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ISO/IEC JTC1/SC29/WG4  
MPEG VIDEO CODING**

ISO/IEC JTC1/SC29/WG4 MPEG/M54944  
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**Source** Poznań University of Technology (PUT), Poznań, Poland  
**Status** Input  
**Title** PUT results for EE2 on Coding for Future MPEG Immersive Video  
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## 1 Introduction

This document provides the results of EE2 experiments [N19491] performed by PUT.

## 2 Experimental results

### 2.1 EE2.a: V17 vs. V17 IVDE

In Table 1 and Figs. 1 – 3 the V17 anchor is compared with V17 IVDE anchor (with depth maps calculated using IVDE, based on all source views).

Table 1. Objective quality evaluation: V17 vs. V17 IVDE (green: V17 IVDE is better).

**Mandatory content - Proposal vs. Low/High-bitrate Anchors**

| Sequence       |    | High-BR<br>BD rate<br>Y-PSNR | Low-BR<br>BD rate<br>Y-PSNR | Max<br>delta<br>Y-PSNR | High-BR<br>BD rate<br>VMAF | Low-BR<br>BD rate<br>VMAF | High-BR<br>BD rate<br>IV-PSNR | Low-BR<br>BD rate<br>IV-PSNR |
|----------------|----|------------------------------|-----------------------------|------------------------|----------------------------|---------------------------|-------------------------------|------------------------------|
| ClassroomVideo | SA | ---                          | ---                         | 2.81                   | ---                        | ---                       | ---                           | 1250.4%                      |
| Museum         | SB | ---                          | ---                         | 21.97                  | ---                        | ---                       | ---                           | ---                          |
| Hijack         | SC | ---                          | ---                         | 25.36                  | ---                        | ---                       | ---                           | ---                          |
| Chess          | SN | ---                          | ---                         | 26.77                  | ---                        | ---                       | ---                           | ---                          |
| Kitchen        | SJ | ---                          | 140.2%                      | 17.91                  | 99.2%                      | 32.1%                     | 200.9%                        | 80.7%                        |
| Painter        | SD | 67.4%                        | 44.2%                       | 9.61                   | 34.7%                      | 28.9%                     | 88.0%                         | 51.3%                        |
| Frog           | SE | -14.0%                       | -13.1%                      | 5.63                   | -11.0%                     | -11.6%                    | -13.9%                        | -12.8%                       |
| Carpark        | SP | 56.0%                        | 55.8%                       | 9.97                   | 58.6%                      | 58.2%                     | 26.5%                         | 40.1%                        |
| <b>MIV</b>     |    | ---                          | ---                         | <b>15.00</b>           | ---                        | ---                       | ---                           | ---                          |

**Optional content - Proposal vs. Low/High-bitrate Anchors**

|            |    |        |        |              |              |             |        |        |
|------------|----|--------|--------|--------------|--------------|-------------|--------|--------|
| Fencing    | SL | 11.9%  | 15.4%  | 12.33        | 23.2%        | 20.4%       | 8.9%   | 13.5%  |
| Hall       | ST | ---    | -71.8% | 18.42        | -61.0%       | -54.5%      | -82.8% | -67.1% |
| Street     | SU | 52.8%  | 47.2%  | 9.06         | 38.9%        | 41.4%       | 25.9%  | 34.2%  |
| Group      | SR | ---    | ---    | 21.91        | 223.1%       | 96.4%       | ---    | ---    |
| Fan        | SO | -53.7% | -63.0% | 10.91        | -51.7%       | -61.5%      | -40.5% | -56.9% |
| <b>MIV</b> |    | ---    | ---    | <b>14.52</b> | <b>34.5%</b> | <b>8.4%</b> | ---    | ---    |

