



FORUM 2023
TRADITION REIMAGINED

The Optimal Method for ECG Printing Applications

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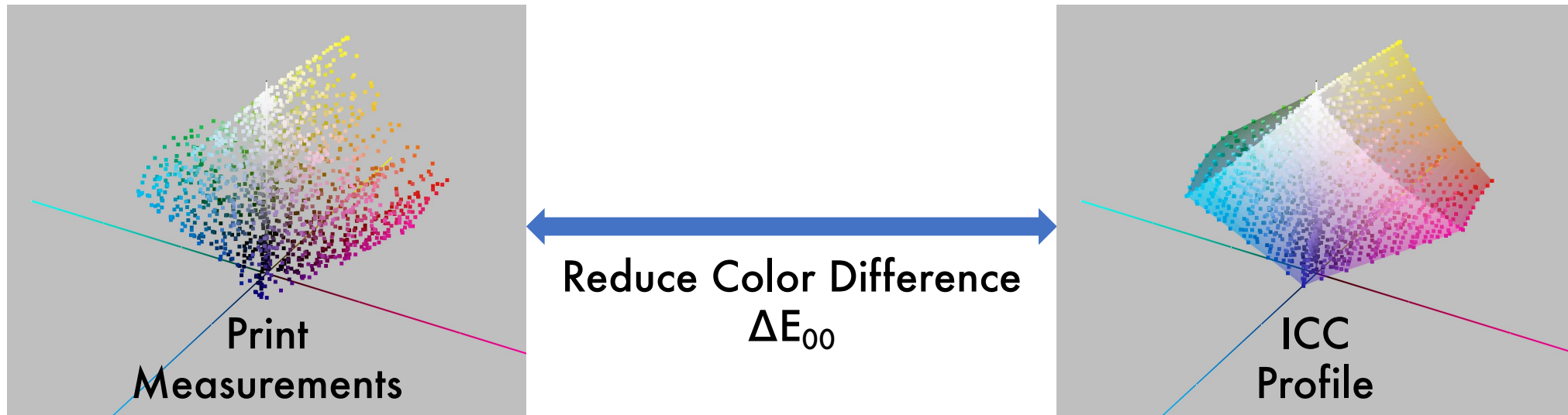
Calibration Methods

- TVI/SCTV
 - Use **Curves** to match prescribed tonality of process colors
- Near Neutral
 - Use **Curves** to match prescribed gray balance and tonality
- Color Management
 - Use **Color Management** to match an **ICC Profile**
- Optimal Method
 - Use **Curves** to match an **ICC Profile**



