MaxCLL and MaxFALL Information

Warner Bros.

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Maximum Content Light Level (MaxCLL) calculation

```
CalculateMaxCLL()
{
        set MaxCLL = 0
        for each ( frame in the sequence )
        {
                set frameMaxLightLevel = 0
                for each ( pixel in the active image area of the frame )
                {
                                convert the pixel's non-linear (R',G',B') values to linear values (R,G,B) calibrated to cd/m$^2$
                                set maxRGB = max(R,G,B)
                                if( maxRGB > frameMaxLightLevel )
                                        set frameMaxLightLevel = maxRGB

                }

                if( frameMaxLightLevel > MaxCLL )
                                set MaxCLL = frameMaxLightLevel
        }
        return MaxCLL
}
```

Maximum Frame Average Light Level (MaxFALL) calculation

```
CalculateMaxFALL()
{
        set MaxFALL = 0
        for each ( frame in the sequence )
        {
                set runningSum = 0
                for each ( pixel in the active image area of the frame )
                {
                                convert the pixel's non-linear (R',G',B') values to linear values (R,G,B) calibrated to cd/m²
                                set maxRGB = max(R,G,B)
                                set runningSum = runningSum + maxRGB
                }

                set frameAverageLightLevel  = runningSum / numberOfPixelsInActiveImageArea

                if( frameAverageLightLevel  > MaxFALL )
                                set MaxFALL = frameAverageLightLevel
        }
        return MaxFALL
}
```

Maximum Content Light Level (MaxCLL) information

For MaxCLL, the unit is equivalent to cd/m^2 when the brightest pixel in the entire video stream has the chromaticity of the white point of the encoding system used to represent the video stream. Since the value of MaxCLL is computed with a max() mathematical operator, it is possible that the true CIE Y Luminance value is less than the MaxCLL value. This situation may occur when there are very bright blue saturated pixels in the stream, which may dominate the max(R,G,B) calculation, but since the blue channel is an approximately 10% contributor to the true CIE Y Luminance, the true CIE Y Luminance value of the example blue pixel would be only approximately 10% of the MaxCLL value.

# Maximum Frame Average Light Level (MaxFALL) information

For MaxFALL, the unit is equivalent to cd/m^2 when the maximum frame average of the entire stream corresponds to a full-screen of pixels that has the chromaticity of the white point of the encoding system used to represent the video stream. The frame-average computation used to compute the MaxFALL value is performed only on the active image area of the image data. If the video stream is a "letterbox" format (e.g. where a 2.40:1 aspect ratio is put inside a 16:9 image container with black bars on the top and bottom of the image), the black bar areas are not part of the active image area and therefore are not included in the frame-average computation. This allows the MaxFALL value to remain an upper bound on the maximum frame-average light level even if image zooming or pan/scan is performed as a post-processing operation.

