Telescope and multi-axis optical alignment

telescope-alignment

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

Scope

Alignment of primary and secondary mirrors, sensor boresights and laser transmit/receive paths.

Equipment and configuration guidance

• Autocollimator and collimator

• Large flat or autocollimation target

• Precision mounts and thermal stability

Principle and calculation

Secondary tilt θ shifts focus by $\Delta = 2f \cdot \tan\theta$ for a two-reflection system; offset shifts the image and adds coma.

On-site checklist

• Main axis defined

• Adjustments tied to readings

• Re-measured when stable

• Offset and tilt separated

Limitations

Laboratory results need star or long-range verification; turbulence limits field accuracy.

Detailed teaching example

Worked secondary-mirror tilt and focal shift example at f = 1200 mm

Scenario and task

Teaching example: a 1200 mm reflector with the secondary tilted 5″; the focal-plane shift follows from the double reflection, and eccentricity is distinguished from tilt.

Preparation and measurement steps

01. Define the main axis, mechanical datum and pointing budget.

02. Establish an infinity target and check the primary return.

03. Adjust secondary, focal plane and detector, logging each change.

04. Separate offset from tilt by two sections or image rotation.

Teaching example readings

• Secondary tilt 5″ measured by autocollimator, repeatability 0.1″.

• Focal shift Δ = 2f·tanθ ≈ 58.2 μm.

• Star test: tilt shows coma, decentre shows image shift.

Calculation procedure

Δ = 2 × 1200 × tan(5π/648000) × 1000 = 58.2 μm. The factor 2 comes from the single fold of a reflective surface; a refractor uses 1.

Example result and interpretation

A shift of 58.2 μm may pass on a short-focus camera but not with small pixels; converge on both the star test and the autocollimator reading.

Example verification checklist

• Never touch optical surfaces with fingers or ordinary tissue.

• Re-check axis versus mechanical datum; do not optimise one field only.

• Record temperature and star images before and after.

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