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Camera Calibration for Reproduction



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Settings for Acrobat

Edit / Preferences / General / Page Display (since version 6)
Custom Resolution 72 dpi / **View by zoom 100% or 200%**

Edit / Preferences / General / Color Management (full version only)
sRGB
Euroscale Coated or ISO Coated or SWOP
Gray Gamma 2.2

1.1 Introduction

A camera calibration is hardly useful for arbitrary scenes, lighting and camera parameters. The situation is quite different if the camera is used for the reproduction of real world images. This means: a target is placed at the position of the image, a shot is taken, the camera is calibrated. Later a shot is taken from the image and the camera profile is applied to the image data.

The author is trying in this doc to explain how the calibration can be done by two different targets: the common IT8.7/2 target and the GretagMacbeth ColorChecker.

Targets

The IT8 target (IT) was made by Wolf Faust [1]. The actual version is already five years old. Minor deviations from the measured reference file can be expected.

The target contains 288 patches. The neutral grays have wavy reflectance spectra [6].

GMB Colorchecker (CC) is supplied by GretagMacbeth [2]. Both names are registered trademarks.

The colors and the production process were chosen deliberately so: neutral grays have flat reflectance spectra, the colors are typical for real world surface colors and they are not much affected by metamerism. ColorChecker contains only 24 patches. Is it possible to create reliable ICC profiles ?

Lighting

Both targets were mounted on a vertical plate and illuminated by Just Normlicht Studio Light HF 5000, which consists of a couple of fluorescent tubes (title photo).

The mean light direction has relative to the horizontal target normal the elevation angle 0 degrees and the azimuth angle 45 degrees. Thus specular highlights are avoided. The distance is 1.5 m.

The illuminance in width direction varies a little: 1160lux at the left side and 1280lux at the right side (values depending on the orientation of the integrating hemisphere). The color temperature is about 5000K.

Camera parameters

The camera Nikon D100 works in manual mode: aperture F6.3, exposure time 1/25 s, focal length 80mm. ISO 200. Everything else is 'normal'. Autofocus was used.

The camera white balance is in mode 'flash'. The color temperature for flash is about 5500K. The raw image appears somewhat yellowish and a little underexposed in order to avoid clipping.

RGB spaces

The shot was saved as `Target.nef`. NEF is the Nikon RAW format. Then opened by Nikon Capture 4. No image processing was applied. It would be rather difficult to store a processing workflow - possibly a source of confusion. Three versions were saved as TIFF with 16 bits per channel for further handling by ProfileMaker 5 and Photoshop 7:

<code>Target-sRGB.tif</code>	sRGB
<code>Target-aRGB.tif</code>	AdobeRGB(98)
<code>Target-Prop.tif</code>	ProPhotoRGB (should have been called <code>Target-pRGB.tif</code>)

Calibration

Calibration and Profiling was done by ProfilMaker 5. The three target images were used twice: calibration by the CC part and by the IT part. This results in six profiles:

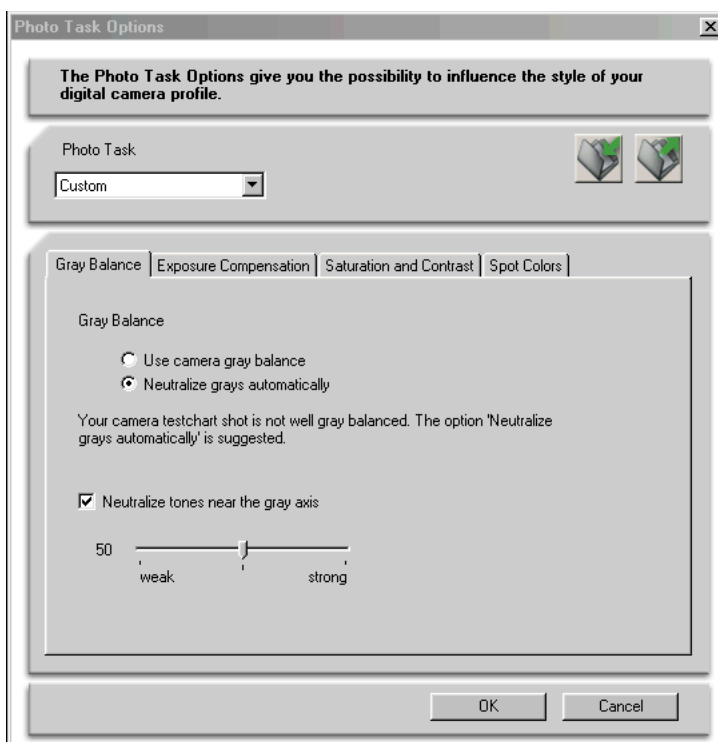
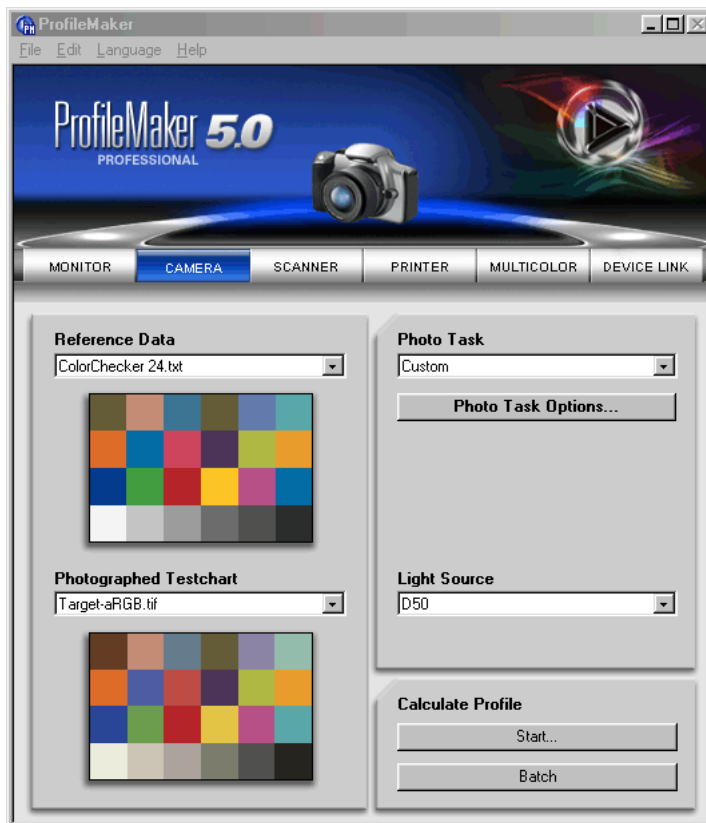
<code>1-CC-sRGB-15122006.icc</code>	use sRGB file / calibrate by CC
<code>1-CC-aRGB-15122006.icc</code>	use aRGB file / calibrate by CC
<code>1-CC-Prop-15122006.icc</code>	use pRGB file / calibrate by CC
<code>1-IT-sRGB-15122006.icc</code>	use sRGB file / calibrate by IT
<code>1-IT-aRGB-15122006.icc</code>	use aRGB file / calibrate by IT
<code>1-IT-Prop-15122006.icc</code>	use pRGB file / calibrate by IT

1.2 Introduction

ProfileMaker 5 settings

The camera calibration is based on mode 'Reproduction', but the gray balance was modified: grays are neutralized automatically, and even *almost* gray colors are neutralized. This is useful for a simultaneous gray balance for both targets in one image, using any of the profiles.

Please use zoom 200%.

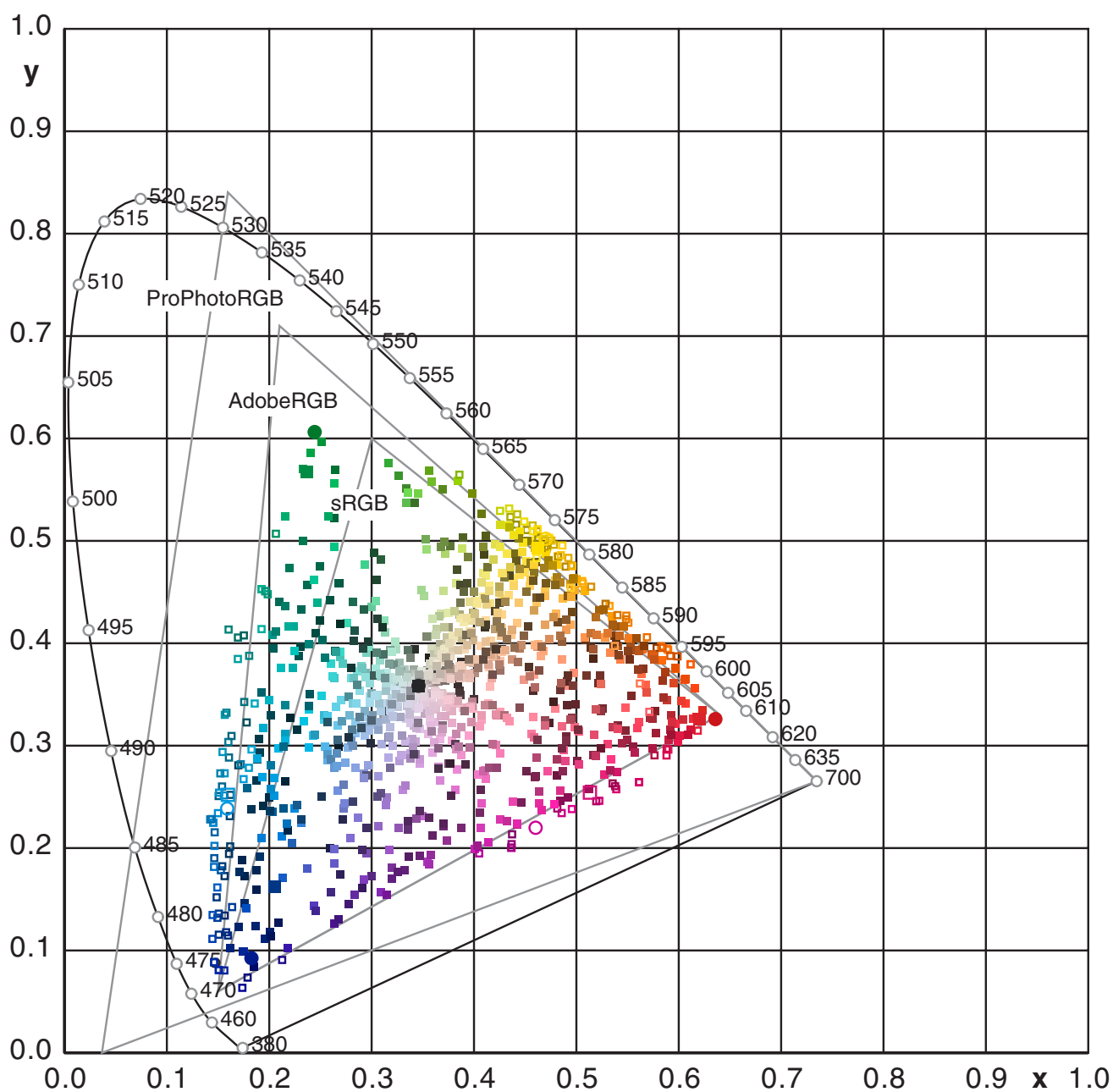


2.1 Real World Surface Colors / Spot Inks

The chromaticity diagram below [8] shows the coordinates for more than 1100 spot inks (spot colors on coated paper), the primary inks for an inkjet, and CMYK and Hexachrome inks.

Colors in-gamut for AdobeRGB are shown by filled squares or circles. Out-of-gamut colors appear stroked. It is safe to say that other real world surface colors do not exceed the gamut range of spot colors.

This page can be loaded by Photoshop in Lab mode for reading RGB and CIELab values.



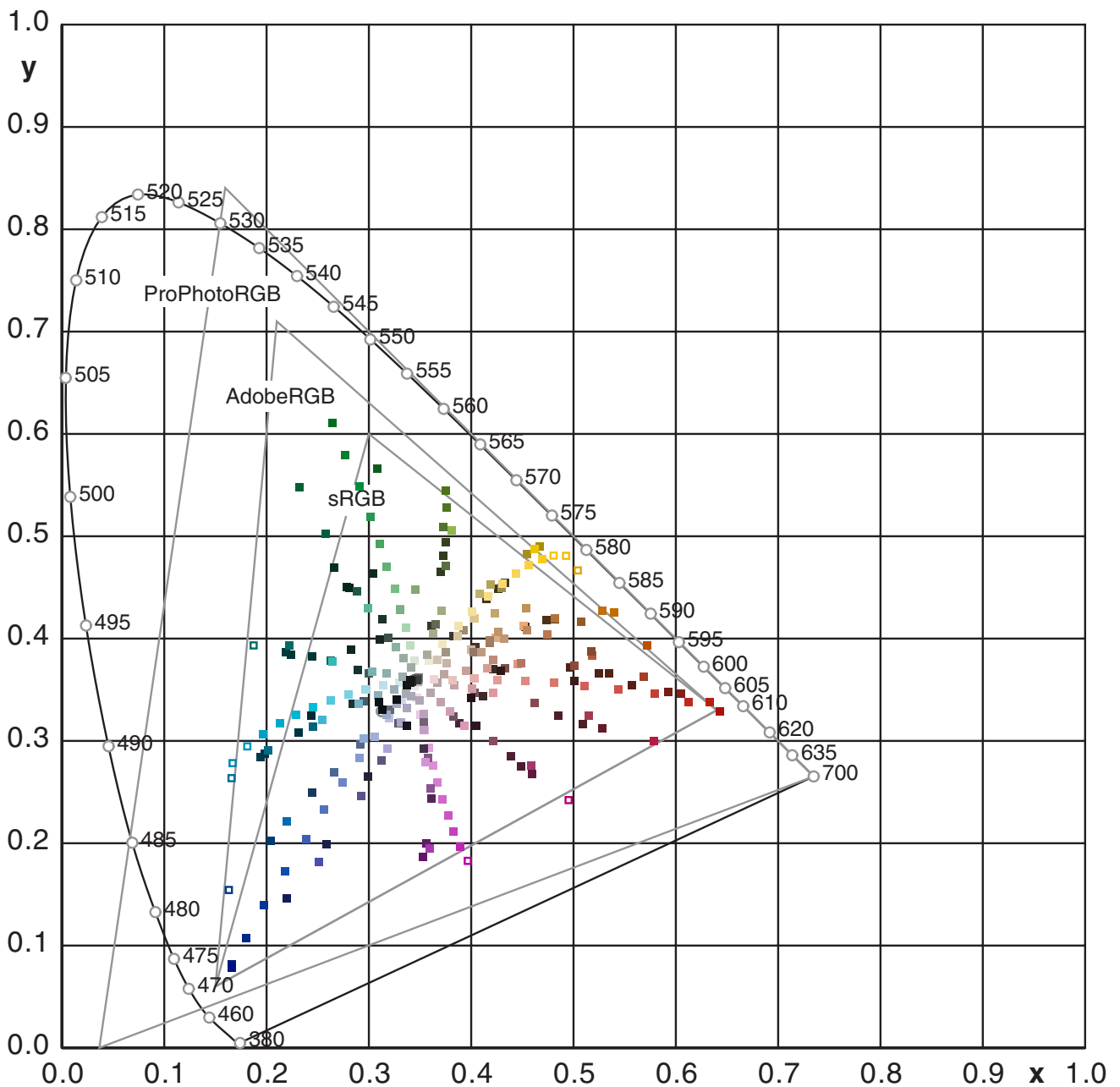
3.1 Targets / IT8.7/2

This chromaticity diagram [8] shows the coordinates for measured values for the IT8 target (images in chapter 5). The target covers practically the range of real world surface colors.

Again out-of-gamut for AdobeRGB is indicated by stroked symbols.

The visualized triangular region is not exactly valid for the gamut boundary calculation because of an inherent chromatic adaptation transform.

This page can be loaded by Photoshop in Lab mode for reading RGB and CIELab values.



3.2 Targets / ColorChecker

D.Pascale, BabelColor [3], has done much work interpreting the somewhat contradictory or inaccurate data for the ColorChecker (images in chapter 5). Some calculations here confirm his results.

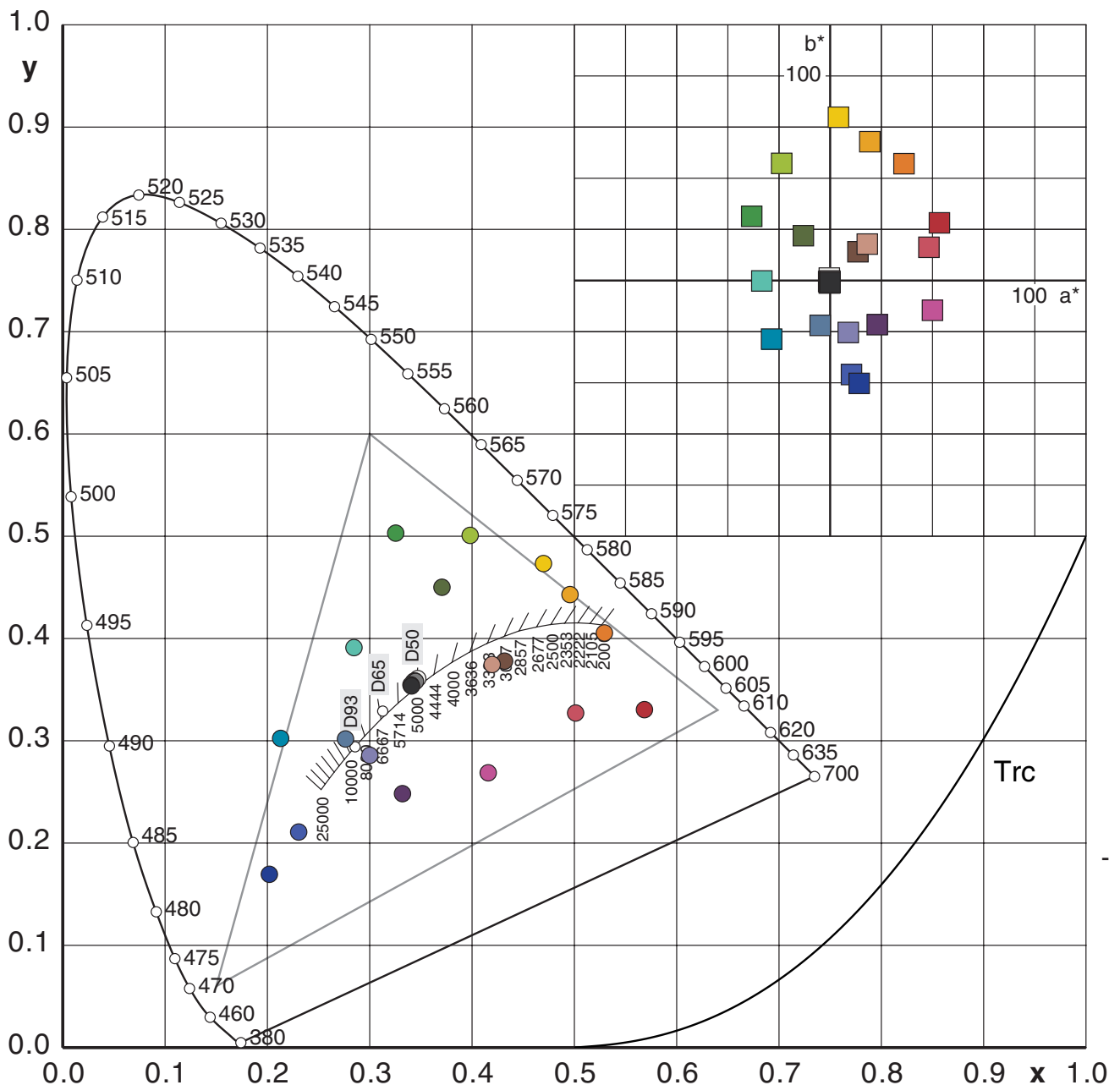
GretagMacbeth is distributing CIELab data (2005) which are not accurately encountered in the final product. BabelColor had published averaged tables. Here we use the GMB Lab reference data as an unambiguous data base.

In ProfileMaker5 the data are available as spectral values. Lab values based on spectral data are slightly different (chapter 8). But for No.15 the spectral value a^* is 56.38 instead of 53.38 - a major deviation.

The diagram below [11] shows that the ColorChecker colors do not cover the whole range of real world colors. In fact the colors are inside sRGB, except for Cyan, No.18. This color is practically on the gamut boundary because we have in linear RGB $R = -9.5$, which can be clipped for $R' = 0$ without a significant error.

On the next pages are all color coordinates for sRGB, AdobeRGB and ProPhotoRGB. The same results as by BabelColor, but often different to GMB-sRGB. GMB-sRGB values are not consistent with the CIELab reference values.

This page can be loaded by Photoshop in sRGB mode for reading RGB and CIELab values.



4.1 ColorChecker / sRGB

ColorCalc G.Hoffmann Dec.16 / 2006		Med.White: Ref.White: Input:	D65 D50 Lab	Primaries: Trc: Bradford:	Rec.709 sRGB Yes	Intent: Set:	RelCol 5	
No Nm	1 dark skin	2 light skin	3 blue sky	4 foliage	5 blu.flower	6 blu.green	7 orange	8 purpl.blue
X	0.115230	0.391797	0.168081	0.109080	0.241921	0.304258	0.407209	0.123270
Y	0.100824	0.349504	0.183601	0.132516	0.230366	0.417815	0.311809	0.112630
Z	0.050902	0.192251	0.257171	0.052917	0.334376	0.346119	0.049931	0.298735
x	0.431643	0.419684	0.276061	0.370373	0.299903	0.284835	0.529566	0.230569
y	0.377682	0.374381	0.301553	0.449952	0.285579	0.391142	0.405500	0.210668
z	0.190675	0.205935	0.422386	0.179675	0.414518	0.324023	0.064934	0.558764
L*	37.9900	65.7100	49.9300	43.1400	55.1100	70.7200	62.6600	40.0200
a*	13.5600	18.1300	-4.8800	-13.1000	8.8400	-33.4000	36.0700	10.4100
b*	14.0600	17.8100	-21.9300	21.9100	-25.4000	-0.1990	57.1000	-45.9600
R	44.1399	144.9246	26.4307	25.9018	56.4969	27.5378	190.5954	14.6882
G	20.9410	74.6330	49.9571	37.9793	55.0369	131.1740	51.1531	26.8165
B	14.4691	55.6793	84.5269	13.2279	110.8194	105.2268	7.1595	102.7441
R'	115.5180	198.5653	90.5946	89.7171	129.5496	92.3987	224.2697	67.8789
G'	80.9224	147.2085	122.3757	107.6530	127.9920	189.9158	123.7269	91.2281
B'	67.3675	128.6803	155.7923	64.3821	176.0788	172.0210	46.6862	170.1792
CCT	2842 K	3052 K	9766 K	none	8134 K	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No Nm	9 mod.red	10 purple	11 ye.green	12 or.yellow	13 blue	14 green	15 red	16 yellow
X	0.296699	0.085179	0.353614	0.487862	0.068620	0.149852	0.216327	0.593411
Y	0.193723	0.063711	0.444526	0.435698	0.057528	0.231827	0.125648	0.598012
Z	0.101519	0.107751	0.089488	0.060609	0.213806	0.078989	0.038468	0.071928
x	0.501230	0.331900	0.398381	0.495709	0.201851	0.325292	0.568619	0.469712
y	0.327268	0.248248	0.500802	0.442706	0.169222	0.503241	0.330267	0.473354
z	0.171503	0.419852	0.100816	0.061584	0.628926	0.171467	0.101113	0.056934
L*	51.1200	30.3300	72.5300	71.9400	28.7800	55.2600	42.1000	81.7300
a*	48.2400	22.9800	-23.7100	19.3600	14.1800	-38.3400	53.3800	4.0400
b*	16.2500	-21.5900	57.2600	67.8600	-50.3000	31.3700	28.1900	79.8200
R	144.5232	28.3175	88.0763	202.6215	4.3640	14.2660	116.2553	218.6175
G	21.4737	10.7907	129.7190	91.6516	12.8069	76.5526	7.7314	144.7176
B	30.5146	36.4582	12.6028	5.2324	74.5225	17.5212	10.4187	1.7479
R'	198.3197	93.6439	158.7279	230.4230	35.3704	66.8895	179.9100	238.2860
G'	81.9215	58.0036	188.9701	161.6160	63.3325	148.9237	48.6618	198.4387
B'	97.0490	105.5982	62.8165	39.2503	147.1090	74.1243	56.9584	19.7128
CCT	none	none	none	2488 K	none	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No Nm	17 magenta	18 cyan	19 white 9.5	20 neutral 8.0	21 neutral 6.5	22 neutral 5.0	23 neutral 3.5	24 black 2.0
X	0.310853	0.136113	0.878243	0.565789	0.348154	0.184433	0.084690	0.029897
Y	0.200911	0.193031	0.913160	0.589425	0.363283	0.191567	0.088326	0.031051
Z	0.235643	0.309422	0.739720	0.489258	0.302933	0.159176	0.075942	0.026829
x	0.415909	0.213154	0.346978	0.344055	0.343222	0.344622	0.340179	0.340605
y	0.268810	0.302289	0.360772	0.358428	0.358136	0.357951	0.354783	0.353750
z	0.315281	0.484557	0.292250	0.297517	0.298642	0.297427	0.305039	0.305645
L*	51.9400	51.0400	96.5400	81.2600	66.7700	50.8700	35.6600	20.4600
a*	49.9900	-28.6300	-0.4250	-0.6380	-0.7340	-0.1530	-0.4210	-0.0790
b*	-14.5700	-28.6400	1.1860	-0.3350	-0.5040	-0.2700	-1.2310	-0.9730
R	136.0895	-9.5448	232.7258	147.8673	90.5139	48.4753	21.7545	7.7308
G	22.5967	62.9896	233.3157	150.9751	93.2028	48.9324	22.6696	7.9396
B	78.4210	102.1153	227.8922	151.3026	93.7397	49.2430	23.6123	8.3502
R'	193.0660	0.0000	244.9470	200.3534	160.7042	120.6750	82.4422	48.6595
G'	83.9812	136.2072	245.2203	202.2193	162.8486	121.2028	84.1128	49.3595
B'	150.5691	169.7086	242.6921	202.4147	163.2724	121.5598	85.7928	50.7052
CCT	none	none	4959 K	5056 K	5084 K	5036 K	5186 K	5168 K
RGB	in-gam	out-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam

4.2 ColorChecker / AdobeRGB(98)

ColorCalc G.Hoffmann Dec.16 / 2006		Med.White: D65 Ref.White: D50 Input: Lab		Primaries: Trc: Bradford:	AdobeRGB 2.2 Yes	Intent: Set:	RelCol 6	
No	1	2	3	4	5	6	7	8
Nm	dark skin	light skin	blue sky	foliage	blu.flower	blu.green	orange	purpl.blue
X	0.115230	0.391797	0.168081	0.109080	0.241921	0.304258	0.407209	0.123270
Y	0.100824	0.349504	0.183601	0.132516	0.230366	0.417815	0.311809	0.112630
Z	0.050902	0.192251	0.257171	0.052917	0.334376	0.346119	0.049931	0.298735
x	0.431643	0.419684	0.276061	0.370373	0.299903	0.284835	0.529566	0.230569
y	0.377682	0.374381	0.301553	0.449952	0.285579	0.391142	0.405500	0.210668
z	0.190675	0.205935	0.422386	0.179675	0.414518	0.324023	0.064934	0.558764
L*	37.9900	65.7100	49.9300	43.1400	55.1100	70.7200	62.6600	40.0200
a*	13.5600	18.1300	-4.8800	-13.1000	8.8400	-33.4000	36.0700	10.4100
b*	14.0600	17.8100	-21.9300	21.9100	-25.4000	-0.1990	57.1000	-45.9600
R	37.5311	124.9004	33.1328	29.3424	56.0810	57.0612	150.8719	18.1433
G	20.9410	74.6330	49.9571	37.9793	55.0369	131.1740	51.1531	26.8165
B	14.7355	56.4595	83.1039	14.2467	108.5233	106.2949	8.9704	99.6188
R'	106.7310	184.3494	100.8521	95.4337	128.1075	129.1204	200.8791	76.7011
G'	81.8675	145.8782	121.5481	107.3085	127.0179	188.5022	122.8622	91.6077
B'	69.7803	128.4998	153.1840	68.7185	172.9402	171.3169	55.6870	166.3394
CCT	2842 K	3052 K	9766 K	none	8134 K	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No	9	10	11	12	13	14	15	16
Nm	mod.red	purple	ye.green	or.yellow	blue	green	red	yellow
X	0.296699	0.085179	0.353614	0.487862	0.068620	0.149852	0.216327	0.593411
Y	0.193723	0.063711	0.444526	0.435698	0.057528	0.231827	0.125648	0.598012
Z	0.101519	0.107751	0.089488	0.060609	0.213806	0.078989	0.038468	0.071928
x	0.501230	0.331900	0.398381	0.495709	0.201851	0.325292	0.568619	0.469712
y	0.327268	0.248248	0.500802	0.442706	0.169222	0.503241	0.330267	0.473354
z	0.171503	0.419852	0.100816	0.061584	0.628926	0.171467	0.101113	0.056934
L*	51.1200	30.3300	72.5300	71.9400	28.7800	55.2600	42.1000	81.7300
a*	48.2400	22.9800	-23.7100	19.3600	14.1800	-38.3400	53.3800	4.0400
b*	16.2500	-21.5900	57.2600	67.8600	-50.3000	31.3700	28.1900	79.8200
R	109.4696	23.3245	99.9392	171.0091	6.7692	32.0099	85.3396	197.5653
G	21.4737	10.7907	129.7190	91.6516	12.8069	76.5527	7.7314	144.7176
B	30.1424	35.4017	17.4236	8.7896	71.9822	19.9510	10.3081	7.6328
R'	173.6240	85.9788	166.5824	212.6508	48.9976	99.2838	155.0437	227.0718
G'	82.8077	60.5657	187.5489	160.1549	65.4700	147.5720	52.0491	197.1122
B'	96.6078	103.9346	75.3028	55.1740	143.4999	80.0850	59.3190	51.7462
CCT	none	none	none	2488 K	none	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No	17	18	19	20	21	22	23	24
Nm	magenta	cyan	white 9.5	neutral 8.0	neutral 6.5	neutral 5.0	neutral 3.5	black 2.0
X	0.310853	0.136113	0.878243	0.565789	0.348154	0.184433	0.084690	0.029897
Y	0.200911	0.193031	0.913160	0.589425	0.363283	0.191567	0.088326	0.031051
Z	0.235643	0.309422	0.739720	0.489258	0.302933	0.159176	0.075942	0.026829
x	0.415909	0.213154	0.346978	0.344055	0.343222	0.344622	0.340179	0.340605
y	0.268810	0.302289	0.360772	0.358428	0.358136	0.357951	0.354783	0.353750
z	0.315281	0.484557	0.292250	0.297517	0.298642	0.297427	0.305039	0.305645
L*	51.9400	51.0400	96.5400	81.2600	66.7700	50.8700	35.6600	20.4600
a*	49.9900	-28.6300	-0.4250	-0.6380	-0.7340	-0.1530	-0.4210	-0.0790
b*	-14.5700	-28.6400	1.1860	-0.3350	-0.5040	-0.2700	-1.2310	-0.9730
R	103.7584	11.1184	232.8939	148.7527	91.2799	48.6055	22.0152	7.7903
G	22.5967	62.9897	233.3158	150.9751	93.2029	48.9324	22.6696	7.9396
B	76.1232	100.5048	228.1154	151.2891	93.7176	49.2302	23.5735	8.3333
R'	169.4465	61.3949	244.7030	199.5916	159.8593	120.0421	83.7504	52.2287
G'	84.7488	135.0541	244.9044	200.9416	161.3814	120.4084	84.8730	52.6814
B'	147.1950	167.0103	242.4079	201.1314	161.7859	120.7409	86.3947	53.8531
CCT	none	none	4959 K	5056 K	5084 K	5036 K	5186 K	5168 K
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam

4.3 ColorChecker / ProPhotoRGB

ColorCalc G.Hoffmann Dec.16 / 2006		Med.White: Ref.White: Input:	D50 D50 Lab	Primaries: Trc: Bradford:	ProPhoto 1.8 No	Intent: Set:	AbsCol 12	
No Nm	1 dark skin	2 light skin	3 blue sky	4 foliage	5 blu.flower	6 blu.green	7 orange	8 purpl.blue
X	0.115230	0.391797	0.168081	0.109080	0.241921	0.304258	0.407209	0.123270
Y	0.100824	0.349504	0.183601	0.132516	0.230366	0.417815	0.311809	0.112630
Z	0.050902	0.192251	0.257171	0.052917	0.334376	0.346119	0.049931	0.298735
x	0.431643	0.419684	0.276061	0.370373	0.299903	0.284835	0.529566	0.230569
y	0.377682	0.374381	0.301553	0.449952	0.285579	0.391142	0.405500	0.210668
z	0.190675	0.205935	0.422386	0.179675	0.414518	0.324023	0.064934	0.558764
L*	37.9900	65.7100	49.9300	43.1400	55.1100	70.7200	62.6600	40.0200
a*	13.5600	18.1300	-4.8800	-13.1000	8.8400	-33.4000	36.0700	10.4100
b*	14.0600	17.8100	-21.9300	21.9100	-25.4000	-0.1990	57.1000	-45.9600
R	32.3099	109.1726	42.3645	28.1077	63.6508	72.6742	118.7729	31.0702
G	23.0407	81.0135	48.6165	36.0942	56.7515	120.2491	63.6304	27.7617
B	15.7313	59.4154	79.4790	16.3540	103.3394	106.9687	15.4313	92.3245
R'	80.9270	159.1691	94.0726	74.8990	117.9470	126.9620	166.7993	79.1869
G'	67.0680	134.8599	101.5490	86.0631	110.6637	167.9479	117.9259	74.3855
B'	54.2553	113.5202	133.4348	55.4382	154.3867	157.3759	53.6781	145.0161
CCT	2842 K	3052 K	9766 K	none	8134 K	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No Nm	9 mod.red	10 purple	11 ye.green	12 or.yellow	13 blue	14 green	15 red	16 yellow
X	0.296699	0.085179	0.353614	0.487862	0.068620	0.149852	0.216327	0.593411
Y	0.193723	0.063711	0.444526	0.435698	0.057528	0.231827	0.125648	0.598012
Z	0.101519	0.107751	0.089488	0.060609	0.213806	0.078989	0.038468	0.071928
x	0.501230	0.331900	0.398381	0.495709	0.201851	0.325292	0.568619	0.469712
y	0.327268	0.248248	0.500802	0.442706	0.169222	0.503241	0.330267	0.473354
z	0.171503	0.419852	0.100816	0.061584	0.628926	0.171467	0.101113	0.056934
L*	51.1200	30.3300	72.5300	71.9400	28.7800	55.2600	42.1000	81.7300
a*	48.2400	22.9800	-23.7100	19.3600	14.1800	-38.3400	53.3800	4.0400
b*	16.2500	-21.5900	57.2600	67.8600	-50.3000	31.3700	28.1900	79.8200
R	87.8721	23.6753	91.2156	138.2379	17.0135	35.2877	65.5486	163.7344
G	33.8321	13.2376	122.3246	100.1335	13.7144	68.7634	18.4821	147.9605
B	31.3748	33.3008	27.6563	18.7314	66.0771	24.4118	11.8886	22.2294
R'	141.0881	68.0880	144.0459	181.4725	56.6692	84.9893	119.8879	199.3660
G'	83.0234	49.2947	169.5521	151.7073	50.2735	123.1197	59.3368	188.4560
B'	79.6172	82.2965	74.2284	59.7802	120.4240	69.2568	46.4373	65.7455
CCT	none	none	none	2488 K	none	none	none	none
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam
No Nm	17 magenta	18 cyan	19 white 9.5	20 neutral 8.0	21 neutral 6.5	22 neutral 5.0	23 neutral 3.5	24 black 2.0
X	0.310853	0.136113	0.878243	0.565789	0.348154	0.184433	0.084690	0.029897
Y	0.200911	0.193031	0.913160	0.589425	0.363283	0.191567	0.088326	0.031051
Z	0.235643	0.309422	0.739720	0.489258	0.302933	0.159176	0.075942	0.026829
x	0.415909	0.213154	0.346978	0.344055	0.343222	0.344622	0.340179	0.340605
y	0.268810	0.302289	0.360772	0.358428	0.358136	0.357951	0.354783	0.353750
z	0.315281	0.484557	0.292250	0.297517	0.298642	0.297427	0.305039	0.305645
L*	51.9400	51.0400	96.5400	81.2600	66.7700	50.8700	35.6600	20.4600
a*	49.9900	-28.6300	-0.4250	-0.6380	-0.7340	-0.1530	-0.4210	-0.0790
b*	-14.5700	-28.6400	1.1860	-0.3350	-0.5040	-0.2700	-1.2310	-0.9730
R	90.5132	30.0985	232.2411	149.3762	91.8551	48.7341	22.3178	7.8868
G	35.3326	56.9566	233.1050	150.6786	92.9535	48.8962	22.6062	7.9306
B	72.8259	95.6275	228.6118	151.2060	93.6221	49.1935	23.4700	8.2914
R'	143.4285	77.8013	242.0940	189.4556	144.6060	101.6853	65.8907	36.9701
G'	85.0493	110.8858	242.5939	190.3716	145.5641	101.8731	66.3623	37.0841
B'	127.1091	147.8758	239.9848	190.7415	146.1449	102.2167	67.7594	38.0121
CCT	none	none	4959 K	5056 K	5084 K	5036 K	5186 K	5168 K
RGB	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam	in-gam

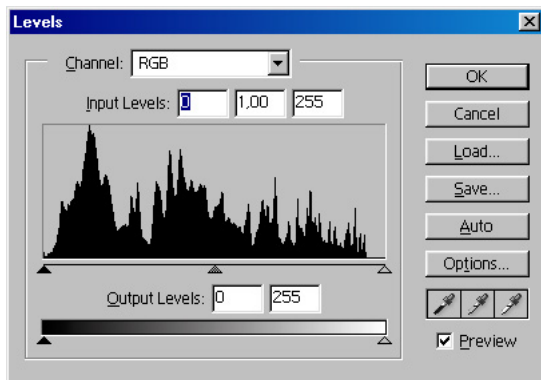
5.1 Calibration / General

This is the original RAW image, saved as sRGB TIFF. The white balance of the camera for 'flash' is not exactly correct for the Just Normlicht fluorescent tubes.

The histogram below shows that the image is a little underexposed. This happened on purpose in order to avoid clipping.

Please use zoom 200%.

Below is the ColorChecker in sRGB mode. This template and the CIE Lab version are available on request (PostScript EPS).



Target-sRGB-sRGB

<p>1 dark skin Lab sRGB 37.99 115.52 13.56 80.92 14.06 67.37</p>	<p>2 light skin Lab sRGB 65.71 198.57 18.13 147.21 17.81 128.68</p>	<p>3 blue sky Lab sRGB 49.93 90.59 -4.88 122.38 -21.93 155.79</p>	<p>4 foliage Lab sRGB 43.14 89.72 -13.10 107.65 21.91 64.38</p>	<p>5 blue flower Lab sRGB 55.11 129.55 8.84 127.99 -25.40 176.08</p>	<p>6 bluish green Lab sRGB 70.72 92.40 -33.40 189.92 -0.20 172.02</p>
<p>7 orange Lab sRGB 62.66 224.27 36.07 123.73 57.10 46.69</p>	<p>8 purplish blue Lab sRGB 40.02 67.88 10.41 91.23 -45.96 170.18</p>	<p>9 moderate red Lab sRGB 51.12 198.32 48.24 81.92 16.25 97.05</p>	<p>10 purple Lab sRGB 30.33 93.64 22.98 58.00 -21.59 105.60</p>	<p>11 yellow green Lab sRGB 72.53 158.73 -23.71 188.97 57.26 62.82</p>	<p>12 orange yellow Lab sRGB 71.94 230.42 19.36 161.62 67.86 39.25</p>
<p>13 blue Lab sRGB 28.78 35.37 14.18 63.33 -50.30 147.11</p>	<p>14 green Lab sRGB 55.26 66.89 -38.34 148.92 31.37 74.12</p>	<p>15 red Lab sRGB 42.10 179.91 53.38 48.66 28.19 56.96</p>	<p>16 yellow Lab sRGB 81.73 238.29 4.04 198.44 79.82 19.71</p>	<p>17 magenta Lab sRGB 51.94 193.07 49.99 83.98 -14.57 150.57</p>	<p>18 cyan Lab sRGB 51.04 0.00 -28.63 136.21 -28.64 169.71</p>
<p>19 white 9.5 Lab sRGB 96.54 244.95 -0.43 245.22 1.19 242.69</p>	<p>20 neutral 8.0 Lab sRGB 81.26 200.35 -0.64 202.22 -0.34 202.41</p>	<p>21 neutral 6.5 Lab sRGB 66.77 160.70 -0.73 162.85 -0.50 163.27</p>	<p>22 neutral 5.0 Lab sRGB 50.87 120.68 -0.15 121.20 -0.27 121.56</p>	<p>23 neutral 3.5 Lab sRGB 35.66 82.44 -0.42 84.11 -1.23 85.79</p>	<p>24 black 2.0 Lab sRGB 20.46 48.66 -0.08 49.36 -0.97 50.71</p>

GMB ColorChecker (TM) / Template sRGB by G.Hoffmann / December 30 2006 / No.18 clipped

5.2 Calibration / ColorChecker

The three TIFF files for sRGB, AdobeRGB and Pro-PhotoRGB were used for calibration, based on the ColorChecker target (upper part of the image).

Each image was loaded by Photoshop 7. The respective ICC profile was assigned. Then the image was converted into sRGB with 8 bits per channel. This is necessary for a unique presentation in the PDF document.

The small squares in the CC images are rendered by sRGB values according to chapter 4.1.

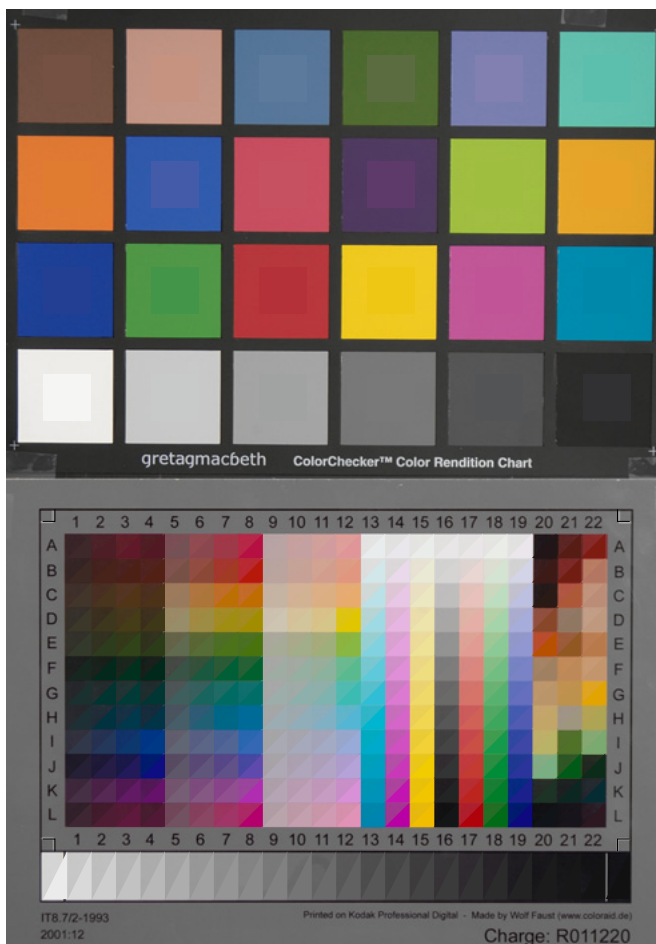
The triangles bottom right in the IT images are rendered by sRGB values according to target numbers. A couple of colors are out of gamut for sRGB. This does not affect the comparison.

Please use zoom 200%.

This page can be loaded by Photoshop in sRGB mode for reading RGB and CIELab values.



Target-sRGB-CC-sRGB



Target-aRGB-CC-sRGB



Target-Prop-CC-sRGB

5.3 Calibration / Target IT8

The three TIFF files for sRGB, AdobeRGB and Pro-PhotoRGB were used for calibration, based on the IT8 target (lower part of the image).

Each image was loaded by Photoshop 7. The respective ICC profile was assigned. Then the image was converted into sRGB with 8 bits per channel. This is necessary for a unique presentation in the PDF document.

The small squares in the CC images are rendered by sRGB values according to chapter 4.1.

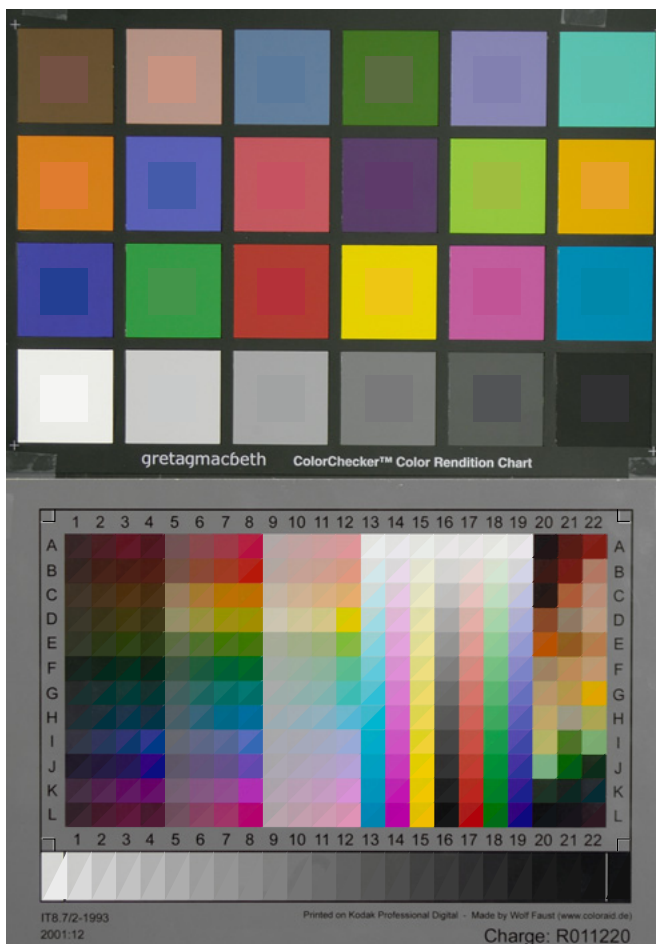
The triangles bottom right in the IT images are rendered by sRGB values according to target numbers. A couple of colors are out of gamut for sRGB. This does not affect the comparison.

Please use zoom 200%.

This page can be loaded by Photoshop in sRGB mode for reading RGB and CIELab values.



Target-sRGB-IT-sRGB



Target-aRGB-IT-sRGB



Target-Prop-IT-sRGB

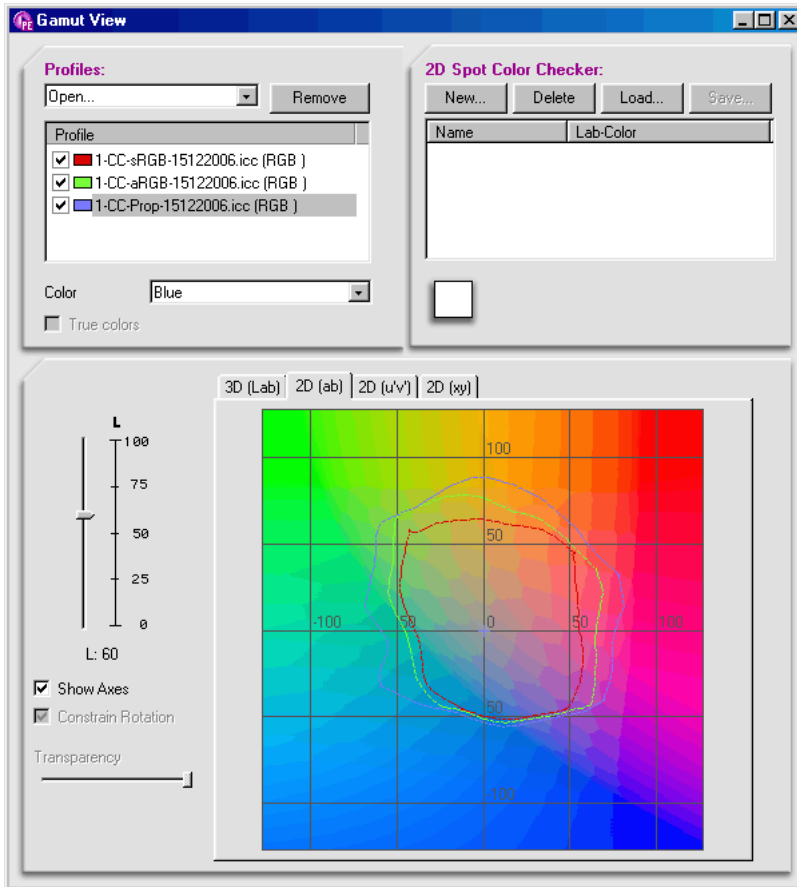
6.1 Real World Painting Reproduction

This is a painting by *Monika Hoffmann*. The small images are inkjet prints. Photos by Nikon D100, using a studio flash. Best view by zoom 200%. Workflow:

1. Take photo (1) of painting without ColorChecker.
2. Take photo (2) of painting with ColorChecker in the middle.
3. Save RAW images as TIFFs, using AdobeRGB(98).
4. Create ICC profile by ProfileMaker 5, using the target in photo (2).
5. Open photo (1) in Photoshop 7. Assign ICC profile. Convert into sRGB. Rectify and crop.
6. Additionally apply Photoshop's AutoContrast.
7. Print photos without and with AutoContrast by calibrated inkjet.
8. Assemble inkjet prints on painting.
9. Take new photo (3) of assembly as below. Proceed as in 5 (no AutoContrast).
10. Apply JPEG compression by Distiller.



