

*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 2<sup>nd</sup> JCT-3V meeting in Shanghai (13-19 October 2012) and the 3<sup>rd</sup> meeting in Geneva (17-23 January 2013). Activities focused on the integration of tools adopted at the 2<sup>nd</sup> meeting into a common code base.

## 1 Mandates

Title	Chairs	Mtg
<p><b>3D-HEVC Software Integration (AHG5)</b></p> <ul style="list-style-type: none"> <li>• Coordinate development of the HTM software and its distribution to JCT-3V members</li> <li>• Produce documentation of software usage for distribution with the software</li> <li>• Prepare and deliver HTM 5.0 software version and the reference configuration encodings according to JCT3V-B1100 based on common conditions suitable for use in most core experiments (expected within 4 weeks after the meeting).</li> <li>• Prepare and deliver HTM 5.1 software that include additional items not integrated into the 5.0 version (expected within 2 weeks after the 5.0 software release).</li> <li>• Perform analysis and reconfirmation checks of the behaviour of technical changes adopted into the draft design, and report the results of such analysis.</li> <li>• Suggest configuration files for additional testing of tools.</li> <li>• Coordinate with MV-HEVC Draft and 3D-HEVC Test Model editing AhG to identify any mismatches between software and text.</li> <li>• Set up a bug tracking system.</li> </ul>	<p>G. Tech L. Zhang (co-chairs) Y. Chang K. Wegner (vice chairs)</p>	<p>N</p>

## 2 Method of working

Development of the software was co-ordinated with the parties needing to integrate changes. Development of HTM-5.0 was conducted in two parallel tracks each performing sequential integration. Software of both tracks were merged by the software coordinators. HTM-5.1 was developed using a single track.

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/](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/

## 3 History of software tags

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 changes made for each tag and achieved coding gains.

### 3.1 *Version HTM-5.0*

Normative Tools:

- (JCT3V-B0096) CE5.h Removal of dependency between multiple PUs in a CU for disparity vector derivation
- (JCT3V-B0111) CE5.h Decoupling inter-view candidate for AMVP
- (JCT3V-B0135) CE5.h Modified disparity vector derivation process for memory reduction
- (JCT3V-B0136) CE5.h Support of parallel merge in disparity vector derivation
- (JCT3V-B0047) CE5.h Improvements for disparity vector derivation
- (JCT3V-B0048+B0069+B0086) CE5.h Merge candidates derivation from disparity vector
- (JCT3V-B0045) CE2.h Results of Illumination Compensation for Inter-View Prediction
- (JCT3V-B0039) CE6.h Simplified Wedgelet search for DMM modes 1 and 3
- (JCT3V-B0083) CE3.h Related: Unconstrained motion parameter inheritance
- (JCT3V-B0036) CE6.h Results on Simplified Depth Coding with an optional Depth LUT
- (JCT3V-B0068) CE3.h Depth Quadtree Prediction for 3DHTM 4.1

Non-normative tools:

- (JCT3V-B0131) CE4.h Results on Depth distortion metric with a weighted depth fidelity term
- (JCT3V-B0065) CE3.h Related: Motion Parameter Inheritance Improvement [Bug fix only]
- (JCT3V-B0092) Removing temporal motion vector prediction for depth map coding [Encoder parameter]

Bug fixes with impact on coding performance

- Fix of erroneous termination condition in RDO (insignificant)

### HTM-5.0 vs. HTM-4.1 (CTC, three view configuration)

	video 0	video 1	video 2	video only	synthesized only	coded & synthesized	enc time	dec time	ren time
Balloons	0,0%	-2,4%	-2,8%	-1,2%	0,5%	-0,1%	75,6%	95,4%	98,4%
Kendo	0,0%	-4,3%	-5,3%	-2,1%	0,1%	-0,2%	77,0%	92,8%	98,3%
Newspapercc	0,0%	-1,8%	-1,9%	-0,8%	-0,1%	-0,8%	68,0%	93,2%	97,5%
GhostTownFly	0,0%	-1,2%	-1,2%	-0,4%	-0,9%	-1,0%	70,7%	91,5%	97,9%
PoznanHall2	0,0%	-1,2%	-2,0%	-0,9%	-1,2%	-1,8%	70,6%	94,5%	96,3%
PoznanStreet	0,0%	-0,9%	-1,6%	-0,5%	-0,6%	-0,8%	71,3%	97,1%	99,7%
UndoDancer	0,0%	-0,9%	-0,8%	-0,3%	-1,7%	-1,6%	73,3%	93,1%	96,5%
1024x768	0,0%	-2,8%	-3,3%	-1,4%	0,2%	-0,4%	73,4%	93,8%	98,1%
1920x1088	0,0%	-1,0%	-1,4%	-0,5%	-1,1%	-1,3%	71,5%	94,0%	97,6%
<b>average</b>	<b>0,0%</b>	<b>-1,8%</b>	<b>-2,2%</b>	<b>-0,9%</b>	<b>-0,6%</b>	<b>-0,9%</b>	<b>72,3%</b>	<b>93,9%</b>	<b>97,8%</b>

### 3.2 Version HTM-5.0.1

Bug fixes with impact on coding performance

- Fix of bug that causes encoder/decoder mismatches under certain conditions different from CTC.

