# High End Systems SolaSpot Pro 2000

By: Mike Wood

Figure 1: Fixture as tested.

High End Systems' website proudly proclaims, "We are LED," and indeed, the company seems to have gone completely over to LEDs as light sources for its luminaires. It has a couple of legacy HID-based units listed, but the vast majority (and everything currently planned for the future, I am told) is LED-based.

I don't have to tell you the history of High End Systems; it has been active in the automated light arena just about as long as any company and, like the others, has seen its fortunes wax and wane with changing trends and fashions. After leaving bread-and-butter workhorse luminaires for a while to produce some very specific effects lighting units, High End has returned somewhat to its roots with the SolaSpot and SolaWash ranges of fixtures. Very much designed as workhorse products, these constitute a range of white LED-based units using dichroic colors and subtractive CMY color-mixing. You'll know my thoughts on this mix of technologies from previous reviews. It seems to me to be a little strange when one of the plus points of LEDs is the ease of additive mixing. However, the plus points are clear. White LEDs are where all the R&D dollars are going, so white LEDs are the most efficient right now. If a fixture is going to be used in, or near, white a lot of the time, there are advantages to using white LEDs as the light source: no worries about homogenizing differently colored LEDs, stable color rendering, and much-reduced LED droop problems. You lose efficacy compared to an additive color LED unit when making saturated colors, but I suspect most of the market for this kind of product doesn't worry about that too much, anyway.

This month, we are taking a look at the SolaSpot Pro 2000. This is the top of the SolaSpot range for output and has features that will be familiar to anyone looking for an automated spot unit. This review is based on my tests of a single SolaSpot Pro 2000 supplied to me by High End Systems. All tests were run on a nominal 115V 60Hz supply; however, the SolaSpot Pro 2000 is rated to run on voltages from 100-240V 50/60Hz (Figure 1).

## Light source

The light source in the SolaSpot Pro 2000 is a black-box-sealed unit from Appotronics. It contains a single array of high-power white LEDs adjusted during manufacture for consistency and accurate color temperature. Figure 2 shows a view through the front, fly-eye, homogenizing lens

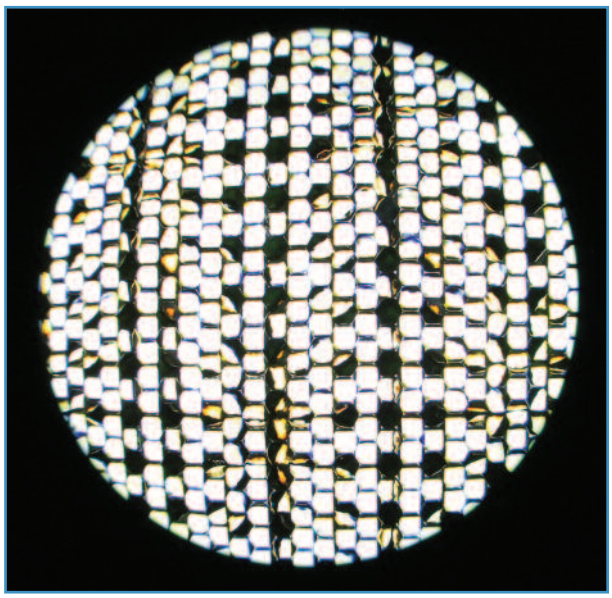

Figure 2: LED array.

of the light engine into the array. I measured the power consumed by the LED subsystem at around 700W, which, even with the efficiency of LEDs, means a lot of heat to get rid of. The SolaSpot Pro 2000 has a large rear heat plate backing the LEDs, which is, in turn, cooled by a set of heat pipes leading to a large, fan-cooled heat sink on the rear of the unit (Figure 3).

Figure 3: Heat pipes.

