

Advancement of LCD Technologies & Consistent Presentation of Image

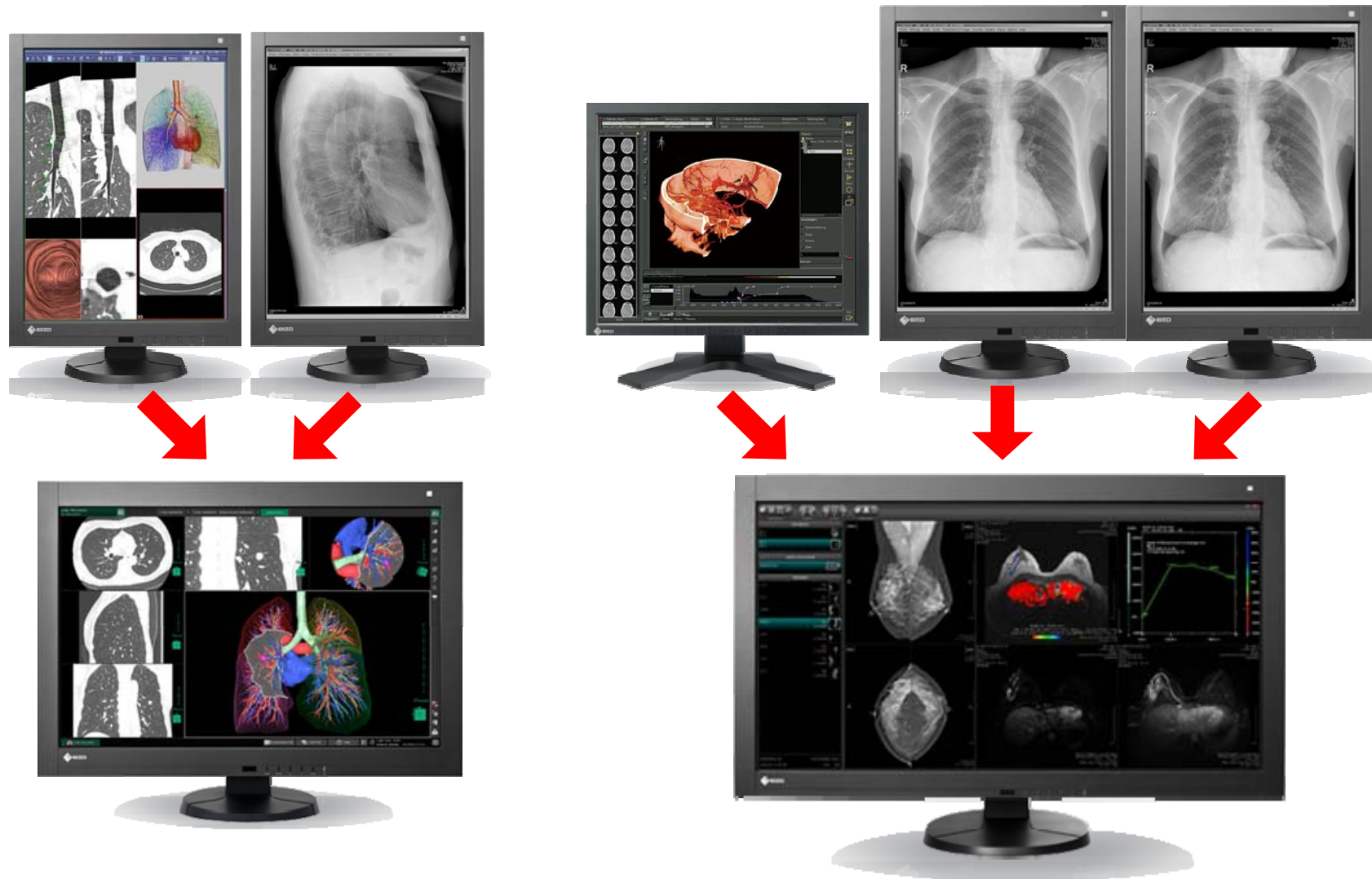


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Kensuke Nagashima
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Agenda

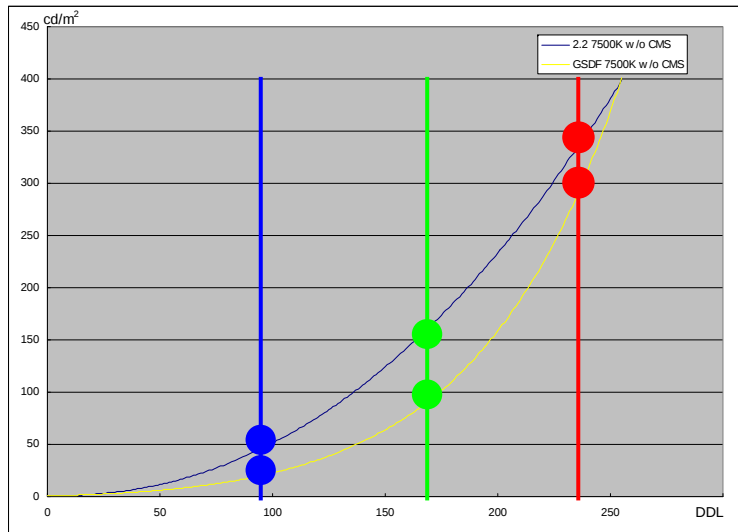
- Probable Issues
- Existing Solution
 - Switching of Display Mode
- Potential Solution
 - Color Management System w/ ICC Profile
 - Window based Display Mode Assignment
- Answer to key question:
“What one step we should take in order to improve the handling of color ”

