



Stereoscopic Projection

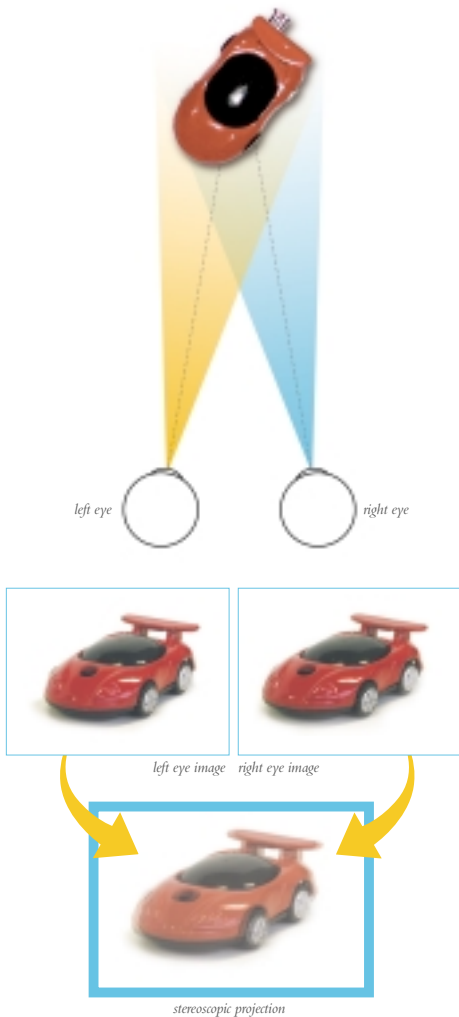
3D PROJECTION TECHNOLOGY



BARCO

innovators in image processing

Barco: The Quali



The Principle of 3D Imaging

Due to the 4-6 cm (1.6-2.3 inch) **separation between the eyes**, each eye has a slightly different viewpoint. The images from these **two different viewpoints** are sent to the brain and this difference, which is termed **parallax**, is interpreted as **depth**.

Stereoscopic projection is based on the same principle: **two slightly different images** are projected onto the screen and the imaging system must enable the left eye to see only the left eye image, and the right eye to see only the right image.

Barco's quality of separation guarantees that the images of the two eyes are separated and displayed in such a way that the final **3D images appear fully focused** and not blurred.

Photo courtesy of
Rover, UK.



Engineers experience new designs virtually before they are actually produced.

BrookHaven National
Laboratory,
New York, USA.
Photo courtesy of
Tom Sobolik.



Chemists analyze complex molecular structures and simulate how new drugs might interact with the human body.

Photo courtesy of
Schlumberger
Dairy Ashford, Texas,
USA.



Oil and Gas specialists determine where to drill by virtually exploring geoseismic data of the earth below its surface.

Photo courtesy of
Polytechnic University,
Hong Kong.



Edutainment is especially captivating when one is immersed in a virtually created imaginary world.

ty Solution for Stereoscopic Viewing

Barco offers a **complete range of high-end projection platforms** covering all technologies - CRT, LCD and DLP™ - for active and/or passive stereo applications.

High quality optional **application-specific optimizations** for **multi-screen** stereoscopic projection onto **flat, curved and dome-shaped** screens result from years of experience in the field.

Barco's projection solutions include:

- Optimized **mechanics** and **screens**
- Proprietary high-quality **eyewear**
- **Software** for dedicated image distortion and easy adjustment and maintenance

Barco has a **proven track record of high-quality installations** in the most demanding 3D markets worldwide.



Automotive designers evaluate the looks and ergonomics of future cars, reducing the costly and time-consuming effort of physical prototyping.



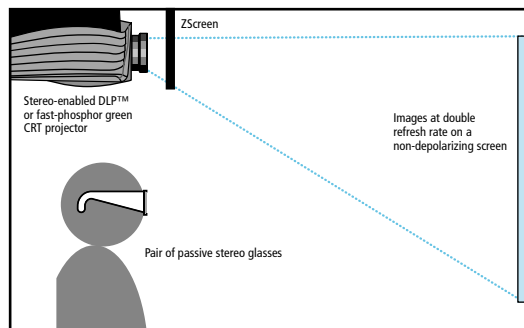
Photo courtesy of Terminal V, Austria.

Passive 3D DISPLAY SYSTEMS

Barco has developed very high quality passive stereo displays **based on the principle of light polarization**. The viewer wears a pair of glasses containing two oppositely polarized filters - one for the left eye and one for the right eye. The light from each of two projected images is polarized and can only pass through its corresponding filter.

