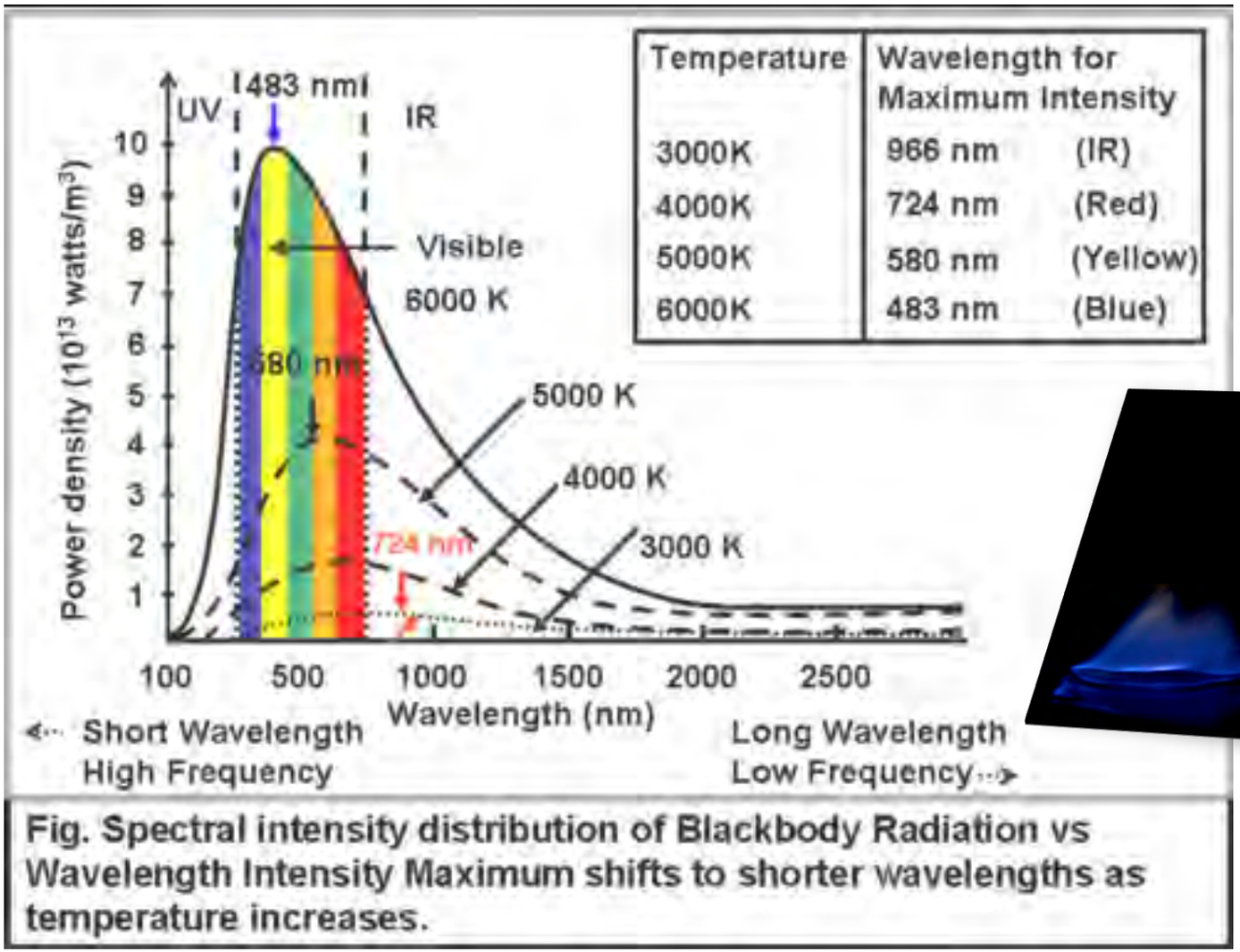
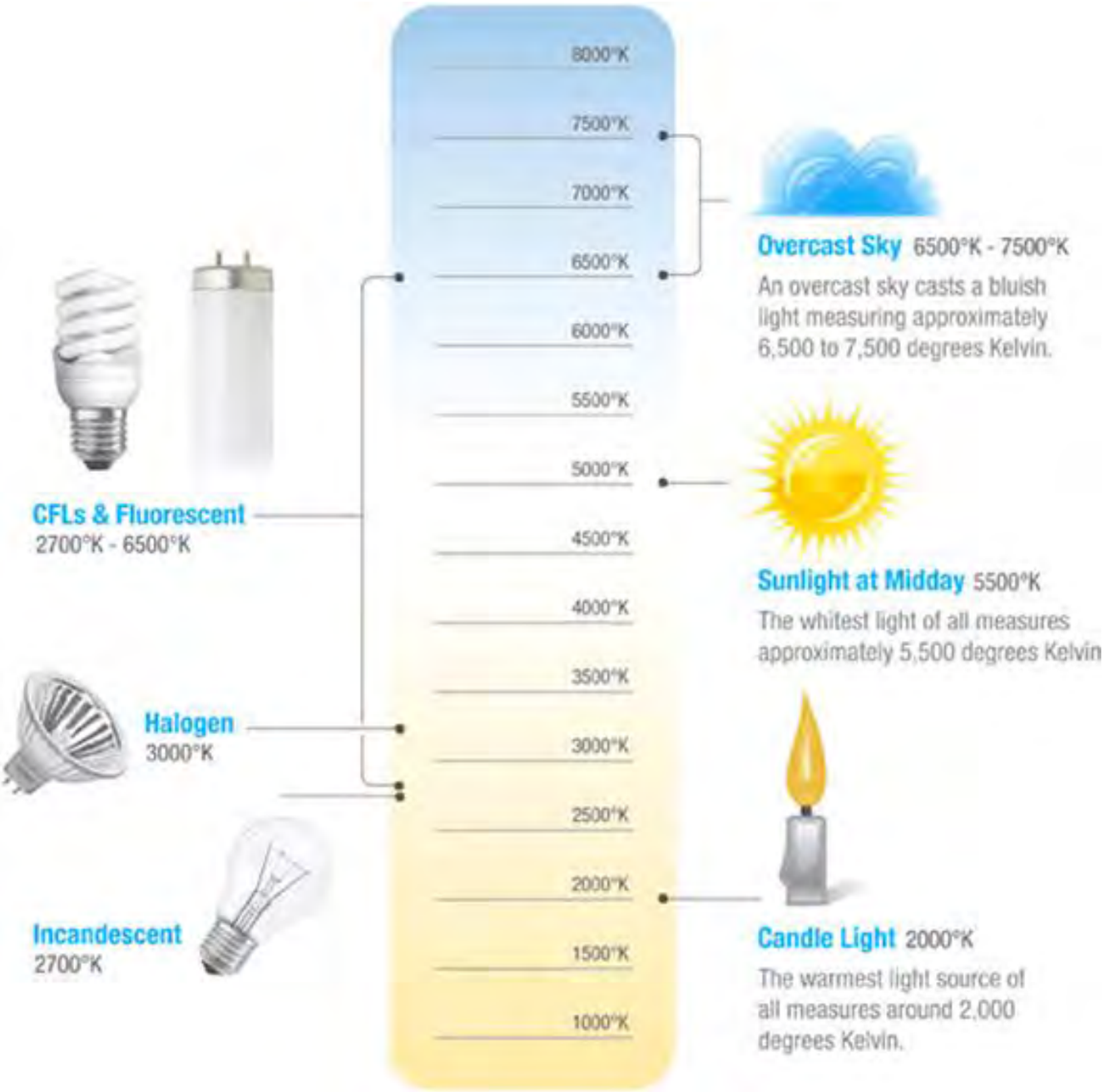


Fig. Spectral intensity distribution of Blackbody Radiation vs Wavelength Intensity Maximum shifts to shorter wavelengths as temperature increases.

מושגי יסוד - CCT



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היסטוריה של מדידת איכות הצבע

1965 CIE E1.3.2 recommends the CIE General Color Rendering Index (R_a). Research dates to 1937.

1974 Major revision of CRI (CIE 13.2-1974). Some limitations addressed.

1995 Last revision of CRI (CIE 13.3-1995). No major changes.

1991 CIE TC1-33: *Color Rendering*
[No Agreement Reached; Closed 1999]

"This committee was not successful in its purposes mainly due to the disagreement between those who advocated including the advances of science and those who recommended that industry did not want change."[1]

2002 CIE TC1-62: *Color Rendering of White LED Light Sources*
[Published CIE 177:2007, recommends a new metric be developed]

"The Committee recommends the development of a new colour rendering index…This index…shall not replace the current CIE colour rendering index immediately. The usage of the new index or indices should provide information supplementary to the current CIE CRI, and replacement of CRI will be considered after successful integration of the new index."[2]

היסטוריה של מדידת איכות הצבע

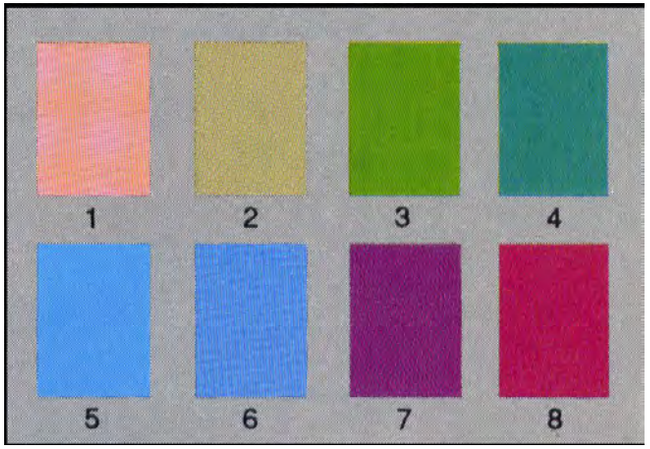
2006 CIE TC1-69: *Color Rendition by White Light Sources*
Goal of developing single number replacement for CRI, with a focus on psychophysical research.
[No Agreement Reached]

2012 CIE TC1-90: *Color Fidelity Index*
[Ongoing]

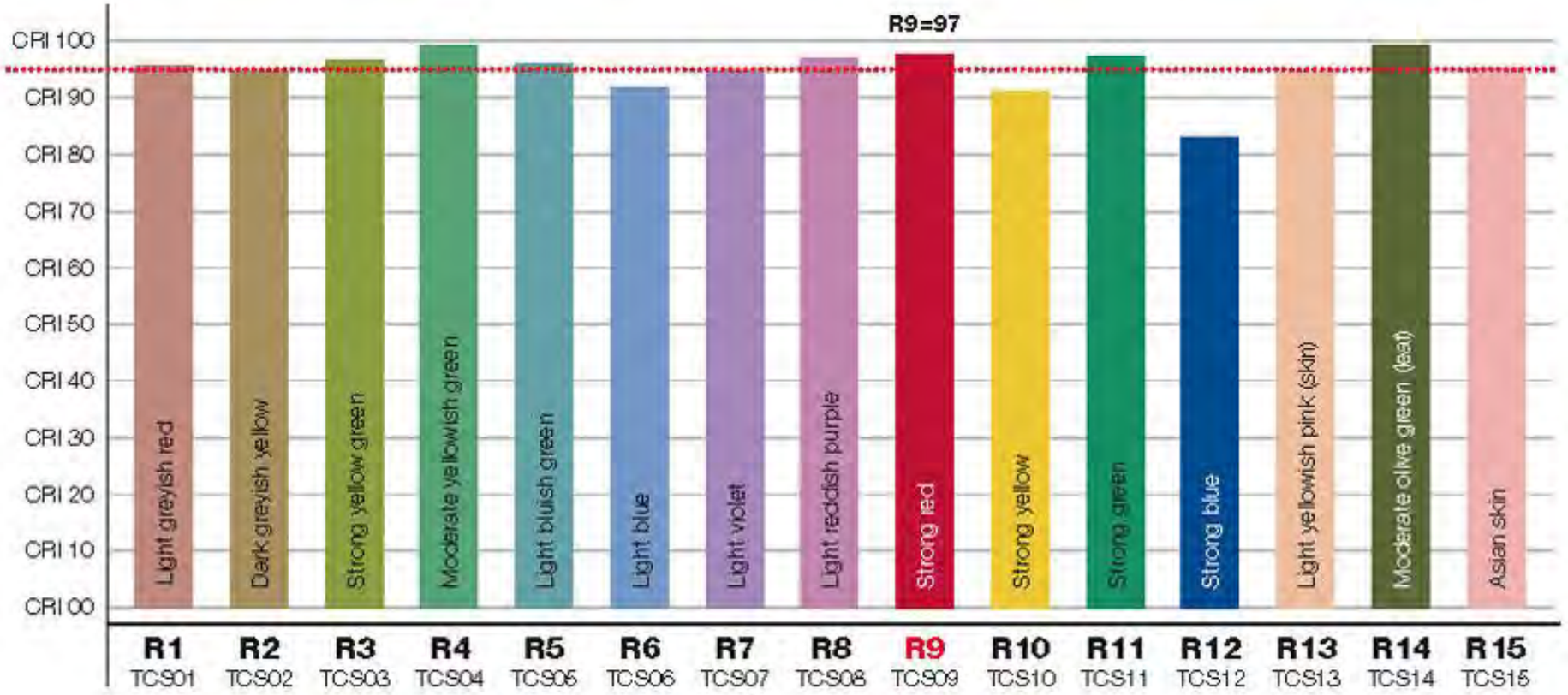
2012 CIE TC1-91: *New Methods for Evaluating the Colour Quality of White-Light Sources*
[Ongoing]

