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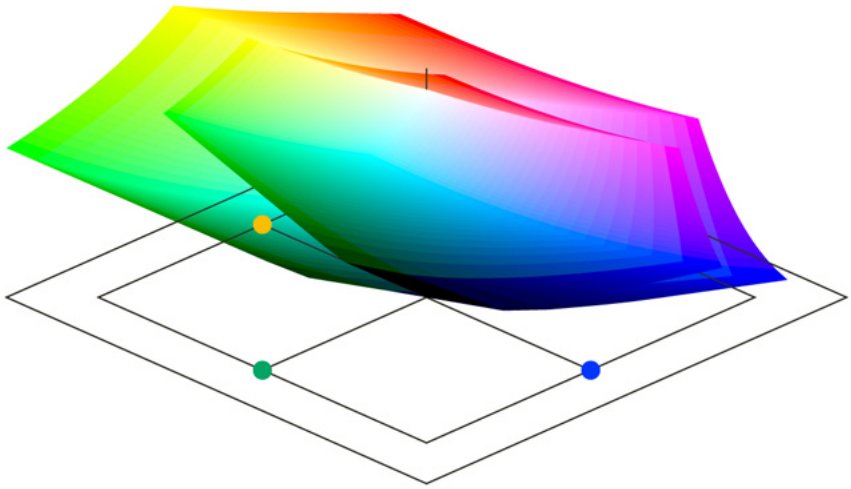
Color Mathematics by PostScript

ColorCalc
SpectroCalc



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1. Introduction

ColorCalc [8] and *SpectroCalc* [9] are PostScript EPS programs. The source codes can be changed by any text editor.
The programs generate diagrams and text as vector graphics.
The page content can be shown by all programs with PostScript interpreter, e.g. PSAlter, PageMaker 7.0, InDesign, Photoshop or GhostScript (not tested).

PSAlter [4] is an editor and PostScript Level 2 interpreter - the best choice for editing *ColorCalc*.
Printing should be done by PageMaker or InDesign in order to retain vector quality.
Photoshop rasterizes the page. Good printing quality requires a resolution of 300 ppi to 600 ppi.

ColorCalc accepts inputs XYZ, xyY, Lab, RGB. Outputs are graphics and XYZ, xyz, Lab, RGB.

SpectroCalc calculates XYZ, xyY, Lab, RGB for a given reflectance factor spectrum and two illuminants. Graphics are shown as well.

The integration of spectra by *SpectroCalc* is based on 5nm steps for the wavelength. Two methods were investigated: Euler integration and Trapezoid integration.
Average results are better with the simple Euler integration. This is used finally. Older docs were updated.
Data by Avantes Spectrocam are already interpolated for steps 5 nm.
Data by GretagMacbeth Eye-OnePro and X-Rite DTP-22 are delivered for steps 10 nm and interpolated by the program.

Everything is based on the CIE (1931) Standard Observer for 2°.

Thanks to *Danny Rich* for helpful advice.

Major revision of *ColorCalc and SpectroCalc*:
December 02-05 / 2006:
New arrangement of tables and graphics.
Linear and nonlinear RGB values.
Matrices $\mathbf{C}_{rx}$ and $\mathbf{C}_{xr}$ or adapted matrices $\mathbf{M}_{rx}$ and $\mathbf{M}_{xr}$.

2.1 ColorCalc / Input

2.1.1 Color space

```
%--Choose one standard set
/S 5 def
S  0 eq {} if                                          % None, use settings above
S  1 eq {Prims709  WhiteD65 RefD65 Gam24 BradF RendA} if % sRGB          AbsCol
S  2 eq {PrimsAd98 WhiteD65 RefD65 Gam22 BradF RendA} if % AdobeRGB(98)  AbsCol
S  3 eq {PrimsOpti WhiteD65 RefD65 Gam22 BradF RendA} if % OptiRGB       AbsCol
S  4 eq {PrimsProp WhiteD50 RefD50 Gam18 BradF RendA} if % ProPhoto      AbsCol

S  5 eq {Prims709  WhiteD65 RefD50 Gam24 BradT RendR} if % sRGB          RelCol
S  6 eq {PrimsAd98 WhiteD65 RefD50 Gam22 BradT RendR} if % AdobeRGB(98)  RelCol
S  7 eq {PrimsOpti WhiteD65 RefD50 Gam22 BradT RendR} if % OptiRGB       RelCol
S  8 eq {PrimsProp WhiteD50 RefD50 Gam18 BradT RendR} if % ProPhoto      RelCol

S  9 eq {Prims709  WhiteD65 RefD50 Gam24 BradF RendA} if % sRGB          AbsCol
S 10 eq {PrimsAd98 WhiteD65 RefD50 Gam22 BradF RendA} if % AdobeRGB(98)  AbsCol
S 11 eq {PrimsOpti WhiteD65 RefD50 Gam22 BradF RendA} if % OptiRGB       AbsCol
S 12 eq {PrimsProp WhiteD50 RefD50 Gam18 BradF RendA} if % ProPhoto      AbsCol
```

A complete set contains:

Prims	Primaries, e.g. Rec.709, AdobeRGB(1998)
White	Media white point, e.g. D65
Ref	Reference white point, e.g. D50
Gam	Tone reproduction curve (TRC) Gamma=1.0,1.8, 2.2 or 2.4 which is used in a more complex TRC in sRGB The *effective* Gamma for sRGB is 2.2
Brad	Bradford chromatic adaptation transform (CAT), false or true
Rend	Rendering Intent. With CAT: RelCol. Without CAT: AbsCol Relevant if media white and reference white are different

The Bradford CAT is based on the cone response model as explained in [1], [3], [7].

The first group S=1...4 is useful for interpreting the physical parameters of a color space, e.g. for a monitor or for sRGB.
The second group S=5...8 converts everything to D50. This mode is used in all ICC profiles.
E.g. the primaries for a monitor or working space like sRGB will appear shifted (adapted primaries).
Not really useful, but a standard. For ProPhoto both sets in the list mean exactly the same.
New sets can be defined easily, using available modules like WideGamut, NTSC etc..

2.1.2 Input mode

```
%--Choose one input mode
/Mode 4 def
 Mode 1 eq { XYZMode } if
 Mode 2 eq { xyYMode } if
 Mode 3 eq { LabMode } if
 Mode 4 eq { RGBMode } if        % gamma encoded
 Mode 5 eq { RGBModeLinear} if   % linear
```

2.1 ColorCalc / Input

2.1.3 Headline

```
%--Define headline
/head (any text) def
```

2.1.4 Show CT-Curve in Lab-plane

```
%--Choose Show CT-Curve in Lab
/CTLab 0 def
% 0 No
% 1 Yes
```

2.1.5 Colors

```
/XYZ [ 0.86783 0.89743 0.78069
       0.84808 0.87618 0.80035 ] def

/xyY [  0.2 0.2 0.8
        0.3 0.3 0.8
        0.4 0.4 0.8 ] def

/LAB [  60  +25 +25
        60  +50 +50
        60  +75 +75
        60 +100 +100 ] def

/RGB [ 255 255 255
       255   0   0
         0 255   0
         0   0 255
         0 255 255
       255   0 255
       255 255   0 ] def
```

Up to nine colors in each color space can be defined, each color by three numbers in a row. More colors are possible by extending the bounding box of the EPS doc.

For this example the program would calculate two colors for XYZ, three colors for xyY, four colors for Lab and seven colors for RGB, depending on the input mode.

2.2 ColorCalc / Output

2.2.1 Graphics

Please refer to the examples.

CIE chromaticity diagram xyY
Curve for the Planckian radiator, with color temperatures
White points D50, D65 and 9300K (D93)
Round color dots in xyY (colors in device RGB)
Small Lab plane a*b*
Square color dots in a*b* (colors in device RGB)
Tone reproduction curve

2.2.2 Header

Head	Arbitrary header text, e.g. date
Med.White	Media white point (ICC: ‘media’.The author’s opinion: should be ‘medium’)
Ref.White	Reference white point
Primaries	Primaries
Trc	Tone reproduction curve
Input	Input data mode

2.2.3 Numbers

XYZ	CIE XYZ as stimulus values
xyY	CIE xyY as stimulus values
L*a*b*	CIE Lab in reference space
RGB	Linear RGB values in media space, not clipped
RGB’	Gamma encoded values in media space, clipped for 0...255
CCT	Correlated color temperature This calculation is based on tables, not very accurate but practically sufficient ‘None’ is indicated if the color is too far away from the curve for the Planckian radiator
RGB	In-gamut or out-of-gamut for RGB Out-of-gamut, if at least one value is less than -0.49 (rounded to 0) or greater than 255.49 (rounded to 255)

2.3 ColorCalc / Calculation sequence

2.3.1 Nomenclature

s	Stimulus, general index for XYZ and xyY as inputs and outputs
m	Media white point for RGB systems, inputs and outputs
n	Reference white point for CIELab (XYZ_n are internal variables)
T	Tone Reproduction Curve, e.g. $y=x^{2.2}$
T^{-1}	Inverse Tone Reproduction Curve, e.g. $y=x^{0.4545}$
B	Bradford matrix, uses media and reference white points [7, 2.6]
B^{-1}	Inverse Bradford matrix
M_{rx}	Matrix for $R^T = M_{rx}\, X^T$
M_{xr}	Matrix for $X^T = M_{xr}\, R^T$ These matrices contain the Bradford matrix, which can be an identity matrix: $M_{rx} = C_{rx}B^{-1}$, $M_{xr} = B\ C_{xr}$ Matrices C_{rx} and C_{xr} are calculated using the chromaticities and the white point of the media space, [7, 2.5].
N	Matrix diag (X_n, Y_n, Z_n)
N^{-1}	Matrix diag ($1/X_n$, $1/Y_n$, $1/Z_n$)
L	Calculation of CIELab values, [7, 2.1]
L^{-1}	Inverse calculation [7, 2.2]
P	Projection of XYZ onto xy, [7, 2.3]
P^{-1}	Inverse projection

2.3.2 Input mode XYZ

$$XYZ_s \rightarrow [\,N^{-1}\,] \rightarrow XYZ_n \rightarrow [\,L\,] \rightarrow LAB_n$$
$$\rightarrow [\,P\,] \rightarrow xyY_s$$
$$\rightarrow [\,M_{rx}\,] \rightarrow RGB_m \rightarrow [\,T^{-1}\,] \rightarrow RGB'_m$$

2.3.3 Input mode xyY

$$xyY_s \rightarrow [\,P^{-1}\,] \rightarrow XYZ_s \rightarrow [\,N^{-1}\,] \rightarrow XYZ_n \rightarrow [\,L\,] \rightarrow LAB_n$$
$$\rightarrow [\,M_{rx}\,] \rightarrow RGB_m \rightarrow [\,T^{-1}\,] \rightarrow RGB'_m$$

2.3.4 Input mode Lab

$$LAB_n \rightarrow [\,L^{-1}\,] \rightarrow XYZ_n \rightarrow [\,N\,] \rightarrow XYZ_s \rightarrow [\,M_{rx}\,] \rightarrow RGB_m \rightarrow [\,T^{-1}\,] \rightarrow RGB'_m$$
$$\rightarrow [\,P\,] \rightarrow xyY_s$$

2.3.5 Input mode RGB

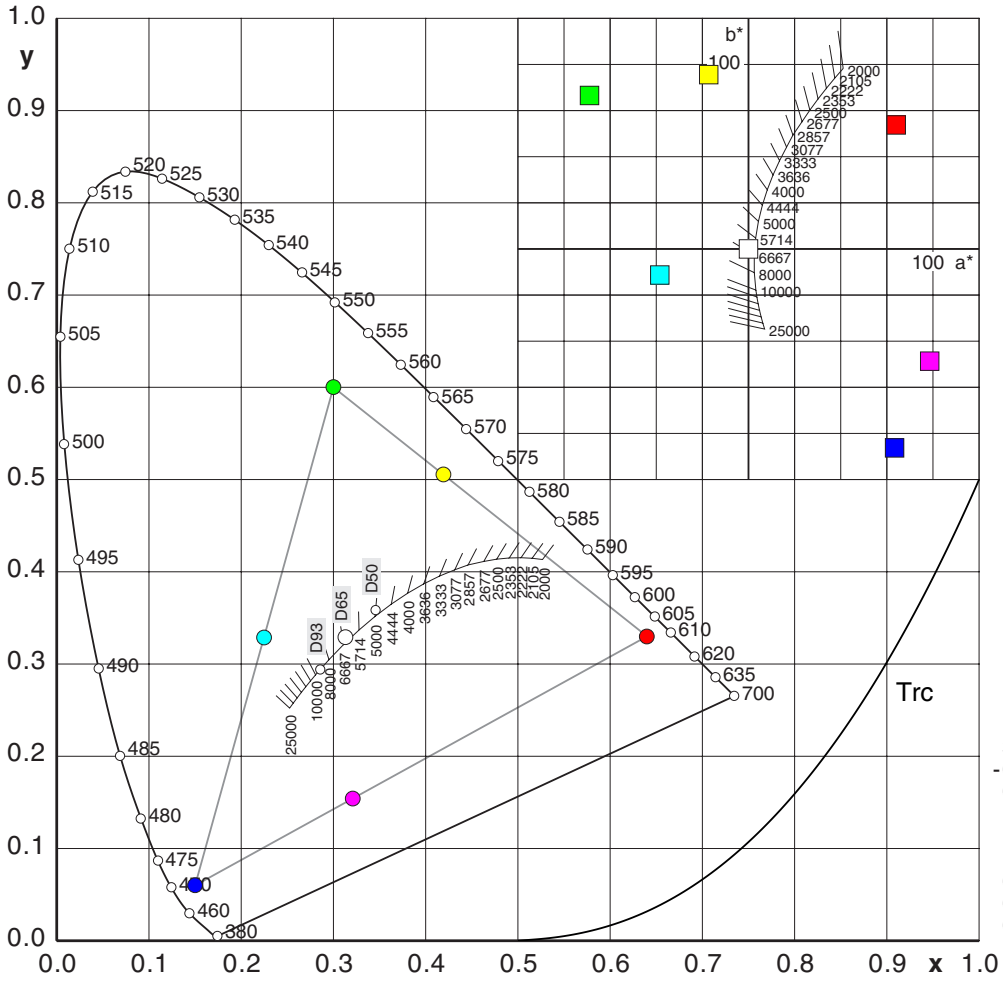
$$RGB'_m \rightarrow [\,T\,] \rightarrow RGB_m \rightarrow [\,M_{xr}\,] \rightarrow XYZ_s \rightarrow [\,N^{-1}\,] \rightarrow XYZ_n \rightarrow [\,L\,] \rightarrow LAB_n$$
$$\rightarrow [\,P\,] \rightarrow xyY_s$$

2.3.6 Input mode RGBlinear

$$RGB_m \rightarrow [\,M_{xr}\,] \rightarrow XYZ_s \rightarrow [\,N^{-1}\,] \rightarrow XYZ_n \rightarrow [\,L\,] \rightarrow LAB_n$$
$$\rightarrow [\,P\,] \rightarrow xyY_s$$
$$\rightarrow [\,T^{-1}\,] \rightarrow RGB'_m$$

2. 4.1 ColorCalc / Examples / sRGB without CAT

ColorCalc G.Hoffmann Dec.04 / 2006		Med.White: Ref.White: Input:	D65 D65 RGB'	Primaries: Trc: Bradford:	Rec.709 sRGB No	Intent: Set:	AbsCol 1
X	0.950456	0.412391	0.357584	0.180481	0.538065	0.592872	0.769975
Y	1.000000	0.212639	0.715169	0.072192	0.787361	0.284831	0.927808
Z	1.089058	0.019331	0.119195	0.950532	1.069727	0.969863	0.138526
x	0.312700	0.640000	0.300000	0.150000	0.224647	0.320893	0.419306
y	0.329000	0.330000	0.600000	0.060000	0.328731	0.154166	0.505257
z	0.358300	0.030000	0.100000	0.790000	0.446622	0.524941	0.075437
L*	100.0000	53.2371	87.7355	32.3009	91.1148	60.3227	97.1386
a*	0.0000	80.0901	-86.1816	79.1953	-48.0789	98.2374	-21.5600
b*	0.0000	67.2033	83.1866	-107.8555	-14.1290	-60.8289	94.4838
R	255.0000	255.0000	0.0000	0.0000	0.0000	255.0000	255.0000
G	255.0000	0.0000	255.0000	0.0000	255.0000	0.0000	255.0000
B	255.0000	0.0000	0.0000	255.0000	255.0000	255.0000	0.0000
R'	255.0000	255.0000	0.0000	0.0000	0.0000	255.0000	255.0000
G'	255.0000	0.0000	255.0000	0.0000	255.0000	0.0000	255.0000
B'	255.0000	0.0000	0.0000	255.0000	255.0000	255.0000	0.0000
CCT	6493 K	none	none	none	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam



Matrix Crx

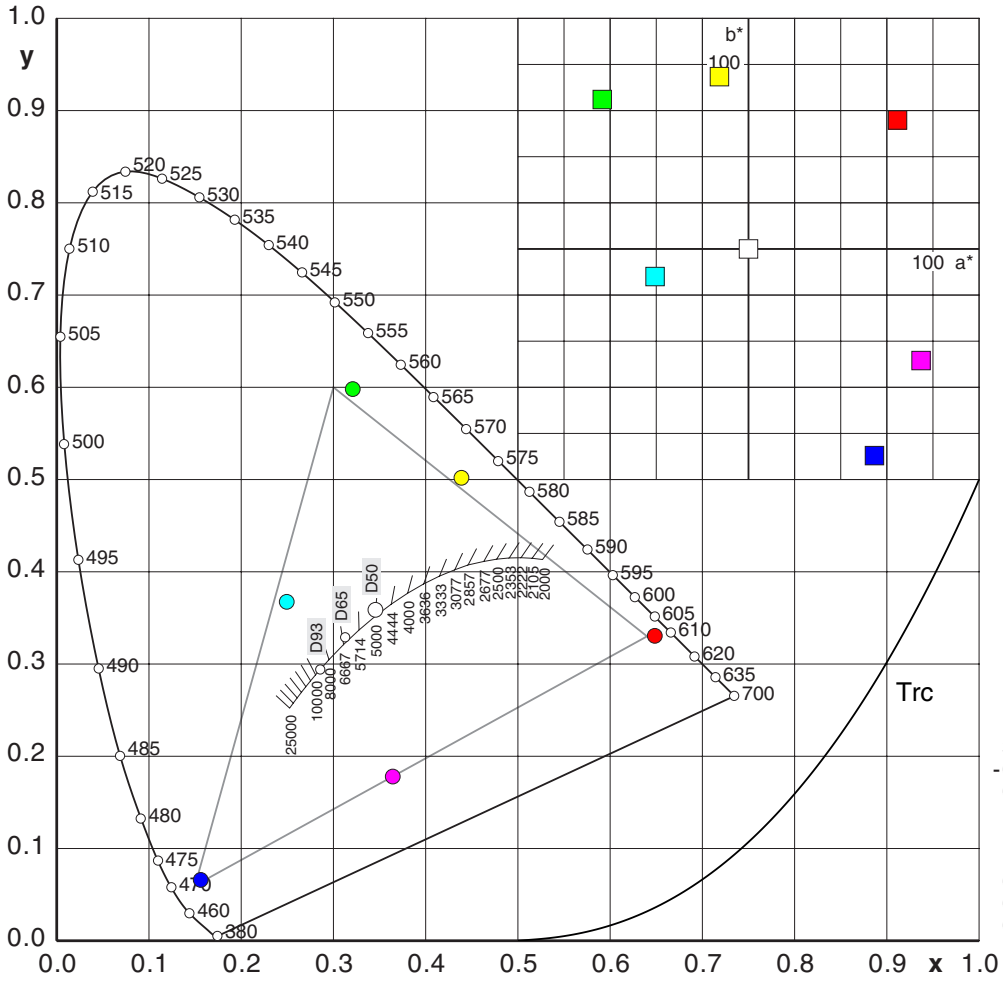
3.240970	-1.537383	-0.498611
-0.969243	1.875967	0.041555
0.055630	-0.203977	1.056971

