
LCEVC x264 Report: 1080p VMAF/Subjective Quality

— Jan Ozer, July, 2020 —
APPENDIX

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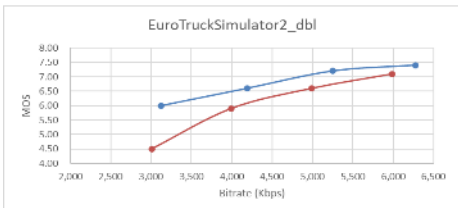
Core Report (separate document)

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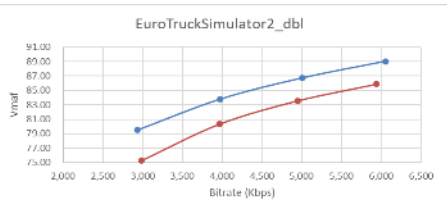
Appendix I: Detailed VMAF & MOS results

- Individual clips results - eGames
- Individual clips results - Animations
- Individual clips results - Movies
- Individual clips results - Sports
- Individual clips results - Various

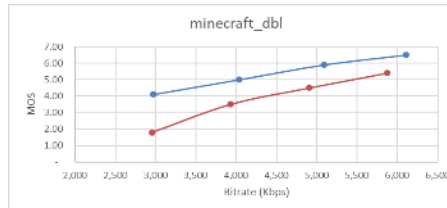
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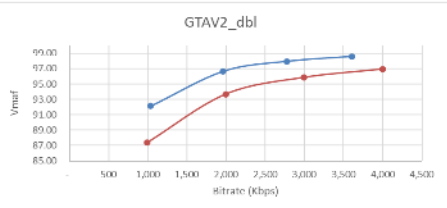
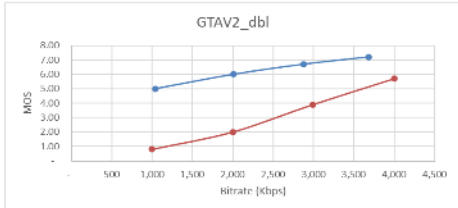
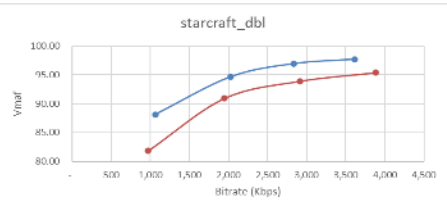
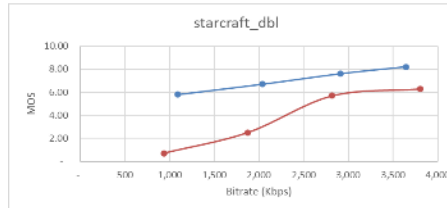
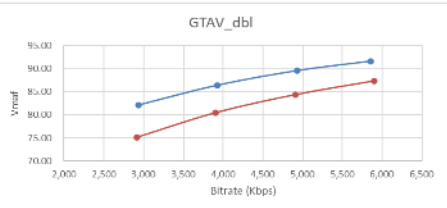
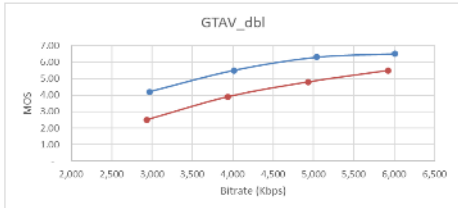
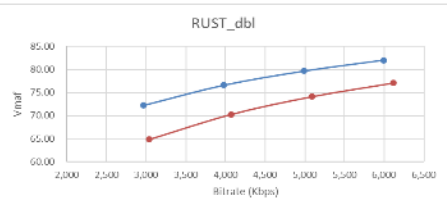
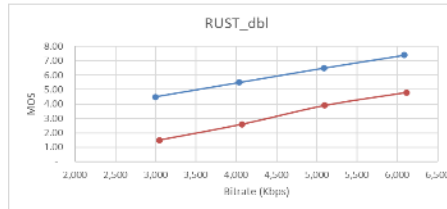
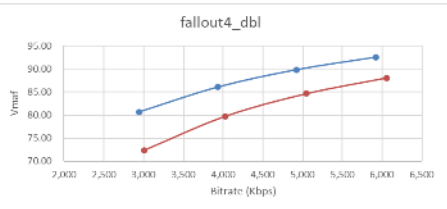
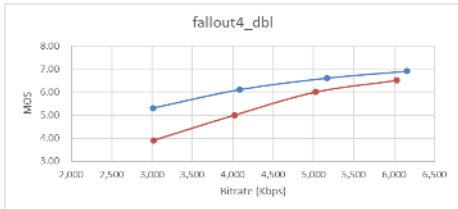
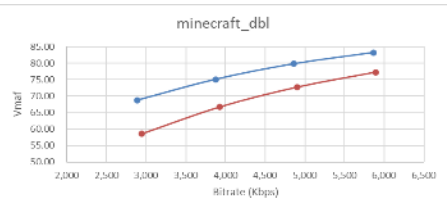
VMAF



MOS



VMAF

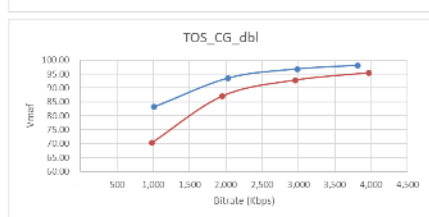
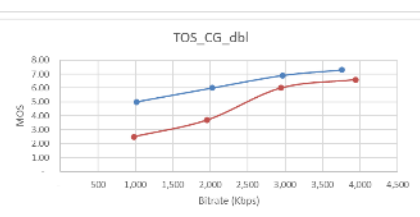
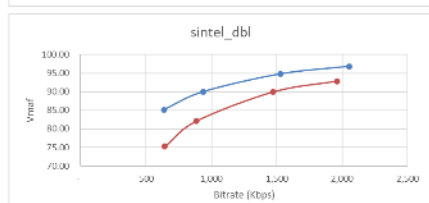
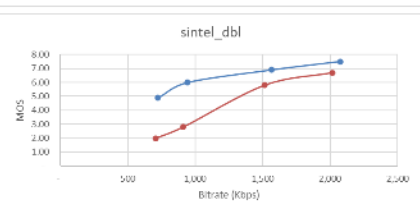
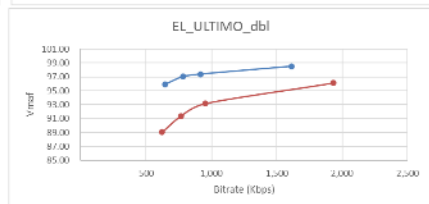
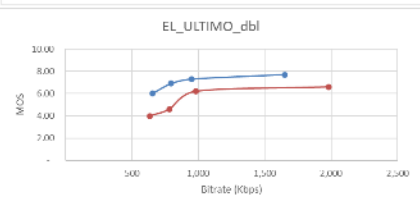
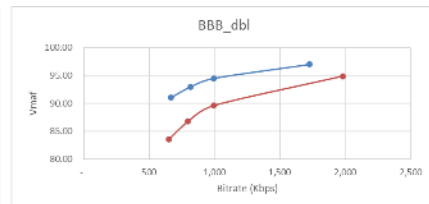
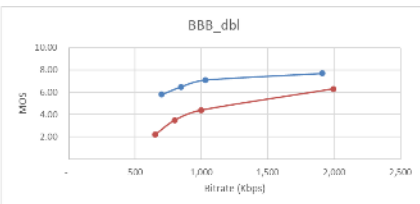


Animations

— LCEVC x264 — x264

MOS

VMAF

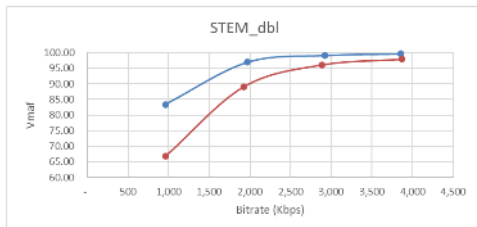
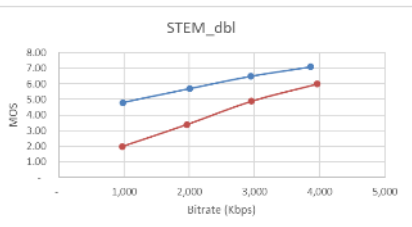
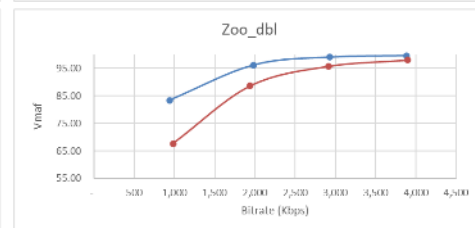
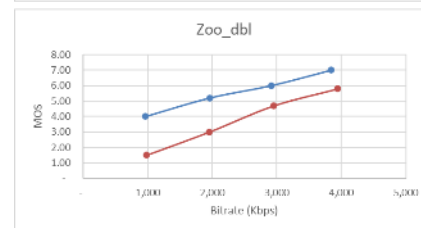
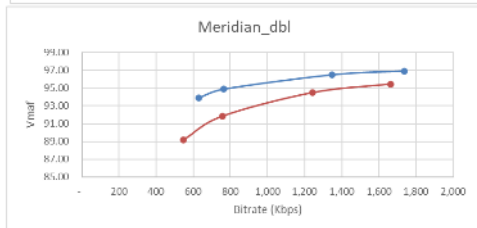
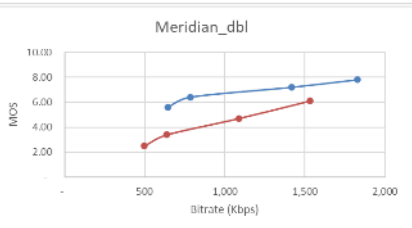
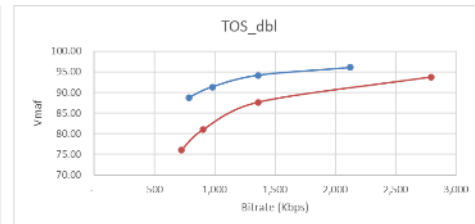
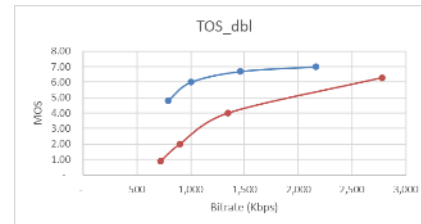
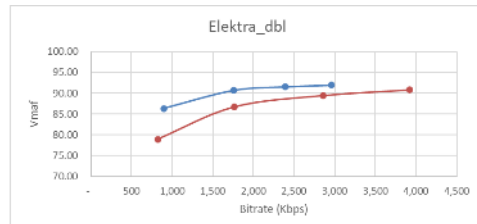
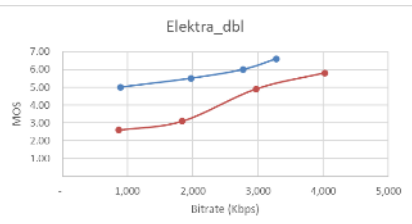


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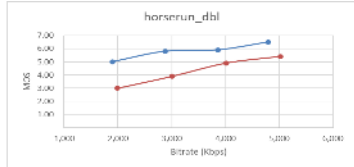
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MOS

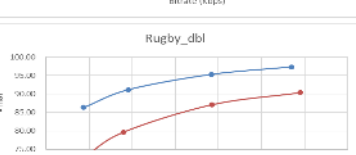
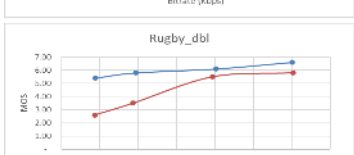
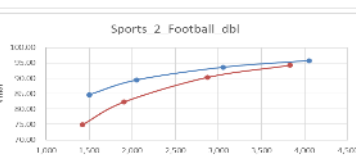
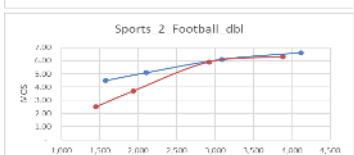
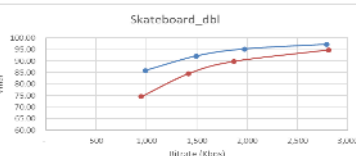
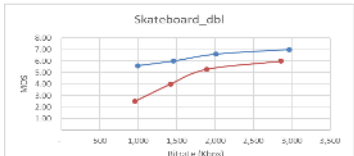
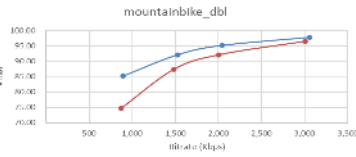
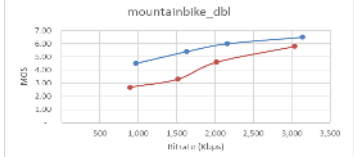
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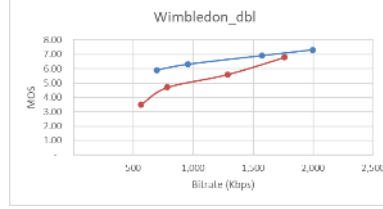
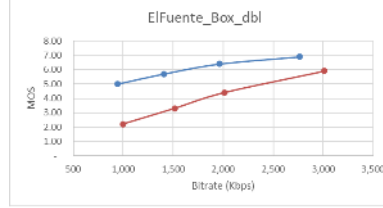
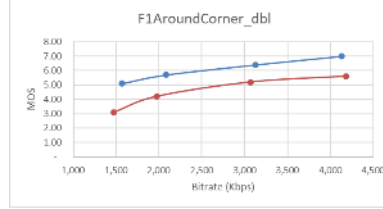
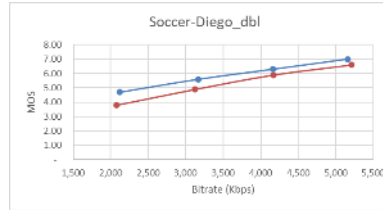
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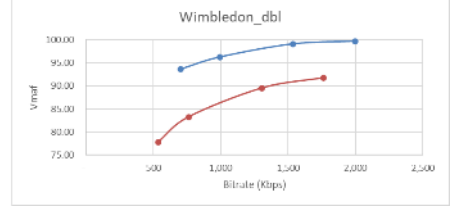
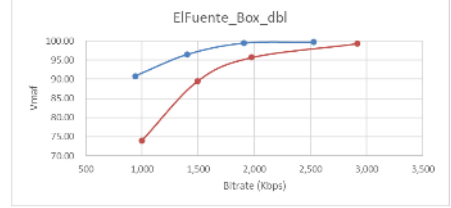
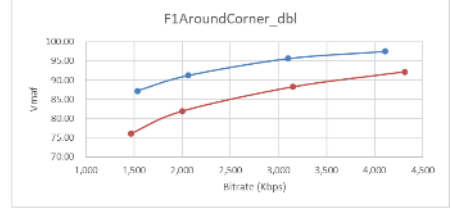
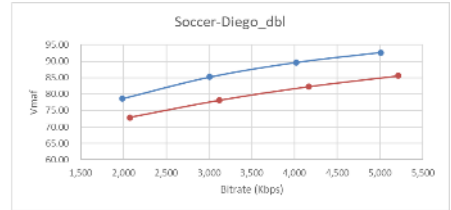
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MOS



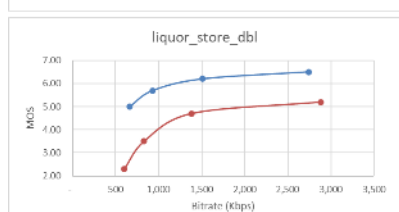
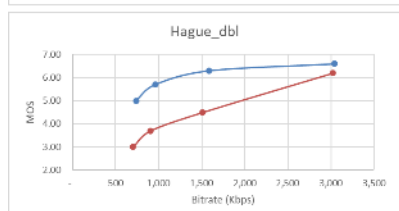
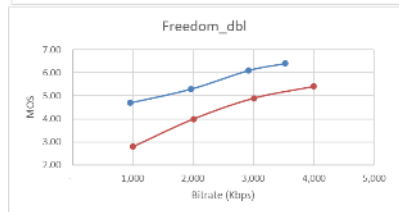
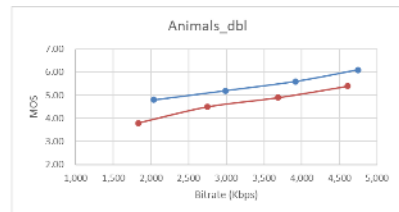
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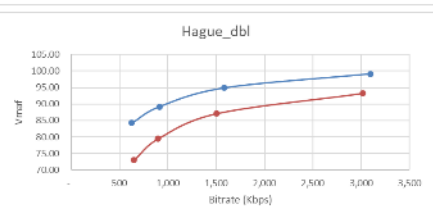
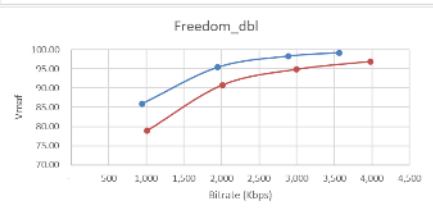
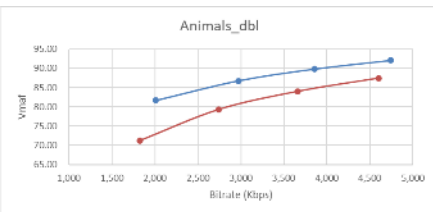
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— LCEVC x264 — x264

