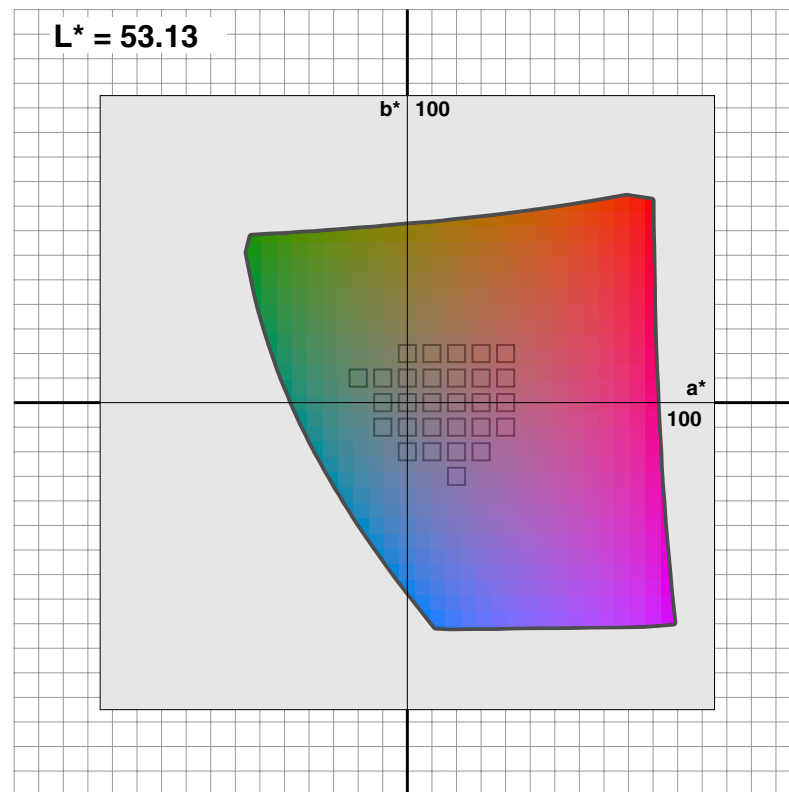


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CMYK Gamuts in CieLab



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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 $L^* = \text{const.}$ 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 which 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.

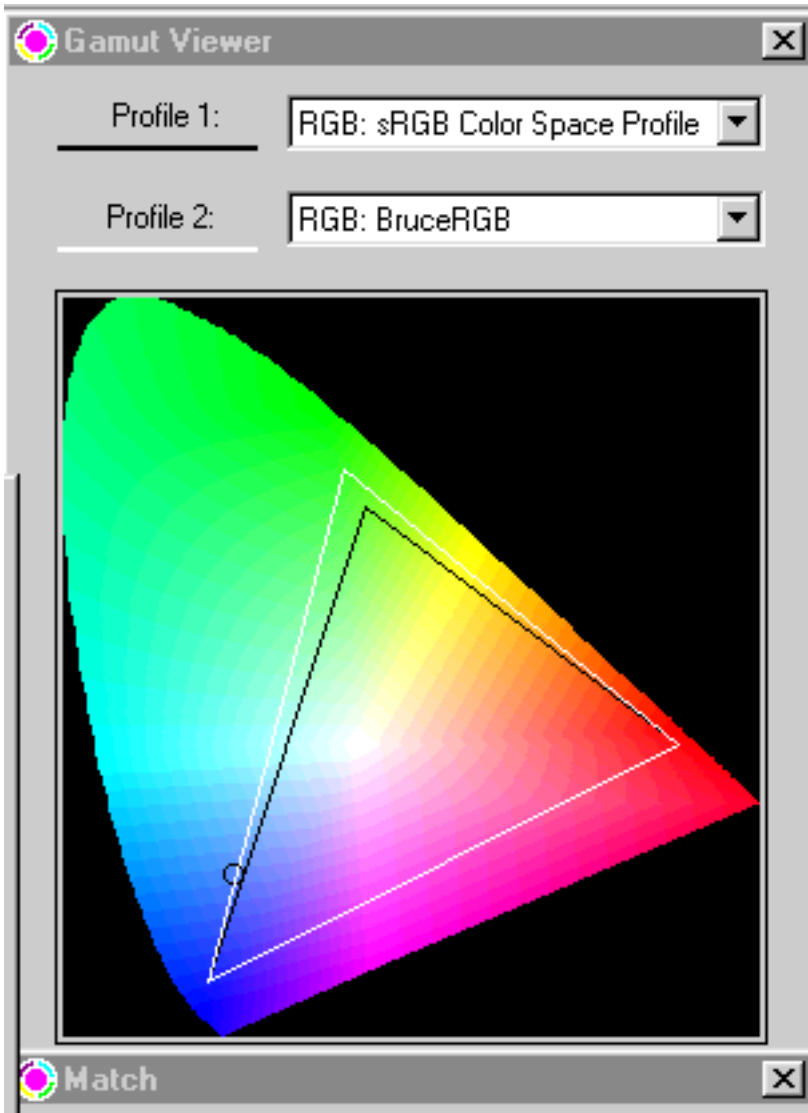
The CMYK gamuts are indicated by a grid with three times the original grid point resolution. Photoshop5 Default CMYK has linear Input Tables, therefore the original grid width appears unchanged.

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.