With a Single Projector

- The **projector** alternates the left eye information with the right eye information at **double refresh rate**.
- A '**ZScreen**' in front of the projector's lenses **alternates the polarization** of the projected image in such a way that the image of each eye passes only through its corresponding polarizing filter of the pair of passive stereo glasses.



1 CRT Projector

When using **CRT projection** a "fast-phosphor" green CRT is needed to obtain the required high refresh rate. Barco CRT projectors such as the BARCOREALITY 908, 909 and 912 can be delivered with this option already installed.

1 DLP™ Projector

The ZScreen for a DLP™ (Digital Light Processing™) projector such as the **BARCO GALAXY** is smaller because it must cover only one lens, while a CRT projector has three lenses.

LCD projectors cannot operate at a high enough vertical refresh rate to produce a high-quality stereo display with a single projector (at least 96 Hz is recommended).

Linear & Circular Light Polarization

A light wave rotates in any direction. The specific orientation at any given moment determines the polarization of a light wave. By passing unpolarized light through a polarizer, only one of its orientations emerges.

By organizing the **polarization** oppositely **for the left and right eye** we can direct different information to the left and right eye, thus creating **depth perception**. As the human eye itself is largely insensitive to polarization, changing the orientation of polarized light does not change what we see.

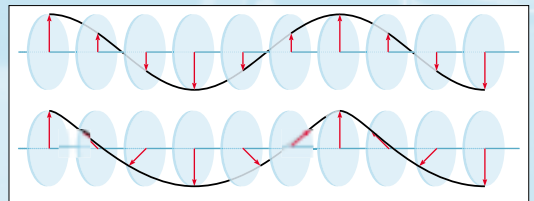
Linear Polarization

If **light is polarized in a single direction** (north/south, east/west, or even oriented diagonally), it is defined as linear polarization. When one changes the orientation of linear-polarized glasses by tilting his or her head, so that the resulting orientation of polarization does not match that of the polarization filter mounted on a projector, there will be a loss of stereo information as perceived by the viewer.

Nevertheless, linear polarization is a **cost-effective** technology that can produce excellent image separation between the left and right eye, for stereoscopic applications whereby head tilting is limited.

Linear polarized light

Circular polarized light



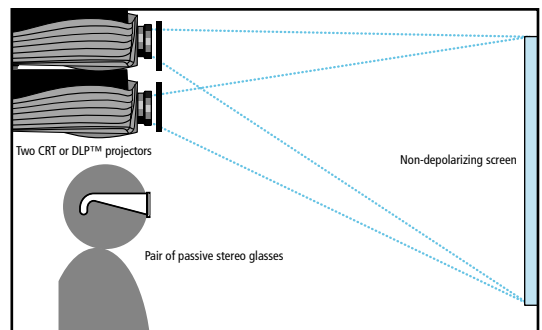
Passive 3D DISPLAY SYSTEMS

With Two Projectors

One projector displays the left eye information and the other displays the right eye information, both at a standard refresh rate.

A **polarizing filter** mounted in the optical light path of each projector ensures that the correct information passes through its corresponding filter in the pair of passive stereo glasses.

This **two-projector** approach has the **added value of providing higher brightness**.



2 CRT Projectors

Although weaker in light output, a CRT projector allows for **the highest resolution** large screen images, with **unparalleled visual fidelity**.

Barco CRT projectors offer a **motorized polarization filter** as an option for stereoscopic projection, whereby the filter can be rotated away from the lens for standard non-stereoscopic projection.

2 DLP™ Projectors

In **high ambient light** conditions or for **very large screen applications**, this solution is optimal.

Barco offers a range of high-quality DLP™ (Digital Light Processing™) projectors with light output from 5,000 to 18,000 ANSI lumens. For **stereoscopic use**, however, "**stereo lumen**" - which equals less than half the ANSI lumen value - is the **realistic measurement of brightness**.

Linear-polarized **Barco glasses** are matched to linear-polarized Barco projectors, and they offer an excellent quality-to-price value for **stereo viewing with large audiences**.

Circular Polarization

With circular polarization, the viewer can tilt his head and change his viewing angle relative to the stereoscopic projection display, because the light is not polarized in a single direction.

As this high-end technology demands **greater precision** and requires a tighter match between the polarizing filters in the light path of the projectors and those in the glasses, the use of **Barco high-quality circular eyewear** is recommended.

Easy to use and comfortable to wear, polarized passive stereo eyewear have no active components and are thus **very affordable for large audiences**.

