



Balancing Regulatory Compliance and Color Performance: The CMYKOV Ink Gamut for Direct Food Contact Offset Printing

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Color & Comfort

Direct Food Contact Printing is Different

- Direct contact
→ strict safety focus.
- Direct Food Contact (DFC) inks differ from standard inks.
- Safety limits pigment choice.
- Brands expect aesthetics + sustainability.



Food-Contact Regulations

- Direct Food Contact printing is strictly regulated for food safety.
 - **EU:** EC 1935/2004
 - **US:** FDA 21 CFR
- Pigment options are restricted.
- Limited pigments → reduced gamut and unreachable hues.



EC1935/2004



**U.S. FOOD & DRUG
ADMINISTRATION**

Mapping Achievable Pantone Colors

- Prior work in Europe.
- 9 available food-safe colorants.
- Method: mapping Pantone Solid Coated colors to $CIEDE2000 < 2$
- 1,801 reproducible colors
- Baseline for understanding limitations



Explore ECG for DFC Printing

- Sustainability pressures
- Customer demand for better color fidelity

Hypothesis:

Regulatory pigment restrictions do not prevent meaningful gamut expansion when ECG is applied in DFC printing workflows.

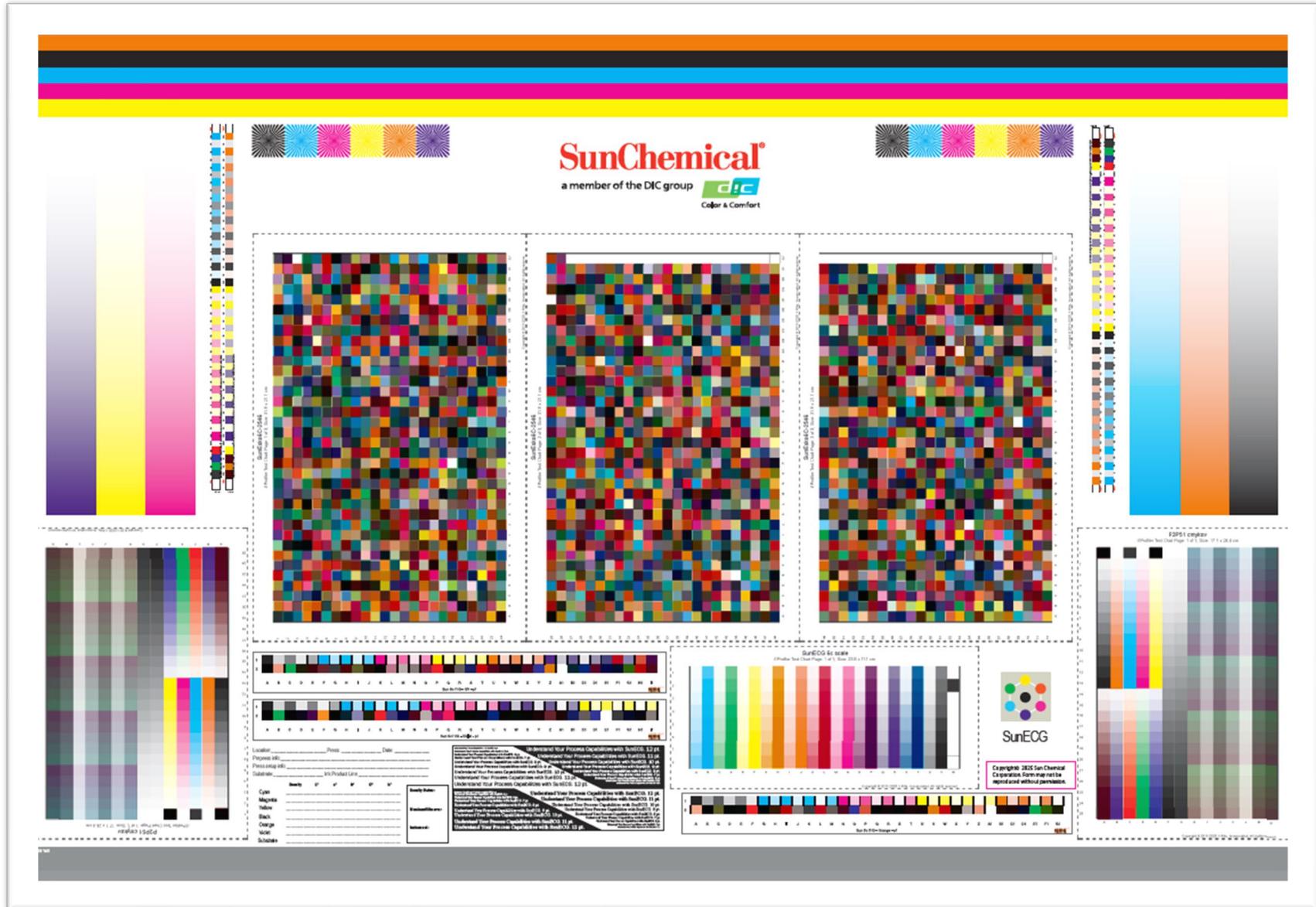
ECG: Expanded Color Gamut

Introduction to the CMYKOV Ink Set

- Formulated specifically for direct food contact sheetfed offset
- Components CMYKOV: Cyan, Magenta, Yellow, Black, Orange, Violet
- Goal: expand chroma while staying compliant.



