EVALUATION AND PHOTOGRAPHIC STUDY OF THE SIGMA ZOOMS 18-35mm AND 50-100mm FOR CINEMATOGRAPHY

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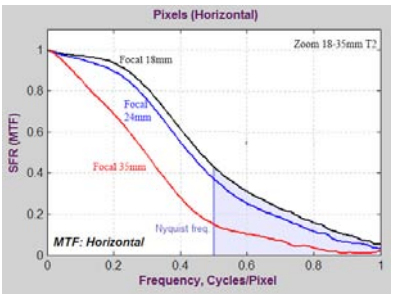
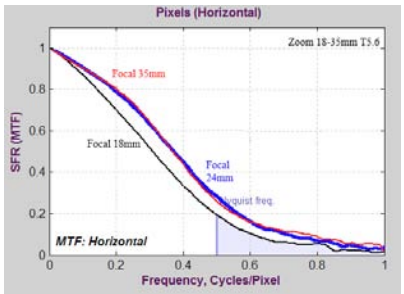
In this article we are going to study two of the Sigma zooms designed for cinematography, the most wide-angle, 18-35mm, and the most telephoto, 50-100mm, both of them with a T2. The study focuses on every aspect related to the image quality provided by the lenses, such as the resolution, color, bokeh or spatial construction, among others. We have used the last Red One Weapon 8K camera recording in 4kHD Raw format, 8:1 compression at 25pfs and 1/50 shutter speed. The analysis of the different tests is made under theoretical considerations: we worked on resolution and color charts and then we analyzed through the Imatest, ImagJ or Color Inspector programs. We used different light sources adjusted with the Sekonic C700 spectrometer and the Sekonic l-588/Cine light meter.

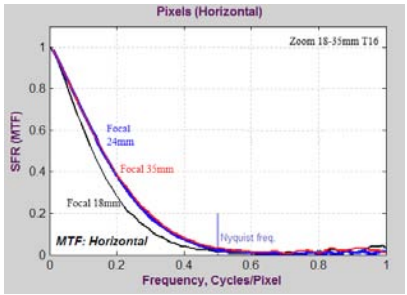
In addition to the technical study, we shot outdoor locations images in the Madrid range, Spain, and its surrounding areas in order to get a more subjective evaluation about the look provided by the lenses. The frames showed in the article are from the original ones, and they were used as mere references since they are compressed.

Resolution

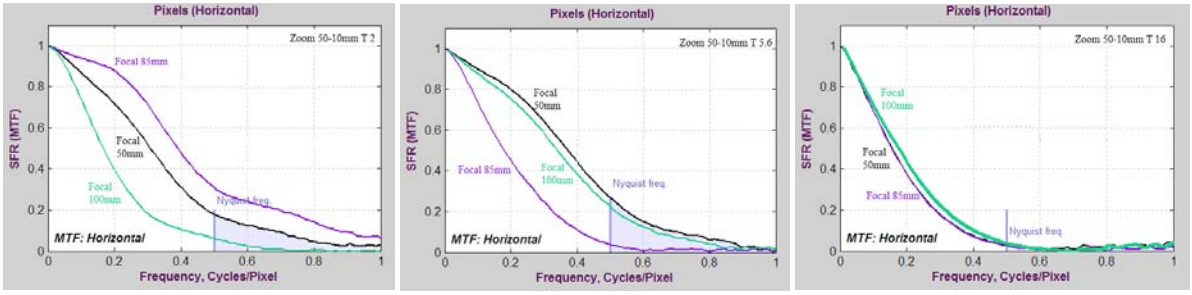
To study the resolution we shot the usual frequencies charts as well as some texture charts and natural outdoor locations in the Madrid range. The resolution to be studied is the sum of the different elements involved in the process, such as sensor, compression process or the viewing system; changing at any of them entails different outcomes. However, since we worked with a high performance camera the conclusions can be extrapolated to other professional systems environments. In view of the fact that we are testing zoom lenses we evaluated the different aspects of them through three different focal lengths, the widest, the most telephoto and an intermediate. Next, we show the MTF graphs of the Zoom 18-35mm in the center of the image obtained from the analysis with Imatest of the ISO 12232 chart for the three focal lengths at three different T- values: T 2, T 5.6 and T 16.







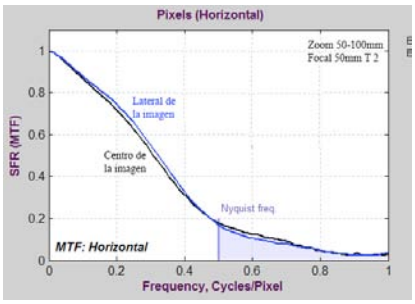
As we can see, at T5.6 value the resolution is practically the same throughout the focal lengths, at T2 the resolution is slightly lower than most telephoto, the 35mm, and finally at T16 the loss of resolution is significant and caused by the diffraction effect at all of the focal lengths. It is usually difficult for a zoom to keep the same conditions at all of the focal lengths, as a result, manufactures try to optimize the longest range possible. Let us see now the Zoom 50-100mm.

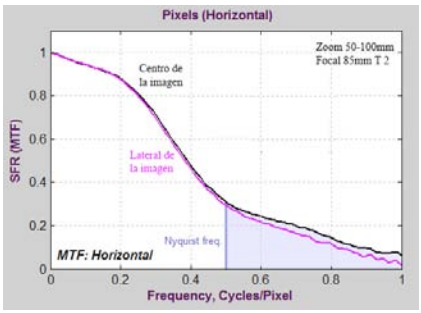


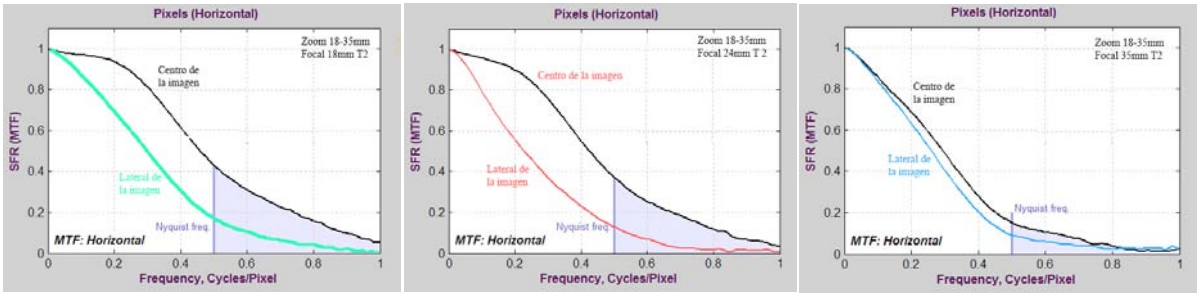
In this case at T 2 the differences of resolution are higher for all of the focal lengths, at T 5.6 values are alike, although to 85mm the resolution is lower than to both 50mm and 100mm; at T16 the resolution is substantially low caused by the refraction effect. With regard to the sigh such differences are not easily perceptible, however if we enlarge sufficiently the image we can notice that at T 2 and to100mm the image is softer than to 50mm. If we check the resolution on the image borders to the same zoom we can see that there is hardly loss of it. The right graphs show the MTF curves on the center and border of the image o 50mm and 85mm at T 2. We can see that there is not any difference.

