

High Dynamic Range Photography & **Imaging standards**

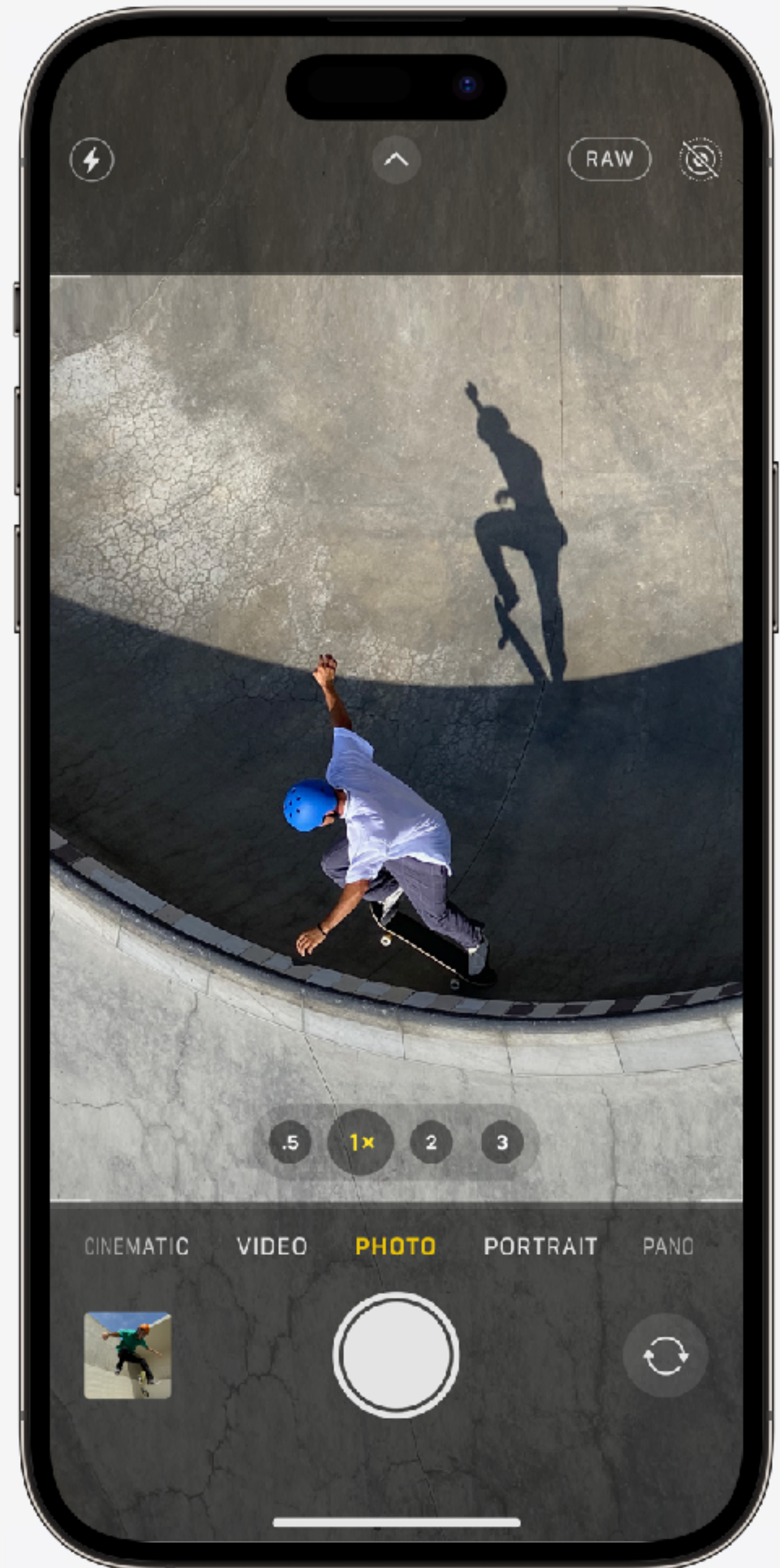
Nicolas Bonnier, ICC Color Symposium, November 3, 2025

Why is HDR important

HDR images look beautiful on HDR displays

“Real” HDR images better represent the large range of light intensity in the scene

- More and more smartphones are HDR capture devices - trillions HDR images are captured on billions of iPhones by Apple users
- Displays are rapidly transitioning to HDR technologies



SDR vs HDR displays

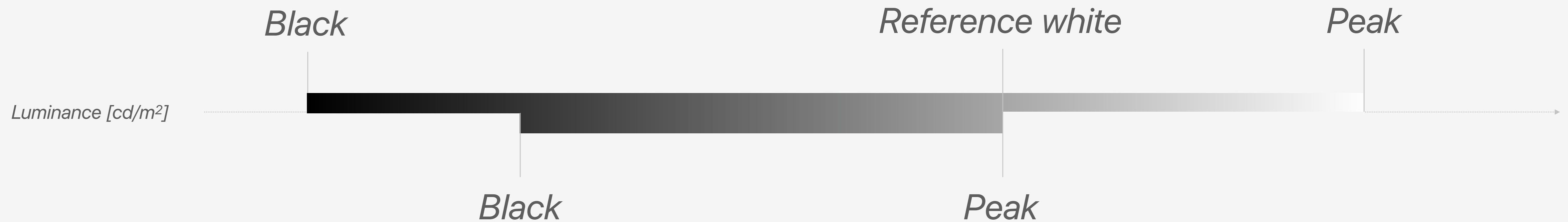
HDR displays offer a significantly greater dynamic range