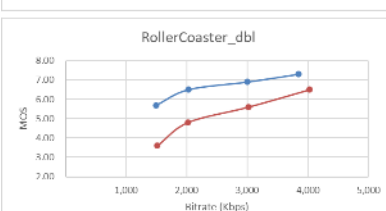
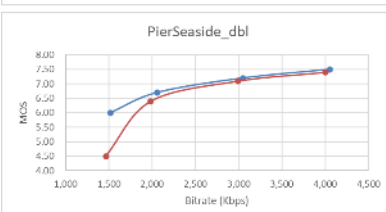
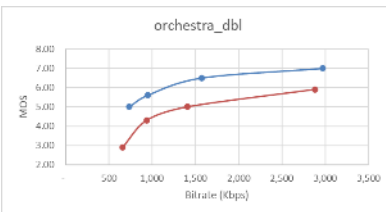
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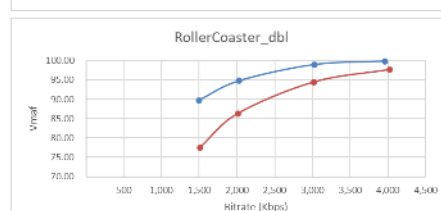
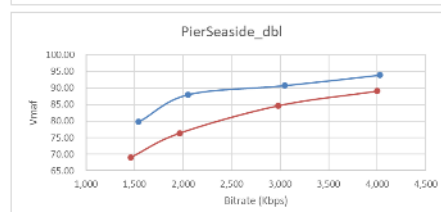
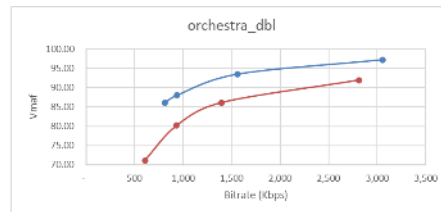
VMAF



MOS



VMAF



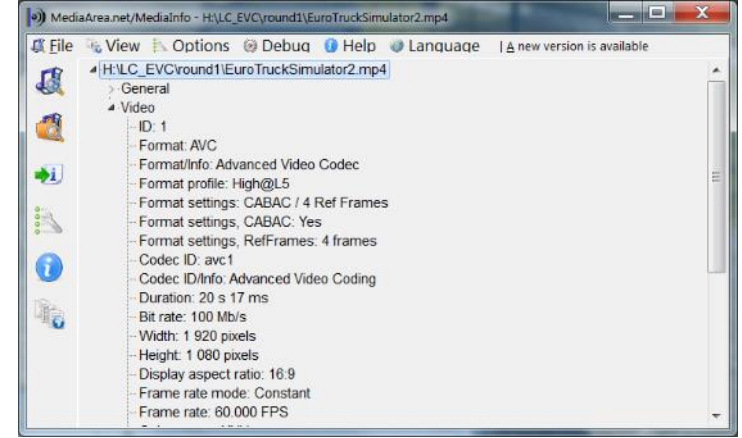
Appendix II: Test Clips

- eGames
- Animations
- Movies
- Sports
- Various

eGames

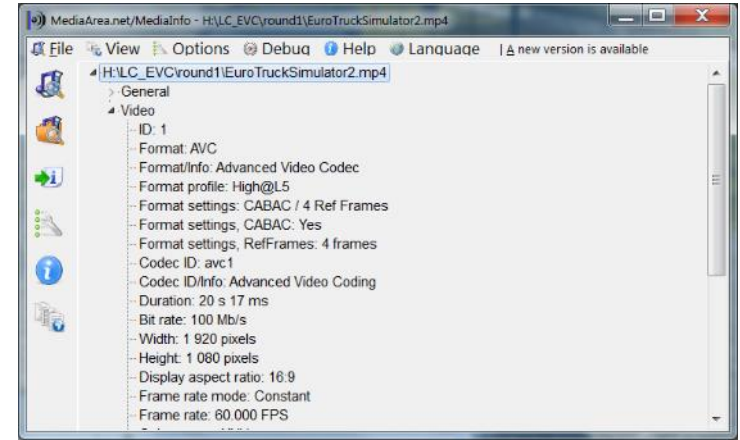
- EuroTruck Simulator 2
- Fallout4
- GTAV
- GTAV2
- Minecraft
- Rust
- Starcraft
- Witcher3

EuroTruck Simulator 2 Description



- Highly realistic, finely detailed, and well lit
- Converted from original source so high quality input

Fallout4 Description



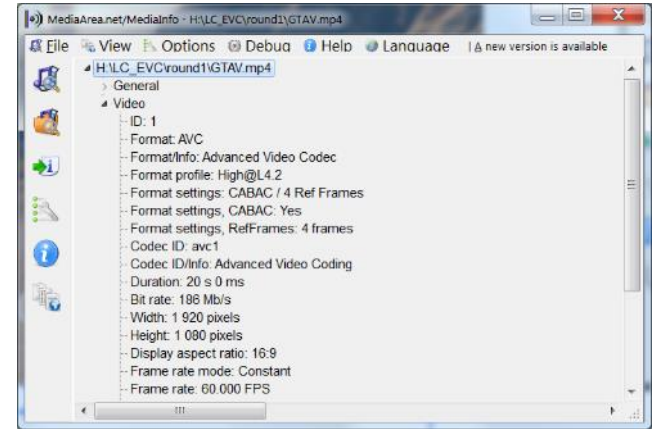
- First person shooter; busy screen but not a lot of fine detail

- Converted from original source so high quality input

GTAV Description



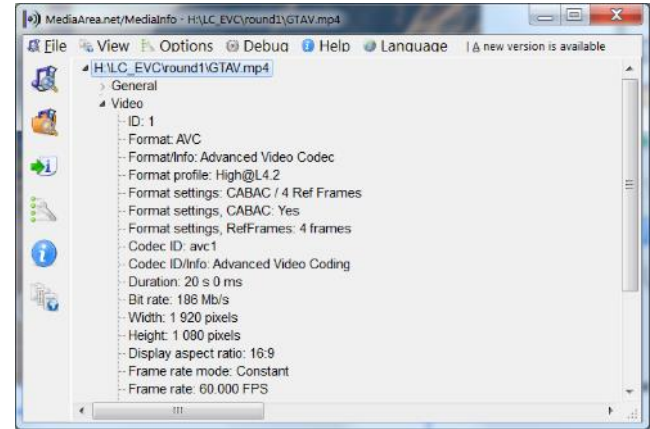
- Classic car chase game
- Very high quality source



GTAV2 - Description



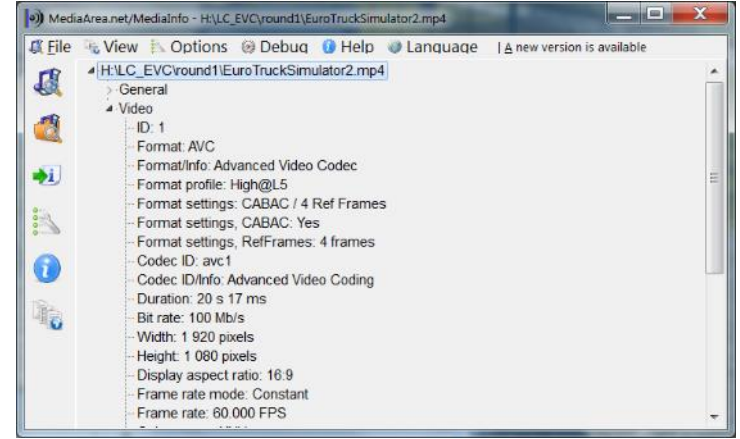
- Classic car chase game
- Primarily dark and low detail airplane sequence



Minecraft Description

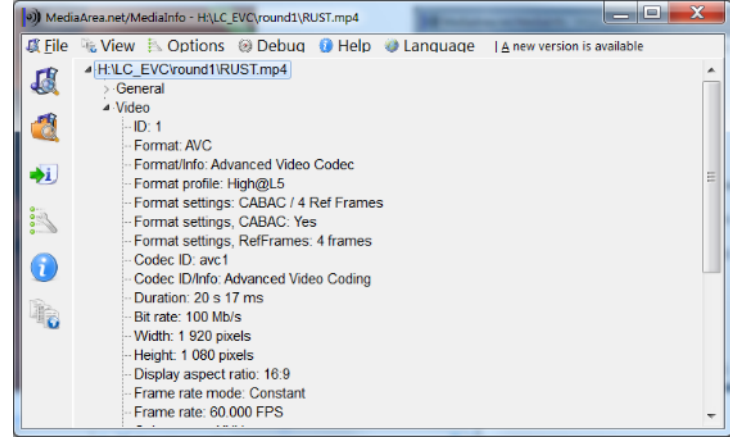


- Blocky and low detail but fast moving game



- Converted from original source so high quality input

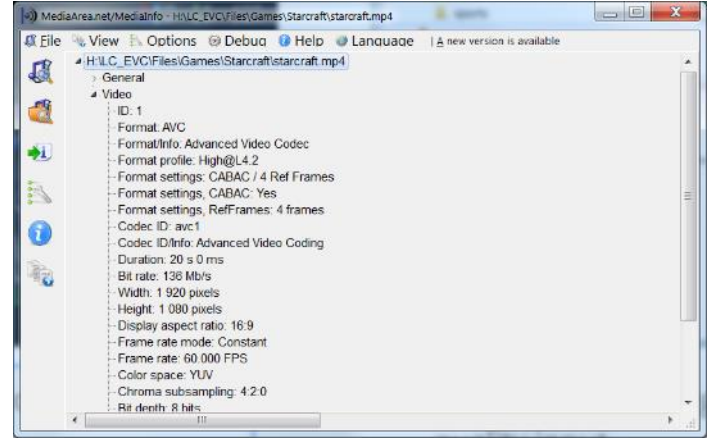
Rust Description



- Dark, not too highly detailed first-person game

- Taken from original source so very high quality input
- Brightened input before output to improve visibility

StarCraft Description



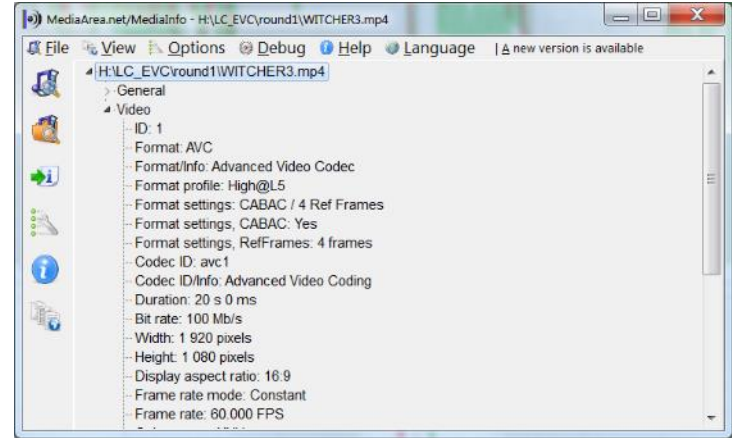
- Dark, 2D game with lots of tiny moving parts

- Converted from original source so high quality input

Witcher3 Description



- Low detail, high action game



- Captured from YUV source so input quality was very high

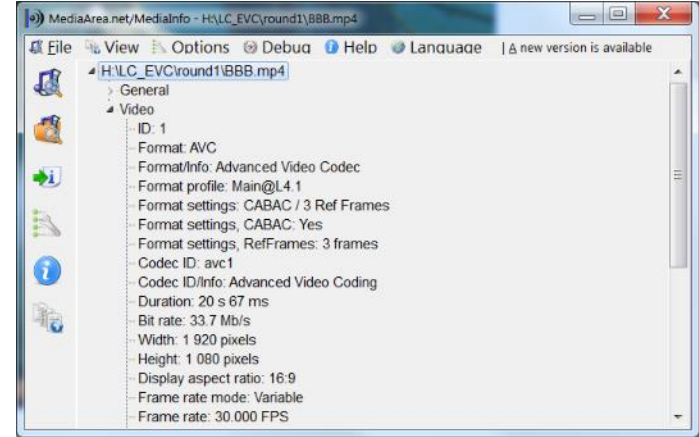
Animations

- Big Buck Bunny
- El Ultimo
- Sintel
- TOS CG

Big Buck Bunny Description



- Simple animation

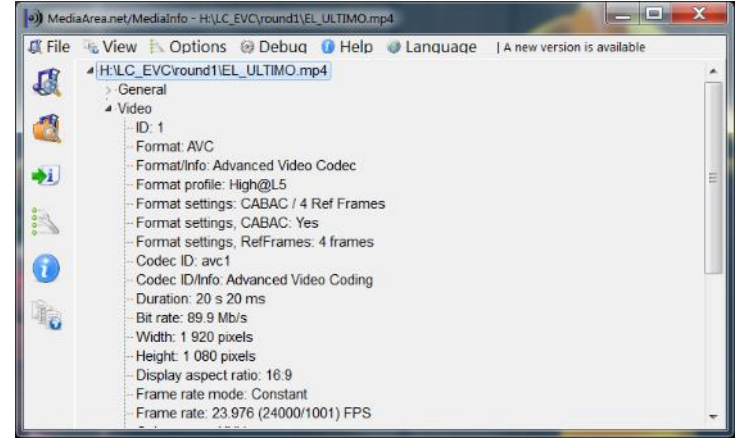


- Converted from original source (won't encode at 100 mbps)

El Ultimo Description



- Relatively simple animation
- Some detail but few complicated textures (no fur)

