

Gernot Hoffmann

Measuring Gamut Volumes by Hundred Slices

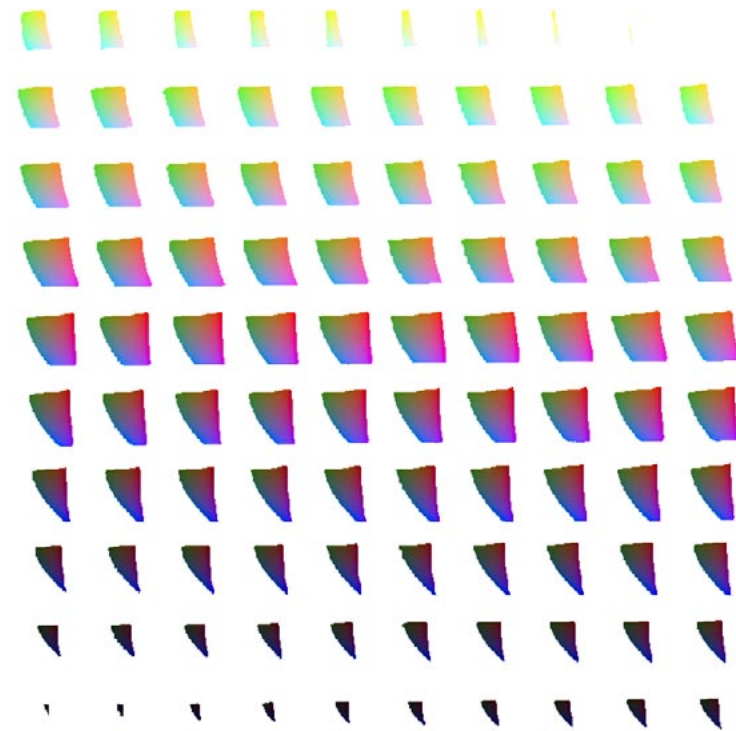


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Settings for Acrobat

Edit / Preferences / General / Page Display (since version 6)

Custom Resolution 72dpi / **View by zoom 100% or 200%**

Edit / Preferences / General / Color Management (full version only)

sRGB

Euroscale Coated or ISO Coated or SWOP

Gray Gamma 2.2

1. Introduction

A test pattern was created by PostScript. It contains 100 small images for CIE Lab colors. Each small image is valid for a luminance L^* from 1 to 100 with stepsize 1. Each small image shows the Lab values a^* , b^* from -100 to +100 with 72 pixels edge length.

PostScript cannot encode CIE Lab directly. CIE XYZ is used as a transfer color space. This is called CIEBasedABC color space.

Finally the PostScript file was interpreted by Photoshop and saved as LZW Tiff [1].

2. Application by Photoshop 7.0 / Photoshop CS2

- 1 Download test pattern [1]
- 2 Set graphics card for at least 1280x1024, TrueColor 24/32 bit
- 3 Open test pattern in Lab Color Mode, 72dpi, 254mm (Lab means CIE Lab)
- 4 Preferences: choose White=RGB=255/255/255 for the gamut warning
- 5 View / Proof Setup: choose any color space (ICC profile and rendering intent)
- 6 View / Gamut Warning: 100 gamut volume slices are shown immediately
Go to 5. For measuring the gamut volume go to 7.
- 7 View / Actual Pixels
- 8 Make screenshot
- 9 Open new document in RGB mode
- 10 Place screenshot
- 11 Make rectangular marquee selection with fixed size 720x720 pixels
- 12 Crop
- 13 Save as RGB TIFF
- 14 Count pixels in the white area by Histogram (total number 720 x 720=518400)

The Histogram cannot be applied directly to the actual test pattern in Lab mode because the indicated white area does not belong to the image. It is necessary to copy the screen content by a screenshot.