HDR images use the dynamic range of modern displays

HDR displays offer a greater dynamic range for HDR content

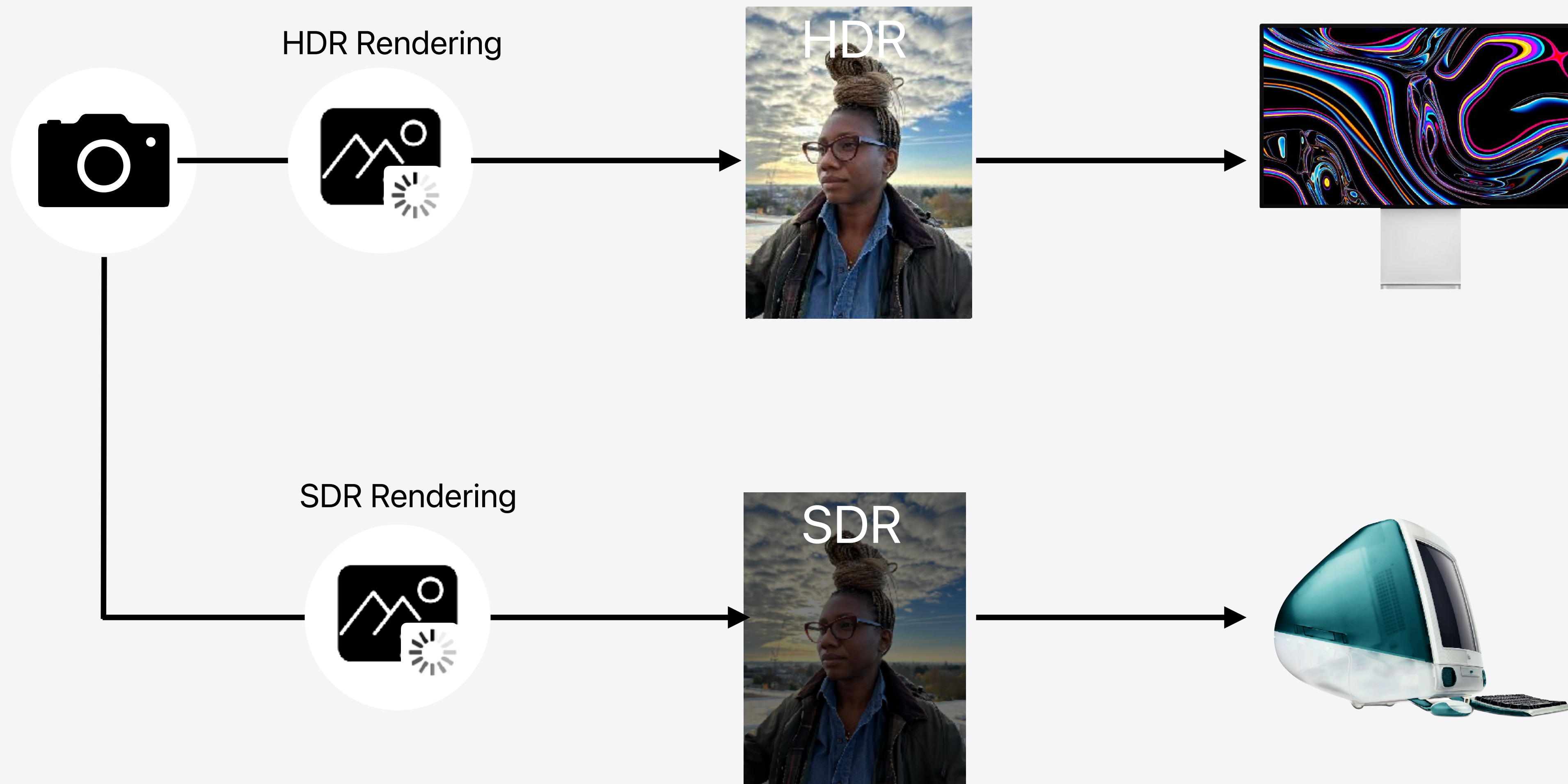
HDR



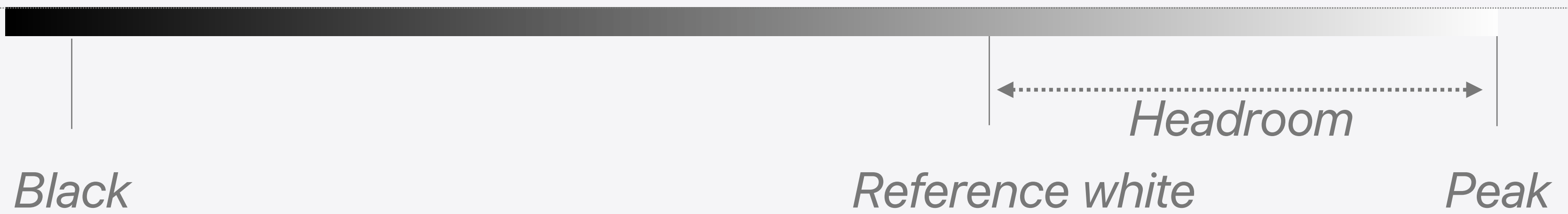
SDR

Creating HDR content

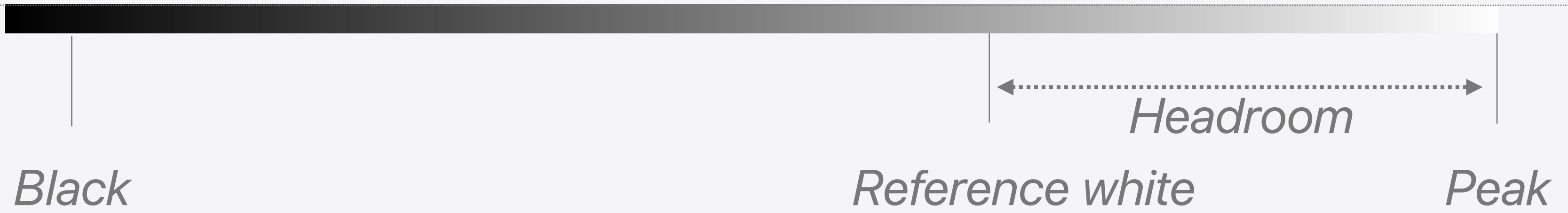
From the same RAW capture, an SDR and/or an HDR image can be generated



SDR



HDR



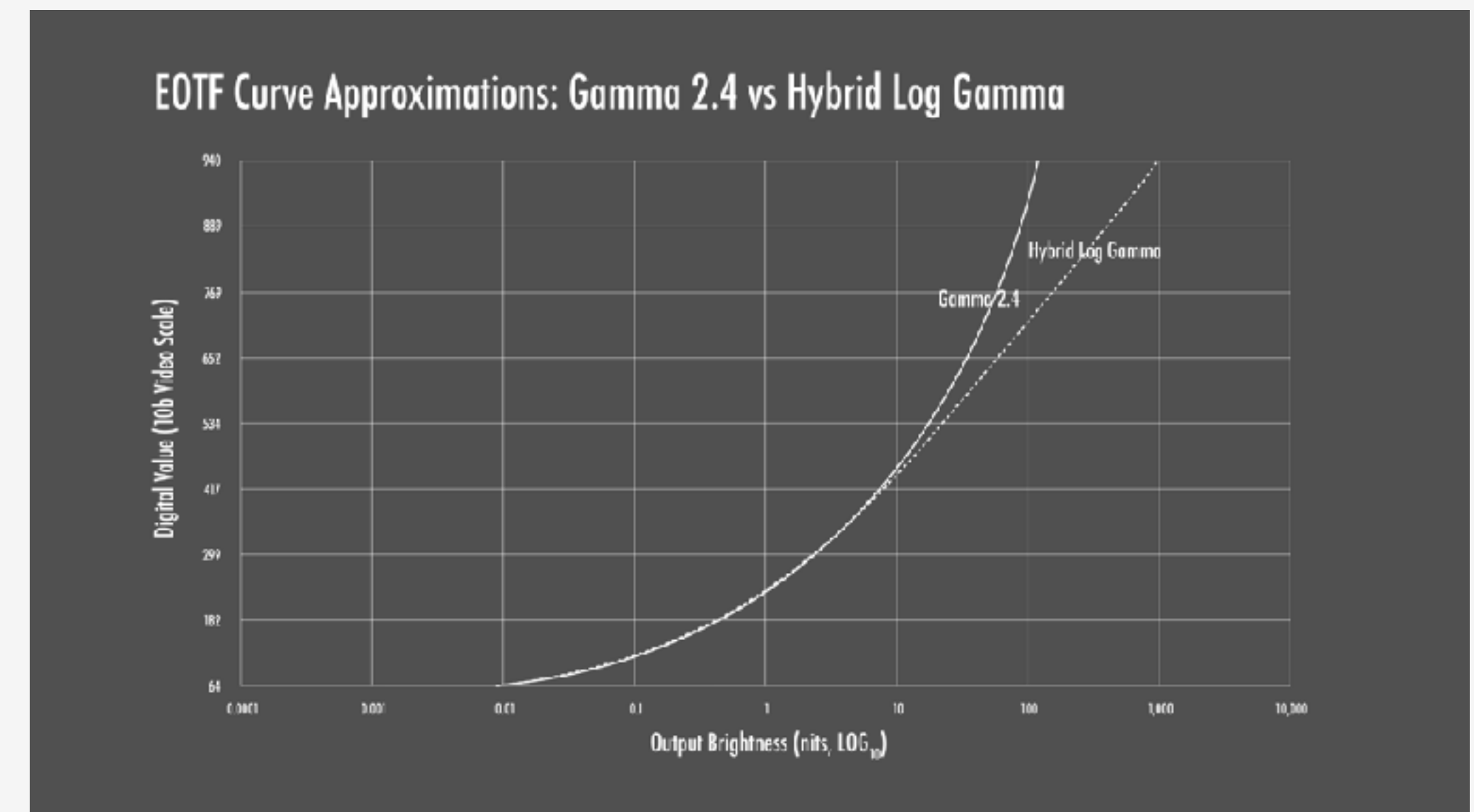
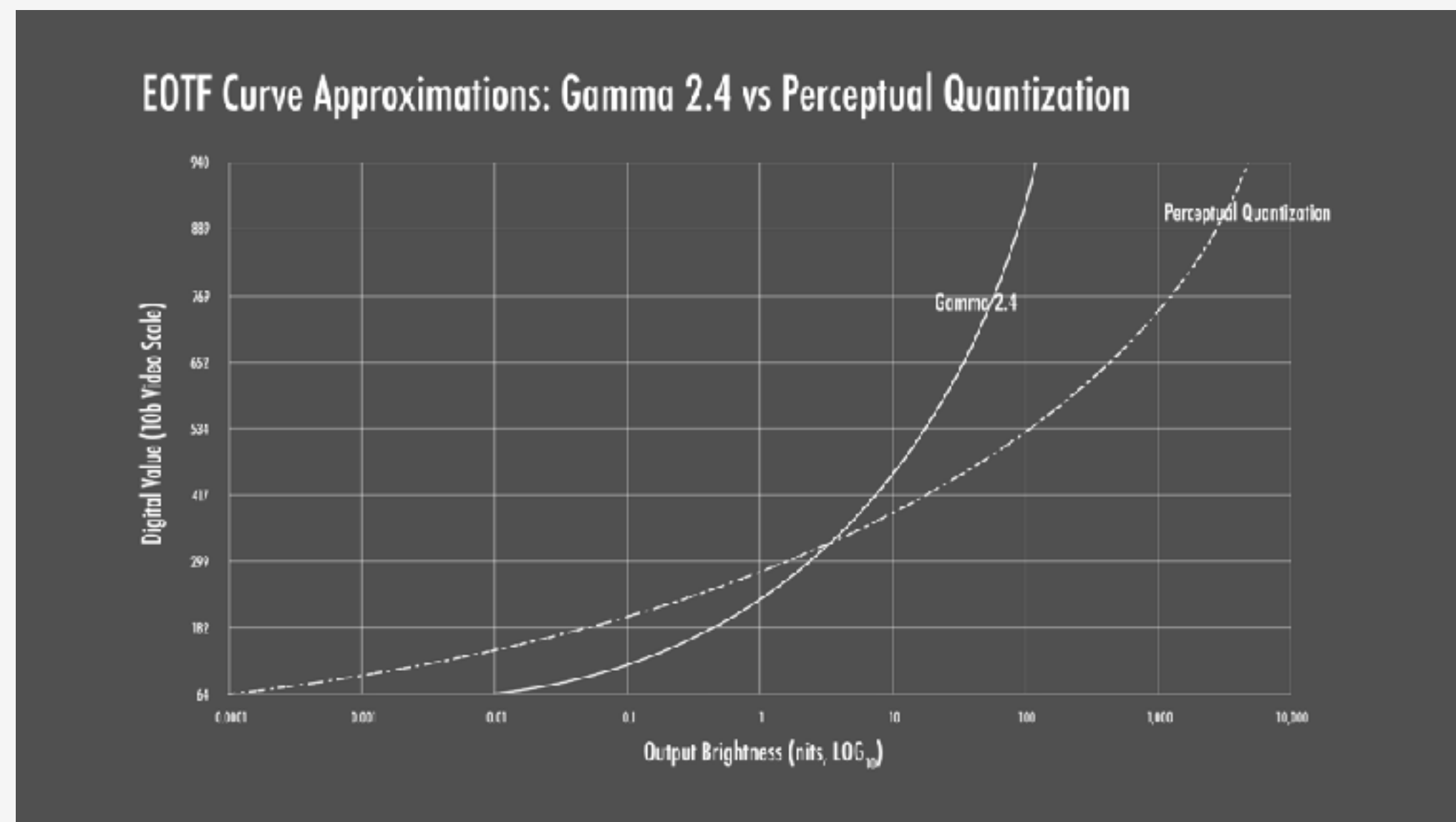
ITU-R HDR Electro-Optical Transfer Curves

Two EOTF curves have been standardized in ITU-R BT.2100-2.

