

Digital Press Benchmarking

PRESENTED BY
DAVID HUNTER

Audience:

Make Up?

- Brand Companies?
- Printing Company?
- Prepress Company?
- Manufacturers?
- In Market to Purchase Digital Device?

Agenda:

Questions at any Time

- How to Quantify Customer's "Match" Expectations
- Apply to Machine Capabilities
- Customer Requirements for Print
- Actual Device Performance Compared
- Range of Color- Gamut
- Precision- consistency, repeatability, reproducibility
- Accuracy- Match to target reference
- Quality of Print- Addressability, Resolution

Terminology

Definitions for this Presentation

- Delta E (ΔE)- Metric defining color difference
 - *Higher the Number- Larger the perceived difference*
 - *One Color compared to another Color*
- *E-Factor* : CRF 95th CRF of the Delta E
 - *Version of Delta E but for comparing Images or Pages*
 - *Coined term: E-Factor (**E**xpectation and form ΔE)*

Terminology

Definitions for this Presentation

- Precision

- *Consistency- Within Page, Within jobs, Between jobs*
- *Quantify via E-Factor (CRF)*



- Accuracy

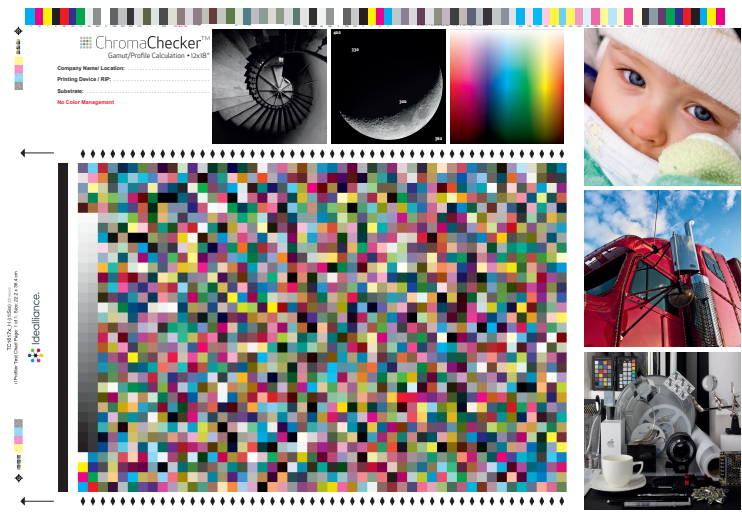
- *How Close to Reference Condition*
- *How close to GRACoL (CRF)*



Output Devices Covered:

Digital Presses and Large/Grand Format

- Similar Test forms
- Visual, and Measurement Targets
- Invited Every Major Vendor to participate
 - Vendor has choice to make data blind
- Most data came from customers



Every Day Problems

Industry Poll of Printers (1500+)

- Not Matching Color on same device between jobs
- Not Matching Spot colors “close enough”
- Not Matching Color between Devices

This Presentation Covers all of these Issues!

Old Way to Assess Printing Devices

Normal Considerations for Purchase

- Format Size
 - *How big?*
- Substrate Capabilities
 - *What can it print on*
- Budget
 - *Overall Cost, Maintenance costs*
- Does it Look OK...
 - *Visual Assessment... compared to what?*

New Way to Evaluate Printers

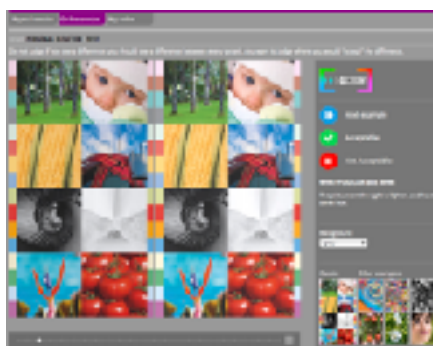
Better Purchase Considerations

- Understand the devices Range of Color (Gamut)
 - *Can it match/exceed a GRACoL Printing Aim*
 - *Can it match important Spot Colors*
- Define the Precision
 - *Within print, and between prints, between jobs*
- What is the Accuracy?
 - *Dependent on Operator/RIP performance*
- Define Machine Capabilities vs. Expectation
 - *Actual Customer Requirements*

Customer Job Requirements

Define Customer Expectations

- Quantify Expectations- Images/Spot
 - *Use E-Factor Exercise to quantify “Match” Requirements*



- Can Output Device Meet Customer Expectations
 - *Within customer's Expectations of a “Match”*
 - *If Customers Expectations is 2, Apply to Printing Device*

Customer Job Requirement

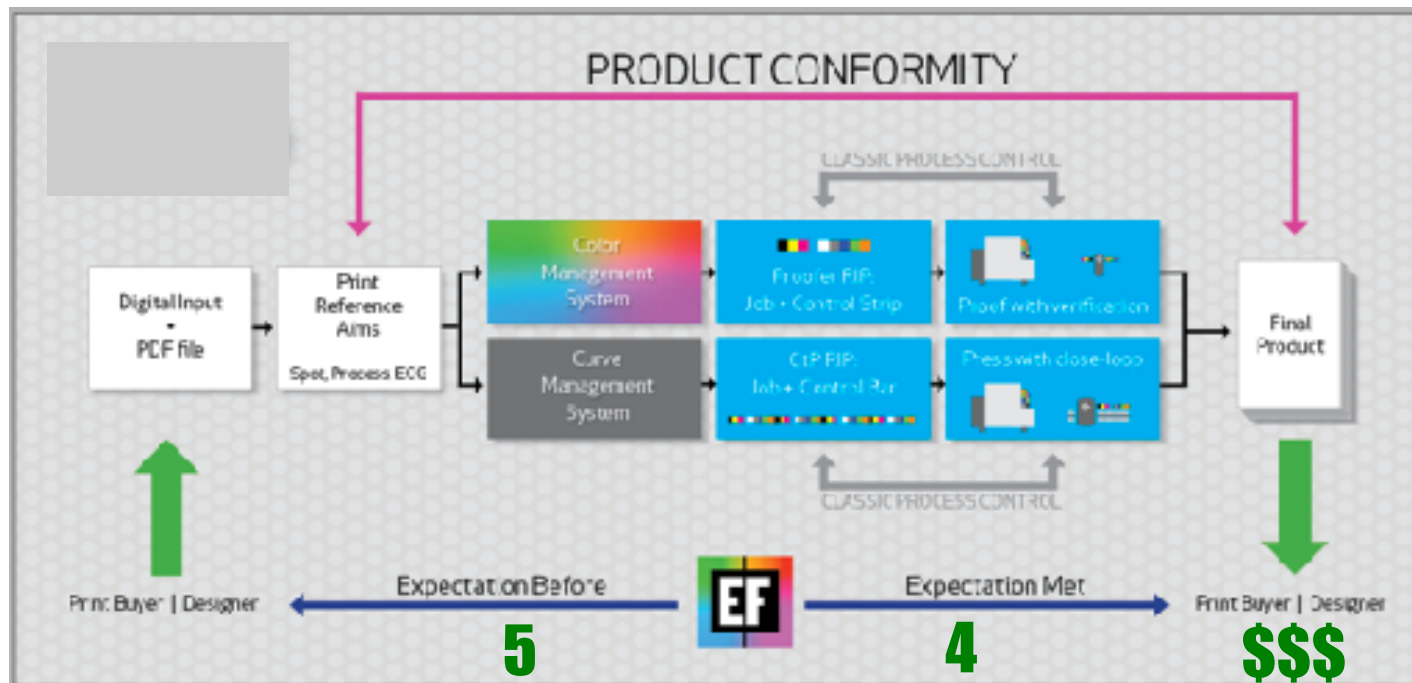
Apply Expectations to Machine Capabilities

- If Customer's Expectations for "Match" is 2
- Output devices Machine capabilities must 2 or less
 - *If Output device is equal or less than Expectations... \$\$\$*
- Apply E-Factor to all Aspects of Output Devices
 - *Are Colors Within Gamut?*
 - *Are Colors consistent within page*
 - *Are Colors consistent throughout a multi page run*
 - *Are Colors consistent from week to week*
 - *Are Colors "matching" colors on other output devices*

CRF 95th Percentile – E-Factor

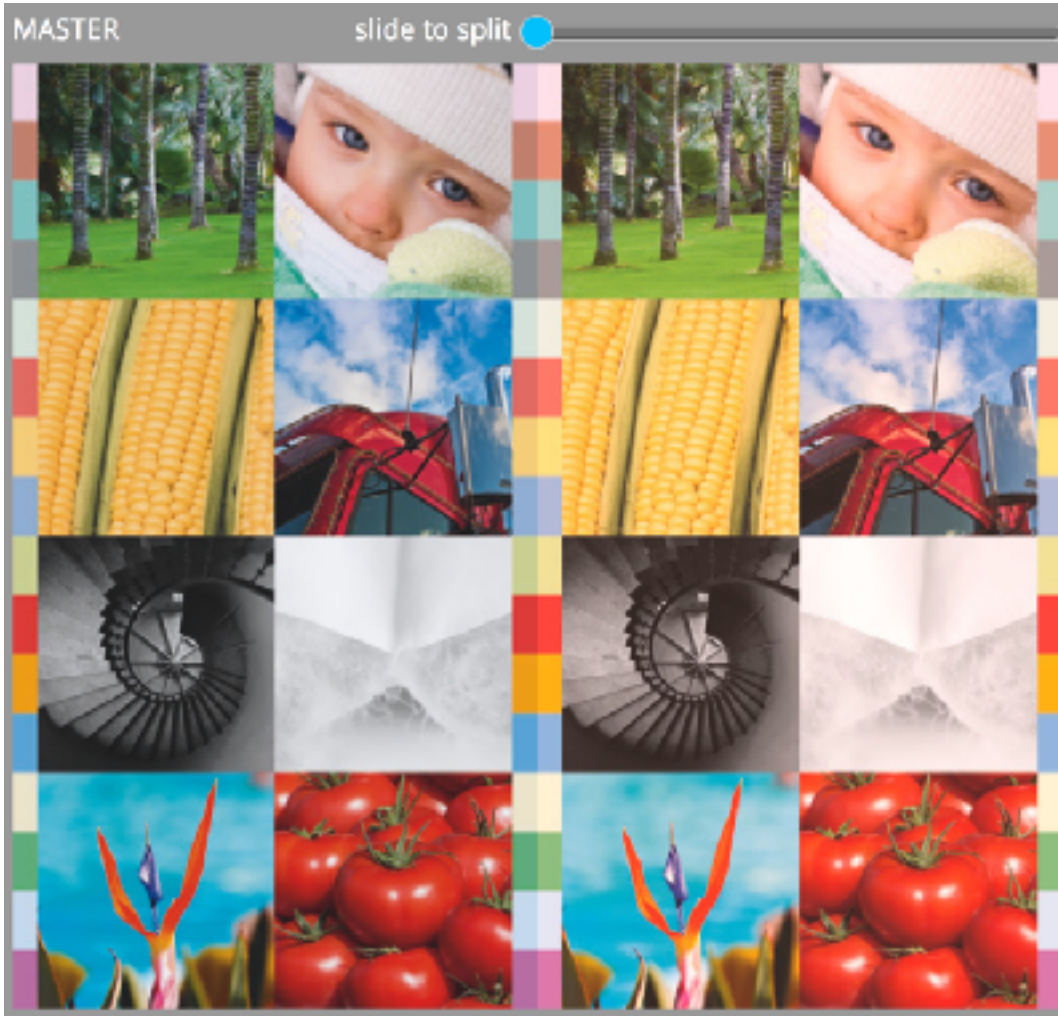
Visual Score Card= Visual Appearance

- Color Conformance- Not Process Control
- Relative Difference *only, Doesn't tell you why*



CRF 95th Percentile – E-Factor

Visual Score Card= Visual Appearance



**Psychometric Tests:
CRF 95% Stated**

E-Factor: 9 or more

Unacceptable

CRF 95th Percentile – E-Factor

Visual Score Card= Visual Appearance



**Psychometric Tests:
CRF 95% Stated**

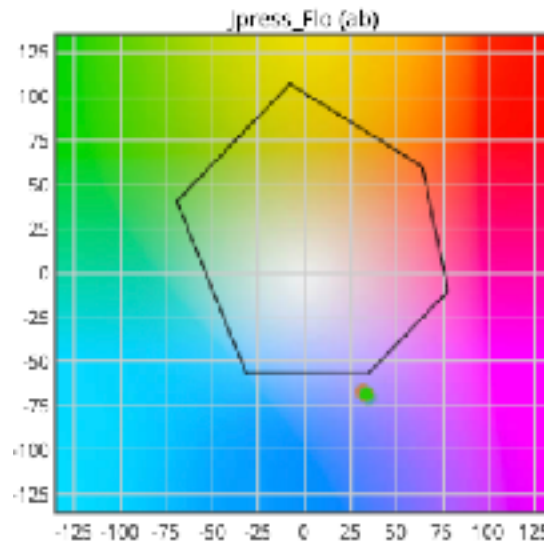
E-Factor: 2 or less

Excellent/Very Good

1. Are Colors Within Gamut?

Measure Colors- Assess Against Device

- Optimize Paper color to help your gamut
- Reflex Blue
- If Customer Expectations <5



	RGB(sRGB)								B-bit CMYK (jpress_Flo - M0)								RAL Design	
		R	G	B	hex	L*	a*	b*	ΔE ₀₀	Cyan	Magenta	Yellow	Black	L*	a*	b*		ΔE ₀₀
M0		0	28	140	#00108C	18.90	38.74	-62.40	5.59	100.00	84.71	0.00	9.80	20.69	25.27	-57.45	5.39	292 21 64
M1		0	29	144	#001090	19.60	39.59	-63.72	5.69	100.00	85.10	0.00	8.24	20.76	25.64	-57.86	5.31	292 22 65
M2		0	29	137	#001089	18.73	37.05	-60.80	5.80	100.00	83.92	0.00	12.55	20.65	24.25	-56.76	5.32	291 21 62
M3		0	24	134	#001086	17.34	38.88	-61.22	6.19	100.00	83.92	0.00	16.08	20.41	23.43	-55.71	6.87	291 19 62

1. Are Colors Within Gamut?

Measure Colors- Assess within Device

Virtual Spot Print

Device: BARBARA ICC profile: PRTON_TORQUECOLOR_M1_M_V0001.M1 - All 2000 Threshold

Statistics

Sample	Sample standard	Mean	Average	Std. dev.
24	24 (100%)	1.86	8.23	0.23

Export

File Format: CMYK color in CMYK conversion

Download

Color list

ID		Name	Device Gamut			PRTON_TORQUECOLOR_M1				Device Gamut			All 2000
			L*	a*	b*	Cyan	Magenta	Yellow	Black	L*	a*	b*	
05		Surfside Sun	88.51	0.88	0.70	3.00	1.06	29.18	87.58	1.16	0.70	1.89	
06		Cosier Pearl	91.81	-0.38	-0.2	5.12	1.86	6.27	91.28	-0.33	-0.1	0.48	
07		Bliss White	92.11	0.62	0.08	8.88	1.18	1.70	92.28	0.42	0.28	0.46	
075		Isle Gaudi	92.11	0.41	0.68	8.78	1.86	6.68	92.58	0.71	1.42	0.41	
077		Earl Chumale	88.6	0.29	1.39	3.60	1.86	7.86	88.88	0.10	1.04	0.31	
08		ETOPAR 108	89.62	-0.38	0.14	8.198	1.92	28.81	89.62	-0.48	0.88	0.27	
09		Hidden Geka	82.36	0.75	18.7	36.38	39.68	55.68	82.75	0.88	19.79	0.25	
07		Warrior Lime	90.73	0.9	18.95	8.38	1.14	19.12	90.82	0.92	11.28	0.18	
022		Boys White	86.29	0.19	7.07	7.05	5.40	15.47	86.88	0.14	7.32	0.22	
028		Antique Lace	91.26	1.15	8.9	1.18	1.52	15.68	91.53	1.15	13.18	0.22	
03		PeachBurr	58.58	-4.86	-21.78	74.51	23.14	5.88	0.25	58.30	-4.311	-21.689	
071		Earl Sun	72.83	0.09	10.89	15.22	27.88	65.27	73.08	0.85	10.20	0.21	
075		Jeep Dove	91.29	0.4	0.61	1.96	1.86	6.41	91.27	0.18	0.1	0.20	
020		FeatherBare	85.76	0.08	4.71	18.04	13.38	28.06	86.88	1.03	4.62	0.17	
07		EdithaGAMMA	78.36	0.27	-1.16	30.20	20.88	20.18	78.67	0.28	-1.18	0.75	
079		Guiliga's Tail	90.3	0.58	6.03	8.71	4.37	13.33	90.88	0.66	6.12	0.13	
079		AFROSA 137	70.26	0.08	15.72	25.70	21.87	48.28	70.37	0.09	15.89	0.18	
08		TransitTense	61.71	0.03	3.8	44.21	33.38	48.85	62.88	0.06	3.70	0.12	
078		Klonsing Pig	84.39	0.08	0.63	14.76	1.06	11.37	84.87	0.12	1.80	0.13	
08		Jeetrali Gum	80.94	0.9	5.17	18.62	13.79	23.96	80.30	0.95	5.86	0.12	
02		Green Sea	54.72	-3.77	0.31	63.63	14.29	59.22	54.45	-3.79	0.71	0.68	
016		Amelililar	91.59	1.26	-1.47	4.78	1.52	4.31	91.79	1.28	-1.59	0.06	
08		Ume Bunk	74.28	-1.422	46.5	35.08	5.88	79.22	74.28	-1.457	45.47	0.04	
07		ETAPAR 108	51.78	-0.78	-0.781	37.28	25.13	18.78	51.78	-0.778	-0.778	0.18	

2a. Are Colors Consistent within Page

Ganging jobs on Page- Consistency?



2b. Are Colors Consistent within Job?

First Page “same” as Last?



2c. Colors Consistent Week to Week

Operator to Operator, Press to Press?

Monday January 15



Friday February 19



Week to Week, Location to Location...

3. Are Colors “Matching” Target Ref.

Characterized Reference Printing Conditions

Proof



Offset Press



Digital Press 2



4. Is Resolution Sufficient

Bar Codes, Small Text- Extremely Important



Four Benchmarks Conducted

◆ 1. Gamut Size

- ◆ *ISO Formula calculation, and Percent of PMS w/in 2 ΔE*

◆ 2. Variation (Precision) Benchmarks

- ◆ *a. Within Page Uniformity, VI 816 Target and M-Score*
- ◆ *b. Repeatability- 1000 page press run for digital*
- ◆ *c. Reproducibility: Consistency over days, weeks*

◆ 3. Accuracy

- ◆ *How Close Match to GRACoL and G7 Color Space*
- ◆ *Dependent on Operator Knowledge- Caution*

◆ 4. Resolution (Partial)

- ◆ *Spatial Frequency Response, Visual*

Manufacturers and Printers

Customers and Manufacturers submissions

- Domino Digital
 - Fuji J-Press*
 - HP Indigo Sheet*
 - HP Indigo Roll*
 - Kodak Nexpress*
 - **Kodak Prosper**
 - Konica Minolta KM 1*
 - **Konica Minolta KM1**
 - Xerox iGen*
 - Xeikon *
 - 5 Blind Submissions
- Durst Rho*
- Fuji Acuity**
- Fuji Inca*
- HP Latex*
- Swiss Q**
- EFI Vutek LX**

*** Customer Submitted**

Four Benchmarks Conducted

- ◆ Dashboard to Easily Visualize Results
 - ◆ *Each Track- Different Benchmark*
- ◆ Green is Good, Red... Lower Number is Better

ACCURIOJET KM1 PRESS **									
Track name		Tools	Substrate	Reference Printing Condition	Details				
Test #1 Gamut Size = 513,880 - 75% PM5		0 files		ISOA GRACoL2005_Coated1v2					
Test #2a- Within Page Uniformity		5 files 5.0		Within Page Uniformity	1.3	✓			
Test #2b - Repeatability Within 1000 µg Job		47 files 5.0		Page One- Within Page Uniformity	2.0	✓			
Test #3 - Accuracy to GRACoL		1 files 5.0		GRACoL 2005_Coated1v2	2.2	✓			
M-Score track		1 files 1.0			1.6				

Four Benchmarks Conducted

- ◆ Dashboard to Easily Visualize Results
 - ◆ *Each Track- Different Benchmark*
- ◆ Green is Good, Red... Lower Number is Better

DIGITAL PRESS N									
Track name		Tools	Substrate		Reference Printing Condition		Details		
Test #1 Gamut Size= 351,900	1 file				SOCA GRACoL2006_Coated1v2				
Test #2a- Within Page Uniformity	3 files 5.0				V816_FRI.pdf	5.1			
Test #2b Repeatability SHORT	6 files 5.0				V816_FL1.pdf	5.5			
Test #3 - Accuracy to GRACoL	0 files 5.0				SOCA GRACoL2006_Coated1v2				
M-Score track= 49	1 file 1.0					4.7			
SHOW HIDDEN SETUP ASSISTANT									

Four Benchmarks Conducted

◆ Gamut Size

- ◆ *ISO Formula calculation, and Percent of PMS w/in 2 ΔE*

◆ Variation (Precision) Benchmarks

- ◆ *Within Page Uniformity, VI 816 Target and M-Score*
- ◆ *Repeatability- 1000 page press run for digital*
- ◆ *Reproducibility: Consistency over days, weeks*

◆ Accuracy

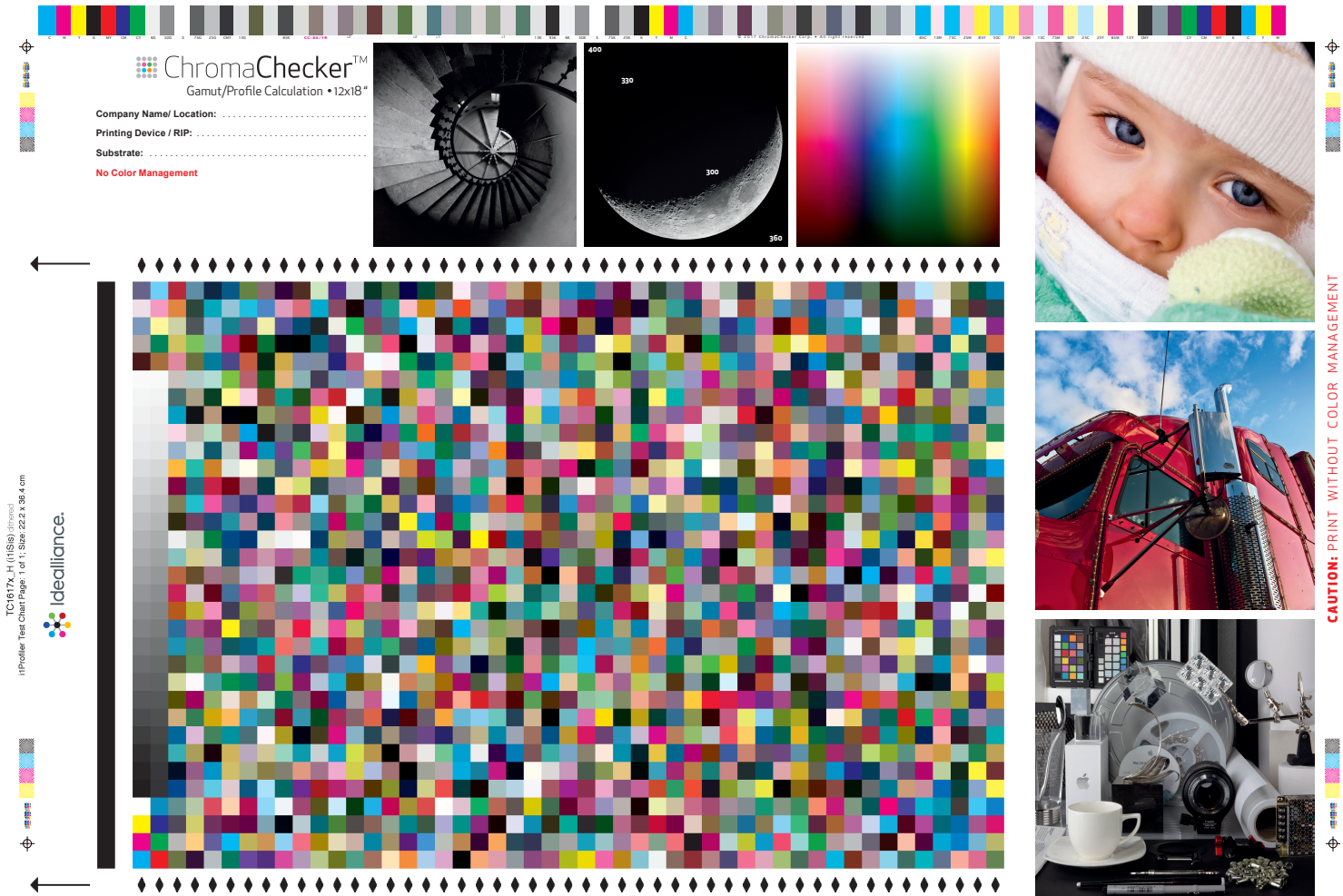
- ◆ *How Close Match to GRACoL and G7 Color Space*
- ◆ *Dependent on Operator Knowledge- Caution*

◆ Resolution

- ◆ *Spatial Frequency Response, Visual*

Benchmark #1 Gamut Size

IT8 7/5 (TC1617) Target w/o CMS



Device Gamut Test #1

Gamut Size of the output device

- Larger is better- more vivid, more colors
- Calculate PMS colors accurately simulated
- Calculate if device can Simulate GRACoL
- Same Target and measurements
- Compare with Gamut Comparison Tool

Device Gamut Test #1

Gamut Size of the output device

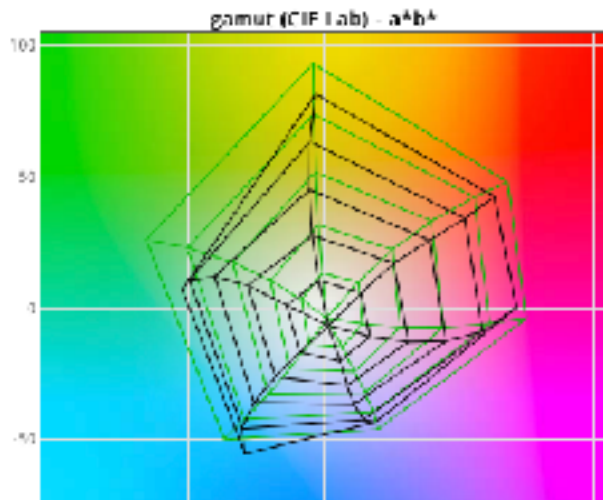
GS3250r_VIGGS3250r13oV_600x360_CMYKcm

CGATS21_CRPC6

Compare

0 2 4 6 8 10 12 14

Gamut

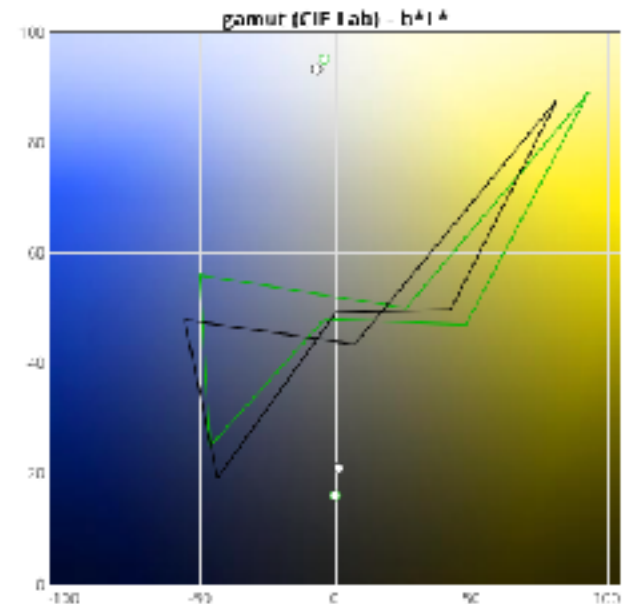
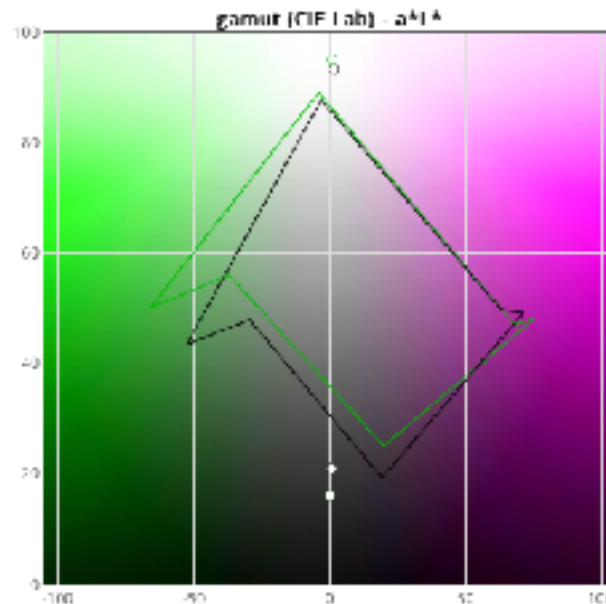


8.73

Max 14.73

Average 4.35

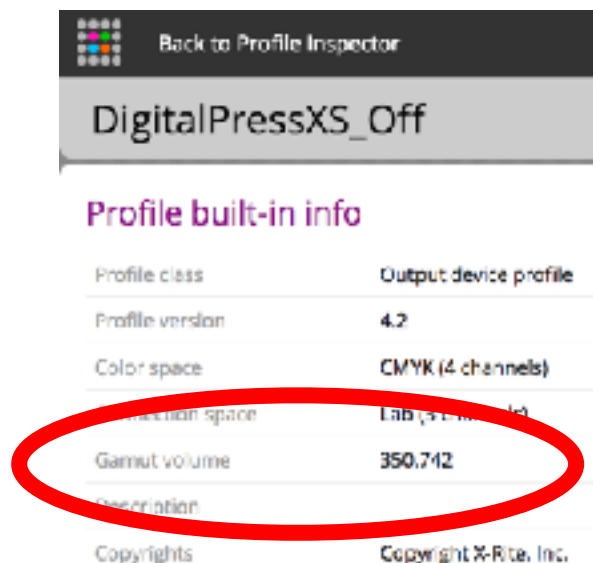
Standard deviation 2.06



Benchmark #1 Gamut Size

IT8 7/5 (TC1617) Target w/o CMS

- ◆ Told vendor best substrate for color range
- ◆ ISO TS 18621-11 Metric



Back to Profile Inspector

DigitalPressXS_Off

Profile built-in info

Profile class	Output device profile
Profile version	4.2
Color space	CMYK (4 channels)
Connection space	Lab (5 channels)
Gamut volume	350,742
Description	
Copyrights	Copyright X-Rite, Inc.

