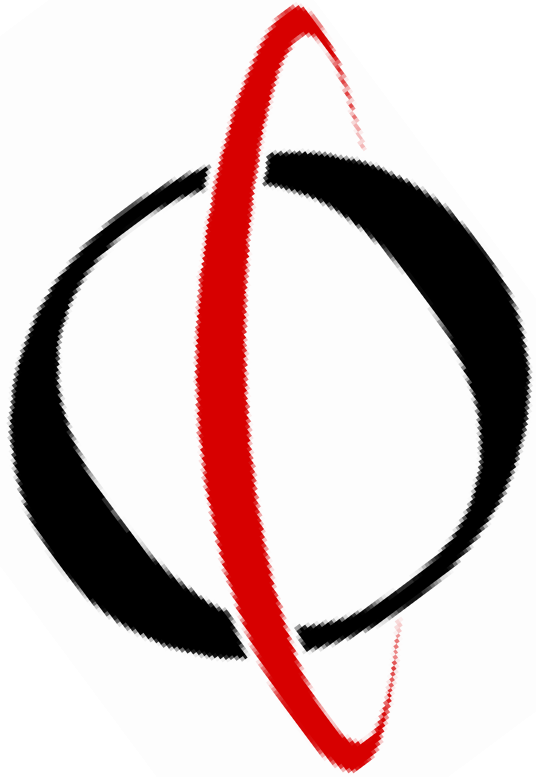

CONFIDENTIAL
GEOmetry PROfile

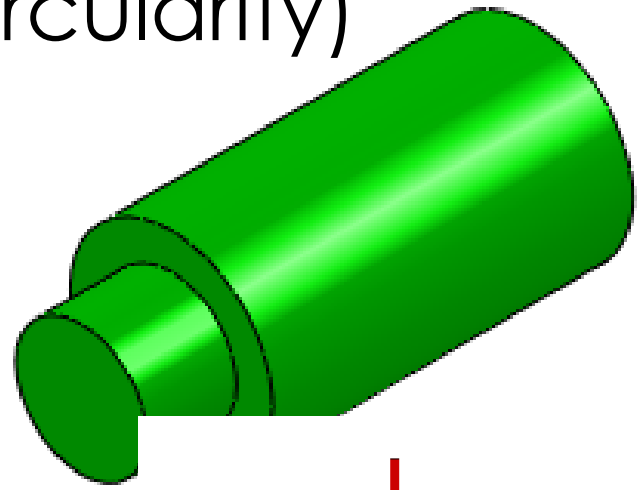


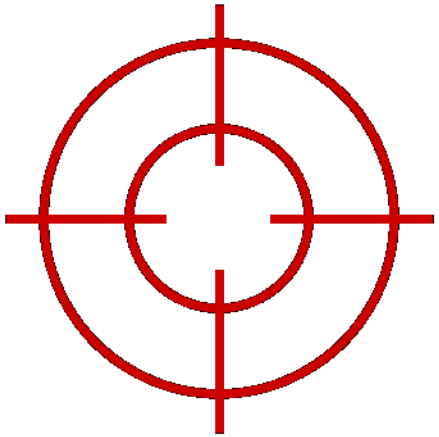
GEOPROfile metry

GEOPROfile metry

Application modules

- **Casing Vibration**
- **Contact Displacement** (circularity)
  - Roundness.
  - Coaxiality.
  - Concentricity.
  - Radial run-out.
  - Axial run out
- **Non-Contact Displacement**