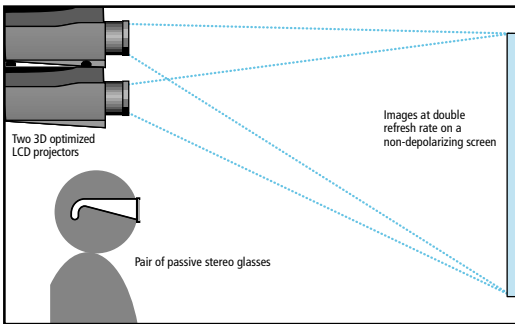


Overview Barco glasses: www.vr.barco.com

Some alternative technologies available today, like Barco INFITEC, incorporate stereo information into the color wavelengths of the projected image. This solution results in excellent separation, especially in combination with DLP™ projectors, while reducing the color range and brightness.



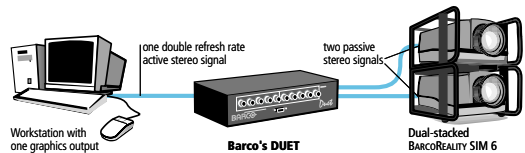
Barco's MICA™, MINI CADWALL.
(Photo courtesy of Schlumberger, GeoQuest)



DUET

Single Active Stereo > Passive Stereo

The BARCO DUET converter **splits an active stereo image into a left and right eye component** and then passes these two images to the two corresponding internally polarized **BARCOREALITY SIM 6 projectors**.



Barco DUET

The active-to-passive stereo converter for the BARCOREALITY SIM 6 projector offers automated left/right signal and sync detection and automatically chooses the resolution and refresh rate for optimal passive stereo display.

2 LCD Projectors

Barco LCD projectors are each internally **polarized** to its corresponding left and right eye information, eliminating the requirement for external filters. With Barco's internal polarization 70% of the original light output is maintained, making this technology **the most efficient method available** to obtain **high stereo lumen brightness levels**.



Barco's high-quality circular eyewear



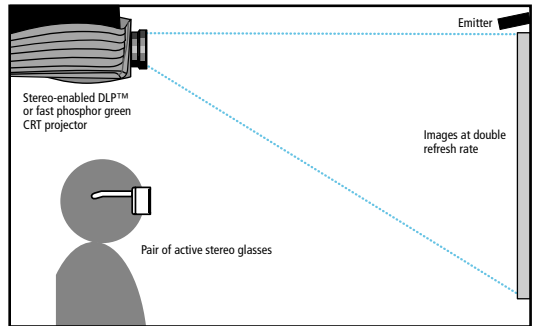
Photo courtesy of ItalDesign, Italy.

Active 3D DISPLAY SYSTEMS



Single Projector, Double Refresh Rate

The viewer wears **special eyewear** comprising two IR-controlled LCD **light shutters working in synchronization with the projector**. When the projector displays the left eye image, the right eye shutter of the active stereo eyewear is closed, and vice versa. The single projector used must be capable of displaying at a refresh rate high enough that the viewer does not perceive a flicker between alternate frames.



1 CRT Projector

Due to the **higher refresh rate** of the incoming signal, a projector with a **'fast phosphor' green CRT** is required. Barco's CRT projectors can be delivered with this option already installed.

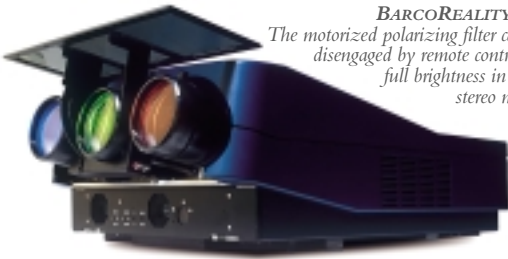
1 DLP™ Projector

The **BARCO GALAXY stereoscopic DLP™** projector offers stereo capabilities at **SXGA resolution** up to 110Hz. This higher refresh rate is complemented by an extremely bright and high-contrast image, resulting in an active stereo 3D projection display of **unparalleled clarity and vividness**.

Light Efficiency

Stereo Lumens

With stereo projection, **light output is at least halved** in the process of creating a separate left and right eye picture. Projectors employing different technologies but with the same ANSI lumen specs can give quite different stereo lumen results. The **stereo lumen** is the **only practical value** for accurately measuring brightness in **Virtual Reality** applications.



BARCOREALITY 909
The motorized polarizing filter can be disengaged by remote control for full brightness in non-stereo mode.



BARCO GALAXY DLP™
An impressive 205 MHz A/D conversion bandwidth ensures compatibility with high resolution and high refresh rate sources for active stereo.