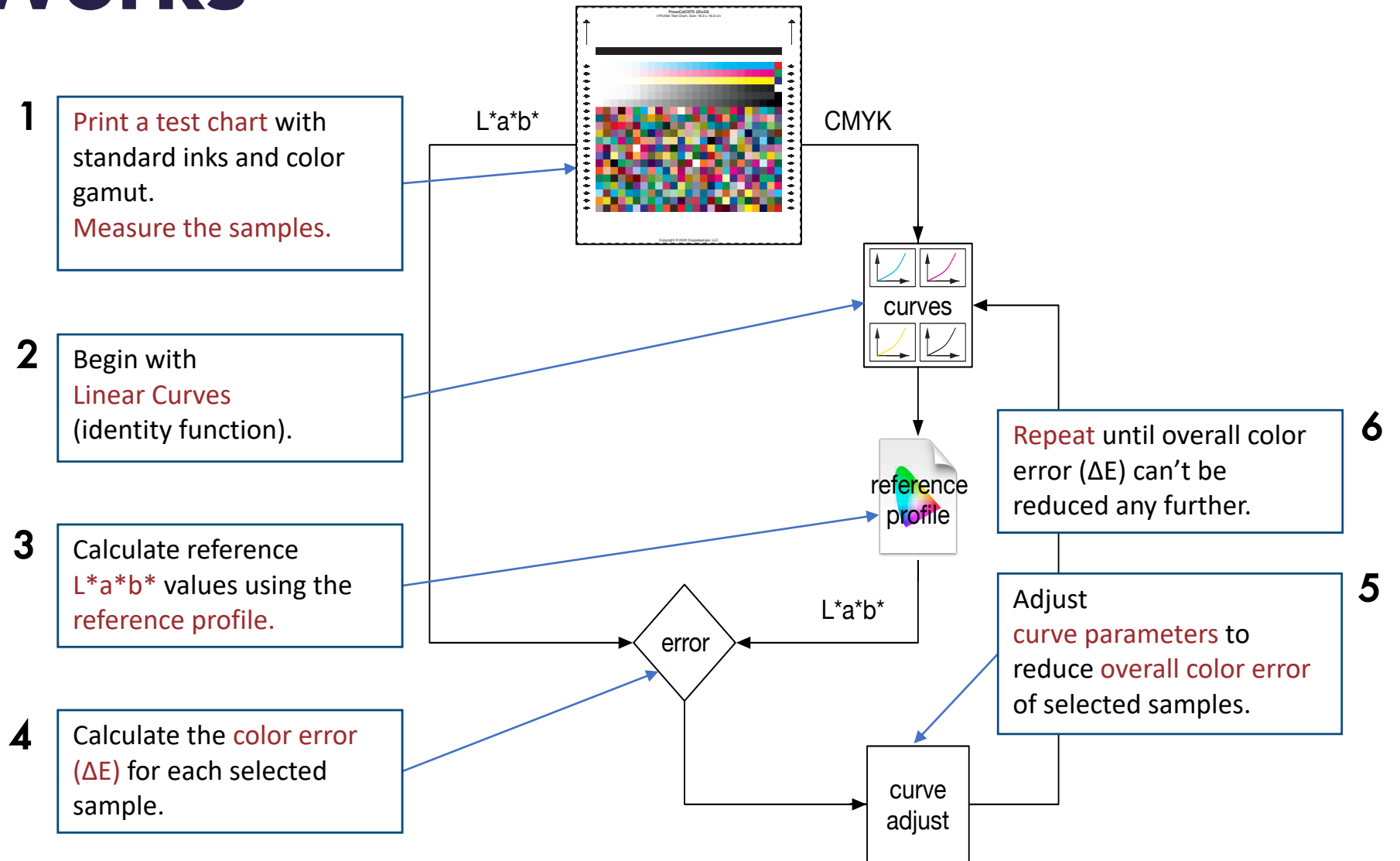
How It Works

- Reduce overall color difference (ΔE) between printing and an ICC Profile



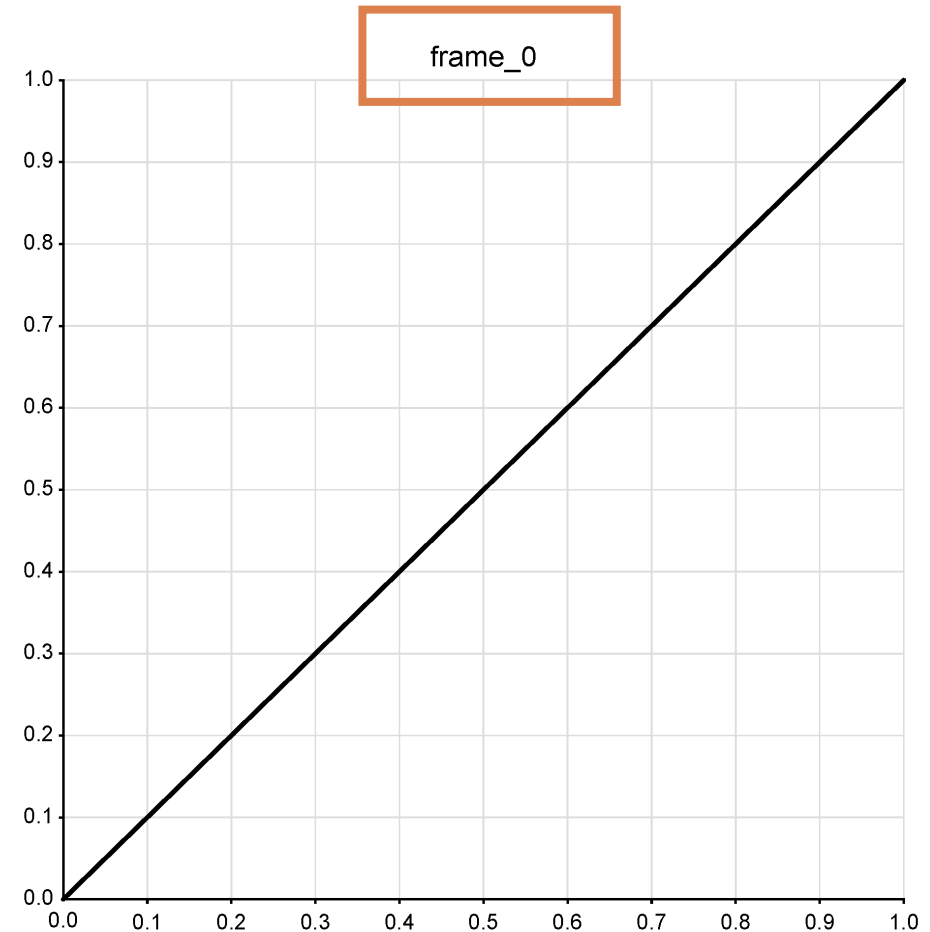
How It Works

- Iterative software loop
- Stops when the overall color error (ΔE) can't be reduced any further (Optimal)



Animation

- Each frame shows an iteration or loop
- **Stops** when overall color difference is **Lowest (OPTIMAL)**
- That took **145** iterations for this example



Optimal Method Properties

- Color reference is an ICC profile
- Printing process can have any number of inks
- Calibration test chart can use any sample set
- Minimizes color errors for the sample set
- Makes smooth vector curves from rough data
- Ideal calibration technique for ECG printing



ECG Reference Profiles



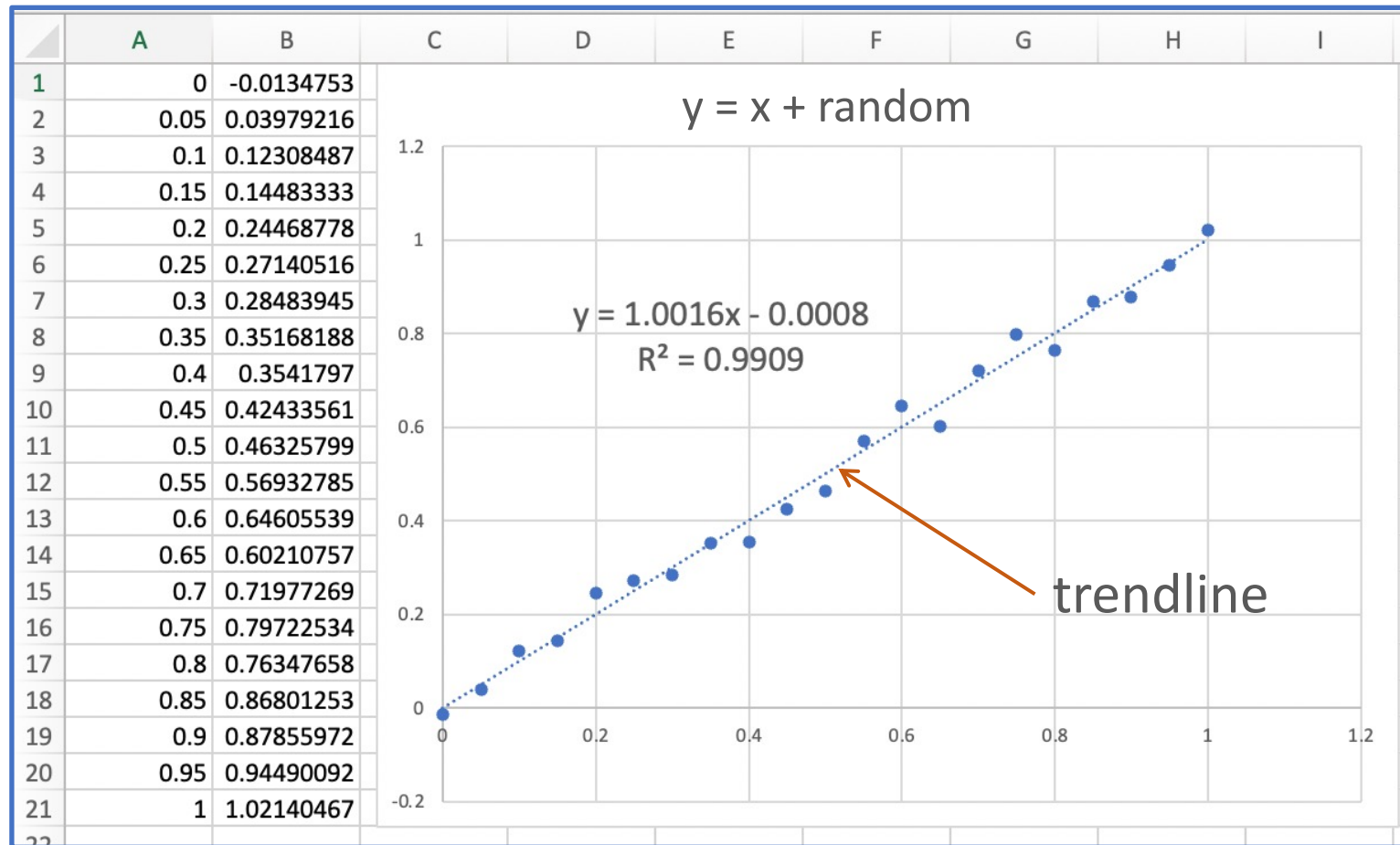
P5000_CMYKOGV.icc				
#	Tag	Data	Size	Description
z	Header		128	
1	'desc'	'mluc'	62	Multi-localized description strings
2	'cprt'	'mluc'	72	Multi-localized strings
3	'wtpt'	'XYZ '	20	Media white-point tristimulus
4	'A2B0'	'mAB '	526,280	Intent-0, device to PCS conversion table
5	'A2B1'	'mAB '	526,280	Intent-1, device to PCS conversion table
6	'A2B2'	'mAB '	526,280	Intent-2, device to PCS conversion table
7	'B2A0'	'mBA '	560,648	Intent-0, PCS to device conversion table
8	'B2A1'	'mBA '	560,648	Intent-1, PCS to device conversion table
9	'B2A2'	'mBA '	560,648	Intent-2, PCS to device conversion table
10	'gamt'	'mBA '	80,180	PCS to gamut check table
Size: 1.2 MB (1,167,516 bytes)				
Preferred CMM:				
Specification Version: 4.3.0				
Class: Output				
Space: 7-Color				
PCS: Lab				
Created: 10/16/19, 2:43 PM				

