EVALUATION AND CINEMATOGRAPHY STUDY OF THE FUJIFILM X-H2S CAMERA

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In this article we are going to study the FujiFilm X-H2S camera in its video option. The tests have been carried out recording in ProRes 422 HQ 10 bits at 23.98 Fps with a shutter of 1/60 sec and different ISO values considering the FLog2 curve with an IE recommended by the manufacturer of 1250 with a 4k DCI resolution (4096 x 2160) and no in-camera noise reduction. As for the lenses we have used the MK 18-55mm and 50-135mm zoom with Fuji X mount.

The analysis of the different tests has been carried out with programs such as Imatest, ImageJ or color inspector. We have used different light sources adjusted by the Sekonic C700 spectrometer and the Sekonic L-558/cine photometer. Likewise, the detailed observation of the material has been carried out in the color room using Davinci resolve.

In addition to the more theoretical study, we have shot a short film entitled *Reencuentro* in Río Cedro, Colombia with photography by Adriana Bernal ADFC and direction by Cecilia Vásquez and Adriana Bernal. In this article, frames extracted from the originals are included, so they are mere references as they are compressed.

Resolution

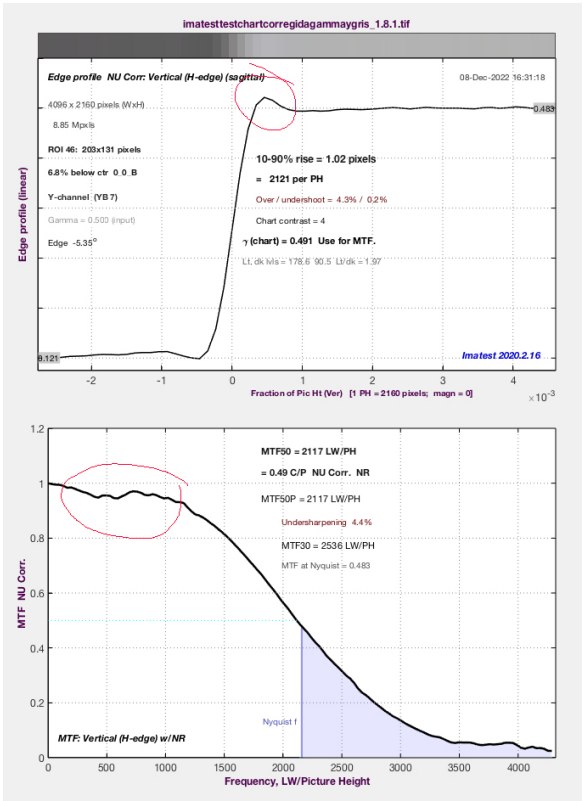


Figure 1Curva MTF en el centro de la imagen.

We must remember once again that we must not associate format with resolution; As much as the size of the format, and thus the number of pixels, influence the resolution, they are not the resolution itself. The resolution of our image will depend on the sensor, the electronic signal processing, the recording system, the lens, the viewing system, and of course, the distance at which we see the image. For all these reasons, images with the same formats may have different resolution/sharpness, measured in TV Lines, lp/mm, cyc/pixel or any other common unit. Therefore, the measurements that we put here are with the aforementioned camera and lens configuration.

The camera works from an S35mm sensor and the resolution has been measured with specific resolution cards and evaluated by Imatest. The extraction of the frames for their analysis was done both in scene reference mode, with the Davinci YRGB color science and applying the Fuji XH2S_FLog2_FGamut_to_WDR_BT.709_33grid_V.0.90.cube lut. as in the ACES environment with an IDT 2020 and an ODT 709.

The MTF curve that we show in *figure 1* comes from the recording in ProRes 422 HQ 10 bits with a resolution of 4096 x 2160. The value at 50% is 2117 LW/PH, at picture center, a high value for this resolution that suggests a slight increase in contrast created by the camera itself. This resolution will allow us to have good sharpness in the image with sufficient texture. If we consider the 30% MTF value more suitable for viewing on televisions, the sharpness rises to 2536 LW/PH.
We have observed, however, that aliasing occurs on some frequency lines on the chart around 1873 LW/PH.

However, in general, the sharpness of the image is quite high, appreciating the texture very well as can be seen in the Prêt-à-porter card (*figure 2*) using the edge detector.

Figure 2 *Original test chart* *Edge detection*

In the following image you can better appreciate the sharpness in a detail of the chart (figure 3).

Figure 3 *Original test chart* *Edge detection*

We have compared the resolution of the file in ProRes with the H265 (figure 4) and we see that with the first one there is a little more texture although in the low frequency area where we perceive the sharpness the most are the same and in fact in the inspection visual of the rainbow card, we have not found any difference. Yes, there is in color, especially in oranges and yellows. In general, with ProRes the image is more organic and natural than with H265, which gives a *rougher* impression (figure 5).

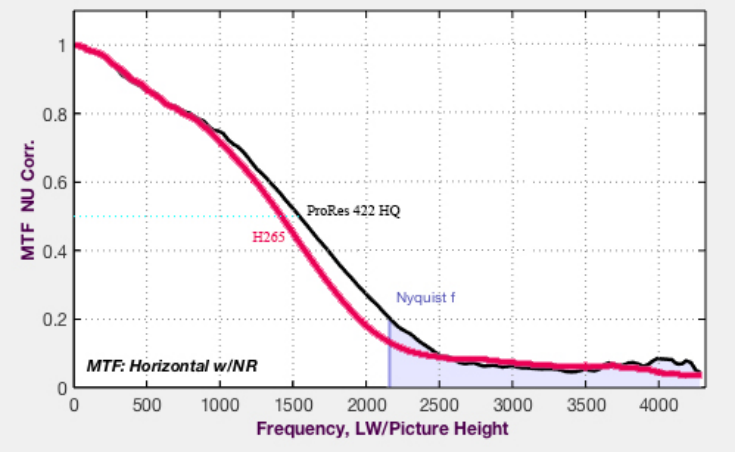


Figure 4. MTF comparison ProRes 422HQ versus H265

Figure 5 ProRes 422HQ

H265

During the shooting of the short film, we were able to verify the good resolution of the camera in shots like this one, where a lot of fine detail has to be defined (figure 6 and 7).

Figure 6. Original Flog2 23.98 1/60 5.500ºK.IE1250.Polarizing

Edge detection

Figure 7. Original Flog2 23.98 1/60 5.500ºK.IE1250. Polarizing

Edge detection

Dynamic range

For the evaluation of the dynamic range, we have started by shooting a scale of densities from white to black and representing 13.4 Stop (Stouffer Strip). We have analyzed this strip with the two gamma curves Flog and Flog2 (figure 9) without noise reduction. The new Flog2 curve places the value of gray 18% at a value of CV400, white of 90% at 570 and black reflectance 0 at 95 (values in 10 bits). White clipping occurs at 872 hp. The curve establishes a base EI of 1250 ISO. In the graph you can see the difference of the two curves (figure 8).

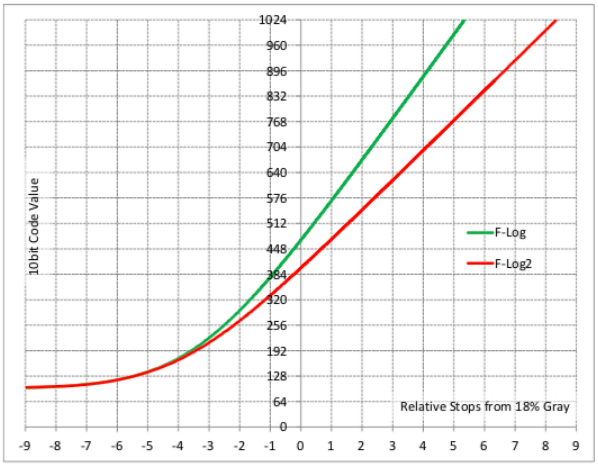


Figure 8

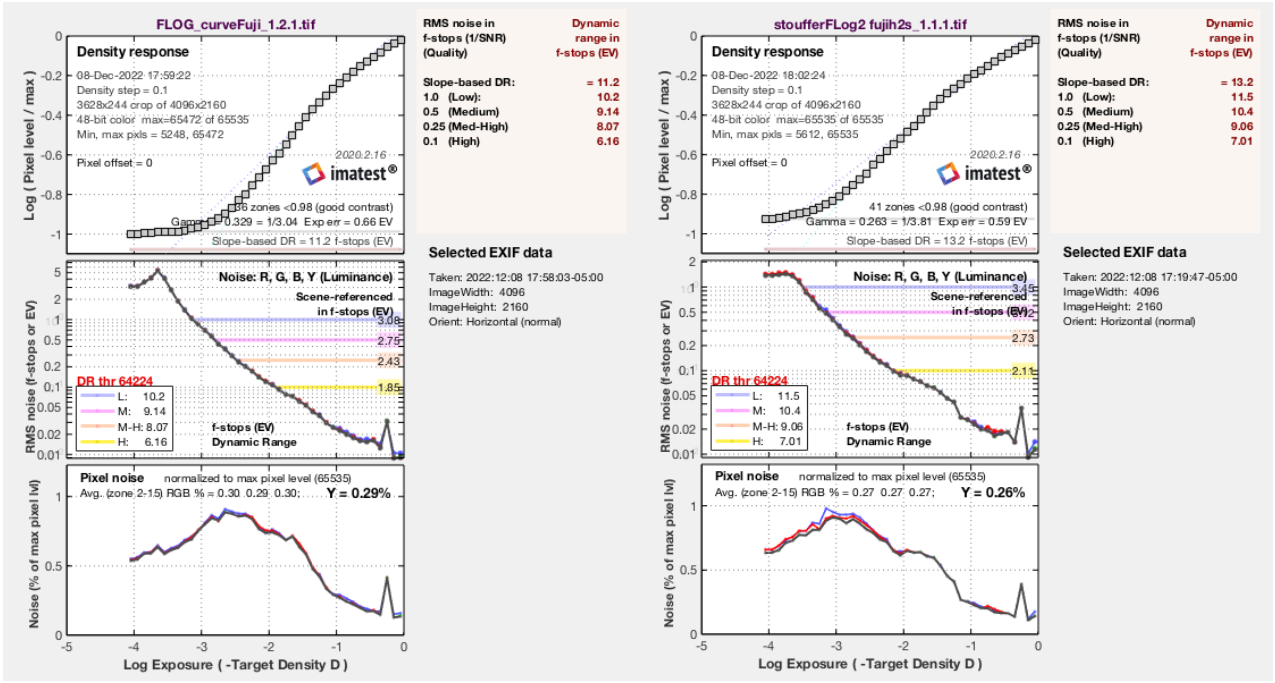


Figure 9

With the Flog curve we have a total dynamic range of 11.2 stops, while with the new Flog2 curve we have a total of 13.2 stops. If we consider a certain level of noise (Medium) the value with the Flog is 9.14, while with the Flog2 is 10.4, this is 1.3 stops more range (*figure 9*). With these results we have used from now the Flog2 curve for the rest of the tests.

To determine the effective dynamic range, that is, the one that we can consider taking into account the noise level and the disappearance of the texture both in the highlights and in the shadows, we have made a series of exposures with the death card (CDM). In *figure 10* we show the original camera image with the corrected one, both overexposing and underexposing. The correction has been made trying to match the middle gray, highlights and shadows of each exposure to the base exposure.

From the observation of the loss of detail in the high lights, we see that we can recover the texture up to 5 1/3 stops, above this the image is cut losing all information, in addition said cut has a slightly yellowish tint, indicative of that not all channels are clipping at the same time. In *figure 12* we can see in more detail the texture limits with an overexposure of +3 and +4. The value of the white fabrics is 2 1/3 stops above the 18% gray card (*figure* 11). With +3 these fabrics are then at +5 1/3, with +4 they would already be at +6 1/3 and some of them already appear trimmed (PB 5 and 6), although not all of them. We can approximate through this test that the effective dynamic range above the middle gray would be about 5 1/3, if we want to make sure that we have all the texture of the whites, I would place it around 5 stops. In *figure 12* we can see this in detail using the edge detector. In samples PB 4, 5 and 6, the loss of texture is noticeable with +4 overexposure.