## Color

High End has mounted all the major systems on two drop-in modules. The first module, in the optical train after the light engine, is for color control. The SolaSpot Pro 2000 has both color-mixing and a color wheel, which can be used separately or together. First in line are color mixing flags. High End uses a "pair-of-curtains"-style system, where each of the four sets of graded dichroic colors (cyan, magenta, yellow, and CTO) come in as two plates, one from each side of the beam. This two-sided approach, as opposed to a single wheel or flag, produces a much more even color across the beam. Figure 4 shows the linear color flags as they cross the beam. Each flag has a shaped leading edge, followed by a graded etched pattern, to increase the color density as the flag is moved across the beam.

Note: One reason this kind of two-sided approach works well is the human eye sees edges and changes much more clearly than it does flat areas. If a beam changes color from one side to the other, this is made apparent at the edges, where it contrasts with the surrounding background color. Coming in from both sides with color-mixing reduces the actual color spread across the beam and also confines any errors to the center of the beam versus the edge, which is much less apparent to the viewer.

I measured the output from the color-mixing system as follows. The colors are nicely saturated and I was able to mix good even ambers, aquas, and lavenders (the three colors that are always the hardest to mix with a subtractive system).

**MIXING**

| Color | Cyan | Magenta | Yellow | Red | Green | Blue | CTO |
|---|---|---|---|---|---|---|---|
| Transmission | 18% | 2.9% | 79% | 2.3% | 10% | 0.3% | 28% |

When inserted fully, the CTO flags reduced color temperature from a native 6,920K with a TM-30-15 Rf value of 67 (CRI 72) down to a CCT of 2,745K and an Rf of 59 (CRI 64).

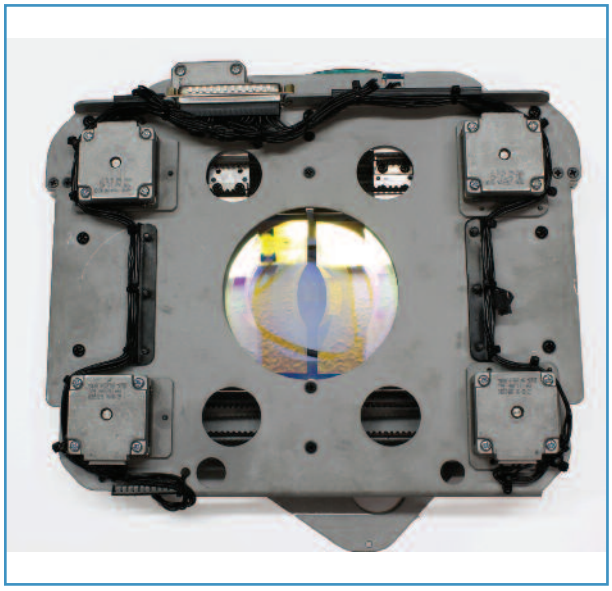

Figure 4: Color module.

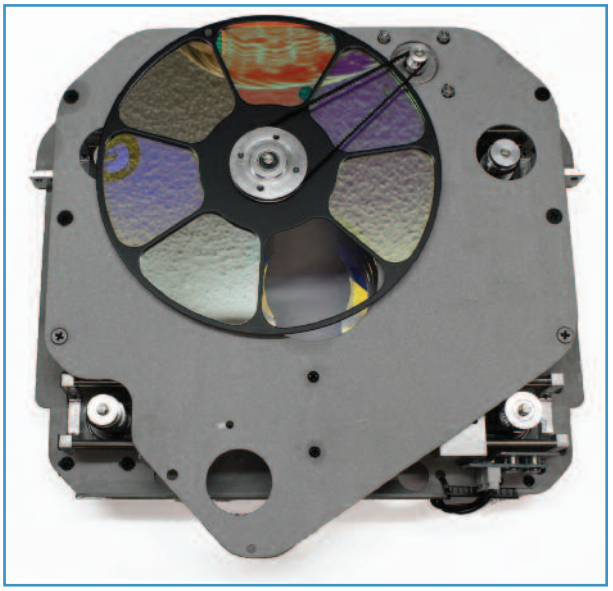

Figure 5: Color module 2.