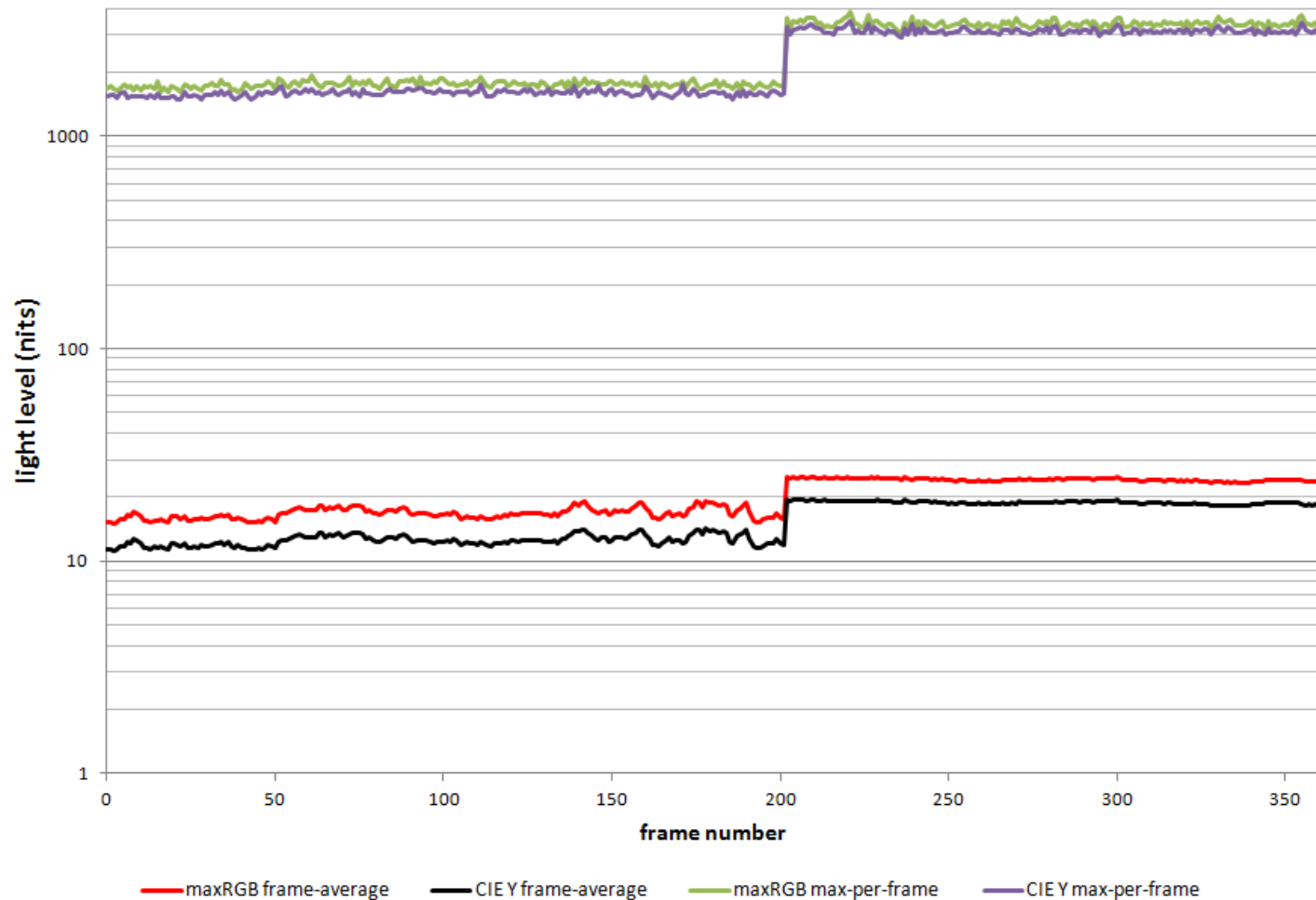HDR StEM Warm Night Scene - Sequence Statistics - Full-Frame