Better suited for encoding HDR data than gamma curves, both are widely adopted by video HDR/WCG ecosystems

- Hybrid-Log Gamma (HLG), specified as a scene light signal encoding
- Perceptual Quantizer (PQ), specified as an absolute colorimetric display-referred encoding

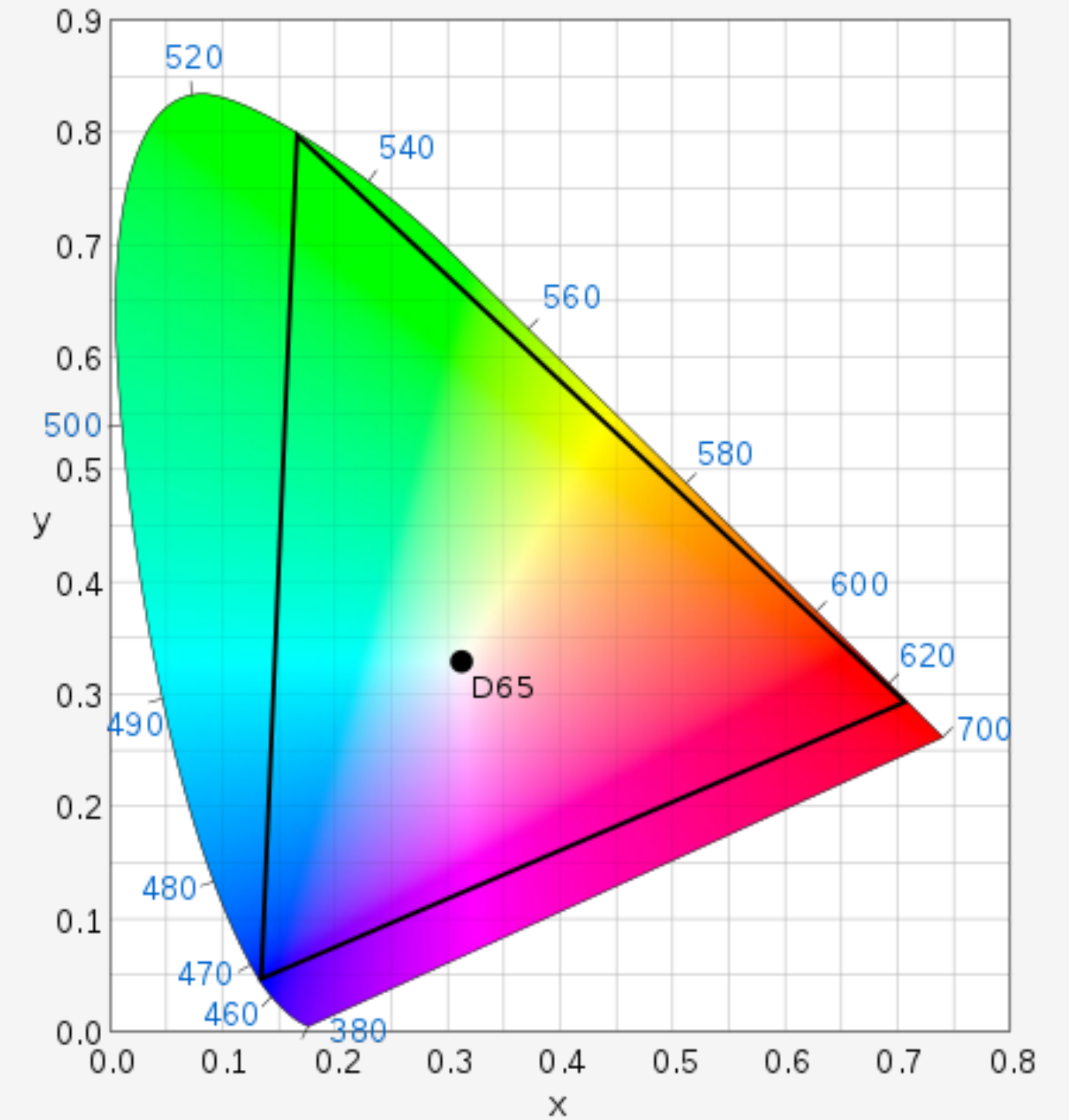
Wide color gamut was specified in ITU-R BT.2020-2



ITU Wide Color Gamut

ITU-R BT.2020-2

- A wide color gamut was specified in ITU-R BT.2020-2
- Wider than current displays
- Better suited for data archiving and exchange



Color space	White point		Primaries					
	x_W	y_W	x_R	y_R	x_G	y_G	x_B	y_B
ITU-R BT.2020	0.3127	0.3290	0.708	0.292	0.17	0.797	0.131	0.046

https://en.wikipedia.org/wiki/Rec._2020

Building a new HDR standard for still images

Project initiated in the Fall of 2019

The goal is to define the color encodings, the mandatory and optional metadata, and the reference viewing conditions for HDR/WCG images

Based on ITU-R BT.2100-2

This foundational standard will be leveraged in the specification of HDR file formats

It will help establish an open HDR/WCG ecosystem, to take better advantage of HDR cameras and displays

ISO HDR TS 22028-5

The first standard for HDR photography



10bit, PQ/HLG, BT.2020

HDR reference display

HDR metadata

Adopted by:

- HEIF
- AVIF
- PNG
- JPEG XL

A screenshot of the ISO website showing the details for ISO/TS 22028-5:2023. The page features a navigation bar with 'Standards', 'Sectors', 'About ISO', 'News', 'Taking part', and 'Store' links, along with a search bar. The main content area displays the standard's title, a thumbnail of the cover page, and a 'Read sample' button. The title is 'ISO/TS 22028-5:2023' and the subtitle is 'Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange'. Below this, it specifies 'Part 5: High dynamic range and wide colour gamut encoding for still images (HDR/WCG)'. The status is 'Published (Edition 1, 2023)'. At the bottom, there are sections for 'Abstract' and 'General information'. The abstract states: 'This document defines a set of colour image encodings for use in storage, transmission, and display of high dynamic range and wide colour gamut (HDR/WCG) digital still images. It defines the colour encodings, the mandatory and optional metadata, and the reference viewing conditions for HDR/WCG images.' The general information section includes: 'Status : Published', 'Publication date : 2023-06', 'Stage : International Standard to be revised [90.92]', 'Edition : 1', and 'Number of pages : 21'.

ISO HDR TS 22028-5

Reference display and viewing environment



Reference display

Parameter	Values
Default nominal peak luminance	1 000 cd/m ²
Default black point	0.0005 cd/m ²
Reference white luminance	203 cd/m ²
Default reference color volume	ITU-R BT.2020-2 RGB

Reference viewing environment

Parameter	Values
Colour temperature of surround and periphery	Neutral grey at D65
Luminance of surround	5 cd/m ²
Luminance of periphery	≤ 5 cd/m ²
Spatial distribution of ambient lighting	No direct specular light sources shall be incident upon the eyes of the observer or the display.

ISO HDR



sRGB

ISO HDR TS 22028-5

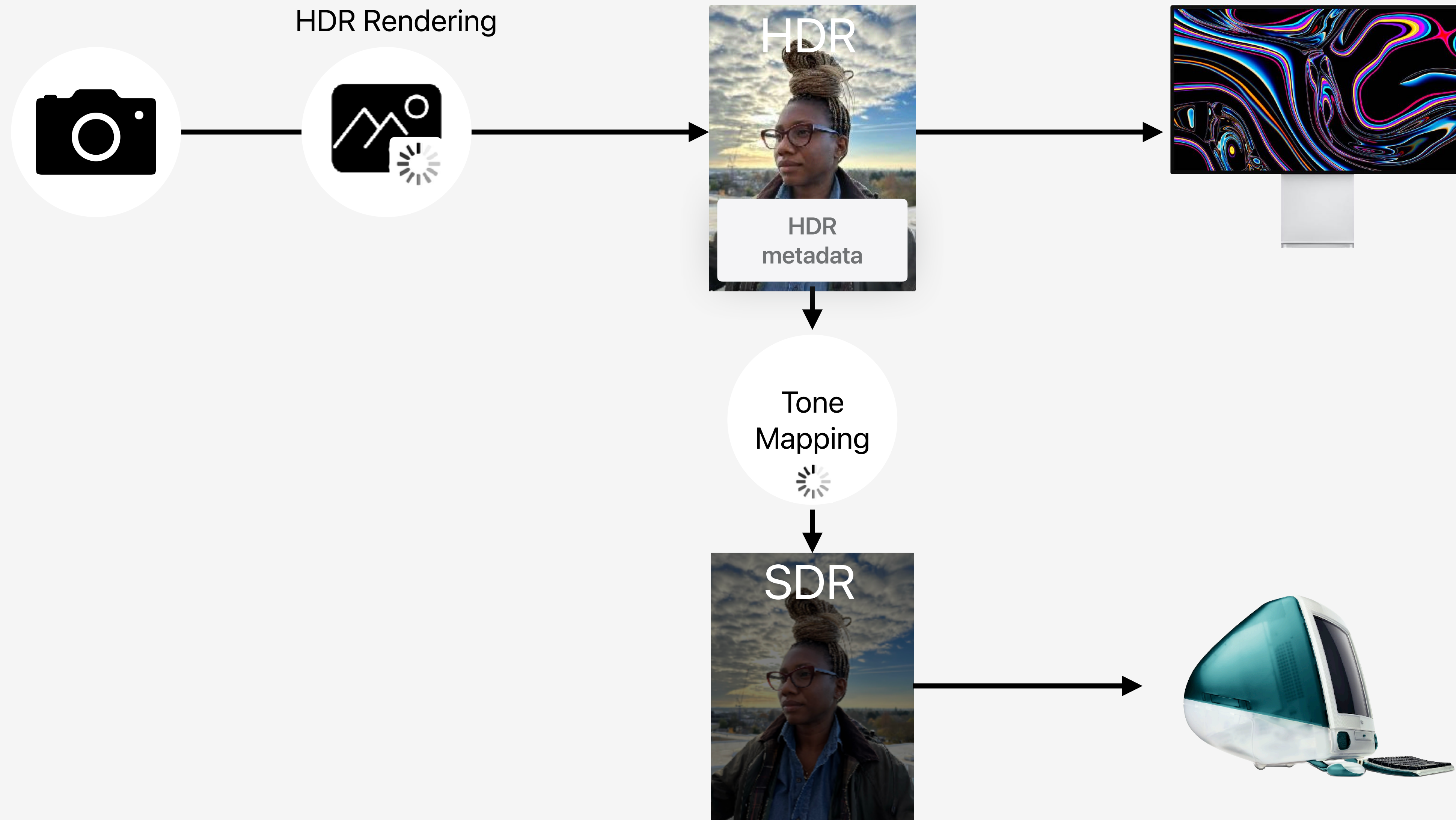
Metadata



Mandatory (Existing standards)	CICP tag or ICC profile with an CICP tag (Coding-independent code points for video signal type identification)
Optional (Existing standards)	<ul style="list-style-type: none">• MDCV (Mastering Display Colour Volume)• CCV (Content Colour Volume)• CLL (Colour Light Level (CLL, 2 values))
Optional - New	<ul style="list-style-type: none">• Scene-referred metadata (In the absence of this metadata, images are considered display viewing)• Reference white luminance metadata• Reference viewing environment

