Optics

Velocity of light

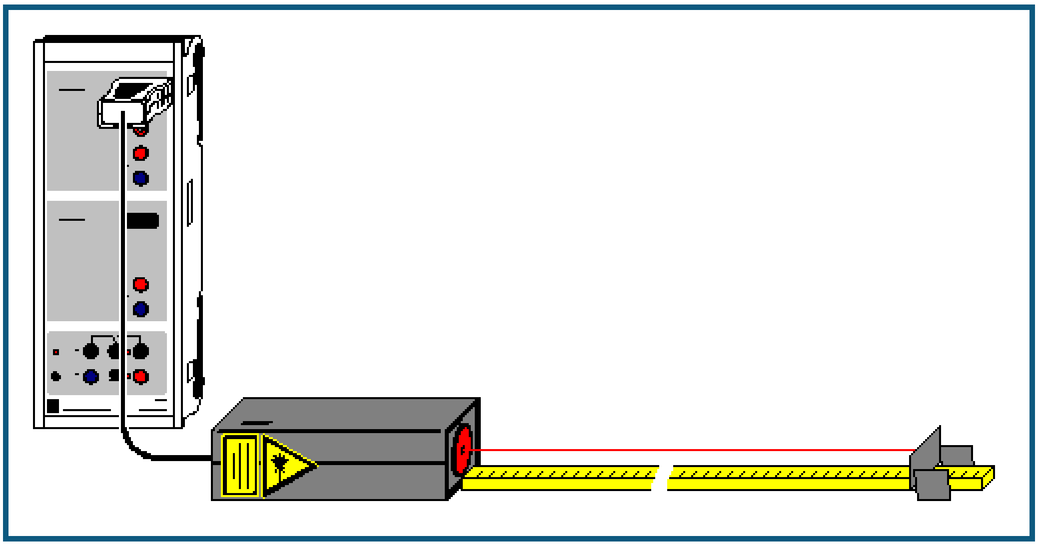
Measuring with an electronically modulated signal

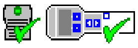
Determining the velocity of light using a periodical light signal at a short measuring distance - measuring with the laser motion sensor S and CASSY

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Velocity of light in air



 can also be carried out with Pocket-CASSY and Mobile-CASSY

Safety note

Mind the safety notes in the instruction sheet of the laser motion sensor S.

Experiment description

Modern distance meters use a periodically modulated laser beam for the measurement. They determine the phase shift between the emitted and the reflected modulated laser beam and, with the modulation frequency being known, obtain the time-of-flight t of the light on its path to and back from the reflector. Only afterwards do the distance meters calculate the distance with the aid of the known velocity of light.

In this experiment, the laser motion sensor S (laser S) is used as a time-of-flight meter because it is also capable of outputting the time-of-flight t directly. The proportionality between the distance and the time-of-flight of light is confirmed, and the velocity of light is calculated.

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	Laser motion sensor S	524 073
1	End buffer	from 337 116
1	Wooden ruler	311 03
1	PC with Windows XP/Vista/7/8	

Experiment setup (see drawing)

Lay the laser S on the table with its broad side down, and connect it to the input A of the CASSY. Stick a piece of retroreflecting foil enclosed with the laser S to the end buffer, and put the end buffer on the ruler at a distance of 30 cm from the laser so that the laser beam impinges perpendicularly on the center of the foil.

Before the measurement, allow the laser S to warm up for approximately 5 minutes in order that the zero shift becomes as small as possible.

Carrying out the experiment

Load settings

- Define the zero of the time-of-flight (→ **0** ← in Settings ΔtA1).
- Enter the distance d=0 in the first column of the table (click on the first field of the table with the mouse).
- Record the first measuring point (d=0 m, Δt) with ⏱.
- Displace the end buffer away from the laser by 10 cm, and enter the distance 0.1 m in the first column of the table (click on the second field of the table with the mouse).
- Record the second measuring point (d=0.1 m, Δt) with ⏱.
- Repeat the measurement for greater distances up to approximately 50 cm.

Evaluation

The optical path s of the laser beam is equal to twice the distance d. This is already taken into account in the s(t) diagram in the **Velocity of Light** display. The proportionality between s and t, i.e. $s = c \cdot t$, is confirmed by the s(t) diagram. Fitting a straight line through the origin leads to the proportionality constant c = 0.3 m/ns = 300,000 km/s.