What you don’t see

// 35mm-film in the LED-Volume

Summary

The premise of “What you don’t see” was to prove that, despite much widespread skepticism, shooting analog film in an LED-Volume is possible, and to uncover the advantages and challenges involved. Together with HYPERBOWL, Studio L’Equipe, ARRI Rental München, oh, boy! films GmbH and SILBERSALZ we set up a series of tests and used the acquired learnings to realize a 2-minute narrative short film. To identify the differences of shooting analog vs digital in the volume, we shot on both Kodak Vision3 250d, ARRICAM ST and an ARRI Amira with ROE DIAMONDS LED-panels. It was found that shooting 35mm analog film in an LED-Volume is not only possible, but even beneficial when it comes to color rendering of skintones and defining specific looks. Virtual Production is not restricted to digital production workflows, even if there are challanges such as calibrating, monitoring and synchronization.

In the following, we will take a closer look at the advantages and disadvantages of analog film in a virtual production setting.

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

Setup

Studio: Hyperbowl

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

Analog

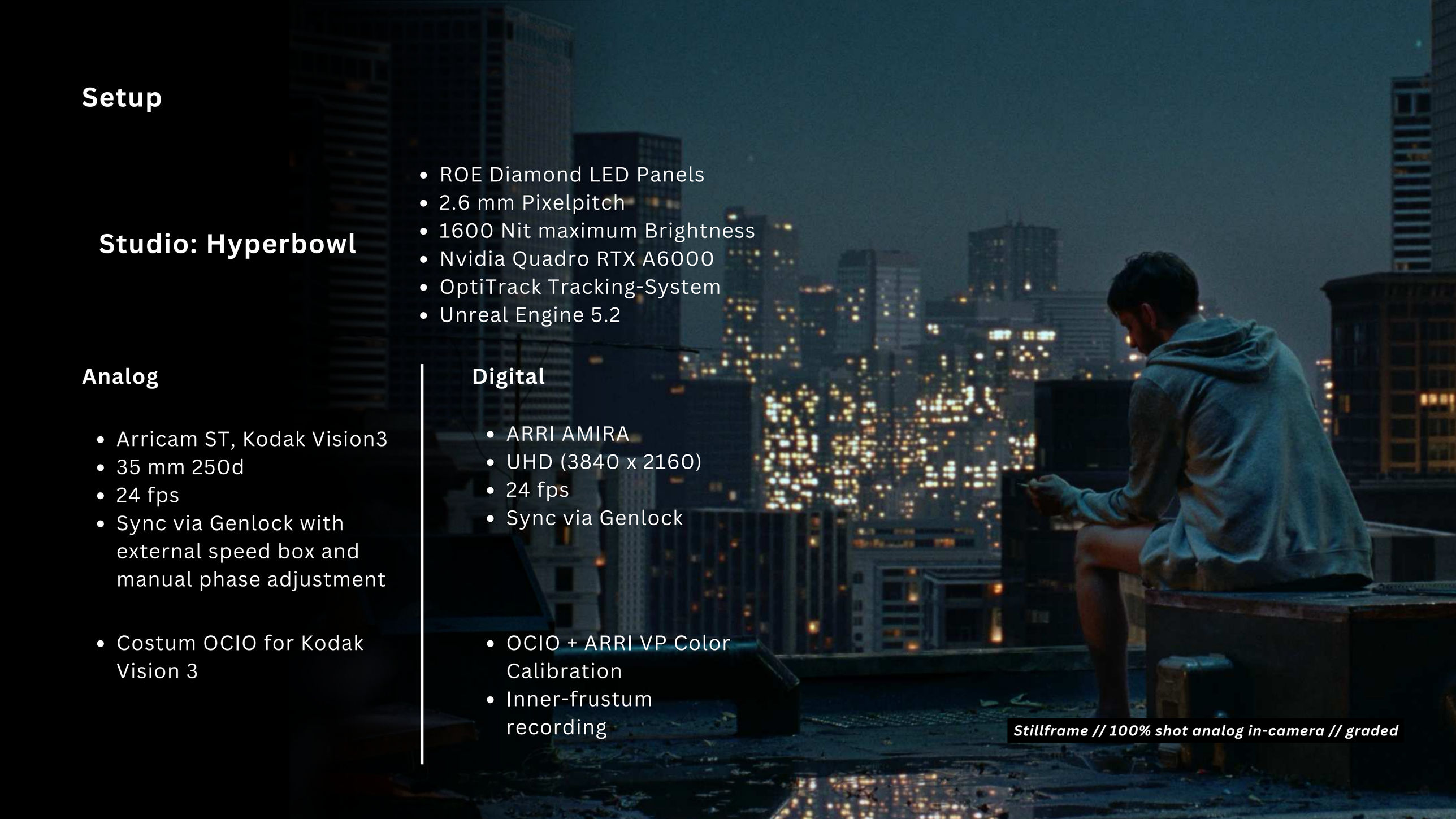
- Arricam ST, Kodak Vision3
- 35 mm 250d
- 24 fps
- Sync via Genlock with external speed box and manual phase adjustment