ECG Reference Profiles



inks	samples
4	1617
5	10254
6	65023
7	412328

Statistically Accurate Calibration



Choosing Samples for Calibration

L*a*b*

CMYKOGV

1	L*	a*	b*		C	M	Y	K	O	G	V
227	58.00	-29.01	-43.48		76.57	7.06	4.56	0.45	1.25	9.03	5.44
228	58.00	-29.01	-28.90		67.03	13.26	12.98	2.99	2.14	13.93	4.70
229	58.00	-29.01	-14.32		60.10	17.40	23.12	6.63	2.45	16.05	3.17
230	58.00	-29.01	0.25		54.55	19.31	34.01	9.46	2.71	18.20	1.98
231	58.00	-29.01	14.83		49.74	19.36	45.26	10.01	4.19	21.63	2.02
232	58.00	-29.01	29.41		43.85	17.81	57.52	9.27	7.39	27.63	2.84
233	58.00	-29.01	43.98		34.62	14.21	72.34	7.84	13.14	36.47	3.53
234	58.00	-29.01	58.56		20.69	7.75	88.39	5.35	23.24	48.57	2.77
235	58.00	-14.39	-43.48		66.37	12.40	5.07	1.04	1.71	4.23	12.55
236	58.00	-14.39	-28.90		58.87	20.11	12.60	5.35	2.41	6.35	8.28
237	58.00	-14.39	-14.32		52.74	24.23	21.31	11.48	2.07	7.59	4.37
238	58.00	-14.39	0.25								51
239	58.00	-14.39	14.83								36
240	58.00	-14.39	29.41								16
241	58.00	-14.39	43.98								20
242	58.00	-14.39	58.56		19.24	12.10	86.15	3.29	27.99	39.29	3.60
243	58.00	0.22	-43.48		54.40	17.88	4.33	1.09	1.93	2.22	19.99
244	58.00	0.22	-28.90		49.08	26.38	11.24	6.44	2.44	2.99	13.00
245	58.00	0.22	-14.32		44.12	30.87	18.51	14.88	1.86	2.45	6.76
246	58.00	0.22	0.25		38.76	32.96	25.82	26.94	0.01	0.00	0.00
247	58.00	0.22	14.83		36.21	32.52	40.92	17.18	7.33	7.25	2.06
248	58.00	0.22	29.41		32.45	30.58	53.57	10.52	13.40	13.47	3.56
249	58.00	0.22	43.98		26.46	26.10	67.96	6.01	21.06	21.00	4.75
250	58.00	0.22	58.56		17.56	17.64	83.25	2.10	32.49	30.96	4.51
251	58.00	14.84	-43.48		40.52	23.32	2.69	0.53	1.88	1.32	26.98
252	58.00	14.84	-28.90		37.92	33.40	9.74	4.61	3.11	2.17	17.90
253	58.00	14.84	-14.32		34.78	38.83	17.41	10.75	3.59	2.03	10.02

ICC Profile
B2A1 Tag

"Realistic" Colors



PressCal Test Chart Tool

CMYK Ramps

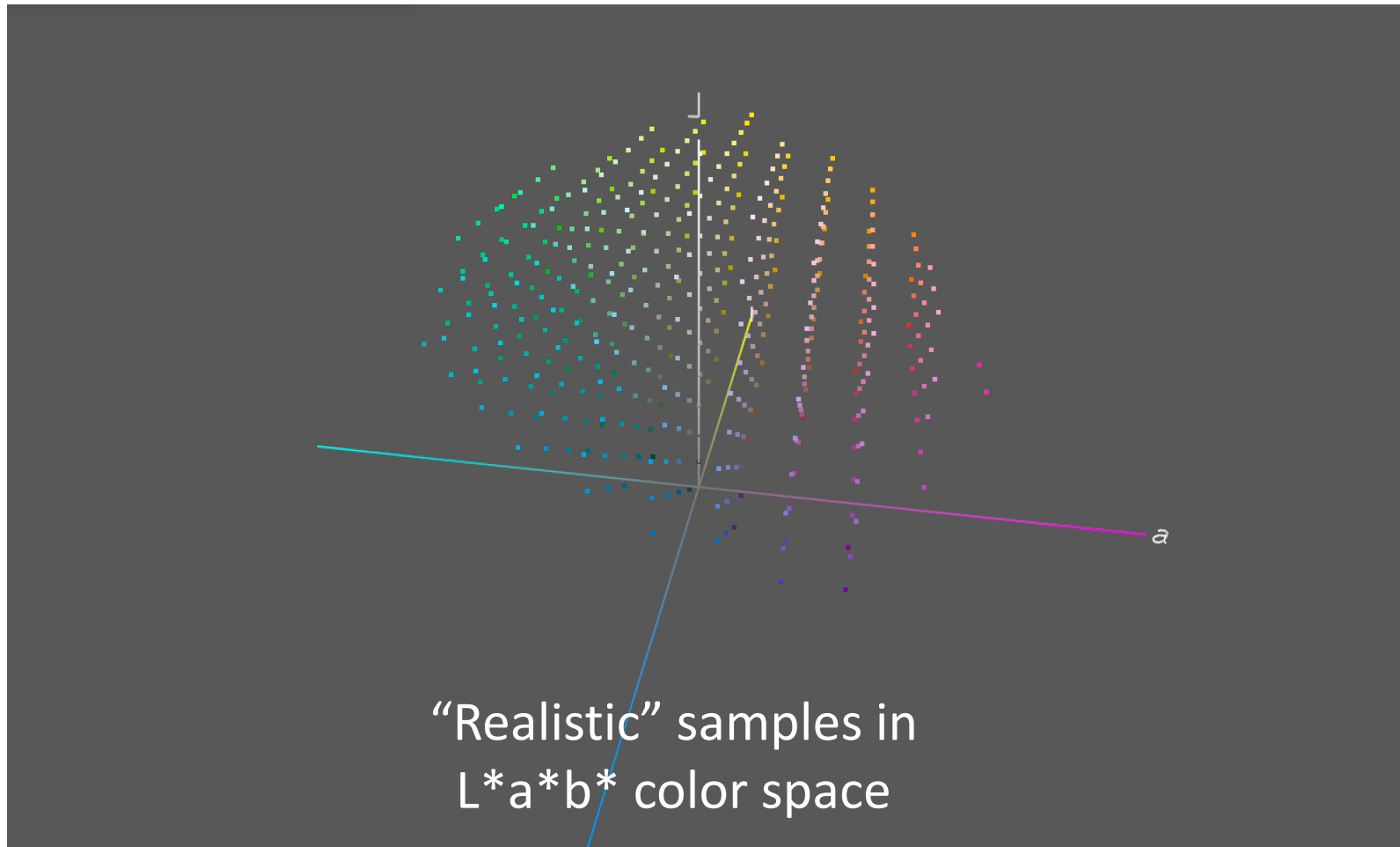
Gray Ramps

OGV Ramps

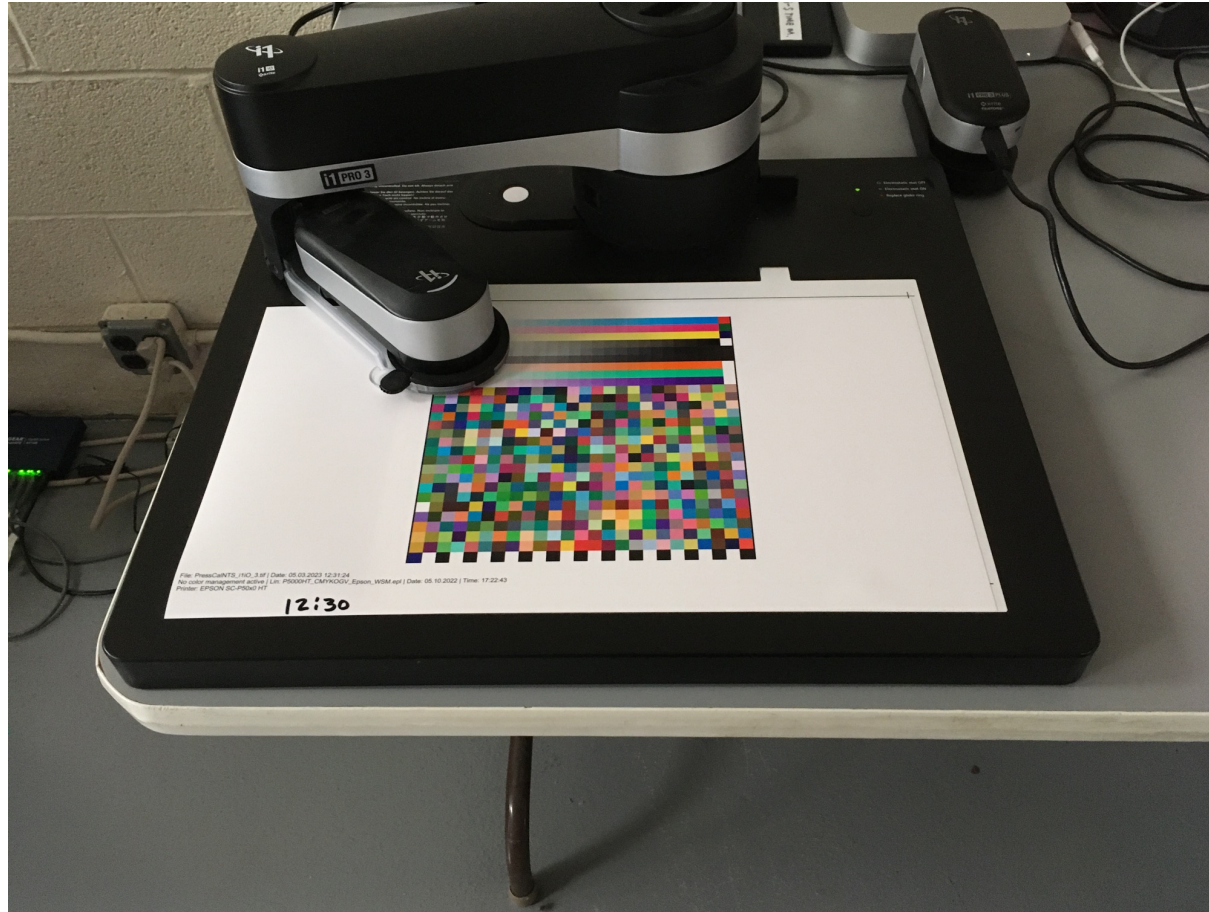
“Realistic” Samples
(CMYKOGV)



