What you don’t see

// 35mm-film in the LED-Volume

Who are we?

Why should you shoot film in a LED-Volume?

Stillframe // 100% shot analog ICVFX // graded

our goals

- simulate real Set conditions
- push the limits
- advantages & challenges
  -> Moiré, Colors, Workflow...

Stillframe // 100% shot analog in-camera // graded

Hard Facts

Studio: Hyperbowl Munich

- ROE Diamond LED Panels
- 2.6 mm Pixelpitch
- 1600 Nit maximum Brightness
- Nvidia Quadro RTX A6000
- OptiTrack Tracking-System
- Unreal Engine 5.2

Stillframe // 100% shot analog ICVFX // graded

Hard Facts

Analog

- Arricam ST, Kodak Vision3
- 35 mm 250d
- 24 fps
- Sync via Genlock with external speed box and manual phase adjustment

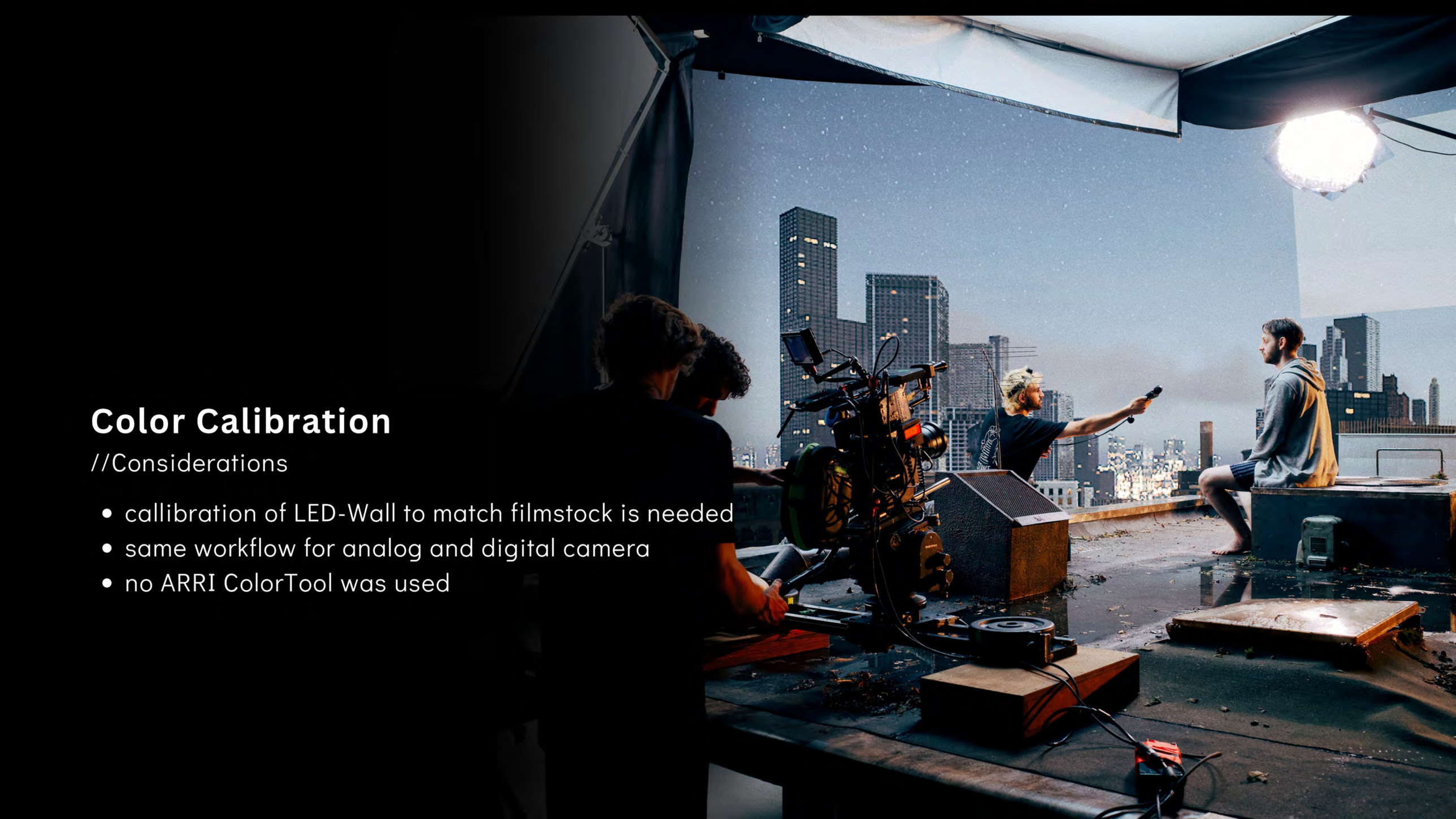
- Costum OCIO for Kodak Vision 3

Digital

- ARRI AMIRA
- UHD (3840 x 2160)
- 24 fps
- Sync via Genlock

- Custom OCIO
- Inner-frustum recording

Stillframe // 100% shot analog ICVFX // graded



Color Calibration

//Considerations

- callibration of LED-Wall to match filmstock is needed
- same workflow for analog and digital camera
- no ARRI ColorTool was used