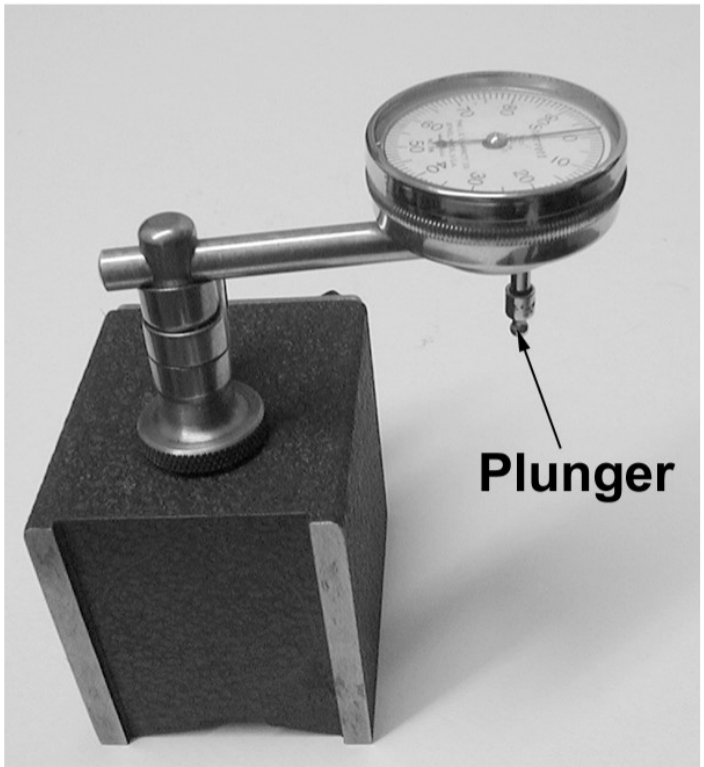


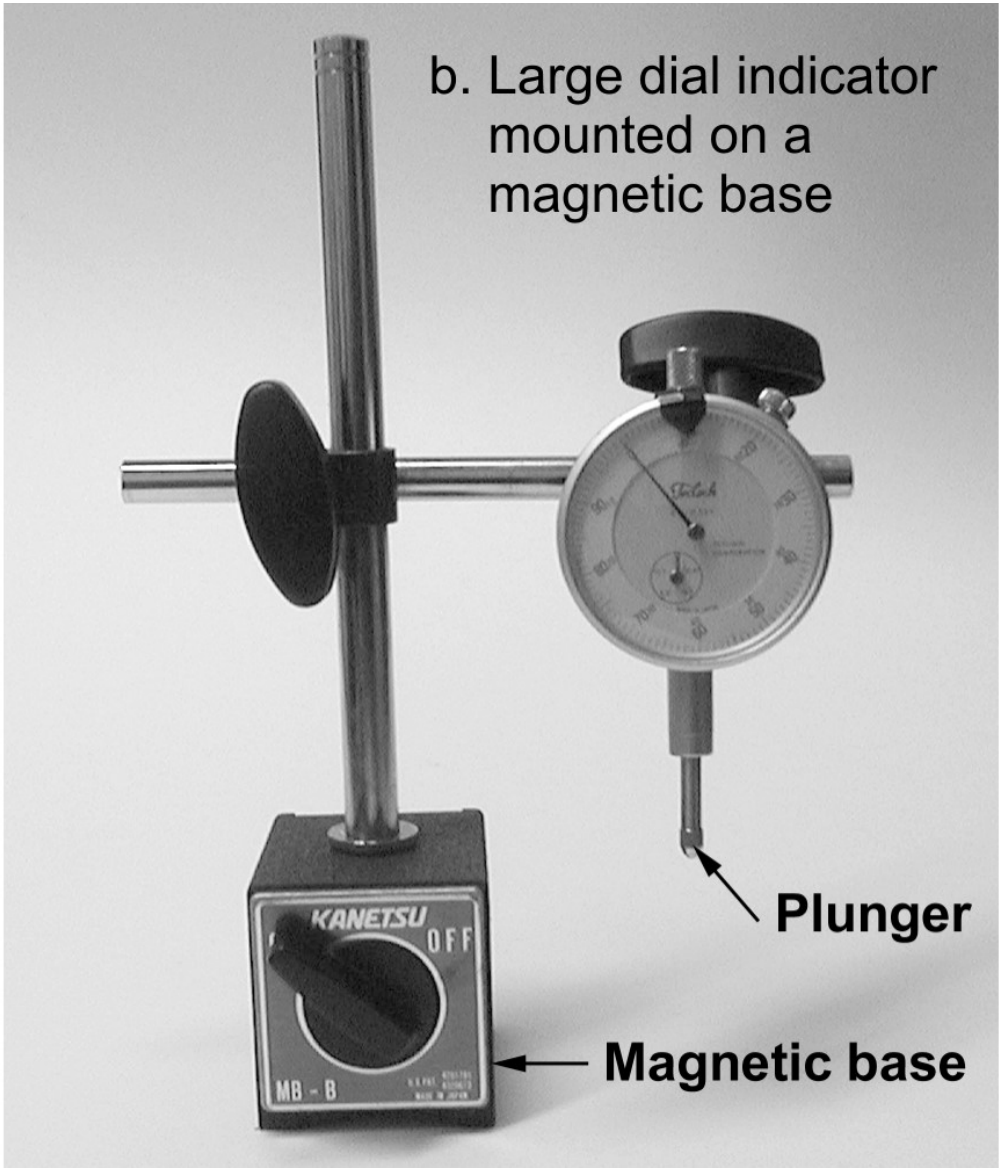
Roundness & Geometry

- ISO 1101:2004 Geometrical Tolerance - Form, orientation, location and run-out
- ISO 12180-1 & 2:2003 Cylindricity - Terms, definitions and parameters of cylindrical form
- ISO 12181-1 & 2:2003 Roundness - Terms, definitions and parameters of roundness
- ISO 12780-1 & 2:2003 Straightness - Terms, definitions and parameters of straightness
- ISO 12781-1 & 2:2003 Flatness - Terms, definitions and parameters of flatness