PressCal Test Chart Tool



Making ECG Tone Curves



PressCal_Extended_Gamut.yml — PressCal_Basic_Settings

PressCal_Extended_Gamut.yml

PressCal_Basic_Settings

PressCal_Default.yml

PressCal_Dissimilar.yml

PressCal_Extended_Gamut.yml

PressCal_Flexo.yml

PressCal_G7_Proof.yml

PressCal_G7.yml

PressCal_Media_Profile.yml

PressCal_Minimal.yml

PressCal_Multi.yml

PressCal_Normalize.yml

PressCal_Optimal.yml

PressCal_Proof.yml

PressCal_PSD.yml

PressCal_RGB.yml

PressCal_SCTV.yml

PressCal_TVl.yml

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```
# settings for Extended Color Gamut (ECG)~
~
# the color gamut of a printing process may be extended by adding inks outside the CMYK gamut.~
# there may be one or more additional inks. orange, green, and violet, in some combination, are commonly used.~
~
# the Optimal method works with any number of ink channels, so there is nothing special required for ECG.~
~
# here is an example calibrating an Epson P5000 printer using CMYKOGV inks.~
~
# set path to reference profile~
profile_path: ~/Data/Test/P5000_CMYKOGV.icc~
~
# set path to press measurement file -or- folder~
# press_path: ~/Data/Test/P5000_CMYKOGV.mxf~
press_path: ~/Data/Test/P5000_CMYKOGV_realistic.mxf~
~
# set ink map, an array indicating how each tone curve is derived~
# options are: 0, 1, 2, ... (optimize), S (SCTV), A - F (TVI), N (G7K), L (linear)~
ink_map: [0, 1, 2, 3, S, S, S]~
~
# set measurement condition (M0, M1, M2, M3, 0 - 1 (OBA effect), auto, ignore)~
condition: M0~
~
# set sample selection token(s) (see user manual for options)~
# select: rt(10) k nosub~
select: rt(10, -2) ramps nosub sort(error) # round-trip using RMS differences~
~
# set curve output token(s) (see user manual for options)~
output: text_iso_18620~
~
# set rendering (luminance, cast)~
# rendering: [0, 0] # media relative~
# rendering: [1, 1] # absolute~
~
# set gamut scale factor (comment out to optimize)~
gsf: 1~
~
# set Bernstein polynomial degree (comment out for auto-select)~
degree: 6~
~
# set flag to print L*a*b* solid ink values~
print_LCh: 1~
~
# set Optimal level (offset)~
optimal_level: offset~
~
```

Line: 29:23

YAML

Tab Size: 4

output



PressCal_Extended_Gamut.yml — PressCal_Basic_Settings

PressCal_Extended_Gamut.yml

PressCal_Basic_Settings

PressCal_Default.yml

PressCal_Dissimilar.yml

PressCal_Extended_Gamut.yml

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PressCal_SCTV.yml

PressCal_TVl.yml

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profile_path: ~/Data/Test/P5000_CMYKOGV.icc~
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# set path to press measurement file -or- folder~
# press_path: ~/Data/Test/P5000_CMYKOGV.mxf~
press_path: ~/Data/Test/P5000_CMYKOGV_realistic.mxf~
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# set ink map, an array indicating how each tone curve is derived~
# options are: 0, 1, 2, ... (optimize), S (SCTV), A - F (TVI), N (G7K), L (linear)~
ink_map: [0, 1, 2, 3, S, S, S]~
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# set measurement condition (M0, M1, M2, M3, 0 - 1 (OBA effect), auto, ignore)~
condition: M0~
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# set rendering (luminance, cast)~
# rendering: [0, 0] # media relative~
# rendering: [1, 1] # absolute~
~
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gsf: 1~
~
# set Bernstein polynomial degree (comment out for auto-select)~
degree: 6~
~
# set flag to print L*a*b* solid ink values~
print_LCh: 1~
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optimal_level: offset~
~
```

Line: 29:23

YAML

Tab Size: 4

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PressCal_Extended_Gamut.yml — PressCal_Basic_Settings

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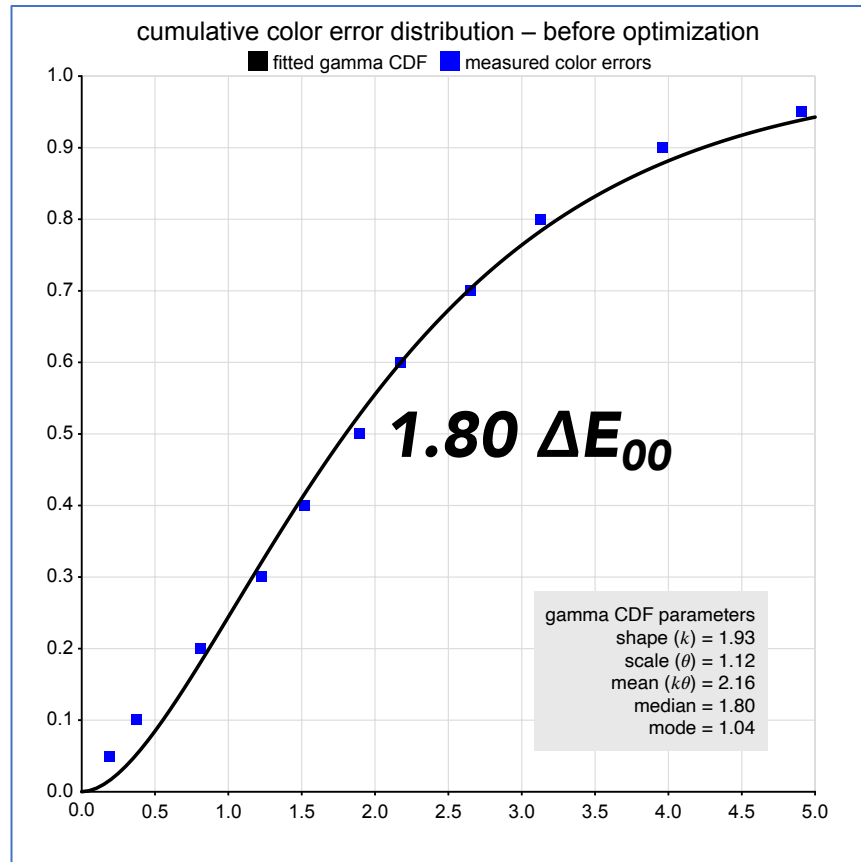
47

