White Paper

6P RGB Laser Projection: New Paradigm for Stereoscopic 3D

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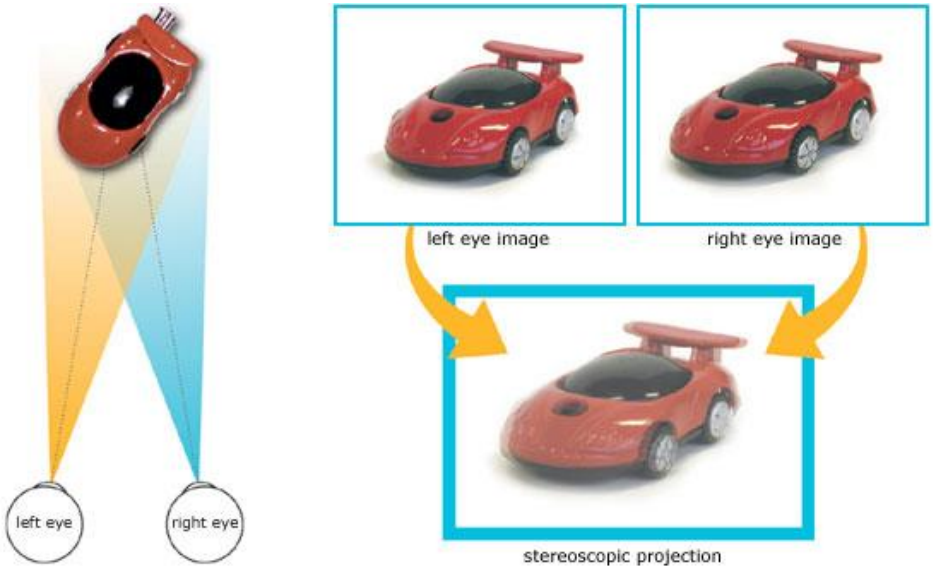
With the 6P (six primary) laser projection systems becoming mainstream and being capable of generating brighter 2D and 3D images a curious discussion started taking place regarding new and advanced 3D projecton enabled by 6P RGB Laser technology.

The airm of this White Paper is to explain this new 3D technology; how it works and the benefits it brings to the users of this technology.

Stereo 3D technology

The principle of 3D imaging

In real life scenario, due to the 4-6 cm (1.6-2.3 inch) separation between our eyes, each eye has a slightly different viewpoint of same 3D object. The images from these two different viewpoints are sent to the brain and this difference, which is termed parallax, is interpreted as depth by our brain.



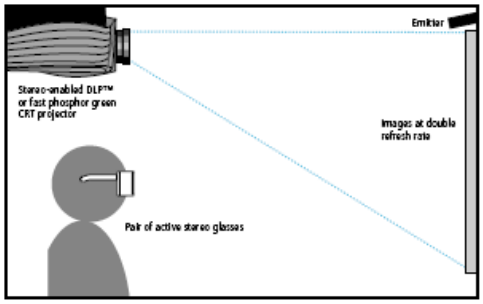
Stereoscopic projection is based on the same principle: two slightly different images are projected onto the screen and the imaging system must enable the left eye to see only the left eye image, and the right eye to see only the right image.

There are various technologies available in the market to achieve this. When it comes to high-end demanding professional applications like dedicated scientific research, automotive design, Oil & Gas exploration & molecular medical imaging etc., users have, till recent past, mainly found only four technologies acceptable, in terms of stereo visualization using projection systems viz. **Active stereo, Polarised Passive stereo, Passive Infitec & Active Infitec+.** With the 6P Laser projection, a new 3D technology has evolved, **6P Laser3D (Or Laser Color 3D)**.

Active Stereo

This technology uses **one projector** per channel to project images for two eyes. The images are sent out frame sequentially one after the other. The viewer wears special eyewear consisting of two "IR or RF" controlled LCD light shutters working in synchronization with the projector & the IR or RF emitter. When the projector displays the left eye image, the right eye shutter of the active stereo eyewear is closed, and vice versa.

To enable this technology the single projector used must be capable of displaying at a refresh rate to alternate high enough that the viewer does not perceive a flicker between alternate frames. The refresh rates required for this technology is 96-120Hz.