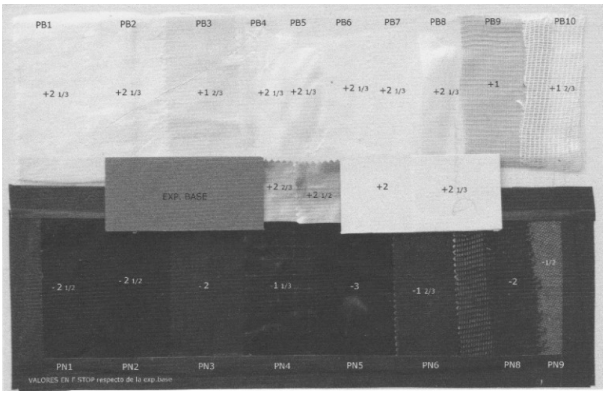


Figure 11. *Reflectance values with respect to gray 18%*

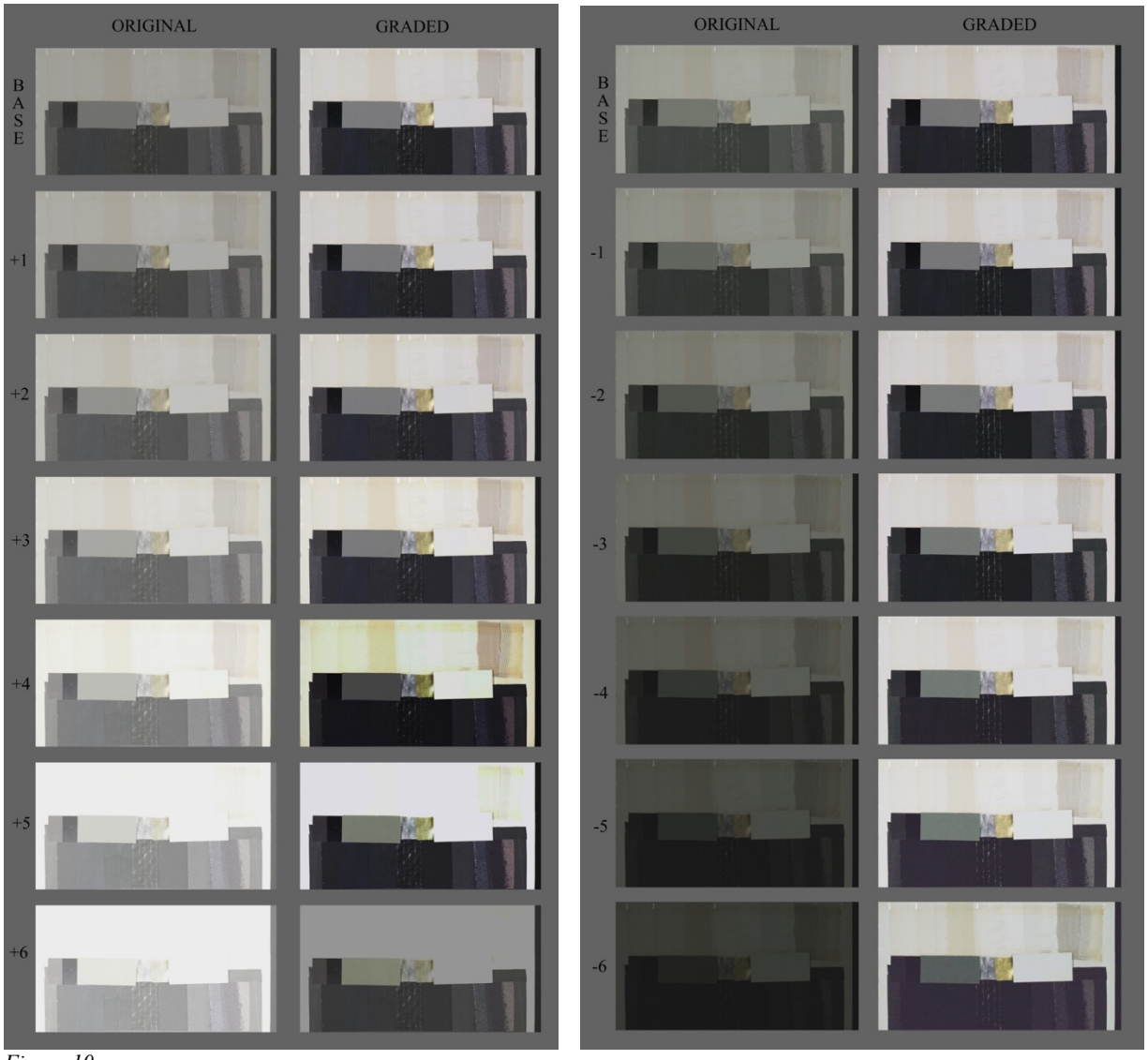


Figure 10

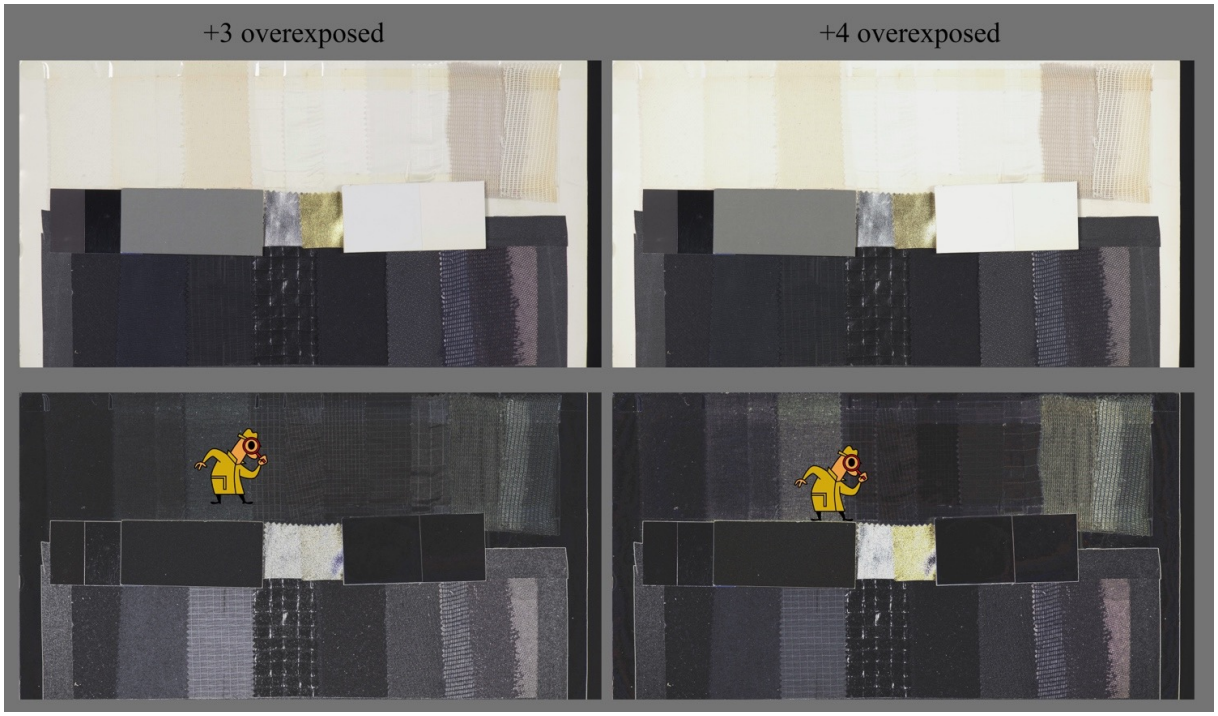


Figure 12

Let us now observe the shadows (*figure 13*).

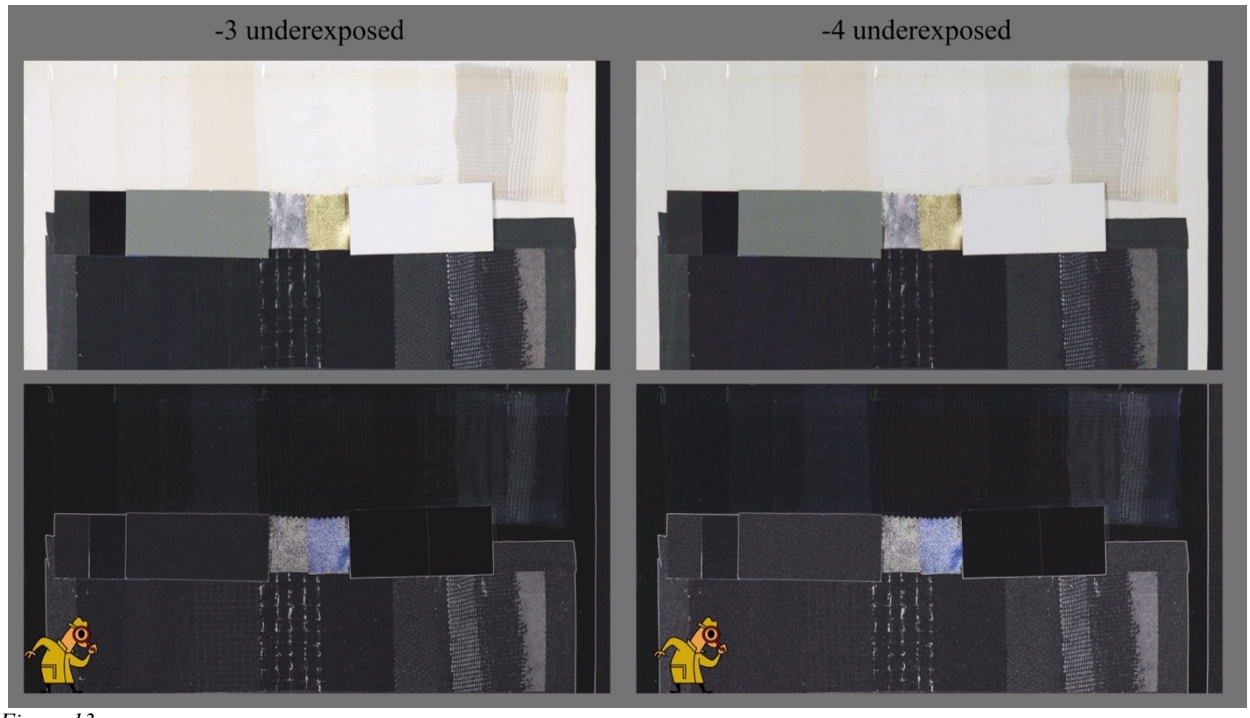


Figure 13

The noise level masks the texture of the blacks towards -4, that is, when PN 1 and 2 are at 6 ½. With a value of minus -3 (PN 5 ½ below gray) the texture of the samples can be distinguished, although noise is still visible. At -2 (PN 4 ½ below gray) the textures appear well defined and without significant noise. With this we can establish that the effective dynamic range below the middle gray is at 4 ½ stops.

From the study of this chart, we can conclude that the effective range is around 10 stops, 5 1/3 above and 4 ½ below, considering that in the shadows the camera continues to see differences in brightness up to 6 stops. This evaluation coincides with the Medium value (0.5 stop) of the Imatest analysis. We can thus represent the range in the FLog2 curve (*figure 14*).

