FOCAL

DIGITAL PRODUCTION CHALLENGE

Digital Intermediate

Digital shooting

Film shooting

Digital postproduction

Digital workflow

How to choose ?

Thursday 13 to Saturday 15November 2014, Berlin (Germany)

Philippe Ros AFC Cinematographer & Digital Imaging Supervisor www.philipperos.com`

The first questions

What is the feature or program's end destination?

- **D-cinema digital projection (2K / 4K)? 3D?**
- **35 mm theater exhibition? Imax? Imax 3D?**
- **HD digital projection? E-cinema? Large displays?**
- **Ultra HD? HDTV broadcast? 3D broadcast?**
- **Internet? VOD? Mobile phones?**
- **Current TV broadcast?**
- **DVD - HD distribution?**

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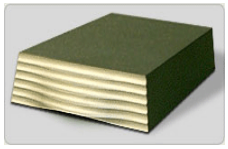
The DCP

The first questions

The DCP or Digital Cinéma Packaging is the release format for D-Cinéma (Digital Cinema), the frame being encoded in JPEG 2000.

- **D-cinema digital projection (2K / 4K)? 3D ?**

D-Cinema 2K frame format: 2048 pixels x 1080 lines (this is neither HD nor 2K).
D-Cinema 4K frame format: 4096 pixels x 2160 lines.



FORMAT: Compressed, split up in 'reels'

SECURITY: Encrypted using 128-bit AES

Reusable hard disk capacity:
2 long-feature films

Commun hard disk dimensions:
17 x 12 x 4 cm (L x l x h)

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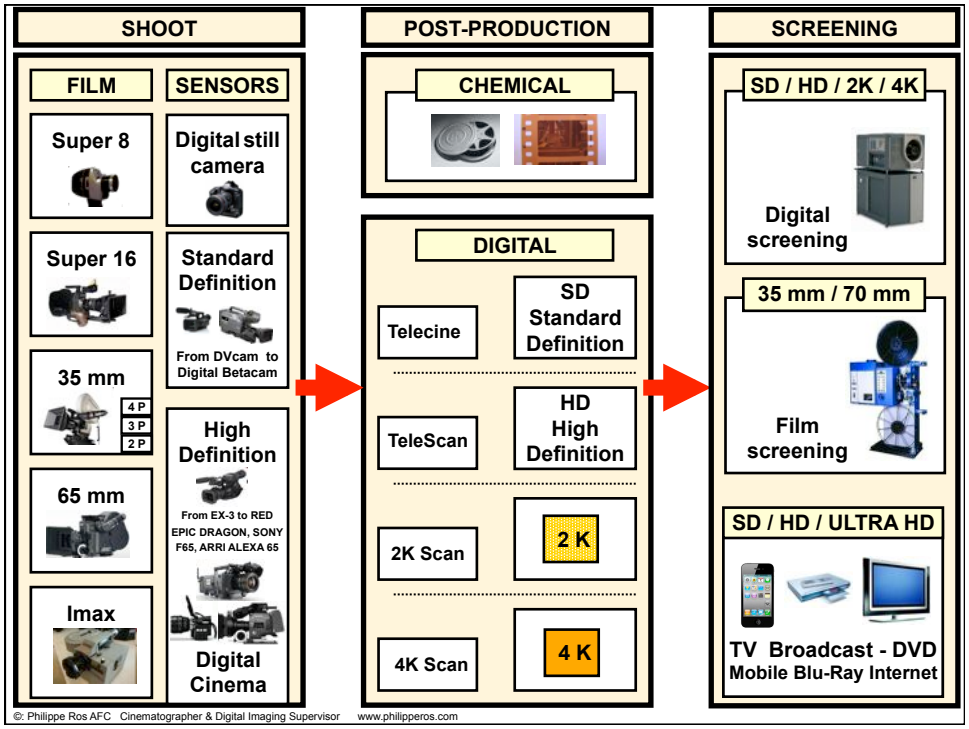

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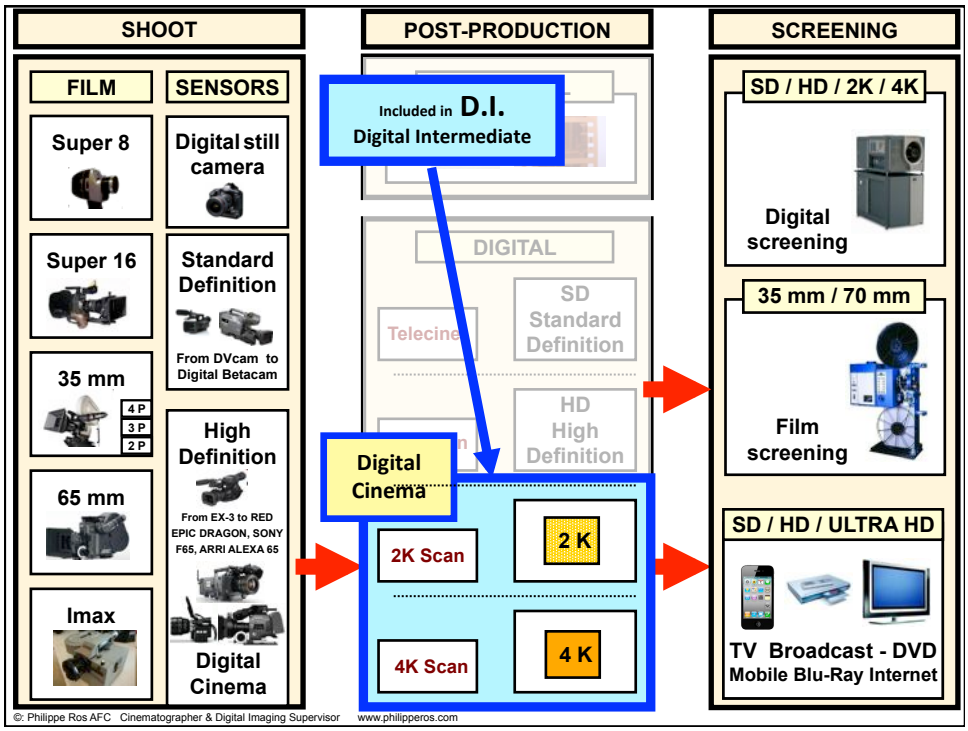

The first questions

This diagram represents only a chronological flow but does not allow to choose shooting and postproduction tools

SHOOT → POSTPRODUCTION → EXHIBITION

We prefer answering questions in the opposite order

SHOOT ← POSTPRODUCTION ← EXHIBITION

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The digital intermediate

The digital intermediate

The process consists of the following components:

- Editorial Prep
- Scanning (when it's film)
- Assembling
- Color Correction
- Dustbusting
- Digital Opticals
- Special VFX
- Digital Previewing
- Recording
- Digital Deliverables

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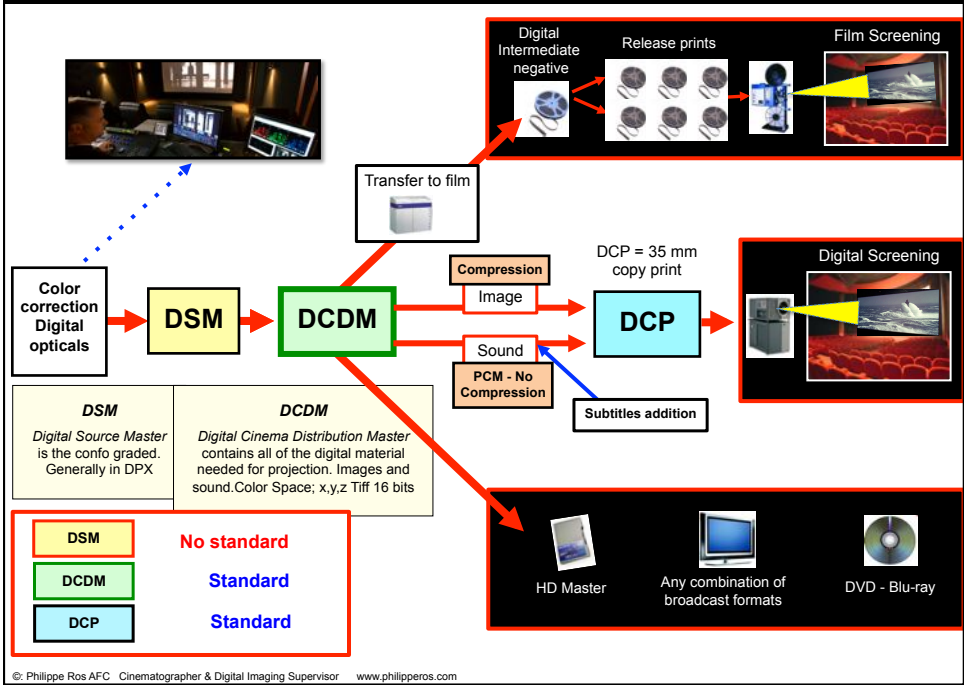
The digital intermediate



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Format: good appellation?
Or **File types?**
How to define a digital data stream
7 parameters by **Franck Montagne**
Postproduction Supervisor / Instructor

- **Mode of treatment**
  Color sampling
  - Raw
  - RGB 4:4:4
  - Y-Cb-Cr
    - 4:2:2
    - 4:2:0
    - 4:1:1
    - 3:1:1
- **Quantification**
  Color depth
  - 16 bits
  - 12 bits
  - 10 bits
  - 8 bits
- **Resolution**
  Number of pixels
  - 8K
  - UHD
  - 4K
  - 2K
  - HD
- **Frequence (speed)**
  Type of scanning:
  Progressive
  - 60, 50, 48 P (HFR)
  - 25 P
  - 24 P

  Shooting interlace is not an option in DCI
- **Codec**
  Level and type of compression
- **Bitrate**
  - Mbp/s
- **Container**
  Define the structure of the file

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Format – File types

- **Mode of treatment**
  Color sampling
  - Raw
  - RGB 4:4:4
  - **Y-Cb-Cr**
    - **4:2:2**
    - 4:2:0
    - 4:1:1
    - 3:1:1

AVC-Intra 100
Digital Betacam
DVCPRO50 and DVCPRO HD
ProRes (HQ, 422, LT, and Proxy)
XDCAM HD422 …

Format: good appellation?
Or **File types?**
How to define a digital data stream
7 parameters by
Franck Montagne

TV Broadcasting
Displays
8K: 7680 x 4320 pixels
4K: 4096 x 2160 pixels
Ultra HD: 3840 x 2160 pixels (over or with a minimum of)
Old designation Quad Full HD (QFHD)
HD: 1920 x 1080 pixels
Real HD: 1280 x 720 pixels

- **Resolution**
  Number of pixels
  - **8K**
  - **4K**
  - **2K**
  - **HD**

Theater Release DCI SPECIFICATIONS
D-Cinema 2K frame format:
1:1,85: 2048 pixels x 1080 lines (this is neither HD nor 2K)
1:2,39: 2048 pixels x 858 lines
D-Cinema 4K frame format:
1:1,85: 4096 pixels x 2160 lines.
1:2,39: 4096 pixels x 1716 lines

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Role of **Quantification & Sampling**

Alexa (Arri SxS recording)
12 bits 4:4:4:4
330 Mb/s

4096 shades of grey in the **Red** channel
4096 shades of grey in the **Green** channel
4096 shades of grey in the **Blue** channel