2013 IES Color Metrics Task Group
[Developed TM-30-15]

שיטת מדידה – CRI (Color Rendering Index)

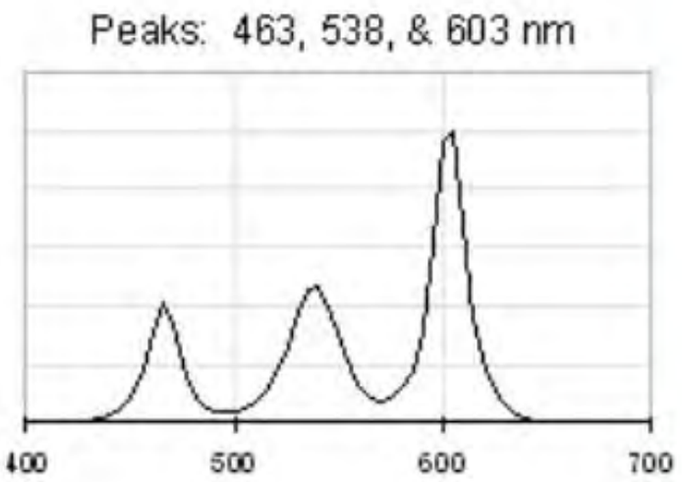


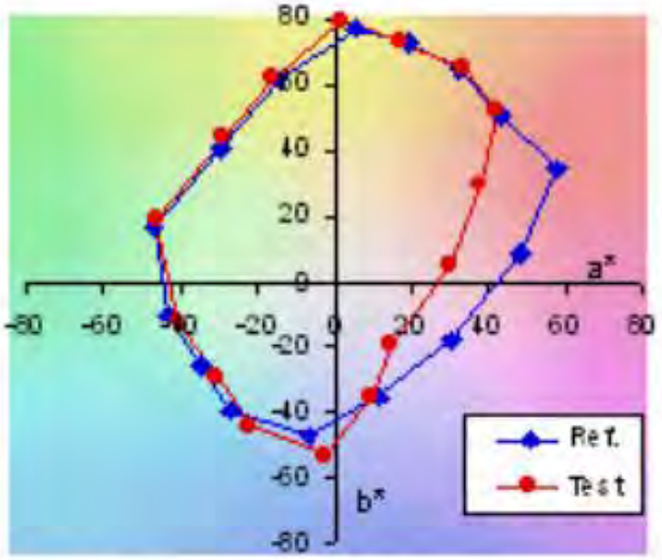
- מקדם מסירת צבע
- שיטה שמתבססת על ממוצע 15 גוונים
- Ra = R1 - R8
- R9 – אדום ,R-13 ו- R-15 גווני עור של אדם לבן ואסייתי



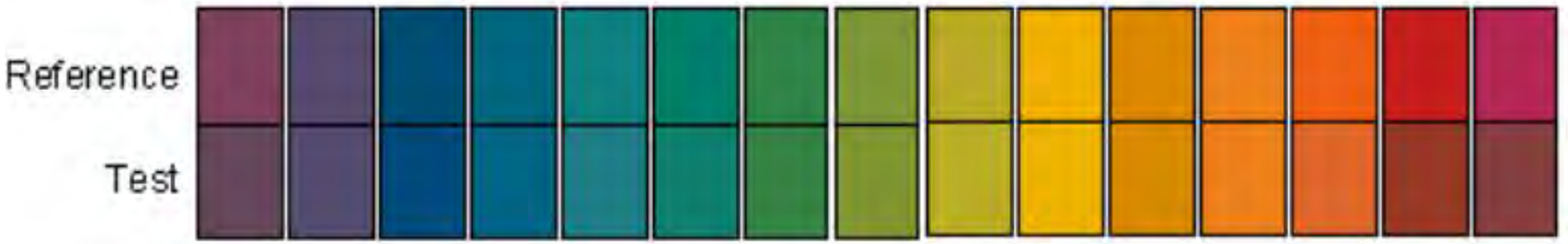
שיטת מדידה – CQS (Color Quality Scale)

- ממוצע 15 גוונים שמתאימים יותר לשימוש ב- LED
- משתמש בגוונים בעלי פיזור אחיד יותר על הספקטרום
- יש משקל גבוה יותר לגווני האדום





Ra = 80 CQS = 73



שיטת מדידה – TM - 30 15

CRI Calculation Engine (1974)		TM-30 Calculation Engine (2015)
CIE 1964 U*V*W*	⇨	CAM02-UCS (CIECAM02)
8 color samples Medium chroma/lightness Spectral sensitivity varies Munsell samples only	⇨	99 color samples Uniform color space coverage Spectral sensitivity neutral Variety of real objects
Fidelity Metric Only	⇨	Fidelity, Gamut, Graphical, Detailed
Ref Illuminant Step Function	⇨	Ref Illuminant Continuous (Uses same reference sources, but blended between 4500 K and 5500 K)
No lower limit for scores	⇨	0 to 100 scale (fidelity)

למה צריך את שיטת המדידה – TM - 30 15 ?

"Original"

"CRI = 80" Saturated

"CRI = 80" Desaturated

הסבר שיטת המדידה – TM - 30 15

IES Method for Color Rendition

Color Fidelity — דיוק הצבע

The accurate rendition of color so that they appear as they would under familiar (reference) illuminants

Fidelity Index (R_f)
(0-100)

Color Gamut — מכלול הצבעים

The average level of saturation relative to familiar (reference) illuminants.

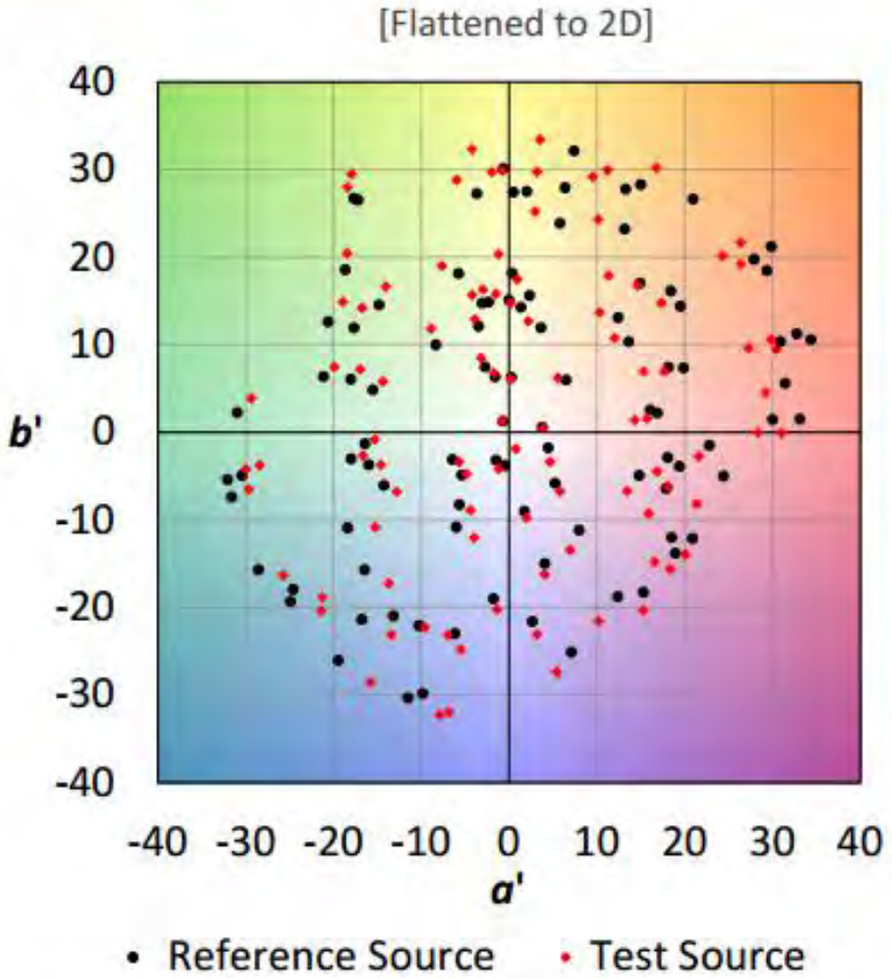
Gamut Index (R_g)
~60-140 when $R_f > 60$

Graphics — תוצאה גרפית

Visual description of hue and saturation changes.