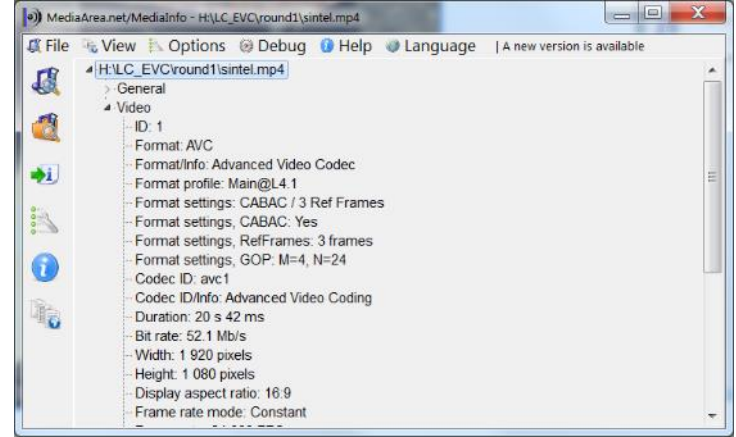


- South American sourced program

Sintel Description

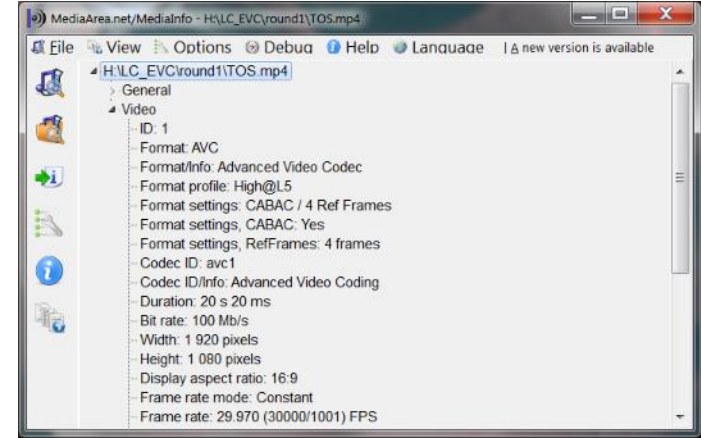


- Relatively low motion portion of animated film



- Source quality reasonably good

Tears of Steel CG Description



- Region with almost all CG

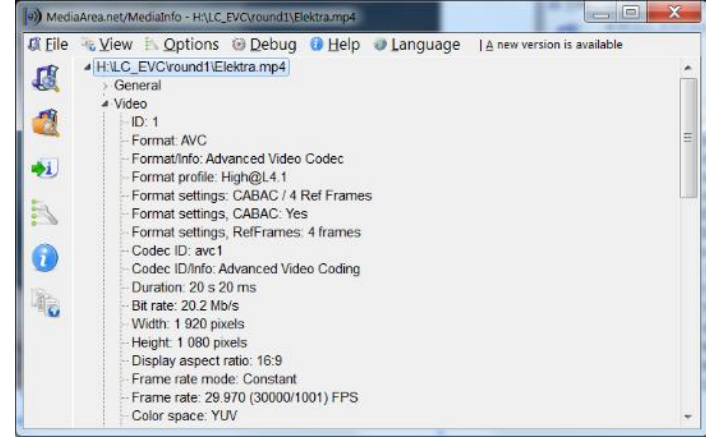
Movies

- Elektra
- Meridian
- STEM
- TOS Actor
- Zoolander

Elektra Description



- Low motion segment with dialog
- Clip has tons of film grain

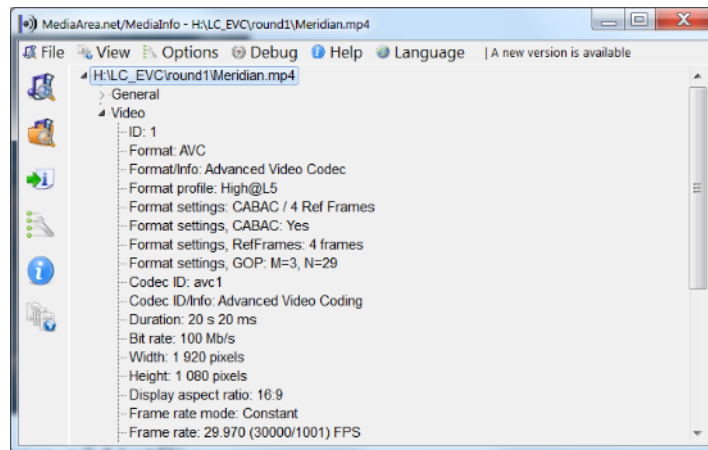


- Grabbed from movie version distributed to OTT house at around 20 mbps

Meridian Description

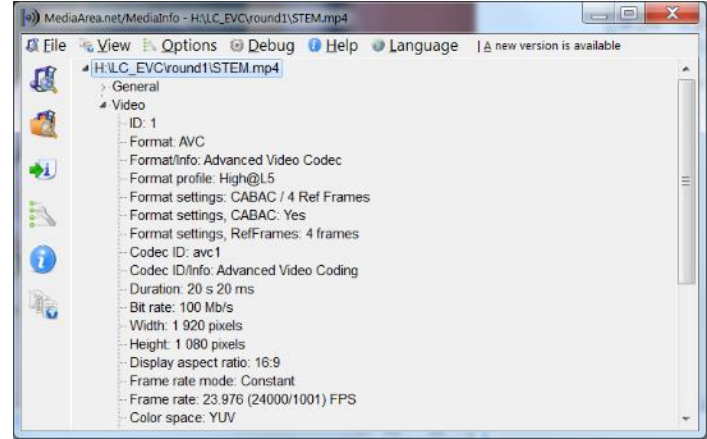


- Low motion opening scene of Netflix test clip



- From original test clip so very good quality input

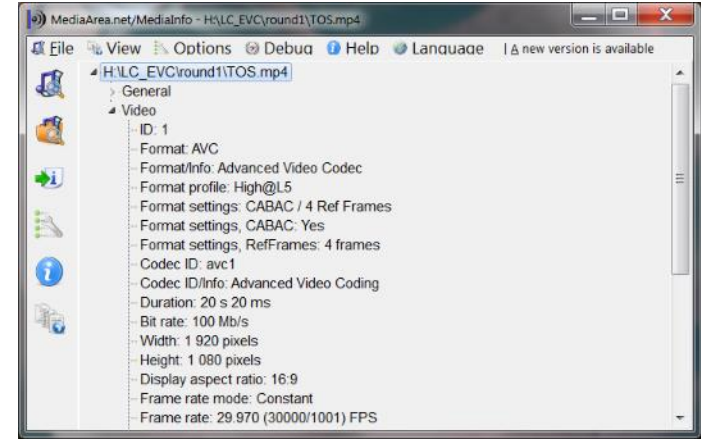
STEM Description



- Standard test footage, don't know from where (consulting project)
- Relatively easy encode; slow motion, not a lot of details

- Test file from original source so quality is very high

Tears of Steel Description



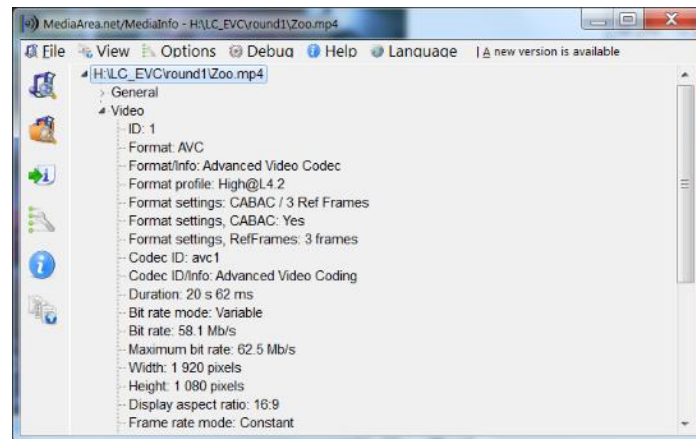
- Region with very little CG (above and girls “robot hand”)

- Produced from original source so high quality

Zoolander Description



- Opening sequence of Zoolander 1 movie
- Red carpet sequence, fast moving, flash bulbs, and lots of film grain

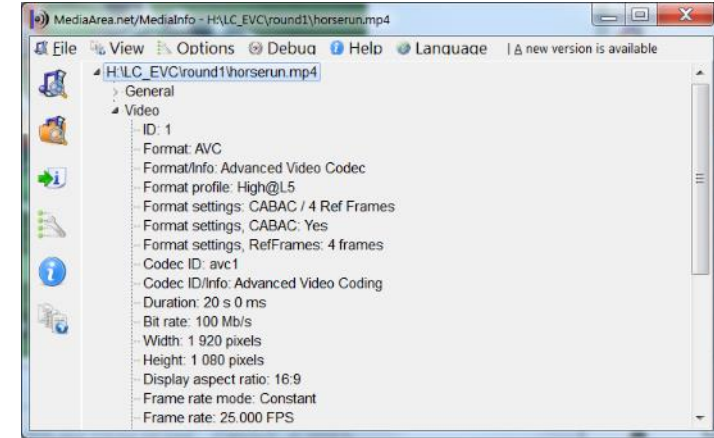


- Captured from ~20 mbps source provided by OTT consulting client

Sports

- Horserun
- Mountainbike
- Skateboard
- Football
- Soccer
- Formula 1
- Boxing
- Wimbledon

Horse Run Description



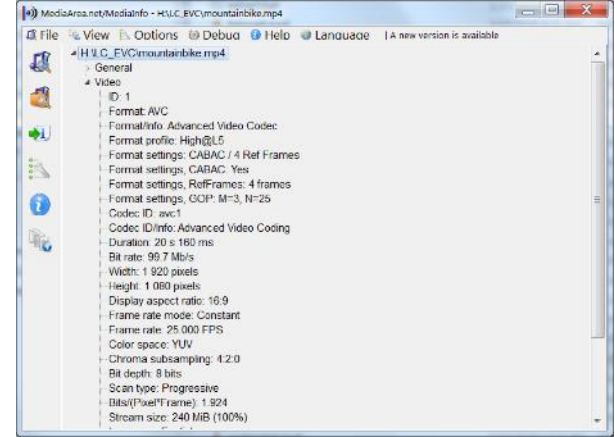
- 10 seconds horserace/ten seconds race close up
- Both from high quality source stock art clips

- Challenging footage
 - Horserace - high motion and high detail
 - Run - very high motion, much detail
 - Test clips from purchased stock video footage clips so very high

Mountain Bike Slow Mo Description

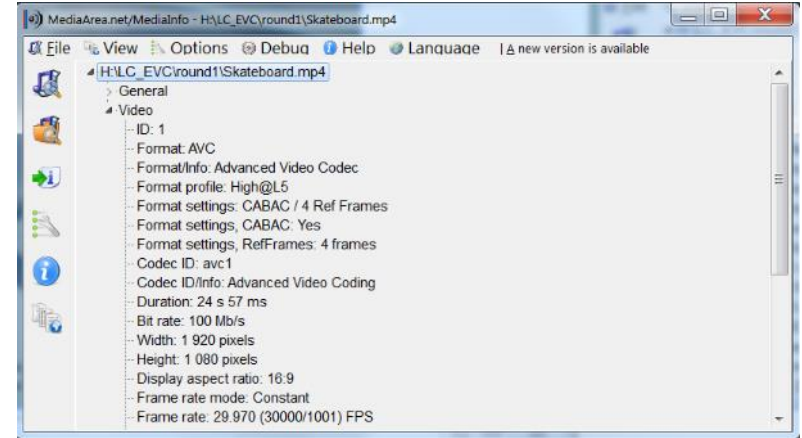


- 20 seconds of slow motion



- Pretty simple footage because it's slow motion

Skateboard Description

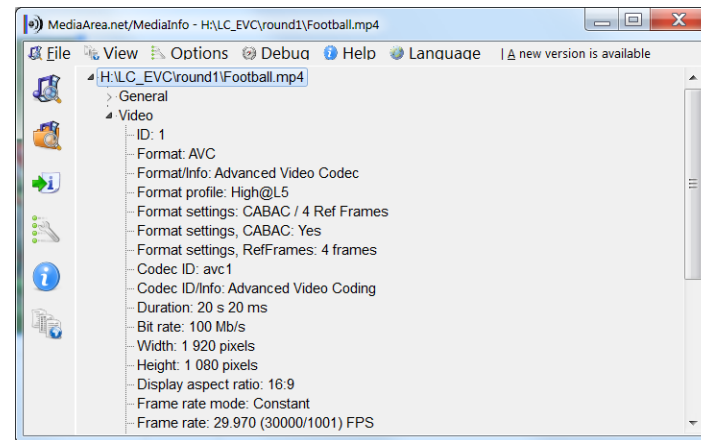


- 30 fps version of Harmonic test clip
- Low detail
- High motion

Football Description



- 30 fps version of Harmonic test clip
- Lots of detail (artificial turf, uniforms)
- Lots of motion
- Lots of issues first time around



- Very relevant for US sporting channels

Soccer 2 Description



- Soccer clip - high action, small bodies
- Input doesn't seem as high quality as other soccer clip (not so much detail)

Formula 1 Description



- Fast moving car turning corner
- Fairly high quality input

El Fuente Boxing Description



- Boxing practice with high motion but low detail

Wimbledon Description

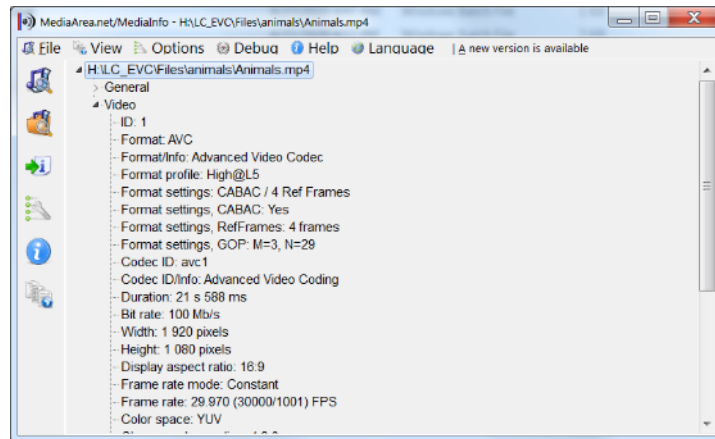


- Wimbledon tennis match
- Relatively small figures and lots of hard straight lines

Other

- Animals
- Freedom
- Hague
- Liquor Store
- Orchestra
- Carlot
- Pier Seaside
- RollerCoaster

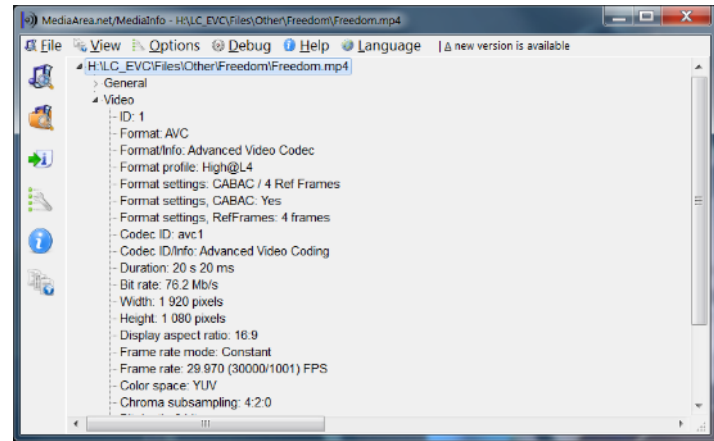
Animals Description



- A test clip from Harmonic featuring shots of animals in the wild, including several tough to encode shots

- Captured from very high quality source so quality is very good
- Clips at 4 Mbps

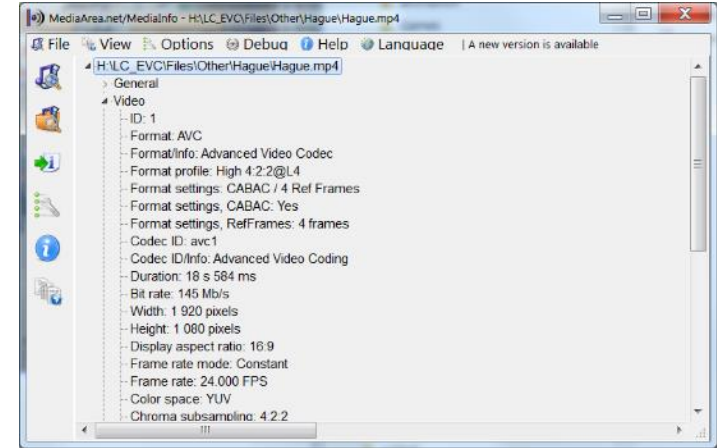
Freedom Description



- Live concert video of Josiah C Weaver; shot in AVCHD

- Converted from edited source; decent quality source

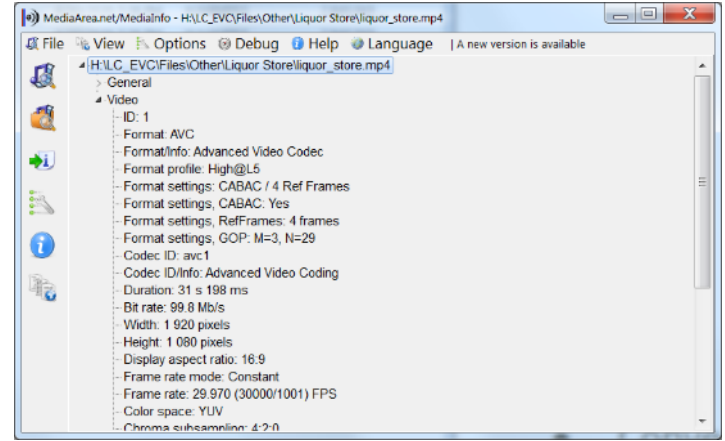
Hague Description



- Busy, crowded, detailed shot of a street in the Hague

- Stock art clip; pretty good quality

Liquor Store Description

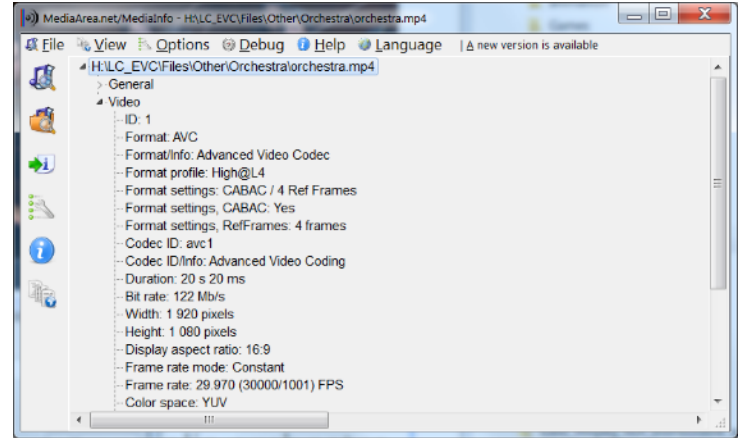


- Sample footage from a security camera project performed a few years ago
- Converted from original Red camera 4K source.