Matrix Cxr

0.412391	0.357584	0.180481
0.212639	0.715169	0.072192
0.019331	0.119195	0.950532

2. 4.2 ColorCalc / Examples / sRGB with CAT

ColorCalc G.Hoffmann Dec.04 / 2006		Med.White: Ref.White: Input:	D65 D50 RGB'	Primaries: Trc: Bradford:	Rec.709 sRGB Yes	Intent: Set:	RelCol 5
X	0.964295	0.436066	0.385151	0.143078	0.528230	0.579144	0.821217
Y	1.000000	0.222493	0.716887	0.060620	0.777507	0.283113	0.939380
Z	0.825105	0.013924	0.097081	0.714099	0.811181	0.728023	0.111005
x	0.345700	0.648441	0.321195	0.155893	0.249528	0.364177	0.438778
y	0.358500	0.330853	0.597844	0.066049	0.367283	0.178027	0.501912
z	0.295800	0.020705	0.080960	0.778058	0.383190	0.457796	0.059310
L*	100.0000	54.2905	87.8185	29.5683	90.6660	60.1689	97.6070
a*	-0.0000	80.8049	-79.2711	68.2874	-50.6565	93.5396	-15.7499
b*	0.0000	69.8910	80.9946	-112.0297	-14.9617	-60.5008	93.3936
R	255.0000	255.0000	0.0000	0.0000	0.0000	255.0000	255.0000
G	255.0000	0.0000	255.0000	0.0000	255.0000	0.0000	255.0000
B	255.0000	0.0000	0.0000	255.0000	255.0000	255.0000	0.0000
R'	255.0000	255.0000	0.0000	0.0000	0.0000	255.0000	255.0000
G'	255.0000	0.0000	255.0000	0.0000	255.0000	0.0000	255.0000
B'	255.0000	0.0000	0.0000	255.0000	255.0000	255.0000	0.0000
CCT	5001 K	none	none	none	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam



Matrix Mrx

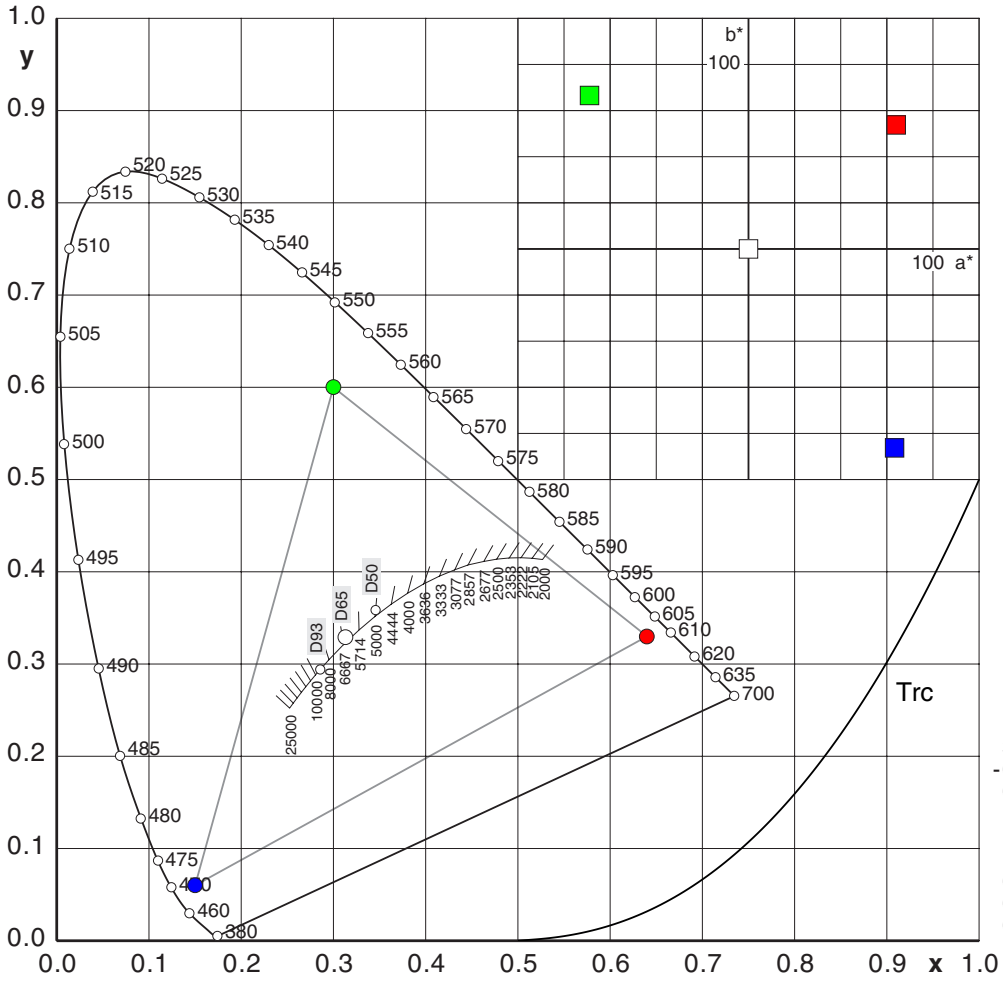
3.134137	-1.617386	-0.490662
-0.978796	1.916254	0.033443
0.071955	-0.228977	1.405386

Matrix Mxr

0.436066	0.385151	0.143078
0.222493	0.716887	0.060620
0.013924	0.097081	0.714099

2.4.3 ColorCalc / Examples / sRGB without CAT, XYZ-Input

ColorCalc		**Med.White:**	**D65**	**Primaries:**	**Rec.709**	**Intent:**	**AbsCol**
G.Hoffmann		**Ref.White:**	**D65**	**Trc:**	**sRGB**		
Dec.04 / 2006		**Input:**	**XYZ**	**Bradford:**	**No**	**Set:**	**1**
X	0.950456	0.412391	0.357584	0.180481			
Y	1.000000	0.212639	0.715169	0.072192			
Z	1.089058	0.019331	0.119195	0.950532			
x	0.312700	0.640000	0.300000	0.150000			
y	0.329000	0.330000	0.600000	0.060000			
z	0.358300	0.030000	0.100000	0.790000			
L*	100.0000	53.2371	87.7355	32.3008			
a*	0.0000	80.0902	-86.1818	79.1957			
b*	-0.0000	67.2031	83.1866	-107.8556			
R	255.0000	255.0001	-0.0004	0.0003			
G	254.9999	-0.0001	255.0002	-0.0002			
B	255.0001	0.0001	0.0000	254.9999			
R'	255.0000	255.0000	0.0000	0.0041			
G'	254.9999	0.0000	255.0000	0.0000			
B'	255.0000	0.0007	0.0006	254.9999			
CCT	6493 K	none	none	none			
RGB	in-gam	in-gam	in-gam	in-gam			



Matrix Crx

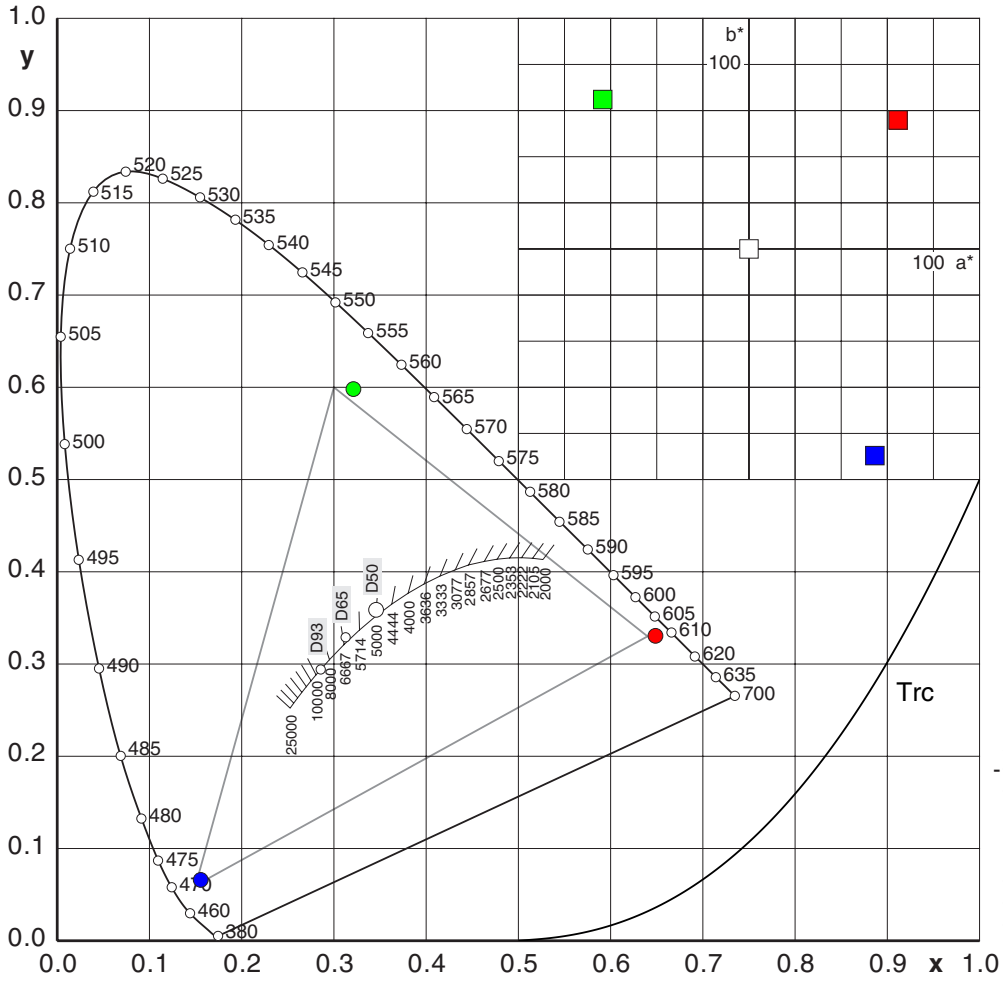
3.240970	-1.537383	-0.498611
-0.969243	1.875967	0.041555
0.055630	-0.203977	1.056971

Matrix Cxr

0.412391	0.357584	0.180481
0.212639	0.715169	0.072192
0.019331	0.119195	0.950532

2.3.4 ColorCalc / Examples / sRGB with CAT, XYZ-Input

ColorCalc		**Med.White:**	**D65**	**Primaries:**	**Rec.709**	**Intent:**	**RelCol**
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**sRGB**		
Dec.04 / 2006		**Input:**	**XYZ**	**Bradford:**	**Yes**	**Set:**	**5**
X	0.964295	0.436066	0.385151	0.143078			
Y	1.000000	0.222493	0.716887	0.060620			
Z	0.825105	0.013924	0.097081	0.714099			
x	0.345700	0.648442	0.321195	0.155893			
y	0.358500	0.330853	0.597845	0.066049			
z	0.295800	0.020705	0.080960	0.778058			
L*	100.0000	54.2905	87.8185	29.5683			
a*	-0.0001	80.8051	-79.2712	68.2869			
b*	-0.0000	69.8908	80.9947	-112.0296			
R	254.9996	255.0003	-0.0003	-0.0004			
G	255.0001	-0.0002	255.0001	0.0002			
B	255.0001	0.0000	-0.0001	254.9998			
R'	254.9998	255.0000	0.0000	0.0000			
G'	255.0000	0.0000	255.0000	0.0025			
B'	255.0000	0.0006	0.0000	254.9999			
CCT	5001 K	none	none	none			
RGB	in-gam	in-gam	in-gam	in-gam			



Matrix Mrx

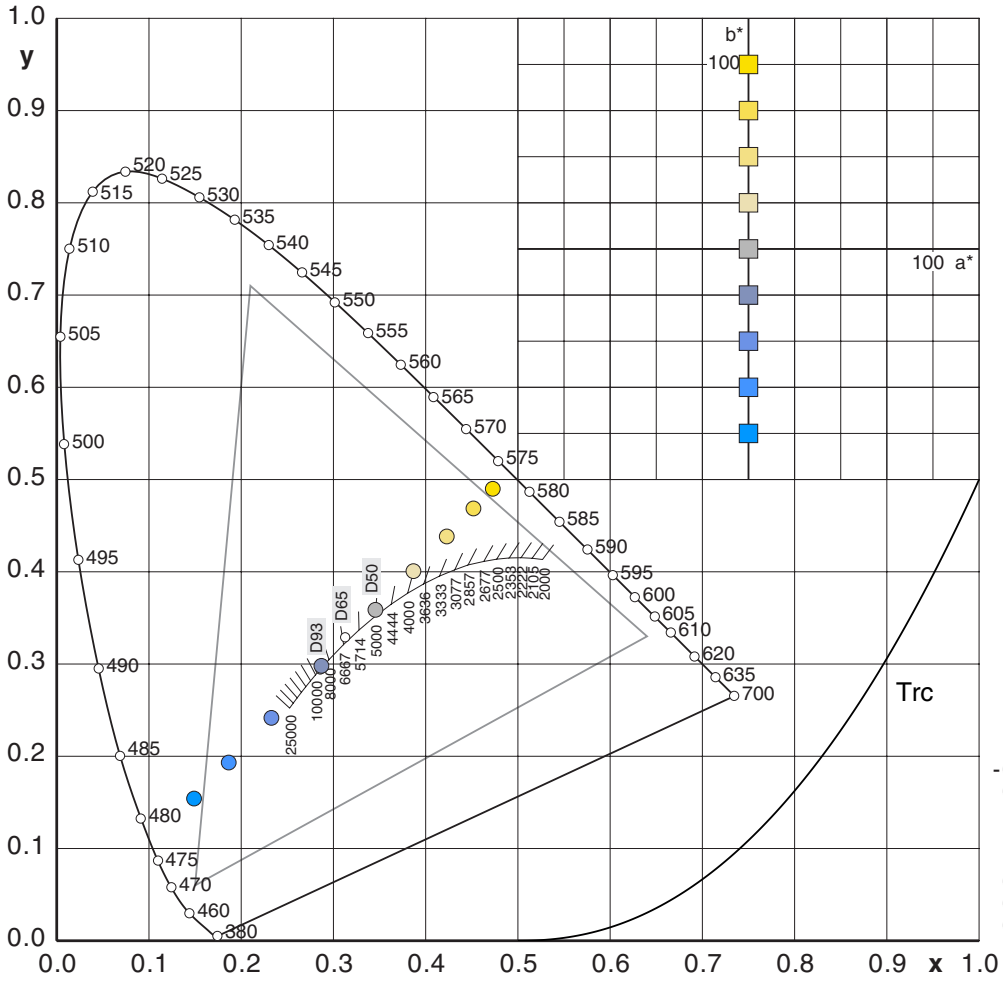
3.134137	-1.617386	-0.490662
-0.978796	1.916254	0.033443
0.071955	-0.228977	1.405386

Matrix Mxr

0.436066	0.385151	0.143078
0.222493	0.716887	0.060620
0.013924	0.097081	0.714099

2.3.5 ColorCalc / Examples / AdobeRGB(98) with CAT, Lab-Input

ColorCalc		**Med.White:**	**D65**	**Primaries:**	**AdobeRGB**	**Intent:**	**RelCol**		
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**2.2**				
Dec.04 / 2006		**Input:**	**Lab**	**Bradford:**	**Yes**	**Set:**	**6**		
X	0.271192	0.271192	0.271192	0.271192	0.465544	0.735790	0.735790	0.735790	0.735790
Y	0.281233	0.281233	0.281233	0.281233	0.482781	0.763033	0.763033	0.763033	0.763033
Z	1.271889	0.902067	0.611932	0.391815	0.398345	0.404947	0.241328	0.129055	0.058460
x	0.148654	0.186451	0.232911	0.287207	0.345700	0.386491	0.422831	0.451993	0.472483
y	0.154158	0.193355	0.241535	0.297841	0.358500	0.400801	0.438487	0.468729	0.489977
z	0.697187	0.620194	0.525553	0.414952	0.295800	0.212708	0.138682	0.079278	0.037540
L*	60.0000	60.0000	60.0000	60.0000	75.0000	90.0000	90.0000	90.0000	90.0000
a*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b*	-100.0000	-75.0000	-50.0000	-25.0000	0.0000	25.0000	50.0000	75.0000	100.0000
R	-18.7999	13.3918	38.6469	57.8073	123.1092	214.1273	228.3698	238.1427	244.2877
G	80.5822	77.4284	74.9541	73.0770	123.1092	192.6579	191.2625	190.3051	189.7030
B	429.3924	302.1833	202.3847	126.6703	123.1092	117.3050	61.0243	22.4056	-1.8772
R'	0.0000	66.8124	108.1619	129.8852	183.1430	235.5346	242.5307	247.1945	250.0738
G'	151.0535	148.3369	146.1632	144.4878	183.1430	224.4904	223.7498	223.2400	222.9187
B'	255.0000	255.0000	229.5730	185.5323	183.1430	179.1665	133.1222	84.4222	0.0000
CCT	none	none	none	8864 K	5001 K	4011 K	3500 K	none	none
RGB	out-gam	out-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	out-gam



Matrix Mrx

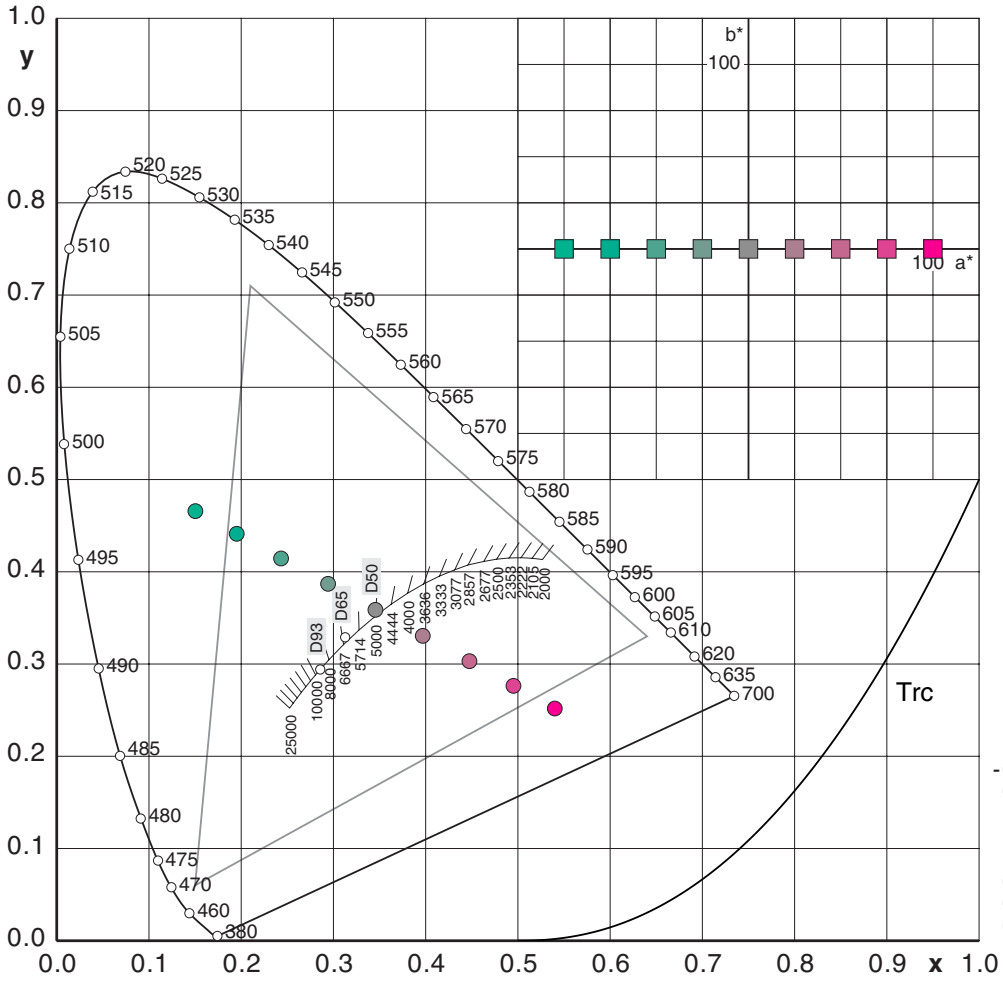
1.962467	-0.610742	-0.341358
-0.978796	1.916255	0.033443
0.028705	-0.140675	1.348914

