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**Coding of moving pictures and audio**

**Convenorship: Japan (JISC)**

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# Introduction

This document contains the draft plan for the video verification test to be conducted to verify the coding performance of the VVC Main profile. A formal subjective evaluation will be conducted comparing the VVC Main 10 profile to the HEVC Main 10 profile.

Verification testing is planned with first priority for the following categories:

* SDR HD, SDR UHD
* HDR HD, HDR UHD
* 360° (extracted viewports)

Verification testing is planned with secondary priority for the following categories:

* Screen content (perhaps with 2 HEVC anchors – Main 10 and SCC profiles)
* Scalability
* 4:4:4 content

# Verification test coordination

The coordinators of the VVC verification tests are

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# Test sites

Test sites capable of conducting formal subjective assessments in accordance with ITU-R BT.500-14 are invited to contact the test coordinators for participation in and contribution to the VVC verification tests. Test sites capable of conducting formal subjective assessments in the following categories are sought:

1. SDR UHD 4:2:0 10 bit, 30 to 60 Hz
2. SDR HD 4:2:0 10 bit, 25 to 60 Hz
3. HDR-PQ UHD 4:2:0 10 bit, up to 60 Hz
4. HDR-HLG UHD 4:2:0 10 bit, up to 60 Hz

Test sites are invited to apply for conducting subjective assessments in one or more of the categories listed above. For participation in the verification tests, volunteering test sites are mandated to successfully conduct a calibration experiment.

It is intended to conduct the subjective assessment for each category in more than one test site. The score data of the subjective assessments at all test sites are to be collected and aggregated by the test coordinators.

Test sites conducting subjective assessments for the VVC verification tests are reimbursed by a fee of approximately 100€ per test subject per day. Financial contributions from companies and institutions, especially those that have participated in the development of VVC standard, are hereby called for in order to cover the testing fees. It is guaranteed that any such contribution will be used solely toward covering the fees incurred due to verification testing. In order to ensure that no testing facility will profit preferentially from such donations, the total expense will be calculated and then divided equally among companies and institutions who pledge their financial support, up to the maximum amount pledged by any individual company. Each company or institution will be invoiced by the test labs accordingly.

The tests in the SDR UHD category are planned to be conducted before and reported at the 20th JVET meeting, starting on 2020-10-07. GBTech, Rome, Italy has volunteered as a test site in this category.

# Test categories, coding conditions, and test sequences

Test cases for standard dynamic range (SDR), high dynamic range (HDR), and 360° video content are defined for the verification tests. The test conditions and configurations for these cases are defined below.

## Standard Dynamic Range

### Coding conditions

The following test conditions will be used for the VVC verification test.

1. Number of sequences and video resolutions:
   1. 5 sequences for HD (1920x1080) and UHD (3840x2160) resolutions each
2. Bitstreams
   1. Generated with VTM 9.0 for VVC bitstreams
   2. Generated with HM 16.22 for HEVC bitstreams
   3. In addition to a. and b., other VVC and/or HEVC bitstreams generated with encoders that are optimized for subjective quality may be tested if available.
3. Encoding parameters
   1. Fixed QP.
      1. Five bitrate points per sequences covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Bit depth of 10 bits for all video resolutions
   3. Coding structure
      1. UHD using Random access, RA (storage/streaming)
         1. Intra refresh at approximately 1 second intervals.
         2. GOP size 32
         3. Picture reordering allowed.
      2. HD using Low delay, LD (video conferencing)
         1. No Intra refresh.
         2. Without picture reordering.
   4. Other settings as in the configuration files, with the Picture Hash SEI deactivated
      1. VTM: cfg/encoder\_randomaccess\_vtm.cfg, and cfg/ encoder\_lowdelay\_vtm.cfg
      2. HM: cfg/encoder\_randomaccess\_main10.cfg and encoder\_lowdelay\_main.cfg

### SDR UHD Test sequences and QP settings

The set of test sequence candidates for the SDR category in UHD resolution as established at the 19th JVET meeting is listed in the table below.

Five rate points for each test sequence are determined for the quality assessment of the test sequences. The rate points were selected such that the VTM/HM pair for a rate point would represent approximately same quality while at the same time allow for approximate rate matching of the HM rate point with the next VTM rate point. Thereby both assessment of rate-savings at similar quality and assessment of quality improvement at similar rates are enabled.

Table 1 – SDR UHD test sequences

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Test sequence** | **Resolution** | **fps** | **Frames** | **md5** |
| 01 | DrivingPOV3 | 3840x2160 | 60 | 0:599 | e81b65724c4235128b2749ccb3b0fb4a |
| 02 | Marathon2 | 3840x2160 | 30 | 0:299 | c065dfb87be3b2e2ab0ce35094fd4eb4 |
| 03 | MountainBay2 | 3840x2160 | 30 | 0:299 | f27b6b70244fb083baac546958fcf696 |
| 04 | NeptuneFountain3 | 3840x2160 | 60 | 0:599 | 88fd87ea57df4a36200946025e8618aa |
| 05 | TallBuildings2 | 3840x2160 | 30 | 0:299 | 9a0a3f261d004fa86754751c82fb8b47 |

The test sequences are provided in ITU-R BT.709 colour space [4][5] and are available on the JVET ftp site ([ftp.ient.rwth-aachen.de](ftp://ftp.ient.rwth-aachen.de)) in the folder /ahg/verificationtests/vtsequences using the general JVET login credentials (available from the JVET chairs).

Table 2 – QP settings for the HM and VTM software for the SDR UHD test sequences

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Test sequence** | **HM-16.22 QP** | **VTM-9.0** |
| 01 | DrivingPOV3 | 30, 33, 36, 39, 43 | 30, 34, 39, 42, 46 |
| 02 | Marathon2 | 28, 32, 36, 39, 43 | 30, 34, 39, 42, 46 |
| 03 | MountainBay2 | 27, 30, 33, 36, 39 | 30, 33, 36, 39, 42 |
| 04 | NeptuneFountain3 | 30, 32, 35, 37, 39 | 33, 35, 37, 39, 42 |
| 05 | TallBuildings2 | 28, 31, 35, 39, 43 | 30, 34, 38, 42, 46 |

#### Schedule

The formal test for SDR UHD is planned to be completed by October 2020.

Encoding of sequences completed: August 24th, 2020

Subjective evaluation starts: September 7th, 2020

Subjective evaluation completed: September 14th, 2020

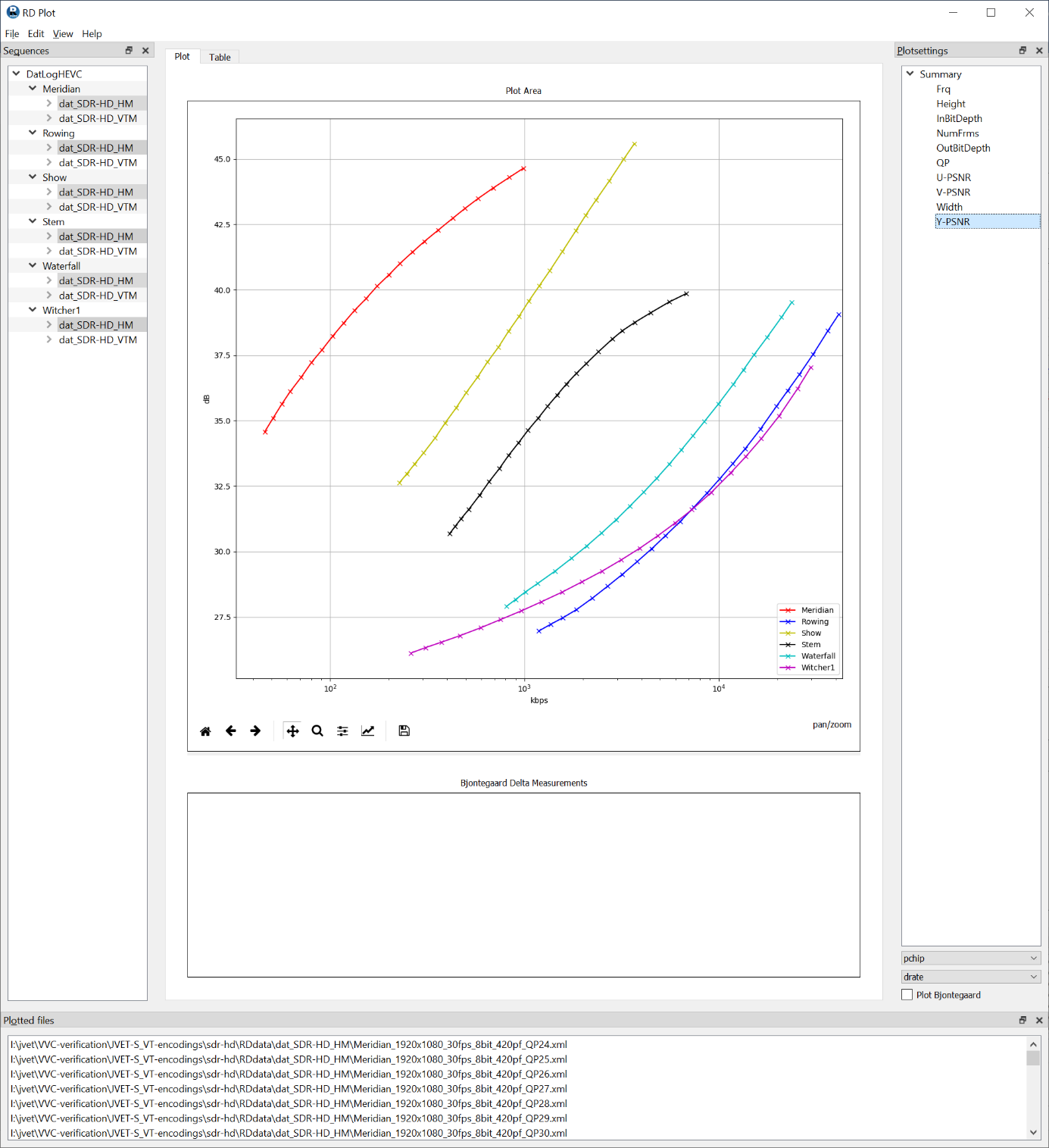
Subjective evaluation results available: September 28th, 2020.

### SDR HD test sequences under consideration and QP selection process

A set of test sequence candidates in HD resolution for the SDR category as investigated at the 19th JVET meeting is listed in the table below. Further SDR HD test sequences are sought and may be added to the candidate test set upon consideration of AHG4.

Table 3 – SDR HD test sequences under consideration

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No.** | **Test sequence** | **Resolution** | **fps** | **Frames** | **md5** |
| 11 | Rowing | 1920x1080 | 60 | 603 | 77534c15d75ef495b3f2edb809f2e47b |
| 12 | Show | 1920x1080 | 25 | 248 | 4ea64ce60a5642f41a18276050a62aa1 |
| 13 | Stem | 1920x1080 | 25 | 250 | 9e17f565a8c1beb46a5bc02e680c64ff |
| 14 | Waterfall | 1920x1080 | 60 | 603 | a463beab434c49031ad75037d1769d41 |
| 15 | Witcher1 | 1920x1080 | 30 | 300 | f099b22d6bdf479d0c7d32e821255515 |



**Figure 1 – Rate-distortion plot for test sequences 11-15. PSNR-Y over log bitrate**

For each candidate test sequence, the rate points to be considered shall be selected such that the full quality range from close-to-transparent (expected DMOS ~8) down to almost bad quality (expected DMOS ~3) is covered. Two types of comparison are considered: Quality improvement at identical rate, and rate saving at identical quality.

The flowing steps are planned to be pursued for achieving this task

1. **Encoding.** Bitstreams for HM-16.20 and VTM-9.0 in LowDelayB configuration. An initial QP range of QP=24 to QP=50 with a step size of 1 for the HM and QP=26 to QP=50 with a step size of 4 for the VTM is considered. This range may be extended and refined depending on the visual assessment of the sequences.
2. **Selection.** Based on data available after the 19th JVET meeting, the test coordinators preselect rate points for the sequences covering the specified quality and rate ranges.
3. **Packing.** Viewing of raw YUV files under laboratory conditions is not expected to be available under self-isolation rules established in most countries. Therefore, the HM and VTM bitstreams are to be packed in a format suitable for remote assessment without the need for professional viewing equipment.
   1. HM bistreams can be packed into mp4 container e.g. using ffmpeg with the following command line  
      ffmpeg -y -r <fps> -i <hevc.bin> -vcodec copy <out.mp4>
   2. VTM bitstreams need to be transcoded at sufficiently high quality into a format decodable by conventional video players on a state-of-the-art PC. A possible transcoding operation can be achieved with ffmpeg using the following command line (note that mkv used)  
      ffmpeg -video\_size <pix>x<lin> -pix\_fmt yuv420p10le -r <fps> -i <VTMyuvoutput> -c:v libx265 -crf 5 <out.mkv>
4. **Viewing.** Packed files are prepared by the test coordinators and distributed to participating experts who are equipped with a computer capable of providing fluid playback of the video sequences on a monitor (or TV set) of at least 32” size; the recommended set-up includes a UHD 55” OLED TV set (regardless the brand). The viewing is performed during an online meeting with moderation by the test coordinators. Observations and recommendations are collected and documented to form the basis for the selection of candidate sequences and candidate rate points.
5. **Report.** A report on the activity is produced as input to the next meeting.

