Rawtherapee-Colorimetry

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Jacques cast down

Objectives of this document:

This paper has several objectives relating to colorimetry:

1. Summarize the process of processing a raw file from the viewpoint of **colorimetry** and highlight key points, gaps
2. Explain the principles of the essential steps so that the user can assess the issues
3. Cut the manual of certain functions that may seem obscure to the uninitiated.

Note that this document deals exclusively with RT4 work with real numbers, not RT3.

Raw initial process before RGB conversion

1) Read the Raw file and use its data:

- The first step, provided mainly by the base Dcraw (D.Coffin thank you) is to read the raw files of all types, with their own encodings: depth of 12 or 14 bit data, sensor saturation, white balance, ... and of course the data or rggb rgbg;
- white balance default is the one chosen by the user on the casing at the time of shooting;
- interpolation (AMAZE, AHD, DCB ...) then occurs by changing the data in RGB (image can be evaluated visually on a screen): the interpolation does not change (or not) and colorimetry is the case for all these interpolations in RT (the deltaE94 of the interpolation is approximately a negligible), for against the limits (specular highlights, ...) artifacts can appear for some of them .
- RGB data are modified to make them look more realistic, by either: a color matrix (Adobe origin) or an ICC profile "input", we will return below to these profiles, their preparation and their use ;
- rgb values are without color space - this is fundamental (eg choosing sRGB or AdobeRGB proposed on the case concerns only JPG files)

2) ICC profiles "input": development, use, gaps

- apply these profiles (as defined colorimetry "apply" and not "convert") or as external profiles after converting RGB (as does Capture NX2) to RGB data, so theoretically no intention (relative, absolute, perceptual, saturation) . They modify the Lab values, but not the rgb values - the histograms remain the same, either as internal profiles as does RT (theoretically no intention ...);
- they try to reduce the gap between their initial values (those of the sensor) and a target value theoretically perfect;
- they are theoretically valid for: a given illuminant (D50, C, shadows, ...), the conditions of the shooting of the target, target shooting ...
- However, we can safely use them provided that they remain substantially in the same environment, for example flash instead of daylight, D55 instead of D50 ...

- development:
  - photographing a test pattern under ideal conditions shooting that fit your desired use (outdoors, studio, ...);
  - over the gamut of the target is large, the better the result, for example ColorChecker24 is close to sRGB, even if it performs well in normal cases, how can it effectively assess the actual colors that are beyond sRGB (flowers, artificial colors ...)?
  - more the focus will be a number of large cells, the better the result (better guidance of the profile)
  - such as information for my D200, the results of deltaE94 obtained from the shadow (NEF) of 468 colors on my radar which I apply the input profile or matrix:
    - original color matrix (Dcraw): mean = 4.37, SD = 1.82, maximum = 13.75
    - ICC profile in the directory "Iccprofile" developed from the ColorChecker24 close to sRGB: mean = 3.66, SD = 2.08, maximum = 11.28
    - ICC profile, developed by me from the target color gamut 468 wide near WideGamutRGB: mean = 2.05, SD = 1.44, maximum = 8.8
    - Of course in most cases, the profile will be made with a ColorChecker24 enough!

  - take pictures of the pattern 12 to direct sunlight (a) or overcast (b), or in the shade (c) or with a tungsten light (d), or with a lamp studio Solux (e) which has a spectrum very close to daylight, or f) any other lighting that fits your needs:
    - put the box in manual mode (exposition. ..)
    - adjust the white balance on a) 5000K (or equivalent "sun"), b) 6000K c) 8000K d) 2850K tungsten e) Sun 4700K f) ...
    - ensure that there is no reflection
    - take several shots by 1/3 EV
    - ensure the most perfect equality between the exhibition center and the four edges of the pattern
  - put (s) file (s) in a RAW file RT
  - Raw open with a profile pp3 "neutral" and choose "Prophoto" as "working profile" in "Input Profile" choose "No profile"
  - assess exposure from a gray cells of the pattern whose luminance is between L = 40 and L = 60 and examine the difference in exposure between the dark edges of the pattern, select the image with the best compromise ; again optionally shooting

- adjust the exposure with "raw black-white point" - "white point: linear corr.factor" ensuring that "HL White Point Preserving corr (EV)" is zero, so that the value of L the reference cell gray is the closest possible to the reference.
- adjust the white balance with SpotWB, choosing a gray cell (L> 20 - <80) with values "a" and "b" are as close to zero (the values for this operation "a" and "b "must be less than 0.5, otherwise if the cell has values 'a' and 'b' close to 1, adjust the sliders with" temperature "and" color "(or even further notes on the white balance) in such thereby achieving the Lab values of the reference cell.
- then click on "Save reference image for profiling"
- use your "profile" which will be according to the manufacturer of the spectral values or XYZ values or Lab: Build a profile type for reproduction illuminant corresponding to the shooting (D50, D65, Solux, etc..).

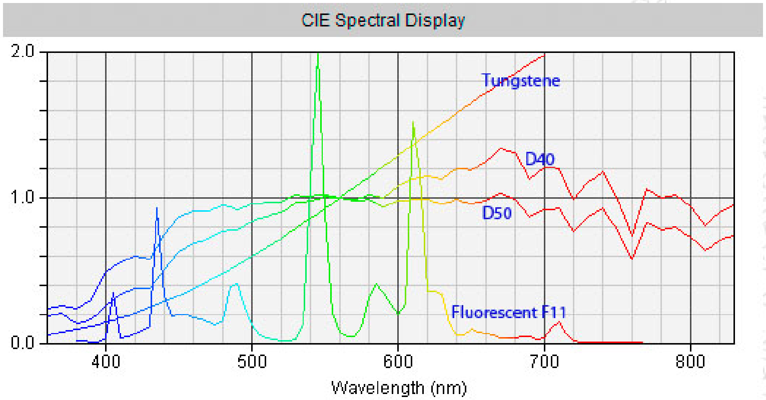
* use:
  - set up the profile in the "ICCdirectory" RT is \ windows \ system32 \ spool \ drivers \ color for Windows and / usr / share / color / icc for other systems. careful not to confuse this issue with one of ICC profiles "input" of RT (ICCprofiles / input).
  - choose "custom" in "Input Profile" (or "gold standrad Camera ICC" if it was placed in profile ICCprofile) and select the profile you have developed.

* RT-gap LCMS2:
  - the color management system used by RT is simple and free. Nevertheless it has some "flaws". Indeed when compared to the system Adobe (Photoshop CS), there is no possibility to apply a profile without using an intention (relative, perceptual, ...), which has consequences for the rgb values negative and greater than 65535 are clipped, which is not good example to use these profiles with "vibrance" or overexposed images.
  - I changed "Rawimagesource.cc" so that the profile is always applied (not in the sense Adobe) with profile-Prophoto so the clipping data will be minimal, then do a double conversion XYZ RGB values to maintain negative and greater than 65535.

3) White Balance:

Gaps of white balance:

- white balance is really effective only if used "SpotWB" a perfect gray ("a" and "b" Lab to zero), but as it is almost impossible to put a gray card on each photo taken (if not to do so to the Alfred Hitchcock), usually you have to go if you want to adjust the white balance of the housing by the sliders "Temperature" and "Tint";
- But the sliders to give an amplitude 1200K 12000K, and the calculation basis corresponding to illuminant D (daylight) is not valid below 4000K (the calculations are an extrapolation)
- More information becomes incorrect if the illuminant is different from the daylight (D) such illuminant "blackbody" or "Fluorescent"
- So caution, caution when being outside of the illuminant D (daylight) and temperatures below 4000K



- this graph (B.Lindbloom) represents the spectral data for four illuminants I have chosen arbitrarily: D50 (5000K), D40 (4000K), A (tungsten - 2850K) and F11 (fluorescent). It clearly shows the difficulty in extrapolating the illuminant D. ..
- it is therefore necessary to review the algorithms "white balance" (see below).

White balance - principles:

- **Taken:**
- During the shooting, two basic options available to the user: a) work in RAW mode, in this case errors are allowed and editing is possible with RAW processing software, for example RT b) JPEG work, in this case if the choice of white balance on the case is different lighting conditions retouching is difficult or impossible. We will favor the study of Raw mode.
- However a case has, (essential in JPEG, RAW desirable) of several white balance settings. Of course these features depend on the make and model, but often found:
- an "auto" mode: it is the electronic box that decides what is good value, from algorithms "home." This method generally works quite well, except when there are strong color casts.
- A "manual" mode, where the user, for some brands, between a temperature value, eg 7000K. This choice is made by an informed user based on his experience.
- A fashion "preselection" where the user can choose from a predetermined number of situations in "factory", "Sun", "shadow," "covered", "flash", "Glow", "fluorescent", ...
- Note that each brand and each box to its specificities, for example fluorescent mode
- Canon equips its boxes with a single mode;
- Fuji gives 3;
- Pentax gives 3;
- Nikon gives up to 7 (D3S, D300, ...)
- etc..
- Note also that the value "flash" is different from one brand to another, for example:
- Nikon D300, the flash illuminating substantially corresponds to 6400K
- Leica R9, the flash illuminating substantially corresponds to 5500K
- a Sony A900, the flash illuminating substantially corresponds to "shade" or, to 7000K ...
- course in most cases the choice of screening is pretty obvious, but in other cases the user will know what to choose ... In fact at an exhibition, museum visits, etc.. What is the lighting used?
- All these settings affect the multipliers of channels;
- In final during treatment "raw" this choice will appear in RT as "Camera"

- **Processing raw**
- until today (November 2011), RT offers four options:
- "Camera" (see above)
- "Auto": The software evaluates the white balance by an "average" data vis-à-vis a theoretical neutral gray;

- "Custom": the user can choose the temperature and tint (see "gaps of white balance")
- "WB Spot": the user selects a neutral gray area as reference. This assumes the almost mandatory presence at the picture of a gray card.

- **Colored object - illuminating - observer**
- By simplifying the colorimetry can be summarized in three types of data:
- Colored object: it is characterized by its pigments (red, blue, ...) whatever the light source illuminating. It can be evaluated with a specto, which will give a unique representation
- Illuminant or light source: this data characterizes the nature of the light source (sun at midday, Shade, Flash, tungsten light, fluorescent tube ...). It is evaluated by two data: its spectral distribution and temperature correlated; attention to two light sources that have the same temperature are not identical because their spectral data are different.
- Observer: made the following experiment, observe the color of a painted wall, then that of the sample that allowed you choose, you will find that the sensation of color is different. The CIE (International Commission on Illumination) has defined two "observer s', 2 ° and 10 °, characterized by the angle of looking at the color.
- To calculate the observed values of a colored object under illuminant X, it is necessary to intervene in the calculation of the spectral data of the object, the illuminant and observer
- XYZ these values will be specific to the temperature of the illuminant (eg 6500K); in software (Photoshop, RT ...) is to use the standard D50. It is therefore imperative to make an adaptation chromatic values XYZ (illuminant) to XYZ (D50). Why several methods exist for the less efficient to more efficient: Von Kries, Bradford, CIECAM02.

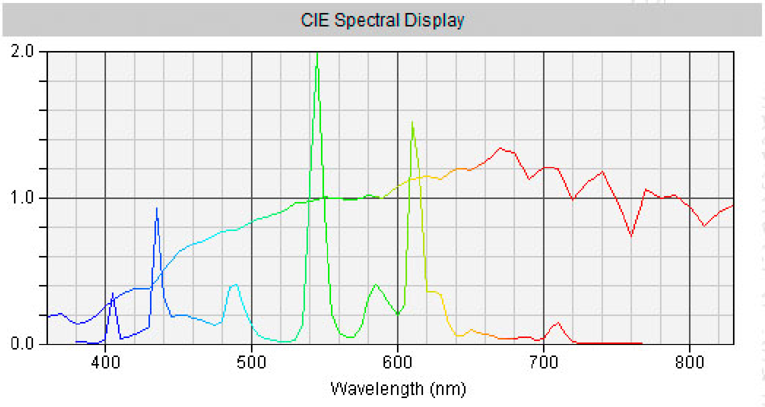
- **The daylight illuminant (Daylight):**
- This illuminant has been the subject of numerous studies by Judd, MacAdam and Wyszecki, from several hundred examples.
- Briefly illuminating the "D" is the sum of three parts: S (lambda) = S_0 (lambda) + $M_1 * S_1$ (lambda) + M_{*2} S_2 (lambda)
- some "fixed" So which is the average of all samples tested;
- Part one "variable" S_1 which is the change "blue / yellow" due to the presence or absence of clouds or the position and intensity of direct sunlight;
- a second part "variable" S_2 which is the change "pink / green" due to the presence of moisture as a vapor or mist ... ;
- In practical terms this translates into a formula "simple" that determines two values x_D y_D and depending on the temperature of the illuminant
- $x\_D = 0.244063 + 0.0991 * 10^3 / T + 2.9678 * 10^6 / T^2 - 4.6070 * 10^9 / T^3$ to 4000K <T <7000K
- $x\_D = 0.237040 + 0.24748 * 10^3 / T + 1.9018 * 10^6 / T^2 - 2.0064 * 10^9 / T^3$ to 7000K <T <25000K
- $y\_D = -3.0 * x\_D^2 + 2.87 * x\_D-0275$
- these formulas are used to calculate the parameters M1 (x_D, y_D) and M2 (x_D, y_D) S (lambda) = S_0 (lambda) + $M_1 * S_1$ (lambda) + M_{*2} S_2 (lambda) - it was not the case so far in RT. Earlier in RT values xD and yD used directly to calculate the multiplier channels, now these values are used to determine the spectral values of the illuminant at temperature T. It is then that seulemnt second values calculated for determining multipliers channels.