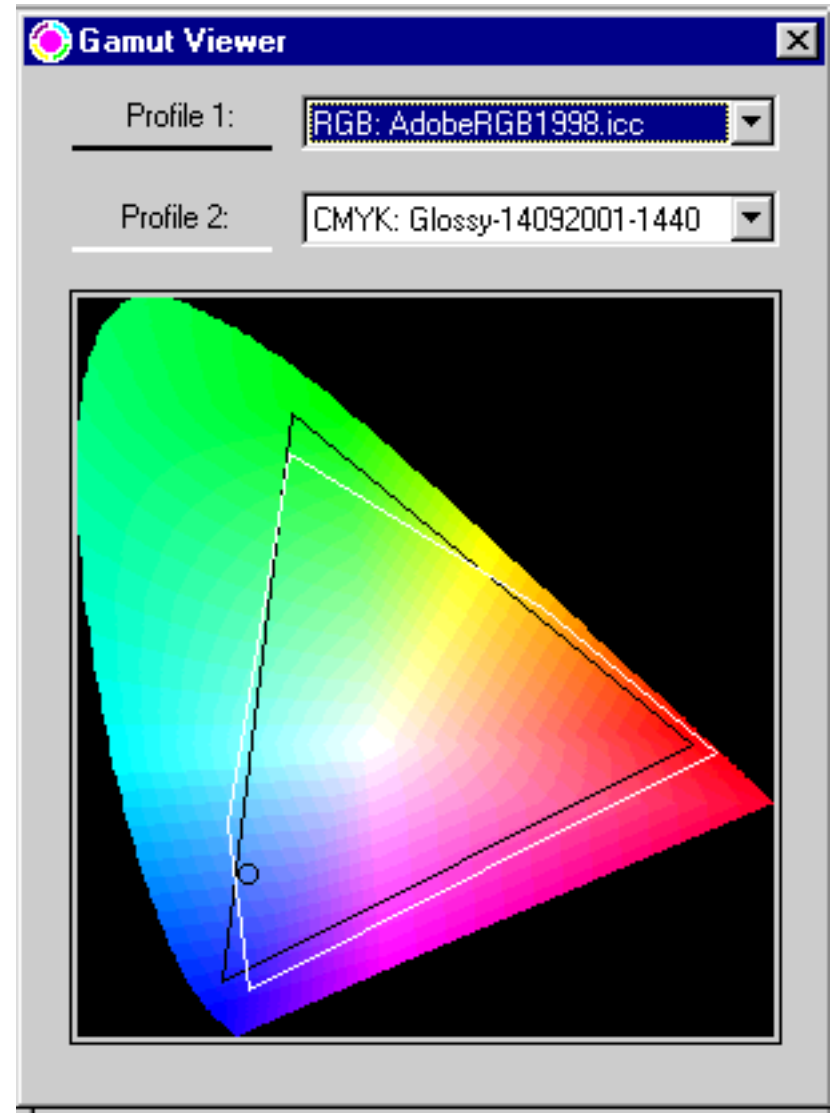
A sophisticated investigation about the 3D visualization of gamuts can be found in [9].

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 ?