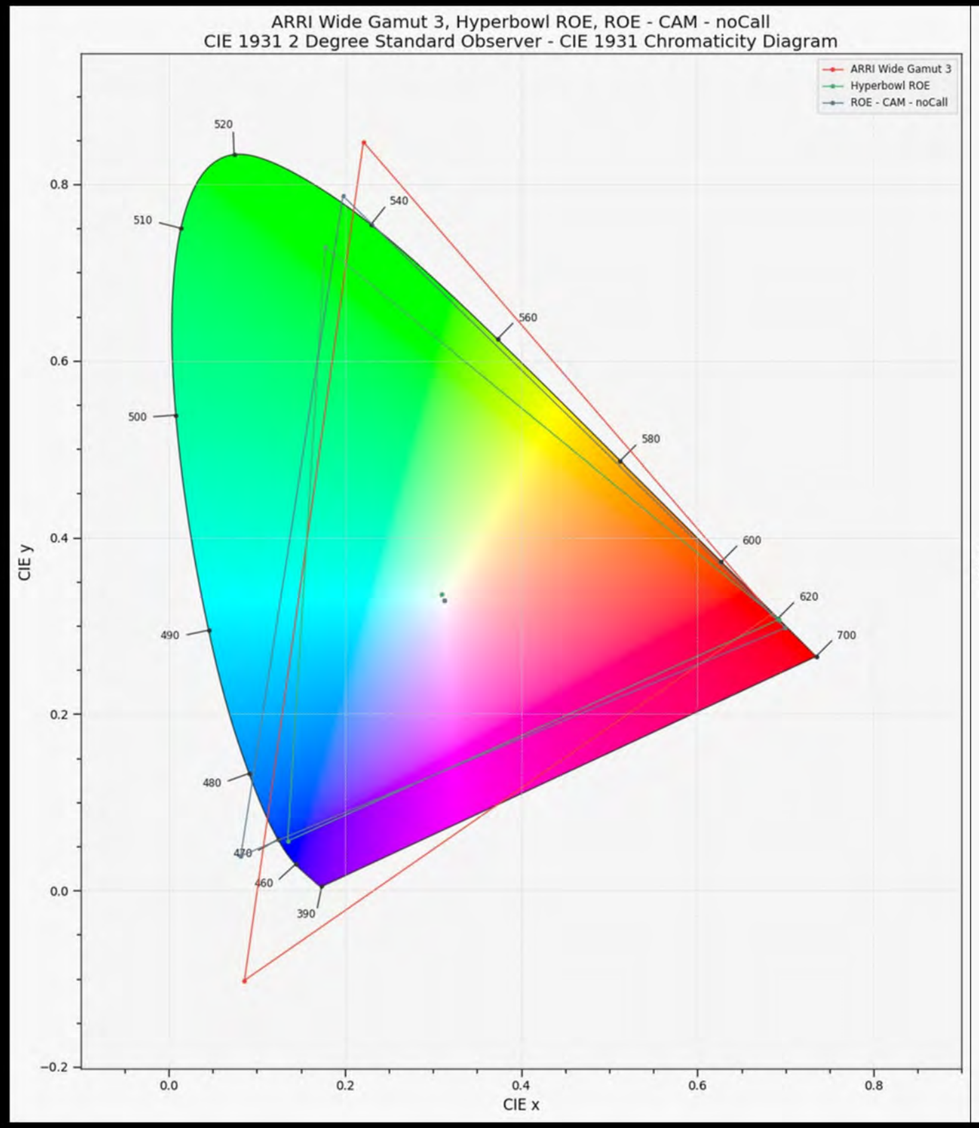
Color Calibration

//Workflow

- measurement of LED Primaries
- capturing of the primaries with specific filmstock
- developing and scanning
- calculating u’v’ coordinates and correction matrix
- implementing correction matrix as OCIO in Unreal Engine

Color Calibration

//Results



Color Calibration

//Workflow

- unexpected gammut results
- communication and timing challenges
- decision to shoot filmstock with same callibration as AMIRA for practical reasons
- footage in the end was scanned with ARRI scan

Synchronisation

//connecting digital and analog worlds

- in digital world precise sync is extremly important
- in analog context scanline artefacts are not to be expected
- doubleframes are visible if not synchronised
- sync source for camera with genlock via sdi and external speedbox
- sync pulse for Virtual System and ARRICAM ST is needed

Visual sync via red bars

Synchronisation

//manual syncing

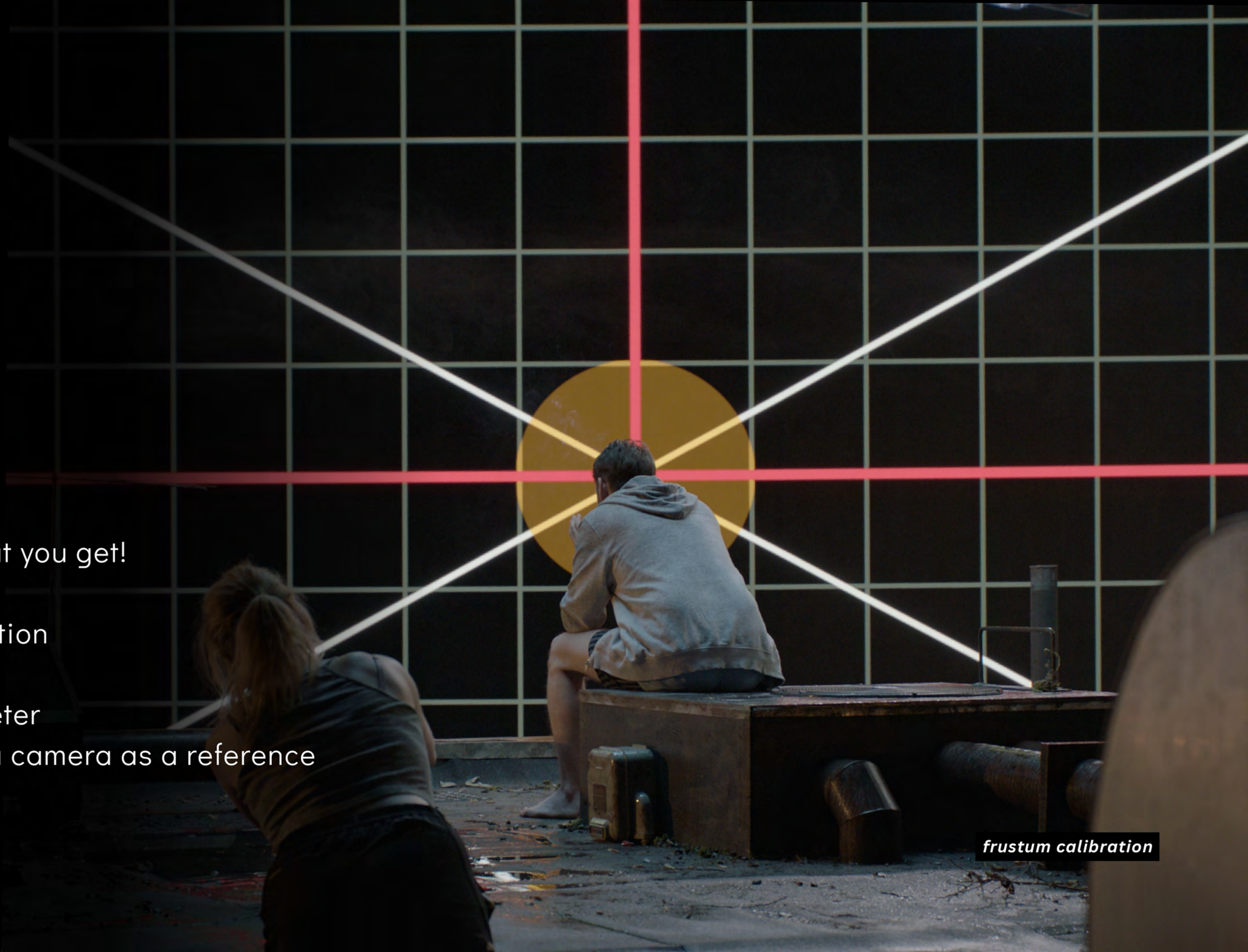
- checking optical with vertical moving bars
- manual adjusting the offset
- aiming for maximal doubleframes visible in the viewfinder (180° phase switch)
- camera speeds to offset to genlock -> solid sync

Visual sync via red bars

Monitoring

//What you see is not what you get!

- challenges & issues
  - filmstock & calibration
  - artifacts
- importance of light meter
- using a digital cinema camera as a reference