- Costum OCIO for Kodak Vision 3

Digital

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

- OCIO + ARRI VP Color Calibration
- Inner-frustum recording



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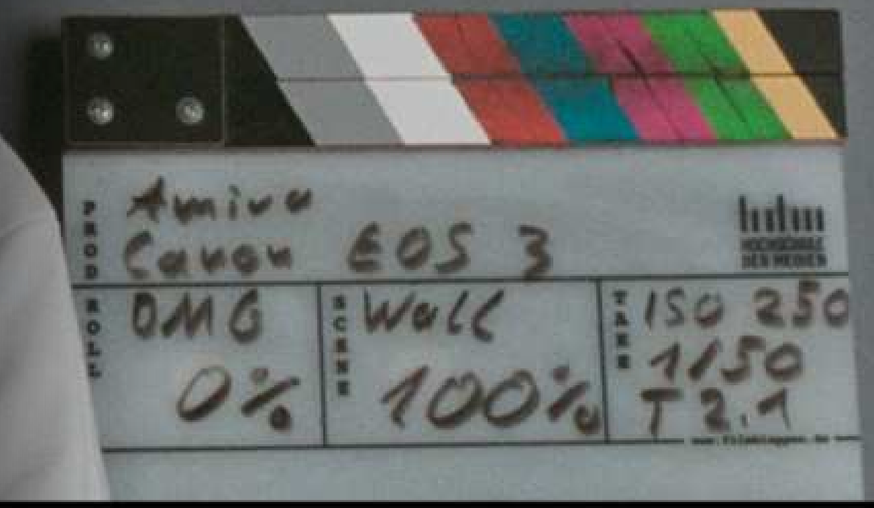
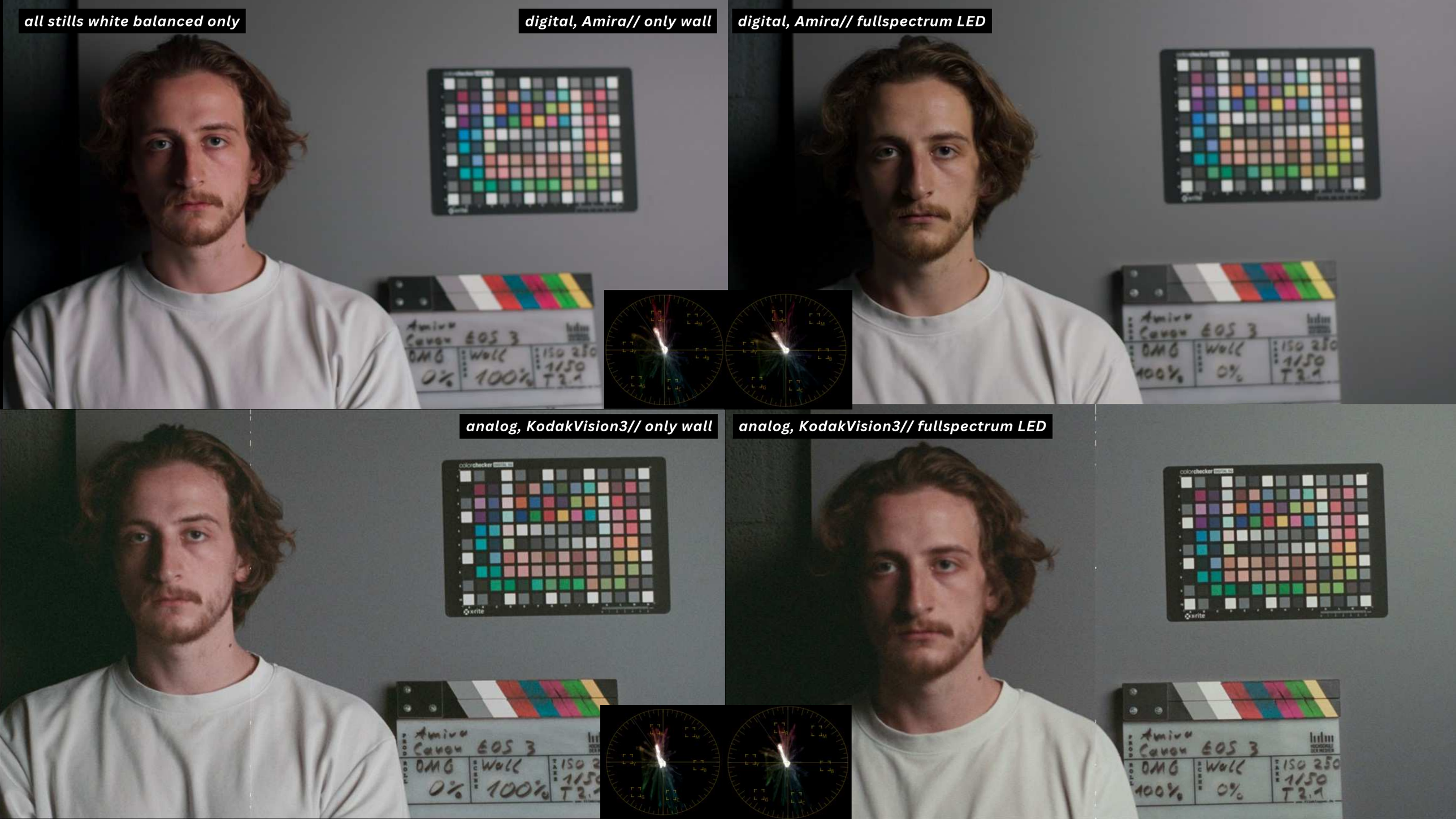
Advantages

