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CMYK Gamuts in CieLab
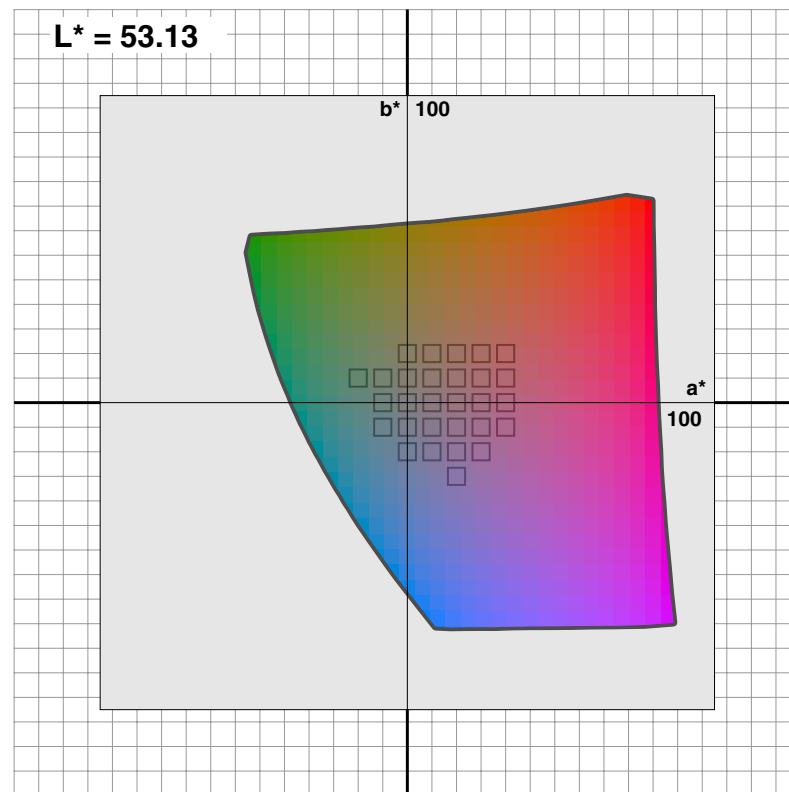
Contents

1. Introduction

The CIE xyY gamuts (by X-Rite ColorShop) on the next page show generally the maximal contour projection of all colors in XYZ onto the xy plane. This is often misleading. A color out of gamut in xyY is really out of gamut, but the opposite is not true.

The document shows gamuts of CMYK ICC profiles by interpreting the Gamut CLUT (Color Look-Up Table) in L*=const. planes of the CieLab color space.

Additionally the sRGB color space is visualized by a color area, using the D50 reference illuminant in CieLab and the Bradford correction. The actual sRGB gamut depends on the luminance, calculated by iterations until each value R,G,B is between 0 and 1. The correct Tonal Reproduction Curve for sRGB was taken into account.

Each value L*,a*,b* has to be converted by so-called Input Tables into new values L',a',b'. Table outputs L',a',b' are then the inputs of the CLUT and the CLUT output is either z=0 for 'in gamut' or z>0 for 'out of gamut'. The ICC specifications are quite unclear about the meaning of numbers z>0.
The Input Tables are mostly nonlinear for a* and b*, perhaps for a better interpolation in the other CLUTs wich deliver the CMYK outputs.

All CLUTs have a very low resolution, mostly 33 grid points for each axis. Some ICC profiles have only 16 grid points, one of them is shown.

The CMYK gamuts are indicated by a grid with three times the original grid point resolution. Photoshop5 Default CMYK has linear Input Tables, therefore the original grid width appears unchanged.

Euroscale Coated and Photoshop 5 Default CMYK were tested by Photoshop 6, using the gamut indicator. The results are reasonable if we construct in advance a smooth convex hull (mostly convex, in some parts concave) by appearance. There is always some lack of gamut area in outer red regions.
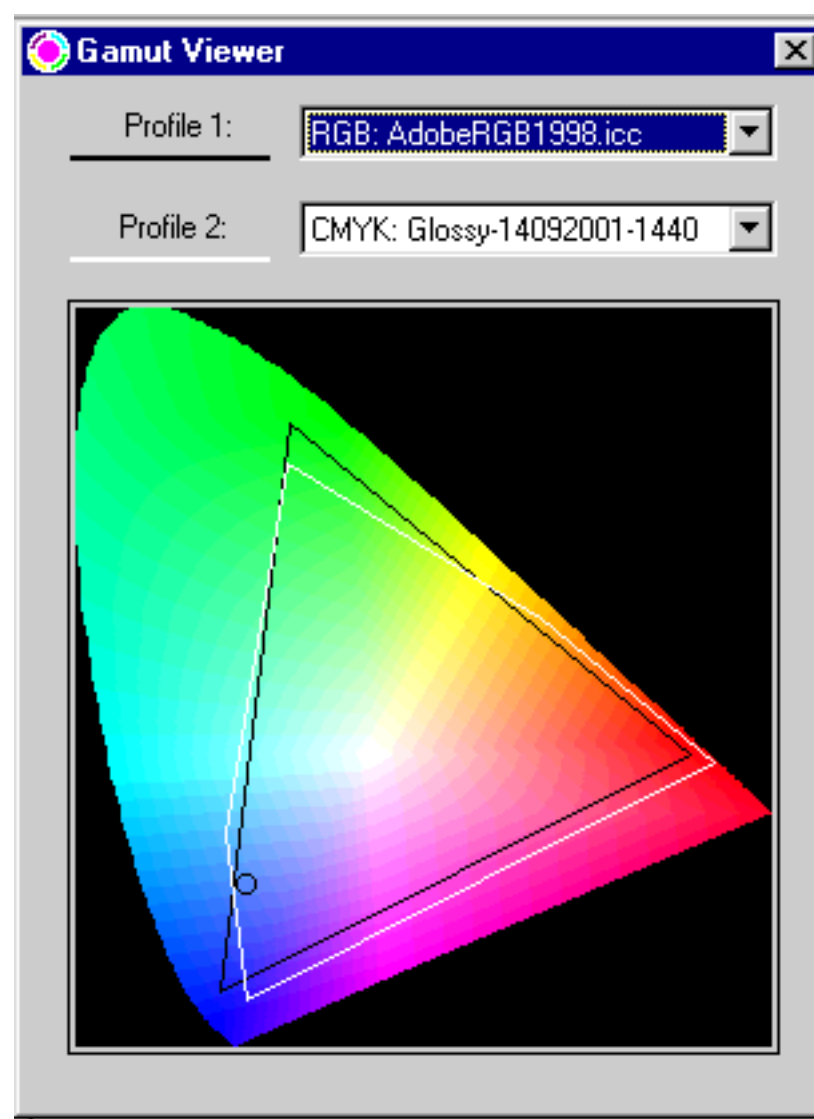
A sophisticated investigation about the 3D visualization of gamuts can be found in [9].

