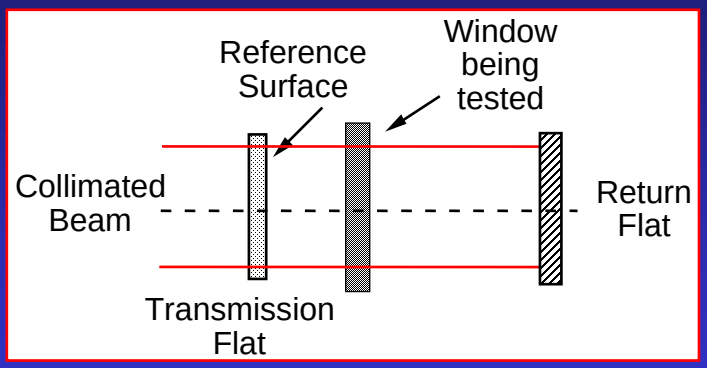
Part 3
Specialized Optical Tests

- Testing windows, prisms, and corner cubes
- Measuring radius of curvature
- Measuring index inhomogeneity
- Testing cylindrical surfaces

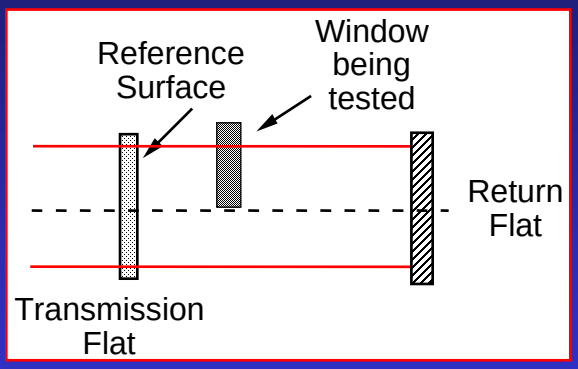
Testing Windows in Transmission



δt = window thickness variations

OPD measured = 2 (n-1) δt

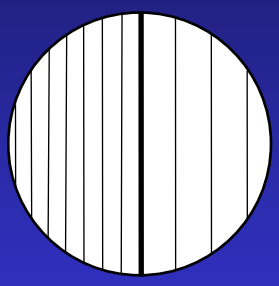
Measuring Window Wedge



Tilt difference between two interferograms gives window wedge.

Calculating Window Wedge

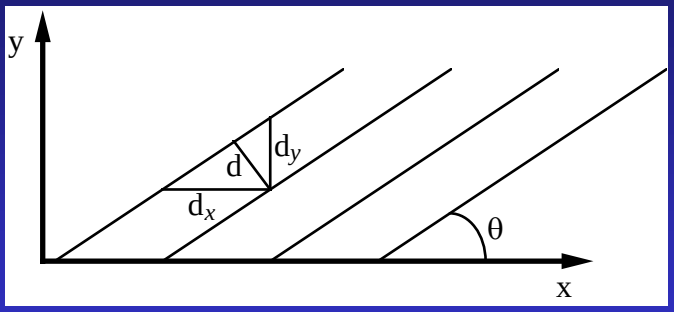
Tilt difference between two interferograms gives window wedge.



α = window wedge

$$\alpha = \frac{\text{tilt difference}}{2(n-1)}$$

Calculation of Tilt



d = fringe spacing

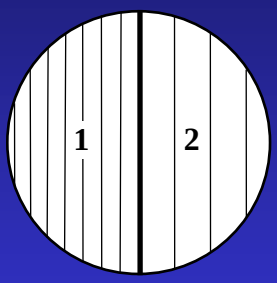
$d_x = d / \sin\theta$ $d_y = d / \cos\theta$

