

Epic. Photographic observations

By Alfonso Parra AEC

In the current study we are going to evaluate some photographic aspects of the Epic camera. Since the camera uses the same sensor as the RedOneMX it was not our intention to elaborate a comprehensive test as we have done on other occasions. Therefore, we have focused on those aspects that may differ in a major way. For example among them, on the resolution, since the (Epic) camera can reach to record at 5K format, or on the HDR system (high dynamic range), which enlarges the camera dynamic range until 18 stops. So, we were curious about what these differences consist in. For that, we have contrasted results with the two cameras, on the one hand from the most theoretic views of our charts and, on the other hand from the recorded images in outdoor and indoor locations, along with the fiction short shooting *Los huecos del tiempo*.



Camera crew in Las Palmas de Gran Canaria (Spain)

To evaluate the different options of resolution, we have used the 12332 ISO and the Putora charts, both of them analyzed through Imatest or ImageJ, in addition of our Prêt-à-Porter (chart), specially designed for observing textures.

With regard to the dynamic range, we have shot the Stouffer strip and the Death chart. For lighting adjustment and evaluation of recorded images we have used apart from the HD Cine-tal monitor, the Sekonic L-558/Cine light meter and the Minolta Color meter IIIIF, all of them suitably calibrated. To evaluate the exposure we have used the histogram provided by the camera.

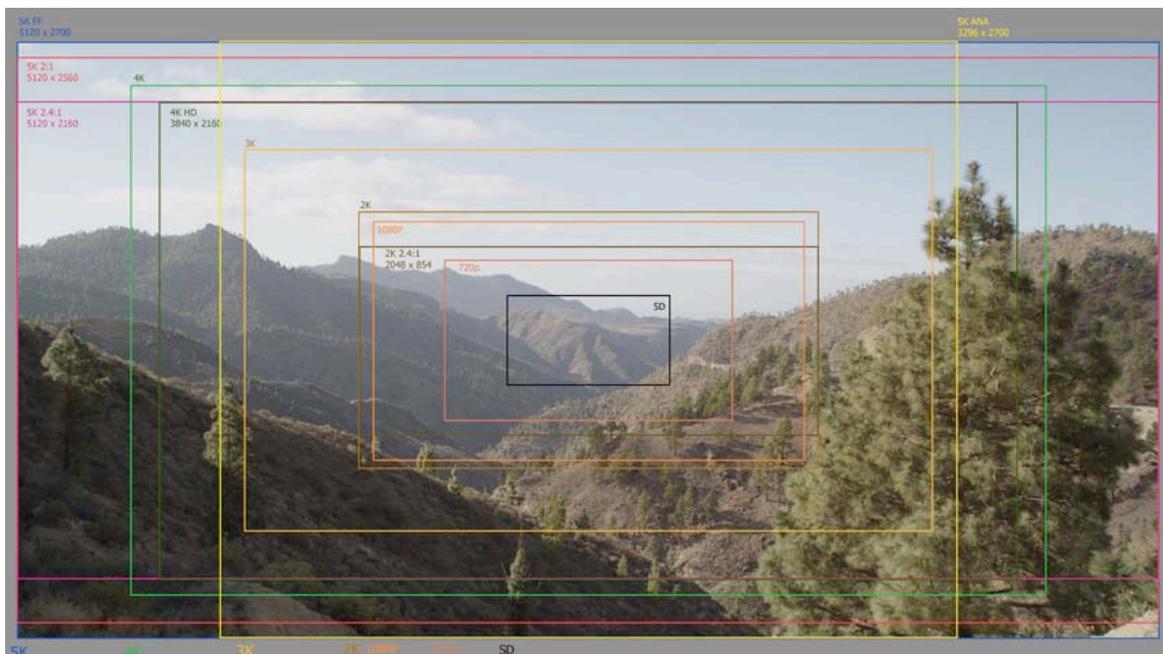
Postproduction was made with both RedCineXPro and Davinci Resolve programs in the *Gigantes y Molinos*' postproduction room in Madrid.

Outdoor locations shooting and the short were made in La Palma island, which offers beautiful natural landscapes for photography, in addition we had the invaluable help of the technical crew of the island.

Article images are from the original frames, but turned into CMYK space. They should be used merely as a comparative reference.

RESOLUTION

Let us remember again that we should not confuse format with resolution: despite resolution depends on size, format and the number of pixels, it does not mean that they provide the resolution itself. Resolution of our image will depend on the sensor, the electronic image processing, the recording system, the lens, the viewing system, and of course, the distance between the image and us. Therefore; images with the same format can show different resolution/sharpness, measured in TV Lines, lp/mm, cyc/pixel or any other usual unit.



Formats comparison

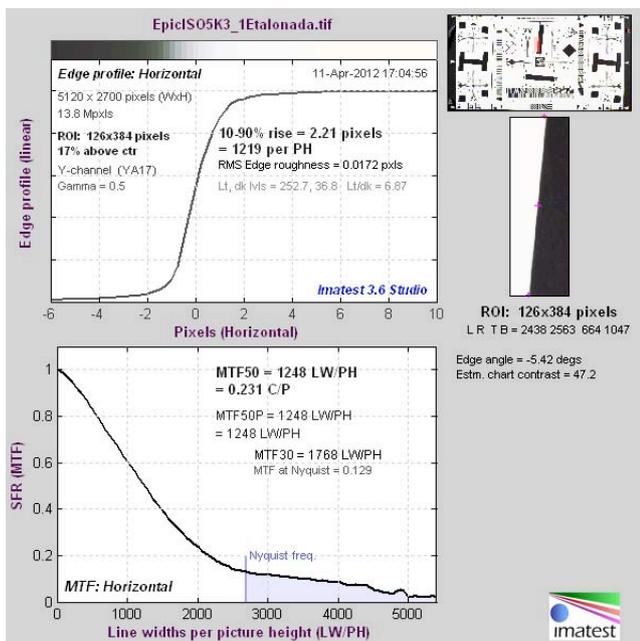
The Epic camera gives several recording formats, ranging from 5K Full Frame to 2K, through 3K and 4K. These formats depend on the number of horizontal and vertical pixels. On the other hand, the recording quality of formats can range from 3:1 to 18:1 being definitely this the expression of compression degree that camera applies.

The questions I ask myself are: at equal format, does Epic provide more resolution/sharpness than RedOneMX? How do different levels of compression affect the resolution? And finally, how much resolution have we gained with the 5K format? In order to answer these questions, we have shot with both Epic and RedOneMX. our ISO, Putora and Prêt-à-Porter charts, apart from the outdoor locations and images from the *Los huecos del tiempo* short.

