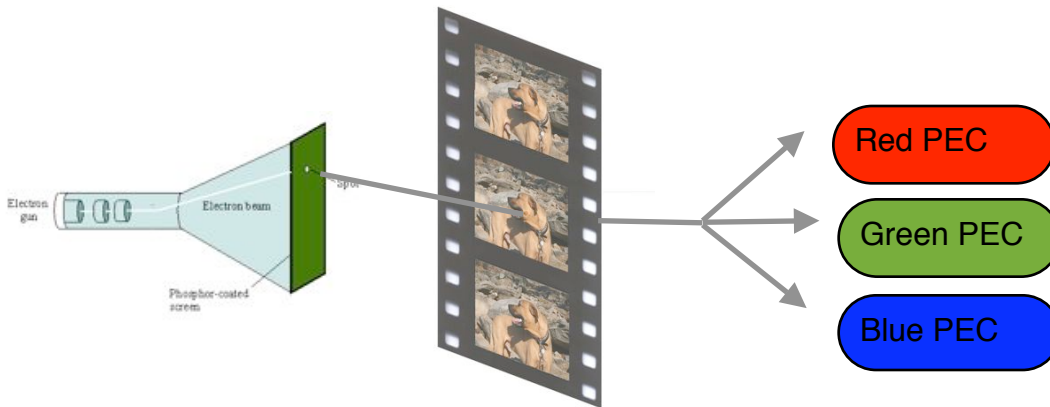


HD Telecine Guide

Theory of Operation:

The film is scanned using a flying spot system.

Scanning



For each digital pixel of resolution a sample is taken from a constantly moving beam of light which is emitted by a CRT through the film. The beam or “spot” is then split into its primary colors Red, Green and Blue. Each color sampled by a PEC (photo sensor). For 1080p video, the beam’s R,G, and B values are sampled 2,073,600 (1920x1080) times per frame.

Color Correction

Each spot sampled is a pixel in a digital frame. These raw RGB samples are a measure of color density at a spot on a film frame. They need to be corrected, possibly reversed, and manipulated to present a pleasing video image.

Storage

The digital frames are outputted from the telecine as a serial digital stream. There are a limited number of frame resolutions and rates at which they can be transmitted as specified through SMPTE protocols. This (HD-SDI) data stream is then recorded to tape or hard drive.

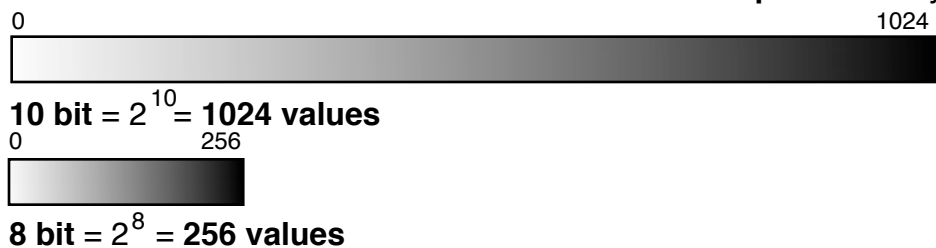
Digital Video Background

Pixel This is the smallest unit of a digital video frame. A pixel contains three values. These values either represent RGB or YUV. RGB and YUV are called **color spaces**.

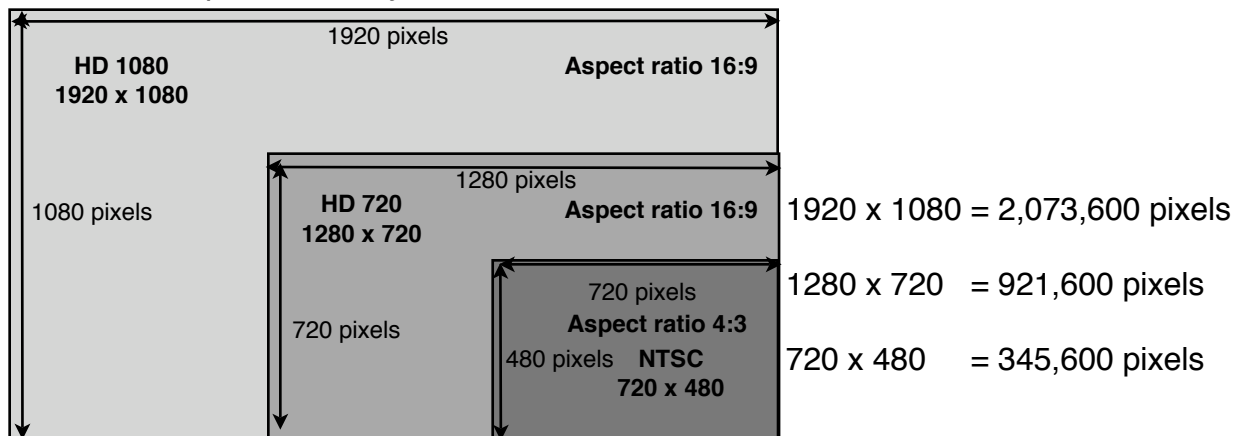
Y'CBCR or YUV is the color space in which many digital video formats store data. Three components are stored for each pixel—one for luma (Y) and two for color information (CB for the blue difference signal and CR for the red difference signal).