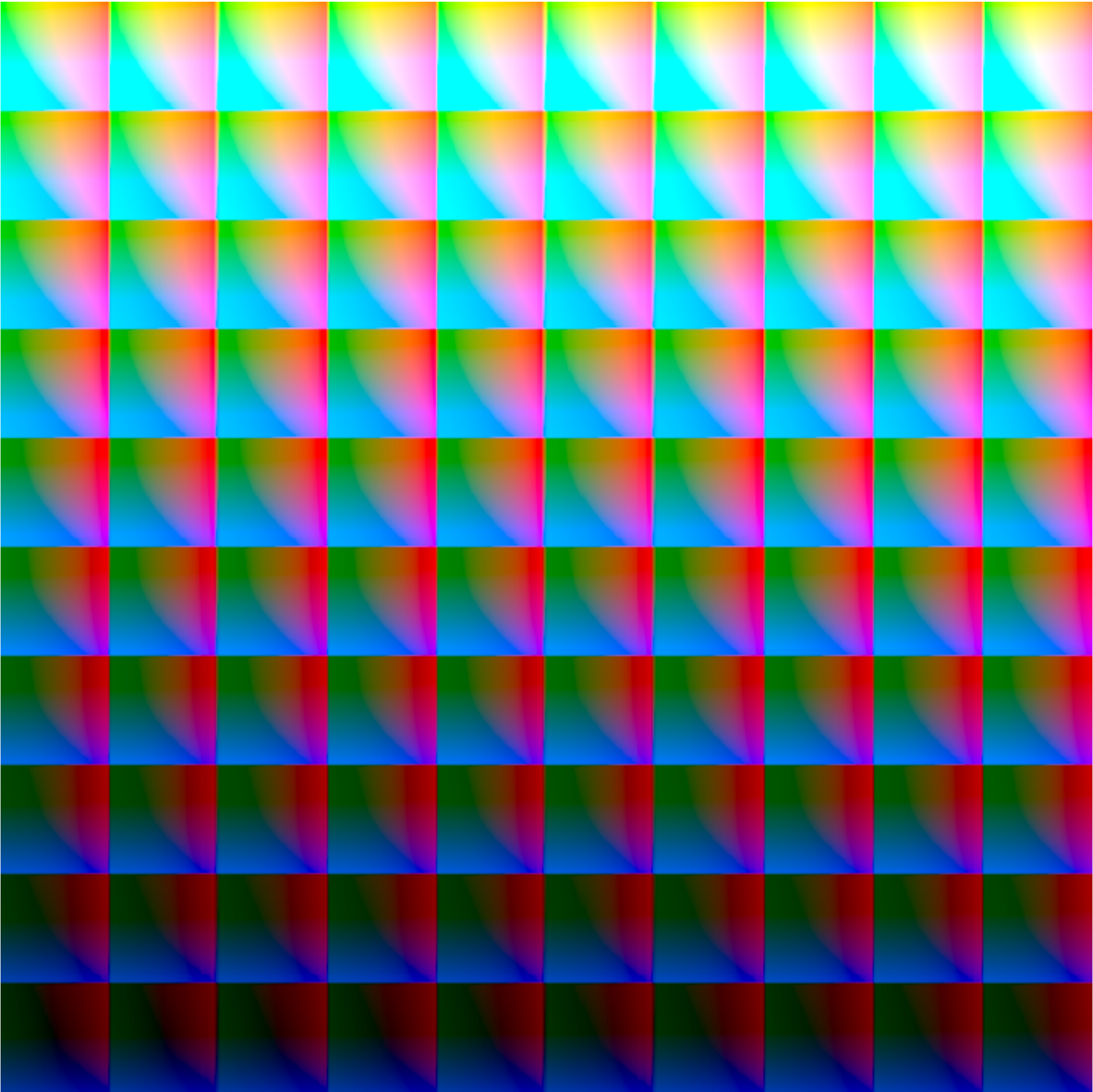
For a gamut visualization without measuring as shown on page 4 use the test pattern with fixed grid [2].

A new test image with switchable grid can be built easily:

Download grid pattern [3]. Open as EPS in Lab mode 720x720 pixels, 72 dpi, transparent background. Select all, copy and paste into a second layer of the pattern [1]. Save by new name as PSD. If 'Helvetica' is not found then replace in the EPS text file 'Helvetica' by an available PostScript font by PostScript name.

