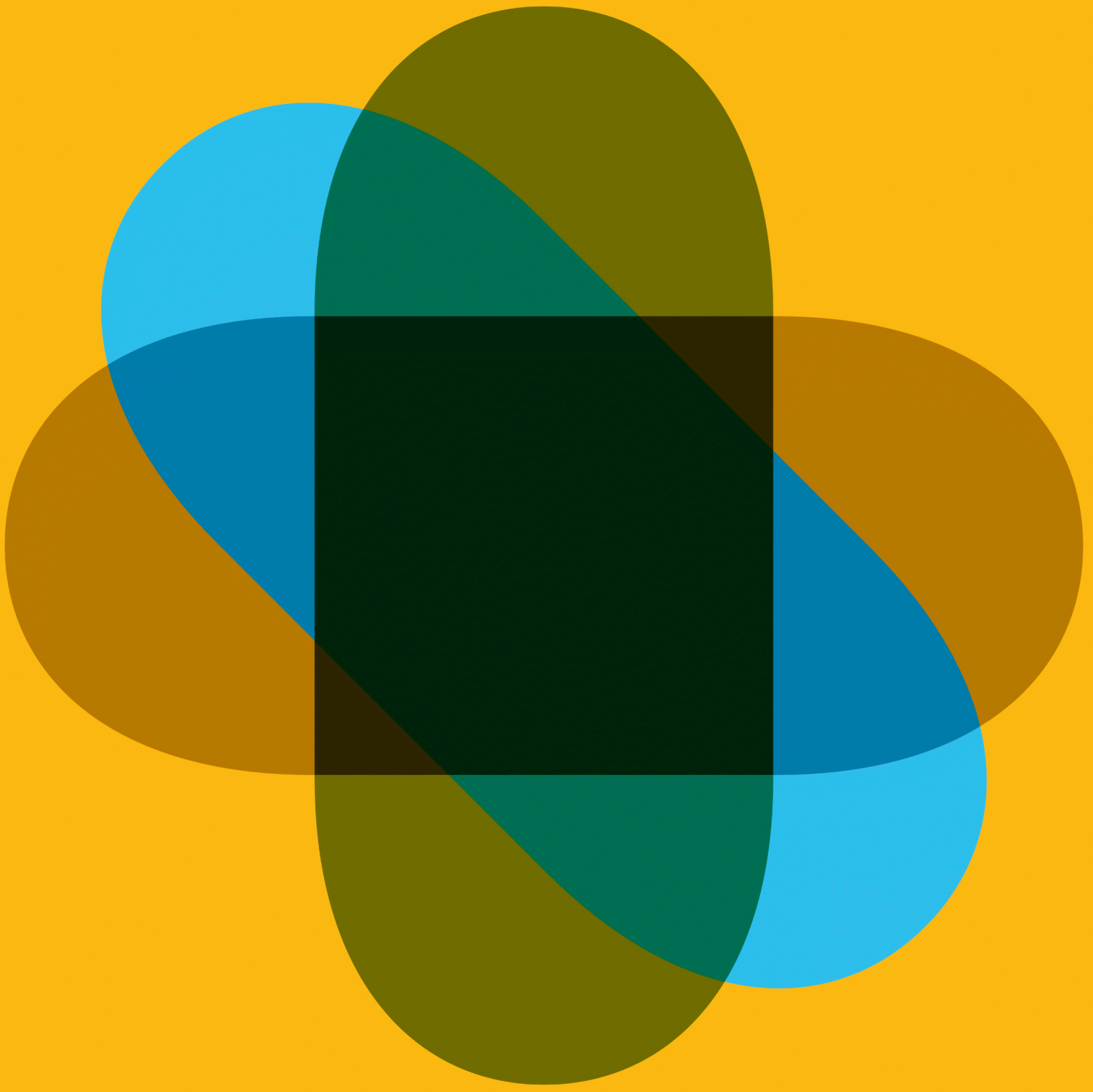

megapixel™

GhostFrame®

2025-03-24

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About Megapixel

Megapixel is the unrivaled authority in cutting-edge professional display technology and video processing for top-tier brands, creatives and design-led homes. Led by Jeremy Hochman and Keith Harrison, our unrivaled team of engineers and designers consistently delivers the most unique and breakthrough LED solutions to market, helping our visionary clients bring their ideas to life in ways that inspire a sense of wonder and make the seemingly impossible possible. With over 300 patents and award wins from Live Design, the Emmys, and the Oscars, we endeavor to always be at the forefront of digital displays and technology for which we set the bar as the industry standard.

We are the unrivaled authority in cutting-edge professional visual technology and video processing for top-tier brands.