Colour depth:
4096 x 4096 x 4096=
More than 68 billion of colors

F35 (Sony)
10 bits 4:4:4
440 Mb/s or 880 Mb/s

1024 shades of grey in the **Red** channel
1024 shades of grey in the **Green** channel
1024 shades of grey in the **Blue** channel

Colour depth:
1024 x 1024 x 1024=
More than 1 billion of colors

EOS C300 (Canon)
8 bits 4:2:2
50 Mb/s

256 shades of grey in the **Red** channel
256 shades of grey in the **Green** channel
256 shades of grey in the **Blue** channel

Colour depth:
256 x 256 x 256
with component Y Cb Cr sampling:
More than 16 million of colors
but less possibilities due to compression

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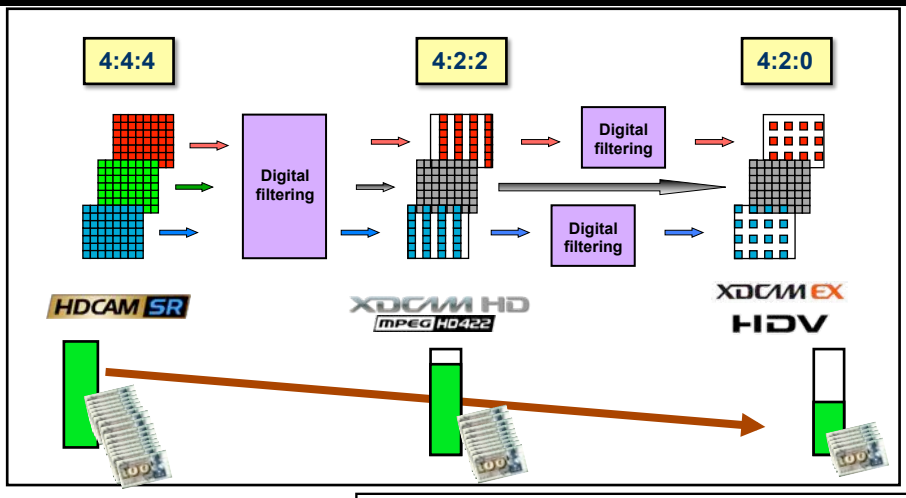
Consequences of bitrate and compression choices



Chroma sub sampling
Practice of encoding images by implementing less resolution for **Chroma Information (R and B)** than for **Luma information (Y, grey pixels)**. It is used in many **Video Encoding** schemes - both analog and digital - and also in **JPEG Encoding**.

Role of **Color subsampling** **Example: 4:2:2 & 4:2:0**

Difference of storage between 4:4:4 and 4:2:2: 25%
Difference of storage between 4:4:4 and 4:1:1: 50%

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Media the 8Th parameter

MEDIA

WHAT IS IMPORTANT TO KNOW ABOUT MEDIA PERFORMANCES

- Type of file format recordable (Codec, frame rate, resolution, bitrate, color sampling, quantification, container)
- High speed recording capacities. Frame rate is an important parameter
- Recording times/capacities
- Minimum/maximum read/write speed
- Some manufacturers guarantee speeds, some not.
- Transfer speeds (offload) linked to readers/accessories/adapters. Transfer speeds vary and are dependent on host device.
- Combination between camera and media (example: Arri Amira approves or not media)

WHAT IS IMPORTANT TO KNOW ABOUT THE WAY CAMERA MANUFACTURERS ARE HANDLING & CHOOSING THE MEDIA - THE RECONSTRUCTION

- Example: **SxS Cards**, they are designed for motion picture and they contain safety tools (controller with an intelligence function). Files can be reconstructed in a special Sony center in Brussels

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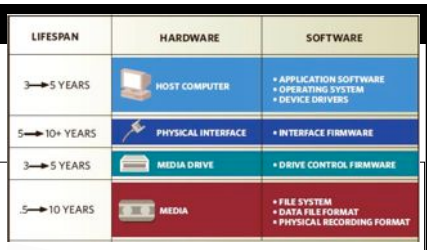
Interfaces, connections

Computerized world has no mercy! Lifespan of:

- Hardware/software is between 3 and 5 years
- Physical interface or firmware interface is between 5 to 10+ years
- A media drive is 3 to 5 years



Universal serial Bus
USB 1.1 = 17 Mbits/sec
USB 2.0 = 480 Mbits/sec
USB 3.0 = 4,8 Gbits/sec

FireWire = IEEE 1394 = i.LINK
Fire Wire 400 = 400 Mbits/sec
Fire Wire 800 = 800 Mbits/sec

Ethernet

Ethernet = 10 Mb/sec
Fast Ethernet = 100 Mb/sec
Gigabit Ethernet = 1000 Mb/sec

External Serial Advanced Technology Attachment
S-ATA = 1,2 Gbits/sec
S-ATA II = 3 Gbits/sec

Thunderbolt = 10 Gbits/sec

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Consequences of bitrate and compression choices

What is the advantage for SFX and grading of having :

- 10 bits rather than 8 bits ?
- 10 bits RGB rather than 10 bits Y-Pb-Pr ? :
  - Keying made easier
  - Compositing made easier
  - Better rendering of flesh tones
  - Color correction made easier

All these choices are not trivial.

The consequences on the finished film's quality and cost must totally be taken into account.

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Bitrate and codec

The bitrate **(number of information per second) depends :**

- **On the image width** (from 960 pixels to 4096 pixels, even more)
- **On the image height** (from 720 pixels to 3072 pixels, even more)
- **On the signal processing** (Raw, RVB or Component YCbCr)
- **On the quantification`** (8-bit, 10-bit, 12-bit, 16-bit, 32-bit)
- **On the frequency (or speed)** (23.98, 24, 25, 29.97,30, 50, 59.94,60 fps, …)
- **On the Codec type used** (Jpeg 2000, ProRez, XAVC, Mpeg2…)

Codec : Coding - Decoding

Example : JPEG 2000 (300 Mb/s) - ProRes 12-bit 4:4:4:4 (280Mb/s) - AVC-Intra 100 (100 Mb/s)

Three important notions

Bitrate

Compression

Information reduction

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Consequences of bitrate and compression choices

The higher the bitrate,
The lower the compression

→ The higher the image quality is.
The more expensive the production is

?

Quality

Production costs

Post-production costs

The lower the bitrate,
the higher the compression,

→ The higher the image quality,
The less expensive the production is

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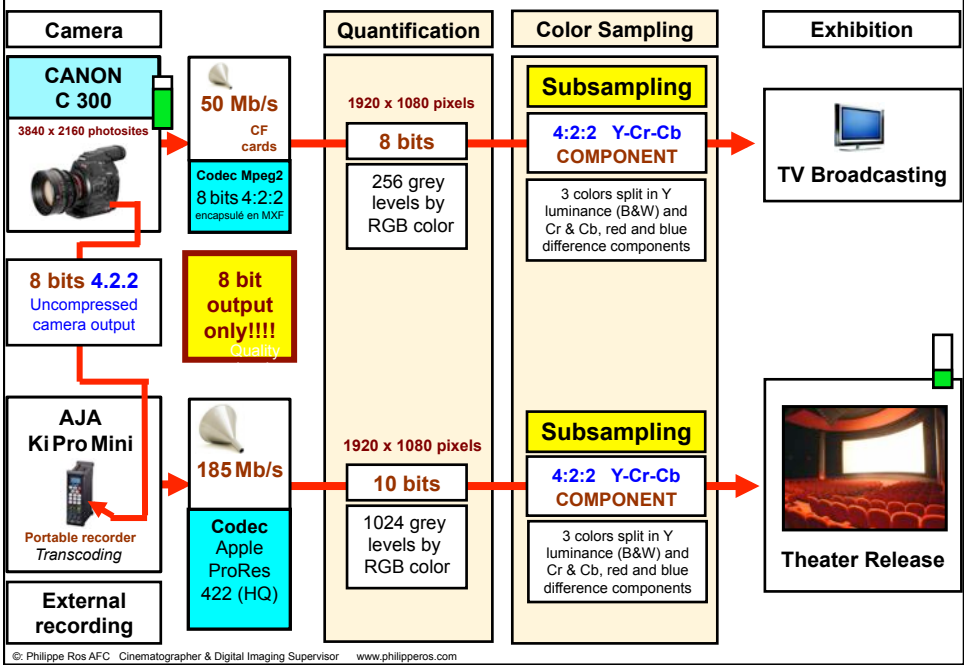
Consequences of bitrate and compression choices



