Joint Collaborative Team on 3D Video Coding Extension Development of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11
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Title: **JCT-3V AHG Report: 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 4th JCT-3V meeting in Incheon and the 5th JCT-3V meeting in Vienna. Activities focused on the integration of tools adopted at the 4th meeting into a common code base, and the update of HTM software to the latest HM version.

1 Mandates

Title	Chairs	Mtg
3D-HEVC Software Integration (AHG5) • 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 7.0 software version and the reference configuration encodings according to JCT3V-D1100 based on common conditions suitable for use in most core experiments (expected within 4 weeks after the meeting). • Prepare and deliver HTM-DEV 1.0 software version that includes HLS from MV-HEVC draft 4 and non-normative tools from 3D-HEVC test model 4 version (expected within 4 weeks after the meeting). • Coordinate the migration of low-level tools from HTM 7.0 into HTM-DEV 1.0. • 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.	G. Tech L. Zhang (co-chairs) Y. Chang K. Wegner (vice chairs)	N

• Maintain the bug tracking system.		

2 HTM version 7.0 tool integration

Development of the software was co-ordinated with the parties needing to integrate changes. Development of HTM-7.0 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.

Prior to each integration source code to be integrated has been reviewed by the software coordinator and suggestions for improvement have been made to the integrators when necessary.

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_3DVCSoftware/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 Version HTM-7.0r1

Starting point for development of HTM-7.0r1 was HTM-6.2.

2.1.1 Integrated items

Track 1 (integrations mainly related to Merge / AMVP / HLS):

JCT3V-D0122 CE5: AMVP candidate list construction

JCT3V-D0191 CE1: Clean-ups for BVSP in 3D-HEVC

JCT3V-D0060 CE5: Removal of parsing dependency for illumination compensation

JCT3V-D0156 CE1: A high level syntax suggestion for stereo compatibility in 3D-HEVC

JCT3V-D0092 CE1: BVSP mode inheritance

JCT3V-D0091 CE5: Inter-view SAO process in 3DV coding (Update SW?)

JCT3V-D0135 CE5: Unification of disparity vector rounding

Track 2 (integration mainly related to Disparity derivation/Motion compensation/Residual prediction):

JCT3V-D0181 CE2: CU-based Disparity Vector Derivation in 3D-HEVC

JCT3V-D0177 CE4: Advanced residual prediction for multiview coding

JCT3V-D0138 CE2: Simplified DV derivation for DoNBDV and BVSP

JCT3V-D0105 CE1: Simplifications on view synthesis prediction

JCT3V-D0139 CE1: Results on removal BVSP for depth coding

JCT3V-D0112 CE2: Default disparity vector derivation

JCT3V-D0165 CE1: VSP Complexity Analysis and Constraint VSP (CVSP)

JCT3V-D0166 CE1: On reference view selection in NBDV and VSP

Track 3 (integrations mainly related to Depth Intra):

JCT3V-D0036 CE6: Results on aligning 3D- S/W with 3D-draft for Wedgelet pattern construction

JCT3V-D0035 CE6: Results on DLT for DMM deltaDC coding

JCT3V-D0163 CE6: SDC with WVSO metric

JCT3V-D0193 CE6: Clean up for 64x64 SDC

JCT3V-D0183 CE6: Simplified DC predictor for depth intra modes

JCT3V-D0195 CE6: Unification of new intra modes in 3D-HEVC

JCT3V-D0110 CE6: Sample-based simplified depth coding

JCT3V-D0034 CE6: Results on Fixes for Context Initialization and Unary Coding for SDC

JCT3V-D0032 CE6: Results on CABAC Context Reduction for Simplified Depth Coding (SDC)

JCT3V-D0141 CE6: Concatenate binarization for residual index coding

2.1.2 Coding performance

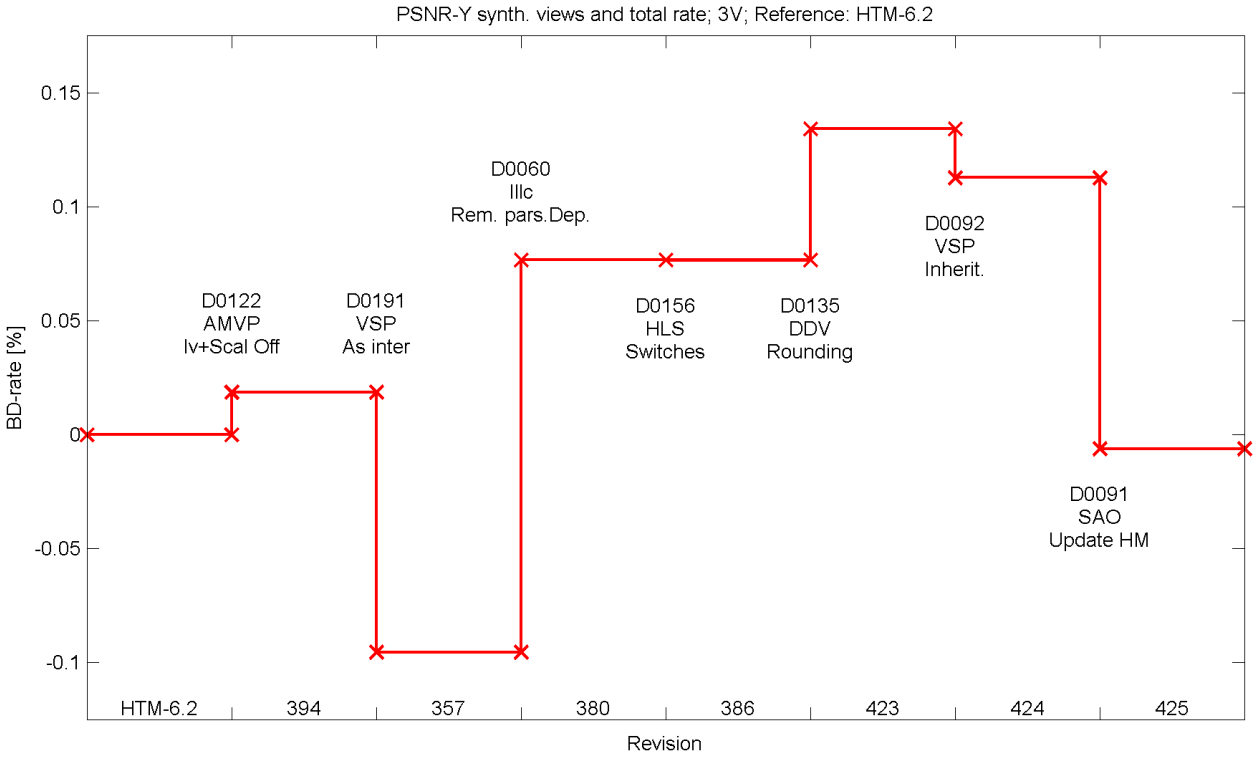
HTM-7.0r1 vs. HTM-6.2 (CTC, three view configuration)

