FOCAL resource

DIGITAL PRODUCTION CHALLENGE II

VILNIUS 2015

Digital shoot,

Film shoot

Digital postproduction

Digital workflow

How to choose ?

Wednesday 4 to Saturday 7 November 2015 (in synergy with Scanorama)

Philippe Ros Cinematographer, AFC - Digital imaging Supervisor www.philipperos.com

The first questions

What is the feature or program's end destination?

Multi-platforms production Cross-media

- 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?
- Augmented/Virtual Reality distribution?
- Internet? VOD? Mobile phones?
- DVD? Blu-ray distribution?
- Current TV broadcast?

The first questions

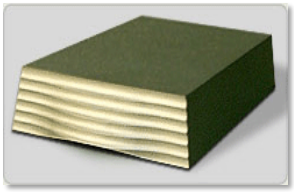
The DCP

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

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

D-Cinema 2K frame format: 2048 pixels x 1080 lines

D-Cinema 4K frame format: 4096 pixels x 2160 lines



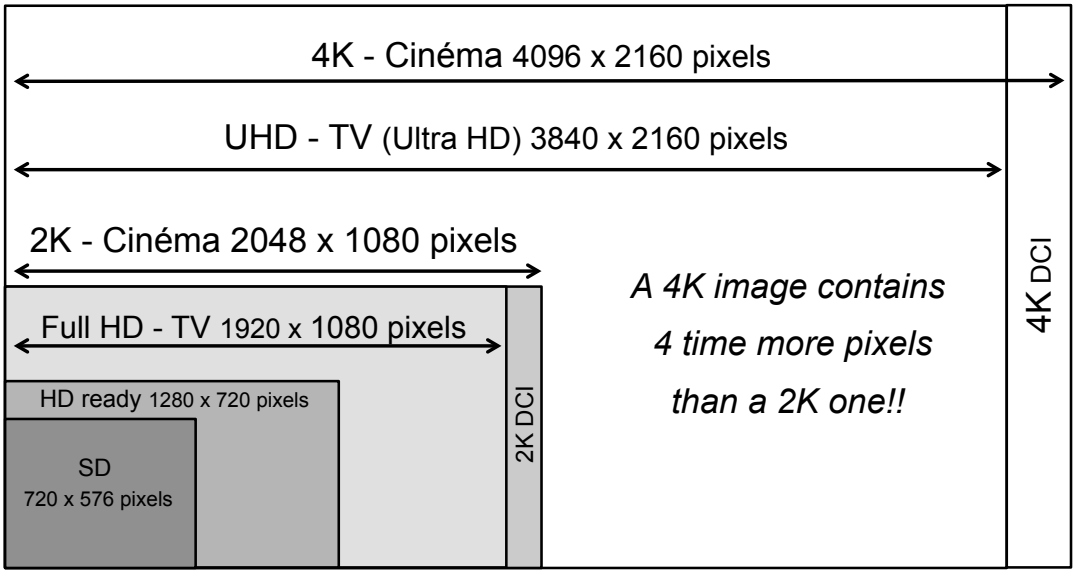
Reusable hard disk capacity:

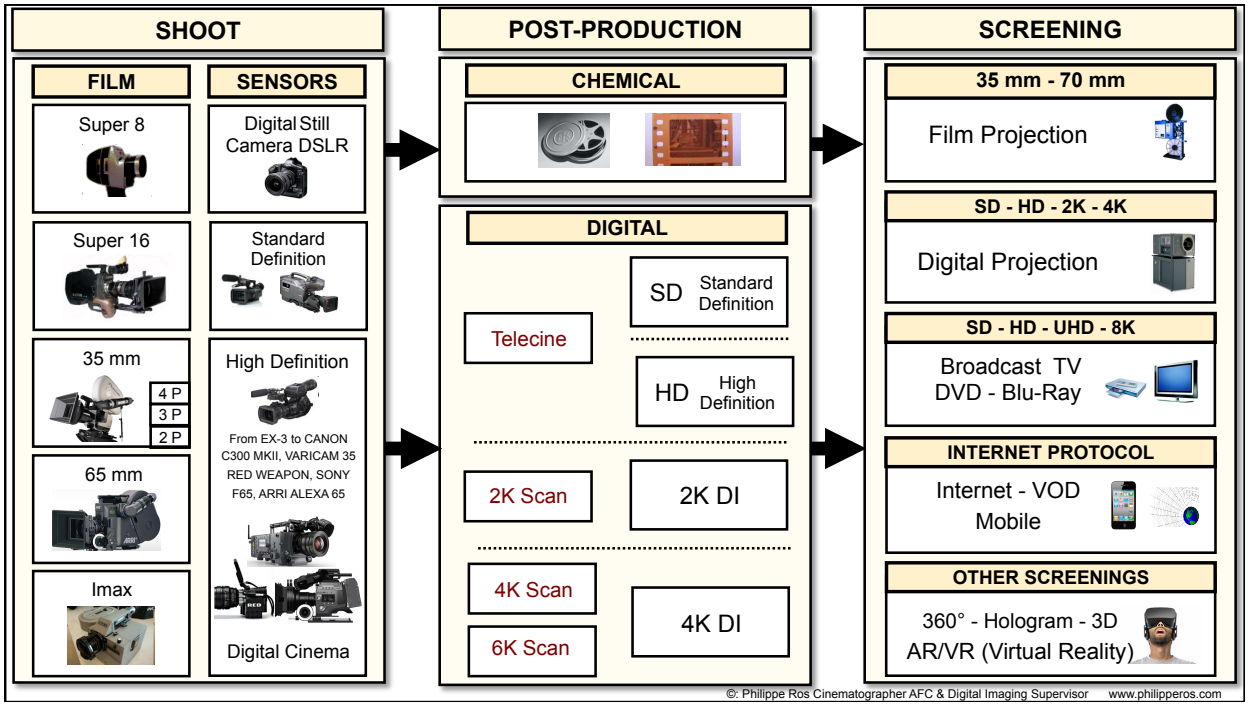
2 long-feature films

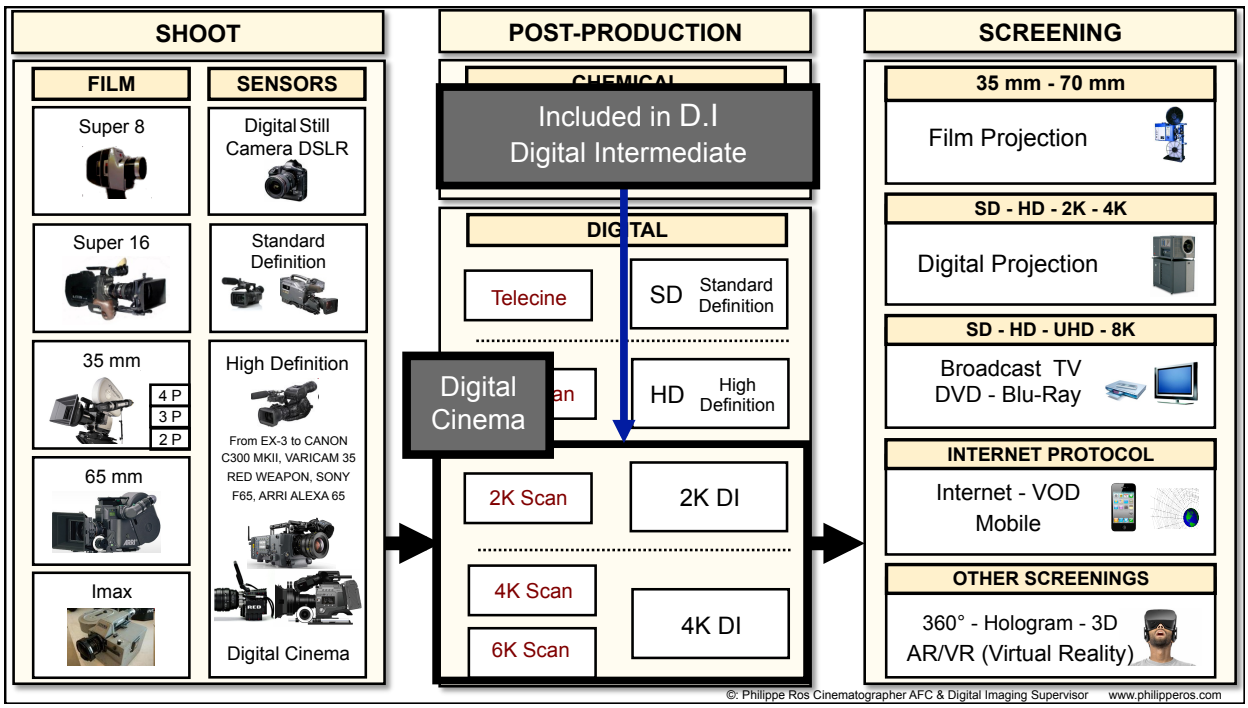
FORMAT: Compressed, split up in "reels"

SECURITY: Encrypted using 128-bit AES

Number of pixels in a broadcasted image or in an released image in a theater




SHOOT
FILM
SENSORS
Super 8
Digital Still Camera DSLR
Super 16
Standard Definition
35 mm
4 P
3 P
2 P
High Definition
From EX-3 to CANON C300 MKII, VARICAM 35 RED WEAPON, SONY F65, ARRI ALEXA 65
65 mm
Imax
Digital Cinema
POST-PRODUCTION
CHEMICAL
DIGITAL
Telecine
SD Standard Definition
HD High Definition
2K Scan
2K DI
4K Scan
6K Scan
4K DI
SCREENING
35 mm - 70 mm
Film Projection
SD - HD - 2K - 4K
Digital Projection
SD - HD - UHD - 8K
Broadcast TV
DVD - Blu-Ray
INTERNET PROTOCOL
Internet - VOD
Mobile
OTHER SCREENINGS
360° - Hologram - 3D
AR/VR (Virtual Reality)
© Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com


