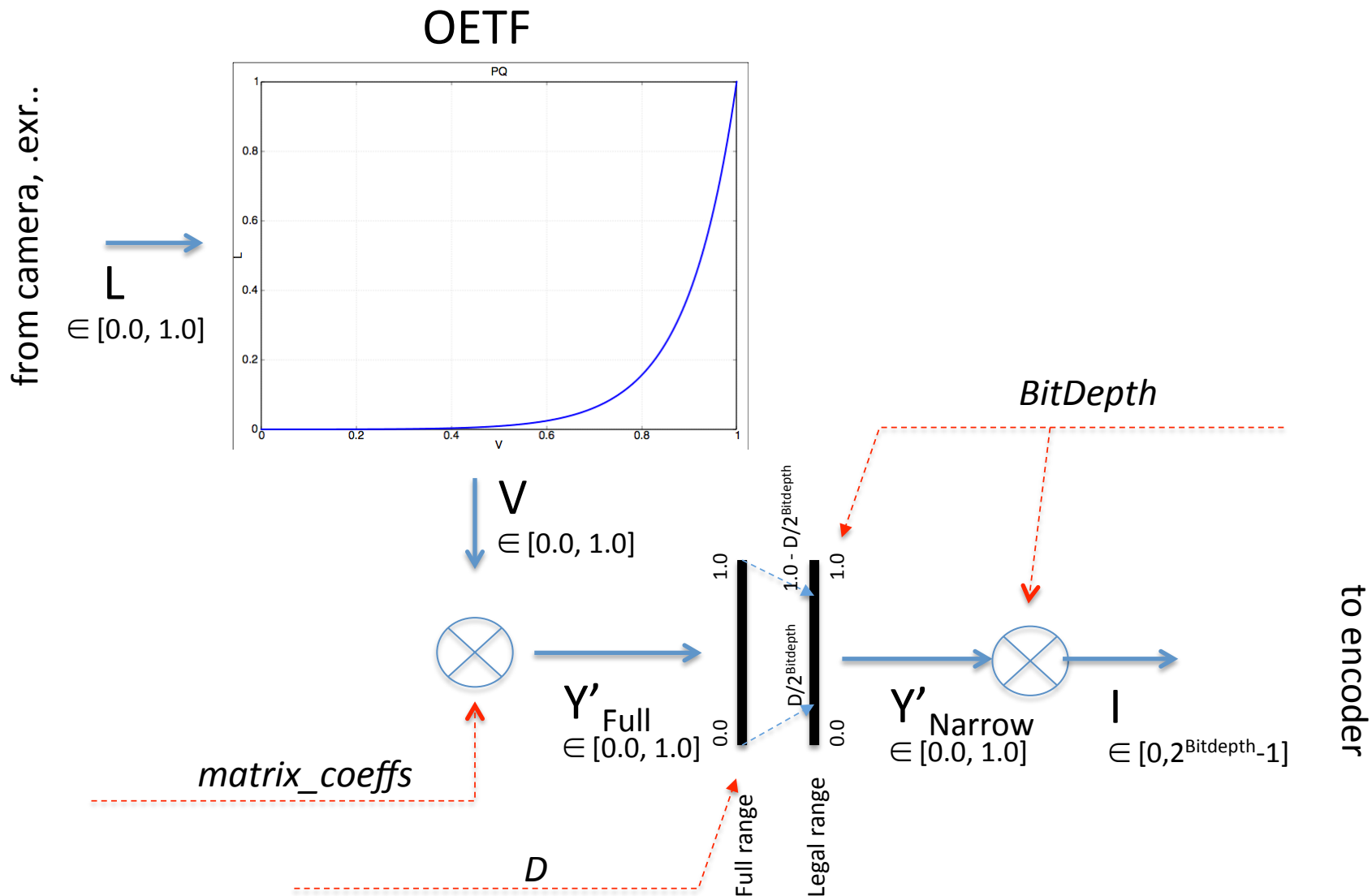


VUI proposal
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Mapping real signal to integer code level



