Boost Brightness with the Right Screen

Maximize Your Laser's Brightness By Choosing the Screen That Best Meets Your Needs

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Many times in the laser show business we are forced to project laser graphics onto a wall, building or other structure dictated by the show site. In these cases, we are at the mercy of the color, shape, orientation and reflectivity of this existing surface. Often the only tool available to produce a bright display is lots of laser power.

In venues where we have the opportunity to provide our own screen, it makes sense to use one that will maximize the apparent brightness of the laser graphics. But far too often, optimal screen type is completely overlooked. We simply go for whatever is available to project onto. This article introduces several fundamental screen concepts which will help in selecting the right screen for the job. Doing so often makes the display appear brighter and results in a more satisfied audience and client.

This information has been gathered from personal experience and from information provided by two screen manufacturers: Stewart Filmscreen Corporation and DA-LITE Screen Company, Inc. Both Stewart and DA-LITE offer sample kits with small pieces of screen material for evaluation. These samples demonstrate the quality of the screen material, but they are so small that you can't really get a feel for how reflective or transmissive they are. It is best to arrange for a visit from a company representative for a more complete evaluation.

Gain vs. Dispersion

Two fundamental terms that characterize screen performance are the gain and the dispersion of a screen. The screen's gain number indicates how much brightness is visible from the screen's center when viewed on-axis to that center. Dispersion, also known as viewing angle, is the number of degrees the viewer can move off-axis before the gain decreases by 50 percent. There is usually a trade-off between these two numbers: as the gain is increased, the viewing angle is usually decreased.

Theoretically, a matte white surface has a gain of 1 and a 180-degree viewing angle. Since light that strikes such a surface is greatly diffused, the observed brightness of this screen does not change with the viewing angle.

Front vs. Rear Projection

The gain of a front-projection screen is determined by the direction travelled by the reflected light—highly directional, mirror-like reflections translate into high gain while dispersed reflections from a matte-like surface translate into low gain. Screen manufacturers can take this factor into account when designing a screen.

In a rear-projection screen, the gain is controlled by the density of the screen's surface coating. Low-density diffusion coatings are engineered to reduce the scattering of projected light rays; this allows more light to pass through the screen at small exit angles, which in turn produces higher on-axis brightness.

Higher density coatings more thoroughly scatter the incoming light, which decreases the on-axis gain but expands the size of the audience viewing angle.

Keep in mind that although a higher gain will generally provide a brighter image, gain does not imply amplification. No screen can add power to a display. Therefore, with all diffusion screens, the higher the gain, the smaller the viewing angle. But in those situations where the audience is not widely spaced, a higher gain screen can be beneficial. Why put the light where none of your audience members sit?

Front and rear projection screens are fundamentally alike. They both disperse the projected beam so that some portion of each incoming light ray is scattered across the screen's total field-of-view.

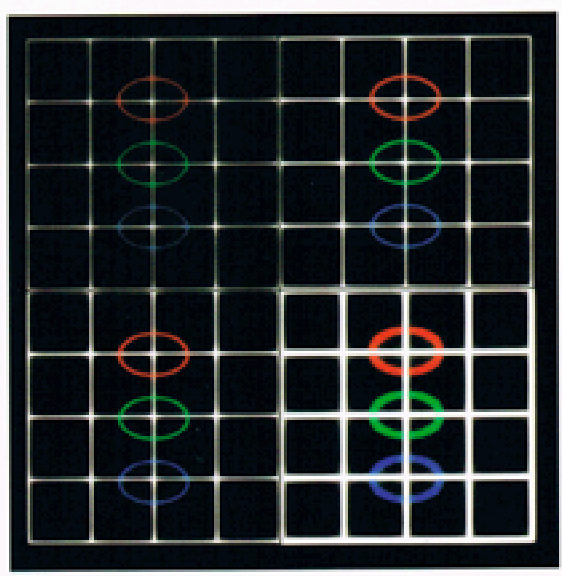
With this underlying similarity established, which screen type is preferred? The single greatest difference is that rear projection screens make it easier to combat ambient light that can detract from the display.

A front projection screen, for example, indiscriminately reflects all light that strikes its surface with equal efficiency. This means that light from the projector will be diluted by light from other sources, such as room lights and windows. This being the case, front projection screens are best suited to environments where ambient light can be controlled.

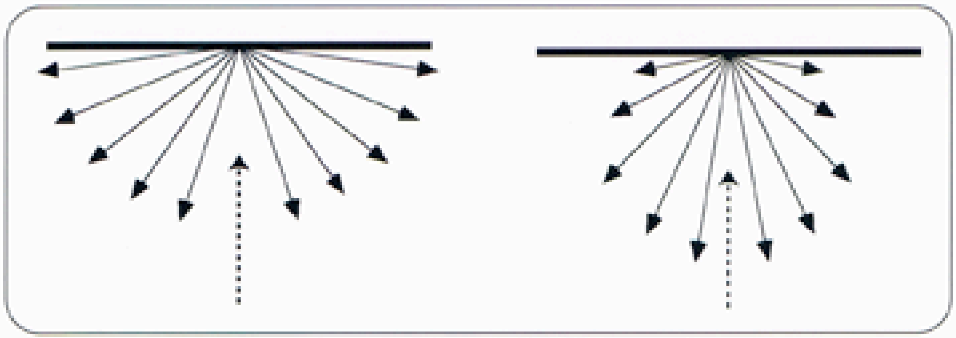
Since a rear projection screen is transmissive in both directions, only a small fraction of the ambient light that strikes its front surface is reflected back towards the audience — the major portion passes harmlessly through the screen and is absorbed behind it. At the same time, a high proportion of light from behind the screen will be transmitted through it and directly towards the audience. This makes it easy to ensure that the only light aimed *directly* at the audience comes from the projector.