Larger Size/Higher Luminance → Color/Monochrome on Same Screen

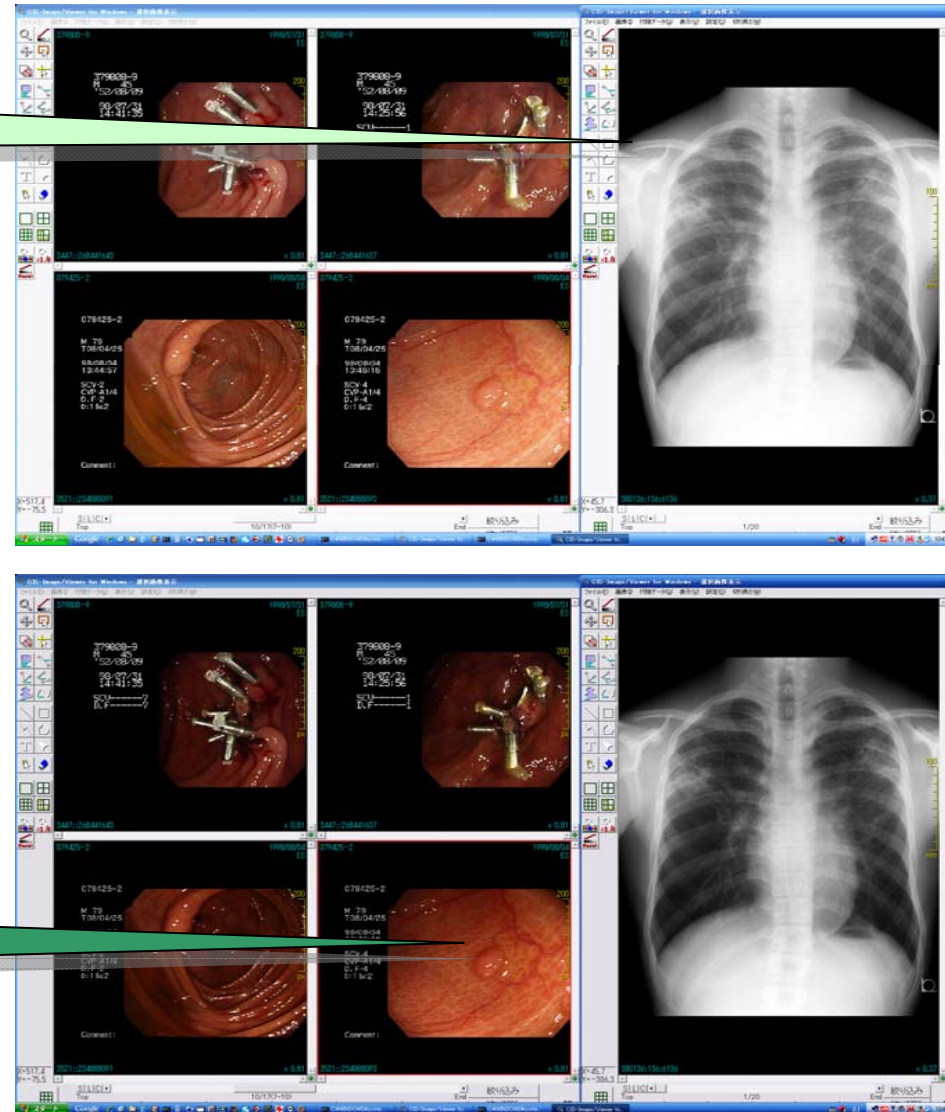


Only One Tone Curve Per Screen: Issue #1

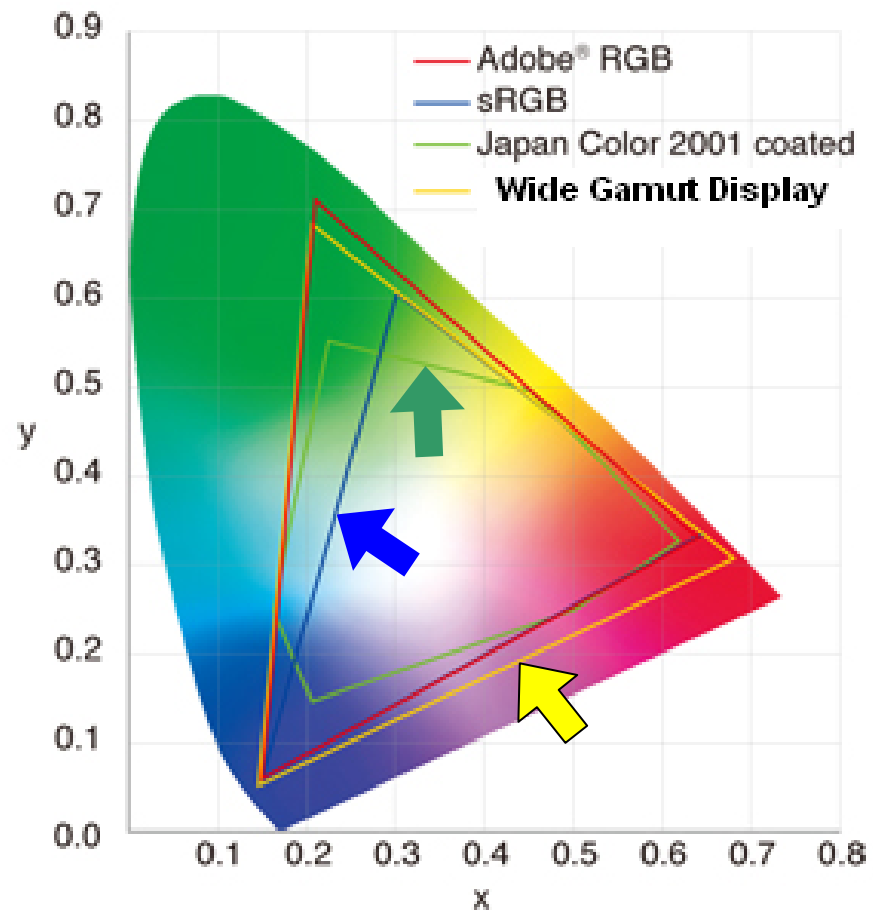
Too bright!



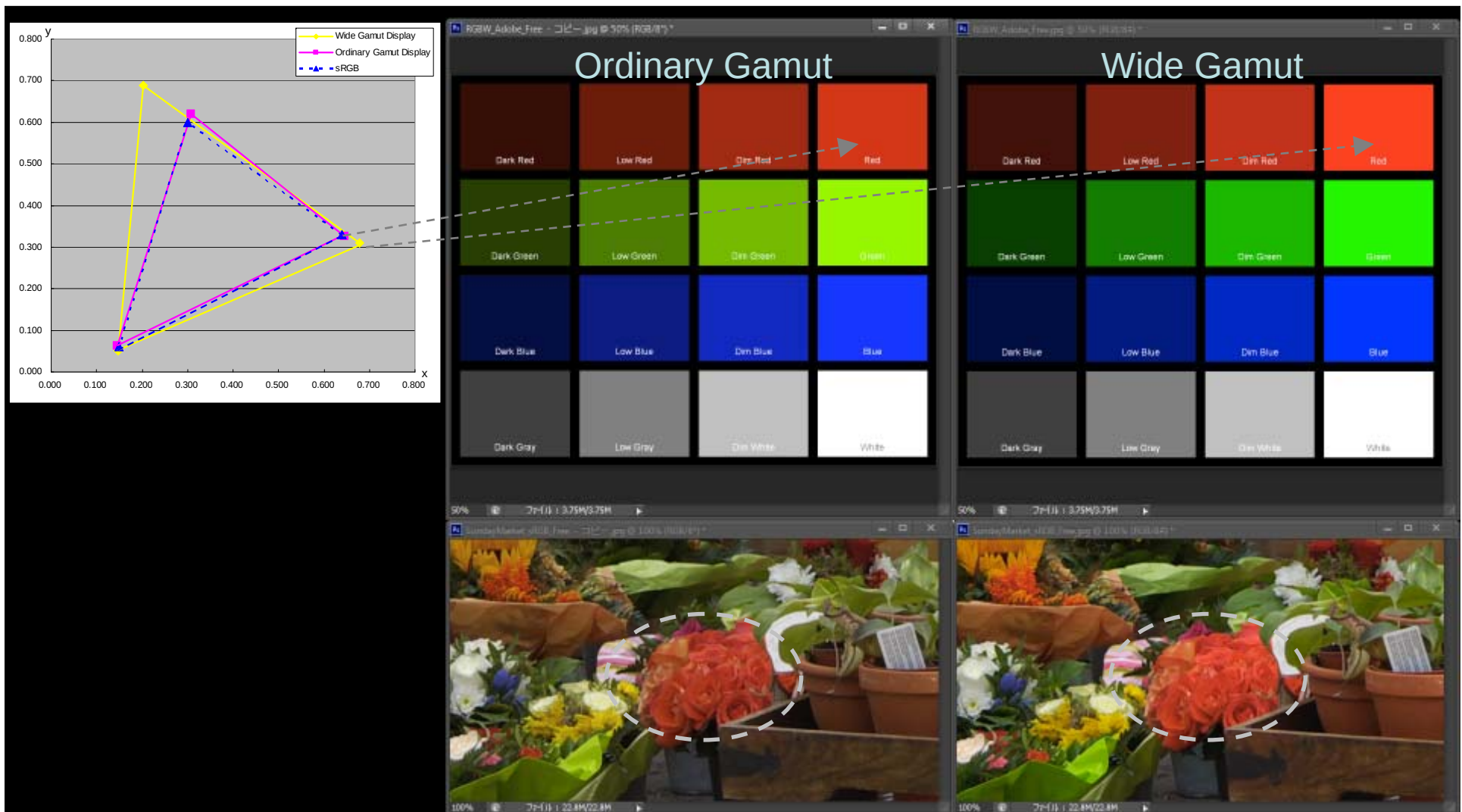
Color Shifted!