On the other side of the color module is the fixed color wheel. Figure 5 shows this clearly. This has six fixed trapezoidal dichroic colors plus an open hole.

**FIXED COLOR WHEEL**

| Color | Red | Blue | Green | Amber | Lavender | Deep Blue |
|---|---|---|---|---|---|---|
| Transmission | 1.9% | 72% | 19% | 10% | 64% | 54% |

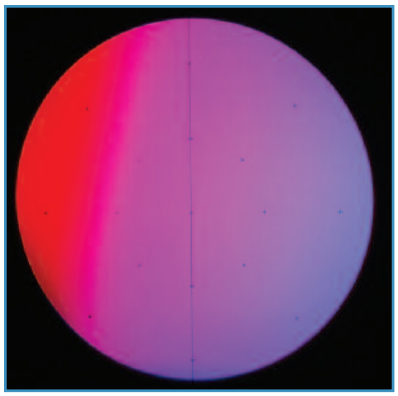

Figure 6: Half color.

The trapezoidal shape means you can make half-colors with no black bar between colors. There is good definition to the open hole from the blue and dark blue on either side, but the other half-colors are a little fuzzy. Figure 6 shows an example of one of the other transitions. Color change speed was good, with very smooth transitions and slow wheel rotations possible.

**COLOR SYSTEMS**

| | |
|---|---|
| Color change speed – adjacent | 0.2 sec |
| Color change speed – worst case | 0.5 sec |
| Maximum wheel spin speed | 0.675 sec/rev = 89 rpm |
| Minimum wheel spin speed | 328 sec/rev = 0.2 rpm |
| Color mix speed – worst case | 0.5 sec |

Figure 7: Gobo module.

## Imaging effects

Now we move onto the next optical module. As can be seen in Figure 7, this contains the gobo wheels, animation wheels, and iris.

The SolaSpot Pro 2000 has two independent large-format animation wheels, both of which can be moved across the beam and rotated either separately or together. As shipped, and clearly visible in Figure 7, one wheel has a large break-up pattern while the other has a textured dichroic glass that grades in color through yellows and ambers. The photograph shows the wheels in their parked position outside the beam. They can be moved across the beam in 0.2 seconds. Depth of field is very short on the SolaSpot Pro 2000, so the focus distance on the animation wheels is quite a long way from the rotating gobo wheels. Nevertheless, they provide an interesting range of texture effects.

Right behind the animation wheels are the gobo wheels. The two gobo wheels are essentially identical. Each has six rotating, indexing gobos plus an open hole. Any slot can have a metal or dichroic pattern or a breakup glass. There are no heat problems with an LED source to limit choices. As is the norm these days, the gobos are mounted in snap-in cartridges to make for quick, easy changes.

**ROTATING GOBO SPEEDS – BOTH WHEELS**

| | |
|---|---|
| Gobo change speed – adjacent | 0.4 sec |
| Gobo change speed – worst case | 0.6 sec |
| Maximum gobo spin speed | 0.36 sec/rev = 166 rpm |
| Minimum gobo spin speed | 344 sec/rev = 0.17 rpm |

Positioning and rotation of both wheels was quick and smooth, with a good range of rotation speeds. The rotating wheel showed very little bounce when changing direction, and I measured the accuracy as 0.08° of hysteresis error, which equates to 0.3" at a throw of 20' (13mm at 10m). All wheels use a quick-path algorithm to minimize change times.

Focus quality on all gobos was excellent, with very acceptable edge-to-center difference and almost no color-fringing. Figure 8 shows an example of the gobo morph effect from one wheel to the other.

Figure 8: Gobo morph.

## Iris

The iris is at the rear of the module, after the gobo wheels. I measured the opening/closing time at around 0.5 seconds. The fully closed iris reduces the aperture size to 17% of its full size, which gives equivalent field angles of 1.2° at minimum zoom and 5.6° at maximum zoom.

