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Subject: Optical Propagation and Interference

In this lab, optical waves produced by a laser were studied using a photodiode. With a photodiode, the voltages generated by the laser and also ambient light (the surrounding light) could be displayed on the oscilloscope. A waveguide was used to produce interference and to break the light beam into a reflected and a refracted beam. The voltages produced by these different beams was measured and recorded so the irradiance ratio could be determined.

Appendix 1: Voltage Measurements and Calculations

Appendix 2: Measured Lengths of Pulses

The observations seem to show that the irradiance's magnitude is the electric field's magnitude squared and scaled, just as was predicted in the prelab. Since the time-averaged irradiance is seen, it doesn't appear to vary with time. The photodiode is incapable of displaying instantaneous irradiance, and can only display the time averaged irradiance (which is converted to give voltage readout on the oscilloscope).

Optical Propagation and Interference *(continued)*

The pattern exiting the fiber consisted of a spot when some of the laser's light was being reflected, and formed a ring when the laser light was allowed to completely pass through to the fiber. If the fiber allows different effective wavelengths, then for many different wavelengths, some would cancel or add together to produce a phase shift on the oscilloscope. The light coming out of the end of the fiber would range from being a bright spot to a perfect ring.

Pulse lengths change as the mode velocities do. From the data in lab, it seems that the less the velocity is, the more the period is (the pulse after the third lens had a lesser period than the pulse out of the exit end).

Appendix 1: Voltage Measurements and Calculations

Optical Propagation and Interference

	Incident Beam	***Reflected Beam***	***Transmitted From Plate***
$V_{ambient}$	130.8 mV	140.7 mV	130.4 mV
$V_{ambiant+laser}$	145.1 mV	145.1 mV	141.2 mV
V_{laser}	14.3 mV	4.4 mV	10.8 mV

Irradiance Ratios:

$I_{reflected}$ Ratio: **.3077**
$I_{transmitted}$ Ratio: **.7552**

Percentage lost in plate:

% loss = |10.8 - 14.3| * 100 / 14.3 = **24.48 % loss**

E-Field Ratios:

$I \propto E_{field}^2$

E_{field} Ratio = $\sqrt{}$ I Ratio

$E_{reflected}$ Ratio: **.5547**
$E_{transmitted}$ Ratio: **.8690**

When inductance equals resistance of load, at $\angle 45°$, f =7.875 MHz *and* 37.39 MHz

In lead wire, $Z_{eq}=j\omega L+R$. When $\angle 90°$, $|Z_{eq}|=\omega L$.

Therefore, **L=**$|Z_{eq}|/2*\pi*f$ = **1.1 μH**

Appendix 1: Measured Lengths of Pulses

Optical Propagation and Interference

Temporal length of pulse just after third lens: **20.4 ms**

Temporal length of pulse at exit end: **24.4 ms**