EVALUATION AND PHOTOGRAPHIC STUDY OF THE SIGMA PRIME LENSES

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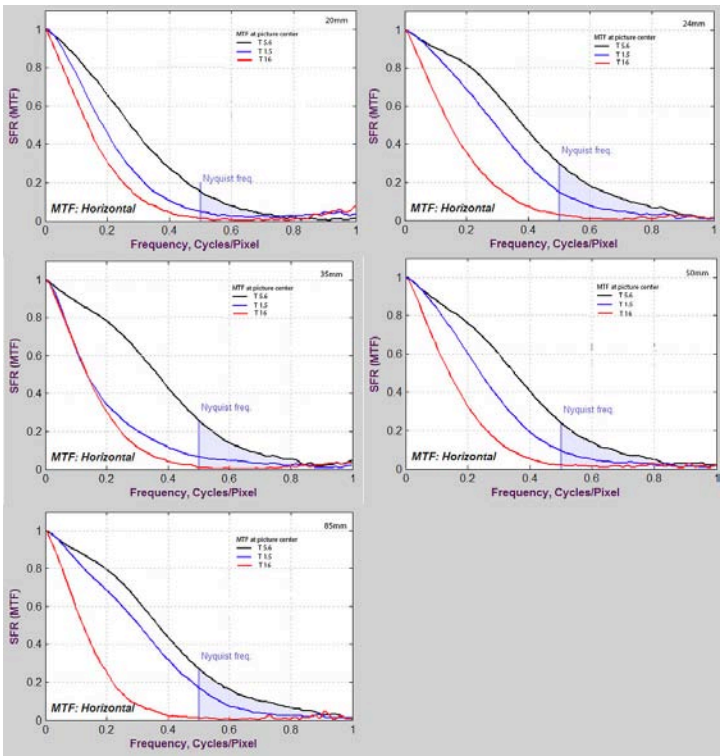
In this article we are going to study the set of Sigma prime cine lens that offers the focal lengths 20mm, 24mm, 35mm, 50mm and 85mm at the moment of the test. The study focuses on every aspect related to the image quality provided by the lenses, such as the resolution, color, Bokeh or spatial construction, among others. We 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 with 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 order to study the material we used Davinci, Prelight and Scratch.

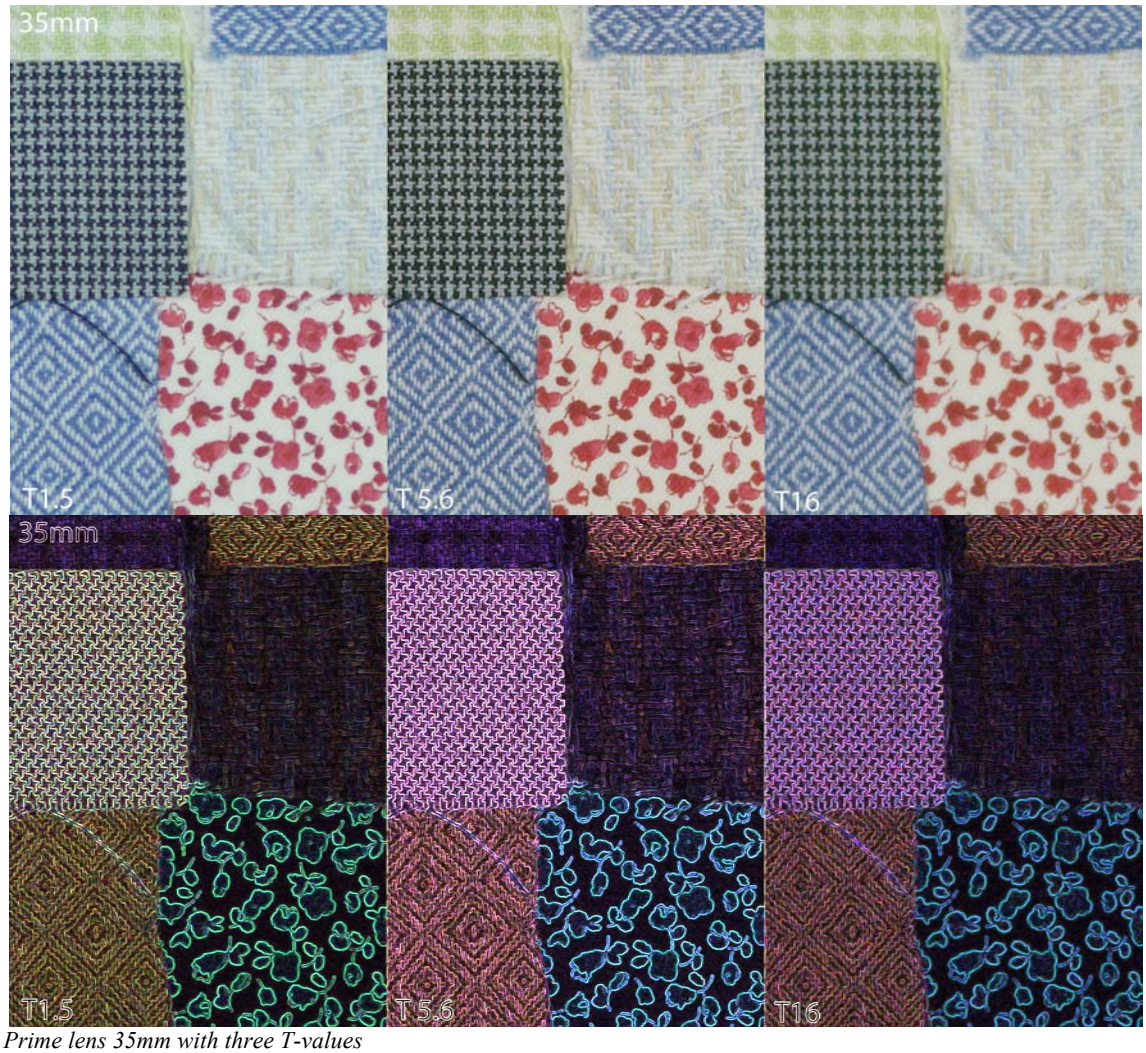
In addition to the technical study, we shot outdoor locations images in Sierra del Guadarrama, Spain, and its surrounding areas in order to get a more subjective evaluation about the look provided by the lenses. The frames showed in the document are from the original ones, and they are used as mere references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