$$\beta = \text{Tilt} = \frac{\lambda}{d}$$

$$\beta_x = \frac{\lambda}{d_x} \qquad \beta_y = \frac{\lambda}{d_y}$$

Calculation of Tilt Difference

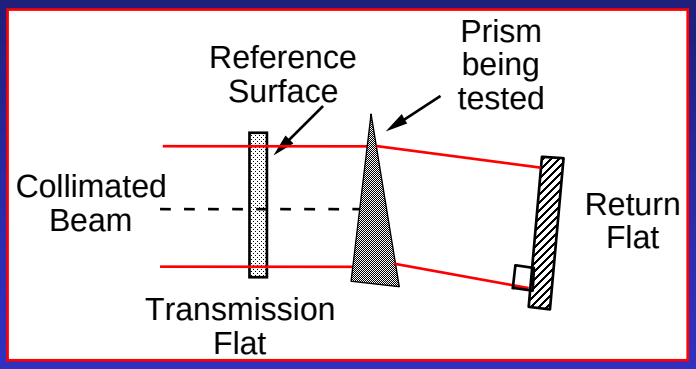
Tilt β_{x1}, β_{y1}



Tilt β_{x2}, β_{y2}

$$\text{Tilt Difference} = \sqrt{(\beta_{x1} - \beta_{x2})^2 + (\beta_{y1} - \beta_{y2})^2}$$

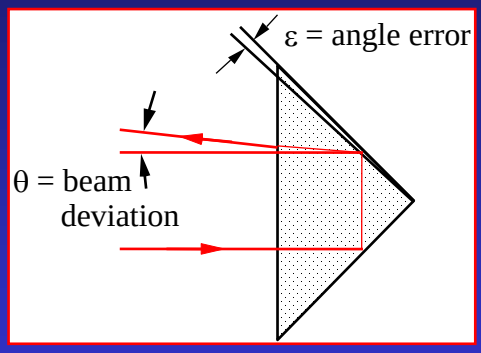
Testing Prisms in Transmission



δt = error in prism thickness

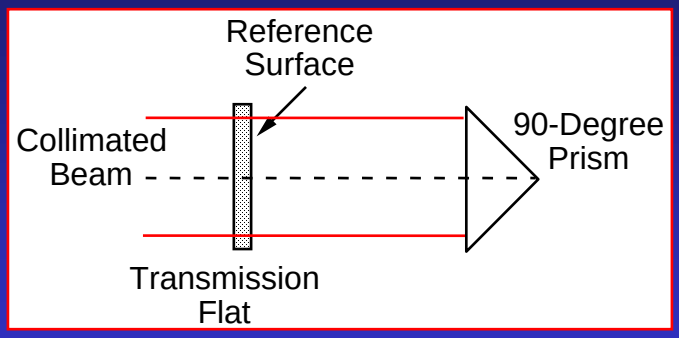
OPD measured = 2 (n-1) δt

Angle Accuracy of 90-Degree Prisms



$$\varepsilon = \frac{\theta}{2n}$$

Testing 90-Degree Prisms (Single Pass)

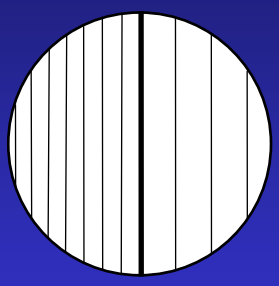


Tilt difference between two interferograms gives error in 90-degree angle.

Errors in collimated beam do not cancel.

Calculating Error in 90-Degree Prism (Single Pass)

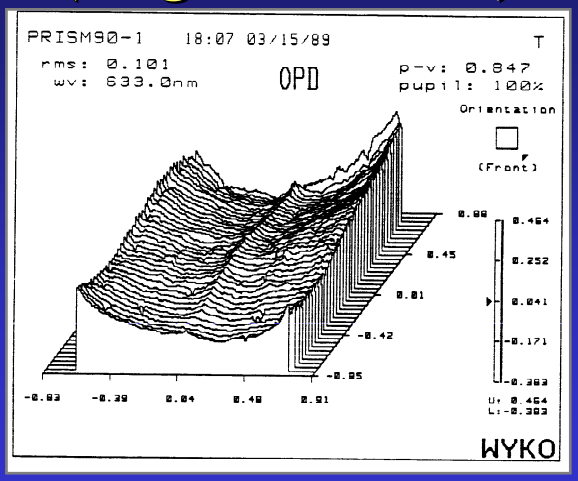
Tilt difference between two interferograms gives prism angle error.



