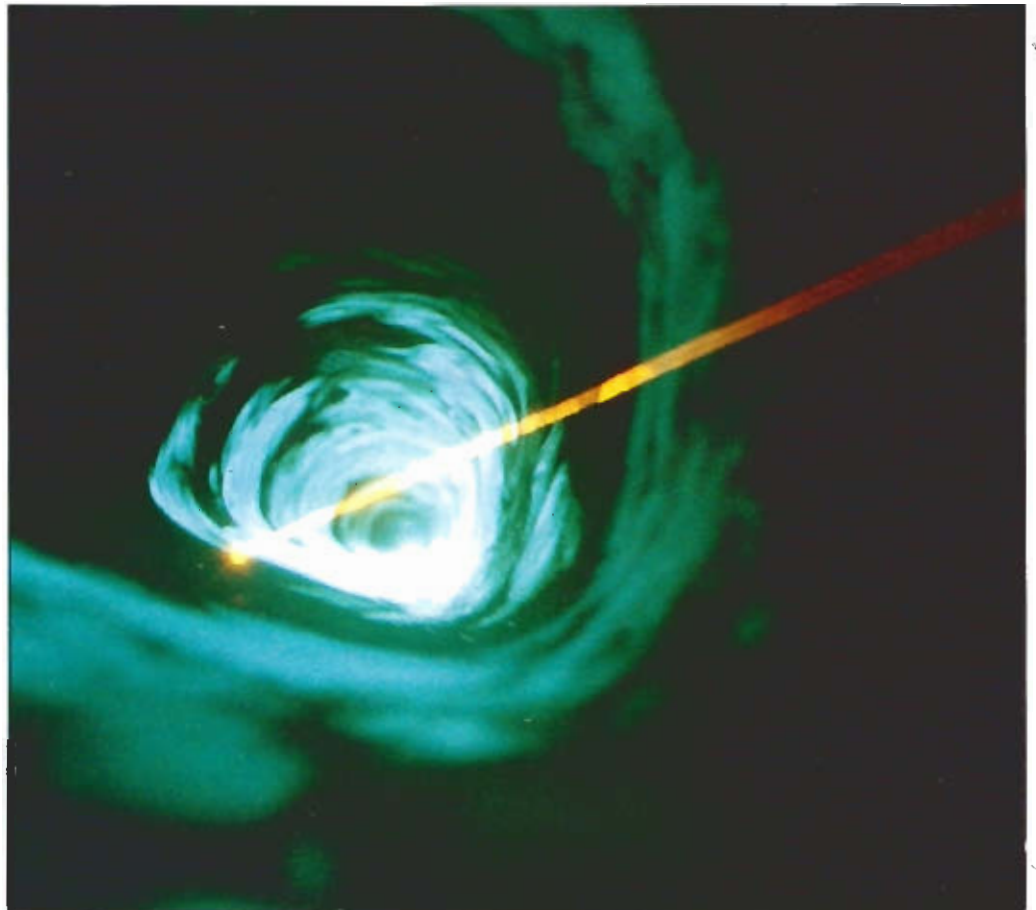


**Above:** Time exposure (1/4 second) of multi-colored un-scanned beams in rapid automatic chase sequence. **Right:** Krypton yellow/red laser beam pierces Argon blue/green scanned laser tunnel.



# CREATING Lasers in

As lasers become more familiar and less intimidating tools for lighting designers, LDs approach us with increasingly ambitious and fantastic applications for our laser systems. Most recently we've seen great interest in the truly three-dimensional uses of laser light, as opposed to apparently 3-D scanned laser patterns projected onto two-dimensional screen surfaces.

## From Two To Three Dimensions

Laser light, like all light, is seen only when it is reflected from a diffusing surface. A two-millimeter diameter laser beam

# LIGHT SCULPTURE: Three Dimensions

By Dick Sandhaus, President  
Science Faction Corporation

travelling through clear air will strike a white screen, and what you will see is an extremely bright, approximately two-mm diameter spot on the screen. If you eliminate almost all competing and ambient light in the room, the contrast ratio between the brightness of the highly focused, defined spot and the relative darkness of the screen will be so high (several hundred to one) that the dot will seem to float in mid-air, because the reference plane of the screen has been lost or blocked out.

Now, if you add some reflective scattering particles to the air in the room (dust, cigarette smoke, fog), you actually begin to see the beam in real three-dimensional space. The airborne particles serve as a collection of tiny screen surfaces. Whenever a particle intersects the path of the laser beam, the laser beam is visible to the eye. This is how and why it is possible to achieve *Star Wars*-type effects in real time in real three-dimensional space, to surround people with laser beams and scanned laser beam sculpture.

## Popular 3-D Effects

The coherent laser beam allows the creation of sharply defined, apparently tangible elements that are made up only of light energy. Among the most popular 3-D laser effects in discotheques are overhead strobed, chasing beams, light ceilings (scanned planes of light), and moving tunnels of light that actually — though briefly — surround people.

To explain how these three-dimensional effects are created, it is useful to refer to the two-dimensional images that are part of the package. If an unscanned laser beam projected onto a screen produces a dot, then a scanned laser beam moving at sufficient velocity and frequency back and forth across the screen will produce a line. This is because the motion of the dot is faster than the eye can detect. So persistence of vision makes you perceive a continuous line, just as

you perceive continuous motion in a movie where a series of still frames is projected onto the screen at a high enough rate.