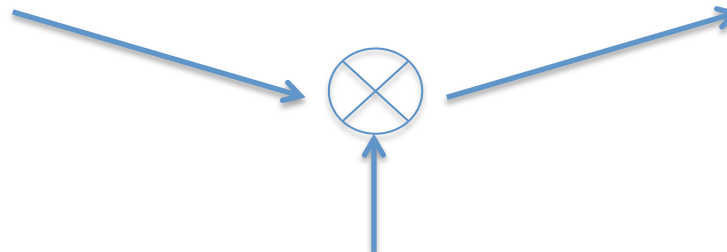
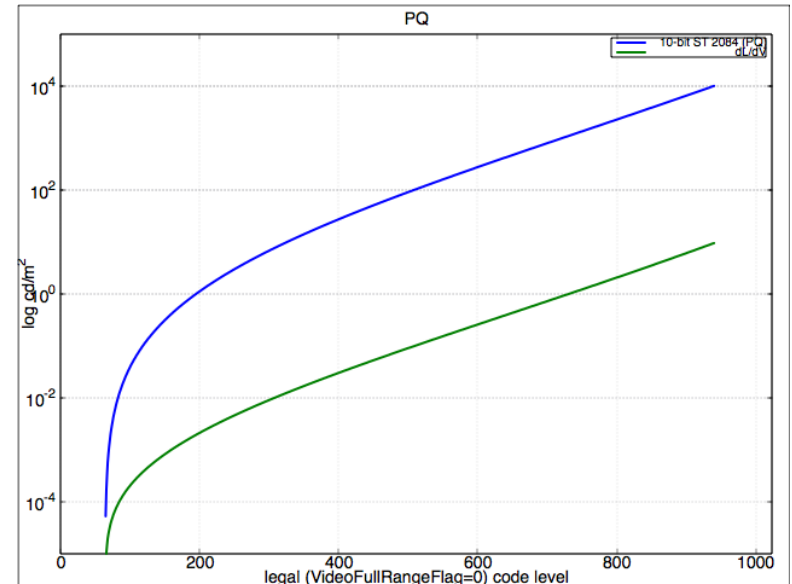
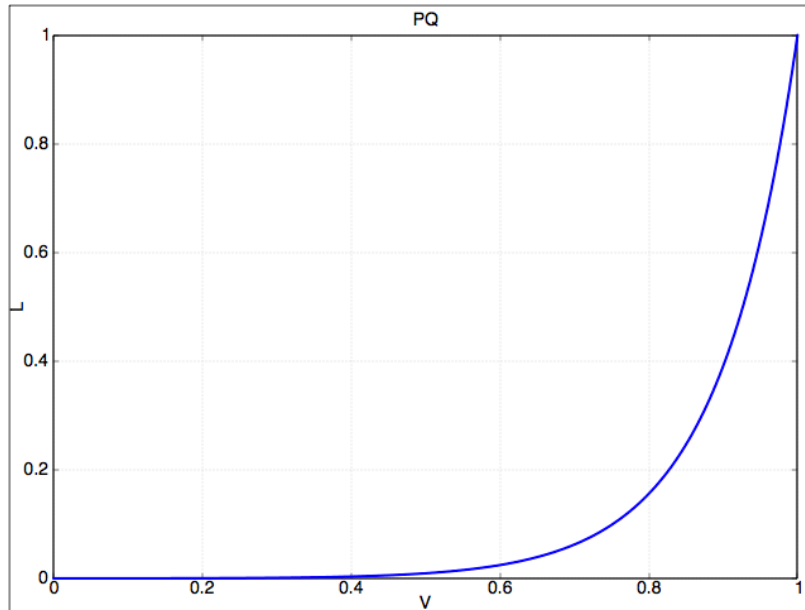
What VUI provides

- A precise map between sample code levels (in the range $[0, 2^{\text{BitDepth}} - 1]$) and display intensities (candela/m²) in the primaries domain of the coded video signal.
- The map consists of: BitDepth (in SPS), video range (full or legal), matrix_coeffs (to convert video samples to primaries), and primaries (wavelength of light).
- Also: chroma sample phase (_loc), conformance window, bar metadata (DVB)...
- VUI is static metadata: its values do not change; constants specified by service (DVB, BD, ATSC, ..)

Problem 1: intensity

- Many transfer functions referenced by VUI do not state the intensities assumed.
- Bt.1886 many years after Bt.709 finally stated intensity to be 100 nits (Lw) by example.
- CEA defines traditional gamma as 100 nits at unity.
- The intensity assumed by the authoring process should be conveyed to the decoder and passed on downstream to display post-processing. Necessary for tone mapping and hue correction (which is a function of intensity).

transfer function to intensity map



Luminance at unity

Intensity solutions

1. Update Annex E (VUI) Table E-4 to specify intensities for all transfer functions.
 - Problem: not all are known, and some are variables such as gamma or some of the log transfer functions listed in Table E-4.
2. Add a variable to specify intensity
 - Problem: VUI cannot be updated; need SEI
3. Define new SEI
 - State intensity at unity (and zero)
 - Unity = peak unless signaled otherwise.
 - Add: white reference level ?

vui_info: supplemental indicators

vui_info (payloadSize) {	Descriptor
vui_info_luminance_at_unity	u(16)
vui_info_luminance_at_zero	u(16)
vui_info_transfer_function_unity_code_level	u(16)
vui_info_transfer_function_zero_code_level	u(16)
}	