SHOOT
FILM
SENSORS
Super 8
Digital Still Camera DSLR
Super 16
Standard Definition
35 mm
4 P
3 P
2 P
High Definition
From EX-3 to CANON C300 MKII, VARICAM 35 RED WEAPON, SONY F65, ARRI ALEXA 65
65 mm
Imax
Digital Cinema
POST-PRODUCTION
Included in D.I
Digital Intermediate
DIGITAL
Telecine
SD Standard Definition
HD High Definition
Digital Cinema
2K Scan
2K DI
4K Scan
6K Scan
4K DI
SCREENING
35 mm - 70 mm
Film Projection
SD - HD - 2K - 4K
Digital Projection
SD - HD - UHD - 8K
Broadcast TV
DVD - Blu-Ray
INTERNET PROTOCOL
Internet - VOD
Mobile
OTHER SCREENINGS
360° - Hologram - 3D
AR/VR (Virtual Reality)
© Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com

The first questions

The questions of camera and workflow choice are often answered in the

program production chronological order:

We prefer answering questions in the opposite order

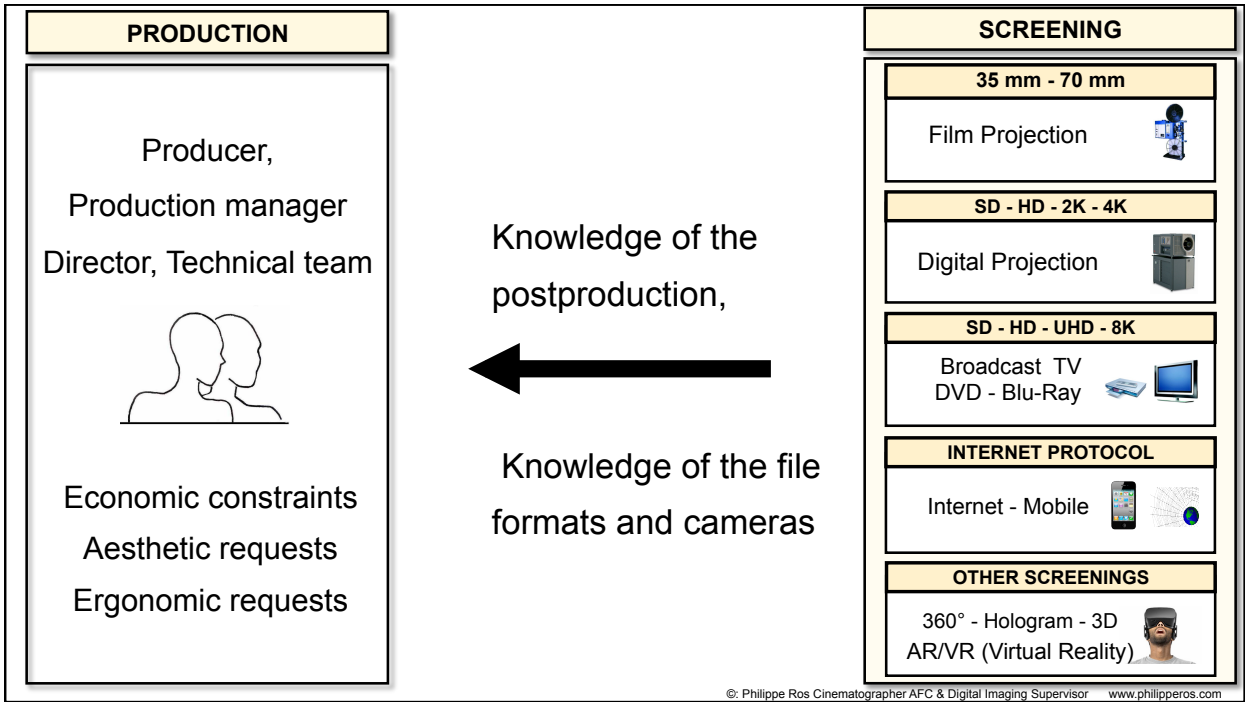
The digital intermediate

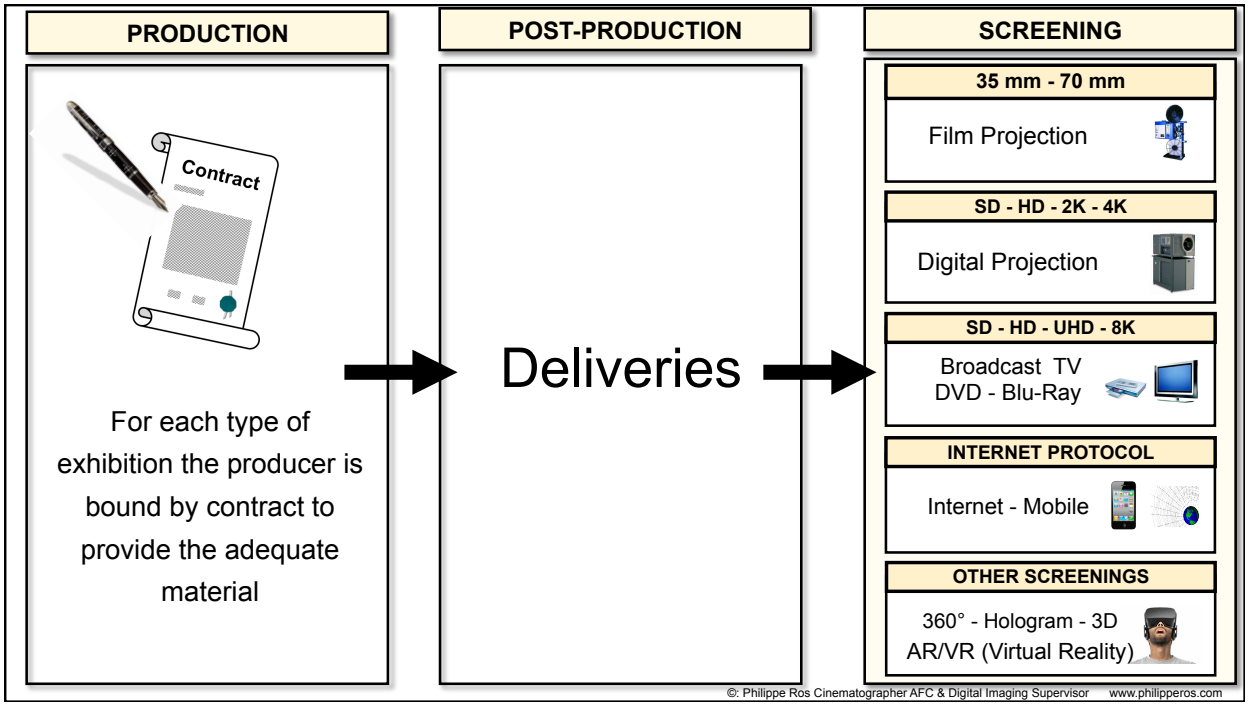
The digital intermediate

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

The original capture can be
a regular film as well as a digital one.


PRODUCTION
Producer,
Production manager
Director, Technical team
Economic constraints
Aesthetic requests
Ergonomic requests
Knowledge of the postproduction,
Knowledge of the file formats and cameras
SCREENING
35 mm - 70 mm
Film Projection
SD - HD - 2K - 4K
Digital Projection
SD - HD - UHD - 8K
Broadcast TV
DVD - Blu-Ray
INTERNET PROTOCOL
Internet - Mobile
OTHER SCREENINGS
360° - Hologram - 3D
AR/VR (Virtual Reality)
©: Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com


PRODUCTION
Contract
For each type of exhibition the producer is bound by contract to provide the adequate material
POST-PRODUCTION
Deliveries
SCREENING
35 mm - 70 mm
Film Projection
SD - HD - 2K - 4K
Digital Projection
SD - HD - UHD - 8K
Broadcast TV
DVD - Blu-Ray
INTERNET PROTOCOL
Internet - Mobile
OTHER SCREENINGS
360° - Hologram - 3D
AR/VR (Virtual Reality)
©: Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com

Some infos

- 1 bits
- 1 Byte = 1 Octet = 8 bits
- One disk of 320 Mo or 320 MB
- A feature film width : 1h ½ = 1,2 To