To the Zoom 18-35mm we did see such loss of sharpness on the sides, which we also saw on our Vía Stellae chart when we test the chromatic aberrations.

Next, we show the MTF curves, at T2 to the three focal lengths, 18mm, 24mm and 35mm.

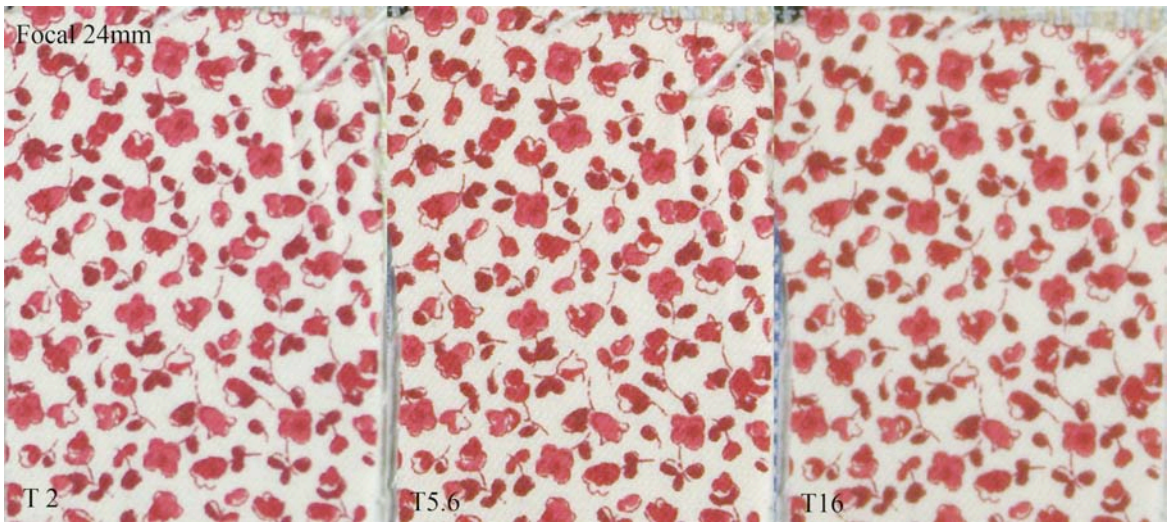






There is not any loss of resolution with the longest focal length, the 35mm, on the contrary there is some with the widest ones, to both the 18mm and 24mm.

We contrasted such results with the Prêt-à-porter chart. We enlarged the image and cut it. Let us see some examples.



To the 24mm focal length of the Zoom 18-35mm we can see that the best resolution is at T5.6; at T2 there is a slight loss of sharpness, which is hardly appreciable compared with the T5.6, and what is more evident at T16.

We show the chart cut to the Zoom 50-100mm at the three T values. As we have already seen in the MTF curves, the resolution is slightly better with the maximum aperture diaphragm T2 than with the T5.6. We can also see the loss of sharpness at T16.

Next, we can see the tables with the horizontal resolution at 50% to the two Zooms.

Zoom lens 18-35mm AVERAGE	Horizontal resolution MTF 50%Center LW/PH	Zoom lens 50-100mm AVERAGE	Horizontal resolution MTF 50%Center LW/PH
T 2	**1698**	T 1.5	**1243**
T 5.6	**1507**	T 5.6	**1284,2**
T 16	**636.3**	T 16	**699,8**

According to the results we can infer that the Zoom 18-35mm is sharpest than the 50-100mm, in addition, both of them have a significant loss of resolution at high T values. If we do not want to lose resolution we have to bear in mind the diffraction limit, which we can place between T8 and T11. The average values show a much better resolution to the chosen format which is the 4KHD, even show high resolution to the 18-35mm.

These differences are hardly appreciable beyond the charts. It entails a general feeling of the image in the frames from outdoor locations. Let us see some examples.

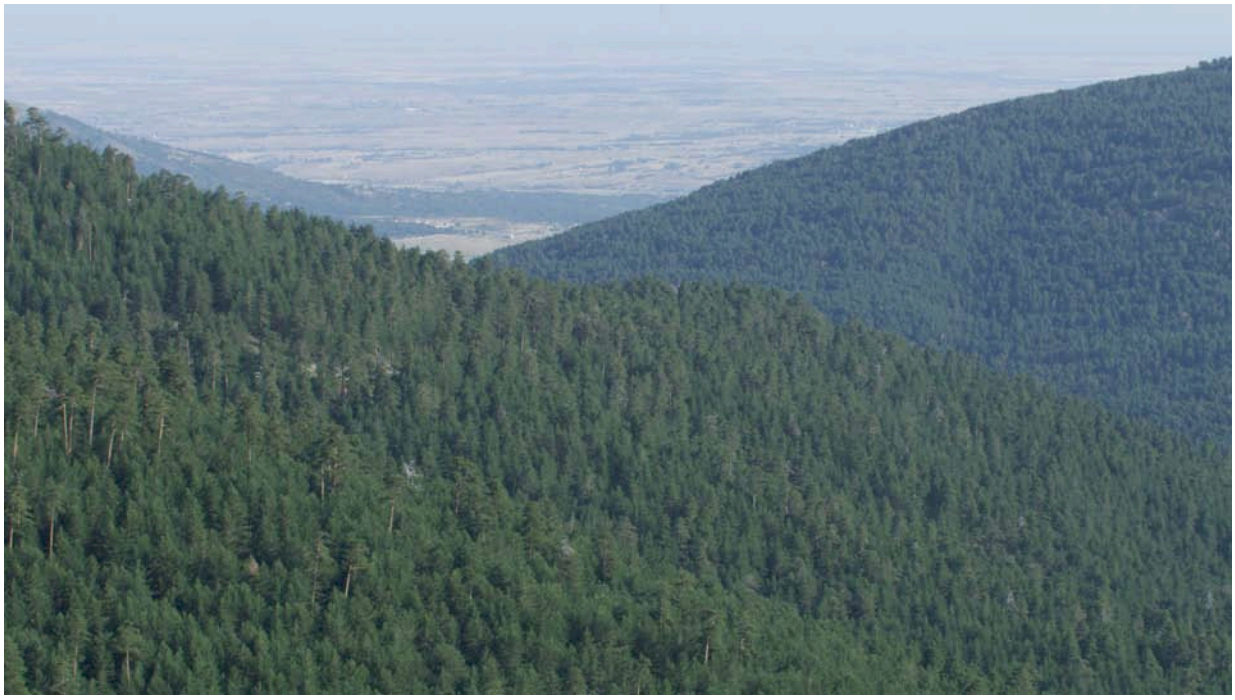
Zoom 18-35mm. Cut of the center to 18, 24 and 35mm

Zoom 18-35mm. Image cuts of the center and the border in comparison

The upper above images show the comparison of the sharpness among the three focal lengths, enlarged x2000, we can hardly see significant differences. The lower above images show the comparison between the center of the frame and the border one to the 18mm focal length; we cannot see significant differences either.