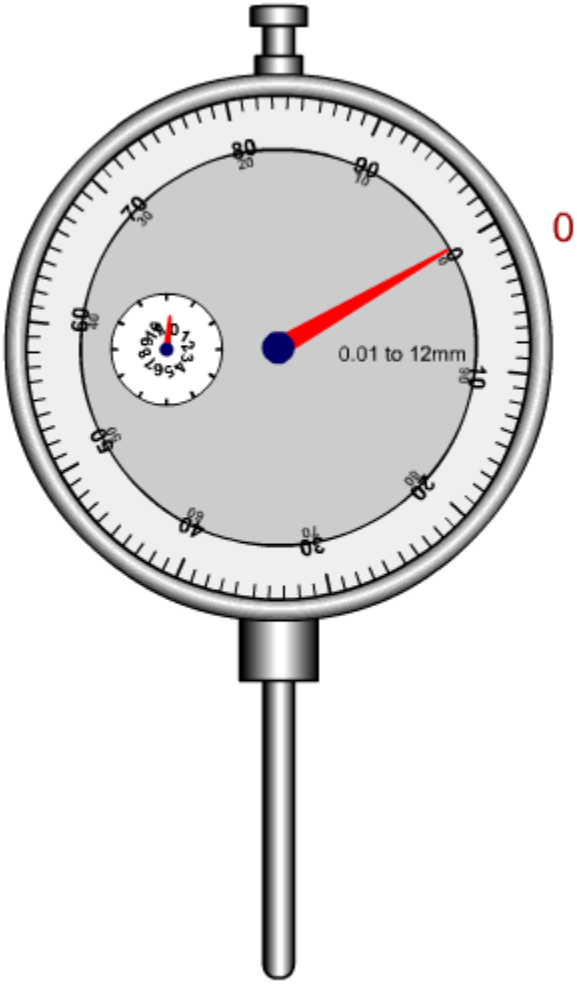
Dial Gage indicator

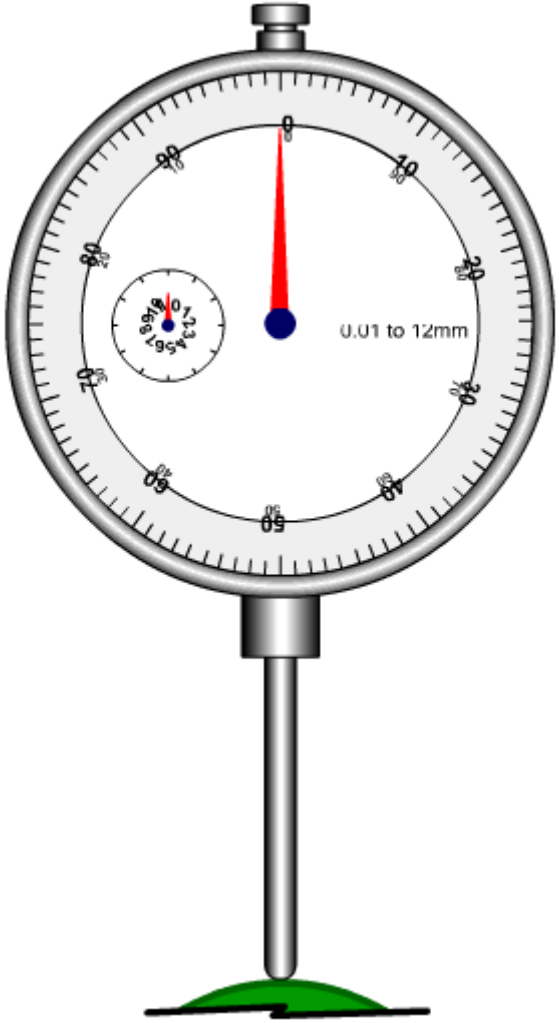
a. Small dial indicator



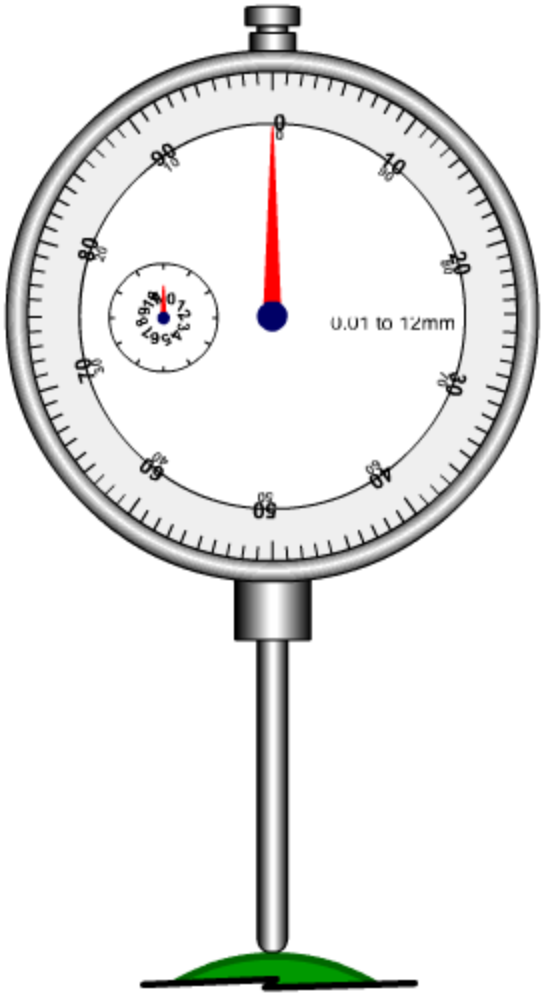


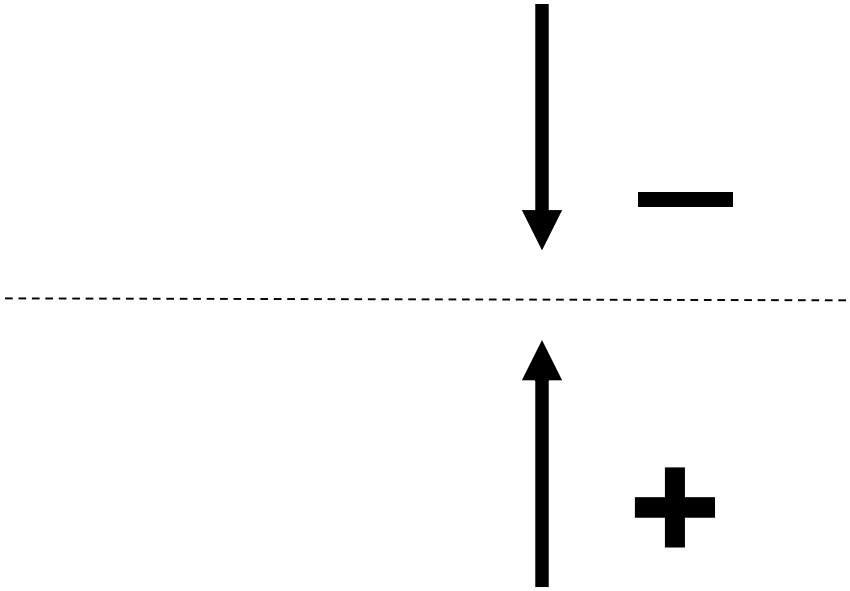
Dial setup





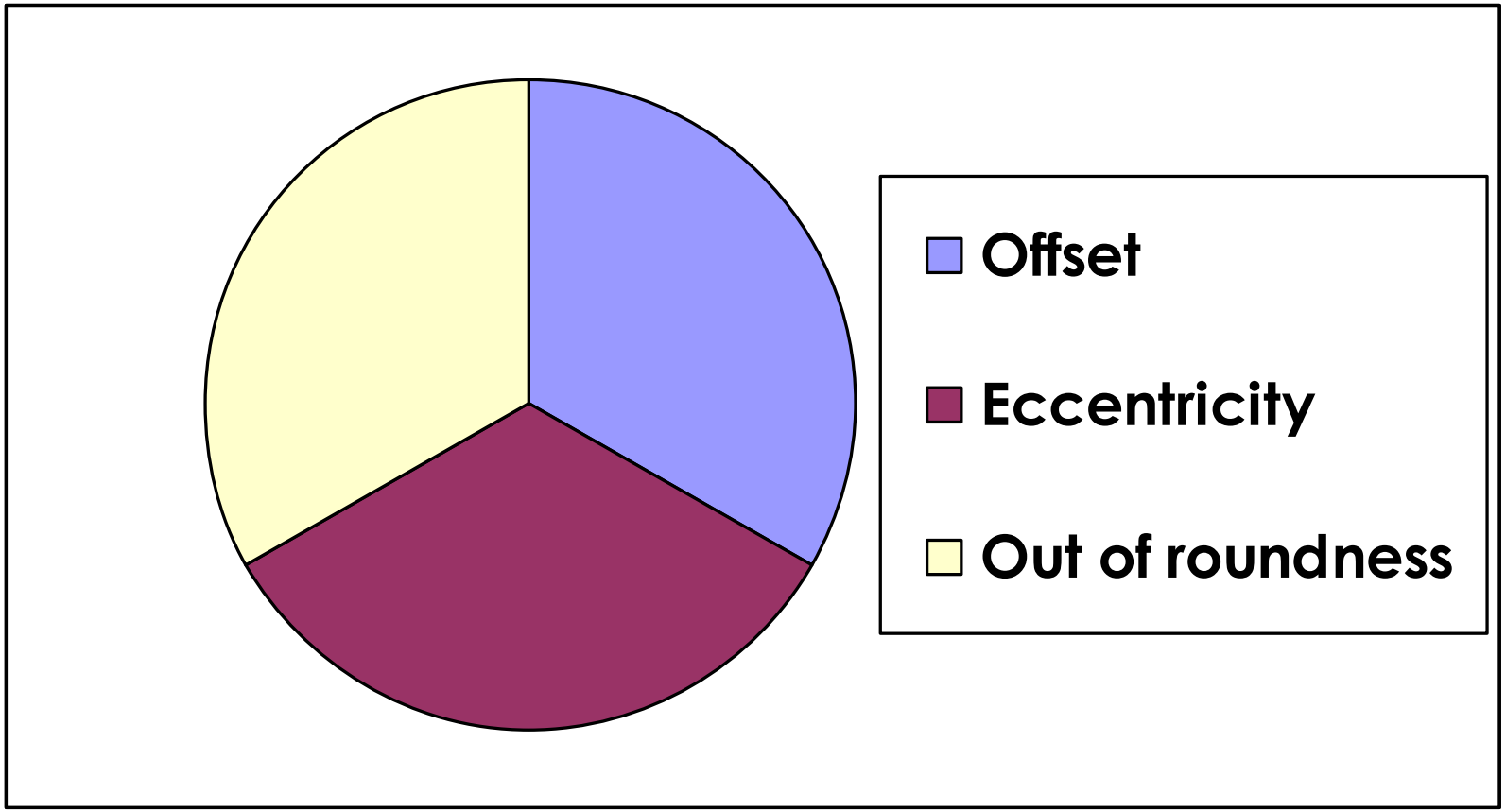
Dial setup





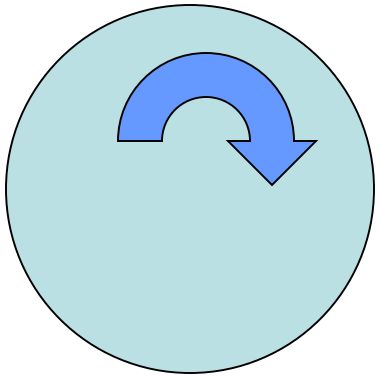
Plunger movement

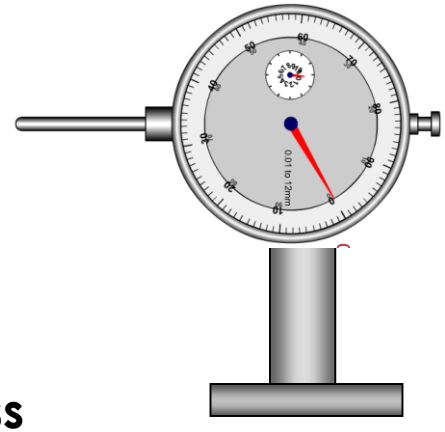
Run-out measurement