Test Form Used for Color Characterization



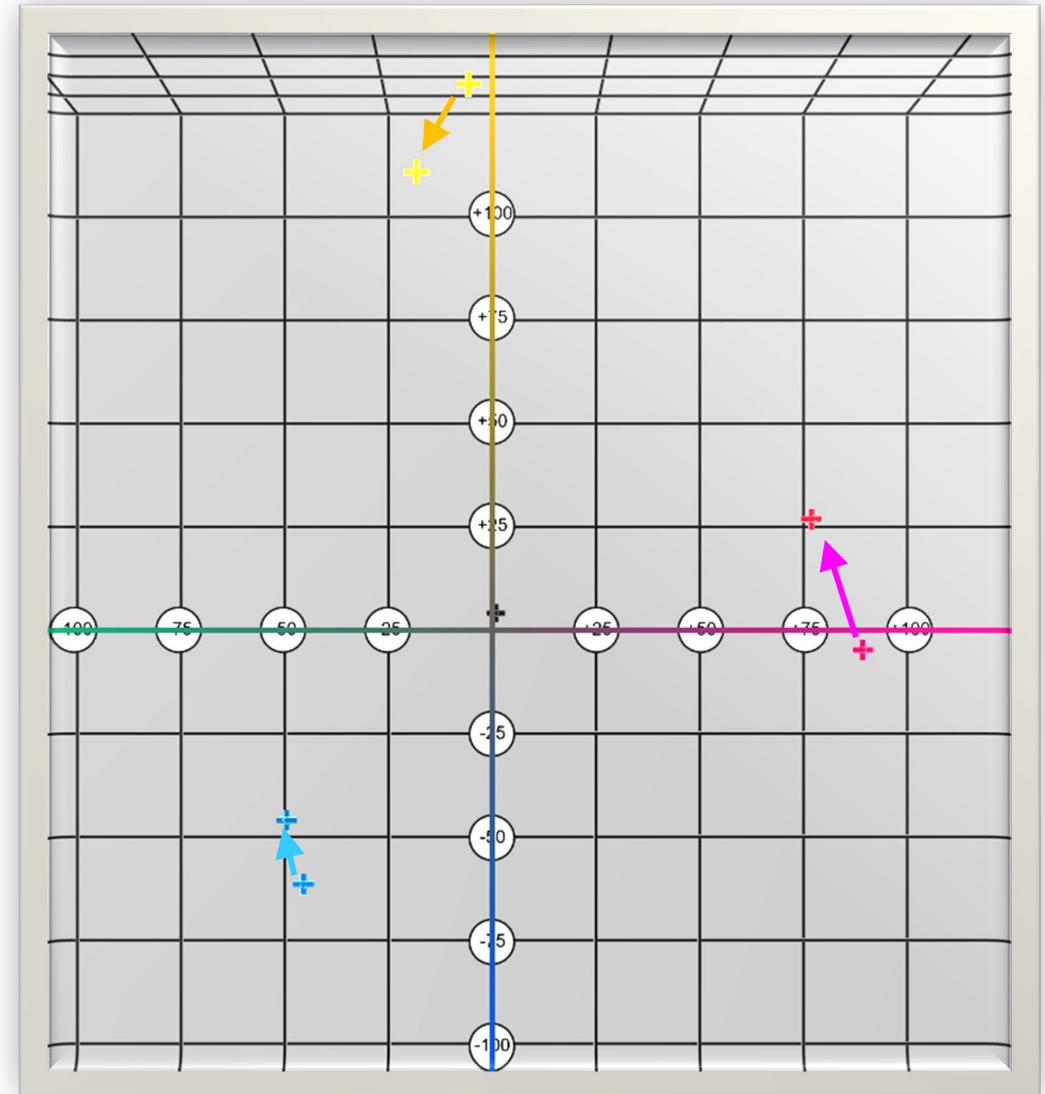
2026



CMYK

Direct Food Contact vs. CRPC-6

	Direct Food Contact CMYK			CRPC-6 CMYK			ΔC^*	ΔH	ΔE_{00}
	L*	A*	B*	L*	A*	B*			
Cyan	53.2	-40.8	-37.9	56	-37	-50	-6.6	-10.9	5.6