Multiple of Octets		
Name	**Symbol**	**Value**
Kilooctet	Ko	10^3
Mégaoctet	Mo	10^6
Gigaoctet	Go	10^9
Téraoctet	To	10^{12}
Pétaoctet	Po	10^{15}
Exaoctet	Eo	10^{18}
Zettaoctet	Zo	10^{21}
Yottaoctet	Yo	10^{24}

Bitrate required to transmit one HD image

- 1920 pixels (L) x 1080 lines (H) x 3 (colour chanels) x 10 bits x 25 fps = 1,55 Gb/s
- 1920 pixels (L) x 1080 lines (H) x 3 (colour chanels) x 8 bits x 25 fps = 1,25 Gb/s

Technical basis

FILE FORMAT OR FILE TYPES & STORAGE DEVICES

- Resolution (space)
- Resolution (time) Frequence (speed)
- Color depth (quantization)
- Color sampling
- Codec
- Bitrate
- Container
- Media

How to define a digital data stream
7 parameters by Franck Montagne

File types & Storage device

Resolution

Number of pixels L x H

- 8K 7680 x 4320
- 4K 4096 x 2160
- UHD 3840 x 2160
- 2K 2048 x 1080
- HD 1920 x 1080
- HD 1280 x 720

Frequence (speed)

Type of scanning:

Progressive (P)

- 60 P, 59,98 P, 50 P, 48 P
- 30 P, 29,97 P
- 25 P, 24 P
- 23,97§ P

Interlace (i)

Shooting interlace is not an option in DCI

Color depth

Quantization

- 16 bits
- 12 bits
- 10 bits
- 8 bits

Color sampling

Mode of treatment

- RAW
- RGB 4:4:4
- Y-Cb-Cr
  - 4:2:2
  - 4:2:0
  - 4:1:1
  - 3:1:1

Codec

Level and type of compression

Bitrate

Mbp/s

Container

(wrapper)

Define the structure of the file

Storage device

(media)

- Reliability
- Professional/Consumer
- Speed

Storage device (Media)

STORAGE DEVICE - 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

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

The new balances

Generally each program results from a compromise between:

Quality

Production costs

Nowadays:

Quality

Production costs

Post-production costs

Exhibition costs

TRANSMEDIA

Bitrate & Codec

The bitrate, Mbp/s (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 Y-Cb- Cr)
- On the quantization (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 **- Dec**oding

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

Consequences of bitrate and compression choices

What is the advantage for SFX and grading of having :