Orchestra Description

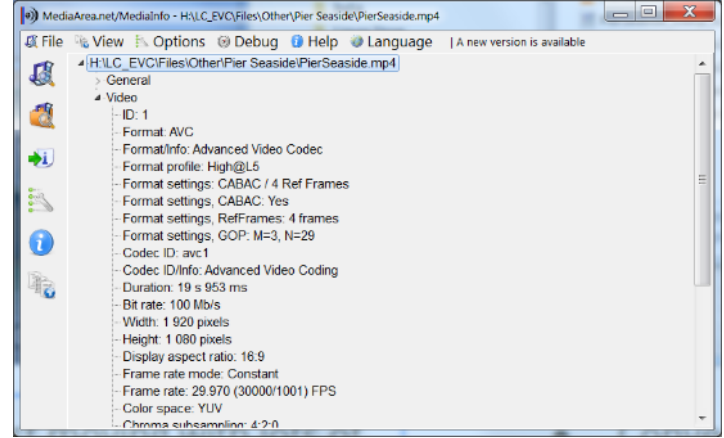


- Test clip from the Minneapolis orchestra (a consulting client)
- Lots of motion and detail



- Originally supplied at 50 mbps so pretty good quality

Pier Seaside Description



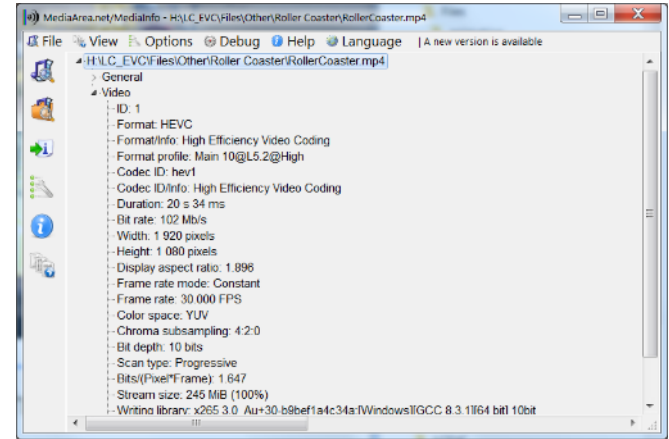
- Netflix test clip; fast moving with lots of detail and water
- Sky and low motion at first; then gets very fast and high detailed

- Converted from YUV source; very high quality

Roller Coaster - Description



- Netflix test clip - shot from a roller coaster



- Very high quality source

Appendix III: Frame grabs

- Frame grabs - eGames
- Frame grabs - Animations
- Frame grabs - Movies
- Frame grabs - Sports
- Frame grabs - Various

Frames Analysis: Overview

In this analysis we look beyond the scores and examine the lowest quality frames from two videos in each genre. We choose the two by selecting the videos where LCEVC exhibited the best and worst MOS advantage over x264.


Then we grabbed the lowest quality frame in each clip and the same frame from the other clip. As you'll see, these are presented with the source clip first, then x264, then LCEVC.

Many of the lowest quality frames show only minor issues. However, in several instances (BBB, Zoolander), the blockiness and other artifacts in H.264 are much more noticeable than LCEVC.

The videos in this section are presented genre by genre

BD-rate LCEVC vs x264 (negative = LCEVC better)				
#	Type	video_name	Vmaf	MOS
1	eGames	EuroTruckSimulator2	Worst	-17.9%
2	eGames	fallout4	-25.7%	-23.7%
3	eGames	GTAV	-29.4%	-31.4%
4	eGames	GTAV2	Best	-65.0%
5	eGames	minecraft	-26.7%	-28.1%
6	eGames	RUST	-33.0%	-46.9%
7	eGames	starcraft	-30.5%	-59.7%
8	eGames	WITCHER3	-22.7%	-51.0%
9	Animation	BBB	Best	-58.3%
10	Animation	EL_ULTIMO	-65.9%	-42.2%
11	Animation	sintel	-36.9%	-40.7%
12	Animation	TOS_CG	Worst	-39.7%
13	Movies	Elektra	-52.3%	-52.5%
14	Movies	Meridian	-35.3%	-54.4%
15	Movies	STEM	-40.1%	-52.7%
16	Movies	TOS	Best	-57.9%
17	Movies	Zoo	Worst	-47.3%
18	Sports	horserun	Best	-57.0%
19	Sports	mountainbike	-22.3%	-41.8%
20	Sports	Skateboard	-34.0%	-50.1%
21	Sports	Sports_2_Football	Worst	-11.5%
22	Sports	Rugby	-51.4%	-49.5%
23	Sports	Soccer-Diego	-36.2%	-17.8%
24	Sports	F1AroundCorner	-45.8%	-48.7%
25	Sports	ElFuente_Box	-37.8%	-54.2%
26	Sports	Wimbledon	-100.0%	-37.8%
27	Various	Animals	-34.0%	-33.1%
28	Various	Freedom	-37.1%	-54.1%
29	Various	Hague	-47.4%	-61.8%
30	Various	liquor_store	Best	-71.8%
31	Various	orchestra	-47.3%	-55.1%
32	Various	PierSeaside	Worst	-9.8%
33	Various	RollerCoaster	-35.5%	-53.4%
Total			-40.7%	-44.8%

BBB - Full Resolution Frame Grabs



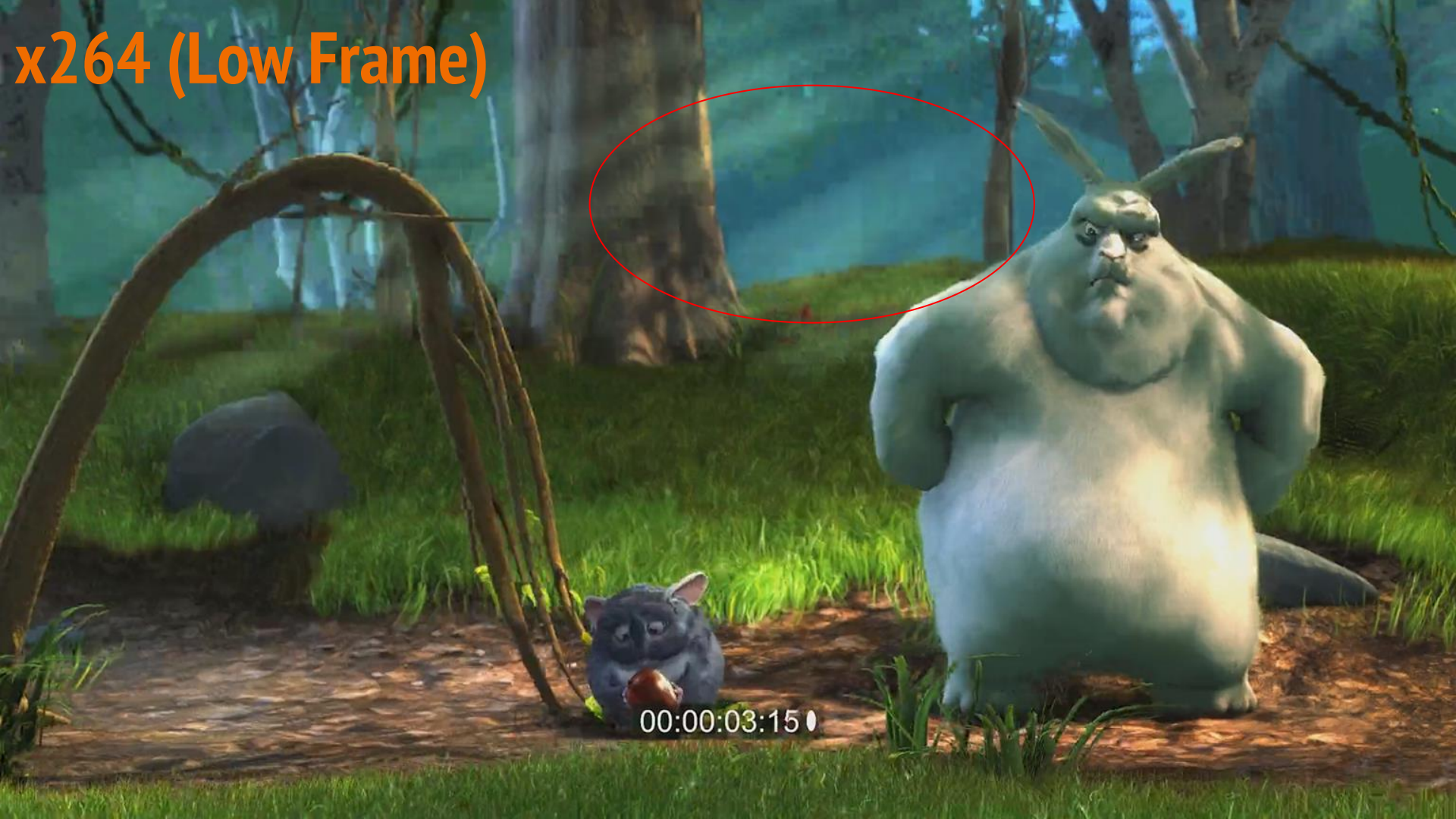
	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	107									
LCEVC	111									

- Order
 - Source
 - x264
 - LCEVC

Source



x264 (Low Frame)




00:00:03:15

LCEVC - Equivalent



BBB - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTA V2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	107									
LCEVC	111									

- Order
 - Source
 - x264
 - LCEVC

Source



00:00:03:19

x264 - Equivalent



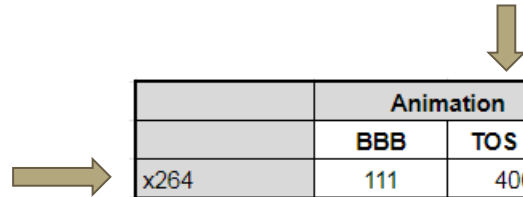
00:00:03:19

LCEVC Low Frame



00:00:03:16

TOS CG - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400								
LCEVC	150	456								

- Order
 - Source
 - x264
 - LCEVC

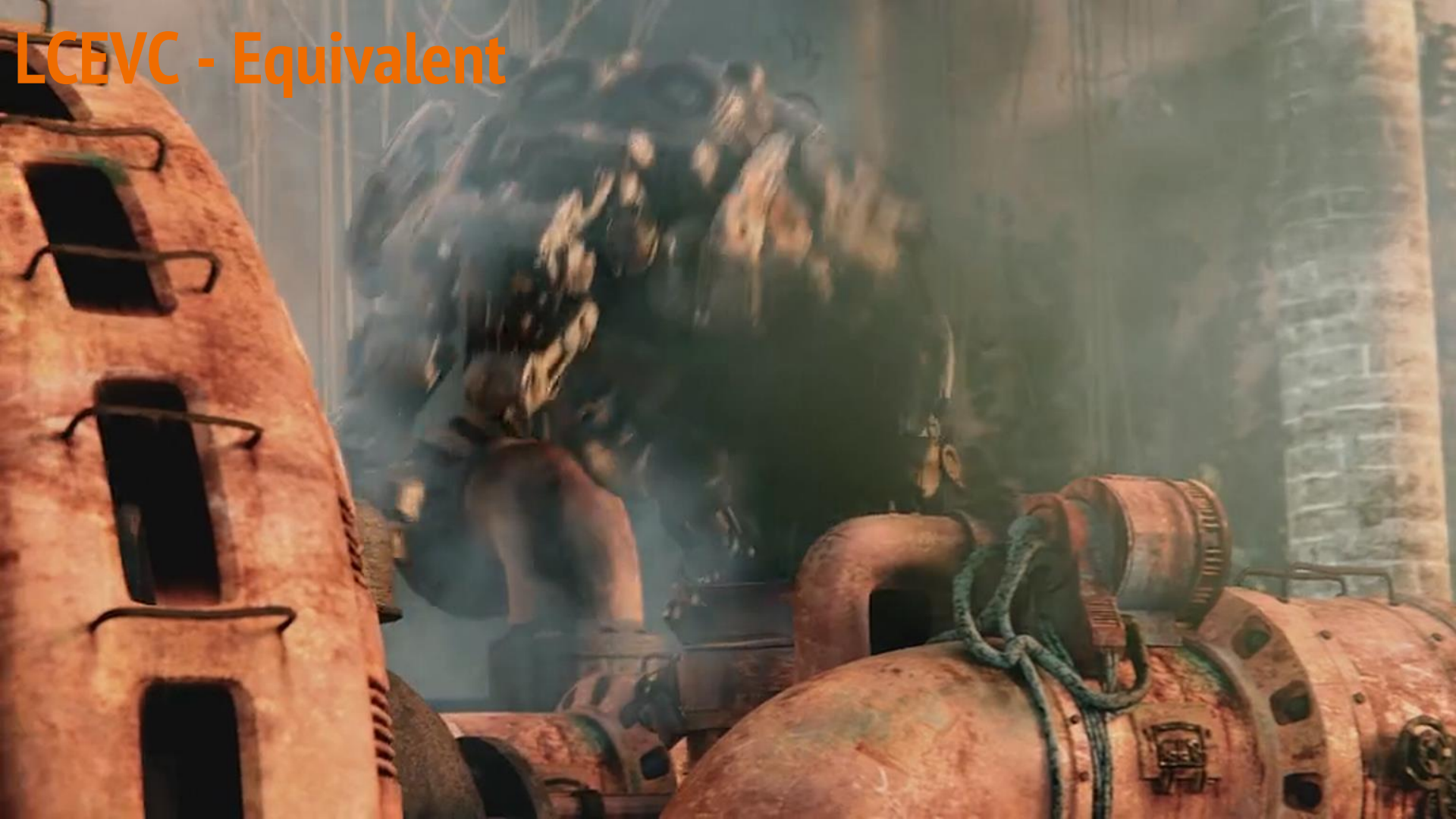


Source

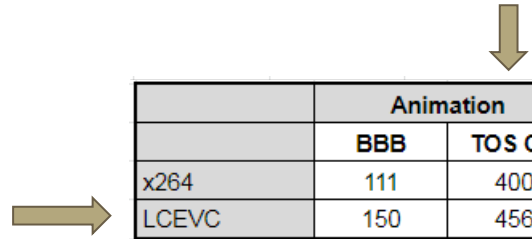
x264 (Low Frame)



LCEVC - Equivalent



TOS CG - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTA V2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400								
LCEVC	150	456								

- Order
 - Source
 - x264
 - LCEVC

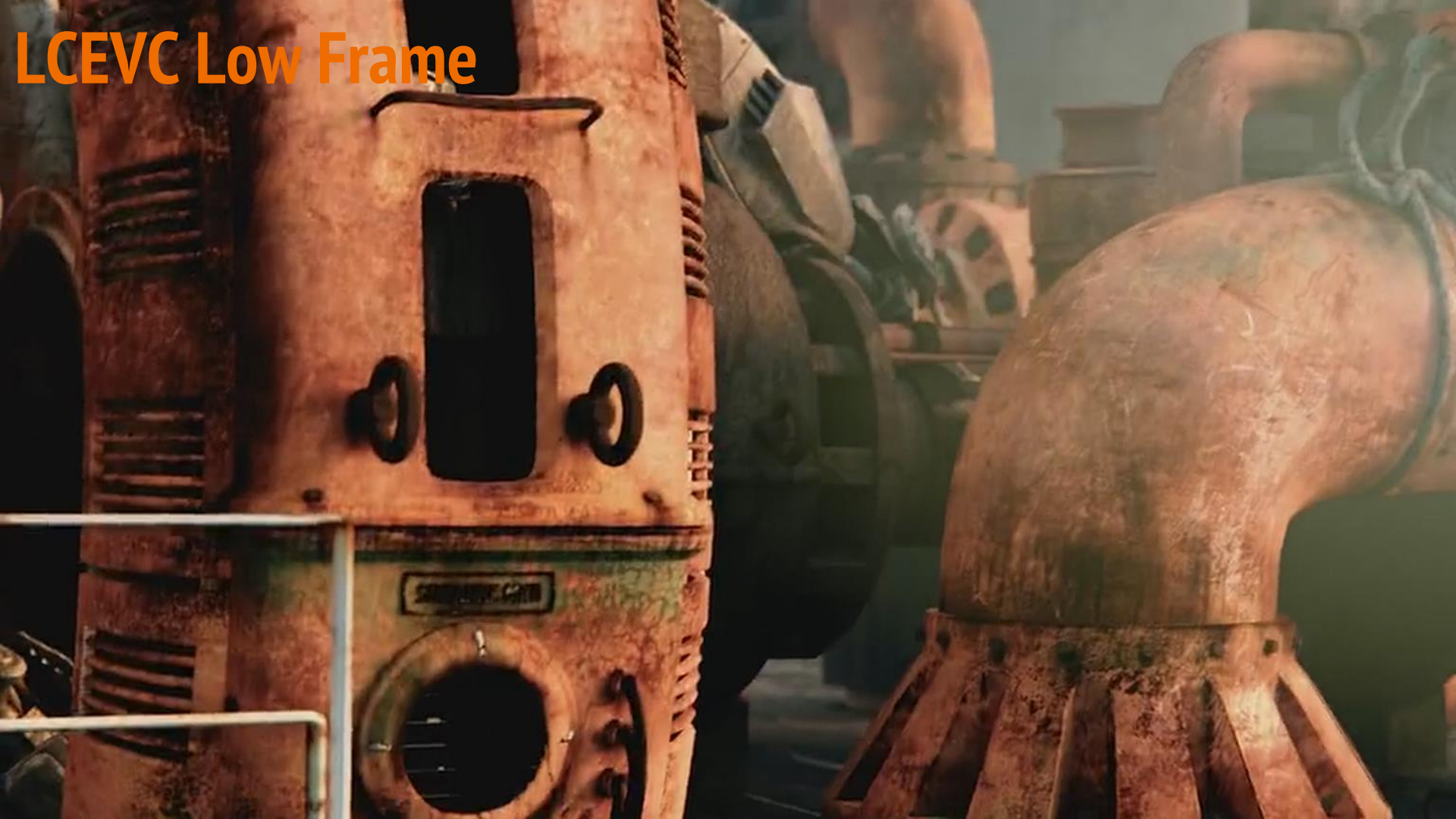
Source



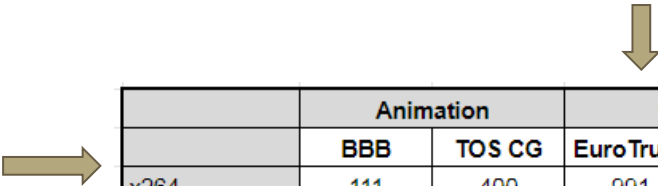
x264 - Equivalent



LCEVC Low Frame



EuroTruck Simulator 2 - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991							
LCEVC	150	456	128							