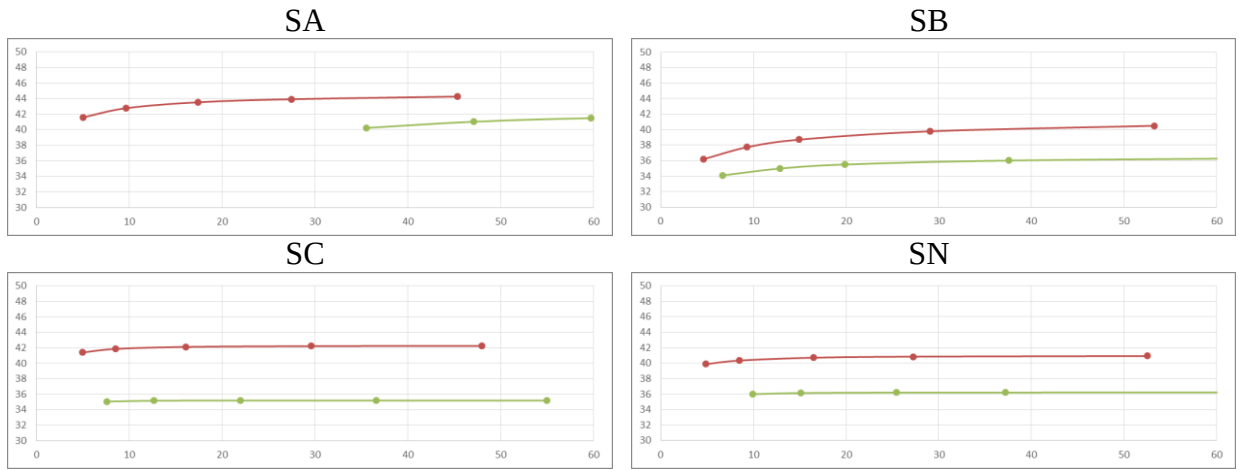


Fig. 1. IV-PSNR: V17 anchor (red) vs. V17 IVDE anchor (green): ERP content.

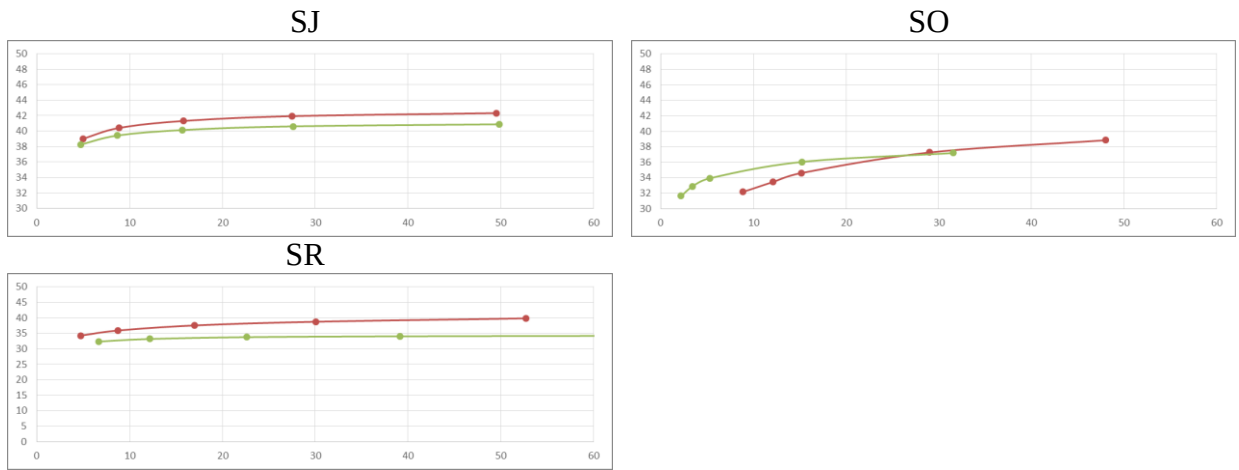


Fig. 2. IV-PSNR: V17 anchor (red) vs. V17 IVDE anchor (green): perspective CG content.

