
Performance Evaluation Xilinx U30

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Overview

	Xilinx U30	NVIDIA T4	x265 Medium	x265 Veryfast
Start-Up Latency	1	4	2	3
VMAF quality rank	2	4	1	3
PSNR quality rank	3	4	1	2
Subjective quality	2	4	1	3
Quality consistency	2	4	1	4
Overall	2	4	1	3

- Overall, U30 ranked second (score is an average of all tests with no weighting)
- The U30 quality rankings were relatively consistent and the U30 ranked ahead of NVIDIA and Veryfast (except for PSNR with Very fast)
- The U30's quality consistency was high which promotes QoE
- Though not reflected in the chart above, we couldn't produce a single encoding ladder using x265 Medium or Slow on our 96-core AWS C5.metal test bed
- While x265 Medium ranked first overall, it may be challenging to find an encoding station that can affordably produce a full encoding ladder using this codec/preset

Agenda

- Codecs tested: Xilinx U30, NVIDIA T4, x265 Veryfast, x265 Medium
- Clips: Crowdrun, Football, GTAV, Meridian
- Metrics: VMAF, PSNR, RD-Curves, BD-Rate Stats
- Subjective: GBT Tech
- Data rate consistency

Xilinx U30

- Test bed
- Script/capacity
- Command strings
 - Objective
 - Subjective

U30 Test Bed/ Script

```
u30_hevc_jan_ozier_perf2.sh x
1  #!/bin/bash
2  if [ $# -ne 2 ]
3  then
4      echo "Incorrect arguments supplied"
5      echo "Usage: ./"$0" <1080p60 input> <br_1080p>"
6      exit 1
7  fi
8
9  filename=$(basename -- "$1")
10 filename="${filename%.*}"
11
12 out_path=/scratch/output
13 #/proj/ipeng/staff/umam/nobkup/00_benchmark/32_jan_ozier/u30_hevc_perf_final
14 #
15
16 mkdir -p $out_path
17
18 ffmpeg -f rawvideo -s 1920x1080 -r 60 -i $1 \
19 -filter_complex "[0:v] split[a][b]; [b]framerate=fps=30[c]; [c]multiscale_xma=outputs=3:\
20 out_1_width=1280:out_1_height=720:out_1_pix_fmt=vcu_nv12:\
21 out_2_width=960:out_2_height=540:out_2_pix_fmt=vcu_nv12:\
22 out_3_width=640:out_3_height=360:out_3_pix_fmt=vcu_nv12 [d][e][f]; [a]split[aa][ab]" \
23 -map '[aa]' -c:v mpsoc_vcu_hevc -b:v 6M -max-bitrate 6M -slice-qp -1 -g 120 -qp-mode auto \
24 -bf 2 -lookahead_depth 20 -f mp4 -y $out_path/football_U30_1080p_6MB.mp4 \
25 -map '[ab]' -c:v mpsoc_vcu_hevc -r 30 -b:v 4M -max-bitrate 4M -slice-qp -1 -g 60 -qp-mode auto \
26 -bf 2 -lookahead_depth 20 -f mp4 -y $out_path/football_U30_1080p_4MB.mp4 \
27 -map '[d]' -c:v mpsoc_vcu_hevc -r 30 -b:v 2.5M -max-bitrate 2.5M -slice-qp -1 -g 60 \
28 -qp-mode auto -bf 2 -lookahead_depth 20 -f mp4 -y $out_path/football_U30_720p_2_5MB.mp4 \
29 -map '[e]' -c:v mpsoc_vcu_hevc -r 30 -b:v 1.2M -max-bitrate 1.2M -slice-qp -1 -g 60 \
30 -qp-mode auto -bf 2 -lookahead_depth 20 -f mp4 -y $out_path/football_U30_540p_1_2MB.mp4 \
31 -map '[f]' -c:v mpsoc_vcu_hevc -r 30 -b:v 0.8M -max-bitrate .8M -slice-qp -1 -g 60 \
32 -qp-mode auto -bf 2 -lookahead_depth 20 -f mp4 -y $out_path/football_U30_360p_800K.mp4 >
   perf_output.txt 2>&1
```

- Achieved 1 full ladder on Xilinx internal test machine

U30 Start-up Latency

Preset	Latency
U30	.6 (sec)

- Recorded screen with Camtasia
- Pasted in command string
- Computed time from paste until first frame appeared
- Ran three tests and averaged time

U30 Command Strings

- Objective

```
ffmpeg -f rawvideo -s 1920x1080 -r 60 -re -i Football_1080p.yuv -vsync 0  
-an -b:v 3M -max-bitrate 3M -c:v mpsoc_vcu_hevc -slice-qp -1 -g 120  
-qp-mode uniform -bf 2 -lookahead_depth 20 -spatial-aq 0 -temporal-aq 0  
-rate-control-mode 0 -f mp4 -y Football_U30_tune_3MB.mp4
```

- Subjective

```
ffmpeg -f rawvideo -s 1920x1080 -r 60 -i Football_1080p.yuv -vsync 0  
-an -b:v 3M -max-bitrate 3M -c:v mpsoc_vcu_hevc -slice-qp -1 -g 120  
-qp-mode auto -bf 2 -lookahead_depth 20 -spatial-aq 0 -temporal-aq 0  
-rate-control-mode 0 -f mp4 -y football_U30_viz_3MB.mp4
```

NVIDIA T4

- Test bed
- Script/capacity
- Command strings
 - Objective
 - Subjective

T4 Performance Test Script

```
ffmpeg -re -y -hwaccel cuvid -c:v h264_cuvid -i Football_1080p.mp4 \  
-c:v hevc_nvenc -preset fast -qmin 0 -bf 2 -spatial_aq 1 -rc-lookahead 20 -  
i_qfactor 0.75 -b_qfactor 1.1 -g 120 -keyint_min 120 -sc_threshold 0 -b:v 6M -  
bufsize 6M -maxrate 12M out1/Football_NVEnc_1920_6.mp4 \  
-c:v hevc_nvenc -preset fast -qmin 0 -bf 2 -spatial_aq 1 -rc-lookahead 20 -  
i_qfactor 0.75 -b_qfactor 1.1 -r 30 -g 60 -keyint_min 60 -sc_threshold 0 -b:v 4M  
-bufsize 4M -maxrate 8M out1/Football_NVEnc_1920_4.mp4 \  
-c:v hevc_nvenc -vf scale_npp=1280:720 -preset fast -qmin 0 -bf 2 -spatial_aq 1  
-rc-lookahead 20 -i_qfactor 0.75 -b_qfactor 1.1 -r 30 -g 60 -keyint_min 60 -  
sc_threshold 0 -b:v 2.5M -bufsize 2.5M -maxrate 5M  
out1/Football_NVEnc_720_2_5.mp4 \  
-c:v hevc_nvenc -vf scale_npp=960:540 -preset fast -qmin 0 -bf 2 -spatial_aq 1 -  
rc-lookahead 20 -i_qfactor 0.75 -b_qfactor 1.1 -r 30 -g 60 -keyint_min 60 -  
sc_threshold 0 -b:v 1.2M -bufsize 1.2M -maxrate 2.4M  
out1/Football_NVEnc_540_1_2.mp4 \  
-c:v hevc_nvenc -vf scale_npp=640:360 -preset fast -qmin 0 -bf 2 -spatial_aq 1 -  
rc-lookahead 20 -i_qfactor 0.75 -b_qfactor 1.1 -r 30 -g 60 -keyint_min 60 -  
sc_threshold 0 -b:v .8M -bufsize .8M -maxrate 1.6M  
out1/Football_NVEnc_360_800k.mp4
```

- Achieved 2 full ladders on AWS Instance

T4 Start-up Latency

Preset	Latency
T4	1.38 (sec)

- Recorded screen with Camtasia
- Pasted in command string
- Computed time from paste until first frame appeared
- Ran three tests and averaged time

Command String - Metrics

Analysis

We encoded files with and without the AQ switches noted below and PSNR and VMAF scores were higher. For this reason, we encoded files for objective metric comparisons and subjective comparisons with AQ using the command string below.

	Tune (no AQ)	Viz (with AQ)
PSNR	34.29	34.76
VMAF	81.87	83.56

```
ffmpeg -re -y -hwaccel_output_format cuda -c:v h264_cuvid -i Football_1080p.mp4 -c:v  
hevc_nvenc -spatial_aq 1 -i_qfactor 0.75 -b_qfactor 1.1 -preset fast -cbr 1 -an -qmin 0 -  
bf 2 -rc-lookahead 20 -g 120 -keyint_min 120 -sc_threshold 0 -b:v 3M -maxrate 3M -bufsize 6M  
Football_NVEnc_Tune_3MB_fast.mp4
```

T4 Command Strings

- Objective

```
ffmpeg -re -y -hwaccel_output_format cuda -c:v h264_cuvid -i Football_1080p.mp4  
-c:v hevc_nvenc -spatial_aq 1 -i_qfactor 0.75 -b_qfactor 1.1 -preset fast -cbr 1  
-an -qmin 0 -bf 2 -rc-lookahead 20 -g 120 -keyint_min 120 -sc_threshold 0  
-b:v 3M -maxrate 3M -bufsize 6M Football_NVEnc_Tune_3MB_fast.mp4
```

- Subjective

```
ffmpeg -re -y -hwaccel_output_format cuda -c:v h264_cuvid -i Football_1080p.mp4  
-c:v hevc_nvenc -spatial_aq 1 -i_qfactor 0.75 -b_qfactor 1.1 -preset fast -cbr 1  
-an -qmin 0 -bf 2 -rc-lookahead 20 -g 120 -keyint_min 120 -sc_threshold 0  
-b:v 3M -maxrate 3M -bufsize 6M Football_NVEnc_Viz_3MB_fast.mp4
```

x265 Veryfast and Medium

- Test bed
- Script/capacity
- Command strings
 - Objective
 - Subjective

x265 Capacity/Cost

Model	vCPU	Memory (GiB)	Instance Storage (GiB)	Network Bandwidth (Gbps)	EBS Bandwidth (Mbps)
c5.metal	96	192	EBS-Only	25	19,000

- Tested on an AWS C5.metal
- Running 2nd gen Intel Xeon Scalable Processors (Cascade Lake) with a sustained all-core Turbo CPU frequency of 3.6GHz.
- On-demand pricing - \$4.08/hour