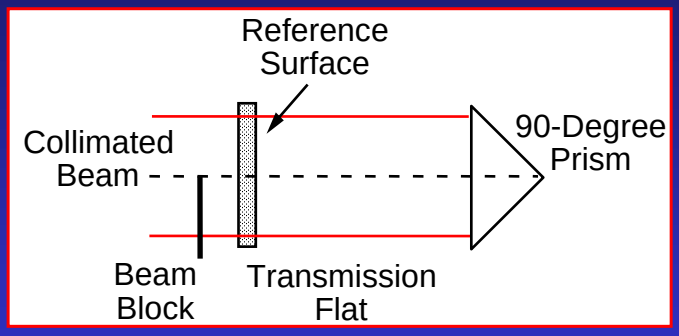
ε = prism angle error

$$\varepsilon = \frac{\text{tilt difference}}{4n}$$

90-Degree Prism (Single Pass OPD)



Testing 90-Degree Prisms (Double Pass)

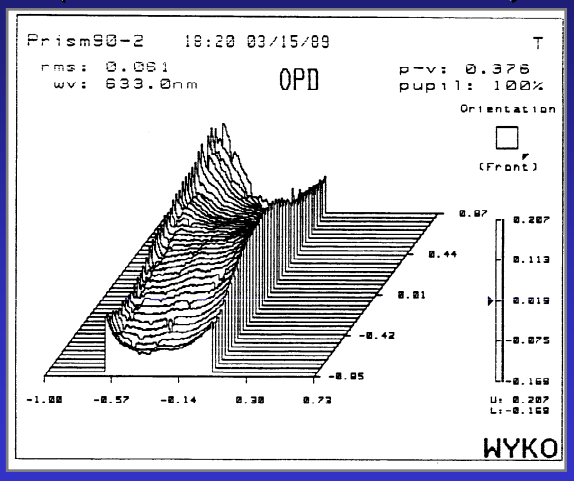


$$\varepsilon = \frac{\text{x tilt in interferogram}}{4n}$$

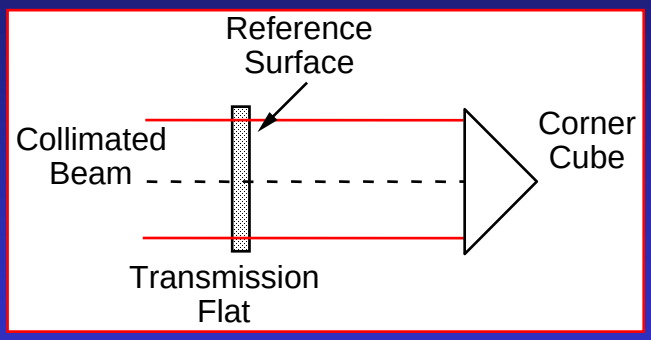
ε = prism angle error

Errors in collimated beam cancel.

90-Degree Prism (Double Pass OPD)



Testing Corner Cubes (Single Pass)

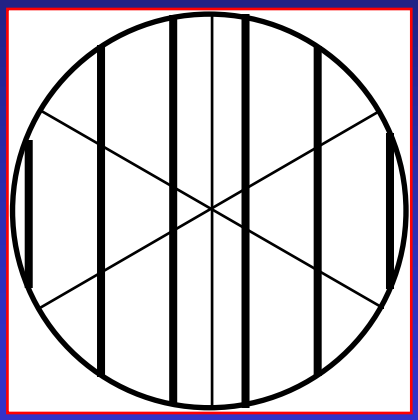


Errors in collimated beam do not cancel.

