

Title: **JCT-3V AHG Report: MV-HEVC and 3D-HEVC Software Integration (AHG5)**

Status: AHG report input to JCT-3V

Purpose: AHG report

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Source: AHG

Abstract

This report summarizes the activities of the AhG on 3D-HEVC Software Integration that have taken place between the 7th JCT-3V meeting in San Jose and the 8th JCT-3V meeting in Valencia. Activities focused on the integration of tools adopted at the 7th meeting into a common code base.

1 Mandates

Title	Chairs	Mtg
<p>MV-HEVC and 3D-HEVC Software Integration (AHG5)</p> <p>(jct-3v@lists.rwth-aachen.de)</p> <ul style="list-style-type: none"> • Coordinate development of the HTM software and its distribution to JCT-3V members • Produce documentation of software usage for distribution with the software • Prepare and deliver HTM 10.0 software version and the reference configuration encodings according to JCT3V-G1100 based on common conditions suitable for use in most core experiments (expected within four weeks after the meeting). • Prepare and deliver HTM 10.1 software that include additional items not integrated into the 10.0 version (expected within one week after the 10.0 software release). • Perform analysis and reconfirmation checks of the behaviour of technical changes adopted into the draft design, and report the results of such analysis. • Suggest configuration files for additional testing of tools. • Coordinate with MV-HEVC Draft and 3D-HEVC Test Model editing AhG to identify any mismatches between software and text. 	<p>G. Tech</p> <p>L. Zhang (co-chairs)</p> <p>Y. Chang</p> <p>K. Wegner (vice chairs)</p>	<p>N</p>

2 HTM tool integration

Development of the software was coordinated with the parties needing to integrate changes.

The distribution of the software was announced on the JCT-3V e-mail reflector and the software was made available through the SVN server:

https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSsoftware/tags/

Anchor bitstreams have been created and uploaded to:

<ftp.hhi.fraunhofer.de>; login: mpeg3dv_guest; path: /MPEG-3DV/HTM-Anchors/

Multiple versions of the HTM software were produced and announced on the JCT-3V email reflector. The following sections give a brief summary of the integrated tools and achieved coding gains.

2.1 Versions HTM-10.0 / HTM-10.0r1

Starting point for development of HTM-10.0 was HTM-9.3. Development of HTM-10.0 was conducted in three parallel tracks each performing sequential integration. Development of each branch has been supervised by one software coordinator. Software of all three tracks was merged by the software coordinators.

After release of HTM-10.0, a bug critical under CTC has been reported. Therefore an additional version HTM-10.0r1 has been issued.

2.1.1 Integrated items

Track 1 (Sub-PU, Merge, coordinated by Yulin Chang):

- [JCT3V-G0119](#) CE2: Sub-PU based MPI
- [JCT3V-G0098](#) CE2: Performance evaluation on depth Merge mode candidate
- [JCT3V-G0077](#) CE1: MCP Size and DV for Sub-PU Prediction
- [JCT3V-G0074](#) CE2: Simplification of DV Derivation for Depth
- [JCT3V-G0069](#) CE1: Restricted bi-prediction for sub-PU
- [JCT3V-G0063](#) CE2: results on additional merging candidates for depth
- [JCT3V-G0147](#) CE1: Simplification of sub-PU level temporal iv motion prediction
- [JCT3V-G0148](#) CE1: Motion parameters stored for VSP-coded blocks
- [JCT3V-G0106](#) CE3: Results on Depth-based Block Partitioning (DBBP)

Track 2 (IC, ARP, Misc, coordinated by Li Zhang):

- [JCT3V-G0072](#) CE4: Results on IC and ARP Flags Signaling
- [JCT3V-G0055](#) CE2: A texture-partition-dependent depth partition for 3D-HEVC
- [JCT3V-G0067](#) Avail. checking of temp. inter-view MV candidate and VSP candidate
- [JCT3V-G0053](#) HLS: On ARP reference picture signaling
- [JCT3V-G0061](#): Simplification on CABAC contexts for IC and ARP Flags

Track 3 (Depth Coding, coordinated by Gerhard Tech):

- [JCT3V-G0122](#) CE5: Generic SDC for all Intra modes in 3D-HEVC
- [JCT3V-G0130](#) CE5: Unif. of delta DC coding and sign. for inter and intra SDC
- [JCT3V-G0101](#) CE5: Segment-wise depth inter mode coding
- [JCT3V-G0123/G0111](#) CE5: Simplification of 64x64 Intra SDC mode in 3D-HEVC

- [JCT3V-G0143](#) CE5: On neighbouring reference pixel selection for depth intra coding
- [JCT3V-G0163](#) VSD bugfix and improvement

Fix in HTM-10.0r1

- Uncompressed InterDir.

2.1.2 Coding performance

MV-HEVC: The coding results for MV-HEVC are identical to results obtained from version HTM-9.3.

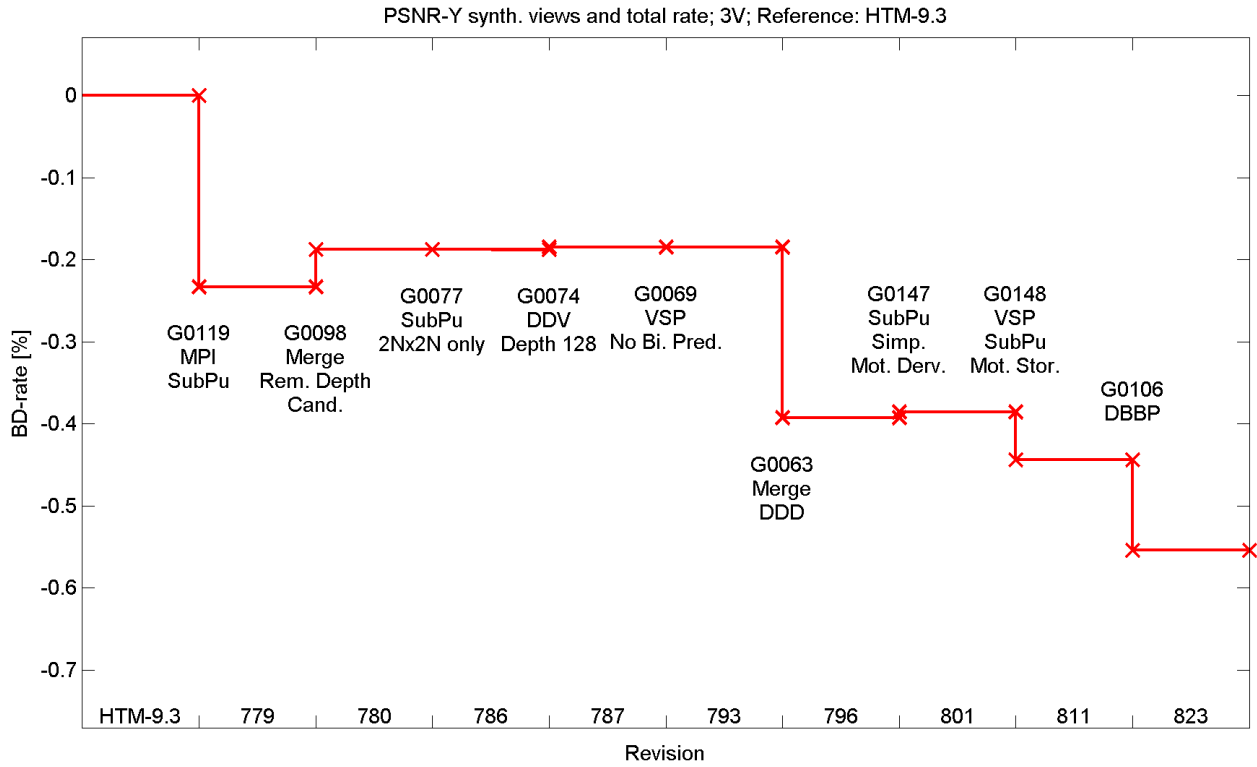
3D-HEVC: HTM-10.0r1 vs. HTM-9.3 (CTC, three view configuration)