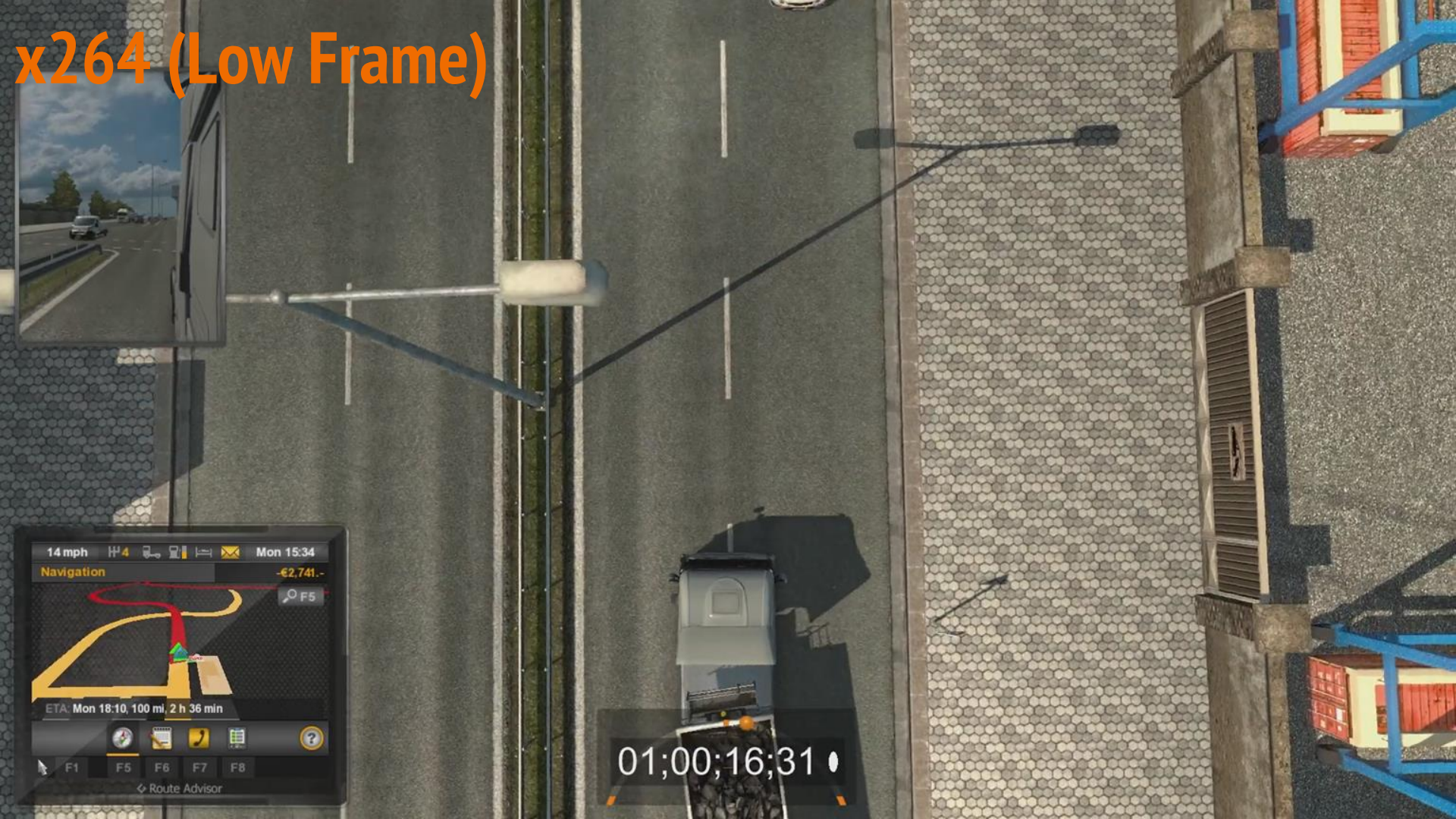
- Order
 - Source
 - x264
 - LCEVC

Source



01;00;16;31

x264 (Low Frame)



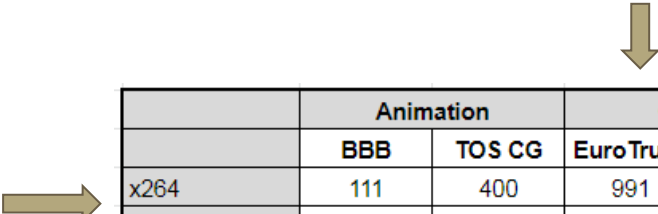
01;00;16;31

LCEVC - Equivalent



01;00;16;31

EuroTruck Simulator 2 - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991							
LCEVC	150	456	128							

- Order
 - Source
 - x264
 - LCEVC

Source



11 mph 3 Mon 15:34

Navigation

-€2,741.-



ETA: Mon 18:10, 100 mi, 2 h 36 min



F1

F5

F6

F7

F8

Route Advisor

01;00;02;08

x264 - Equivalent



11 mph 3 Mon 15:34

Navigation -€2,741.-



ETA: Mon 18:10, 100 mi, 2 h 36 min



F1 F5 F6 F7 F8

Route Advisor

01;00;02;08

LCEVC Low Frame



11 mph 3 11 Mon 15:34

Navigation

-€2,741.-

F5



ETA: Mon 18:10, 100 mi, 2 h 36 min

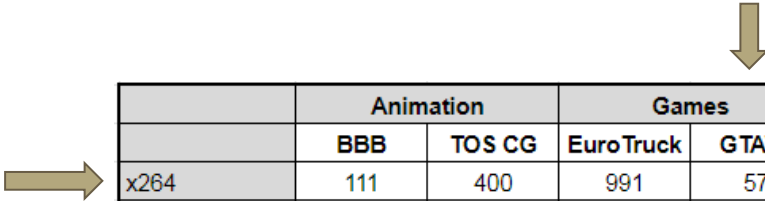


F1 F5 F6 F7 F8

Route Advisor

01;00;02;08

GTAV2 - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57						
LCEVC	150	456	128	106						

- Order
 - Source
 - x264
 - LCEVC

1377
Source

★★★★★



00:00:22:57



1377

x264 (Low Frame)

☆☆☆☆



00:00:22:57

1377
LCEVC - Equivalent



00:00:22:57

GTAV2 - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57						
LCEVC	150	456	128	106						

- Order
 - Source
 - x264
 - LCEVC

1426
Source



00:00:23:46



1426

x264 - Equivalent



00:00:23:46



1426

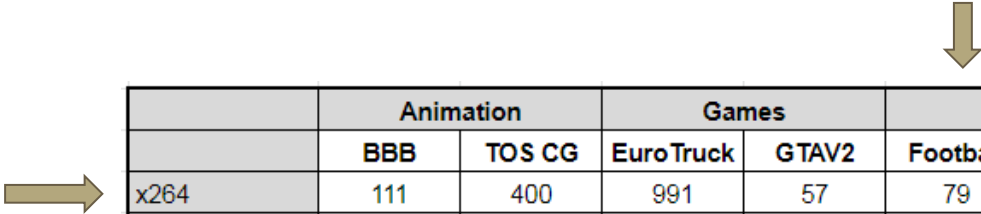
LCEVC Low Frame



00:00:23:46



Football - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTA V2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79					
LCEVC	150	456	128	106	74					

- Order
 - Source
 - x264
 - LCEVC

Source



01:00:02:19 •

harmonic.

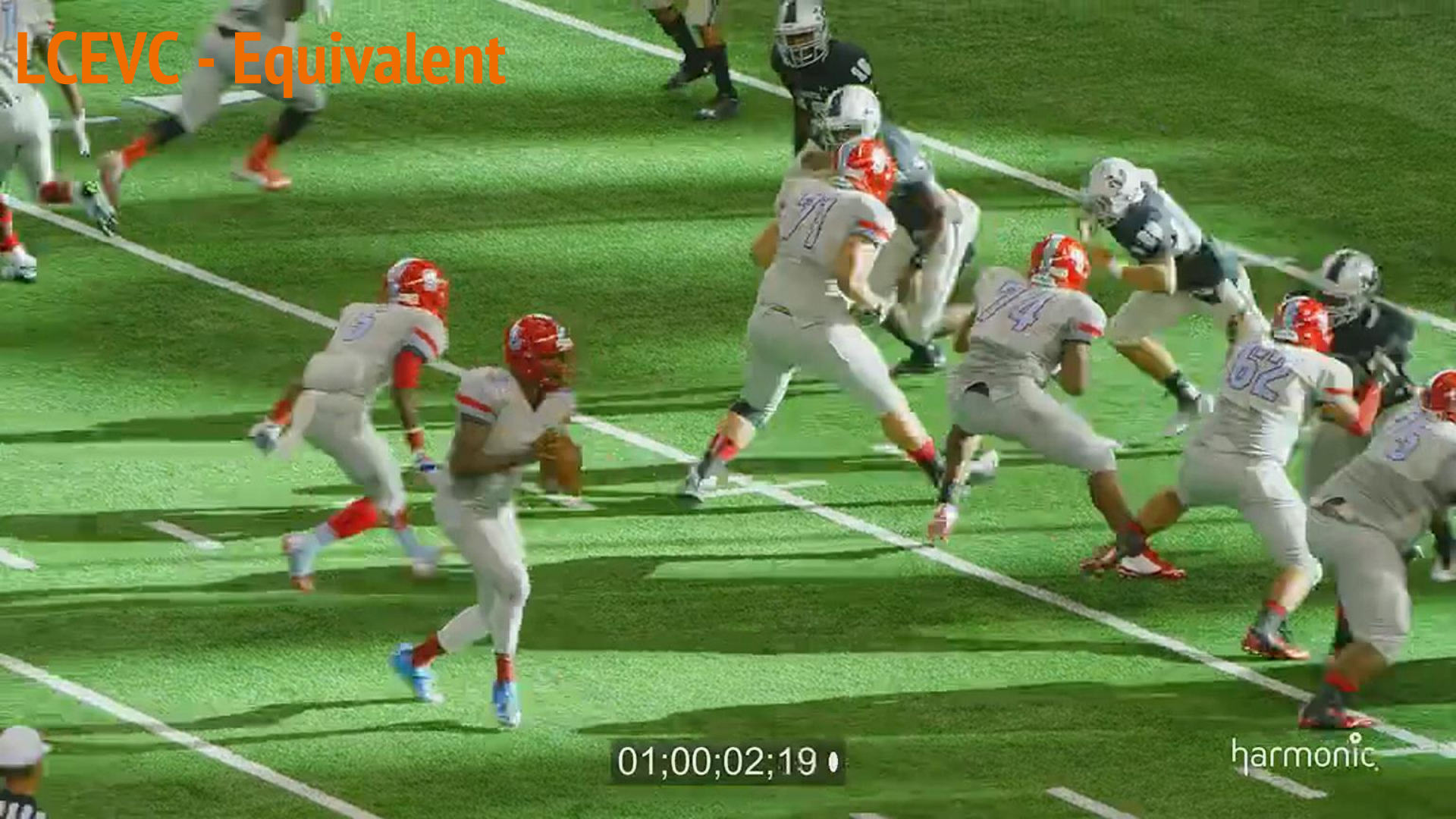


x264 (Low Frame)

01:00:02:19 •

harmonic

LCEVC - Equivalent



01:00:02:19 •

harmonic.

Football - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTA V2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79					
LCEVC	150	456	128	106	74					