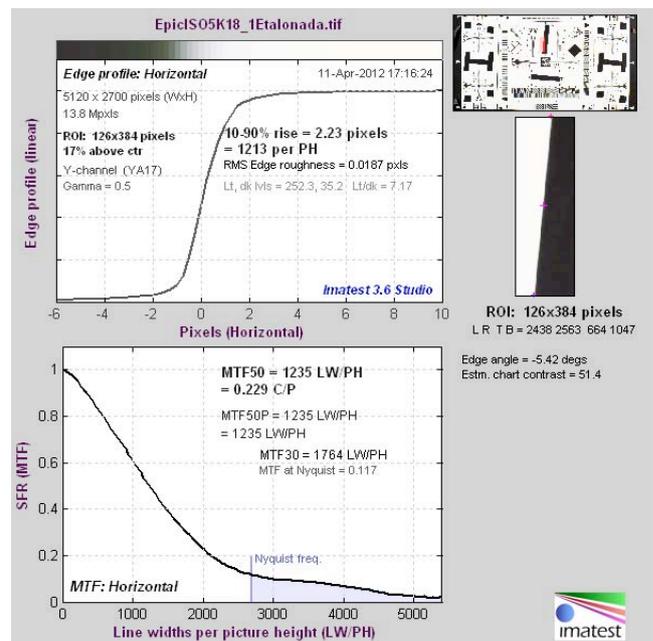
Let us begin with the 12232 ISO chart. It was evaluated through Imatest with a 50mm Ultraprime and 3:1 quality. The MTF curve, in the center of the image, shows a 50% value of 1248 LW/PH, in other words, around 2.3K of resolution; this value is very similar, though slightly superior to the one we have obtained from the RedOne's MX sensor. We have analyzed the chart with all the compression values and we have not observed significant differences, for example, at 18:1, the MTF value to 50% is 1235LW/PH. Previous values are from horizontal resolution, vertical resolution shows very similar results.



Alfonso Parra AEC and Alejandro Santana, First Assistant shooting resolution test in Bentayga. It was very cold, despite of being in Canary islands, the Fortunate Islands (Spain).

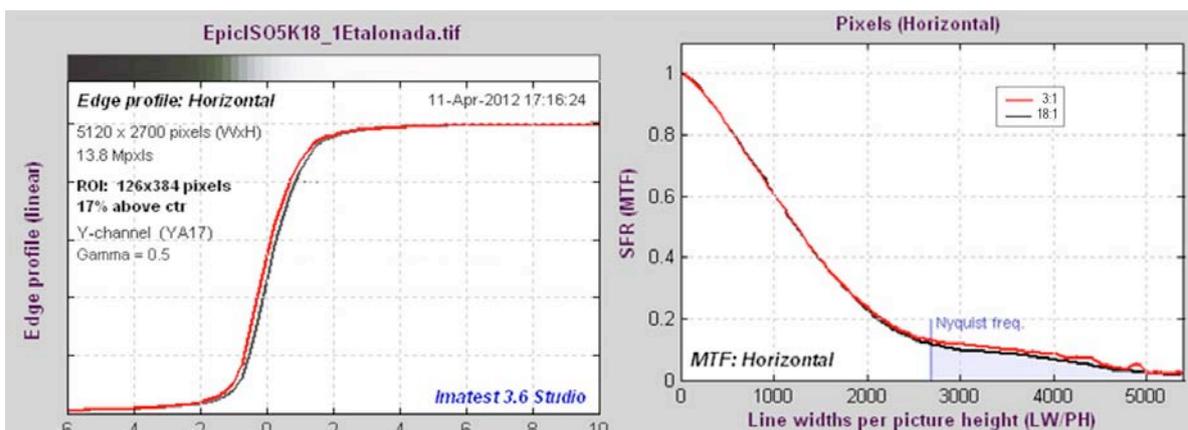


Epic 5K Full Frame. 3:1



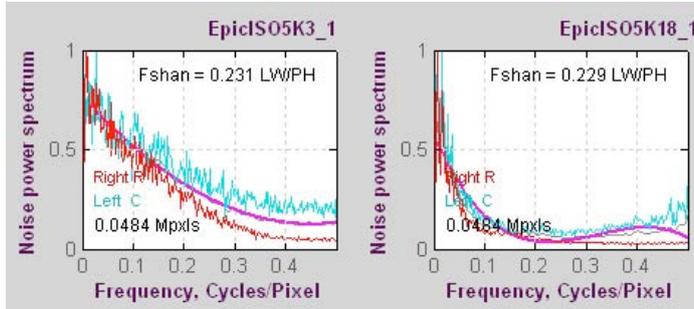
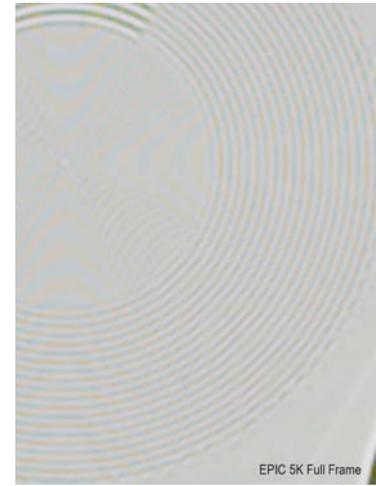
Epic 5K Full Frame. 18:1

On the next graph, I superimpose MTF curves and the edge profile to show the comparison of the compressions, that is, how many pixels we need to go from black to white, which is a level indicator of sharpness. Indeed, as we have already said, difference is very small, 3:1 compression is a bit sharper, above all at very high frequencies.



We have seen same effects of Moire Chrome at very high frequencies (on the right image).

We cannot conclude any difference from visual inspection between the different compression values. The only difference is what we can see in the graph of noise spectrum, that is, how noise is showed at different frequencies and what the influence of its treatment on the image is. Curve slope comes from certain degree of applied blurring, it could be caused by the algorithms used through Debayerization process, and noise reduction systems (NR). With 18:1, we can see how the curve falls quickly from low frequencies, and from middle ones, it shows a very small value. What does it mean? This means that these frequencies and finest details with low contrast are a bit less sharp than those provided by a 3:1 compression, (there, curve slope is more constant). However; from a visual point, it is hardly observable.



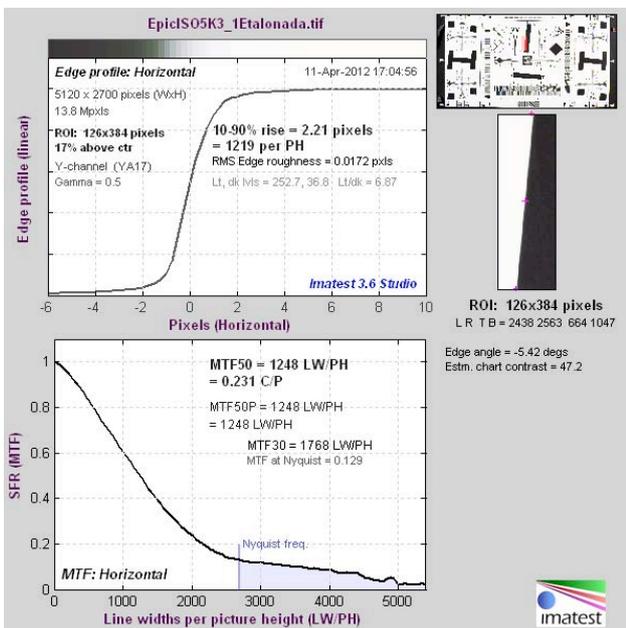
Noise Spectrum 3:1

18:1

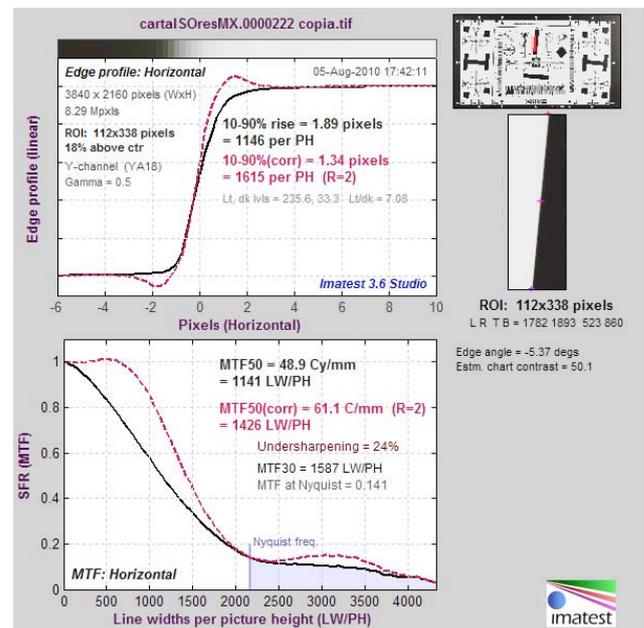
At 5K, we have a larger image, with more pixels, however we also have to take in account that a lot of lenses used in 35mm cannot cover the greater diagonal of the sensor, so they make vignetting on the image. Moreover, even though other lenses cover it, they need to use more their edges, where resolution is usually shorter and aberrations increase.