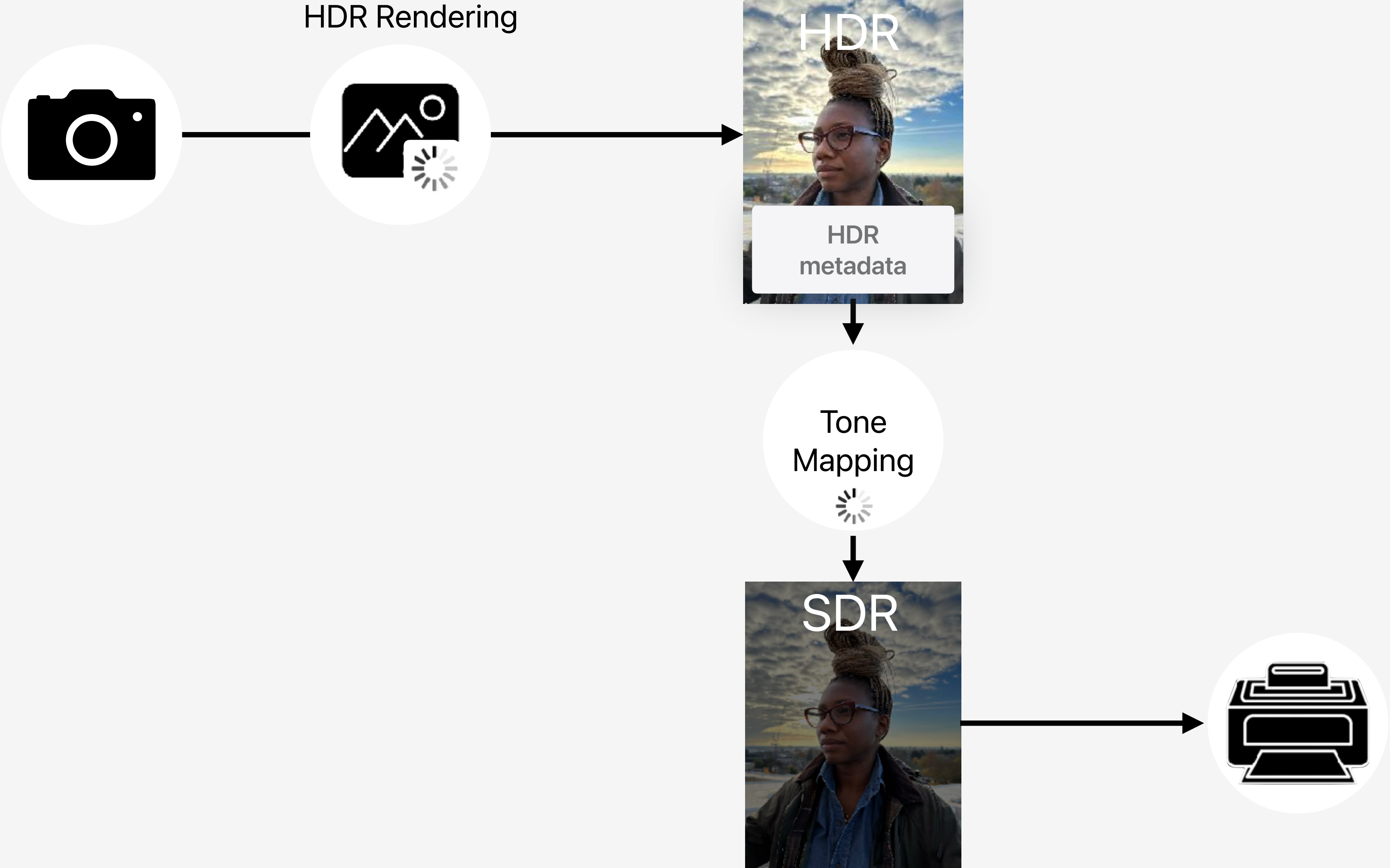
Tone mapping to SDR

ISO HDR files need to be adjusted to SDR when viewed on SDR displays



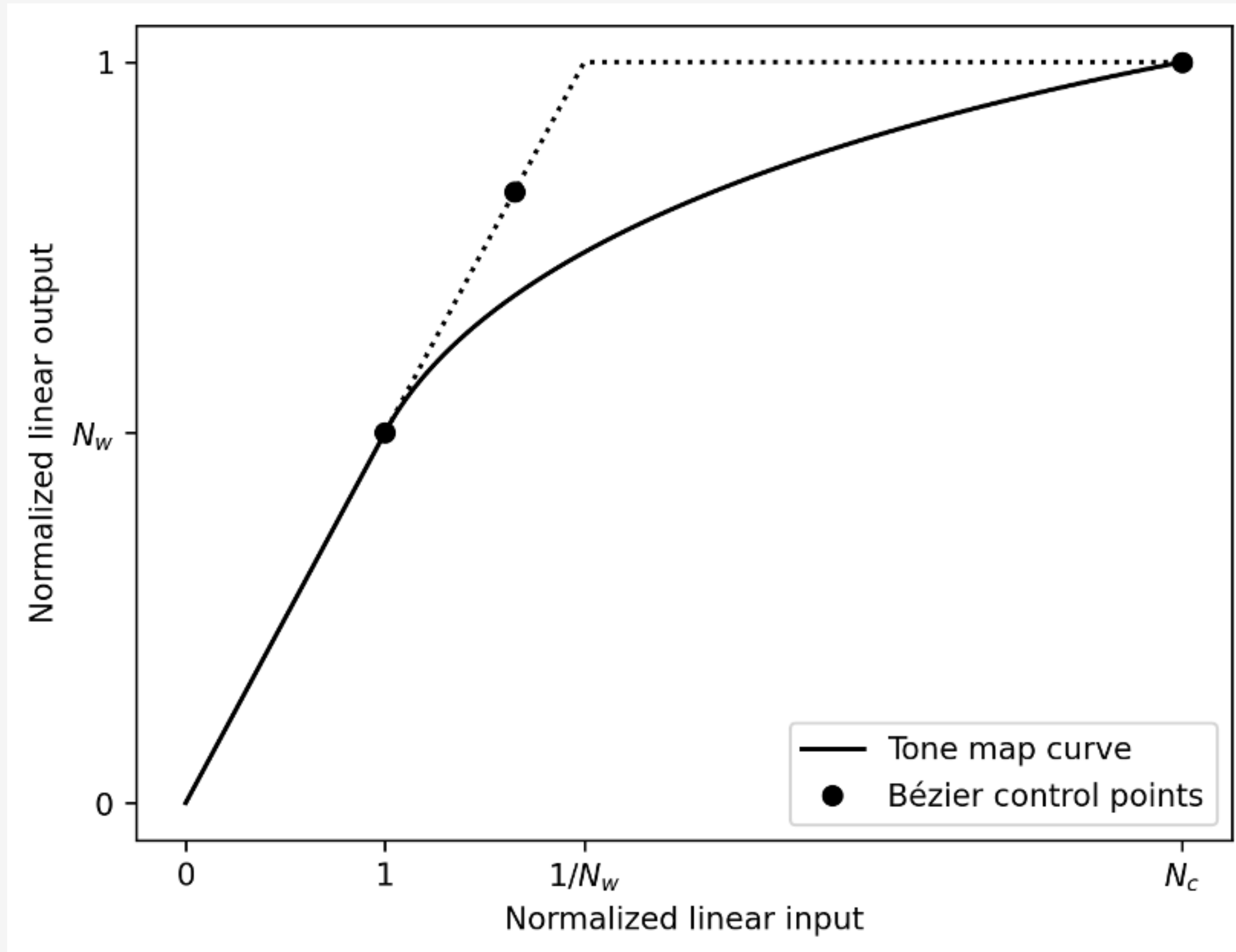
Printing ISO HDR assets

ISO HDR files need to be tone mapped to SDR when printed



Default HDR to SDR Tone Mapping Algorithm

Annex G of upcoming revision of ISO 22028-5