The interpretations of CMYK gamuts by ICC profiles in our paper is somewhat limited, nevertheless they may point into the right direction: where is the gamut too small ?
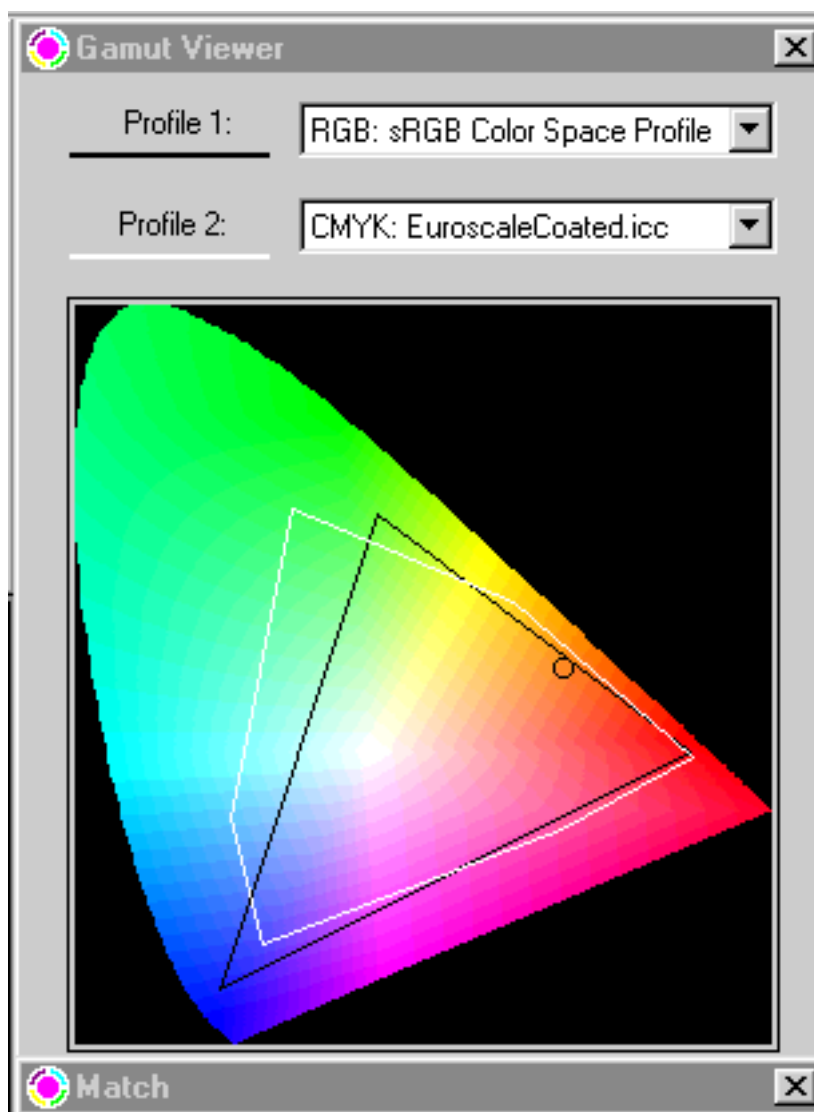
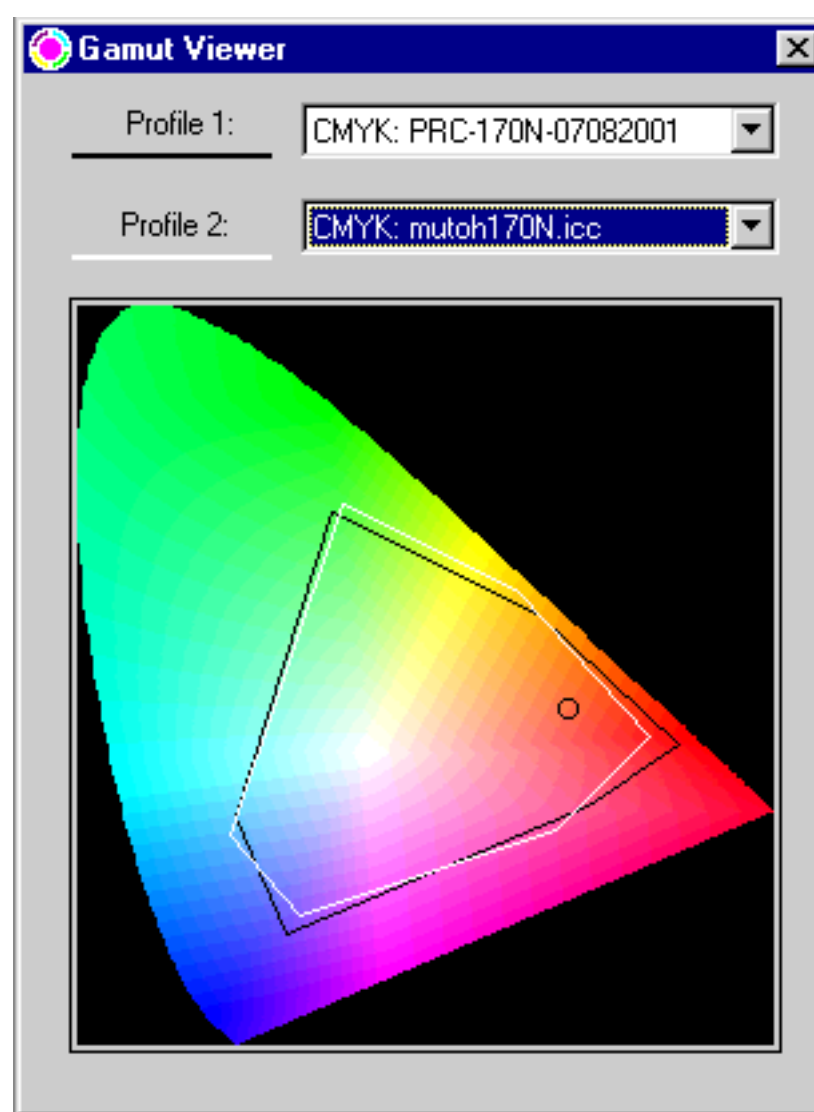# 2. Gamuts in CIE xyY
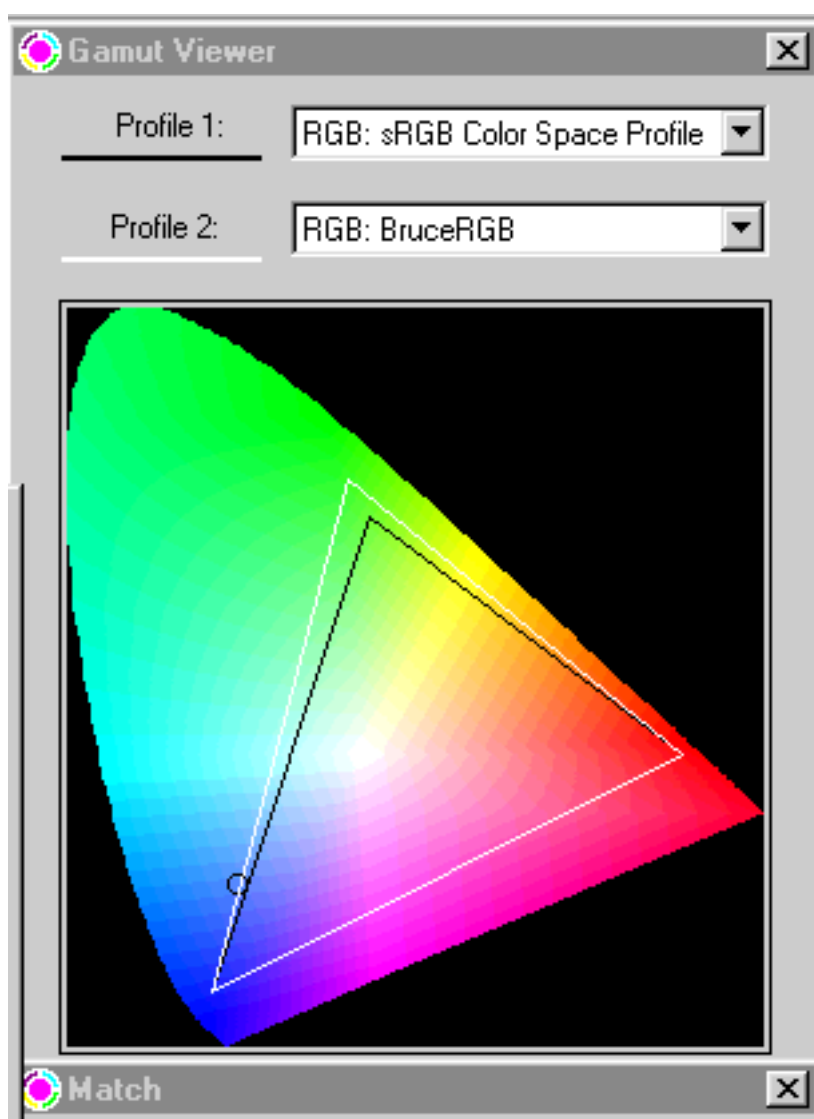
sRGB and Bruce RGB