Magenta	52.0	63.6	22.3	48	75	-4	-7.7	27.6	14.4
Yellow	91.3	-12.7	77.2	89	-4	93	-14.9	10.2	6.5
Black	25.8	0.8	3.8	16	0	0	3.9	0.0	7.7



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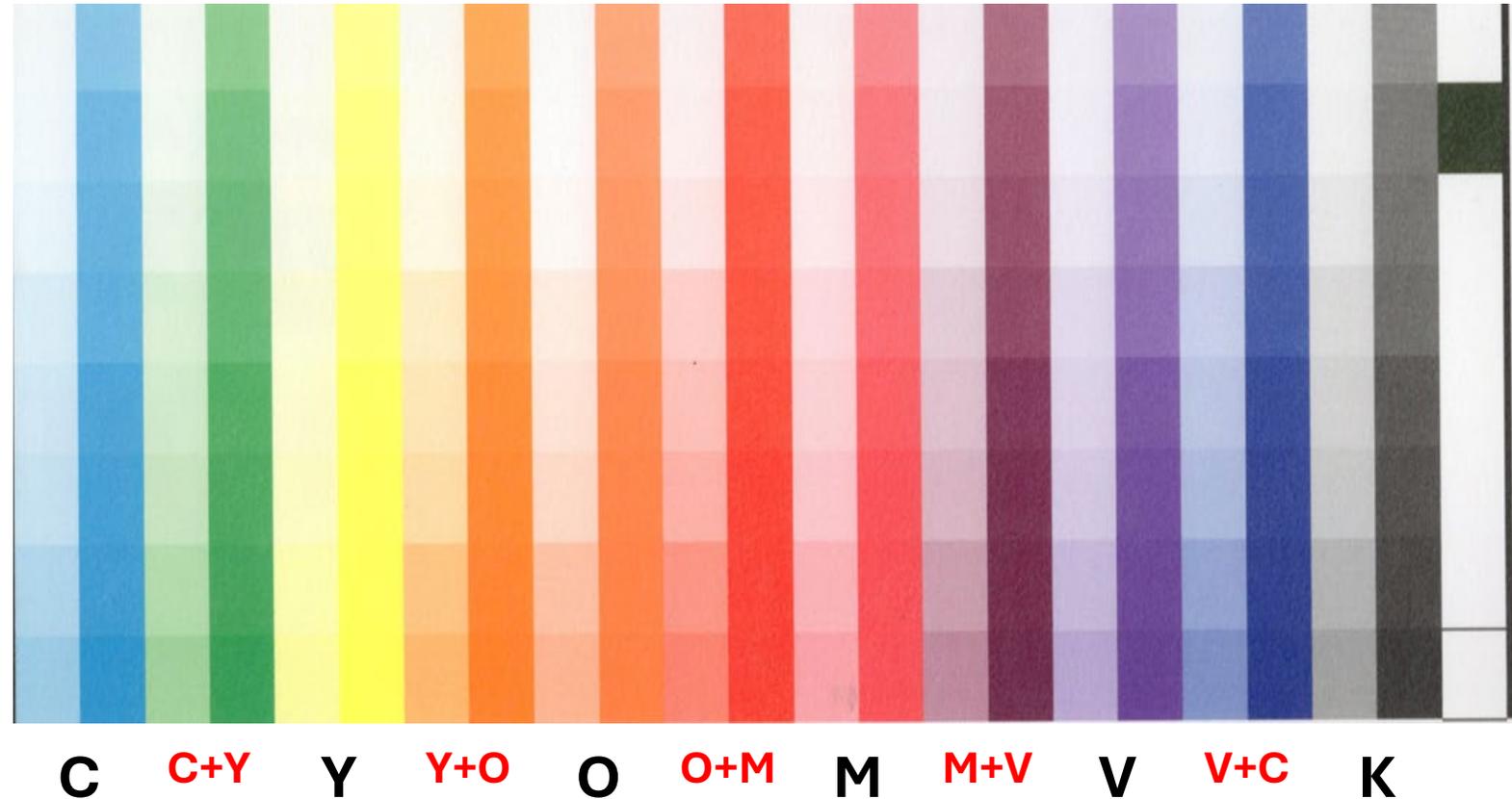