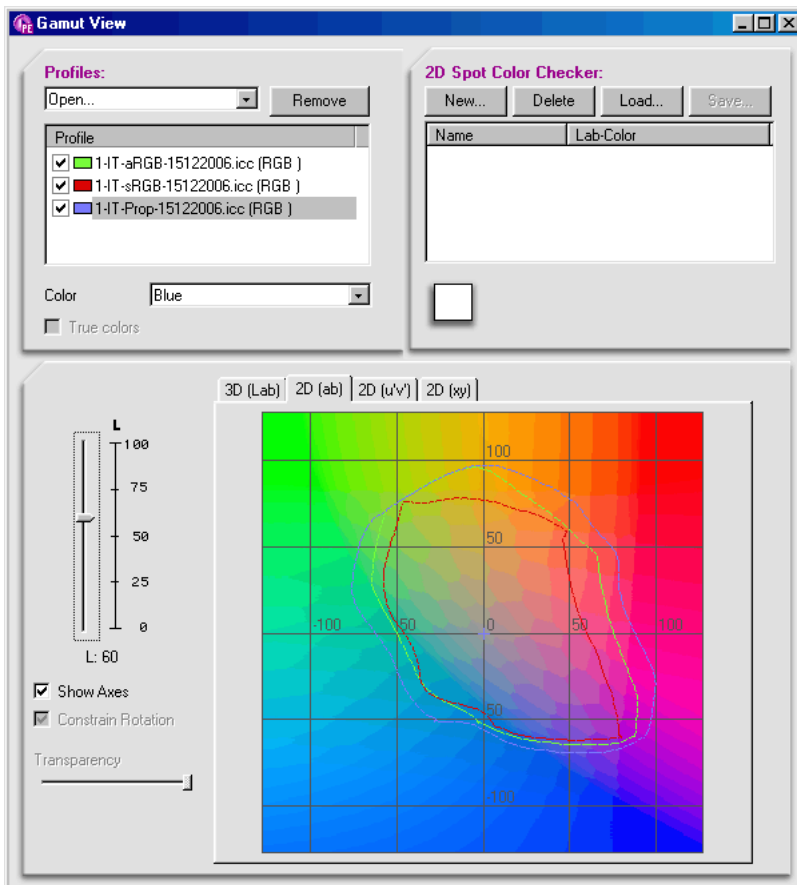
7.1 Conclusions



The three TIFF files for sRGB, AdobeRGB and ProPhotoRGB were used for calibration, based on the CC target.

It turns out that the size of the available gamut depends on the color space of the file. This is rather surprising because the target data should be inside the sRGB gamut.

Please use zoom 200%.



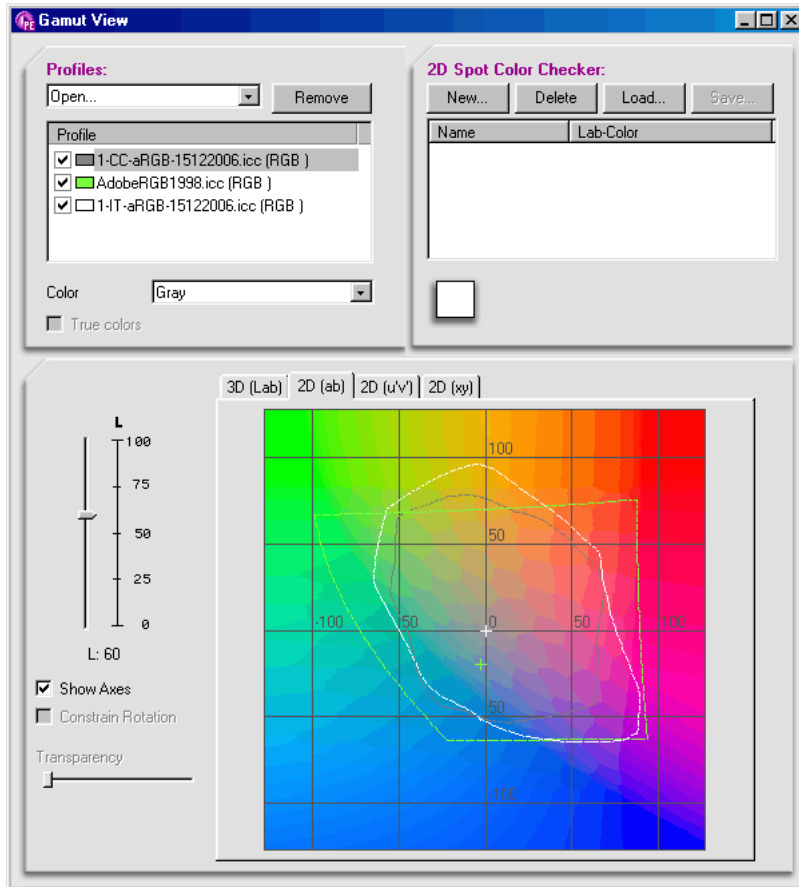
The three TIFF files for sRGB, AdobeRGB and ProPhotoRGB were used for calibration, based on the IT target.

Again it turns out that the size of the available gamut depends on the color space of the file.

Additionally, the gamut volume grows because the IT gamut is larger than that of ColorChecker.

Please use zoom 200%.

7.2 Conclusions



This is a comparison for AdobeRGB: Calibration by CC and IT, and the AdobeRGB gamut itself.

The graphic seems to say that AdobeRGB is too small - a good argument for moving to ProPhotoRGB [7].

The author's opinion: AdobeRGB is really large enough for practical purposes - as shown in chapter 5.

ProPhotoRGB requires saving of files and image processing by 16 bits per channel.

Please use zoom 200%.

So far, the investigation shows that camera calibration by two different targets can lead to visually pleasing results. In this sense the accuracy of the target reference values is not the most important issue. Everything is anyway averaged. Really relevant is the gray balance. ProfileMaker's forced gray balance seems to be of high value.

The CIELab deviations ΔE can be fairly large. Mainly for saturated colors the visual deviation is much less important, especially if a direct comparison is not possible.

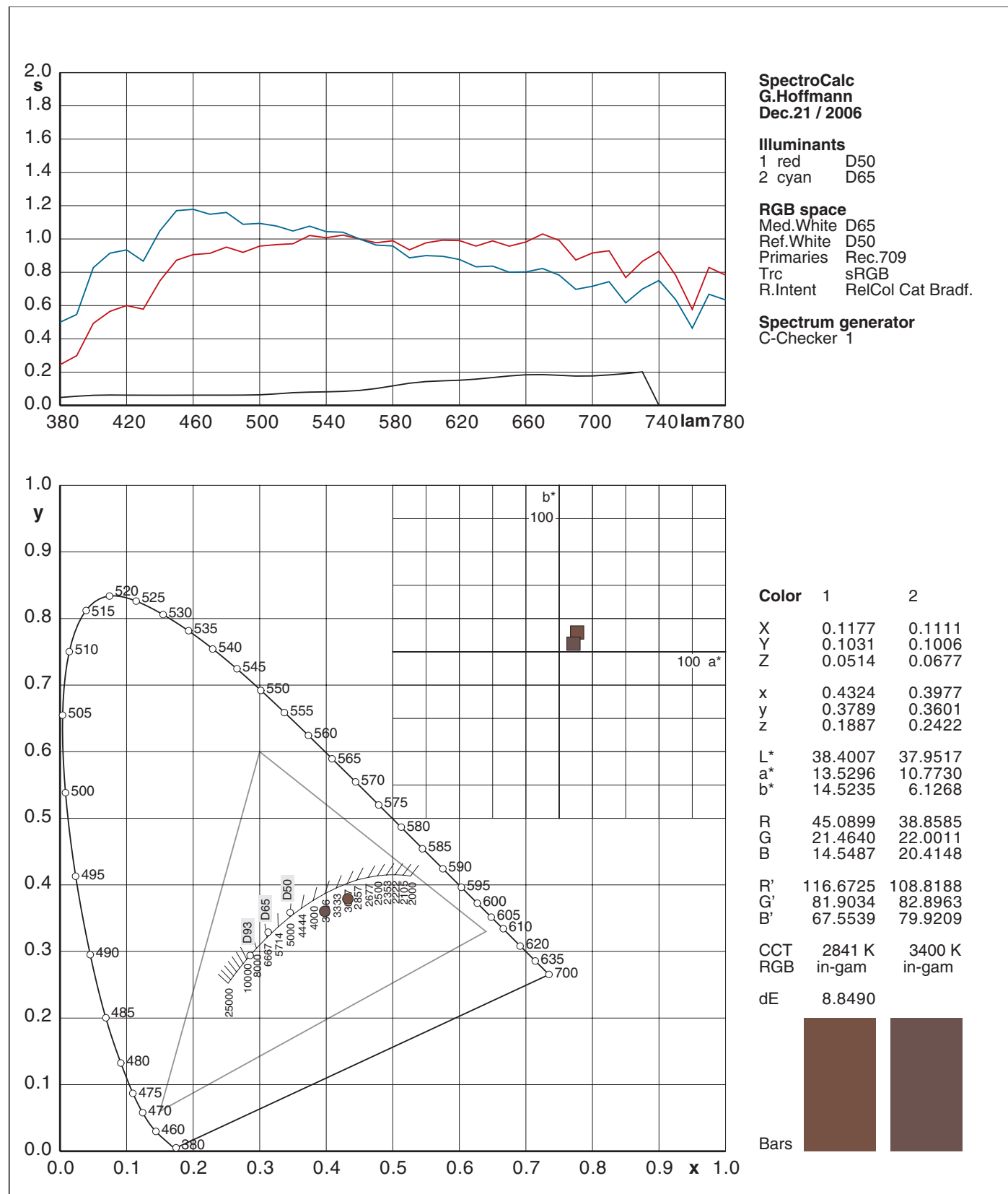
The target colors appear more accurate in target images which were used for the calibration: Calibrated by CC, the colors in the CC target are matching well, whereas the colors in the IT target differ visibly. And vice versa, as expected.

Checking the numbers is left to the reader. This PDF should be loaded in Photoshop in mode sRGB, resolution at least 144 dpi. Use 5x5 point sampling for measuring colors. The raster images in chapter 5 had to be compressed by JPEG for a reasonable file size. ZIP/LZW cannot be used efficiently because the color areas are not uniform. JPEG can cause small color shifts (hardly visible). Screenshots were converted into Indexed Color (posterized as above).

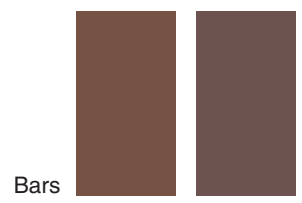
Vector graphics in chapter 2.1 and 2.2 are coded by CIELab numbers.

8.1 ColorChecker Spectral Data

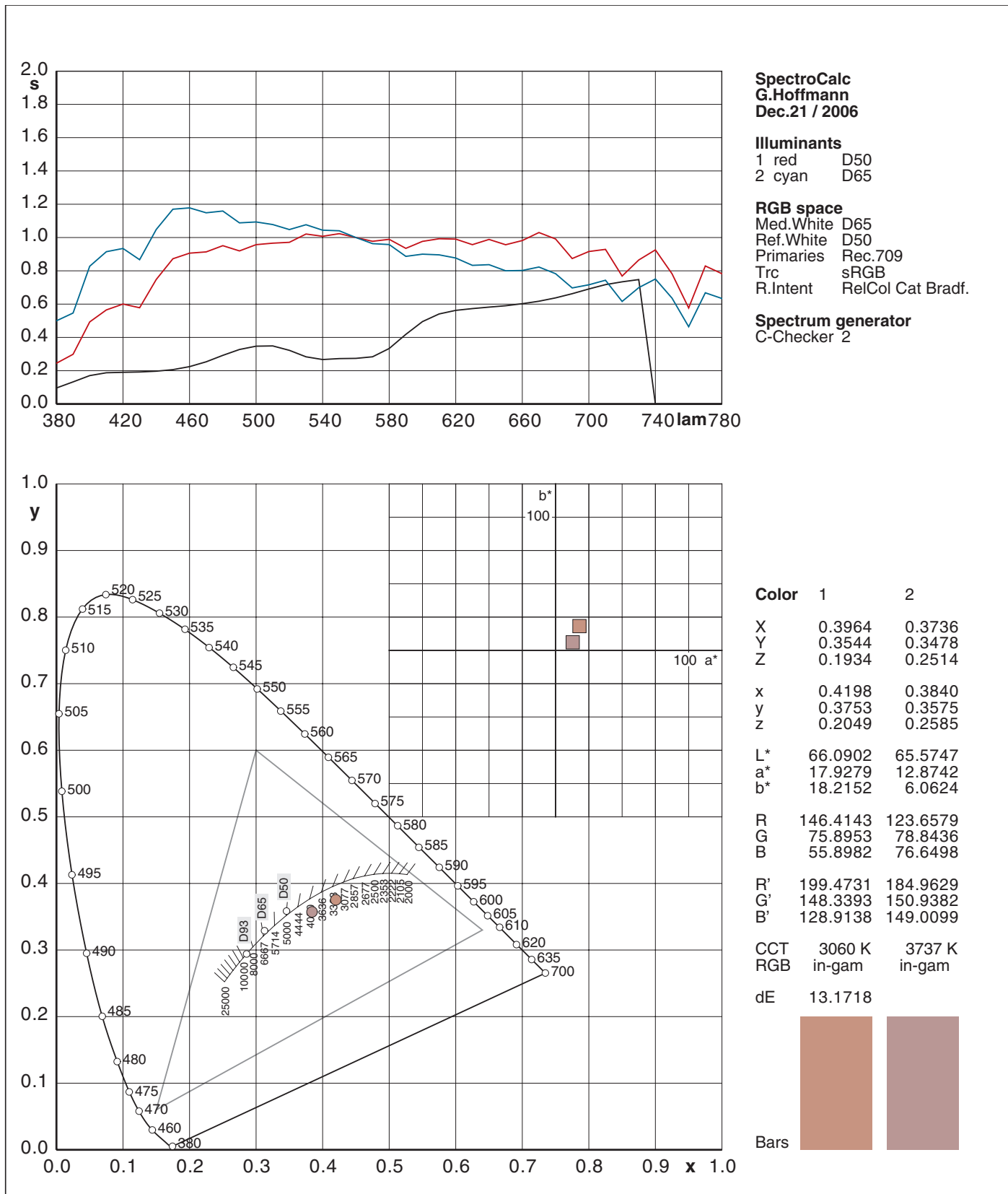
Spectral data were taken from the ProfileMaker5 spectral reference file 2/5/2004. The stepsize 10nm was linearly interpolated for 5nm. The integration was done by Euler (rectangle). Illuminants are D50 and D65. Working space is sRGB with white point D65. Reference white point for CIE Lab is D50. Chromatic adaptation transform by linearized Bradford.



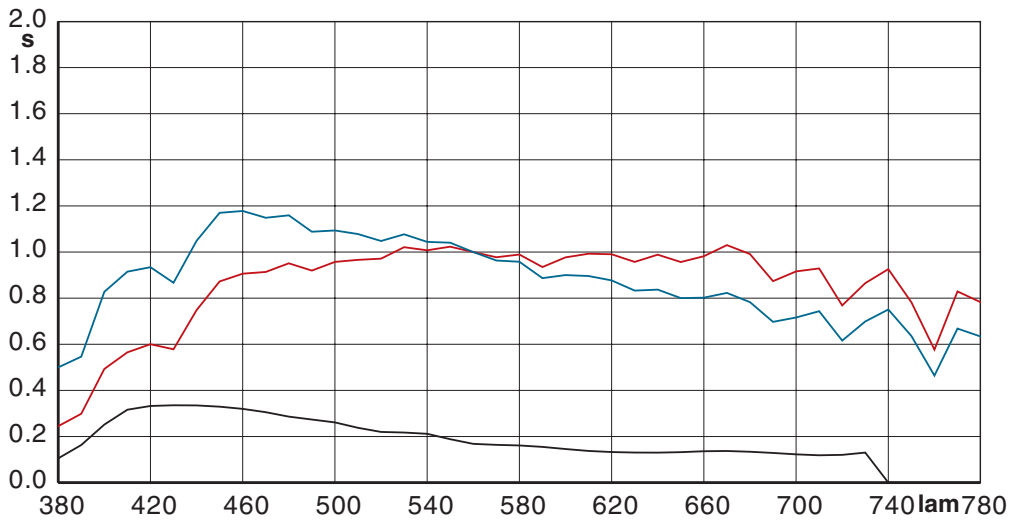
Color	1	2
X	0.1177	0.1111
Y	0.1031	0.1006
Z	0.0514	0.0677
x	0.4324	0.3977
y	0.3789	0.3601
z	0.1887	0.2422
L*	38.4007	37.9517
a*	13.5296	10.7730
b*	14.5235	6.1268
R	45.0899	38.8585
G	21.4640	22.0011
B	14.5487	20.4148
R'	116.6725	108.8188
G'	81.9034	82.8963
B'	67.5539	79.9209
CCT	2841 K	3400 K
RGB	in-gam	in-gam
dE	8.8490	



8.2 ColorChecker Spectral Data



8.3 ColorChecker Spectral Data

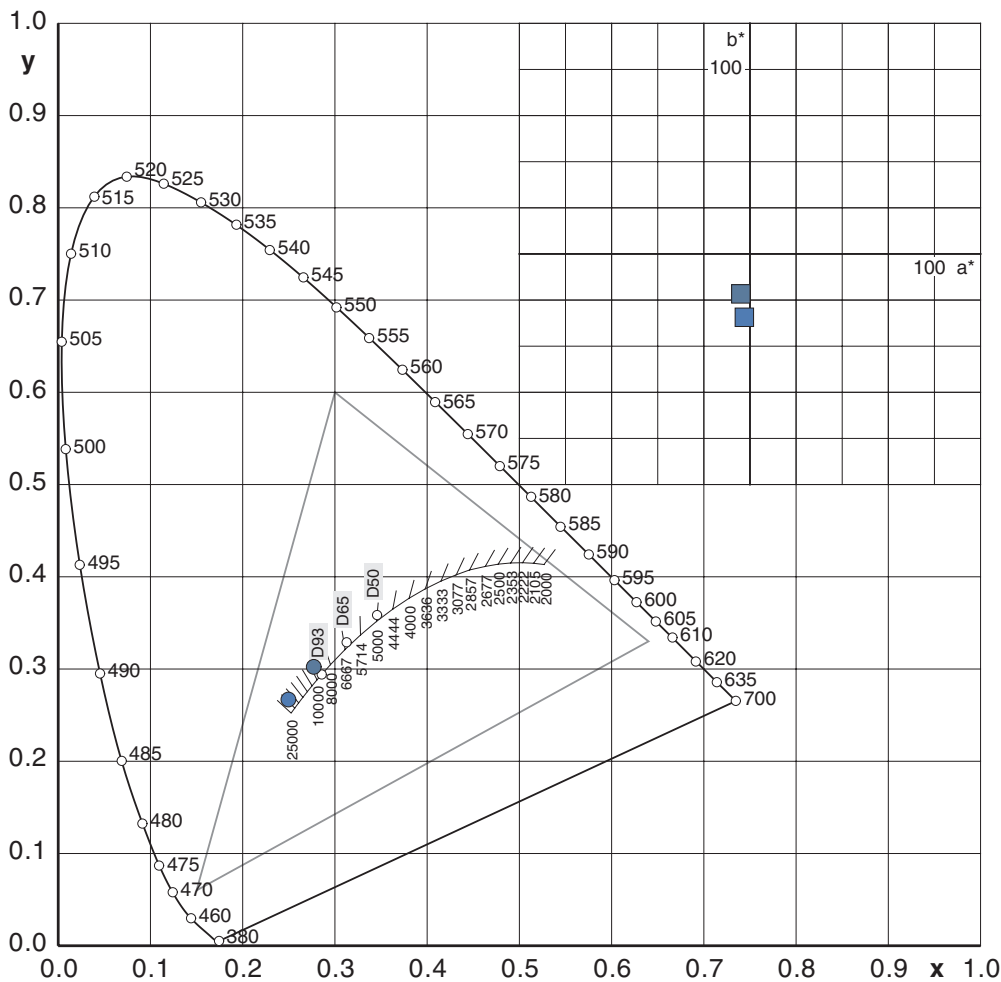


SpectroCalc
G.Hoffmann
Dec.21 / 2006

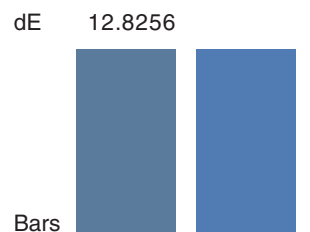
Illuminants
 1 red D50
 2 cyan D65

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

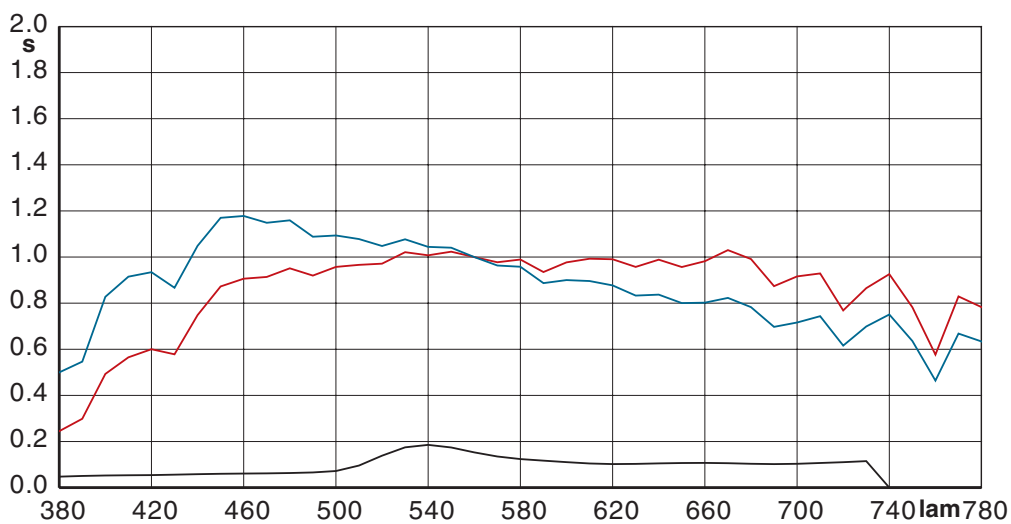
Spectrum generator
 C-Checker 3



Color	1	2
X	0.1699	0.1769
Y	0.1857	0.1894
Z	0.2581	0.3425
x	0.2769	0.2496
y	0.3026	0.2672
z	0.4205	0.4832
L*	50.1812	50.6147
a*	-4.9435	-3.0456
b*	-21.6558	-34.3328
R	26.9248	20.4005
G	50.5333	51.3150
B	84.7622	114.9135
R'	91.4050	79.8936
G'	123.0289	123.9083
B'	155.9891	178.9741
CCT	9633 K	19078 K
RGB	in-gam	in-gam



