Memo

DATE
20 April 2018

CC

TO
whom it may concern

FROM
Product Management Projection

White Paper: Convergence & Lateral Chromatic Aberration

The image quality of 3-chip DLP projectors depends on a lot of factors: image sharpness, color saturation and accuracy, video processing and so on. Another important point is the alignment of the images of the red, green and blue chip on the screen. There are two major factors contributing to this alignment: convergence and lateral chromatic aberration.

- Convergence is defined as the correct opto-mechanical alignment of the 3 DLP chips, with regards to each other and the color splitting and recombination prism. The convergence error is stated in a vertical and horizontal shift of the red and blue DLP chips with reference to the green DLP chip.

- Lateral chromatic aberration (also called lateral color error) is a property of the projection lens. The projection lens projects a magnified image of the chips onto a screen. The magnification for each chip is not always exactly the same. This is due to the different index of refraction for different wavelengths in optical glass. This physical phenomenon is called dispersion.
  Lateral chromatic aberration is minimized during the design of the projection lens, by combining different glass types and lens shapes. More complex lenses offer the possibility to reduce the lateral chromatic aberration. It can depend on the projection distance and zoom position. It is only slightly influenced by manufacturing tolerances. Typically, two projection lenses of the same type, used at the same projection distance and zoom position, will show the same level of lateral chromatic aberration.

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Let us look at some examples of how these two factors influence the image. We consider a perfect theoretical projector with a test image showing 9 white (exaggerated) pixels. The projector has no convergence error and the projection lens has no lateral chromatic aberration.

Figure 1: Image from a perfect projector, with no convergence error or lateral color error

If the projector has some convergence mismatch, the image will look as in figure 2. This image shows a convergence error for the red chip vs green of ½ pixel down and ¼ pixel right, while the blue chip has a convergence error of ½ pixel left and 0 pixel up/down vs green.

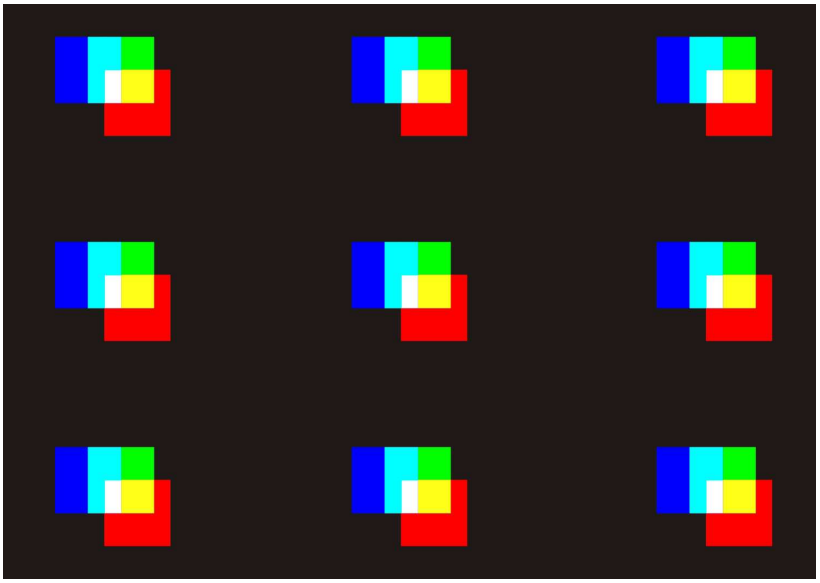

Figure 2: Image from a projector with some convergence error, but no lateral color error

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If the projector has no convergence error, but the projection lens shows lateral chromatic aberration, the image is as in figure 3. The further from the center of the screen, the bigger the effect is. In this example the image of the red chip is too small, while the image of the blue chip is too big.

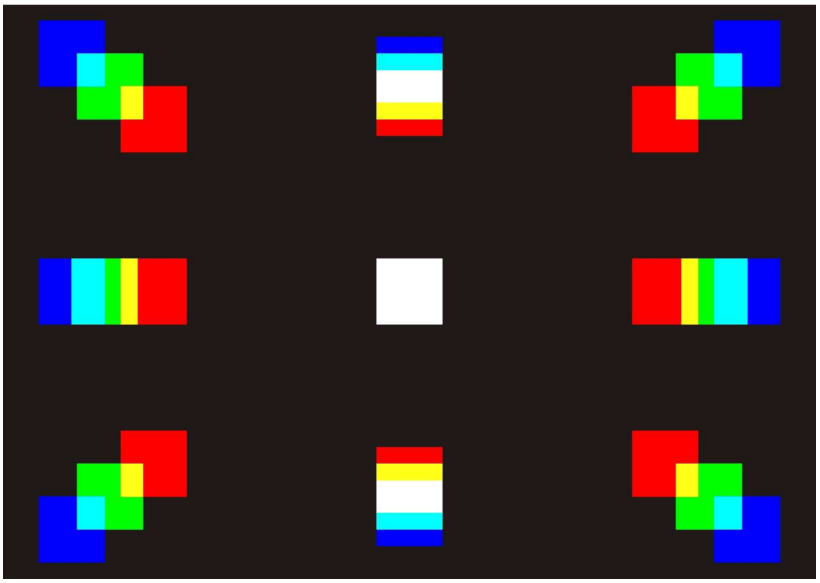

Figure 3: Image from a projector with no convergence error, but with lateral color error.