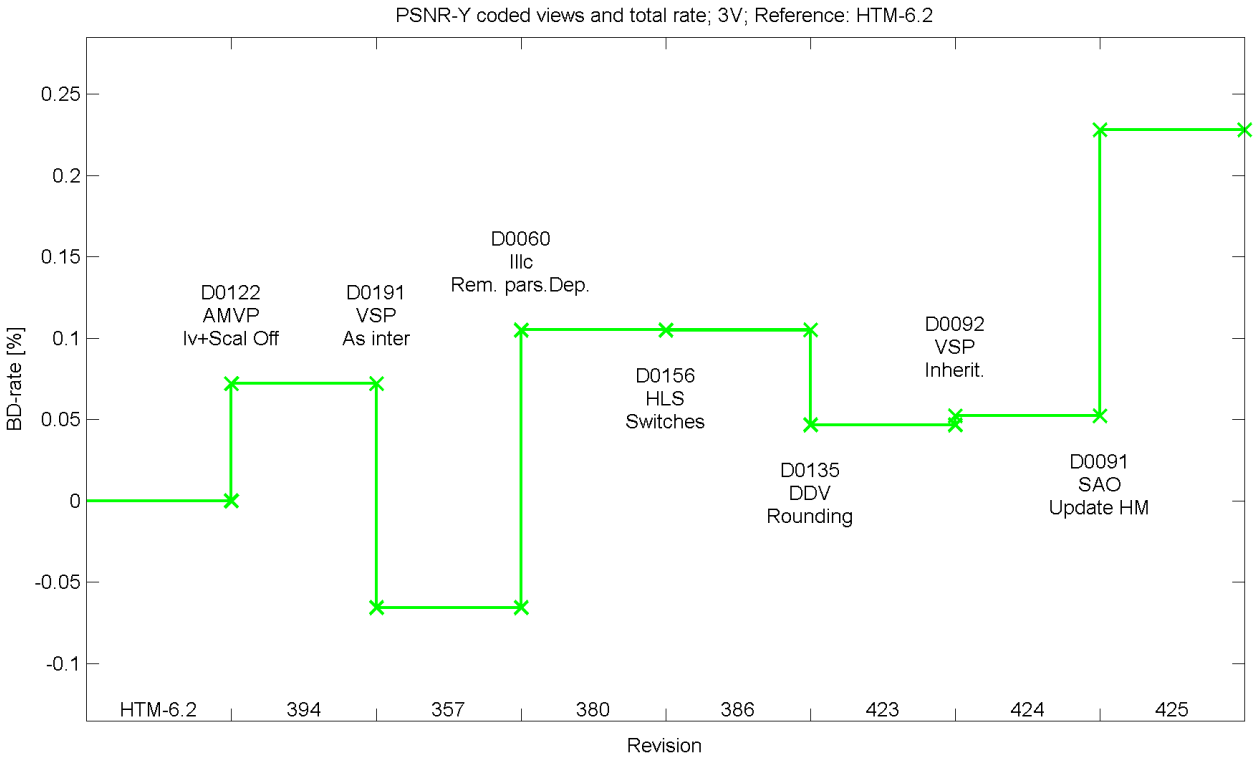
	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	-0,3%	-0,3%	-0,8%	104,7%	88,7%	99,4%
Kendo	-0,3%	0,2%	-0,8%	100,5%	94,3%	98,3%
Newspaper_CC	-0,8%	-0,7%	-1,2%	103,8%	92,7%	98,3%
GT_Fly	-0,5%	-1,1%	-1,6%	106,3%	91,0%	103,4%
Poznan_Hall2	-0,1%	-0,3%	-0,4%	108,4%	95,7%	101,3%
Poznan_Street	-1,0%	-1,4%	-1,5%	106,7%	90,1%	104,4%
Undo_Dancer	-0,5%	-0,6%	-1,3%	109,9%	85,3%	100,2%
1024x768	-0,5%	-0,2%	-0,9%	103,0%	91,9%	98,7%
1920x1088	-0,5%	-0,9%	-1,2%	107,8%	90,5%	102,3%
average	**-0,5%**	**-0,6%**	**-1,1%**	**105,7%**	**91,1%**	**100,8%**