Interferogram for Perfect Corner Cube (Single Pass)

6 interferograms obtained.

Straight fringes obtained for perfect corner cube.

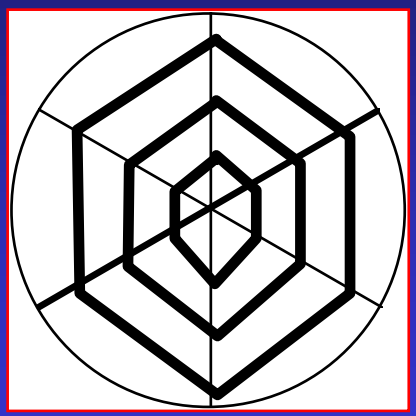


Analyzing Corner Cube Interferograms (Single Pass)

6 interferograms obtained.

Tilt difference between any 2 interferograms gives one angle error in corner cube.

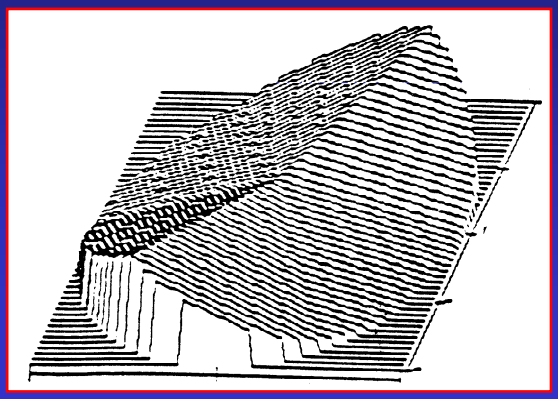
n is refractive index of corner cube.



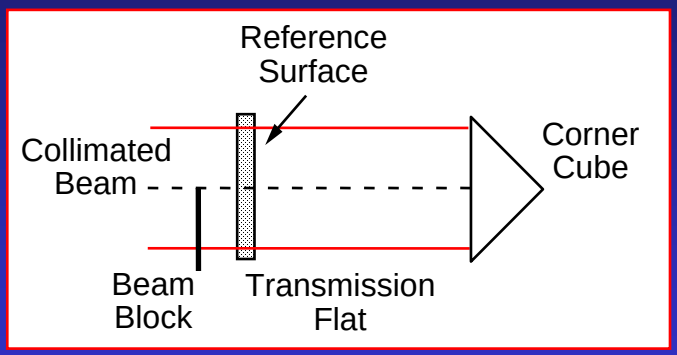
Error = Tilt difference/(3.266 n)

Corner Cube (Single Pass OPD)

RMS: 0.045 P-V: 0.191



Testing Corner Cubes (Double Pass)

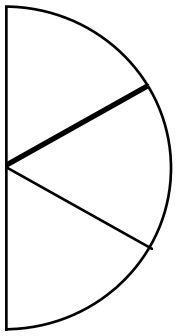


Errors in collimated beam cancel.

Interferogram for Perfect Corner Cube (Double Pass)

3 interferograms obtained

One fringe covers the entire interferogram

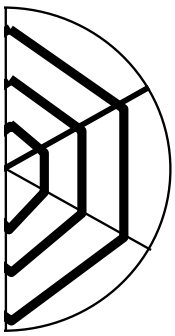


Analyzing Corner Cube Interferograms (Double Pass)

3 interferograms obtained.