Wide Color Gamut



Saturated Color on Wide Gamut Screen: Issue #2

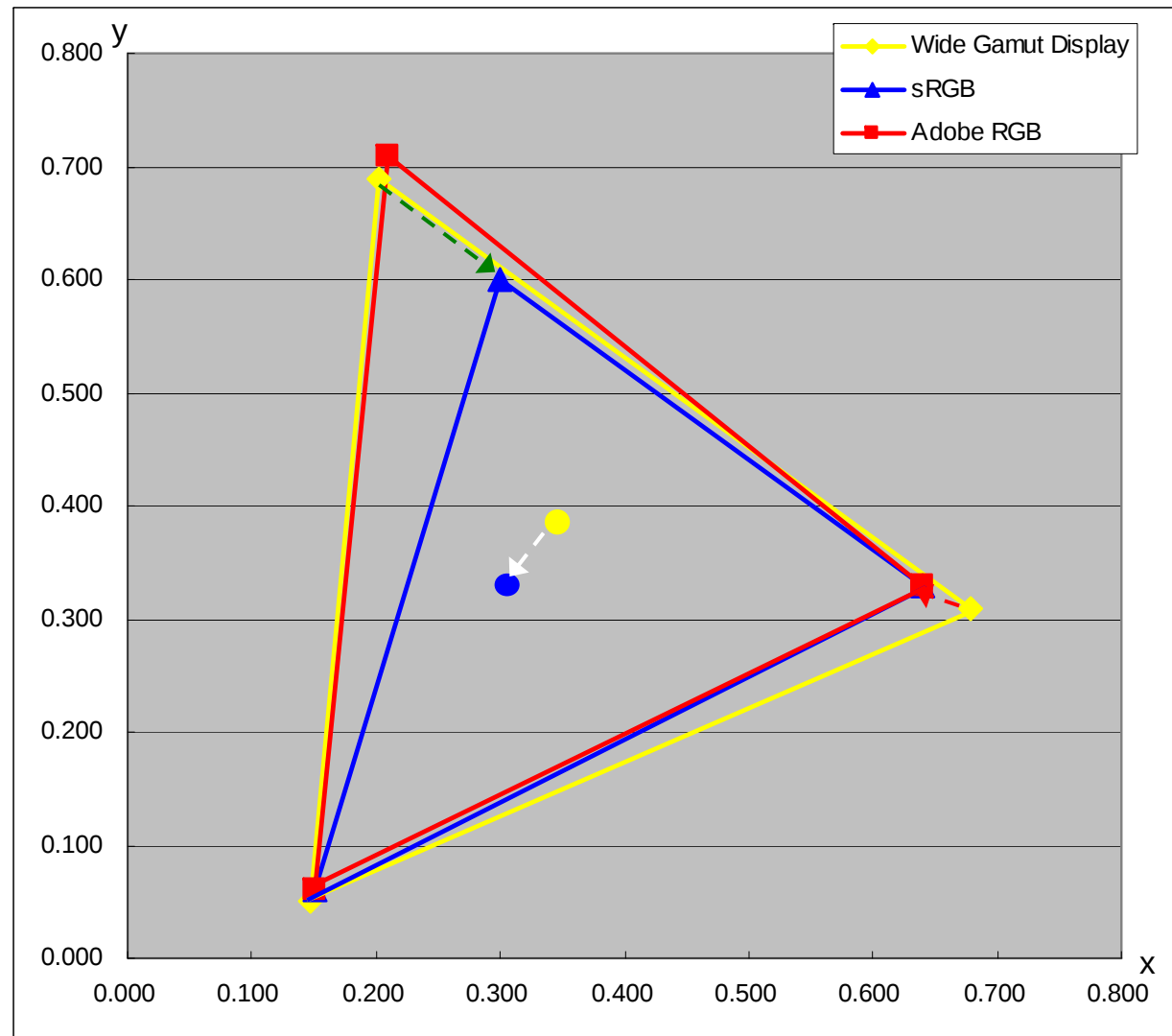


Existing Solution

- Switching of Display Mode
 - Tone characteristics
 - e.g. DICOM GSDF
 - Max/Min luminance
 - e.g. 400 cd/m², 1 cd/m²
 - White point
 - e.g. 7500 K
 - Primary chromaticity also if necessary
 - e.g. R (0.64, 0.33), G (0.30, 0.60), B (0.15, 0.06) for sRGB mode



