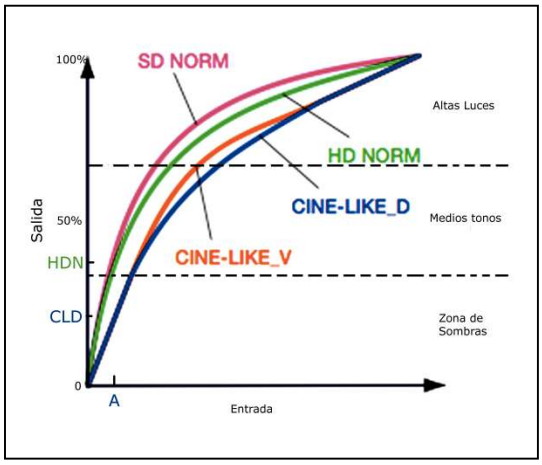
Test on the Panasonic HVX 200 camera.
Elogio de la distancia (In praise of distance)
By Alfonso Parra AEC

We wanted a small, discreet, easily handled camera that could be taken anywhere to film the documentary "Elogio de la distancia" (In Praise of Distance). After studying the different options on the market, we chose to test the Panasonic HVX200 camera. The following is our analysis and conclusions from the test.

Building an image:

Choosing the **gamma** curve is key to the image's final appearance so tests have to be carried out to choose the right one for a project. The camera has 8 different gamma curves:

NEWS: This curve gives a bright image, preserving greater detail in mid tones and high lights.
HD NORM: The curve recommended for filming in HD. This curve is typical in a video camera.
LOW: Curve for high-contrast scenes. It softens the image making it slightly flatter, preserving more detail in shadows and slightly darkening the mid-tones.
SD NORM: Curve recommended for filming in standard formats.
HIGH: This curve increases brightness in shadows, giving the image less contrast.
B.PRESS: This curve generates more contrast and stronger blacks for low-contrast scenes, especially modifying mid-tones.
CINE-LIKE_D: This curve allows the user to capture a greater dynamic range. It is used for working on the image in post-production.
CINE-LIKE_V: Like the previous one but increasing the contrast somewhat, giving denser blacks.



The graph above shows some of the gamma curves that come with the camera. From these, you can evaluate some of the differences in sensitivity and latitude. Notice that for an entry value A, you can obtain different exit values according to the curve chosen. As you can see for A, the exit value for the Normal HD curve is greater than for the CineLikeD curve, which means that the HD curve gives more luminous shadows, allowing for more detail in that area. That's why in low-lit interior scenes I chose the HIGH curve, similar to this one. Though it has to be said that even tough the CineLikeD curve gives less detail in shadows, it discriminates small luminous variations better compared to the Normal HD curve. The latter gives more contrast in shadows, eliminating small nuances of different luminosity. This is due to the different slope of the curve shown by both. And, on the contrary, you can see how the Cinelike curve preserves greater detail in high lights compared to the SD and HD curves. Obviously, handling high lights in video is difficult and this curve helps retain more detail in said areas. That is why this curve is recommended for shooting in exteriors where light control is less and in high contrast scenes. In general, I use this curve to obtain a greater dynamic range in all types of situations with an acceptable light level and then submitting the images to a meticulous grading process in post-production.



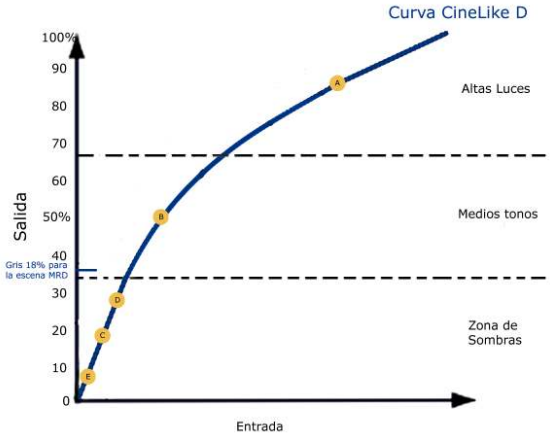
Image taken with the GDR configuration, using the Cinelike-D Gamma curve. I also used a Polarizer filter and an ND soft clip for the sky.

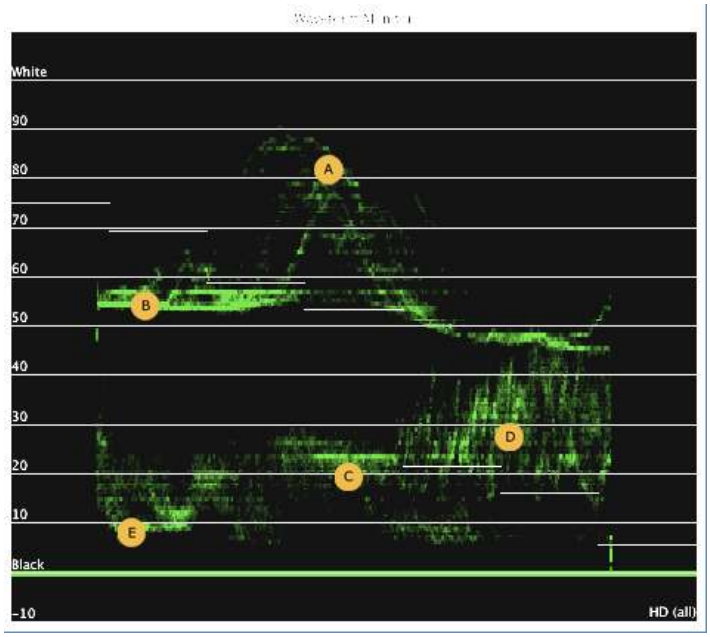


Image taken with the low-lit interior configuration, using the High curve. Sources of light are the side and back windows of the house.

In any case, don't be fooled by the names; don't think that because you are using a curve called Cinelike your image is going to look like a printed 35mm negative. Suffice it to say that the dynamic range of a cinematographic negative reaches 1000:1, while the Cinelike curve only goes to 100:1. The same happens with the color. The color space used by the camera is far from 35mm in terms of color tone. And the same goes if we compare the Normal HD curve with professional HD systems where the dynamic range reaches 600:1 and where the color gamut begins to extend to gain tones beyond SD video (RGB instead of Y Cb Cr). You therefore have to use the camera's possibilities to get the maximum performance, but not trying to imitate other professional formats that are far ahead in image quality, and, obviously, in cost.







These images show the brightness values for the scene both in the waveform monitor and the gamma curve. In this case, the different luminosities come within the camera's dynamic range, generating a soft image and with a lot of detail. There are several factors that intervene in this shot to enter into the camera's range. First, the camera's position with respect to the sun; second, the use of a polarizer and neutral density grad filters; third, the use of the Cinelike-D curve; fourth, the underexposure of the image later corrected in post-production.
The following images show the effect of each of the gamma curves.

Normal HD Gamma Curve		
Grey 18%	45%	N
White Chart	100%	+2 2/3
Black Cloth	20%	-2





Normal HD Gamma Curve



Normal SD Gamma Curve



HIGH Gamma Curve



LOW Gamma Curve



CineLike-D Gamma Curve



CineLike-V Gamma Curve



B.Press Gamma Curve

Latitude:

I used two different configurations in the shoot. The first one created to obtain the greatest dynamic range (GDR) and another to obtain the greatest detail in shadows, that is, the greatest possible sensitivity for low-lit interiors (LLI). For the latitude tests I used the GDR scene (Greatest Dynamic Range).

