SONY PXW-FX9 CAMERA TEST

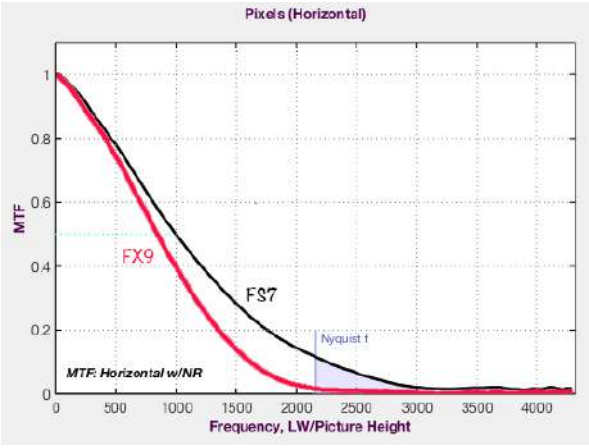
*by ALFONSO PARRA ADFC*

In this document we are going to study the characteristics of the Sony FX9 camera, a camera that incorporates an FF sensor. The study of it is carried out from the point of view of the direction of photography and for this we have focused on the fundamental aspects of digital image quality such as resolution, dynamic range, noise, sensitivity and color as well as contemplating the most subjective evaluations of the participants in the tests, both cinematographers and assistants and post-production staff.

The recording format used is 3840 x 2160 pixels 16: 9 with the XAVC-I 10-bit 4: 2: 2 YCbCr codec and also in Raw through the XDCA extension and the Atomos Shogun 7 recorder. Although the sensor is 6k in size, the image we get is 4KUHD in the internal camera recording and 4KDCI with the external Atomos recorder. We have shot as usual ISO 12232 and Putora resolution cards, Macbeth color cards, or texture cards such as the rainbow card, we have also created multi-exposure strips with the models, as well as chroma and finally the planes shot in natural exteriors , in this case in the city of Cartagena de Indias and in a flower farm in Facatativa, both in Colombia. For lighting we have used velvet led screens; Arri tungsten and HMI and KinoFlo fluorescent displays. The various light settings have been made with the Sekonik C700 spectrometer and the Sekonic L-558 / Cine photometer. With programs like Imatest, ImageJ or DavinciResolve we have analyzed the images and extracted the results and conclusions. Regarding the lenses, we have used the Sigma cine lenses, Sony's own 28-135mm zoom, the Zeiss CP3 prime and the Loxia and Batis lenses also from Zeiss. The colorization has been done in DavinciResolve. The images in this document come from the original frames, although compressed, so they must be taken as references.

## EVALUATION OF THE RESOLUTION

The FX9 camera has a 35.7x 18.8 mm 6K full frame sensor that derives DCI 4k, Ultra HD or HD formats, so the first thing we have asked ourselves is if the resolution in the same format is greater, less than or equal to an FS7 with a sensor S35. We have carried out this test by photographing a resolution chart putting the 3840 x 2160 format on both cameras in XAVC-I and with the Sony 28-135mm zoom corresponding to the same T and focal value. The lighting conditions have been identical, as well as the process of obtaining the image to be analyzed. What we see in the result is that the FS7 has a little more resolution in the medium and high frequencies. It follows from this that the image of the FX9 will appear slightly softer than the FS7, especially on skin tones. It is possible that in the design of the camera it was considered to give the image a little more smoothness without losing detail, in the same sense as the Venice or that the zoom has lower performance in FF than in S35, when using the first more surface of the lens projection circle.

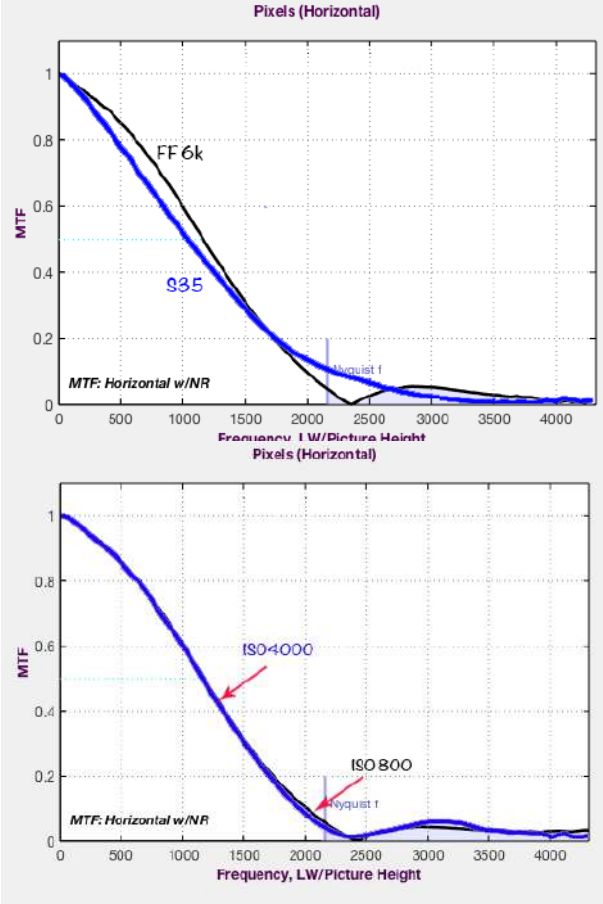


We must remember again that you do not have to associate format with resolution; no matter how the size of the format, and with it the number of pixels, influences the resolution, they are not the resolution itself. The resolution of our image will depend on the sensor, the electronic signal processing, the recording system, the lens, the viewing system, and of course, the distance at which we see the image. Therefore, images with the same formats may have different resolution / sharpness, measured in TV Lines, lp / mm, cyc / pixel or any other common unit.

The camera as indicated records images up to 4K in FF or S35. We have compared the resolution measured in the center of the image both ways, obtaining that at the same frame size, 3840 x 2160, the resolution is slightly higher in FF than in S35 as we show in the graph. Resolution at 50% in FF is 1165 LW / PH while in S35 mode it is 1040 LW / PH. We also wanted to check if the two base values of sensitivity influence the resolution, considering the noise, and we verified that in both ISO the resolution is identical.

Taking a 3840 x 2160 image from a 6k sensor would lead us to think there would be a substantial improvement in resolution compared to the S35 with which we have been working, but in reality, it does not seem to be the case. The texture and the level of detail that we get from the FX9 is not far from what we have with an FS7 in a S35 format. Although there is a slight difference in the sense that the images of the FX9 appear somewhat softer; from the point of view of image sharpness we can work with the camera in either FF or S35 without observing considerable differences.

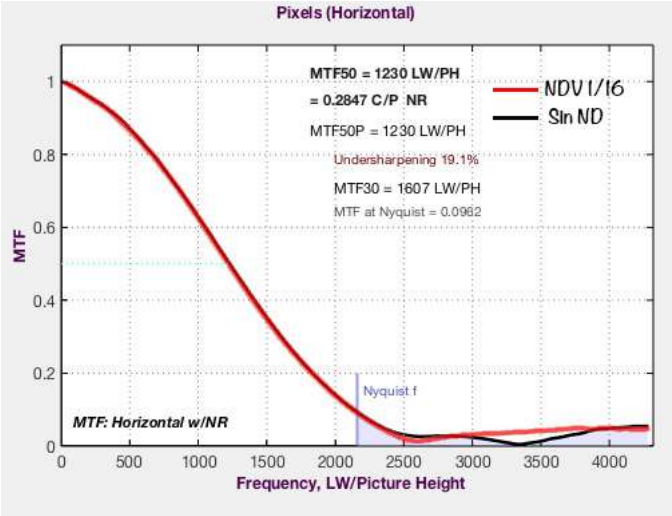
In the *prêt-à-porter* test chart you can see that there is really no visual difference between FF and S35.




In the next frame we can appreciate the textures of the woods, the glass, the sweets and the stone, which are shown with clarity and resolution, but without strident results, nothing “rabid”.


*Clock square. Cartagena de Indias. Colombia. FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 YCbCr 4:2:2. 10 bits. XAVC Intra. Zeiss Compact Prime CP3 lens*

Another aspect that we have evaluated from the point of view of resolution is how the use of the neutrals of the camera affects it. As we know, the camera has two ways of handling neutrals, one that is determined values, for example, 1 is ¼ (two stops) 1/8, 1/16, etc. and the other system is to use the variable ND, which adjusts, either manually or automatically, the exposure. I have been using the variable ND since its introduction in the FS7 and it is really a very effective tool, so much so that I do not contemplate bringing external neutrals with these cameras. The question that could arise is how the use of these variable ND affects the resolution of the image. The answer is in no way. In this graph you can see the comparison of the MTF curves between the variable ND "off" and a value of 1/16 (4 stops, equivalent to a 1.2 ND) in variable mode. The two curves are superimposed and are identical.




We will see in the color part how the use of NDs does not affect it. As I said, this variable ND tool is extremely useful, precise, of a high quality, so I think it should even be installed in Venice. Let's see to finish this analysis two more frames to appreciate the smooth and organic texture generated by the FX9, which in a way is reminiscent of the Venice. In the image of the fish we can see all the texture of the scales, gently differentiated, as well as the trim of the fins and tails. Here the camera resolves all the diagonals very well with a very natural appearance.

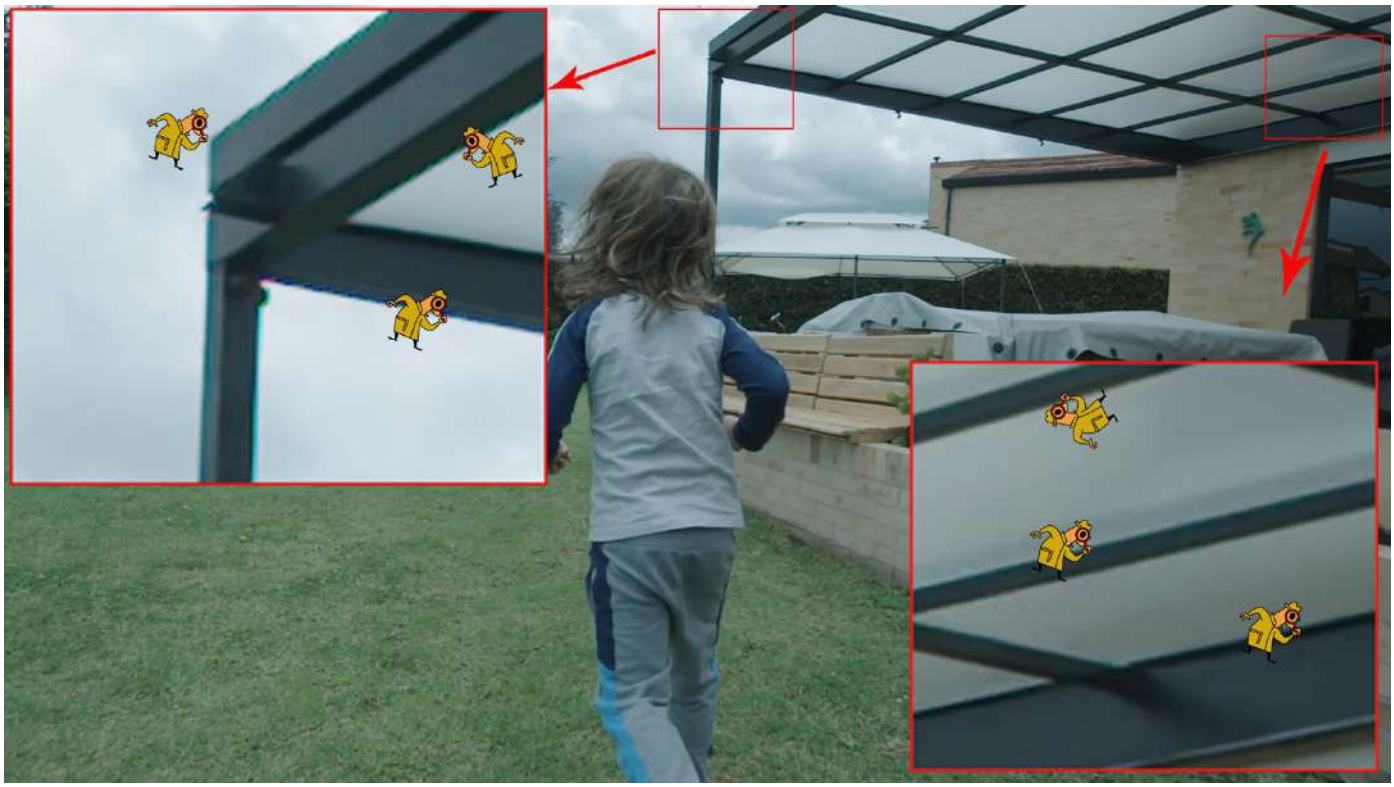
*Bazurto market. Cartagena de Indias. Colombia. FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/120 YCbCr 4:2:2. 10 bits. XAVC Intra. Zeiss Compact Prime CP3 lens*

In this second image we show the texture of the fruit, as well as the plastic in which they are wrapped. We can also appreciate the lines of the plastic cups that contain them, the seeds in the watermelons or the fibers in the papaya.

*Cartagena de Indias. Colombia. FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 ND 1/19 YCbCr 4:2:2. 10 bits. XAVC Intra. Zeiss Compact Prime CP3Lens*

*Colibri Flowers. Facatativá, Cundinamarca. Colombia XDCA-FX9 ProRes RAW on Shongun 7 by Atomos, with Lut 709 Type A 29.97 fps, 4128x 2192 1:1,88 ISO800. 5.500K. Obt 1/60.*

We can conclude that the general sensation is that of having a camera with the resolution corresponding to a 3840 x 2160 image and with a good lens it is between 1100 and 1300 Lw / PH at 50% with moderate sharpness, giving an organic impression and increasingly removed from that artificial sensation of the digital / broadcast world. It is practically identical to shoot with the camera in FF as in S35, since the final resolution in the frame is very similar.

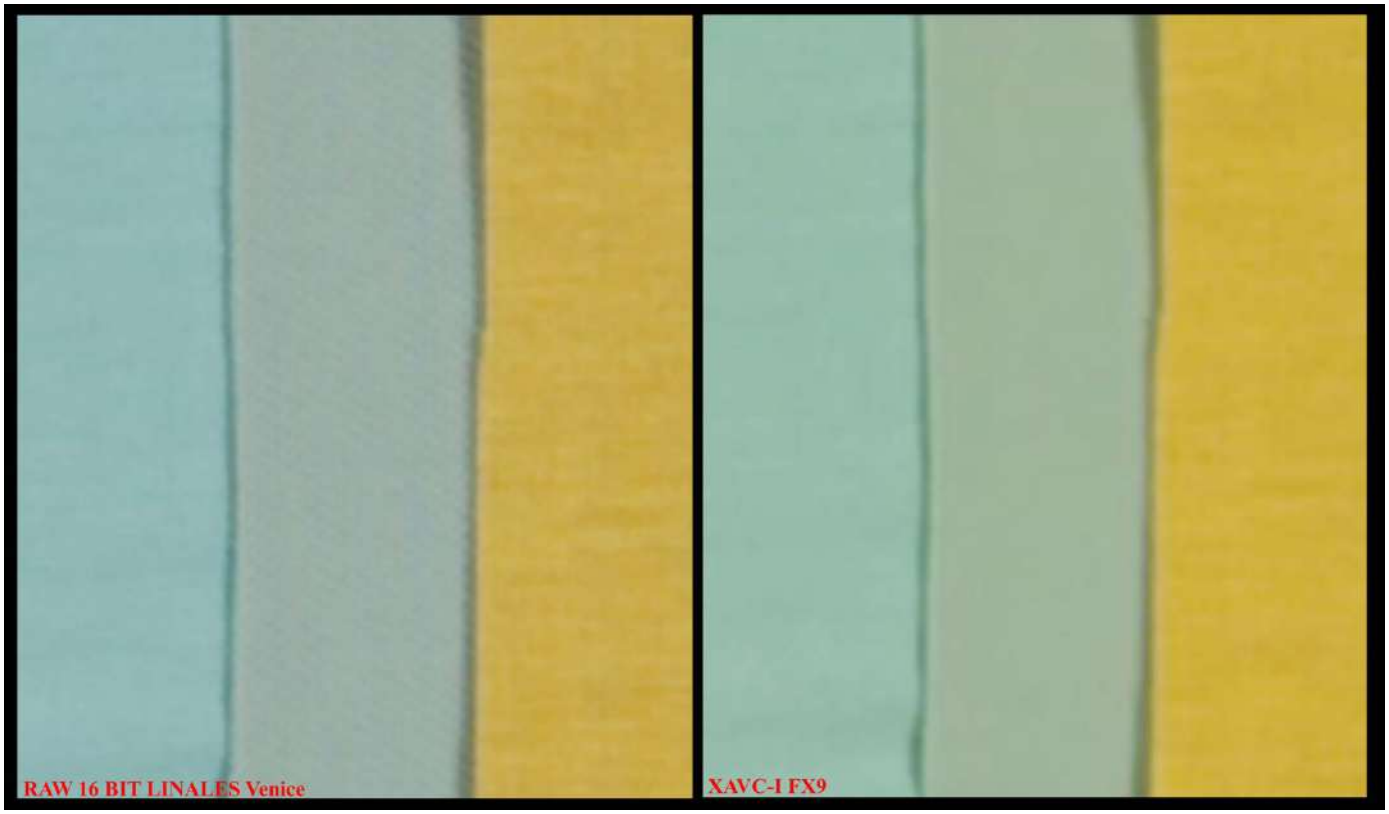


*FX9 EI Mode Slog3/S-Gamut3.Cine. 180 fps, 1920x1080 16:9 ISO800. 4.200K. Obt 1/90. YCbCr 4:2:2. 10 bits. XAVC Intra. (frame courtesy of Luís Fernando Villa).*

Another aspect that we want to highlight is how resolution is affected when we use higher frame rates to achieve slow motion effects. In the frame of the child running we show the aliasing and artifacts that can be seen shooting at 180 fps in HD. It reminds us, somewhat, of the same effect we observed with the F55, where if you remember, that to record at high speed you had to change the OLPF filter. We do not know if the camera is sampling using the pixel binning process, but we do know that, not only very noticeable saw teeth appear, but obvious compression artifacts as well.

Another condition that we want to point out is the difference in resolution and texture that we can observe if we compare the RAW format with the compression of the XAVC-I.

