AHG9: Experiments on using local QP adaptation in the context of an HLG container

JCTVC-AB0040 / JVET-G0123

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E. François, F. Hiron

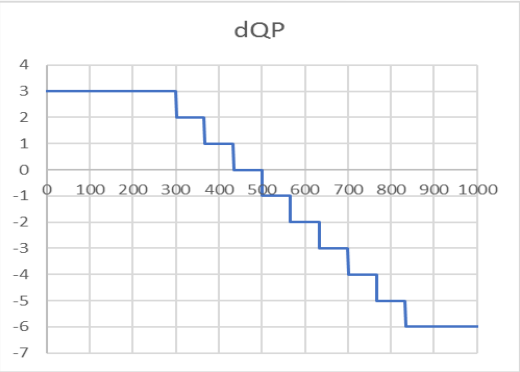
Purpose:

Investigation of the QP adaptation approach for BT.2100 HLG content, based on previous work made for BT.2100 PQ content

HM / JEM HDR anchors

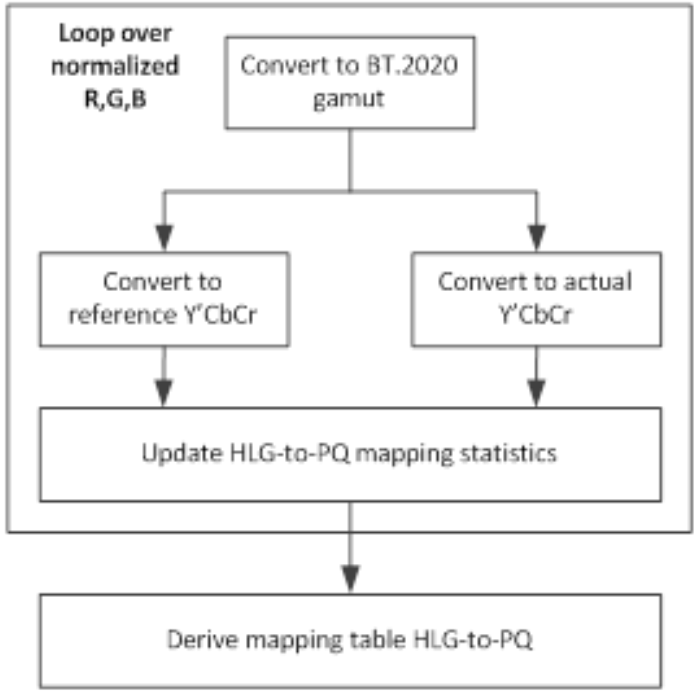
- Luma-based QP adaptation: QP dependent on average luma (original or prediction) of the CU/CTU
- Non-normative: explicit coding of the dQP values
- Using a dQP table experimentally adjusted based on visual checks

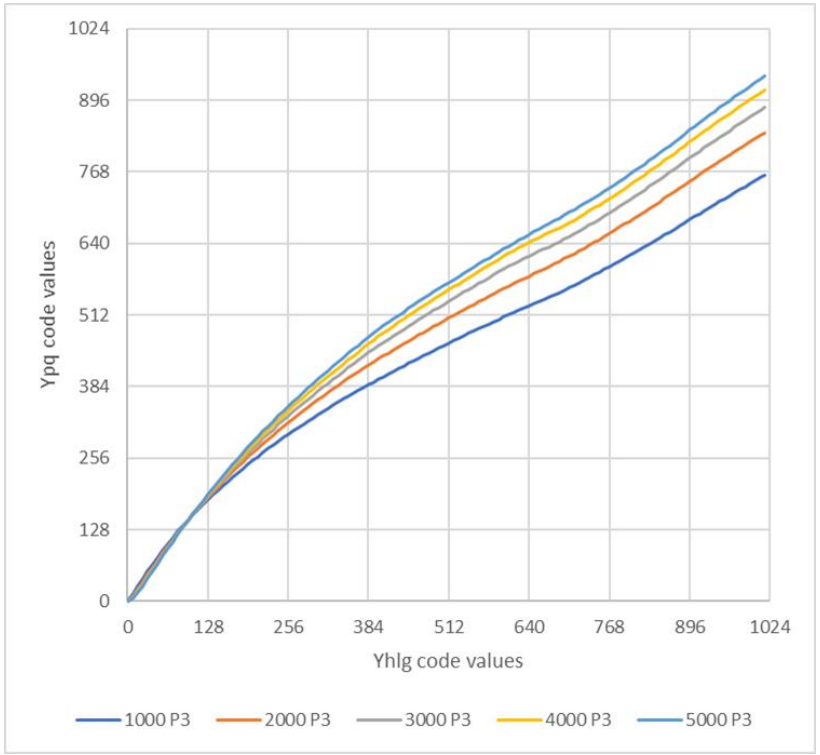
luma range (avgY)	dQP
avgY < 301	3
301 ≤ avgY < 367	2
367 ≤ avgY < 434	1
434 ≤ avgY < 501	0
501 ≤ avgY < 567	-1
567 ≤ avgY < 634	-2
634 <= avgY < 701	-3
701 <= avgY < 767	-4
767 <= avgY < 834	-5
intL >= avgY	-6