	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	-0,2%	-0,4%	-1,1%	136,1%	108,8%	99,9%
Kendo	-0,2%	-0,8%	-1,6%	137,4%	109,4%	100,5%
Newspaper_CC	-0,1%	-0,3%	-1,7%	145,2%	108,1%	99,6%
GT_Fly	-0,2%	-0,4%	-2,0%	131,3%	106,1%	100,4%
Poznan_Hall2	-0,2%	-0,1%	-1,1%	127,6%	105,7%	100,8%
Poznan_Street	-0,2%	-0,3%	-1,0%	133,7%	115,7%	100,6%
Undo_Dancer	-0,5%	-0,7%	-1,5%	125,2%	107,9%	102,8%
Shark	-0,3%	-0,7%	-2,5%	127,2%	111,7%	99,4%
1024x768	-0,2%	-0,5%	-1,5%	139,6%	108,8%	100,0%
1920x1088	-0,3%	-0,5%	-1,6%	129,0%	109,4%	100,8%
average	-0,2%	-0,5%	-1,5%	133,0%	109,2%	100,5%

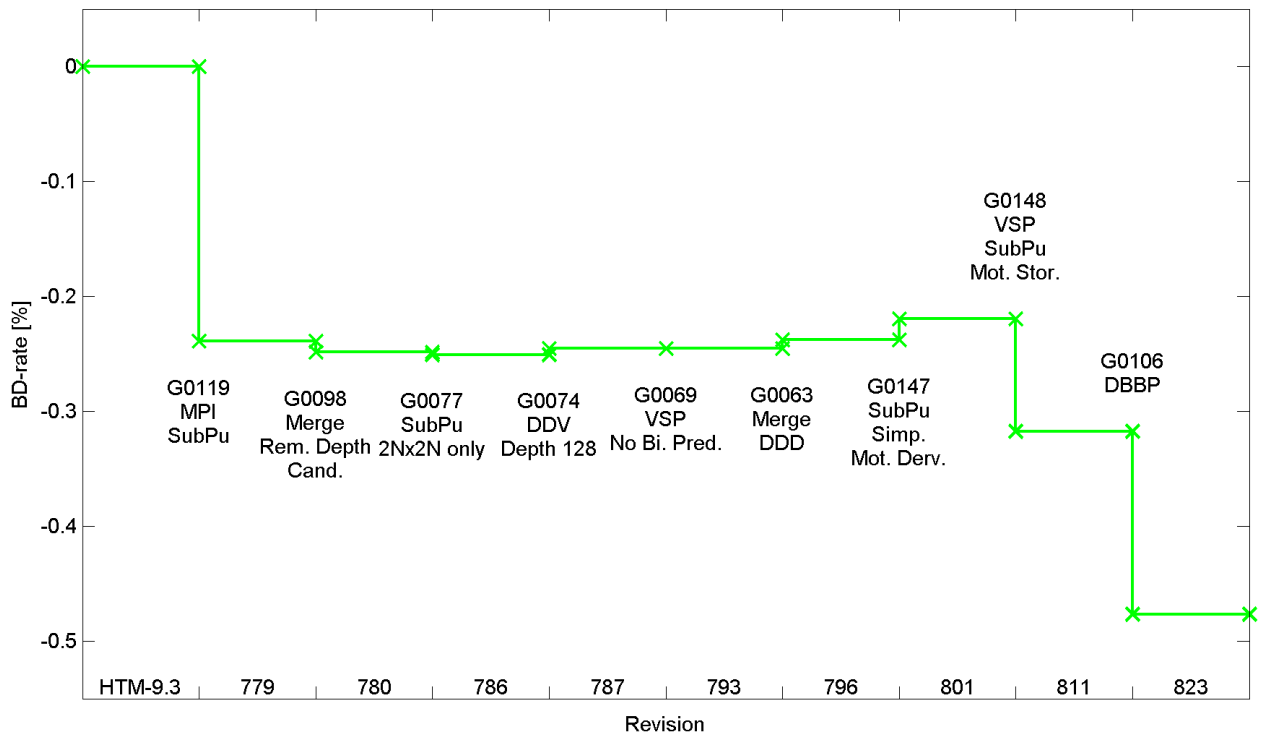
2.1.3 History of revisions

The following sections give a brief summary of average rate savings and runtimes of the different software revisions produced during the integration the period. Results are not cross verified. Simulations were performed using CTC for the three view case.