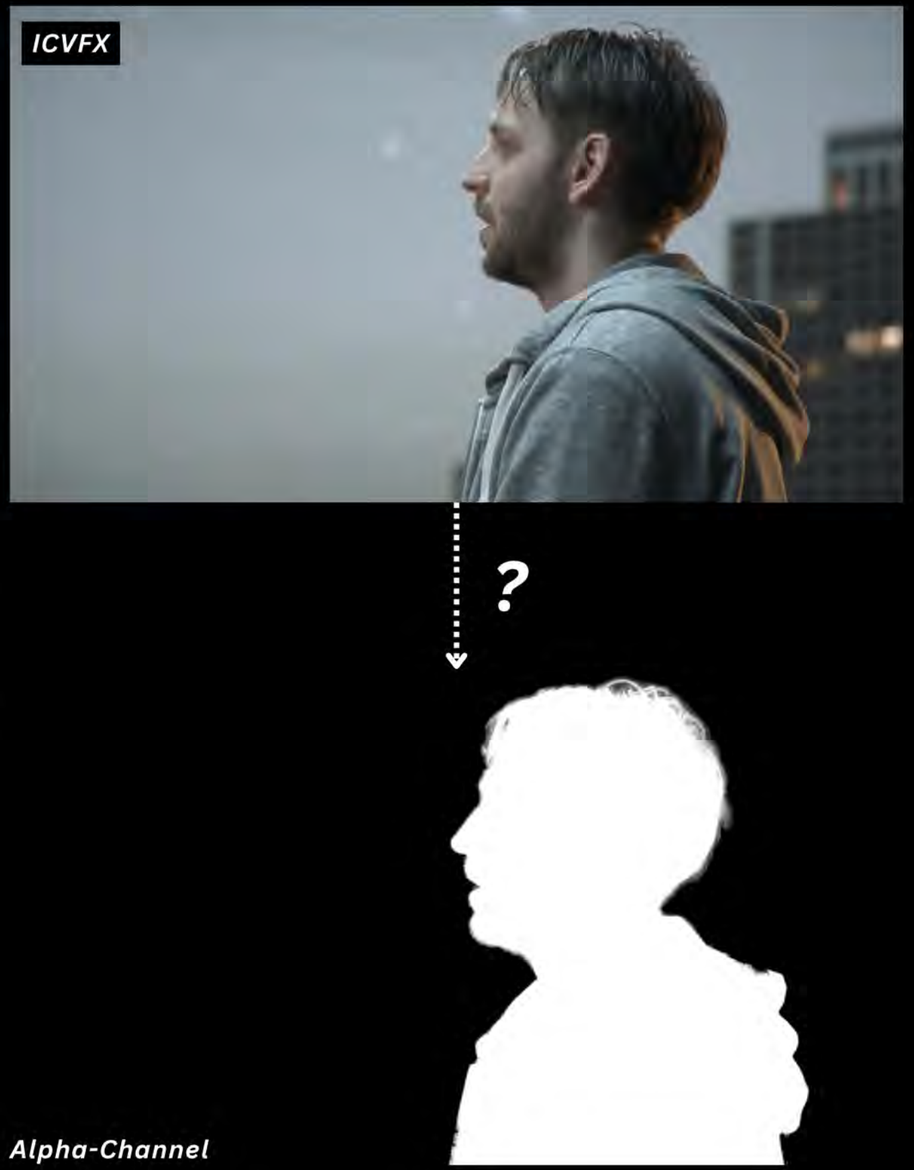


frustum calibration

Workflow-engineering

//Postproduction Advantages

- in ICVFX there is no keying channel,
- alpha channel useful for postproduction adjustings, bug fixing, grading mattes
- searching for an easy way to reproduce an accurate background matte without rotoscoping
- Traditionally keying is realized with mathimatical definable values (Chromakeying, Lumakeying)
- AI-based Depth Estimation lacks of detail needed for highend production
- What about difference keying?



Workflow-engineering

//Postproduction Advantages

- different approaches tested in this production
- best working concept based on frustum capturing
- inner frustum is captured on a headless server running in the cluster
- synchronized with virtual colorchecker

Workflow-engineering

//Postproduction Advantages

- simulation of background by training a neural network in a supervised learning process
- Realised shot specific with Nuke's CopyCat
- Model contains optical and electronical system

learn function

Workflow-engineering

//Postproduction Advantages

- A second pretrained model solves the background substraction from Nuke's Cattery [1]
- accurate Alpha channal generated

AI-Background Substraction

1) Based on Lin et al. (2020)

Workflow-engineering

//Postproduction Advantages

- changes can be realized and rerendered in unreal
- trained model conatins MTF -> reduces the need of comp adjustments
- dual model approach is useful for common workflows

