High End Systems SolaWash Pro 2000

By: Mike Wood

It's getting hard to remember that, as recently as five years ago, we were still looking at LED-sourced luminaires as something of a novelty. Interesting products to be sure, but they could never replace the high-power discharge lamp luminaires that were the staple of every concert show. However, LED technology has progressed incredibly rapidly, and today we see just about every luminaire type using LED sources. Perhaps the last to change will be the extremely narrow-angle spot units, such as followspots, but I'm sure even they will eventually succumb to the lure of solid-state lighting. Discharge lamps will eventually follow incandescent lamps into light source oblivion. I see this as a friendly oblivion, along with limelight and carbon arcs, not the special hell reserved for compact fluorescents!

The fixture on the test bench this month is a prime example of the increasing reach of this disruptive technology. The High End Systems SolaWash Pro 2000 competes head-on with prior generations of discharge lamp-based wash lights. If you can achieve the light output you want but with the advantages of LEDs—long-life, no warm-up time, and instant responsiveness—then why wouldn't you? The SolaWash Pro 2000 is an example of what I've dubbed "hybrid" luminaires, in which a white-only LED source is used and color comes from conventional dichroic filters and color mixing. To my mind, there are both advantages and disadvantage to this approach. On the plus side, the optics and source can be more compact if only one color of LED is being used, and white LEDs are extremely efficacious. On the minus side, color changes are still mechanical and have the subsequent speed limitations, and efficacy is lost when using subtractive filters. The color gamut is also different, but this is neither a positive nor a negative. Both three-color LED additive-color mixing and dichroic CMY subtractive mixing have their own limited gamuts. Each has colors that are strong and others that are weak. I'd argue that neither type of unit is better nor worse than the other. Each has its own foibles that the lighting designer learns to deal with and optimize.

As usual for these reviews, I start at the light source and then work my way through to the output lenses, reporting what I see and what I can measure as we go along. All the reported results are based on the measurement of a single unit sent to me by High End Systems (Figure 1).

All tests were run with the SolaWash Pro 2000 operating on a nominal 115V 60Hz supply. However, the unit is specified for any supply between 100 — 240 VAC, 50/60Hz,with automatic voltage selection through the switched mode power supplies.

Figure 1: Fixture as tested.

Firstly, although the SolaWash Pro 2000 is described as a "wash" light, it actually has a bit more control than that. In its native mode, the beam edge can be quite sharp—not as sharp as a spot unit, but more like PC optics. It has two stages of wash mode (achieved through variable frost filters), which get progressively softer and softer. In all modes you have the option of using the framing shutters—which are really more barn door-like than framing —to shape and control the beam. We'll come to all of those features as we go through.

Light source

The SolaWash Pro 2000 uses a large array of phosphor-converted white LED emitters. The LED unit is sealed, so I wasn't able to determine exactly how many. Figure 2 shows a view into the LED array through the front lens to give you some idea. The array is capped by an optical element that includes, at least, a fly-eye lens to homogenize and collimate

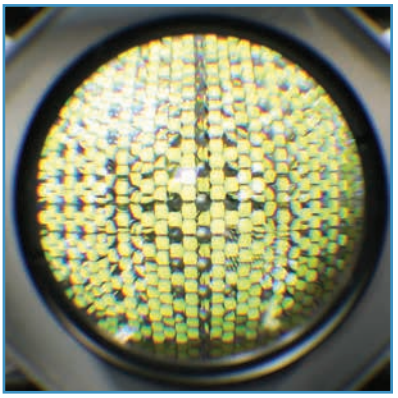

Figure 2: LED array.

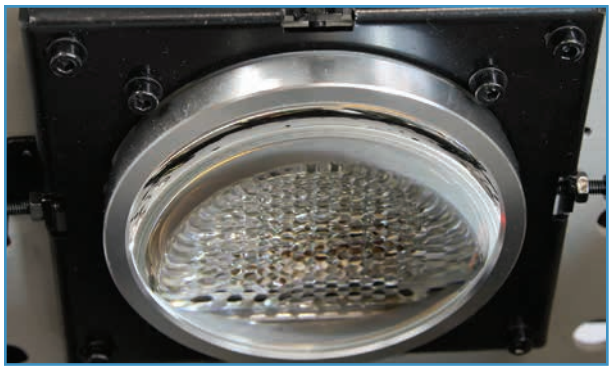

Figure 3: Fly-eye lens.