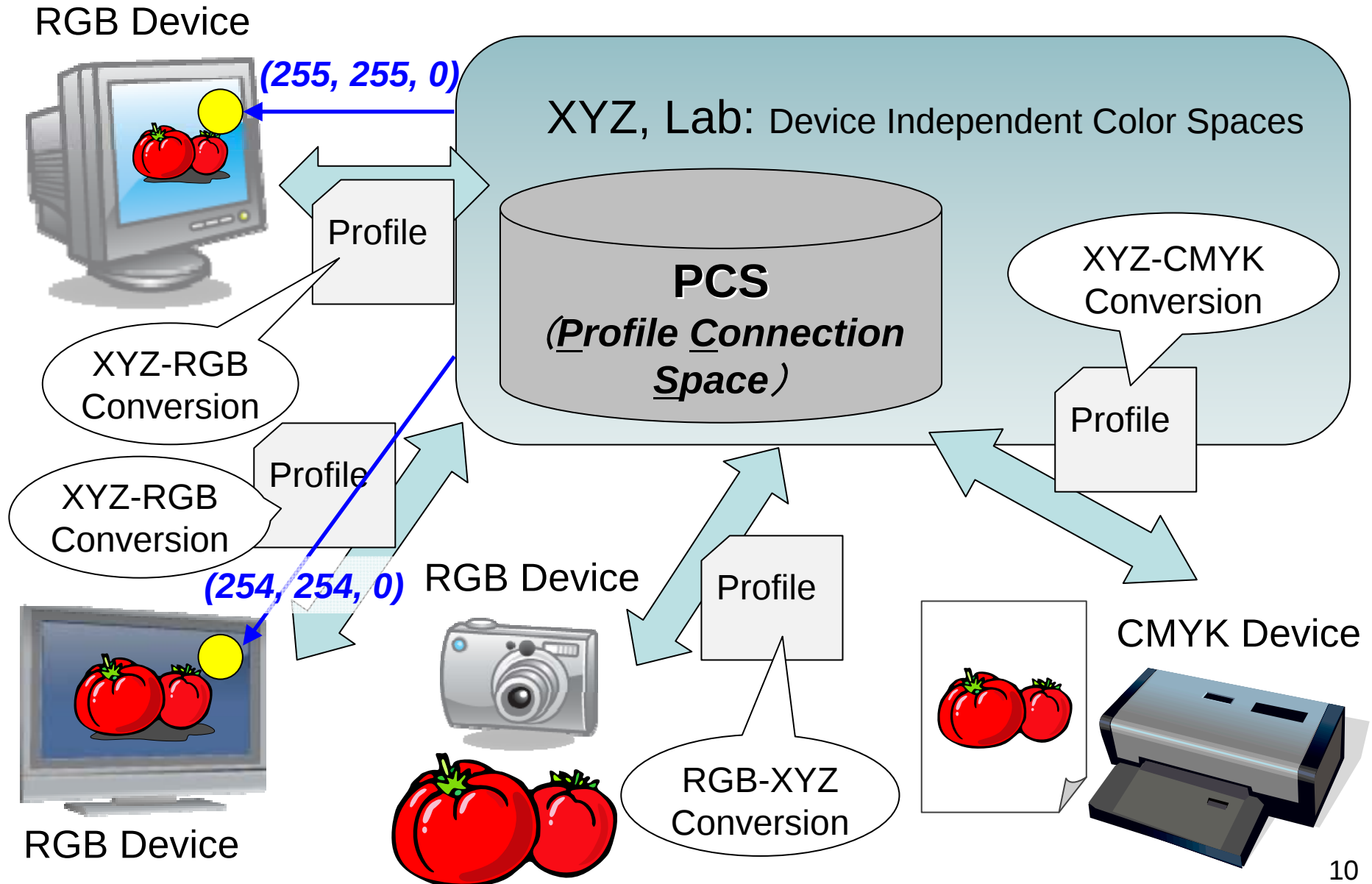
Primary Color Adjustments



Potential Solutions

- Color Management System (CMS)
- Window based Display Mode Assignment

ICC Color Management System

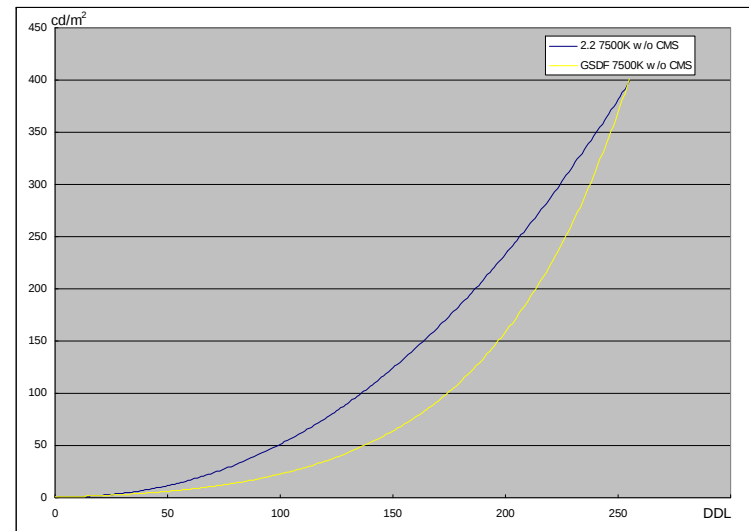


Trial of CMS

On the display screen of tone curve: DICOM
GSDF and white point: 7500K

1. Reproduce different tone curve

- **Gamma = 2.2**

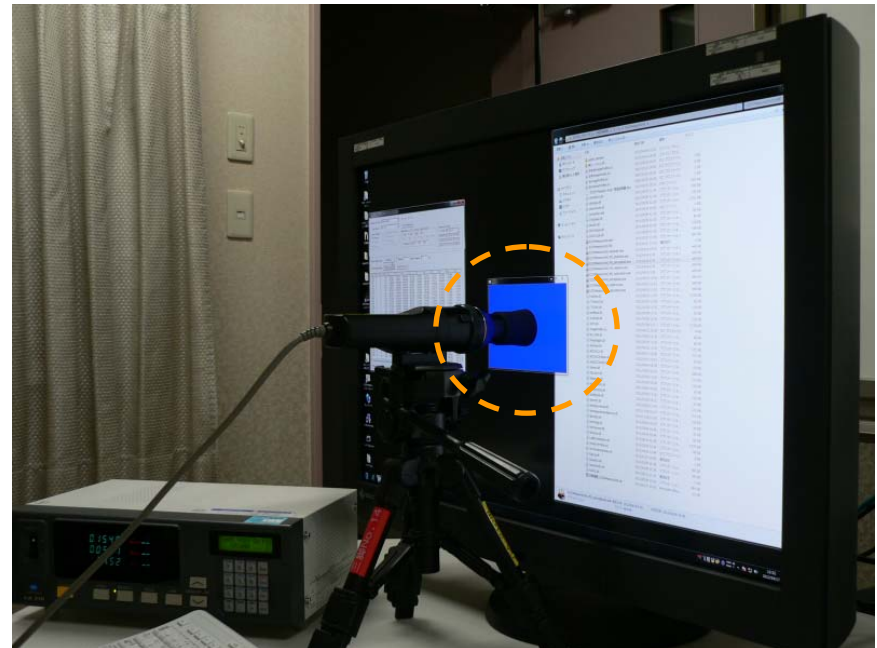


2. + Reproduce different white point

- **White point: 6500K**

Measurement Environment

- CA-310 by Konica Minolta
- Patch Viewer Applet controlling CA-310
 - *Taking advantage of Color Management Module (CMM)*
- OS: Windows 7
- Adobe Photoshop CS6 for reference of visual evaluation



Color Patches Defined in IEC 61966-4

	R	G	B	R	G	B	
	32	32	32	0	0	128	
	64	64	64	64	64	196	
	96	96	96	0	0	255	
	128	128	128	128	128	255	
	160	160	160	128	128	0	
	192	192	192	196	196	64	
	224	224	224	255	255	0	
	255	255	255	255	255	128	
	128	0	0	128	0	128	
	192	64	64	196	64	196	
	255	0	0	255	0	255	
	255	128	128	255	128	255	
	0	128	0	0	128	128	
	64	196	64	64	196	196	
	0	255	0	0	255	255	
	128	255	128	128	255	255	

