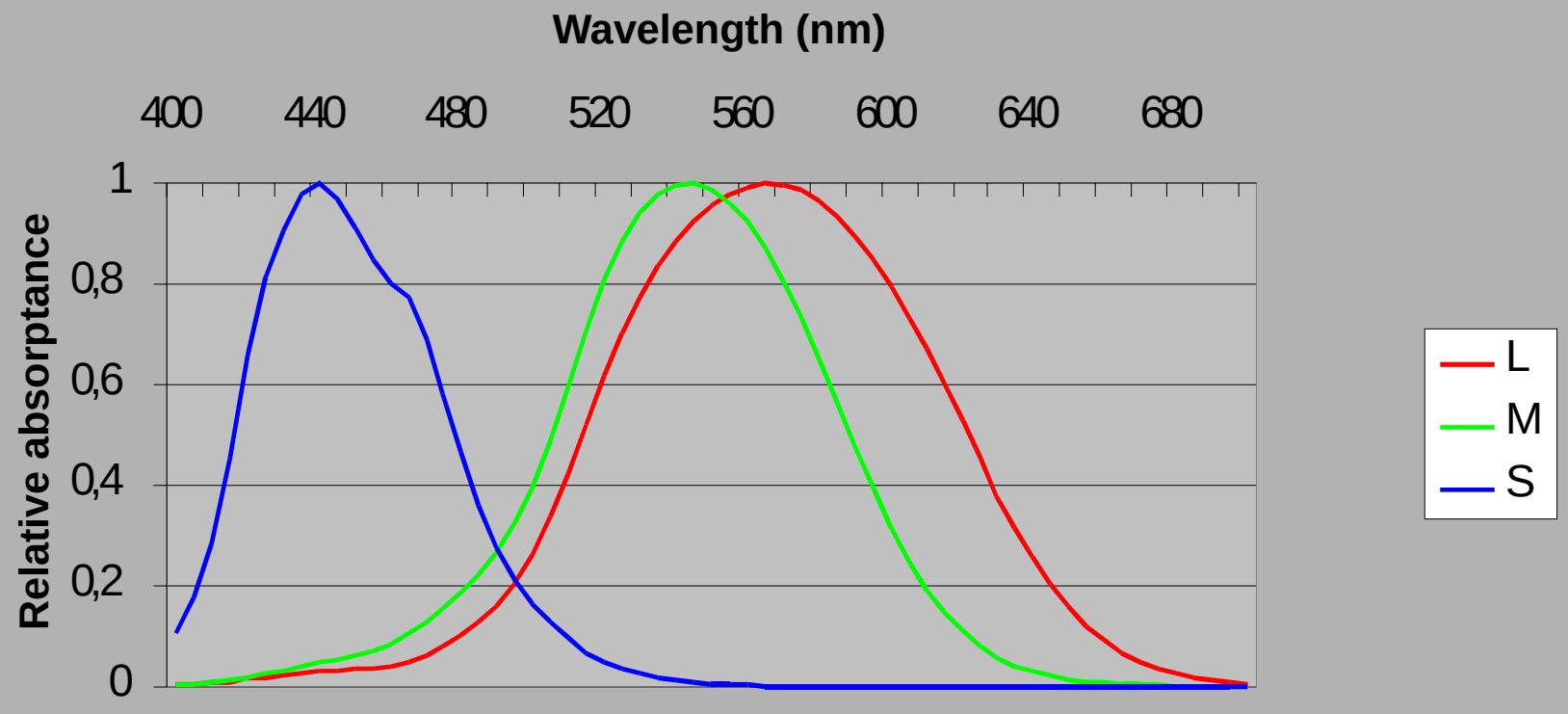
Digital Color

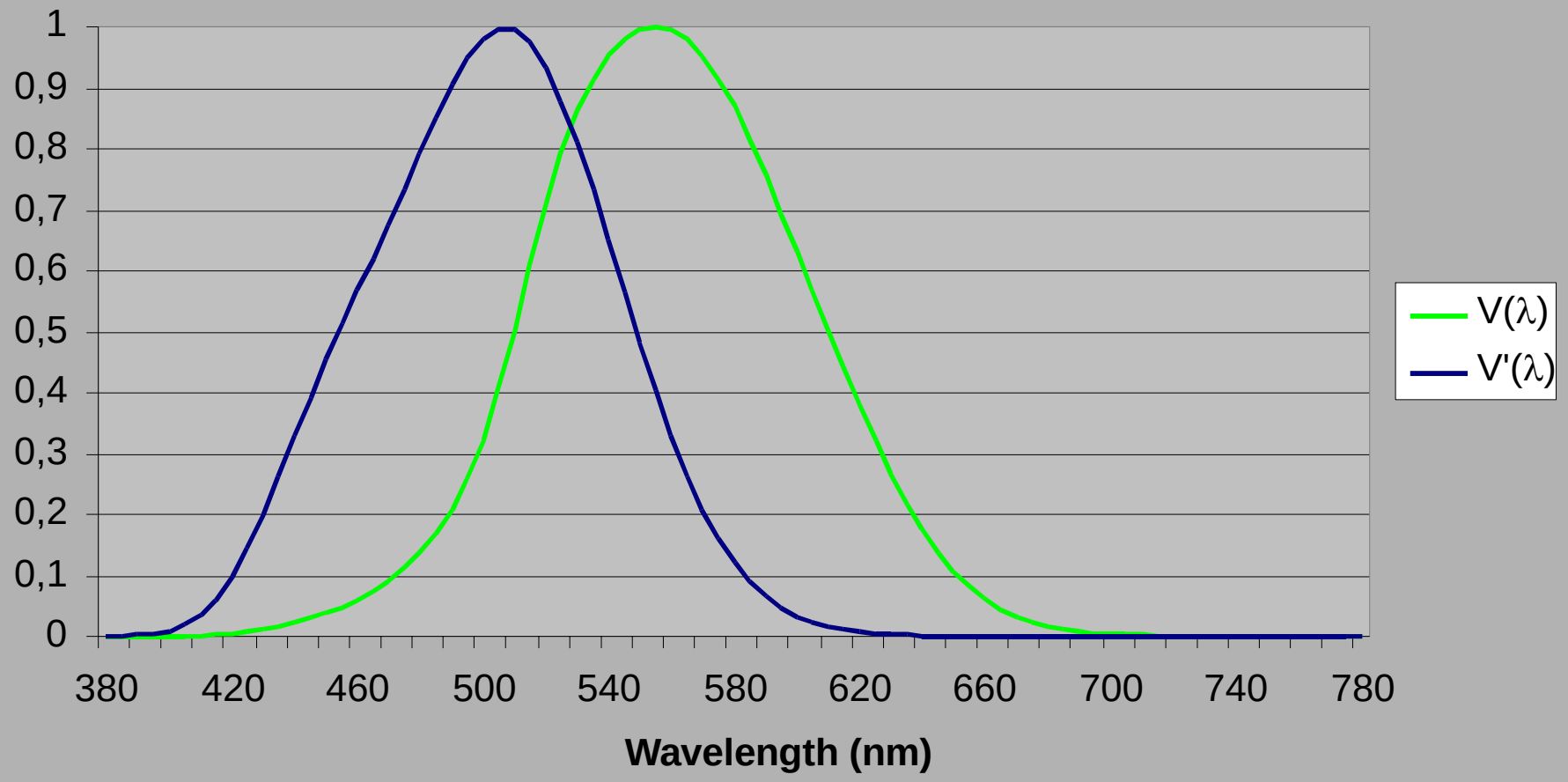
Lecture 3

Color coordinate systems and
light source spectra

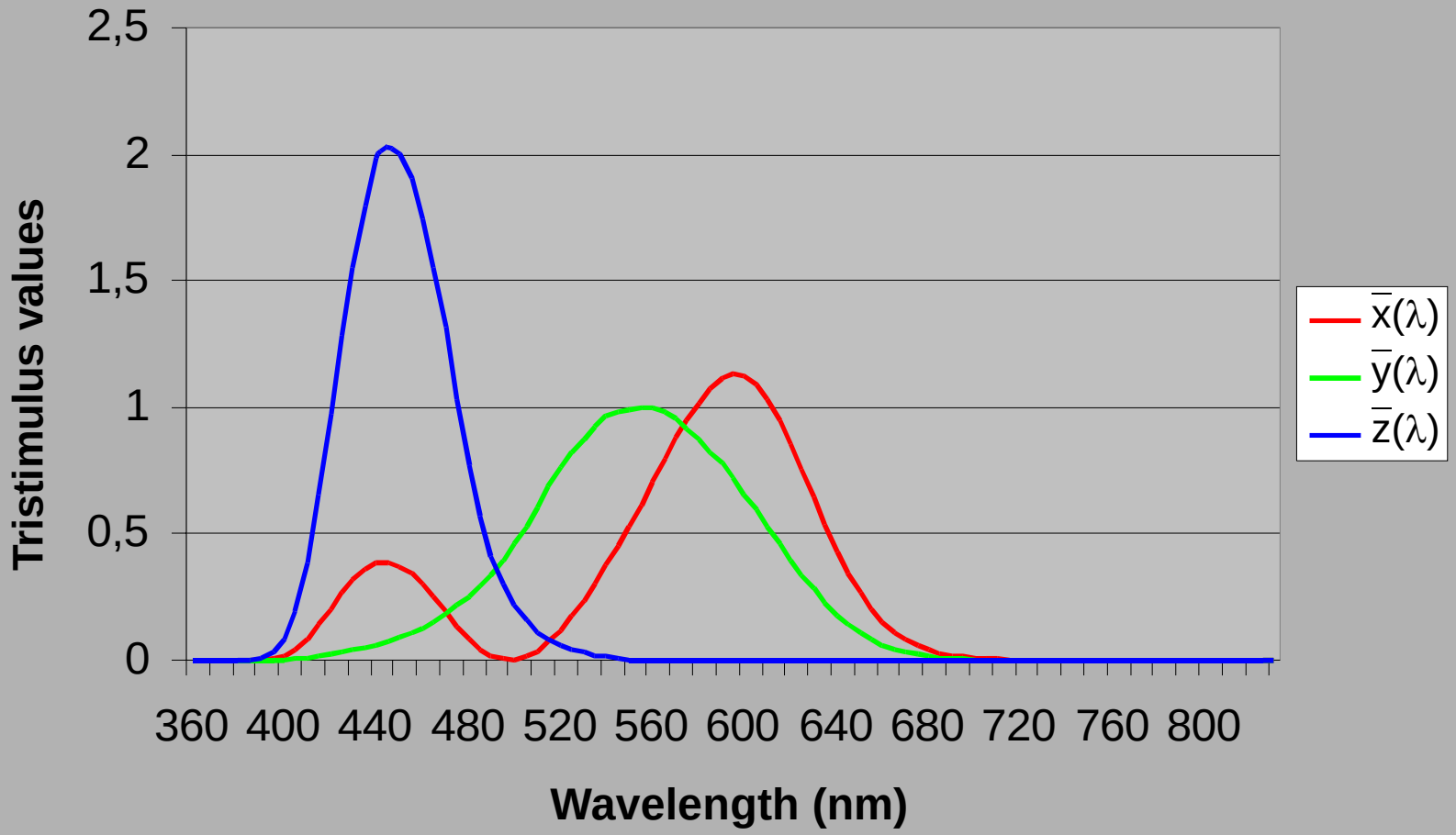
Smith, Pokorny & DeMarco (1992) cone fundamentals