## Prism and frost systems

The SolaSpot Pro 2000 has two prisms, either of which can be inserted across the beam in around 0.5 seconds and then rotated at speeds varying from 0.5sec/rev (116rpm) down to 328sec/rev (0.18rpm). Figure 9 shows the effect and image separation with both prisms, a three-facet circular and a four-facet linear. Although the two prisms are mounted independently on their own motors and arms, they take the same position in the optical train, so only one at a time can be used. Both prisms move back and forth on the rear of Lens Group 1.

Last but not least, and mounted in a similar fashion on the front of Lens Group 2, and moving with it, is the frost flag. This can be inserted or removed in 0.1 second. When partially inserted, the effect is that of a contrast reducer, not a frost. It acts as a true frost with softened edges only when fully inserted. Figure 10 shows an example of the effect.

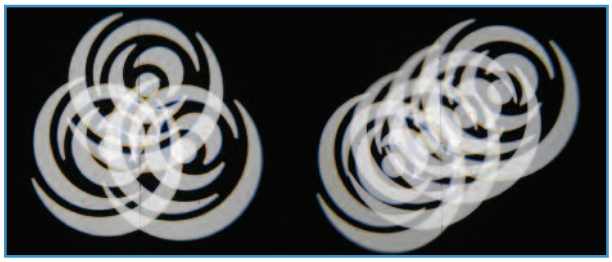

Figure 9: Prisms.

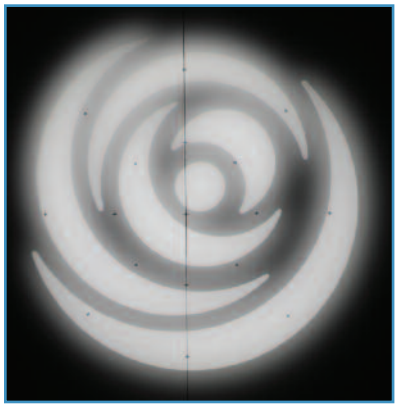

Figure 10: Frost.

## Lenses and output

The lens system is the typical three-group zoom, with the front group fixed as the output lens and the other two groups moving to provide zoom and focus control. Figure 11 shows the first two groups along with the two prisms. Zoom took 1.4 seconds to run from maximum to minimum while focus took 1.1 seconds from end to end.

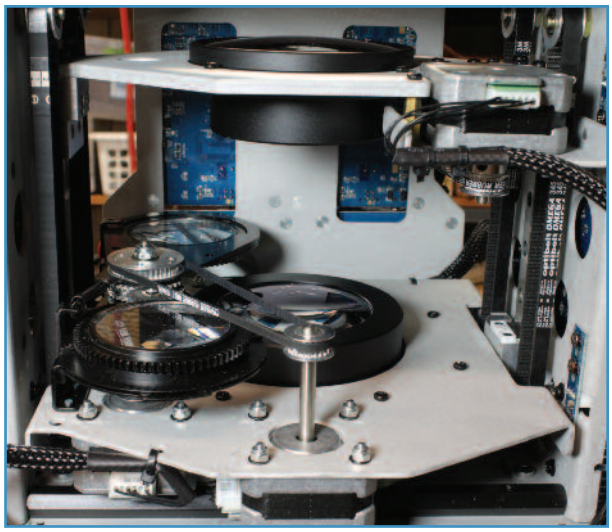

Figure 11: Lenses and prisms.

I measured the field output of the SolaSpot Pro 2000 at 20,600 lumens at 33.4º at the wide angle end of zoom ramping down to 9,440 lumens at a narrow angle of 6.9º. The field is extremely flat at all positions as can be seen in the beam profiles, as seen in Figures 12 and 13. These measurements are field lumens (output within the 10% field angle) taken after running the unit at full power for at least 30 minutes. As is often the case with LED-based units, the SolaSpot Pro 2000 shows some output droop as it warms up. Over the first ten minutes, after turning on at full power, the output dropped by 14%.

