

PressCal Software

Universal Print Calibration Tool

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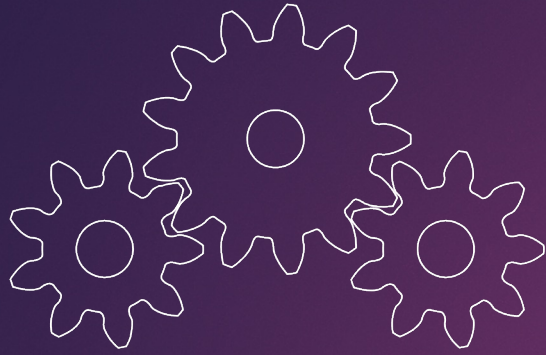
OPTIMAL  METHOD

What is PressCal?

- ▶ Open-source software tool for calibrating print processes
- ▶ Reference implementation of the Optimal Method
- ▶ Calibrates any printing process, with any number of inks
- ▶ Supports legacy calibration techniques – TVI, G7, SCTV
- ▶ Computes color error statistics, before and after optimization
- ▶ Includes integrated ink-setting and grading tools

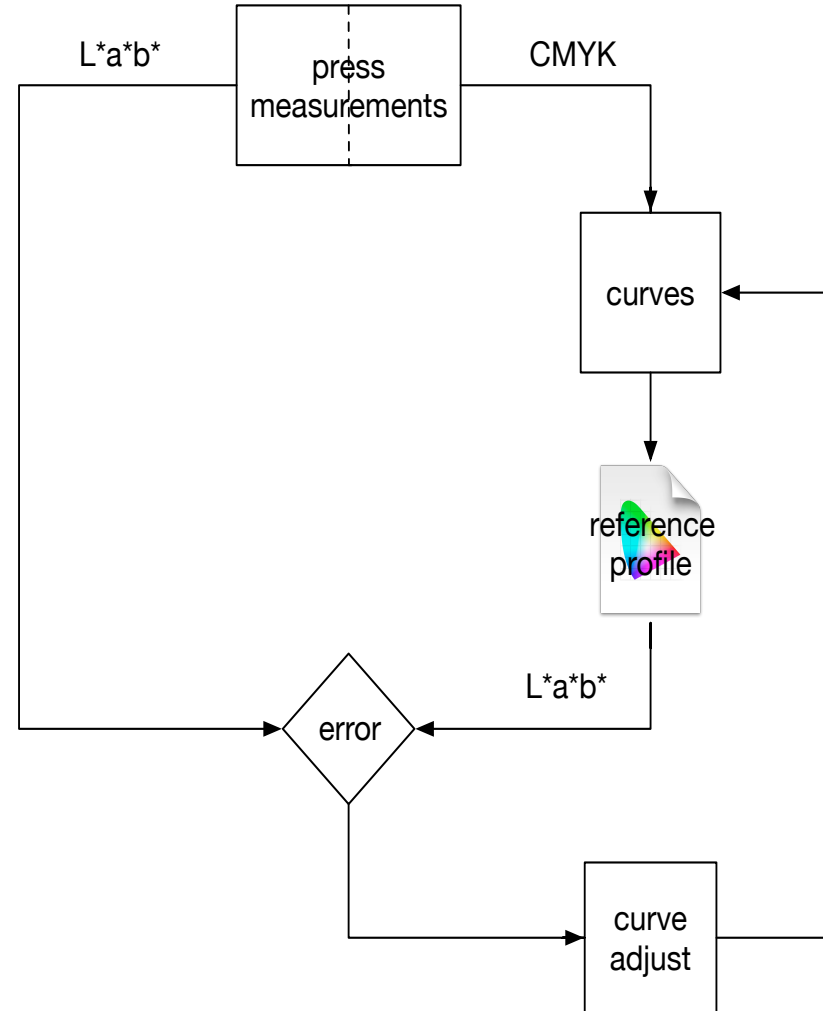
What is the Optimal Method?

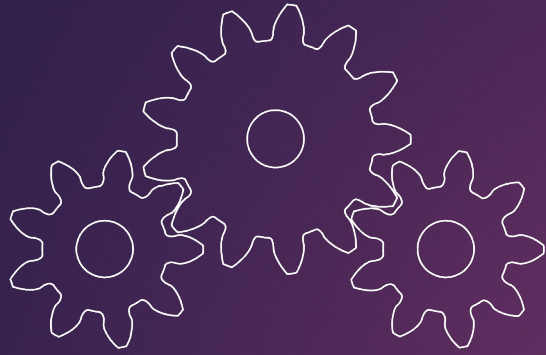
- ▶ An advanced technique for calibrating print processes
- ▶ Color reference is an ICC profile
- ▶ Press sheet measurements are compared to reference values
- ▶ Color errors are minimized using mathematical optimization
- ▶ Full color gamut of realistic samples may be used
- ▶ Robust, unaffected by normal measurement variations



How It Works

- ▶ This **flowchart** illustrates the essential function of the software
- ▶ **Color error** is minimized using the well-known **Gauss-Newton** optimization algorithm
- ▶ This is an **iterative process**.
- ▶ The **sample set** and **error function** are adjustable

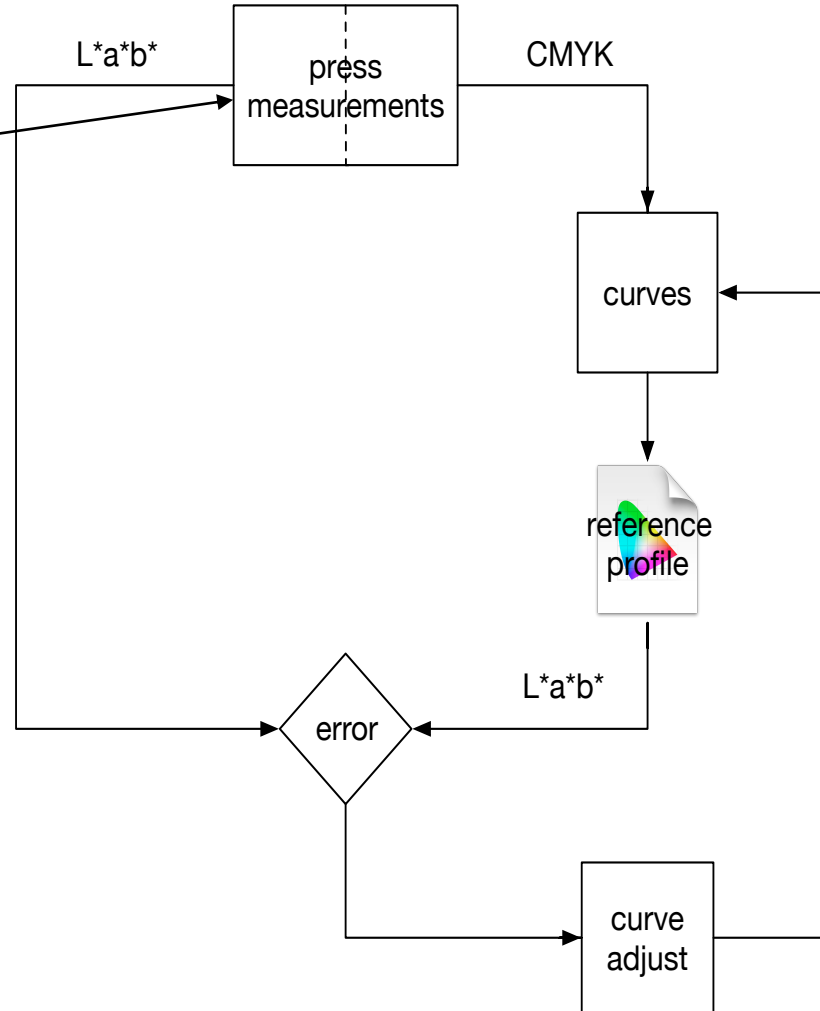


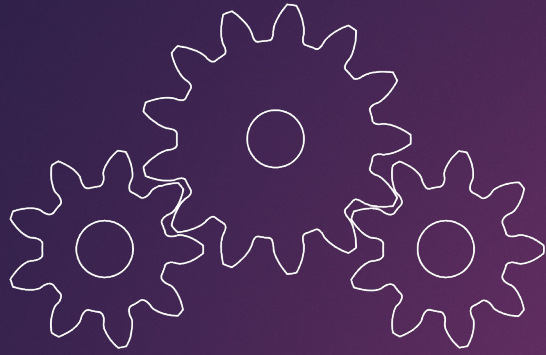


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Print a test chart with standard inks and color gamut.
Measure the samples.



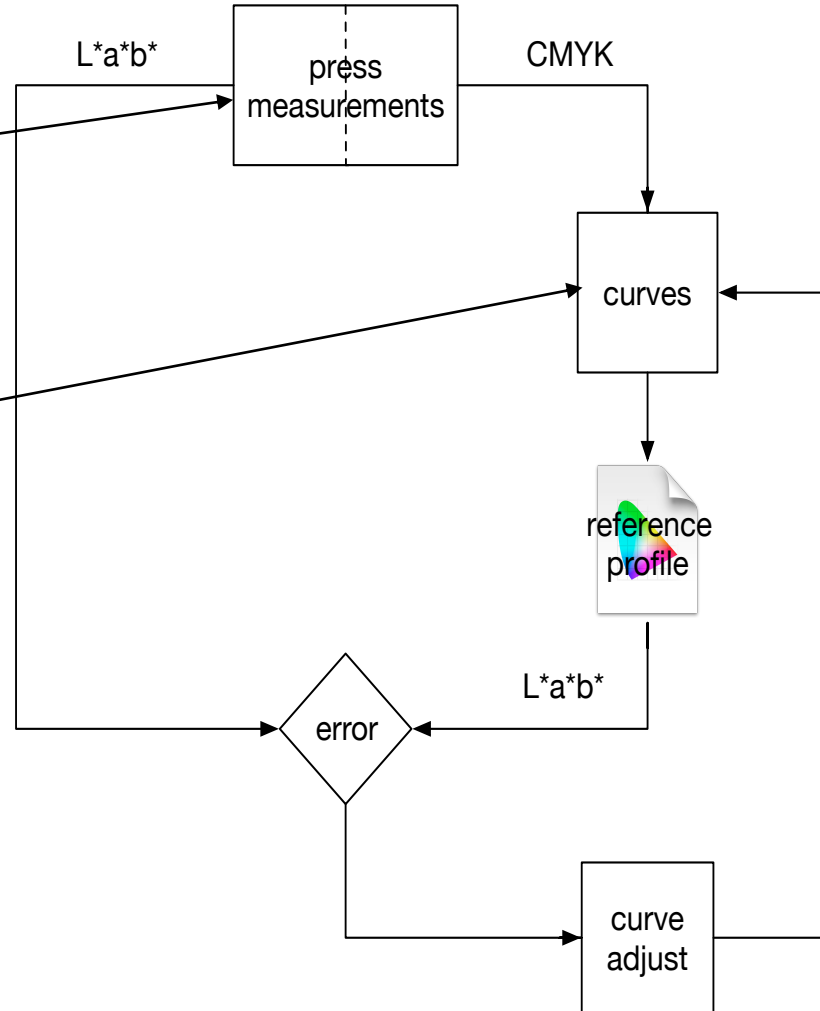


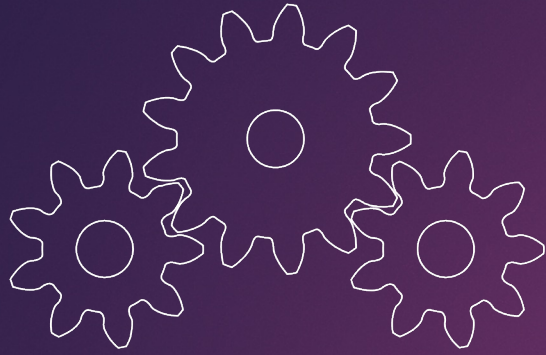
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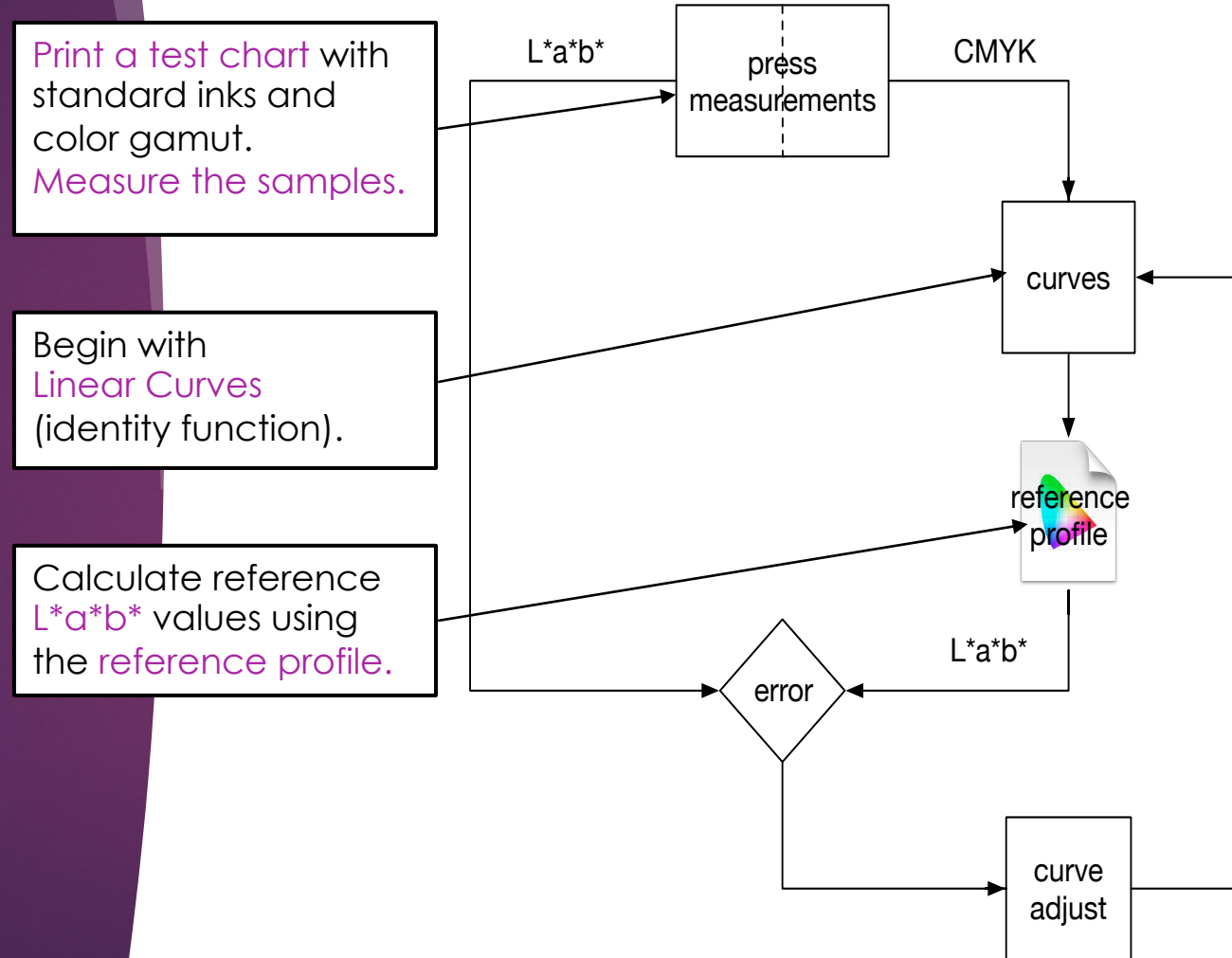
Begin with **Linear Curves** (identity function).