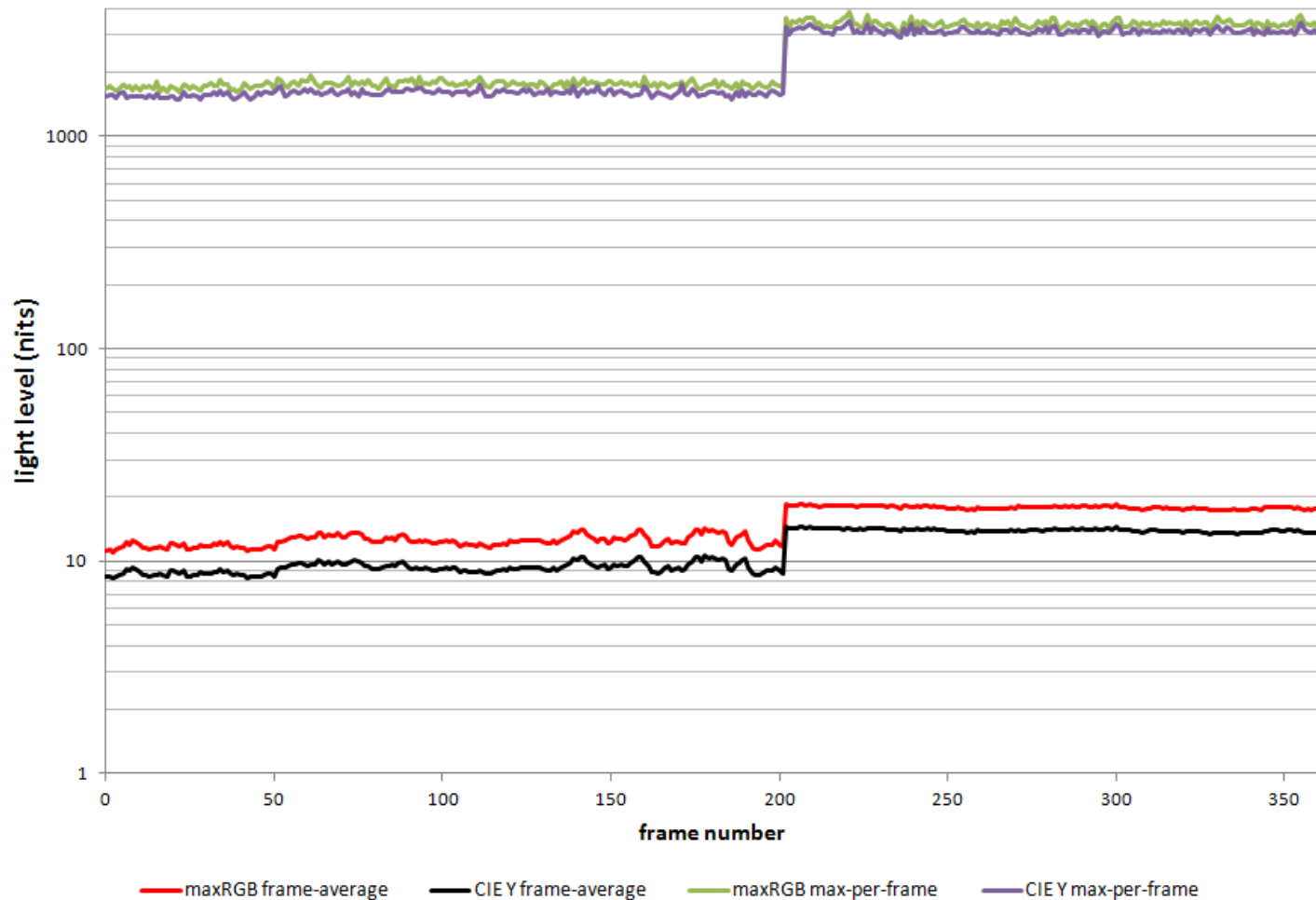
MaxRGB max-per-frame + frame-average-per-frame