Dimming was very smooth and followed a default square law well, with no jerkiness and no artifacts at low dim levels (Figure 14). I measured the PWM rate at a snappy 2.4kHz.

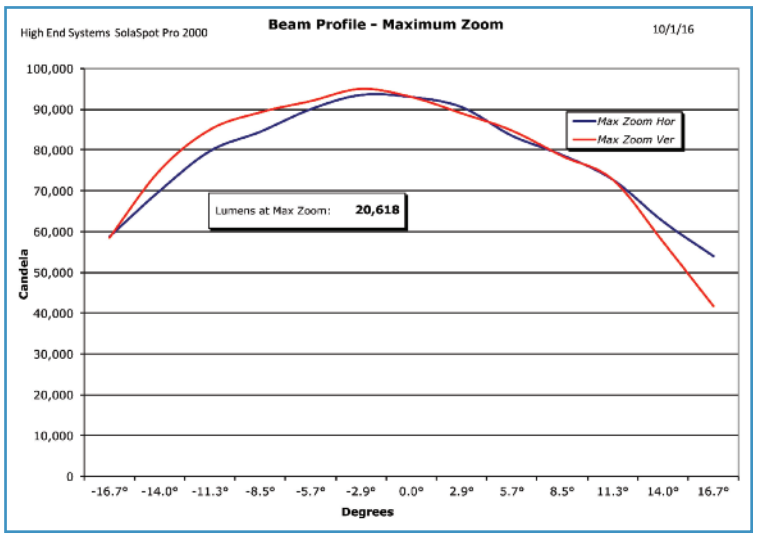


Figure 12: Maximum zoom.

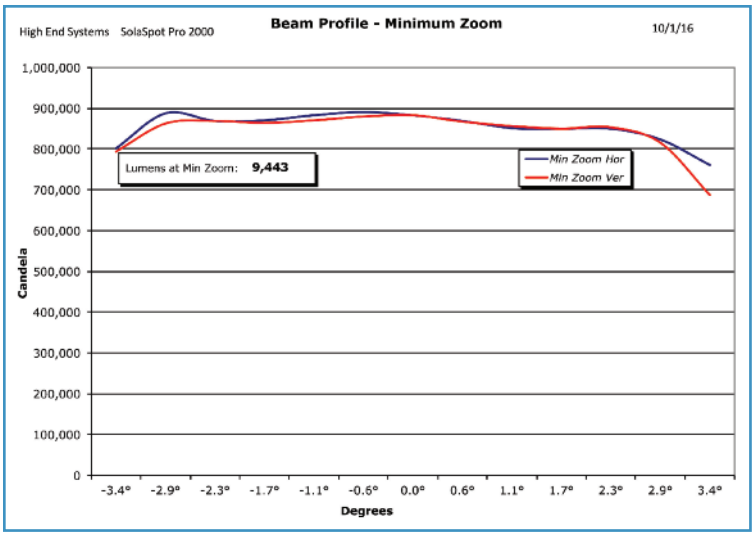


Figure 13: Minimum zoom.

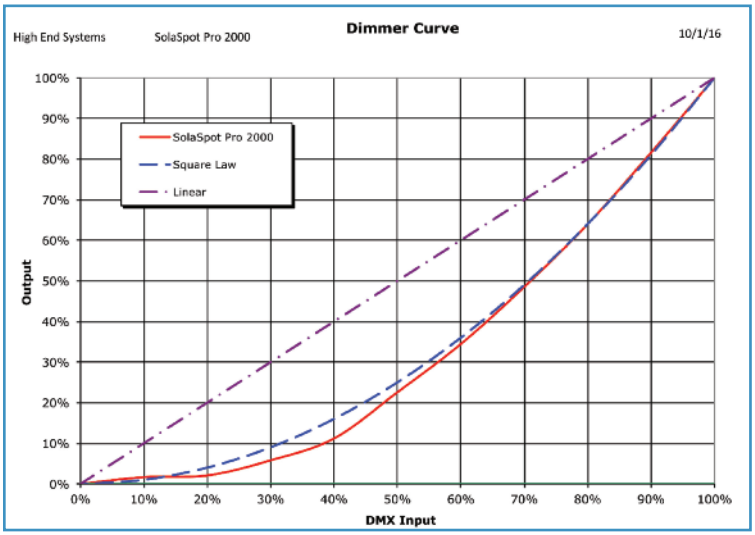


Figure 14: Dimmer curve.