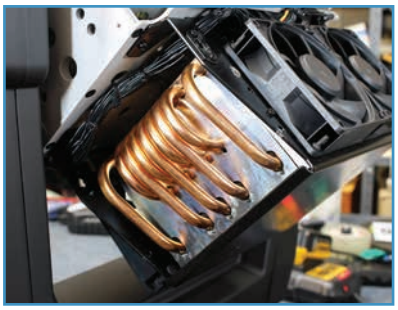

Figure 4: Cooling.

the individual beams into a single output directed towards the aperture (Figure 3). High End states that this array consumes 600W, which means that, efficient as LEDs are, there is still quite a lot of heat to get rid of. To do this, the SolaWash Pro 2000 has an array of heat pipes which pull heat out of the LED mounting and transfer it into cooling fins along the rear of the module (Figure 4). Four thermostatically controlled fans complete the picture, extracting the hot air out of the rear of the luminaire. As LED output is temperature-sensitive, and it takes this large mass a little while to reach thermal equilibrium, I didn't take any measurements until the unit had been running for at least 30 minutes.

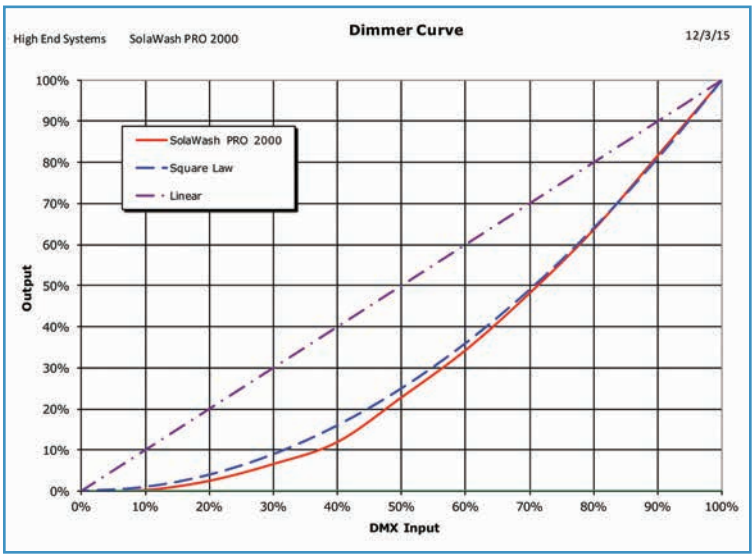

Figure 5: Dimmer curve.

Strobe and dimmer

With full control of the LEDs electronically there are no mechanics needed for dimming, of course. Figure 5 shows the dimming curve of the SolaWash Pro 2000. It's a close match to a standard square law and provided smooth operation with no obvious stepping. The separate strobe channel gave me measured strobe rates up to 28Hz. I measured the PWM rate underlying the dimming at 1.6kHz. This should be fast enough for most normal video use. (I recommend 1kHz or higher PWM frequencies for any LED unit being used for TV or video. Even then, you can still have issues with rolling shutters.)

Color systems

Immediately after the lamphouse is the color module. This contains four etched dichroic color mixing wheels (cyan, magenta, yellow, and variable CTO) and two fixed color wheels. Figure 6 shows an overall view of this module when removed from the unit. The variable wheels providing CMY color mixing are large and have a very fine density pattern etched through the dichroic. The end result is very smooth color mixing. There is some difference in color visible across the beam in pastel colors such as lavender (a very hard color for CMY to make cleanly), but nothing objectionable. The smoothness improved, as you would expect, when running in wash mode with either of the frost filters inserted. The transmission figures were as follows with, as usual, yellow being the highest output. Figure 7 shows the spectrum of the white LED sources which have, as is common, fairly low output in deep red, thus the red output of the luminaire is also somewhat low. The color mixing wheels took a maximum of 0.7 seconds to change from color to color.

Figure 6: Color module.

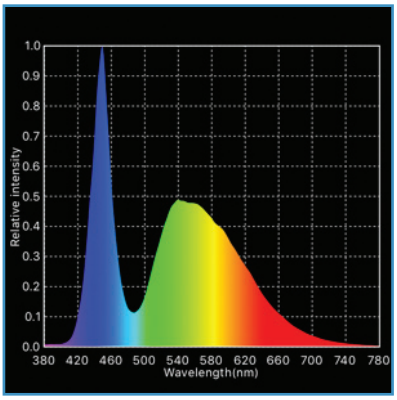

Figure 7: Spectrum.