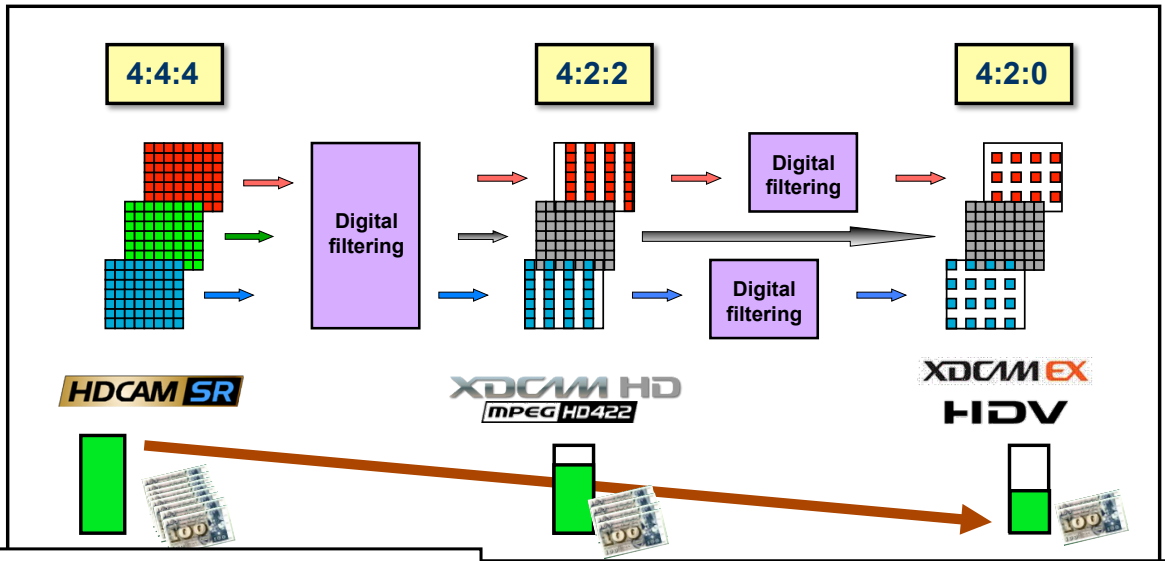
- 10 bits rather than 8 bits ?
- 10 bits RGB rather than 10 bits Y-Pb-Pr ?:
  - ✓ Keying made easier
  - ✓ Compositing made easier
  - ✓ Better rendering of flesh tones
  - ✓ Color correction made easier

All these choices are not trivial.
The consequences on the finished film's quality and cost must totally be taken into account.

Consequences of bitrate and compression choices

		
Alexa (Arri SxS recording) 12 bits 4:4:4:4 330 Mb/s	F35 (Sony) 10 bits 4:4:4 440 Mb/s or 880 Mb/s	EOS C300 (Canon) 8 bits 4:2:2 50 Mb/s
4096 shades of grey in the Red channel	1024 shades of grey in the Red channel	256 shades of grey in the Red channel
4096 shades of grey in the Green channel	1024 shades of grey in the Green channel	256 shades of grey in the Green channel
4096 shades of grey in the Blue channel	1024 shades of grey in the Blue channel	256 shades of grey in the Blue channel
Colour depth: 4096 x 4096 x 4096= More than 68 billion of colors	Colour depth: 1024 x 1024 x 1024= More than 1 billion of colors	Colour depth: 256 x 256 x 256 But with component Y Cb Cr sampling: More than 16 million of colors but less possibilities due to compression

Consequences of bitrate and compression choices



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

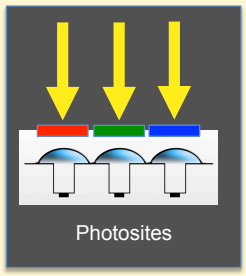
Difference of storage between 4:4:4 and 4:1:1: 50%

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

Sensor types

Sensor choices - What impact on shoot? - What impact on post-production?

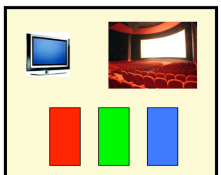
Light energy



Electrical energy

Because photosites are monochrome devices, they are unable to tell the difference between different wavelengths of light.

CONE CELLS



RGB OUTPUT

A sensor detects light information but doesn't detect color informations, the human vision need three color planes.

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).

Camera sensor - Pixels vs Photosites

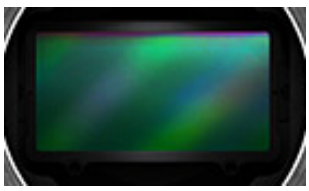
Great confusion or / and good marketing between:

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

In postproduction 2K and 4K refers to the output of a line array scanner scanning film, so that for each frame scanned at 4K, you wind up with 4K red pixels, 4K green and 4K blue.