Benchmark #1- PMS Percentages

IT8 7/5 (TC1617) Target w/o CMS

- ◆ Told vendor best substrate for color range
- ◆ ISO TS 18621-11 Metric
- ◆ Calculate Percent of PMS Colors w/in $2\Delta E$

Virtual Spot Print

PANTONE+ Solid Coated-V3

ICC profile

JPress_Fin_Gloss_80lb_Cvr_GrC12013_M1 ▾

M. cond.

MD ▾

ΔE Formula

ΔE 2000 ▾

ΔE Threshold

2

show

Benchmark #1 Gamut Size

IT8 7/5 (TC1617) Target w/o CMS

- ◆ ISO TS 18621-11 Metric
- ◆ Calculate Percent of PMS Colors w/in $2\Delta E$

Back to Color Inspector

opa:0.01
⌂
🔍
TOOLS
📄
?
🔧

Virtual Spot Print

Library: PANTONE+ Solid Coated-V3 ICC profile: [Press_Fx_Gloss_80% Cv_GRC2013_M1] M_cand_L_M ΔE 1000 Threshold 2

Statistics

Samples	Samples < threshold	Max	Average	Std. Dev.	ΔE FACTOR
1846	1471 (80%)	17.23	1.21	1.72	4.98

Export

HIERARCHY:
CMYK LAB + CMYK + devices
Download

Color list

ID		Name	Original L*a*b*			Press: Fo Gloss: 80% Cv: GRC2013_M1				Roundrip L*a*b*			ΔE 2000
			L*	a*	b*	Cyan	Magenta	Yellow	Black	L*	a*	b*	
R747		PANTONE 2728 C	11.23	42.38	-72.61	100.00	80.00	10.20	34.12	19.56	19.06	-43.93	17.23
R1828		PANTONE Reflex Blue C	11.29	33.81	-68.82	100.00	77.65	11.76	32.05	20.26	8.06	-43.79	16.11
R1807		PANTONE Blue 072 C	17.5	44.36	-76.94	100.00	81.57	5.88	20.39	20.99	16.21	-51.44	13.64
R749		PANTONE 2720 C	14.04	49.70	-99.39	96.47	92.94	4.71	23.10	18.42	24.39	-48.12	10.79
R773		PANTONE 285 C	23	20.36	-70.1	100.00	67.45	7.45	12.94	26.16	5.20	-52.87	1.88
R751		PANTONE 2747 C	11.93	22.78	-55.52	100.00	82.35	12.94	41.18	17.96	9.53	-35.70	1.78
R763		PANTONE 2749 C	11.93	23.97	-66.46	100.00	83.60	11.76	40.78	17.74	11.06	-46.40	1.26
R862		PANTONE 330 C	71.46	-46.87	-4.02	52.16	0.00	28.24	0.00	72.38	-29.01	-4.51	1.00
R749		PANTONE 2745 C	11.11	36.82	-55.64	95.69	95.29	7.45	38.82	17.80	28.89	-42.06	1.91
R417		PANTONE 2240 C	66.28	-67.13	-2.46	72.16	0.00	38.43	0.00	62.95	-48.21	-3.86	1.53

Benchmark #1 Gamut Size: Results

	<u>ISO Gamut</u>	<u>% PMS within 2 ΔE</u>
◆ Fuji J-Press*	558,700	75%
◆ Kodak Prosper	515,200	74%
◆ Konica Minolta KM1	512,900	76%
◆ Domino	504,100	71%
◆ Digital Press NI	459,400	70%
◆ Indigo 12000*	451,100	66%
◆ Digital Press O	445,300	68%
◆ Indigo WS6600*	420,900	63%
◆ Igen 4 Press*	401,300	65%
◆ Digital Press N	351,900	57%
◆ Kodak Nexpress*	350,700	57%

Four Benchmarks Conducted

◆ Gamut Size

- ◆ *ISO Formula calculation, and Percent of PMS w/in 2 ΔE*

◆ Variation (Precision) Benchmarks

- ◆ *Within Page Uniformity, VI 816 Target and M-Score*
- ◆ *Repeatability- 1000 page press run for digital*
- ◆ *Reproducibility: Consistency over days, weeks*

◆ Accuracy

- ◆ *How Close Match to GRACoL and G7 Color Space*
- ◆ *Dependent on Operator Knowledge- Caution*

◆ Resolution

- ◆ *Spatial Frequency Response, Visual*

Chicken Does come before Egg

Have to have **Precision** before **Accuracy**

- *Need Device consistency to know how to build ICC Profile*
- *Without consistent imaging (proper consumables and maintenance) no sense Color Managing*
- ***Assign E-Factor for Precision- Variation Allowed***
- ***Assign E-Factor for Accuracy- Deviation Allowed***
- ***Conformance requires both Precision/Accuracy***
- ***Metric “Delta E” bigger the number, bigger difference***

Device Precision- 3 Variation Tests

1st Calculate Within page variation

Variation within a Page

2nd Calculate Within Job variation

Repeatability between multiple pages in job

3rd Calculate Between Job Variation

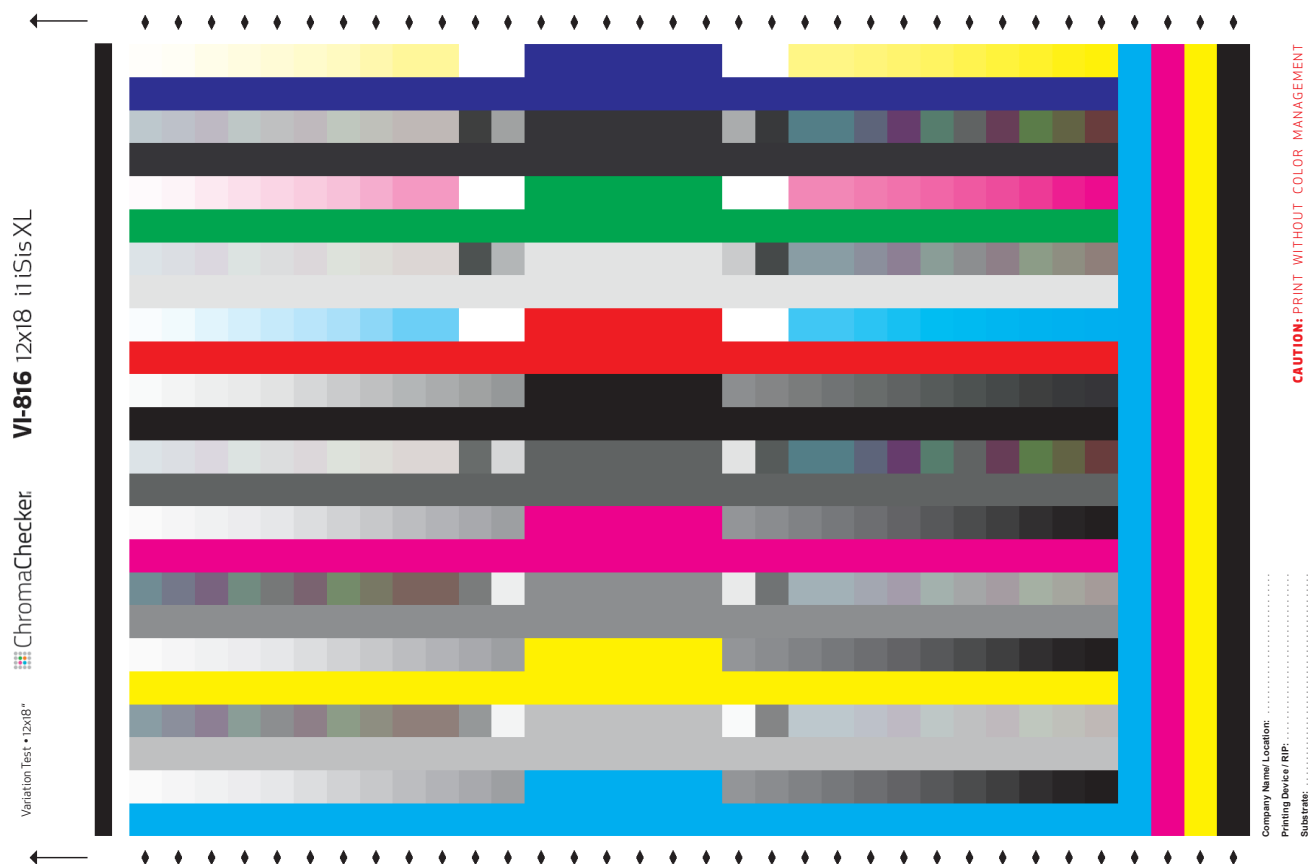
Reproducibility: multiple jobs after calibration

Understand what Normal is, dependent on operator maintenance, and procedures

Device Variation Benchmark

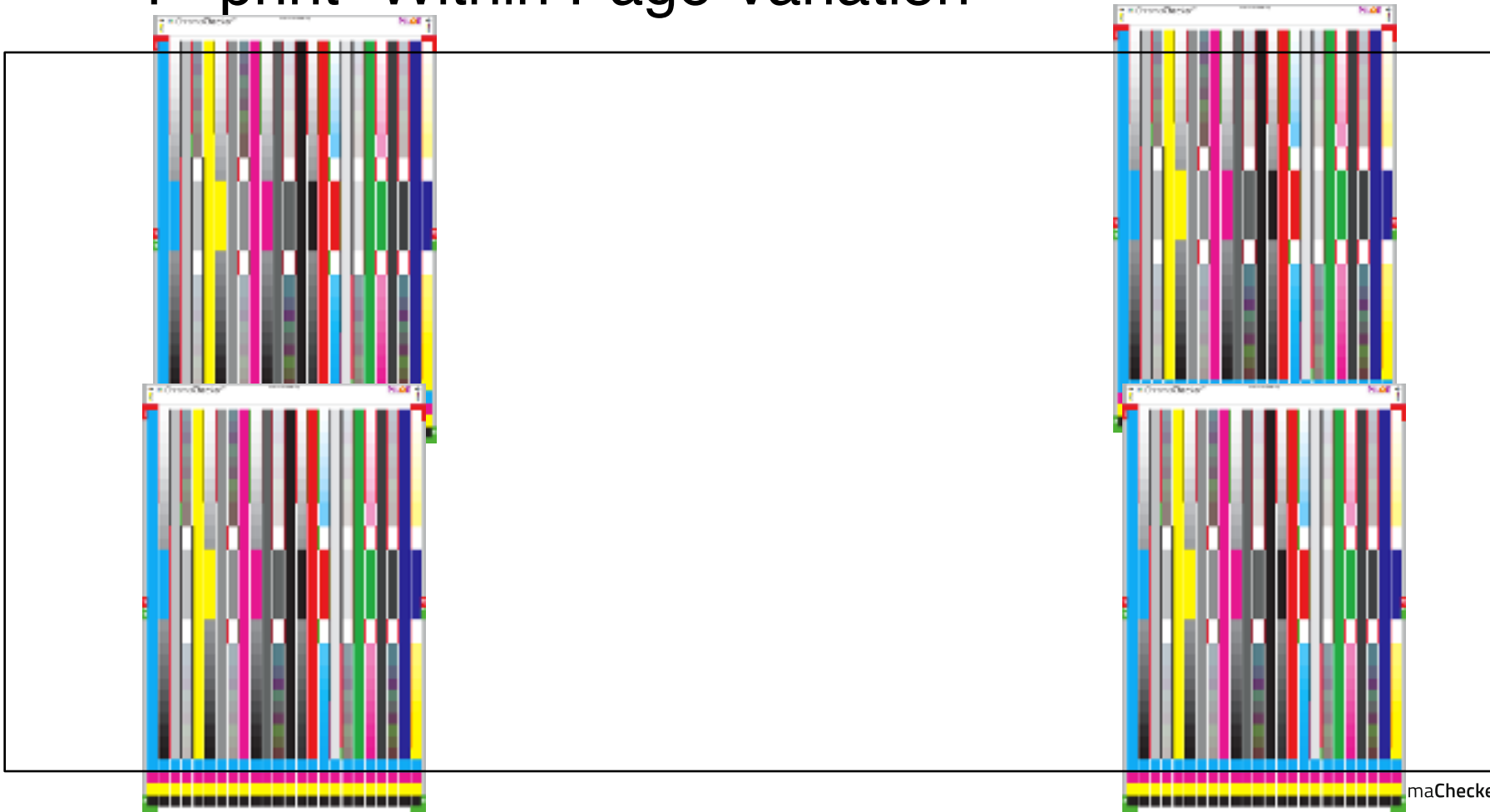
Superset of P2P- Repeating Patches (7120)

- Cover Page Area- may need multiple targets



Large Format Within Page

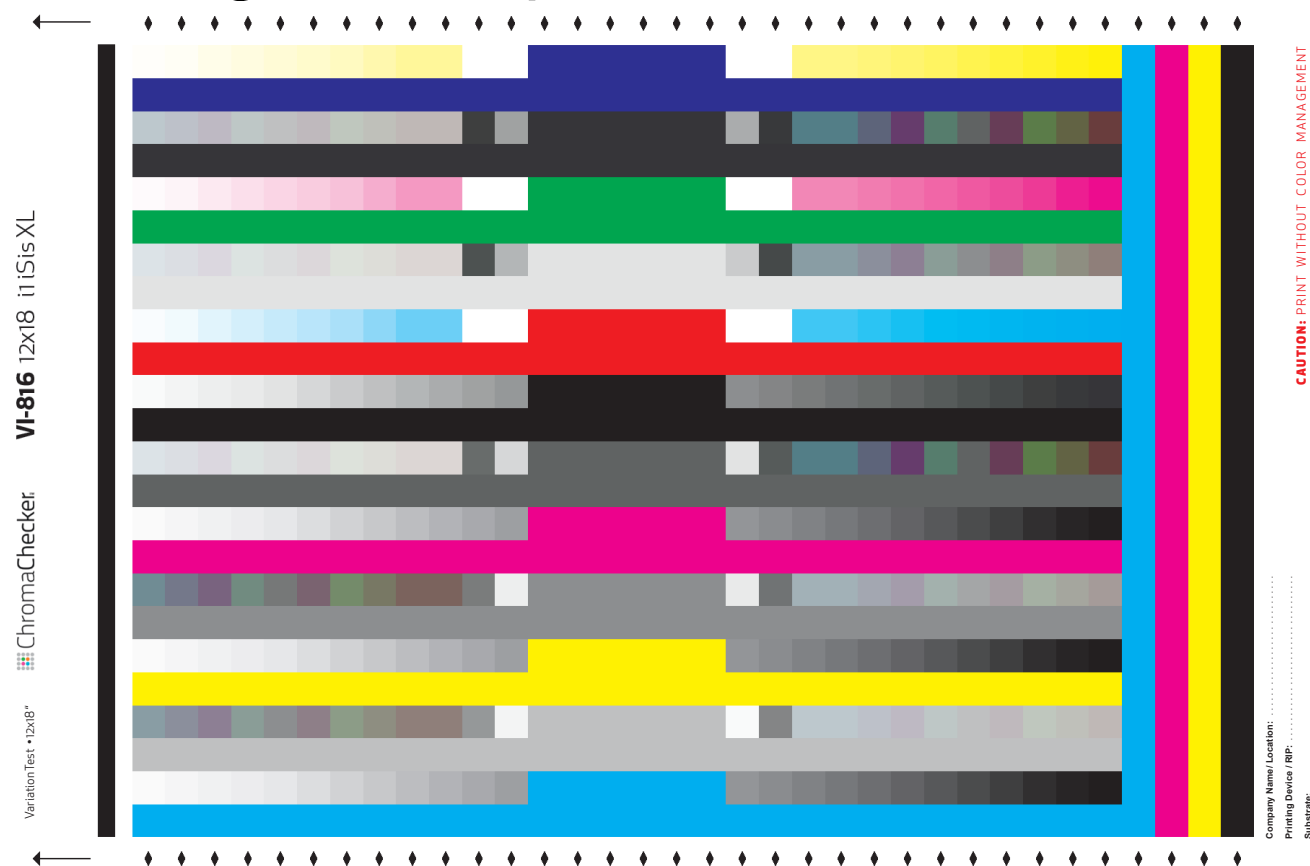
- Size Test Form for your output media (28,610)
- 1st print- Within Page Variation



Device Variation Benchmark

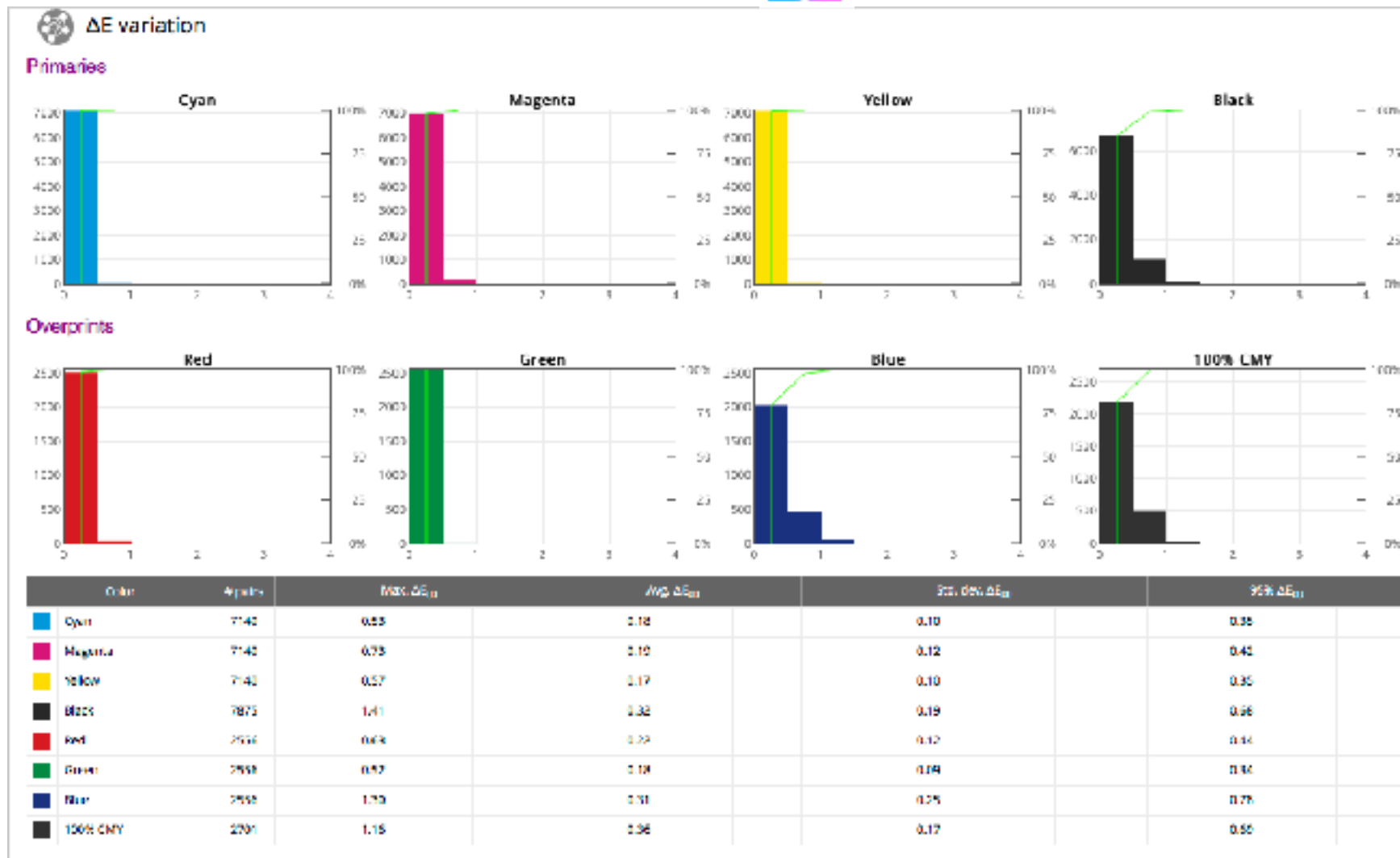
Within Page, Within Job, Between Jobs

- Same Target, Multiple Calculations at same time




Sample Result #2a: Within Page

■ Printer A: Within Page  = 1.1

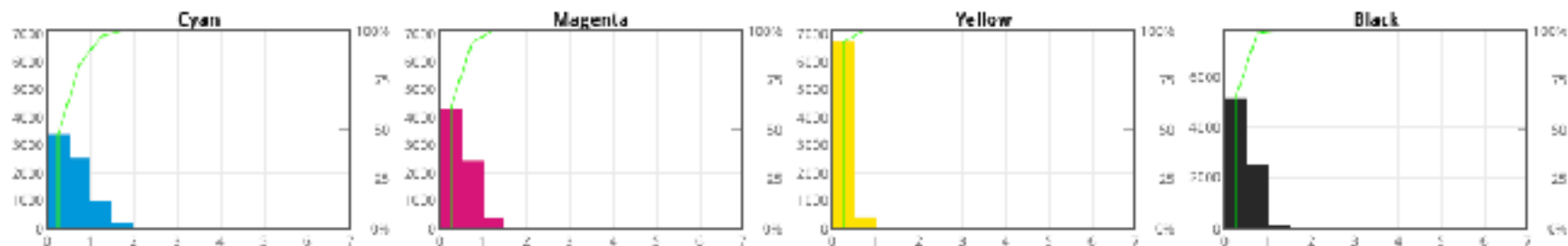


Sample Result #2a: Within Page

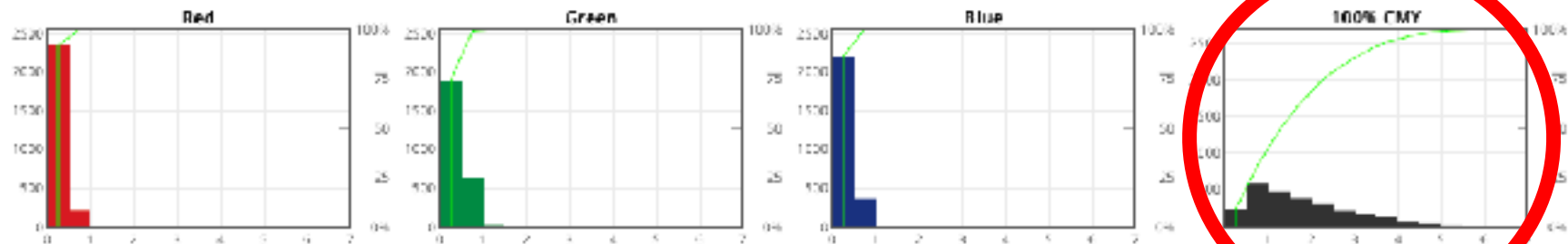
■ Printer B: Within Page  = 4.2









 ΔE variation

Primaries



Overprints



Color	# points	Min. ΔE_{95}	Avg. ΔE_{95}	Std. dev. ΔE_{95}	Max. ΔE_{95}
 Cyan	7140	2.11	0.60	0.40	
 Magenta	7140	1.40	0.45	0.28	1.00
 Yellow	7140	0.79	0.25	0.14	0.51
 Black	7875	1.53	0.44	0.21	0.93
 Red	2590	0.91	0.28	0.14	0.54
 Green	2590	1.21	0.39	0.21	0.76
 Blue	2590	0.96	0.32	0.16	0.68
 100% CMY	2701	0.90	1.84	1.21	4.21

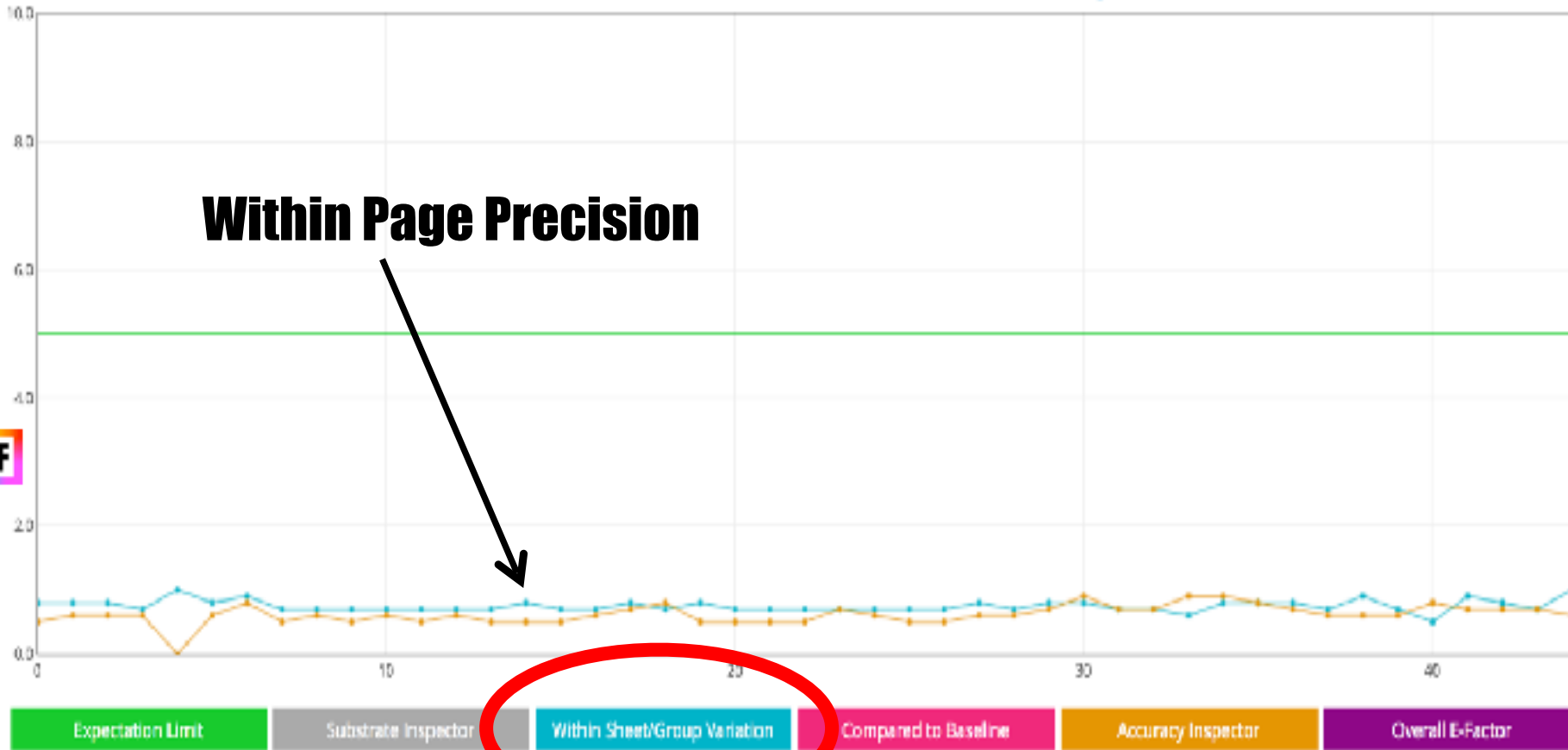
Sample Result #2b: Within Job

■ Printer A: 1000 Page Run  =1.0

Timeline:

 You can drag timeline graph to zoom in. Click on the timeline to zoom out.


Within Page Precision



Sample Result #2b: Within Job

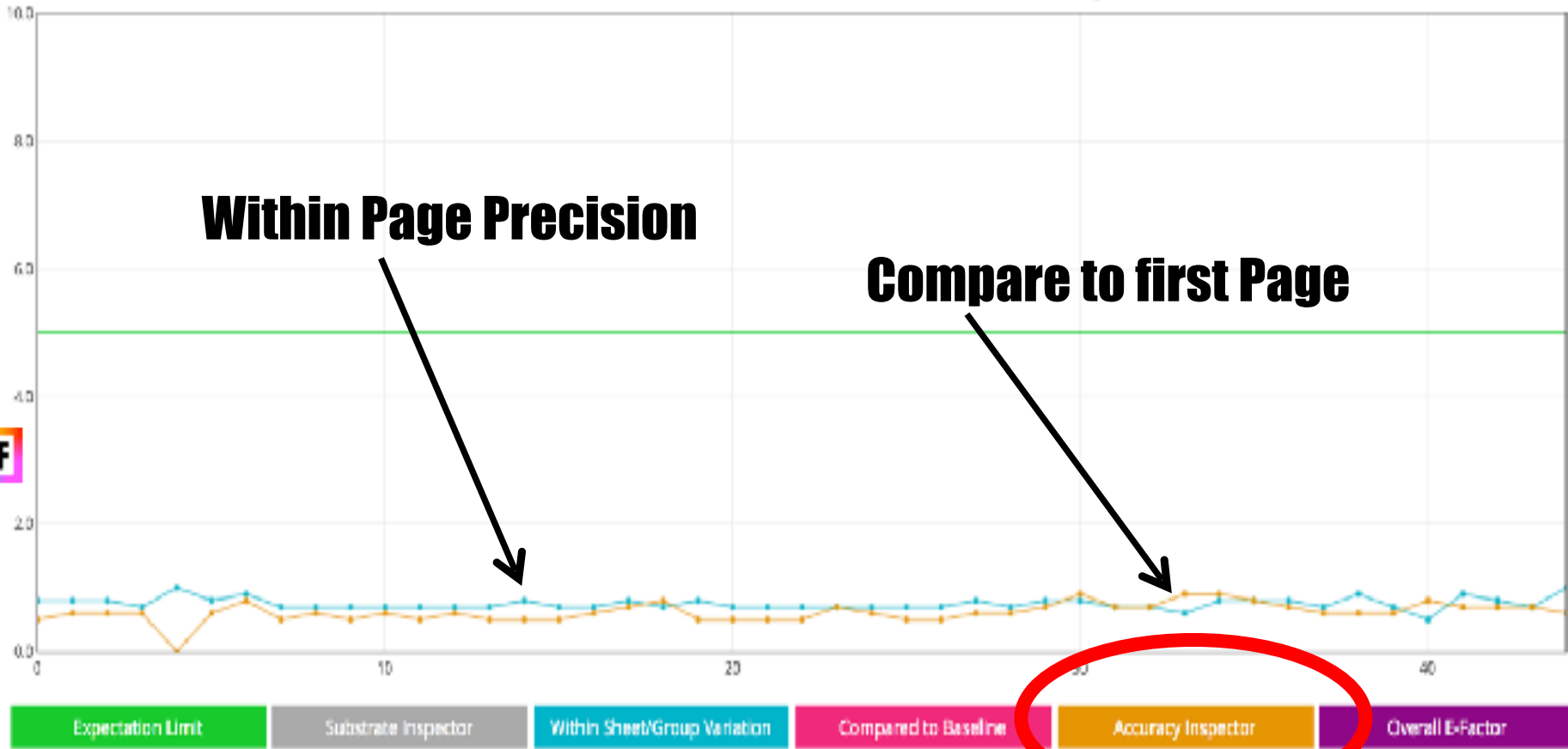
■ Printer A: 1000 Page Run  =1.0

Timeline:

 You can drag timeline graph to zoom in. Click on the timeline to zoom out.

Within Page Precision


Compare to first Page



Sample Result #2b: Within Job

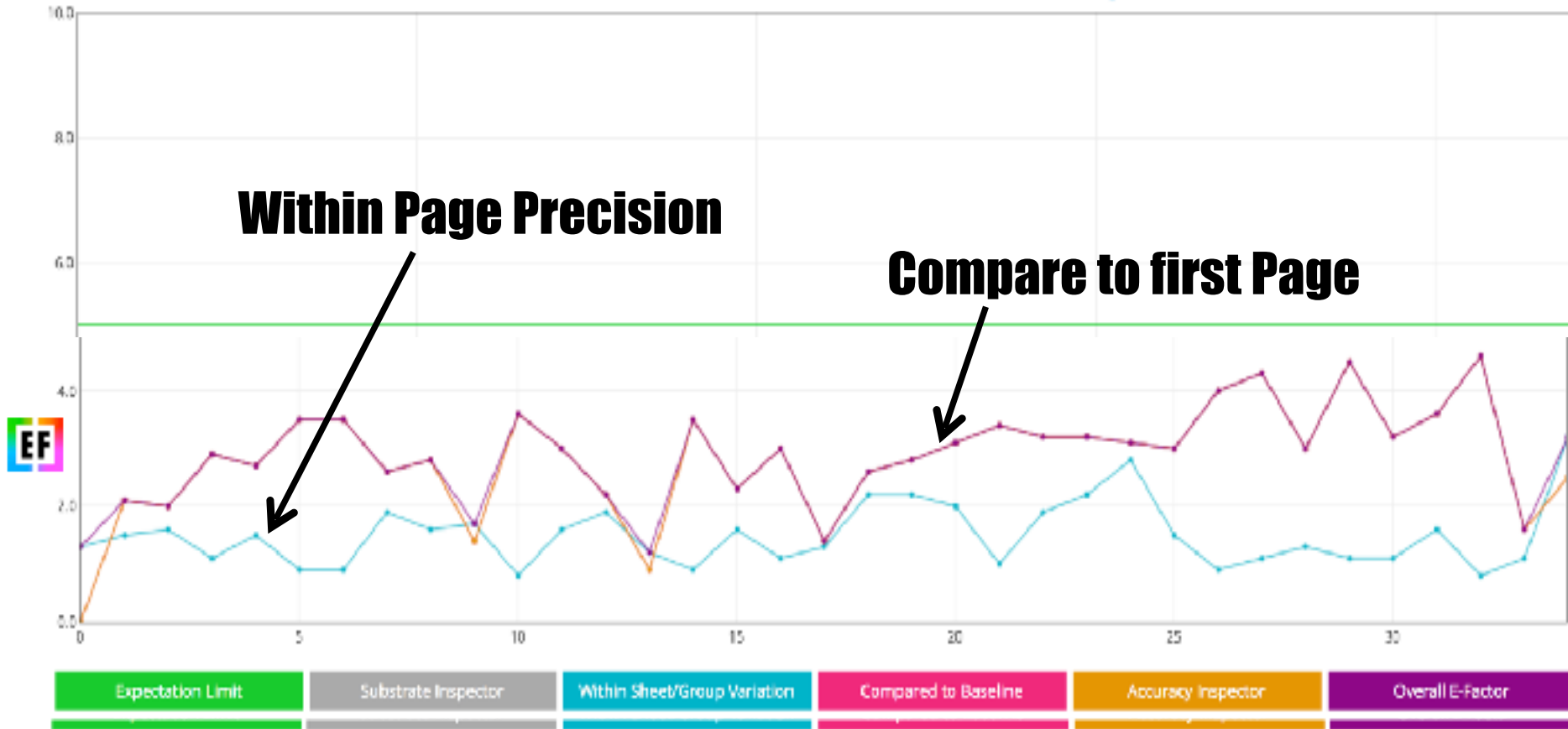
■ Printer A: 1000 Page Run  = 3.2

Timeline:

 You can drag timeline graph to zoom in. Click on the timeline to zoom out.