Results

On the display screen of tone curve: DICOM GSDF and white point: 7500K

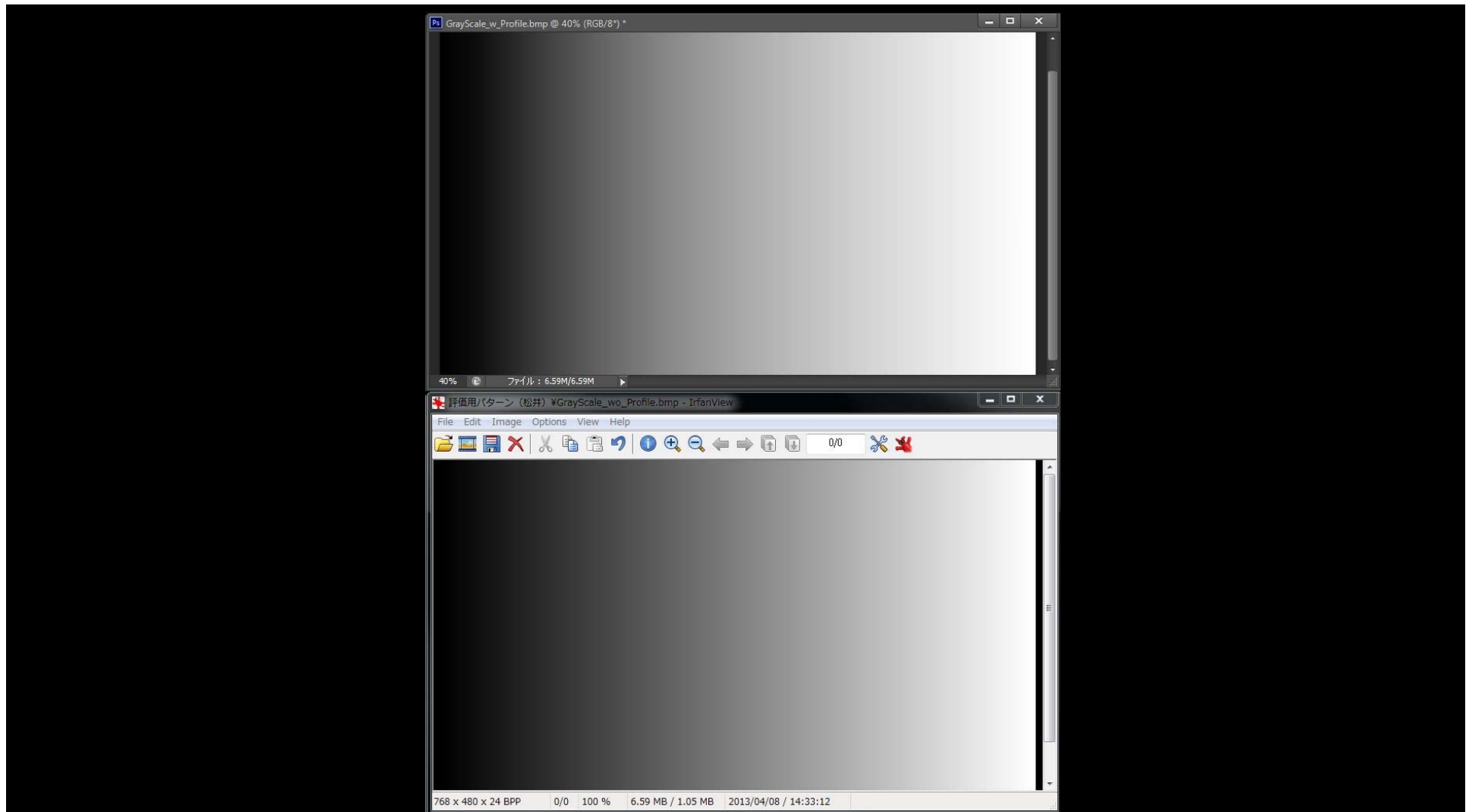
1. Different tone curve reproduction

- **Gamma = 2.2** Targeted tone curve reproduced with loss of 39 gray tones

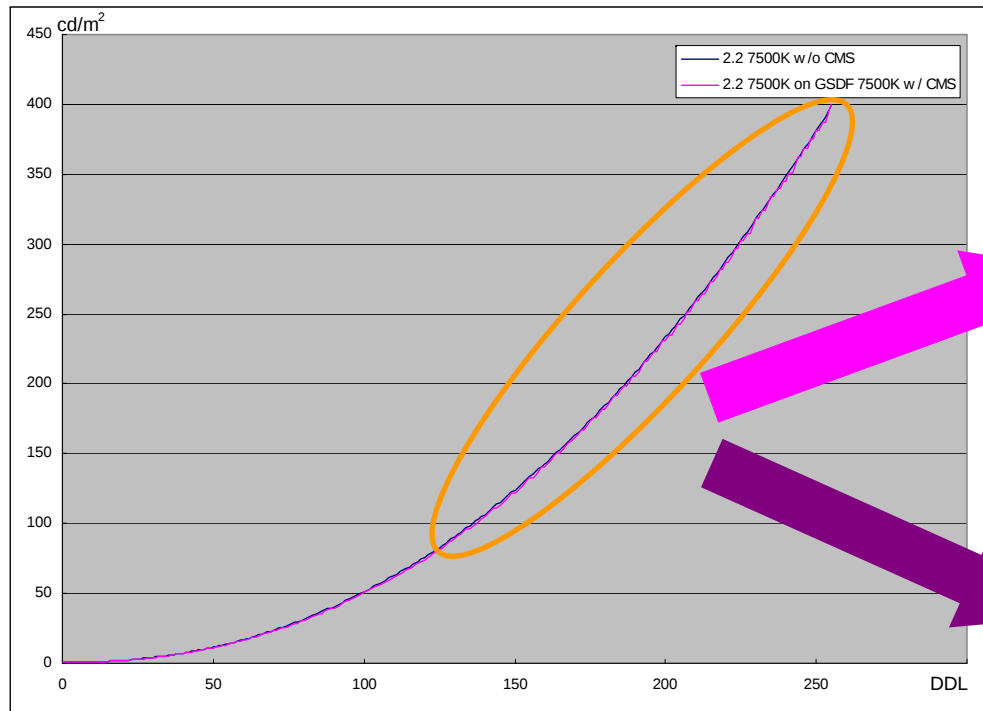
2. + Different white point reproduction

- **White point: 6500K** Targeted white point not reproduced

Different Tone Curves Reproduced on Same Screen



Quantitative E

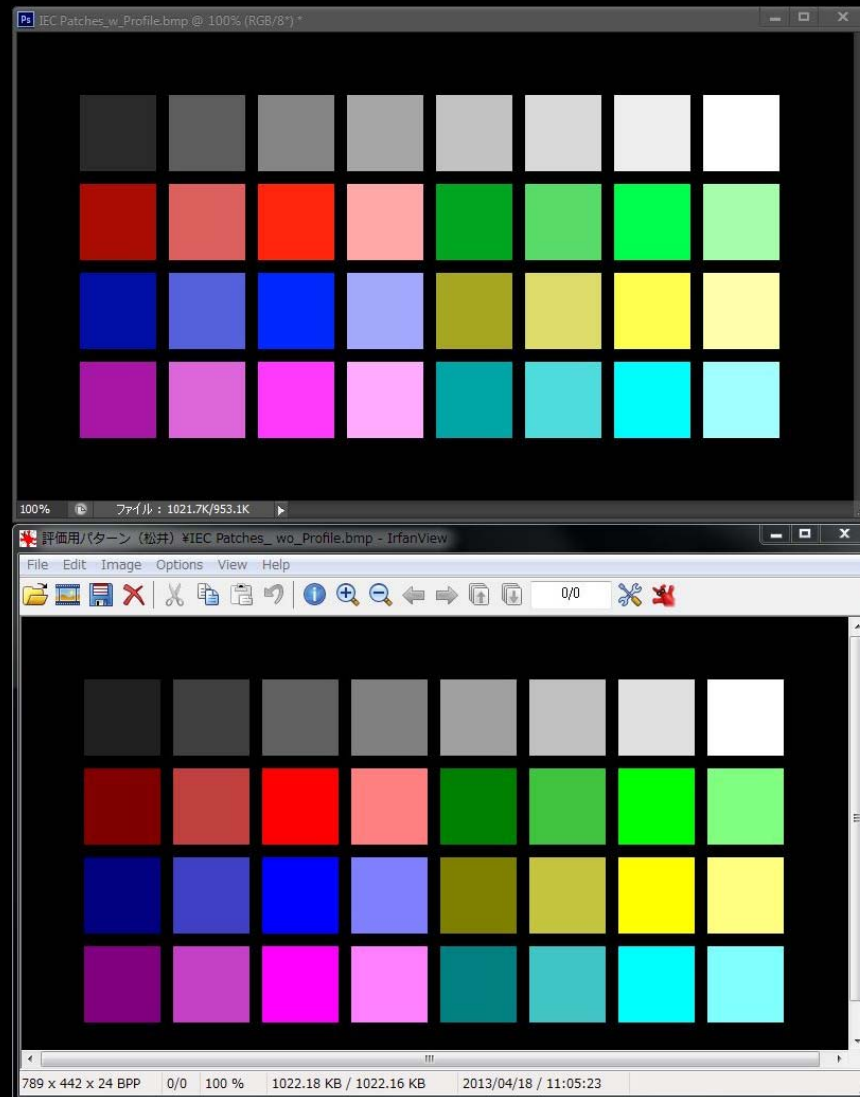


Gamma 2.2 on GSDF w/ CMS

**39 Gray Tones
are lost!**

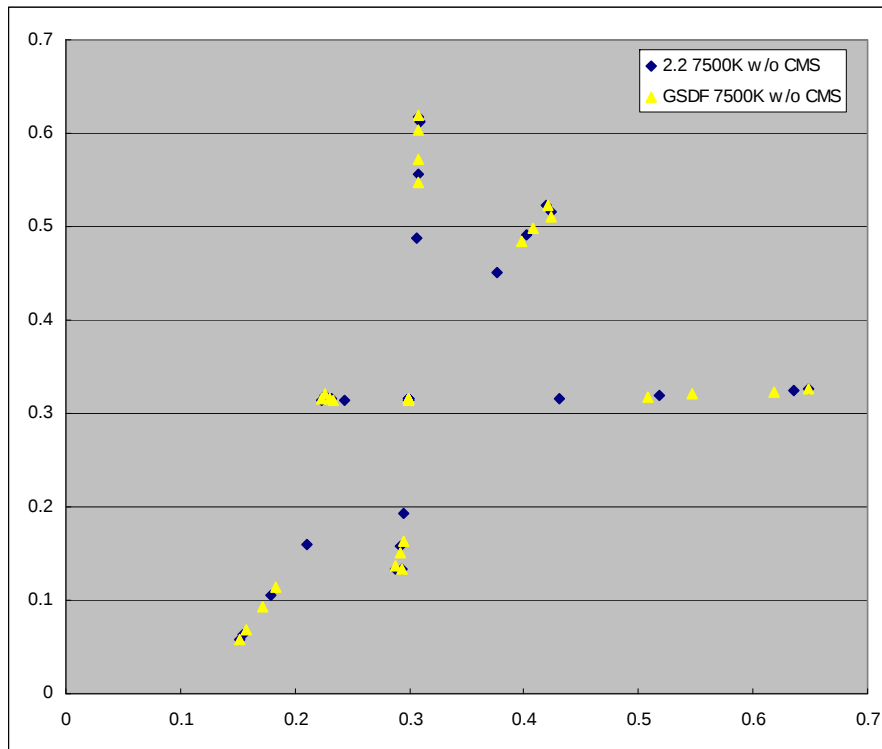