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Introduction

In an industry where precision and flexibility are paramount, Megapixel's GhostFrame technology offers a pioneering solution for modern visual production. An exclusive feature of the HELIOS® LED Processing Platform and compatible with ROE LED displays, GhostFrame allows for simultaneous, multi-layered content capture, hidden cues, and improved post-production workflows. With a suite of features designed to enhance camera tracking, chromakey functionality, and multi-camera feeds, GhostFrame technology revolutionises in-camera LED video production, delivering efficiencies and creative possibilities previously out of reach.

GhostFrame Overview

GhostFrame leverages the power of HELIOS and ROE LED panels, providing cutting-edge technology designed to support high-resolution (4K and 8K) workflows without compromising on processing power. With over 50 pending and granted patents, GhostFrame technology allows production teams to capture multiple images within a single frame, supporting different feeds and visual perspectives while maintaining a single-take capture workflow.

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Key Benefits of GhostFrame Technology

- **Multi-Camera Freedom -** GhostFrame supports multiple, freely moving cameras that can simultaneously capture different frustums. This allows unrestricted camera movement without occlusion artifacts. Each camera can record distinct background perspectives, enabling efficient multi-angle shooting.
- **Hidden Chromakey and VFX Integration -** GhostFrame technology allows for seamless capture of chromakey and background elements in a single take. This makes post-production simpler by reducing the need for additional visual effects. Artists can adjust individual frames without re-rendering the entire scene, resulting in significant time and cost savings.
- **Invisible Camera Tracking and Markers -** GhostFrame embeds high-precision camera tracking markers within the screen, eliminating the need for physical markers. This approach enables automatic, accurate virtual set extensions without impacting bandwidth, providing a streamlined process for content creators.
- **Enhanced Talent Cueing -** The hidden cue markers and prompts improve on-set guidance for actors and talent, keeping them informed without distracting visible markers. This setup promotes smoother filming sessions and minimises performance interruptions.

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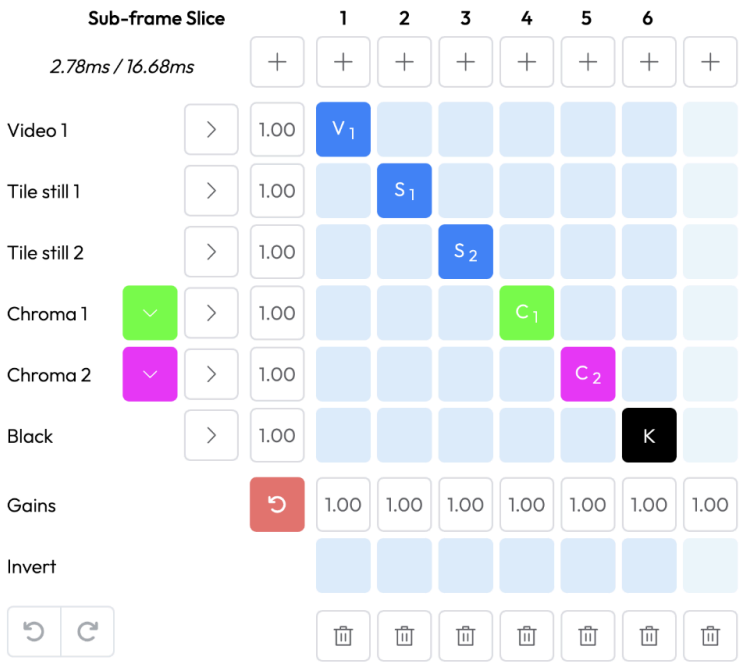
How GhostFrame works

GhostFrame uses two (2) key factors to operate on a highly controlled frame cycle:

- **Frame Slicing -** Each frame is divided into slices for different visual content. At designated intervals within the frame, the camera's shutter synchronises with visible and hidden elements. These can be the visible background image, tracking markers or chromakey backgrounds.
- **Synchronization with Shutter Timings -** The shutter opens and closes in synchronization with GhostFrame, allowing cameras to capture a variety of layered cues and backgrounds that can be reassembled and fine-tuned in post-production without loss of quality or resolution.

The GhostFrame user interface below shows how the types of GhostFrame content slices are selected to be displayed. Enable content in the light blue subframe slice grid from the column of options on the left. The **invert** option at the bottom is used to minimize the appearance of content by displaying the visually inverted version of the content.



Ghostframe UI - Sub-frame Slice Selection

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Camera shutter Compatibility

Camera Compatibility

Most cameras with tri-level genlock or PTP sync and adjustable exposure time (Shutter Angle / Speed) are theoretically compatible with GhostFrame. However, certain factors can enhance workflow possibilities and accommodate a wider range of configurations.