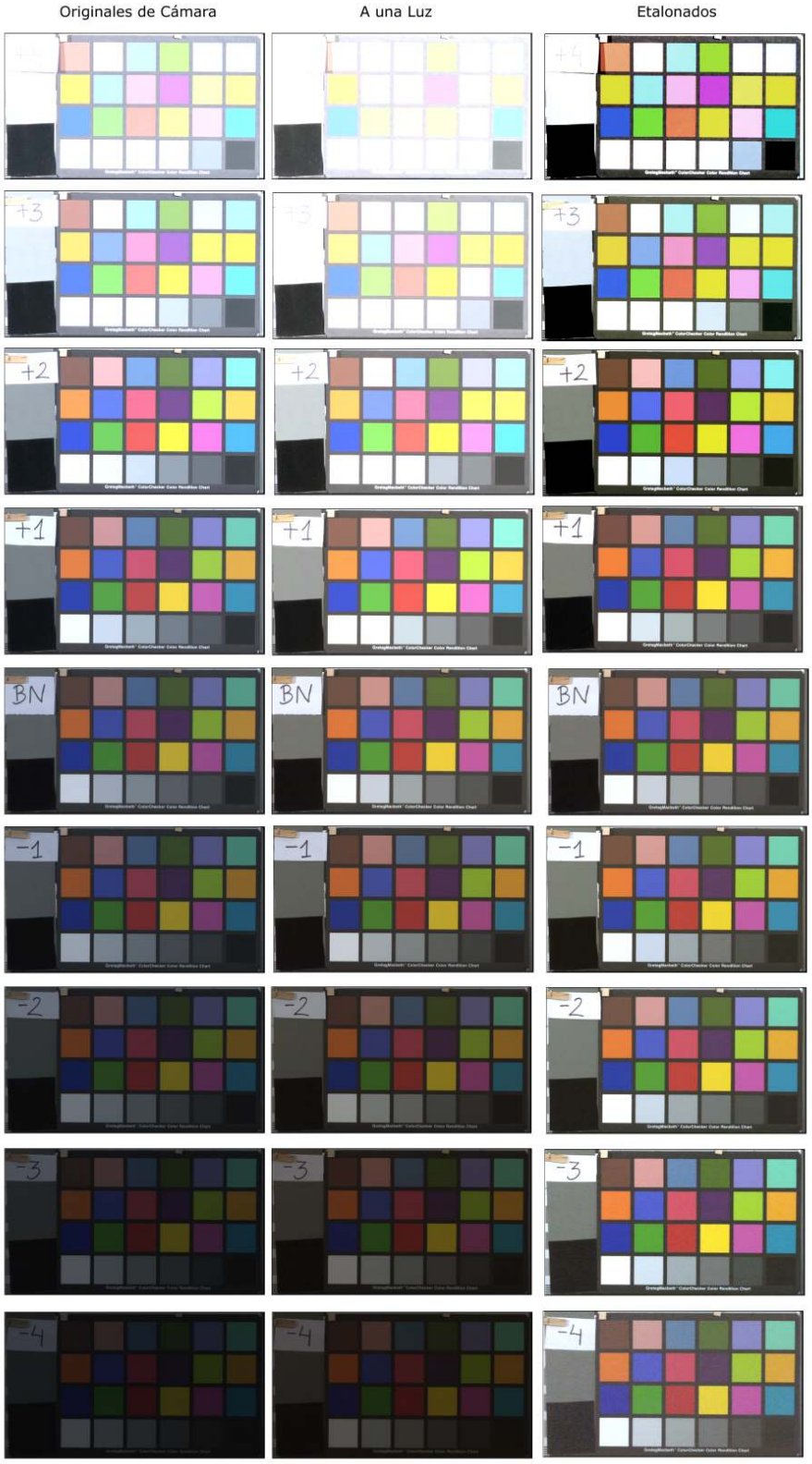
The latitude is around 6 stops, 2 above and 4 below the average value. As is visible in the color charts, the camera with the scene to get the greatest latitude handles up to 2 stops above the mid-grey very well. Practically all the detail in colors can be recovered and only a slight deviation towards cold tones in the mid-greys is visible.

Skin tone is lost as of 2 stops even though a lot of color detail can still be recovered. Color deviation in the grey is now considerable and the neutral tone cannot be recovered. The pink tones become more magenta and the skin tone has disappeared. With 4 stops overexposure, the colors are very modified, the skin tones and the softer tones disappear completely, the cyan becomes turquoise and the yellow acquires a brownish-grey tone. The orange disappears to become a brownish-grey yellow.

In underexposures, the behavior is much better. With 4 stops underexposed I have detail in the entire chart, respecting, in great measure, its tones, even if at the expense of a high level of noise noticeable from 2 stops underexposed.

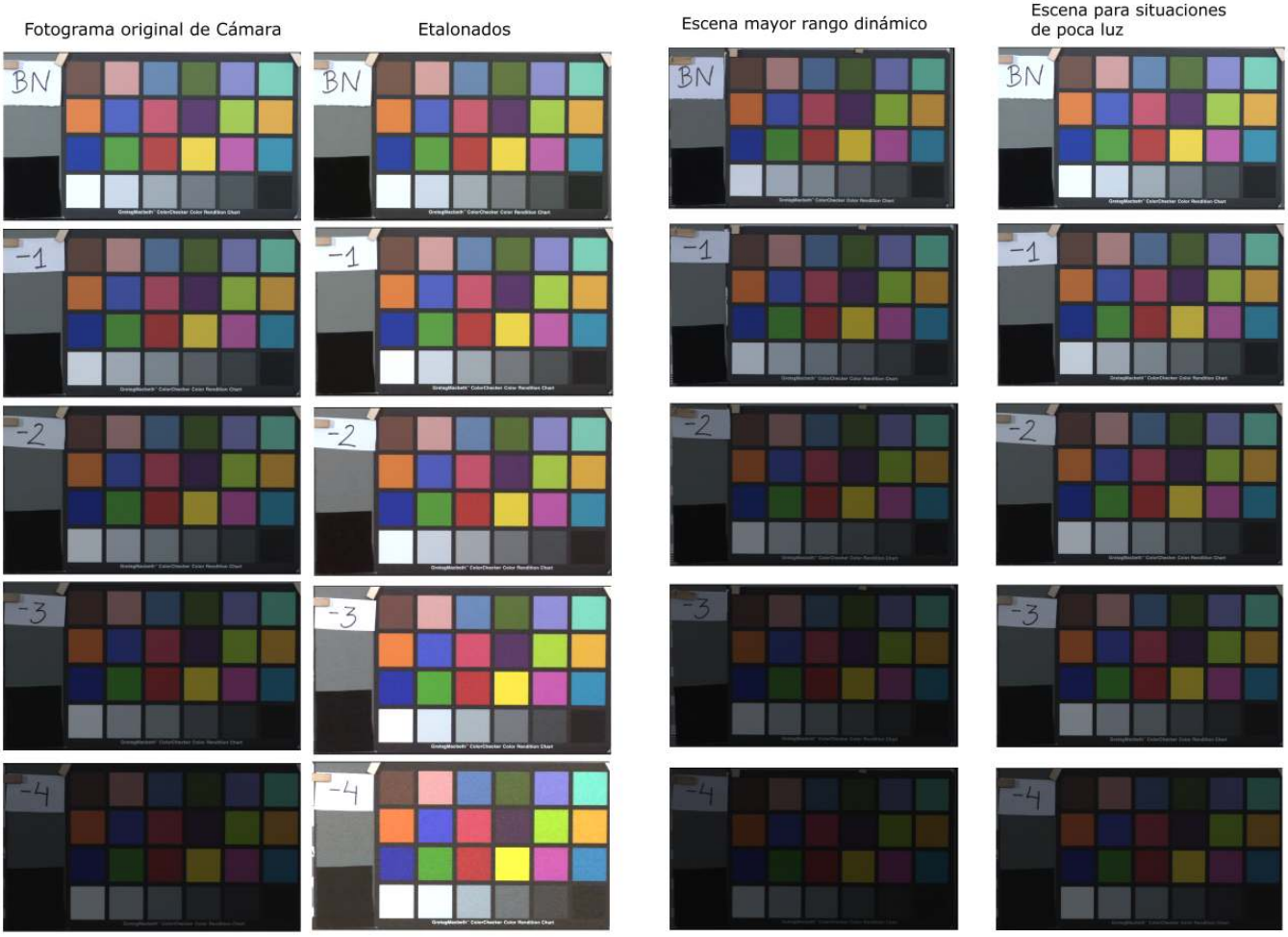
In general, the camera's latitude is what can be expected from 8bit video, even though it is HD, that is, with a dynamic range slightly above 100:1. Care must therefore be taken with high lights and avoid overexposure. In the GDR scene I modified the iris level to underexpose (each value modifies the image by 1/3 stop, from –4 to +4) the image, recovering its correct value in post-production and thus having more detail in high lights. During the filming of the documentary, I had to constantly modify the diaphragm; I even underexposed the shot up to 1 stop when I could. With the LLI scene, I used the High gamma curve, which reduces the image's noise with respect to the Cinelike curves and increases sensitivity somewhat more than half a stop with respect to the GDR scene, giving more detail in shadows. I kept the Iris level at 0 with this scene.

