10.1117/2.1200805.1108

# Novel laser sources for large-venue projection markets

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*Efficient blue and green surface-emitting lasers enable high-performance, low-cost light engines for displays.*

Lamp-based projection sources for use in large venues such as convention halls, theaters, and museums are not easily scalable. These projectors typically combine up to four 200W ultra-high-power lamps in order to provide sufficient projection. As an alternative, xenon lamps of 6000–7000W have been employed in digital cinema projectors. However, the large étendue (the spread of the light in area and angle) of the lamps makes for inefficient light collection and projection. Moreover, the cost of ownership for such equipment is considerable due to the high electrical consumption associated with operating and cooling the projectors and the high cost of lamp replacements. There is a need in the industry for projection systems with longer lifetimes, low étendue, and wider color gamuts.

New laser-based light sources suitable for large venues are highly desired as they will produce a wide range of colors and are extremely stable. They permit constant power operation over a narrow wavelength emission with no wasted IR or UV spectral content, minimizing the need for color rebalancing. In addition, they allow for faster warm-up times and exhibit low noise compared to lamps. The overall system efficiency and improved thermal performance offer a significant enhancement over lamp-based projectors. Lasers would also enable 3D movies since they offer as much as a 60% power advantage over lamp-based systems. Insight Media estimated approximately $7800 in energy savings per year from using laser sources instead of lamps in digital cinema projectors.[1]

The green and blue range of visible wavelengths necessary for RGB (red, green, blue) displays have been especially difficult to obtain.[2,3] To address this, Novalux developed frequency-doubled vertical extended-cavity surface-emitting lasers (VECSELs, also referred to as Necsels: Novalux extended-cavity surface-emitting lasers).[4–6] These lasers emit circular Gaussian beams with 8–10% power conversion efficiencies for blue and green wavelengths. Other wavelengths such as cyan and yellow can be added in the future using the same technology.

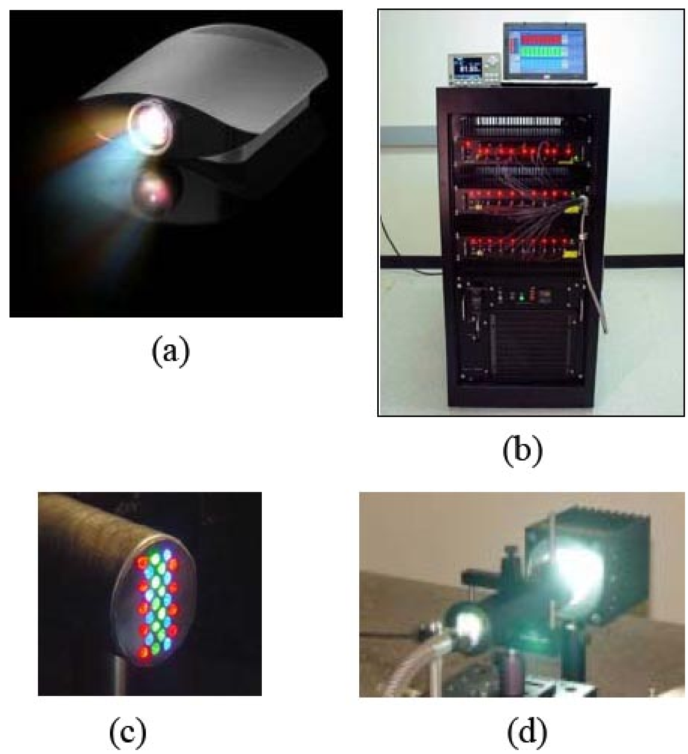

*Figure 1. Components of a large venue fiber-coupled laser projector. (a) The projector. (b) The rack housing the laser sources, power supplies, and a chiller that controls the operating temperature of the lasers. The fiber-coupled lasers are joined in a 10m-long bundle and terminated with a custom connector. (c) The custom connector. The fibers in the connector are set in a 9×16mm format. (d) The connector is inserted in front of the light tunnel housed in the projector seen in (a), in place of the lamp and lamp housing, which were removed. Thus, the laser light source is remote from the projector, which offers great servicing flexibility and may lead to new projector designs.*

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In addition to developing efficient blue and green lasers, we recently reported on a laser-based white light source for large-venue projectors[7] using red edge-emitting lasers at 640nm and green and blue Necsel arrays of 24 emitters each operating at 532 and 465nm, respectively. Twenty-seven fiber-coupled 3W RGB lasers (nine per color) were used to produce over 81W of RGB power, equivalent to about 20,000 lumens at the source (see Figure 1). The system used a closed-loop chiller, dissipated less than 1kW of power, and used a standard AC electrical outlet. A side benefit of more laser emitters is reduced speckle. The light source achieved a 4.5% speckle contrast with no additional de-speckling (this is very close to the industry goal of 2%).

Laser-based projectors offer a reduced cost of ownership by virtue of their higher efficiency and the much longer lifetime of the light source over that of lamps. The Novalux Necsel platform of intracavity-doubled vertical-emitting semiconductor lasers offers an expanded color gamut and brightness levels almost several orders of magnitude greater than lamps. It enables high-performance, scalable, reliable, easily manufactured, and ultimately low-cost light engines that will meet the demands of the next-generation projection display markets.

The real future benefits will come, however, from a superior viewing experience. The much broader color spectrum, better contrast, lower noise, and improved 3D rendering will impress audiences and provide new impetus for content creators to generate videos that can take advantage of these features. Our work is now focused on laser sources with twice the power per laser (6W or greater), which will result in a simpler integration and even lower overall system cost.

## Author Information

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Michael Jansen runs M. Jansen Consulting. He has spent over 23 years in the photonics industry where he has held vice president of engineering and chief technical officer (CTO) positions as well as general manager and chief operating officer (COO) executive positions. As COO and CTO at Novalux, he spearheaded the development of RGB laser sources for display and illumination.

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