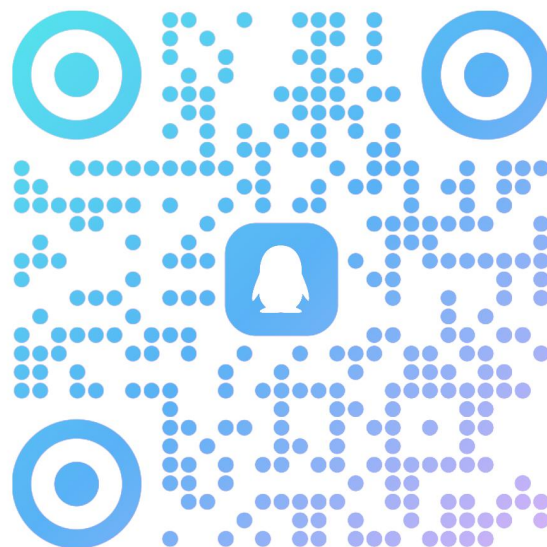




Physics EXP IICD

群号: 1058406552



扫一扫二维码，加入群聊



Measuring Laser wavelength and Index of Refraction of Air by Michelson Interferometer

University Physics Experiment Center



Content

- 1 Background
- 2 Aim
- 3 Principle
- 4 Equipment
- 5 Procedure
- 6 Questions
- 7 Expand training
- 8 Experimental data recording and processing

Significance

Invariance of the speed of light , promote the development of special relativity

Michelson's important contribution

•Determination of the speed of light

1924~1926 Southern California mountains 22 miles long optical path , 299796 ± 4 km/s

•Determination of the reference length

1893, Determination of the wavelength of the red cadmium line 643.84696 nm, for the standard length, recognized by the world , until 1960.

•Michelson interferometer

for: Michelson - Morley experiment 、 LIGO (LIGO) measuring gravitational 、 Detecting extrasolar planets

•Echelle

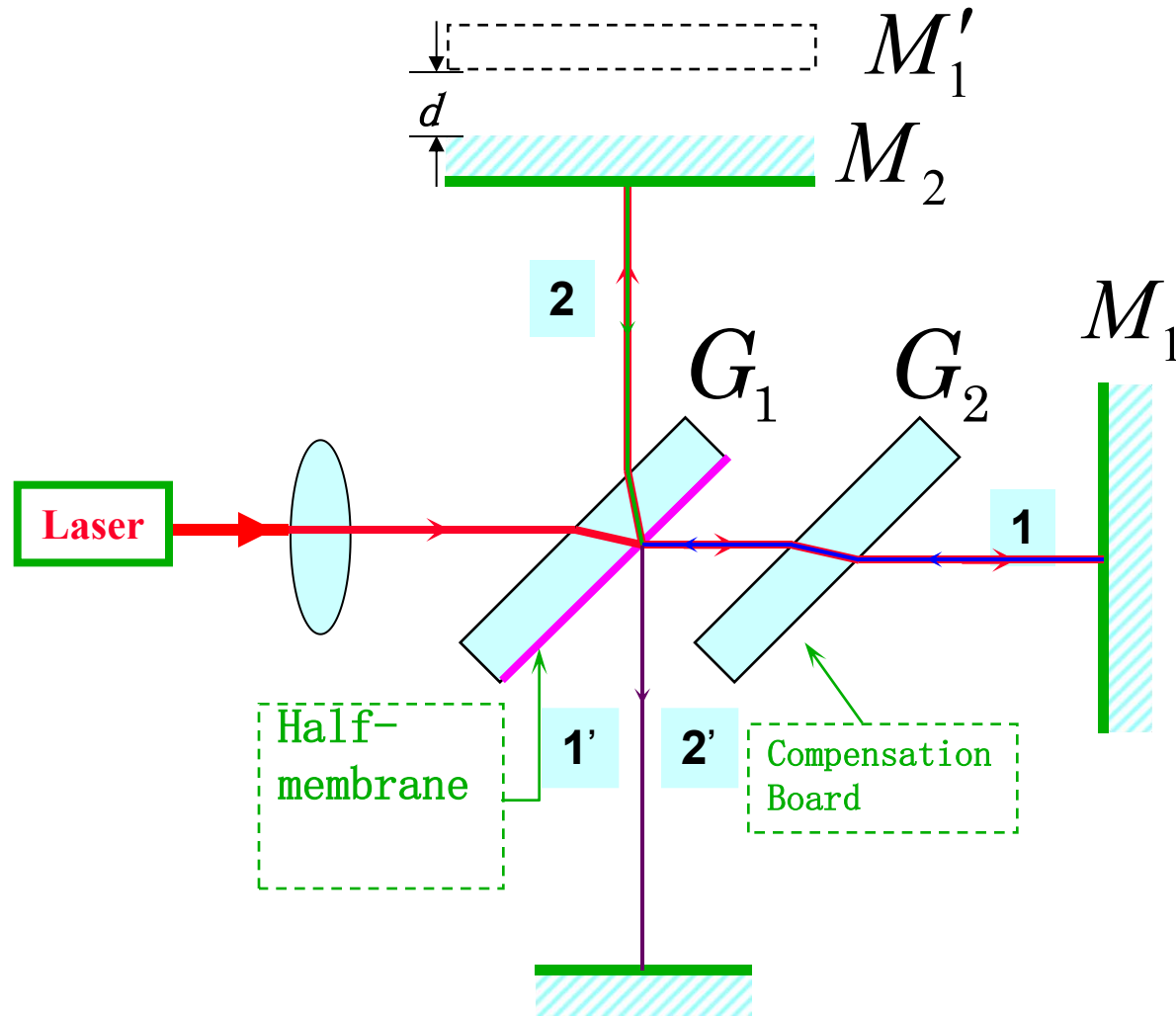
Especially for Broad-band, high dispersion, high resolution.

