Optical metrology teaching and laboratory plan

teaching-metrology

SHANGHAI MICROCRE OPTICS-MECH TECH CO.,LTD

Telephone: 400-812-7833 | 021-58391850

Address: 1478 Nanfeng Road, Fengcheng Town, Fengxian District, Shanghai, China | Postal code: 201411

Contact email: shanghai@yr17.net

Service email: rockwei@yr17.net

Application template; not a claim of a completed customer project.

Scope

Reproducible exercises for autocollimation, angular conversion, profile reconstruction and error evaluation. Keep example data separate from measured records.

Equipment and configuration guidance

• Teaching-appropriate autocollimator and reflector

• Stable bench, known-span base and fine adjustment

• Record sheets, calculation tools and reference readings

Principle and calculation

1 arcsecond = π/648000 radians. For a teaching example with L = 100 mm and θ = 1 arcsecond, Δh is approximately 0.484814 μm. This example is not an accuracy claim.

On-site checklist

• Example and measured data clearly labelled

• Units and signs verified

• Calculation steps reproducible

Suggested records

• Principle explanation

• Raw readings and calculations

• Error sources and improvement proposals

Limitations

Teaching calculations are not calibration certificates. The instructor defines supervision, difficulty and operating limits.

Detailed teaching example

Classroom comparison of two references for the same angular dataset

Scenario and task

Teaching demonstration, not a real customer project. All data are constructed examples. Three constructed interval angles teach arcsecond conversion, accumulated heights, endpoint reference and least-squares reference. Students calculate manually before checking with the website tool and see why reference choice changes residual metrics.

Workflow overview

Define sampling geometry → Convert angles to height → Accumulate four stations → Residuals for two references → Explain metric differences

Preparation and measurement steps

01. The instructor defines one reading per interval and sets both effective reflector span and sampling step to 100 mm; supply demonstration angles, not field measurements.

02. Convert 1″ to π/648000 rad and convert [+1,+1,−1]″ into three height increments, retaining enough decimal places.

03. Accumulate four station heights from initial zero, keeping raw angles, distance units and positive direction; do not independently rezero intermediate stations.

04. Subtract the line through the endpoints, then fit a least-squares line to the same four heights; list both residual sequences and peak-to-valley values.

05. Compare results and explain that least squares minimizes squared residuals, not their range; submit calculations, unit checks and omitted uncertainty sources.

Teaching example readings

• Interval angles in arcseconds: [+1,+1,−1]; step and effective span L=100 mm.

• Positive increment a=100×tan(π/648000)×1000≈0.484813681 μm; station heights [0,a,2a,a].

• Endpoint residuals/a=[0,2/3,4/3,0]; least-squares residuals/a=[−0.4,0.2,0.8,−0.6].

Calculation procedure

For station index i=0,1,2,3, hfit/a=0.4+0.4i. Endpoint residual PV=4a/3≈0.646418 μm; least-squares residual PV=1.4a≈0.678739 μm. Neither is automatically a minimum-zone result.

Example result and interpretation

Different references give different residual peak-to-valley values for the same profile, and the least-squares value need not be smaller. The example verifies calculation definitions, not instrument accuracy or workpiece acceptance.

Example verification checklist

• Check the factor of 1000 from mm to μm and the conversion from arcseconds to radians.

• Verify the interval-angle, support-span and step convention; use a different reconstruction model when sampling geometry differs.

• Label demonstration data, real readings, statistical uncertainty and calibration certificates separately.

Document generated: 2026-11-16