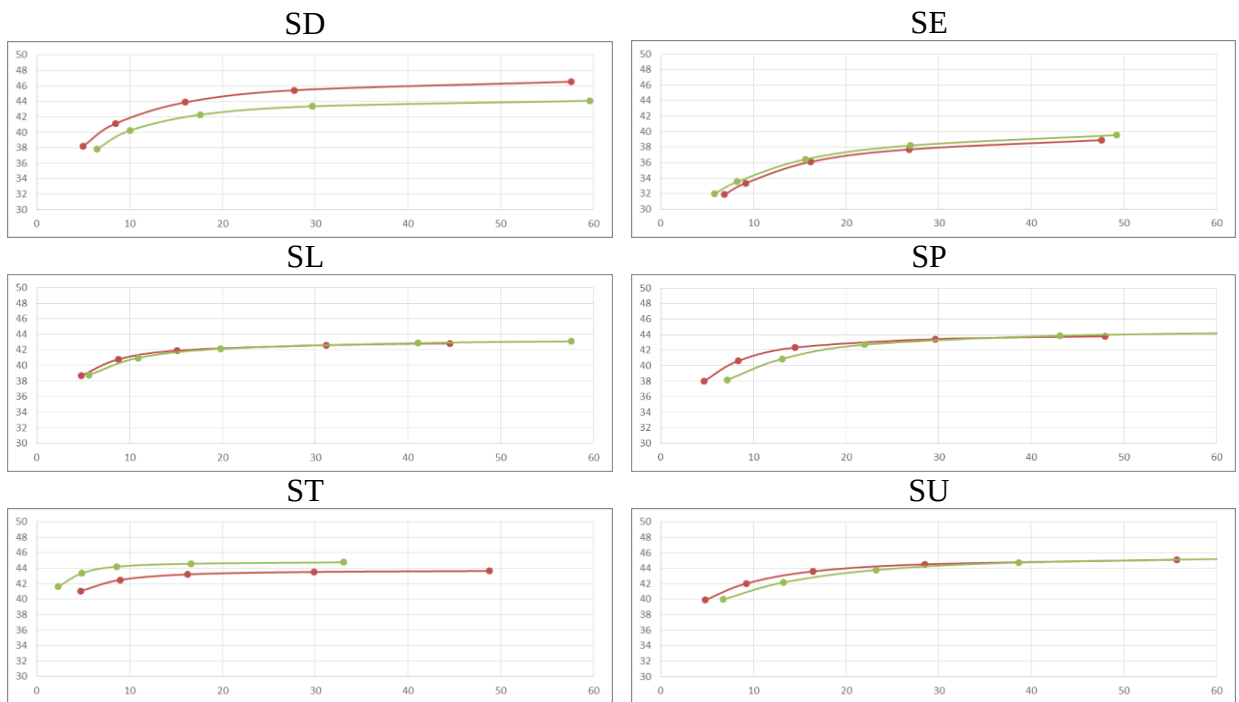


Fig. 3. IV-PSNR: V17 anchor (red) vs. V17 IVDE anchor (green): perspective natural content.

Remarks:

- For almost all CGI sequences the quality of the anchor is unsurprisingly better. The exception is SO, where the details of a fan highly increase the bitrate of encoded depth maps.
- For 2 out of 6 natural sequences IVDE-generated depth maps provided better quality than the current anchor. Most of anchor depth maps were already generated using IVDE, but for different configuration or for different (processed) input views.

## 2.2 EE2.b: V17 vs. GA17

In Table 2 and Figs. 4 – 6 the V17 anchor is compared with GA17 anchor (with depth maps calculated using IVDE, based on transmitted, decoded views).

Table 2. Objective quality evaluation: V17 vs. GA17 (green: GA17 is better).

|                |    | Mandatory content - Proposal vs. Low/High-bitrate Anchors |         |        |         |         |         |         |
|----------------|----|-----------------------------------------------------------|---------|--------|---------|---------|---------|---------|
| Sequence       |    | High-BR                                                   | Low-BR  | Max    | High-BR | Low-BR  | High-BR | Low-BR  |
|                |    | BD rate                                                   | BD rate | delta  | BD rate | BD rate | BD rate | BD rate |
|                |    | Y-PSNR                                                    | Y-PSNR  | Y-PSNR | VMAF    | VMAF    | IV-PSNR | IV-PSNR |
| ClassroomVideo | SA | ---                                                       | ---     | 6.27   | ---     | ---     | ---     | 317.6%  |
| Museum         | SB | ---                                                       | ---     | 19.93  | ---     | 685.9%  | 668.9%  | 389.4%  |
| Hijack         | SC | ---                                                       | ---     | 23.13  | ---     | ---     | ---     | ---     |
| Chess          | SN | ---                                                       | ---     | 26.57  | ---     | ---     | ---     | ---     |
| Kitchen        | SJ | ---                                                       | -36.6%  | 15.45  | ---     | -27.6%  | -56.0%  | -18.3%  |
| Painter        | SD | -10.3%                                                    | -29.0%  | 8.97   | -23.8%  | -36.6%  | 13.7%   | -20.6%  |
| Frog           | SE | -36.6%                                                    | -36.6%  | 6.22   | -40.0%  | -40.4%  | -36.5%  | -36.7%  |
| Carpark        | SP | -17.8%                                                    | -41.6%  | 10.39  | -25.1%  | -45.0%  | -47.4%  | -52.7%  |
| MIV            |    | ---                                                       | ---     | 14.62  | ---     | ---     | ---     | ---     |