x265 Veryfast

- Did not produce a single ladder

```
xilinx_AWS.tlp - ubuntu@3.84.249.59:22 - Bitwise xterm - ubuntu@ip-172-31-64-1...
frame= 1658 fps= 44 q=25.4 q=34.3 q=33.5 q=36.0 q=35.0 size= 19968
kB time=00:00:27.88 bitrate=5866.7kbits/s dup=0 drop=3304 speed=0.74
frame= 1690 fps= 45 q=33.9 q=26.4 q=25.3 q=27.6 q=25.9 size= 20224
kB time=00:00:28.41 bitrate=5830.4kbits/s dup=0 drop=3368 speed=0.75
frame= 1709 fps= 45 q=33.6 q=34.8 q=33.8 q=36.1 q=34.2 size= 20480
kB time=00:00:28.73 bitrate=5838.4kbits/s dup=0 drop=3404 speed=0.74
frame= 1734 fps= 45 q=31.9 q=34.7 q=33.7 q=35.9 q=34.2 size= 20736
kB time=00:00:29.14 bitrate=5829.2kbits/s dup=0 drop=3456 speed=0.74
frame= 1764 fps= 45 q=32.3 q=34.1 q=33.5 q=35.7 q=34.2 size= 20992
kB time=00:00:29.65 bitrate=5799.2kbits/s dup=0 drop=3516 speed=0.75
frame= 1797 fps= 45 q=33.5 q=34.0 q=32.7 q=35.4 q=33.2 size= 21248kB
frame= 1820 fps= 45 q=33.4 q=26.0 q=24.8 q=27.0 q=25.4 size= 21504kB
frame= 1842 fps= 45 q=33.4 q=31.9 q=30.9 q=33.5 q=31.7 size= 21760kB
frame= 1874 fps= 45 q=31.8 q=34.1 q=32.3 q=35.5 q=33.9 size= 22016kB
frame= 1905 fps= 45 q=33.0 q=32.9 q=32.4 q=34.7 q=33.1 size= 22528kB
frame= 1934 fps= 46 q=31.3 q=33.1 q=32.0 q=34.6 q=33.0 size= 22784kB
frame= 1951 fps= 45 q=34.5 q=31.9 q=30.4 q=32.9 q=31.4 size= 23040kB
frame= 1978 fps= 45 q=33.9 q=34.3 q=32.7 q=35.5 q=33.8 size= 23552kB
frame= 2008 fps= 46 q=33.8 q=24.8 q=23.7 q=25.9 q=24.1 size= 23808kB
frame= 2044 fps= 46 q=32.8 q=33.6 q=32.2 q=34.5 q=32.9 size= 24064kB
frame= 2065 fps= 46 q=32.8 q=33.8 q=31.9 q=34.9 q=33.1 size= 24320kB
frame= 2081 fps= 46 q=33.7 q=33.5 q=31.9 q=34.0 q=33.2 size= 24576kB
frame= 2108 fps= 46 q=24.7 q=34.6 q=32.9 q=35.5 q=33.8 size= 24832kB
frame= 2132 fps= 46 q=32.9 q=31.7 q=30.6 q=32.8 q=31.0 size= 25088kB
time=00:00:35.77 bitrate=5744.7kbits/s dup=0 drop=4248 speed=0.768x

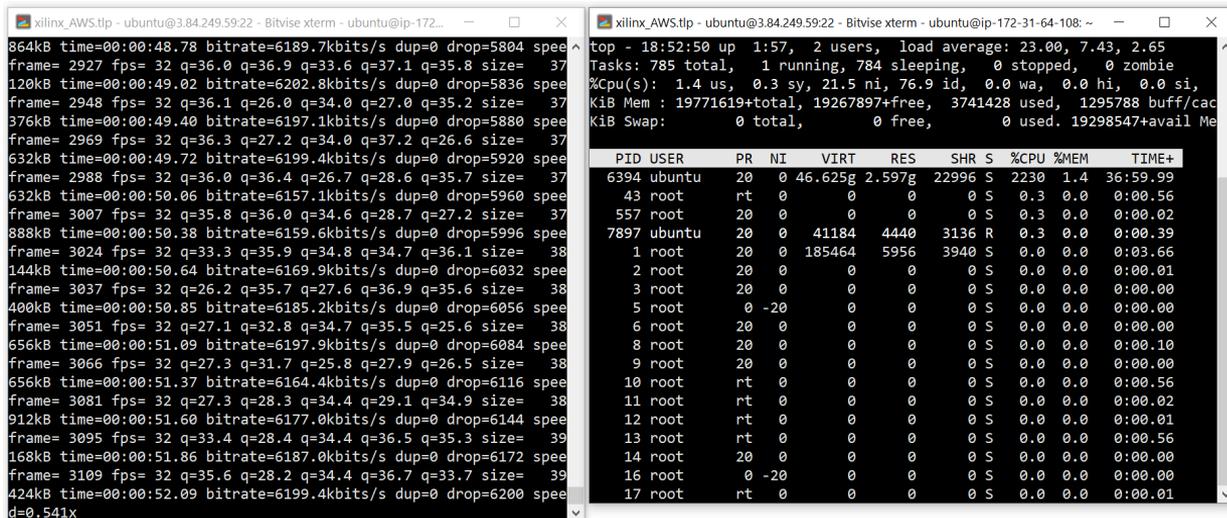
xilinx_AWS.tlp - ubuntu@3.84.249.59:22 - Bitwise xterm - ubuntu@ip-172-31-64-108: ~
top - 18:55:00 up 1:59, 2 users, load average: 20.99, 13.10, 5.45
Tasks: 787 total, 1 running, 786 sleeping, 0 stopped, 0 zombie
%Cpu(s): 1.9 us, 0.2 sy, 19.4 ni, 78.5 id, 0.0 wa, 0.0 hi, 0.0 si,
KiB Mem : 19771619+total, 19323747+free, 3280624 used, 1198084 buff/cache
KiB Swap: 0 total, 0 free, 0 used, 19344460+avail Mem

PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+
7899 ubuntu 20 0 46.169g 2.163g 22976 S 2077 1.1 15:09.90
7897 ubuntu 20 0 41184 4440 3136 R 0.7 0.0 0:01.06
1 root 20 0 185464 5956 3940 S 0.0 0.0 0:03.66
2 root 20 0 0 0 0 S 0.0 0.0 0:00.01
3 root 20 0 0 0 0 S 0.0 0.0 0:00.00
5 root 0 -20 0 0 0 S 0.0 0.0 0:00.00
6 root 20 0 0 0 0 S 0.0 0.0 0:00.00
8 root 20 0 0 0 0 S 0.0 0.0 0:00.12
9 root 20 0 0 0 0 S 0.0 0.0 0:00.00
10 root rt 0 0 0 0 S 0.0 0.0 0:00.56
11 root rt 0 0 0 0 S 0.0 0.0 0:00.02
12 root rt 0 0 0 0 S 0.0 0.0 0:00.01
13 root rt 0 0 0 0 S 0.0 0.0 0:00.56
14 root 20 0 0 0 0 S 0.0 0.0 0:00.00
16 root 0 -20 0 0 0 S 0.0 0.0 0:00.00
17 root rt 0 0 0 0 S 0.0 0.0 0:00.01
18 root rt 0 0 0 0 S 0.0 0.0 0:00.56
19 root 20 0 0 0 0 S 0.0 0.0 0:00.00
```

```
ffmpeg -y -re -i Football_1080p.mp4 \
-c:v libx265 -preset veryfast -x265-params keyint=120:min-keyint=120:scenecut=0:bitrate=6000:vbv-
maxrate=6000:vbv-buf-size=12000:open-gop=0 Football_1080p_6MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -preset veryfast -x265-params keyint=60:min-keyint=60:scenecut=0:bitrate=4000:vbv-
maxrate=4000:vbv-buf-size=8000:open-gop=0 Football_1080p_4MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 1280x720 -preset veryfast -x265-params keyint=60:minkeyint=60:scenecut=0:
bitrate=2500:vbv-maxrate=2500:vbv-buf-size=5000:open-gop=0 Football_720p_2_5MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 960x540 -preset veryfast -x265-params keyint=60:minkeyint=60:scenecut=0:
bitrate=1200:vbv-maxrate=1200:vbv-buf-size=2400:open-gop=0 Football_540p_1_2MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 640x360 -preset veryfast -x265-params keyint=60:min-keyint=60:scenecut=0
:bitrate=800:vbv-maxrate=800:vbv-buf-size=1600:open-gop=0 Football_360p_800kb_x265_veryfast.mp4
```

x265 Medium

- Did not produce a single ladder



The image shows two terminal windows. The left window displays the output of the 'top' command, showing system performance metrics such as CPU usage, memory usage, and process statistics. The right window displays the output of the 'ps' command, showing a list of processes with columns for PID, USER, PR, NI, VIRT, RES, SHR, S, %CPU, %MEM, and TIME+.

```
xilinx_AWS.tlp - ubuntu@3.84.249.59:22 - Bitwise xterm - ubuntu@ip-172...
864kB time=00:00:48.78 bitrate=6189.7kbits/s dup=0 drop=5804 spee
frame= 2927 fps= 32 q=36.0 q=36.9 q=33.6 q=37.1 q=35.8 size= 37
120kB time=00:00:49.02 bitrate=6202.8kbits/s dup=0 drop=5836 spee
frame= 2948 fps= 32 q=36.1 q=26.0 q=34.0 q=27.0 q=35.2 size= 37
376kB time=00:00:49.40 bitrate=6197.1kbits/s dup=0 drop=5880 spee
frame= 2969 fps= 32 q=36.3 q=27.2 q=34.0 q=37.2 q=26.6 size= 37
632kB time=00:00:49.72 bitrate=6199.4kbits/s dup=0 drop=5920 spee
frame= 2988 fps= 32 q=36.0 q=36.4 q=26.7 q=28.6 q=35.7 size= 37
632kB time=00:00:50.06 bitrate=6157.1kbits/s dup=0 drop=5960 spee
frame= 3007 fps= 32 q=35.8 q=36.0 q=34.6 q=28.7 q=27.2 size= 37
888kB time=00:00:50.38 bitrate=6159.6kbits/s dup=0 drop=5996 spee
frame= 3024 fps= 32 q=33.3 q=35.9 q=34.8 q=34.7 q=36.1 size= 38
144kB time=00:00:50.64 bitrate=6169.9kbits/s dup=0 drop=6032 spee
frame= 3037 fps= 32 q=26.2 q=35.7 q=27.6 q=36.9 q=35.6 size= 38
400kB time=00:00:50.85 bitrate=6185.2kbits/s dup=0 drop=6056 spee
frame= 3051 fps= 32 q=27.1 q=32.8 q=34.7 q=35.5 q=25.6 size= 38
656kB time=00:00:51.09 bitrate=6197.9kbits/s dup=0 drop=6084 spee
frame= 3066 fps= 32 q=27.3 q=31.7 q=25.8 q=27.9 q=26.5 size= 38
656kB time=00:00:51.37 bitrate=6164.4kbits/s dup=0 drop=6116 spee
frame= 3081 fps= 32 q=27.3 q=28.3 q=34.4 q=29.1 q=34.9 size= 38
912kB time=00:00:51.60 bitrate=6177.0kbits/s dup=0 drop=6144 spee
frame= 3095 fps= 32 q=33.4 q=28.4 q=34.4 q=36.5 q=35.3 size= 39
168kB time=00:00:51.86 bitrate=6187.0kbits/s dup=0 drop=6172 spee
frame= 3109 fps= 32 q=35.6 q=28.2 q=34.4 q=36.7 q=33.7 size= 39
424kB time=00:00:52.09 bitrate=6199.4kbits/s dup=0 drop=6200 spee
d=0.541x

xilinx_AWS.tlp - ubuntu@3.84.249.59:22 - Bitwise xterm - ubuntu@ip-172-31-64-108:~
top - 18:52:50 up 1:57, 2 users, load average: 23.00, 7.43, 2.65
Tasks: 785 total, 1 running, 784 sleeping, 0 stopped, 0 zombie
%Cpu(s): 1.4 us, 0.3 sy, 21.5 ni, 76.9 id, 0.0 wa, 0.0 hi, 0.0 si,
KiB Mem : 19771619+total, 19267897+free, 3741428 used, 1295788 buff/cache
KiB Swap: 0 total, 0 free, 0 used. 19298547+avail Mem

  PID USER      PR  NI  VIRT  RES  SHR  S  %CPU  %MEM    TIME+
 6394 ubuntu    20   0 46.625g 2.597g 22996 S 2230 1.4 36:59.99
   43 root      rt    0    0    0    0 S 0.3 0.0 0:00.56
  557 root      20   0    0    0    0 S 0.3 0.0 0:00.02
 7897 ubuntu    20   0 41184 4440 3136 R 0.3 0.0 0:00.39
   1 root      20   0 185464 5956 3940 S 0.0 0.0 0:03.66
   2 root      20   0    0    0    0 S 0.0 0.0 0:00.01
   3 root      20   0    0    0    0 S 0.0 0.0 0:00.00
   5 root      0 -20   0    0    0 S 0.0 0.0 0:00.00
   6 root      20   0    0    0    0 S 0.0 0.0 0:00.00
   8 root      20   0    0    0    0 S 0.0 0.0 0:00.10
   9 root      20   0    0    0    0 S 0.0 0.0 0:00.00
  10 root      rt    0    0    0    0 S 0.0 0.0 0:00.56
  11 root      rt    0    0    0    0 S 0.0 0.0 0:00.02
  12 root      rt    0    0    0    0 S 0.0 0.0 0:00.01
  13 root      rt    0    0    0    0 S 0.0 0.0 0:00.56
  14 root      20   0    0    0    0 S 0.0 0.0 0:00.00
  16 root      0 -20   0    0    0 S 0.0 0.0 0:00.00
  17 root      rt    0    0    0    0 S 0.0 0.0 0:00.01
```

```
ffmpeg -y -re -i Football_1080p.mp4 \
-c:v libx265 -preset veryfast -x265-params keyint=120:min-keyint=120:scenecut=0:bitrate=6000:vbv-
maxrate=6000:vbv-buf-size=12000:open-gop=0 Football_1080p_6MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -preset veryfast -x265-params keyint=60:min-keyint=60:scenecut=0:bitrate=4000:vbv-
maxrate=4000:vbv-buf-size=8000:open-gop=0 Football_1080p_4MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 1280x720 -preset veryfast -x265-params keyint=60:minkeyint=60:scenecut=0:
bitrate=2500:vbv-maxrate=2500:vbv-buf-size=5000:open-gop=0 Football_720p_2_5MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 960x540 -preset veryfast -x265-params keyint=60:minkeyint=60:scenecut=0:
bitrate=1200:vbv-maxrate=1200:vbv-buf-size=2400:open-gop=0 Football_540p_1_2MB_x265_veryfast.mp4 \
-c:v libx265 -r 30 -s 640x360 -preset veryfast -x265-params keyint=60:min-keyint=60:scenecut=0
:bitrate=800:vbv-maxrate=800:vbv-buf-size=1600:open-gop=0 Football_360p_800kb_x265_veryfast.mp4
```

x265 Start-up Latency

Preset	Latency
Veryfast	.94 (sec)
Medium	.92 (sec)