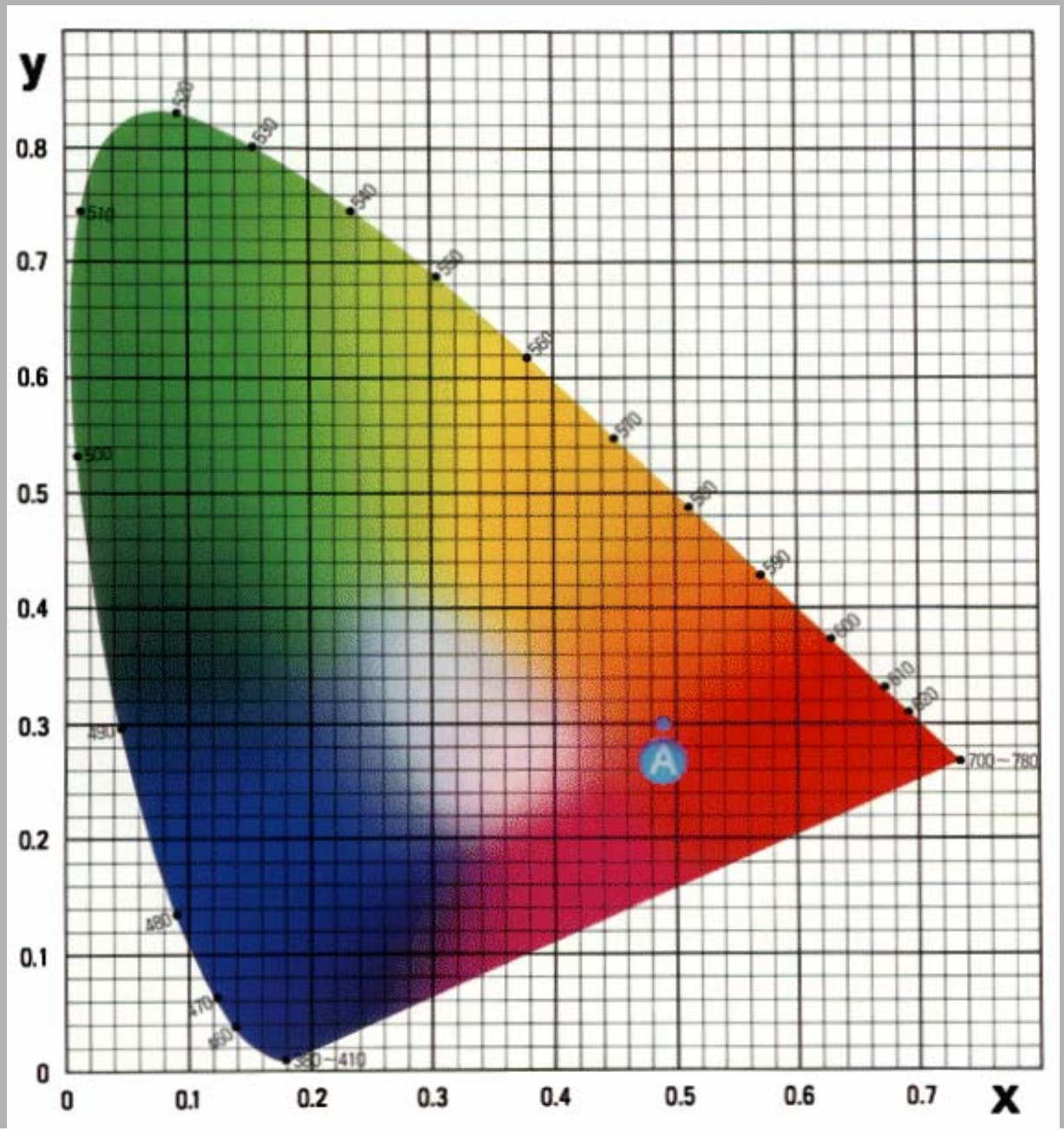
CIE (1924) Photopic V(λ) and CIE (1951) Scotopic V'(λ)