In terms of projection technology; this technology is typically implemented by using a **DLP** projector capable of displaying images frame-sequentially at high refresh rates of more than 96Hz.

This technology gives excellent stereo separation fit for many demanding stereo visualization applications. However, the audience size & freedom of movement is dependent on the range of IR emitter as it uses an IR emitter to control the active glasses. These glasses also need maintenance as they're battery driven. The use of bulky active eyewear could be at times strenuous for the users when used for extended hours.

Polarized Passive Stereo

This technology uses **two projectors** per channel to project images for two eyes. This technology works on the principle of light polarization.

One projector displays the left eye information, the other displays the right eye information, both at standard refresh rate. Polarizing filters are mounted in the optical light path of each projector. These filters polarize the light from each of these projectors in opposite directions. The viewer wears a pair of glasses containing two corresponding polarized filters, thus ensuring that the image meant for a particular eye reaches only that eye.

This technology requires a special "non-depolarising" screen to maintain the polarization till the image reaches the viewer eye-wear.

This technology can also be implemented by using a single Active Stereo capable projector together with a polarizing wheel or switcher in front of the lens by synchronizing the change of polarity with the frame-sequential 3D output from projector. This, however, in practice eats away a lot of projector light.

Principle of 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 non-polarized 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 alone does not change what we see.

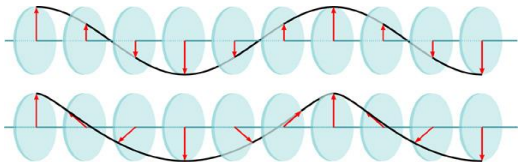
There are two ways to polarize the light viz. linear & circular.

- **Linear Polarization**

If light is polarized in a single direction (north/south, east/west, or even oriented diagonally), it is defined as linear polarization.

Linear polarization

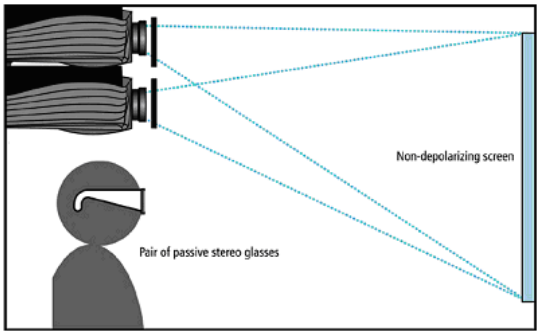
Circular polarization



- **Circular Polarization**

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

In terms of projection technology; this technology can be implemented by using 1-chip DLP, 3-chip DLP, LCD projectors working at standard refresh rates. LCD projectors can be optimised to give more light output in stereo when working in polarized passive stereo.



This technology gives sufficiently good stereo separation for applications which require minimum of head-tilt like a theatre for example. As it uses **two projectors** instead of one like Active stereo, the light output is quite efficient in this stereo technology. The glasses are cheaper & comfortable to wear. However, for applications where lot of head-tilt & movement of viewer are required, there can be a loss of stereo information as perceived by the viewer which is also termed as ghosting. It also uses a special "non-depolarizing" screen. The use of **two projectors** per channel also results into more maintenance costs.

Passive INFITEC™ Stereo

Having experienced Active Stereo & Polarized Passive Stereo technologies, the industry was now looking for a technology which could give stereo separation as good as Active Stereo, should give full freedom of head-tilt & user movement and at the same time should allow working for extended hours like polarized passive stereo.

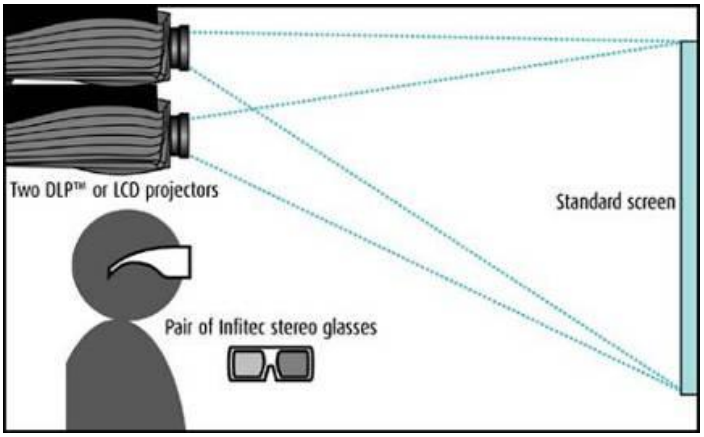
It took one of the major users of stereo technology and the leading automotive company **DaimlerChrysler AG** to develop a stereo technology at their labs in Germany to invent a new stereo technology called passive INFITEC™(*). Barco, a renowned projector manufacturer, also invented and had patent for a Color separation 3D technology.