**Timeline**

1. Selection completed: August 24th 2020
2. Packing completed: August 25th 2020
3. Online Viewing Sessions with invited experts: during August 27th – September 2nd, 2020, duration 2h max, precise time and schedule to be agreed among participants. One or more viewing sessions are expected to be scheduled.
4. An AHG session on the results is scheduled on September 3rd, 2020.
5. Report on activity by input document to the 20th JVET meeting.

## High Dynamic Range

The goal of the High Dynamic Range verification test is to evaluate and verify the performance of VVC for content represented with both HLG and SMPTE ST 2084 transfer functions.

### Coding conditions

The following test conditions will be used for the High Dynamic Range verification test.

1. Number of sequences and video resolutions:
   1. Five sequences represented with the HLG transfer function and with a spatial resolution of UHD (3840x2160)
   2. Five sequences represented with the SMPTE ST 2084 transfer function and with a spatial resolution of UHD (3840x2160)
2. Bitstreams
   1. Generated with VTM 8.2 for VVC bitstreams, where the VTM is configured for HDR content according to the configuration defined in JVET-P2011.
   2. Generated with HM 16.20 for HEVC bitstreams, where the HM is configured for HDR content according to the configuration defined in ISO/IEC TR 23008-14:2018.
   3. In addition to a. and b., other VVC and/or HEVC bitstreams generated with encoders that are optimized for subjective quality may be tested if available.
3. Encoding parameters
   1. Fixed QP.
      1. Five bit rate points per sequence covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Bit depth of 10bits for all video resolutions
   3. Coding structure
      1. Random access, RA (Storage/Streaming)
         1. Intra refresh at approximately 1 second intervals.
         2. Picture reordering allowed.
   4. Other settings as in the configuration files, with the Picture Hash SEI deactivated
      1. VTM: Configured for HDR content according to the configuration defined in JVET-S2011.
      2. HM: Configured for HDR content according to the configuration defined in ISO/IEC TR 23008-14:2018.

### Test sequences

A set of test sequence candidates for the HDR category as investigated at the 19th JVET meeting is listed in the table below.

Table 4 – HDR UHD test sequences under consideration

|  |  |  |
| --- | --- | --- |
| **No.** | **Test sequence** | **Transfer Function** |
| 31 | Chimera HDR3 | SMPTE ST 2084 |
| 32 | Chimera HDR5 | SMPTE ST 2084 |
| 33 | Chimera HDR7 | SMPTE ST 2084 |
| 34 | Meridian HDR2 | SMPTE ST 2084 |
| 35 | Meridian HDR5 | SMPTE ST 2084 |
| 41 | HLG3 | HLG |
| 42 | HLG4 | HLG |
| 43 | H3-AMS1 | HLG |
| 44 | H3-AMS3 | HLG |
| 45 | H3-AMS9 | HLG |

### Timeline and methodology for selection of candidate test sequences

For each candidate test sequence, the rate points to be considered shall be selected such that the full quality range from close-to-transparent (expected DMOS ~8) down to almost bad quality (expected DMOS ~3) is covered. Two types of comparison are considered: Quality improvement at identical rate, and rate saving at identical quality.

For quality improvement comparison at same rate, the lowest point should be selected such that VTM still has somewhat acceptable quality (as would be used by typical application), and HM would show more prominent impairments at the same rate. The highest point should be that VTM starts becoming transparent, and HM still shows artifacts. For the rate comparison, the lowest/highest quality point selection should be identical, but as HM should have somewhat similar quality as VTM, the HM quality could be used as starting point.

The flowing steps are planned to be pursued for achieving this task

1. **Display Calibration**. Calibration of HDR displays will be performed for both the PG and HLG test conditions. This calibration will consist of normalizing the displays to use similar configuration and, if needed, developing a pre-processing stage to create similar dynamic range capabilities. In the event that displays cannot be calibrated for only one of the transfer functions, then the test plan will continue for that transfer function while calibration will continue for the second transfer function.
2. **Encoding.** Bitstreams for HM-16.20 and VTM-8.2 in Random Access configuration with the IRAP interval set to 24,32,48,64,128 for the sequences selected during pre-screening at 24/25Hz, 30Hz, 50Hz, 60Hz, and 120Hz, respectively. An initial QP range of QP=24 to QP=46 with a step size of 1 for the HM and QP=26 to QP=46 with a step size of 4 for the VTM is considered. This range may be extended and refined depending on the visual assessment of the sequences.
3. **Selection.** Based on data generated by the encoding, the test coordinators preselect rate points for the sequences covering the specified quality and rate ranges.
4. **Packing.** Viewing of raw YUV files under laboratory conditions is not expected to be available under self-isolation rules established in most countries. Therefore, the HM and VTM bitstreams are to be packed in a format suitable for remote assessment without the need for professional viewing equipment.
5. **Viewing.** Packed files are prepared by the test coordinators and distributed to participating experts who are equipped with a computer capable of providing fluid playback of the video sequences on a monitor (or TV set) of at least 32” size; the recommended set-up will be defined as part of the workplan but is anticipated to a UHD OLED TV with HDR capabilities. The viewing is performed during an online meeting with moderation by the test coordinators. Observations and recommendations are collected and documented to form the basis for the selection of candidate sequences and candidate rate points.
6. **Report.** A report on the activity is produced as input to the next meeting.

**Timeline**

1. Display calibration: August 31st 2020
2. Encoding completed: August 31st 2020
3. Selection completed: September 18th 2020
4. (Re-)Encoding and packing completed: September 25st 2020
5. Initial viewing completed: October 2nd 2020
6. Completion of report to be input to the 20th JVET meeting: October 7th, 2020

## 360° Video

### Coding conditions

The following test conditions will be used for the 360° video part of the VVC verification test.

1. Number of sequences and video resolutions:
   1. 7 sequences at different input resolutions, 8192x4096, 6144x3072, and 4320x2160
2. Bitstreams
   1. Generated with VTM 8.0 and 360Lib 10.1 for VVC bitstreams, in two projection formats, padded equirectangular (PERP) and generalized cubemap projection (GCMP)
   2. Generated with HM 16.20 and a [patched version of 360Lib 5.0](https://vcgit.hhi.fraunhofer.de/sauer/hm-16.16-360lib-5.0-padded-cmp.git) for HEVC bitstreams, in two projection formats, PERP and padded cubemap projection (PCMP).
3. Encoding parameters
   1. Fixed QP.
      1. Five bitrate points per sequence covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Coding bit depth of 10 bits for all video resolutions, coding resolution depends on the input resolution and coding projection format, as listed in Table 5:

Table 5 – Coding resolution for different input resolutions and coding projection formats

|  |  |  |
| --- | --- | --- |
|  | PCMP/GCMP (before padding) | PERP (before padding) |
| 4K (4320x2160) | 1184 x 1184 per face  --CodingFaceWidth=1184  --CodingFaceHeight=1184 | 4096x2048  --CodingFaceWidth=4096  --CodingFaceHeight=2048  --WrapAroundOffset=4096 (only for VTM) |
| 6K & 8K | 1280 x 1280 per face  --CodingFaceWidth=1280  --CodingFaceHeight=1280 | 4432x 2216  --CodingFaceWidth=4432  --CodingFaceHeight=2216  --WrapAroundOffset=4432 (only for VTM) |

* 1. Random access, RA (Storage/Streaming) coding structure will be used:
     + 1. Intra refresh at approximately 1 second intervals.
       2. Picture reordering allowed.
  2. Other settings as in the configuration files, with the Picture Hash SEI deactivated
     1. VTM: cfg/encoder\_randomaccess\_vtm.cfg
     2. HM: cfg/encoder\_randomaccess\_main10.cfg
     3. 360Lib: cfg-360Lib/ encoder\_360\_PERP.cfg,

cfg-360Lib/ encoder\_360\_CMP.cfg,

cfg-360Lib/ encoder\_360\_GCMP.cfg

### Test sequences

A set of 360° video test sequence candidates as established at the 19th JVET meeting is listed in Table 6.

Table 6 – 360 video test sequences under consideration

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No. | Sequence | Frame rate | Resolution | BD | Camera |
| 51 | GT\_Sheriff | 30 | 4320x2160 | 8 | static |
| 52 | basketball | 30 | 8192x4096 | 10 | static |
| 53 | jam\_session | 30 | 8192x4096 | 8 | static |
| 54 | SkateboardTrick | 60 | 8192x4096 | 8 | static |
| 55 | SkateBoardAtBridge | 30 | 6144x3072 | 8 | moving |
| 56 | HarborBiking2 | 30 | 8192x4096 | 8 | moving |
| 57 | KiteFliteWalking2 | 30 | 8192x4096 | 8 | moving |

Indicative rate-distortion plots showing luma end-to-end weighted spherical PSNR (E2E WSPSNR) over bitrate are provided in Section 5.

Static and dynamic viewports with 78.1×49.1 degrees of field of view will be used to generate viewport video at the resolution of 1920×1080 and viewed on conventional HD displays. After initial viewing of extracted viewports, QP settings for the HM and VTM encoding using the PERP and PCMP/GCMP formats are provided in Table 7 and Table 8. The extracted viewports in the form of MP4 files are are available on the JVET ftp site ([ftp.ient.rwth-aachen.de](ftp://ftp.ient.rwth-aachen.de)) under the folder /ahg/verificationtests/JVET-S\_VT/360/mp4/.

Table 7 – QP settings for the HM and VTM software for the 360° video test sequences using the PERP projection format

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Test sequence** | **HM-16.20 QP** | **VTM-8.0** |
| 51 | GT\_Sheriff | 42, 38, 35, 32, 27 | 46, 42, 38, 34, 30 |
| 52 | basketball | 37, 34, 31, 28, 24 | 40, 36, 33, 30, 26 |
| 53 | jam\_session | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| 54 | SkateboardTrick | 42, 38, 34, 30, 27 | 46, 42, 38, 34, 30 |
| 55 | SkateBoardAtBridge | 43, 40, 36, 32, 27 | 46, 42, 38,34, 30 |
| 56 | HarborBiking2 | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| 57 | KiteFliteWalking2 | 43, 39, 35, 31, 28 | 46, 42, 38, 34, 30 |

Table 8 – QP settings for the HM and VTM software for the 360° video test sequences using the PCMP / GCMP projection format

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Test sequence** | **HM-16.20 QP** | **VTM-8.0** |
| 51 | GT\_Sheriff | 43, 39, 35, 32, 27 | 46, 42, 38, 34, 30 |
| 52 | basketball | 28, 35, 32, 29, 25 | 40, 37, 34, 30, 26 |
| 53 | jam\_session | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| 54 | SkateboardTrick | 42, 38, 34, 30, 26 | 46, 42, 38, 34, 30 |
| 55 | SkateBoardAtBridge | 42, 40, 37, 33, 27 | 46, 42, 38,34, 30 |
| 56 | HarborBiking2 | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| 57 | KiteFliteWalking2 | 43, 39, 35, 31, 27 | 46, 42, 38, 34, 30 |

It is expected that four candidate sequences will be selected from the available set of seven test sequences using either the PERP and/or GCMP/PCMP projection formats.

### Timeline and methodology for selection of candidate sequences

The general methodology for sequence selection as outlined in 4.1.3applies to the 360° video category as well, except for the following additional considerations that have been given to the 360° video category:

1. **Encoding.** Bitstreams for HM-16.20 and VTM-8.0 in Random Access configuration with the IRAP interval set to 32 and 64 for sequences at 30Hz and 60Hz, respectively. An initial QP range of QP=24 to QP=46 with a step size of 1 for the HM and QP=26 to QP=46 with a step size of 4 for the VTM is considered. For projection format conversion and E2E WSPSNR calculation, 360Lib-11 is used for VTM-10.0 and a patched version of 360Lib-5.0 is used for HM-16.20. Coding resolution depends on input resolution and projection format, as listed in Table 5. Regardless of input bit depth, the coding bit depth is set to10 bits.
2. **Sequence, rate and viewport selection.** Upon completion of encoding, the test coordinators preselect rate points, viewports, and projection formats for the sequences covering the specified quality and rate ranges. Viewport videos will be generated at resolution of 1920x1080.
3. **Packing.** The same protocols as in 4.1.3will be used.
4. **Viewing.** The same viewing protocols as those for HD SDR sequences are planned to be used for 360° video.
5. **Report.** The activity will be included in the 360 video part of the report document at the next meeting.