We also have to consider that the angle of vision changes regarding the S35 1.78:1 standard, it changes approximately in a multiplication factor of 0.88, since the enlargement factor is 1.134, that is, a 50mm at 5K Full Frame is approximately related to a 40mm with the S35 format already pointed out. Therefore; if we want to keep the same frame size as the one provided by the usual S35 format, then we will have to zoom in the camera. In other words, the same 35mm with S35 would mean a bit more than a 57mm with 5K Full Frame. Since there are no such focal distances among the lens sets that we usually use, the only solution we have is to zoom in the camera in order to get amplitude of angles equivalent to S35. In my opinion, this is the case, where it is essential to use a lens that I like very much: the 65mm; with 5K Full Frame it would approach to the 50mm with S35.

Therefore; we need very high quality lenses to make the most of the 5K, it means that we should increase the resolution around 100 LW/PH regarding 4K formats, in addition this resolution has to be the same in the center of the projected image and on its sides. For example, let us check the previous 50% MTF curve; it was 1248 LW/PH as opposed to 1141LW/PH from the RedOne's MX sensor, 4KHD format with a MasterPrime lens and redcode 42 (7:5:1). If we bear in mind the different sharpness of the two lenses, difference in lines is not so large, although we can verify visually the sharpness increase with Epic at 5K.

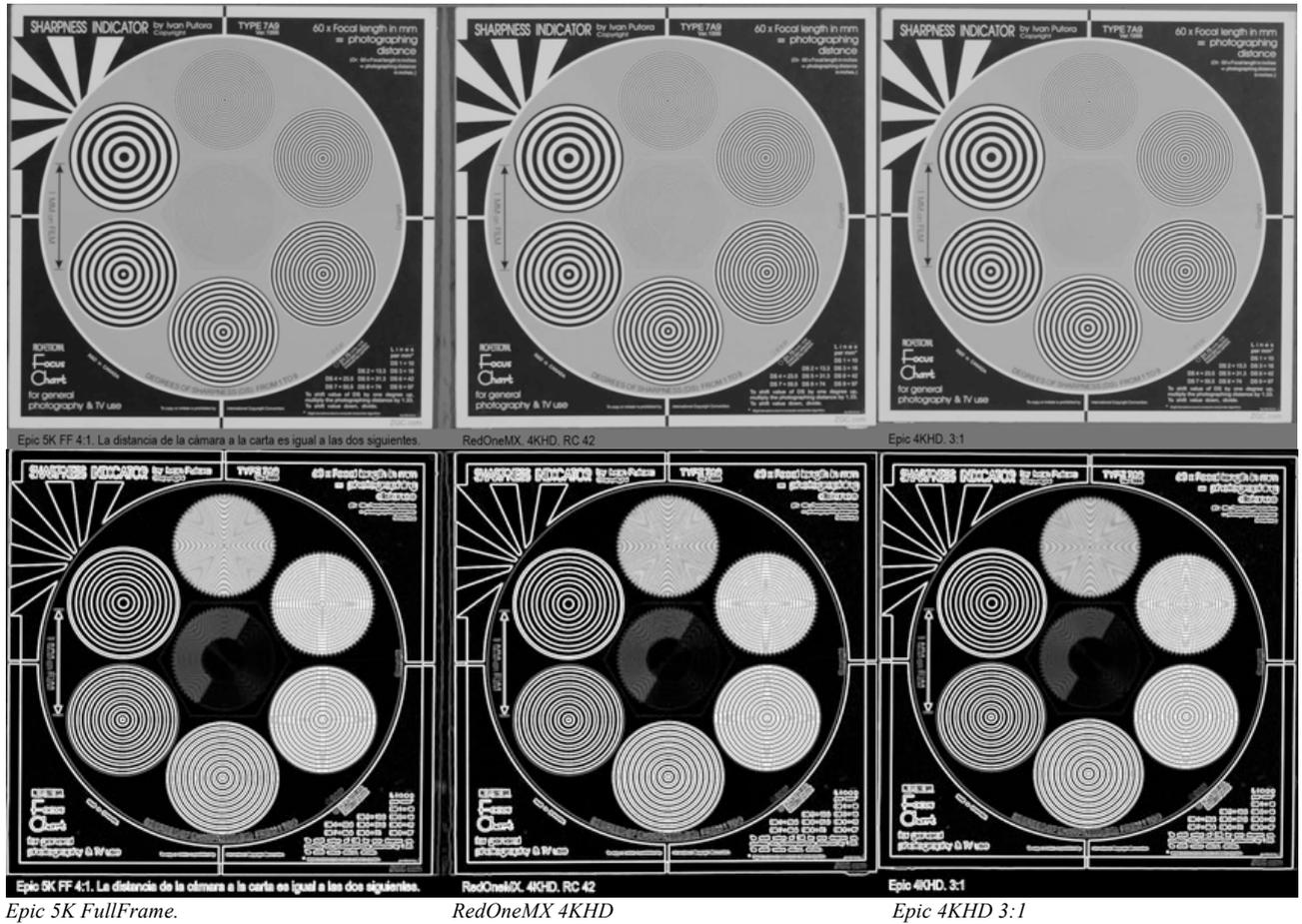


EPIC 5K FullFrame. 3:1. UltraPrime lens 50mm T4.4



RedOneMX 4KHD. RedCode42. MasterPrime lens 50mm. T 4.4

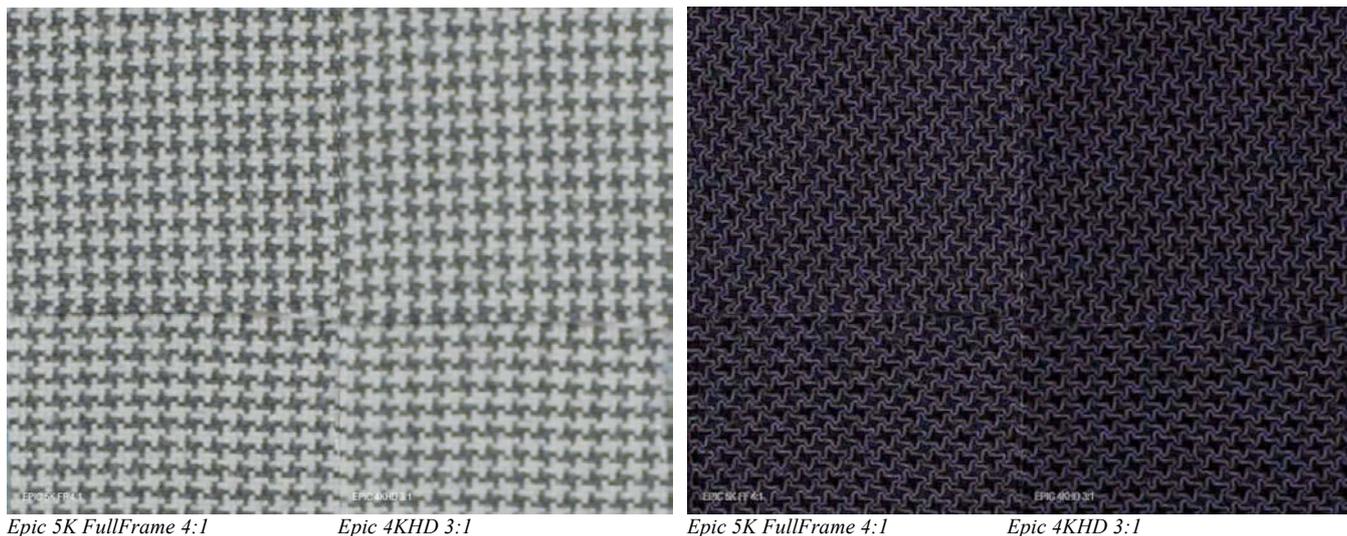
What is more, if we compare the values provided by the two cameras at the same format, for example, 4KHD, we will see that there is no difference, neither in resolution nor in sharpness.