CMYK: Cyan, Magenta, Yellow, Black

CRPC-6: Characterized Reference Printing Condition 6 (ISO DIS 15339-2)

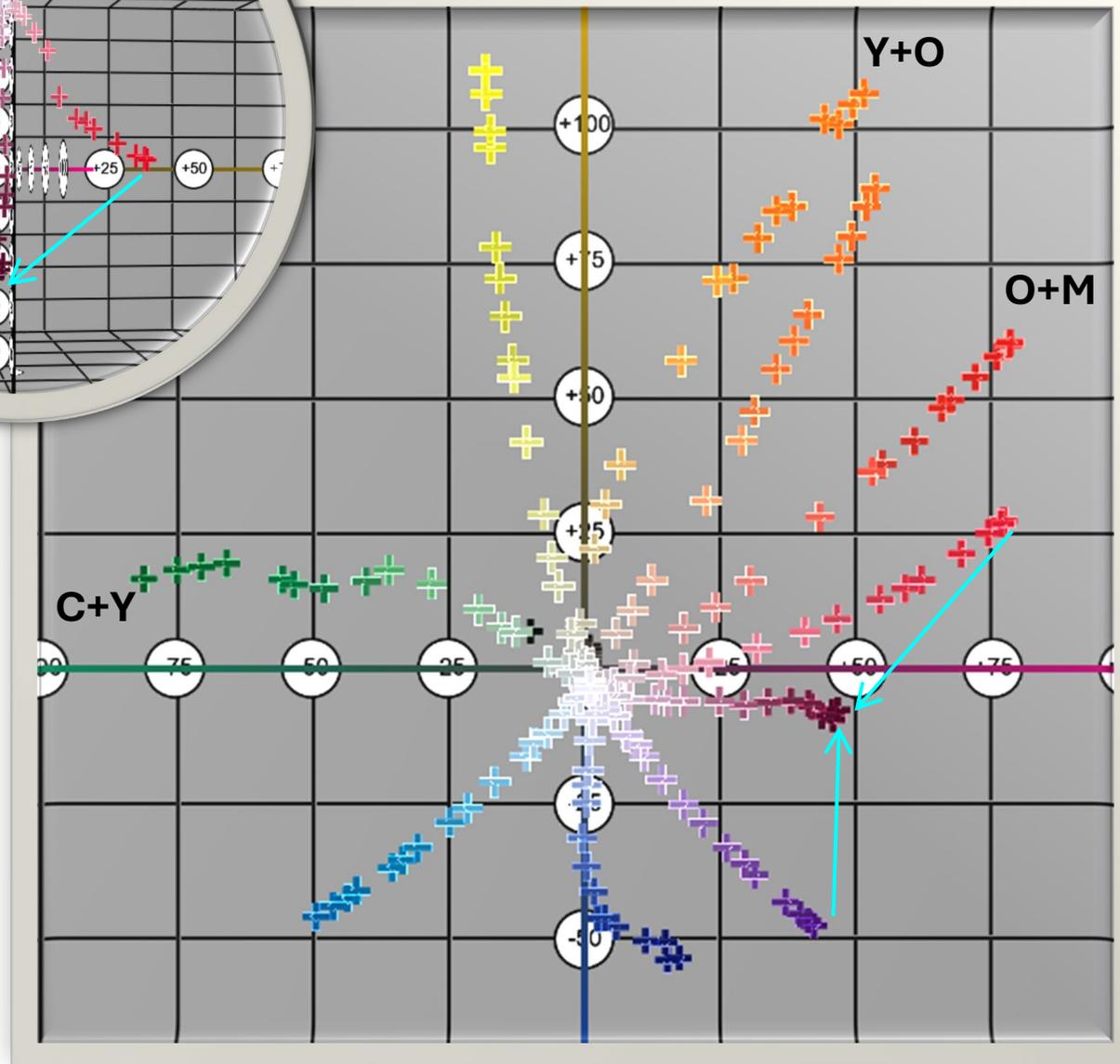
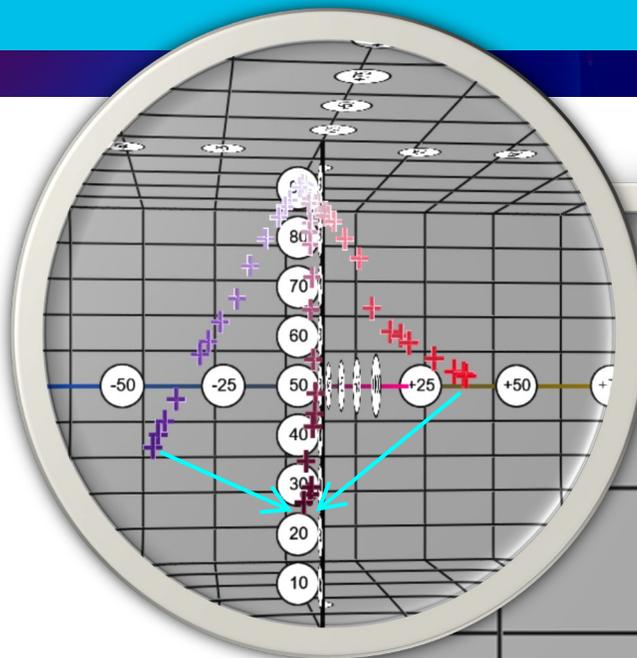
New Solid Ink Targets for a New Ink System