//Color Rendering

The LED-walls commonly utilized in Virtual Production today typically only consist of red, green, and blue LEDs. Their emitted spectra are rather poor, causing color rendering or “metameric” failures. These color reproduction errors are especially noticeable in human skintones and make them appear “unnatural”. Since digital sensors and celluloid film capture color information fundamentally different and have different spectral sensitivities, film also handles these problematic spectrums differently.

The scene in a comparative test setup between Kodak Vision3 and an ARRI Amira was lit by an RGB lightsource with narrow band spectrum, mimicing common LED-walls. The same scene was then lit by a broad spectrum lightsource mimicing daylight and giving the reference for “optimal”, natural color reproduction. Senior Colorists Florian “Utsi” Martin (ARRI) and Steffen Paul (BasisBerlin) evaluated the footage of the test setups. They found that in the analog footage, the tested caucasian skintone and the colors on the colorchart showed less deviation from the respective optimal colors when being exposed by RGB light than in the footage shot on the Amira. The analog footage seemed to retain more natural colors overall, showing less meatmeric failure and therefore proving to be very beneficial in the grading.




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

Advantages

//Moiré

Whereas the photosites on digital sensors are organized in a regular grid structure, celluloid crystals are distributed in irregular patterns on the negative. This means that when shooting on film there are no two grid structures overlaying when plainly filming the LED-wall and moiré artifacts can't be captured in camera. However, as soon as the negative is scanned and translated into the digital realm, moiré can occur since digital images, being devided into concrete pixels, naturally provide a second grid pattern. This phenomenon only occures when the pixel-grid of the LED-wall is resolved clearly enough in the negative so its "visible" to the scanner and is influenced by the pixelpitch of the wall and the physical imaging chain of the lens, the aperture, the focal length and focal point etc. Whether this captured grid then interferes with the digital grid of the scanner or display depends on the technology of the scanner, it's resolution, sampling algorithms and the resolution of the display in use, which makes moiré hard to predict.

Hence, moiré cannot be completely prevented even with film, unless the entire post-production and delivery process is analog. However, film can still be advantageous for moiré, as the negative, compared to a digital workflow, is an additional step between the scene and the digital image. This intermediate step has a blurring effect, which tends to diffuse the grid of the LED-wall in the image before it's digitazion. Additionally, moiré artifacts are not baked into the image after capture and can potentially be avoided in post-production by scanning in different resolutions.