The Putura test chart with the 5K Full Frame format is at the same distance as the other two ones, that is, the chart does not change size with the three formats, although with 5K Full Frame the total size of the image is greater. We could check this fact on the image from our Prêt-à-Porter that we show next. We cannot see any difference regarding resolution and sharpness between the two cameras at the same format.



However; we can obviously see the difference of sharpness with Epic, between the greater format 5K Full Frame and the smaller one, for example, 4KHD. Next, we show a cutting chart of its central part, with the two formats and through the edge detector.



With all of the gathered information, we can already answer the questions that we have asked before. At equal format, does Epic provide different resolution/sharpness than its predecessor, RedOneMX? No, it does not. Both of them show the same resolution, even if we use lower compression codes with Epic. It is not a surprise, since the Epic's sensor is an MX, the same as the RedOne's sensor.

Next question to answer was: How do the different compression degrees of the camera affect the image resolution? Minimally, if we check visually images, then we cannot see any difference, and only through the charts analysis, we can see some small differences. These differences occur between the greater and smaller compressions, since we cannot distinguish any difference at middle values, for example, if we use 3:1, 4:1 or 5:1. So, what do we gain with Epic regarding the resolution? The camera at its 5K Full Frame format resolves a bit more than 100 LW/PH of the predecessor. Is it too much? Is it few? In order to appreciate this fact, finally let's have a look at images from outdoor locations.



Bentayga (Spain). Epic 5K FullFrame (1.9:1). F 80mm T8. ND0.9 filter. 25 fps 180°Shutter. MTD5600°K.MTD800 ISO. Graded



Andén Verde. Epic 5K FullFrame (1.9:1), F 21mm T6.3, ND0.9 filter. RedCode 7:1. 25 fps 180° Shutter. MTD 5600°K. MTD 800 ISO. Graded

We can see the excellent resolution of the camera in these two images, as well as its ability to show the textures of the rock. Clouds do not lose neither their delicate detail nor the outlines among their different degrees of brightness. The coast line is clear, diaphanous, and the sand is not flat. Mainly, I like the first image from Bentayga, here; the different folds of the rocks are very sharp. Indeed, we have seen that images are sharper, more crystalline than those provided by the RedOneMX. Outlines, confines, and the general feeling are of a higher quality with Epic.

Next, we show two more examples to see textures.



Epic 5K FullFrame (1.9:1), F 42mm .T 7.1. RedCode 7:1. 30 fps 180°Obt. MTD 5600°K. MTD 800 ISO. Graded.

This frame is from *Los huecos del tiempo* short. I have chosen this one to see the excellent ability of the camera for showing the wood textures, its cracks, its decline, and therefore, how well the pass of time is reflected on the material. We can also see on the screen wall textures, glasses, net curtains, as well as our actress' face.

Next frame, we can see how Epic works properly; it distinguishes the fine outlines of the leaves, as well as their textures.



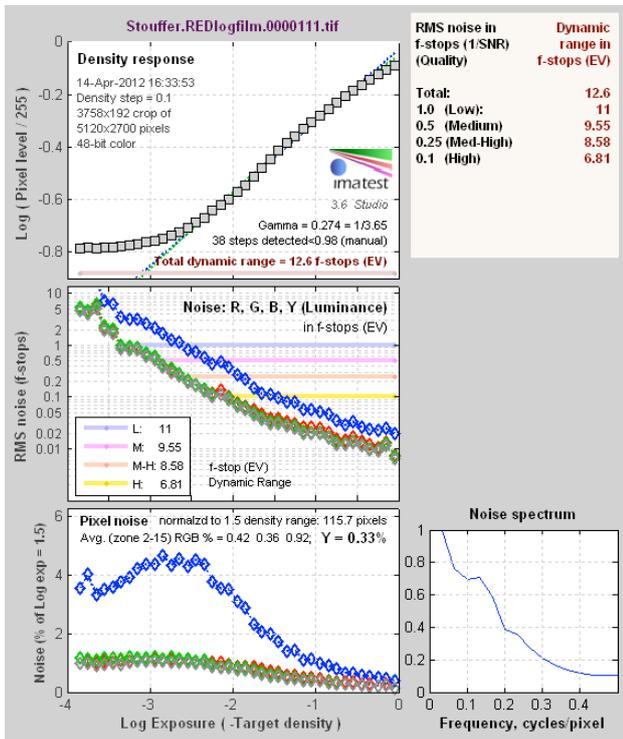
Epic 5K FullFrame (1.9:1), F 42mm .T 2.8. RedCode 7:1. 30 fps 270°Obt. MTD 5600°K. MTD 800 ISO. Graded.

DYNAMIC RANGE (DR)

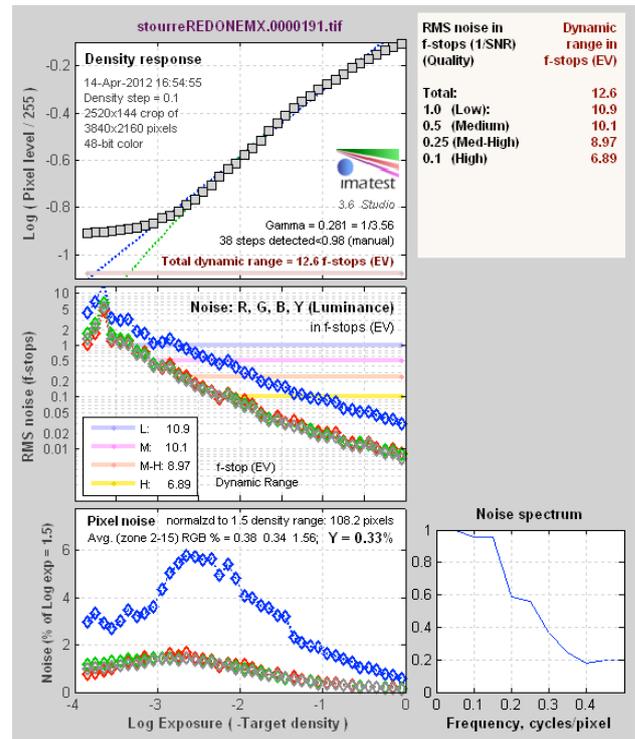
Epic's major innovation regarding its predecessor is the integration of the HDR system. According to the manufacturer, it extends the dynamic range up to 18 stops. However; first of all we are going to evaluate the DR without applying this system to observe differences with the previous camera, the RedOneMX. As might have been expected difference is not significant, since the two cameras use the same sensor. Next, we show the analysis of the Stouffer strip with both Epic and RedOneMX.