Zoom 50-100mm. Center of the frame's cut to different focal lengths

Zoom 50-100mm. Border of the frame's cut to different focal lengths



Zoom 50-100mm. Focal length 50mm. Long shot

Zoom 50-100mm. Focal length 8mm. Long shot

Previously we saw the good resolution in the frames to the two Zooms, which distinguish the nuances of the tree textures, their branches and the fine details in the distance, behind the mountains.

In addition, we show two more frames in which we can appreciate the texture of Sara's face, our model; it shows a natural feeling, soft, very kind. We can also see the pine trees texture as well as a general feeling of moderate contrast. Both of the Zooms provide the same feeling. We shot the first image with the 18-35mm, and the second one with the 50-100mm.

Zoom 18-35mm. Focal length 18mm

Zoom 50-100mm. Focal length 50mm

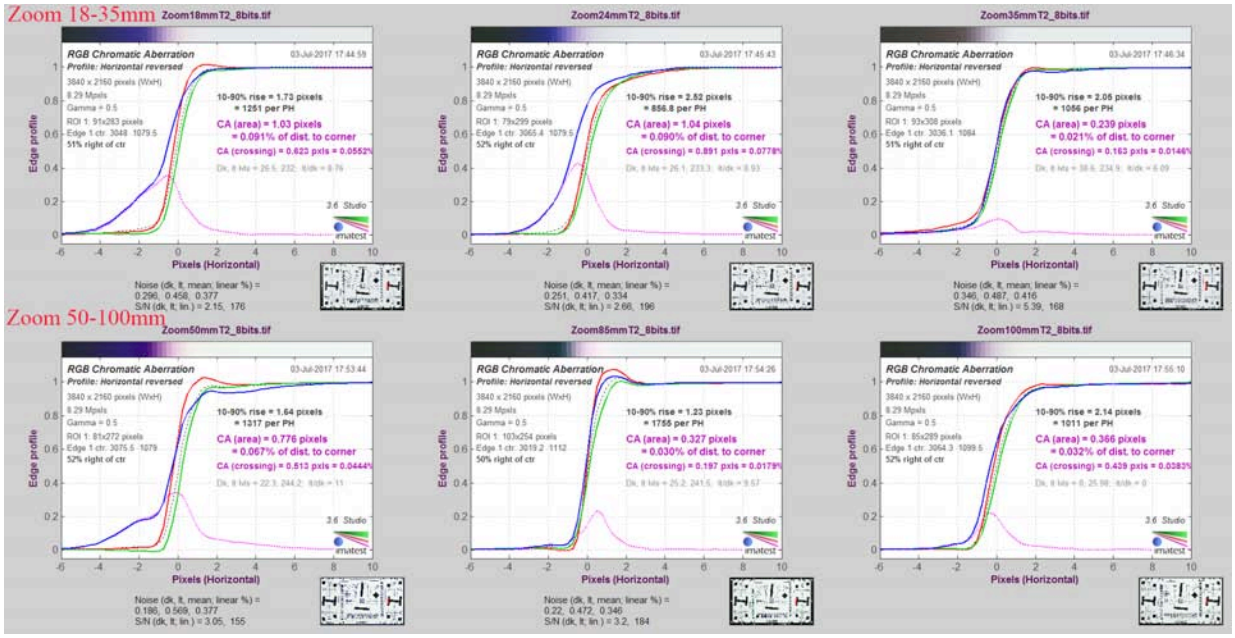
Chromatic aberrations

One of the most typical aberrations that we can experiment on digital images is the chromatic aberration, either axial or transverse. It is characterized by a sequence of color strips which contour the image outline, being more visible on the most contrasted sides. The closest we are to the image borders the transverse aberration increases, whereas the axial appears on the whole image, in both the center and the sides. It is sure that such aberration is one of the most difficult ones to fix, above all when the lenses are working with digital sensors. In the latest lenses manufacturers bear in mind the particular features of the sensors in order to make designs which are more or less telecentric and have aspheric elements; such improvements minimize the aberration and increase the image sharpness.

To evaluate this aberration we analyzed the ISO 12232 chart with Imatest, as well as the Vía Stellae chart. We also analyzed the frames shot in outdoor locations.

Next, we show the values provided by Imatest of the chromatic transverse aberration. The graphs show the RGB shifting, which is showed by the CA area under the magenta dotted line, expressed in number of pixels. The greater CA value is, the aberration is clearer. We have also evaluated the aberration

showing the distance of the center of the image (percentage ratio), according to the table provided by Imatest. We have to bear in mind that such gradation is regarding the still-photography, rather than motion picture which is obviously enlarged, above all on the theatre screens.

