UE4060100

DETERMINATION OF THE VELOCITY OF LIGHT

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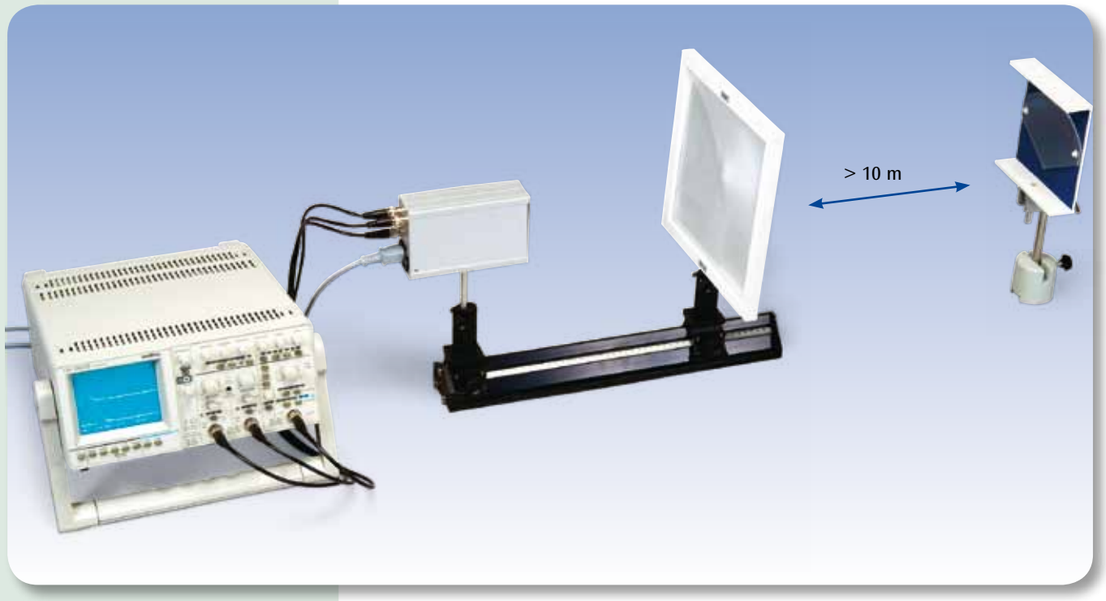

EXPERIMENT PROCEDURE

- **Measuring the transit time of a short pulse of light across a known distance, by using an oscilloscope to compare it with a reference signal.**
- **Determining the velocity of light in air as a quotient of the distance travelled and the transit time.**

OBJECTIVE

Determine the velocity of light from the transit time of short light pulses.

SUMMARY

The fact that light is propagated at a finite speed can be demonstrated by a simple transit time measurement. This is achieved by using very short light pulses of only a few nanoseconds duration and determining the time for them to travel out and back over a distance of several metres, which is measured by an oscilloscope. From the transit time and the distance from the transmitter to a triple-prism reflector one can calculate the velocity of light.

REQUIRED APPARATUS

Quantity	Description	Number
1	Speed of Light Meter (115 V, 50/60 Hz)	**1000882 or**
	Speed of Light Meter (230 V, 50/60 Hz)	**1000881**
1	Analogue Oscilloscope 2x150 MHz	**1002729**
1	Optical Bench U, 600 mm	**1003040**
2	Optical Rider U, 75 mm	**1003041**
1	Barrel Foot	**1001045**
1	Stainless Steel Rod 1500 mm	**1002937**
1	Universal Clamp	**1002830**
1	Pocket Measuring Tape, 2 m	**1002603**

BASIC PRINCIPLES

The fact that light is propagated at a finite speed can be demonstrated by a simple transit time measurement using modern measurement techniques. This is achieved by using very short light pulses of only a few nanoseconds duration and determining the time for them to travel out and back over a distance of several metres, which is measured by an oscilloscope.

In the experiment, the short light pulses from a pulsed LED are passed via a beam-splitter onto two photoelectric cells whose amplified signals are recorded as voltage pulses by the oscilloscope. Photocell A receives light pulses reflected back by a triple-prism reflector at a large distance, whereas photocell B records the locally generated light pulse as a reference pulse that is not delayed by transit. The oscilloscope trace is triggered by a voltage pulse from output C, which precedes the reference pulse by 60 ns.

Using a two-channel oscilloscope, one measures the transit time as the difference t between the two pulses. From this and the distance s from the transmitter to the triple-prism reflector, we can calculate the velocity of light as:

(1) $$c = \frac{2 \cdot s}{t}$$

The experiment can be made more impressive by varying the distance to the reflector and observing the resulting change of the pulse separation on the oscilloscope. This can be done very easily, as careful and precise adjustments in repositioning the triple-prism reflector are not required, rather, an approximate adjustment will suffice.

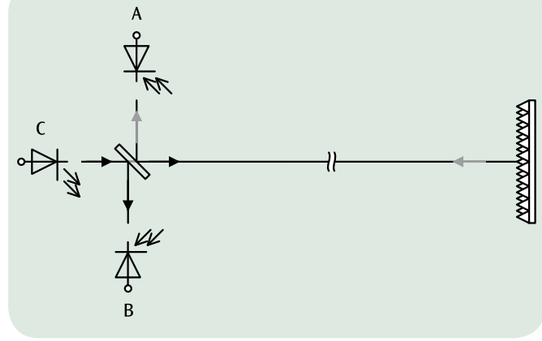

Fig. 1: Measurement principle.

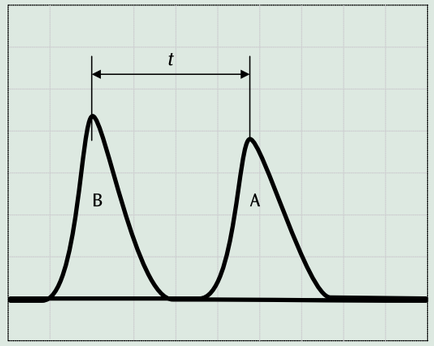

Fig. 2: Measuring the transit time with the oscilloscope.