- Compliant pigments require new density targets.
- Target curves calibrated to ISO 12647-2 Curve A
- Solids + overprints define the profiling backbone.



Overprint Interactions and Gamut Impact

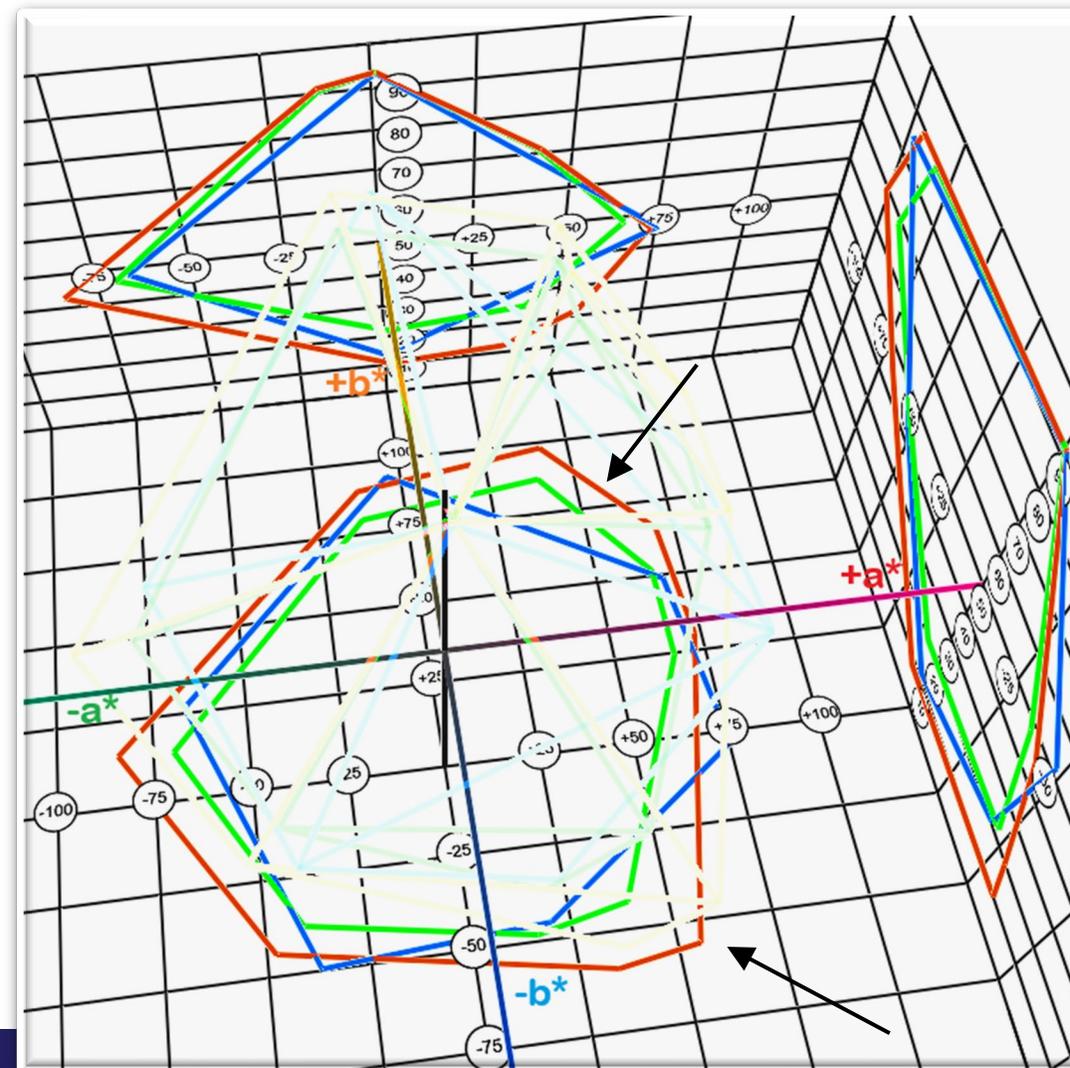
- **Warm overprints (M–O–Y):** strongest chroma gain.
- **M–V:** dull maroon → no fourth-quadrant benefit.
- **C–Y:** creates strong greens but unstable tone progression.



