

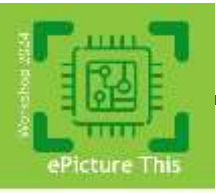
Cameras and LED walls – A challenging relationship

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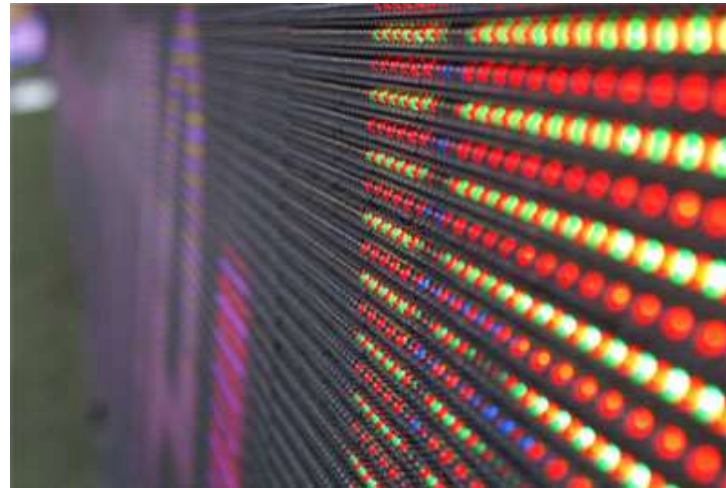
Cameras and LED walls - A challenging relationship

- LED walls are used in many broadcast applications
- In news studios, in entertainment productions, in VR/AR application
- The way images are displayed on the LED wall and captured by the camera presents a number of challenges

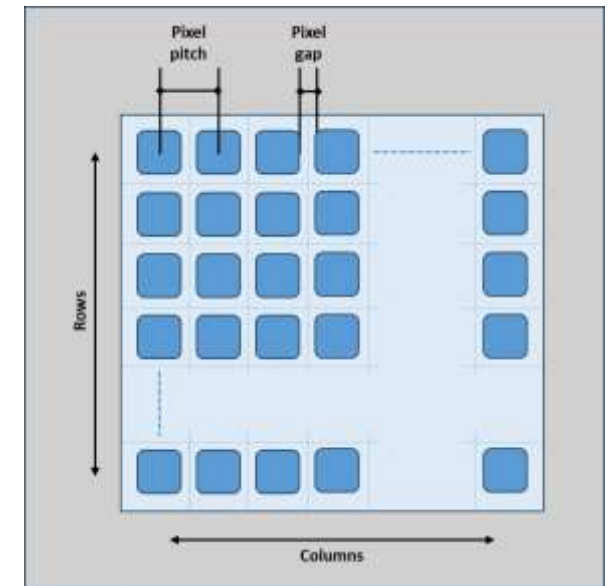
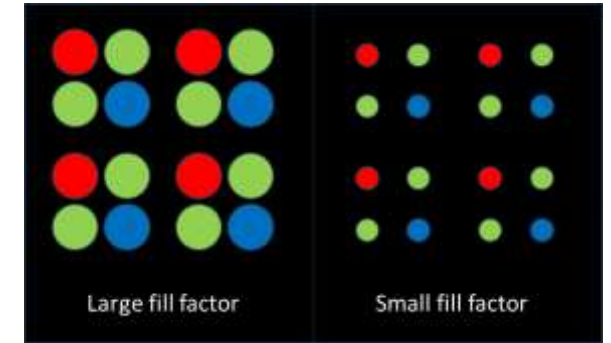


Cameras and LED walls - A challenging relationship

- LED walls represent the image with individual light-emitting pixels
- Important parameters are the pixel pitch and the fill factor
- In general:
 - A smaller pixel pitch is better
 - A larger fill factor is better
- Cameras capture the image with a pixel structure
- At a certain point, the two structures will interfere with each other