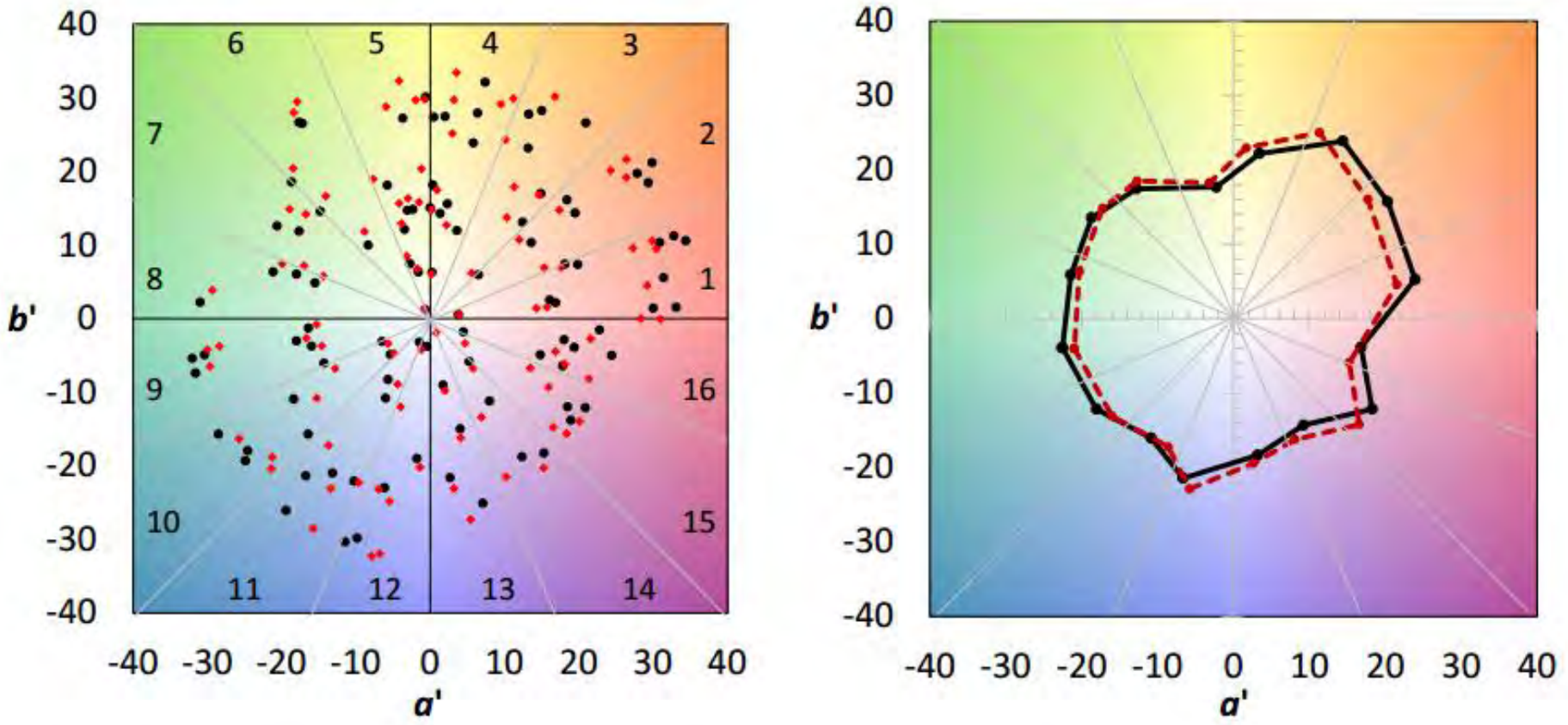
Color Vector Graphic

Fidelity Index: R_f



- Average similarity in appearance of test and reference sources
- Analogous to CIE R_a, greater accuracy
- Scores 0 to 100
- Scale similar to CIE R_a, but high scores harder to achieve
- Equal weight to all directions of shift
- Should not be expected to correlate with any single object

Relative Gamut Index: R_g



An R_g value greater than 100 indicates an average increase in saturation and an R_g value less than 100 indicates an average decrease in saturation.

הסבר שיטת המדידה – TM - 30 15

Original

CRI = 95

R_f = 93

R_g = 100

Desaturated

CRI = 80

R_f = 78

R_g = 90

Red-Enhanced

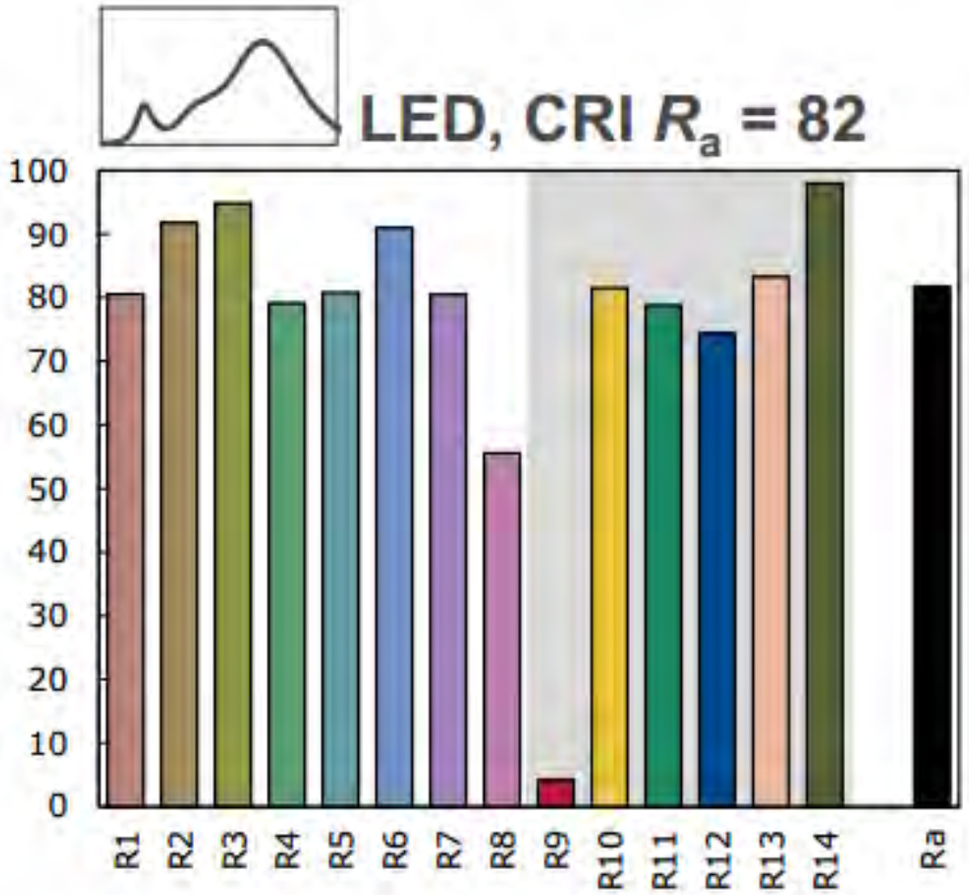
CRI = 80

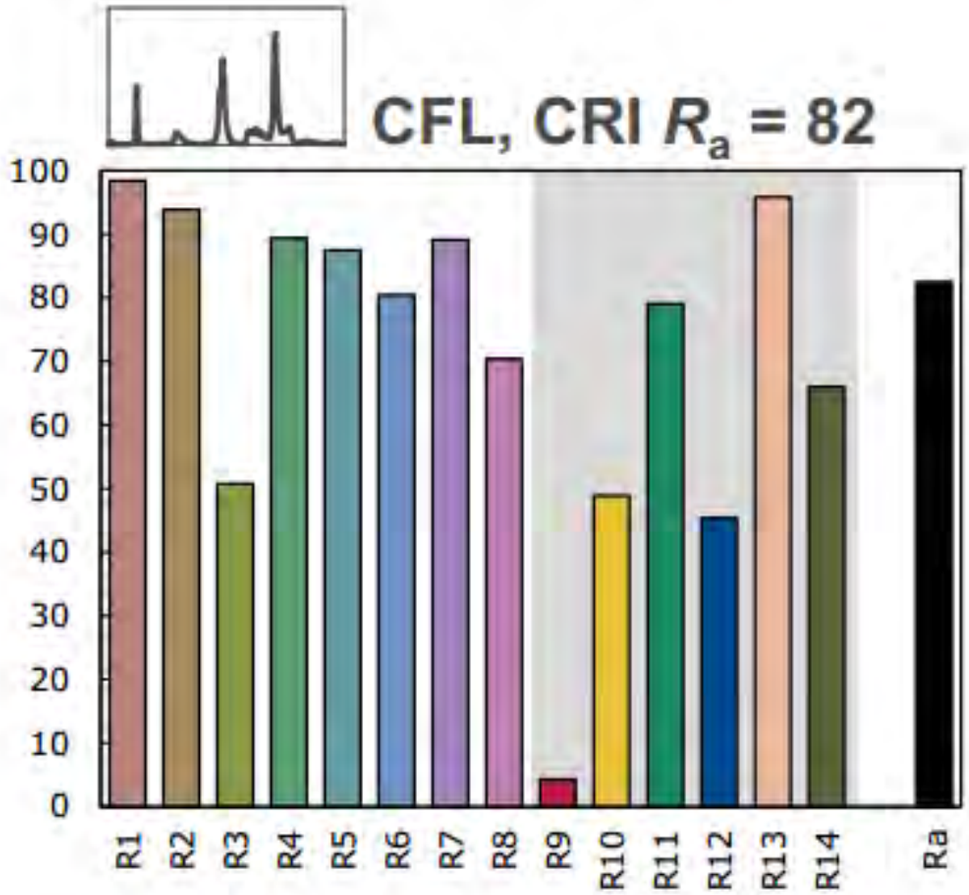
R_f = 78

R_g = 110

האם ניתן להסתפק בשיטות מדידה אלו ?

שימוש בשיטות מדידה של ממוצע
יכול להעלים לנו מידע מאוד חשוב

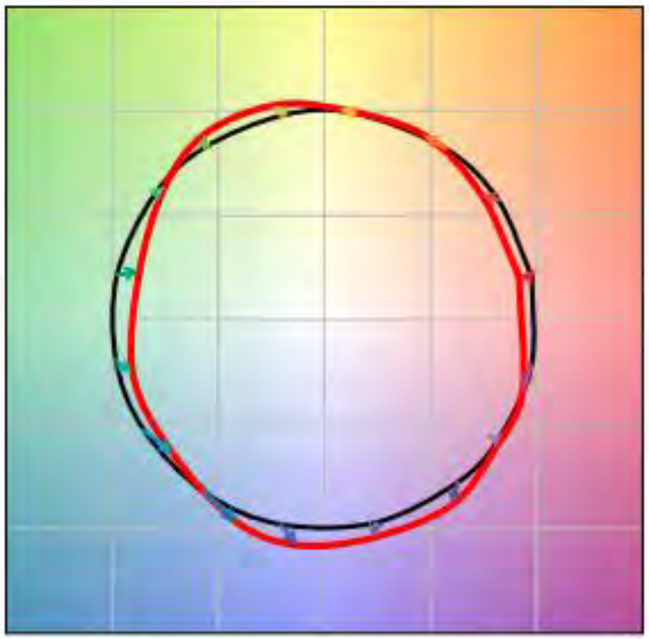




השימוש בווקטור צבע גרפי

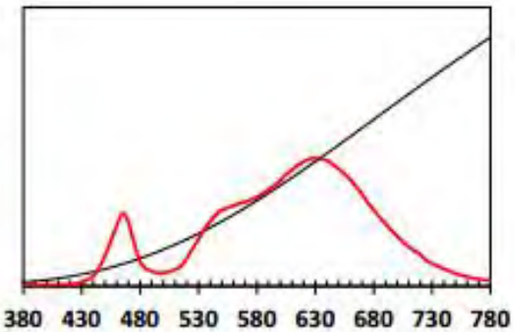
Color Vector Graphic

"Gamut" is not a dimension of perception. It is best interpreted with reference to a complementary graphic.