David Panizo, First Assistant



Epic.MTD800.Redcolor3.RedLogFilm



RedOneMX.MTD800.Redcolor3.RedLogFilm

Both strips have been “developed” under the same conditions, and as we can see here the differences are not significant. We only have to point out that there is a bit more noise at the blue channel with the RedOneMX; such noise shows in different way at different frequencies (Noise spectrum). However, if we “develop” the strip from the RedOneMX through RedCineX, as we have made in a previous test (Cameraman-Number 46), we can see differences between the two cameras. Epic shows less noise, for example on Y, a 0.33% opposite to 0.46%. This noise variation allows to increase the DR for shadows around 1/3 stop regarding the RedOneMX which was tested at the time. We believe that both the new processing of the sensor signal provided by the camera and its handling through RedCineXPro with the new tools make images cleaner. We have checked with our Death chart that DR without HDR, recoverable or effective, is approximately 10 ½ stops, about 4 ½ above middle gray and 6 stops below.

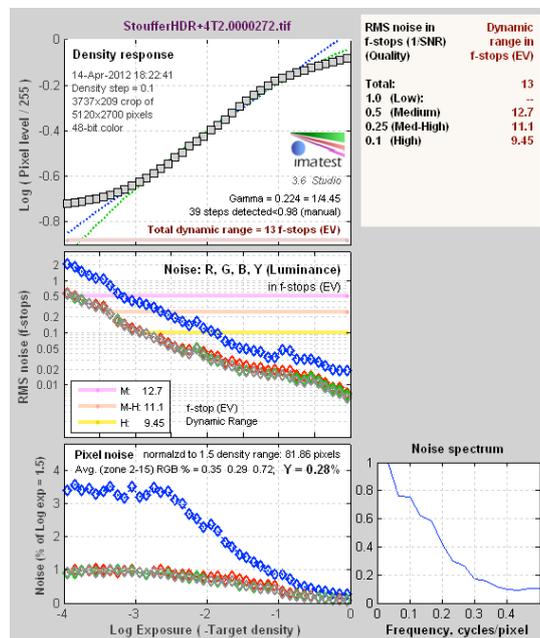
It should be pointed out that DR estimations provided by manufacturers are usually related to the number of photons which saturate the sensor regarding the noise floor. So, these estimations are always larger than the ones we get if we regard detail, texture, and sharpness.

Now, let us study the HDR system, included in Epic. I have to emphasize that the next study is based on RedCineXPro’s work system and its tools which handle the HDR: Simple Blend y Magic Motion.

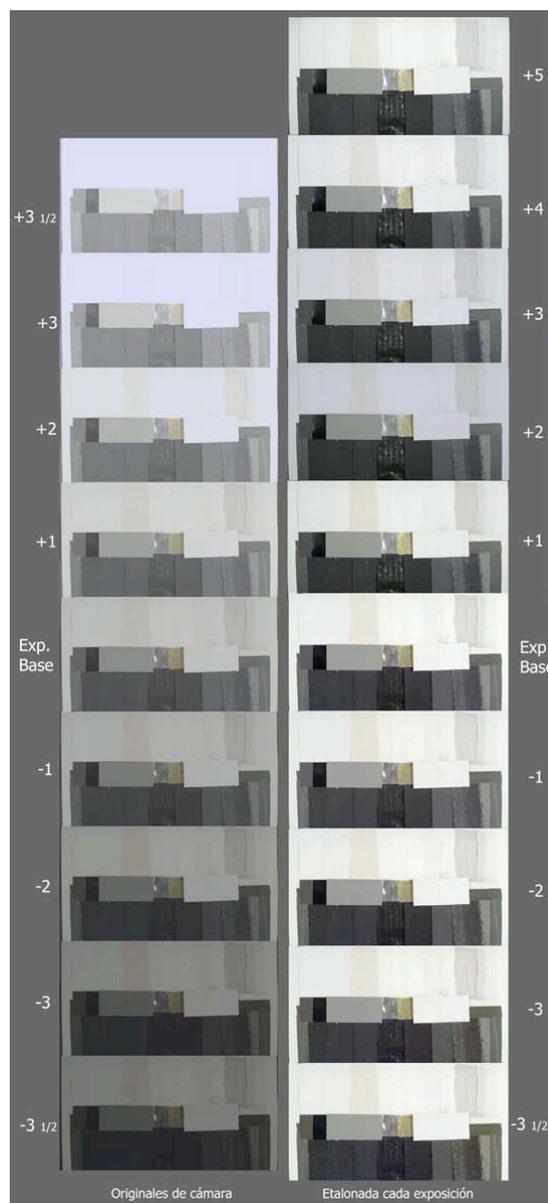
According to the manufacturer, the HDR is an option to extend the dynamic range (at highlights) of the camera from +1 up to +6stops regarding the basic dynamic range that the camera gives. In other words, if the dynamic range is 13.5 stops, with the largest value of HDR +6, it would be 19.5 stops. I understand that 13.5 stops is related to the captured dynamic range and not the effective one, which is around 10 ½ stops in our test (Cameraman-Number 46), so it would entail around 16 ½ stops applying the largest HDR value.

How are these 16 ½ stops allocated? Since we get the X-Frame changing the shutter angle (it closes in steps of 1 stop), we will use all of these extra 6 stops of latitude to recover detail for highlights. If we consider that the range above middle gray is 4 ½ stops, we will have around 10 ½ applying the HDR. However; HDR application entails to darken the shadows when we mix up the two frames with different exposure; that is, it entails loss of detail for shadows, and therefore, dynamic range decreases there. If we consider around 6 stops below middle gray, we will have around 5 stops applying the HDR. Altogether the recoverable dynamic range is between 15 and 16 stops.

When I observe the Stouffer strip I wonder if I could see all of the strip steps using the HDR. This is why I expose for shadows (exactly what manufacturer advises not to do), because I want to see acceptably the patch41. It entails that I lose detail in the first steps of the strip. It should be noticed that step 1 is exposed on the right limit of the histogram, at viewRaw mode when I photograph without the HDR, and therefore, if I want to see more obscure steps. I have to open the diaphragm. Nevertheless; if I close it, the first steps would remain clipped, so how do I make up loss for highlights? I am going to apply the HDR.



Stouffer strip with HDR+4. Exposure to see the patch 41. Applying SimpleBlend at 0.00



