Colorimetric Image Technology (CIT)

German proposals for International Standards and Technical Specifications or Reports of SC28

Version 1.0, 054501, ww.ps.bam.de/AWG05.PDF

Prof. Dr. Klaus Richter, BAM and TU Berlin
Federal Institute for Materials Research and Testing (BAM)
Working Group VIII.34, Visual Methods and Image Reproduction
Unter den Eichen 87, D-12205 Berlin
Tel. +49 30 8104 1834; Fax +49 30 8104 1807

klaus.richter@bam.de

For many ISO/IEC-test charts and other publications see the URL
http://www.ps.bam.de

Overview

Introduction

- ISO/IEC-test charts with 16 step colour series
- Colour circle, colour double cone and hexagon
- Basis and Goal: Colorimetric Image Technology (CIT)
- Equivalent colorimetric coordinates and CIELAB
- Colour management by CIT and ISO/DIS 15076 (ICC)
- absolute and relative CIELAB coordinates
- linear relationship to device coordinates *olv*, cmy**
- Colour triangle for chromatic and black generation
- Example for 12 equivalent coordinates of CIT
- Material and visual efficiency of colour device output

Introduction

– Different ISO/IEC standards and technical reports define analog and digital ISO/IEC-test charts for the different applications colour copiers, printers, scanners, monitors and projection screens.

–The ISO/IEC-test charts include 16 step colour scales which are visually equally spaced and show equal distances in the CIELAB colour space (therefore CIELAB spacing equals visual spacing)

– Many users require equal 16 step spacing on any output device

– On any colour output device high visual efficiency is reached if the 16 steps appear equally spaced.

– Then the ISO/IEC-Landolt-rings are recognized in the shadow, the mean and the high light areas.

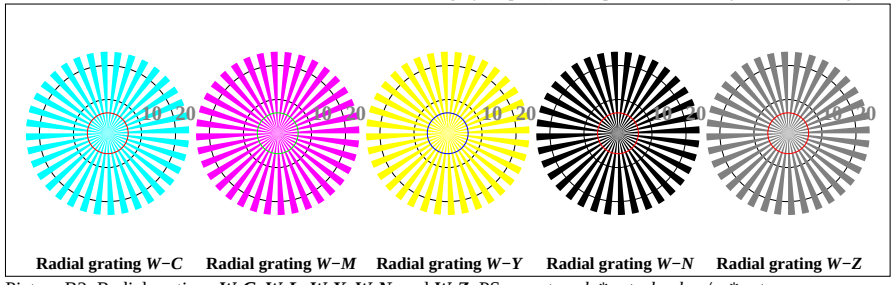
Figure 1: ISO/IES-test chart for the test of monitor or printer output

www.ps.bam.de/DE97/10L/L97E00NP.PS/.PDF; start output
N: No Output Linearization (OL) data in File (F), Startup (S) or Device (D)

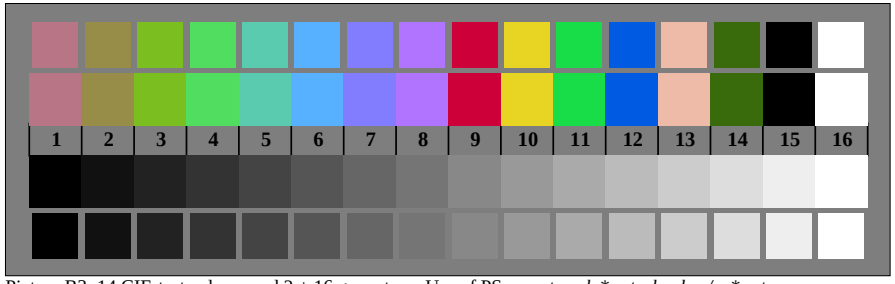
See for similar files: http://www.ps.bam.de/DE97/
Information and Order: http://www.ps.bam.de Version 2.0, io=1,1

BAM registration: 20030101-DE97/10L/L97E00NP.PS/.PDF BAM material: code=rha4ta
application for monitors (Yr=2.5) and printers

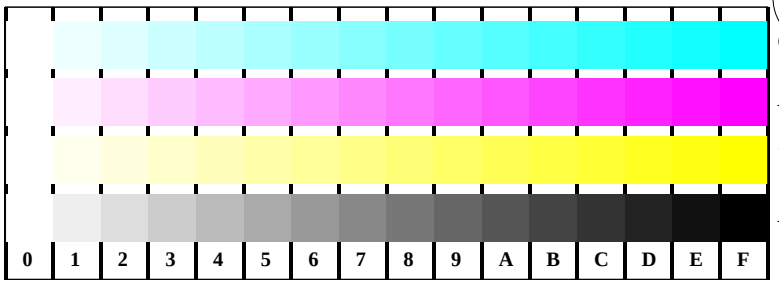
Picture B1: Flower motif, 14 CIE-test colours and 2 + 16 grey steps (sf); PS operators *settransfer, 3 colorimage*



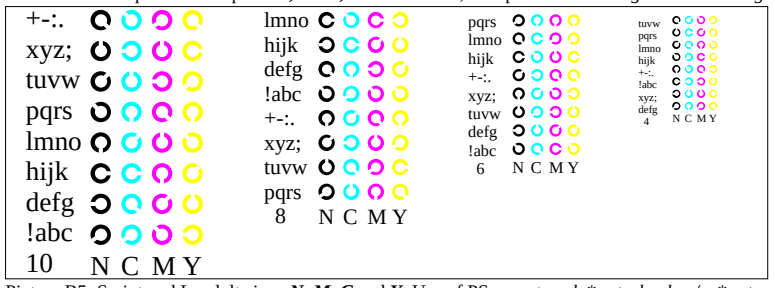
Picture B2: Radial gratings ***W-C, W-L, W-Y, W-N,*** and ***W-Z***; PS operator *olv* setrgbcolor / w* setgray*



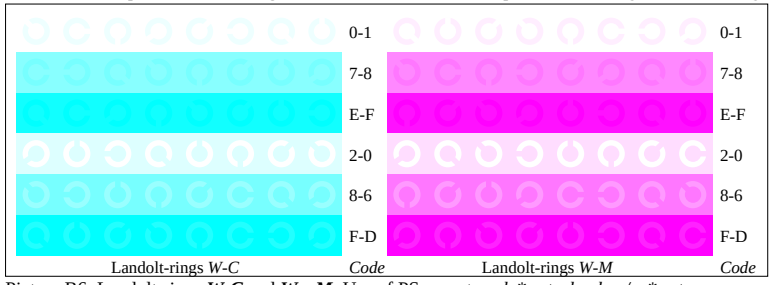
Picture B3: 14 CIE-test colours and 2 + 16 grey steps; Use of PS operator *olv* setrgbcolor / w* setgray*



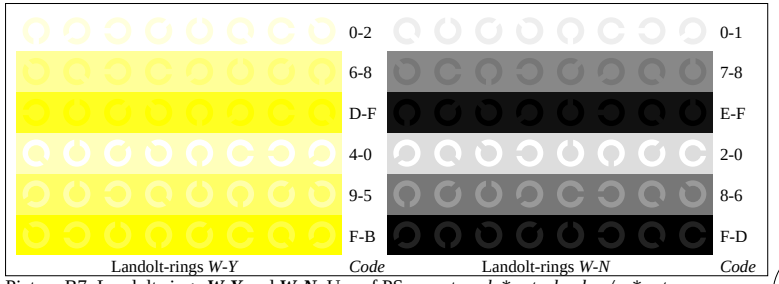
Picture B4: 16 equidistant steps ***W-C, W-M, W-Y*** and ***W-N***; PS operator *olv* setrgbcolor / w* setgray*



Picture B5: Script and Landolt-rings ***N, M, C*** and ***Y***; Use of PS operator *olv* setrgbcolor / w* setgray*



Picture B6: Landolt-rings ***W-C*** and ***W−-M***; Use of PS operator *olv* setrgbcolor / w* setgray*



Picture B7: Landolt-rings ***W-Y*** and ***W-N***; Use of PS operator *olv* setrgbcolor / w* setgray*

Fig. B1 to B7 of ISO/IEC-test chart 2; ISO/IEC 15775 and TR ISO/IEC 24705; input: *olv* setrgbcolor / w* setgray*
output: *no change compared to input*

Introduction continued

looking at ergonomical, economical and environmental issues

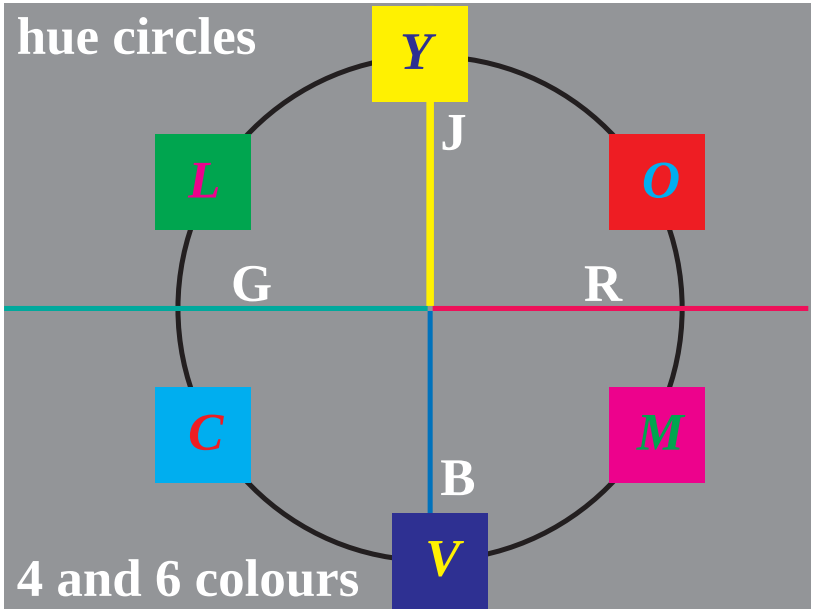
– The colour printer output reaches high efficiency if the 16 steps are recognized and equally spaced.

NOTE Use for output as much as possible and less expensive black ink and do not print grey colours by three chromatic colours on top of each other. Goal: Calculate the ink amounts by CIT

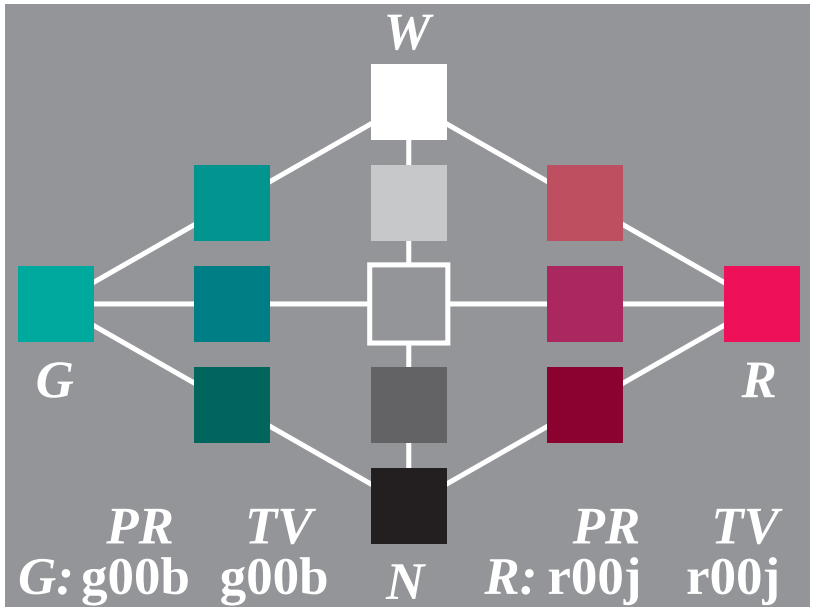
– The colour monitor output reaches high efficiency if the 16 steps are recognized and equally spaced.

NOTE Equal 16 step spacing in a dark room is destroyed by the illumination at the office work place. Users require software and hardware solutions for recognition of the 16 steps at work places.

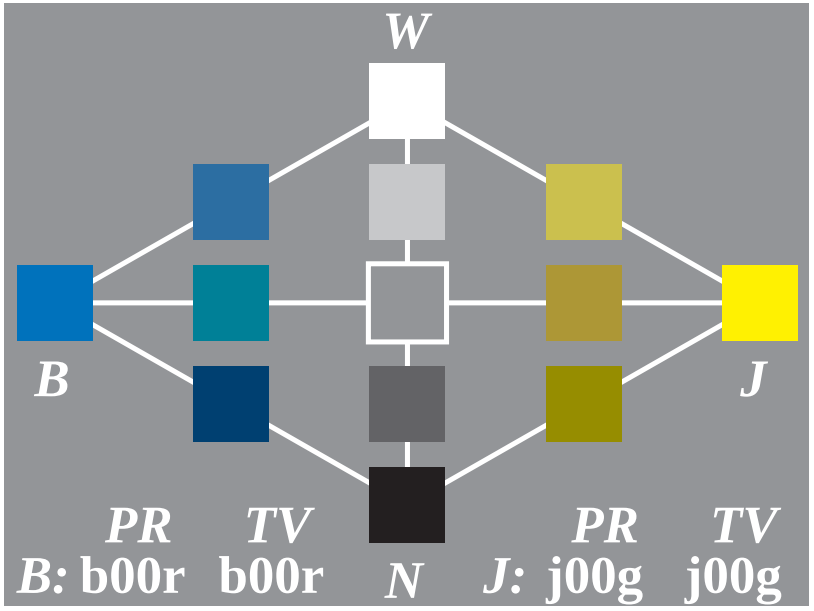
Figure 2: Colour Circle, Colour Double Cone and Colour Hexagon



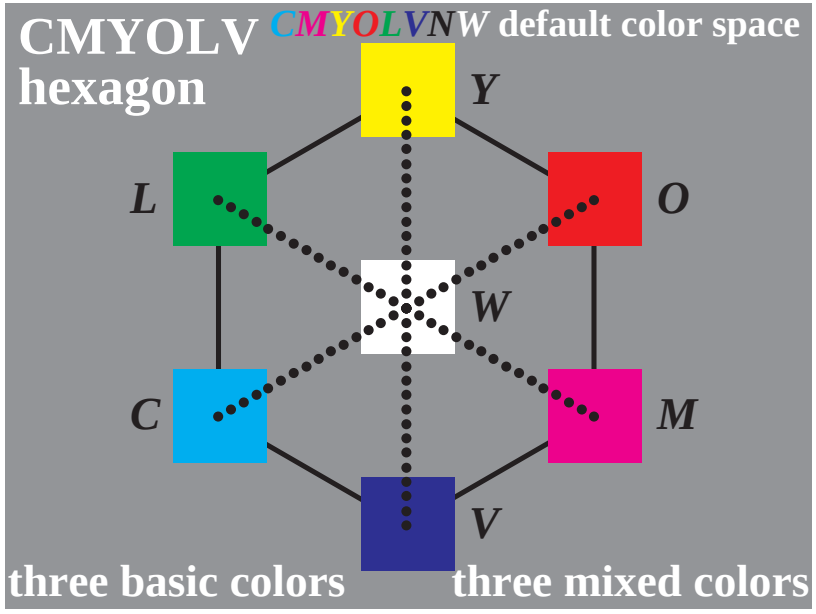
LE410−3, 4 and 6 colours in hue circle



LE410−7, Double cone: Hue planes R and G



LE410−8, Double cone: Hue planes J and B



LE410−1, 16 step colours in regular hexagon

Figure 3: Colour order Systems and Colorimetric Image Technology (CIT)

Application of colour in daily life or in Information Technology (IT):

Design, architecture, art, industrial products
Measured for CIE standard illuminant D65

colour order system: name and coordinates

RAL Design System (CIELAB):
LCH*, lightness, chroma, hue

Munsell Colour System:
VCH*, lightness (Value), Chroma, Hue

Natural Colour System (NCS):
nce*: blackness, chromaticness, elementary hue

Information technology of printers
Measured for CIE "other" illuminant D50

Device system name and coordinates:

Printer system (illuminant D50):
cmy, content of "cyan", "magenta", "yellow"

Display system (standard illuminant D65):
rgb/sRGB, content of "red", "green", "blue"

IT colour coordinates confuse the users!
Nearly no connection to colour order systems!