2. aim

- **Familiar Michelson interferometer configuration, grasp the adjustment methods and techniques.**
- **Understanding and equal inclination interference conditions and equal thickness interference fringes changes of formation.**
- **measuring the wavelength of the light source and measuring the refractive index of air.**
- **Enhance the fringe visibility and awareness of temporal coherence.**

3. principle

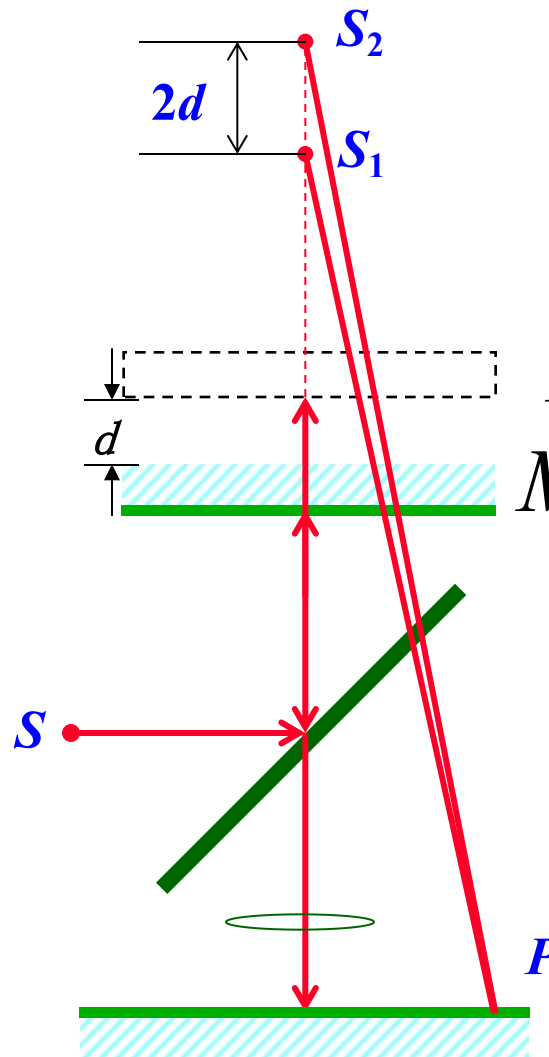
3.1 Michelson interferometer



The same: M_1 , M_2 air film between the interference generated.