CRT Fast Green Phosphor

CRT projectors offer a **high dynamic range**, displaying detail from bright highlight areas to dark shadow areas. Color matching and **color uniformity** is excellent.

For active stereo applications, where double refresh rates are required, the persistence and decay time of the phosphor on the green cathode ray tube (CRT) must be shortened.

Barco offers active stereo CRT projectors with **fast-phosphor green tubes** at sizes of 7", 8", 9", and even 12".

DLP™ BARCO GALAXY

Barco's **multi-channel-capable stereo-optimized GALAXY**, equipped with DMD™ (Digital Micromirror Device™) optimized polarizers, displays active stereo at SXGA resolution up to 110Hz.

Barco's SynLock technology ensures **synchronization** between the **Image Generator**, the **BARCO GALAXY** and the active **stereo shutter glasses**.

For passive stereo, Barco offers a range of DLP™ projectors with light output from 5,000 to 18,000 ANSI lumens.

LCD Internally Stereo Optimized

By internally polarizing Barco LCD projectors, external polarizing filters are not needed, thus avoiding the excessive light loss caused by external polarization. In this way Barco LCD stereo-optimized projectors are able to **maintain about 70% of the original light output**.

Barco's Transport Delay Reduction technology essentially eliminates the delay between the input signal and the projected image for **optimal real-time interaction** with projected images.

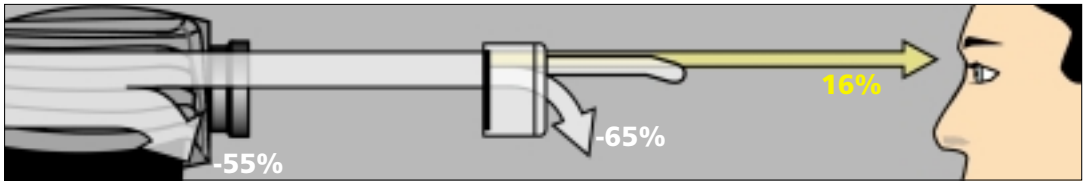
BARCOREALITY SIM 6
This LCD projector, which is specially designed for applications in Simulation and Virtual Reality, offers built-in Warp6™ non-linear image mapping technology. Warp6™ enables high-order pre-distortions electronically with virtually no frame delay, for use with curved-screen and dome applications.
The BARCOREALITY SIM 6 projectors shown here are equipped with Barco's external blending plates, for seamless soft-edge matching across multi-channel displays.



more product info on www.vr.barco.com

> ACTIVE STEREO

SINGLE CRT OR DLP™ PROJECTOR



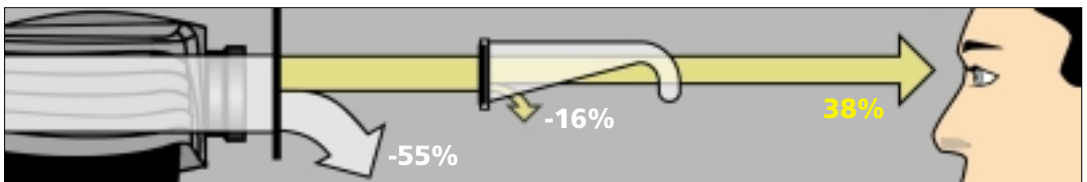
As the projector sequentially projects the left and right eye images, the duty cycle is 50%. However, the **extra blanking** between the left and the right image that is required to ensure a good stereo separation further **diminishes the light output**, resulting in an efficiency of about 45%.

Due to polarizing filters that are utilized in active

stereo eyewear, each eye receives **less than half of the remaining light**. As the shutter glasses do not open and close instantaneously, and due to the light lost from the polarization, efficiency of the active stereo eyewear is rated at about 35%. The **overall efficiency** of the **active stereo** process therefore equals about 45% x 35%, or approximately 16%.

> PASSIVE STEREO

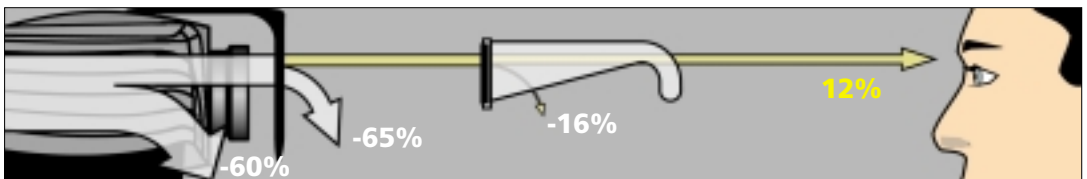
TWO CRT OR DLP™ PROJECTORS



The unpolarized light coming from each projector is externally polarized, which diminishes the brightness by more than half and reduces the efficiency to about 45%. Then the polarized image is viewed through

passive stereo glasses that transmit the polarized light at about 84% efficiency, resulting in a **final efficiency rate of approximately 38%**.

