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Wireless Access Method and Physical Layer Specifications

Title: **Safety on Laser Diodes.**

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Introduction:

Laser Diodes have characteristics that makes them much better than LEDs for IR Wireless Transmission. Two drawbacks had made them unusable for indoor environments: their price and safety problems. The success of CD players and laser printers has reduced the LD prices to the same level of good LEDs, so only the eye safety limits their use. In this paper we present a method to make LDs' beams safe to the human eye.

The key topic is not the optical power emitted by a LD, because a 25 watts bulb produces an optical power level many times larger. The problem with LDs is their spatial coherence. This property of all laser beams is the responsible of their low apperture, and makes possible to focuse them in very small area. This is good for CD players because it allows to pack a great deal of information on an small disk. But for the eye the problem arises when a laser beam impinges on the eye lens, then the beam is focused on an small spot on the retin. Although the power is not too high, the power density can be large enough to burn a small area of the retin, causing a serious damage to the eye. To get a safe LD beam we have to elliminate its spatial coherence.

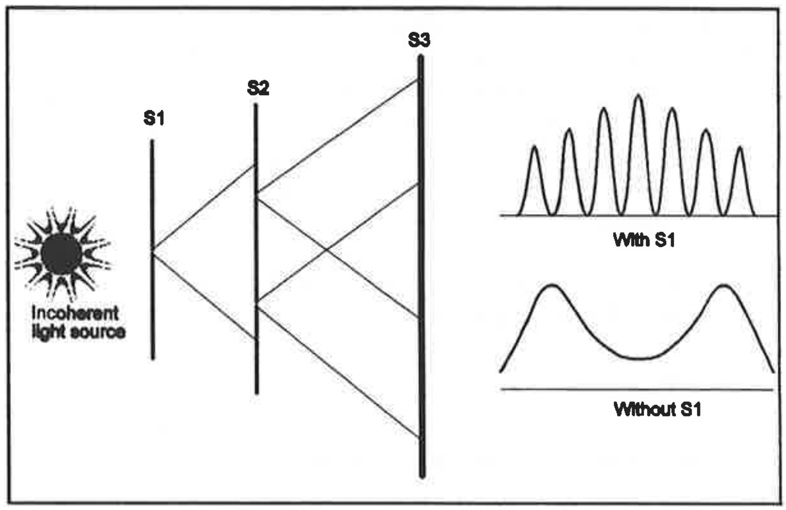

Figure 1. Young's Experiment

Experimental setup:

Spatial coherence is related to the existence of smooth wave phase surfaces across the beam. Non-laser light sources have random phase relations between points of these surfaces, so they do not act as true wavefronts. This can be easily seen through the well known Young's interferometer (figure 1.)

When Young made this experiment demonstrating the wave nature of light, there were not lasers, so to obtain an interference pattern he used a first screen with a small hole (S1) as light source. In this case, the points from which the light cames are so near that the beam is coherent. After crossing the small hole in S1, the light reaches a second screen (S2) with two close slots which are secondary emitters. Then, the light arrives to the screen S3 where an interference pattern can be seen.

In order to get a clear interference figure (a set of bright and dark lines) several conditions are necessary: the hole in S1 has to be very small (less than 1 mm), the slots have to be very narrow and very close one to another. If any of these condition is not fulfilled, the image on S3 is not an interference pattern but an smooth shadow of the slots. This is due to the lack of coherence of common light sources, including LEDs.

On the other hand, the experiment can be easily repeated with a laser. In this case, the fist screen, S1, is not needed, and a high contrasted pattern is obtained, because there is a close phase relation between any two points of the wavefront.

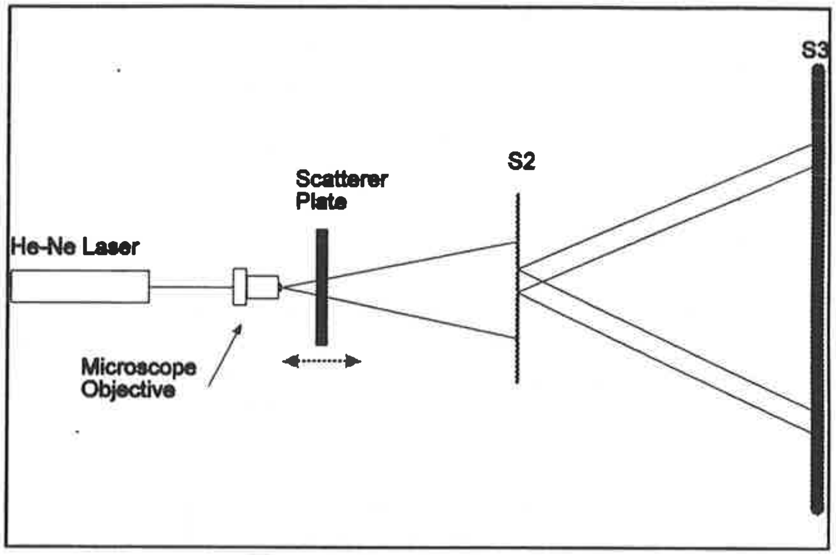

Figure 2. Experimental setup.

We placed a scatterer medium in the light path to destroy the spatial coherence of the laser beam. A simple experiment has been made in our laboratory to confirm it. In figure 2, the experimental setup is presented. As it can be seen is the Young's experiment slightly modified. The screen with the hole,S1, has been replaced by a microscope objective. Behind the focus an scatterer plastic plate is placed.

When the scatterer plate was on the focus of the microscope lens, the fringe pattern can be clearly seen, but when we moved it several millimeters apart from the focus, the pattern disapeared, indicating that the output beam was not spatially coherent.

Conclussions:

Spatial coherence can be elliminated using a very cheap plastic plate, making LDs safe for the human eye.

Roughly, half of the light is scattered back to the source, so the cost will be a loss of 6dB for the power emitted. This power loss can be reduced placing a reflector on the LD side to resend the light to the air.

We think that superb low cost LDs characteristics: high power and modulation rate, makes them very useful for Wireless IR transmission.
In any case, a further and more detailed study on eye effects must be done if LDs are to be used in indoors environments.