We consider this dQP table as a reference (dQPref), and want to derive the tables for HLG case from this reference dQP table dQPref

Mapping from HLG to PQ





$$f_{HLG\text{-}PQ}(x)$$

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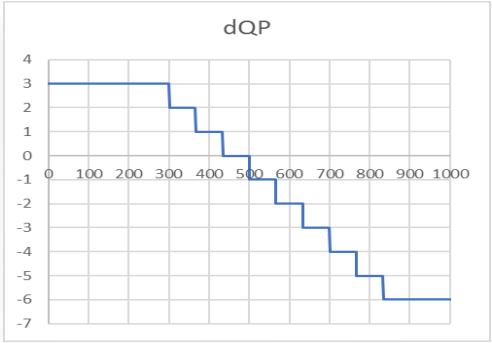
Derivation process of the dQP tables for HLG

- The reference PQ dQP table, dQPref, is linked to a scaling function f'_{PQ}

$$dQPref[\,x\,] = Int(\,-6 * \log2(\,f'_{PQ}\,(\,x\,)\,)\,)$$



- the Scaling function f'_{PQ} corresponding to dQPref can be approximated as

$$f'_{PQ}(\,x\,) = 2\text{^}\max(\,-3,\,\min(6,\,0.015*x - 1.5 - 6)\,)\,/\,6\,)$$

- mapping f_{HLG} HLG-to-SDR-like signal = concatenation of conversion HLG-to-PQ, then PQ-to-SDR-like signal

$$f_{HLG}\,(\,x\,) = f_{PQ}\,(\,f_{HLG\text{-}PQ}\,(\,x\,)\,)$$

- Scaling function f'_{HLG} HLG-to-SDR-like signal

$$f'_{HLG}\,(\,x\,) = f'_{PQ}\,(\,f_{HLG\text{-}PQ}\,(\,x\,)\,) * f'_{HLG\text{-}PQ}\,(\,x\,)$$

- dQP value finally derived as

$$dQP_{HLG}\,(\,x\,) = Round(\,-6 * \log2(\,f'_{HLG}\,(\,x\,)\,)\,)$$

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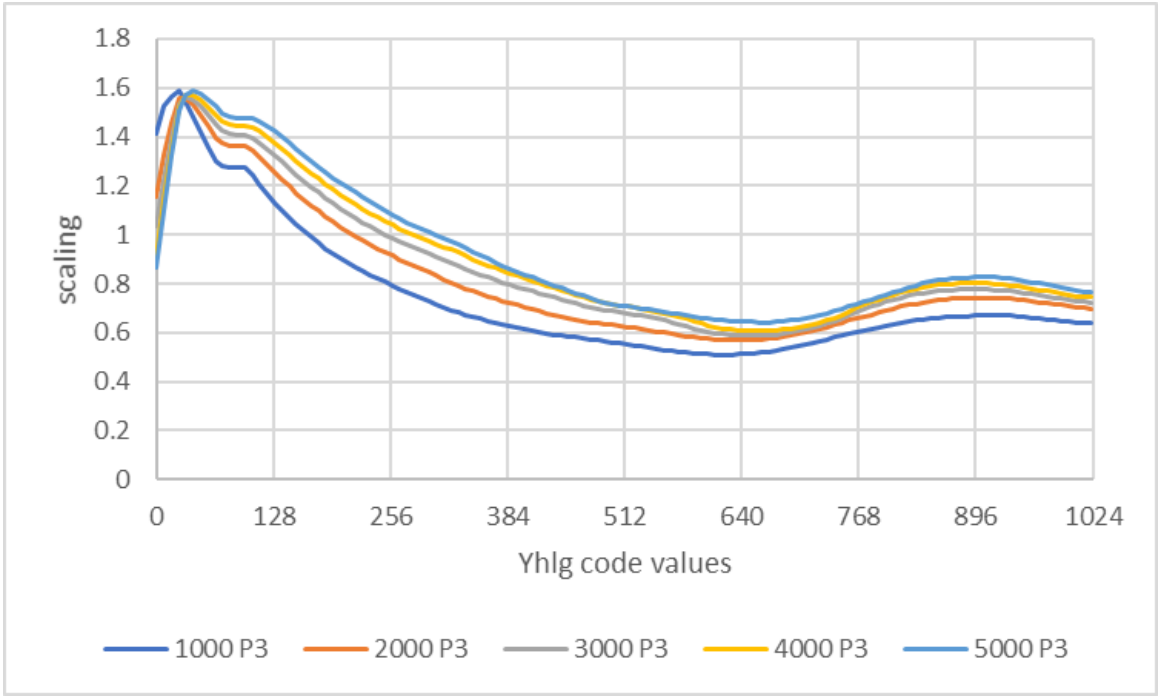
Scaling function f'$_{HLG}$