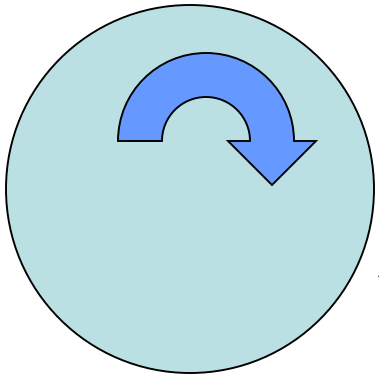
Offset or Eccentricity = Total Indicated Run-out (TIR) / 2

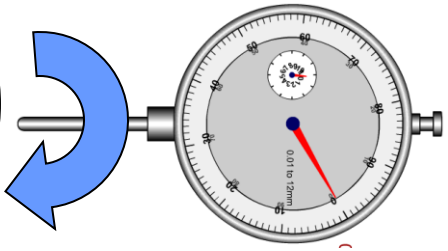
Run-out measurement



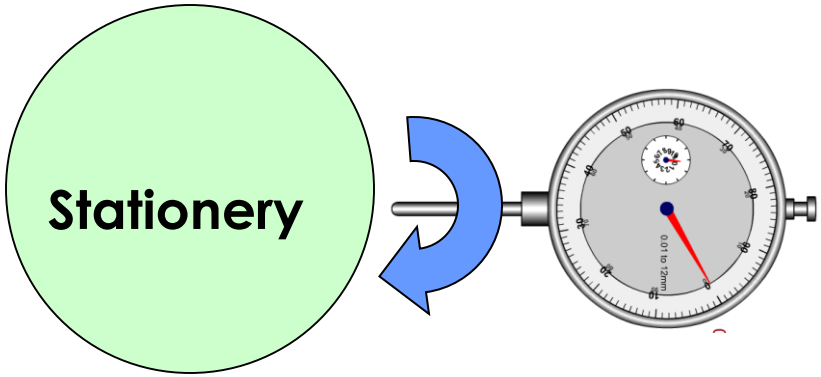


Eccentricity,
Out of roundness





Only Offset

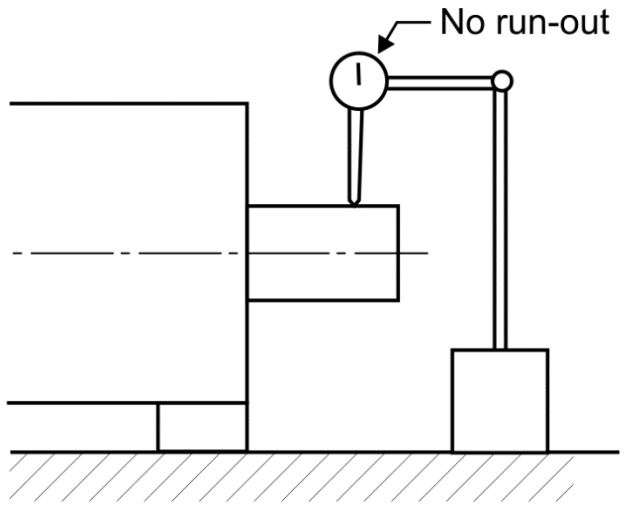


Eccentricity,
Out of roundness
Offset

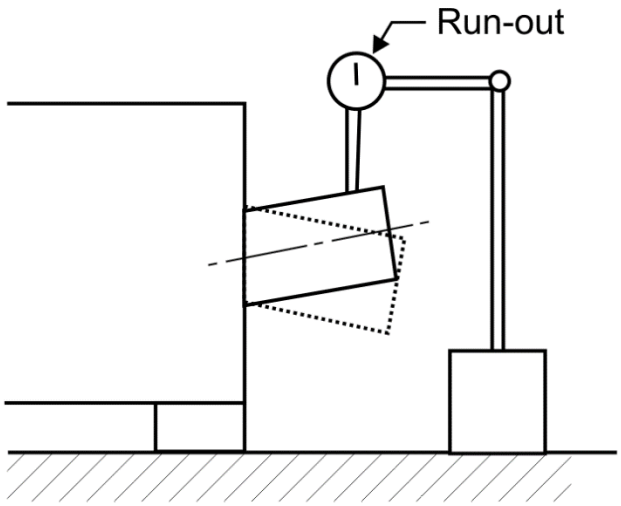
Offset or Eccentricity = Total Indicated Run-out (TIR) / 2

