Framerates, Formats, Conversions, and Pulldown
FRAMERATES: Interlaced vs. Progressive

• **Film is progressive** (whole frame exposed at once) 24fps. When projected, projector blades divide images so that viewer actually sees 48 images per second; this eliminates flicker, creates impression of continuous movement.

• **Interlaced video** scans odd lines, then even; two fields are blended into one image, so 29.97 fps **NTSC video is 59.94 fields per second**.

• **24p video** scans whole frame progressively, closer to film motion blur (but without benefit of projector blades will look jumpier on playback than film). **24p is optimal for projects that are finished on film**.

• **30p video** is a good compromise for projects finished on video. It is progressive, closer to film look than 60i, but has fewer strobing issues than 24p in video playback.
Interlaced Video
Interlaced Video Artifacts

• **edge tear / combing** – image lands between two fields and blurs, common for rapid lateral movement

• **aliasing / stair-stepping**

• **twitter** – image shimmers (common in rolling credits in interlaced video); happens when image contains thin horizontal lines that only show up in one field.
**TYPES OF 24p**

• **24p NATIVE** - True 24p is recorded to memory card or hard drive (tapeless). Needs to be converted for NTSC / PAL playback.

• **24p WITH NORMAL PULLDOWN** - technique of embedding 24p stream in 60i recording to make it compatible with 60i decks and monitors (this is how both 480i and 1080i record progressive framerates); All NTSC video tape runs at 60i.
2:3 (NORMAL) PULLDOWN CADENCE

**ORIGINAL 24p STREAM**

1. A
2. B
3. C
4. D

**PULLDOWN TO 29.97 fps (60i)**

1. A1
2. A2
3. B1
4. B2
5. B3
6. C1
7. C2
8. D1
9. D2
10. D3

**RECOVERED 24p MEDIA**

1. A
2. B
3. C
4. D

Note: The diagram shows the process of converting a 24p original stream to a 29.97fps pull-down stream, and then recovering the 24p media.
2:3 (NORMAL) PULLDOWN CADENCE

- 6 extra frames are created per second, frame rate goes up from 24 to 30.
- Speed of movie doesn't change, motion looks normal.
- REVERSE telecine / reverse pulldown can be done when footage is brought into NLE - extracts 2:3 pulldown restores footage back to 24p.
- Reverse telecine requires decompression and recombination of frames 3 and 4 to extract C-frame image; process degrades video quality.
2:3:3:2 or 24p ADVANCED PULLDOWN

ORIGINAL 24p STREAM

PULLDOWN TO 29.97 fps (60i)

RECOVERED 24p MEDIA

1 2 3 4

A1 A2 B2 B3 C1 C2 C3 D1 D2

1 2 3 4

SKIP FRAME

A B C D
COLOR SAMPLING

• Digital recording records in grid / pixel array, e.g. 720 x 480, but this resolution refers ONLY to brightness / luminance of each pixel, not to color resolution.

• The human eye is more attuned to changes in brightness than changes in color; color sampling takes advantage of this by making color resolution lower than luma resolution in most video formats.
POSSIBLE SAMPLING FORMULAE

• **4:4:4** – each pixel has its own unique color; luma res and chroma res are equal (this basically doesn’t exist in video).

• **4:1:1** – For every 4 luma pixels there is 1 color sample; so on every horizontal scan line, each group of 4 consecutive pixels is the same color (though not the same luminance). So the chroma resolution for 720x480 video would be 180x480 (**4:2:0** is same res with different pattern)

• **4:2:2** – 1 color sample per 2 pixels = double chroma resolution of 4:1:1 (=360x480)
HVX200 VIDEO FORMATS

1. DV

• Very common worldwide, compatible with many editing and broadcast systems
• Uses 4:1:1 Color Sampling in 720 x 480 pixel array
• SD (Standard Def.) Video Format
• 1 hour of DV uses about 13 GB of hard drive space (so it’s more economical than high res formats)
• Is inherently interlaced (but it can use pulldown to embed a progressive signal in an interlaced data stream, e.g. 480i / 24p)
• PRO: maximum recording time per GB
• CON: lowest resolution and interlaced
2. DVC PRO (DVC 25)

- Basically the same resolution as DV
- But flagged to be compatible with DVC PRO editing and broadcast technology
3. DVCPRO 50

- Still SD Video format, but is the highest quality SD possible
- Compression is milder
- Color resolution is much better at 4:2:2
- 1 hour of DVCPRO 50 uses about 26 GB of hard drive space (double the size of DV)
4. DVCPRO HD

- Can be either 720p or 1080i (these are two different official broadcast standards for HD)
- Both use 4:2:2 color sampling and identical compression ratio, same pixels per sec.

- **720p:**
  - uses luma grid of 960 x 720 pixels
  - is always true progressive scan
  - can record about 40 min. to a 16GB card

- **1080i:**
  - uses luma grid of 1280 x 1080 pixels
  - is always 60i interlaced (but can embed progressive signal to interlaced stream)
  - can record about 16 min. to a 16GB card