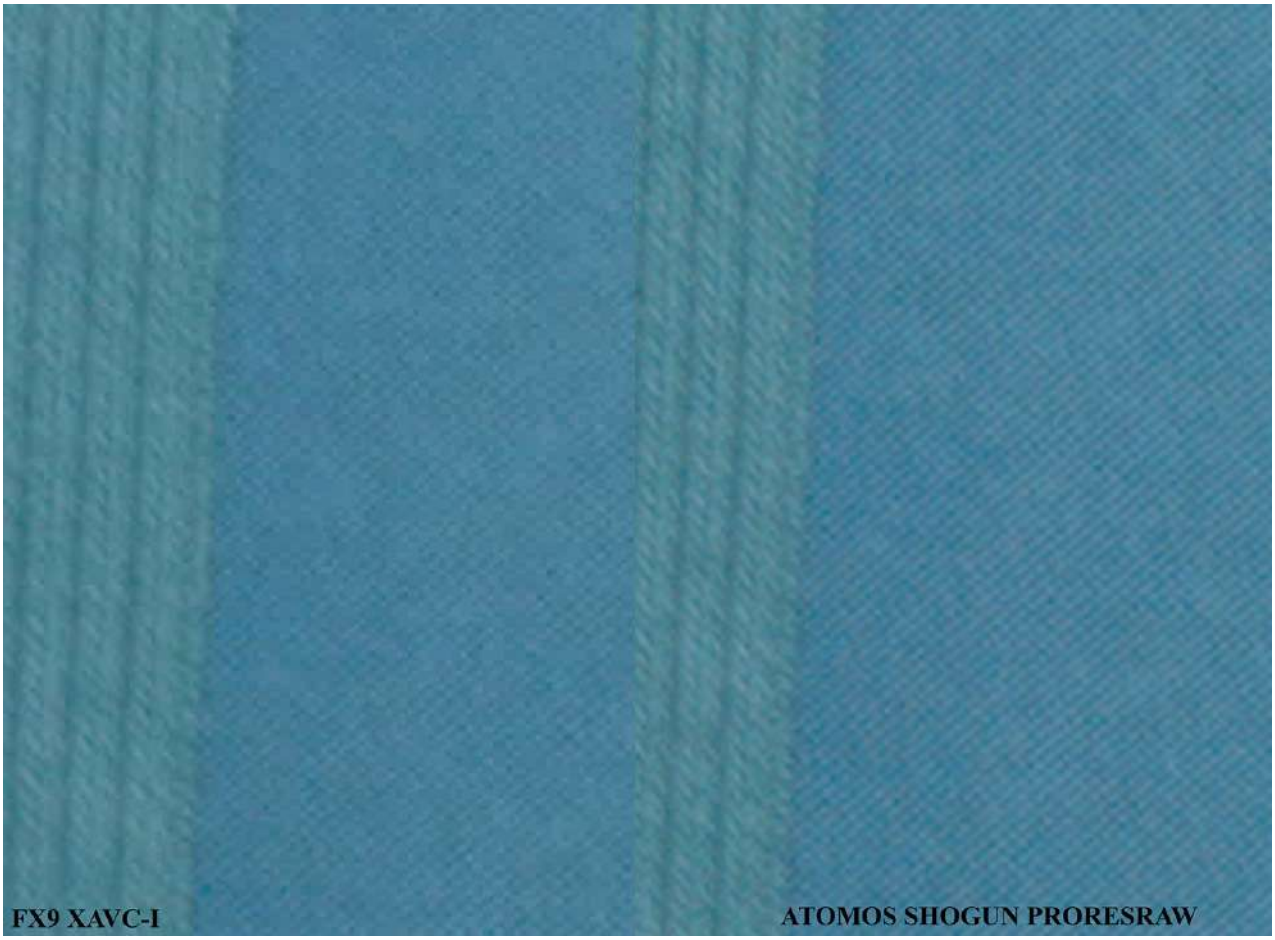

*Resolution tests with ISO 12232 chart.*



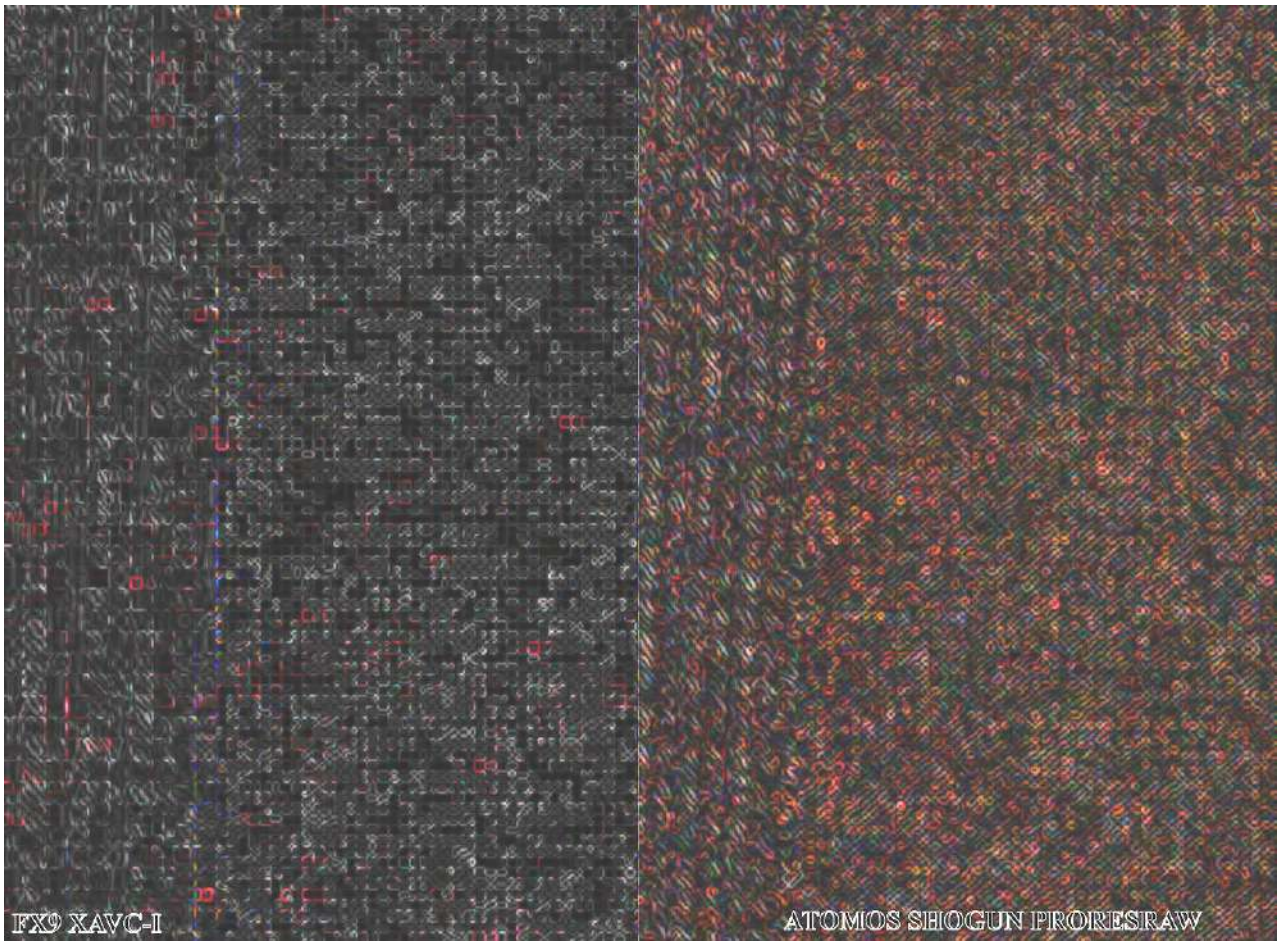

In this image we compare a part of the x1000 magnified rainbow chart between Venice's raw16 bit and the FX9's XAVC-I. The format on both cameras is the same 4K UHD and with the same lens. You can see the clear difference in texture between the two.

The XDCA adapter allows, among other things, to take the Raw format out of the FX9 and record it on an external recorder, in this case we have used the Shogun 7 by Atomos. A 16-bit linear raw comes out of the adapter, which is converted to 12-bit and recorded using the ProRes RAW codec. This recently developed codec encodes the brightness value of each pixel coming from the sensor, which allows, on the one hand, a higher image quality with a lower transfer rate, and on the other hand, the possibility of having a more robust material in post-production. Since the shogun with this codec records the raw sensor data, it must be processed in the corresponding applications, where debayering and other image construction processes take place. In our case we have used Premiere to open these files and we have compared them with the XAVC coming from the same camera. What we see is that with the ProRes RAW we have a more natural texture and with more detail than the XAVC, which shows compression effects that do not appear in the ProRes RAW. Here we put two examples of the rainbow card where we have cut some parts and we have enlarged them x2000

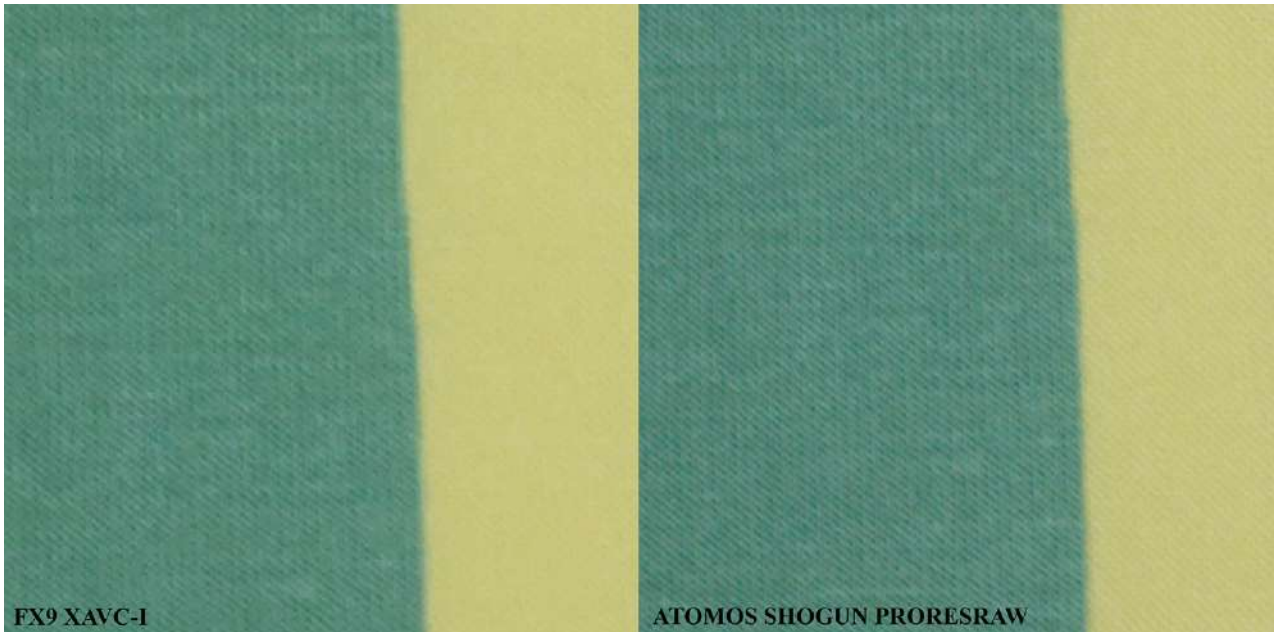

*XDCA-FX9 con el Shogun 7 de Atomos*



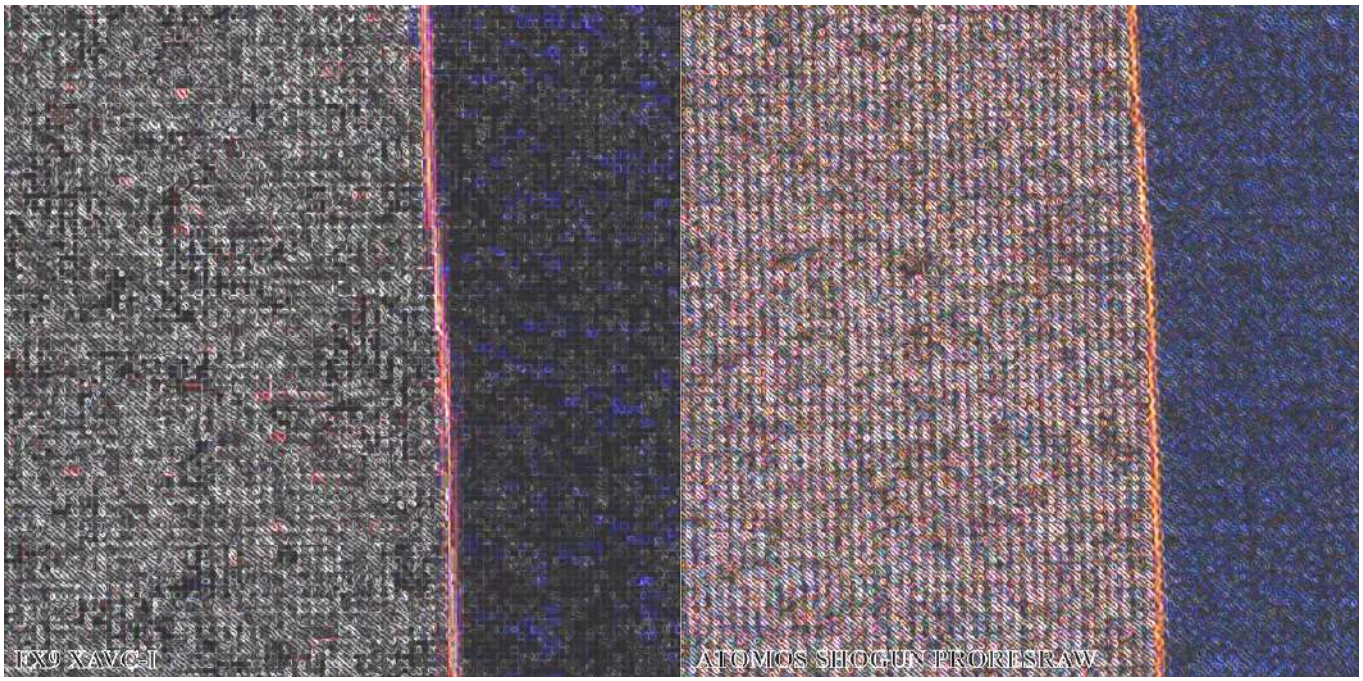

In the clipping of the fabrics, it can be seen how the XAVC shows blurring, with certain areas as plastered, also if we look at the image of the edge detector we will see in the compression structure of the XAVC something that does not happen with the ProRes RAW.




Another example




Let's look at the yellow texture, which with the XAVC is like paste, without showing the lines of the fabric that, if they appear in the ProRes RAW, it also appears blurring derived from the compression.




The combination of the FX9 with the Shogun 7 by Atomos gives the highest possible image quality, with natural colors and textures, very organic and with that painterly tone that we refer to when we talk about Venice. With ProRes RAW we gain in image quality, taking advantage of the raw format in post-production that we can work in Log, linear, or any other way we need. The contrasts are rich in detail and depth in both the highlights and the deepest shadows and the 12 bits give us colors full of nuances that we can work very well in colorization. Let's see some frames.

*Colibri Flowers. Facatativá, Cundinamarca. Colombia XDCA-FX9 ProRes RAW on Shongun 7 by Atomos, with Lut 709 Type A 29.97 fps, 4128x 2192 1:1,88 ISO800. 5.500K. Obt 1/60.*


*Colibri Flowers. Facatativá, Cundinamarca. Colombia XDCA-FX9 ProRes RAW on Shongun 7 by Atomos, with Lut 709 Type A 29.97 fps, 4128x 2192 1:1,88 ISO800. 5.500K. Obt 1/60.*

In conclusion, we can determine that:

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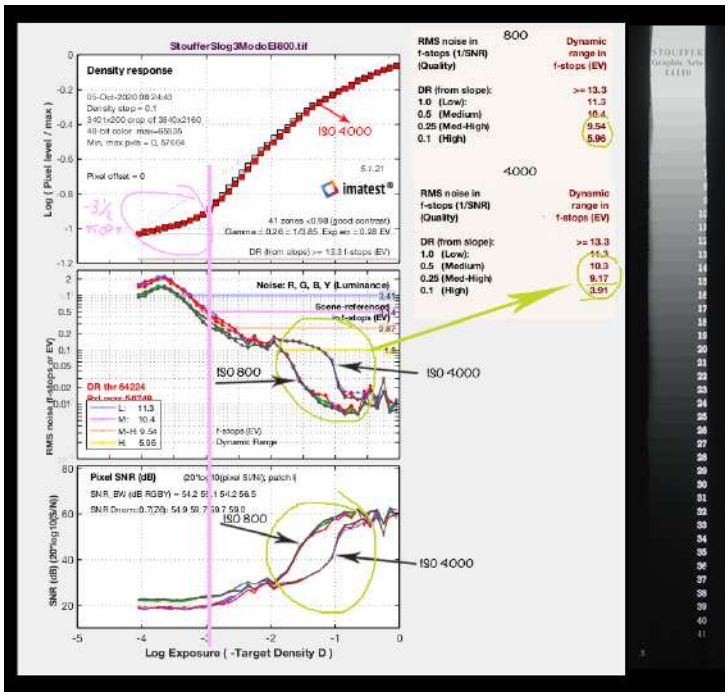
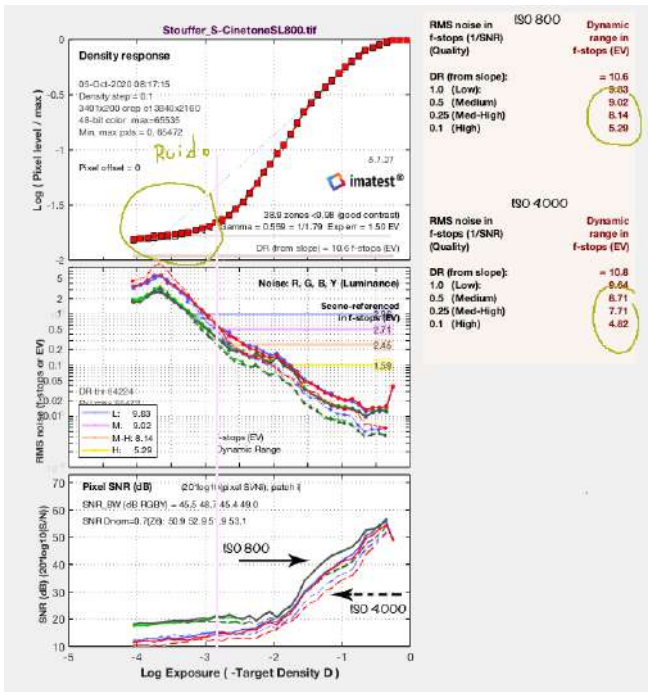
1- The camera maintains the average resolution of a 3840 x 2160 format, manifesting itself somewhat smoother in the textures than the FS7.
2- The resolution is not affected by the use of the ND that the camera incorporates.
3- The resolution is not affected in the base ISO values, and in general noise does not affect it except for very high ISO values and at very high frequencies, which we hardly perceive.
4- At high frame rates, the camera introduces aliasing and compression artifacts visible at least in this firmware version.
5- The final resolution observed and measured is not very different between shooting in FF 6k or shooting in S35. From this point of view you can use the camera in S35 without any problem and use the lenses that cover that format.
6- XAVC-I compression, as it could not be otherwise, contributes to the loss of texture in the image, if we compare it with RAW recording systems.

EVALUATION OF THE DYNAMIC RANGE

The dynamic range of the FX9 follows the same path as its predecessor, the FS7, improving somewhat on this due to less noise in the shadows. To evaluate the range we have used the well-known SLog3 gamma curve and the new S-Cinetone. We have started by photographing a Stouffer strip with 41 density steps that is equivalent to 13.4 Stops.

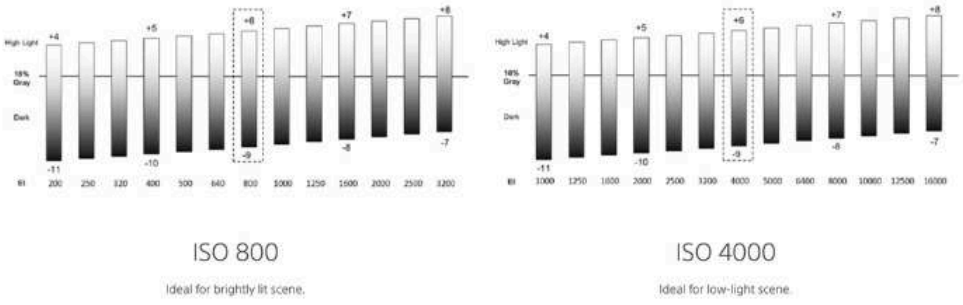



*Slog3 curve comparison to Iso 800 and 4000 values*

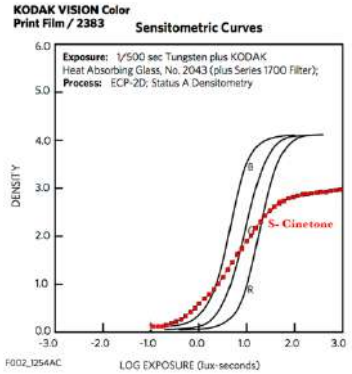


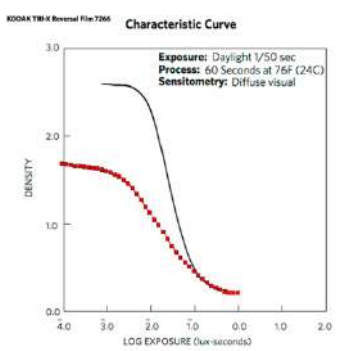

*S-Cinetone curve comparison at Iso 800 and 4000 values*

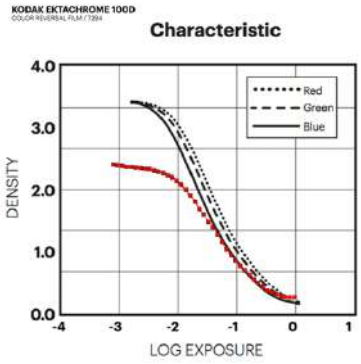
Let us start with the SLog3 curve. In the graphs, we compare the dynamic range to the two ISO values, 800 and 4000, as we see in the topmost, the distribution of the range is the same in both cases and considering a noise value of 0.5 (medium) the range is practically the same. With noise levels below 0.5, the range is less at 4000 than at 800. This can be clearly seen in the noise curves compared, for example, with ISO 4000 the db value is less than 800 in average exposure values. However, without the ISO 4000, it is very similar in the shadows. In the upper curve of the graph I indicate the 3 ½ stops, on the *toe* of the same that will not be usable in the sense of recovering information, since there the noise masks the texture and the resolution. From the 9 stops below the middle gray indicated by Sony, at least these 3 1/2 must be subtracted to determine the effective dynamic range, so we will be talking about between 5 and 6 stops in the shadows. Sony indicates that its range and distribution is the same in 800 as in 4000, which we can effectively verify by superimposing the two curves.



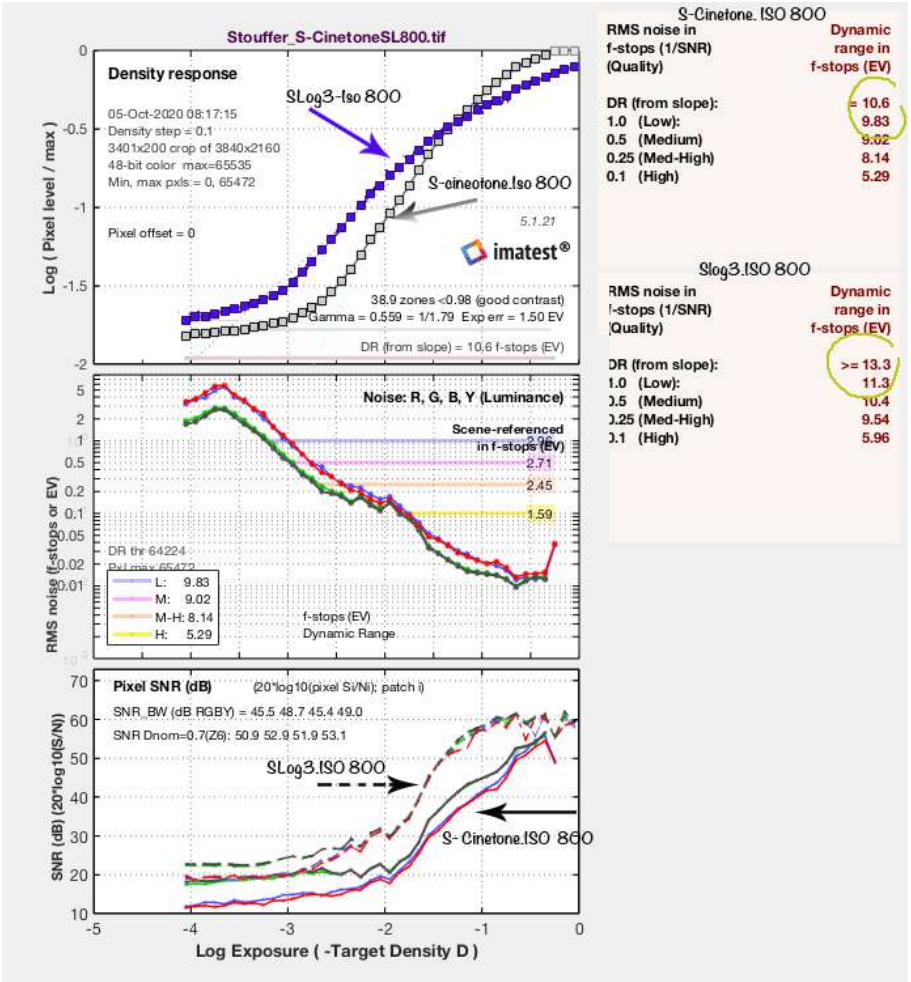
We will see later in more detail and with other tests where we will determine the effective range in both shadows and highlights. At the moment with the analysis we can consider an effective range between 10 and 11 stops for the Slog3 curve. Let us now study what happens with the S-Cinetone curve. Sony points out that this curve is created to mimic the cinematic tonal range, but I wonder exactly what tonal range they refer to the tonal range of the projection positive? The reversible material in B / W or in color? So I have compared in a somewhat relative way the shape of the densitometric curves of emulsions with the S-Cinetone curve.