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

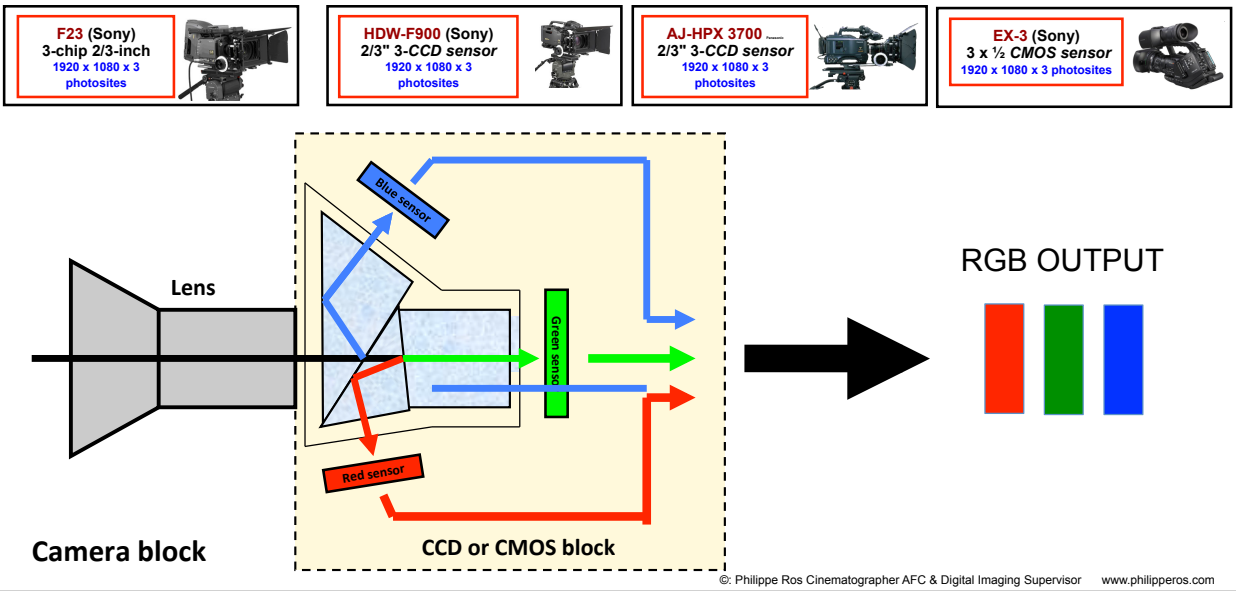
The type of sensor will have a direct influence on the workflow and therefore on the budget



SENSOR	RECORDING	POSTPRODUCTION & EXHIBITION
PHOTOSITES	SAMPLING & PIXELS	PIXELS

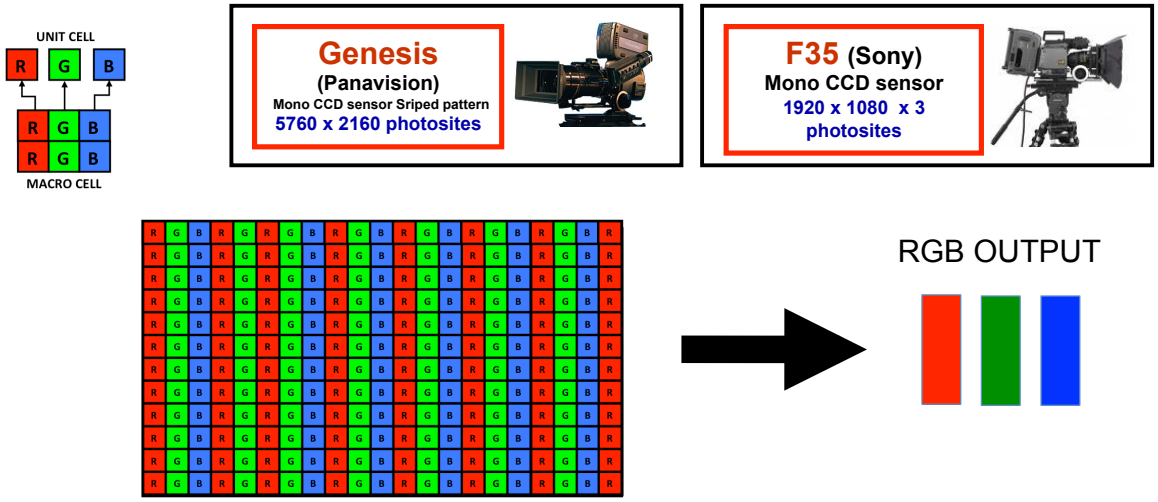
Sensor types

- The 3 x sensors cameras (examples)



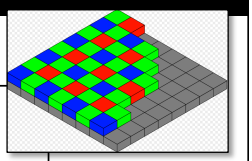
Sensor types

- The 1 x sensor cameras - The Striped pattern (examples)



Sensor types

- The 1 Sensor cameras - The Bayer pattern - The CFA



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. The CFA (Color Filter Array or CFM Color Mosaic Array) is positioned on top of the sensor to filter out the red, green, and blue components of light falling onto it.

B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R
B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R
B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R

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.