Measurement of OFFSET is suitable for ALIGNMENT

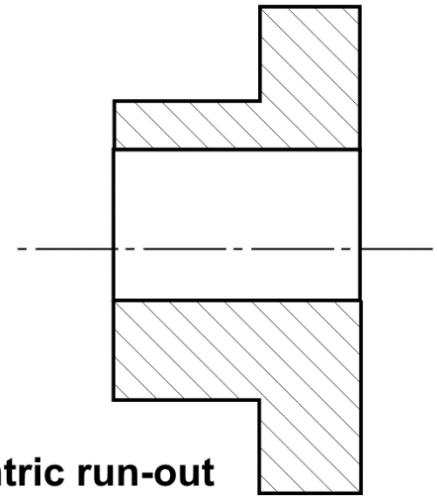
Run-out measurement



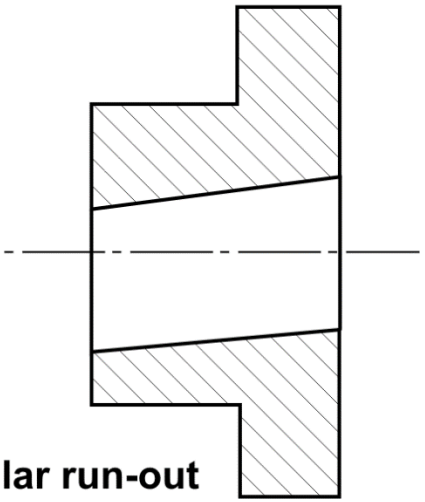
a. Concentric shaft



b. Eccentric shaft

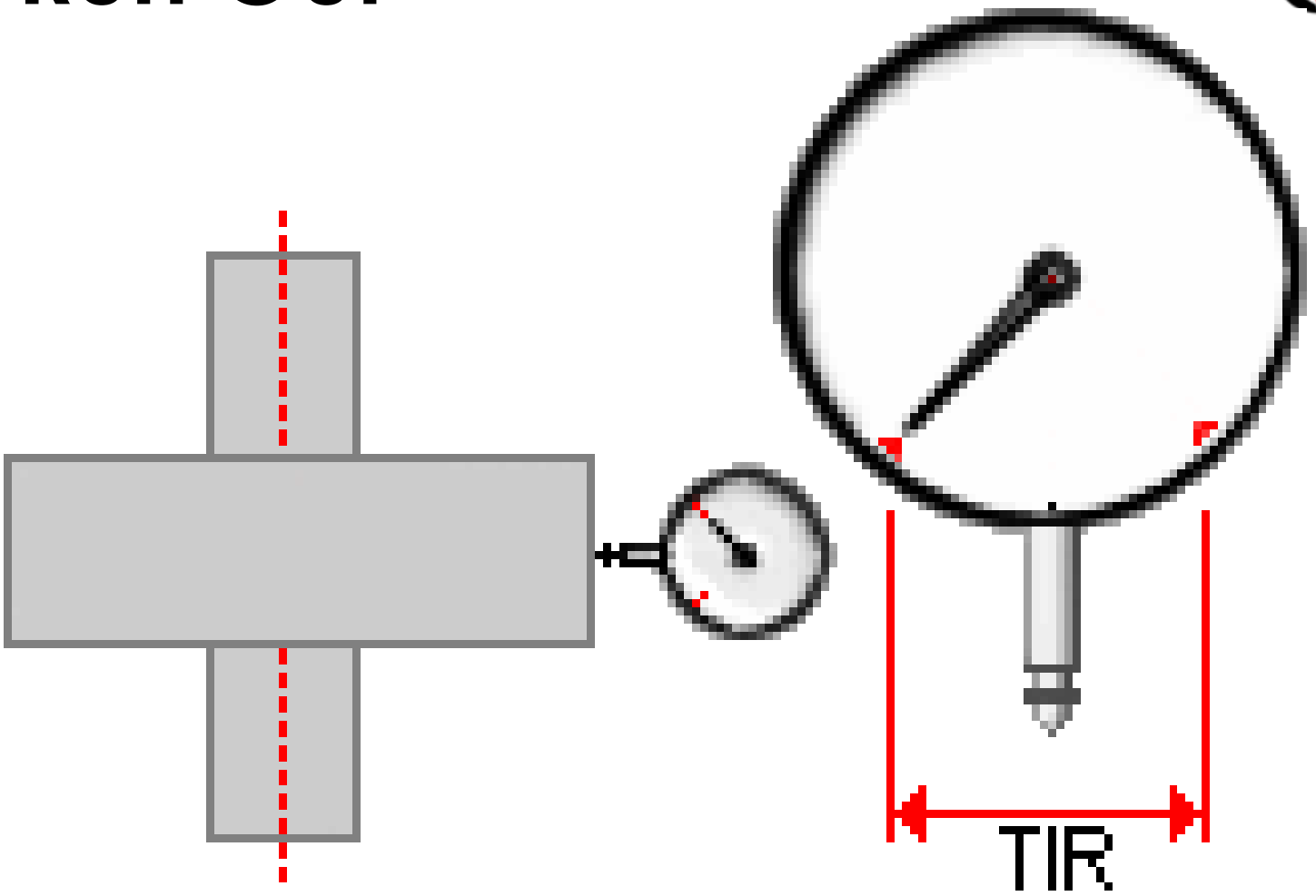


c. Eccentric run-out



d. Angular run-out

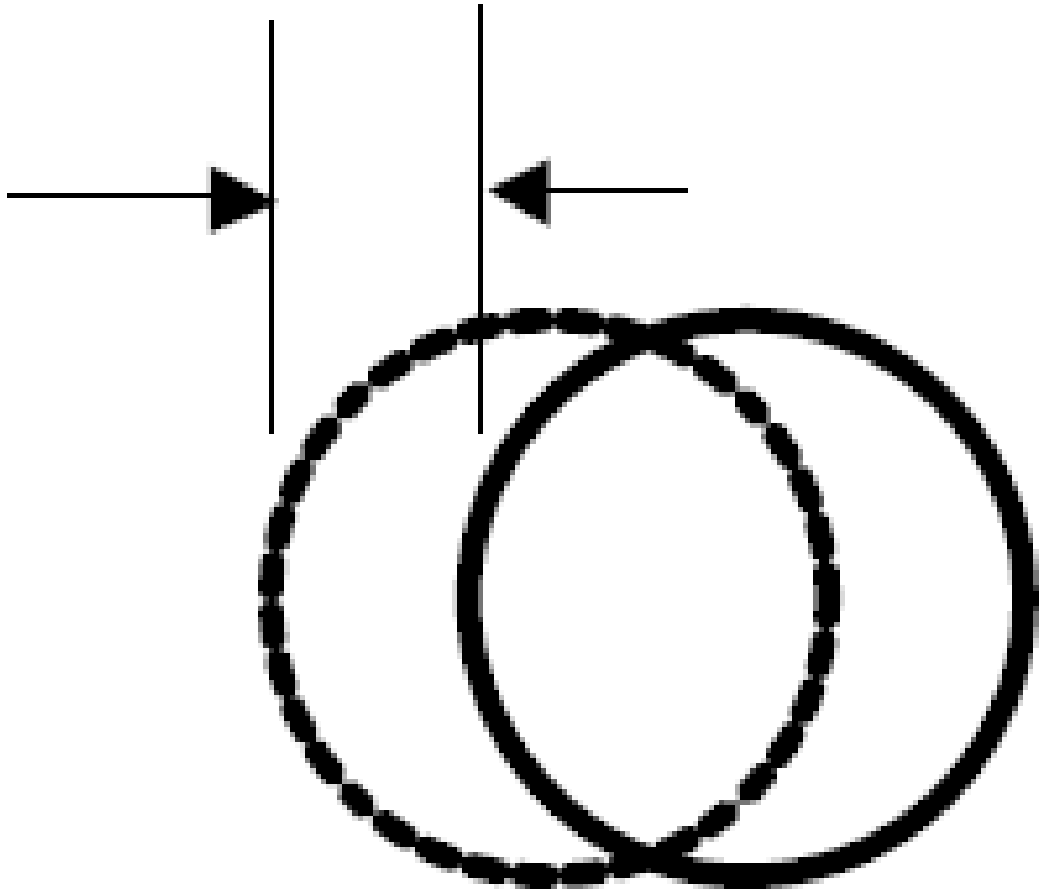
Run Out