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# press_path: ~/Data/Test/P5000_CMYKOGV.mxf~
press_path: ~/Data/Test/P5000_CMYKOGV_realistic.mxf~
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# set ink map, an array indicating how each tone curve is derived~
# options are: 0, 1, 2, ... (optimize), S (SCTV), A - F (TVI), N (G7K), L (linear)~
ink_map: [0, 1, 2, 3, S, S, S]~
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# set measurement condition (M0, M1, M2, M3, 0 - 1 (OBA effect), auto, ignore)~
condition: M0~
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# set sample selection token(s) (see user manual for options)~
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output: text_iso_18620~
~
# set rendering (luminance, cast)~
# rendering: [0, 0] # media relative~
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degree: 6~
~
# set flag to print L*a*b solid ink values~
print_LCh: 1~
~
# set Optimal level (offset)~
optimal_level: offset~
~
```

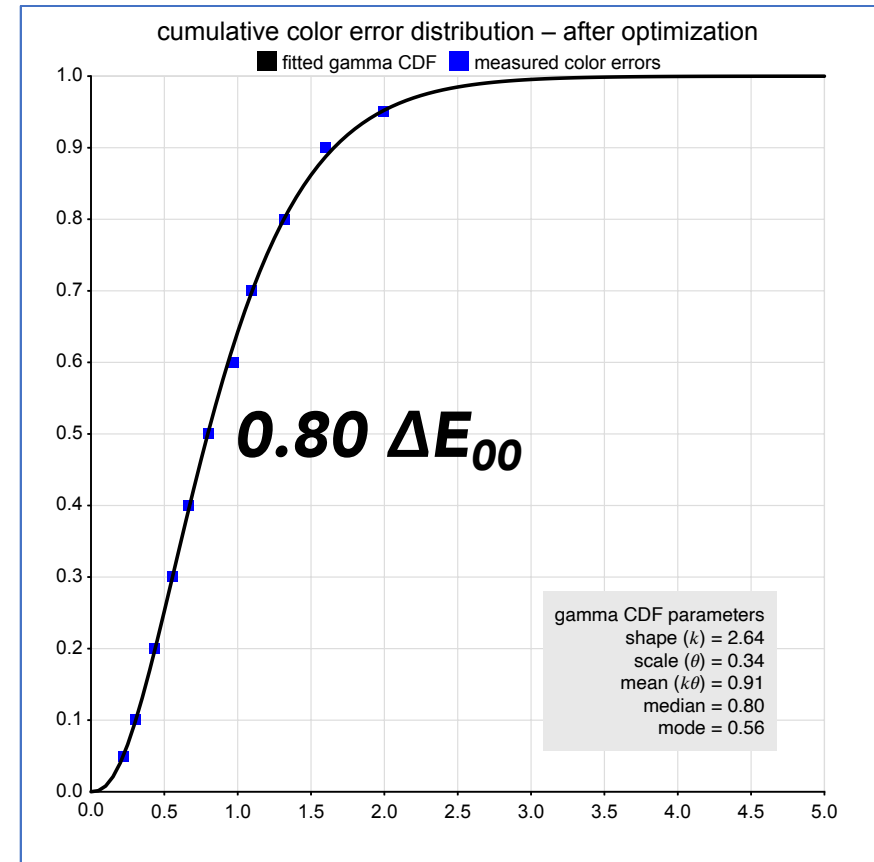


Color Errors Are Reduced

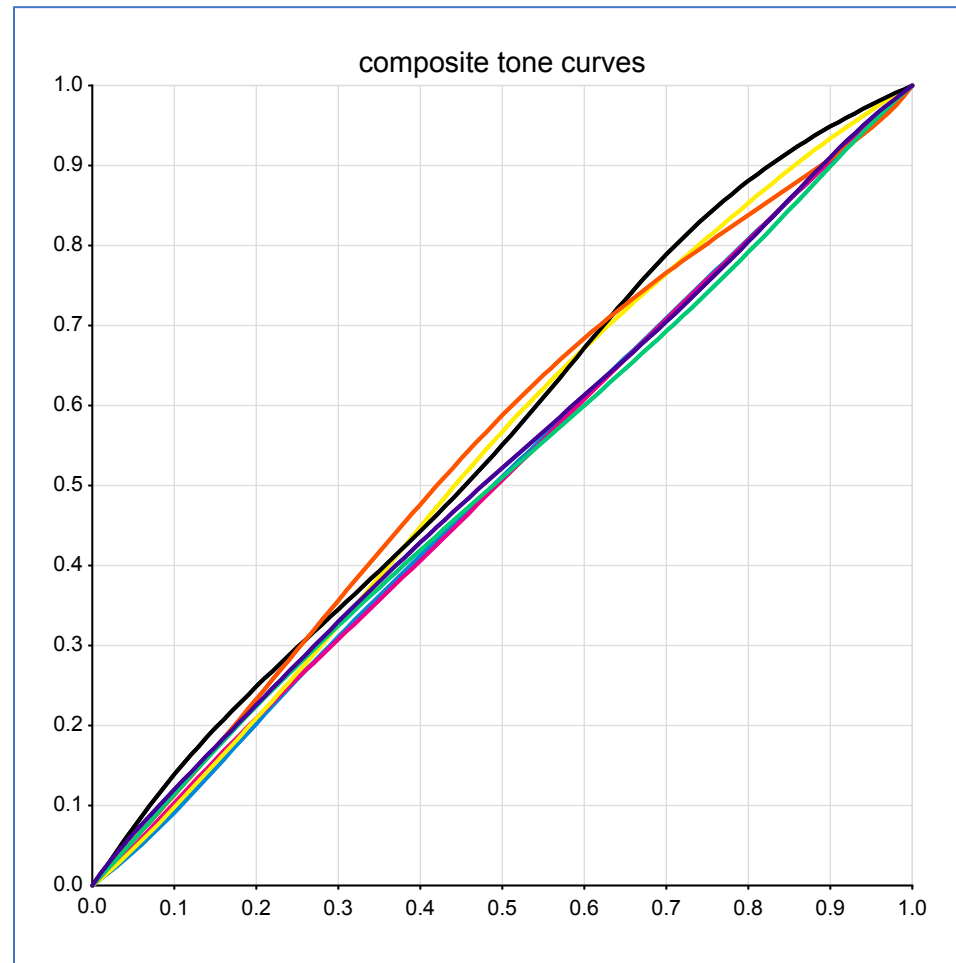
Before (uncalibrated)



After (curves applied)



Applying Curves



Applying Curves

token	output format	file type	colors	steps
apogee	Agfa Apogee	XML	CMYK	Y
cgats	CGATS.17 text format	text	n-color	Y
device_link	ICC device link profile	binary	n-color	N
efi	EFI XF .vpc/.vcc	text	CMYK + 4 spot	Y
equios	DS Equios	text	CMYK	N
fuji_xmf	Fuji XMF	text	CMYK	N
harlequin	Harlequin-based RIP	text	CMYK	N
heidelberg	Prinect (CTS 2.1, measured or calibration)	text	CMYK	Y
hybrid	Hybrid PACKZ	JSON	n-color	Y
indigo	HP Indigo	text	CMYK	N
iso_18620	ISO 18620 (Esko .ted)	XML	n-color	Y
navigator	Xitron Navigator (push calibration)	Postscript	n-color	N
photoshop	Photoshop .acv	binary	n-color	Y
prinergy	Kodak Prinergy Harmony (Colorflow)	text	CMYK	N
process	process control report (details)	text	n-color	Y
rampage	Rampage curve set	text	CMYK	N
sierra	Xitron Sierra	text	CMYK	N
trueflow	Screen Trueflow	binary	CMYK	N
text	tab-delimited text	text	n-color	Y



Spot Color Simulation



Adding Spot Color Mixes to the Calibration Chart

```
90 15 15
90 15 30
90 15 45
90 15 60
100 0 0
realistic samples: 436

spot colors:
PANTONE 116 C      85.446   8.244  89.470
PANTONE 185 C      49.779  77.431  49.228 **
PANTONE 485 C      49.730  69.101  54.630
PANTONE 228 C      31.341  53.003  -7.145
PANTONE 348 C      46.552 -54.131  26.075
PANTONE 421 C      73.129  -0.717   0.335
PANTONE 277 C      79.737  -5.343 -19.363
PANTONE 707 C      80.895  27.381   3.329
PANTONE 563 C      70.139 -29.172  -2.887
PANTONE 610 C      84.464  -6.277  62.370
PANTONE 300 C      35.780  -9.704 -62.004 **
PANTONE 469 C      31.610  17.439  25.241
PANTONE 281 C      12.826   8.993 -40.571 **
PANTONE Warm Red C  58.663  70.049  51.189
PANTONE Reflex Blue C 14.929  31.863 -67.088 **
(** color is out-of-gamut)

chart size: 676
```

Program exited with code #0 after 1.76 seconds.

[copy output](#)

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Adding Spot Color Mixes to the Calibration Chart