- We immediately see two things:
- there is no reference "Daylight" below 4000K, the previous formula used in RT (1200K to 4000K of) was "invented" in the context of ufraw;
- there is no reason to modify RT to get the maximum value of 12000K 25000K to

- **Illuminant "black body" (blackbody) and "A: tungsten"**
- "Illuminant CIE is used to represent the light of a typical tungsten filament of a lightbulb home. Its relative spectral distribution is that of a Planck radiator at an approximate temperature of 2856 K. Illuminant CIE can be used in all applications of colorimetry involving the use of incandescent light, unless there are specific reasons to use another illuminant. "
- illuminating the "black-body" (blacbody) can be calculated by Planck's formula is the generalization of the illuminant in terms of T:
- S (lambda) = c1 * pow (wavelength, -5.0)) / (exp (c2 / (wavelength blackbody_Temp *)) - 1.0);
- where two values c1 and c2 correspond to: a) c1 = 2 * pi * h * c ^{2} Planck constant h = c = speed of light, b) c2 = h * c / kk = Boltzmann constant
- This illuminant is connected well to 4000K with illuminant "Daylight" with minor deviations
- I chose to use RT below 4000K and 2000K down, illuminating the "black-body" (it seems that "CAB" has made the same choice)

- **Fluorescent illuminants:**
- standardization provided 12 illuminants of this type, corresponding to tubes commercially available:
- F1: daylight fluorescent - 6430K
- F2: White fluorescent cold - 4230K
- F3: White Fluorescent - 3450K
- F4: Warm White Fluorescent - 2940K
- F5: daylight fluorescent - 6350K
- F6: White fluorescent light - 4150K
- F7: D65 simulator - 6500K
- F8: Simulator D50 - 5000K
- F9: Deluxe Cool White - 4150K

- F10: T85 Philips - 5000K
- F11: T84 Philips - 4000K
- F12: T83 Philips - 3000K
- these illuminants (see "gaps of white balance") have a spectral distribution very different among themselves and between the illuminant "daylight" and "blackbody". It is therefore advisable to change very little - in a fluorescent lighting - the lighting in question (eg F11 4000K), by an equivalent "Daylight 4000K"



- on this graph we see that for the same temperature, the illuminant Daylight 4000 (spectrum) is very different from F11 Fluorescent (4000K)., so it will bring a different color rendering.
- In fact the white balance, calculated from spectral data, two coefficients xD, yD multipliers that modify channels: the calculation of xD and yD acts like a calculus averaged. While the white balance "average" will be good but picks or deviations of the spectral data compared to a theoretical ideal (black-body or daylight) locally to bring some color variations of hue more or less important.
- There is a concept "CRI = Color Rendering Index" that reflects the quality of the light source. This "CRI" is a figure that is 100 for a perfect source. An estimated values greater than 90 give acceptable results. For example:
- Fluo F4 "warm white": CRI = 51
- Clear Mercury Vapor: CRI = 17
- several LEDs with "LIRA" between 50 and 96
- Solux 4700: CRI = 92
- etc..
- this concept is implemented in RT with the following choices:
- 20 standard colors including 8 "standard" Colorchecker24 more, 4 skin tones, 4 gray (white - black), 3 blue
- for use of chromatic adaptation CIECAM02
- using CIE Lab to calculate deltaE
- To remedy this (partially), simply make an ICC profile input (see the relevant paragraph) with the desired light source corresponding spectral data matched.

Other illuminants:

- there are other derivatives of the illuminants and illuminant A close to "daylight": B and C that I have not implemented in RT, but it is possible to do
- an illuminating power equal to: "E"
- illuminant of studio lights (cinema, stage lighting, museums, photo studio, etc..) found under the names: HMI, GTI, Solux 4700K, JudgeIII, Solix4100K, Solux3500K, etc.., which are located in RT.
- LED illuminants: these lamps are often large gaps in the blues. Some have characteristics quite satisfactory
- The illuminating flash "owners" (Canon, Nikon, Pentax ...) and studio flashes: generally they are very close to daylight, but each at different temperatures: I made several groupings to 5500K , 6000K and 6500K, for studio flash would need to have their characteristics
- in theory it would be necessary to have the spectral data of each flash (I do not have) over the data vary according to the power of lightning ...
- So I preferred to use the equivalent "daylight"

As you can see the situation is not simple and there are many problems with Raw processing software, including RT.

Diagrams of illuminants and Color Rendering Index (CRI)

The notion of CRI and correlated temperature:

You can find information about these concepts, http://en.wikipedia.org/wiki/Color_rendering_index

What choice have I done for RT:

- using two panels of color: a) standard, with eight colors from the ColorChecker24, b) expanded with 12 additional colors: 4 gray / white / black skin 4 shades, 2 blue skies, a green foliage a blue gamut important (beyond WideGamut):
- I list the 20 colors with their reference (Colorchecker24, ColorcheckerSG, ColorcheckerDC, JDC_468) Lab Portfolio (D50) provided that calculations are performed with the spectral values of these colors.
- panel 8 colors (D50):

A	2	3	4	5	6	7	8
ColChc24: C3	ColChc24: A2	ColChc24: D3	ColChc24: E2	ColChc24: B3	ColChc24: F3	ColChc24: D2	ColChc24: E3
Red	Orange	Yellow	Green	Green	Cyan	Purple	Magenta
L = 42	L = 62	L = 82	L = 72	L = 55	L = 50	L = 31	L = 51
a = 56	a = 34	a = 4	a = -23	a = -39	a = -27	a = 21	a = 49
b = 29	b = 60	b = 79	b = 57	b = 33	b = -28	b = -21	b = -13

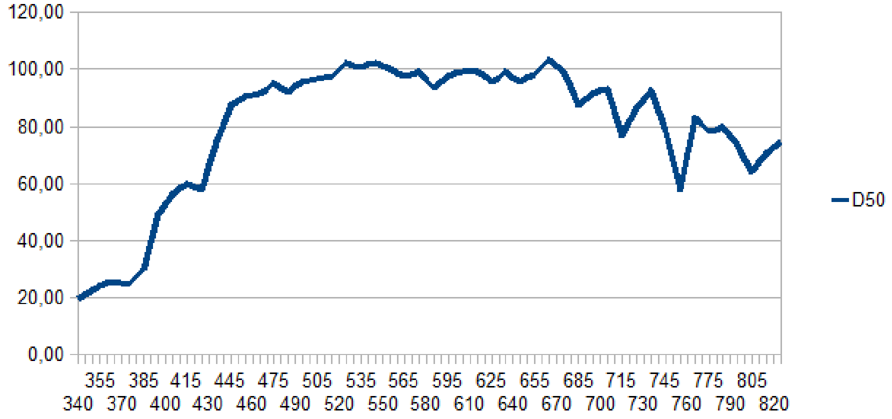
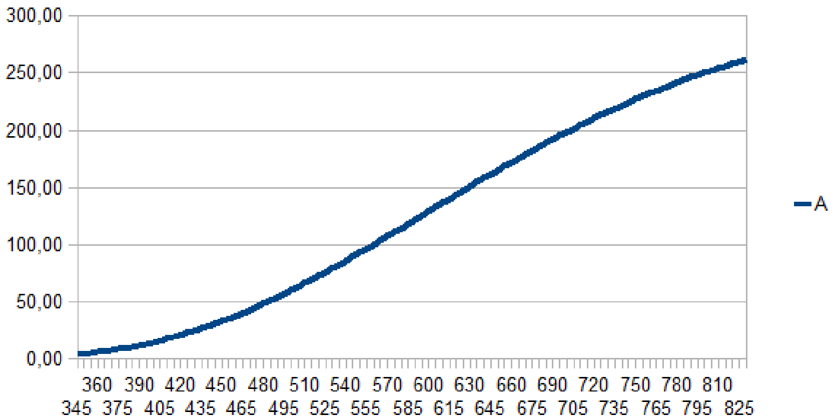
- -16 Additional panel colors:

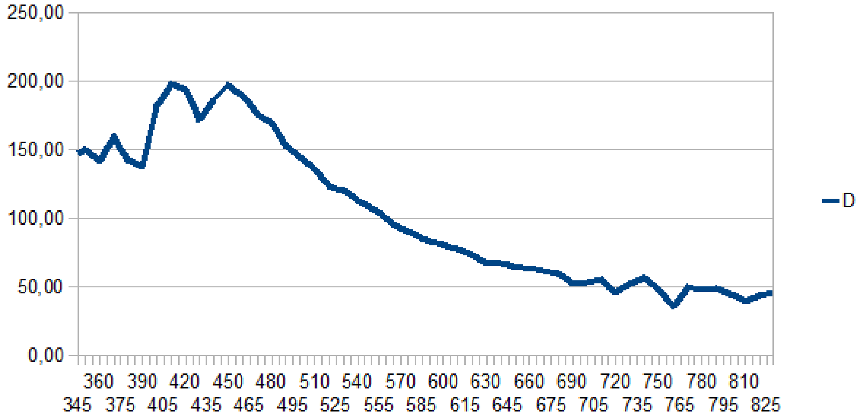
9	10	11	12	13	14
ColChc24: A1	ColChc24: C4	ColChc24: B1	ColChc24: C1	ColCh_DC: N8	ColCh_SG: F7
Skin	Gray	Skin	Blue sky	Blue sky	Skin
L = 38	L = 66	L = 66	L = 50	L = 81	L = 63
a = 14	a = -0.14	a = 16	a = -5	a = -7	a = 14
b = 16	b = 0.03	b = 18	b = -22	b = -15	b = 26

15	16	17	18	19	20
ColCh_SG: K2	ColChc24: A4	ColChc24: D1	ColCh_SG: N3	JDC_468: K14	JDC_468: H10
Skin	White	Green leaf	Black	Gray	Blue
L = 85	L = 95	L = 43	L = 6	L = 44	L = 30
a = 10	a = -0.3	a = -14	a = 0	a = 0.3	a = 5
b = 17	b = 2.5	b = 21	b = -0.3	b = -0.4	b = -71

- calculate the XYZ values with spectral data of these colors, those of the illuminant, and observe 2
- perform chromatic adaptation by CIECAM02 significantly better than Von Kries or Bradford
- calculate deltaE by CIE Lab, significantly outperforms CIEUVW
- Adjust the coefficient to calculate the ICC in order to achieve results comparable to the values "normal"
- display data CRI and sigma to show the lighting quality on average and dispersion.
- Correlated to determine the temperature, I use the formula of Robertson and the code developed by B.Lindbloom

Illuminating	**IRC standard deviation**	**CRI expanded RT, SD**
Illuminant D50	CRIs = 100 sigma = 0	CRI = 100 sigma = 0

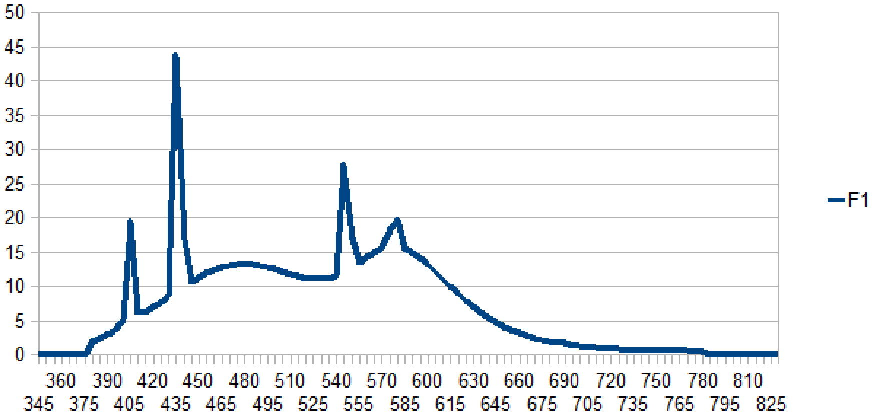
 		
<u>Illuminant A (2856K)</u>  	CRIs = 100 sigma = 0	CRI = 100 sigma = 0
<u>Illuminant D 150 (15000K)</u>		