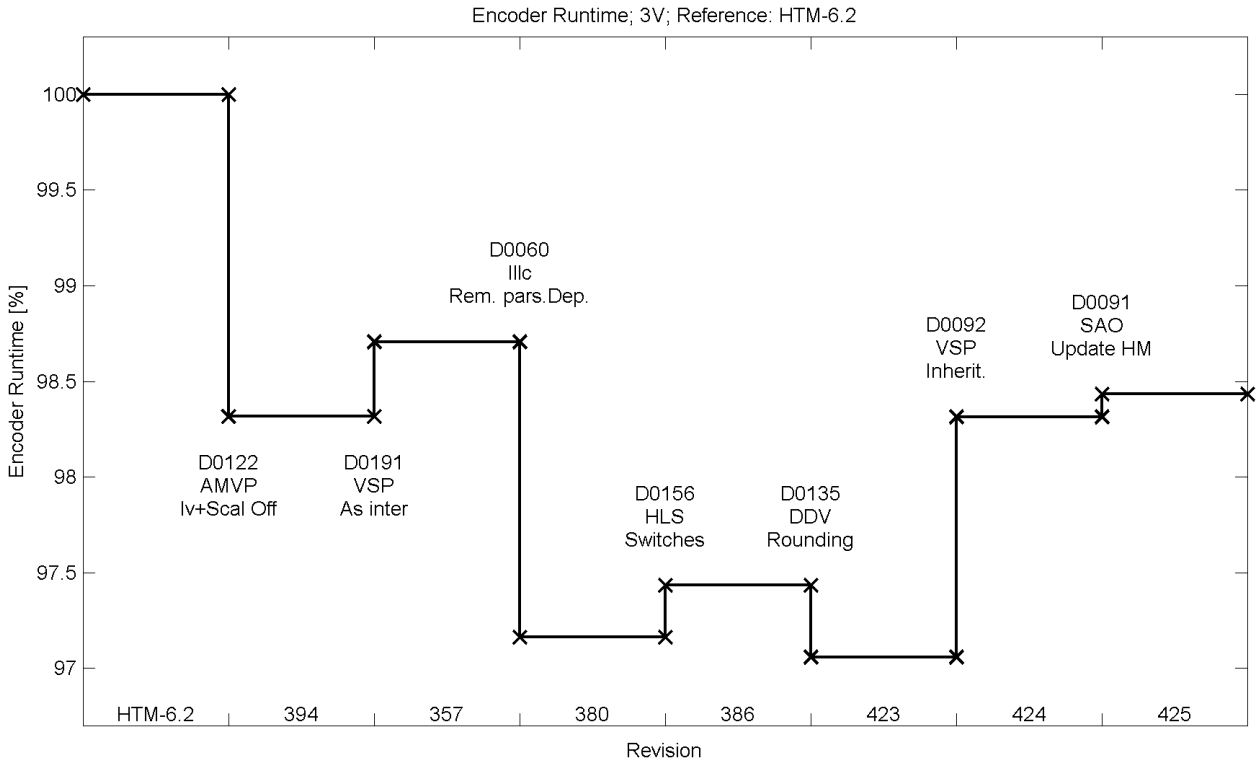
2.1.3 History of revisions

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.