**Timeline**

1. Preliminary viewport and projection format selection completed: July 10th, 2020
2. (Re-)Encoding completed: July 16th, 2020
3. Online Viewing Sessions with invited experts: during August 24-28th 2020, duration 2h max, precise time and schedule to be agreed among participants. One or more viewing sessions are expected to be scheduled.
4. AHG meeting September 4th 2020
5. Completion of report to be input to the 20th JVET meeting: October 7th, 2020

# Encoding results

## Standard Dynamic Range

### UHD Random Access

The rate-distortion results in this section are based on data acquired in the preparation phase of the verification test using VTM-8.0 with GOP size 16 and HM-16.20. They do not represent results of the final configuration and quantizer settings. Results of a dry run subjective assessment of these bitstreams are provided in JVET-S0246 [8].

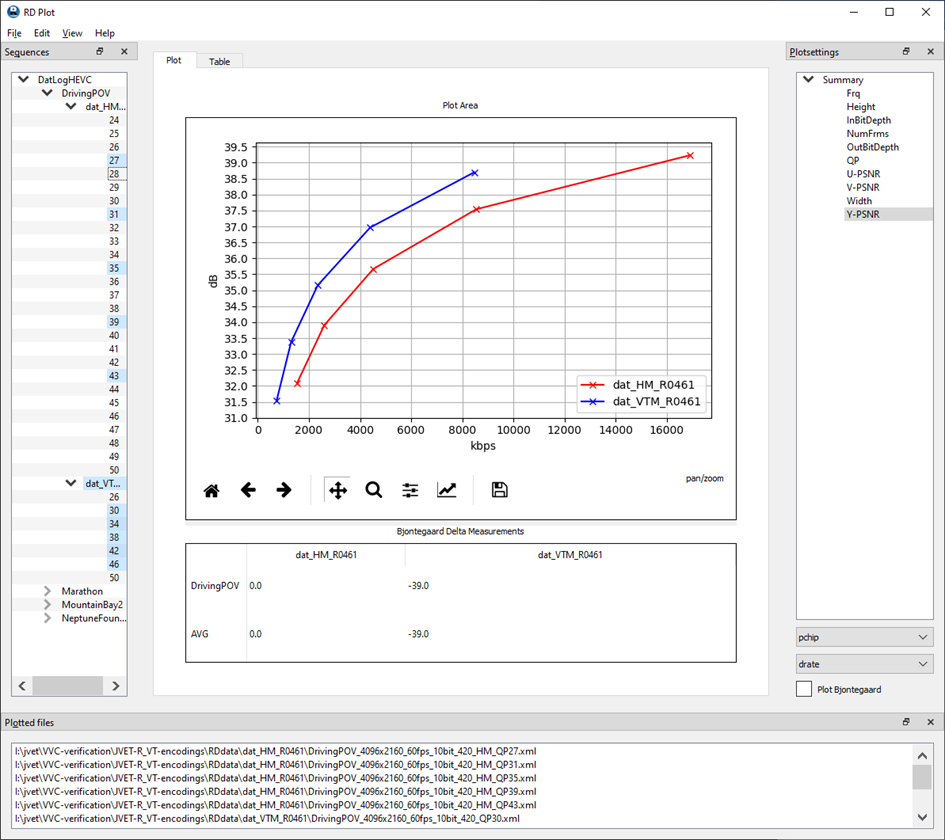
Table 9– Preliminary PSNR-Y BD rate savings for the SDR UHD test sequences

|  |  |  |
| --- | --- | --- |
| **No.** | **Test sequence** | **PSNR Y BD rate savings** |
| 01 | DrivingPOV3(1) | -39.00 % |
| 02 | Marathon2 | -32.53 % |
| 03 | MountainBay2 | -26.27 % |
| 04 | NeptuneFountain3(2) | -25.45 % |
| 05 | TallBuildings2 | -26.83 % |

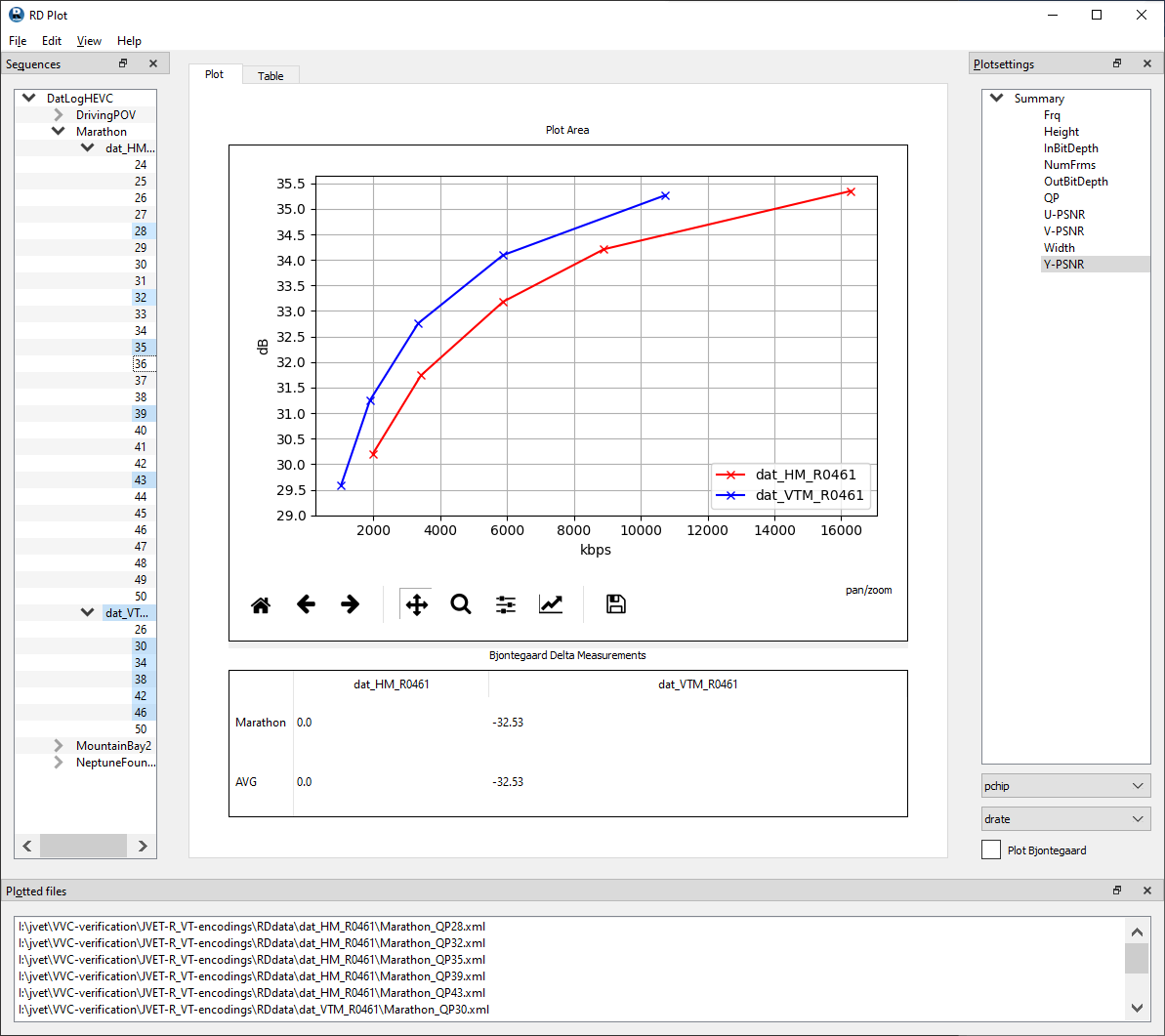
(1) Note: DrivingPOV3 is a version of Netflix\_DrivingPOV\_4096x2160\_60fps\_10bit\_420.yuv, cropped to 3840x2160. The rate-distortion results in this section are reported for the 4096x2160 version.

(2) Note: The reported rate-distortion results for NeptuneFountain3 have been generated with VTM-9.0 using the GOP16 configuration.

