

# JCTVC-R0139

## Modulation channel information SEI

18<sup>th</sup> JCTVC Meeting: Sapporo, June-July 2014

technicolor



# Purpose of the proposal

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New SEI message aiming at using a modulation channel in combination with a limited bit-depth channel

Primary intent:

- High bit-depth video coding while re-using existing limited bit-depth HEVC implementations (typically of 8 or 10 bits)
- Can even deal with floating-point format signals (e.g. EXR)

Difference with JCTVC-N0142/-O0090/-P0162/-P0173:

- Use of a multiplicative approach based on modulation instead of an additive approach of 2 layers

Mechanism having similarities with alpha channel

# Purpose of the proposal

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HBD picture 16b 4:4:4



Modulation picture 10b 4:0:0



LBD picture 10b 4:2:0

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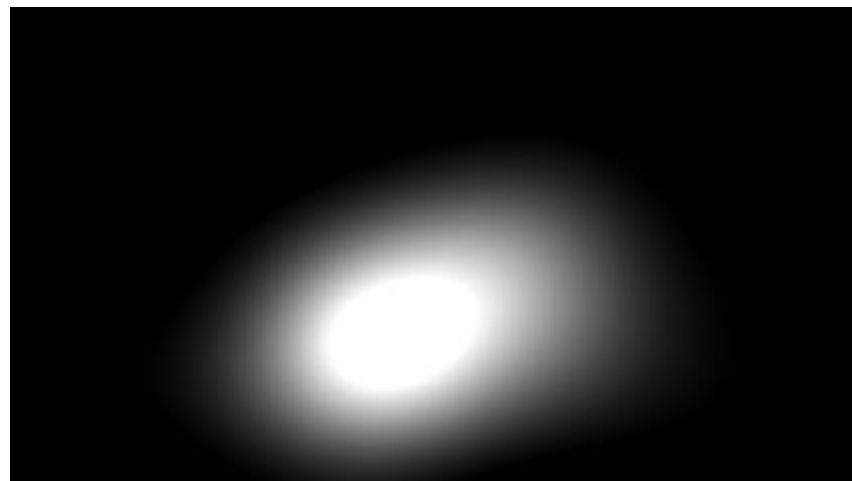


# Purpose of the proposal

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HBD picture 16b 4:4:4



Modulation picture 10b 4:0:0



LBD picture 10b 4:2:0

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# Process description

## Encoding side : Demodulation

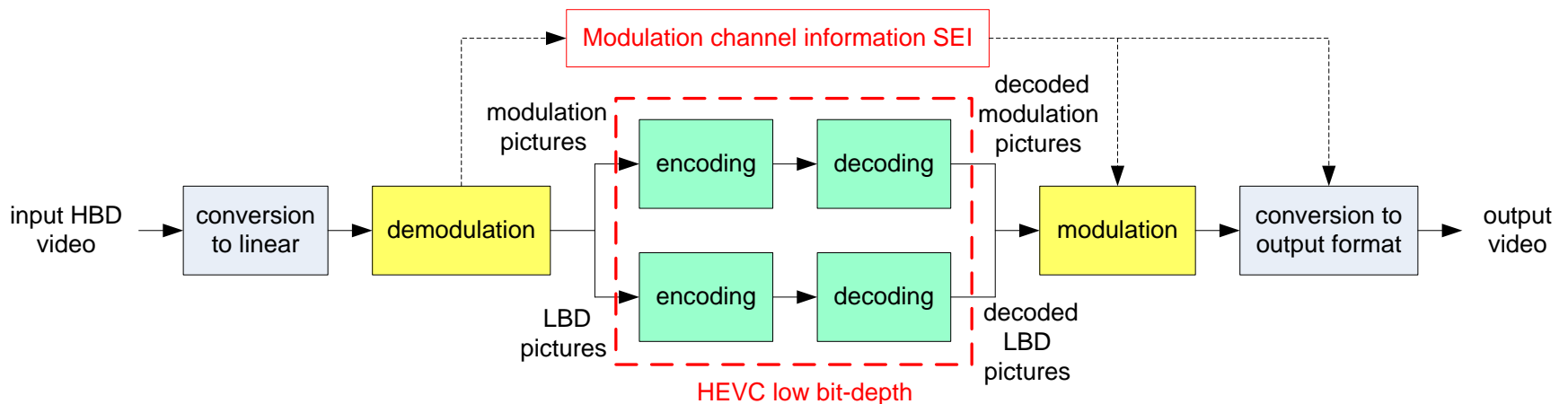
- Input picture split into 1 modulation picture + 1 LBD picture