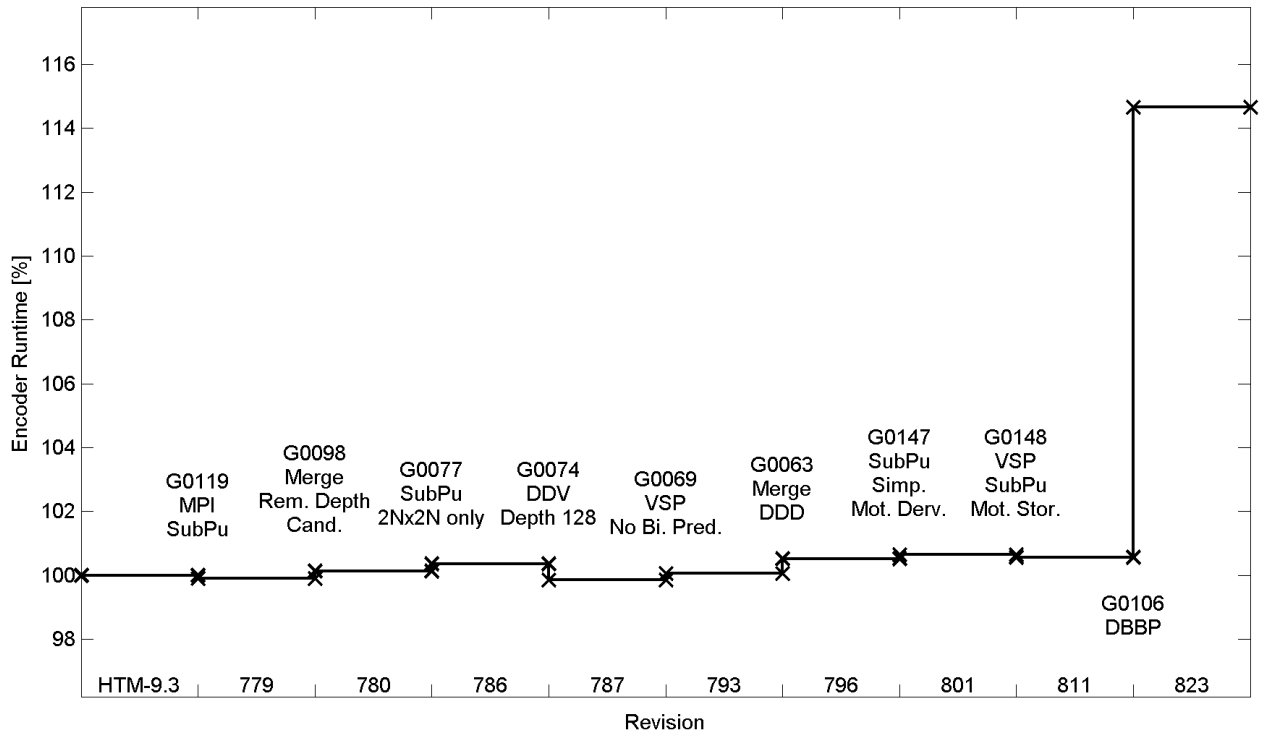
2.1.3.1 Track 1 (*Sub-PU, Merge*)



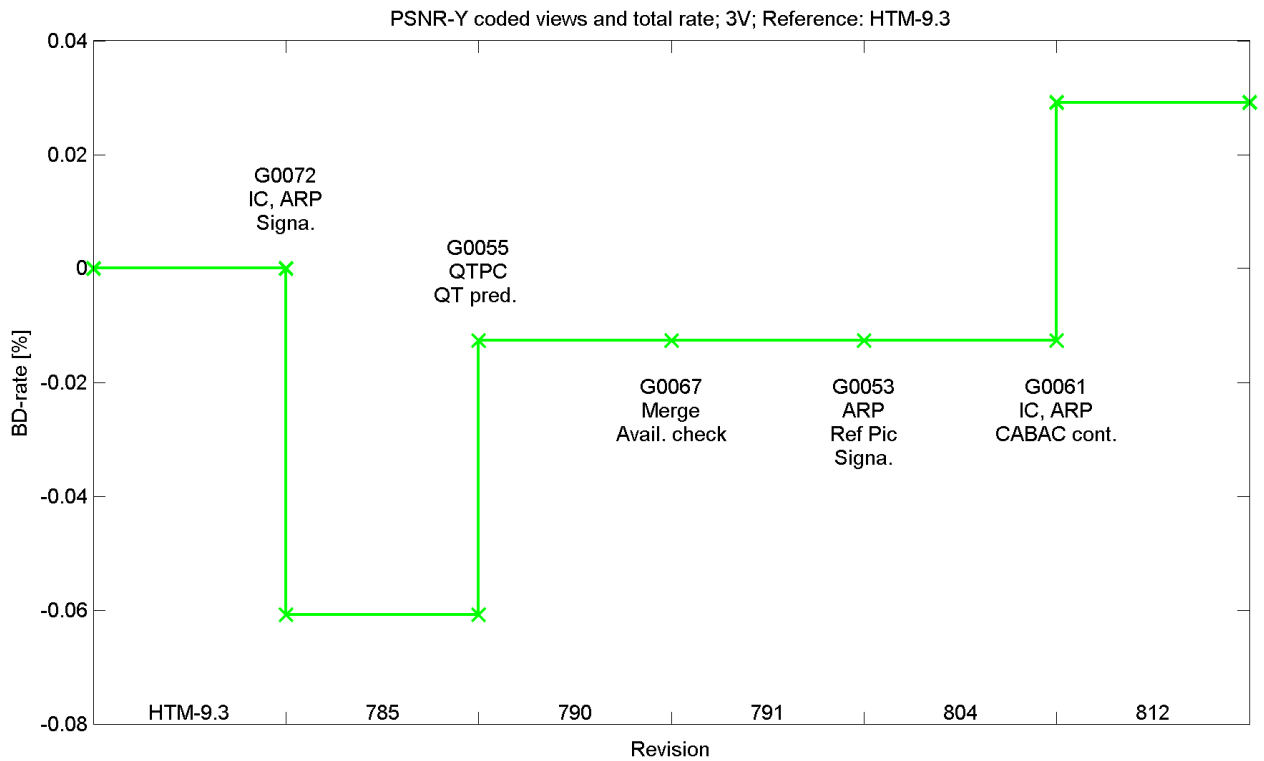