analog, KodakVision3// 6k ARRISCAN

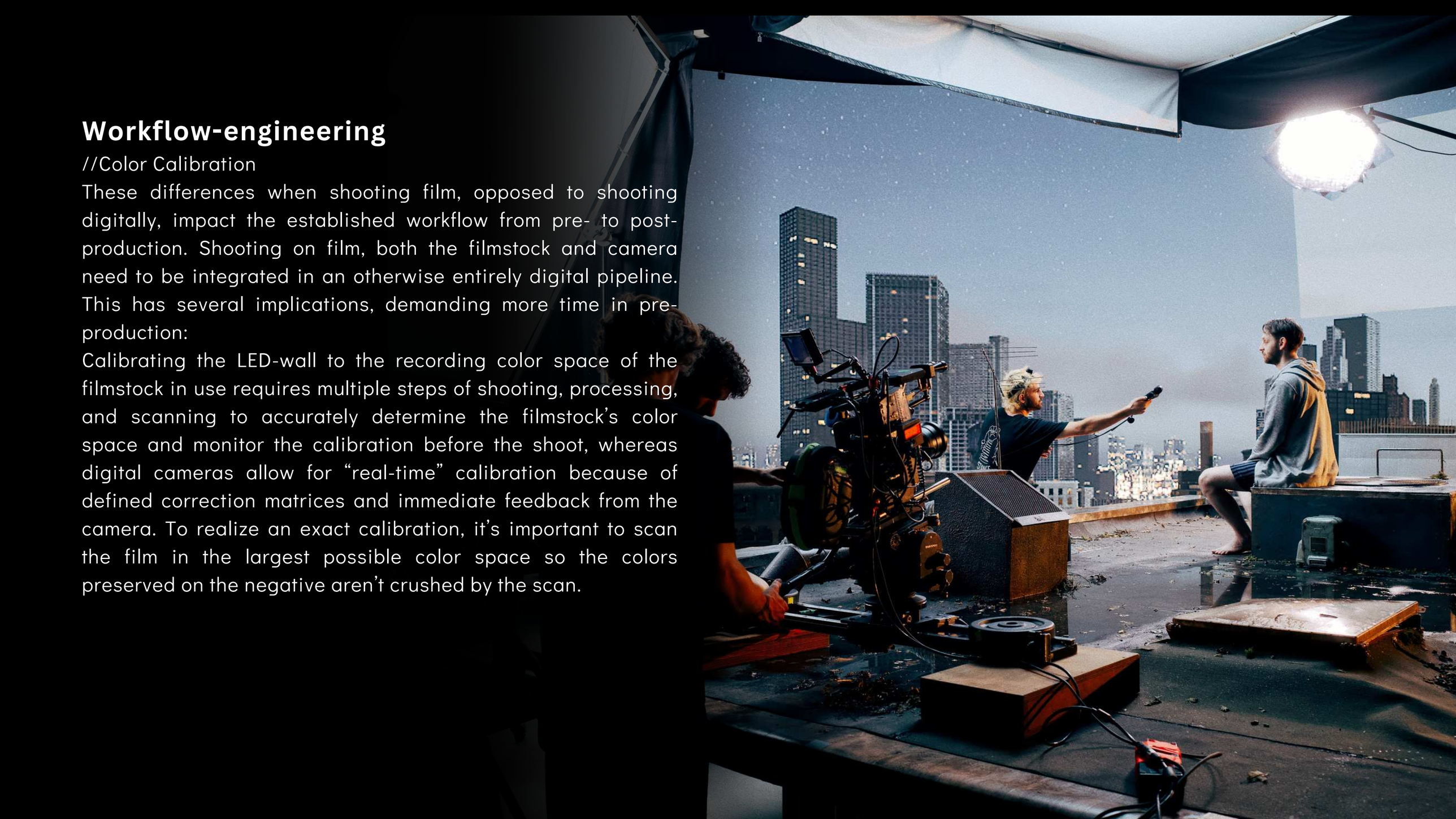
analog, KodakVision3// 3k ARRISCAN

Workflow-engineering

//Color Calibration

These differences when shooting film, opposed to shooting digitally, impact the established workflow from pre- to post-production. Shooting on film, both the filmstock and camera need to be integrated in an otherwise entirely digital pipeline. This has several implications, demanding more time in pre-production:

Calibrating the LED-wall to the recording color space of the filmstock in use requires multiple steps of shooting, processing, and scanning to accurately determine the filmstock's color space and monitor the calibration before the shoot, whereas digital cameras allow for "real-time" calibration because of defined correction matrices and immediate feedback from the camera. To realize an exact calibration, it's important to scan the film in the largest possible color space so the colors preserved on the negative aren't crushed by the scan.



