Solutions for a Multi Definition World

1080i and 720p

Interlaced Vs Progressive

In a progressive system the image is scanned horizontally into a number of lines one complete set makes up a frame. The number of frames per second equals the frame rate. In an interlaced system the frame is scanned in two parts with half the number of lines each. These lines are scanned so that the second set lies exactly between the first. The two fields together make a full frame. For a slow moving or static image the vertical resolution is the same as for a progressive one. As objects move faster and faster the audience sees smooth motion equivalent to the 50hz or 60hz field/frame rate but in an interlaced system the apparent vertical resolution is reduced. In the limit this would be half that of a progressive one

A progressive system scans all the lines in one frame. For recording and transmission this requires double the bandwidth so the vertical and horizontal resolution is reduced to compensate. However this resolution is the same for static or fast moving images. To a viewer motion looks equally smooth interlaced or progressive.

In HD for 50hz or 60hz this means that progressive systems use 720 lines of 1280 pixels per line where as interlaced systems use 1080 lines of 1920 pixels.

If the images are to be processed for example, up-converted, frame rate converted or ‘slow motioned’ interlaced systems require greater processing to produce the same vertical sharpness as a progressive systems.

In Summary

	1080i	720p	Comment
Resolution for still or slow moving objects (H X V)	1920 X 1080	1280 X 720	720 is 2/3 in H and V of 1080
Resolution for fast moving objects	1920 X 540	1280 x 720	720 is 2/3 in H of 1080. 1080 is ¾ of 720 in V
Temporal resolution	60 or 50Hz	60 or 50Hz	Essentially the same
Uncompressed data rate for 50hz 8 bits 4:2:2	829Mb/s	737Mb/s	13% greater for 1080i

Applications

Practically what this means is that 1080i tends to be preferred for many applications such as, drama, documentaries and any studio based programs because of its ultimately higher resolution. For sport applications 720i has some advantages because there is more fast action. Though its resolution is lower overall it is constant. This is mostly visible when slow motion replays are used were 720 can produce judder free images without any processing

It should be noted that in the 50hz countries the vast majority of transmissions are in 1080i and so this advantage would be lost in transmission unless 720p was also used.

Real cameras for 720p and 1080i

Sensors

For a camera to be able to capture the full resolution of either format the sensor has to have at least as many pixels H and V in each colour as the standard. For 1080 this means 1920 X 1080 or approximately 2.2M pixels in R,G and B. For 720 this is 1280 x 720 or approximately 0.9M pixels in R,G and B. Cameras not meeting these minimum limits need not be considered for this discussion.

Most professional cameras now use 2.2M pixel sensors. When operating in 1080 this means for each image pixel there is one sensor pixel. When capturing images in lower resolutions there are several possible approaches.

a. Use a smaller part of the sensor. Not normally practical because it requires the lens system to produce a different sized image.
b. Scan all the pixels but throw away the samples that are not required. Called sub sampling.
c. Scan all the samples but average some together on the chip to produce a lower resolution image.
d. Scan but average some together in digital after the sensor chip.
e. Scan all the samples to produce a 1080i image then average some of the pixels together in digital at the output of the camera taking into account the interlacing.

The results from c, d and e are likely to be very similar depending on the particular algorithms used and hardware implementation. However C could potentially result in a better S/N ration as the process happens before digitization. As noted a, is impractical. b would result in a poorer S/N ration because the effective pixel size would be much smaller than the equivalent lower resolution but similar sized senor. Also b could cause aliasing artifacts if there were no precautions taken in the optical path.

There is a practical difference for option e. c and d require a switch so that the camera can operate in either 720p or 1080i where as option e could potentially allow the simultaneous output of both 720p and 1080i. It could be argued that producing 720 this way is not the same as actually scanning in progressive. However the actual results would all depend on the quality of processing used.

For ease of processing some cameras take yet another approach this is to produce a 480p image on the sensor chip giving a good S/N ration because of the increased pixel size on the sensor. Then up-convert the 480p to produce a 720p image.

Finally one manufacturer has taken a completely different approach and uses a much higher resolution sensor than 1080 which has sufficient lines (>4000) such that all standards can be produced on chip simply by combining multiples of pixels. The downside of this approach is that it can only done on FT sensors which have their own unique advantages and disadvantages. (See discussions on FT vs. FIT)

Evaluation.

Given the above discussion because so much depends on manufacturers actual implementations it is important to evaluate camera quality using side by side tests on real material. Make sure there is the opportunity to evaluate both low lighting and good lighting performance. Also consider highly detailed static scenes and moving scenes.

If possible have access to a slow motion replay device to check actual results on slow motion and stills.

Also consider your actual workflows. Where will the cameras be used and for which applications? Who will you be producing material for and what format can they use? Finally consider the wider picture, such as ease of operation, reliability, facilities and so on.