Mucap LED Calibration System

Cenap Ş. Özben

University of Illinois, Department of Physics,

1110 W. Green Street, Urbana, IL 61801

April 18, 2003

In this short report, design and some measurements of the MUCAP LED calibration system is discussed.

Our design is based on a blue LED driven by an avalanche type pulser, dispersive mylar layers, Plexiglas mixing blocks, distribution fibers and SMA type connectors. For 64 tubes, two light tighted NIM modules, each one contains two independent distribution systems are used. Each distribution system contains 16 fibers to carry the attenuated and uniform blue light into the photomultipliers. Figure 1 shows this system.

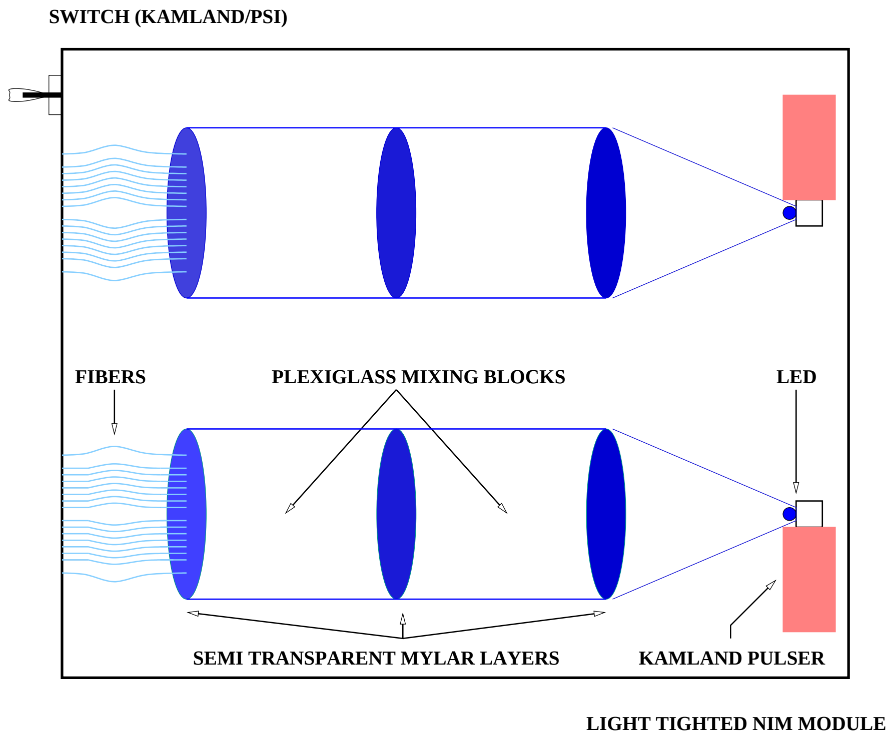

Fig. 1 : Mucap fiber distribution box.

In this project, the HP type with 30^0 emission angle LED's are used. In order to have relatively uniform distribution in the first mylar layer on the path of the light, LED is located in a certain distance. Thickness of the mylar layer is small ($\approx$200 μ) and can be changed by putting more layers on top of each other to obtain the necessary attenuation. After the mylar layer, a Plexiglas cylinder with 6 cm height and $\approx$2 cm diameter is placed in order to have better dispersion. This configuration is repeated and ended with another semi transparent mylar layer. The whole distribution system is wrapped with first mylar sheet and then Kevlar paper to optically isolate the second system in the same box.
Uniformity measurements took place by measuring the DC light level across the surface of the end of the distribution Assembly. This was done by locating a fiber with a micrometer (the one that used in the optical bench tables) and sweeping the surface in the direction of x and y (one dimension at a time) (Figure 2). Since the distributed light is going to be carried by 16 fibers (1 mm thick) 8 mm $\times$ 8 mm area is necessary (Figure 3).

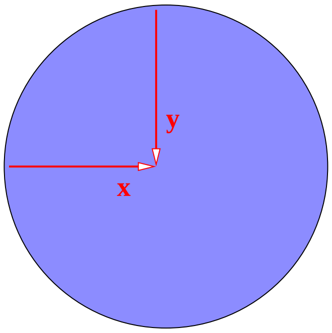

Fig. 2 : Uniformity measurements.

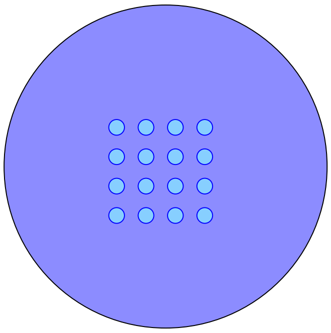

Fig. 3 : The location of the fibers.