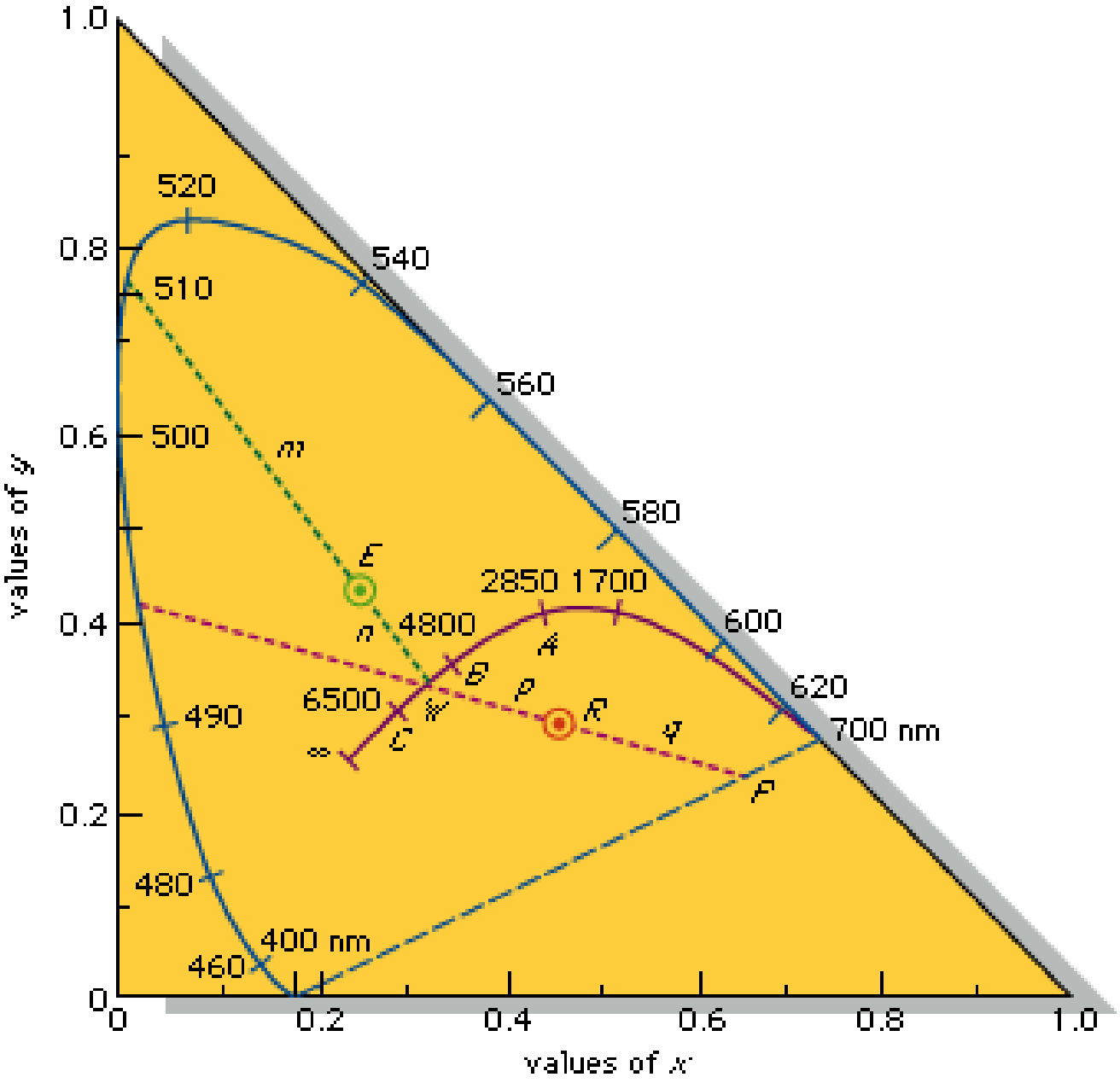


CIE 1964 Color matching functions

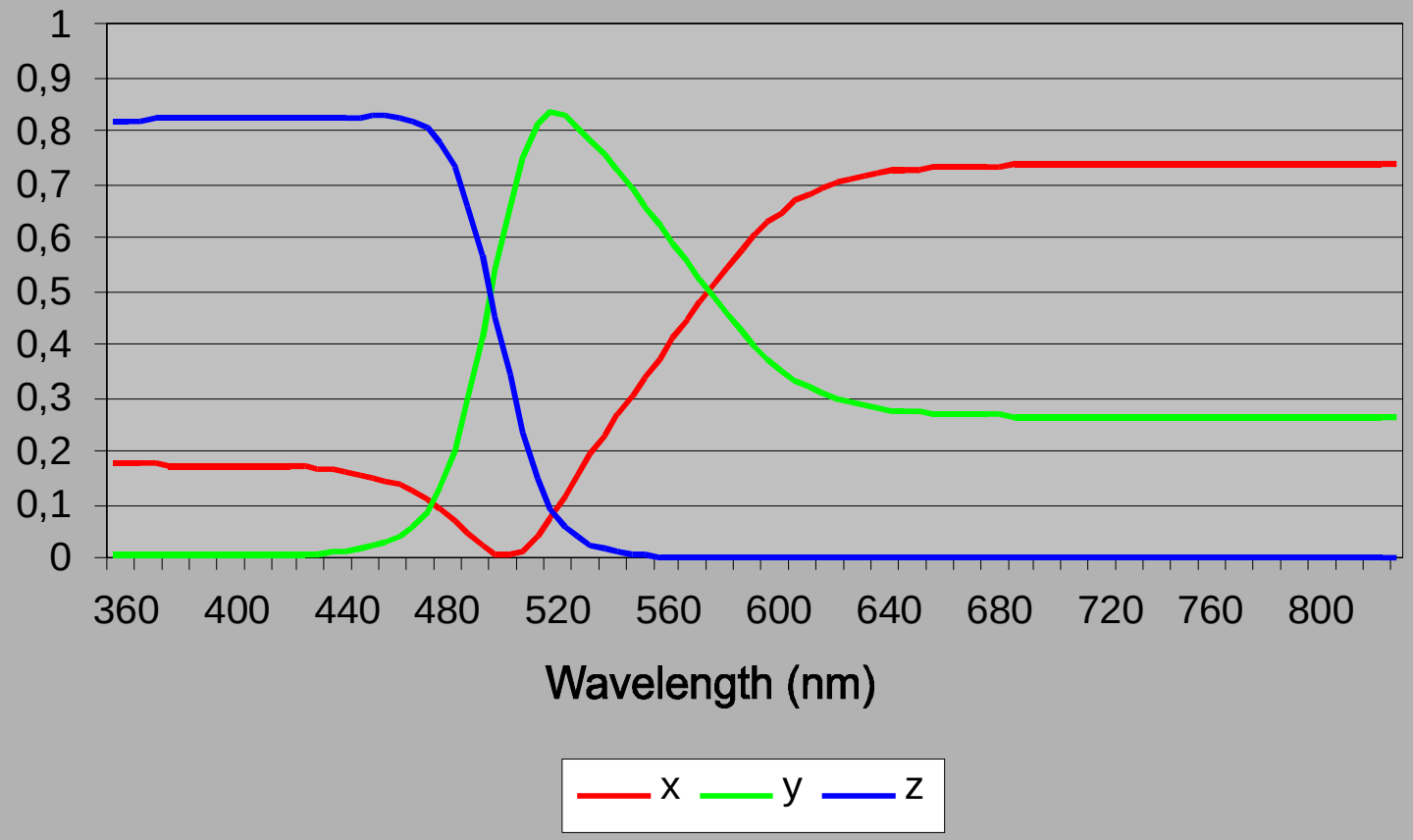


1931 x,y chromaticity diagram

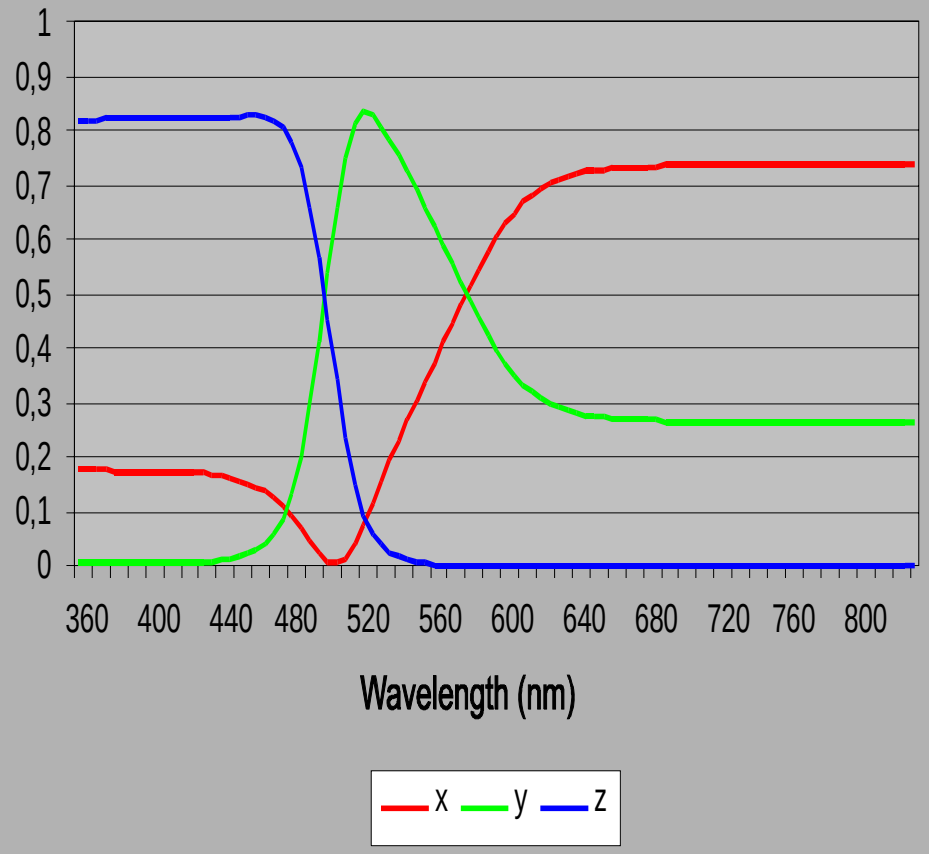


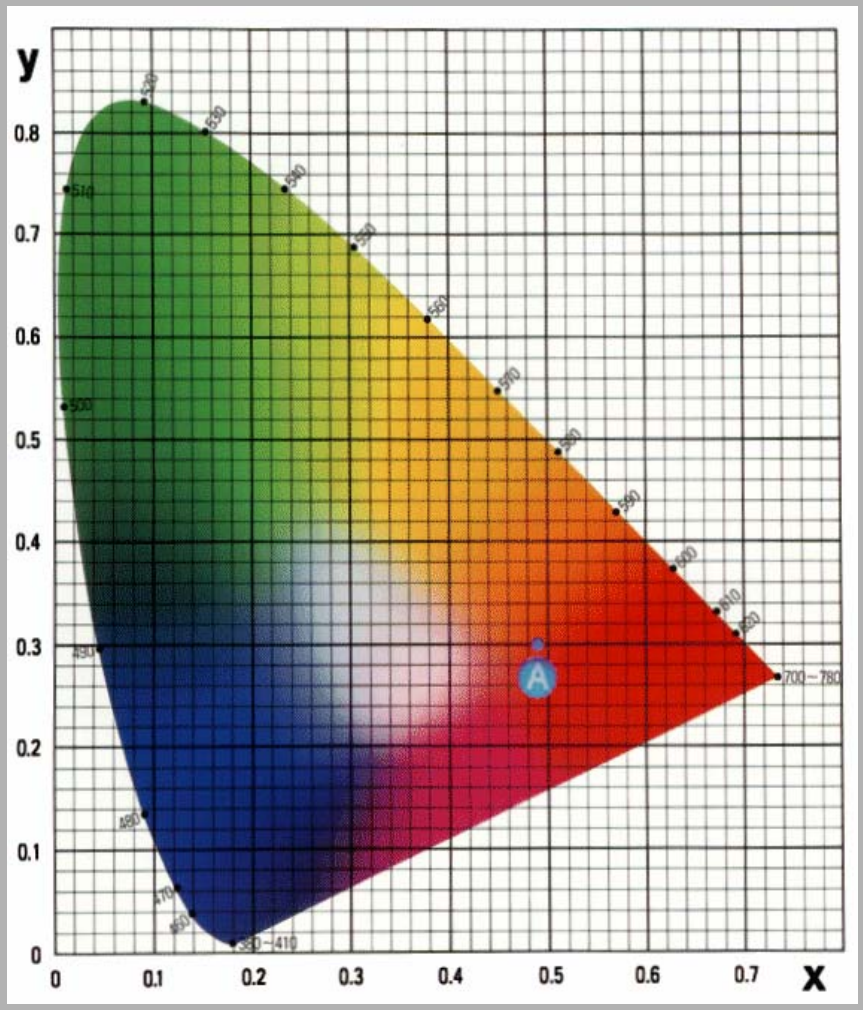


CIE (1931) xyz-chromaticity coordinates

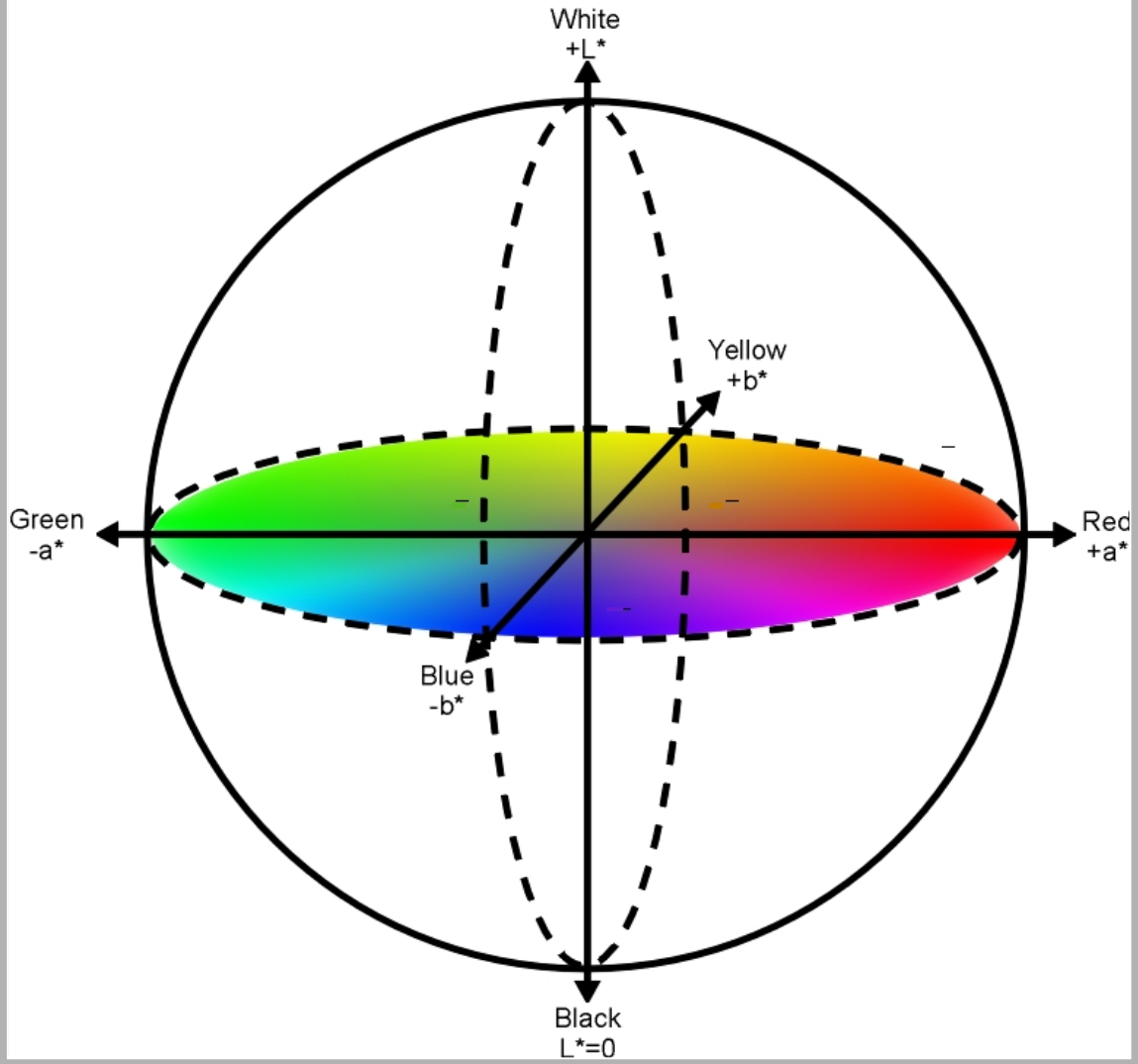