Workflow-engineering

//Synchronization

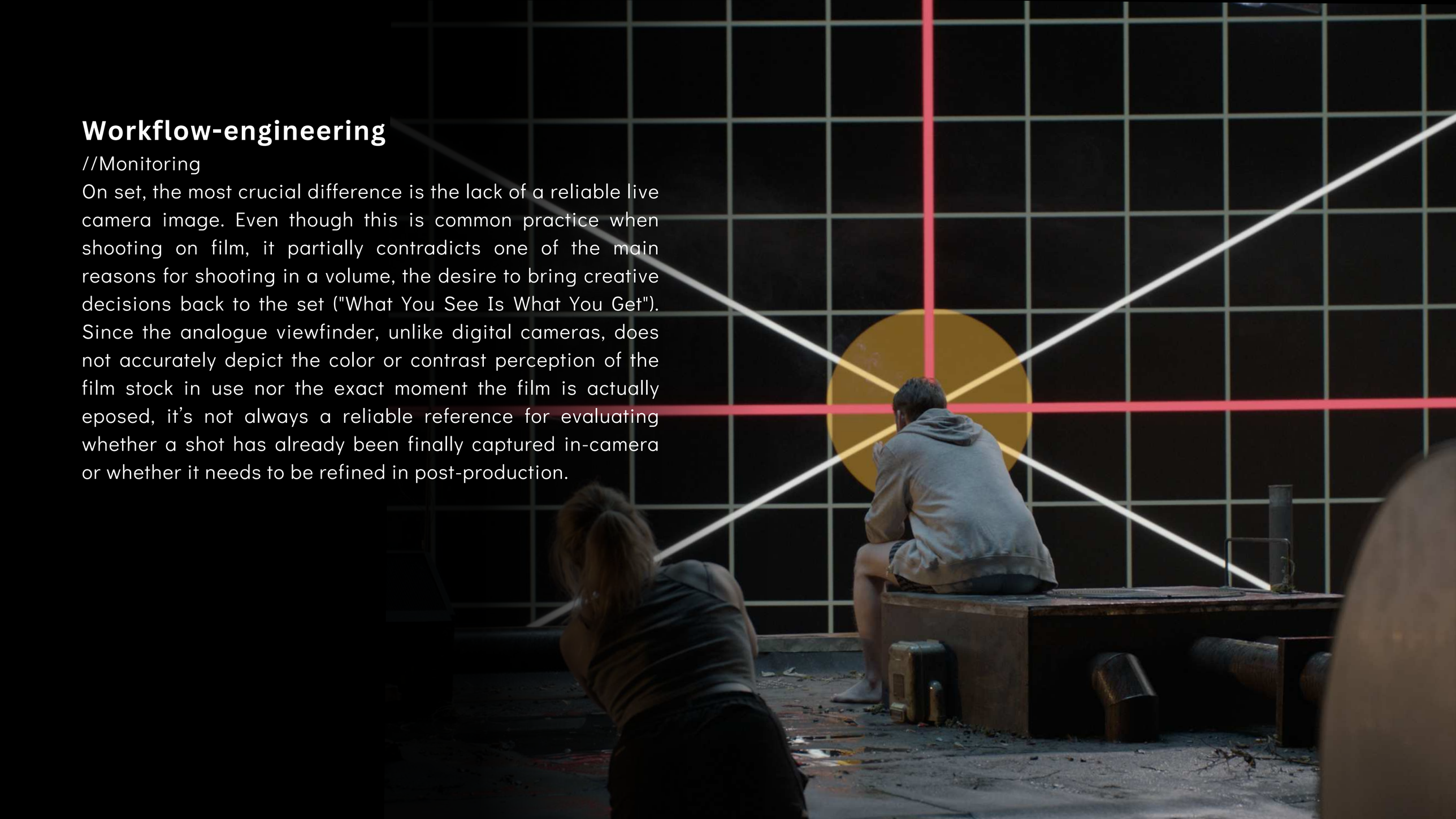
While camera tracking follows the same principle as when shooting digitally, setting up the synchronization between the LED-wall and the camera requires work arounds due to the lack of compatibility between todays standard genlock signals and available film cameras. With the help of two separate synchronization signals and the ARRIcam ST's external Speed Box, both components can be run at the same pulse. However, accurate synchronization can only be judged visually by manually adjusting the phase of the cameras shutter. By ensuring maximal off-sync images being visible in the viewfinder, double images on the exposed film can be prevented since the film records images that are 180° phase switched to the ones projected on the telly.