```
90 15 15
90 15 30
90 15 45
90 15 60
100 0 0
realistic samples: 436
```

spot colors:

PANTONE 116 C	85.446	8.244	89.470	
PANTONE 185 C	49.779	77.431	49.228	** ←
PANTONE 485 C	49.730	69.101	54.630	
PANTONE 228 C	31.341	53.003	-7.145	
PANTONE 348 C	46.552	-54.131	26.075	
PANTONE 421 C	73.129	-0.717	0.335	
PANTONE 277 C	79.737	-5.343	-19.363	
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PANTONE Warm Red C	58.663	70.049	51.189	
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(** color is out-of-gamut)

chart size: 676

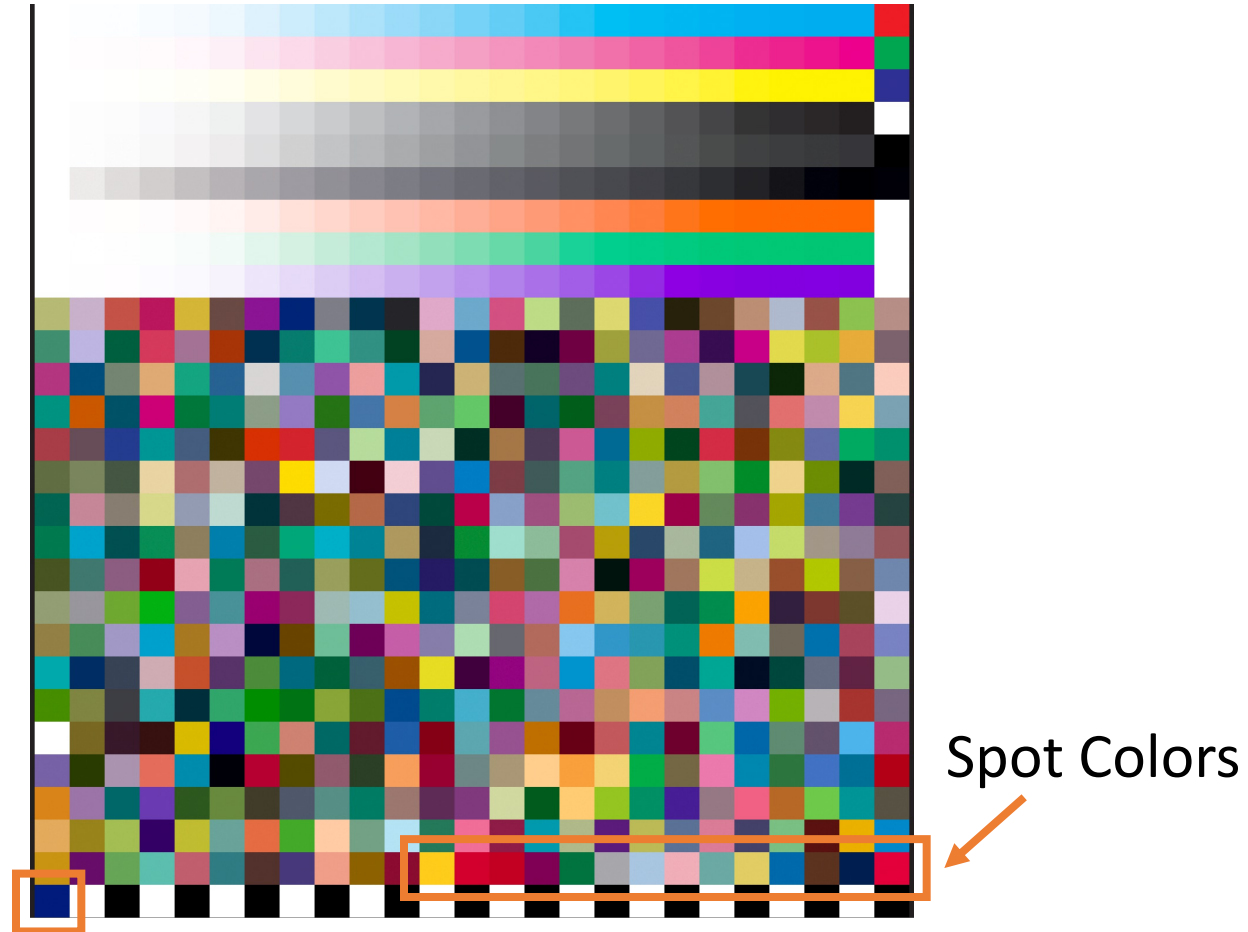
Program exited with code #0 after 1.76 seconds.

[copy output](#)

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Adding Spot Color Mixes to the Calibration Chart



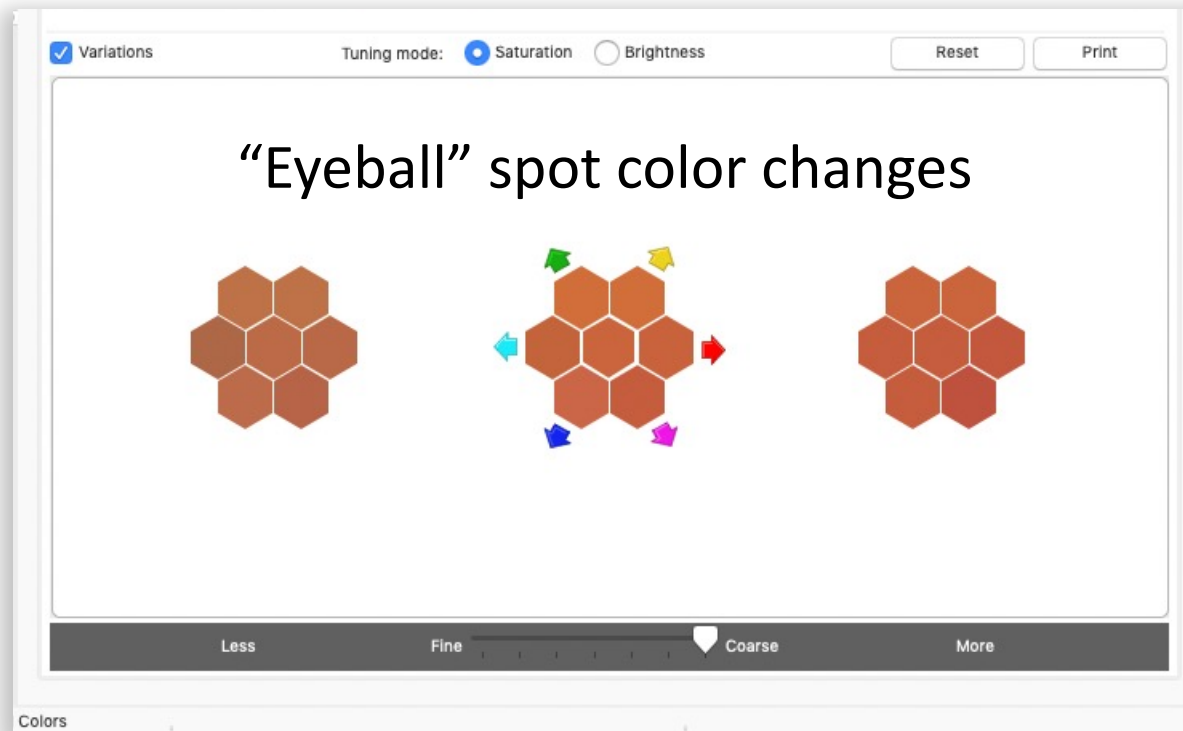
Color Management May Not Be Accurate Enough for Spot Colors

Running "PressCal_realistic_fine-tune_spots.plx"...

sample name	L*a*b* (target)			L*a*b* (measured)			dE00
PANTONE_116_C	85.4	8.2	89.5	85.0	7.3	85.7	0.9
PANTONE_185_C	49.8	77.4	49.2	49.1	74.5	44.0	1.9 **
PANTONE_485_C	49.7	69.1	54.6	49.4	68.7	47.8	2.9
PANTONE_228_C	31.3	53.0	-7.1	33.5	56.9	-8.5	2.1
PANTONE_348_C	46.6	-54.1	26.1	49.7	-56.6	26.6	3.2
PANTONE_421_C	73.1	-0.7	0.3	73.7	-0.5	0.1	0.5
PANTONE_277_C	79.7	-5.3	-19.4	80.4	-6.0	-16.2	1.9
PANTONE_707_C	80.9	27.4	3.3	80.9	25.5	3.5	0.9
PANTONE_563_C	70.1	-29.2	-2.9	72.2	-27.5	-1.6	1.9
PANTONE_610_C	84.5	-6.3	62.4	84.5	-6.1	56.1	1.7
PANTONE_300_C	35.8	-9.7	-62.0	37.8	-13.2	-60.7	2.4 **
PANTONE_469_C	31.6	17.4	25.2	37.6	17.6	27.0	5.0
PANTONE_281_C	12.8	9.0	-40.6	14.4	9.6	-43.2	1.4 **
PANTONE_Warm_Red_C	58.7	70.0	51.2	58.0	67.2	44.2	2.5
PANTONE_Reflex_Blue_C	14.9	31.9	-67.1	15.7	34.0	-66.1	1.7 **
(** color is out-of-gamut)							

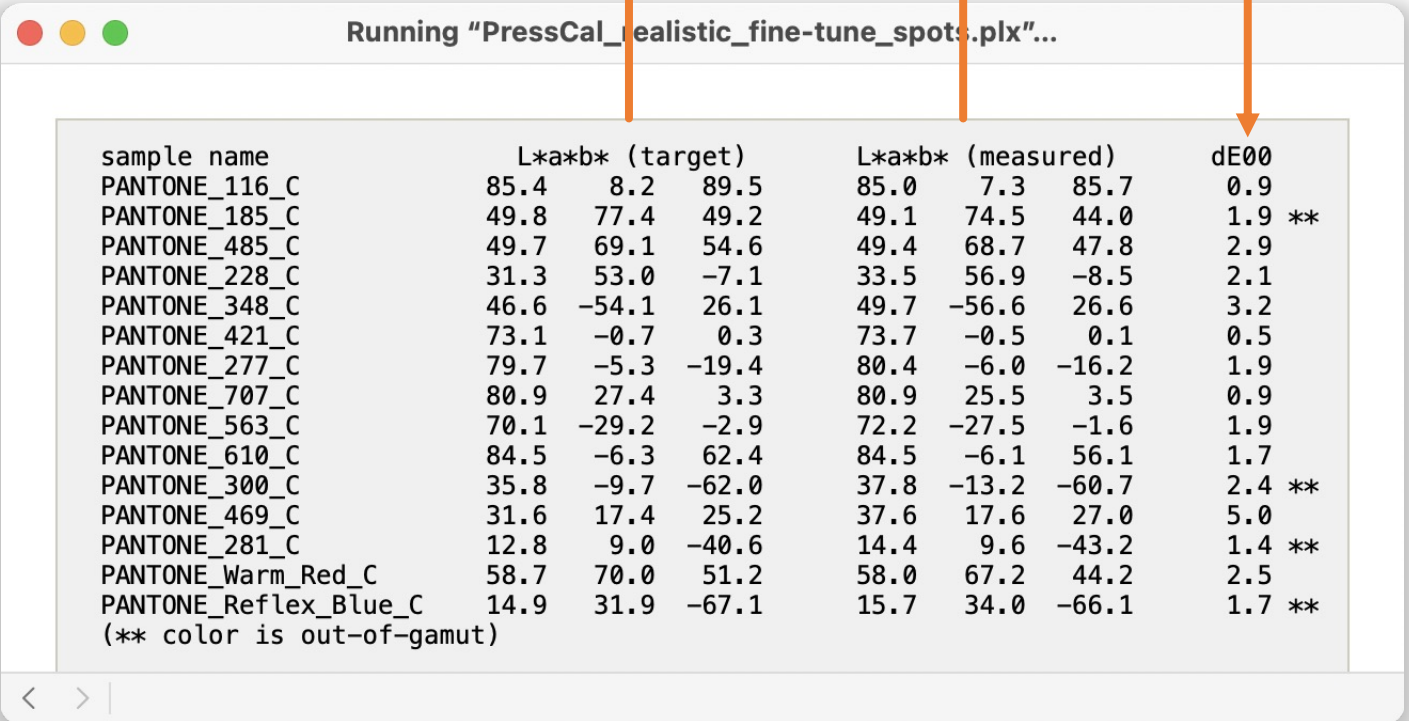


Color Management May Not Be Accurate Enough for Spot Colors



PressCal Spot Color Tool

Compares L*a*b* values



Running "PressCal_realistic_fine-tune_spots.plx"...

sample name	L*a*b* (target)			L*a*b* (measured)			dE00
PANTONE_116_C	85.4	8.2	89.5	85.0	7.3	85.7	0.9
PANTONE_185_C	49.8	77.4	49.2	49.1	74.5	44.0	1.9 **
PANTONE_485_C	49.7	69.1	54.6	49.4	68.7	47.8	2.9