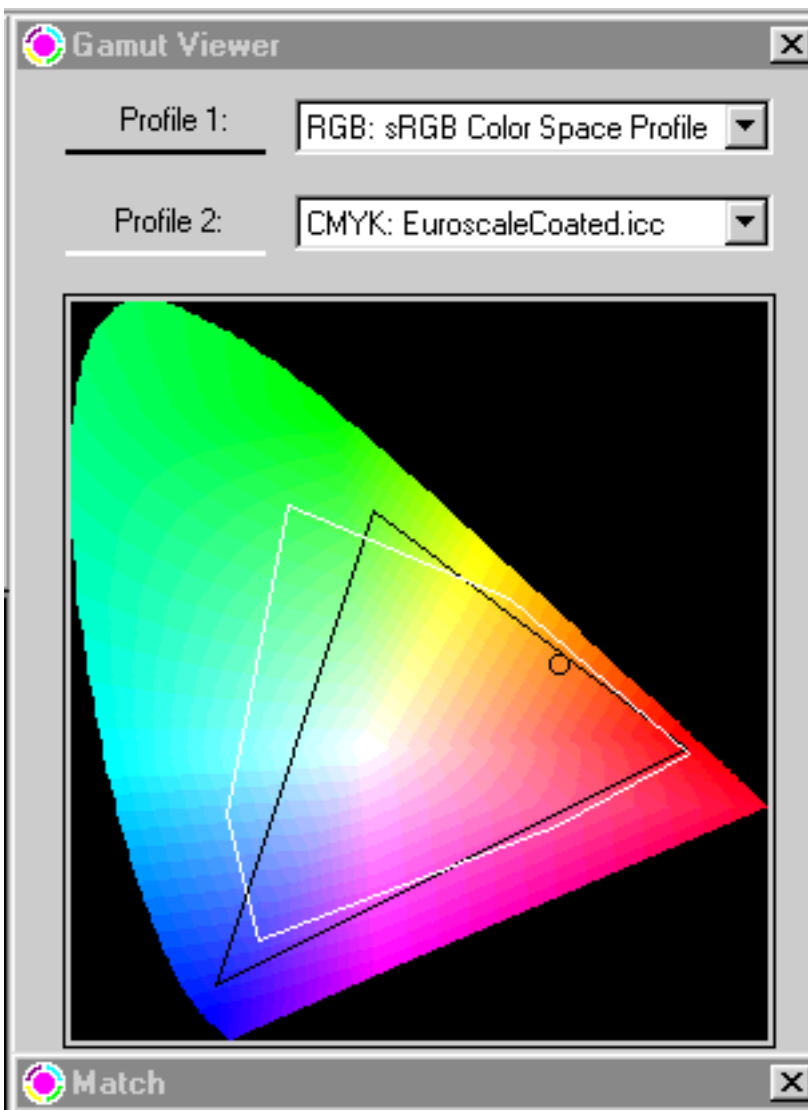
2. Gamuts in CIE xyY



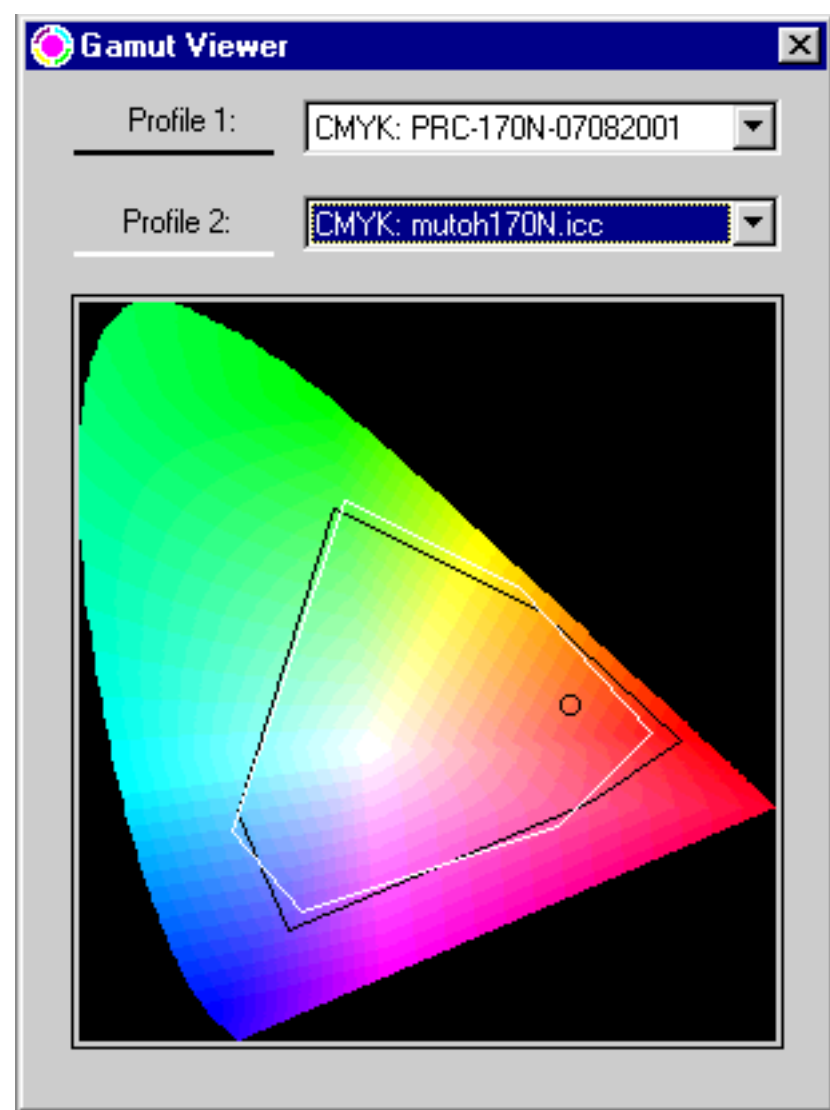
sRGB and Bruce RGB



Adobe RGB (98) and