CRIs = 100 sigma = 0

CRI = 100 sigma = 0

Fluorescent lighting F1 'Daylight' 6430K



CRIs sigma = 77 = 10

Colors most deficient (N, CRIs):

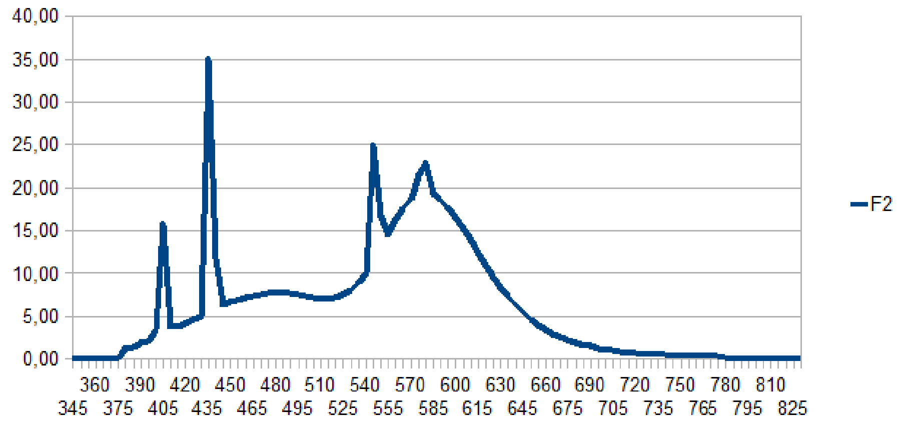
1 to 55

8-68

CRI = 84 sigma = 12

Additional colors most deficient (N - CRI):

From 20 to 57

Fluorescent lighting F2 "coolwhite" 4230K 	CRIs sigma = 64 = 12 Colors most deficient: 1 to 41 6-59 8-57	CRI = 75 sigma = 19 Additional colors most deficient: 20-20
Fluorescent lighting F3 "white" 3450K	CRIs sigma = 60 = 12 Colors most deficient: 1 to 38 6-52 8-53	CRI = 72 sigma = 22 Additional colors most deficient: 20-5

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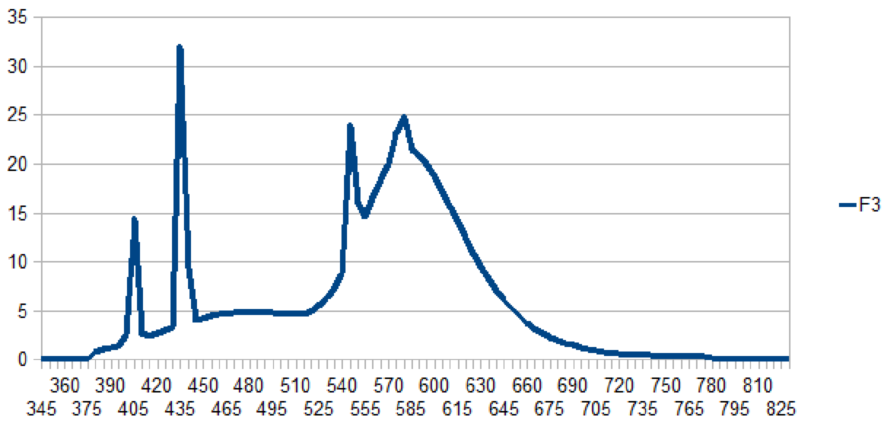
<td>
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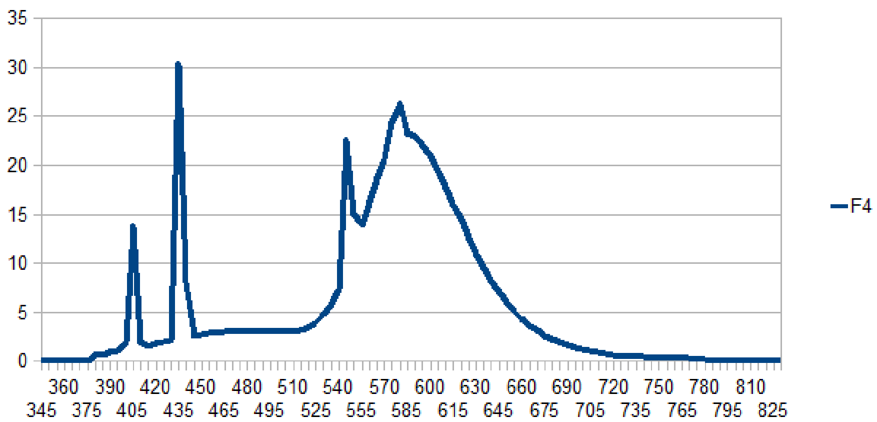
<tr>
<td><u>Fluorescent lighting F4 "warm white" 2940K</u>

</td>
<td>CRIs sigma = 54 = 11

Colors most deficient:
1 to 34
3-52
6-46
8-49</td>
<td>CRI = 67 sigma = 25

Additional colors most deficient:
20-0 (11)</td>
</tr>
<tr>
<td><u>Fluorescent lighting F5 'Daylight' 6350K</u></td>
<td>CRIs sigma = 74 = 12</td>
<td>CRI = 83 sigma = 14</td>
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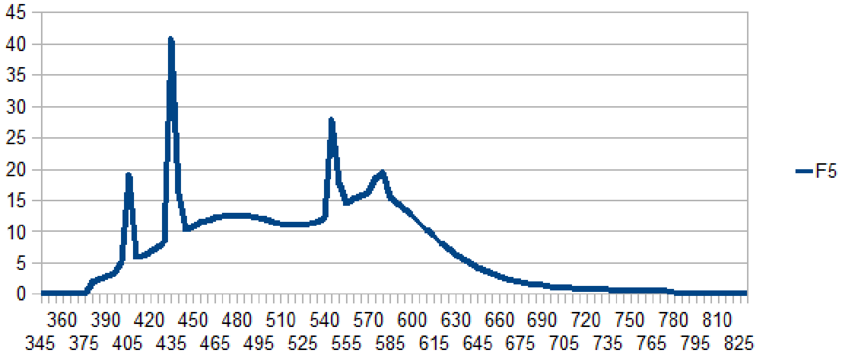
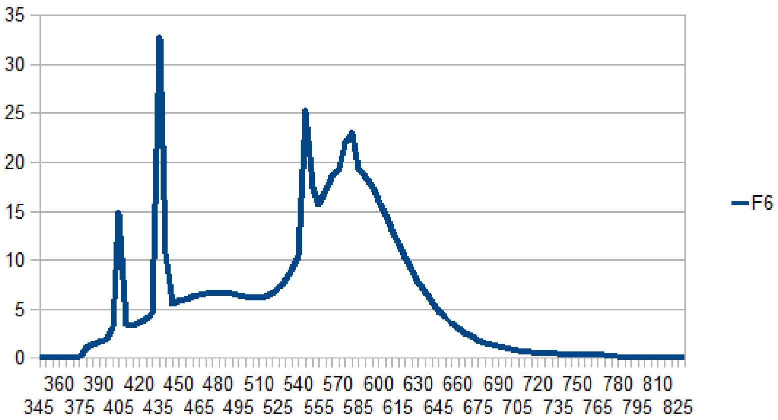
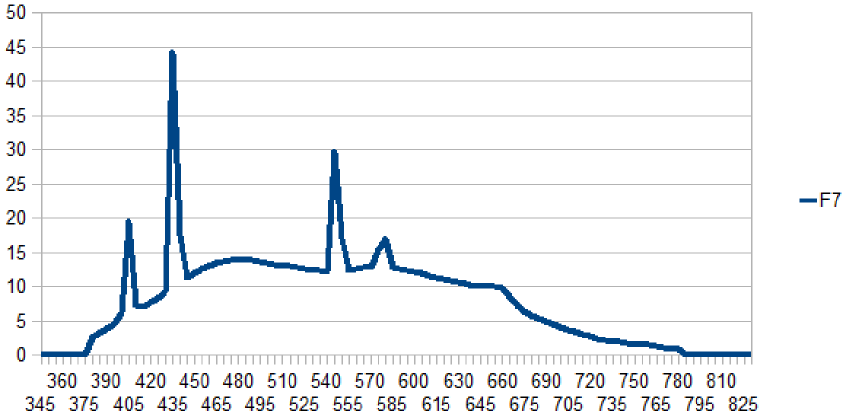
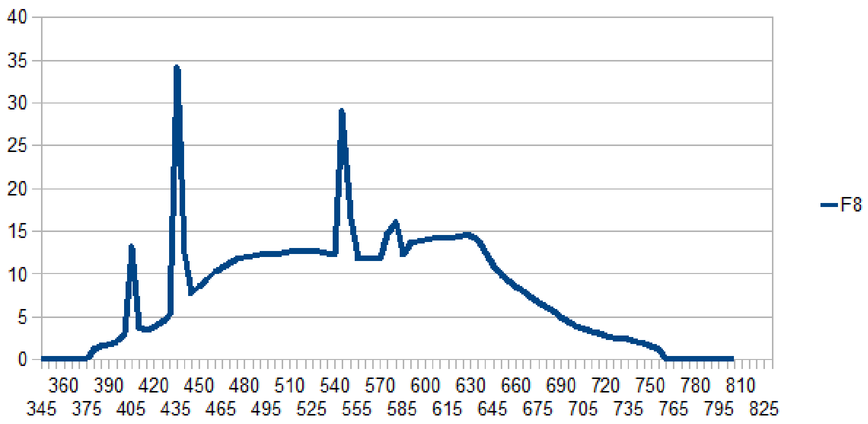
	Colors most deficient: 1 to 49 8-63	Additional colors most deficient: From 20 to 55
<u>Fluorescent lighting F6 "Lite White" 4150K</u> 	CRIs sigma = 61 = 13 Colors most deficient: 1 to 34 6-55 8-52	CRI = 73 sigma = 21 Additional colors most deficient: 20 to 14
<u>Fluorescent F7 illuminant "D65 Simulator" 6500K</u>	CRIs sigma = 90 = 2	CRI = 93 sigma = 6

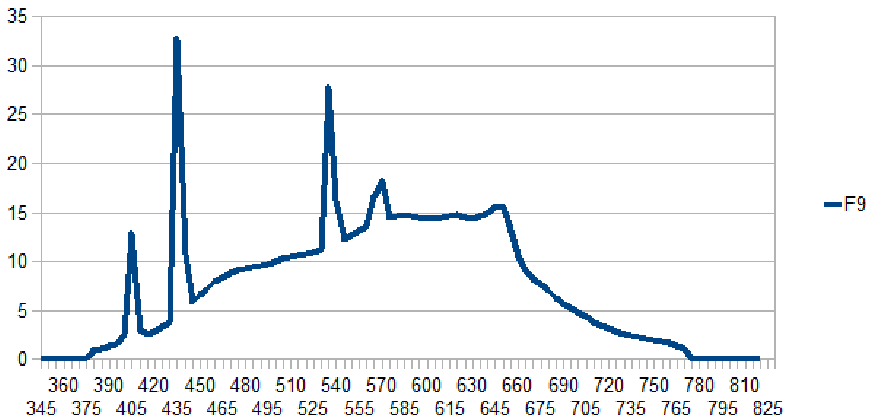
 	Colors most deficient: 1 to 88 3-88	Additional colors most deficient: From 20 to 71
<u>Fluorescent F8 illuminant "D50 Sylvania F40" 5000K</u>	CRIs = 94 sigma = 1.4 Colors most deficient:	CRI = 95 sigma = 4 Additional colors most deficient:



1 to 91

From 20 to 83

Fluorescent lighting F9 "Deluxe Cool White" 4150K (T corr = 4330K)



CRIs = 89 sigma = 1.7

Colors most deficient:

1 to 87

8-88

CRI = 92 sigma = 6

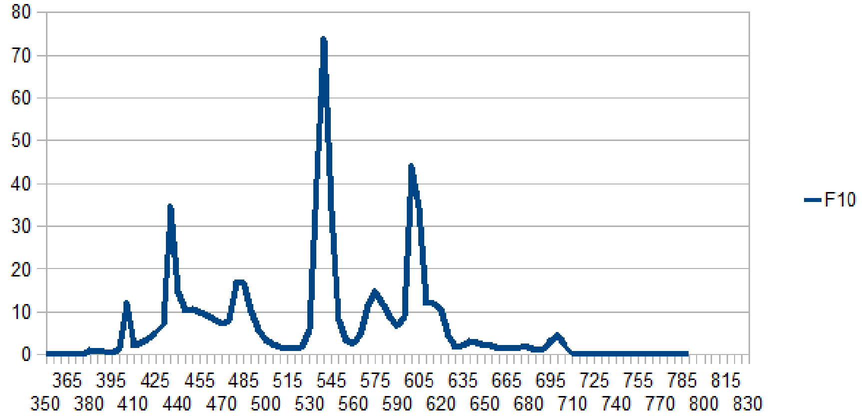
Additional colors most deficient:

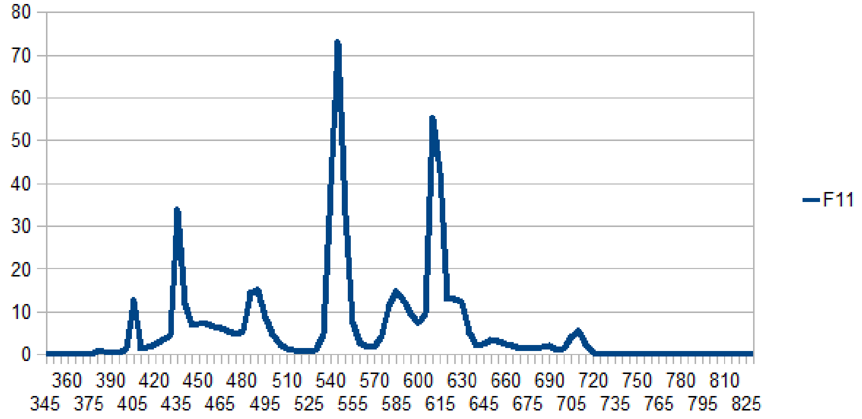
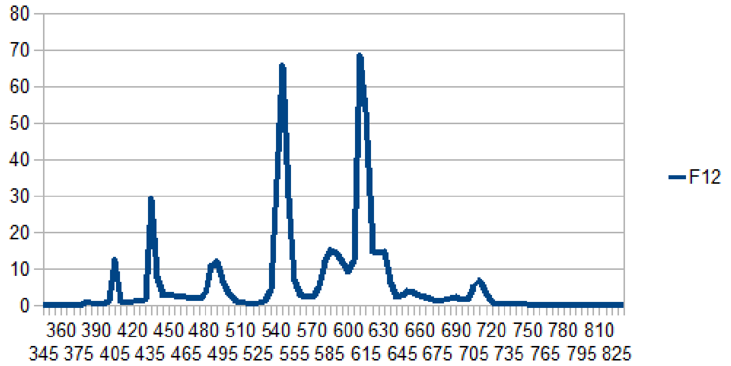
From 20 to 71

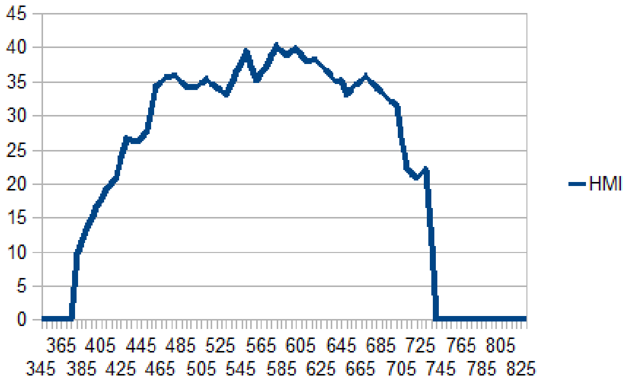
Fluorescent lighting F10 "Philips TL85" 5000K

CRIs sigma = 72 = 11

CRI = 81 sigma = 18

 	Colors most deficient: 1 to 47 8-68	Additional colors most deficient: 20 to 25
Fluorescent lighting F11 "Philips TL84" 4150K (T corr = 4000K)	CRIs sigma = 77 = 9 Colors most deficient: 3-63 4-67 6-73	CRI = 82 sigma = 20 Additional colors most deficient: From 17 to 62 20-10

		
Fluorescent lighting F12 "Philips TL83" 3000K 	CRIs sigma = 78 = 8 Colors most deficient: 3-69 4-70	CRI = 83 sigma = 17 Additional colors most deficient: From 17 to 58 20 to 27
	CRIs = 97 sigma = 1.2	CRI = 98 sigma = 1.4 Additional colors most deficient:

<table>
<tr>
<td><u>Illuminant Lamp HMI - 4800K</u>

</td>
<td>Colors most deficient:</td>
<td></td>
</tr>
<tr>
<td><u>Illuminant Lamp GTI - 5000K</u></td>
<td>CRIs = 90 sigma = 1.8

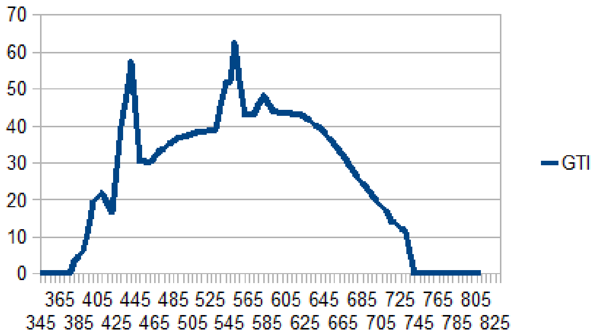
Colors most deficient:

1 to 88</td>
<td>CRI = 93 sigma = 6

Additional colors most deficient:

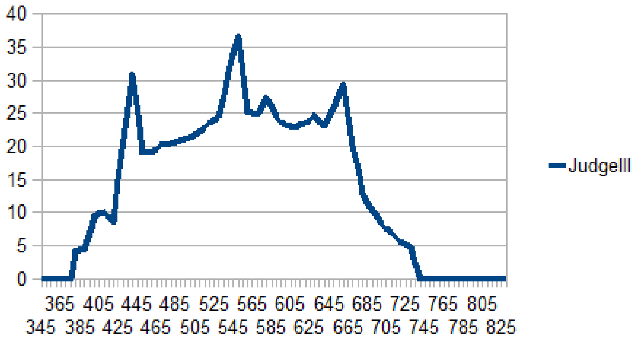
From 20 to 73</td>
</tr>
</table>

<table>
<tr>
<td>



</td>
<td>2-88</td>
<td></td>
</tr>
<tr>
<td>

<u>Illuminant Lamp JudgeIII - 5000K</u>



</td>
<td>

CRIs = 92 sigma = 1.8

Colors most deficient:

6-89

</td>
<td>

CRI = 94 sigma = 5

Additional colors most deficient:

From 20 to 75

</td>
</tr>
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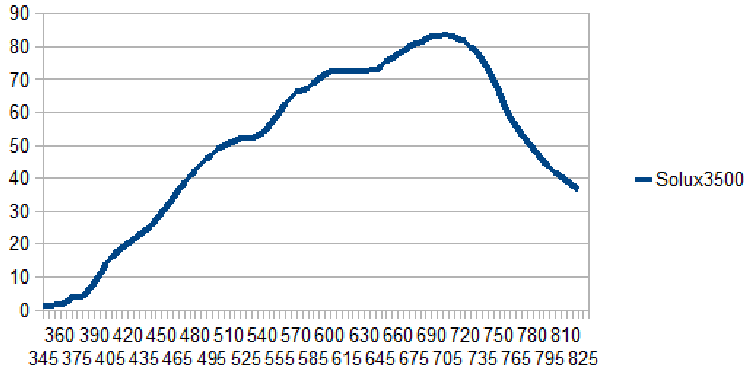
Illuminant Lamp 3500K Solux  	CRIs = 95 sigma = 1.8 Colors most deficient:	CRI = 97 sigma = 2 Additional colors most deficient: From 20 to 90
Illuminant Lamp 4100K Solux	CRIs = 98 sigma = 0.3 Colors most deficient:	CRI = 98 sigma = 0.7 Additional colors most deficient:

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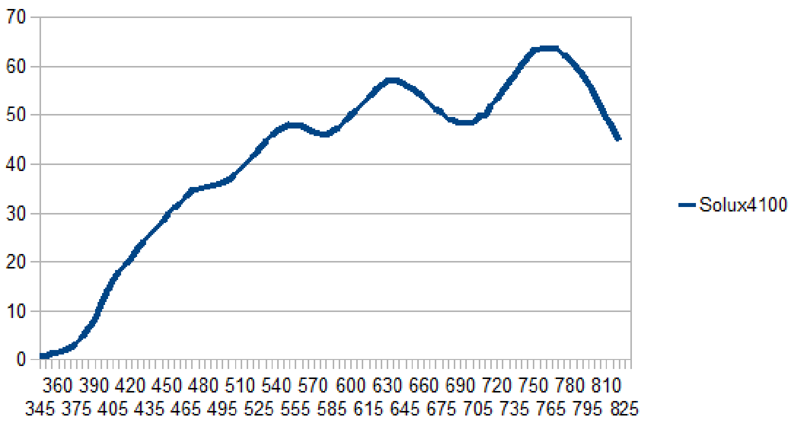
<tr><td>
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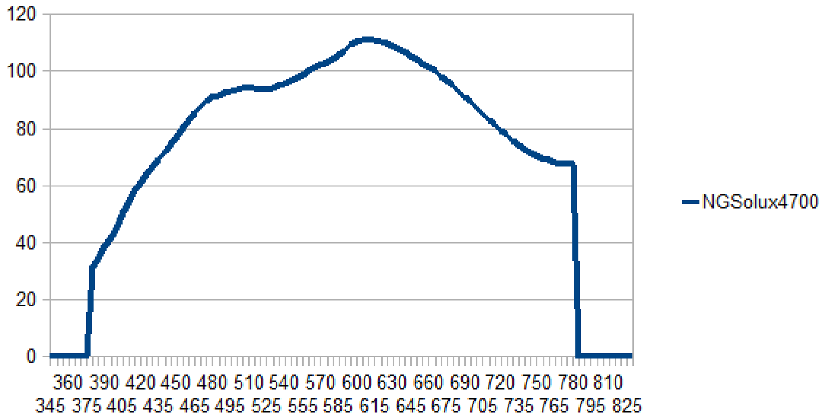
<tr><td><u>Illuminant Lamp Solux NG 4700K (4480K Tcorrel)</u>

</td><td>CRIs = 97 sigma = 0.9

Colors most deficient:</td><td>CRI = 98 sigma = 1.1

Additional colors most deficient:</td></tr>
<tr><td><u>Illuminating LED LSI Lumelex 2040 (3000K)</u></td><td>CRIs sigma = 90 = 2</td><td>CRI = 91 sigma = 3

Additional colors most deficient:</td></tr>
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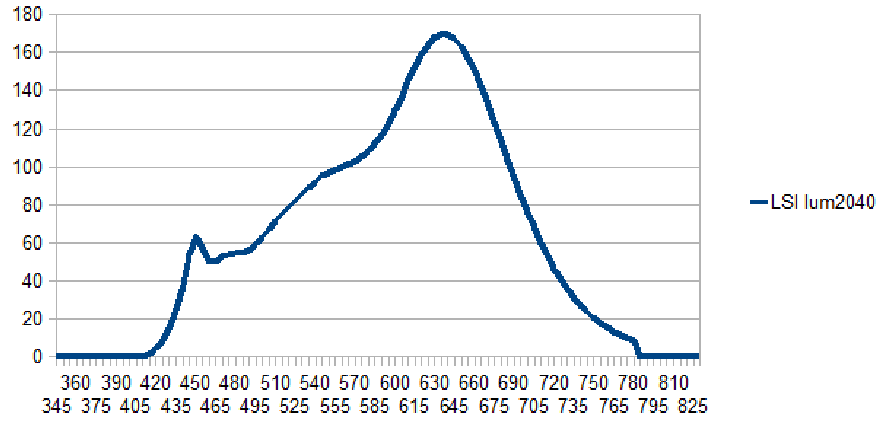
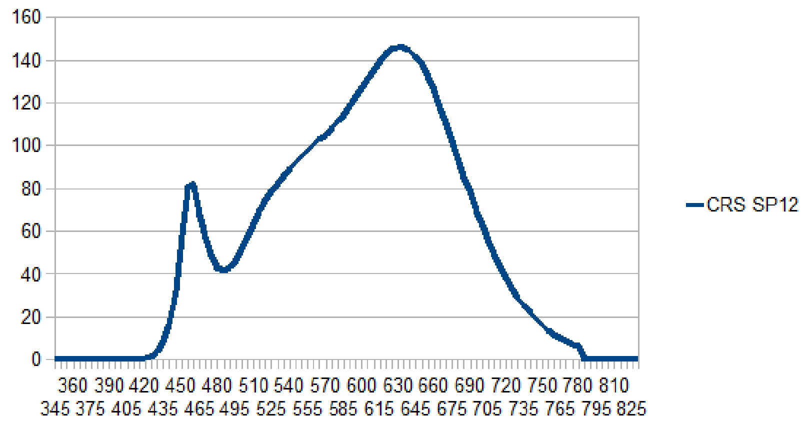
	Colors most deficient: 7-87	From 20 to 84
<u>CRS LED lighting WWMR16 SP12 (3050K)</u>	CRIs sigma = 94 = 3 Colors most deficient: 6-88	CRI = 96 sigma = 5 Additional colors most deficient: From 20 to 79



The choices I made for RT

1. use "daylight" daylight 4000K to 25000K (adjustable temperature and tint)
2. use "blackbody" black-body at 2000K 4000K (adjustable temperature and tint)
3. give the user the following choices:

- illuminant "A tungsten 2856K" which is a special case of "blackbody" with hue = 1.0 (adjustable)
- Three illuminants individuals within the "Daylight" 3 corresponding to situations such as "Sun Direct - 5300K", "Overcast or cloudy - 6200K" and "Shadow - 7600K" color with = 1.0 (adjustable); values 5300K, 6200K , 7600K are average values for each manufacturer (Canon, Nikon, Pentax, Leica has its specific values)
- 12 fluorescent illuminants with color adjustable (default 1.0)
- 7 illuminants studio lamps (with adjustable color):
- Studio HMI lamp "Osram"-4800K (for film, theater, studio ...)
- GTI lamp studio Graphiclite and ColorMatch for Photography - 5000K
- Solux - studio light - 3500K
- Solux - studio light - 4100K

- JudgeIII - studio light - 5000K
- Solux - lamp studio near daylight (used for example in the Musée d'Orsay) - 4700K
- the same but with the values obtained by testing (National Gallery) that gets an equivalent temperature of 4480K
- 3 illuminating flash (with adjustable color): 5500K (Leica), 6000K (Canon, Pentax ...), 6500K (Nikon, Sony ...)
- 2 LED illuminants it is implanted in the GUI.