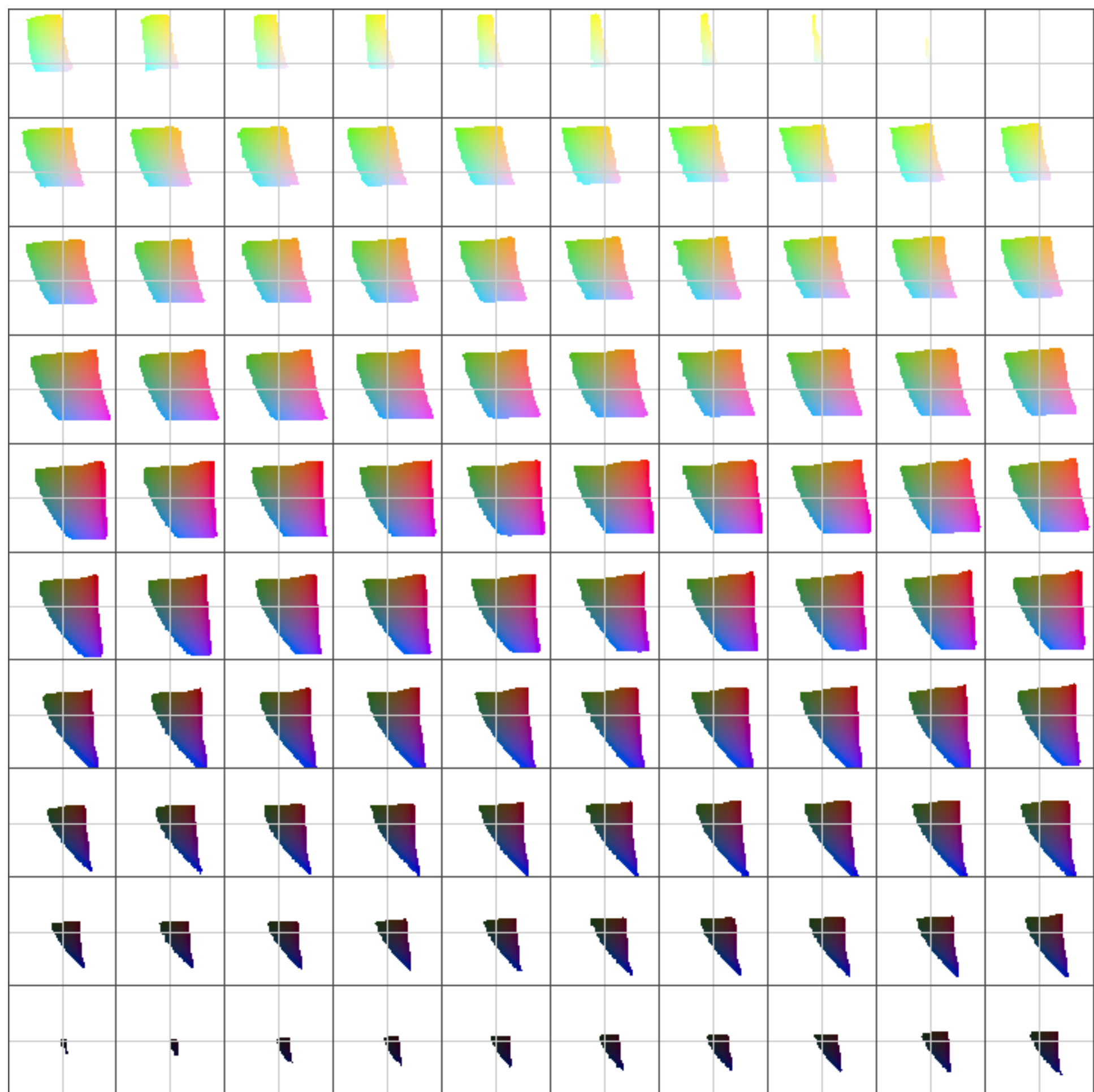
3. Test pattern

This is the test pattern [1]. It is necessary to download the Lab Tiff version because this PDF document is encoded for sRGB.



4. Gamut for sRGB

This is the result of the gamut test for sRGB using the test pattern with grid [2].
The CIELab values start bottom left with $L^*=1$. Top right is $L^*=100$.
Use 72 dpi and zoom 100% for this PDF.