Adobe RGB (98) and
Mutoh 6100 Glossy, Dye

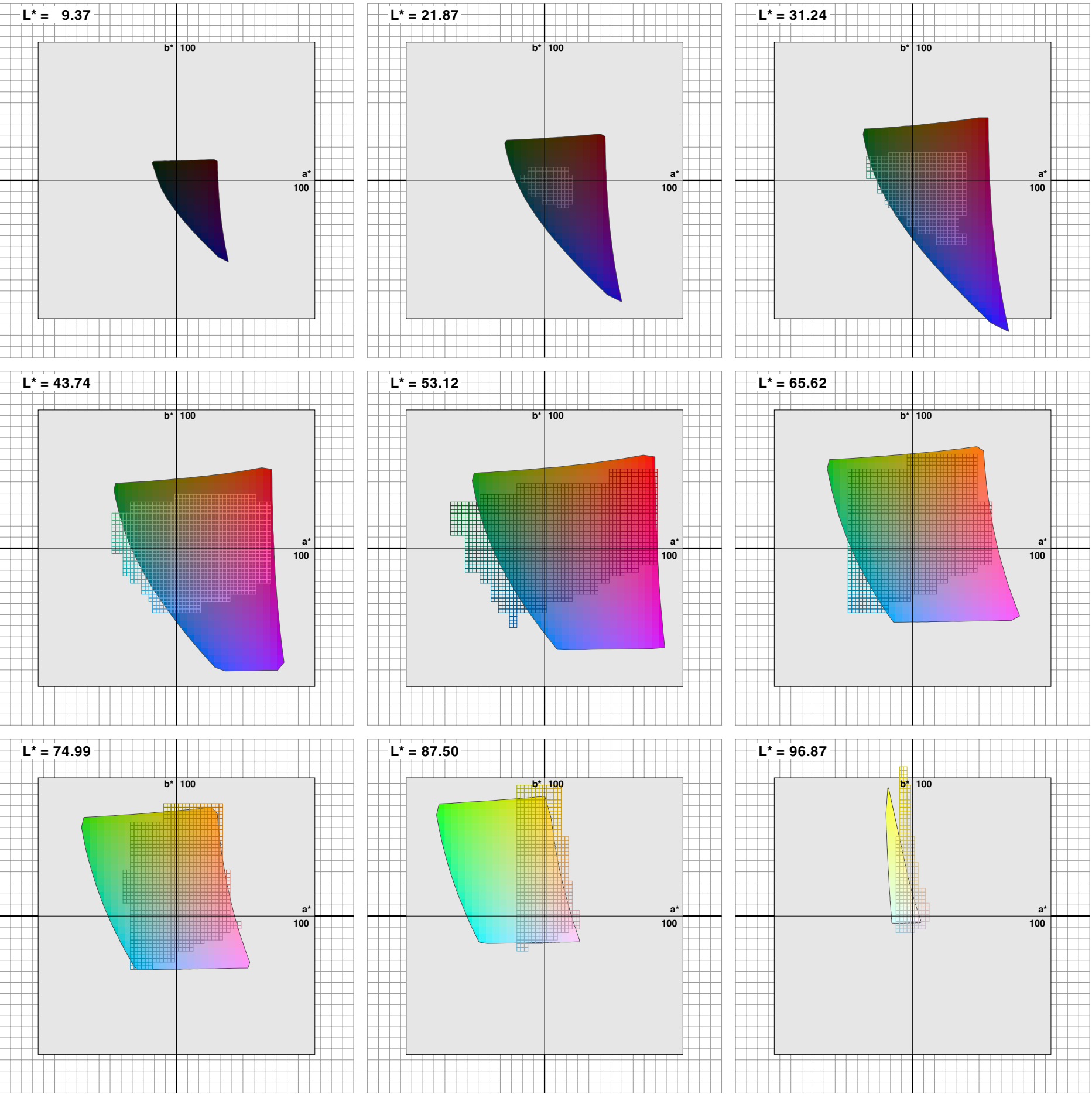sRGB and EuroScaleCoated

Mutoh 6100 Matte Paper
Dye (1), Pigment(2)

Banded because of ZIP(4) compression for small file size

3. Euroscale Coated

Best view zoom=300% or 400%

Input tables
L* red
a* green
b* blue

Output table ▪
Clipped at 255

```
EuroscaleCoated.icc
Number of tags        10
Offset of gamut       520152
Length of gamut       37009
Type mft1 or mft2     mft1
Input  channels       3
Output channels       1
Gridpoints            33
Matrix                1.0  0.0  0.0
                      0.0  1.0  0.0
                      0.0  0.0  1.0
Input tab entries     256
Outpt tab entries     256

Primaries RGB part    709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part        sRGB
```

4. Eul340m7

Best view zoom=300% or 400%

Input tables
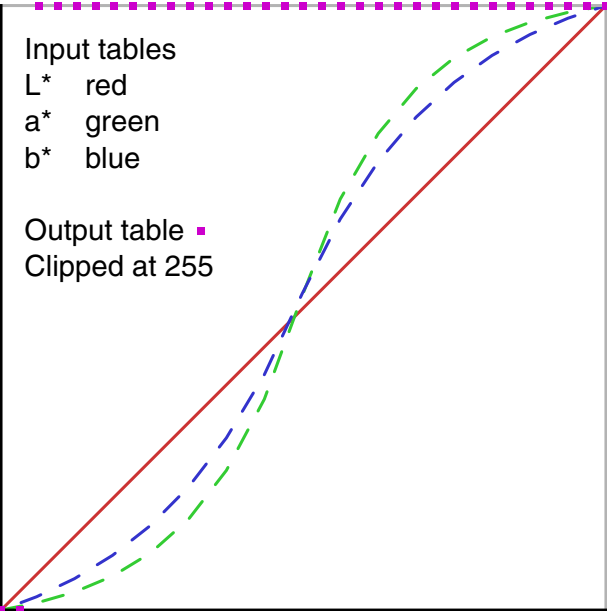L*   red
a*   green
b*   blue