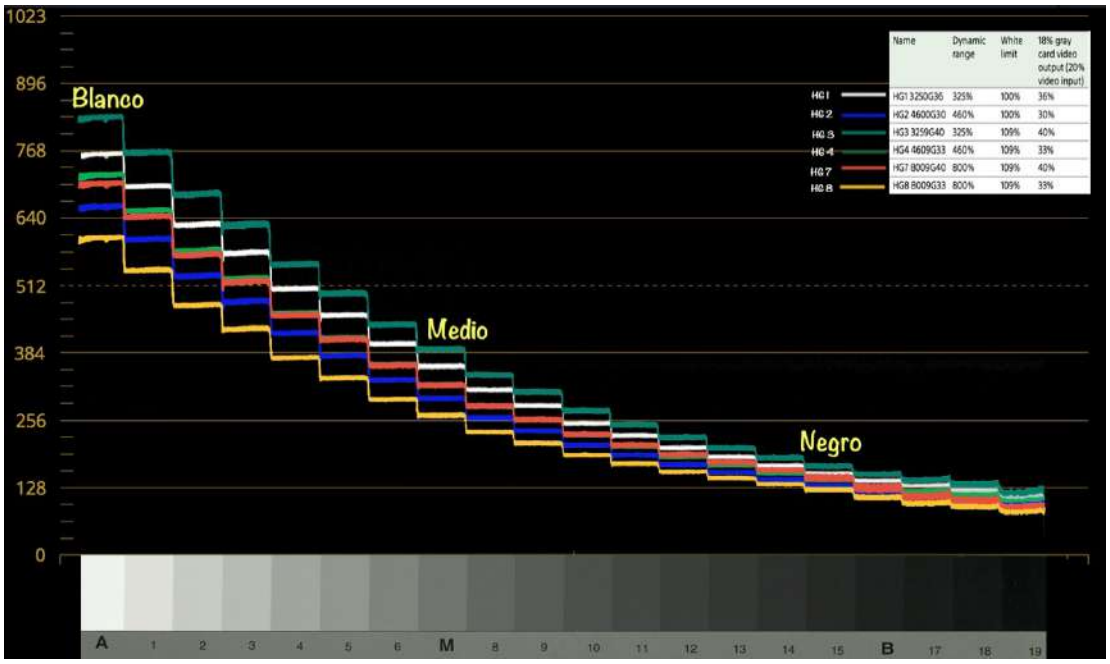




The graph on the left corresponds to the Kodak 2383 projection positive. The one in the center to the Kodak Tri-x reversal Film 7266, and so far the S-Cinetone is far from representing the tonal range of the emulsions, however, in the third graphic, S-Cinetone bears resemblance (distance notwithstanding) to the Ektachrome 100D emulsion in the darkest shades and tones. So we suspect that shooting with the S-Cinetone curve would be as if we were doing it with a reversible material, and we all remember the latitude that this material had, will it be the same with this new curve?

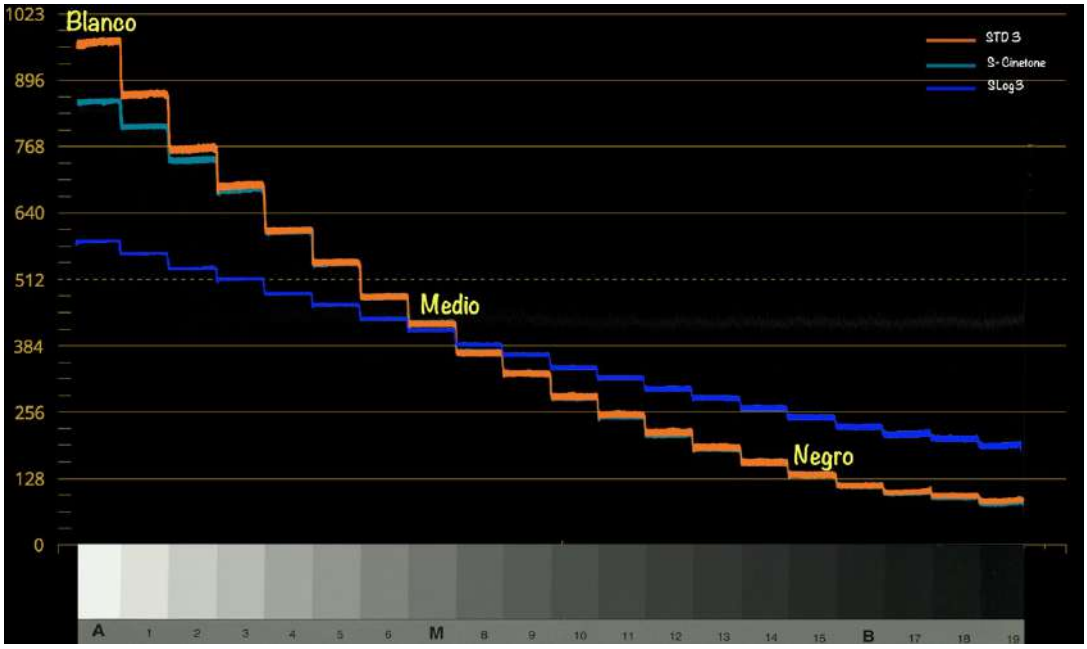



With the value referred to noise of 0.5 stop (medium) the range is from 9.02 to 800 Iso and from 8.71 to 4000. If we look at the total RD without considering noise, we have that with 4000 ISO the value is 10.8 and 10.6 at 800. If we compare it with the Slog3 curve we see that it can distinguish brightness values up to 13.3 stops, that is, with the Log curve we can see up to almost three more stops as can be seen in the following graph where I compare both curves. The difference in range gets smaller as we consider different levels of noise. Its behavior is better with the Slog3 curve with a higher DB value.

We can continue investigating the S-Cinetone curve, and see where it is located in reference to the rest of the gamma curves with which the camera is equipped. Here we show the comparison between the different Hypergamma curves.

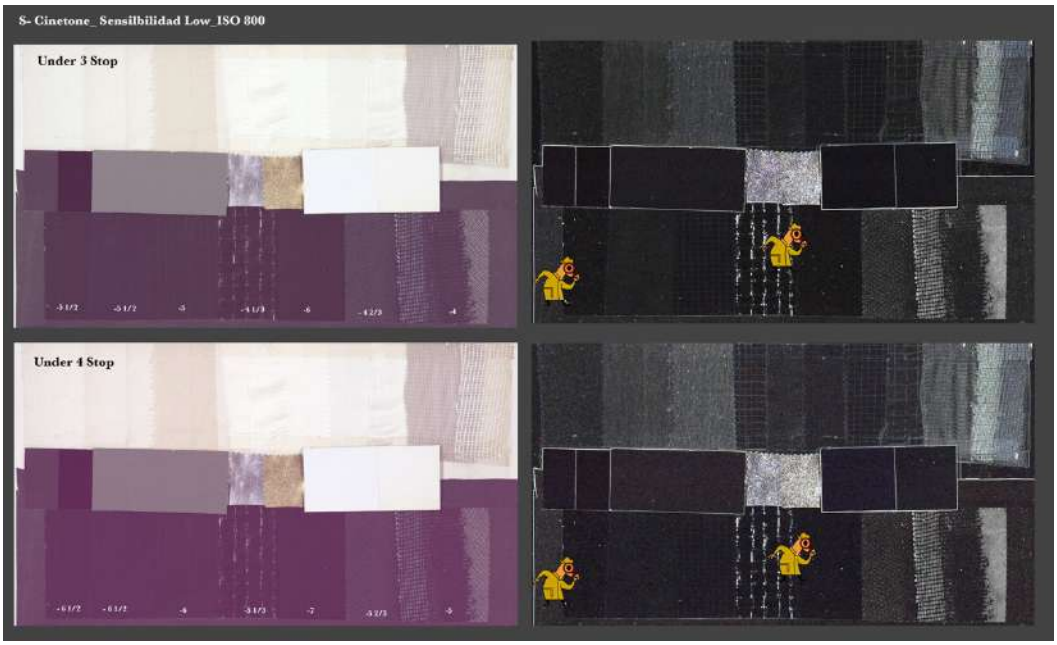



This other comparison shows three gamma curves, the S-Cinetone, the Slog3 and the STD3. We see that the S-Cinetone curve has the same tonal gradation as the STD3 in the shadows and midtones while the whites are a little more compressed, so it does not seem that this new curve is that new. Rather it looks like an STD with knee compression in the highs.

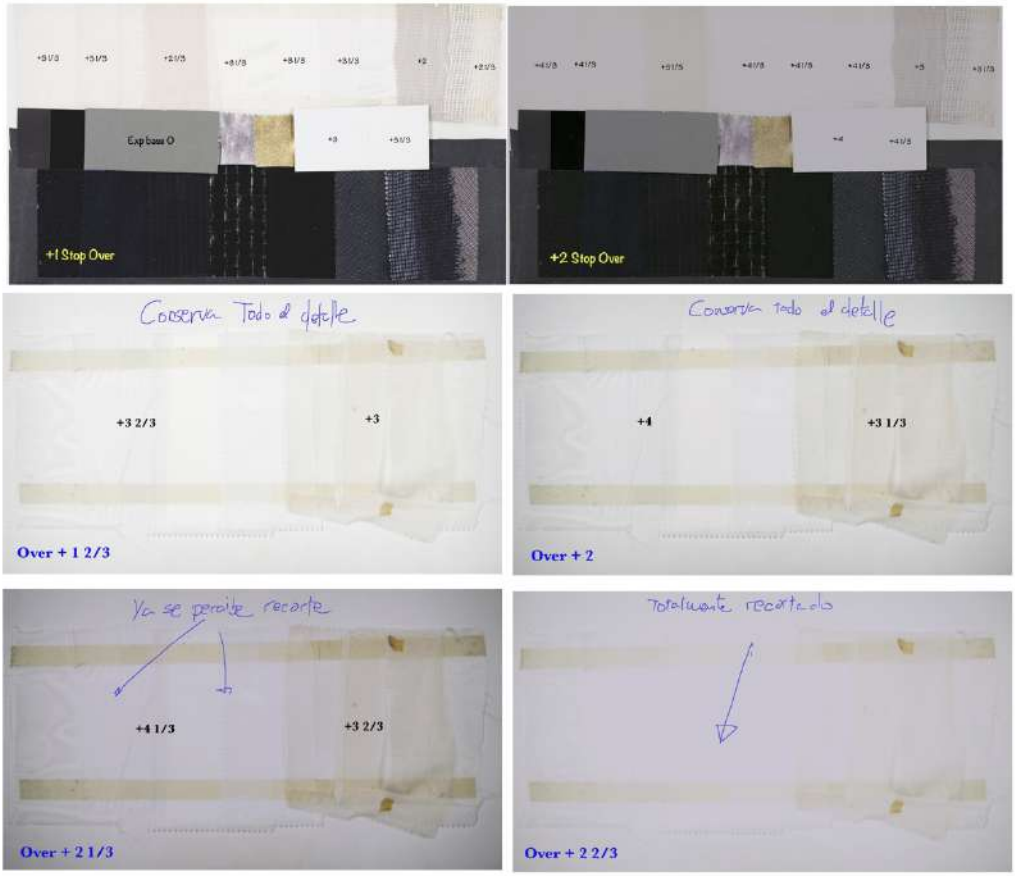



We will now look for the effective range of the two curves that we are analyzing. For this we have shot a death test chart, which consists of samples of black and white fabrics of similar reflectance. We have overexposed and underexposed the letter and then correct in post-production observing where the detail is lost, both in highlights and in the darkest shadows.

**The S-Cinetone curve**

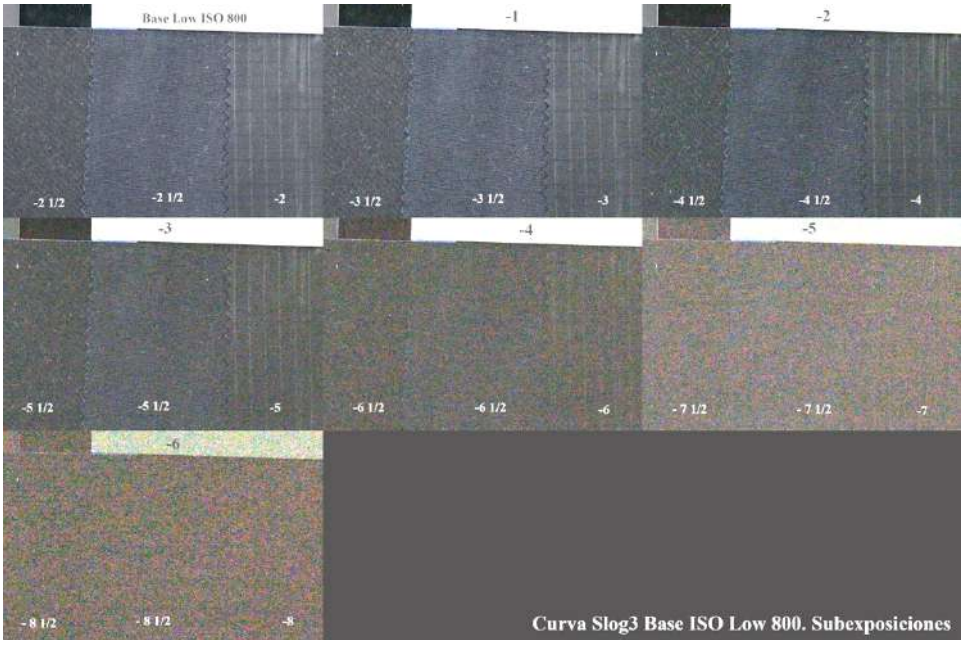



With 3 underexposed stops we can observe detail and texture up to 6 stops, although with some noise there, beyond 6 stops the noise begins to mask the texture of the fabrics. We can determine that at 5 stops below the medium gray the texture is recoverable and that at that level the darknesses appear clean, transparent, I would say transparent. Not bad for an STD curve, to go that deep. We will talk about the color intonation that the shadows take in the color section.



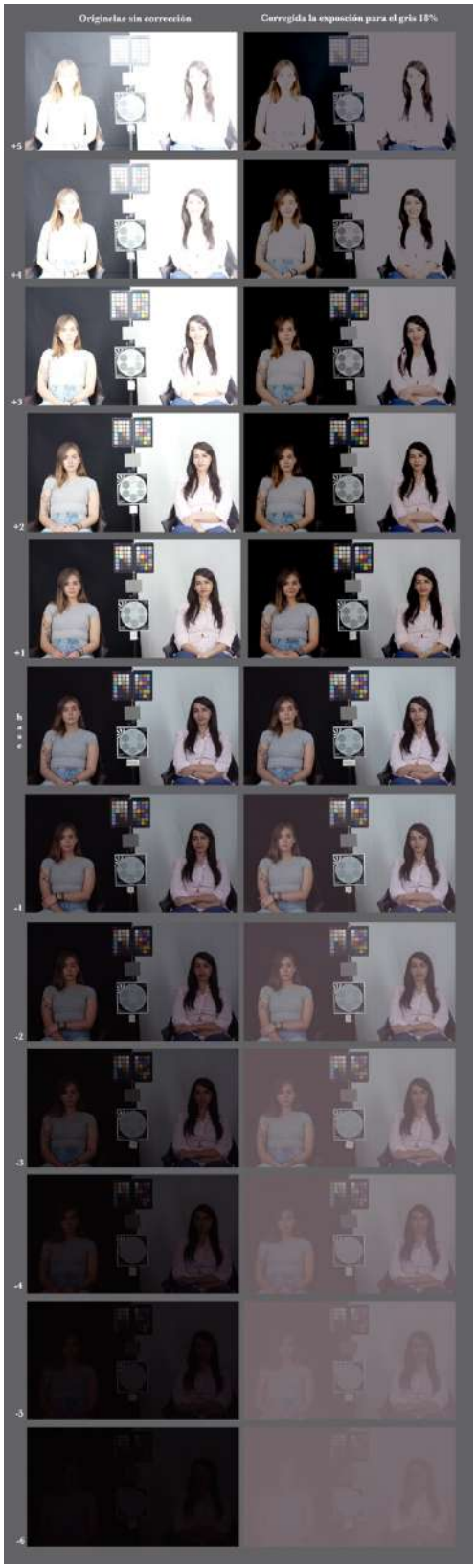
In the highlights, the texture of the most subtle whites reaches 4 stops, from this value the whites lose texture and end up cut off. Although, to guarantee all the detail in whites, I would stick with a value of 3 1/3 especially considering how this compression of the highlights affects the skin tone. So from the study of the chart we can conclude that the effective range will be around 8 stops.

**The SLog3 curve.**

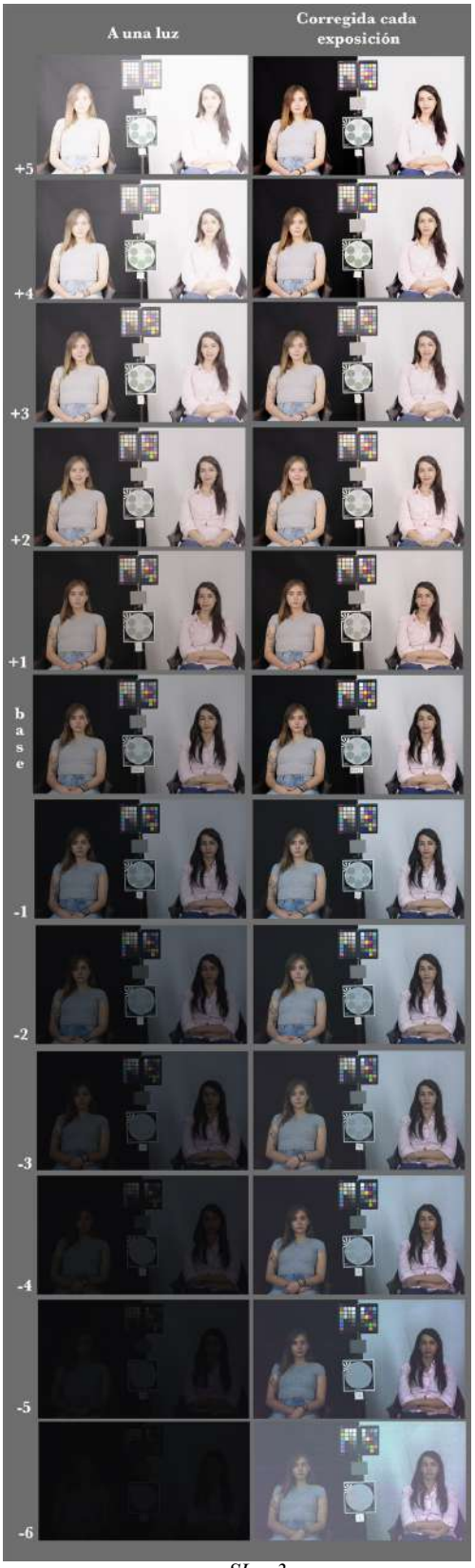



Practically in the shadows we can see detail up to approximately 5 1/3, like the S-Cinetone curve, although the texture in the shadows with the log curve is less contrasted, smoother, if you want more organic when a Lut of correction 709.


In the overexposures we manage to maintain the detail approximately up to 5 ½ stops, beyond these, the whites appear without texture and cut off. With this we can define the effective range of the FX9 with the Slog 3 curve in about 10 stops. This is 2 stops more than the S-Cinetone curve. It should be noted that the dynamic range is conditioned not only by the gamma curve used, but also by the color sampling, the bit rate or the compression system. If we compare this RD of the FX9 camera with the RD of Venice shooting in raw, we will see that in the highlights Venice reaches detail and texture up to +6 stops and in the shadows up to another -6, with which the total range is at 12 effective stops.