The surface quality after polishing of the individual fibers and fiber to fiber couplings are other important factors for uniformity. Individual fibers are polished in a superficial way to observe the uniformity differences at the end of the fibers. Fiber to fiber surface quality differences increased the inhomogenity to 5% from 2%. This can be obviously reduced by applying better polishing techniques and careful process.

Figure 4 shows the result of the uniformity measurements. This shape is completely related with the emitting property of the LED. There is an obvious angle dependence in the emission and this is what we see. An area is selected around the center where is the most uniform region as it is shown in the figure 4. The RMS spread in this area is 0.16 unit in both x and y directions. The average intensity is 13.50 units. Therefore we can conclude the uniformity is $\sqrt{2} \times 0.16/13.50$ and $\approx 2\%$. If better uniformity is desired, one can place the fibers in a circle, centered in the center of the cylinder.

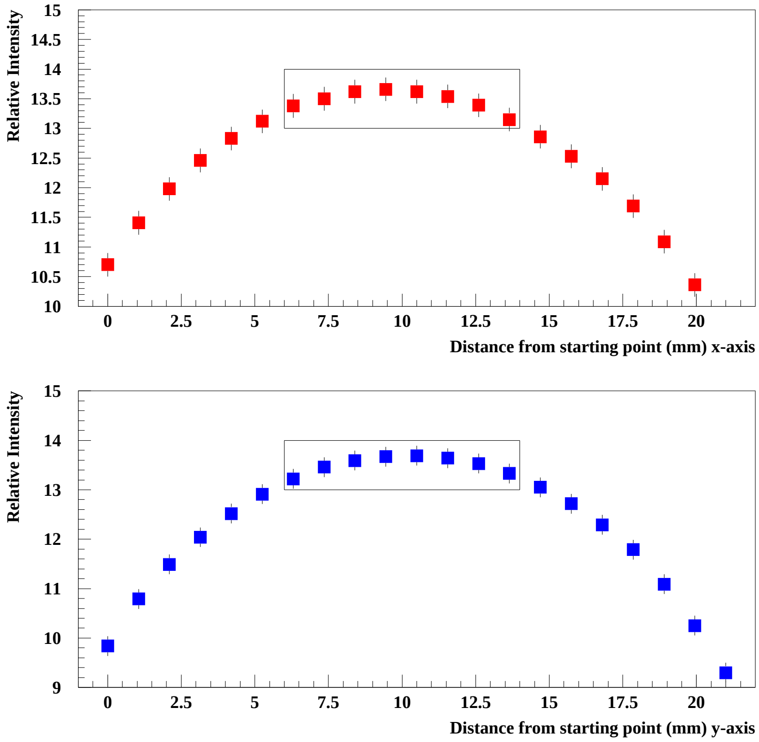

Fig. 4 : Uniformity measurements.

Four distribution assembly (named as A, B, C, D) each carries 16 fibers $(1-16)$ are going to be mounted to the light mixers on the photomultipliers in the following order. Our scintillator detectors were named as upstream, downstream, inner and outer. All fibers carry the light generated via the distribution assembly $A1 - A16$ is going to be connected to Inner-Upstream detectors in the same order. $B1 - B16$ is connected to Outer-Upstream detectors. $C1 - C16$ is connected to Inner-Downstream detectors. $D1 - D16$ is connected to Outer-Downstream detectors. Figure 5 shows principle connection of one fiber.

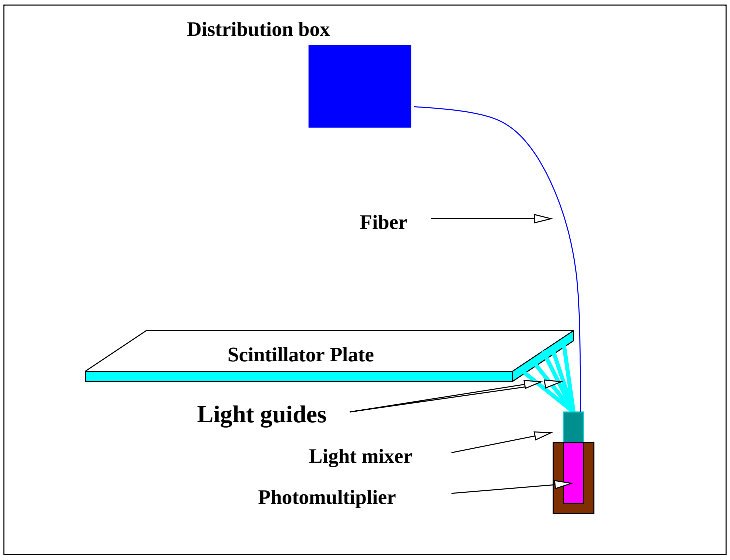

Fig. 5 : Connection of a fiber to the detector.