Color matching between BVM-HX310 and BVM-X300

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Sony Imaging Products & Solutions Inc.

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1. Introduction

After the launch of Sony's first OLED (Organic Light Emitting Diode) professional master monitor in 2011, it was found that the colors between CRT and OLED displays, even though they were calibrated to have the same xy chromaticity values, did not match based on human visual perception.

At that time, an investigation was conducted following research documented in various academic papers on color science and the Sony display group carried out several experiments on color matching in cooperation with color probe providers. It was found that a Judd modified Color Matching Function improved the color matching between CRT and OLED for human visual perception. As a result, Sony has been applying an xy offset calculated by the Judd modified color matching function to Sony professional OLED monitors in order to match the display characteristics of CRT monitors (Please, refer to Sony's white paper "Color Matching Between OLED and CRT").

In 2019, more recent market-driven requirements led Sony to release a new master monitor, this time using a new type of LCD technology. The BVM-HX310 has been positioned as the improved successor of our 4K OLED master monitor, the BVM-X300, achieving 1000 cd/m^2 in full screen (*1) and with new support of 12G-SDI interfaces, Quad View display mode and User 3D LUTs.

This white paper will present color matching techniques between the BVM-HX310 and BVM-X300.

*1 Panel specification, typical value measured at D65 (x=0.3127, y=0.3290) and not a guaranteed value.

2. Offset value calculated by a Judd modified color matching function for the BVM-HX310

The BVM-HX310 employs a newly developed LCD panel. The LCD panel has high power color-rendering LEDs to realize a wider color gamut resulting in a spectrum characteristic different from that of OLED (Figure 1).

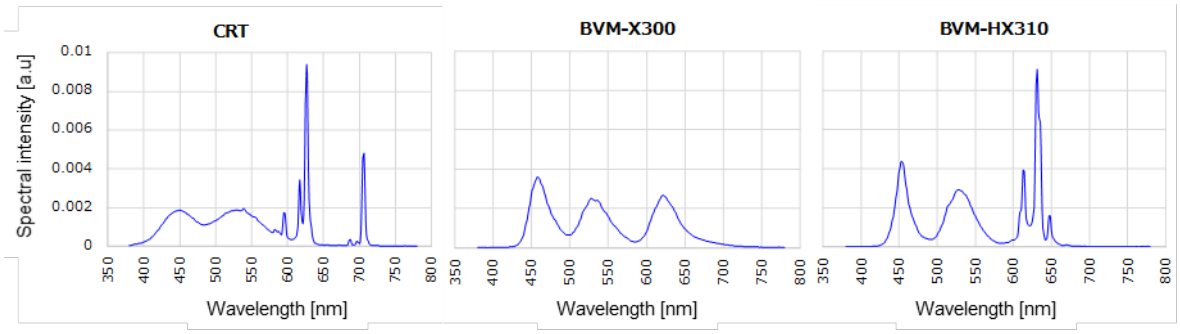

Figure 1. Spectrum of CRT, BVM-X300 and BVM-HX310

Based on the technical background for the development of the Judd offset for the BVM-X300 to match to CRT, Sony also tried to use the offset values calculated by the Judd modified color matching function with the BVM-HX310. However, the result was that the colors between BVM-HX310 and BVM-X300 did not match human visual perception. The CIE-170 color matching function was also tried, but the result was not acceptable. The results of these experiments indicated that the use of Judd offsets and CIE-170 do not work well when implemented with the BVM-HX310.

The most important factor leading to unmatched colors is the variations in individual eye characteristics. It is difficult to assume the use of a single color matching function as a typical value of spectral sensitivity for the human visual system (As described in the white paper “Color Matching Between OLED and CRT”).

3. Color matching between BVM-HX310 and BVM-X300

The white point of D65 for the BVM-HX310, at factory shipment, is adjusted to be the same xy target as used in the BVM-X300. Please, see chart below.

Model number	White point at factory shipment(offset value)	
	x	y
BVM-X300	0.3067 (-0.006)	0.318 (-0.011)
BVM-HX310	0.3067 (-0.006)	0.318 (-0.011)

This offset value was determined by color matching experiments between BVM-HX310 and BVM-X300 display devices carried out by Sony's display group. These experiments showed variations of the best offset value as experienced by each person participating in the tests. Hence, it was decided, at the time, to select and average value of the various results.

However, since the release of the BVM-HX310 Sony has received feedback from many customers indicating that the BVM-HX310 appears more reddish than the BVM-X300. It was recently decided to conduct a new series of experiments for evaluation of the color matching between BVM-HX310 and BVM-X300.

＜Experiment＞

・Testers:　13 persons

・Method:

-Use a BVM-X300 with factory settings as a reference

-Adjust the white balance of BVM-HX310 by utilizing critical images to match the reference BVM-X300 as closely as possible

・Environment: Dark room (approx. 100 lux), Viewing distance 1.5m

・Test images: 18 scenes (Human, Sky, Grass, etc)

＜Result＞

・Variations in individual perceptions was found to be around ±0.005 xy

・The current white point of BVM-HX310 as set during factory shipment was not found to be at the average value in the range of variations.