|          |    | Optional content - Proposal vs. Low/High-bitrate Anchors |         |        |         |         |         |         |
|----------|----|----------------------------------------------------------|---------|--------|---------|---------|---------|---------|
| Sequence |    | High-BR                                                  | Low-BR  | Max    | High-BR | Low-BR  | High-BR | Low-BR  |
|          |    | BD rate                                                  | BD rate | delta  | BD rate | BD rate | BD rate | BD rate |
|          |    | Y-PSNR                                                   | Y-PSNR  | Y-PSNR | VMAF    | VMAF    | IV-PSNR | IV-PSNR |
| Fencing  | SL | -24.7%                                                   | -56.9%  | 12.50  | -52.5%  | -64.2%  | -52.5%  | -62.2%  |
| Hall     | ST | -56.2%                                                   | -76.0%  | 18.91  | -86.8%  | -86.8%  | -52.6%  | -75.3%  |
| Street   | SU | -0.7%                                                    | -28.4%  | 9.21   | -20.4%  | -35.7%  | -35.5%  | -40.9%  |
| Group    | SR | ---                                                      | ---     | 25.17  | -38.1%  | 7.9%    | ---     | ---     |
| Fan      | SO | -79.4%                                                   | -79.6%  | 9.39   | -69.1%  | -71.9%  | -62.5%  | -67.7%  |
| MIV      |    | ---                                                      | ---     | 15.04  | -53.4%  | -50.2%  | ---     | ---     |

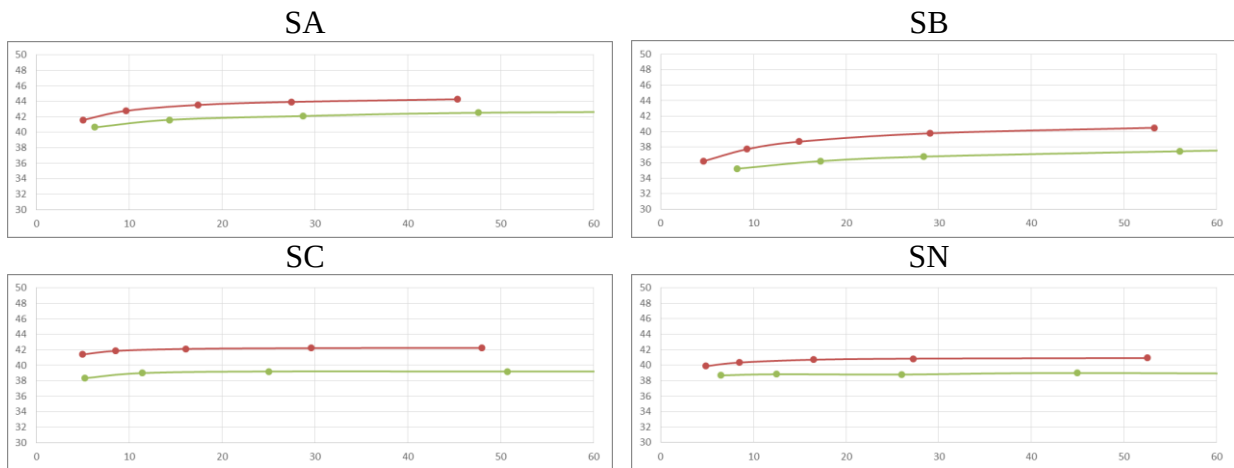


Fig. 4. IV-PSNR: V17 anchor (red) vs. GA17 anchor (green): ERP content.

