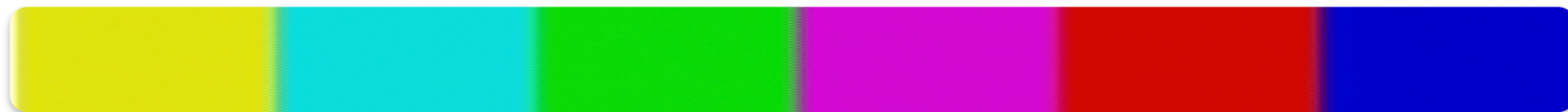


Erhaltung von Farbe bei dateibasiertem Video



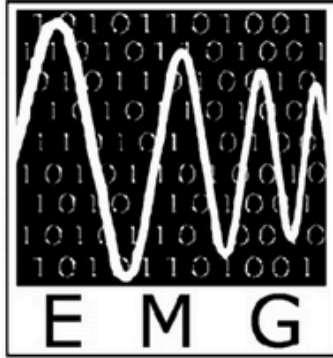
Sophie Bunz
MA Konservatorin-Restauratorin
für moderne Materialien und Medien



Flaminia Fortunato
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Electronic Media Review

The postprint publication of AIC's Electronic Media Group

AIC's 44th Annual Meeting

Sunday, May 15th 2016, 3:00 pm - 3:30 pm

(Electronic Media Session)

How Sustainable is File-based Video

Speaker

Brian Castriota & Flaminia Fortunato

How Sustainable is File-based Video Art? Exploring the Foundations for Best Practice Development

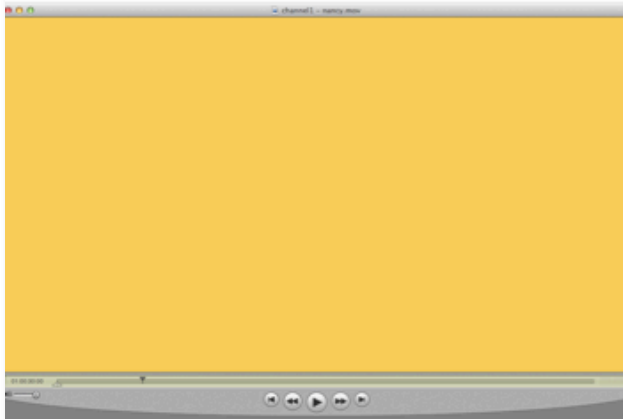
Sophie Bunz, Brian Castriota, Flaminia Fortunato

The Electronic Media Review, Volume Four: 2015-2016

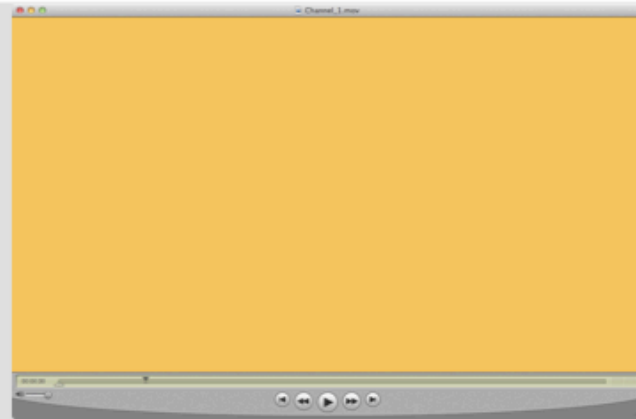
Life After Tape: Collecting Digital Video Art
Vortrag von Agathe Jarczyk & Joanna Phillips,
2014, AIC's 42nd Annual Meeting

3. Normalization

GUGGENHEIM
VIDEOKONSERVIERUNG.CH



Artist's native production format
DVCPro HD



Artist provided normalized file in
8bit-4:2:2-uncompressed

Life After Tape: Collecting Digital Video Art
Vortrag von Agathe Jarczyk & Joanna Phillips,
2014, AIC's 42nd Annual Meeting

Was sind mögliche Ursachen für
Farbverschiebungen bei datei-
basiertem Video?

3. Normalization

GUGGENHEIM
VIDEOKONSERVIERUNG.CH

DVCPro HD, chroma subsampling:
 $3 : 1.5 : 1.5$



8bit-4:2:2-uncompr., chroma subsampling,
 $4 : 2 : 2$



Videodateiformate

Ingest- und
Archivformat



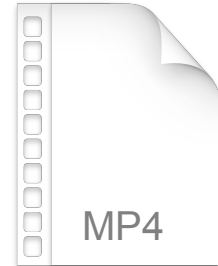
10bit-uncompressed422.mov

Produktions- und
Mezzanin-Format



AppleProRes422LT.mov

Ausstellungs- und
Distributionsformat



H.264.mp4

Videodateiformate

Aufnahmeformat
(z. B. MiniDV)