TIR (Total Indicator Reading): The total variation in a direction perpendicular to the axis of rotation of an indicated surface from a plane surface of revolution.

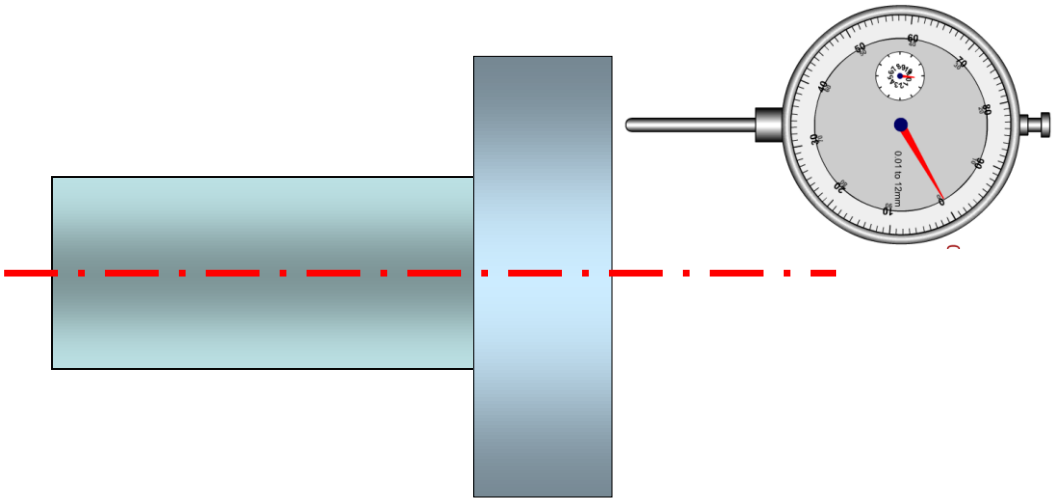
Run Out

TIR

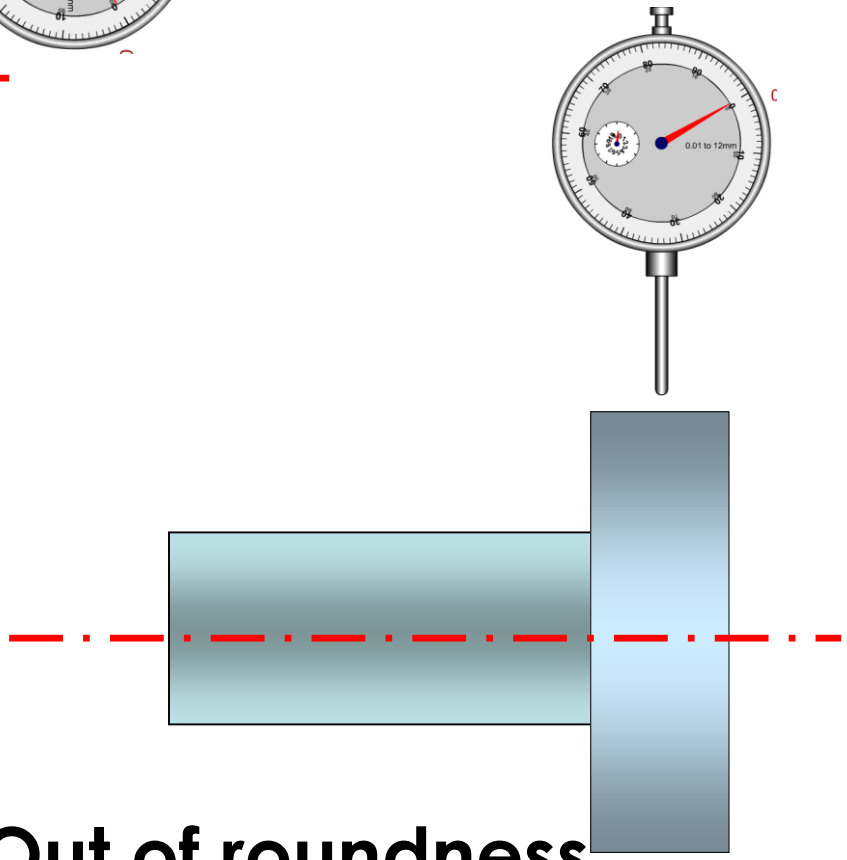


TOTAL INDICATED READING (TIR)
Difference between the most minimum and most maximum value