・The average white point in this experiment was found to be (x, y)= (0.307, 0.320)

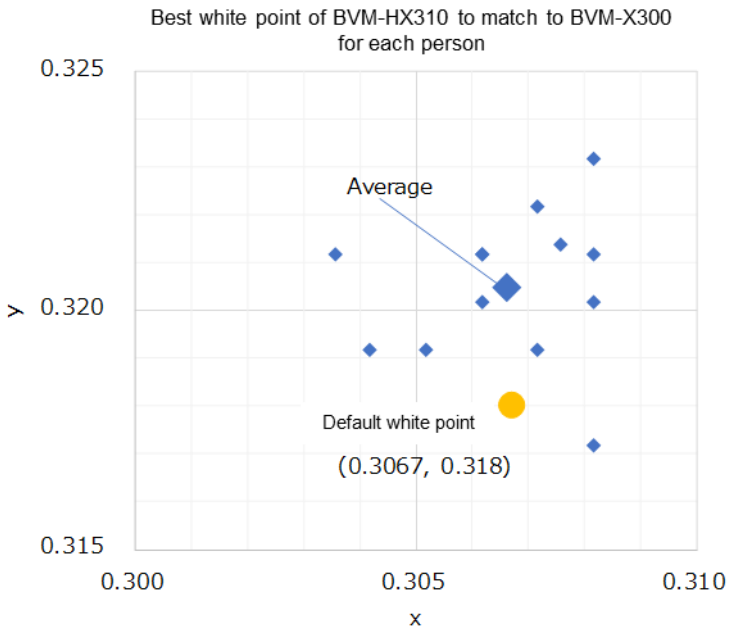

Figure 2. Result of a color matching experiment

According to the results of this latest experiment, Sony is proposing a better offset value for BVM-HX310 to color match to BVM-X300 as described below.

Model	White point (Offset value)	
	x	y
BVM-X300	0.3067 (-0.006)	0.318 (-0.011)
BVM-HX310	0.3067 (-0.006)	0.3205 (-0.0085)

This offset value can be applied for all EOTFs and color spaces.

Please note that these values are just reference values - because there is a wide range of variation in the characteristics of the human visual system, and therefore these values cannot guarantee perfect color matching.

4. Color matching between BVM-HX310 and PVM-X2400/X1800

In September 2020, Sony released new 4K HDR high grade picture monitors, the PVM-X2400 and PVM-X1800. These monitors offer the same color gamut as the BVM-HX310, facilitating easy and accurate color matching between the devices (Figure 3 and 4).

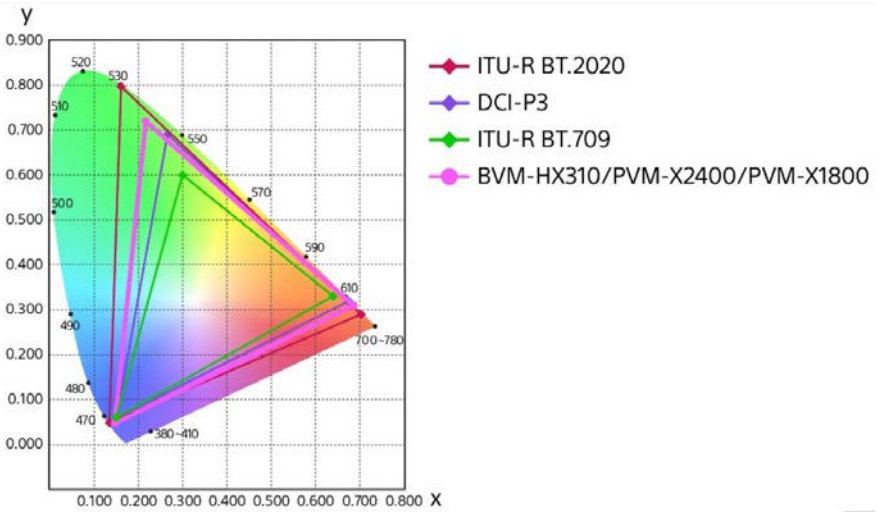

Figure 3. xy color chart

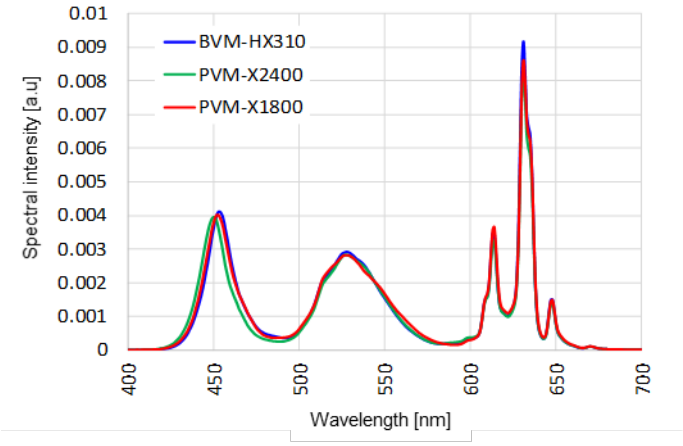

Figure 4. Comparison of spectrum

The shape of the spectrum of these three models is almost same, thus the same white point can be used to realize accurate color matching between them.