## Decoding side : Modulation

- Decoded modulation and LBD signals recomposed into Target HBD output signal
- Output format indicated in the SEI

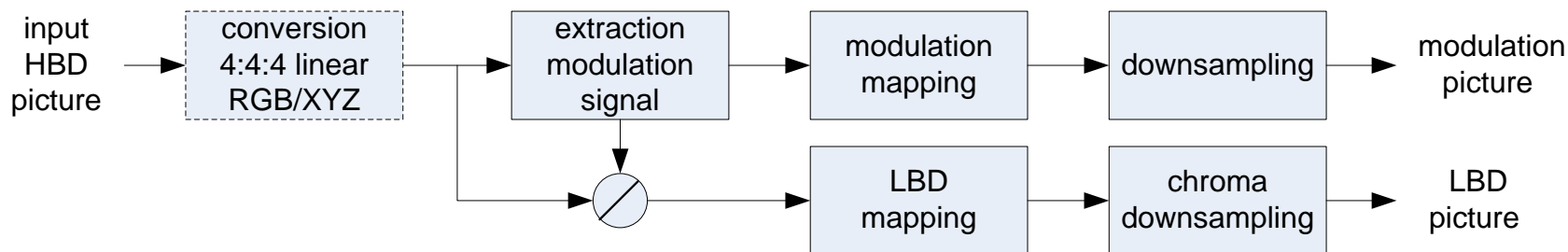
## Modulation channel info SEI:

- Contains the parameters useful for the recomposing (modulation) process

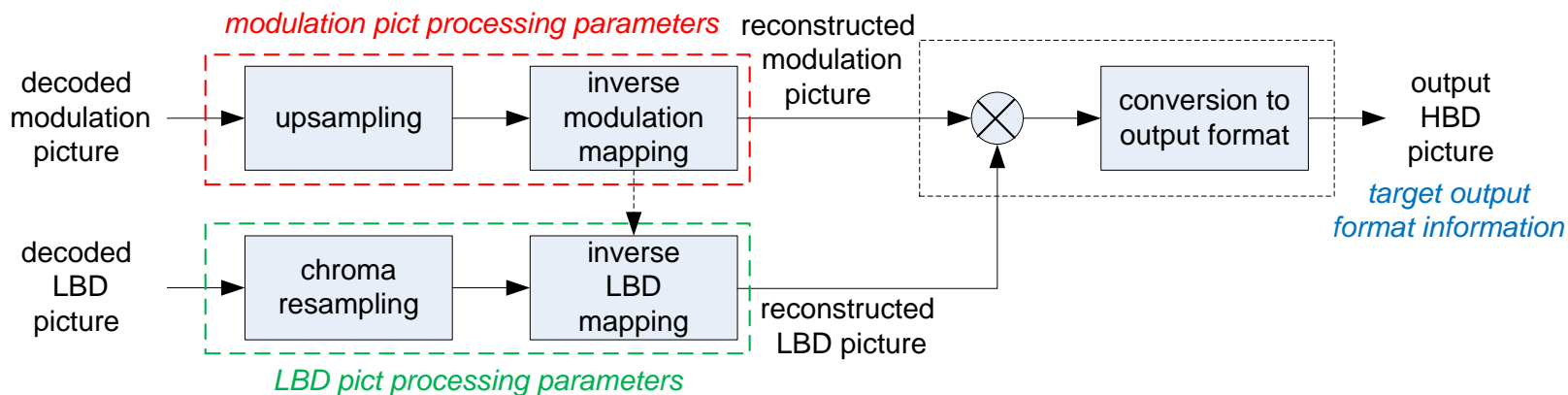


# Demodulation / Modulation

## Encoding side: demodulation



## Decoding side: modulation



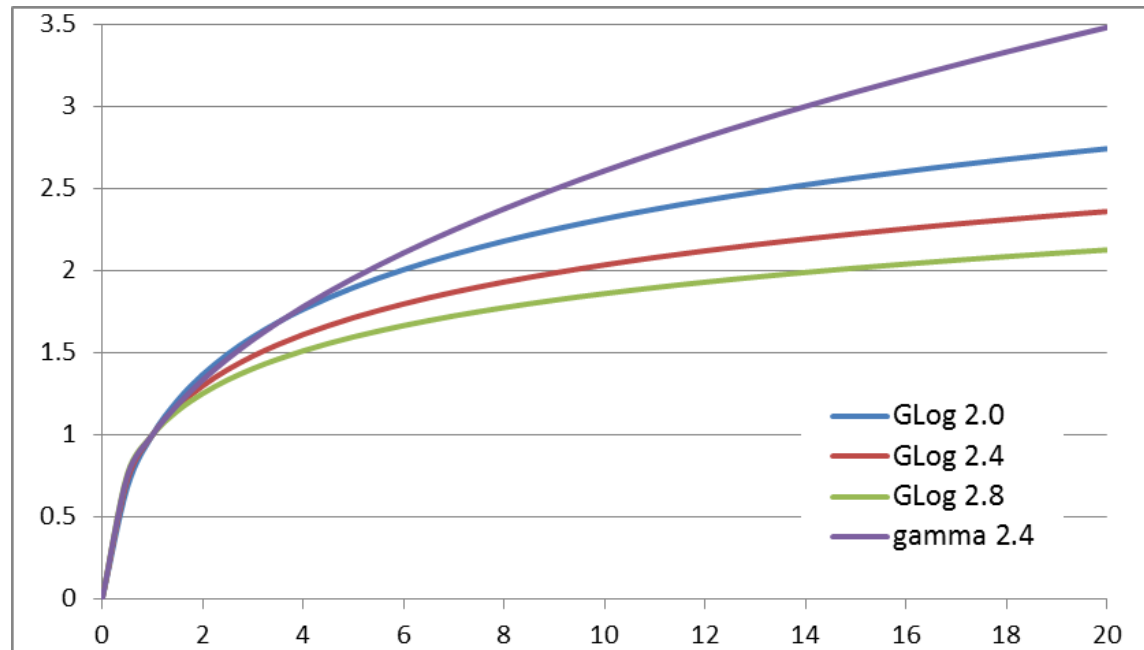
### SEI embeds

- modulation pict processing parameters
- LBD pict processing parameters
- target output format information

# Mapping function applied to LBD signal

Transfer function defined as a log-like correction (noted GLog):

- $GLog(x) = a_0 * \ln(x + b_0) + c_0$
- parameters  $a_0$ ,  $b_0$ ,  $c_0$  determined such that 0 and 1 are invariant ( $GLog(0) = 0$  and  $GLog(1) = 1$ ) - the derivative in 1 defined as  $GLog'(1) = \gamma$
- Enables to lower high lights more aggressively than usual gamma, while preserving black lights as usual gamma



# Modulation

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## 2 functional modes considered

### ■ YCbCr mode

- Decoded LBD channel is 'compatible' with Rec.709 or Rec.2020
- Can be directly rendered on displays conform to Rec.709 or Rec.2020

### ■ Lab mode

- Works in a perceptual color space (derived from CIE Lab color space)
- No viewability on Rec.709 or Rec.2020 displays without adaptation
- Optimal coding efficiency



# Modulation YCbCr mode

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## Modulation channel inverse mapping

- Corresponds mathematically to an inverse log transfer function

## YCbCr LBD channel inverse mapping

- Color space conversion from YCbCr to RGB
- Inverse transfer function:  $s_{tf} = \text{LumaFact} * \text{GLog}^{-1}(s * \text{Scal})$
- Color space conversion from RGB to XYZ

## Modulation

- $X_{HBD} = X_{tf} * \text{mod}_{rec}$        $Y_{HBD} = Y_{tf} * \text{mod}_{rec}$        $Z_{HBD} = Z_{tf} * \text{mod}_{rec}$

# Modulation Lab mode

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## Modulation channel inverse mapping

- Corresponds mathematically to an inverse log transfer function

## Lab LBD channel inverse mapping

- Rescaling depending on local modulation value  $m$

$$L_1 = L / \text{scal}(m) \quad a_1 = a / \text{scal}(m) \quad b_1 = b / \text{scal}(m)$$