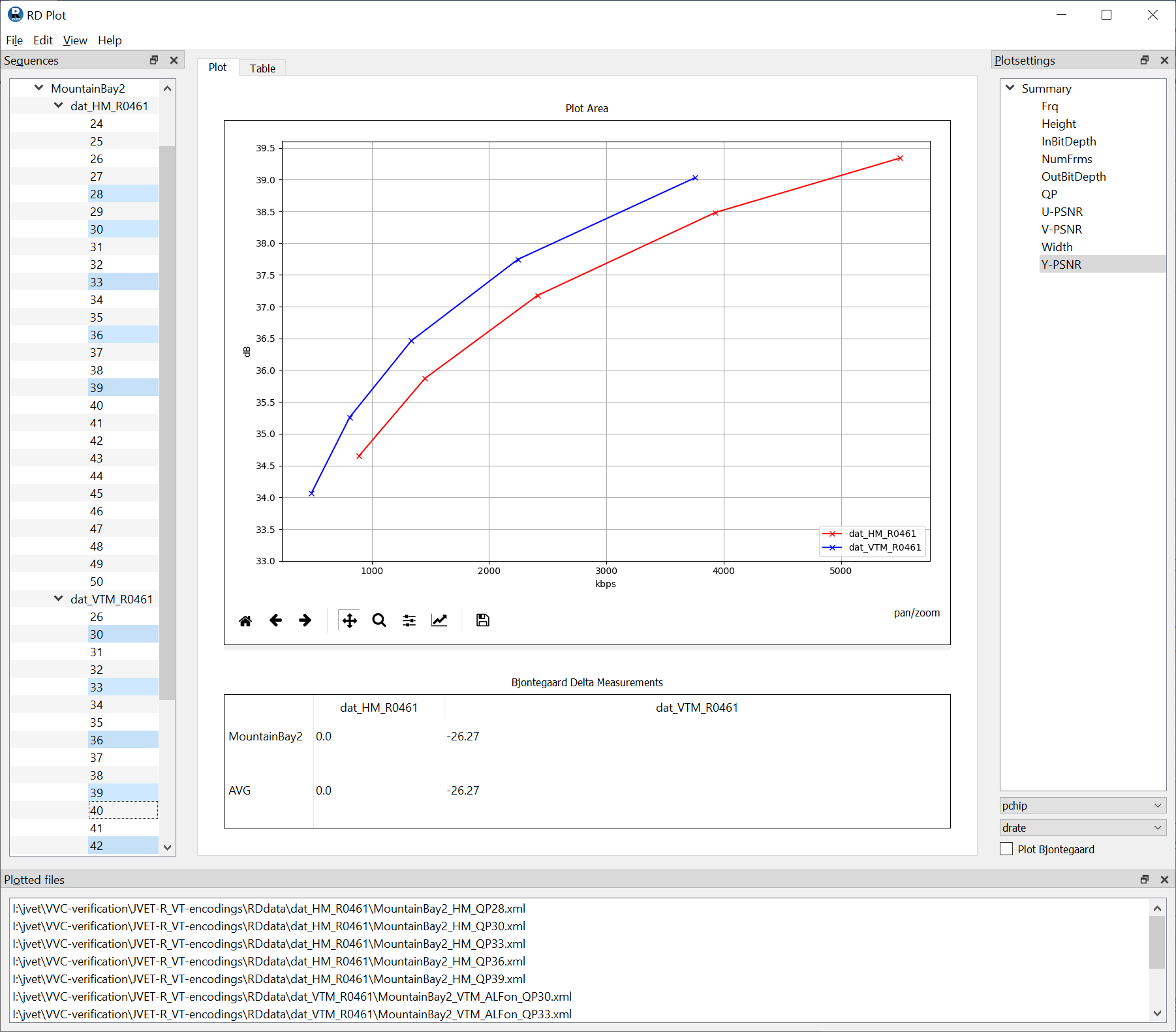
#### DrivingPOV



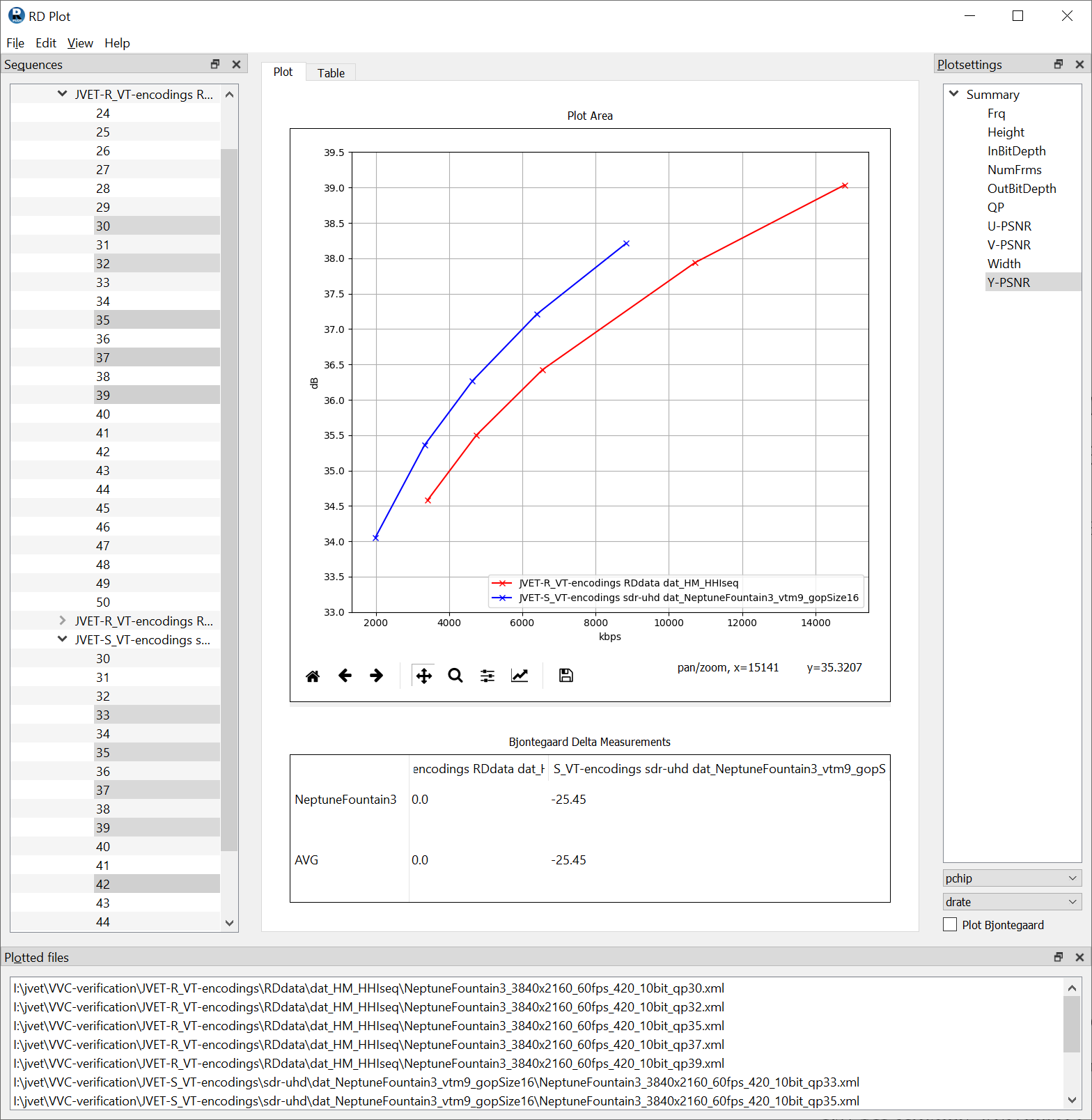
#### Marthon



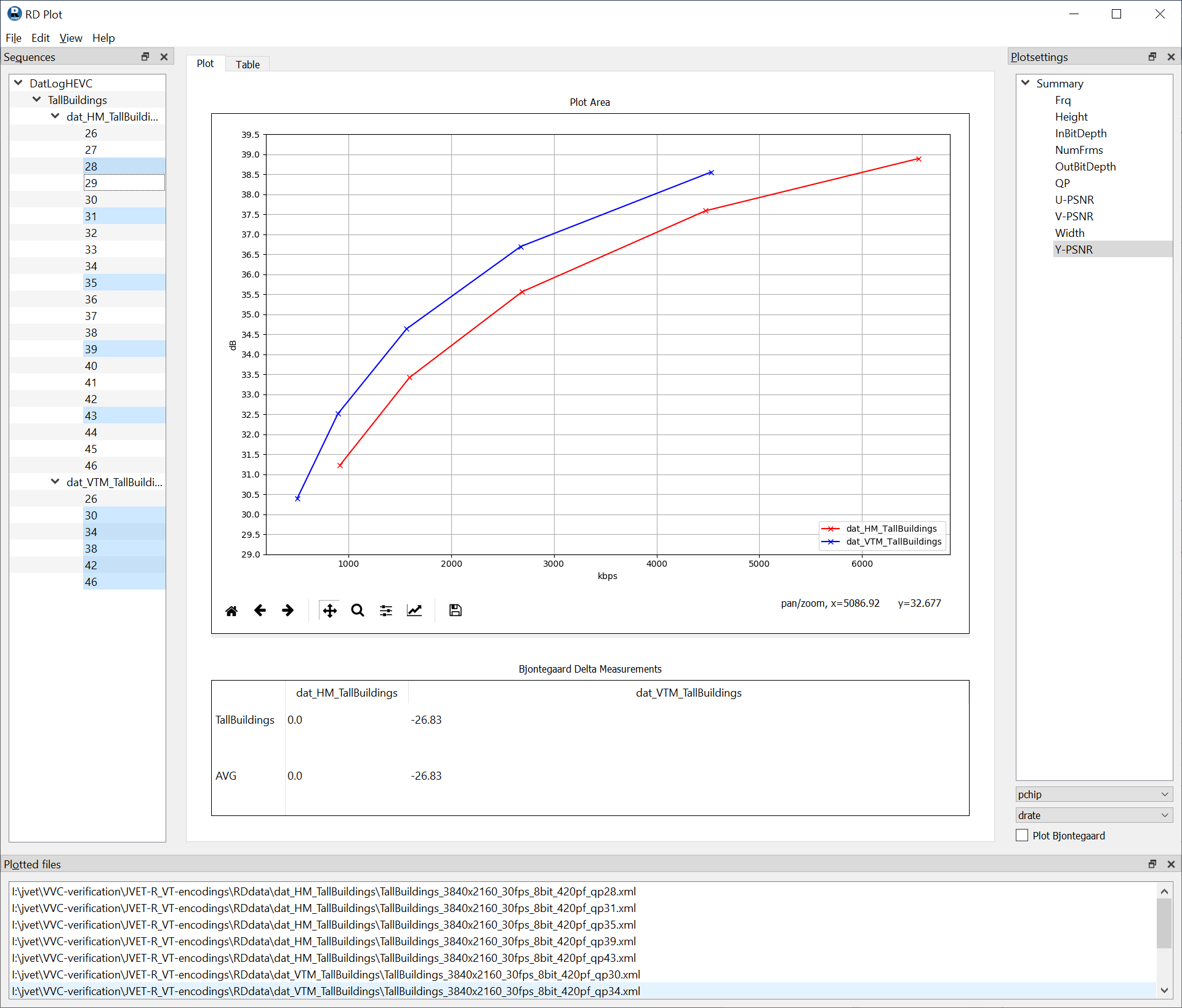
#### MountainBay2



#### NeptuneFountain3



#### TallBuildings



### HD Low Delay

Rate-distortion results for the SDR HD test category will be provided upon determination of the applicable VTM and HM QP values.

## HDR

Rate-distortion results for the HDR test category will be provided upon determination of the applicable VTM and HM QP values.

## 360° Video

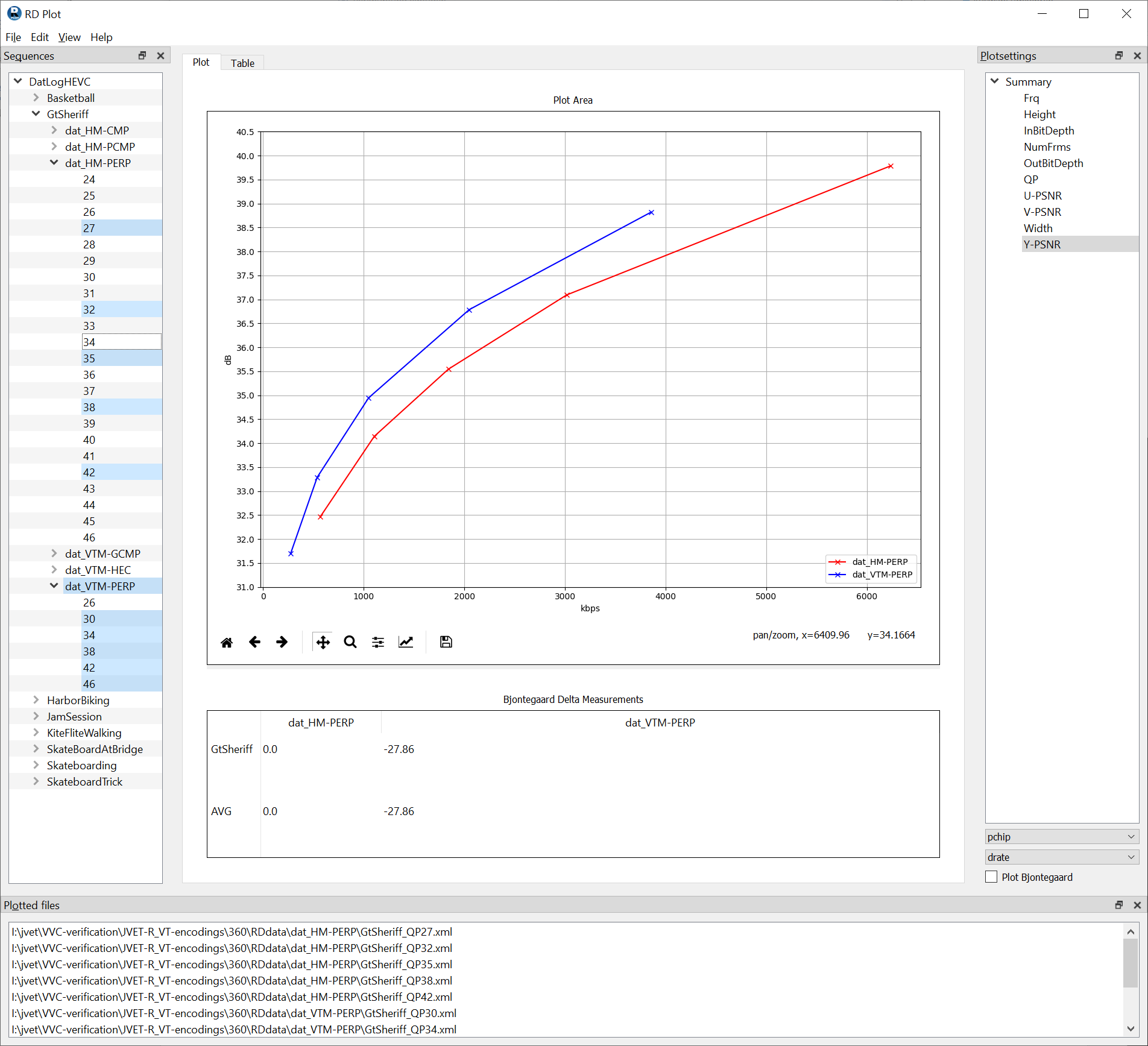
The rate-distortion results in this section are based on data acquired in the preparation phase of the verification test using VTM-8.0 with GOP size 16 and HM-16.20. They do not represent results of the final configuration and quantizer settings.

