

Lab 9 - Centering

Centering; or the smart way to align centered optical elements and systems

This lab will make use of concepts used in the previous labs

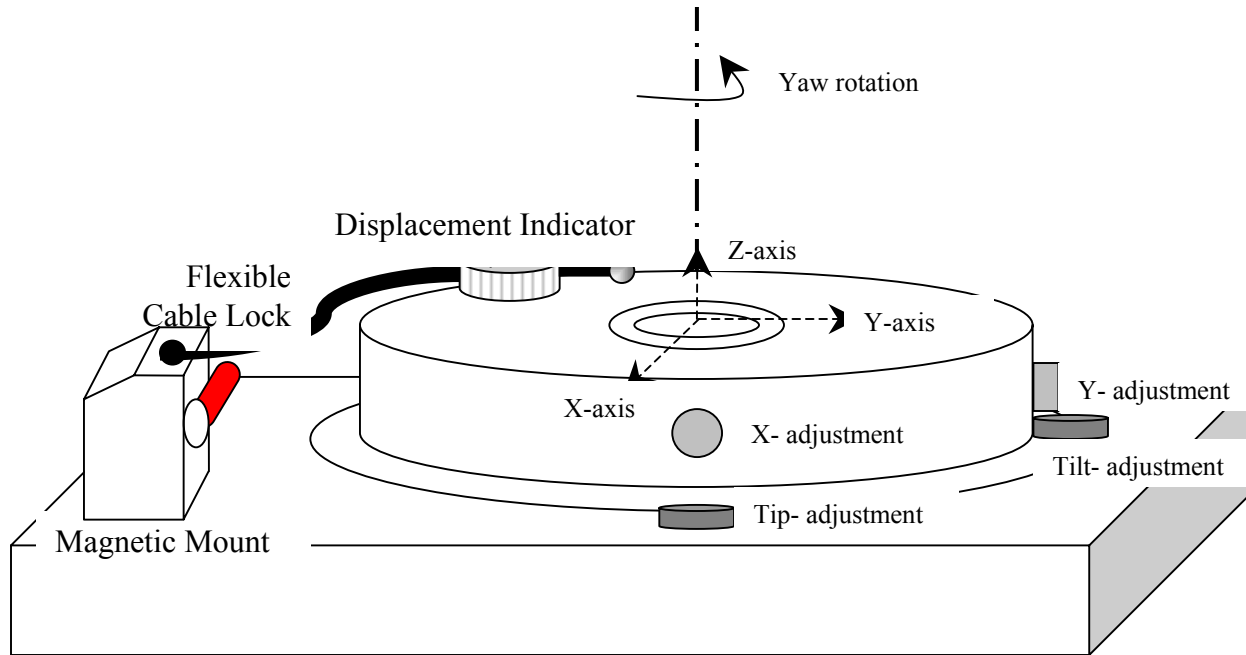
We will use an air bearing rotary table – it is accurate but delicate