8.4 ColorChecker Spectral Data

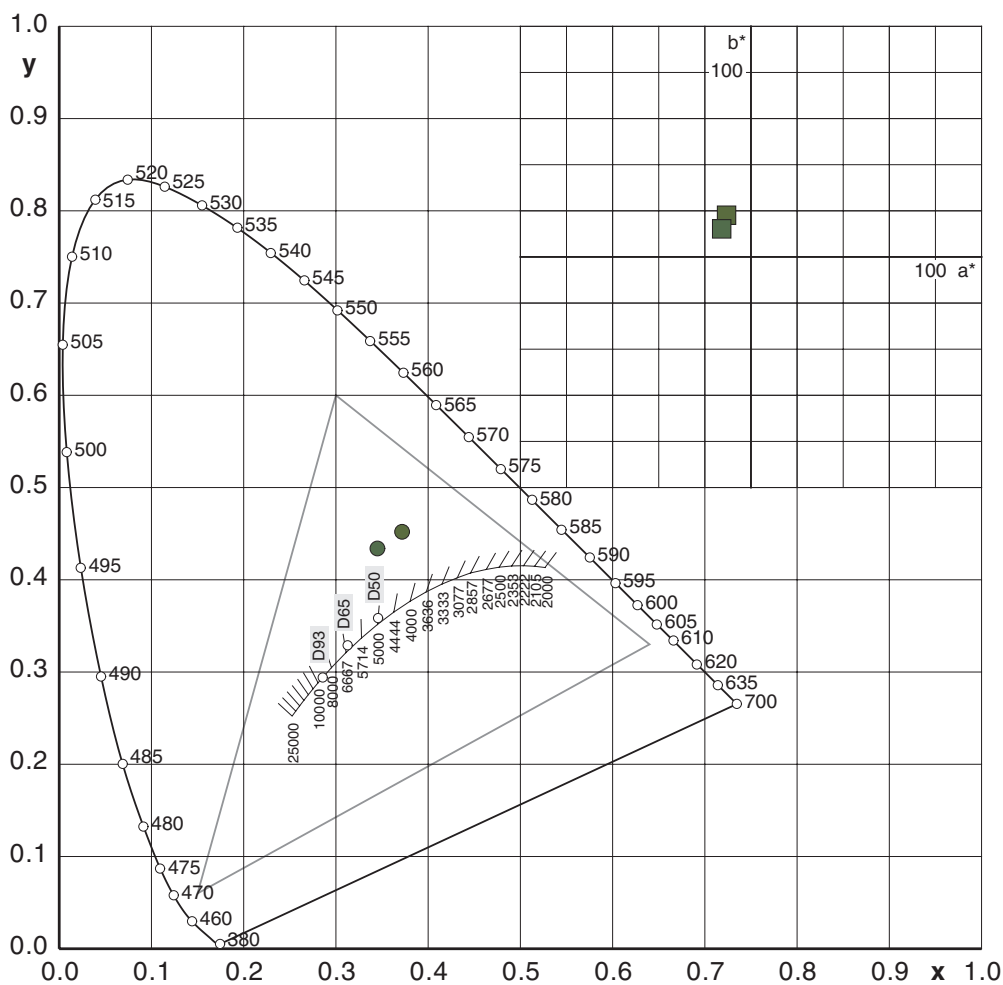


SpectroCalc
G.Hoffmann
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Illuminants
1 red D50
2 cyan D65

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

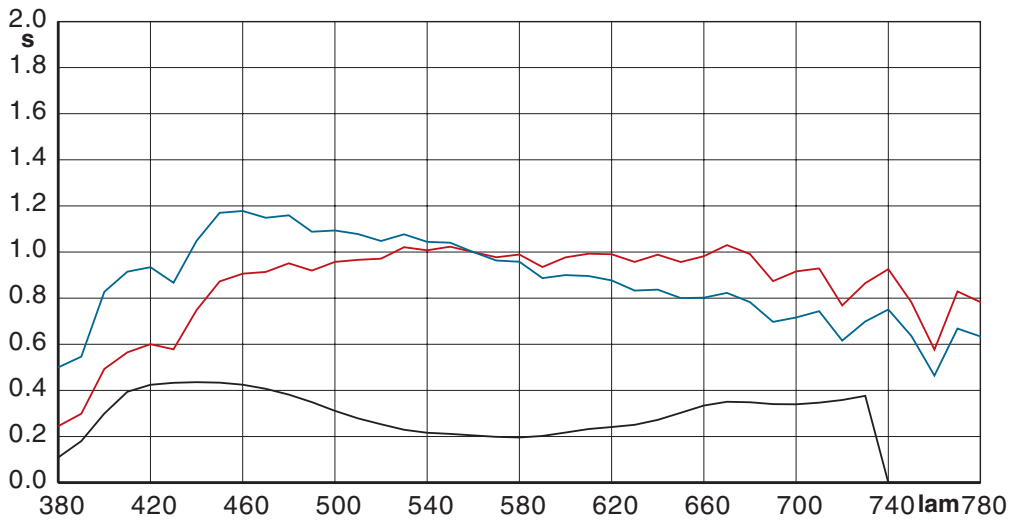
Spectrum generator
C-Checker 4



Color	1	2
X	0.1095	0.1059
Y	0.1333	0.1331
Z	0.0519	0.0677
x	0.3717	0.3452
y	0.4522	0.4340
z	0.1761	0.2207
L*	43.2498	43.2304
a*	-13.2372	-15.8744
b*	22.6118	15.2109
R	26.0871	21.2463
G	38.2183	39.2003
B	12.8311	18.4342
R'	90.0256	81.4968
G'	107.9714	109.2679
B'	63.3935	76.0099
CCT	none	none
RGB	in-gam	in-gam
dE	7.8567	



8.5 ColorChecker Spectral Data

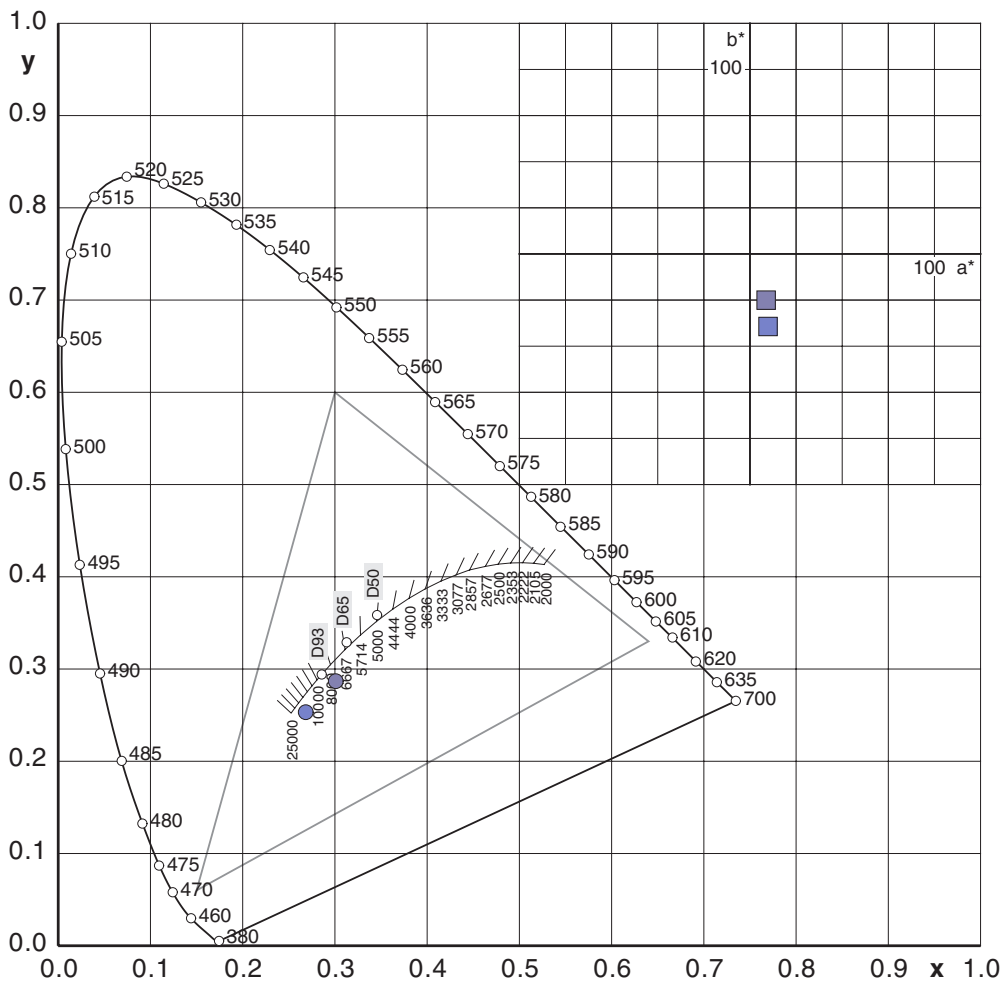


SpectroCalc
G.Hoffmann
Dec.21 / 2006

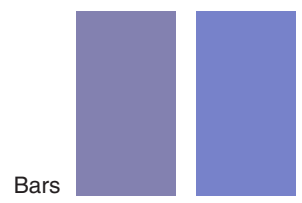
Illuminants
 1 red D50
 2 cyan D65

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

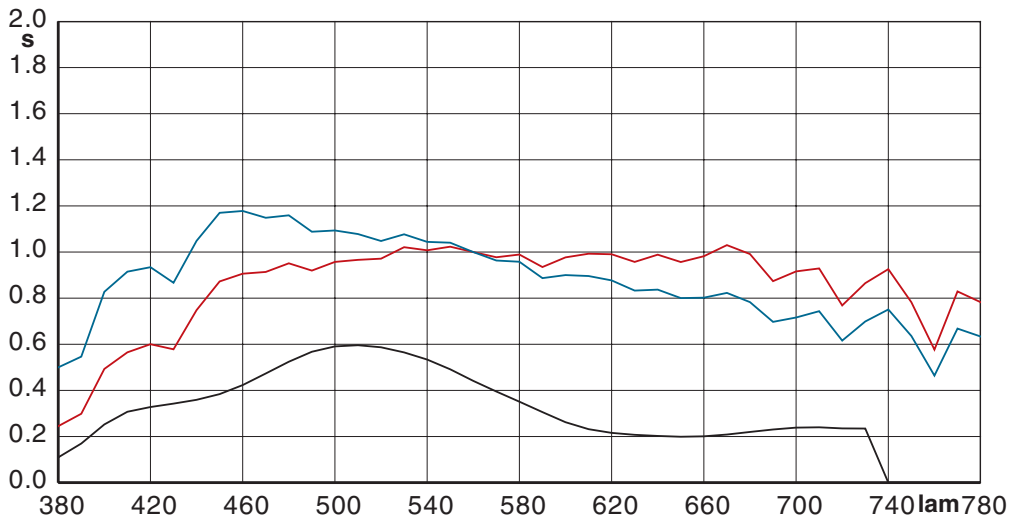
Spectrum generator
 C-Checker 5



Color	1	2
X	0.2455	0.2502
Y	0.2341	0.2363
Z	0.3364	0.4465
x	0.3009	0.2682
y	0.2869	0.2533
z	0.4123	0.4785
L*	55.4931	55.7180
a*	8.7519	9.7729
b*	-25.0439	-39.3260
R	57.5838	46.6224
G	55.9812	56.8408
B	111.4080	150.7992
R'	130.6941	118.5054
G'	129.0021	129.9132
B'	176.4989	202.1143
CCT	8010 K	17147 K
RGB	in-gam	in-gam
dE	14.3203	



8.6 ColorChecker Spectral Data

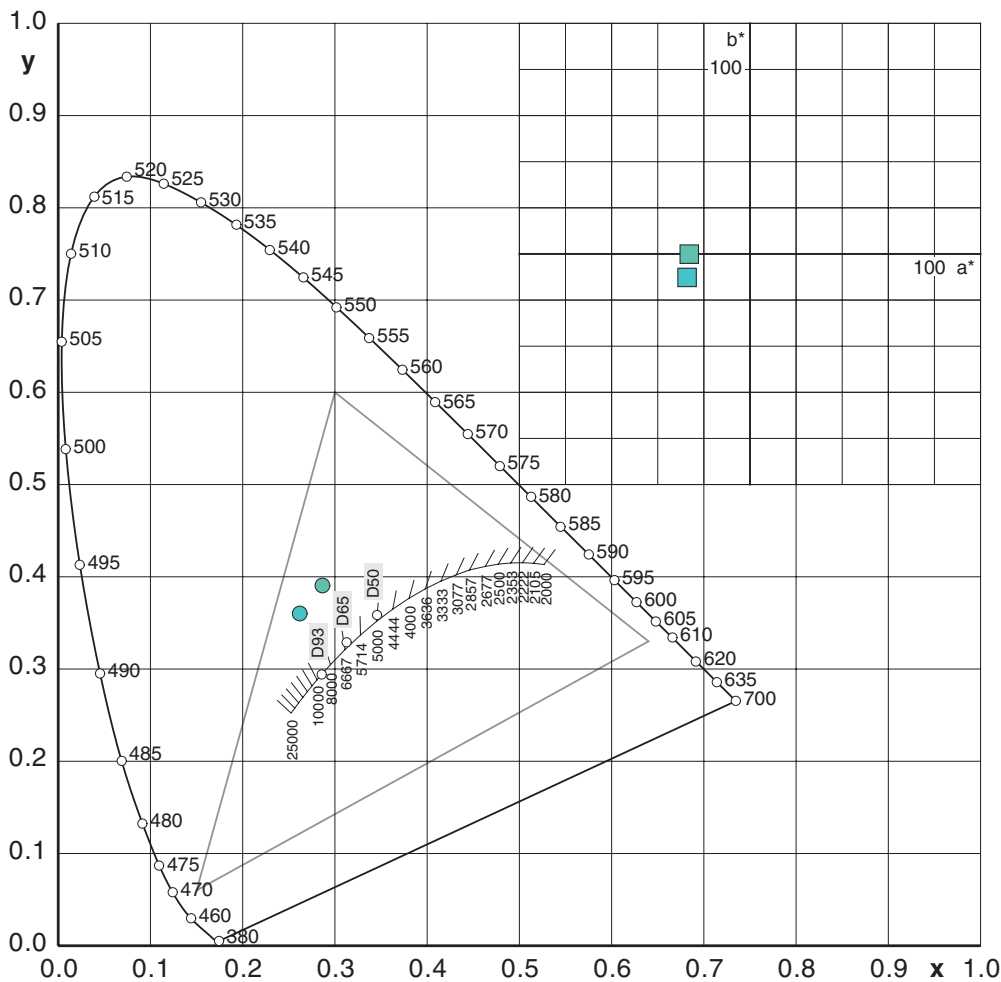


SpectroCalc
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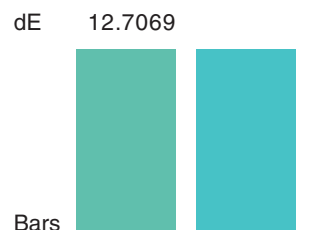
Illuminants
 1 red D50
 2 cyan D65

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

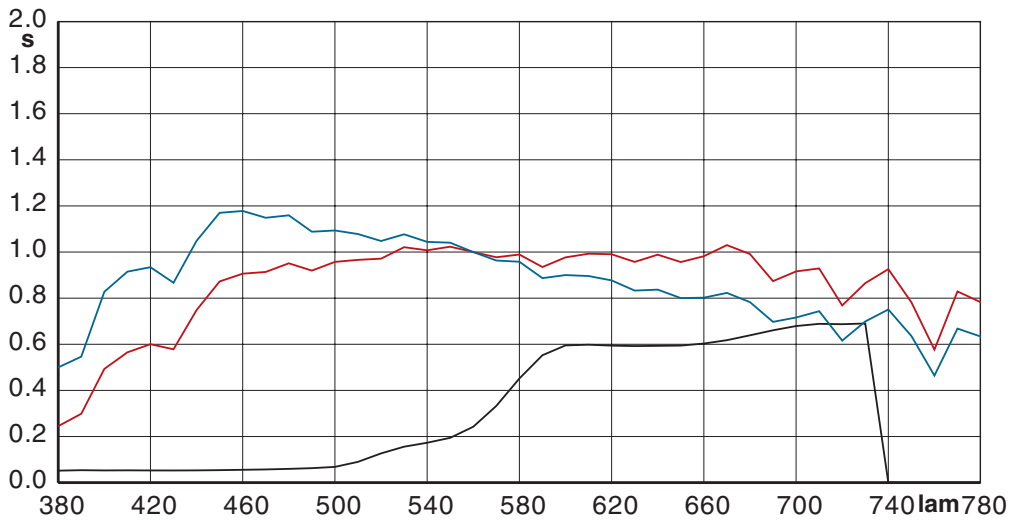
Spectrum generator
 C-Checker 6



Color	1	2
X	0.3114	0.3157
Y	0.4252	0.4346
Z	0.3515	0.4568
x	0.2862	0.2616
y	0.3907	0.3600
z	0.3230	0.3784
L*	71.2246	71.8653
a*	-32.9185	-34.1153
b*	-0.0960	-12.7301
R	29.5810	15.9325
G	133.0123	137.4537
B	106.8463	144.1179
R'	95.6202	70.7016
G'	191.1018	193.9284
B'	173.2087	198.0714
CCT	none	none
RGB	in-gam	in-gam



8.7 ColorChecker Spectral Data

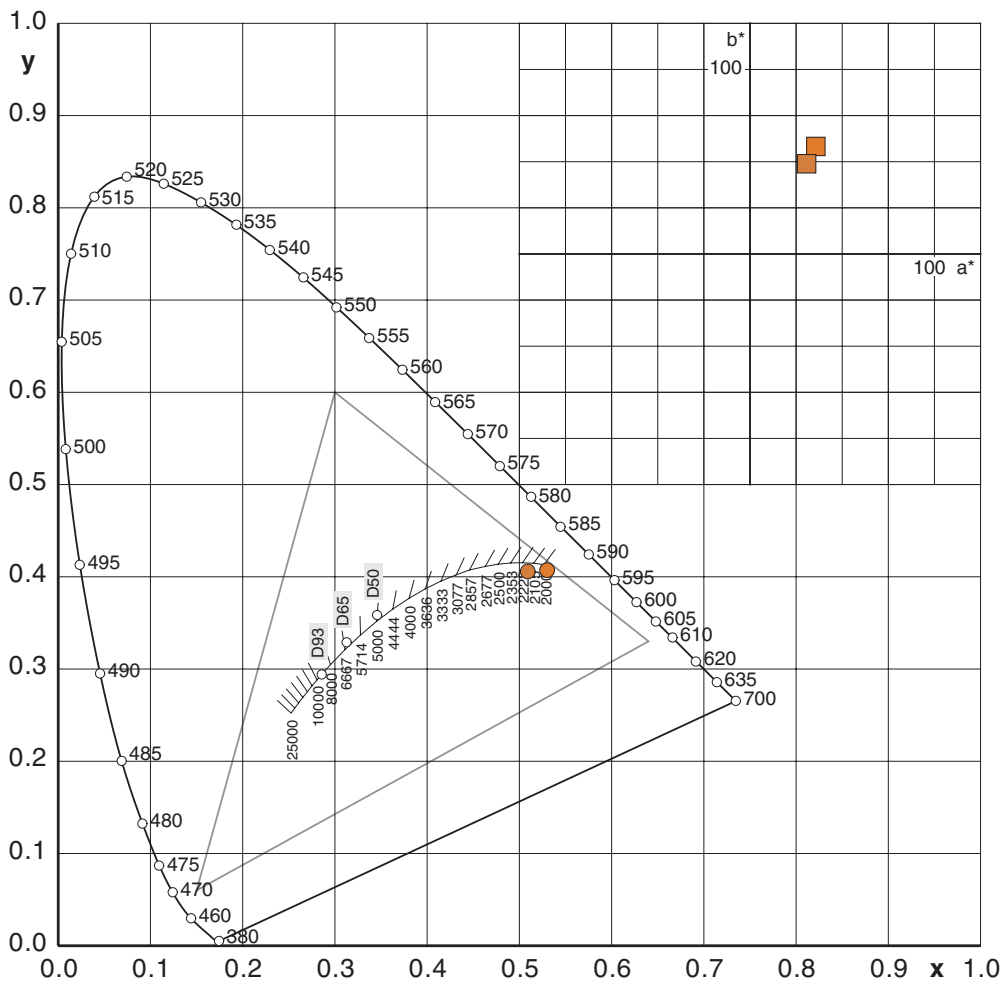


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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
 C-Checker 7

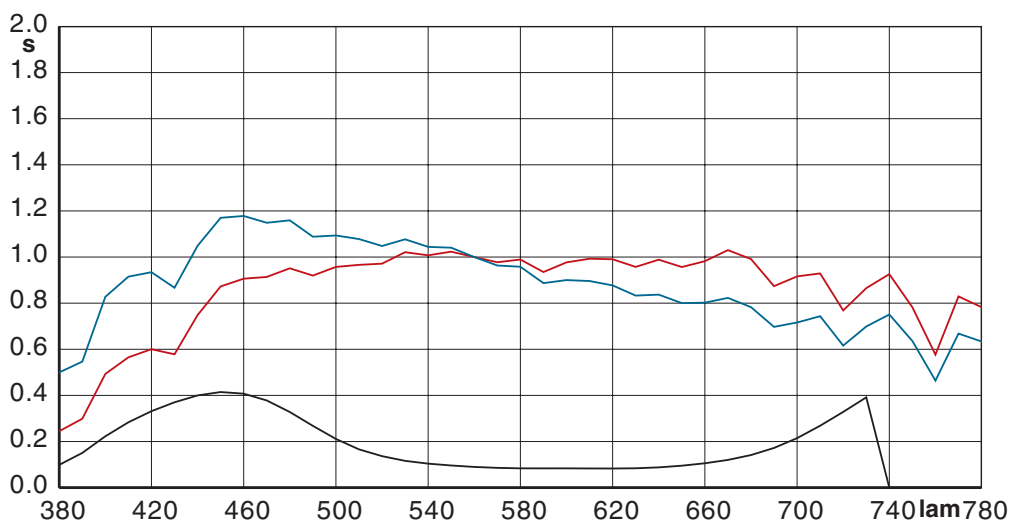


Color	1	2
X	0.4085	0.3749
Y	0.3138	0.2986
Z	0.0483	0.0629
x	0.5301	0.5091
y	0.4073	0.4055
z	0.0627	0.0854
L*	62.8307	61.5354
a*	35.7248	30.7186
b*	58.2691	48.8773
R	190.9808	168.5805
G	51.8153	52.8883
B	6.4726	11.9852
R'	224.4703	212.3893
G'	124.4671	125.6549
B'	44.1878	61.2245
CCT	none	2103 K
RGB	in-gam	in-gam
dE	10.7213	