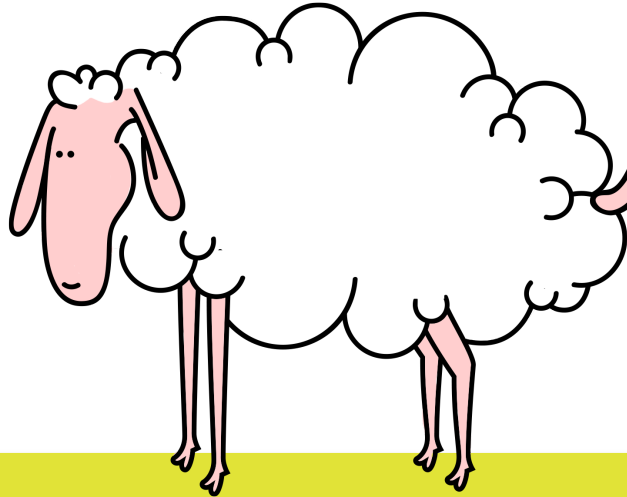
DV.mov

Produktionsformat

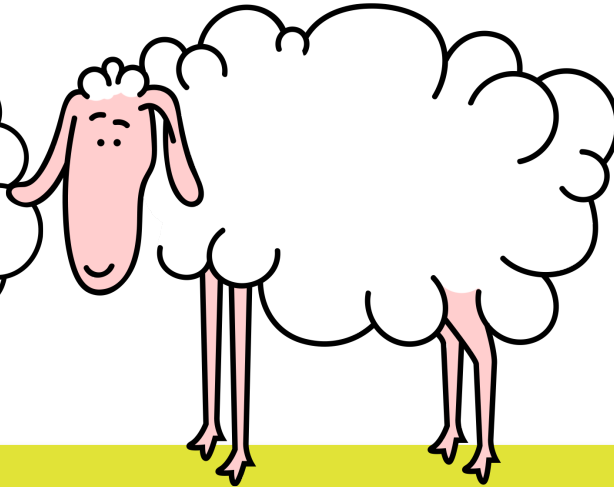


DNxHD.mov

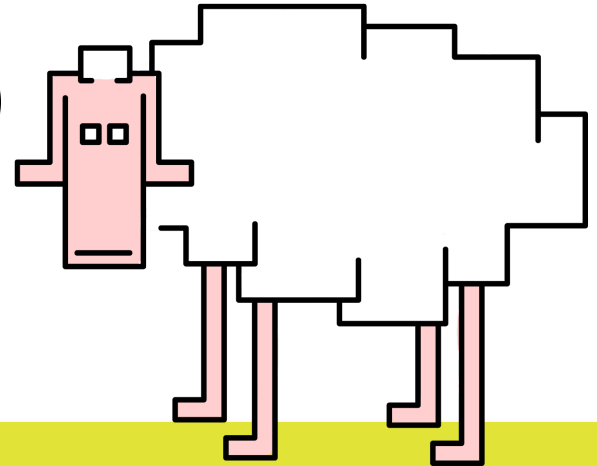
Lossless



Visually Lossless

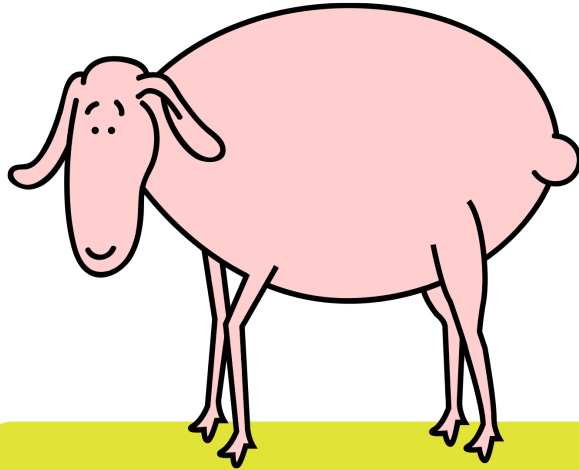


Lossy

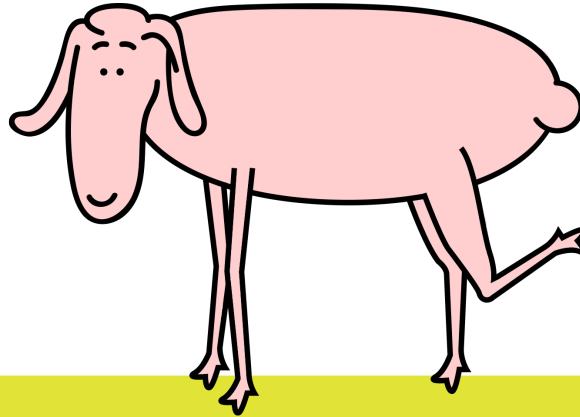


Betrachtung im Software Mediaplayer

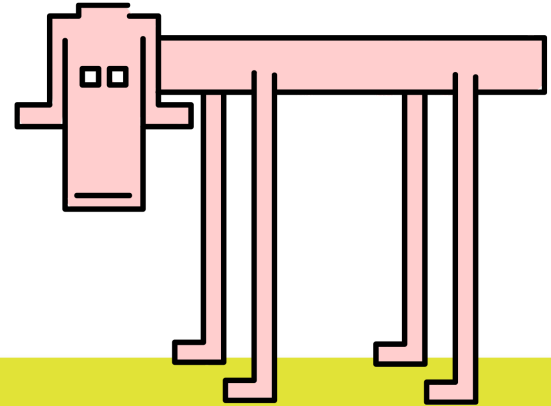
Lossless



Visually Lossless

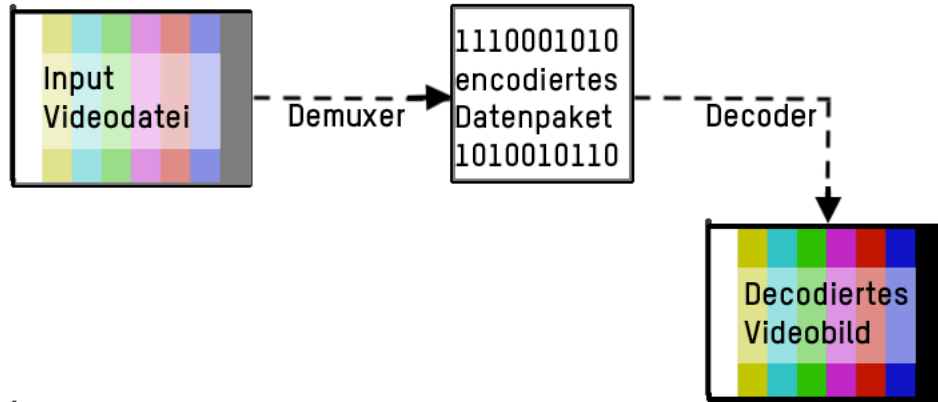


Lossy



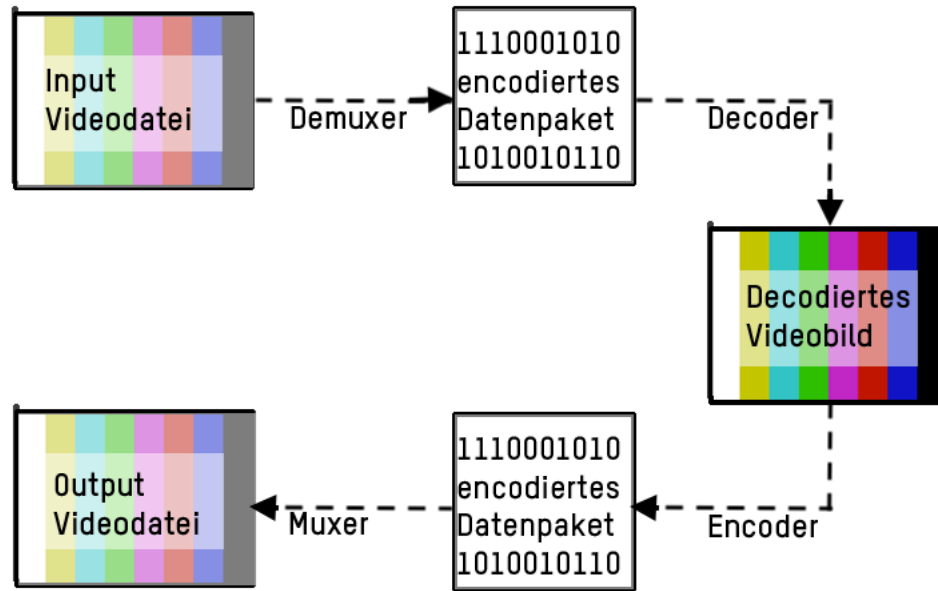
Datenvolumen

Videocodec



Codec ist die Abkürzung für Compressor/Decompressor und bezieht sich auf das Decodieren und Encodieren von Video-(pixel)daten. Beim Abspielen eines Videos entschlüsselt der Decoder die (komprimierten) Videodaten und liefert eine Folge von Bildern

Videocodec



Beim Transcodieren wird das decodierte Videobild mithilfe des Encoders komprimiert. Der Muxer führt die encodierten Video- und Audiodaten in einem Container zusammen

Obsoleszenz bei dateibasiertem Video?



The movie could not be opened.

An invalid public movie atom was found in the movie.

OK



Windows Media Player cannot play the file. The Player might not support the file type or might not support the codec that was used to compress the file.

Close

Web Help

Error.mp4



The document "want-to-believe.avi" not be opened. The movie is not in a format that QuickTime Player understands.

You may need to install additional software to this type of file.

Tell Me More

AvLib/FFmpeg Error



Codec not found

OK

Codec Library von QuickTime 7

```
$ cd /Library/QuickTime  
$ ls
```



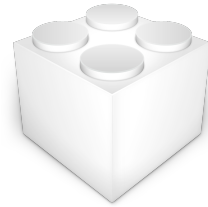
Volume (HD)



Library



QuickTime



AppleProRes422.component

Informationen über installierte QuickTime Codec Komponenten mit qt_thing extrahieren

\$ qt_thing

dvb.omino.com/sw/qt_tools/



QT_TOOLS

v2.9 build 589 [tests]

2018_11_09-16:30:09

[[[download](#)]]

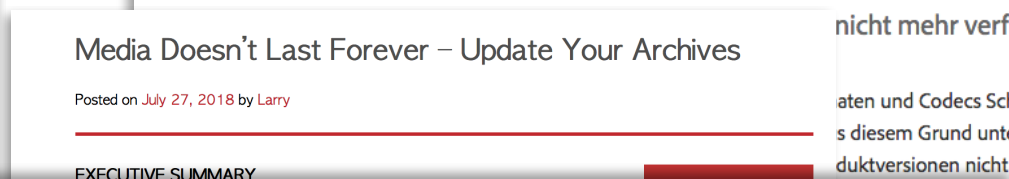
by david van brink

e-mail poly (ai tee) omino (dee oh tee) com
subject must start with 'quicktime' please
Help Support Freeware With [Money](#)...