Within Page Precision

Compare to first Page

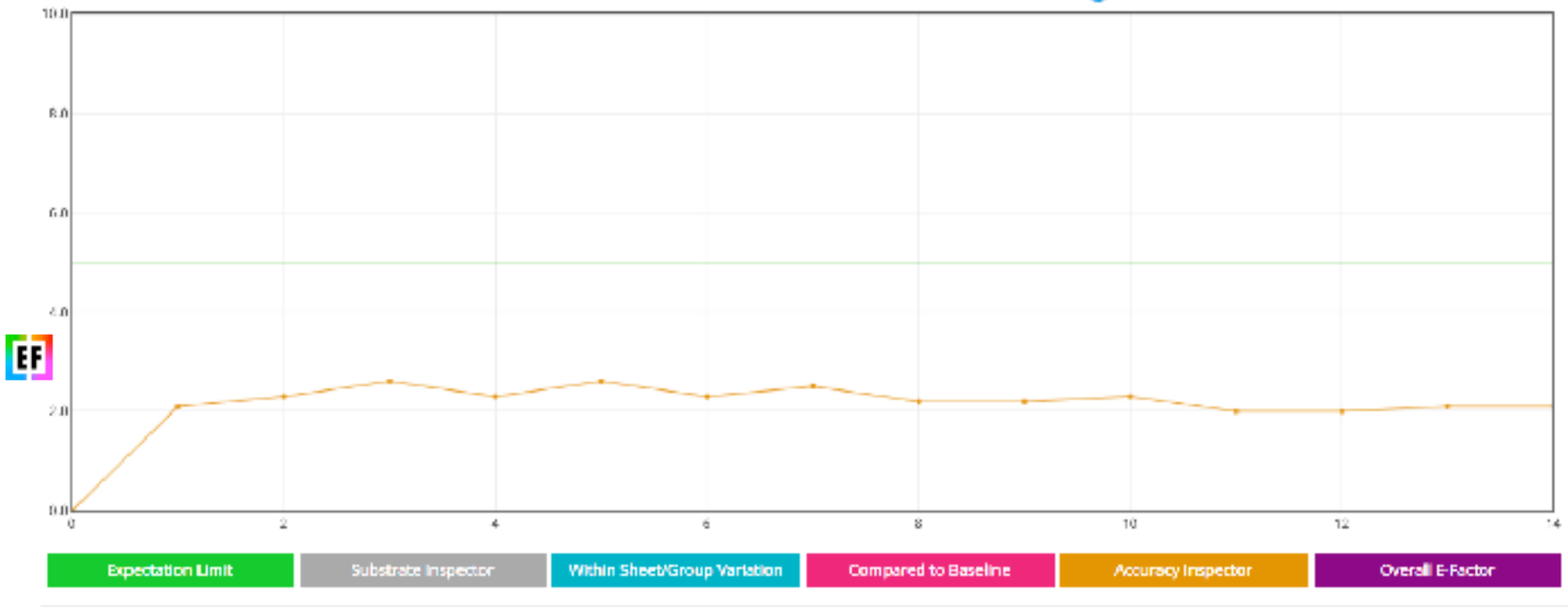


Sample Result #2b: Within Job

- Printer Anny: 1000 page run, every 50 sheets
- E-Factor (CRF 95%): Compared to first sheet

Timeline:


 You can drag timeline graph to zoom in. Click on the timeline to zoom out.

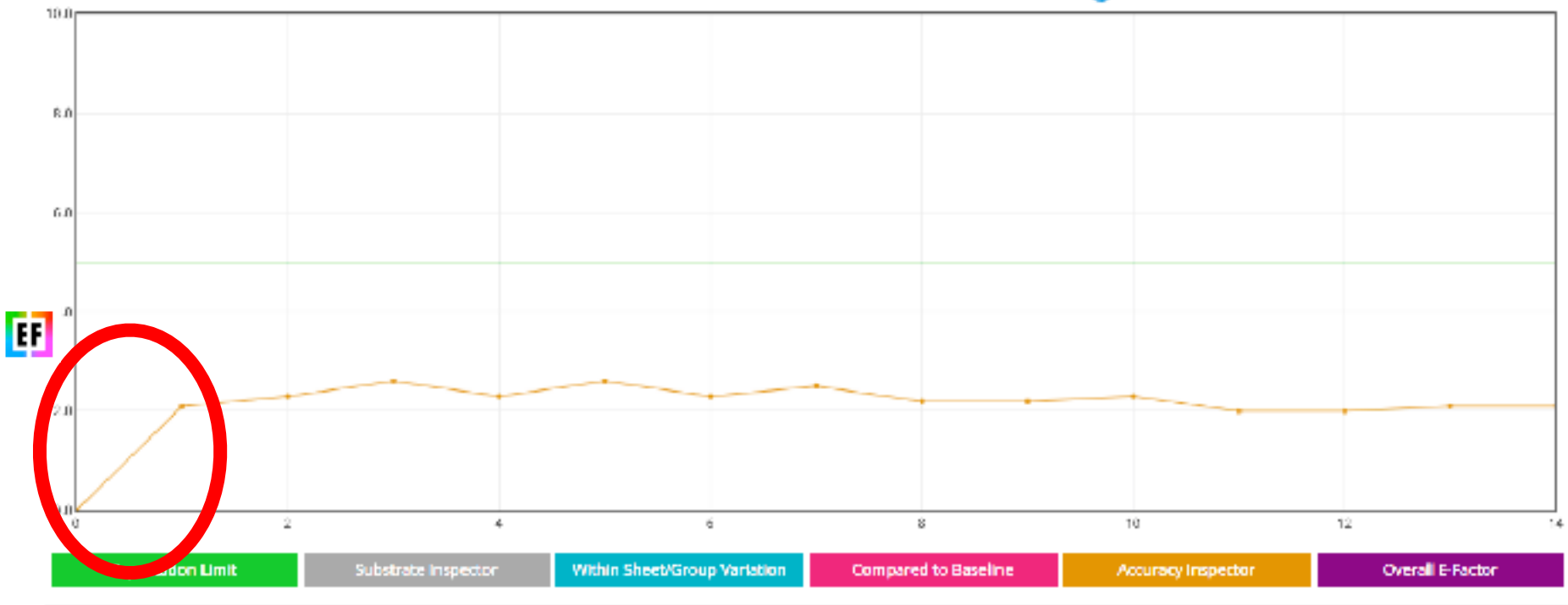


Sample Result #2b: Within Job

- Printer Anny: 1000 page run, every 50 sheets
- E-Factor (CRF 95%): Compared to first sheet?

Timeline:

 You can drag timeline graph to zoom in. Click on the timeline to zoom out.

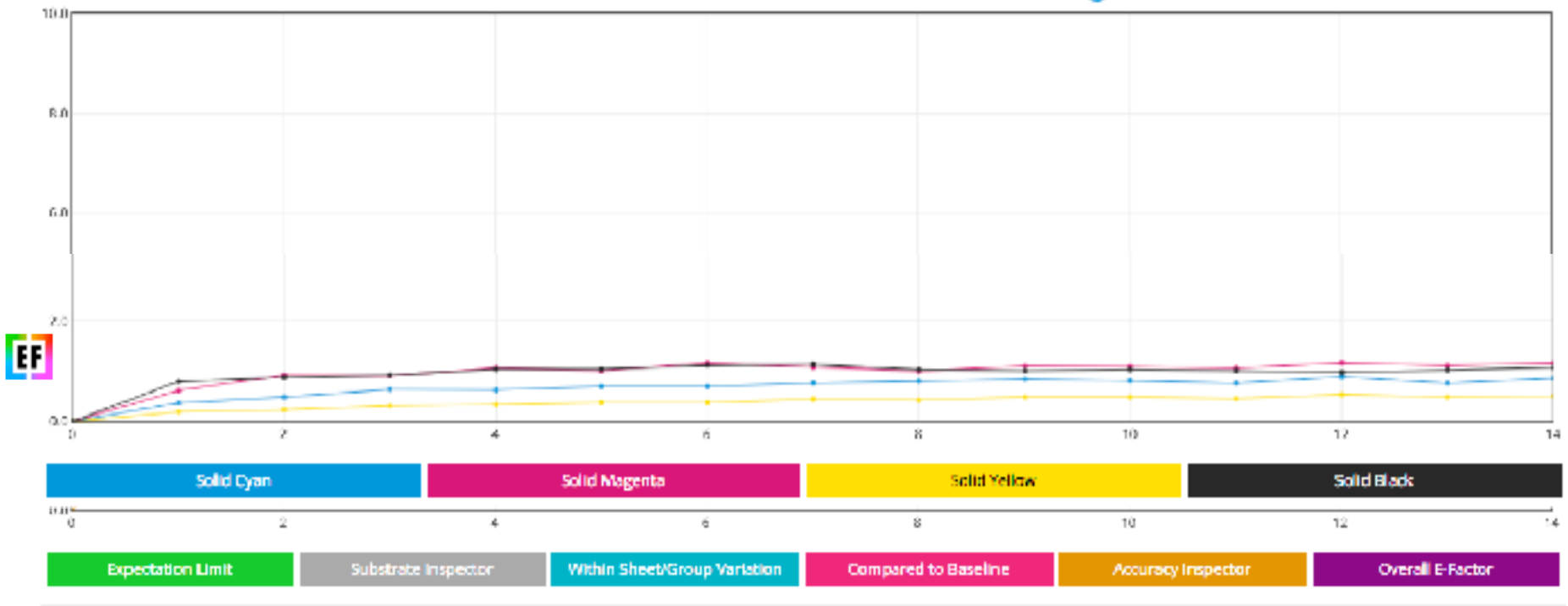


Sample Result #2b: Repeatability

- Printer Anny: 1000 page run, every 50 sheets
- CMYK Solids, Compared to first sheet

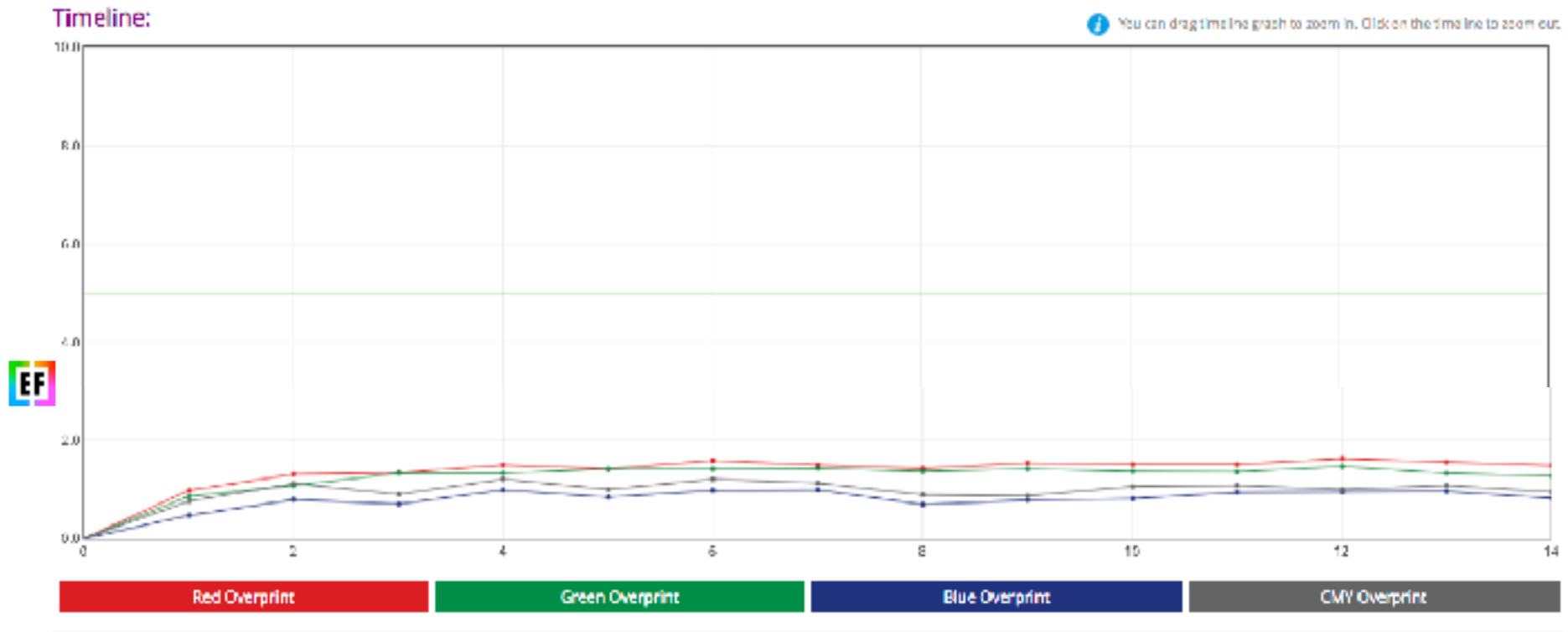
Timeline:

 You can drag timeline graph to zoom in. Click on the timeline to zoom out.



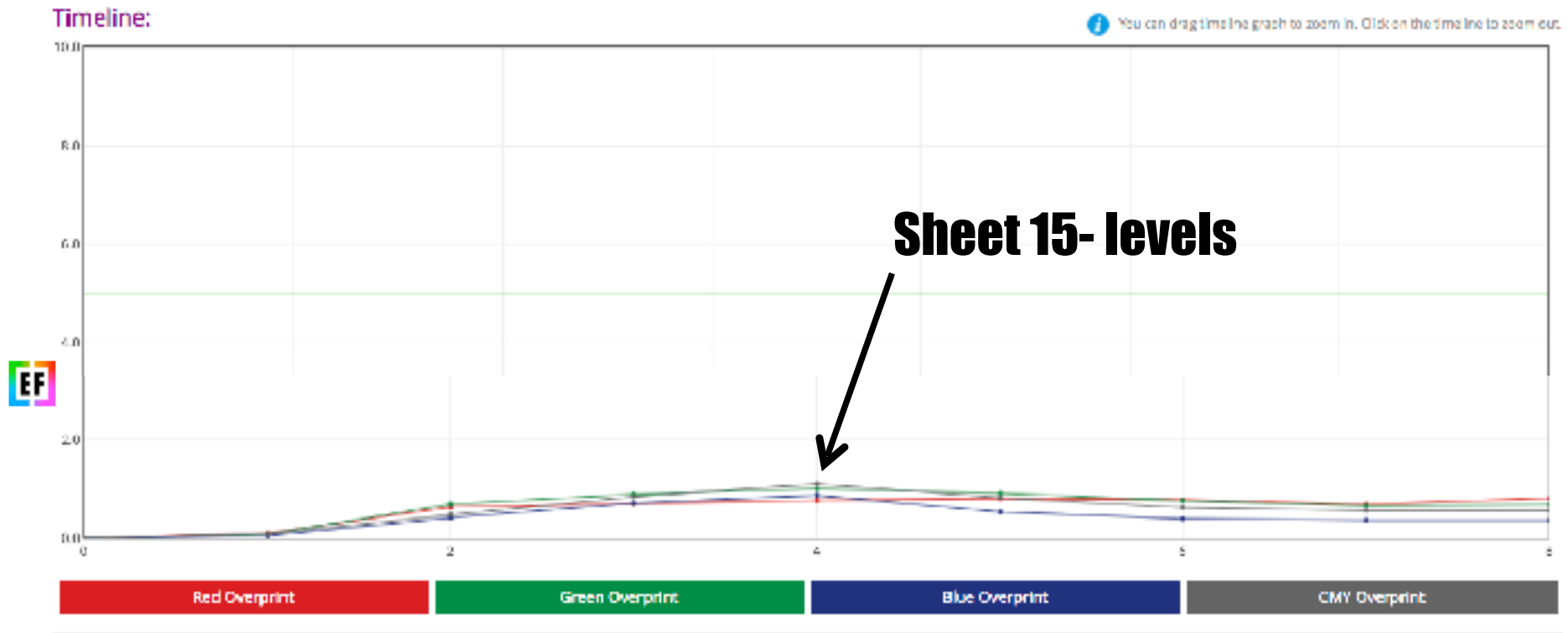
Sample Result #2b: Repeatability

- Printer Anny: 1000 page run, every 50 sheets
- RGB Overprints, Compared to first sheet



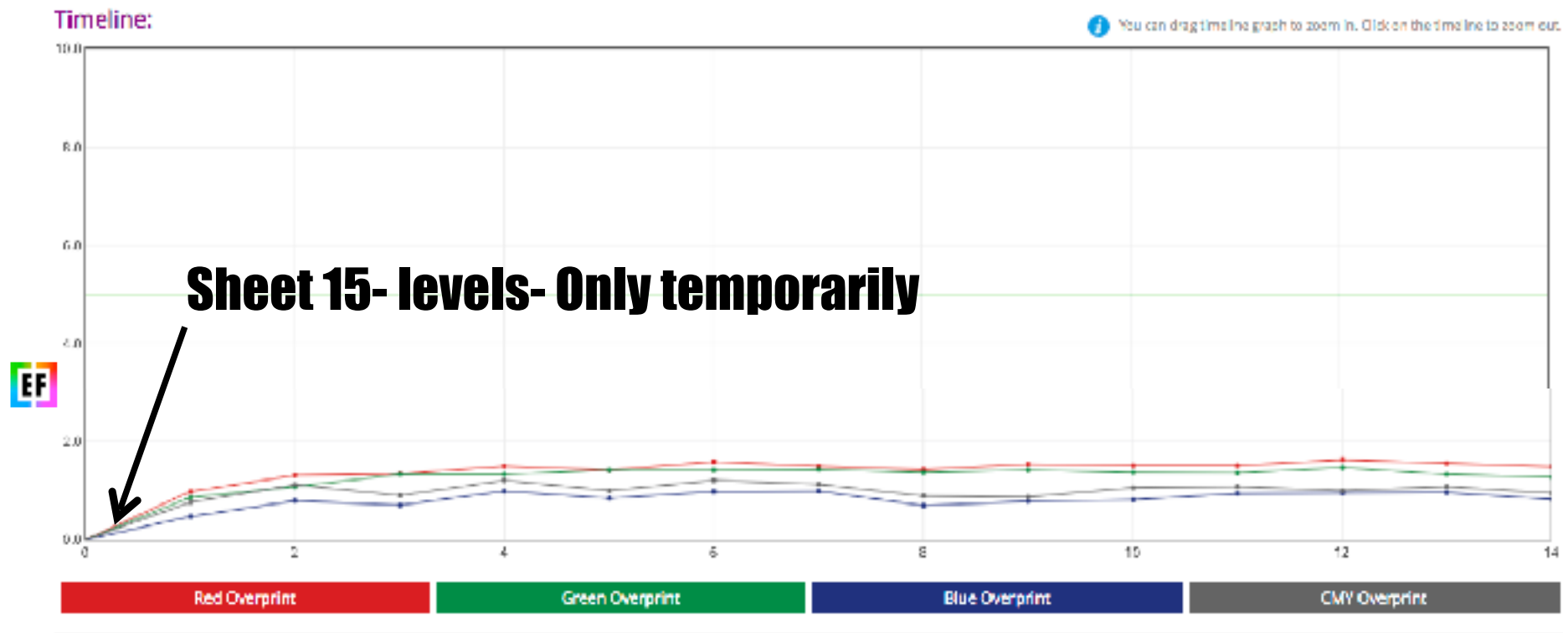
Sample Result #2b: Repeatability

- Printer Anny: First 50 sheets (every 5)
- RGB Overprints, Compared to first sheet



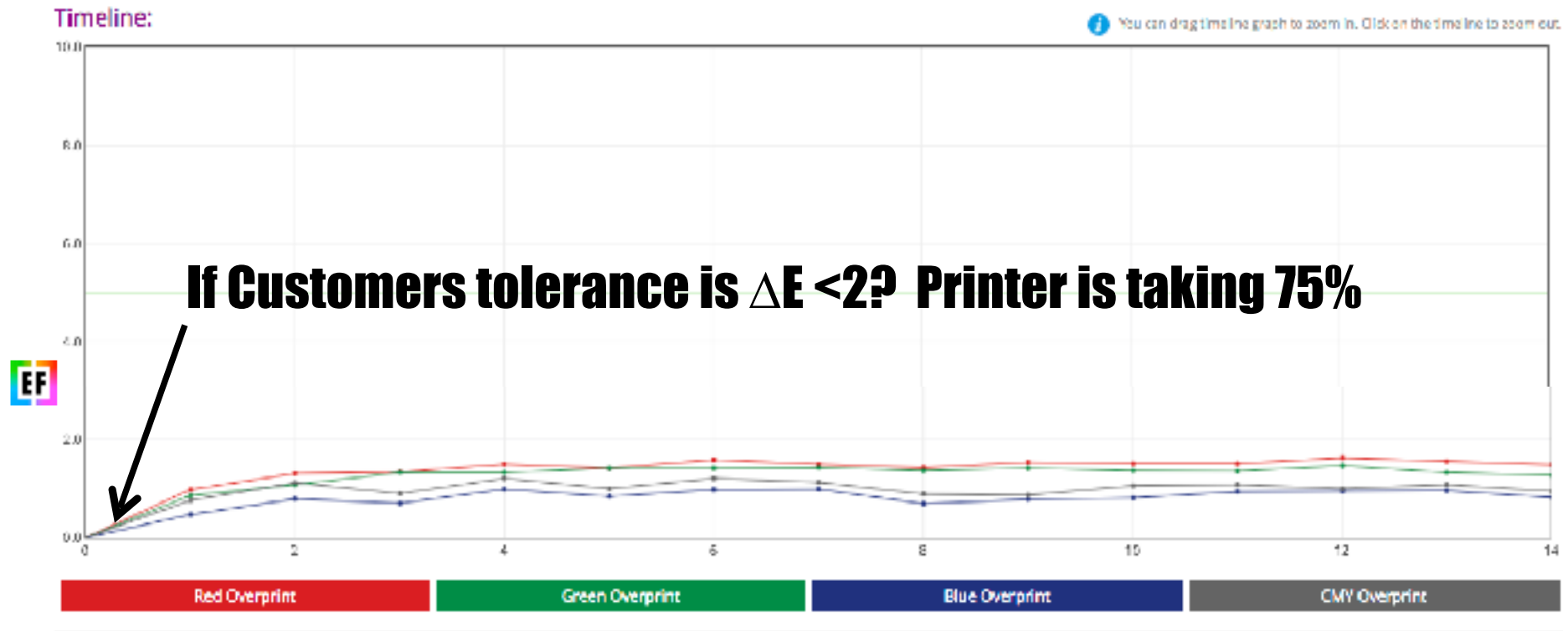
Sample Result #2b: Repeatability

- Printer Anny: 1000 page run, every 50 sheets
- RGB Overprints, Compared to first sheet



Sample Result #2b: Repeatability

- Printer Anny: 1000 page run, every 50 sheets
- RGB Overprints, Compared to first sheet



M-Score Target: Another Within Page

- 3 Targets: Thousand of Same Patch, 20, 40, 65
- Formula to Calculate M-Score: 49



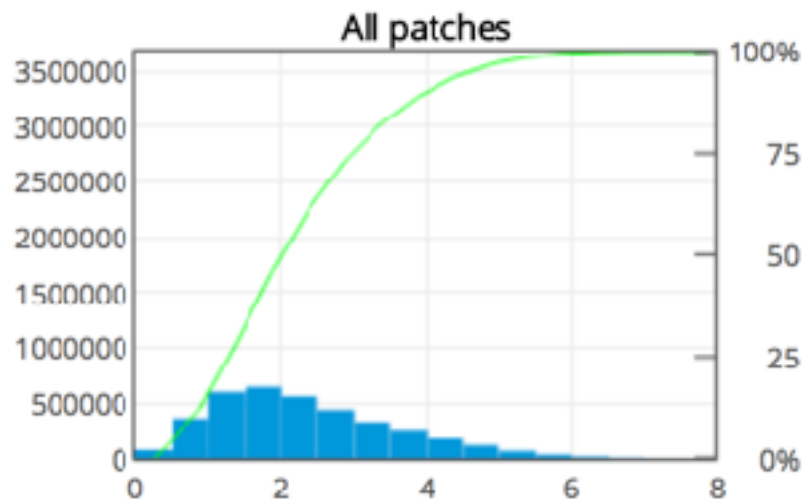
M-Score Target: Another Within Page


- Calculate E-Factor of all patches: 4.7



ΔE variation

All patches



Color	# pairs 	Max. ΔE_{00}	Avg. ΔE_{00}	Std. dev. ΔE_{00}	95% ΔE_{00}
All patches	3681541	7.70	2.34	.23	4.69

Benchmark #2 Variation: Results

Printer	With/in Between			E-Factor M	
◆ Indigo 12000*	1.0	P	1.0	P	1.1
◆ Domino press	1.0	P	1.0	P	1.1
◆ Fuji J-Press*	1.2	P	1.1	P	1.1
◆ KM1 Press*	1.3	P	2.0	P	1.6
◆ Kodak Nexpress*	1.2	P	1.8	F	2.9
◆ Konica Minolta KM1	1.4	P	1.2	F	1.1
◆ Digital Press O	2.3	F	3.2	F	2.2
◆ Igen 6 Press*	2.5	P	2.2	P	2.8
◆ Kodak Prosper	3.0	F	1.4	F	3.6
◆ Digital Press N	5.1	F	5.5	F	4.7
◆ Indigo 6600 *	.9	P	Incomplete		3.0
◆ Indigo 6000 *	1.8	F			

Four Benchmarks Conducted

◆ Gamut Size

- ◆ *ISO Formula calculation, and Percent of PMS w/in 2 ΔE*

◆ Variation (Precision) Benchmarks

- ◆ *Within Page Uniformity, VI 816 Target and M-Score*
- ◆ *Repeatability- 1000 page press run for digital*
- ◆ *Reproducibility: Consistency over days, weeks*

◆ Accuracy

- ◆ *How Close Match to GRACoL and G7 Color Space*
- ◆ *Dependent on Operator Knowledge- Workflow Caution*

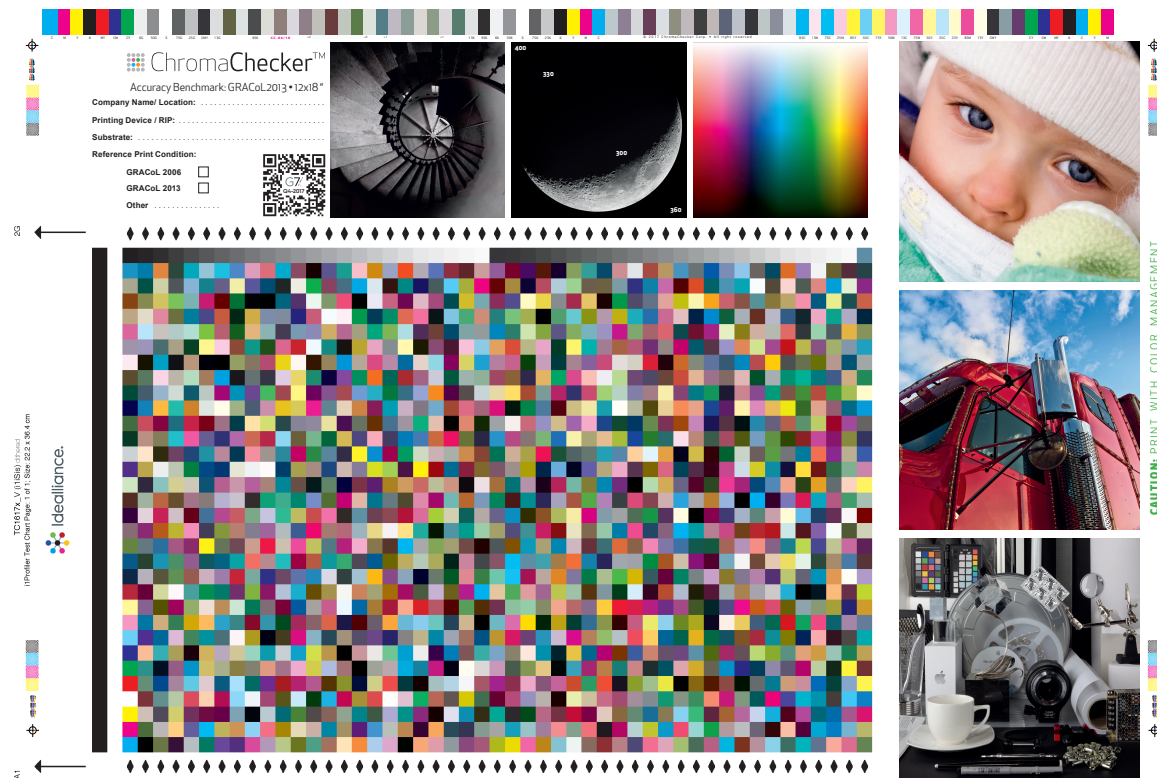
◆ Resolution

- ◆ *Spatial Frequency Response, Visual*

Device Accuracy Benchmark #3

Two Main Calculations- Print with CMS

- E-Factor- How Close to GRACoL (lower better)
- Pass/Fail G7 Color Space Conformance



Why E-Factor and G7 Calculations

Just Because G7- Not necessarily Sellable
Not G7 doesn't mean not Sellable

File list:

	Measurement	# Shots	Created																	
	 korner_2017-11-03_10_26_000.sx7	3	2017-11-03 10:06	ICC	✓	✗	✓			✓	✗			Δ7.2		4.3	4.3	✓		
	 korner_2017-10-30_14_16_41_240.sx7	3	2017-10-30 14:16	ICC	✓	✗	✓			✗	✗			Δ7.2		4.6	4.6	✗		
	korner_2017-10-27_12_57_35_810.sx7	4	2017-10-27 12:57	ICC	✓	✓	✓			✓	✗			Δ2.2		4.2	4.2	✓		
	 korner_2017-10-26_13_23_01_541.sx7	1	2017-10-26 13:02	ICC	✓	✓	✓			✓	✗			Δ3.7		4.0	4	✓		
	 korner_2017-10-24_11_07_36_421.sx7	3	2017-10-24 11:07	ICC	✓	✓	✓			✓	✗			Δ4.2		4.1	4.2	✓		
	Select opposite																			

- *Does that mean the failed one is not sellable?*
- *Visual Appearance is consistent*

Real World Scenario #2:

Multiple devices- Multiple Cities- G7

TF100 FLEET							
TRUCK NAME			SUBSTRATE		Reference Mining Location		Details
<input type="checkbox"/> Atlanta	7 files	5.0			SHCA CoarboGRACOL2006HM3E		
<input type="checkbox"/> Austin	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
<input type="checkbox"/> Boston	8 files	5.0			SHCA CoarboGRACOL2006HM3E		
<input type="checkbox"/> Chicago	7 files	5.0			SHCA CoarboGRACOL2006HM3E		
<input type="checkbox"/> Dallas	7 files	5.0			SHCA CoarboGRACOL2006HM3E		
<input type="checkbox"/> Denver	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	19 files	5.0			SHCA CoarboGRACOL2006HM3E		
	101 files	5.0			SHCA CoarboGRACOL2006HM3E		
	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	9 files	5.0			SHCA CoarboGRACOL2006HM3E		
	7 files	5.0			SHCA CoarboGRACOL2006HM3E		
	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	9 files	5.0			SHCA CoarboGRACOL2006HM3E		
	13 files	5.0			SHCA CoarboGRACOL2006HM3E		
	9 files	5.0			SHCA CoarboGRACOL2006HM3E		
	7 files	5.0			SHCA CoarboGRACOL2006HM3E		
	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	14 files	5.0			SHCA CoarboGRACOL2006HM3E		
	9 files	5.0			SHCA CoarboGRACOL2006HM3E		
	9 files	5.0			SHCA CoarboGRACOL2006HM3E		
	5 files	5.0			SHCA CoarboGRACOL2006HM3E		
	15 files	5.0			SHCA CoarboGRACOL2006HM3E		

Real World Scenario #2:

Multiple devices- Multiple Cities- G7

TF100 FLEET								
TABLE NAME				SUBSTRATE		REFERENCE MINING LOCATION		LEGEND
<input type="checkbox"/> Atlanta	7 files	5.0				SECA COARBOGRACOL2006HM3E		
<input type="checkbox"/> Austin	5 files	5.0				SECA COARBOGRACOL2006HM3E		
<input type="checkbox"/> Boston	8 files	5.0				SECA COARBOGRACOL2006HM3E		
<input type="checkbox"/> Chicago	7 files	5.0				SECA COARBOGRACOL2006HM3E		
<input type="checkbox"/> Dallas	7 files	5.0				SECA COARBOGRACOL2006HM3E		
<input type="checkbox"/> Denver	7 files	5.0				SECA COARBOGRACOL2006HM3E		
	19 files	5.0				SECA COARBOGRACOL2006HM3E		
	111 files	5.0				SECA COARBOGRACOL2006HM3E		
	5 files	5.0				SECA COARBOGRACOL2006HM3E		
	9 files	5.0				SECA COARBOGRACOL2006HM3E		
	7 files	5.0				SECA COARBOGRACOL2006HM3E		
	5 files	5.0				SECA COARBOGRACOL2006HM3E		
	9 files	5.0				SECA COARBOGRACOL2006HM3E		
	13 files	5.0				SECA COARBOGRACOL2006HM3E		
	9 files	5.0				SECA COARBOGRACOL2006HM3E		
	7 files	5.0				SECA COARBOGRACOL2006HM3E		
	5 files	5.0				SECA COARBOGRACOL2006HM3E		
	5 files	5.0				SECA COARBOGRACOL2006HM3E		
	14 files	5.0				SECA COARBOGRACOL2006HM3E		
	9 files	5.0				SECA COARBOGRACOL2006HM3E		
	9 files	5.0				SECA COARBOGRACOL2006HM3E		
	5 files	5.0				SECA COARBOGRACOL2006HM3E		
	15 files	5.0				SECA COARBOGRACOL2006HM3E		