5.1 PostScript code

```
%!PS-Adobe-3.0      EPSF-3.0
%%BoundingBox:      0 0 720 720
%%Creator:          Gernot Hoffmann
%%Title:            hungams17042004
%%CreationDate:     April 18 2004
%%EndComments

% Without grid

/in {72 mul} def

/na 36 def
/nb na def

/dx 2 na div def
/dy dx def

/da 200 na 1 sub div def
/db da def

/k1 0.206893 def %    6/29 =24/116 PLRM p.191
/k2 0.137930 def %    4/29 =16/116
/k3 0.128419 def % 108/841=1/7.787

/c1 1 116 div def
/c2 1 500 div def
/c3 1 200 div def

% D50
/Xn 0.9642 def
/Yn 1.0      def
/Zn 0.8249 def

% Lab D50-XYZ
[/CIEBasedABC
  <<
  /RangeABC [0 100 -128 127 -128 127]
  /DecodeABC
    [ { 16 add c1 mul    } bind
      { c2 mul           } bind
      { c3 mul           } bind ]
  /MatrixABC
    [ 1 1 1
      1 0 0
      0 0 -1 ]
  /RangeLMN [ -0.236 1.254 0 1 -0.635 1.640 ]
    % -128/500 1+127/500 0 1 -127/200 1+128/200
  /DecodeLMN
    [ { dup k1 ge { dup dup mul mul}
        { k2 sub k3 mul } ifelse Xn mul } bind
      { dup k1 ge { dup dup mul mul}
        { k2 sub k3 mul } ifelse      } bind
      { dup k1 ge { dup dup mul mul}
        { k2 sub k3 mul } ifelse Zn mul } bind ]
  /WhitePoint [ Xn Yn Zn ]
  >>
] setcolorspace
```