Elogio de la Distancia
Curva de Gamma CineLike D. Pruebas de Latitud. Configuración para obtener el mayor rango dinámico.



Elogio de la Distancia
Pruebas de Latitud con la curva de gamma High. Configuración para situaciones de poca luz.

Fotogramas originales de cámara



Above. Notice how it is possible to recover up to 4 underexposure points with the LLI scene, although with an increase in noise. However, it is lower than with the GDR scene.

Comparison of shadows between the GDR and LLI configuration. Notice how the LLI scene has more detail in shadows and less noise.



Original camera frames

The images above show the camera's latitude limitations (I used the GDR configuration). The exposure for the picture on the left was done for shadows and mid-tones, with details disappearing in the clouds. On the right, the exposure was adjusted for high lights, preserving all the detail in the clouds but with the loss of detail in the shadows. The grading was done with IRIDAS and it was impossible to recover detail in the clouds in the image exposed for shadows because that detail does not exist. However, recovery of most detail in mid-tones and shadows is possible in the other image but up to a certain point. In this recovery, there is a lack of information in the blacks and dark shadows.




Graded frames

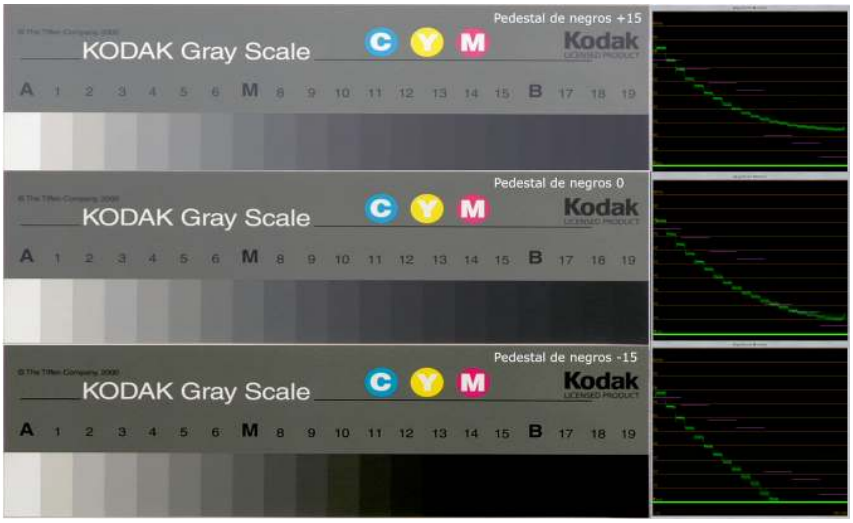


The picture on the left is a blow-up of the darkest part of the man's sweater after correction. You can see the lack of detail in said area (there are no bits of information). If the image is meant for the big screen, this defect would appear and would clearly make it ugly. If, on the contrary, the image is meant for a common TV screen, there can be a lack of information in the blacks and a slight increase in grain, keeping in mind the image's final appearance. In this case, the sky is very present in the shot and therefore should not be too overexposed as in the first picture.

The shot was taken in the late evening so using the pola was not recommendable so as to not lower the camera's sensitivity. And, on the other hand, degraded neutral density filters cannot be used; otherwise the man in the foreground would be darkened.

In sum, during filming, the best possible exposure for each case has to be evaluated, always thinking about post-production and the camera's limitations.

Black pedestal:



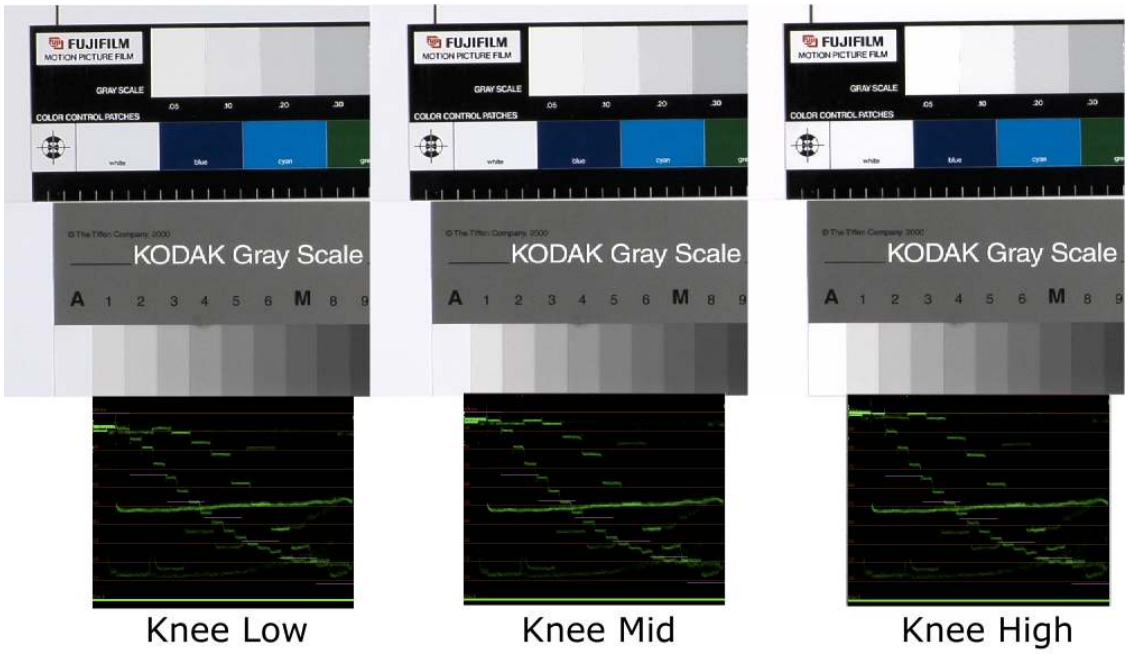
It is clear from the image that the black value can be changed and adjusted between –15 and +15, changing the camera's ability to see details in shadows and affecting its sensitivity. When it comes to configuring the black pedestal, keep in mind that it acts according to the gamma curve chosen. For the LLI scene I used a +3 value and a +2 value for the GDR. In both cases, a slight increase in the pedestal implies somewhat more detail in shadows but also more noise.