CIE (1931) xyz-chromaticity coordinates

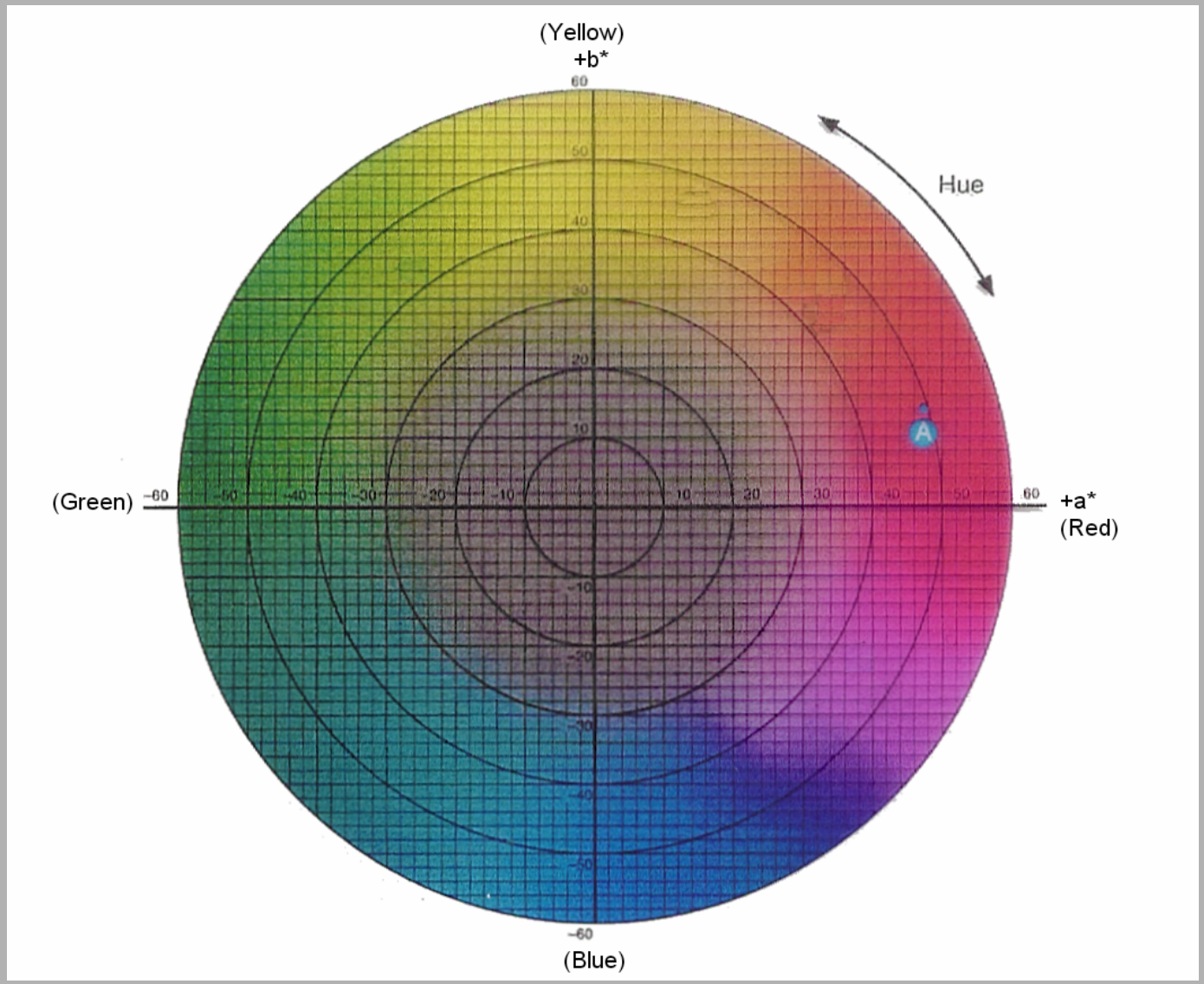


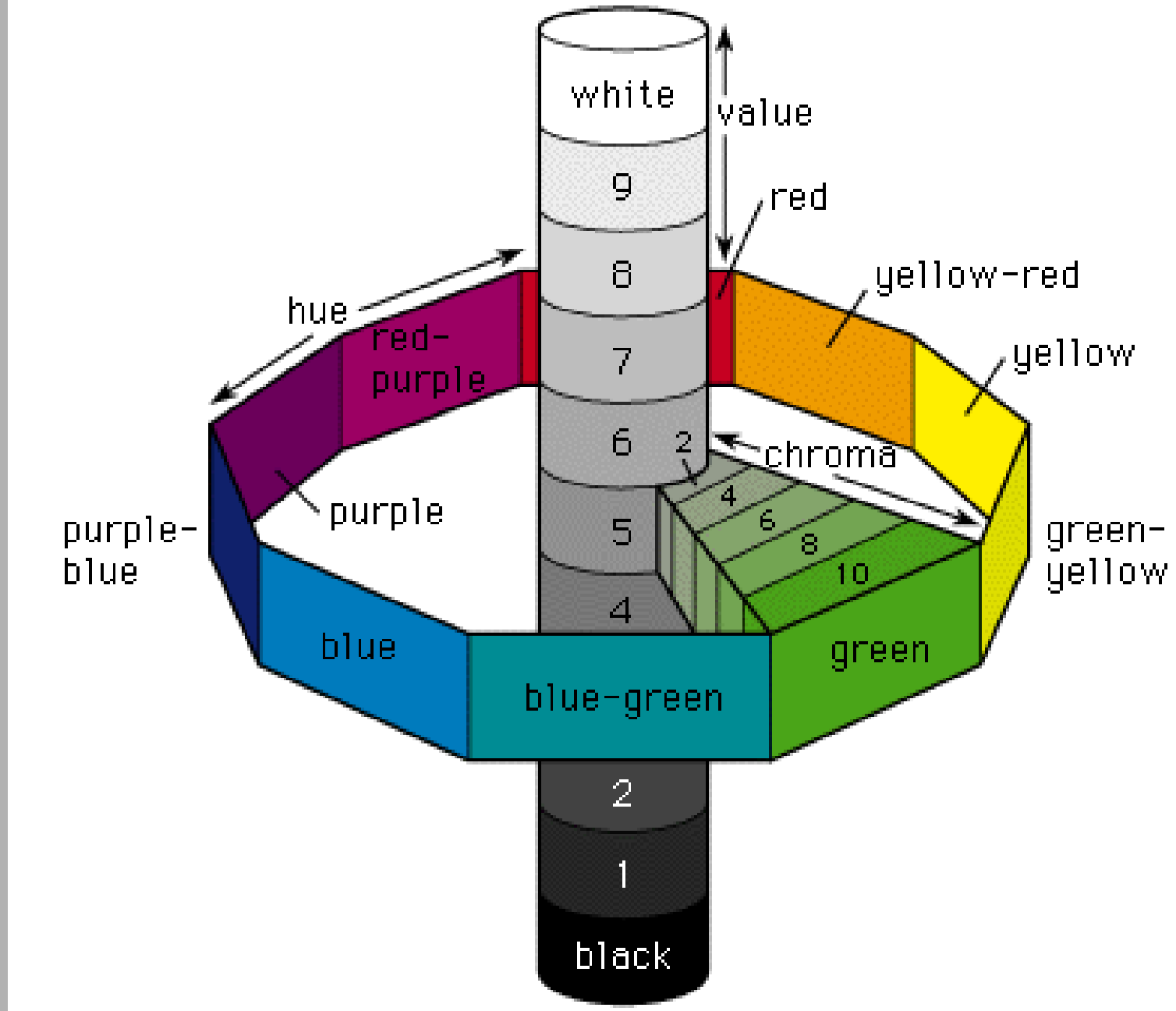


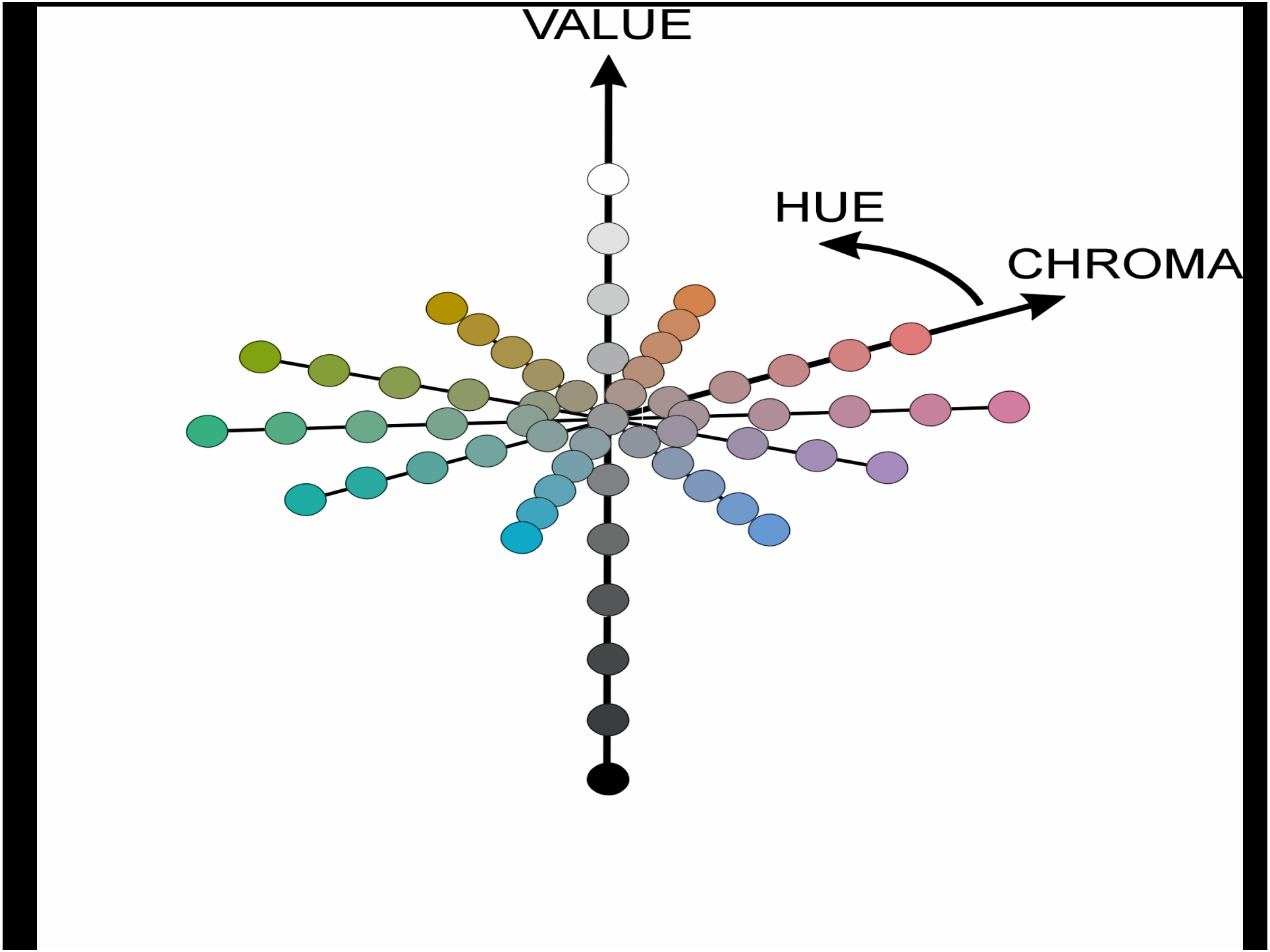
CIEL*a*b* chromaticity diagram



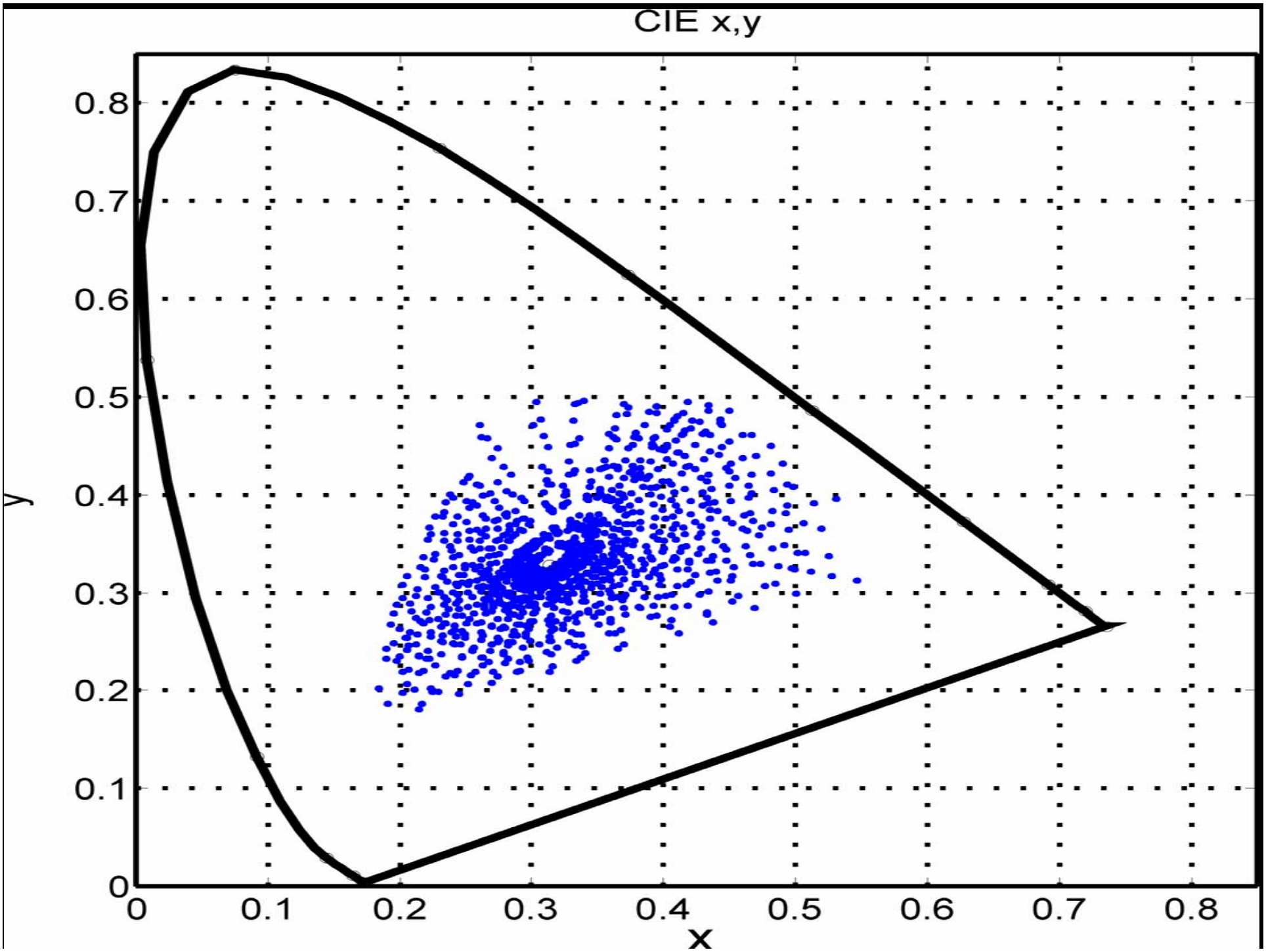
L*a*b*-color coordinate system





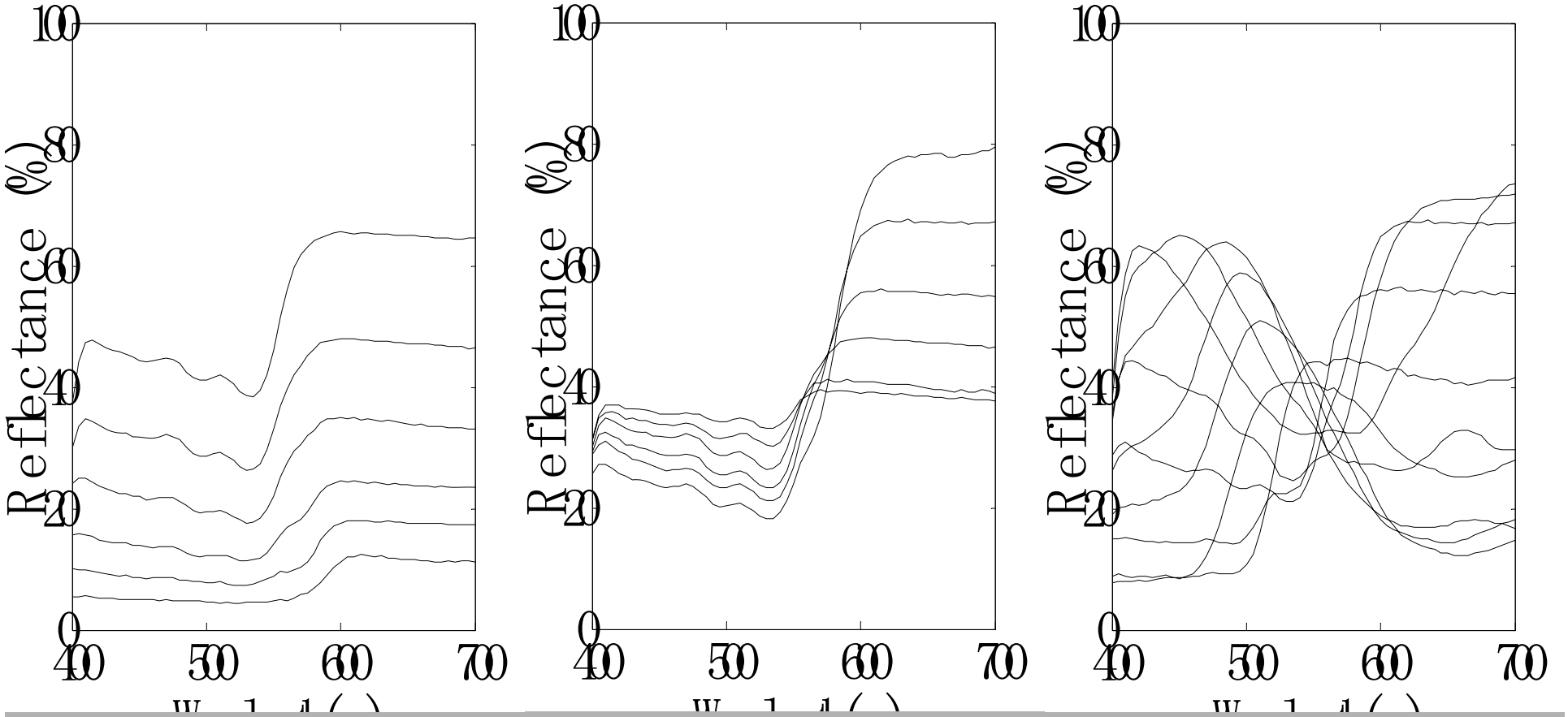

VALUE
HUE
CHROMA