- Inverse transform from locally perceptual color space

$$\hat{C}^2 = a_1^2 + b_1^2 \quad C = ( \exp( k * \hat{C} ) - 1 ) / k$$

$$a_2 = a_1 * C / \hat{C} \quad b_2 = b_1 * C / \hat{C}$$

*Note: quantization  $\tilde{a}=a\hat{C}/C$  and  $\tilde{b}=b\hat{C}/C$  aims at preserving the perceptual distance in Lab94 space*

- Inverse transform from the CIE Lab-like space

$$Y' = L_1 / 116 \quad X' = a_2 / 500 + Y' \quad Z' = b_2 / 500 + Y'$$

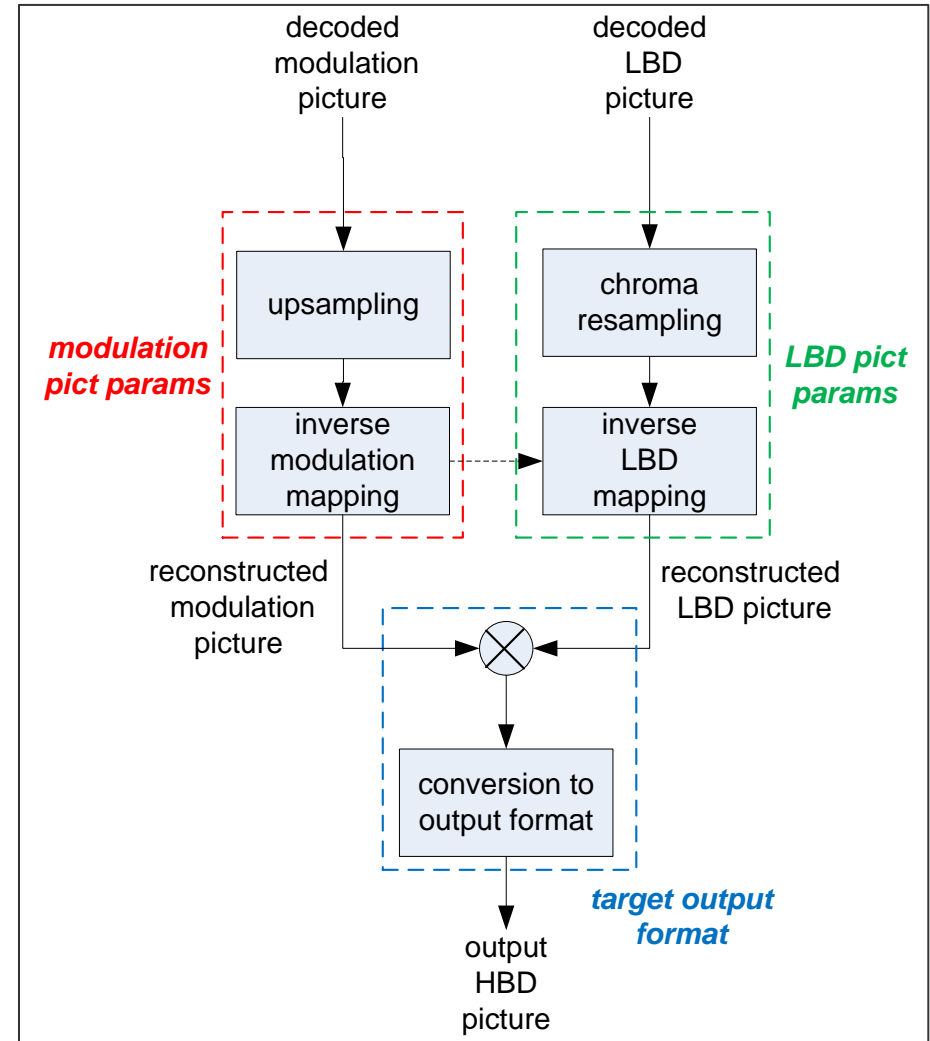
- Inverse TF (applies to each X, Y and Z sample)  $s_{\text{tf}} = \text{GLog}^{-1}(s)$

## Modulation

- $X_{\text{HBD}} = X_{\text{tf}} * 0.9505 * \text{mod}_{\text{rec}}$   $Y_{\text{HBD}} = Y_{\text{tf}} * \text{mod}_{\text{rec}}$   $Z_{\text{HBD}} = Z_{\text{tf}} * 1.0890 * \text{mod}_{\text{rec}}$