Matrix Mxr

0.609775	0.205300	0.149221
0.311125	0.625653	0.063222
0.019471	0.060879	0.744755

2.3.6 ColorCalc / Examples / AdobeRGB(98) with CAT, Lab-Input

ColorCalc		**Med.White:**	**D65**	**Primaries:**	**AdobeRGB**	**Intent:**	**RelCol**			
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**2.2**					
Dec.04 / 2006		**Input:**	**Lab**	**Bradford:**	**Yes**	**Set:**	**6**			
X	0.090936	0.124317	0.165004	0.213721	0.271192	0.338140	0.415287	0.503358	0.603075	
Y	0.281233	0.281233	0.281233	0.281233	0.281233	0.281233	0.281233	0.281233	0.281233	
Z	0.232047	0.232047	0.232047	0.232047	0.232047	0.232047	0.232047	0.232047	0.232047	
x	0.150503	0.194977	0.243266	0.293976	0.345700	0.397148	0.447234	0.495120	0.540218	
y	0.465451	0.441083	0.414625	0.386840	0.358500	0.330311	0.302868	0.276631	0.251921	
z	0.384046	0.363940	0.342109	0.319184	0.295800	0.272541	0.249898	0.228249	0.207861	
L*	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	60.0000	
a*	-100.0000	-75.0000	-50.0000	-25.0000	0.0000	25.0000	50.0000	75.0000	100.0000	
b*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
R	-18.4907	-1.7863	18.5748	42.9544	71.7145	105.2171	143.8240	187.8971	237.7984	
G	116.7050	108.3736	98.2184	86.0588	71.7145	55.0048	35.7494	13.7675	-11.1211	
B	70.3951	70.6394	70.9373	71.2938	71.7145	72.2045	72.7692	73.4139	74.1438	
R'	0.0000	0.0000	77.5250	113.4840	143.2571	170.5251	196.5580	221.9516	247.0320	
G'	178.7493	172.8318	165.2724	155.6363	143.2570	126.9842	104.3973	67.6582	0.0000	
B'	142.0530	142.2769	142.5492	142.8745	143.2570	143.7012	144.2109	144.7902	145.4428	
CCT	none	none	none	none	5001 K	3098 K	none	none	none	
RGB	out-gam	out-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	out-gam	



Matrix Mrx

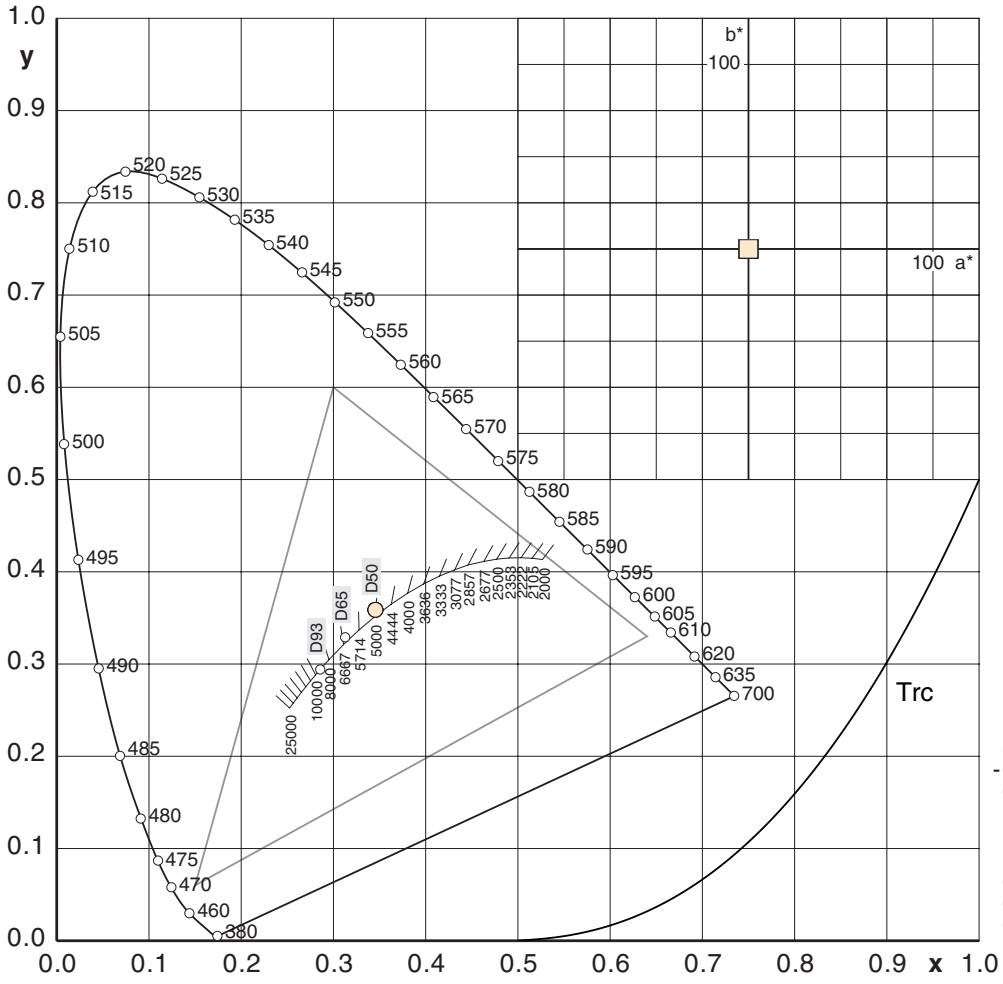
1.962467	-0.610742	-0.341358
-0.978796	1.916255	0.033443
0.028705	-0.140675	1.348914

Matrix Mxr

0.609775	0.205300	0.149221
0.311125	0.625653	0.063222
0.019471	0.060879	0.744755

2.3.7 ColorCalc / Examples / sRGB AbsCol, Lab-Input light gray

ColorCalc		**Med.White:**	**D65**	**Primaries:**	**Rec.709**	**Intent:**	**AbsCol**	
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**sRGB**			
Dec.04 / 2006		**Input:**	**Lab**	**Bradford:**	**No**	**Set:**	**9**	
X	0.964296	0.939571	0.915273	0.891398	0.867941	0.844900	0.822270	0.800047
Y	1.000000	0.974360	0.949162	0.924403	0.900078	0.876183	0.852715	0.829670
Z	0.825104	0.803949	0.783158	0.762729	0.742658	0.722943	0.703579	0.684565
x	0.345700	0.345700	0.345700	0.345700	0.345700	0.345700	0.345700	0.345700
y	0.358500	0.358500	0.358500	0.358500	0.358500	0.358500	0.358500	0.358500
z	0.295800	0.295800	0.295800	0.295800	0.295800	0.295800	0.295800	0.295800
L*	100.0000	99.0000	98.0000	97.0000	96.0000	95.0000	94.0000	93.0000
a*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
b*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R	299.9984	292.3065	284.7472	277.3193	270.0219	262.8536	255.8132	248.8997
G	248.7824	242.4037	236.1349	229.9752	223.9235	217.9790	212.1406	206.4074
B	184.0536	179.3345	174.6968	170.1397	165.6626	161.2647	156.9453	152.7038
R'	255.0000	255.0000	255.0000	255.0000	255.0000	255.0000	255.0000	252.2994
G'	252.2471	249.3809	246.5209	243.6672	240.8198	237.9787	235.1440	232.3158
B'	220.8271	218.2991	215.7765	213.2595	210.7481	208.2423	205.7421	203.2476
CCT	5001 K	5001 K	5001 K	5001 K	5001 K	5001 K	5001 K	5001 K
RGB	out-gam	out-gam	out-gam	out-gam	out-gam	out-gam	out-gam	in-gam



Matrix Crx

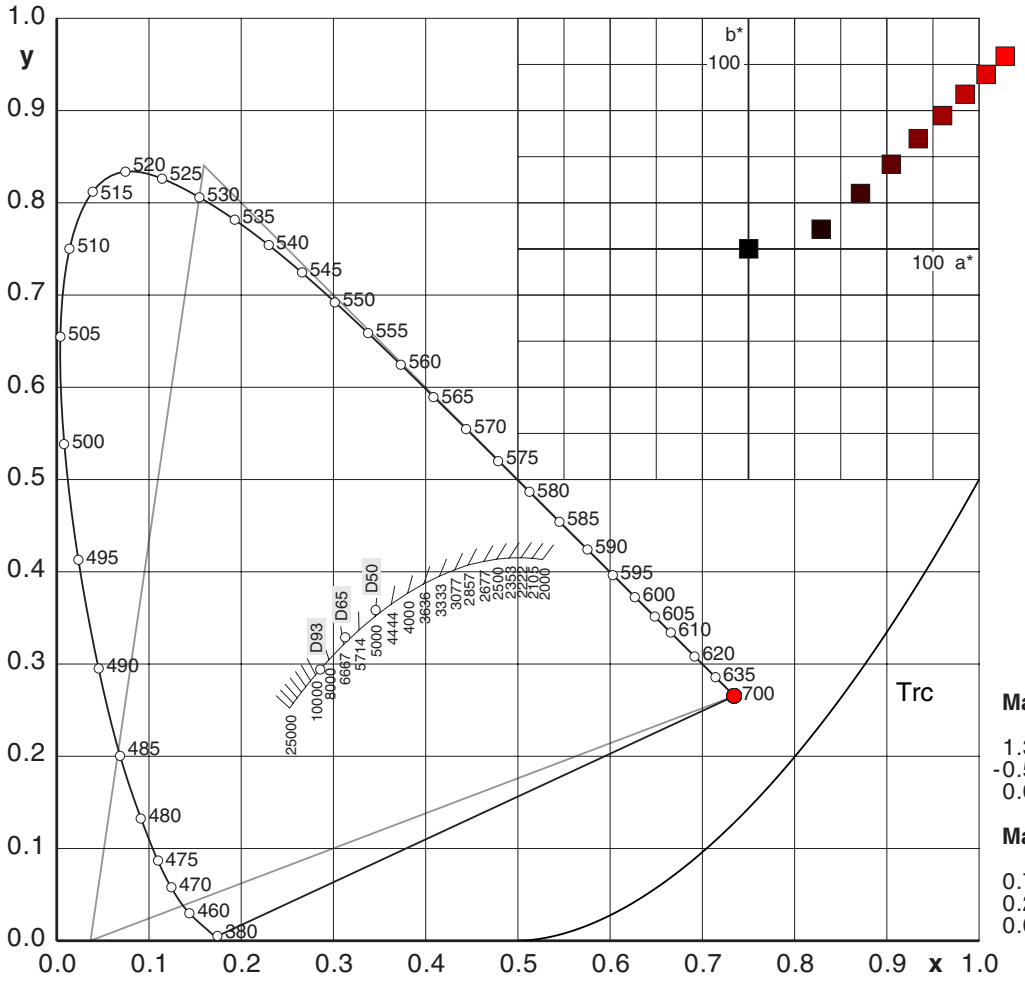
3.240970	-1.537383	-0.498611
-0.969243	1.875967	0.041555
0.055630	-0.203977	1.056971

Matrix Cxr

0.412391	0.357584	0.180481
0.212639	0.715169	0.072192
0.019331	0.119195	0.950532

2.3.8 ColorCalc / Examples / ProPhotoRGB / Red

ColorCalc		**Med.White:**	**D50**	**Primaries:**	**ProPhoto**	**Intent:**	**AbsCol**			
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**1.8**					
Dec.04 / 2006		**Input:**	**RGB'**	**Bradford:**	**No**	**Set:**	**4**			
X	0.000037	0.019027	0.066256	0.137464	0.230717	0.344761	0.478678	0.631754	0.797763	
Y	0.000013	0.006871	0.023925	0.049639	0.083313	0.124494	0.172852	0.228129	0.288075	
Z	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
x	0.734698	0.734698	0.734698	0.734698	0.734698	0.734698	0.734698	0.734698	0.734698	
y	0.265302	0.265302	0.265302	0.265302	0.265302	0.265302	0.265302	0.265302	0.265302	
z	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
L*	0.0121	6.2063	17.4254	26.6316	34.6635	41.9217	48.6175	54.8791	60.6114	
a*	0.0978	39.3942	60.7147	77.4370	92.0263	105.2102	117.3726	128.7463	139.1586	
b*	0.0209	10.7005	30.0439	45.9166	59.7646	72.2787	83.8232	94.6191	104.5023	
R	0.0119	6.0819	21.1783	43.9396	73.7473	110.2006	153.0066	201.9363	255.0000	
G	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
B	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
R'	1.0000	32.0000	64.0000	96.0000	128.0000	160.0000	192.0000	224.0000	255.0000	
G'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
B'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
CCT	none	none	none	none	none	none	none	none	none	
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	



Matrix Crx

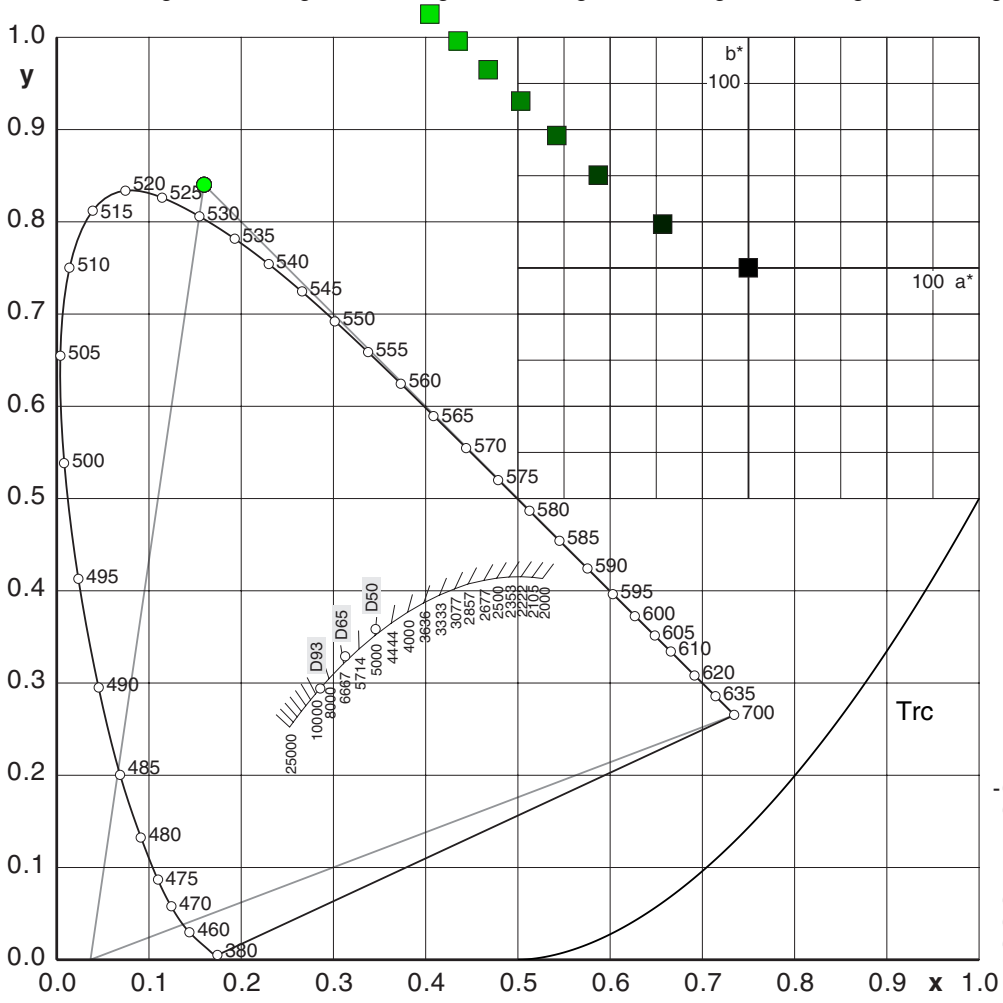
1.345795	-0.255577	-0.051105
-0.544636	1.508254	0.020526
0.000000	0.000000	1.211967

Matrix Cxr

0.797763	0.135183	0.031350
0.288075	0.711833	0.000092
0.000000	0.000000	0.825105

2.3.9 ColorCalc / Examples / ProPhotoRGB / Green

ColorCalc		**Med.White:**	**D50**	**Primaries:**	**ProPhoto**	**Intent:**	**AbsCol**			
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**1.8**					
Dec.04 / 2006		**Input:**	**RGB'**	**Bradford:**	**No**	**Set:**	**4**			
X	0.000006	0.003224	0.011227	0.023294	0.039096	0.058421	0.081113	0.107052	0.135183	
Y	0.000033	0.016978	0.059119	0.122658	0.205866	0.307625	0.427118	0.563706	0.711833	
Z	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
x	0.159599	0.159599	0.159599	0.159599	0.159599	0.159599	0.159599	0.159599	0.159599	
y	0.840401	0.840401	0.840401	0.840401	0.840401	0.840401	0.840401	0.840401	0.840401	
z	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
L*	0.0300	13.8138	29.1892	41.6354	52.4940	62.3067	71.3590	79.8243	87.5740	
a*	-0.1037	-46.5239	-81.4564	-103.8915	-123.4648	-141.1526	-157.4700	-172.7292	-186.6986	
b*	0.0516	23.8168	50.3262	71.7852	90.5069	107.4253	123.0327	137.6280	150.9897	
R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	0.0119	6.0819	21.1783	43.9396	73.7473	110.2006	153.0066	201.9363	255.0000	
B	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
R'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G'	1.0000	32.0000	64.0000	96.0000	128.0000	160.0000	192.0000	224.0000	255.0000	
B'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
CCT	none	none	none	none	none	none	none	none	none	
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	



Matrix Crx

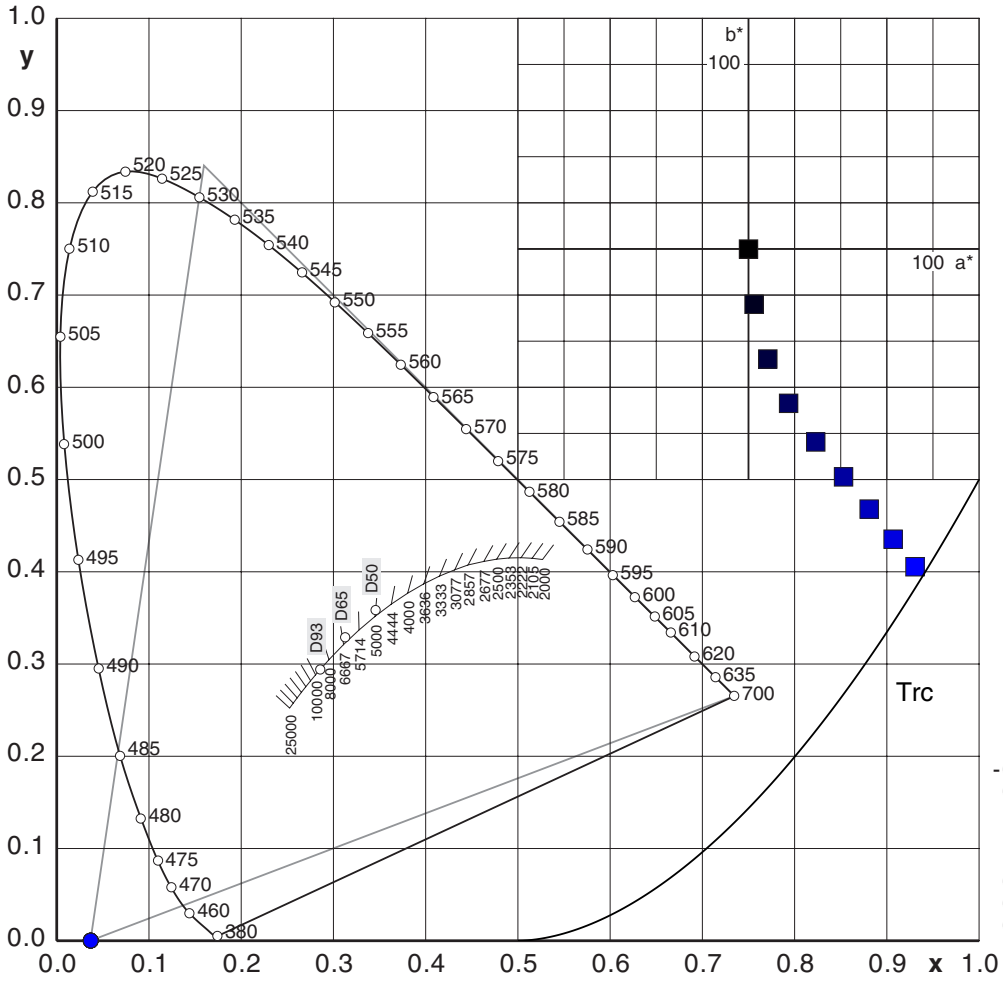
1.345795	-0.255577	-0.051105
-0.544636	1.508254	0.020526
0.000000	0.000000	1.211967