AVK — -bash — 138x42

```
+ 1 @0x00010026 imco:2Vuy:BMAG "Blackmagic 8 Bit (2Vuy)"
+ 2 @0x0001005b imco:2vuy:KeyG "Apple FCP Uncompressed 8-bit 4:2:2"
+ 3 @0x0001020d imco:8BPS:appl "Apple Planar RGB"
+ 4 @0x00010001 imco:AV1x:AVID "AVID 1:1x"
+ 5 @0x00010051 imco:AVC1:Mg3b "x264Encoder"
+ 6 @0x00010199 imco:AVDJ:AVID "AVID Meridien Compressed Codec"
+ 7 @0x00010050 imco:AVUI:AVID "AVID Meridien Uncompressed Codec"
+ 8 @0x00010004 imco:AVd1:AVID "AVID DV100 Codec"
+ 9 @0x000100f4 imco:AVdn:AVID "AVID DNxHD Codec"
+ 10 @0x0001000e imco:AVdv:AVID "AVID DV Codec"
+ 11 @0x000100e6 imco:AVup:AVID "AVID Packed Codec"
+ 12 @0x00010229 imco:SVQ1:SVis "Sorenson Video? Compressor"
+ 13 @0x0001022b imco:SVQ3:SMI "Sorenson Video 3 Compressor"
+ 14 @0x00010227 imco:WRLE:appl "Apple BMP"
+ 15 @0x000100da imco:apch:appl "Apple ProRes 422"
+ 16 @0x000100db imco:apcn:appl "Apple ProRes 422"
+ 17 @0x000104ae imco:avc1:appl "H.264"
+ 18 @0x0001021f imco:cvid:appl "Apple Cinepak"
+ 19 @0x00010204 imco:dv5n:appl "Apple DVCPRO50 - NTSC"
+ 20 @0x00010205 imco:dv5p:appl "Apple DVCPRO50 - PAL"
+ 21 @0x00010201 imco:dvc:appl "Apple DV/DVCPRO - NTSC"
+ 22 @0x00010202 imco:dvcv:appl "Apple DV - PAL"
+ 23 @0x000100ec imco:dvh2:appl "Apple DVCPRO HD 1080p25"
+ 24 @0x000100eb imco:dvh3:appl "Apple DVCPRO HD 1080p30"
+ 25 @0x000100ea imco:dvh5:appl "Apple DVCPRO HD 1080i50"
+ 26 @0x000100e9 imco:dvh6:appl "Apple DVCPRO HD 1080i60"
+ 27 @0x000100e7 imco:dvhp:appl "Apple DVCPRO HD 720p60"
+ 28 @0x000100e8 imco:dvhq:appl "Apple DVCPRO HD 720p50"
+ 29 @0x00010203 imco:dvpp:appl "Apple DVCPRO - PAL"
+ 30 @0x00010225 imco:h261:appl "Apple H.261"
+ 31 @0x00010223 imco:h263:appl "H.263"
+ 32 @0x0001009b imco:hdv1:appl "Apple HDV 720p30"
+ 33 @0x0001009e imco:hdv2:appl "Apple HDV 1080i60"
+ 34 @0x0001009f imco:hdv3:appl "Apple HDV 1080i50"
+ 35 @0x00010099 imco:hdv4:appl "Apple HDV 720p24"
```

Zäsur “Legacy Codecs”



Thoughts on 32-bit codecs being phased out in macOS



Software Mediaplayer (Open Source)



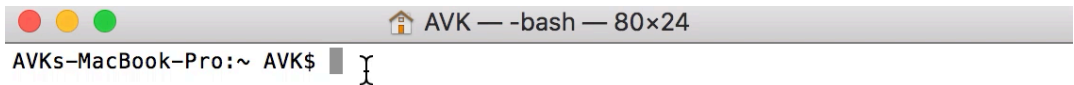
VLC media player





FFmpegs libavcodec

```
$ ffmpeg -codecs
```

A screenshot of a macOS terminal window. The title bar shows three colored window control buttons (red, yellow, green) and the text 'AVK — -bash — 80x24'. The terminal content shows the prompt 'AVKs-MacBook-Pro:~ AVK\$' followed by a cursor icon.

AVKs-MacBook-Pro:~ AVK\$

Forschungsfragen

- 1.) Was sind mögliche Ursachen für Farbverschiebungen und inkonsistente Wiedergabe von dateibasiertem Video?

Forschungsfragen

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- 2.) Ist Normalisierung eine geeignete Strategie, um die Zugänglichkeit von dateibasierten Videos, mit all ihren charakteristischen Eigenschaften, zu erhalten? Welche Richtlinien sollten bei der Normalisierung beachtet werden, um signifikante Eigenschaften zu erhalten?

Forschungsfragen

- 1.) Was sind mögliche Ursachen für Farbverschiebungen und inkonsistente Wiedergabe von dateibasiertem Video?
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- 3.) Welche Software Mediaplayer sind für die objektive/reproduzierbare Wiedergabe, welche Tools für die Metadatenextraktion und Qualitätskontrolle von digitalem Video geeignet?

Experteninterviews

- Eric Hoffert, Mitbegründer von QuickTime
- Reto Kromer, Filmrestaurator, Informatiker und Entwickler
- Jérôme Martinez, Entwickler und Gründer von MediaArea
- Erik Piil, Archivar für digitale AV Medien
- Julien Reichel, Entwickler und Experte für Videokompression (H.264)
- Dave Rice, Archivar und Technologie für AV Medien

Normalisierung

Welche Richtlinien sollten bei der Normalisierung beachtet werden, um eine originalgetreue Archivkopie zu erhalten?

AppleProRes422LT.mov
AppleProRes422HQ.mov
H.246.mp4
DV
HDV
DVCPRO HD
...



Archivstandard
z. B.
FFV1.mkv

Normalisierung von Testfiles mit unterschiedlichen Programmen



Final Cut Pro 6
Final Cut Pro 7



MPEG Streamclip



Adobe Premiere Pro



QuickTime Pro 7



FFmpeg

Normalisierung

AppleProRes422LT.mov
AppleProRes422HQ.mov
H.246.mp4
DV
HDV
DVCPRO HD
...