# Syntax of Modulation channel information SEI

modulation_channel_info( payloadSize ) {	Descriptor	
<b>mod_channel_cancel_flag</b>	u(1)	<b>related to the output signal format</b>
if ( !mod_channel_cancel_flag ) {		
<b>mod_chroma_format_idc</b>	ue(v)	
<b>mod_sample_format_idc</b>	ue(v)	
if( mod_sample_format_idc == 1 ) {		
<b>mod_bit_depth_luma_minus8</b>	u(3)	
<b>mod_bit_depth_chroma_minus8</b>	u(3)	
}		
<b>mod_video_full_range_flag</b>	u(1)	
<b>mod_colour_primaries</b>	u(8)	
<b>mod_transfer_characteristics</b>	u(8)	<b>related to the modulation picture processing</b>
<b>mod_matrix_coeffs</b>	u(8)	
<b>mod_modpic_bit_depth_minus8</b>	u(3)	<b>related to the LBD picture processing</b>
<b>mod_lbd_bit_depth_luma_minus8</b>	u(3)	
<b>mod_lbd_bit_depth_chroma_minus8</b>	u(3)	
<b>mod_lbd_format</b>	u(2)	
if( ( mod_lbd_format == 1 )    ( mod_lbd_format == 2 ) ) {		
<b>lbd_glog_a0</b>	u(15)	
<b>lbd_glog_b0</b>	u(14)	
<b>lbd_glog_c0</b>	u(10)	
<b>lbd_scaling_factor</b>	u(10)	
<b>lbd_luminance_balance_factor</b>	u(10)	
}		
}		
<b>mod_channel_persistence_flag</b>	u(1)	
}		



# Possible containers for the Modulation channel

Several possible ways of conveying the modulation channel

## ■ Auxiliary picture

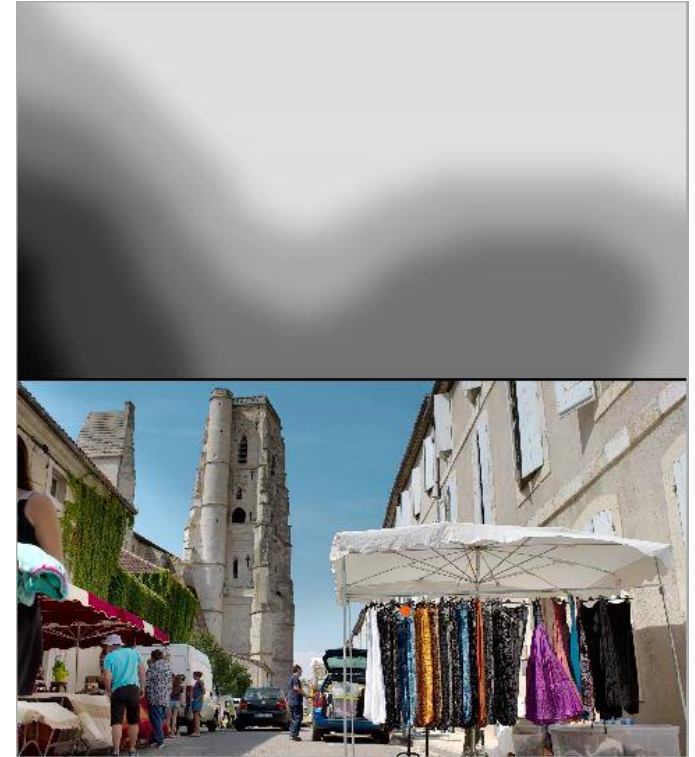
- close to the Alpha channel concept
- SHVC framework
- No synchro issue