**10 Fail and 12 Pass
10 are not sellable?**

Real World Situation:

Multiple devices- Multiple Cities-



TF100 FLEET			Reference Mining Location			Details		
TABLE NAME								
<input type="checkbox"/> Atlanta	7 files	5.0		SECA COARBOGRACOL2006HM3E	3.9	✗		
<input type="checkbox"/> Austin	5 files	5.0		SECA COARBOGRACOL2006HM3E	4.6	✗		
<input type="checkbox"/> Boston	8 files	5.0		SECA COARBOGRACOL2006HM3E	3.8	✓		
<input type="checkbox"/> Chicago	7 files	5.0		SECA COARBOGRACOL2006HM3E	3.5	✓		
<input type="checkbox"/> Dallas	7 files	5.0		SECA COARBOGRACOL2006HM3E	4.0	✓		
<input type="checkbox"/> Denver	19 files	5.0		SECA COARBOGRACOL2006HM3E	5.0	✗		
				SECA COARBOGRACOL2006HM3E	3.2	✓		
				SECA COARBOGRACOL2006HM3E	5.9	✗		
				SECA COARBOGRACOL2006HM3E	3.2	✓		
				SECA COARBOGRACOL2006HM3E	3.8	✓		
				SECA COARBOGRACOL2006HM3E	4.0	✗		
				SECA COARBOGRACOL2006HM3E	4.2	✓		
				SECA COARBOGRACOL2006HM3E	4.1	✗		
				SECA COARBOGRACOL2006HM3E	4.7	✓		
				SECA COARBOGRACOL2006HM3E	3.7	✗		
				SECA COARBOGRACOL2006HM3E	5.1	✗		
				SECA COARBOGRACOL2006HM3E	3.3	✓		
				SECA COARBOGRACOL2006HM3E	3.6	✓		
				SECA COARBOGRACOL2006HM3E	4.6	✗		
				SECA COARBOGRACOL2006HM3E	3.7	✓		
				SECA COARBOGRACOL2006HM3E	3.7	✓		
				SECA COARBOGRACOL2006HM3E	1.1	✗		
				SECA COARBOGRACOL2006HM3E	12	✗		

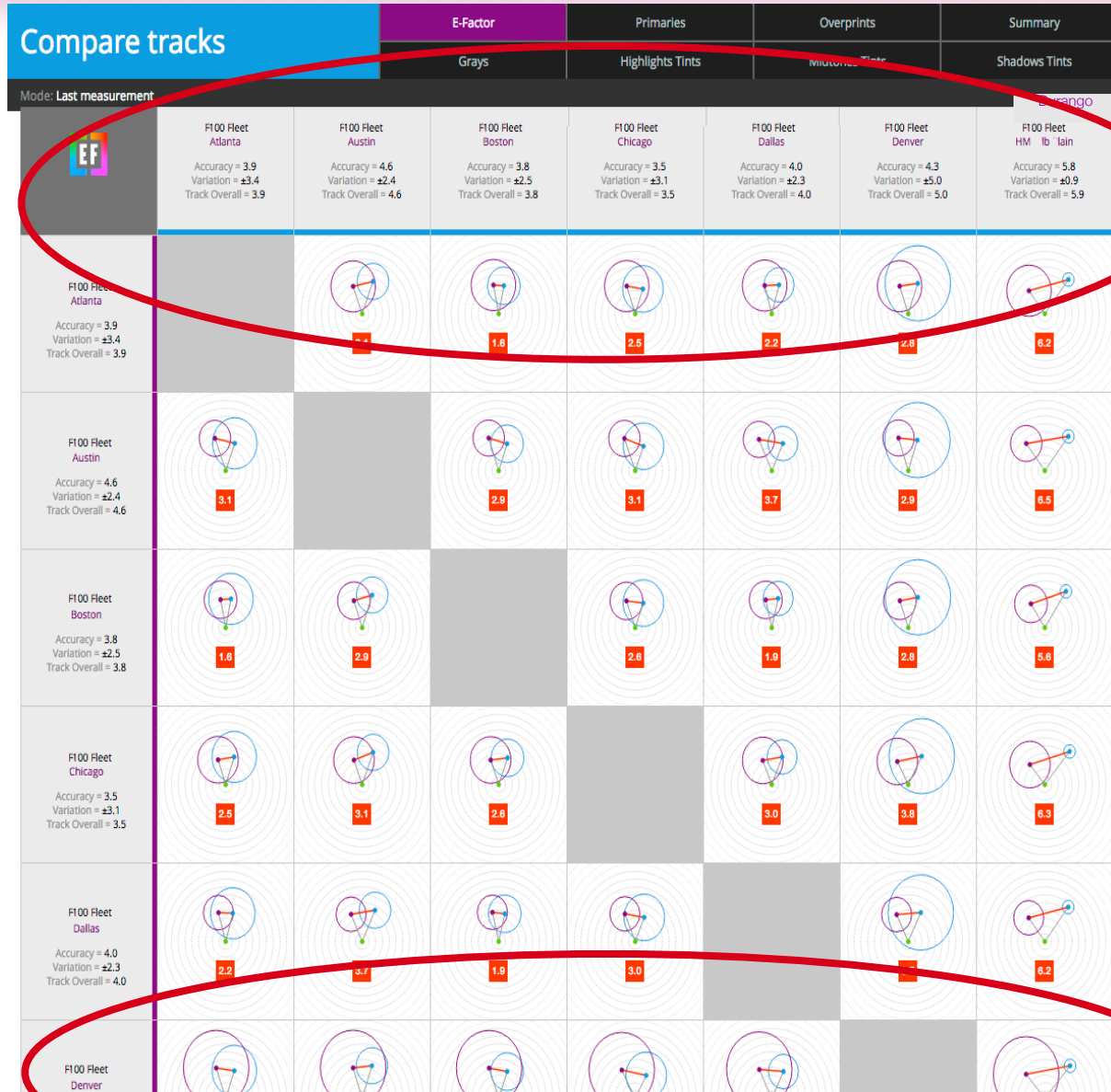
**2 Fail and 22 Pass
2 are not sellable**

Real World Situation:

Compare Multiple devices- To

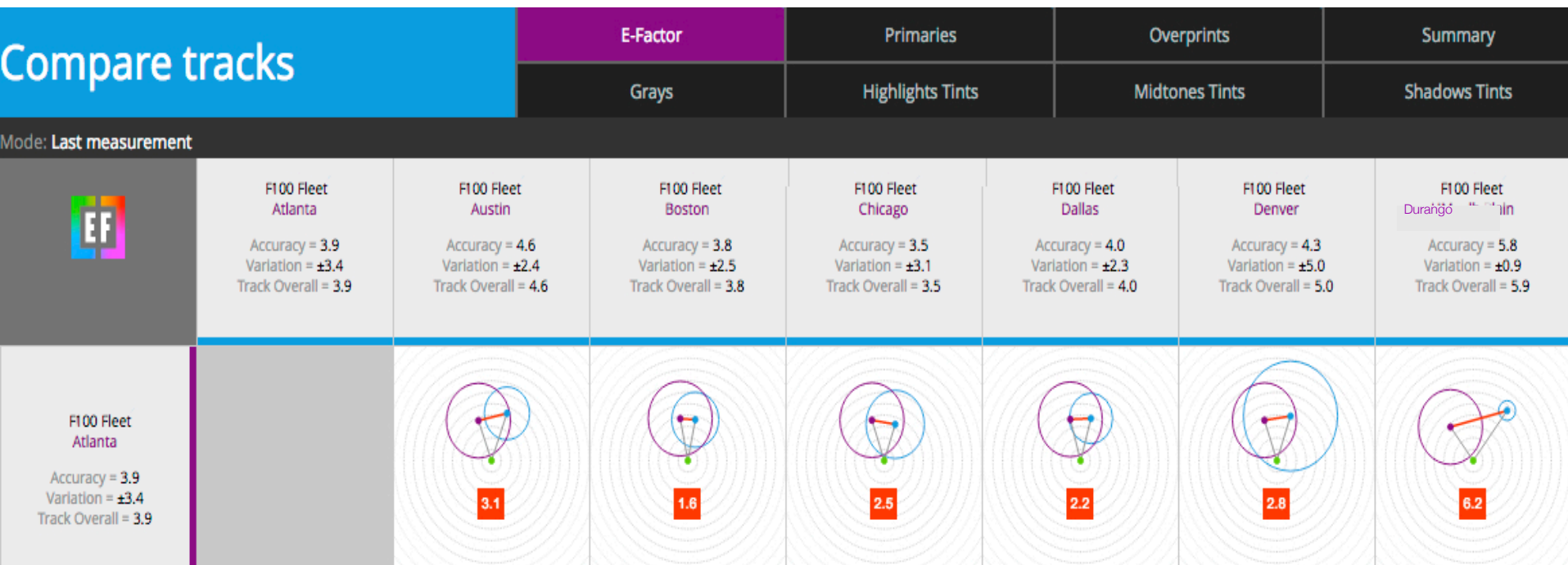
TF100 FLEET					Substrate	Reference Printing Condition		Details
Track name								
<input checked="" type="checkbox"/> Atlanta	7 files	5.0			SCCA CoatedGRACoL2006HM32	3.9	✗	
<input checked="" type="checkbox"/> Austin	5 files	5.0			SCCA CoatedGRACoL2006HM32	4.6	✗	
<input checked="" type="checkbox"/> Boston	5 files	5.0			SCCA CoatedGRACoL2006HM32	3.8	✓	
<input checked="" type="checkbox"/> Chicago	7 files	5.0			SCCA CoatedGRACoL2006HM32	3.5	✓	
<input checked="" type="checkbox"/> Dallas	7 files	5.0			SCCA CoatedGRACoL2006HM32	4.0	✓	
<input checked="" type="checkbox"/> Denver	5 files	5.0			SCCA CoatedGRACoL2006HM32	5.0	✗	
<input type="checkbox"/> Duluth	19 files	5.0			SCCA CoatedGRACoL2006HM32	3.3	✓	
<input checked="" type="checkbox"/> Durango	101 files	5.0			SCCA CoatedGRACoL2006HM32	5.9	✗	
Las Vegas	5 files	5.0			SCCA CoatedGRACoL2006HM32	3.8	✓	
	9 files	5.0			DUPLO CoatedGRACoL2006HM32	3.8	✓	
	7 files	5.0			SCCA CoatedGRACoL2006HM32	4.0	✗	
	5 files	5.0			SCCA CoatedGRACoL2006HM32	4.2	✓	
	9 files	5.0			SCCA CoatedGRACoL2006HM32	4.1	✗	
	13 files	5.0			SCCA CoatedGRACoL2006HM32	4.7	✓	
	9 files	5.0			DUPLO CoatedGRACoL2006HM32	3.7	✗	
	7 files	5.0			SCCA CoatedGRACoL2006HM32	5.1	✗	
	5 files	5.0			SCCA CoatedGRACoL2006HM32	3.3	✓	
	5 files	5.0			SCCA CoatedGRACoL2006HM32	3.6	✓	
	14 files	5.0			SCCA CoatedGRACoL2006HM32	4.6	✗	
	9 files	5.0			DUPLO CoatedGRACoL2006HM32	3.7	✓	
	9 files	5.0			SCCA CoatedGRACoL2006HM32	3.7	✓	
	5 files	5.0			SCCA CoatedGRACoL2006HM32	4.2	✗	
	15 files	5.0			SCCA CoatedGRACoL2006HM32	12		

Goal: Match Color Between Plants



Compare Devices to Each Other

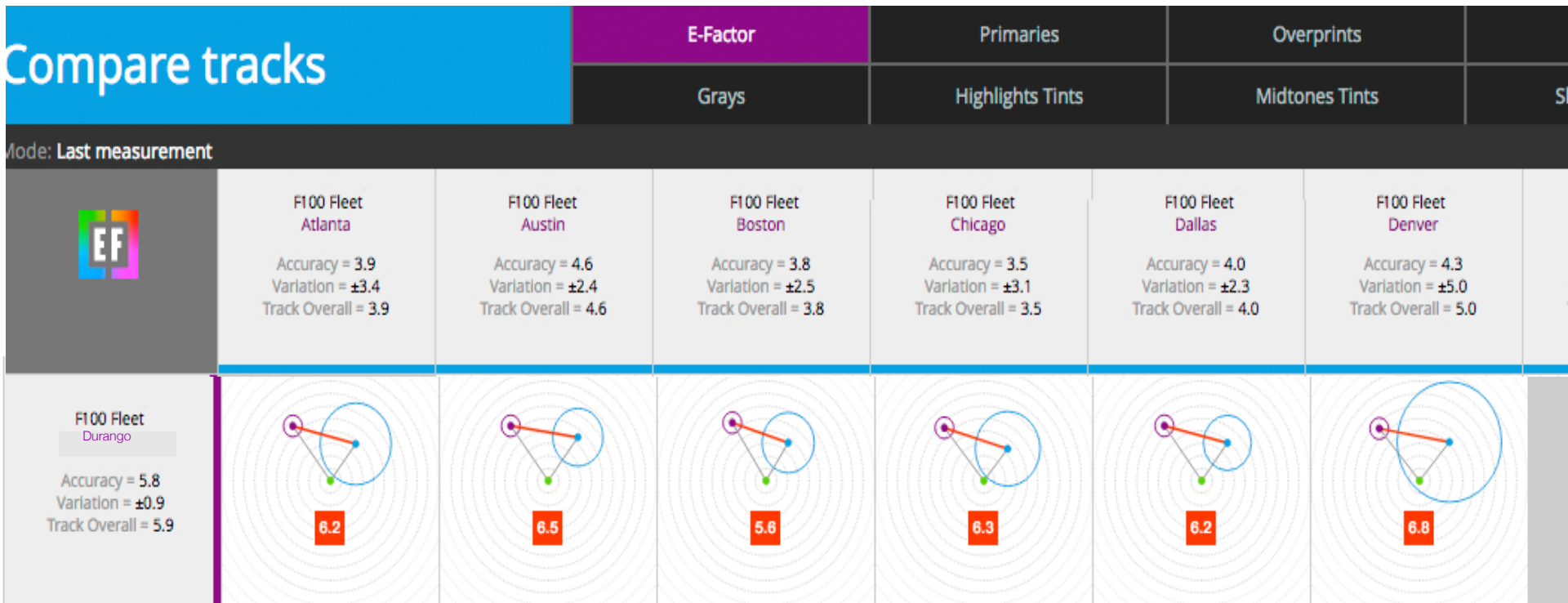
How Close Do They Match One Another



- *Atlanta Compared- 3.1, 1.6, 2.5, 2.2, 2.5, 6.2*
- *Durango: 6.2 is the problem, confirm- different*

Compare “Like” Devices Each Other

How Close Do They Match One Another



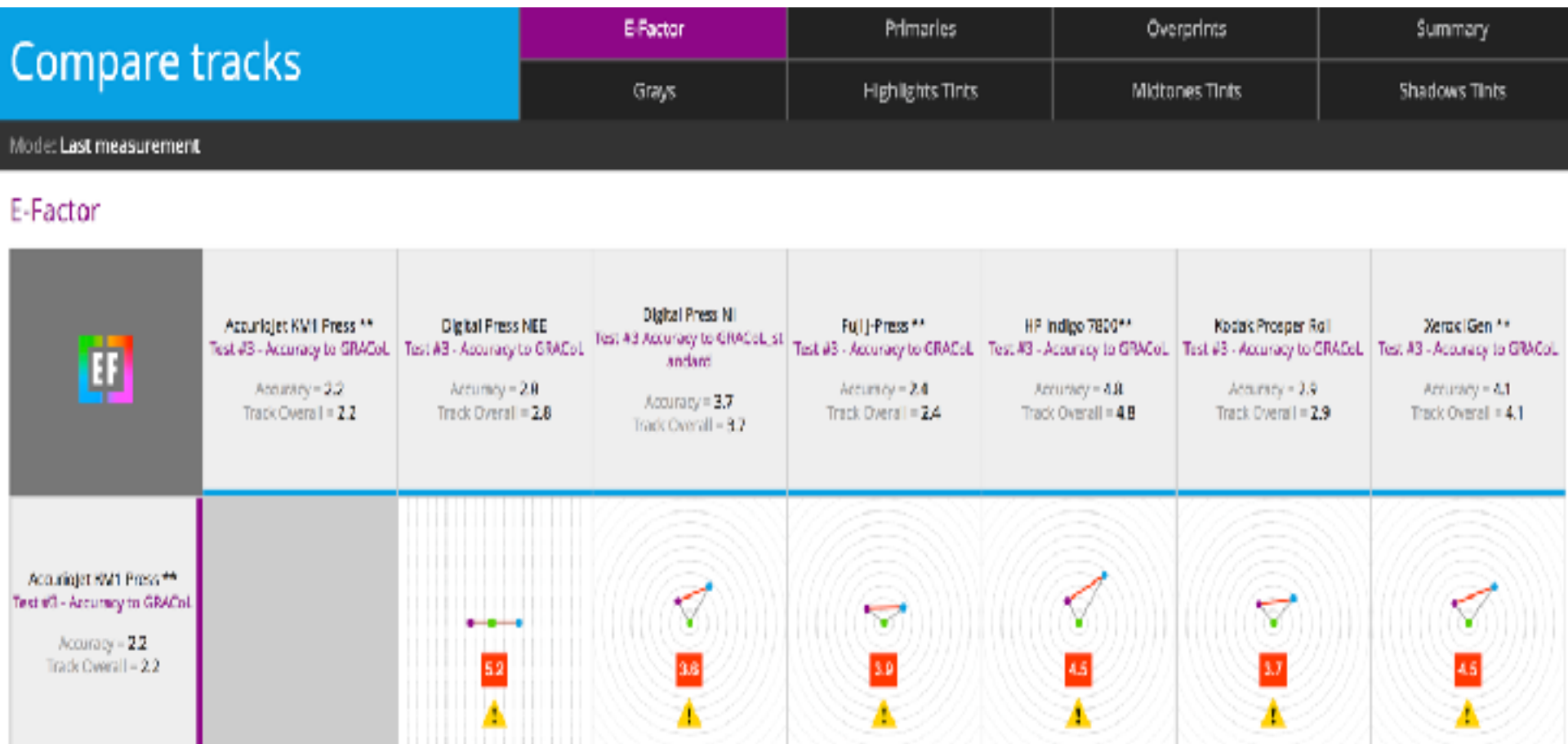
- *Durango Compared- 6.2, 6.5, 5.6, 6.3, 6.2, 6.8*

Benchmark #3 Accuracy: Results

Printer	CRF Gracol	G7 ColorSpace
◆Konica Minolta KM1	2.0	P
◆KM1 Press**	2.2	P
◆Fuji J-Press**	2.4	P
◆Indigo 12000**	2.8	P
◆Domino	2.8	P
◆Kodak Prosper	2.9	P
◆Digital Press NI	3.7	P
◆Igen 6 Press**	4.1	P
◆Digital Press O	4.9	F
◆Kodak Nexpress**	6.8	F

Device to Device Color Conformance

How close are G7 CS devices to one another?



Four Benchmarks Conducted

◆ Gamut Size

- ◆ *ISO Formula calculation, and Percent of PMS w/in 2 ΔE*

◆ Variation (Precision) Benchmarks

- ◆ *Within Page Uniformity, VI 816 Target and M-Score*
- ◆ *Repeatability- 1000 page press run for digital*
- ◆ *Reproducibility: Consistency over days, weeks*

◆ Accuracy

- ◆ *How Close Match to GRACoL and G7 Color Space*
- ◆ *Dependent on Operator Knowledge- Caution*

◆ Resolution

- ◆ *Spatial Frequency Response, Visual*

Methods Judging Resolution

1. Visualize Graphics

- Judge clarity of lines, Look for over spray
- Judge clarity of text at different sizes

1. Measure Resolution

- Spatial Frequency Response- SFR
- Method to calculate resolution, Measurement device

Contrast / Resolution Target

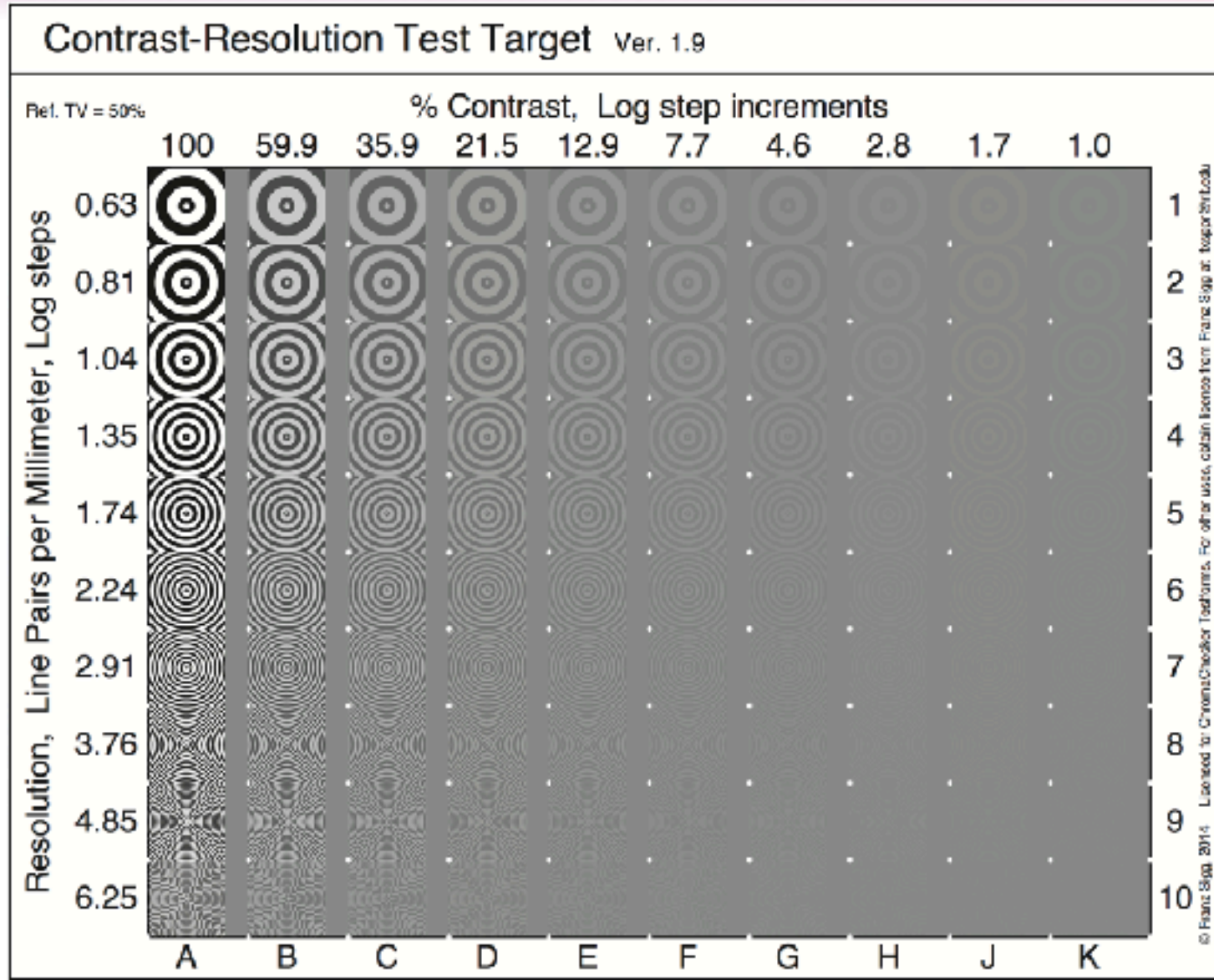


Image Target on output devices

Visualize from normal viewing distance

- Judge clarity of lines
- Look for over spray
- Judge clarity of text at different sizes
- Look where the circles blend
- Great way to compare multiple devices and see the differences
- Vendors all calculate these values differently

Image Target on output devices

These two printer advertise same resolution

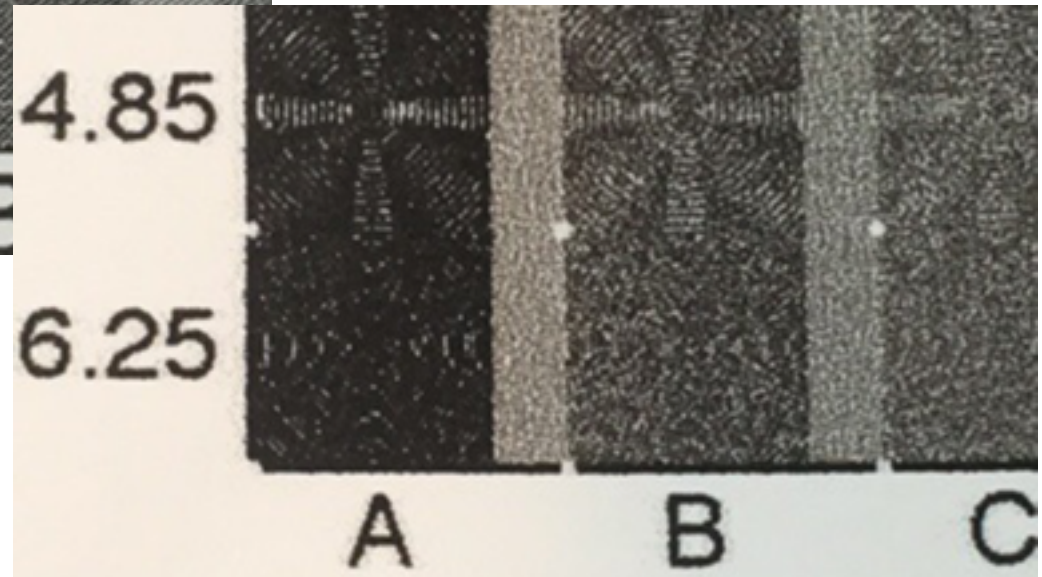
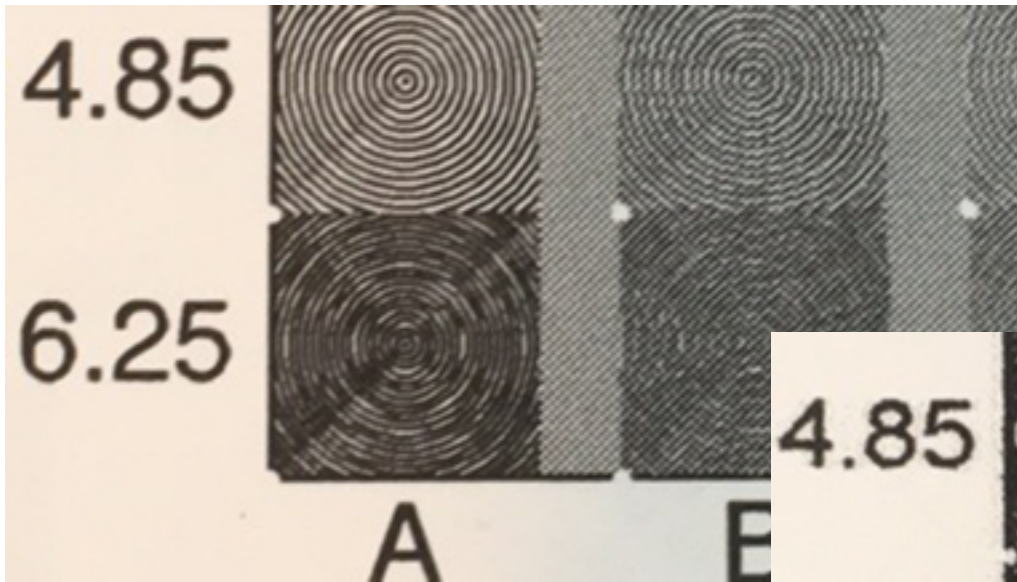
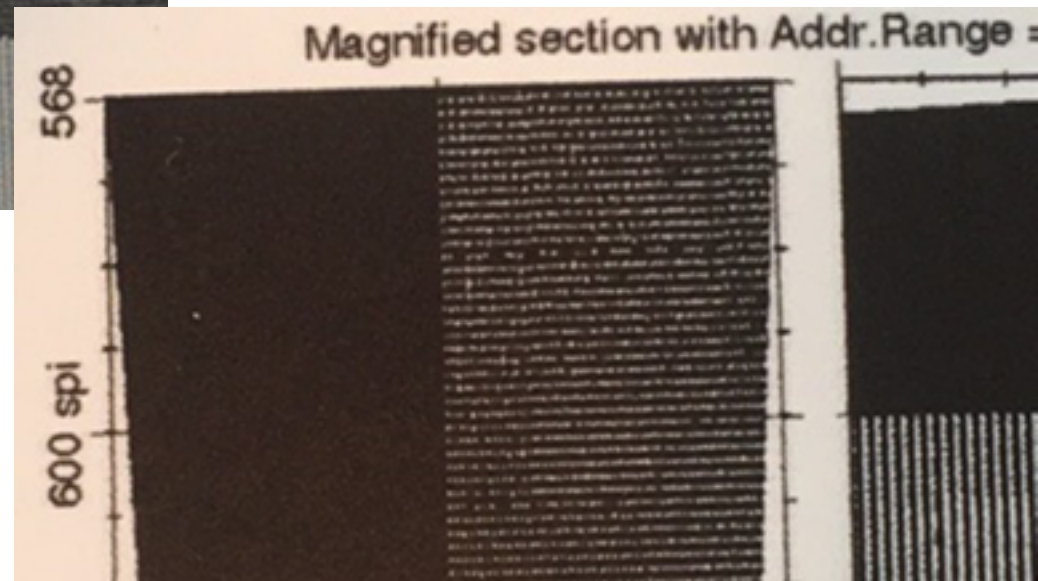
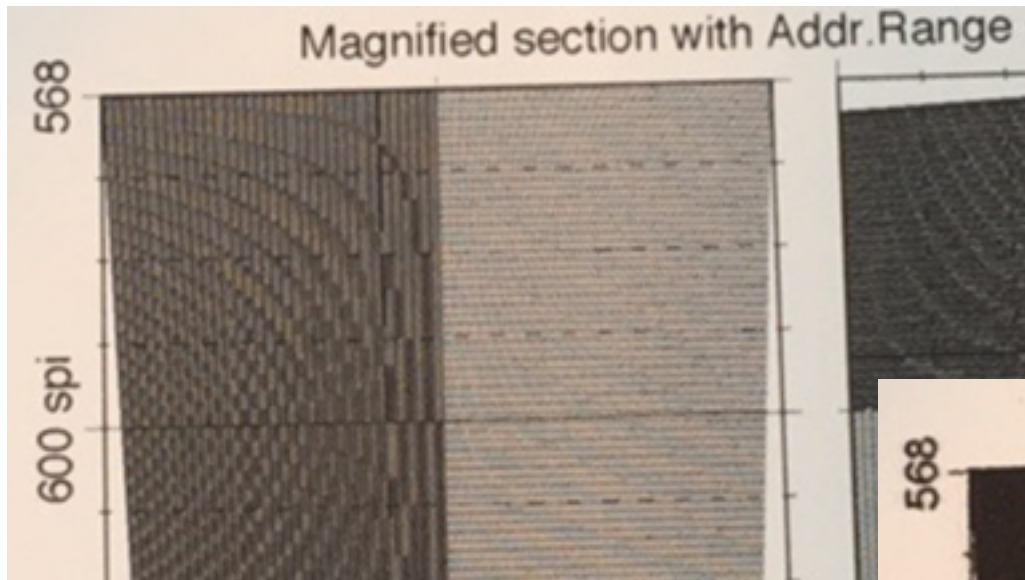


Image Target on output devices

These two printer advertise same resolution




Quantifying Resolution w/ Instrument

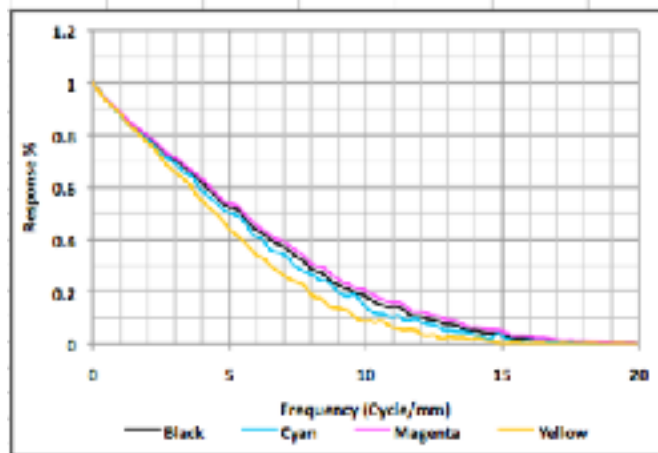
Many Ways to Judge Resolution/Contrast


- Spatial Frequency Response
 - *Calculated Value base on Measurement Device*
- Vertical Lines/Horizontal Lines
 - *Same Size Lines*
- High Light Dots
 - *RIP Settings for Large Format devices*