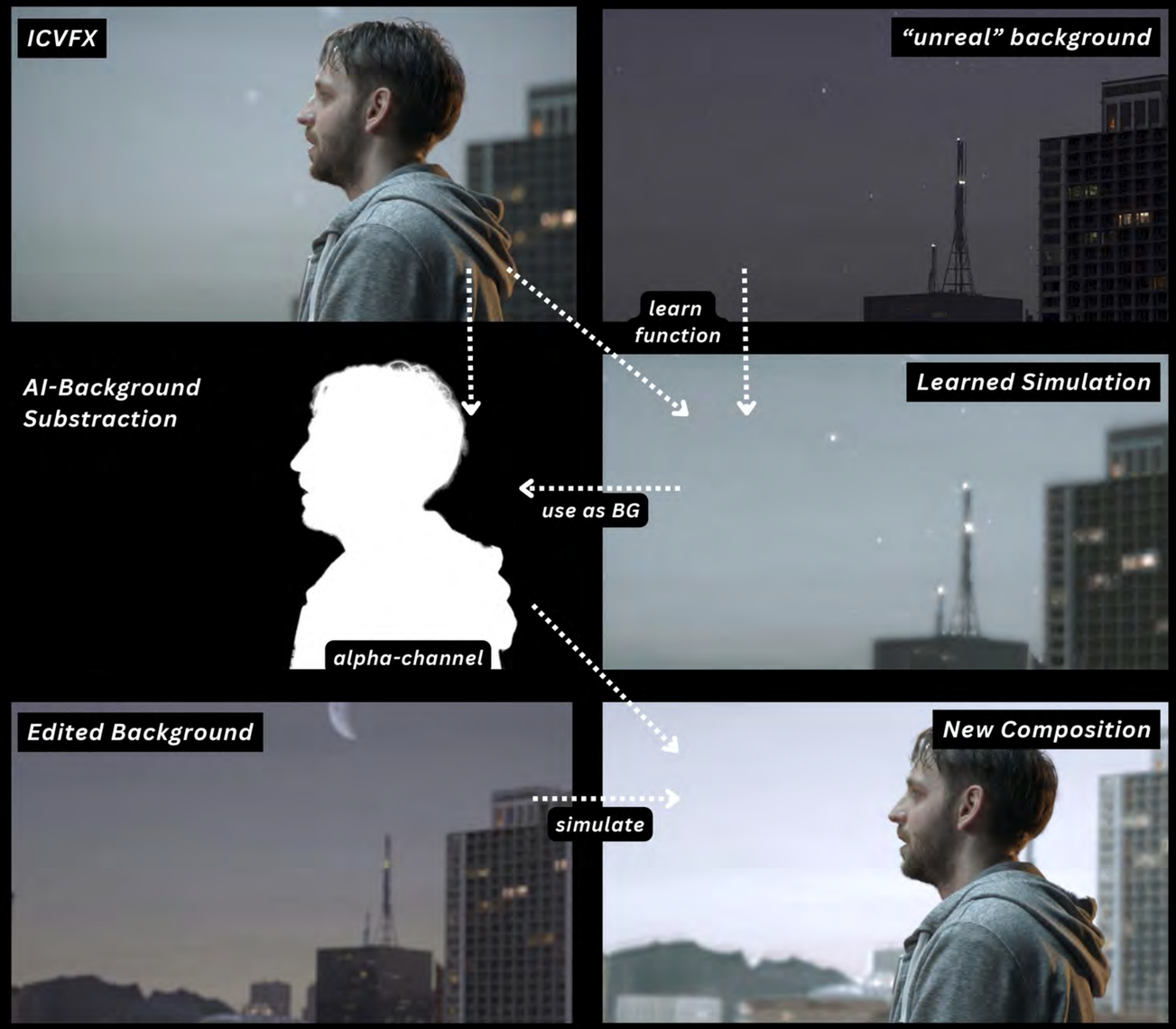
Alphachannel

simulate

Workflow-engineering

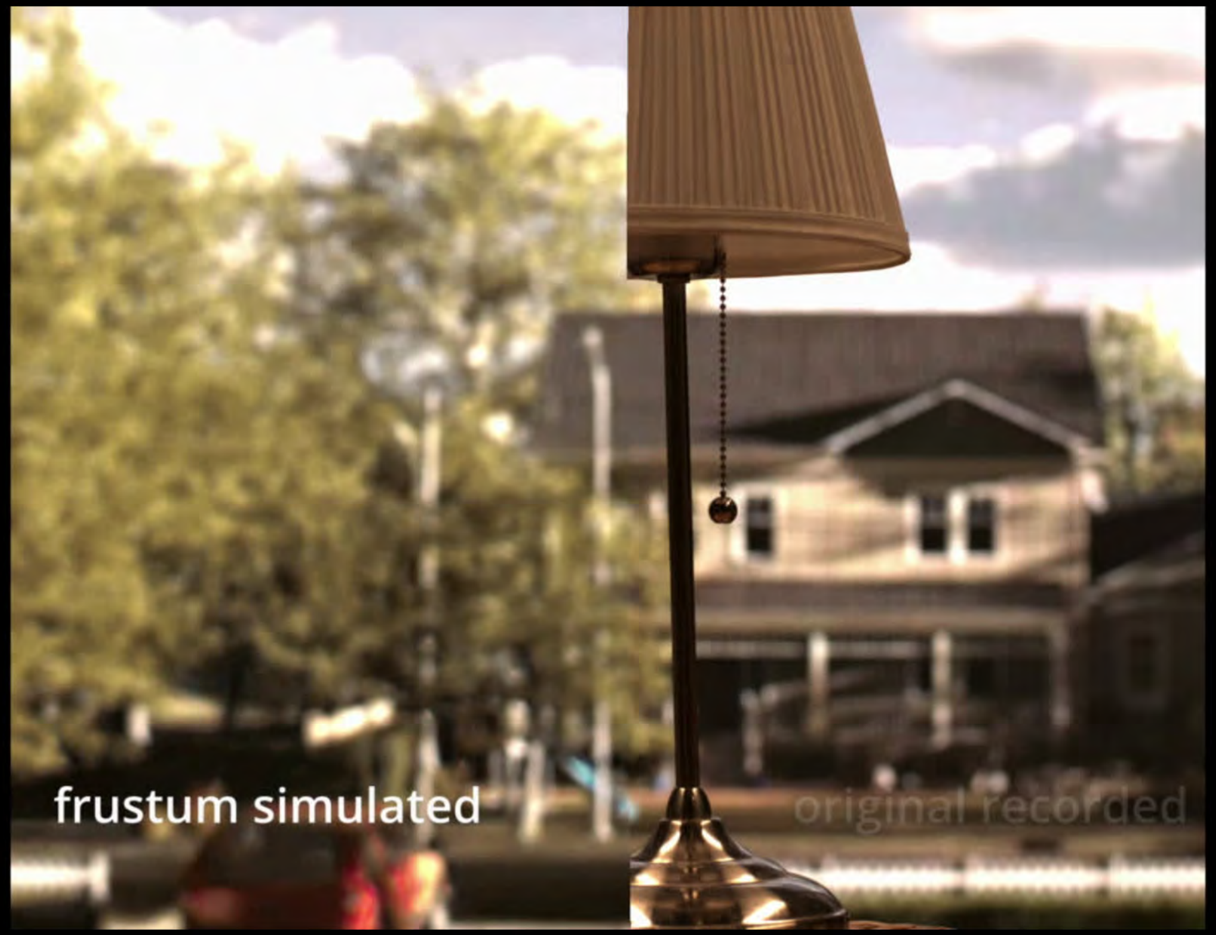
//Postproduction Advantages

- overview
- has limits



Workflow-engineering

//Postproduction Advantages



Workflow-engineering

//Postproduction Advantages

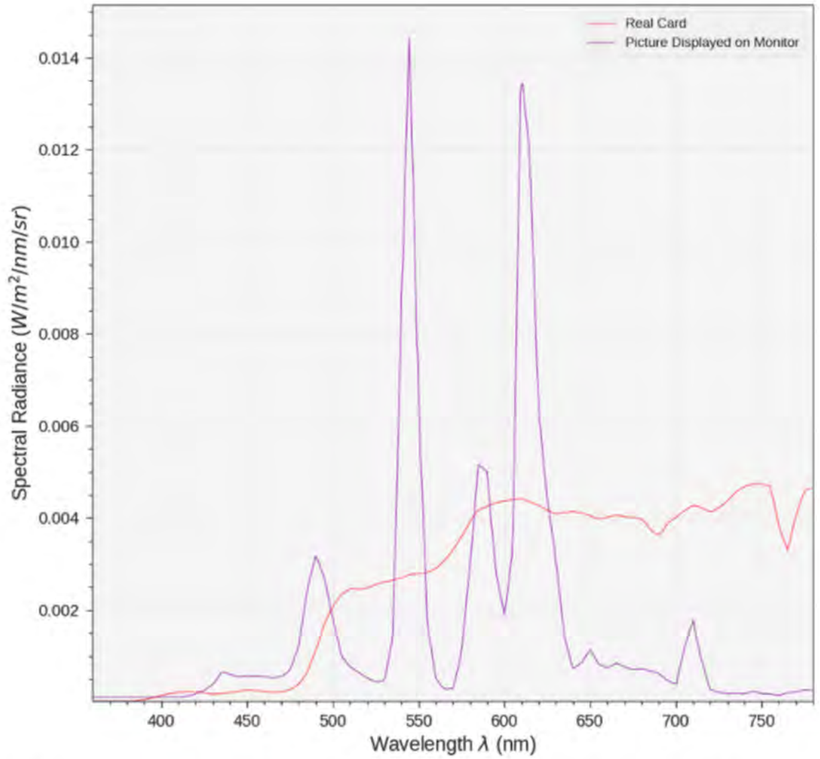
Color Rendition

//Challenges of lighting in the volume

- LED-walls are not only a set extension but powerfull light source
- However, the LED panels are not designed for that purpose