Never rotate the table without at least 50 psi air pressure, check the gauge

The adjustment screws have a limited range; do not force beyond range

We will use dial indicators to help with centering as well as the PSM

Details of air bearing rotary table



There are two tilt and two centering fine adjustments on the table

Do not force adjustments; they should only be turned a revolution or two

This is delicate equipment; please try to be careful

Rotary table defines an axis

A line or axis is a theoretical concept

A good rotary table is a physical realization of a mechanical axis

Just as the alignment telescope defined an optical axis

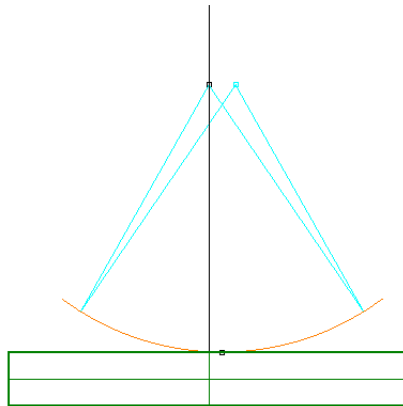
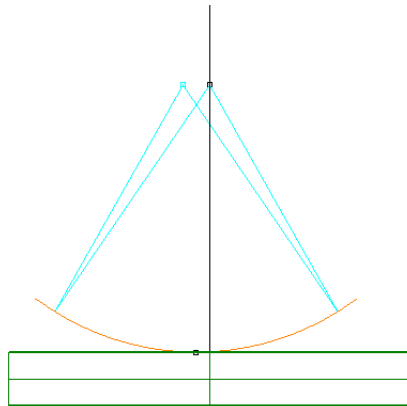
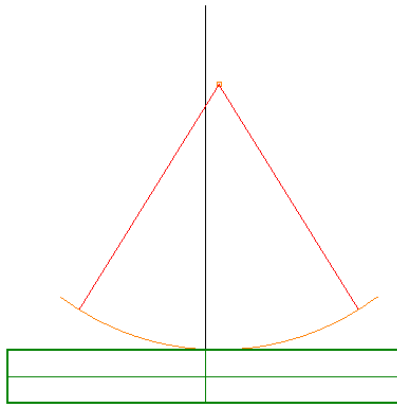
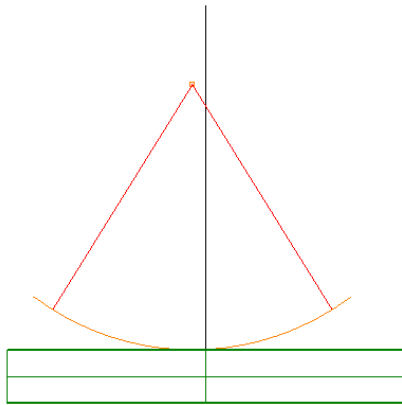
The table top defines a plane – 3 degrees of freedom

One is simply height

The periphery defines an end of the axis – 2 degrees

Centering is moving optical surfaces until their axis lies on the mechanical axis defined by the table

Examples



Mirror is decentered

If table rotated 180° , C of C moves by twice the decenter

Indicator motion will depend on geometry

If object is on axis, image moves in circle 4x the decenter

Mirror is centered when image does not move

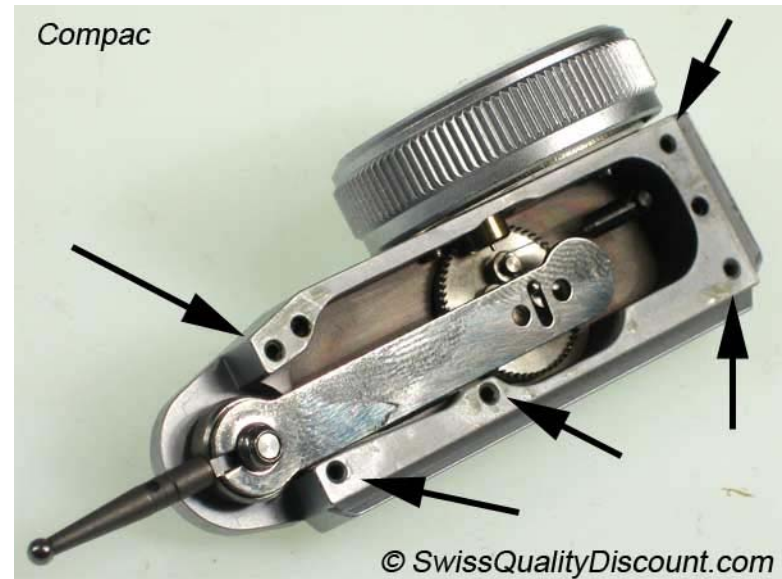
Image does not have to be in center of video screen

Level the rotary table

Check to see there is air to the table. If so, gently see if it rotates easily

Attach a tenth indicator to the flexible arm of the magnetic base indicator stand

See that the indicator reads correctly when the tip is pushed upward



Level the rotary table, con't

Loosen the lock on the flexible arm and move indicator tip to top edge of table

With tip slightly above table lock the flexible arm

Slowly rotate the table and watch the gap between the tip and table
Use a shred of paper to mark the high point

Use the leveling screws to make table top level by eye

Lower indicator tip to just touch table and rotate table slowly. Mark high point

How should the tip be adjusted to be most sensitive?

Continue leveling until table is level to 0.0001" total indicator reading (TIR)

How level is the table now in angle?

Centering a plane parallel disk

Place a plane parallel disk on the rotary table

Center the disk by eye using the grooves

Put a long travel indicator in the indicator stand

Position the indicator tip to point normally to the periphery of the disk

Gently move the indicator toward the disk until you get a reading all around

Mark the disk with a shred of paper and tap disk to center it to 0.001”

How does the roundness of the disk affect your ability to center?

Now measure the upper surface; is the disk parallel?