Algorithm:

- I use the basic algorithm "Daylight": a) calculating values and x_D y_D that are passed as parameters to M1 and M2 (S (lambda) = S0 (lamda) + M1 * S1 (lamda) + M2 * S2 (lambda) which is derived Xi, Yi, Zi by matrix calculus [XiYiZi] = [xyz observ2 °] [S (lambda)] and then calculate the multipliers changes channels by a simple matrix calculation [mulrgb] = [sRGBd65_xyz] * [XiYiZi]
- I used the work of John Walker (public domain), of B.Lindbloom-increasing accuracy and spectral range - including the "Spectrum_to_xyz" also called "CIE_colour_match" that converts spectral data (350 - 830nm) of a color or illuminating in xbar values, Ybar, zBar (via data Observer 2). Output we obtain the x and y values.
- Black-body (blackbody) I use Planck's formula: the connection between the two formulas is done very well with a very slight shift values xD and yD to 4000K (which can be seen with the histogram between 3995K and 40005K):
- 4000K daylight: xD yD = 0382 = 0383 (for information to 4500K: xD yD = 0362 = 0370 for 7000K xD yD = 0.30 = 0.32, = 0.25 for 25000K xD yD = 0.25)
- 4000K blackbody: xD yD = 0381 = 0377;

- for other illuminants, the work I did earlier on the calibration (target 468 colors) led me to seek (and find) the spectral data of selected illuminants I (Tungsten, Fluorescent, HMI, GTI , Solux, etc.).

Use:

- the user now has at its disposal from the dropdown menu:
- the four above possibilities with an expansion of "daylight" to 25000K, and an algorithm "balckbody" between 2000K and 4000K (adjustable temperature and tint)
- "Glow - tungsten - 2856K with tint = 1.0;
- "Daylight" for three typical situations: "Sun Direct", "Cloudy", "Shadow" that correspond to the situation "Custom" but with tint = 1.0
- 12 Fluorescent: F1 - F12 (adjustable color)
- 7 studio lamps: HMI, GTI, Solux 4700K, ..., (adjustable color)

- in the general case, "daylight" or routine situations, there are no differences in use compared to the previous version of RT
- except that the user can choose the typical situations (sun, clouds, shadows ...)
- below 4000K, the algorithm is different and uses the "black-body" (blackbody) - as are the settings "factory" boxes.
- In the case of light "fluorescent" or the user knows the nature of the light source (among 12), or it proceeds by trial and error.
- In the case of light "studio" again if the user knows the source, including HMI, GTI, JudgeIII, Solux 4700, Solux4100K, Solux3500K the choice is easy, if not:
- lighting is not among one of the sources cited (HMI, GTI, Solux, etc..), but you have the spectral data, in this case no problems, in the other cases (no data), the choice of "daylight" with adjustable temperature and tint should provide an answer satisfactory enough, these lamps especially Solux having in theory a spectrum similar to daylight.
- In case of composite lighting, to date RT can not evaluate a single spectral system (like most software), however, ultimately it should be possible by (a) control points, to have a "bottom "of a given spectral type, plus one or two areas with another type of spectral data.
- Sometimes when shooting, to forget a previous setting, for example you have interior pictures in "glowing" and you make a shot in sunny outside (with the box set in "incandescent). Of course the raw mode allows a recovery, but it is highly likely that the blue channel is overexposed ... To prevent the rise of noise, I recommend lowering exposure with "Raw white-point."

Converting rgb ==> RGB (working space "Working Profile")

This "conversion", converts the RGB (without color space) in the workspace specified by the user.

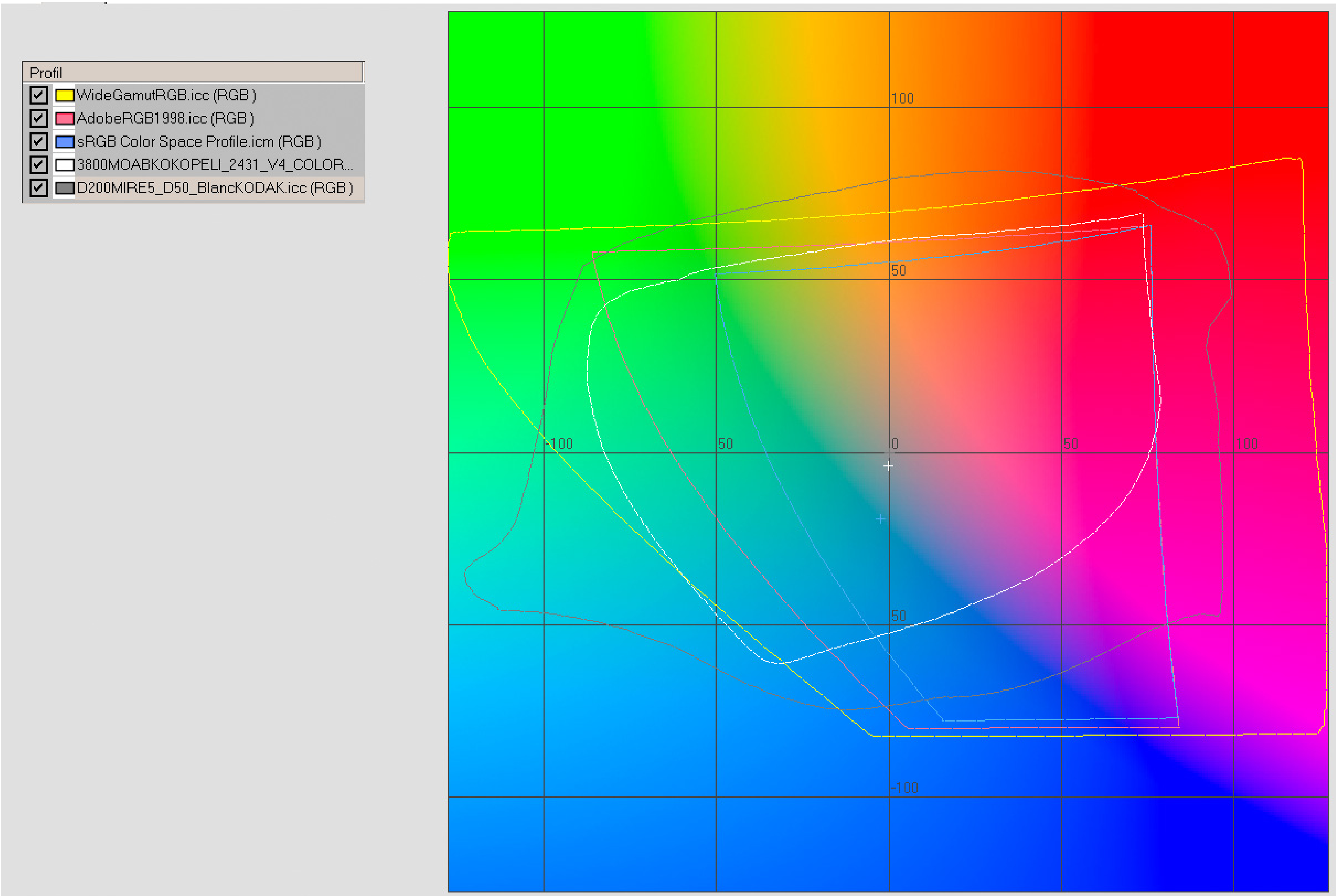
These "working space" There are 7 (which I think is more than enough surplus see ...): sRGB, AdobeRGB, Prophoto, Widegamut, BruceRGB, BetaRGB, BestRGB. 4 of these 7 profiles are wide gamut: BetaRGB (B.Lindbllom origin), BestRGB, and WideGamut Prophoto.

Note that other programs have made other choices:

- Adobe offers four choices with ACR (Adobe RGB, ColorMatch, and Prophoto SRGB)
- Adobe Lightroom: no choice but space Prophoto modified with a gamma sRGB (Melissa)
- DxO: no choice, but a space Adobe
- NX2: choice in the spaces available output
- ...

Which to choose?

- extensive debate in which supporters of small spaces oppose supporters of the great ...: between data loss and posterization ...
- my answer is pragmatic: to choose the space that best suits! But on what basis?
    - do you mostly print jobs with a CMYK printer driver?: in this case it is not useful to choose a wide gamut profile
    -



do you print jobs with an inkjet printer of high quality? In this case it is desirable to choose Prophoto (printers of this type have a gamut that some colors, exceeds WidegamutRGB), as "Working Profile", but also as "Output Profile" and choose the course good printer profile ... on this graph we see the gamut: a) 3 usual color spaces (sRGB in blue, pink AdobeRGB, WideGamut in yellow), b) the ICC profile for my D200 in gray, c) Profile of the Epson printer and paper to wide gamut "3800MOABKOKOPELI_2431_V4"