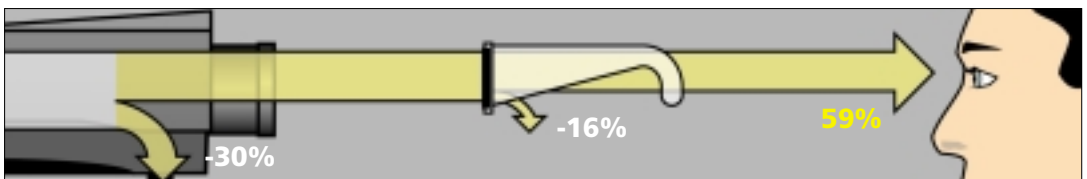
SINGLE PROJECTOR WITH ZSCREEN



When a **ZScreen** is used to polarize the light, a single projector is driven in active stereo mode. As a ZScreen is even slower than active glasses **more blanking** is needed between the left and right signal, resulting in a **duty cycle efficiency of about 40%**.

The ZScreen polarizes light with a brightness efficiency of about 35%. With the **passive stereo eyewear** having an efficiency rating of 84%, the final efficiency rating is about 12%.

TWO LCD PROJECTORS



LCD panels polarize the light that passes through them in different directions. Through the use of **internal polarization** Barco is able to maintain about 70% of the original **light output**.

Combined with the 84% efficiency of the **passive glasses** an overall projection **efficiency of 59%** is reached.

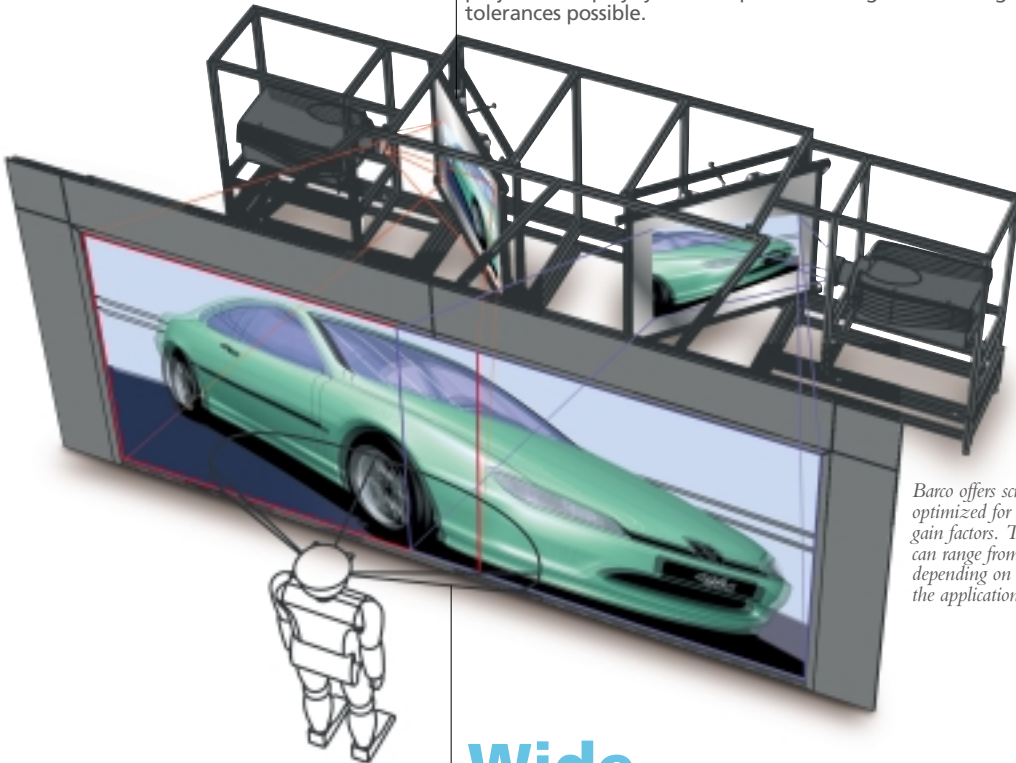
Advanced Screen Technology

Although the projection screen is one of the **key components** in a display system, its significance is often overlooked. The type of screen technology employed is critical for **multi-channel displays** and especially for passive **stereoscopic projection**. In close collaboration with the world's leading screen suppliers, Barco is constantly evaluating the latest screen technologies and has developed proprietary and customized screen solutions for the most demanding applications.