#### HTM-5.0.1 vs. HTM-5.0 (CTC, three view configuration)

	video 0	video 1	video 2	video only	synthesized only	coded & synthesized	enc time	dec time	ren time
Balloons	0,0%	0,0%	-0,1%	0,0%	0,0%	0,0%	100,3%	103,0%	99,5%
Kendo	0,0%	0,0%	-0,1%	0,0%	0,0%	0,0%	100,3%	100,9%	100,1%
Newspapercc	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%	100,7%	100,5%
GhostTownFly	0,0%	-0,2%	-0,1%	0,0%	0,0%	0,0%	100,1%	107,3%	99,6%
PoznanHall2	0,0%	0,0%	-0,5%	-0,1%	-0,1%	-0,1%	99,7%	100,4%	100,9%
PoznanStreet	0,0%	-0,2%	-0,1%	0,0%	0,0%	0,0%	99,8%	92,5%	95,4%
UndoDancer	0,0%	-0,1%	-0,1%	0,0%	0,0%	0,0%	99,7%	103,6%	99,1%
1024x768	0,0%	0,0%	-0,1%	0,0%	0,0%	0,0%	100,2%	101,5%	100,0%
1920x1088	0,0%	-0,1%	-0,2%	0,0%	0,0%	0,0%	99,8%	100,8%	98,7%
<b>average</b>	<b>0,0%</b>	<b>-0,1%</b>	<b>-0,1%</b>	<b>0,0%</b>	<b>0,0%</b>	<b>0,0%</b>	<b>100,0%</b>	<b>101,1%</b>	<b>99,3%</b>

### 3.3 Version HTM-5.1

Non-Normative Changes (off by default):

- (JCT3V-B0046) MV-HEVC configuration
- (JCT3V-B0037) Vertical length restriction of inter-view vector for HEVC simple 3D extension
- (M23723) Flexible coding order

Modifications for alignment with MV-HEVC (on by default)

- (JCT3V-B0046) Treatment of interview-reference pictures as long-term pictures
- (JCT3V-B0046) Removal of IDV NAL unit type
- (JCT3V-B0046) Reference index for temporal merging candidate is set equal to 0

HTM-5.1 vs. HTM-5.0.1 (CTC, three view configuration)

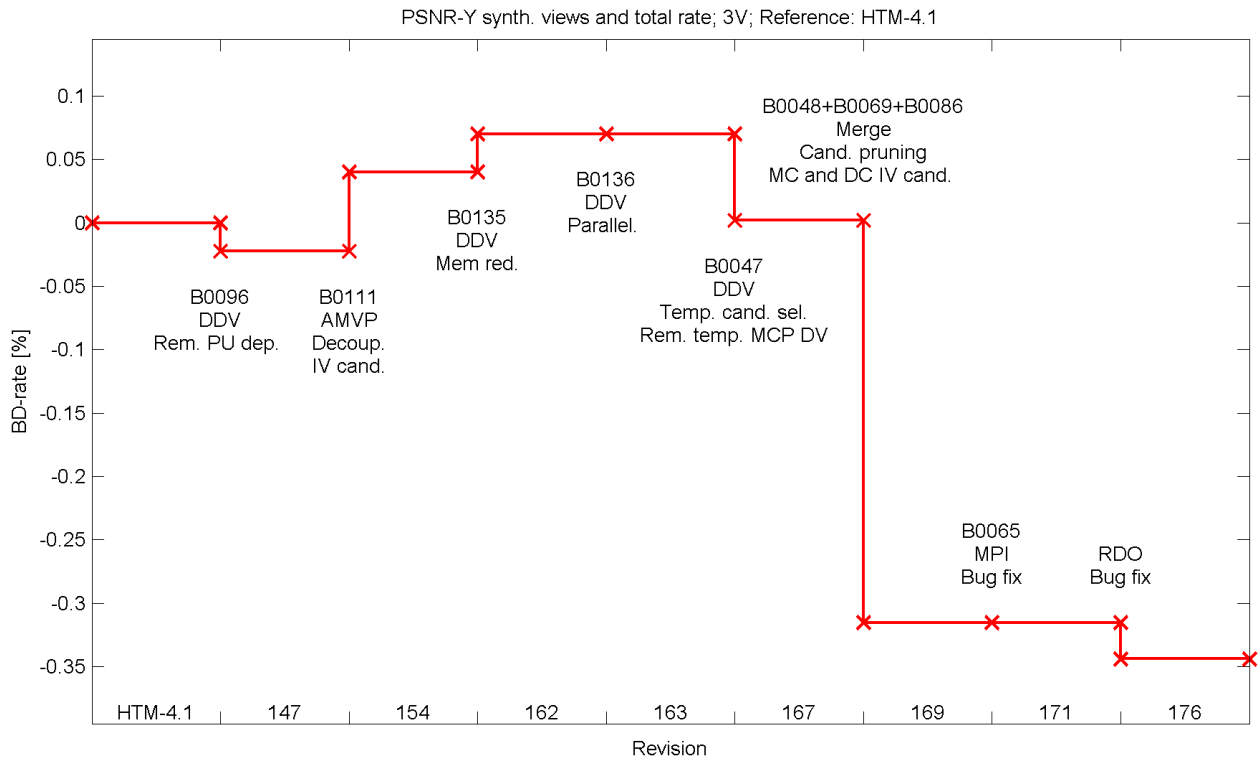
	video 0	video 1	video 2	video only	synthesized only	coded & synthesized	enc time	dec time	ren time
Balloons	0,0%	0,8%	0,3%	0,2%	0,2%	0,2%	99,8%	97,7%	99,9%
Kendo	0,1%	0,8%	0,6%	0,3%	0,3%	0,3%	99,5%	101,5%	101,1%
Newspapercc	0,0%	0,1%	0,0%	0,0%	0,0%	0,0%	100,1%	100,8%	100,0%
GhostTownFly	0,0%	1,3%	0,7%	0,3%	0,2%	0,2%	100,3%	99,2%	101,0%
PoznanHall2	0,0%	0,2%	0,6%	0,2%	0,2%	0,2%	100,3%	99,7%	98,8%
PoznanStreet	0,0%	-0,1%	0,5%	0,1%	0,1%	0,1%	99,8%	106,3%	100,6%
UndoDancer	0,0%	0,3%	0,1%	0,1%	0,1%	0,1%	100,0%	99,7%	100,7%
1024x768	0,0%	0,6%	0,3%	0,2%	0,2%	0,2%	99,8%	100,0%	100,3%
1920x1088	0,0%	0,4%	0,5%	0,1%	0,1%	0,1%	100,1%	101,2%	100,3%
<b>average</b>	<b>0,0%</b>	<b>0,5%</b>	<b>0,4%</b>	<b>0,2%</b>	<b>0,2%</b>	<b>0,2%</b>	<b>100,0%</b>	<b>100,7%</b>	<b>100,3%</b>