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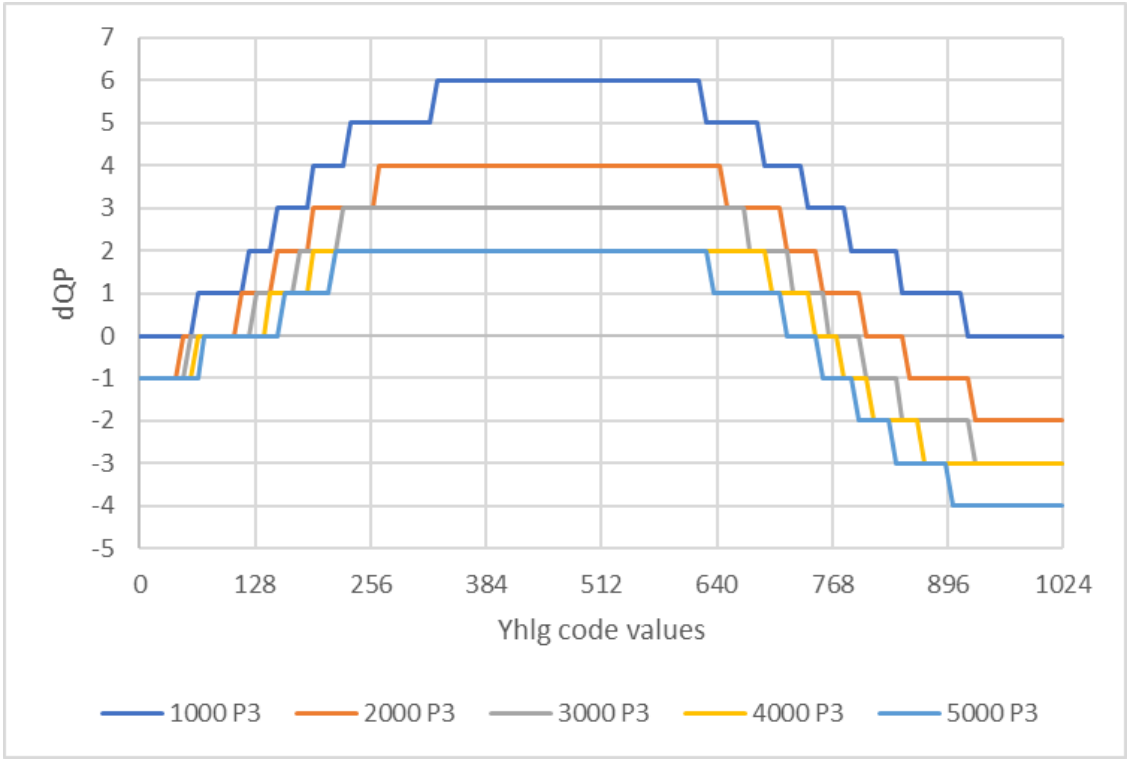
dQP tables for HLG