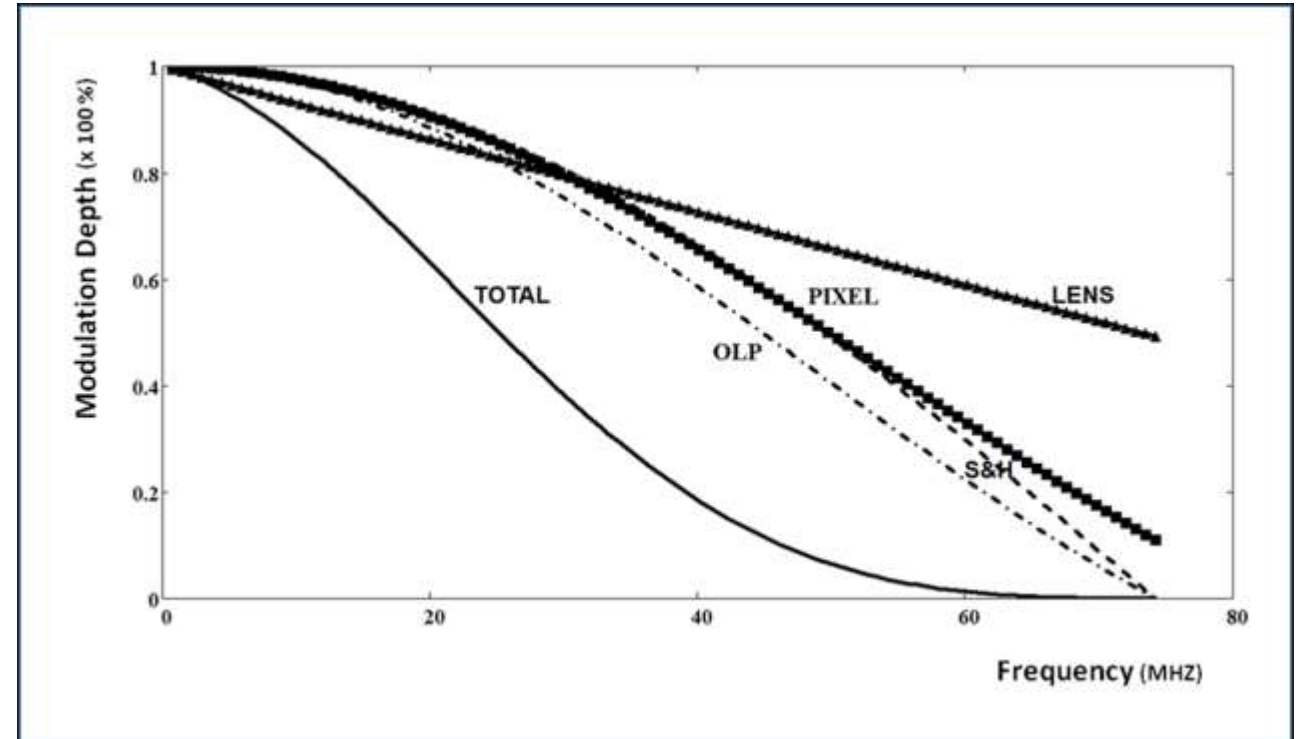
Close up of a LED wall



Pixel structure of a camera imager

Resolution and sharpness

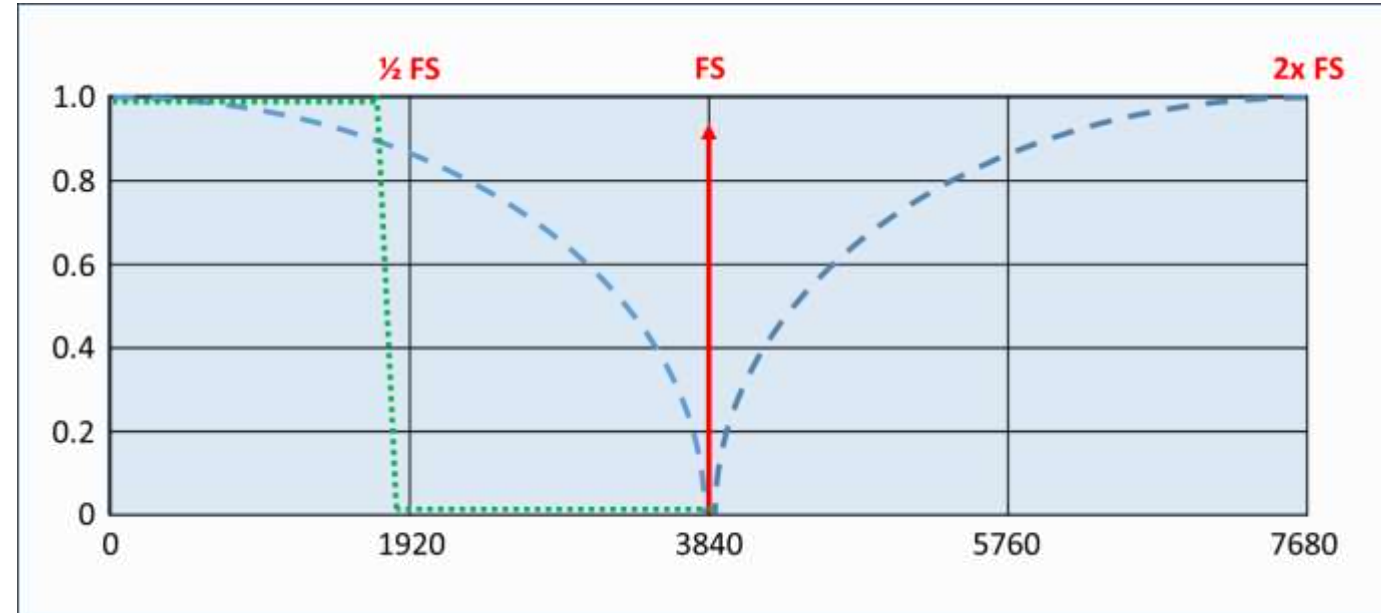
- In a camera system, several parameters affect resolution and image sharpness, including :
 - Number of pixels
 - MTF performance of the lens
 - Optical low-pass filtering
- The number of pixels is determined by the video format
- The MTF performance of the lens has practical limits
- The only thing that can be influenced is the optical low-pass filtering