Headroom



starlight

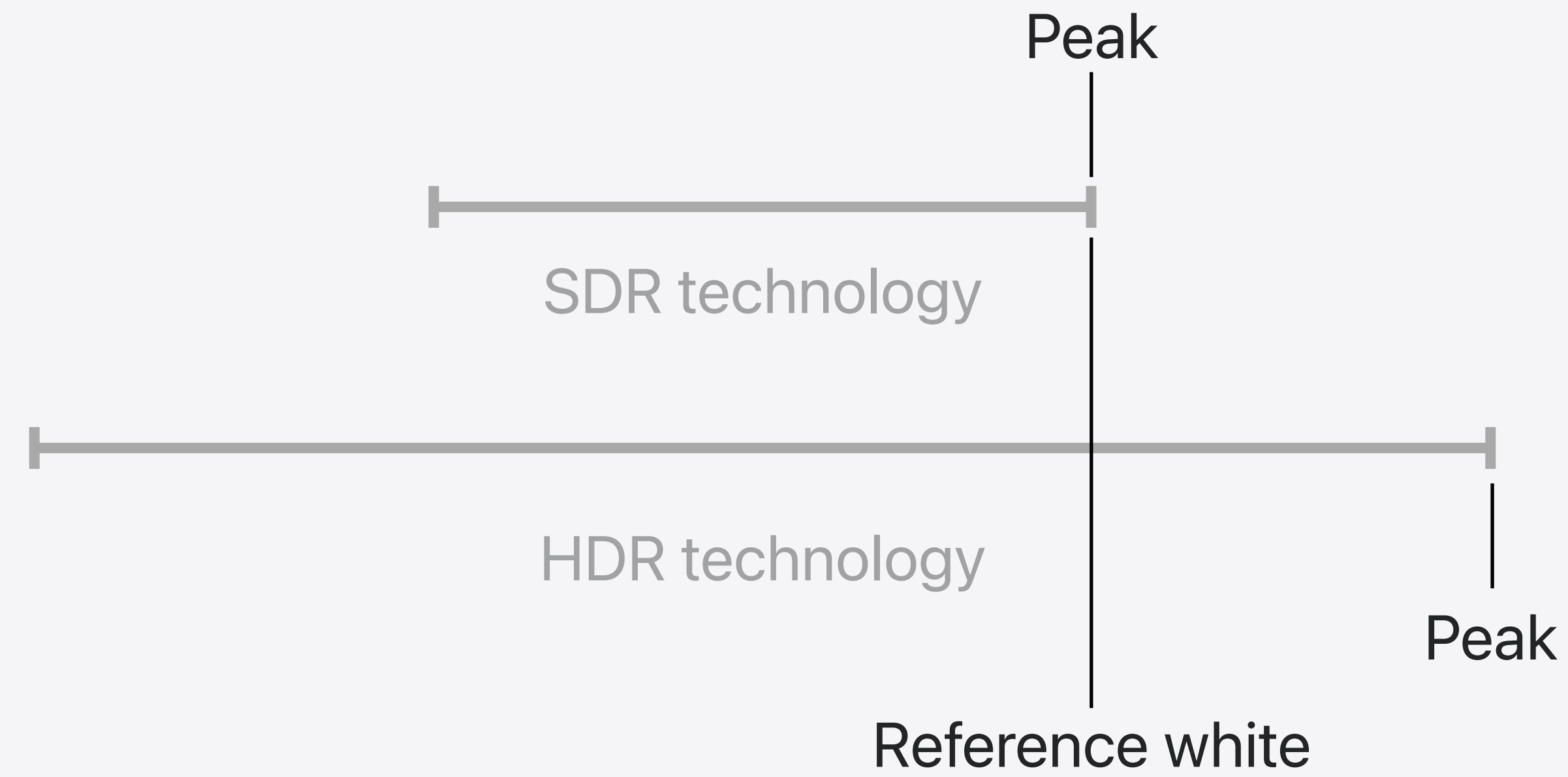
moonlight

sunset

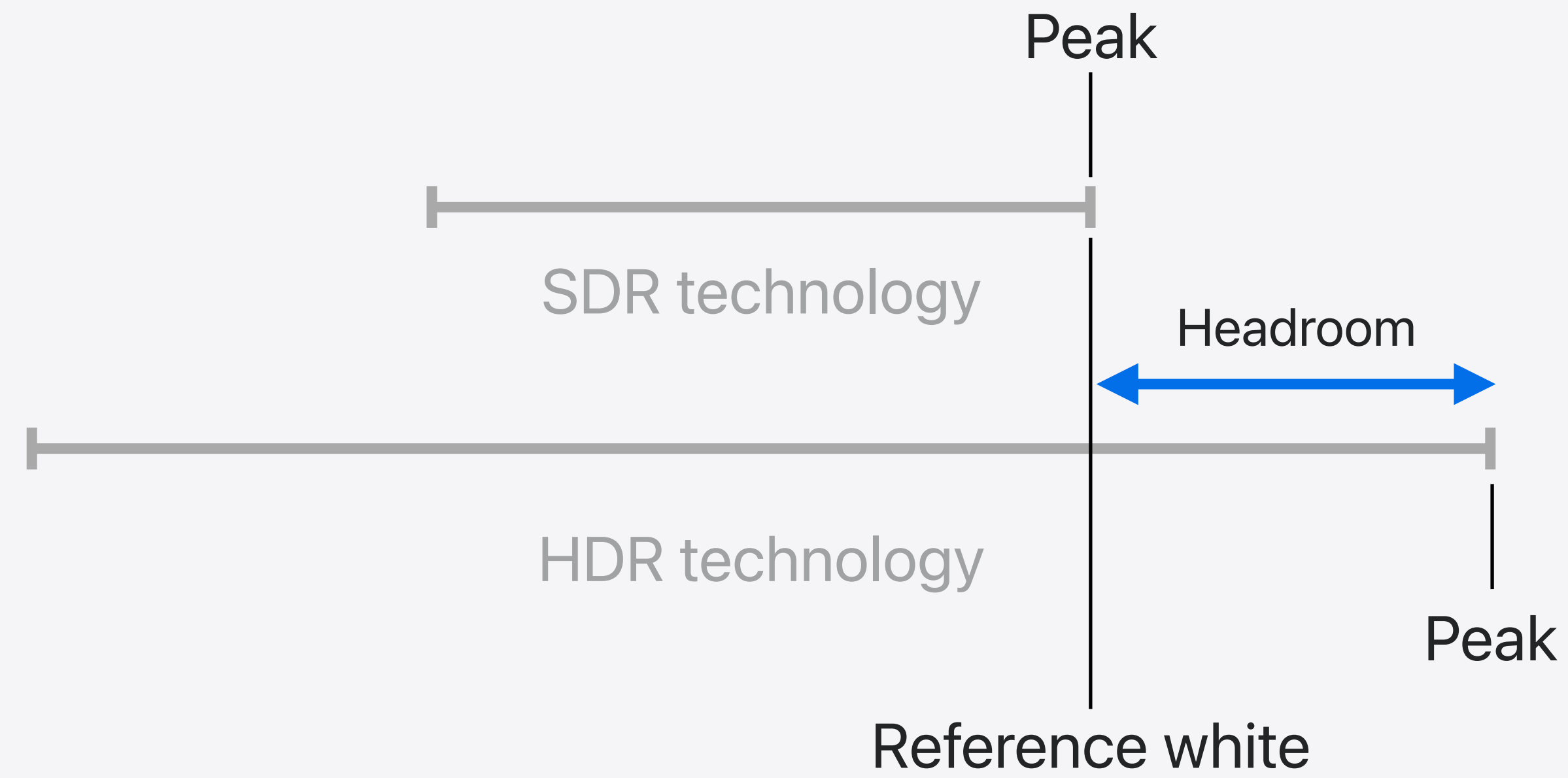
indoor

outdoor

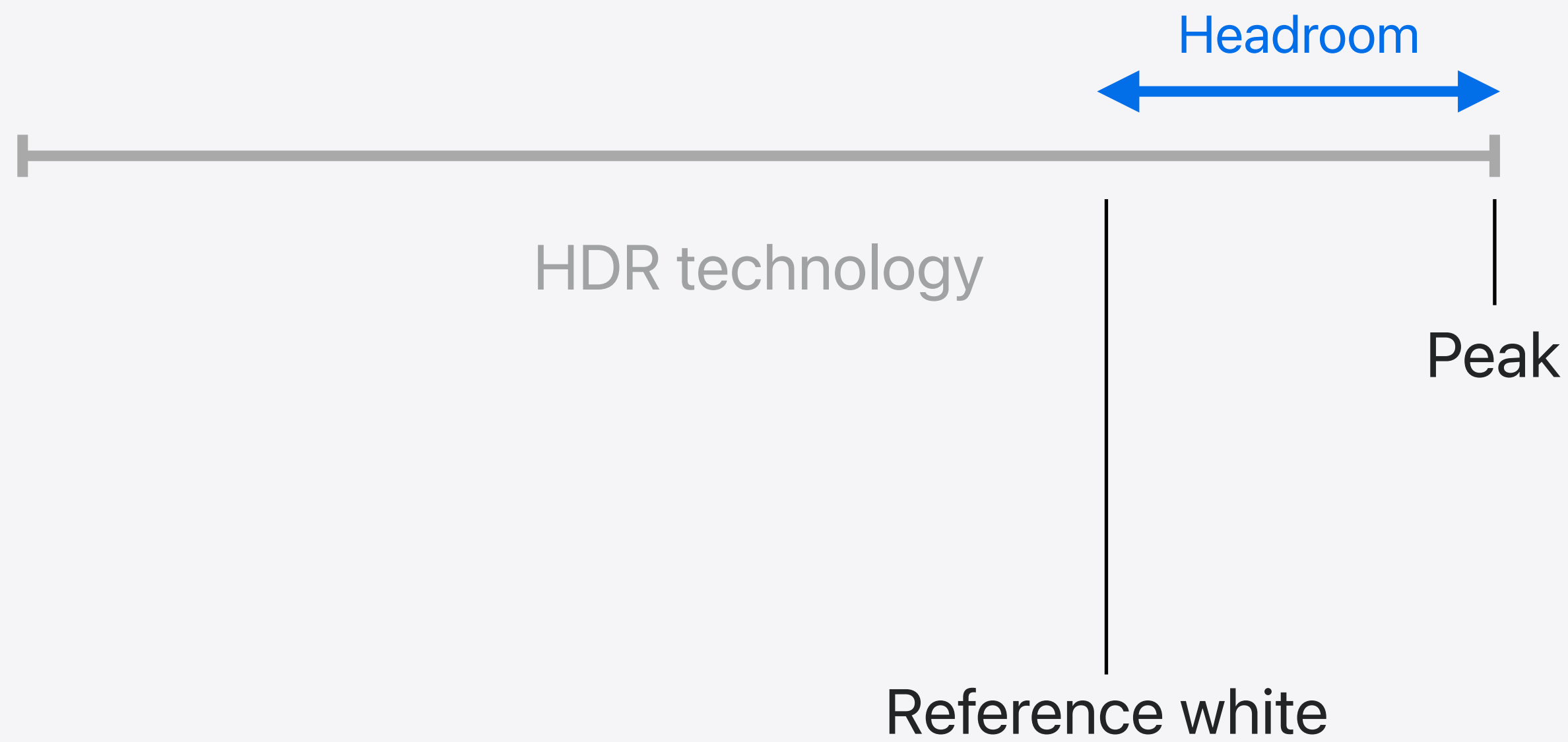
sunlight



Headroom

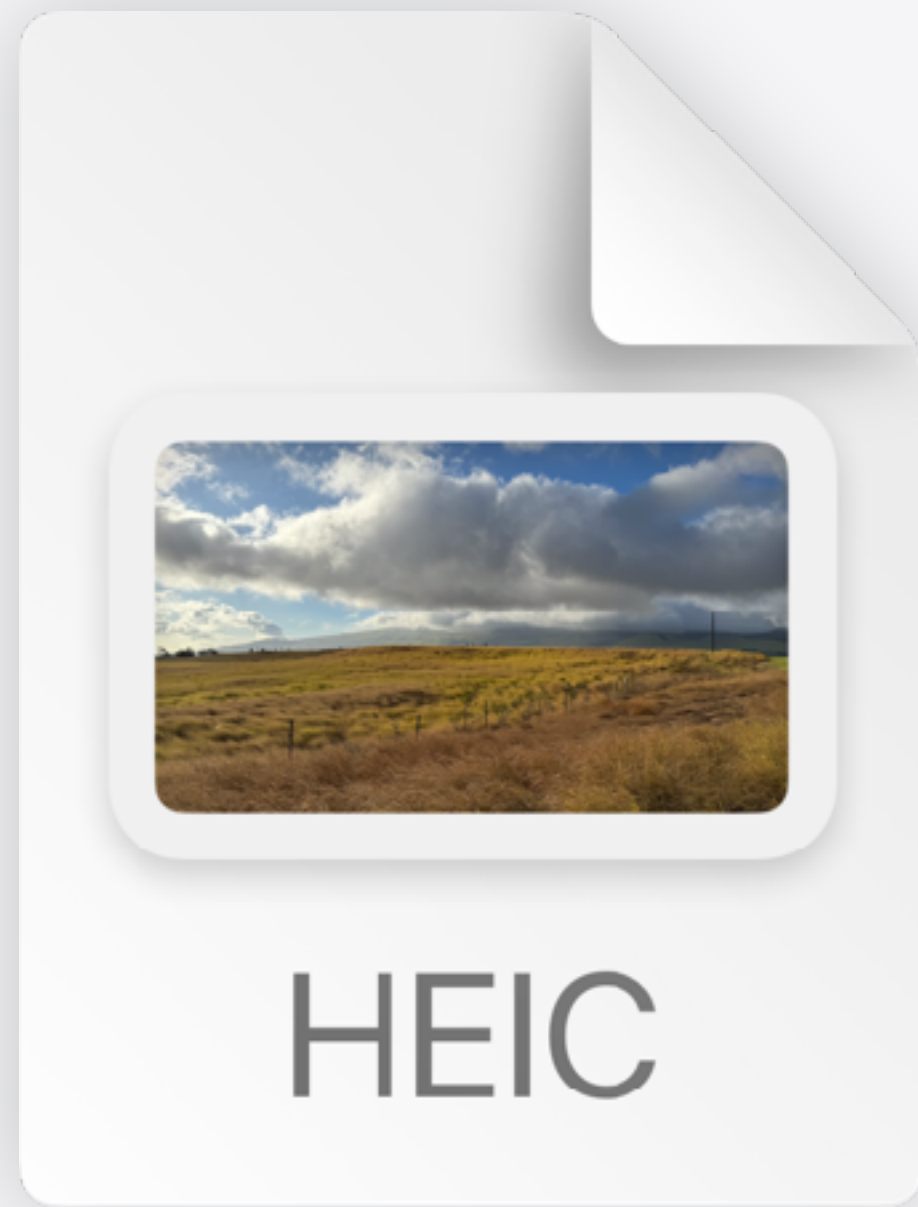


Headroom



$$\text{Headroom} = \log_2 \left(\frac{\text{Peak}}{\text{Reference White}} \right)$$