Sensor types

- The 1 Sensor cameras - The Bayer pattern

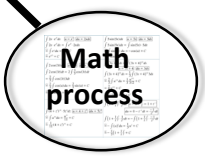
A Bayer filter could be defined as a **digital negative** which is used during post-production to restore an RGB flow

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 waysthan the mcamera manufacturer (Irridas, Glue Tools, Phantom, ColorFront)

B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R
B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R
B	G	B	G	B	G	B	G	B	G
G	R	G	R	G	R	G	R	G	R

Debayering

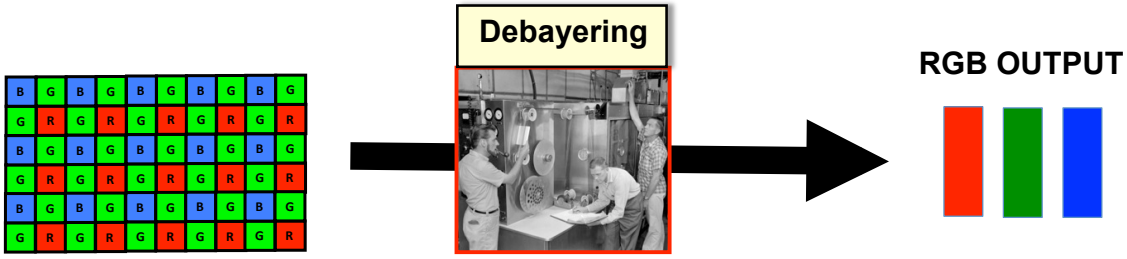
RGB OUTPUT



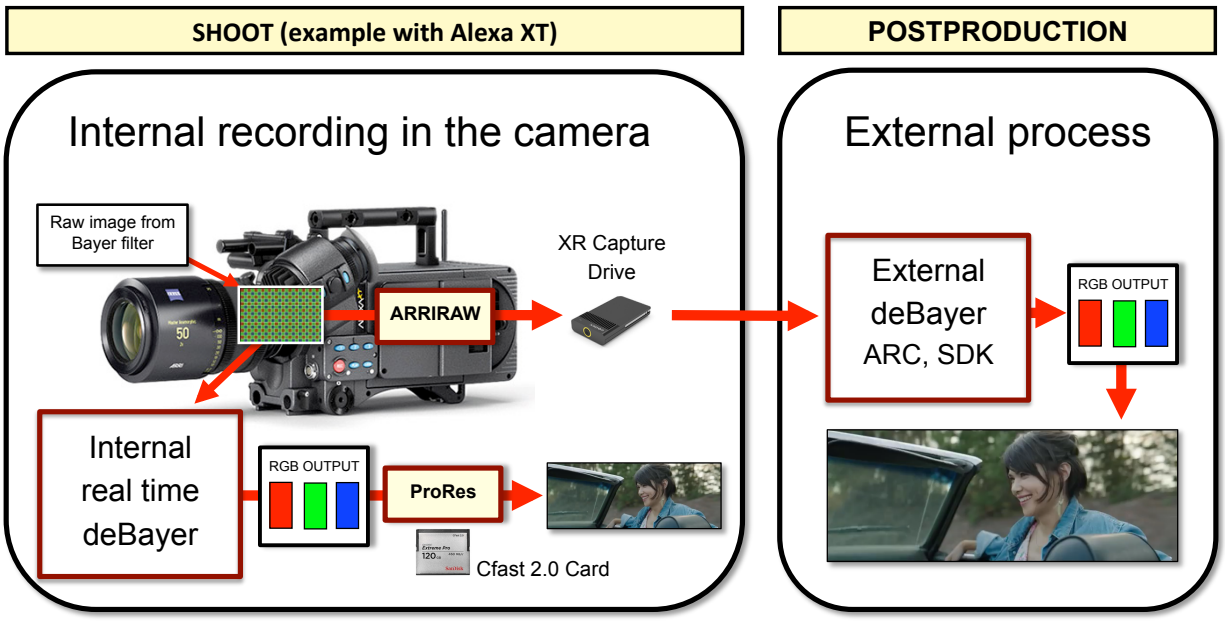
Debayering is not only a mathematic process but also an artistic process.