Bars

8.8 ColorChecker Spectral Data

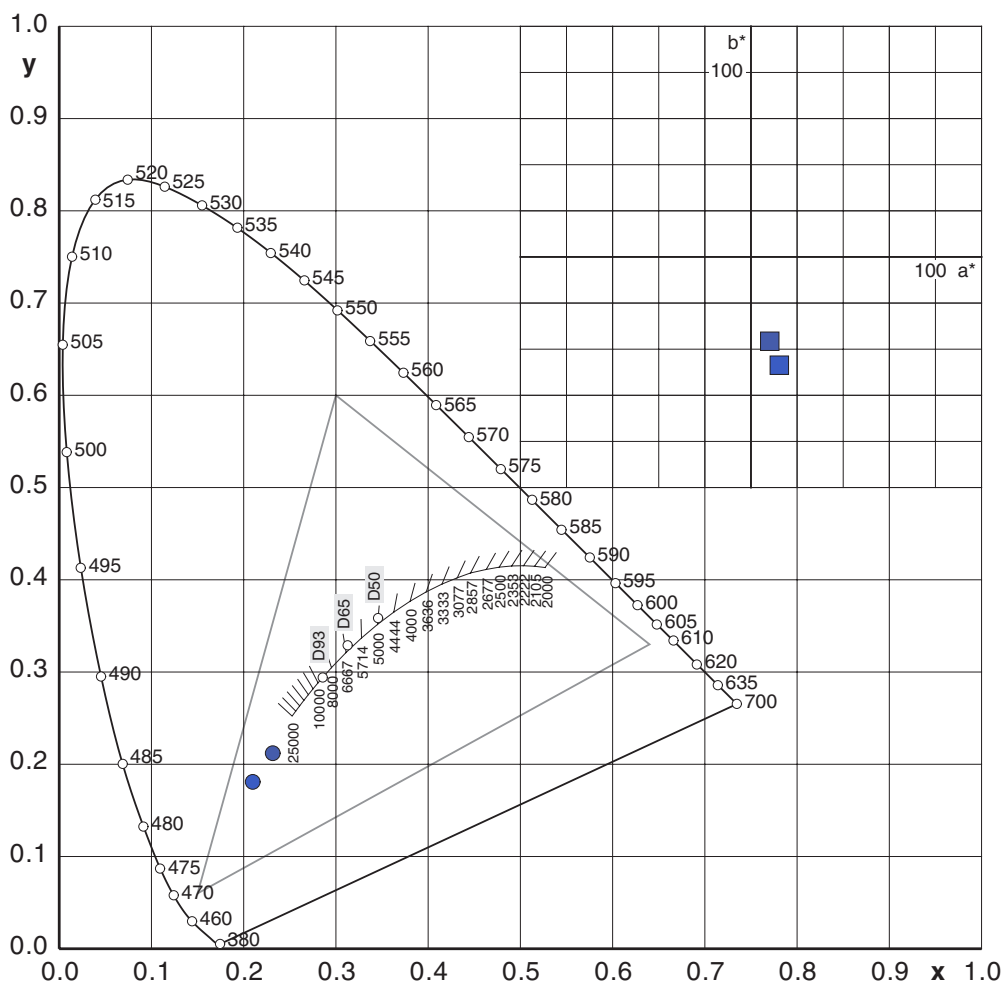


SpectroCalc
G.Hoffmann
Dec.21 / 2006

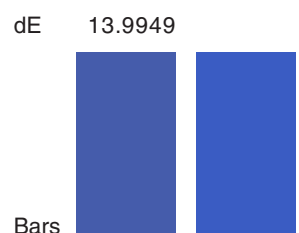
Illuminants
1 red D50
2 cyan D65

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

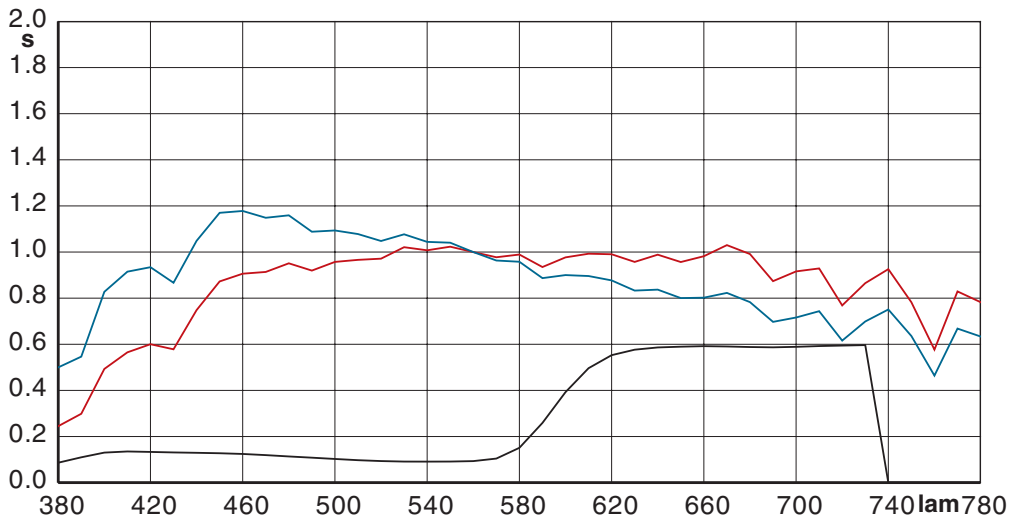
Spectrum generator
C-Checker 8



Color	1	2
X	0.1248	0.1372
Y	0.1144	0.1186
Z	0.3002	0.3988
x	0.2313	0.2096
y	0.2121	0.1812
z	0.5566	0.6092
L*	40.3076	40.9952
a*	10.1877	15.3687
b*	-45.7001	-58.6825
R	14.9817	10.8524
G	27.3068	27.1128
B	103.2024	138.4943
R'	68.5569	58.1748
G'	92.0258	91.7111
B'	170.5211	194.5829
CCT	none	none
RGB	in-gam	in-gam



8.9 ColorChecker Spectral Data

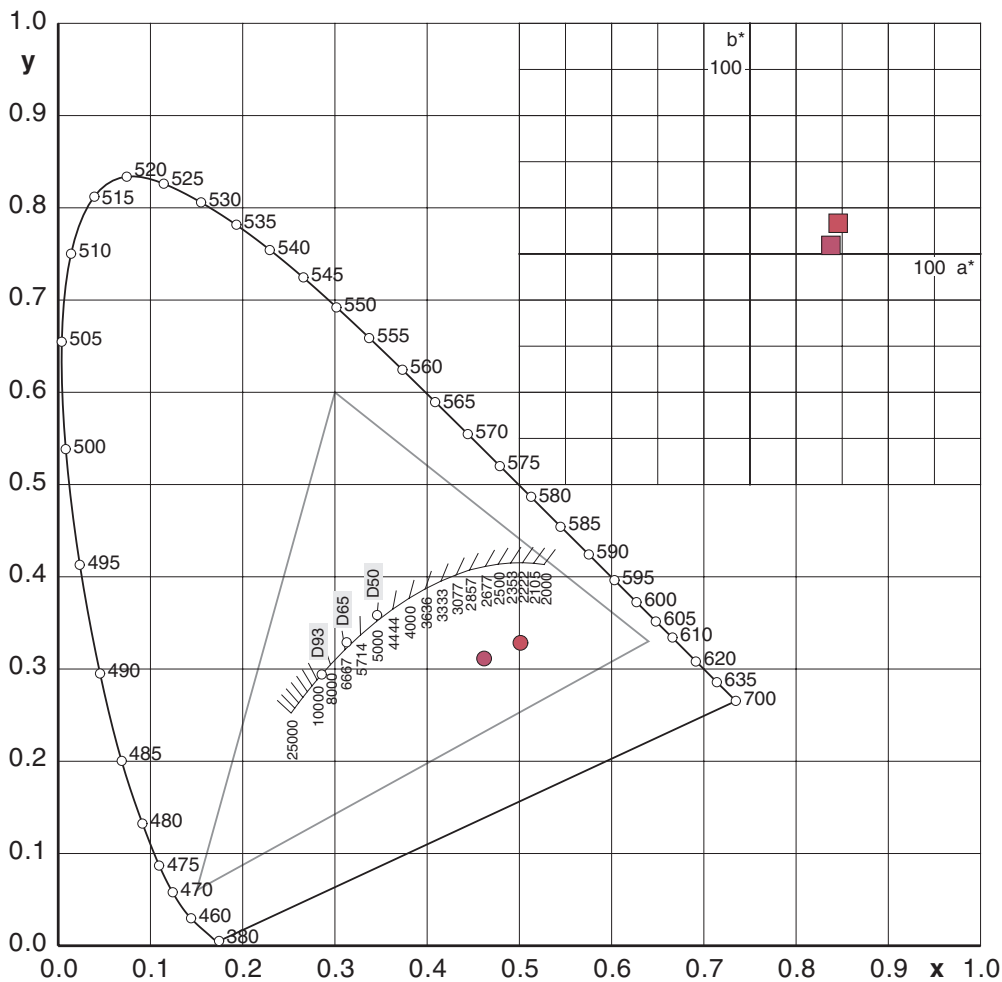


SpectroCalc
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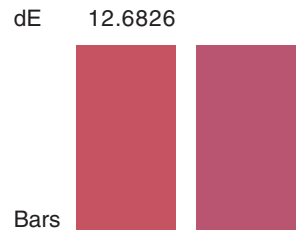
Illuminants
 1 red D50
 2 cyan D65

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

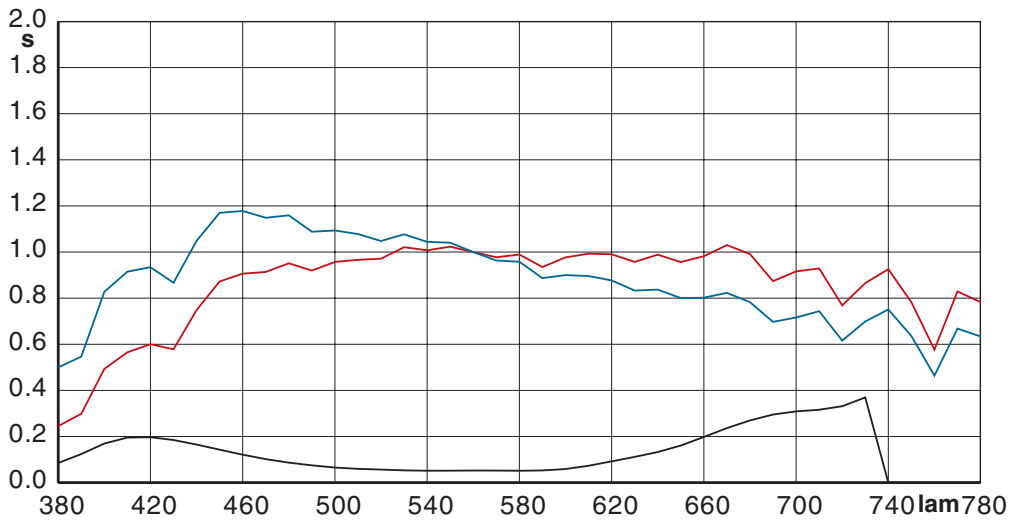
Spectrum generator
 C-Checker 9



Color	1	2
X	0.2976	0.2736
Y	0.1953	0.1846
Z	0.1013	0.1344
x	0.5009	0.4617
y	0.3287	0.3114
z	0.1705	0.2268
L*	51.3031	50.0442
a*	47.8000	43.8879
b*	16.6388	4.6406
R	144.6324	125.7442
G	22.0186	23.0351
B	30.3586	42.4131
R'	198.3866	186.3549
G'	82.9284	84.7690
B'	96.8120	113.3818
CCT	none	none
RGB	in-gam	in-gam



8.10 ColorChecker Spectral Data

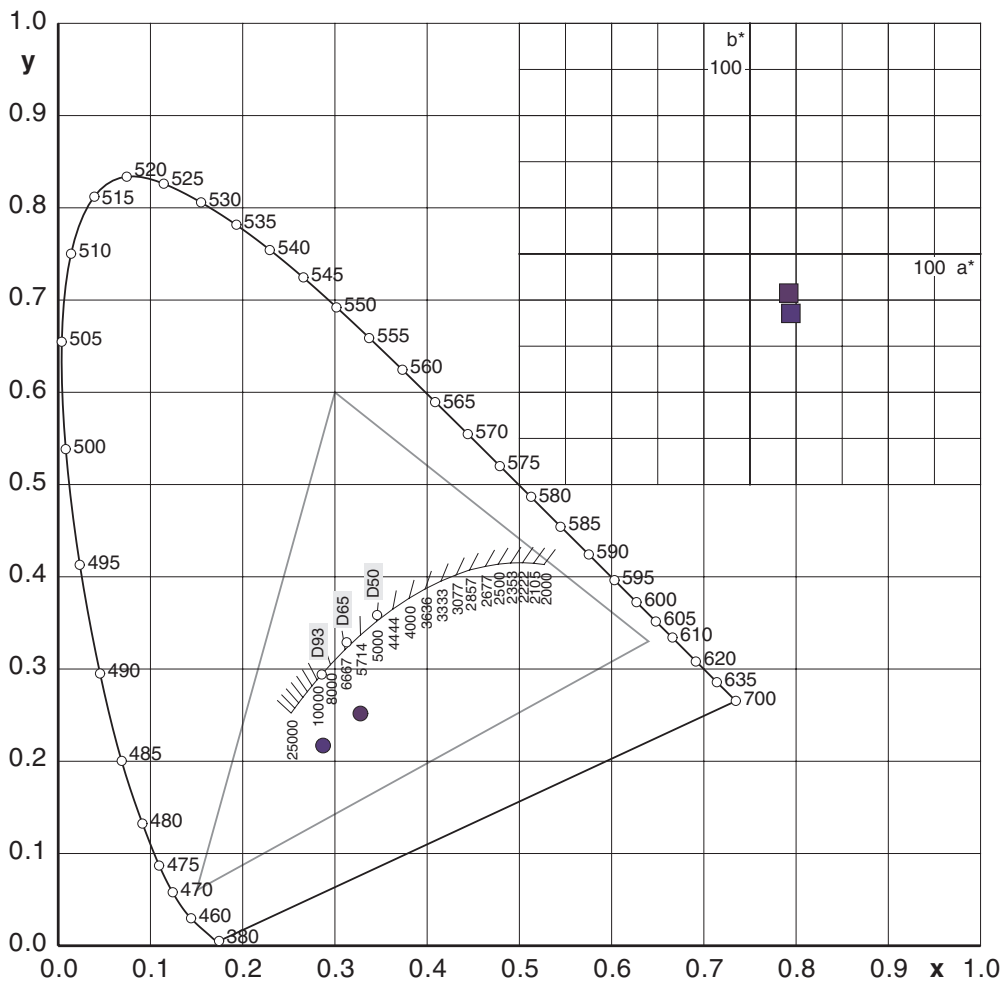


SpectroCalc
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Dec.21 / 2006

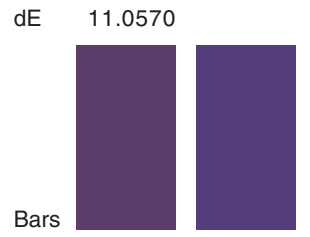
Illuminants
 1 red D50
 2 cyan D65

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

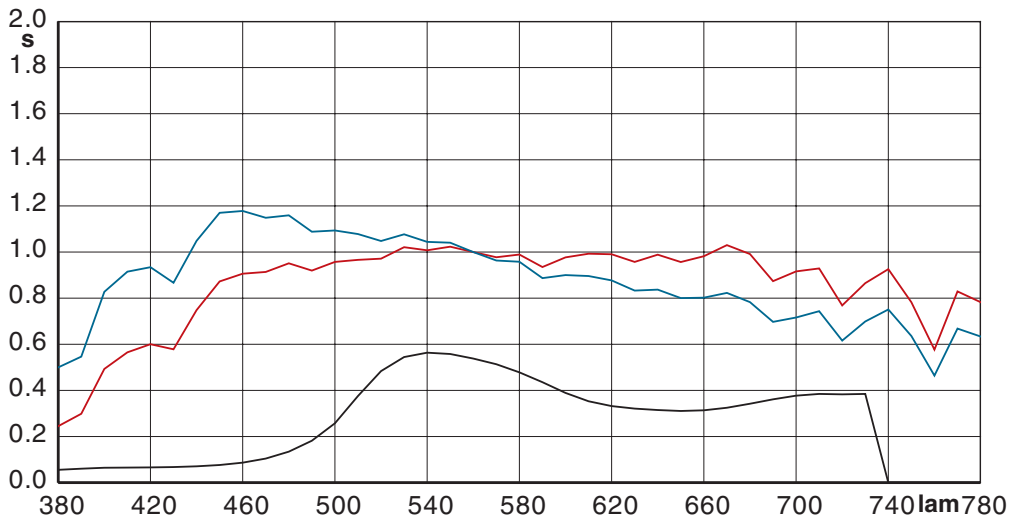
Spectrum generator
 C-Checker 10



Color	1	2
X	0.0838	0.0844
Y	0.0644	0.0638
Z	0.1075	0.1455
x	0.3276	0.2874
y	0.2519	0.2173
z	0.4205	0.4953
L*	30.4982	30.3536
a*	21.0308	22.1920
b*	-21.2270	-32.2219
R	26.9427	22.9326
G	11.4778	11.3558
B	36.3086	49.9492
R'	91.4343	84.5856
G'	59.8802	59.5518
B'	105.3935	122.3667
CCT	none	none
RGB	in-gam	in-gam



8.11 ColorChecker Spectral Data

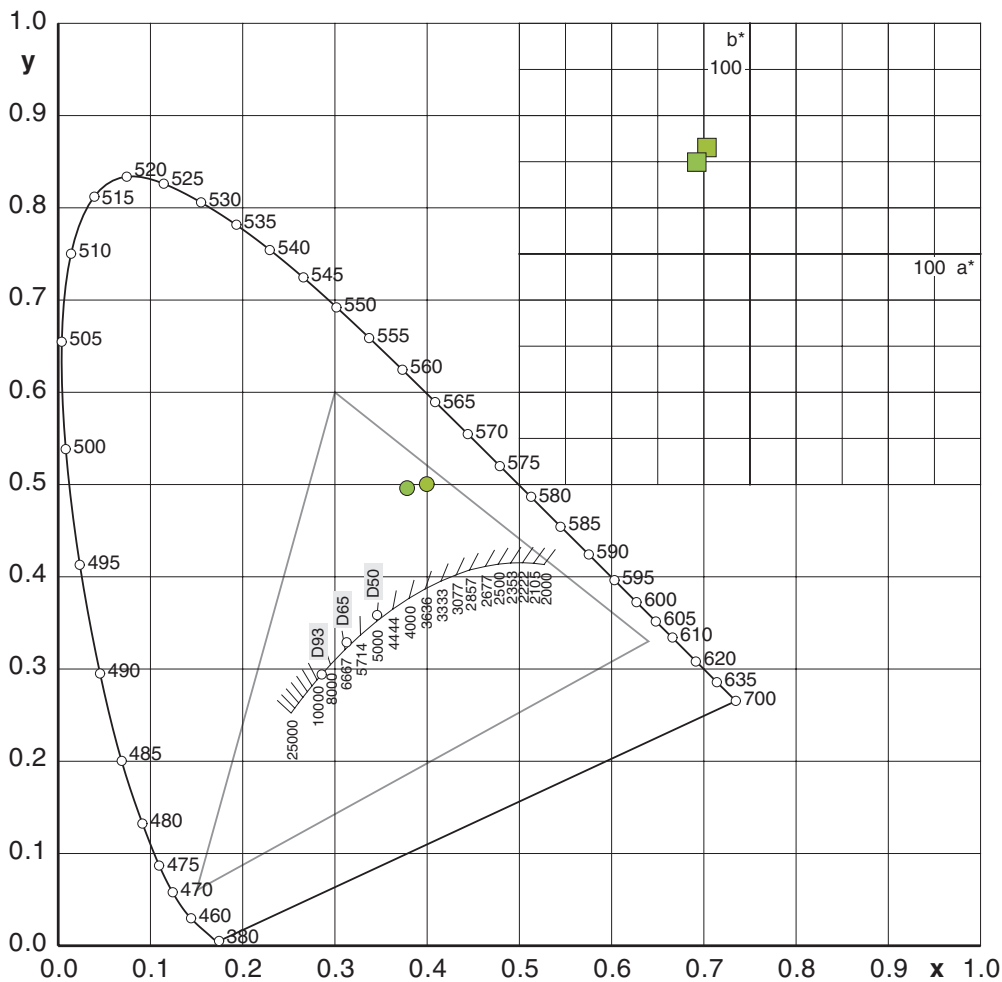


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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.

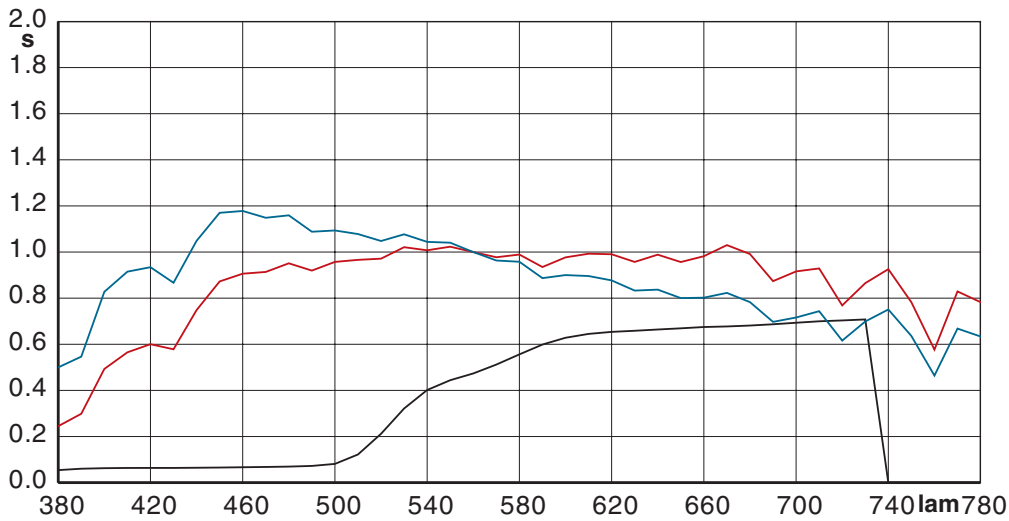
Spectrum generator
C-Checker 11



Color	1	2
X	0.3598	0.3422
Y	0.4504	0.4488
Z	0.0902	0.1138
x	0.3996	0.3782
y	0.5002	0.4960
z	0.1002	0.1258
L*	72.9175	72.8140
a*	-23.3094	-28.8188
b*	57.6847	49.7952
R	90.5068	74.1613
G	131.0487	134.8663
B	12.6200	20.8548
R'	160.6985	146.7832
G'	189.8346	192.2883
B'	62.8601	80.7594
CCT	none	none
RGB	in-gam	in-gam
dE	9.6233	



8.12 ColorChecker Spectral Data

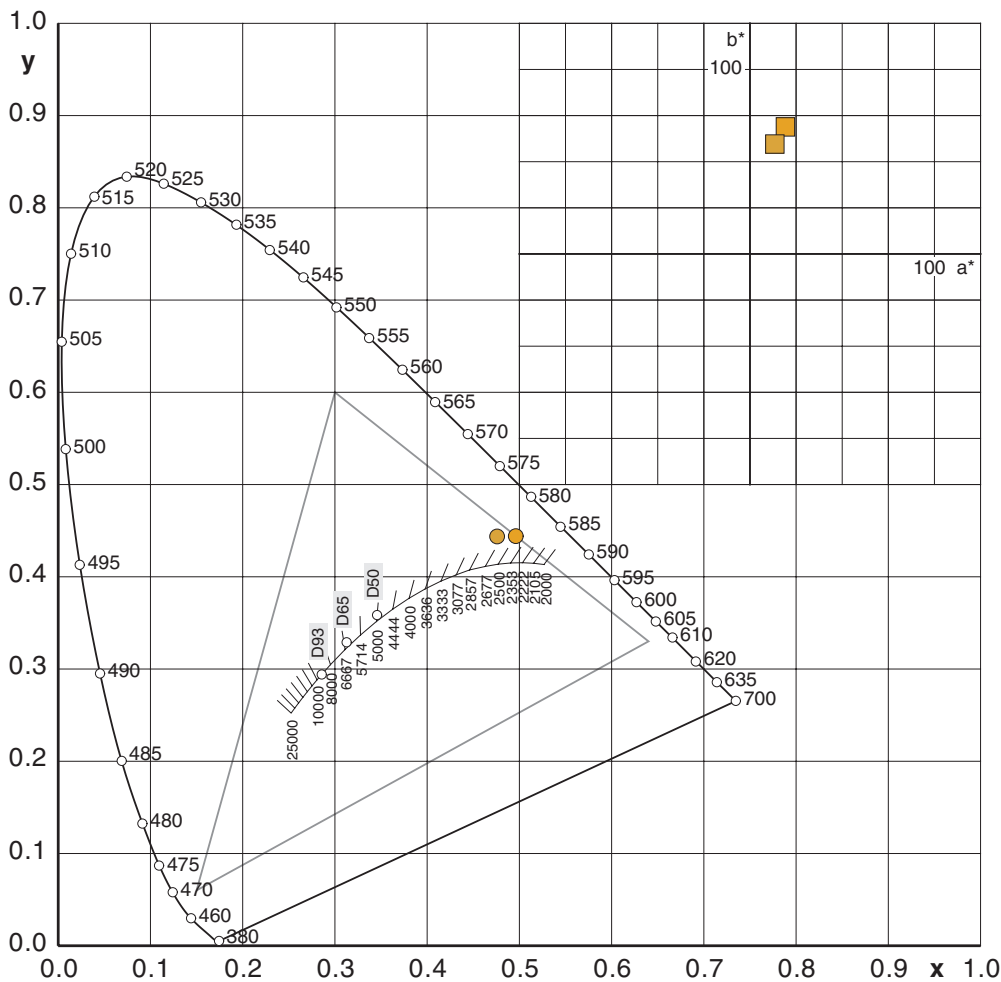


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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
 C-Checker 12