Headroom



Content headroom

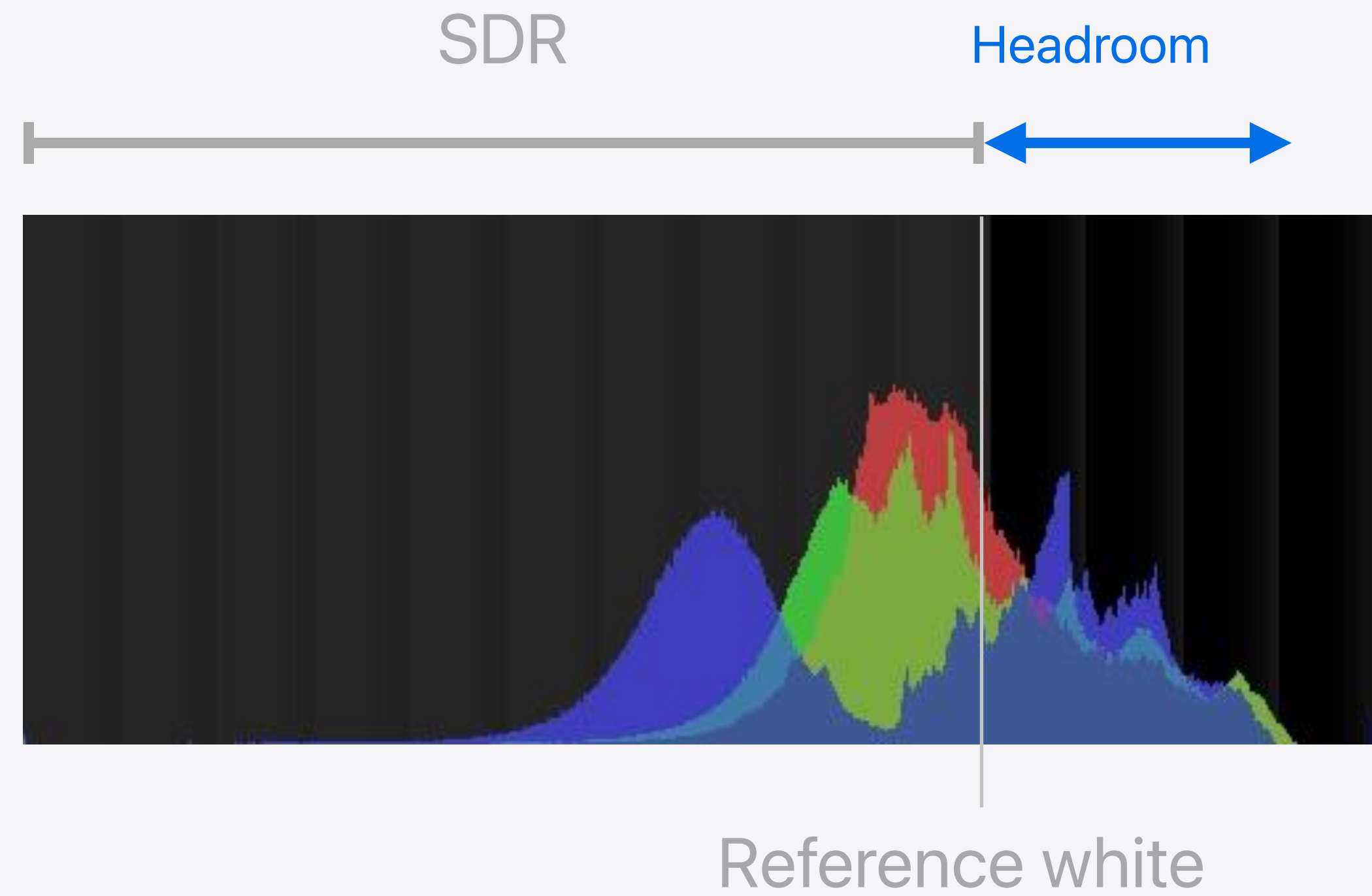


Display headroom

Content headroom

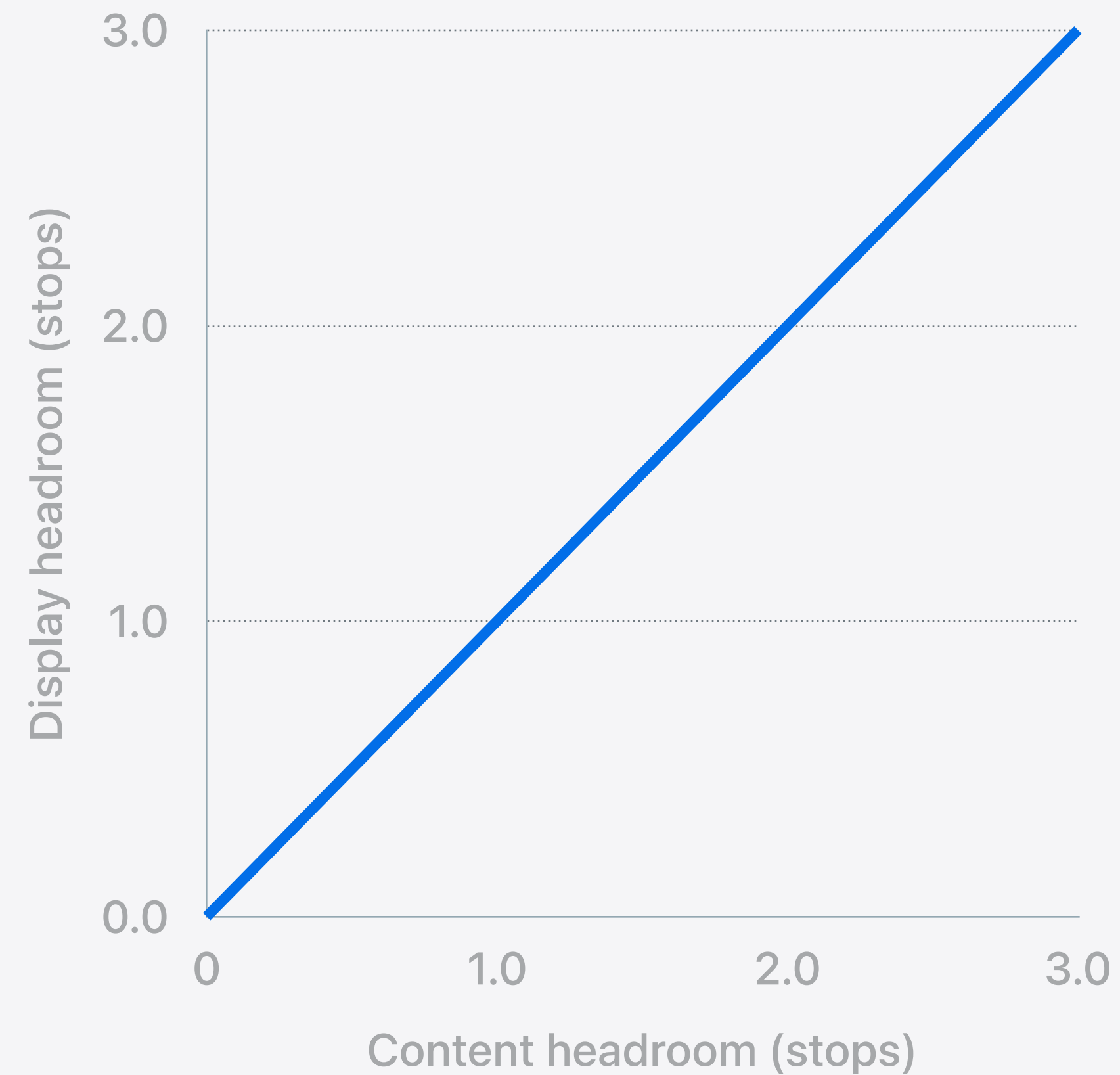


Content headroom



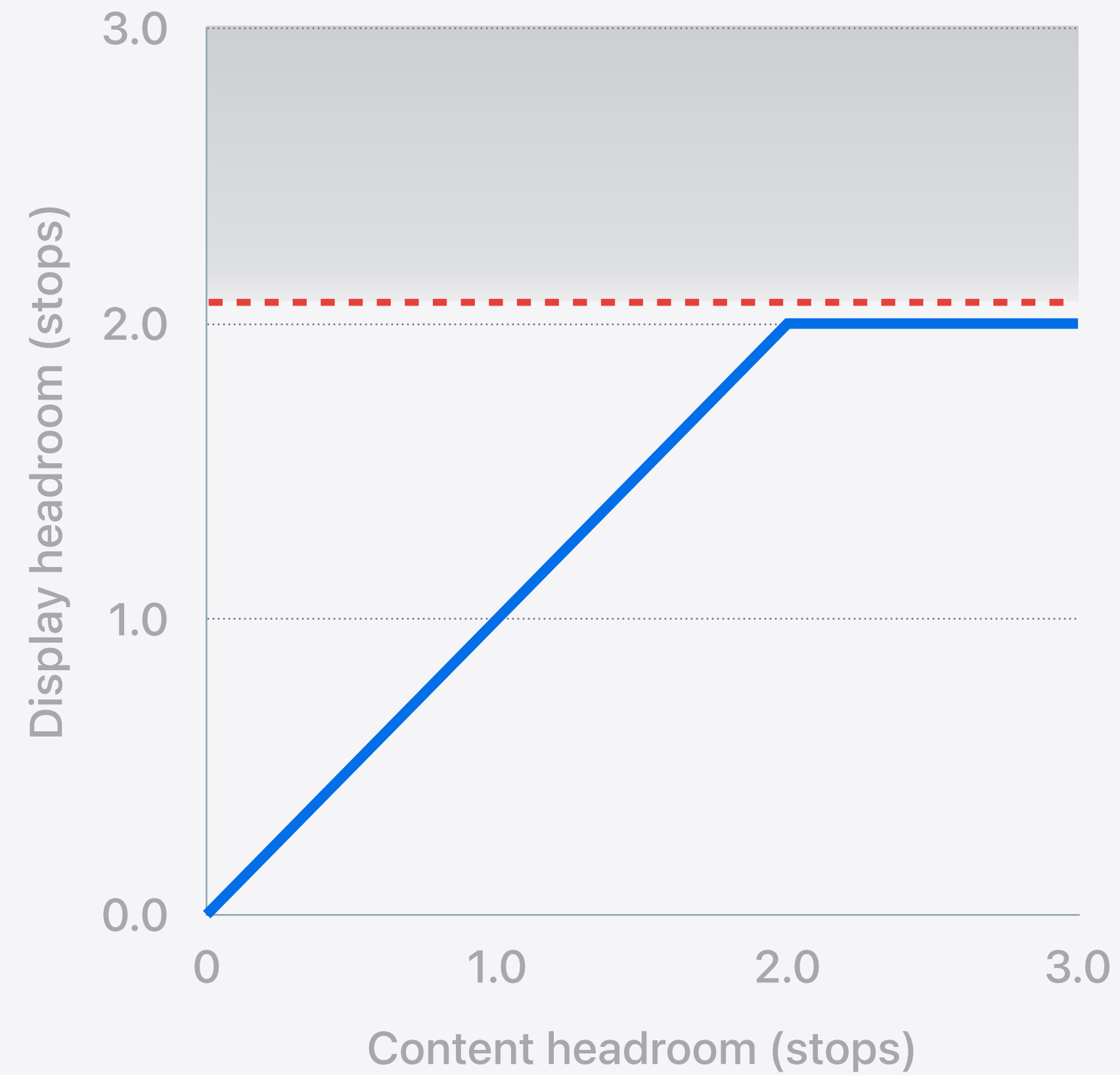
Display headroom

In reference conditions, highlights are reproduced using display headroom



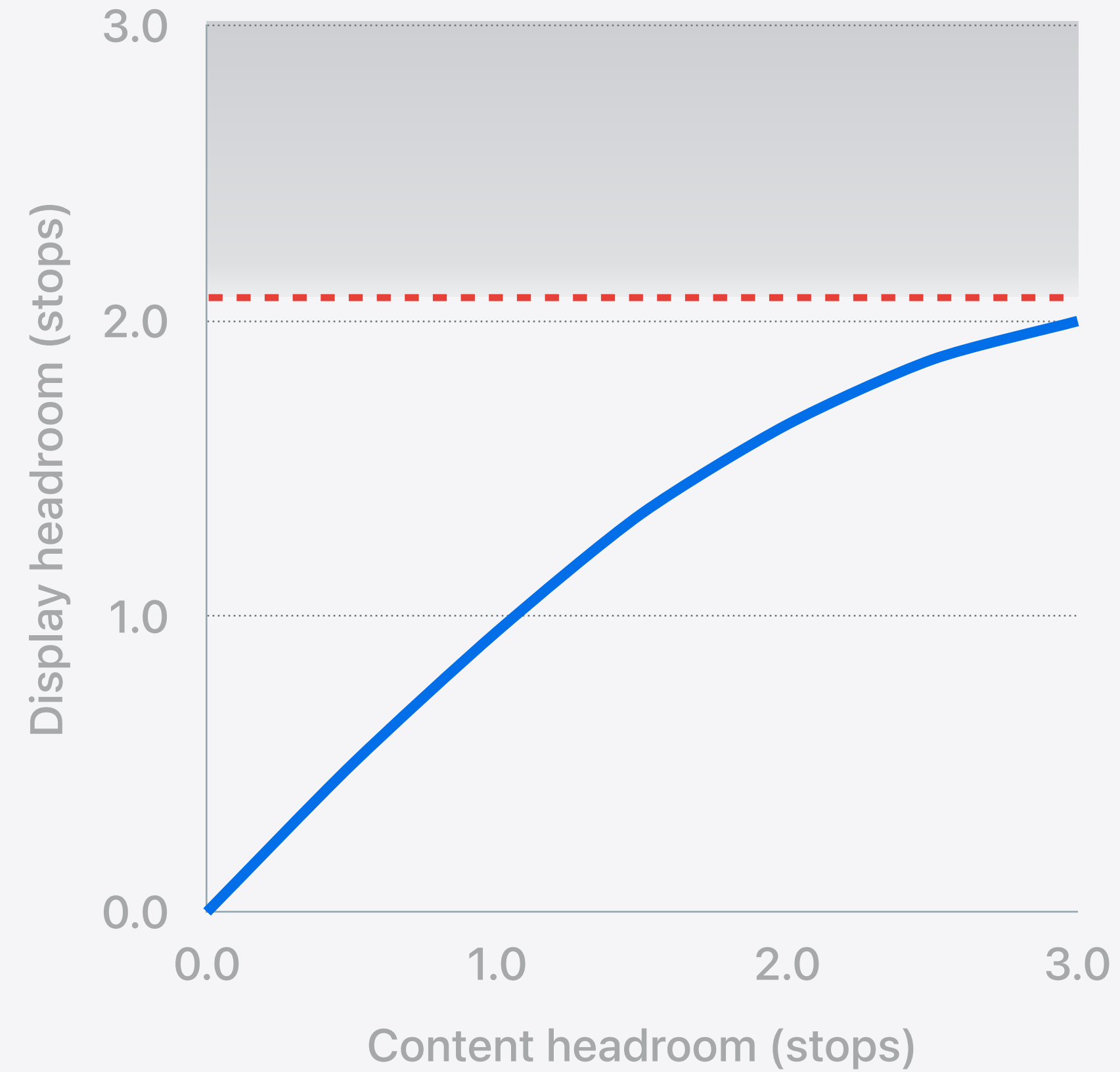
Display headroom

When headroom is limited, clipping might occur



Display headroom

When headroom is limited, headroom management preserves image quality



Gain map concept



Gain map

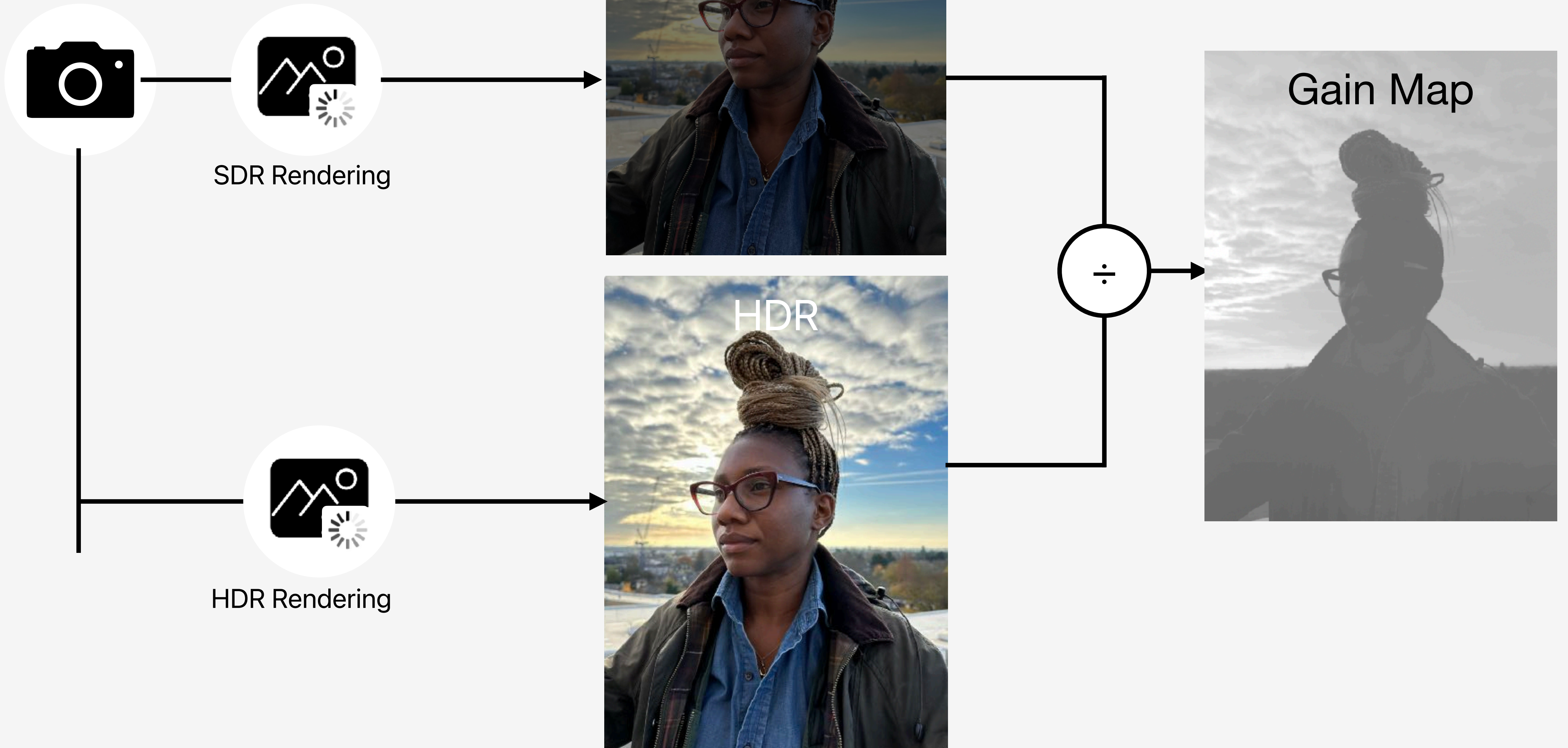
Gain map metadata

The central part of the diagram illustrates the gain map concept. It features a grayscale version of the scene from the SDR image, labeled "Gain map". Below it is a white box containing the text "Gain map metadata". A right-pointing arrow connects this central block to the HDR image on the right.



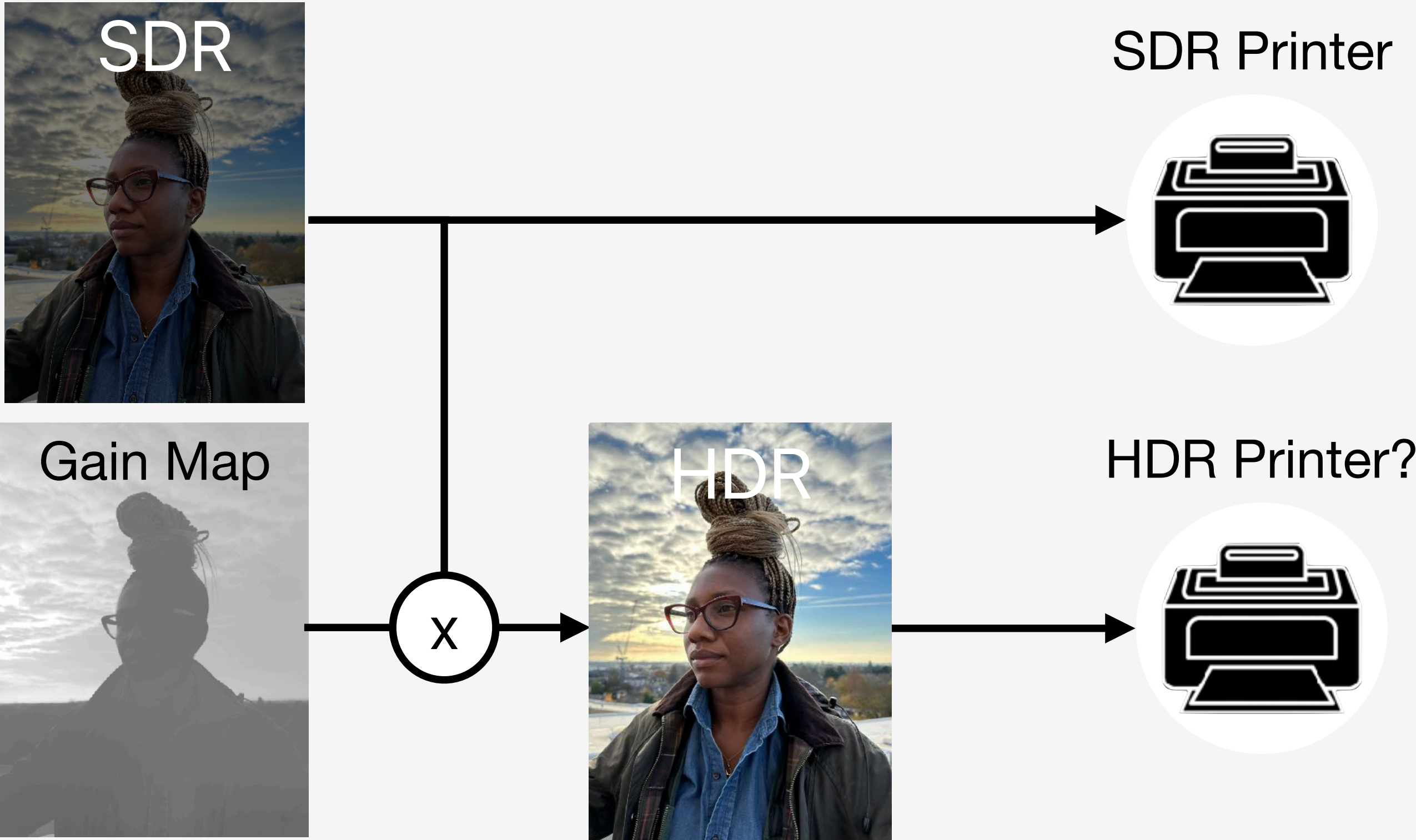
Adaptive HDR

Computing the gain map



Printing HDR photos

Most printers are SDR, HDR printing getting investigated



ISO HDR Gain Map

ISO 21496-1 – Digital Photography -- Gain map metadata for image conversion
-- Part 1: Dynamic Range Conversion



Scope