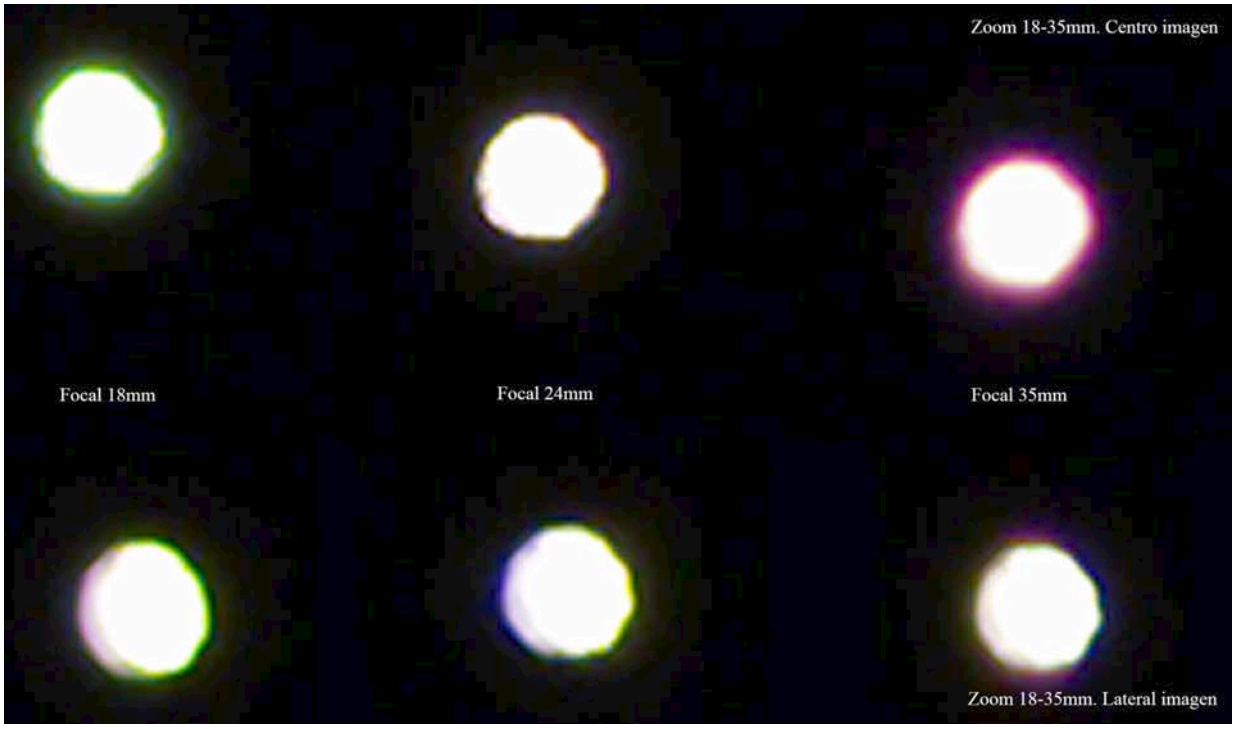


To the Zoom 18-35mm the chromatic aberrations are very small with the 35mm focal length, but we can see with the widest one, above all with the 24mm. To the Zoom 50-100mm the chromatic aberration is significant with the 50mm, but is lower with the most telephoto lengths. With regard to Imatest, the aberration is moderate, however such values are from enlargements of relative small scale whether we put in comparison with the enlarged images on the screen theatres. Thus, for example, the 50mm shows a deviation of 0.067%, we can consider the value low for small enlargement as we can usually see on TV, although to greater enlargements the deviation looks moderate. On the other hand, the 18mm shows a deviation of 0.091, which is moderate, but it clearly visible on a theatre screen.

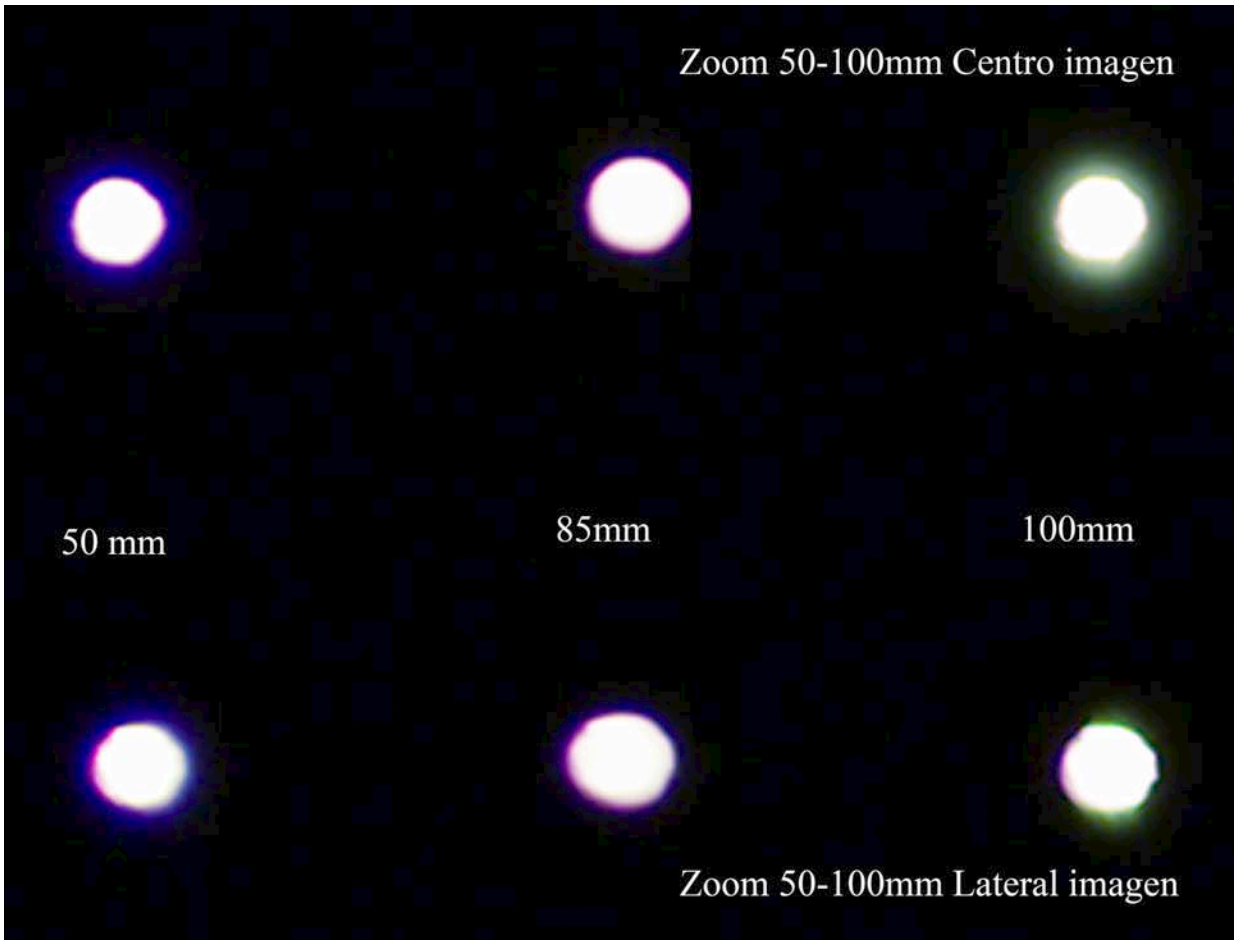
0-0.04	Negligible
0.04-0.08	Low. Difficult to see unless it is looked in detail
0.08-0.15	Moderate. It can be seen when the image is substantially enlarged
Por encima de 0.15	High. It can be clearly seen when the image is enlarged

The aberration above mentioned is lateral, however we have also seen certain axial aberration, and sometimes under extreme overexposures we have also seen the Blooming effect.

We used the Vía Stellae chart to test the aberrations. The chart is made of a group of back lighted small holes. We checked the aberration increasing the image size in 1500%. To the Zoom 18-35mm we can see aberrations in both the center of the image and sides, learning that they are different regarding the focal length.