Knee

The knee value marks the starting point for white compression. The camera allows for the knee value to be put on automatic or manual in LOW, MID and HIGH values.

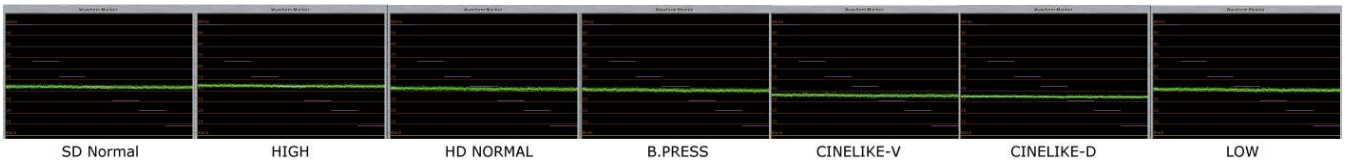
Modifying the knee lets you capture more detail in high lights and protecting them from overexposure. However, care must be taken not to put the knee value too low as this may produce very artificial greyish whites. With the knee in LOW, the lessening of the signal begins at 80%. With the value in MID at 90% and in HIGH the Knee does not affect the signal until it exceeds 100% and up to a maximum value of 109%. Set at automatic, the camera decides what value to apply.

With the Cinelike Gamma curves, the knee goes on automatic, allowing it to capture greater detail in high lights.



Sensitivity

The camera's sensitivity varies according to the filming format, the gamma curve used, the black pedestal and shutter speed. With the Cinelike D curve, the one that gives the greatest latitude, the mid-grey value on the waveform monitor is 35%; with the Cinelike V curve the value is 38% and, for example, with the High curve the mid-grey value is 45%.

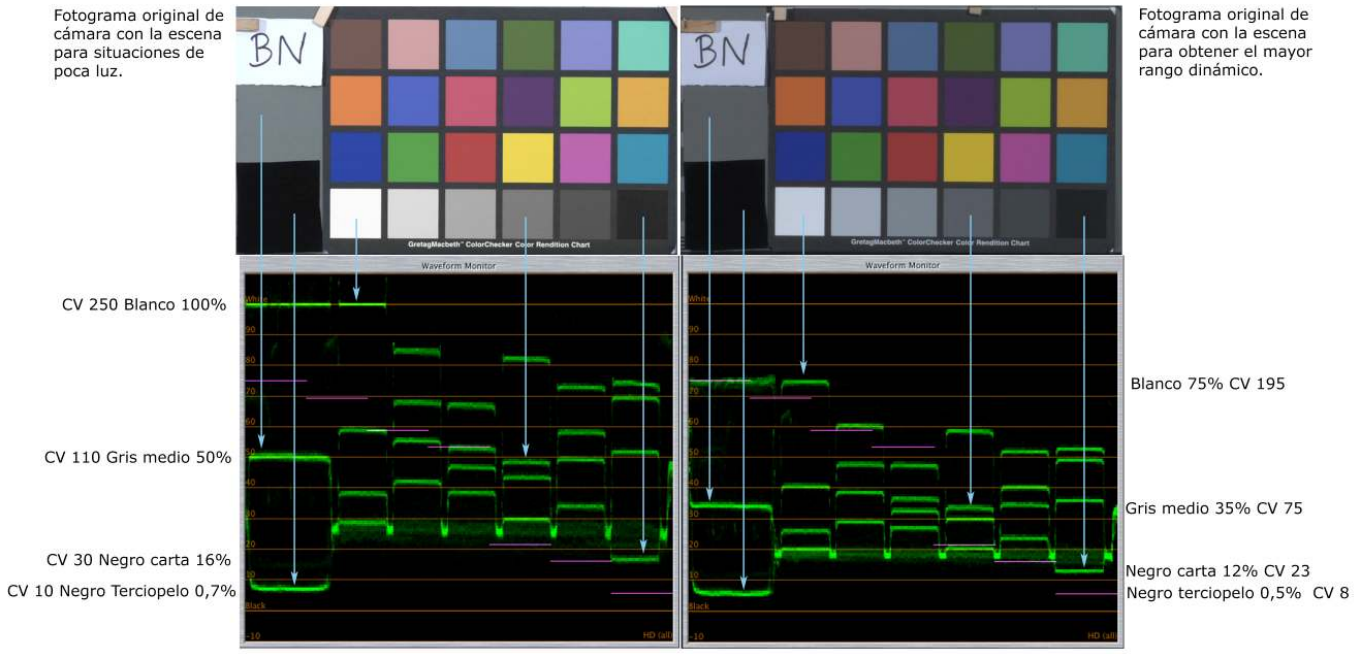


Variation of the 18% mid-grey value according to the different gamma curves.

The image below shows the difference in sensitivity from one scene to the next. In the LLI scene using the High curve and raising the black pedestal the mid-grey value is 50%, or 2/3 stop in sensitivity increase compared to the GDR scene. Grey value for the latter is around 35%, bearing in mind that the Iris level is at –1. Our conclusion is that the sensitivity value is between 250 Asa and 400 Asa. I used the 250 Asa value for the GDR scene and 400 Asa for the LLI scene.

As is known, and given digital cameras' capacity to see in the shadows, it is best to place the mid-grey around 40%, either modifying the iris level or underexpose the diaphragm around 2/3 during shooting. This would allow for the recovery of more detail in the grading process without too much noise or "defects" in the image due to lack of bit depth or compression.

Of course, sensitivity can be increased by means of the camera's gains at the expense of increasing the noise in the image. Another way of modifying the sensitivity is by handling the shutter speed and modifying the camera's recording speed. For very dark interiors where there is no movement, you can record at 12 frames per second gaining one extra stop of sensitivity. Modifying the shutter also gives a different sensitivity. In the LLI scene configuration, the shutter is set ay 260º (changing the shutter entails modifying the feeling of movement in the image).

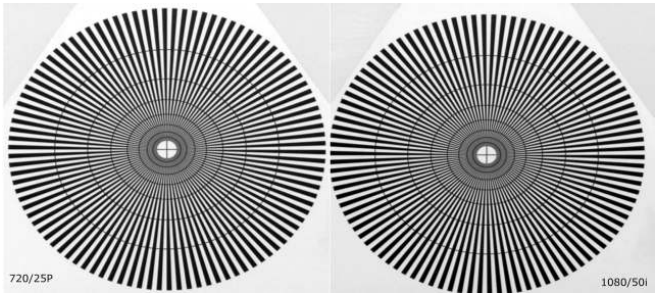


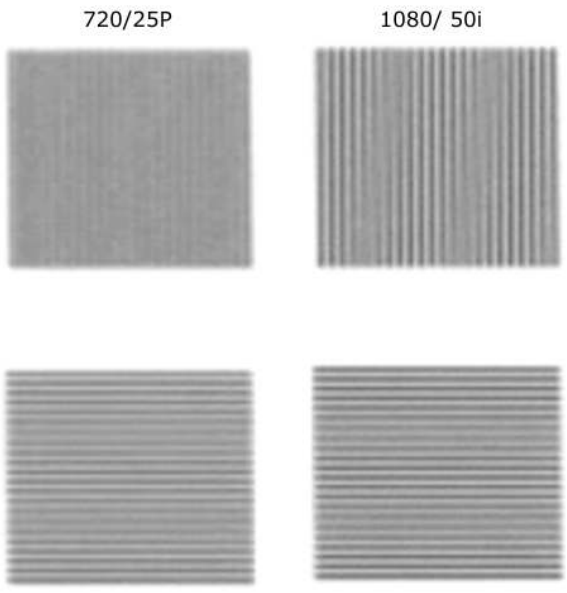
Comparison of the two LLI and GDR configurations

Resolution

One of the many discussions going round the digital forums is the choice of the 720p or 1080i format. The following images show that the difference is minimal, however, the 1080i format does give greater horizontal resolution. But don't be fooled, these are still shots and it's not really the way to effectively evaluate resolution; the best way is with dynamic resolution, that is, in movement, and here is where the interlace will lose out. 1080i means there are two fields (with a time gap between them) of 540 lines each that when joined give a resolution that is an average of both fields, around 1080 and 540, depending on the speed of movement and the angle of the camera. However, it does produce the typical problems of saw teeth and interlace moving effects. Moreover, the 1080 generates more "defects" in the image with the compression processes than the progressive one.