Resolution



As a DoP I evaluated the lenses resolution regarding the whole structure which they form with the camera and its recording system. We are interested in the evaluation of the resolution as a whole from the photographic point of view, being the lenses an essential part to achieve the sharpness of the images. Thus, the resolution in not only caused by the lens, but also by the sensor, OFLP filters, compression processing and recording, last but not least the monitors, film projectors and the distance of the spectator regarding them. For the analysis of the resolution we have used frequency test charts such as ISO 12232 or ESSER Test Chart, analyzed by Imatest and ImageJ, in addition to the observation of the shots in natural exteriors and texture test charts.

We show the MTF curves on the right imge provided by the different focal lengths with three dyaphragms, T 1.5, T 5.6 and T 16 We can see how the performance of the different lenses is. The 20mm shows the least resolution, whereas the rest of the lenses keep value alike to T 5.6. As normally would be expected the resolution decreases with wider values, T 1.5, and higher ones, T 16, caused by the diffraction effect. This fact is significant because it entails a limit of diffraction relatively low to these kinds of lenses and camera; it can be placed between T 8 and T 11. The loss of resolution with the widest T is lower, although it is still visible. Let us see an enlarged cutting of the chart of texture Prêt-à-Porter to the 35mm focal length.



Prime lens 35mm with three T-values

With regard to the T 5.6 we can see the difference of resolution on both the small flowers and on the geometric patterns of the fabrics. To the T 1.5 the loss of resolution is lower than with T 16, however we can still see certain loss of texture in the center as well as in the small flowers. We can also see color changing what we are going to study forward. The set of prime lenses performances alike, and, as we have already said, just the 20mm shows a lower loss of resolution. Next, we show a table with the MTF values at 50% with T 5.6.; we can see the loss of resolution sharpness with the T-values which we have already mentioned. The 24 mm appears as the lens with more sharpness.

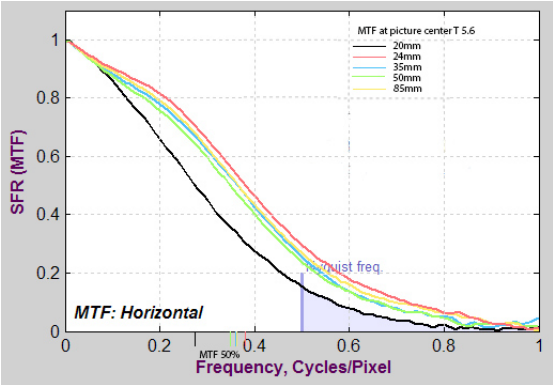
20mm Lens	Horizontal resolution MTF 50%Center LW/PH
T 1.5	**793.3**
T 5.6	**1182**
T 16	**597.1**
24mm Lens	
T 1.5	**1274**
T 5.6	**1654**
T 16	**631.1**
35mm Lens	
T 1.5	**594.9**
T 5.6	**1581**
T 16	**588.4**
50mm Lens	
T 1.5	**1.048**
T 5.6	**1.509**
T 16	**607.1**
85mm Lens	
T 1.5	**1322**
T 5.6	**1588**
T 16	**533.9**

The resolution at 50% to the 4KHD format is really good with the T 5.6, it is exceptionally good to the 50mm, 85mm and 25 mm focal length with T 1.5 and a bit lower with the 35mm and 20mm with the extreme aperture.

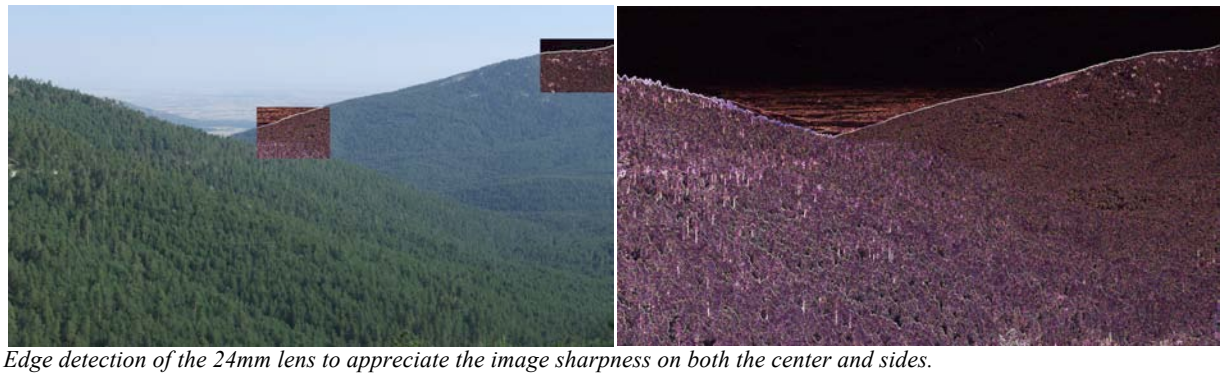
The diffraction effect is related to the aperture diameter of the diaphragm as well as the pixel size of the sensor and the CoC. We made test of diffraction, and then we learnt that the detail is soft but with a good sharpness to values from T 1.5 until T 11; to larger T-values the loss of resolution is obvious. We also analyzed the loss of resolution on the sides which is clear with T 1.5, being practically half lower with the 50 mm or 85 mm. However, it is not especially visible on long shots in outdoor location.