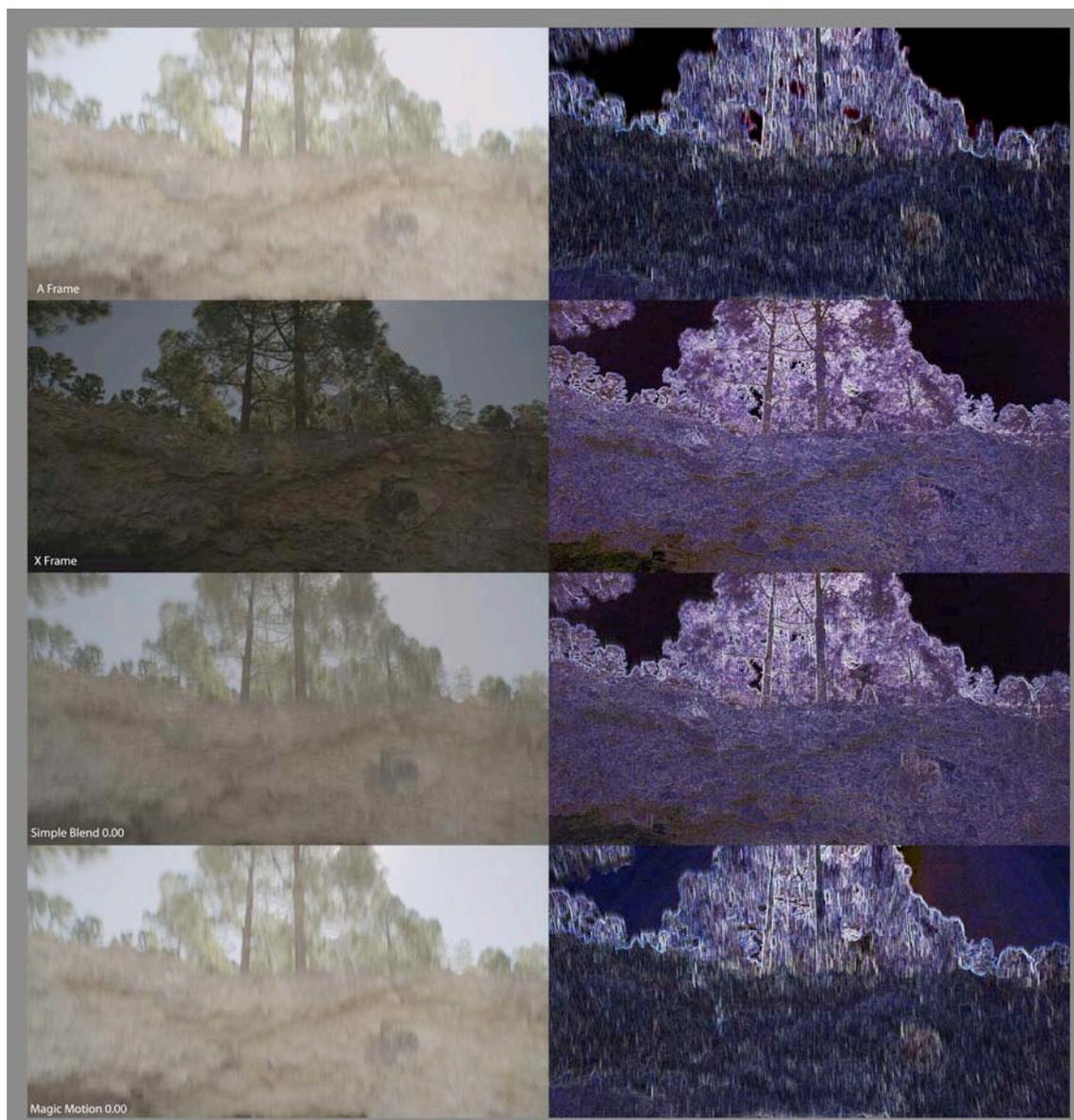
Above, in the graph, we show the analysis of the strip exposed in this way, applying +4 HDR. Well then, there is a surprise here: the DR is hardly greater than without HDR. What is happening? Well, when we mixed up the two frames through RedCineXPro's tools, shadows darken in direct proportion to the gained detail for highlights. In other words, with this process, I gain the dynamic range for highlights, but at the same time I lose it *in some way* for shadows. So, the first conclusion is: if we want to keep detail for shadows applying the HDR, we have to work with shadow regardless highlights in postproduction, through masks, more or less complex, more or less dynamic. This is what we did with our Death chart above. I have overexposed in steps of 1 stop, and then I have recovered these stops applying the HDR changing the way of mixing the two frames, and finally I have graded. The result is that I gain all the detail for highlights (up to +8 above gray), and I see all of the white fabrics without problems, in addition black fabrics keep similar level of bright. Each exposure requires a slightly different grading.

Therefore; in order to secure the best possible results, we need supplementary tools and different processing from what RedCineXPro offers. As Light Illusion's Steve Shaw states in CML:

But as the two exposures have different 'aperture open' durations, you need to be able to align this in post, especially with motion within the frame. This means having to use an optical flow based process to match the motion 'blur' between the two exposures.

Then you need to be able to 'mix' the two clips using a dynamic 'keying' process to merge the two invisibly. All this needs to be real-time and non-destructive to ensure the final result is as good as possible, as you need to try the likely values and adjust as necessary on a shot-by-shot basis.

On next frames, let us see more closely what means the shutter angle variation to capture more detail for highlights.



Epic. 24mm lens T 5.6 MTD 800ISO. 5600°k ND6 filter. RedColor 3, RedLogFilm. Original from cámara

This frame is from the center of a panoramic shot from top to bottom. The top image is the A-frame, that is, the exposure was made with a normal shutter, 1/50s. Next is the X-Frame, applying +6 HDR, that is, 1/3200s. The third image is the mixture of the two previous images through Simple Blend at 0.00 value. And the last image is the mixture of the A-Frame and X-Frame through Magic Motion at 0.00 value. In order to see much better shutter effect and images mixture, I have applied the edge detector to all of them. It is clear how the outlines of the X-Frame are shaper than the those of the A-Frame, moreover as it is also clear that the X-Frame is darker than the A-Frame. According to the Epic's user guide, the Magic Motion system adds certain quantity of Motion Blur in the A-Frame regarding the X-Frame's sharpness, when both frames are mixed up. It creates a kind of feeling of movement, similar to the one provided by the film camera shooting at 24fps and a shutter angle of 180°. Indeed, if we compare the two frames and their outlines, we can see how Simple Blend shows more sharpness in motion than Magic Motion.

Once understood how the shutter is working, now we are going to focus on the next frame with motion.



This image is from an intermediate frame with vertical motion from bottom to top over the cliff. A- and X-frames are mixed up with Simple Blend at 0.00 value. We can see the double exposure on the silhouette of the mountains. This double silhouette makes that certain slight “leaps” could be seen on the images during the motion. I would repeat that we are working with RedCineXPro; we are not using any other postproduction tool, like for example, the one that Red recommends in its user guide, MNMB, designed by The Foundry. We have seen this effect on all of the frames with motion, with both Simple Blend and Magic Mountain, although in different ways.