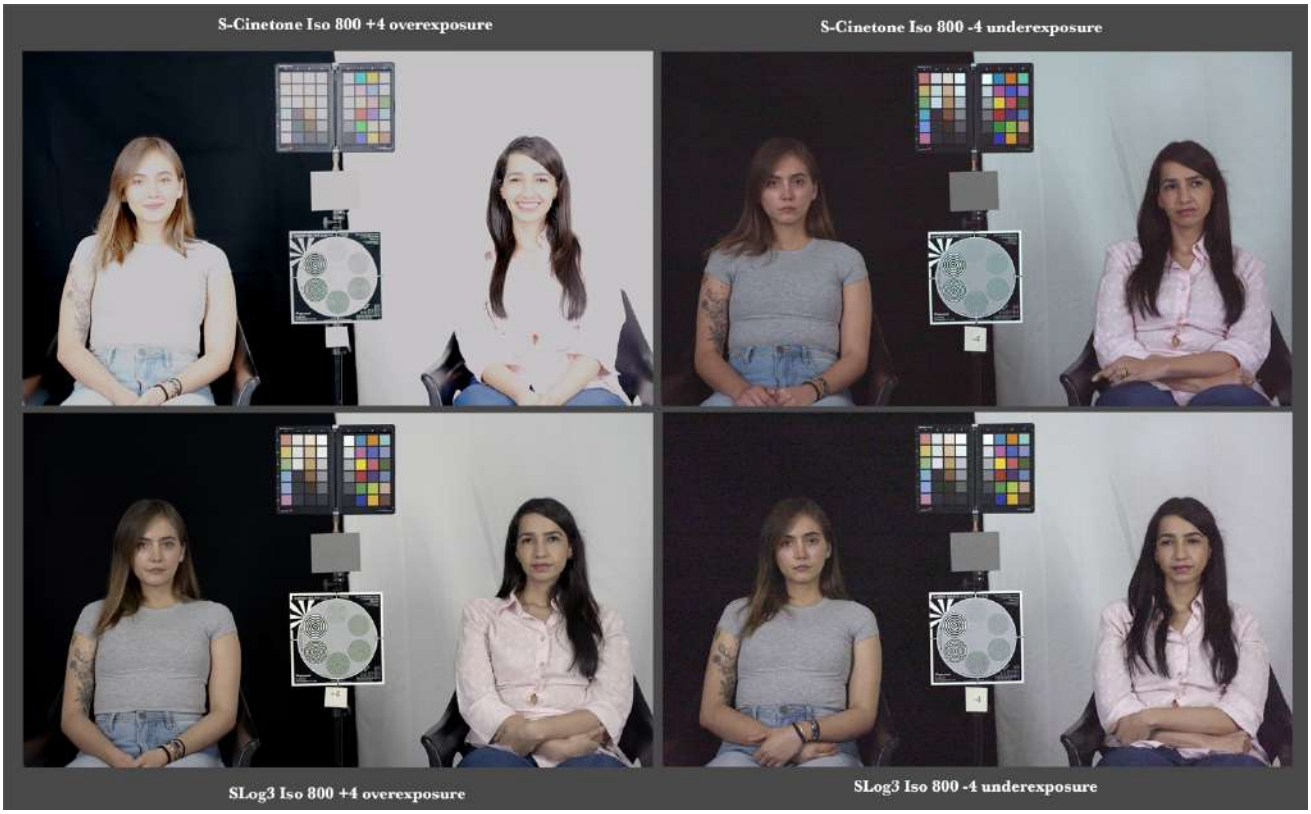

*S-Cinetone*




*SLog3*

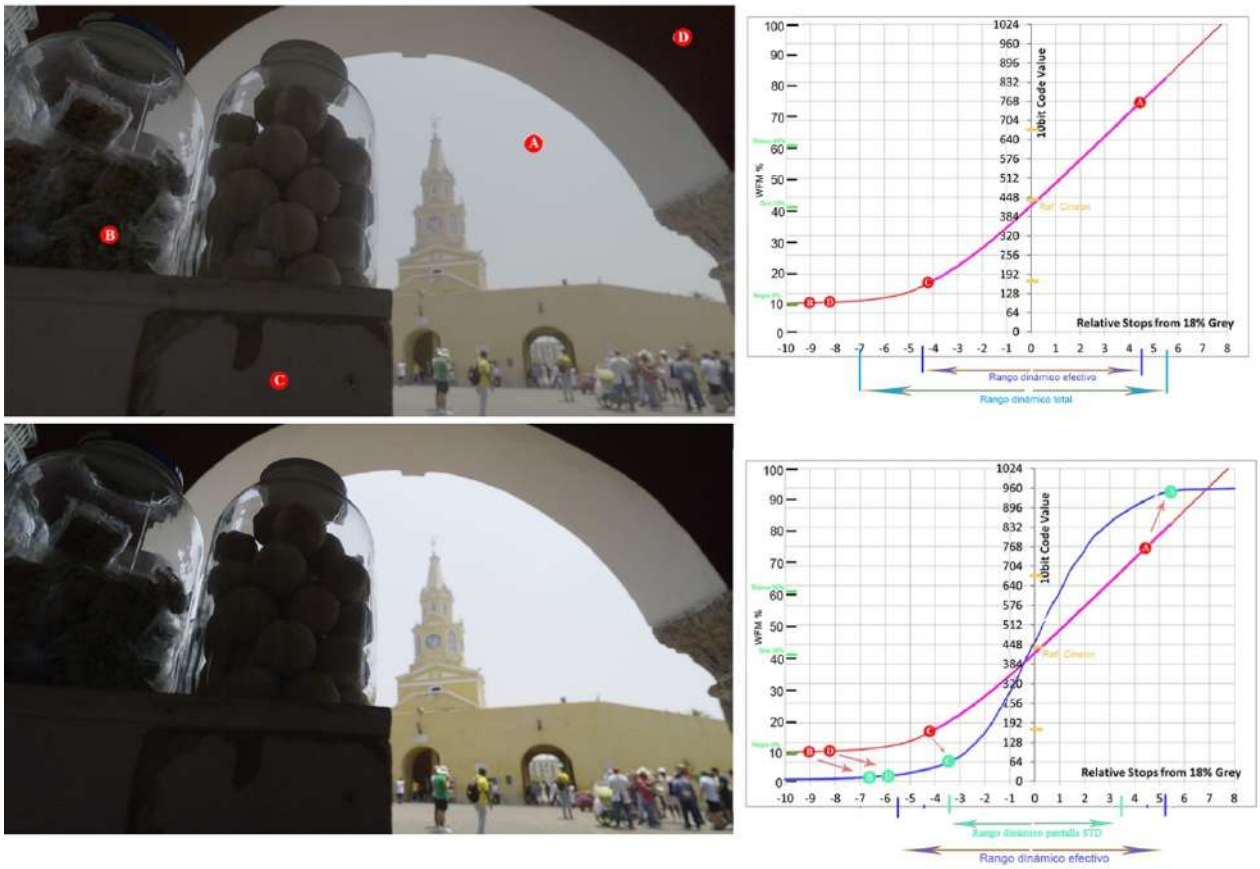
Observing the multi-exposure strips we see that with the Slog3 detail is recovered in highlights with +4 stops, although we are at the limit, that is, the white background at +5 1/3 stops is already slightly trimmed. On the lighter model's face we are at +4 1/2 stops and the cheeks already have a slight cut, so we can leave the value at about 5 stops without loss of texture and detail. As for the shadows, we recover information up to -2 stops, that is, the black cloth is -5 ½, although it already has noise. At higher underexposure values, noise masks texture and detail.

As for the S-Cinetone curve, we recover texture and detail with +2 stops, being there practically at the cut-off limit; the white fabric is at + 3 1/3 stops, with higher values of overexposure the white is clipped and is not recoverable. In the shadows, we recover detail in the black fabric down to -2 stops, where it is at -5 ½ stops. With -3 stops of underexposure the noise is already visible, with -4 stops it is high, but still some of the texture of the fabric is perceived. Due to the contrast shown by the blacks in the S-Cinetone curve, the textures are perceived less subtle, with less delicacy than with the SLog3 curve, so it has more depth in the half-light.

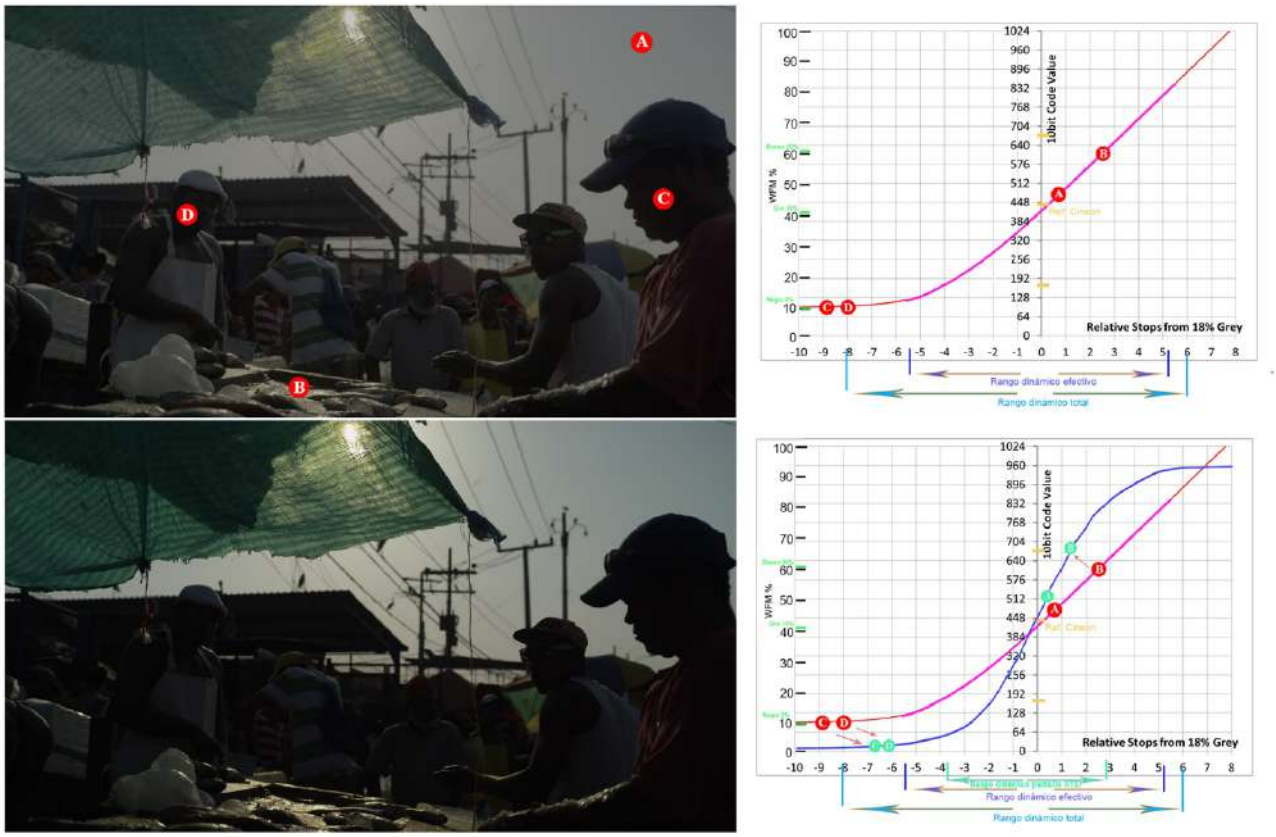



*Comparison between the S-Cinetone and Slog3 curves at 4 stops overexposed and 4 stops underexposed.*


Next, let's see these two stills shot in Cartagena within the framework of the FICCI and where different directors of photography from the ADFC participated. The first image where you see the clock tower and the sweets in the foreground, the exposure is set for the outside. The sky, the brightest area, is about 5 stops above mid-gray and therefore within range to maintain detail and texture. The white table on which the sweets are located is at -4 ½ stops, so we have the texture and the detail of it, although some noise is perceived. The D and B values are already completely outside the effective range of the camera, but even so, certain nuances of texture can be appreciated in the sweets, which allows that when we correct the image with the Lut 709 Type A there is a good depth of the blacks . The Slog3 curve gives us the possibility through color correction to adjust the range of the image to the contrast range of an STD screen, if indeed the sweets and the table itself will be in silhouette against the illuminated background, giving a deep black, clean where you can intuit the textures.

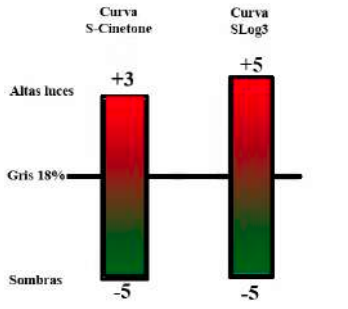



*FX9 EI Mode Slog3/S-Gamut3.Cine, con Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 YCbCr 4:2:2 10 bits. XAVC Intra.*




*FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/120 YCbCr 4:2:2 10 bits XAVC Intra.*

In this second image the value A of the sky is practically in the middle gray and a little more above this the brightness values B of the fish. Faces C and D are in complete silhouette in the backlight, well below the effective range in the shadows, so we will not be able to retrieve any information there. If we enlarge the image in those areas, we will see that we have a high level of noise.



Comparación relativa del rango dinámico en las curvas S-Cinetone y SLog3. (codec xavc-i)

After all these tests, the range that I am going to consider and that I will put in the Spotmeter or in the wfm will be for the Slog3 curve of 5 stops below the middle gray in the shadows and 5 stops in the highlights above gray. In total an effective dynamic range of 10 stops, although I know that in the highs I can go up to 5 ½ stops in some cases and in the shadows up to ½ stop more. However, with these values that I indicate I guarantee to have all the texture and detail.

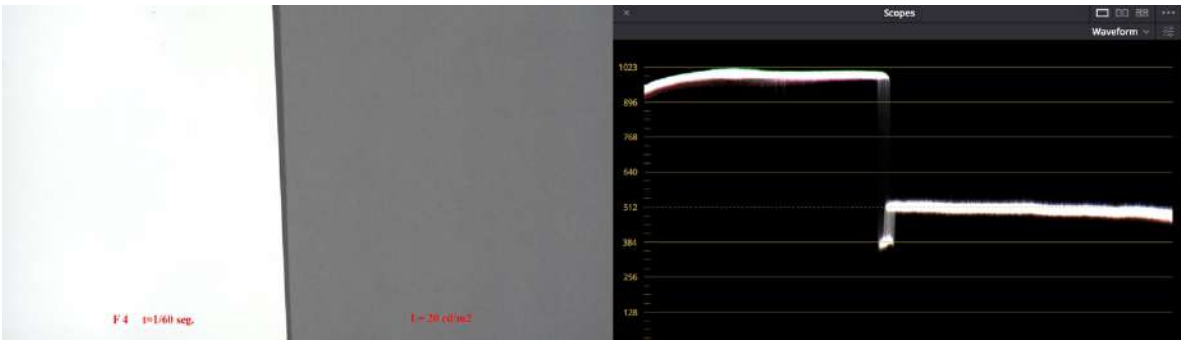
For the new S-Cinetone curve I will use a range of 3 1/3 stops in the highlights and about 5 in the shadows, in total about 8 1/3 stops. Although, I can see in the highs up to 1/3 of a stop more without clipping and in the shadows it could also go up to ½ stop more.

**NOMINAL / EFFECTIVE EVALUATION OF THE EXPOSURE INDEX (IE).**

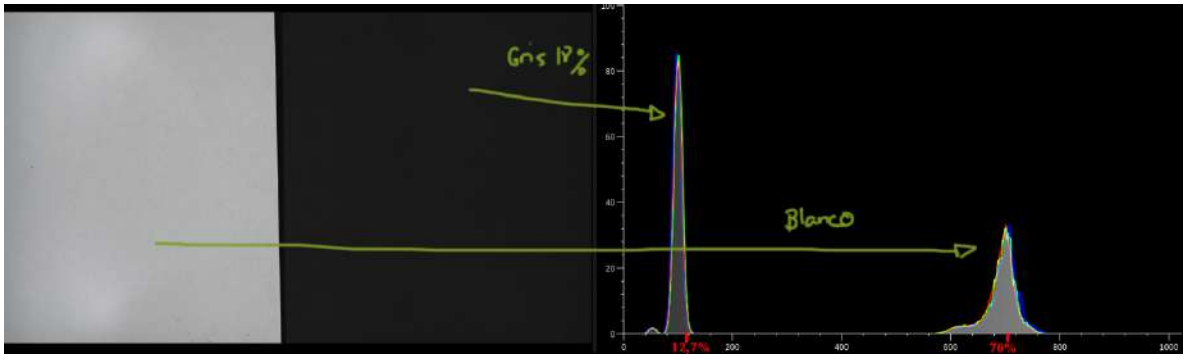
As is usual in our tests, we have looked for the nominal exposure index, to use it as a starting point and compare it with that of the camera to see if they match or not. We obtain this nominal EI in accordance with the standards established by manufacturers or professional associations. We have used the formula proposed by Kodak in their App Note MTD / PS-0234, and which is derived from the formula on base saturation proposed by CIPA DC-X004-2004
(http://www.cipa.jp/english/index.html)

$$ISO = \frac{15.4 \cdot f\#^2}{L \cdot t}$$

The value 15.4 is a constant that is derived from considerations, including but not limited to, lens paperwork or vignetting factor. The value f is our diaphragm squared, L is the value of the light reflected by the 18% gray chart and t is the exposure time in seconds, considering a gamma of 2.4, that is, the STD 5 curve.



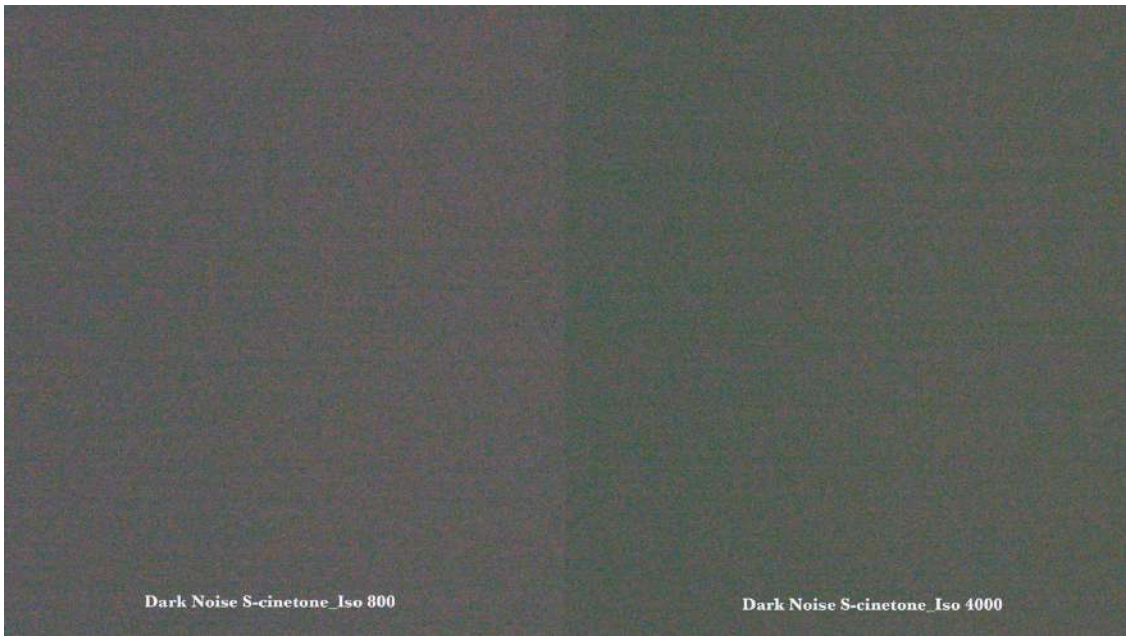

Although these camera sensitivity ratings are intended for digital still image sensors, we believe they are also applicable to digital motion picture cameras, considering a 2.4 gamma and YCbCr color space. The camera is configured in its base value Low, that is 800. The value we have obtained is 770 Iso, that is, practically the value of 800 that is used as a reference in the camera. Another way to check it is by analyzing the image of the gray and white card in linear mode, that is, without applying the gamma curve, according to the ISO standard the value of gray is 12.7% and white is 70% , we check again that this is the case with the ISO of the camera at 800.



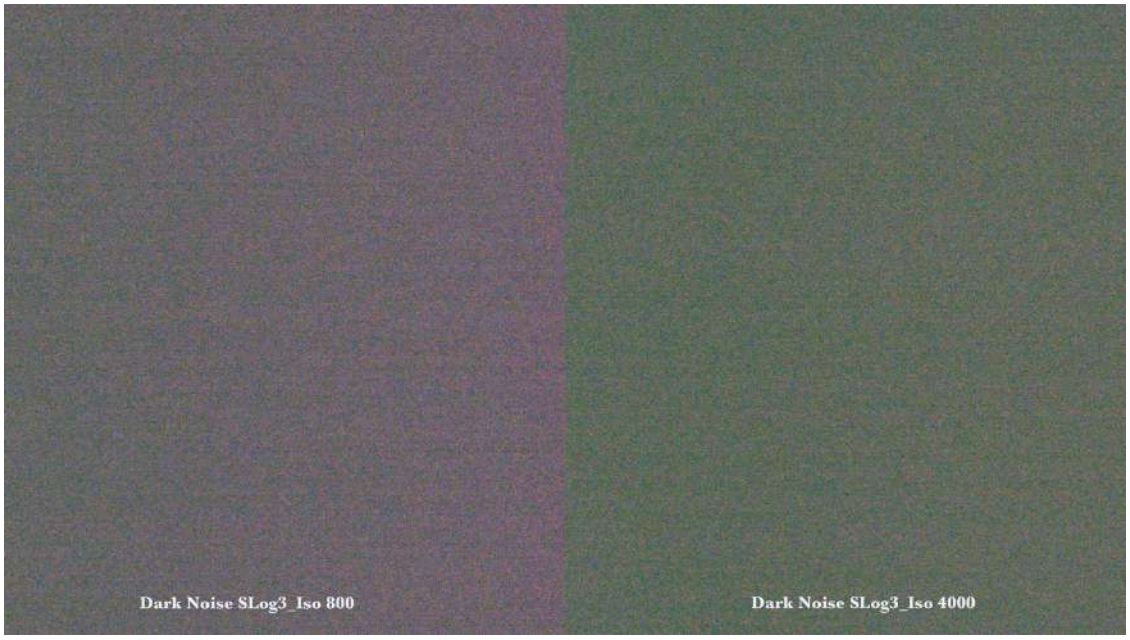

The coincidence of the results obtained by means of the references to the standards with the values of the camera also occurs with the base of the ISO high (4000). The introduction of the Dual ISO, leads us to determine that now the effective ISO values that we can handle to determine the Exposure Index are much broader than in previous cameras that did not have this system. So much so that we are going to analyze the noise and we will see that we can use practically all the ISO values without a significant deterioration of the image.

**Noise**

One of the areas where one expects a noticeable improvement with the new FX9 camera is noise. Noise, that random variation in brightness and that comes from different sources, significantly affects the quality of the image, especially in what has to do with the dynamic range and resolution. We have started by observing the base noise of the camera, that is, the noise that is not affected by light, for this we have recorded a few seconds with the sensor covered. We have done it after having carried out a black balance.