Electronic strobe of the LEDs is variable from 0.79Hz up to 27.8Hz.

## Pan and tilt

The SolaSpot Pro 2000 has 540º of pan and 265º of tilt movement. I measured pan speed over the full travel at 5.2 seconds and 2.5 seconds for 180°. In tilt, the figures were 3.2 seconds for the full 265° and 2.7 seconds for 180°. Movement on both axes was very smooth, with minimal hysteresis and just a little overshoot. Pan exhibited 0.12º of hysteresis which is 0.5" at a throw of 20' (21mm at 10m). Tilt was less, at 0.06°, 0.3" at 20' (10mm at 10m). Figure 15 shows both yoke arms with the tilt motor system and encoder wheel clearly visible.

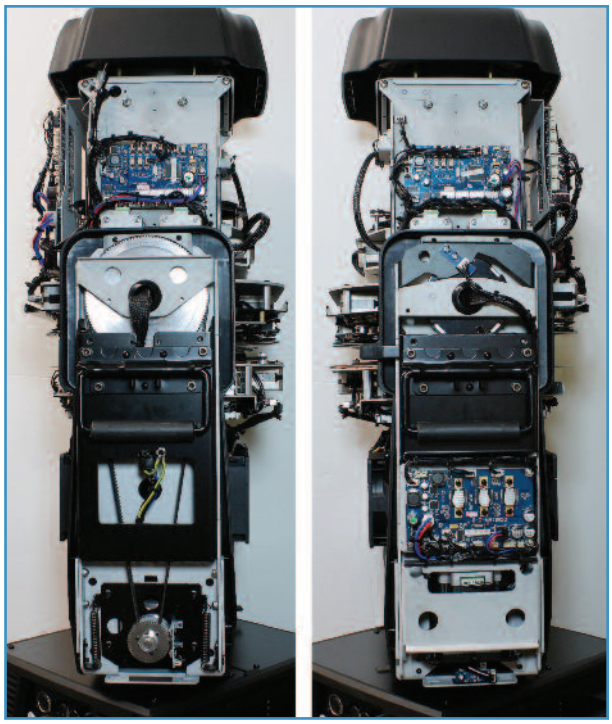

Figure 15: Yokes.

## Noise

Zoom and focus were just about the only two functions to get noticeably above the noise floor from the fan. There is also a “studio mode” for fans available through the DMX control channel. This reduces the fan noise by around 4dBA, with a corresponding drop in light output to 75%.

**SOUND LEVELS**

| | |
|---|---|
| Ambient | <35dBA at 1m |
| Stationary | 47.6dBA at 1m |
| Homing/Initialization | 64.7dBA at 1m |
| Pan | 49.2dBA at 1m |
| Tilt | 48.9dBA at 1m |
| Color | 50.7dBA at 1m |
| Zoom | 55.7dBA at 1m |
| Focus | 56.2dBA at 1m |
| Frost | 47.8dBA at 1m |
| Gobo | 48.7dBA at 1m |
| Gobo Rotate | 49.0dBA at 1m |
| Prism | 50.2dBA at 1m |
| Animation Wheels | 48.3dBA at 1m |

## Homing/initialization time

The SolaSpot Pro 2000 took a measured 72 seconds to complete a full initialization from power up and 52 seconds from a DMX reset command. The reset is badly behaved in that the LEDs aren’t dimmed out before reset starts and fade up again before final positioning.