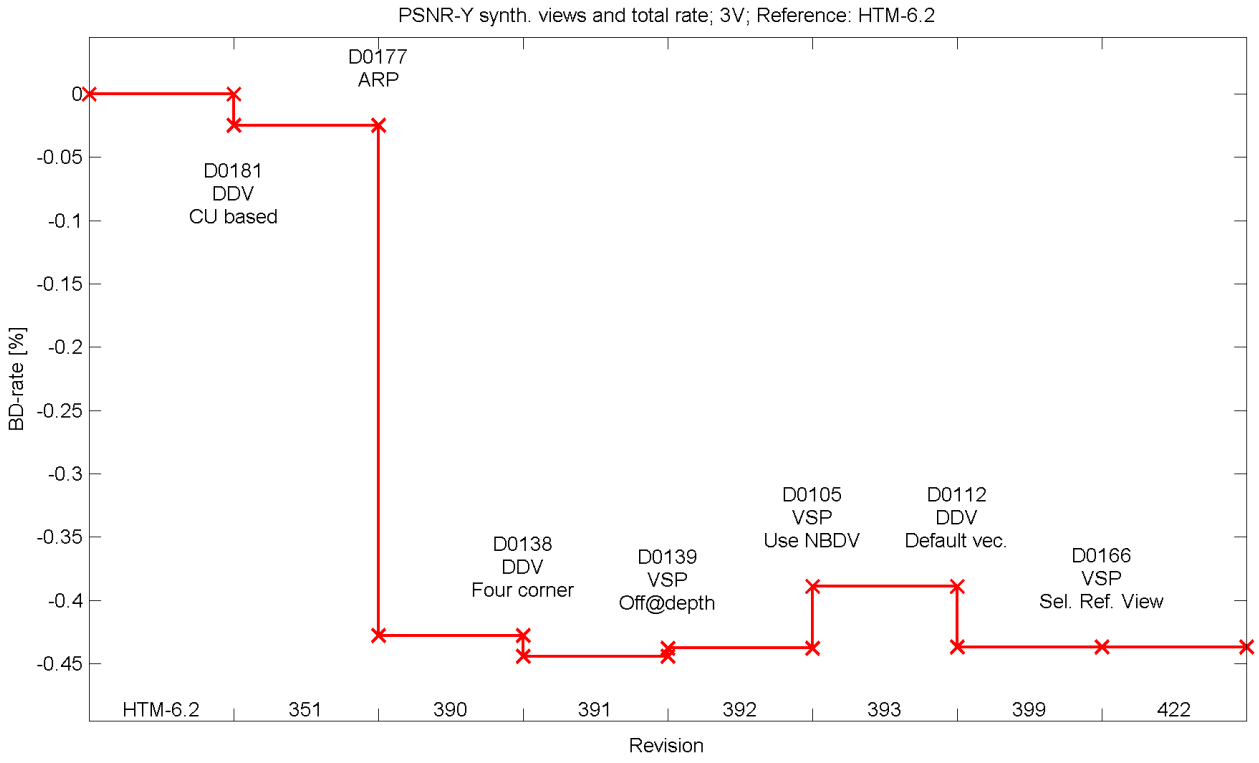
2.1.3.1 Track 1

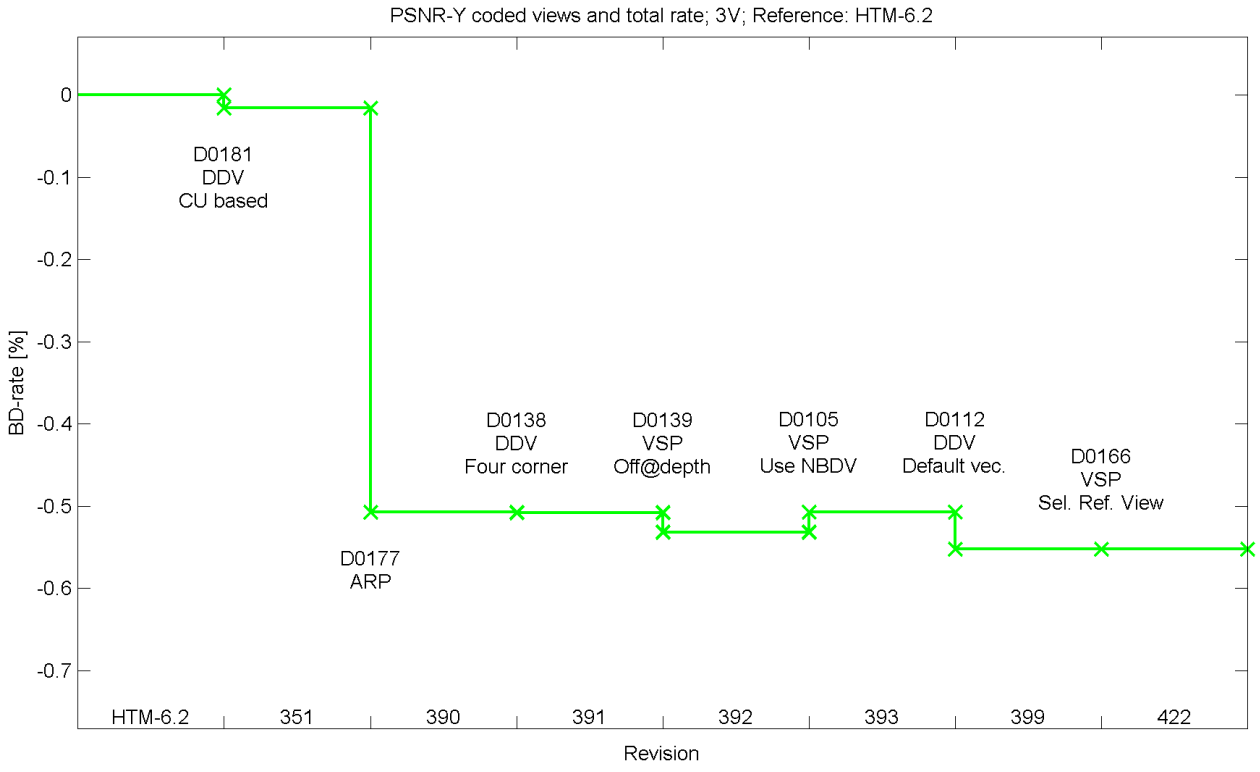


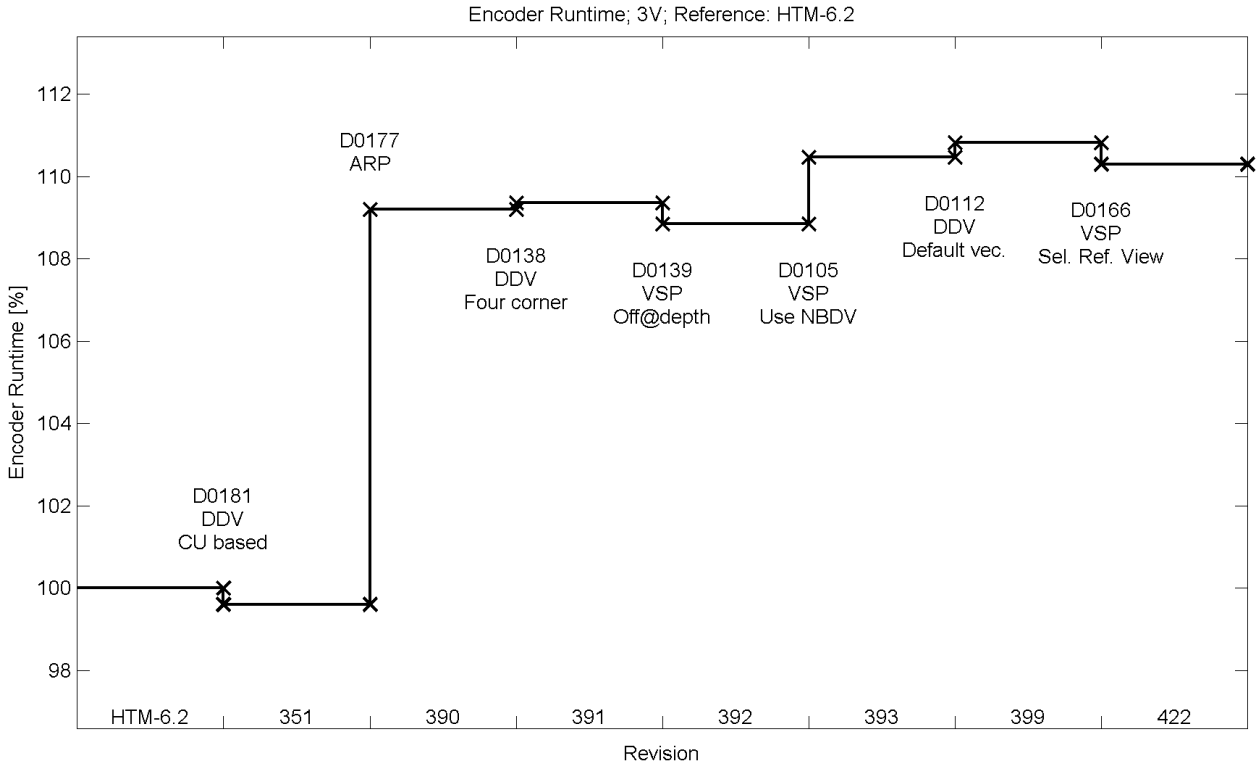



Encoder Runtime; 3V; Reference: HTM-6.2
Encoder Runtime [%]
100
99.5
99
98.5
98
97.5
97
D0122
AMVP
Iv+Scal Off
D0191
VSP
As inter
D0060
IIIc
Rem. pars.Dep.
D0156
HLS
Switches
D0135
DDV
Rounding
D0092
VSP
Inherit.
D0091
SAO
Update HM
HTM-6.2
394
357
380
386
423
424
425
Revision