Color Vector Graphic

Color Distortion Graphic



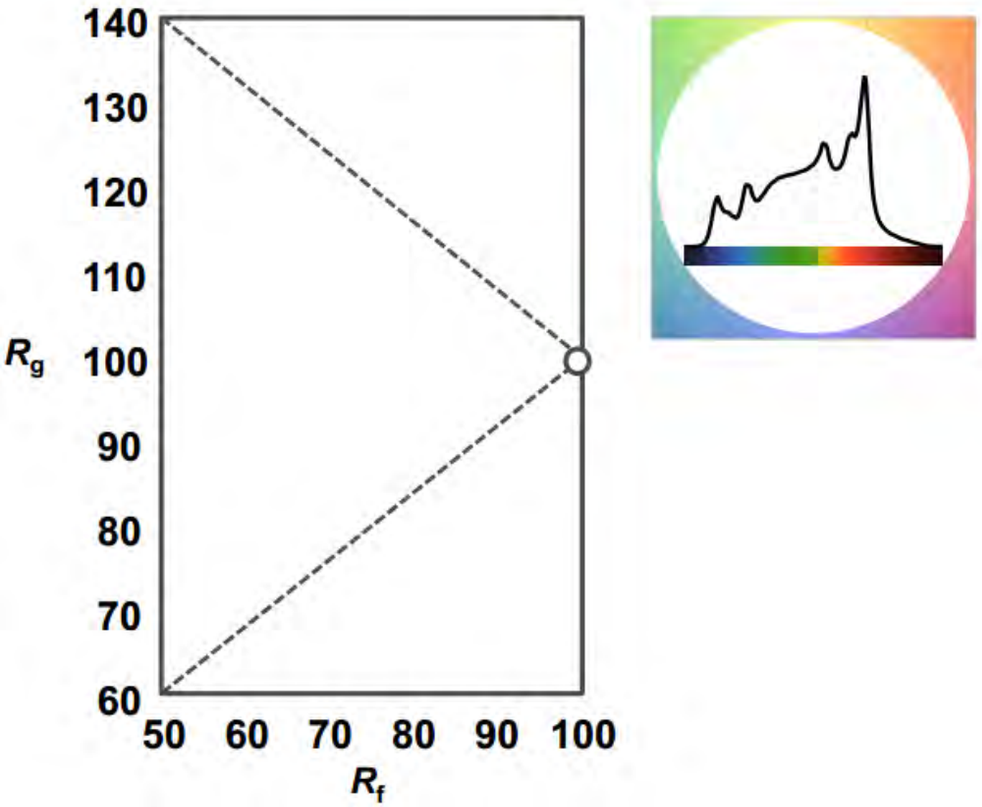
R_f	=	81
R_g	=	101
CCT	=	2496 K
R_a	=	88

(Source No. 286)

השילוב בין Rf , Rg ווקטור צבע גרפי

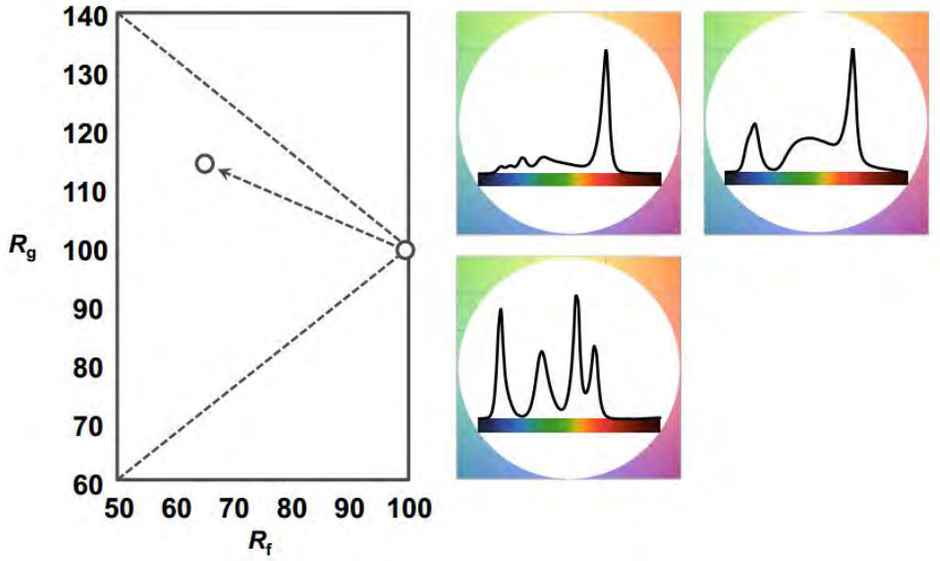
R_f, R_g and Color Vector Graphic

CCT = 3500 K, R_f = 100, R_g = 100



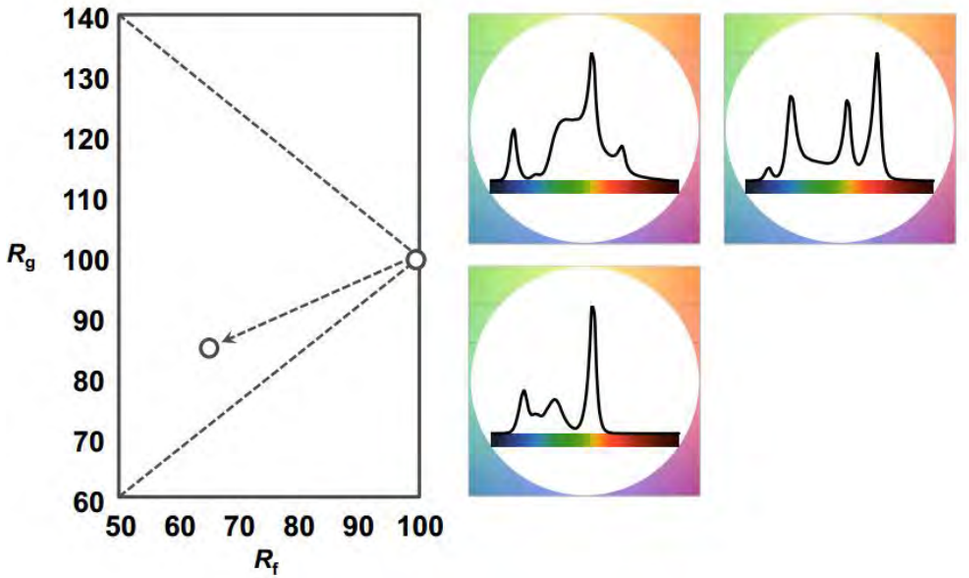
R_f, R_g and Color Vector Graphic

CCT = 3500 K, R_f = 65, R_g = 115

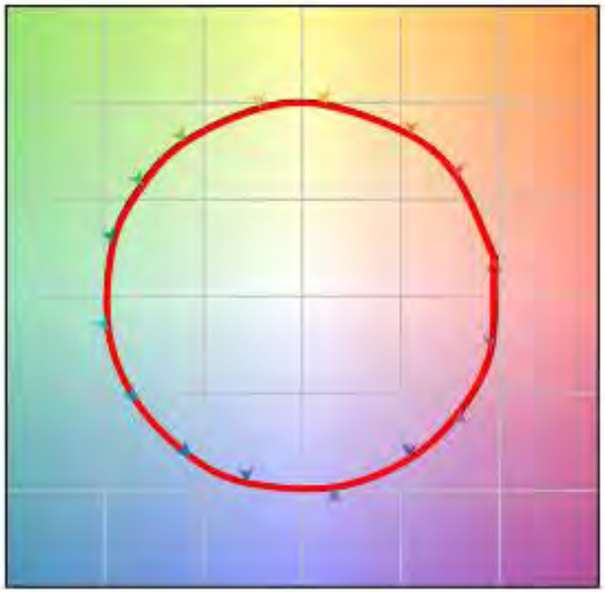


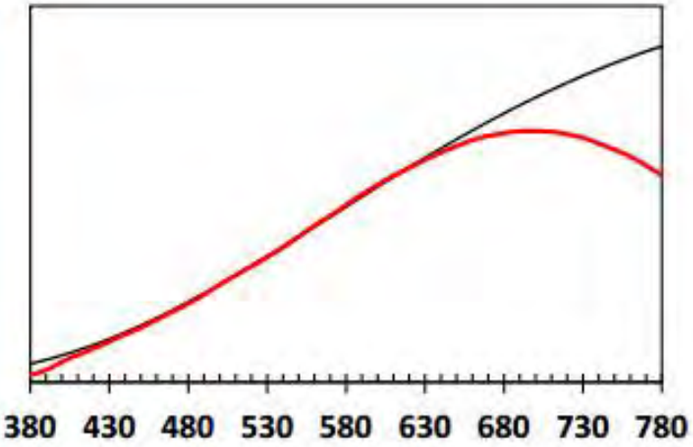
R_f, R_g and Color Vector Graphic

CCT = 3500 K, R_f = 65, R_g = 85



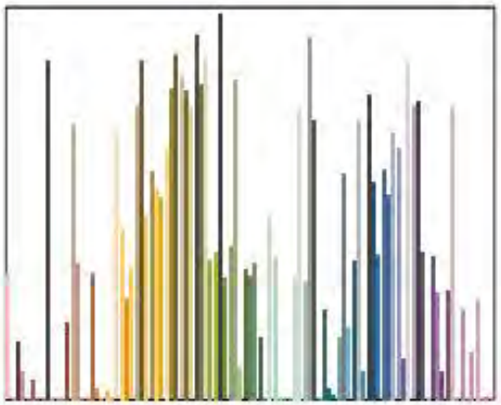
Halogen MR16, 3000 K (Source No. 80)

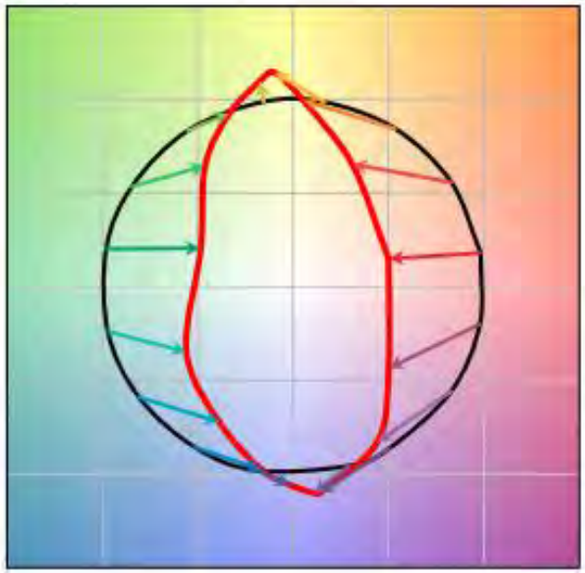


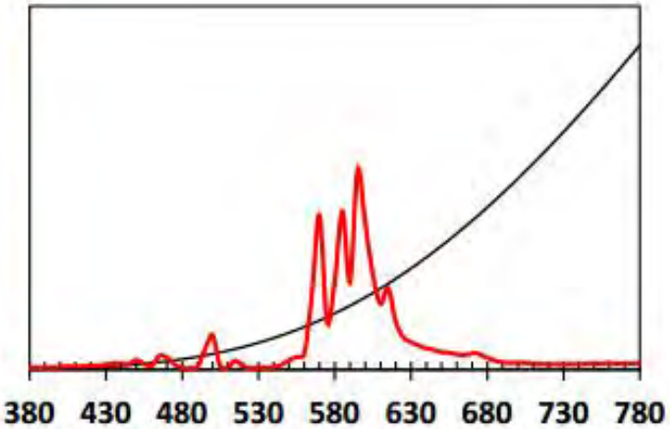


R_f	=	99
R_g	=	99
$R_{f,skin}$	=	99
CCT	=	2988 K
D_{uv}	=	0.0010
R_a	=	99
R_9	=	93

High Pressure Sodium (Source No. 56)



