

# Barco LCoS white paper

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## Fast Projection for Fast Jets: LCoS and the Power of Advanced Simulation

### Executive Summary

The world of simulation is changing rapidly. Organizations in the military and commercial sectors require increasingly reliable, high-performance, and low-smearing projection systems to maximize readiness, safety, and efficiency. To stay on top, they require a cost-effective solution that can project high-fidelity imagery at fast processing speeds without compromising image reproduction. Yet conventional projection systems are limited. While technologies like DLP and LCD are options for maritime and air traffic control simulation, they are inadequate for fast jet projection. And while CRT projectors offer high-quality low-smearing imagery, this technology is being slowly phased out for much brighter and lower maintenance systems.

LCoS technology offers a revolutionary alternative to conventional projection systems. In terms of resolution, LCoS projectors already match or exceed the very best CRT projectors; they offer advanced image quality and lower operating costs. Barco's SIM 7 series LCoS projection system pushes the envelope of display technology to provide extremely realistic simulation with low latency. The SIM 7 series is specifically engineered to meet the real-world demands of commercial and military flight training and mission rehearsal applications. In terms of performance, fidelity, image reproduction, multi-channel control, and low cost of ownership, the SIM 7 series is the perfect solution for ultra-realistic simulation.

### Introduction

Today's simulation industry faces a conflict in visualization. Military training centers require projectors capable of extremely realistic, high-quality image reproduction to ensure the effectiveness and the safety of their jet aircraft pilots. Commercial aviation corporations share the military's need for quality; their pilots must be prepared for the complexities of the high skies before they can safely shuttle their passengers.

The problem is that the conventional methods of projection, however effective for other forms of simulation, simply cannot meet the demands of fast jet simulation. DLP projectors are excellent for most slow simulation environments, but their inherent 1-frame transport delay makes them inadequate for systems requiring a fast throughput. LCD systems offer an extremely high light output, but they are limited by smearing at high rates of image reproduction. And CRT projectors, traditionally the fallback for the

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commercial and military training sectors, are also costly to purchase and maintain.

As businesses in the simulation industry survey the market, they face the challenge of identifying a system that maintains high fidelity and accuracy while also remaining cost-effective. Fortunately, a new solution has emerged, one with the proven potential to revolutionize simulation as we know it.

LCoS technology offers a superior alternative to conventional systems. In terms of resolution, LCoS projectors can already match or exceed CRT projectors in most situations, reaching 3 million and 8 million pixels depending on the system. LCoS projectors also offer higher brightness capabilities than CRT projectors, while remaining relatively cost-effective in terms of initial investment and cost of ownership.

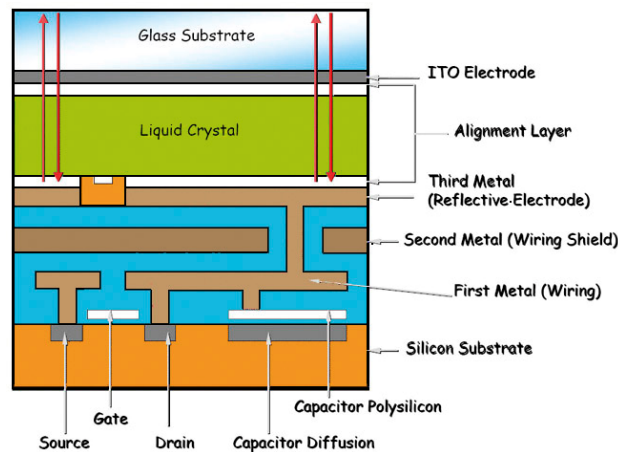
All signs indicate that LCoS will grow even more sophisticated in the near future, offering performance capabilities far in excess of the very best CRTs. Barco is paving the road to the future with the state of the art SIM 7 series LCoS projectors.