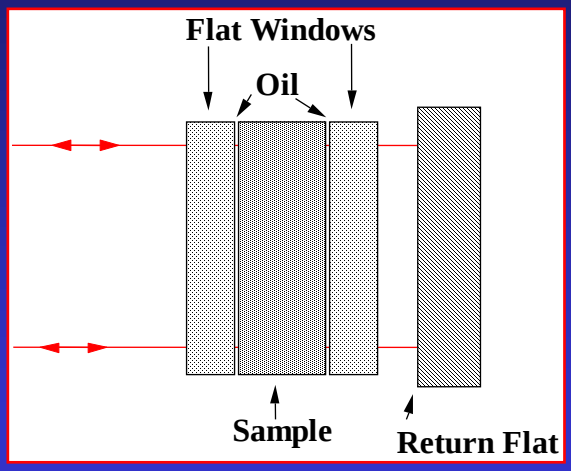
Tilt of each interferogram gives one angle error in corner cube.

n is refractive index of corner cube.

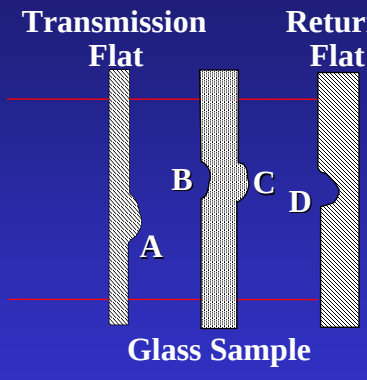


Error = Tilt/(3.266 n)

Measuring Index Inhomogeneity (Classical Technique)



Measuring Index Inhomogeneity Without Oil-On Plates



4 Measurements Required

Surface Errors in Test Optics and Glass Sample Cancel.

Measuring Index Inhomogeneity

1. Measure light reflected from front surface of sample.

   $OPD_1 = 2(B-A)$

2. Measure light through sample and reflected off second surface.

   $OPD_2 = 2(B-A)+2n_0(C-B)+2\delta$

3. Measure through sample and reflected off return mirror.

   $OPD_3 = 2(B-A)+2n_0(C-B)+2(D-C)+2\delta$

4. Remove sample and measure cavity.

   $OPD_4 = 2(D-A)$

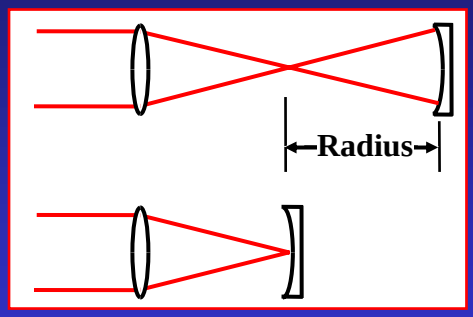
$\delta = [n_0(OPD_3-OPD_4)-(n_0-1)(OPD_2-OPD_1)]/2$

$= (n-n_0)T$

Index Inhomogeneity Test Results

RMS: 0.168 wv P-V: 0.711 wv wv: 632.8nm

Measuring Radius of Curvature

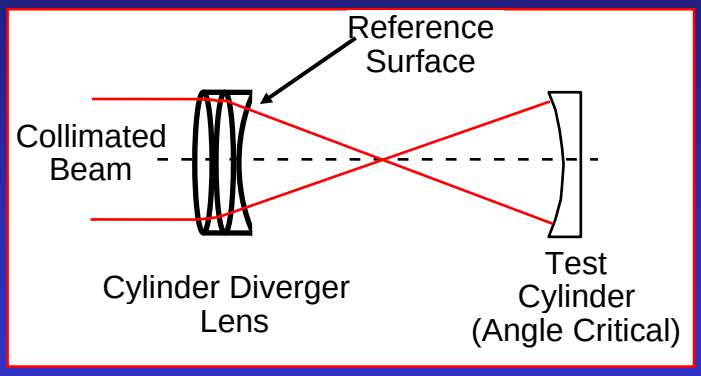


Two positions which give null fringe for spherical mirror.

Cylindrical Surface Test

- Need cylindrical wavefront
  - Reference grating: Off-axis cylinder
  - Cylinder null lens: Hard to make
- Direct measurement - No modifications to interferometer
- Concave and convex surfaces
- Quantitative - phase measurement

Cylinder Null Lens Test Setup



Cylinder Grating Test Setup