

Rec.2020

KAMERA/TECHNIK

ITU-R Empfehlung BT.2020 (Rec.2020) definiert den Farbraum für UHD- und 4K-Fernsehen. Sie legt einen 30% größeren Farbraum als Rec.709 fest, essentiell für modernes HDR und Wide-Color-Gamut-Displays.

Rec.2020 Wide Color Gamut Standard Rec.2020, formally ITU-R Recommendation BT.2020, defines the color space for Ultra High Definition Television (UHDTV) and 4K content. It specifies a significantly larger color gamut (approximately 30% wider than Rec.709), enabling superior color reproduction on modern displays and essential for HDR content delivery. Historical Context Rec.2020 addresses UHD and HDR requirements: Standardization : ITU-R in 2012 Motivation : UHD television requires wider color gamut Gamut Size : ~30% larger than Rec.709 Modern Standard : Primary color space for 4K and HDR HDR Integration : Works with PQ and HLG transfer functions Color Space Definition Rec.2020 specifies wider color primaries: Color Primaries (CIE 1931): Red (R) : $x=0.708$, $y=0.292$ Green (G) : $x=0.170$, $y=0.797$ Blue (B) : $x=0.131$, $y=0.046$ White Point (D65) : $x=0.3127$, $y=0.3290$ (same as Rec.709) Gamut Expansion : Significantly wider than Rec.709 red and green More saturated red primary More saturated green primary More saturated blue primary Better represents colors visible on nature (spectral colors) Transfer Characteristics Standard Transfer (SDR) : Traditional gamma 2.4 (like Rec.709) Backward compatible with Rec.709 workflows Can be OETF encoded or linear light HDR Transfer Functions : PQ (Perceptual Quantizer) : ITU Rec.2084 (cinema HDR) HLG (Hybrid Log-Gamma) : Alternative broadcast HDR 10-bit minimum for Rec.2020 HDR Technical Specifications Resolution Support : 3840×2160 (4K/UHD) primary 7680×4320 (8K) supported Frame rates: 24p, 30p, 50p, 60p standard Bit Depth Requirements : SDR : 8-bit or 10-bit HDR : 10-bit minimum (typically 12-bit capable) Higher precision maintains color information Rec.2020 in Professional Production 4K Content Creation : Digital cinema camera acquisition (4K DCI) Professional UHD video recording 4K mastering and grading standard Premium streaming content HDR Production : Essential for HDR content Works with PQ transfer function Required for UHD Blu-ray NextGen TV (ATSC 3.0) standard Streaming Platforms : Netflix 4K uses Rec.2020 Amazon Prime 4K content YouTube UHD delivery Apple TV+ premium content Rec.2020 vs. Rec.709 Aspect Rec.709 Rec.2020 Primary Use HD Television 4K/UHD Television Color Gamut Standard 30% wider Primary Saturation Moderate Enhanced HDR Support Limited Excellent Bit Depth Typically 8-bit Typically 10-bit + Display Technology Standard TV Modern displays Industry Status Established HD Growing 4K standard Color Management Workflow Rec.2020 Production Pipeline : Acquisition : Digital camera records Rec.2020 native Monitoring : Rec.2020 LUT applied for on-set review Post-Production : Grading in Rec.2020 color space Delivery : Mastered at Rec.2020 (Rec.709 downconvert optional) Archive : Native Rec.2020 for future distribution Monitor Calibration Rec.2020 Monitoring : Reference displays must support Rec.2020 99% DCI-P3 or Adobe RGB minimum Professional color-grading monitors essential Streaming platforms increasingly monitor Rec.2020 Challenges : Consumer displays don't fully support Rec.2020 Viewing environment affects perceived color Compensation strategies necessary HDR monitoring requires advanced displays Backward Compatibility Rec.2020 Challenges : Consumer displays limited to ~80% gamut Rec.709 downconversion necessary for legacy systems Color mapping required for older displays Distribution requires multiple masters

Solutions : Wide-gamut master in Rec.2020 Rec.709 version generated from master Intelligent color mapping preserves intent Multiple deliverables for platform needs HDR and Rec.2020 PQ (Perceptual Quantizer) Integration: Rec.2020 color gamut with PQ transfer function Professional HDR cinema standard 10-bit or 12-bit required Most cinematically accurate HDR HLG (Hybrid Log-Gamma) : Broadcast HDR alternative Rec.2020 color gamut Compatible with SDR displays (display-referred) IPTV and broadcast standard Practical Implementation On-Set Considerations : Cameras acquiring Rec.2020 natively Wide-gamut LUT for monitoring Color reference charts in Rec.2020 Color-managed workflow essential Post-Production Considerations : Rec.2020 grading platform capability Color-grading monitor calibration Proper LUT management HDR metadata generation Metadata and Tagging Color Space Signaling : H.265 encodes Rec.2020 in VUI Container metadata specifies color space Critical for proper playback Archive documentation essential HDR Metadata : MaxCLL/MaxFALL for peak brightness Tone mapping curve for SDR downconversion Transfer function specification Content light level information Archive and Preservation Rec.2020 as Archive Standard : Future-proof color gamut Supports both SDR and HDR Compatible with emerging displays Long-term color accuracy preservation Master Creation : Create Rec.2020 native master Preserve full color information Generate Rec.709 deliverable Document HDR/SDR options Future of Rec.2020 Rec.2020 will remain standard for: UHD and 4K content HDR production and delivery Professional mastering Long-term archive preservation Newer standards (Rec.2100) extend Rec.2020 with HDR integration, but Rec.2020 as color gamut remains central to modern color management.