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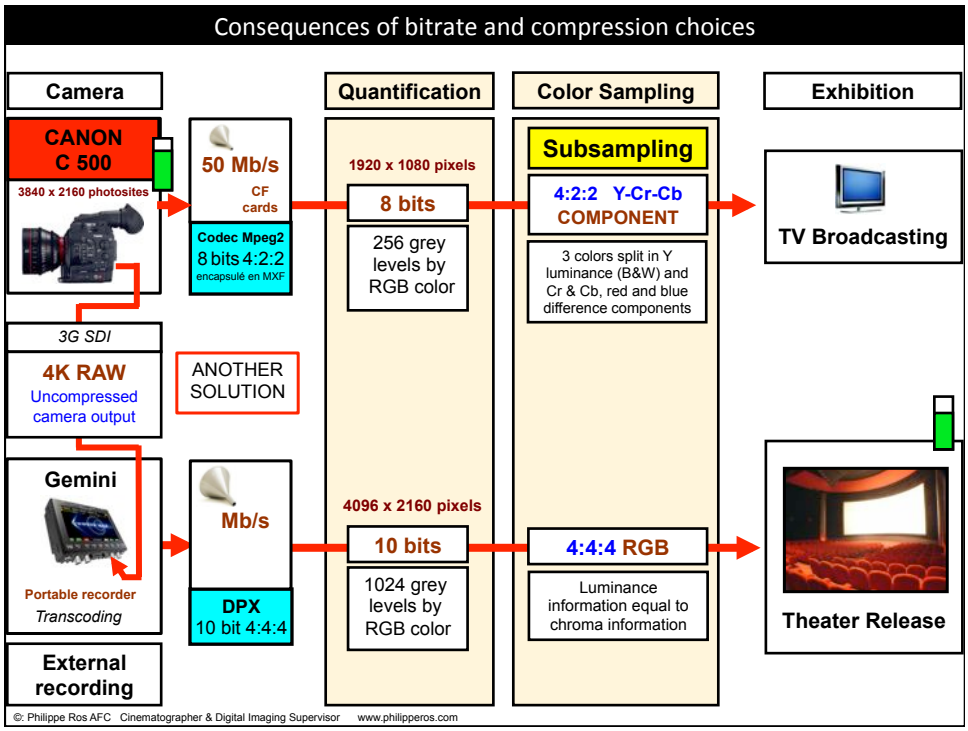
Consequences of bitrate and compression choices
Camera
Quantification
Color Sampling
Exhibition
CANON C 500
3840 x 2160 photosites
50 Mb/s
CF cards
Codec Mpeg2
8 bits 4:2:2
encapsulé en MXF
1920 x 1080 pixels
8 bits
256 grey levels by RGB color
Subsampling
4:2:2 Y-Cr-Cb COMPONENT
3 colors split in Y luminance (B&W) and Cr & Cb, red and blue difference components
TV Broadcasting
3G SDI
4K RAW
Uncompressed camera output
ANOTHER SOLUTION
Gemini
Portable recorder
Transcoding
Mb/s
DPX
10 bit 4:4:4
4096 x 2160 pixels
10 bits
1024 grey levels by RGB color
4:4:4 RGB
Luminance information equal to chroma information
Theater Release
External recording
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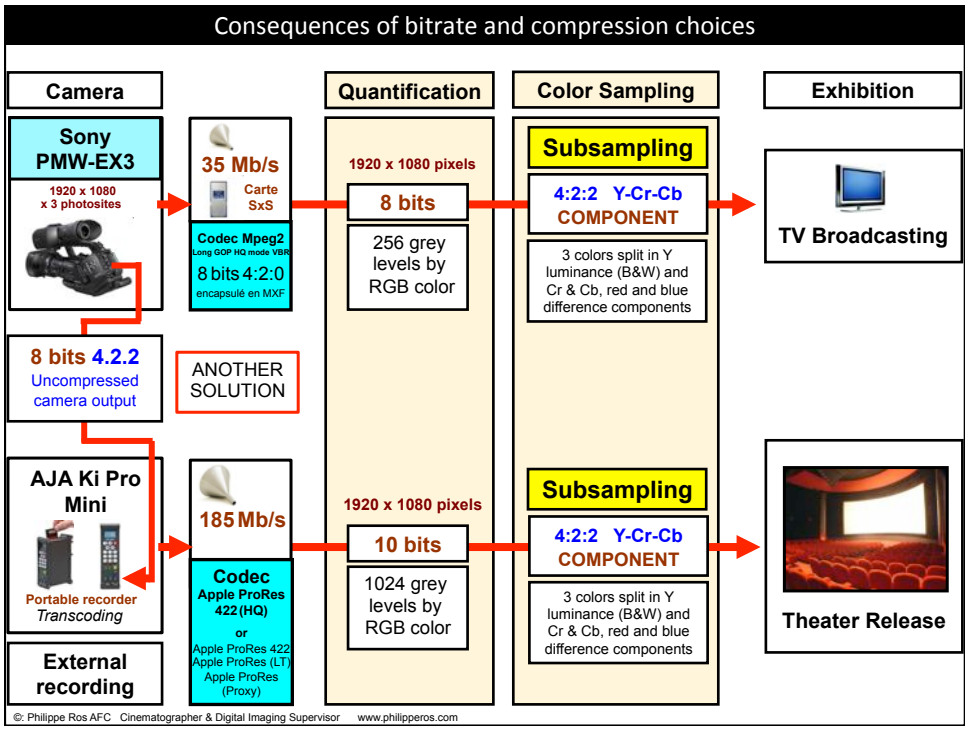
Consequences of bitrate and compression choices
Camera
Quantification
Color Sampling
Exhibition
Sony PMW-EX3
1920 x 1080 x 3 photosites
35 Mb/s
Carte SxS
Codec Mpeg2
Long GOP HQ mode VBR
8 bits 4:2:0
encapsulé en MXF
1920 x 1080 pixels
8 bits
256 grey levels by RGB color
Subsampling
4:2:2 Y-Cr-Cb COMPONENT
3 colors split in Y luminance (B&W) and Cr & Cb, red and blue difference components
TV Broadcasting
8 bits 4.2.2
Uncompressed camera output
ANOTHER SOLUTION
AJA Ki Pro Mini
Portable recorder
Transcoding
185 Mb/s
Codec
Apple ProRes 422 (HQ)
or
Apple ProRes 422
Apple ProRes (LT)
Apple ProRes (Proxy)
1920 x 1080 pixels
10 bits
1024 grey levels by RGB color
Subsampling
4:2:2 Y-Cr-Cb COMPONENT
3 colors split in Y luminance (B&W) and Cr & Cb, red and blue difference components
Theater Release
External recording
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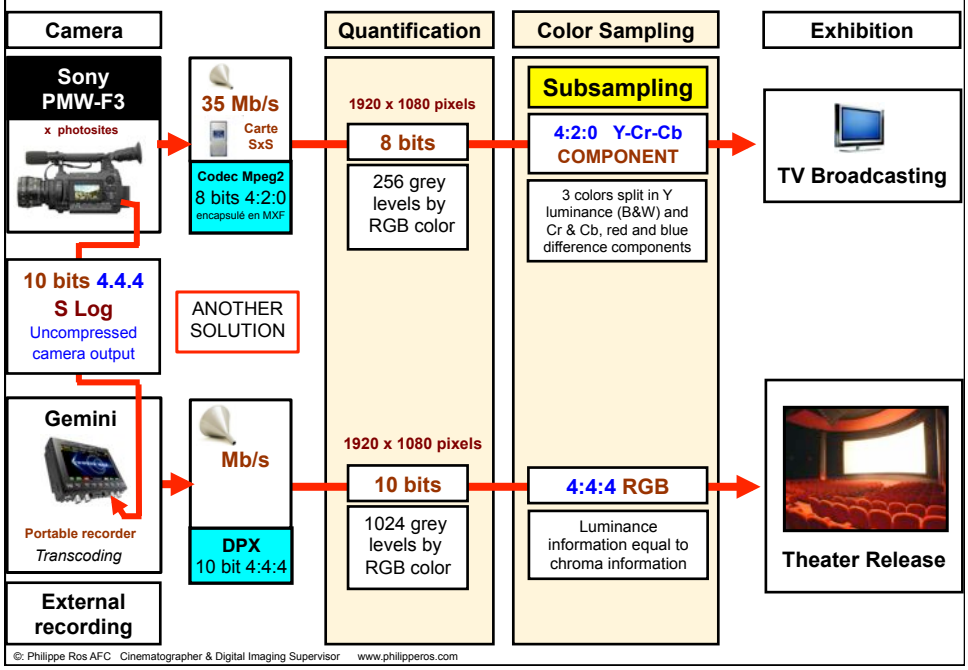
Consequences of bitrate and compression choices



Bitrate and codec

Issues related with frequencies?

Countries in 60 Hertz (USA, Canada, Japon…):
More easy when editing and mixing with 23.98, 29.97, 59,94 fps

Countries in 50 Hertz (Europe…):
More easy when editing and mixing with 24, 25, 50 fps

Before choosing frequency:
Better to know the country where postproduction will be done

In Europe, better shooting and postproducing in 25 fps,
or in 24 fps if you have to send deliveries to USA, Canada, Japon

Playtime of programmes depends on contracts and depends on frequency.
Better to anticipate safeties during editing for all foreign deliveries.

When shooting abroad, the choice of shutter speed depends on country-specific frequency

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Pixels vs Photosites

Great confusion or / and good marketing between:

- Number of photosites
- Size of the sensor
- Number of sensors
- Type of sensor
- Number of pixels recorded
- Resolution / sharpness / MTF
- Recording format
- Exhibition format

There are no pixels on a sensor but photosites. Pixels appears during sampling and recording

The type of sensor will have a direct influence on the workflow and therefore on the budget

FINAL RESOLUTION

Marketing stories

The fact that a camera can deliver a 4 K image doesn't mean that it has the required numbers of photosites to deliver a real 4K resolution.

Whitout carefully paying attention, all these matched informations can lead to wrong decisions and to wrong process (during post: SFX, keying).

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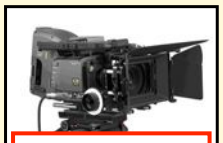
Sensor types

- **The 3 Sensors cameras (examples)**

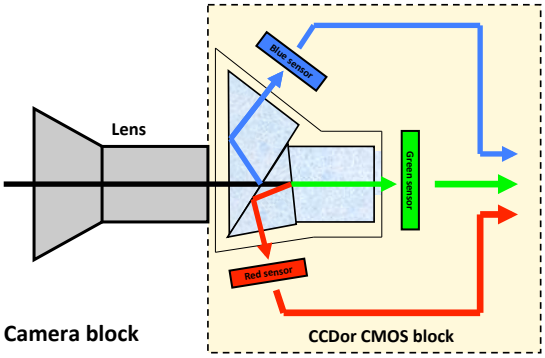


F23 (Sony)
3-chip 2/3-inch
1920 x 1080 x 3 photosites

HDW-F900 (Sony)
2/3" 3-*CCD sensor*
1920 x 1080 x 3 photosites

AJ-HPX 3700 Panasonic
2/3" 3-*CCD sensor*
1920 x 1080 x 3 photosites

EX-3 (Sony)
3 x ½ -*CMOS sensor*
1920 x 1080 x 3 photosites



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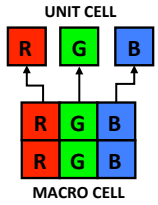
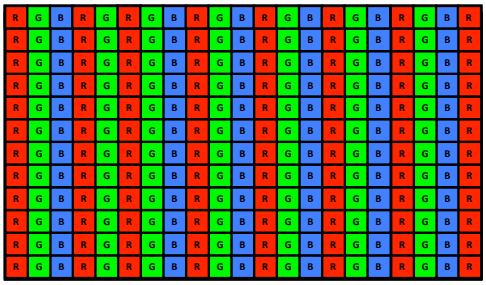
Sensor types

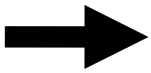
▪ The 1 Sensor cameras - The Striped pattern (examples)



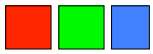
Genesis
(Panavision)
Mono CCD sensor Sriped pattern
5760 x 2160 photosites

F35 (Sony)
Mono CCD sensor
1920 x 1080 x 3 photosites





RGB OUTPUT



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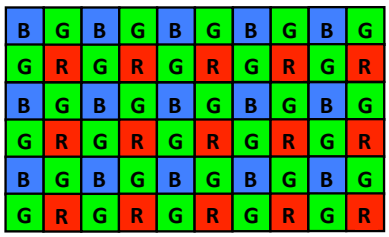
Sensor types

▪ The 1 Sensor cameras - The Bayer pattern

In the Bayer pattern, green samples are arranged in a checkerboard pattern, and the red and blue samples are arranged in rectangular grid pattern.

The density the green samples are twice that of the red and blue ones.



2 x G G for 1 x R & 1 x B

The reason for why there are more green samples than red or blue samples is that the human visual system is more sensitive to luminance rather than chrominance.

Luminance contains important spatial information, and we would like to preserve as much spatial detail as possible during the process.

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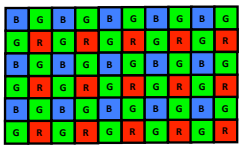
Sensor types

▪ The 1 Sensor cameras - The Bayer pattern

A Bayer filter could be defined as a **digital negative** which is used during post-production to restore an RGB flow

We are in front of a **lab**, a software which develops images and which:

- Is not always built-in
- Is not always done real time.
- Can be done in various ways (Irridas, Glue Tools, Phantom, Red, Arri, etc



Debayering

RGB OUTPUT

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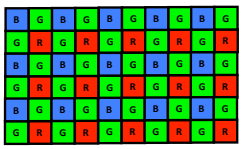
Sensor types

▪ The 1 Sensor cameras - The Bayer pattern (examples)



Debayering

RGB OUTPUT

Debayering is not only a mathematic process but also an artistic process.