Sample pages of Munsell Book of Color

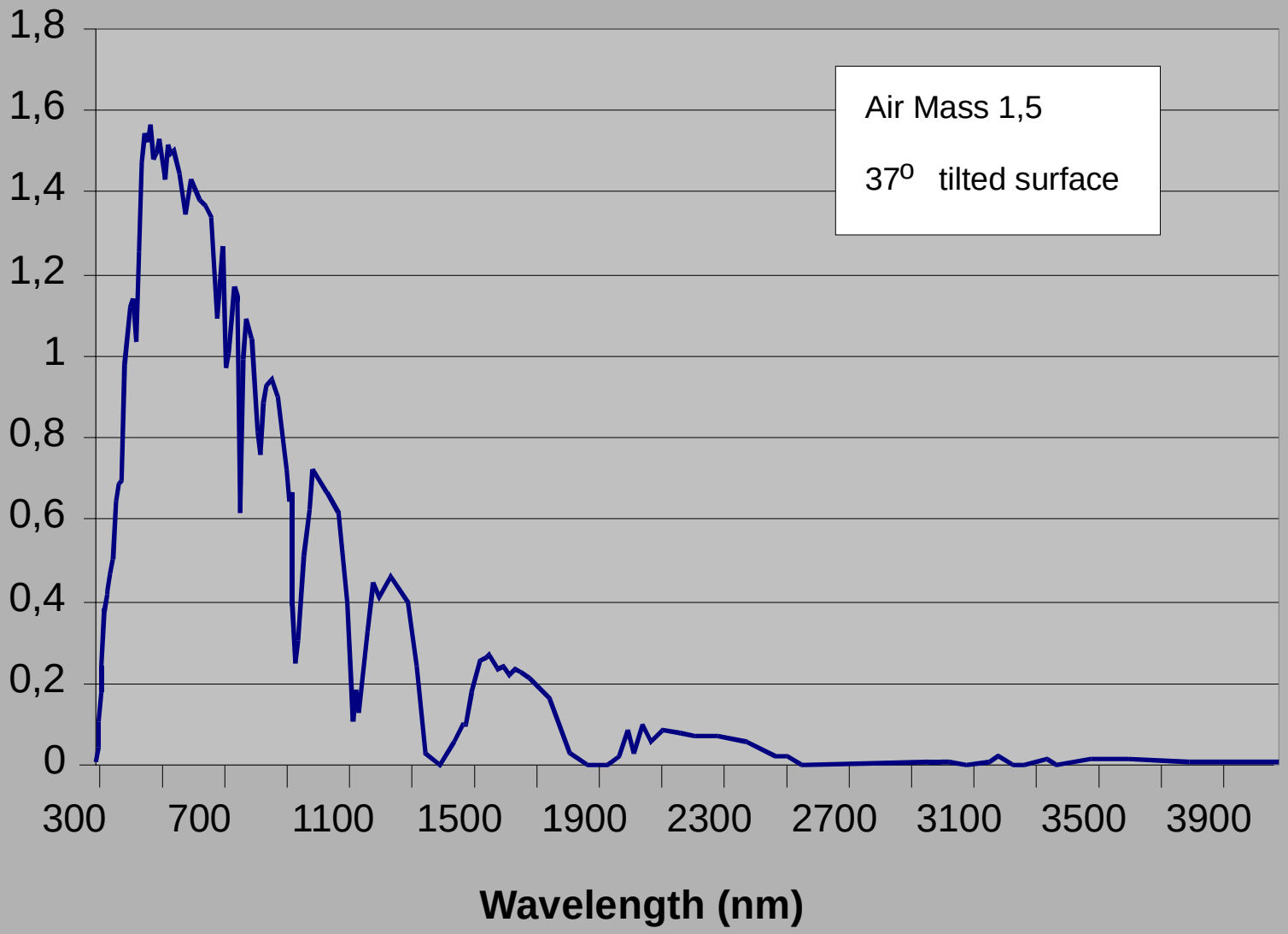

CIE x,y
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
y
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x

Some color standards

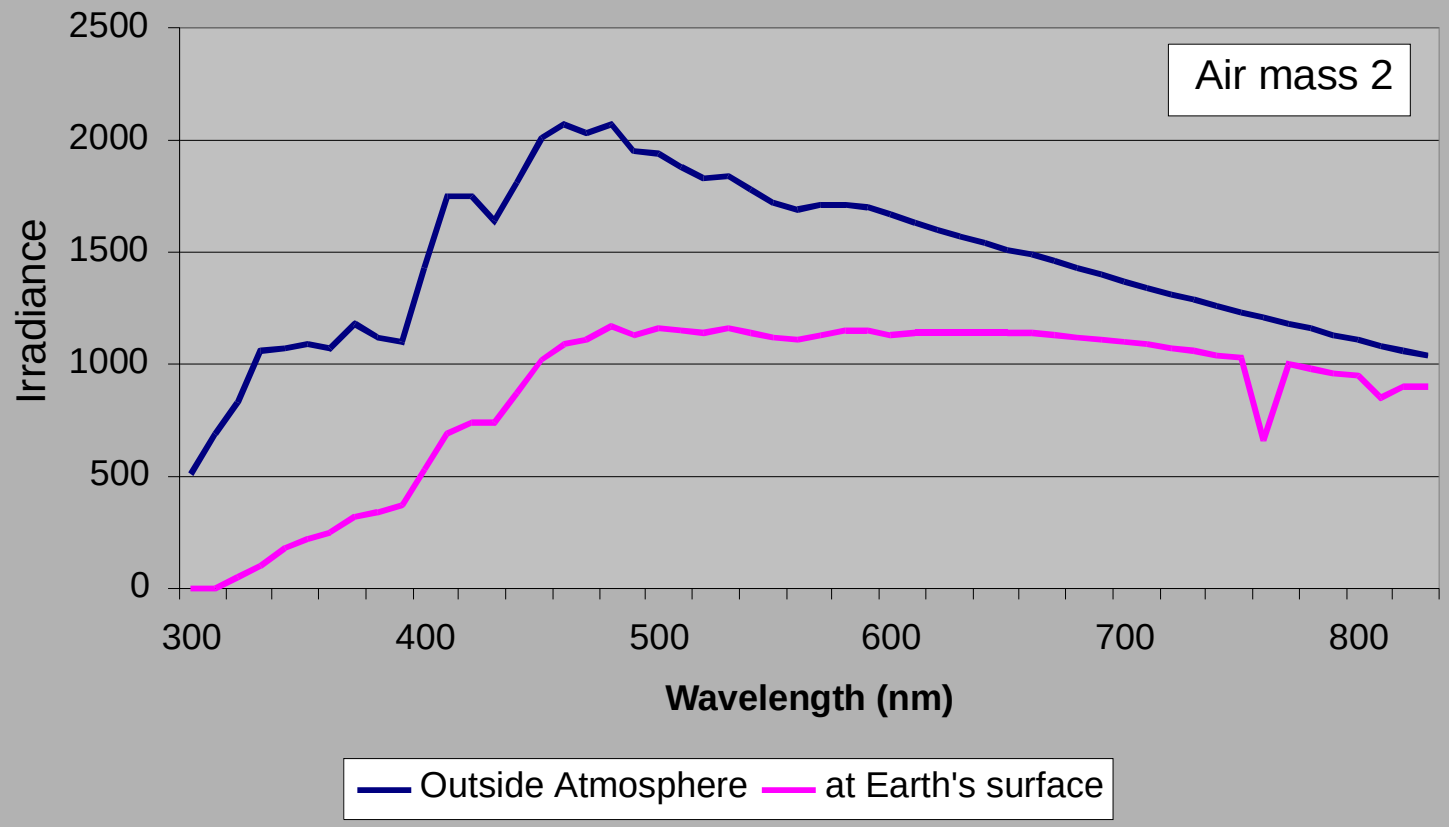
Munsell Spectra of same Hue, Saturation, and Value, respectively