Centering a lens

Place the three ball fixture on the rotary table

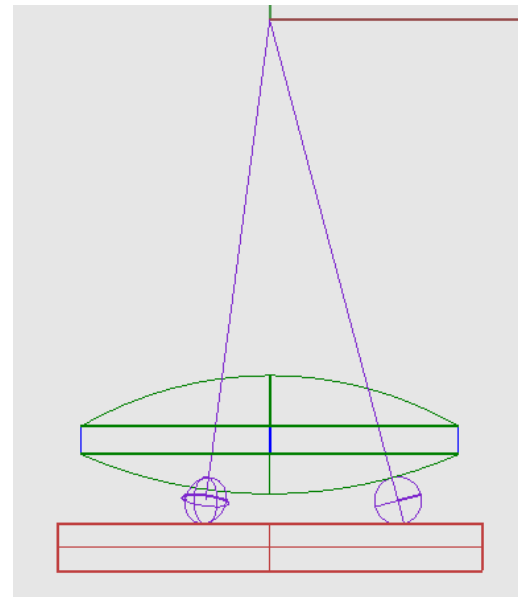
Set the convex surface of a lens on the balls

Adjust a short range indicator to be just below the lower lens surface

Tap the three ball fixture to center the gap between lens and tip

This centers the fixture so the balls

are equi-distant from the table axis



Centering a lens, con't 1

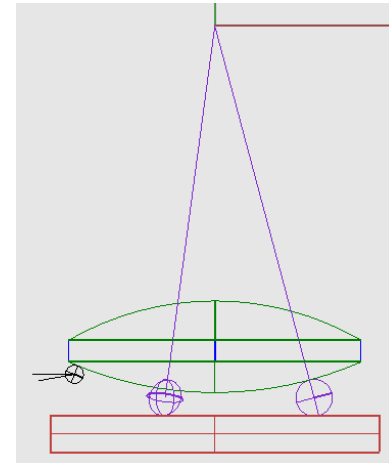
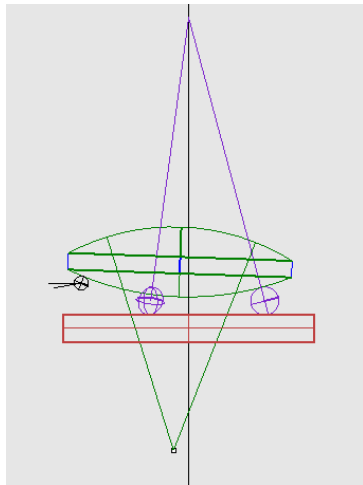
Where is the center of curvature of the lens lower surface?

How does the lens lower surface contact the three balls?

How many degrees of freedom does a spherical surface have?

Bring the indicator tip up to the lens lower surface

Center by tapping fixture and finally by adjusting centering screws



Centering a lens, con't 2

Now bring the indicator above the top surface

Tap the lens (using something plastic) to center the upper surface

What happens to the lower surface?

When centered by eye bring indicator down on surface

Continue to 0.0001" TIR

Where is the center of curvature of the upper surface

Indicate the periphery of the lens. Is the edge concentric with the OA?

What does this say about the coincidence of the optical and mechanical axes?

How well have you done?

Use the alignment telescope to check the centering

Lower the plane mirror over the rotating lens so lens can be seen with the alignment telescope

Does the bullseye pattern move?

Can you do any better by using the fine adjustment knobs?

Use the PSM to pick up the centers of curvature from the two surfaces

Does the spot move?

Can you do any better by using the fine adjustment knobs?

Checking centering of a lens

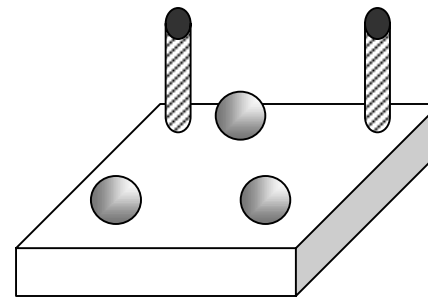
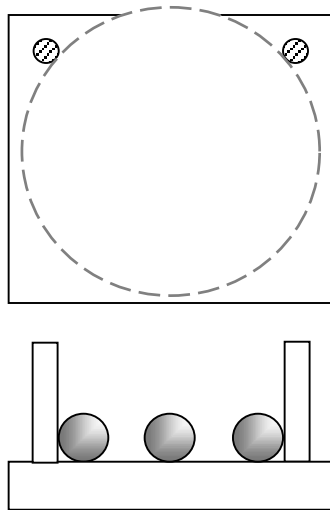
Method of checking lens centering without a rotary table

Is periphery concentric with the optical axis

Use fixture in picture; controls five degrees of freedom

Three balls are datum A, the two pins datum B, the axis

Rotate lens on balls holding it against pins, indicate upper surface



Isometric View