# JCTVC-W0094 HDR CE2: Report of CE2.b-2, CE2.c and CE2.d experiments (for reshaping setting 2)
# JCTVC-W0093 HDR CE2: Report of CE2.a-3, CE2.c and CE2.d experiments (for reshaping setting 2)

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# Introduction

- Reshaper parameter derivation in CE2 ETM Reshaping Setting = 2[1]
- Joint optimization of reshaper and encoder used in CE2 Reshaping Setting = 2
  - CE2.c and CE2.d

# Reshaper Parameter Derivation

- In m_37092[3], we showed that if the input TF and the inverse of display TF are both gamma-type functions with the same power-factor , ($\alpha_i = \frac{1}{\gamma_d}$), we can reach a type of SDR backward compatibility in which the chromaticity of samples are preserved by:
  - Arbitrary mapping of luma samples, e.g. $Y_S = f(Y_H)$, perhaps with the goal to increase contrast or remove a system gamma.
  - Reshaping of chroma samples based on the given mapping of "collocated" luma samples as follows:

$$C_S = S_c \frac{Y_S + b_S}{Y_H + b_H} \cdot C_H$$

  where $b_s$ and $b_H$ are the black-level-lifts which are very small to take care of singularity.

# Reshaper Parameter Derivation

- In case that input TF can be estimated with a gamma function which power factor might be different than the inverse of display TF, the luma reshaping is a power function determined by the mismatch between input and display TF as well as the video brightness characteristics:
  - Reshape luma with a power function where the power value is:

$$Y_S = {Y_H}^{\alpha_r}$$

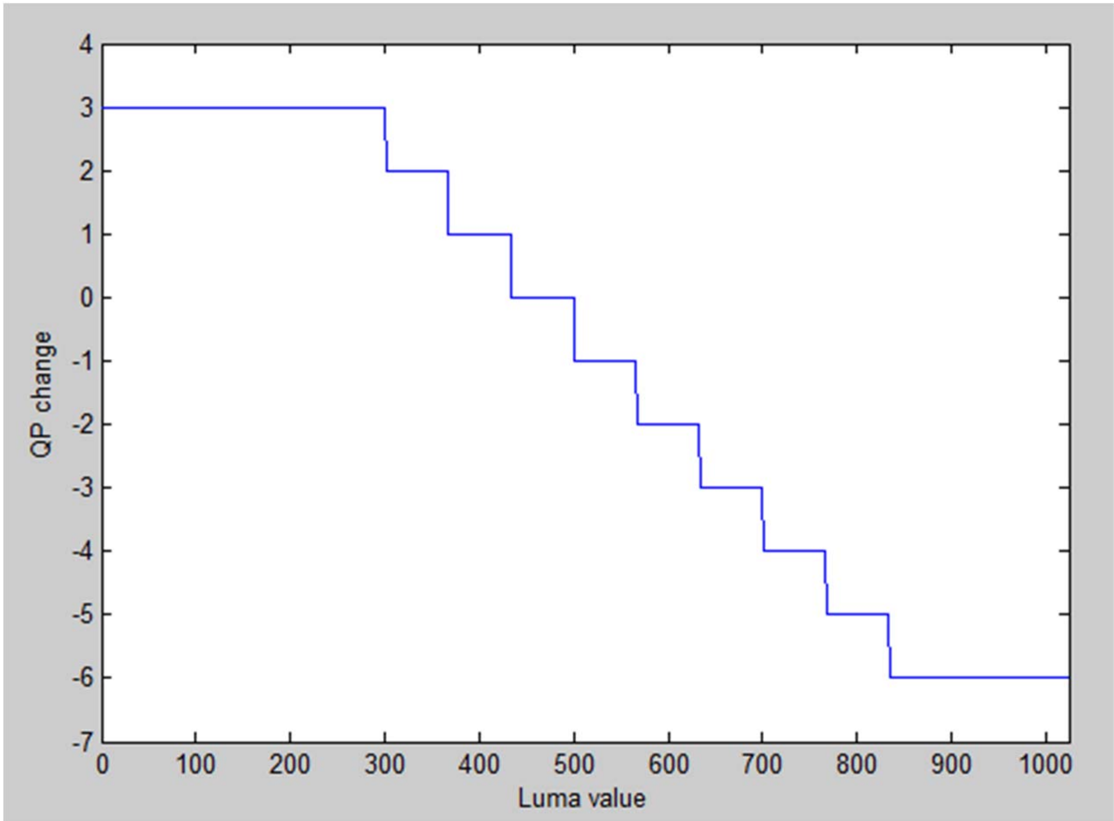
where $\alpha_r = \frac{1}{\alpha_i \cdot \gamma_d \cdot \gamma_s}$ and $\gamma_s$ is the estimated system gamma, which is calculated based on the temporal average and peak brightness of the sequence.