For this documentary, after viewing the images in motion, I didn't doubt using the progressive system, which takes up less space and the disk and the cards. The 1080i interlace system seems to follow the inertia of older ways of treating an image in analog where the transmission bandwidth doesn't allow you to send much information. And it doesn't seem to offer any improvements with respect to the 720p; on the contrary, because compression systems are also needed to transmit digitally (the compression range for DTV is around 70:1) and the progressive system accepts heavier compressions much better than the interlaced.







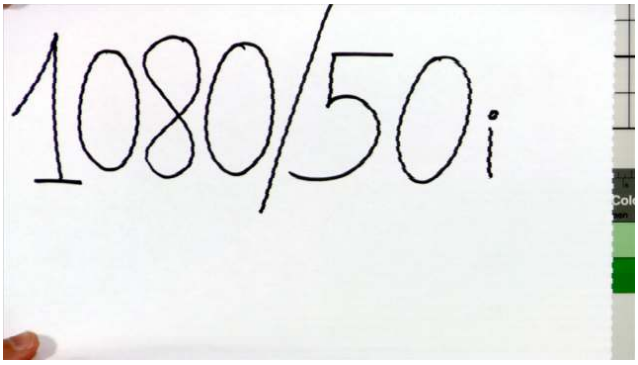


On this matter, I highly recommend reading an article by Randy Hoffner, entitled Good HDTV: It's More Than a Numbers Game, on ABC Television's choice of the 720p format for HDTV.

Since it is still impossible to place a moving image on paper, I include this frame "in motion" where the typical interlace effect is visible.

It must also be pointed out that the camera captures the luminance channel with a resolution of 960 x 720 and in red and blue at a resolution of 480 x 720 (4:2:2).

The image has to be rescaled to 1280x720 to be reproduced, as shown in the following frames:





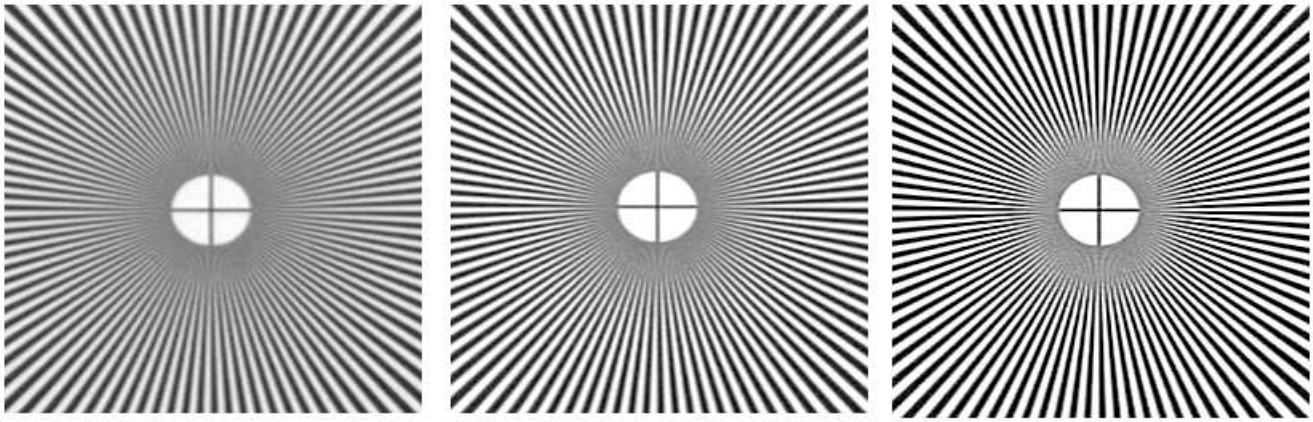
Camera original



Rescaled to 1280x720

Detail

You can modify the camera's detail from –7 to +7. Detail is an electronic embossing to give the appearance of greater resolution. For this documentary I used –7, which gives the image a more natural appearance, not at all electronic, and generates less noise. Below in the images you can see the effect of detail.



Color

One of the biggest advantages of the HVX200 is that the sampling system is 4:2:2. This gives the camera great color tone reproduction quality. You can modify the way the camera sees color with the Matrix, changing the color temperature, the phase and the chroma level.

The Matrix:

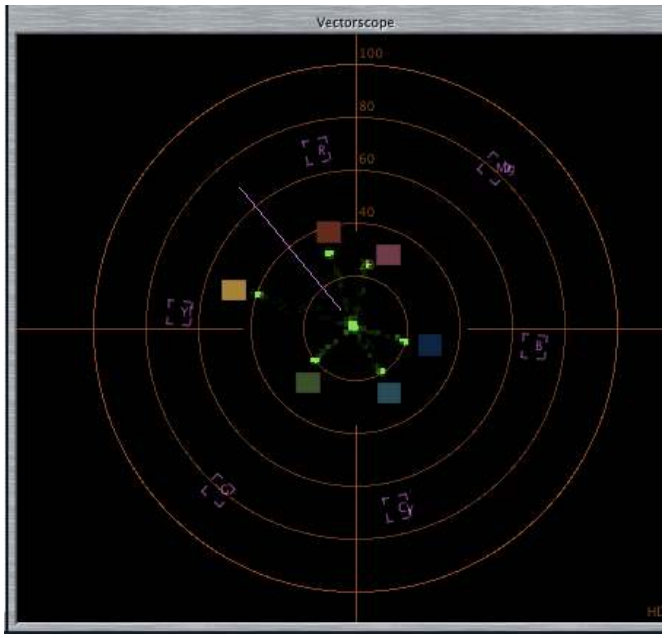
The camera offers 4 ways of viewing color:

Normal 1: Standard color base with very little saturated colors.

Normal 2: This configuration reproduces slightly warmer red and yellow tones than Normal 1, that is, the red is slightly more orange and the yellow slightly greener. The rest of the colors remain practically the same as Normal 1.

CineLike: The colors maintain the same tones as in Normal 1 but more saturated. That is, with Cinelike the colors are more intense and it is recommended for projects that will end up in analogue format for projection.

Fluorescent
This configuration corrects color deviations from fluorescent lamps and is recommended for spaces lit with this type of light.



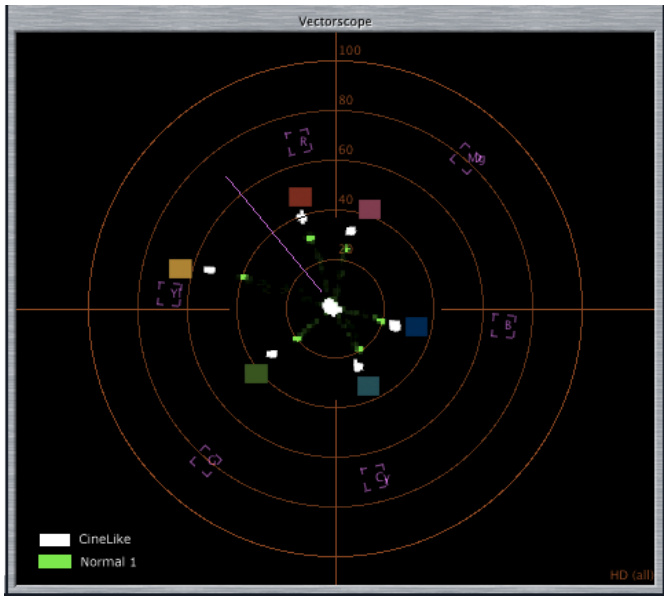
Color values with the Matrix Normal 1



In choosing the color, I gave priority to reproducing the most natural skin tone possible, modifying the phase and slightly desaturating the CineLike values.