Math process

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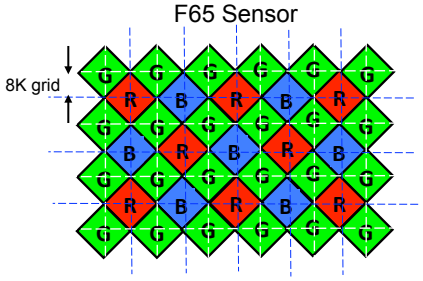
Pixels vs Photosites

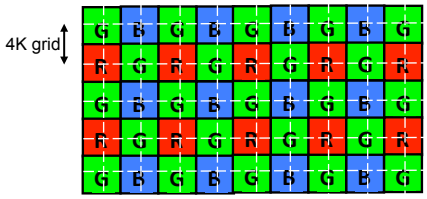
▪ The 1 Sensor cameras - The F65 pattern

- Super 35mm 3-perf.
- Total Pixel Count: 20.0M
- 8K CMOS Image Sensor

F65 Sensor



Conventional 4K Bayer Sensor



Photosites arrayed on 45-degree diagonals allow to lower the aliasing issues

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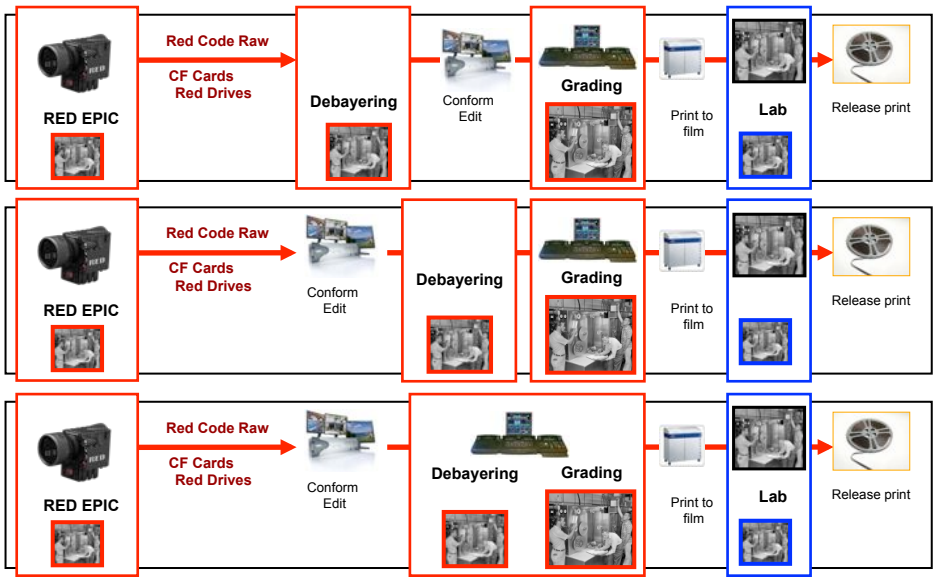
Essential features of a digital workflow

Digital shooting **Red digital cameras (One, MX, Epic) - 3 ways of Debayering after shoot.**
This features can be applied to all cameras using bayer pattern



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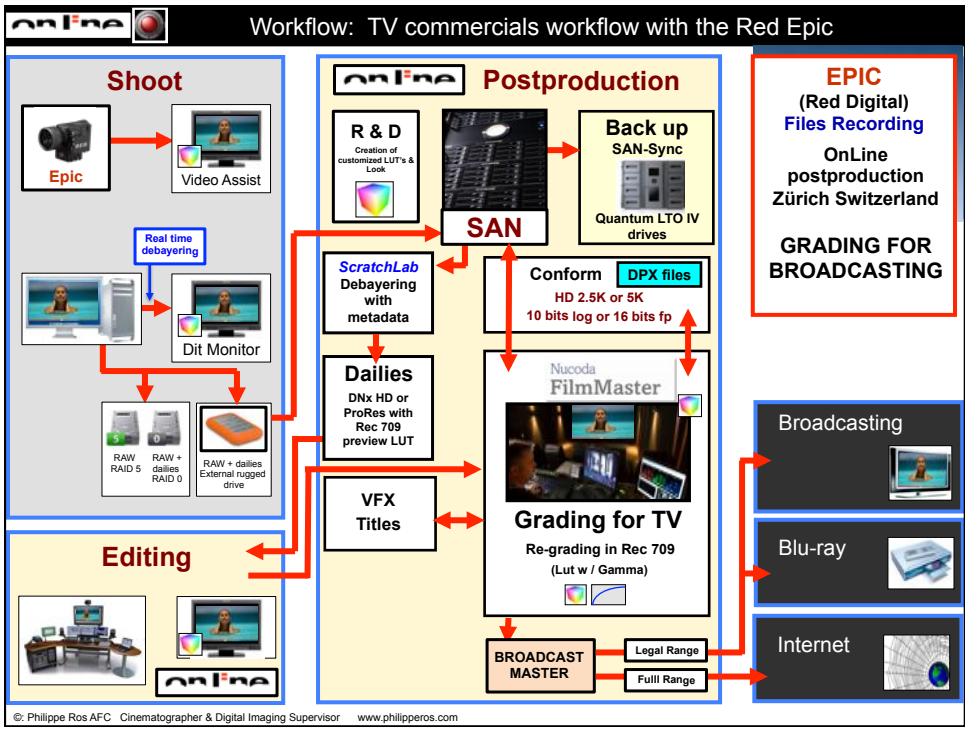
Workflow: TV commercials workflow with the Red Epic
Shoot
Epic
Video Assist
Real time debayering
Dit Monitor
RAW RAID 5
RAW + dailies RAID 0
RAW + dailies External rugged drive
Editing
Postproduction
R & D
Creation of customized LUT's & Look
SAN
Back up
SAN-Sync
Quantum LTO IV drives
ScratchLab
Debayering with metadata
Conform
DPX files
HD 2.5K or 5K
10 bits log or 16 bits fp
Dailies
DNx HD or ProRes with Rec 709 preview LUT
Nucoda FilmMaster
VFX Titles
Grading for TV
Re-grading in Rec 709
(Lut w / Gamma)
BROADCAST MASTER
Legal Range
Full Range
EPIC
(Red Digital)
Files Recording
OnLine postproduction Zürich Switzerland
GRADING FOR BROADCASTING
Broadcasting
Blu-ray
Internet
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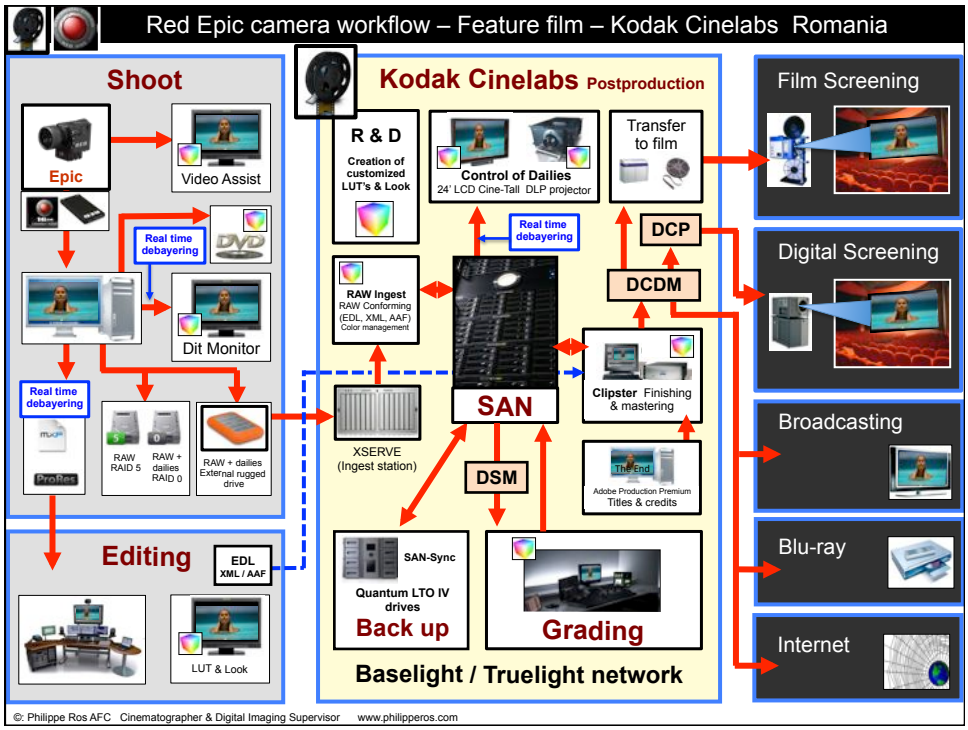
Red Epic camera workflow – Feature film – Kodak Cinelabs Romania
Shoot
Epic
Video Assist
Real time debayering
Dit Monitor
RAW RAID 5
RAW + dailies RAID 0
RAW + dailies External rugged drive
Editing
EDL XML / AAF
LUT & Look
Kodak Cinelabs Postproduction
R & D
Creation of customized LUT's & Look
Control of Dailies
24' LCD Cine-Tall DLP projector
Transfer to film
RAW Ingest
RAW Conforming (EDL, XML, AAF)
Color management
SAN
XSERVE
(Ingest station)
DSM
DCP
DCDM
Clipster Finishing & mastering
Adobe Production Premium
Titles & credits
SAN-Sync
Quantum LTO IV drives
Back up
Grading
Baselight / Truelight network
Film Screening
Digital Screening
Broadcasting
Blu-ray
Internet
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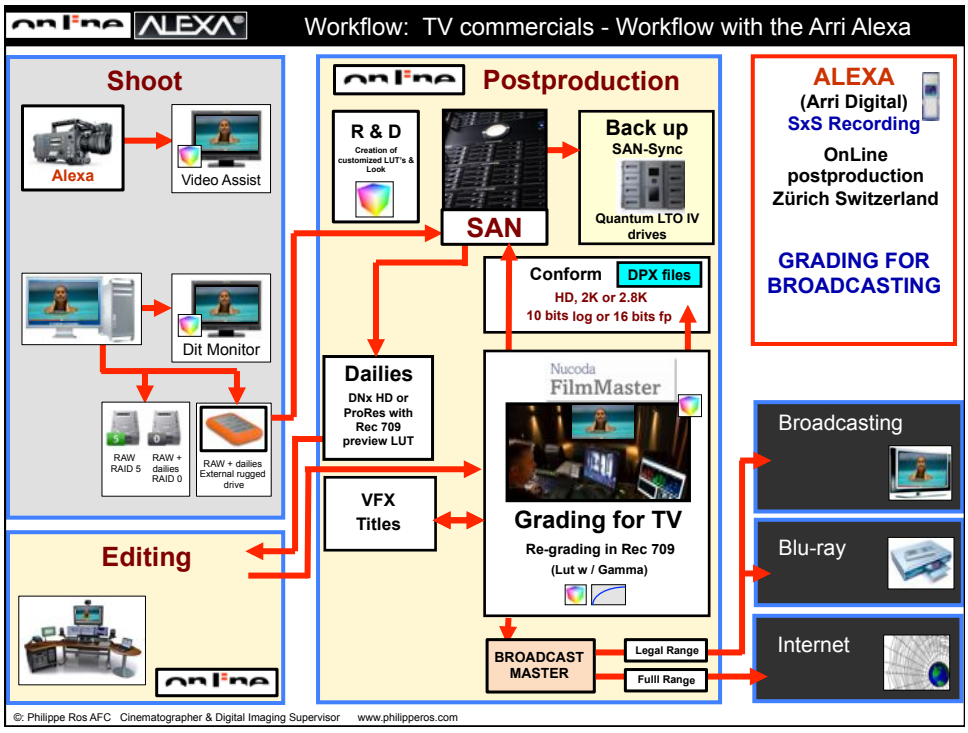
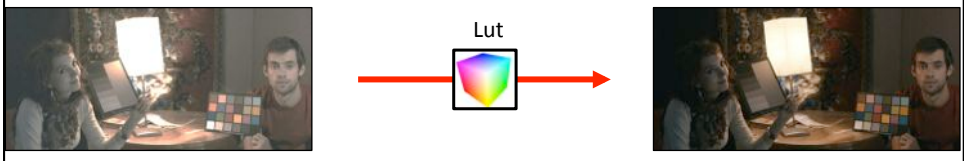


Previsualization

With new cameras using log curves, it is impossible to show to producers and directors the flat, low, desaturated image without pre-grading. A table of conversion (Lut: Look-up table) is used to correct the image and/or to simulate a space color of final destination (example: Kodak or Fuji film lut for a film out).