Now, turn down the lights, add fog, and look at the three-dimensional representation of that horizontal line of laser light. Viewed from above or below, you perceive a triangular plane of light. The beam originates from a point source at one end of the room and terminates as a line at the other end. When the scanning beam itself is visible, it connects the moving dots and forms a continuous sheet of light.

Instead of drawing a line with the laser beam, you might scan the beam in a circular path. In this case, you see a point source at one end, a circle at the other, and a cone of light in between. We have produced varieties of this "tunnel of light" effect for both still and motion photography. For limited periods of time, we are also able to surround disco dancers and audiences with constantly moving tunnels. They change size and shape, direction and speed of rotation, and then disappear. This has proven to be a particularly effective way to really touch an audience with light, and to unify an entire space while actively involving the audience.

## Preset Scanning for Safety

It should be noted that unless appropriate safety features are implemented, putting people inside laser tunnels will usually involve unsafe exposure to laser radiation levels. In discotheques, we must preset our scanning systems to ensure that the velocity and frequency of the beam are appropriate to the laser output power and to the distance between the laser source and the closest point at which someone may intersect the beam path. Measurements and calculations then determine for how long direct exposure to the scanning beam is safe, and our timer circuitry is preset accordingly.

To produce additional visual interest with a ceiling, wall or tunnel of laser light, the beam may be turned on and off very rapidly to produce discrete beams of light. These beams can also be chased back and forth at variable speeds. It is also possible to mix and alternate colors within light sculptural elements, as is illustrated in the photos at left.

For the *Star Wars* lasers-as-weapons effects, we rapidly sequence intensely bright, unscanned beams to preset target points. These beams may simply terminate on a diffusing surface, or may strike an optical element that diffracts them and sends back a spray of thousands of less intense beams. Beams may also be targeted to photosensors which trigger other effects like strobes or pyrotechnics. Beams may also, of course, be reflected from mirror to mirror to mirror to create complex matrices of light. Effects incorporating unscanned beams must be implemented in such a way that people can never intersect the beam path(s). Even relatively low-power beams which are unscanned can cause serious, immediate eye injury. Accordingly, the Bureau of Radiological Health requires three-meter vertical and 2.5-meter lateral separation between people and beams (unscanned or scanned) which exceed the Class I exposure level.

## Scattering Media

Parallel, in-phase laser beams directed overhead and toward (but not at) the viewer will appear to be significantly brighter than beams directed from behind or from the side. In order to optimize any three-dimensional laser lighting effect, competing light sources must be minimized and an evenly dispersed scattering medium must be provided. Discotheques, concert halls and arenas can usually be counted on for substantial amounts of smoke in the air, but the use of a suitable number of well-placed fog machines will guarantee optimal display. A light, well-dispersed fog is preferable to dense clouds of fog, which will tend to absorb and significantly diffuse laser projections.

Whether you're looking for strobing beams, a ceiling or curtain of light, or a whole environment of light, the highly controllable laser beam can be an extremely useful tool.

*Note: Dick Sandhaus can be contacted at The Science Faction Corporation, 445 Park Avenue, New York, N.Y. 10022, (212) 688-7786, Telex 237077. Photos by Tetsu Okuhara. Photos © and courtesy of Science Faction Corporation, © 1979.*

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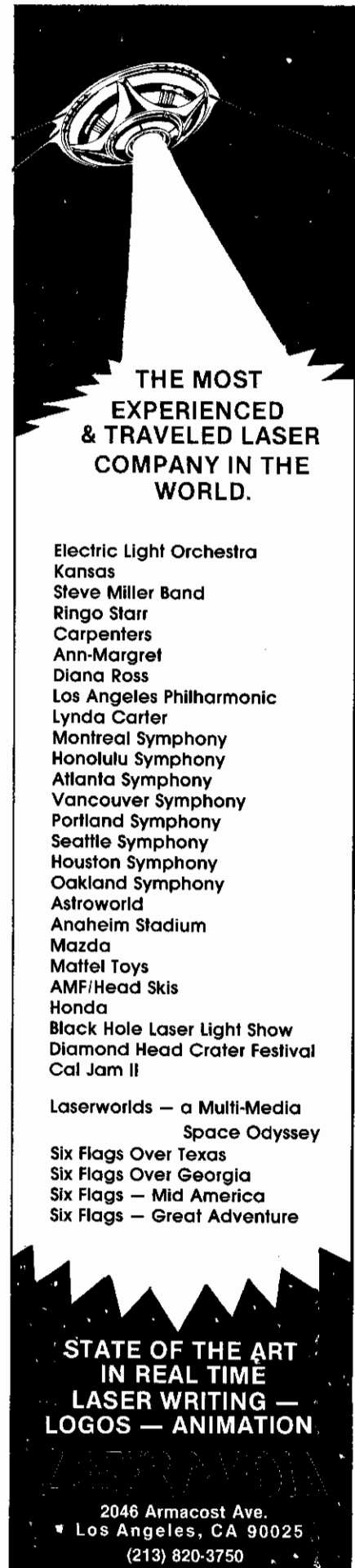
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