PANTONE_228_C	31.3	53.0	-7.1	33.5	56.9	-8.5	2.1
PANTONE_348_C	46.6	-54.1	26.1	49.7	-56.6	26.6	3.2
PANTONE_421_C	73.1	-0.7	0.3	73.7	-0.5	0.1	0.5
PANTONE_277_C	79.7	-5.3	-19.4	80.4	-6.0	-16.2	1.9
PANTONE_707_C	80.9	27.4	3.3	80.9	25.5	3.5	0.9
PANTONE_563_C	70.1	-29.2	-2.9	72.2	-27.5	-1.6	1.9
PANTONE_610_C	84.5	-6.3	62.4	84.5	-6.1	56.1	1.7
PANTONE_300_C	35.8	-9.7	-62.0	37.8	-13.2	-60.7	2.4 **
PANTONE_469_C	31.6	17.4	25.2	37.6	17.6	27.0	5.0
PANTONE_281_C	12.8	9.0	-40.6	14.4	9.6	-43.2	1.4 **
PANTONE_Warm_Red_C	58.7	70.0	51.2	58.0	67.2	44.2	2.5
PANTONE_Reflex_Blue_C	14.9	31.9	-67.1	15.7	34.0	-66.1	1.7 **

(** color is out-of-gamut)

PressCal Spot Color Tool

Adjusts CMYKOGV values

Running "PressCal_realistic_fine-tune_spots.plx"...

sample name	device values (nominal)							device values (adjusted)						
PANTONE_116_C	0.3	1.8	88.1	0.0	19.5	2.5	0.4	0.1	1.3	91.0	0.0	19.7	1.5	0.2
PANTONE_185_C	0.0	100.0	9.2	0.2	67.4	0.0	2.3	0.0	100.0	6.3	-1.1	72.8	0.0	-0.9
PANTONE_485_C	1.0	90.4	21.2	4.3	72.0	1.4	5.7	0.5	89.3	22.0	4.9	78.4	1.5	4.8
PANTONE_228_C	17.1	96.3	13.4	8.5	24.5	2.1	46.0	19.9	95.3	14.9	13.1	28.7	2.2	47.6
PANTONE_348_C	64.9	10.5	69.5	20.1	4.9	47.5	1.2	66.5	11.1	73.3	26.2	5.2	47.9	1.0
PANTONE_421_C	25.9	22.0	18.8	12.3	0.2	0.9	0.1	26.5	22.4	19.3	12.6	0.3	1.2	0.2
PANTONE_277_C	27.3	6.7	2.4	0.8	0.6	2.2	6.1	28.5	6.1	1.0	0.4	0.6	1.8	7.4
PANTONE_707_C	2.6	25.8	5.6	0.1	14.4	0.6	1.3	1.7	26.9	4.6	0.1	14.9	0.5	1.1
PANTONE_563_C	41.2	10.2	19.7	2.3	1.9	22.1	2.3	45.2	10.8	20.9	2.6	2.0	22.4	2.5
PANTONE_610_C	4.2	4.4	65.5	0.0	9.9	10.2	1.9	3.6	4.0	72.5	0.0	10.2	10.2	1.8
PANTONE_300_C	99.8	17.0	1.8	8.9	0.2	14.3	24.2	98.3	19.6	1.0	8.8	0.2	15.4	27.7
PANTONE_469_C	25.7	41.6	49.9	45.3	48.5	24.6	9.2	24.2	41.8	47.7	57.6	58.8	28.9	12.2
PANTONE_281_C	99.6	53.4	2.6	50.6	8.9	15.1	42.2	100.0	53.3	0.6	56.6	10.6	13.7	42.7
PANTONE_Warm_Red_C	0.0	72.9	15.4	0.0	64.7	0.0	0.5	0.0	72.1	11.8	0.0	72.2	-0.9	-0.2
PANTONE_Reflex_Blue_C	100.0	59.3	0.0	14.8	1.9	12.4	68.7	100.0	58.1	0.0	16.6	2.0	14.4	65.0

Program exited with code #0 after 0.71 seconds.

[copy output](#)



Improved Spot Color Accuracy

sample name	L*a*b* (target)			L*a*b* (measured)			dE00