Comparison Normal 1 and Normal 2

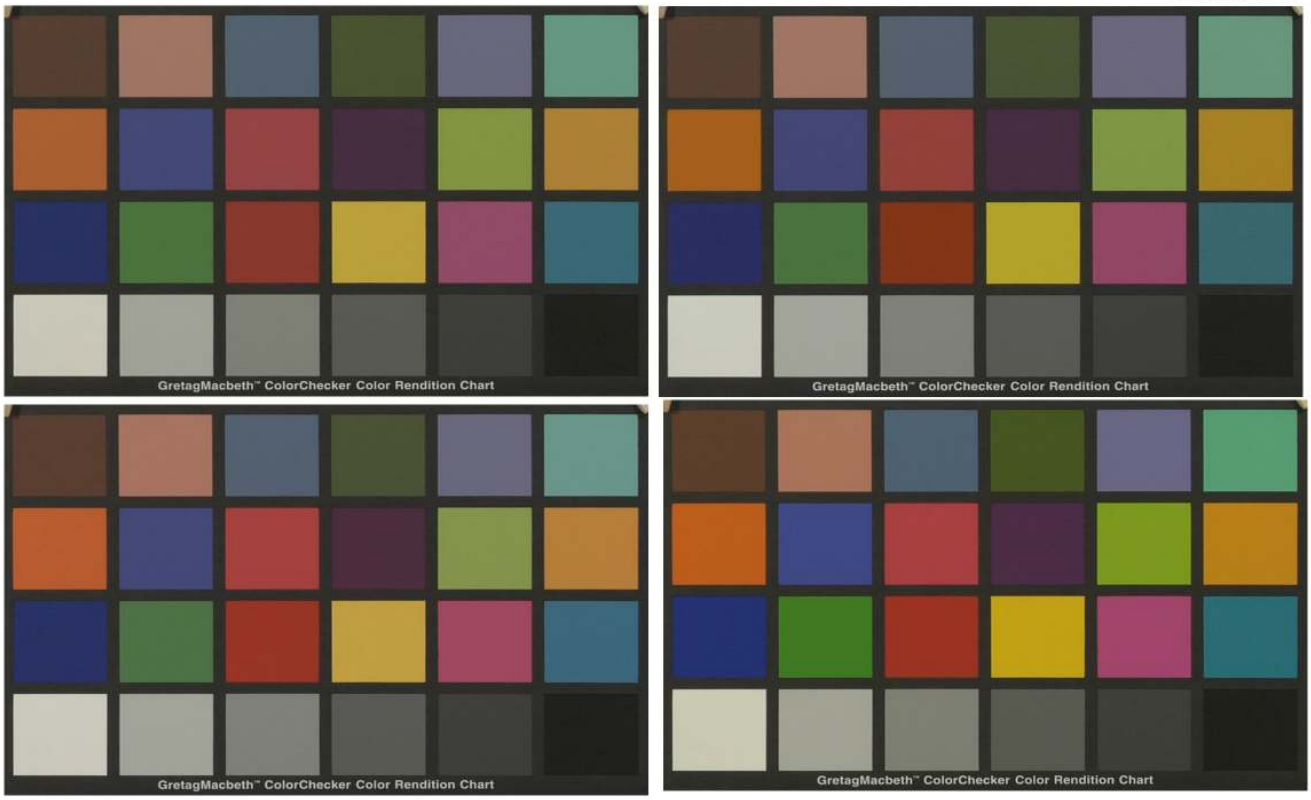


Comparison Normal 1 and CineLike

MATRIX

Normal 1

Normal 2

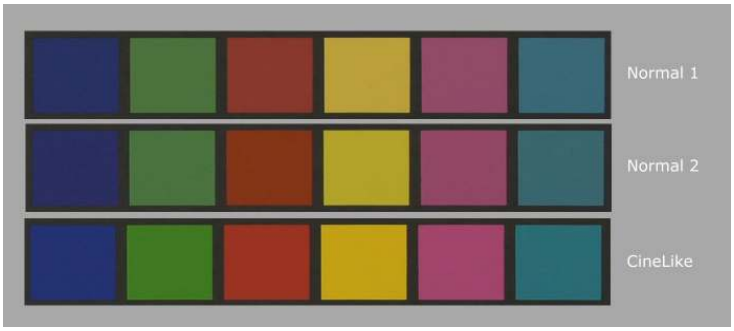


Fluorescente

CineLike

These frames show how the Matrix Cinelike saturates the colors more, maintaining the same tone as Normal 1. It also shows the variation of the red and yellow between Normal 1 and Normal 2.

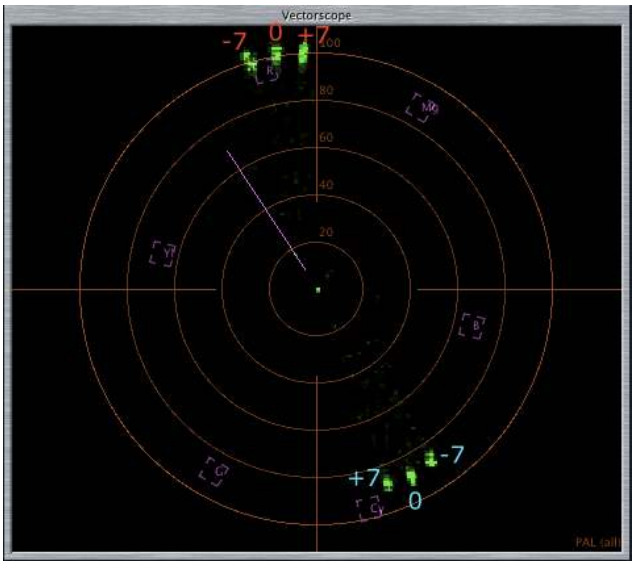
Observe on the right the different Matrix modifications on the primary and secondary colors. For the documentary, I started with the Matrix Cinelike both for the LLI and GDR scene.



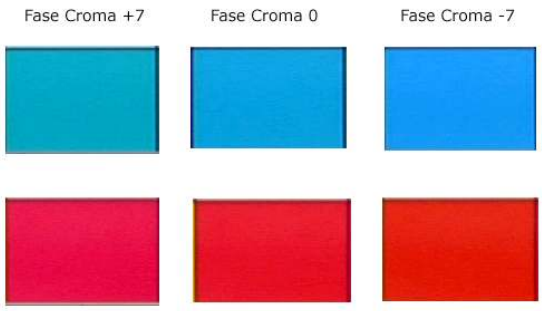
Phase and Chroma level:

You can modify the chroma phase from –7 to +7, which could make all the warm tones more or less warmer and the cold ones more or less colder. At –7 value the red is somewhat more orange and the cyan more blue. At +7 the red is more magenta and the cyan greener. For the documentary, both interiors and exteriors, I used a +2 value, so that the reds were colder, which favors skin tones. At the same time, the cyan tones were less cold, boosting the green value, something very appropriate for the mountain.