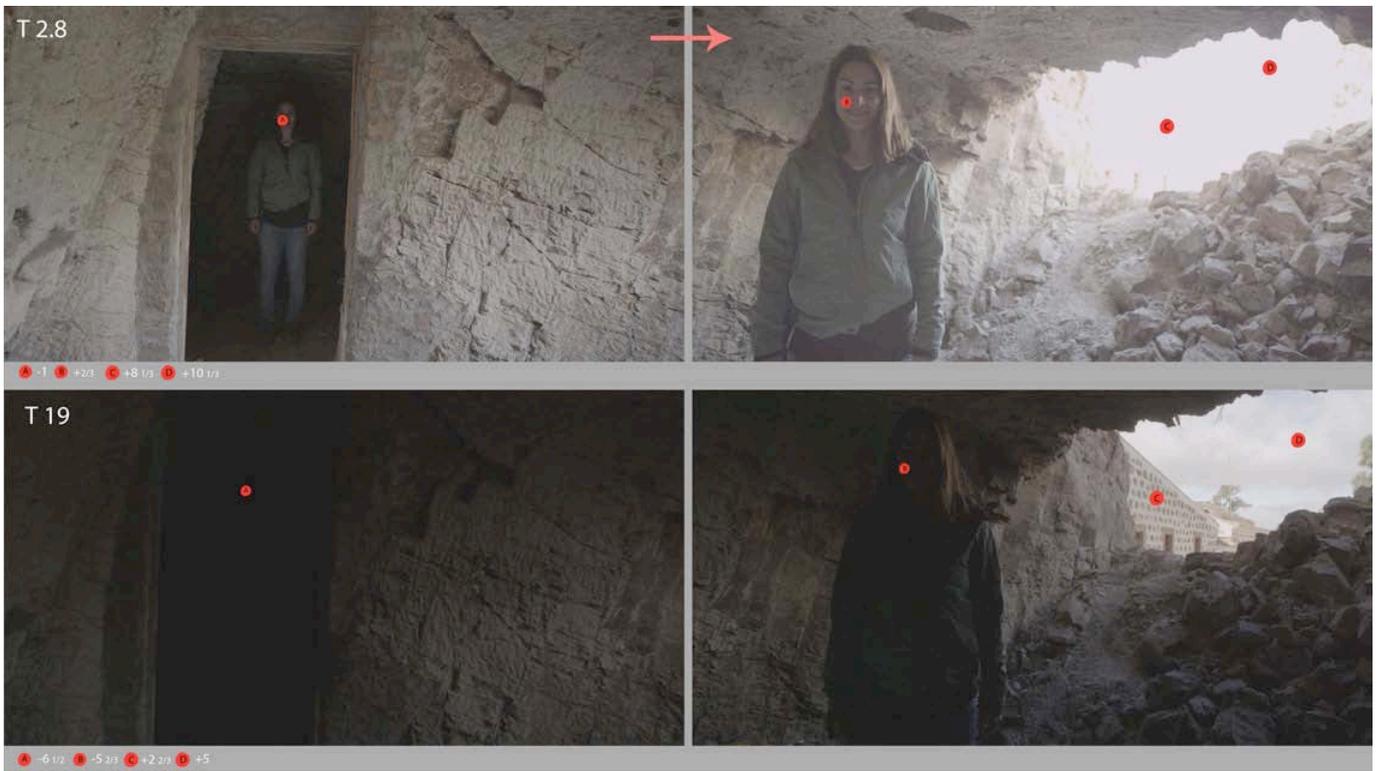
Therefore, to avoid these “leaps” or “movements” which are very visible over the contrasted outlines, we have to use some kind of correction in postproduction.

On the other hand, if we superimpose the two frames through RedCineXPro, shadows darken, look more gray-like, and slightly flat, in addition, noise increases and there is a slight loss of sharpness and texture. For that reason, again in postproduction, we have to use dynamic masks which use only the necessary part of every exposed frame.

Now, let us go to another HDR feature, the exposure. Red, according to the manufacturer's instructions (RED Epic Operation Guide, p. 12), recommends to make a “normal” exposure in order to get the best exposures in postproduction, and so, taking advantage of the dynamic range of the sensor. But; what does a “normal” exposure” mean? Adjusting exposure regarding 18% as middle gray? Adjusting highlights regarding the right limit of the histogram? There is no such thing named “normal” exposure, in my opinion, but the necessary exposure. One exposes regarding a lot factors: dynamic range of scene, and camera, used diaphragm, speed, shutter, sensitivity, etc.

Let us consider the following example.





We have made a panoramic in this cave in company of this lovely shepherdess who is leaving home. Top image is exposed for shadows, whereas the next one is exposed for highlights. In this latter one we can see the exterior whereas in the first one, we cannot see it because it is totally underexposed. To me, the “normal” exposure is the first one, T 2.8, since I want to see our protagonist’s face, I want to see her in such way that, after, in postproduction, I can give the degree of darkness I believe necessary without seeing noise or being clipped black.

With T 2.8 exposure, the brightest outside is more than 10 stops; if I consider that my DR above middle gray is around 4 ½ stops, then I ought to apply a +6 HDR to get detail in clouds, and so getting 10 1/3 from D point. The following images are the result.

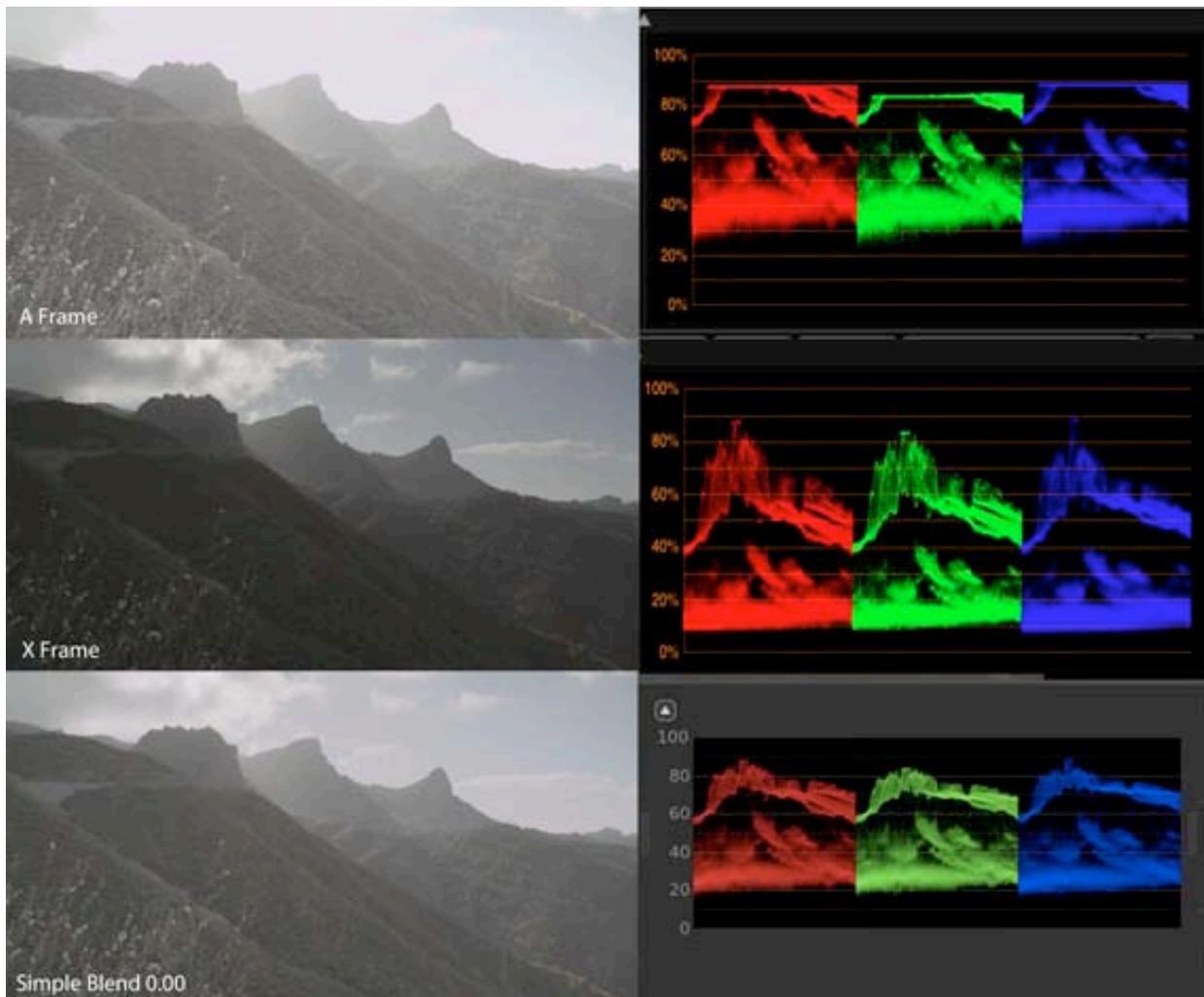




These images are not graded. What we see is that mixing up the two frames we can recover the outside detail, although face is “gray-like”, and inside rocks are slightly flat. We have also increased noise in the deepest shadows of the inside of the house, where the frame begins. On the other hand, we can see the different shutter of the two frames in the fast motion of the panoramic. For the proper grading of this image, and in general, of all of those images which use HDR, Jaime Climent, our colorist clarifies: “... we have to create a new source through a layer, and working with it to integrate it to the original frame. To make such integration we can use all of the tools provided by DaVinci, for example, key, masks, or composites. We have got the best results using composites during the tests. Integration through masks gives

also good result, however processing is more laborious; it is easier to make with composite programs as Nuke, Flame or AE. The problem is that X-Frame shows an obvious lack of Motion Blur with camera in motion (depending on shutter-speed); what makes difficult integration. Solution is to analyze the X-Frame through a system of vector analysis, which applies Motion Blur to the image, and so leveling to the frame. Visual Effects Company offers the Reel Smart plug in, which is compatible with a lot of programs; it works well applying Motion Blur to X-Frame (<http://www.revisionfx.com/products/rsmb/>).