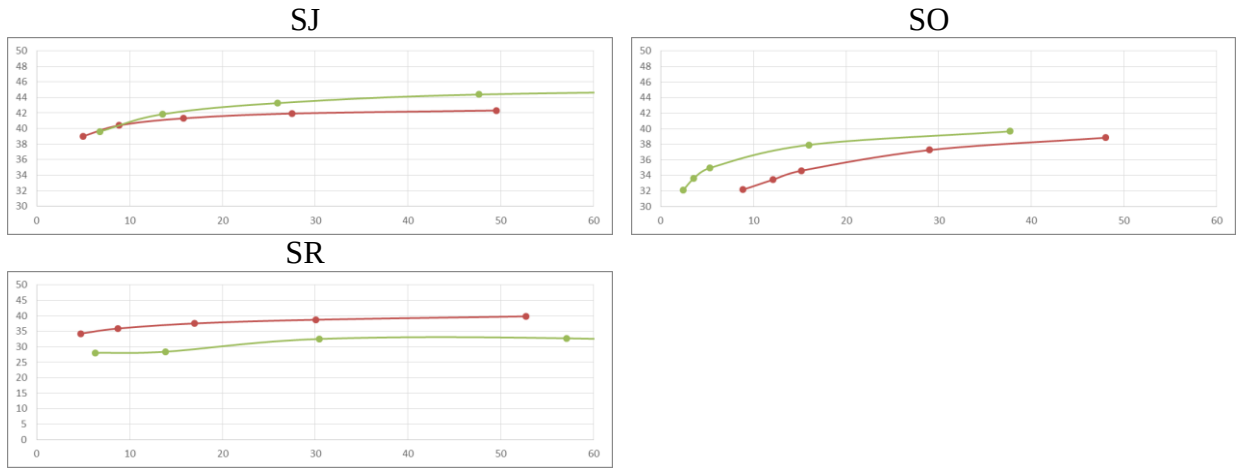


Fig. 5. IV-PSNR: V17 anchor (red) vs. GA17 anchor (green): perspective CG content.