I modified the chroma level to – 4 in LLI and to –2 in the GDR scene. If you start out with the Matrix Cinelike configuration, the LLI color saturation would be slightly higher at Normal 1; and in exteriors (GDR), saturation is normally mid-way between Normal 1 and Cinelike. Since the documentary will be broadcast on TV, the Cinelike configuration, as I was able to verify during some tests, creates excessive colors, somewhat loud and with an electronic appearance, especially with the LLI scene.



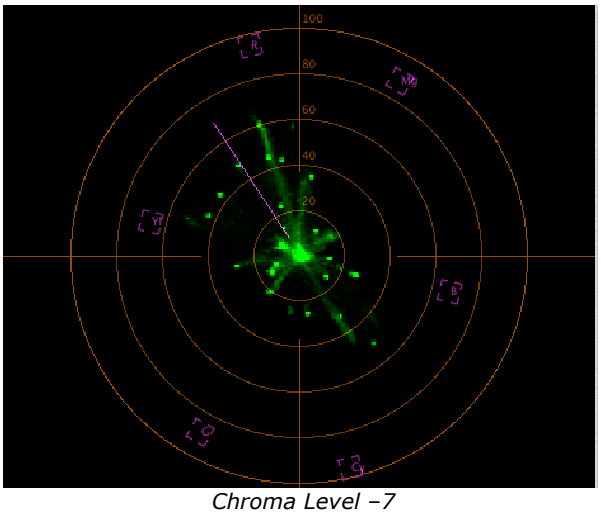




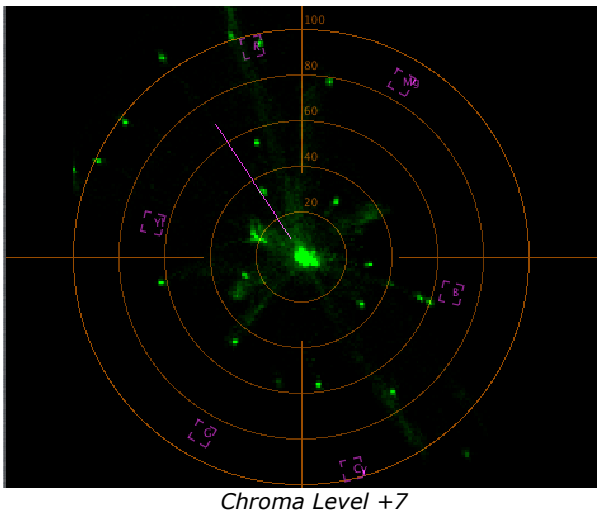
With positive values, the cyan turns greener and the red becomes colder, (+ magenta). On the other hand, with negative values the cyan is bluer, losing green, and the red is warmer, becoming more orange (+yellow).



The degree of saturation is controlled with the chroma Level. In the center, the value is at 0; on the left, at –7 and on the right at +7.
In the waveform monitor you can see the difference in degree of saturation between the maximum and minimum values.



Chroma Level –7



Chroma Level +7

Color temperature

Modifying color temperature over a certain value lets you "cool down" or "warm up" an image. This function only works when you are using white values in A or B and not in preset.

I didn't modify this parameter for the documentary, although I did have a white memorized in A at 5.600 K and another in B at 8000 K, with the preset at 3.200K. If the sun rises in the morning, I use memory A, and if it's cloudy, I use B. If the image, for example in exteriors on a very cloudy day, is too cold, then I change the color temperature value to –2.



Noise

One of the aspects I really had to look after when configuring the scenes was the noise (variation in color and pixel intensity). In general, images always present noise, especially in dark areas. The noise can increase or decrease according to how you manage:

-The black pedestal: the higher the positive value, the greater the noise.

-The detail: The higher the positive value for detail, the greater the noise.

-Detail coring: The higher the positive value, the less noise. The effect of this parameter is only noticeable when you apply the Detail Level. The higher the value in the Detail Level, the greater the effect of Detail Coring.

-Gamma curve: The CineLike-D gamma curve generates more noise than the High curve.

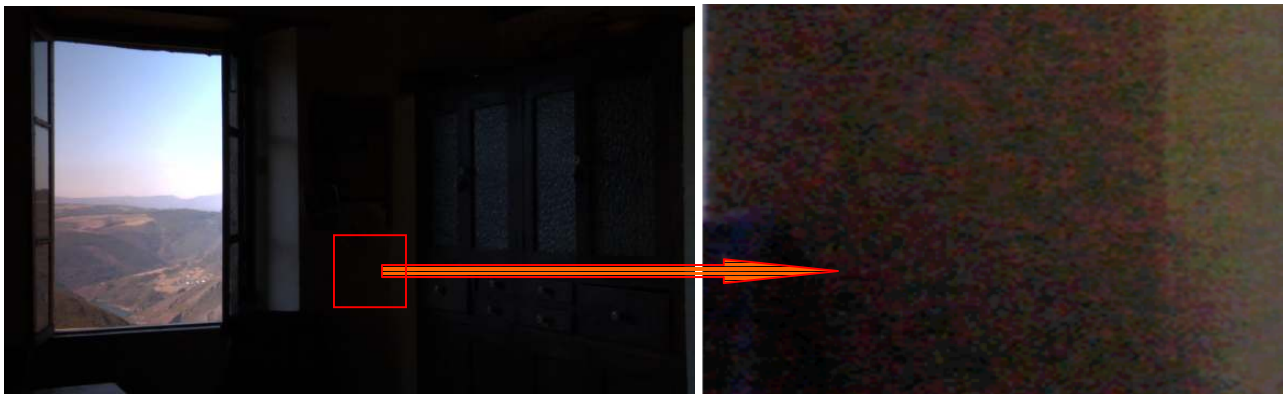
-Chroma level: The higher the positive value for chroma, the more noise level.

-The chosen color matrix: CineLike generates more noise than the Normal.

-Iris level: The greater the underexposure value, the more noise.

-The gain: The greater the gain, the greater the noise level in the image.

I tried to combine all of these parameters to obtain the least possible noise.



Blow-up of an image's shadows to see the noise

Handling the camera and other matters

Focusing

Without a doubt, this camera is the bane of all focus pullers. Only its reduced price can justify its amateurish way of focusing. Since a camera recording in HD needs greater resolution than any other current standard format, you need greater precision when focusing. Focusing here can be endless; in other words, there are no distance marks on the focus ring. You can see the distances marked by the camera in the LCD, but I've verified that they're not always correct nor always the right measure needed for an image. Since there are no direct focusing references, you end up constantly changing from auto focus to manual in order to measure. As everybody knows, using the auto-focus leaves the choice of where to place the camera to the camera itself and not the operator; not to mention how ugly it is to see the auto-focus changes in the same shot. Another thing is that evaluating the focus is practically impossible (especially in the medium and general shots) through the viewfinder or the LCD screen, so much that the camera comes with the possibility of increasing the image on screen (an electronic zoom) in order to adjust the focus. This "trick" is useful but bothersome, especially when you're filming a documentary where speed is essential to capture reality. In my case, I usually frame the shot from the viewfinder while my focus puller uses the LCD to focus, using the "trick" and the EVF DTL on, although this tires my eyes. I can say that I've seen my assistant sweat and not necessarily because of the heat.

In reality, the best way to make sure the focus is good is by viewing the image through a large HD monitor, but, of course, this wasn't possible in the documentary.