Gamma = 2.2 w/o CMS

Some Colors Reproduced Differently on Same Screen

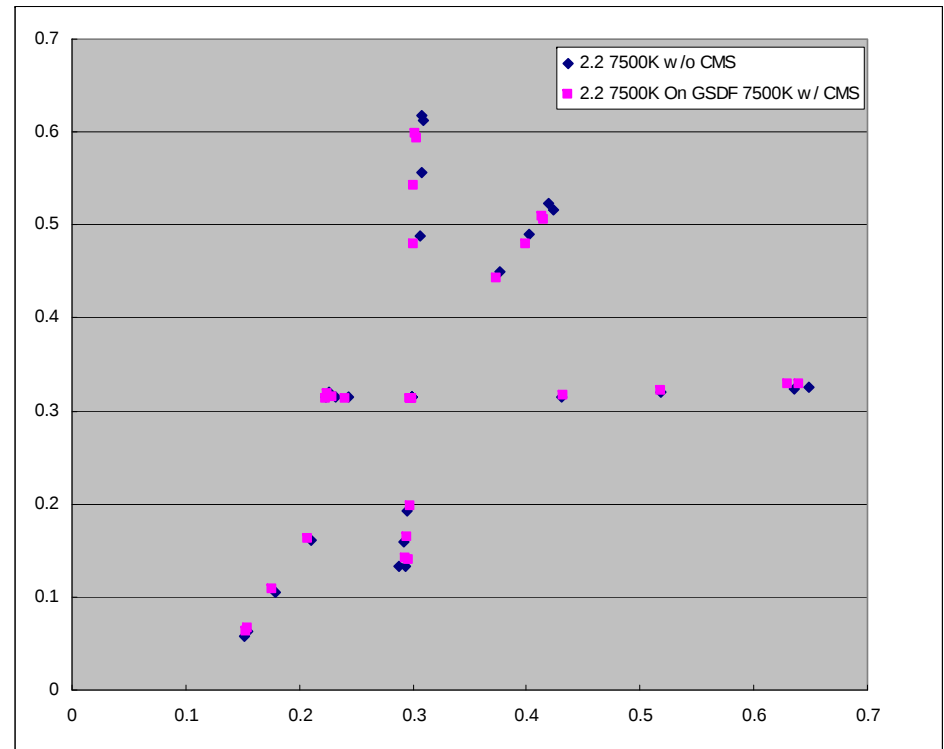


Quantitative Evaluation

GSDF w/o CMS vs.
Gamma = 2.2 w/o CMS



Gamma 2.2 on GSDF w/ CMS
vs. Gamma = 2.2 w/o CMS



Additional Comments to Results

On the display screen of tone curve: DICOM GSDF and w

Effects of gray tone loss may depend on application and usage

1. Different tone curve reproduction

- **Gamma = 2.2** Targeted tone curve reproduced

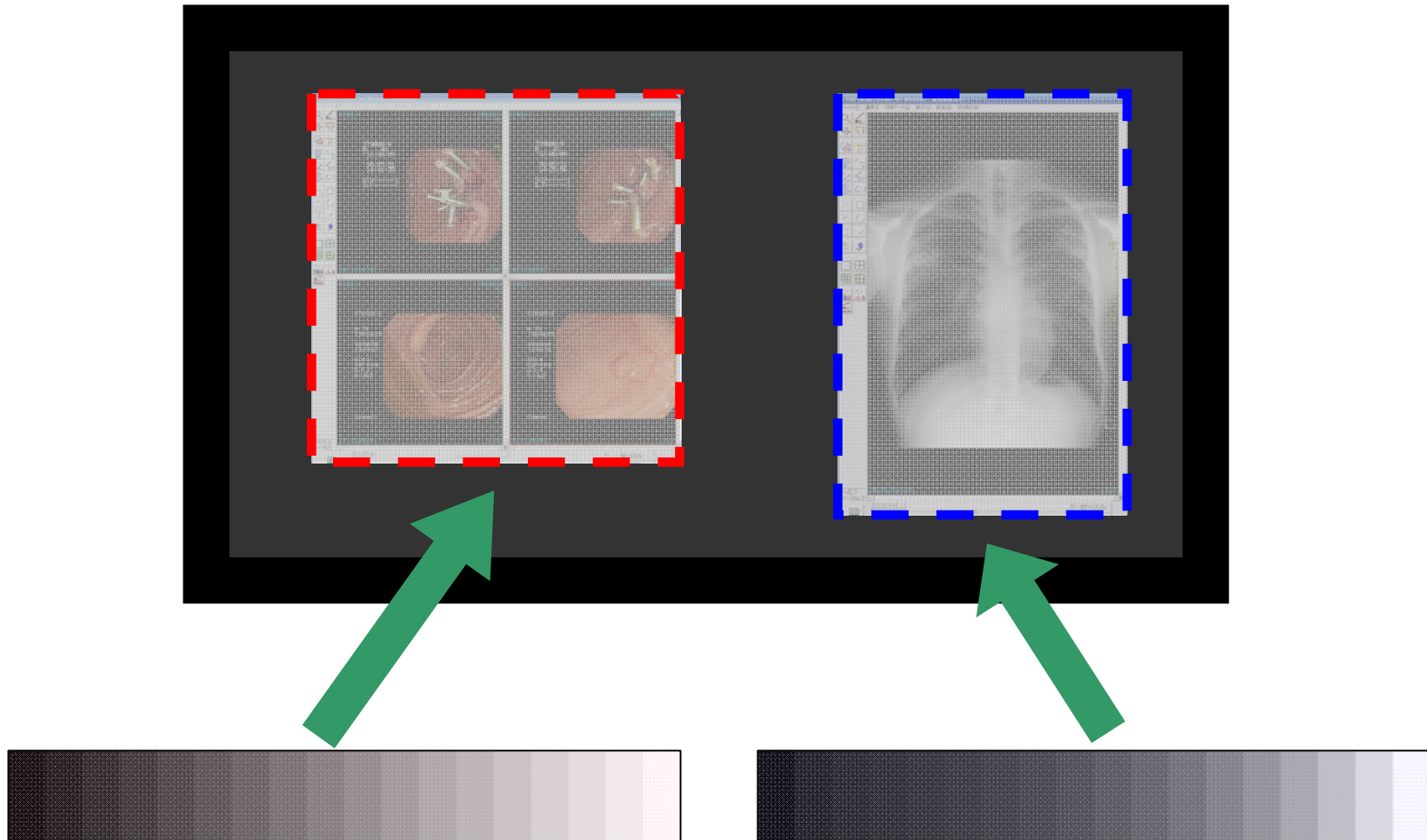
The result may depend on implementation of specific CMM