In the graph on the right the whole lens set is compared.

We can appreciate the good performance of the lenses in outdoor locations regarding the resolution, as we can see in the long shot of Madrid range. The difference of resolution between the center and side is hardly perceptible on this long shot, which needs not only the lens with a good definition but also the sensor to resolve the details. Both in the center and on the sides the details of tree trunks, the leaves texture and the horizon are very clear. We can also see very well the soil and plain in the valley background.



Prime lenses MTF with T5.6. Horizontal resolution in the center of the image



Edge detection of the 24mm lens to appreciate the image sharpness on both the center and sides.

Let us see another image from the cutting (left, bottom) of the frame, enlarged with two lenses.

The resolution is really good with such enlargement, enough for any cinema projection

Finally, we can appreciate in the next frame the texture of Sara's skin tone as well as the fine details of her hair and clothes or even the tree trunks.

35mmn lens

85mm lens

We can conclude regarding the resolution that the lens set has a high resolution, but at the same time it shows softly the textures and detail. Such features keep consistently in the whole prime lenses set. It is recommended not to use T-values above 11 because of the resolution losses caused by the diffraction effect. The image sharpness decreases slightly with T 1.5, but is not significant under normal shooting circumstances.

Chromatic aberrations

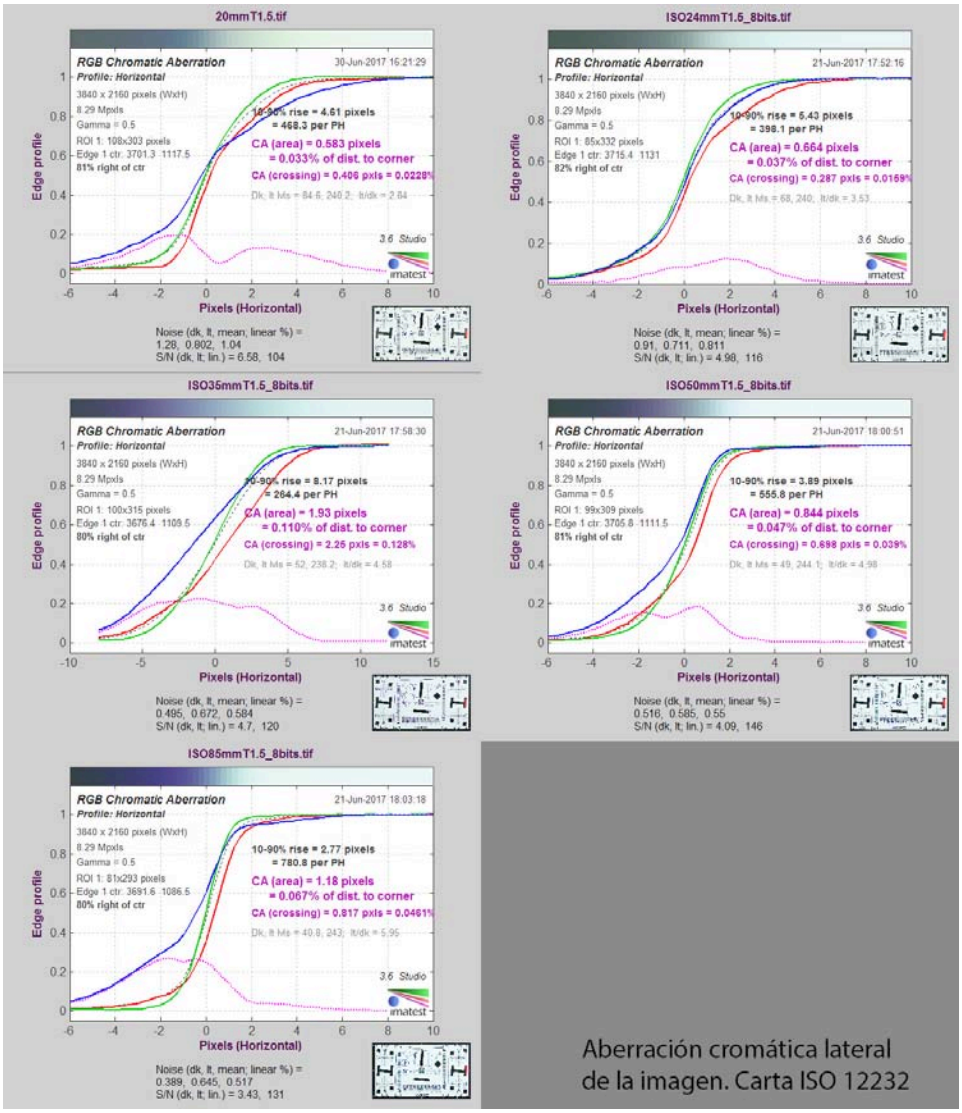
One of the most typical aberrations that we can see on digital images is the chromatic aberration, either axial or lateral. It is characterized by a sequence of color strips which contour the image outline, being more visible on the most contrasted borders. The closer to the image sides we are, the larger the lateral aberration is, whereas the axial appears on the whole image, in both the center and on the side. To evaluate this aberration we have analyzed the ISO 12232 chart through Imatest, as well as the *Via Stellae* chart. We have also analyzed the frames shot in outdoor locations.

Next, we show the values provided by Imatest of the chromatic lateral aberration. The graphs present the RGB shifting, which is shown by the CA area under the magenta dotted line, expressed in number of pixels. The greater the CA value is, the clearer the aberration appears. 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.