Mutoh 6100 Glossy, Dye



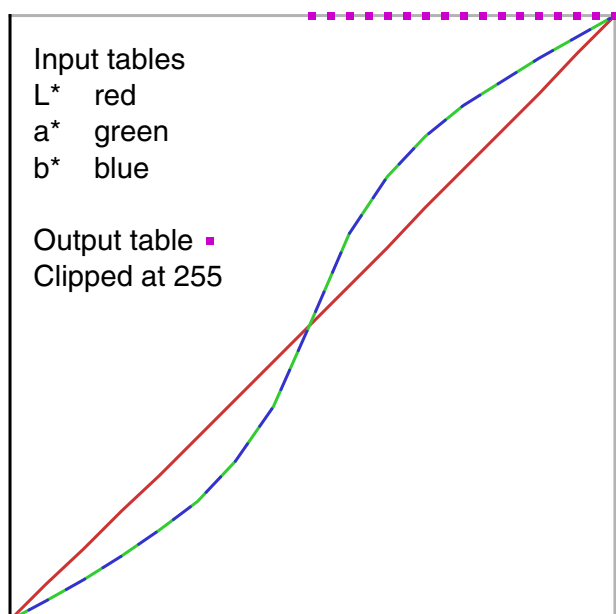
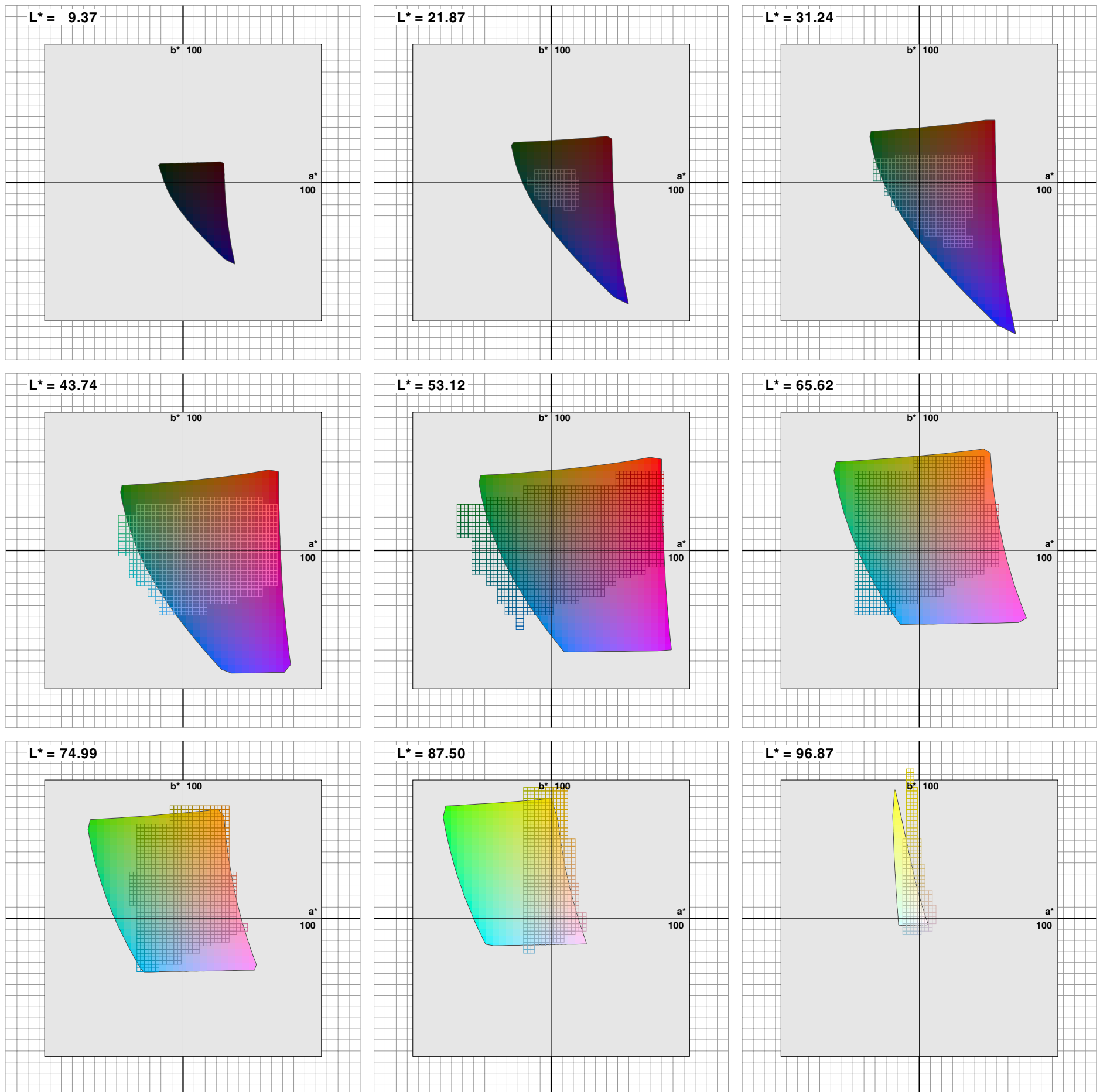
sRGB and EuroScaleCoated