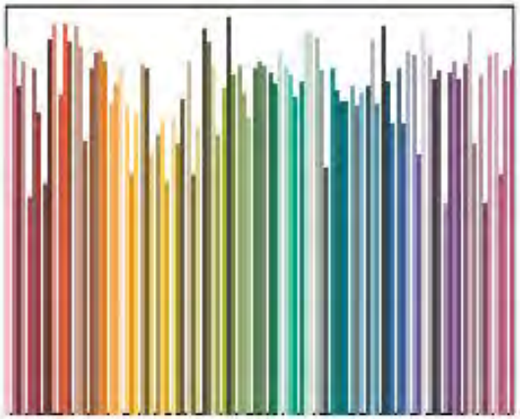


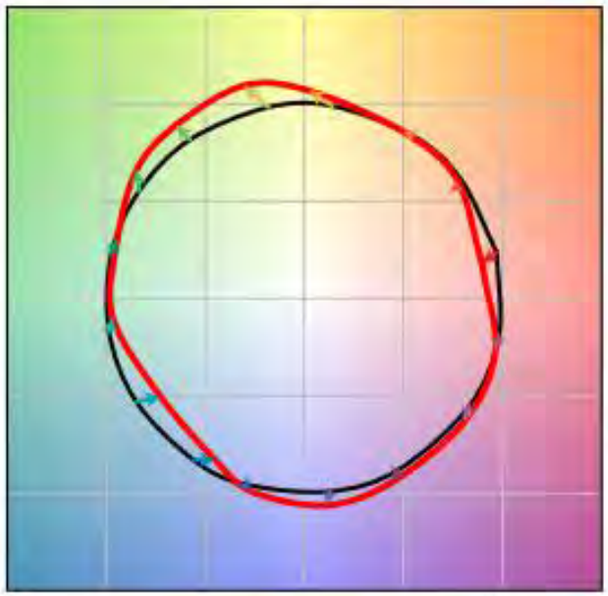


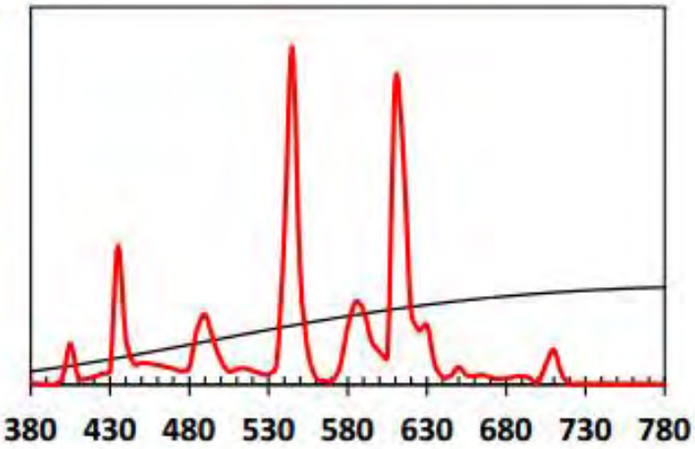
R_f	=	32
R_g	=	61
$R_{f,skin}$	=	34
CCT	=	1967 K
D_{uv}	=	-0.0002
R_a	=	16
R_9	=	-226

מדידת נורת פלורסנט T8

F32T8 835 (Source No. 37)



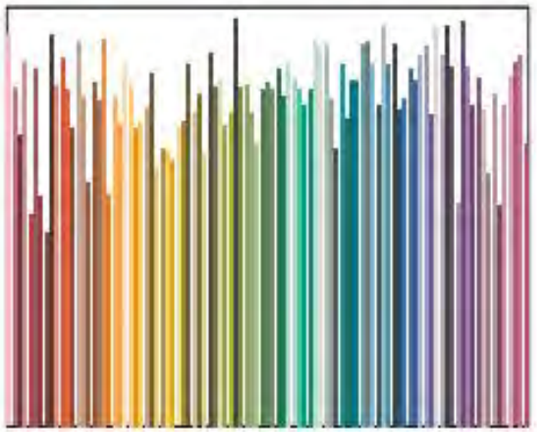


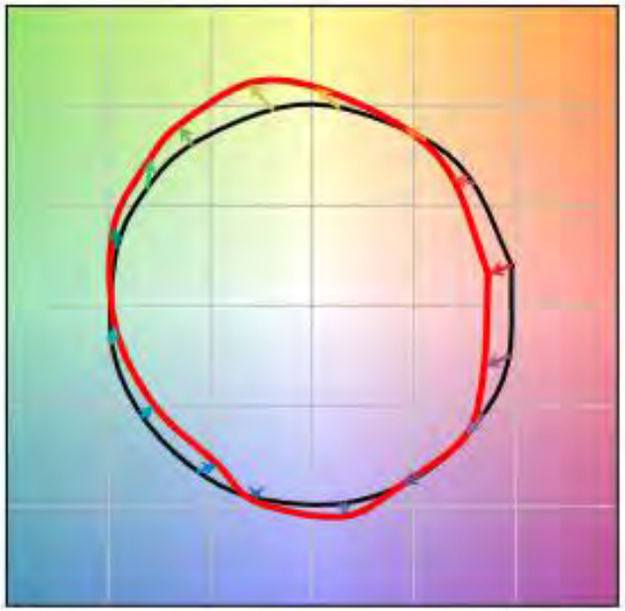


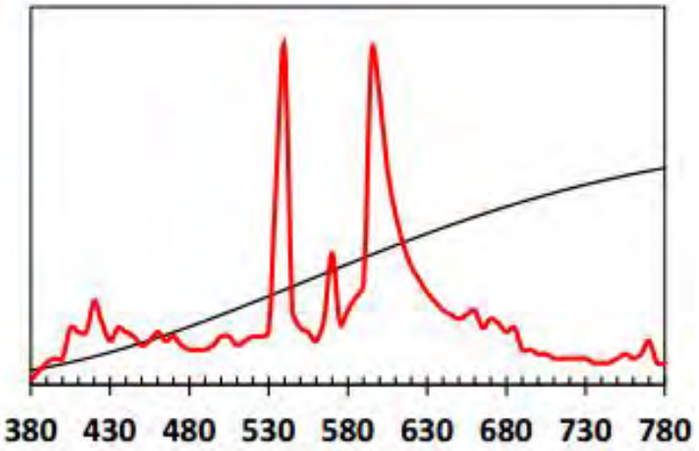
R_f	=	80
R_g	=	102
$R_{f,skin}$	=	89
CCT	=	3480 K
D_{uv}	=	0.0007
R_a	=	86
R_9	=	15

מדידת נורת מטל הלייד

Ceramic Metal Halide, 3000 K (Source No. 62)







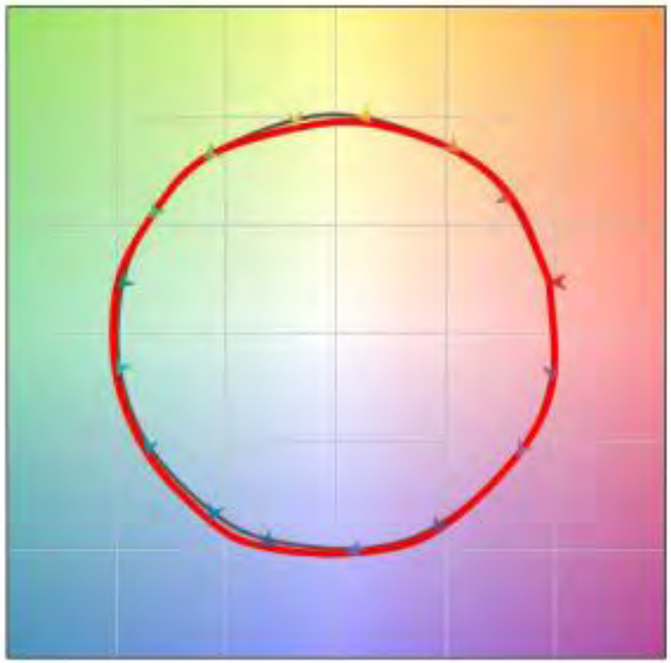
R_f	=	79
R_g	=	100
$R_{f,skin}$	=	78
CCT	=	3080 K
D_{uv}	=	-0.0024
R_a	=	84
R_9	=	-30

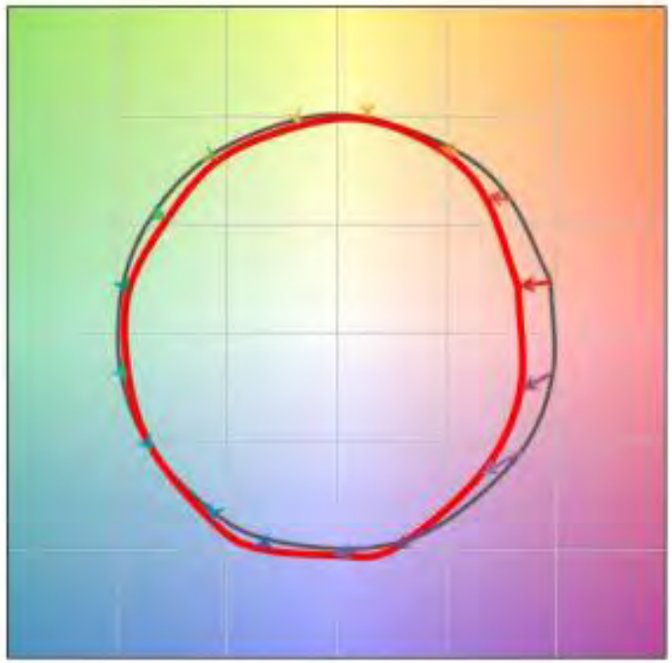
מדידת נורת מטל הלייד

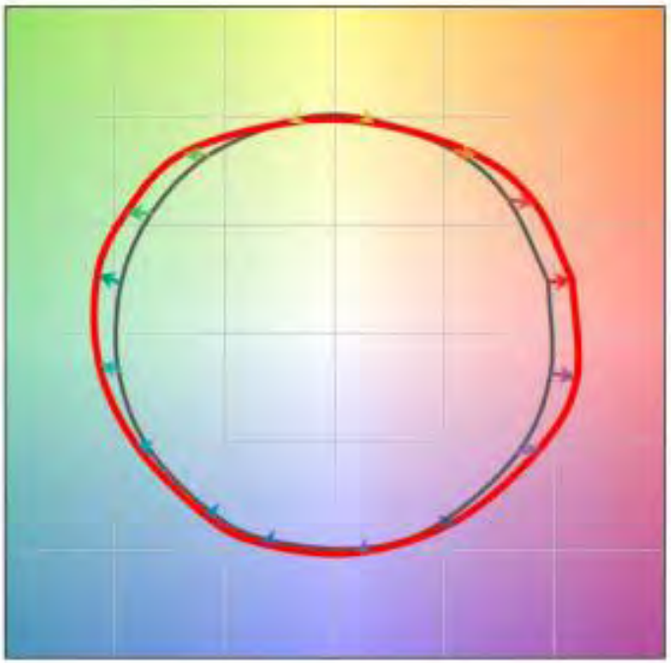
Original

Desaturated

Red-Enhanced







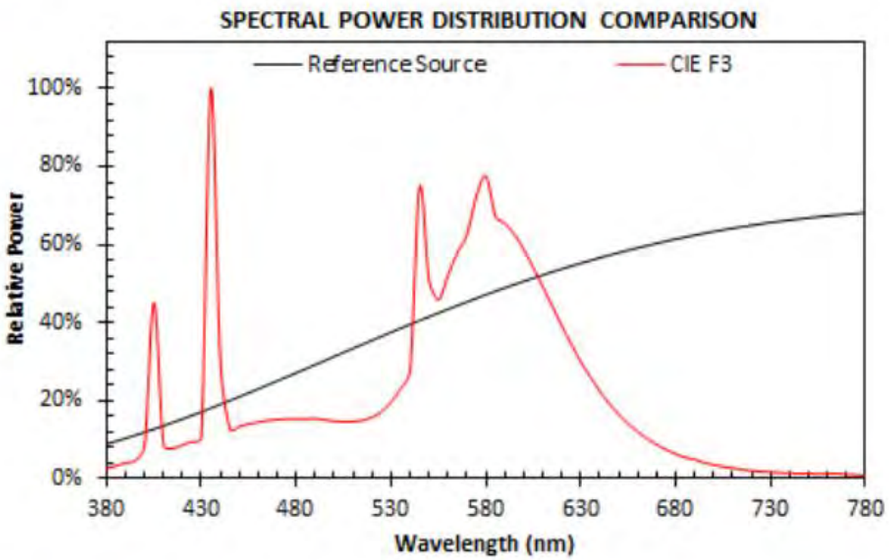
איך נראית המדידה בפועל ?