Matrix Cxr

0.797763	0.135183	0.031350
0.288075	0.711833	0.000092
0.000000	0.000000	0.825105

2.3.8 ColorCalc / Examples / ProPhotoRGB / Blue

ColorCalc		**Med.White:**	**D50**	**Primaries:**	**ProPhoto**	**Intent:**	**AbsCol**			
G.Hoffmann		**Ref.White:**	**D50**	**Trc:**	**1.8**					
Dec.04 / 2006		**Input:**	**RGB'**	**Bradford:**	**No**	**Set:**	**4**			
X	0.000001	0.000748	0.002604	0.005402	0.009066	0.013548	0.018811	0.024826	0.031350	
Y	0.000000	0.000002	0.000008	0.000016	0.000027	0.000040	0.000055	0.000073	0.000092	
Z	0.000038	0.019679	0.068527	0.142176	0.238624	0.356577	0.495084	0.653406	0.825105	
x	0.036600	0.036600	0.036600	0.036600	0.036600	0.036600	0.036600	0.036600	0.036600	
y	0.000107	0.000107	0.000107	0.000107	0.000107	0.000107	0.000107	0.000107	0.000107	
z	0.963293	0.963293	0.963293	0.963293	0.963293	0.963293	0.963293	0.963293	0.963293	
L*	0.0000	0.0020	0.0069	0.0143	0.0239	0.0358	0.0497	0.0656	0.0828	
a*	0.0059	3.0105	10.4830	21.7496	36.4620	51.5296	65.4169	78.3912	90.2572	
b*	-0.0725	-29.9803	-59.6617	-83.6824	-104.6335	-123.5612	-141.0171	-157.3361	-172.2711	
R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
B	0.0119	6.0819	21.1783	43.9396	73.7473	110.2006	153.0066	201.9363	255.0000	
R'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G'	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
B'	1.0000	32.0000	64.0000	96.0000	128.0000	160.0000	192.0000	224.0000	255.0000	
CCT	none	none	none	none	none	none	none	none	none	
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	



Matrix Crx

1.345795	-0.255577	-0.051105
-0.544636	1.508254	0.020526
0.000000	0.000000	1.211967

Matrix Cxr

0.797763	0.135183	0.031350
0.288075	0.711833	0.000092
0.000000	0.000000	0.825105

3.1 SpectroCalc / Input

3.1.1 Color space (same as in chapter 2.1)

```
%--Choose one standard set
/S 5 def
S 0 eq {} if                                          % None, use settings above
S  1 eq {Prims709  WhiteD65 RefD65 Gam24 BradF RendA} if % sRGB          AbsCol
S  2 eq {PrimsAd98 WhiteD65 RefD65 Gam22 BradF RendA} if % AdobeRGB(98)  AbsCol
S  3 eq {PrimsOpti WhiteD65 RefD65 Gam22 BradF RendA} if % OptiRGB       AbsCol
S  4 eq {PrimsProp WhiteD50 RefD50 Gam18 BradF RendA} if % ProPhoto      AbsCol

S  5 eq {Prims709  WhiteD65 RefD50 Gam24 BradT RendR} if % sRGB          RelCol
S  6 eq {PrimsAd98 WhiteD65 RefD50 Gam22 BradT RendR} if % AdobeRGB(98)  RelCol
S  7 eq {PrimsOpti WhiteD65 RefD50 Gam22 BradT RendR} if % OptiRGB       RelCol
S  8 eq {PrimsProp WhiteD50 RefD50 Gam18 BradT RendR} if % ProPhoto      RelCol

S  9 eq {Prims709  WhiteD65 RefD50 Gam24 BradF RendA} if % sRGB          AbsCol
S 10 eq {PrimsAd98 WhiteD65 RefD50 Gam22 BradF RendA} if % AdobeRGB(98)  AbsCol
S 11 eq {PrimsOpti WhiteD65 RefD50 Gam22 BradF RendA} if % OptiRGB       AbsCol
S 12 eq {PrimsProp WhiteD50 RefD50 Gam18 BradF RendA} if % ProPhoto      AbsCol
```

3.1.2 Headline

```
%--Define headline
/head (any text) def
```

E.g. the date

3.1.3 Illuminants

```
%--Choose two illuminants
/Ilu1 4 def
/Ilu2 108 def
% 0   Equal Energy
% 1   A
% 2   B
% 3   C
% 4   D50
% 5   D55
% 6   D65
% 7   D75
% 101 F1
% 102 F2
% 103 F3
% 104 F4
% 105 F5
% 106 F6
% 107 F7
% 108 F8
% 109 F9
% 110 F10
% 111 F11
% 112 F12
```

Choose illuminant Equal Energy for the simulation of emitting light sources.

3.1.4 Zoom factor

```
%--Choose zoom factor for fluorescent spectrum graphic
/Fscale 4 def
```

3.1.5 Show CT-Curve in Lab-plane

```
%--Choose Show CT-Curve in Lab
/CTLab 0 def
% 0 No
% 1 Yes
```

3.1.6 Spectrum mode

```
%--Choose spectrum mode
/SMode 0 def
% 0 Perfect Reflector
% 1 Spectrum Function
% 2 Spectrum Table
% 3 Spectrum Spectrocam
% 4 Spectrum Eye-One Pro
% 5 Spectrum DTP-22
```

Spectrum mode Perfect Reflector (perfect diffuser) uses the constant reflectance factor 1.0. This is useful for measuring the parameters of the illuminants themselves.

Spectrum mode Function builds a reflectance spectrum by the sum of three Gaussian bell curves. This is useful for metamerism tests.

Spectrum mode Table uses a few values and fills the table by linear interpolation.

Spectrum mode Spectrocam uses spectral data by Avantes Spectrocam.

Spectrum mode Eye-One Pro uses spectral data by GretagMacbeth Eye-One Pro

Spectrum mode DTP-22 uses spectral data by X-Rite DTP-22

3.1.6.1 Spectrum Function

```
%--Define spectrum function by three Gaussian bells
/lam1 420 def % center in nm
/lam2 520 def
/lam3 620 def
/sig1 20  def % standard deviation in nm
/sig2 20  def
/sig3 20  def
/amp1 0.9 def % peak amplitude 0..1
/amp2 0.3 def
/amp3 0.9 def
```

Each of the Gaussian bell curves has three parameters: the center wavelength `lami`, the standard deviation `sigi` and the peak amplitude `ampi`. Amplitudes can have any sign and size. The graph is clipped for the rectangle (380,0) to (780,2).

3.1.6.2 Spectrum Table

```
%--Define spectrum by table, steps 5nm
%--Minimal entries: at 380nm,at any between,at 780nm
/CwT [380 0.2
      560 0.8
      780 0.2 ] def
%--Actual table
/CwT [380 0.2
      420 0.9
      520 0.7
      620 0.9
      780 0.2 ] def
```

The table has at least three pairs of entries. The wavelengths are integer in steps of 5nm. Missing values are generated by linear interpolation.

3.1.6.3 Spectrum Spectrocam

```
%—Spectrocam: complete data, re-arranged for 10 number columns
/CwC
[
Nr    X      Y      Z      L      a      b      C      hue    Y      M
      C      Vis    x      y      u      v
      Illuminant/Observer
      Density status
      380    385    390    395    400    405    410    415    420    425
      430    435    440    445    450    455    460    465    470    475
      480    485    490    495    500    505    510    515    520    525
      530    535    540    545    550    555    560    565    570    575
      580    585    590    595    600    605    610    615    620    625
      630    635    640    645    650    655    660    665    670    675
      680    685    690    695    700    705    710    715    720    725
      730    735    740    745    750
A1    68.04  69.67  2.93   86.84  1.87   111.58 111.59 89.04  1.7626 0.2110
      0.0814 0.1593 0.48   0.50   0.24   0.56   D50 2  E
      2.18   2.03   1.94   1.77   1.61   1.61   1.60   1.70   1.68   1.73
      1.65   1.64   1.67   1.66   1.77   1.80   1.81   1.81   1.75   1.72
      1.65   1.58   1.98   3.81   8.30   16.45  28.08  41.59  54.44  64.22
      70.56  74.26  76.20  77.41  78.37  79.14  79.91  80.61  81.09  81.52
      81.79  82.24  82.32  82.52  82.67  82.79  82.89  83.03  83.11  83.30
      83.47  83.56  83.83  83.93  84.05  84.32  84.34  84.34  84.35  84.22
      84.31  84.41  84.60  84.87  85.12  85.46  85.58  85.82  86.02  86.05
      86.36  86.68  86.55  86.67  86.69
] def
```

Use the complete file, re-arrange for 10 number columns and write data in brackets as above. The numbers after ‘E’ are the reflectance factors. Only these are extracted.

Modification February 23, 2006.

3.1.6.4 Spectrum Eye-One Pro

```
%--Eye-One Pro: use only spectral data from file *.lcp by ColorPicker
%--From 380nm to 730nm, step 10nm. Re-arrange for 4 columns. Delete kommas.
/CwE
[    0.0170541442930698 0.0158690381795168 0.0147084509953856 0.0141440043225884
     0.0137486308813095 0.0138662662357092 0.0139446845278144 0.0143155101686716
     0.0146184880286455 0.0150265172123909 0.0169226862490177 0.0271776393055916
     0.0787448436021805 0.2387251853942870 0.4879423379898070 0.6712245345115660
     0.7550856471061710 0.7915746569633480 0.8096777796745300 0.8240625262260440
     0.8303878307342530 0.8356326222419740 0.8380561470985410 0.8414235711097720
     0.8443459868431090 0.8456398844718930 0.8489986658096310 0.8527597784996030
     0.8562397956848140 0.8583341836929320 0.8615325093269350 0.8655382990837100
     0.8712845444679260 0.8773978352546690 0.8816110491752620 0.8868564963340760
] def
```

Not valid for files by i1share. Use ColorPicker and *.lcp file.
Not very convenient because the komma after each number has to be removed.

Feature since February 24, 2006

3.1.6.5 Spectrum DTP-22

Define standard settings in ColorShop Preferences.E.g. output XYZ, Lab and spectrum.
Choose format 'Tab-delimited text option' and save as *.txt.
The file will look like this, already somewhat ordered for better readability here:

```
Color Name   CIE Lab              CIE XYZ
Spectral Data(nm)
390  400  410  420  430  440  450  460  470  480
490  500  510  520  530  540  550  560  570  580
590  600  610  620  630  640  650  660  670  680
690  700
Unnamed  87.59    2.56     112.33   69.86    71.22    3.00
0.0208   0.0200   0.0192   0.0184   0.0175   0.0169   0.0167   0.0170   0.0144
0.0200   0.0289   0.0958   0.304    0.5351   0.6795   0.7720   0.8134   0.8258
0.8371   0.8434   0.8460   0.8471   0.8499   0.8536   0.8584   0.8629   0.8655
0.8665   0.8647   0.8633   0.8659   0.8713
```

Now delete all data, here by comments (%), with the exception of spectral data.
Write relevant data in brackets as below.

```
%--DTP-22: use only spectral data from file *.txt
%--From 390nm to 700nm, step 10. Re-arrange for 10 columns
% Color Name  CIE Lab          CIE XYZ
% Spectral Data(nm)
%     390  400  410  420 430 440  450  460  470  480
%     490  500  510  520 530 540  550  560  570  580
%     590  600  610  620 630 640  650  660  670  680
%     690  700
% Unnamed  87.59 2.56 112.33   69.86  71.22  3.00
/CwD
[
      0.0208  0.0200  0.0192  0.0184  0.0175  0.0169  0.0167  0.0170  0.0144  0.0200
      0.0289  0.0958  0.3040  0.5351  0.6795  0.7720  0.8134  0.8258  0.8371  0.8434
      0.8460  0.8471  0.8499  0.8536  0.8584  0.8629  0.8655  0.8665  0.8647  0.8633
      0.8659  0.8713
] def
```

The values in CwD are the reflectance factors.
The complete file cannot be read by PostScript because its structure is not fixed. There may be any other data besides the spectral data, depending on the Preference settings.

3.2 SpectroCalc / Output

3.2.1 Graphics

Please refer to the examples.

Spectrum for two illuminants and the reflectance spectrum
CIE chromaticity diagram xyY
Curve for the Planckian radiator, with color temperatures
White points D50, D65 and 9300K (D93)
Round color dots in xyY (colors in device RGB)
Small Lab plane a*b*
Square color dots in a*b* (colors in device RGB)
Two color patches

3.2.2 Header

Head	Arbitrary header text, e.g. the date
I1,I2	Two illuminants
Med.White	Media white point
Ref.White	Reference white point
Primaries	Primaries
Trc	Tone reproduction curve
Mode	Spectrum generator mode With parameters for Spectrum Function and Spectrum Table

3.2.3 Numbers

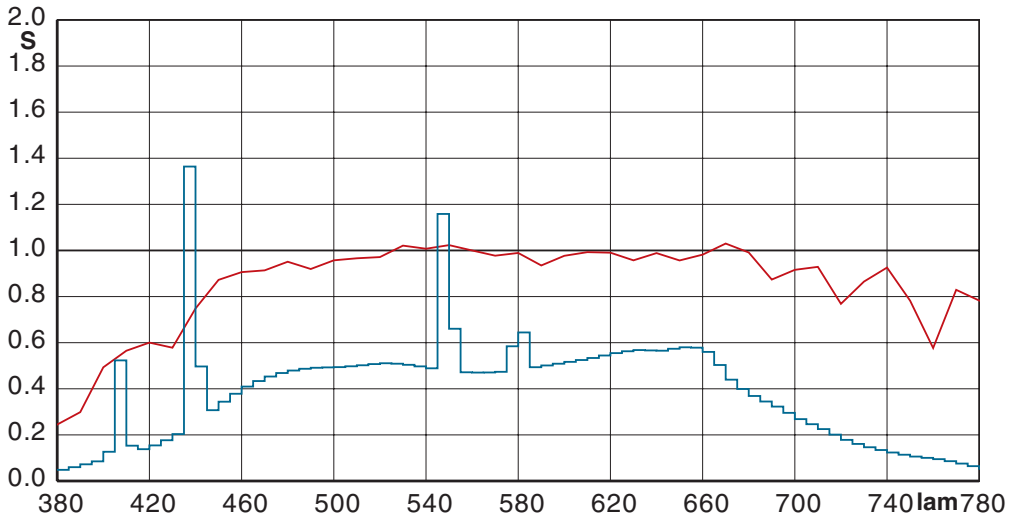
XYZ	CIE XYZ as stimulus values
xyY	CIE xyY as stimulus values
L*a*b*	CIE Lab in reference space
RGB	Linear RGB values in media space, not clipped
RGB’	Gamma encoded values in media space, clipped for 0...255
CCT	Correlated color temperature This calculation is based on tables, not very accurate but practically sufficient ‘None’ is indicated if the color is too far away from the curve for the Planckian radiator
RGB	In-gamut or out-of-gamut for RGB Out-of-gamut, if at least one value is less than -0.49 (rounded to 0) or greater than 255.49 (rounded to 255)

3.3 SpectroCalc / Calculation sequence

SpectroCalc works similarly to ColorCalc, entry point XYZ Input 2.3.2.
Spectra for Illuminants are normalized for Y=100.
XYZ values are calculated by multiplying and summing spectral values of illuminant, reflectance factor and color matching functions (Euler or rectangle integration for stepsize 5nm).

3.3.1 SpectroCalc / Examples / sRGB with CAT / Illumin. D50+F8

The fluorescent tube Type F8 has approximately the correlated color temperature 5000K.
Spectrum mode: Perfect Reflector.