## **What is LCoS (Liquid Crystal on Silicon) Technology?**

Before addressing the many benefits of LCoS and SIM 7 for the simulation industry, it is important to consider the unique nature of the technology itself. Liquid Crystal on Silicon, or LCoS, is a hybrid created from industry-standard LCD and DLP technology. LCD technology is transmissive in nature. LCD projectors apply liquid crystals to glass panels; the crystals modulate light as it passes through the panels. DLP projectors, by contrast, use tiny mirrors to reflect light, tilting the mirrors to modulate the light.

LCoS, the latest in reflective light valve technology, combines the best of LCD and DLP into a single solution. With LCoS, light passes through a liquid crystal layer and bounces off a reflective surface. In this way the light is modulated and the image is projected. Like LCD projectors, LCoS projectors deliver red, green, and blue light components simultaneously, without relying on a spinning color wheel like a single-chip DLP projector. The end result is superior image reproduction which functions at high speeds for fast jet simulation applications.

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*LCoS, the latest in reflective light valve technology, works by light passing through a liquid crystal layer and bouncing off a reflective surface.*

## Advantages of LCoS

The military and commercial training market has a variety of projection solutions that offer certain advantages and disadvantages for advanced simulation applications. Popular technologies include CRT, LCD, DLP, laser projection, and—of course—LCoS.

CRT projection is perhaps the most common technology used for flight simulators today. CRT systems provide superb visual fidelity and exceptional black levels. They offer a relatively long service life; some CRT systems even offer color matching, edge blending, and automated alignment options that result in heightened accuracy. However, CRT systems like raster-calligraphic projectors are expensive; because of their consumable tubes, they are also costly to maintain. By most accounts, CRT projectors have reached their maximum potential in terms of fidelity. While they produce clear, bright imagery, they lack the potential to grow with the evolving simulation industry.

Another common solution, LCD, offers extremely high light output and high resolution for the most demanding slow simulation applications. However, LCD systems are affected by smearing, particularly with high speed applications. Furthermore, LCD panels have somewhat limited life-spans, and they are costly to replace.

Some companies have turned to DLP technology for their visualization needs. DLP provides exceptional light output and high resolution with a reduced pixelized “screen door” effect. Because of this, DLP systems are excellent for slow simulation applications. However, due to the inherent 1-frame transport delay resulting from the DLP chip, DLP systems are less than ideal for fast jet simulators which necessitate a speedy throughput. A total system latency of

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33 ms at 60 Hz confines DLP systems to applications such as air traffic control and ship bridge simulators, where interaction to the projected image is less critical.

Laser projection, a potentially viable simulation technology, is still in its infancy. While some visualization firms are investing in laser R&D, and while certain prototypes exist on the market, it may be years before laser systems take prominent commercial form. Already, industry experts are predicting that the costs associated with these systems will outweigh their benefits for some time.

In light of the various technologies available today, LCoS projection systems have emerged as an optimal alternative, particularly for the fast jet simulation market. QXGA and QHD LCoS systems are the first light-valve projectors to match or exceed the pixel resolution of CRT projectors. Previous light-valve technology, such as DLP and LCD, has been limited to 2-megapixel resolution or less. The higher resolution of LCoS presents today's demanding simulation world with highly realistic, accurate simulation. Like DLP and LCD projectors, LCoS projectors are very bright as compared to CRT projectors.

LCoS projectors have a reduced pixelized "screen door" effect, similar to DLP technology, but without the visual artifacts. LCoS projectors also smear less than LCD. The transport delay or "latency" of LCoS projectors is comparable to CRT and LCD technology, and LCoS projectors have the best contrast for a light-valve device.

Furthermore, LCoS projectors offer relatively low costs of entry and of ownership when compared with the comparatively high fidelity CRT systems.

LCoS is the visualization technology of the future, perfect for commercial and military flight simulation training. Barco's SIM 7 series takes this remarkable technology and transforms it into something practical, comprehensive, and truly revolutionary.

