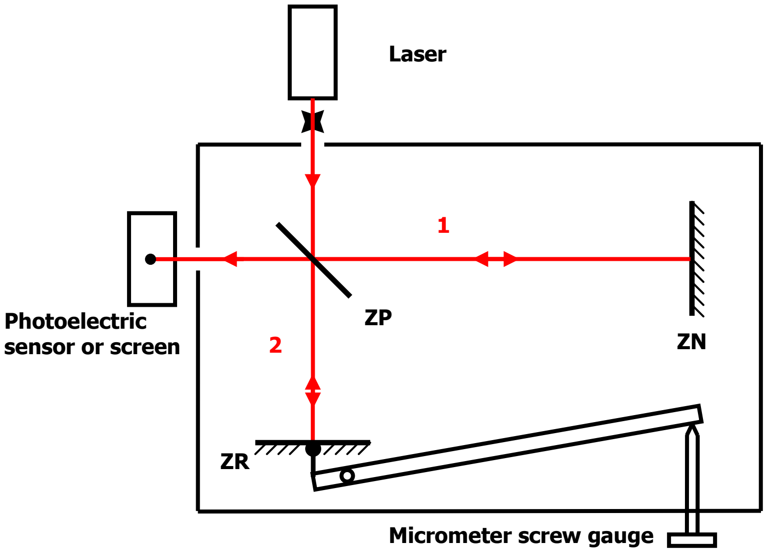
25 – MICHELSON INTERFEROMETER



Michelson interferometer scheme:
ZP – half-silvered mirror
ZN – fixed reflecting mirror
ZR – adjustable reflecting mirror
The laser beam falls on a half-silvered mirror (a so-called beam splitter) that splits the beam into two beams: (1) one of them falls on the mirror ZN and after reflection Falls on a screen or a sensor; the second beam (2) Falls on the mirror ZR and after a sequence of reflections reaches the screen as well. Both beams interfere, creating an interference image on the screen. The shape of the interference image depends on the type of the applied mirrors. If two perfect planar mirrors are used, the displayed image should consist of parallel fringes. In case of non-ideal mirrors, the image can look diversely (in the discussed case, the image consists of rings).
A shift of the adjustable mirror **ZR** causes a motion of the fringes. Please note that the shift of the mirror of a **d** distance causes change of the optic path of **2d**. Thus the condition of interference maximums is $N\lambda=2d$. The shift factor between the screw gauge and the mirror is 1:10 so the shift to the mirror is 10 times smaller than the gauge readout.

Michelson interferometer is an example of application of the interference phenomenon in measurement devices. It is usually used for measurement of the wavelength or measurement of very small displacements of the same order of magnitude as the light source wavelength. The Michelson interferometer significantly supported the progress in physics as it was used, among others, in the Michelson-Morley experiment. This experiment is the experimental base for the special theory of relativity. It was carried out to confirm or deny the existence of aether and dependence of the speed of light on the direction of its propagation.
The decisive measurement were carried out by Albert Michelson and Edward Morley at the beginning of July 1887. They come to the following conclusion "There is no significant difference in the speed of light independent of the direction of motion of the observer". (American Journal of Science, nr 207, 1887).

Operation of the electronic frequency meter-counter
The device connected to the photodetector is a universal meter that can be used as frequency meter, timer or pulse counter. In this experiment, it is used as pulse meter.
1. Turn the device on - the display will show "**P1-F**" and the device will start in frequency measurement mode. (If the external light is on, the display should show the value of approx. 100.)
2. Press the right top button twice (labeled **UP**). The display will show "**P3-CU**" and the device will switch to pulse counting mode. (If the room light is on, the meter should count the pulses of fluorescent lamps.)
3. Turn the room lights off – the counter should stop counting.
4. The left bottom button serves as the counter reset. If the micrometer screw is at the desired position, reset the counter (the display should show zero).

CAUTION:
The interferometer is a very precise and sensitive optical device. All the operations should be performed with care. The measurement range is within the range of 2.5 to 4.5 mm on the micrometer screw (green laser). During the measurement the screw has to be rotated VERY SLOWLY in one direction only (do not turn the screw in the opposite direction). The fringes should be clearly visible, and their width on the screen should exceed the diameter of the hole. During the measurement the screw step should remain within the 0.2 - 0.5 mm range (the mirror shift is 10 times smaller!).

Measurement procedure:
1. Set the screw position within the measurement range (for example 3.5 mm).
2. Reset the counter.
3. Rotate the screw slowly by about 0.1 mm for example (less than 0.5 mm).
4. Repeat the measurement several times by turning the screw in both directions (please remember not to exceed the measurement range) by 0.1; 0.2; 0.3; 0.4 i 0.5 mm respectively.
5. Based on the measurement result find the laser light wavelength and estimate the uncertainty (use the least squares method).