- Recorded screen with Camtasia
- Pasted in command string
- Computed time from paste until first frame appeared
- Ran three tests and averaged time

x265 Command Strings

- Objective

```
ffmpeg -y -re -i Football_1080p.mp4 -c:v libx265 -preset veryfast -tune psnr  
-x265-params keyint=120:min-keyint=120:scenecut=0:bitrate=3000:vbv-  
maxrate=3000:vbv-buffersize=6000:open-gop=0 Football_1080p_3MB_x265_vf_tune_buf.mp4
```

- Subjective

```
ffmpeg -y -re -i Football_1080p.mp4 -c:v libx265 -preset veryfast  
-x265-params keyint=120:min-keyint=120:scenecut=0:bitrate=3000:vbv-  
maxrate=3000:vbv-buffersize=6000:open-gop=0 Football_1080p_3MB_x265_vf_viz_buf.mp4
```

About The Tests

- We ran encoding trials and objective metrics on four files, three of which were 2 minutes long (Football, Meridian, GTAV) and one that was 10 seconds long (Crowdrun)
 - Objective metrics were produced using the Moscow State University Video Quality Measurement Tool
- Subjective tests were performed on ten-second segments of the three longer files and the full 10-second clip
 - Subjective tests were 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
 - The tests produced the Double Stimulus Impairment Scale Mean Opinion Score according to the ITU-R Recommendation BT 500 (<https://www.itu.int/rec/R-REC-BT.500-14-201910-1/en>)

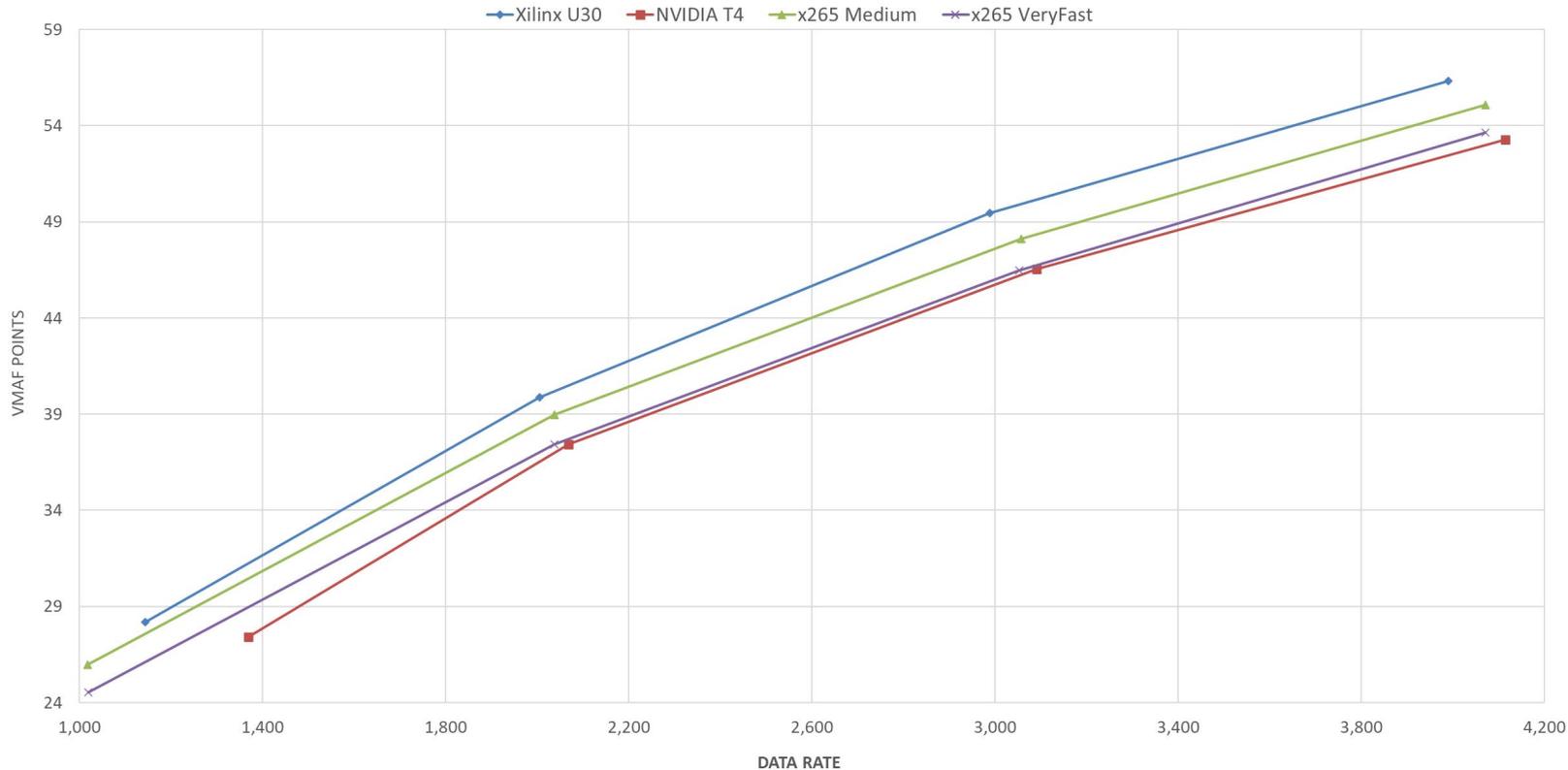
U30 Quality Results

- Four videos
 - Crowdrun
 - Harmonic Football
 - GTAV
 - Netflix Meridian
 - All 1080p60
- Tested at 2-5 Mbps

Crowdrun

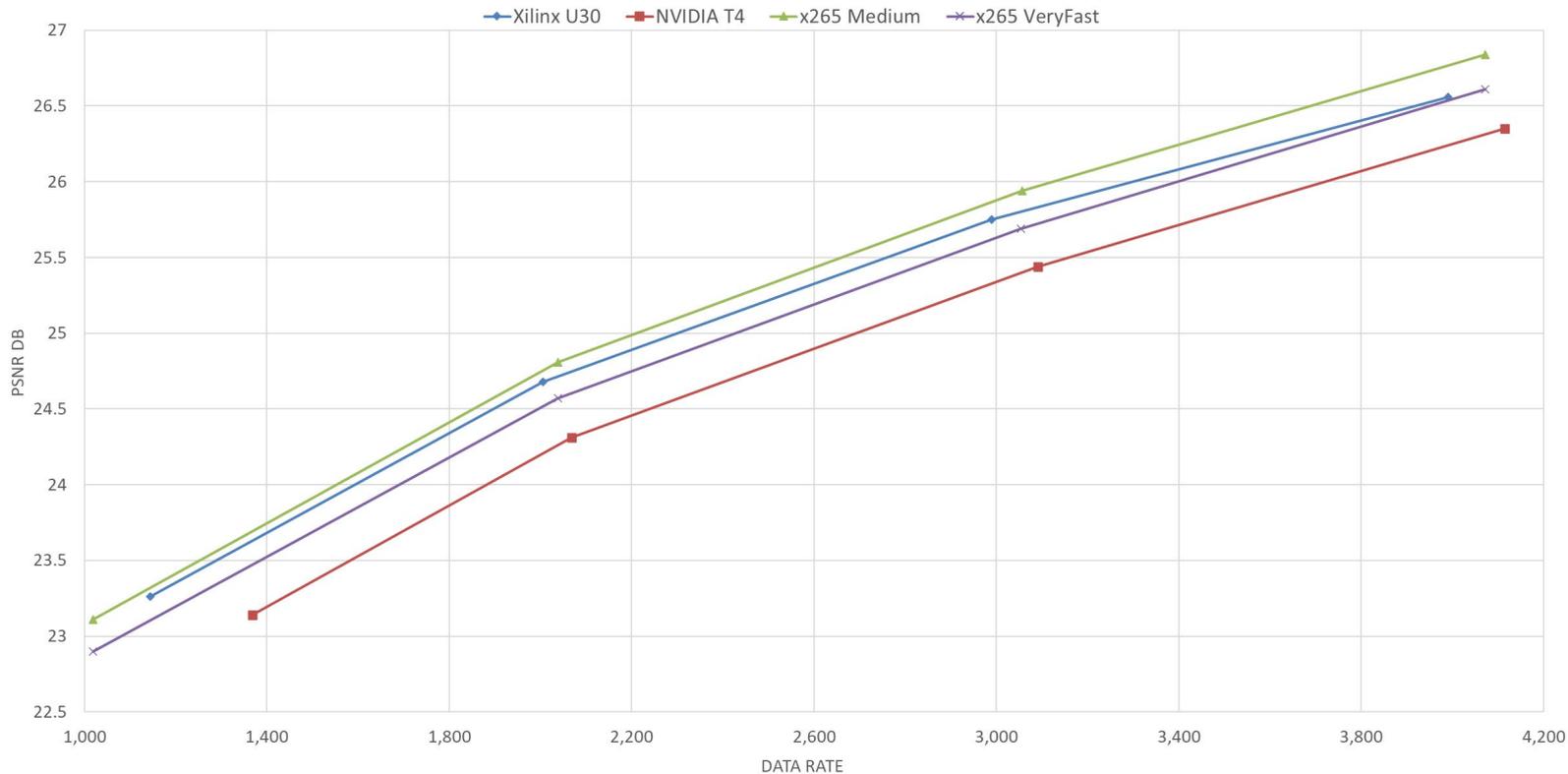
- VMAF
- PSNR
- Subjective
- Results plot (U30 vs. T4, x265 Medium, x265 Veryfast)
- Quality consistency

CROWDRUN 1080P60 - VMAF



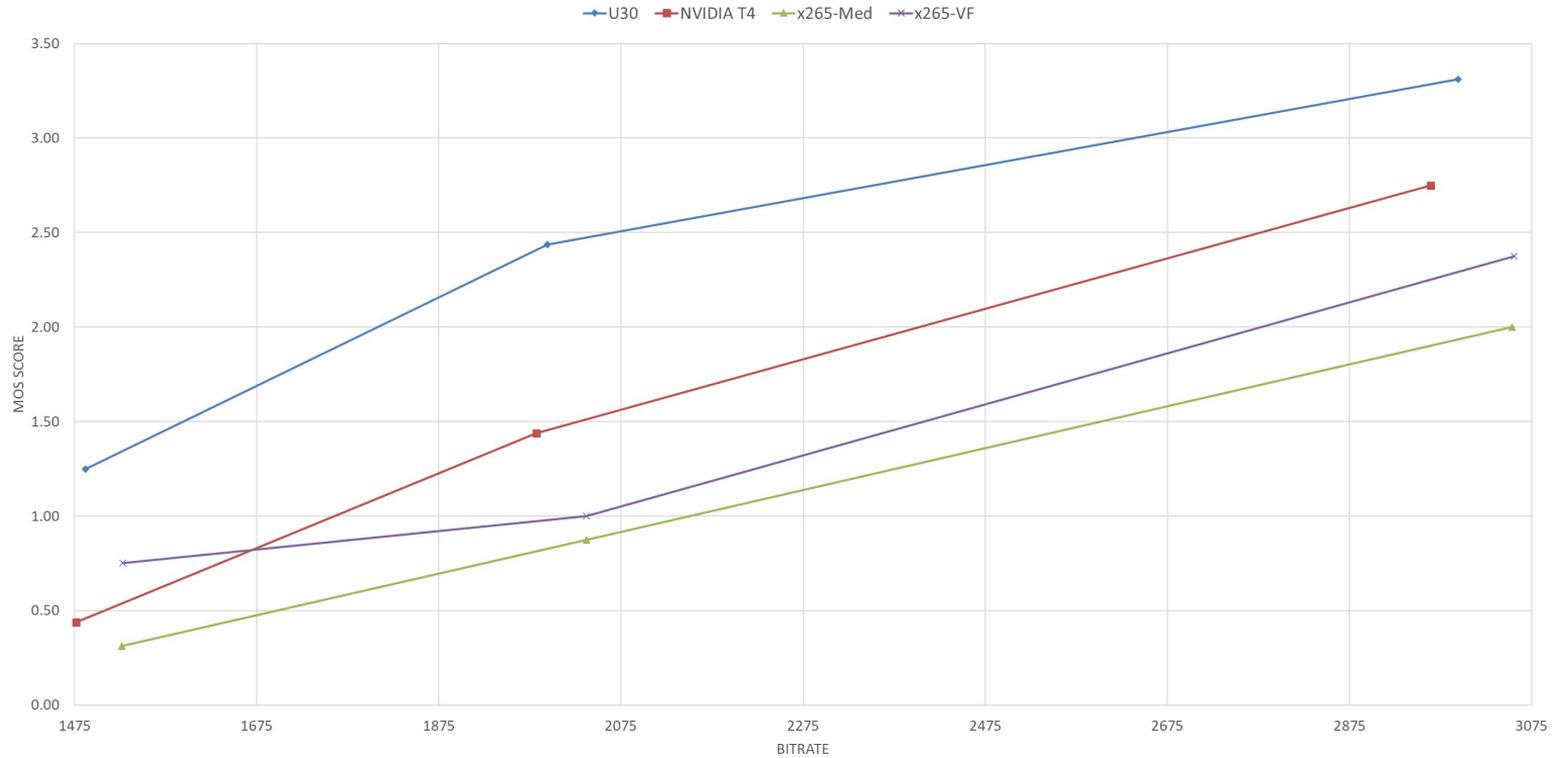
	VMAF - CrowdRun	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
①	Xilinx U30	X	-14.35	-5.66	-12.05
④	NVIDIA T4	16.76	X	10.63	2.98
②	x265 Medium	5.99	-9.61	X	-6.96
③	x265 VeryFast	13.70	-2.90	7.48	X