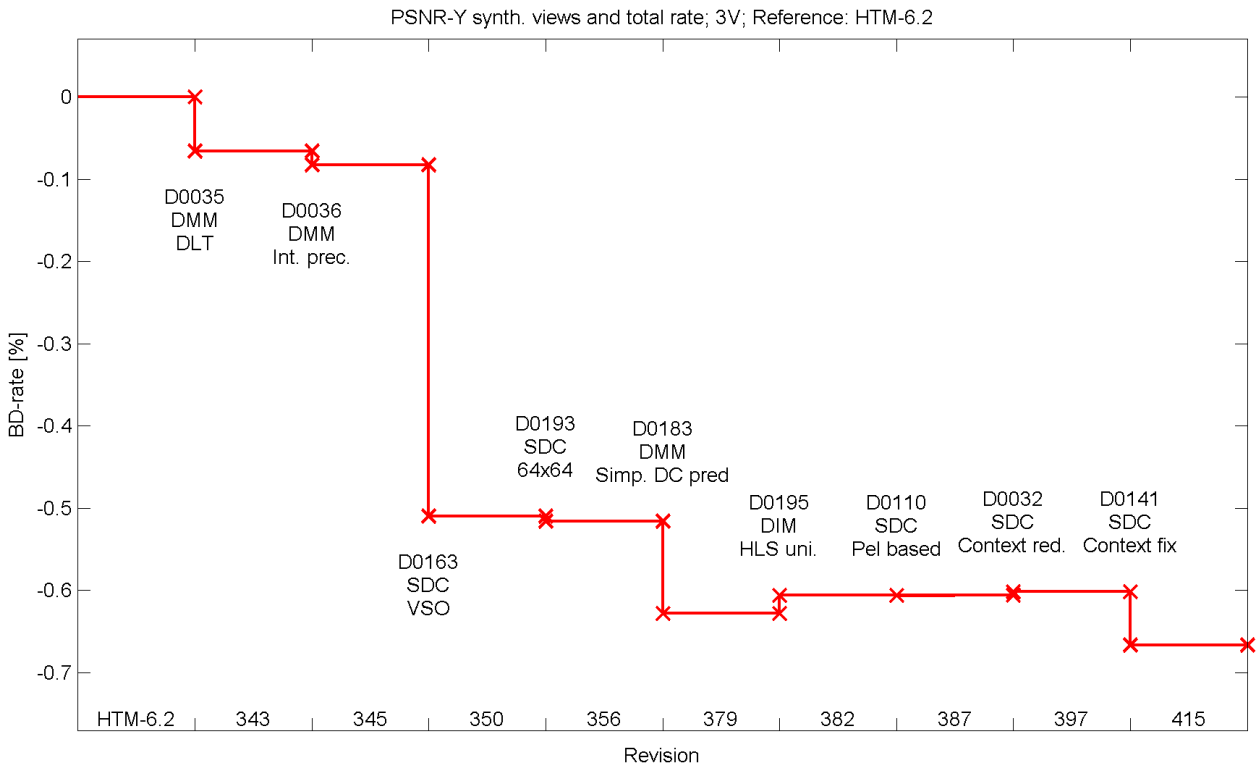
2.1.3.2 Track 2

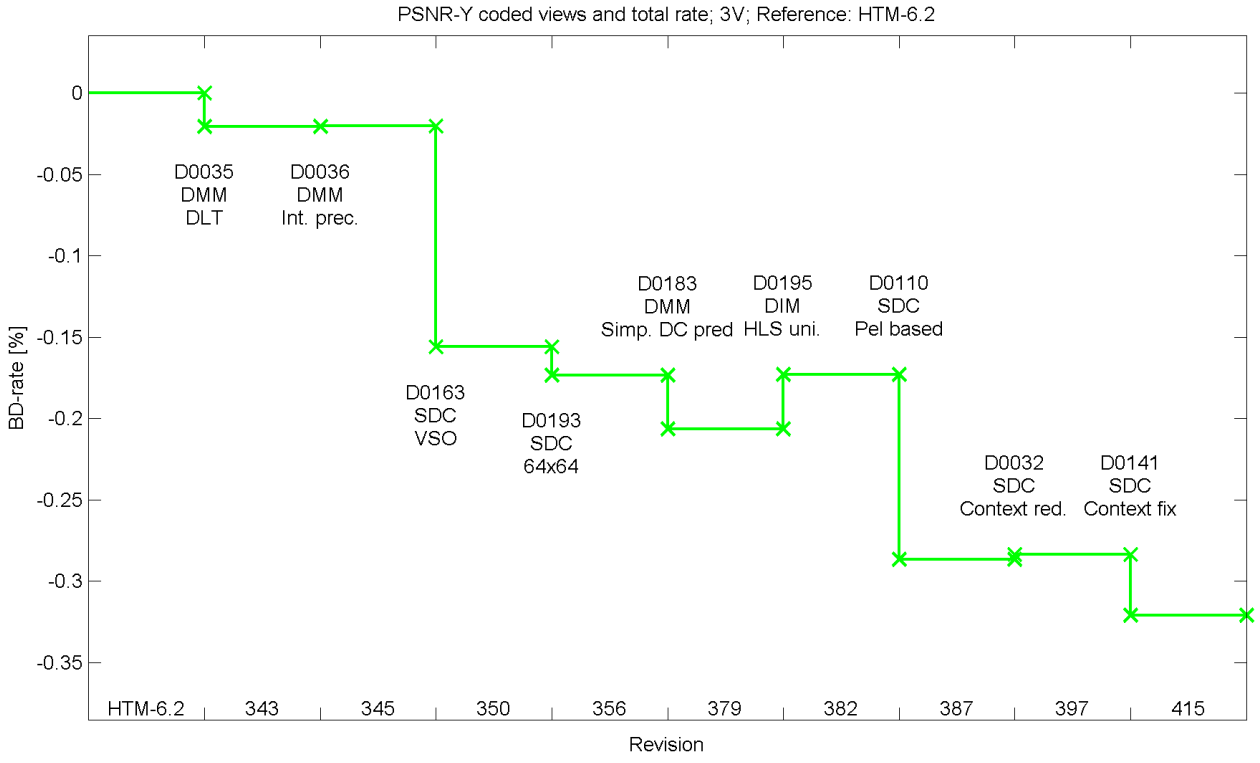

PSNR-Y synth. views and total rate; 3V; Reference: HTM-6.2
BD-rate [%]
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
D0177
ARP
D0181
DDV
CU based
D0138
DDV
Four corner
D0139
VSP
Off@depth
D0105
VSP
Use NBDV
D0112
DDV
Default vec.
D0166
VSP
Sel. Ref. View
HTM-6.2
351
390
391
392
393
399
422
Revision