Gamut Expansion with CMYKOV

- Focus on the 2-D silhouettes (not the wire frames).
- Biggest gains: orange and violet vs CMYK.
- Coated side > CRPC-6; uncoated side < CRPC-6 (smaller gamut).

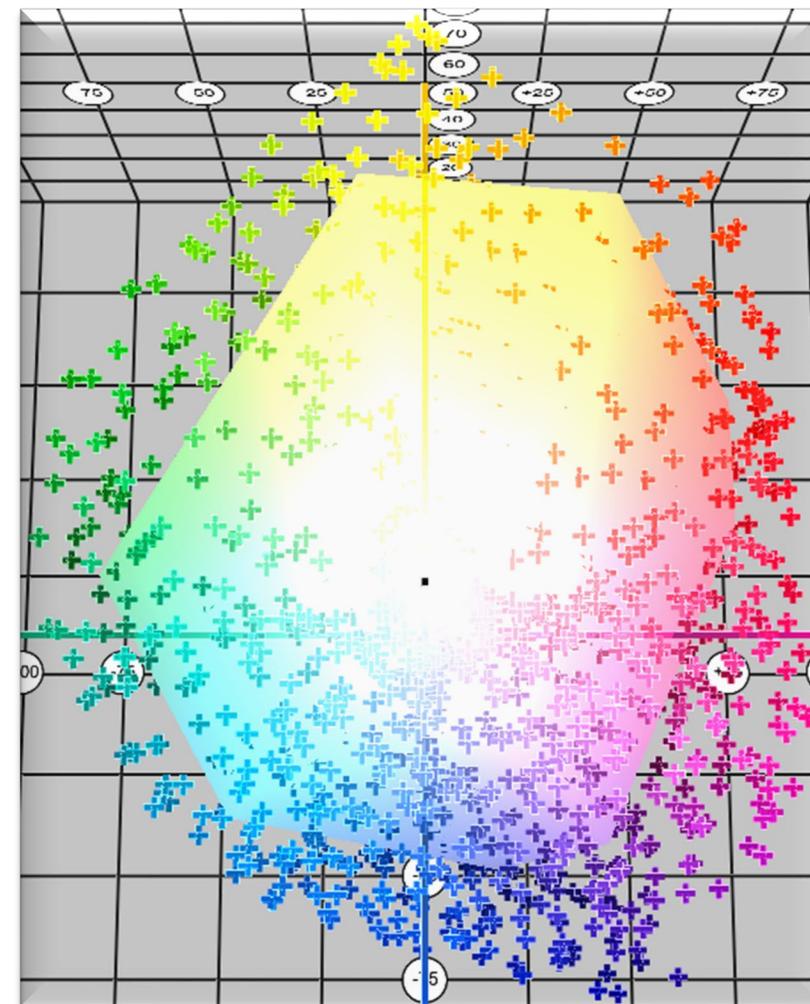
CMYKOV Coated	539,274 unit
CGATS21_CRPC6	358,590 unit
CMYKOV Uncoated	351,670 unit



