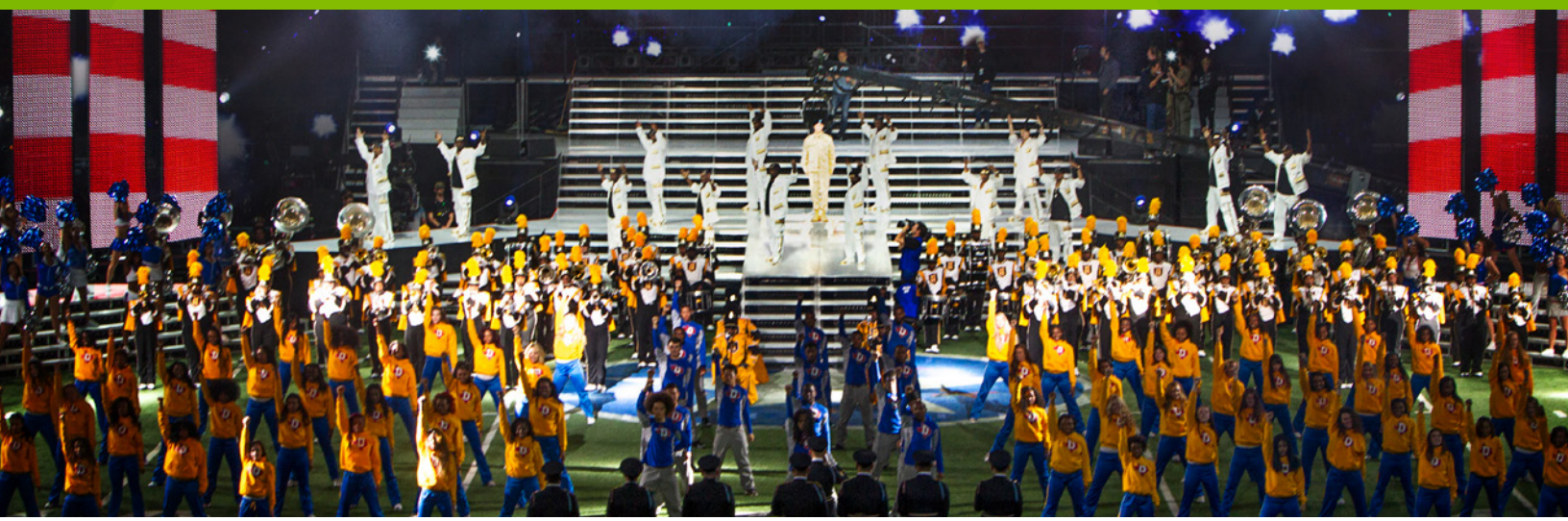
BILLY LYNN'S LONG HALFTIME WALK



NVIDIA

Billy Lynn's Long Halftime Walk reaches a record-setting 120 frames per second with NVIDIA GPUs.

AT A GLANCE

SUMMARY

> Billy Lynn's Long Halftime Walk marks a new era in filmmaking, as the first major motion picture captured in 120 FPS, in 3D at 4K resolution and in High Dynamic Range. Made possible by NVIDIA GPUs and innovative new software from ColorFront, FilmLight, and The Foundry, this film gave director Ang Lee the freedom to blend multiple high-tech advancements to tell a moving, visually striking story.

SOFTWARE

> ColorFront Express Daily

> FilmLight Baselight 4.4m1

> The Foundry NUKE and Ocula Stereo plugins

HARDWARE

> Variety of NVIDIA® Quadro® and GeForce® GTX GPUs

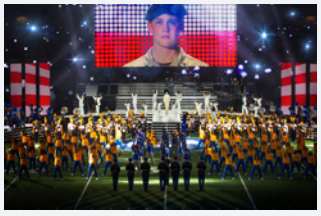
> NVIDIA Quadro Sync Card

> FilmLight Baselight X

> Christie Mirage 4K 120 Hz 3D Stereoscopic digital projectors

REASONS FOR NVIDIA GPUs

1. Image processing and high fidelity display on dual 3D Stereoscopic digital projectors
2. Interactive, multilayer color grading at 4K 120 Hz
3. Highly immersive 4K projection



Cover: Image Courtesy of Sony Pictures Entertainment

Any film from two-time Oscar-winning director Ang Lee would be highly anticipated. But *Billy Lynn's Long Halftime Walk* was shot and produced in a revolutionary new format that's years ahead of its time. It's the first major motion picture captured in 120 frames per second (FPS) 3D at 4K resolution, and in High Dynamic Range (HDR).

Lee's adaptation of the novel by Ben Fountain stars Vin Diesel, Kristen Stewart, Garrett Hedlund, and Steve Martin. The harrowing drama about war and remembrance—shot by two-time Oscar-winning cinematographer John Toll—immerses the viewer in hyper-real battle footage unlike anything ever depicted on screen.

The director blended several high-tech innovations to result in a film beyond the capacity of even existing movie theaters. Shooting in stereo on two Sony F65 cameras meant that every stage of the process, from capture through post-production, required technical innovation and new thinking.