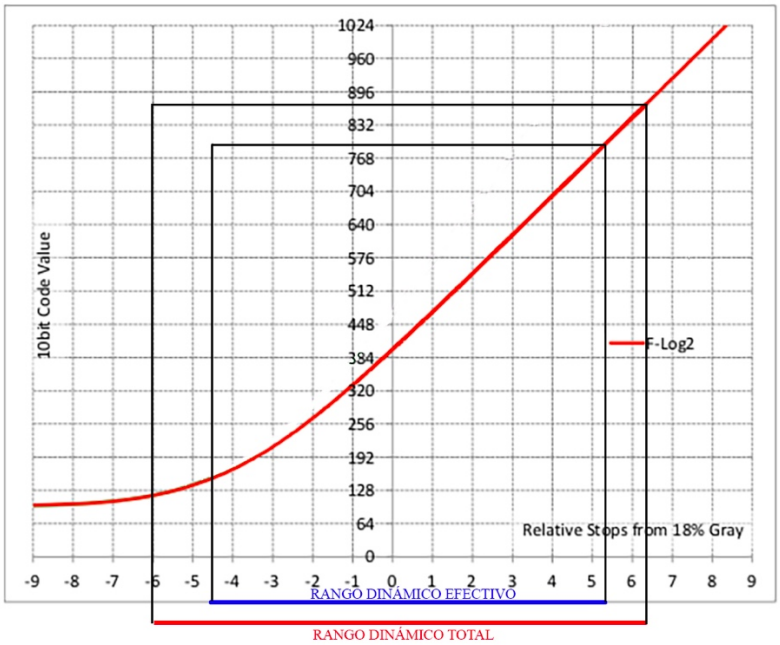


Figure 14

Let's look at some shots below to see where the luminance values fall in the dynamic range we have established. For this, and although it is not exactly like that, we have averaged the RGB values of the image to make the visualization easier.

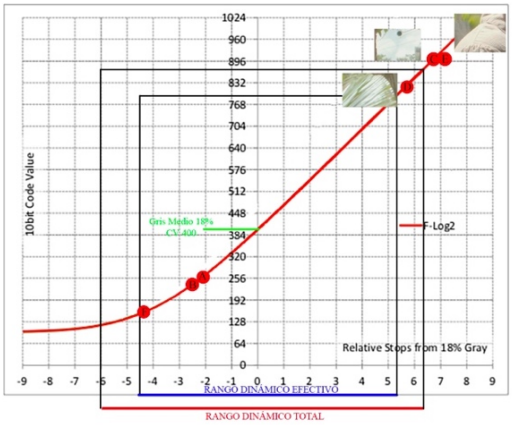
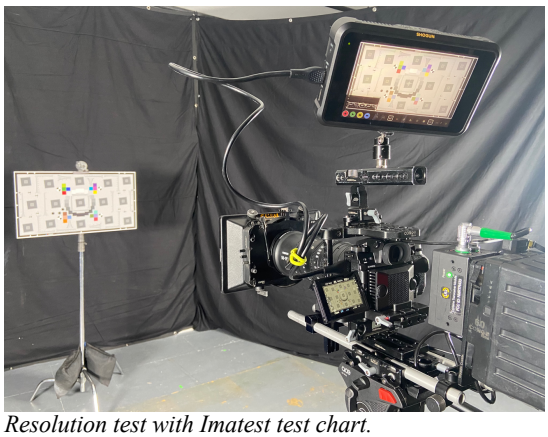


Figure 15

This shot (*Figure 15*) shows an extreme contrast ratio, on the one hand, the skin tone of the actress in the face that is located 2 stops below the medium gray, and there it shows all the texture, the arm falls somewhat more than 4 stops and effectively there is still the texture of the skin, without any deterioration by noise. At the top of the curve, we have slightly cropped clouds, leaf undersides, and her shoulder in the light shirt that are out of the camera's effective dynamic range. In all these areas we have lost detail that we cannot recover, although the roll off is quite smooth and in general the image is not conditioned by those clipping.

In *figure 16* we show the original image and its correction.



Resolution test with Imatest test chart.

Figure 16 *Original Flog2* *Graded ACES CCT AP1 IDT2020 ODT709*

In this other shot (*figure 17*) we see that the highest brightness is the flashlight that is within the range and where we can effectively see the texture of the light. The darkest part shows a lot of noise level, but still some color cast. Indira's skin tone is between -3 and -4, still preserving the texture with a noise that does not disturb.

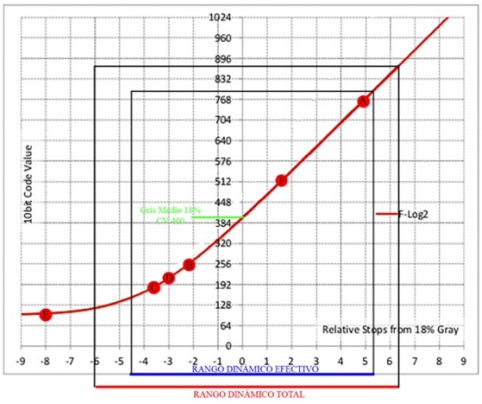


Figure 17

In *figure 18*, we show the original image in Flog2 and the color correction.

Figure 18 *Original Flog2* *Graded ACES CCT AP1 IDT2020 ODT709*

Let's check out dynamic range again, but now with its effect on skin tones and color. For them we have created another exposition strip with two models and a color chart. We show only the frames corrected with respect to the original Flog2, matching the different exposures to the base frame as best as possible, respecting the neutral gray value (*figure 19*).

Camera X-H2S. Rio Cedro. Colombia

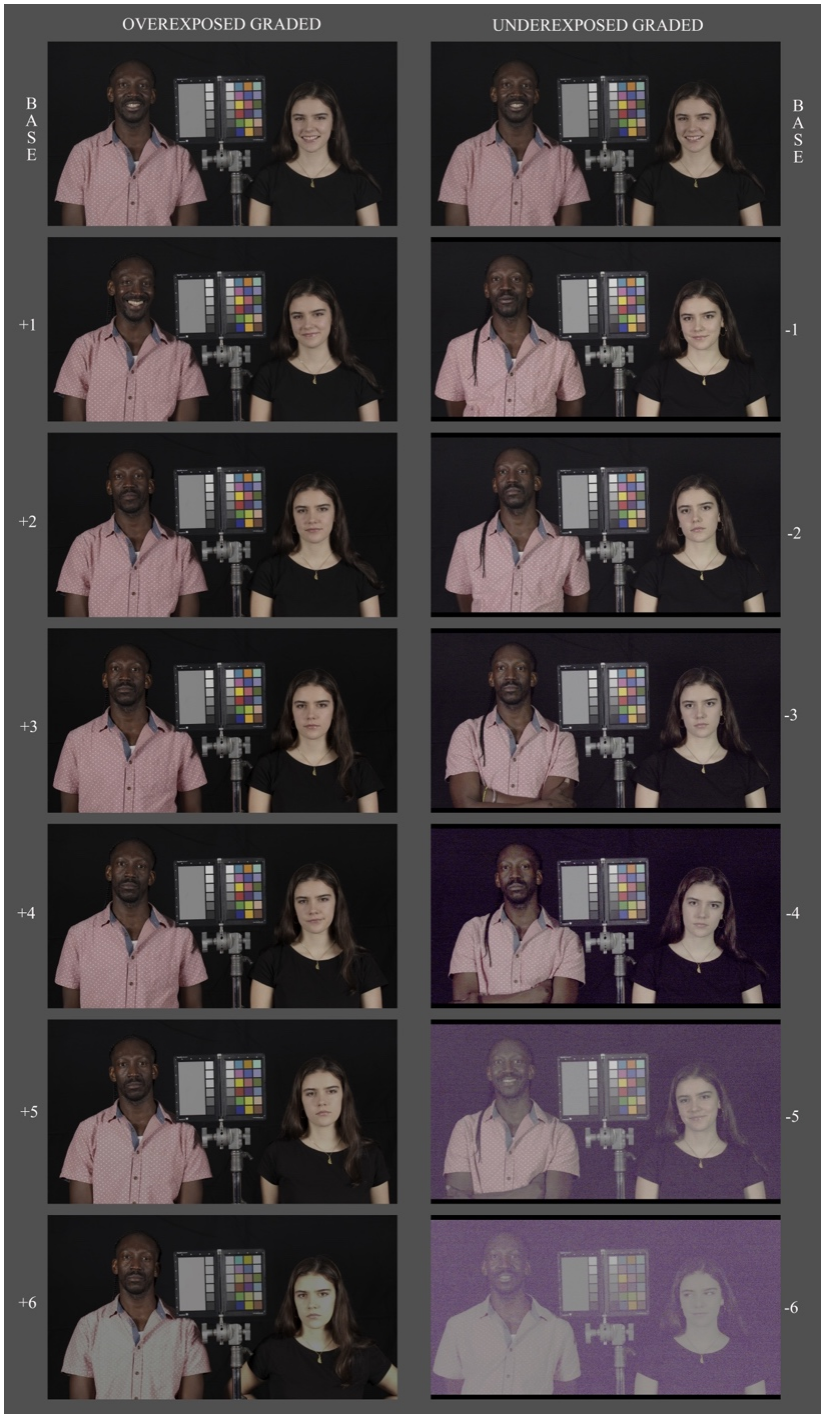


Figure 19

In overexposures, with +5 the white skin tone still maintains the texture, although it appears slightly flat, the skin is at 5 1/2, with a value of +6 (the face then at 6 1/2) it already appears completely cropped and with a yellowish dominant (*figure 20 and 21*). Up to +5 overexposure when correcting the exposure, the value of the middle gray and also of black and white is well maintained without appreciable color deviations, however, the lighter skin tone already acquires a slight green/yellowish tint that does not is at +4. When going to +6 the gray is unbalanced and the blue channel cuts before the red and green, the skin tone there is completely green / yellow.

In the underexposures (*figures 22* and *23*) correcting to maintain the middle gray, a slight deviation towards magenta is observed in the darkest shadows, especially from -4. We have Leo's skin texture without problems up to -2 (his skin is then at -3 1/3) With values of -3 and -4 we can still distinguish the very dark skin tone of our model, although the Noise masks it enough.