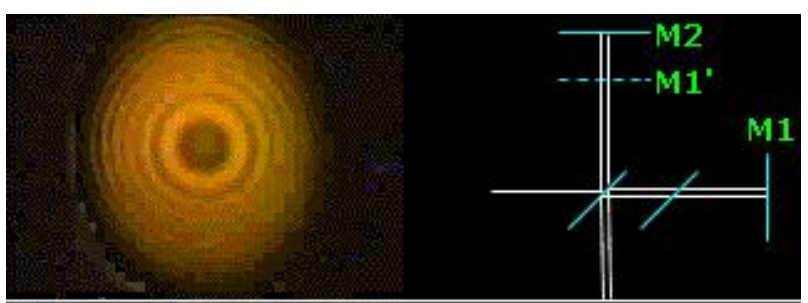
3.2 Equal thickness interference and equal inclination interference

$M_1 \perp M_2$ perpendicular \rightarrow Equal inclination interference



The diagram illustrates the setup for equal inclination interference. A light source S emits a beam that reflects off a diagonal mirror M_1 . The beam then reflects off a horizontal mirror M_2 at a distance d from the front surface. A virtual image S_2 is formed at a distance $2d$ from the front surface. The beams recombine at point P . The diagram shows the geometry of the mirrors and the light paths.

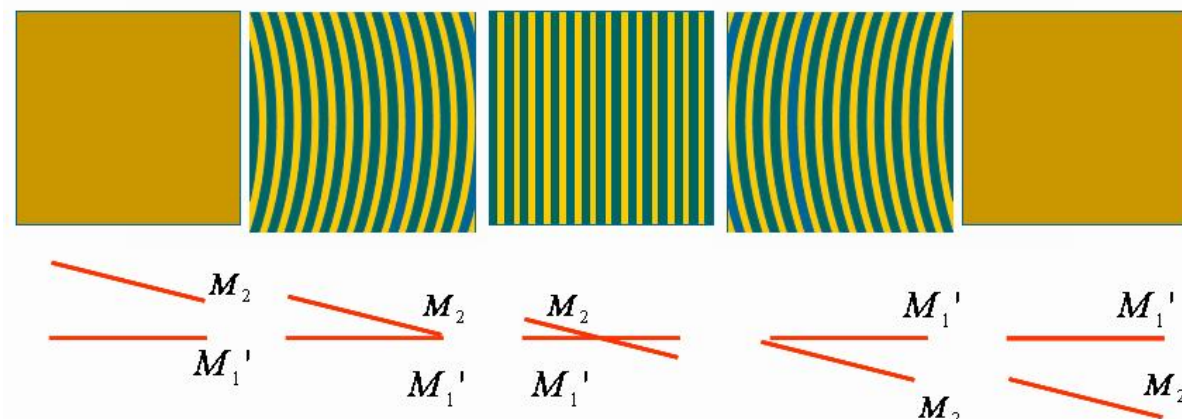
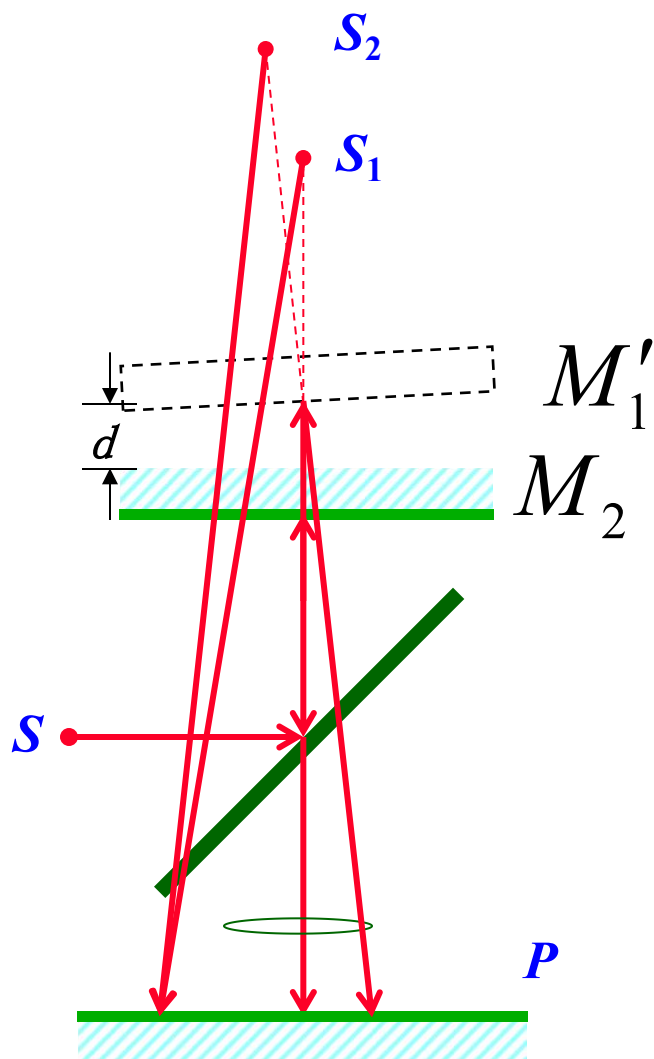
Below the diagram, five square images show the resulting interference patterns. From left to right: concentric circular fringes, concentric circular fringes with a central dark spot, a uniform yellow field, concentric circular fringes with a central bright spot, and concentric circular fringes. Below these images, the corresponding mirror configurations are shown as pairs of horizontal lines. The first two show M_2 and M_1' as separate lines. The third shows them as a single line, labeled M_2 与 M_1' 重合 (coincide). The fourth and fifth show them as separate lines again.