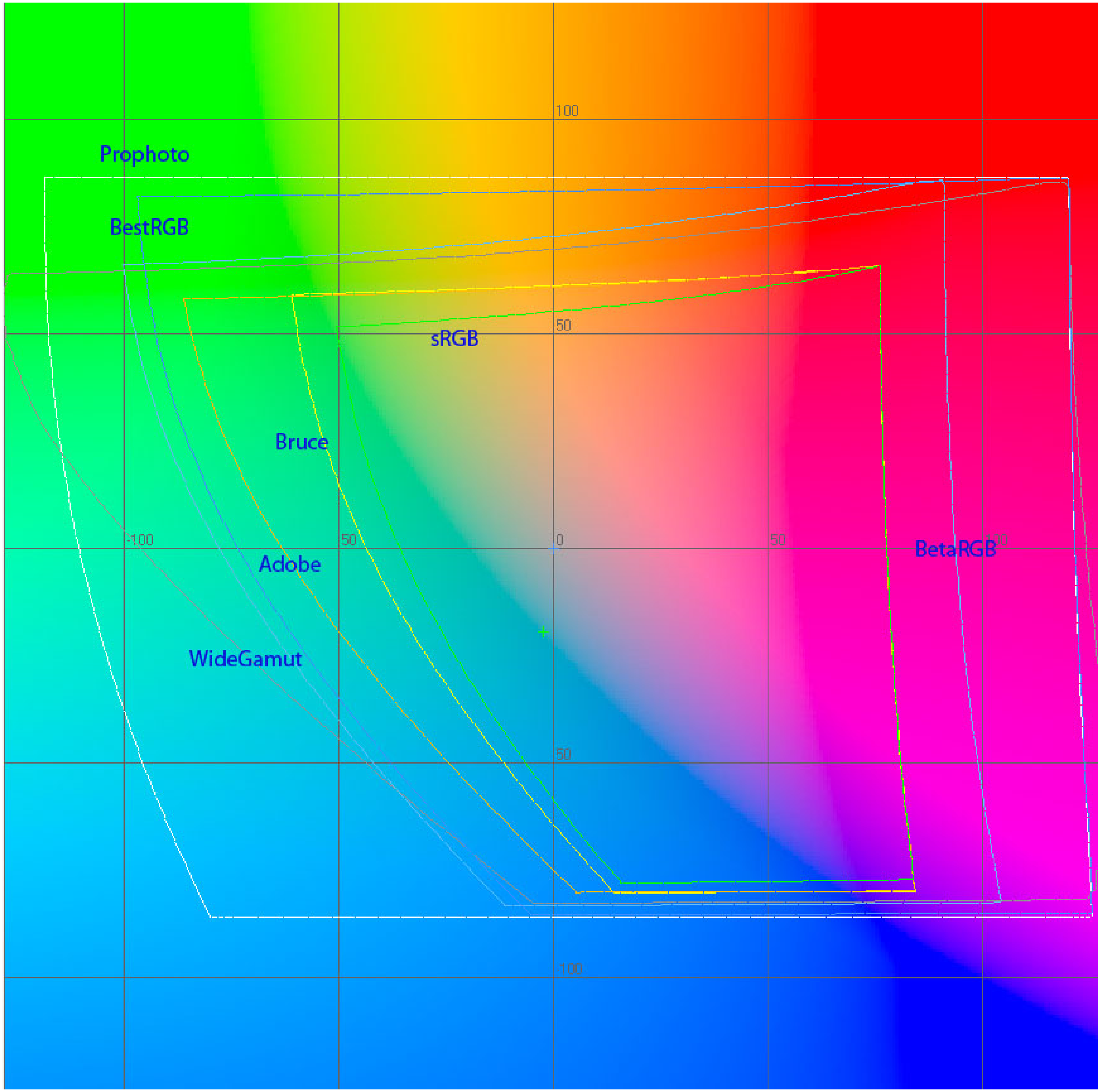
    - do you have a very high quality monitor which is close to AdobeRGB gamut WideGamutRGB or, in this case take a wide gamut profile.
- means a "simple" to evaluate the profile minimum is to use the statistics provided by "vibrancy" in debug mode (with verbose = true). In the window Rawtherapee.exe, you will see a message:
    - Gamut: G1negat iter = x - y = iter G165535 - G2negat iter = z - w = iter G265535
    - if a value (x or y) is greater than 0 for one or two G1 is that the original image (with checks made upstream: contrast, exposure, ...) exceeds the gamut of space selected "working profile"
    - if a value (z or w) greater than 0 appears for the one or the other of the two G2 is that the saturation established by "vibrancy" has exceeded the gamut ..
    - You decide if you want to keep these values (see above) or bring it within the gamut ("vibrance" is in charge, and "avoid clipping color" + "enable saturation limit"), but you " lose "color!
- converting rgb ==> RGB is done using matrices present in "iccmatrices.h" and can work with the "float" to preserve the essential and negative values above 65535.

<u>Work within the color space selected by the user</u> ***(workspace "Working Profile")***

- RT was the (good) choice of working in Lab mode (or its variants Luv or Lch) and with real. This allows to better preserve color and gamut.
- Functions in "Exposure", do not change the color, except "Saturation" by the fact that failure of the Lab mode (see the paragraph on the subject "Munsell" in "vibrance's tool")
- it is the same for "Lab adjustements" slider for "saturation" and for curves "a" and "b".
- "Channel Mixer" and "HSV equalizer" profoundly alter the colorimetry: For use with full knowledge of the consequences on colorimetry
- Functions: contrast, Brigthness, tone curve, .. deep enough can change the color gamut (see above control using statistics "vibrance")

<u>Choice of the output space</u> ***(space "Output Profile")***

- the first thing to consider is: what are the output profiles that are installed on your machine? This depends on: a) operating system (*a priori* Linux does not install any profile), b) in other graphics programs that are installed (Capture NX2, Photoshop CS, DxO, etc..), each owner installs profiles, by example NX2 installs NKsRGB.icm NkAdobe.icm, etc.. which are protected by copyright ... c) profiles that you may have downloaded from the web, for example on the Adobe site or that of B.Lindbloom.
- In principle I would recommend to check the installation or install output profiles corresponding to the profiles of work (working profile) - which are files *. Icm or *. Icc physically present on your machine and have nothing to do with the calculation of matrices "iccmatrices.h". If these files are not output to TIFF or JPG will not be able to perform these profiles, but will default (if the file "RT_sRGB.icm" is present) to the output space SRGB.
- These profiles have the following names (you can find others with similar characteristics or similar characteristics), generally they are protected by copyright and may not be distributed by an Open-Source software without authorization. They are available on the Web: ProPhoto.icm; SRB Color Space Profile.icm; AdobeRGB1998.icc; BestRGB.icm; BetaRGB.icc; Bruce.icm; WideGamutRGB.icc;
- Of course you can install others: CIE.icc; Colormatch.icc, etc..
- These profiles are to be installed in the "ICCdirectory" RT is \ windows \ system32 \ spool \ drivers \ color for Windows and / usr / share / color / icc for other systems.
- When you choose an output profile, such AdobeRGB1998 and you have chosen a work profile Prophoto, LCMS2 will convert with intent (selected by default in the RT options: on, perceptual, ...) of RGB data the workspace to the output space.
- What is the representation of these profiles (their respective sizes to an average luminance L = 50)



- course notes on the choice of the output space are similar to those of the workspace (print, screen, ...)
- but beware outputs 8-bit JPG therefore are almost mutually exclusive - significant risk of posterization - with spaces large gamut (Prophoto, WideGamut ...)

What happens if there is no file ". Icm" or "*. Icc" in this "Iccdirectory" or "ICCprofiles / output"?*

- in this case, the conversion is done by calculation to sRGB, but until a very recent change (November 2011), this output was accompanied by a colorimetric defective. Indeed, conversion to RGB working space, RGB output space converts the RGB data but does not affect the file header and the Lab values, as does "Apply" (applied in Photoshop) profile. Because of this missing information, colorimetry is defective.
- I have to correct you by adding the following files in the folder ICCprofiles / output. These files icc / icm that I developed are similar to the original sRGB.icm, AdobeRGB1998.icc, Prophoto.icm; their white point and Tag Rxyz, gXYZ, BXYZ: show minor deviations from the originals without *a priori* consequences quality sorties.Par cons I brought a change from the original by creating LUTs "RT" in place of CRT functions to gamma constant. They bring a "plus" in terms of rendering output images (JPG or TIFF) and makes it less necessary to use "Output Gamma '(see this section for the understanding and appreciation of" Output gamma ").
- RT_sRGB.icm: similar to gamma sRGB.icm internal standard sRGB near g = 2.40 slope = 12.92
- RT_sRGB_gBT709.icm: similar to gamma sRGB.icm internal standard BT709: slope = 2.22 g = 4.5
- RT_sRGB_g10.icm: similar to standard gamma sRGB.icm internal liénaire: g = 1.0 slope = 0
- RT_Middle_gsRGB.icc: AdobeRGB1998.icc similar standard with internal gamma close to sRGB: slope = 2.40 g = 12.92
- RT_Large_gsRGB.icc: similar to standard ProPhoto.icm with internal gamma close to sRGB: slope = 2.40 g = 12.92 (close to "Melissa" used by Lightroom)
- RT_Large_gBT709.icc: similar to gamma Prophoto.icm internal standard BT709: slope = 2.22 g = 4.5
- RT_Large_g10.icc: similar to standard gamma ProPhoto.icm internal liénaire: g = 1.0 slope = 0
- These files (if installed in ICCprofiles / output) will appear in the dropdown menu "Output Profile" under their name above without terminating icc / icm
- more as a result of the conversion work RGB ==> RGB output, I modified the code and I apply the profile "RT_sRGB.icm" colorimetry is therefore correct .. but in sRGB.
- These files can be used as such by selecting "Output Profile": they will give images with histograms corresponding to the examples in "Output Gamma '

Shortcoming of RT

- the user can easily see that the output "output" is not "preview". This is not due to a lack of "output" but in the development of "curves" that take into account the wrong notion of TRC (incorporating ICC profile, to change the rendering of the interior colors)
- This is one reason that led me to give the possibility of variable outputs:
- either by choosing an output profile with another gamma;
- is variable with a gamma (gamma and slope)
- or possibly to achieve a linear output and adjust it in Photoshop ...
- (See the diagram of histograms)

What is "Output Gamma"?

- From my perspective, Output Gamma is one of the key points of a successful exit in TIFF or JPEG, for several reasons: since adding profiles icc / icm above, this option is of interest because the smaller use of these nicknames and profiles Prophoto SRGB "new" provides similar benefits to Output Gamma when selecting sRGB and Prophoto nickname! (See above). This option allows the bearing part of the RT gap (difference "output" / "preview");
- The ideal would have been to "Output gamma" in the tabs before the first treatment "Exposure", "Highlights reconstructions", "Shadows / Highlights", etc.. But I think and this is a shortcoming of RT, the change s 'proved impossible without causing significant artifacts: the different "pipelines" of RT overlap and colorimetry in the initial part of the treatment appears to more of "tinkering" at a level of professionalism ...
- I have therefore chosen to implement this process in the terminal phase, which is not totally outlandish (although I think it would have been better in the initial phase).

Some thoughts:

The gamma is acting a little like a combination between "Exposure curves" + "black point" + "tonecurves" present in RawTherapee, but more radically alter the contrast, the distribution of the histogram between the particular and lowlights highlights, by changing simultaneously (that can do the above functions), the TRC curves of the file header similar to an ICC profile input. A photographer friend told me recently, "at first I thought we could simulate the gamma contrast and tonal curves .. but the result is different"

Try the image: ASC4145.NEF

Just trying to achieve the equivalent of the output "BT709 G2.2 S4.5" ...

Why indeed with Adobe Lightroom he made "Melissa" is a color space sRGB Prophoto with a gamma, that is to say, a linear part up to r = 12.92 and a gamma of 2.4?

Why D.Coffin has long been established in Dcraw a linear gamma, gamma and a variable?

I could have chosen as another example that gamma "BT709".

In theory, if color management is perfect, whatever the gamma output (standard variable ...) the image should be the same as color management uses data Lab (or XYZ) and that is called the PCS (Profile Connection Space in D50), in practice the image to look like, but if you look at the shadows you can realize that there are differences, but certainly quite low enough for RT users may have said: the output image is different from "preview"

On the other hand, for software that does not support colors like many web browsers (Chrome, ...) the output image will depend on the gamma so it is important that RT provides a visual display that will be the file Release (soft proofing). Several factors must be taken into account to date:

- conversion of the workspace ("working profile") to the output space (output profile): this may seem obvious that if the image out of gamut colors for the two spaces, or both, if extent of space is different, clearer images will be different;
- presence or absence of color management: in the case of RT, or an editor that supports colors, the differences (in output space and the same working) will be lower but still significant, in the case of software that not manage the impact of gamma colors will be very important
- ability to set the soft proofing, the intent and black point.
- Ultimately it must be easily possible to simulate a print by converting the output to the printer profile; Note that in this case, a display of printable colors would be more important.

The various "Output gamma"

From the dropdown menu you have 7 preset gamma:

- BT709: slope = 4.5 gamma = 2.2
- sRGB: 12.92 slope = gamma = 2.4
- linear: gamma = 1.0
- Standard: slope = 0 gamma = 1.8
- Standard: slope = 0 gamma = 2.2
- High: slope = 3.35 Gamma = 1.3
- Low: slope = 6.9 gamma = 2.6

"BT709" will better handle shadows (they will be less gray) than sRGB and *a fortiori* standard 2.2 or 1.8

"Low" will increase the image contrast a bit poor, and allow better post-treatment images overexposed

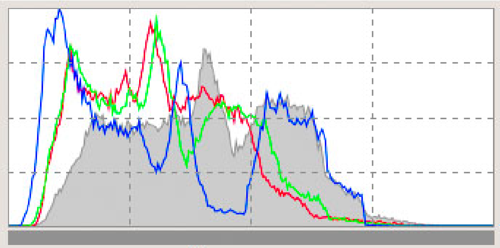
"High" on the other hand will reduce the contrast ...

Linear: allows processing images in Photoshop with very high dynamics by adjusting curves in Photoshop RGB (difficult exercise ...)

In addition you can "free gamma" which allows you to associate an output profile any slope value and gamma

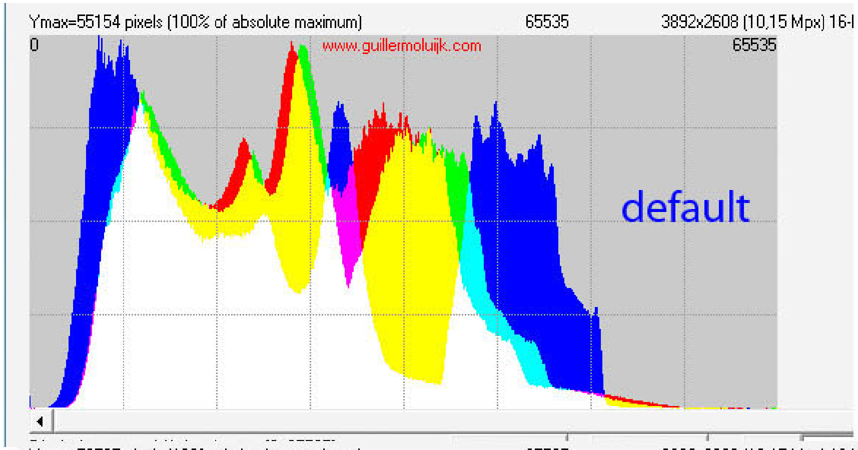
- well you can if you want to go outside of new releases related to new profiles icc / icm added
  - with sRGB standard gamma 1.8
  - in WideGamut with gamma BT709
  - sRGB with gamma: 2.2 and 6.5 slope
  - etc..