- Order
 - Source
 - x264
 - LCEVC

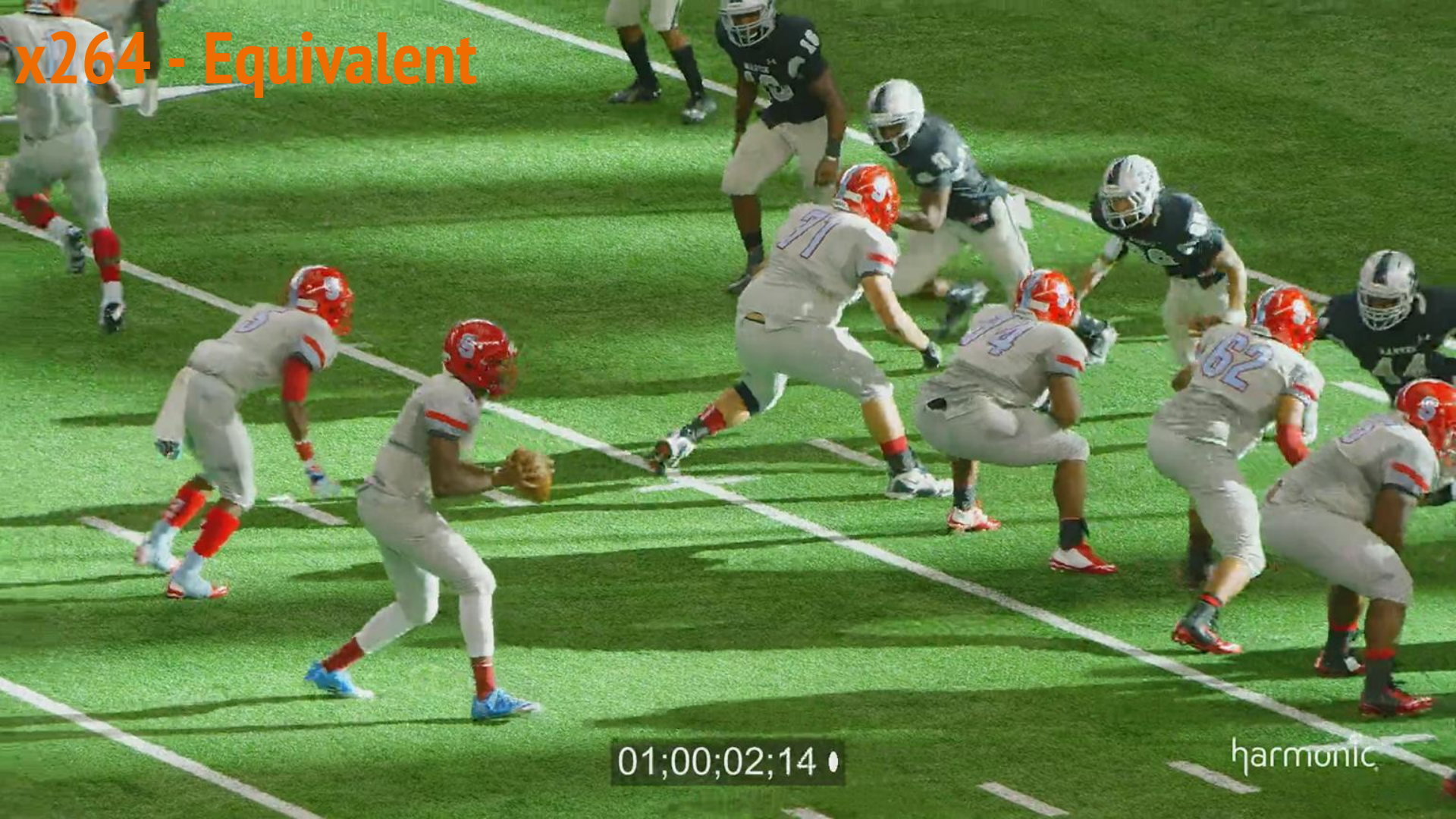


Source

01:00:02:14 •

harmonic

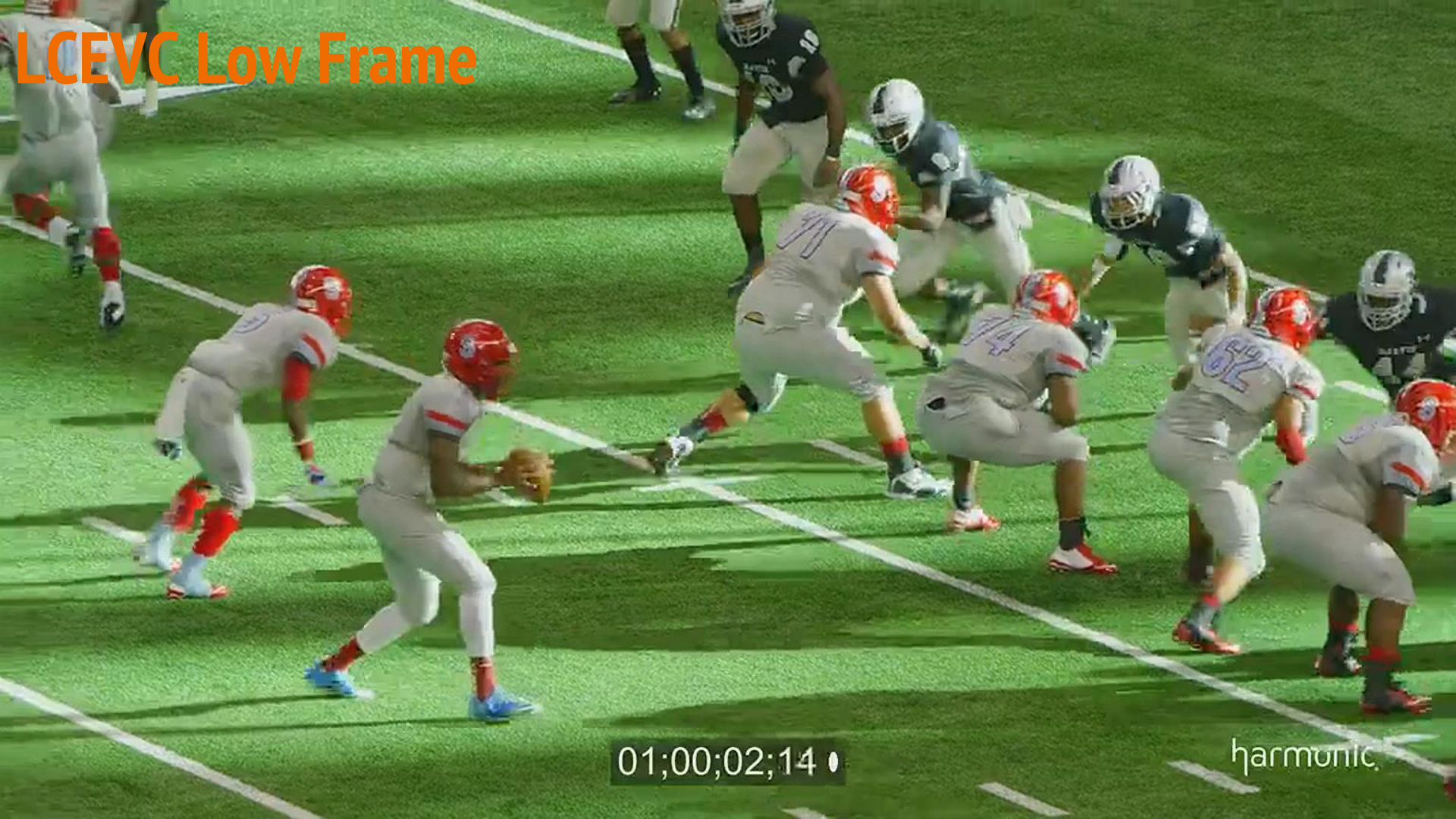
x264 - Equivalent



01:00:02:14 •

harmonic

LCEVC Low Frame



01:00:02;14

harmonic

HorseRun - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	Euro Truck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264				
LCEVC	150	456	128	106	74	364				

- Order
 - Source
 - x264
 - LCEVC



Source

01:00:10:14 •



x264 (Low Frame)

F918

5199

3093

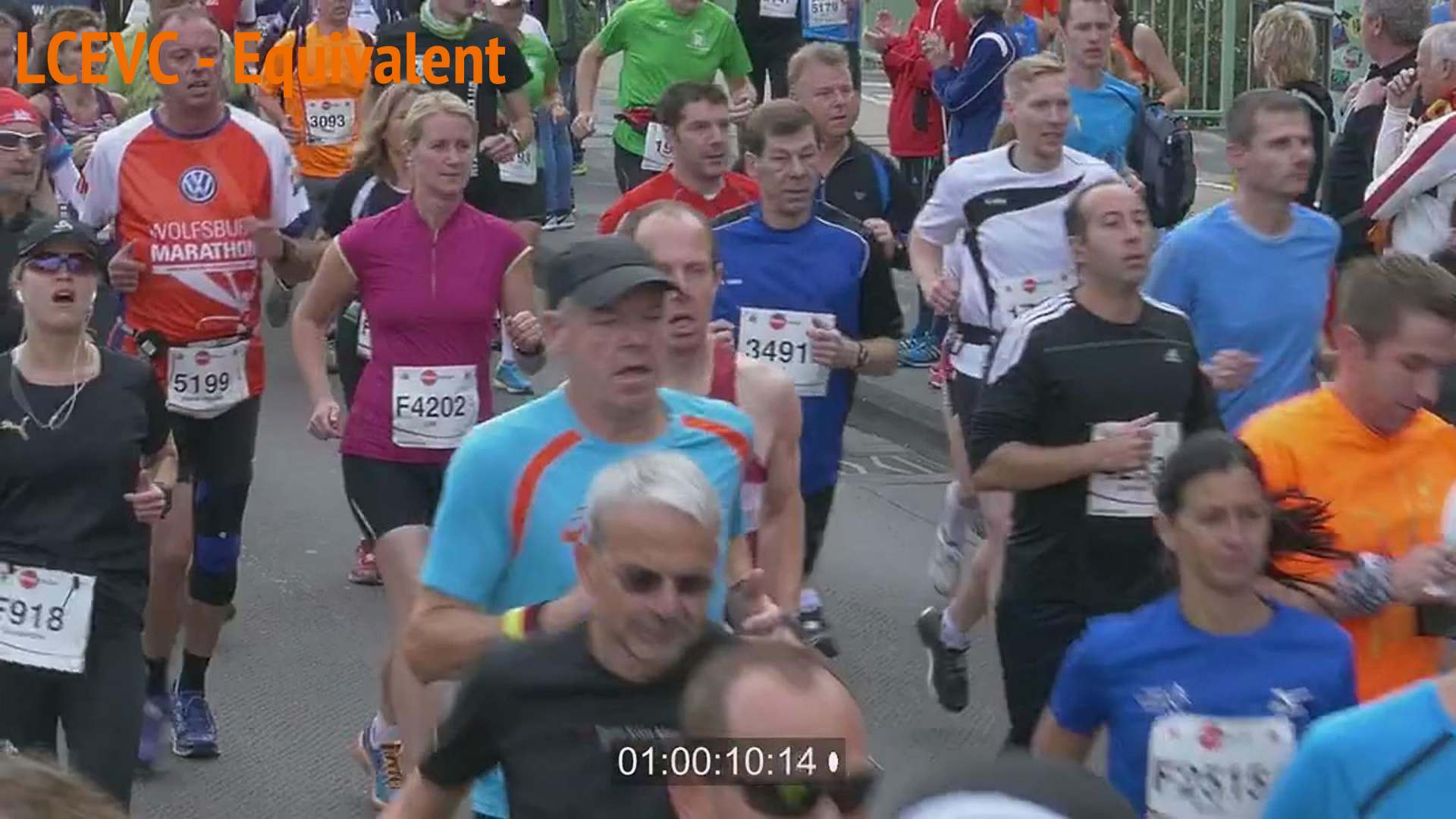
F4202

3491

01:00:10:14

F2518

LCEVC - Equivalent



01:00:10:14

HorseRun - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264				
LCEVC	150	456	128	106	74	364				

- Order
 - Source
 - x264
 - LCEVC



Source

01:00:14:14 •



x264 - Equivalent

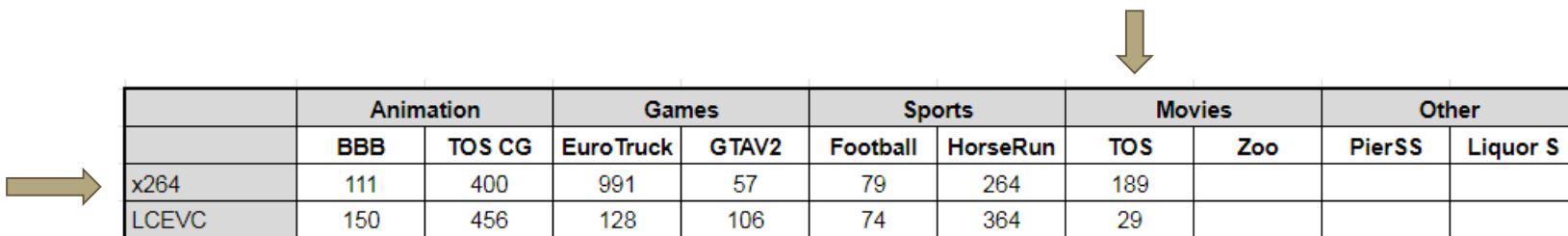
01:00:14:14 •



LCEVC Low Frame

01:00:14:14

TOS - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189			
LCEVC	150	456	128	106	74	364	29			

- Order
 - Source
 - x264
 - LCEVC

Source

01;00;06;09 •


x264 (Low Frame)

01;00;06;09 •

LCEVC - Equivalent

01;00;06;09 •

TOS - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTA V2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	107									
LCEVC	111									

- Order
 - Source
 - x264
 - LCEVC

Source



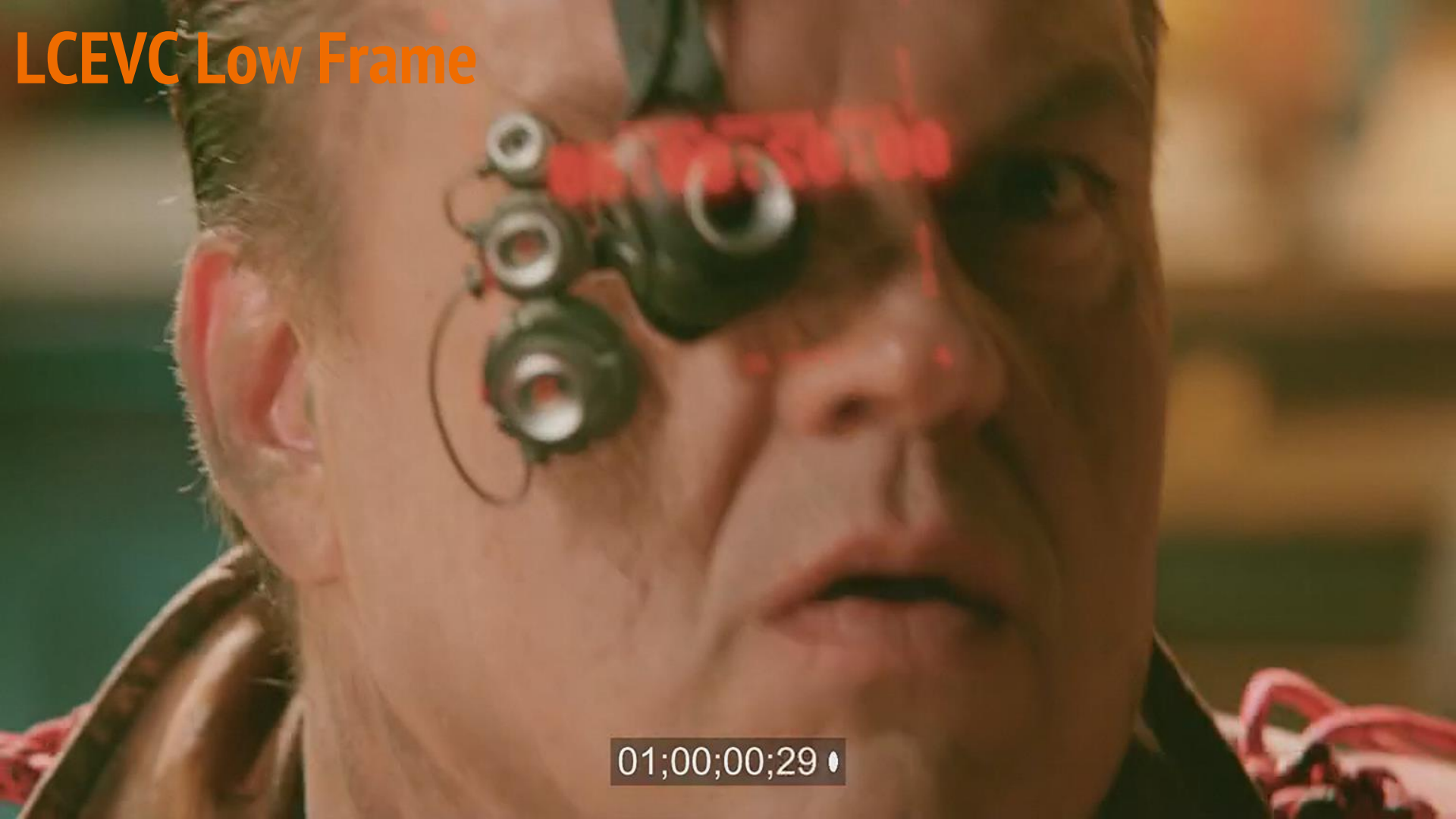
01;00;00;29 •

x264 - Equivalent



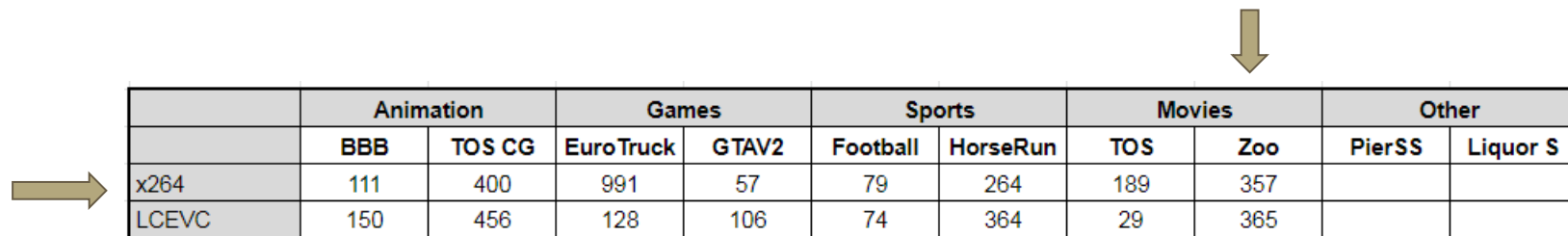
01;00;00;29 •

LCEVC Low Frame



01;00;00;29 ◉

Zoolander - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357		
LCEVC	150	456	128	106	74	364	29	365		

- Order
 - Source
 - x264
 - LCEVC

Source



00:00:14:21



x264 (Low Frame)

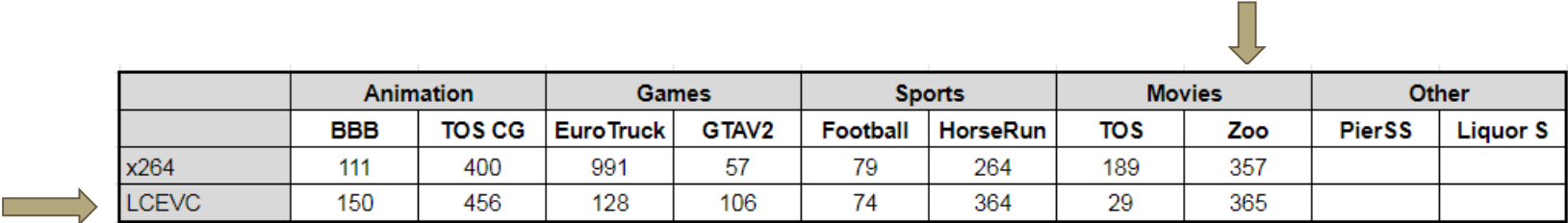
00:00:14:21

LCEVC - Equivalent



00:00:14:21

Zoolander - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357		
LCEVC	150	456	128	106	74	364	29	365		

- Order
 - Source
 - x264
 - LCEVC

Source



00:00:15:05

x264 - Equivalent





00:00:15:05



LCEVC Low Frame

00:00:15:05

Pier Seaside - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357	515	
LCEVC	150	456	128	106	74	364	29	365	539	

- Order
 - Source
 - x264
 - LCEVC

Source

00:00:17:07 •



x264 (Low Frame)

00:00:17:07 ●

LCEVC - Equivalent

00:00:17:07 •

Pier Seaside - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357	515	
LCEVC	150	456	128	106	74	364	29	365	539	