Color Rendition

//Challenges of lighting in the volume



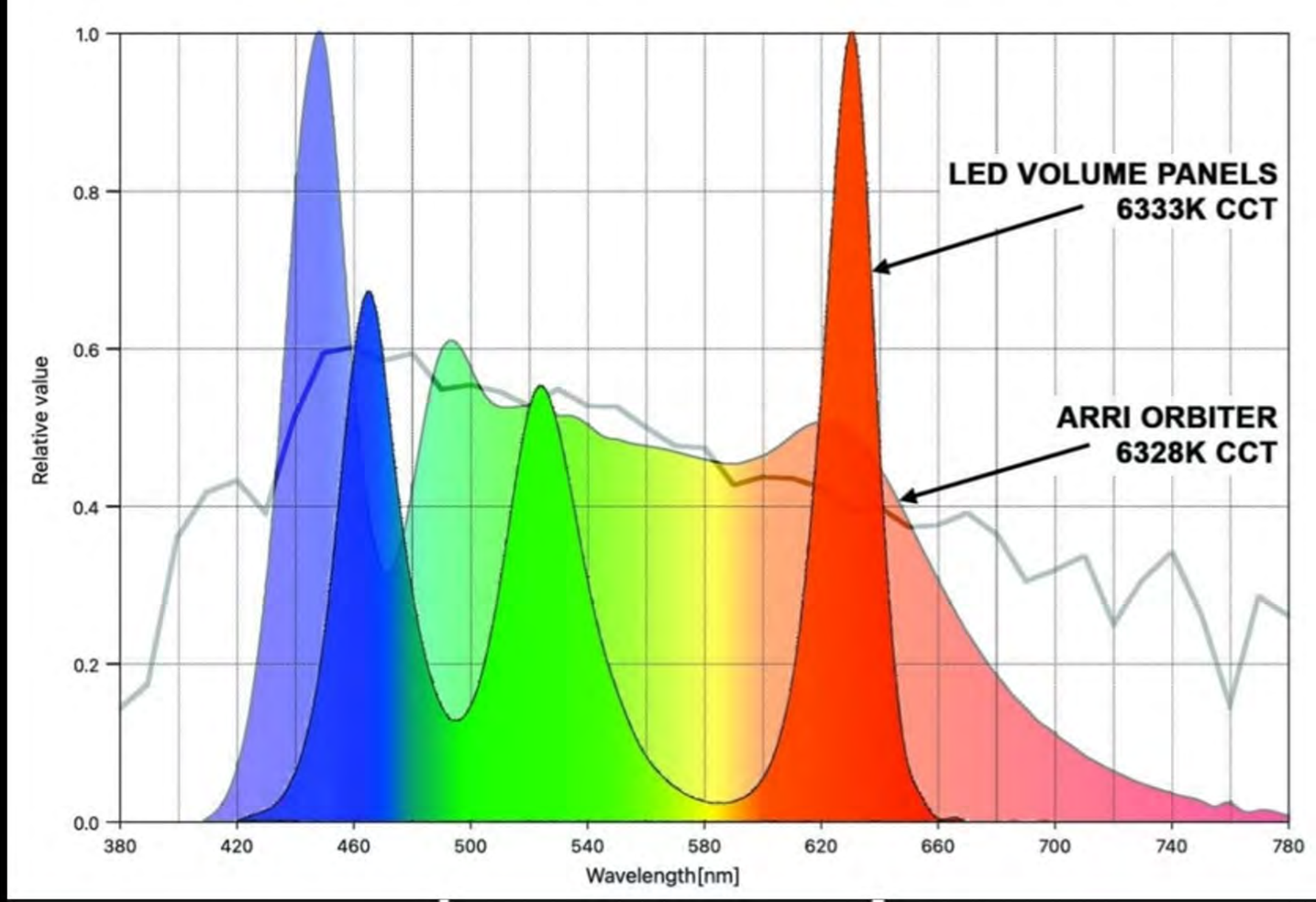
Yellow metamerism: two metameric spectral distributions producing the same color stimuli (metamers) even though the spectral distributions are radically different. The real card spectral distribution is relatively smooth while the spectral distribution of the picture of the card displayed on the monitor exhibits spikes from the monitor primaries. Spectral distributions and image courtesy of David Long (RIT).

- LED-walls used for VP typically only consist of red, green, and blue LEDs
- When the unreal scene emulates lightsouces like daylight the emitted spectrum differs from the spectrum of the physical equivalent
- two lightsources can produce the same color stimuli to the observer even though they have differing spectral power distributions (they are metamers)

Color Rendition

//Metameric failure

- When reflecting off objects, the spectrum make a difference
- The spectrum of RGB-LED sources often causes metameric failures
- These color reproduction errors are especially noticeable in human skintones
- how would film handle these problematic spectrums?



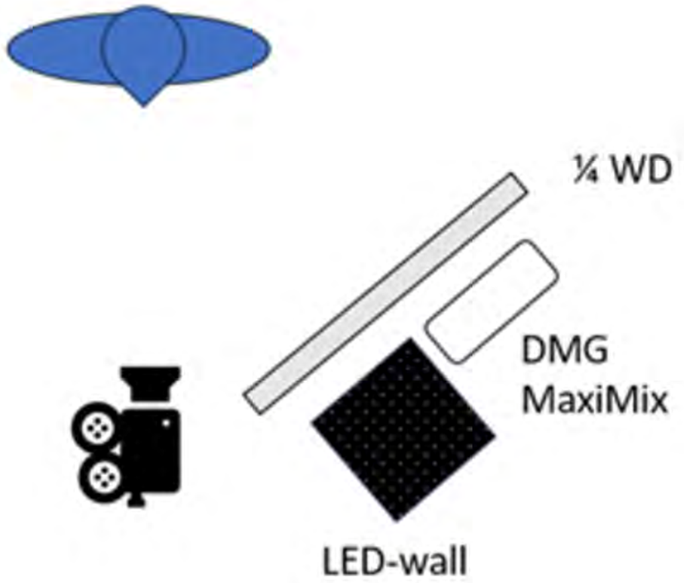
Kadner, N (2021). Color Fidelity in LED-Volumes. https://theasc.com/articles/color-fidelity-in-led-volumes

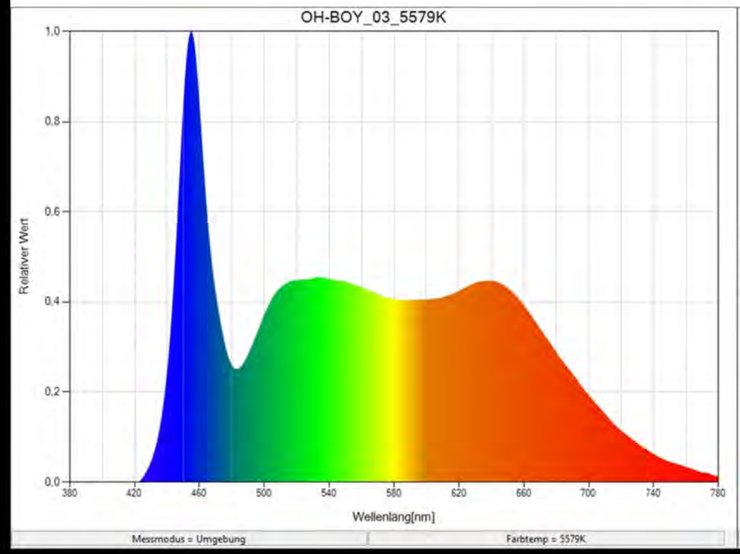
Color Rendition

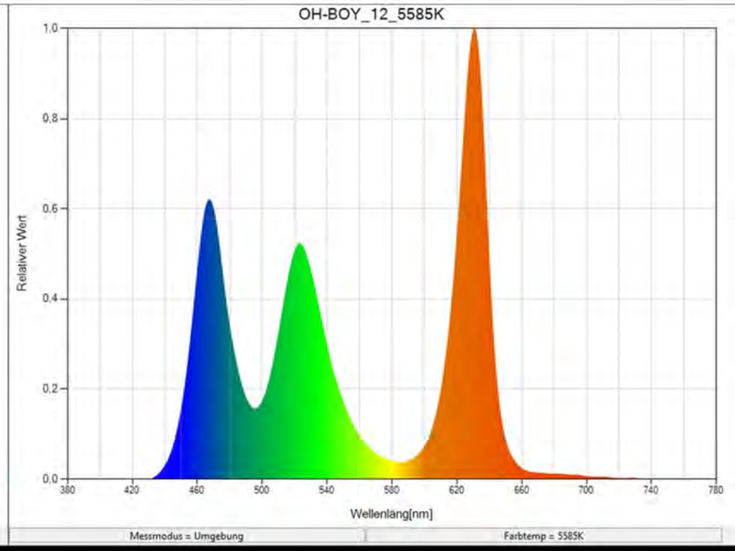
//Testing for Metameric failure on Film and digital