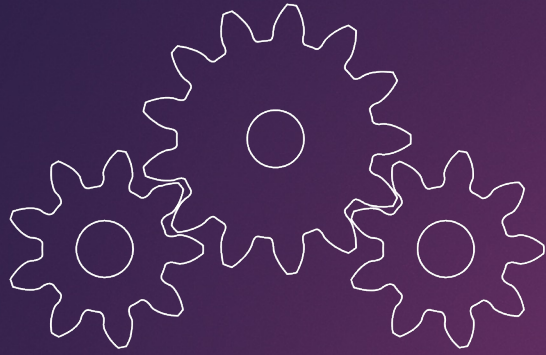




How It Works

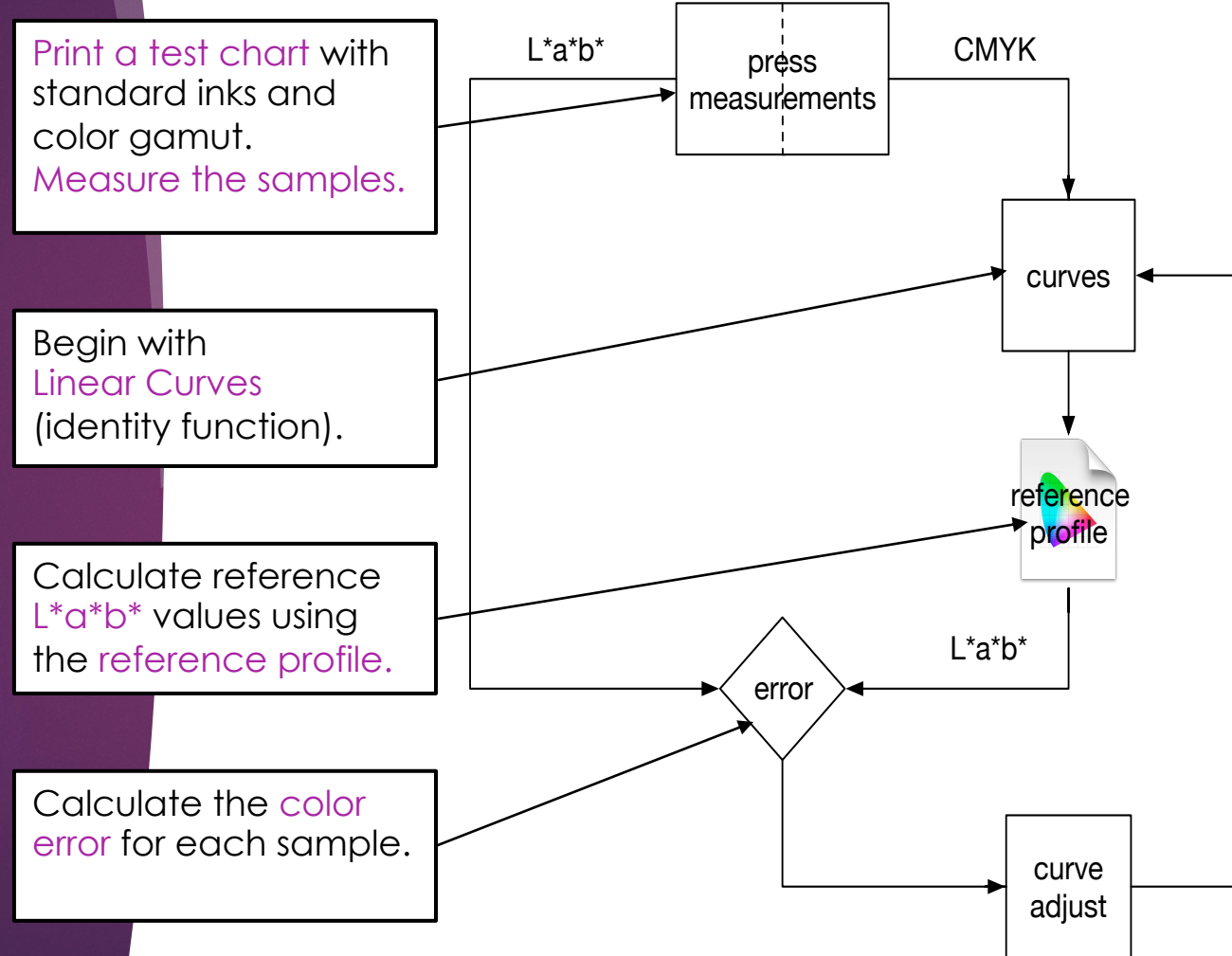
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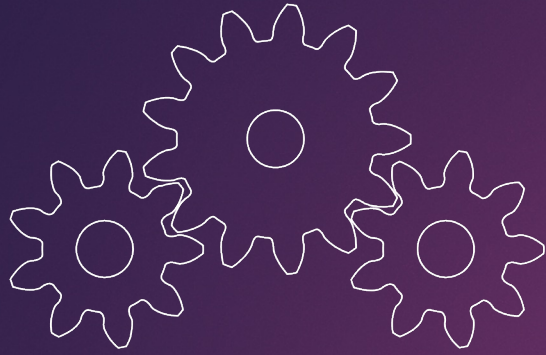




How It Works

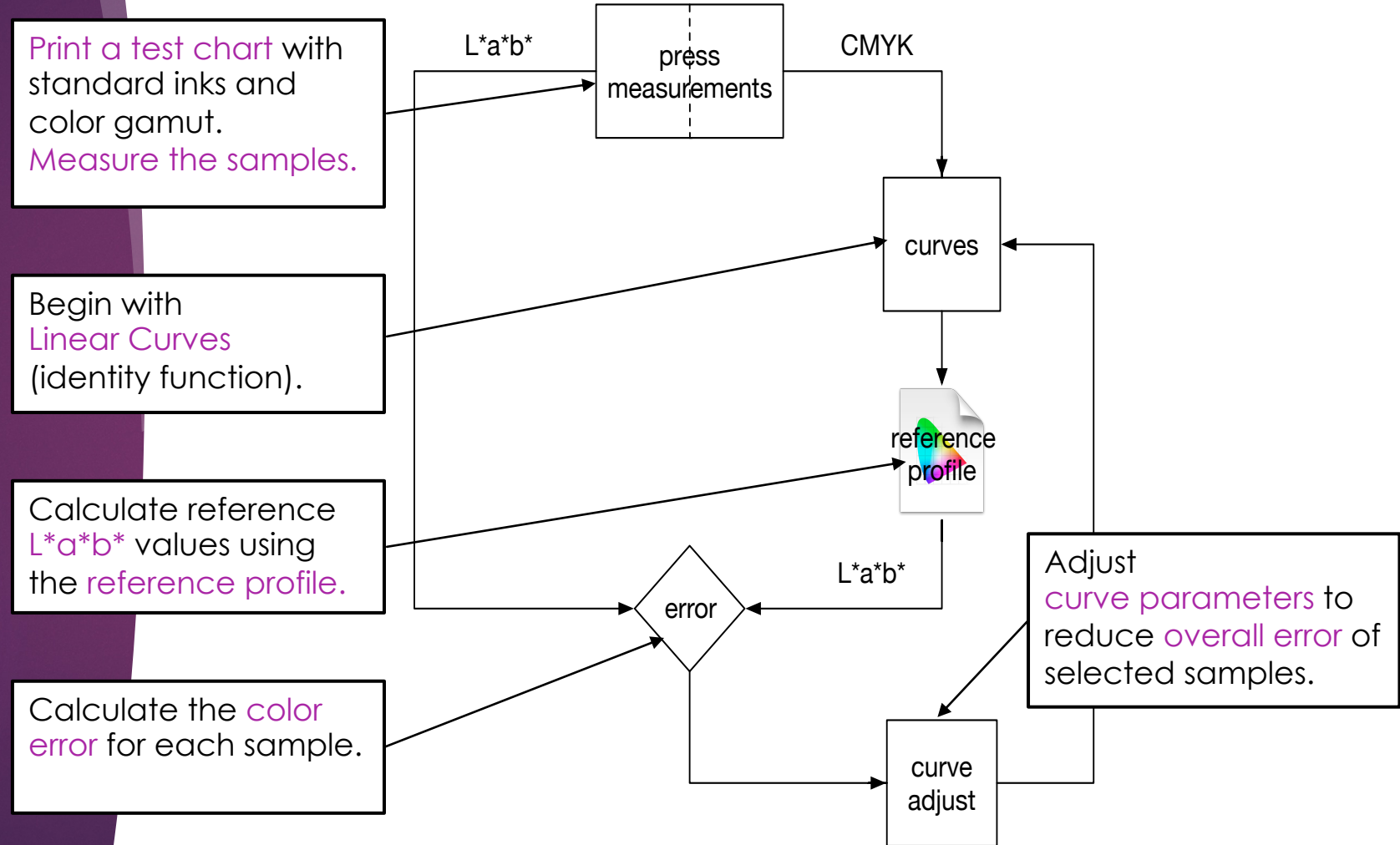
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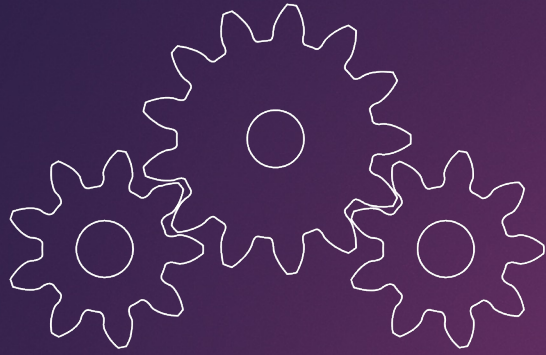




How It Works

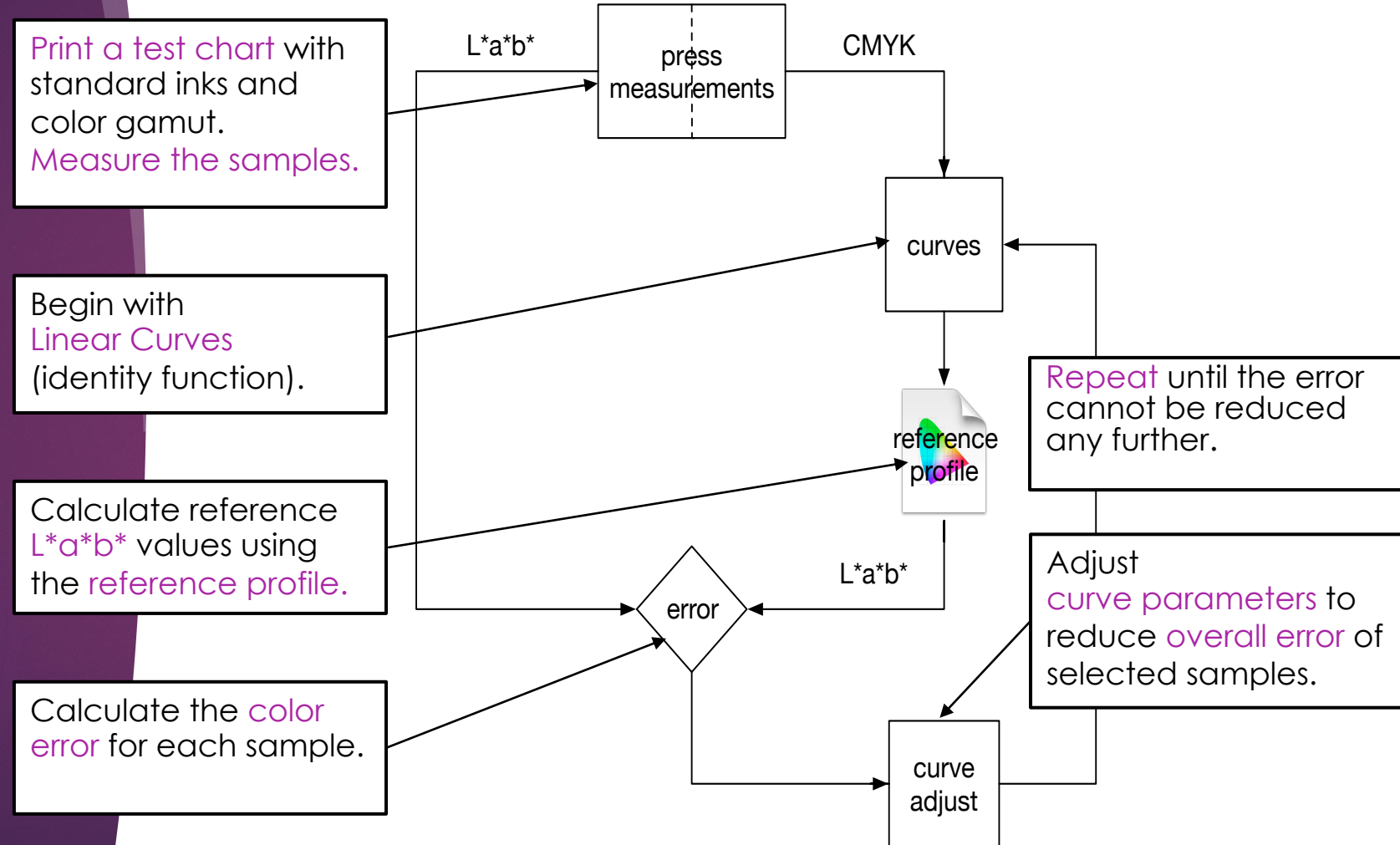
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How It Works

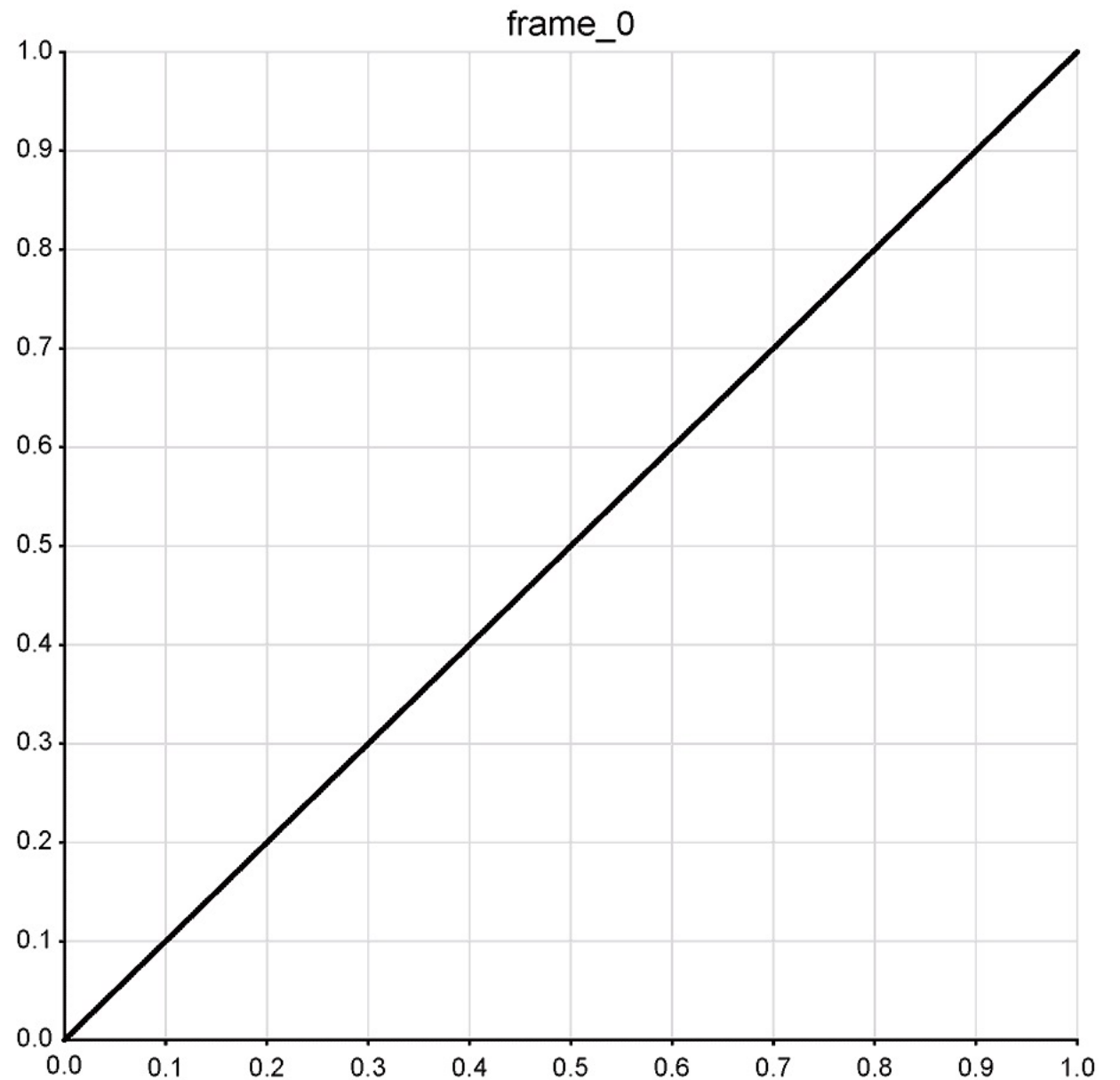
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Visualization

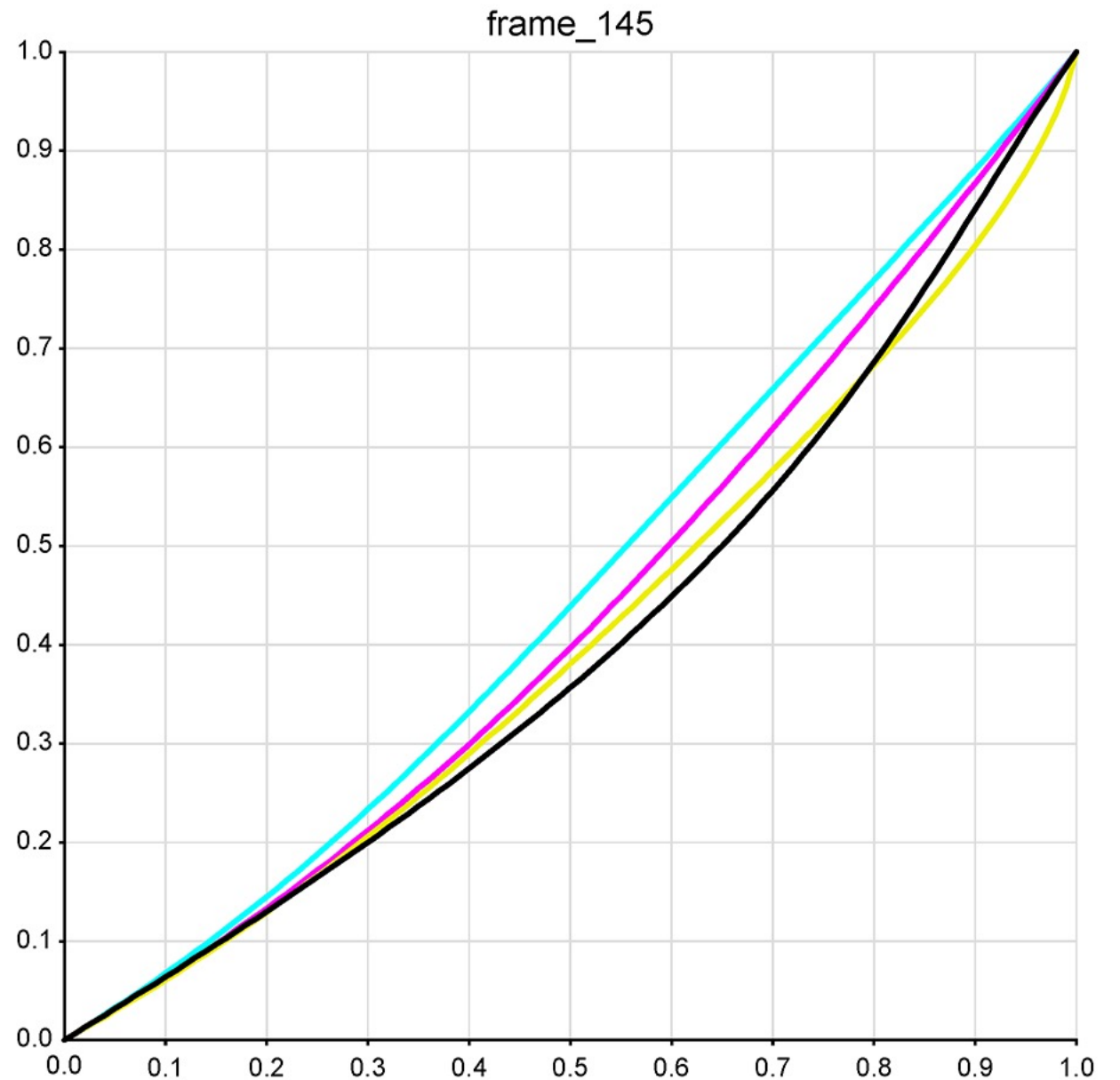
- ▶ **Animation** shows the optimization process at work
- ▶ The initial curves are **linear**
- ▶ In this example, optimization required **145** iterations