Parameter influencing resolution and image sharpness

Optical low-pass filtering

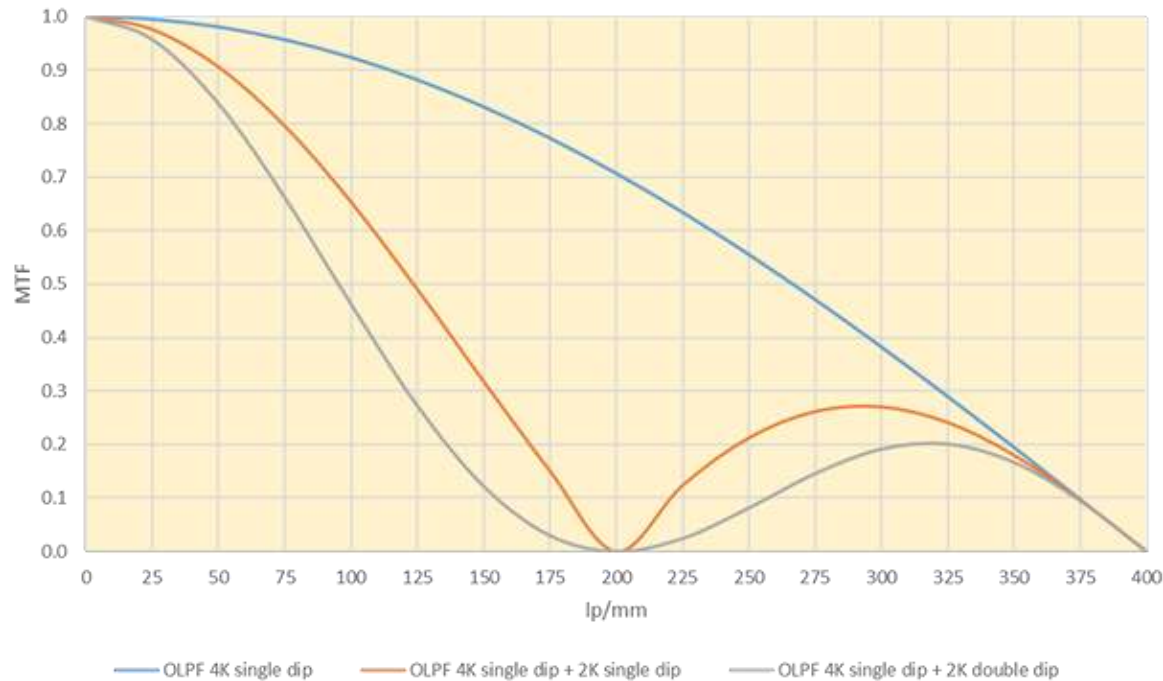
- According to Nyquist, there should be no signal above half the sampling frequency
- An ideal OLPF should cut off with a steep edge just below half the sampling frequency
- Optical brick-wall filter do not exist, the compromise used is a filter with a notch at the sampling frequency
- This provides a good compromise between sharpness and aliasing



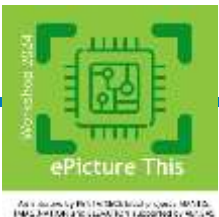
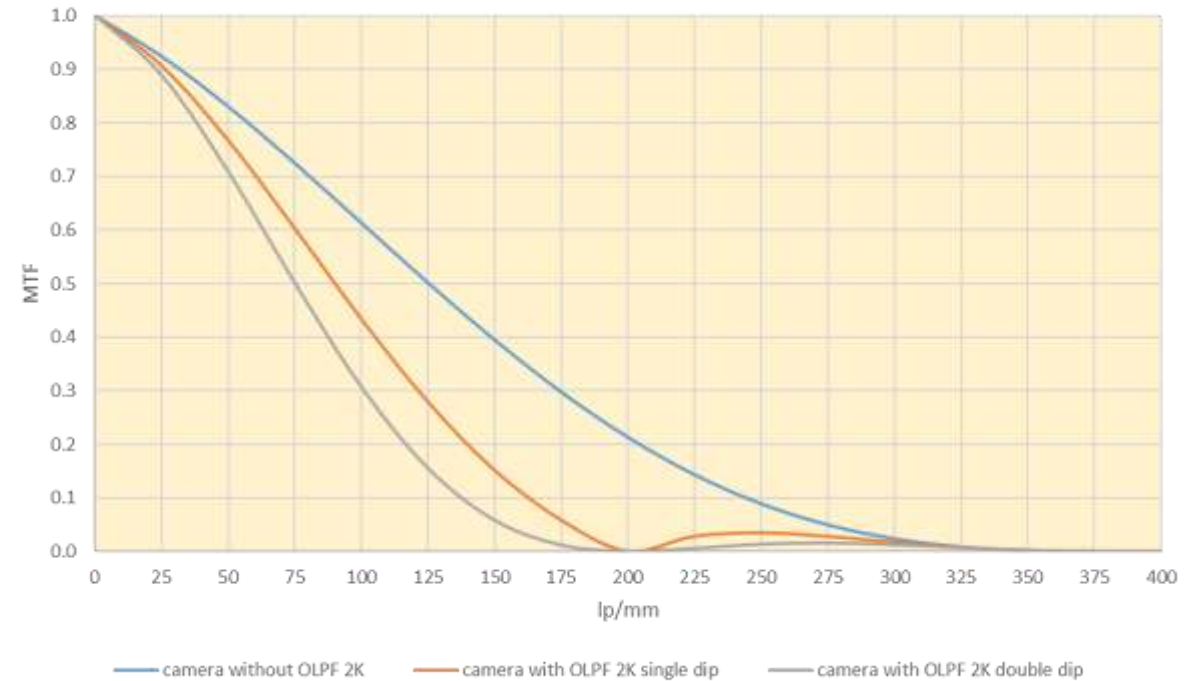
Optical low-pass filtering for good resolution and image sharpness