INFITEC GmbH is an independent enterprise licensed by DaimlerChrysler AG to commercialize the INFITEC™ development results. (*)

Passive INFITEC™ uses **two projectors** per channel to deliver superior stereo separation without ghosting, with full freedom of motion independent of head tilt.

Compared to active stereo it is completely free of flickering, better performing in stereo lumens and comes with more affordable glasses.

Compared to polarization based passive stereo it achieves superior separation providing full freedom of motion independent of head-tilt, independent of screen technology and therefore resulting in better uniformity.



Infitec (acronym for interferenz filter technik) is a trademark from DaimlerChrysler Research and Technology Ulm.

(*) Source: http://www.infitec.net/about.html

HOW DOES INFITEC™ WORK?

Two optical Infitec filters (illustrated by a thick and a dotted line) split the color spectrum of image in 2 parts: one for the left and one for the right eye information (fig. 1).

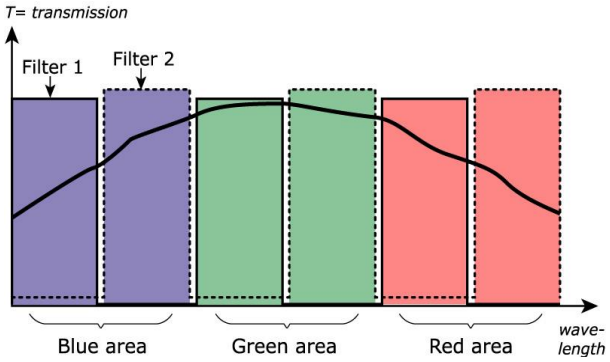
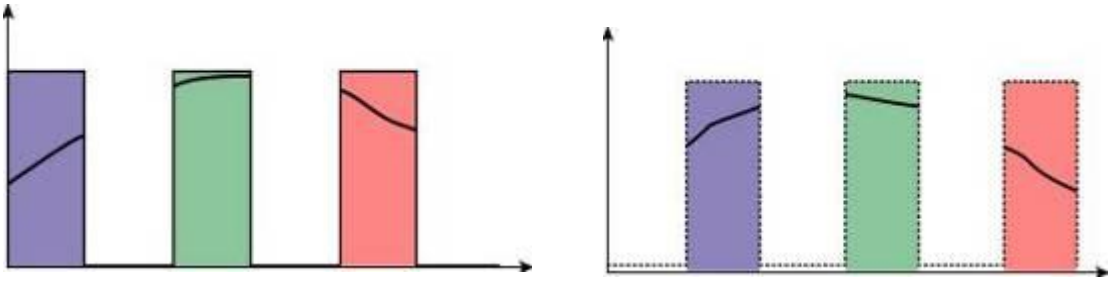


fig. 1

If each of the two Infitec filters is mounted into the optical light path its own projector, then a stereoscopic image can be made by putting the left eye information in the image of one projector, the right eye information in the image of the other and by using the matching Infitec filters in the pair of Infitec glasses in front of the corresponding eye (fig. 2). Both projectors display their information at standard refresh rate.



Left eye information *Right eye information*

fig. 2

Infitec (acronym for interferenz filter technik) is a trademark from DaimlerChrysler Research and Technology Ulm.

This technology is also referred to as "WAVELENGTH MULTIPLEXING Technology"

Active Infitec + Stereo

Active Infitec+ **combines Active** stereo & passive **INFITEC™** stereo technologies to offer **best of both worlds** to the user.