Figure 20

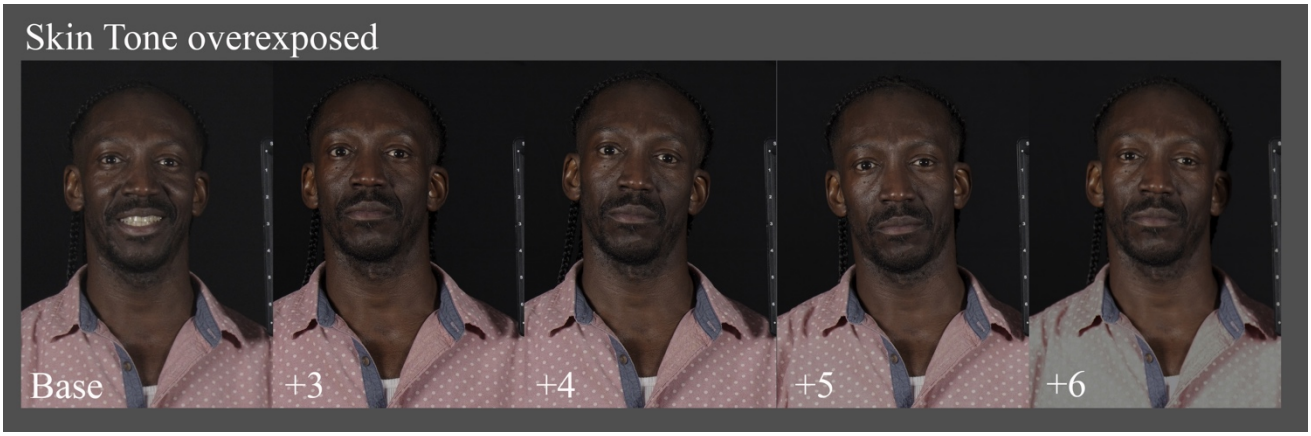


Figure 21

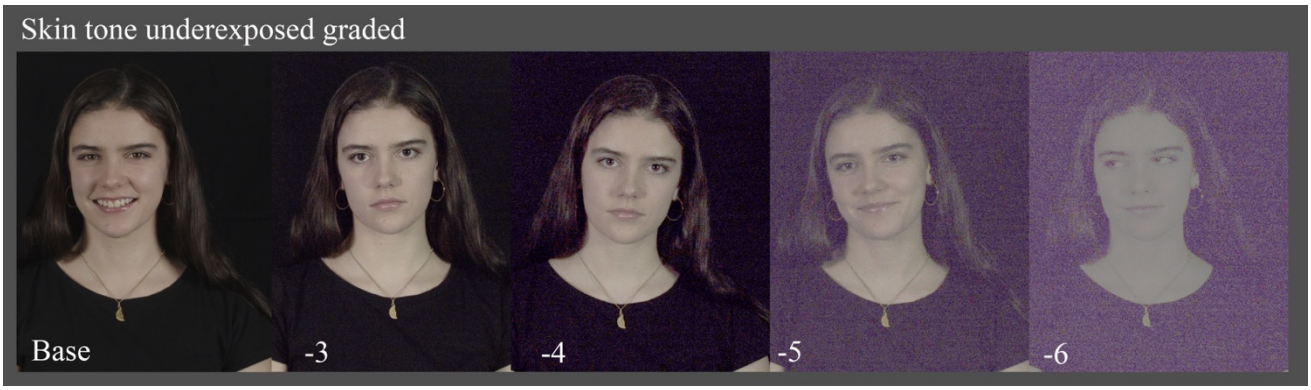


Figure 22

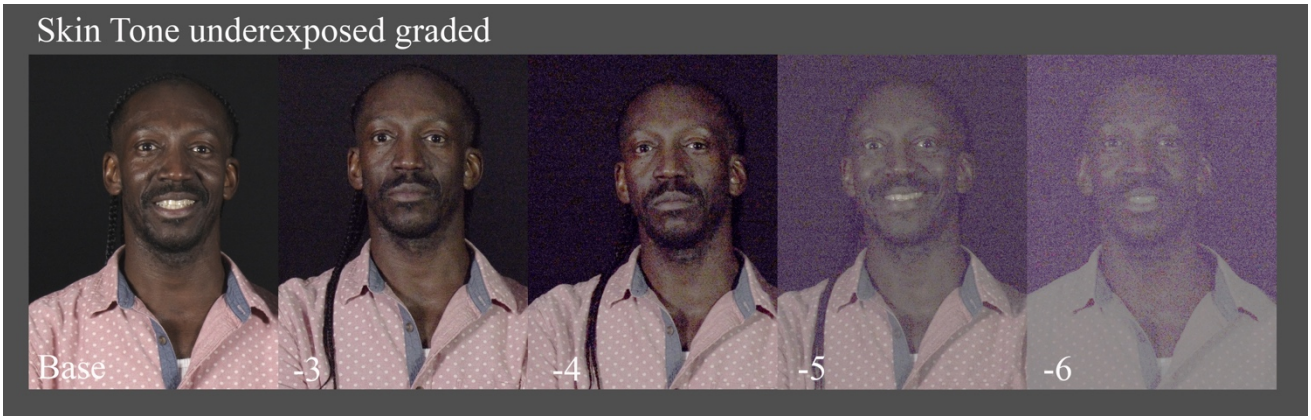


Figure 23

Again, with these observations we can conclude that the effective range that the camera manages is about 10 stops, 5 1/3 above and about 4 ½ below, although the camera continues to see differences in

brightness up to 6 ½ above and the -7 below allowing to have a smooth roll of in the highlights and deep blacks. For my work and for the exposure, I prefer to consider 5 stops above and 4 below, with this I guarantee all the texture and detail in both highlights and shadows. This is a more than adequate dynamic range for a camera of these features.

Noise

One of the aspects that we study is noise, insofar as it affects the quality of the image and in what it has to do with the dynamic range, sharpness and color. The first test we have carried out has been to evaluate the base noise of the camera; for this we have recorded clips in black at different ISO values that we have then corrected in DaVinci to see its structure (*figure 24*).

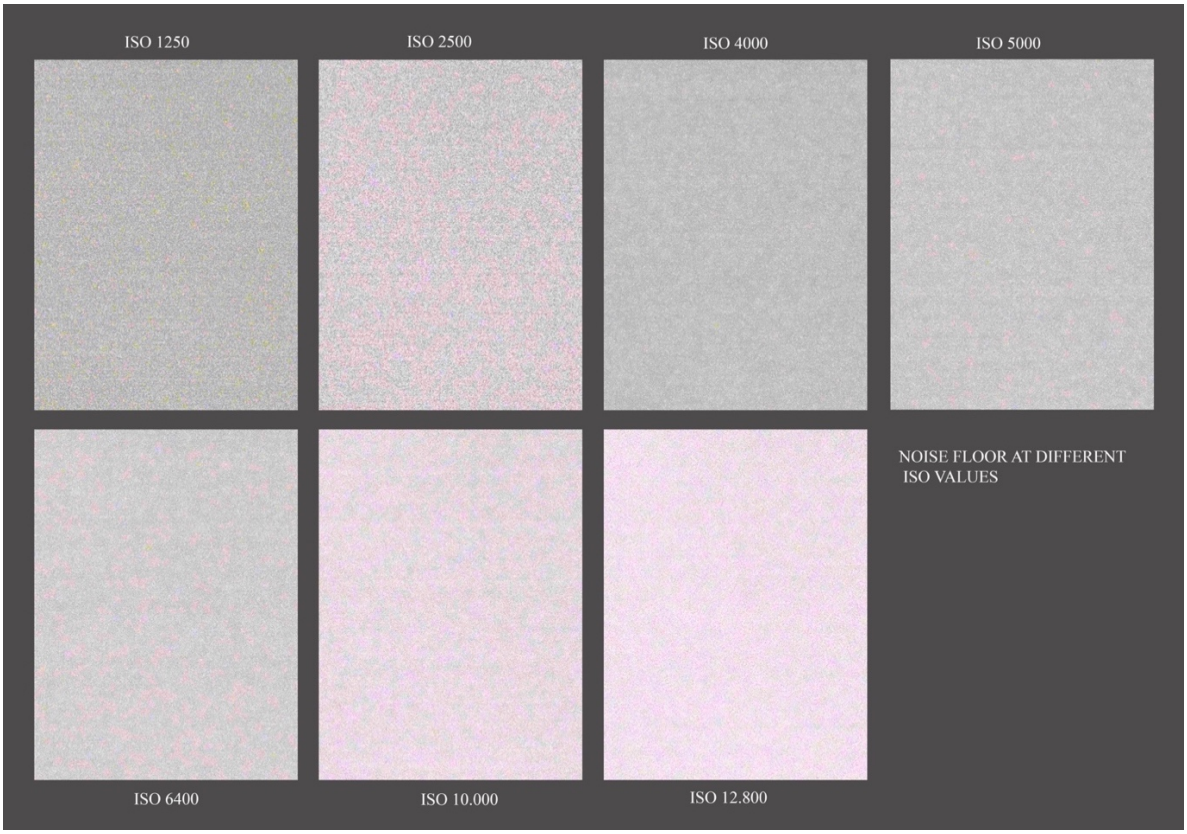


Figure 24

We observe that the "color" of the noise is not only not equal to different ISO values, but in some cases, it is greater at a lower ISO compared to a higher one, for example, at 2500 ISO the noise is magenta and greater than at 4000 ISO. At maximum values the noise is completely colored towards magenta. This behavior seems somewhat irregular to us and we will see later how it influences the image. To further clarify the noise level, we have analyzed the gray scale of the Macbeth card with Imatest, here we show the results:

VALORES ISO	R	G	B	Y
1250	0,68	0,59	0,64	0,56
2500	0,99	0,84	0,94	0,82
4000	0,91	0,78	0,89	0,75
5000	1,01	0,85	0,96	0,82
6400	1,2	1,01	1,08	0,99
10000	1,38	1,2	1,27	1,17
12800	1,58	1,39	1,46	1,37

Average noise value between sample 2 and 5 in RGB and Y

VALORES ISO	R	G	B	Y
1250	0,78	0,65	0,7	0,61
2500	1,17	0,92	1,02	0,89
4000	1,09	0,88	1,02	0,84
5000	1,23	0,95	1,09	0,9
6400	1,41	1,12	1,19	1,08
10000	1,65	1,34	1,41	1,3
12800	1,84	1,54	1,62	1,52

Noise value in the middle gray (chart sample 4) in RGB and Y

These values represent a % of the total CV values of the image and we can consider them moderate. In figures 25 and 26 we show the comparison at different ISO values of the noise % obtained in the analysis of the Macbeth chart. We can see how there is more noise at 2,500 ISO than at 4,000.

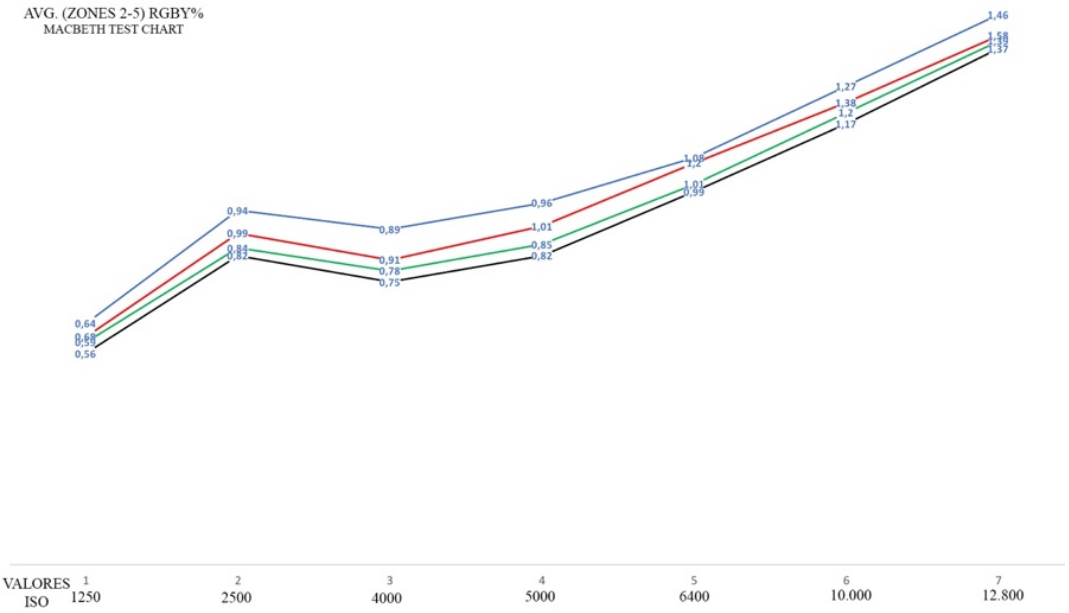


Figure 25

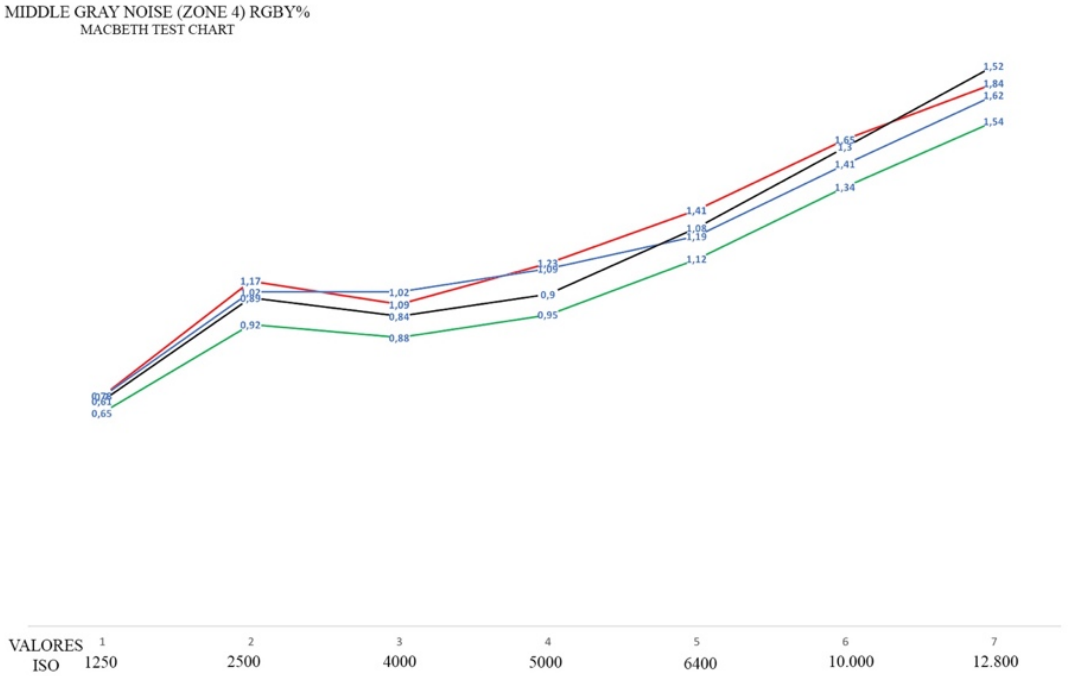


Figure 26

The noise in the average value of the samples from 2 to 5, the blue channel is the one that shows the highest level of noise in all the ISO values, however, in the middle gray (sample 4 only) from 5000 ISO the highest noise is displayed by the red channel.