Problem 2: video full range

There is more than one type of full range

vui info range type	
0	$Y = \text{Floor}((219 * D * V + D + 0.5)$ $C = \text{Floor}(D * (224 * V + 128) + 0.5)$
1	$CV = \text{Floor}((2^{\text{BitDepth}} - 1) * V + 0.5)$
2	$\text{Floor}((1015 \div 4) * D * V + D + 0.5)$ [not originally defined for 8-bit in ST 2084]
3	SMPTE RP-2077 protected full range (SMPTE ST 292)
4-255	reserved

N is the nonlinear signal, nominally from zero (0.0) to unity (1.0), sometimes called E' or V
 $D = 2^{\text{BitDepth} - 8}$

SMPTE RP-2077: $CV_P = \text{clamp}(2^{\text{BitDepth}-8}, (2^{\text{BitDepth}} - 2^{\text{BitDepth}-8} - 1), CV_{FULL})$

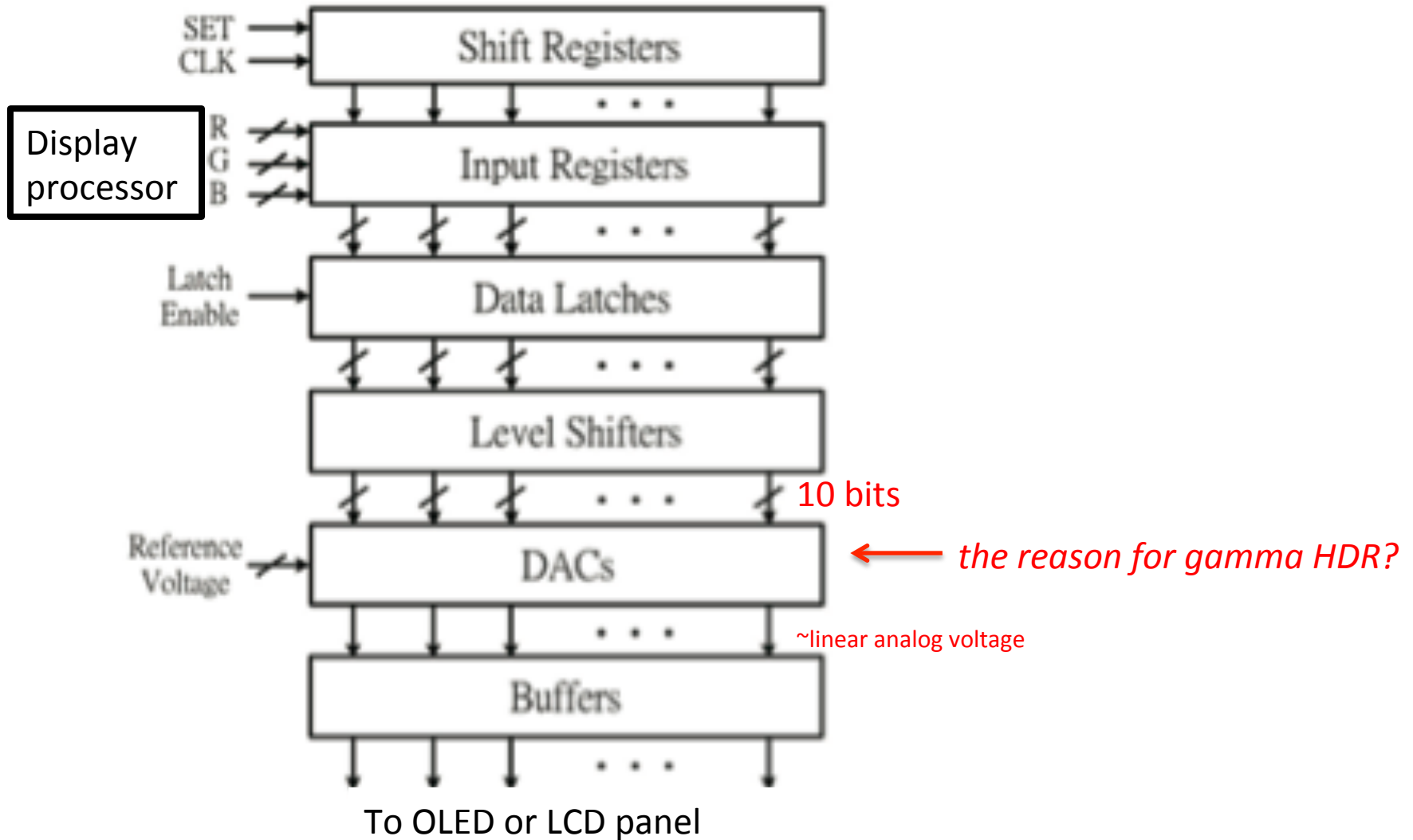
where

$$\text{clamp}(a, b, x) = \begin{cases} x, & \text{if } x \in [a, b] \\ a & \text{if } x < a \\ b & \text{if } x > b \end{cases}$$