New: Application connection by coordinates *olv*, cmy*, tce*, ... und linear relation to LAB*

CIELAB: ***LAB**** : lightness, red-green and jellow-blue chroma; ***LCH**** : lightness, chroma, hue

Definition of device coordinates similar to coordinates of colour order systems

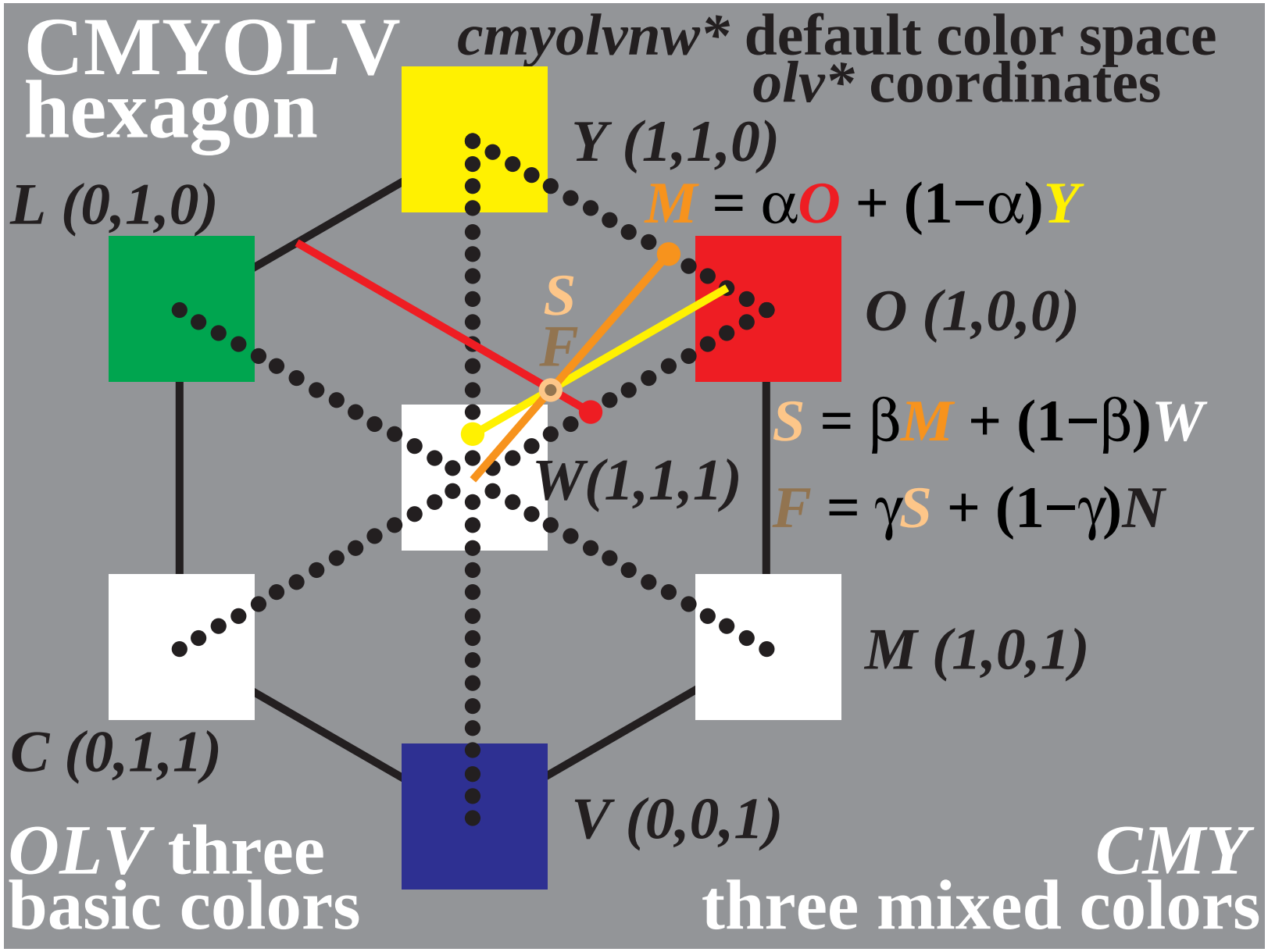
lch*: relative lightness, chromaticness, hue

tch*, tce*: triangle lightness, chromaticness, hue or elementary hue

nce*: blackness, chromaticness, elementary hue

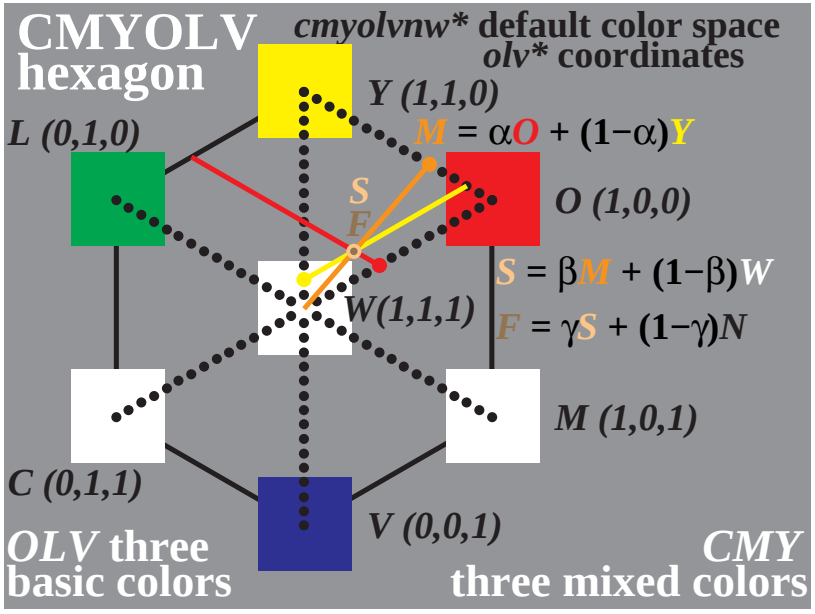
LE430−3, Application connection with coordinates *olv*, cmy*, tch*, tce*, nce*, ...* and linear relationship to *LAB**

Figure 4: Components α, β, γ of colour F mixed by 4 colours O,Y,N,W in sector O-Y

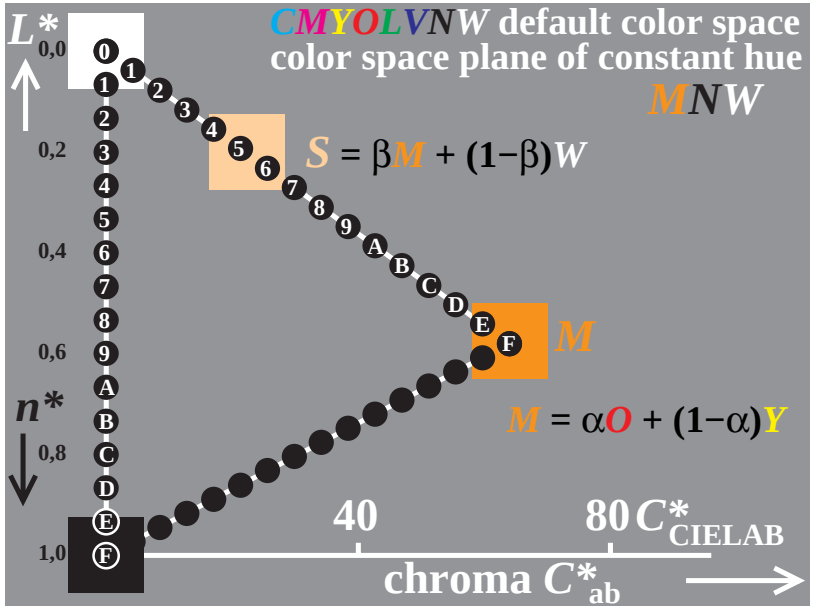


ME310−1, Colorimetric linear hexagon mixture α, β, γ

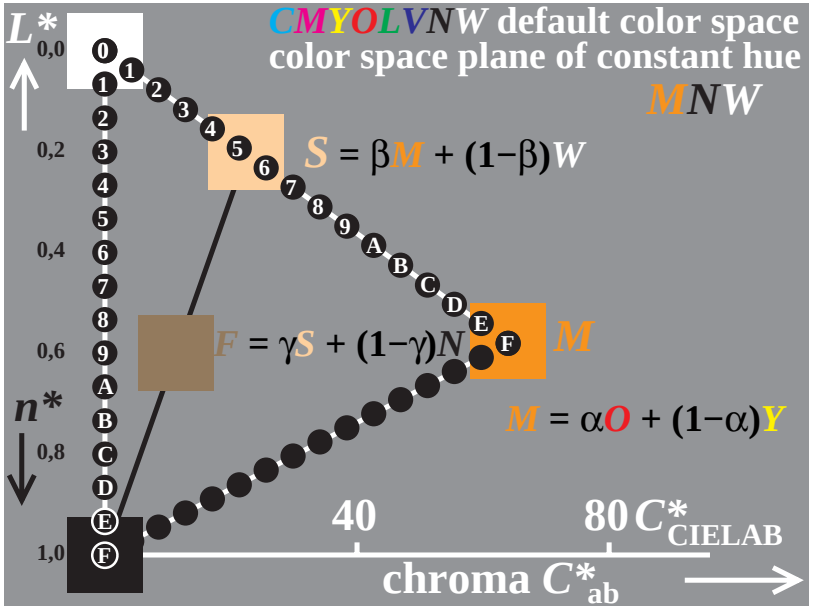
Figure 5: Colour hexagon and constant hue plane mixture



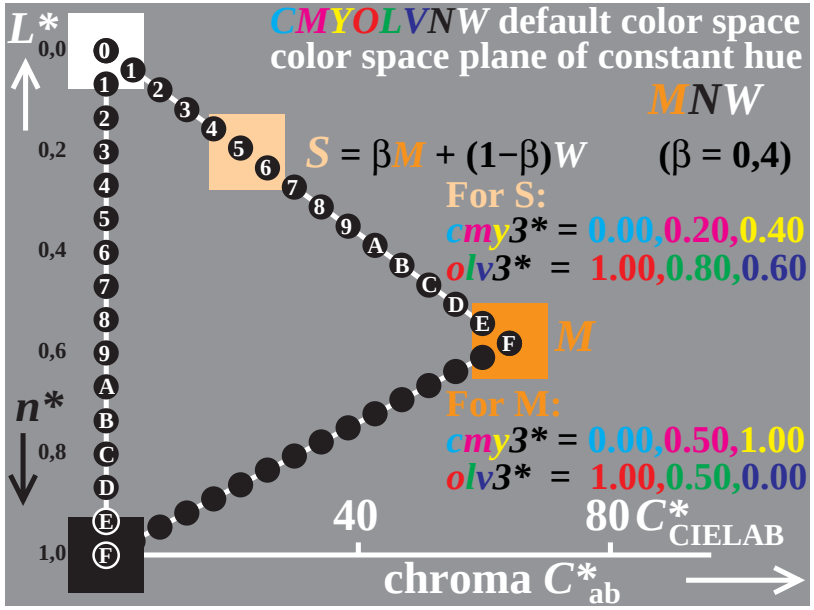
ME310−1, Colorimetric linear hexagon mixture α, β, γ



ME310−2, Hue constant mixture α, β of *O-Y, W-M*

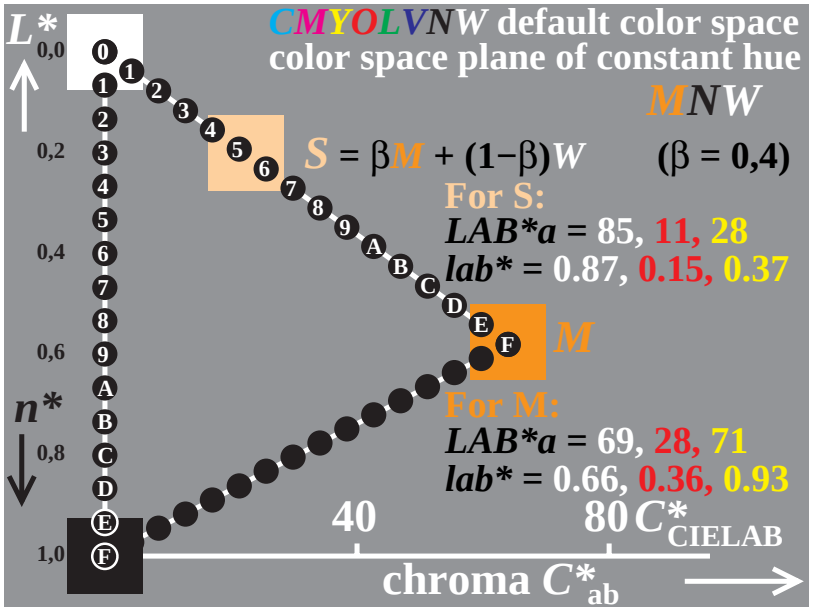


ME310−3, Hue constant mixture α,β,γ of *O-Y, W-M, S-N*

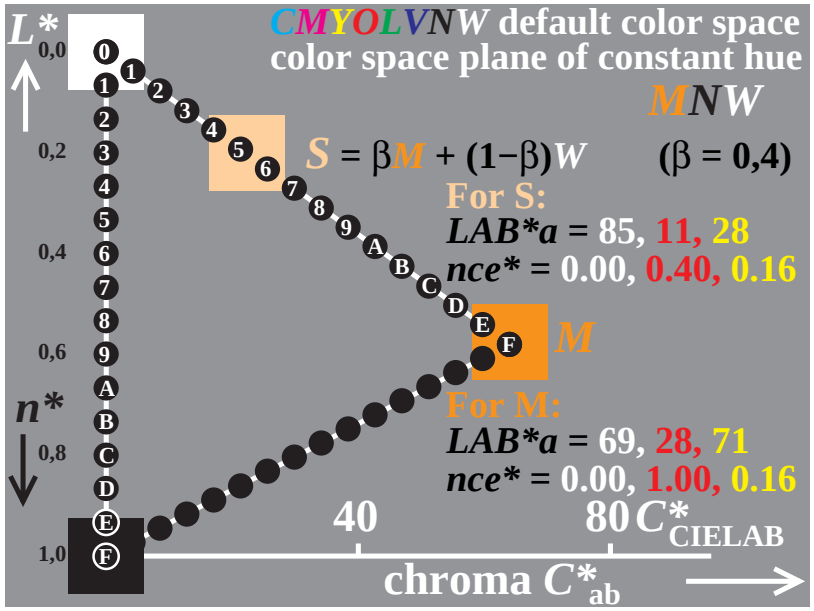


ME310−4, Hue constant mixture β of *W-M*

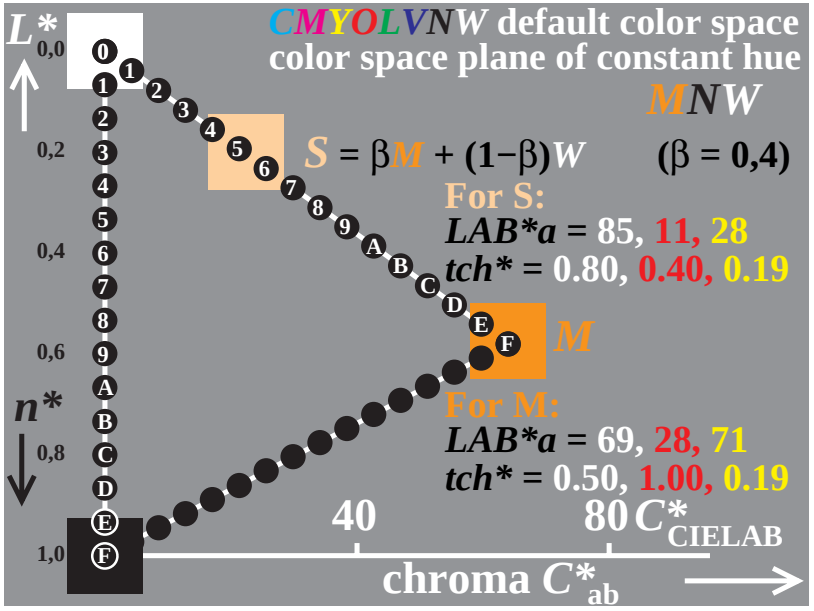
Figure 6: Relative CIELAB coordinates *lab*, tch*, nce* ncE* in constant hue plane