In general, noise values above 1% are already visible in the image and 1% or less are minus relevant.

In *figure 27* you can see a clipping of the CDM in the black samples passed through the edge detector and there we can see how the image is losing sharpness as we vary the ISO value.

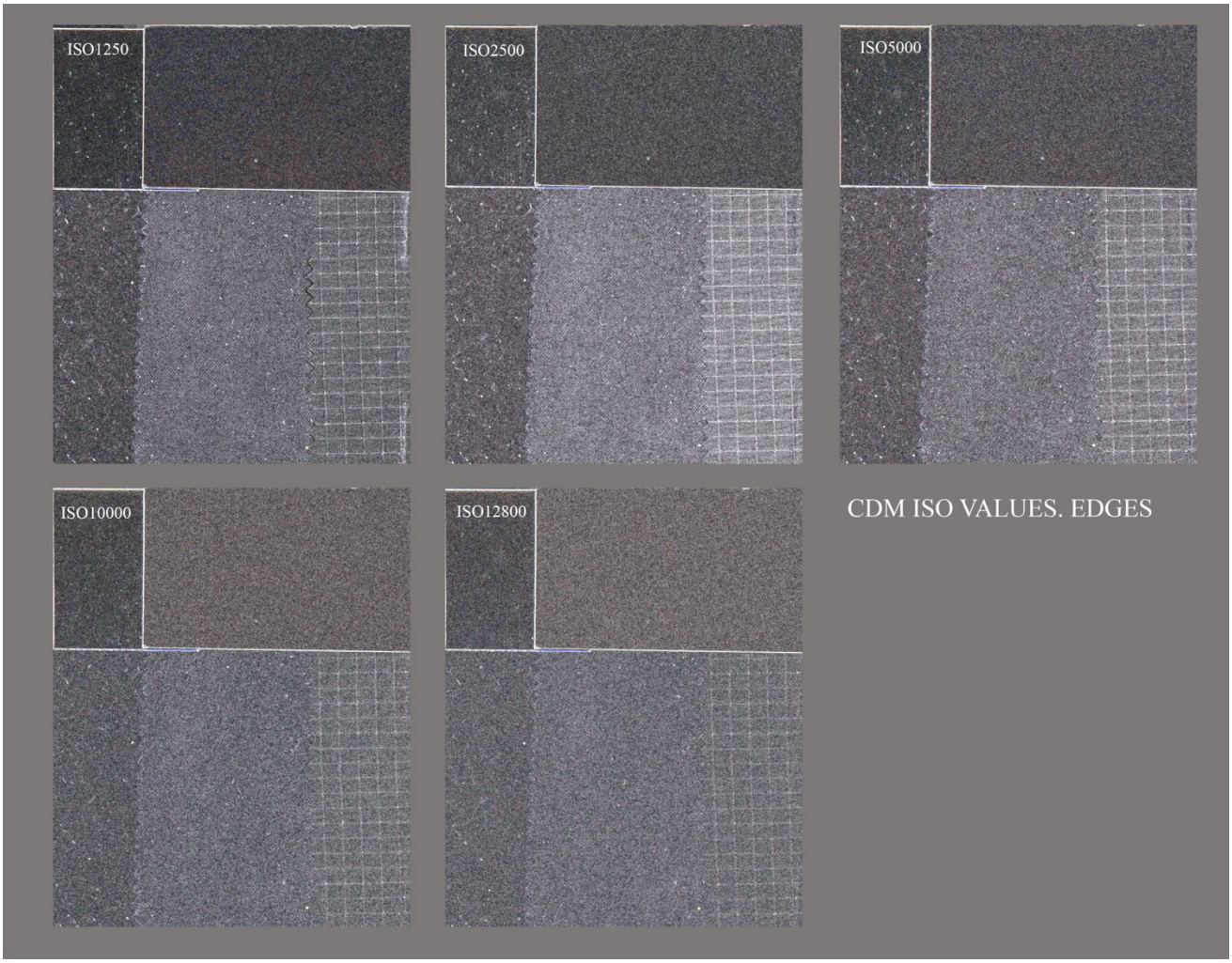


Figure 27

Although with high values the texture is altered by the noise, it seems that the behavior in general is sufficient to be able to work with high ISO values, especially around 4000 where the behavior of the noise seems very efficient in relation to the general sharpness of the image.
In *figure 28* we can compare the still life at different ISO values, if we enlarge the image, we can see the noise texture and how it affects the different areas of the frame, for example, the flowers in the vase or the cosmetic paints in the case (*Figure 29*), where we see the original at three ISO values and those same values raised to see the noise. In this crop we can verify that for the shooting it is always better to shoot with the necessary ISO value and not to do it with lower ISO values thinking that we will be able to raise it in post-production.

Alfonso Parra AEC, ADFC measuring in the still life

Figure 28

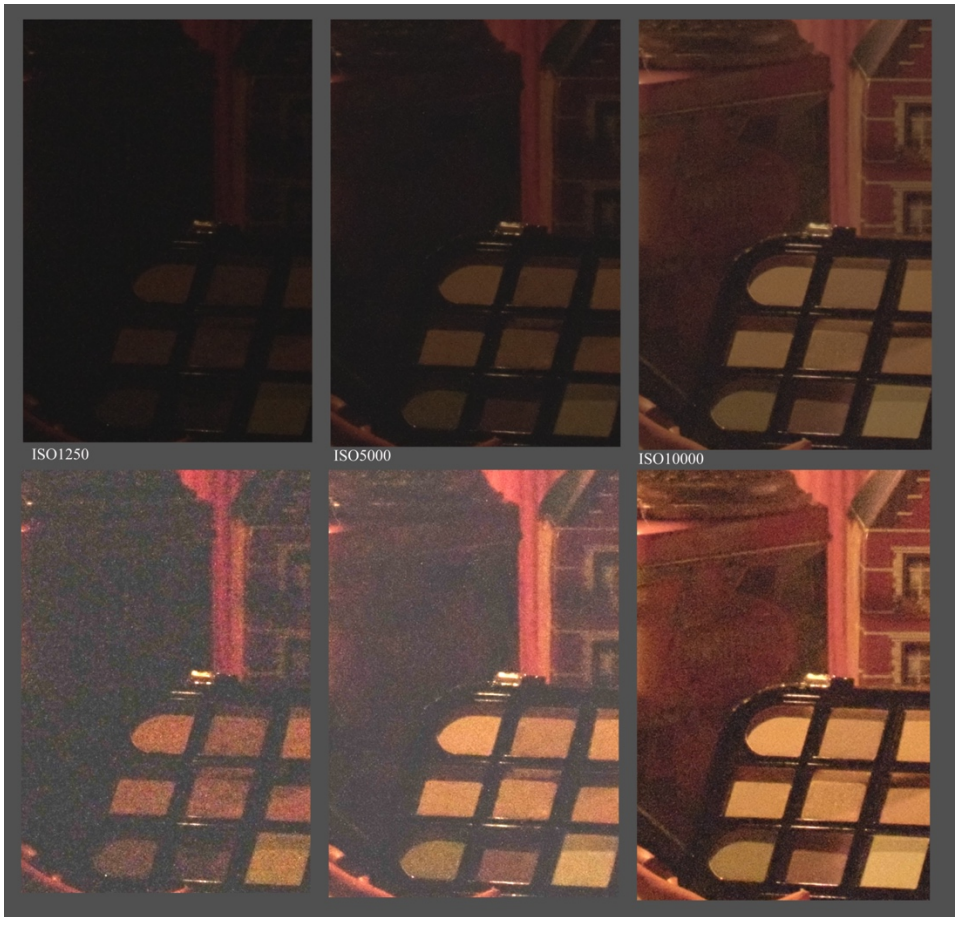


Figure 29

Although high ISO values maintain good sharpness even in the most problematic channel, which is blue, especially when the still life is illuminated by a very warm color temperature (*figure 30*), the noise movement becomes very noticeable at higher values above 4000 or in areas of the image that are underexposed beyond 4 stops.

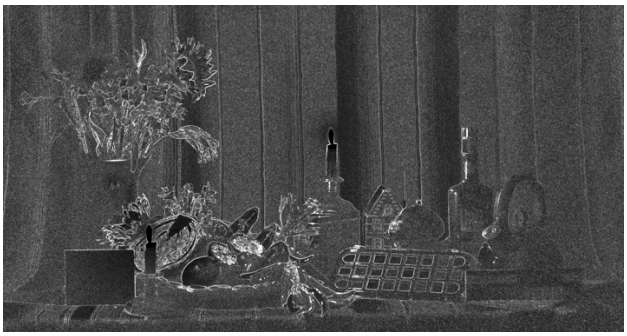


Figure 30 *Blue channel ISO 6400* Blue Channel Edge Detector *ISO 6400*

As with the dynamic range, we have carried out the test of observing the skin tones with different ISO values (*figure 31*).

Figure 31

We have extracted the blue channel at four ISO values from the original material and processed it by the edge detector (*Figure 32*). On the black background you can see the noise as well as the compression.