How to see the same image all the way through the workflow?

Monitoring / shoot

Monitoring / editing

Grading

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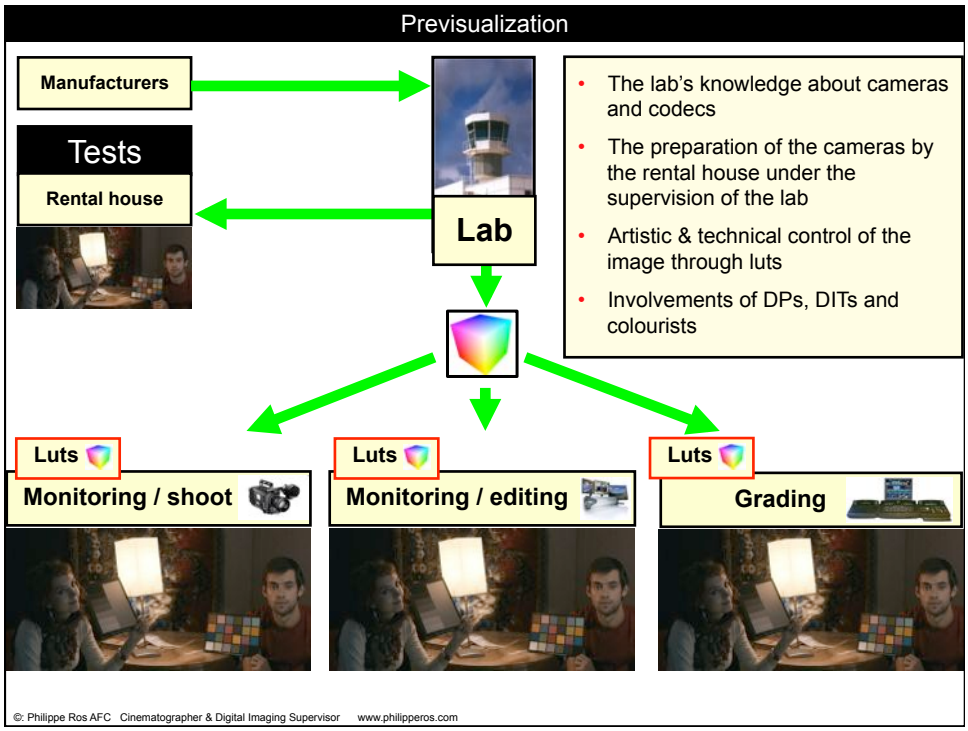
Previsualization
Manufacturers
Tests
Rental house
Lab
The lab's knowledge about cameras and codecs
The preparation of the cameras by the rental house under the supervision of the lab
Artistic & technical control of the image through luts
Involvements of DPs, DITs and colourists
Luts
Monitoring / shoot
Luts
Monitoring / editing
Luts
Grading
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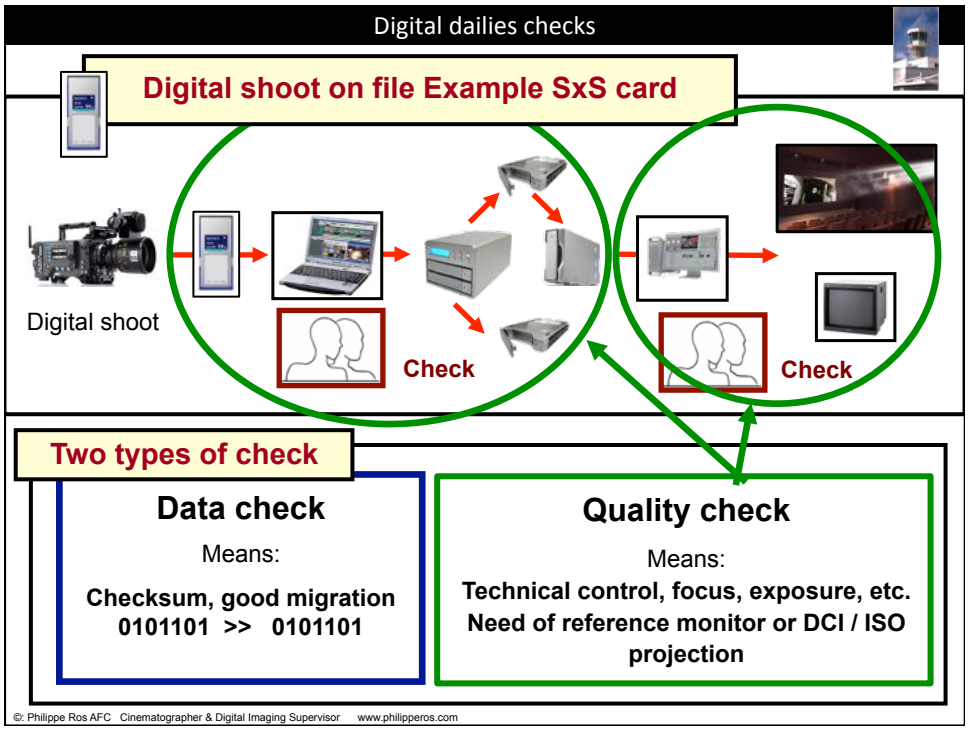
Digital dailies checks
Digital shoot on file Example SxS card
Digital shoot
Check
Check
Two types of check
Data check
Means:
Checksum, good migration
0101101 >> 0101101
Quality check
Means:
Technical control, focus, exposure, etc.
Need of reference monitor or DCI / ISO projection
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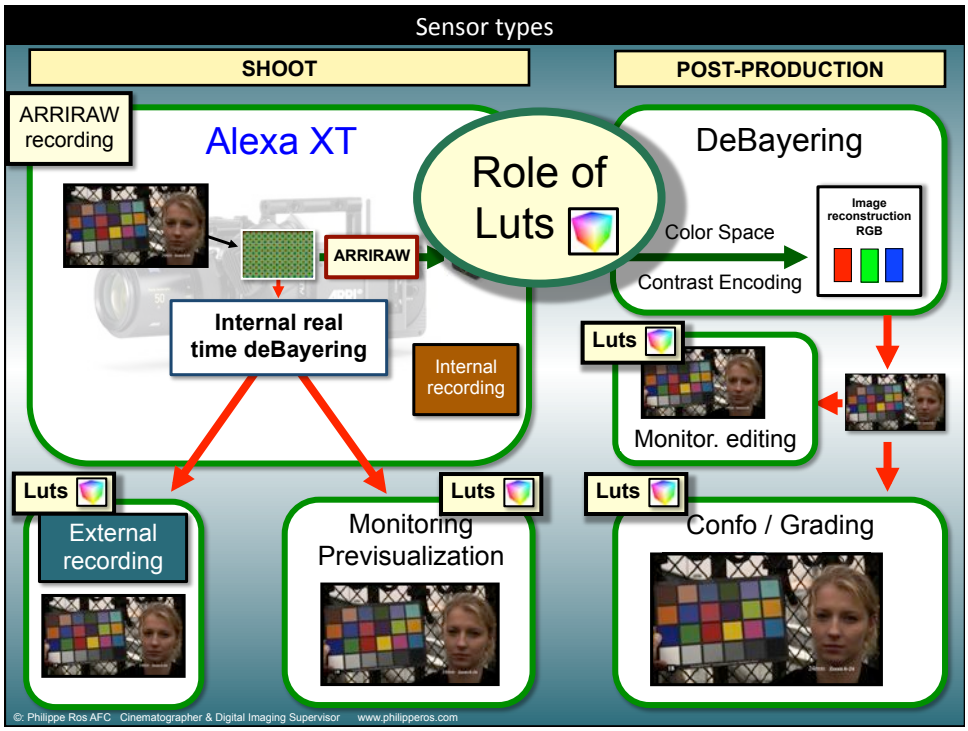
Sensor types
SHOOT
POST-PRODUCTION
ARRIRAW recording
Alexa XT
Role of Luts
ARRIRAW
Internal real time deBayering
Internal recording
DeBayering
Color Space
Contrast Encoding
Image reconstruction RGB
Luts
Monitor. editing
Luts
External recording
Luts
Monitoring Previsualization
Luts
Confo / Grading
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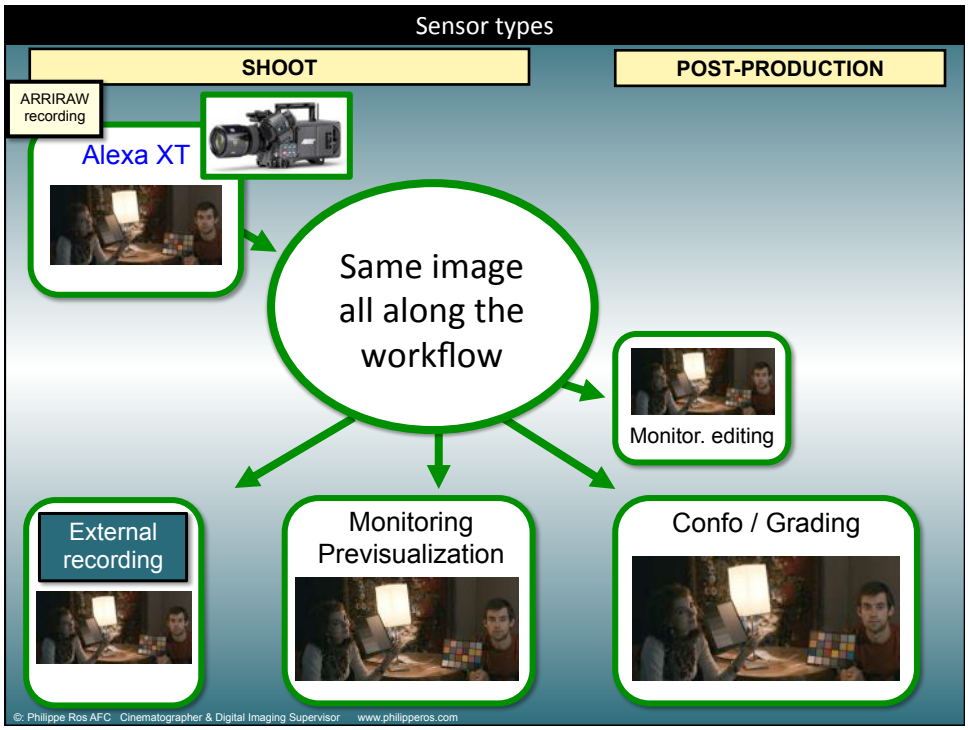
Sensor types
SHOOT
POST-PRODUCTION
ARRIRAW recording
Alexa XT
Same image all along the workflow
Monitor. editing
External recording
Monitoring Previsualization
Confo / Grading
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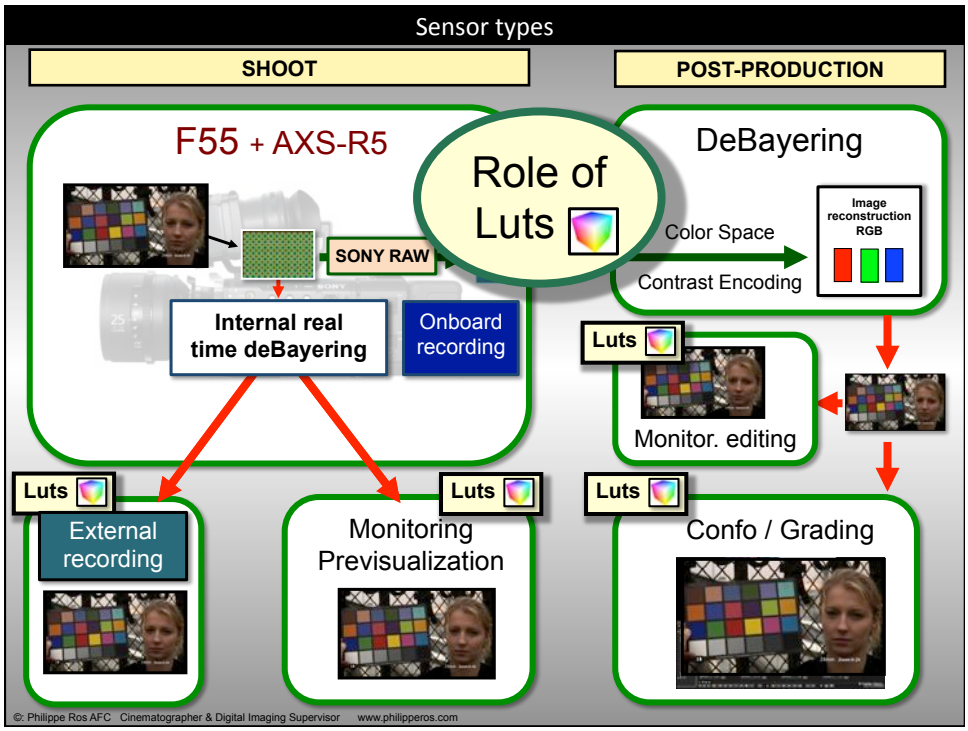
Sensor types
SHOOT
POST-PRODUCTION
F55 + AXS-R5
Role of Luts
SONY RAW
Internal real time deBayering
Onboard recording
DeBayering
Color Space
Contrast Encoding
Image reconstruction RGB
Luts
Monitor. editing
Luts
External recording
Luts
Monitoring Previsualization
Luts
Confo / Grading
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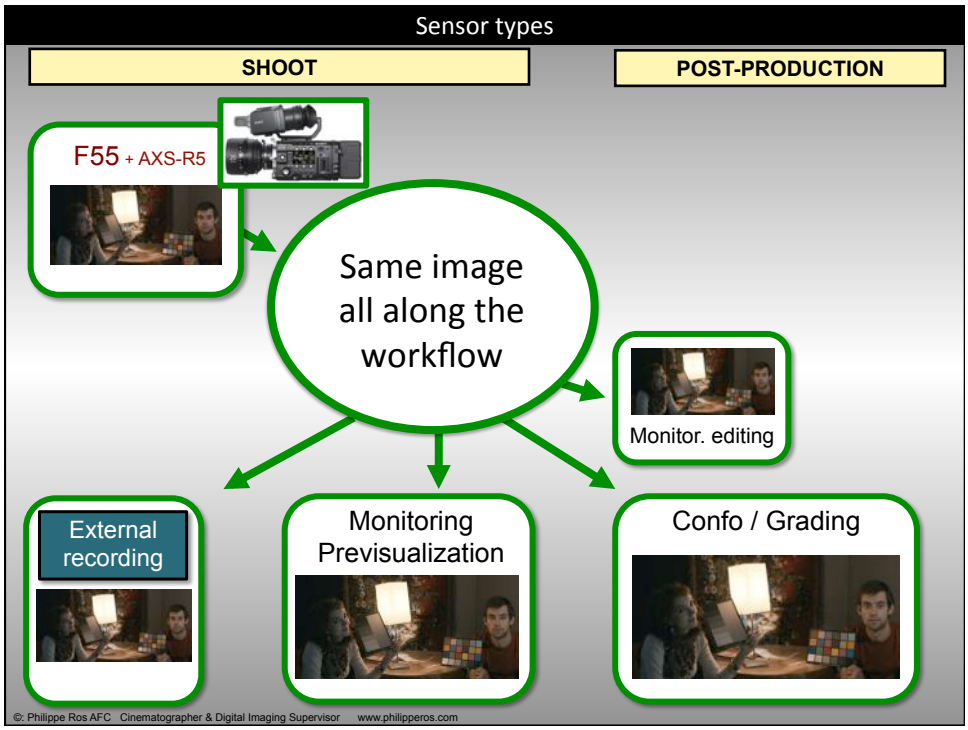
Sensor types
SHOOT
POST-PRODUCTION
F55 + AXS-R5
Same image all along the workflow
Monitor. editing
External recording
Monitoring Previsualization
Confo / Grading
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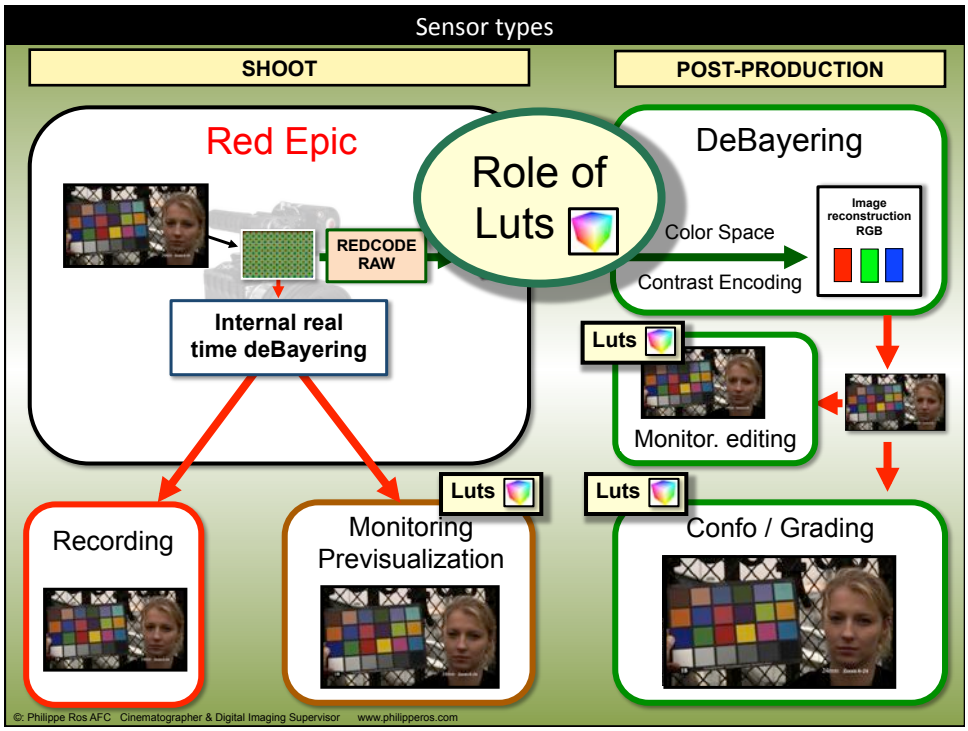
Sensor types
SHOOT
POST-PRODUCTION
Red Epic
Role of Luts
REDCODE RAW
Internal real time deBayering
DeBayering
Color Space
Contrast Encoding
Image reconstruction RGB
Luts
Monitor. editing
Luts
Luts
Recording
Monitoring Previsualization
Confo / Grading
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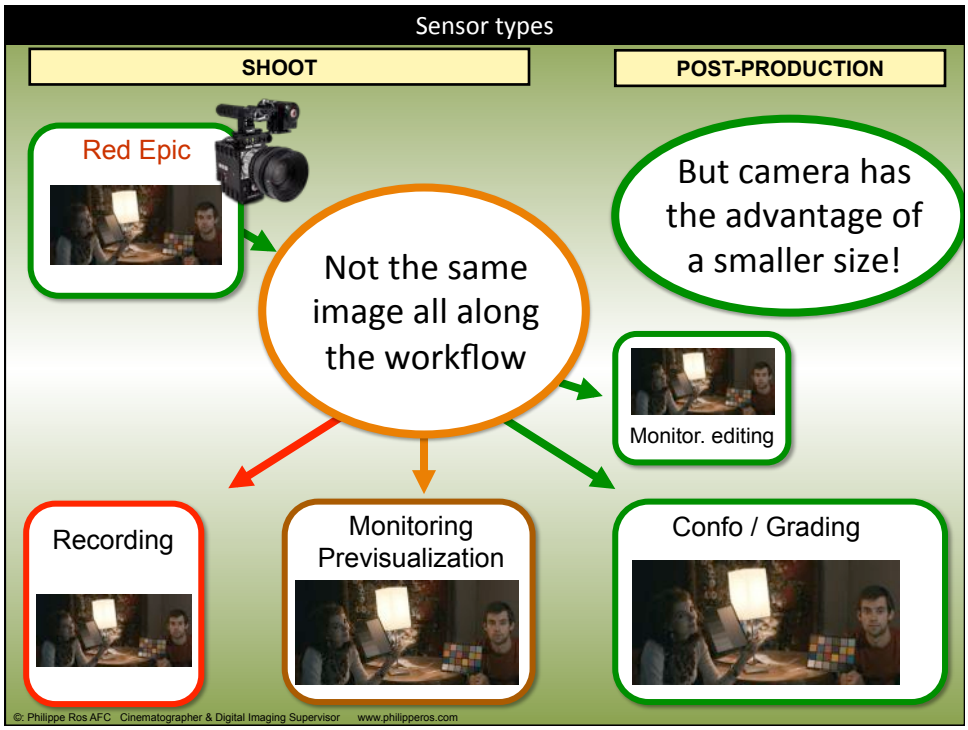
Sensor types
SHOOT
POST-PRODUCTION
Red Epic
Not the same image all along the workflow
But camera has the advantage of a smaller size!
Monitor. editing
Recording
Monitoring Previsualization
Confo / Grading
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Recording options