- Order
 - Source
 - x264
 - LCEVC

Source

00:00:18:01 •

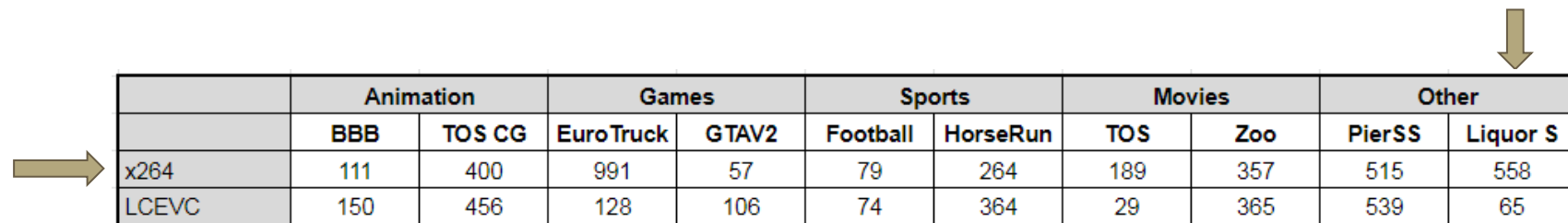
x264 - Equivalent

00:00:18:01 •

LCEVC Low Frame

00:00:18:01 •

Liquor Store - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357	515	558
LCEVC	150	456	128	106	74	364	29	365	539	65

- Order
 - Source
 - x264
 - LCEVC

Source





x264 (Low Frame)



LCEVC - Equivalent



Liquor Store - Full Resolution Frame Grabs



	Animation		Games		Sports		Movies		Other	
	BBB	TOS CG	EuroTruck	GTAV2	Football	HorseRun	TOS	Zoo	PierSS	Liquor S
x264	111	400	991	57	79	264	189	357	515	558
LCEVC	150	456	128	106	74	364	29	365	539	65

- Order
 - Source
 - x264
 - LCEVC

Source



x264 - Equivalent



LCEVC Low Frame



Appendix IV: GB Tech Report

- Methodology overview
- Profiles of test coordinators
- DSIS methodology
- Lab set-up
- Scope of analysis
- MOS results – summary
- Observations



MPEG-5 LCEVC subjective testing

Overview of DSIS MOS results

Vittorio Baroncini, Giacomo Baroncini
Rome, May 2020

Methodology overview

- Production of **DSIS MOS (Mean Opinion Score)** according to the **ITU-R Recommendation BT 500** (<https://www.itu.int/rec/R-REC-BT.500-14-201910-I/en>)
- Experiment designed and overseen by the MPEG Test Chair Vittorio Baroncini and performed by the independent laboratory GBtech under the supervision of the Test Administrator Giacomo Baroncini
- DSIS – or **Double Stimulus Impairment Scale** – protocol is known to be an efficient (in term of cost and human resources) and but effective and reliable methodology. The double-stimulus method is cyclic in that the assessor is first presented with an unimpaired reference, then with the same image impaired (in this case, either compressed with x264 or LCEVC). Following this, he is asked to vote on the second, keeping in mind the first. In sessions, which last up to half an hour, the assessor is presented with a series of sequences in random order and with random impairments covering all required combinations. At the end of the series of sessions, the mean score for each test condition and test image is calculated.

Profiles of test coordinators

Vittorio Baroncini (VABTECH ltd)

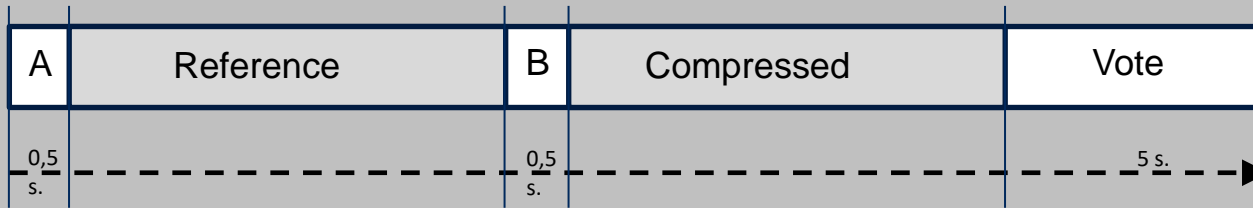
Working in the area of video since late 80s, member of ISO and ITU since mid 90s, expert in subjective and objective video quality assessment; co-founder of the VQEG (1998) and Chair of ITU-R WP6Q (2000-2009) releasing the first standard on objective TV quality metric. Chair (from 2002) of the SC29 WG11 (MPEG) test sub-group, designed and conducted all the Call for Evidence, Competition and Verification tests made in MPEG for Digital Cinema, AVC, HEVC and VVC standards. Designed several new objective and subjective test methods. Run over hundreds subjective test experiments serving many industries all over the world. At the moment member of BSI (British Standard Institute)

Giacomo Baroncini (GBTech)

Active in the area of subjective video quality assessment since 2006; Contributing to the visual testing activities of SC29 WG11 (MPEG) test sub-group since 2013, acting as Test Administrator in all the Call for Evidence, Competition and Verification tests made in MPEG for HEVC and VVC standards. Run more than a hundreds subjective test experiments serving many industries all over the world. Member of UNINFO (the Italian Informatic Technologies normative group)

DSIS methodology

BTC example



- DSIS test method is based on a Basic Test Cells (BTC) for each test point. Each BTC foresees the sequential presentation of:
 - Announcement of Reference video clip (letter A, 0.5 s.)
 - Reference uncompressed video clip (i.e., source)
 - Announcement of Compressed video clip (letter B, 0.5 s.)
 - Compressed video clip (either x264 or LCEVC in this experiment)
 - Voting time (announced by a message on screen – 5 s.)
- A DSIS test sessions includes:
 - One BTC for each test point (coding condition)
 - A stabilization phase; three BTC showing high, mid and low quality
 - One or two check BTC in which Reference is compared to Reference
- A test sessions stands for around 15 – 20 minutes
- When more time is required more test sessions are designed
- Each test session has “stabilization phase” and check BTCs

DSIS protocol – Impairment scale

- The DSIS test is based on the 11 grades impairment scale reported on the right
- The scale is a unilateral Likkert scale, measuring the difference between the “reference” (source) and the “coded” video clips
- The 11 grades impairment scale adopted is taken from Rec. BT-2095 (EVP)

DSIS impairment scale

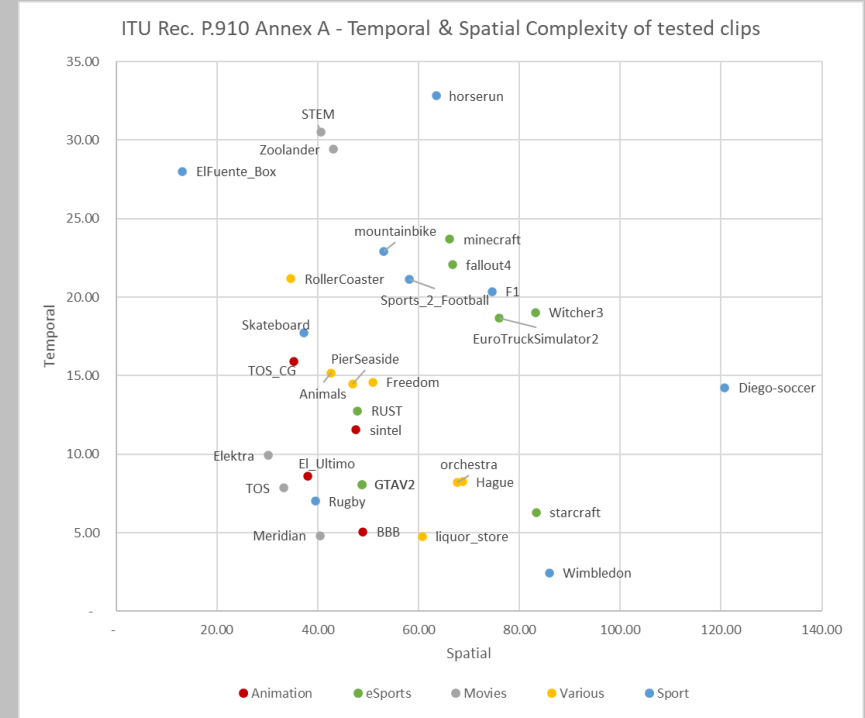
Score	Impairment item	
10	Imperceptible	
9	Slightly perceptible	somewhere
8		everywhere
7	Perceptible	somewhere
6		everywhere
5	Clearly perceptible	somewhere
4		everywhere
3	Annoying	somewhere
2		everywhere
1	Severely annoying	somewhere
0		everywhere

Lab set-up

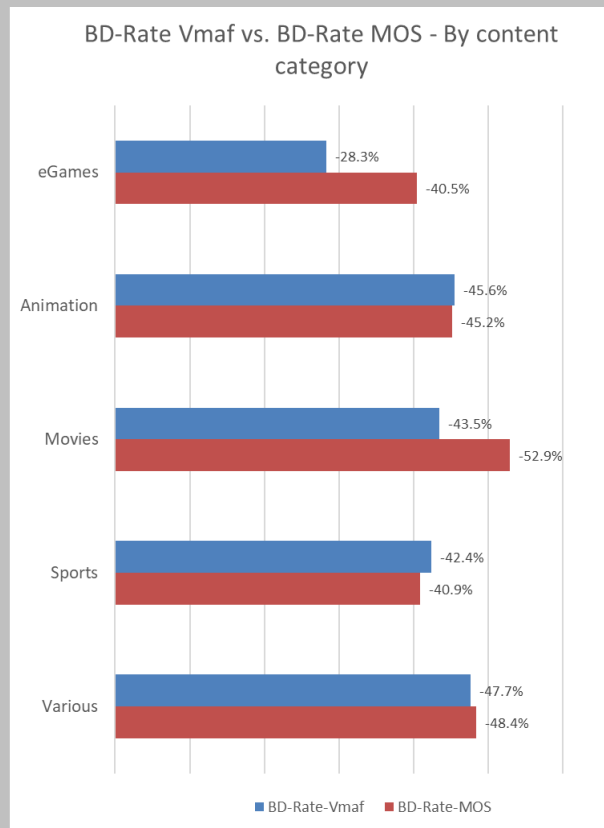
- Custom SW player designed for formal subjective assessment (MUP)
- 32" Professional computer monitor (ASUS ProArt PA329Q)
- Calibration made by Xrite i1 Display Pro
- Viewing distance 3H
- Viewing angle $< 30^\circ$ (two viewers)
- Low ambient light (< 30 nits) behind the monitor
- Non reflecting dark gray floor, walls and ceiling

Scope of analysis

- 33 test sequences across 5 content types (sports, eGames, movies, animations, various)
- Test sequences widely spread across the ITU P.910 temporal and spatial complexity (see chart on the right)
- Full HD 1080p CBR encodings at different frame rates (24, 25, 30, 60 fps)
- Two tested codecs: x264 (very slow), MPEG-5 LCEVC x264 (base layer: x264 very slow)
- A total of 264 observations: 4 bitrates for each sequence to cover a broad quality range (70-95 Vmaf range)
- MOS scores for each sequence used to calculate BD-Rate-MOS, computed using an excel implementation of Bjontegaard function and compared to BD-Rate-Vmaf provided by V-Nova



MOS results - summary

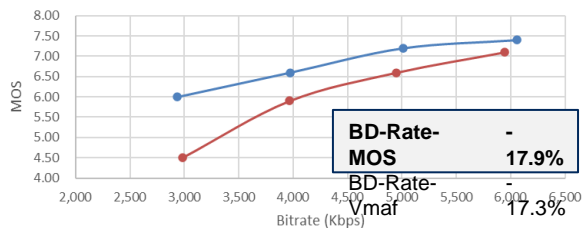


			BD-rate LCEVC vs x264 (negative = LCEVC better)	
#	Type	video_name	Vmaf	MOS
1	eGames	EuroTruckSimulator2	-17.3%	-17.9%
2	eGames	fallout4	-25.7%	-23.7%
3	eGames	GTAV	-29.4%	-31.4%
4	eGames	GTAV2	-41.1%	-65.0%
5	eGames	minecraft	-26.7%	-28.1%
6	eGames	RUST	-33.0%	-46.9%
7	eGames	starcraft	-30.5%	-59.7%
8	eGames	WITCHER3	-22.7%	-51.0%
9	Animation	BBB	-42.8%	-58.3%
10	Animation	EL_ULTIMO	-65.9%	-42.2%
11	Animation	sintel	-36.9%	-40.7%
12	Animation	TOS_CG	-36.7%	-39.7%
13	Movies	Elektra	-52.3%	-52.5%
14	Movies	Meridian	-35.3%	-54.4%
15	Movies	STEM	-40.1%	-52.7%
16	Movies	TOS	-49.5%	-57.9%
17	Movies	Zoo	-40.1%	-47.3%
18	Sports	horserun	-31.3%	-57.0%
19	Sports	mountainbike	-22.3%	-41.8%
20	Sports	Skateboard	-34.0%	-50.1%
21	Sports	Sports_2_Football	-23.0%	-11.5%
22	Sports	Rugby	-51.4%	-49.5%
23	Sports	Soccer-Diego	-36.2%	-17.8%
24	Sports	F1AroundCorner	-45.8%	-48.7%
25	Sports	ElFuente_Box	-37.8%	-54.2%
26	Sports	Wimbledon	-100.0%	-37.8%
27	Various	Animals	-34.0%	-33.1%
28	Various	Freedom	-37.1%	-54.1%
29	Various	Hague	-47.4%	-61.8%
30	Various	liquor_store	-100.0%	-71.8%
31	Various	orchestra	-47.3%	-55.1%
32	Various	PierSeaside	-32.5%	-9.8%
33	Various	RollerCoaster	-35.5%	-53.4%
Total			-40.7%	-44.8%