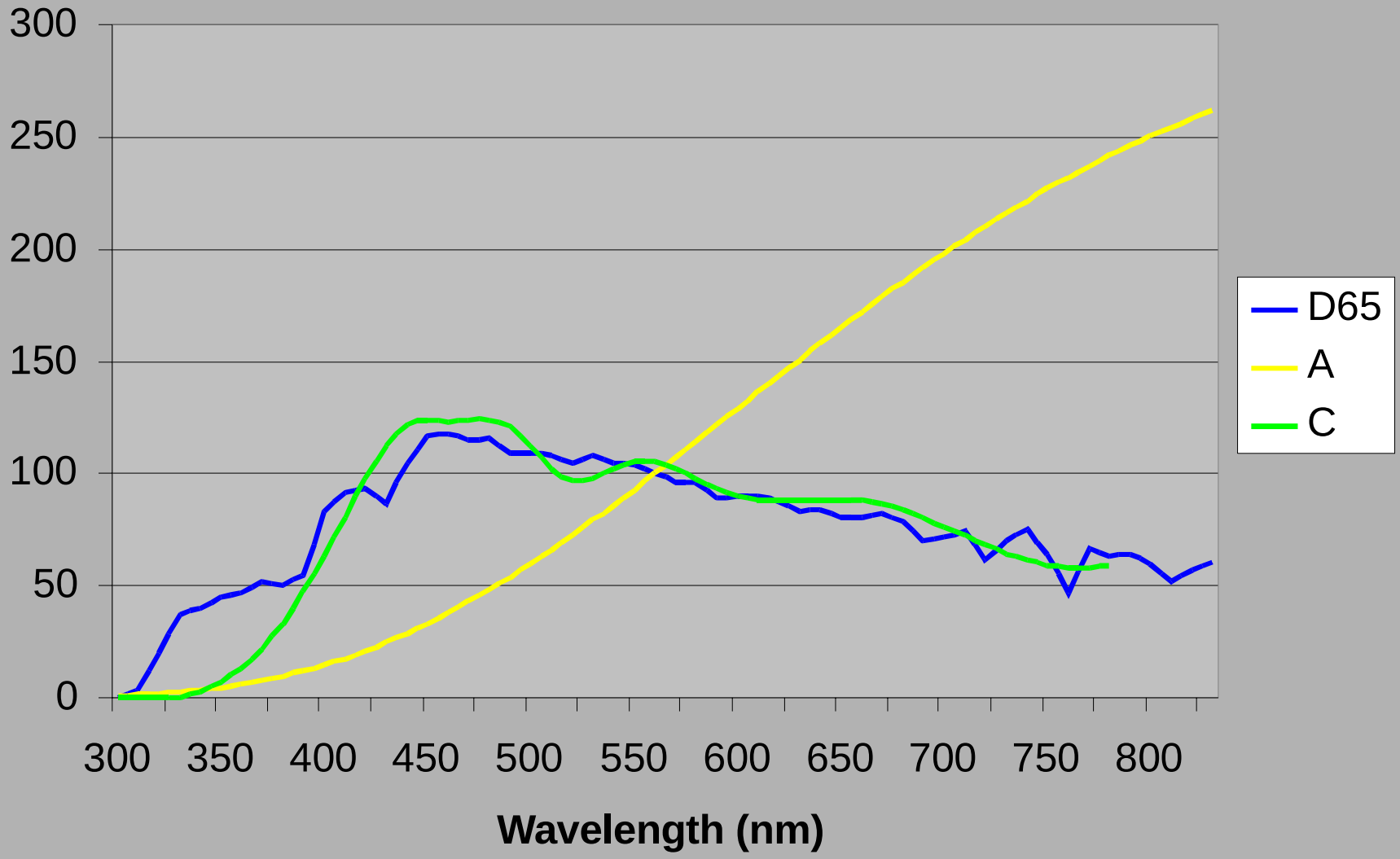
Solar Spectral Irradiance



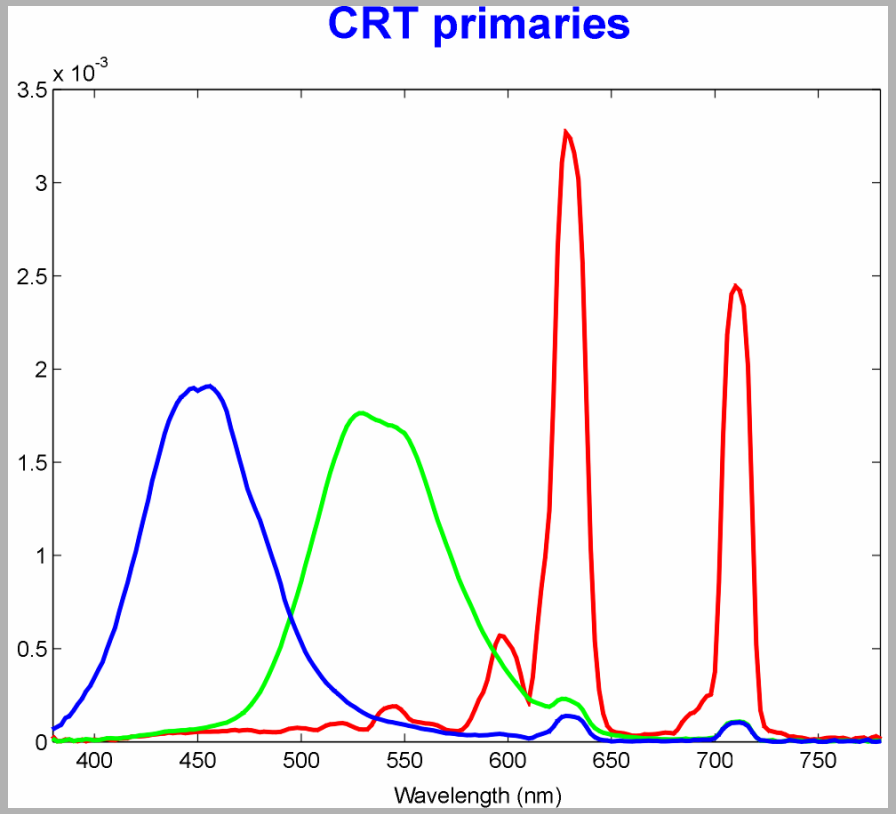
NASA Standards of Solar Irradiance

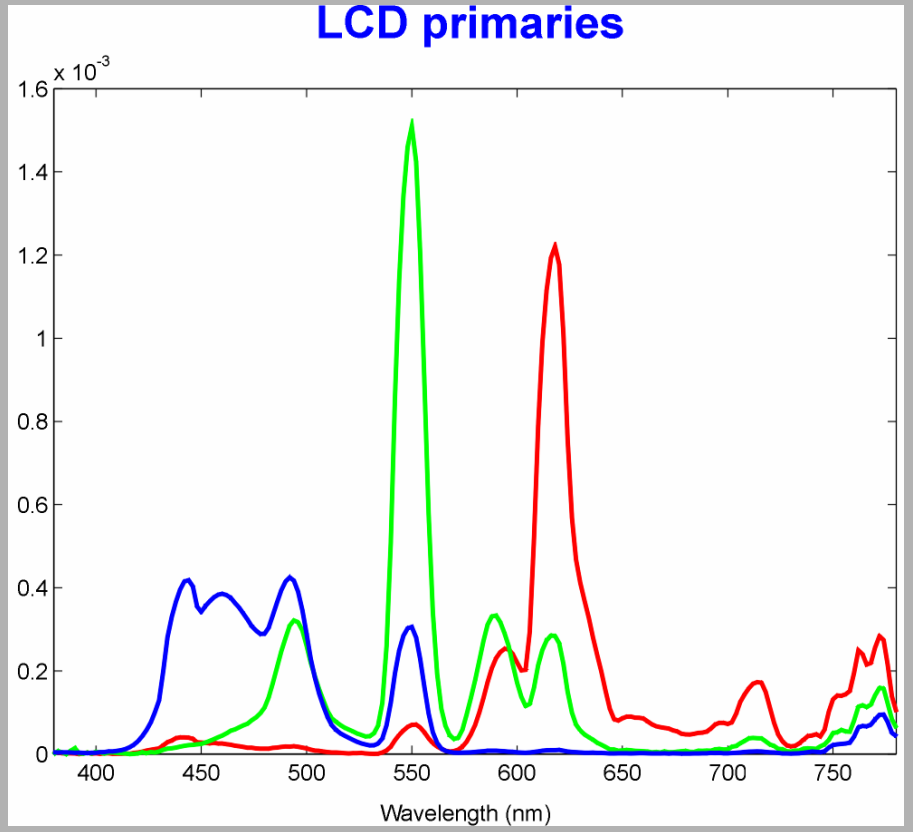


CIE Illuminations D65, A and C

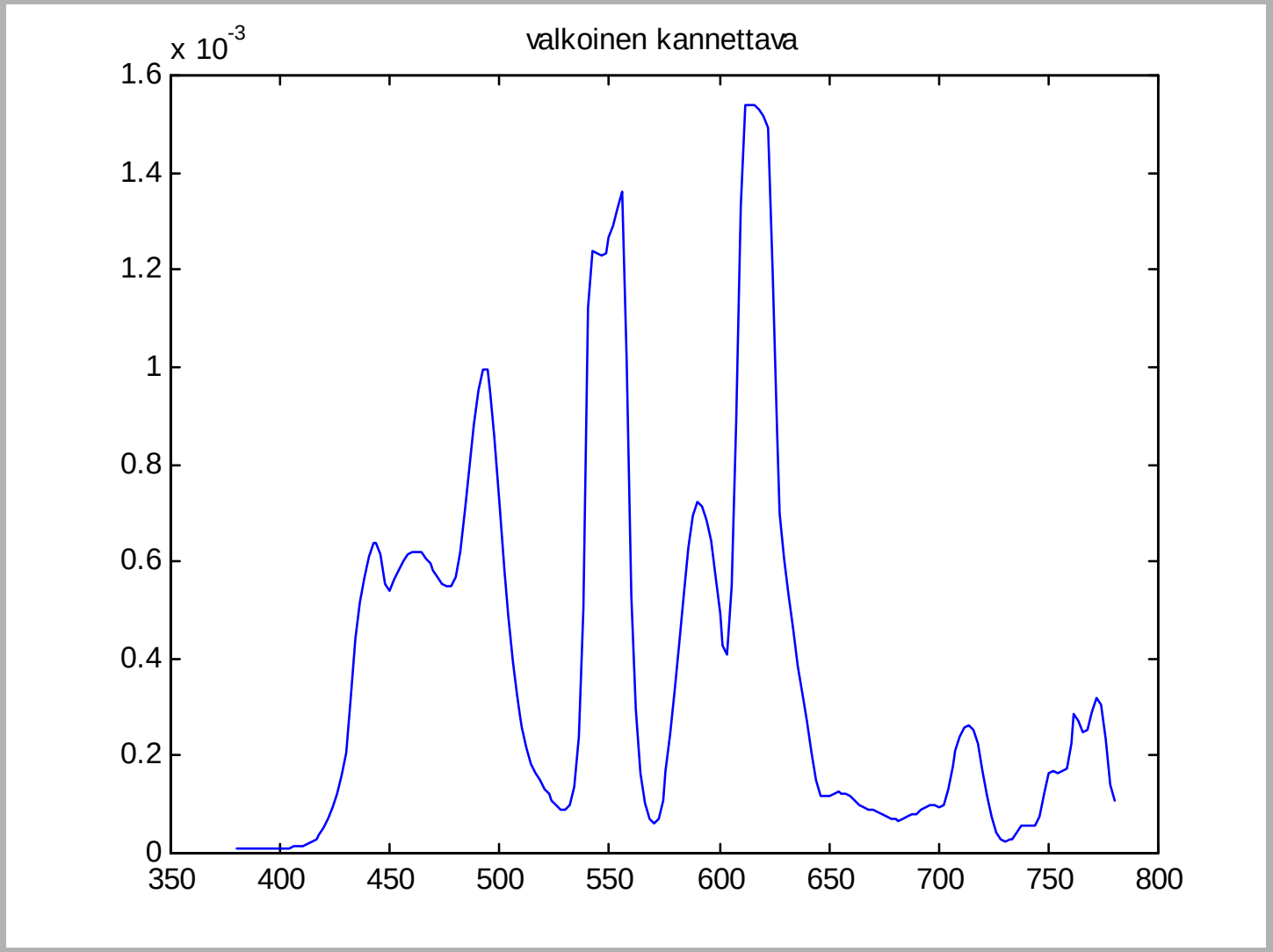


Display characterictics

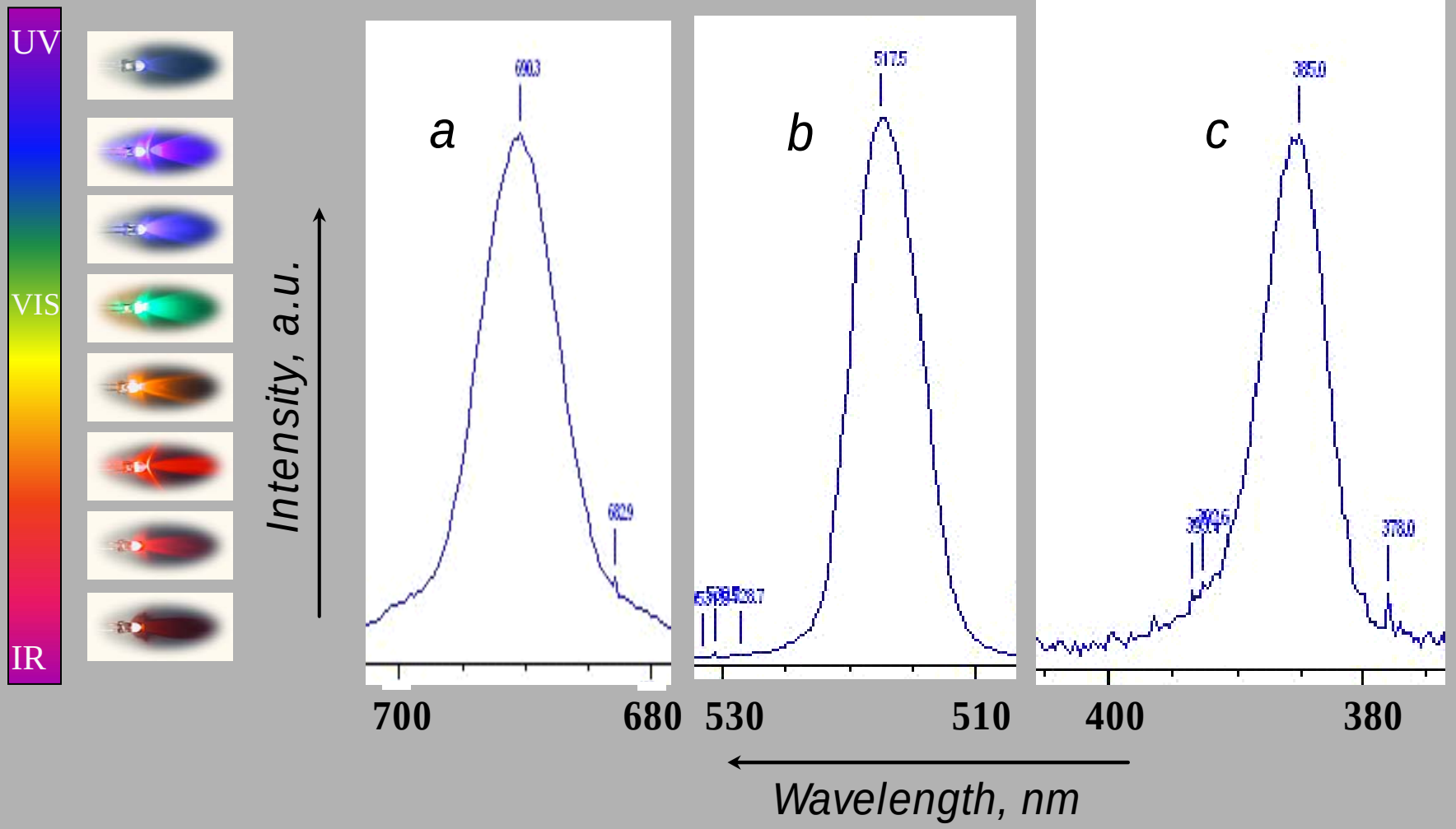


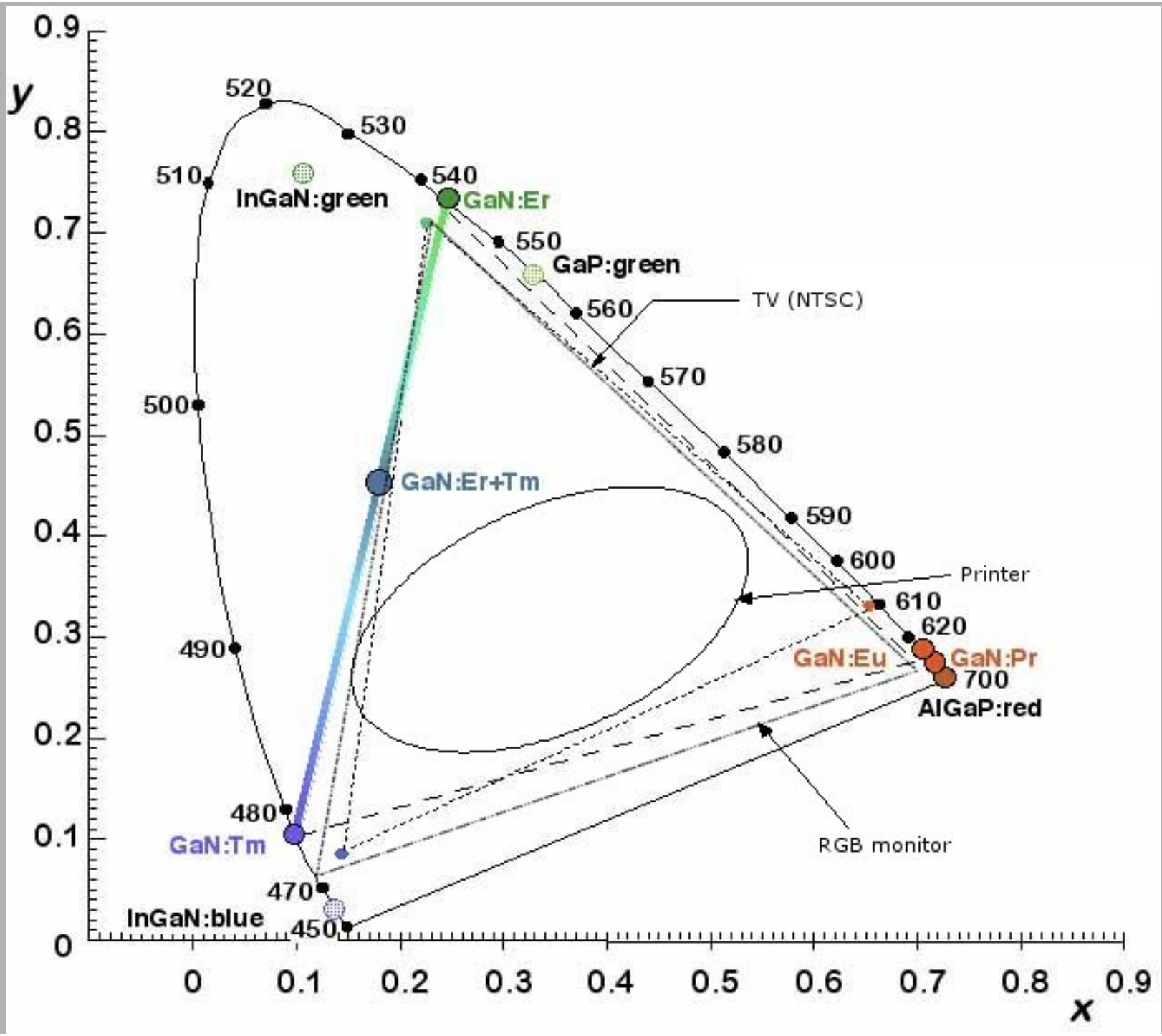


Laptop, white color on display

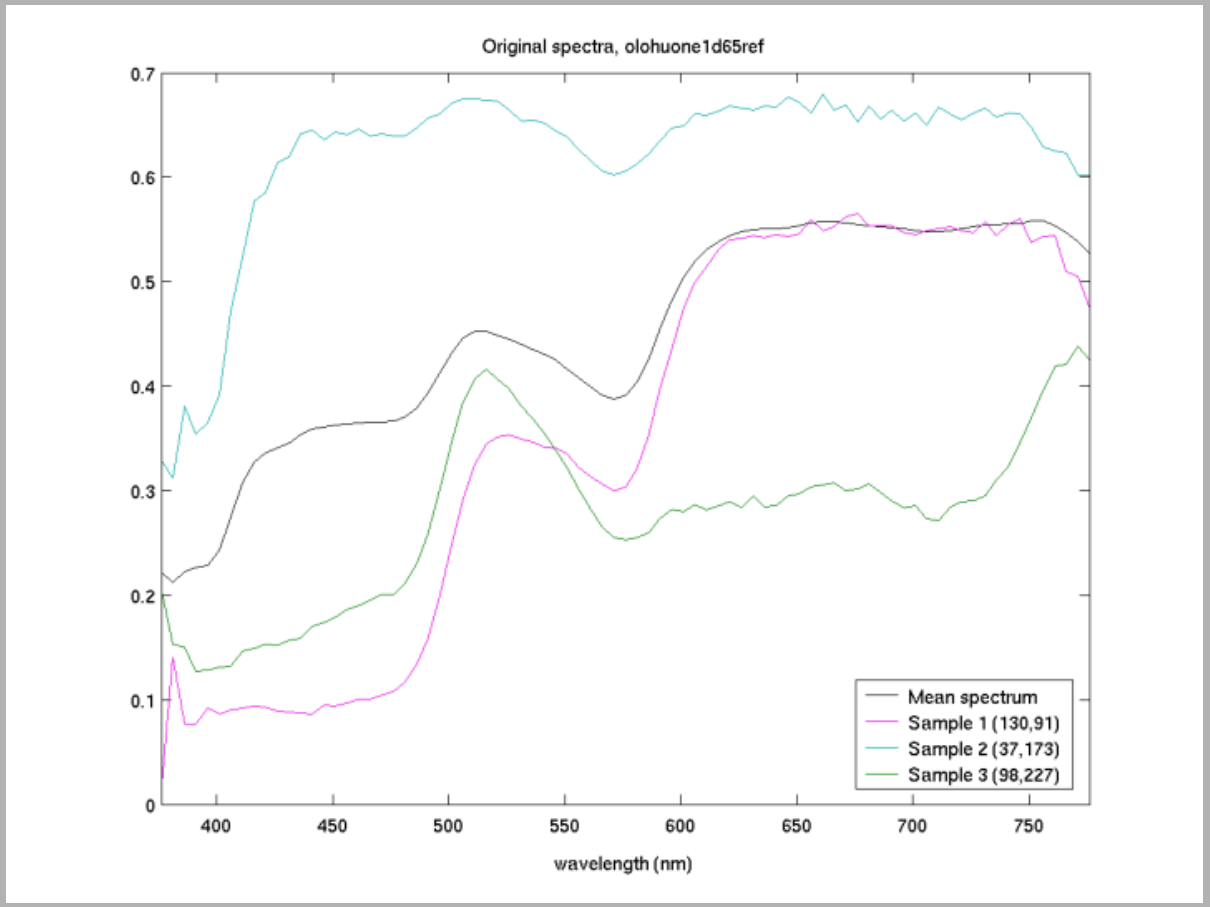


Spectral bandwidth of LED's

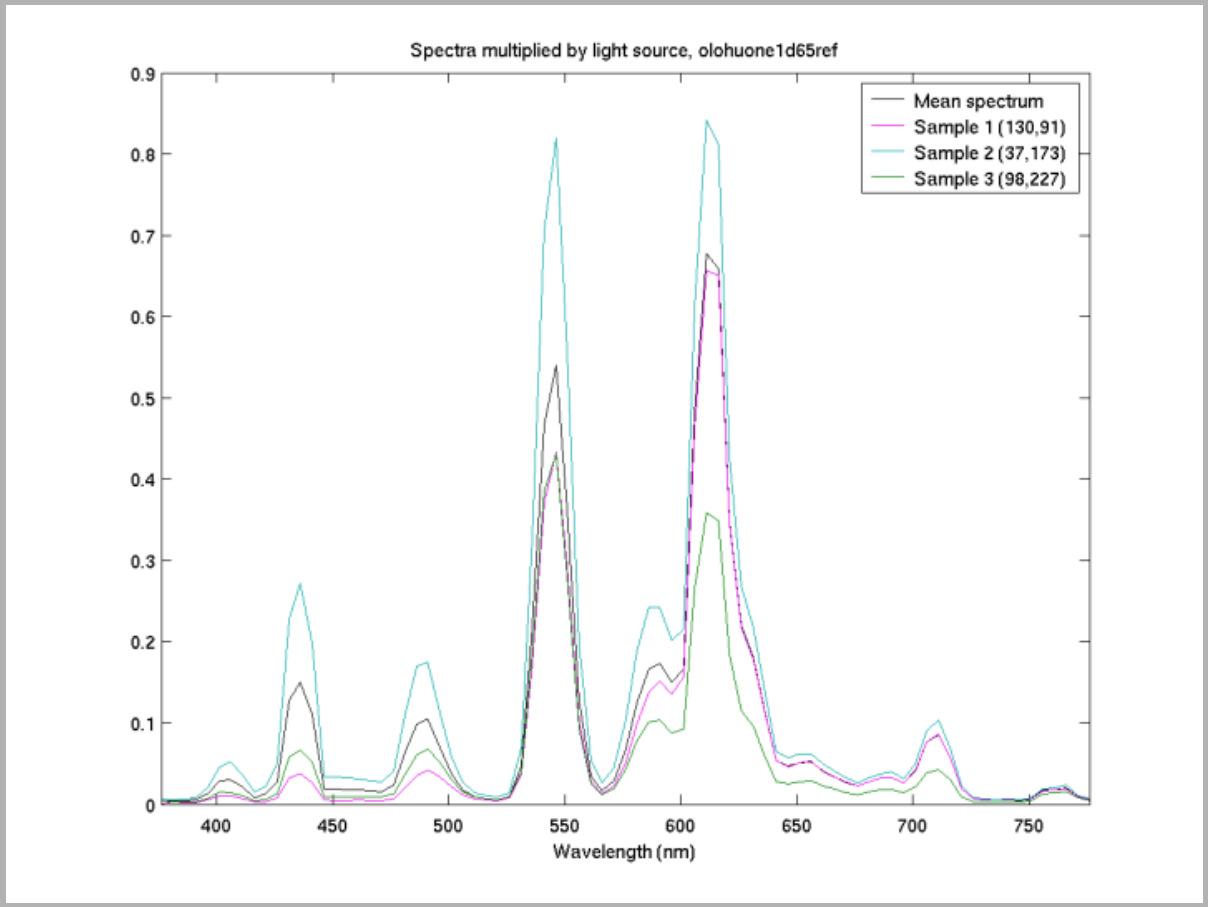


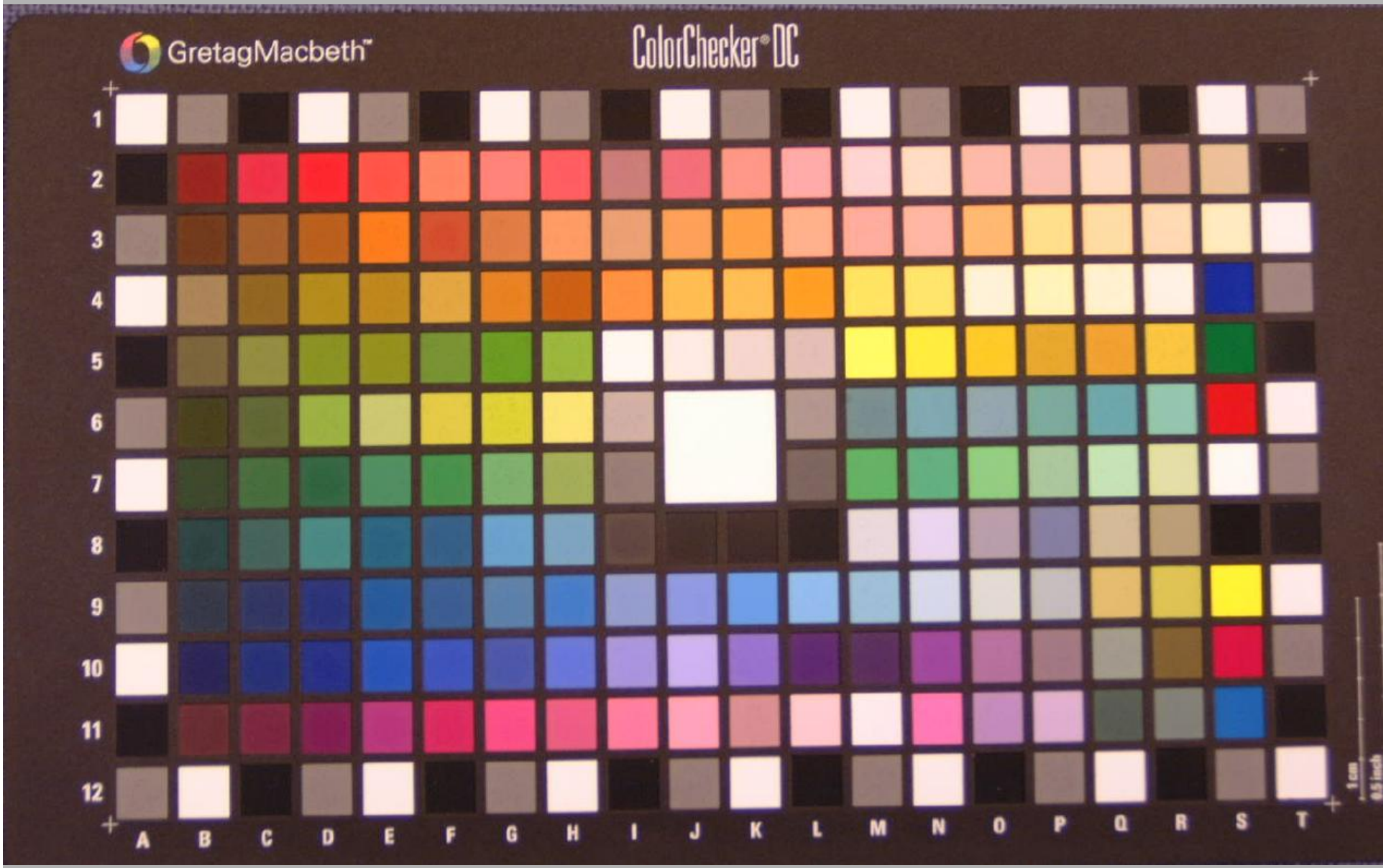

y
x
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
520
530
540
550
560
570