Visualization

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- ▶ The initial curves are **linear**
- ▶ In this example, optimization required **145** iterations





Implementation

- ▶ PressCal is a **Perl script**
- ▶ Normal interface is a **text editor** (TextMate)
- ▶ **Settings** are entered as a **free-form text file** (YAML)
- ▶ TextMate **runs** the script, using your settings (⌘R)
- ▶ May also be run from the **command line** (CLI)

```
1 # these are the default settings, as explained in the PressCal User Manual
2
3 # set path to reference profile
4 profile_path: ~/Data/Test/GRACoL2013_CRPC6.icc
5
6 # set path to press measurement file -or- folder
7 press_path: ~/Data/Test/Endurance_silk_105XL.mxf
8
9 # set ink map, an array indicating how each tone curve is derived
10 # options are: 0, 1, 2, ... (optimize), S (SCTV), A-F (TVI), N (G7K), L (linear)
11 # ink_map: [0, 1, 2, 3, S, S]
12
13 # set measurement condition (M0, M1, M2, M3, 0--1 (OBA effect), auto)
14 # condition: auto
15
16 # set sample selection token(s) (see user manual for options)
17 select: rt(10) k nosub
18
19 # set curve output token(s) (see user manual for options)
20 output: text
21
22 # set gamut scale factor (comment out to optimize)
23 # gsf: 1
24
25 # set Bernstein polynomial degree (comment out for auto-select)
26 # degree: 6
```



Settings

- ▶ There are **over 40** settings
- ▶ Settings are fully documented in the **user manual**
- ▶ Only a few settings are normally required
- ▶ Settings are entered as a **free-form text file** (YAML)
- ▶ A collection of **basic settings** templates is provided

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Settings Reference

Reference Profile Path

```
# set path to reference profile
profile_path: ~/Data/Test/GRACol2013_CRP06.icc
```

The **profile_path**: selects the reference ICC profile which defines the desired printing result. See the section on [file/folder paths](#). This would normally be the same profile used to make your proofs. [Standard reference profiles](#) are available from organizations like IDEAlliance and ECI. **This setting is required for optimization - there is no default value.**

Press Measurement Path

```
# set path to press measurement file -or- folder
press_path: ~/Data/Test/Endurance_silk_105XL.mxf
```

The **press_path**: selects the measurements of your printing process. This could be a single file, or a folder containing several data sets to be averaged. See the section on [file/folder paths](#). Measurement file(s) may be in either CGATS (text) or CxF3 (XML) format. Plates, if used, would normally be made without tone curves, i.e. linear plates. **This is a required setting - there is no default value.**

Ink Map

```
# 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)
# ink_map: [0, 1, 2, 3, S, 5]
```

The **ink_map**: setting controls the method used to calculate each tone curve. For each ink channel, its curve may be calculated using optimization, TVI, SCTV, NPDC, or set as linear. By default, press ink channels are mapped to profile device channels, and curves are optimized. If there are more press ink channels than profile device channels, the extra channels are linearized using SCTV. The ink map must contain an entry for each ink channel in the press measurement data set.

Measurement Condition

```
# set measurement condition (M0, M1, M2, M3, 0 - 1 (OBA effect), auto)
condition: auto
```

The **condition**: setting selects the measurement condition of the **press_path**: data. This setting applies only to measurements in CxF3 format (.mxf files). These files may contain M0, M1, and/or M2 data. If the **press_path**: measurements don't include the measurement condition you specified, an error will occur. The default value is **M0**; therefore, you need only activate this setting to select **M1** or **M2** data. This setting may also be the **OBA effect** value (0 to 1), which blends the M1 and M2 data. A setting of **auto** will determine the OBA effect for minimum color error between the reference profile and the press substrate. **This is especially useful for substrates with heavy OBAs.**

Sample Selection Token(s)

```
# set sample selection token(s) (see user manual for options)
select: rt(10) k nosub
```

The **select**: setting selects a subset of the press measurement samples. This setting is a string of [sample selection tokens](#), each of which selects a group of samples having some common property. Some tokens have parameters to control the selection. The groups are combined and duplicates are removed.

In the example above, the **rt(10)** token (round-trip) selects samples that are realistic, based on the reference profile. The **k** token (black) selects samples containing only black. The **nosub** token removes substrate samples, which are unnecessary when the curve highlights are pinned. This combination of tokens will produce good results in most situations. The sample selection setting is an important feature of PressCal, which allows the software to simulate other curve building methods.

The default setting is to use all samples in the data set.

Curve Output Token(s)

```
# set curve output token(s) (see user manual for options)
output: text
```

The **output**: setting selects the output format(s) for the optimized curves. This setting is a string of [curve output tokens](#), which cause the curves to be output in the specified DFE format. The tokens may have optional parameters.

In the example above, the token is **text** (tab-delimited ASCII).

The default setting is for no output.

Gamut Scale Factor (gsf)

```
# set gamut scale factor (comment out to optimize)
# gsf: 1
```

The **gsf**: setting controls the black point compensation applied to the reference profile color values. This setting is used to adapt the reference profile to the gamut of the press. If the **gsf**: setting is 1, there is no black point compensation, and the gamut size is unchanged. A value less than 1 reduces the gamut, and a value greater than 1 increases the gamut (of the reference profile).

Normally, the solid ink densities on a press are adjusted to match the reference. If this is done correctly, a **gsf**: setting of 1 is appropriate. But when the press gamut doesn't match the reference, black point compensation may be used to align them.

By default, the gamut scale factor will be optimized along with the curves. The final optimized **gsf**: value is shown at the end of the output log.

If the **shadow**: [endpoints](#) float (are set to **undef**), the **gsf**: value must be fixed. In this case, the default **gsf**: value is 1.