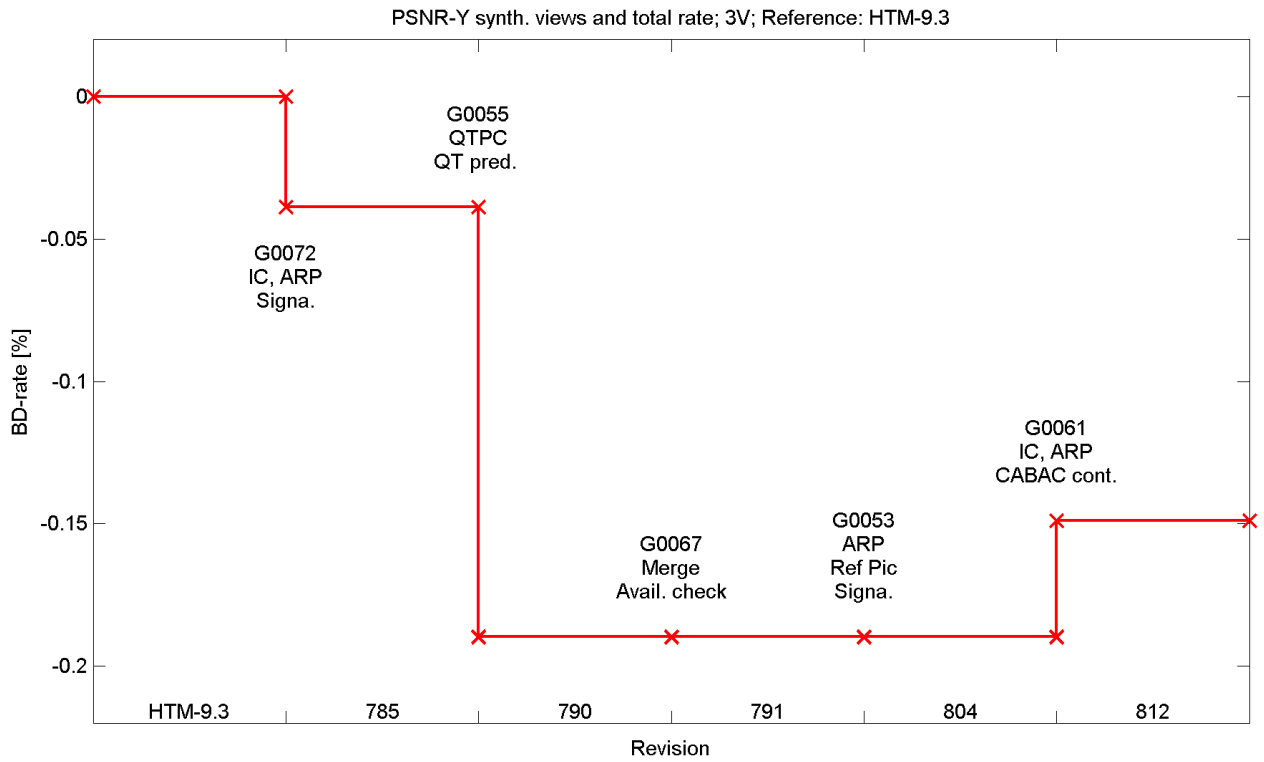
PSNR-Y coded views and total rate; 3V; Reference: HTM-9.3