Optimized filtering for alias-critical situations

MTF OLPF

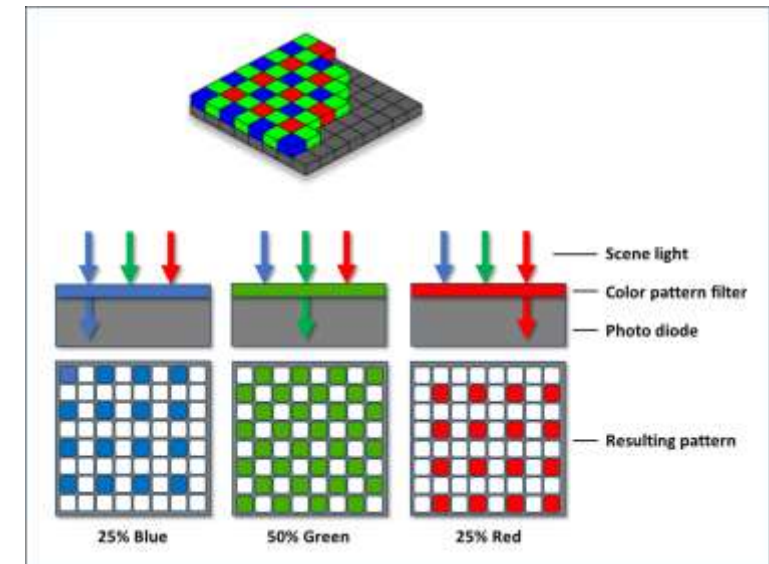
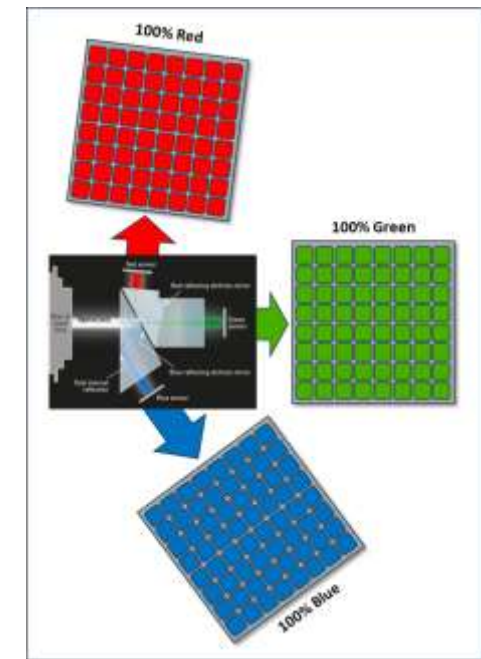