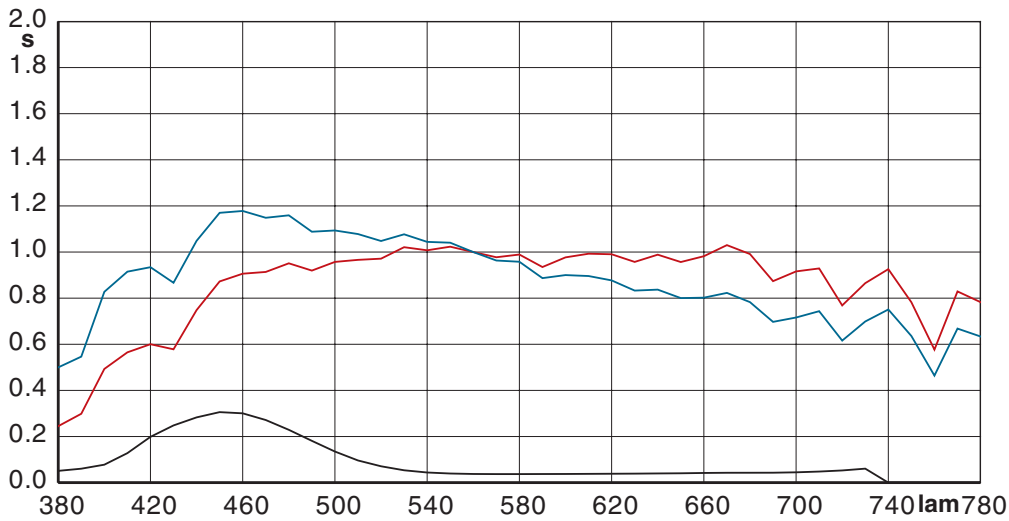
Color	1	2
X	0.4923	0.4558
Y	0.4404	0.4252
Z	0.0596	0.0773
x	0.4961	0.4756
y	0.4438	0.4437
z	0.0601	0.0806
L*	72.2535	71.2281
a*	19.2132	13.4915
b*	68.8583	59.5726
R	204.3634	179.2124
G	92.8204	94.6767
B	4.6865	11.2245
R'	231.2964	218.2331
G'	162.5458	164.0087
B'	36.8599	59.1963
CCT	2491 K	2736 K
RGB	in-gam	in-gam

dE 10.9551



Bars

8.13 ColorChecker Spectral Data

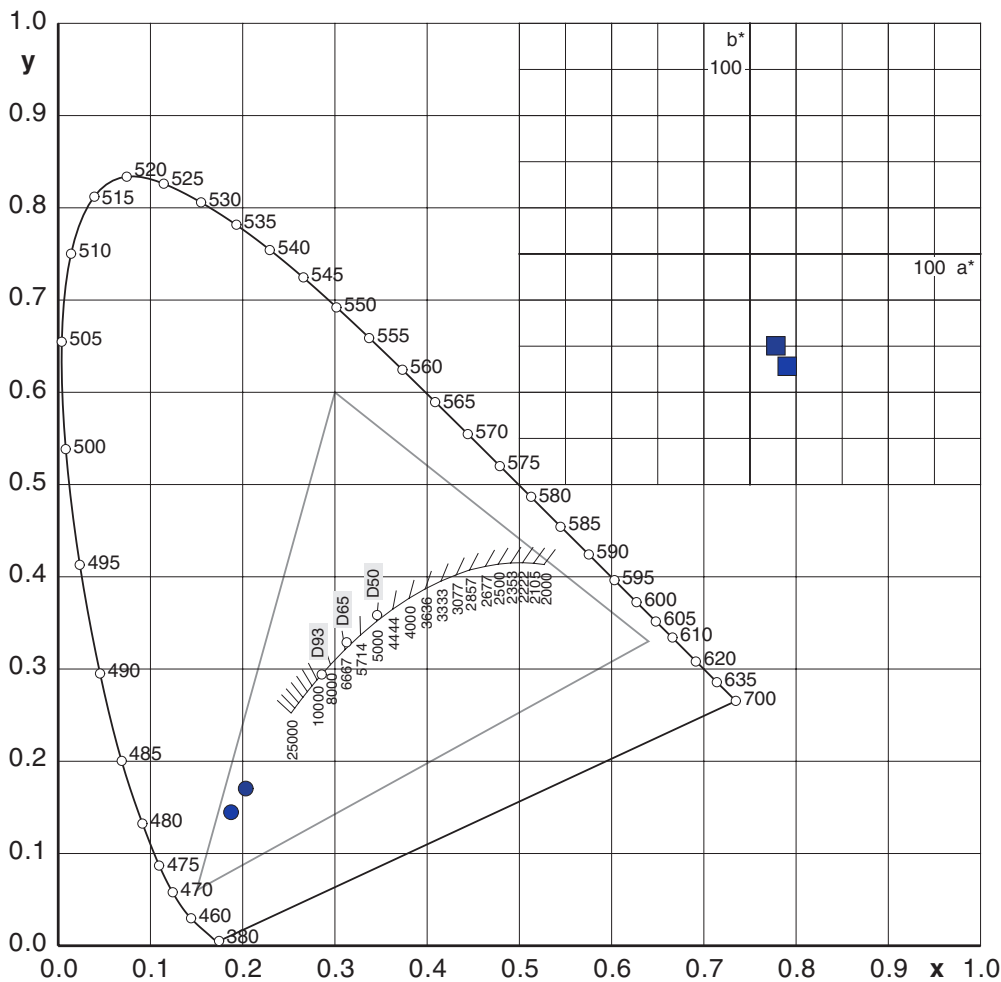


SpectroCalc
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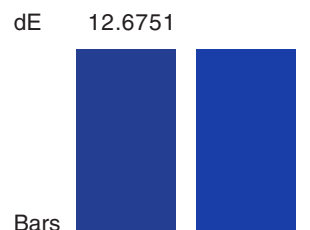
Illuminants
 1 red D50
 2 cyan D65

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

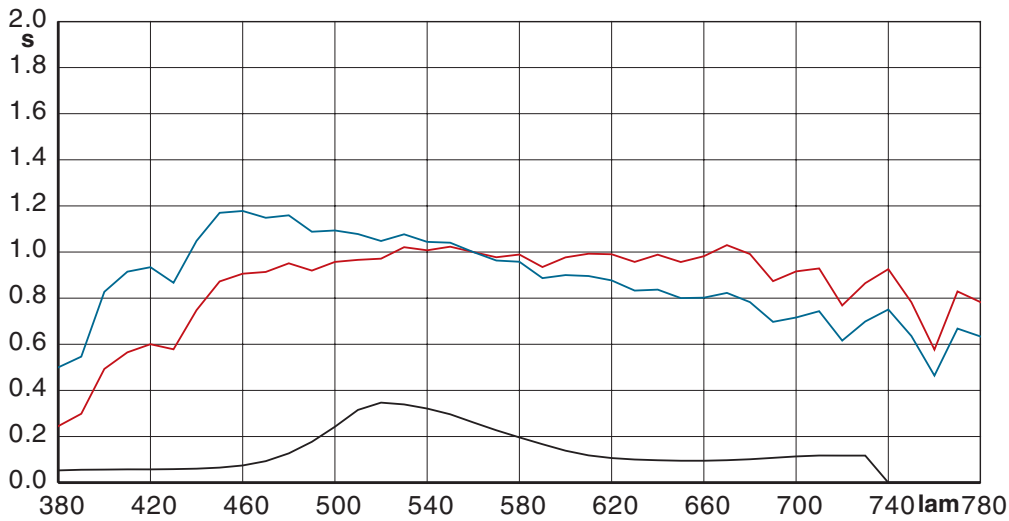
Spectrum generator
 C-Checker 13



Color	1	2
X	0.0684	0.0785
Y	0.0574	0.0607
Z	0.2111	0.2799
x	0.2030	0.1873
y	0.1704	0.1448
z	0.6266	0.6679
L*	28.7555	29.5874
a*	14.0721	20.1828
b*	-49.8087	-60.8824
R	4.5680	2.6705
G	12.7909	12.4576
B	73.5665	98.1965
R'	36.3196	26.2292
G'	63.2923	62.4462
B'	146.2445	166.7371
CCT	none	none
RGB	in-gam	in-gam



8.14 ColorChecker Spectral Data

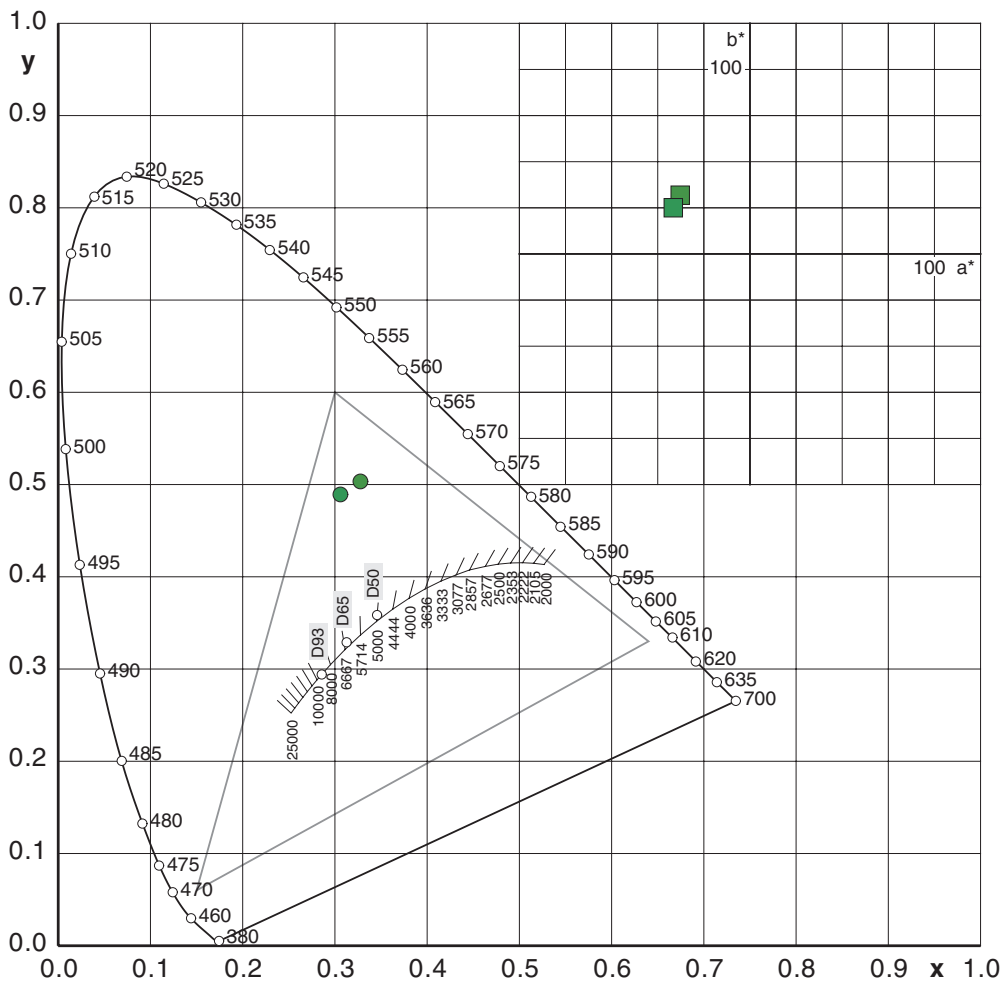


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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.

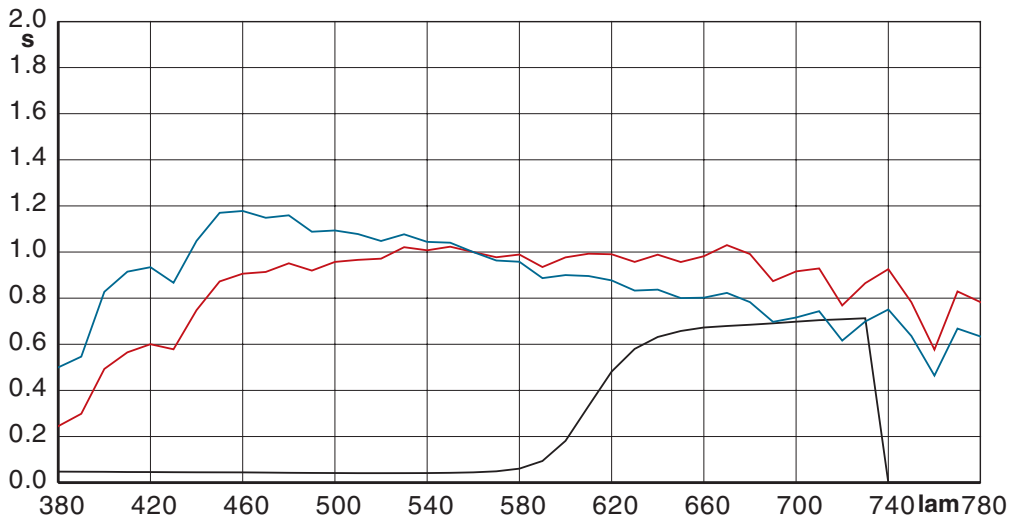
Spectrum generator
 C-Checker 14



Color	1	2
X	0.1515	0.1479
Y	0.2329	0.2365
Z	0.0783	0.0990
x	0.3275	0.3059
y	0.5034	0.4893
z	0.1692	0.2048
L*	55.3692	55.7381
a*	-37.8184	-41.5696
b*	31.8371	25.0404
R	15.2470	8.2688
G	76.6523	79.5044
B	17.2313	24.3841
R'	69.1631	50.4418
G'	149.0121	151.5128
B'	73.5138	87.1397
CCT	none	none
RGB	in-gam	in-gam
dE	7.7719	



8.15 ColorChecker Spectral Data

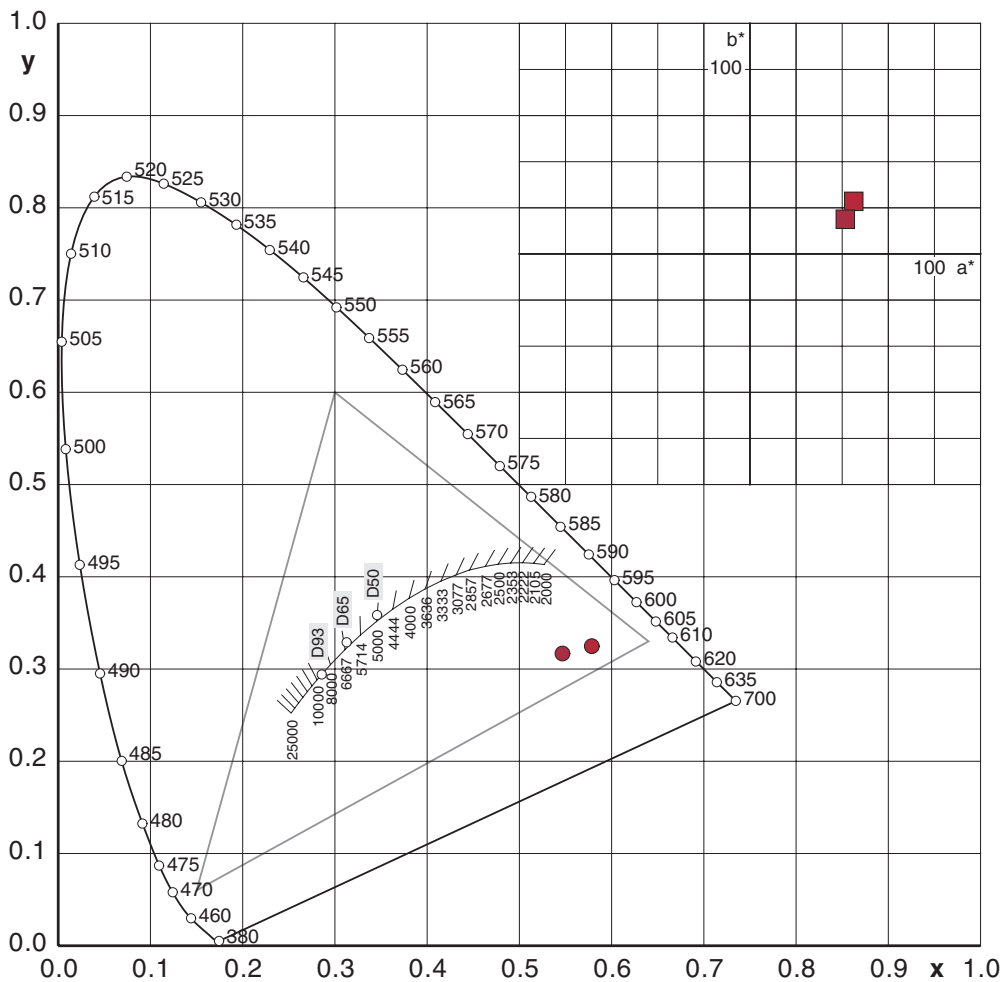


SpectroCalc
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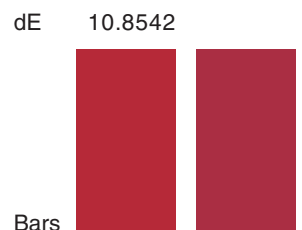
Illuminants
 1 red D50
 2 cyan D65

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

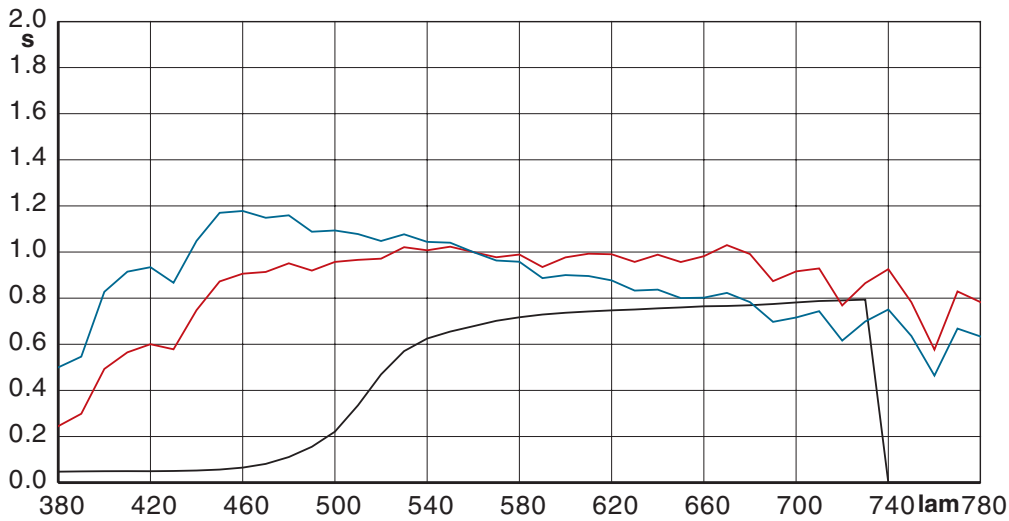
Spectrum generator
 C-Checker 15



Color	1	2
X	0.2175	0.1936
Y	0.1222	0.1121
Z	0.0365	0.0482
x	0.5782	0.5469
y	0.3248	0.3168
z	0.0970	0.1363
L*	41.5636	39.9374
a*	56.2618	51.6711
b*	28.5191	18.8188
R	118.8989	102.4507
G	5.7253	6.8810
B	9.9344	14.2938
R'	181.7354	169.9598
G'	41.2869	45.6908
B'	55.5644	66.9552
CCT	none	none
RGB	in-gam	in-gam



8.16 ColorChecker Spectral Data

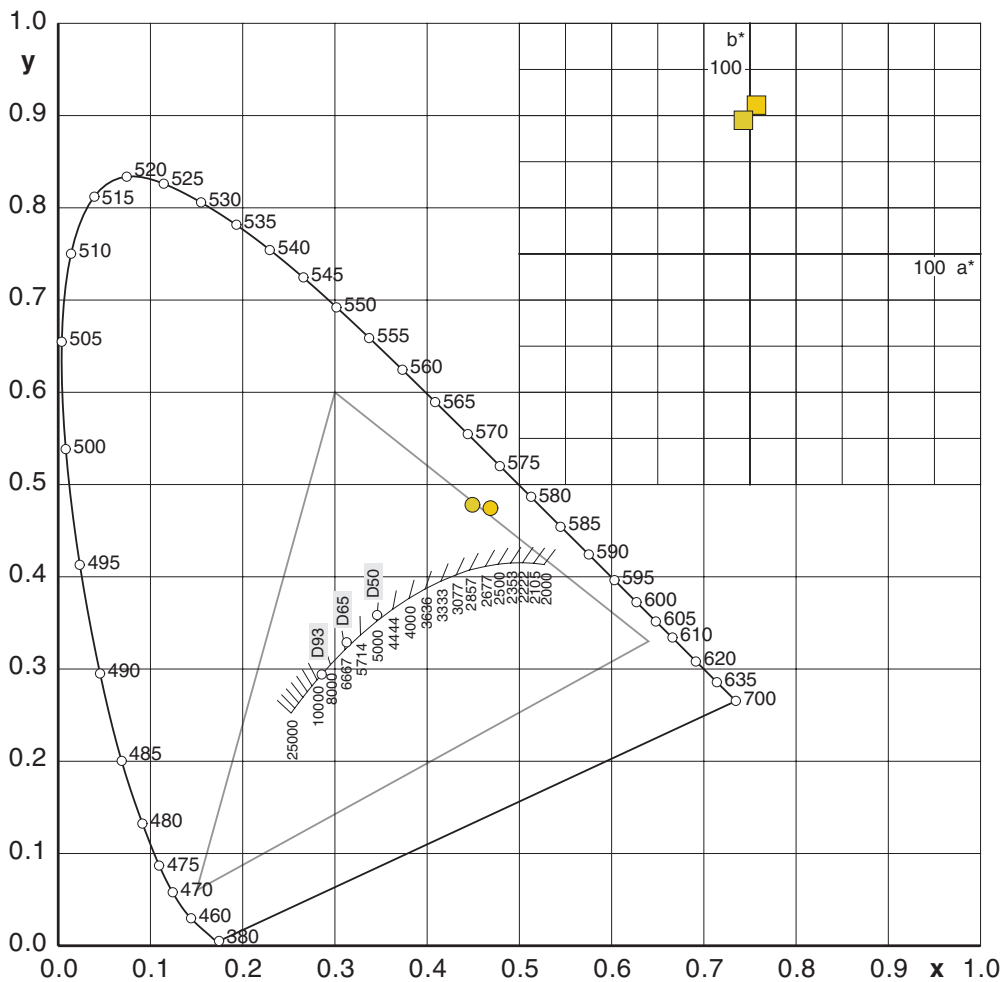


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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
 C-Checker 16

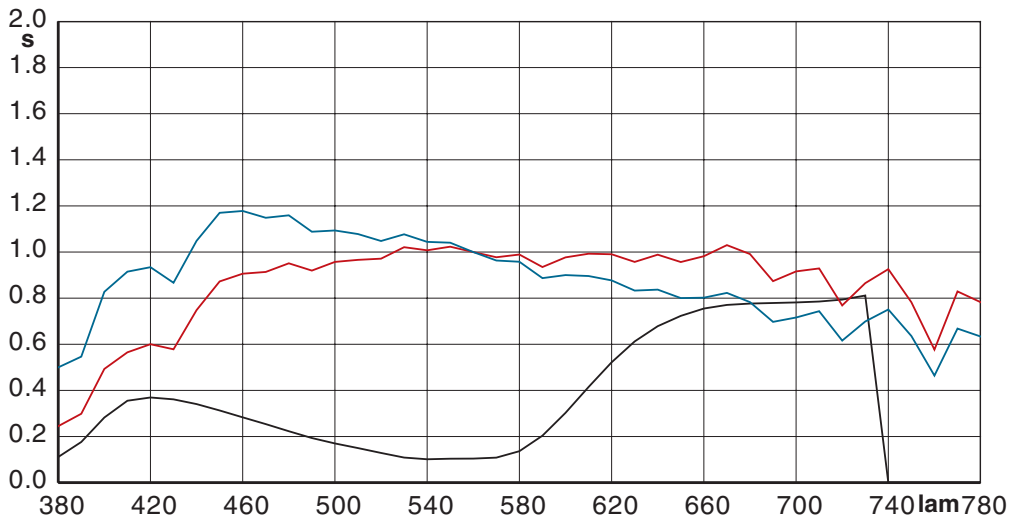


Color	1	2
X	0.6059	0.5632
Y	0.6129	0.5991
Z	0.0733	0.0917
x	0.4689	0.4491
y	0.4743	0.4778
z	0.0567	0.0731
L*	82.5358	81.7876
a*	3.5308	-3.5611
b*	80.6432	72.4546
R	222.2779	191.5362
G	148.8986	152.9526
B	1.6031	8.2038
R'	240.0377	224.7591
G'	200.9751	203.3951
B'	18.5186	50.2300
CCT	none	none
RGB	in-gam	in-gam
dE	10.8586	