Output table ▪
Clipped at 255
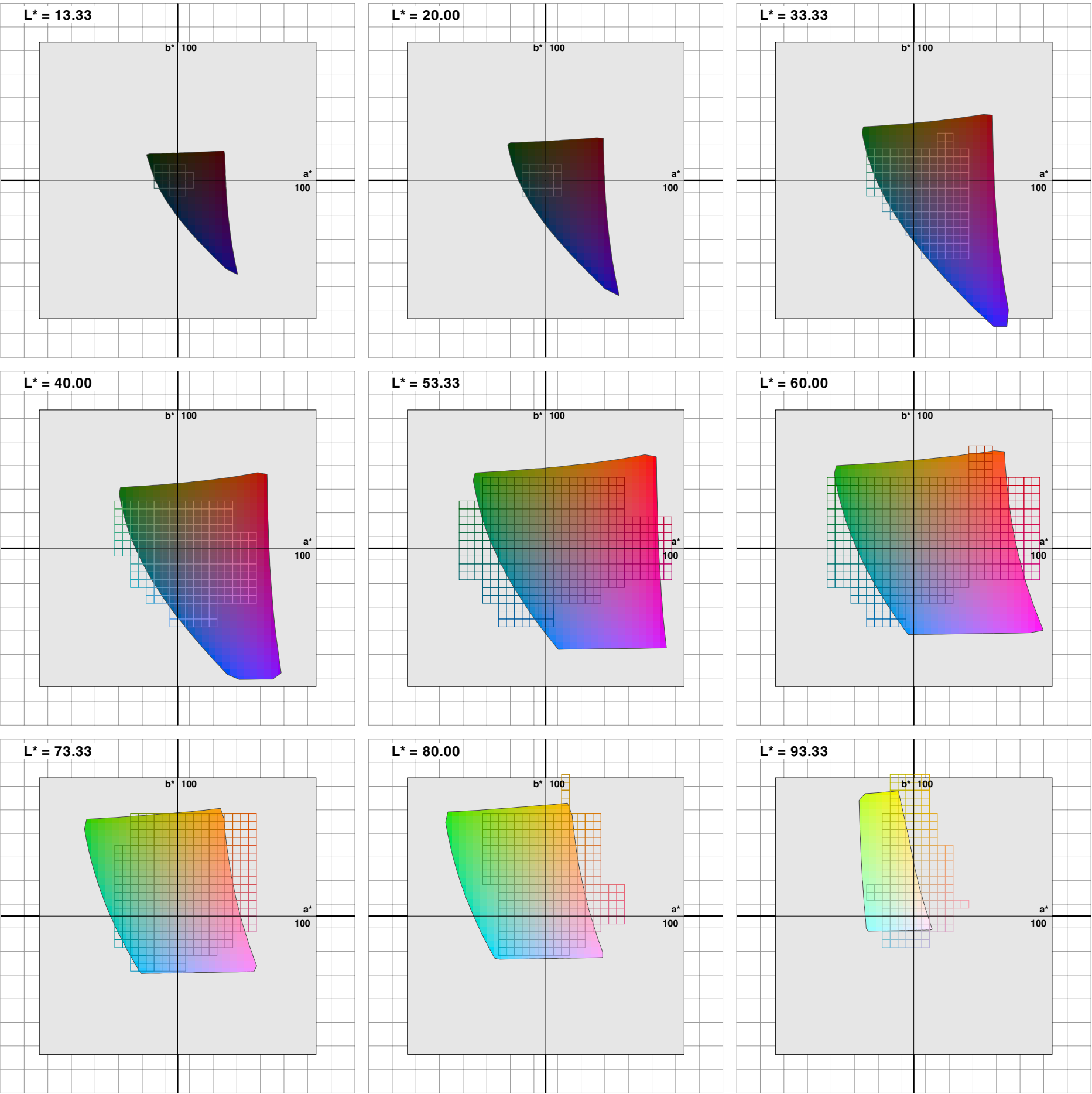
```
Eul340m7.icm
Number of tags        39
Offset of gamut       406520
Length of gamut       17972
Type mft1 or mft2     mft2
Input  channels       3
Output channels       1
Gridpoints            16
Matrix                1.0  0.0  0.0
                      0.0  1.0  0.0
                      0.0  0.0  1.0
Input tab entries     256
Outpt tab entries     4096

Primaries RGB part    709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part        sRGB
```