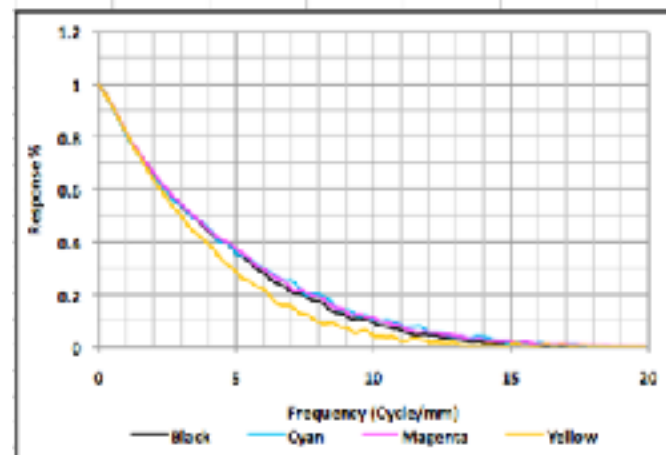
Spatial Frequency Response

- Metric to attempt to define “smoothness”
- Start with devices that everyone knows:

HB D18et		SFR Summ		Frequency, F [cy/plx]	Response (%)
		MTF50	5.405	0.126	50
		MTF30	7.903	0.184	30
		MTF10	12.131	0.282	10
		RNyq	43.055	1	3.691
		RNyq50	21.532	0.5	0.236
		Rx	1	0.023	88.759
SQF		87.975			
File					
Directory					
Color		K (Ref)			
DensStd		Status T			
Illuminant		D65			
Observer		10°			

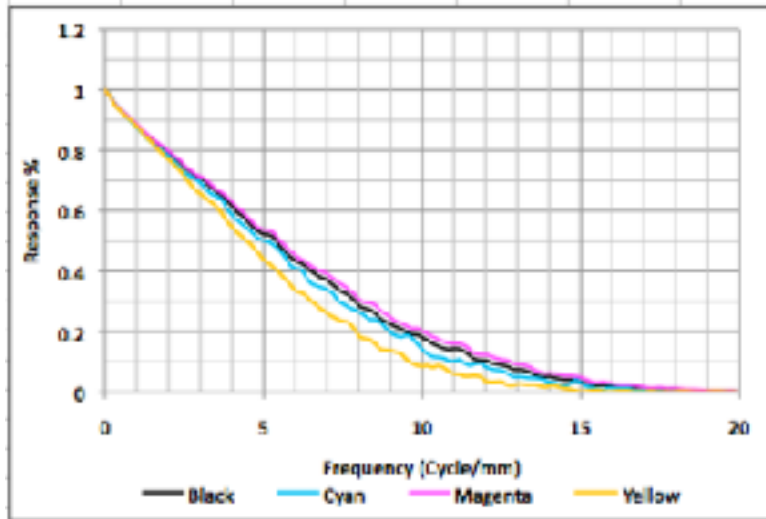
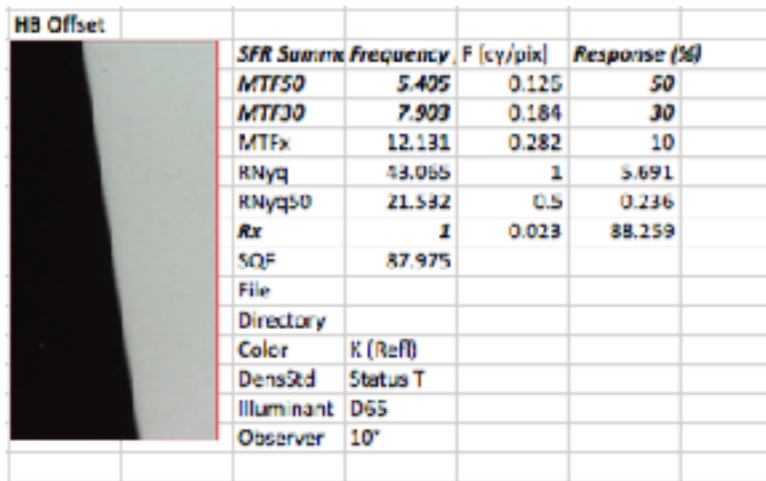


Epson Proofer		SFR Summ		Frequency, F [cy/plx]	Response (%)
		MTF50	3.358	0.073	50
		MTF30	5.588	0.132	30
		MTF10	9.822	0.228	10
		RNyq	43.055	1	8.549
		RNyq50	21.532	0.5	0.119
		Rx	1	0.023	81.242
SQF		81.896			
File					
Directory					
Color		K (Ref)			
DensStd		Status T			
Illuminant		D65			
Observer		10°			

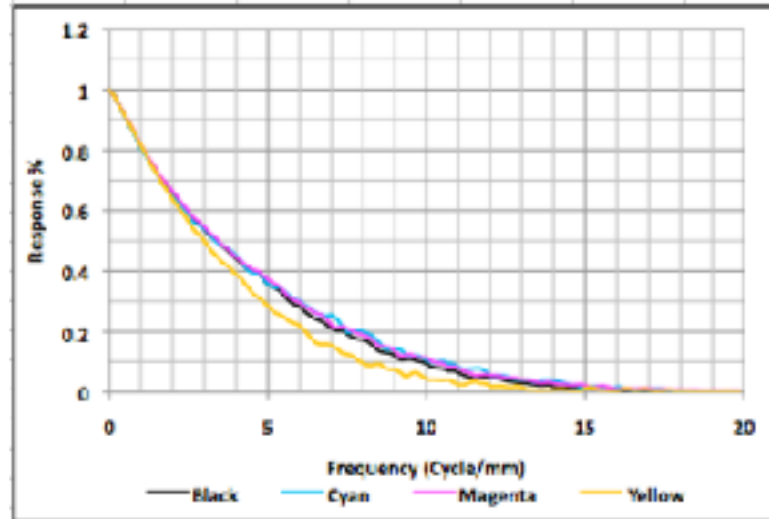
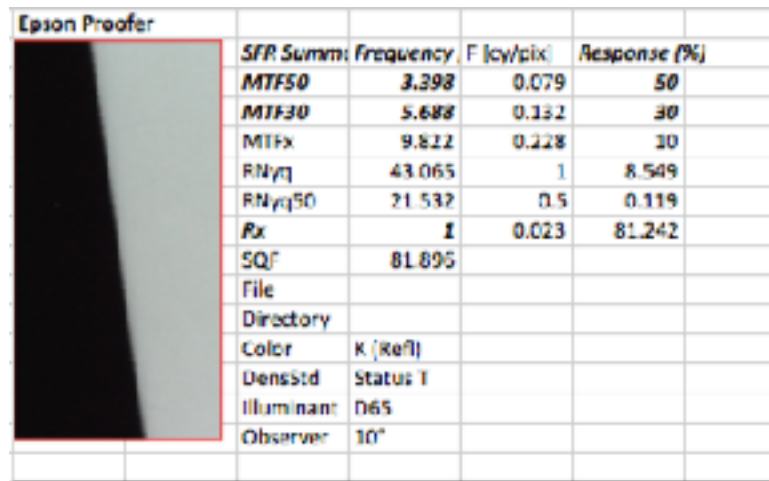


B. Spatial Frequency Response

■ Heidelberg Press

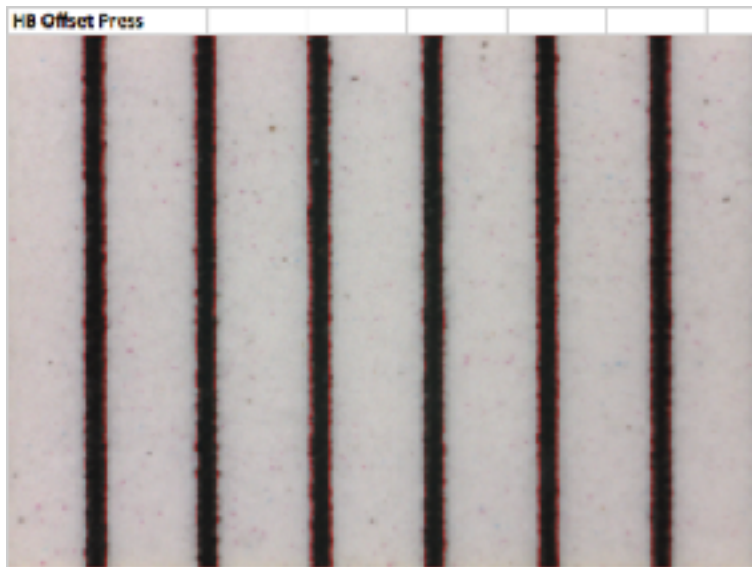


Epson Proofer

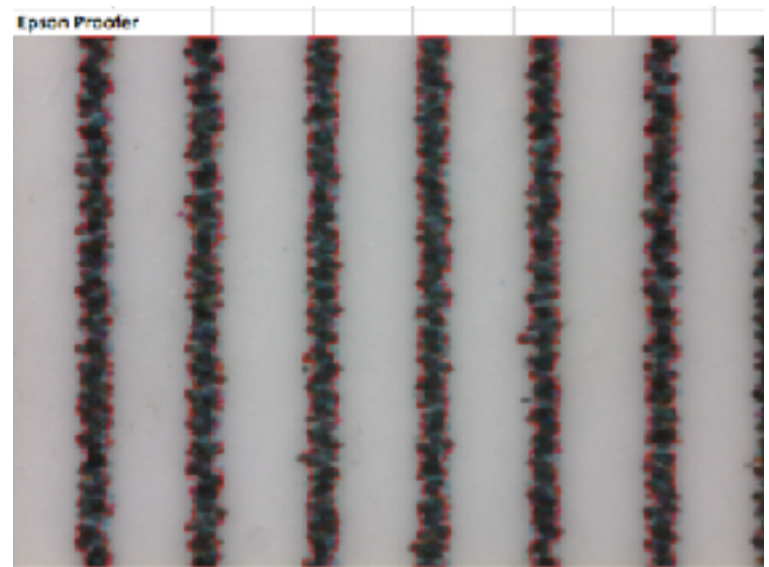


C. Vertical Lines

- Heidelberg Press




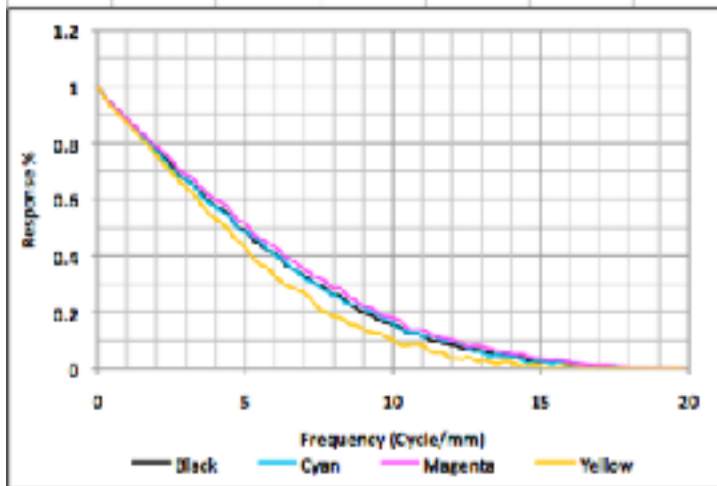
Epson Proofer




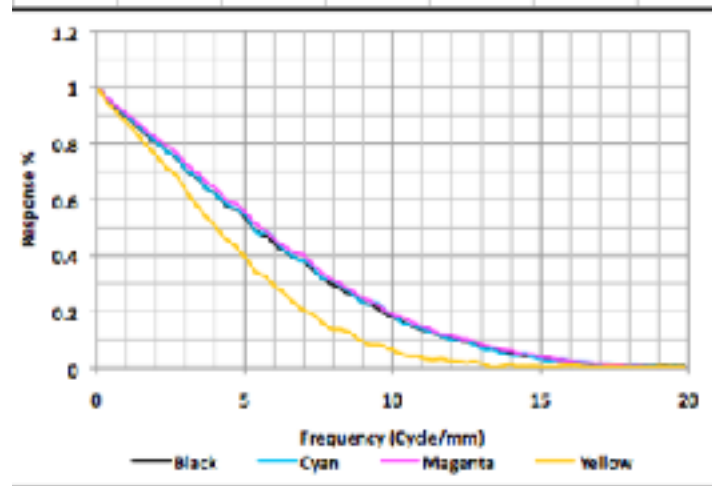
SFR Digital Presses

Comparing Devices Digital Devices

	iGen		
	SFR Summ Frequency F [cy/px]		
	MTF50	4.798	0.111
	MTF30	7.43	0.173
	MTFx	11.291	0.262
	RNyq	43.065	1
	RNyq50	21.532	0.5
	Rx	1	0.023
	SQF	87.365	
	File		
	Directory		
	Color	K (Ref)	
	DensStd	Status T	
	Illuminant	D65	
	Observer	10°	

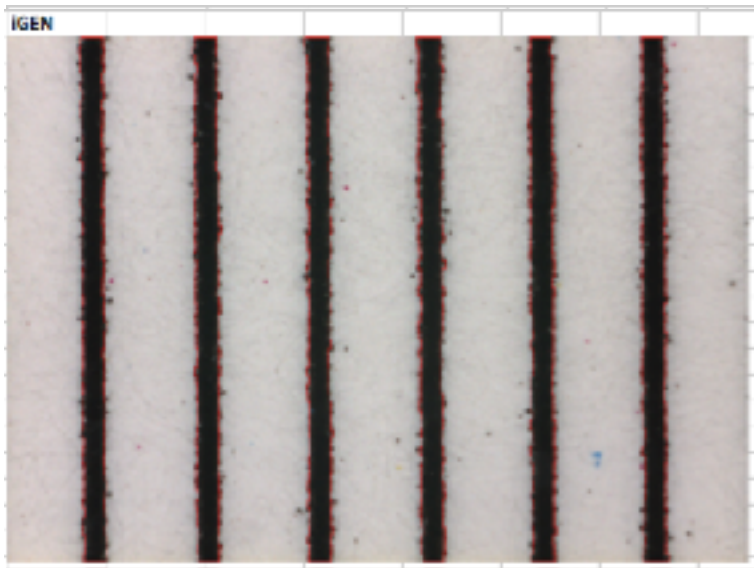


	KML		
	SFR Summ Frequency F [cy/px]		
	MTF50	5.297	0.123
	MTF30	7.902	0.193
	MTFx	12.164	0.282
	RNyq	43.065	1
	RNyq50	21.532	0.5
	Rx	1	0.023
	SQF	88.952	
	File		
	Directory		
	Color	K (Ref)	
	DensStd	Status T	
	Illuminant	D65	
	Observer	10°	

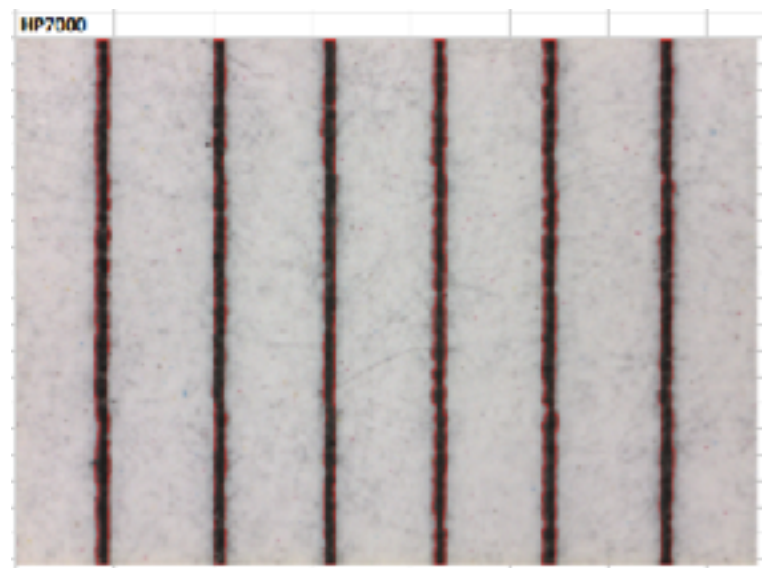


C. Vertical Lines

- iGEN

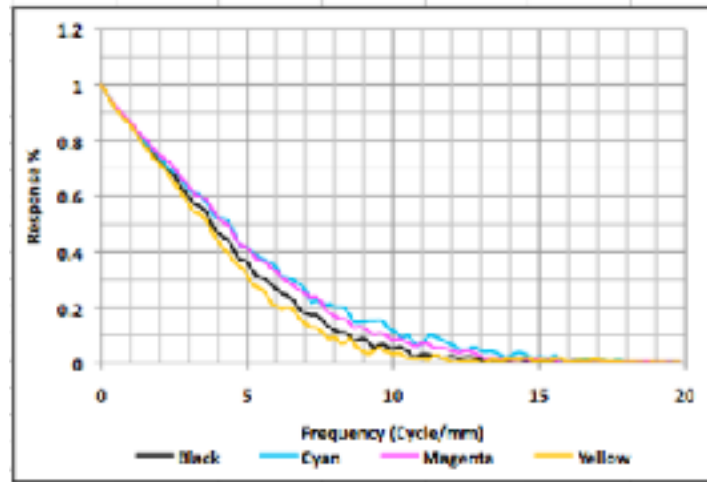
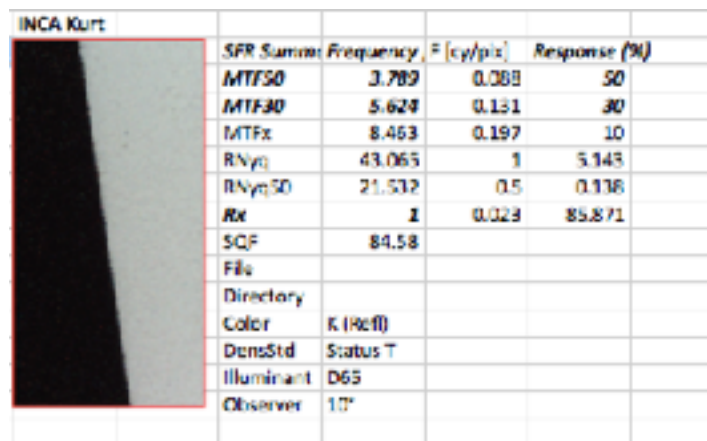
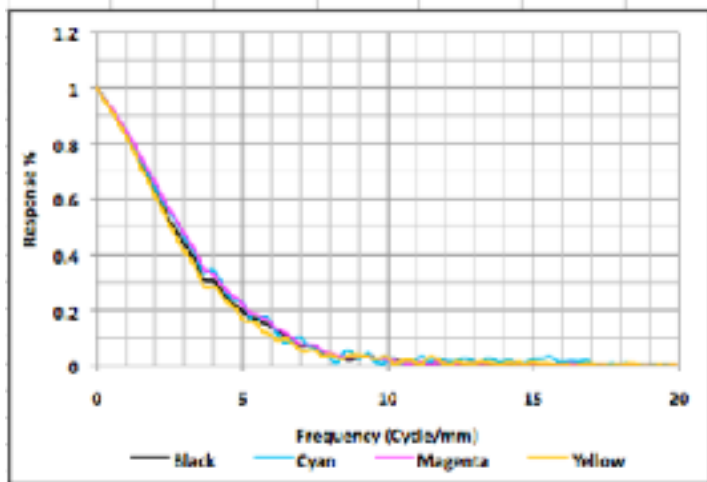
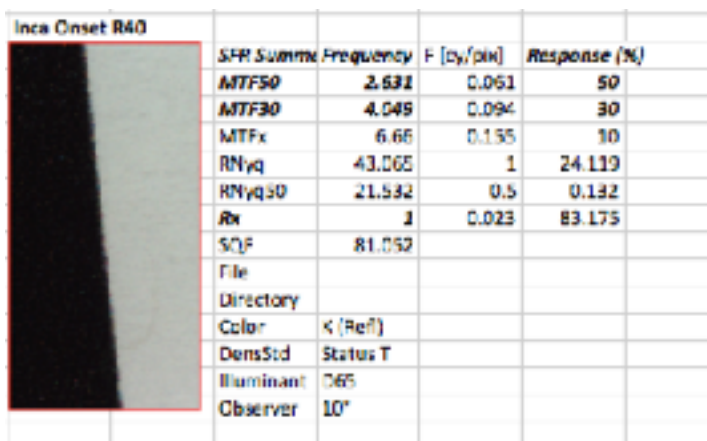


Indigo



SFR Large Format Devices

Comparing Devices- Customizable Resolution

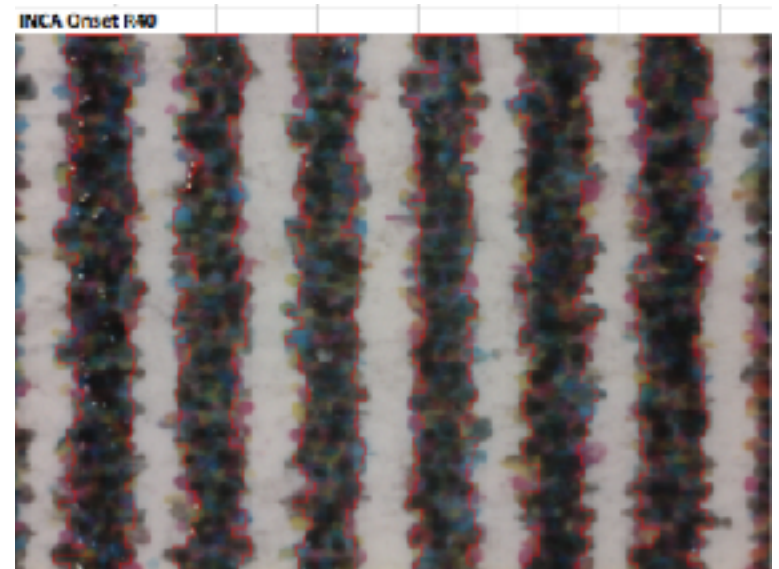


C. Vertical Lines

- Domino



Inca



Critical- Machine Capabilities

Troubleshooting Requirement

- *Color Gamut: (Range of Color)*
 - Manufacturer, RIP Settings and Substrate
- *Precision: (Consistency to itself)*
 - Calibration and Maintenance (Operator)
- *Accuracy: (How Close to Target Reference, bulls eye)*
 - Prepress, Color Specialist, RIP/Workflow Implementation
- *How Close to Other Color Devices- (Proof to Press)*
 - Substrate, and more accurate, closer to one another
- *By Tracking all- Know where to look to fix problem*

Conclusion: Digital Press Benchmark

Access the Data


- *500,000 Measurements and Counting*
- *Data is to share- Share the Results*
- *Request the Targets to make your Own Benchmarks*
- *Provide Great Visual Tools – educate E-Factor*
 - *Before – After Color Management*
- *Do you want to access this information?*

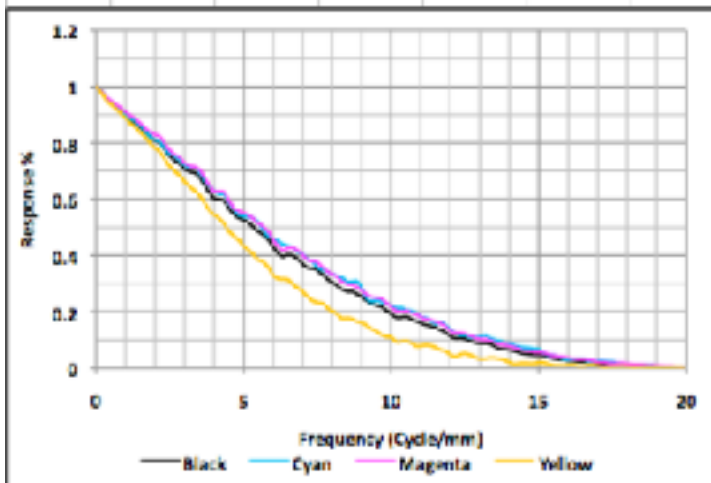
Contact me, Dave Hunter


- david@chromachecker.com
- *651.717.0590 – Answer any questions for you...*

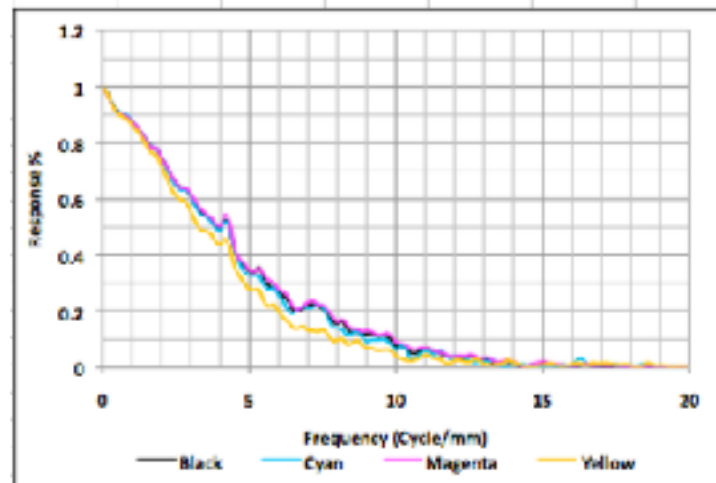
SFR Digital Presses

Comparing Devices Digital Devices

HP Indigo					
		SFR Summ.	Frequency	F [cy/pix]	Response (%)
		MTF50	5.348	0.129	50
		MTF30	8.085	0.188	30
		MTF10	12.59	0.292	10
		RNyq	43.065	1	8.672
		RNyq50	21.532	0.5	0.244
		Rx	1	0.023	89.832
		SQF	89.116		
		File			
		Directory			
		Color	K (Ref)		
		DensStd	Status T		
		Illuminant	D65		
		Observer	10°		




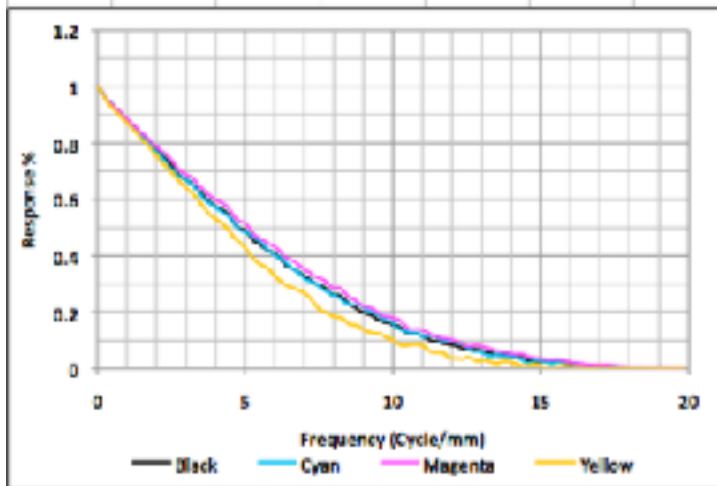
Screen BoC					
		SFR Summ.	Frequency	F [cy/pix]	Response (%)
		MTF50	3.881	0.09	50
		MTF30	5.617	0.13	30
		MTF10	9.704	0.225	10
		RNyq	43.065	1	35.491
		RNyq50	21.532	0.5	0.398
		Rx	1	0.023	87.483
		SQF	85.304		
		File			
		Directory			
		Color	K (Ref)		
		DensStd	Status T		
		Illuminant	D65		
		Observer	10°		




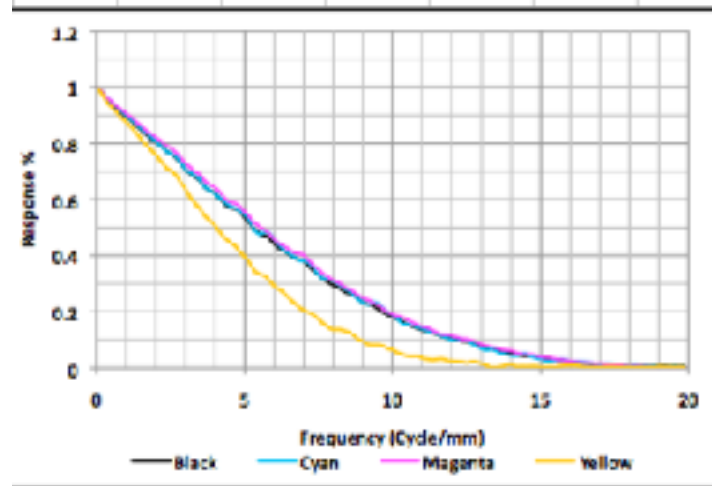
Vertical Lines Digital Presses

Comparing Devices Digital Devices

	iGen			
	SPR Summ	Frequency	F [cy/px]	Response (%)
	MTF50	4.798	0.111	50
	MTF30	7.43	0.173	30
	MTFx	11.291	0.262	10
	RNyq	43.065	1	4.483
	RNyq50	21.532	0.5	0.236
	Rx	1	0.023	87.914
	SQF	87.365		
	File			
Directory	Color	K (Ref)		
	DensStd	Status T		
	Illuminant	D65		
	Observer	10°		

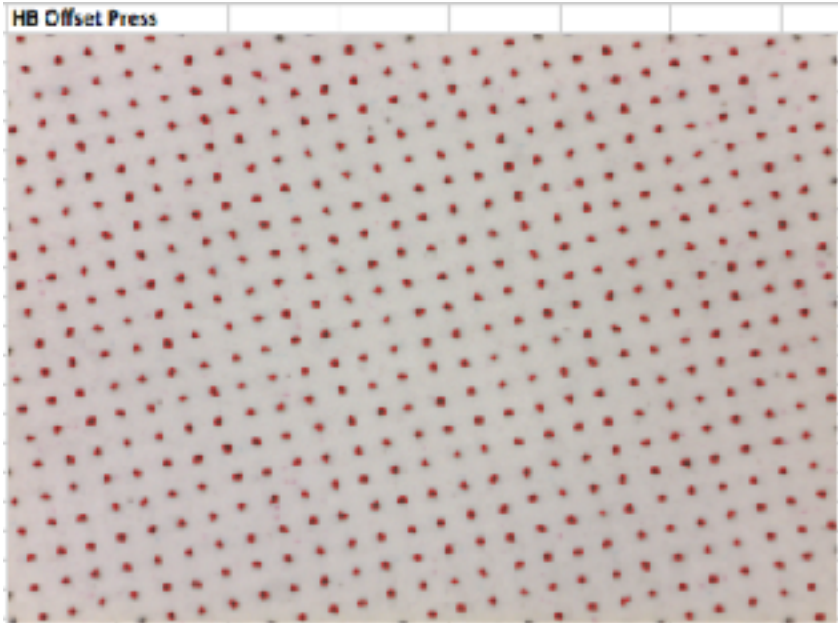


	KML			
	SPR Summ	Frequency	F [cy/px]	Response (%)
	MTF50	5.297	0.123	50
	MTF30	7.902	0.193	30
	MTFx	12.164	0.282	10
	RNyq	43.065	1	8.014
	RNyq50	21.532	0.5	0.231
	Rx	1	0.023	83.54
	SQF	88.952		
	File			
Directory	Color	K (Ref)		
	DensStd	Status T		
	Illuminant	D65		
	Observer	10°		

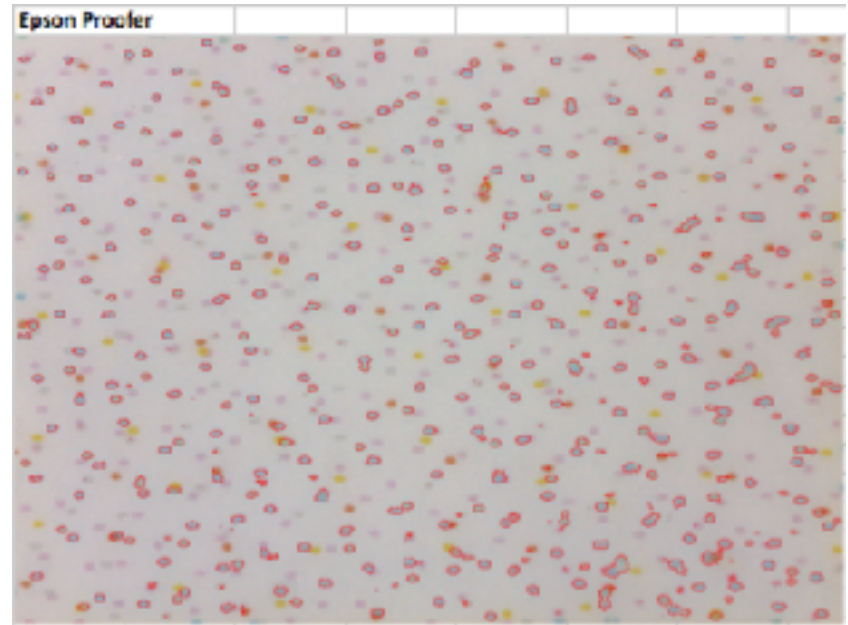


D. Highlight Dots

■ Heidelberg Press



Epson Proofer



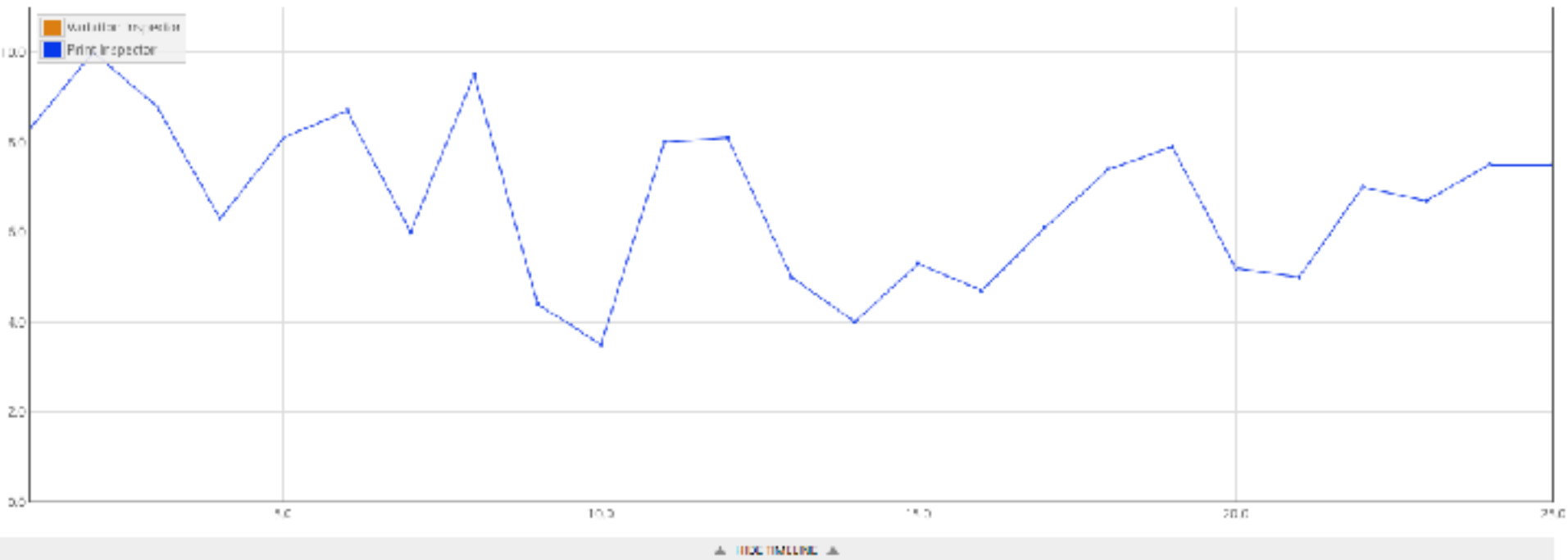
Customer Job Requirement

Product Label Multiple Colors

- Consider printing on digital device
 - *Within customer's Expectations of a "match"*
 - *If Customer's Expectations E-Factor is 2*
- Can device reproduce job customer's expectations
 - *Are Colors Within Gamut?*
 - *Are Colors consistent within page*
 - *Are Colors consistent throughout a multi page run*
 - *Are Colors consistent from week to week*
 - *Are Colors matching colors on other output devices*

Qualification Module

Assessing How Many Profiles do you need?