Sony F55 + AXS-R5

Option board *CBKZ-55PD*
ProRes & DNxHD

Version 5.0
Dec 2014

External recording
from AXS-R5

1920 x 1080 - **10-bit 4:2:2**
RECORDING + MONITORING
Closer to RAW demozaicing

HD 16:9

SLog 2

HD-SDI

External recording
Live output

Real-time 4K output

HDMI Terminal

1 x MON OUT

Up to **4K** or **QFHD**

4096/3840 x 2160 **8-bit 4:2:0**
4K or **QFHD MONITORING**

4 x REC OUT

Real-time 4K live production output
Each Channel
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p

Configurable
4 x 3G-SDI or
2 x HD-SDI Outputs
2 x HD-SDI Monitor Outputs

4096/3840 x 2160 **4K/QFHD**
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p
PRODUCTION + MONITORING

Up to **4K** or **QFHD**

Internal recording

Access Memory Card
AXS-512 S24

AXS-R5
Onboard RAW Recorder

Onboard recording

RAW

4K 17:9 — 4096 x 2160 **16-bit Lin 4K RAW**

2K 17:9 — 2048 x 1080 **16-bit Lin 2K RAW**

2K: No Crop factor, no telephoto conversion, need CBK-55F2K Optical Filter to reduce aliasing

F55
+ Recorder

SxS PRO+

Quick Time

SxS-1
SxS PRO

Option board *CBKZ-55PD*

ProRes — **HD 16:9**
- 1920 x 1080 **ProRes** - **12-bit 4:4:4:4**
- 1920 x 1080 **ProRes** - **10-bit 4:2:2 HQ**
- 1920 x 1080 **ProRes** - **10-bit 4:2:2**