Visual sync via red bars

Workflow-engineering

//Monitoring

On set, the most crucial difference is the lack of a reliable live camera image. Even though this is common practice when shooting on film, it partially contradicts one of the main reasons for shooting in a volume, the desire to bring creative decisions back to the set ("What You See Is What You Get"). Since the analogue viewfinder, unlike digital cameras, does not accurately depict the color or contrast perception of the film stock in use nor the exact moment the film is actually eposed, it’s not always a reliable reference for evaluating whether a shot has already been finally captured in-camera or whether it needs to be refined in post-production.

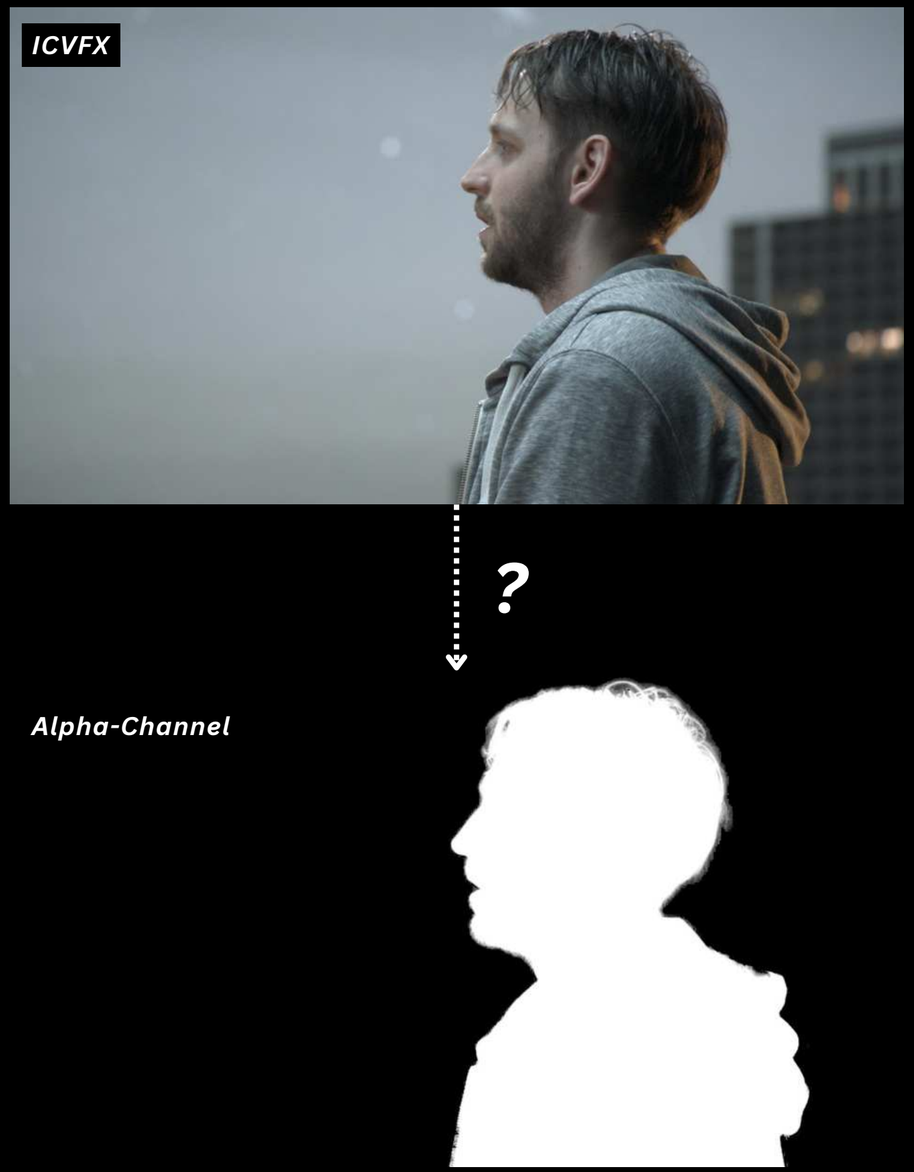


Workflow-engineering

//AI supported Postproduction

Whenever additional VFX is needed to refine a shot, the difficulty of a missing alpha-channel becomes a problem. In traditional greenscreen shooting the alpha-channel is generated through established keying methods. If there is no mathematically defined set of pixels that defines the background (such as green pixels when shooting in a greenscreen-environment), it is difficult to sperate the image in accurate layers. In ICVFX there's no such defined set, since the captured image is already composited. But in case of occuring errors or creative wishes the background has to be fixed sometimes.

AI-based depth estimation or image segmantation tools lack the amount of details needed for an accurate key for VFX. Manual rotoscoping often remains the only solution. In this production a new approach was developed and tested.