Settings

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```
1  # settings to make G7 curves for a CMYK process~
2  ~
3  # the ink map, {0, 1, 2, N}, defines how each curve is created~
4  # CMY curves are optimized against the reference profile~
5  # CMY samples with G7 gray balance are selected with the 'g7' token~
6  # K curve is built using the black NPDC as defined in TR 015~
7  # the color error metric is ΔL* and ΔCh, per G7 pass/fail requirements~
8  # select the reference profile for your printing conditions~
9  ~
10 # set path to reference profile~
11 # the CRPC reference profiles use M1 measurement condition~
12 # profile_path: ~/Data/Test/CGATS21_CRPC1.icc~
13 # profile_path: ~/Data/Test/CGATS21_CRPC2.icc~
14 # profile_path: ~/Data/Test/GRACoL2013UNC_CRPC3.icc~
15 # profile_path: ~/Data/Test/CGATS21_CRPC4.icc~
16 # profile_path: ~/Data/Test/SWOP2013C3_CRPC5.icc~
17 profile_path: ~/Data/Test/GRACoL2013_CRPC6.icc~
18 # profile_path: ~/Data/Test/CGATS21_CRPC7.icc~
19 # profile_path: ~/Data/Test/SWOP2013C5.icc~
20 ~
21 # these reference profiles use M0 measurement condition~
22 # profile_path: ~/Data/Test/GRACoL2006_Coated1v2.icc~
23 # profile_path: ~/Data/Test/SWOP2006_Coated3v2.icc~
24 # profile_path: ~/Data/Test/SWOP2006_Coated5v2.icc~
25 ~
26 # set path to press measurement file -or- folder~
27 # press_path: ~/Data/Test/CGATS21-2-CRPC6.txt~
28 press_path: ~/Data/Test/P2P51_test_data.mxf~
29 ~
30 # set ink map, an array indicating how each tone curve is derived~
31 # options are: 0, 1, 2, ... (optimize), S (SCTV), A -F (TVI), N (G7K), L...
32   (linear)~
33 ink_map: [0, 1, 2, N]~
34 ~
35 # set measurement condition (M0, M1, M2, M3, 0 -1 (OBA effect), auto)~
36 condition: M1~
37 ~
38 # set sample selection token(s) (see user manual for options)~
39 select: g7 nosub sort(1)~
40 # select: iso nosub sort(1) # use isometric samples when chart has no G7...
41   samples, e.g. IT8.7/4~
42 ~
43 # set curve output token(s) (see user manual for options)~
44 output: text~
45 ~
46 # set renderina (luminance, cast)~
```



Reference Profile

- ▶ Color reference is an **ICC profile**
- ▶ Defines **paper** and **solid ink** colors
- ▶ Defines **tonality** and **gray balance**
- ▶ Defines **black generation** (for sample selection)
- ▶ **Any number of channels**, RGB, CMYK, or n-color

#	Tag	Data	Size	Description
-	z	Header	128	
1	'desc'	'mluc'	68	Multi-localized description strings
2	'cprt'	'mluc'	72	Multi-localized strings
3	'wtpt'	'XYZ'	20	Media white-point tristimulus
4	'bkpt'	'XYZ'	20	Media black-point tristimulus
5	'A2B0'	'mAB'	534,044	Intent-0, device to PCS conversion table
6	'A2B1'	'mAB'	534,044	Intent-1, device to PCS conversion table
7	'A2B2'	'mAB'	534,044	Intent-2, device to PCS conversion table
8	'B2A0'	'mBA'	328,600	Intent-0, PCS to device conversion table
9	'B2A1'	'mBA'	320,412	Intent-1, PCS to device conversion table
10	'B2A2'	'mBA'	320,412	Intent-2, PCS to device conversion table
11	'gamt'	'mBA'	80,180	PCS to gamut check table
12	'chad'	'sf32'	44	Chromatic adaptation matrix
13	'CxF'	'ZXML'	75,334	
14	'gbd0'	'gbd'	183,532	
15	'gbd1'	'gbd'	183,532	
16	'gbd2'	'gbd'	183,532	
17	'gbd3'	'gbd'	183,532	
18	'meta'	'dict'	72	
19	'view'	'view'	36	



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SAMPLE SELECTION ROUND-TRIP TABLE

Gray Samples Round-Trip Table (CMYK → GRACoL2013 L*a*b* → CMYK)

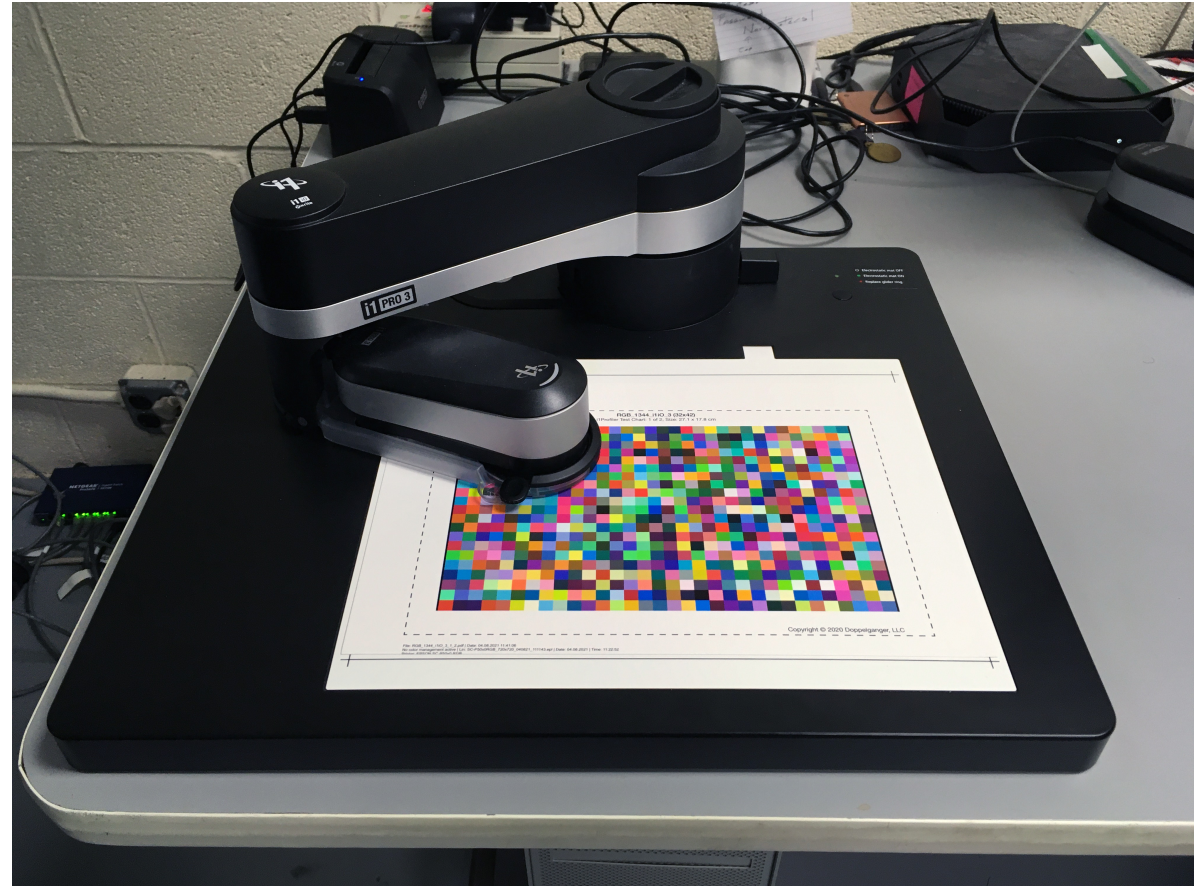
C	M	Y	K	L*	a*	b*	C	M	Y	K
0	0	0	0	95.0	1.0	-4.0	0.0	0.0	0.0	0.0
2	1.5	1.5	0	93.3	1.2	-3.8	2.0	1.5	1.5	0.0
4	3	3	0	91.7	1.3	-3.7	4.0	2.9	3.0	0.0
6	4.5	4.5	0	90.1	1.2	-3.6	6.0	4.4	4.5	0.0
8	6	6	0	88.5	1.1	-3.5	8.0	5.9	6.0	0.0
10	7.5	7.5	0	86.9	1.1	-3.5	10.0	7.4	7.5	0.0
15	11.2	11.2	0	83.0	0.9	-3.2	15.0	11.2	11.2	0.0
20	15	15	0	79.1	0.8	-3.1	20.0	15.0	15.0	0.0
25	18.9	18.9	0	75.4	0.8	-2.9	24.8	18.7	18.7	0.3
30	22.8	22.8	0	71.8	0.7	-2.7	29.0	22.0	22.1	1.3
35	26.9	26.9	0	68.2	0.6	-2.6	32.7	25.1	25.2	2.9
40	31.1	31.1	0	64.6	0.6	-2.3	36.2	28.0	28.1	5.3
45	35.5	35.5	0	61.0	0.5	-2.2	39.4	30.8	30.9	8.0
50	40	40	0	57.5	0.4	-2.1	42.5	33.5	33.7	11.2
55	44.7	44.7	0	53.9	0.3	-1.9	45.6	36.3	36.5	14.7
60	49.7	49.7	0	50.3	0.2	-1.8	48.6	39.2	39.5	18.5
65	54.9	54.9	0	46.6	0.2	-1.5	51.7	42.4	42.8	22.7
70	60.4	60.4	0	43.0	0.3	-1.1	54.8	45.6	46.2	27.1
75	66.1	66.1	0	39.3	0.3	-0.7	57.7	48.8	49.6	32.3
80	72.2	72.2	0	35.7	0.3	-0.3	60.4	51.7	52.8	38.5
85	78.6	78.6	0	32.2	0.3	0.0	62.7	54.6	55.7	45.3
90	85.3	85.3	0	28.8	0.4	0.2	64.8	57.3	58.4	52.4
95	92.5	92.5	0	25.6	0.0	0.0	67.5	59.4	60.5	59.5
98	96.9	96.9	0	23.9	0.0	-0.0	68.9	60.8	61.6	63.5
100	100	100	0	23.0	0.0	-0.0	69.5	61.5	62.3	65.7
				20.0	0.0	0.0	71.6	63.9	64.1	73.0
				17.0	0.0	0.0	73.3	65.9	65.0	80.6
				14.0	0.0	0.0	75.3	68.2	65.4	88.4
				11.0	0.0	0.0	78.2	70.8	64.5	96.1

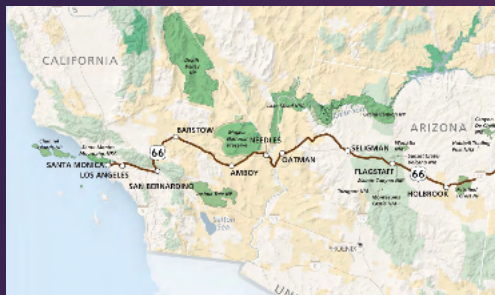
(Selecting Realistic Samples is continued on the next page)



Press Measurements

- ▶ Characterize test printing
- ▶ Commonly used formats (**ASCII** and **CxF3**) supported
- ▶ **Spectral** and **L*a*b*** measurements supported
- ▶ Full **CIE 015:2018 colorimetry** supported
- ▶ Measurement condition (**M0**, **M1**, **M2**, **M3**) supported

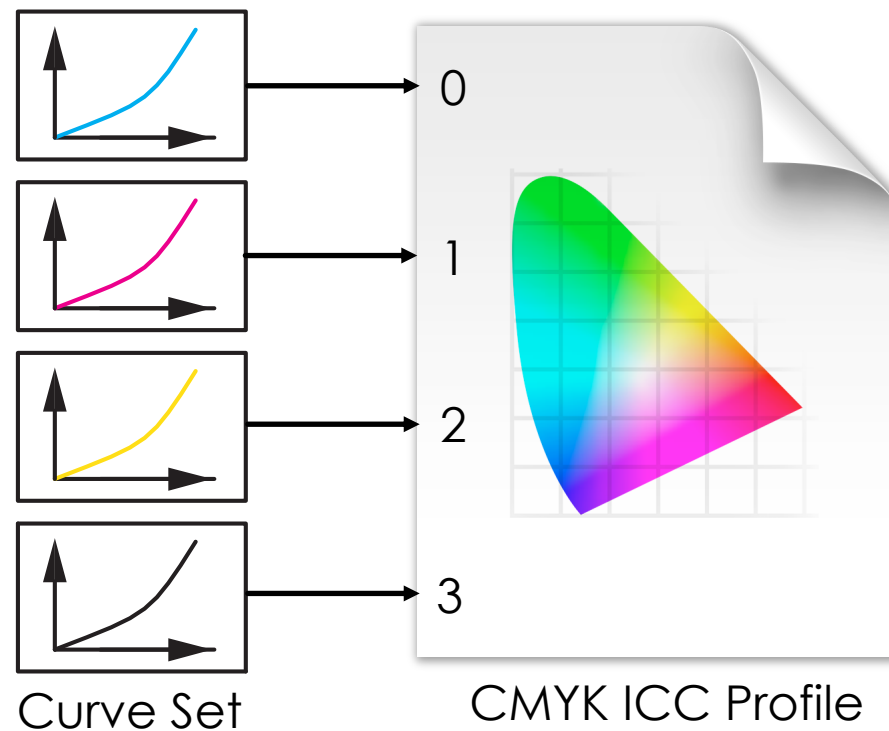




Ink Map

- ▶ Selects the method used to compute each curve
- ▶ Curves correspond to the **press measurement** ink channels
- ▶ Connects the **curves** to the **reference profile** for optimization
- ▶ Alternately, selects the **TVI, G7K, or SCTV** computation methods

ink_map: [0, 1, 2, 3]

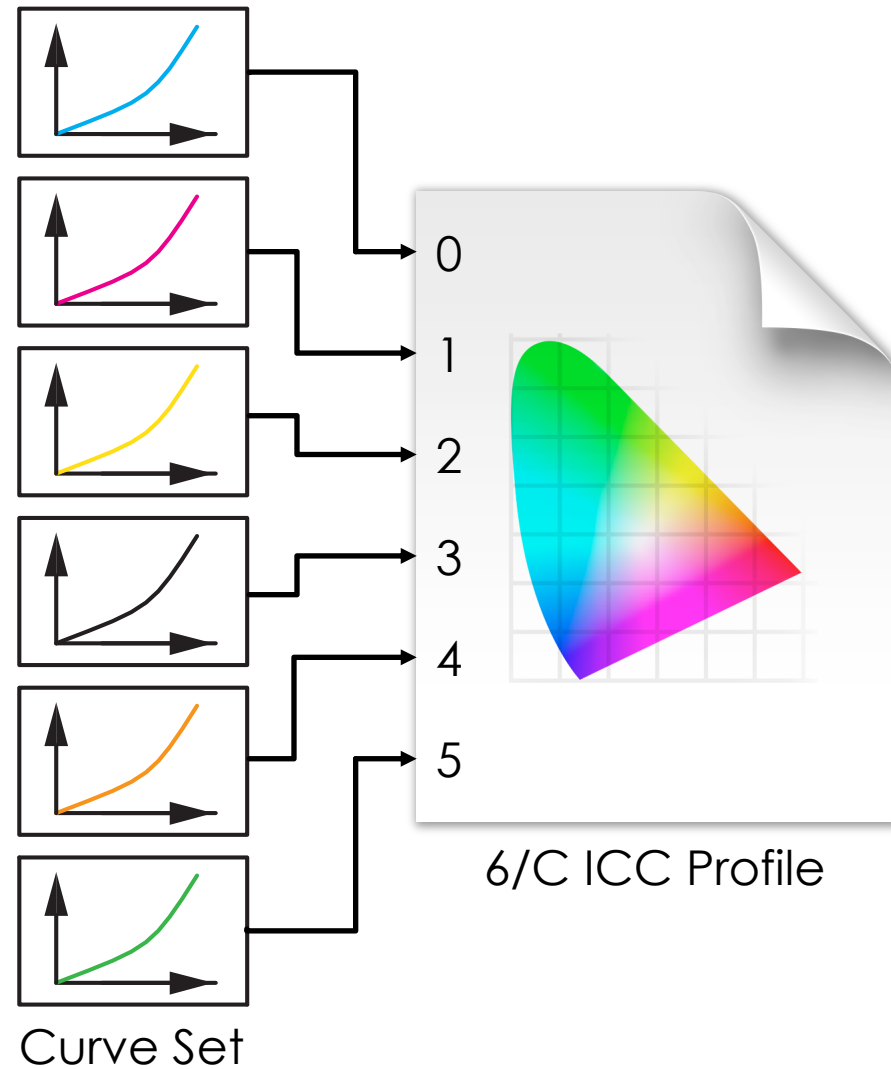




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ink_map: [0, 1, 2, 3, 4, 5]

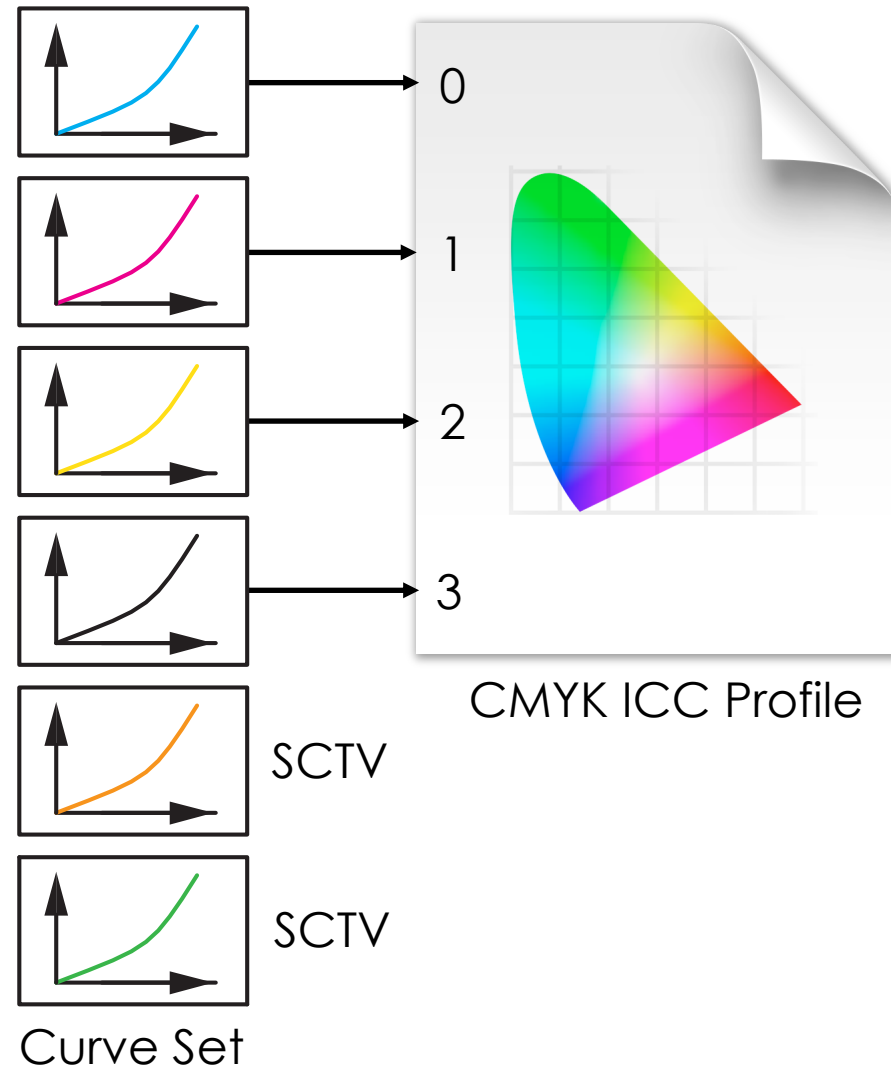




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- ▶ Alternately, selects the **TVI, G7K, or SCTV** computation methods

ink_map: [0, 1, 2, 3, S, S]

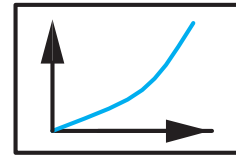




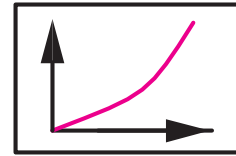
Ink Map

- ▶ Selects the method used to compute each curve
- ▶ Curves correspond to the **press measurement** ink channels
- ▶ Connects the **curves** to the **reference profile** for optimization
- ▶ Alternately, selects the **TVI, G7K, or SCTV** computation methods

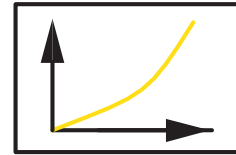
ink_map: [A, A, A, B]



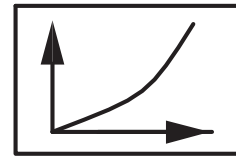
TVI Curve A



TVI Curve A



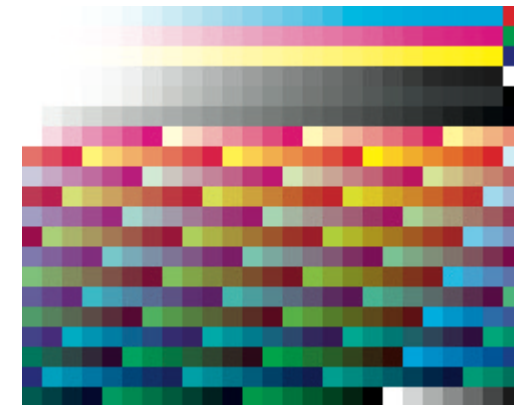
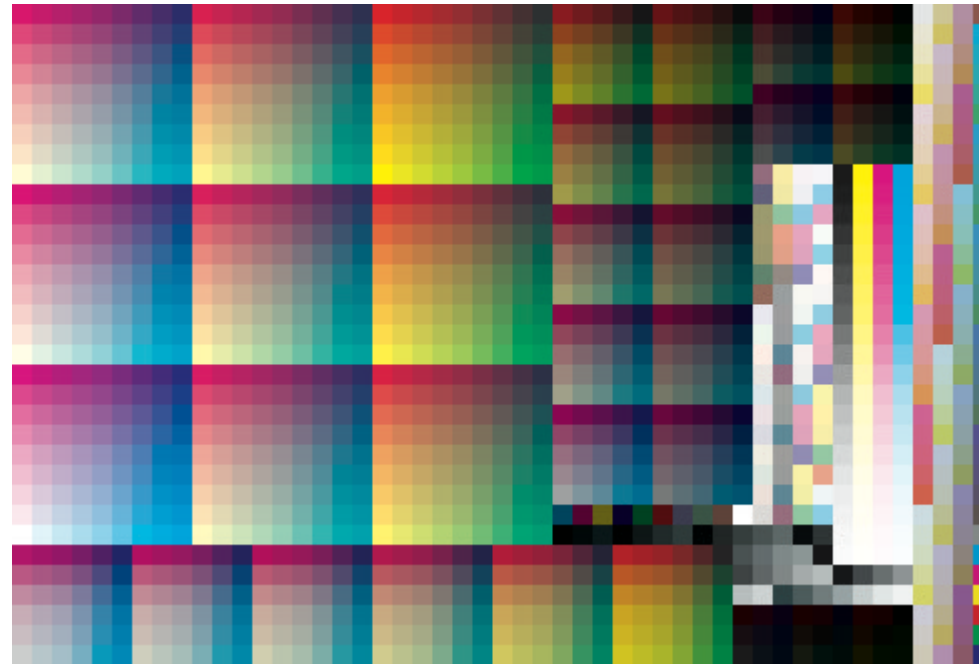
TVI Curve A



TVI Curve B

Test Charts

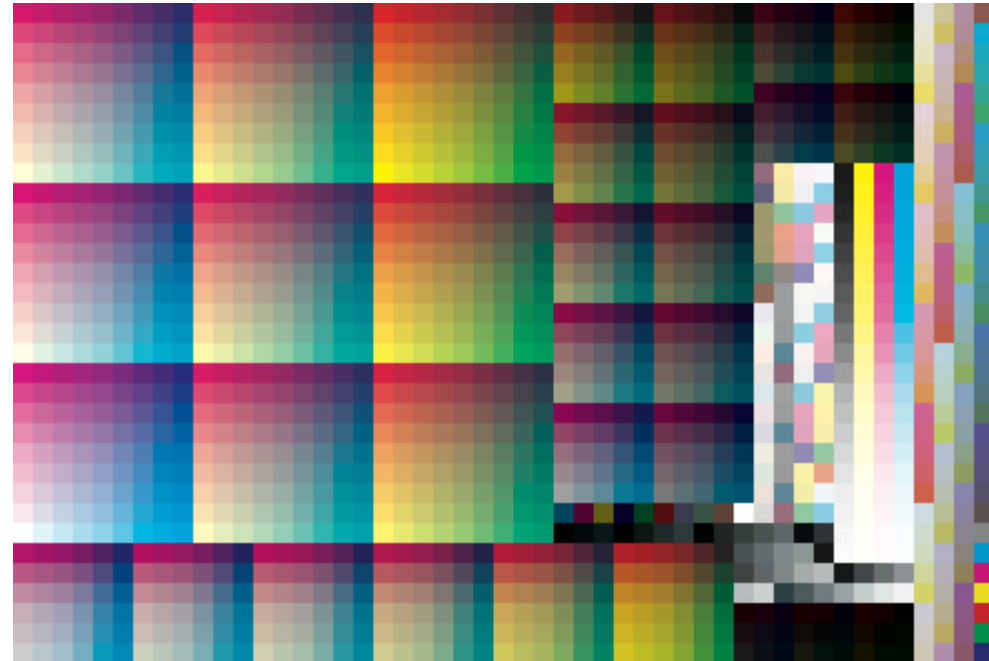
- ▶ Any test chart may be used
- ▶ **Degree** setting controls curve **complexity**
- ▶ Degree is **limited** by the samples used
- ▶ Degree is determined automatically by default, but may be set manually
- ▶ **Realistic** test charts are provided



Sample Selection

- ▶ Optimization uses all chart samples, by default
- ▶ Samples are selected using **tokens**
- ▶ Selection is based on **device values, color** or **location**
- ▶ **Multiple** tokens may be used
- ▶ Outliers may be identified and removed

select: all



Sample Selection

- ▶ Optimization uses all chart samples, by default
- ▶ Samples are selected using **tokens**
- ▶ Selection is based on **device values, color** or **location**
- ▶ **Multiple** tokens may be used
- ▶ Outliers may be identified and removed

select: ramps



Sample Selection

- ▶ Optimization uses all chart samples, by default
- ▶ Samples are selected using **tokens**
- ▶ Selection is based on **device values, color** or **location**
- ▶ **Multiple** tokens may be used
- ▶ Outliers may be identified and removed

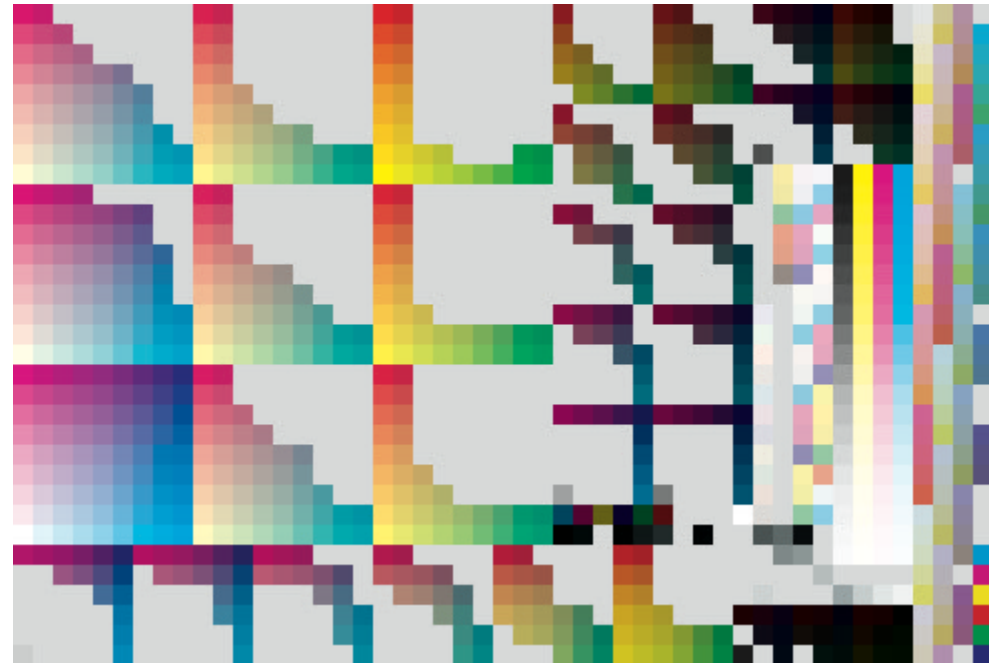
select: gray(5) k



Sample Selection

- ▶ Optimization uses all chart samples, by default
- ▶ Samples are selected using **tokens**
- ▶ Selection is based on **device values, color** or **location**
- ▶ **Multiple** tokens may be used
- ▶ Outliers may be identified and removed

select: rt(10) k



Sample Selection

- ▶ Optimization uses all chart samples, by default
- ▶ Samples are selected using **tokens**
- ▶ Selection is based on **device values, color** or **location**
- ▶ **Multiple** tokens may be used
- ▶ Outliers may be identified and removed

SAMPLE SELECTION TOKENS

Sample Selection Tokens

token	selection
all	all samples
c	cyan ramp
m	magenta ramp
y	yellow ramp
k	black ramp
cmyk	cyan, magenta, yellow, black ramps
ramps	all ink ramps, including spot colors
ramps(1)	ramp(s) by ink channel, ink 1 is normally cyan
ramps(1, 2, 3)	ink ramps 1, 2, 3, normally cyan, magenta, yellow
ramps(1 .. 3)	same, using the Perl range operator
rt(10)	round-trip black change $\leq 10\%$
gray(5)	near-neutral cmy samples, C^* (chroma) ≤ 5
gray(5, 50)	near-neutral cmy samples, C^* (chroma) ≤ 5 and $L^* \geq 50$
iso	isometric samples ($c = m = y$, all others 0%)
iso(50)	isometric samples ($c = m = y$, all others 0%), ink values $\leq 50\%$
g7	gray cmy samples per TR015
g7(50)	gray cmy samples per TR015, cyan ink $\leq 50\%$
cmy	cmy ramps
cmy(50)	cmy ramps, ink values $\geq 50\%$
c+m+y(200)	cmy total ink $\leq 200\%$
tac(280)	total ink less $\leq 280\%$, including spot colors
nr(33)	chart has 33 rows (number of rows, if missing from data set)
rows(1 .. 5, 7, 9)	rows 1, 2, 3, 4, 5, 7, 9
cols(1 .. 5, 7, 9)	columns 1, 2, 3, 4, 5, 7, 9
rect(1, 4, 3, 7)	rectangular chart area, rows 1 – 4, columns 3 – 7
plus(1, 2, 3)	add samples 1 – 3
minus(4, 5, 6)	remove samples 4 – 6
nosub	remove substrate samples (all ink values 0%)
nobin	remove binary samples (all ink values 0% or 100%)
sort(4, 3, 2, 1)	sort by black, yellow, magenta, cyan
sort(error)	sort by optimization error value

Program Log

- ▶ Solid ink color errors (gamut)
- ▶ Sample set errors (before optimization)
- ▶ Sample set errors (after optimization)
- ▶ Final curve parameters
- ▶ Curve output