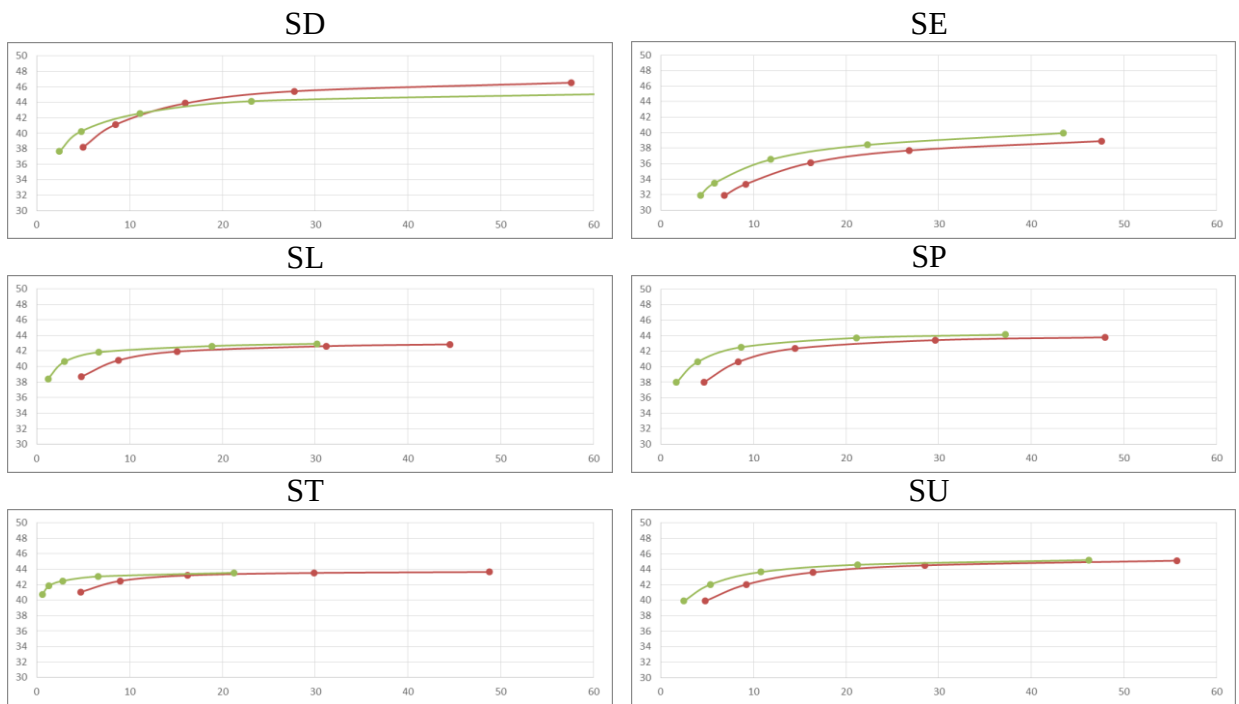


Fig. 6. IV-PSNR: V17 anchor (red) vs. GA17 anchor (green): perspective natural content.

Remarks:

- In this experiment, GA17 outperforms V17 for perspective content. The exception is for the optional sequence SR, for which we will investigate the poor quality of estimated depth maps.

### 2.3 EE2.ab: V17 IVDE vs. GA17

In Table 3 and Figs. 7 – 9 the V17 IVDE anchor (with depth maps calculated using IVDE, based on all source views) is compared with the GA17 anchor (with depth maps calculated using IVDE, based on transmitted, decoded views).

Table 2. Objective quality evaluation: V17 IVDE vs. GA17 (green: GA17 is better).

| Mandatory content - Proposal vs. Low/High-bitrate Anchors |    |                              |                             |                        |                            |                           |                               |                              |
|-----------------------------------------------------------|----|------------------------------|-----------------------------|------------------------|----------------------------|---------------------------|-------------------------------|------------------------------|
| Sequence                                                  |    | High-BR<br>BD rate<br>Y-PSNR | Low-BR<br>BD rate<br>Y-PSNR | Max<br>delta<br>Y-PSNR | High-BR<br>BD rate<br>VMAF | Low-BR<br>BD rate<br>VMAF | High-BR<br>BD rate<br>IV-PSNR | Low-BR<br>BD rate<br>IV-PSNR |
| ClassroomVideo                                            | SA | ---                          | ---                         | 6.27                   | ---                        | ---                       | -77.2%                        | -81.5%                       |
| Museum                                                    | SB | ---                          | ---                         | 19.93                  | ---                        | -57.4%                    | -69.4%                        | -52.0%                       |
| Hijack                                                    | SC | ---                          | ---                         | 23.13                  | ---                        | ---                       | ---                           | ---                          |
| Chess                                                     | SN | ---                          | ---                         | 26.57                  | ---                        | ---                       | ---                           | ---                          |
| Kitchen                                                   | SJ | ---                          | ---                         | 15.45                  | ---                        | -46.4%                    | ---                           | -51.3%                       |
| Painter                                                   | SD | -52.7%                       | -54.5%                      | 8.97                   | -46.7%                     | -52.1%                    | -48.4%                        | -51.6%                       |
| Frog                                                      | SE | -26.6%                       | -26.8%                      | 6.22                   | -33.0%                     | -32.7%                    | -26.1%                        | -27.1%                       |
| Carpark                                                   | SP | -47.5%                       | -62.5%                      | 10.39                  | -53.3%                     | -65.4%                    | -56.4%                        | -65.2%                       |
| MIV                                                       |    | ---                          | ---                         | 14.62                  | ---                        | ---                       | ---                           | ---                          |

| Optional content - Proposal vs. Low/High-bitrate Anchors |    |        |        |       |        |        |        |        |
|----------------------------------------------------------|----|--------|--------|-------|--------|--------|--------|--------|
| Fencing                                                  | SL | -31.4% | -62.7% | 12.50 | -61.1% | -70.2% | -54.7% | -66.4% |
| Hall                                                     | ST | ---    | -4.8%  | 18.91 | -62.8% | -70.1% | 229.8% | -20.6% |
| Street                                                   | SU | -35.2% | -51.2% | 9.21  | -43.3% | -54.6% | -48.0% | -55.6% |
| Group                                                    | SR | 349.4% | 313.8% | 25.17 | ---    | -38.0% | ---    | 362.8% |
| Fan                                                      | SO | -61.9% | -50.8% | 9.39  | -41.2% | -32.2% | -43.8% | -29.3% |
| MIV                                                      |    | ---    | 28.9%  | 15.04 | ---    | -53.0% | ---    | 38.2%  |