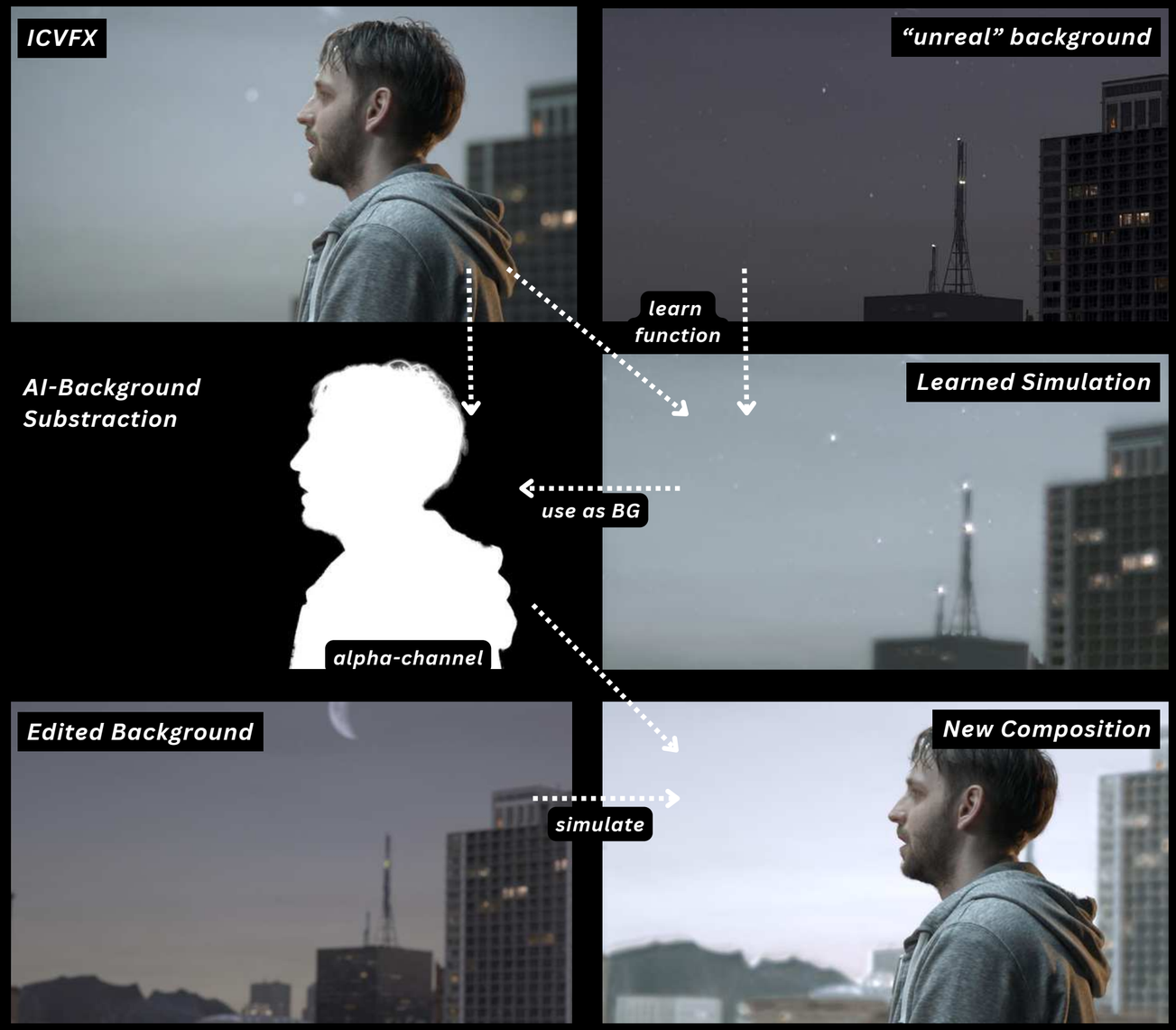
Workflow-engineering

//AI supported Postproduction

A solution developed and evaluated in this production is the concept of capturing the virtual background separately, train a neural network to simulate how the camera would capture it and calculate the foreground-alpha of the image by subtracting the background with a pretrained neural network. With this technique, the time-consuming process of rotoscoping could be prevented.

The simulation of the background is necessary because the inner frustum is recorded separately, meaning that there is no camera capturing it from the LED screen. With the simulation, a Background Subtraction Model can accurately calculate an alpha channel. In addition, the learned function can be used to make a newly rendered background appear as if it were filmed from the screen.

The developed method of saving the foreground matte through Virtual Production could be a huge advantage for VP, since it combines classic Compositing-Concepts with the In-Camera features, not just for analog shooting.



New Looks

//Precise Control

The LED-Volume provides precise control of the virtual scene in terms of colors, brightnes and the time of day. Shooting low light scenes, like dusk, dawn or a night exterior in the volume enables filmmakers to adjust the brightness of the sky and the level of detail in the clouds and stars exactly to their liking and to the ISO of film stock in use. Shooting such scenes on film on location on the other hand, would often result in the night sky falling 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, reminiscent of analog long exposure night photography.

Shooting on film doesn't hinder the capabilities of the powerful Virtual Production tool.

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