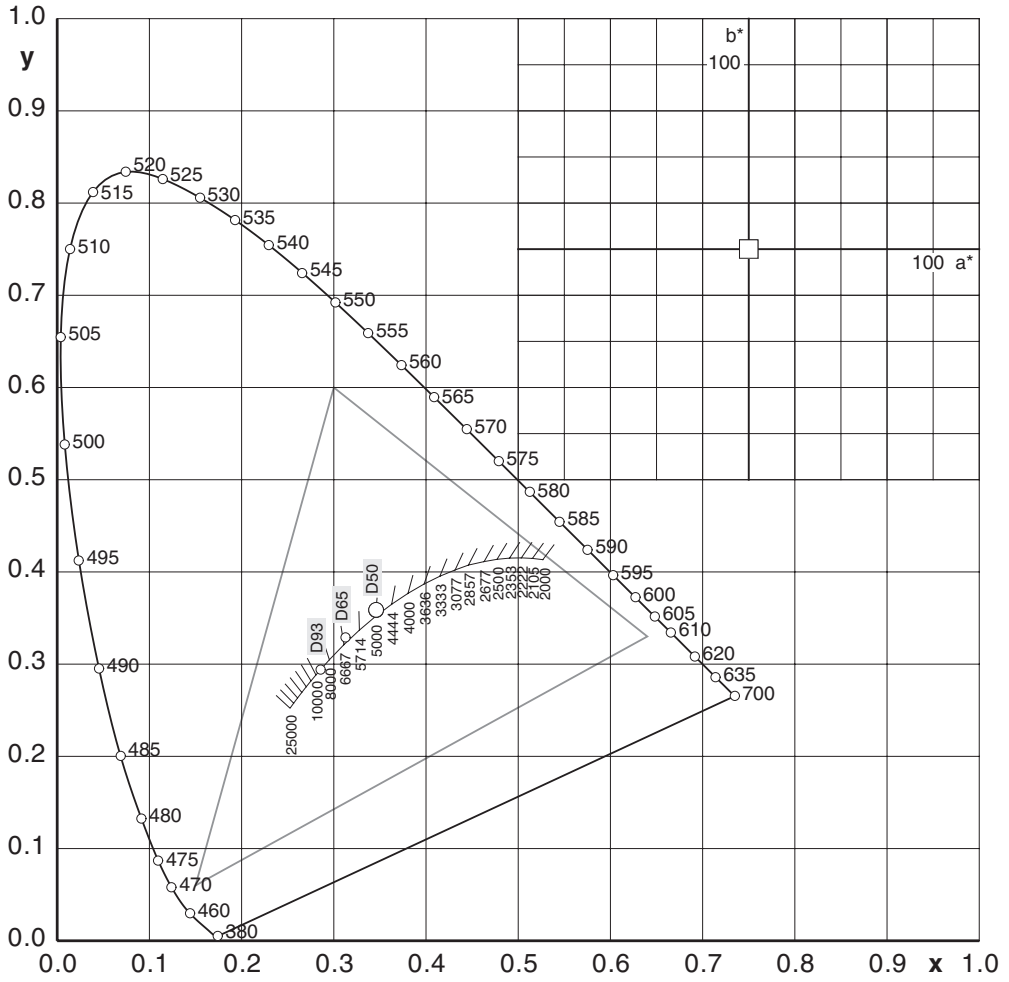


SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan F8 zoom 4

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

Spectrum generator
Perfect reflector

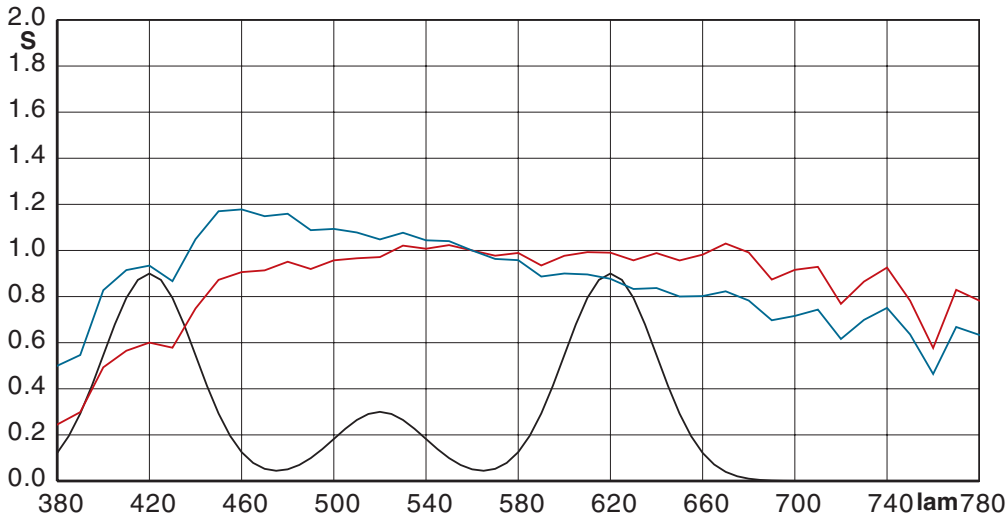


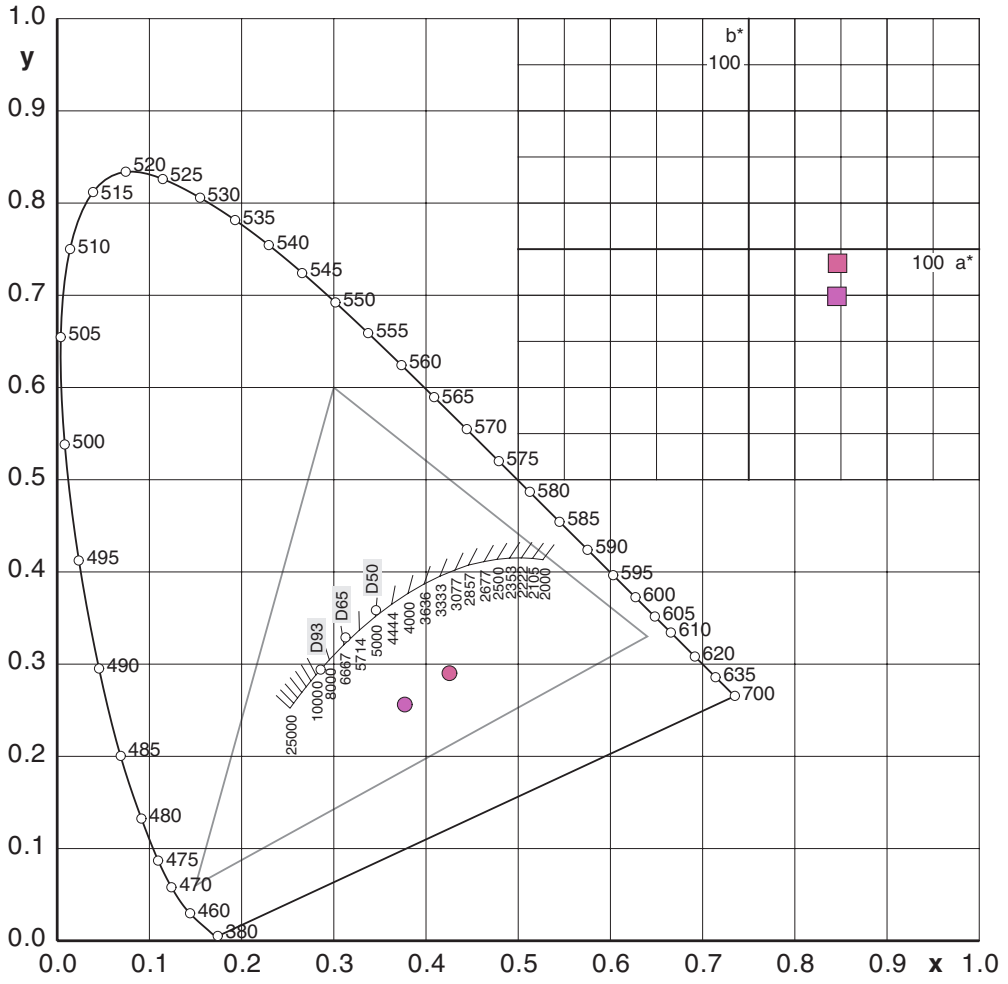
Color	1	2
X	0.9642	0.9643
Y	1.0000	1.0000
Z	0.8251	0.8242
x	0.3457	0.3458
y	0.3585	0.3586
z	0.2958	0.2956
L*	100.0000	100.0000
a*	-0.0168	-0.0037
b*	-0.0008	0.0726
R	254.9210	255.0953
G	255.0243	254.9976
B	255.0016	254.6777
R'	254.9652	255.0419
G'	255.0107	254.9989
B'	255.0007	254.8583
CCT	5001 K	4997 K
RGB	in-gam	in-gam
dE	0.0745	

Bars

3.3.2 SpectroCalc / Examples / sRGB with CAT / Illumin. D50+D65

A magenta spectrum is rather sensible to illuminant changes.
Spectrum mode: Function.





SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants

1 red	D50
2 cyan	D65

RGB space

Med.White	D65
Ref.White	D50
Primaries	Rec.709
Trc	sRGB
R.Intent	RelCol Cat Bradf.

Spectrum generator
Function

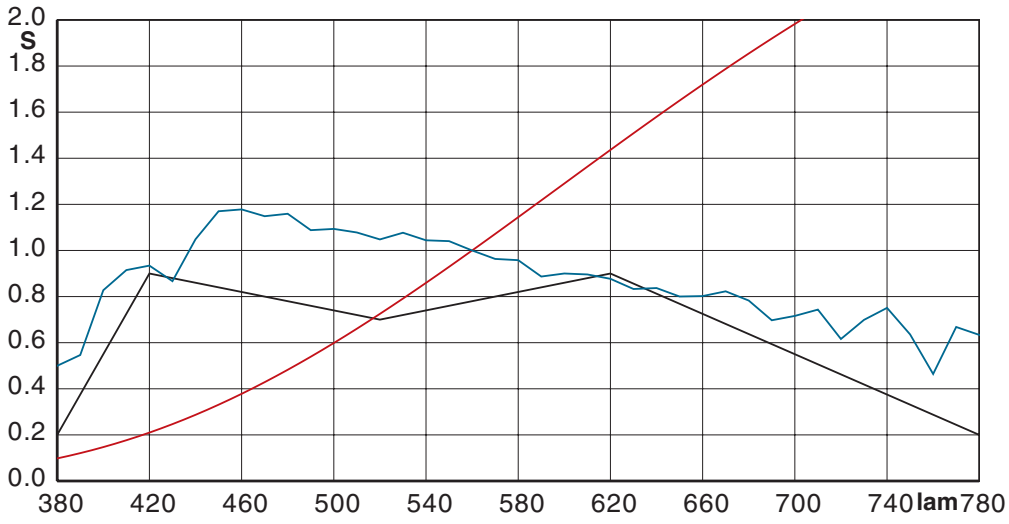
L1	420.0000
S1	20.0000
A1	0.9000
L2	520.0000
S2	20.0000
A2	0.3000
L3	620.0000
S3	20.0000
A3	0.9000

Color	1	2
X	0.3890	0.3756
Y	0.2653	0.2556
Z	0.2603	0.3657
x	0.4253	0.3768
y	0.2901	0.2564
z	0.2846	0.3668
L*	58.5360	57.6133
a*	48.1584	47.8513
b*	-7.6464	-25.5651
R	168.8753	149.0185
G	34.7706	34.2526
B	84.9450	123.0186
R'	212.5543	201.0472
G'	103.2592	102.5280
B'	156.1418	184.5336
CCT	none	none
RGB	in-gam	in-gam
dE	17.9451	

Bars

3.3.3 SpectroCalc / Examples / sRGB with CAT / Illumin. A+ D65

This non-realistic spectrum is rather sensible to illuminant changes, here for illuminants A and D65.
Spectrum mode: Table.



SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants

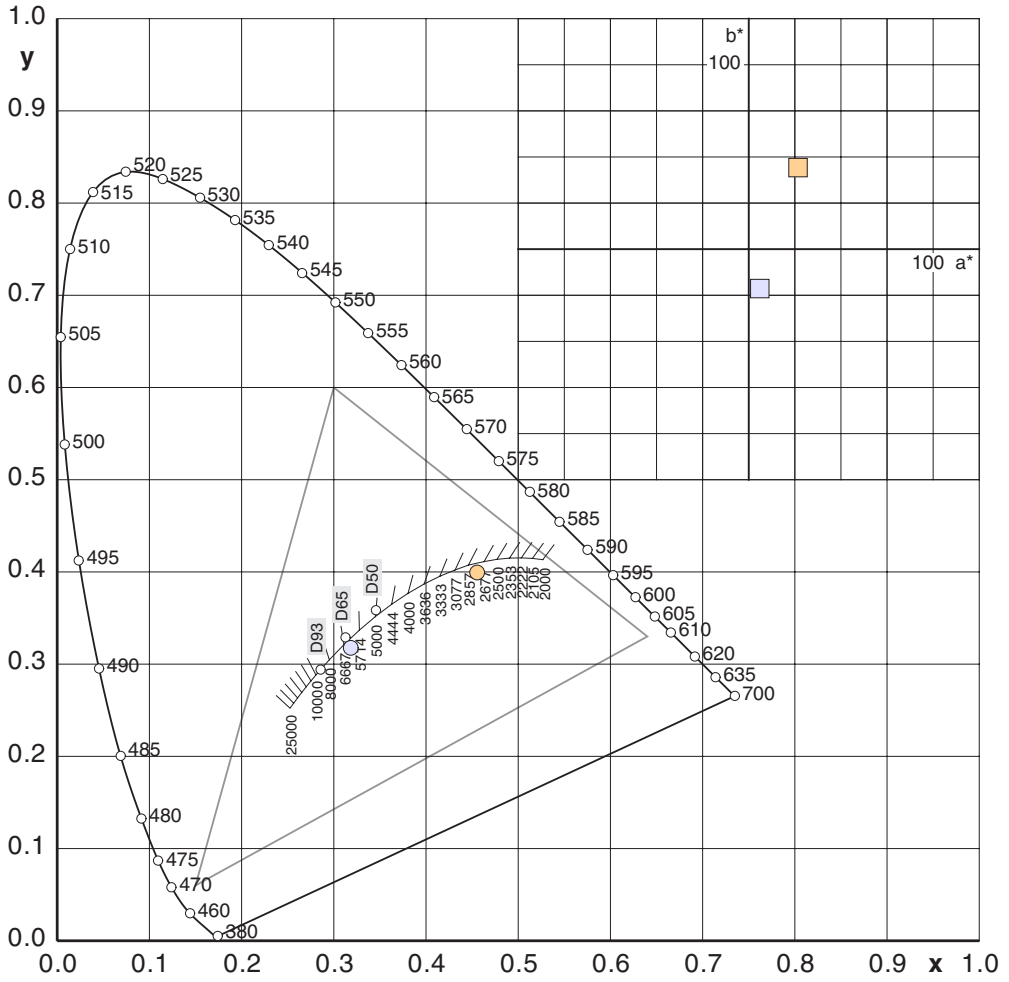
1 red	A
2 cyan	D65

RGB space

Med.White	D65
Ref.White	D50
Primaries	Rec.709
Trc	sRGB
R.Intent	RelCol Cat Bradf.

Spectrum generator
Table

380	0.2000
420	0.9000
520	0.7000
620	0.9000
780	0.2000

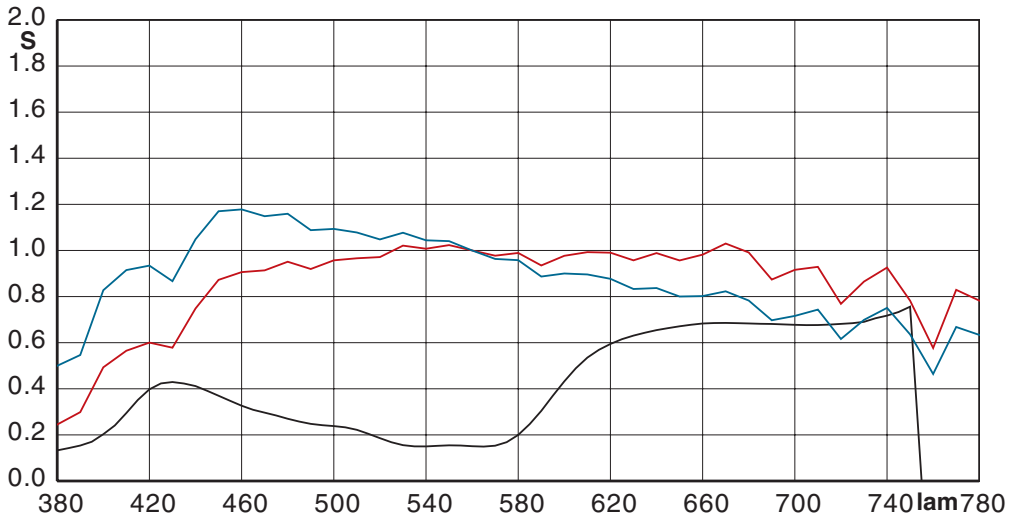


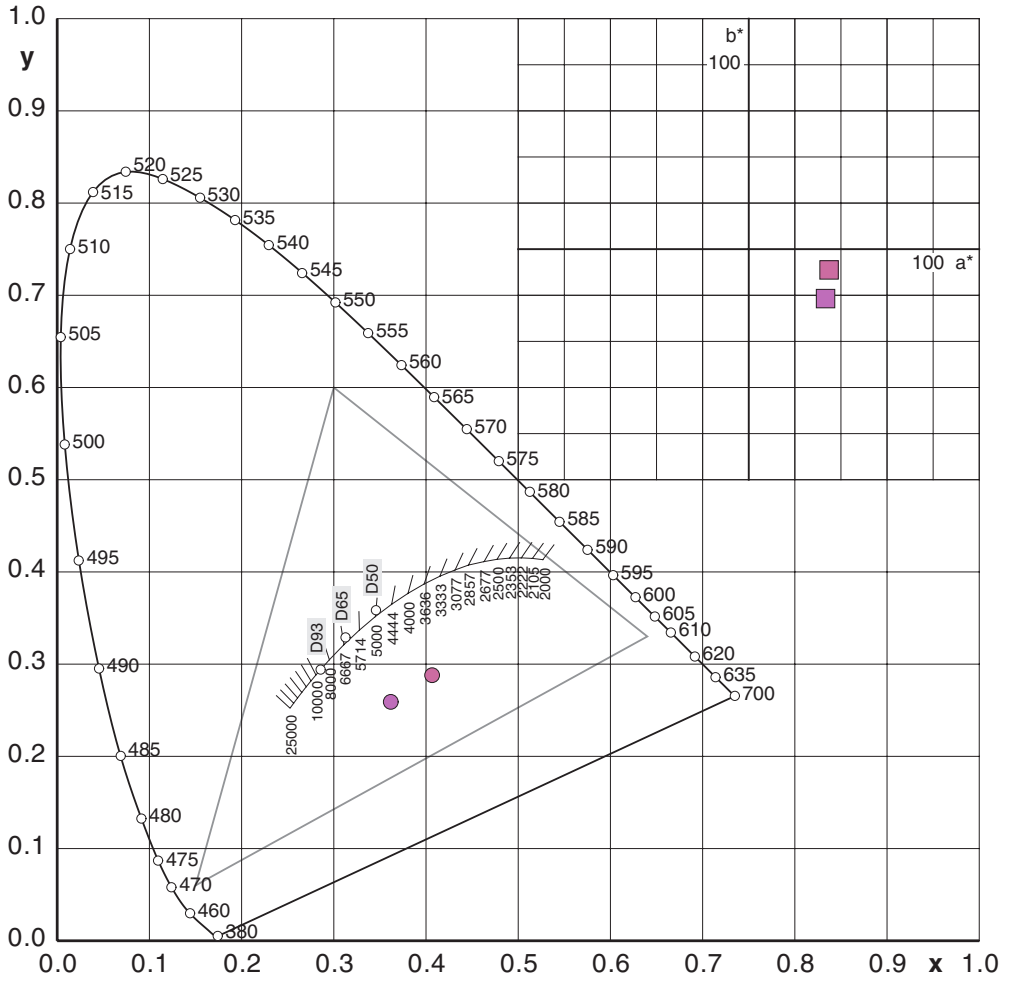
Color	1	2
X	0.9077	0.7836
Y	0.7956	0.7817
Z	0.2896	0.8962
x	0.4555	0.3183
y	0.3992	0.3176
z	0.1453	0.3641
L*	91.4861	90.8564
a*	26.7180	5.9915
b*	44.2361	-21.3479
R	361.0753	191.7162
G	164.6702	194.0319
B	74.0014	289.8924
R'	255.0000	224.8526
G'	210.1861	226.0506
B'	146.6386	255.0000
CCT	2686 K	6248 K
RGB	out-gam	out-gam
dE	68.7841	

Bars

3.3.4 SpectroCalc / Examples / sRGB with CAT / Illumin. D50+ D65

This spectrum was measured by Spectrocam: the first patch of example 3.3.2, printed by a toner printer. Spectrum mode: Spectrocam.





SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan D65

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

Spectrum generator
Spectrocam

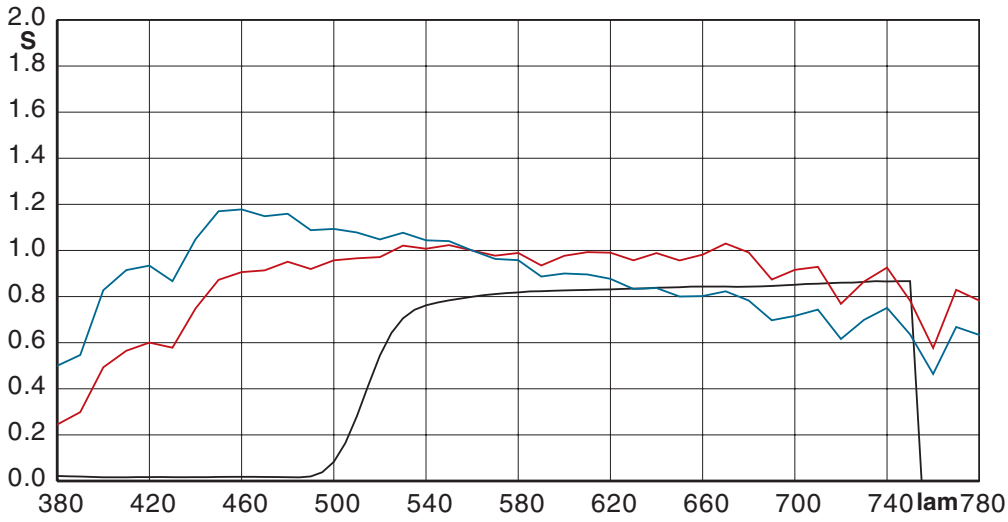
Color	1	2
X	0.3717	0.3557
Y	0.2630	0.2547
Z	0.2793	0.3735
x	0.4067	0.3615
y	0.2877	0.2588
z	0.3056	0.3796
L*	58.3183	57.5277
a*	43.5603	41.6576
b*	-11.2450	-26.7912
R	153.6948	132.5124
G	38.0992	38.8482
B	91.5483	125.5056
R'	203.8340	190.7803
G'	107.8130	108.8052
B'	161.5335	186.1964
CCT	none	none
RGB	in-gam	in-gam
dE	15.6821	

Bars

3.3.5 SpectroCalc / Examples / Main test for Spectrocam data

Pantone Yellow 012C (old swatch book). Spectrum mode: Spectrocam. Lab values.