Bars

8.17 ColorChecker Spectral Data

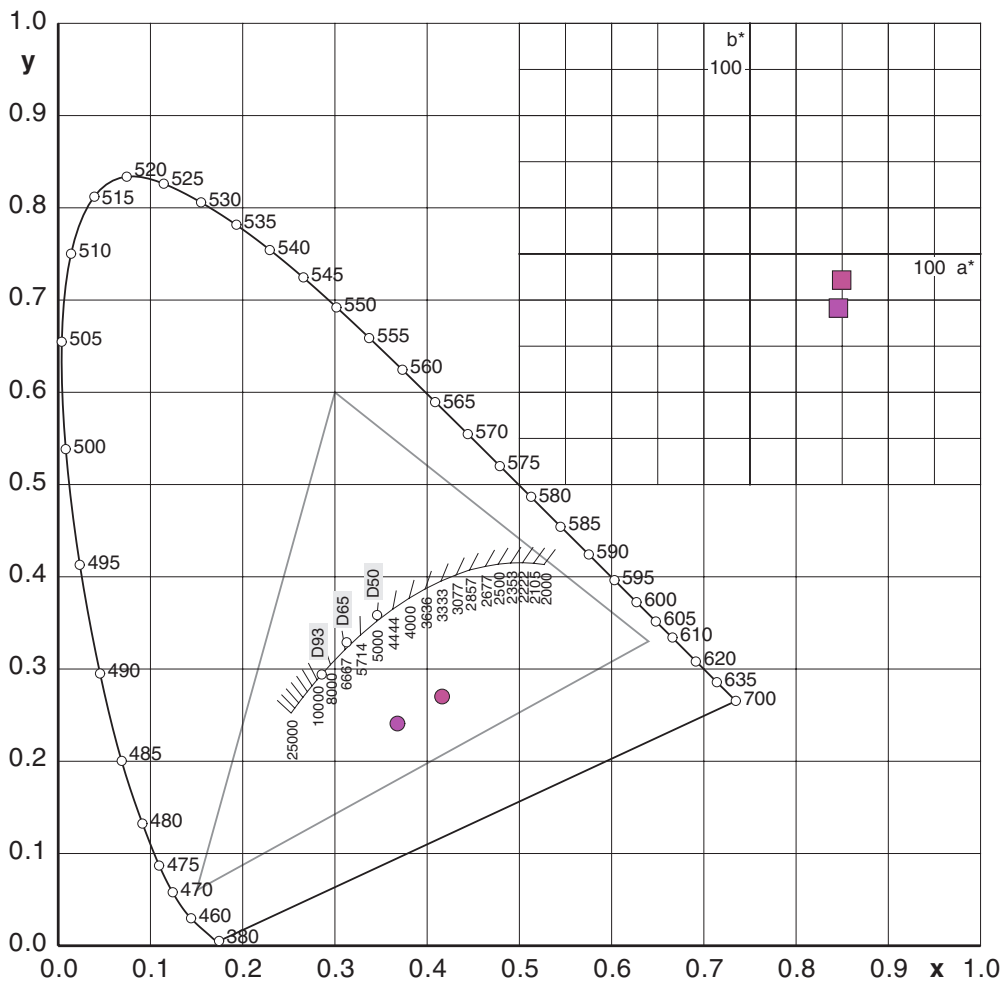


SpectroCalc
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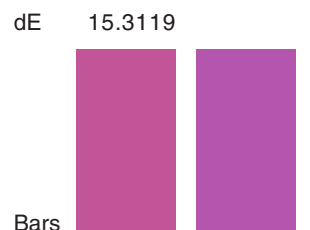
Illuminants
 1 red D50
 2 cyan D65

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

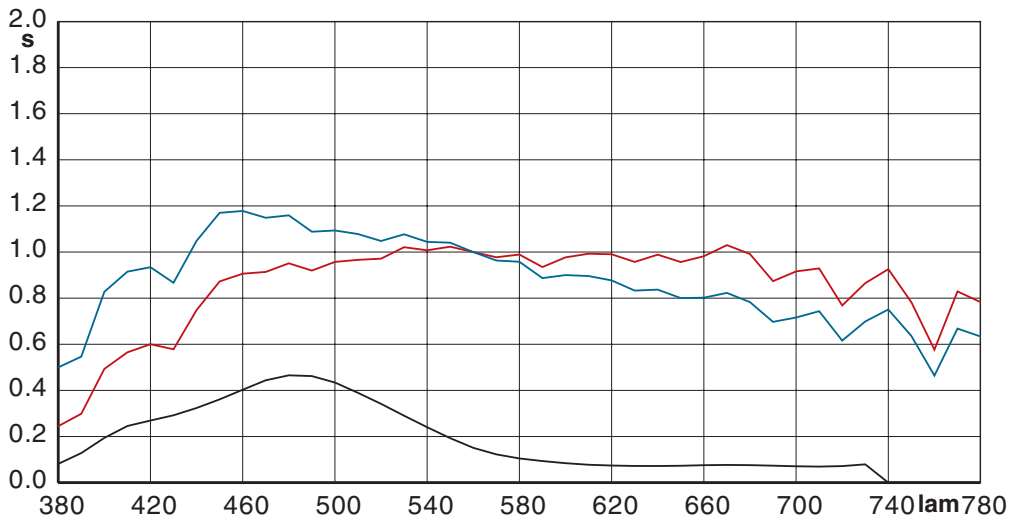
Spectrum generator
 C-Checker 17



Color	1	2
X	0.3138	0.2983
Y	0.2037	0.1955
Z	0.2364	0.3172
x	0.4162	0.3678
y	0.2702	0.2411
z	0.3135	0.3911
L*	52.2544	51.3245
a*	49.7074	47.9472
b*	-14.1605	-29.3424
R	137.1837	118.0524
G	23.2416	23.7926
B	78.5663	107.7208
R'	193.7581	181.1535
G'	85.1369	86.1098
B'	150.6961	173.8457
CCT	none	none
RGB	in-gam	in-gam



8.18 ColorChecker Spectral Data

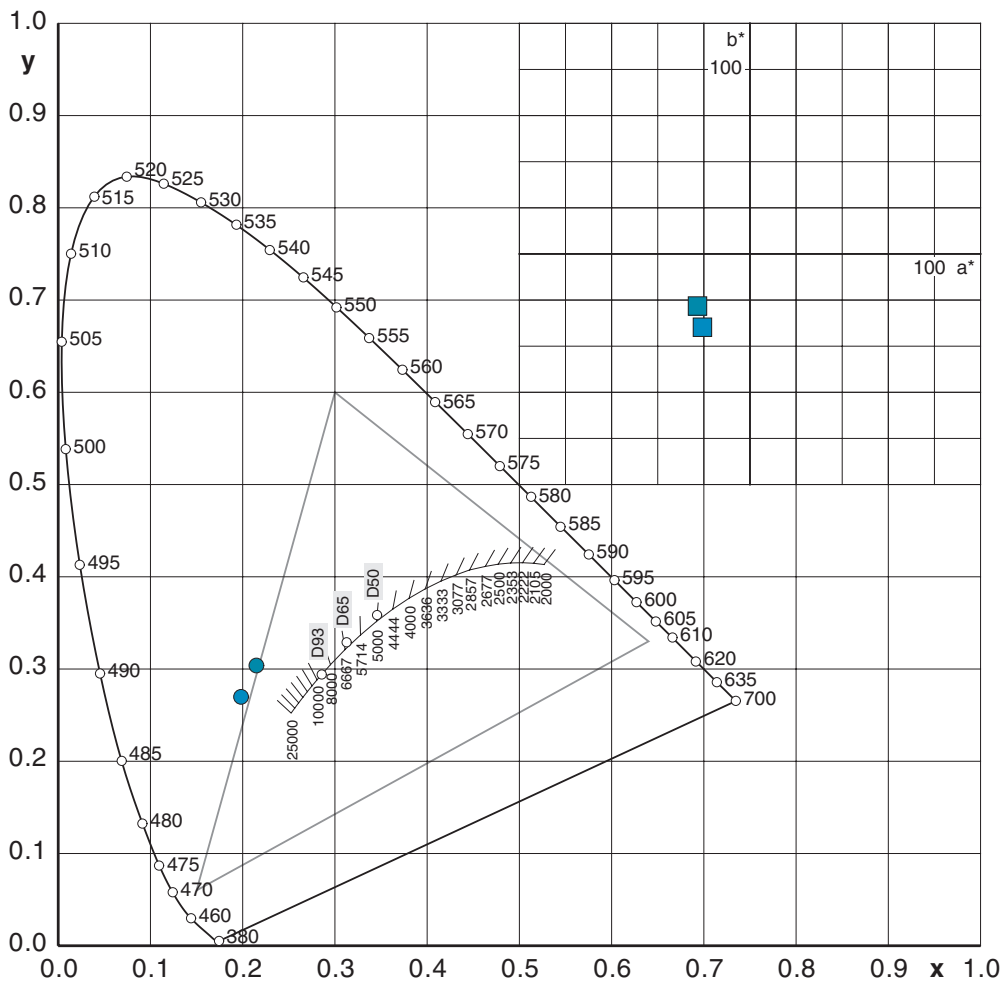


SpectroCalc
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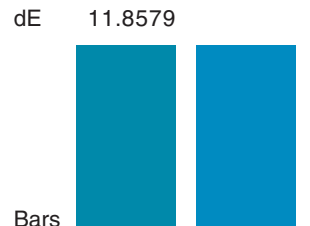
Illuminants
 1 red D50
 2 cyan D65

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

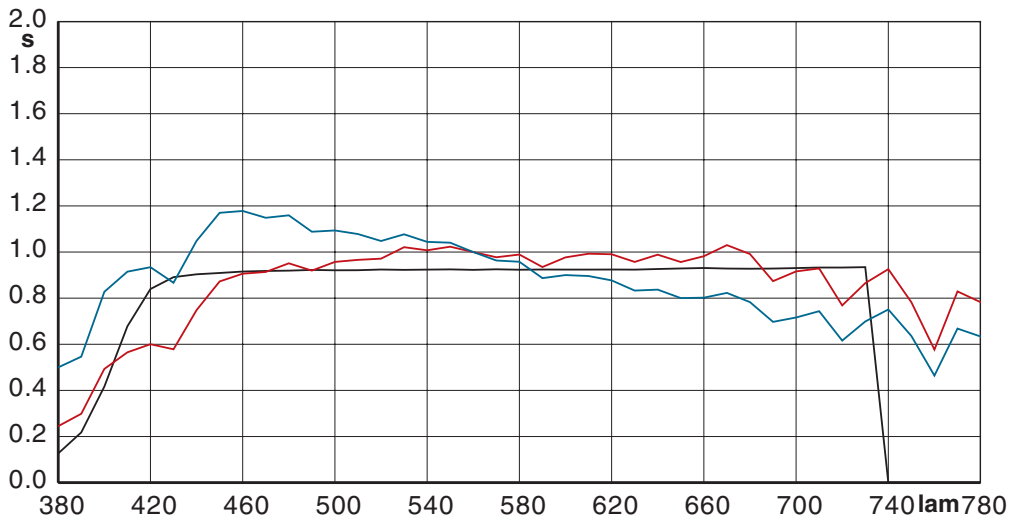
Spectrum generator
 C-Checker 18



Color	1	2
X	0.1388	0.1507
Y	0.1961	0.2056
Z	0.3107	0.4050
x	0.2150	0.1980
y	0.3038	0.2700
z	0.4812	0.5320
L*	51.3923	52.4607
a*	-28.4458	-25.7706
b*	-28.2232	-39.7259
R	-8.8118	-15.0152
G	63.8240	66.2897
B	102.4262	135.8928
R'	0.0000	0.0000
G'	137.0331	139.4379
B'	169.9415	192.9412
CCT	none	none
RGB	out-gam	out-gam



8.19 ColorChecker Spectral Data

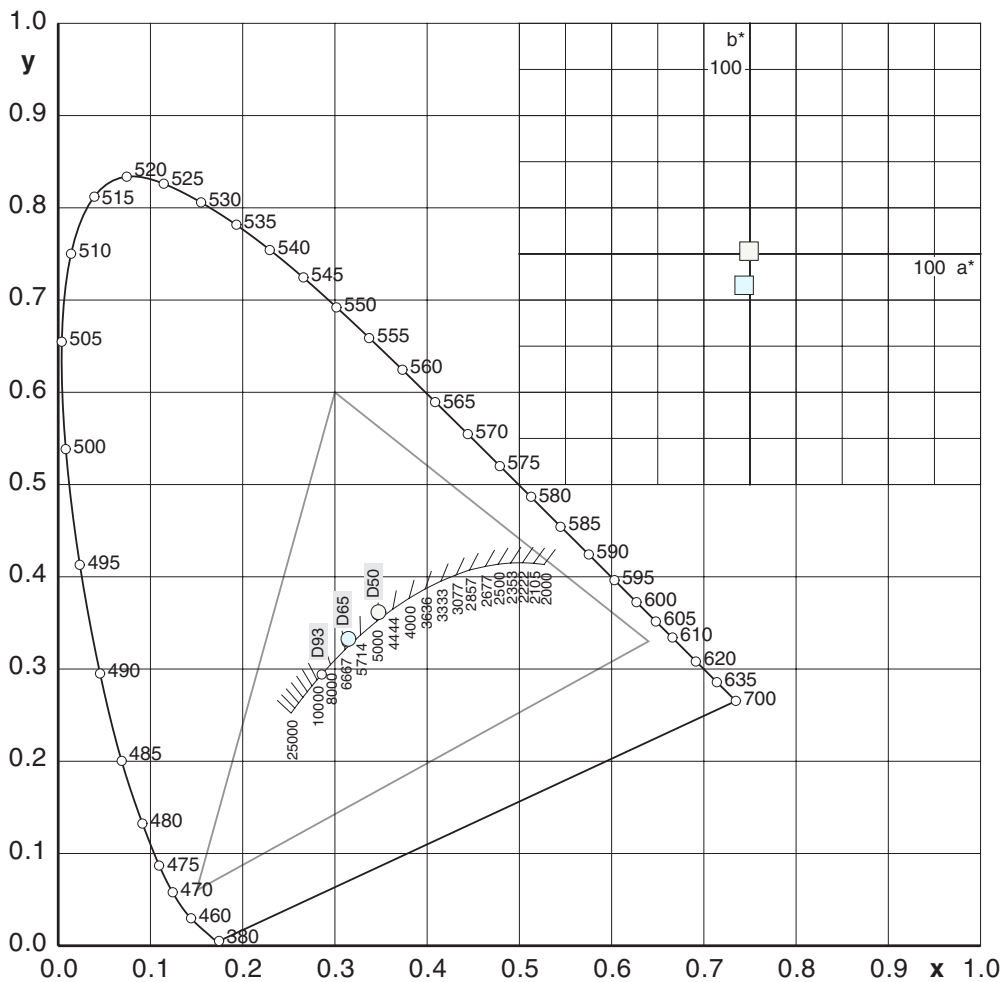


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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.

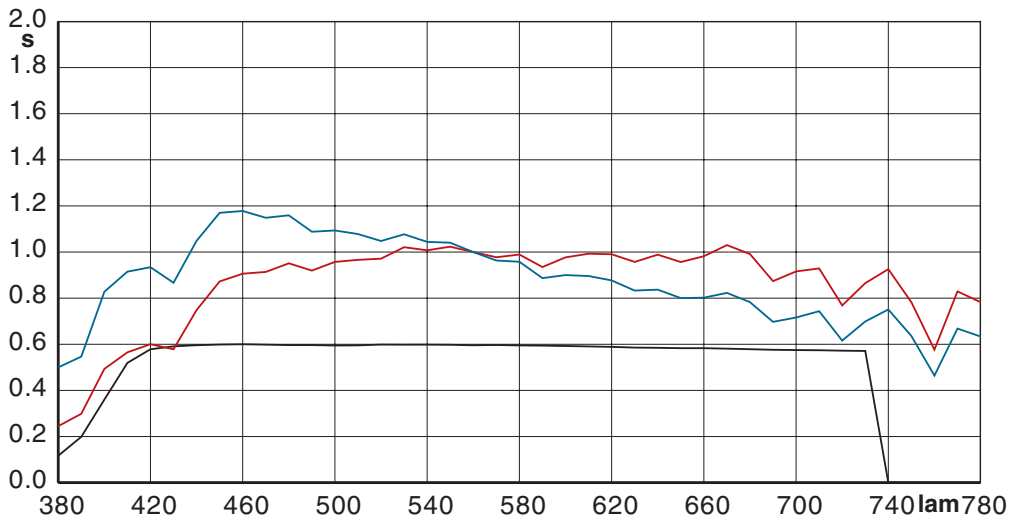
Spectrum generator
 C-Checker 19



Color	1	2
X	0.8876	0.8731
Y	0.9235	0.9233
Z	0.7443	0.9792
x	0.3474	0.3146
y	0.3614	0.3326
z	0.2913	0.3528
L*	96.9614	96.9548
a*	-0.5232	-3.1642
b*	1.5180	-16.9980
R	235.4016	194.4570
G	236.0464	241.5985
B	229.0935	313.0314
R'	246.1835	226.2696
G'	246.4802	249.0160
B'	243.2551	255.0000
CCT	4946 K	6363 K
RGB	in-gam	out-gam
dE	18.7034	



8.20 ColorChecker Spectral Data

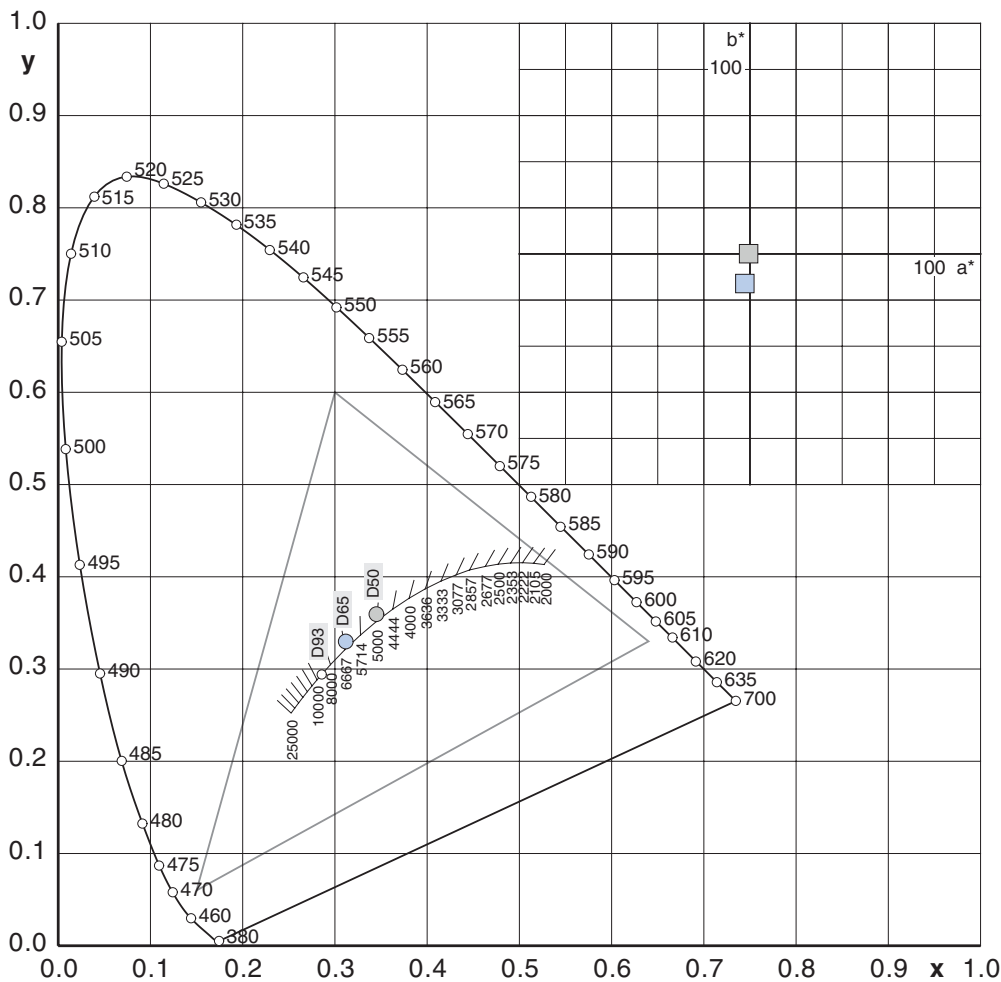


SpectroCalc
G.Hoffmann
Dec.21 / 2006

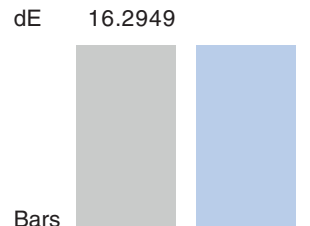
Illuminants
 1 red D50
 2 cyan D65

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

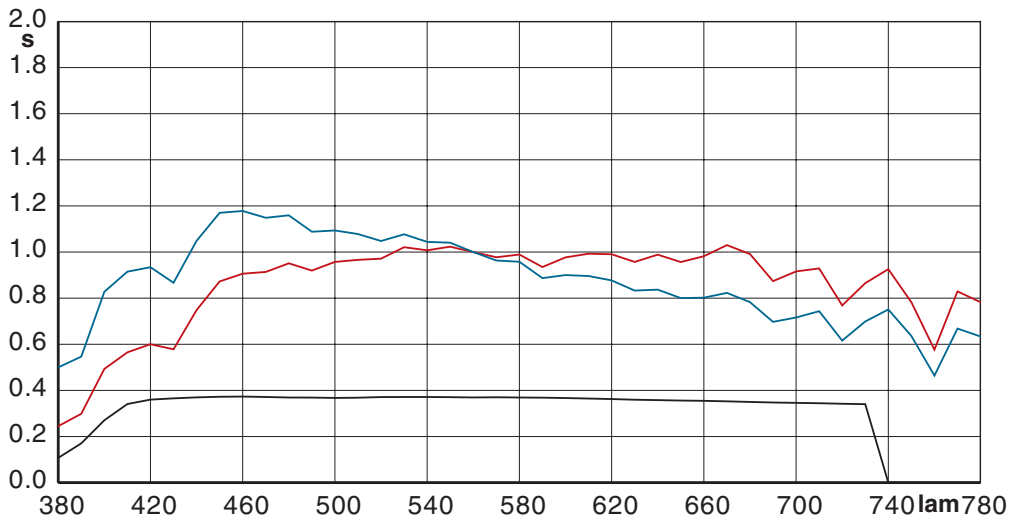
Spectrum generator
 C-Checker 20



Color	1	2
X	0.5709	0.5628
Y	0.5952	0.5954
Z	0.4900	0.6456
x	0.3447	0.3120
y	0.3594	0.3301
z	0.2959	0.3579
L*	81.5739	81.5867
a*	-0.7398	-2.7784
b*	0.1244	-16.0425
R	149.4836	123.4792
G	152.5089	155.9604
B	151.3181	206.9286
R'	201.3266	184.8430
G'	203.1320	205.1664
B'	202.4239	232.5748
CCT	5036 K	6523 K
RGB	in-gam	in-gam