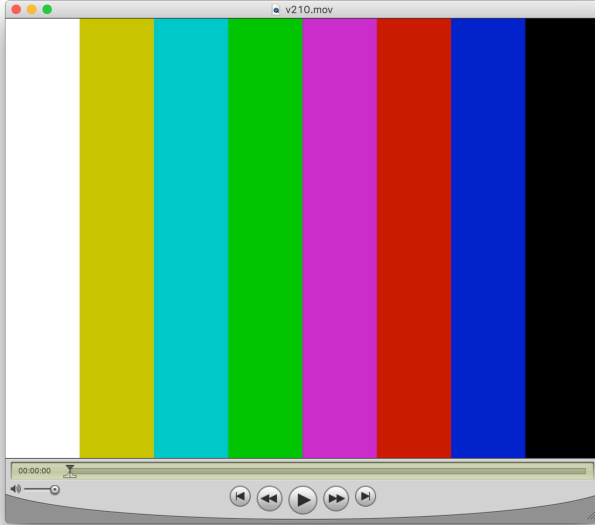


10bit-uncompressed4:2:2 (v210)
.mov
.avi
.mkv

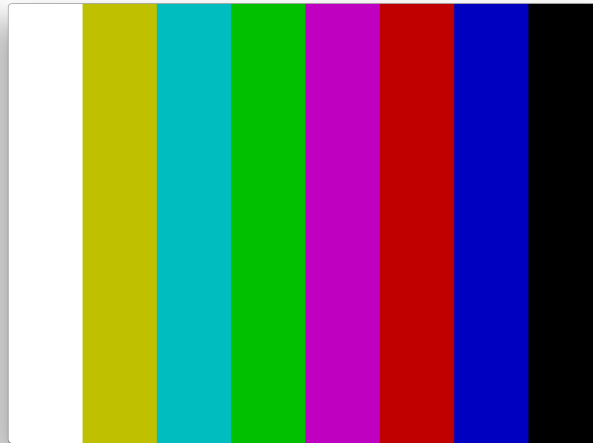
Betrachtung der Testfiles in unterschiedlichen Mediaplayern



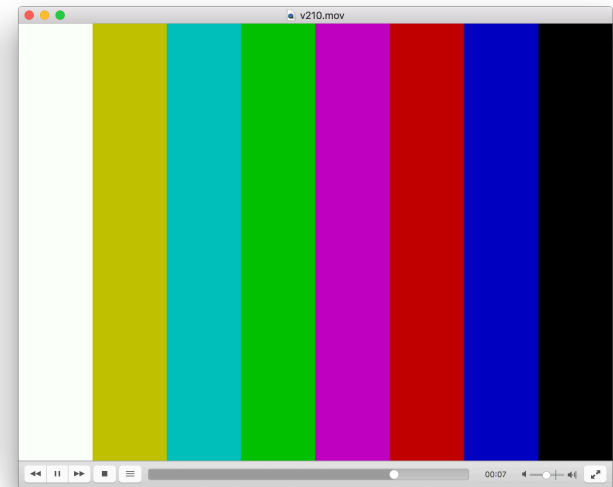
QuickTime Player 7 (Pro)



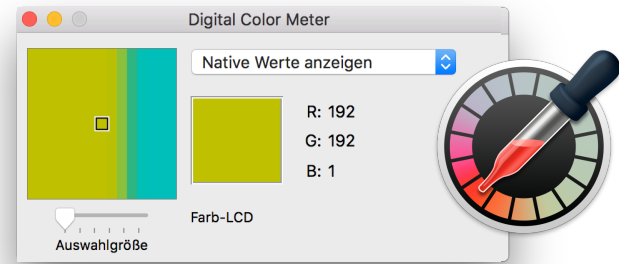
QuickTime Player X



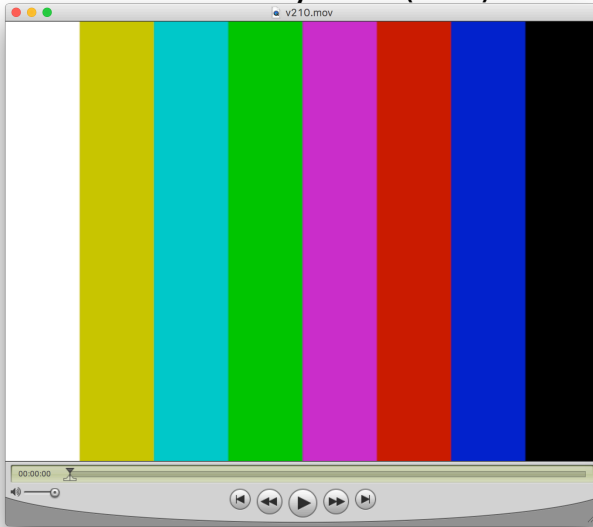
VLC media player



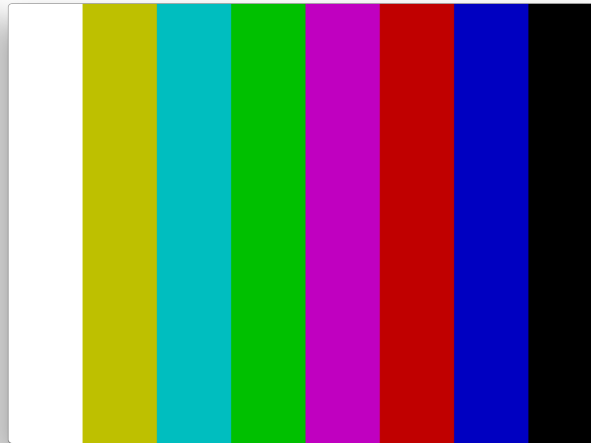
Betrachtung der Testfiles in unterschiedlichen Mediaplayern



QuickTime Player 7 (Pro)



QuickTime Player X



VLC media player



Original



Betrachtung eines Apple ProRes LT Testfiles
und dessen transkodierten v210 Kopien mit
dem QuickTime Player 7 Pro