Do you “need” 25 profiles?

Groups Device Conditions

Based on your E-Factor; if 3 E-Factor

Print Condition Qualifier

Number of files: 25

Number of groups: 13

ΔE threshold: 3.0

Mode: 99%

Calculate

Group qualification

Group 1:				DR	CRPC	L*			
1	Epson_Mactac_Gloss.txt			81.37	CRPC7	90.45			
Group 2:				DR	CRPC	L*			
18	A2550_Rebel.txt			65.57	CRPC3	96.10			
Group 3:				DR	CRPC	L*			
21	Acculy11_Xidling.txt			67.54	CRPC5	88.30			
Group 4:				DR	CRPC	L*			
22	Acculy11_Rebel.txt			72.31	CRPC4	96.03			
Group 5:				DR	CRPC	L*			
24	Acculy11_Dunaplast.txt			77.59	CRPC6	90.66			
Group 6:				DR	CRPC	L*	max. ΔE	avg. ΔE	std. dev. ΔE
10	Fuji_Pelright_2.txt			73.84	CRPC6	94.34	1.83	1.83	0.00
11	Fuji_Pelright1.txt			73.28	CRPC6	93.72	1.83	1.83	0.00

Then you need references

Groups Device Conditions

If E-Factor= 6 Only need 5 Profiles

Print Condition Qualifier

Number of files: 25

Number of groups: 5

ΔE threshold: 6.6

Mode: 95% 1

Calculate

Group qualification

Group 1:				DR	CRPC	L*			
9	Epson_Nactac_Gloss.txt			81.07	CRPC7	92.45			
Group 2:				DR	CRPC	L*	max. ΔE	avg. ΔE	std. dev.
34	Acuity11_Dumplast.txt			7759	CRPC6	82.66	4.49	4.12	0.52
21	Acuity11_Paleht.txt			7797	CRPC6	84.00	3.75	3.94	1.01
21	Acuity11_12pt.txt			7683	CRPC6	83.66	4.49	3.41	1.53
Group 3:				DR	CRPC	L*	max. ΔE	avg. ΔE	std. dev.
20	Acuity11_Rebel.txt			7201	CRPC4	89.09	4.80	4.57	0.17
21	Acuity11_Xding.txt			6754	CRPC5	88.30	3.99	5.58	0.47
6	Fuji_30psstyrene_2.txt			7033	CRPC5	80.64	3.51	3.98	1.79
16	AZ50_Curaplast.txt			7249	CRPC5	80.94	3.99	3.24	1.89
5	Fuji_30psstyrene_1.txt			6986	CRPC5	80.84	3.71	3.95	1.91
12	Fuji_Dumplast_2.txt			7368	CRPC6	82.98	3.87	3.73	2.02
Group 4:				DR	CRPC	L*	max. ΔE	avg. ΔE	std. dev.
18	AZ50_Rebel.txt			6567	CRPC3	83.10	3.93	5.23	0.47
14	Fuji_Conjugated_2.txt			6822	CRPC4	83.62	3.81	4.73	0.85

Sho

Device Accuracy Test #5 Conclusion

Determines How many ICC Profiles Required

- Shows you which condition to profile
- Shows you the Reference Print Condition

Group qualification

Group 1:			DR	CRPC	L*	
17	Epson_Matteo_GlossJet		81.07	CRPC7	92.46	
Group 2:			DR	CRPC	L*	max. ΔE
2	Acuity11_OuroborosJet		77.53	CRPC6	90.65	4.40
3	Acuity11_PalladiumJet		77.53	CRPC6	90.65	4.40
1	Acuity11_12ptJet		76.63	CRPC6	89.65	4.45
Group 3:			DR	CRPC	L*	max. ΔE
5	Acuity11_XtremeJet		67.54	CRPC5	88.33	4.80
4	Acuity11_RebelJet		72.01	CRPC5	89.03	4.80
Group 4:			DR	CRPC	L*	max. ΔE
8	A2530_RebelJet		66.67	CRPC3	89.10	4.92
7	A2530_12ptJet		73.71	CRPC6	89.69	4.71
25	Fuji_12ptG25Jet		77	CRPC4	89.07	4.66
26	Fuji_12ptG25_2Jet		71.95	CRPC5	88.92	4.92
Group 5:			DR	CRPC	L*	max. ΔE
9	A2530_PalladiumJet		73.63	CRPC6	90.10	4.85

Colors Within Gamut?

Considerations

- 1) Is Color In Gamut of the device condition
 - *Within customer's Expectations of a “match”*

Virtual Spot Print

PANTONE+ Solid Coated-V3

ICC profile

JPress_Flo Gloss_80lb Cvr_GRC2013_M1

M. cond.

M1

ΔE Formula

ΔE 2000

ΔE Threshold

2


show

Customer Reproducing PMS Red

Considerations

- 1) Is Color In Gamut of the device condition
 - *Within customer's Expectations of a "match"*
 - *If Customers Expectations is 2 ΔE ...*

Statistics

Samples	Samples < threshold	Max.	Average	Std. dev.	
1846	1425 (77%)	16.78	1.29	1.81	5.29

Export

File format: COATS Lab + CMYK + deviation E

Download

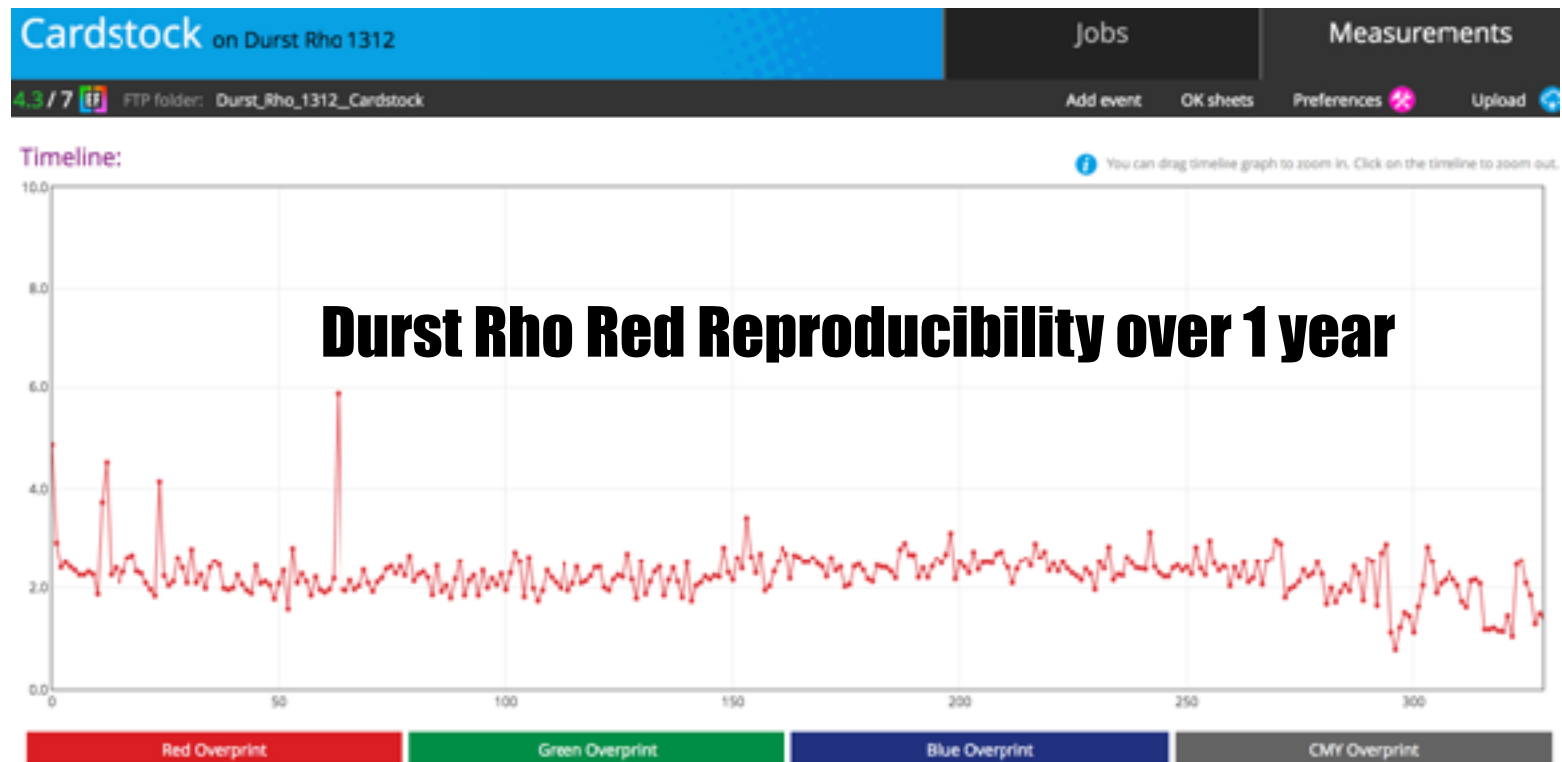
Color list

ID		Name	Original Lab*			_Press_Rio_Gloss_80lb_Cat_GRO_2013_M1				Roundtrip Lab**			ΔE 2000
			L*	a*	b*	Cyan	Magenta	Yellow	Black	L*	a*	b*	
R131		PANTONE 184 C	60.87	66.71	14.15	0.00	73.73	34.90	0.00	58.03	53.85	11.03	4.32
R132		PANTONE 185 C	55.03	72.03	45.45	0.00	80.58	51.57	0.00	48.22	60.90	35.24	3.95
R133		PANTONE 186 C	49.25	67.36	36.62	0.00	87.25	64.16	0.00	45.44	59.36	36.58	0.34
R134		PANTONE 187 C	32.35	55.81	37.33	10.59	96.47	62.25	18.83	37.91	56.90	36.64	0.25
R135		PANTONE 188 C	19.74	78.27	12.92	24.31	89.05	65.98	36.61	28.86	58.72	12.07	0.42

Customer Reproducing PMS Red

Considerations- Machine Capabilities

- 2) Can device reproduce consistently
 - *Amount of variation within page, between jobs*



Solutions for Output Improvement

- Need Cause of Problem- to provide solution
- Why:
 - *Customer File Volatility*
 - *Multiple Substrates*
 - *Temperature/ Humidity Changes*
 - *Operator not Re-linearizing*
- All Devices have variation
 - *How to control and manage*
 - *Important to understand for troubleshoot*



Low Accuracy

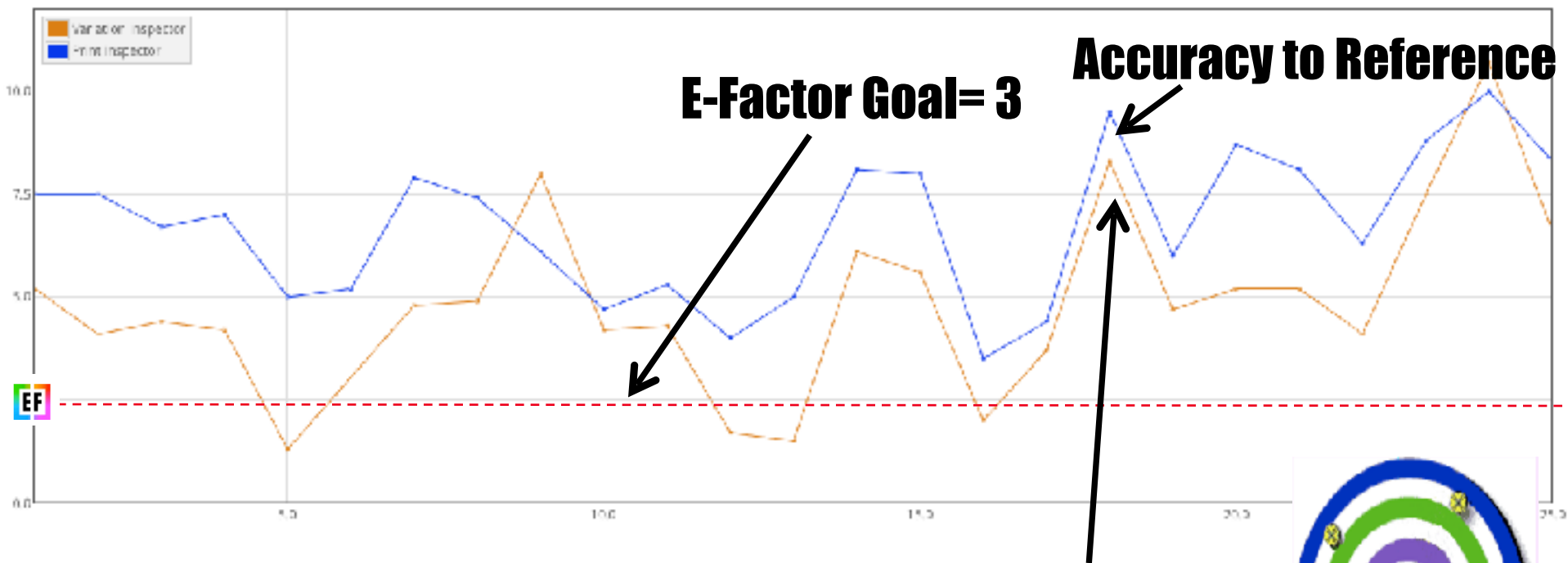
Low Precision

EF = 9

Provides Operations Actionable Data

Line Graph showing any level of history

Timeline



- Device **NOT** Consistent to itself

EF = 7



Fix Problem based on Result

Problem #1= Poor Precision

- ***Symptoms:***

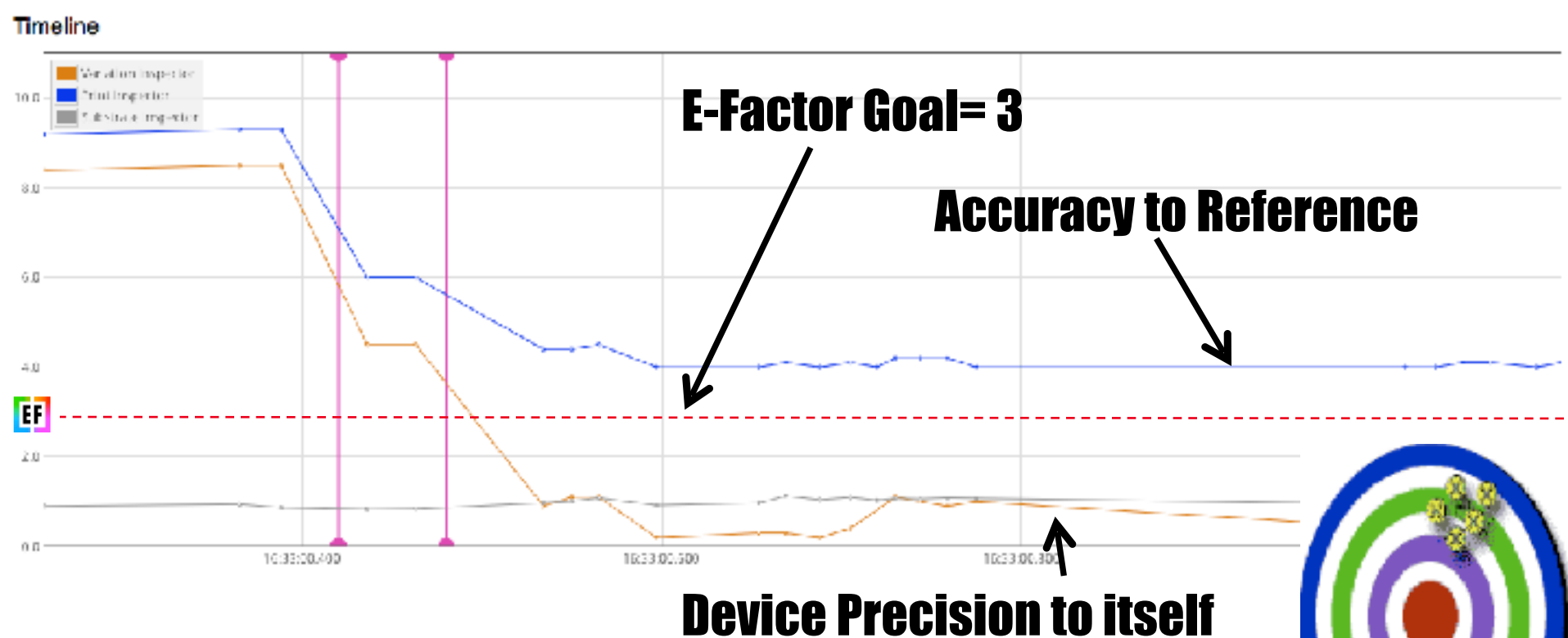
- Device does not match Proof
- Device doesn't match job run last month
- 3rd shift does not match 1st shift

- ***Solutions:***

- Fix the Mechanics of Output Device

Provides Operations Actionable Data

Line Graph showing any level of history



EF = 7

Fix Problem based on Result

Problem #2= Poor Accuracy

- ***Symptoms:***

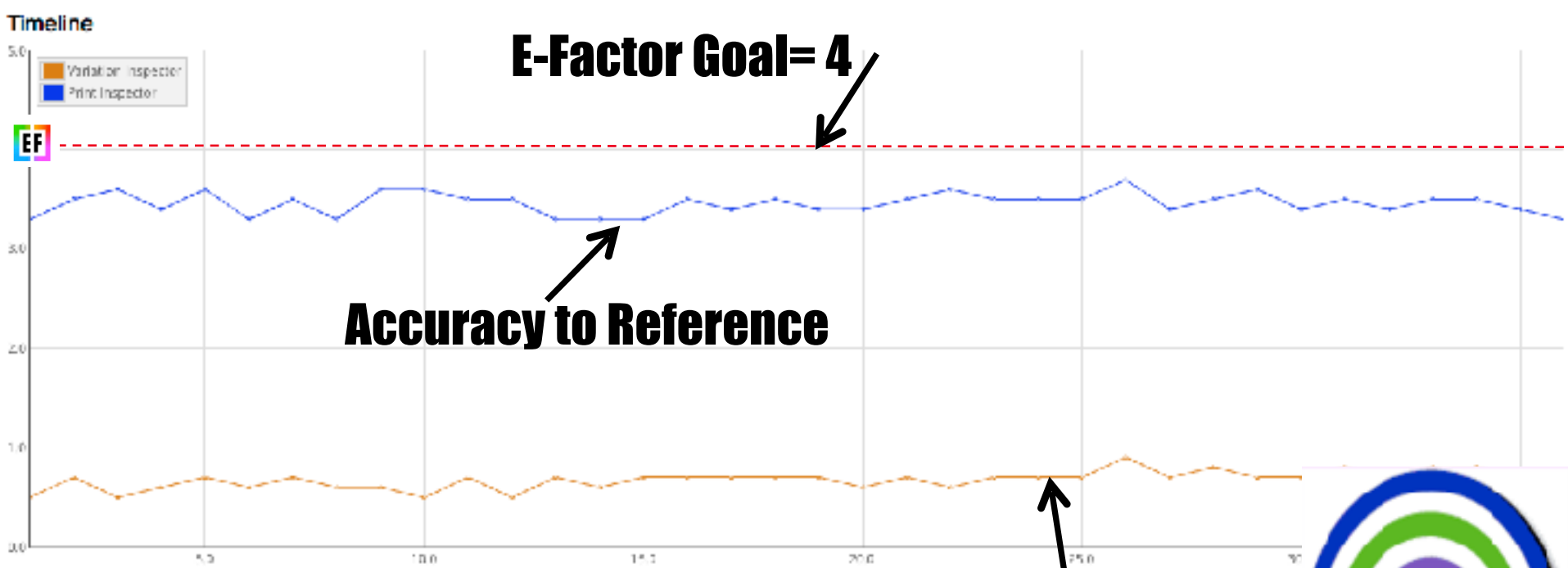
- Output does not match Proof
- Output doesn't match other jobs

- ***Solutions:***

- Fix the Workflow/RIP Color Conversions
- Add G7 Curves, and or ICC Profiles

Provides Operations Actionable Data

Line Graph showing any level of history



- After Color Server and Plate Curves

EF=3.4



Summary

Specialize Helping Companies Control Color

- *Providing Resources to help customers be self sufficient*
- *ChromaChecker.com Free On-Line Tutorial for testing*
- *ChromaChecker.com Qualification, Tracking and Process*
- *Free Audit for one device, you print, we measure...*

Contact me, Dave Hunter

- david@pilotmarketing.com
- *651.717.0590 – Answer any questions for you...*

How Printers Reproduce Color

- Most Printers Print: ***Any Way- Any Day***
 - Even with the same output device



Low Accuracy
Low Precision

**Not Meeting
Customer
Expectations**



Difference Between:

- Precision (Consistency) versus Accuracy



**Low Accuracy
Low Precision**



**Low Accuracy
High Precision**



**High Accuracy
Low Precision**



**High Accuracy
High Precision**

Five C's of Color Control

- ***Color Capture Measurement Device***
- ***Calibration for Output device***
- ***Characterization for Output device***
- ***Conversion- Convert from one color space to another***
- ***Conformance ensures output is correct***

Difference : Precision vs. Accuracy

- *Precision (Repeatability) Depends on:*
 - Correct **Color Measurement** Devices
 - Proper **Calibration**: Devices/Instruments
- *Accuracy (Match to Condition) Depends on:*
 - Valid **Characterization** (ICC Profiles)
 - Proper **Color Conversions** (RIP)
- **Conformance** *Verifies Everything is Working*
 - Verifies Precision and Accuracy

Manufacturing Industry Standards

Specifications for Tolerances

- ◆ Every Industry has Tolerance Metrics
- ◆ Regular Bolt Tolerances- ASME B18.2
 - ◆ *Up to 1" = $\pm .02$ to $.03$*
- ◆ Structural Bolt Tolerances- ASTM A325
 - ◆ *.3% = $\pm .0015$*
 - ◆ *Tensile Strength: 120ksm min*
- ◆ What Manufacturing Tolerances do we use Print?
 - ◆ *Delta E for Spot*
 - ◆ *G7 Conformance for Process*



How do Printers Print Color

Industry Shows

- Most Printers print different everyday
 - Due to variation raw materials, mechanical and/or operator variation
- Some Printers print the same everyday
 - With some of their output devices
- Few Printers print an Industry Print Aim everyday
 - With some of their output devices

Determine Color Expectations!!!

Learning Experience

- Understand how close is “acceptable” to customers
- Different Customers have different levels tolerance
- Need to understand your devices capabilities
- Often choose a tolerance tighter then device limits
- Industry standard TR016 defines 4 Categories
 - *Levels 1-4 with 1 being the tightest at 2 delta E*

Performing E-Factor Exercise

On-Line Exercise- Compare one to other

- *In all the above cases, is the difference close enough or would you change the file or workflow to make closer*

Actual Print Exercise

- Do not judge where you see a difference- Judge where you ***accept*** the difference
- Ways to Think of the Differences
 - *Judge 1st sample as proof, the 2nd as print*
 - *Judge 1st as print one day, the 2nd as print another day*
 - *Judge 1st as print on one device, 2nd as another device*
 - *Judge 1st print on one substrate, 2nd as another*

How to Quantify E-Factor

- Tolerances in Delta E (00)



2 delta E
2 E-Factor

How Close is Close Enough?

- Tolerances in Delta E (00)



5 delta E

5 E-Factor

How Close is Close Enough?

- Tolerances in Delta E (00)



9 delta E
9 E-Factor

Once You have your “E-Factor”

Applies to all aspects of Color Configuration

- Determine **Precision** of your Device condition
 - *Is it less than your Desired tolerance? If not, need to perform maintenance on device or calibrate more often*
- Determine **Accuracy** of your Device condition
 - *Is it less than your Desired tolerance? If not, need to make a more accurate profile and or color conversion*
- This will ensure that your Digitally Printed pages will meet customers expectations
- Required Measurement Device to measure results
 - *Make sure Measurement device is Accurate*

In Market for new Output Device?

We can Qualify Device- Before Purchase

- Make sure device meets your needs
- Qualify your desired E-Factor
- We provide test targets for your vendors to print
- Mail targets to us, we Qualify Precision/Accuracy
- Provide you with Report, compare output devices
- Make PO with FAT- Factory Authorized Test
 - Ensures your output device performs as Demo device or \$ back
 - Protection that Device will meet your expectations

ChromaChecker tracks into future

Color is Output, Not Correct

Head Scratching Moment

- *Why is it Wrong?*
- *Does not match Proof?*
- *Does not Match Previous Print?*
- *Does not match Customer's Memory?*
- *Very Subjective, Very Dangerous*
- *Try and fix through Trial and Error- Never reproducible- Chasing Tail*

Troubleshooting Procedures

One of Three Problems

1) Output Device not Printing as Expected

Cause: Mechanics or Calibration Failure

2) RIP/Workflow not configured correctly

Cause: RIP/Workflow Profile Configuration

3) File not built in actual Printing Aim Gamut

Cause: Customer built file wrong/preflight did not fix

What is the Problem?

Troubleshooting Color Issues

Checking Conformance

- Operator Level
- Very easy procedures
- Maximum two prints, understand if problem is:
 - *Mechanics of Output device*
 - *Configuration in the RIP settings*

Train Operator to Measure Color bar

Choose a Good Calibration Control Bar

- *Assess Precision and Accuracy*
- *One that allows iterating the TRC based on G7*
- *ChromaChecker PI-64, Like a mini P2P target*

ChromaChecker™
PI64_2R v1.0



Configure Software to assess >2 Condition

- *Production Condition and Baseline Condition*

Operator Measures Control Strip

Place on edge of live jobs



Use Verification Software to assess condition

Measure with i1 Device in Seconds

Instantly Receive a Pass or Fail- Make Label



Difference Between:

Precision versus Accuracy

- *Precision (Repeatability) Depends on:*
 - Proper Calibration procedures
 - Preventative Maintenance and Consumable Changes
- *Accuracy (Color Match) Dependent on:*
 - Proper Color Conversion in Workflow or DFE/RIP
 - Correct Tone Reproduction Curve control Gray Balance

Difference Between:

Precision versus Accuracy

- *Precision (Repeatability) Depends on:*
 - Proper Calibration procedures
 - Preventative Maintenance and Consumable Changes
 - **Digital Operator Responsibilities**
- *Accuracy (Color Match) Dependent on:*
 - Proper Color Conversion in Workflow or DFE
 - Correct Tone Reproduction Curve control gray balance
 - **Prepress/Prep Responsibilities**
- *Need Both parties to attain Precision and Accuracy*

Using this Procedure Troubleshooting

1) File Prep Operator; Responsible for:

- *Files are separated in Correct Color Space*
- *Color Conversion Policies are correct*
- *Proofer printing color correctly*

2) Device Operator; Responsible for:

- *That Device is Properly Calibrated for desired **Precision***
- *Preventative Maintenance is performed and change out end of life consumables as required for **Precision** goals*

Troubleshooting Procedure

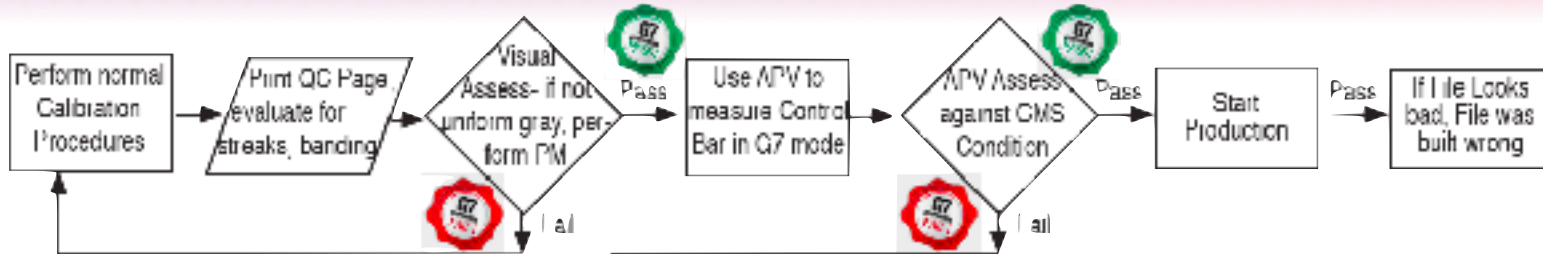
Easy, Fast Technique to Determine Problem

Maximum of Two Prints and Two Measurements

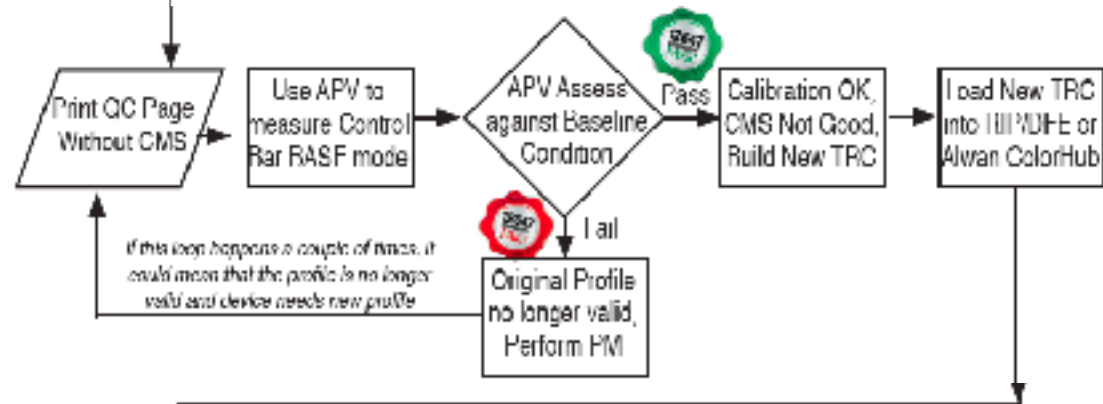
- Will Pinpoint where the problem is
 - *Device not printing correctly,*
 - *RIP is not configured/working correctly*
 - *File is not built correctly*
- Will Help Determine Problem