Zoom 18-35mm. Chromatic aberrations on the center and borders of the image



Zoom 50-100mm. Chromatic aberrations on the center and borders of the image

We can see the aberrations in the images bellow shot in the outdoor locations of Boca del Asno site, Sierra de Guadarrama, Spain.

As we already saw in the Imatest curves. To the Zoom 18-35mm the aberrations are not significant with the 35mm focal length, but they are clearly visible with the widest lengths. We can see the typical cyan/magenta outline on the contrast limits between the sky and the tree trunk with the 18mm and 24mm lengths.

The Zoom 50-100mm shows clearer the aberrations with the 50mm focal length than with the most telephotos lengths, where are negligible. Images are enlarged 2500%.

Shooting full shots in Sierra del Guadarrama, Spain. From left to right, Alfonso Parra AEC, ADFC and José Novillo, camera assistant.

Geometric aberrations

The different magnification of the field covered by the lens causes the barrel and pincushion distortions. In order to evaluate these distortions we used a grid that we have analyzed with Imatest. Table shows the distortions measured by Imatest in SMIA* TV. The SMIA value differs from the traditional definition given by the television industry: the SMIA distortion value is double than the one traditionally used. We obtained low values but they are higher than those provided by the prime lenses of the same manufacturer.

Zoom lens 18-35mm	SMIA TV distortion %
18mm	- 0.728 Barrel
24mm	- 0.155 Barrel
35mm	0.13 pincushion
Zoom lens 50-100mm	SMIA TV distortion %
50mm	- 0.227 Barel
85mm	0.154 pincushion
100mm	0.23 pincushion

To the 18-35mm the distortion at 24mm is practically invisible under normal circumstances; the distortion is very small at 18mm too. The variations to the 50-100mm are also superb. Let us see the next images from outdoor locations.

We can see Sara in upper image with the Zoom 18-35mm to the 18mm focal length. The camera is really close to her and we cannot see any significant distortion.

Zoom 50-100mm. 100mm focal length

We cannot see geometric distortion either to the 50-100mm.

Perspective distortion and spatial configuration

We show the perspective distortion in the upper images to the two zooms with their different focal lengths. To make it we shot a cylinder perpendicularly to the sensor in a manner that the optical axis coincides with the cylinder one. If we compare the distance between the cylinder bases, we can see how each lens builds the spatial relation, not only regarding the appearance of the relative distances but also

the size of the objects placed in different depth of field. Thus, for example, the objects placed in the background look more distant at 18mm, they are smaller, and vanishing quicker than the ones shot to 35mm. To the zoom 50-100mm the relation between the 85mm and 100mm focal lengths are alike; the 50mm shows the objects in the background slightly smaller than the two previous focal lengths. Next, let us see how such condition appears in different images.

Zoom 18-35mm

We can see the relative size of the chart regarding the model's face. We can also see how the 18mm and 24mm focal lengths alter her face, not only changing the face's size, but also its whole bone structure.

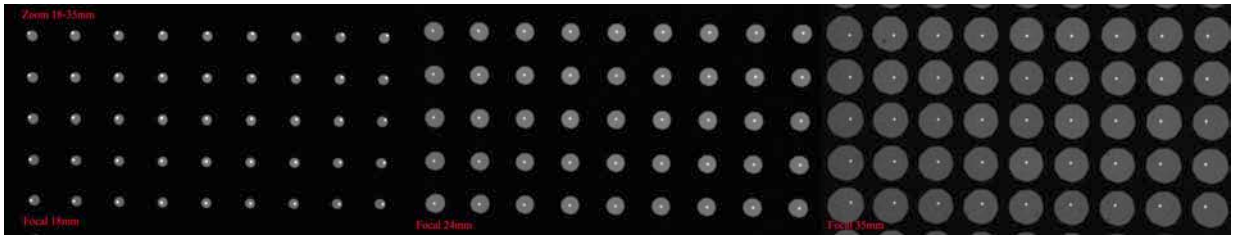
With regard to the zoom 50-100mm we can clearly observe the relation between the chart size and the Sara's face is alike to the 85mm and 100mm focal lengths, and slightly different to the 50mm one.

Zoom 50-100mm at 50mm, 85mm and 100mm focal lengths

Zoom 18-35mm at 50mm, 85mm and 100mm focal lengths

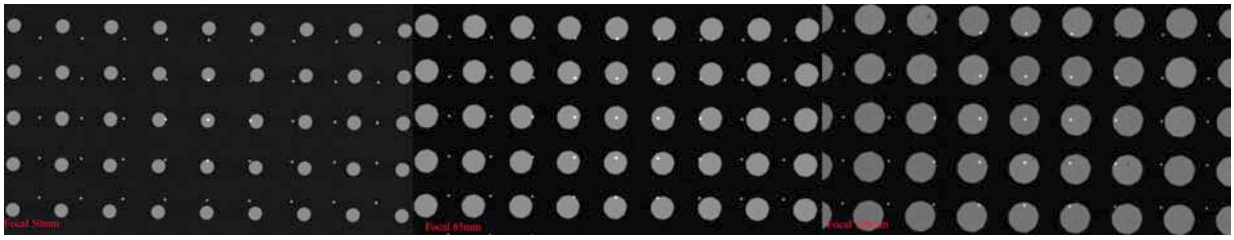
The differences of sizes and relative distances are consistent with the zoom 50-100mm and reasonably different with the zoom 18-35mm; in this case, the relation between the 24mm and 35mm focal lengths is good, to the 18mm there is significant perspective distortion regarding the two other focal lengths, however it is expected for a wide angle lens.

We also paid attention to other aspects, such as the lens breathing, in other words, whether the frame size changes when we change the focal distances to the different focal lengths. To do this, we have again used the Vía Stellae chart. We have overlapped a focused chart on other out-of-focus one; the small white point is focused and the largest one is unfocused. If both points are concentric we can state that the lens does not breathe. The less concentric are the circles; the largest is the frame variation regarding the focal length changing.