Convergence error and lateral chromatic aberration can compensate each other or enhance each other. Figure 4 shows a projector with the same lateral chromatic aberration as in figure 3, but a degree of convergence error has been added. At the top right corner, the two effects cancel each other, but in the lower left corner, the result is a very big shift.

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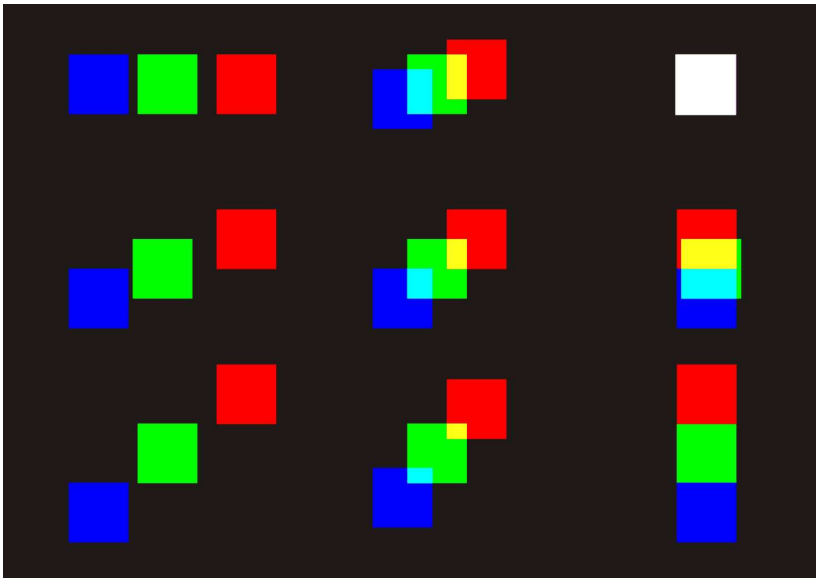

Figure 4: Image from a projector with convergence error and lateral color error.

There is an easy procedure to determine the convergence error of a projector, regardless of any lateral convergence error of the projection lens.

- Set up the projector, with the lens in the on-axis position.
- Measure the misalignment of the red and blue pixels to the green pixels as follows:
  - Center of the screen: up/down and left right misalignment
  - Center top and center bottom: left/right misalignment
  - Center left and center right: up/down misalignment

This procedure is illustrated in figure 5. The result of this measurement would be:

Red to Green

	3/4 right	
1/2 up	1/2 up / 3/4 right	1/2 up
	3/4 right	

Blue to Green

	5/8 left	
1/2 down	1/2 down / 5/8 left	1/2 down
	5/8 left	

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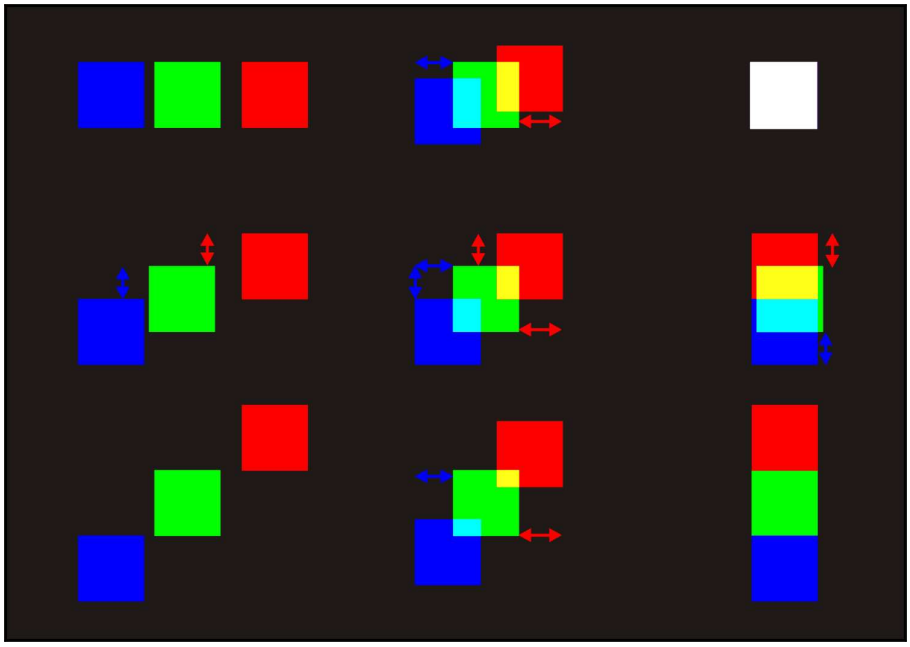

Figure 5: measuring convergence error

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The convergence test pattern in the projectors shows 9 test positions with at each test position test lines in 4 directions. Figure 6 shows the lines that should be used for measuring the convergence. The other positions and lines are useful for determining lateral color error and for adjusting the convergence error.