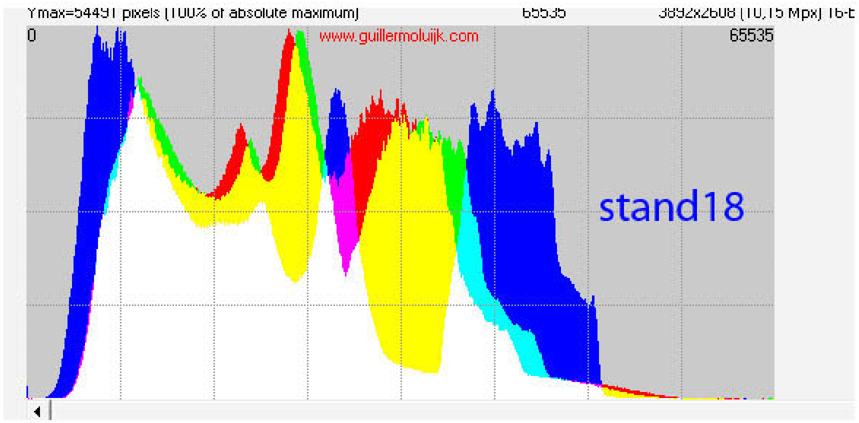
  As an example here with the same NEF file with various different histograms and gamma reference histogram RT (preview) with the same settings (workspace Prophoto, profile "neutral" profile = Prophoto output and its variations in gamma)
-

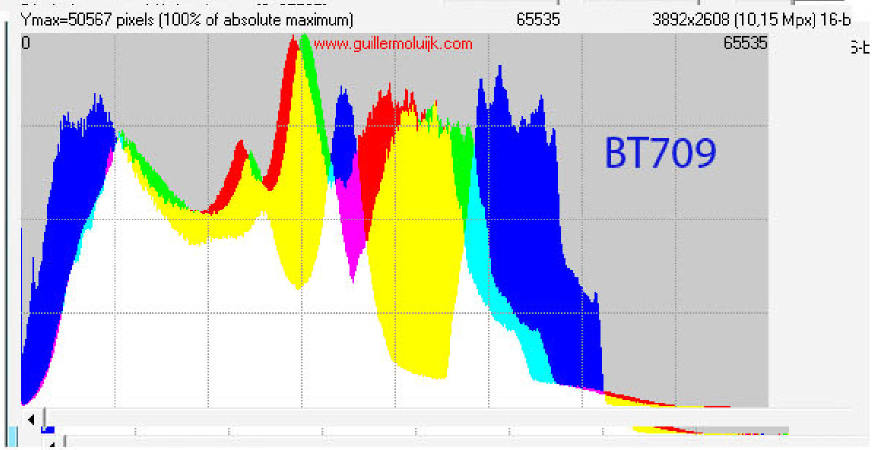


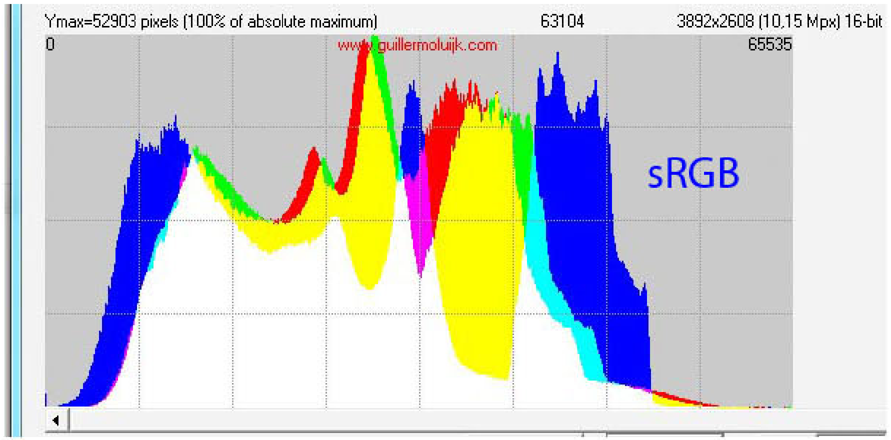
we see immediately that although RT histograms (above) and "default" below are close .. they are different ...

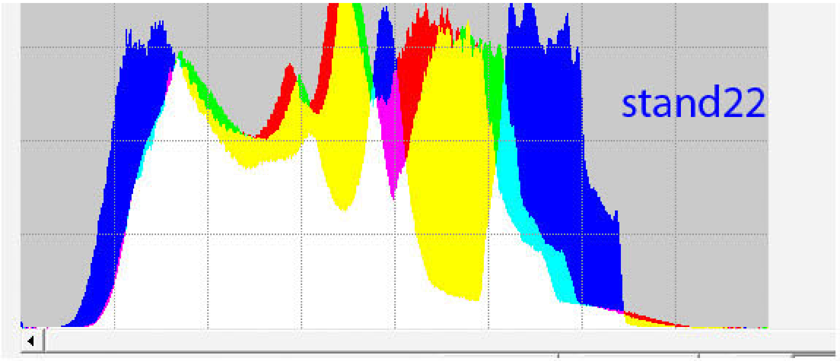
- more, it's not because the histograms are strictly similar as to render frames will be similar. Indeed involved the notion of "CRT" for both the "preview" for the output file. This "TRC" is on the header file (ICC Profile) and modifies the tonal data. If "TRC" Output file is definitely good because it is determined by the characteristics of the output file (Prophoto.icm, RT_srgb.icc, ...), I think it is not even for the "preview" ... (see the remarks on the output sRGB).