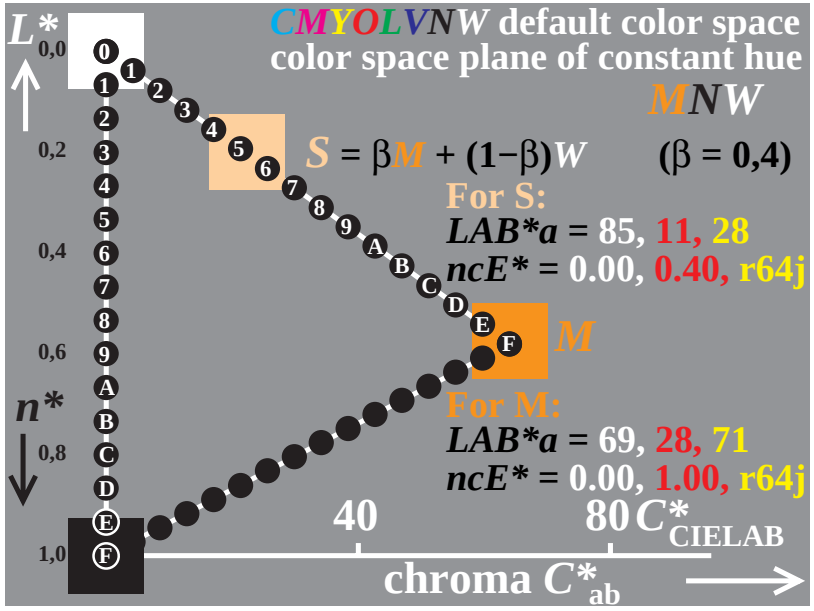
ME310−5, Hue constant mixture β of *W-M, LAB*a & lab*lab*



ME310−7, Hue constant mixture β of *W-M, LAB*a & lab*nce*

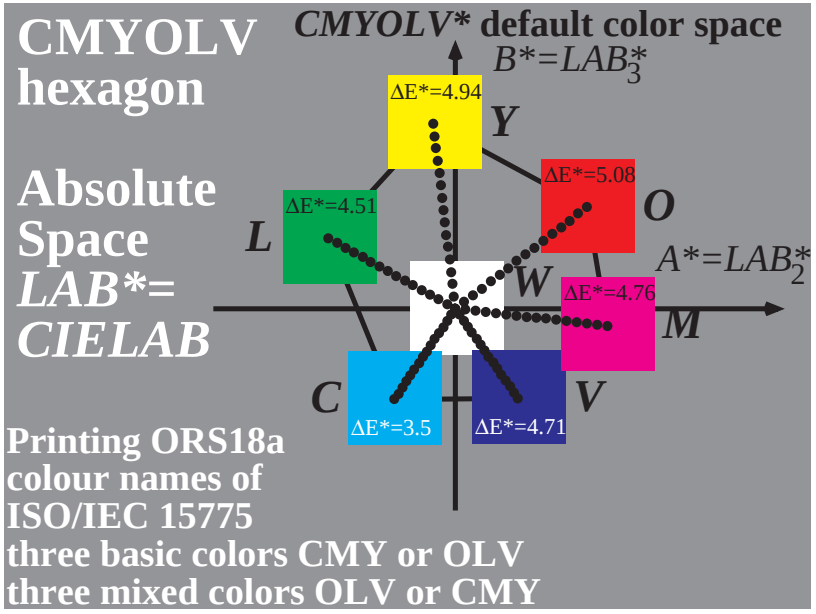


ME310−6, Hue constant mixture β of *W-M, LAB*a & lab*tch*

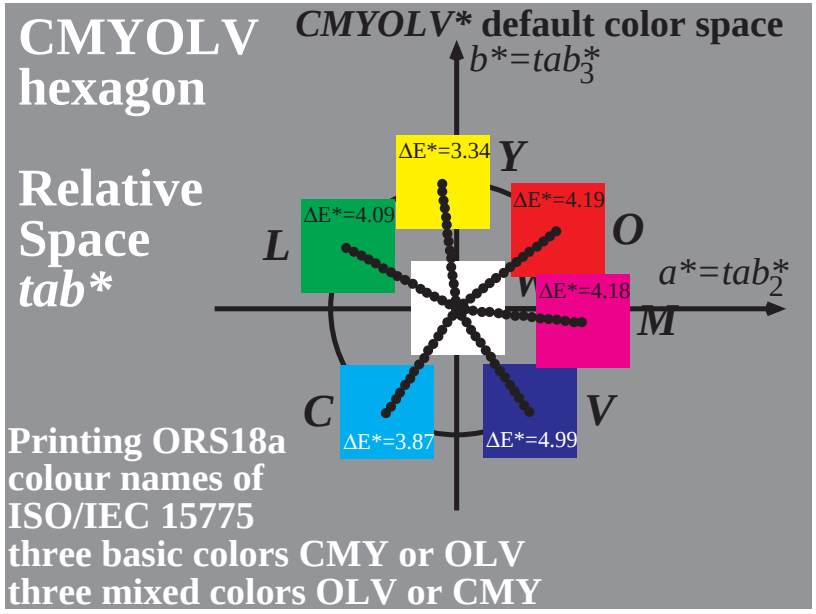


ME310−8, Hue constant mixture β of *W-M, LAB*a & lab*ncE*

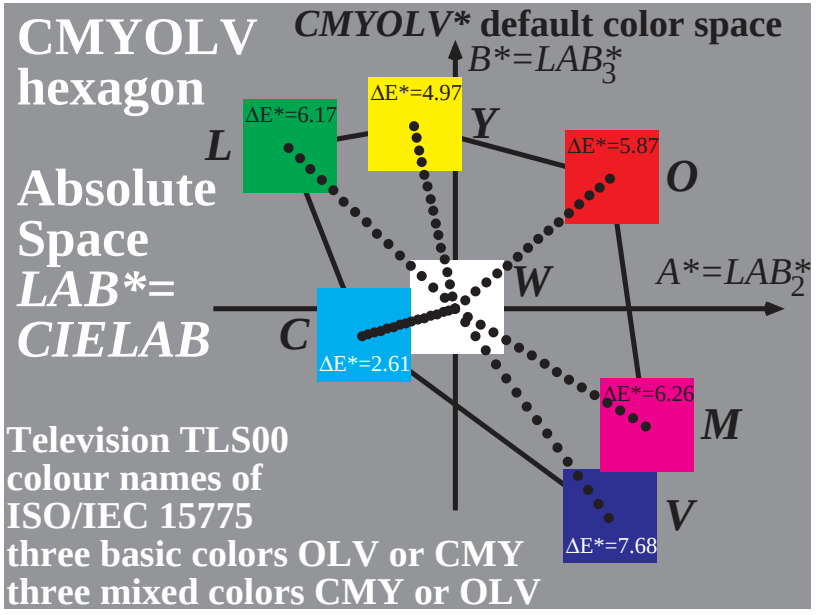
Figure 7: Colour coordinates *LAB and *lab** of printing ORS18a and television TLS00**



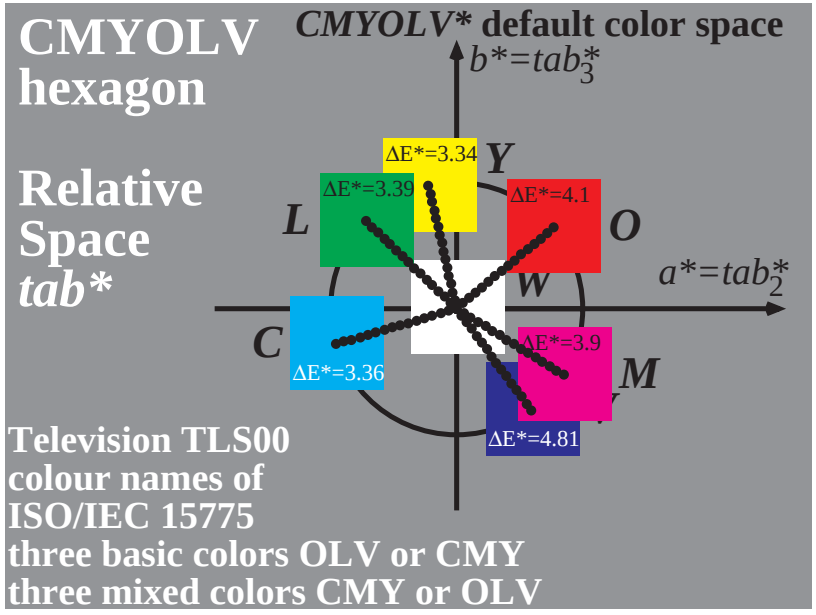
BE370−4, ORS18a in hue plane *AB** of *LAB**



BE380−4, ORS18a in hue plane *ab** of *tab**

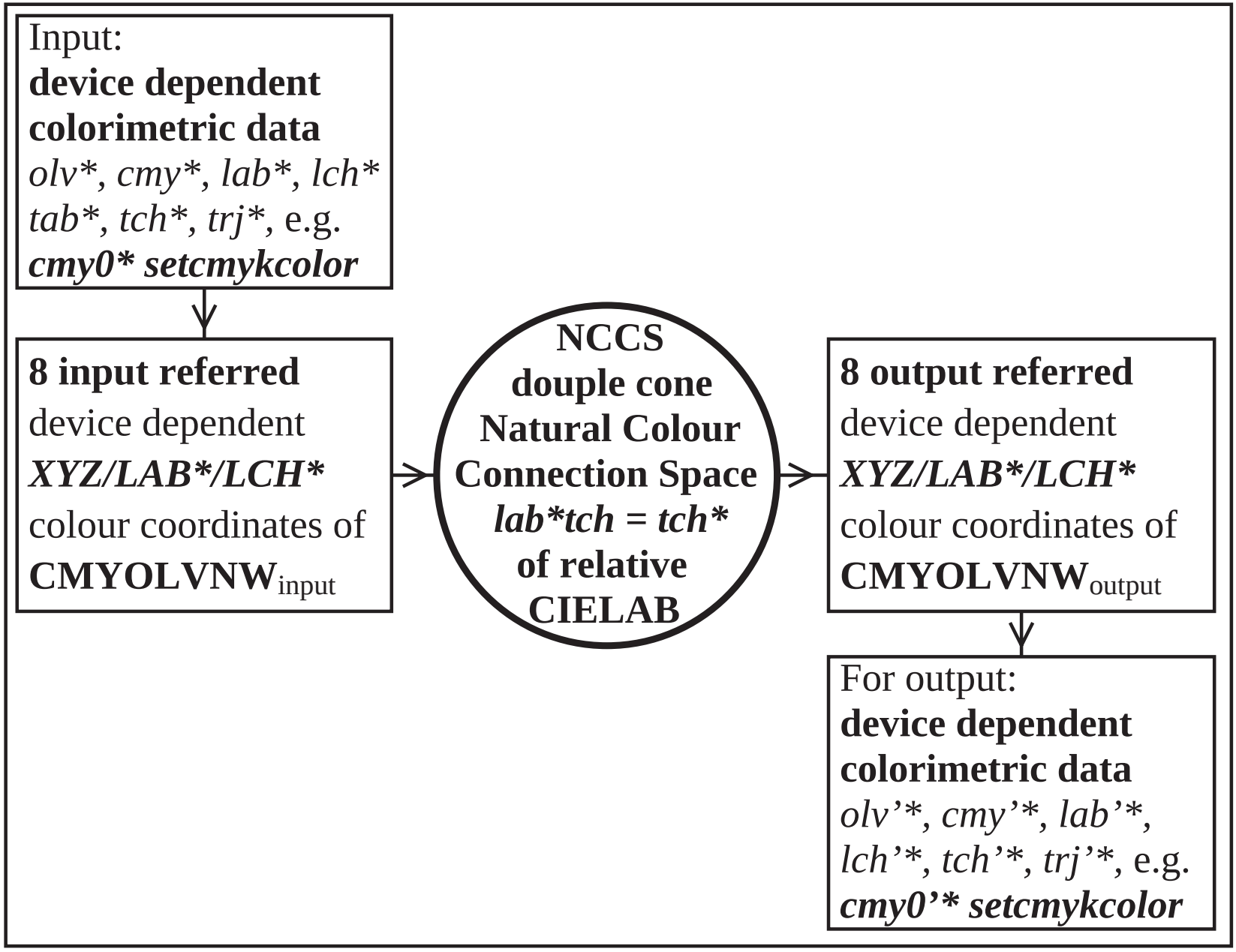


BE390−1, TLS00 in plane *AB** of *LAB**



BE381−1, TLS00 in hue plane *ab** of *tab**

Figure 8: Colour Management via the Natural Colour Connection Space (NCCS)



LE450−7, Transfer from device dependent *cmy0** data; output via NCCS with new *cmy0'** data

Figure 9: Calculation of device dependent relative CIELAB colour coordinates

Connection equations between the NCCS and the CIELAB space

For the calculations lightness L*, chroma C*ab and hue H* of CIELAB are used.