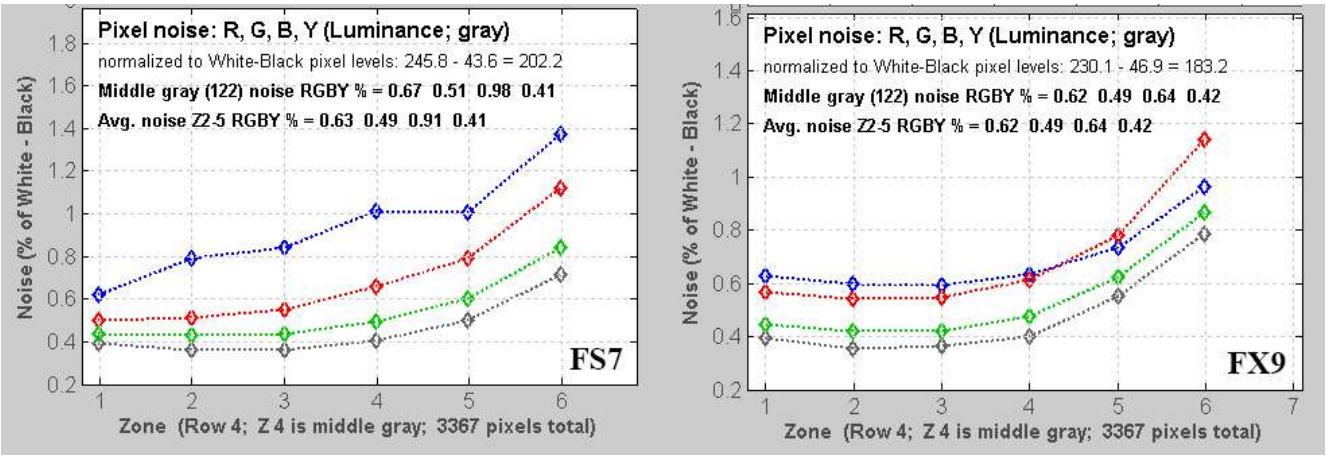


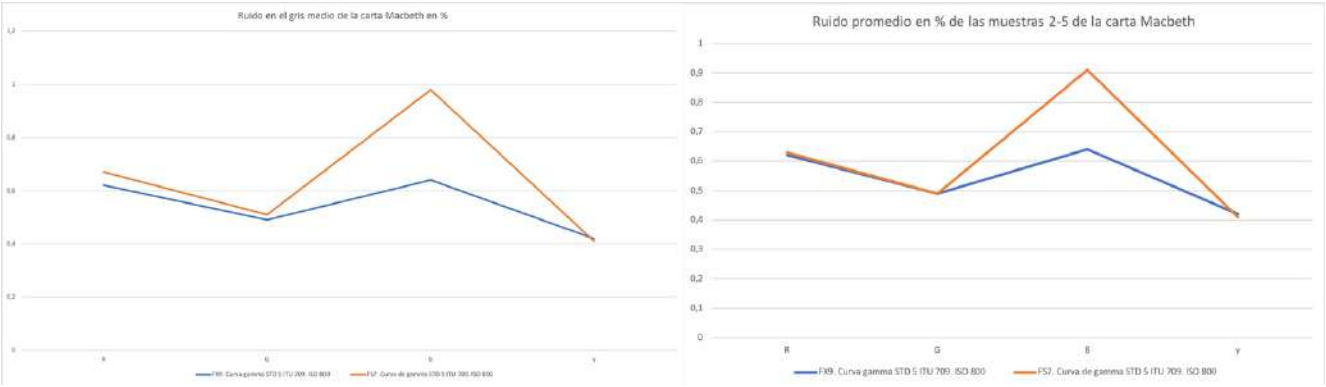

With the S-Cinetone curve, the appearance of the noise in terms of its movement and “thickness” is practically identical to the ISO 800 and 4000 values, but what does change significantly is the “color” of the noise as seen in the image. The same happens with the Slog3 curve in EI mode, although at 800 there is a more intense magenta cast than with S-Cinetone.



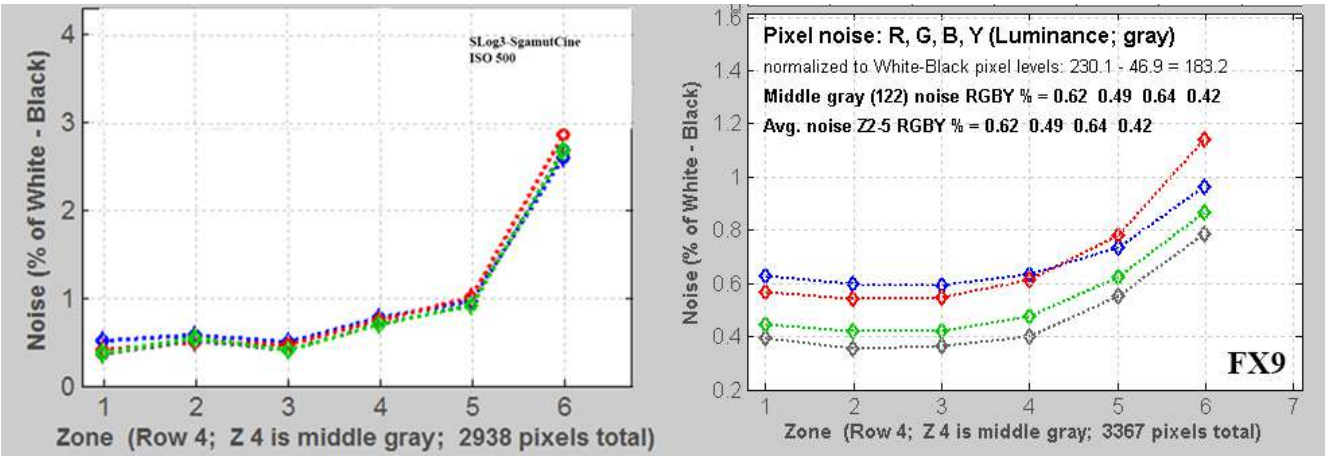

To observe the base noise we have increased the exposure and contrasted the image in an exaggerated way. The fact that at the two base ISO values of the camera the "color" of the noise is different can lead us to think about the need to perform the black balance several times to see if they are balanced or to perform the black balance each time it is changed the ISO value or ultimately think that this variation is inherent to the camera regardless of the black balance. Let's now see the noise in its context, that is, with the image, and let's see it in two ways, the amount of noise and its ratio in the three channels. For this, we will first see the noise comparison with the FS7. We have shot the Macbeth load and analyzed the noise with Imatest, the two cameras were in the same conditions and the same light. The reference value we have taken is 800 ISO in both cameras with the STD 5 curve.

The horizontal axis shows the gray scale and the vertical axis shows the % of noise refers to the total CV from black to white.

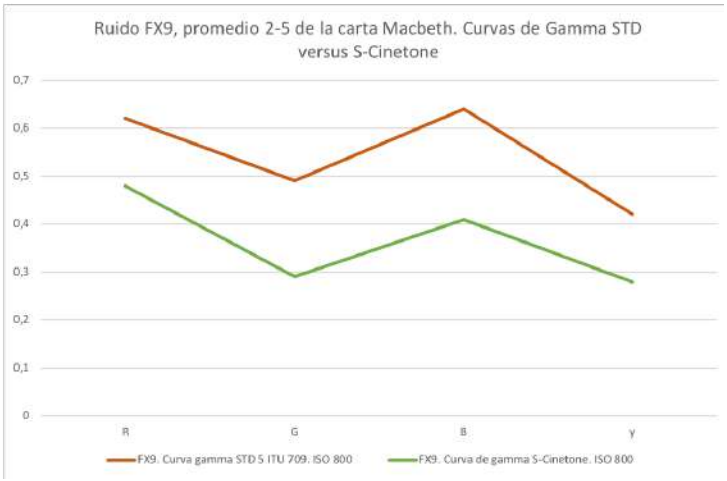


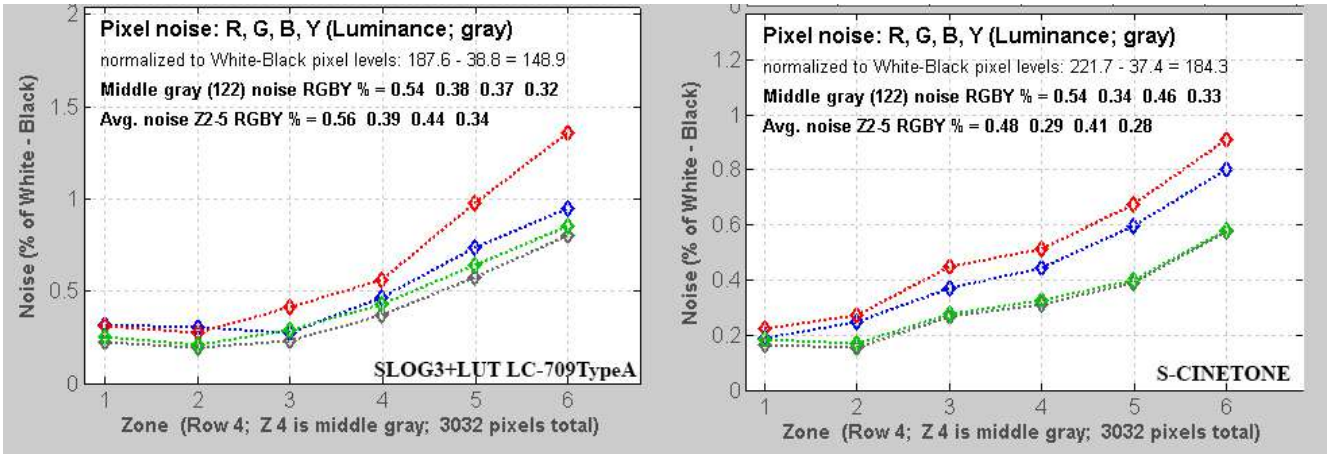



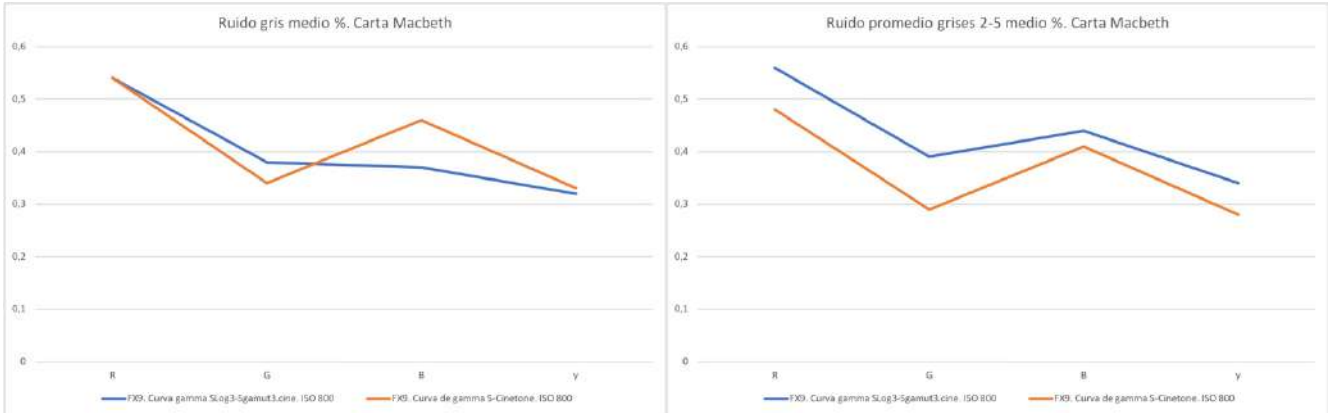

In the graphs we see that the noise in the channels is lower in the FX9 especially in the blue, for example, in the middle gray the FS7 shows a value of 0.98% while in the FX9 it is 0.64%, a notable difference. In addition, we see how the noise is distributed among the three channels, being more uniform and homogeneous in the FX9. But to put the camera in context, let's also compare it to the Venice camera. Although the noise values are low in both cameras and similar, what is very different is the balance between the noise of each channel, being the same in the Venice while in the FX9 the noise of the blue and red is higher than the green channel. This makes the appearance of the noise, its "color" more organic and more balanced on the Venice than on the FX9.



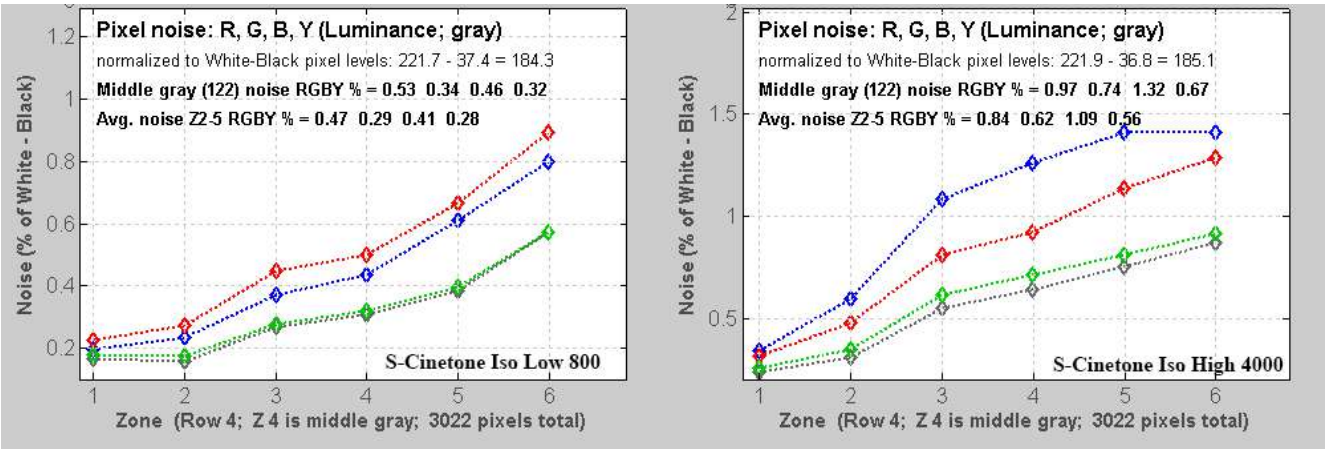
The noise visibility will depend on the gamma curve that we are using, if we compare the STD5 curve with the new S-Cinetone, we will see that it shows less noise as it has more contrast in the blacks. Finally, we can compare two curves, two different ways of distributing the brightness values, the S-Cinetone curve with the Slog3 curve. The base ISO is 800 and the Slog3 curve is corrected with Lut 709 Type A. In the middle gray the SLog3 shows slightly less noise, but in the overall gray average it shows more noise than the S-Cinetone. The gray scale balance is for the middle gray 18%.

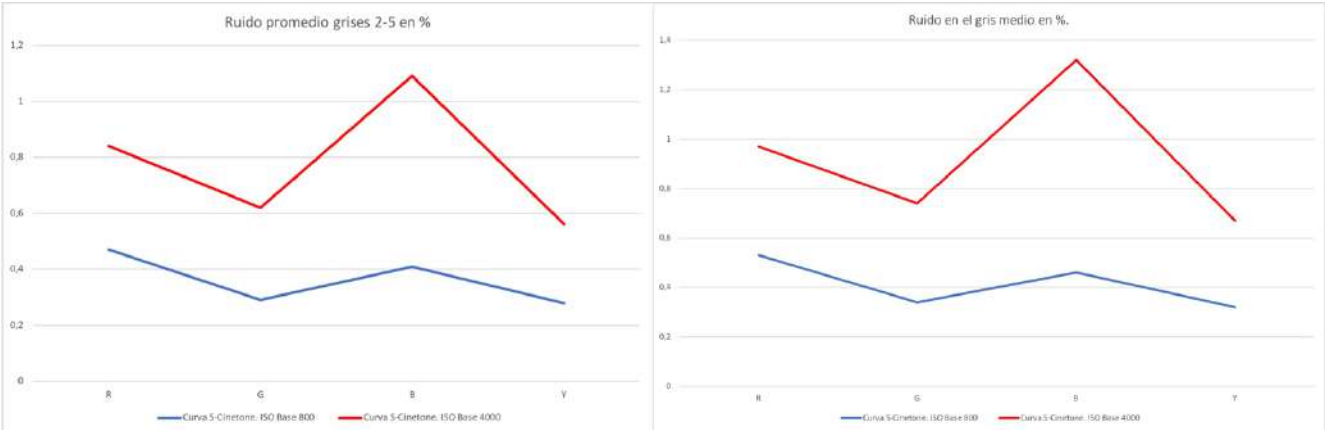



We can say that in general the noise does not change substantially when we use different gamma curves and its visibility will be somewhat subject to the contrast that each one of them handles. Another approach that we can give to noise is to study it in the dual ISO that the camera handles, a low ISO (low) whose value is 800 and another high (high) of 4000.

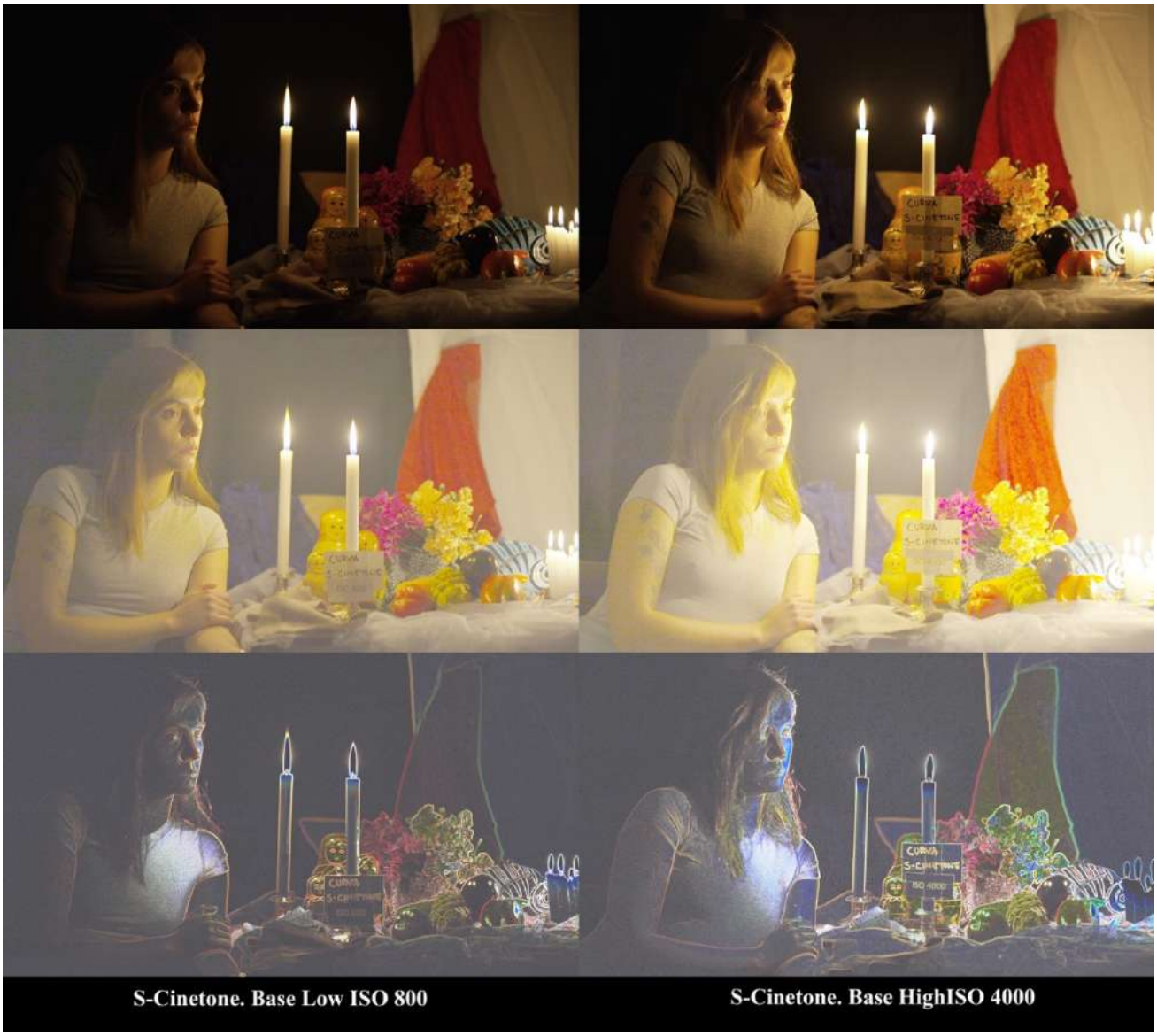


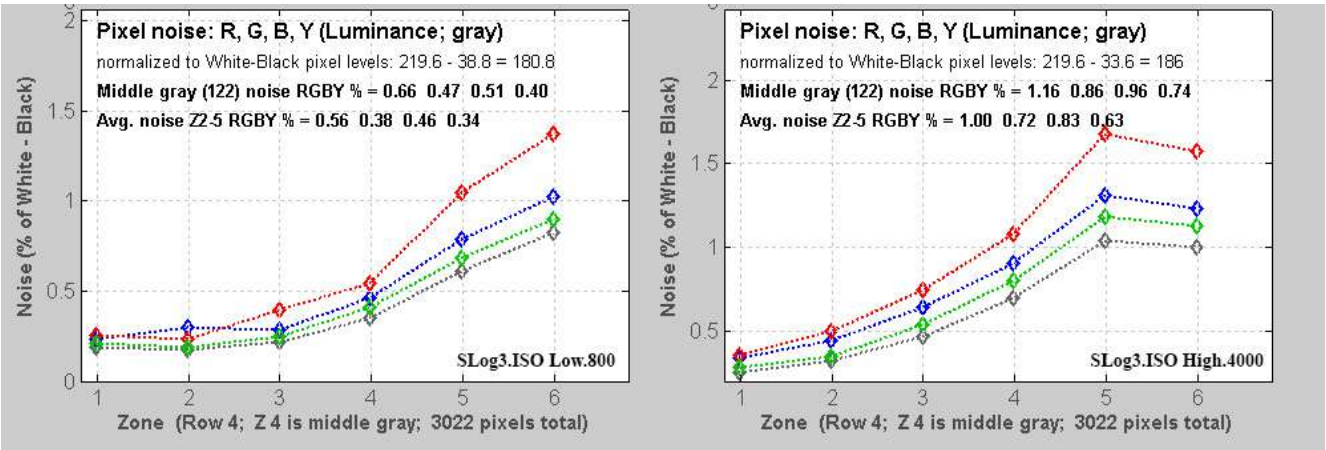

There is an increase in noise with 4000 ISO, especially in the blue channel which, at 800 ISO is 0.46% and with 4000 1.32% measured in the middle gray. Average grayscale noise (patterns 2 to 5) shows a blue channel value of 1.09% at ISO 4000 and 0.41% at ISO 800. This increase in noise, however, is not visually relevant as we can see in these frames of the model with candles.