MTF 4K camera



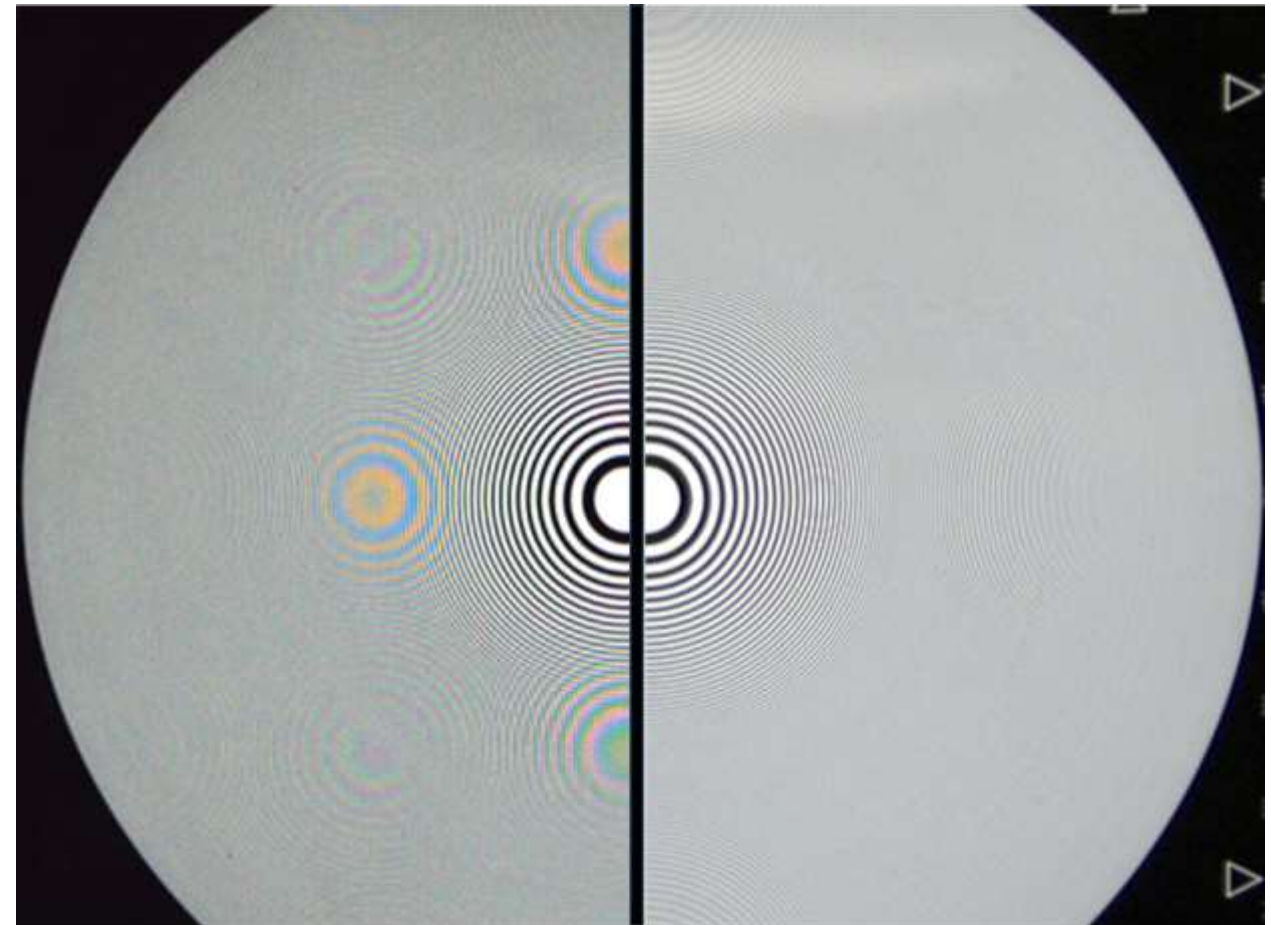
Single versus 3-imager

- Most broadcast cameras use three image sensors, with a prism color splitter
- The scanning frequency is identical for all three colors and the optimal optical pre-filtering is identical for all colors
- In a single-imager camera with a Bayer pattern filter every second pixel has a green filter and every fourth pixel has either a blue filter or a red filter
- The different colors have a different sampling frequency and optimal optical low-pass filtering for all colors at the same time is not possible



Single versus 3-imager

- The "wrong" filtering of the red and blue signal leads to colored moiré in the image
- 3-sensor cameras with optimized optical low-pass filtering have no colored moiré