Within a hue triangle (CIELAB hue angle *H** = const.) there is the classical Ostwald equation: relative blackness + relative chromaticness + relative whiteness equals 1

or $\boldsymbol{n^*} + \boldsymbol{c^*} + \boldsymbol{w^*} = 1 \qquad (0 <= \boldsymbol{n^*, c^*, w^*} <= 1)$ (1)

A hue triangle in the CIELAB space is defined by the CIELAB coordinates of the given colour (F), the colours Black (N), White (W) and the colour of maximum chroma (M). For the colour F the **relative** coordinates chromaticness ***c**** , lightness ***l**** , triangle lightness ***t**** , whiteness ***w**** and blackness ***n**** may be calculated in the following sequence of the equations (2) to (6).

$$\boldsymbol{c^*}\,(F) = C^*ab\,(F) / C^*ab\,(M) \quad (2)$$

$$\boldsymbol{l^*}\,(F) = [\,L^*\,(F) - L^*\,(N)\,] / [\,L^*\,(W) - L^*\,(N)\,] \quad (3)$$

$$\boldsymbol{t^*}\,(F) = \boldsymbol{l^*}\,(F) - \boldsymbol{c^*}\,\{\,[\,L^*\,(M) - L^*\,(N)\,] / [\,L^*\,(W) - L^*\,(N)\,] - 0.5\,\} \quad (4)$$

$$\boldsymbol{w^*}\,(F) = \boldsymbol{t^*}\,(F) - 0.5\,\boldsymbol{c^*}\,(F) \quad (5)$$

$$\boldsymbol{n^*}\,(F) = 1 - \boldsymbol{c^*}\,(F) - \boldsymbol{w^*}\,(F) \quad (6)$$

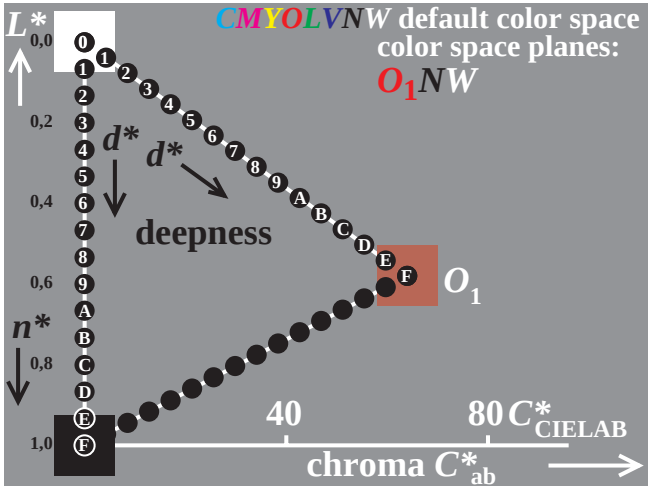
The coordinates of the new relative device dependent space NCCS (small letters) are given in **bold** and *italics* and the CIELAB coordinates (capital letters) are given only in *italics* for easy identification.The coordinates are completed by the relative hue ($0 <= \boldsymbol{h^*} <= 1$) and two cartesian components $-1 <= \boldsymbol{a^*, b^*} <= 1$

$$\boldsymbol{h^*}\,(F) = H^*\,(F) / 360 \quad (7)$$

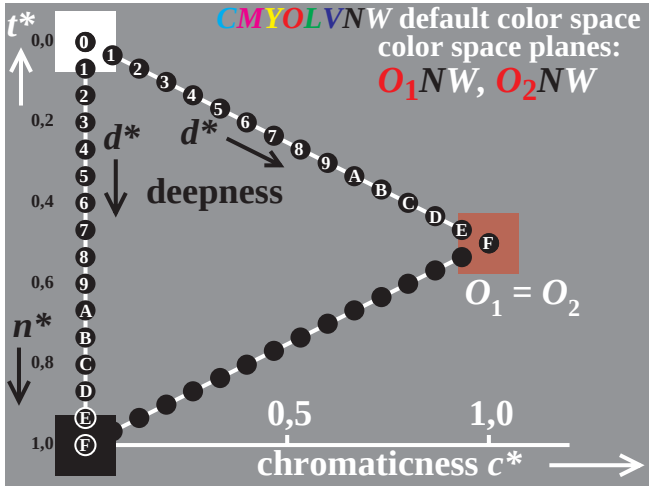
$$\boldsymbol{a^*}\,(F) = \boldsymbol{c^*}\,(F)\cos\,(H^*\,(F)) \quad (8)$$

$$\boldsymbol{b^*}\,(F) = \boldsymbol{c^*}\,(F)\sin\,(H^*\,(F)) \quad (9)$$

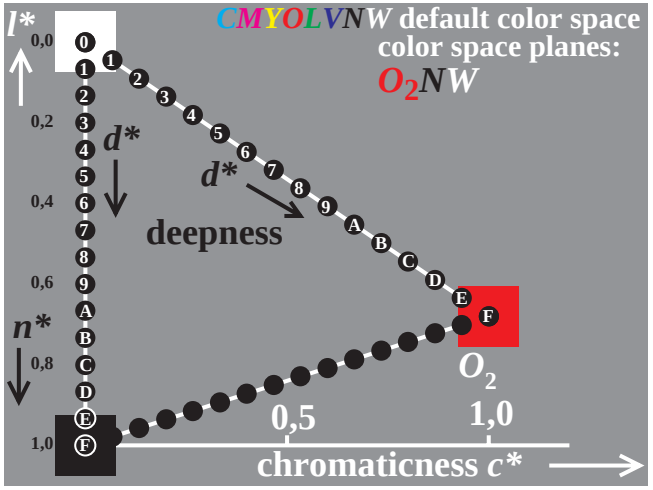
Figure 10: 16 steps from Input to output via NCCS



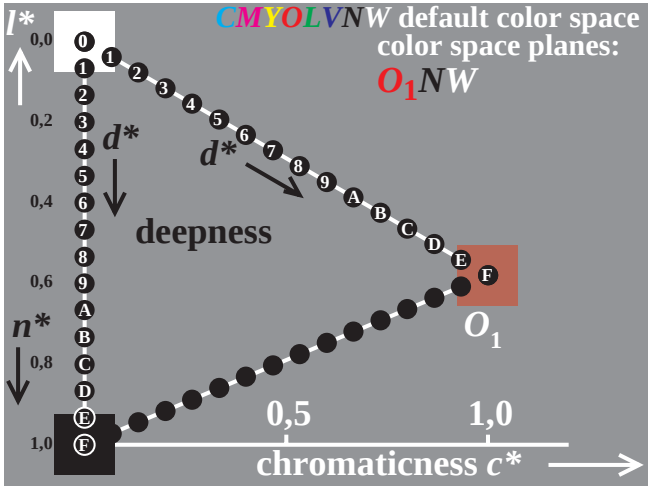
BE090−2, lightness L^*, chroma C^*_{ab} of O1



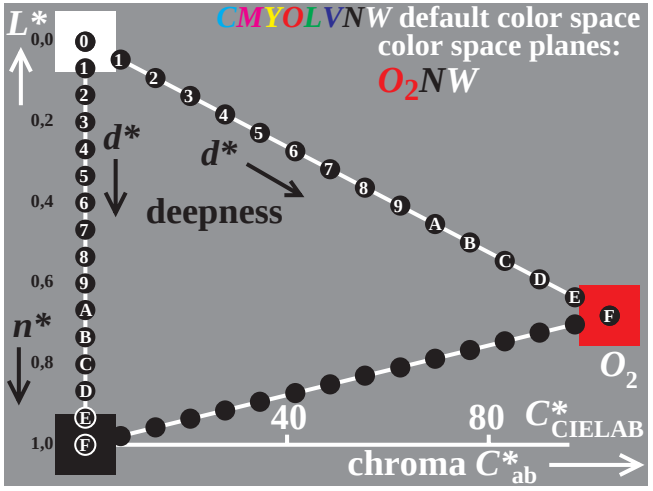
BE090−4, lightness t^*, chromaticness c^*



BE090−5, lightness l^*, chromaticness c^*

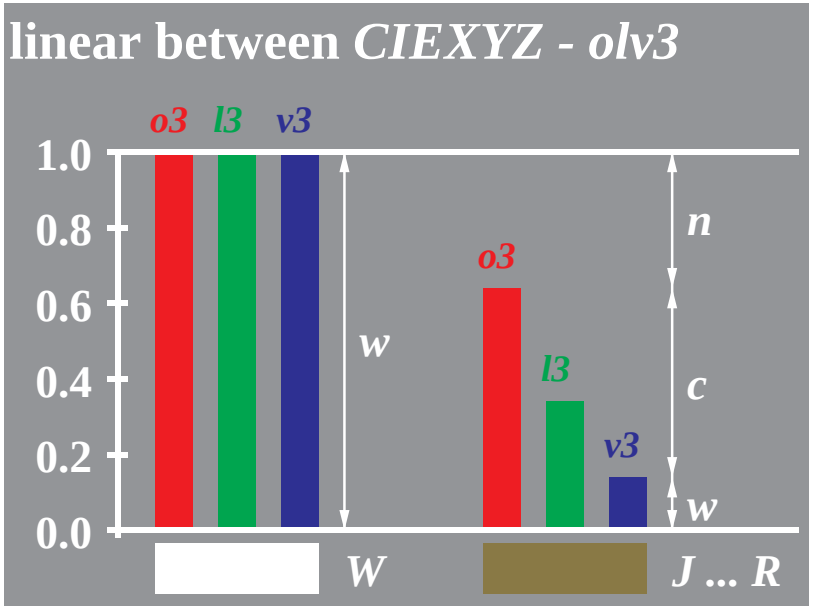


BE090−3, lightness l^*, chromaticness c^*

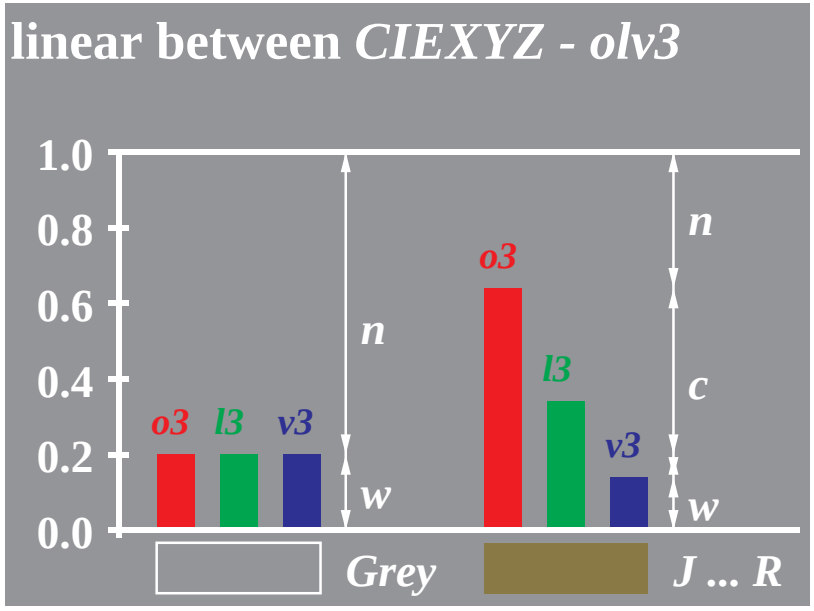


BE090−6, lightness L^*, chroma C^*_{ab} of O2

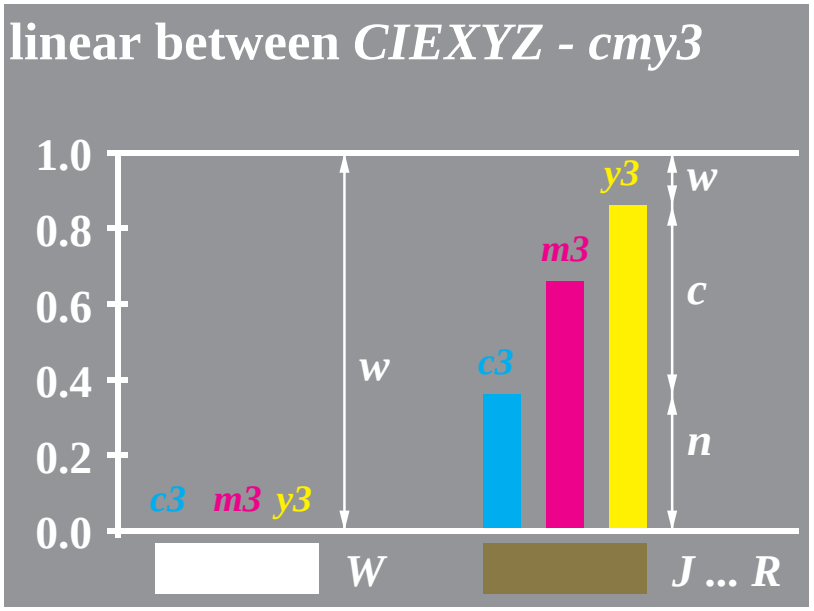
Figure 11: Linear reloationship olv3 – CIEXYZ and cmy3 – CIEXYZ



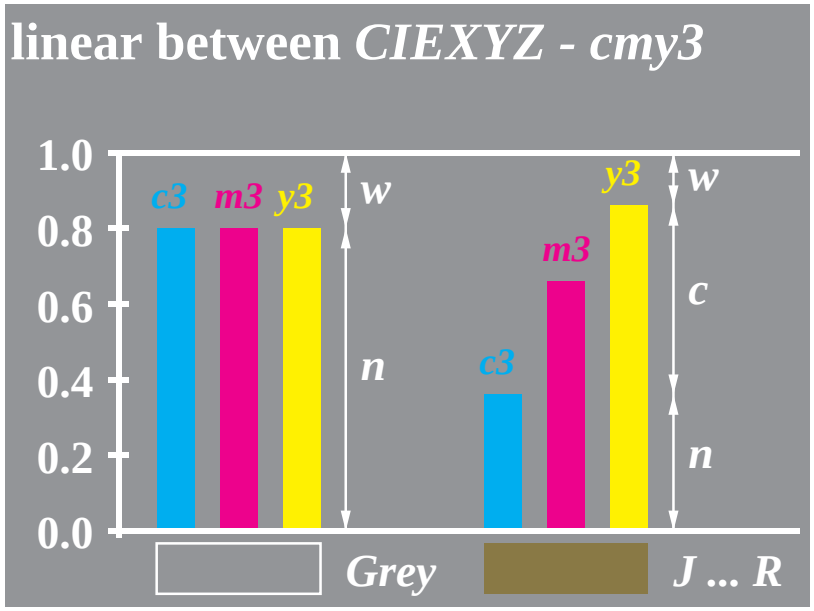
ME311−1, *olv3:* linear between *olv3 and XYZ*