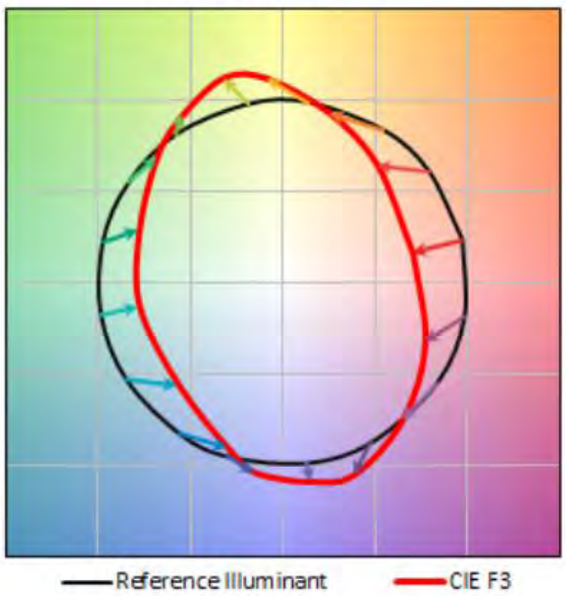
Source:

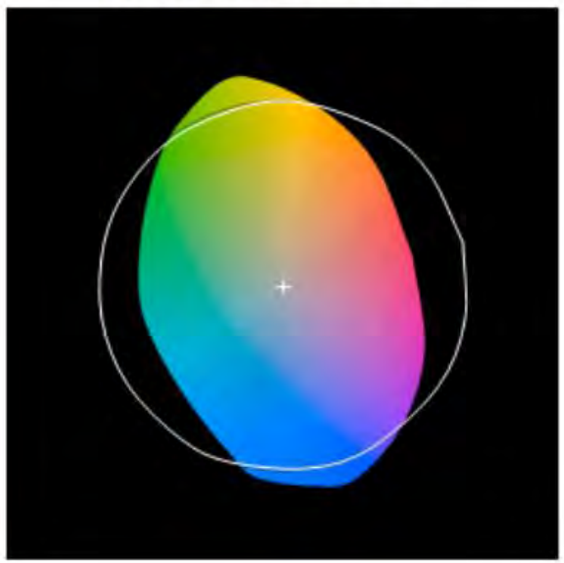
CIE F3

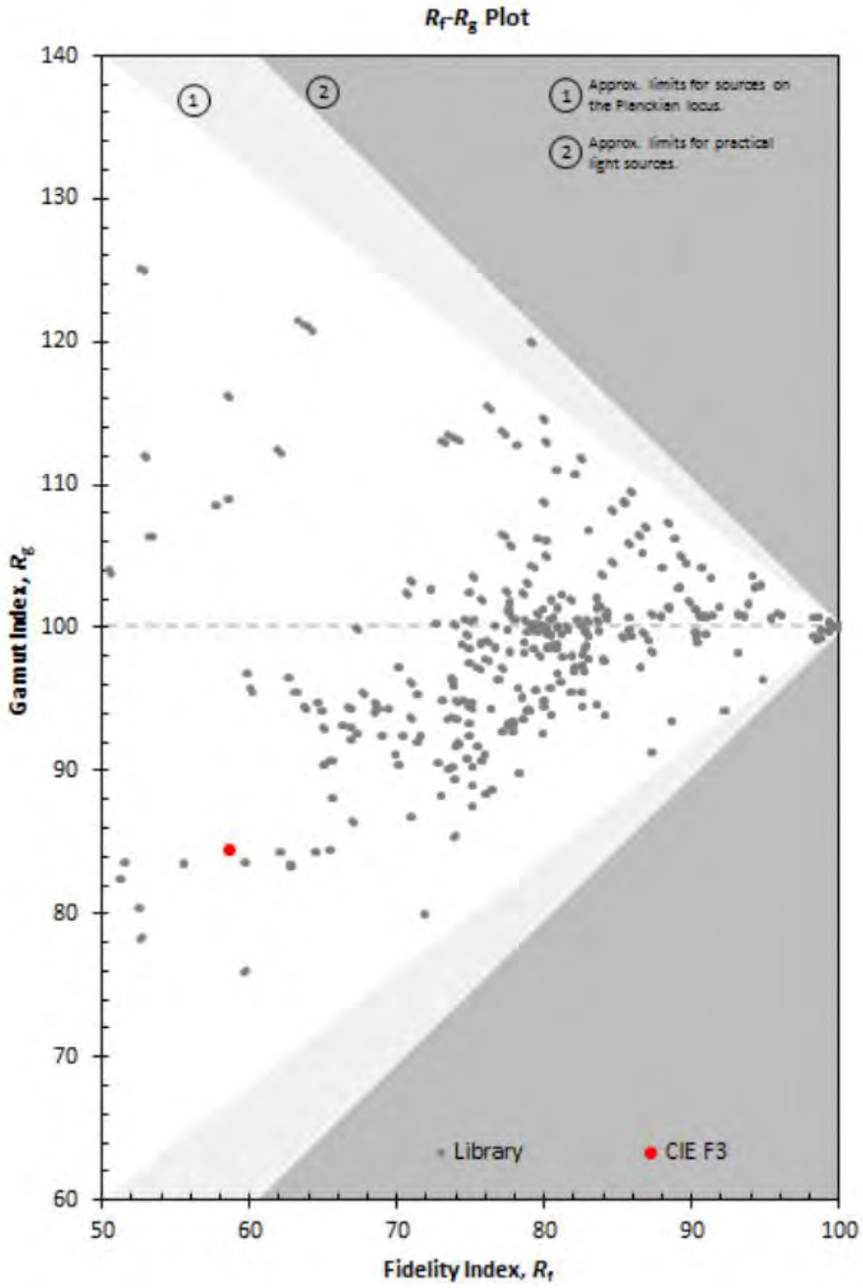
R_f	59
R_g	84
CCT (K)	3446
D_{uv}	0.0007
x	0.4091
y	0.3941
CIE R_a	57

0





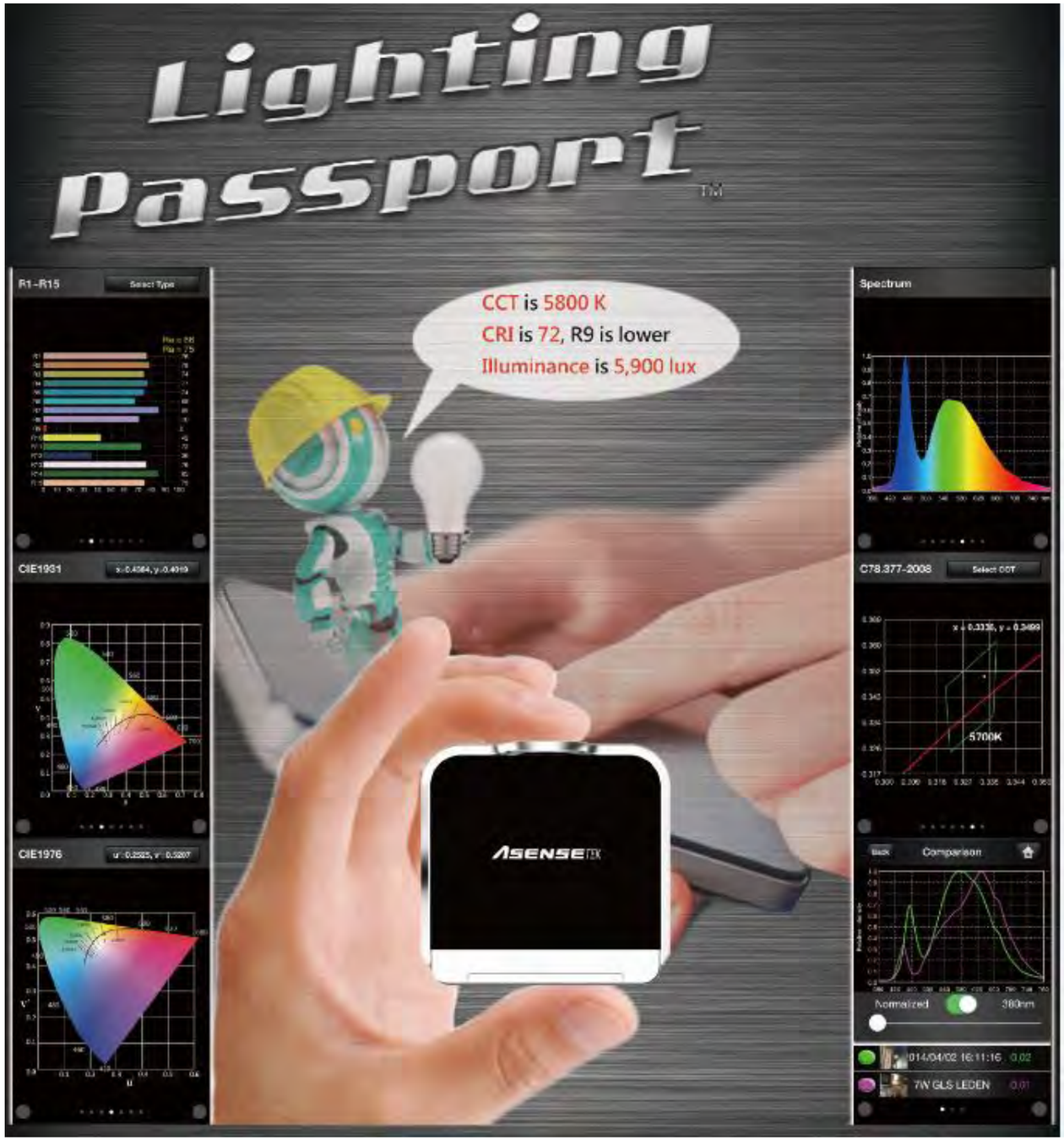




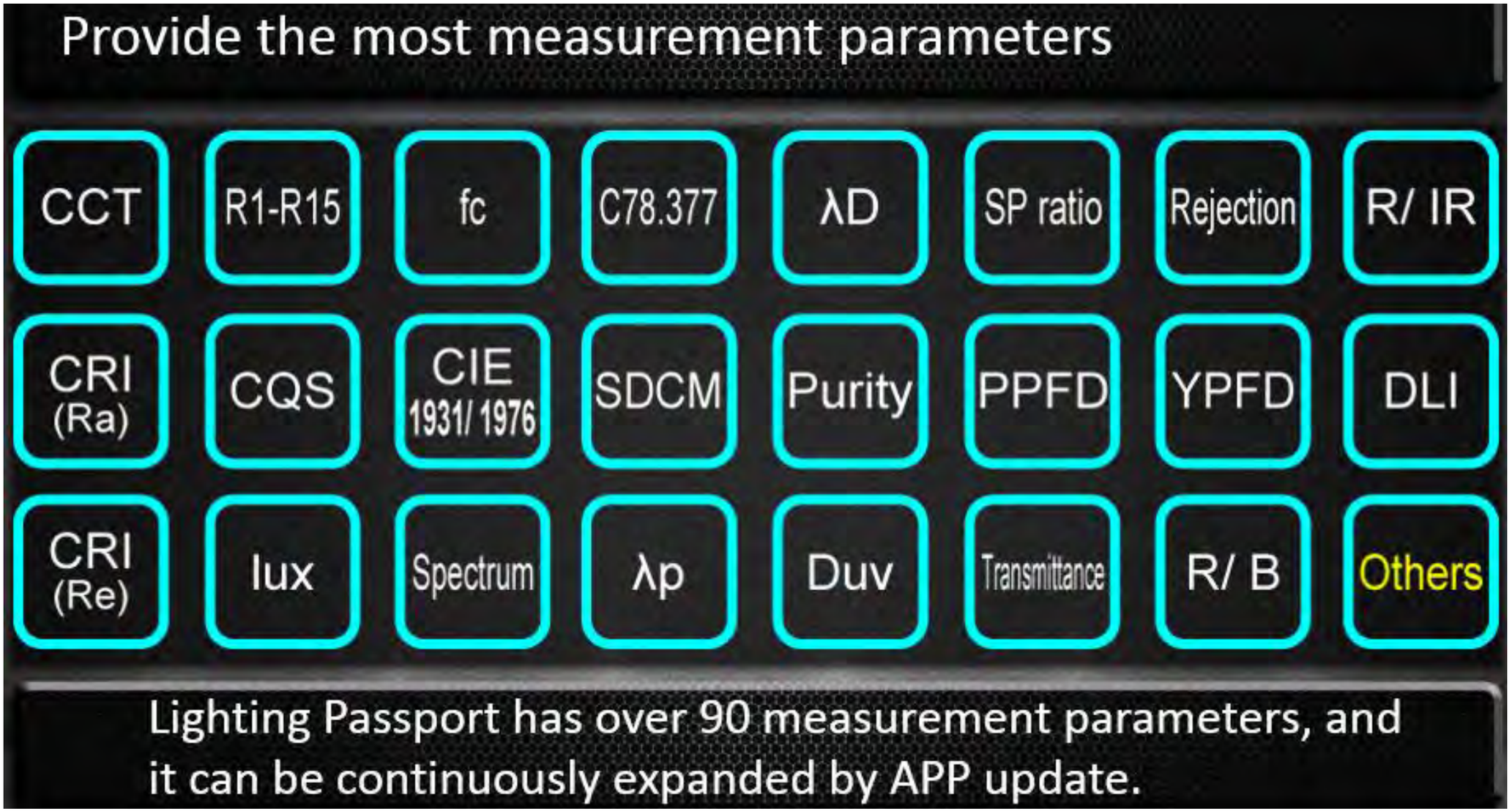
- חזרה קצרה על מושגי יסוד בתאורה
- CRI, CQS, TM-3015 – מדידת איכות הצבע
- Lighting Passport - מדידת איכות האור