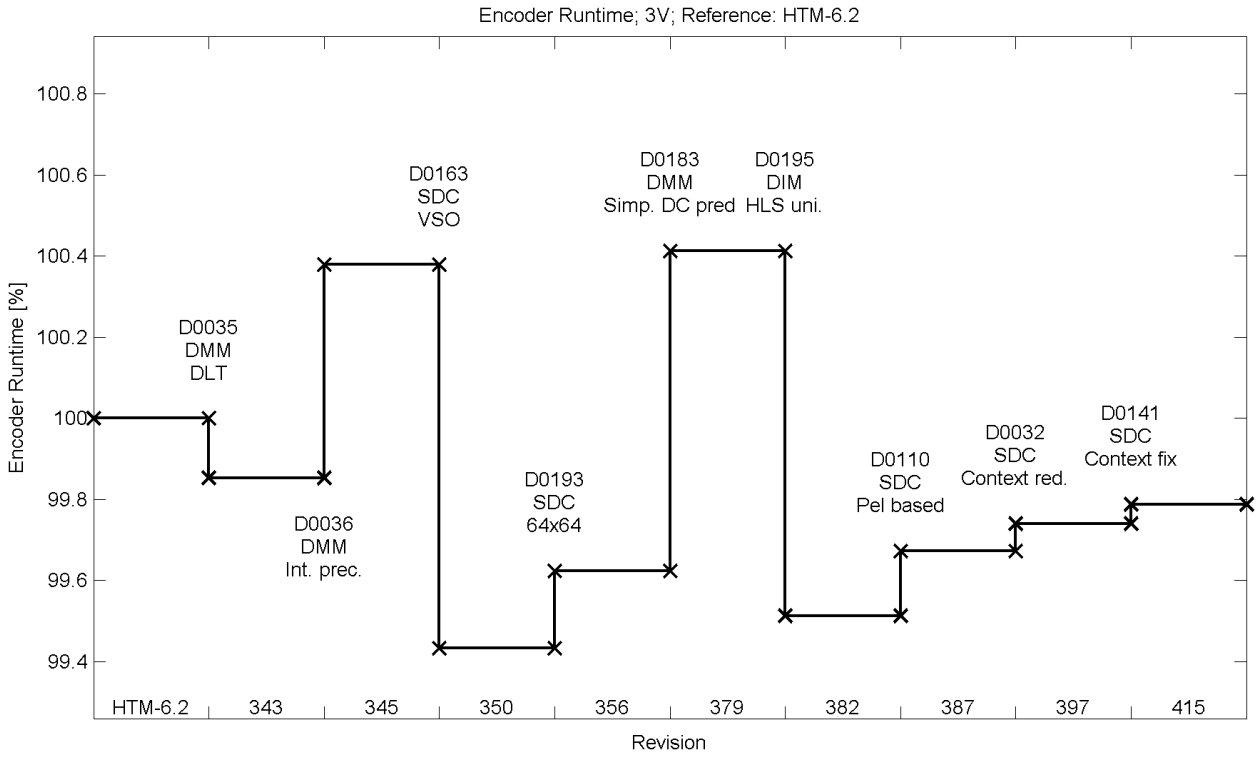

PSNR-Y coded views and total rate; 3V; Reference: HTM-6.2
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
D0181
DDV
CU based
D0177
ARP
D0138
DDV
Four corner
D0139
VSP
Off@depth
D0105
VSP
Use NBDV
D0112
DDV
Default vec.
D0166
VSP
Sel. Ref. View
HTM-6.2
351
390
391
392
393
399
422
Revision


Encoder Runtime; 3V; Reference: HTM-6.2
Encoder Runtime [%]
112
110
108
106
104
102
100
98
D0177
ARP
D0138
DDV
Four corner
D0139
VSP
Off@depth
D0105
VSP
Use NBDV
D0112
DDV
Default vec.
D0166
VSP
Sel. Ref. View
D0181
DDV
CU based
HTM-6.2
351
390
391
392
393
399
422
Revision

