

Distribution of HDR in an SDR World

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SDR+HDR

Vast majority is SDR:

- Content
- Displays
- Broadcasts

HDR & SDR Coexistence:

- HDR to SDR?
- SDR to HDR?
- Immersiveness?
- HDR or SDR distribution?

Creative Intent

- All production targets SDR
- Is HDR best for creative intent?
- SDR intent incorporates display limitations?
- Is automated HDR tone-mapping to SDR possible?
- Human vision response is logarithmic?
- Linear 1:1 camera to display preserves local contrast?
- HDR Camera + Linearity → HDR displays?
- SDR → saturation + loss of local contrast?

Carousel (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to Rec709



Thanks to original at
<https://hdr-2014.hdm-stuttgart.de>

Carousel (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to HDR10 at 1000 nits, clipped to Rec709



Beerfest_lightshow (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to rec709



Beerfest_lightshow (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to HDR10 at 1000 nits, clipped to Rec709



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HDR to SDR+ Tone Mapping

- Preserve local contrast?
- Preserve creative intent?
- Minimize saturation?
- Are artifacts inevitable?
- Automation?
- Leverage SDR infrastructure without metadata?
- Invertible back to HDR?

Immersive HDR

- HDR Cameras
- 10-bit?
- ST 2084 (PQ)?
- 4:2:0 chroma?
- Wide Color Gamut?
- High Frame Rates?
- UHD?

Signal Degradations

- Noise?
- Blur?
- Motion Judder?
- Flicker?
- Halos?
- Contouring?
- Compression artifacts?

Low frame rates → Motion Judder → shutter angle → Motion Blur

Motion-compensated noise reduction

Remastering SDR for Distribution

- Original sources?
- Bigger, brighter displays
- Deinterlacing/pulldown/FRC → progressive broadcasting!
- Noise reduction
- Computationally intensive algorithms?
- 10-bits out
- SDR/SDR+ broadcasting?
- Inverse tone mapping to HDR at TV/STB?
- Open signal standards – no new metadata

SDR+ → HDR for HDR TVs

- Legacy SDR remastering?
- 10-bit SDR/SDR+ → 10-bit HDR in STB?
- Highlights: peak SDR/SDR+ → peak HDR
- Peak white SDR → text/sky saturation
- HDR TV manufacturers limit brightness
- Automated HDR → SDR+ → HDR?
- Open formats/standards?

Metadata in Distribution

- ST-2086 for HDR10
 - 1) Transfer characteristics
 - 2) Mastering display color primaries
 - 3) Mastering display luminance
 - Max content light level (MaxCLL)
 - Max frame average level (MaxFALL)
- MaxCLL/MaxFall – 2 passes → no live option!
- 0 → unknown
- TV manufacturers ignore MaxCLL/MaxFALL
- Metadata needed for TM or inverse-TM?

OTT

- Flexible
- No standards – only conventions!
- No channel limitations
- Redirect IP requests

Broadcast

- Broadcast needs dual SDR/HDR?
- Proprietary 2nd layer?
- Invertible SDR → HDR with/without metadata?
- HLG squashes SDR
- SDR+ enhances SDR

Bistro (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to rec709



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Bistro (original: BT2020 ST-2084, graded to 4000 nits)
tone mapped to HLG10 and shown as Rec709



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Dynamic Metadata

- TM harder than inverse TM – SDR broadcast?
- Internet – find broadcast channel info – peak lum?
- Unnormalized HDR peaks → STB TM down 100:1
- Rec709 or HLG – fixed peak lum – no metadata!
- Proprietary systems
 - extra layer?
 - Decode → FRC → re-encode?
 - Metadata recalculation?

HDR/SDR Bitrates

- AVC/HEVC/VP9 work for HDR
- HDR > SDR bitrates?
- SDR+ similar to HDR
- MC NR -50% typical
- Flicker
- HD+TV scalers vs UHD +200%

Transitioning from SDR/SDR+ to HDR

- Takes time
- SDR+ during transition?
- Migrate out from HDR cameras - “wave-front”?
- ATSC → ATSC3.0 for SDR+/HDR
- SDI → ST-2022-6 (IP)
- 10-bit SDR/HDR10 mix?

HDR/SDR Conversion Implementation

- HDR TM to 10/12-bit SDR+
- SDR/SDR+ inverse TM to 10/12-bit HDR
- Splitting + GPU-acceleration

Conclusions

- Automatic HDR → SDR+
- Automatic SDR/SDR+ → HDR at STB
- Preserve creative intent
- HDR10 - ST-2086 metadata
- OTT open formats for HDR/SDR+
- ATSC3.0: 10-bit SDR+ broadcast

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