  - Reshape chroma based on the given mapping of collocated luma samples as follows:

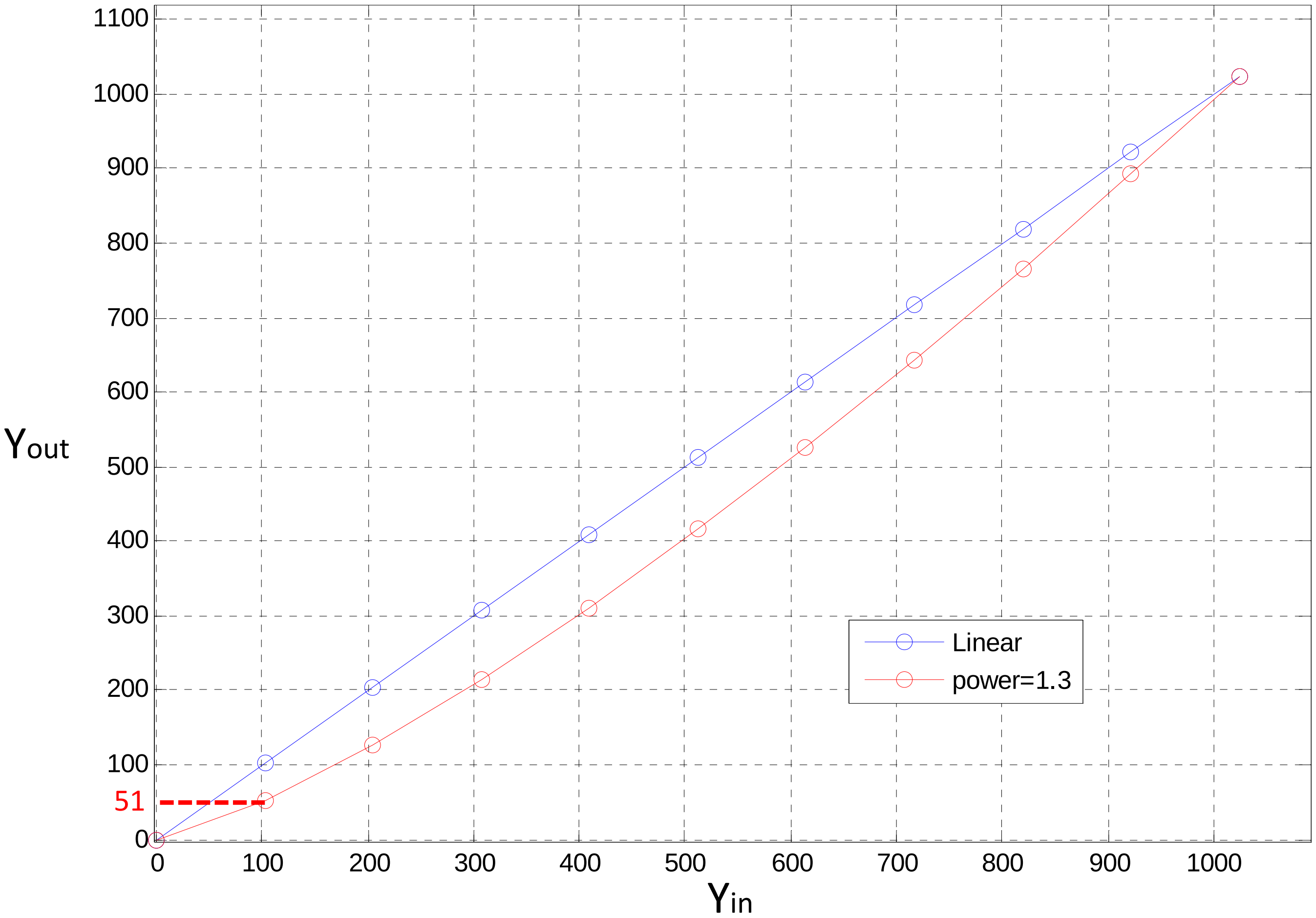
$$C_S = S_c \frac{Y_S + b_S}{Y_H + b_H} \cdot C_H$$

# Encoder Optimization

– Based on the similar algorithm proposed in CE1 with adjusted deltaQP mapping Table
  - The same CE1 deltaQP mapping Table as the Target mapping Table
  - Adjusted deltaQP by joint Reshaper & Encoder based Optimization