## 4 History of revisions

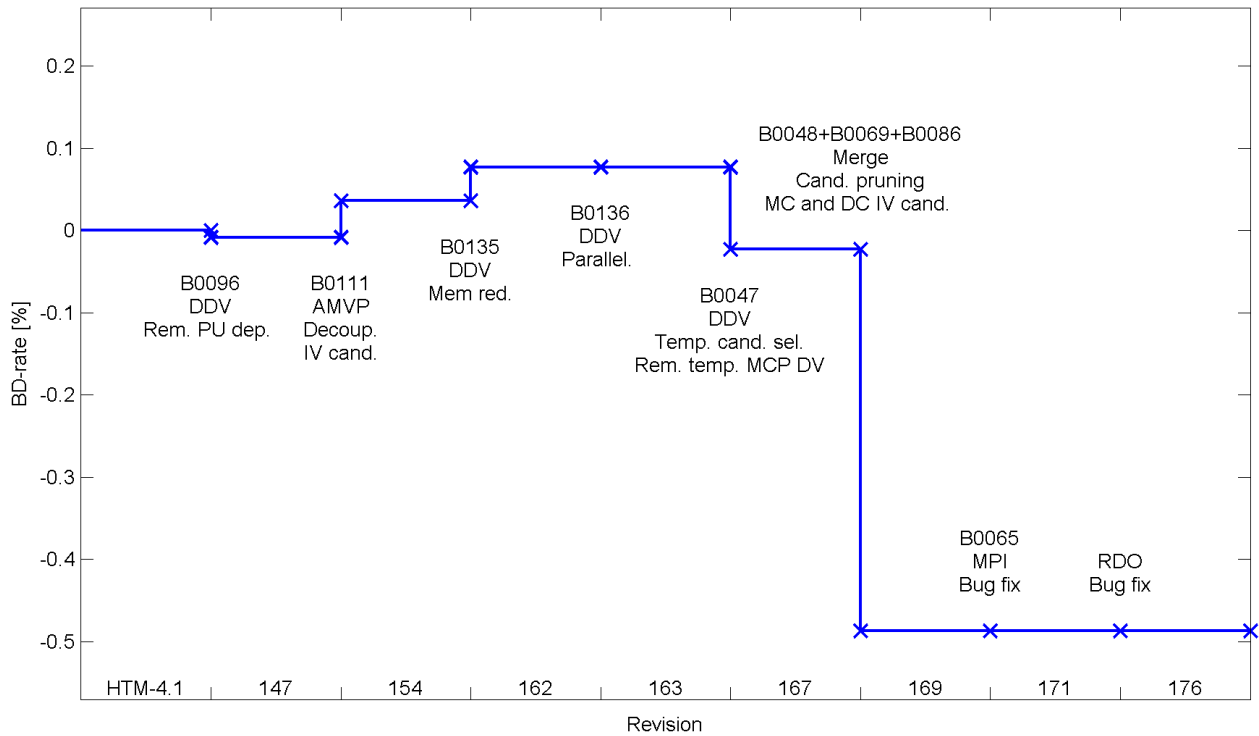
The following sections give a brief summary of average rate savings and runtimes of the different software revisions produced during the integration the period.