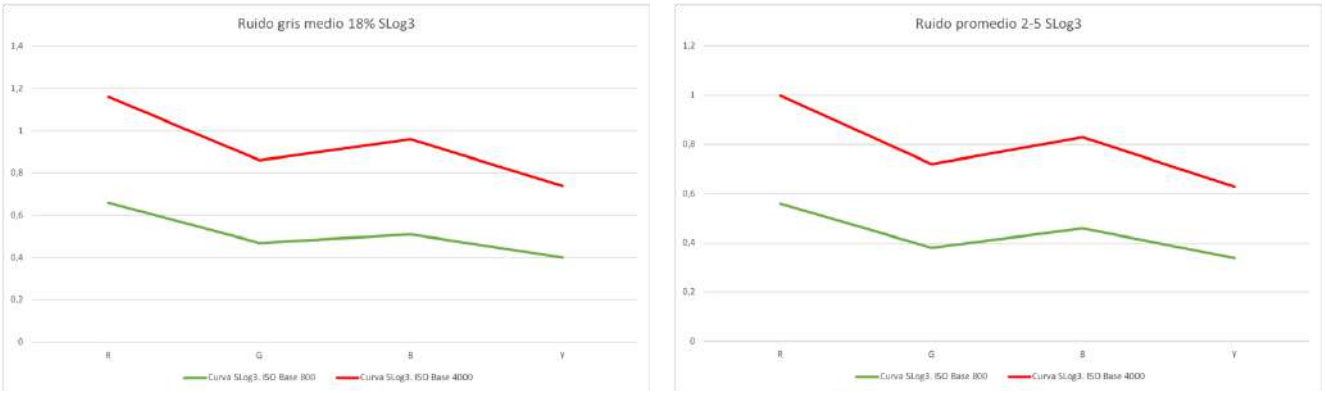
*Sergio García ADFC in the Walls of Cartagena.*

*Mateo Guzmán ADFC in Bolívar's square. Cartagena de Indias*



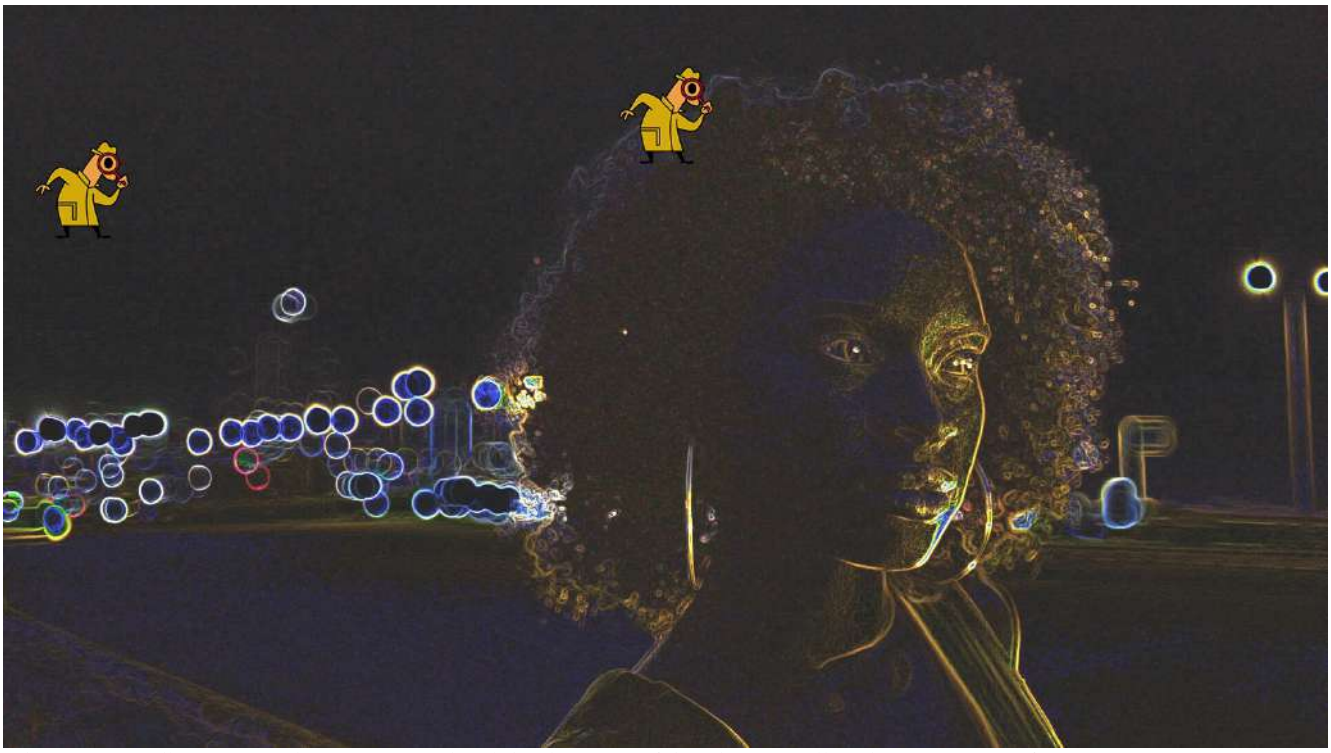

The upper image is the original camera frame with the S-Cinetone curve, in the middle one we have raised the exposure and the midtones to visualize the noise, which as we can see visually is very similar between both values, although there is a slight increase in 4000 but that seems irrelevant to us. In the last row we show the frame passed through the edge detector, which allows us to observe how, although there is a slight increase in noise to 4000 (see the background behind the candles), it is really low and what is more interesting, this noise does not decrease the resolution, the edges of the objects are still visible in detail. Something similar happens with the SLog3 curve, there is an increase in noise in the value 4000 compared to 800, practically the noise increases twice as we see in the graphs, although the average noise in the gray scale does not exceed 1% . This means that the noise is really low in both sensitivities and this is how we can observe it in the frames of the model shot in Cartagena de Indias with the sodium vapor night light.




In these exterior shots we again check the good noise behavior at 4000 ISO.

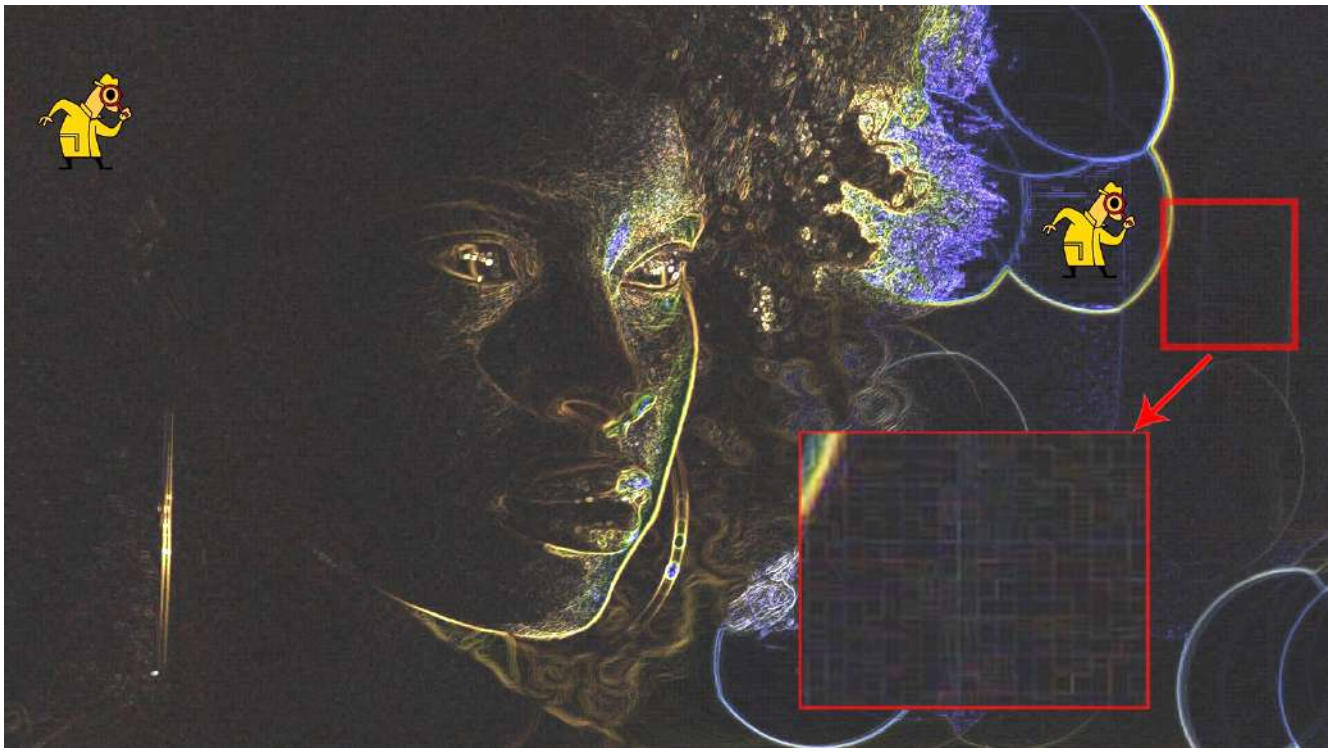
*FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 23.98, ISO 4000. 5.500K. YCbCr 4:2:2 10 bits XAVC Intra. 23.98fps*



*Edge Detector allows you to observe in more detail the sharpness of the edges as well as the appearance of noise.*

In this shot, the noise in the sky illuminated by the glare of the streetlights is hardly noticeable, showing itself in a very discreet way, the same happens in the darkest part of the model's face and it is necessary to observe the good behavior towards the details, for example, the model's hair is sharply cut against the dark background. In the short shot, the noise from the darkest part of the face, including the hair, is hardly noticeable, although we highlight the structure of the compression that we can see by enlarging a part of the frame and passing it through the edge detector. Magnification is x1000

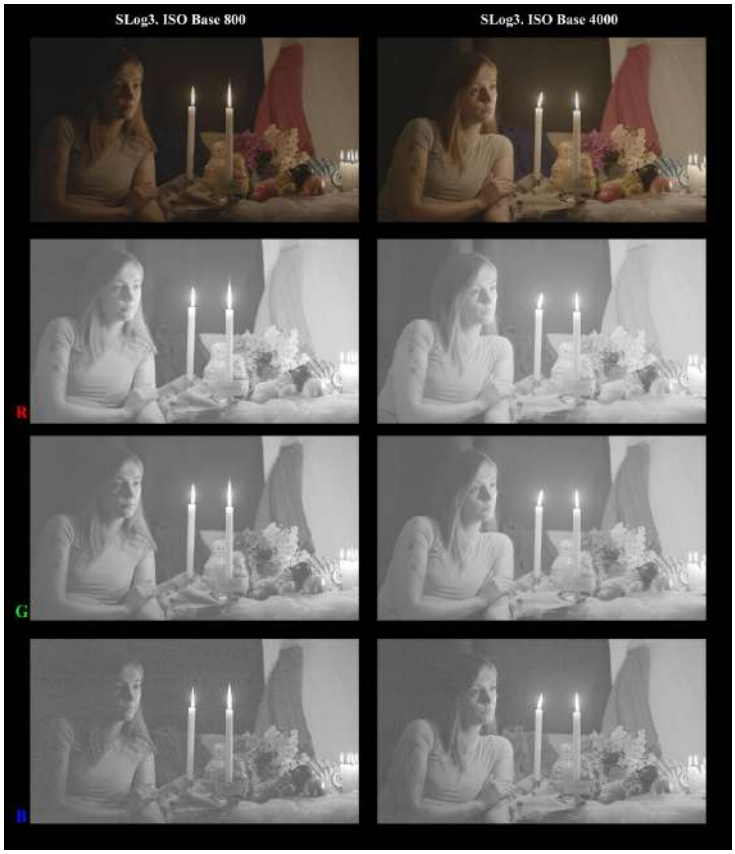
*FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 23.98, ISO 4000. 5.500K. YCbCr 4:2:2 10 bits XAVC Intra. 23.98fps*



By choosing a base ISO value we can always modify it up or down in Custom mode. In IE cinema mode the image is recorded at either 800 or 4000. But if we shoot in Custom, we can use other values than the base and the question is when do I have more noise, if I roll with base low and go up to 1600 or if I use the base high 4000 and low to 2000? Well, if we look at the example below in the blue channel we will see that with base 4000 we have less noise if we put 2000 ISO than if we use the base low and go up to 1600 ISO.

*ISO Base Low. ISO 1600. Blue Channel*

*ISO base High. ISO 2000. Blue Channel*

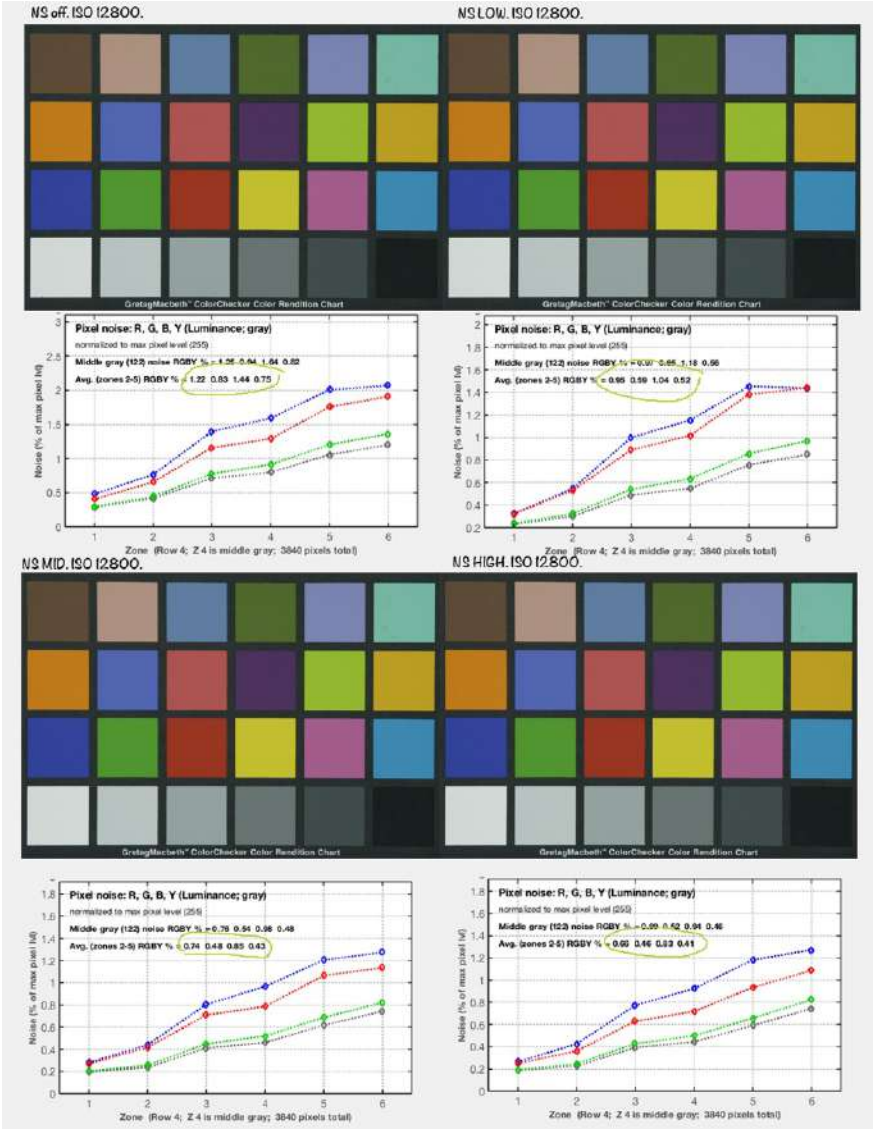




In the Slog3 curve we can handle two values of IE, 800 and 4000 as you can see the noise in the three channels is very similar in both Exposure Index, being the most visible noise in the blue channel. The average noise, as we saw with the analysis of the gray scale of the Macbeth chart, is in both cases below 1%, which gives the image a very clean appearance with depth and detail in the half-light and darkness.

In summary, we can say that the FX9 is an advance in relation to the FS7 in what has to do with noise, showing first a relative reduction between 10 and 15% compared to the second. We can also indicate that the noise distribution in the FX9 is more homogeneous and equal than in the FS7, but without reaching the quality of the Venice. While there is a difference in noise between the two base IE, being higher at 4000 than at 800, it is not visually relevant and the images at both values appear quite clean, with no masking of detail at the higher ISO. Average levels at the highest ISO value (4000) do not exceed the 1% level with the SLog3 curve and are slightly above the S-Cinetone curve. We consider a noise level of 1% or less to be really low and not visually significant. The difference between the two base ISO values, still existing, is not relevant when handling one or the other or mixing them in the same sequence..

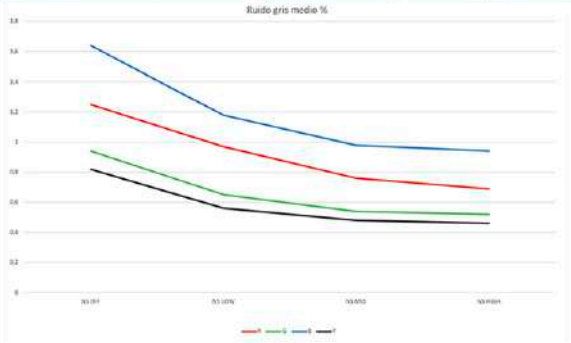
**The noise suppression system.**

The camera has a noise suppression menu that may or may not be on and when it is, noise reduction can be done at three levels: low, medium and high. We have analyzed this tool first by evaluating the noise level on the gray scale of the Macbeth chart, starting from an ISO value of 12,800. In the graphs you can see the noise values in % referring to the relation to all the brightness values from 0 to 255, the maximum brightness value, that is the noise value of the graph represents that % of the total of brightness values, correspond to this. The graphs show us two values, one the middle gray and the other the average of the samples 2 to 5 of the chart, and it does so in both the RGB channels and the Y value (luminance).




| Canales | Valores del gris medio en % | | | |
|---|---|---|---|---|
| | NS OFF | NS LOW | NS MID | NS HIGH |
| R | 1,25 | 0,97 | 0,76 | 0,69 |
| G | 0,94 | 0,65 | 0,54 | 0,52 |
| B | 1,64 | 1,18 | 0,98 | 0,94 |
| Y | 0,82 | 0,56 | 0,48 | 0,46 |

| Canales | Valor promedio % grises 2-5 | | | |
|---|---|---|---|---|
| | NS OFF | NS LOW | NS MID | NS HIGH |
| R | 1,22 | 0,95 | 0,74 | 0,66 |
| G | 0,83 | 0,59 | 0,48 | 0,46 |
| B | 1,44 | 1,04 | 0,85 | 0,83 |
| Y | 0,75 | 0,52 | 0,43 | 0,41 |





The noise with the reducer decreases considerably, so for example we see that in Y it goes from a value in the middle gray of 0.82 to 0.46 with the High value. We can consider that the tool is really effective, but what other consequences does applying the noise reducer have? Normally when applying noise reducers, resolution is sacrificed, especially at very high frequencies, those that determine the finest details, but in this

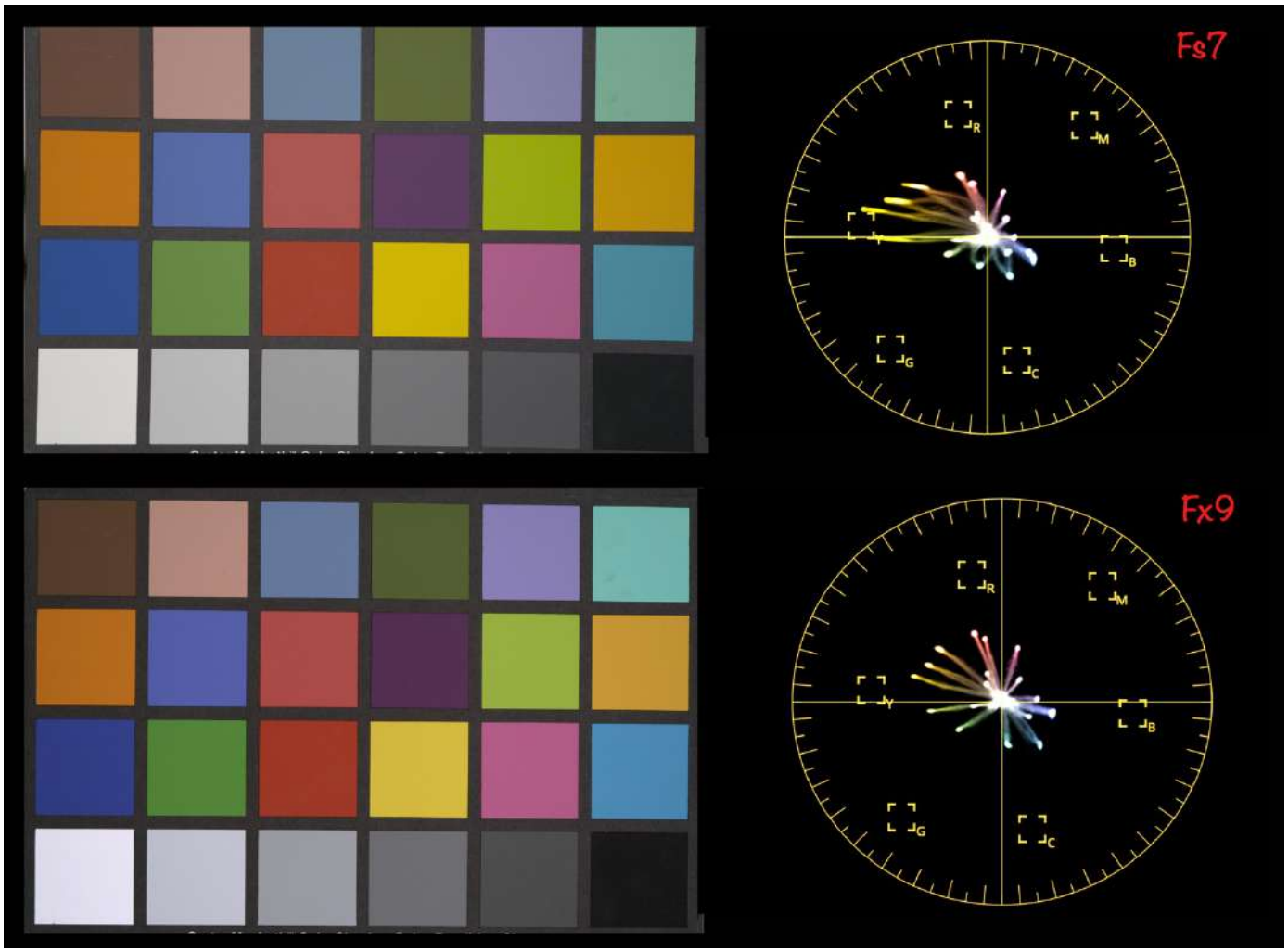
case we have not observed such an effect. To do this, we have photographed the ready-to-w *prêt-à-porter* test chart and have passed it through the edge detector, first at an ISO value of 12800 and then with the same ISO but with the NS in High value, as can be seen there is no loss of resolution in the textures of the fabrics.