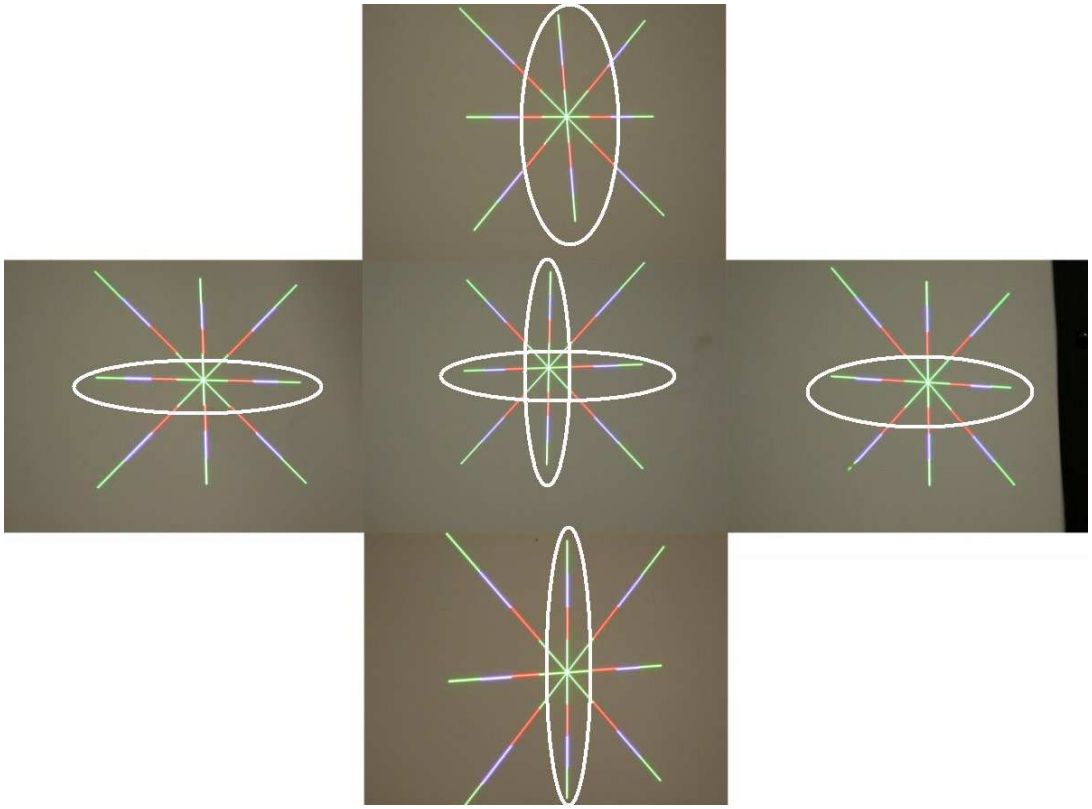

Figure 6: test lines for measuring convergence error.

Specifications for the convergence of projectors will be depending on the pixel size, hence resolution and size of the DMD chip of the projector.

***important notes:**
-the convergence can only be evaluated with a projector that is in regime temperature. This means 20-25°C ambient and 20 minutes lamp/ lasers on time with image projecting.

-instructions for convergence adjustment are explained in the service manual.

-before adjusting/evaluating convergence, the sheimflug needs to be correctly adjusted (see service manual) .

-adjustments of the above needs to be performed by qualified service engineer
Production spec convergence (measured with a TLD + 2.0-2.8 lens R9862020) for 0.9x DLP

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-SXGA+, WUXGA, HD = 0.75 pixels
-WQXGA = 1 pixel

Regarding convergence drift:
It can occur over the projector's lifetime. The possible reason of convergence drift can be identified as
-heat up / cool down of the projector
-external temp change
-not well/not correctly tightened DMD support
-vibrations or bad transport
However, if the adjustment of the convergence has been done according to the Barco specification and procedure, the drift should be minimal.

Important: the convergence might drift more during the first months of use after it left the factory. This effect is generated by mechanical settlement in the opto-mechanical path. After a month of use there will be reduction of convergence drift to normal as describes in the previous paragraph "regarding convergence drift"

Any questions regarding this? Please feel free to contact our service desk.

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