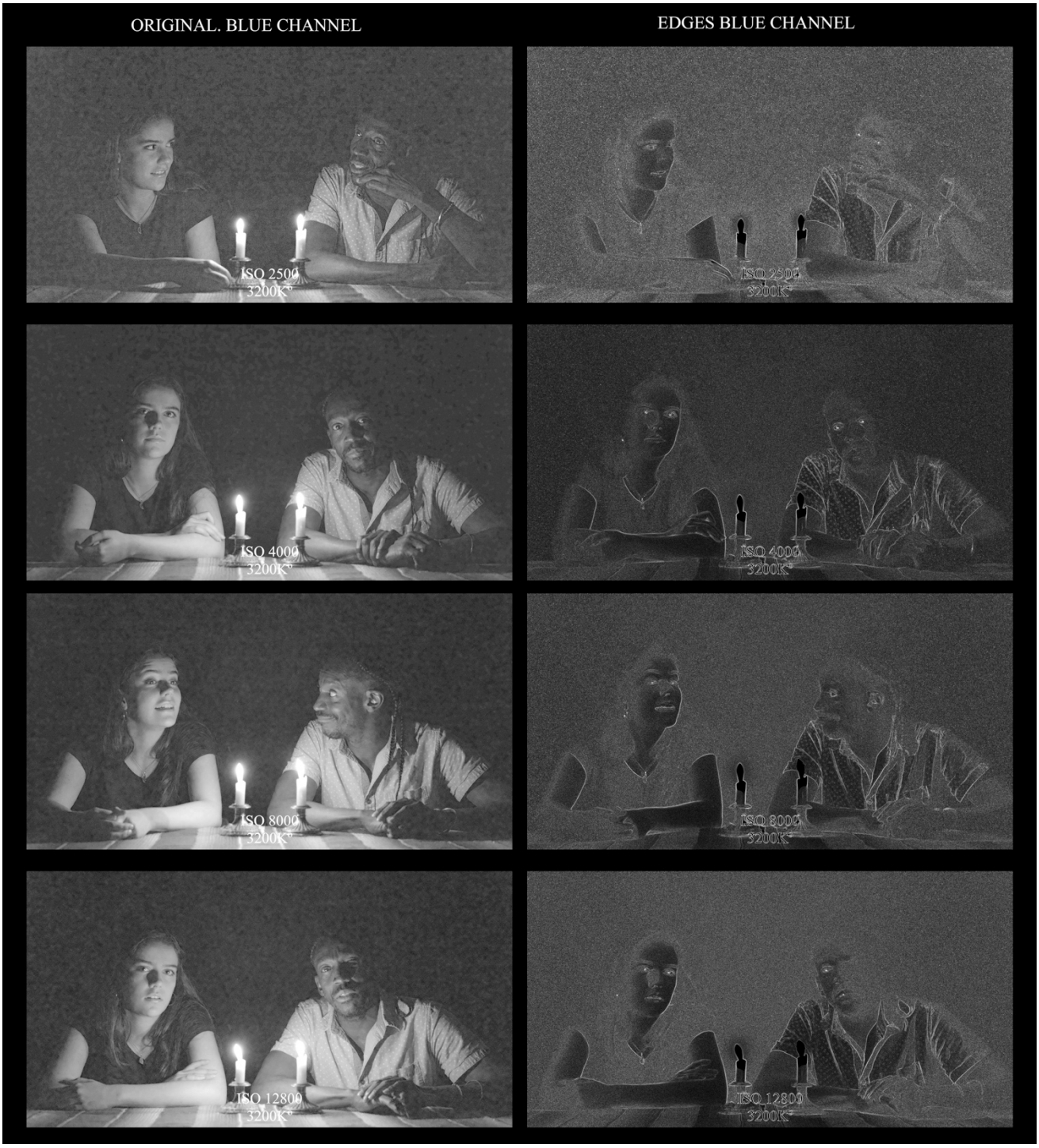


Figure 32

And in *figure 33* a cut of the center of the image comparing the background black noise of the blue channel image passed by the edge detector. We have contrasted it to better see the noise texture, which would seem typical of salt and pepper.

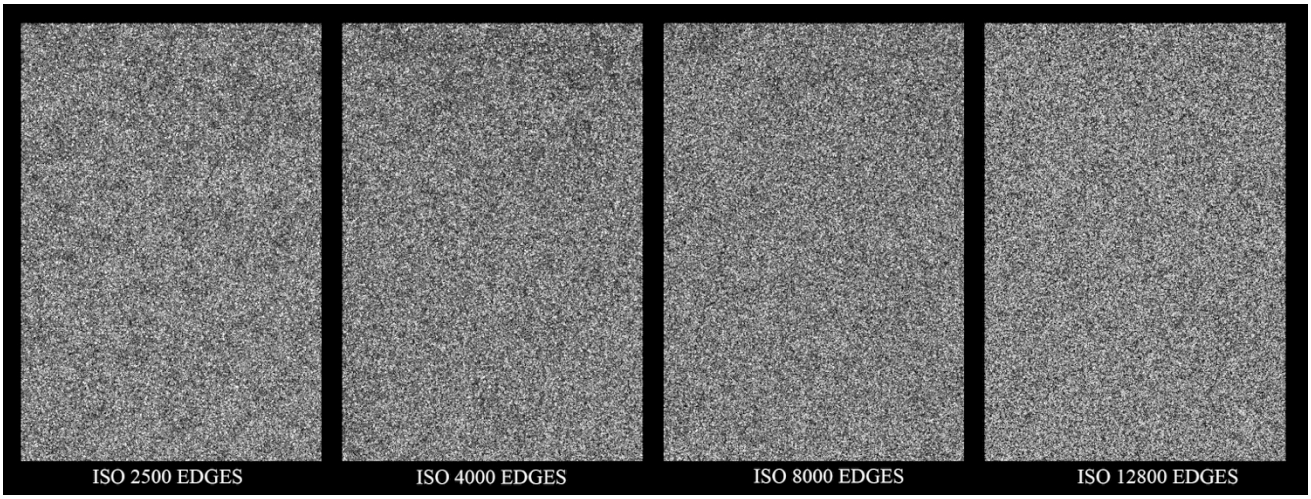


Figure 33

In this frame (*Figure 34*) we can already observe the noise behavior in a real shooting situation.


Figure 34 Flog2 23.98 1/60 3.200ºK. IE 8000. Watch video

We have observed the noise in the area on the right of the frame, in the foliage, which is on average about 5 stops below the middle gray, and there we can observe quite a lot of noise at an ISO value of 8000 (*Figure 35 and 36*). In this particular plane we have used a noise reducer to minimize its visibility with very good results.

Reencuentro. DOP Adriana Bernal ADFC

Figure 35 Blue Channel

Figure 36 Green Channel

We can see an area enlarged to compare both channels (*figure 37*)

Shooting the short film Reencuentro

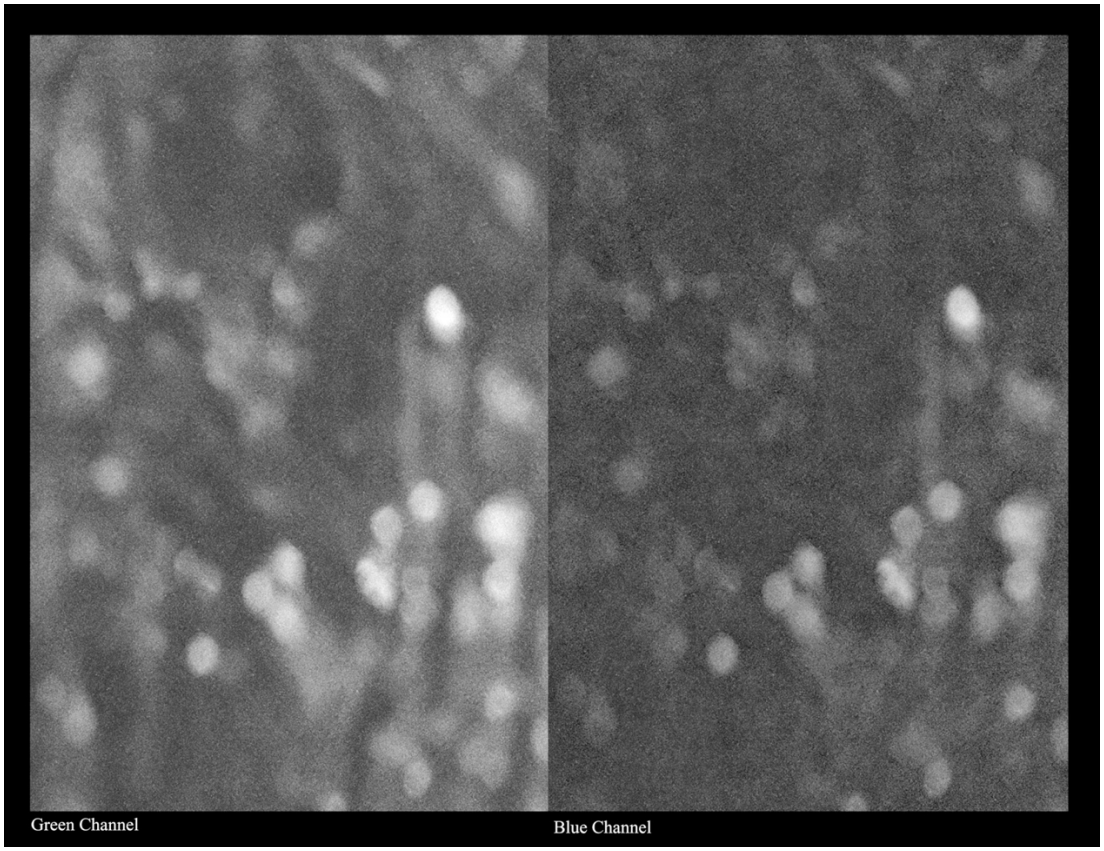


Figure 37

From all these tests and the viewing of the moving images we conclude that the noise has a somewhat irregular behavior in relation to the sensitivity values and that the effective ISO range would be, with this gamma curve between 1250 and 4000, avoiding working at 2500 and being able in certain cases and knowing the level of noise generated, to work up to 8000 considering the possibility of a noise reducer in post-production.

In the appreciation of noise, a subjective aspect also intervenes and has to do with the tolerance that each one has for its appearance; in my case I prefer the cleanest possible images and my noise tolerance margins are not very high.

Color

In the evaluation of color, we have considered different aspects, first a more theoretical analysis of how colors behave in conventional spaces; For this we have analyzed the Macbeth card recording in Flog2 and converting the image using Fuji Lut XH2S_FLog2_FGamut_to_WDR_BT.709_33grid_ V.0.90.cube. (*Figure 39*). The square of the graph represents the ideal or standard tone of the chart pattern in space 709 and the point is the value read from the recorded image, as we can see the difference is not very large and in any case what it tells us it's how the camera and its post processing sees colors, so for example yellow is slightly more saturated than standard and a bit more greenish, sample 13 is however less saturated than standard and slightly more cyan, skin tones 5 and 6 are equal to the reference value. The average of ΔC *(ΔC is the difference in chroma*)

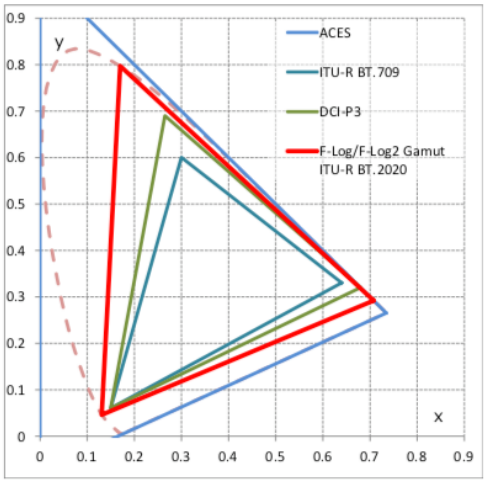


Figure 38

is 5.02 and ΔE (*indicates the total difference in the visual perception of color between the pattern and the photographed*) is 6.58, values that, although they indicate a deviation from the norm, are not remarkable in the eyes of a conventional viewer.
We have also studied the chart in the 2020 space (Figure Right) working in ACES, with an IDT 2020 and an IDT 2020. According to the Fuji document, the color space (Gamut) associated with the Flog2 curve uses the same primaries as the Flog2 curve. ITU-R BT2020 standard (*figure 38*).