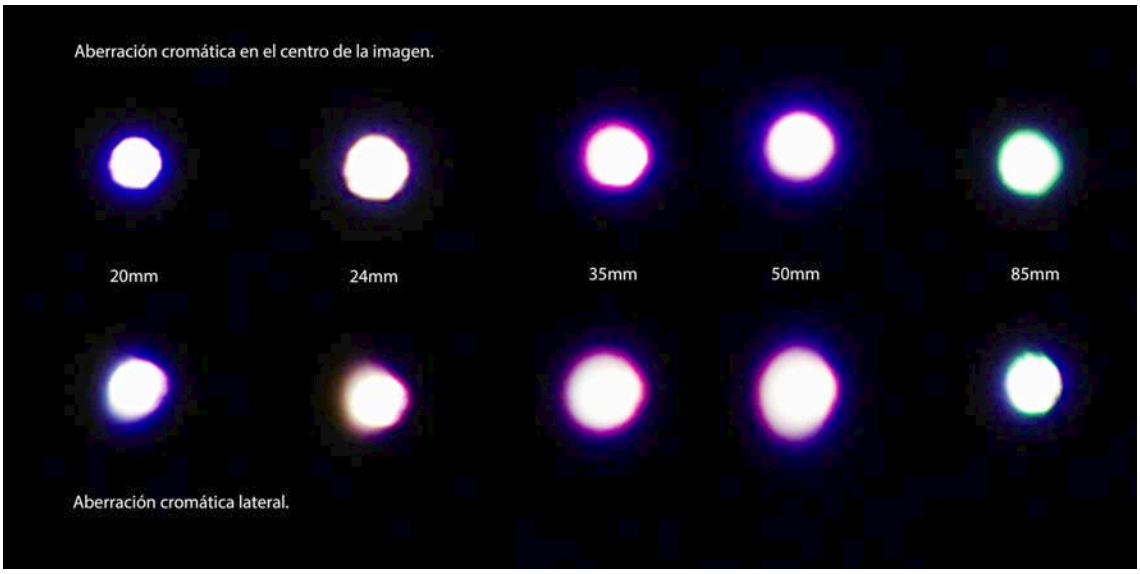
Lateral chromatic aberration Percentage ratio of the image's distance from the image	Grade
0-0.04	Negligible
0.04-0.08	Low. Difficult to see unless it is looked in detail
0.08-0.15	Moderate. It can be seen when the image is substantially enlarged
Above de 0.15	High. It can be clearly seen when the image is enlarged

The values are generally moderate, it means that such aberrations can be seen not only on sides but also over the closest parts to the center. Its visibility depends on the grade of enlargement of the image and the distance of the spectator from the screen. We can see the aberration both in the center and on the sides of the image.

We can see in the next graphs the aberration on the right side, we have values between low and moderate to such aberration; so the 35mm lens is at 1.93 pixels (0.110% distance to the frame corner) or the 85mm lens is at 1.18 pixels (0.067%). The rest of the lenses varies between 0.0583 (0.033%) to the 20 mm lens and 0.844 (0.047%) to the 50 mm lens.

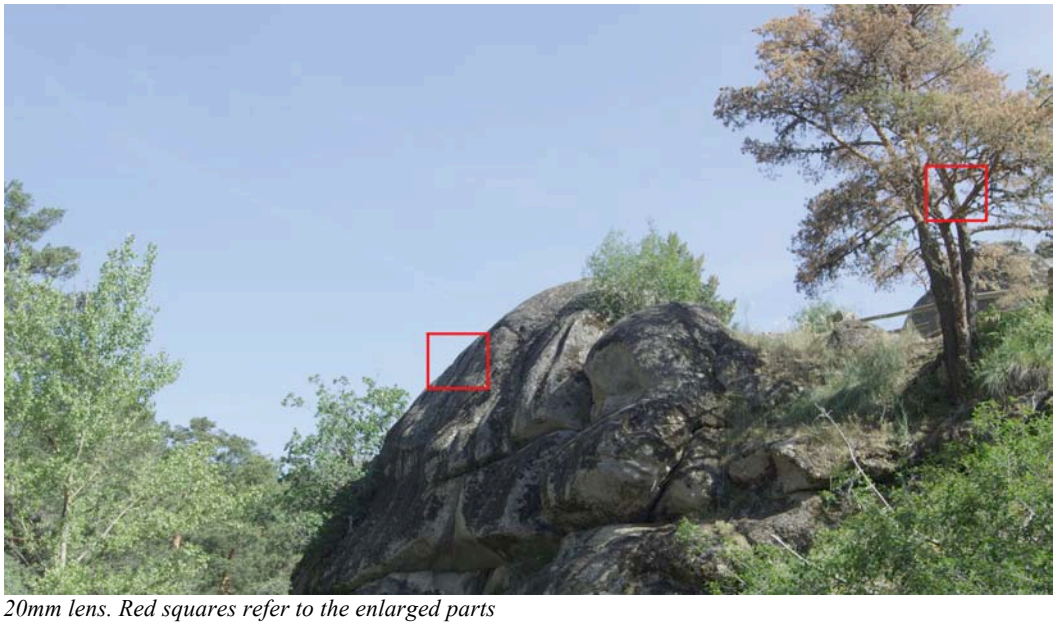


We can clearly see such aberrations on the *Vía Stellae* chart which is made of a group of back lighted small holes; such small holes are distributed for the entire chart surface. We can see in the next image not only the chromatic aberration but also the loss of sharpness on the sides regarding the center. We have also seen through the chart that the color aberration changes if we change the focus on them, and sometimes magenta turns into green.



At the top, the chromatic aberration in the center of the image. In the lower part, the lateral chromatic aberration.

We can see such aberration in the next shots from outdoor locations.