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*Barco SIM 7 series LCoS projector is specifically designed for higher-fidelity, highly realistic, fast simulation.*

## **Barco SIM 7 Series LCoS Projectors**

Barco's SIM 7 series is designed with advanced simulation applications in mind. Equipped with the industry's latest and fastest switching LCoS technology, the SIM 7 series offers superb fidelity and image reproduction. Barco introduces two versions for demanding simulation applications: the SIM 7Q and SIM 7H. This paper details the features and advantages of the SIM 7Q system.

Barco's SIM 7Q projector is equipped with QXGA resolution (2048x1536) and 2,000 to 3,000 ANSI lumens of brightness. Although off-the-shelf LCoS projectors have been criticized for mediocre contrast, Barco's SIM 7Q challenges this assumption with a 2000:1 standard contrast ratio and an extended contrast ratio of up to 10,000:1. This feature enables the system to approximate CRT black levels. The SIM 7Q also features Dual DVI and RGB inputs to handle a broad range of image processing requirements.

In contrast to competing LCoS technologies, Barco's SIM 7Q features 120Hz True Motion Reproduction (TMR), an optional smear-reduction feature with <5ms response time, which effectively reduces smearing to minimal CRT levels. Moreover, to ensure zero frame delay, Barco has equipped the SIM 7Q with Warp™, the industry's most advanced geometric distortion technology. Through these optimizations, Barco's SIM 7Q displays fine detail at high speeds while effectively suppressing resampling artifacts.

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*Fast-switching LCoS technology coupled with Barco's TMR optimization preserves the sharpness of moving images.*

The SIM 7Q is also motion simulator compatible, and through its remarkable extended contrast ratio (ECR) and cross-cockpit display (CCD) features is capable of any type of night vision goggles (NVG) stimulation. This includes the demanding requirements of full-range stimulation for Generation 4 NVGs and beyond. The bottom line: SIM 7 has the power and the versatility to meet and exceed the demands of the most advanced flight simulation applications in the military and commercial markets.

## **Optimized for Multi-channel Setup and Control**

Barco's SIM 7Q offers many advantages over other LCoS projection solutions because it is specifically engineered for fast jet simulation. It includes a number of simulation-specific features optimized for immersive, multi-channel projection. These features enable the multi-channel projection system to effectively work in concert to deliver a blended, uniform high-fidelity image.

An efficient multi-channel setup necessitates consistent brightness. Linked CLO (Constant Light Output) monitors and adjusts brightness values for the SIM 7Q multi-channel system. Because of its linked configuration, CLO maintains constant brightness across all the projectors, independent of lamp life.

Gray Level Definition tracks and controls the grayscale levels of each SIM 7Q projector to match gradient definitions across the multi-channel system. Linked Dynacolor™ tracks color coordinates to maintain accurate matching, automatically aligning the projectors to a common color triangle. As a result, the SIM 7Q projectors share the same primary and secondary color coordinates.

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To ensure seamless blending, Barco includes the proprietary Optical Soft Edge Matching and Electronic Edge Matching capabilities with advanced signal processing technology to create a perfect wide field-of-view image with invisible blends.

One of the primary problems with off the shelf projectors is their failure to integrate successfully into the simulation environment and operate as a system. Barco has developed proprietary tools with which to design and install the SIM 7Q multi-channel projection system. Barco's SimCAD™, a simulator design tool, clarifies display parameters and translates system requirements into a highly detailed raytracing-based model. SimCAD optimizes projector placement and orientation, and yields accurate real-time predictions of brightness, contrast and resolution. As a result, Barco application engineers can effectively implement a superior multi-channel system.

Barco's LDAT™ (Laser Diode Array Tool) guides the installation process by marking reference points to effectively align the SIM 7Q display channels. Using 30 dedicated laser light sources to independently direct points on the screen, LDAT ensures proper alignment of the most complex, multi-channel systems—perfect for the needs of the advanced flight simulation industry. Polaris™, Barco's own pattern generating program, generates the necessary test patterns projected by the display system to match the geometry on the fixed reference points provided by the LDAT.