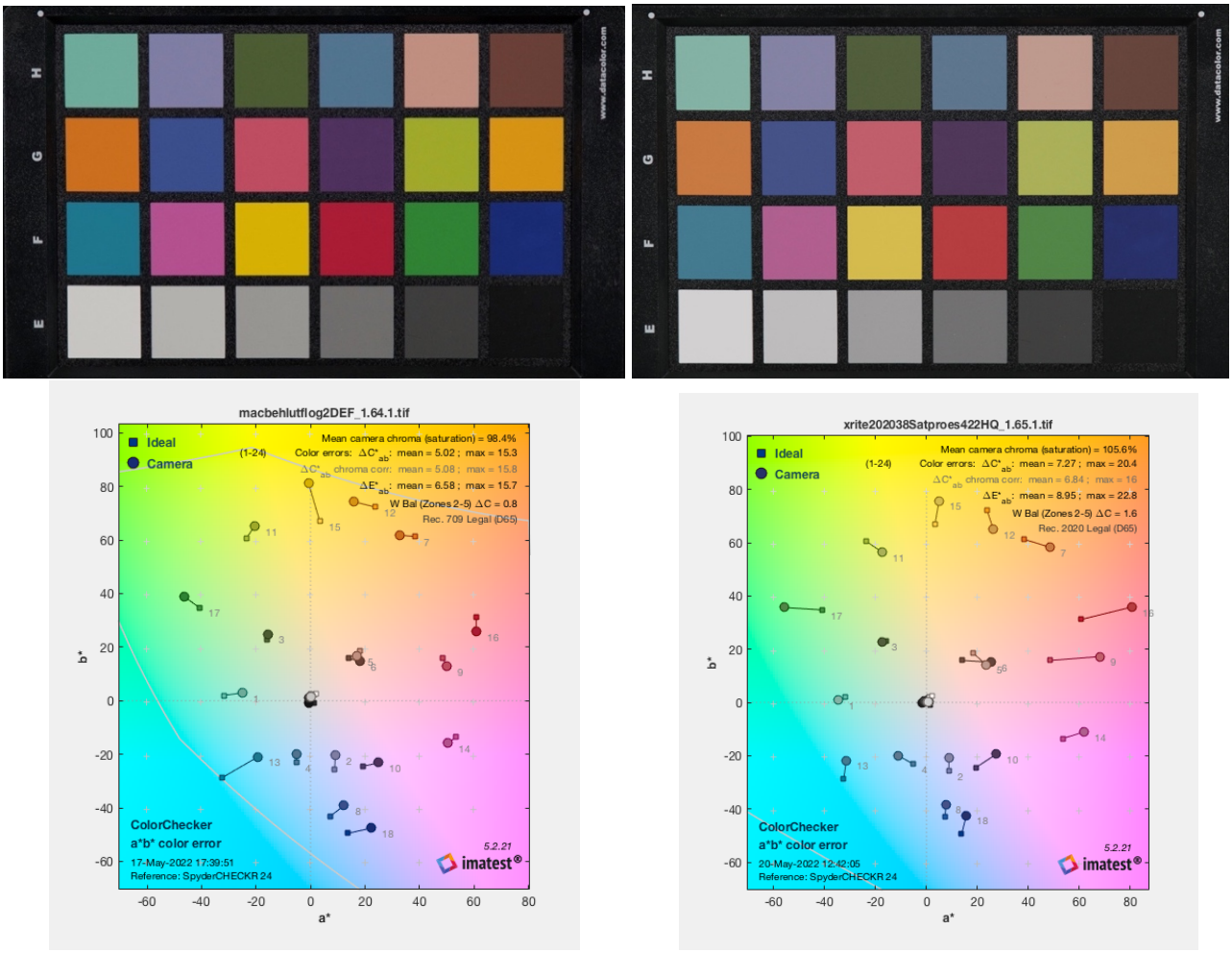


Figure 39

In this case the average deviation ΔC is 7.27 and the ΔE is 8.95. However, it is important to note the significant deviation in samples 9 and 16, which correspond to the salmon and red colors that are shown deviated towards magenta. This deviation especially affects skin tones, especially dark tones, as we have been able to verify during the color correction work for the medium-length film *Reencuentro*.

Studio color test

One of the fundamental aspects when evaluating color is its consistency in relation to luminance, for this we have made a series of still life exposures (*Figure 40*).

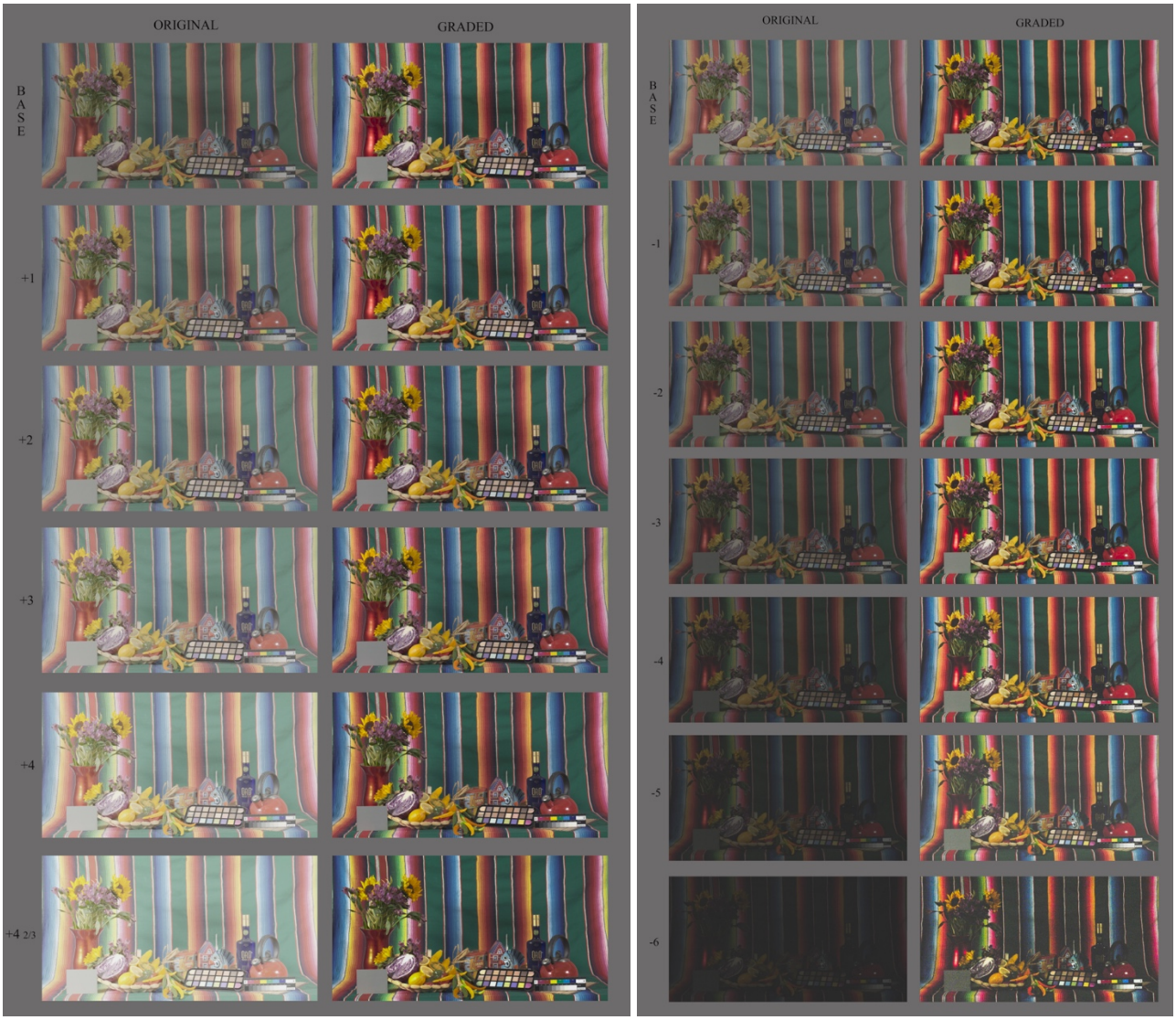


Figure 40. Watch video

In the overexposures we have a very consistent color up to +4 stops above the medium gray, with +5 the tone is still maintained, but a certain deviation towards yellow begins to be noticed, which means that, for example, sunflowers or lemons acquire a more "plastic" appearance as if the color were no longer the natural one of the objects. In the underexposures the tone is maintained until -2 stops, from there the noise begins to mask itself, something that can be clearly seen in the flower petals or in the makeup palette. In *Figure 41* we can see the comparisons in detail.

Alfonso Parra AEC, ADFC director of photography doing tests with the camera.

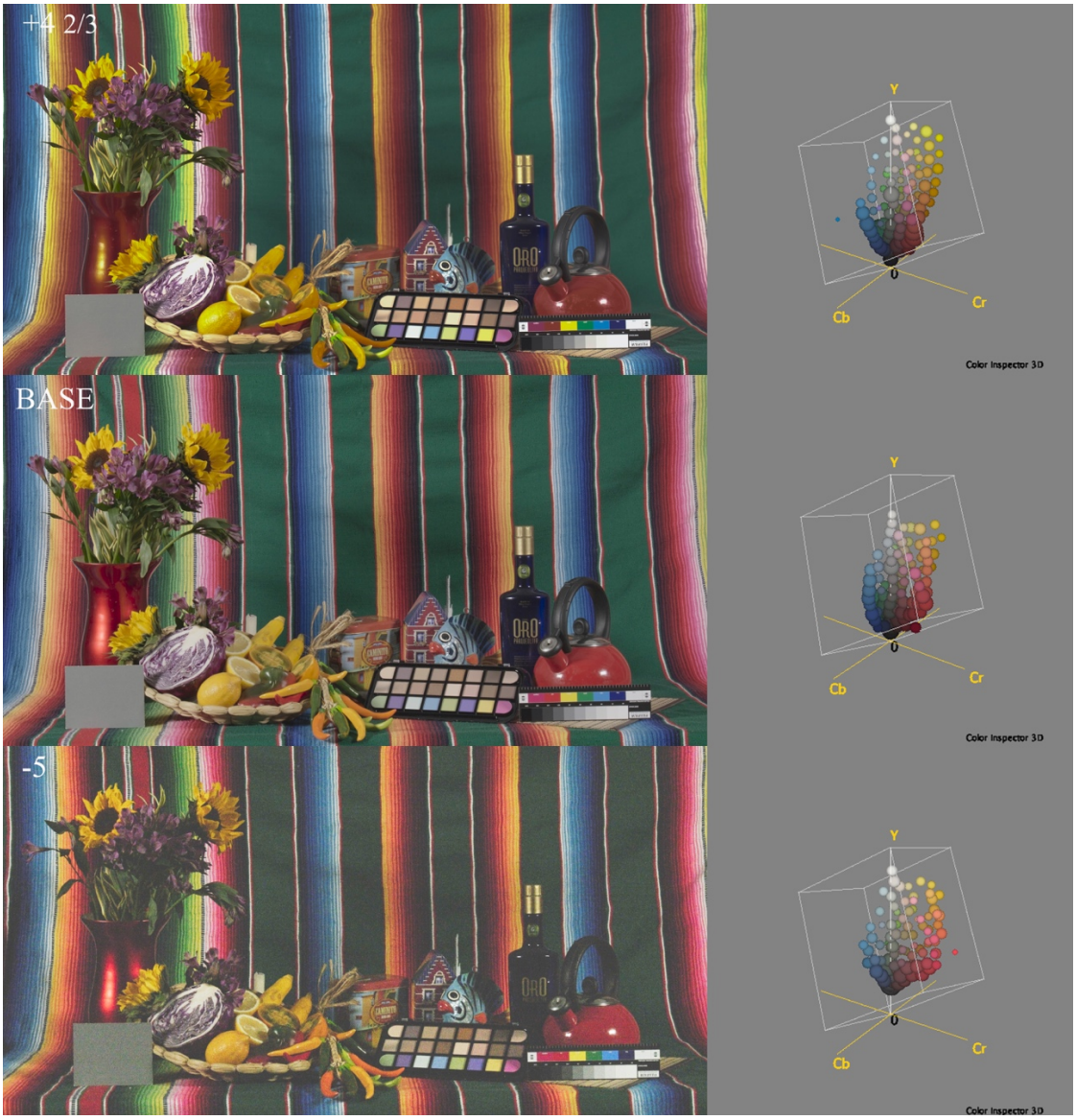


Figure 41.

Next, we put in a detail of the sunflowers (*figure 43*) with an underexposure of -5 corrected to match the base. We see how the subtle violets are overshadowed by the noise. However, the tone is maintained to a certain extent.