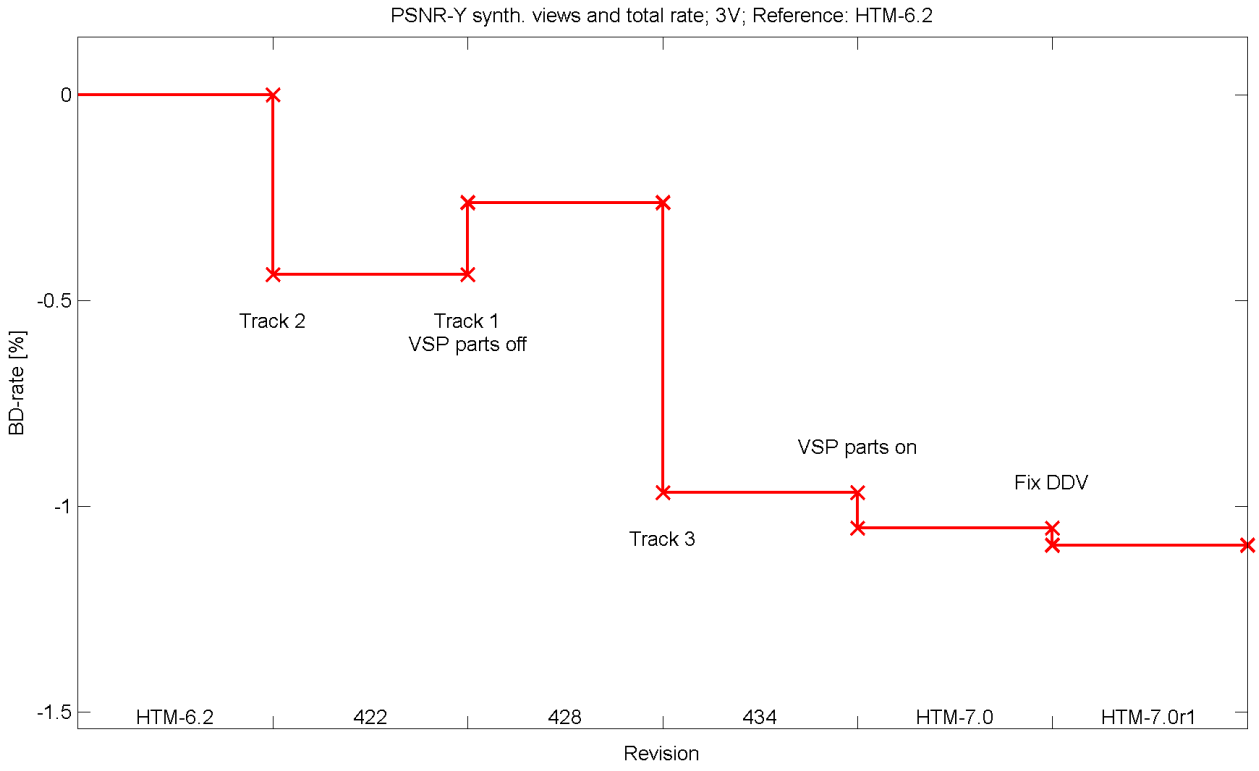
2.1.3.3 Track 3

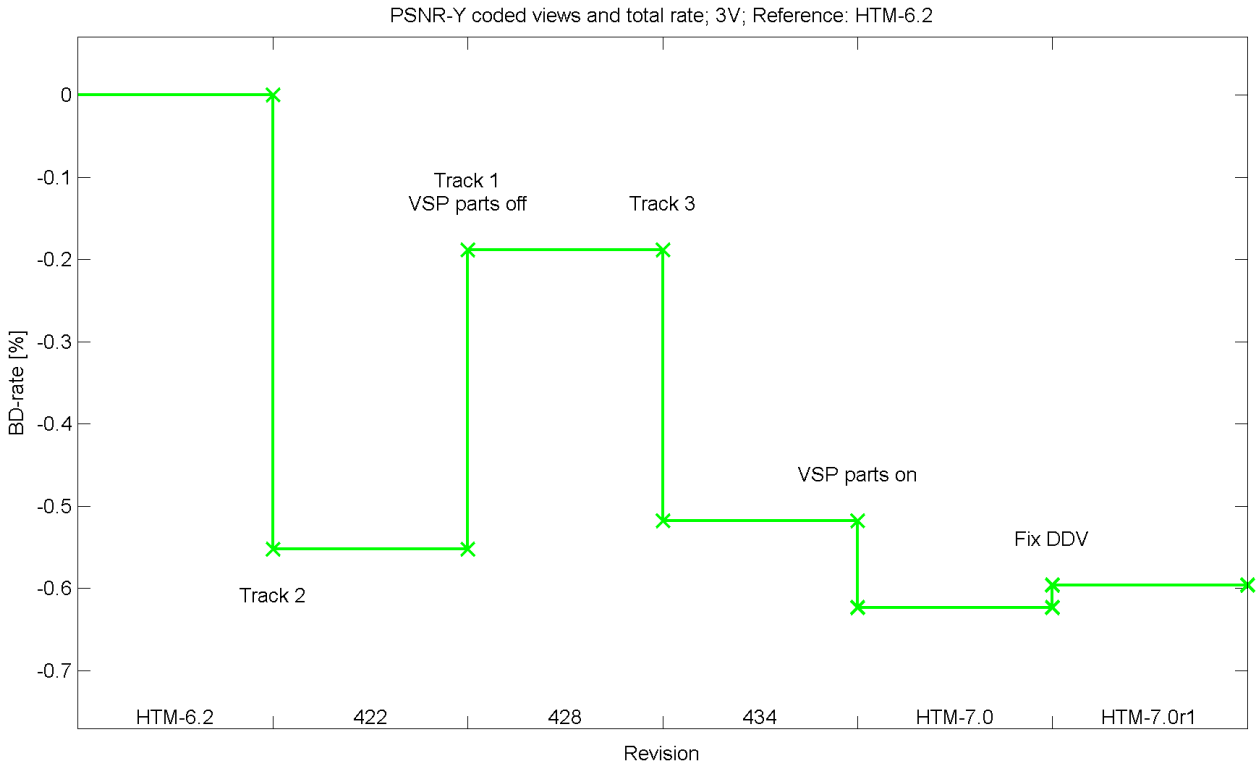

PSNR-Y synth. views and total rate; 3V; Reference: HTM-6.2
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
D0035 DMM DLT
D0036 DMM Int. prec.
D0163 SDC VSO
D0193 SDC 64x64
D0183 DMM Simp. DC pred
D0195 DIM HLS uni.
D0110 SDC Pel based
D0032 SDC Context red.
D0141 SDC Context fix
HTM-6.2
343
345
350
356
379
382
387
397
415
Revision