There is no magic screen material nor configuration or set-up that performs perfectly for every installation

Mirror Configurations

To **minimize the floor space** required for rear-projection installations, optical mirror systems are often used to fold the light path. Barco uses only specially selected front-coated mirrors of the highest quality. Advanced **3D engineering software** is utilized to calculate the optimal positioning of the mirrors, projectors, and screen, as the **complex light paths** within a projection display system are precision-designed to the tightest tolerances possible.

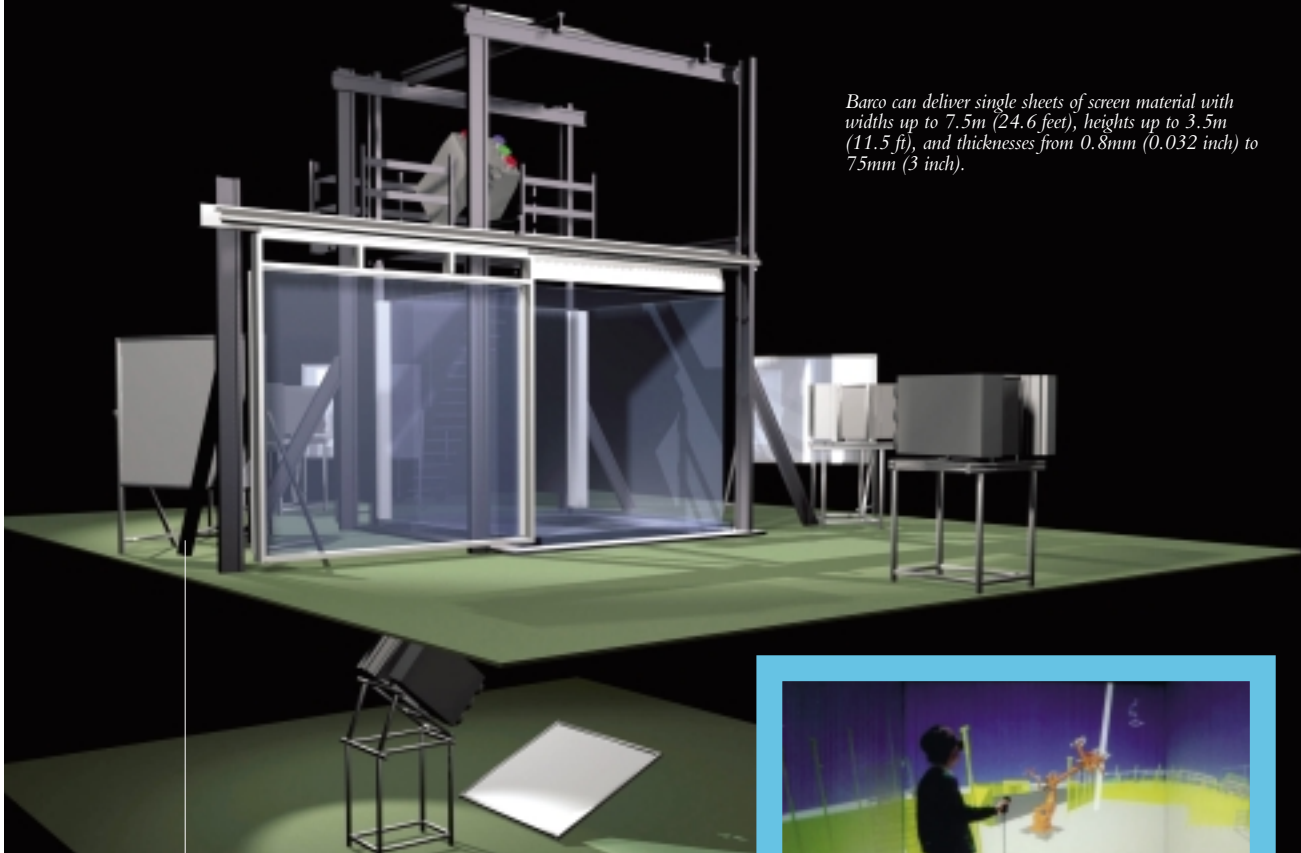


Barco offers screens that can be optimized for diffusion with different gain factors. Total half-gain angles can range from 45 to 100 degrees, depending on the specific needs of the application.