CROWDRUN 1080P60 - PSNR



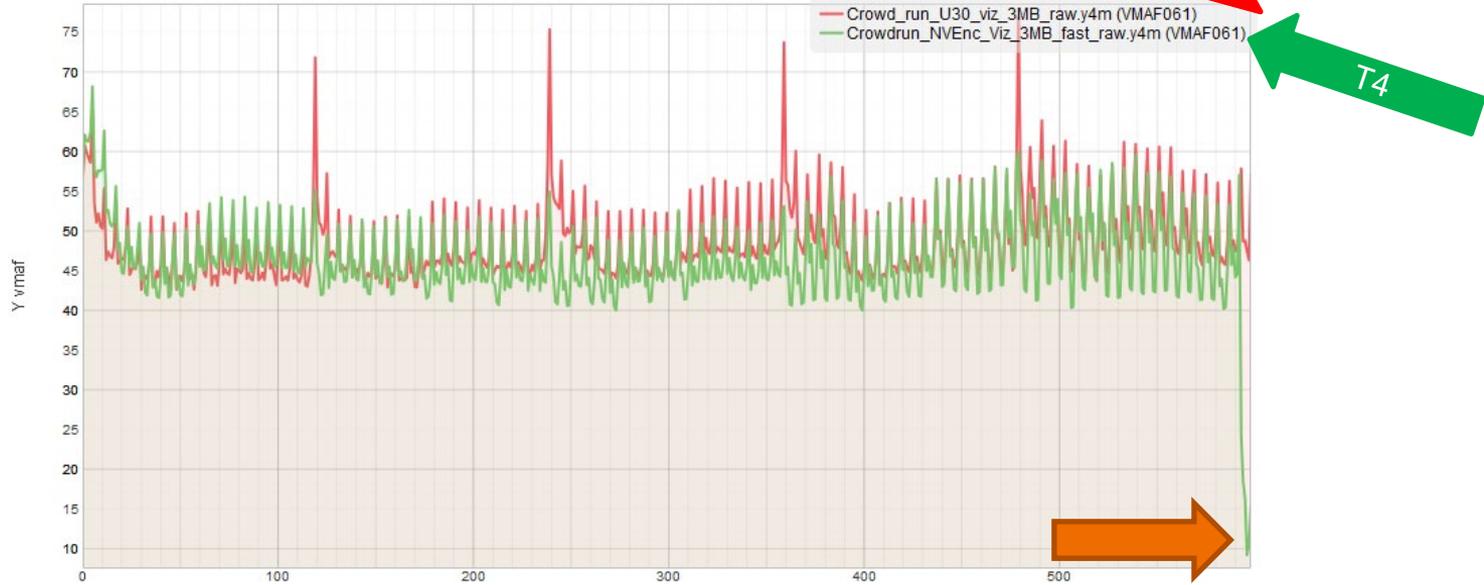
	PSNR - Crowdrun	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
②	Xilinx U30	X	-14.98	4.27	-4.50
④	NVIDIA T4	17.62	X	22.81	12.35
①	x265 Medium	-4.09	-18.57	X	-8.41
③	x265 VeryFast	4.71	-11.00	9.18	X

CROWD RUN - U30 - SUBJECTIVE



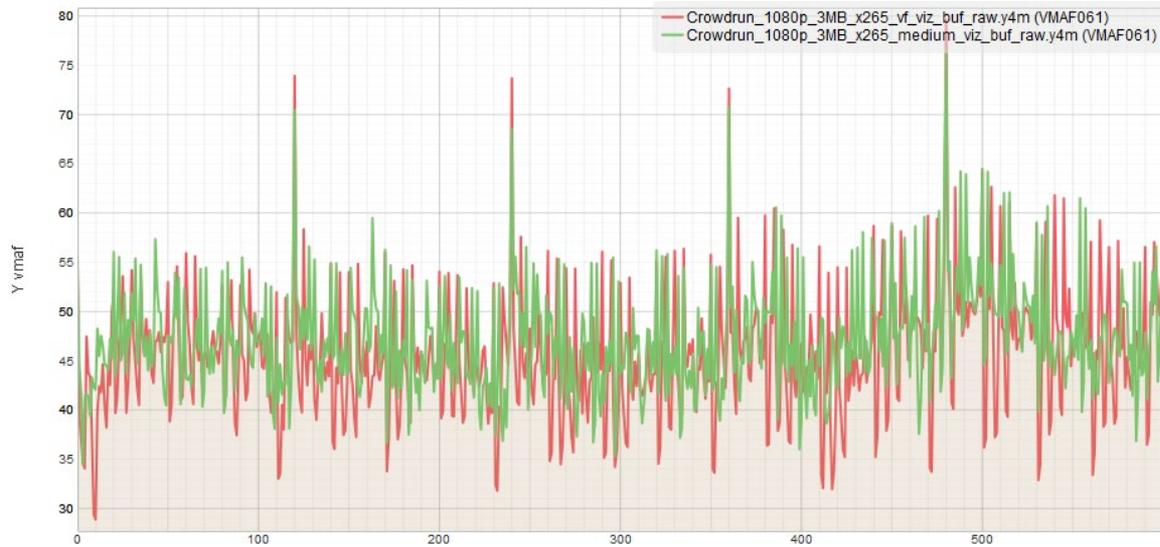
	Crowdrun - Sub	Xilinx-U30	NVIDIA T4	x265-Med	x265-VF
①	Xilinx-U30	X	-24.83%	-41.37%	-39.75%
②	NVIDIA T4	33.04%	X	-19.71%	-17.57%
④	x265-Med	70.57%	24.55%	X	4.73%
③	x265-VF	65.99%	21.32%	-4.52%	X

Results Plot Comparison



- Ignore errors at the end of files (no impact on QoE)

Results Plot Comparison



- x265 veryfast shows much more variability which can degrade QoE

Quality Variability - Crowdrun

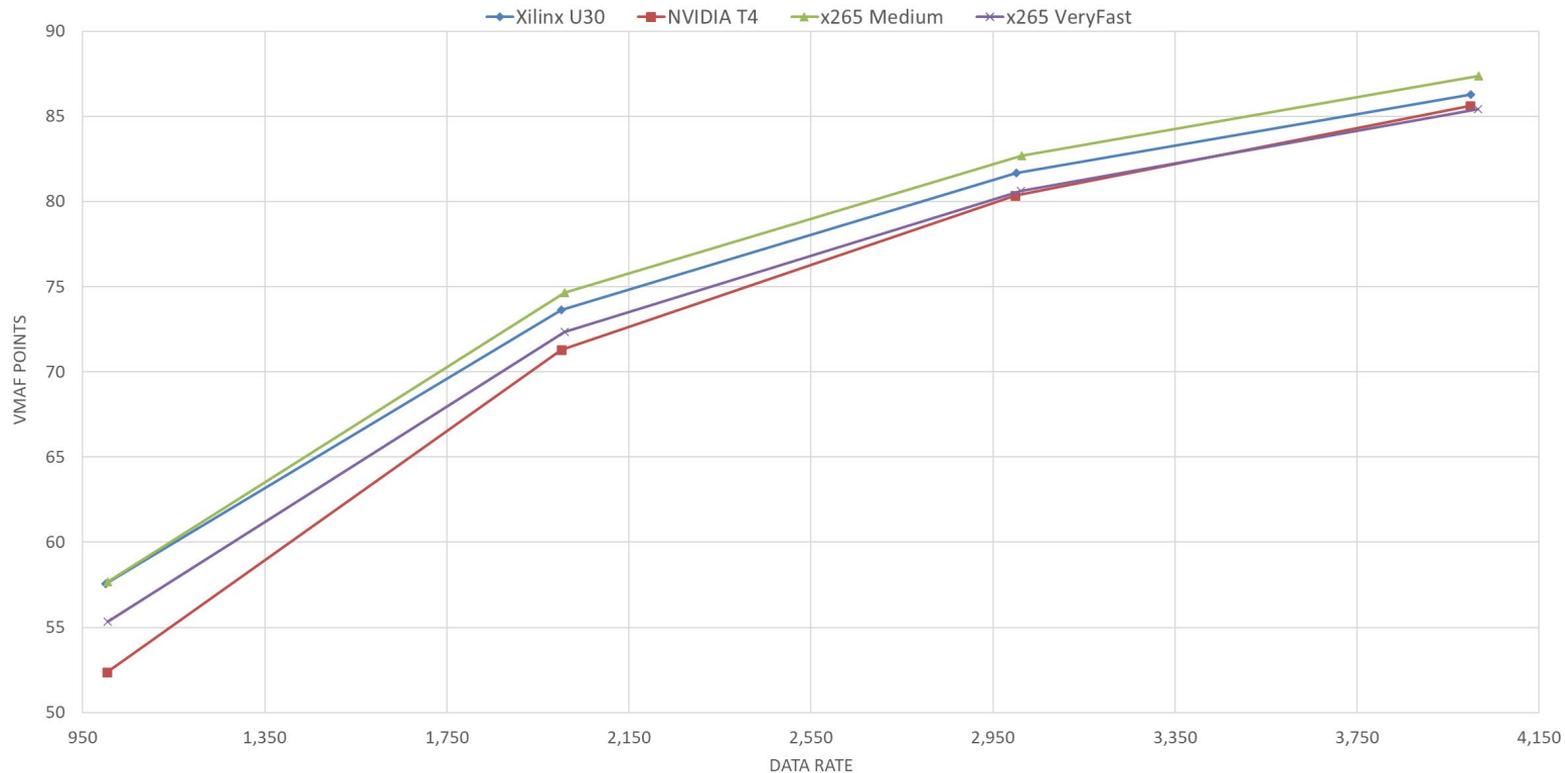
	U30	T4	Medium	Very Fast
Low frame VMAF	42.52	30.51	34.52	28.87
Standard Deviation	4.82	5.52	5.63	6.46
Ranking	1	2	2	4

- Ranking is average rank for low-frame (higher is better) and standard deviation (lower is better)