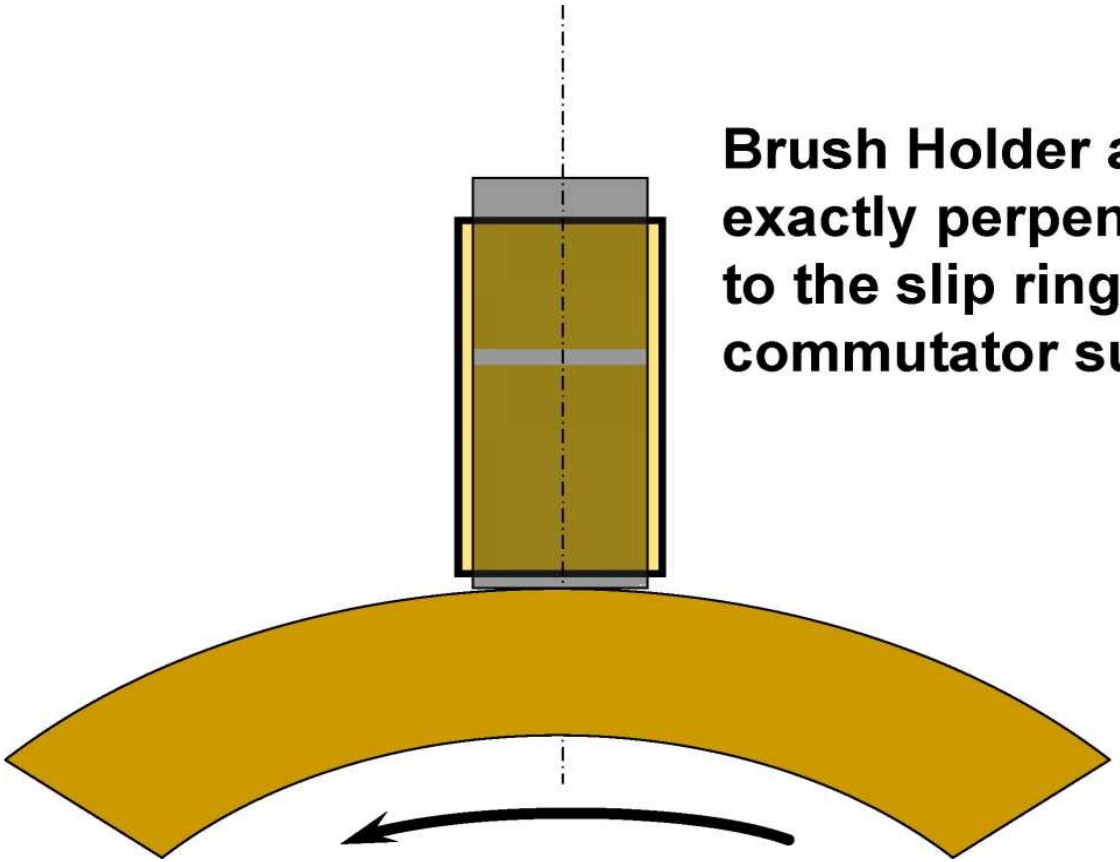
Error Verification

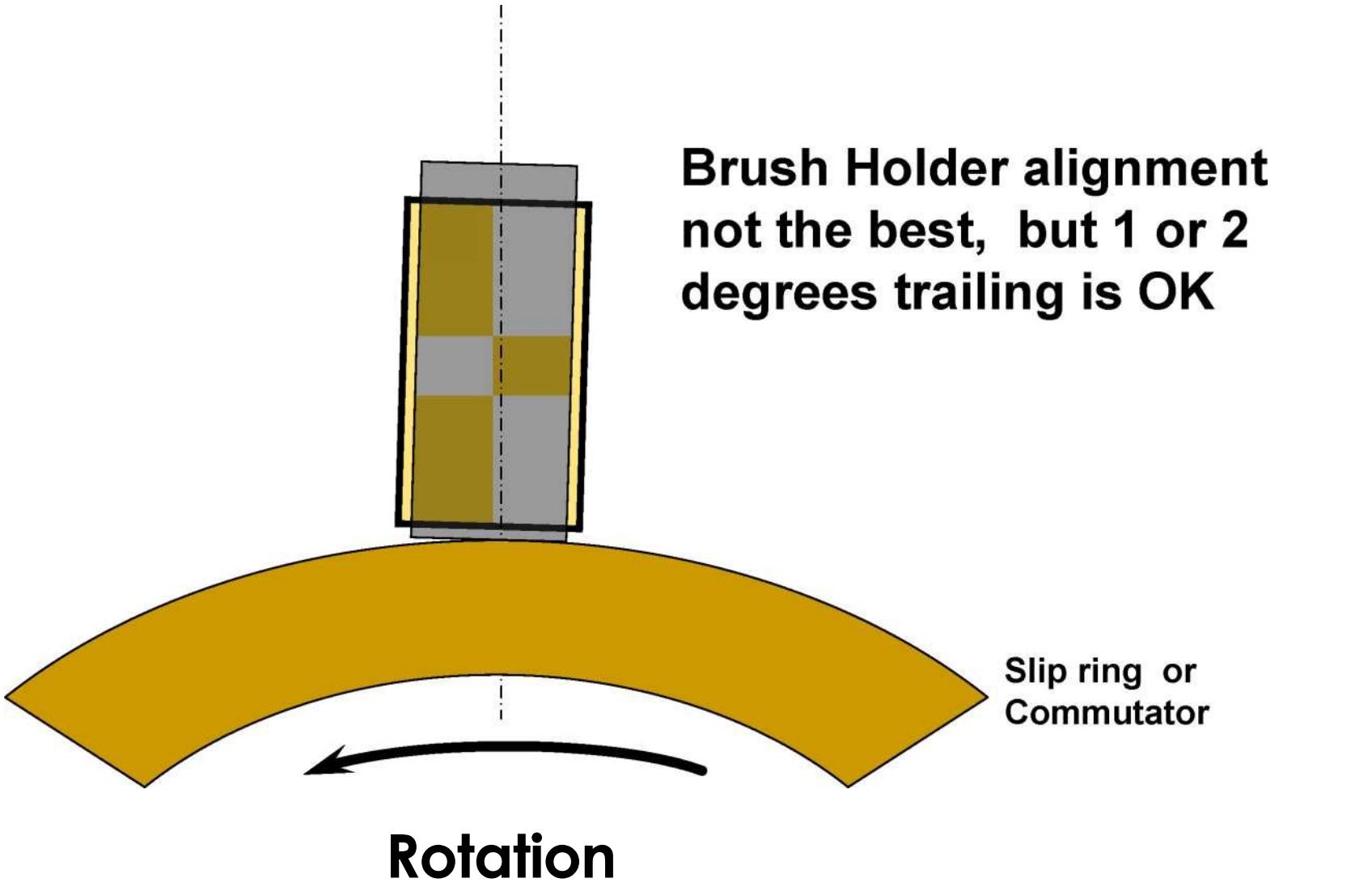


Coupling Face out

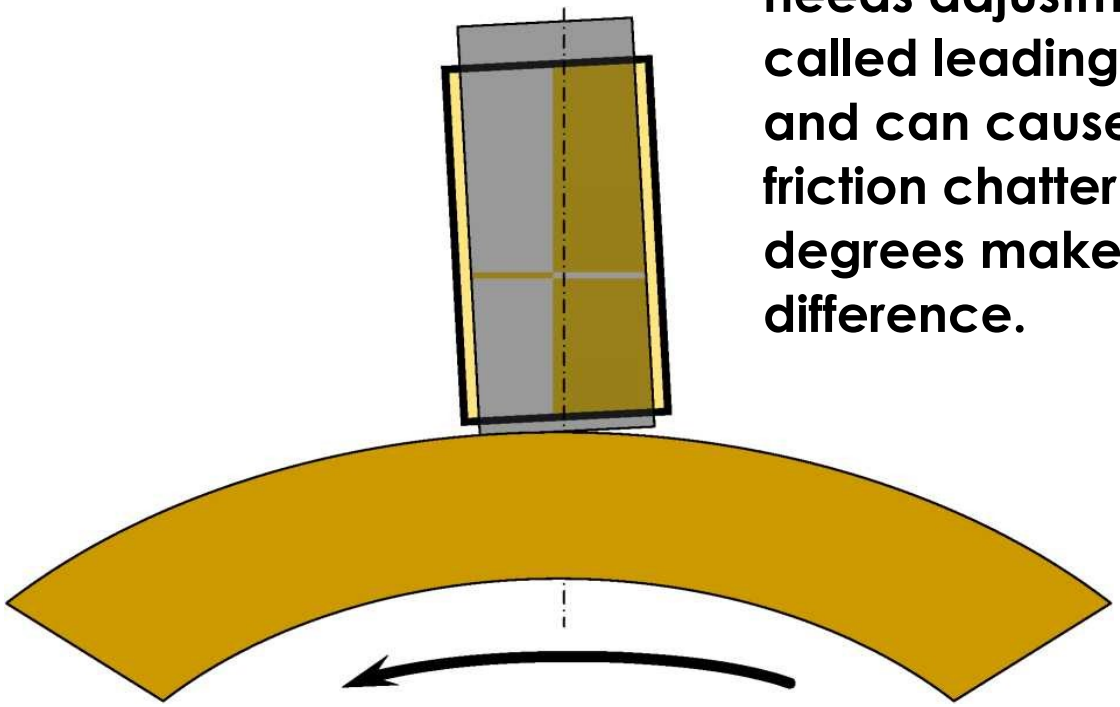


Rim- Out of roundness

