9. Coefficient of refraction *(10 points)*

i) We direct the laser beam radially into the semi-cylinder: perpendicularly through its cylindrical surface. The beam enters the plate without refraction and reaches the opposing flat face at the axis of the cylinder. Depending on the angle between that face and the beam, there may or may not be a refracting beam, but there is always a reflecting (from the flat face) beam. We rotate the semi-cylinder around its axis to find the position, when the refracting beam appears/disappears; the angle α between the flat face and the incident beam correspond to the angle of complete internal reflection, i.e. $n = 1/\cos\alpha$. We can measure $\cos\alpha$ using the graph paper: we draw the beam as a segment AO and the flat face of the semi-cylinder as a line BO so that $\angle ABO = \pi/2$; then, $n = |AO|/|BO|$. The uncertainty can be found using the formula $\Delta n = n\left(\frac{\Delta|AO|}{|AO|} + \frac{\Delta|BO|}{|BO|}\right)$ and by estimating the uncertainties of the direct length measurements $\Delta|AO|$ and $\Delta|BO|$.

ii) We drop the liquid on the prism and press it against the flat face of the semi-cylindrical plate. Further we study the complete internal reflection at the boundary between the semi-cylinder and prism (which is filled with the liquid) by repeating the above described experiment. Thereby we measure new lengths $A'O$ and $B'O$; the condition of complete internal reflection is now $n/n_l = |A'O|/|B'O| \Rightarrow n_l = n|B'O|/|A'O|$, where n_l stands for the coefficient of refraction of the liquid. The uncertainty is now calculated as $\Delta n_l = n_l\left(\frac{\Delta|A'O|}{|A'O|} + \frac{\Delta|B'O|}{|B'O|} + \frac{\Delta n}{n}\right)$.