580
590
600
610
620
700
510
500
490
480
470
450
InGaN:green
GaN:Er
GaP:green
TV (NTSC)
GaN:Er+Tm
Printer
GaN:Eu
GaN:Pr
AlGaP:red
GaN:Tm
RGB monitor
InGaN:blue


50
100
150
200
250
300
50
100
150
200
250


Original spectra, olohuone1d65ref
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
450
500
550
600
650
700
750
wavelength (nm)
Mean spectrum
Sample 1 (130,91)
Sample 2 (37,173)
Sample 3 (98,227)


50
100
150
200
250
300
50
100
150
200
250


Spectra multiplied by light source, olohuone1d65ref
Mean spectrum
Sample 1 (130,91)
Sample 2 (37,173)
Sample 3 (98,227)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
450
500
550
600
650
700
750
Wavelength (nm)


GretagMacbeth™
ColorChecker® DC
1
2
3
4
5
6
7
8
9
10
11
12
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
1 cm
0.5 inch

Some tests with mobile phones cameras

Nokia 6600	*Siemens S65*	*Samsung SGH-D500*
Original mobile phone images		
		
Images improved using 2nd order polynomial model		
		

Some preliminary tests with mobile phones cameras

Error between RGB values of camera image and ideal sRGB values calculated from spectra.

First row: error between the original image and ideal values.
Second row: error between the corrected image and ideal values.
Note that the scale of y-axis of diagrams varies between images.