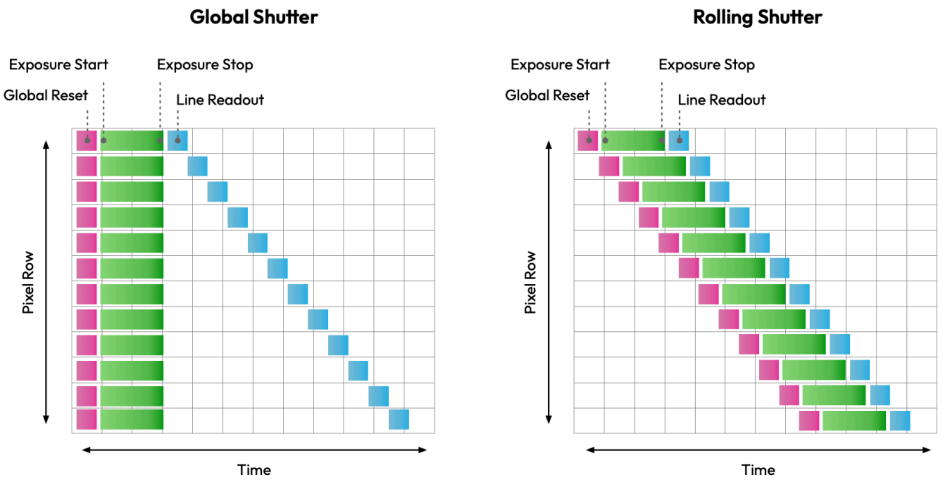
Types of Camera Shutters

There are two main types of camera shutters:

Global Shutter: Exposes pixel rows simultaneously. Effectively zero readout time, capturing all light data simultaneously in a buffer memory layer. Global shutters allow for artifact-free capture of fast light events (e.g., pyrotechnics, lightning). While historically less performant and more expensive, global shutter systems are now increasingly standard as technology advances.

Rolling Shutter: Reads data line by line, converting each photosite's analog values to digital. Since the light is captured line by line, this can lead to motion artifacts and other synchronization issues. Higher resolution sensors have longer readout times.

Global Shutter vs Rolling Shutter



Camera Sensor Readout Time

Sensor readout time, is the amount of time (usually milliseconds) it takes for the image data to be read from the sensor. Sensor readout time is crucial for clean captures of LED walls, as LED drivers operate similarly to shutters in the sense that they scan vertically over time. Different operating modes on rolling shutter cameras can affect sensor readout time. Thorough testing of LED panel and camera combinations is crucial before production.

Global Shutter is preferred

Global Shutter cameras are always highly encouraged, but there are some cases where a rolling shutter camera is more readily available to a project.

Potential Issues with Older Cameras

Cameras over 10 years old may exhibit artifacts like Parasitic Light Sensitivity, where LED frames appear to blend over time regardless of shutter settings. Pre-production testing is essential to avoid delays.

Successful Camera Models

Megapixel has successfully used the following cameras with GhostFrame:

- RED V-Raptor-X
- RED Komodo-X
- Grass Valley Global Shutter Broadcast
- Sony Global Shutter Broadcast
- Sony VENICE 2

For other camera models, contact Megapixel support for testing assistance.

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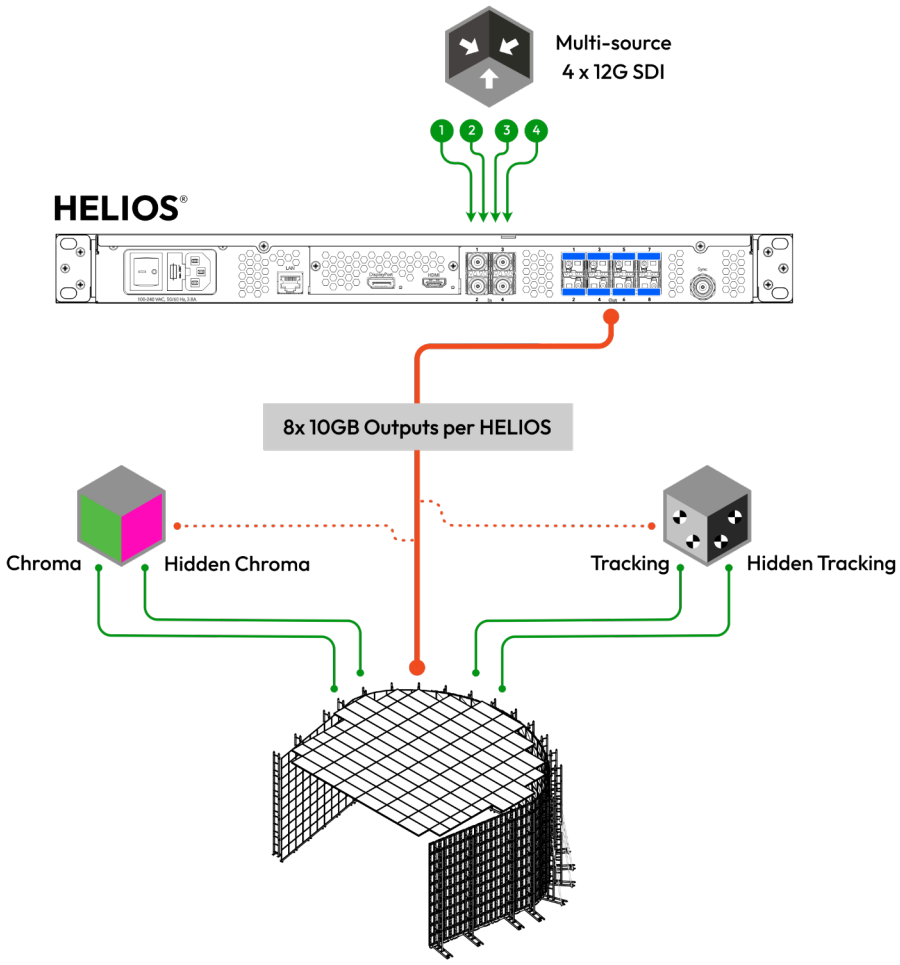
Technical Setup