Football

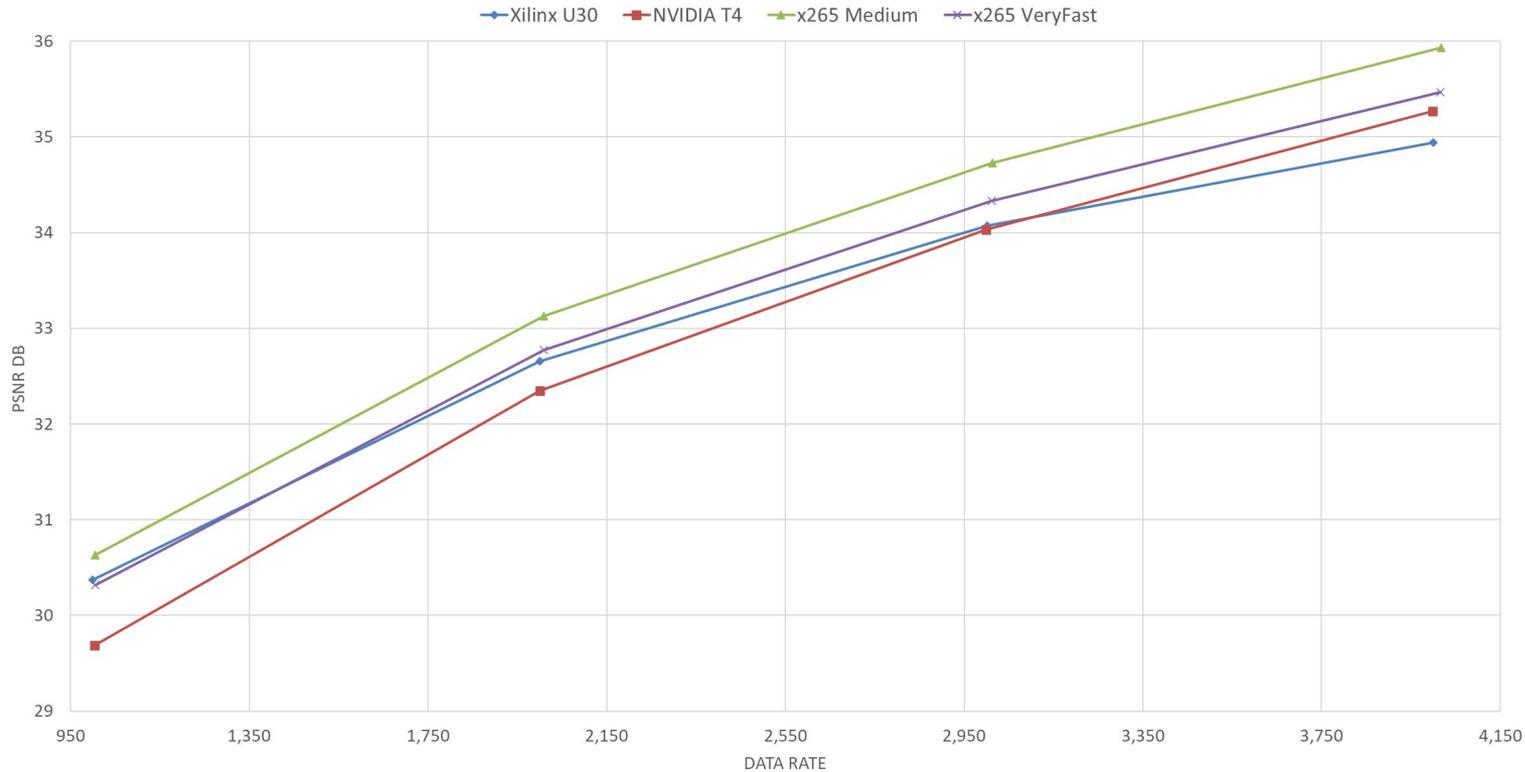
- VMAF
- PSNR
- Subjective
- Results plot (U30 vs. T4, x265 Veryfast vs. Medium)
- Quality consistency

U30 COMPS - FOOTBALL 1080P60 - VMAF



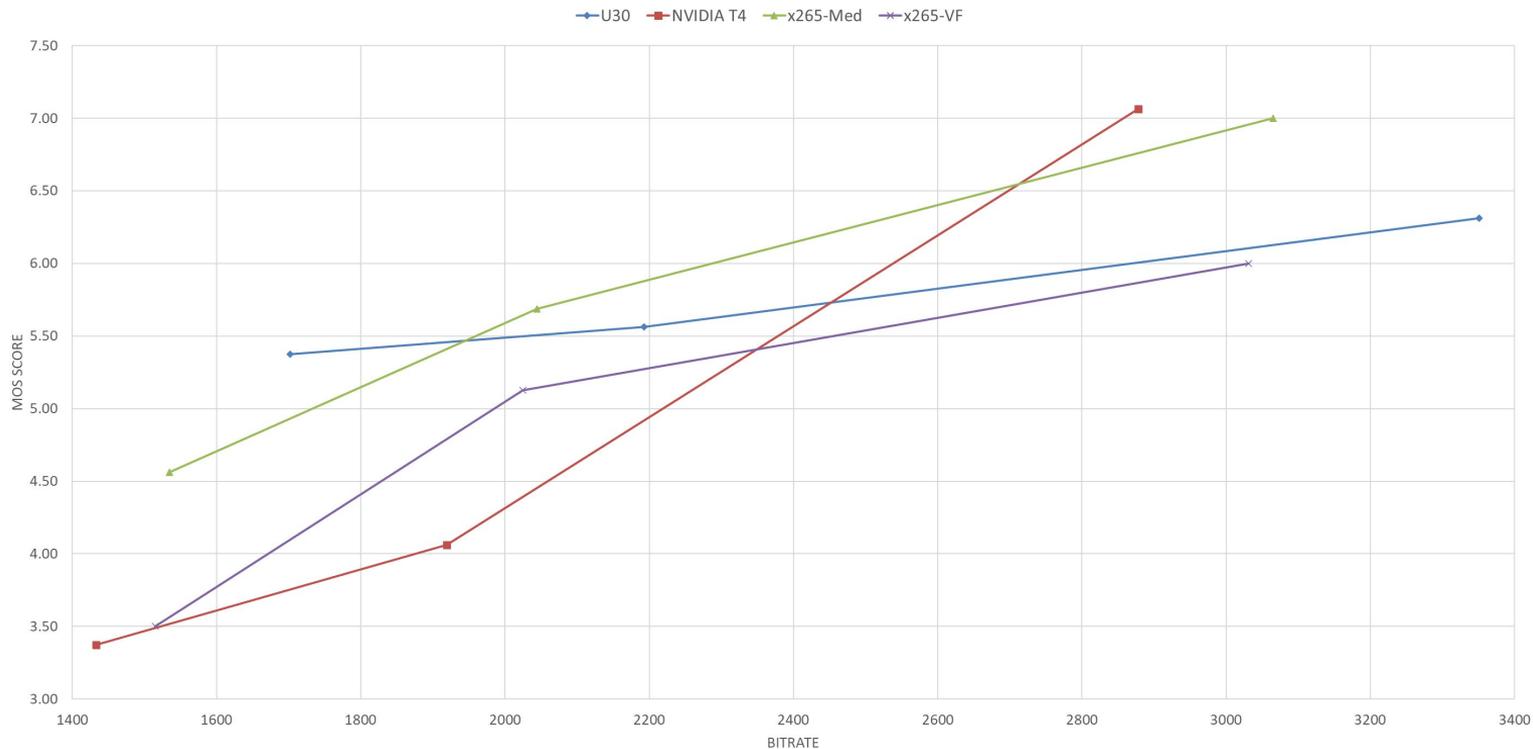
VMAF - Football	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
② Xilinx U30	X	-10.09	3.83	-6.38
④ NVIDIA T4	11.23	X	15.37	4.62
① x265 Medium	-3.69	-13.32	X	-9.75
③ x265 VeryFast	6.81	-4.42	10.80	X

U30 COMPS - FOOTBALL 1080P60 - PSNR



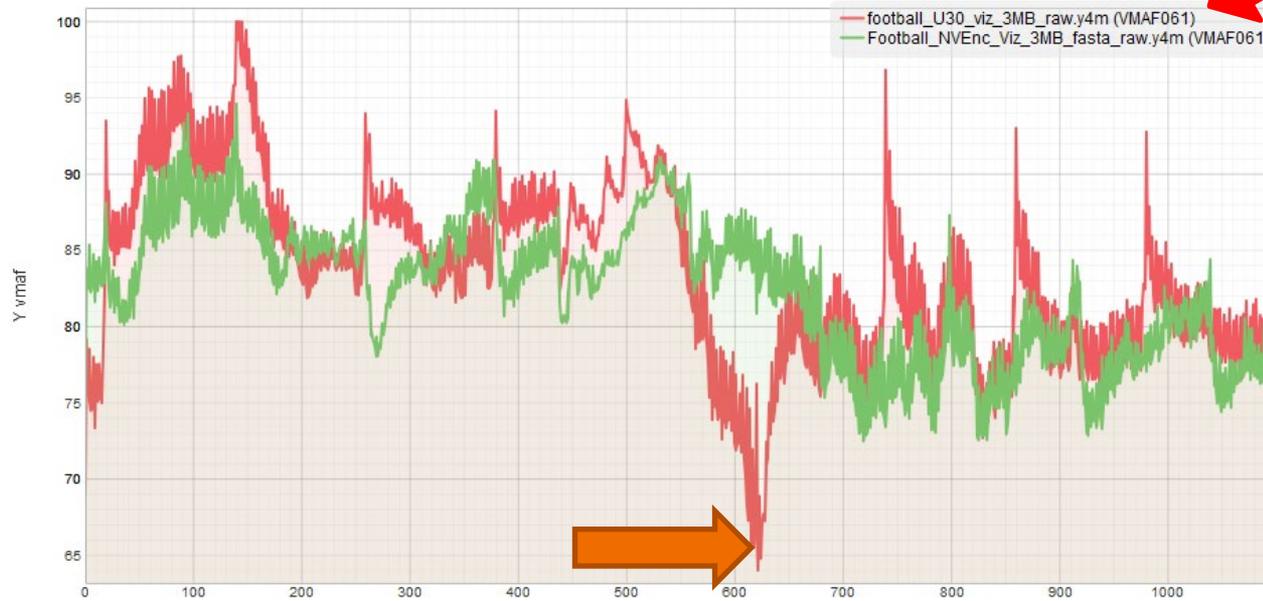
PSNR - Football		Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
③	Xilinx U30	X	-6.69	14.34	3.57
④	NVIDIA T4	7.17	X	21.38	10.67
①	x265 Medium	-12.54	-17.62	X	-9.24
②	x265 VeryFast	-3.45	-9.64	10.18	X

FOOTBALL- U30 - SUBJECTIVE



	Football - Sub	Xilinx-U30	NVIDIA T4	x265-Med	x265-VF
②	Xilinx-U30	X	-0.03%	23.90%	-6.60%
④	NVIDIA T4	0.03%	X	21.87%	13.49%
①	x265-Med	-19.29%	-17.95%	X	-16.27%
③	x265-VF	7.07%	-11.89%	19.43%	X

Results Plot Comparison



- U30 significant drop; not really visible (see following frames)

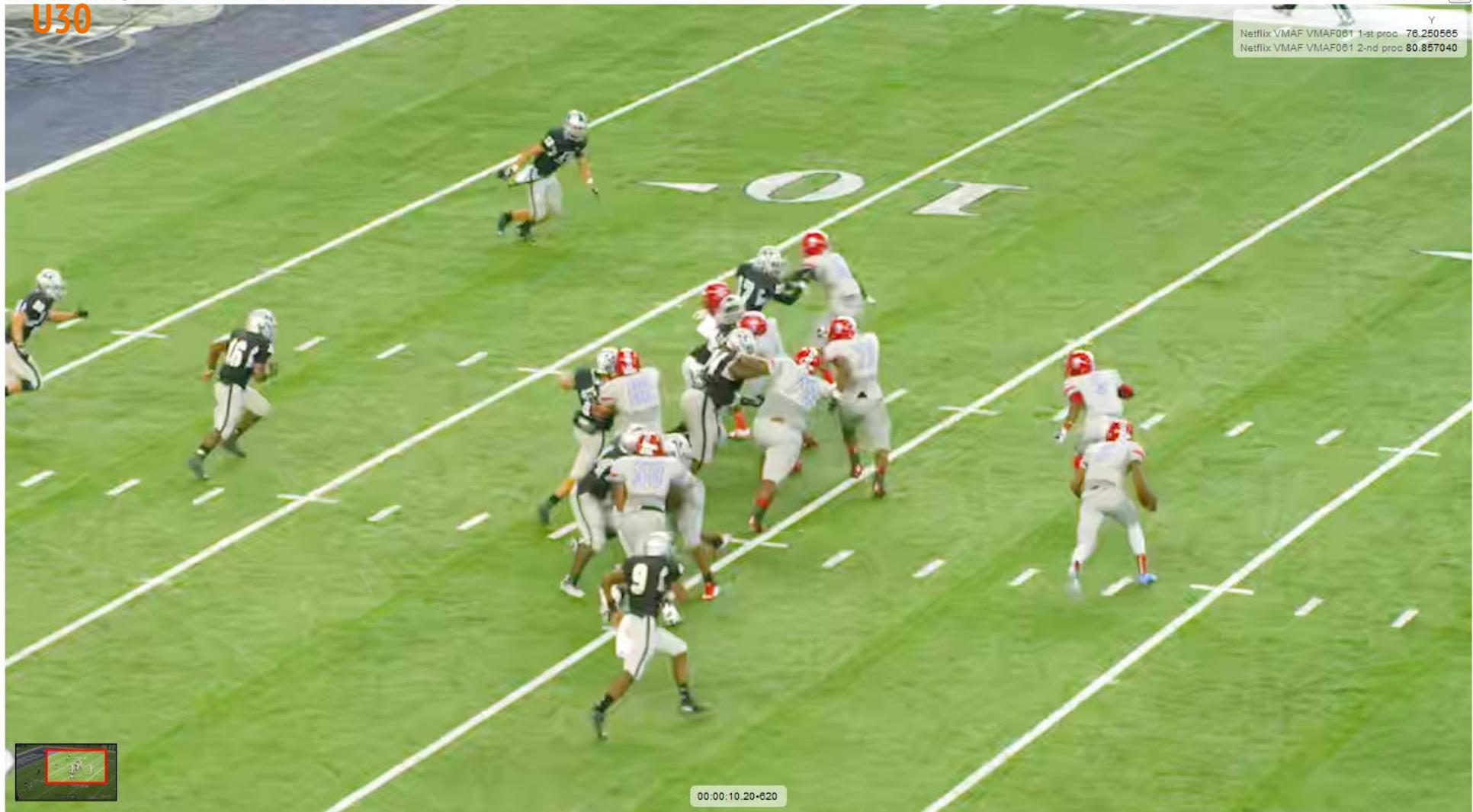
Source

Netfix VMAF VMAF001 1-st proc 76.250565
Netfix VMAF VMAF001 2-nd proc 80.857040



U30

Y
Netflix VMAF VMAF061 1-st proc 76.250565
Netflix VMAF VMAF061 2-nd proc 80.857040