Wide Viewing Angles

Providing **wide horizontal and vertical viewing angles** and maintaining **consistent corner-to-center brightness** levels are essential for large-format stereoscopic projection display systems. In order to eliminate hot spots and color shifts the **gain and diffusion properties of a screen must be matched precisely** to the type of projection technology utilized (CRT, LCD, or DLP™). The positioning of the projectors (on-axis or off-axis), their brightness level, and the type of stereoscopy (active or passive) are important considerations as well.

Barco can deliver single sheets of screen material with widths up to 7.5m (24.6 feet), heights up to 3.5m (11.5 ft), and thicknesses from 0.8mm (0.032 inch) to 75mm (3 inch).



Barco's Transportable I-SPACE™4
(Photo Courtesy of Dassault Systèmes Group and SAS' consortium)



Mechanical Requirements

While screens should be as **rigid** as possible in order to prevent distortion of the projected image, they must also have the **flexibility** to pass through doors or windows to reach an installation site. When used on the floor of an immersive cubic environment, the screen must be **solid** and stable enough to support several people, yet **thin** enough to prevent doubled images. There should be no visible seams between the walls, floor and ceiling.

Setup	Channels	Stereo	● Rigid or Flexible Screen
● front	● single	● none	● flat
● rear	● multi*	● active	● cylindrical curved
		● passive linear	● spherical curved
		● passive circular	● conical curved

* blending optimized

PASCAD Passive Stereo Screen

Excellent Stereo Separation
When excellent passive stereo separation is achieved by integrating Barco projectors with polarization technology, it is perfectly maintained by the **optimal non-depolarizing properties** of Barco's proprietary PASCAD passive stereo screen.

Barco's PASCAD screen



Standard screen: ghosting due to inadequate non-depolarization of the screen.

ACTCAD Active Stereo Screen

After extensive testing of numerous different screen materials, which were selected based on a thorough understanding of their mechanical and optical characteristics, Barco has developed its proprietary ACTCAD screens. Delivering a **higher brightness** level and **better color uniformity** than standard diffuse screens, the ACTCAD screen offers **optimal viewing from almost any angle**.

Expert Alignment Software



Barco's Projector Alignment Tool



For easy and fast alignment of complex multi-screen projection systems to their maximum capabilities, Barco has developed its own proprietary dedicated software.

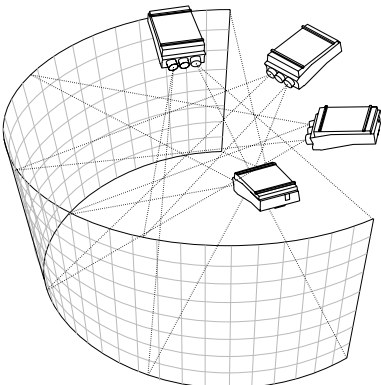
With an intuitive user interface, Barco's Polaris software is driven by **multi-pipe, multi-channel image generators** to calculate and generate user-specified pre-distorted test patterns.



Accurate Reference Points

To enable the alignment of several projectors onto a multi-channel display, **accurate reference points** must be **marked on the screen structure**.

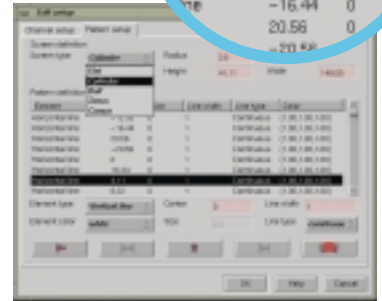
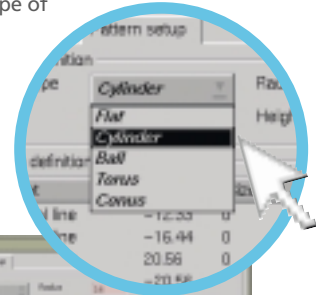
To achieve the highest level of accuracy possible, Barco has developed its own procedures and corresponding hardware.



The user enters the dimensions and shape of the screen (flat, cylindrical, spherical, toroidal, dome-shaped, conical) and Polaris **calculates and generates the pre-distorted geometry, gray scale and color alignment patterns**.

Camera settings and parameters for each display channel can be specified in coordinates or as field-of-view angles, either symmetrical or asymmetrical.

When applicable, **patterns can be saved independently** from the graphics configuration of the image generator.



AutoAlign™

After one source has been aligned, BARCO AUTOALIGN technology **automatically adjusts** the other sources to obtain optimal geometry, edge matching and convergence. This automated alignment process results in a precise matching of **adjacent channels in the blend areas**. Remote access is possible through a local network.

AUTOALIGN is also a great help in performing a quick touch-up to maintain optimal **multi-channel geometry and convergence** (including on green).