RGB Red, Green, and Blue. The RGB color space has a very large gamut, meaning it can reproduce a very wide range of color, however each must be fully sampled (4:4:4) requiring a high data rate.

For each color channel component of a pixel, the range of possible values is determined by the number of bits used to define the value. The **Bit depth** is usually 8 or 10 bits.



A two dimensional array of pixels is a **Frame**. The **Frame Size** is expressed by the number of pixels wide by the number tall. There are three common frame sizes.



Frame Rate is the number of frames per second. Relevant frame rates are:

14.98 (2k)	29.97[59.94i] (HD & SD NTSC)
23.98p(HD)	29.97p (HD)
24p(HD)	30p (HD)
25[50i](HD & SD Pal)	
25p(HD Pal)	

Interlaced	Progressive
2 fields per frame. Odd lines and even lines. Intended to be displayed 1/(2xFPS) seconds apart.	Full frame of sequential lines intended to be displayed sequentially.

Frames can be **interlaced(i)** or **progressive(p)**

Nova Output Capabilities:

Video Output Formats

NTSC
PAL
720p 59.94
720p 60
1080p 23.98
1080p 24
1080psf 23.98
1080psf 24
1080i 50
1080i 59.94
1080i 60
2k 14.98

Colorspaces

4:2:2 YUV
4:4:4 YUV
4:4:4 RGB

Film can be transferred From 2 - 30 fps

1080 vs 720

As shown before a 1080 frame has more pixels than 720.

1920 x 1080 = 2,073,600 pixels

1280 x 720 = 921,600 pixels

1080i has 30 whole frames per second while 720p has 60.

(1080) 2,073,600 pixels x 30 = 62,208,000pps

(720) 921,600 pixels x 60 = 55,296,000pps

So 720p 60 and 1080i 59.94 have similar pixels per second .

Most film is shot at 24 fps or less so the 1080 standards will capture more resolution of the film as compared to 720 standards.

The strength of the 720p standards ,being higher amount of full frames per second, is not utilized by film

1080p vs 1080i

1080p 23.98 and 1080i 59.94 have the same amount of film data. The 59.94 contains the 3:2 pulldown plus the 24 film frames. With the prevalence of progressive displays (lcd, dlp, plasma) and the reduction in CRTs, progressive formats are becoming more popular.

Advantages of 1080p:

No redundant data resulting in smaller file size

Better on progressive displays

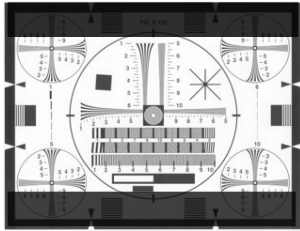
1:1 ratio of film frames to video frames

Advantages of 1080i:

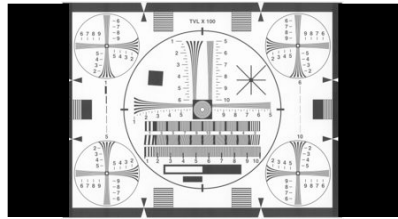
Compatible with NTSC upconverts

Compatible with 1080i video

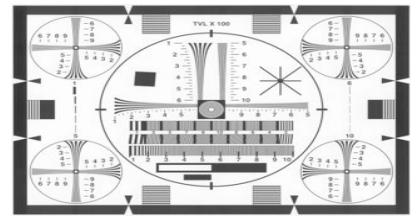
Framing 4:3 Film to HD



**16:9 extraction(full east west)
25% loss of image
(12.5% bottom and top)**



**Pillarbox
Full film image
25% video resolution
unused**



**Anamorphic 4:3
Vertical Squeeze
Full Film Frame
Needs to be manipulated
for use**

Regular 16mm

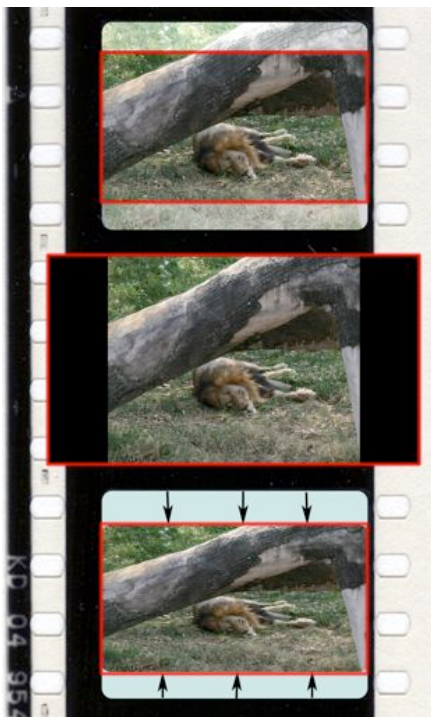


16:9 extraction



Pillarbox

Academy 35mm



16:9 extraction(full east west)

Pillarbox

4:3 Anamorphic

Super 35mm



Colorlab HD Tape Formats

HDCAM

HDCAM INFO

8-bit
DCT compressed
3:1:1
1440x1080
144mbps
4 channel audio
About 7.1:1 compression ratio

HDCAM Recording Formats

1080i	YUV 29.97
1080i	YUV 25
1080p	YUV 24
1080p	YUV 23.98

HDCAMSR

HDCAM SR INFO

10-bit
MPEG4 Studio Compression
4:2:2/4:4:4 RGB/YUV
1920x1080
440/880 mbps
12 channel audio
About 2.7:1 (YUV 4:2:2) compression
About 4.2:1 (RGB 4:4:4) compression

HDCAM SR Recording Formats

1080i	RGB/YUV 29.97
1080i	RGB/YUV 25
1080p	RGB/YUV 24
1080p	RGB/YUV 23.98

HDV

HDV INFO

8-bit
MPEG-2 Compression
4:2:0
1440x1080
25 mbps
4 channel audio

HDV Recording Formats

1080i	YUV 29.97
1080i	YUV 25

Colorlab HD File Formats

All frame rates and resolutions can be recorded to file. There are many different digital file formats. This is a listing of common file formats.

Quicktime (.mov)

Uncompressed 4:2:2 8 Bit YCbCr
Uncompressed 4:2:2 10 Bit YCbCr
Uncompressed 4:4:4 10 Bit RGB (lin/log)
DVCPRO HD
ProRes (full raster)
HDV

AVI

Uncompressed 4:2:2 8 Bit YCbCr
Uncompressed 4:2:2 10 Bit YCbCr
Uncompressed 4:4:4 10 Bit RGB (lin/log)

AVID

DNxHD

Still Image (frame based)

YUV/422/v210/420
DPX, Cineon, Tiff

Linear vs Log

Log video is representative of film density. Must have a LUT applied to display properly. Wider range of values from the film. Used for DI.

Linear video is standard video.

Uncompressed file formats are full 1920 x 1080 and require SCSI/Fiber Arrays.

DVCPROHD - 100mbps 1280 x 1080 4:2:2 Firewire Drive Capable

ProRes - 200mbps 1920 x 1080 4:2:2 Firewire800 Drive Capable

Uncompressed Data Rates

720p HDTV uncompressed;
8 bit @ 1280 x 720 @ 59.94field = 105 MB per/sec, or 370 GB per/hr.
10 bit @ 1280 x 720 @ 59.94field = 140 MB per/sec, or 494 GB per/hr.

1080i and 1080p HDTV uncompressed;
8 bit @ 1920 x 1080 @ 24fps = 95 MB per/sec, or 334 GB per/hr.
10 bit @ 1920 x 1080 @ 24fps = 127 MB per/sec, or 445 GB per/hr.

8 bit @ 1920 x 1080 @ 25fps = 99 MB per/sec, or 348 GB per/hr.
10 bit @ 1920 x 1080 @ 25fps = 132 MB per/sec, or 463 GB per/hr.

8 bit @ 1920 x 1080 @ 29.97fps = 119 MB per/sec, or 417 GB per/hr.
10 bit @ 1920 x 1080 @ 29.97fps = 158 MB per/sec, or 556 GB per/hr.

1080i and 1080p HDTV RGB (4:4:4) uncompressed;
10 bit @ 1920 x 1080 @ 24PsF = 190 MB per/sec, or 667 GB per/hr.