Table 10 – Preliminary WSPSNR-Y BD rate savings for the 360° video test sequences

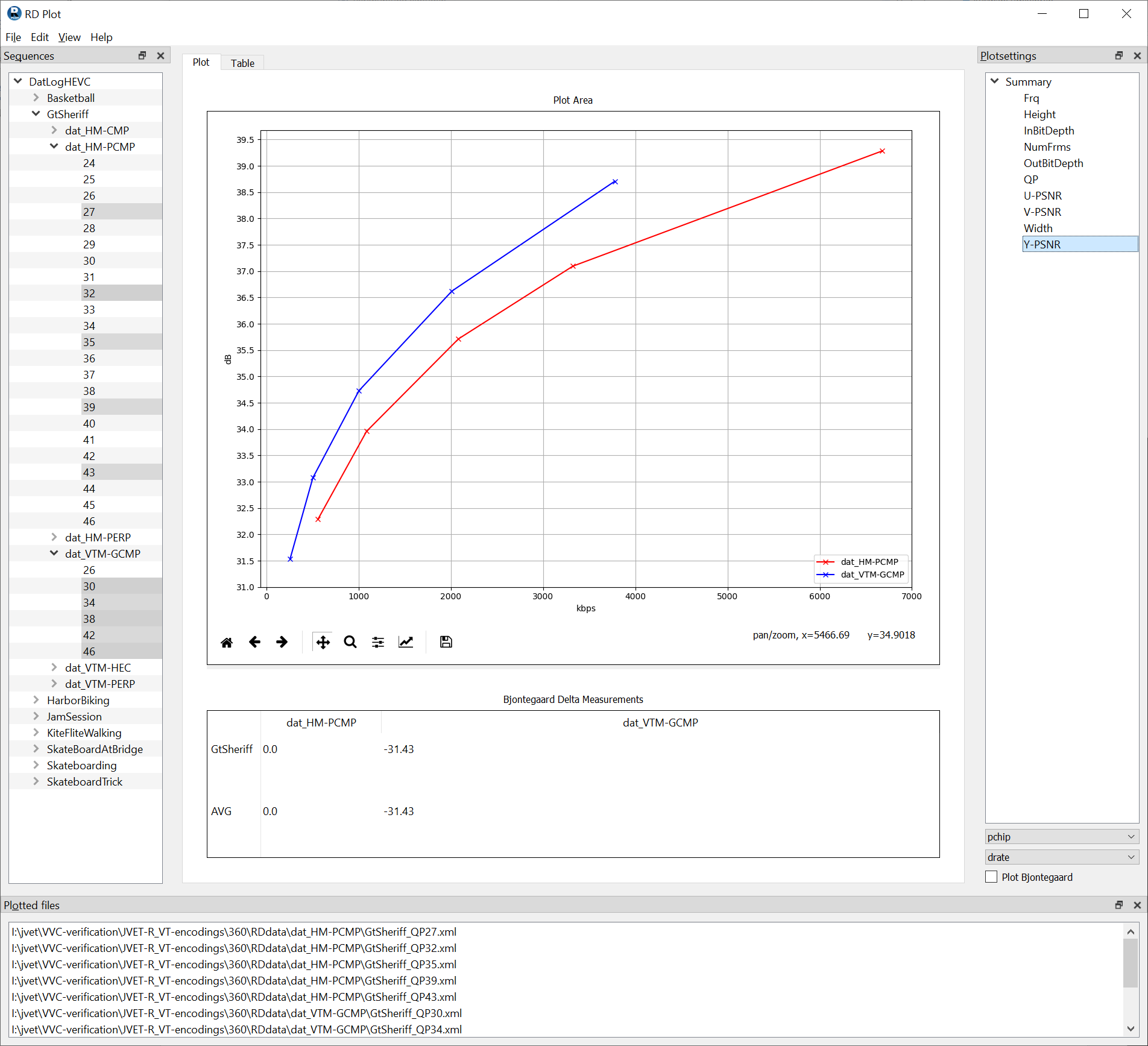
|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Test sequence** | **PERP WSPSNR Y BD rate savings** | **GCMP/PCMP PSNR Y BD rate savings** |
| 51 | GT\_Sheriff | -27.86 % | -31.43 % |
| 52 | basketball | -17.78 % | -22.67 % |
| 53 | jam\_session | -30.89 % | -34.99 % |
| 54 | SkateboardTrick | -26.47 % | -32.01 % |
| 55 | SkateBoardAtBridge | -49.32 % | -56.57 % |
| 56 | HarborBiking2 | -40.65 % | -42.66 % |
| 57 | KiteFliteWalking2 | -33.64 % | -34.78 % |