R 135
G 135
B 135

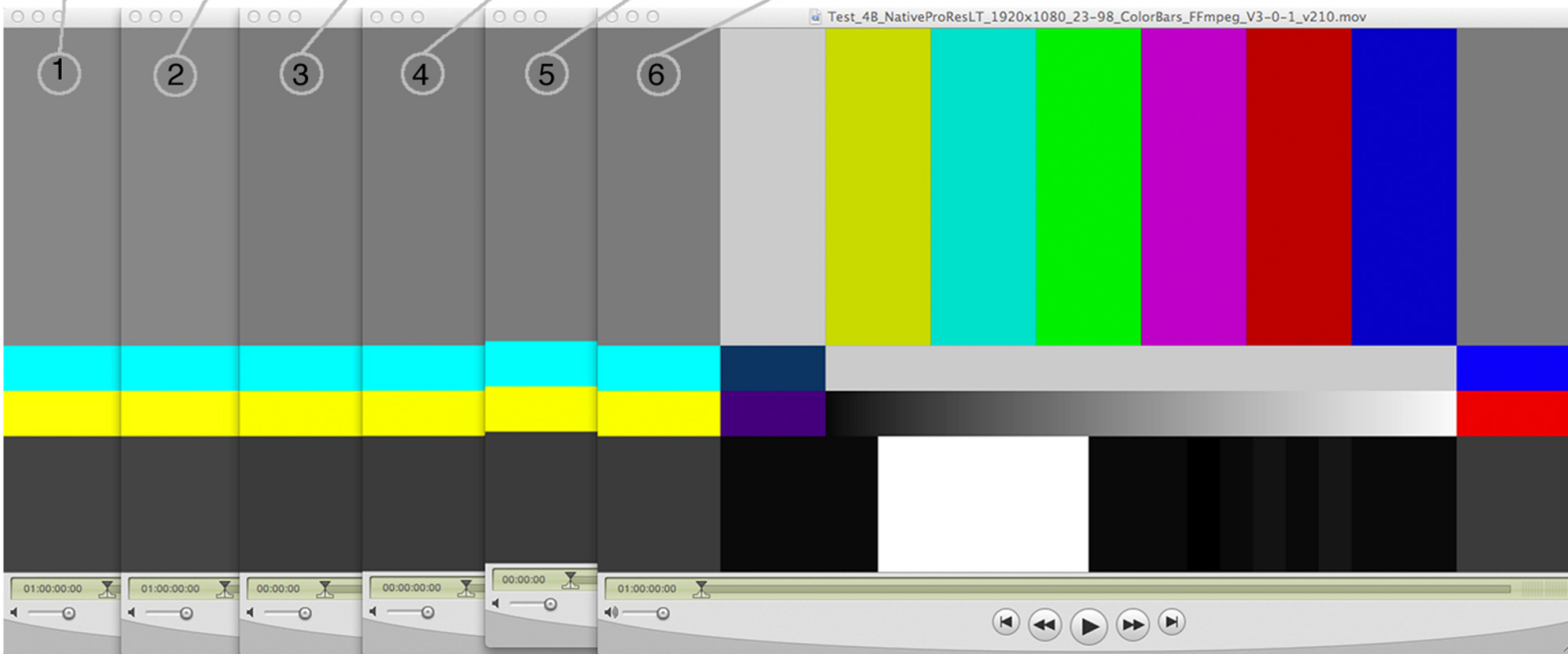
R 135
G 135
B 135

R 123
G 123
B 123

R 123
G 123
B 123

R 123
G 123
B 123

R 123
G 123
B 123



Untersuchung der Metadaten



MediaInfo &
MediaTrace



Invisor



FFprobe



DV Analyzer



QCTools



Atom Inspector

	General	Extended	Comparison
	Q Search		
Writing application	Lavf58.20.100	Lavf58.20.100	Lavf58.20.100
Video			
ID	1	1	1
Format version	Version 0		
Format profile	422 HQ		
Codec ID	apch	v210	v210
Codec ID/Hint		AJA Video Systems Xena	AJA Video Systems Xena
Duration	10 s 0 ms	10 s 0 ms	10 s 0 ms
Bit rate mode	Constant	Constant	Constant
Bit rate	6 567 kb/s	1 327 Mb/s	218 Mb/s
Width	1 920 pixels	1 920 pixels	720 pixels
Height	1 080 pixels	1 080 pixels	567 pixels
Pixel aspect ratio	1.000	1.000	1.067
Display aspect ratio	16:9	16:9	4:3
Frame rate mode	Constant	Constant	Constant
Frame rate	30.000 FPS	30.000 FPS	25.000 FPS
Frame count	300	300	250
Color space	YUV	YUV	YUV
Bit depth	8bits	10 bits	10 bits
Scan type		Progressive	Interlaced
Compression mode		Lossless	Lossless
Bits/(Pixel*Frame)	0.106	21.333	21.333
Stream size	8.21 MB (100.0%)	1.66 GB (100.0%)	272 MB (100.0%)
Writing library	Lavc		
Language	English	English	English
Chroma subsampling	4:2:2	4:2:2	4:2:2
Color primaries		BT.709	
Clean aperture display aspect ratio		16:9	4:3
Format	ProRes	YUV	YUV
Clean aperture height		1 080 pixels	567 pixels
Matrix coefficients		BT.709	
Transfer characteristics		BT.709	
Clean aperture width		1 920 pixels	720 pixels

Original

v210.mov

v210.avi

v210.mkv

v210.mov

Betrachtung eines Apple ProRes LT Testfiles
und dessen transkodierten v210 Kopien mit
dem QuickTime Player 7 Pro

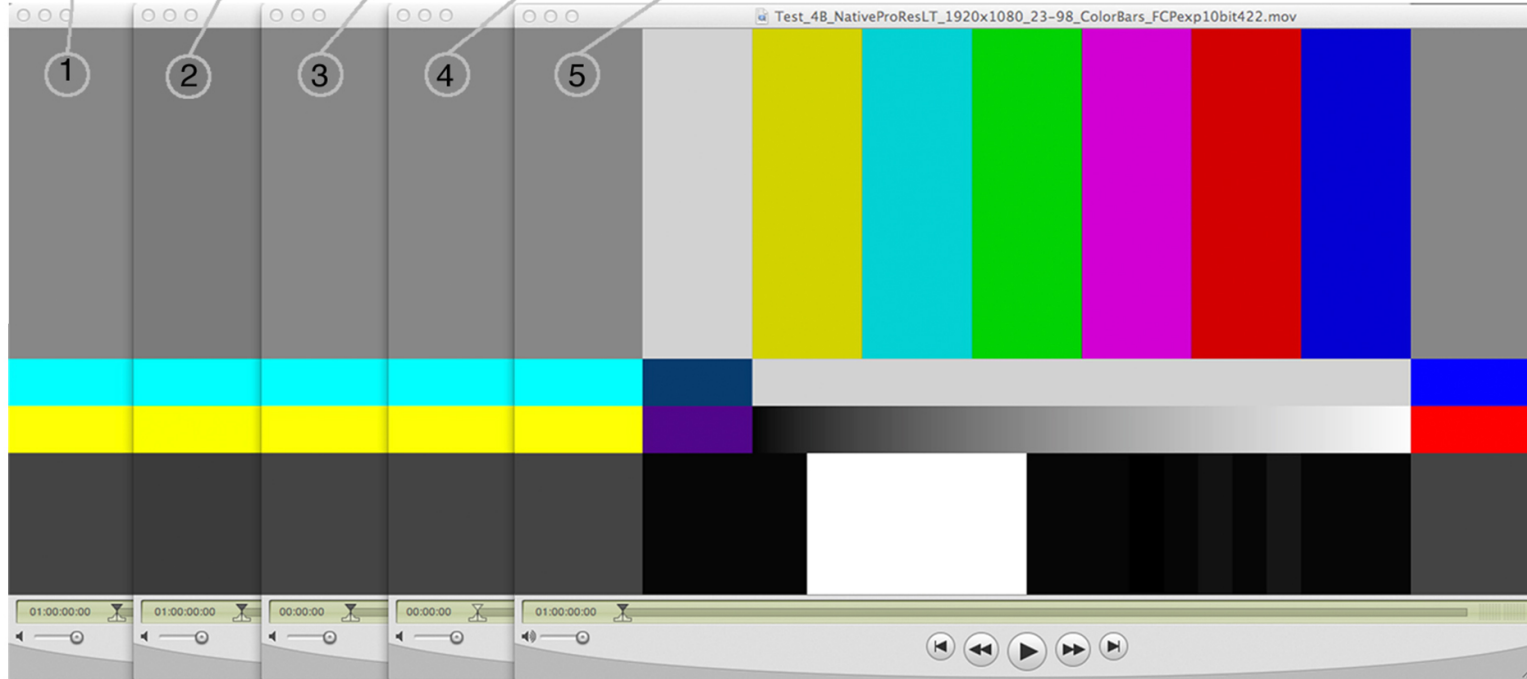
R 135
G 135
B 135

R 123
G 123
B 123

R 135
G 135
B 135

R 135
G 135
B 135

R 135
G 135
B 135



Untersuchung des MOV Containers mit dem Atom Inspector

- ① Original (AppleProResLT.mov)
- ② Transkodiertes File (210.mov) mit FFmpeg
mit folgendem Command erstellt:

```
$ffmpeg -i input -c:v v210 -c:a copy output.mov
```

std - Sample Descriptions

```
version 0
entry count 1
entries
  ① video sample entry
    size 174
    type v210
    reserved 0x000000000000
    data reference index 1
    pre defined 0
    reserved 0
    pre defined
      pre defined 1634758764
      pre defined 0
      pre defined 1023
    width 1920
    height 1080
    horiz resolution 72.0
    vert resolution 72.0
    reserved 0
    frame count 1
    compressor name
      Apple ProRes 422 (LT)
    depth 24
    color
      parameter type nclc
      index 1
      transfer function index 1
      matrix index 1
    fiel
```

std - Sample Descriptions

```
version 0
entry count 1
entries
  ② video sample entry
    size 96
    type v210
    reserved 0x000000000000
    data reference index 1
    pre defined 0
    reserved 0
    pre defined
      pre defined 1179012432
      pre defined 512
      pre defined 512
    width 1920
    height 1080
    horiz resolution 72.0
    vert resolution 72.0
    reserved 0
    frame count 1
    compressor name
      Lavc57.24.102 v210
    depth 24
    pre defined -1
    fiel

hex entries
0x01 0x00
```