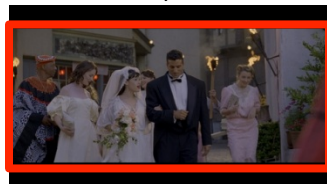Calculations performed over full-frame (including non-active black-bar area) lead to lower average values
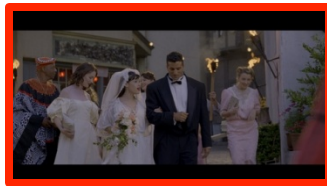
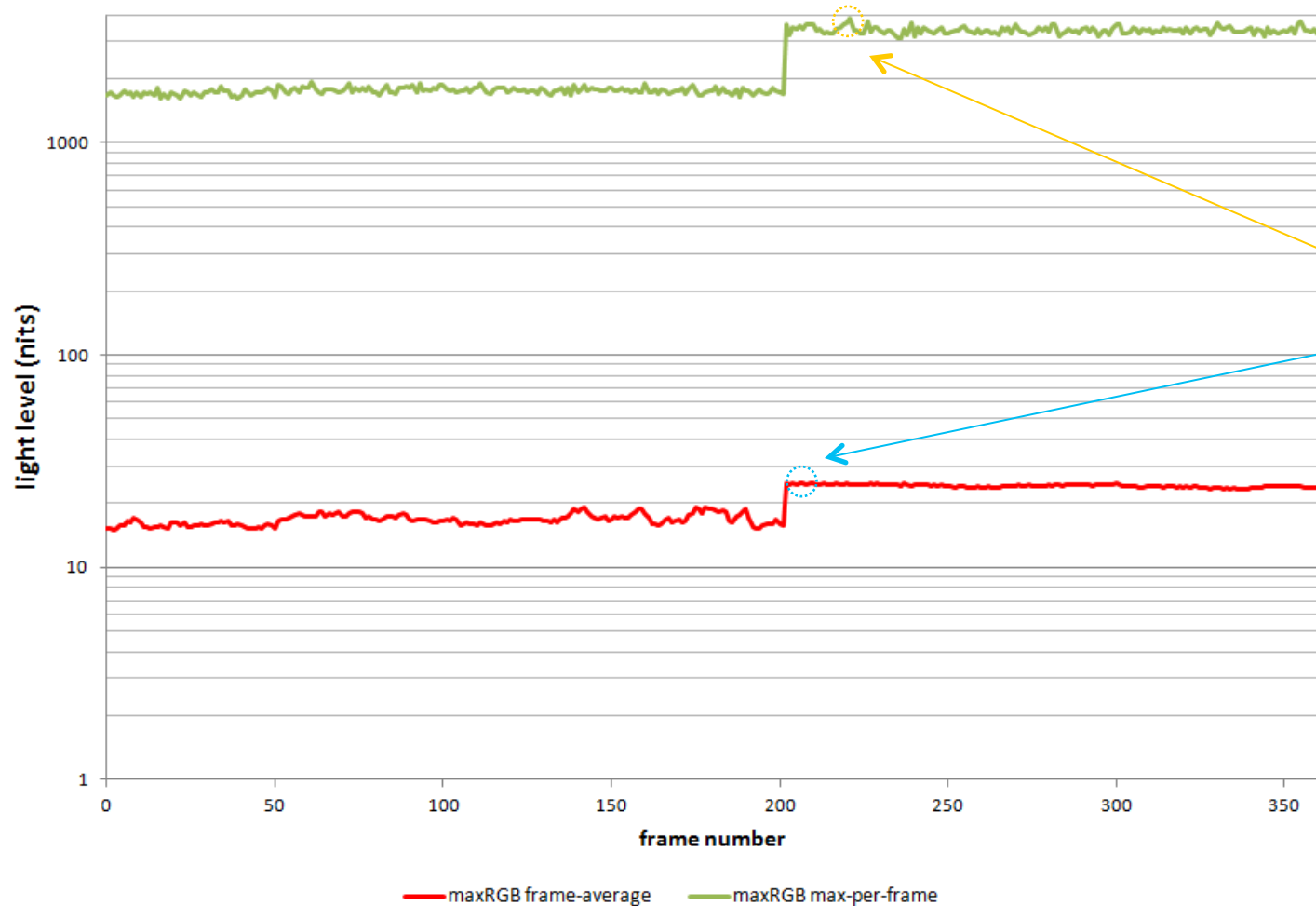HDR StEM Warm Night Scene - Sequence Statistics - Active-Area

MaxRGB max-per-frame + frame-average-per-frame

Calculations performed over active-area only (not including black-bar area) lead to higher average values (more conservative)

legend: maxRGB frame-average — CIE Y frame-average — maxRGB max-per-frame — CIE Y max-per-frame

MaxCLL and MaxFALL representation

- The MaxCLL and MaxFALL values can be coded as an unsigned 16-bit value in units of 1 cd/m^2, where 0x0001 represents 1 cd/m^2 and 0xFFFF represents 65535 cd/m^2.

- If for some reason the MaxCLL and or MaxFALL values are unknown, the value 0x0000 can be used to represent unknown.