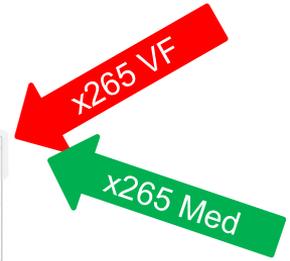
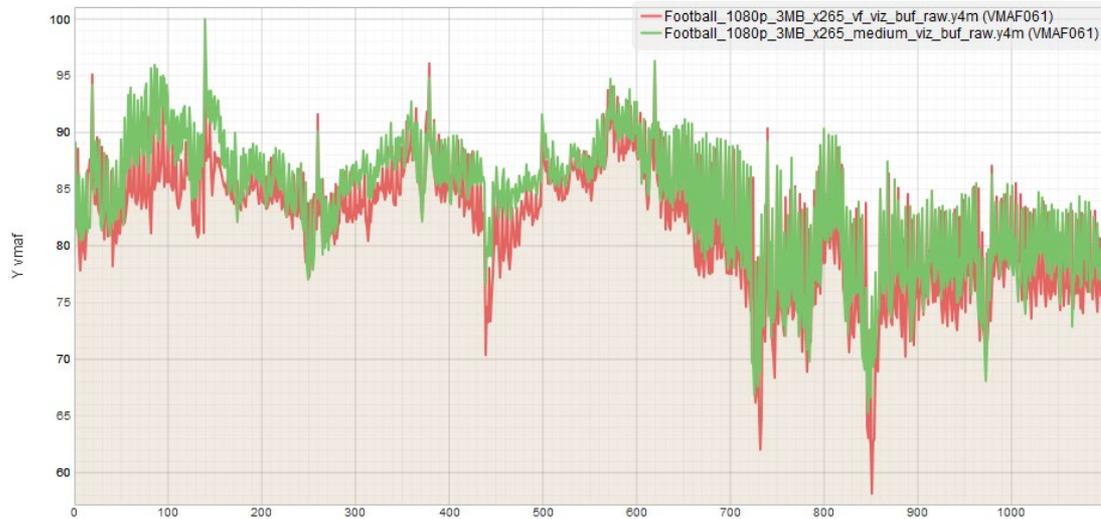
T4

Netfix VMAF VMAF061 1-st proc 76.250565
Netfix VMAF VMAF061 2-nd proc 80.857040



00:00:10.20-620

Results Plot Comparison



- x265 veryfast shows lower low-frame scores and more quality variability which can degrade QoE

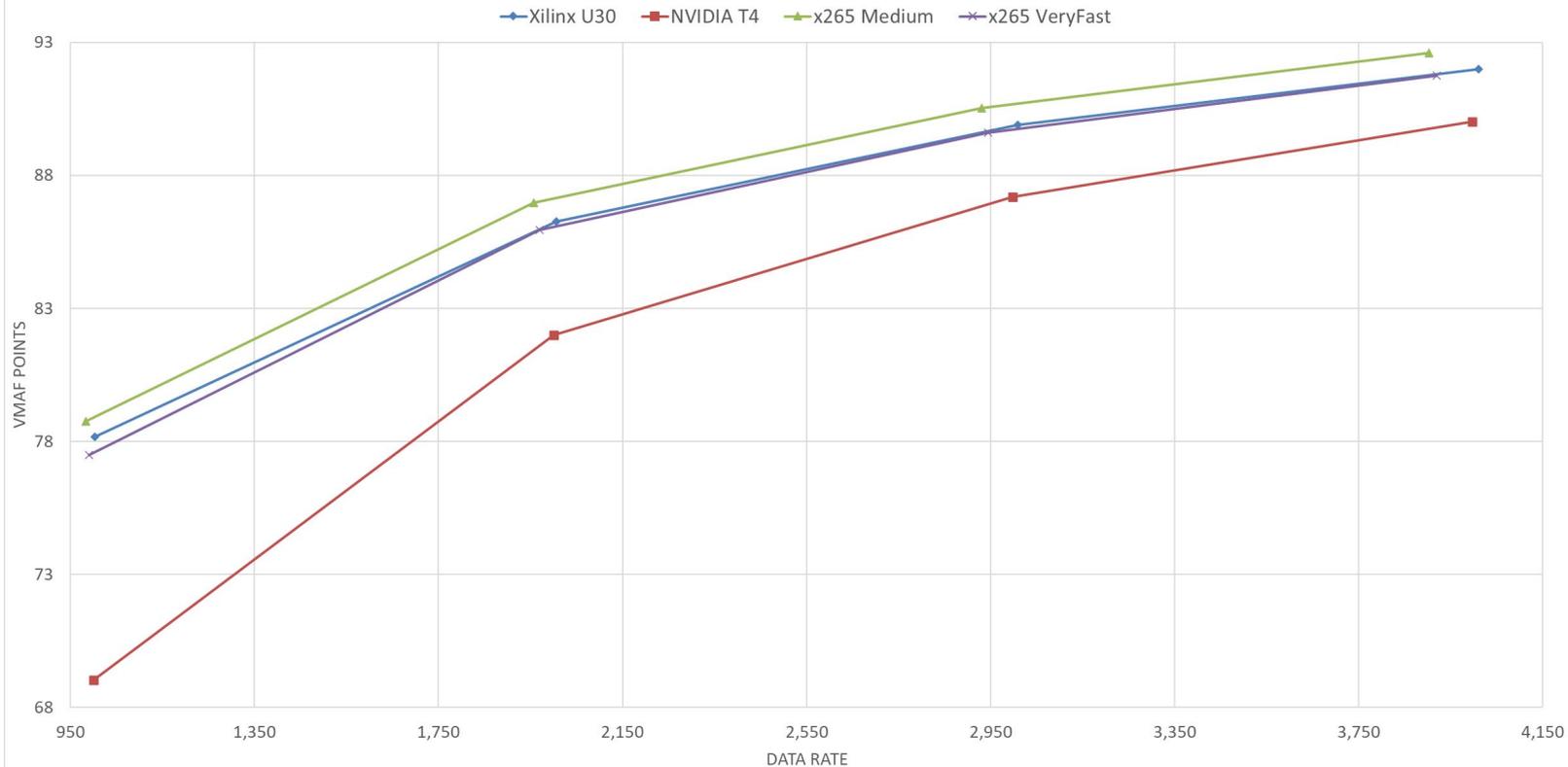
Quality Variability - Football

	U30	T4	Medium	Very Fast
Low frame VMAF	64.02	72.49	65.31	58.17
Standard Deviation	6.03	4.51	5.46	5.50
Ranking	4	1	2	4

GTAV

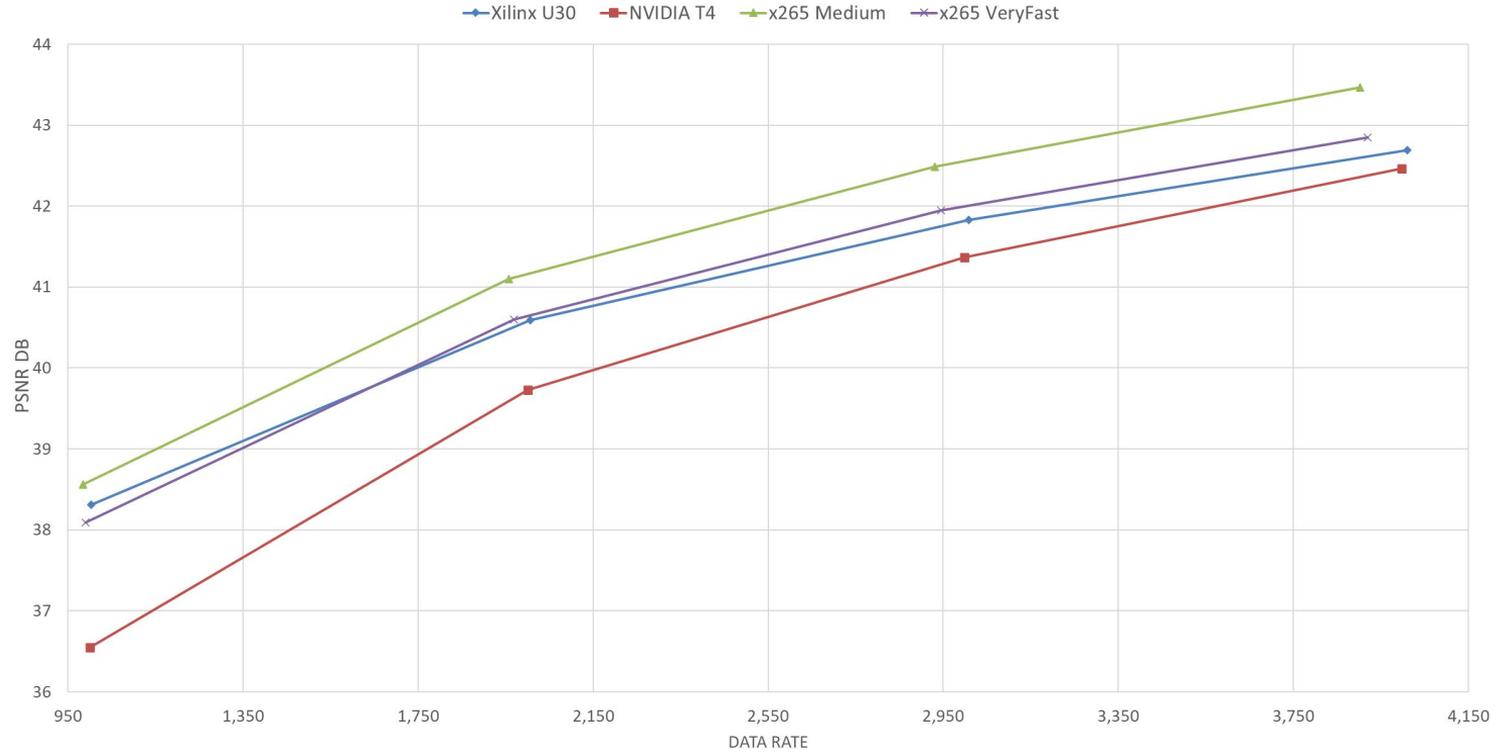
- VMAF
- PSNR
- Subjective
- Results plot (U30 vs. T4, x265 Veryfast vs. Medium)
- Quality consistency