### 4.1 HTM-5.0.1 Integration

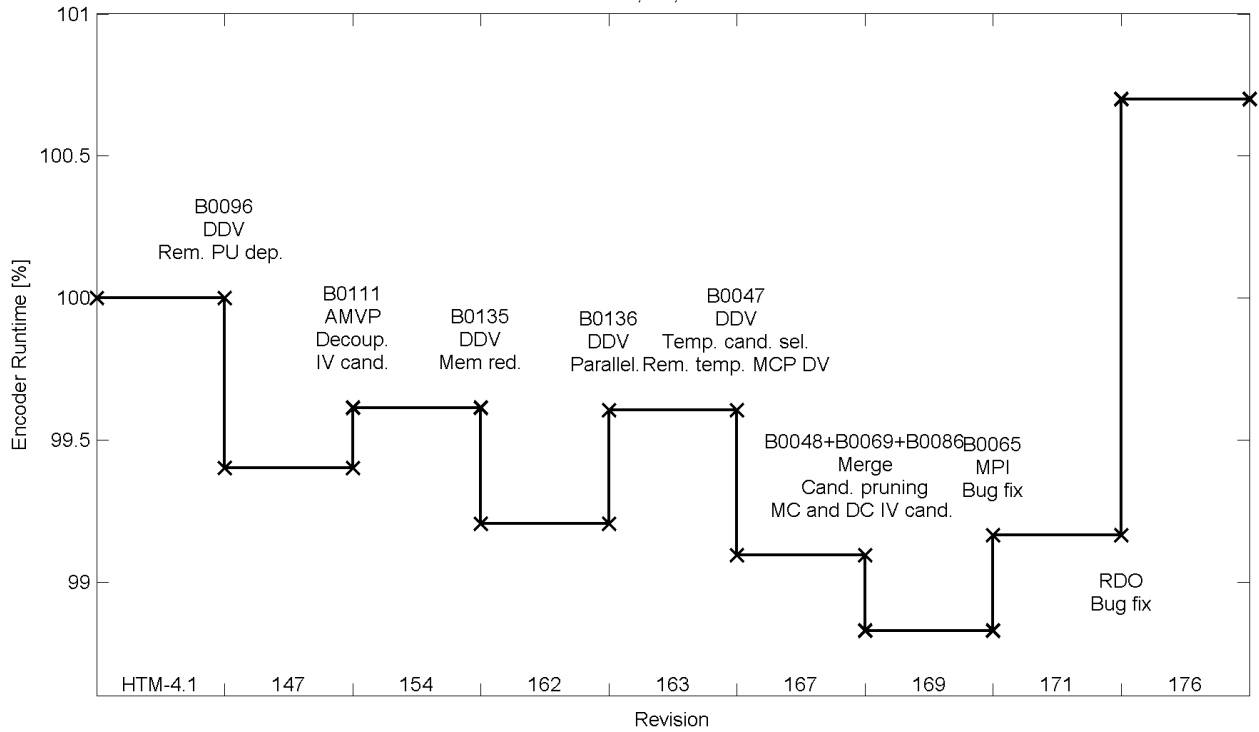
#### 4.1.1 Track 1



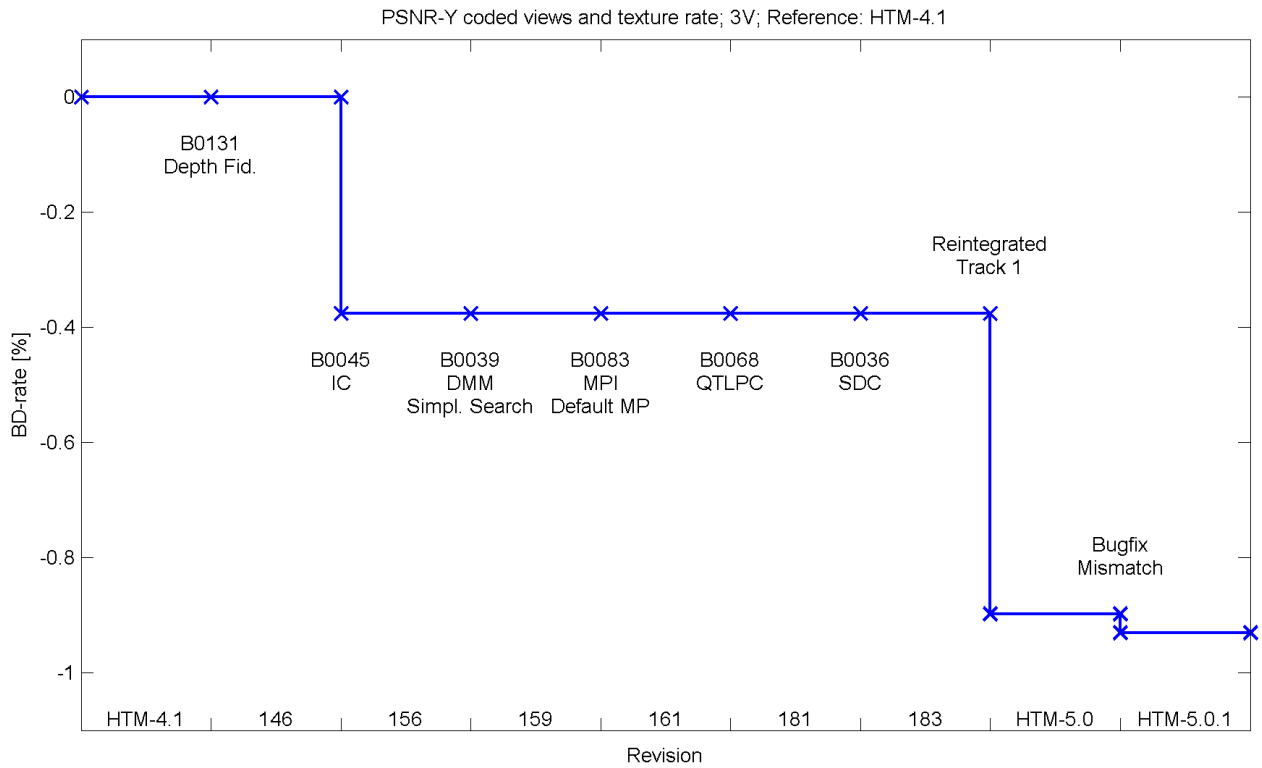