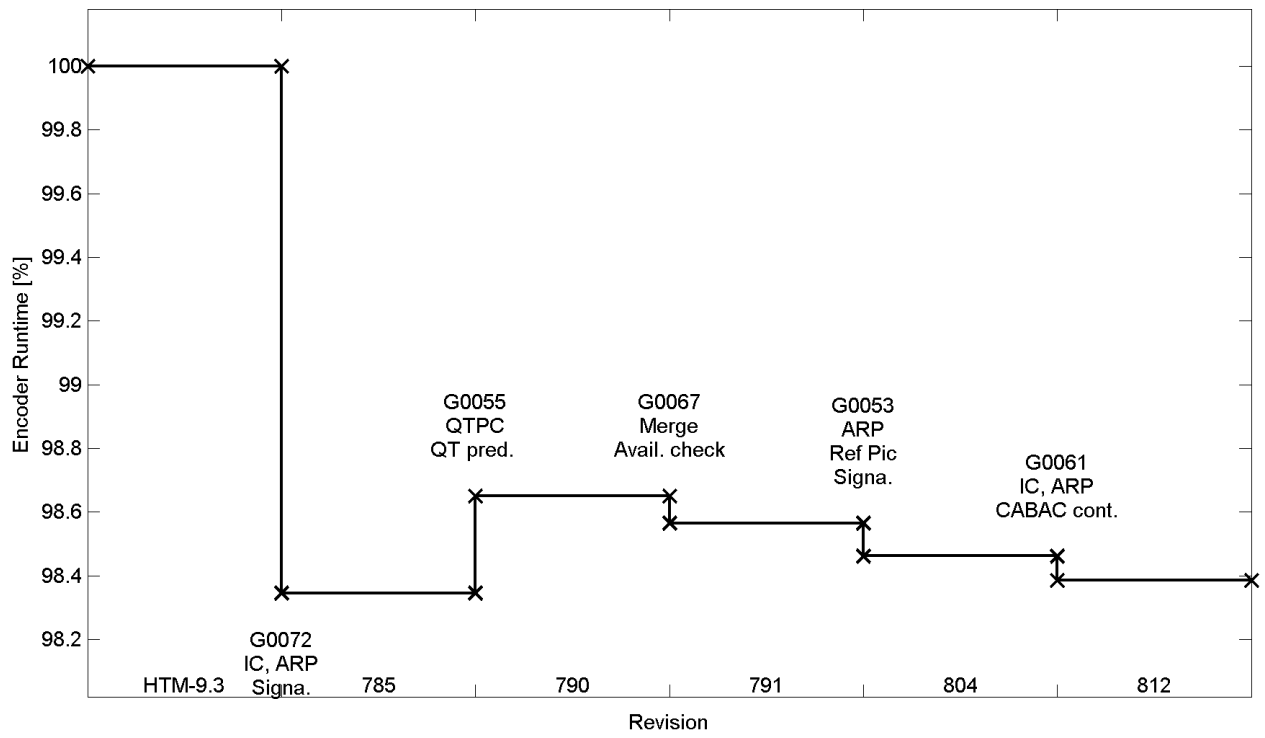
Encoder Runtime; 3V; Reference: HTM-9.3



2.1.3.2 Track 2 (IC, ARP, Misc)

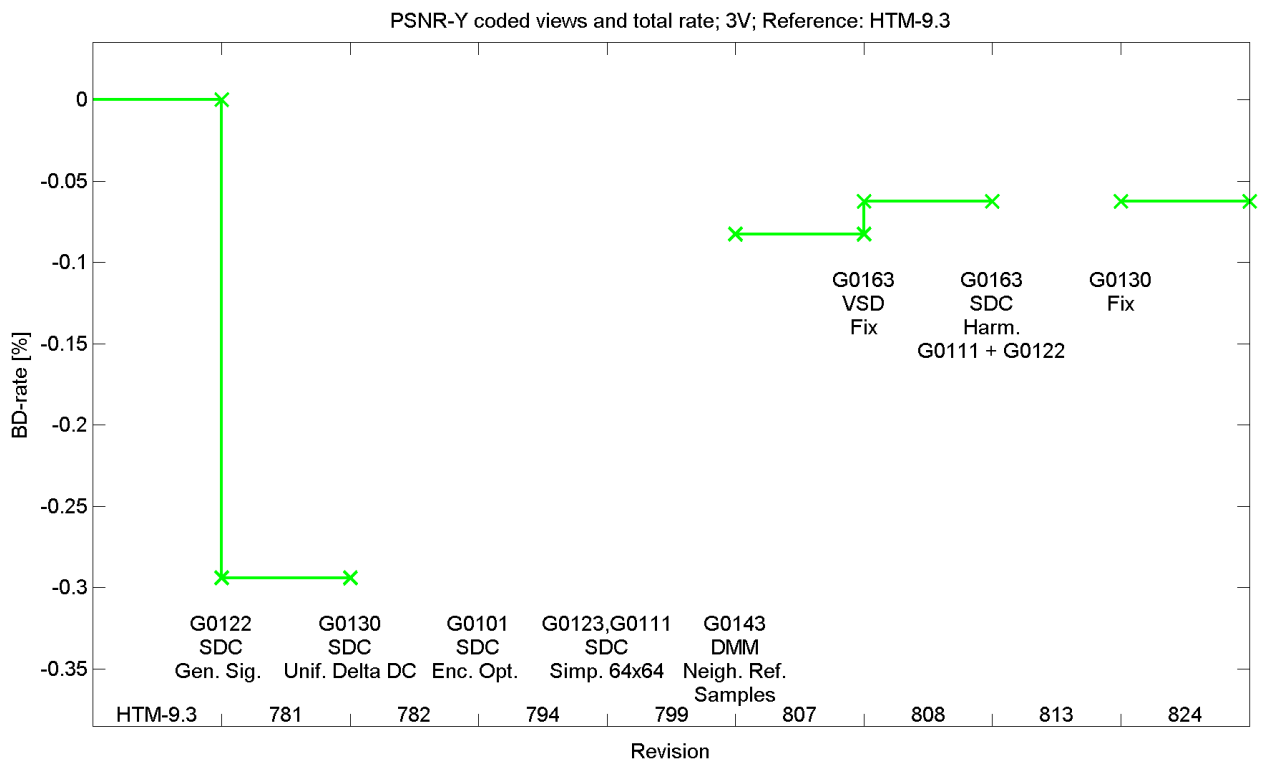
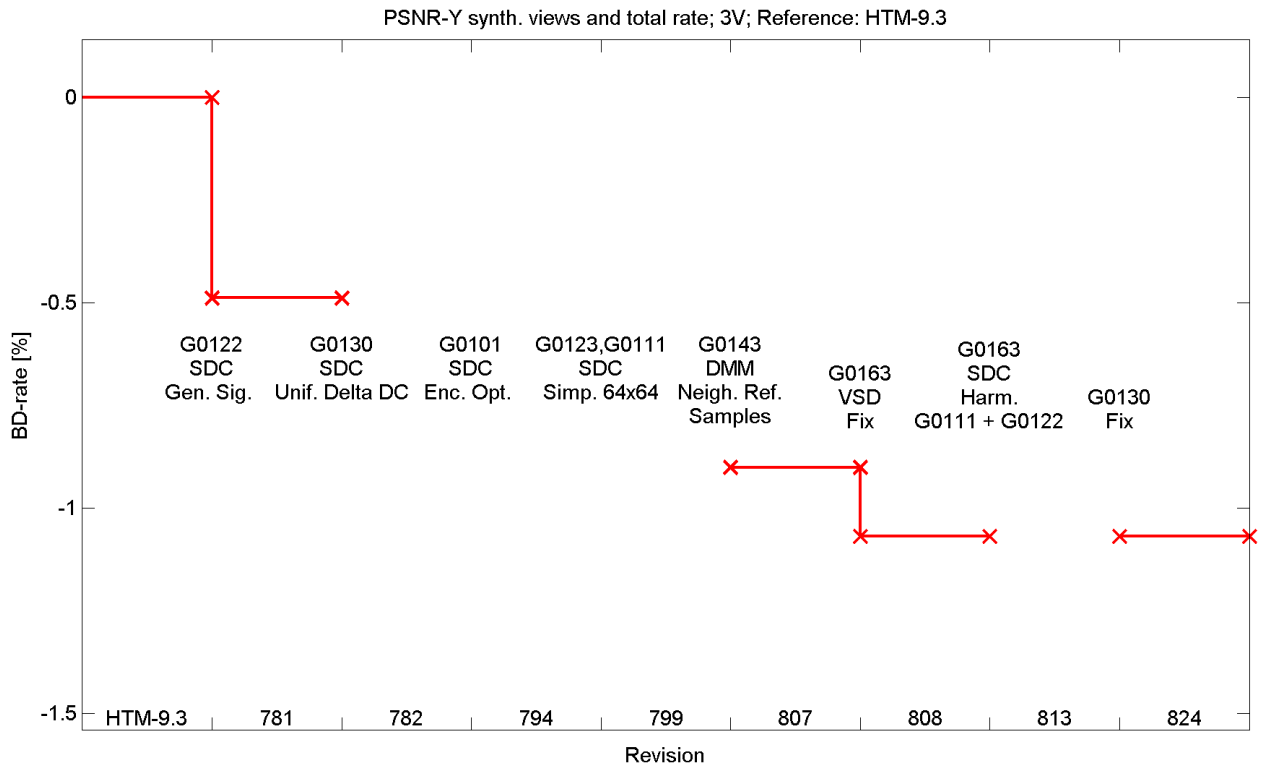