Test Setup:

- Kodak Vision3 250d vs ARRI Amira
- first lit by a full spectrum LED-panel giving the reference for “optimal”, natural color reproduction
- then lit by an RGB lightsource with narrow band spectrum, mimicing common LED-walls

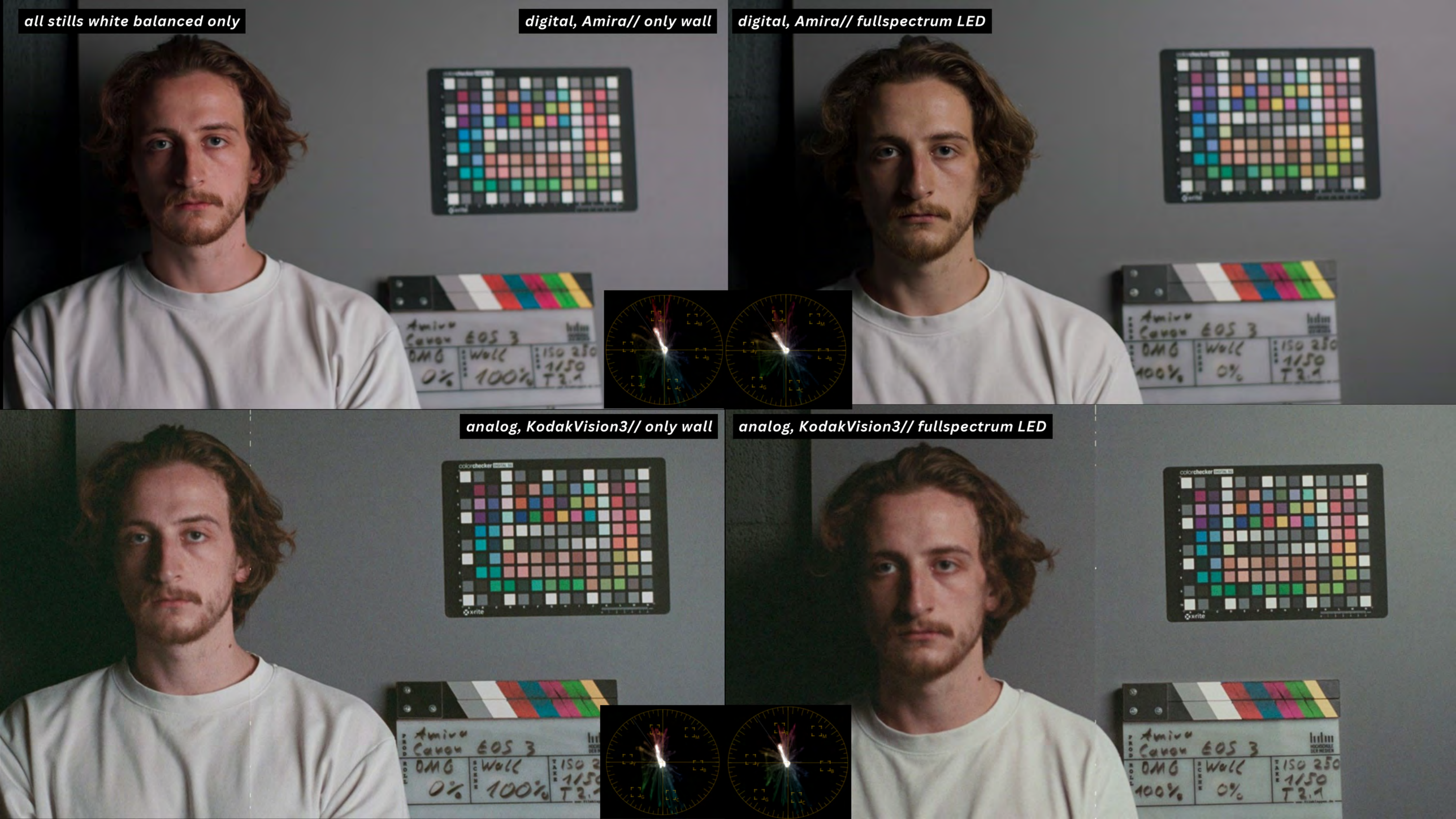






Fullspectrum LED// Optimum

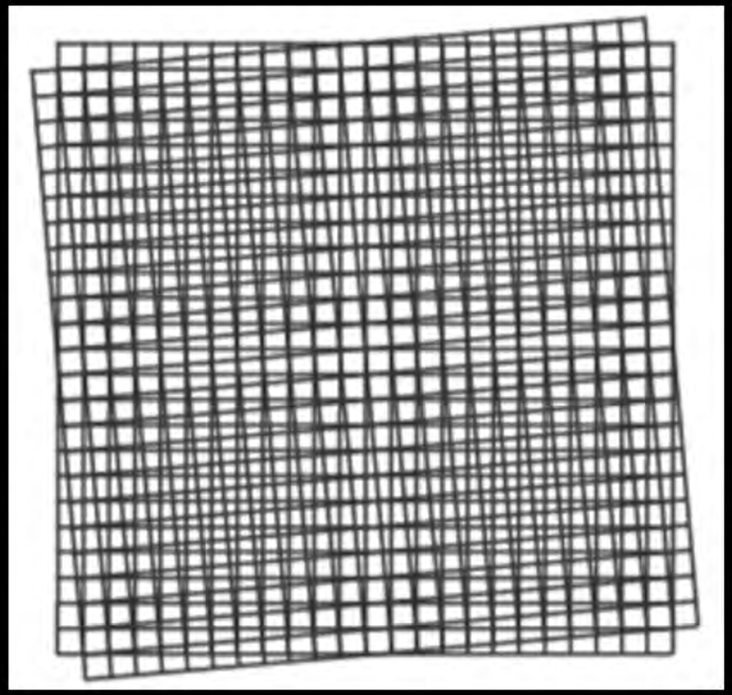
RGB LED// Volume


all stills white balanced only
digital, Amira// only wall
digital, Amira// fullspectrum LED
analog, KodakVision3// only wall
analog, KodakVision3// fullspectrum LED

Moiré

//What causes moiré

- image artifact caused by two overlaying periodic patterns
- Shooting in the volume heavily provokes moiré because of the grid pattern of the LED-wall
- Moiré occures at insufficient sampling frequency (defined by Nyquist frequency)
- ratio of the samplefrequency (sensor) to the sampled frequency (LED-wall) also depends on Pixelpitch and focallength, distance to the wall ect.