In addition, rear projection screens can actually improve the contrast of a display by the inclusion of darkening agents in

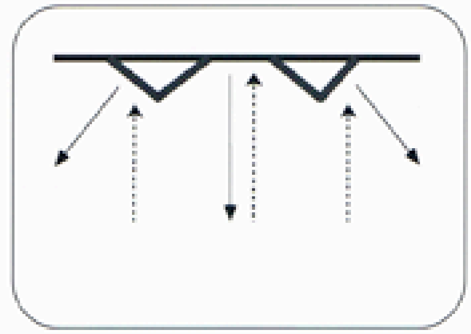
(continued on p.16)



See the difference: A laser grid with colored circles is projected on four swatches of DA-LITE screens. Clockwise, from upper left: Matte-white, gain=1; Video-spectra, gain=1.5; ; High-power, gain=2.8; Pearlescent, gain=2.0.



All screens are not created equal: a front-projection screen with a gain of 1, shown on left, scatters light evenly over 180 degrees. A screen with a higher gain, shown at right, reflects more light along the axis of projection (shown in dotted line), but less light to side areas.



Best of both: A silver-lenticular screen, above, features a three-mirror surface structure that produces high gain and a wide viewing angle.

(continued from p. 15)

their surface coatings. To understand how a darkening agent in a rear-projection screen can enhance the image, consider how contrast actually works. Contrast depends exclusively on the ratio between the maximum and minimum light levels within any image. The contrast ratio is determined according to the formula: *(maximum - minimum)/minimum*, where maximum and minimum are measured in such units as foot candles or Lamberts.

Here is how darkening agents in a rear-projection screen can help: if we determine that the Max from a conventional rear-projection screen is 100 units of brightness and the Min is measured at 5 of the same units, we know from the formula above that the contrast ratio is 19:1. Suppose we put a bit of darkening agent into the surface coating—just enough to reduce the transmission by 2 brightness units.

Our new tinted screen has a maximum that has been reduced to 98 and a minimum that has been reduced to 3. While the new screen is a little less bright (2%), the benefit of that reduction is a contrast ratio that has jumped 72% to nearly 33:1. If we compared the two screens side by side, the brightness differential wouldn't be noticeable, but the improved contrast would be recognizable instantly.

With front projection screens, the options for increasing contrast ratio are limited to controlling ambient light — keeping energy from all light sources other than the projector from striking the screen. Carefully recessed ceiling lighting and properly shaded task lights are examples of controlling ambient light. Darkening agents are not effective on front projection screens.

Up until now, this article has described diffusion screens – screens that have a substantially flat surface that diffuses the light.

Other Screen Types

But other screen types exist that offer several advantages to laserists, although they also are usually more expensive than diffusing screens:

- *Silver lenticular screens* offer both high gain and a wide viewing angle. This is achieved with a profile structure that is similar to three mirror elements – one mirror reflects light toward the center of the audience, one reflects light toward the left side and one reflects light toward the right side. Since the screen is aluminized, each element of the screen has high gain and a narrow viewing angle. But when the three elements are combined, you wind up with a screen with a gain of 2.5 and a horizontal viewing angle of 70 degrees.
- *Glass beaded screens* offer extremely high gain, albeit at a narrow viewing angle. The surface of a glass beaded screen is comprised of a huge number of tiny glass balls distributed evenly across a white vinyl field. The average diameter of the glass beads is around 65 microns. Glass beaded screens act more like a retroreflector than a mirror, sending a very large amount of light directly back toward the projector. Typically, glass beaded screens have a gain of 2.5. DA-LITE offers a glass beaded screen called High Power that achieves a gain of 2.9 by using beads only 9 microns in diameter.
- *Fresnel-lenticular screens* are commonly found in rear-projection television sets. This screen is comprised of a relatively thick (approximately 7mm) piece of acrylic. This substrate plays host to a fresnel lens that is chemically etched into the rear surface and a lenticular lens that is etched into the front surface.

The screen's fresnel lens condenses and directs the incident light from the projector and turns it into a system of parallel light rays. The screen's lenticular lenses act like a series of cylinder lenses and provide a wide horizontal viewing angle. The result is a screen with an exceptionally high gain (up to 5) and very wide viewing angles (exceeding 110 degrees). As you might imagine, this is by far the most expensive type of screen. A 4 foot x 4 foot piece of fresnel lenticular screen, for example, costs about $2,300 US, almost five times that of other screens.

The Bottom Line

When preparing for a show, laserists may want to develop a checklist to guide them in screen selection. For example, the size of the audience's viewing angle is of paramount importance: a wide viewing angle dictates a screen with good dispersion, but a restricted angle allows the use of high-gain screens. The next consideration would be ambient light levels—if there is considerable ambient light, a rear projection screen will provide a brighter display without needing to boost laser power. Finally, laserists must weigh how much the investment in screen materials are worth. A fresnel-lenticular lens, for example, offers both good gain and wide dispersion, but its high cost could be prohibitive.

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