It uses only **one projector** per channel working in **Active stereo mode** in high refresh rate, displaying the left and right images sequentially, in combination with high quality **INFITEC™** color filtering incorporated inside the projector.

The Infitec filtering inside the projector is synchronized with the projector already doing frame-sequential projection. Thus, it incorporates stereo information into the color wavelengths of the projected image using **a single projector** to sequentially display images for each eye while allowing users to use passive INFITEC™ glasses.

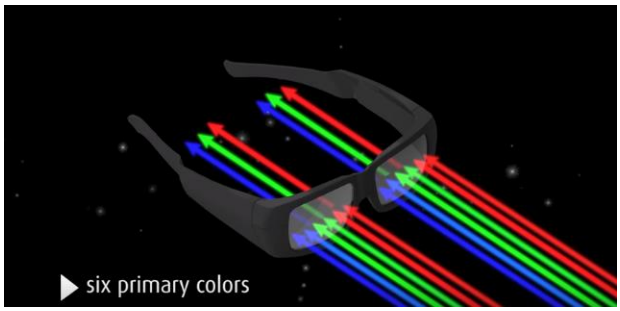
As *IR emitters & active eyewear are not required* while using Active Infitec+, the viewer gets a flicker free image and at the same time a bigger audience size could be accommodated as the audience area is not limited **b**y the IR range of emitters.

As the projector is basically running in Active Stereo mode, user can switch OFF the **Active INFITEC+** filtering and then the same projector can be used in combination with Active LCD shutter Eyewear & IR emitters for **Active Stereo** visualization. Thus, the user gets a very flexible solution offering **two technologies from a single system**.

6P Laser3D (Laser Color 3D)

This 3D technology is only possible with 6P RGB Laser technology. 6P stands for '6P' laser primaries. This means that for every primary color (red, green or blue), there are two sets of laser wavelenghts: two slightly different reds, two greens and two blues. Hence 6P: 6 primary colors.

Apart from providing good despeckling on screen, the 6P Laser also provides the projector with an integrated 3D system, without a need for external equipment (other than 3D glasses) by providing Laser3D or Laser Color 3D technology.



As on date, 6P Laser3D or Laser Color 3D projection is acheived majorly in two different ways:

a) using one 3-chip DLP projector with integrated 6P laser light sources
b) using two 3-chip DLP projectors with external 3P light sources

Laser Color 3D using one 3-chip DLP projector with integrated 6P laser light sources

Principally, this method works in the same way as Active Infitec+ (or Wavelength multiplexing using a single projector).

The projector takes in a standard frame-sequential Active stereo 3D input from a 3D source (and in some cases also support Left/Right passive pair) and then also projects a frame-sequential output. Using the inbuilt (integrated) laser banks, the projector electronics then must allow full synchronization of Laser banks with the 3D image on the DMD chipset (= DLP chip), thus shining the correct (alternate) set of RGB wavelengths in full syncronization with the frame-sequential Stereoscopic 3D image on the DMD chipset.

At the user side, matching Laser3D glasses will then filter the correct wavelengths, and thus the correct image (L or R) reaches the eye it is intended for.