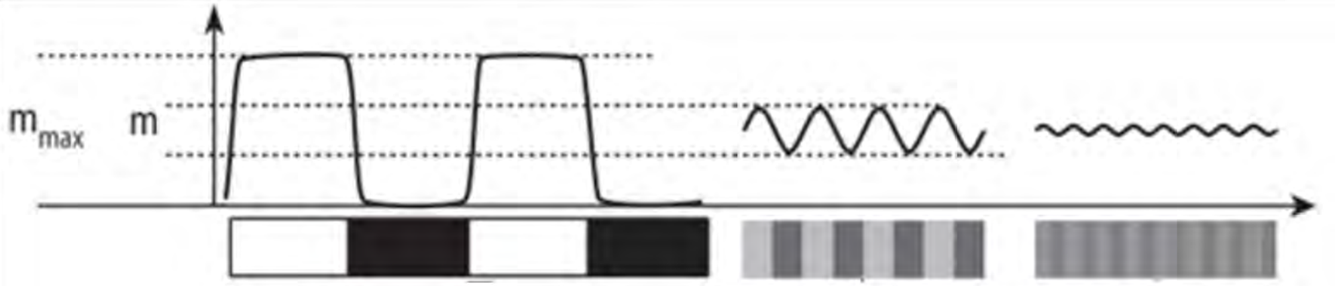


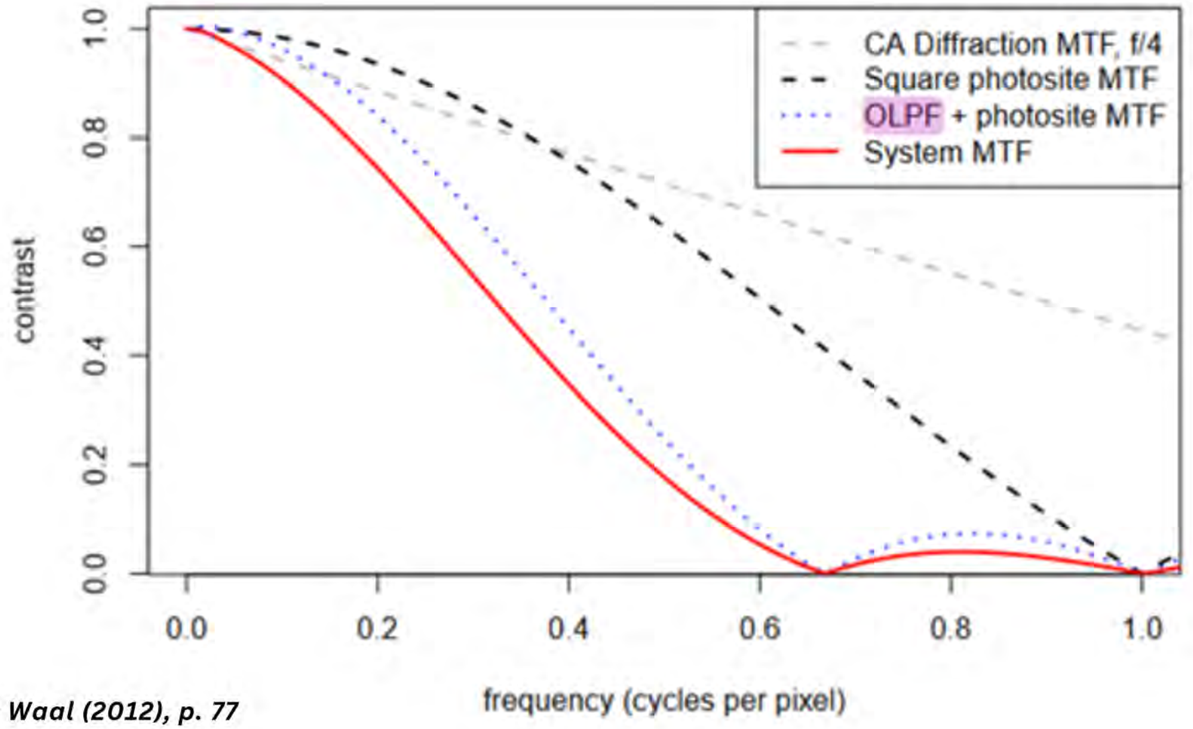
Moiré

//When to expect moiré

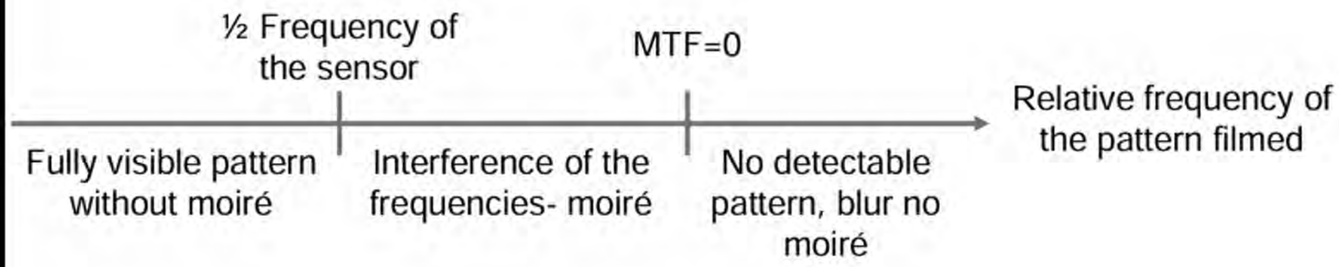
- Moiré occurs when
  f ledwall > f sensorpattern/2
- simultaneously the resolution must be high enough for the sensor to “see” the grid of the LED-wall to interfere with it
- this depends on Modulation Transfer Fuction (MTF)

--> 2 thresholds: the frequency of the sensor in relation to the frequency of the pattern filmed and the contrast rendition