## Power, electronics, control, and construction

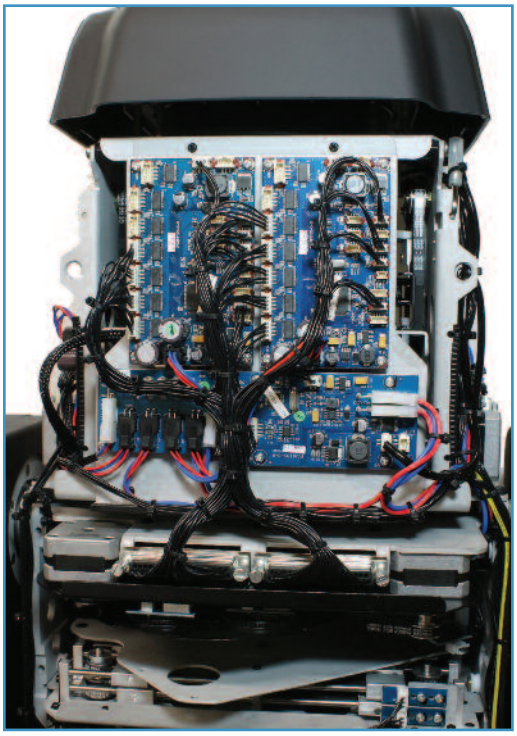

Figure 16: Head.

Running as I did with a 115V 60Hz supply, the SolaSpot Pro 2000 consumed 7.24A when running at full output and warmed up. This equated to 839W and a power factor of 0.97. The quiescent load with the unit powered up but no LEDs on was 1.13A, 131W, power factor 0.96.

Drive electronics are distributed throughout the unit with the majority on a set of boards in the head. Figure 16 shows one set. As I've already mentioned, the bulk of the head optical components are mounted on two modules. These run on rollers in the chassis and are very easy to remove and insert for maintenance or cleaning.

Power supplies for both electronics and lamp are in the top box. There is also a battery system in the top box, which allows setting fixture parameters before the unit is powered up.

Figures 17 and 18 show the color LCD display and menu system and the set of connectors. The menu is straightforward and provides access to the usual fixture set-up and maintenance functions. The SolaSpot Pro 2000 uses a powerCON connector for power in and provides both three-pin and five-pin XLR connectors for DMX512 data.


Figure 17: Display.


Figure 18: Connectors.

## Conclusion

The SolaSpot Pro 2000 has one more feature, one which has become a bit of a High End Systems trademark. That is the four indigo highlighter LEDs on the front of the unit (Figure 19). These can be controlled, dimmed, and strobed separately from the main light source.

As I mentioned earlier, the SolaSpot Pro 2000 is clearly designed as a workhorse unit with the normal range of standard features, but all driven from a white LED engine. How does it compare with other units on the market? Can white LED replace HID? I'll end, as I always do, by sidestepping any hard conclusions and reminding you that, although I've given you some facts and figures, it's your decision as to whether or not the SolaSpot Pro 2000 will work for you.

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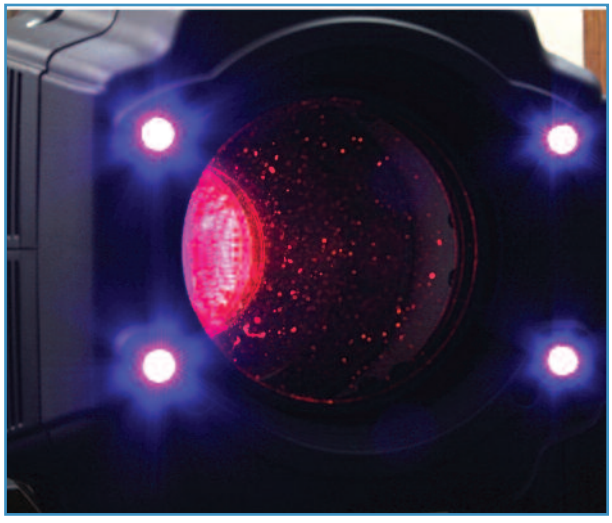

Figure 19: Highlighters.