Therefore, with regard to the exposure, HDR system has sense to keep detail for highlights when I expose for shadows of the scene, since then there are bright values which exceed the dynamic range of the camera for highlights, which is the case of the lovely shepherdess in her cave. Obviously, if I expose for highlights I do not need HDR. But what about if I make an averaged exposure, that is, I leave shadows darker and I lose a bit of detail at highlights? Then, if I apply corresponding HDR, it darkens more shadows in exchange for keeping detail for highlights. Therefore, the best way to keep detail for both shadows and highlights is working the two *Frames* separately in postproduction. One more example; to keep detail of the slope shadows, we have made a mask which keeps detail of the A-Frame, and then we have separately graded the sky area and the slope.





A-Frame (Exposure for the shadow of hillside)



X-Frame (HDR+4)



Mask to keep detail in A-Frame



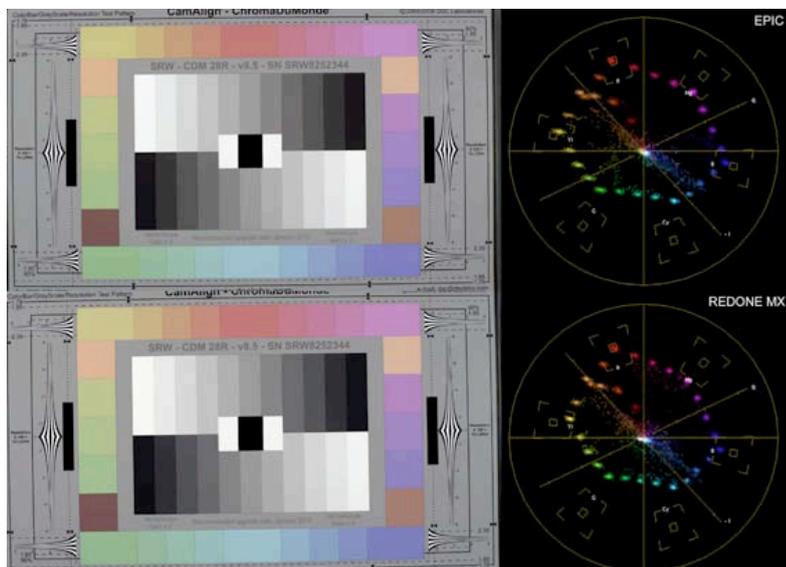
Final result

Next, we show another example from the short. We have made a panoramic from left to right, through the net curtains which cover the interior courtyard-facing windows. We have separately worked the two frames in this image; we have adjusted shadow values from the A-Frame through masks, in addition we have also adjusted the shutter difference between the two frames.



Epic 5K FullFrame (1.9:1). Zoom Angenieux 40mm lens. T 2.8. 25fps. 180°. ND9 filter. MTD 1600ISO and 5.600°K.Redcolor 3 and RedLogFilm. HDR +5. Exposures for shadows.Granted

COLOR



We have also wanted to focus on other feature; the color. We have shot images with both RedOneMX and Epic cameras under the same conditions, and then we have put them in comparison. In other words, we have used the same light, metadata, and identical values of “recording” at RedCineXPro. Then we show the ChromaDuMonde chart. As we can see on the vectorscope, there is no difference at all on the skin tones, and we can only see a greater saturation in orange and yellow with Epic. This greater saturation encourages skin tones, it gives a more natural appearance, and in general, nicer.

UltraPrime50mm lens. T 4. 25fps. 180°. MTD 800ISO andy 3400°K. Open with RedcineXPro, Redcolor 3 and RedLogFilm. Graded for neutral gray



UltraPrime50mm. T 3.3. 25fps. 180°. MTD 800ISO and 3400°K. Open with RedcineX-pro, Redcolor 3 and RedLogFilm. Graded for neutral gray

We have to say that differences of color between the two cameras are minimal, it is true that the appearance with Epic is more natural, softer and more organic. Let us see these frames with three different skin tones.



Epic 5K FullFrame (1.9:1).Zoom Angeniux 27mm lens. T 5.0. 25fps. 180°. MTD 800ISO and 5.600°K. Redcolor 3 and RedLogFilm. Graded



5K FullFrame (1.9:1).Zoom Angeniux 40mm lens T 2.8. 25fps. 180°. MTD 1600ISO and 5600°K. Redcolor 3 and RedLogFilm. Graded

ABOUT NOISE

There is little to be said about noise, except that Epic is in line with its predecessor, that is, it gives low level of noise with high ISO values, and its texture is less and less “electronic”. However, we have seen that Epic’s image is more contrasted than the one provided by RedOneMX

We have forced ISO to 3200 in the following image. We have photographed our model Elisa, and the candles in the same way with both cameras.



UltraPrime50mm lens. T 2. 25fps. 180°. MTD 3200ISO and 3400°K. Open with RedcineX-pro, Redcolor 3 and RedLogFilm. Without grading

We can see the difference of color on these images. Epic shows a red-like tone opposite to RedOneMX, which shows more yellow-like. We can also see more detail on the deepest shadows which shows slightly more sharpness. We can see better this nuance if we watch, through the blue channel, the right side of the pullover, as well as the model's hair.



Blue channel.. UltraPrime50mm lens.. T 2. 25fps. 180°. MTD 3200ISO and 3400°K. Open with RedcineX-pro, Redcolor 3 and RedLogFilm. Without grading

Our feelings regarding this material is that Epic sees shadows a bit sharper with a similar level of noise than RedOneMX.

CONCLUSIONS

On strictly photographic grounds, we have not observe great difference between Epic and its predecessor, RedOneMX, that is, sensitivity is very similar, resolution regarding identical format is the same, and dynamic range is equal if we do not consider the HDR. This last process, indeed, does not satisfy our expectations, since it needs an adequate and laborious composite work in postproduction to show a correct result. Since we are subject to the Ockham's razor that says "pluralitas non est ponenda sine necessitate", that is, plurality should not be posited without necessity; or in other words, between two theories (in our case processes) which give identical results, we must choose the one which uses less steps. We prefer to work with cameras which provide a high dynamic range on the own image in a single step.

Despite the minor differences between the two cameras, however, we felt that Epic provides a *more natural*, *softer* and *more balanced image* than its predecessor.

Of course, Epic presents important changes regarding the "formal" aspect, and the relation with its interface by the user; but these aspects are not our target, neither is improvements made in RedCineXPro, improvements that we leave for assistants and DITs to evaluate

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