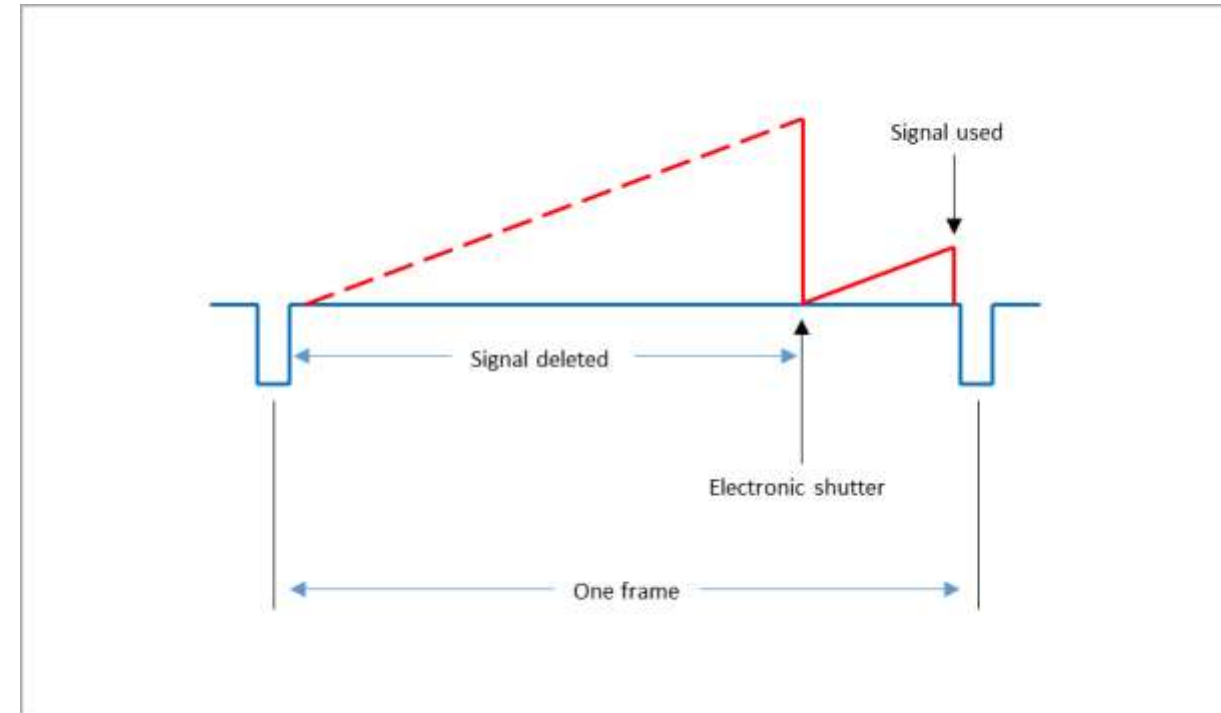


Single imager

3-Imager

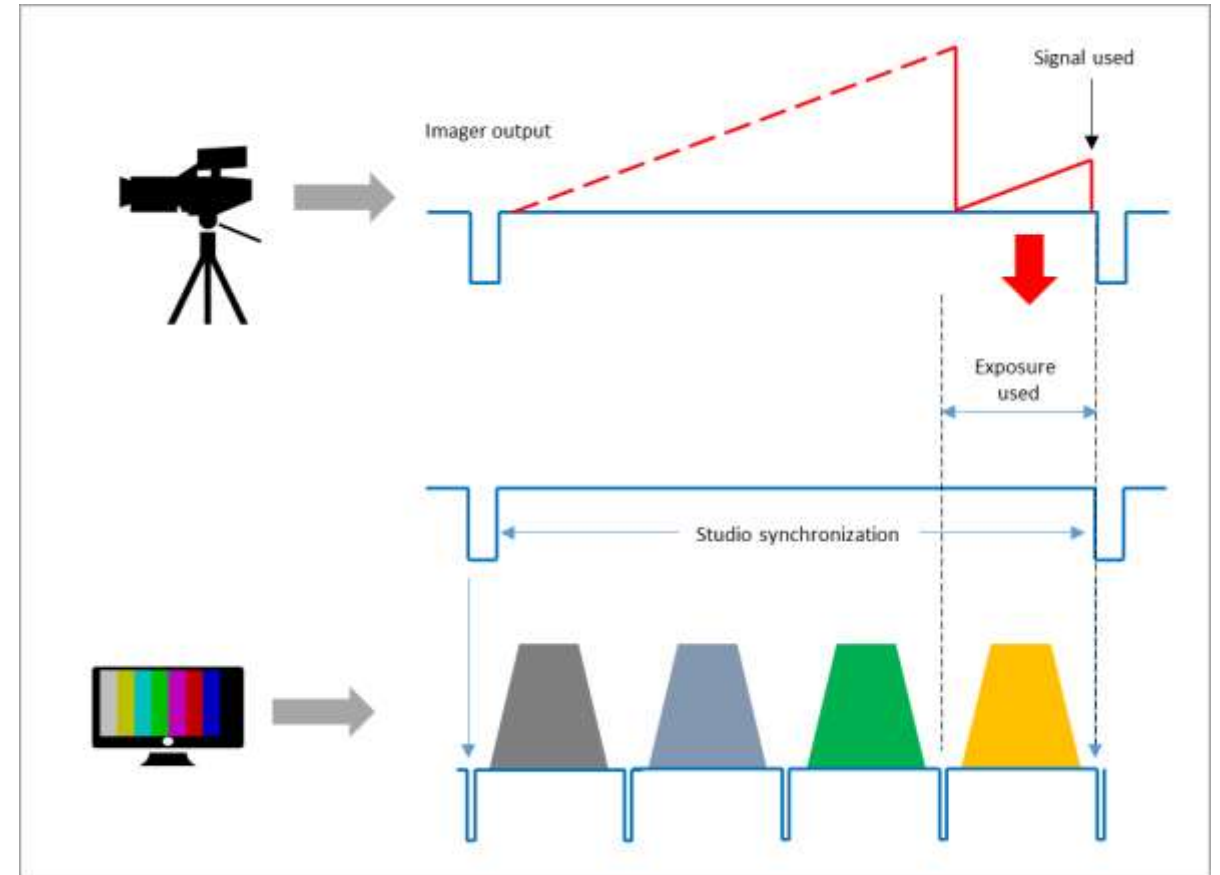
New Applications – VR/AR

- There are applications in which the LED wall is operated with an increased frame rate, which pose completely new challenges for the camera technology
- A global shutter is required to expose and read out all pixels simultaneously
- The camera is operated with a short-time exposure, which is coordinated with the exposure time of a single image reproduced by the LED wall