COLOR MIXING

Color	Cyan	Magenta	Yellow	Red	Green	Blue
Transmission	10%	3.5%	88%	3.3%	5.0%	0.2%

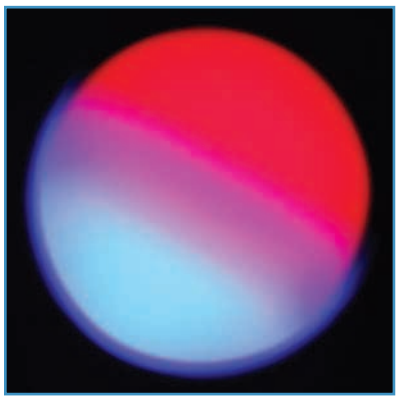

Figure 8: Half colors.

Both color wheels have trapezoidal dichroic glass filters. On one, these filters are permanently attached, while those on the other can be replaced by using a clip-in system. In both cases, the colors are close to each other and provide good half colors and clean transitions from one color to the next. Figure 8 shows an example of a half color when in spot mode.

COLOR WHEEL 1

Color	Red	Blue	Green	Orange	Lavender	Dark Blue
Transmission	1.6%	5.6%	23%	24%	3.6%	0.9%

COLOR WHEEL 2

Color	Magenta	Pink	Minus Green	CTB-1	CTB-2	Amber
Transmission	7.6%	23%	70%	63%	54%	52%

Color change speed is good: approximately 0.1 seconds between adjacent colors, and a maximum of 0.4 seconds between the most distant colors. The unit always takes the quickest path between colors to minimize this time. The color wheel can also be rotated continuously at speeds I measured, varying from 0.2rpm up to 90rpm.

This might be a good point to talk about the color temperature control options on the unit. I measured the native, uncolored beam at 7,200K. The variable CTO filter allowed reducing this, controllably, down to a warm 2,700K while the two fixed CTB filters on the color wheel provided 10,000K and 13,700K respectively. In open white, I measured the various color rendering metrics as CQS of 69, CRI 73, TLCI 49, and Δuv of -0.0006.

Framing

Next in the optical chain are the framing shutters. These are mounted on a second removable module along with an iris. Figures 9 and 10 show the two sides of this module and its ten motors. Each of the four shutter/barn door blades can be adjustably inserted fully across the beam and, once in place, can be tilted through +/- 22.5°. The entire framing module can also be rotated through 90°. It took 0.5 seconds for each blade to move its full travel and three seconds to rotate the entire assembly 90°. Each blade runs in its own dedicated layer and can pass behind or in front of its neighbors, without interference, all the way down to a fully closed aperture. This system provides very flexible configurable soft-edge beam control and, in conjunction with the frost systems, gives the user a lot of options. Figure 11 shows a simple framed shape when used with the three frost options. The left image is the native unsoftened beam, while the other two images show the same framing pattern with the two levels of frost added.

Figure 9: Framing module side A.

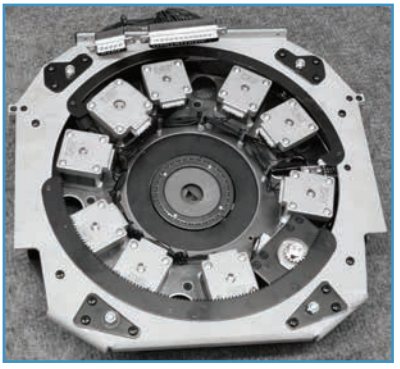

Figure 10: Framing module side B.

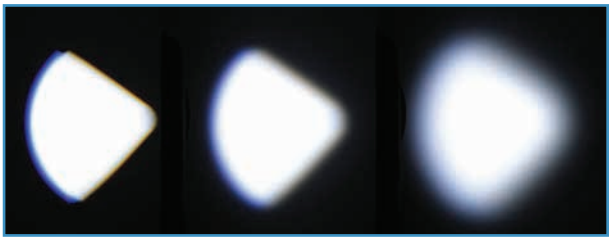

Figure 11: Framing and frost.

Iris

As can be seen in Figure 10, the iris is positioned as close as possible to the framing blades. The fully closed iris reduces the aperture size to 17% of its full. I measured the opening and closing time at around 0.6 seconds.