Foto courtesy of Fraunhofer LAO, Germany

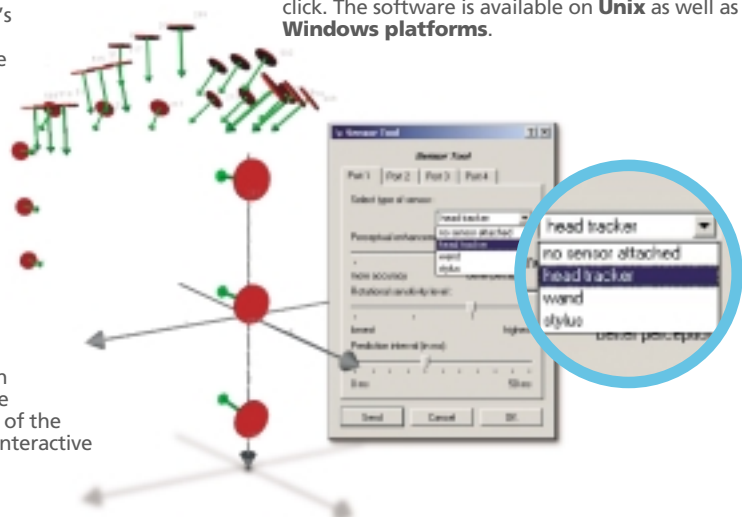
iWizard Tracking Software

As a user's **head** moves, turns or tilts in a virtual environment, the computer-generated image he sees must continually update accordingly with no noticeable lag, jitter or distortion. If a user employs a wand to interact with the environment, the computer must interact in real time with the movements and spatial orientation of the **wand** as well.

Accurate tracking of the user's movements and subsequent feedback to the computer are integral components of a **successful interaction between the user and the computer**.

The technology or combination of technologies chosen for interaction will determine its efficiency in a given application. Barco has accumulated considerable experience with the various interactive devices and tracking technologies and can insure a superior performance and a "seamless" integration of the tracking system into a given interactive display system.

For the accurate and efficient calibration of ultrasonic tracking devices, Barco has developed its "iWIZARD" software. In combination with integrated marking hardware, this software is used to configure the **position and orientation of each transmitter**. For reconfigurable systems such as the BARCO MOVE™ different setups can be activated by a single button click. The software is available on **Unix** as well as on **Windows platforms**.



In Virtual and Augmented Reality Highest Added Value for Optimal Return on Investment has a Name: BARCO

Barco Simulation Products develops high-performance visual display systems for flight simulators, ship bridge simulators, Air Traffic Control, mission rehearsal simulators and entertainment applications. Active on a worldwide scale – with main offices in Kuurne (Belgium) and Xenia (Ohio, US) – Barco Simulation Products has gained an international reputation for its customer-driven application engineering and projection system optimization know-how.



US headquarters at Xenia, Ohio



European headquarters at Kuurne, Belgium

Barco's Virtual & Augmented Reality (V&AR) division offers a wide range of high-end solutions for 3D stereo and multi-screen applications, ranging from curved-screen reality centers and multi-channel CADWALLS™, to immersive virtual environments such as the MoVE™ and the I-SPACE™. These top-of-the-line V&AR solutions are developed and manufactured for a variety of markets, such as Automotive, Oil&Gas, Military, Pharmaceutical, Medical, Edutainment and Engineering.

BARCO Simulation Products

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BARCO

- Expertise in all aspects that create and impact stereo image quality
- Global experience in a wide variety of demanding V&AR applications

Renault - Italdesign - Pharmacia - Cineca -
ELF - Volvo - General Motors - Italdesign
National Center for Atmospheric Research -
Center for Human Simulation - SGI - EDS -
Boeing - AGIP - University of Vienna - Lancia
- Schlumberger - Volkswagen - PSA -
University of Munster - Fraunhofer Institut -
Skoda - Cineca - University of Tokyo - FIAT -
SAIC - Pininfarina - Adler Planetarium -
Conoco - US Army - Brown University - Alfa
Romeo - World Expo Hanover 2000 -
University of Tübingen - Sanofi - University
of Mississippi - Avantis Pharma - Stola
Group - University of Osaka - Matsushita
Sonatrach HMD - Digital Earth - University
of Illinois - Naval Undersea Warfare Center -
NASA Ames Research Center - BMW - Maui
High Performance Computing Center -
Brookhaven National Laboratory ...

DLP™ technology by Texas Instruments offers crystal clear images with superior quality. DLP, Digital Light Processing, DMD, Digital Micromirror Device are trademarks of Texas Instruments.



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