Pantone via CMYKOV, No Spot Colors

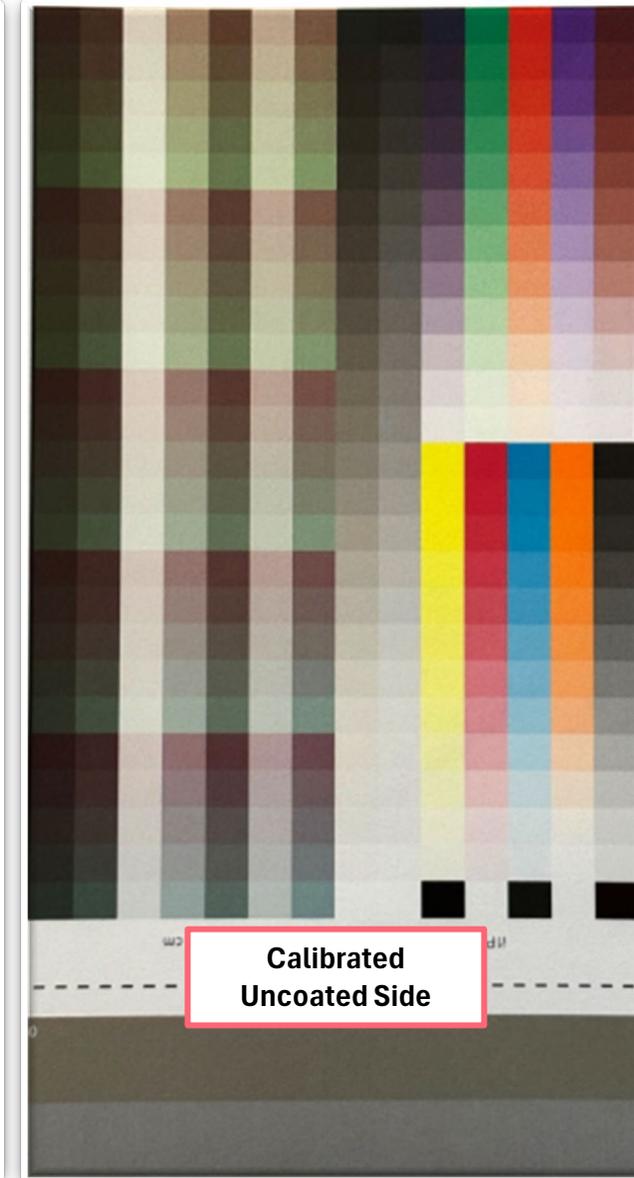
- $\Delta E_{00} < 2$: **250** Pantone Solid Coated matches with CMYKOV-uncoated.
- $\Delta E_{00} 2-4$: **1,641** more colors within extended tolerance.
- Net value: Reduces reliance on spot inks while keeping full compliance.

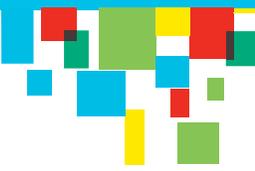
Pantone Solid Coated matches		
	CMYKOV-uncoated	CGATS21_CRPC6
$\Delta E_{00} < 2$	250	253
$\Delta E_{00} 2-4$	1,641	1,611



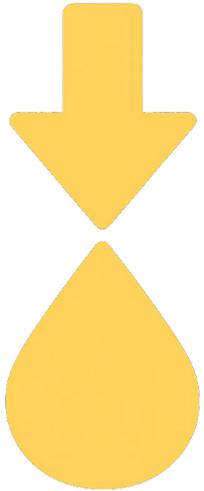
Problem Observed:

- Too dark
- No density standards.
- Green cast
- TVI calibration insufficient

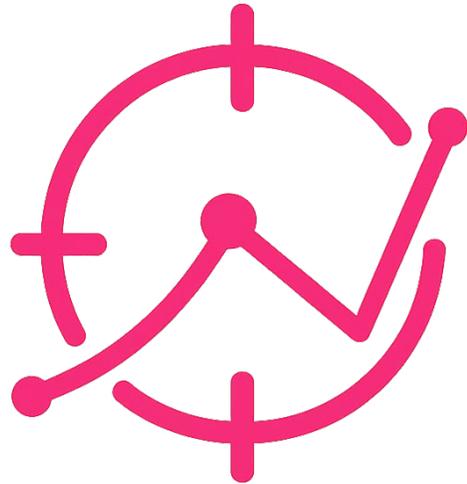




Potential Solution



Lighter densities



Spectral or G7+ Calibration



New solid-ink targets



Before



After

Spectral-based control

Benefits of Converting to 6-Color CMYKOV

Orange and violet maintain vibrancy



CMYK

Benefits of Converting to 6-Color CMYKOV

Orange and violet maintain vibrancy



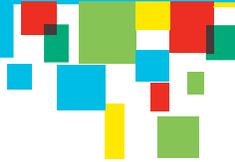
DFC CMYKOV

Benefits of Converting to 6-Color CMYKOV

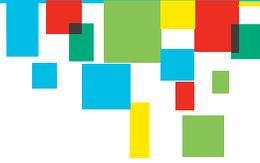
Orange and violet maintain vibrancy



DFC CMYKOV adjusted



Limitations of CMYKOV in DFC Printing



Lower Vibrancy

Compliant pigments produce weaker chroma for CMYK.