# Joint Reshaper and Encoder Optimization

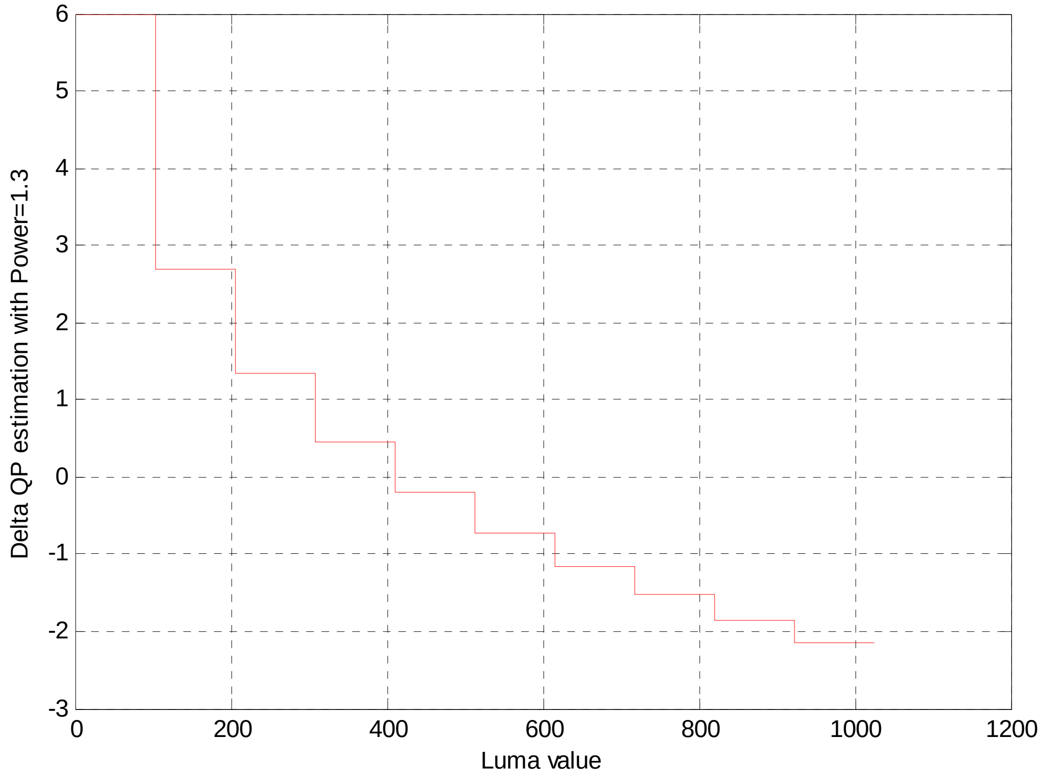



DQP_adj = DQP_target - DQP_Reshaper

DQP_Reshaper = (-6* $\log_2 \frac{Y_{out}(n)-Y_{out}(n-1)}{Y_{in}(n)-Y_{in}(n-1)}$ )

# Encoder Optimization

- Example of Reshaper Luma Delta QP Estimation with luma reshaping power = 1.3




- Example: for Yin ∈ [0 100], DQP_target = 3, DQP_adj = 3 + 6* $\log_2 \frac{51-0}{100-0}$ = -3

- Constant Chroma QP offset
  - CbQpOffset = -4; CrQpOffset = -4

# Simulation Result

### Table 1. Simulation result of CE2.b-2 with encoding optimization vs Anchor 3.2

| | | X | Y | Z | XYZ | tOSNR-XYZ | DE100 | MD100 | PSNRL100 |
|---|---|---|---|---|---|---|---|---|---|
| class A | FireEaterClip4000r1 | 9.6% | 19.2% | -15.7% | 4.5% | 2.6% | -6.8% | -34.1% | 17.6% |
| | Market3Clip4000r2 | 1.6% | 1.4% | -7.2% | -2.2% | -3.5% | -12.3% | -84.8% | -1.3% |
| | SunRise | 1.8% | 4.6% | -18.7% | -6.2% | -11.4% | -30.5% | -57.5% | 6.6% |
| class B | BikeSparklers cut 1 | 3.9% | 4.2% | -3.9% | 1.0% | 1.7% | -10.6% | -33.2% | 4.8% |
| | BikeSparklers cut 2 | 4.0% | 4.6% | -5.1% | 1.0% | 2.0% | -10.2% | -38.8% | 5.9% |
| | GarageExit | 1.9% | 3.9% | -3.7% | -0.5% | -0.6% | -12.2% | -31.5% | 3.1% |
| class C | ShowGirl2Teaser | 4.4% | 7.9% | -1.3% | 3.2% | 2.1% | -20.2% | -46.6% | 3.8% |
| class D | StEM_MagicHour cut 1 | 3.7% | 10.9% | -7.0% | -0.2% | -1.8% | -25.7% | -34.9% | 8.1% |
| | StEM_MagicHour cut 2 | 7.3% | 11.0% | -3.4% | 2.7% | 1.4% | -23.0% | -25.4% | 6.1% |
| | StEM_MagicHour cut 3 | 7.0% | 11.7% | -4.9% | 1.5% | 0.1% | -20.7% | -7.0% | 6.4% |
| | StEM_WarmNight cut 1 | 6.2% | 11.3% | -6.3% | 1.9% | 0.6% | -26.7% | -20.2% | 5.2% |
| | StEM_WarmNight cut 2 | 5.2% | 11.2% | -7.7% | 0.1% | 1.5% | -21.7% | -56.0% | 6.6% |
| class G | BalloonFestival | 6.5% | 10.0% | -10.1% | -0.3% | -4.0% | -13.7% | -43.4% | 2.5% |
| class H | EBU_04_Hurdles | 1.5% | -0.2% | -8.5% | -3.6% | -4.4% | -2.7% | -5.9% | -1.6% |
| | EBU_06_Starts | 3.5% | 0.9% | -11.8% | -4.2% | -5.2% | 0.9% | -14.9% | -2.4% |
| | **Overall** | 4.5% | 7.5% | -7.7% | -0.1% | -1.3% | -15.7% | -35.6% | 4.8% |