5. Photoshop 5 Default

Best view zoom=300% or 400%

Input tables
L*   red
a*   green
b*   blue

Output table ▪
Clipped at 255

```
Photoshop5DefaultCMYK.icc
Number of tags        12
Offset of gamut       685420
Length of gamut       37009
Type mft1 or mft2     mft1
Input  channels       3
Output channels       1
Gridpoints            33
Matrix                1.0  0.0  0.0
                      0.0  1.0  0.0
                      0.0  0.0  1.0
Input tab entries     256
Outpt tab entries     256

Primaries RGB part    709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part        sRGB
```
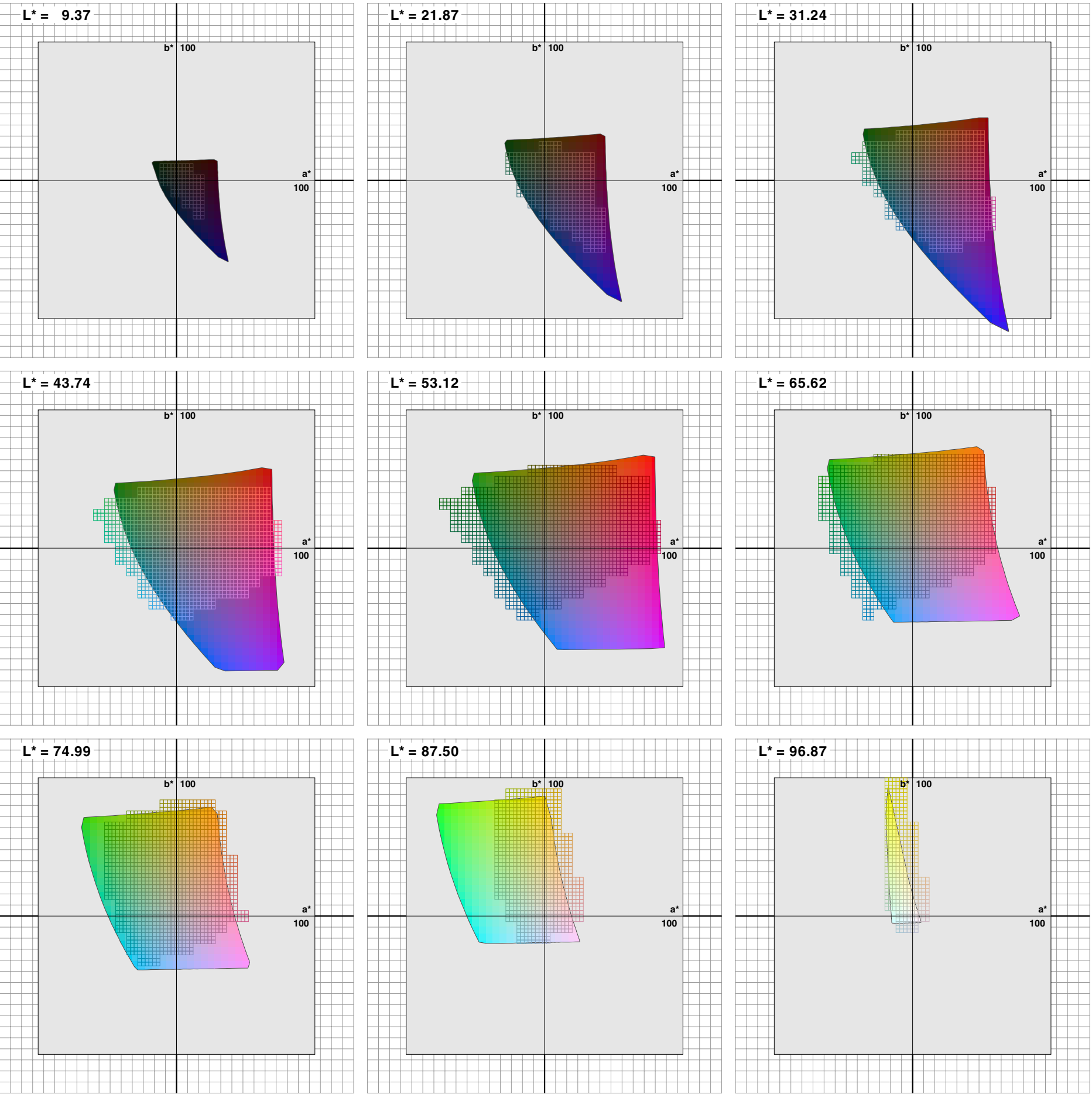
6. SWOP

Best view zoom=300% or 400%

Input tables
L*   red
a*   green
b*   blue

Output table ▪
Clipped at 255

```
USWebCoatedSWOP.icc
Number of tags        10
Offset of gamut       520156
Length of gamut       37009
Type mft1 or mft2     mft1
Input  channels       3
Output channels       1
Gridpoints            33
Matrix                1.0  0.0  0.0
                      0.0  1.0  0.0
                      0.0  0.0  1.0
Input tab entries     256
Outpt tab entries     256

Primaries RGB part    709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part        sRGB
```
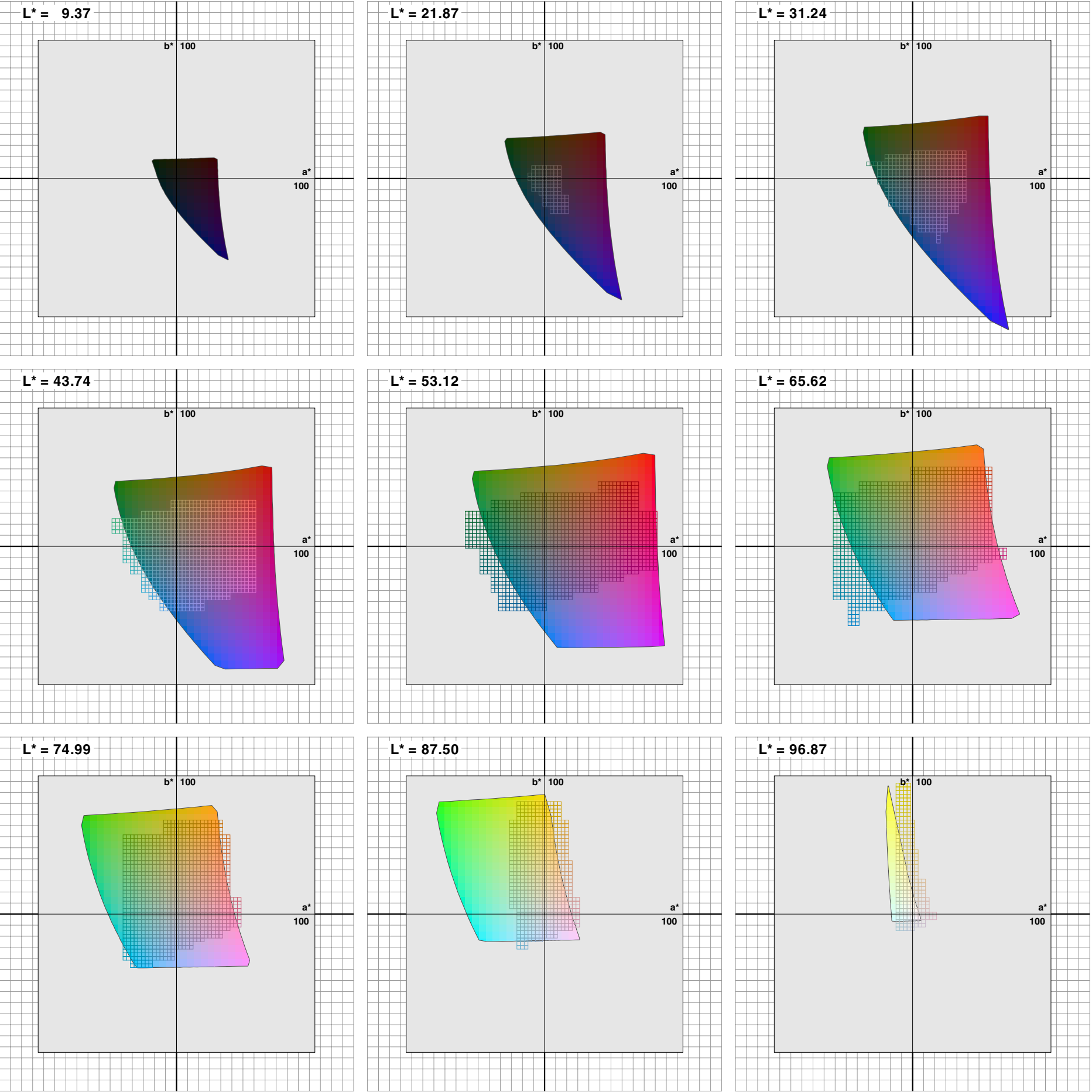
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7. Mutoh 6100, pigment ink, proofing paper