Figure 42

A detail of the makeup palette (*Figure 43*)

Figure 43

We can establish that from the point of color consistency we have a total range of about 7 stops, 4 above the middle gray and about 3 below.

Another aspect that we have also considered is how the color tone is maintained at different color temperatures of light. In *figure 44* we can see the comparison.

Figure 44

The tones are practically identical at both color temperatures, although at 6500ºK the still life appears slightly more saturated. For this test we have adjusted the camera and the light to the same color temperature, balancing the image for the middle gray in colorization.

Another aspect to highlight is how skin tones are seen, something very important for directors of photography (*figure 45*)

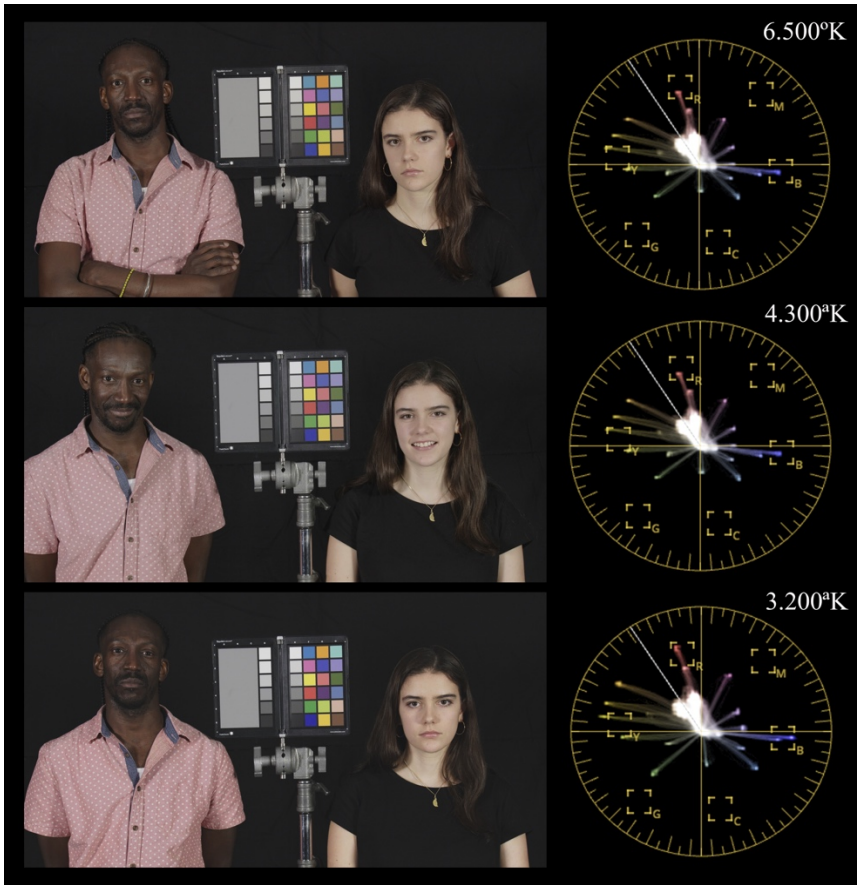


Figure 45. Watch video

A fairly high consistency is also observed with the different color temperatures. Despite this, at the time of color correction of the short film we have found it difficult to work the skin tones accurately, especially with very dark tones such as Leo's, which acquires a reddish hue, as soon as simple corrections are made. In this image (*figure 46*) we compare the skin tones without correction to gray and without touching the saturation and we clearly see some red cast in the faces at temperatures of 4300 and 3200, while at 6500 it is slightly yellow in comparison.

Figure 46

In the vectorscope (*figure 47*) you can see this slight color difference.

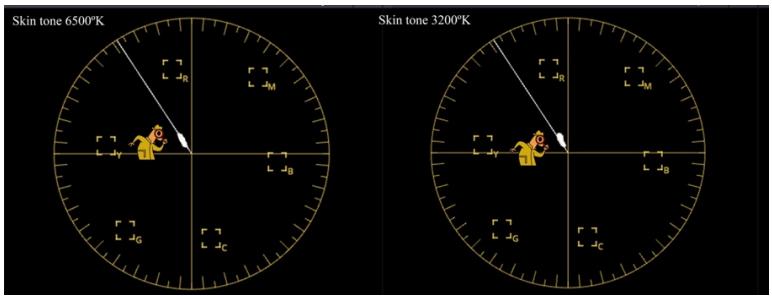


Figure 47

In the same way, we have observed in the *Reencuentro* correction, something that we already saw in the study tests, and that is that in the highlights, any correction that is made of a certain depth causes said lights to go towards yellow, it seems that the blue channel clips before red and green. We have had to introduce correction nodes per channel to find the white balance.

We have concluded after all these tests that a very precise exposure is necessary for a good color correction in post-production and that the skin is difficult to work with as soon as different color temperatures appear in the shot or it is contaminated with the infinity of temperatures of color that exists in real spaces. We think this may also be due not so much to the camera as to the lack of a clearly established color flow for the Flog2 curve and its color space. Let's see these examples already in the shooting.

Figure 48

In this image (*figures 48 and 49*) after color correction, the tones appear soft and natural, reminding us somewhat of Fuji emulsions, especially 8583 400 Eterna.

Figure 49

The workflow

To work on the images from the camera in post-production, we have missed the Fuji IDTs for Flog2 working in ACES, which is the usual nowadays, although we have used a 2020 IDT that corresponds to the color space determined for said curve. logarithmic It is of crucial importance to have a color flow that allows you to get the most out of the camera and avoid working in uncontrollable environments such as scene reference. However, we have tried to work in this way applying the luts created by Fuji without obtaining good results, especially since the Luts are especially aggressive, destroying information and creating artifacts. Let's see these examples (figures 50 to 52) where we compare the original color chart with the same one passed through the luts. We can appreciate the deterioration in the edges as well as the loss of tones.

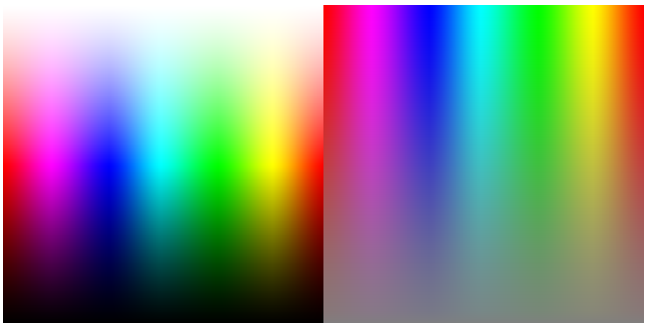
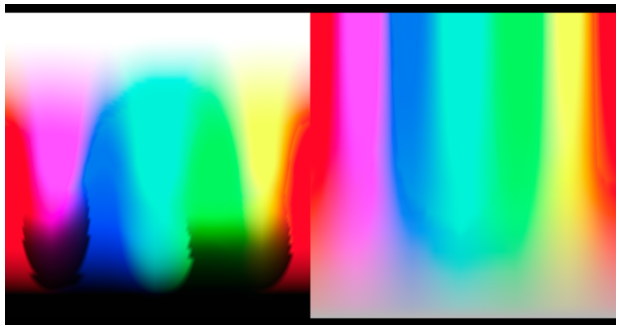


Figure 50 Original test chart



XH2S_FLog2_FGamut_to_ETERNA-BB_BT.709_33grid_V.0.90.cube

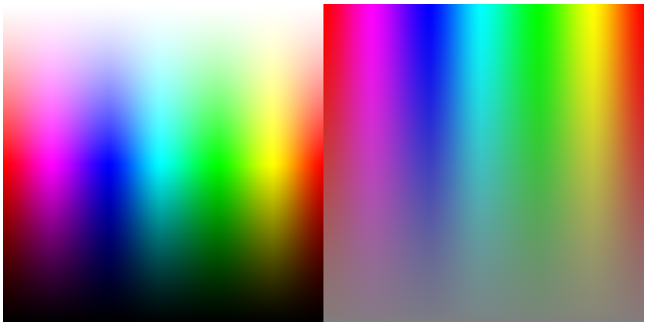
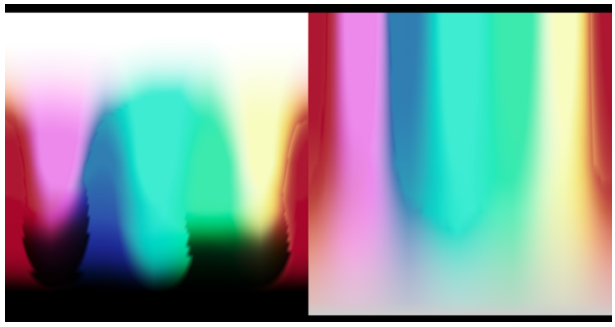


Figure 51 Original test chart



XH2S_FLog2_FGamut_to_ETERNA_BT.709_33grid_V.0.90.cube

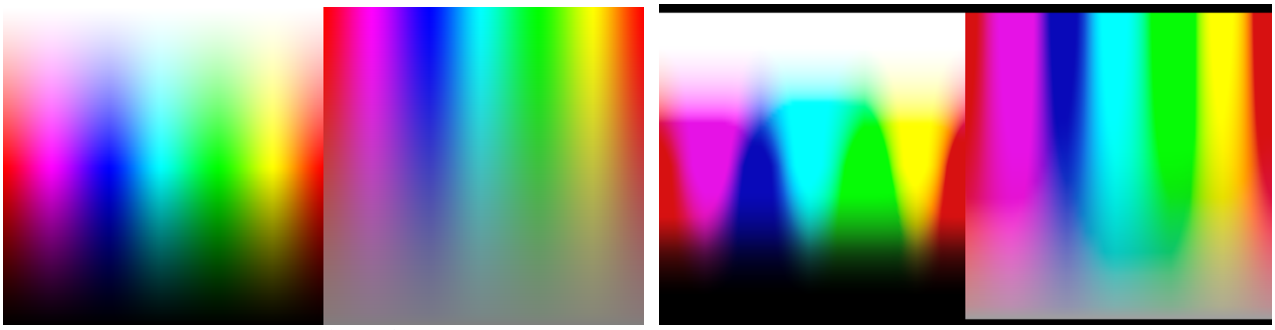


Figure 52 *Original test chart* *XH2S_FLog2_FGamut_to_WDR_BT.709_33grid_V.0.90.cube*

Other considerations

Regarding the handling of the camera, we can say that they are versatile, that they adapt well to environments, even like the ones we had on the set of *Reencuentro* under the inclement tropical heat and high humidity. The fan that is installed in the rear part is a very important finding, which during filming we had to set to maximum speed to prevent the camera from stopping due to heating. Camera handling is made much more comfortable with the usual accessories for this type of camera: the box, dummies to put more powerful batteries, sun visors with their bars, focus control and of course, a small monitor, in our case a Atomos Shogun or an Atomos Ninja V+. In general, we can say that the camera runed well. The conjunction of the MK lenses with the camera seemed ideal for this market segment.

Conclusions

The first thing to highlight after all the tests we have carried out is the excellent quality/price ratio of the camera. For a very affordable cost, the camera offers high image quality in terms of dynamic range, resolution or sensitivity. Consistent color throughout the dynamic range with minor variations in overexposures, underexposures and color temperatures, although adjustments to the colorization process have to be made specially to achieve good skin tones. The camera allows you to work up to 4000 ISO with reasonable noise that can also be corrected by noise reducers, especially if you are going to use values higher than 4000. The camera has shown itself to be versatile working in very adverse conditions, both in terms of temperature and humidity. The final result of the short film *Reencuentro* is of a high image quality that honors the visual richness of the Colombian Caribbean.

Video link: https://vimeo.com/780919596

Collaborators

* *This article is included within the Phoenix project financed by FUJIFILM*
* *For this test we used a prototype camera.*