*Alfonso Parra ADFC. Cinematographer*

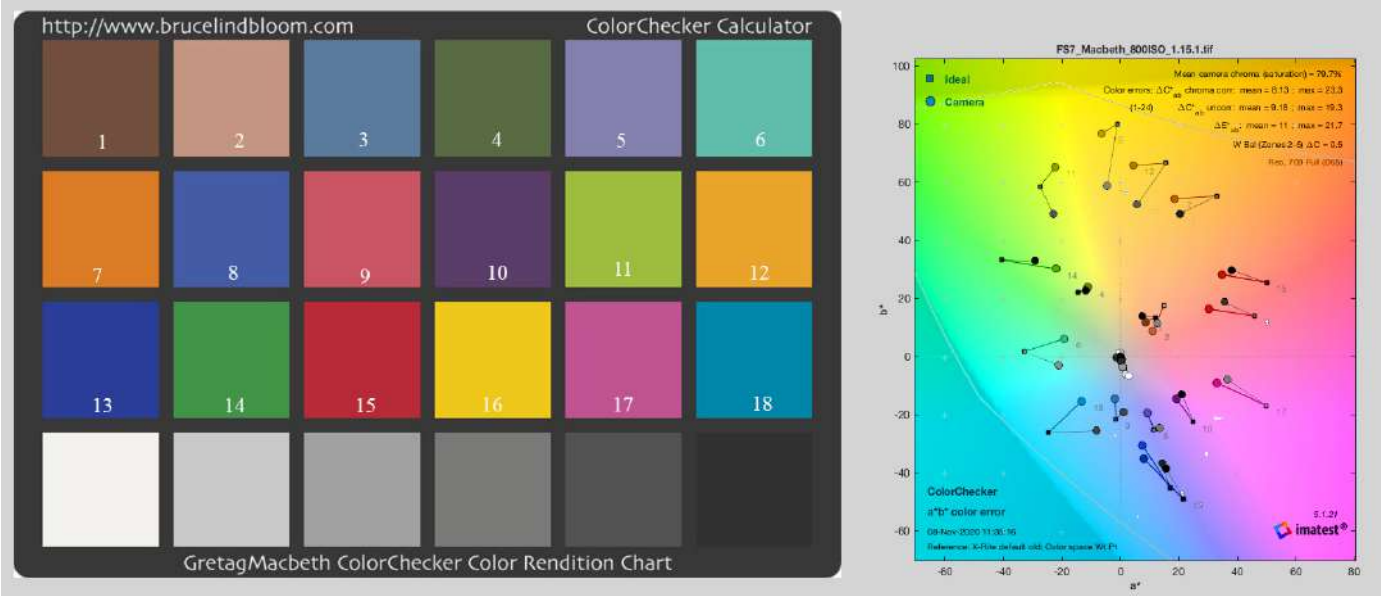
*Adriana Bernal ADFC. Cinematographer*

COLOR EVALUATION

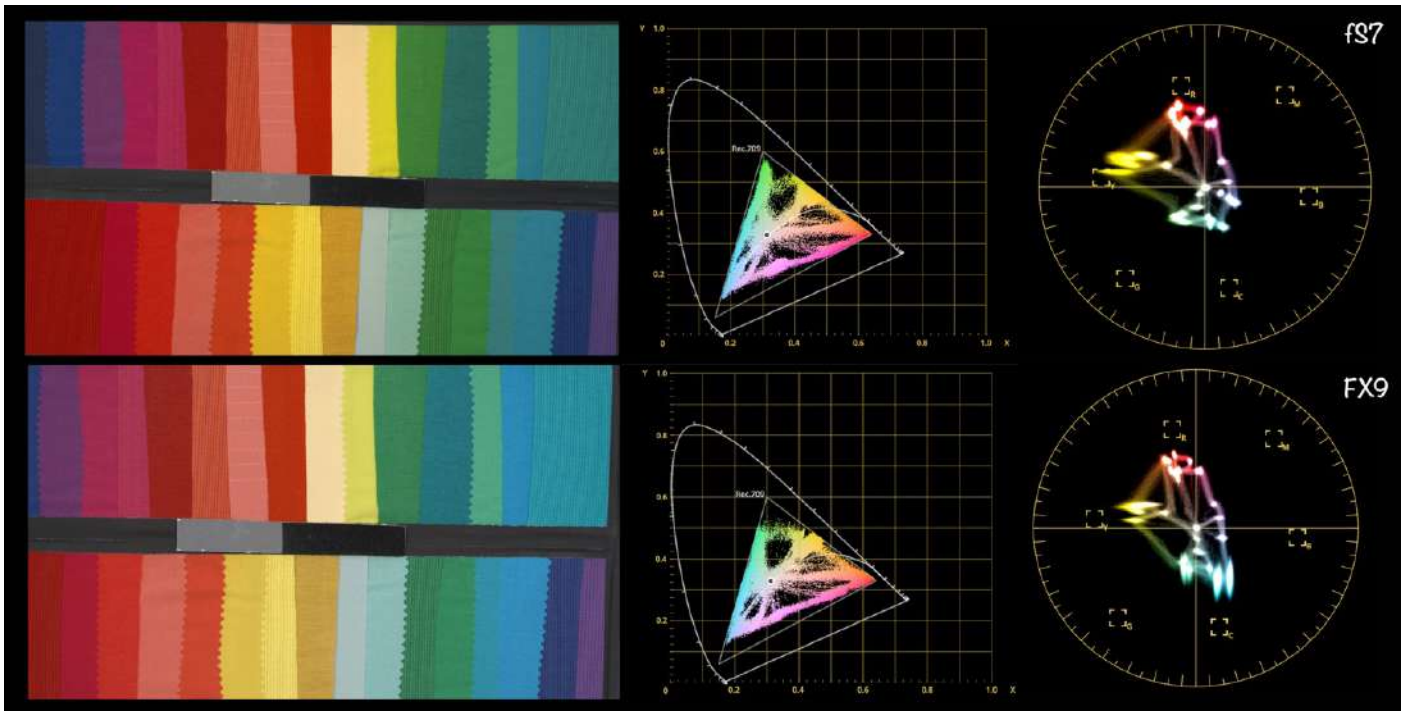
One of the novelties that Sony points out in the FX9 is a new color science, which is closer to that of the Venice than to that of the FS7, so we have started by analyzing a color chart with both cameras.



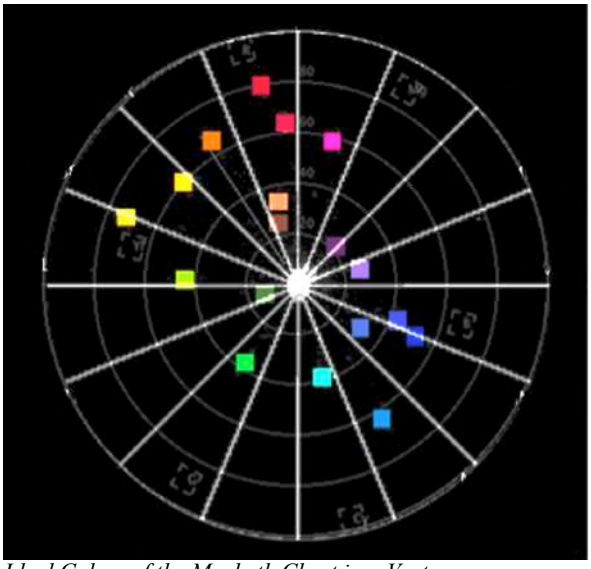

In the process of analyzing the cards we have to indicate that while in the FS7 the neutral gray appears as such considering that the color temperature of the camera corresponds to the color temperature of the sources. In the FX9 the gray is deviated towards the blue, giving a colder gray. The light sources are corrected so that they do not have deviations, an adjustment that was made using the Sekonic C700 spectrometer and the vectorscope. The configuration of both cameras is identical. From the outset, we note that the yellow / orange tones are much more saturated on the FS7, the greens, cyans and blues slightly more saturated on the FX9, the cyan being somewhat colder. The following graph generated by Imatest compares the Macbeth values in the two cameras; in gray tones are the values of the FX9 and in color those of the FS7. There are noticeable differences in samples 6, 11 and 18, that is, the shades of cyan, turquoise and yellow-green. Reds, blues, and purples are similar in intonation, as are skin tones (samples 1 and 2).



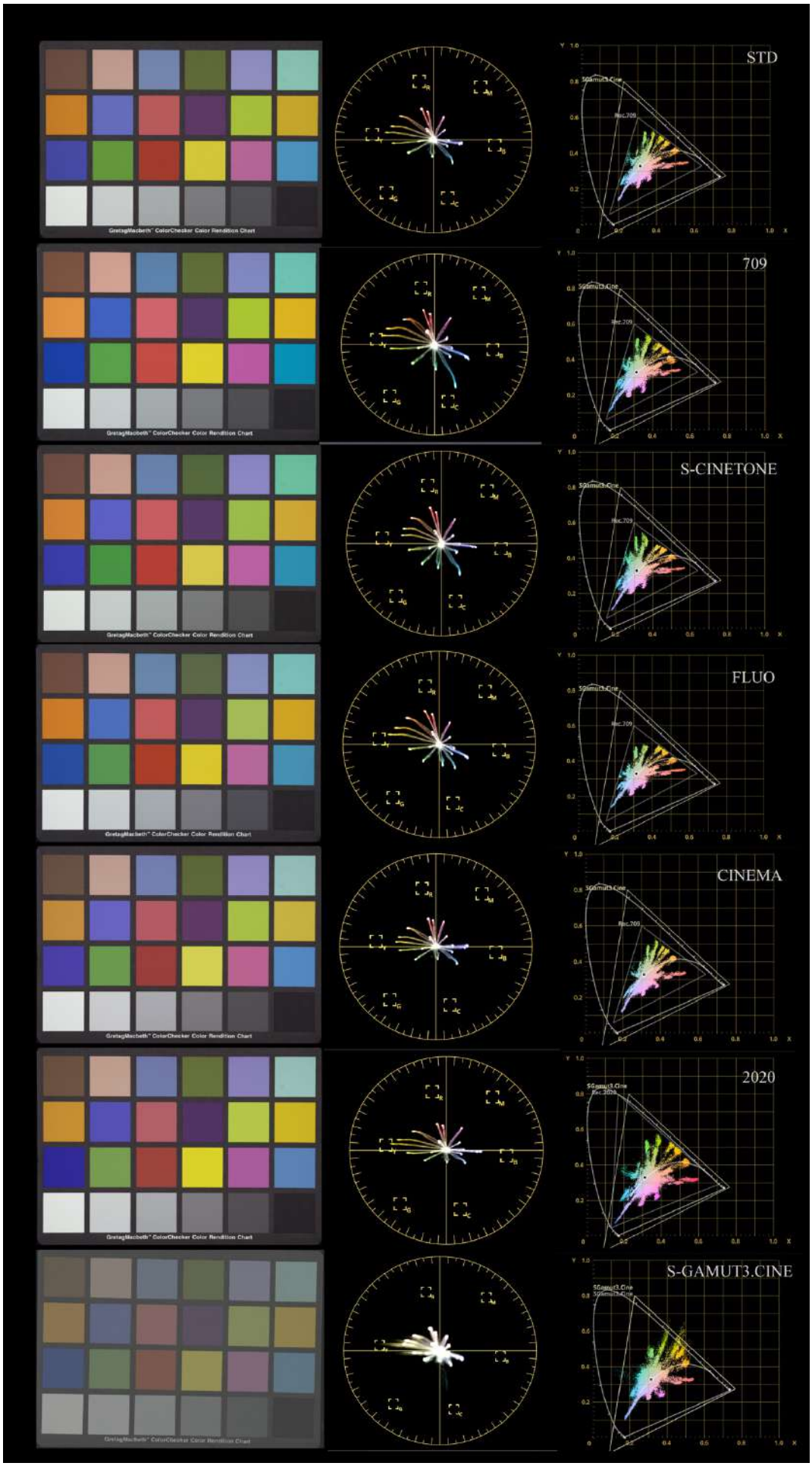

In our rainbow chart we can observe these differences in more detail. In reds, magenta, and pinks, tones are similar, although they appear less saturated on the FX9 than on the FS7. The differences are greatest in shades of green, turquoise, and cyan. On the FX9 they are slightly cooler with a shift towards blue that the FS7 does not have. Both in the CIE diagram and in the vectorscopes these differences can be carefully appreciated..

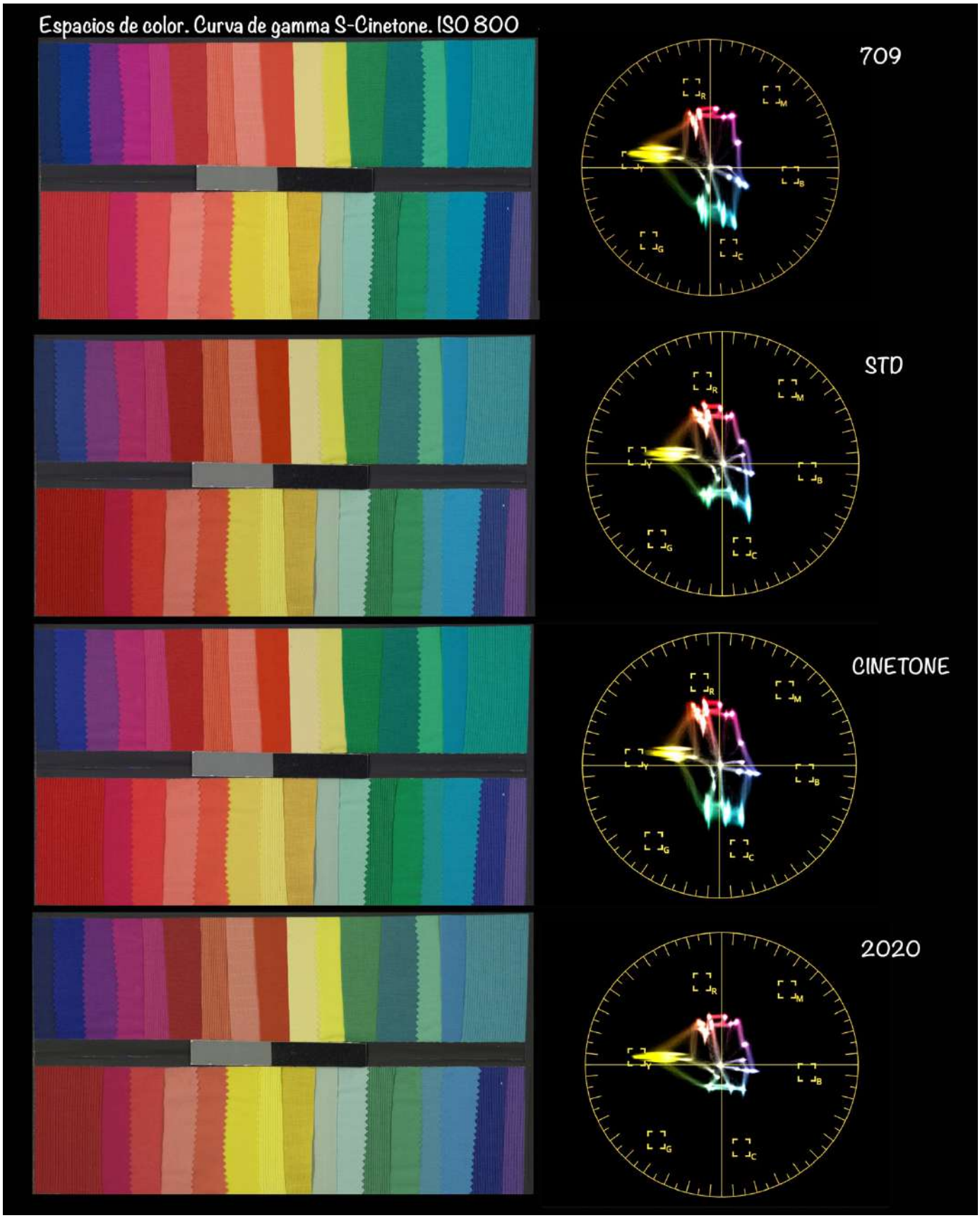


In these comparisons between the two cameras we have used the space 709 as a reference. The FX9 as usual includes different color spaces, from STD to the new S-Cinetone or 2020 for viewing in HDR. Here we compare the different color spaces. We have the different "flavors" within the conventional space, with slight nuances, for example, the tones are more saturated in the 709 space than in the STD, and much less in the CINEMA, where the violet and blue tones are slightly more magenta . The red and magenta tones are similar in all. In the larger 2020 or S-Gamut3.cine spaces, the colors acquire a greater tonal range, that is, more capacity to show shades of very similar tones. In the rainbow test chart, this can also be observed in the different fabric samples.



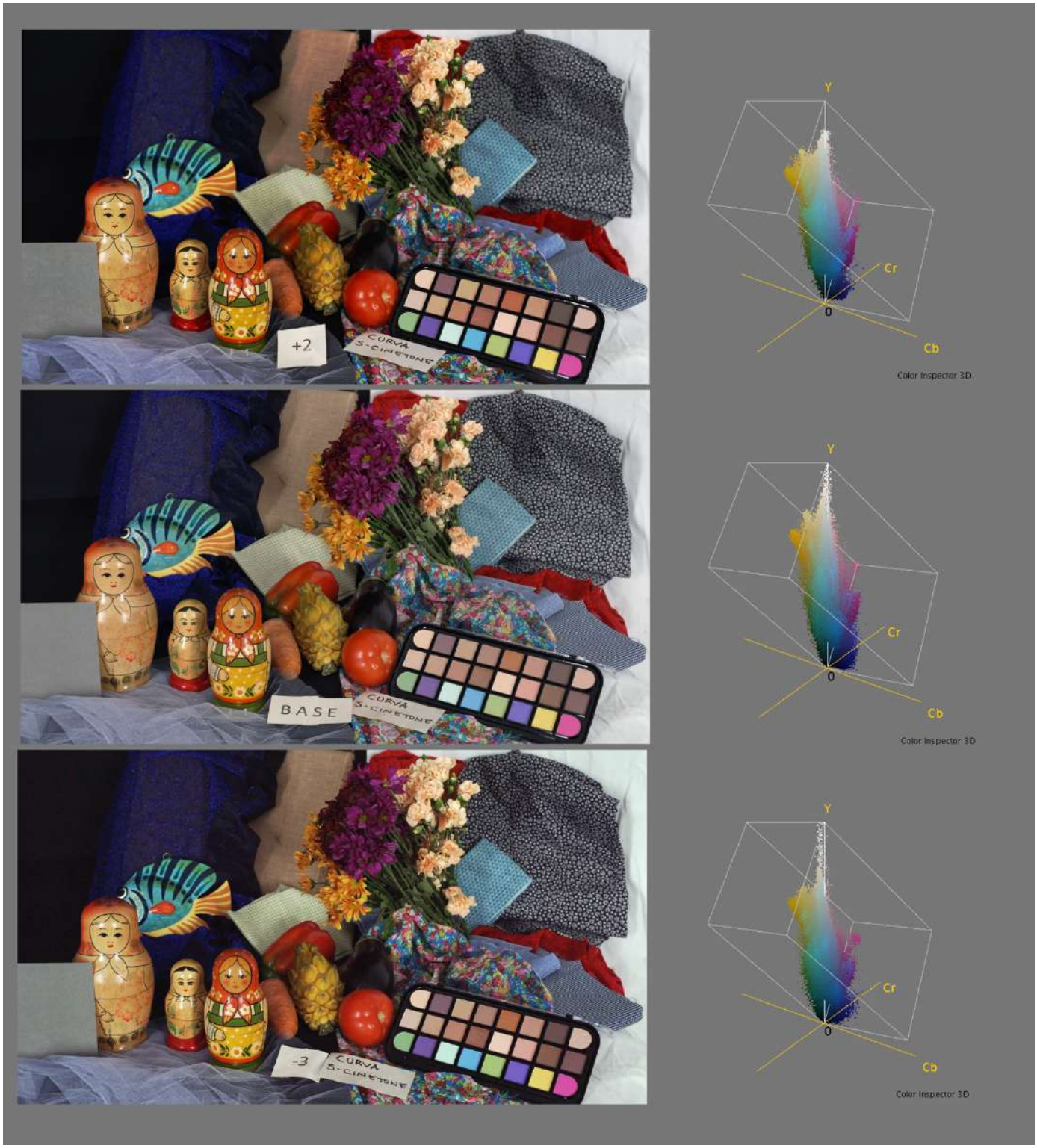
*Ideal Colors of the Macbeth Chart in a Vectorscope*