ME311−2, *olv3:* linear between *olv3 and XYZ*

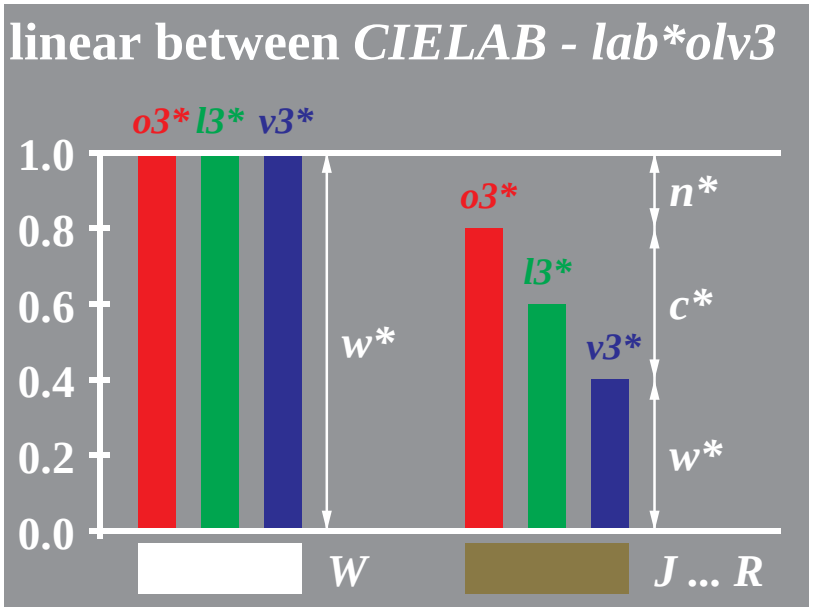


ME311−5, *cmy3:* linear between *cmy3 and XYZ*

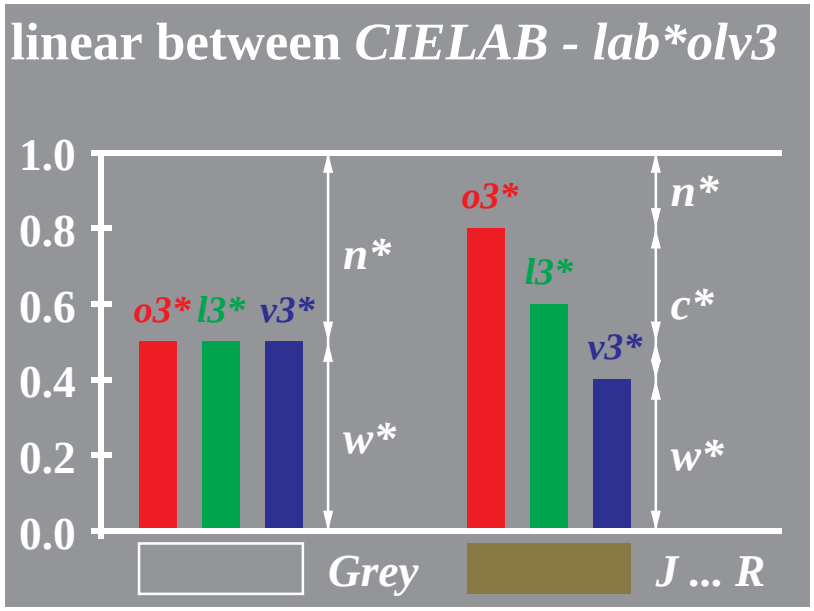


ME311−6, *cmy3:* linear between *cmy3 and XYZ*

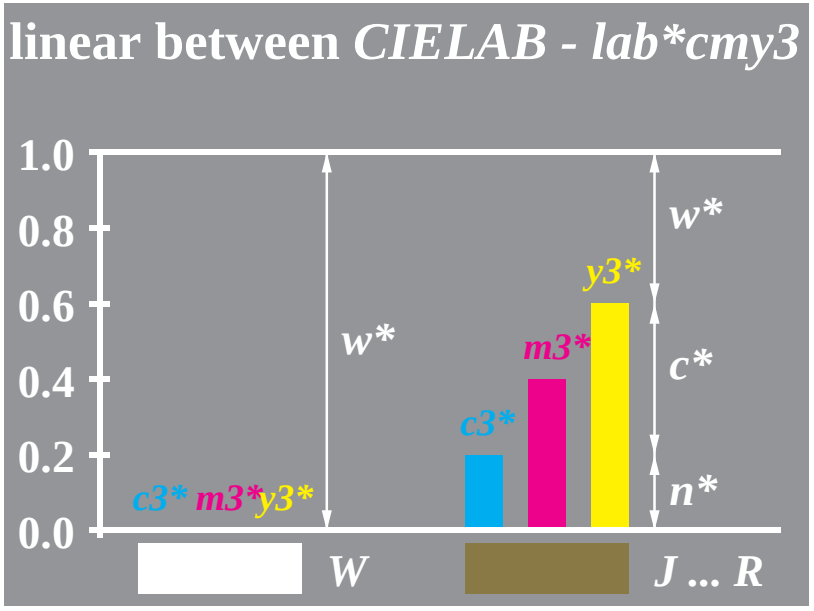
Figure 12: Linear reloationship olv3* – CIELAB and cmy3* – CIELABReference offset colours and change of monitor colours by room light



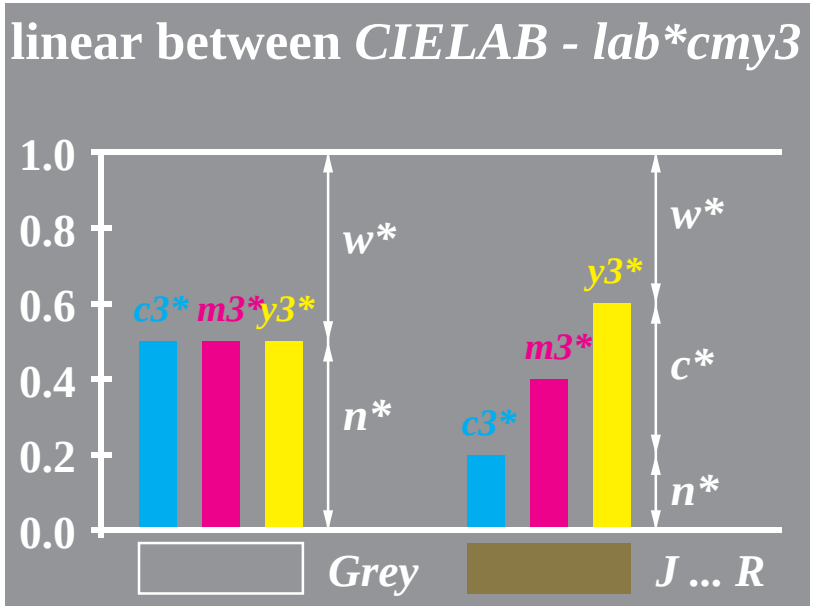
ME311−3, *lab*olv3:* linear between *olv3* and LAB**



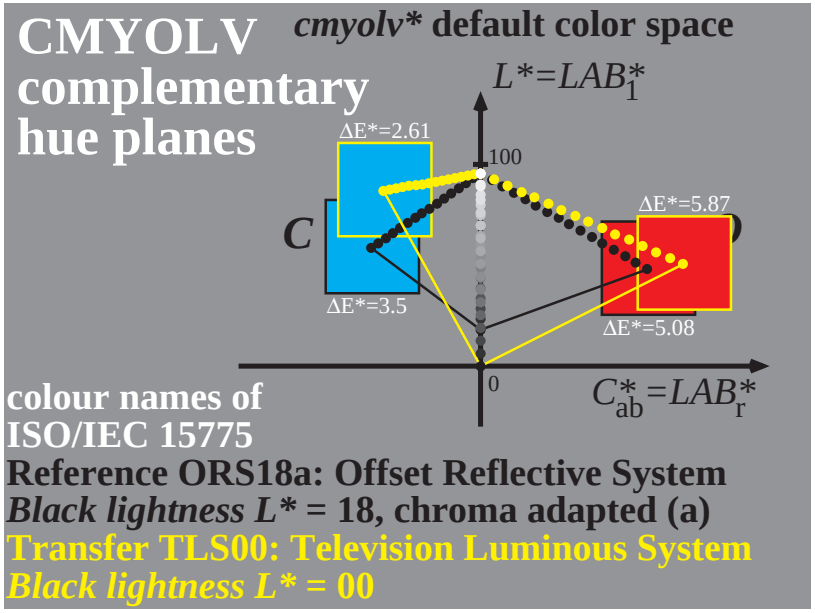
ME311−4, *lab*olv3:* linear between *olv3* and LAB**



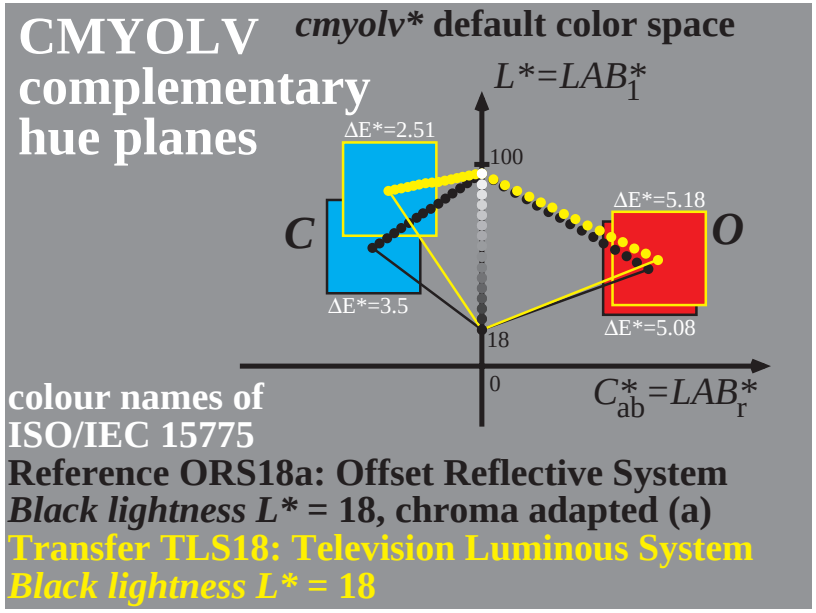
ME311−7, *lab*cmy3:* linear between *cmy3* and LAB**



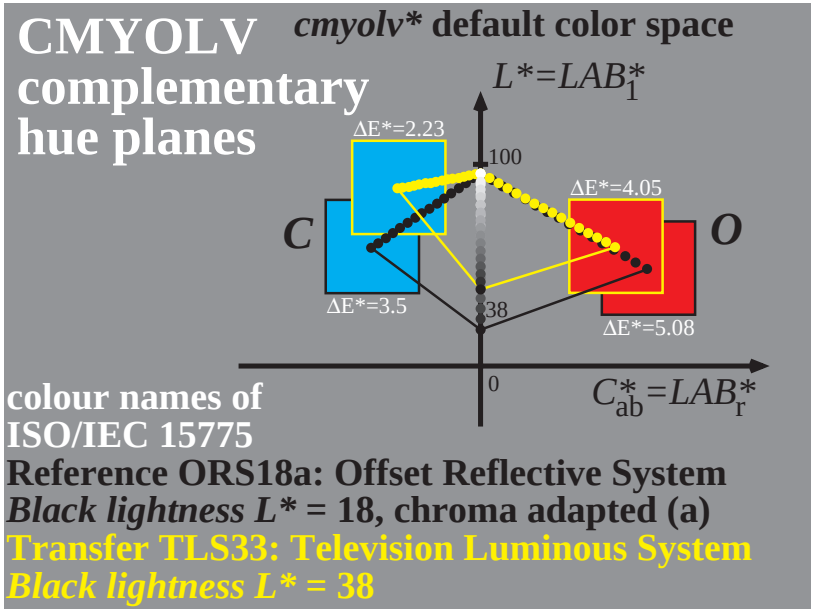
ME311−7, *lab*cmy3:* linear between *cmy3* and LAB**



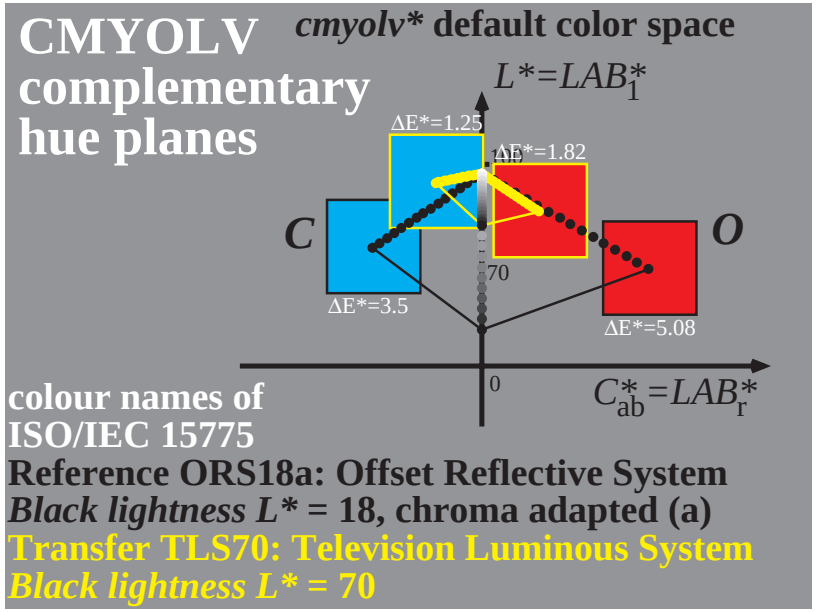
BE340−1, ORS18a − TLS00 in hue plane $O-C$



BE340−2, ORS18a − TLS18 in hue plane $O-C$

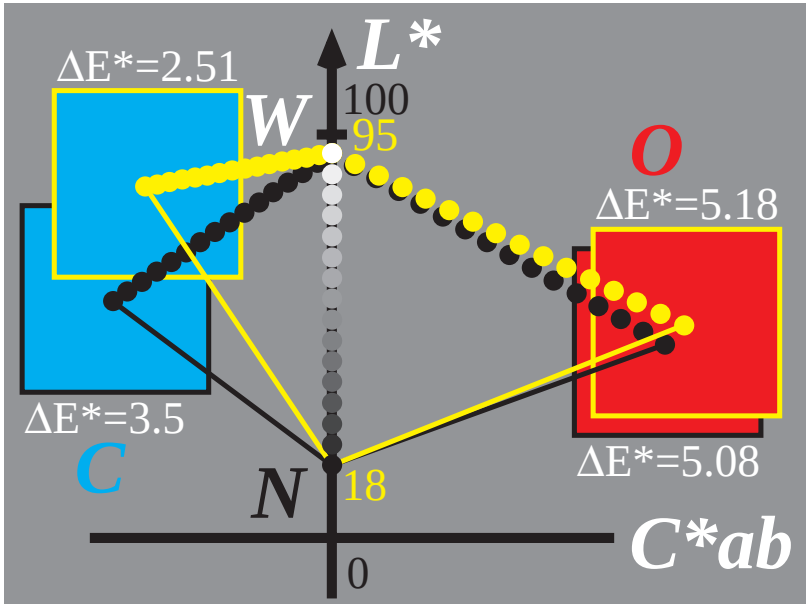


BE340−3, ORS18a − TLS33 in hue plane $O-C$

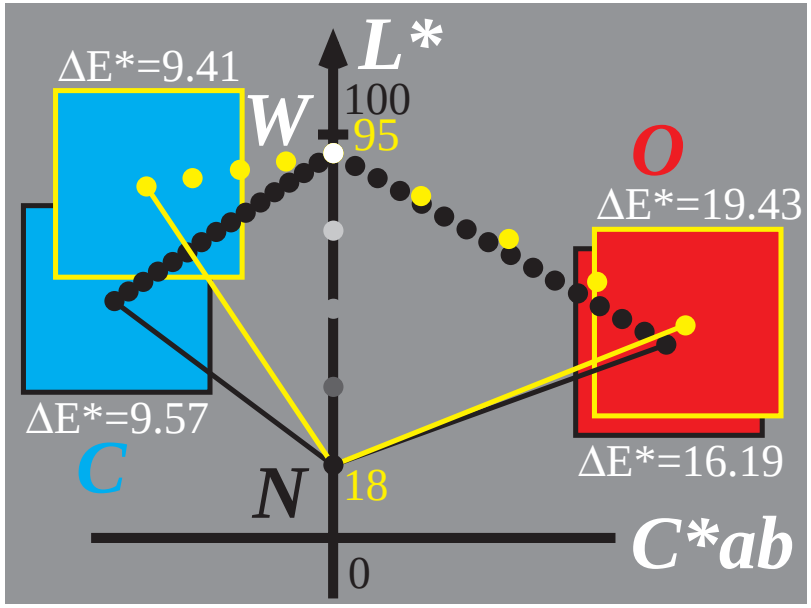


BE340−4, ORS18a − TLS70 in hue plane $O-C$

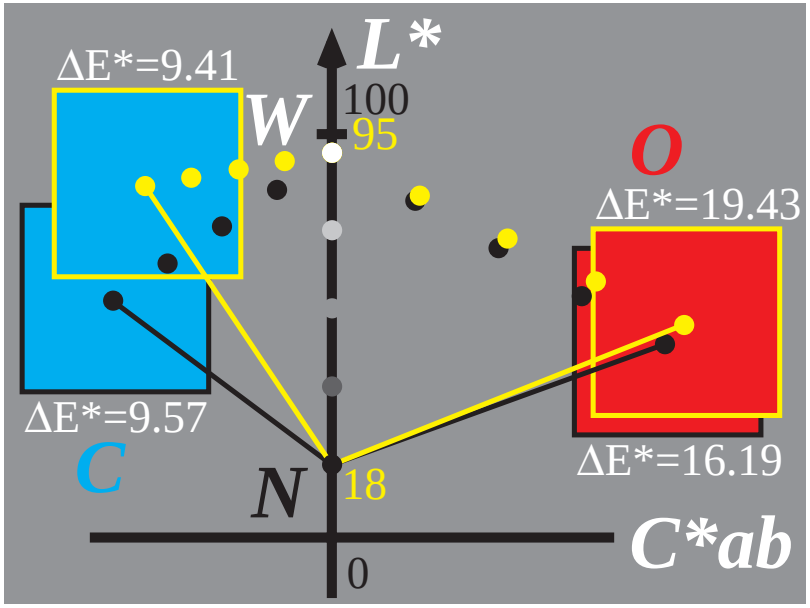
Figure 13: ISO/IEC TR 24705 linearized output steps and NCCS color management method