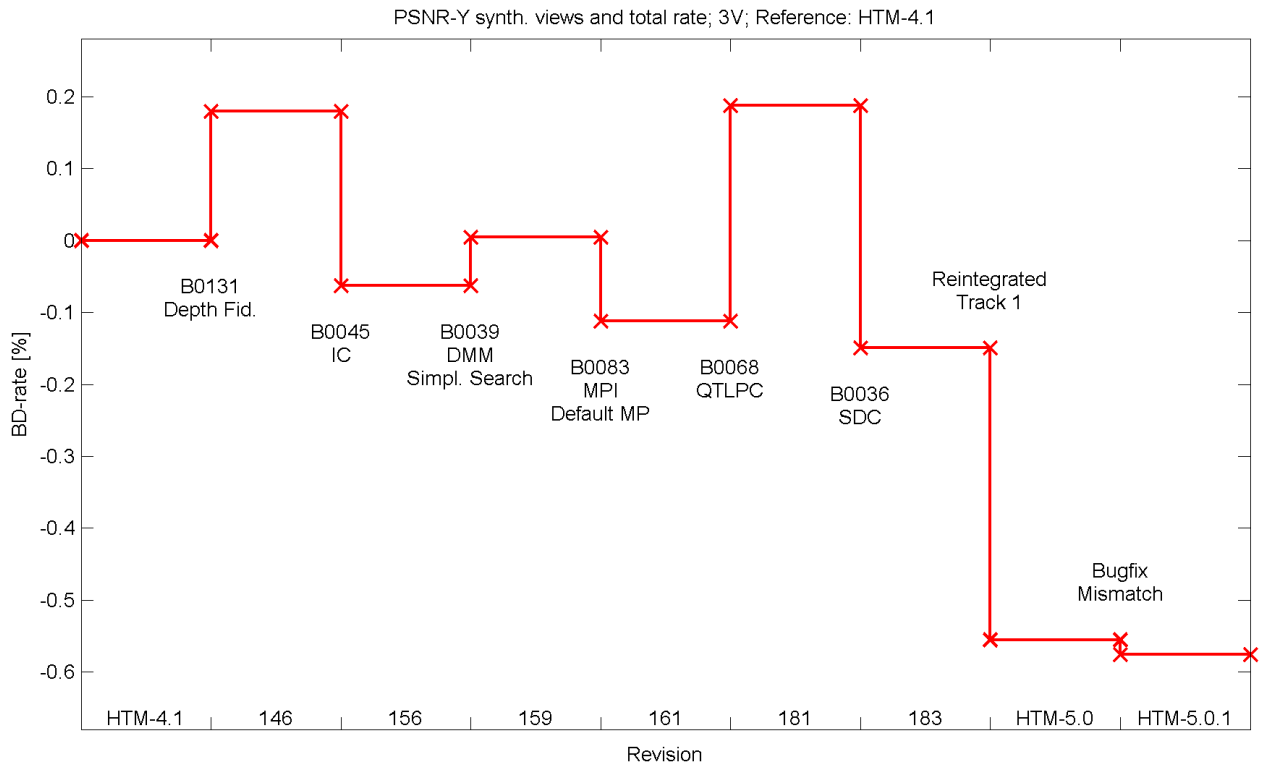
PSNR-Y coded views and texture rate; 3V; Reference: HTM-4.1