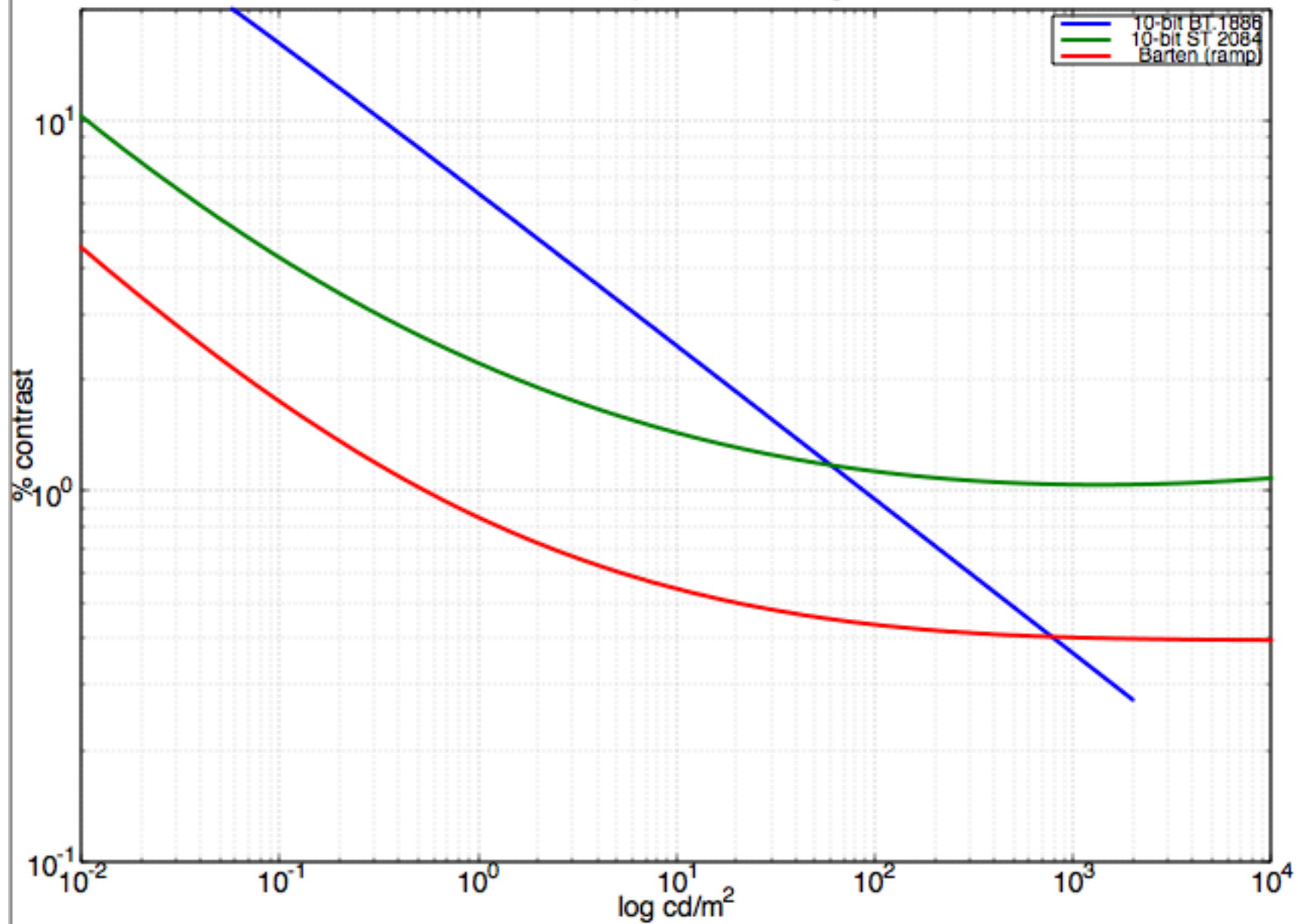
Range Solutions

1. Update VUI semantics with case for ST 2084 etc. style full range:
 - When `transfer_characteristics = 16` & `video_full_range = 1`
$$I = \text{Floor}((1015 \div 4) * D * V + D + 0.5)$$
 - Problem: does not take into account SDI protected clamping.
 - (Also update VUI with constant-luminance equations
`matrix_coeffs=10` ?)
2. Define new variable that extends `video_full_range_flag`, thus allowing transfer functions other than ST 2084 to utilize its $V \rightarrow I$ (integer) style map.
3. Specify the code level that corresponds to unity and zero; protected code range.

Display panels



EOTF CV% Comparison including Barten



EOTF CV% Comparison including Barten