```

Running "PressCal_Default.yml"...
PressCal version 16U modified 2019-12-17
reference profile: ~/Data/Test/GRACoL2013_CRPC6.icc
press: ~/Data/Test/Endurance_silk_105XL.mxf
file contains M0 M1 M2 measurement condition(s)
measurement condition: M0
chart type: PressCalZ, nominal samples: 625, colorspace: CMYK, created: 2017-07-31, 03:57 PM GMT
solid ink cluster size: 2.1
solid ink errors:

```

	abs L*a*b* values	→	ref L*a*b* values	press L*a*b* values	ΔEab	ΔE00
paper	95.0 1.0 -4.0		94.6 1.6 -4.5	94.6 1.5 -4.4	0.02	0.02
cyan	56.0 -37.0 -50.0		55.8 -36.5 -50.3	55.6 -32.7 -50.2	3.80	1.45
magenta	48.0 75.0 -4.0		47.8 75.2 -4.3	49.8 73.5 -3.7	2.73	2.09
yellow	89.0 -4.0 93.0		88.6 -3.4 92.5	89.4 -5.9 93.7	2.86	1.39
red	47.0 68.0 48.0		46.8 68.2 47.7	48.4 67.5 45.8	2.55	1.72
green	50.0 -66.0 26.0		49.8 -65.5 25.7	50.1 -65.0 29.1	3.48	1.45
blue	25.0 20.0 -46.0		24.9 20.2 -46.1	25.0 21.0 -45.4	1.08	0.86
iso	23.0 0.0 -0.0		22.9 0.2 -0.2	22.9 -0.4 -2.0	1.91	1.94
black	16.0 0.0 -0.0		15.9 0.2 -0.1	17.8 0.8 1.7	2.79	2.41
cmyk	9.0 0.2 0.4		9.0 0.3 0.3	9.9 0.7 -0.2	1.13	0.92

```

degree: 4, sample selection: 'rt(10) k nosub', samples: 372

```

sample	device values	ref L*a*b* values	press L*a*b* values	ΔE00
1	0.000 1.000 1.000 0.000	46.8 68.2 47.7	48.4 67.5 45.8	1.72
2	1.000 0.000 1.000 0.000	49.8 -65.5 25.7	50.1 -65.0 29.1	1.45
3	1.000 1.000 0.000 0.000	24.9 20.2 -46.1	25.0 21.0 -45.4	0.86
6	0.000 1.000 1.000 0.000	46.8 68.2 47.7	48.8 67.3 45.7	2.09
11	0.000 1.000 1.000 0.200	40.4 56.7 39.2	37.8 51.2 33.5	3.15
16	0.000 1.000 1.000 0.400	34.0 45.9 31.5	29.0 38.9 23.7	5.28
22	1.000 0.400 0.000 0.600	25.5 -8.7 -26.9	20.0 -3.9 -20.9	6.22
24	0.000 1.000 1.000 1.000	11.0 8.3 7.2	13.1 8.6 4.1	2.87
25	0.898 0.851 0.851 1.000	9.4 0.0 0.5	10.5 0.7 -0.0	1.40
26	1.000 0.000 0.000 0.000	55.8 -36.5 -50.3	55.6 -32.7 -50.2	1.45
27	0.000 1.000 0.000 0.000	47.8 75.2 -4.3	49.8 73.5 -3.7	2.09
28	0.000 0.000 1.000 0.000	88.6 -3.4 92.5	89.4 -5.9 93.7	1.39
29	0.000 0.000 0.000 1.000	15.9 0.2 -0.1	17.8 0.8 1.7	2.41
31	0.000 0.700 1.000 0.000	57.7 47.2 57.2	56.5 51.5 54.5	3.10
36	0.000 0.700 1.000 0.200	49.3 39.3 47.9	43.9 38.2 41.0	5.98

Program Log

- ▶ Solid ink color errors (gamut)
- ▶ Sample set errors (before optimization)
- ▶ Sample set errors (after optimization)
- ▶ Final curve parameters
- ▶ Curve output

```

Running "PressCal_Default.yml"...
578 0.000 0.000 0.004 0.000 94.6 1.5 -4.1 94.6 1.5 -4.2 0.12
579 0.000 0.000 0.000 0.004 94.4 1.5 -4.4 94.4 1.5 -4.5 0.03
580 0.004 0.003 0.003 0.000 94.3 1.6 -4.4 94.4 1.6 -4.4 0.06
581 0.000 0.200 0.000 0.000 84.7 14.7 -6.4 80.3 22.5 -8.6 5.68
582 0.200 0.200 0.000 0.000 77.7 7.2 -15.3 71.2 11.0 -20.0 5.92
583 0.400 0.200 0.000 0.000 70.6 -0.7 -24.1 64.0 2.6 -28.8 5.67
584 0.700 0.200 0.000 0.000 59.6 -14.0 -37.5 54.5 -8.8 -40.5 5.62
585 1.000 0.200 0.000 0.000 50.0 -26.8 -48.7 47.2 -18.5 -49.4 4.75
590 1.000 0.200 0.000 0.200 42.9 -22.9 -41.8 37.4 -15.8 -37.9 6.03
595 1.000 0.200 0.000 0.400 36.1 -19.4 -34.8 29.2 -12.4 -28.6 6.96
597 0.400 0.700 0.700 0.600 26.9 12.5 8.9 20.7 11.2 7.3 4.70
598 1.000 1.000 0.000 0.600 17.1 11.0 -24.0 14.2 8.0 -19.6 3.11
600 0.400 0.400 0.000 1.000 12.3 2.8 -3.3 13.8 2.0 -2.0 1.74
607 0.200 0.000 0.000 0.000 86.7 -5.1 -14.0 83.9 -8.7 -17.6 3.99
608 0.400 0.000 0.000 0.000 78.8 -12.2 -23.5 75.6 -15.8 -27.3 3.34
609 0.700 0.000 0.000 0.000 66.5 -24.7 -37.9 64.7 -25.2 -40.0 1.67
610 1.000 0.000 0.000 0.000 55.8 -36.5 -50.3 56.0 -32.6 -49.7 1.46
611 0.000 0.000 0.000 0.200 80.8 1.3 -3.9 72.4 1.0 -2.9 6.09
615 1.000 0.000 0.000 0.200 48.0 -32.1 -42.7 43.9 -27.1 -36.7 4.62
616 0.000 0.000 0.000 0.400 67.1 1.0 -3.3 54.9 0.7 -1.4 10.76
620 1.000 0.000 0.000 0.400 40.3 -27.4 -35.4 34.2 -21.5 -27.3 6.28
621 0.000 0.000 0.000 0.600 52.6 0.8 -2.5 40.1 0.7 -0.1 12.23
622 0.400 0.400 0.700 0.600 33.3 0.1 13.1 25.5 1.9 12.1 6.49
623 1.000 0.700 0.000 0.600 20.8 1.8 -25.5 16.6 3.1 -20.6 4.61
624 0.400 1.000 0.000 0.800 16.5 21.1 -6.4 15.0 13.7 -6.3 4.99

initial average error: 4.70

optimizing curves for minimum ΔE00...
L-M optimization completed at 146 iterations
error values with optimized curves are below...

sample device values ref L*a*b* values press L*a*b* values ΔE00
1 0.000 1.000 1.000 0.000 47.1 67.6 46.3 48.4 67.5 45.8 1.32
2 1.000 0.000 1.000 0.000 50.0 -64.6 25.3 50.1 -65.0 29.1 1.50
3 1.000 1.000 0.000 0.000 25.6 19.5 -45.3 25.0 21.0 -45.4 0.98
6 0.000 1.000 1.000 0.000 47.1 67.6 46.3 48.8 67.3 45.7 1.73
11 0.000 1.000 1.000 0.200 37.7 50.7 33.9 37.8 51.2 33.5 0.44
16 0.000 1.000 1.000 0.400 29.8 37.1 24.6 29.0 38.9 23.7 1.36
22 1.000 0.400 0.000 0.600 20.4 -3.7 -20.1 20.0 -3.9 -20.9 0.52
24 0.000 1.000 1.000 1.000 12.7 7.5 6.0 13.1 8.6 4.1 2.05
25 0.898 0.851 0.851 1.000 11.1 0.1 0.3 10.5 0.7 -0.0 1.16
26 1.000 0.000 0.000 0.000 55.9 -36.2 -50.0 55.6 -32.7 -50.2 1.37
27 0.000 1.000 0.000 0.000 48.0 74.6 -4.3 49.8 73.5 -3.7 1.82
28 0.000 0.000 1.000 0.000 88.7 -3.4 91.7 89.4 -5.9 93.7 1.41
29 0.000 0.000 0.000 1.000 17.1 0.2 -0.3 17.8 0.8 1.7 2.19
31 0.000 0.700 1.000 0.000 55.0 52.4 53.3 56.5 51.5 54.5 1.63
36 0.000 0.700 1.000 0.200 43.5 39.1 40.0 43.9 38.2 41.0 0.95
41 0.000 0.700 1.000 0.400 34.1 28.4 29.1 33.7 29.2 29.7 0.47
46 0.400 1.000 0.400 0.600 19.3 16.8 0.6 18.2 18.7 -1.1 1.85
47 1.000 0.000 0.000 0.600 26.0 -16.8 -22.3 25.8 -15.6 -19.4 1.51
49 0.000 0.400 1.000 1.000 14.8 2.0 7.9 15.2 3.8 6.5 2.82
50 0.844 0.778 0.778 1.000 11.3 -0.0 0.5 10.7 0.6 -0.0 1.14
51 0.996 0.000 0.000 0.000 56.0 -36.1 -49.9 55.8 -32.6 -50.0 1.38
52 0.000 0.996 0.000 0.000 48.1 74.5 -4.3 49.9 73.3 -3.7 1.83
53 0.000 0.000 0.996 0.000 88.7 -3.4 91.6 89.4 -6.0 93.3 1.42
54 0.000 0.000 0.000 0.996 17.3 0.2 -0.3 18.2 0.8 1.7 2.21
    
```

Program Log

- ▶ Solid ink color errors (gamut)
- ▶ Sample set errors (before optimization)
- ▶ Sample set errors (after optimization)
- ▶ Final curve parameters
- ▶ Curve output

```

Running "PressCal_Default.yml"...
552 0.000 0.008 0.000 0.000 94.0 2.4 -4.6 94.2 2.2 -4.7 0.36
553 0.000 0.000 0.008 0.000 94.5 1.4 -3.3 94.6 1.4 -3.7 0.39
554 0.000 0.000 0.000 0.008 93.7 1.5 -4.4 94.0 1.5 -4.4 0.14
555 0.008 0.006 0.006 0.000 93.6 1.7 -4.3 93.8 1.6 -4.3 0.20
556 0.000 0.400 0.000 0.000 69.6 36.6 -7.8 70.0 38.4 -9.5 1.08
557 0.200 0.400 0.000 0.000 62.0 25.0 -18.6 61.9 26.1 -20.5 0.98
558 0.400 0.400 0.000 0.000 56.1 15.6 -26.9 55.6 16.7 -28.9 1.07
559 0.700 0.400 0.000 0.000 47.6 1.7 -38.2 47.0 3.9 -40.1 1.16
560 1.000 0.400 0.000 0.000 40.9 -9.7 -46.7 40.6 -7.2 -48.5 1.32
564 0.700 0.400 0.000 0.200 37.8 1.8 -30.2 37.5 2.6 -30.7 0.55
565 1.000 0.400 0.000 0.200 32.7 -7.1 -36.7 32.4 -6.9 -38.0 0.45
570 1.000 0.400 0.000 0.400 26.1 -5.3 -27.9 25.5 -5.4 -29.0 0.65
573 1.000 0.000 0.400 0.600 25.6 -24.0 -5.3 25.1 -23.5 -3.9 1.04
575 0.400 1.000 0.000 1.000 11.1 9.5 -1.3 11.9 5.8 -1.6 3.73
576 0.004 0.000 0.000 0.000 94.4 1.3 -4.8 94.4 1.4 -4.4 0.36
577 0.000 0.004 0.000 0.000 94.3 2.0 -4.5 94.5 1.7 -4.5 0.35
578 0.000 0.000 0.004 0.000 94.6 1.5 -3.9 94.6 1.5 -4.2 0.30
579 0.000 0.000 0.000 0.004 94.2 1.5 -4.4 94.4 1.5 -4.5 0.12
580 0.004 0.003 0.003 0.000 94.1 1.6 -4.4 94.4 1.6 -4.4 0.20
581 0.000 0.200 0.000 0.000 80.5 20.5 -7.0 80.3 22.5 -8.6 1.33
582 0.200 0.200 0.000 0.000 71.8 10.2 -18.3 71.2 11.0 -20.0 1.11
583 0.400 0.200 0.000 0.000 65.0 1.7 -27.0 64.0 2.6 -28.8 1.00
584 0.700 0.200 0.000 0.000 55.3 -11.1 -38.9 54.5 -8.8 -40.5 1.57
585 1.000 0.200 0.000 0.000 47.7 -22.0 -47.9 47.2 -18.5 -49.4 1.86
590 1.000 0.200 0.000 0.200 37.9 -17.0 -37.7 37.4 -15.8 -37.9 0.77
595 1.000 0.200 0.000 0.400 29.8 -13.1 -28.9 29.2 -12.4 -28.6 0.68
597 0.400 0.700 0.700 0.600 21.5 9.5 7.5 20.7 11.2 7.3 1.73
598 1.000 1.000 0.000 0.600 15.7 8.6 -16.9 14.2 8.0 -19.6 2.30
600 0.400 0.400 0.000 1.000 13.1 3.5 -3.3 13.8 2.0 -2.0 2.12
607 0.200 0.000 0.000 0.000 84.3 -7.2 -16.9 83.9 -8.7 -17.6 1.26
608 0.400 0.000 0.000 0.000 76.3 -14.7 -26.5 75.6 -15.8 -27.3 0.83
609 0.700 0.000 0.000 0.000 64.9 -26.3 -39.8 64.7 -25.2 -40.0 0.58
610 1.000 0.000 0.000 0.000 55.9 -36.2 -50.0 56.0 -32.6 -49.7 1.33
611 0.000 0.000 0.000 0.200 74.2 1.1 -3.6 72.4 1.0 -2.9 1.46
615 1.000 0.000 0.000 0.200 44.5 -29.4 -38.8 43.9 -27.1 -36.7 1.19
616 0.000 0.000 0.000 0.400 56.8 0.8 -2.7 54.9 0.7 -1.4 2.21
620 1.000 0.000 0.000 0.400 34.7 -23.0 -29.8 34.2 -21.5 -27.3 1.21
621 0.000 0.000 0.000 0.600 41.9 0.5 -1.8 40.1 0.7 -0.1 2.27
622 0.400 0.400 0.700 0.600 25.4 1.0 10.4 25.5 1.9 12.1 1.62
623 1.000 0.700 0.000 0.600 17.6 3.5 -18.6 16.6 3.1 -20.6 1.58
624 0.400 1.000 0.000 0.800 14.9 15.3 -4.9 15.0 13.7 -6.3 1.58