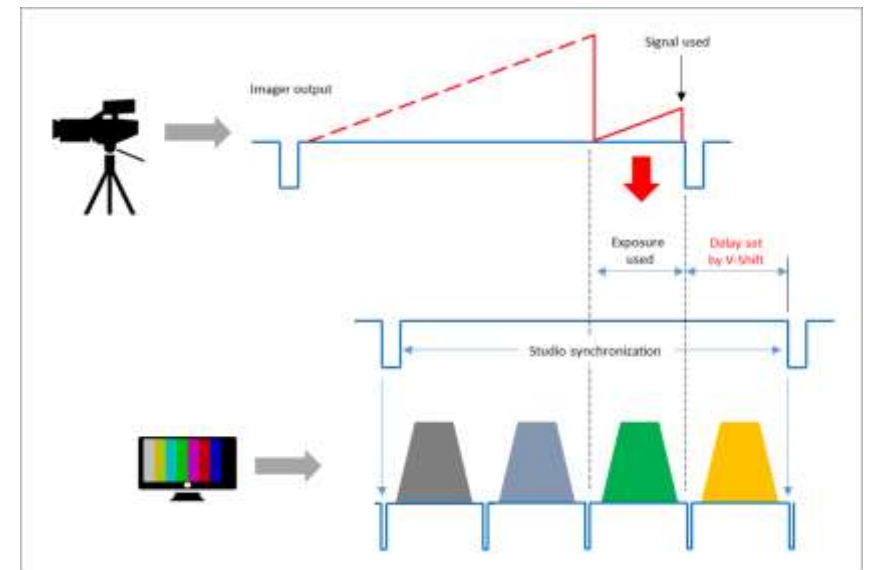
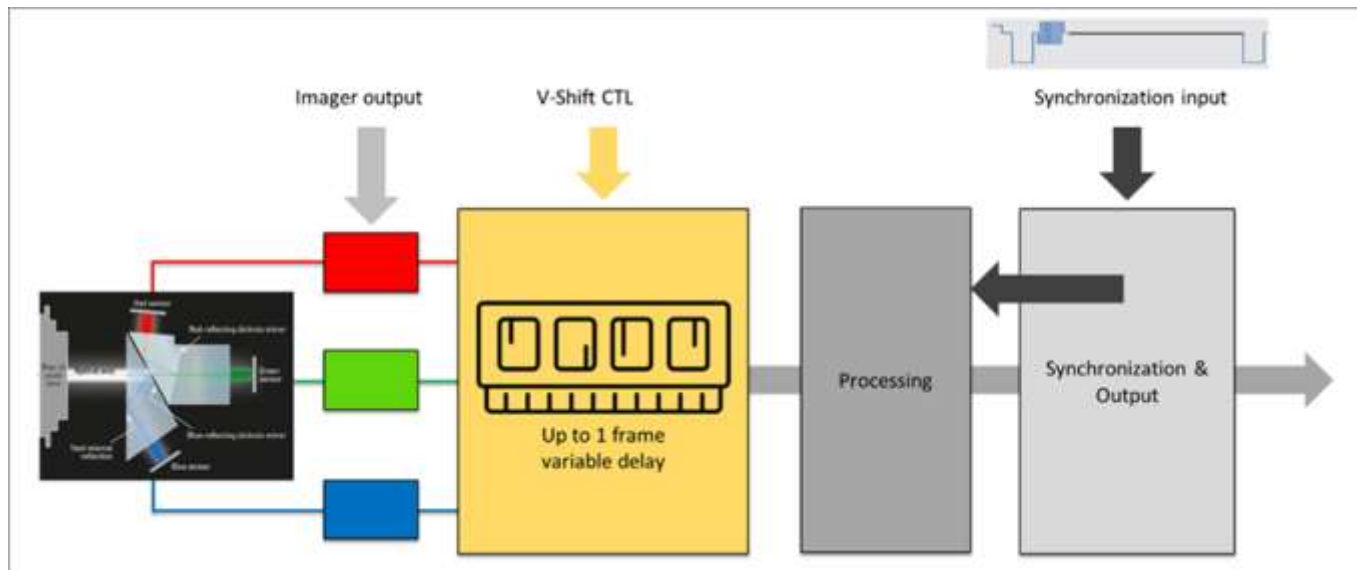
How to select the image

- The time of exposure cannot be freely selected, it is always the period immediately before the camera sensor is read out
- The synchronization signal for the camera could be shifted so that the exposure time occurs exactly when it is needed