A projection system is only as good as its control and alignment tools. Barco's proprietary automated alignment system and xRACU™ multi-channel controller interface with the SIM 7Q projectors to establish a comprehensive system.

Barco's automated alignment enables simulation center technicians to perform fast, repeatable, and accurate brightness and color level adjustments to the SIM 7Q projection system. This tool examines each projector channel to capture and store the brightness and color information. When these variables drift, Barco's automated alignment makes automatic adjustments to ensure optimal, uniform performance. This automated alignment tool integrates perfectly with xRACU to provide an intuitive remote interface to enable simultaneous projector control. The xRACU enables the user to effortlessly maneuver on-board controls and system functions to operate, calibrate, configure, and diagnose the multi-channel projection system. Through the combined power of Barco's automated alignment and xRACU, the SIM 7 system offers unprecedented accuracy and precision for high-end simulation.

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## Low Operating and Maintenance Costs

In addition to the many visual benefits of Barco's SIM 7Q projector, the system presents a low total cost of ownership because of its modest operating and maintenance costs.

Compared with LCD panels, LCoS panels have a superior life-span. Similarly, the chips which power the SIM 7Q system last substantially longer than those which power other types of display systems.

One particular advantage to Barco's SIM 7Q is the low consumption cost. In fact through its unique optimized design for extending lifetime, the only consumable in the SIM 7 projector is the UHP lamp itself. In this way the SIM 7 has a significant advantage over the comparatively high fidelity CRT; the CRT operates on red, green, and blue tubes which require periodic replacement. Particularly given the intense visualization requirements of flight simulation, a projector with fewer consumables is certain to last longer and function better.

Barco's proprietary alignment and control tools, automated alignment and xRACU, automatically maintain brightness and color so users can perform daily operational tasks faster, better, and more cost effectively. As such, simulation centers realize big savings from SIM 7Q, savings which directly benefit the bottom line.

## Applications

The SIM 7Q is specifically designed to meet the real-world demands of commercial and military flight training and mission rehearsal scenarios. The SIM 7 is motion-based compatible and weighs less than 40 lbs (20 Kg) with the lens. It is optionally ruggedized to withstand up to 3G acceleration. It can be easily integrated into simulation systems with spherical, curved, or flat projection surfaces.

The SIM 7Q is particularly beneficial for military training exercises. Today's combat scenarios take place primarily at night; pilots must be trained to fly under these exacting conditions in order to achieve their mission objectives. The SIM 7Q is useful for this kind of advanced military training due to its effective display of night vision stimulation. With ECR and NVG optimizations, the SIM 7Q offers ultra-realistic blooming and halo night vision effects at the full range of light intensity levels even for the most demanding Generation 4 NVGs.

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*Barco's ECR technology and night vision goggles (NVG) optimization enables the SIM 7Q to be used for true, realistic NVG stimulation.*

Of course, with its high brightness and extended contrast features, the SIM 7Q series delivers exceptional visual performance for both night and daytime simulation. With its versatility and its superior fidelity, SIM 7Q is an optimal, cost effective upgrade for light-valve or CRT-based installations.

## Conclusion

We have examined the nature of LCoS technology as a revolutionary solution for advanced military and commercial flight simulation applications. We have discussed Barco's SIM 7Q projection system, and the ways its unique optimizations and low costs of ownership make it an ideal alternative to LCD, DLP, and CRT projectors. But the question remains—is SIM 7Q right for you?

The bottom line is that Barco's SIM 7Q projectors will save you money while providing you with image quality that meets or exceeds the very best of conventional projection technology. Giants in the simulation industry have already taken notice of these cutting edge systems; as Barco continues to develop the SIM 7 series over the months and years to come, even more powerful products will emerge.

Find out how Barco's SIM 7 series projectors can enhance your simulation applications. Contact a Barco Simulation sales representative today.

*\*SimCAD, LDAT, Polaris, and xRACU are trademarks of Barco.*