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

3. Euroscale Coated

Best view zoom 300% or 400%



```

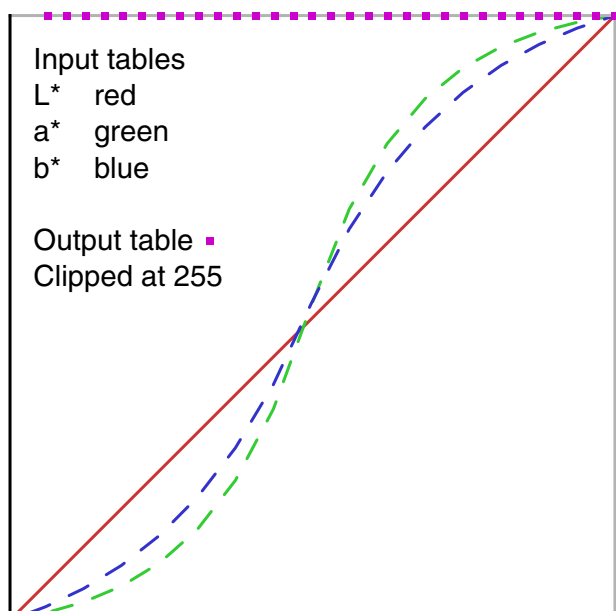
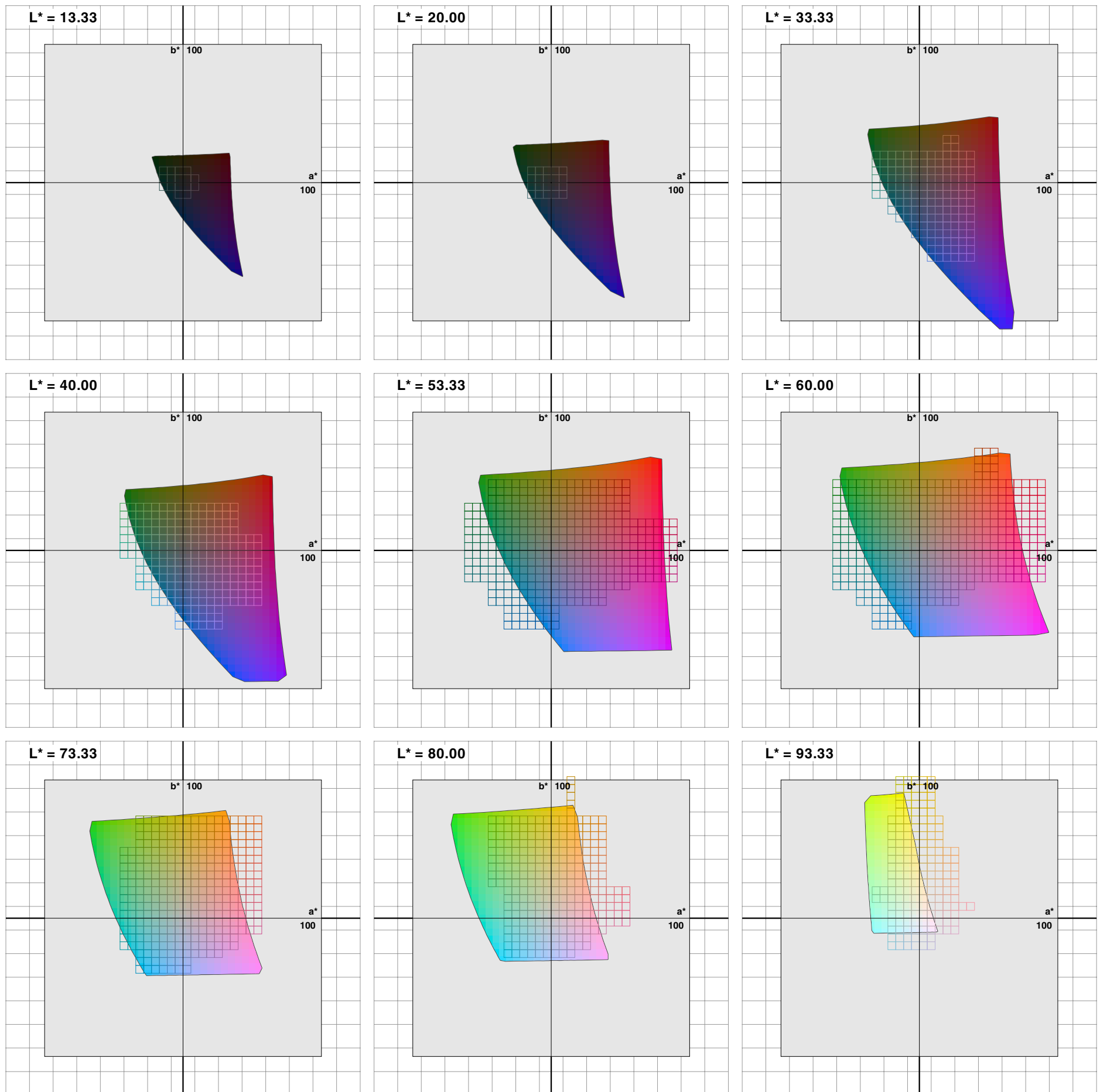
EuroscaleCoated.icc
Number of tags          10
Offset of gamut        520152
Length of gamut        37009
Type mft1 or mft2     mft1
Input channels          3
Output channels         1
Gridpoints              33
Matrix                 1.0  0.0  0.0
                    0.0  1.0  0.0
                 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

Input tab entries      256