20mm lens. Red squares refer to the enlarged parts

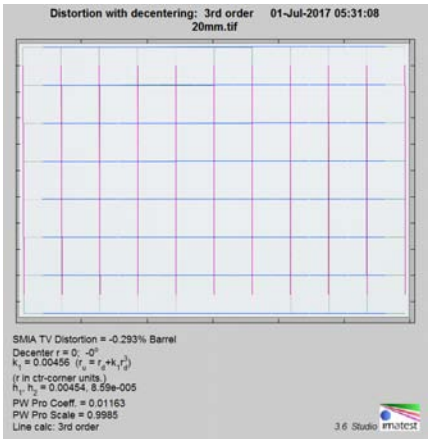
We can appreciate in the two enlargements (x2000) the green and magenta edges on the corner image as well as the green edge on the image from the center.

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 have really low values, we cannot significantly appreciate any distortion even with the widest apertures.

We show next shots from outdoor locations. We cannot see any distortion in the focal lengths, neither in the center of the image nor on its sides.



Lens	SMIA TV distortion %
20mm	- 0.293 Barrilete
24mm	- 0.339 Barrilete
35mm	- 0.208 Barrilete
50mm	- 0.046 Barrilete
85mm	-0.0078 Barrilete

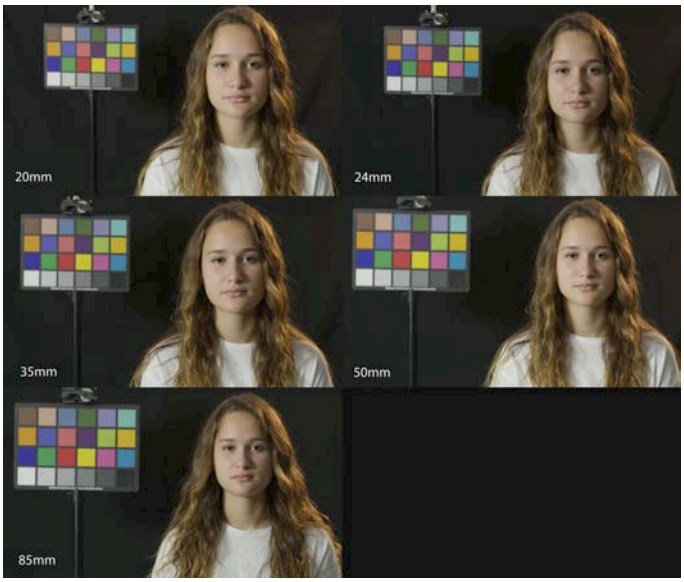
20mm lens

We have shot in the upper image with the wide-angle lens, near to the model. As we can see, the distortion is neglible.

Perspective distortion and spatial configuration

Sigma Prime lenses

We show the perspective distortion in the upper images to the five 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 with the 20m, they are smaller, and vanishing quicker than the ones shot to the 50mm. Such lenses feature depends on the decision of the manufacturer during their design.

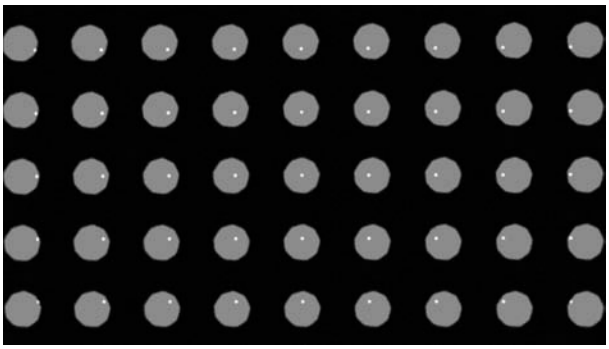


As DOP it is very important to me how the lenses project the reality over the sensor, in other words, how our three-dimensional world is converted in two-dimensional one, and how this change is kept throughout the lenses. Since we are usually changing our lenses during shootings in order to get different narratives, we have to know how the lenses set changes the spaces, if it changes more or less regarding the different lenses. Let us see the next example in which we can appreciate what we have seen with the cylinder, that is, how the Macbeth chart size changes regarding Sara, who keeps her size in the frame.

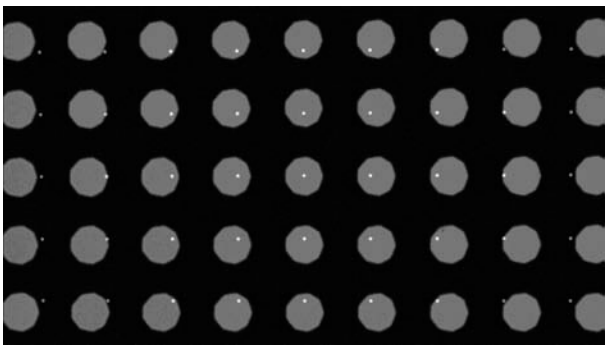
The size of the chart is relatively small with the most wide-angle apertures, and it changes significantly inasmuch as the aperture is near to the telephoto; with the 85 mm the chart is bigger than the model's face. The chart size changes, and consequently the distance between the model and chart too. It means that the spatial conception will change in our natural environments regarding the lens used, thus we have to pay special attention to the selected lenses in relation to themselves in order to build an appropriate audiovisual narrative.

We can see on the right images the relative distances and size throughout the lenses set in Boca del Asno Bridge. We can use such image to understand how the lenses work and so having a reference mark to handling them.

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. Let us see the next example with two lenses:



50mm lens



35mm lens

As we can see in the center of the image, both the centers of the focused and unfocused points coincide absolutely. But inasmuch as we get away from the center of the image the points does not coincide; it indicates that the lens breaths more or less. To a greater or lesser degree, every lens of the set breaths, so it changes the frame size regarding the focus movement. We show in the next example a shot with the 35 mm focal length, in which we can clearly see such effect with the focus movement.

In this case if we unfocus we can see how the distance between the tree and the frame side decreases regarding the focused shot. 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. It entails that the out-of-focus is a bit "hard", above all with normal T-values, those which are between 2.8 and 8. We can see in the upper image about the out-of-focus forest, not only the breathing but also the light points on the right with a geometric pattern instead of circle-like.
Let us see the next example.