Vergleich der Metadaten mit MediaInfo & Invisor

	①	②
Format	ProRes	YUV
Color primaries	BT.709	
Matrix coefficients	BT.709	
Transfer characteristics	BT.709	
Clean aperture width	1 920 pixels	1 920 pixels
☒ Highlight differences ☐		

① Original (AppleProResLT.mov)

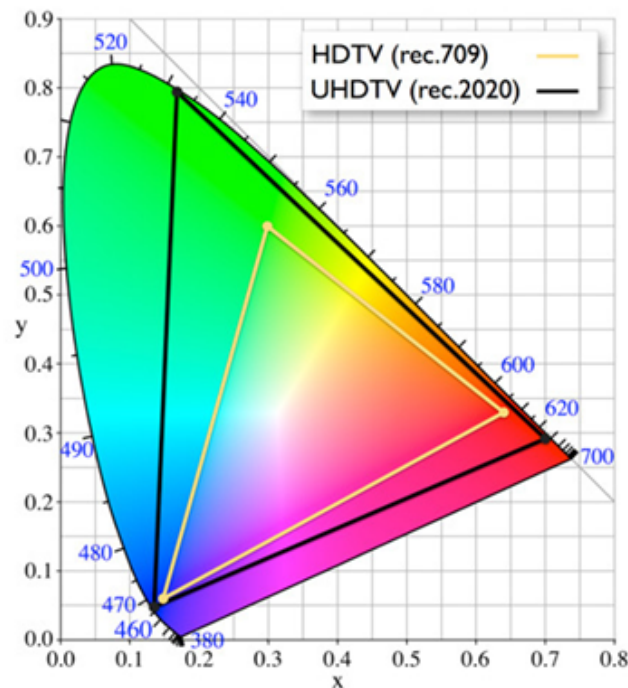
② Transkodiertes File (210.mov) mit FFmpeg
mit folgendem Command erstellt:

```
$ffmpeg -i input -c:v v210 -c:a copy output.mov
```

Mögliche Ursachen für Farbverschiebungen

Keine oder falsche Angaben zum Farbraum

SD Video	BT.601	ITU-R Empfehlung für die Digitalisierung von SD Komponenten-video; SDTV; DVDs
HD Video	BT.709	ITU-R Empfehlung für HDTV; HD-DVD; Blu-Ray
UHD Video	BT.2020	ITU-R Empfehlung für UHDTV



Transkodieren von QuickTime Videodateien mit FFmpeg
und dem `-write_colr` movflag

```
$ffmpeg -i input -c:v v210 -c:a copy -movflags +write_colr output.mov
```

	Original.mov	TransFFmpegDefault.mov	-movflags+write_colr_mapg.mov	
Video				
ID	1	1	1	
Format	ProRes	YUV	YUV	
Format version	Version 0			
Format profile	422 LT			
Codec ID	apcs	v210	v210	
Codec ID/Hint		AJA Video Systems Xena	AJA Video Systems Xena	
Duration	10s 10ms	10s 11ms	10s 11ms	
Bit rate mode	Constant	Constant	Constant	
Bit rate	14.5 Mbps	1 061 Mbps	1 061 Mbps	
Width	1 920 pixels	1 920 pixels	1 920 pixels	
Height	1 080 pixels	1 080 pixels	1 080 pixels	
Pixel aspect ratio	1.000	1.000	1.000	
Display aspect ratio	16:9	16:9	16:9	
Frame rate mode	Constant	Constant	Constant	
Frame rate	23.976 fps	23.976 fps	23.976 fps	
Frame count	240	240	240	
Color space	YUV	YUV	YUV	
Chroma subsampling	4:2:2	4:2:2	4:2:2	
Bit depth		10 bits	10 bits	
Scan type	Progressive	Progressive	Progressive	
Compression mode		Lossless	Lossless	
Bits/(Pixel*Frame)				
Stream size				
Writing library				
Language				
Encoded date				
Tagged date				
Color primaries				
Clean aperture d				
aspect ratio				
Clean aperture h				
Matrix coefficient				
Transfer characteristics				
Clean aperture width				
Audio				

	(1)	(2)	(3)
Encoded date	UTC 2014-05-19 00:13:26	UTC 1904-01-01 00:00:00	UTC 2014-05-18 23:13:26
Tagged date	UTC 2014-05-19 00:13:27	UTC 1904-01-01 00:00:00	UTC 2014-05-18 23:13:26
Color primaries	BT.709		BT.709
Matrix coefficients	BT.709		BT.709
Transfer characteristics	BT.709		BT.709

Transkodieren von QuickTime Videodateien mit FFmpeg
und dem `-write_colr` flag

```
$ffmpeg -i input -c:v v210 -c:a copy -movflags +write_colr output.mov
```

[FFmpeg-devel] avformat/movenc: always write a colr atom
Submitted by [James Almer](#) on July 16, 2019, 1:47 p.m.

Untersuchung der Compliance zu TN2162 mit MediaConch



The screenshot shows the MediaConch application window with a 'Policy report' dialog box open. The dialog box has a title bar with a close button (X). Inside, there are two dropdown menus: 'Policy' set to 'TN2162 compliant?' and 'Display' set to 'MediaConchHtml'. Below these, the report content is displayed.

Policy report

Policy: TN2162 compliant? Display: MediaConchHtml

 **MediaConch Report**

File: /Users/AVK/Desktop/bars75Apple210720aspect_colr.mov

- ▼ TN2162 compliant?  pass
Test compliance with Apple's Technical Note 2162 (dated December 14, 1999) on Uncompressed Y'CbCr Video in QuickTime Files. This policy covers QuickTime's ImageDescription version 2 as documented by TN2162 and not version 0 or 1 as documented by its Backwards Compatibility section.
Type: and **Rules run:** 8 **Fail count:** 0 **Pass count:** 8
 - ▶ Using a TN2162 video fourcc?  pass
 - ▶ Compression type follow requirements?  pass
 - ▶ Contains required descriptive atoms?  pass
 - ▶ Follows TN2162 ImageDescription requirements?  pass
 - ▶ Follows color parameter requirements?  pass
 - ▶ Follows field/frame description requirements?  pass
 - ▶ Follow pixel aspect ratio requirements or is not used?  pass
 - ▶ Follows clean aperture requirements?  pass

Compliance zur Memoriav Empfehlung



MediaConch

Checker Policies

☐ Enable fixer ☐ Full parse

Select files Dateien auswählen Keine ausgewählt

File added successfully

Results

Apply a policy to all results Choose a new policy to apply

Show 10 entries

Files	Implem	Policy	MediaInfo	MediaTrace	Status
bars75Apple210720aspect_colr...	✓ Valid	✓ TN2162 compliant?	👁️ ⓘ	👁️ ⓘ	✓
bars75Apple210720aspect_colr...	✓ Valid	✓ Memoriav Video files Recomme...	👁️ ⓘ	👁️ ⓘ	✓