Troubleshooting Flow Chart

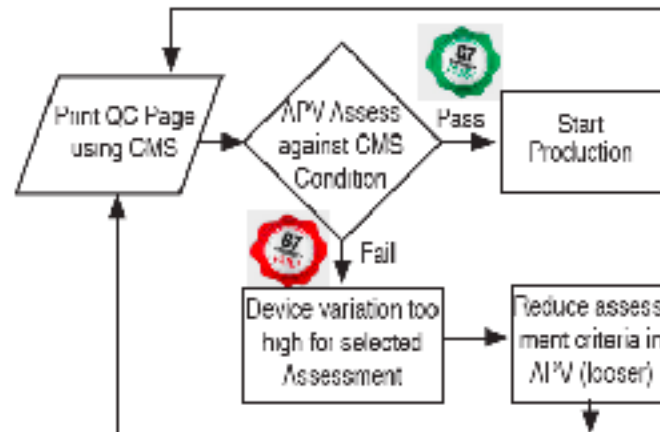
Production Verification



Baseline Verification



TRC Adjusted Verification



Define Two Device Conditions

Reference “Printing Aim” Condition (RPC)

- *Production Condition- sellable color*
- *The shop “Target” that all devices are trying to match*
- *Master “Stake in the Ground”*
- *Targeted Condition after **Color Conversion** applied*

Baseline Condition- Actual Print Condition (APC)

- *Device in a repeatable state, it’s **Calibrated State***
- *Assess the device against it’s Baseline Condition*
- *Condition that the device is in “when it is profiled”*
- *Calibrated/Linearized and Ink Limited*

Conclusion: Precision

Establishing Your Precision capabilities

- Determine most important customers
- Determine most important jobs
- May strategize to only have one or two devices hold the highest precision- Costs more time and money
- Understand- Higher Precision costs more Money
- Need to learn how to charge for Increase Precision
- Reference TR016 Standard for Differentiation

ChromaChecker Color Cloud

Transition: Graphic Arts to Manufacturing

- Reports, Tracks and Notifies for any Device
 - ChromaChecker.com assesses virtually every variable in process
- Web View or iPad View of entire process
 - Provides Owner, Primary Stakeholder how manufacturing is going
- 20+ Variables required to print accurately
 - Customize time frames to check and audit equipment
 - Assign to multiple operators who will receive emails when due
 - Managerial reporting for operators that are on vacation or out

Industry Provided 7 Printing Aims

CGATs 21

- Substrate Based- NOT Print Process based
 - *Works for any Print Process!!!*
- Common References for entire supply chain
 - *Set Customers expectations for Proofing*
 - *Set Expectation for Spot Color Simulation*
 - *Standard Conditions that any Printer match*
 - *Can output any where in world and get similar*
- And Tolerances for Acceptability

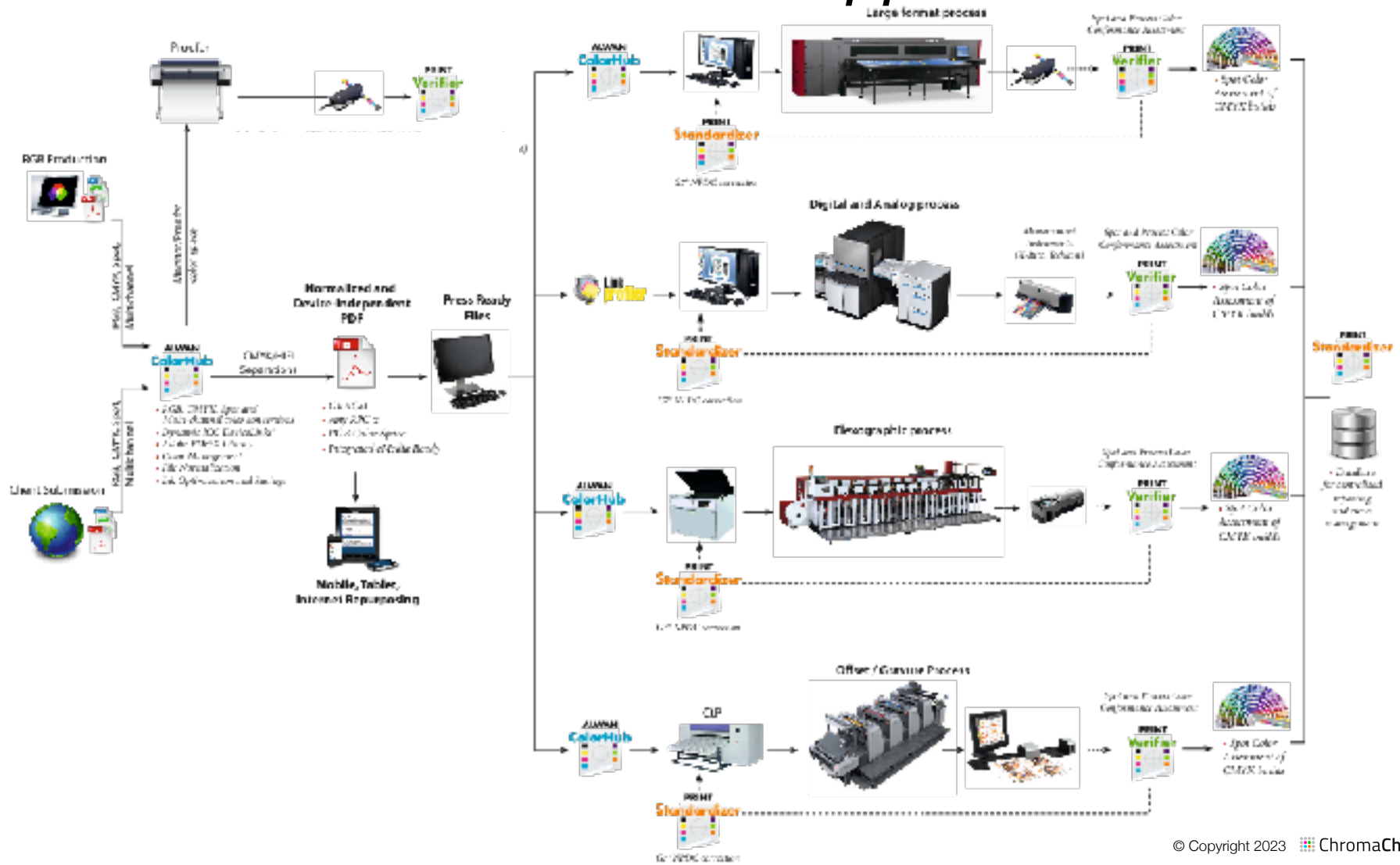
Reference Print Conditions (RPC Aims)

CGATs21- 7 RPCs, Small Gamut to Large

- 1) Coldset Newsprint (Gray)
- 2) Heatset Newsprint (White)
- 3) Uncoated Paper
- 4) Super Calendared
- 5) #5 Paper Coated (SWOP)
- 6) #1-2 Coated (GRACoL)
- 7) Large Gamut (Large Format, and Digital)

- Project- 8- Unreachable Gamut- Extreme Gamut

Provide a Shared Visual Appearance on all



Shared Visual Appearance- G7 Process

- Printing Simulation= different paper, different gamut



Manufacturing Dashboard

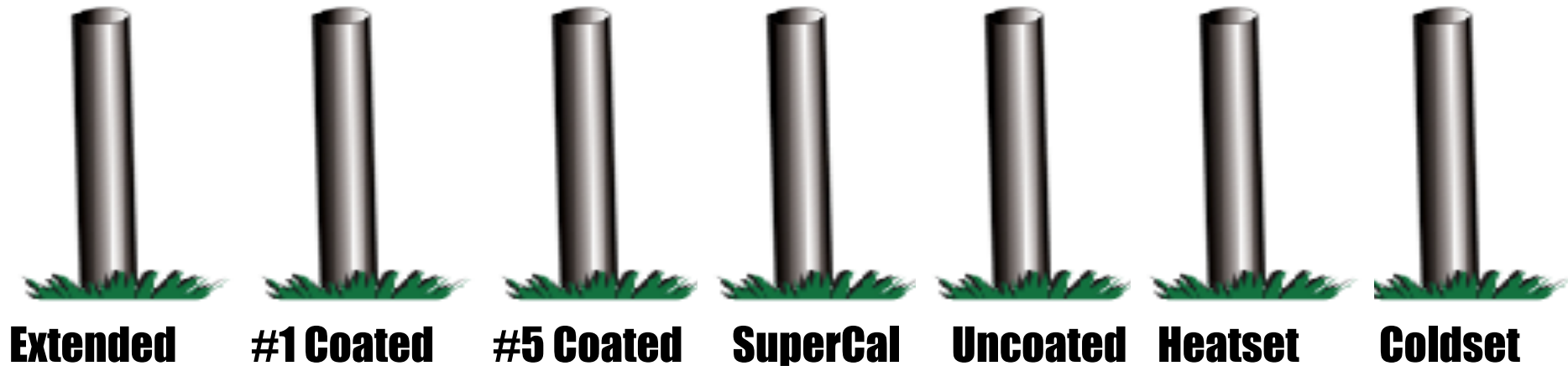
Real time reporting on all output devices!

Tracks

CANON_ARIZONE360									
Track name		Tools	Substrate		Printing		Details		
<input type="checkbox"/> Canon_Arizona_Styrene	3 files	3.0			SCD_Ariz360KT_Styrene	0.7			
<input type="checkbox"/> Canon_Styrene_67	4 files	4.0			SCD_ICCATS21_ONPDE_V2	2.3			
EPSON 4900									
Track name		Tools	Substrate		Printing		Details		
<input type="checkbox"/> Proofer EA	28 files	3.0	Standard Proofing Paper 205		ISOCoated_v2_eci	1.9			
HP INDIGO 01									
Track name		Tools	Substrate		Printing		Details		
<input type="checkbox"/> Press quality monitoring	5 files	4.0	HP calibration substrate ME	1.5	SCD_GRACol2006_Coated1Q	3.6			
KBA105_ME									
Track name		Tools	Substrate		Printing		Details		
<input type="checkbox"/> Walmart Spot Colors	1 files	2.5							
<input type="checkbox"/> Premium Coated Glossy	23 files	3.0	Premium Coated Glossy ME	0.3	SCD_GRACol2006_Coated1Q	3.0			
<input type="checkbox"/> Premium Coated Matt	30 files	4.0	Premium Matt Glossy ME	0.3	SCD_GRACol2006_Coated1Q	3.5			
PRE-PURCHASE UV-LED PRESS									
Track name		Tools	Substrate		Printing		Details		
<input type="checkbox"/> metalized (printed white)	11 files	4.0			SCD_ISOCoated_v2_eci	3.5			
<input type="checkbox"/> PP film	9 files	4.0			SCD_ISOCoated_v2_eci	3.8			
<input type="checkbox"/> Premium Coated Glossy	13 files	3.0			SCD_GRACol2006_Coated1Q	8.4			
<input type="checkbox"/> transparent film (printed white)	0 files	5.0			SCD_ISOCoated_v2_eci	5.2			

Printing Aims

- Different Target Print Conditions



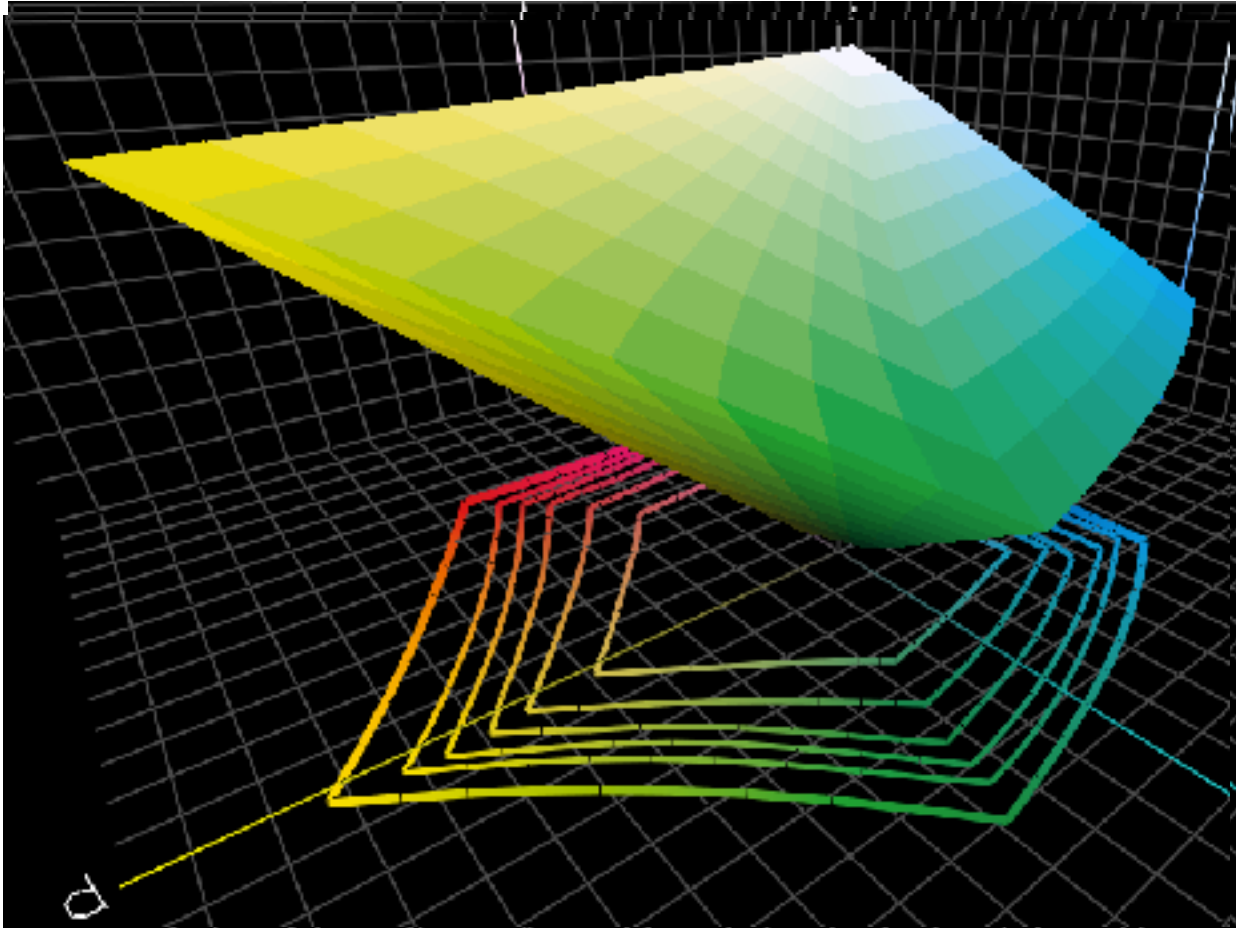
Printing Aim Differences in Delta E

- Delta E difference between substrates



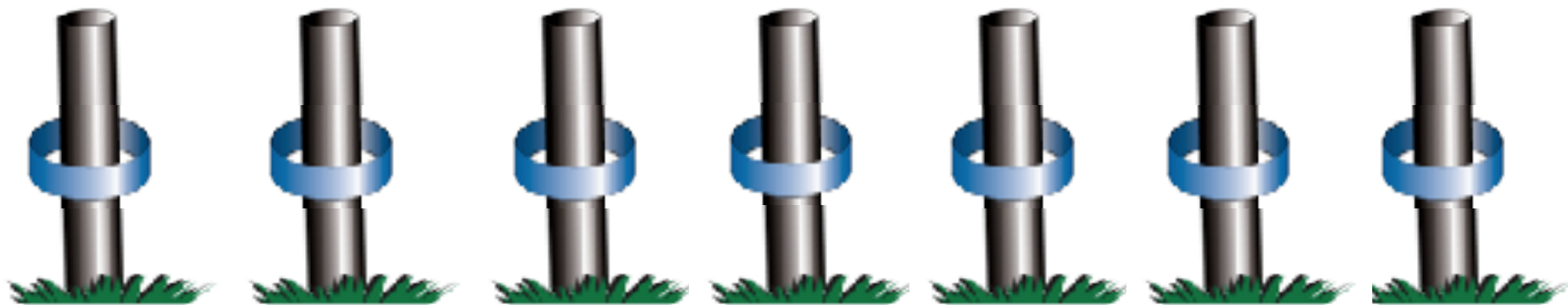
Printing Aims-Color Gamut

Map the Printing Aims to Color Space



Conformance based on CGATs 21

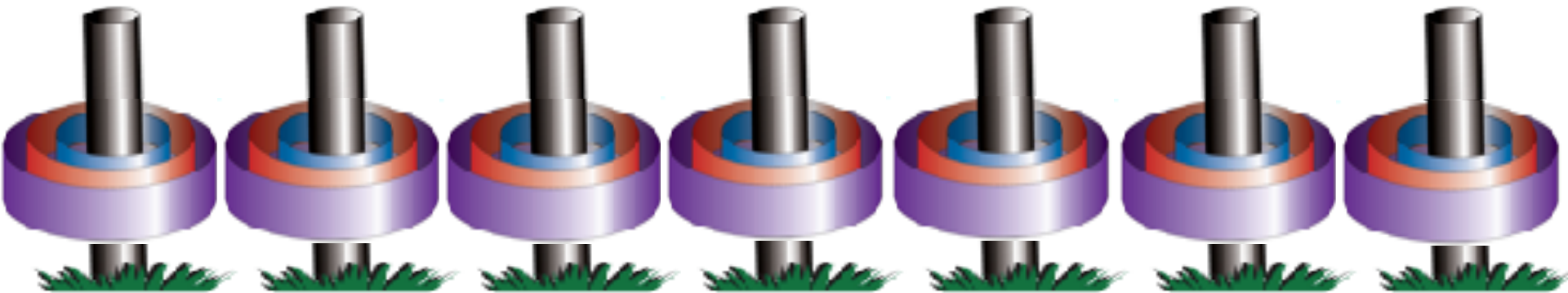
- Different Target Print Conditions



- Accuracy to Actual Print Condition- ***Conformance***

Conformance based on TR016

4 Assessments=A-Best, B-Better, C-Good, D-OK



- Accuracy to Actual Print Condition- **Conformance**
- **Level 1 (A)= 2 delta E (00), Level 2 (B)= 3 delta E**
- **Level 3 (C)= 4.5 delta E; Level 4 (D)= 6 delta E**

Determine the RPC for Your work

Keep it Simple to Start

- Printing on Coated stock, choose GRACoL (RPC6)
 - *Profile is available on line- choose GRACoL2013 if using M1 measurement devices*
 - *If Paper has Optical brighteners (glows under black light) Strongly recommend using M1*
 - *If paper does not have optical brightener- you can use GRACoL2006 and an M0 device*
- Add Additional References in future if needed
 - *Uncoated is a popular condition (RPC3)*













Qualification Module

Assessing Precision for any output device

Substrate Variation (Consistency)

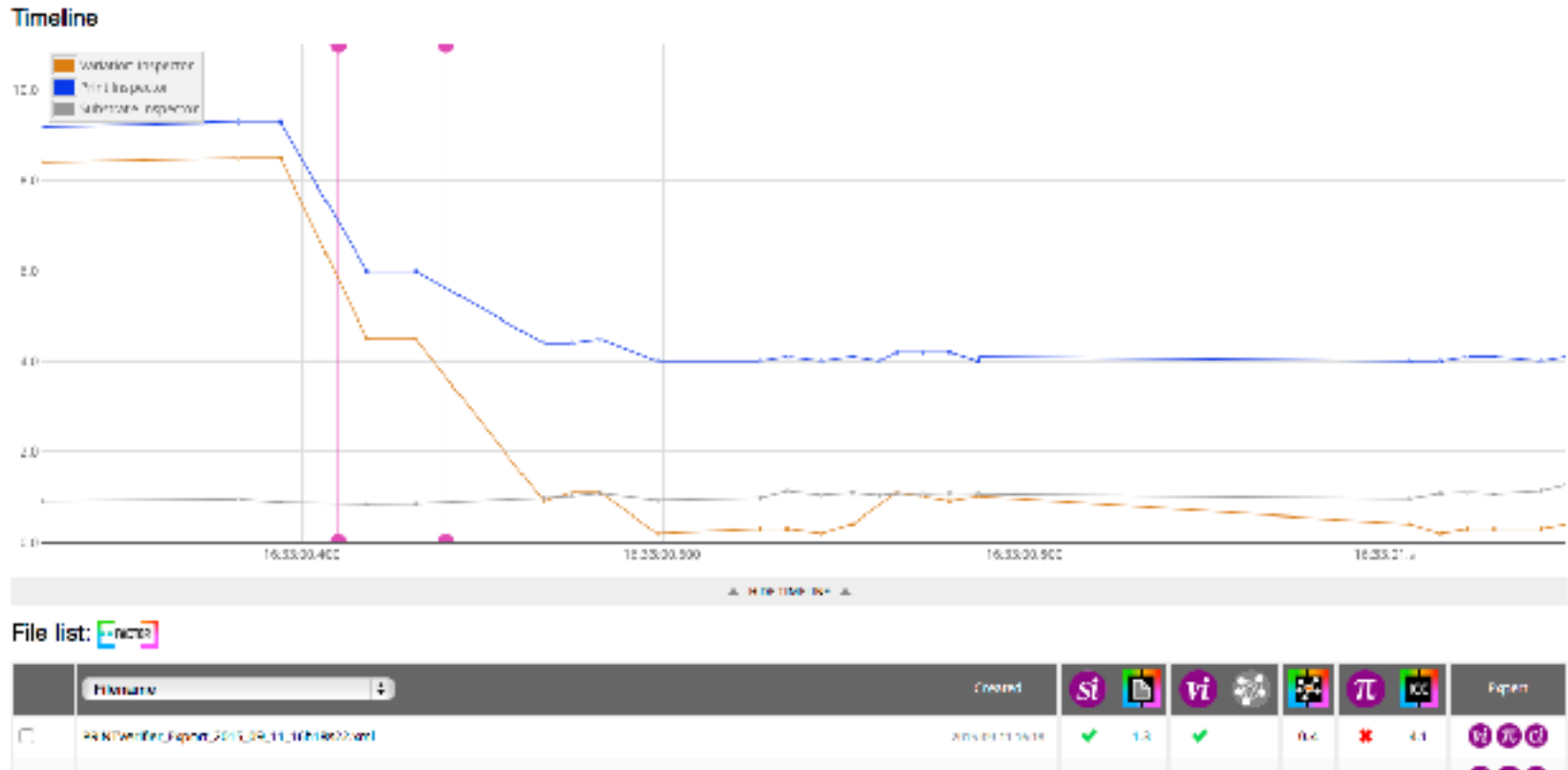
color		count	Max. ΔE 2000			Avg. ΔE 2000	Std. dev. ΔE 2000	95% ΔE 2000
			Res. #1	Tolerance	Pass/Fail			
	Substrate	66	0.20	2	✓	0.09	0.06	0.17

ΔE Variation (Precision)

color	count	Max. ΔE 2000			Avg. ΔE 2000			Std. dev. ΔE 2000			95% ΔE 2000		
		Res. #1	Tolerance	Pass/Fail	Result	Tolerance	Pass/Fail	Result	Tolerance	Pass/Fail	Result	Tolerance	Pass/Fail
	Cyan	1770	0.12	✓	4	0.11	2	✓	0.07		0.21	3	✓
	Magenta	1770	0.27	✓	4	0.09	3	✓	0.06		0.18	3	✓
	Yellow	1770	0.51	✓	4	0.15	3	✓	0.09		0.31	3	✓
	Black	1915	1.08			0.31		0.20			0.68	5	✓
	Red	590	0.44			0.14		0.08			0.29	5	✓
	Green	590	0.34			0.11		0.05			0.21	5	✓
	Blue	590	0.67			0.13		0.11			0.41	5	✓
	10% CMY gray	703	0.80			0.28		0.13			0.51	3	✓
	25% CMY gray	741	0.74			0.25		0.11			0.45	3	✓
	50% CMY gray	741	1.25			0.38		0.19			0.73	3	✓
	75% CMY gray	741	1.14			0.37		0.19			0.70	3	✓
	100% CMY gray	566	0.90			0.51		0.15			0.59	3	✓

Tracking Module: Production View

Fail Accuracy, Pass Baseline, Color Conversion



Color Expectations- Blind Audit

Actual Print Buyer- sent to 10 Printers

- Web to Print Printers
- Assessed Precision and Accuracy
 - *Sent Same Content twice, once in “Defined” RGB*
 - *Second time four weeks later in “Defined” CMYK*
 - *Measured the results through the run (Precision)*
 - *Measured results against Print Aim (Accuracy)*
 - *Plotted the Values*
- Defining Precision and Accuracy

Actual Prints- Precision (Variation)

Same Printer over time



5 E-Factor

8 E-Factor

Actual Prints- Deviation (Accuracy)

What is “Correct” : Print Aim: GRACoL



**10th Place
15 E-Factor**

**1st Place 5
E-Factor**

**Target
Printing
Aim:
“GRACoL”**

Quantify Quality Print Reproduction

E-Factor: Manufacturing Process Control

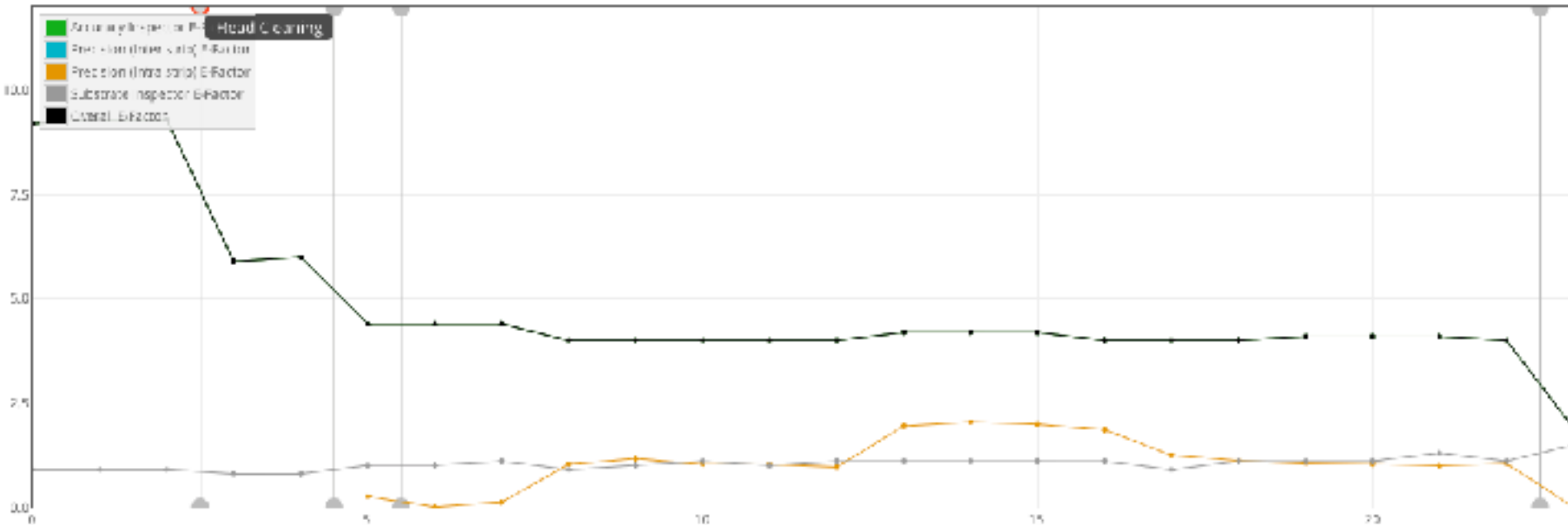
- Based on Customer's E-Factor (Expectations)
- Easy to associate all variables using one metric
- Understand immediately if device not good enough
- Differentiate your company from Competitors

ChromaChecker addresses these issues

Know effect of Maintenance on Color

Track Consumable. Maintenance vs Color

Timeline:



Vertical Gray lines show maintenance Events

Horizontal lines show Color Precision and Accuracy

Print Reproduction as Manufacturing

All Variables Influence Color Reproduction

- Output Device
 - Operator Skill
- Instrumentation
- Lighting
- Substrates
- Environment
- Plating or Imagesetting, Anilox Type

Can Compare Devices to Itself or Comparison

Summary

ChromaChecker Blueprint: Manufacturing

- Reports Color Conformity for all output devices
- Reports Precision for all supporting devices
- Works with existing Color Capture software
- Can send Alerts and Reminders when necessary
- Free Audit of existing devices, or potential new
- Guaranteed Customer Satisfaction

The way all Color will be handled within 5 yrs

Print Reproduction as Manufacturing

Need to Monitor Process Control

- Too much Time, Effort, Money to collect
- No Centralized Location to store data
- No Standard way to compare unlike data
 - Compare Instrument data vs Output data
- No Easy way to view the data
- No way to tie the information together
 - Instrument, Lighting, Substrate Variation affects Output Variation

ChromaChecker addresses these issues

ChromaChecker- Color Checker

Goals for the System

- Easy for Ownership = Understand results
- Easy for Management = make actionable results
- Provide one global location for all Process Info
- Easy to upload/enter data by operators
 - Alerts when they do not
- Open architecture- Any software, Any color bar
- Grow as you need
- Tie all Variables together to show cause/effect

ChromaChecker addresses these issues

ChromaChecker- Industry Firsts

Taking Our 30 year Industry Experience...

- Coining word “**E-Factor**,” applying it to all variables
- Compare **Output** to Standard- and to other Output
- Compare **Instrument** to itself, and other Instrument
- Compare **Lighting** to itself, and other Lighting
- **Substrate** Best Match function- find Proofing stock
- **Group** Press Conditions on E-Factor
 - Minimizing the amount of Curves, or Profiles that have to be manage

Compatibility List of Software

Supports any software that exports color file

- CGATs, CXF, SVF, XML
- Supports any Color Bar or Target (P2P, IT8)

Compatibility list & Metadata

solution	APV X	APV X	APV X	II Profiler	II Profiler	PressSIGN	IC	Patch Tool	Patch Tool	ColorPort	MeasureColor	IntelliTrax	Gateway
version	5.1.0	5.1.0	5.1.0	1.6.3	1.6.3	7	5.0	4.7.0	4.7.0	2.0.5	15	1.7	4.3
vendor	Alwan	Alwan	Alwan	X-Rite	X-Rite	Bodoni	Heidelberg	Babel Color	Babel Color	X-Rite	MeasureColor	X-Rite	Bodoni
extension	.xml	.bit	.svf	.bit	.svf	.xml	.bit	.bit	.svf	.bit	.svf	.svf	.bit
format	XML	CGATS	SVF	CGATS	CXF	XML	CGATS	CGATS	CXF	CGATS	SVF	SVF	CGATS
Date of creation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UTC support	✓	✓	✓	✓*	✓		✓	✗	✓	✗			

Master Dashboard shows status

Easy to Understand: Color

Expected Color Accuracy

Actual Color Accuracy



Track name	F / G	EF	Instrument	Substrate	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5				0.8	SCT
<input type="checkbox"/> Plastic	0 / 0	3.0			SOCA GRACOL2000_Coated192	4.1	
<input type="checkbox"/> Premium Coated Glossy	16 / 4	3.0		Premium Coated Glossy ME	0.3	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 3	3.5		Premium Matt Glossy ME	0.3	2.4	

- Output device E-Factor ≤ Customer = Expectations
- Do NOT have to understand Color to comprehend

Master Dashboard shows status

One View instantly shows All Variables

Instrument Precision

KBA105_ME									
Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5	X-Rite i1 iGd XL	0.05	BOP	0.7		0.8	<div>SCT</div>
<input type="checkbox"/> Plastic	1 / 0	3.0	X-Rite i1 iGd XL	0.05	PVC	1.7	name GRACol2006_Coated1v0	4.1	
<input type="checkbox"/> Premium Coated Glossy	18 / 4	3.0	X-Rite i1 iGd XL	0.05	Premium Coated Glossy ME	0.3	score GRACol2006_Coated1v0	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 5	3.5	X-Rite i1 iGd XL	0.05	Premium Matt Glossy ME	0.3	score GRACol2006_Coated1v0	2.4	

Substrate Precision

Master Dashboard shows status

If Instrument Precision is too high relevant to your Expectations, Number will show in Red

Instrument Precision

KBA105_ME									
Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5	X-Rite II Pro 1	0.40	BOP	0.7		0.8	SCT
<input type="checkbox"/> Plastic	1 / 0	3.0	X-Rite II Pro XL	0.05	PVC	1.7	ColorChecker 2000 Coated 1x2	4.1	
<input type="checkbox"/> Premium Coated Glossy	18 / 4	3.0	X-Rite II Pro XL	0.05	Premium Coated Glossy ME	0.3	ColorChecker 2000 Coated 1x2	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 5	3.5	X-Rite II Pro XL	0.05	Premium Matt Glossy ME	0.3	ColorChecker 2000 Coated 1x2	2.4	

Substrate Precision

- Easily Alerts users to *inappropriate* tools being used to hit tight Expectations

Tie All Variables Together

Provides a Complete Picture of Accountability

- When Color is wrong- one place to see what's off
- Allows for complete Accountability
- Know everyone is doing what they are supposed to
- Eliminates Finger Pointing
- Understanding the Cause and Effect of Variables








Tying All Variables to Dashboard

**Green = Good; Yellow = Has not been checked;
Red = Device fails Conformance**

Platesetter Check

Lighting Inspector

Environment Inspector

KBA105_ME									
  									
Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5	X-Rite i1 iS XL	0.05	BOP	0.7		0.8	   
<input type="checkbox"/> Plastic	1 / 0	3.0	X-Rite i1 iS XL	0.05	PVC	1.7	scod GRACol 2006_Colortest192	4.1	
<input type="checkbox"/> Premium Coated Glossy	18 / 4	3.0	X-Rite i1 iS XL	0.05	Premium Coated Glossy ME	0.3	scod GRACol2006_Colortest192	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 5	3.5	X-Rite i1 iS XL	0.05	Premium Matt Glossy ME	0.3	scod GRACol2006_Colortest192	2.4	


Customized timing for Analysis, once a day/week etc

Tying All Variables to Dashboard

Green = Good; Yellow = Has not been checked; Red = Device fails Conformance

Lighting Turned Yellow- Due to be Checked



KBA105_ME									
Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5	X-Rite i1 iS XL	0.05	BOP	0.7		0.8	
<input type="checkbox"/> Plastic	1 / 0	3.0	X-Rite i1 iS XL	0.05	PVC	1.7	scod GRACol 2006_Colortivity2	4.1	
<input type="checkbox"/> Premium Coated Glossy	18 / 4	3.0	X-Rite i1 iS XL	0.05	Premium Coated Glossy ME	0.3	scod GRACol2006_Colortivity2	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 5	3.5	X-Rite i1 iS XL	0.05	Premium Matt Glossy ME	0.3	scod GRACol2006_Colortivity2	2.4	

Can send out alerts when devices have not been checked in the desired time frame

Dashboard- All Devices

Proofer, Large Format, Digital Press, Press

EPSON 4900										
Track name		F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Proofer EA		25 / 1	3.0	s-D50 Pro 2 FA	0.59	Standard Printing Paper 70G	1.3	500x350x2_Lux1	4.1	

GS-6000

Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Basic Print Condition	1 / 0	6.0	X-Rite D11-Six XL	0.11			SOA_CRACol_2005_ColorsetV2	5.3	

HP INDIGO 01

Track name	F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/> Press quality monitoring	2 / 0	3.7	X-Rite D11-Six XL	0.11	HP calibration substrate ME	1.6	SOA_CRACol_2005_ColorsetV2	3.7	

KBA105_ME										
Track name		F / G	EF	Instrument	EF	Substrate	EF	Printing	EF	Details
<input type="checkbox"/>	Walmart Spot Colors	0 / 0	2.5	X-Rite D11 Six XL	0.05					SCT
<input type="checkbox"/>	Premium Coated Glossy	18 / 5	3.0	X-Rite D11 Six XL	0.05	Premium Coated Glossy MP	0.3	SOA_CRACol_2005_ColorsetV2	1.9	
<input type="checkbox"/>	Premium Coated Matt	24 / 5	3.5	X-Rite D11 Six XL	0.05	Premium Matt Glossy MP	0.3	SOA_CRACol_2005_ColorsetV2	2.4	

Extensive Training on Web Site

Operator Training Courses to help educate:

- How to make devices more consistent, accurate
- Specific Courses for: Free, Self Paced, Repeat
 - *Traditional Press Operator*
 - *Large Format Operators*
 - *Digital Press Operators*
- Complete Manual with Videos on Site
 - *Covers all aspects of ChromaChecker*
 - *Covers best practice procedures for all aspects of color*

Grade Output Conformance?