DNxHD — **HD 16:9**
- 1920 x 1080 **DnxHD** 220x/185x/175x **10-bit 4:2:2**
- 1920 x 1080 **DnxHD** 145x/120x/115x **8-bit 4:2:2**

MXF → **XAVC**
- **4K 17:9** — 4096 x 2160 **XAVC 4K** **10-bit 4:2:2**
- **QFHD 16:9** — 3840 x 2160 **XAVC QFHD** **10-bit 4:2:2**
- **2K 17:9** — 2048 x 1080 **XAVC 2K** **10-bit 4:2:2**
- **HD 16:9** — 1920x 1080 **XAVC HD** **10-bit 4:2:2**

MXF → **MPEG4** SStP SR FILES — **HD 16:9**
- 1920 x 1080 **SR SStP - HD 10-bit 4:4:4**
- 1920 x 1080 **SR SStP - HD 10-bit 4:2:2**

MXF → **MPEG2** — **HD 16:9**
- 1920 x 1080 **MPEG2** **8-bit 4:2:2**
- 1280 x 720 **MPEG2** **8-bit 4:2:2**

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Recording options

Sony F55 + AXS-R5

Option board *CBKZ-55PD*
ProRes & DNxHD

Version 5.0
Dec 2014

FPS range comparison

NO 2 x ANAMORPHIC

External recording
from AXS-R5

1920 x 1080 - **10-bit 4:2:2**
RECORDING + MONITORING
Closer to RAW demozaicing

HD 16:9

SLog 2

HD-SDI

External recording
Live output

Real-time 4K output

HDMI Terminal

1 x MON OUT

Up to **4K** or **QFHD**

4 x REC OUT

Real-time 4K live production output
Each Channel
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p

Fps range: Up to 30 fps
4096/3840 x 2160 **8-bit 4:2:0**
4K or **QFHD MONITORING**

Configurable
4 x 3G-SDI or
2 x HD-SDI Outputs
2 x HD-SDI Monitor Outputs

Fps range: Up to 60 fps
4096/3840 x 2160 **4K/QFHD**
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p
PRODUCTION + MONITORING

Up to **4K** or **QFHD**

Internal recording

Access Memory Card
AXS-512 S24

AXS-R5
Onboard RAW Recorder

Onboard recording

RAW

4K 17:9 — 60p 1-60p S&Q — t Lin 4K RAW

2K 17:9 — 240p 1-240p S&Q — t Lin 2K RAW

2K: No Crop factor, no telephoto conversion, need CBK-55F2K Optical Filter to reduce aliasing

F55
+ Recorder

SxS PRO+

SxS-1
SxS PRO

Option board *CBKZ-55PD*

Quick Time

MXF

ProRes	HD 16:9	23.98 / 24 / 25 / 29.97p	12-bit 4:4:4:4
		23.98 / 24 / 25 / 29.97 /50 59,94p 50/59,94i	10-bit 4:2:2 HQ
			10-bit 4:2:2
DNxHD	HD 16:9	23.98/25/29.97p 50/59,94i	220x/[illegible] 10-bit 4:2:2
		NO 24P	145x/120x/115x 8-bit 4:2:2
XAVC	4K 17:9	60p 1-60p S&Q	10-bit 4:2:2
	QFHD 16:9	60p 1-60p S&Q	10-bit 4:2:2
	2K 17:9	180p 1-180p S&Q	10-bit 4:2:2
	HD 16:9	180p 1-180p S&Q	10-bit 4:2:2
MPEG4 SStP SR FILES	HD 16:9	Up to 30 fps	) 10-bit 4:4:4
		Up to 30 fps	) 10-bit 4:2:2
MPEG2	HD 16:9	23.98 / 25 / 29.97 / 30p 60p - 50/59.97i	8-bit 4:2:2
		720p Up to 60p	8-bit 4:2:2

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Recording options

Sony F5 + AXS-R5

Version 5.0
Dec 2014

External recording
from AXS-R5

- 1920 x 1080 - **10-bit 4:2:2** RECORDING + MONITORING
- Closer to RAW demozaicing
- HD 16:9
- SLog 2
- HD-SDI

External recording
Live output

- Real-time 4K output
- HDMI Terminal
- 1 x MON OUT
- Up to 4K or QFHD
- 4096/3840 x 2160 **8-bit 4:2:0** 4K or QFHD MONITORING
- 4 x REC OUT
- Real-time 4K live production output Each Channel **10-bit 4:4:4 Up to 30p** **10-bit 4:2:2 Over 30p**
- Configurable **4 x 3G-SDI** or **2 x HD-SDI** Outputs **2 x HD-SDI** Monitor Outputs
- Up to 4K or QFHD
- 4096/3840 x 2160 **4K/QFHD** **10-bit 4:4:4 Up to 30p** **10-bit 4:2:2 Over 30p** PRODUCTION + MONITORING

Internal recording

- Access Memory Card **AXS-512 S24**
- **AXS-R5** Onboard RAW Recorder

Onboard recording

- RAW
  - 4K 17:9 → 4096 x 2160 **16-bit Lin 4K RAW**
  - 2K 17:9 → 2048 x 1080 **16-bit Lin 2K RAW**
  - 2K: No Crop factor, no telephoto conversion, need CBK-55F2K Optical Filter to reduce aliasing

- **F5** + Recorder

- SxS PRO+
- SxS-1 SxS PRO
- Option board *CBKZ-55PD*
- Quick Time
- ProRes → HD 16:9
  - 1920 x 1080 **ProRes** - **12-bit 4:4:4:4**
  - 1920 x 1080 **ProRes** - **10-bit 4:2:2 HQ**
  - 1920 x 1080 **ProRes** - **10-bit 4:2:2**
- DNxHD → HD 16:9
  - 1920 x 1080 **DnxHD** 220x/185x/175x **10-bit 4:2:2**
  - 1920 x 1080 **DnxHD** 145x/120x/115x **8-bit 4:2:2**
- MXF → XAVC
  - 2K 17:9 → 2048 x 1080 **XAVC 2K** **10-bit 4:2:2**
  - HD 16:9 → 1920 x 1080 **XAVC HD** **10-bit 4:2:2**
- MXF → MPEG4 SStP SR FILES → HD 16:9
  - 1920 x 1080 **SR SStP - HD 10-bit 4:4:4**
  - 1920 x 1080 **SR SStP - HD 10-bit 4:2:2**
- MXF → MPEG2 → HD 16:9
  - 1920 x 1080 **MPEG2** **8-bit 4:2:2**
  - 1280 x 720 **MPEG2** **8-bit 4:2:2**

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Recording options

Sony F5 + AXS-R5

Version 5.0
Dec 2014

FPS range comparison

NO 2 x ANAMORPHIC

External recording
from AXS-R5

1920 x 1080 - **10-bit 4:2:2**
RECORDING + MONITORING
Closer to RAW demozaicing

HD 16:9

SLog 2

HD-SDI

External recording
Live output

Real-time 4K output

HDMI Terminal

1 x MON OUT

Up to **4K** or **QFHD**

4 x REC OUT

Real-time 4K live production output
Each Channel
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p

Configurable
4 x 3G-SDI or
2 x HD-SDI Outputs
2 x HD-SDI Monitor Outputs

Fps range: Up to 30 fps
4096/3840 x 2160 **8-bit 4:2:0**
4K or **QFHD MONITORING**

Fps range: Up to 60 fps
4096/3840 x 2160 **4K/QFHD**
10-bit 4:4:4 Up to 30p
10-bit 4:2:2 Over 30p
PRODUCTION + MONITORING

Up to **4K** or **QFHD**

Internal recording

Onboard recording

Access Memory Card
AXS-512 S24

AXS-R5
Onboard RAW Recorder

RAW

4K 17:9	60p 1-60p S&Q	t Lin 4K RAW
2K 17:9	120p 1-120p S&Q	t Lin 2K RAW

2K: No Crop factor, no telephoto conversion, need CBK-55F2K Optical Filter to reduce aliasing

F5
+ Recorder

Option board *CBKZ-55PD*

ProRes — **HD 16:9**

23.98 / 24 / 25 / 29.97p	12-bit 4:4:4:4
23.98 / 24 / 25 / 29.97 /50 59,94p 50/59,94i	10-bit 4:2:2 HQ
	10-bit 4:2:2

DNxHD — **HD 16:9**

23.98/25/29.97p 50/59,94i	220x/185x/175x 10-bit 4:2:2
	NO 24P
	145x/120x/115x 8-bit 4:2:2

SxS PRO+

Quick Time

MXF — **XAVC**

2K 17:9	120p 1-120p S&Q	10-bit 4:2:2
HD 16:9	120p 1-120p S&Q	10-bit 4:2:2

MXF — **MPEG4** SStP SR FILES — **HD 16:9**

Up to 30 fps	10-bit 4:4:4
Up to 30 fps	10-bit 4:2:2

SxS-1
SxS PRO

MXF — **MPEG2** — **HD 16:9**

23.98 / 25 / 29.97 / 30p 60p - 50/59.97/60i	8-bit 4:2:2
720p Up to 60p	8-bit 4:2:2

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Recording options

Alexa XT

Sup 10.1
June 2014

External recording
Live output

- 1 or 2 x MON OUT → HD 16:9 → HD-SDI
  - 1920 x 1080 - 10 bit 4:2:2 YCbCr **MONITORING** Information overlay
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image
  - 1920 x 1080 - **10-bit 4:4:4 RGB**
  - 1920 x 1080 - **10-bit 4:2:2** YCbCr

Internal recording

XR Capture Drive

14:9 ARRIRAW OPENGATE → 3414 x 2198 12-bit uncompressed
4:3 ARRIRAW 2.8K Full → 2880 x 2160 12-bit uncompressed
4:3 ARRIRAW 2.8K Crop → 2578 x 2160 12-bit uncompressed
16:9 ARRIRAW 2.8K → 2880 x 1620 12-bit uncompressed

HD 16:9 — ProRes

1920 x 1080 **ProRes** - **12-bit 4:4:4:4 XQ**
1920 x 1080 **ProRes** - **12-bit 4:4:4:4**
1920 x 1080 **ProRes** - **10-bit 4:2:2 HQ**
1920 x 1080 **ProRes** - **10-bit 4:2:2**

2K 16:9 — ProRes

2048 x 1152 **ProRes** - **12-bit 4:4:4:4 XQ**
2048 x 1152 **ProRes** - **12-bit 4:4:4:4**
2048 x 1152 **ProRes** - **10-bit 4:2:2 HQ**
2048 x 1152 **ProRes** - **10-bit 4:2:2**

2K 4:3 — ProRes

2048 x 1536 **ProRes** - **12-bit 4:4:4:4 XQ**
2048 x 1536 **ProRes** - **12-bit 4:4:4:4**
2048 x 1536 **ProRes** - **10-bit 4:2:2 HQ**
2048 x 1536 **ProRes** - **10-bit 4:2:2**

HD 16:9 — DNxHD

1920 x 1080 **DnxHD 440** - **10 bit 4:4:4**
1920 x 1080 **DnxHD 220x/185x/175x** 10-bit 4:2:2
1920 x 1080 **DnxHD 145x/120x/115x** 8-bit 4:2:2