                                optimized average error: 1.33

final gamut scale factor = 0.997

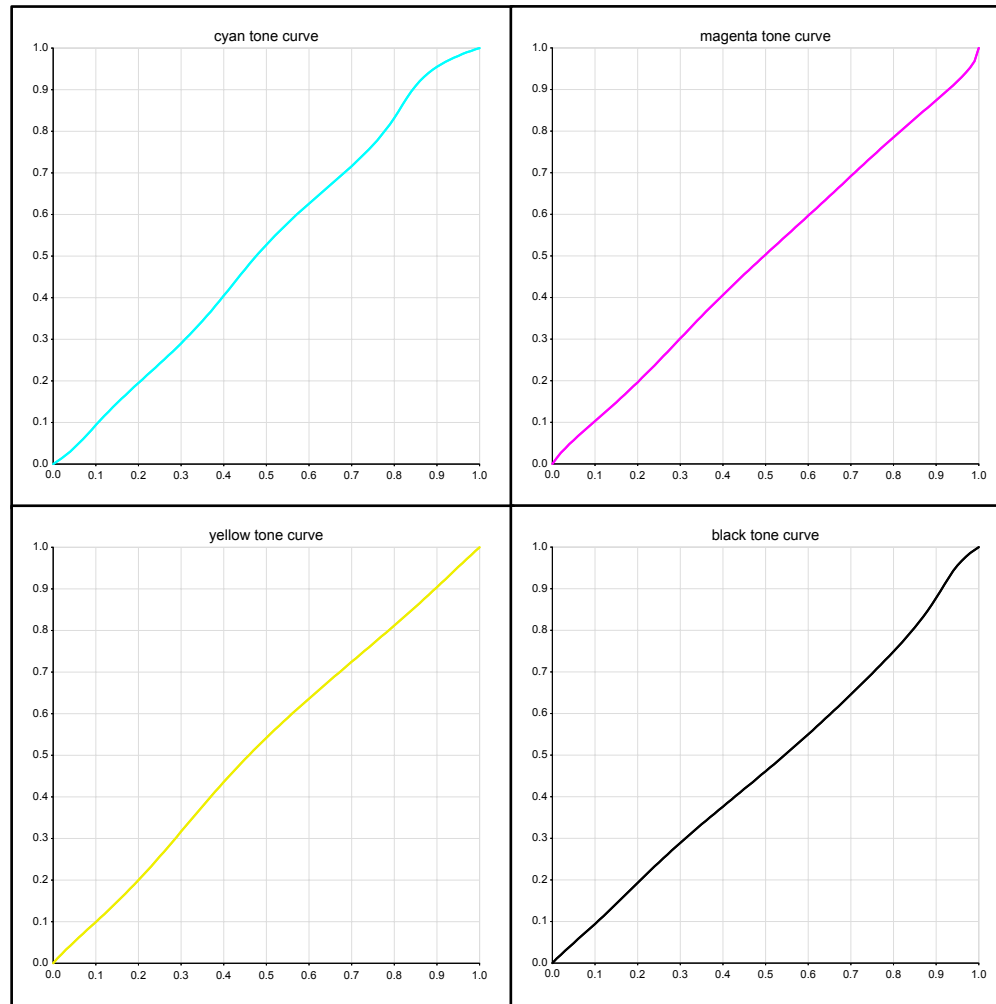
curve parameters:
      HLV  1/4  2/4  3/4  SHV
cyan  0.000 0.390 0.520 0.812 1.000
magenta 0.000 0.414 0.611 0.812 1.000
yellow 0.000 0.411 0.608 0.902 1.000
black  0.000 0.393 0.744 0.832 1.000

writing curves in 'text'      format to /Users/wbirkett/Desktop/tab_delim.txt

Program exited with code #0 after 8.84 seconds.
copy output
  
```

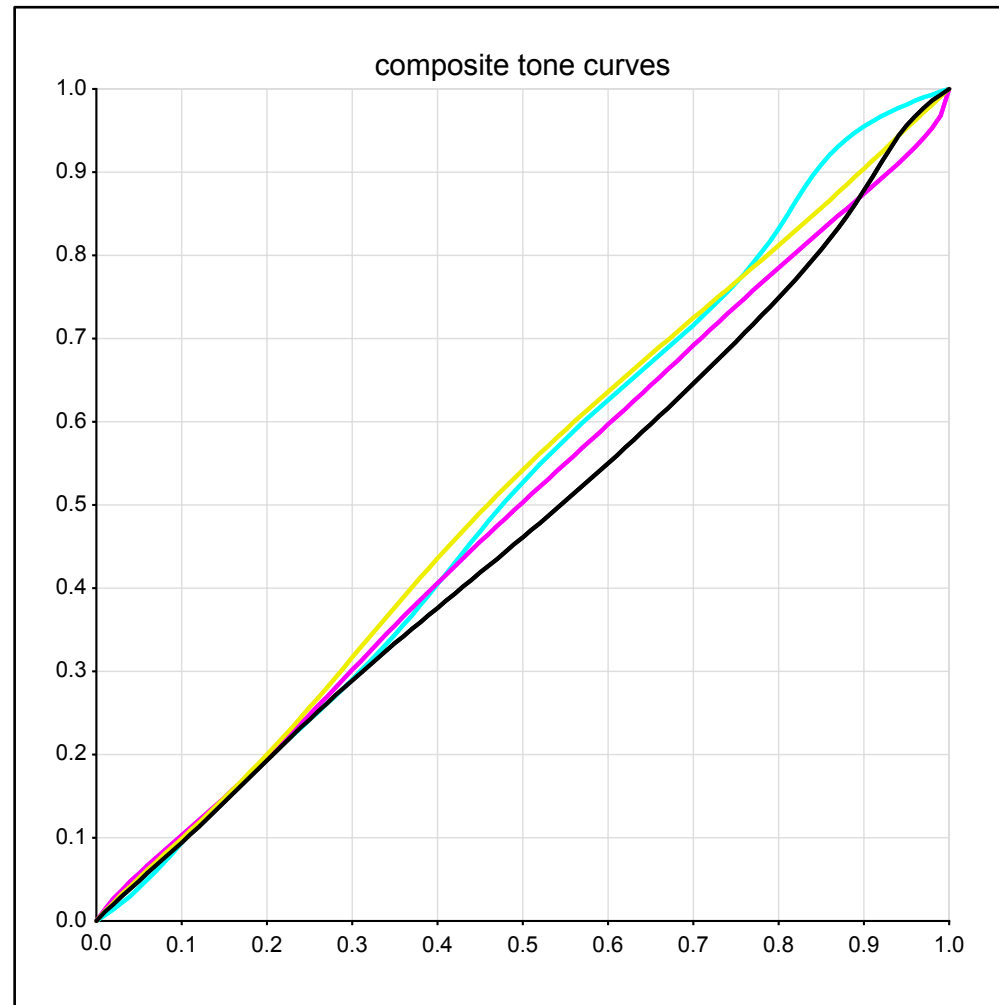
Graphs

- ▶ Displayed as tabs in web browser
- ▶ Curve graphs, individual and composite
- ▶ Color error statistics (before optimization)
- ▶ Color error statistics (after optimization)



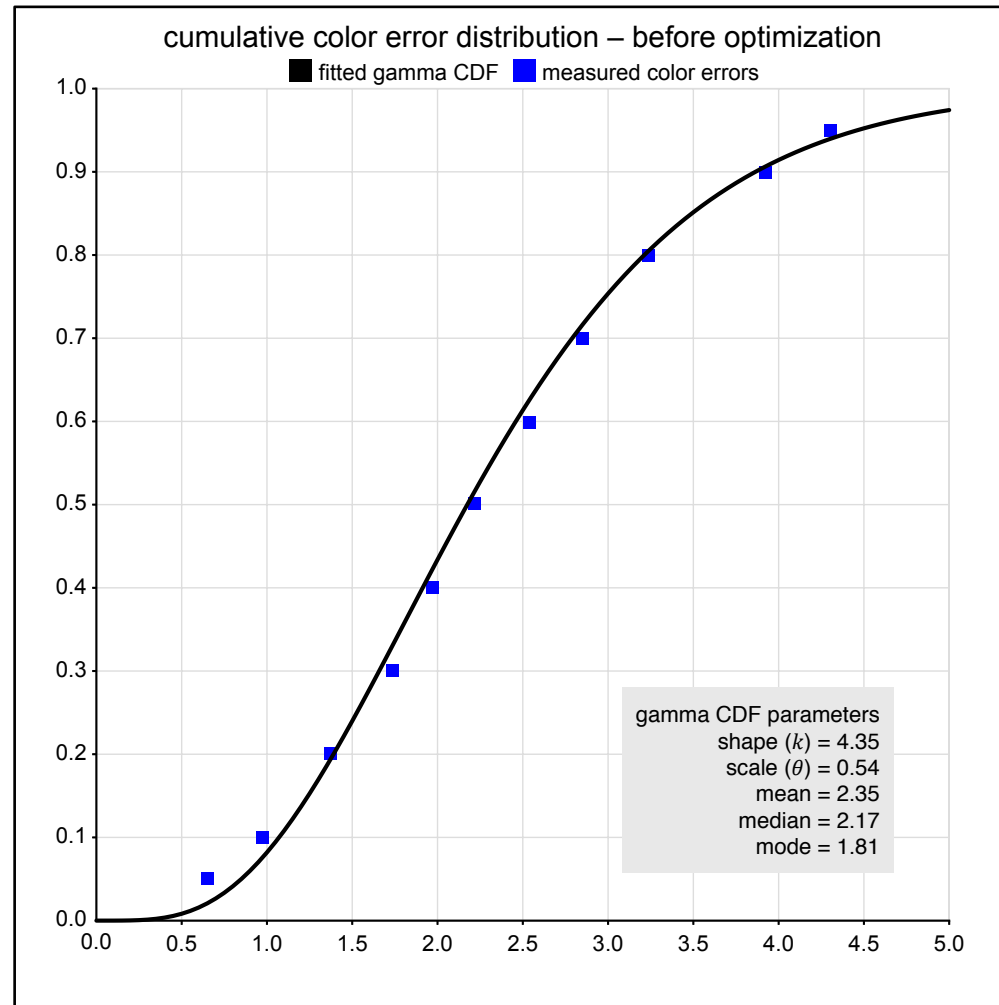
Graphs

- ▶ Displayed as tabs in web browser
- ▶ Curve graphs, individual and composite
- ▶ Color error statistics (before optimization)
- ▶ Color error statistics (after optimization)



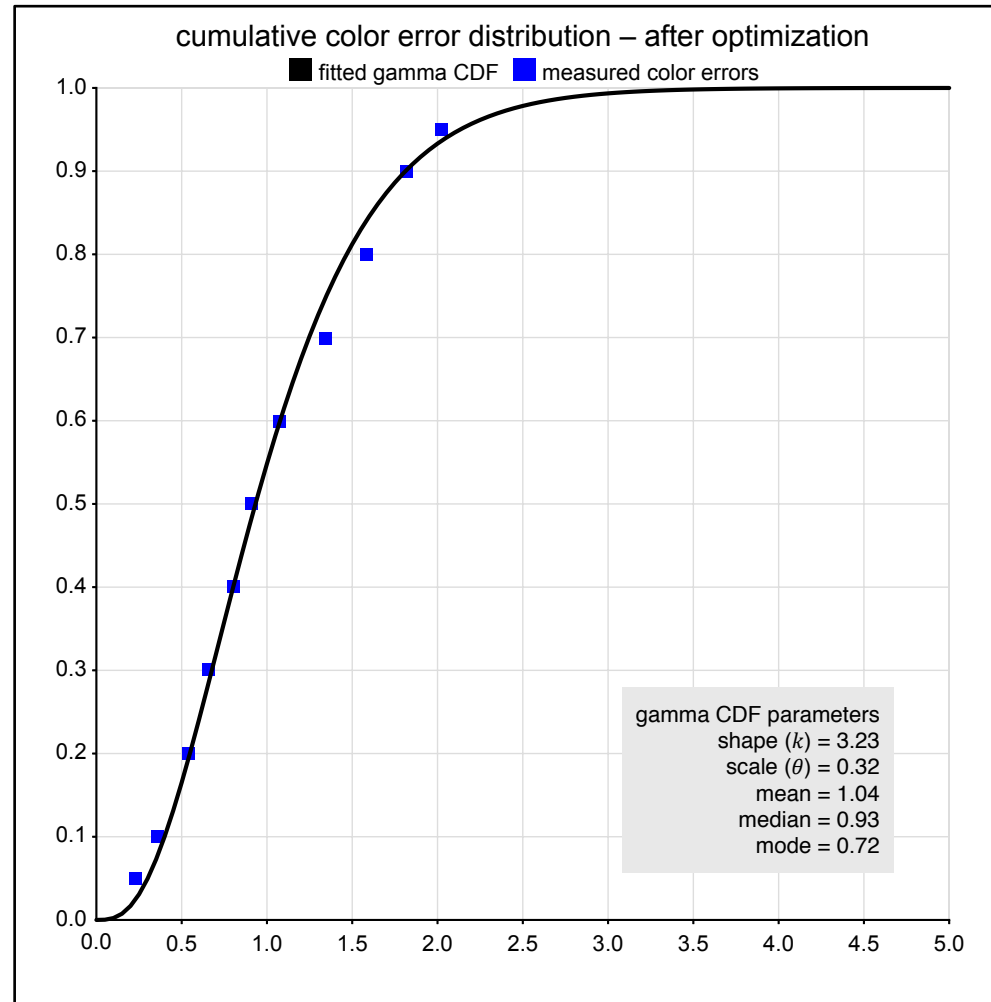
Graphs

- ▶ Displayed as tabs in web browser
- ▶ Curve graphs, individual and composite
- ▶ Color error statistics (before optimization)
- ▶ Color error statistics (after optimization)



Graphs

- ▶ Displayed as tabs in web browser
- ▶ Curve graphs, individual and composite
- ▶ Color error statistics (before optimization)
- ▶ Color error statistics (after optimization)



Curve Output Options

- ▶ Curve output formats are selected using **tokens**
- ▶ Most common **DFE formats** are supported
- ▶ Device link profiles
- ▶ Curves may be **applied to data sets**
- ▶ Curves may be **applied to color profiles**

CURVE OUTPUT TOKENS HASH KEYS

Curve Output Tokens

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
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
indigo	HP Indigo	text	CMYK	N
iso_18620	ISO 18620 (Esco .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
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

Output formats with file types **Postscript**, **text** or **XML** may be opened in TextMate for examination. Curves with file type **binary** must be opened in an app that recognizes them, usually the DFE.

All output formats support CMYK curves. Some support additional colors.

Output formats marked with a **Y** in the **steps** column can have customized steps.

The **device_link** format supports the '**desc**' hash key.

The **heidelberg** format supports the '**type**' hash key, with values '**measured**' or '**calibration**'.

The **iso_18620** format supports the '**inks**', '**origin**', '**Creator**', '**OperatorName**', '**PressName**', '**MediaName**', '**TransferCurveSetID**', '**Side**' hash keys.

The **navigator** format supports the '**inks**', '**name**', '**colorspace**' hash keys.

The **prinergy** format supports the '**Comments**', '**CurveSet**', '**DefaultFrequency**', '**DefaultMedium**', '**DefaultResolution**', '**DefaultSpotFunction**', '**Enabled**', '**FirstName**', '**FreqFrom**', '**FreqTo**', '**ID**', '**Medium**', '**Resolution**', '**ScreeningType**', '**SpotFunction**', '**SpotFunctionMode**' hash keys.

These output tokens are methods of the **ICC::Profile::cvst** object. See the color tool kit [documentation](#) for details. If you need a curve format that's not listed, please contact us. We want to support all popular formats.

Curve Output Options

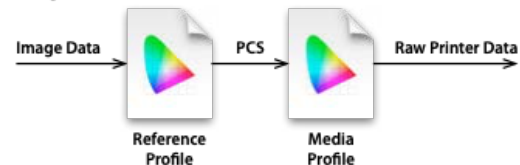
- ▶ Curve output formats are selected using **tokens**
- ▶ Most common **DFE formats** are supported
- ▶ Device link profiles
- ▶ Curves may be **applied to data sets**
- ▶ Curves may be **applied to color profiles**

Calibrating Color-Managed Processes

PressCal may be used to calibrate color-managed printing and proofing processes. In conventional printing, curves are applied in the platemaking step by the DFE. But, digital presses, wide format printers, and proofers may lack the capability to utilize tone curves. For these processes, the **adjusted_profile_path**: **setting** and function provide a solution by applying the curves to an ICC printer profile.

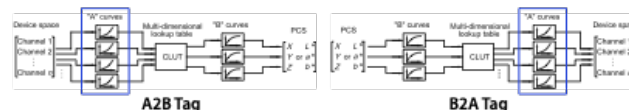
Modifying ICC Profiles

In its most basic configuration, a color-managed device employs a **reference profile** and a **media profile**, connected to form a chain, as in this illustration,



The **image data** is converted to the **PCS** (profile connection space), using the reference profile, then to **raw printer data**, using the media profile. The reference profile is typically a standard working space, such as GRACoL2013 or FOGRA51. The media profile represents the characteristics of the printer/media combination.

Internally, printer profiles contain six color transform tags – A2B0, A2B1, A2B2, B2A0, B2A1, and B2A2. The **A2B** tags transform device values (e.g., RGB, CMYK) to PCS values (e.g., XYZ, L*a*b*). The **B2A** tags do the opposite, transforming PCS values to device values. The last digit of the tag ID indicates the rendering intent – 0 is perceptual, 1 is colorimetric, and 2 is saturation. These tags contain curve elements ("A" curves) that transform the device values.



PressCal combines its curves with these curve elements to create a modified profile. The **A2B** tags of a **reference profile** or the **B2A** tags of a **media profile** are modified. This is done for all three rendering intents (perceptual, colorimetric, and saturation).

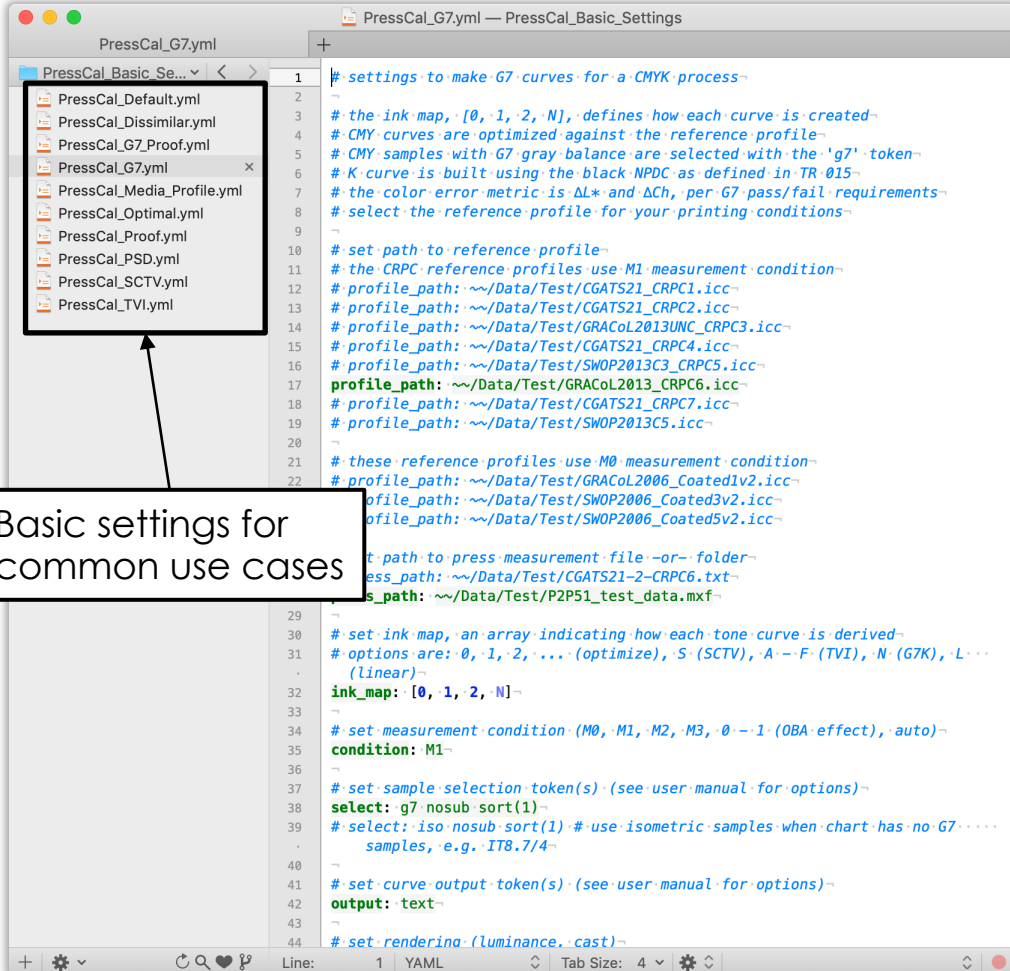
Printer profiles also contain a **media white point tag**, used to compute absolute color rendering. If the media color drifts (e.g., a new lot of material), color errors are introduced. PressCal will optionally update the media white point tag to the media color of the press measurements.

Media Profiles

If your printer drifts out of calibration, it is most likely due to changes in materials (media or inks), environment, or perhaps the printer itself, such as cleaning or replacing a print head. These changes can be countered by modifying the media profile. The **adjusted_profile_path**: **setting** and function are configured to do this by default.

Basic Settings

- ▶ **Template files** for common use cases
- ▶ Settings are saved each time the software is run
- ▶ File names include **Unix date/time**
- ▶ Provides a complete record of the calibration process



The image shows a screenshot of a software interface. On the left, a file explorer window titled 'PressCal_G7.yml' displays a list of template files: PressCal_Default.yml, PressCal_Dissimilar.yml, PressCal_G7_Proof.yml, PressCal_G7.yml, PressCal_Media_Profile.yml, PressCal_Optimal.yml, PressCal_Proof.yml, PressCal_PSD.yml, PressCal_SCTV.yml, and PressCal_TV1.yml. A black box highlights this list, with an arrow pointing to a text box that says 'Basic settings for common use cases'. On the right, a code editor window titled 'PressCal_G7.yml — PressCal_Basic_Settings' shows the contents of the selected file. The code is a YAML configuration for a CMYK process, including settings for ink maps, reference profiles, measurement conditions, and sample selection. The code is as follows:

```
1  # settings to make G7 curves for a CMYK process~
2  ~
3  # the ink map, {0, 1, 2, N}, defines how each curve is created~
4  # CMY curves are optimized against the reference profile~
5  # CMY samples with G7 gray balance are selected with the 'g7' token~
6  # K curve is built using the black NPDC as defined in TR 015~
7  # the color error metric is ΔL* and ΔCh, per G7 pass/fail requirements~
8  # select the reference profile for your printing conditions~
9  ~
10 # set path to reference profile~
11 # the CRPC reference profiles use M1 measurement condition~
12 # profile_path: ~/Data/Test/CGATS21_CRPC1.icc~
13 # profile_path: ~/Data/Test/CGATS21_CRPC2.icc~
14 # profile_path: ~/Data/Test/GRACoL2013UNC_CRPC3.icc~
15 # profile_path: ~/Data/Test/CGATS21_CRPC4.icc~
16 # profile_path: ~/Data/Test/SWOP2013C3_CRPC5.icc~
17 profile_path: ~/Data/Test/GRACoL2013_CRPC6.icc~
18 # profile_path: ~/Data/Test/CGATS21_CRPC7.icc~
19 # profile_path: ~/Data/Test/SWOP2013C5.icc~
20 ~
21 # these reference profiles use M0 measurement condition~
22 # profile_path: ~/Data/Test/GRACoL2006_Coated1v2.icc~
23 # profile_path: ~/Data/Test/SWOP2006_Coated3v2.icc~
24 # profile_path: ~/Data/Test/SWOP2006_Coated5v2.icc~
25 ~
26 # set path to press measurement file -or- folder~
27 # press_path: ~/Data/Test/CGATS21-2-CRPC6.txt~
28 # s_path: ~/Data/Test/P2P51_test_data.mxf~
29 ~
30 # set ink map, an array indicating how each tone curve is derived~
31 # options are: 0, 1, 2, ... (optimize), S (SCTV), A -F (TVI), N (G7K), L...
32 (linear)~
33 # ink_map: [0, 1, 2, N]~
34 ~
35 # set measurement condition (M0, M1, M2, M3, 0 -1 (OBA effect), auto)~
36 # condition: M1~
37 ~
38 # set sample selection token(s) (see user manual for options)~
39 # select: g7 nosub sort(1)~
40 # select: iso nosub sort(1) # use isometric samples when chart has no G7...
41 samples, e.g. IT8.7/4~
42 ~
43 # set curve output token(s) (see user manual for options)~
44 # output: text~
45 ~
46 # set renderina (luminance, cast)~
```

Basic Settings

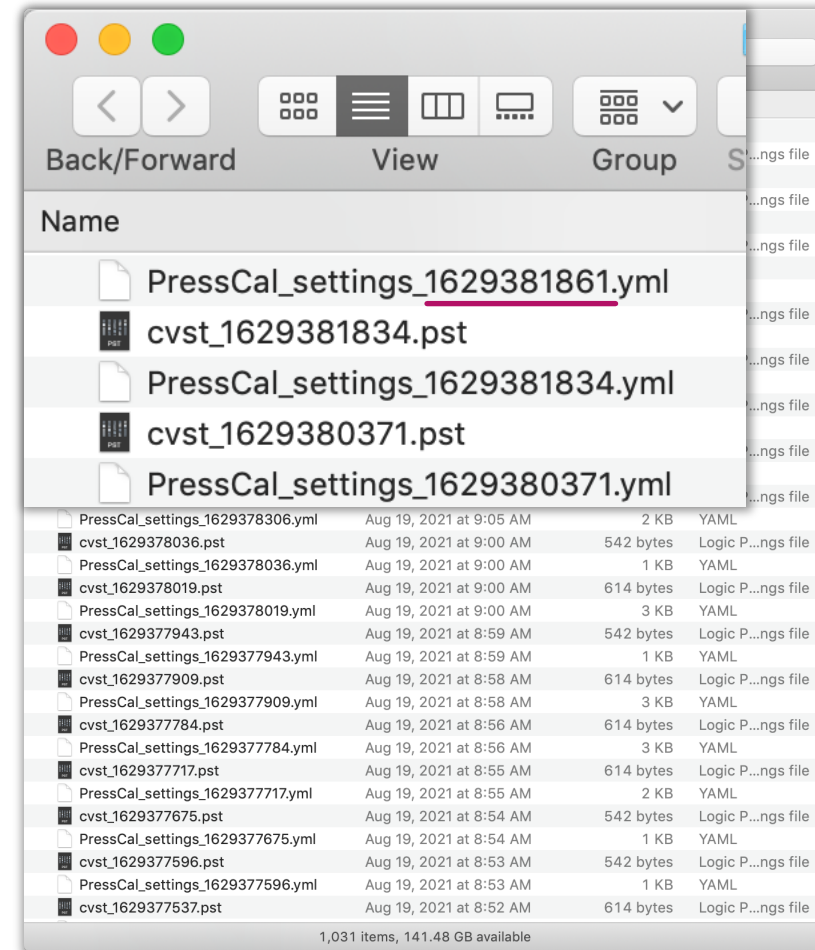
- ▶ **Template files** for common use cases
- ▶ Settings are saved each time the software is run
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Name	Date Modified	Size	Kind
PressCal_settings_1629381861.yml	Aug 19, 2021 at 10:04 AM	2 KB	YAML
cvst_1629381834.pst	Aug 19, 2021 at 10:03 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629381834.yml	Aug 19, 2021 at 10:03 AM	2 KB	YAML
cvst_1629380371.pst	Aug 19, 2021 at 9:39 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629380371.yml	Aug 19, 2021 at 9:39 AM	1 KB	YAML
cvst_1629380220.pst	Aug 19, 2021 at 9:37 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629380220.yml	Aug 19, 2021 at 9:37 AM	1 KB	YAML
PressCal_settings_1629379650.yml	Aug 19, 2021 at 9:27 AM	1 KB	YAML
cvst_1629379485.pst	Aug 19, 2021 at 9:24 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629379485.yml	Aug 19, 2021 at 9:24 AM	1 KB	YAML
cvst_1629379399.pst	Aug 19, 2021 at 9:23 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629379399.yml	Aug 19, 2021 at 9:23 AM	1 KB	YAML
cvst_1629379279.pst	Aug 19, 2021 at 9:21 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629379279.yml	Aug 19, 2021 at 9:21 AM	1 KB	YAML
cvst_1629378376.pst	Aug 19, 2021 at 9:06 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629378376.yml	Aug 19, 2021 at 9:06 AM	1 KB	YAML
cvst_1629378306.pst	Aug 19, 2021 at 9:05 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629378306.yml	Aug 19, 2021 at 9:05 AM	2 KB	YAML
cvst_1629378036.pst	Aug 19, 2021 at 9:00 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629378036.yml	Aug 19, 2021 at 9:00 AM	1 KB	YAML
cvst_1629378019.pst	Aug 19, 2021 at 9:00 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629378019.yml	Aug 19, 2021 at 9:00 AM	3 KB	YAML
cvst_1629377943.pst	Aug 19, 2021 at 8:59 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629377943.yml	Aug 19, 2021 at 8:59 AM	1 KB	YAML
cvst_1629377909.pst	Aug 19, 2021 at 8:58 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629377909.yml	Aug 19, 2021 at 8:58 AM	3 KB	YAML
cvst_1629377784.pst	Aug 19, 2021 at 8:56 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629377784.yml	Aug 19, 2021 at 8:56 AM	3 KB	YAML
cvst_1629377717.pst	Aug 19, 2021 at 8:55 AM	614 bytes	Logic P...ngs file
PressCal_settings_1629377717.yml	Aug 19, 2021 at 8:55 AM	2 KB	YAML
cvst_1629377675.pst	Aug 19, 2021 at 8:54 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629377675.yml	Aug 19, 2021 at 8:54 AM	1 KB	YAML
cvst_1629377596.pst	Aug 19, 2021 at 8:53 AM	542 bytes	Logic P...ngs file
PressCal_settings_1629377596.yml	Aug 19, 2021 at 8:53 AM	1 KB	YAML
cvst_1629377537.pst	Aug 19, 2021 at 8:52 AM	614 bytes	Logic P...ngs file

1,031 items, 141.48 GB available

Basic Settings

- ▶ **Template files** for common use cases
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Ink Balance Tool

- ▶ Adjust ink densities to match reference color gamut
- ▶ Works with CMYK sequential processes, e.g. offset, flexo
- ▶ Requires M1 and M2 spectral measurements
- ▶ Ink balance controlled by weight factors
- ▶ Computes ink trapping

```
trap values:
    red  1.029  0.742
    green 0.958  0.873
    blue  0.868  0.825
    iso   0.796  0.743  0.617

optimizing ink balance
error metric: dEab
error weights: [1, 1, 1, 1, 1, 0]
L-M optimization completed at 258 iterations
optimized ink film thicknesses:
    cyan  1.025
    magenta 1.016
    yellow 0.974
    black  1.050

optimized solid ink errors:
      abs  L*a*b* values  ->  ref  L*a*b* values  press  L*a*b* values  ΔEab  ΔE00
paper  95.0   1.0   -4.0   94.6   1.6   -4.5   94.6   1.5   -4.4   0.02  0.02
cyan   56.0  -37.0  -50.0  55.8  -36.5  -50.3  55.1  -32.5  -50.6  4.12  1.71
magenta 48.0   75.0   -4.0   47.8   75.2   -4.3   49.6   73.7   -3.2   2.55  1.87
yellow  89.0   -4.0   93.0   88.6   -3.4   92.5   89.5   -6.1   92.7   2.77  1.48
red     47.0   68.0   48.0   46.8   68.2   47.7   48.4   68.0   45.2   2.95  1.87
green  50.0  -66.0   26.0   49.8  -65.5   25.7   49.6  -65.2   27.5   1.83  0.77
blue   25.0   20.0  -46.0   24.9   20.2  -46.1   24.4   20.8  -45.4   1.11  0.86
iso    23.0   0.0   -0.0   22.9   0.2   -0.2   22.3   -0.5   -3.3   3.23  3.10
black  16.0   0.0   -0.0   15.9   0.2   -0.1   15.9   0.8   1.7   1.95  1.99
cmyk   9.0   0.2   0.4     9.0   0.3   0.3           sample missing  ----  ----

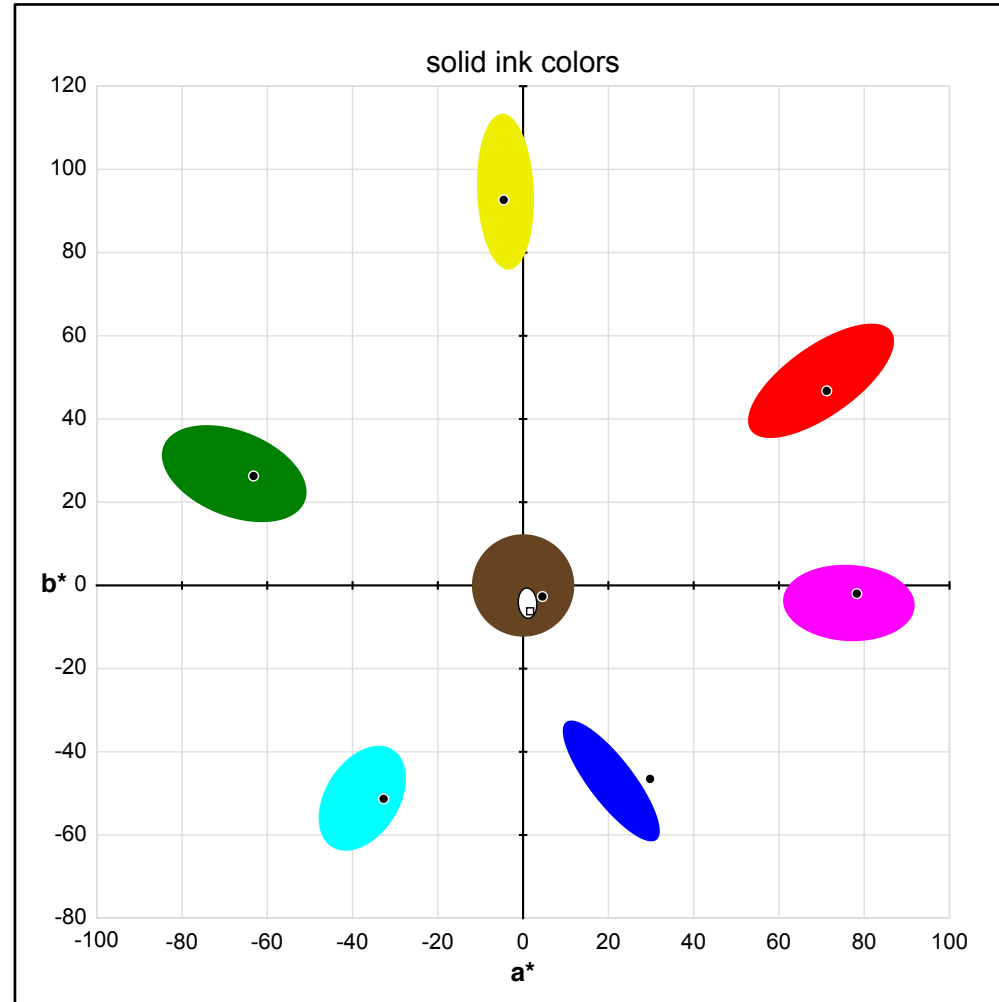
status T densities:
      nom    opt  change
cyan   1.321  1.340  +0.02
magenta 1.313  1.328  +0.02
yellow  1.021  1.005  -0.02
black   1.600  1.677  +0.08