### GT\_Sheriff

#### PERP

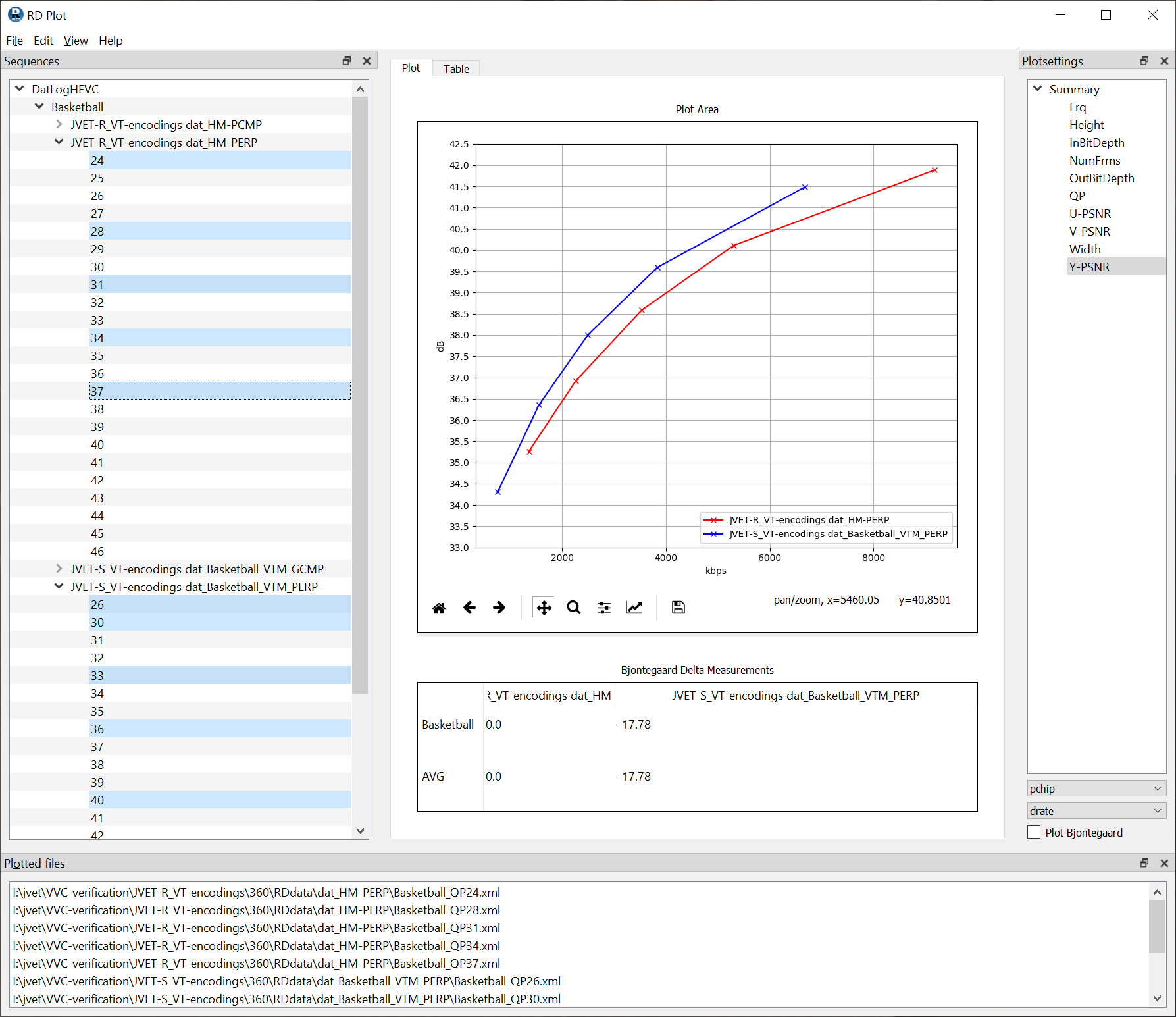


#### PCMP vs. GCMP

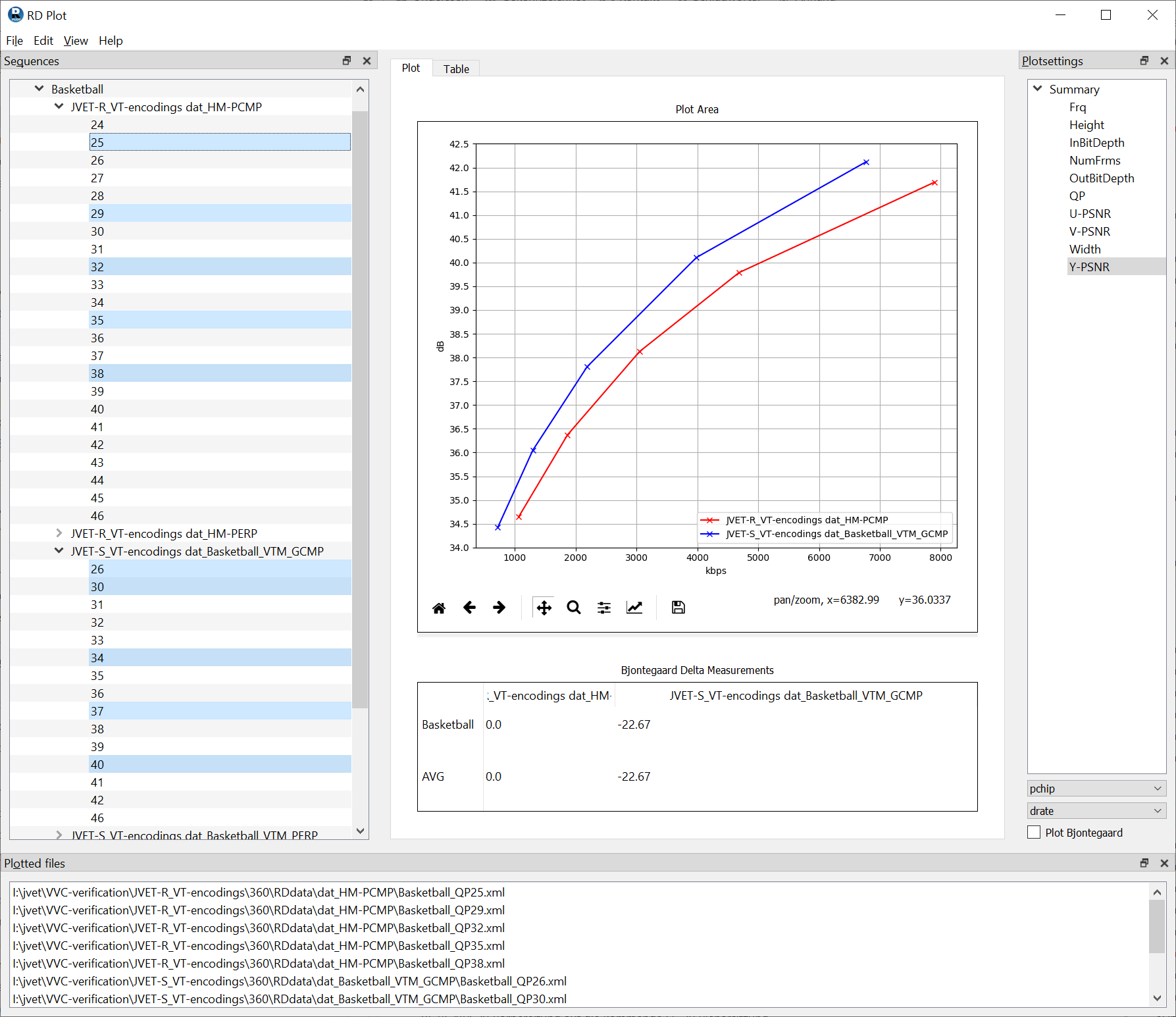


### basketball

#### PERP

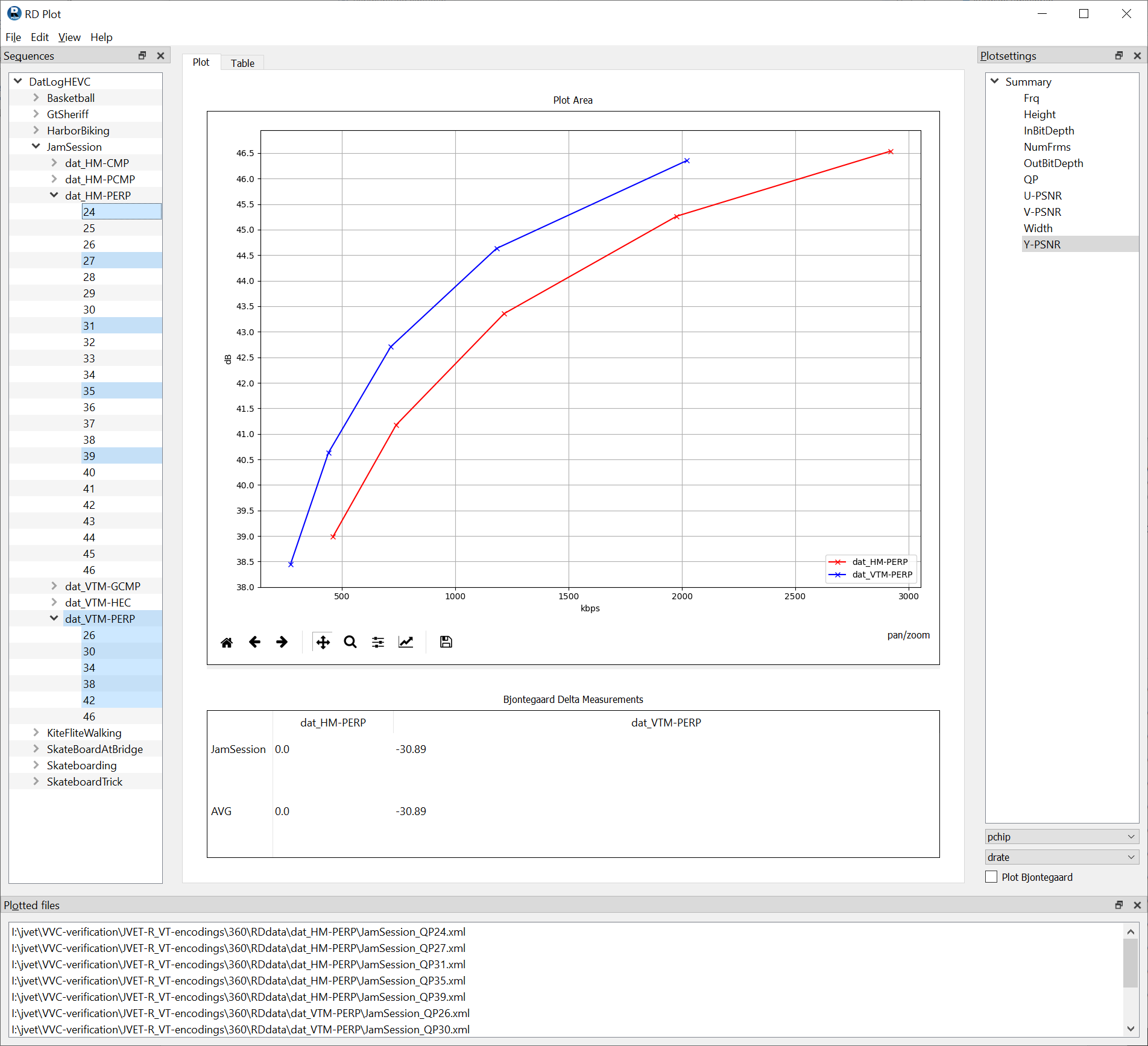


#### PCMP vs. GCMP

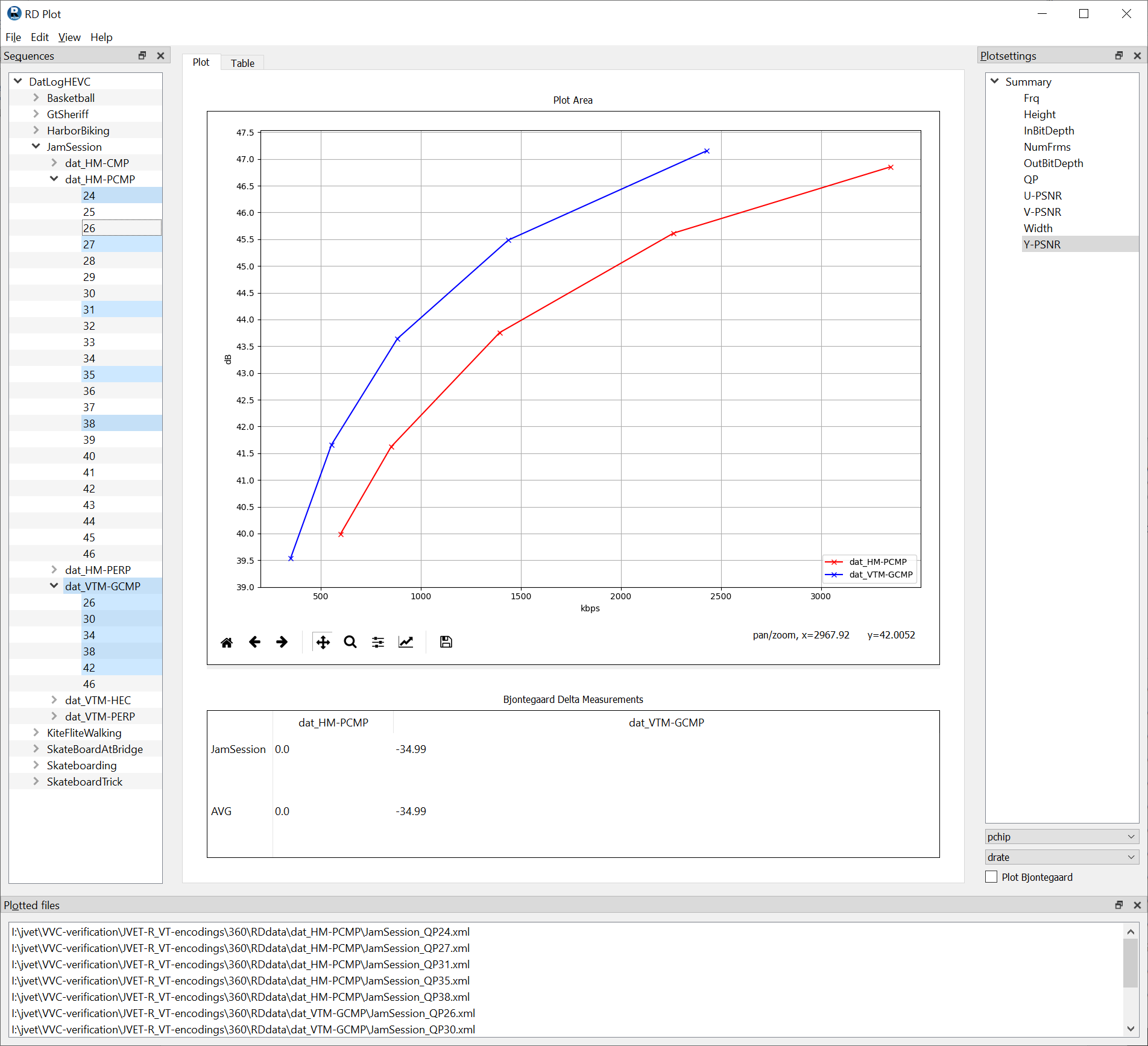


### jam\_session

#### PERP

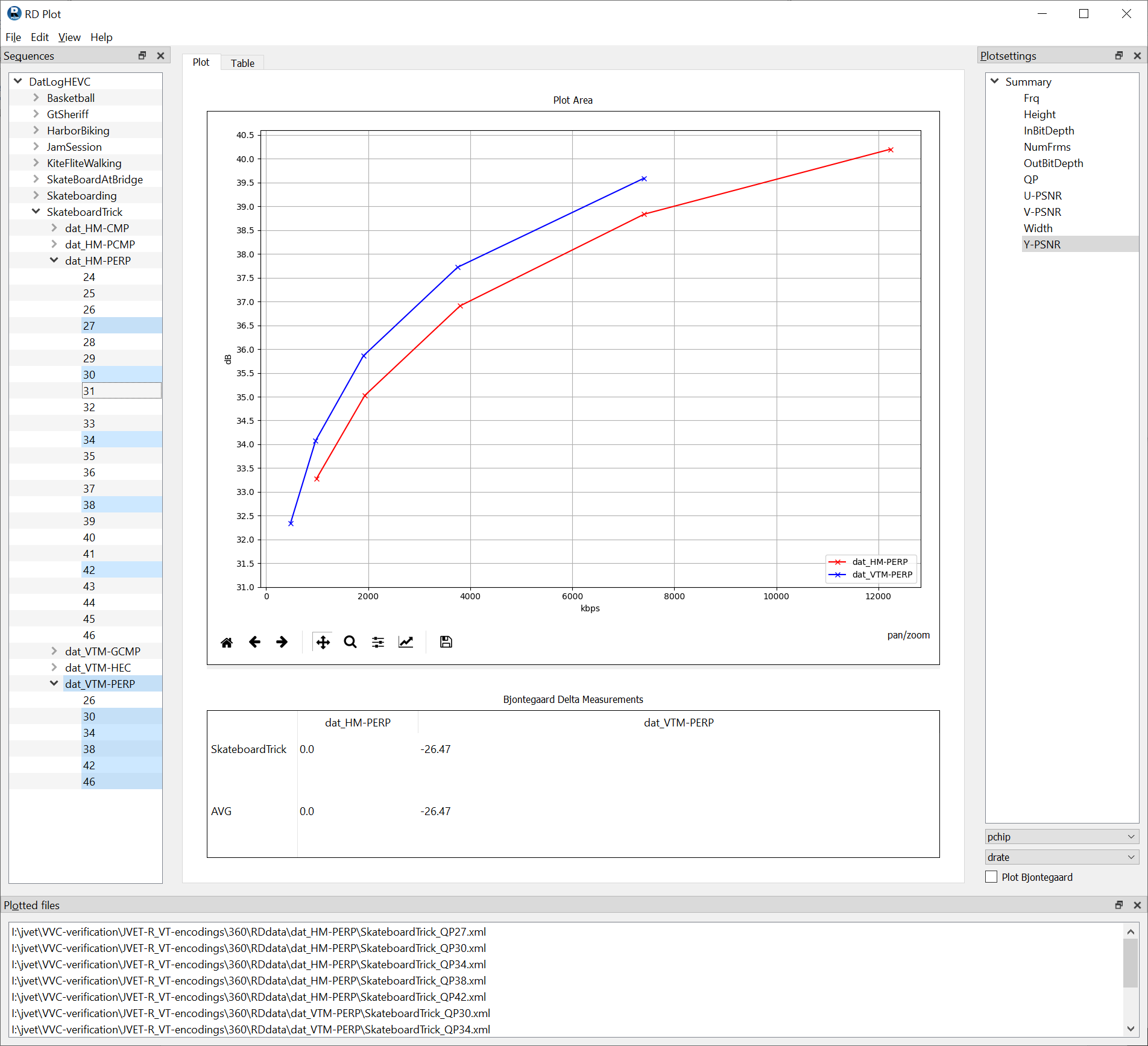


#### PCMP vs. GCMP

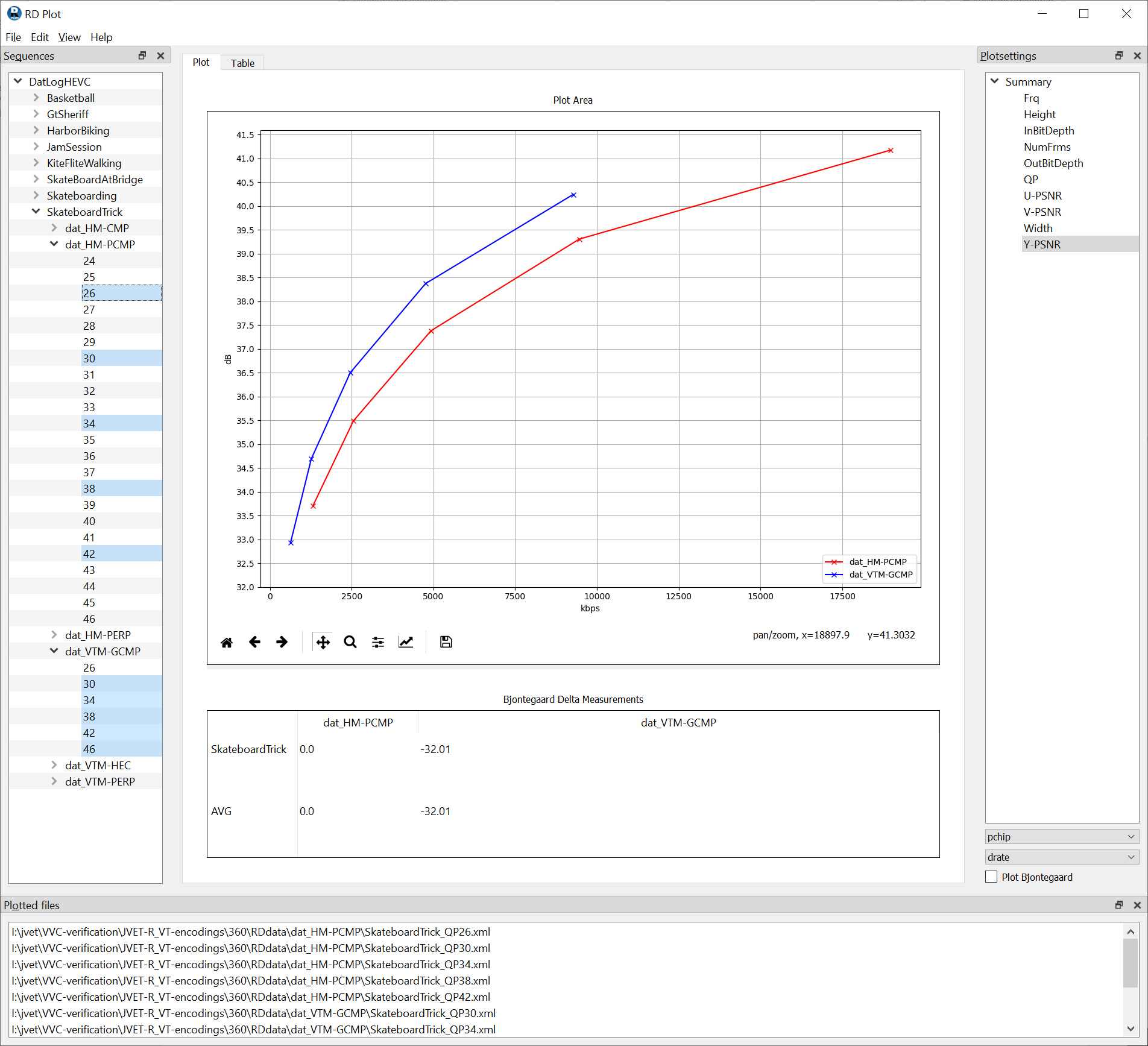


### SkateboardTrick

#### PERP

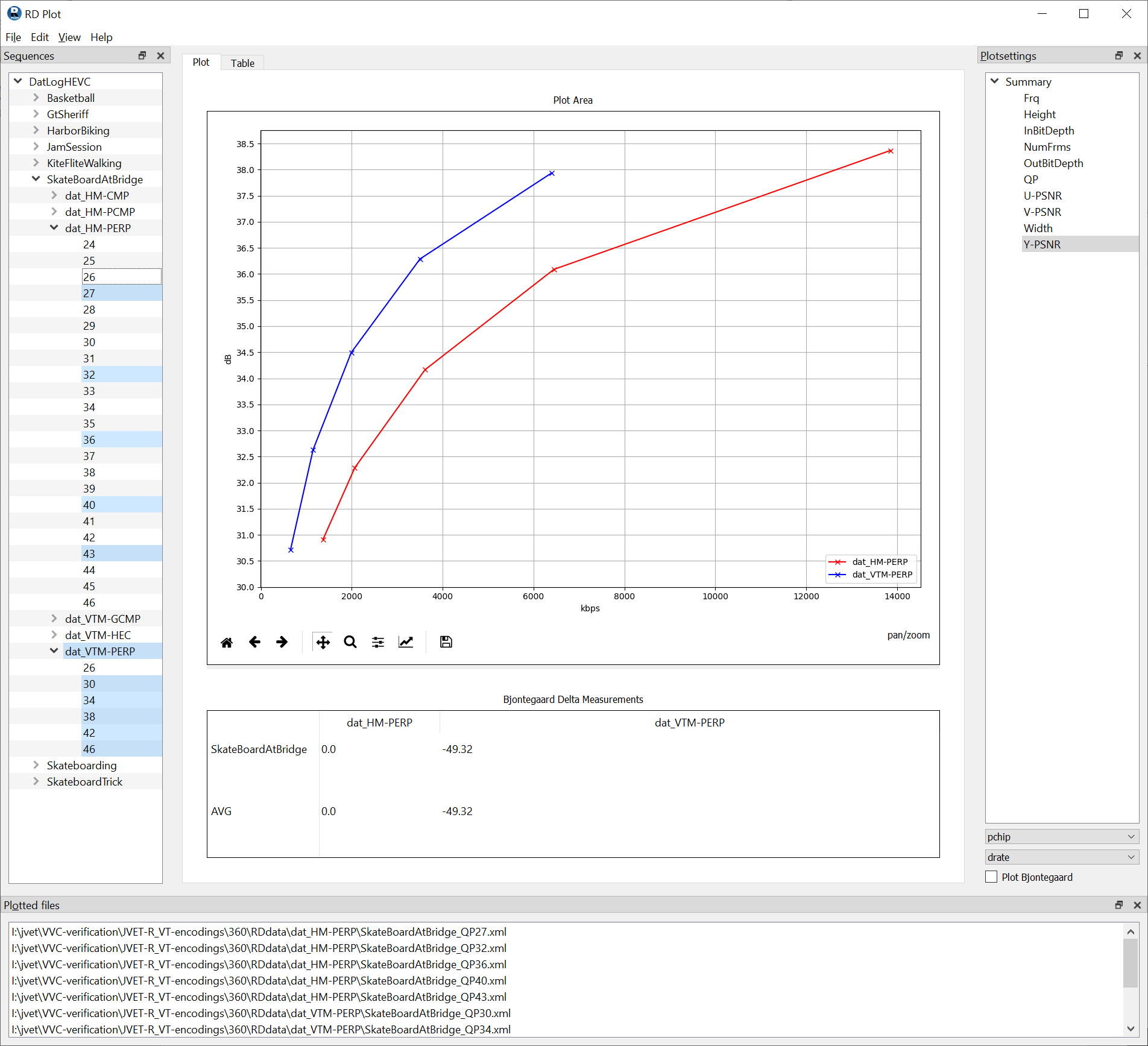


#### PCMP vs. GCMP

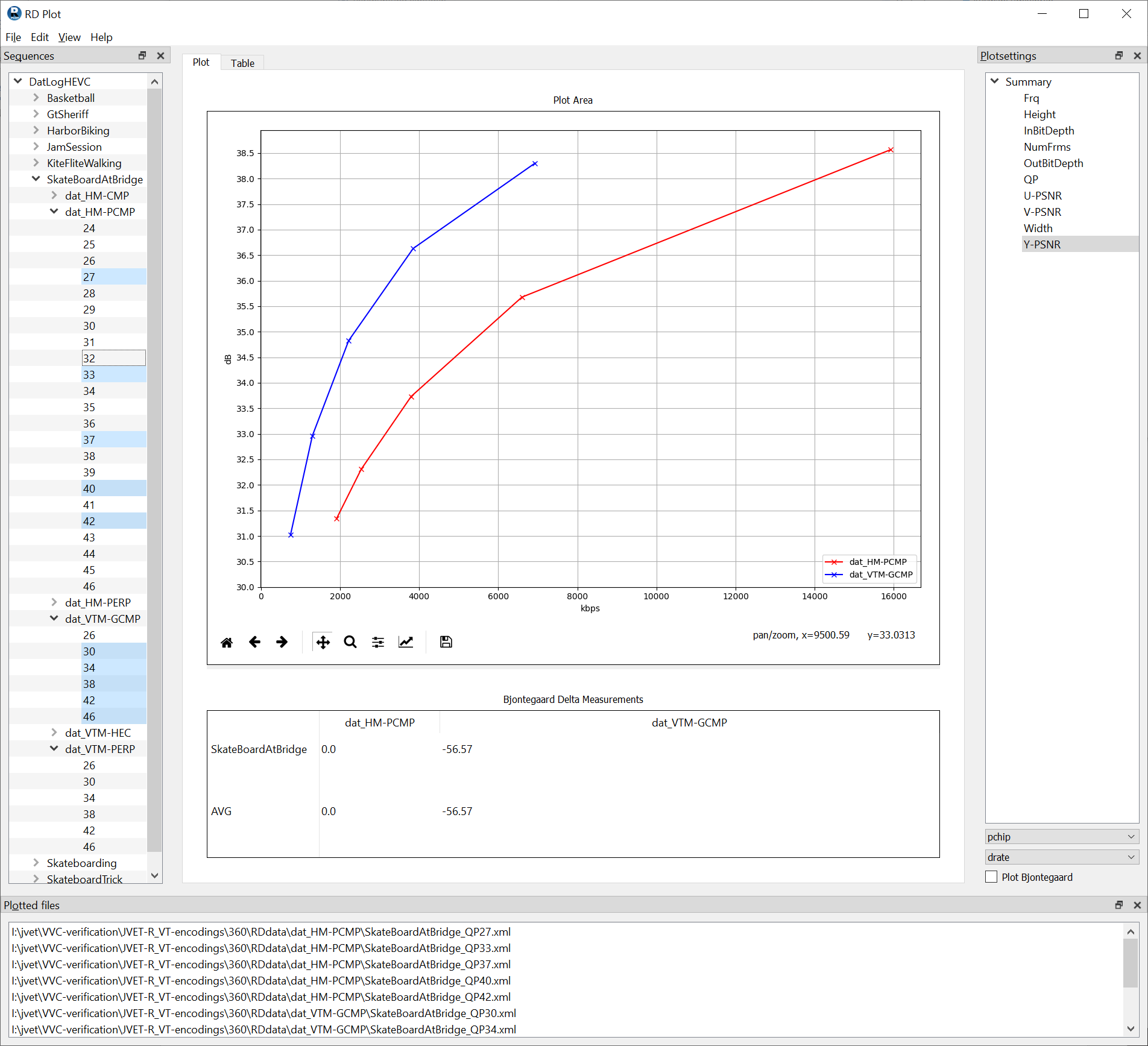


### SkateBoardAtBridge

#### PERP

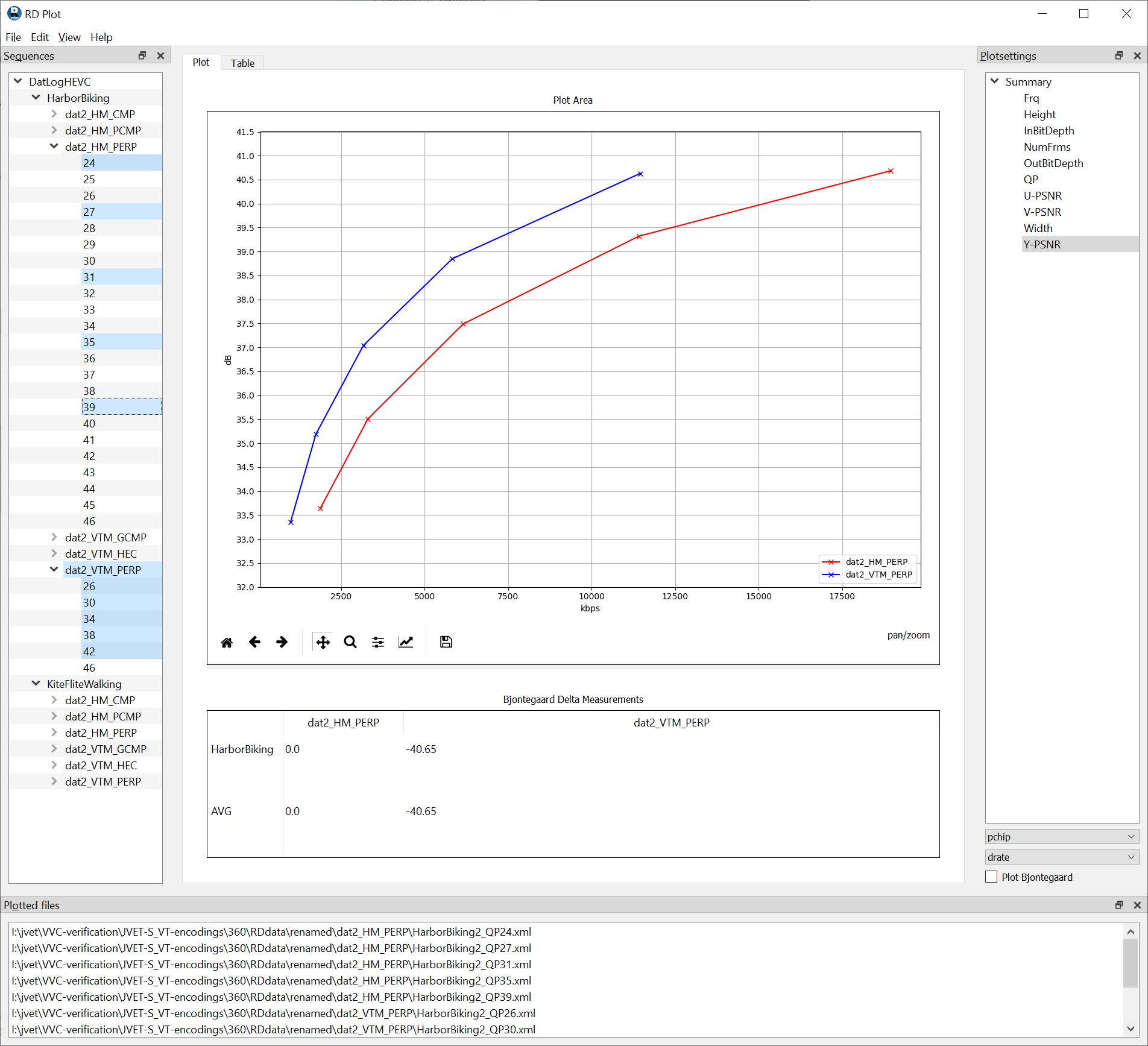


#### PCMP vs. GCMP

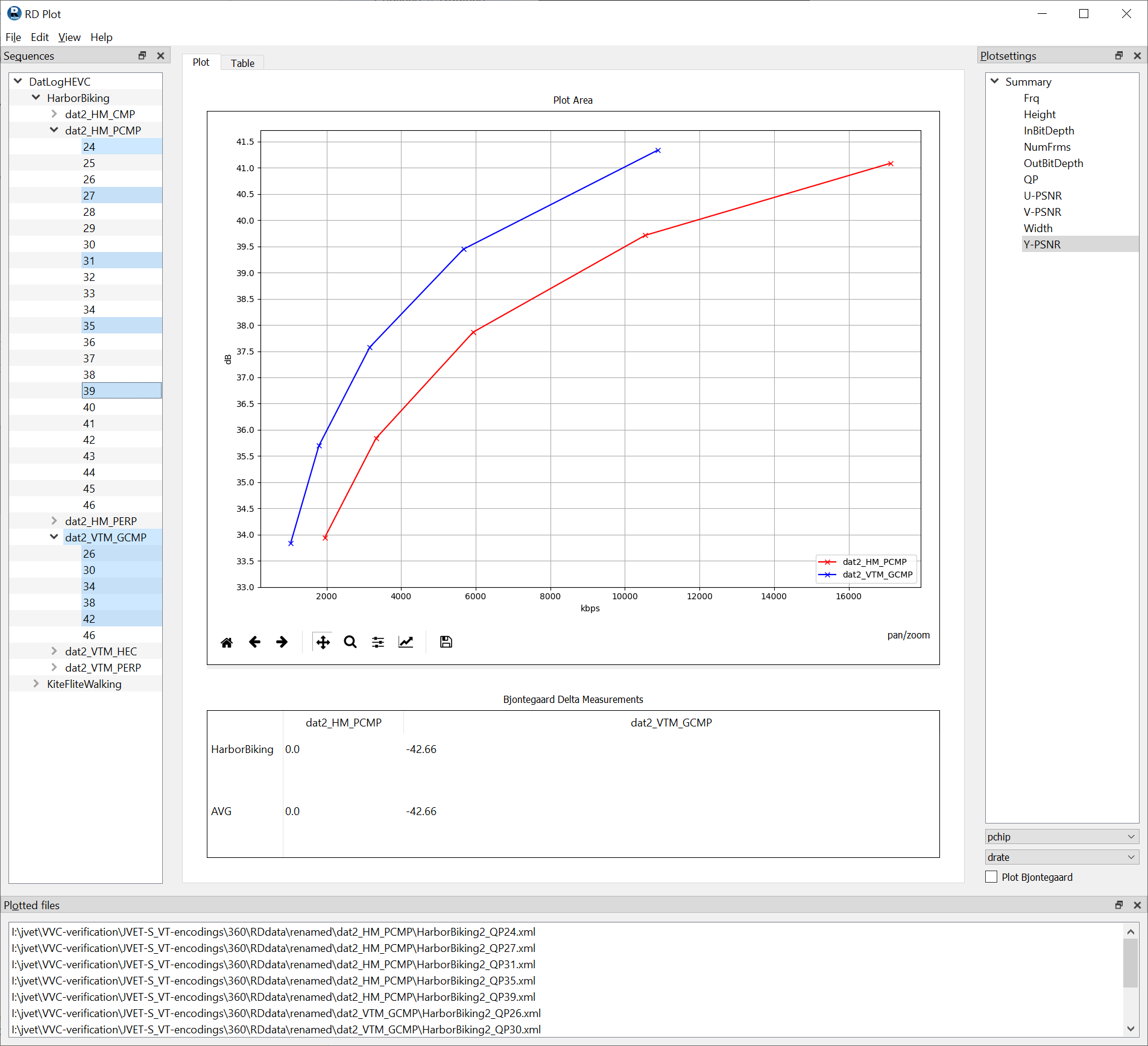


### HarborBiking2

#### PERP

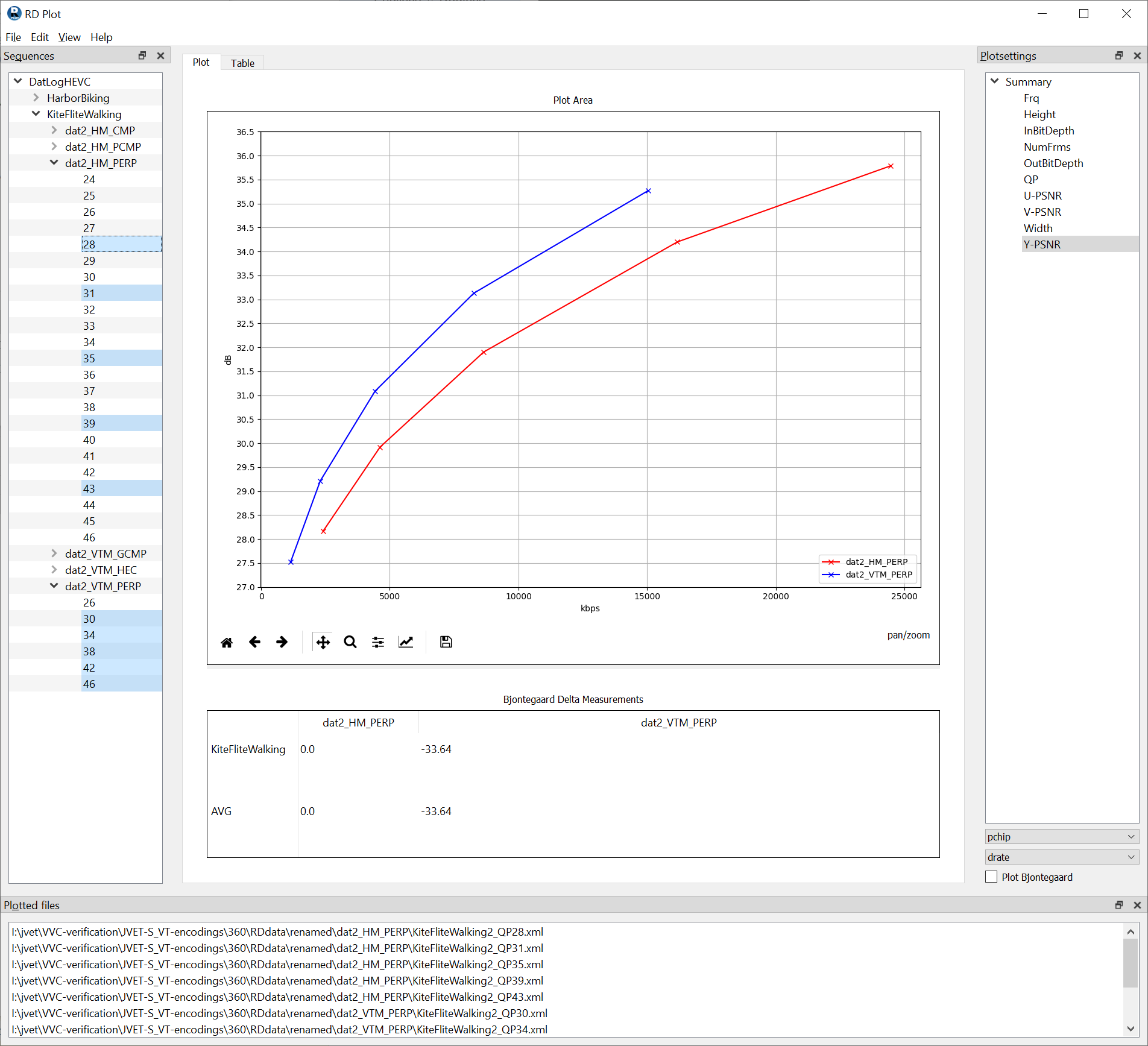


#### PCMP vs. GCMP

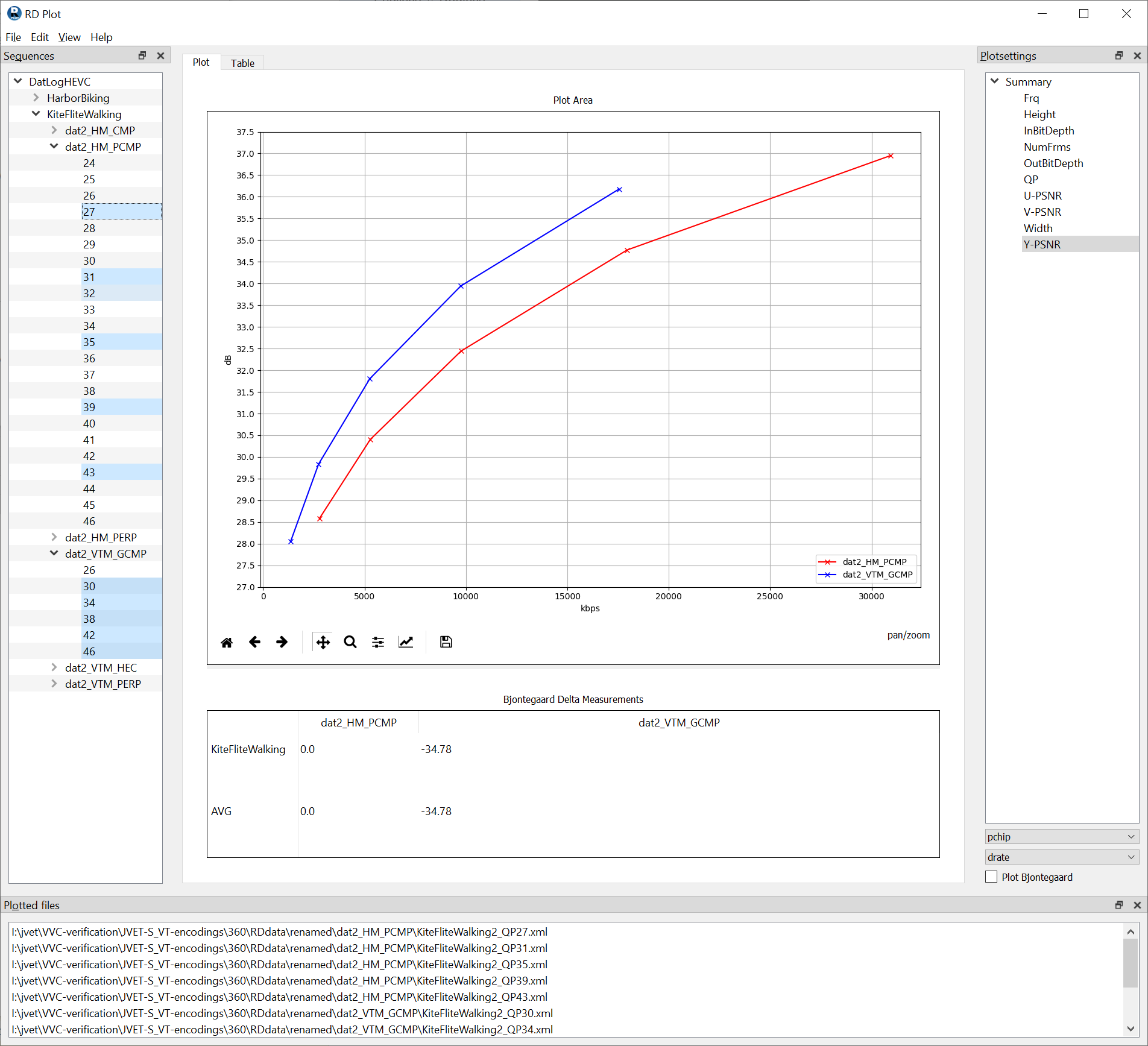