Score Card of Print Attributes:

- Companies have developed their own Score cards
 - *30 Points if Solid CMYK correct, etc.*
- How well does a score represent visual match?
 - *Often- **Not Very Well**- they are attributes that customer or liason will use to get discounts on print*
- E-Factor Cuts through the **Crap**
 - *Based on CRF for Delta E 2000: Modern metric which represents Color Difference based on Human Vision*

Score Card Output Conformance

Score Card of Print Attributes:

- Substrate, Solid Conformance, Overprints, All Colors, Gray Balance, TVI, Overall, E-Factor
- Can make any attribute normative or informative

File list

	Filename	Created									Report
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h19x23.xml	2015-09-11 16:18	✓	✓	✓	✓	✓	✗	✓	✗	4.1
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h19x23.xml	2015-09-11 16:18	✓	✓	✓	✓	✓	✗	✓	✗	4.0
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s43.xml	2015-09-11 16:17	✓	✓	✓	✓	✓	✗	✓	✗	4.1
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s23.xml	2015-09-11 16:17	✓	✓	✓	✓	✓	✗	✓	✗	4.1
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s12.xml	2015-09-11 16:17	✓	✓	✓	✓	✓	✗	✓	✗	4.0
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s54.xml	2015-09-11 16:16	✓	✓	✓	✓	✓	✗	✓	✗	4.0
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12x46.xml	2015-09-11 16:12	✓	✓	✓	✓	✓	✓	✓	✓	4.0
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12x46.xml	2015-09-11 16:12	✓	✓	✓	✓	✓	✓	✓	✓	4.2
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s25.xml	2015-09-11 16:12	✓	✓	✓	✓	✓	✗	✓	✗	4.2
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12s10.xml	2015-09-11 16:12	✓	✓	✓	✓	✓	✗	✓	✗	4.2
<input type="checkbox"/>	baseline	2015-09-11 16:12	✓	✓	✓	✓	✓	✗	✓	✗	4.0
<input type="checkbox"/>	PRINTVerifier_Report_2015_09_11_16h12x46.xml	2015-09-11 16:11	✓	✓	✓	✓	✓	✗	✓	✗	4.1

E-Factor- Expectation Factor/delta E

Scientifically Based

- Easy to Understand Name- Not Intimidating for the non Color Specialist
- Color Specialist- Means: Delta E (00) CRF
 - *Cumulative Relative Frequency, 95th Percentile of color*
- Can be applied to all variables in process
 - *Output Device Precision and Accuracy*
 - *Instrument Precision*
 - *Lighting Precision and Accuracy*
 - *Substrate Precision and Accuracy*

Master Dashboard shows status

Understand- When Color is WRONG

Expected Color Accuracy

Actual Color Accuracy



Track name	F / G	EF	Instrument	Substrate	Printing	Actual EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5				0.8	SCT
<input type="checkbox"/> Plastic	0 / 0	3.0			SOCA GRACOL2000_Coated192	4.1	
<input type="checkbox"/> Premium Coated Glossy	16 / 4	3.0		Premium Coated Glossy ME	0.3	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 3	3.5		Premium Matt Glossy ME	0.3	2.4	

- Output device E-Factor ≤ Customer = Expectations
- Do NOT have to understand Color to comprehend

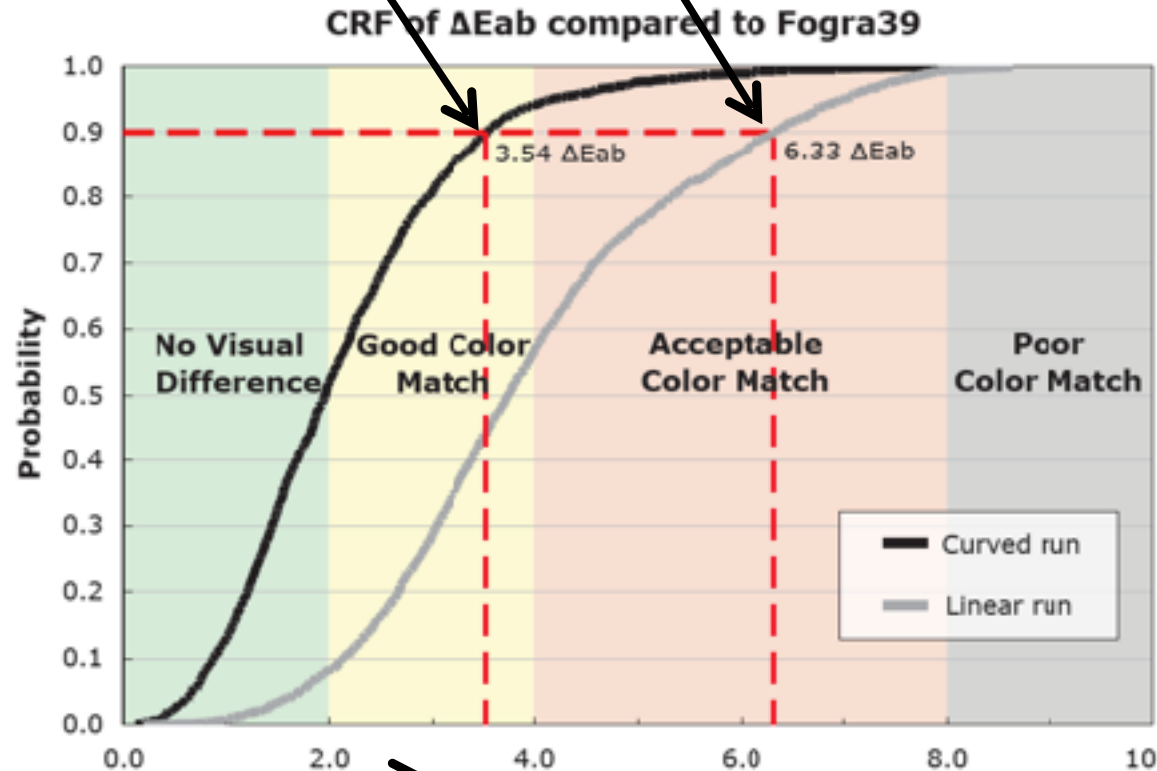
E-Factor- Expectation Factor/delta E

Scientifically Based

- Color Plots %'s of Delta E
- 95% Predicts Probability of Match
- What is Visual, Good, Acceptable Subjective...
- E-Factor Exercise Quantifies Expectations

Press vs Standard before Curve

Press vs Standard After Curve



E-Factor Exercise defines Expectation

- Users compare colors, until Close Enough



5 delta E

E-Factor Exercise

- Hard Copy version, or Free On-Line



2 delta E

E-Factor Exercise

- Eliminates Communication Issues- sets expectations



9 delta E

Chromachecker Color E-Factor

- Scales from 1 to 9 delta E (2000)
- On Line or Hardcopy from Chromachecker.com
- Self administered
- Referenced to TR016
- Part of ISO15339
- Actual size 4x7 inches
- Apply visual assessment to actual numbers
- Quantifies Acceptable Color Match



Provides Operations Actionable Data

If Device goes RED, Click Details for Track

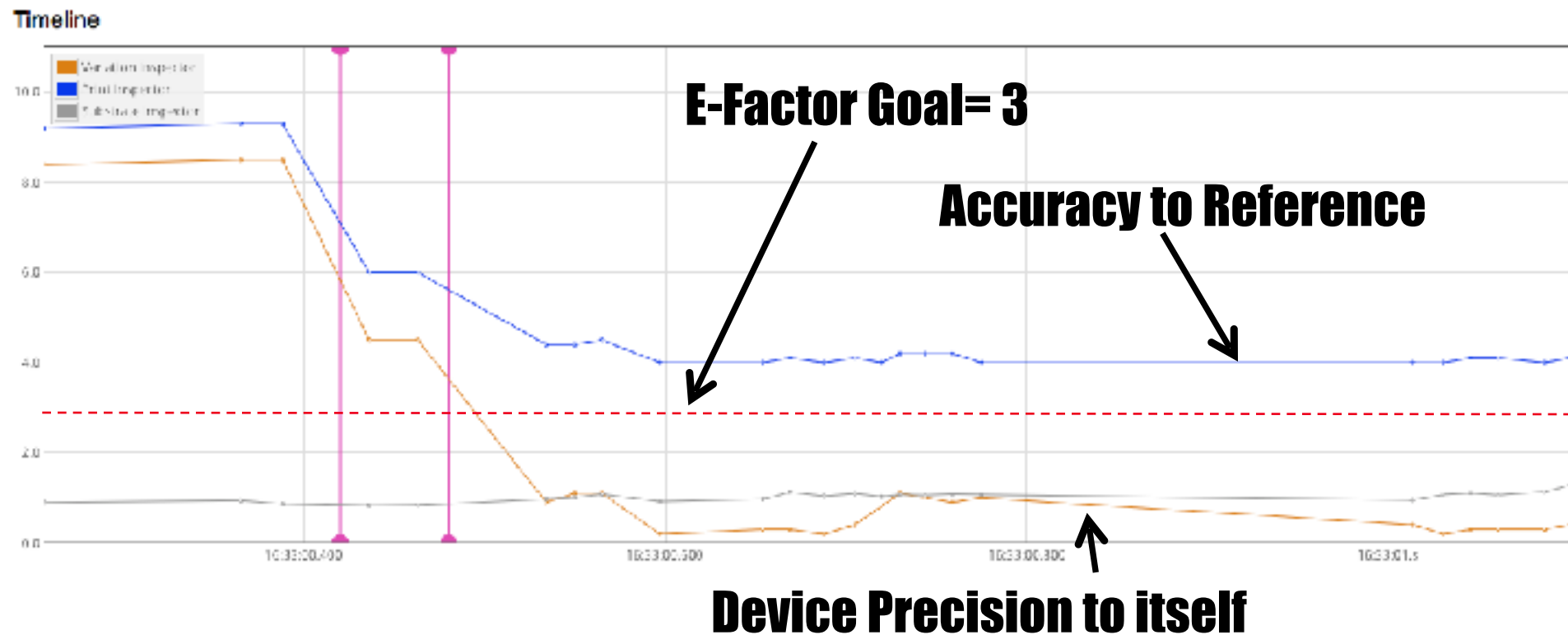


Track name	F / G	EF	Instrument	Substrate	Printing	EF	Details
<input type="checkbox"/> Walmart Spot Colors	0 / 0	2.5				0.8	
<input type="checkbox"/> Plastic	0 / 0	3.0			SOCA GRACOL2006_Coated192	4.1	
<input type="checkbox"/> Premium Coated Glossy	16 / 4	3.0		Premium Coated Glossy ME	0.3	1.9	
<input type="checkbox"/> Premium Coated Matt	24 / 5	3.5		Premium Matt Glossy ME	0.3	2.4	

- Three Levels of Detail to uncover cause of problem
- Viewing Top Level- Owner Level

Provides Operations Actionable Data

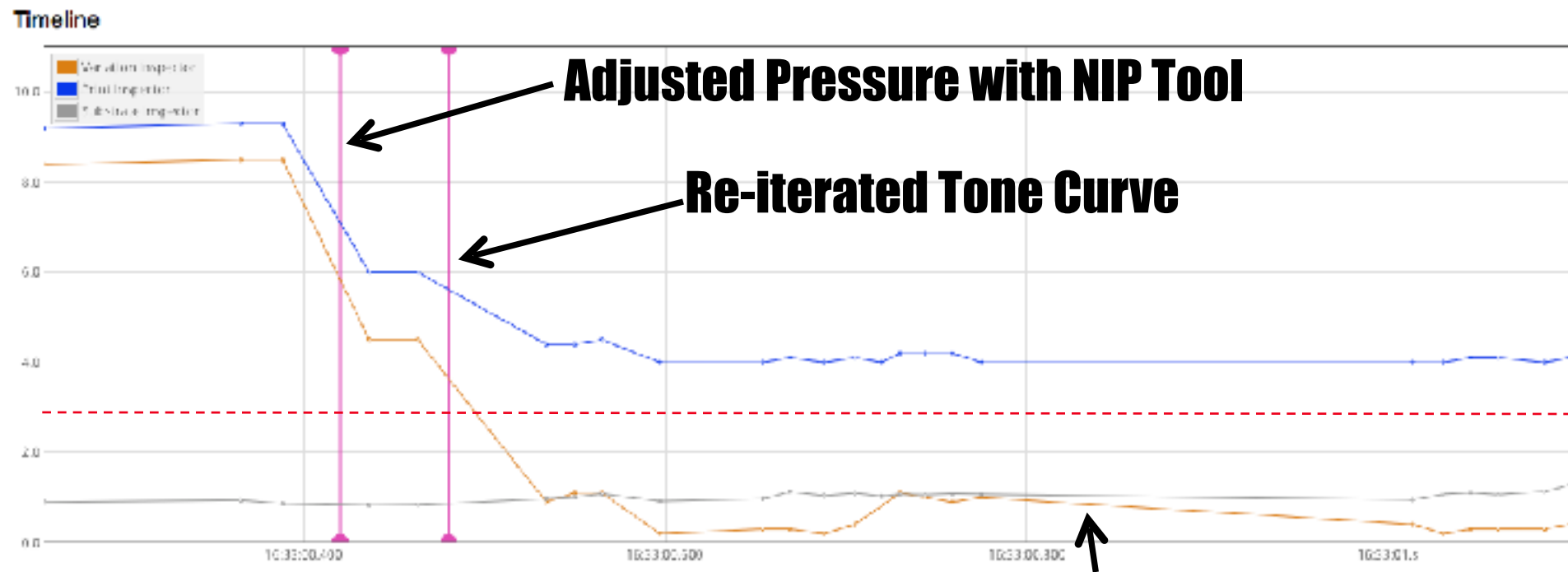
Line Graph showing any level of history



- Accuracy Relates to Color Conversion or Curves

Provides Maintenance Feedback

Any time enter: Maintenance Events



- Can tell if maintenance helped or hurt situation

Print Inspector

Can track operators effect on Print Results

- Spot or Process Conformance

Tracks affects of Substrate, Instrument

- Warns you if either substrate or instruments variation exceeds too much of total E-Factor

Assesses Consistency versus Accuracy

- Consistency- Related to device mechanics
- Accuracy- Related to Curves and or Color Mgmt

Multiple Inspectors and Tools

Designed to Control your Process



Desire Results vs. Actual Results

Desired E-Factor

Actual E-Factor

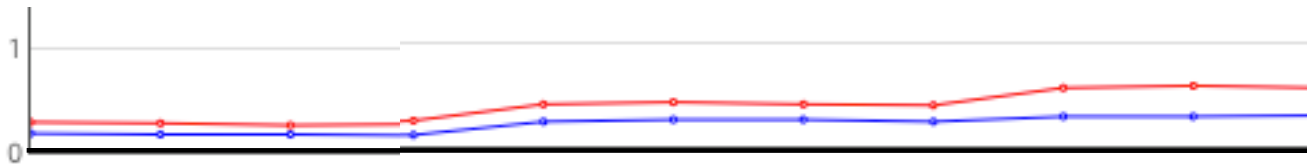
Tracks									
COLORSTREAM									
Track name	F / G	EF	Instrument	Substrate	Printing	Details			
<input type="checkbox"/> ColorStreamIP	12 / 1	3.0	X-Rite II Pro 2	IP AccentSpacuumImageLock	SCX1 COATS21_CIPCI		0.51	8.9	
EPSON COATED									
Track name	F / G	EF	Instrument	Substrate	Printing	Details			
<input type="checkbox"/> EpsonProofer	0 / 0	3.0			CGATS21_CRP06				
<input type="checkbox"/> FujiFinalProof_PVC	1 / 0	3.0	X-Rite II Pro 2		NEA COATS1_CRP05		0.14	2.4	

Instrument E-Factor- Red- too high compare to Target

Instrument Inspector

Unique Target, Printed, Represents 95% Color

- Tracks an instrument to itself













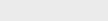




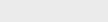




- Compare multiple instruments to one another
- Warns you when Instruments E-Factor makes up too much error compared to print process
- Ensure Instrument Consistency throughout supply chain

Instrument Inspector Comparison

Instrument Differences

Notice:

- 2 i1s
- Different Vendors

SE 2000 Tolerance: A Condition: M1	X-Rite ii i51s XL i1 i51s XL - AA-0214 SB ALL	X-Rite ii Pro 2 EA i1 Pro 2 EA - AA-0214 SB ALL	Barbieri Spectro LFP Barbieri Spectro LFP - AA-0326 after recalibration	Techkon Spectro-Densitometer SpectroDens Premium Techkon SD on AA-0214 smart baseline	X-Rite ii Pro 2 i1-Pro 2 - AA-0214 merged
X-Rite ii i51s XL i1 i51s XL - AA-0214 SB ALL		max: 1.18 95%: 0.99 90%: 0.89 mean: 0.58 stdev: 0.24 	max: 3.67 95%: 2.97 90%: 2.36 mean: 1.66 stdev: 0.60 	max: 1.85 95%: 1.36 90%: 1.31 mean: 0.79 stdev: 0.36 	max: 2.26 95%: 1.33 90%: 1.14 mean: 0.76 stdev: 0.39 
X-Rite ii Pro 2 EA i1 Pro 2 EA - AA-0214 SB ALL	max: 1.18 95%: 0.99 90%: 0.89 mean: 0.58 stdev: 0.24 		max: 2.98 95%: 2.37 90%: 2.12 mean: 1.40 stdev: 0.50 	max: 2.18 95%: 1.49 90%: 1.22 mean: 0.89 stdev: 0.40 	max: 1.59 95%: 0.96 90%: 0.71 mean: 0.51 stdev: 0.39 
Barbieri Spectro LFP Barbieri Spectro LFP - AA-0326 after recalibration	max: 3.67 95%: 2.97 90%: 2.36 mean: 1.66 stdev: 0.60 	max: 2.98 95%: 2.37 90%: 2.12 mean: 1.40 stdev: 0.50 		max: 3.25 95%: 2.99 90%: 2.63 mean: 1.95 stdev: 0.58 	max: 2.72 95%: 2.20 90%: 1.98 mean: 1.36 stdev: 0.45 
Techkon Spectro-Densitometer SpectroDens Premium Techkon SD on AA-0214 smart baseline	max: 1.85 95%: 1.36 90%: 1.31 mean: 0.79 stdev: 0.36 	max: 2.18 95%: 1.49 90%: 1.22 mean: 0.89 stdev: 0.40 	max: 3.25 95%: 2.99 90%: 2.63 mean: 1.95 stdev: 0.58 		max: 2.28 95%: 2.04 90%: 1.57 mean: 0.99 stdev: 0.49 
X-Rite ii Pro 2 i1-Pro 2 - AA-0214 merged	max: 2.26 95%: 1.33 90%: 1.14 mean: 0.76 stdev: 0.39 	max: 1.59 95%: 0.96 90%: 0.71 mean: 0.51 stdev: 0.39 	max: 2.72 95%: 2.20 90%: 1.98 mean: 1.36 stdev: 0.45 	max: 2.28 95%: 2.04 90%: 1.57 mean: 0.99 stdev: 0.49 	

Substrate Inspector

Tracks Consistency during Production

- Instantly see results of inconsistent raw materials

Can be used to Find Best Match

- Find Proofing Stock
- Find similar production stock for different process

Find the Best Match for: Press House Stock

Match filter

Number of results:

☒ Show best CIE whiteness M1 results only

Match criteria

First criteria	Second criteria	Third criteria	Fourth criteria	Fifth criteria
<input type="text" value="M1 white backing ΔE"/> <input type="button" value="⌵"/>	<input type="text" value="CBA Index (ΔCBA)"/> <input type="button" value="⌵"/>	<input type="text" value="M1 white backing ΔCh"/> <input type="button" value="⌵"/>	<input type="text" value="Glossiness"/> <input type="button" value="⌵"/>	<input type="text" value="Basis weight"/> <input type="button" value="⌵"/>
Weight: <input type="text" value="40"/> <input type="button" value="⌵"/>	Weight: <input type="text" value="20"/> <input type="button" value="⌵"/>	Weight: <input type="text" value="15"/> <input type="button" value="⌵"/>	Weight: <input type="text" value="15"/> <input type="button" value="⌵"/>	Weight: <input type="text" value="10"/> <input type="button" value="⌵"/>

Measurement and lighting conditions

Lighting Inspector (Uses i1 of GL)

Assesses ISO 3664 Conformance

- Lighting Standard, both P1 and P2

Can Assess Change over time

- Know when to change bulbs

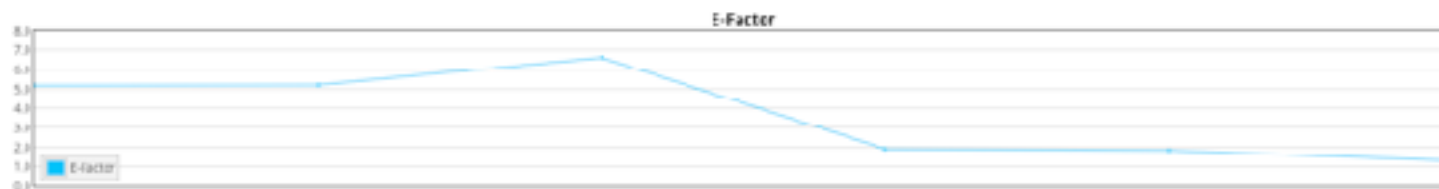
Can Compare multiple Light Booths

- See the difference in Supply Chain

Measurements for Press B Console

Location	London	ISO standard	P1
Type of source of light		Uniformity test (samples)	9
Lightbooth / Console / Lamp brand		Validation period	weekly
Description		Audit period	monthly

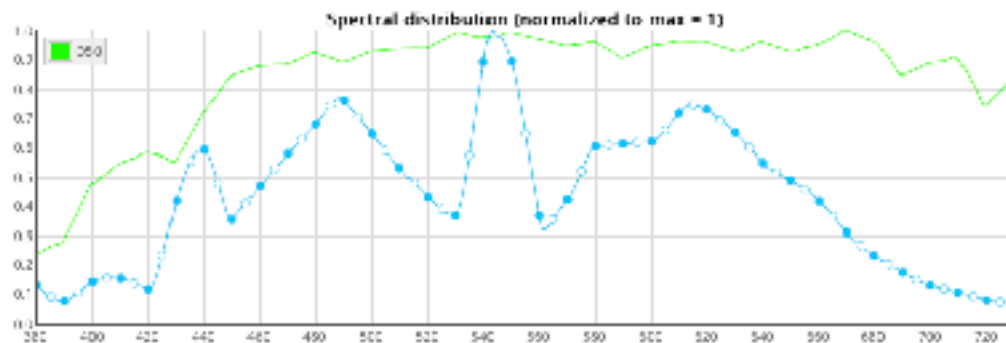
Timeline



Lighting Inspector (Uses i1)

Basic information and spectral curve

Color temperature (CCT)	4857 K
Illuminance	2150 lx
CRI (R_a , CIE 13.2)	95.3
CRI (R_a , 2012)	94.6
CQS (Q_{90})	93
Metamerism Index	1.0 (C class)
ISO 3664 compliance	✓



Lighting E-Factor

	D50 Illuminant				D50 Illuminant				D50 Illuminant				D50 Illuminant			
	AF2000	ΔE_{Jd}	AC	AI	AF2000	ΔE_{Jd}	AC	AI	AF2000	ΔE_{Jd}	AC	AI	AF2000	ΔE_{Jd}	AC	AI
E-FACTOR	1.32				2.46				2.01				1.97			
Max	1.55	1.55	2.00	2.42	2.64	2.35	2.95	3.55	2.15	2.37	4.08	3.81	2.39	2.51	4.55	3.42
95%	1.37	1.48	1.75	1.97	2.45	2.17	2.75	3.32	2.01	2.15	3.59	3.57	1.97	2.17	3.81	3.15
Mean	0.69	0.78	0.77	0.86	1.07	1.05	1.21	1.40	1.11	1.17	1.63	1.60	1.14	1.29	1.40	1.32
Std. dev.	0.32	0.34	0.34	0.51	0.65	0.55	0.65	1.14	0.45	0.52	0.86	1.14	0.54	0.54	0.91	1.02
<div> <div>Color Rendering Vectors</div> </div> <div> <div>Color Rendering Vectors</div> </div> <div> <div>Color Rendering Vectors</div> </div> <div> <div>Color Rendering Vectors</div> </div>																

PlateSetter – Anilox Tool

Know what values plate should be

- Track the raw/linear values (baseline)
- Track the production values
- Track consistency over time

Anilox – Associate with Print Track

- Easily enter data
- Keep track of which anilox goes with which track

Data Logger Tool

Automatically collects Temperature/ Humidity

- Track the atmospheric conditions associate with device performance
- Set high and low alarms
- Track consistency over time

Can be used to measure water/ conductivity

- Automatically upload data



Data Logger Tool

Automatically collects Temperature/Humidity

- Automatically upload data



Start Now:

Take E-Factor Exercise- 3 Minutes

Upload your first 50 measurement- Free

- Learn What your output device “Normal” Is
- Not going to track all your variables right away
- Build your Process Control procedures one variable at a time. Grow as you Go!
 - *Start with your Output Device performance*
 - *Then Instrument, and Substrate, Lighting and Plates*
- Works with Any Target, Any Spectral Measurement
- We will help you get started...

ChromaChecker- Ease of Use

Anyone can Use ChromaChecker.com

- Three Levels of Detail for Output Devices
 - *Top Level- Owner View*
 - *Second Level – Production Manager*
 - *Third Level- Technician, Operator*
- Different Views for Different Devices
- Low Cost of use- Free to start, No Contract, Low cost per upload, only pay as you need

Track Process Control

Contact Me:

- David Hunter
- 651.717.0590
- david@chromachecker.com

Output Conformance- Track what?

Score Card of Print Attributes:

- While you are making production
- Not going to track all your variables right away
- Build your Process Control procedures one variable at a time. Grow as you Go!
 - *Start with your Output Device performance*
 - *Then Instrument, and Substrate, Lighting and Plates*

Complete Process Control Tracking

Requires a lot of work: Many Variables

- While you are making production
- Not going to track all your variables right away
- Build your Process Control procedures one variable at a time. Grow as you Go!
 - *Start with your Output Device performance*
 - *Then Instrument, and Substrate, Lighting and Plates*

Next Steps: E-Factor

Where do we go?

- Feedback for the equations
- Testing with equations
- Will hear more about Substrate Work
- Nothing Else quantifying Human Expectations
- Nothing Else quantifies:
 - *Instrumentation, Lighting, Substrates, Device Performance in Workflow*
 - *And how they interact in workflow (Weakest Link)*
- Easy to Understand for “Average User”

Difference Between:

Precision versus Accuracy

- *Precision (Repeatability/Reproducibility) Depends*
 - Preventative Maintenance and Consumable Changes
 - Proper Calibration procedures
- *Accuracy (Color Match) Dependent on:*
 - Proper Color Conversion in Workflow or DFE/RIP
 - Correct Tone Reproduction Curve control Gray Balance

Difference Between:

Precision versus Accuracy

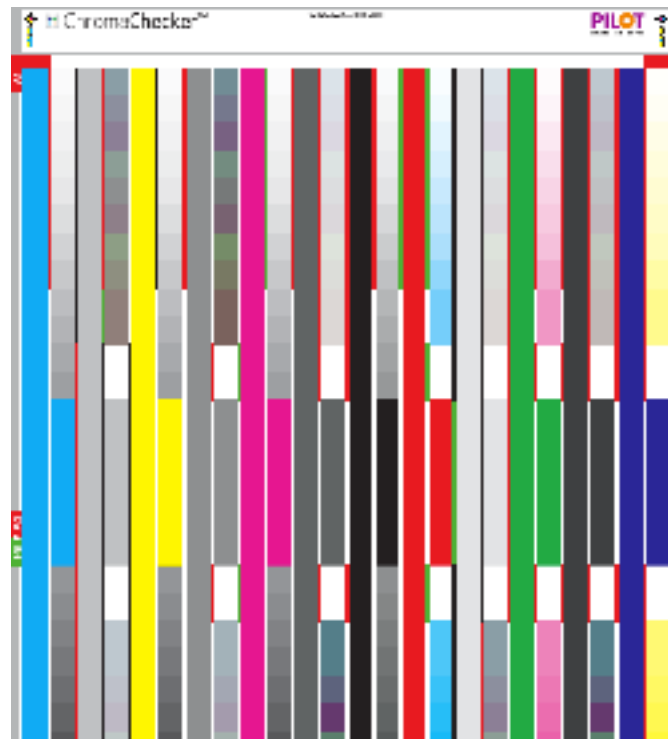
- *Precision (Repeatability/Reproducibility) Depends*
 - Preventative Maintenance and Consumable Changes
 - Proper Calibration procedures
 - **Digital Operator Responsibilities**
- *Accuracy (Color Match) Dependent on:*
 - Proper Color Conversion in Workflow or DFE
 - Correct Tone Reproduction Curve control gray balance
 - **Prepress/Prep Responsibilities**
- *Need Both parties to attain Precision and Accuracy*

Assess Tone Reproduction Curve TRC

Tone Curve iteration Still FAILS

18. The Precision of the device is not tight enough for your assessment criteria


Assess Precision of your Device



Data which makes Line Graph

Consistency and Accuracy of Print Device

- Substrate, Device to Itself, Device to Reference

File list: 

	Information	Created	SI		VI			PI	CC	Expert	
<input type="checkbox"/>	PRINTVerifier_Export_2015_09_11_16h18s22.xml	2015-09-11 16:18	✓	1.2	✓			0.4	✗	4.1	VI PI CC
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<input type="checkbox"/>	baseline	2015-09-11 16:12	✓	1.0		±0.3	0	✗	4.0	VI PI CC	