Output tab entries     256

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

4. Eul340m7

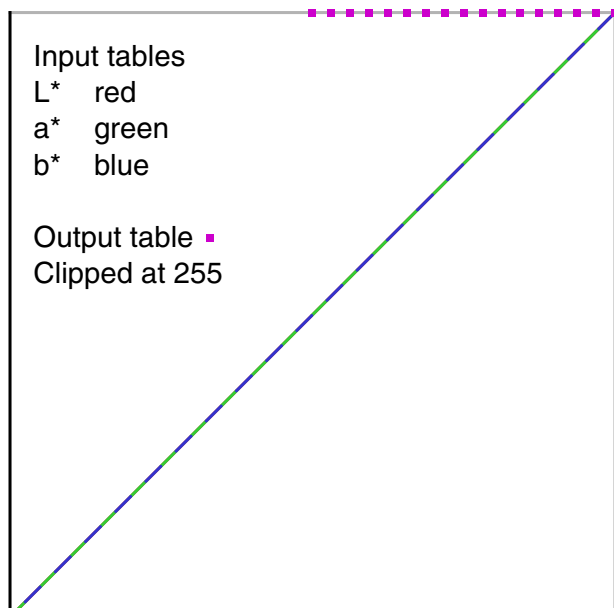
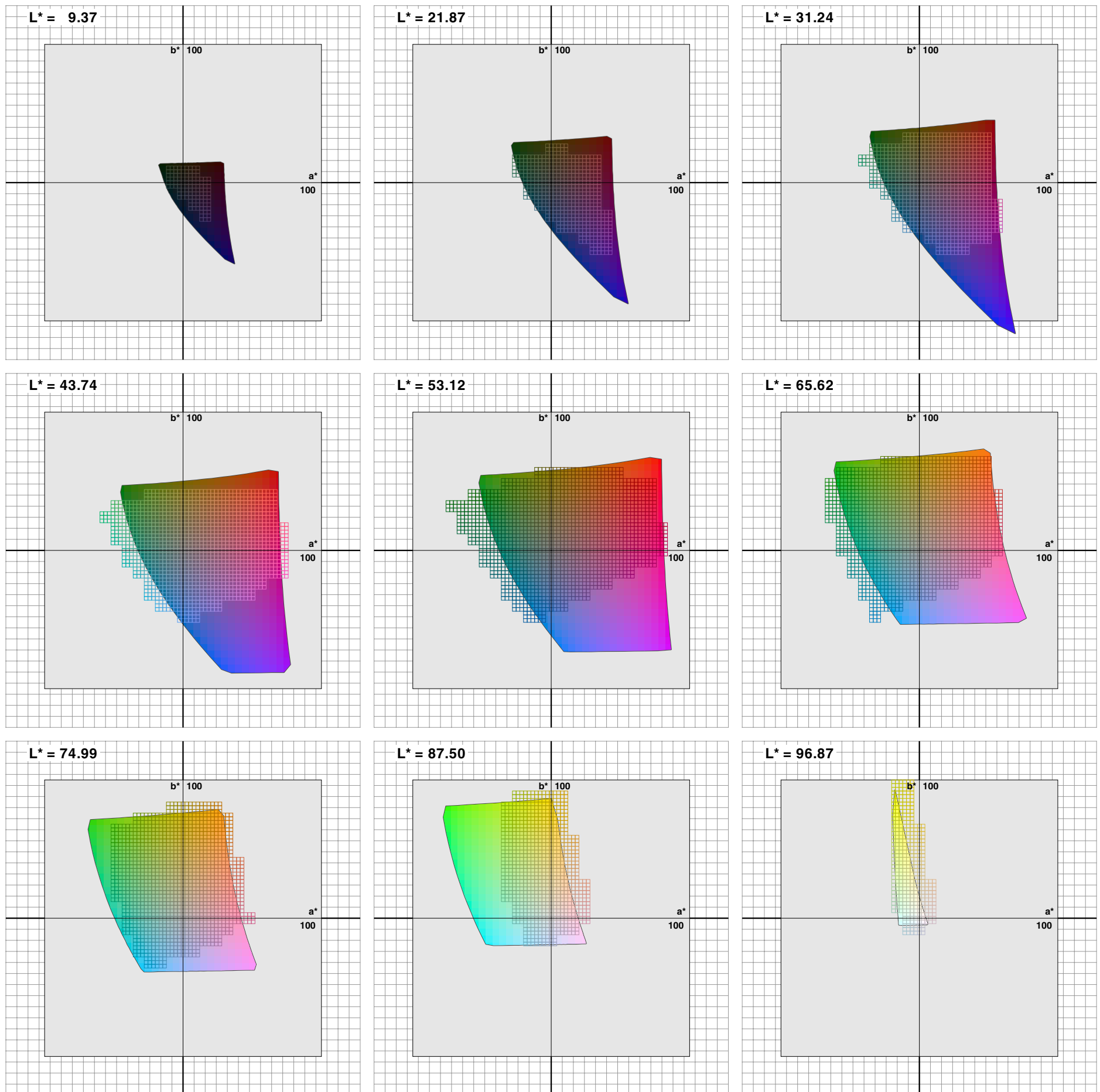
Best view zoom 300% or 400%



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
Output tab entries	4096
Primaries RGB part	709 primaries
WP RGB / Refer.CieLab	D65 / D50
Gamma RGB part	sRGB

5. Photoshop5 Default

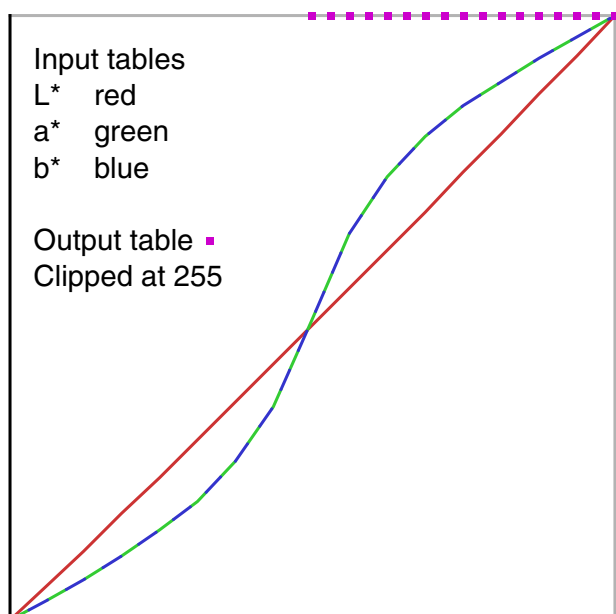
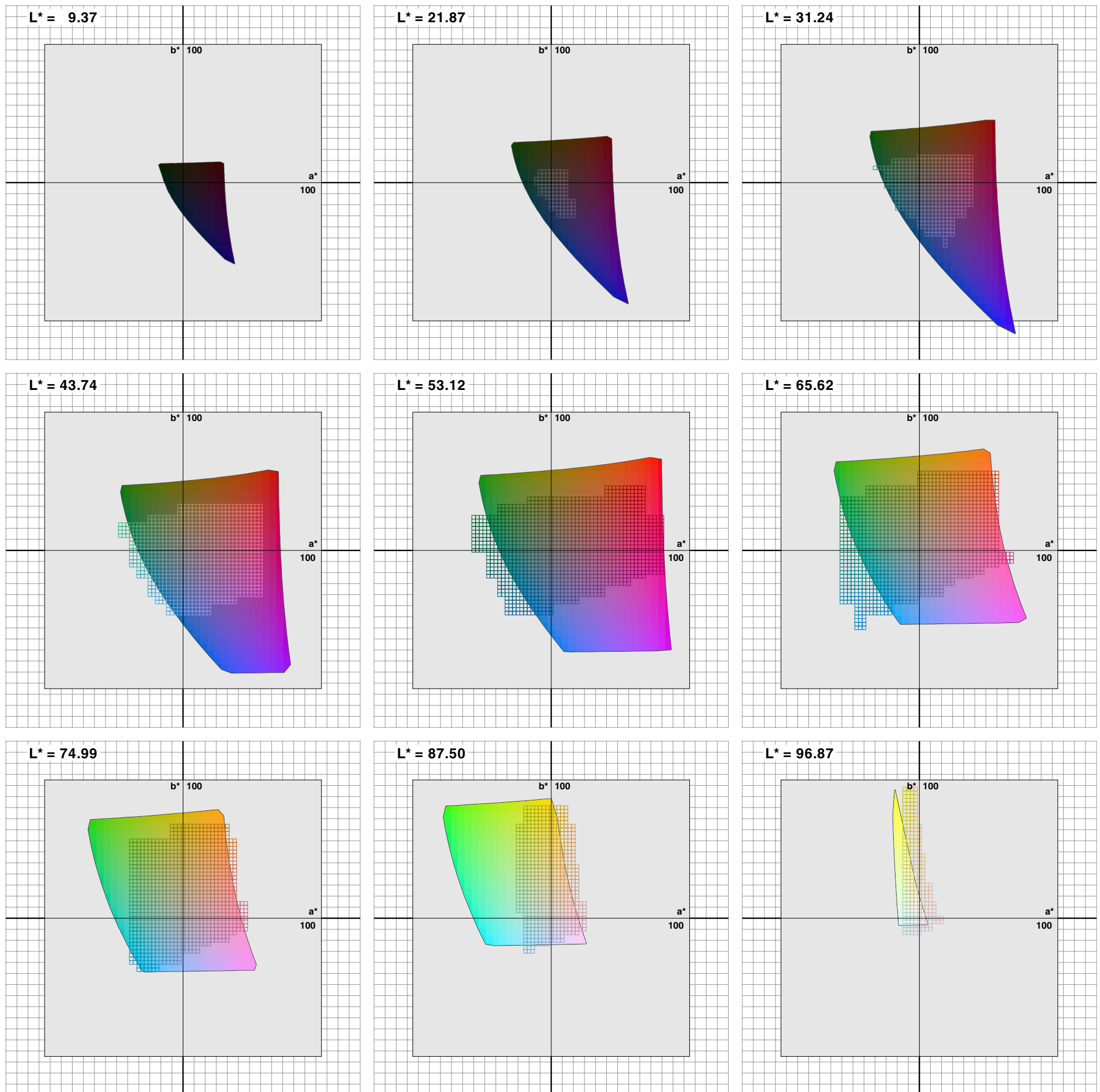
Best view zoom 300% or 400%



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%