CHALLENGE

The industry-standard frame rate for feature films is 24 FPS. The *Billy Lynn* story, though, involves many high-paced action war scenes. If shot at a standard rate, the images would suffer motion stutter, causing headaches and eyestrain for the viewer.

According to Ben Gervais, production systems supervisor for the film, "Ang was looking to solve the problem of motion stutter, which can occur both in 3D and at 24 frames. Viewing motion stutter sends signals to your brain that something is not right. The answer was to increase the frame rate. But that comes with challenges of its own."

Combining the advanced technology of 120 FPS with 3D in High Dynamic Range produces five times the amount of data of a standard film. Adding stereo 4K increases it to 10 times more data than other productions. Over the course of 47 shoot days, 400 terabytes of data were produced. And neither the budget nor the deadlines could suffer, so all that data needed to be processed just as quickly.

"While experimenting with various frame rates in the beginning, we discovered that the human brain adjusts very quickly to the new framery," said Gervais. "I see this as comparable to when sound was introduced to movies in 1927; what is considered 'normal' is about to be redefined."

SOLUTION

Innovation and creative thinking needed to happen at every level to realize Ang Lee's vision for Billy Lynn. NVIDIA GPUs were incorporated across almost all stages of the film's production, including on-set dailies, color, final finishing, and finally projection of 120 FPS screenings.

Stereo Correction and Visual Effects	The Foundry NUKE, Ocula Stereo plugins	3D transformations and compositing accelerated by NVIDIA GPUs
Conform and Final Color Grade	FilmLight Baselight	NVIDIA GPU-accelerated grading, stereo correction, and dual 120P 4K review
HDR Grade	FilmLight Baselight Christie Mirage 4K25 120 FPS projectors	Powered by NVIDIA GPUs

Colorfront's production team needed to process an entirely new level of data for on-set dailies, requiring a configuration with customized software to ensure they could move files as fast as possible. "There are a great many things that NVIDIA GPUs are made for, allowing us to work faster than on a CPU, including debayering, scaling, grading, and color-space conversion to transform the native colors of the camera on a regular computer monitor," said Bruno Munger, director of business development at Colorfront.

For a fully interactive color-grading experience, the production also required a Baselight system driving dual Christie Mirage 4K 120 Hz 3D stereoscopic digital projectors. These are different from typical digital cinema projectors in that they're often used for highly immersive user experiences such theme park rides. Using nine NVIDIA GPUs for

The commercial run of the film will play in a variety of 2D and 3D formats, all of which display the new techniques with which the film was made. Christie Digital has the only projection solution in the world that can show such a high frame rate and resolution in 3D, thanks to its Christie TruLife™ platform—with projectors powered by NVIDIA GPUs.

rendering, display, and a user interface—plus an NVIDIA Quadro Sync card for syncing the signal to the projectors—FilmLight created a custom version of their HFR Baselight X system. This could play back both eyes at 4K 120 Hz, while at the same time allow creative multilayer grading plus sophisticated 3D geometry correction. By providing the very high data rates for real-time uncompressed playback, combined with an interactive grading system, Baselight X provided a smooth, immersive experience.

Steve Chapman, CEO and co-founder of Filmlight said, "We use NVIDIA GPUs all in our grading systems to provide the highest quality in professional color correction. The multi-GPU configuration in the Baselight X system was engineered to allow those same operations to occur at this high resolution and frame rate on top of stereo geometry correction."

"You really have to see this work to understand the experience," he explained. "In the first few seconds, you realize you haven't seen anything like this before; the suspension of disbelief is almost immediate. We never see fast panning movement in film or, if we do, it's choppy and blurred. The footage in Billy Lynn is pin-sharp, so anything that might be fake—makeup, facial expressions, physical actions, and of course color correction—would be immediately exposed..."

RESULTS

While 3D and 4K are increasingly common technologies, they're rarely combined. The addition of 120 FPS produced an immersive, hyper-real experience for Billy Lynn unlike anything ever depicted on screen.

This technology is guaranteed to have an impact on how future films are shot and processed. With the extra clarity added, standard movie tricks of the past came through as fake—makeup couldn't be worn, lighting and staging had to be re-thought, and the acting had to be more subtle and realistic.

GPU-accelerated processing powered each step of the revolutionary workflow created for the film, enabling the handling of huge amounts of data. The resulting experience goes beyond simply observing the print of a film and more like perceiving reality, a visceral event free of eye strain, motion sickness, or distractions. The 120 FPS frame rate is a multiple of 24 (used for cinema) and 30 (used for television), making mastering for both TV and film simpler than usual.

Constant collaboration between the studio and the technical and creative teams enabled the efficient use of technology to tell the story of Billy Lynn in a way that's both emotionally moving and comfortable for viewers to watch. It's truly a watershed moment in filmmaking from one of the most visionary directors of our time. The techniques and workflow he and the team created promise to impact the film industry for years to come.

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