Lenses and output

The SolaWash 2000 Pro has a conventional three-group lens system. The two rear groups move to provide zoom and focus, while the third group is fixed and provides the final visible output lens at the front of the unit. I measured the output from the complete system when running at full power in spot mode at its widest angle at 22,280 field

lumens with a field angle of 39° (Figure 12). This field angle increased to 43° when Frost 2 was used, while the output dropped, as expected, to 17,200 field lumens (Figure 13). At the narrow end of the zoom range, I measured 17,500 lumens with a field angle of 11°. The focus lens took one second to run from one end to the other, while zoom took 1.5 seconds.

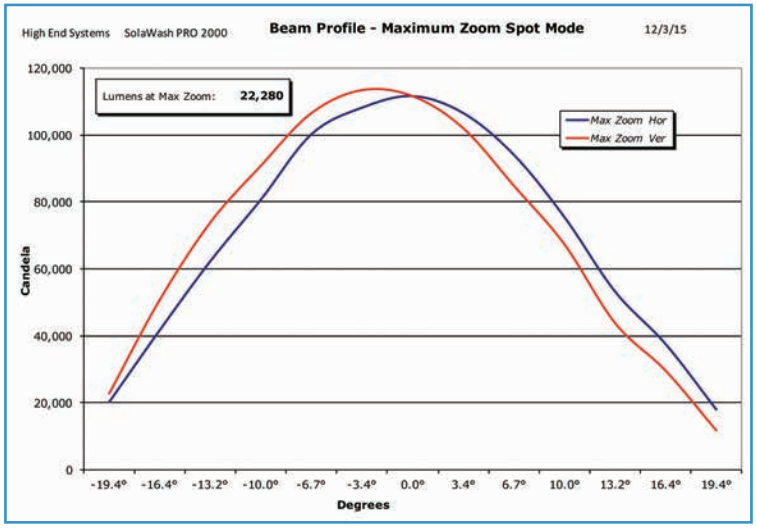

Figure 12: Output maximum zoom spot

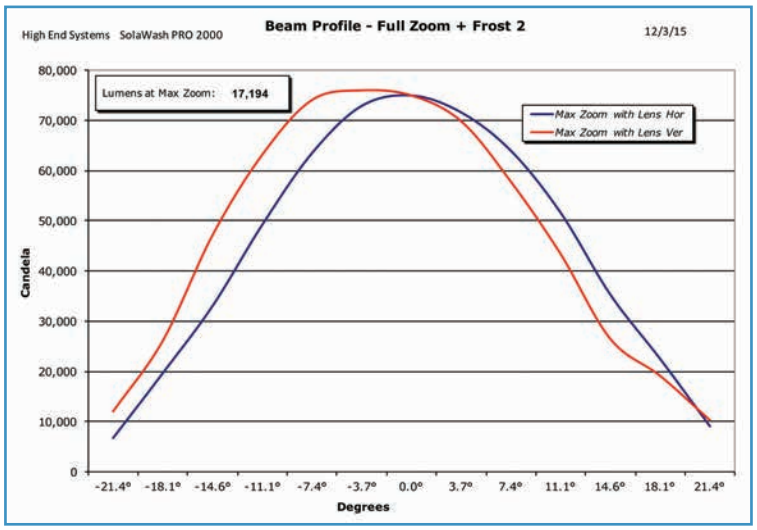

Figure 13: Output maximum zoom wash.

Frost

There are two pairs of variable frost filter flags mounted on the rear side of the second lens group and traveling with that group as it moves (Figure 14). These provide two levels of variable frost to the beam or can be combined to get the softest beam possible from the system. The result was smooth and even.

Pan and tilt

The SolaWash 2000 Pro has a pan range of 540° and a tilt range of 265°. A full-range move of pan took 5.1 seconds while a more typical 180° move took 2.5 seconds. The timing for tilt was 2.8 seconds for a full range move and 2.4 seconds for 180°.

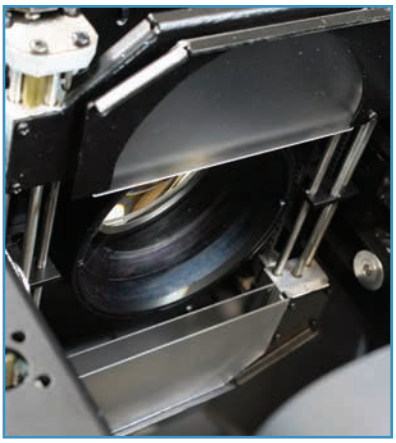

Figure 14: Frost filters.