ALEXA XT

ALEXA XT M

XT

ALEXA XT Plus

ALEXA XT Studio

SxS PRO Card
CFast 2.0 Card
with
SxS Pro or CFast 2,0 adapter

HD 16:9 — Quick Time ProRes / MXF DNxHD

1920 x 1080 **ProRes** - **12-bit 4:4:4:4 XQ**
1920 x 1080 **ProRes** - **12-bit 4:4:4:4**
1920 x 1080 **ProRes** - **10-bit 4:2:2 HQ**
1920 x 1080 **ProRes** - **10-bit 4:2:2**

2K 16:9 — Quick Time ProRes / MXF DNxHD

2048 x 1152 **ProRes** - **12-bit 4:4:4:4 XQ**
2048 x 1152 **ProRes** - **12-bit 4:4:4:4**
2048 x 1152 **ProRes** - **10-bit 4:2:2 HQ**
2048 x 1152 **ProRes** - **10-bit 4:2:2**

2K 4:3 — Quick Time ProRes / MXF DNxHD

2048 x 1536 **ProRes** - **12-bit 4:4:4:4 XQ**
2048 x 1536 **ProRes** - **12-bit 4:4:4:4**
2048 x 1536 **ProRes** - **10-bit 4:2:2 HQ**
2048 x 1536 **ProRes** - **10-bit 4:2:2**

HD 16:9 — Quick Time DNxHD / MXF DNxHD

1920 x 1080 **DnxHD 440** - **10 bit 4:4:4**
1920 x 1080 **DnxHD 220x/185x/175x** 10-bit 4:2:2
1920 x 1080 **DnxHD 145x/120x/115x** 8-bit 4:2:2

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Recording options

Alexa XT

Sup 10.1
June 2014

External recording – Live output

Output	Format	Signal	Details
1 or 2 x MON OUT	HD 16:9	HD-SDI	1920 x 1080 - 10 bit 4:2:2 YCbCr MONITORING Information overlay
2 x REC OUT	HD 16:9	HD-SDI Uncompressed Clean image	1920 x 1080 - 10-bit 4:4:4 RGB
			1920 x 1080 - 10-bit 4:2:2 YCbCr

Internal recording

XR Capture Drive

Format	Resolution	FPS range
14:9 ARRIRAW OPENGATE	3414 x 2198	FPS range: 0,75 - 75
4:3 ARRIRAW 2.8K Full	2880 x 2160	FPS range: 0,75 - 90
4:3 ARRIRAW 2.8K Crop	2578 x 2160	FPS range: 0,75 - 96
16:9 ARRIRAW 2.8K	2880 x 1620	FPS range: 0,75 - 120

Quick Time · ProRes · MXF · DNxHD

Format	FPS	Codec
HD 16:9 1920 x 1080	0,75 - 75 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 120 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 120 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 120 fps	ProRes - 10-bit 4:2:2
2K 16:9 2048 x 1152	0,75 - 60 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 60 fps	ProRes - 10-bit 4:2:2
2K 4:3 2048 x 1536	0,75 - 48 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 48 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 48 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 48 fps	ProRes - 10-bit 4:2:2
HD 16:9 1920 x 1080	0,75 - 96 fps	DnxHD 440 - 10 bit 4:4:4
	0,75 - 120 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
	0,75 - 120 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

FPS range Comparison w/ High Speed license

60/120 GB CFast 2.0 Card with CFast 2,0 adapter

ProRes · Quick Time · DNxHD · MXF

Format	FPS	Codec
HD 16:9 1920 x 1080	0,75 - 75 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 120 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 120 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 120 fps	ProRes - 10-bit 4:2:2
2K 16:9 2048 x 1152	0,75 - 60 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 60 fps	ProRes - 10-bit 4:2:2
2K 4:3 2048 x 1536	0,75 - 48 fps	ProRes - 12-bit 4:4:4:4 XQ
	0,75 - 48 fps	ProRes - 12-bit 4:4:4:4
	0,75 - 48 fps	ProRes - 10-bit 4:2:2 HQ
	0,75 - 48 fps	ProRes - 10-bit 4:2:2
HD 16:9 1920 x 1080	0,75 - 90 fps	DnxHD 440 - 10 bit 4:4:4
	0,75 - 120 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
	0,75 - 120 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

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Recording options

Alexa XT

Sup 10.1
June 2014

External recording
Live output

- 1 or 2 x MON OUT → HD 16:9 → HD-SDI → 1920 x 1080 - 10 bit 4:2:2 YCbCr **MONITORING** Information overlay
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image → 1920 x 1080 - **10-bit 4:4:4 RGB**
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image → 1920 x 1080 - **10-bit 4:2:2** YCbCr

Internal recording

XR Capture Drive

14:9 ARRIRAW OPENGATE	3414 x 2198	FPS range: 0,75 - 75
4:3 ARRIRAW 2.8K Full	2880 x 2160	FPS range: 0,75 - 90
4:3 ARRIRAW 2.8K Crop	2578 x 2160	FPS range: 0,75 - 96
16:9 ARRIRAW 2.8K	2880 x 1620	FPS range: 0,75 - 120

Quick Time ProRes
MXF DNxHD

FPS range Comparison
w/ High Speed license

XT

ALEXA XT Plus

ALEXA XT Studio

SxS PRO /PRO+ 64/128GB
Card with SxS Pro adapter

HD 16:9 1920 x 1080

0,75 - 48 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
0,75 - 120 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 120 fps	ProRes - 10-bit 4:2:2

2K 16:9 2048 x 1152

0,75 - 40 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 60 fps	ProRes - 10-bit 4:2:2

2K 4:3 2048 x 1536

0,75 - 30 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 48 fps	ProRes - 12-bit 4:4:4:4
0,75 - 48 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 48 fps	ProRes - 10-bit 4:2:2

HD 16:9 1920 x 1080

0,75 - 60 fps	DnxHD 440 - 10 bit 4:4:4
0,75 - 120 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
0,75 - 120 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

ProRes
Quick Time
DNxHD
MXF

HD 16:9 1920 x 1080

0,75 - 75 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 120 fps	ProRes - 12-bit 4:4:4:4
0,75 - 120 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 120 fps	ProRes - 10-bit 4:2:2

2K 16:9 2048 x 1152

0,75 - 60 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 60 fps	ProRes - 10-bit 4:2:2

2K 4:3 2048 x 1536

0,75 - 48 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 48 fps	ProRes - 12-bit 4:4:4:4
0,75 - 48 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 48 fps	ProRes - 10-bit 4:2:2

HD 16:9 1920 x 1080

0,75 - 96 fps	DnxHD 440 - 10 bit 4:4:4
0,75 - 120 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
0,75 - 120 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

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Recording options

Alexa XT

Sup 10.1
June 2014

External recording
Live output

- 1 or 2 x MON OUT → HD 16:9 → HD-SDI → 1920 x 1080 - 10 bit 4:2:2 YCbCr **MONITORING** Information overlay
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image → 1920 x 1080 - **10-bit 4:4:4 RGB**
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image → 1920 x 1080 - **10-bit 4:2:2** YCbCr

Internal recording

XR Capture Drive

14:9 ARRIRAW OPENGATE	3414 x 2198	FPS range: 0,75 - 75
4:3 ARRIRAW 2.8K Full	2880 x 2160	FPS range: 0,75 - 90
4:3 ARRIRAW 2.8K Crop	2578 x 2160	FPS range: 0,75 - 96
16:9 ARRIRAW 2.8K	2880 x 1620	FPS range: 0,75 - 120

Quick Time ProRes / MXF DNxHD

HD 16:9 1920 x 1080

0,75 - 25 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 40 fps	ProRes - 12-bit 4:4:4:4
0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 60 fps	ProRes - 10-bit 4:2:2

2K 16:9 2048 x 1152

12-bit 4:4:4:4 XQ	Not Applicable
0,75 - 30 fps	ProRes - 12-bit 4:4:4:4
0,75 - 50 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 60 fps	ProRes - 10-bit 4:2:2

2K 4:3 2048 x 1536

12-bit 4:4:4:4 XQ	Not Applicable
0,75 - 30 fps	ProRes - 12-bit 4:4:4:4
0,75 - 40 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 48 fps	ProRes - 10-bit 4:2:2

HD 16:9 1920 x 1080

0,75 - 30 fps	DnxHD 440 - 10 bit 4:4:4
0,75 - 60 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
0,75 - 60 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

FPS range Comparison
w/ High Speed license

XT

ALEXA XT Plus

ALEXA XT Studio

32 GB SxS Pro
Card with
SxS Pro adapter

Quick Time ProRes / MXF DNxHD

HD 16:9 1920 x 1080

0,75 - 75 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 120 fps	ProRes - 12-bit 4:4:4:4
0,75 - 120 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 120 fps	ProRes - 10-bit 4:2:2

2K 16:9 2048 x 1152

0,75 - 60 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 60 fps	ProRes - 12-bit 4:4:4:4
0,75 - 60 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 60 fps	ProRes - 10-bit 4:2:2

2K 4:3 2048 x 1536

0,75 - 48 fps	ProRes - 12-bit 4:4:4:4 XQ
0,75 - 48 fps	ProRes - 12-bit 4:4:4:4
0,75 - 48 fps	ProRes - 10-bit 4:2:2 HQ
0,75 - 48 fps	ProRes - 10-bit 4:2:2

HD 16:9 1920 x 1080

0,75 - 96 fps	DnxHD 440 - 10 bit 4:4:4
0,75 - 120 fps	DnxHD 220x/185x/175x 10-bit 4:2:2
0,75 - 120 fps	DnxHD 145x/120x/115x 8-bit 4:2:2

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Recording options

Alexa XT

Aug 2014

External recording
Live output

- 1 or 2 x MON OUT → HD 16:9 → HD-SDI
  - 1920 x 1080 - 10 bit 4:2:2 YCbCr **MONITORING** Information overlay
- 2 x REC OUT → HD 16:9 → HD-SDI Uncompressed Clean image
  - 1920 x 1080 - **10-bit 4:4:4 RGB**
  - 1920 x 1080 - **10-bit 4:2:2** YCbCr

Internal recording

XR Capture Drive

- 14:9 ARRIRAW OPENGATE → 3414 x 2198 12-bit uncompressed
- 4:3 ARRIRAW 2.8K Full → 2880 x 2160 12-bit uncompressed
- 4:3 ARRIRAW 2.8K Crop → 2578 x 2160 12-bit uncompressed
- 16:9 ARRIRAW 2.8K → 2880 x 1620 12-bit uncompressed

XT


ALEXA XT


ALEXA XT M


ALEXA XT Plus


ALEXA XT Studio

QuickTime ProRes / MXF DNxHD

	HD 16:9	2K 16:9	2K 4:3
12-bit 4:4:4:4 XQ	1920 x 1080	2048 x 1152	2048 x 1536
12-bit 4:4:4:4	1920 x 1080	2048 x 1152	2048 x 1536
10-bit 4:2:2 HQ	1920 x 1080	2048 x 1152	2048 x 1536
10-bit 4:2:2	1920 x 1080	2048 x 1152	2048 x 1536

SxS PRO Card / CFast 2.0 Card

with SxS Pro or CFast 2,0 adapter

QuickTime ProRes

	HD
10 bit 4:4:4	1920 x 1080
10-bit 4:2:2	1920 x 1080
8-bit 4:2:2	1920 x 1080

MXF DNxHD

	HD
10 bit 4:4:4	1920 x 1080
10-bit 4:2:2	1920 x 1080
8-bit 4:2:2	1920 x 1080

4:3 - REAL 2x ANAMORPHIC

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