U30 COMPS - GTAV 1080P60 - VMAF



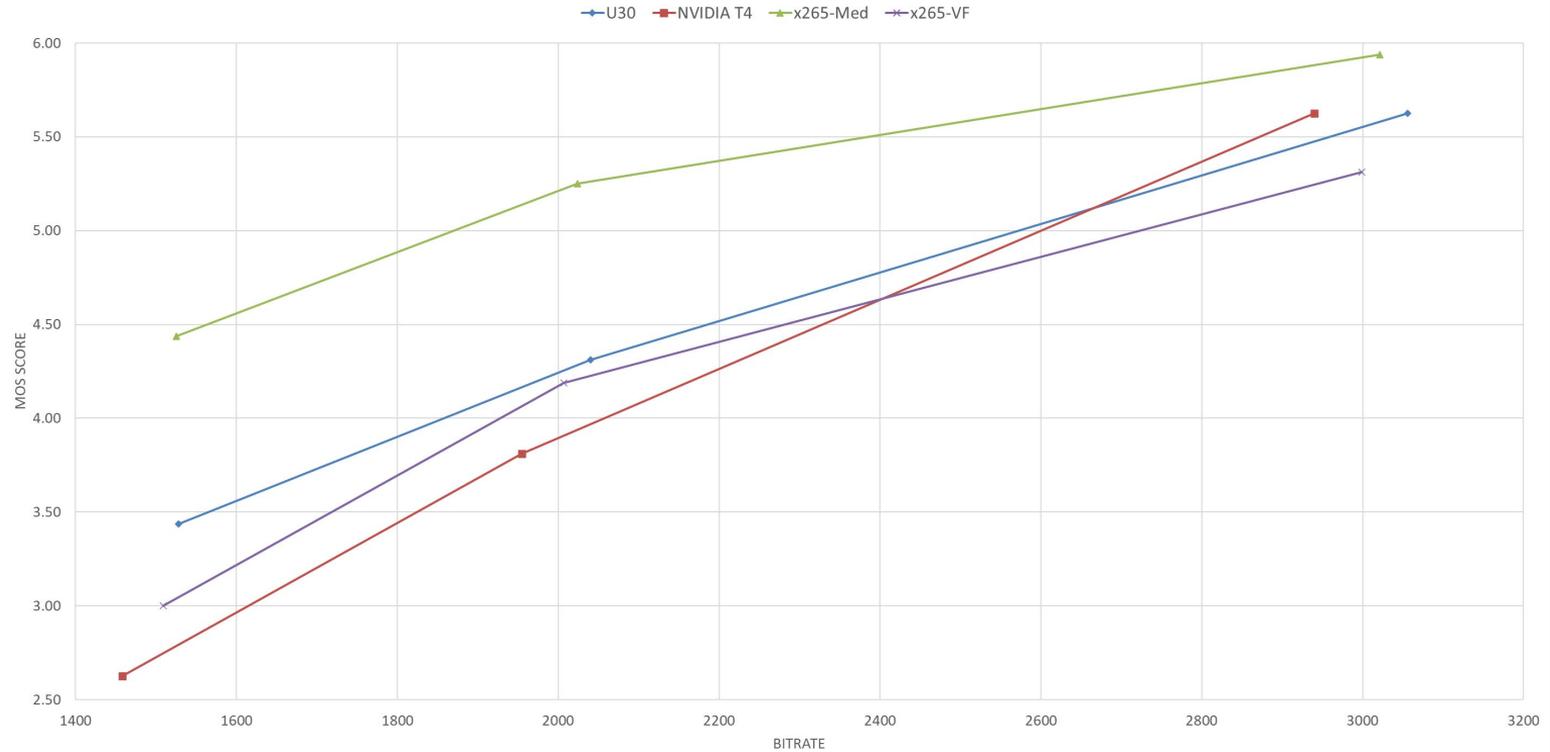
VMAF - GTAV	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
② Xilinx U30	X	-29.76	9.67	-1.82
④ NVIDIA T4	42.37	X	54.79	40.41
① x265 Medium	-8.82	-35.40	X	-10.36
③ x265 VeryFast	1.85	-28.78	11.56	X

U30 COMPS - GTAV 1080P60 - PSNR



	PSNR - GTAV	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
③	Xilinx U30	X	-19.76	18.73	1.75
④	NVIDIA T4	24.62	X	45.98	26.99
①	x265 Medium	-15.78	-31.50	X	-14.10
②	x265 VeryFast	-1.72	-21.25	16.41	X

GTAV - U30 - SUBJECTIVE



	GTAV - Sub	Xilinx-U30	NVIDIA T4	x265-Med	x265-VF
②	Xilinx-U30	X	-5.46%	36.28%	-3.88%
④	NVIDIA T4	5.78%	X	37.88%	3.89%
①	x265-Med	-26.62%	-27.47%	X	-30.79%
③	x265-VF	4.03%	-3.75%	44.48%	X

Results Plot Comparison



- T4 shows very short transient issue
 - Visible in frames
 - Both frames degraded (challenging source, low input file quality)

Source

C:\Users\z840\Google Drive\Xilinx\Visual\GTA_V_1080p.mp4

1920x1080



U30

C:\Users\z840\Google Drive\Xilinx\Visual\Comps\New folder\GTAV_U30_viz_3M8_raw.y4m

1920x1080

Netflix VMAF VMAF001 1st proc: 51.012711
Netflix VMAF VMAF001 2nd proc: 48.701908



of
n: our
e is

00:00:05:41

00:00:04:1+241

x: 282
y: 437
r: 31
l: 135
v: 127



T4

C:\Users\z840\Google Drive\Xilinx\Visual\Comps\New folder\GTAV_NVEnc_Viz_3MB_fast_raw.y4m

1920x1080

Netflix VMAF VMAF001 1st proc 51.012711
Netflix VMAF VMAF001 2nd proc 48.701908



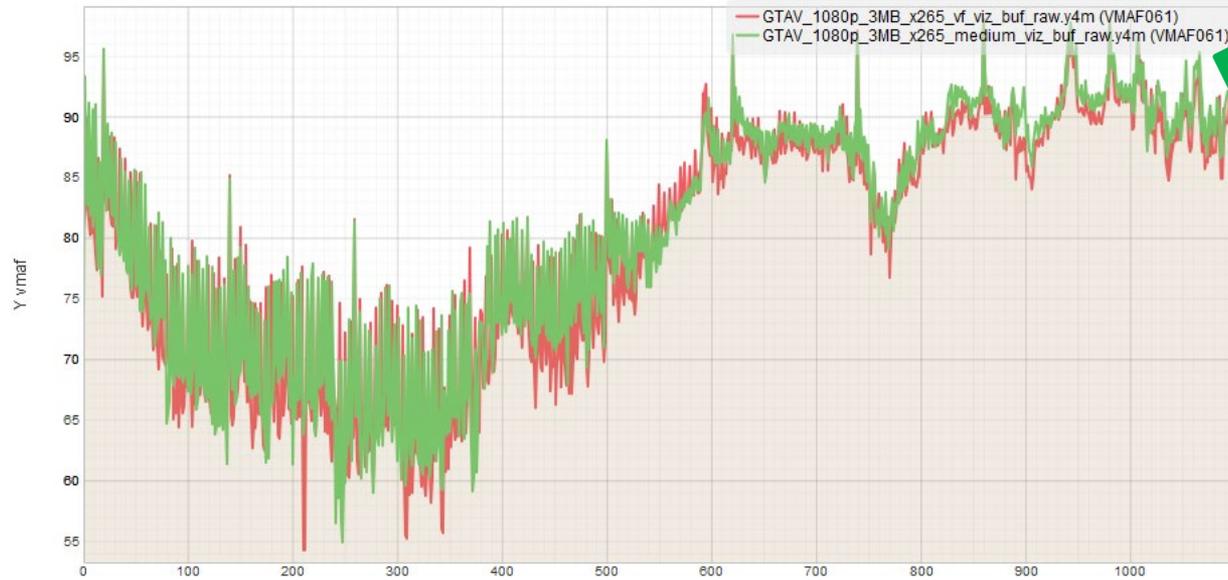
of
n: our
e is

00:00:05:41

00:00:04:1+241

x: 305
y: 426
U: 130
V: 127

Results Plot Comparison



- x265 veryfast show short transient quality issues in multiple locations

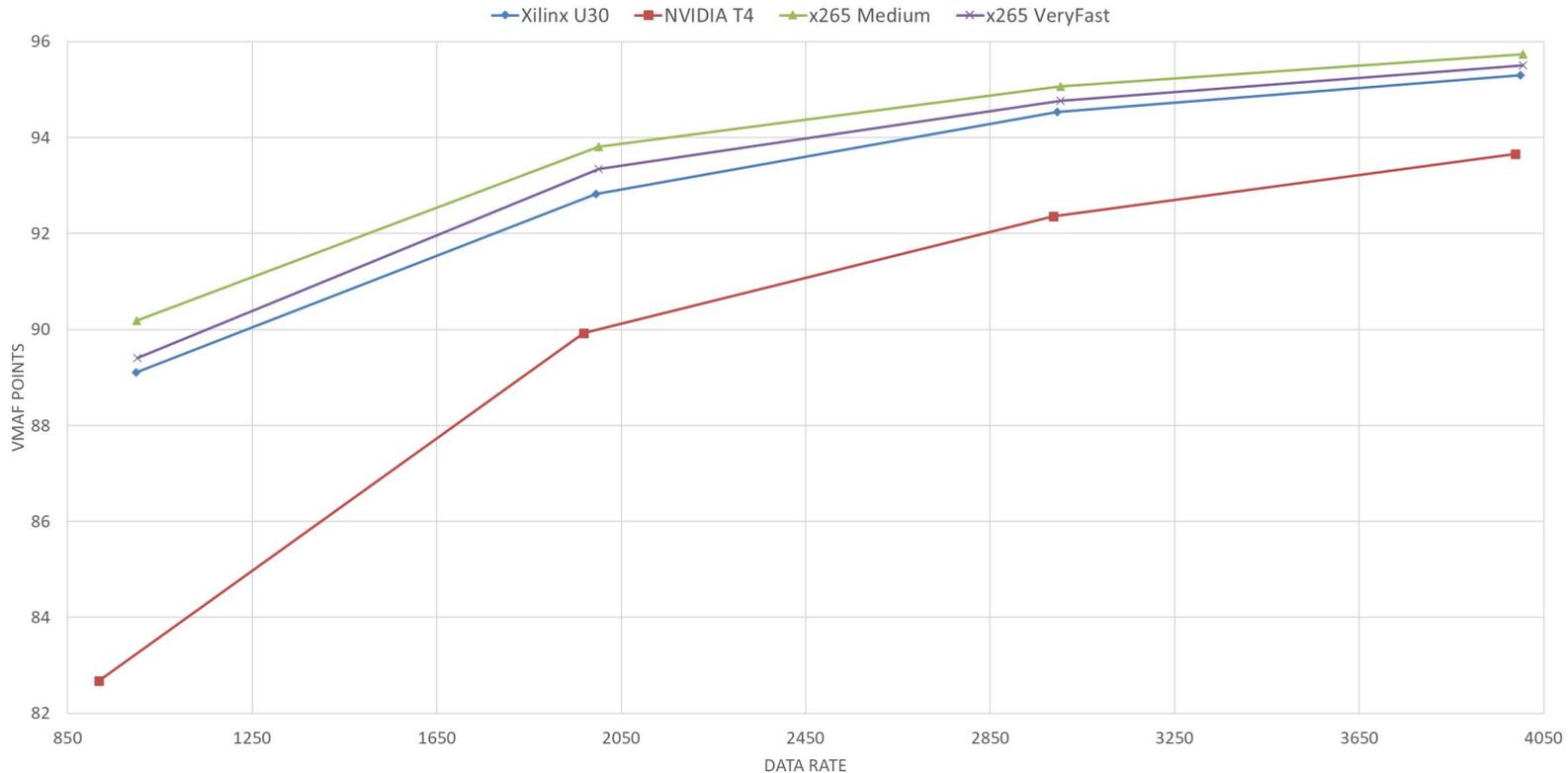
Quality Variability - GTAV

	U30	T4	Medium	Very Fast
Low frame VMAF	50.53	48.10	54.96	54.31
Standard Deviation	10.27	10.33	9.89	10.02
Ranking	3	4	1	2

