# Improving brightness of the LCOS system

***Hun-Wei Chen, Mei Liu, Shih-Min Wu, Chi-Neng Mo***
Central Research Institute, Chunghwa Picture Tubes, Ltd.
1127, Hopin Rd., Padeh City, Taoyuan, Taiwan, 334
E-mail: chenhunw@cptt.com.tw Tel. +886-3-3675151 Fax. +886-3-3773159

## Abstract

*To increase light* efficiency, *utilizing phosphors transfers ultraviolet ray to visible light and the fluorescent characteristic without change the electrical or optical design. Spreading phosphors on the surface of light bulb mirror can compensate the red and blue light to yield this correct white field after being stimulated by reflected ultraviolet ray.*

**Keywords**：Contrast, phosphor.

## 1. Introduction

An ultra-pressured mercury lamp (UHP lamp) is usually adopted as the light source of the projection system. The UHP lamp emits the ultraviolet ray that can destroy the coating on the lenses, so it is necessary to filter out these ultraviolet rays. When compared with red or blue lights, the green light's luminous energy within the UHP lamp is more intense like Fig. 1 [1], causing the white light that is formed by a mix of the primary RGB colors to shift towards green.

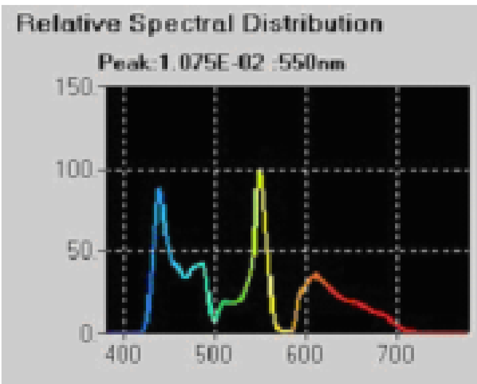


Fig.1 The spectrum of the lamp

Phosphors have been employed in various display devices for dozens of years. According to the law of the conservation of energy, this paper therefore proposes a new method by utilizing the ultraviolet ray energy to stimulate phosphors to shine.

As the light bulb emits the ultraviolet ray which can stimulate the phosphor. Fig. 2 indicates the distribution of the light source from the bulb. We use a UV-IR filter in front of the light bulb to reflect the ultraviolet ray emitted from the bulb back to surface of the mirror on the light bulb. Phosphors were spread on this mirror surface would be stimulated by the reflected ultraviolet rays to compensate the red and the blue light from the bulb to yield a correct white field and to increase the brightness as well. Our invention exploits the fluorescent characteristic of phosphors without change the electrical or optical design.

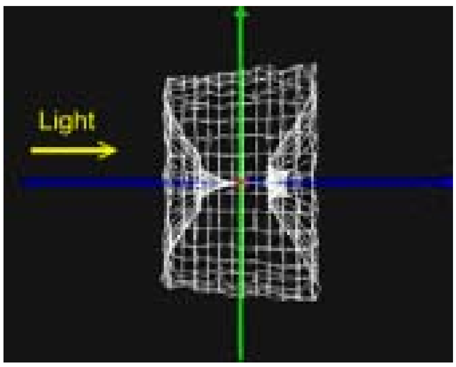


Fig.2 The light marches forward the direction

## 2. The Optical System

### 2.1 Location of the Phosphor

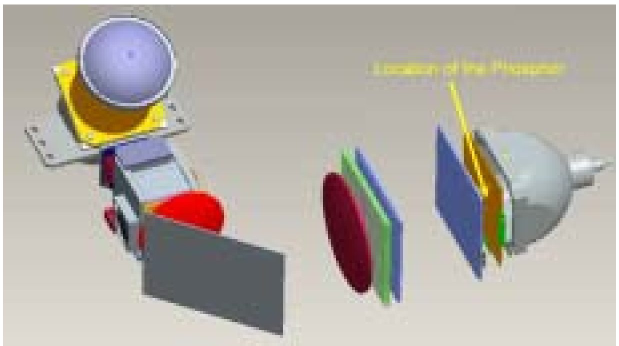

Fig.3 The location of the phosphor

Fig. 3 depicts the structure of our optical system [2]. We spread phosphors in front of the light bulb. How the UV-IR filter is allocated and the path of ultraviolet ray is shown on Fig. 4.