## ■ Frame packing

- already practically used for 3D/multiview services
- No synchro issue

## ■ Additional SEI message

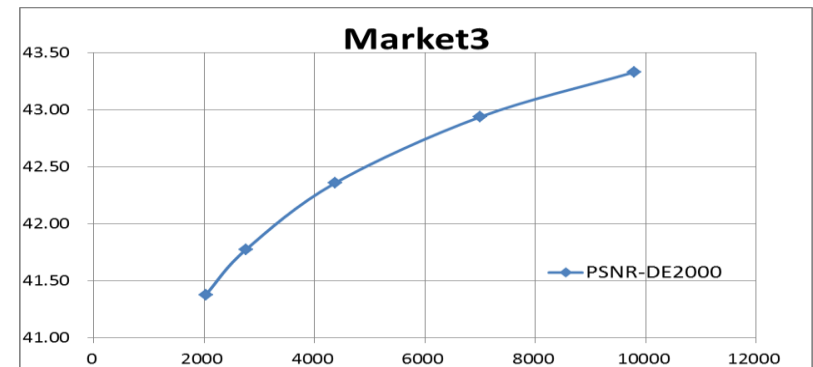
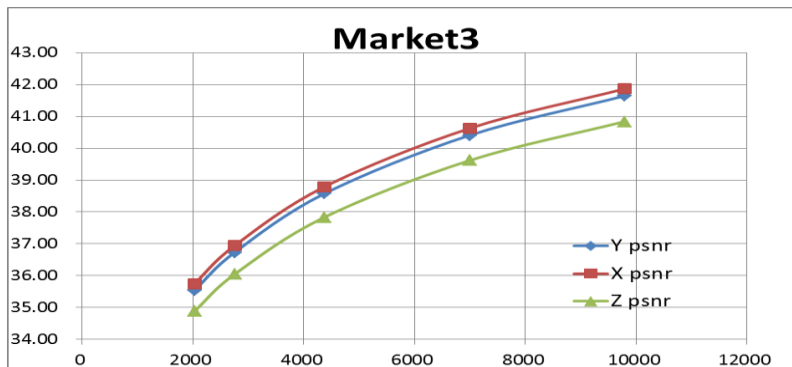
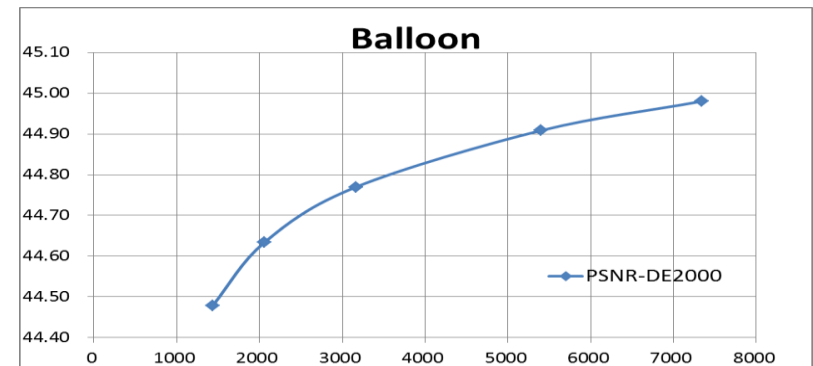
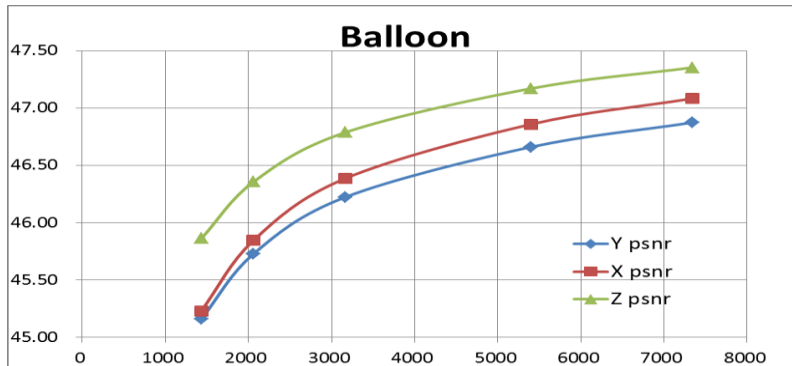
- embedding the modulation picture into an SEI message (one per picture)
- only valuable if the size of the modulation channel is small, that is, resulting from a significant downsampling of the modulation signal



# Experiments

## 2 implementations:

- Auxiliary picture (SHM7.0) / Frame Packing (HM13.0\_RExt6.0rc1)
- Test using EXR 1080p sequences converted to XYZ 16b gamma2.4
- Modulation channel of very low cost
  - Very smooth signal that can be significantly downsampled



# Conclusions

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- A new SEI message proposed to support modulation video channel
- 2 functional modulation modes proposed
  - YCbCr mode: LBD channel is compatible with Rec.709 or Rec.2020
  - Lab mode: perceptual color space (from CIE Lab), no viewability, for improved coding efficiency
- Enables high bit-depth / floating-point video coding using low bit-depth encoding/decoding devices

Thanks to Arris, Orange Labs, Sony for cross-checking