50mm lens. T 5.6

50mm lens. T 1.5

We can see that the out-of-focus small lights at T 5.6 on the left image are clearly polygon-like, whereas with the diaphragm totally open the same light are more circle-like, getting an out-of-focus softer. Thus, the Bokeh will be slightly different regarding the used T-value, harder with closer T-values, softer with opener ones. Let us also see that the image at T 1.5 shows chromatic aberration as well as vignetting effect, the light points in the sides are not circles but ellipses.

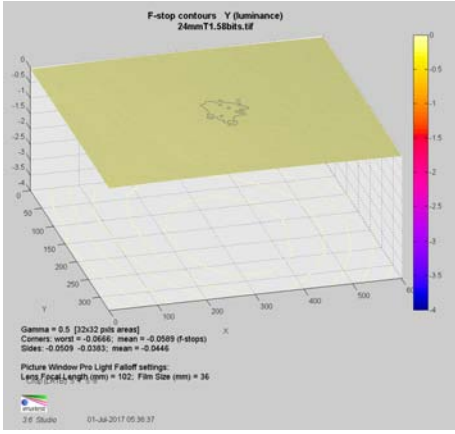
Illuminance uniformity

We have checked the illuminance uniformity in this section of the test. The illuminance uniformity assesses whether the illuminance of the whole frame is uniform or there are deviations on sides and corners (vignetting).

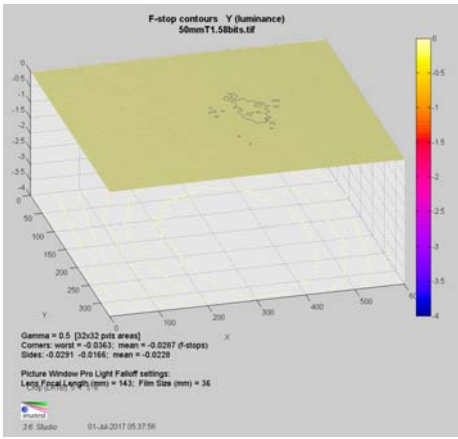
To this test we used the LV5 spherical illuminator, which provides a homogeneously illuminated plane. We analyzed the different shots provided by the different lenses with Imatest. As an example, we show the shots just with two focal lengths because every lens performances alike. We used the widest aperture, T 1.5, because in this case it is usual to see the largest loss of illuminance; since we already know it can be caused by the product of the law of cosines and the vignetting due to the glasses support inside the lens.

The right graphs are 3D-models which show the luminance values over the whole frame. As we can see on both graphs the performance is outstanding. We can hardly see the difference of luminance among the center, sides and corners. The table shows all of the results in f-stops regarding the center. The loss of illuminance with the 20 mm focal length in the corners regarding the center is only 0.12 stops. It is really low and not visible with real images, far from the charts and technical evaluation systems. The rest of the lenses show much lower loss.

From T-2 value there is not any difference of luminance among the center, sides and corners.



24mm lens. T1.5



50mm lens. T1.5

Lens	Average of corners in f-stops	Average of sides in f-stops
20mm	0.129	0.0978
24mm	0.0589	0.0446
35mm	0.0516	0.0405
50mm	0.0287	0.0228
85mm	0.0318	0.0259

Flare and veiling glare

Both flare and veiling glare refers 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 have analyzed the images with Imatest (lower right image). Next, we can see the results.

The results show a moderate veiling which allows us to obtain a good black in the images without much contamination by the high light. The next shots show such performance, albeit we have to see motion pictures to appreciate totally the effect of overexposure in the detail, texture and contrast. In motion, as we open the diaphragm we can see how the different limits of contrast defines. Firstly, we have exposed to outside and then, meanwhile Sara is going straight into the camera, we opened the diaphragm to the suitable exposure at shadows and beyond until the maximum T-value that the lens is able, the T 1.5.

Lens	Veiling Glare %
20mm	0.153
24mm	0.167
35mm	0.16
50mm	0.13
85mm	0.151

35mm lens. T 16 . High light exposure.

35mm lens. T 6.3 . Shadow exposure.

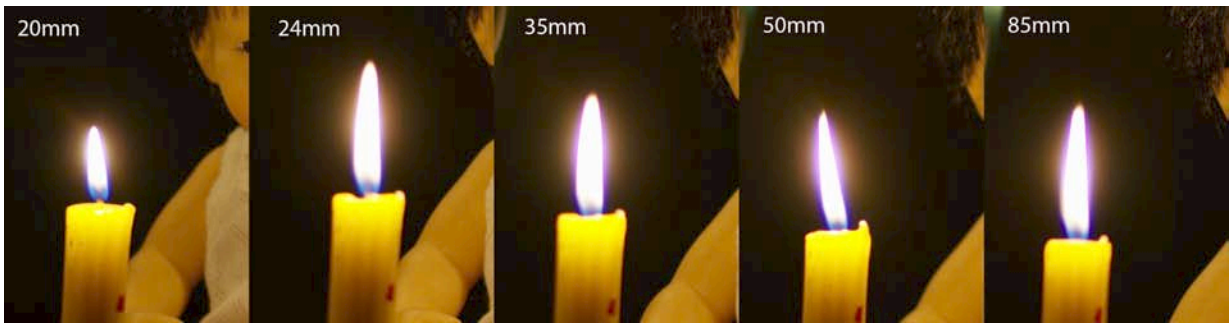
Although there are a lot of high lights in the background, we can see how blacks keep well contrasted, quite clean and nothing at all gray-like, above all on the ground. On the other hand, as we overexpose moderately the image background, whites keep pretty well over their outlines without spreading at internal reflections of the lens which make an extreme veiling and creates a “milky” look. It does not occur as we overexpose extremely the background, the effect in this case is likely creamy. When the exposure is kept within a certain range there is no problem with the highlights in relation to the sharpness and detail in the shadows.