# JCTVC-W0093 HDR CE2: Report of CE2.a-3, CE2.c and CE2.d experiments (for reshaping setting 2)

- Apply a power function of $\alpha$ =1.2 in the RGB domain before PQ TF

**Table 2. Simulation result of CE2.a-3 with encoding optimization vs Anchor 3.2**

| | | X | Y | Z | XYZ | tOSNR-XYZ | DE100 | MD100 | PSNRL100 |
|---|---|---|---|---|---|---|---|---|---|
| class A | FireEaterClip4000r1 | 40.3% | 26.1% | 0.0% | 101.1% | 235.2% | 63.3% | -24.5% | 16.9% |
| | Market3Clip4000r2 | 2.1% | 1.3% | -1.8% | 0.1% | -0.2% | 1.6% | -85.8% | -0.2% |
| | SunRise | 1.3% | 2.6% | -13.3% | -4.6% | -6.7% | -26.5% | -53.6% | 10.3% |
| class B | BikeSparklers cut 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 29.6% | 0.0% |
| | BikeSparklers cut 2 | 0.8% | 0.4% | 4.8% | 2.0% | 1.7% | -2.0% | -35.8% | 3.7% |
| | GarageExit | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -5.3% | 0.0% |
| class C | ShowGirl2Teaser | 15.1% | 12.0% | 51.1% | 26.7% | 33.4% | -1.9% | -48.7% | 3.2% |
| class D | StEM_MagicHour cut 1 | 7.8% | 9.6% | 12.0% | 10.6% | 10.4% | -7.3% | 0.0% | 10.3% |
| | StEM_MagicHour cut 2 | 11.7% | 11.6% | 18.0% | 14.8% | 15.2% | -9.3% | -10.0% | 9.0% |
| | StEM_MagicHour cut 3 | 12.3% | 10.7% | 24.0% | 17.9% | 20.5% | -6.8% | -6.9% | 5.3% |
| | StEM_WarmNight cut 1 | 11.5% | 9.9% | 30.9% | 19.0% | 20.8% | -11.2% | -16.3% | 5.2% |
| | StEM_WarmNight cut 2 | 16.3% | 12.5% | 40.4% | 25.7% | 37.3% | -5.8% | -50.4% | 5.9% |
| class G | BalloonFestival | 7.1% | 9.2% | -0.9% | 4.0% | 1.3% | -6.3% | -45.1% | -0.7% |
| class H | EBU_04_Hurdles | 0.9% | -2.7% | -6.7% | -3.7% | -5.1% | 6.8% | 9.9% | -6.3% |
| | EBU_06_Starts | 1.3% | -3.1% | -7.2% | -4.1% | -4.4% | 9.5% | -2.4% | -5.4% |
| | **Overall** | 8.6% | 6.7% | 10.1% | 14.0% | 24.0% | 0.3% | -23.0% | 3.8% |

# Summary

- Joint reshper and encoder optimization is studied for CE2 with reshaping setting = 2
- Compared with Anchor 3.2, similar perceptual quality is observed
- Backward compatibility is also supported

# Acknowledgement

Thanks Technicolor for the x-check.

# References

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[2]A. Segall, J. Zhao, J. Strom, K. Andersson, M. Pettersson, "AHG on HDR and WCG: Average Luma Controlled Adaptive dQP", JCTVC-W0054, San Diego, US, Feb. 2016

[3] David Baylon, Zhouye Gu, Ajay Luthra, Koohyar Minoo, Yue Yu, "On single layer HDR coding with SDR backward compatibility" m37092, Geneva, CH, Oct. 2015

# Thank You!