Unlike HELIOS Camera and Camera+ modes, GhostFrame is only functional with specific ROE LED tiles (contact ROE or Megapixel for specific tile information). Chroma and tracking textures are generated inside the tile using Megapixel's PX1 tile-side processing technology. This drastically reduces the bandwidth required in comparison to other multi-camera workflows.

Ghostframe - System Diagram



Chroma and tracking are generated in the tile.
These functions are not part of the video feed.

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Use Cases

Hidden Chromakey

A core feature of GhostFrame is hidden chromakey. This allows cameras to capture safety mattes in the event backgrounds need to be replaced in post. Safety mattes used to require a post-production workflow to separate the chromakey frames, but new camera technology from RED has made this easier by separating file recordings and preview outputs directly in the camera body.

Camera Tracking

Tracking is another valuable feature within the GhostFrame toolset. Markers can be inserted for VFX teams in post, or third party tracking systems. These allow through-the-lens tracking - using the LED display itself without requiring separate markers on the ceiling or floor.

Hidden Cue Markers

Cue markers can be hidden to the camera but visible to the naked eye. This allows on set talent to receive blocking cues in real-time. Cue markers are crucial to help talent work within an LED volume because they need context as to their surrounding environment. With this feature they can naturally react to elements that will later be inserted in post, or be shown where to move throughout a scene.

Since these cue markers and blocking are not visible to the camera, the LED volume can still be used for all of the real-time reflections that virtual production is known for.

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Success Stories

FOX Sports successfully deployed GhostFrame to enhance their Football coverage.

Fox NFL Sunday debuted its new studio to kick off the 2022 NFL season with GhostFrame technology at its heart. HELIOS and GhostFrame allowed the production team to seamlessly integrate multi-camera capture of real-time generated studio environments and graphics from Unreal Engine while maintaining an easy to understand environment for the on-set talent to work within.

> “GhostFrame is sort of like the secret sauce to making this work in a live broadcast environment.”

Zac Fields, Senior VP (Graphic Technology) - Fox Sports

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Comparison

There are distinct differences between GhostFrame, Camera+ and other solutions in the market. The below chart highlights the key functionality between the different workflows. Note that both Camera+ and GhostFrame require licences available from Megapixel.

	GhostFrame®	Camera +	Camera	Frame Remapping
Up to two (2) direct feeds w/o additional inline devices *	✓	✓	✓	X
Up to four (4) direct feeds w/o additional inline devices*	✓	✓	X	X
Black time insertion	✓	✓	✓	✓
Chroma key	✓	✓	✓	✓
Camera tracking markers	✓	✓	✓	✓
Talent prompts and markers	✓	✓	✓	✓
Hidden chroma key	✓	✓	✓	X
Hidden camera tracking markers	✓	✓	X	X
Hidden Talent prompts	✓	✓	X	X
Hidden teleprompter	✓	✓	X	X
Hidden video content **	✓	X	X	X
Paid license required ***	✓	✓	X	X
No bandwidth reduction for chroma and markers	✓	✓	✓	✓

*tile capability dependent
**exclusive to ROE Visual tiles
***license FOC with Camera+ certified tiles

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Conclusion

GhostFrame technology by Megapixel is reshaping the boundaries of LED video production in four (4) key ways:

1. Merging simple multi-source capture within a single frame.
2. Enhancing multi-camera operations.
3. Reducing post-production time.
4. Providing seamless chromakey integration.

With its advanced frame slicing technology and compatibility with top-tier camera systems, GhostFrame is an essential tool for modern virtual production supervisors, broadcasters, and filmmakers seeking the next generation of visual production efficiency and creativity.