- Defines a gain map used in HDR digital photography applications, for dynamic range conversion between two image representations.

Purpose and justification

- Ensure that there is no image quality regression when displaying an HDR image on standard dynamic range (SDR) displays.
- Creating a standardized solution that includes storing in the same file a baseline image and a gain map, to convert between HDR and SDR representation.

ISO HDR Gain Map

ISO 21496-1 – Digital Photography -- Gain map metadata for image conversion



The screenshot shows the ISO website interface for the product ISO 21496-1:2025. The navigation bar includes links for Standards, Sectors, About ISO, Insights & news, Taking part, and Store, along with a search bar and a shopping cart icon. The main content area features a product card with a thumbnail image of the standard cover, the title 'ISO 21496-1:2025 Digital photography — Gain map metadata for image conversion Part 1: Dynamic range conversion', and a 'Read sample' button. To the right of the product card is a price tag for CHF 98, a language dropdown menu set to English, and radio buttons for 'PDF + ePub' (selected) and 'Paper'. Below the price tag is an 'Add to cart' button and a link to convert Swiss francs (CHF) to the user's currency. The 'Abstract' section describes the document's purpose in defining gain maps for HDR digital photography. The 'General information' section lists the status as Published, the publication date as 2025-07, the stage as International Standard published [60.60], the edition as 1, and the number of pages as 16. It also identifies the technical committee as ISO/TC 42 and the ICS number as 37.040.99.

Industry adoption

Snapshot of current status

Most majors players in the digital camera industry and in the smartphone industry are involved in the ISO HDR WG

Adoption

- Canon, Sony and Nikon introduced ISO HDR encoding in recent flagship DSRLs and mirrorless cameras
- Hasselblad introduced ISO Gain Maps encoding in recent flagship
- Apple supports
 - ISO HDR in macOS and iOS since 2023
 - Adaptive Gain Maps and Adaptive Gain curves since 2024, in iOS 18 and macOS 15
- Google
 - Supports ISO HDR in Android and Chrome
 - Introduced Ultra HDR, storing gain-map in jpeg files, in Android and Chrome
 - More recently, ISO Gain Maps supported in Android and Chrome
- Adobe support HDR stills in flagship editing software
- Meta's social media and messaging Apps support HDR stills