5.2 PostScript code

```
/PatchCIE
{ % L*=0..100 (external), a*,b*=-100..+100
  /b* -100 def
  /y -1 def
  nb
  {/a* -100 def
    /x -1 def
    na
    {L* a* b* setcolor
      newpath x y moveto dx 0 rlineto 0 dy rlineto dx neg 0 rlineto closepath fill
      /a* a* da add def
      /x x dx add def
    } repeat
    /b* b* db add def
    /y y dy add def
  } repeat
} bind def

/sc 0.5 in def
/xa sc def
/ya sc def
/dL 1 def
/L* 1 def

10
{
  10
  {
    gsave
    xa ya translate
    sc sc scale
    PatchCIE
    /xa xa sc 2 mul add def
    /L* L* dL add def
    grestore
  } repeat
  /ya ya sc 2 mul add def
  /xa sc def
} repeat

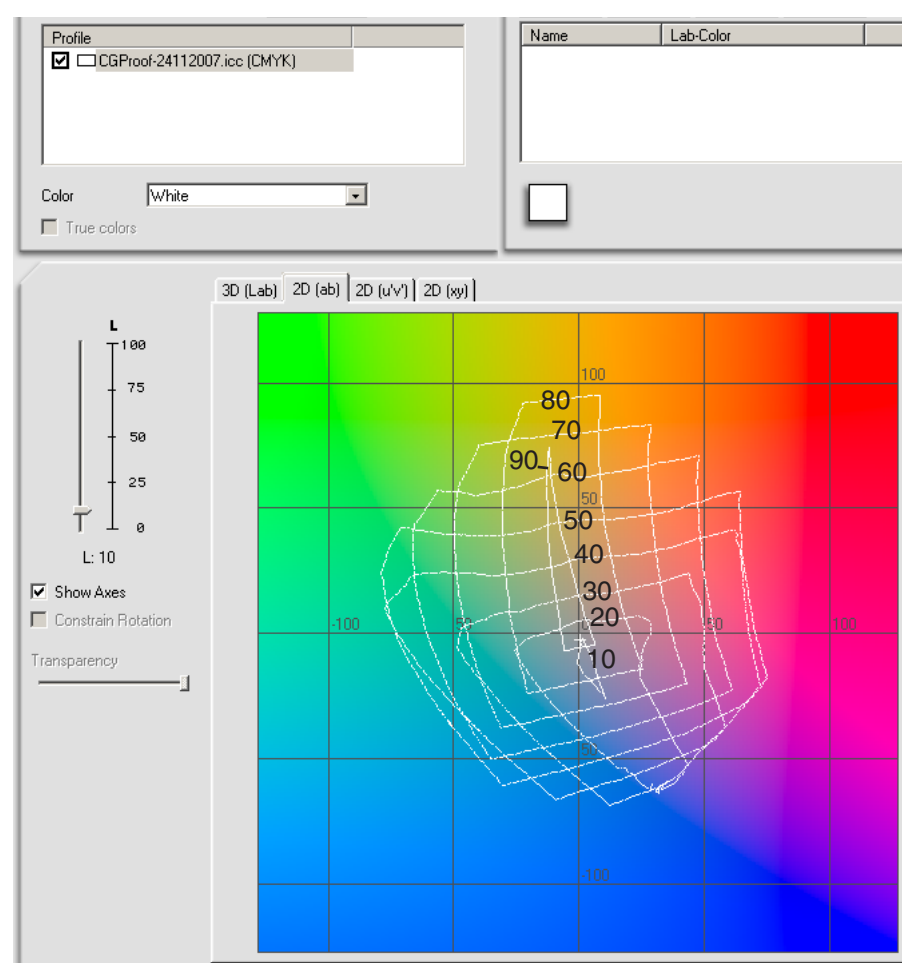
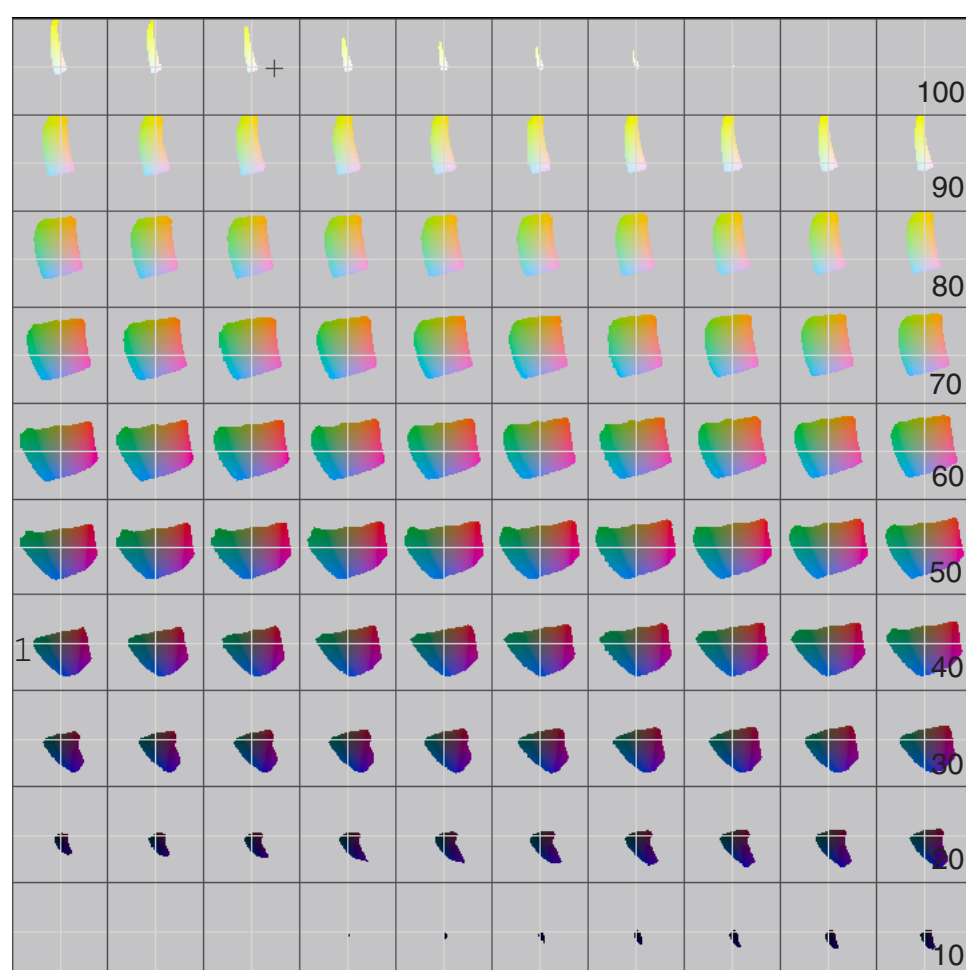
showpage
```

6. Gamut warning for two Rendering Intents

This page shows data for a CMYK profile for an inkjet Mutoh 6100, printing by CMYKcm on proof paper.