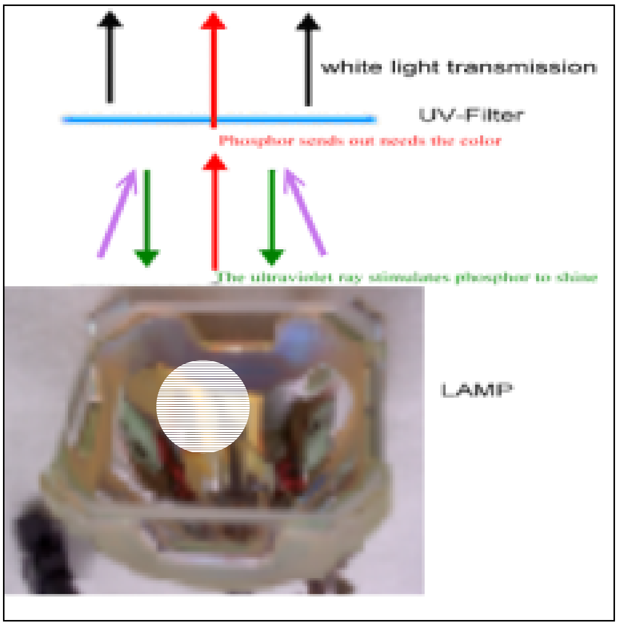


Fig.4 Phosphors experiment principle

### 2.2 Optical simulation

The present paper relies on the ultraviolet ray and uses the ultraviolet ray filter to reflect ultraviolet to stimulate phosphors. Therefore, first it has to simulate the efficiency of light bulb and the reflected light, Fig. 5 and Fig. 6 is the optical distribution map of the light bulb simulation.

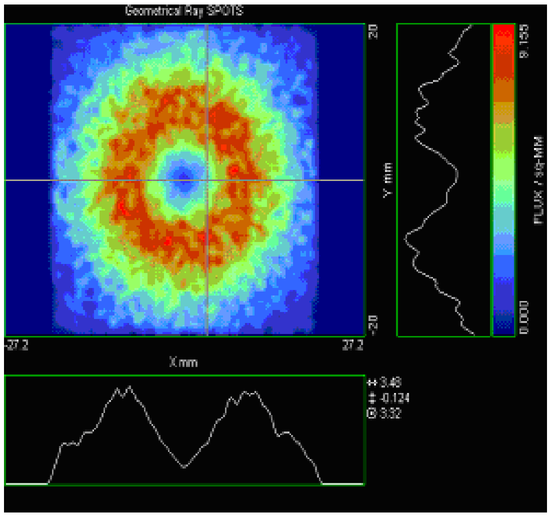


Fig.5 X direction light distribution

First, we setup the optical parameters of the lamp source in software, and then establish a sensory element in front of the light bulb. This sensory element simulates the range and the location of phosphors. One could see the sensory element by Table1 that the range should not be too large, because sensory element blocks part of the light form the lamp and hence reduces the whole brightness. And also the range of the sensory element cannot be too small because the usage efficiency of light that stimulated from phosphors could reduce. Fig. 7 expresses the angle that phosphors absorb the light source. Therefore, we have to consider the range of phosphors can produce the best efficiency of ultraviolet ray usage.