### KiteFliteWalking2

#### PERP



#### PCMP vs. GCMP



# References

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2. Recommendation ITU-R BT.2100-2 (2018), *Image parameter values for high dynamic range television for use in production and international programme exchange*.
3. SMPTE ST 2084, *High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays*, 2014.
4. SMPTE ST 2036-1, *Ultra High Definition Television – Image Parameter Values for Program Production*, 2014.
5. ETSI TS 101 154, *Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcast and Broadband Applications*, 2019.
6. G. Bjøntegaard, “Calculation of average PSNR differences between RD-curves,” in ITU-T SG 16 Q.6 document VCEG-M33, 13th VCEG meeting, Austin, Texas, USA, Apr. 2001.
7. J. Ström, K. Andersson, Rickard Sjöberg, A. Segall, F. Bossen, G. J. Sullivan, J.-R. Ohm, A. Tourapis, “Working practices using objective metrics for evaluation of video coding efficiency experiments (Draft 3),” Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 output document JVET-S2016, 19th JVET meeting by teleconference, June 2020.
8. V. Baroncini, M. Wien, “Results of dry run subjective assessment of SDR UHD verification test,” Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 input document JVET-S0246, 19th JVET meeting by teleconference, June 2020.

# Annex A – Encoding tasks, viewport extraction

## SDR

SDR UHD bitstream generation:

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Test sequence** | **Encoding** | **Verification** |
| 01 | DrivingPOV3 | Tencent | Huawei |
| 02 | Marathon | ByteDance | Tencent |
| 03 | MountainBay2 | Alibaba | ByteDance |
| 04 | NeptuneFountain3 | HHI | Alibaba |
| 05 | TallBuildings2 | Huawei | HHI |

## HDR

[to be filled for the final verification test simulations]

## 360° Video

[to be filled for the final verification test simulations]