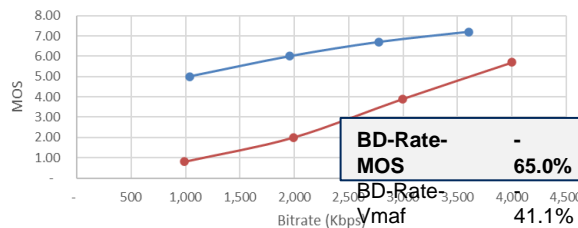
MOS results - eGames



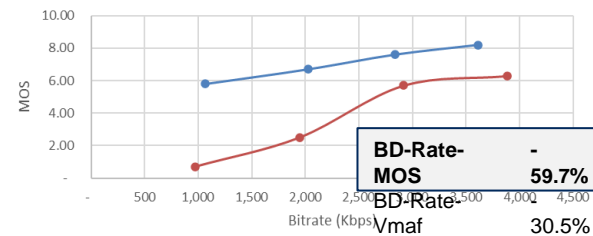
EuroTruckSimulator2_dbl



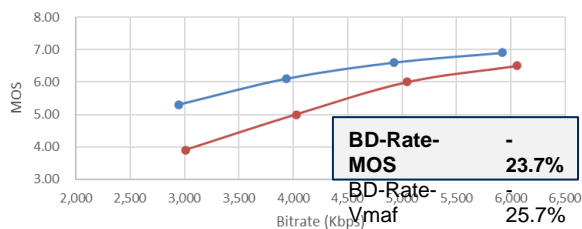
GTAIV2_dbl



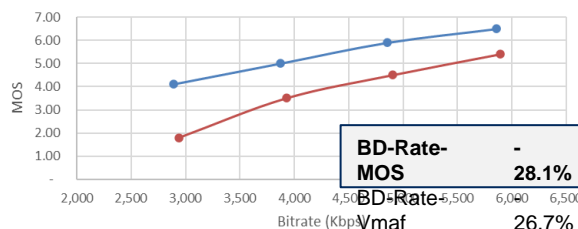
starcraft_dbl



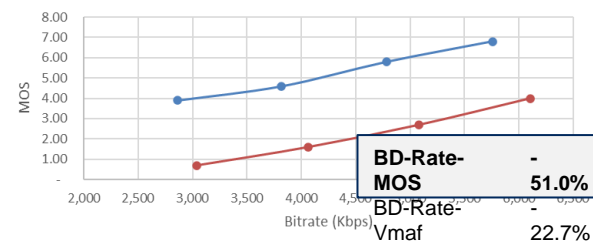
fallout4_dbl



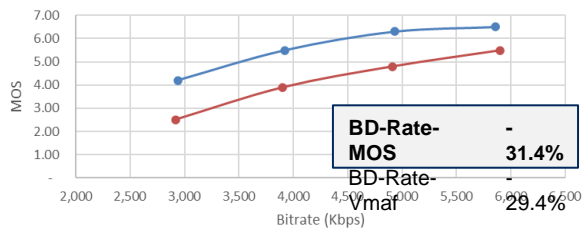
minecraft_dbl



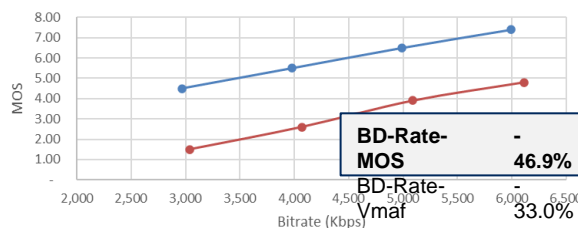
WITCHER3_dbl



GTAIV_dbl



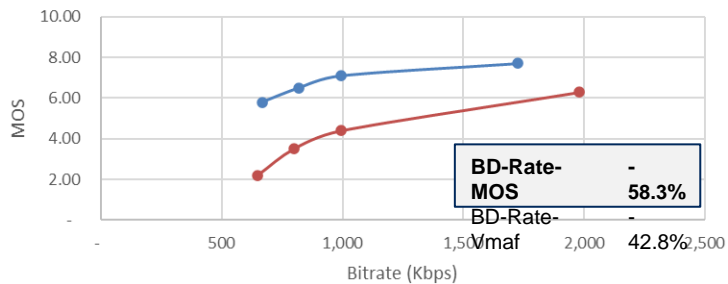
RUST_dbl



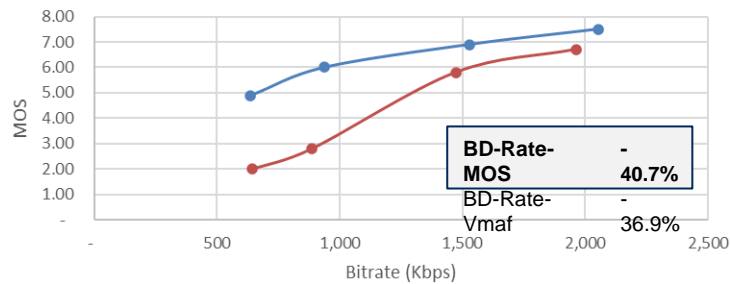
MOS results – Animations

LCEVC x264
x264

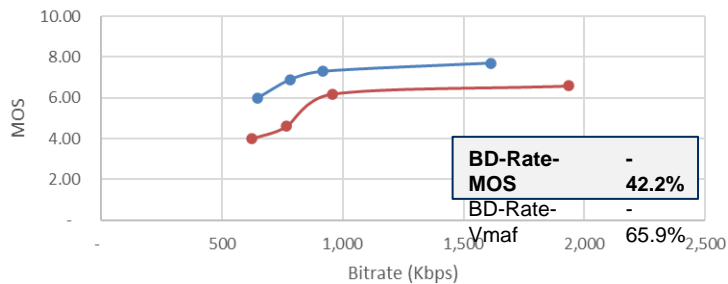
BBB_dbl



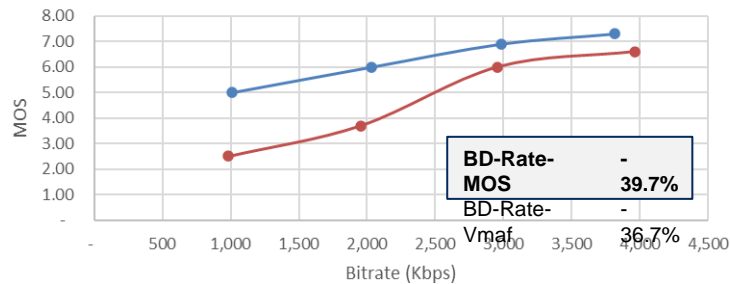
sintel_dbl



EL_ULTIMO_dbl

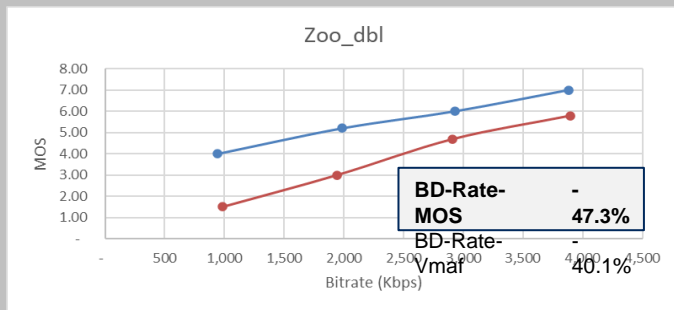
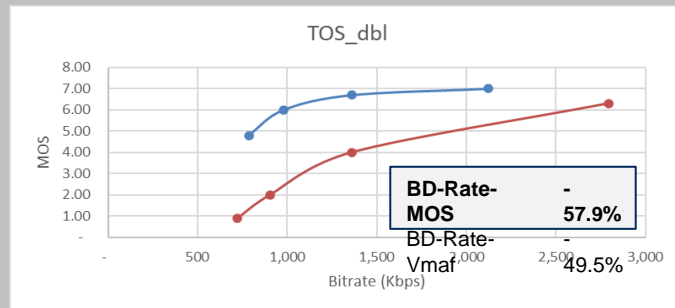
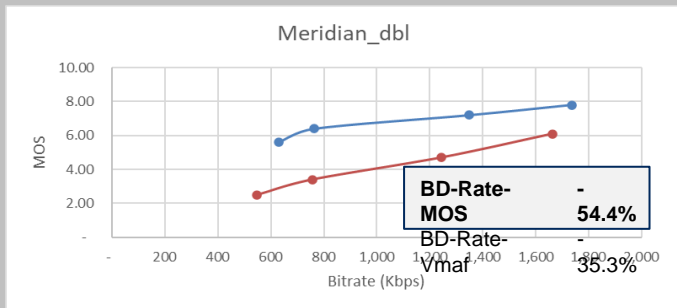
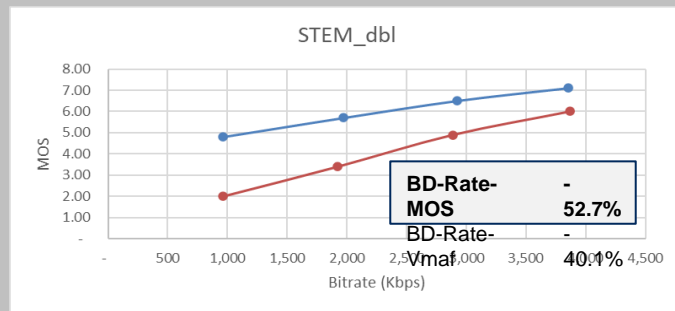
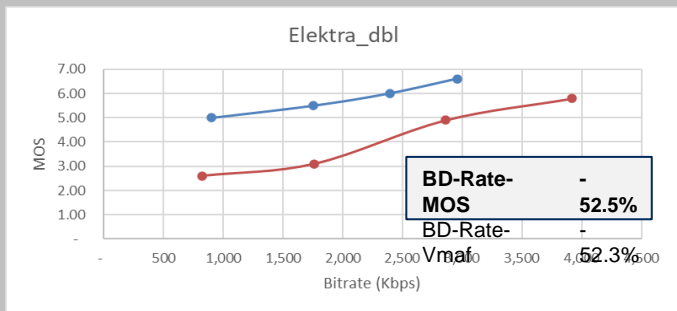


TOS_CG_dbl



MOS results - Movies

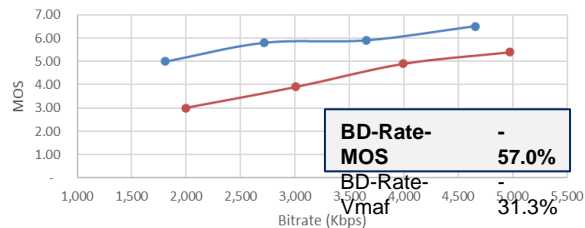
 LCEVC x264
 x264



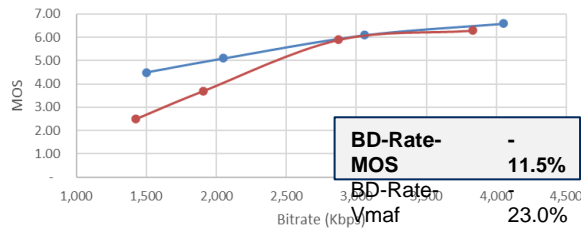
MOS results - Sports

LCEVC x264
x264

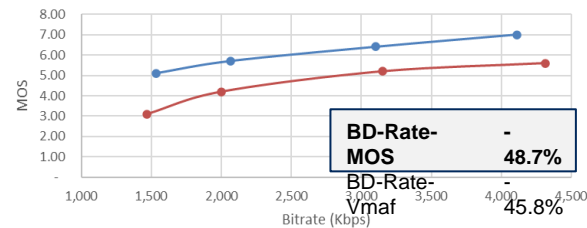
horserun_dbl



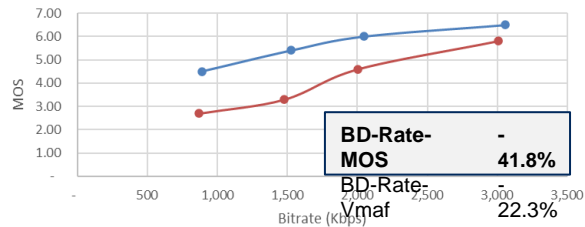
Sports_2_Football_dbl



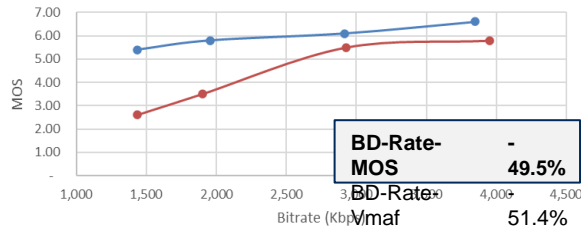
F1AroundCorner_dbl



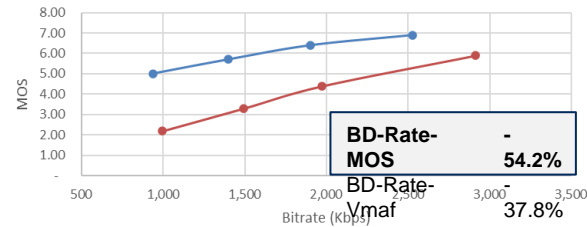
mountainbike_dbl



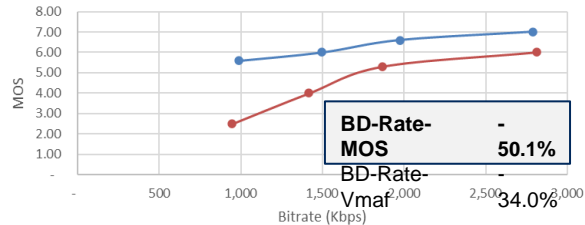
Rugby_dbl



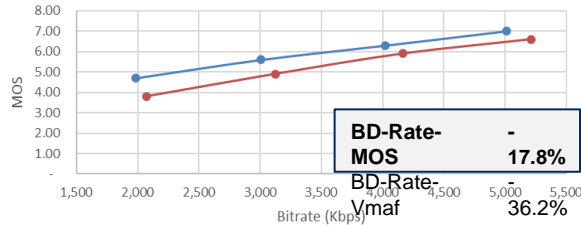
ElFuente_Box_dbl



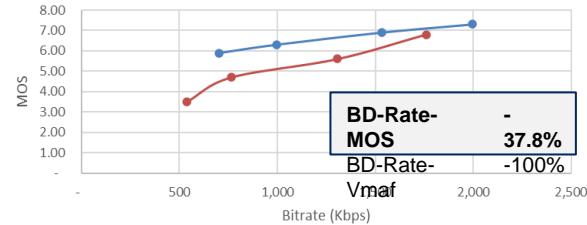
Skateboard_dbl



Soccer-Diego_dbl



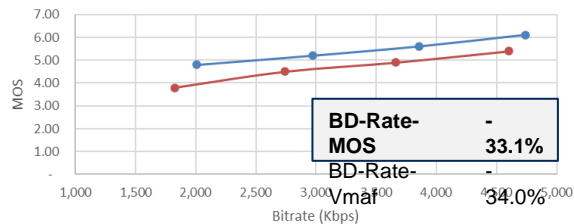
Wimbledon_dbl



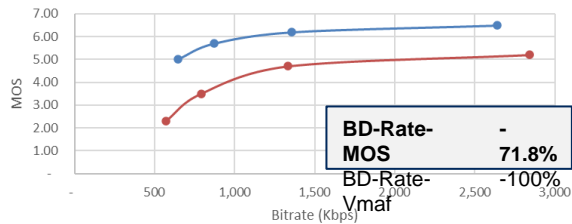
MOS results - Various

LCEVC x264
x264

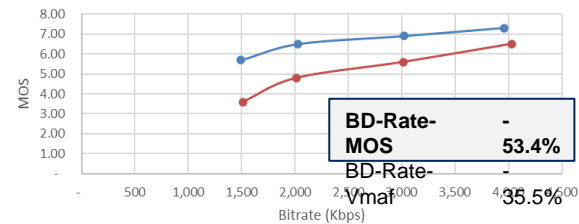
Animals_dbl



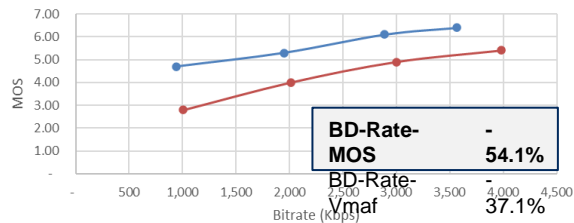
liquor_store_dbl



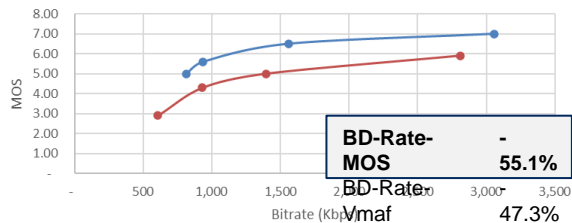
RollerCoaster_dbl



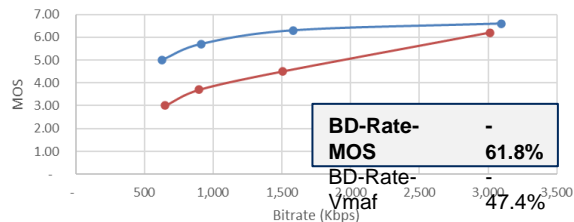
Freedom_dbl



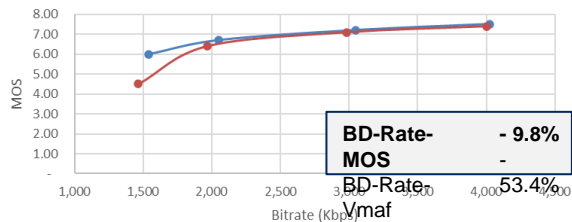
orchestra_dbl



Hague_dbl

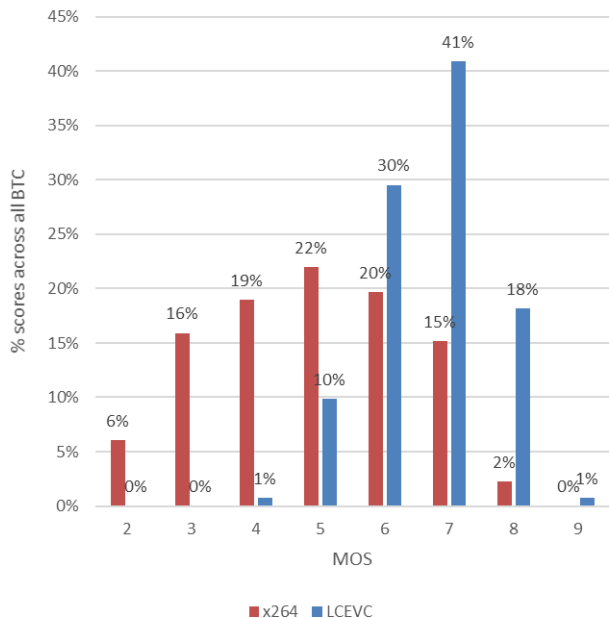


PierSeaside_dbl



Observations

MOS score distribution



- LCEVC consistently outperformed x264 on subjective observations
- x264 at lower data rates often scored <4 in the MOS scale (41% of the total votes were ≤ 4) due to visible impairments in some scenes, such as blocking artifacts, and a general instability in the images, such as flickering at low rates that often persist higher rates. A viewer commented “there were clearly visible blocks which created a moving mesh impossible to ignore”
- LCEVC showed more robustness, scoring 5 and above in 99% of the cases. When bandwidth constrained, LCEVC tends to introduce a general image softening which is typically not perceived by the naïve viewers as an annoying impairment, and is often discarded. At close viewing inspection on still frames and magnification (which was not the focus of this test), x264 is sometime sharper in selected parts, however at higher rates LCEVC preserves the details and doesn't show the perceptible impairments that are often still visible with x264 even at higher rates.