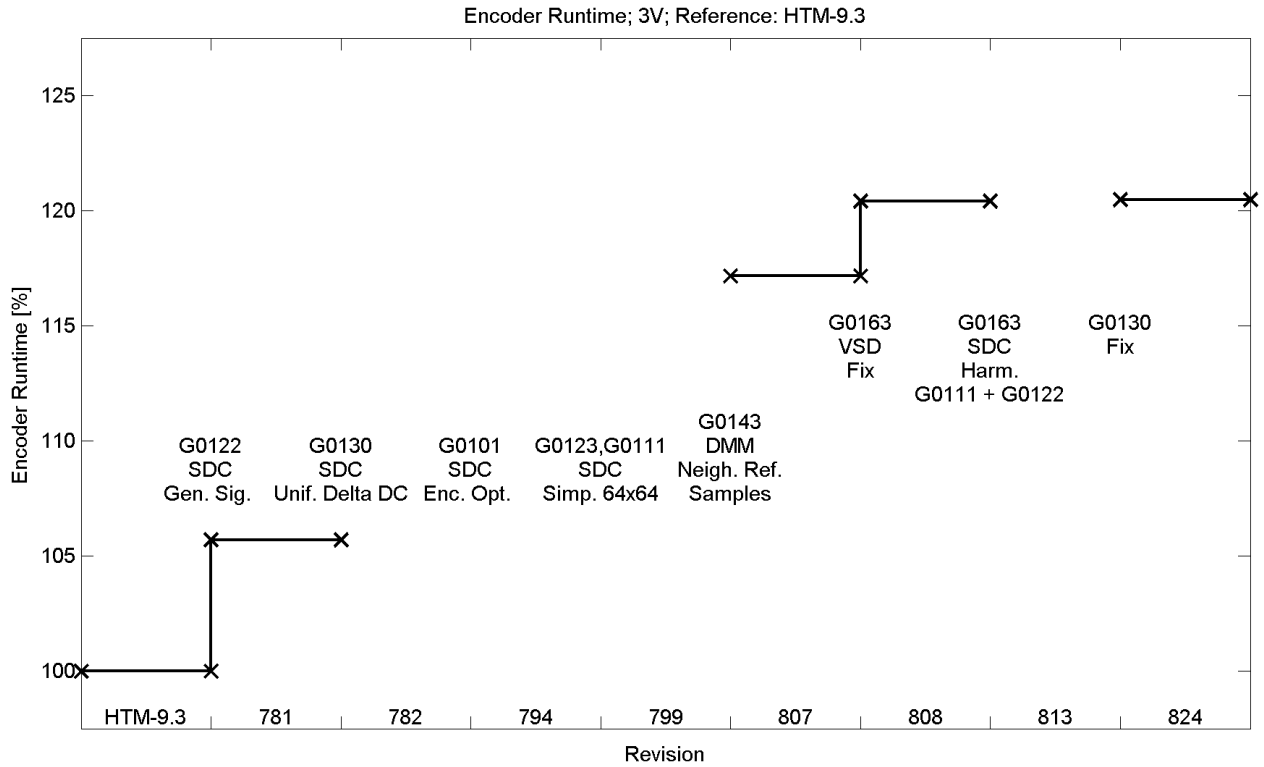
Encoder Runtime; 3V; Reference: HTM-9.3



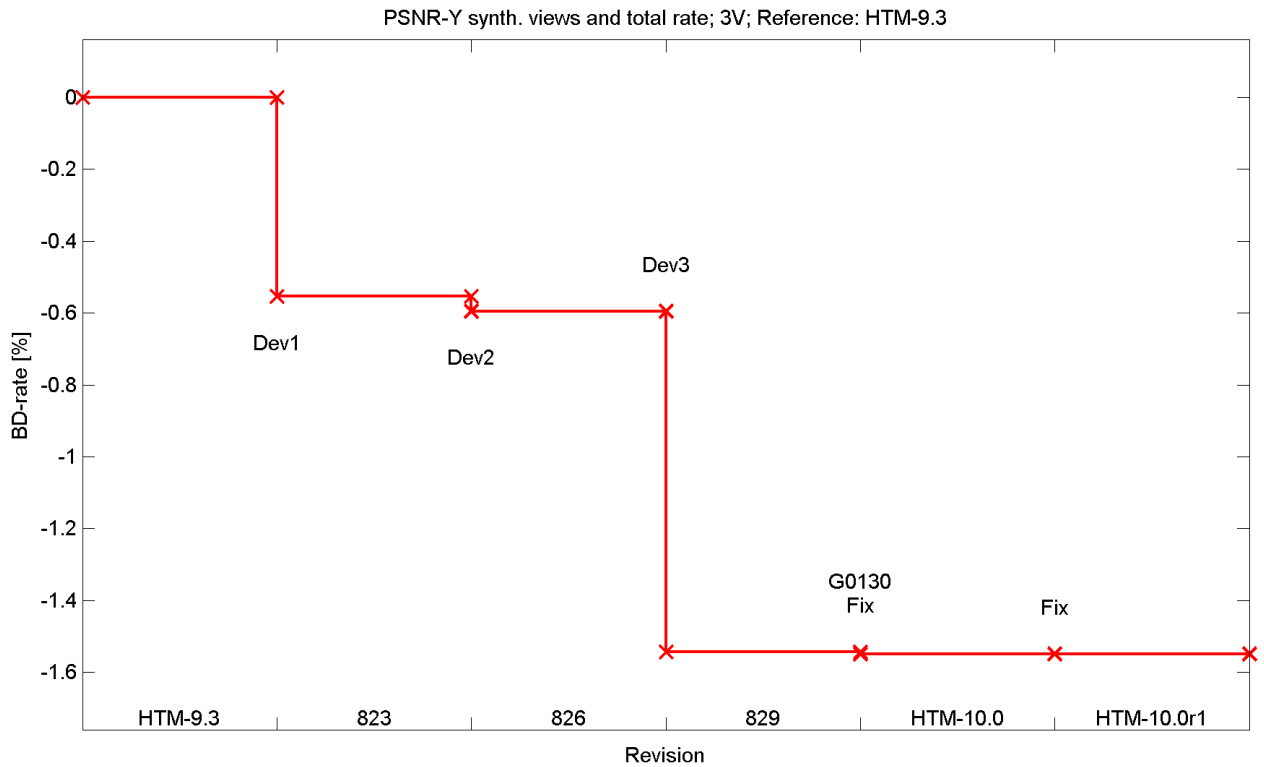
2.1.3.3 Track 3 (Depth Coding)

Due to a bug, which has not been noticed by the integrators, several revisions could not be simulated such that results are missing the following figures.