The quality of the movement was very good, with little to no steppiness visible. I measured the accuracy of positioning as presenting a low hysteresis of 0.06° on both pan and tilt. That's equivalent to 0.3" at a 20' throw (10mm at 10m). There was some bounce and overshoot in final positioning, but the system corrected.

Noise

SOUND LEVELS

	Normal Mode
Ambient	<35 dBA at 1m
Stationary (full)	46.5 dBA at 1m
Homing/Initialization	63.6 dBA at 1m
Pan	47.1 dBA at 1m
Tilt	46.8 dBA at 1m
Color	46.7 dBA at 1m
Framing Shutters	52.1 dBA at 1m
Focus	55.8 dBA at 1m
Zoom	61.7 dBA at 1m

As is so often the case, zoom was the nosiest function. The stationary noise figure reported is with the LEDs and their associated fan running after 30 minutes of use at full power. These figures were measured with the unit running in regular fan mode. When switched to studio fan mode, the noise level while stationary dropped about 4dB to 42.6dBA at 1m.

Electrical parameters and homing/ initialization time

POWER CONSUMPTION AT 115V, 60HZ

	Current, RMS	Power, W	VAR, VA	Power Factor
Quiescent (LEDs off)	0.69A	80W	84VA	0.95
LEDs at full	6.57A	767W	780VA	0.98

Initialization took around 36 seconds, either from a cold start or from a DMX512 reset command. Homing is badly behaved in that the fixture dims up the LEDs before pan and tilt have finished moving to their final position. Wall-plug efficacy with this power consumption is 29lm/W in full zoom spot mode.

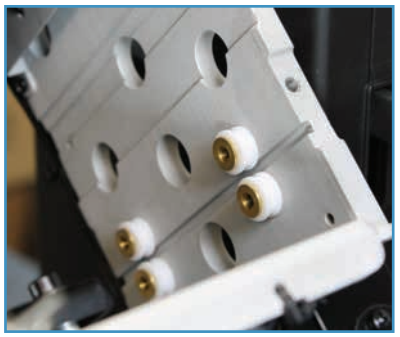

Figure 15: Module rollers.

Figure 17: Yoke arm.

Construction, electronics, and control

The unit features very neat modular construction in the head. Each optical module has a couple of electrical connectors and can then be slid out in one piece. I appreciated the rollers and guides on the module rails, which make service very simple (Figure 15). Figure 16 shows a shot of the head with all modules in place. Control electronics are distributed around the head and the yoke arms (Figure 17). Figure 18 shows the menu and control system. The SolaWash 2000 Pro provides standard five-pin and three-pin DMX512 in and out connectors and a powerCON connector for the power cord (Figure 19). The menu is straightforward and provides access to the usual fixture set-up and maintenance functions.

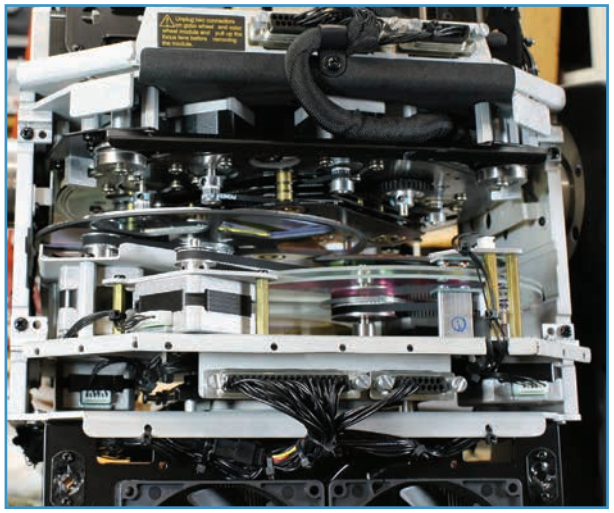

Figure 16: Optical modules.

That's just about it for the High End Systems SolaWash 2000 Pro. It's an interesting mix with its white LED source, dichroic subtractive color mixing, and the extra control of a framing/barn door system. If it looks interesting, I encourage you to try one out for yourself, the final decision has to be yours.

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Figure 18: Display.

Figure 19: Connections.