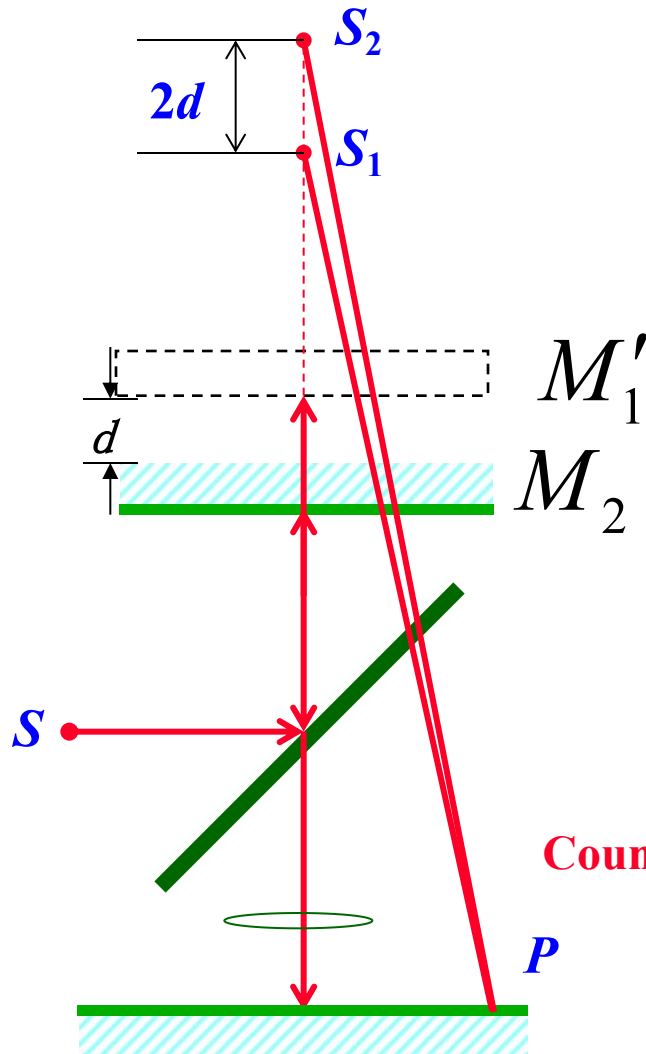
Bright fringes conditions : $2d \left(1 - \frac{r^2}{2Z^2} \right) = K\lambda$