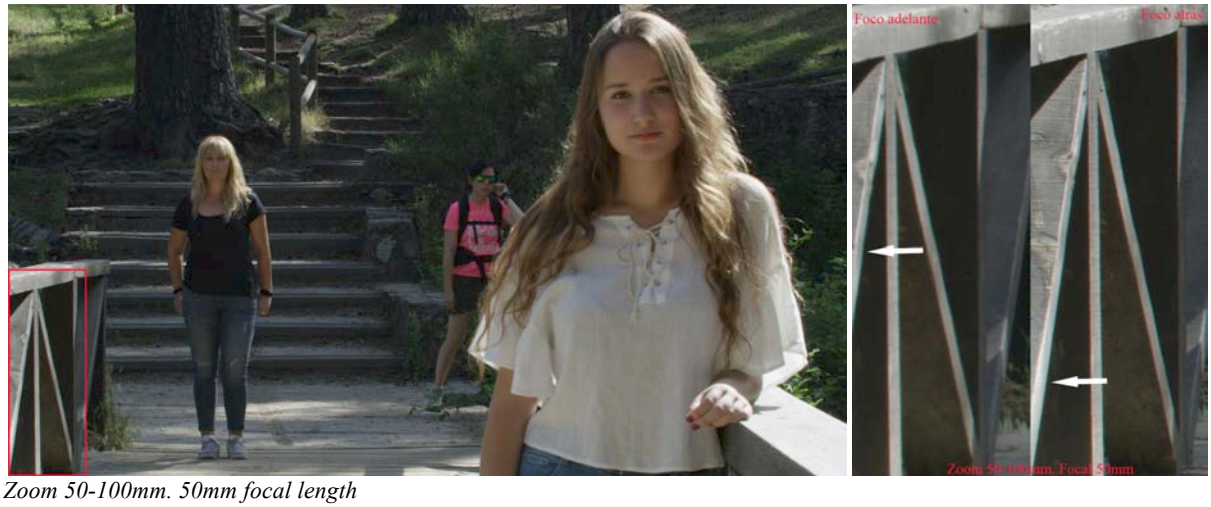
In the upper image we show the response of the zoom 18-35mm. As we can see, the lens breath is hardly significant, being bit more appreciable to the wider focal length. In any case, we can say that the zoom 18-35mm does not breathe.

Next, we can check the zoom 50-100mm.



The lens breathing is significant opposite to the other zoom. The frame displacement is very high on the whole focal length scale, above all to the 50mm.

The next image comes from the zoom 50-100mm. Firstly, we focused on Sara (the model in the nearest distance), and then on Victoria. We enlarged the red square to see the difference between the two focal distances. We can also see the chromatic aberrations in the enlargement.



Zoom 50-100mm. 50mm focal length

The lenses' breathe affects the image in two ways. Firstly, if we change the frame size the camera shows itself to the spectators, and consequently they recognize the trick which is used to tell the story. Secondly, there is a more subtle effect caused by changing the frame while focusing; that is, the room transforms into a different dimension, it is clearer the two-dimensional aspect of the frame, as well as the time provided by such change to the motion picture.

We have to take into account the bokeh too; in other words, how the soft-focus generated by the lens looks. As we already know, above all the bokeh depends on the number of iris diaphragm blades and on how they are placed from the optical design view. In the upper images from the Vía Stellae charts, we can see that the out-of-focus circles do not look like circles but a nine sided polygon, which is directly related to the number of iris blades. The more blades we have, the more circle-like the circle looks, and consequently, looks less polygon-like. In addition, the opener the diaphragm is, the less polygon-like the circle looks.

Zoom 18-35. 18mm focal length. T 2

Zoom 18-35mm. 18mm focal length. T5.6

As in the prime lenses, the zoom 18-35mm provides a softer bokeh with a T-value with narrow aperture, whereas it is a bit harder with a T-value with wide aperture, we can see the out-of focus a bit more geometrical. We can see such condition on the blurred bright points in the background, behind Sara.

Zoom 18-35mm. 35mm focal length. T 5.6

Zoom 50-100mm. 100mm focal length. T2

Zoom 50-100mm. 100mm focal length. T5.6

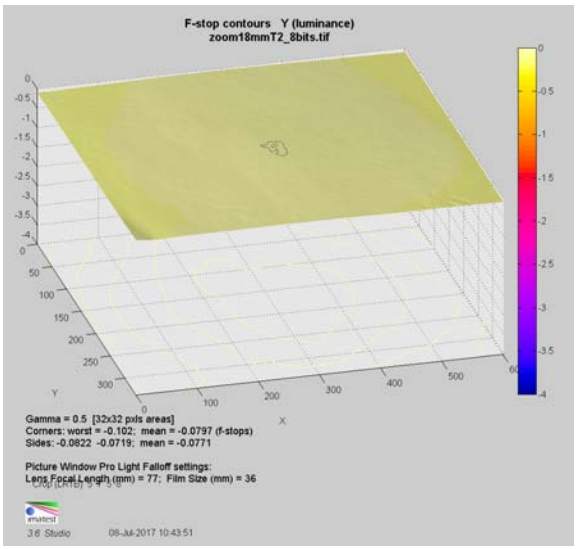
The same happens with the zoom 500-100mm. To the T 5.6 the blurred points are more polygon-like and less polygon-like to T 2, in addition we can see how the points shape like ellipses caused by lens vignetting. We can see the bokeh in the next image as well as the general feeling of the background which is out-of focus, to both the closest and the far in the distance regarding Sara.

Zoom 50-100mm. 100mm focal length. T 5.6

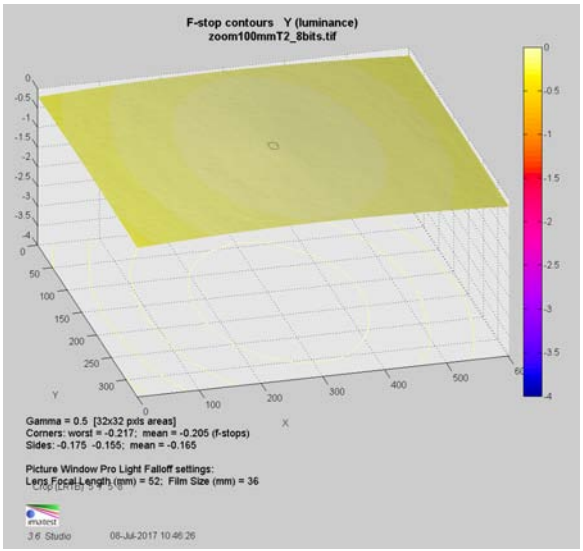
Illuminance uniformity

The illuminance uniformity assesses whether the luminance of the whole frame is uniform or there are deviations on sides and corners (vignetting). To this test we used the LV5 spherical illuminator, which provides a homogeneously illuminated plane. Then we analyzed the images with Imatest. The difference of illuminance contributes to the resolution and sharpness of the image. The lower graphs are 3D-models which show the illuminance values over the whole shot.

As we can see both graphs demonstrate that the performance is outstanding. We can hardly see the difference of illuminance among the center, sides and corners. The next table shows all of the results in f-stops regarding the center. The values are really good, being the 100 mm focal length which shows a bit more of loss.