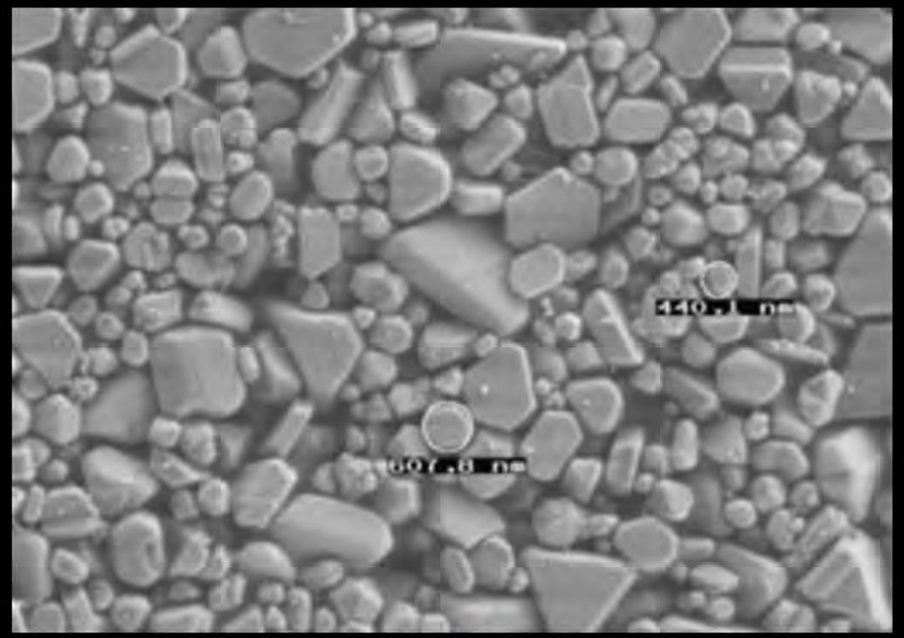
De Waal (2012), p. 77

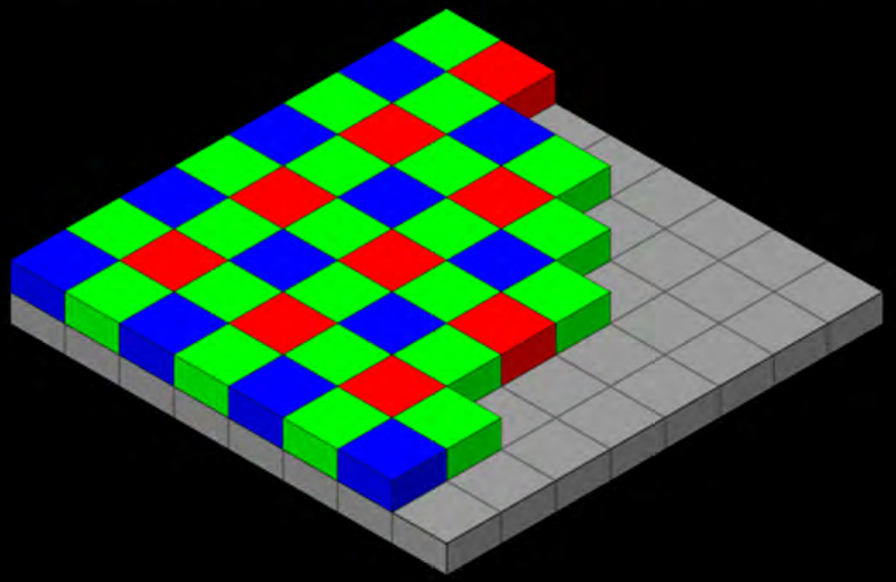


Moiré

//Differences when shooting film

- celluloid crystals are distributed in irregular patterns on the negative
- moiré artifacts can’t be captured on film by plainly filming the LED-Wall





Moiré

//Differences when shooting film

- However moiré can occur in the scan
- digital images naturally provide a second grid pattern
- when the pixel-grid of the LED-wall is resolved clearly enough in the negative so its “visible” to the CMOS scanner, the frequencies can interfere after the same principle
- depending on the scanner, sampling algorithms and potentially even the display in use moiré can occure
- Moiré is not prevented but postponed to the scanning process

Moiré

//Differences when shooting film

- **PRO:**

--> moiré is not baked into the image after capturing

--> the negative is an intermediate step which helps blur the grid before frequencies can interfere

- **CON:**

--> however, no feedback on set, whereas digital cameras give immeadiete feedback and allow for prevention on set

Conclusion

//Practical implications

- shooting on film is less flexible, no plug and play --> more prep required
    - Decide for a filmstock- set up the according color calibration in advance
    - Test whether syncronization is required- set up a sync solution
    - what you see is not what you get- set up a reliable viewfinder

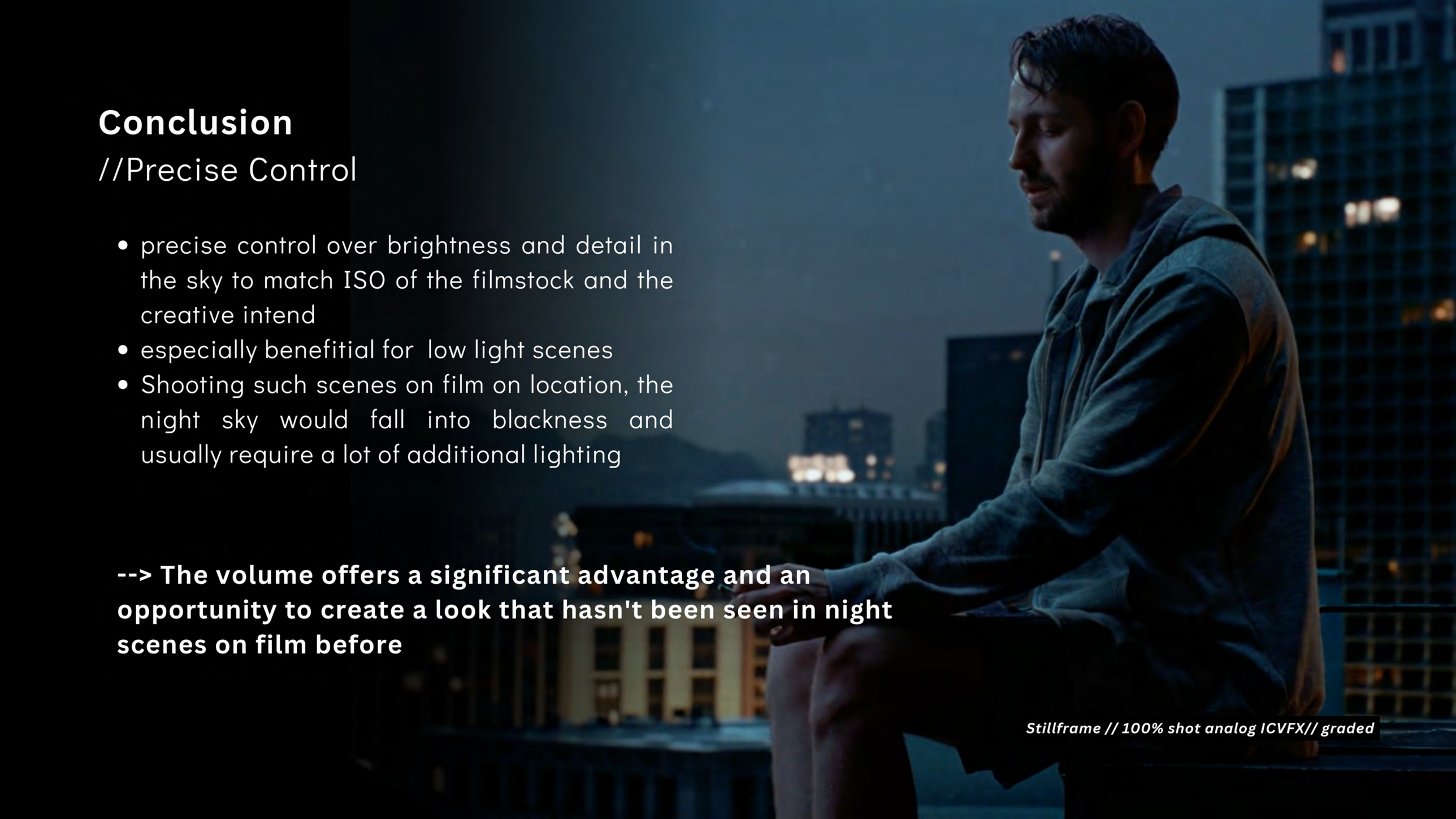
- Pleasing color rendition
- different results for moiré

Conclusion

//Precise Control

- precise control over brightness and detail in the sky to match ISO of the filmstock and the creative intend
- especially benefitial for low light scenes
- Shooting such scenes on film on location, the night sky would fall into blackness and usually require a lot of additional lighting

--> The volume offers a significant advantage and an opportunity to create a look that hasn't been seen in night scenes on film before



Stillframe // 100% shot analog ICVFX// graded

Shooting on film doesn't hinder the capabilities of the powerful Virtual Production tool - it extends it!

Bibliography

Lin, S., Ryabtsev, A., Sengupta, S., Curless, B., Seitz, S. & Kemelmacher-Shlizerman, I. (2020). Real-Time High-Resolution Background Matting. https://arxiv.org/pdf/2012.07810v1.pdf

Kadner, N (2021). Color Fidelity in LED-Volumes. https://theasc.com/articles/color-fidelity-in-led-volumes

De Waal (2012), p. 77

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