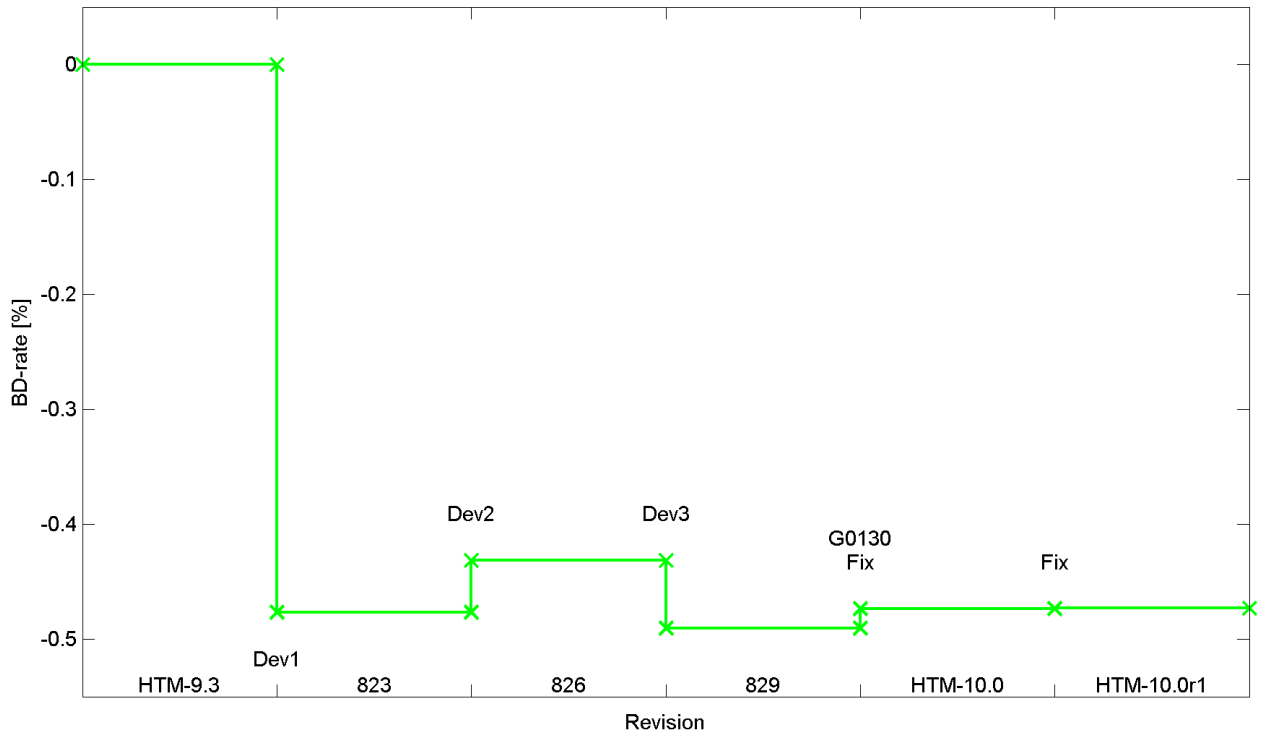




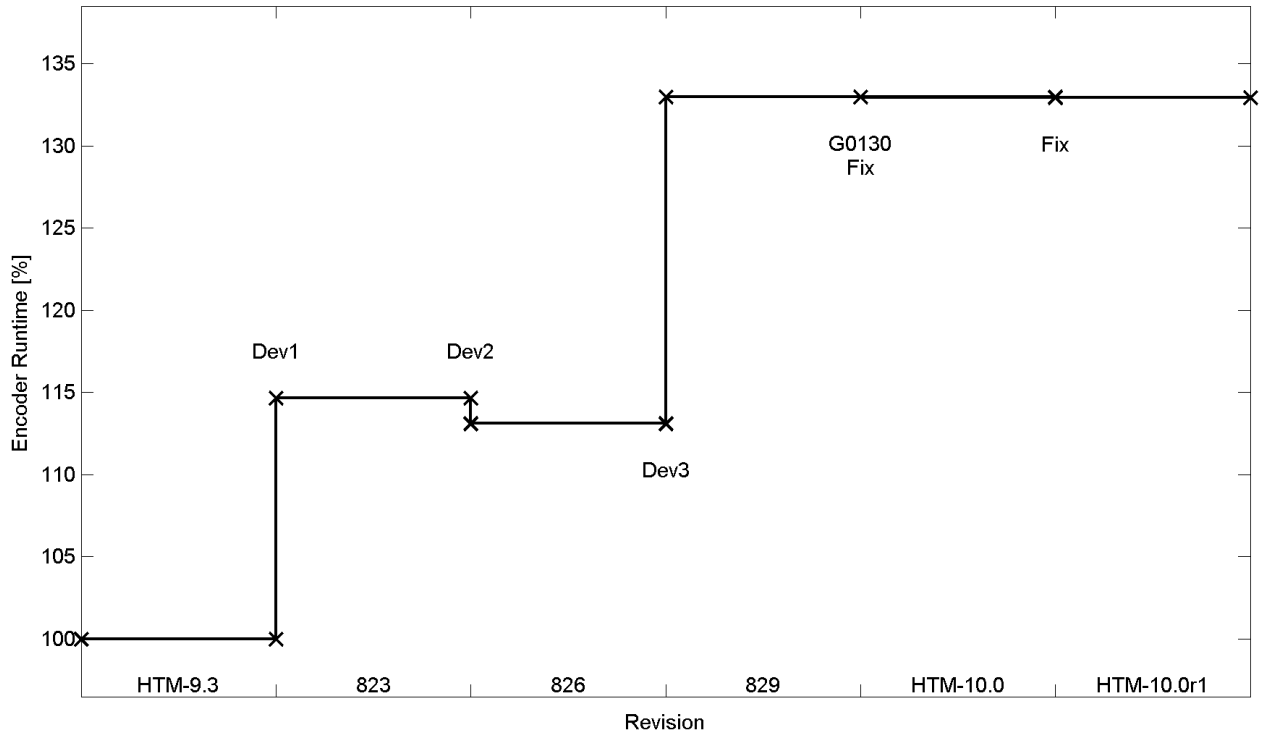
2.1.3.4 Merge of tracks



PSNR-Y coded views and total rate; 3V; Reference: HTM-9.3



Encoder Runtime; 3V; Reference: HTM-9.3



2.2 Version HTM-10.1

MV-HEVC 7 HLS has been integrated in a single track, moreover the software basis was updated to HM-13.0.