Showing 1 to 2 of 2 entries

Previous 1 Next

Choose a new policy to apply

User policies

- AM v210.mov PAL
- New policy

System policies

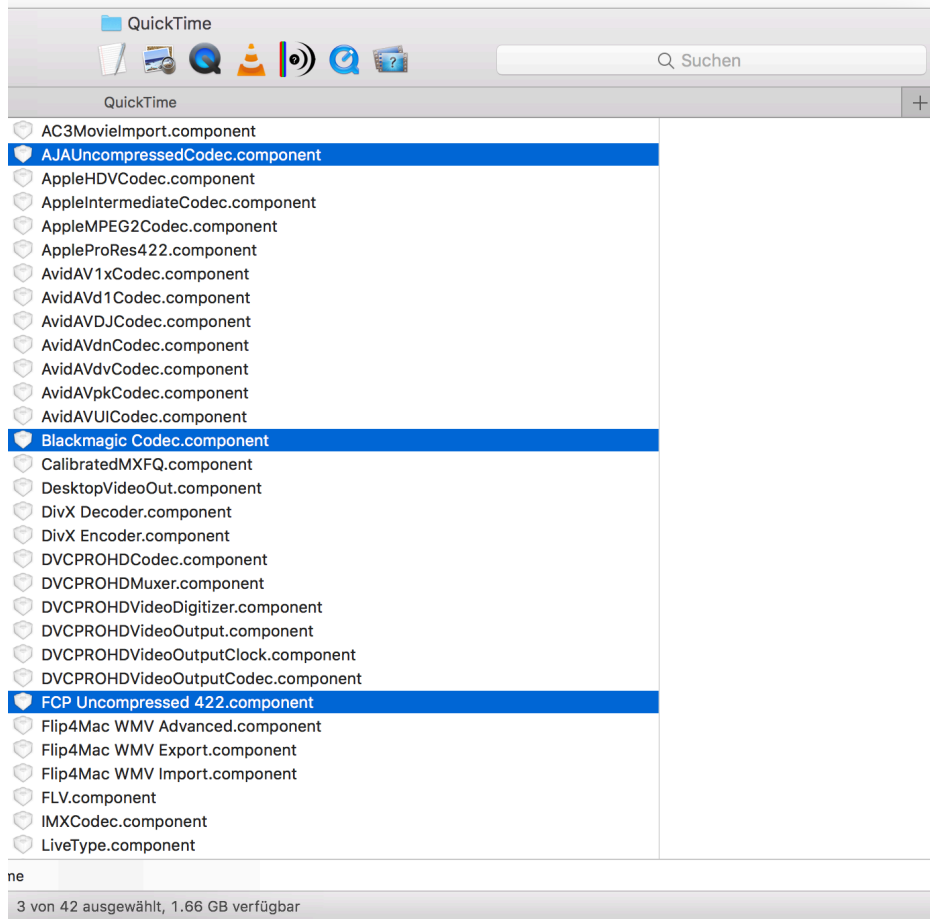
- Is this NTSC or PAL SD?
- Example MKV FFV1 digitization policy
- Matroska is well described?
- CAVPP Preservation Master

Memoriav Video files Recommendations

- TN2162 compliant?

	Environment 1 Mac OS X 10.7.5 Lion*	Environment 2 Mac OS X 10.7.5 Lion*	Environment 3 Mac OS X 10.10.5 Yosemite*	Environment 4 Mac OS X 10.10.5 Yosemite*	
					
	Components installed: 8 (v210) 1225 (total)	Components installed: 2 (v210) 838 (total)	Components installed: 2 (v210) 953 (total)	Components installed: 2 (v210) 1195 (total)	
	QuickTime 7, v7.6.6. QuickTime 10, v10.1 VLC, v2.0.9 DigitalColor Meter, v4.4	QuickTime 7, v7.6.6. QuickTime 10, v10.1 VLC, v1.1.5 DigitalColor Meter, v4.4	QuickTime 7, v7.6.6. QuickTime 10, v10.4 VLC, v3.0.0 DigitalColor Meter, v5.1	QuickTime 7, v. 7.6.6. QuickTime 10, v10.4 VLC, v1.1.12 DigitalColor Meter, v5.1	
<i>Transcode</i> v210, MOV  FFmpeg v.3.0.1 with command: -movflags +write_colr	 R: 135 G: 135 B: 135	 R: 135 G: 135 B: 135	 R: 135 G: 135 B: 135	 R: 135 G: 135 B: 135	  
	 R: 135 G: 135 B: 135	 R: 135 G: 135 B: 135	 R: 123 G: 123 B: 123	 R: 123 G: 123 B: 123	
	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	

	Environment 1 Mac OS X 10.7.5 Lion*  Components installed: 8 (v210) 1225 (total) QuickTime 7, v7.6.6. QuickTime 10, v10.1 VLC, v2.0.9 DigitalColor Meter, v4.4	Environment 2 Mac OS X 10.7.5 Lion*  Components installed: 2 (v210) 838 (total) QuickTime 7, v7.6.6. QuickTime 10, v10.1 VLC, v1.1.5 DigitalColor Meter, v4.4	Environment 3 Mac OS X 10.10.5 Yosemite*  Components installed: 2 (v210) 953 (total) QuickTime 7, v7.6.6. QuickTime 10, v10.4 VLC, v3.0.0 DigitalColor Meter, v5.1	Environment 4 Mac OS X 10.10.5 Yosemite*  Components installed: 2 (v210) 1195 (total) QuickTime 7, v. 7.6.6. QuickTime 10, v10.4 VLC, v1.1.12 DigitalColor Meter, v5.1	
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	 R: 135 G: 135 B: 135	 R: 135 G: 135 B: 135	 R: 123 G: 123 B: 123	 R: 123 G: 123 B: 123	
	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	 R: 122 G: 123 B: 122	



Mehrere 10-bit Uncompressed 4:2:2 Codec
Komponenten in der QuickTime Library

\$ Isuf | grep QuickTime

Dave Rice (2014). *Sustaining
Consistent Video Presentation*. Tate
Online Publikation

Fallstricke bei der Normalisierung/Transkodierung

Mögliche Ursachen für Verfälschungen

Falsche Farbtiefe z. B. 8-bit statt 10-bit

8-bit 265 Farbabstufungen
 16.7 Millionen Farben

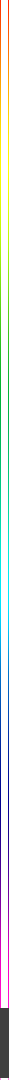
JPEG Foto; Youtube Videos;
Gängige Computermonitore