Mutoh 6100 is a wide gamut inkjet. Here for six inks CMYKLcLm.
The gamut CLUT output doesn´t show reliable results - the in-gamut areas are scattered.

Input tables
L*   red
a*   green
b*   blue

Output table
Clipped at 255

```
Mutoh950S.icc
Number of tags          14
Offset of gamut         2774068
Length of gamut         141990
Type mft1 or mft2       mft2
Input  channels         3
Output channels         1
Gridpoints              41
Matrix                  1.0  0.0  0.0
                        0.0  1.0  0.0
                        0.0  0.0  1.0
Input tab entries       512
Outpt tab entries       512

Primaries RGB part      709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part          sRGB
```
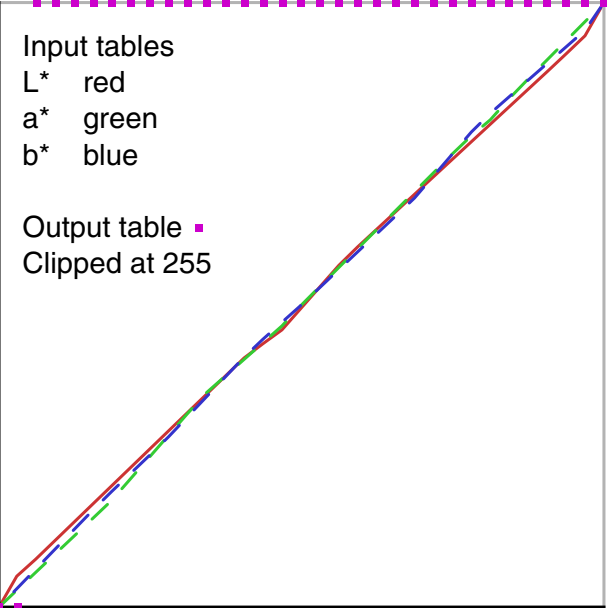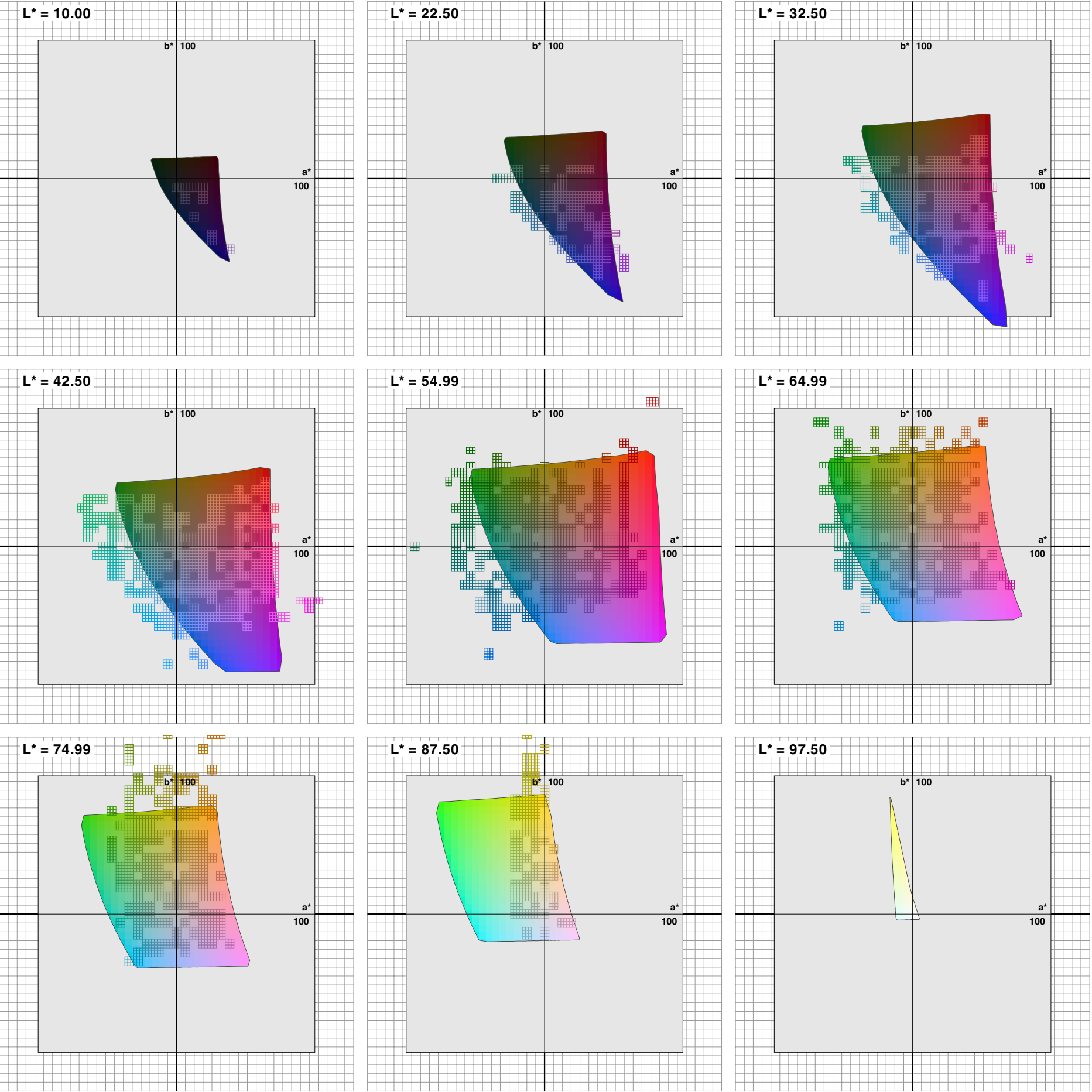
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8. Nonlinear Input Tables