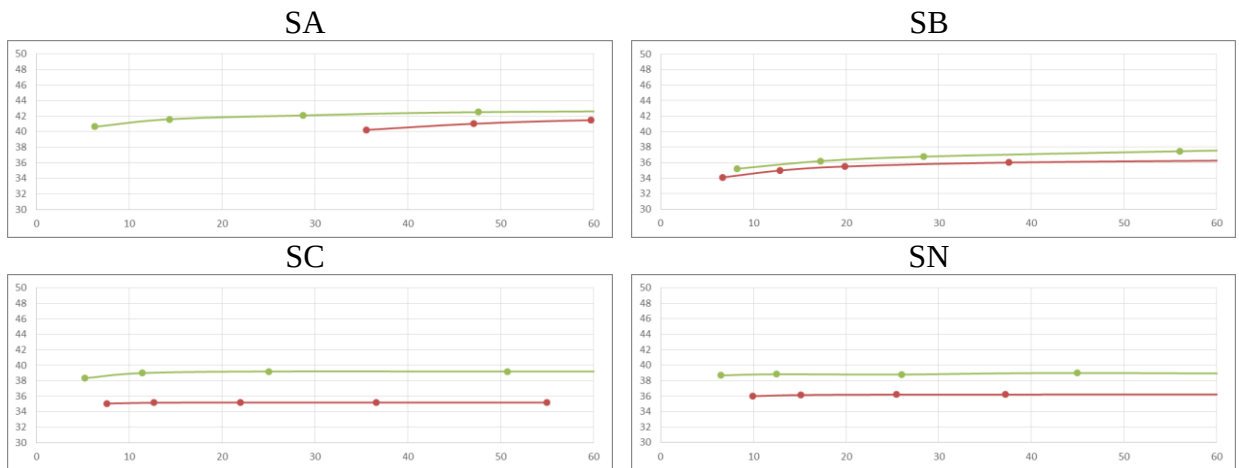


Fig. 4. IV-PSNR: V17 IVDE anchor (red) vs. GA17 anchor (green): ERP content.

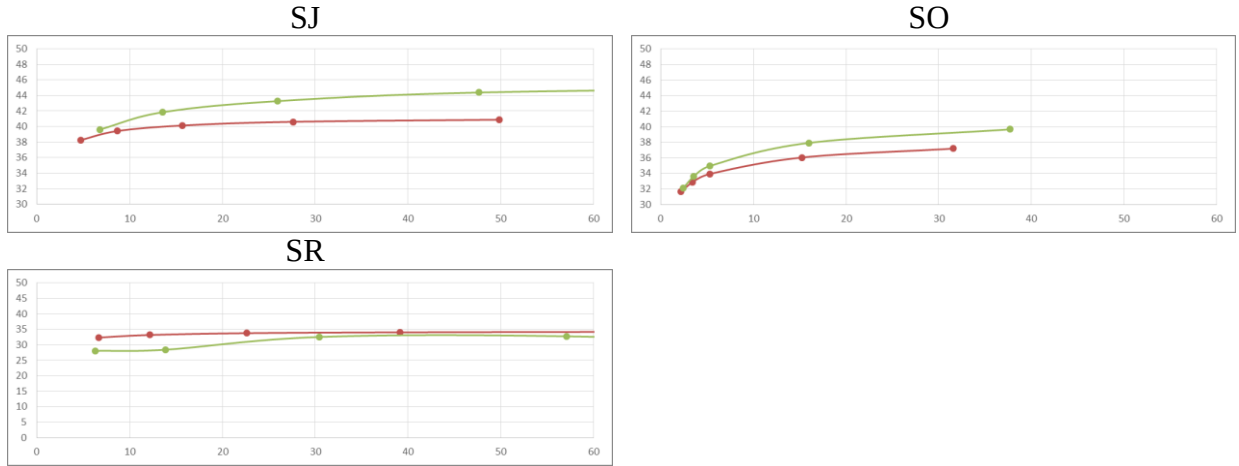


Fig. 5. IV-PSNR: V17 IVDE anchor (red) vs. GA17 anchor (green): perspective CG content.