10-bit 1.07 Billionen Farben

Digitalisierung von analogem Video

16-bit 261 Billionen Farben

Filmscan



10 bit

8 bit

Mögliche Ursachen für Verfälschungen

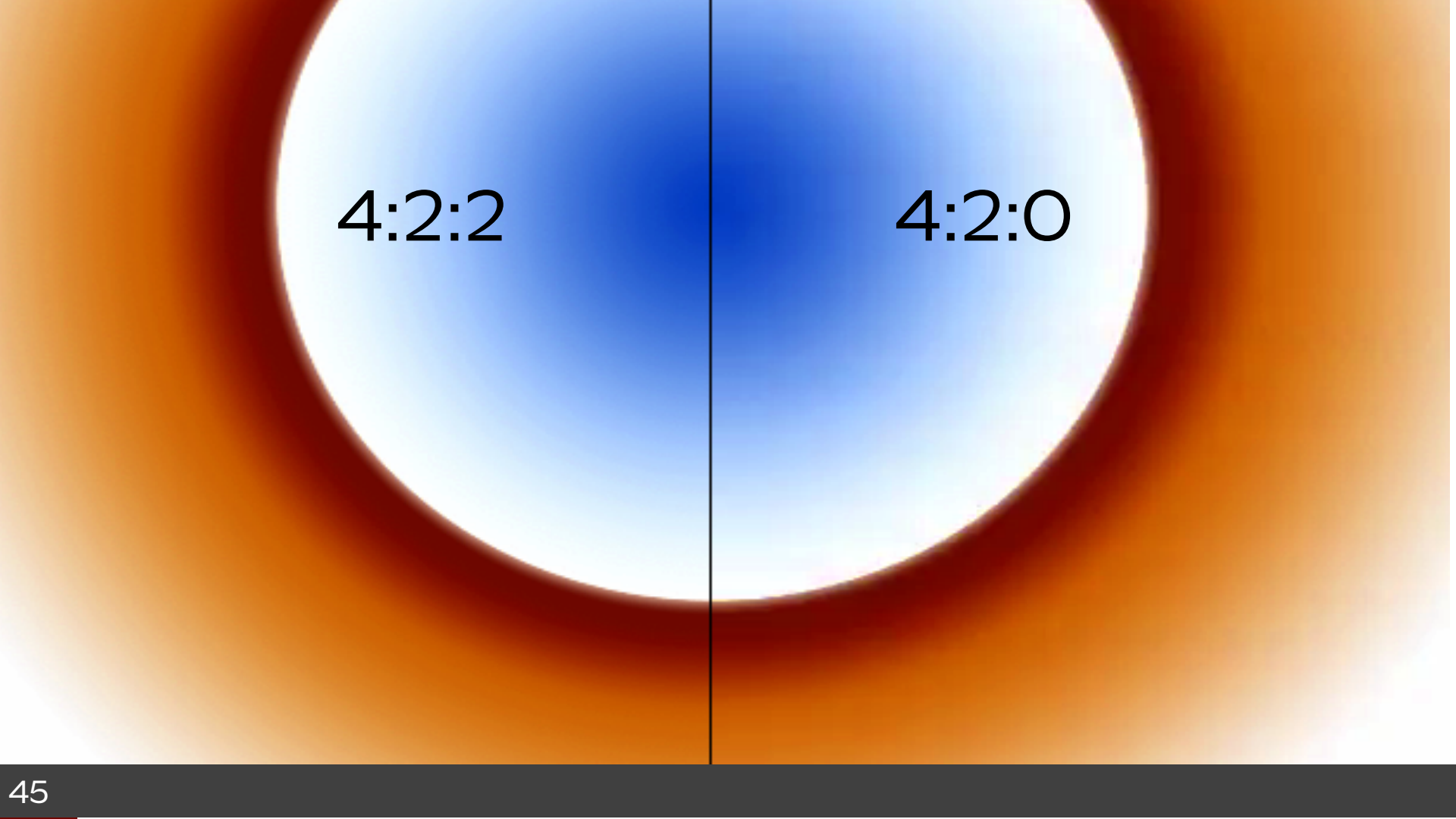
Falsche Farbunterabtastung
z. B. 4:2:0 statt 4:2:2

Farbunter- abtastung

Farbinformation

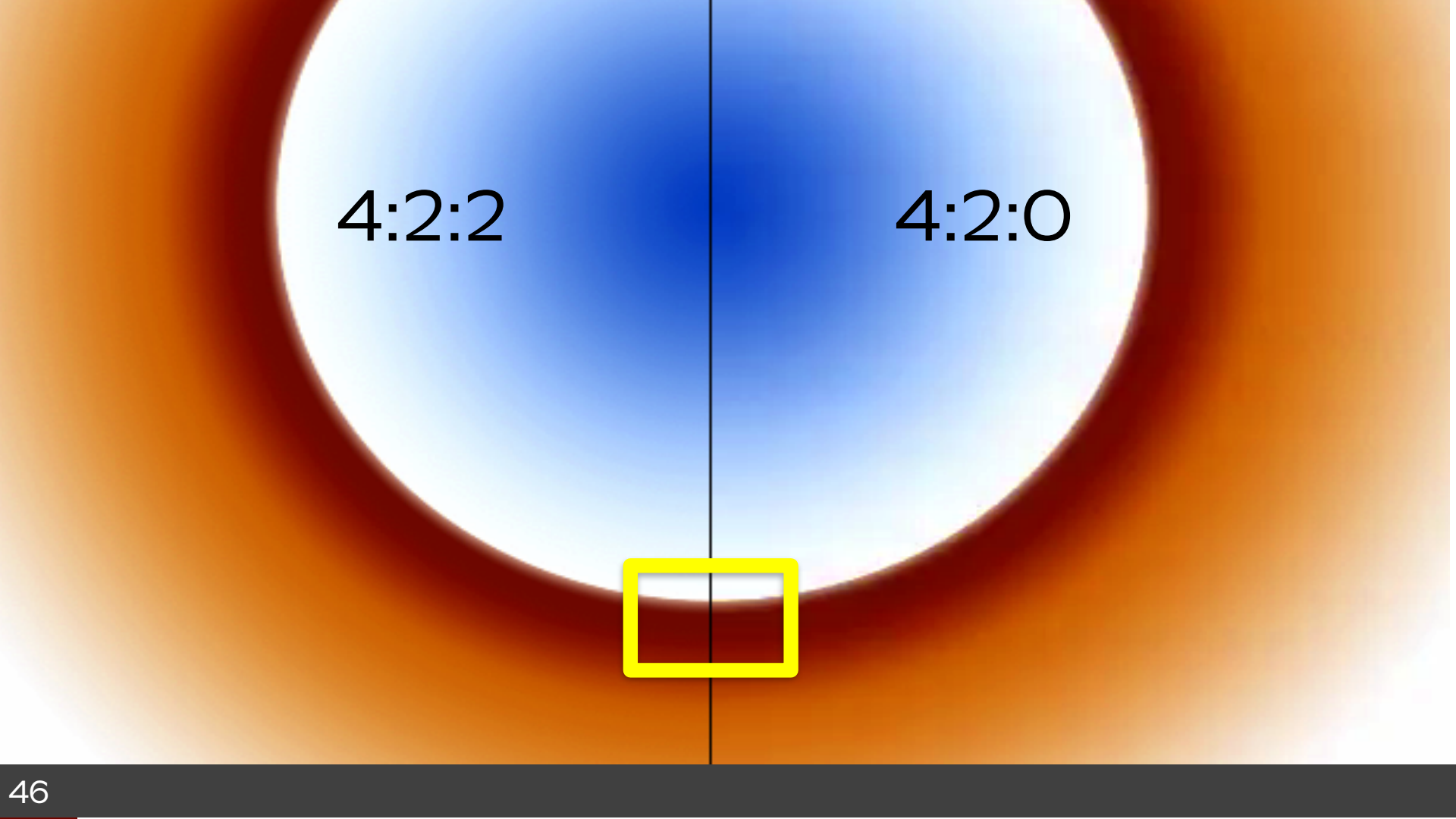
Beispiel

4:4:4	vollständige Farbinformation	v410; Apple ProRes 444
4:2:2	um ein Drittel verringert	v210; Apple ProRes 422
4:1:1	um die Hälfte verringert	DV NTSC
4:2:0	um die Hälfte verringert	DV Pal, H.264
4:4:4:4	mit zusätzlichem Alpha Channel	Apple ProRes 4444 (HQ)



4:2:2

4:2:0



4:2:2

4:2:0

4:2:2

4:2:0

Fazit

Fazit

- Normalisierungsstrategie $\neq$ Batchverarbeitung
- Die Erhaltung eines dateibasierten Videos beinhaltet die Erhaltung seiner nativen Wiedergabeumgebung
- Wiedergabesoftware für den Archivbereich

Dank

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