Zoom 18-35mm. 18mm focal length. T 1.5



Zoom 50-100mm. 100mm focal length. T2

Zoom 18-35mm T1.5	Average of corners in f-stops regarding the center	Average of sides in f-stops regarding the center
18mm	0.0797	0.0771
24mm	0.0906	0.0624
35mm	0.149	0.113
Zoom 50-100mm T2		
50mm	0.097	0.0806
85mm	0.158	0.121
100mm	0.205	0.165

Flare and veiling glare

Both flare and veiling glare refer to how the reflections of the beam of light inside the lens system contribute to change the contrast, sharpness and resolution. Veiling glare is the ratio between the light which falls upon the black sensor regarding the surrounding white. To the test we used a gray scale with a black hole and then we analyzed the images with Imatest. Next, we can see the results.

Zoom 18-35mm	Veiling Glare %	Zoom 50-100mm	Veiling Glare %
18mm	0.203	50mm	0.313
24mm	0.211	85mm	0.405
35mm	0.256	100mm	0.282
AVERAGE	**0.233**	AVERAGE	**0.333**

Zooms show a bit more veiling regarding the prime lenses, however it is clearly moderate. We can obtain images with adequate clean black exposing them under certain conditions, although due to another zooms' features such black are always soft, with detail and texture, but without an extreme sharpness. The zoom 50-1000mm shows more veiling than the wider, which is a bit more contrasted.

Zoom 18-35mm. 35mm focal length. T 16

Zoom 18-35mm. 35mm focal length. T 2

We can see in the upper image which is exposed at high lights how the black is soft, with detail and texture, with a good control over the influence of the high light on it. The same image is now overexposed to T2.

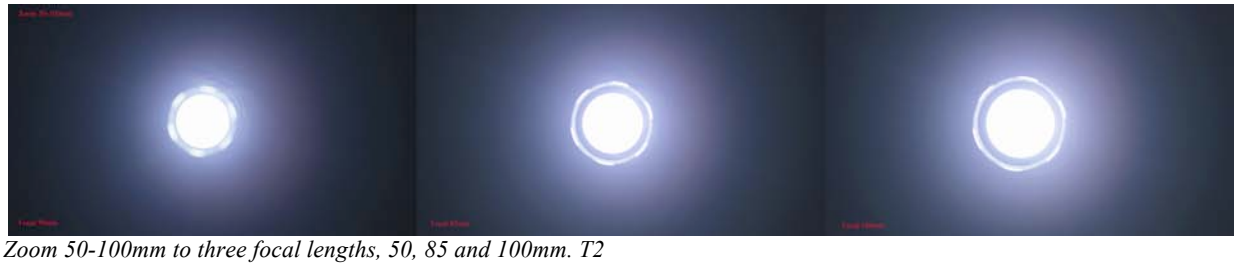
Firstly, we exposed at the high lights in the shot, and then, as Sara moves forward, we have open the diaphragm in order to test how the light in was changing the detail and texture regarding the dispersion among the different lenses. We have seen that the texture and definition of the image to very high overexposed values change into "creamy". We show another example with the zoom 50-100mm.

Zoom 50-100mm. 50mm focal length. T 16

Zoom 50-100mm. 50mm focal length. T 2

We can see with the zoom 50-100mm that blacks are slightly less sharp, a bit softer than with the 18-35mm one. The same is true of the 50-100mm; to an extreme overexposure the limits of contrast between dark and clear are dimmed, blacks are contaminated, they look milky.

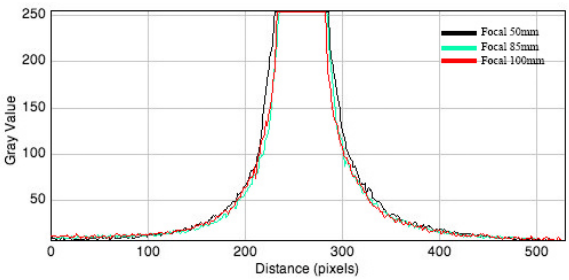
With regard to the flare, we show it through a lantern in direct light to the camera. We can see that flare is quite large, there are a lot of internal reflections and shining. Let us see an example of flare with the zoom 50-100mm which is the highest.



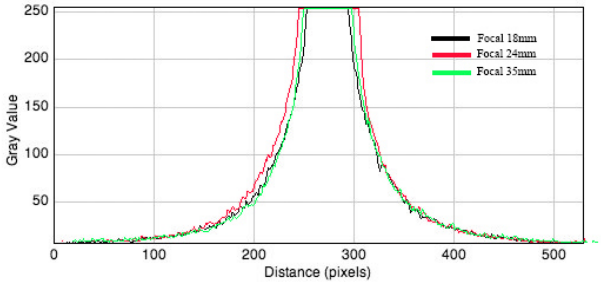
Zoom 50-100mm to three focal lengths, 50, 85 and 100mm. T2

We can see the same in the cutting from the candles of the still-life; first with the zoom 18-35mm at T2, and then with the zoom 50-100mm at T2 too.

Zoom 50-100mm to 50, 85 and 100mm. T2



Zoom 50-100mm



Zoom 18-35mm

We show the pixel values of bright in the upper graphs with the two zooms and their three focal lengths respectively. Values are from the black to the extreme white, being back again to the black. The appearance of the flare is very similar throughout the range with a moderate dispersion with the two zooms.

We show the next two frames from outdoor locations with an extreme flare as it is the direct sunlight in the camera.

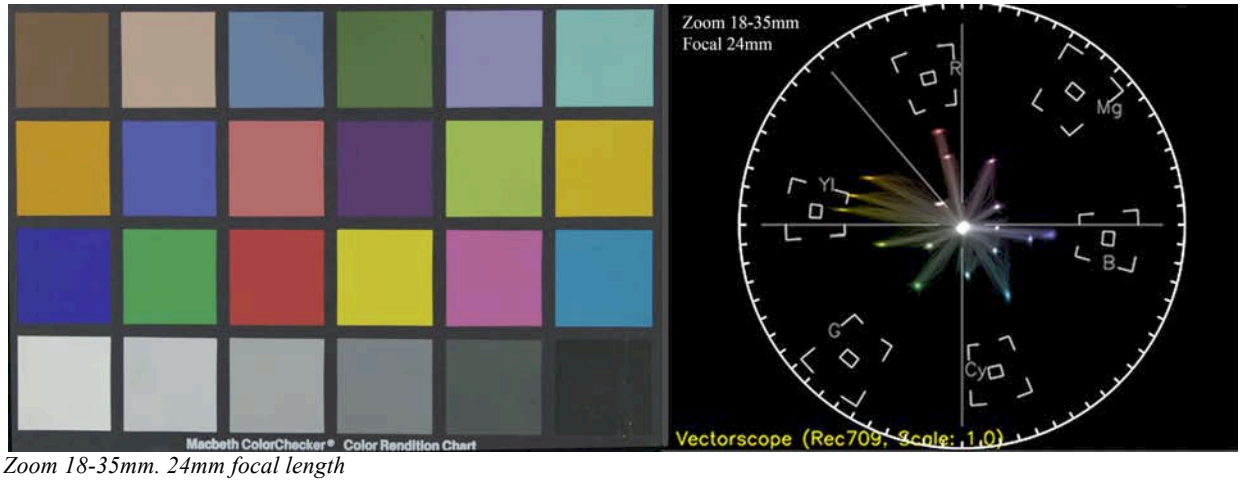
Zoom 18-35mm. 18mm focal length (we can see red points in the lower part, they are related to the camera sensor and they are typical of the RED, not coming from the lens)