2. + Different white point reproduction

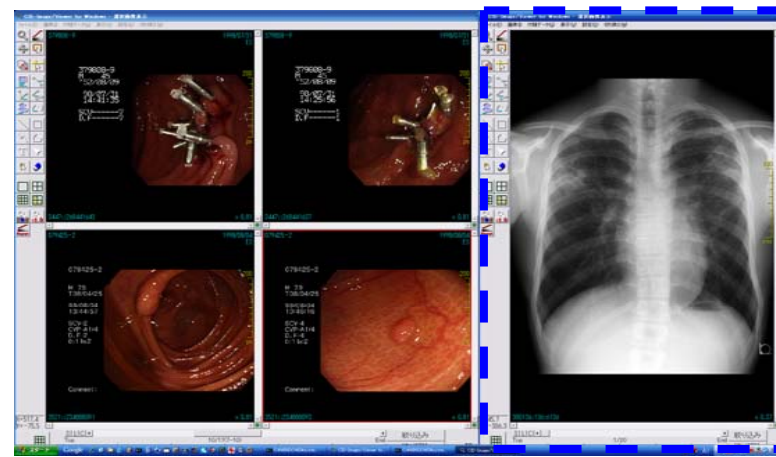
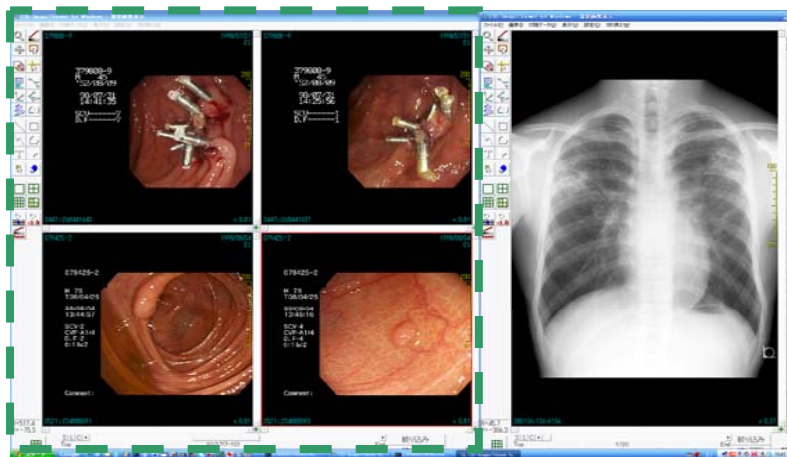
- **White point: 6500K**

Targeted white point not reproduced

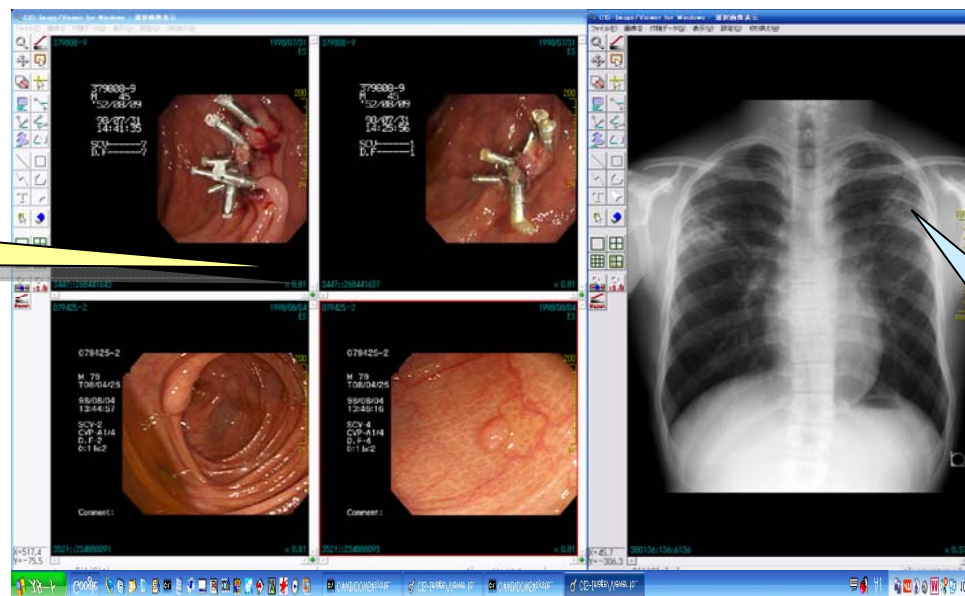
Optimum Display Mode for Each Window



Optimum Tone Curve for Each Window (Cont.)