```

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

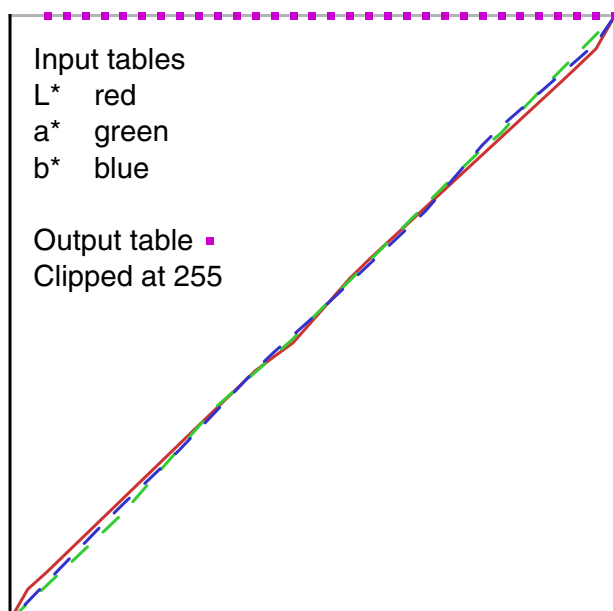
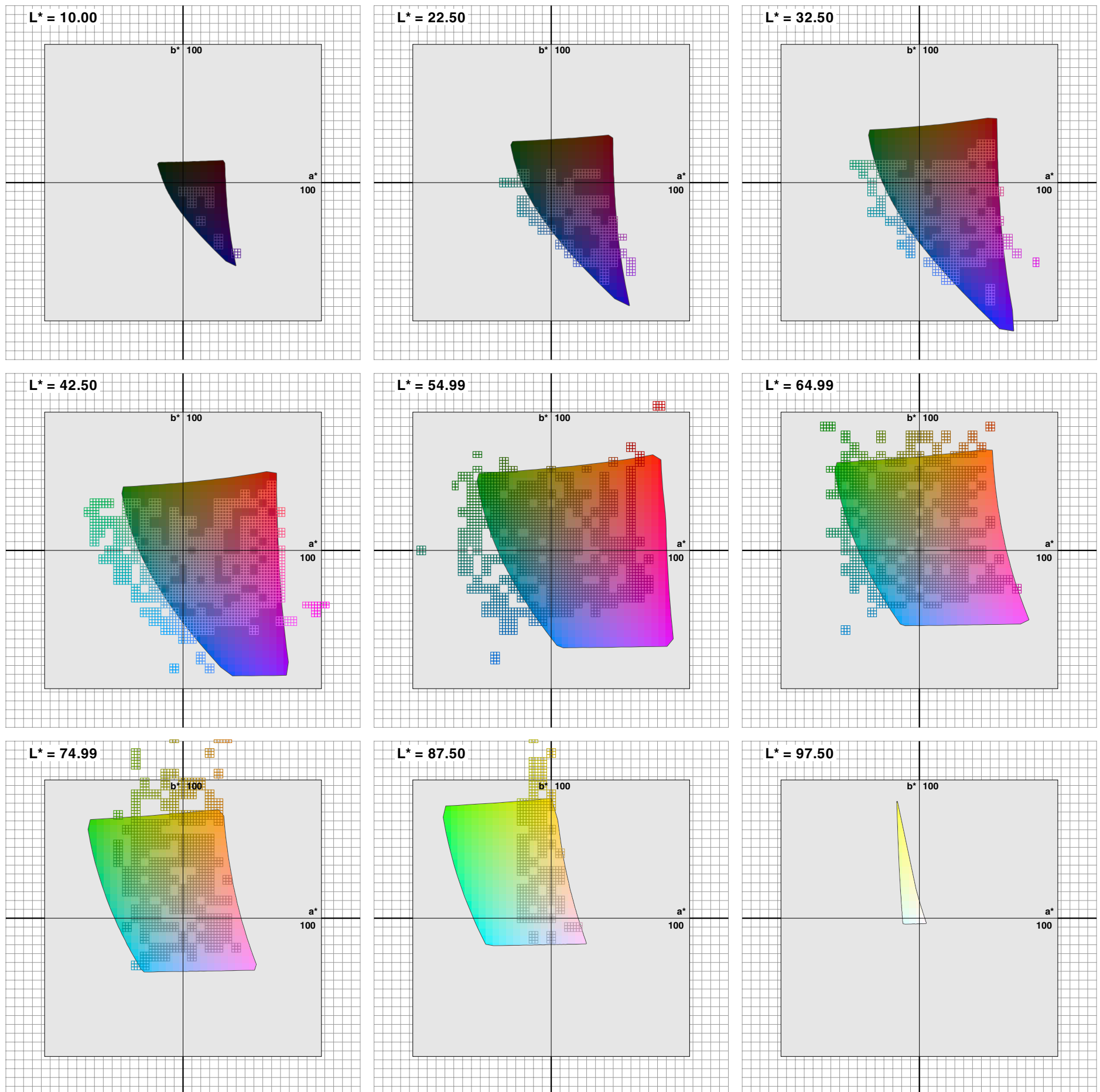
Input tab entries        256
Output tab entries       256