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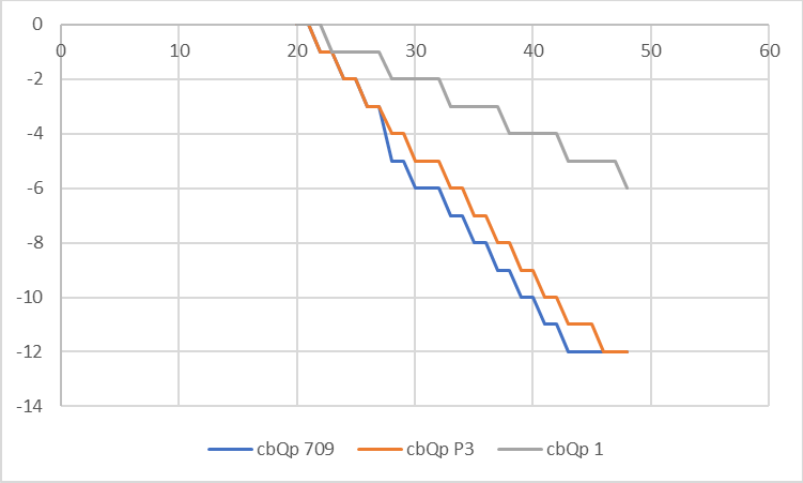
Experiments with non-native HLG content

HDR content test set used in JCT-VC & JVET, provided in EXR or BT.2100 PQ

Converted to HLG following the process described in JCTVC-Z1012

Coding using HM16.15, RA configuration

Tested with and without chroma QP adaptation (using dQP1 shape below)



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Average gains for various dQP tables

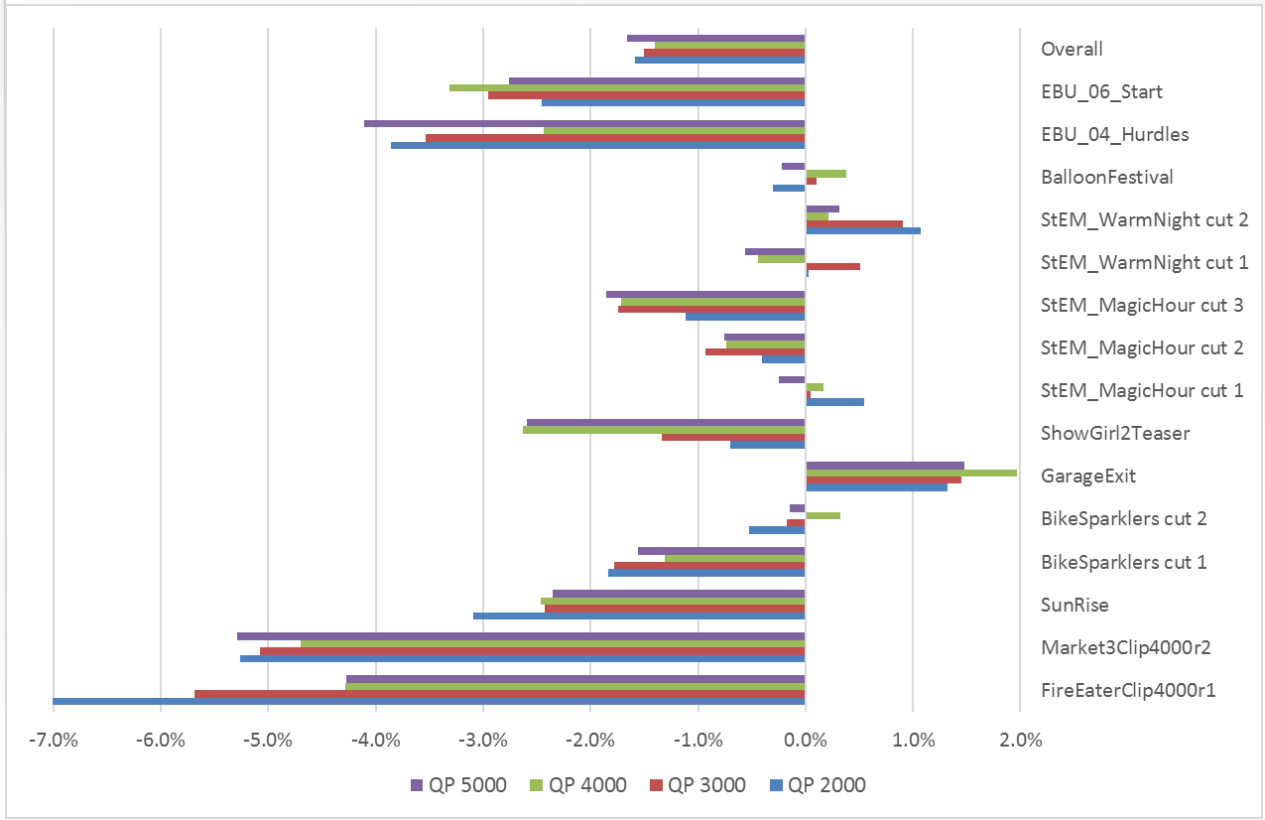
- various dQP tables all lead to slight gains for the different considered metrics
- dQP 2000 nits without Chroma QP adaptation seems to give a satisfying trade-off