Photoshop 7.0	87.00	2.00	114.00	integer, uses table
ProfileMaker ColorPicker 4.1	86.59	2.59	114.22	uses table
ProfileMaker ColorPicker 5.0	87.47	4.03	113.78	uses table
Measured by Pantone Color Cue	86.87	1.83	114.33	uses table after identification
Measured by Spectrocam	86.84	1.87	111.58	
Spectrocam data, calculation by SpectroCalc	86.84	1.86	111.57	

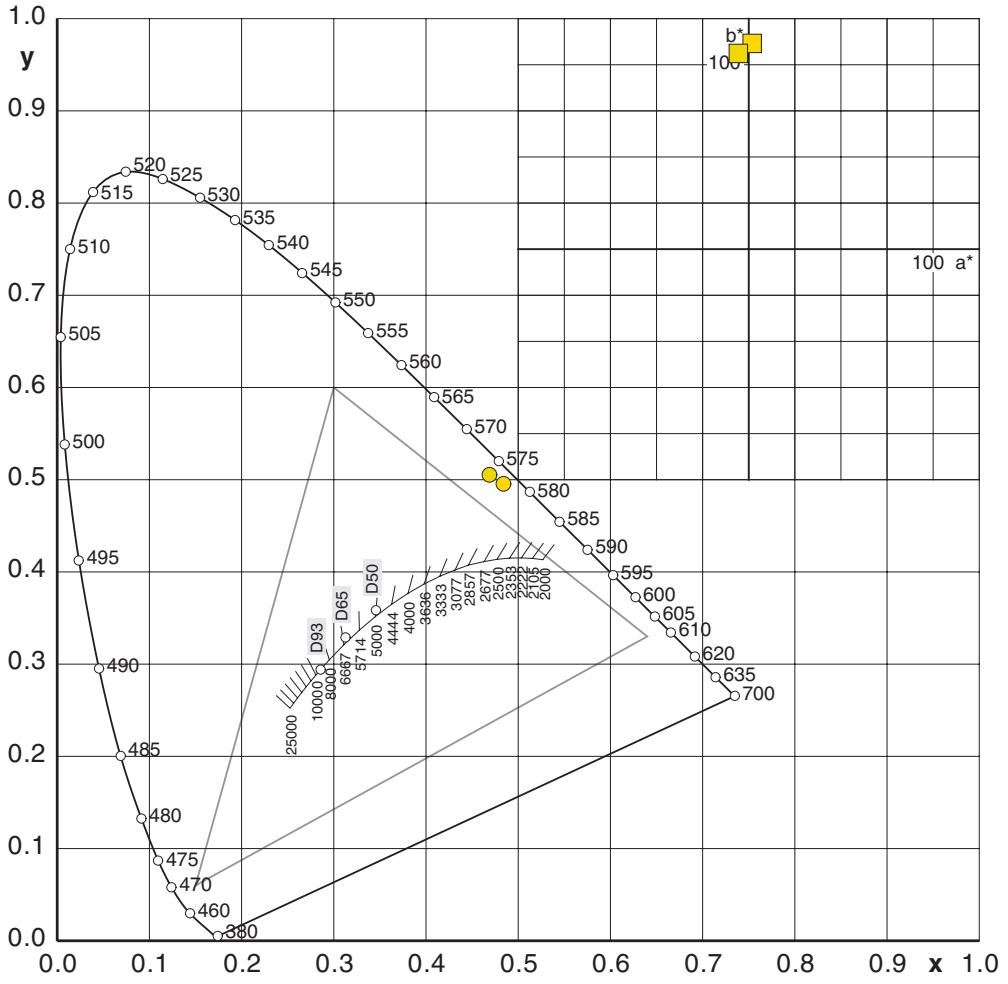


SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan D65

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

Spectrum generator
Spectrocam



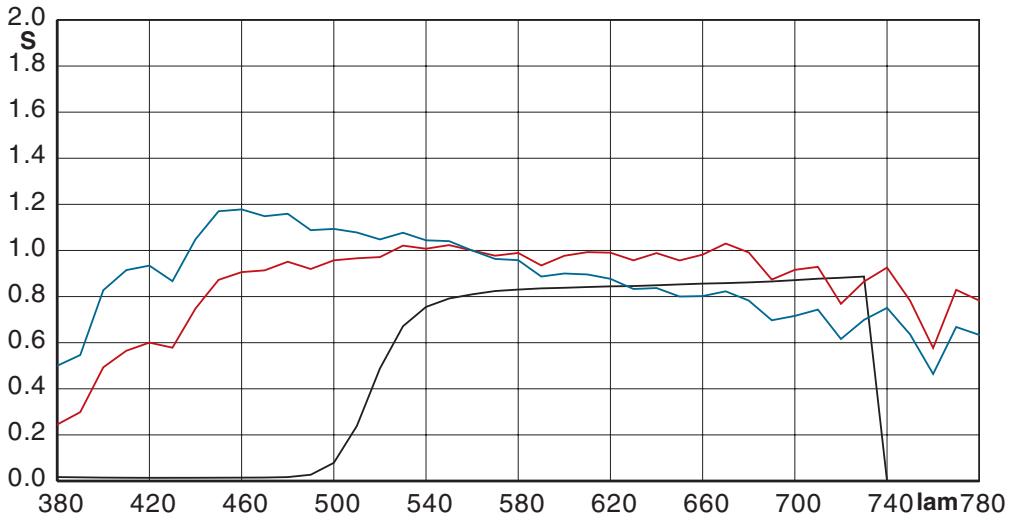
Color	1	2
X	0.6803	0.6304
Y	0.6967	0.6795
Z	0.0293	0.0349
x	0.4838	0.4687
y	0.4954	0.5053
z	0.0208	0.0260
L*	86.8364	85.9829
a*	1.8593	-5.6413
b*	111.5710	106.1335
R	252.7147	219.1578
G	170.8950	175.0124
B	-17.7001	-15.5957
R'	253.9928	238.5457
G'	213.6794	215.9494
B'	0.0000	0.0000
CCT	none	none
RGB	out-gam	out-gam
dE	9.3034	

Bars

3.3.6 SpectroCalc / Examples / Main test for Eye-One Pro data

Pantone Yellow 012C (old swatch book). Spectrum mode: Eye-One Pro.Lab values.

Photoshop 7.0	87.00	2.00	114.00	integer, uses table
ProfileMaker ColorPicker 4.1	86.59	2.59	114.22	uses table
ProfileMaker ColorPicker 5.0	87.47	4.03	113.78	uses table
Measured by Pantone Color Cue	86.87	1.83	114.33	uses table after identification
Measured by GMB Eye-One Pro	86.73	3.98	113.63	
Eye-One Pro data, calculation by SpectroCalc	86.70	4.07	113.29	

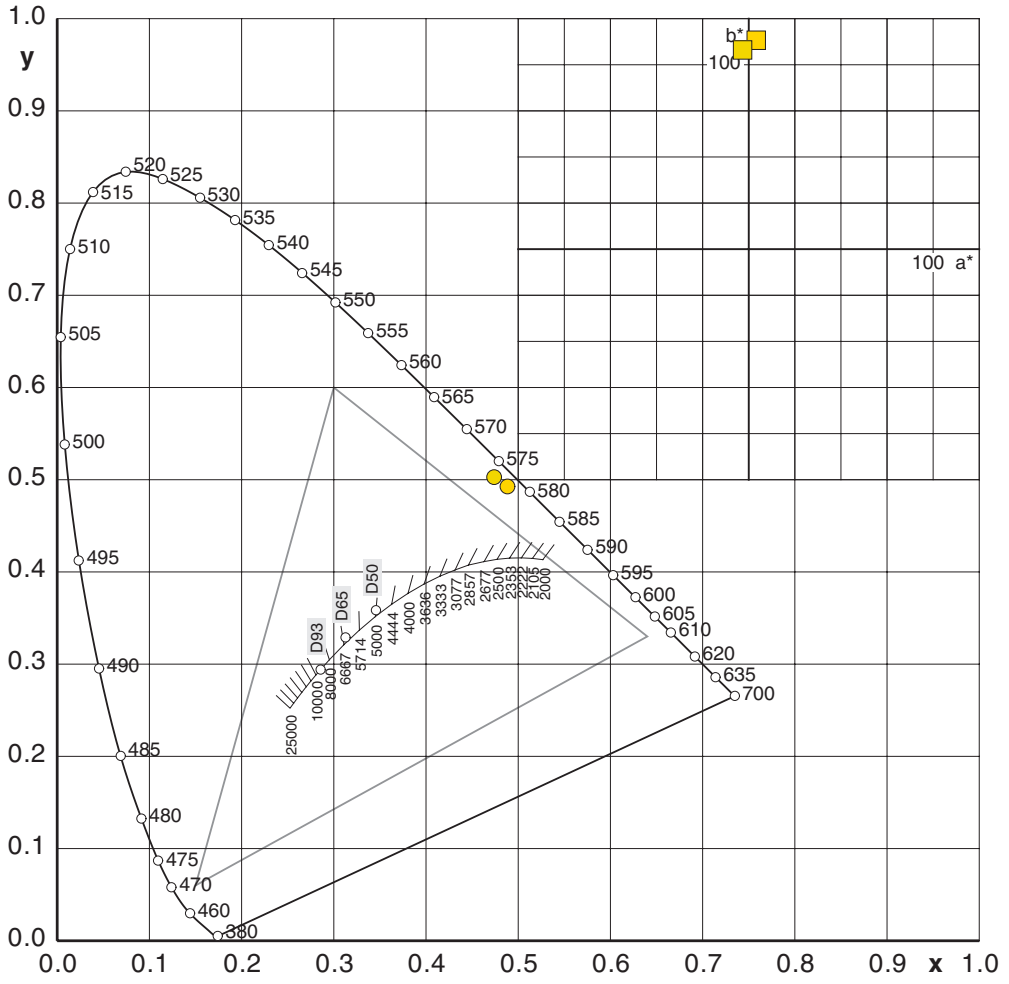


SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan D65

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

Spectrum generator
Eye-One Pro



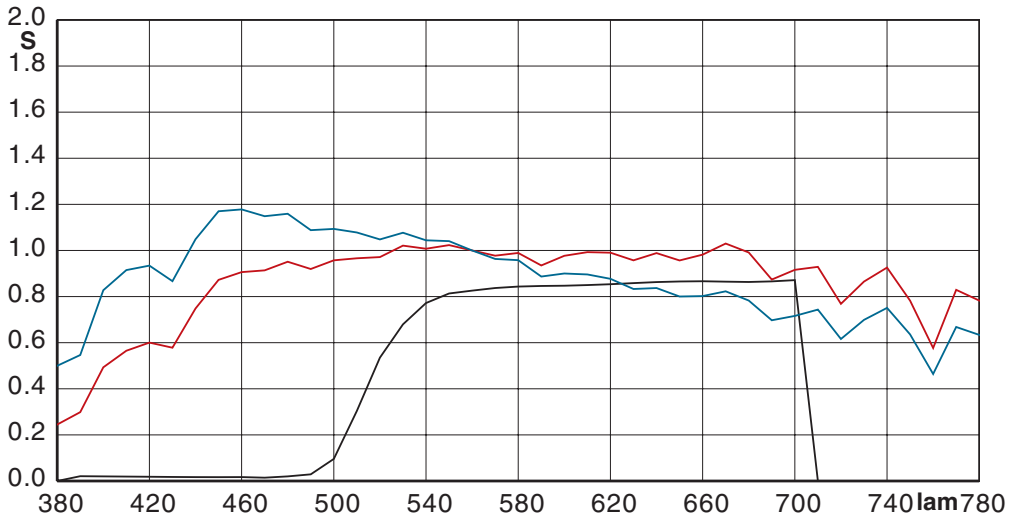
Color	1	2
X	0.6878	0.6368
Y	0.6939	0.6757
Z	0.0267	0.0317
x	0.4883	0.4738
y	0.4927	0.5027
z	0.0190	0.0236
L*	86.6984	85.7908
a*	4.0656	-3.3349
b*	113.2946	108.0290
R	260.1156	226.3112
G	167.6535	171.4985
B	-18.3125	-16.4148
R'	255.0000	241.9485
G'	211.8698	214.0141
B'	0.0000	0.0000
CCT	none	none
RGB	out-gam	out-gam
dE	9.1278	

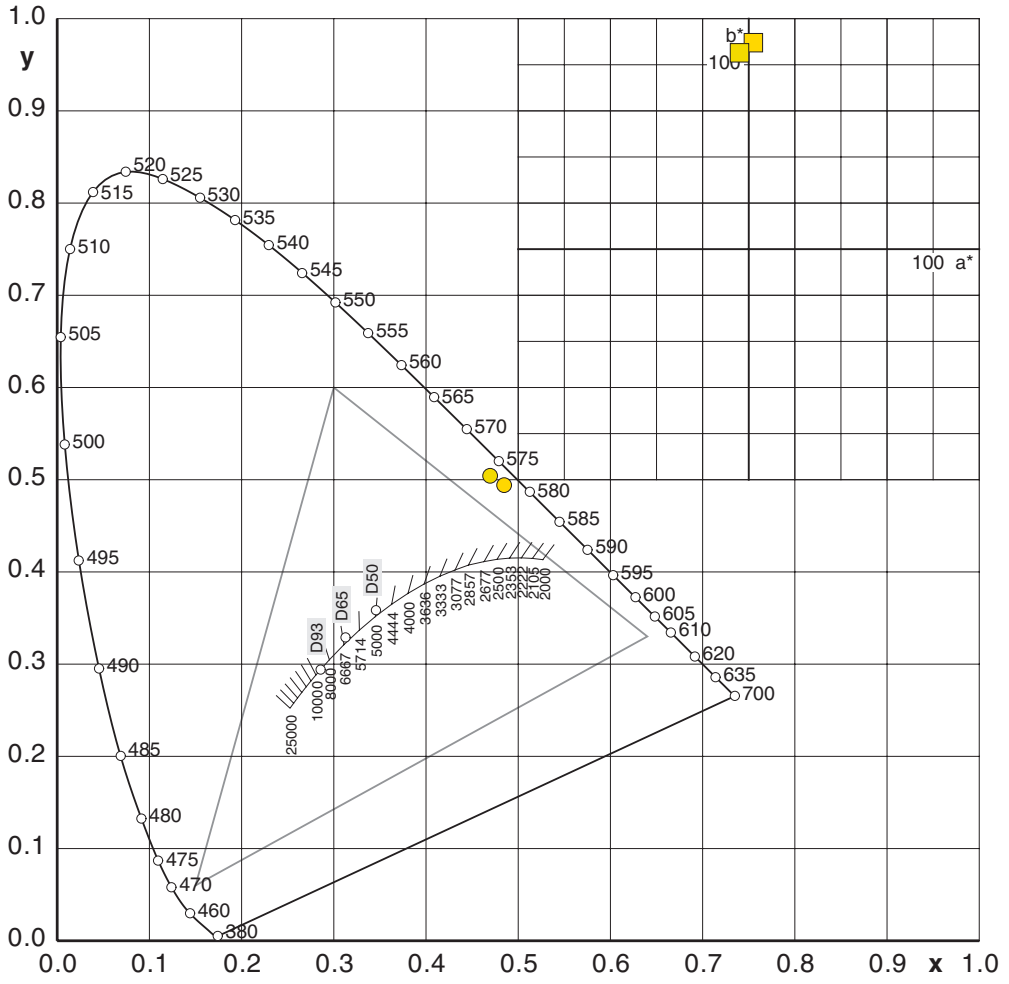
Bars

3.3.7 SpectroCalc / Examples / Main test for DTP-22 data

Pantone Yellow 012C (newer swatch book). Spectrum mode: DTP-22. Lab values.

Photoshop 7.0	87.00	2.00	114.00	integer, uses table
ProfileMaker ColorPicker 4.1	86.59	2.59	114.22	uses table
ProfileMaker ColorPicker 5.0	87.47	4.03	113.78	uses table
Measured by Pantone Color Cue	86.87	1.83	114.33	uses table after identification
Measured by X-Rite DTP-22	87.59	2.56	112.33	
DTP-22 data, calculation by SpectroCalc	87.54	2.52	111.96	





SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan D65

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

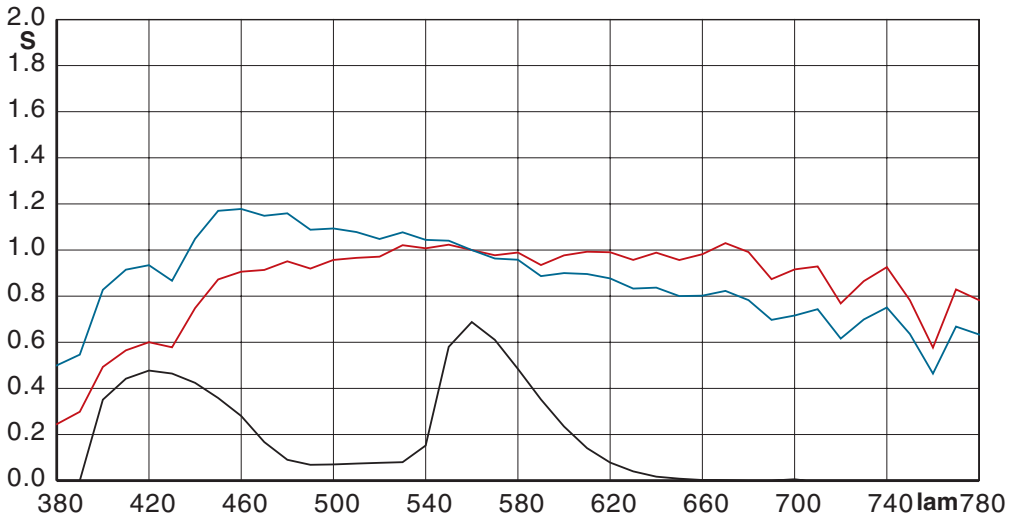
Spectrum generator
DTP-22

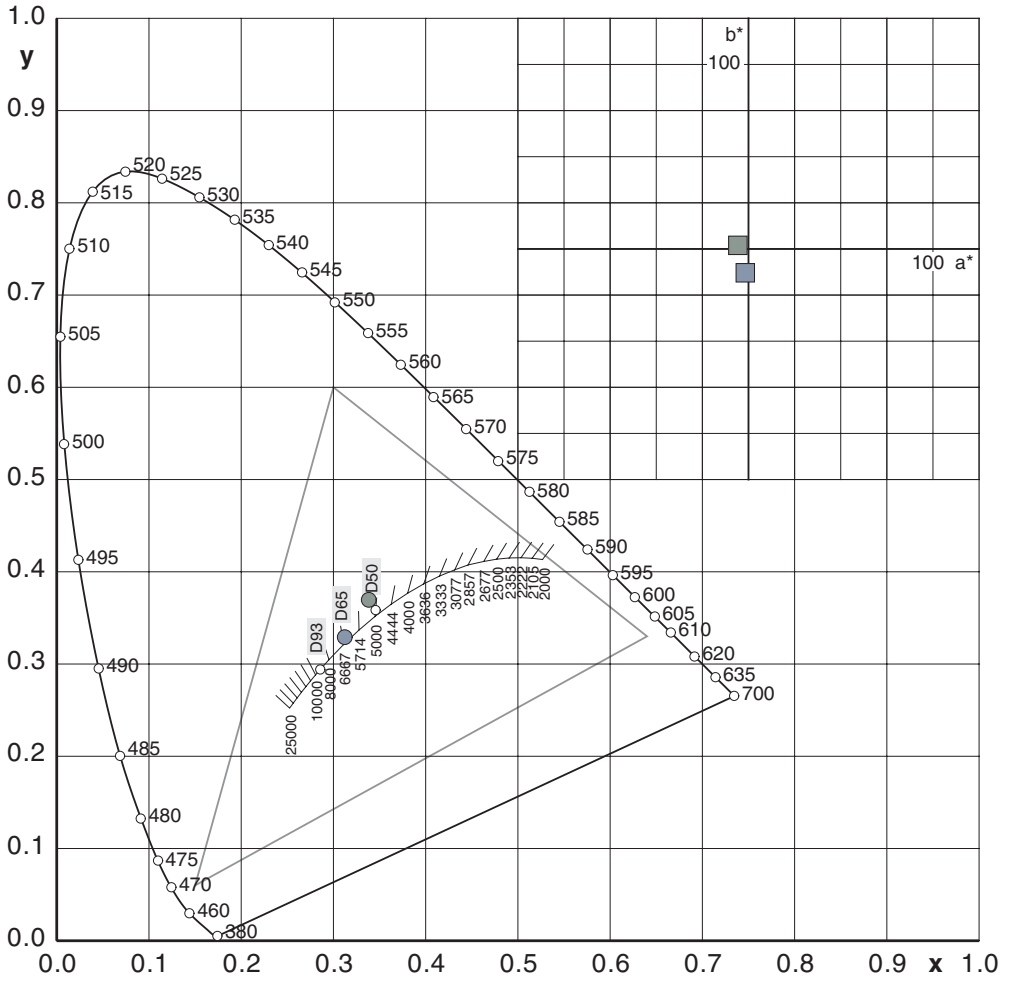
Color	1	2
X	0.6975	0.6462
Y	0.7112	0.6934
Z	0.0304	0.0362
x	0.4847	0.4697
y	0.4942	0.5040
z	0.0211	0.0263
L*	87.5422	86.6717
a*	2.5181	-5.0035
b*	111.9634	106.4691
R	260.2947	225.9450
G	173.6918	177.8411
B	-17.8295	-15.6497
R'	255.0000	241.7759
G'	215.2248	217.4910
B'	0.0000	0.0000
CCT	none	none
RGB	out-gam	out-gam
dE	9.3552	

Bars

3.3.8 SpectroCalc / Examples / Metameric Grays / Gray 1

This page and the next belong together. The spectra show two hypothetical grays which are metamers under D65. The example was taken from [5], Table IV (3.8.2), p. 784, the first two table columns. The color coordinates are almost the same for D65 (column 2 in the diagrams on this page and the next). They are clearly different under D50 (column 1 on both pages).





SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants

1 red	D50
2 cyan	D65

RGB space

Med.White	D65
Ref.White	D50
Primaries	Rec.709
Trc	sRGB
R.Intent	RelCol Cat Bradf.

Spectrum generator
Table

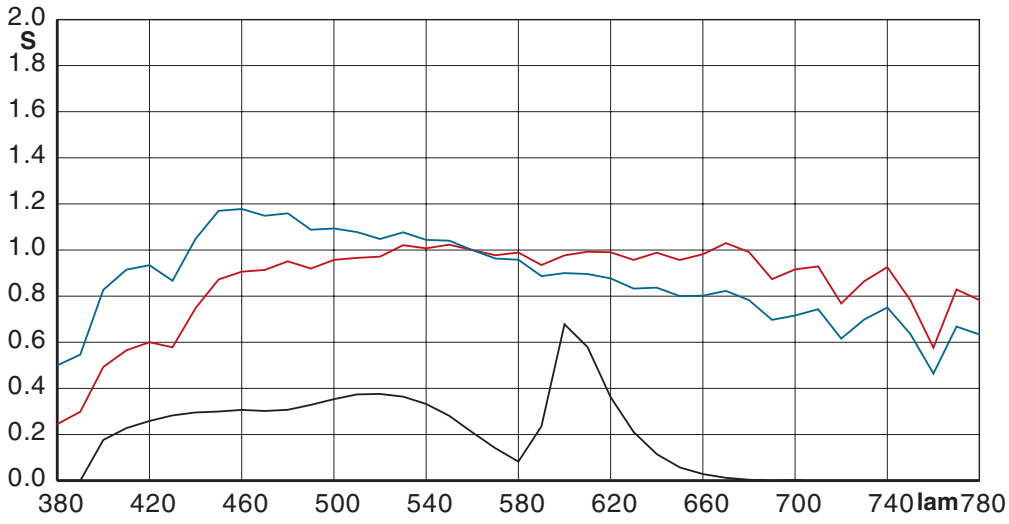
380	0.0000
390	0.0000
400	0.3511
410	0.4422
420	0.4774
430	0.4644
440	0.4241
450	0.3584
460	0.2804
470	0.1674
480	0.0905

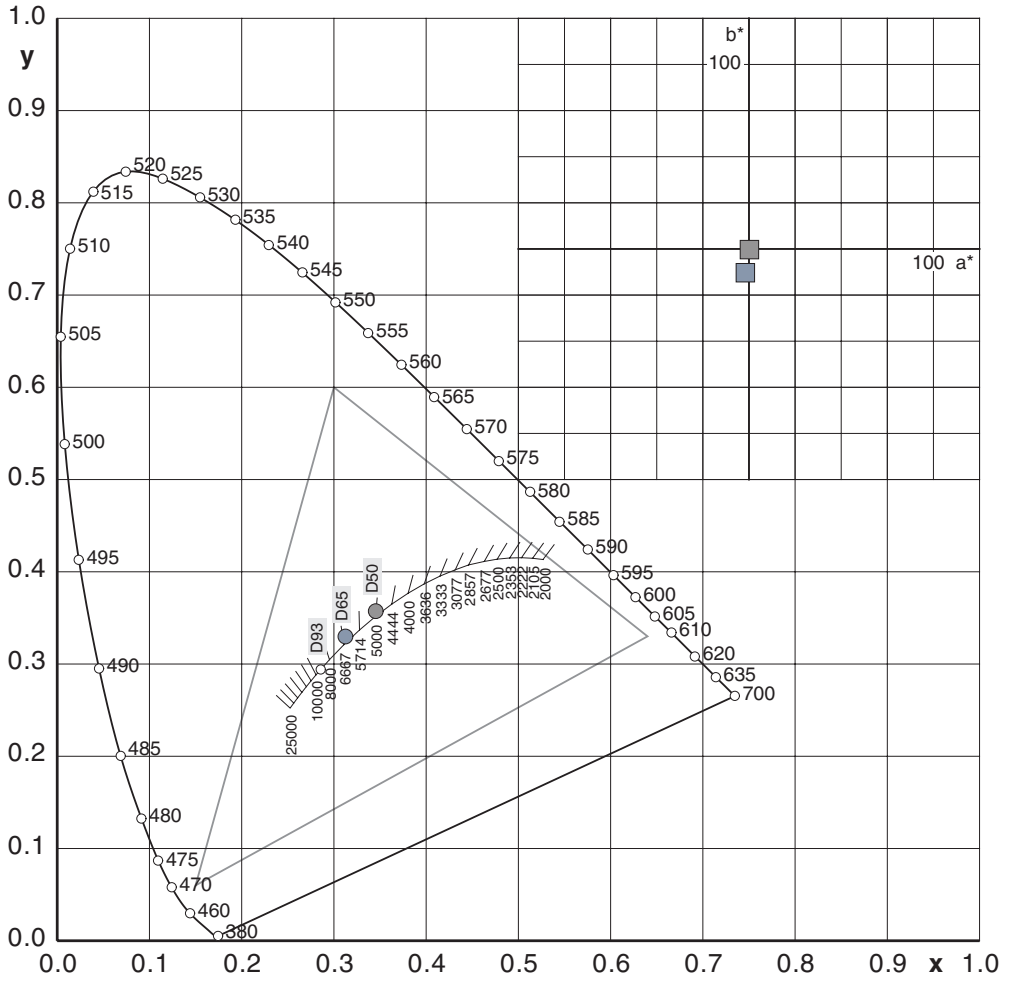
Color	1	2
X	0.2761	0.2842
Y	0.3016	0.2994
Z	0.2382	0.3258
x	0.3384	0.3125
y	0.3697	0.3292
z	0.2919	0.3583
L*	61.7920	61.6040
a*	-5.7486	-1.7396
b*	1.9508	-12.9332
R	66.4962	62.9123
G	80.4866	78.1420
B	72.8031	104.5050
R'	139.6369	136.1303
G'	152.3618	150.3249
B'	145.5494	171.4881
CCT	5275 K	6501 K
RGB	in-gam	in-gam
dE	15.4156	

Bars

3.3.9 SpectroCalc / Examples / Metameric Grays / Gray 2

Please refer to the previous page.





SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants

1 red	D50
2 cyan	D65

RGB space

Med.White	D65
Ref.White	D50
Primaries	Rec.709
Trc	sRGB
R.Intent	RelCol Cat Bradf.

Spectrum generator
Table

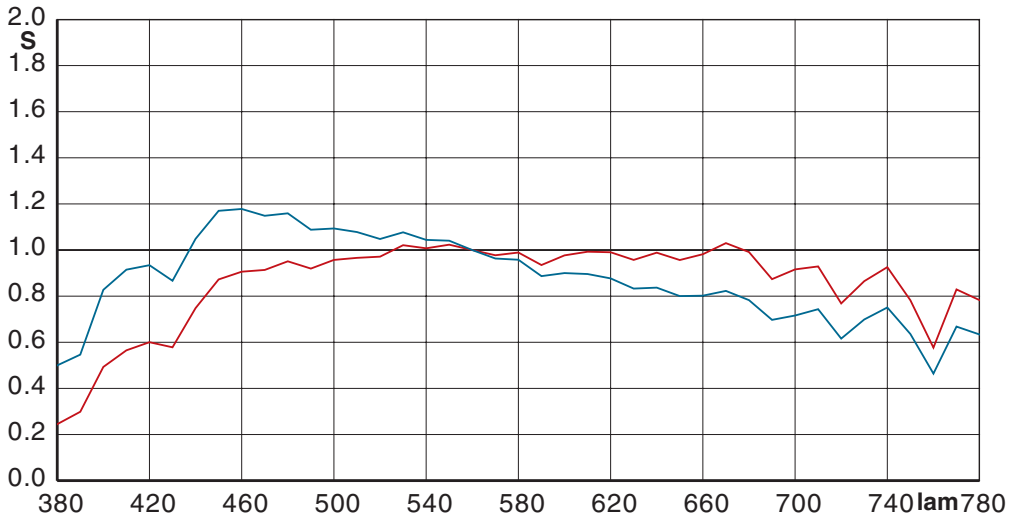
380	0.0000
390	0.0000
400	0.1766
410	0.2278
420	0.2587
430	0.2829
440	0.2957
450	0.2997
460	0.3068
470	0.3021
480	0.3073

Color	1	2
X	0.2889	0.2842
Y	0.2990	0.3000
Z	0.2487	0.3261
x	0.3454	0.3122
y	0.3574	0.3295
z	0.2973	0.3582
L*	61.5651	61.6545
a*	0.2473	-1.9598
b*	-0.3644	-12.8890
R	76.4957	62.6302
G	76.0945	78.4321
B	76.9733	104.5734
R’	148.8732	135.8494
G’	148.5167	150.5788
B’	149.2962	171.5387
CCT	5008 K	6516 K
RGB	in-gam	in-gam
dE	12.7180	

Bars

3.3.10 SpectroCalc / Examples / Show CT-Curve in Lab-plane

The curve for the Planckian radiator can be shown in the Lab-plane a*b*.
Spectrum Mode: Perfect Reflector for the comparison of D50 and D65.

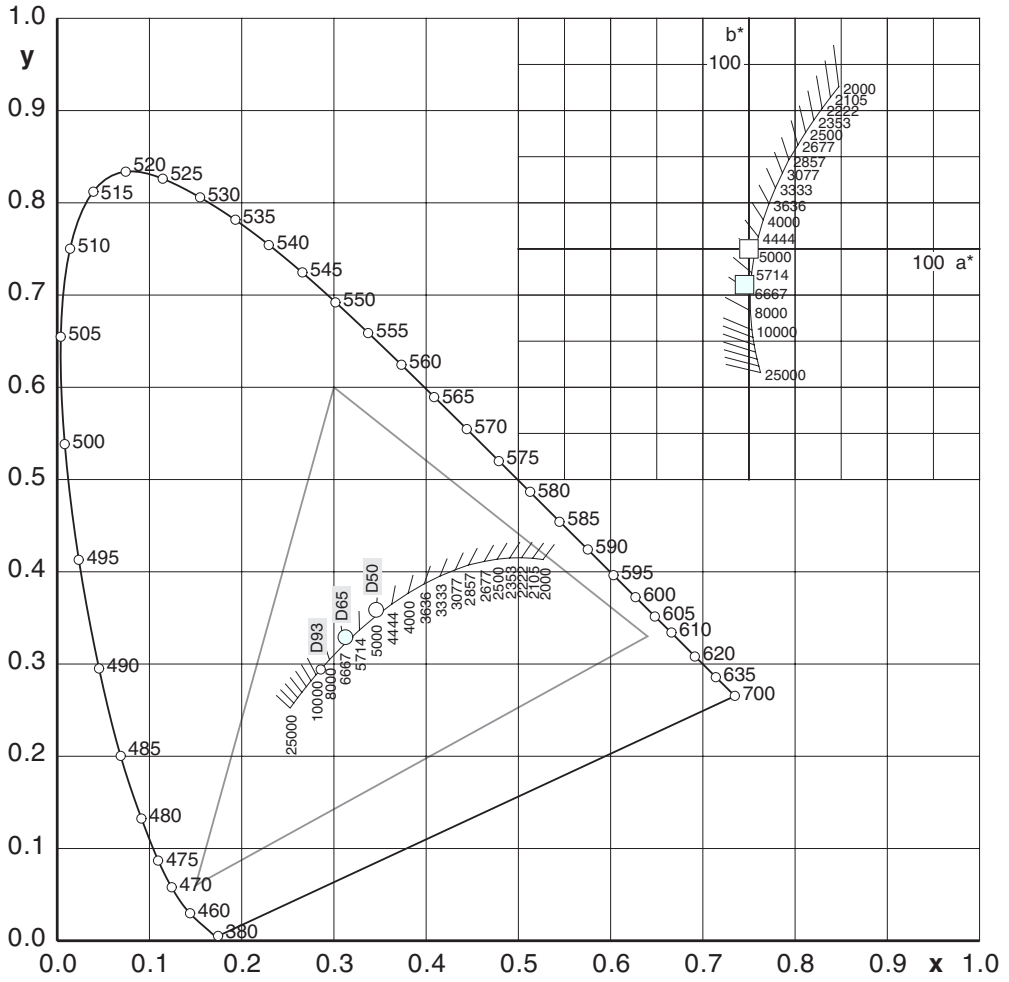


SpectroCalc
G.Hoffmann
Dec.3 / 2006

Illuminants
1 red D50
2 cyan D65

RGB space
Med.White D65
Ref.White D50
Primaries Rec.709
Trc sRGB
R.Intent RelCol Cat Bradf.

Spectrum generator
Perfect reflector



Color	1	2
X	0.9642	0.9504
Y	1.0000	1.0000
Z	0.8251	1.0888
x	0.3457	0.3127
y	0.3585	0.3290
z	0.2958	0.3582
L*	100.0000	100.0000
a*	-0.0168	-2.4088
b*	-0.0008	-19.3683
R	254.9210	210.9243
G	255.0243	260.7104
B	255.0016	349.2400
R'	254.9652	234.5478
G'	255.0107	255.0000
B'	255.0007	255.0000
CCT	5001 K	6491 K
RGB	in-gam	out-gam
dE	19.5147	

Bars

4.1 SpectroCalc-Moni / Input

4.1.0 Introduction

SpectroCalc-Moni is used only for this configuration:
Measure monitor spectra by Eye-One Pro and ProfileMaker Measure

4.1.1 Create Reference file

```
Logo TestChart for Color Monitors
BEGIN_DATA_FORMAT
Sample_ID    RGB_R    RGB_G    RGB_B
END_DATA_FORMAT
BEGIN_DATA
A1   255  0    0
A2   0    255  0
A3   0    0    255
A4   255  255  255
A5   0    255  255
A6   255  0    255
A7   255  255  0
A8   0    0    0
END_DATA
```

4.1.2 Measure Reference file colors

Save as e.g. SpeCalc-Moni-test1.txt

4.1.3 Insert test result in SpectroCalc-Moni

Download the program specalc-moni [11] and rename txt by eps.
Insert SpeCalc-Moni-test1.txt and convert by % each line into a comment.

```
% Original Eye-One Pro file (without %)
% LGOROWLENGTH   2
% CREATED    "9/26/2007"  # Time: 14:28
% INSTRUMENTATION"Eye-One Pro"
% MEASUREMENT_SOURCE  "Illumination=Emission  Filter=No"
% ILLUMINATION_NAME   "Emission"
% OBSERVER_ANGLE "2"
% KEYWORD    "SampleID"
% KEYWORD    "SAMPLE_NAME"
% NUMBER_OF_FIELDS    41
% BEGIN_DATA_FORMAT
% SampleID   SAMPLE_NAME  RGB_R    RGB_G    RGB_B    nm380    nm390    ...
% END_DATA_FORMAT
% NUMBER_OF_SETS 8
% BEGIN_DATA
% 1  A1   255.00   0.00     0.00     -0.0001  -0.0003  -0.0005  -0.0005  ...
% 2  A2   0.00     255.00   0.00     -0.0003  0.0002   -0.0001  -0.0010  ...
% 3  B1   0.00     0.00     255.00   0.0006   0.0007   0.0054   0.0322   ...
% 4  B2   255.00   255.00   255.00   0.0011   0.0012   0.0063   0.0371   ...
% 5  C1   0.00     255.00   255.00   0.0013   0.0017   0.0059   0.0345   ...
% 6  C2   255.00   0.00     255.00   0.0005   0.0012   0.0062   0.0343   ...
% 7  D1   255.00   255.00   0.00     0.0005   0.0003   0.0008   0.0020   ...
% 8  D2   0.00     0.00     0.00     -0.0012  -0.0005  -0.0002  -0.0001  ...
% END_DATA
```

4.1 SpectroCalc-Moni / Input

4.1.3 Edit test result in SpectroCalc-Moni

Pack the relevant part into an array.
Several cases can be distinguished by Cw=1, 2, ..., including specific text.

```
Cw 1 eq
{
/head14 (Example by Gernot Hoffmann) def
/head15 (Eizo CG19 / September 26 / 2007) def
/head16 () def
/CwE1
[
255.00   0.00     0.00     -0.0001  -0.0003  -0.0005  -0.0005  0.0034   ...
0.00     255.00   0.00     -0.0003  0.0002   -0.0001  -0.0010  0.0012   ...
0.00     0.00     255.00   0.0006   0.0007   0.0054   0.0322   0.2027   ...
255.00   255.00   255.00   0.0011   0.0012   0.0063   0.0371   0.2327   ...
0.00     255.00   255.00   0.0013   0.0017   0.0059   0.0345   0.2197   ...
255.00   0.00     255.00   0.0005   0.0012   0.0062   0.0343   0.2171   ...
255.00   255.00   0.00     0.0005   0.0003   0.0008   0.0020   0.0066   ...
0.00     0.00     0.00     -0.0012  -0.0005  -0.0002  -0.0001  0.0005   ...
] def
} if
```

4.1.4 Other inputs

Nothing else should be changed**.**

4.2 SpectroCalc-Moni / Output

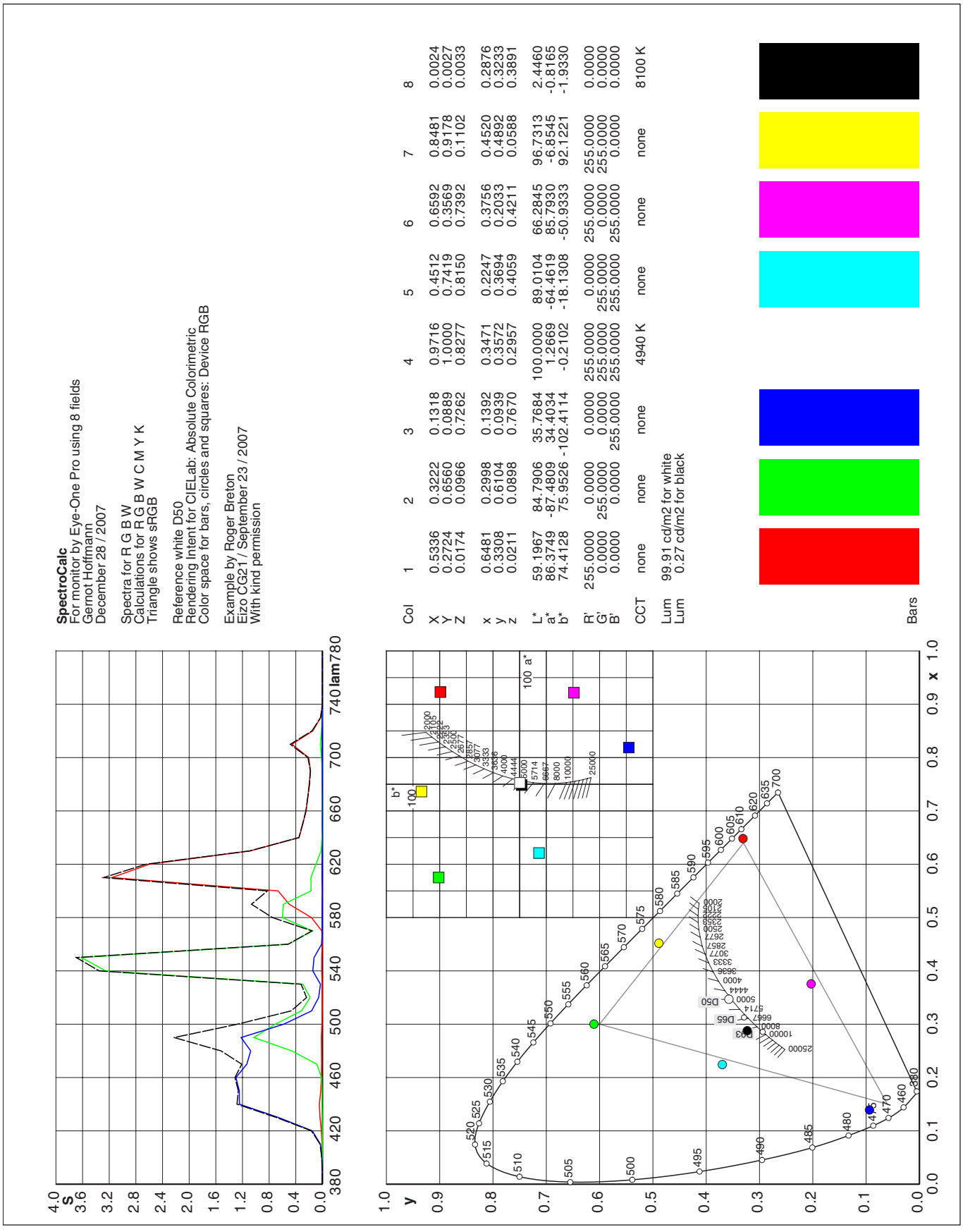
4.2.1 Outputs

As shown by the examples.
Spectra for R G B W.
Calculations for R G B W C M Y K.
RGB values are given in Device RGB 0 or 255.
Indicated RGB colors are shown in Device RGB 0 or 255.
XYZ to CIELab calculations by Absolute Colorimetric.