STD
709
S-CINETONE
FLUO
CINEMA
2020
S-GAMUT3.CINE

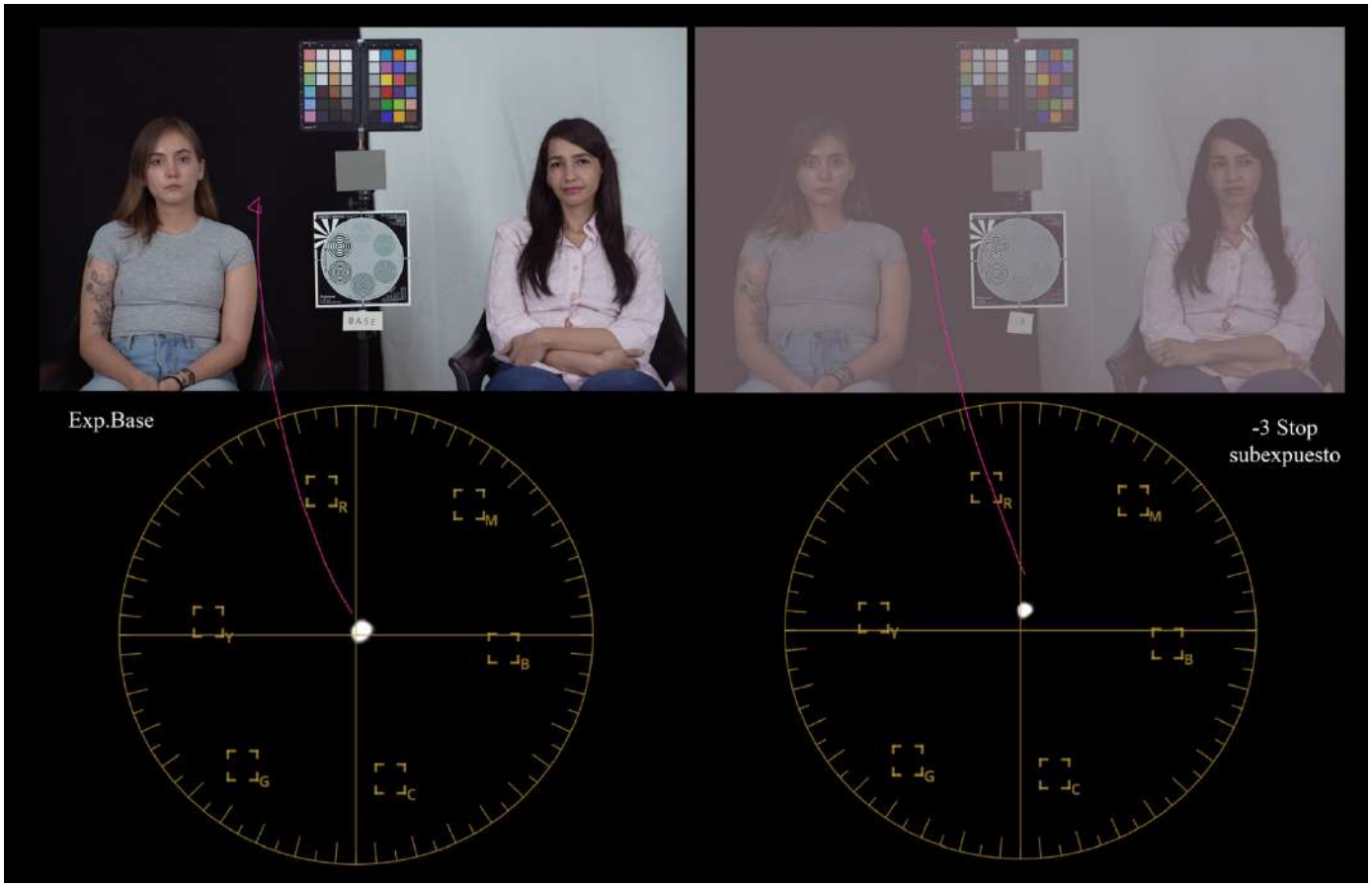



We are only going to comment here on the new S-Cinetone curve and color space, where, for example, the blue samples are more deviated towards violet than the STD or 709 ones, the green ones are less saturated, as are the yellow ones. The reader can make a detailed study of each of the colors.

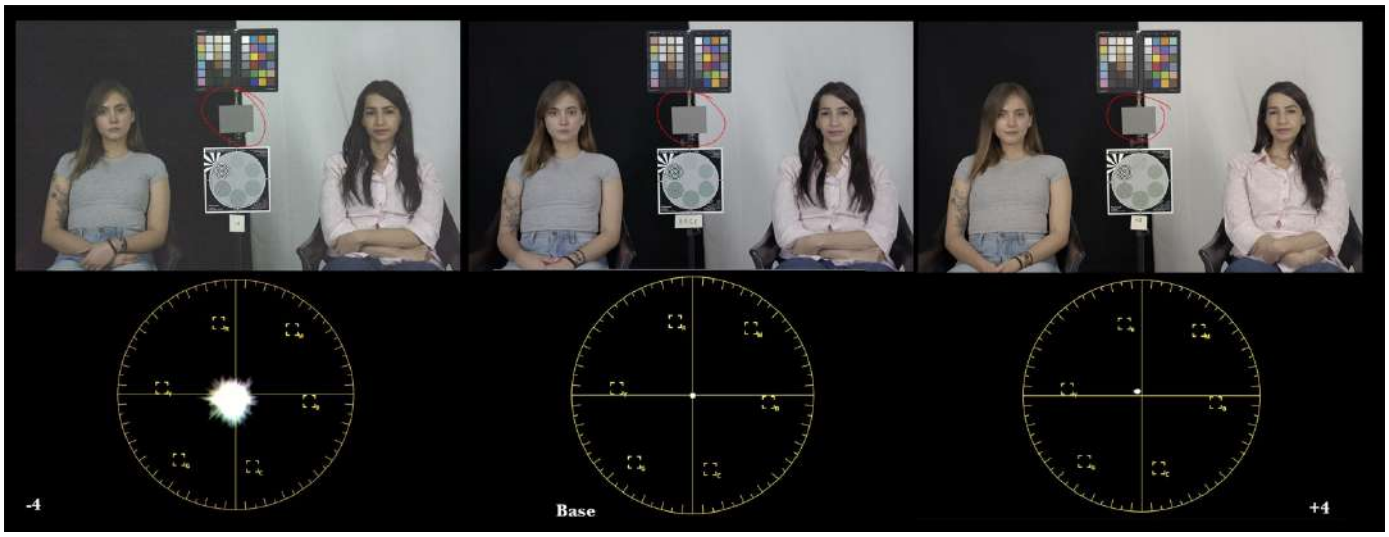
We have wondered how luminosity affects colors and for this we have photographed a still life with the S-Cinetone curve we have been underexposing and overexposing. In this image we have matched the overexposure and underexposure to the base exposure and we see that there is no difference in the color tones.




On the other hand, on the multi-exposure strips of the models corrected to a *one light* we have observed a general intonation balancing the base exposure for gray 18% with the S-Cinetone curve. Black is slightly shifted towards red as can be seen in the vectorscope if we don't adjust the brightness.

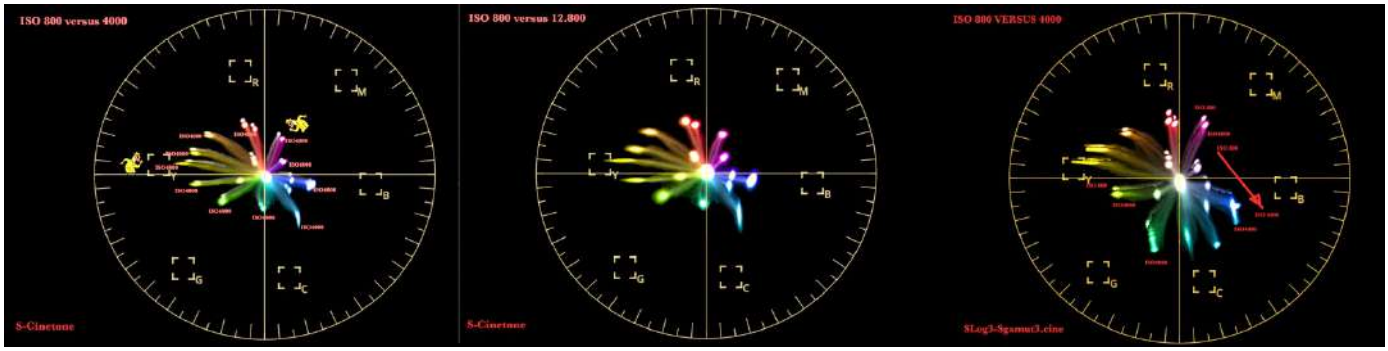



With the Slog3-SGamut3.cine curve, when adjusting the luminance of each exposure without application of the Sony lut, we observe that with respect to the balanced 18% gray of the base exposure, the overexposures have a slightly warmer tone, while the underexposures are toned towards cyan-green mainly due to noise.

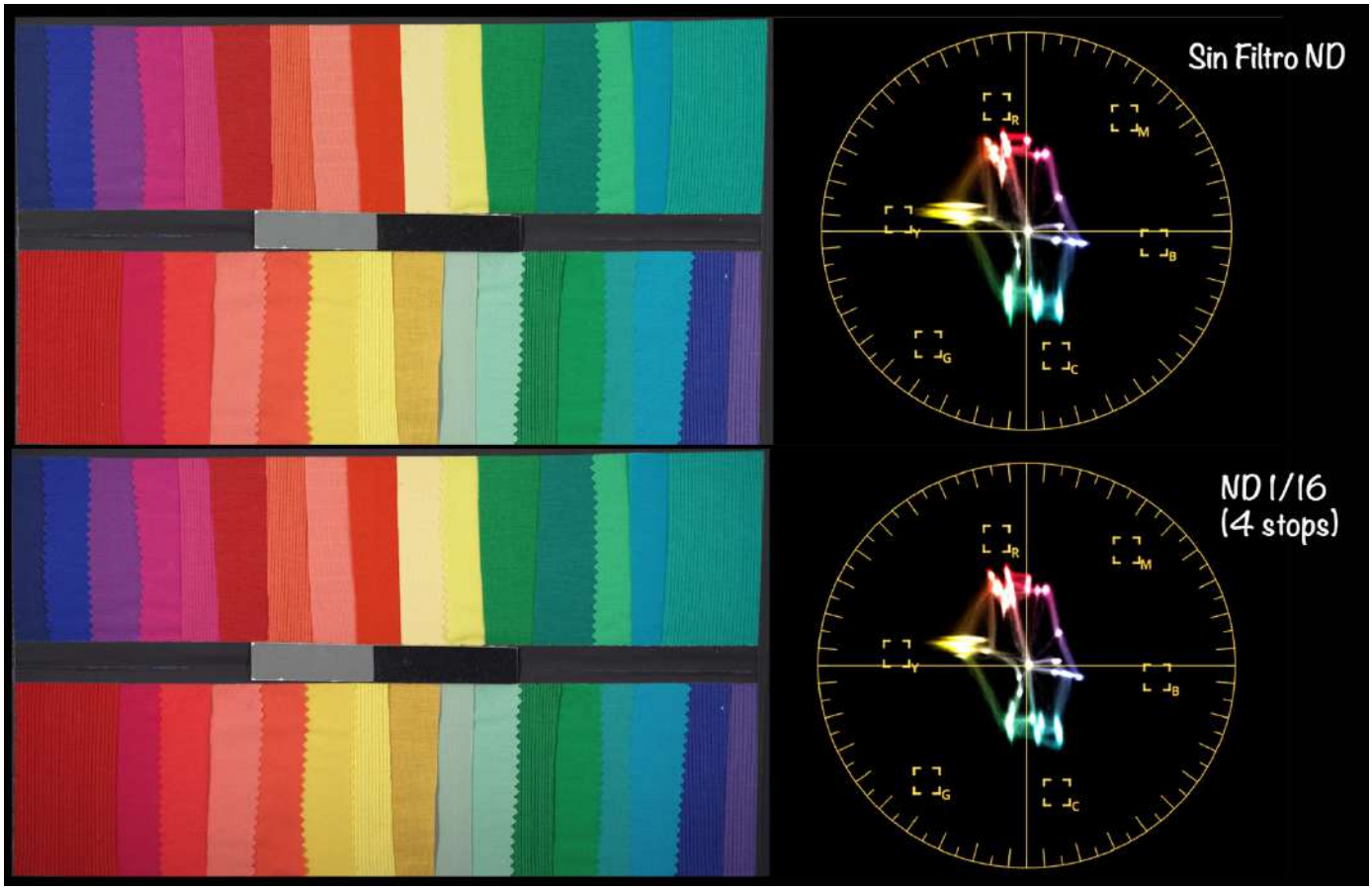



These deviations are perfectly corrected in colorization, without major repercussions on the image quality that the camera offers. We have also checked if there are color variations both when we use different ISO values or the use of neutrals, variable or fixed.
The different ISO values do not really affect the color, although if we can observe some nuances, for example, with the S-Cinetone curve there is a slight variation in the yellow and magenta tone of ISO 800 compared to

4000, we do not observe any change with values of Higher ISOs like 12,800. With the Slog3 curve we see a slight shift of the color in general towards blue cyan when we use the base ISO 4000 compared to ISO 800.




With both fixed and variable ND filters there is no variation in tones.




**Skin tones.**

A good reproduction of the skin tone is subject on the one hand to the resolution of the image, conditioned by the lens, the sensor, the electronic processing of the camera, the compression system, the applied gamma curve, etc. and on the other hand to the color space and the camera's ability to represent subtle shades of color. We are going to focus on looking at the skin tone on the new S-Cinetone curve and the Slog3. With the S-Cinetone curve, we have balanced 18% for the gray card so that it is neutral, its RGB values being equal. We have adjusted the brightness values, with gain, gamma and lift without touching the color directly in any way.


With overexposure, the skin tone becomes more yellowish than the base and the texture of the skin begins to be somewhat "plastic", artificial, however, the tone in underexposure remains quite similar to the base with slightly less saturation. As we saw in the dynamic range section, shooting with the S-Cinetone curve requires precision in the exposure, since it does not withstand overexposure very well, up to 3 1/3 stops. The compression in highlights made by the curve affects skin tones when they are overexposed. With the SLog3-SGamut3-cine curve the tones are maintained both in the highest overexposures and in the underexposures if we do not consider saturation and noise.


Let's look at some skin tones on the exteriors of the Bazurto market in Cartagena de Indias.


*Bazurto. Cartagena de Indias. Colombia FX9 Modo EI Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/120 YCbCr 4:2:2 10 bits XAVC Intra. ND filter ¼ (2 stops)*

Skin tones in these images appear similarly to those from the Venice - gentle, subtle, textured and nuanced, with a more painterly appearance than on the FS7. The gradation, both of the brightest and darkest areas, maintains the tone of the skin with its brightness and gives an organic appearance to the face, as a whole in its diversity. The same happens with our model's face, the darker areas of the skin maintain the tone with a very beautiful sensation on the face. Like the Venice, the visual appearance of the images reminds me of the 16th century Venetian school, for its subtlety and elegance.

*Young man with an arrow. Giorgio da Castelfranco*

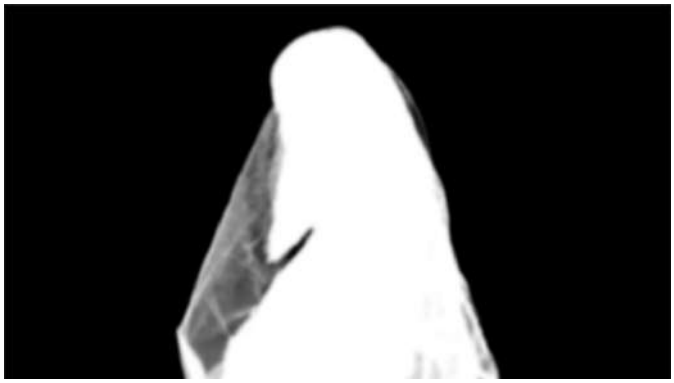

*Rafael Núñez House Museum.Cartagena de Indias. Colombia FX9 Modo EI Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 YCbCr 4:2:2 10 bits XAVC Intra. ND filter 1/13*

Let's also see how skin tone responds to different light sources. For this, we have recorded the models in such a way that the color temperature of the sources is balanced with that of the camera; we have also controlled the color deviations using the spectrometer and the vectorscope. In all cases, slight corrections have been made in post-production so that the 18% gray is neutral. We can observe the enormous differences between the different lights and how these affect skin tones. It is very different in each of the models. With tungsten, the skin tones are warmer towards red, with HMI the greenish tone makes their presence a noticeable, more natural way, however, appears with fluorescence or LED panels, although with these the tone has a slight deviation towards yellow / greenish. The images shown below have been recorded in Slog3-S-Gamut3.cine and in post-production the Sony Type A lut to convert to 709. No further corrections have been made.


In this other image, we compare the skin tones with two color temperature values with an LED panel and two different curves.


With the S-Cinetone curve the tone at 3200º K is more red while at 5600ºK it is more yellow. The same condition occurs with the Slog3 curve, although at 3200ºK it results a more natural skin tone, less saturated, but at 5600ºK there is a clear dominant greenish yellow in the skin tones. Despite having all the sources balanced, the color difference in skin tones is clear depending on the light source and its color temperature, so it is advisable to do tests with the lights that we will use during filming in order to have a precise control

of them. This variation in skin tones occurs with all cameras, although more accentuated in some than others. We have also studied the use of chromas, observing that mattes come out quite well, without visible artifacts, with good edge definition and little noise.



Lastly, some color frames.

*Bolívar square. Cartagena de Indias. Colombia FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 YCbCr 4:2:2 10 bits XAVC Intra. ND filter 1/64 (ND 1.8-6 stops)*

*Bolívar square. Cartagena de Indias. Colombia FX9 EI Mode Slog3/S-Gamut3.Cine, with Lut 709 Type A 23.98 fps, 3840x2160 16:9 ISO800. 5.500K. Obt 1/24 YCbCr 4:2:2 10 bits XAVC Intra.. ND filter 1/64 (ND 1.8-6 stops).*

*Colibri Flowers. Facatativá, Cundinamarca. Colombia XDCA-FX9 ProRes RAW in Shongun 7 de Atomos, with Lut 709 Type A 29.97 fps, 4128x 2192 1:1,88 ISO4000. 5.500K. Obt 1/60.*

In conclusion, we can determine that:

1- The FX9 presents a new colorimetry compared to the FS7, with less saturated color tones in warm tones such as reds and yellows, but slightly more saturated in greens, cyans and blues, these being somewhat cooler than with the FS7. Gray tones appear equally cooler on the FX9 than on the FS7.
2- From this colorimetry, the color spaces offered by the camera are the usual Sony ones that we already know.
3- Color tones remain consistent in both overexposures and underexposures.
4- Regarding neutral gray, blacks acquire a reddish tone with the S-Cinetone curve and slightly yellowish with the SLog3 curve and S-Gamut3-cine color space.
5- Changing the ISO value does not affect the color significantly.
6- The use of the ND, fixed or variable, does not affect the color reproduction.
7- The skin tone appears natural, although with the S-Cinetone curve in overexposure it is slightly toned towards red/yellow. However, in the shadows the tone is maintained. With the Slog3 curve and the S-Gamut3-cine color space, the skin tone is maintained in both overexposure and underexposures.
8- The camera is very sensitive to the characteristics of each light source, so it is convenient to carry out tests with them to make the pertinent corrections.
9- The skin tones finally have a pictorial character, very elegant, close to the Venice camera and with a less "broadcast" appearance than the FS7.
10- Chromas work well, with good edge cut and low noise. Mattes come off relatively easily.
11- Colors in general are vivid, without being saturated, with a variety of tones rich in texture and friendly to the eye, with a very relevant pictorial character.

OTHER CONSIDERATIONS

In this section we are going to consider some of the aspects of the camera that make a difference from its predecessor the FS7.
Automatic focus.
It is known by all the reluctance that cinematographers have towards automatic focus, reluctance that comes from the lack of precision of these systems, but we have to say that with this new camera this tool has improved a lot to the point that one can use it with very good results. In the camera menu you can choose, for example, to prioritize the focus on faces or choose only one and follow it, or give priority to areas of the frame. Face tracking is extremely effective.


In the changes of focus, we can regulate their transition in what has to do with their speed. We can choose the area used for the focus that can be wider, by areas or specific points of the image, which we can choose by moving the focus frame on the screen using the side buttons on the camera or by touching the viewfinder screen. It should be noted that this automatic focus only works at the moment with Sony E-mount lenses and that have the connection between camera and lens. Of the variable NDs, we have already analyzed their characteristics and undoubtedly highlight their precision and quality, which is why they are highly recommended. Also, we can put the variable NDs in automatic mode which allows to compensate an interior with an exterior when the camera moves, and the result is equally satisfactory.


In terms of handling it does not differ at all from the FS7, the camera balances well on the shoulder if it carries the XDCA-FX9 expansion module and V-mount batteries, if not, it happens that all the weight rests not on the shoulder but on the arm leaving the thing quite unbalanced. The XDCA-FX9 has allowed us to take the linear 16 bit Raw image out of the camera and record it in the updated Shogun 7 by Atomos. Access to functions is just as comfortable as on the FS7 and we have not noticed any difference. Likewise, the camera is solid, resistant and easy to transport. In conclusion, this new Sony camera brings two important aspects in terms of image quality, which are less noise than its predecessor and a different colorimetry, very kind to skin tones. The dynamic range is similar to the FS7 with the usual curves and the new S-Cinetone does not add much in our opinion. It should also be noted the sensitivity that is specified in two base ISO values, 800 and 4000 with a similar noise and that allows shooting in almost any condition, something very important especially for documentaries. The FF format does not add too much to the frame but it is because we will have less depth of field, although it should be noted that this lower depth is not due so much to the larger sensor but to the fact that by covering more diagonal of the lens we are varying the distance that we put the camera. If we compare the depth of field with the S35, and use equivalent lenses at equivalent distances and equal T value we will see that there is no difference in it. However, by working with less depth, the automatic focus acquires a great value, especially when we shoot documentaries and we do not have an assistant. The FF, however, does allow larger photosites to be used, which leads to increased sensitivity and less noise. Regarding the resolution, we did not observe big differences for an image size of 3840 x 2160 pixels, neither shooting in FF nor in S35, if perhaps the image appears somewhat softer than the FS7, especially in the micro contrast, something important for the skin tones. The question one can ask is whether it is worth going from the FS7 to the FX9 and the answer in our opinion is yes if we consider sensitivity, noise and color fundamentally.

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Link video: https://vimeo.com/494283085

Have collaborated