	No Ch QP							
	tPSNRY	DE100	PSNRL100	wPSNR Y	wPSNR U	PSNR V	AVG Y/L	AVG Chr
dQP 2000 nits	-2.0%	-3.2%	-1.2%	-1.5%	-0.6%	-2.4%	-1.6%	-2.1%
dQP 3000 nits	-1.1%	-2.2%	-1.7%	-1.8%	-0.3%	-1.3%	-1.5%	-1.3%
dQP 4000 nits	-0.9%	-2.1%	-1.7%	-1.6%	-0.6%	-1.2%	-1.4%	-1.3%
dQP 5000 nits	-0.8%	-2.6%	-2.3%	-1.9%	-0.8%	-1.6%	-1.7%	-1.7%

	Ch QP 1							
	tPSNRY	DE100	PSNRL100	wPSNR Y	wPSNR U	PSNR V	AVG Y/L	AVG Chr
dQP 2000 nits	-0.1%	-13.0%	0.7%	0.7%	-15.5%	-16.6%	0.4%	-15.0%
dQP 3000 nits	0.4%	-10.7%	-0.3%	-0.1%	-12.4%	-13.2%	0.0%	-12.1%
dQP 4000 nits	0.8%	-11.7%	0.0%	0.3%	-14.4%	-14.7%	0.4%	-13.6%
dQP 5000 nits	1.0%	-12.5%	-0.5%	0.2%	-15.1%	-15.6%	0.2%	-14.4%

Experiments with non-native HLG content

Per sequence with various dQP tables



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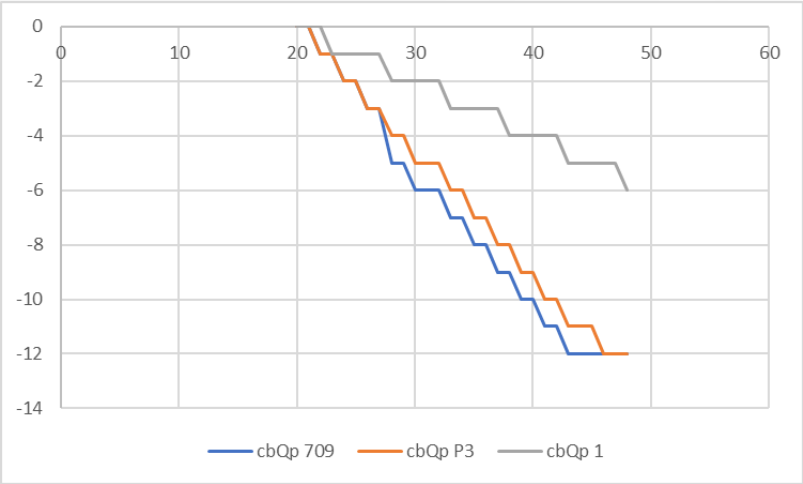
Candidate JVET HLG HDR content

Coding using HM16.15, RA configuration

Tested without chroma QP adaptation (using dQP1 shape below)



Gains are observed in most cases

Sequence HLG4 seems to particularly benefit from the QP adaptation approach

	Y	DE100	PSNRL100	wPSNR Y	wPSNR U	wPSNR V	AVG Y/L	AVG Chr
HLG1-10s	-1.0%	-0.3%	-1.2%	-1.3%	0.0%	-0.3%	-1.2%	-0.2%
HLG2-10s	0.1%	0.2%	0.1%	0.1%	1.2%	1.1%	0.1%	0.8%
HLG3-10s	-0.6%	2.0%	1.0%	-1.3%	4.3%	1.3%	-0.3%	2.5%
HLG4-10s	-6.8%	-12.5%	-8.5%	-8.6%	-16.6%	-3.7%	-8.0%	-10.9%
HLG5-10s	-0.5%	-6.0%	-2.7%	-1.3%	-11.5%	-12.9%	-1.5%	-10.1%
HLG6-10s	-0.4%	1.4%	0.7%	-0.6%	1.5%	3.0%	-0.1%	2.0%
HLG7-10s	0.4%	-1.7%	-0.2%	-0.4%	-12.0%	-9.9%	-0.1%	-7.9%
Overall	-1.2%	-2.4%	-1.5%	-1.9%	-4.7%	-3.0%	-1.6%	-3.4%

Visually ?

Visual differences remain quite small and difficult to catch in video mode

In still picture mode, slight improvements in texture sharpness are generally observed