Hue Shifts

Hue angles differ from standard CMYK, affecting accuracy.



Gray-Balance Issue

Neutrals show a green cast, making balance harder.

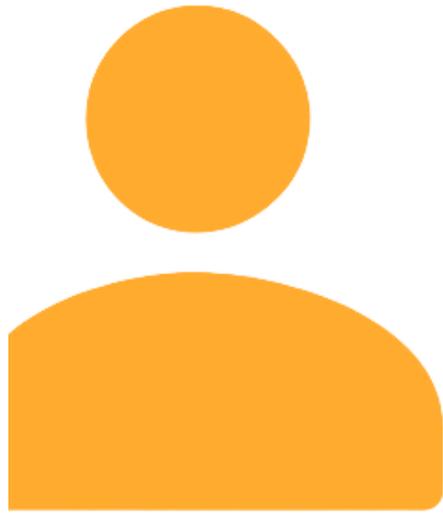


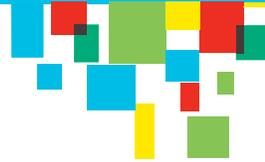
No Density Standards

New ink set lacks established solids or density

Color-Management Implications

- Accurate profiling defines achievable color.
- Soft proofs manage expectations.
- Press control: spectral & G7+ over density.





Practical Guidance – When CMYKOV is a strong fit

1. Warm, Brand-Forward Packaging

- Brands with strong oranges, yellows, or warm reds (snack foods, cereals, confectionery).
- The O–M–Y overprint region gives you noticeably higher chroma than compliant CMYK alone.

2. Jobs Where “Better Than CMYK” Is Enough

- Projects where the goal is *incremental* improvement, not full Pantone matching.
- CMYKOV expands the gamut in targeted regions without violating direct-food-contact pigment rules.

3. Designs With High Saturation but Limited Neutral Requirements

- Illustrations, fruit imagery, playful graphics.
- As long as the job doesn’t rely heavily on neutrals or grays, the green cast and gray-balance issues are less visible.

Practical Guidance – When CMYKOV Will Disappoint



1. Brand Colors in the Blue–Violet or Deep Red Quadrants

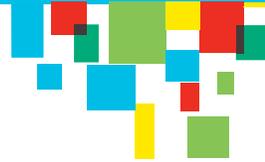
- The V–M overprint produces a dull maroon.
- Blue-violet areas do not expand meaningfully due to pigment restrictions.

2. Jobs Requiring Tight Neutral Gray Balance

- The system shows a green cast in neutrals.
- Without established density targets, gray balance is harder to control.

3. Projects Expecting CRPC-6-Level Vibrancy

- Compliant pigments limit chroma compared to standard commercial inks.
- Even with ECG, the saturation of non-DFC ink sets will not be matched.



Practical Guidance – How to Manage Expectations

1. Position CMYKOV as “Targeted Expansion,” Not “Full ECG”

- Explain that the ink set improves warm-region gamut but cannot expand all quadrants equally.
- Set the expectation early that some Pantone colors remain out of reach.

2. Use Proofing and Soft-Proofing to Show Realistic Outcomes

- Build profiles from the characterization data and show customers the achievable gamut.
- This avoids surprises and reduces subjective debates about vibrancy.

3. Emphasize Process Control Over Density Targets

- Since no density standards exist, highlight the importance of:
 - Consistent ink-film thickness
 - G7+ or similar calibration
 - Stable press conditions

This is a partnership! We can achieve the best results when the process stays controlled!

Summary & Key Takeaways



Regulations

ECG improves color, but gains are capped by compliant-pigment rules.



Targeted Gains

CMYKOV expands orange/violet; watch hue shifts & neutral balance.



Action

Set expectations early; use profiles + spectral/G7+ for predictability.

Future Directions



CMYKOV for Direct Food Contact

Thank you!

- For follow-up after the conference:
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