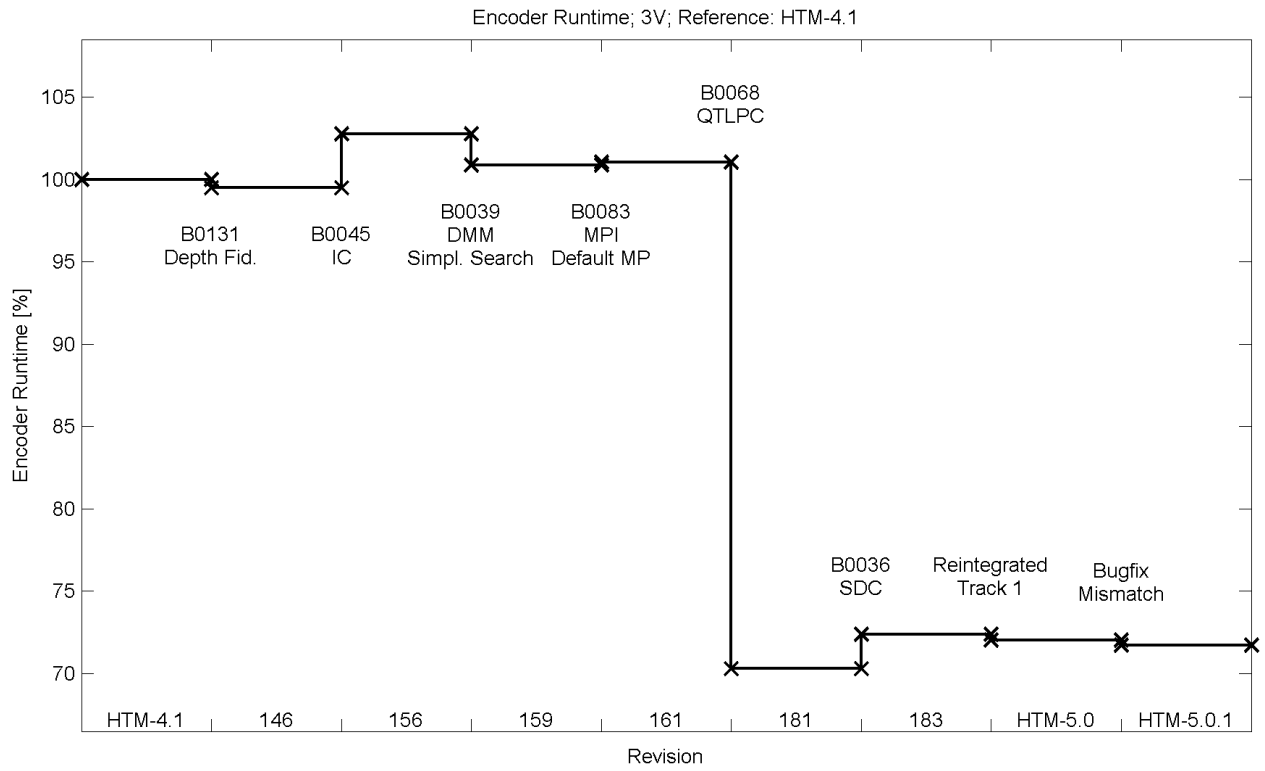


Encoder Runtime; 3V; Reference: HTM-4.1



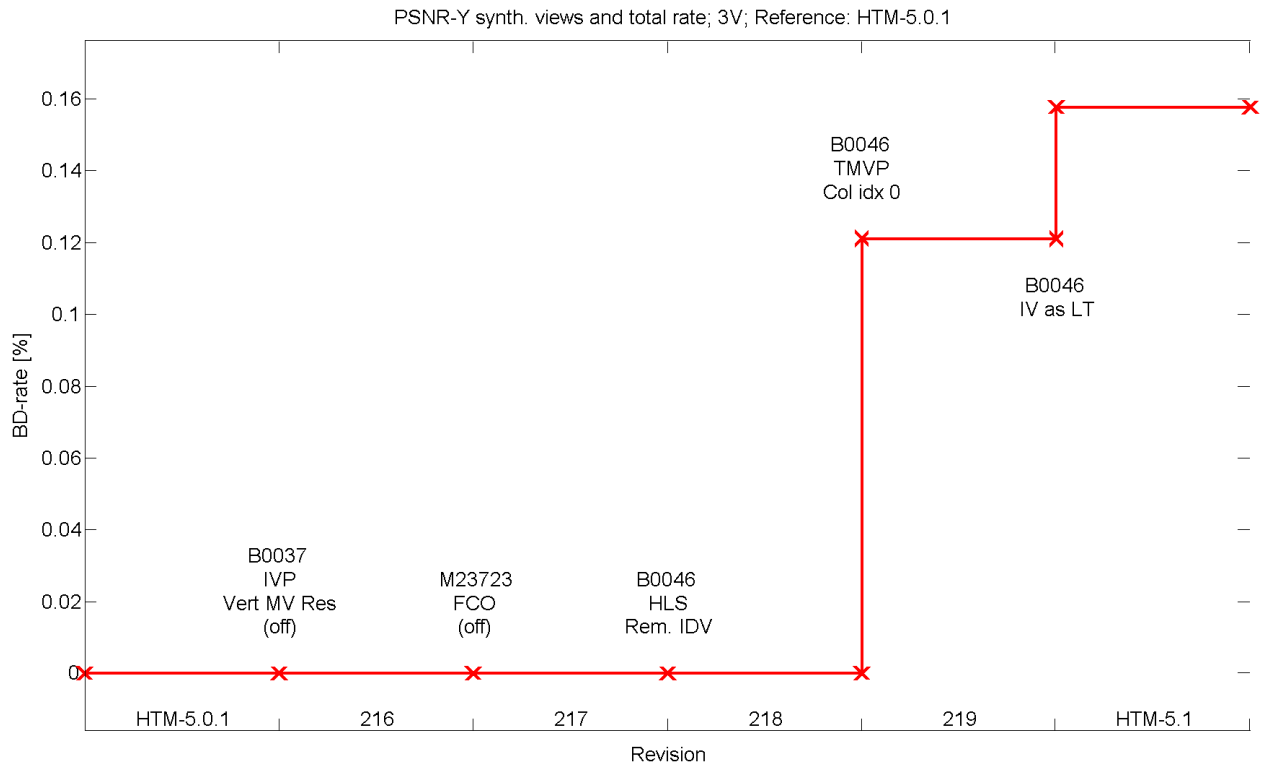