8.21 ColorChecker Spectral Data

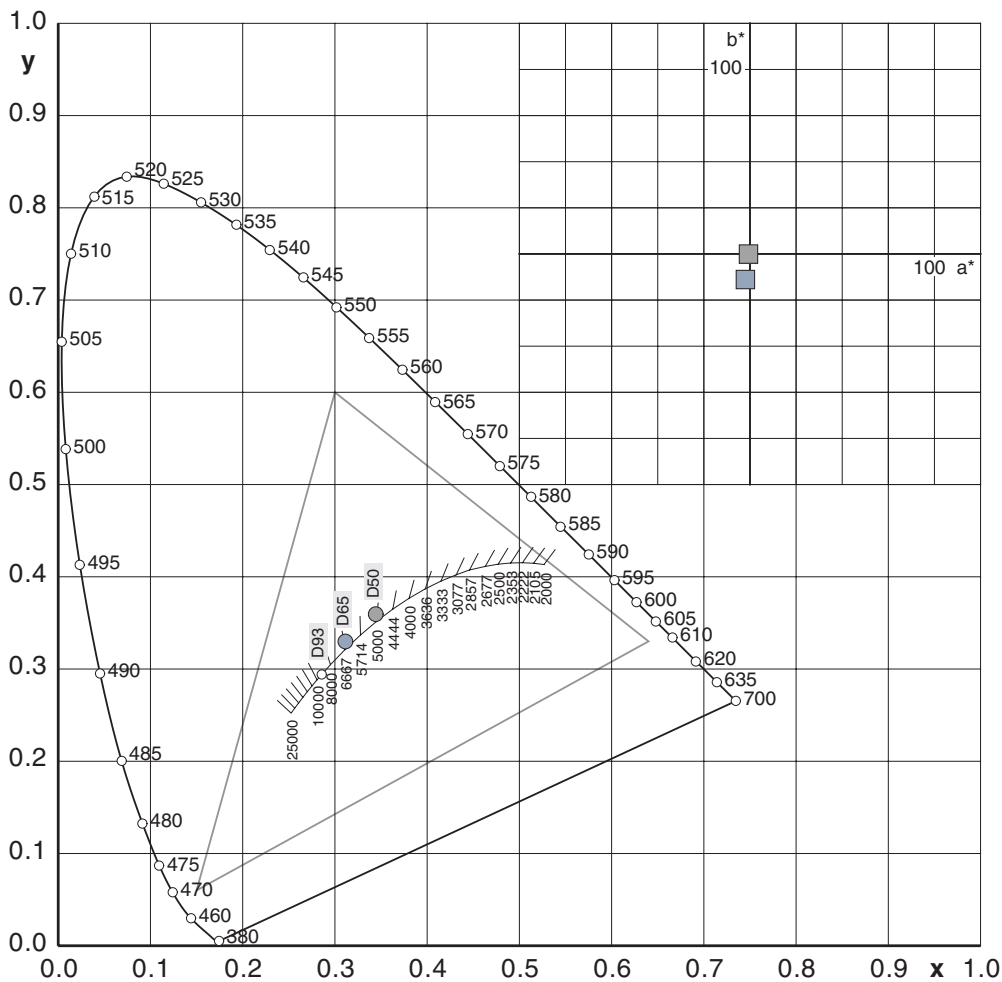


SpectroCalc
G.Hoffmann
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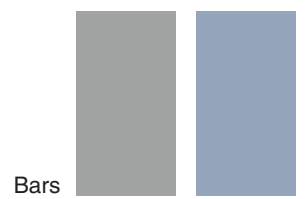
Illuminants
 1 red D50
 2 cyan D65

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

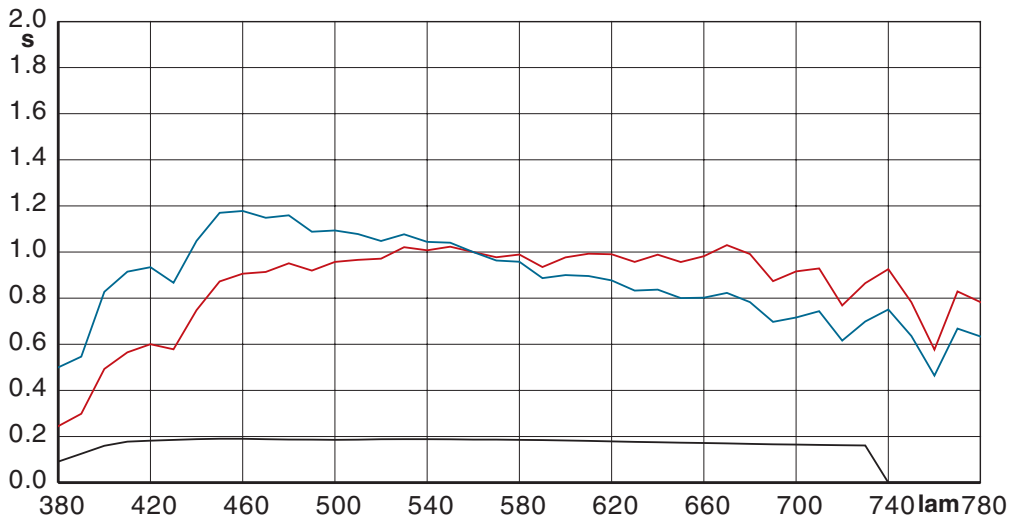
Spectrum generator
 C-Checker 21



Color	1	2
X	0.3530	0.3482
Y	0.3685	0.3687
Z	0.3045	0.4013
x	0.3440	0.3114
y	0.3592	0.3297
z	0.2968	0.3589
L*	67.1649	67.1807
a*	-0.8085	-2.4843
b*	-0.0668	-13.8747
R	91.9990	76.0060
G	94.5719	96.6830
B	94.0779	128.6921
R'	161.8930	148.4379
G'	163.9266	165.5711
B'	163.5386	188.2990
CCT	5059 K	6563 K
RGB	in-gam	in-gam
dE	13.9092	



8.22 ColorChecker Spectral Data

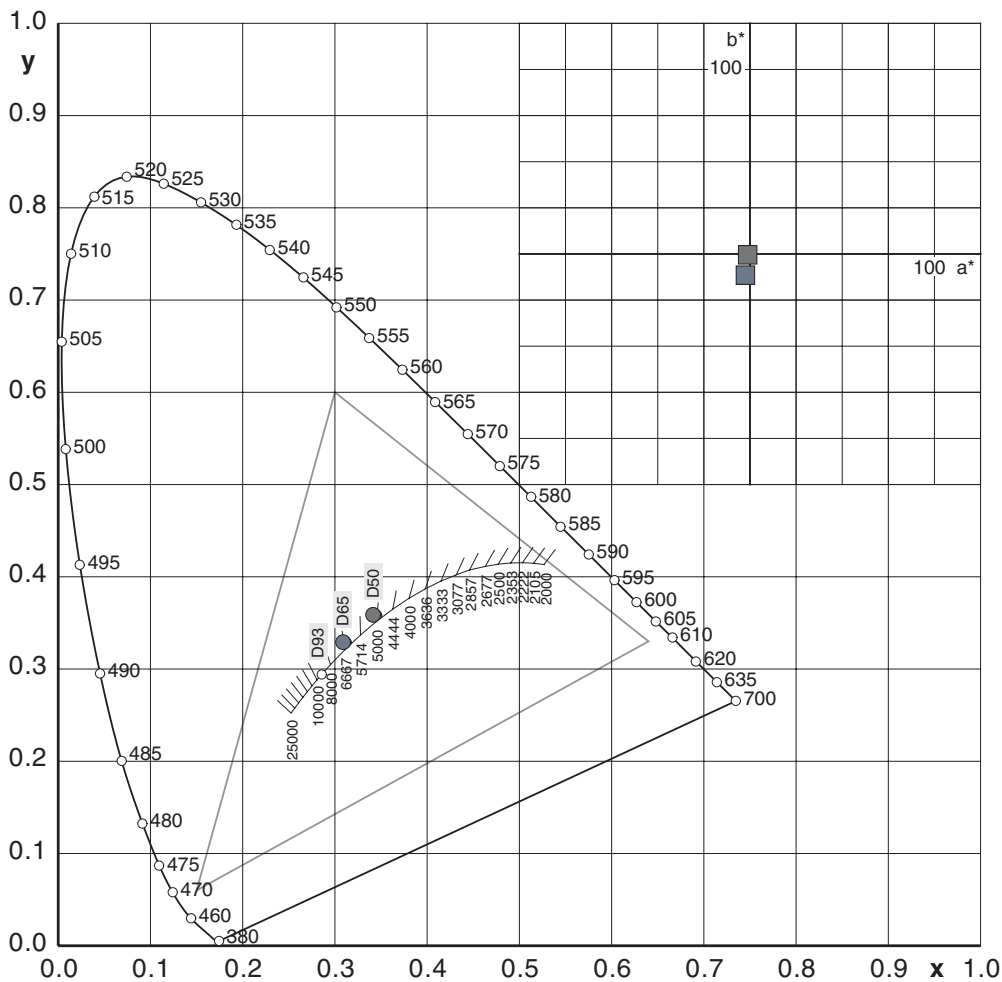


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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.

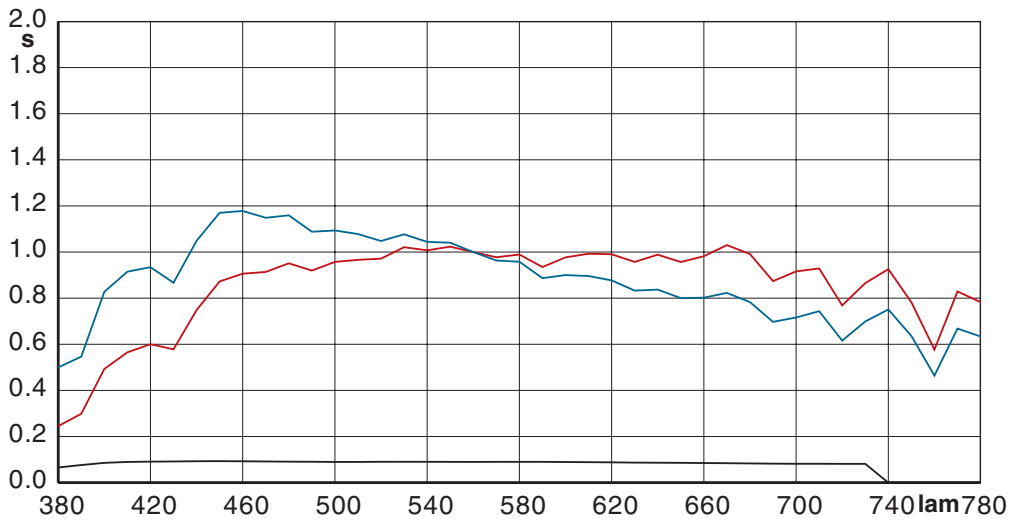
Spectrum generator
 C-Checker 22



Color	1	2
X	0.1765	0.1745
Y	0.1855	0.1857
Z	0.1550	0.2044
x	0.3414	0.3090
y	0.3588	0.3290
z	0.2998	0.3620
L*	50.1530	50.1820
a*	-1.2461	-2.4734
b*	-0.4816	-11.4926
R	45.1857	37.2705
G	47.8942	48.9457
B	47.9497	65.5925
R'	116.7881	106.7016
G'	119.9998	121.2182
B'	120.0645	138.7633
CCT	5149 K	6703 K
RGB	in-gam	in-gam
dE	11.0793	



8.23 ColorChecker Spectral Data

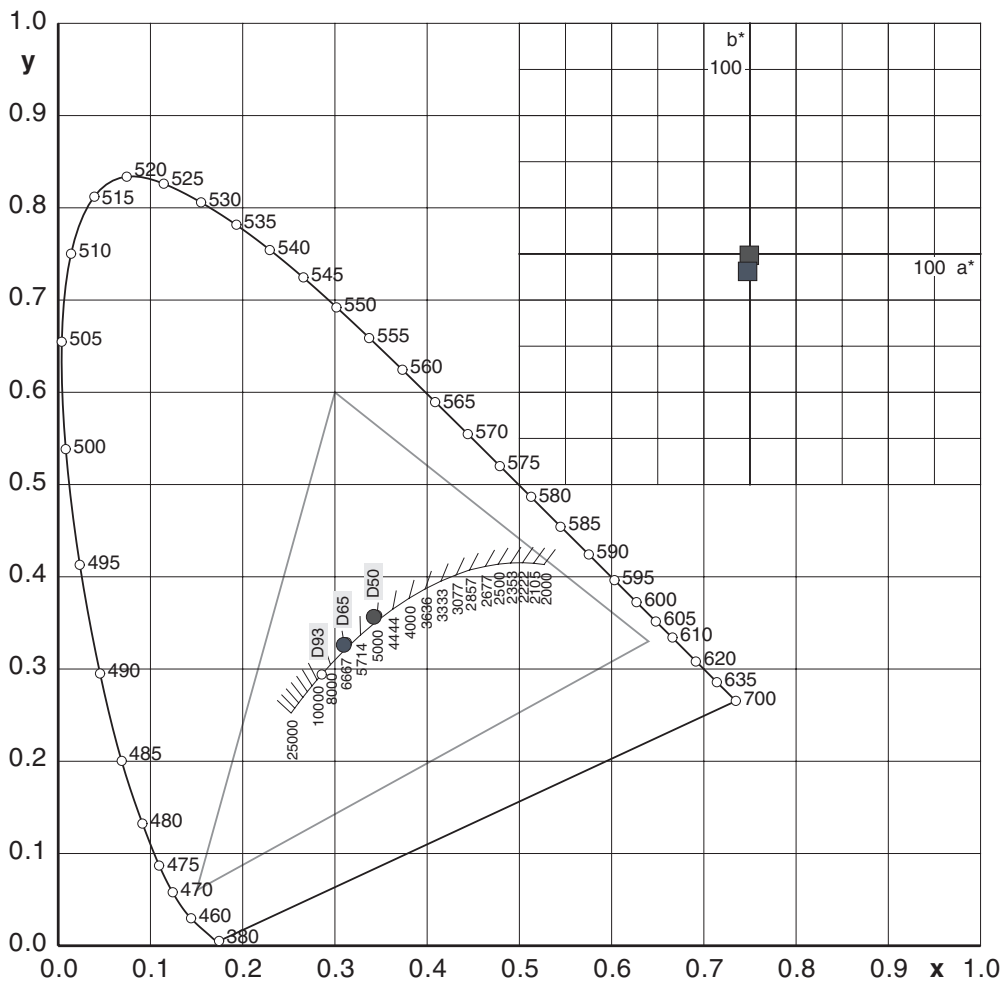


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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.

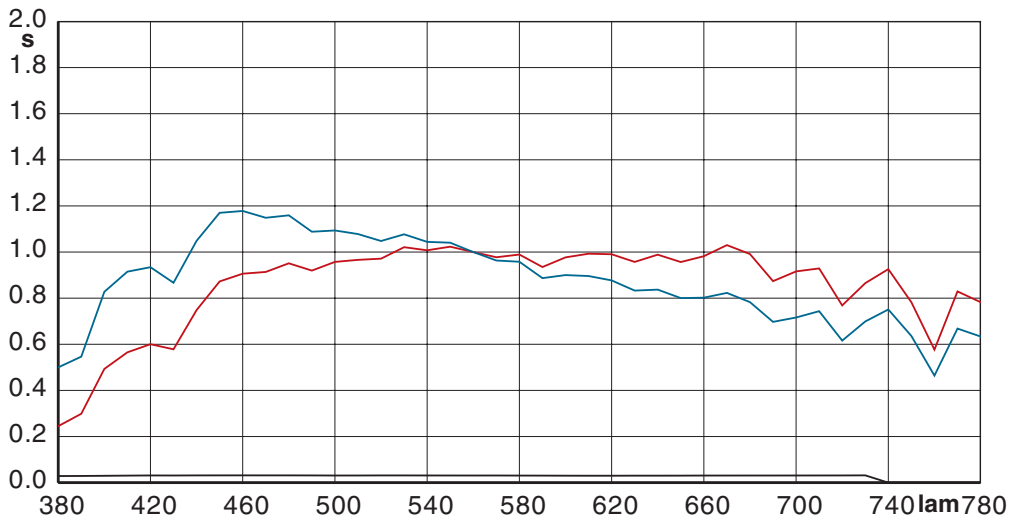
Spectrum generator
 C-Checker 23



Color	1	2
X	0.0862	0.0852
Y	0.0898	0.0899
Z	0.0759	0.1002
x	0.3421	0.3094
y	0.3565	0.3265
z	0.3014	0.3641
L*	35.9442	35.9592
a*	-0.3537	-1.2846
b*	-0.7358	-9.4595
R	22.3392	18.4716
G	23.0149	23.5091
B	23.5493	32.2279
R'	83.5141	76.0860
G'	84.7329	85.6110
B'	85.6818	99.6061
CCT	5119 K	6704 K
RGB	in-gam	in-gam
dE	8.7732	



8.24 ColorChecker Spectral Data

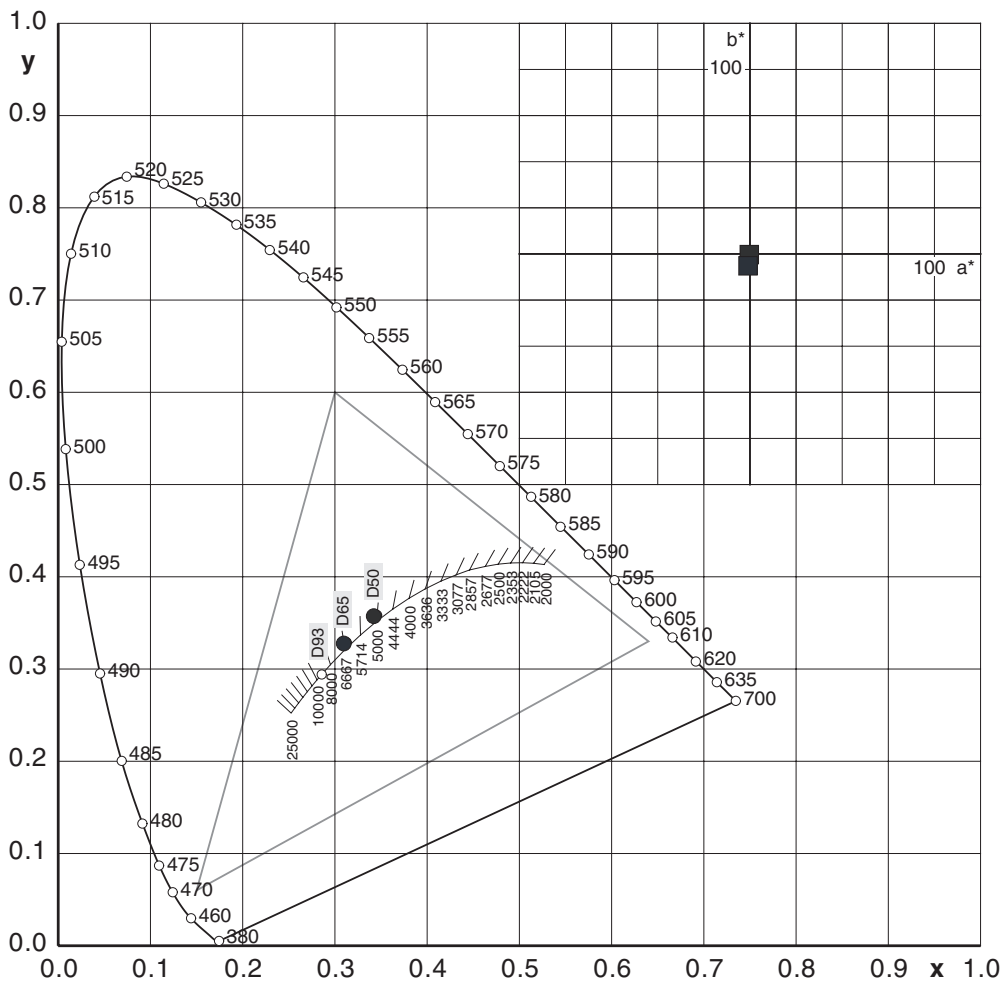


SpectroCalc
G.Hoffmann
Dec.21 / 2006

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
 C-Checker 24



Color	1	2
X	0.0295	0.0292
Y	0.0308	0.0309
Z	0.0259	0.0341
x	0.3423	0.3096
y	0.3575	0.3278
z	0.3001	0.3626
L*	20.3757	20.3872
a*	-0.3688	-1.0696
b*	-0.3627	-6.4447
R	7.6404	6.3010
G	7.9193	8.0957
B	8.0185	10.9711
R'	48.3532	43.5394
G'	49.2919	49.8757
B'	49.6213	58.5029
CCT	5114 K	6684 K
RGB	in-gam	in-gam
dE	6.1223	



9.1 ColorChecker

Measured Lab Values

	Sample	GMB	Spec	DTP-22	Eye-One	Sp.cam
	1 L	37.99	38.40	39.31	39.30	38.94
	a	13.56	13.53	13.37	13.30	13.41
	b	14.06	14.52	14.54	14.70	14.67
	2 L	65.71	66.09	66.50	66.70	65.35
	a	18.13	17.93	19.04	19.20	19.33
	b	17.81	18.22	17.36	17.40	16.79
GMB Reference data by GretagMacbeth Chapter 4	3 L	49.93	50.18	50.23	50.30	48.99
	a	-4.88	-4.94	-4.23	-4.30	-3.76
	b	-21.93	-21.66	-22.42	-22.20	-22.20
Spec Spectral reference by ProfileMaker5 Values according to chapter 8	4 L	43.14	43.25	43.73	43.60	42.58
	a	-13.10	-13.24	-13.49	-13.30	-14.38
	b	21.91	22.61	22.24	22.10	21.86
	5 L	55.11	55.49	55.63	55.70	54.45
	a	8.84	8.75	9.95	9.90	10.38
	b	-25.40	-25.04	-25.33	-25.00	-25.10
DTP-22 X-Rite DTP-22 X-Rite Colorshop	6 L	70.72	71.22	71.04	70.90	69.63
	a	-33.40	-32.92	-33.41	-33.60	-33.24
	b	-0.20	-0.10	-1.20	-1.40	-2.97
Eye-One GretagMacbeth Eye-One Pro ProfileMaker5 / Measure Tool	7 L	62.66	62.83	64.03	64.20	63.01
	a	36.07	35.72	35.04	35.00	34.30
	b	57.10	58.27	58.15	58.70	58.14
	8 L	40.02	40.31	40.85	40.80	39.63
	a	10.41	10.19	11.56	11.60	12.69
	b	-45.96	-45.70	-46.04	-45.90	-46.07
Sp.cam Avantes Spectrocam	9 L	51.12	51.30	52.13	52.30	51.14
	a	48.24	47.80	48.16	48.30	48.20
	b	16.25	16.64	17.62	18.00	18.05
All measurements Absolute D50 Standard observer CIE(1931) 2°	10 L	30.33	30.50	31.96	32.00	31.27
	a	22.98	21.03	21.53	21.70	21.08
	b	-21.59	-21.23	-19.45	-18.90	-18.34
	11 L	72.53	72.92	72.67	72.70	71.20
	a	-23.71	-23.31	-23.49	-23.60	-24.58
	b	57.26	57.68	55.69	55.40	55.54
	12 L	71.94	72.25	71.89	72.90	72.10
	a	19.36	19.21	18.85	18.90	17.65
	b	67.86	68.86	68.91	69.50	68.87
	13 L	28.78	28.76	29.78	29.90	28.25
	a	14.18	14.07	14.40	14.30	16.09
	b	-50.30	-49.81	-50.17	-50.20	-50.41
	14 L	55.26	55.37	55.76	55.90	54.53
	a	-38.34	-37.82	-37.74	-38.00	-38.58
	b	31.37	31.84	31.06	30.90	30.81
	15 L	42.10	41.56	43.67	44.00	43.14
	a	53.38	56.26	53.32	53.50	53.60
	b	28.19	28.52	29.37	29.80	29.99
	16 L	81.73	82.54	83.52	83.80	82.30
	a	4.04	3.53	3.12	3.00	2.11
	b	79.82	80.64	79.89	79.70	78.53
	17 L	51.94	52.25	51.38	52.60	51.41
	a	49.99	49.71	50.33	51.10	50.89
	b	-14.57	-14.16	-13.34	-12.70	-12.20
	18 L	51.04	51.39	51.24	50.90	49.80
	a	-28.63	-28.45	-26.97	-26.80	-25.60
	b	-28.64	-28.22	-29.53	-29.70	-30.45
	19 L	96.54	96.96	97.21	97.10	95.25
	a	-0.43	-0.52	-0.41	-0.60	-0.47
	b	1.19	1.52	0.88	1.20	0.94
	20 L	81.26	81.57	81.96	82.20	80.27
	a	-0.64	-0.74	-0.51	-0.70	-0.66
	b	-0.34	0.12	-0.55	-0.30	-0.40
	21 L	66.77	67.16	67.44	67.30	65.78
	a	-0.73	-0.81	-0.98	-1.20	-1.18
	b	-0.50	-0.07	-0.51	-0.30	-0.47
	22 L	50.87	50.15	51.17	51.00	49.78
	a	-0.15	-1.25	-0.31	-0.40	-0.48
	b	-0.27	-0.48	-0.07	0.20	-0.01
	23 L	35.66	35.94	36.23	36.20	34.88
	a	-0.42	-0.35	-0.57	-0.70	-0.75
	b	-1.23	-0.74	-1.29	-1.10	-1.19
	24 L	20.46	20.38	21.68	21.30	21.28
	a	-0.08	-0.37	-0.06	0.00	-0.20
	b	-0.97	-0.36	-0.57	-0.50	-0.53

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Gernot Hoffmann
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