Zoom 50-100mm. 50mm focal length

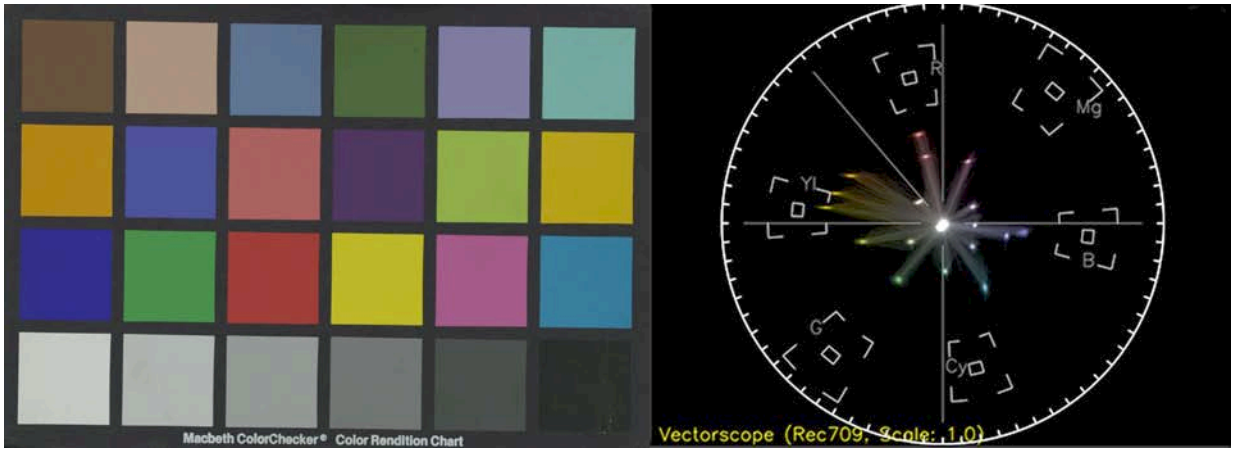
The flare creates iridescent pearls with a vintage look, which is overlapped to the veiled blacks. They are sharper with the zoom 18-35mm and softer with the 50-100mm one.

El color

We studied the color response with a Macbeth chart as well as the observation of frame from outdoor locations. We shot the Macbeth chart with every lens under the same circumstances, that is, the same lighting and parameters of "developing" when we opened the RAW. Our lighting devices were adjusted to 5600K (Led velvet panels) and 3200K (Tungsten). We have not seen any differences between the focal lengths of the zoom at the same T values.



Zoom 18-35mm. 24mm focal length



Zoom 50-100mm. 85mm focal length

The color response with the zooms is not only identical regarding their whole focal lengths range and T-values, but also between the zooms themselves; the response is alike, changing neither the hues nor the color appearance.

Other issues

The zooms seem to us robust, with the appropriate weight and a size easy to handle. We can use the same accessories, from hoods until the different focus selectors, without exchanging them because both zooms keep the same diameters. Both the diaphragm and the focus move softly, with the adequate friction, neither very soft nor too hard. The focus marks are adequate to the zooms. They are easy to handle, and the reflective numbers are adequate for the night shooting. In sum, we can say that they are equipped with everything needed to the professional working.

Conclusions

In order to evaluate the two zooms, we have to take into consideration not only the technical conditions which determine the lens personality (personality that is provided by the decisions that the manufacturer makes during its design), but also the DoP's experience and his/her taste regarding his photographic style.

From the technical point of view, we can point out that the quality of both lenses is good, albeit we believe that the zoom 18-35mm is better than the 50-100mm one regarding both the resolution and veiling, even in something so important as the breathing. Both zooms performance very good resolution, high to a format as 4Khd; such resolution shows soft, with texture far from the extreme sharpness which we do not usually like in the digital environment. The illuminance uniformity is excellent to the two zooms, as well as the geometric aberrations which are practically imperceptible while we are shooting under normal conditions. Both zooms can be classified as the soft lenses, with low contrast and warm.

Hashiguchi_Goyo. Hot Spring Hotel.1921

As a DoP, from my personal taste, I am pleased with the two zooms because I like how they build the perspective regarding the sizes and relative distances of the different objects in the frame. I like specially the look of the images provided by the zoom 50-100mm: soft and delicate, appropriate to the close-up of our actors. Also I like the sharpness provided by the zoom 18-35mm which does not show any chromatic aberration. Moreover, the two zooms can be perfectly combined despite of the differences that we saw during the test. It is especially outstanding the coherence and consistency of the color to the two zooms. Many times we talk about the lenses *personality,* about their *character*. If I had to define it to the zooms Sigma, I would adhere to the Japanese Shin-hanga art movement of the early last century, movement, which was characterized by its soft, colors in naturalistic ambience of light.

Zoom 18-35mm

- Resolution ★★★½☆
-Chromatic aberrations ★★☆☆☆
-Geometric distortion ★★★★★
-Perspective distortion (spatial configuration/breathing) ★★★★☆
-Bokeh ★★★☆☆
-Vignetting and illuminance uniformity ★★★★★
-Veiling glare ★★★★☆
-Flare ★★☆☆☆
-Color ★★★★★
-Ergonomic and handling ★★★★★
-Price-performance ratio ★★★★★
Overall evaluation ★★★★☆

Zoom 50-100mm

- Resolution ★★★½☆
-Chromatic aberrations ★★☆☆☆
-Geometric distortion ★★★★★
-Perspective distortion (spatial configuration/breathing) ★★☆☆☆
-Bokeh ★★★☆☆
-Vignetting and illuminance uniformity ★★★★★
-Veiling glare ★★★☆☆
-Flare ★★☆☆☆
-Color ★★★★★
-Ergonomic and handling ★★★★★
-Price-performance ratio ★★★★★
Overall evaluation ★★★☆☆

Video Test: https://vimeo.com/237291481

Closing credits

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Director of Photography and Technical Director: Alfonso Parra AEC, ADFC
First assistant camera: José Novillo
Second assistant camera: José Luis Luna
Models: Sara Paredes y Victoria Parrilla

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