## 4.1.2 Track 2

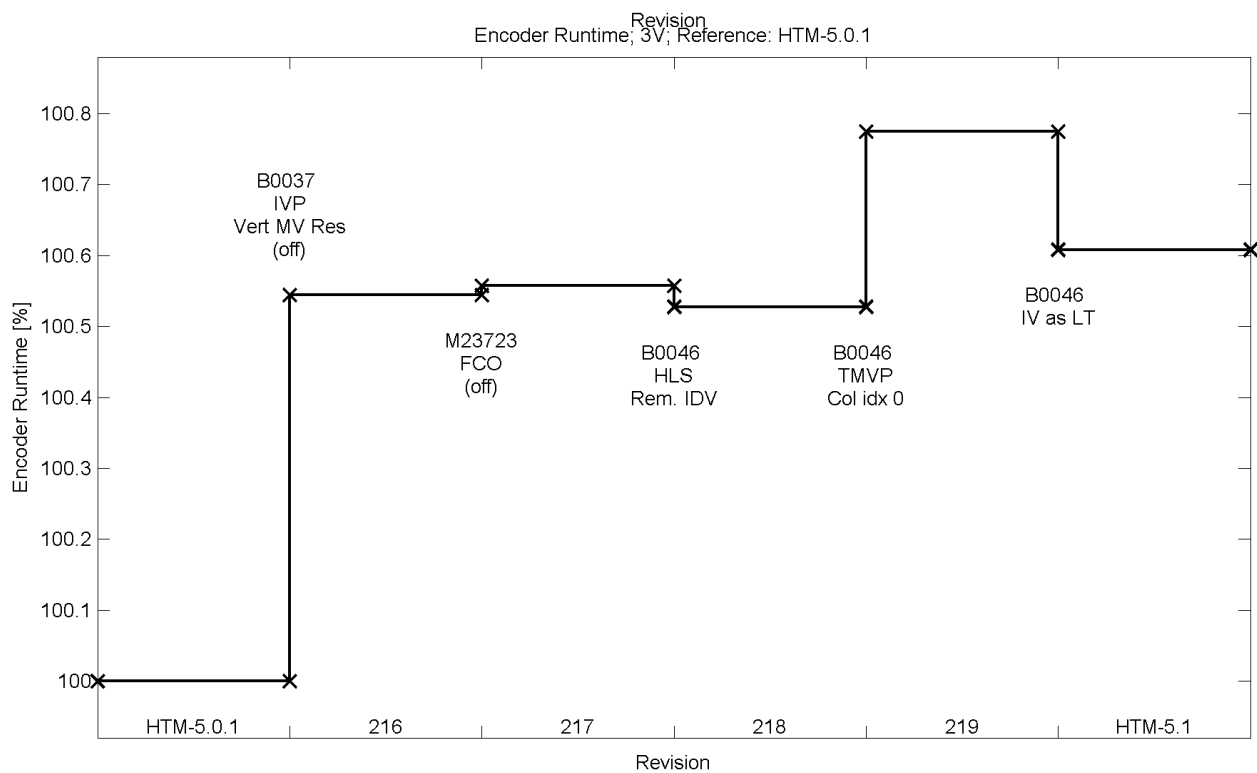
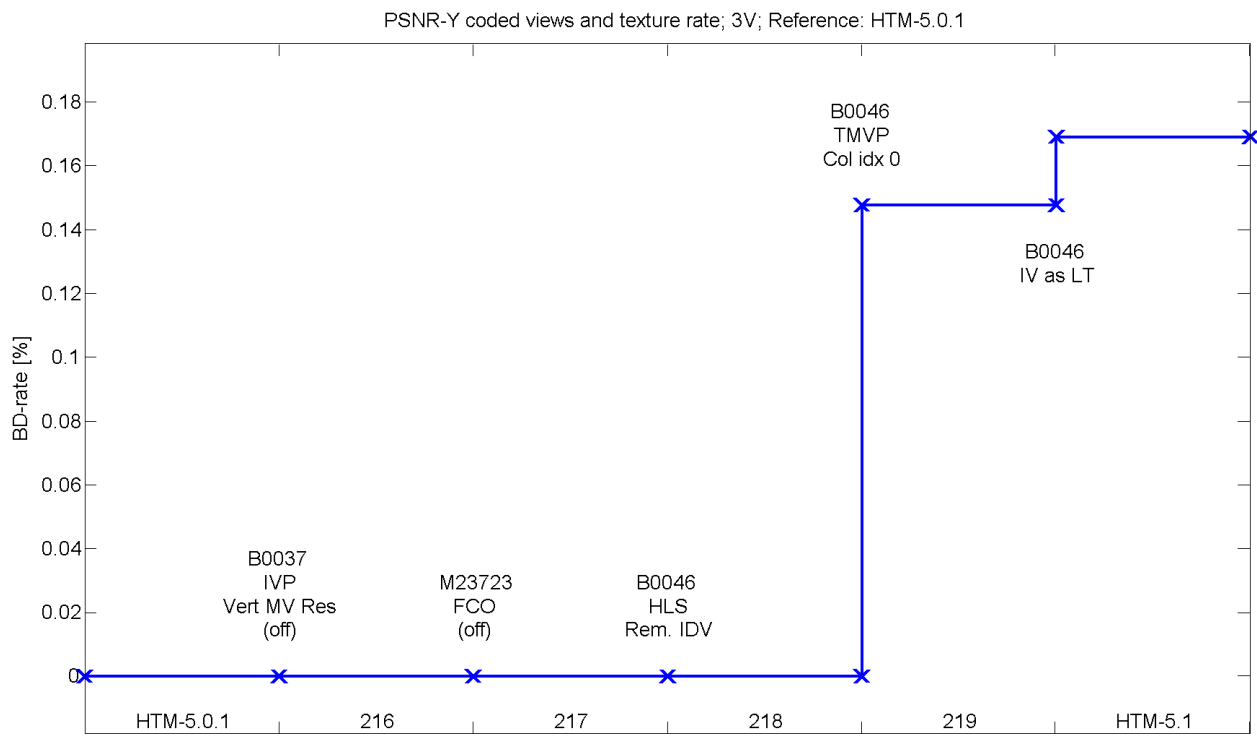