PANTONE_116_C	85.4	8.2	89.5	85.0	7.3	85.7	0.9
PANTONE_185_C	49.8	77.4	49.2	49.1	74.5	44.0	1.9 **
PANTONE_485_C	49.7	69.1	54.6	49.4	68.7	47.8	2.9
PANTONE_228_C	31.3	53.0	-7.1	33.5	56.9	-8.5	2.1
PANTONE_348_C	46.6	-54.1	26.1	49.7	-56.6	26.6	3.2
PANTONE_421_C	73.1	-0.7	0.3	73.7	-0.5	0.1	0.5
PANTONE_277_C	79.7	-5.3	-19.4	80.4	-6.0	-16.2	1.9
PANTONE_707_C	80.9	27.4	3.3	80.9	25.5	3.5	0.9
PANTONE_563_C	70.1	-29.2	-2.9	72.2	-27.5	-1.6	1.9
PANTONE_610_C	84.5	-6.3	62.4	84.5	-6.1	56.1	1.7
PANTONE_300_C	35.8	-9.7	-62.0	37.8	-13.2	-60.7	2.4 **
PANTONE_469_C	31.6	17.4	25.2	37.6	17.6	27.0	5.0
PANTONE_281_C	12.8	9.0	-40.6	14.4	9.6	-43.2	1.4 **
PANTONE_Warm_Red_C	58.7	70.0	51.2	58.0	67.2	44.2	2.5
PANTONE_Reflex_Blue_C	14.9	31.9	-67.1	15.7	34.0	-66.1	1.7 **

(** color is out-of-gamut)



Improved Spot Color Accuracy

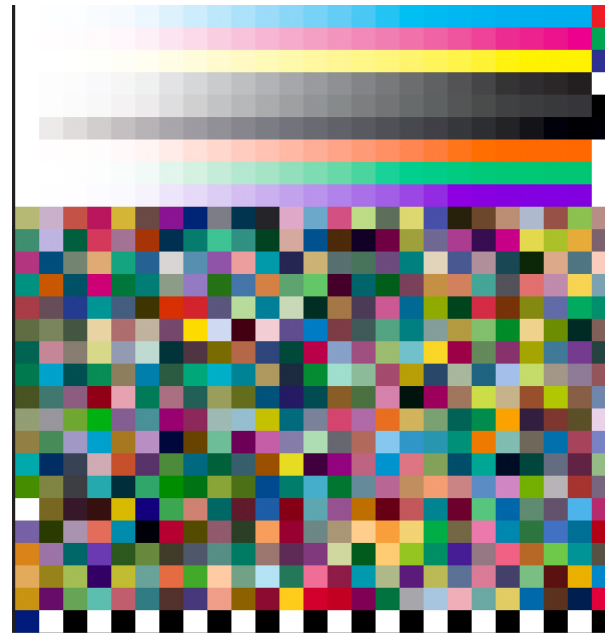
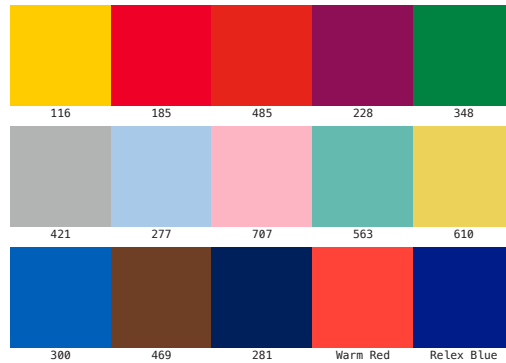
sample name	L*a*b*	L*a*b* (measured)	dE00	dE00
PANTONE_116_C	85.4	85.9 7.9 88.4	0.4	0.9
PANTONE_185_C	49.8 7	50.6 75.5 48.1	0.9 **	1.9 **
PANTONE_485_C	49.7 6	50.5 68.5 54.8	0.8	2.9
PANTONE_228_C	31.3 5	32.8 54.4 -7.6	1.2	2.1
PANTONE_348_C	46.6 -5	47.3 -53.5 26.4	0.8	3.2
PANTONE_421_C	73.1 -	73.6 -0.3 -0.0	0.7	0.5
PANTONE_277_C	79.7 -	80.3 -4.8 -18.8	0.7	1.9
PANTONE_707_C	80.9 2	80.9 26.9 3.0	0.3	0.9
PANTONE_563_C	70.1 -2	70.7 -28.4 -3.1	0.6	1.9
PANTONE_610_C	84.5 -	84.8 -6.2 61.3	0.3	1.7
PANTONE_300_C	35.8 -	37.7 -10.1 -61.3	1.6 **	2.4 **
PANTONE_469_C	31.6 1	31.5 18.0 25.8	0.4	5.0
PANTONE_281_C	12.8	13.7 9.7 -41.5	0.6 **	1.4 **
PANTONE_Warm_Red_C	58.7 7	58.2 68.5 51.0	0.6	2.5
PANTONE_Reflex_Blue_C	14.9 3	17.0 31.2 -65.8	1.4 **	1.7 **

(** color is out-of-gamut)

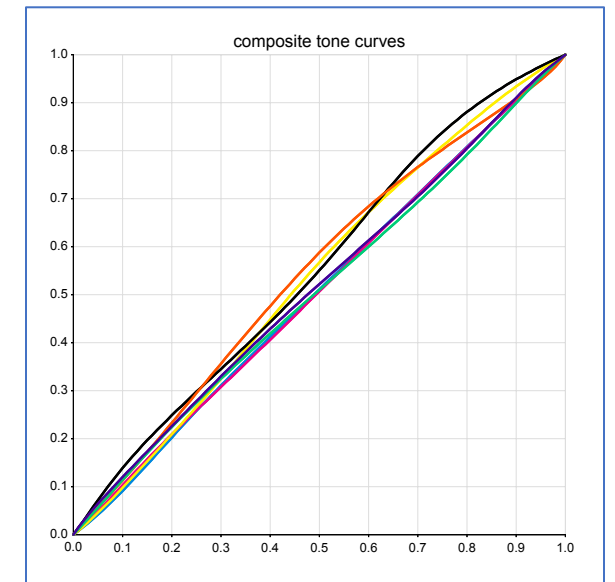


Tone Curves *and* Spot Color Mixes from a Single Test Run!

Spot Color Mixes



Tone Curves



Tone Curves *and* Spot Color Mixes from a Single Test Run!



Free as in Freedom



Tone Curves *and* Spot Color Mixes from a Single Test Run!

Free?



Tone Curves *and* Spot Color Mixes from a Single Test Run!

Free?

What's the catch?



Thank You!

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