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

7. Mutoh 6100, pigment ink, proofing paper

Mutoh 6100 is a wide gamut inkjet. Here for six inks CMYKcm.

The gamut CLUT output doesn't show reliable results - the in-gamut areas are scattered.



```

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

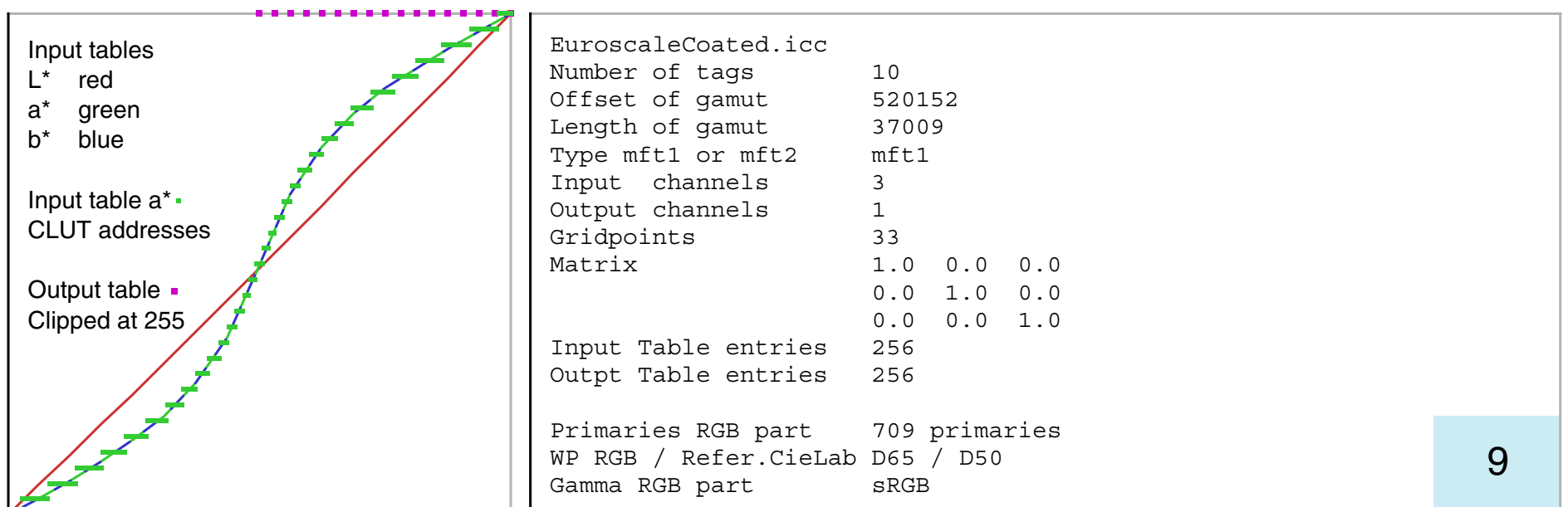
Input tab entries       512
Outpt tab entries      512

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

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 $+128$.



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>