## 4.2 HTM-5.1





## 5 Setup of bug tracking system

The setup of the bug tracking system is pending. It is targeted to unify it with current JCT-VC system. Since the host of the system will change, the JCT-3V system can be set up only after the migration of the JCT-VC system.

## 6 Open issues

- Since the MV-HEVC working draft [1] and the 3D-HEVC Test model Annex G [2] are based on HEVC text specification draft 8 [3] and HTM-5.1 is based on HM-6.1 there are mismatches between draft texts and HTM-software.
- With the integration of tools related to inter-view motion prediction (JCT3V-A0126, JCT3V-A0049, JCT3V-A0097) 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 (Edge intra JCT3V-A0070, Depth QTLPC JCT3V-B0068, normative and non-normative part not independently switchable).

## 7 Related input documents

<a href="#">JCT3V-C0055</a>	AHG5: Bug fix for disparity vector derivation in 3D-HEVC	J. Kang, Y. Chen, L. Zhang, M. Karczewicz(Qualcomm)
<a href="#">JCT3V-C0208</a>	AHG5: Crosscheck of bug fix for disparity vector derivation in 3D-HEVC (JCT3V-C0055)	J. Sung (LG)

In JCT3V-C0046, a bug fix is proposed that removes a “low-delay B check” from HTM software.

## 8 Recommendations

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

- Continue to develop reference software based on HTM version 5.1 and improve its quality
- Remove bug fix related macros introduced in previous HTM versions before starting integration towards HTM 6.0.
- Continue to identify bugs and discrepancies with text, and address them.
- Discuss update of HTM to the most recent version of HM.
- Discuss on how to address open issues.
- Discuss AHG5 related input documents.

## 9 References

- [1] JCT-3V, “MV-HEVC Working Draft 2”, JCT3V-B1004, JCT-3V Meeting, Shanghai, October 2012
- [2] JCT-3V, “3D-HEVC Test Model 2”, JCT3V-B1005, JCT-3V Meeting, Shanghai, October 2012
- [3] JCT-VC, “High Efficiency Video Coding (HEVC) text specification draft 8”, JCTVC-J1003, JCT-VC Meeting, Stockholm, July 2012