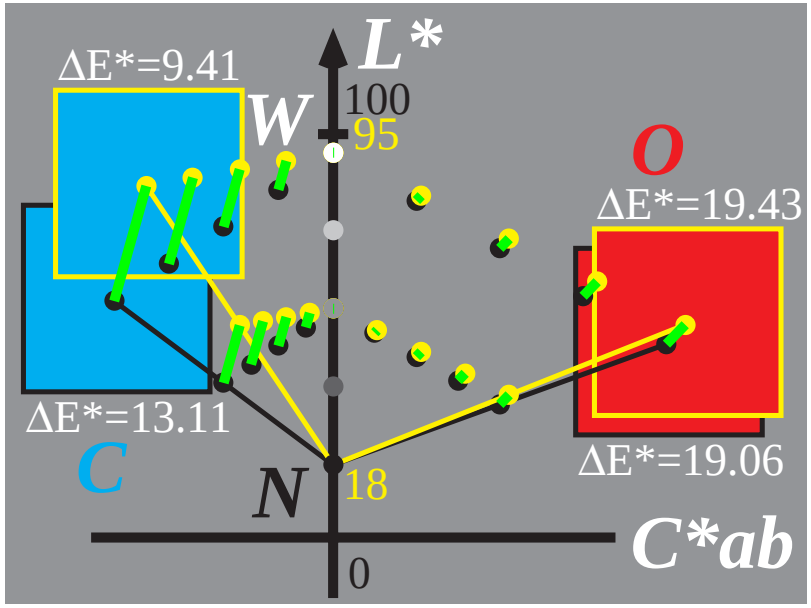
ME320−1, colours in hue planes O-C for TV18 and PR18



ME320−2, colours in hue planes O-C for TV18 and PR18

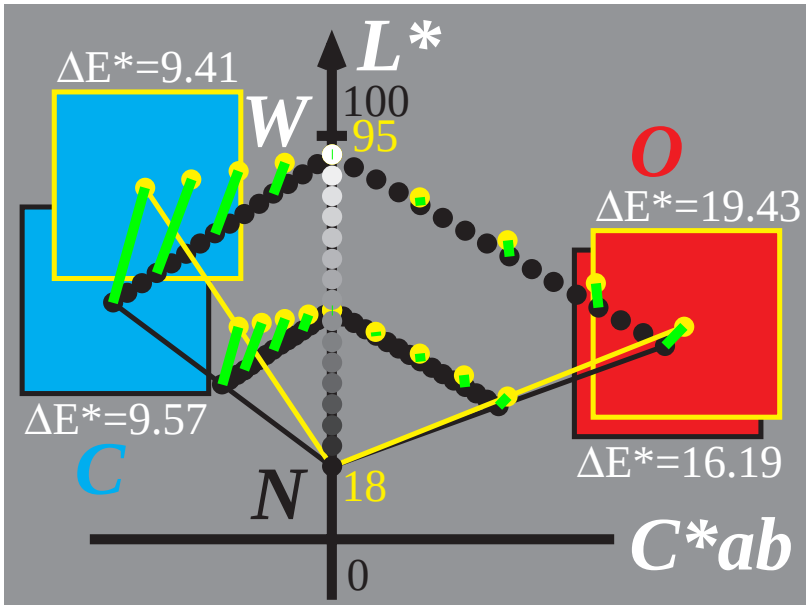


ME320−3, colours in hue planes O-C for TV18 and PR18

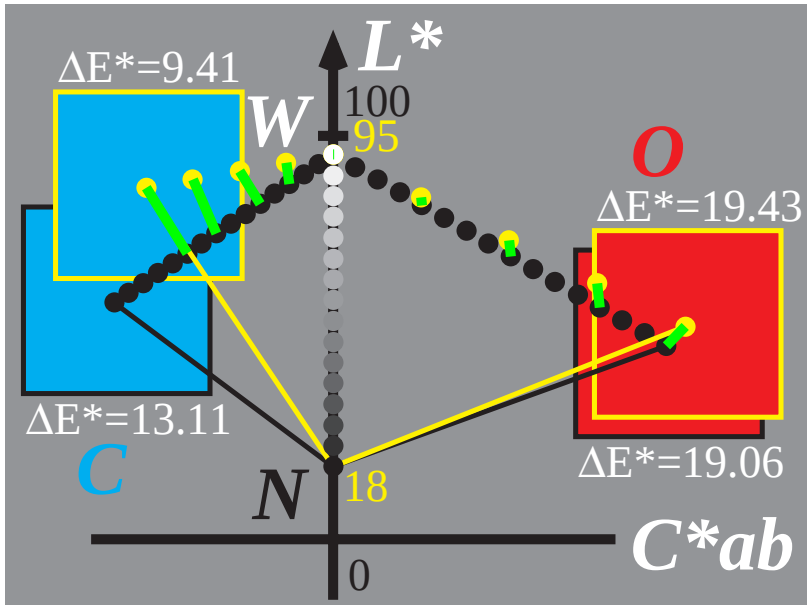


ME321−4, Colour management of hues O-C; TV18 -> PR18

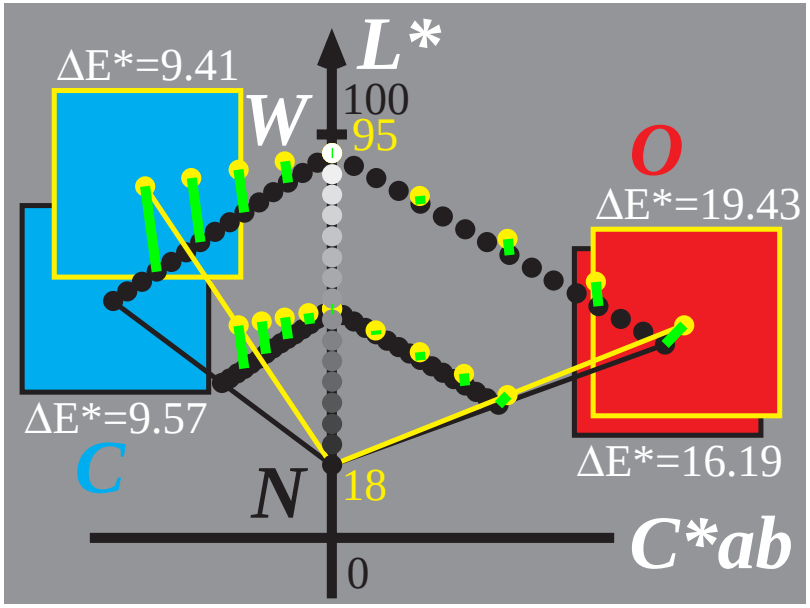
Figure 14: ISO/DIS 15076-1 options for ICC colour management method TV to PR



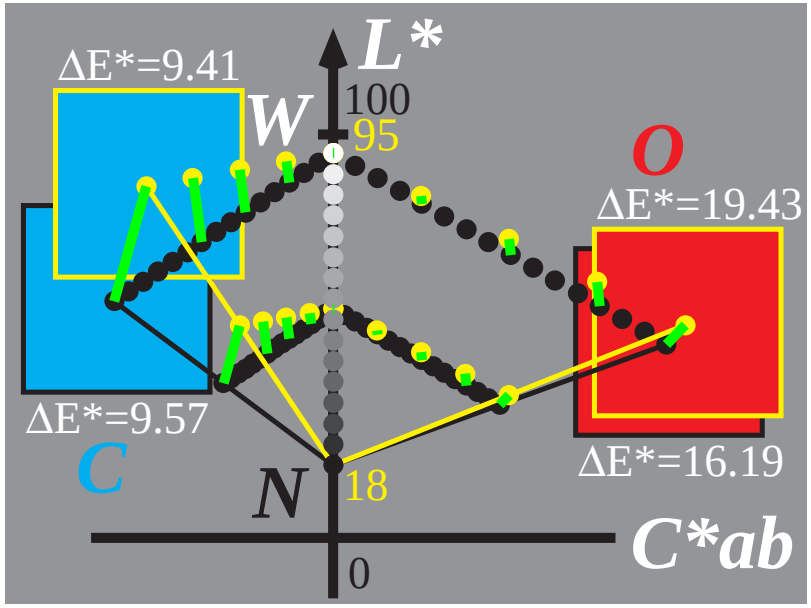
ME321−5, Colour management of hues O-C; TV18 -> PR18



ME320−6, Colour management of hues O-C; TV18 -> PR18



ME321−7, Colour management of hues O-C; TV18 -> PR18



ME321−8, Colour management of hues O-C; TV18 -> PR18

Figure 15: Colour triangle for chromatic and black generation

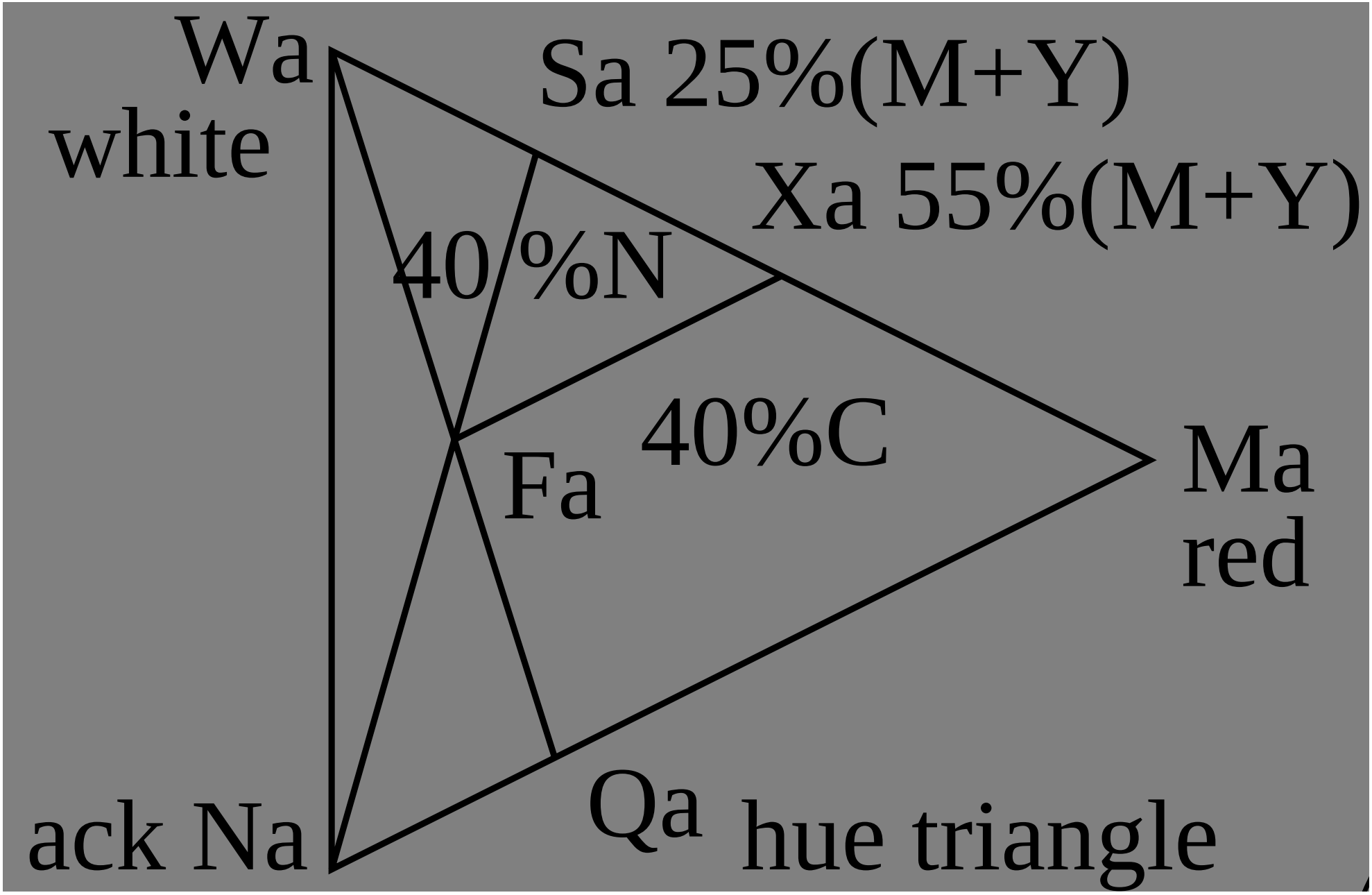
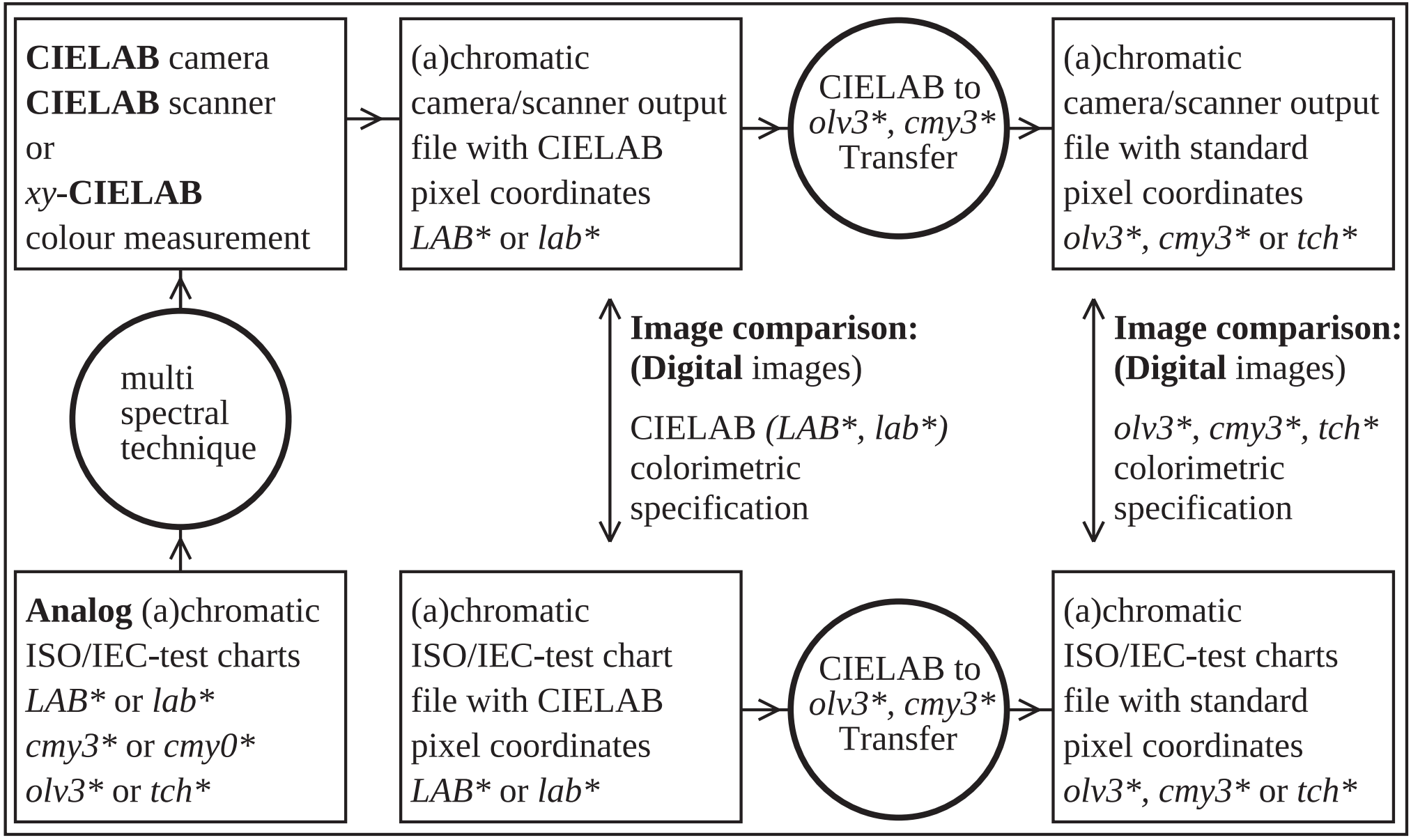