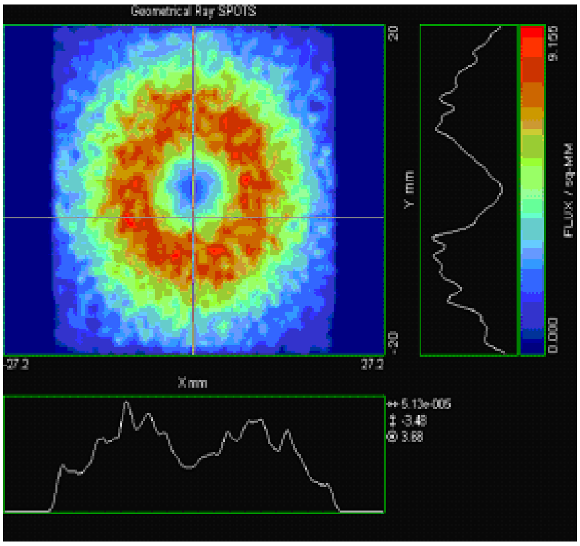


Fig.6 The Y direction light distribution

Table 1 100K ray trace (input 8000 flux) for relative efficiency between lamp and UV-IR filter

| Detector semi-diameter | Distance (Lamp&UV-IR) | Shaded eff. | ON UV-IR | Reflective eff. |
|---|---|---|---|---|
| 2 | 11.8 | 17.59 | 6527.33/666.68 | 40.82 |
| 2.5 | 11.8 | 34.09 | 6510.62/666.68 | 53.10 |
| 3 | 11.8 | 56.52 | 6488.13/666.68 | 71.64 |
| 3.5 | 11.8 | 86.51 | 6458.19/666.68 | 95.08 |
| 4 | 11.8 | 125.30 | 6419.73/666.68 | 142.37 |
| 5 | 11.8 | 244.56 | 6299.34/666.68 | 380.09 |
| | | | | |
| 3.5 | 11.8 | 86.51 | 6458.19/666.68 | 95.08 |
| 3.5 | 16.8 | 86.51 | 6448.46/676.40 | 183.53 |
| 3.5 | 21.8 | 86.51 | 6439.18/685.68 | 338.70 |
| 3.5 | 26.8 | 86.51 | 6428.3/696.07 | 635.44 |
| 3.5 | 31.8 | 86.51 | 6422.63/702.06 | 899.18 |
| 3.5 | 36.8 | 86.51 | 6415.60/701.47 | 1137.18 |

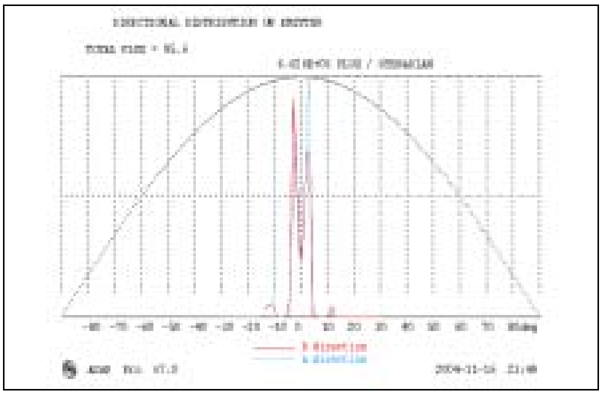

Fig.7 expresses the angle that phosphors absorb the light source.

## 3. Conclusions

The present paper proposed a new way stimulates phosphors using the ultraviolet ray reflected form light filter. First we simulate the range of phosphors and the distance of a UV filter and the lamp by using optical software. And then we find the most suitable range of phosphors and distance of a UV filter and the lamp produces the best efficiency of this UV ray usage. By using this new method, we can compensate the blue and red light from light source and enhance the total luminance of the optical engine.

## 4. References

[1] H. Moench, and H. Giese, el., *"UHP lamps with increased efficiency,"* SID 03 Digest, pp. 758-761, (2003).

[2] C.N. Mo, C.L. Liu, C.J. Lin, S.M. Wu, and H.Y. Chen," *New type LCOS optical engine*," International projection conference (April 1-3, 2004), Beijing, China, pp99-102, (2004).