Meridian

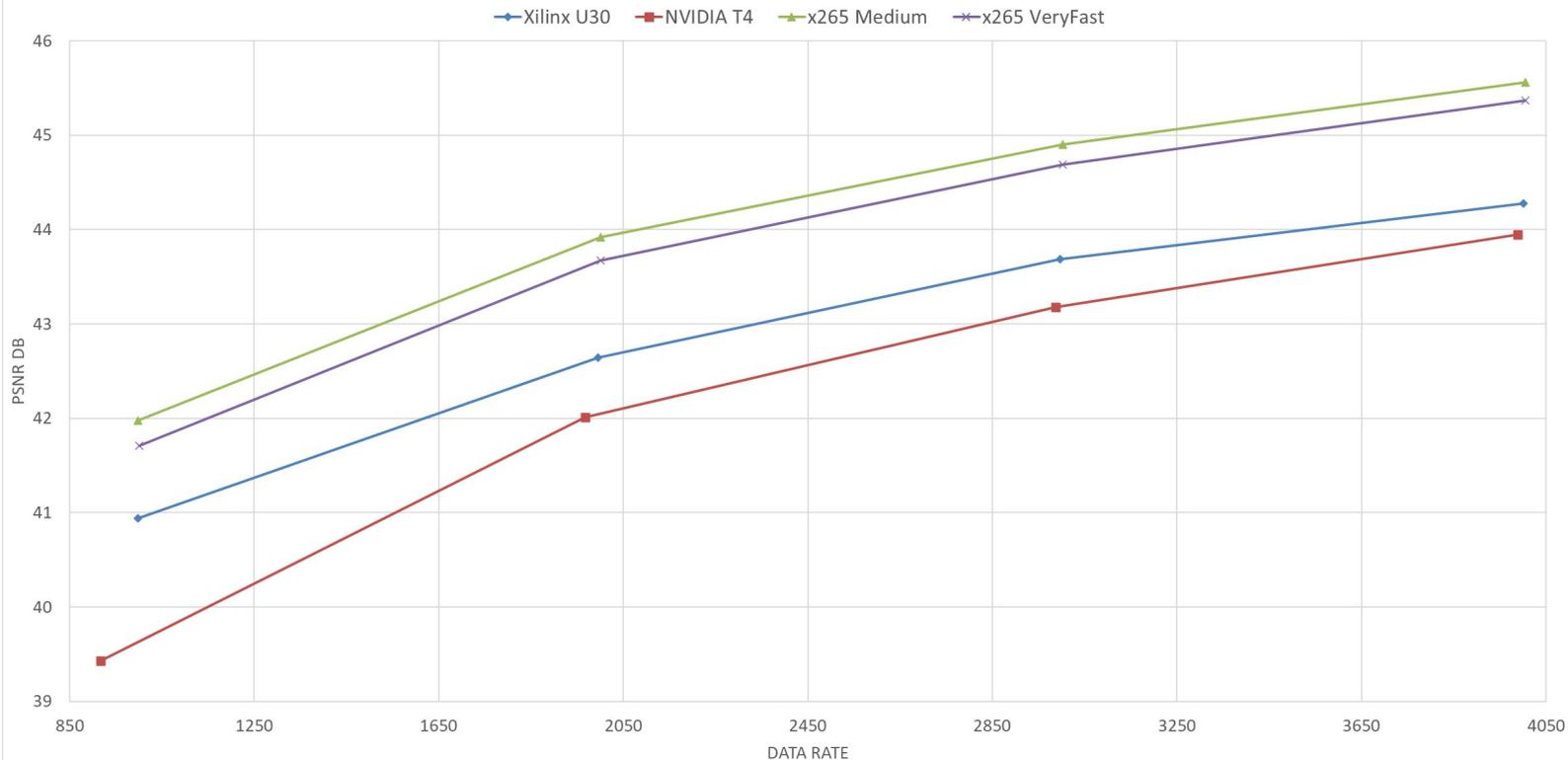
- VMAF
- PSNR
- Subjective
- Results plot (U30 vs. T4, x265 Veryfast vs. Medium)
- Quality consistency

U30 COMPS - MERIDIAN 1080P60 - VMAF



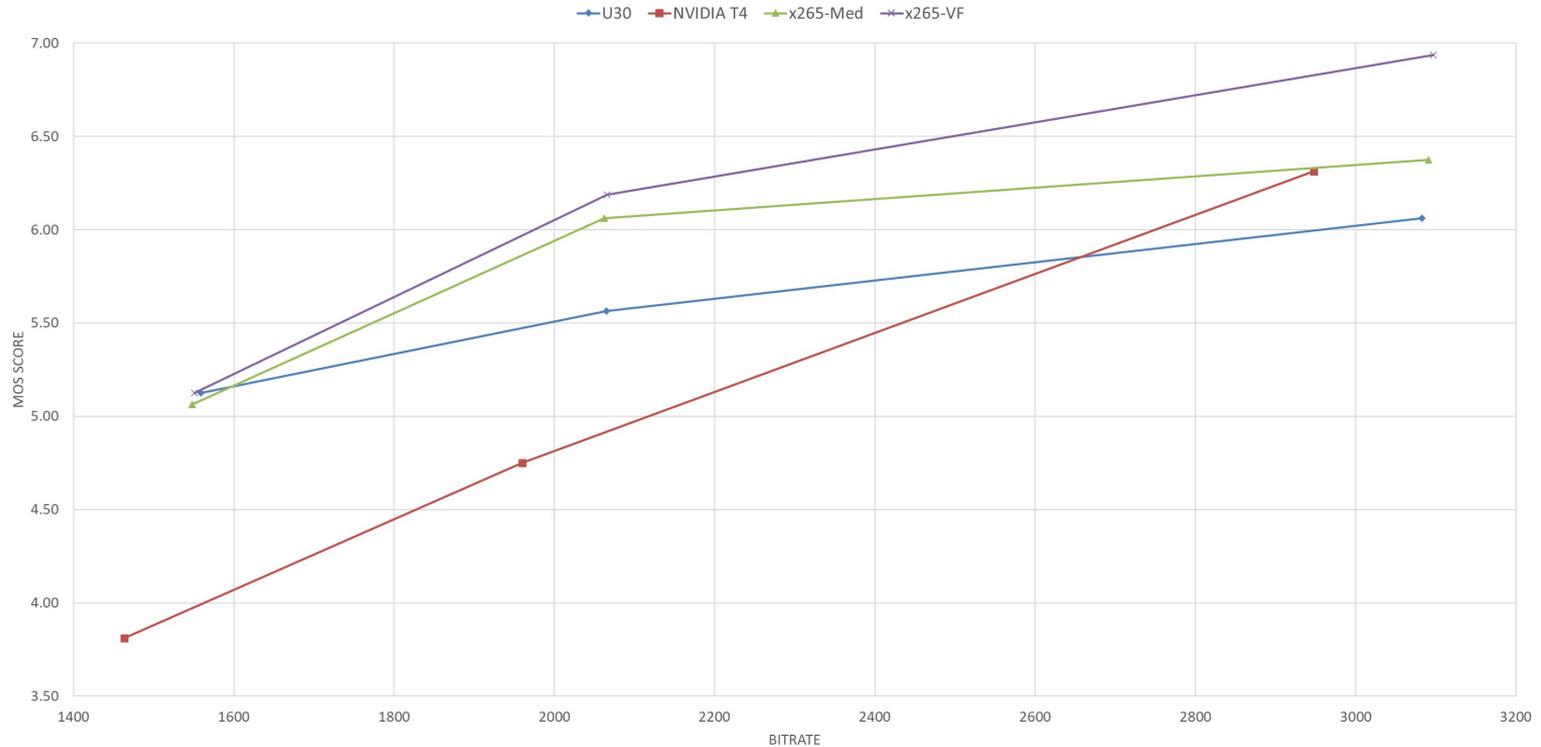
VMAF - Meridian	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
③ Xilinx U30	X	-37.84	25.80	11.72
④ NVIDIA T4	60.88	X	104.90	81.29
① x265 Medium	-20.51	-51.20	X	-11.14
② x265 VeryFast	-10.49	-44.84	12.53	X

U30 COMPS - MERIDIAN 1080P60 - PSNR



	PSNR - Meridian	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
③	Xilinx U30	X	-19.84	62.54	46.89
④	NVIDIA T4	24.75	X	97.47	78.86
①	x265 Medium	-38.48	-49.36	X	-9.03
②	x265 VeryFast	-31.92	-44.09	9.93	X

MERIDIEN - U30 - SUBJECTIVE



	Meridien - Sub	Xilinx-U30	NVIDIA T4	x265-Med	x265-VF
③	Xilinx-U30	X	-13.33%	24.26%	24.55%
④	NVIDIA T4	15.38%	X	38.57%	42.58%
②	x265-Med	-19.52%	-27.84%	X	4.28%
①	x265-VF	-19.71%	-29.87%	-4.10%	X

Results Plot Comparison



- T4 had issues with woman in rear-view mirror

Source

Netfix VMAF VMAF061 1-st proc 81.538803
Netfix VMAF VMAF061 2-nd proc 67.022446



00:00:08.22-502

U30

Y
Netflix VMAF VMAF061 1-st proc 81.538803
Netflix VMAF VMAF061 2-nd proc 67.022446



00:00:08.22-502

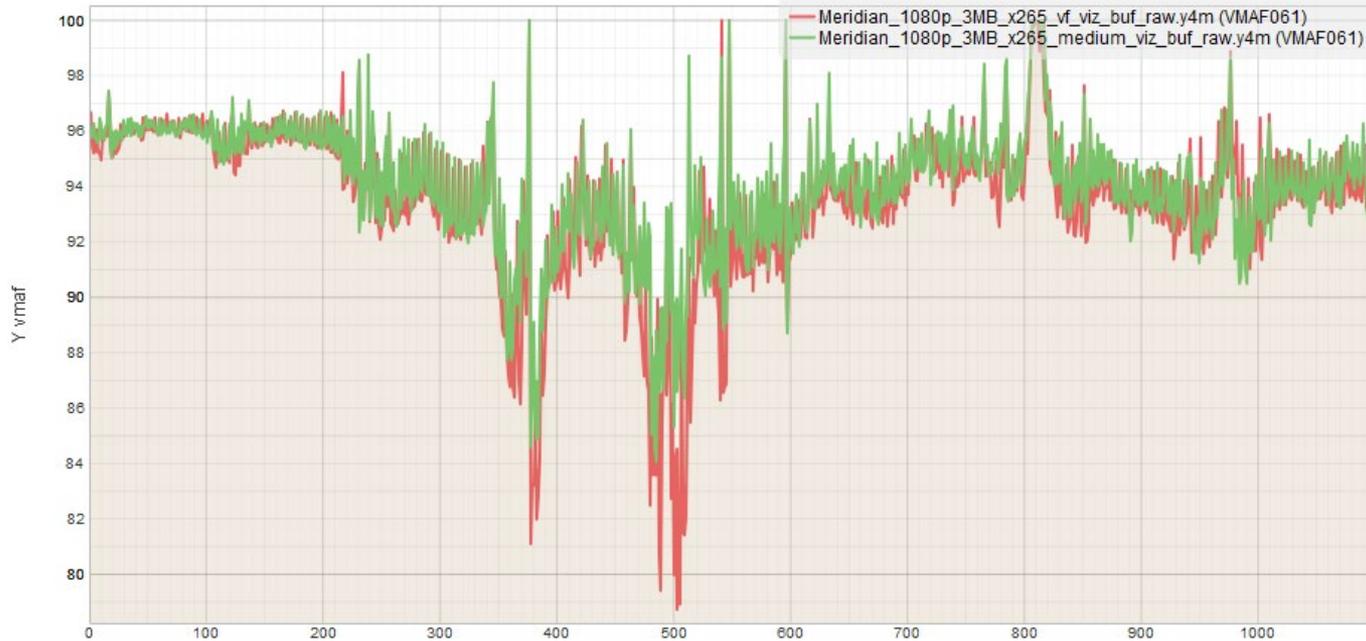
T4

Y
Netflix VMAF VMAF061 1-st proc 81.538803
Netflix VMAF VMAF061 2-nd proc 67.022446



00:00:08.22-502

Results Plot Comparison



x265 VF

x265 Med

- x265 veryfast shows much more variability which can degrade QoE
 - No visible differences in low frames

Quality Variability - Meridian

	U30	T4	Medium	Very Fast
Low frame VMAF	78.27	65.22	84.08	78.73
Standard Deviation	3.49	4.89	2.22	2.86
Ranking	3	4	1	2

Overall

- VMAF
- PSNR
- Subjective
- Scorecard

VMAF Overall Score

	VMAF - Overall	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
②	Xilinx U30	X	-23.01%	8.41%	-2.13%
④	NVIDIA T4	32.81%	X	46.42%	32.33%
①	x265 Medium	-6.75%	-27.38%	X	-9.55%
③	x265 VeryFast	2.97%	-20.23%	10.59%	X

PSNR Overall Score

PSNR - Overall	Xilinx U30	NVIDIA T4	x265 Medium	x265 VeryFast
③ Xilinx U30	X	-15.32%	24.97%	11.93%
④ NVIDIA T4	18.54%	X	46.91%	32.22%
① x265 Medium	-17.72%	-29.26%	X	-10.19%
② x265 VeryFast	-8.09%	-21.49%	11.43%	X

Subjective Overall Score

	Subjective - Overall	Xilinx-U30	NVIDIA T4	x265-Med	x265-VF
②	Xilinx-U30	X	-11.66%	10.77%	-6.42%
④	NVIDIA T4	13.56%	X	19.65%	10.60%
①	x265-Medium	1.29%	-12.18%	X	-9.51%
③	x265-Very Fast	14.35%	-6.05%	13.82%	X

U30 Summary

	Xilinx U30	NVIDIA T4	x265 Medium	x265 Veryfast
Start-Up Latency	1	4	2	3
VMAF quality rank	2	4	1	3
PSNR quality rank	3	4	1	2
Subjective quality	2	4	1	3
Quality consistency	2	4	1	4
Overall	2	4	1	3

- Overall ranking is based upon average of all scores with no weighting