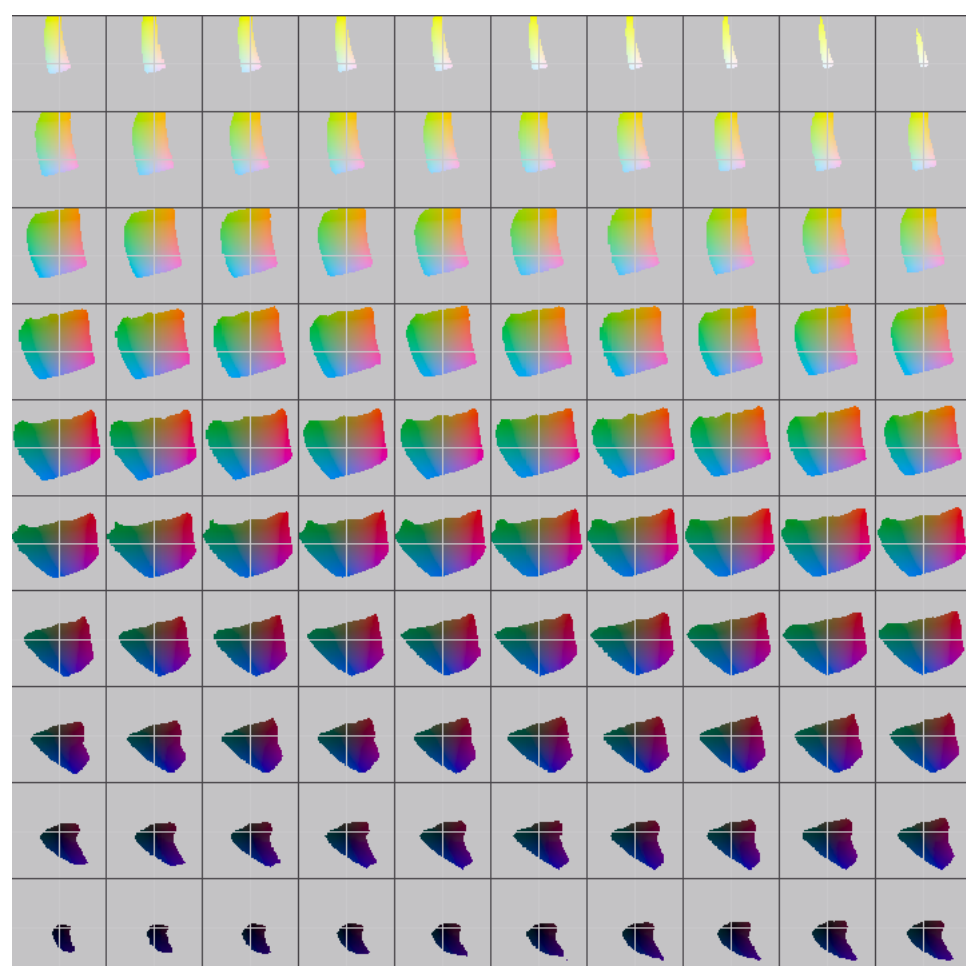
Rendering Intent Absolute Colorimetric

The printer cannot print darker than $L^*=5$ and brighter than $L^*=95$ (both values approximately). The right image shows gamut boundaries for $L^*=10, 20, \dots, 90$ as calculated by ProfileMaker5, ProfileEdit.



Rendering Intent Relative Colorimetric

The brightest white is mapped to paper white. Black Point Compensation was off, but the gamut warning works as if BPC were on: a data value $L^*=0$ would appear by $L^*=10$ on the paper. $L^*=100$ would appear as paper white by about $L^*=95$.



