High Dynamic Range Viewing Preference Test

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Introduction

• Philips has been active in television for more than 70 years and has always been at the forefront of television technology.
• We have been working on high-brightness high-dynamic-range (HDR) television for more than 8 years.
• We showed our first HDR display with a peak luminance of 3,000 cd/m² to selected customers during the 2009 IFA in Berlin, after which we have continued to further develop all required elements of the future HDR-TV chain.
• We produced the world’s first HDR short movie “Missing Minny” in 2011 (see Appendix). Having available a real-time HDR chain on the set enabled the director and DOP to immediately see the scenes on the HDR display.
• We currently have optimized solutions available for HDR video encoding, dynamic range conversion (tone mapping), and color gamut mapping.
Image dynamic range preference test

- Philips performed a viewing test to assess the preference of 5,000 cd/m² peak luminance High Dynamic Range (HDR) versus 400 cd/m² peak luminance Low Dynamic Range (LDR) content in a daytime television viewing environment.
- The level of 400 cd/m² was selected since this is approximately the average peak luminance of LCD TVs that are currently on the market.
- The test materials were extracted from a number of HDR video sources.
  - The test material was first colour graded on a 5,000 cd/m² peak luminance HDR monitor, the SIM2 HDR47ES4K (see Appendix).
  - An LDR grade was derived from the HDR material. For this purpose, the same monitor was used, but set to a peak luminance of 400 cd/m².
- 12 sequences of 10 seconds each were selected:
  - 7 sequences were used for observer training and test score calibration.
  - 5 other sequences were used for the actual test.
Viewing conditions

Daytime viewing

- Two levels of background wall luminance were tested, based upon measurements of the luminance reflected by a non-directly illuminated indoor wall under various outside weather conditions:
  - We have measured the wall luminance to be 250 cd/m² on a very cloudy day and 2500 cd/m² on a sunny day.
  - We have selected 300 cd/m² and 750 cd/m² as representative daylight television viewing environmental luminance levels for our viewing tests (using a D₅₀ floodlight on the wall behind the HDR display).
Viewing conditions

Test room layout

- Test operator
- Streaming PC
- Viewer position
- Viewer position

- Display

- $d_1 = 1.80 \text{ m}$
- $d_2 = 2.70 \text{ m}$

$16^\circ$
Test procedure

• One test presentation consisted of:
  – 3 seconds mid-grey
  – 10 seconds reference sequence A (LDR or HDR, randomly selected),
  – 3 seconds mid-grey
  – 10 seconds test sequence B (HDR or LDR),
  – The above sequences presented again in the same way/order.
  – 10 seconds voting period.
• 19 non-expert observers participated in the first test, 20 in the second test.
• Paper forms were used to record the ratings. The ITU-R comparison scale has been used:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>-3</td>
<td>Much worse</td>
</tr>
<tr>
<td>-2</td>
<td>Worse</td>
</tr>
<tr>
<td>-1</td>
<td>Slightly worse</td>
</tr>
<tr>
<td>0</td>
<td>The same</td>
</tr>
<tr>
<td>+1</td>
<td>Slightly better</td>
</tr>
<tr>
<td>+2</td>
<td>Better</td>
</tr>
<tr>
<td>+3</td>
<td>Much better</td>
</tr>
</tbody>
</table>
Test results

- The figures show the mean and 95% confidence interval for the 5 test sequences as well as the overall mean and confidence interval.
Conclusion

• Philips performed a viewing test to assess the preference of 5 000 cd/m² peak luminance High Dynamic Range (HDR) versus 400 cd/m² peak luminance Low Dynamic Range (LDR) content in a daytime television viewing environment.
• The test results show that the content shown with a 5 000 cd/m² peak luminance level is clearly preferred over the content shown with a peak luminance level of 400 cd/m².
• There was no significant difference in test results between the 300 cd/m² and 750 cd/m² background illumination levels.
Appendix: HDR production
Missing Minny short movie

• The “Missing Minny” movie was post-produced in two versions: a high-dynamic range grade (5000 cd/m2 peak luminance) and a standard dynamic range grade.

• The standard dynamic range grade of the “Missing Minny” movie won two awards in the 2012 New York Festivals international Television & Film Awards category:
  – Gold World Medal - best Cinematography
  – Silver World Medal - best short film

• The standard dynamic range movie can be seen at
  – https://www.youtube.com/watch?v=XdclzsiL-Hs

• Behind the scenes production:
  – https://www.youtube.com/watch?v=pUu6Tp-ea7A
Live HDR chain
Calibrated end-to-end chain:

Camera: Arri Alexa LogC HD-SDI out 10-bit RGB

HD-SDI → Philips real-time processing → DVI

Display: SIM2 HDR display (HDR DVI input)

Real-time processing:

→ Convert LogC to linear light → Map color gamut to Rec.709 RGB → Apply OETF → Apply EOTF → Convert to SIM2 HDR DVI format
HDR post-production colour grading

Calibrated chain:

Davinci Resolve
Rec. 709 gamut
RGB with OETF

HD-SDI

Philips real-time processing

DVI

Display:
SIM2 HDR display
(HDR DVI input)

Real-time processing:

Apply EOTF

Convert to SIM2 HDR DVI format