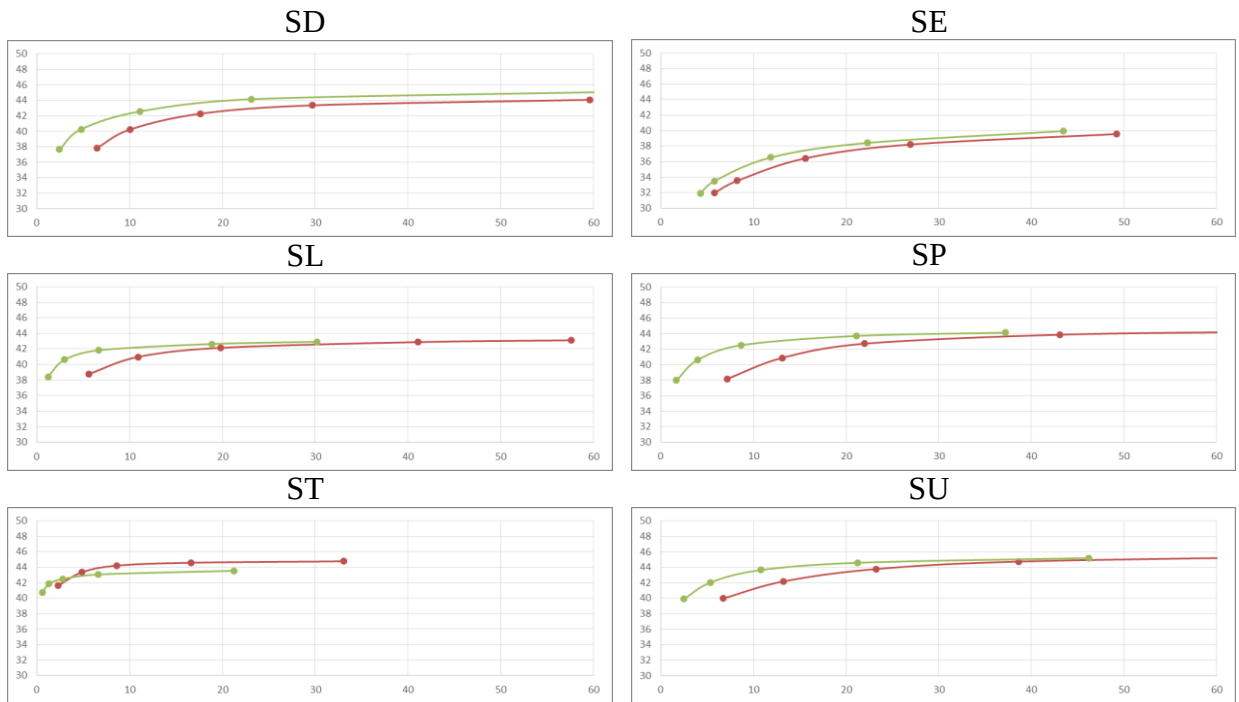


Fig. 6. IV-PSNR: V17 IVDE anchor (red) vs. GA17 anchor (green): perspective natural content.

#### Remarks:

- This experiment proves much better performance of GA17 over V17 when the same software with the same configuration was used to estimate depth maps in both cases (only the number of input views was smaller for GA17, as not all input views can fit into atlases).
- Again, the exception is for the optional sequence SR, for which we will investigate the poor quality of estimated depth maps.
- For natural content, the highest gain is shown for low-bitrate cases, while for CGI the gain is higher for high bitrates.

### **3 Acknowledgement**

This work was supported by the Ministry of Science and Higher Education.

### **4 References**

- [N19491] “Exploration Experiments on Coding for Future MPEG Immersive Video”  
ISO/IEC JTC1/SC29/WG11 MPEG/N19491, July 2020, Online.