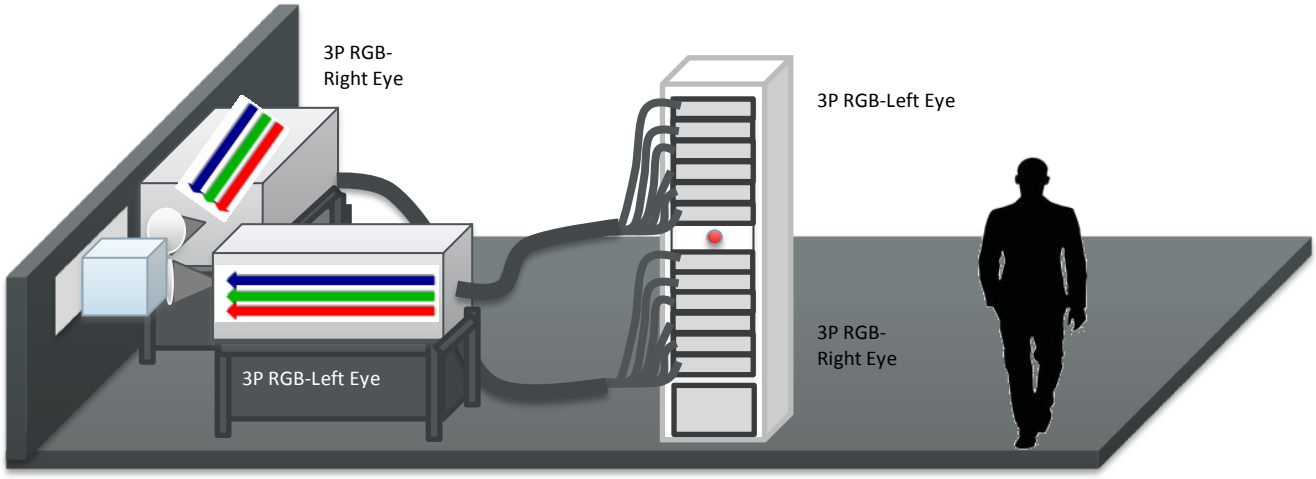
Using strictly selected 6P primaries, there is no need for additional color filtering in the projector. This means that by this method there is no need for a color wheel such as Dolby or Infitec 3D wheel, which are necessary for a lamp-based projection system. Because of this, the efficiency of the Laser Color3D system is much higher than these systems, and thus the system produces a higher 3D brightness per projector lumen.

As this technology requires very precise & continous ON/OFF cycles of Laser banks (= prefectly synchronized with frame-sequential 3D frames), today this is only acheivable with Laser banks completely integrated & being inside the projectors. For projectors utilizing external laser banks (3P, or even 6P or 9P) there is no way to achieve this.

Laser Color 3D using two 3-chip DLP projectors with external 6P laser light sources

Principally, this method works in the same way as Passive Infitec (or Wavelength multiplexing using two projectors).

The projectors take in a frame-sequential Active stereo input converted to Left/Right passive pair (by using Image Processing solutions available in the market like Barco Image Pro, Barco XDS or Christie Spyder) and then project content for each simultaneously (3P per eye).



At the user side, matching Laser3D glasses will then filter the correct wavelengths, by only allowing the the correct image (L or R) to reach the respective eye the image is intended for.

Benefits of 6P Laser Color 3D

- **Effieciency of 3D projection**

Using strictly selected 6P primaries, there is no need for additional color filtering in the projector. This means that by this method there is no need for a color wheel such as Dolby or Infitec 3D wheel, which are necessary for a lamp-based projection system. Because of this, the efficiency of the Laser Color3D system is much higher than these systems, and thus the system produces a higher 3D brightness per projector lumen.

- **Image quality**

The Stereo 3D image quality is defined by the viewing angle of the eyewear, extinction ratio (or crosstalk), and absence of flicker.

The Laser3D glasses have a wide opening, which means that the viewing angle is large.

The extinction ratio, or so-called 'stereo contrast' with Laser Color3D is around 500:1. This means that each filter will transmit only 1/500 of the wrong spectrum (crosstalk of only 0.2%), which is far below the visibility threshold. As a result, the effect of 'ghosting' is not present with this technology.

And because this technology uses passive filter glasses (unlike active shutter glasses using IR receivers), there is absolutely no flicker. This is aided by the fact that the Laser3D system does not use a color wheel, so the dark time between the L-eye and R-eye image is minimized.

- **Projector efficiency (applicable for laser projection with integrated Laser light sources)**

Laser Color3D with one 3-chip DLP projector with integrated Laser light sources also saves projector power. Because the laser wavelengths are shone (powered) in sequence, fully synchronized with the stereo content on the DMD chipset, each laser is ON only half the time, and light is not wasted. This drives down the power consumption of the light source by half.

CONCLUSION

We hope this article has improved your understanding of 6P Laser3D (~ Laser Color3D) and will help you ask the right questions when investing in this state-of-the-art technology. Laser3D today is the best 3D experience adding extra value to your 3D setups. However, not selecting wisely, disregarding other important parameters (screen characteristics, image quality, uniformity, power consumption and total cost of ownership…) can destroy your carefully constructed value proposition. As always, it's important to look at the total picture.