Figure 16: Calculation of equivalent colorimetric coordinates

R50J’

Inform. Techn. (IT) relative:				
*olvi3**	0.6	0.525	0.45	(1.0)
*cmyn3**	0.4	0.475	0.55	(0.0)
*olvi4**	1.0	0.875	0.75	0.6
*cmyn4**	0.0	0.125	0.25	0.4
CIELAB absolute:				
*LAB*LAB*	60.51	3.82	13.07	
*LAB*LABa*	60.51	4.13	10.67	
*LAB*TCHa*	52.5	11.44	68.82	
CIELAB relative:				
*lab*lab*	0.549	0.054	0.14	
*lab*tch*	0.525	0.15	0.191	
*lab*nch*	0.4	0.15	0.191	
Natural Colour (NC) relative:				
*lab*lrj*	0.549	0.079	0.128	
*lab*tce*	0.525	0.15	0.162	
*lab*ncE*	0.4	0.15	r64j	

Figure 17: CIELAB camera image and transfer of *LAB to colorimetric coordinates**



LE430−7, Transfer from device independent data *LAB** to device dependent data *olv3*, cmy3* and tch**

Figure 18: Equivalent colorimetric coordinates of five step grey scale N - W

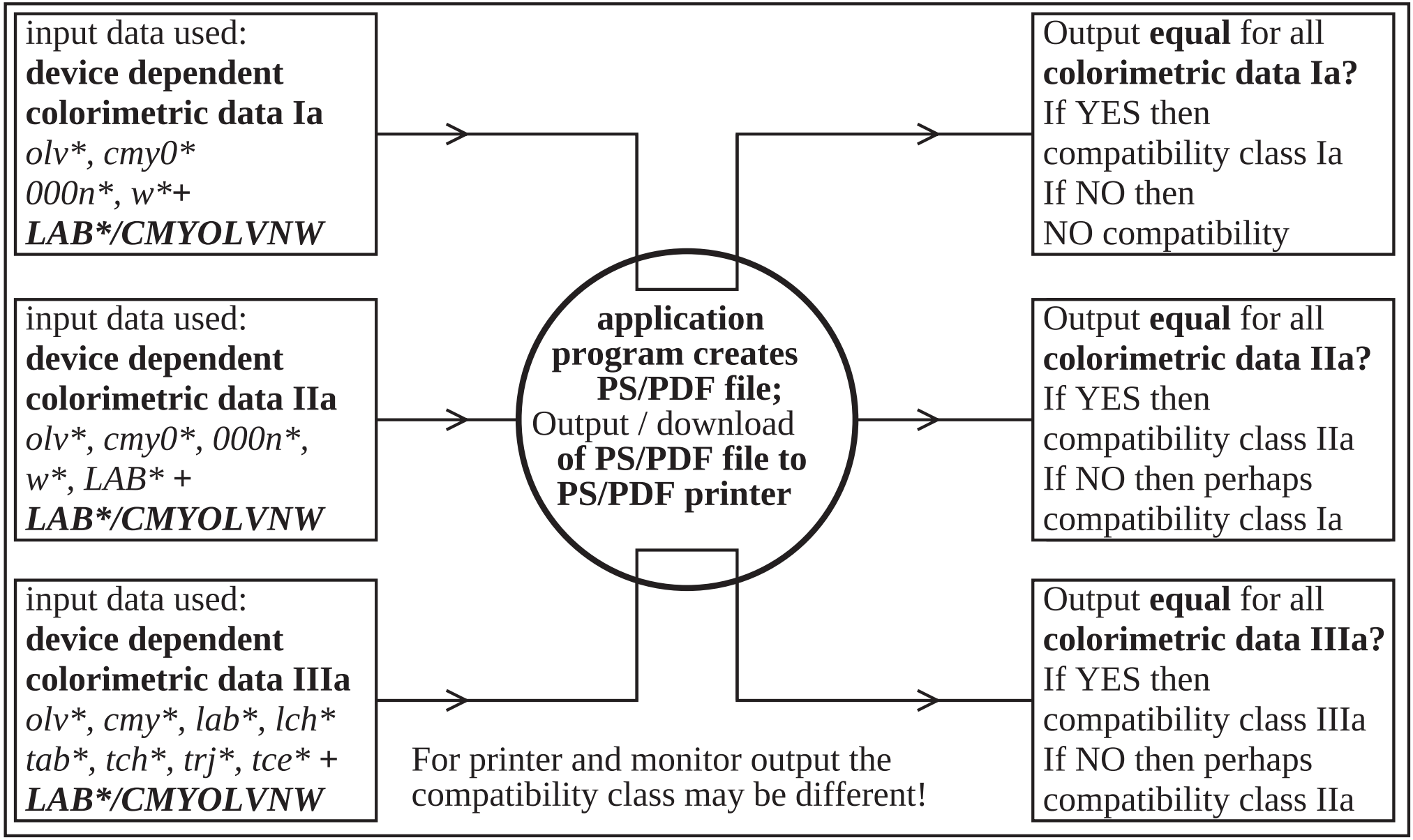
5 steps of grey series black - white (N - W)	**Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12**											
Linear mixture between black and white in CIELAB colour space	***L* CIE w* = l* setgray***		***CMYN (CMYK) 000n* setcmykcolor***				***CMYN (CMYK) cmy0* setcmykcolor***				***OLV (RGB) www* setrgbcolor***			
1,00 N + 0,00 W (black N)	0,00		0,00	0,00	0,00	1,00	1,00	1,00	1,00	0,00	0,00	0,00	0,00	
0,75 N + 0,25 W	0,25		0,00	0,00	0,00	0,75	0,75	0,75	0,75	0,00	0,25	0,25	0,25	
0,50 N + 0,50 W	0,50		0,00	0,00	0,00	0,50	0,50	0,50	0,50	0,00	0,50	0,50	0,50	
0,25 N + 0,75 W	0,75		0,00	0,00	0,00	0,25	0,25	0,25	0,25	0,00	0,75	0,75	0,75	
0,00 N + 1,00 W (white W)	1,00		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,00	1,00	1,00	

LE420−1, colorimetric relationship of *w**, *000n**, *cmy0**, *www** for a 5 step grey scale: black − white

5 steps of colour series black - white (N - W)	**Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12**								
Linear mixture between black and white in CIELAB colour space	**CIELAB adapted *LAB*a (adapted) LAB*a setcolor***			**CIELAB relative *lab*tch = tch* tch* setcolor***			**CIELAB relative *lab*ncE = ncE* ncE* setcolor***		
1,00 N + 0,00 W (black N)	18.01	0.00	0.00	0,00	0,00	−	1,00	0,00	−
0,75 N + 0,25 W	37.35	0.00	0.00	0,25	0,00	−	0,75	0,00	−
0,50 N + 0,50 W	56.70	0.00	0.00	0,50	0,00	−	0,50	0,00	−
0,25 N + 0,75 W	76.05	0.00	0.00	0,75	0,00	−	0,25	0,00	−
0,00 N + 1,00 W (white W)	95.41	0.00	0.00	1,00	0,00	−	0,00	0,00	−

LE420−7, colorimetric relationship of *LAB*a*, *tch**, *ncE** for a 5 step grey scale: black − white

Figure 19: Specification of compatibility class for output of equivalent colorimetric coordinates



LE440−7, Test of the compatibility class of application program which creates PDF/PS files and/or download to printer

Figure 20: Equivalent colorimetric coordinates of five step colour scale C - W

5 steps of colour series cyan blue - white (C - W)	**Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12**		
Linear mixture between cyan blue and white in CIELAB colour space	**CIELAB absolute *LAB*LAB = LAB* LAB* setcolor***	**CIELAB relative *lab*cmy0 = cmy0* cmy0* setcmykcolor***	**CIELAB relative *lab*olv = olv* olv* setrgbcolor***
1,00 C + 0,00 W (cyan blue C)	58.62 -30.62 -42.74	1,00 0,00 0,00 0,00	0,00 1,00 1,00
0,75 C + 0,25 W	67.82 -23.21 -30.86	0,75 0,00 0,00 0,00	0,25 1,00 1,00
0,50 C + 0,50 W	77.02 -15.80 -18.98	0,50 0,00 0,00 0,00	0,50 1,00 1,00
0,25 C + 0,75 W	86.21 -8.39 -7.11	0,25 0,00 0,00 0,00	0,75 1,00 1,00
0,00 C + 1,00 W (white W)	95.41 -0.98 4.76	0,00 0,00 0,00 0,00	1,00 1,00 1,00

LE421−1, colorimetric relationship of *LAB*a, cmy0*, olv** for a 5 step scale: cyan blue − white

5 steps of colour series cyan blue - white (C - W)	**Colour space, colour space coordinates and PostScript operator calculations according to ISO/IEC 15775:1999-12**		
Linear mixture between cyan blue and white in CIELAB colour space	**CIELAB absolute *LAB*LCHa = LCH*a LCH*a setcolor***	**CIELAB relative *lab*tch = tch* tch* setcolor***	**CIELAB relative *lab*ncE = ncE* ncE* setcolor***
1,00 C + 0,00 W (cyan blue C)	58.62 54.29 236.0	0.500 1.000 0.656	0.000 1.000 g21b
0,75 C + 0,25 W	67.82 40.51 236.0	0.625 0.750 0.656	0.000 0.750 g21b
0,50 C + 0,50 W	77.02 27.14 236.0	0.750 0.500 0.656	0.000 0.500 g21b
0,25 C + 0,75 W	86.21 13.57 236.0	0.875 0.250 0.656	0.000 0.250 g21b
0,00 C + 1,00 W (white W)	95.41 0.01 −	1.000 0.001 −	0.000 0.001 −

LE421−7, colorimetric relationship of *LCH*a, tch*, ncE** for a 5 step scale: cyan blue − white

Figure 21: Work place assessment of 5 step grey scales for visual output linearization