NISKO LIGHTING

Lighting Passport

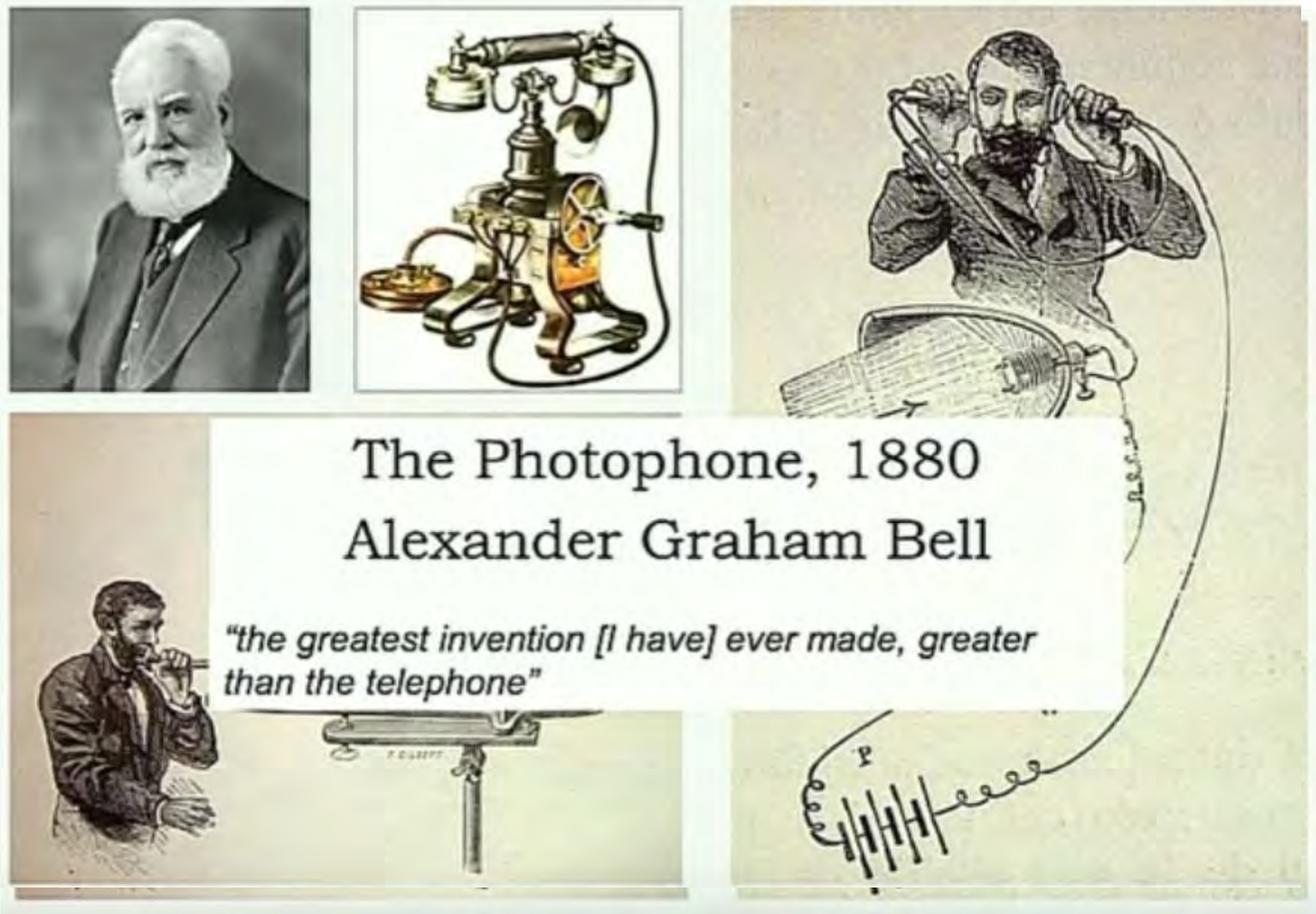


Lighting Passport



תודה על ההקשבה!

מה צופן לנו העתיד ?



מה צופן לנו העתיד ?

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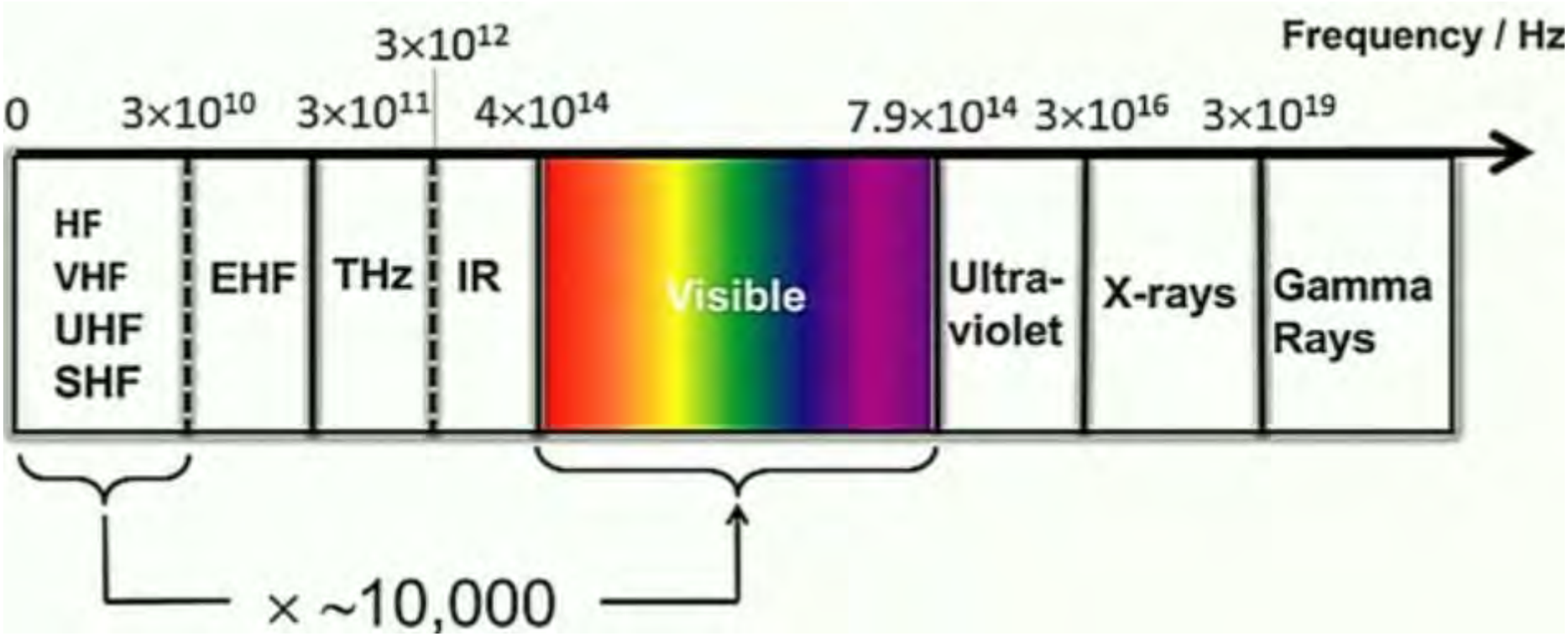
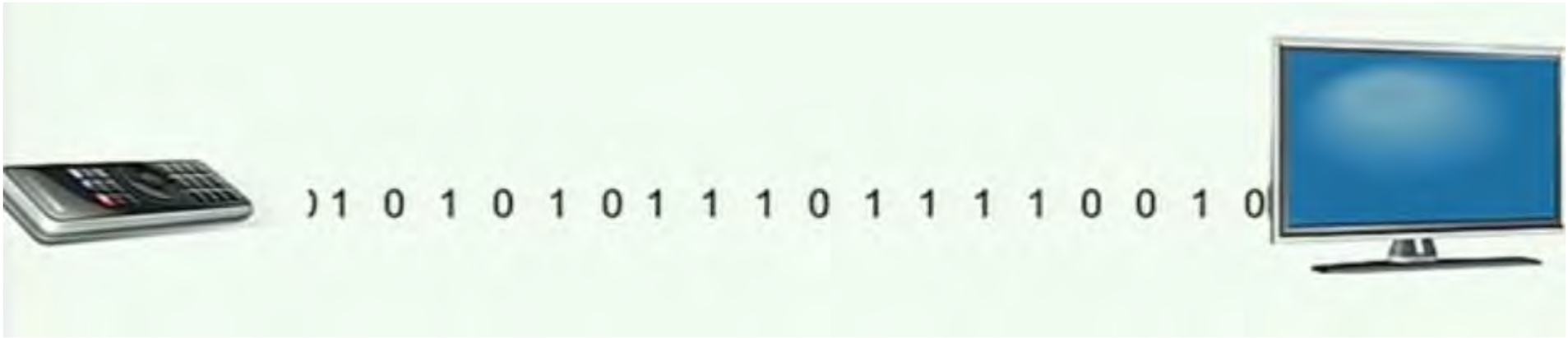
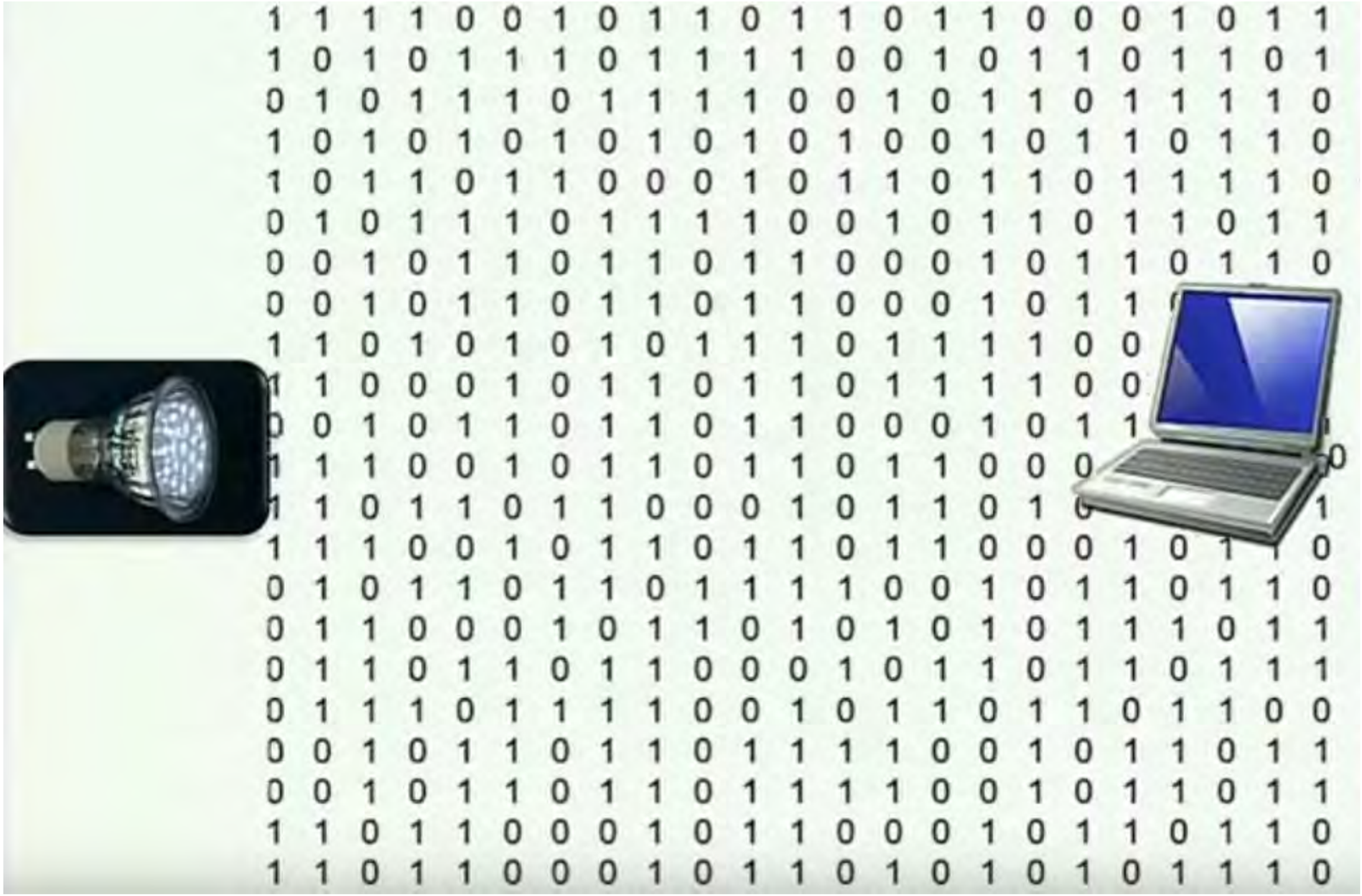
מה צופן לנו העתיד ?