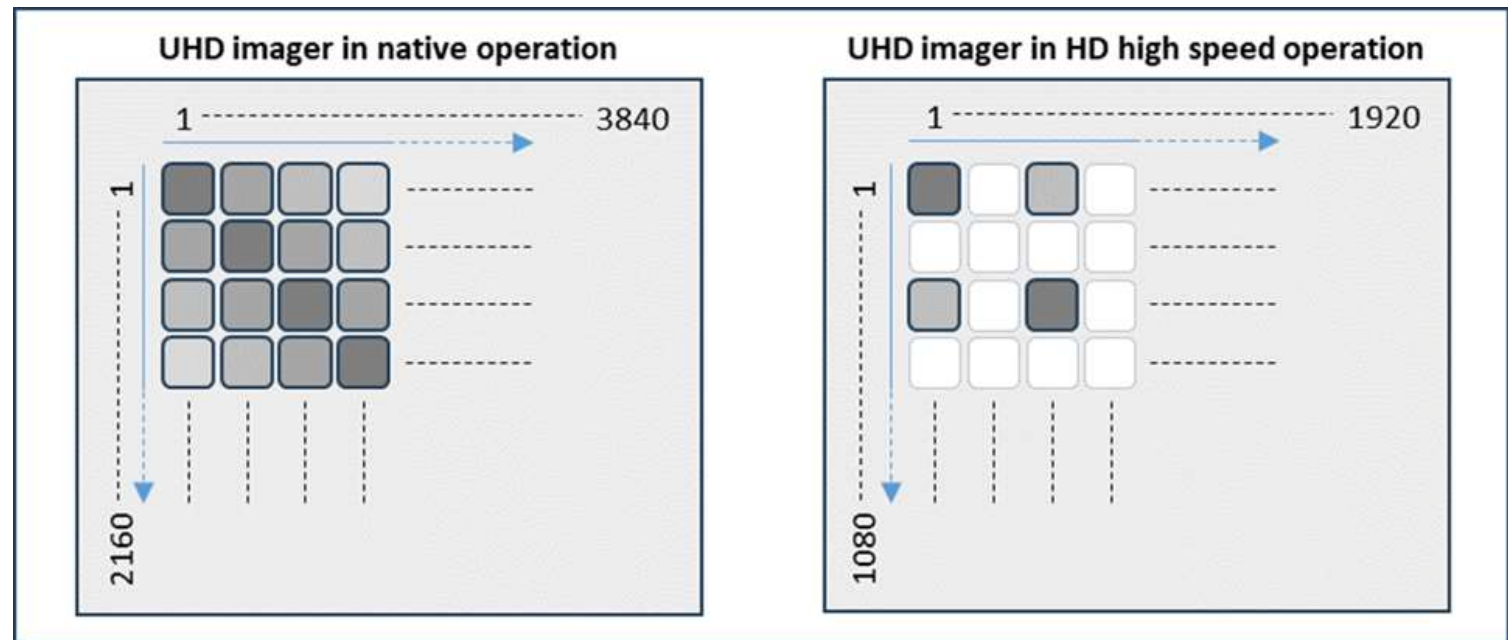
How to select the image

- A circuit called V-shift makes it possible to set a freely selectable delay between the sensor output and the signal processing, which means that the exposure moment can be freely selected for each camera



How to capture multiple images

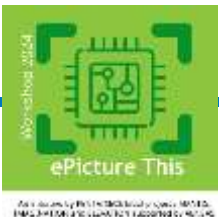
- There are also applications where all images are needed, and the camera must then be operated at the same increased frame rate as the LED wall
- However, UHD cameras in high-speed operation often read out only a small portion of the UHD pixels
- This leads to large light-insensitive areas between the read-out pixels, which in turn cause alias interference

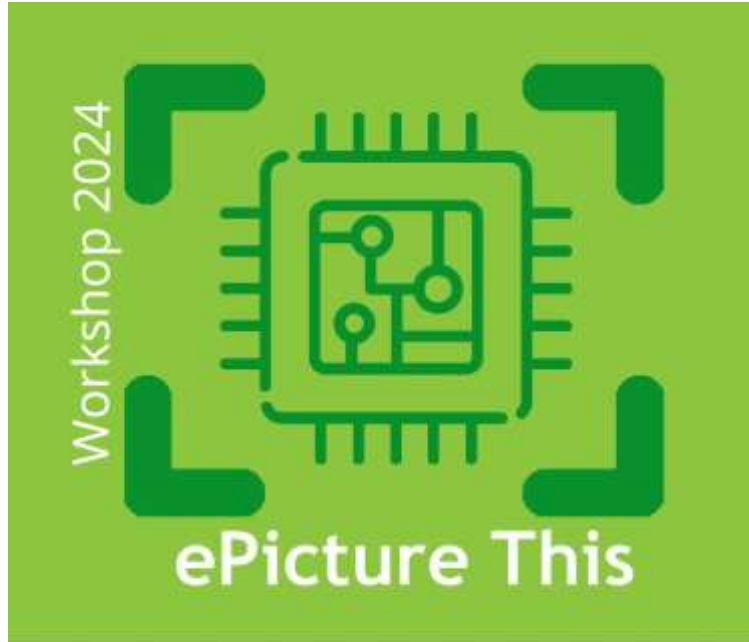


Cameras and LED walls - A challenging relationship

- **Conclusion**

- **The use of cameras together with LED walls brings with it some special challenges**
- **There are solutions to achieve a best possible result despite the challenges:**
 - **Additional optical low-pass filters in the camera that are optimized for LED applications**
 - **Additional delay circuits in the camera signal processing for freely determining the exposure time**
 - **High-speed cameras with three 2/3" image sensors that operate natively with UHD Pixel scanning in the required frame rate**





THANK YOU

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