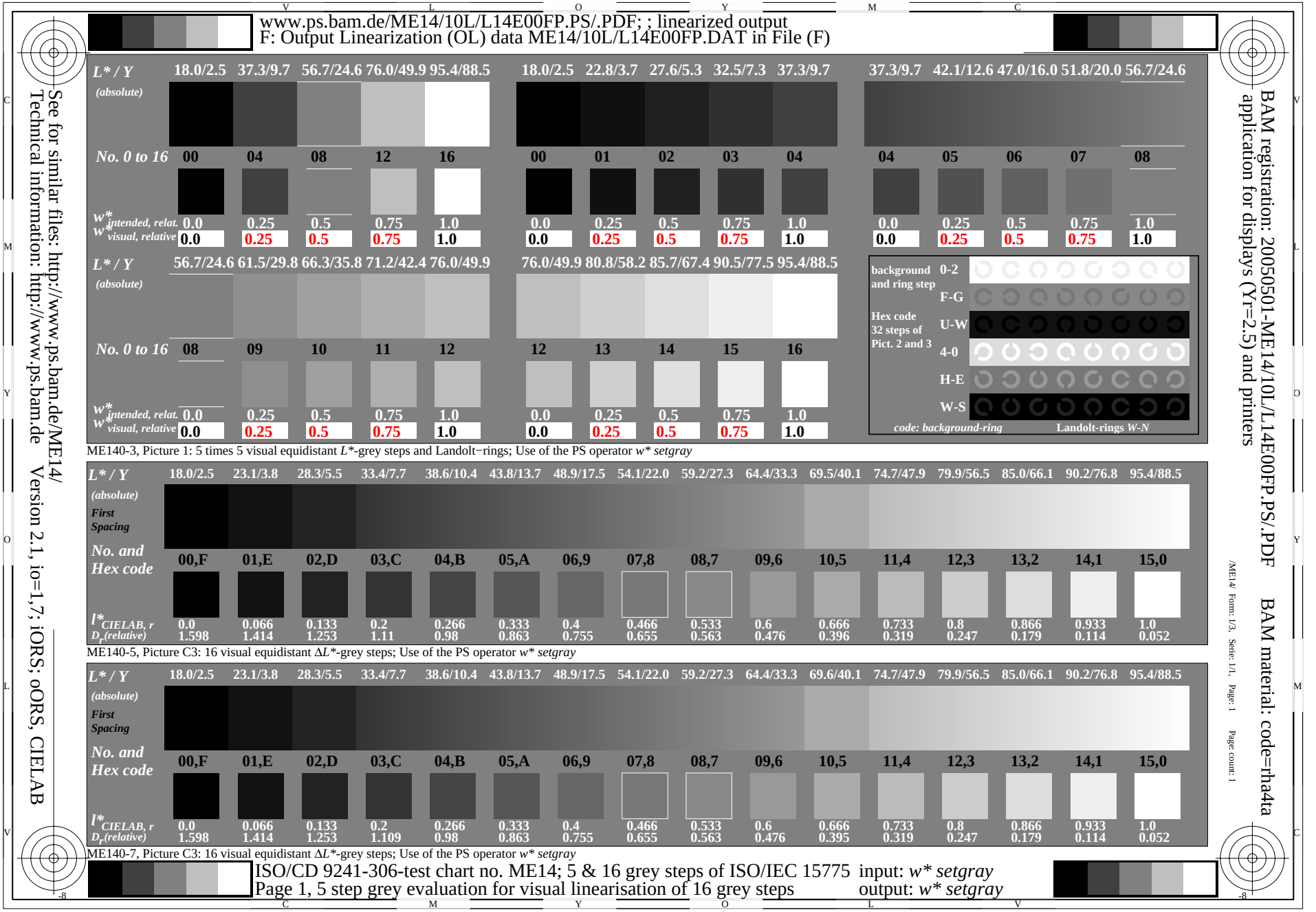


Figure 22: Linearized ouput based on visual 5 step work place assessment

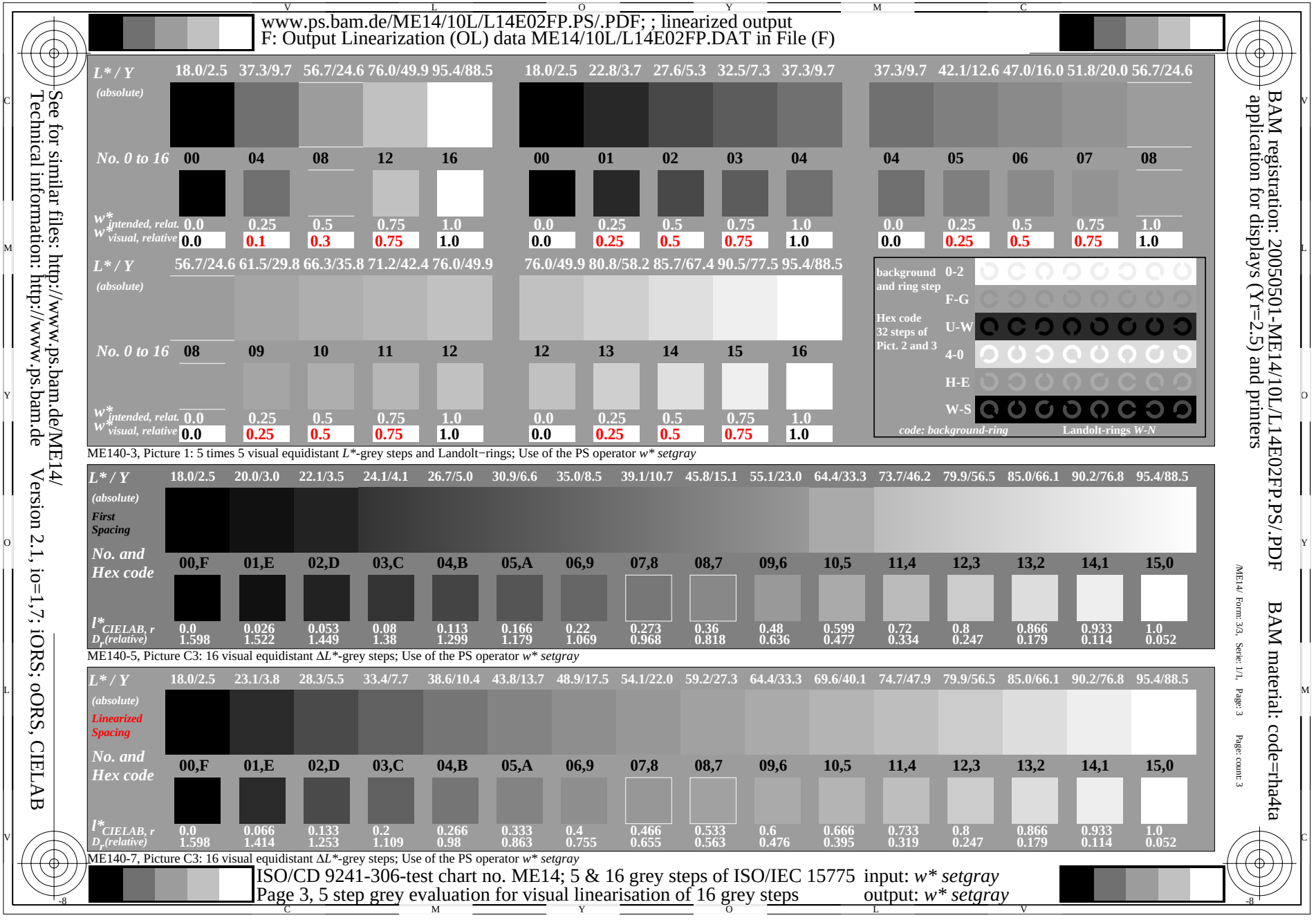


Figure 23: input - output relationship and inverse relation for output linearisation

www.ps.bam.de/ME14/10L/L14E03FP.PS/.PDF; ; linearized output
F: Output Linearization (OL) data ME14/10L/L14E03FP.DAT in File (F)

i	LAB*ref			d*	LAB*out			LAB*out/c-ref	Δ		E*
1	18.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.01
2	23.16	0.0	0.0	0.03	20.07	0.0	0.0	-3.08	0.0	0.0	3.09
3	28.32	0.0	0.0	0.05	22.13	0.0	0.0	-6.18	0.0	0.0	6.19
4	33.48	0.0	0.0	0.08	24.19	0.0	0.0	-9.28	0.0	0.0	9.29
5	38.64	0.0	0.0	0.11	26.77	0.0	0.0	-11.86	0.0	0.0	11.87
6	43.8	0.0	0.0	0.17	30.9	0.0	0.0	-12.89	0.0	0.0	12.9
7	48.96	0.0	0.0	0.22	35.03	0.0	0.0	-13.92	0.0	0.0	13.93
8	54.12	0.0	0.0	0.27	39.16	0.0	0.0	-14.95	0.0	0.0	14.96
9	59.28	0.0	0.0	0.36	45.87	0.0	0.0	-13.4	0.0	0.0	13.41
10	64.44	0.0	0.0	0.48	55.15	0.0	0.0	-9.28	0.0	0.0	9.29
11	69.6	0.0	0.0	0.6	64.43	0.0	0.0	-5.16	0.0	0.0	5.17
12	74.76	0.0	0.0	0.72	73.74	0.0	0.0	-1.01	0.0	0.0	1.02
13	79.92	0.0	0.0	0.8	79.92	0.0	0.0	0.0	0.0	0.0	0.01
14	85.08	0.0	0.0	0.87	85.08	0.0	0.0	0.0	0.0	0.0	0.01
15	90.24	0.0	0.0	0.93	90.25	0.0	0.0	0.01	0.0	0.0	0.01
16	95.4	0.0	0.0	1.0	95.4	0.0	0.0	0.0	0.0	0.0	0.01
17	18.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.01
18	37.35	0.0	0.0	0.11	26.13	0.0	0.0	-11.21	0.0	0.0	11.22
19	56.7	0.0	0.0	0.32	42.52	0.0	0.0	-14.17	0.0	0.0	14.18
20	76.05	0.0	0.0	0.74	75.28	0.0	0.0	-0.76	0.0	0.0	0.77
21	95.4	0.0	0.0	1.0	95.4	0.0	0.0	0.0	0.0	0.0	0.01

Start output S1
Specification according to ISO/IEC 15775 Annex G and DIN 33866-1 Annex G

Mean lightness difference (16 steps)
ΔE^*_{CIELAB} = 6.3
Mean lightness difference (5 steps)
ΔL^*_{CIELAB} = 5.2
Mean colour reproduction index $R^*_{ab,m}$ = 72

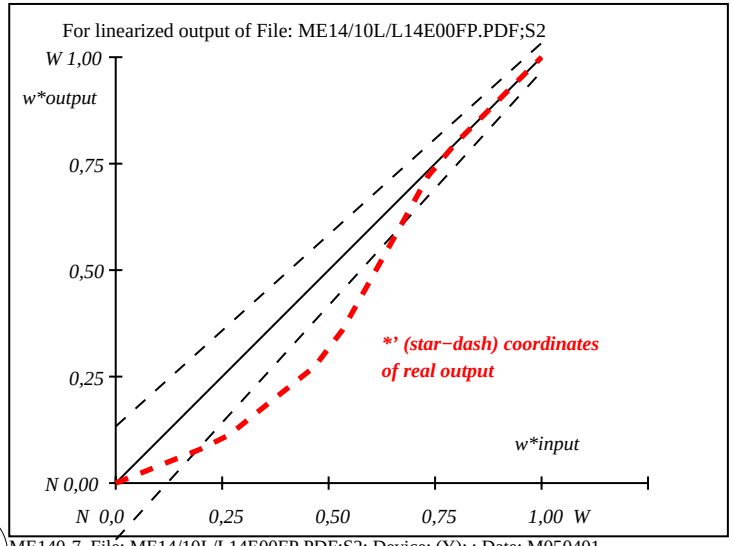
ME140-3, Meas.: ME14/10L/L14E00NP.PDF;S1; Device: (Y); ; Date: M050401

i	LAB*ref			d*	LAB*out			LAB*out/c-ref	Δ		E*
1	18.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.01
2	23.16	0.0	0.0	0.07	23.2	0.0	0.0	0.04	0.0	0.0	0.04
3	28.32	0.0	0.0	0.13	28.3	0.0	0.0	-0.01	0.0	0.0	0.02
4	33.48	0.0	0.0	0.2	33.5	0.0	0.0	0.02	0.0	0.0	0.02
5	38.64	0.0	0.0	0.27	38.6	0.0	0.0	-0.03	0.0	0.0	0.04
6	43.8	0.0	0.0	0.33	43.8	0.0	0.0	0.0	0.0	0.0	0.01
7	48.96	0.0	0.0	0.4	49.0	0.0	0.0	0.04	0.0	0.0	0.04
8	54.12	0.0	0.0	0.47	54.1	0.0	0.0	-0.01	0.0	0.0	0.02
9	59.28	0.0	0.0	0.53	59.3	0.0	0.0	0.02	0.0	0.0	0.02
10	64.44	0.0	0.0	0.6	64.4	0.0	0.0	-0.03	0.0	0.0	0.04
11	69.6	0.0	0.0	0.67	69.6	0.0	0.0	0.0	0.0	0.0	0.01
12	74.76	0.0	0.0	0.73	74.8	0.0	0.0	0.04	0.0	0.0	0.04
13	79.92	0.0	0.0	0.8	79.9	0.0	0.0	-0.01	0.0	0.0	0.02
14	85.08	0.0	0.0	0.87	85.1	0.0	0.0	0.02	0.0	0.0	0.02
15	90.24	0.0	0.0	0.93	90.2	0.0	0.0	-0.03	0.0	0.0	0.04
16	95.4	0.0	0.0	1.0	95.4	0.0	0.0	0.0	0.0	0.0	0.01
17	18.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.01
18	37.35	0.0	0.0	0.25	37.32	0.0	0.0	-0.02	0.0	0.0	0.03
19	56.7	0.0	0.0	0.5	56.7	0.0	0.0	0.0	0.0	0.0	0.01
20	76.05	0.0	0.0	0.75	76.08	0.0	0.0	0.03	0.0	0.0	0.03
21	95.4	0.0	0.0	1.0	95.4	0.0	0.0	0.0	0.0	0.0	0.01

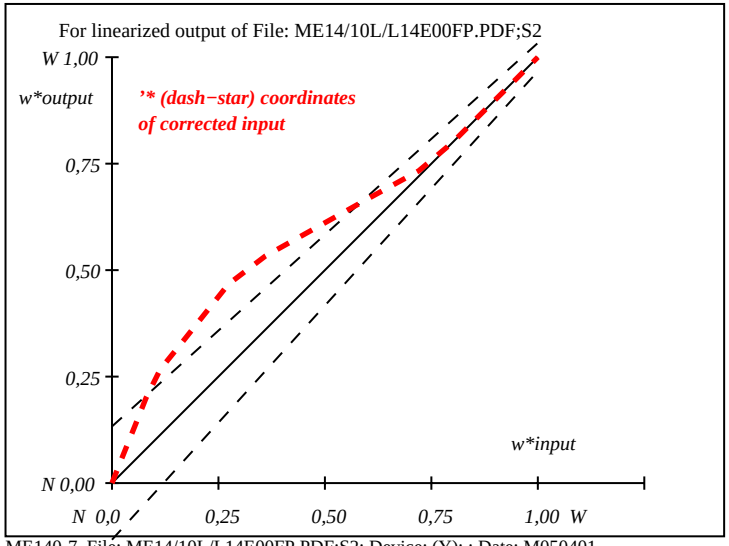
Intended output S2
Specification according to ISO/IEC 15775 Annex G and DIN 33866-1 Annex G

Mean lightness difference (16 steps)
ΔE^*_{CIELAB} = 0.0
Mean lightness difference (5 steps)
ΔL^*_{CIELAB} = 0.0
Mean colour reproduction index $R^*_{ab,m}$ = 100

ME141-3, Meas.: ME14/10L/L14E00FP.PDF;S2; Device: (Y); ; Date: M050401



ME140-7, File: ME14/10L/L14E00FP.PDF;S2; Device: (Y); ; Date: M050401



ME140-7, File: ME14/10L/L14E00FP.PDF;S2; Device: (Y); ; Date: M050401

ISO/CD 9241-306-test chart no. ME14; 5 & 16 grey steps of ISO/IEC 15775 input: *w* setgray*
Page 4, 5 step grey evaluation for visual linearisation of 16 grey steps output: *w* setgray*

See for similar files: http://www.ps.bam.de/ME14/
Technical information: http://www.ps.bam.de Version 2.1, io=1,7; iORS; oORS, CIELAB

BAM registration: 20050501-ME14/10L/L14E03FP.PS/.PDF BAM material: code=rha4ta
application for displays (Yr=2.5) and printers

/ME14/ Form: 4/3, Serie: 1/1, Page: 4 Page count: 4

Summary

- Colorimetric Image Technology (CIT) is the basis for International Standards and Reports
- The ranking and preference is open for dicussion
- The linearization of the monitor or printer system is a basis for high efficiency
- Linearization maintains the details, for example the recognition of Landolt-rings on any device
- Visual efficiency of monitor output is improved if colorimetric methods consider the room light
- CIT is the basis for the scan, the storage, the encoding and decoding of colorimetric coordinates

Standards, Technical Reports and References

The author was active as a leader for the standards [1] to [3] and was editor of the International documents [4] to [7].

[1] **DIN 33870:2000:** Requirements and tests for the remanufacturing of used toner modules black for electrophotographic printers, copiers and fax machines (Anforderungen und Prüfungen für die Aufbereitung von gebrauchten Tonermodulen schwarz für elektrophotographische Drucker, Kopierer und Fernkopierer)

[2] **DIN 33871-1:2003:** Requirements for remanufacturing of used inkjet heads and inkjet tanks of inkjet printers (Aufbereitung von gebrauchten Tintendruckköpfen und Tintentanks für Tintenstrahldrucker)

[3] **DIN 33866-1 bis 5:2000**: Information technology – Office machines – Machines for colour image reproduction: Method for specifying image reproduction of colour devices by digital and analog test charts, This standard includes analog DIN-test charts no. 1 to 4.

[4] **ISO/IEC DIS 19839-1 bis -4:2000**; Information technology - Office machines - Colour image reproduction equipment, Methods for specifying image reproduction of colour devices by digital and analog test charts

[5] **ISO/IEC 15775:1999**; Information technology – Office machines – Machines for colour image reproduction - Method of specifying image reproduction of colour copying machines by analog test charts – Realisation and application

[6] **ISO/IEC TR 19797:2004**, Information technology - Device output of 16-step colour scales, output linearization method (LM) and specification of the reproduction properties, ISO/IEC JTC1/SC28 (21pages)

[7] **ISO/IEC TR 24705:2005** (under publication), Method of specifying image reproduction of colour devices by digital and analog test charts, (79 pages)

[8] Richter, K. (2004), Natural colour connection space (NCCS) between input and output for office systems, International Semina on Information Office Equipment Standardization, Korean Agency for Technology and Standards, pages 71-92, see the URL (1.4 MByte, 27 pages)

http://www.ps.bam.de/BAMAG1.PDF

[9] Richter, K. (2005), Linear relationship between CIELAB and device coordinates for Colorimetric Image Technology (CIT), see the URL (140 kByte, 6 pages)

http://www.ps.bam.de/CIE05.PDF

[10] Richter, K. (2005), Material efficiency for image output on colour printers. For an English version see the URL (6 pages, 88 kByte)

http://www.ps.bam.de/UBAE05.PDF

Richter, K. (2005), Visual efficiency for image output on colour monitors, For an English version see the URL (10 pages, 1..4 MByte)

http://www.ps.bam.de/VISE05.PDF

For several specific New Work Item Proposals of 2004-2005 based on this presentation and the above documents see

http://www.ps.bam.de/NWIP

Remark: For further publications and analog and digital BAM-, DIN-, CEN- and ISO/IEC-test charts, see (> 1 Million connections/per year since 2002):

http://www.ps.bam.de