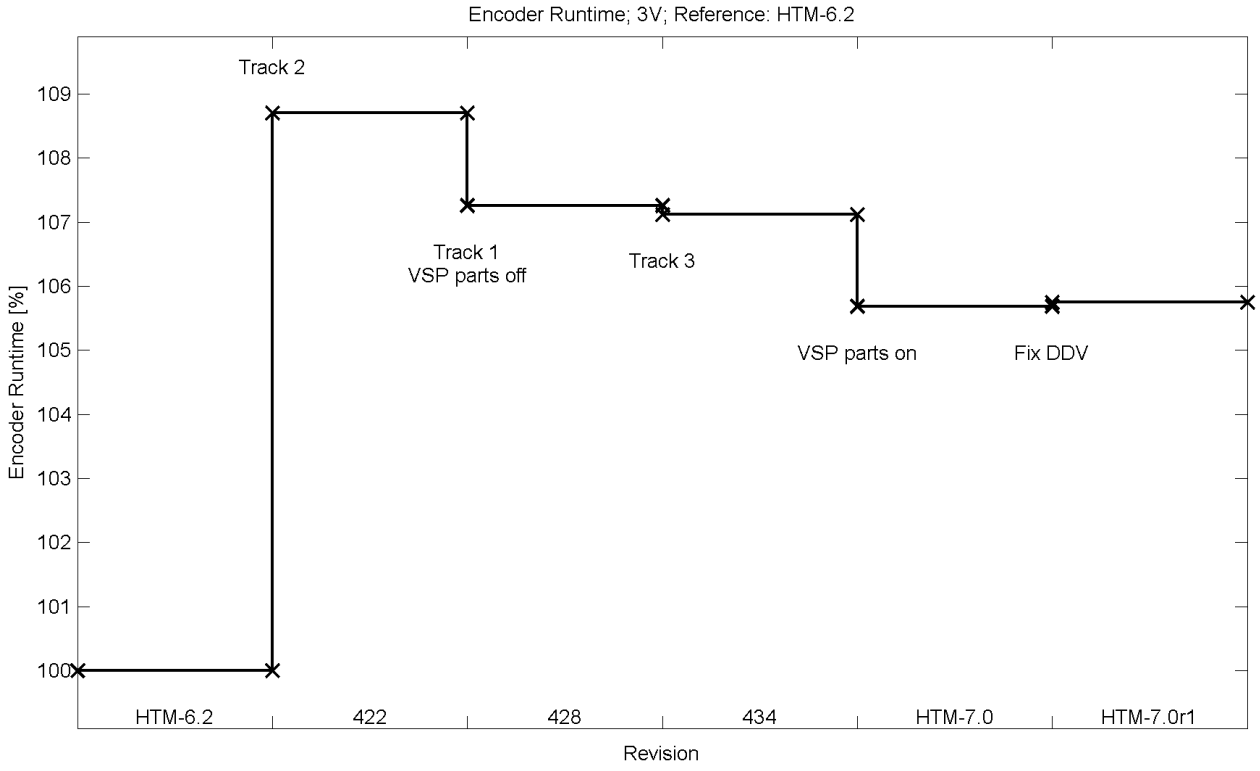

PSNR-Y coded views and total rate; 3V; Reference: HTM-6.2
BD-rate [%]
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
D0035 DMM DLT
D0036 DMM Int. prec.
D0163 SDC VSO
D0193 SDC 64x64
D0183 DMM Simp. DC pred
D0195 DIM HLS uni.
D0110 SDC Pel based
D0032 SDC Context red.
D0141 SDC Context fix
HTM-6.2
343
345
350
356
379
382
387
397
415
Revision



2.1.3.4 Merge of tracks




PSNR-Y coded views and total rate; 3V; Reference: HTM-6.2
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
Track 1
VSP parts off
Track 3
VSP parts on
Fix DDV
Track 2
HTM-6.2
422
428
434
HTM-7.0
HTM-7.0r1
Revision


Encoder Runtime; 3V; Reference: HTM-6.2
Encoder Runtime [%]
109
108
107
106
105
104
103
102
101
100
Track 2
Track 1
VSP parts off
Track 3
VSP parts on
Fix DDV
HTM-6.2
422
428
434
HTM-7.0
HTM-7.0r1
Revision

2.2 Open issues in HTM-7.0r1

- Since the 3D-HEVC Test Model [2] is based on HEVC text specification draft 8 [3] and HTM-7.0r1 is based on HM-6.1 there are mismatches between draft text and HTM-software.
- With the integration of tools related to inter-view motion prediction the issue arose that inter-view motion prediction only works properly under CTC. Moreover there are mismatches with the provided text.
- Some tools are not switchable by encoder configuration, although this would be desirable.
- Other minor issues are listed in the bug tracking system.

3 HTM Update

The update of the HTM software has been continued based on HTM-DEV-0.1. First, two versions have been created using a serial integration:

- HTM-DEV-0.2 including bug fixes and an update to HM 10.1
- HTM-DEV-0.3 including 3D encoder control

After availability to HTM-7.0r1 3D-tools have been merged. Development has been carried out in up to four tracks:

- HTM-DEV-0.3-dev0: MV-HEVC HLS according to MV-HEVC draft text 4 has been integrated. Final revision of this branch has been released as HTM-DEV-1.0.
- HTM-DEV-0.3-dev1: Depth intra tools have been integrated.
- HTM-DEV-0.3-dev2: Integration of inter tools.
- HTM-DEV-0.3-dev2a: Integration of inter tools.

Finally all branches have been merged, missing items have been integrated and software has been updated to HM-11.0. The resulting software has been released as HTM-DEV-2.0.

HTM-DEV-2.0 is based on HM-11.0 and includes:

- All tools of HTM-7.0r1 relevant for core experiments.
- MV-HEVC HLS according to MV-HEVC draft 4.
- 3D-HEVC HLS according to 3D-HEVC test model 4.

MV-HEVC and 3D-HEVC are still strictly separated by parts by macros.

Major open issues are:

- Untested bitstream extractor.
- Flexible coding order.

3.1 Coding performance MV-HEVC

HTM-DEV-2.0 vs. HTM-DEV-0.1

	video PSNR / video bitrate	enc time
Balloons	0,3%	107,5%
Kendo	0,3%	107,5%
Newspaper_CC	0,3%	108,2%
GT_Fly	0,3%	107,5%
Poznan_Hall2	0,3%	108,9%
Poznan_Street	0,1%	109,0%
Undo_Dancer	-0,1%	107,7%
1024x768	0,3%	107,7%
1920x1088	0,2%	108,3%
average	**0,2%**	**108,1%**

3.2 Coding performance 3D-HEVC

HTM-DEV-2.0 vs. HTM-7.0r1

	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	-0,9%	-1,7%	-1,6%	125,5%	92,1%	105,3%
Kendo	-0,9%	-1,7%	-1,4%	117,7%	90,2%	104,8%
Newspaper_CC	-0,6%	-1,6%	-1,5%	127,3%	88,2%	105,1%
GT_Fly	-1,4%	-1,8%	-1,0%	97,2%	95,9%	102,6%
Poznan_Hall2	-1,5%	-2,4%	-1,9%	123,5%	88,5%	105,0%
Poznan_Street	-0,2%	-0,8%	-0,5%	128,7%	90,1%	101,8%
Undo_Dancer	-0,5%	-0,8%	-0,3%	115,7%	90,8%	106,4%
1024x768	-0,8%	-1,7%	-1,5%	123,5%	90,2%	105,0%
1920x1088	-0,9%	-1,4%	-0,9%	116,3%	91,3%	103,9%
average	**-0,9%**	**-1,5%**	**-1,2%**	**119,4%**	**90,8%**	**104,4%**

4 Bug tracking system

The issues with the bug tracking system identified at the last meeting could be resolved. AHG5 wants to thank Karsten Sühring for the support. Missing components for AVC based development can be set up now.

5 Input documents

Following input documents related to AHG 5 have been submitted:

JCT3V-E0099 JCT-3V AHG 5: Checklist for HTM software integration

6 Recommendations

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

- Develop reference software HTM version 8 based on HTM-DEV-2.0 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.
- Discuss on how to address open issues.
- Discuss AHG5 related input documents.

7 References

[1] JCT-3V, “MV-HEVC Draft 4”, JCT3V-D1004, JCT-3V Meeting, Incheon, April 2013

[2] JCT-3V, “3D-HEVC Test Model 4”, JCT3V-D1005, JCT-3V Meeting, Incheon, April 2013

[3] JCT-VC, “High Efficiency Video Coding (HEVC) text specification draft 8”, JCTVC-J1003, JCT-VC Meeting, Stockholm, July 2012