2.2.1 Integrated items

- Update to HTM-13.0
- H_MV_HLS_7_VPS_P0306_22 ue(v) coded syntax elements, several minor modifications to the VPS syntax, consistent with eliminating the previous intention to avoid ue(v) parsing in the VPS
- H_MV_HLS_7_SEI_P0204_26 Add sub-bitstream property SEI message
- H_MV_HLS_7_MISC_P0130_20 Add constraint restricting pictures marked as discardable from being present in the temporal or inter-layer RPS,
- H_MV_HLS_7_VPS_P0125_24 VPS extension offset Keep it as a reserved FFFF value.
- H_MV_HLS_7_VPS_P0307_23 VPS VUI extension Adopt modification in P0307.
- H_MV_HLS_7_POC_P0041 Syntax related to POC reset
- H_MV_HLS_7_OUTPUT_LAYERS_5_10_22_27 Output layer sets, various
- Default output layer sets Three-state approach (text in P0295, decoder shall allow 3 to be present and shall treat 3 the same as the value 2).
- Change alt output layer flag to be signalled within the loop of output layer sets, from JCTVC-P0300-v2.
- Signal output_layer_flag[i][j] for the top layer
- H_MV_HLS_7_HRD_P0156_7 Signal, in the VPS extension, the DPB parameters for an output layer set for sub-DPBs only up to the maximum temporal sub-layers in the corresponding layer set
- H_MV_HLS_7_VPS_P0048_14 Remove profile_ref_minus1 from the VPS extension, from JCTVC-P0048
- H_MV_HLS_7_VPS_P0076_15 Move video signal information syntax structure earlier in the VPS VUI.
- H_MV_HLS_7_SPS_P0155_16_32 Not signal the sps_max_num_reorder_pics[], sps_max_latency_increase_plus1[], and sps_max_dec_pic_buffering_minus1[] syntax elements in the SPS when nuh_layer_id > 0.
- H_MV_HLS_7_GEN_P0166_PPS_EXTENSION Add PPS extension type flags for conditional presence of syntax extensions per extension type, aligned with the SPS extension type flags, from JCTVC-P0166. Further align the SPS extension type flags syntax between RExt and MV-HEVC/SHVC
- H_MV_HLS_7_FIX_SET_DPB_SIZE Fix derivation dpb size parameters
- H_MV_HLS_7_RESERVED_FLAGS Added flags
- SPS SHVC reserved flag The flag will be used for the syntax vert_phase_position_enable_flag in SHVC draft
- VPS SHVC reserved flagT his flag will be used for the syntax cross_layer_phase_alignment_flag in SHVC draft.
- VPS VUI SHVC reserved flags the 3 reserved bits will be used for the syntaxes single_layer_for_non_irap_flag, higher_layer_irap_skip_flag and vert_phase_position_not_in_use_flag in SHVC draft.
- H_MV_FIX_VPS_LAYER_ID_NOT_EQUAL_ZERO Discard VPS with nuh_layer_id > 0
- H_MV_HLS_7_MISC_P0130_EOS EOS NAL layer id Require that end of bitstream NAL unit shall have nuh_layer_id equal to 0, from JCTVC-P0130. Decoders shall allow an end of bitstream NAL unit with nuh_layer_id > 0 to be present, and shall ignore the NAL unit.
- H_MV_HLS_7_MISC_P0182_13 BL PS Compatibility flag, Define the flag (in VPS VUI) with the proposed semantics, without specifying an associated extraction process. Editors to select the position in the VPS VUI.

- H_MV_HLS_7_MISC_P0068_21 Add flag in VUI to indicate that all IRAP pictures are IDR and that all layer pictures in an AU are IDR aligned, from JCTVC-P0068 proposal 1.
- H_MV_HLS_7_FIX_INFER_CROSS_LAYER_IRAP_ALIGNED_FLAG Fix inference of cross_layer_irap_aligned_flag
- H_MV_HLS_7_MISC_P0079_18 Modification of derivation of variable NumActiveRefLayerPics.

2.2.2 Coding performance

3D-HEVC: HTM-10.1 vs. HTM-10.0r1 (CTC, three view configuration)

	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	0,0%	0,0%	0,0%	94,5%	99,0%	99,5%
Kendo	0,0%	0,0%	0,0%	94,1%	96,9%	99,6%
Newspaper_CC	0,0%	0,0%	0,0%	94,4%	98,2%	98,6%
GT_Fly	-0,1%	0,0%	-0,1%	94,3%	98,8%	98,2%
Poznan_Hall2	0,0%	0,0%	-0,1%	93,5%	89,2%	96,6%
Poznan_Street	0,0%	0,0%	0,0%	94,2%	94,4%	96,4%
Undo_Dancer	0,0%	0,0%	0,0%	94,6%	99,0%	98,0%
Shark	0,0%	0,0%	0,0%	94,4%	102,0%	100,8%
1024x768	0,0%	0,0%	0,0%	94,3%	98,1%	99,2%
1920x1088	0,0%	0,0%	0,0%	94,2%	96,7%	98,0%
average	0,0%	0,0%	0,0%	94,2%	97,2%	98,5%

MV-HEVC: HTM-10.1 vs. HTM-10.0r1 (CTC, three view configuration)

	video 0 video 0 rate	video 1 video 1 rate	video 2 video 2 rate	video total rate
Balloons	0,0%	-0,1%	0,2%	0,0%
Kendo	0,0%	-0,1%	0,0%	0,0%
Newspaper_CC	0,0%	0,2%	0,1%	0,1%
GT_Fly	0,0%	0,0%	0,1%	0,0%
Poznan_Hall2	0,0%	0,0%	0,1%	0,0%
Poznan_Street	0,0%	-0,1%	0,0%	0,0%
Undo_Dancer	0,0%	0,1%	-0,1%	0,0%
Shark	0,1%	-0,2%	-0,1%	0,0%
1024x768	0,0%	0,0%	0,1%	0,0%
1920x1088	0,0%	0,0%	0,0%	0,0%
average	0,0%	0,0%	0,0%	0,0%

3 Open issues

- Some minor mismatches related to 3D-HEVC HLS.
- MV-HEVC / 3D-HEVC SEI messages missing.
- Some missing items related to MV-HEVC HLS (POC derivation, Auxiliary pictures, CLRAS)
- Other minor issues are listed in the bug tracking system.

4 Recommendations

The recommendations of the 3D-HEVC Software integration group are:

- Develop reference software HTM version 11 based on HTM-10.1 and improve its quality
- When a proposal is adopted to discuss how to enable it in the HTM software (e.g. encoder parameter / parameter set flag, or always on).
- Continue to identify bugs and discrepancies with text, and address them.
- Fix open issues.
- Discuss on how to address open issues.