Program exited with code #1 after 2.05 seconds.
copy output
```



Ink Balance Tool

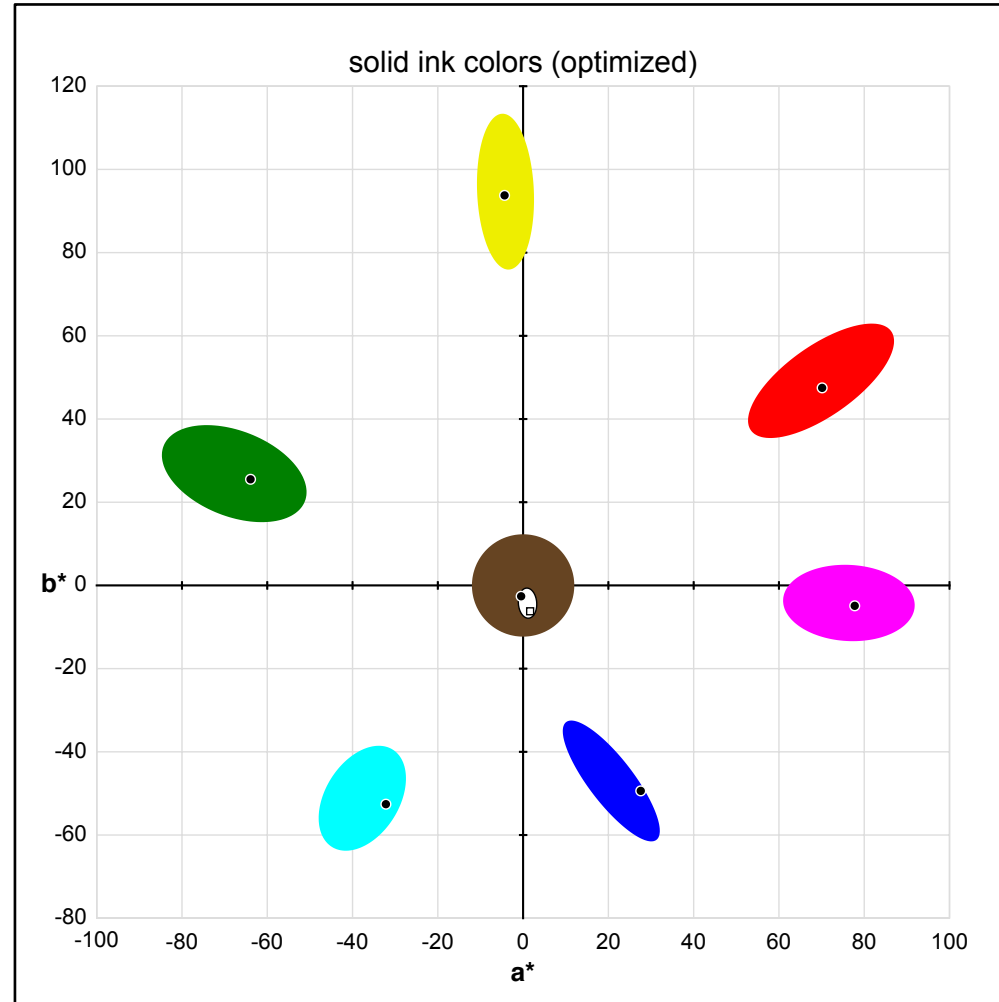
- ▶ Adjust ink densities to match reference color gamut
- ▶ Works with CMYK sequential processes, e.g. offset, flexo
- ▶ Requires M1 and M2 spectral measurements
- ▶ Ink balance controlled by weight factors
- ▶ Computes ink trapping





Ink Balance Tool

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Grading Tool

- ▶ Supports commonly used standards and specifications
- ▶ Displays pass/fail result of individual grading tests
- ▶ Graphs SCTV ink ramps
- ▶ Graphs gray balance errors
- ▶ Graphs color error statistics
- ▶ Custom grading supported

```
solid ink errors:
      abs L*a*b* values  ->  ref L*a*b* values      press L*a*b* values  ΔEab  ΔE00
paper  95.0   1.0  -4.0      94.8   1.3  -3.9      94.8   1.3  -3.9   0.02  0.02
cyan   56.0  -37.0 -50.0     55.9  -36.7 -49.9     56.0  -31.5 -49.8   5.28  2.02
magenta 48.0   75.0  -4.0     47.9  75.1  -4.0     50.4  72.0  -2.9   4.15  2.66
yellow  89.0   -4.0  93.0     88.8   -3.7  92.8     89.6   -6.4  87.9   5.69  1.93
red     47.0   68.0  48.0     46.9  68.1  47.9     49.0  66.6  42.9   5.64  2.85
green  50.0  -66.0  26.0     49.9 -65.7  26.0     50.9 -63.8  25.1   2.39  1.19
blue   25.0   20.0 -46.0     24.9  20.1 -45.9     26.3  21.0 -44.5   2.16  1.63
iso    23.0   0.0  -0.0     22.9   0.1   0.0     24.2   0.3  -4.2   4.40  3.97
black  16.0   0.0  -0.0     15.9   0.1   0.0     21.0   1.0   1.7   5.43  4.03
cmyk   9.0   0.2   0.4       9.0   0.3   0.4     12.1   0.8  -0.4   3.22  2.22

HL dot retention values:
cyan -0.1%
magenta -0.1%
yellow -0.1%
black -0.1%

standard: optimal, version: 2020, level: offset

CMYK solids color error
cyan ΔE00: 2.02 ✓ [3.00]
magenta ΔE00: 2.66 ✓ [3.00]
yellow ΔE00: 1.93 ✓ [3.00]
black ΔE00: 4.03 ✓ [5.00]

RGB solids color error
red ΔE00: 2.85 ✓ [3.00]
green ΔE00: 1.19 ✓ [3.00]
blue ΔE00: 1.63 ✓ [3.00]

gray axis color errors
average ΔL: 1.86 ✗ [1.50]
maximum ΔL: 3.97 ✓ [4.00]
average ΔCh: 2.93 ✗ [1.50]
maximum ΔCh: 5.80 ✗ [4.00]

realistic samples (375)
median ΔE00: 2.31 ✓ [2.50]
95th pct ΔE00: 4.43 ✓ [5.00]
maximum ΔE00: 5.99 ✓ [10.00]

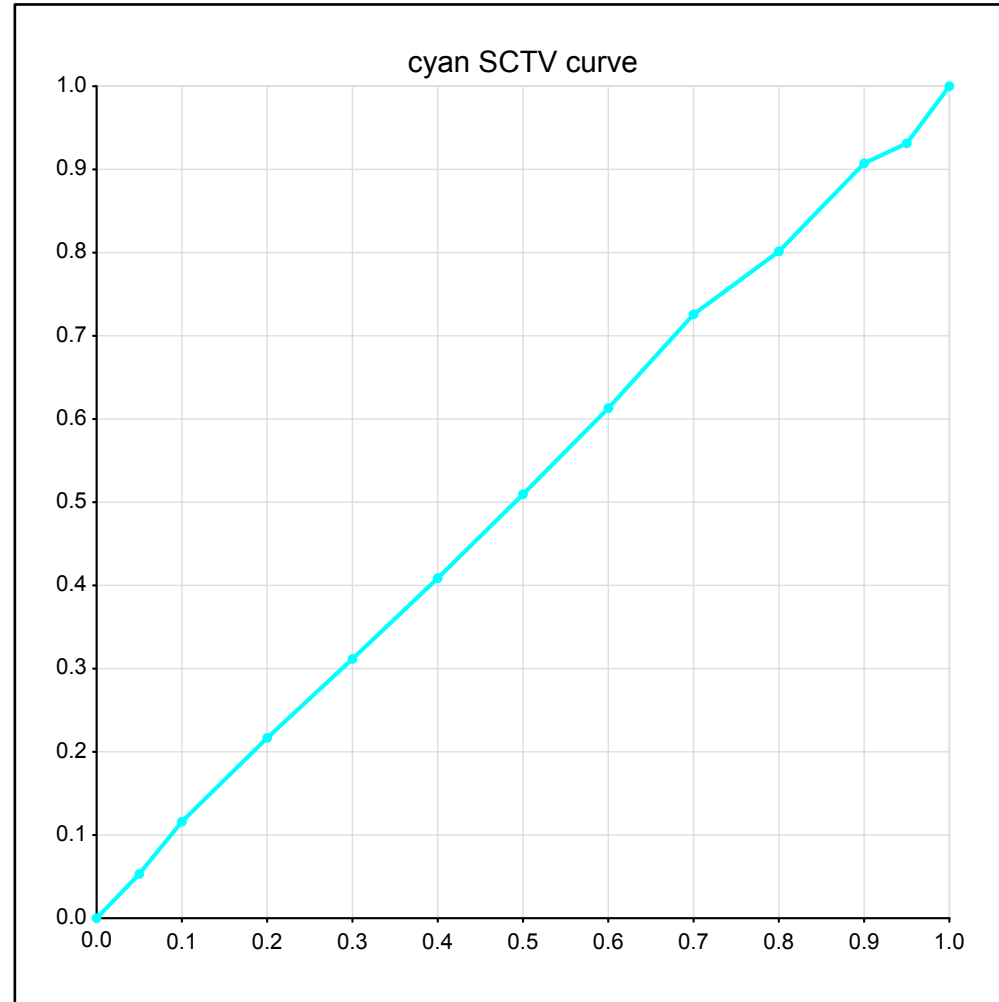
failed 3 tests

Program exited with code #2 after 3.18 seconds.                                     copy output
```



Grading Tool

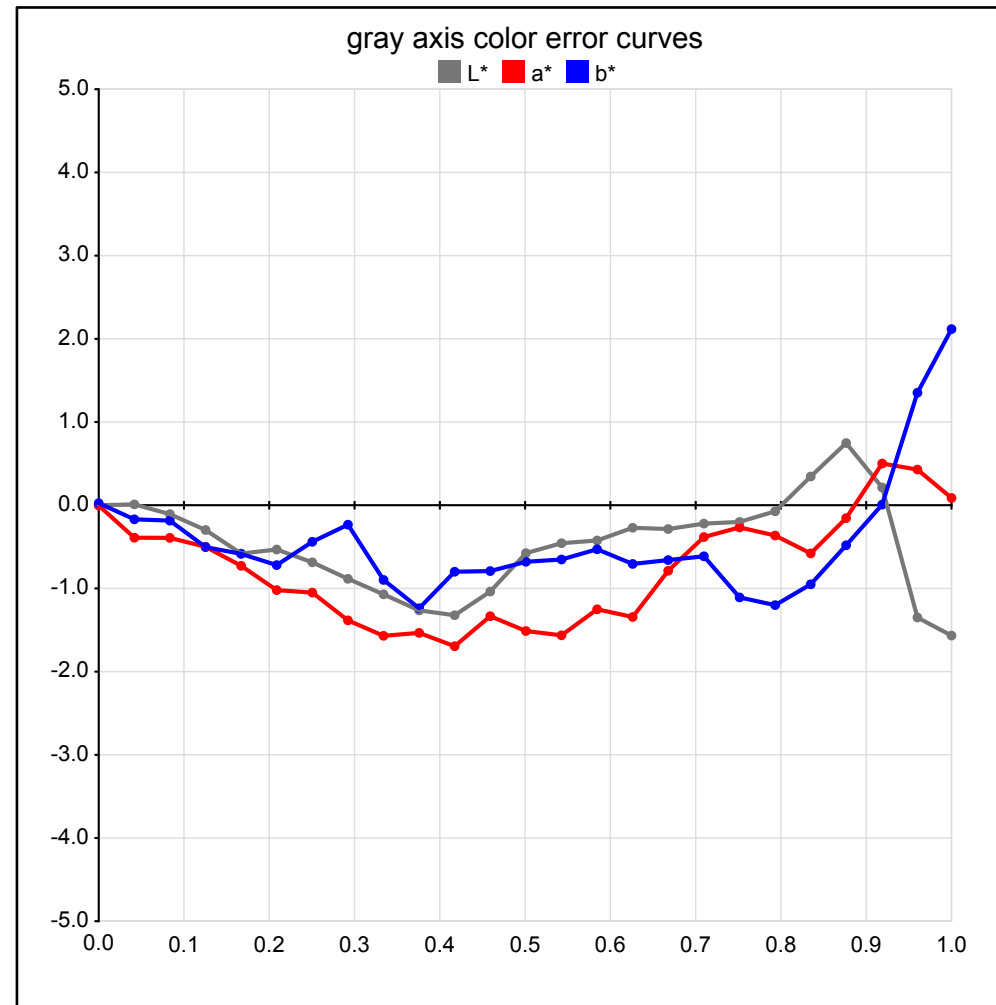
- ▶ Supports commonly used standards and specifications
- ▶ Displays pass/fail result of individual grading tests
- ▶ Graphs SCTV ink ramps
- ▶ Graphs gray balance errors
- ▶ Graphs color error statistics
- ▶ Custom grading supported





Grading Tool

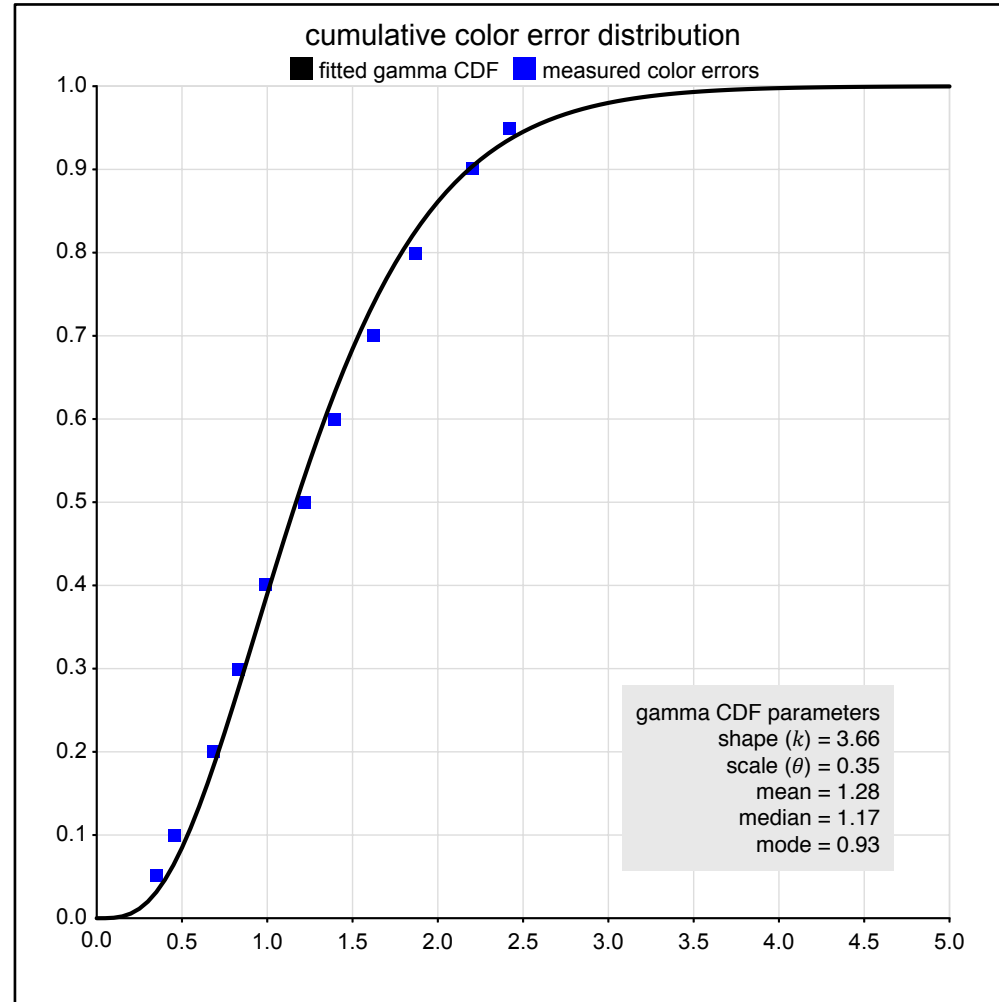
- ▶ Supports commonly used standards and specifications
- ▶ Displays pass/fail result of individual grading tests
- ▶ Graphs SCTV ink ramps
- ▶ Graphs gray balance errors
- ▶ Graphs color error statistics
- ▶ Custom grading supported





Grading Tool

- ▶ Supports commonly used standards and specifications
- ▶ Displays pass/fail result of individual grading tests
- ▶ Graphs SCTV ink ramps
- ▶ Graphs gray balance errors
- ▶ Graphs color error statistics
- ▶ Custom grading supported



Feature Summary

- ▶ Open-source software tool for calibrating print processes
- ▶ Reference implementation of the Optimal Method
- ▶ Calibrates any printing process, with any number of inks
- ▶ Supports legacy calibration techniques – TVI, G7, SCTV
- ▶ Includes integrated ink-setting and grading tools

Feature Summary

- ▶ Color reference is an ICC profile
- ▶ Ink map selects method used to compute each curve
- ▶ Works with any test chart and color measurement format
- ▶ Sample selection using tokens
- ▶ Color errors are minimized using mathematical optimization

Feature Summary

- ▶ Makes vector curves of adjustable complexity
- ▶ Computes color error statistics, before and after optimization
- ▶ Outputs common DFE curve formats
- ▶ Basic setting templates for most common use cases
- ▶ Comprehensive user manual



Contact Info

The Optimal Method **web site** contains software downloads and extensive background information.

Feel free to contact us via **e-mail**

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Chuck.Spontelli@colortuneup.com

Optimal Method Web Site

<https://optimalmethod.org>