- **Prof. Harald Haas - My Li-Fi (Light Fidelity) Revolution**

  - **15,900,000,000,000,000,000** bytes per month by 2018
    - **1.8 million years** of HD video very month
  - **1000** wireless devices per person by 2020
  - Available radio spectrum will run out by 2020
  - Energy consumption equivalent to global air-traffic

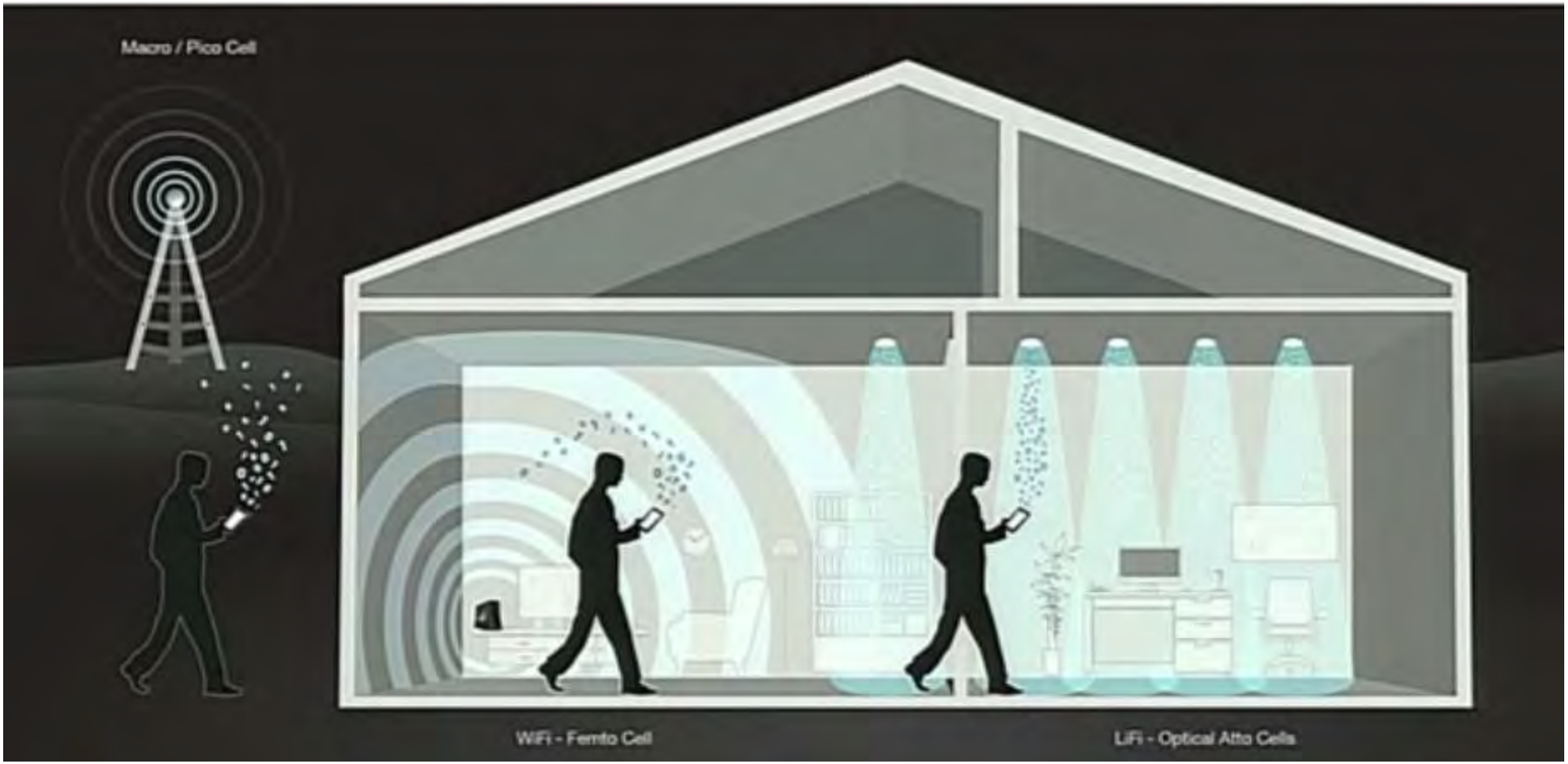

Frequency / Hz
0
3×10^10
3×10^11
3×10^12
4×10^14
7.9×10^14
3×10^16
3×10^19
HF
VHF
UHF
SHF
EHF
THz
IR
Visible
Ultra-violet
X-rays
Gamma Rays
× ~10,000


1 0 1 0 1 0 1 1 1 0 1 1 1 1 0 0 1 0



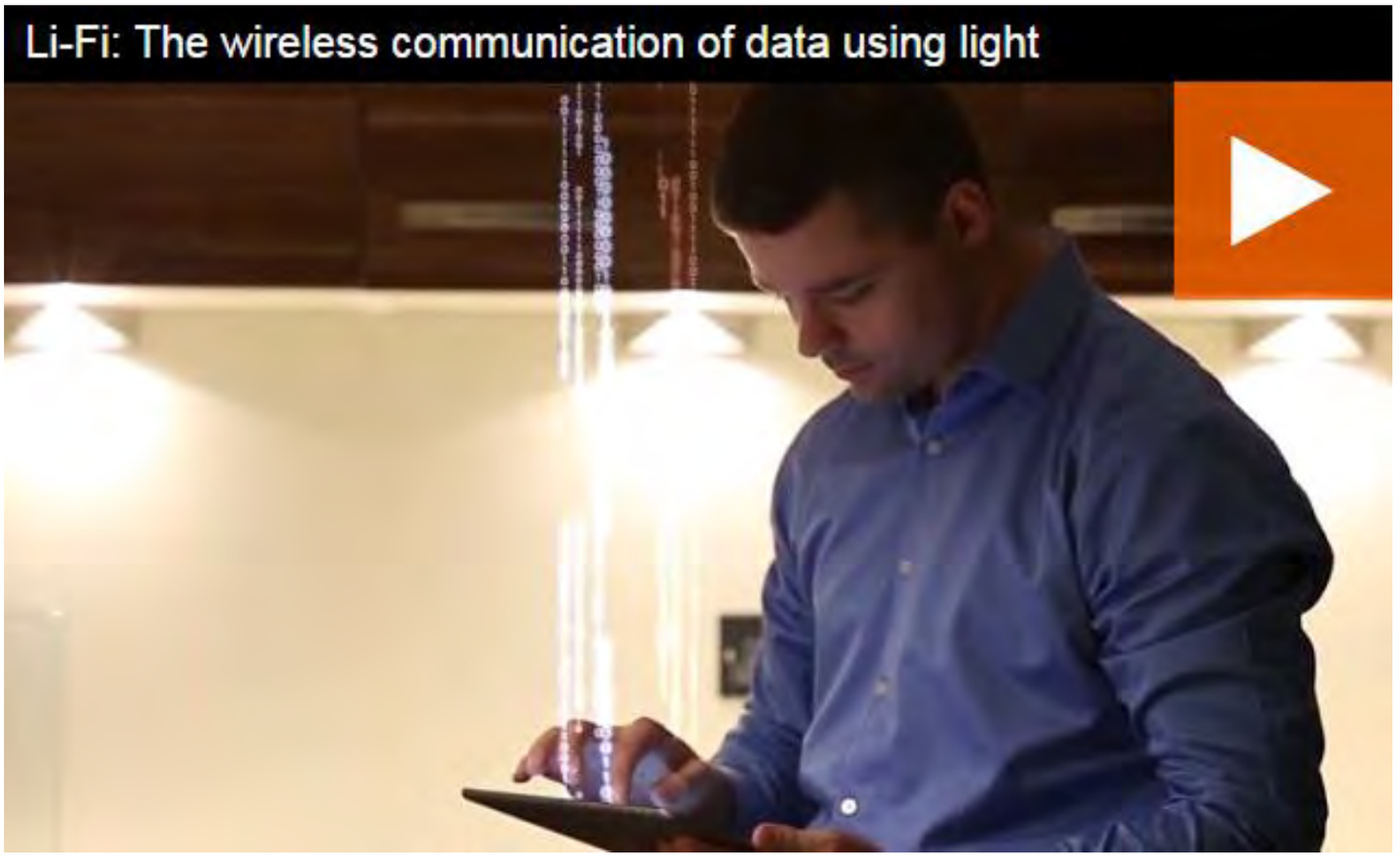
NISKO LIGHTING

Multiple Li-Fi Access Points in a room


Macro / Pico Cell
WiFi - Femto Cell
LiFi - Optical Atto Cells

Comparison – Wi-Fi and Li-Fi

Parameters	Wireless Technology	
	Wi-Fi	Li-Fi
Data Transfer Speed	150 Mbps	> 1 Gbps
Medium through which data transfer occurs	Radio Spectrum	Light Spectrum
Range of Spectrum	Radio Frequency Spectrum range is less than visible light spectrum	Visible Light Spectrum has 10,000 times broad spectrum in comparison to Radio Spectrum
Cost effective	Expensive. It is used Radio Spectrum and need license	Cheaper than Wi-Fi. It is free band does not need license
Network Topology	Point – to – point	Point – to – point
Operating Frequency	2.4 Giga Hertz	Hundreds of Tera Hertz


Li-Fi: The wireless communication of data using light