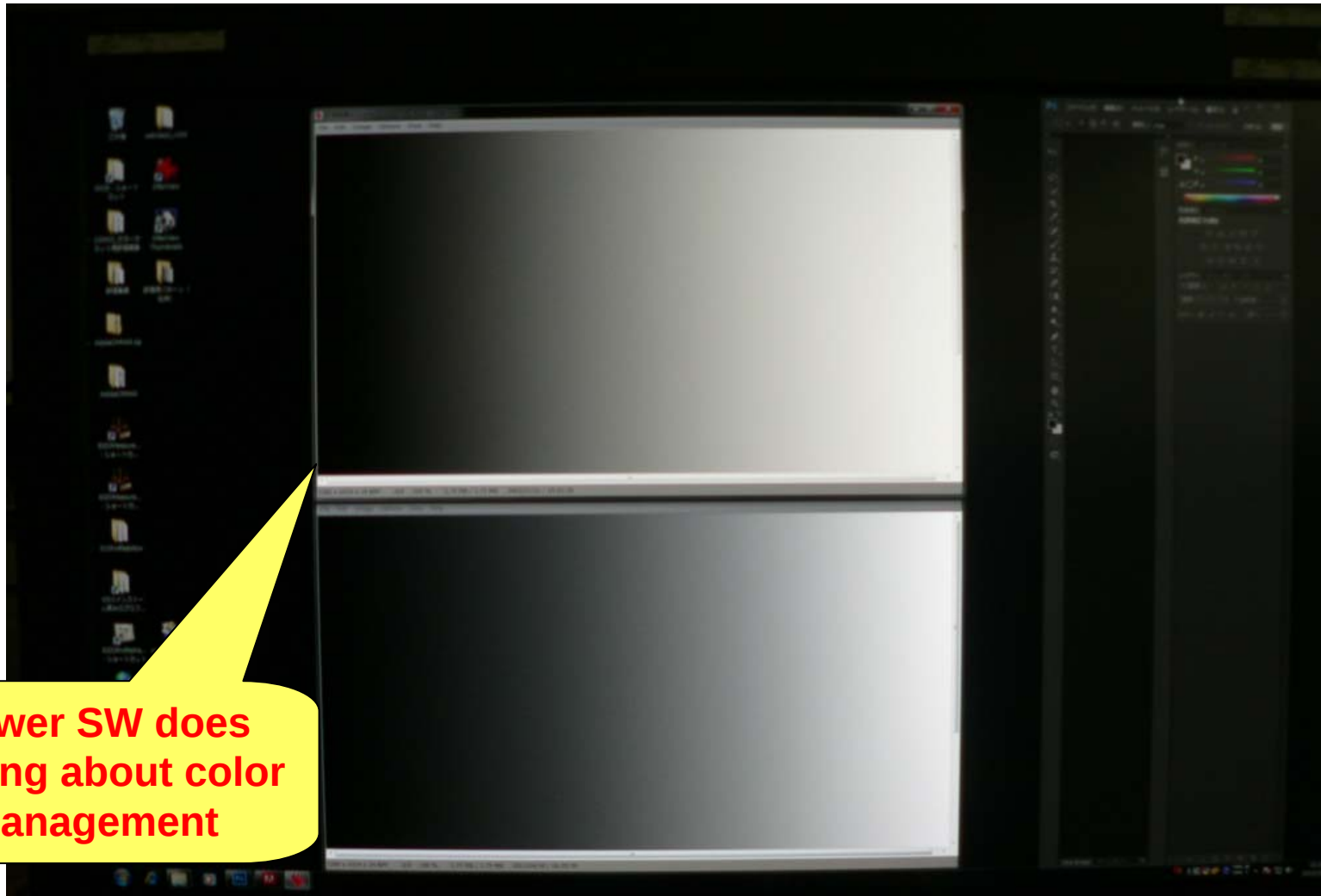


$\gamma = 2.2$



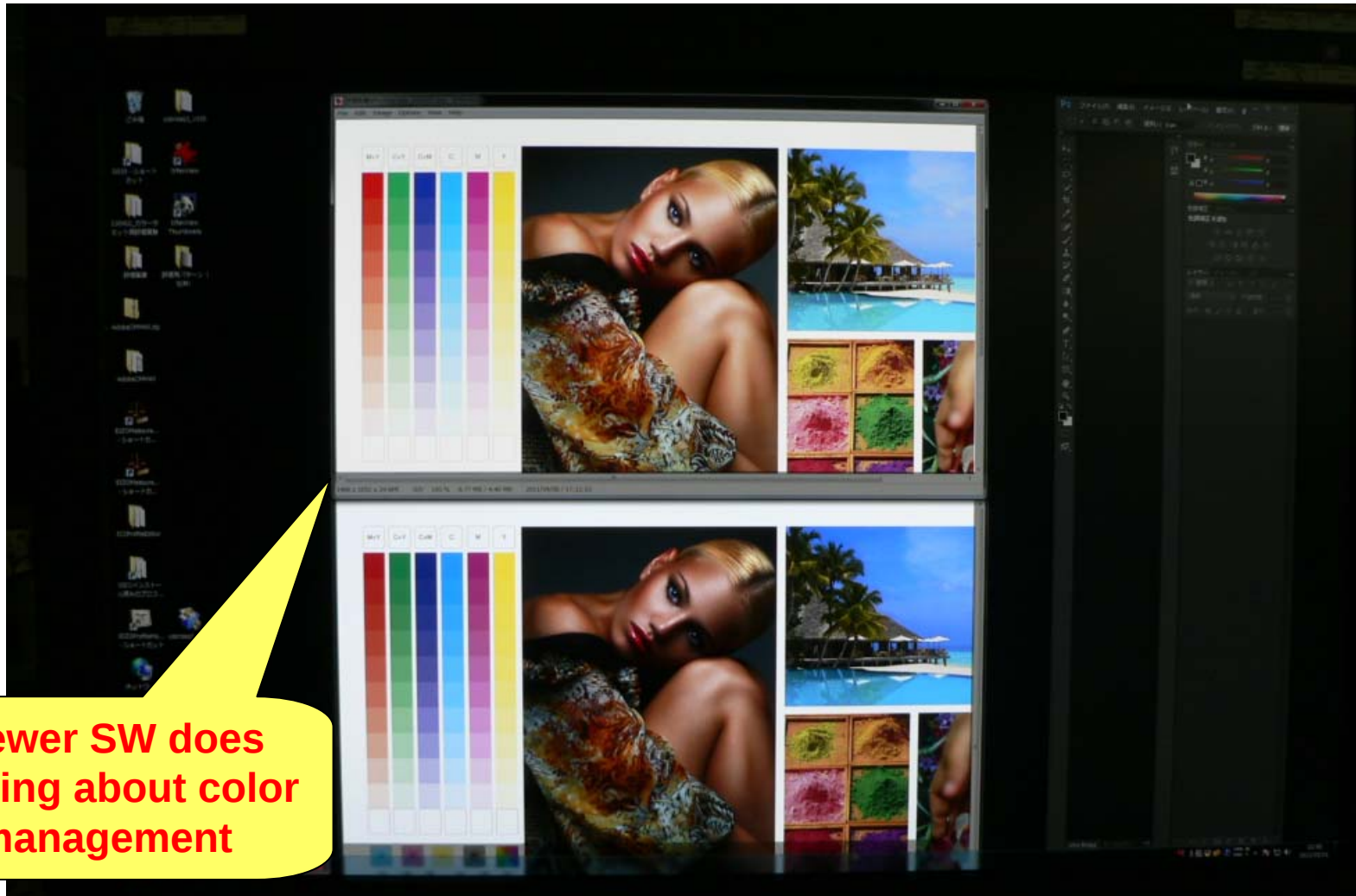
DICOM GSDF

Gamma 2.2, 6500K & GSDF, 7500K on the Same Screen



**Viewer SW does
nothing about color
management**

Gamma 2.2, 6500K & GSDF, 7500K on the Same Screen



What You Heard So Far...

- Probable issues
 - #1. Only one tone curve can be reproduced on the same screen though the screen sizes become large enough to replace two smaller screen displays
 - #2. Wider gamut display sometimes reproduce too vivid or saturated colors unless the color data is processed properly in advance
- Solutions
 - Switching of display modes
 - Window based Display Mode Assignment
 - Color Management System (CMS)

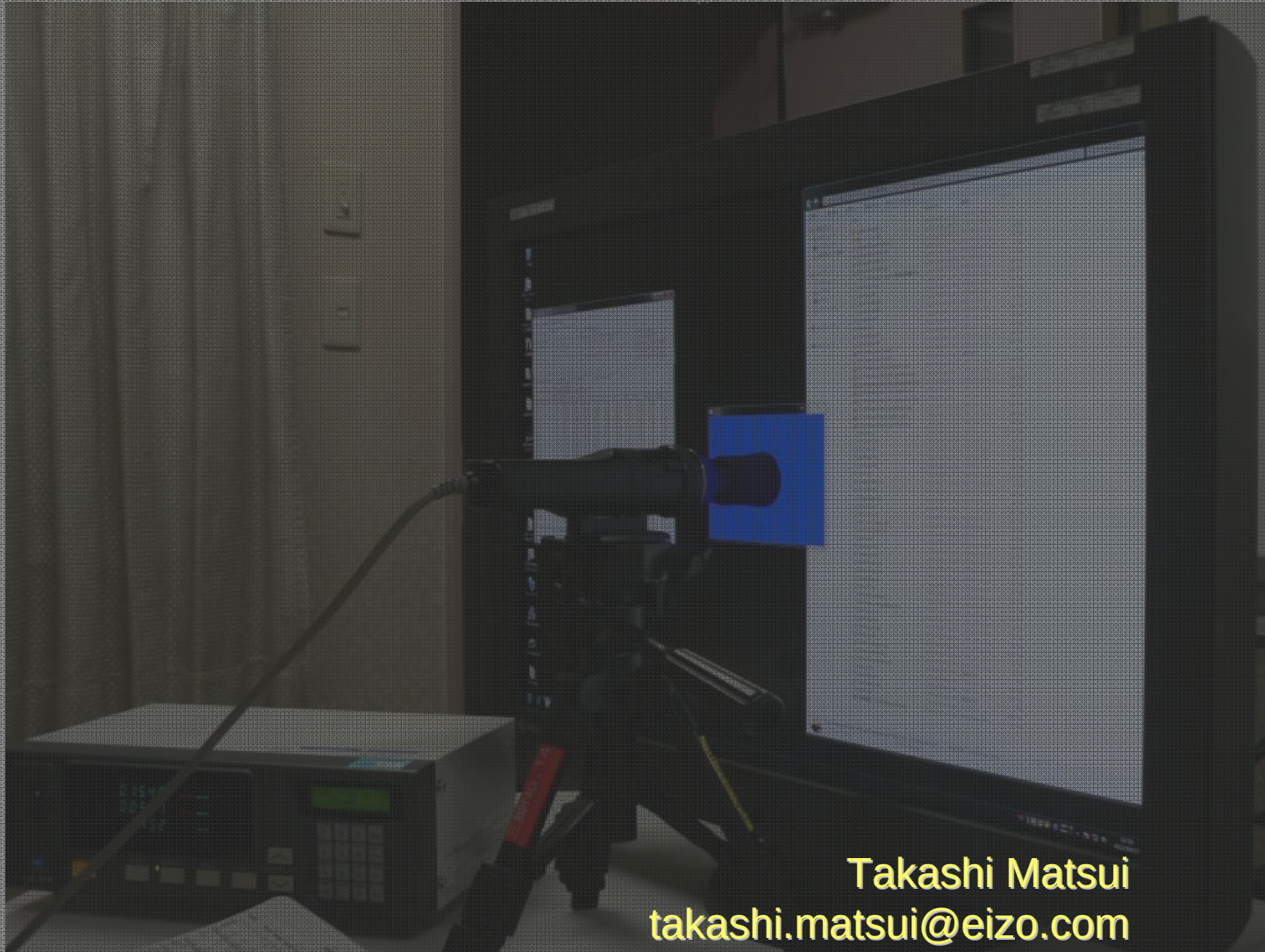
Primary Color Adjustments



Steps to Take to Improve Color handling in Display Devices

1. Input/Output devices comply w/ a certain standardized color space (e.g. sRGB) consisting of criteria values for tone curve, white point and chromaticity of primaries w/ tolerances
 - Can be supported as one of display modes
2. CMS adjusts/compensates color based on device profile (ICC profile) information
 - Very flexible: does not restrict performance improvements of devices like wider gamut.

Thank You!



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