50mm lens. T 16

50mm lens. T 1.5

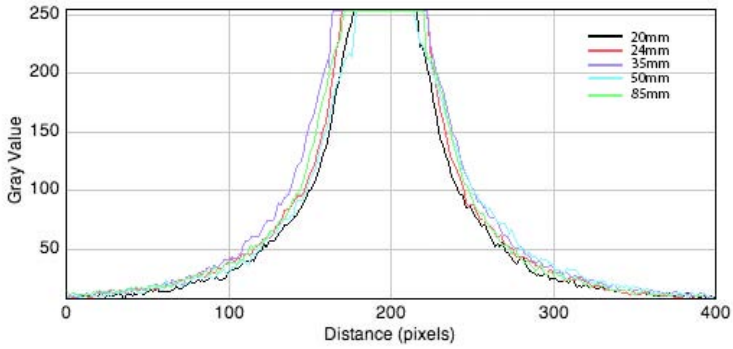
With regard to the flare, we show it through a lantern in direct light to the camera. We can see that flare is quite large, there are a lot of internal reflections and shining.

We can see the same in the cutting from the candles of the still-life.



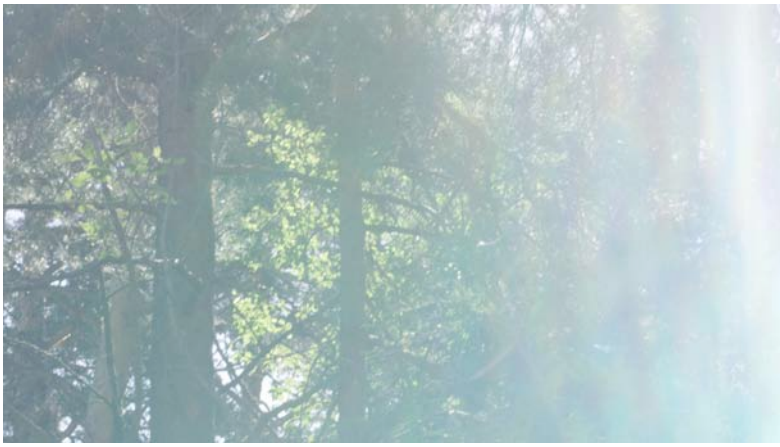
The candles flare is homogeneous through the lenses set as we can see on the right graph, we have measured the pixels bright from the black to the extreme white, as well as the tip of the flame and again the black.

Let us see some flare in outdoor locations.



We have the sun in the frame provided by the 35 mm lens; there is a cascade of reflections and glazes. We also used the 50 mm lens to the next shot, and then the sun is not in the frame but it is coming in from the side. We can also see large glazes and loss of black and detail. The look of the flare depends on the lens design, the glasses quality as well as their different coating. Some manufacturers offer a flare which makes hardly glaze and creates more or less sharp pearls; whereas to other ones a strong incident light creates more or less grey-like glazes and more or less soft aspects.

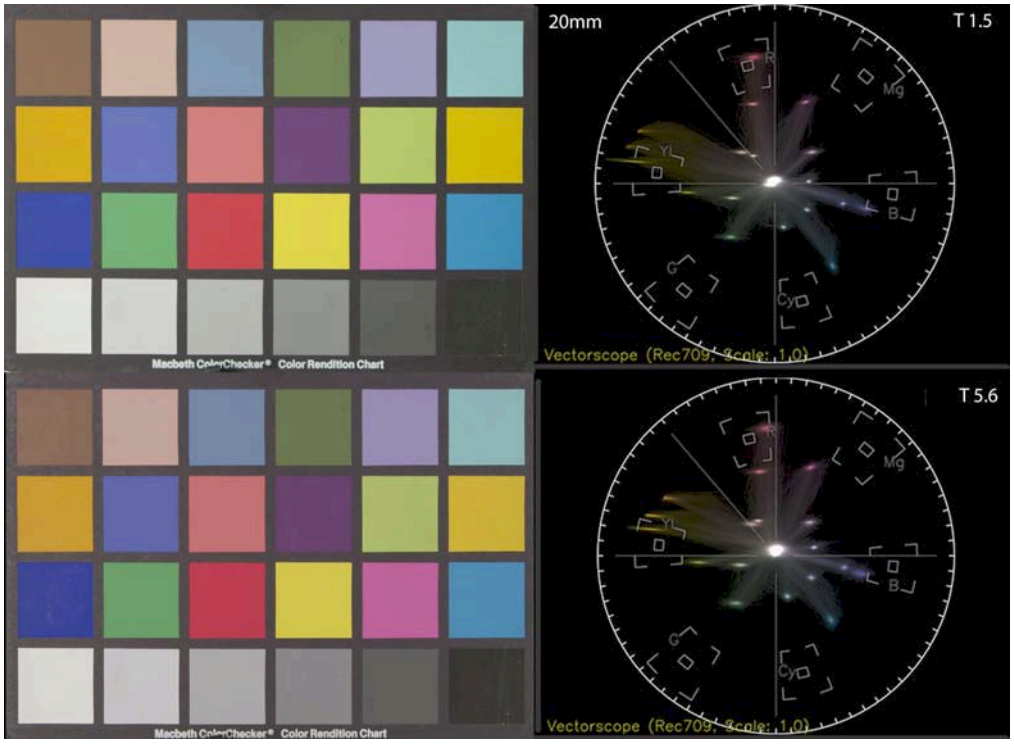
35mm lens (The red points are related to the camera sensor and they are typical of the RED, not coming from the lens)