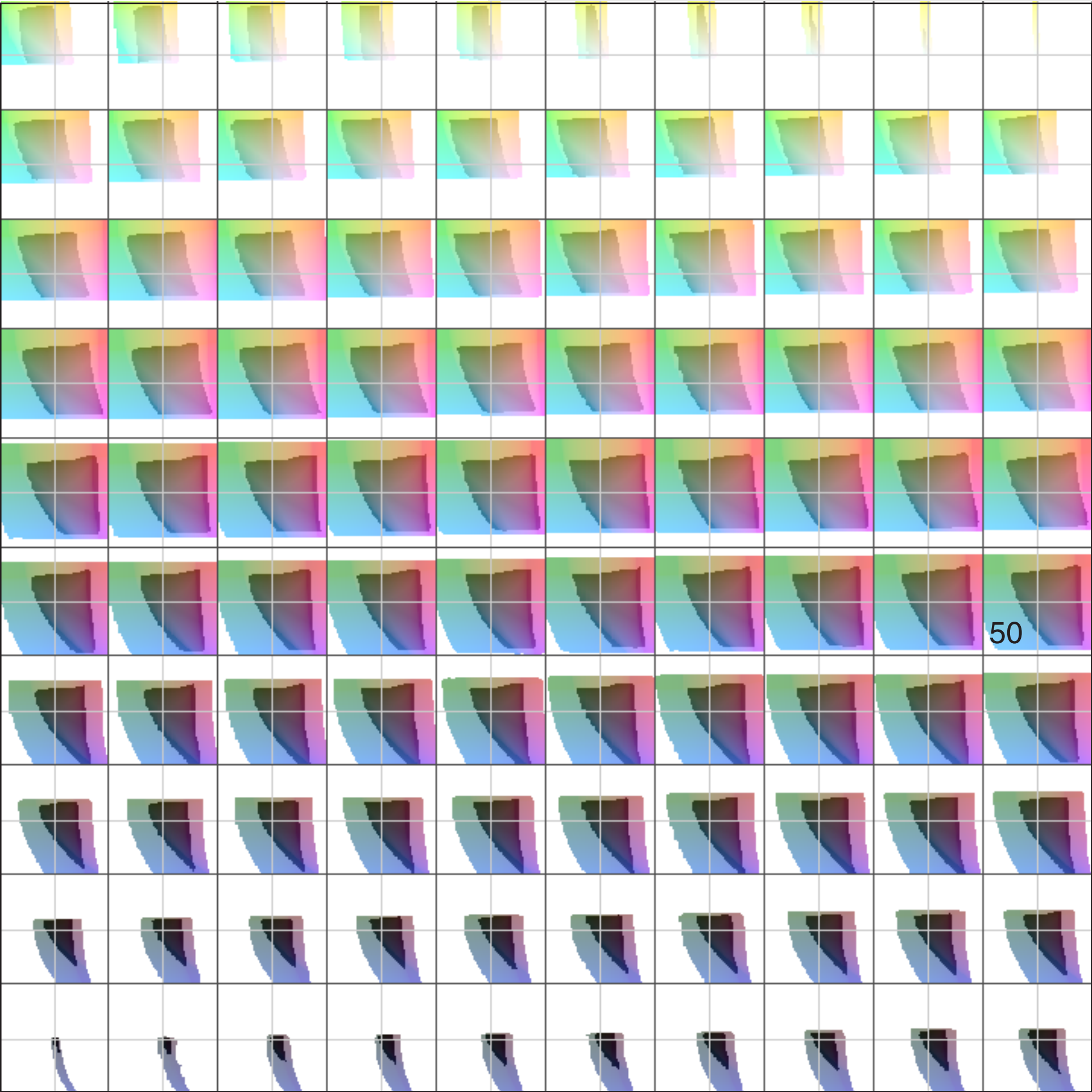
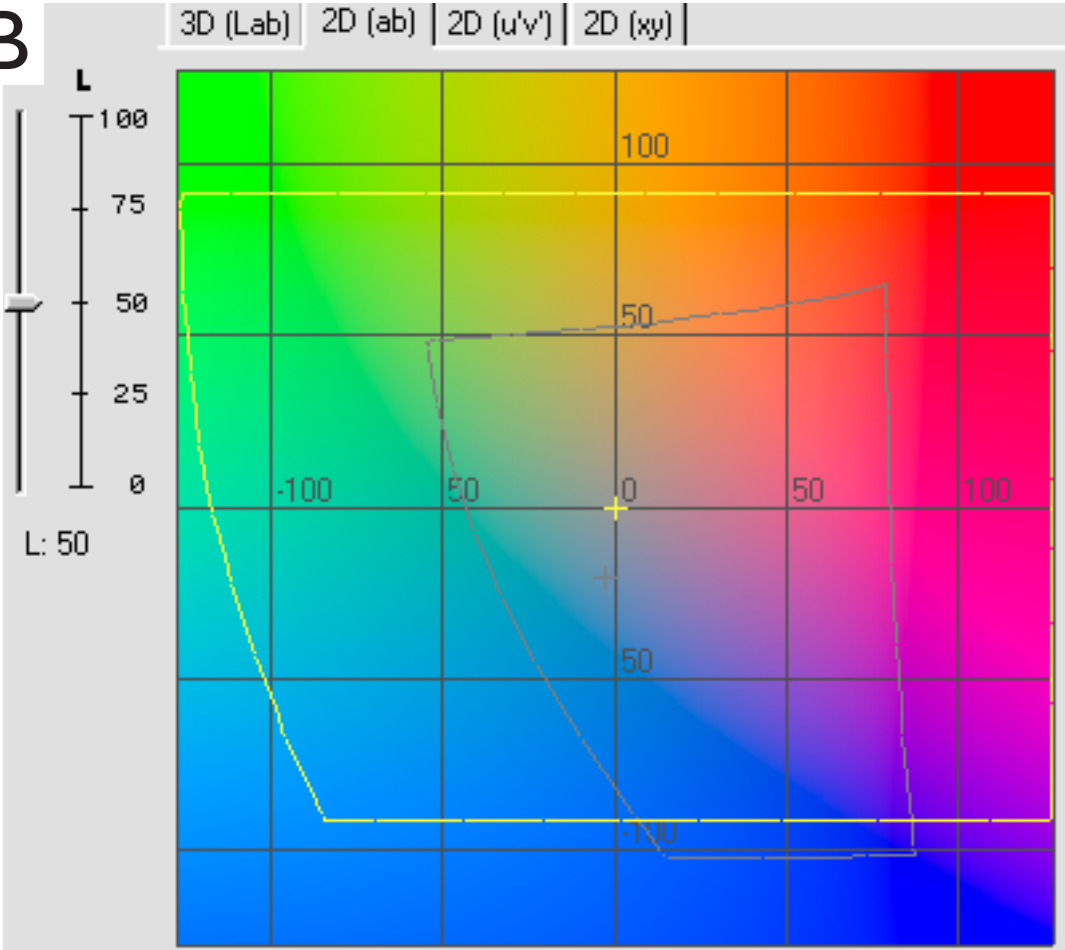
A printer gamut is the set of all printable colors, as defined by physical values XYZ or CIELab. This set is confined by a closed surface.