3.2 Equal thickness interference and equal inclination interference

$M_1 \text{ no } \perp M_2 \rightarrow \text{Equal thickness interference}$



3.3 application



(1) for the wavelength of light

Bright fringe: $2d \left(1 - \frac{r^2}{2Z^2} \right) = K\lambda$

center: $2d = K\lambda$

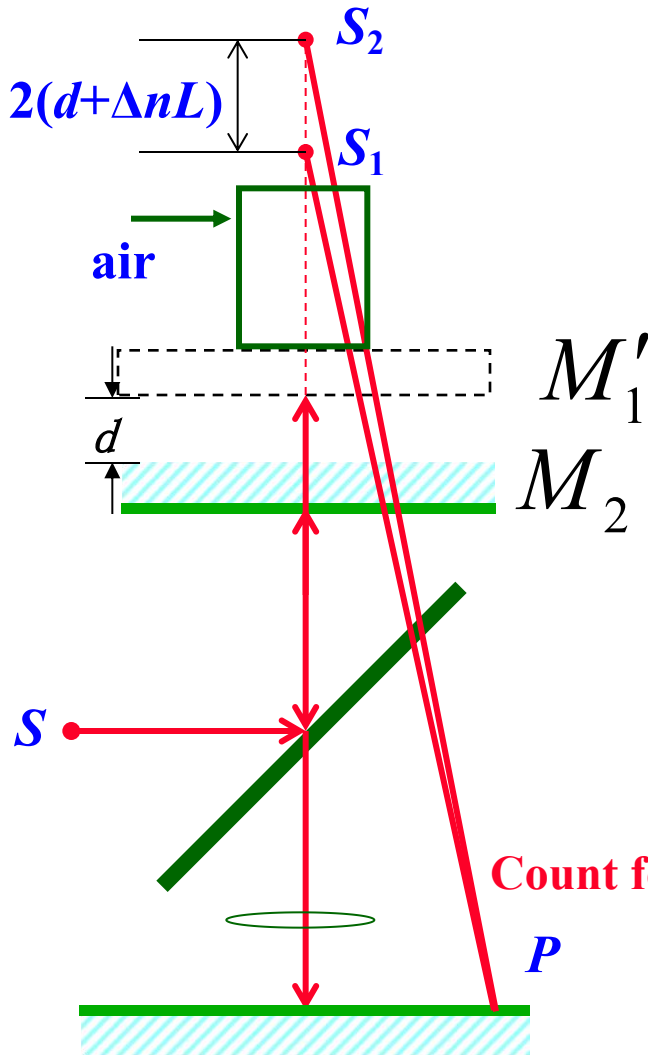
as: $2\Delta d = \Delta K \cdot \lambda$

In advance: $\lambda = \frac{2\Delta d}{\Delta K}$

In this experiment:

Count for 50 bright fringes, and record the length of lens moving

3.3 application



(2) measurement air Index of refraction

Bright fringe center: $2(d + \Delta nL) = K\lambda$

Refraction concerned with air pressure、:

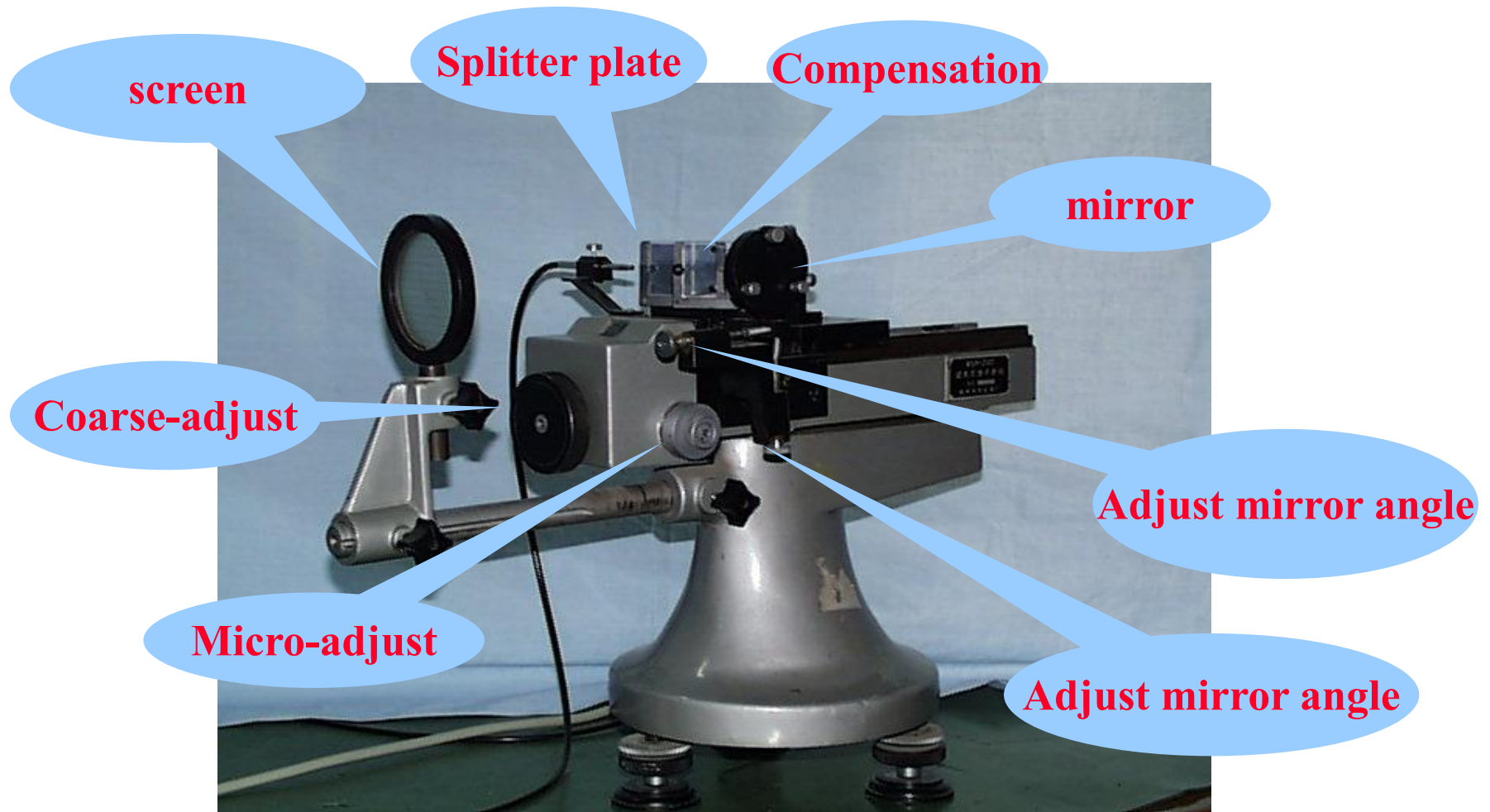
$$\Delta n = \frac{\lambda_0}{2L} \frac{60}{p_p} p_b$$

pressure: $p_b = 1.01325 \times 10^5 \text{ Pa}$

In this experiment:

Count for 60 bright fringes, and record the pressure before and after.

4. Equipment



8. data

8.1 measurement He-Ne laser wavelength

table1 measurement He-Ne laser wavelength

N	0	50	100	150	200	250
d (mm)						
Δd (mm)	$\Delta d_1 = d_{150} - d_0 =$		$\Delta d_2 = d_{200} - d_{50} =$		$\Delta d_3 = d_{250} - d_{100} =$	
$\Delta \bar{d} = \frac{\Delta d_1 + \Delta d_2 + \Delta d_3}{3}$ (mm)						
$\bar{\lambda} = \frac{2\Delta \bar{d}}{\Delta m} = \frac{2\Delta \bar{d}}{3 \times 50}$ (nm)						

8.2 measurement air index of refraction

Table 2 measure of air index of refraction

Trial	1	2	3
p_1 (MPa)			
p_2 (MPa)			
$\Delta p = p_2 - p_1$ (MPa)			
$\Delta \bar{p} = \frac{\Delta p_1 + \Delta p_2 + \Delta p_3}{3}$ (MPa)			
$n = 1 + \frac{\lambda_0}{2L} \frac{60}{\Delta \bar{p}} p$			