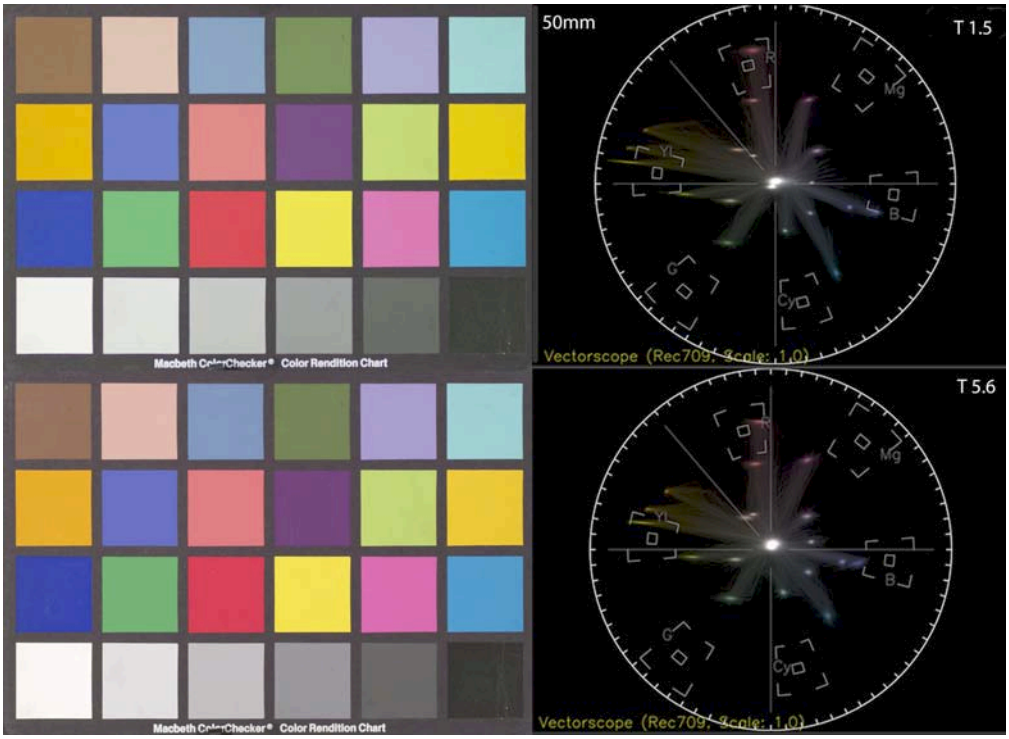


50mm lens

Color

We have studied the color response with a Macbeth chart as well as the observation of frame from outdoor locations. We have shot the Macbeth chart with every lens under the same circumstances, that is, the same lighting and parameters of "developing" when we have open the RAW. Our lighting devices were adjusted to 5600K (Led velvet panels) and 3200K (Tungsten). We have not seen any difference among the focal lengths at the same T values, although we have detected a slightly difference of color with the T 5.6 opposite to another wider aperture.





The whole lenses set show similar performance. The image is a bit more red-like at T 5.6, whereas is more yellow-like at T 1.5. As example, we can see the deviation of red in the vestorscope, into magenta at T 5.6, or we can see how yellow and orange are slightly warmer. It is clear that such deviations are difficult to appreciate in ordinary shots, beyond the charts, and so, it does not complicate our work. I especially like the skin tones because they look very natural in sense of color and texture.

Other issues

The lenses set seems to us robust, with the appropriate weight and usual size to this kind of lenses. We can use the same accessories, from hoods until the different focus selectors, without exchanging them because all of them keep the same diameters. Both the diaphragm and the focus move softly, with the adequate friction, neither very soft nor too much hard. The focus marks are adequate for the focal lengths. They are easy to handle, and the reflective numbers are adequate for the night shooting. In sum we can

state that they are equipped with everything needed to the professional work.

Conclusions

In order to evaluate the lenses set, as a DoP regarding only what the image means, there are two points to take into account; on the one hand from the technical point of view as we have we did throughout the article, on the other hand the subjective evaluation which is related to my professional taste as well as the lenses "personality". It should be pointed out that the Sigma lenses, with no doubt, the excellent price-performance ratio. The lenses make a good resolution at 4K, and consequently a significant sharpness, despite of showing relatively soft. Thus, as a whole, the images provided by the lenses are kind and natural, breaking with the extreme digital sharpness which we do not usually like. It is also worth to stress the lack of vignetting, showing an excellent geometric correction. With regard to the color the prime lenses set shows generally slightly red-like at intermediate T-values and a bit more yellow-like at wider aperture values. We can say that the lenses are subtly "warm", which favors the skin tones which looks quite natural regarding the "soft" definition what we already stated above. However, we have to consider two aspects of the lenses on the debit side. Firstly, the chromatic aberrations; in my opinion despite being Low/moderate they are visible to a lesser or greater degree regarding the enlargement of the image. Undoubtedly, we can hardly see them on TV screens or monitors, above all if we do not look for them. Secondly, the lenses breathing is more or less visible in the prime lenses. My personal evaluation, my perception, is that I like such soft, warm lenses, that are consistent regarding their performance.


Yoshida Hiroshi. Fuji Mountain

If I had to define the lenses personality I would say that they remind me the texture and feelings of the Japanese Shin-hanga art movement, which was under influence of the European impressionism, characterized by its soft colors in naturalistic ambience of light.

With no doubt, it is a superb investment to the high/medium professional market because we can obtain high quality images at relative low cost.

As final the evaluation, I propose the next table:

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

Video test: https://vimeo.com/237289497

Closing credits

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

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CATTS CAMERA

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ESCUELA INTERNACIONAL DE CINE Y TV · SAN ANTONIO DE LOS BAÑOS - CUBA

laOlimpo

CCD CENTRO DE CINEMATOGRAFIA DIGITAL

HoboS