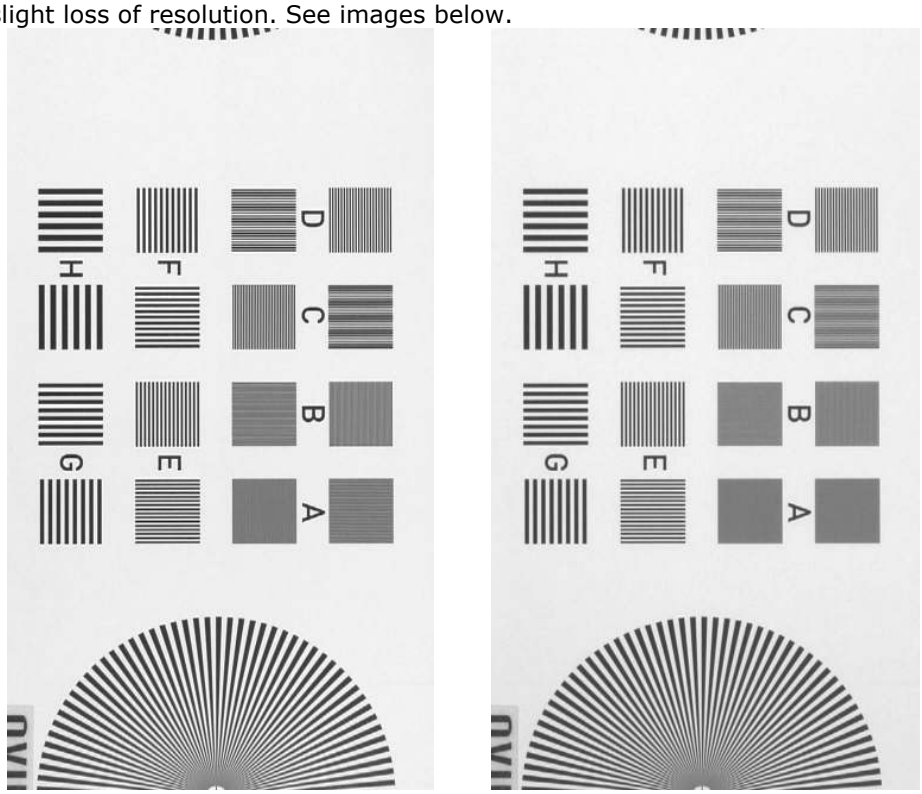
For more information on focusing read the article by Barry W. Green at:
http://www.dvxuser.com/V6/showthread.php?t=49375&highlight=autofocus+HVX200 where he gives a detailed explanation on how to work the focus in the HVX200.

The diaphragm

Another tiresome aspect is the change of diaphragm. You have to press a button for an automatic exposure, then press the same button to leave it in manual again and then adjust it with a small wheel that marks the ½ in ½ stops diaphragm changes on the LCD screen. The brightness, however, varies by 1/6 stops. The variations can be verified in a monitor but it's not that easy to view in the viewfinder or the LCD when in the field. The diaphragm adjustment with the small wheel is totally inaccurate if compared to professional lenses and only tests and experience give you the ability to correctly evaluate the exposure. Again, in this documentary, I had to constantly change the diaphragm if I wanted to see the images correctly in the camera's dynamic range and it is slow, among other reasons, because I'm very clumsy; I never get it right the first time with the small wheels.

The diaphragm values go from F1.6 (Open) to F11 but the lens works better with the diaphragm between 4 and 8.

It's better to avoid high diaphragms (as of F8) when shooting in HD as diffraction effects start to appear, which results in slight loss of resolution. See images below.



The images show the loss of resolution due to a diffraction effect (see A and B). On the left, the diaphragm is at F 3.4 and the one on the right at F11. When shooting in HD with this camera, it's best not to go over F8 (I tried not to use an F higher than 5.6 in the shoot).

Neutral density filters

The camera is equipped with two neutral density filters of 1/8 and 1/64. The first one reduces the light by 3 stops and the second by 6 stops. In general, light reduction with both filters for me was either too much or too little, so I worked with ND, 3, 6, 9 and 1.2 neutral density filters and a polarizer instead; sometimes I combined these on the camera.

The lens

The camera comes with a motorized and manual Zoom Leica Dicomar 13x to F 1.6 up to F11 with a 4.2mm to 55mm focal range, which in 35mm translates into a 32.5mm to 423mm range (the camera uses three 1/3" CCDs)



The wide-angle position gives a recognizable geometric distortion (barrel).

The lenses present chromatic aberrations, obviously, more on the edges than in the center of the image.

Images shot with the wide-angle position present a slight vignette, which can be seen with the waveform monitor on an evenly lit white chart.

As I mentioned before, there are diffraction effects at higher than F5.6.

Though the lens presents good light uniformity in the entire range, I've noticed that in the zoom's tele position the brightness is 1.5 stops below the lens' wide-angle position.

In the widest-angle position, 4.2 mm, the F is at 1.6, while in the most tele position, 55mm, the diaphragm's maximum opening is at F 2.8 and at an intermediate focal distance, 20mm, the opening is at 2.4.

This means that in low-lit interiors you have to avoid using the tele-zoom position so as to not lose more than half the brightness.



Notice the chromatic aberration in the blow-up with the typical magenta-green edges in the contrasted objects.

Recording and post-production

I used two Firestore v.3 disks that allow you to record in 25P native format, which is 25 frames per second with a disk capacity of 220 minutes. I downloaded the disk everyday after shooting onto two 500GB LaCie disks using an Express 32 card with two Firewire 800 connections to a Macbook Pro. Then I viewed the clips using the P2 Log Pro 2.1 program and the FCP.

In some cases I used 8Gb P2 cards de 8Gbs, which were downloaded using the Duel-System adapter for Mac.

The transfer time was generally less than real time and the machines were left processing the images during dinner.



Our "washing machine" coping the files

The information on the disks was transferred onto DLT tapes in order to have copies of everything and onto DVD during filming.

The color correction process, after a few tests, was done with BaseLights, working on the images in 10bits linear format.

We had a bit of a fright while filming; when we were viewing the clips filmed during the day, the computer froze and when we re-booted the files had disappeared. Fortunately, my assistant's caution and having two Firestore disks made it easy to recover the files.

After this event, I recommend:
-Having at least two disks and two cards, just in case something goes wrong while filming.
-Copy the files onto three disks instead of two and check the material independently in each of them.
- Copy the files onto a DVD.
-Update all drivers and firmware of all the peripherals involved.
-Test the entire system before shooting.
-Pray for divine protection from computer evils.

Configurations: I used the ones created by Barry W. Green from his book HVX book

GDR scene	LLI scene
DETAIL LEVEL: -7	DETAIL LEVEL: -7
V DETAIL LEVEL: 0	V DETAIL LEVEL: 0
DETAIL CORING : 7	DETAIL CORING : 7
CHROMA LEVEL: -2	CHROMA LEVEL: -4
CHROMA PHASE: 2	CHROMA PHASE: 2
COLOR TEMP: 0	COLOR TEMP: 0
MASTER PED: 2	MASTER PED: 3
A.IRIS LEVEL: -1	A.IRIS LEVEL: 0
NEWS GAMMA: OFF	NEWS GAMMA: OFF
GAMMA : CINELIKE D	GAMMA : HIGH
KNEE: AUTO	KNEE: HIGH
MATRIX: CINE-LIKE	MATRIX: CINE-LIKE
SKIN TONE DTL : OFF	SKIN TONE DTL : OFF
V DETAIL FREQ : THIN	V DETAIL FREQ : THIN
OPERATION TYPE: FILM CAM	OPERATION TYPE: FILM CAM
FRAME RATE: DEFAULT	FRAME RATE: DEFAULT









References:

https://eww.pavc.panasonic.co.jp/pro-av/index.html
http://www.focusinfo.com/
http://www.imagineproducts.com/
http://www.dvxuser.com/articles/hvxbook/
http://forums.creativecow.net/
www.alfonsoparra.com
http://www.hdforindies.com/labels/HVX200.html

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