The surface does not depend on the rendering intent. Thus it is not understandable why Photoshop's gamut warning indicates a larger gamut for 'RelCol' compared to 'AbsCol'.

As a practical consequence, the CIELab swatchbook [4] would have on page 3 about 50 of 100 swatches out-of-gamut for AbsCol (true), but only half a dozen for RelCol (wrong).

7. ProPhoto versus sRGB

Right: ProPhoto (yellow) and sRGB (gray) by ProfileEditor/GamutView (GretagMacbeth, version 4.1.6). Clipping for some blues at $L^*=50$.
Bottom: ProPhoto (color) and sRGB (gray) by hundred gamut slices. At $L^*=50$ clipping does not happen. ProfileEditor uses wrong chromaticity coordinates for the sRGB blue (clearly visible in the xyY diagram).



8. References

- [1] G.Hoffmann
Test Pattern Hundred Gamuts without Grid
<http://docs-hoffmann.de/hungams17042004.tif>

- [2] G.Hoffmann
Test Pattern Hundred Gamuts with Grid
<http://docs-hoffmann.de/hungams18042004.tif>

- [3] G.Hoffmann
Test Pattern Hundred Gamuts for Grid only
<http://docs-hoffmann.de/hungams19042004.eps>

- [4] G.Hoffmann
Spot Swatch Book
<http://docs-hoffmann.de/swatch16032005.pdf>

- This document
<http://docs-hoffmann.de/hungams17042004.pdf>

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