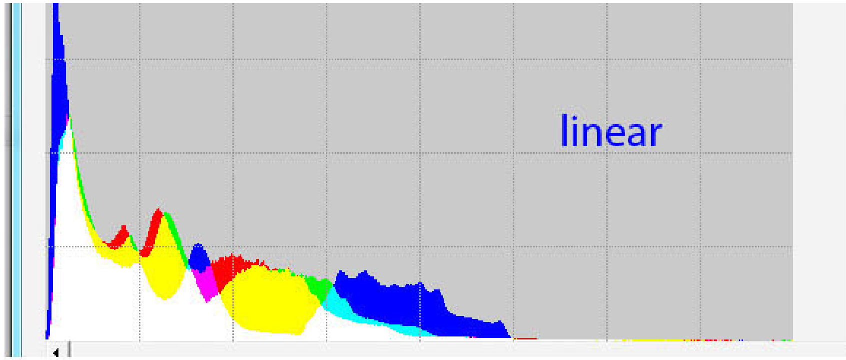


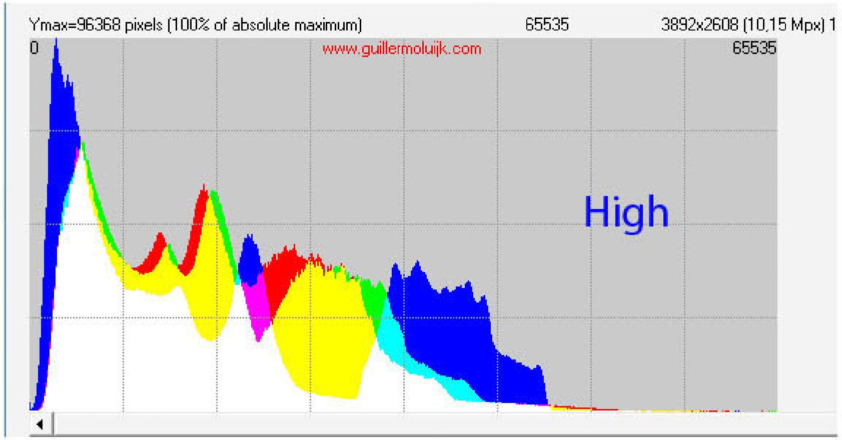


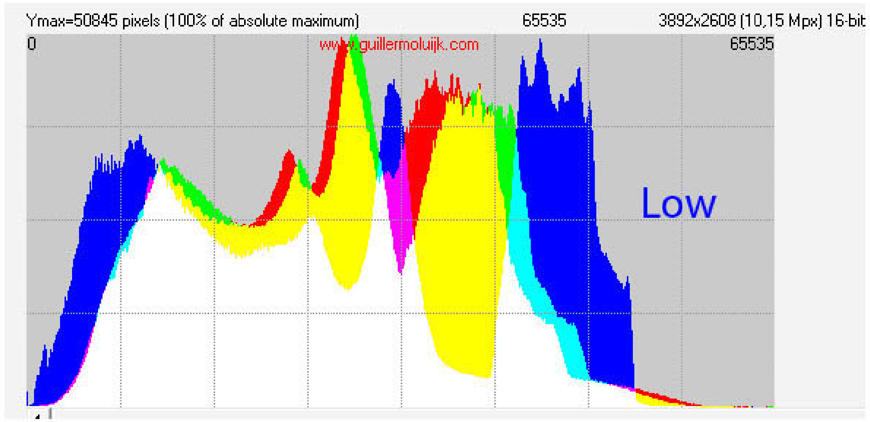






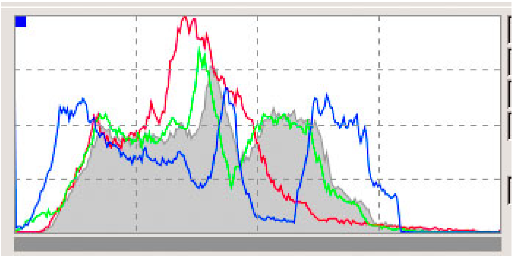


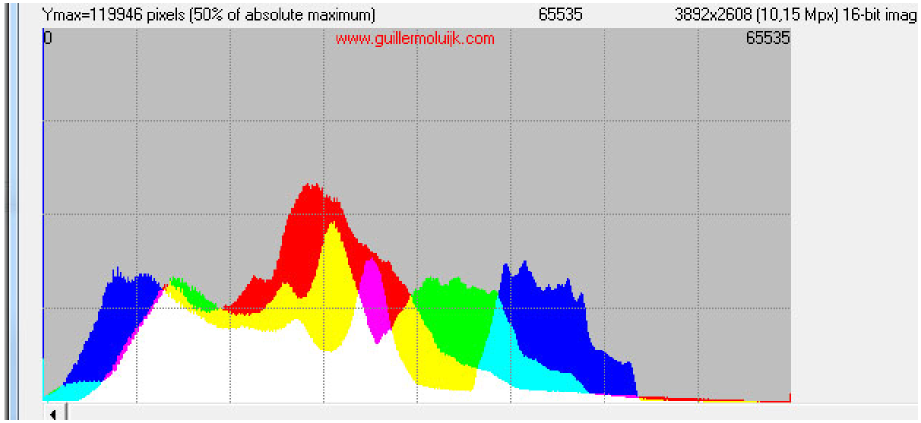
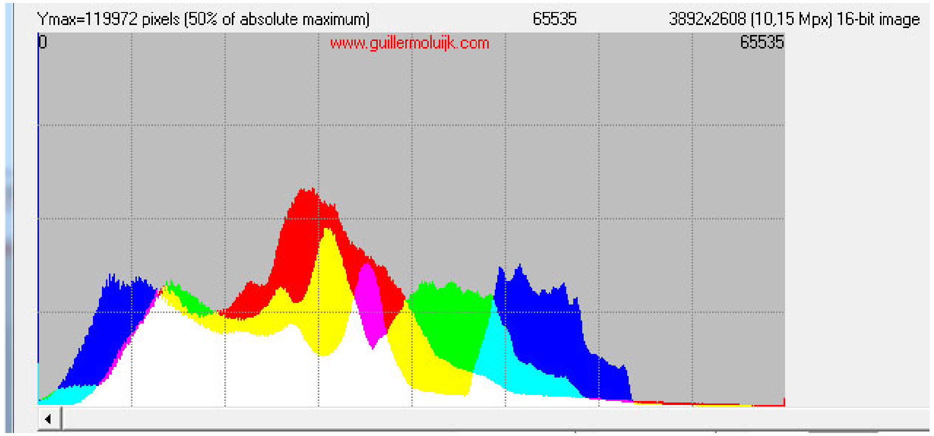
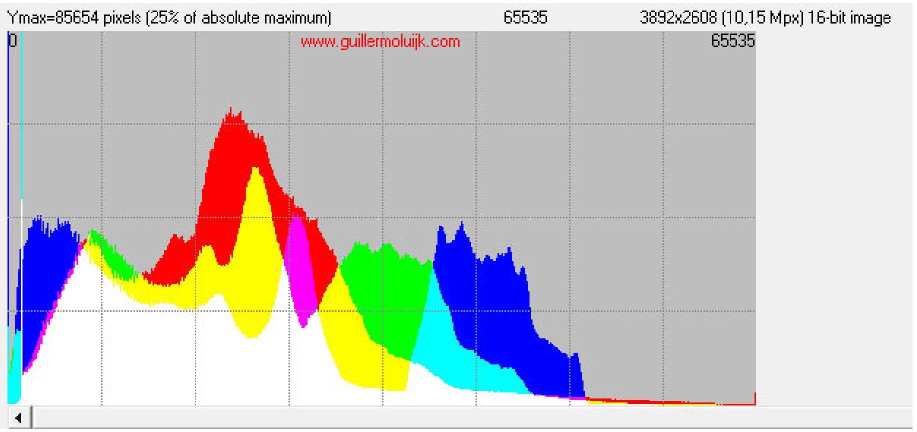
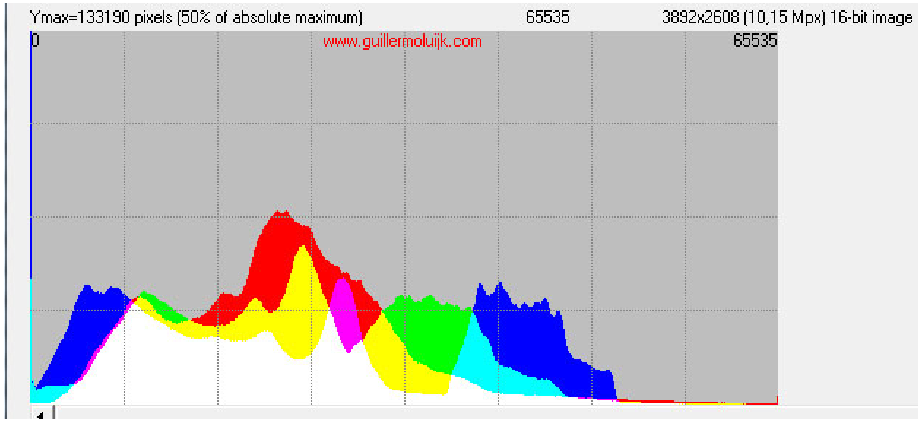




and the same image in workspace sRGB - profile "neutral" and "output profile" sRGB and some variations.

Image histogram preview RT (sRGB working space =)



Output "RT_sRGB"	Output "sRGB Color Space Profile"
	
Output "RT_sRGB_gBT709	Output "sRGB 2.3 gamma slope = 8"
	

Note: 2 images "RT_sRGB" and "sRGB_Color_space_profile" are almost identical, minor differences are due to my choice, to avoid problems with copyright -: the primaries are imperceptibly different.

As against this, sees the impact of the choice of gamma BT709, and a free gamma (g = 2.3 slope = 8.0)

How to use it - how it works?

- for simplicity, the output profile is "derived" Work Profile "working profile" box "Output Profile" grayed out. Which means that output profile = Profile of work
- for example you select "working profile" = Prophoto Free and gamma = 2.1 and slope = 4.0
- then you commit to a TIF or exit the editor and you generate a TIF file output, and Prophoto profile with gamma 2.1 / 4.0. When you want to open the file in an external editor (eg Photoshop CS), it will appear "Use the embedded profile: Large_B709", which corresponds to the profile RT_Large_gBT709, but with an amendment that we discuss later.
- Another example, you select "working profile" sRGB and Free = gamma = 2.3 and slope = 10.0, you will generate a TIFF output with sRGB and gamma 2.3 and slope = 10. When you want to open the file in an external editor (eg Photoshop CS), it will appear "Use the embedded profile: sRGB IEC61966-2.1 (WHR similar to HP BT709 gamma sRGB)" which matches the profile RT_sRGB_gBT709 but with an amendment that we discussed below.
- If you enable the option (Photoshop CS): "Remove the embedded profile", the TIFF file will appear with the new RGB values due to the new values of gamma and slope, but the appearance of the picture will look different (absence of header file)

- the algorithm uses the "CMSToneCurve" of LCMS
  - output spaces are calculated from their primary (red, green, blue) for example Prophoto: p1 = 0.7347, p2 = 0.2653, p3 = 0.1596, p4 = 0.8404, p5 = 0.0366; p6 = 0.0001;
  - the gamma settings are calculated using the "calcgamma" that will function in the gamma and slope determine five parameters to pass to the function of LCMS2 adhoc.
- it creates a pseudo profile, type RGB "Prophoto" and with a gamma corresponding to the selected
- but there is a gap here that LCMS2 creating this profile does not indicate in the header of the corresponding profile, because it works in RGB value not in LUT / Lab. In theory it should be as much in profile with a suitable gamma and not just one. In practice I have brought a profound change to "Output Gamma" and circumvented the gap LCMS2, applying - after converting RGB profile *. Icc has the same features as the profiles *. Icc or *. Icm that 'uses' Output Gamma', but where RTRC Tag, MCRI, BTRC are calculated with "calcgamma".
- To improve understanding of the treatment of a TIF in linear mode, you can read the tutorial (Dcraw) Guillermo Luijk http://www.guillermoluijk.com/tutorial/dcraw/index_en.htm
- Hence the need in the "Iccdirectory" files "*. Icc" and "*. Icm": BestRGB.icm; BetaRGB.icc; Bruce.icm; WideGamutRGB.icc, (as well as files icc / icm added to the pseudo Prophoto, Adobe, SRGB "Iccprofile / output").

-

Adaptation of the configuration of the RT real names of your profiles

- You may have installed profiles. Icc or *. Icm characteristics similar to those outlined above, such a file prophoto.icc who will have the same characteristics, but a different name from the dropdown menu "Output Profile".
- In this case, so that the file is recognized by the system to "Output Gamma 'you must edit the file" option "attached to the folder" Rawtherapee4xxx "(current tag)
- Beware, if you change the core files that are used to "Output Gamma ', they must have the same ending" icm "or" icc "as those provided by default, is generally" icc "except" RT_sRGB "," RT_sRGB_gBT709 "" RT_sRGB_g10 "," BestRGB "," Bruce "who have a termination" icm ".
- for section [Color Management] modify the values associated to the items in "bold". For example if your file appears with the name Prophoto.icc PROPHO the dropdown menu and you want it replaces the file I "installed" by default (RT_Large_gBT709.icc), replace: **= RT_Pro_Photo RT_large_gBT709** by **RT_Pro_Photo = PROPHO**

[Color Management]

ICCDirectory = C: \ \ Windows \ \ System32 \ \ spool \ \ drivers \ \ color

MonitorProfile = C: \ \ Windows \ \ System32 \ \ spool \ \ drivers \ \ color \ \ 2011-11-01 L2000C D5000 min max 2.2 native HQ LabLUT.icm

AutoMonitorProfile = false

Intent = 1

LCMSSafeMode = true

AdobeRGB = RT_Medium_gsRGB

ProPhoto = RT_Large_gBT709

ProPhoto10 = RT_Large_g10

WideGamut = WideGamutRGB

= sRGB RT_sRGB

sRGB10 = RT_sRGB_g10

Beta = BetaRGB

Best = BestRGB

Bruce = Bruce

WhiteBalanceSpotSize = 16

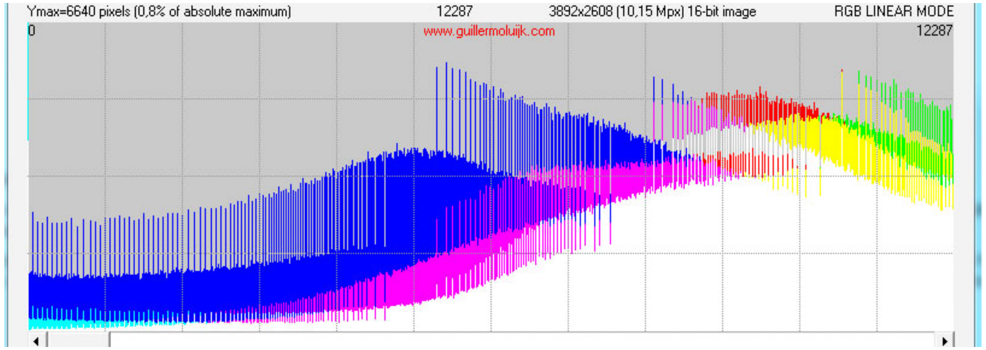
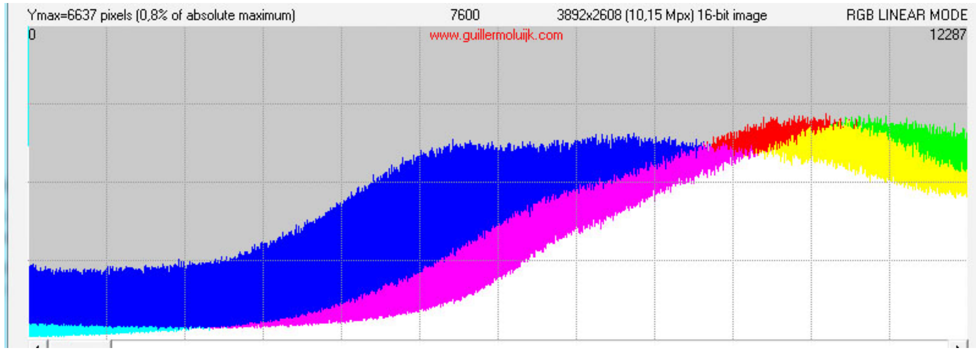
GamutICC = true

Quality of new profiles

The user can rightly ask the question of the validity of profiles "RT" (RT_sRGB, RT_Large, ...).

These profiles have the same characteristics as the "original" (AdobeRGB1998, Prophoto, sRGB Color Space Profile), reflect only small differences in primary and / or white spots that do not affect the quality and level of outputs.

Against by the TRC have more detailed LUT from 1024 points to 4096 points. This results - in the case of sRGB is the most common outlet - a histogram with much less fish bones that can lead in the shadows of postérisations. Here for comparison with the same image, the histogram of the agrandissemnt 16-bit in low light, between "sRGB Color Space Profile" and "RT_sRGB"

<table>
<tr><th>SRGB Color Space Profile (LUT 1024 points)</th><th>RT_sRGB (LUT 4096 points)</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

In summary, the fact that I added the file type near SRGB (s), AdobeRGB, and Prophoto (s) the user can:

- if it has no file installed in "ICCprofile / output" other than RT_sRGB.icm, RT_sRGB_g10.icm, RT_sRGB_gBT709.icm, RT_Middle_gsRGB.icc, RT_Large_gBT709.icc, RT_Large_gsRGB.icc, RT_Large_g10.icc
  - he may in profile "Output Profile", all output files corresponding to the above with any "Working Profile"
  - if it leaves "no ICM sRGB output, it will exit with RT_sRGB with any" Working Profile "
  - if he uses "Output Gamma", it will have the opportunity:
    - Working Profile "- sRGB and all options" Output gamma "
    - Working Profile "- Prophoto and all options" Output gamma "
- if he files ProPhoto.icm; SRB Color Space Profile.icm; AdobeRGB1998.icc; BestRGB.icm; BetaRGB.icc; Bruce.icm; WideGamutRGB.icc more in ICCprofiles / output: RT_sRGB.icm, RT_sRGB_g10.icm, RT_sRGB_gBT709.icm, RT_Middle_gsRGB.icc, RT_Large_gBT709.icc, RT_Large_gsRGB.icc, RT_Large_g10.icc ICCdirectory installed in all combinations "Working profile" + "Output Gamma" are possible

Other aspects of colorimetry

- It is beyond the scope of this document to address all aspects of colorimetry that are not specific to RT, such as: a) print b) the calibration screens.
- However, it is recommended to calibrate the screen with one of the many products on the market: colorimetric sensor, more software. The profile developed only for the monitor and should never be used either as input profile, either as output profile.
- Windows, MacOS or Linux, software like DispalGUI of Argyll, associated with a probe of the same old quality (for example, the probe DTP94 that I have and for which there is more [?] Drivers in Windows7-64) gives very good results; development time is quite high (about 1 hour).
- RT automatically detects the system profile, however you can enter the file name icc screen in "Preferences / Color Management / Monitor Profile"