4.3 SpectroCalc-Moni / Examples

4.3.1 Eizo CG21

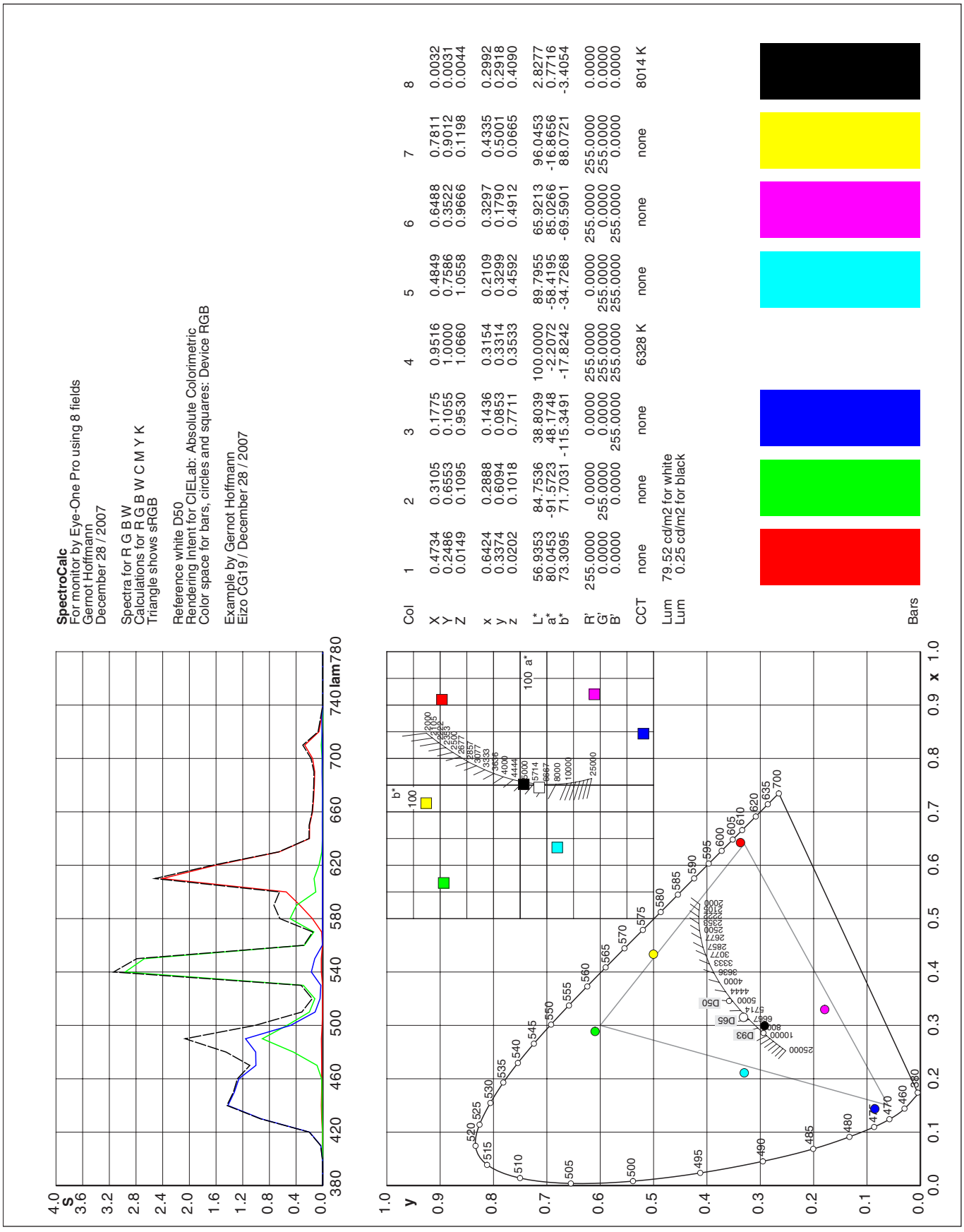
Eizo CG21 by Roger Breton. Calibrated for D50 white point.



4.3 SpectroCalc-Moni / Examples

4.3.2 Eizo CG19

Eizo CG19 by Gernot Hoffmann. Calibrated for D65 white point.



5. References

[1] R.W.G.Hunt
Measuring Colour
Fountain Press, England, 1998

[2] International Color Consortium
http://www.color.org

[3] Specification ICC.1:21001-12
File Format for Color Profiles (Version 4.0.0)
http://www.color.org/newiccspec.pdf

[4] PSAlter
http://www.quite.com

[5] G.Wyszecki + W.S.Stiles
Color Science
John Wiley & Sons, New York .., 1982/2000

[6] G.Hoffmann
CIE (1931) Color Space
http://www.fho-emden.de/~hoffmann/ciexyz29082000.pdf

[7] G.Hoffmann
CIELab Color Space
http://www.fho-emden.de/~hoffmann/cielab03022003.pdf

[8] G.Hoffmann
ColorCalc PostScript Code
http://www.fho-emden.de/~hoffmann/colcalc03022006.txt
Rename as *.eps

[9] G.Hoffmann
SpectroCalc PostScript Code
http://www.fho-emden.de/~hoffmann/specalc03022006.txt
Rename as *.eps

[10] G.Hoffmann
Color Management by ICC profiles
http://www.fho-emden.de/~hoffmann/cmsicc08102003.pdf

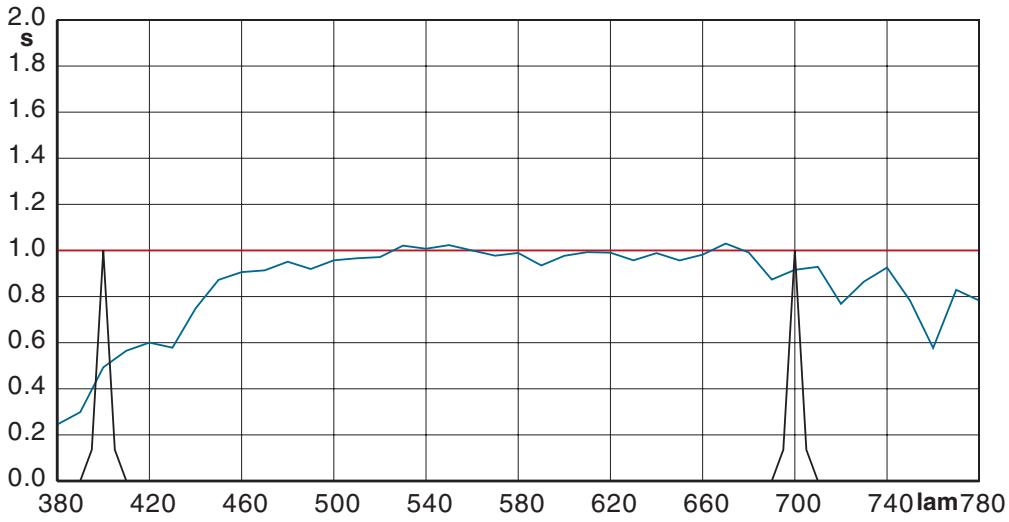
[11] G.Hoffmann
SpectroCalc-Moni PostScript Code for Monitors
http://www.fho-emden.de/~hoffmann/specalc-moni.txt
Rename as *.eps

This doc:
http://www.fho-emden.de/~hoffmann/colcalc03022006.pdf

Gernot Hoffmann
January 04 / 2008
Website
Load browser / Click here

6.1 Appendix 1.1 Narrow Band Spectrum / 2.5nm

Narrow band reflectance factor spectrum.
Values were taken from a Gaussian bell.
Standard deviation 2.5nm.
400nm to 700nm step 10nm.

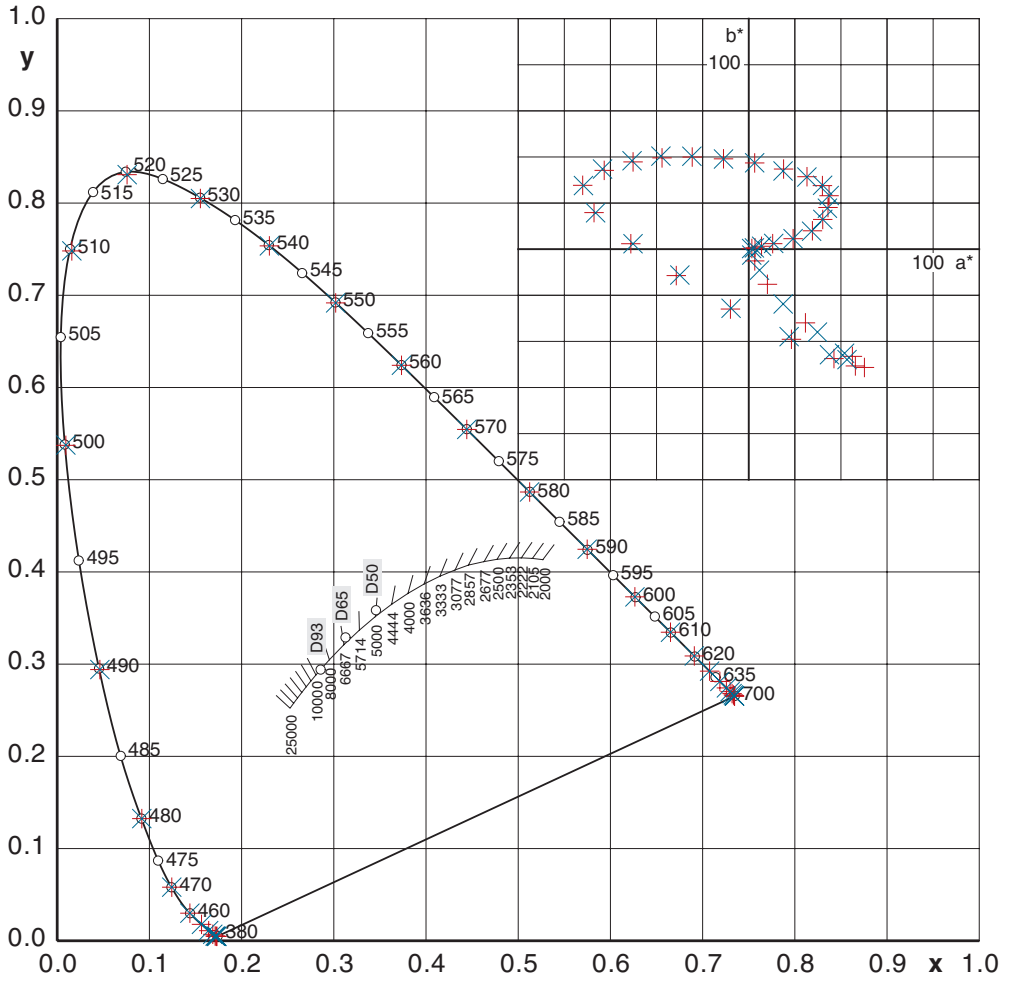


SpectroCalc
G.Hoffmann
Dec.25 / 2006

Illuminants
1 red Equal E.
2 cyan D50

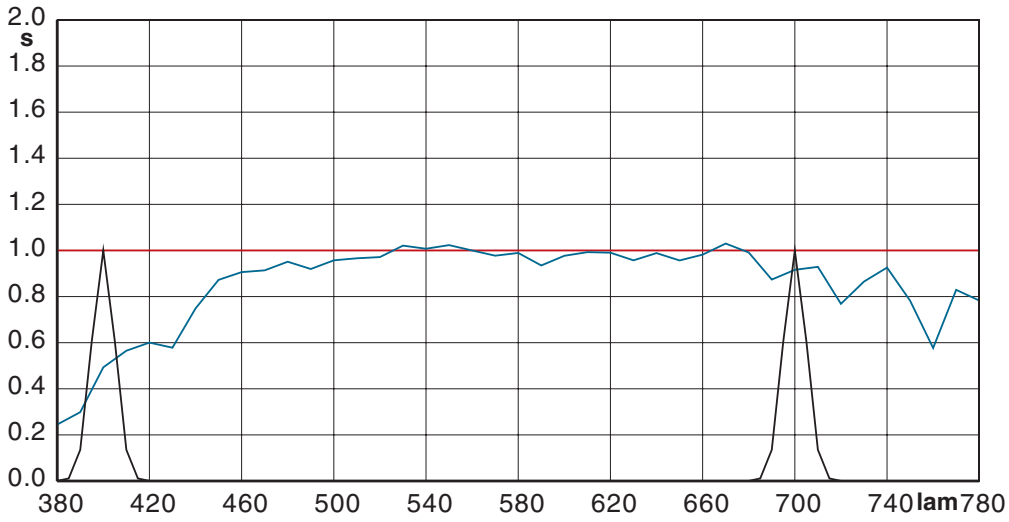
RGB space
Med.White Equal E.
Ref.White Equal E.

Spectrum generator
Function
Sigma 2.5



6.2 Appendix 1.2 Narrow Band Spectrum / 5nm

Narrow band reflectance factor spectrum.
Values were taken from a Gaussian bell.
Standard deviation 5nm.
400nm to 700nm step 10nm.

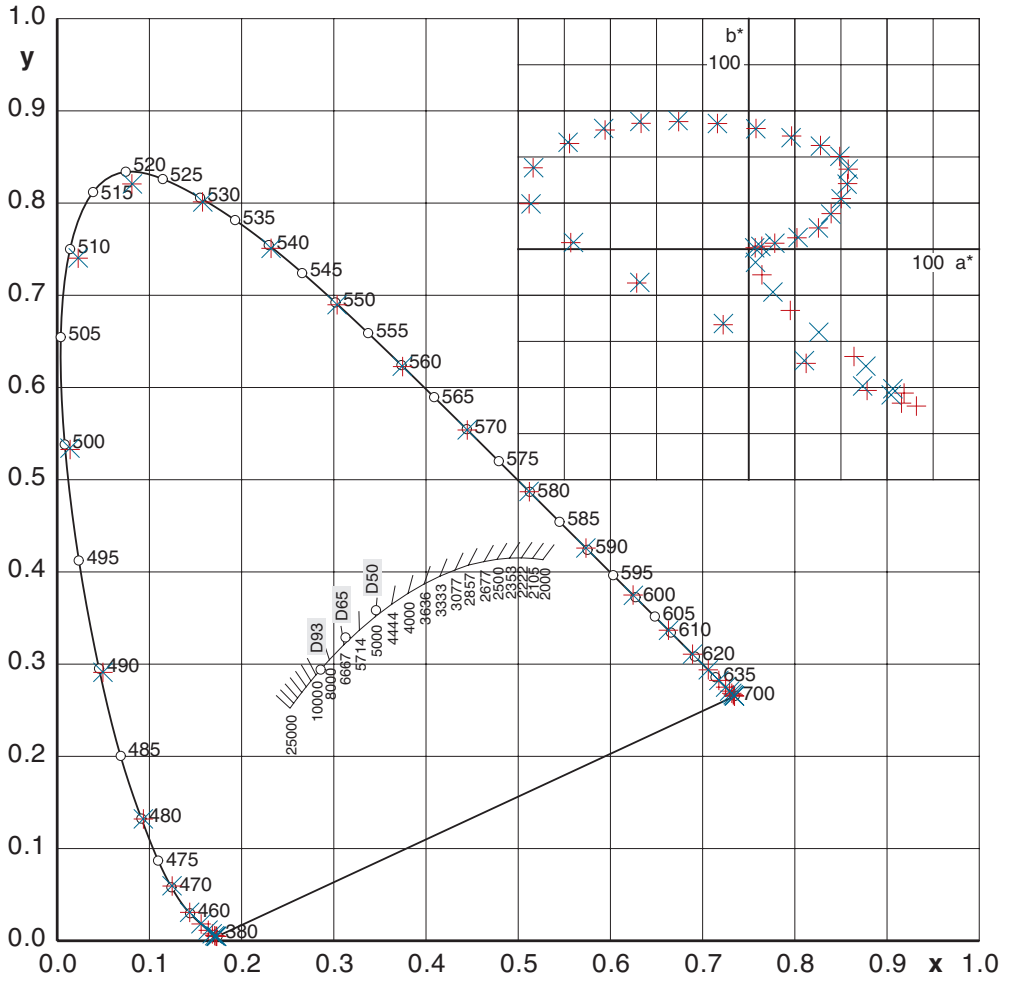


SpectroCalc
G.Hoffmann
Dec.25 / 2006

Illuminants
1 red Equal E.
2 cyan D50

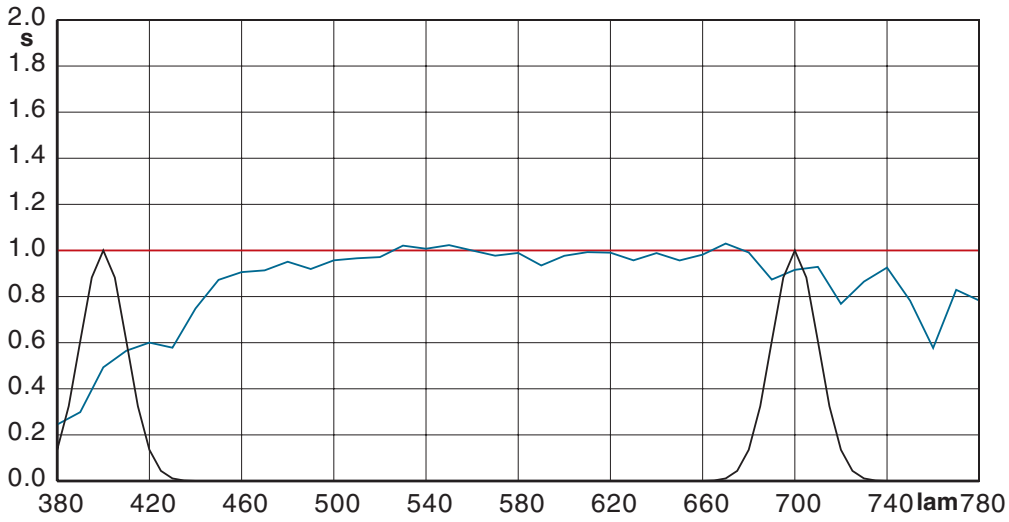
RGB space
Med.White Equal E.
Ref.White Equal E.

Spectrum generator
Function
Sigma 5



6.3 Appendix 1.3 Narrow Band Spectrum / 10nm

Narrow band reflectance factor spectrum.
Values were taken from a Gaussian bell.
Standard deviation 10nm.
400nm to 700nm step 10nm.



SpectroCalc
G.Hoffmann
Dec.25 / 2006

Illuminants
1 red Equal E.
2 cyan D50

RGB space
Med.White Equal E.
Ref.White Equal E.

Spectrum generator
Function
Sigma 10