Nonlinear Input Tables assign for center values in the region of a*=0 and b*=0 more CLUT entries than for remote values a* and b*. These are rare, therefore the more important center part should consume more CLUT content.

The green bars show in vertical direction the addresses 0 to 32 of the CLUT and in horizontal direction the respective input range, for a*=-128 to +128 .

Input tables
L*   red
a*   green
b*   blue

Input table a* ▪
CLUT addresses

Output table ▪
Clipped at 255

```
EuroscaleCoated.icc
Number of tags          10
Offset of gamut         520152
Length of gamut         37009
Type mft1 or mft2       mft1
Input  channels         3
Output channels         1
Gridpoints              33
Matrix                  1.0  0.0  0.0
                        0.0  1.0  0.0
                        0.0  0.0  1.0
Input Table entries     256
Outpt Table entries     256

Primaries RGB part      709 primaries
WP RGB / Refer.CieLab D65 / D50
Gamma RGB part          sRGB
```
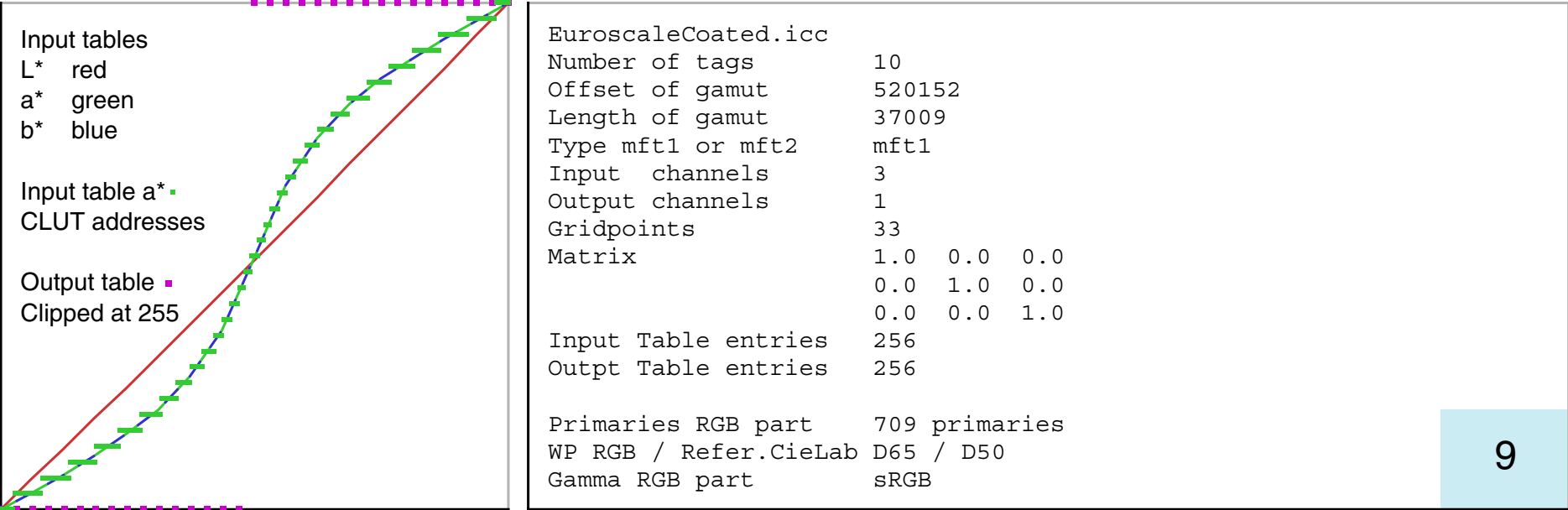
9. References

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

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

[3]   References for Color Science
http://www.fho-emden.de/~hoffmann/colcie290800.pdf

[4]   References for PostScript
http://www.fho-emden.de/~hoffmann/pstutor22112002.pdf

[5]   Everything about Color and Computers
http://www.efg2.com

[6]   M.Nielsen + M.Stokes
The Creation of the sRGB ICC Profile
http://www.srgb.com/c55.pdf
Year unknown, after 1998

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

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

[9]   K.Guyler
Visualization of Expanded Printing Gamuts Using 3-Dimensional Convex Hulls
http://www.efg2.com/Lab/Library/Color/KarlEGuyler_TAGA2000Paper.pdf

[10]   Free ColorManagement System
Profile Viewer IccInspect
http://www.littlecms.com

[11]   CieLab Color Space
http://www.fho-emden.de/~hoffmann/cielab03022003.pdf

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September 28, 2003
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