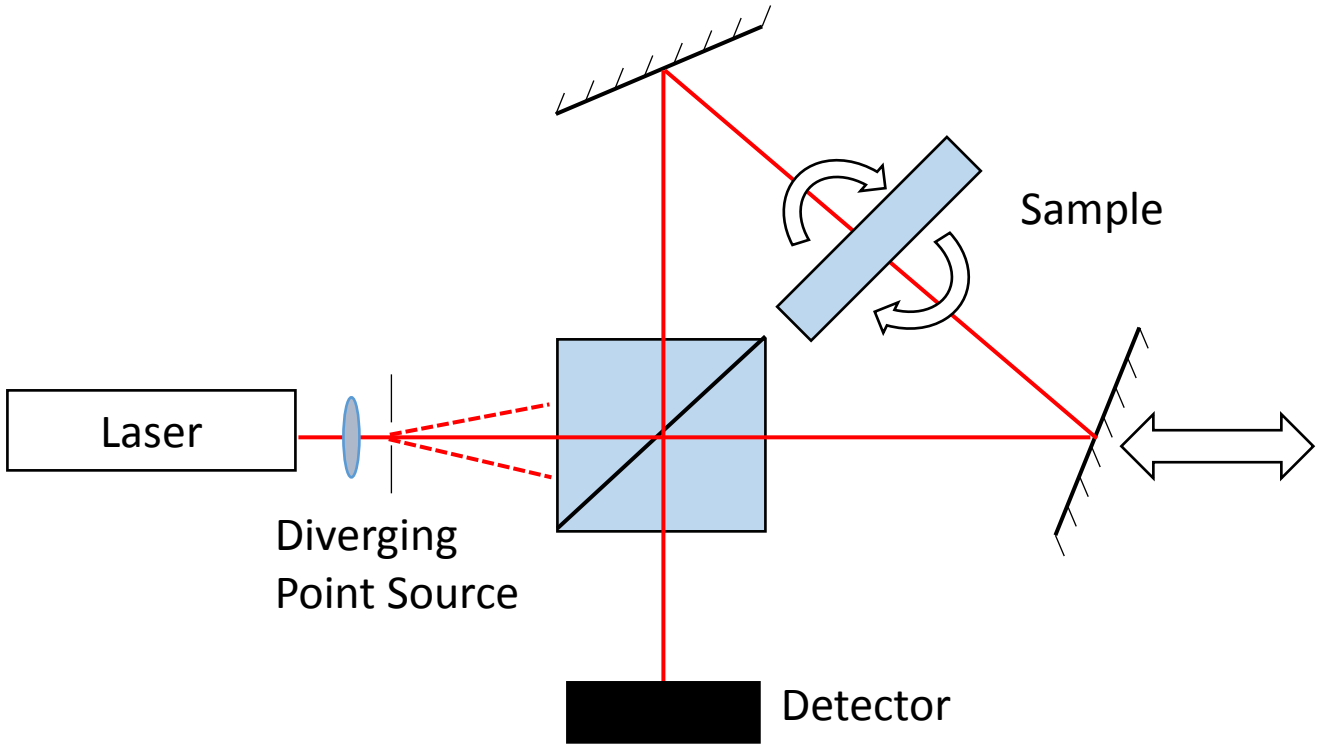
Sagnac Ring Interferometer for Absolute Index of Refraction Measurements

Instrument Overview
Sample Preparation
Measurement Uncertainty

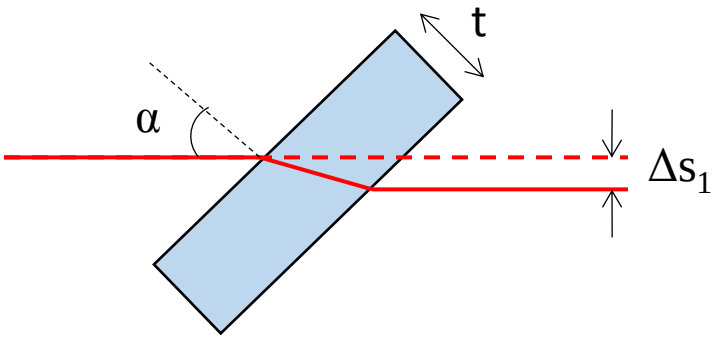
University of Rochester
Gradient-Index Research Group

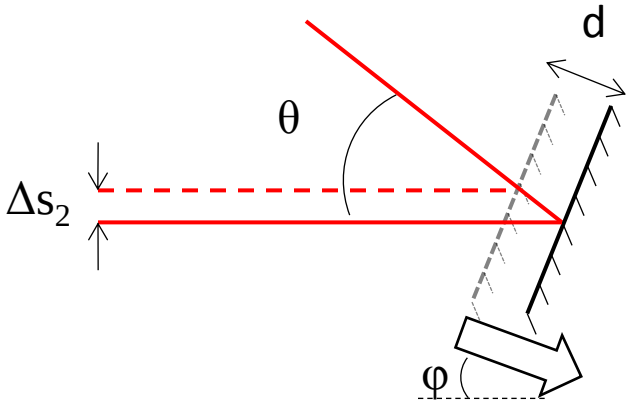
Absolute Index: Sagnac Interferometer

- Wavelength range covered
  - 0.355 – 1.064µm, 1.55 – 4.6µm, 8 – 12µm
- Measurement accuracy
  - δn = 1E-4 (for a well-finished sample)
- Sample prep requirements
  - Thick (> 5mm), plane, parallel window
  - Diameter > 15mm
  - Surface curvature less than one wave over a 10 mm aperture
  - Wedge less than 2 arc min for most accurate results



Shear in Sagnac Ring Interferometer





$$\Delta s_1 = t\cos\alpha\left\{\tan\alpha - \tan\left[\sin^{-1}\left(\frac{n_a}{n_s}\sin\alpha\right)\right]\right\}$$

$$\Delta s_2 = d\left(\frac{\sin\theta\cos\left(\theta/2 - \phi\right)}{\cos\left(\theta/2\right)}\right)$$

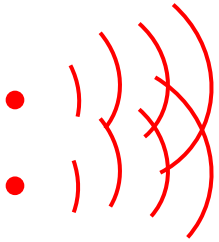
$$n_s = \frac{n_a\sin\alpha}{\sin\left\{\tan^{-1}\left[\tan\alpha - \frac{d\sin\theta\cos\left(\theta/2 - \phi\right)}{t\cos\alpha\cos\left(\theta/2\right)}\right]\right\}}$$

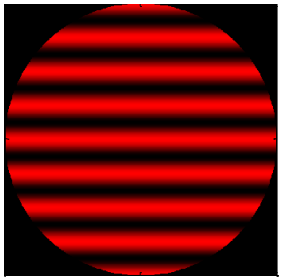
Index

$$\delta n_s = \left(\frac{n_s^2}{n_{air}} - n_s\right)\frac{\delta t}{t}$$

Index Uncertainty

When Shear is Present:





- Shear can be seen in interferogram and eliminated to within a fraction of λ
- Index can be calculated for many different shears and averaged
- Index uncertainty: limited by sample thickness uncertainty (δt typically 1 μm)