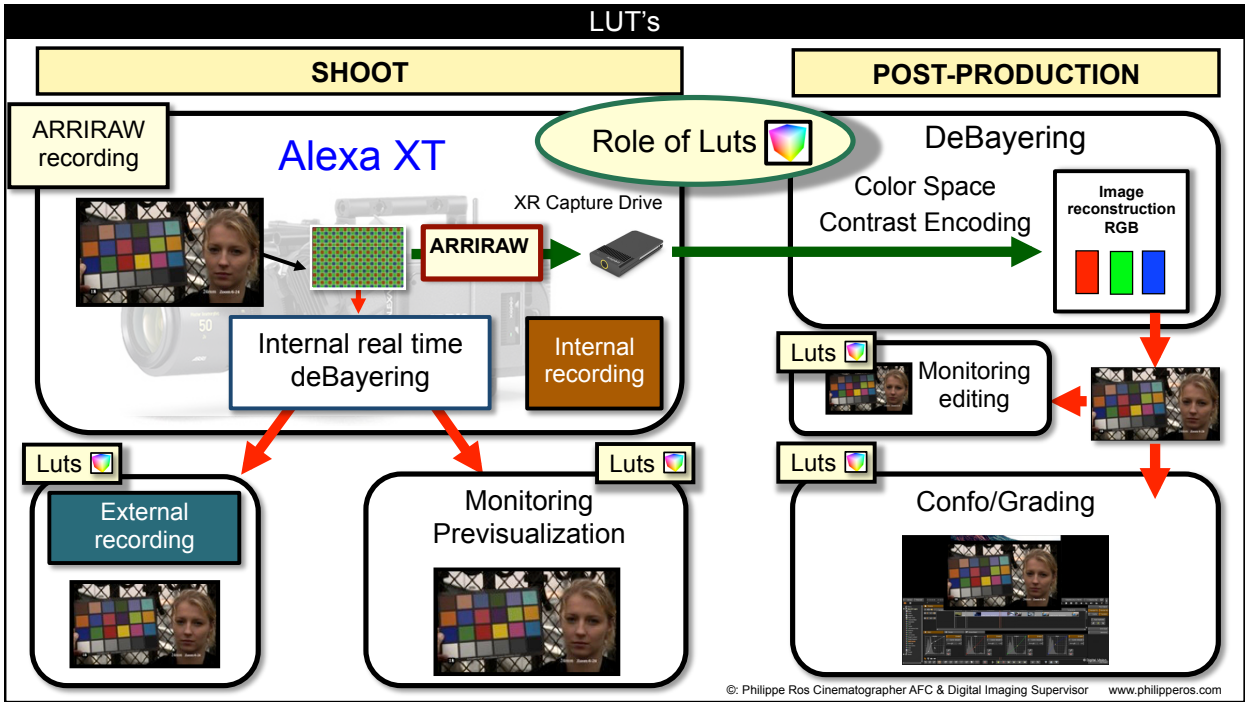
Sensor types

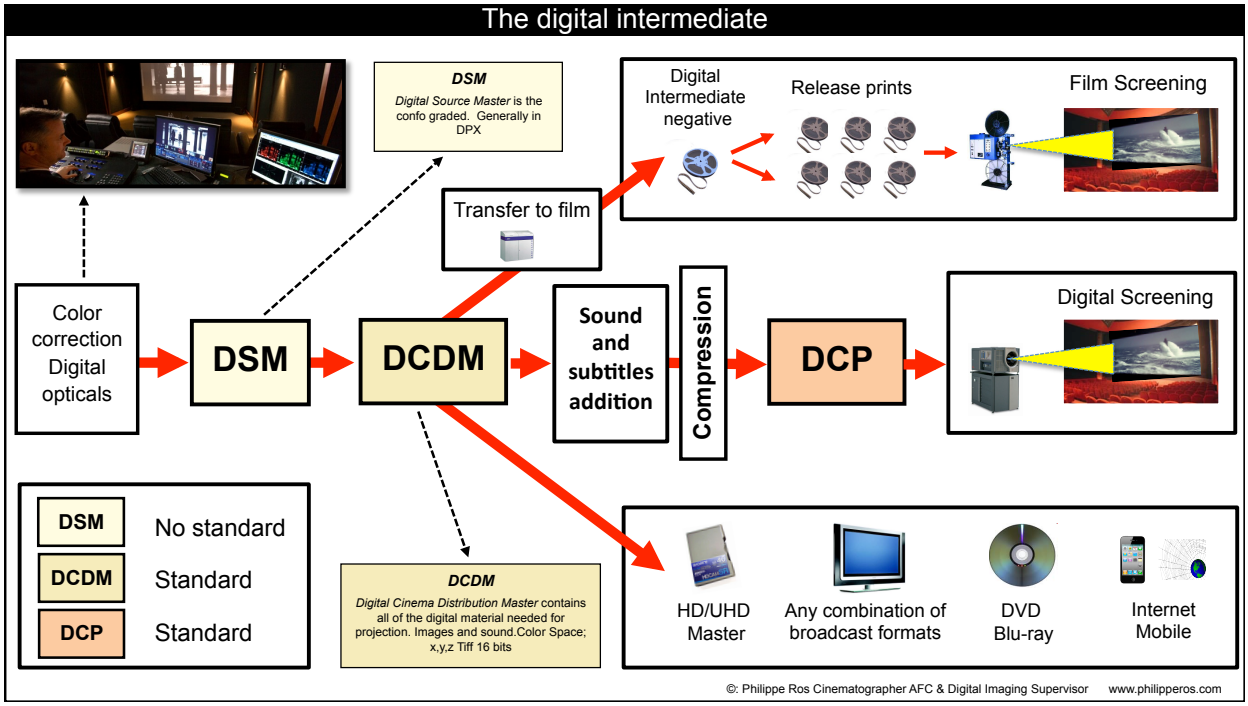
- **The 1 Sensor cameras - The Bayer pattern**



Different deBayer




LUT's
SHOOT
POST-PRODUCTION
ARRIRAW recording
Alexa XT
Role of Luts
DeBayering
Color Space
Contrast Encoding
Image reconstruction RGB
XR Capture Drive
ARRIRAW
Internal real time deBayering
Internal recording
Luts
Monitoring editing
Luts
External recording
Luts
Monitoring Previsualization
Luts
Confo/Grading
© Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com


The digital intermediate
DSM
Digital Source Master is the confo graded. Generally in DPX
Digital Intermediate negative
Release prints
Film Screening
Transfer to film
Color correction Digital opticals
DSM
DCDM
Sound and subtitles addition
Compression
DCP
Digital Screening
DSM No standard
DCDM Standard
DCP Standard
DCDM
Digital Cinema Distribution Master contains all of the digital material needed for projection. Images and sound.Color Space; x,y,z Tiff 16 bits
HD/UHD Master
Any combination of broadcast formats
DVD Blu-ray
Internet Mobile
© Philippe Ros Cinematographer AFC & Digital Imaging Supervisor www.philipperos.com