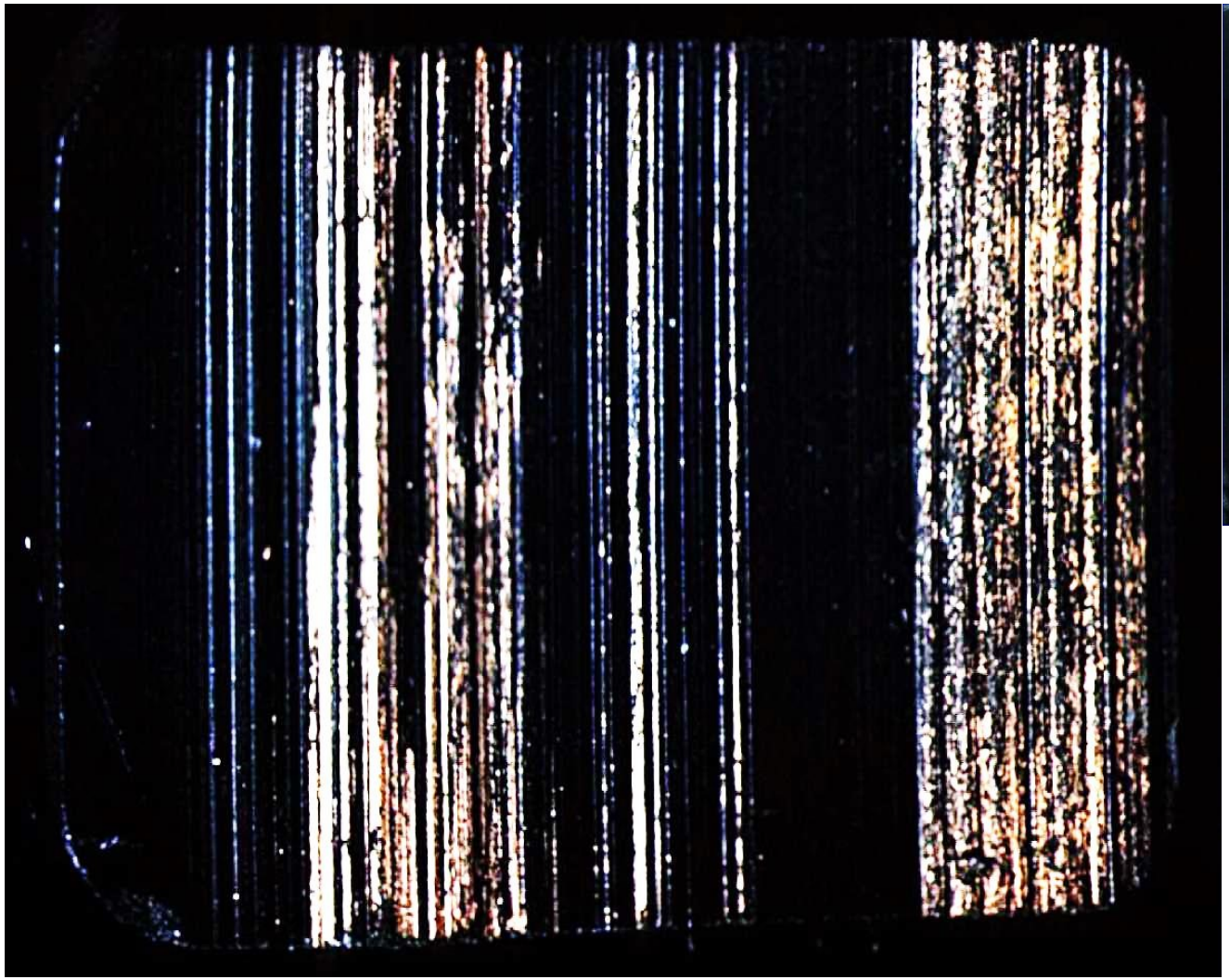

Brush Holder alignment OK,
exactly perpendicular
to the slip ring surface or
commutator surface
Slip ring or
Commutator
Rotation


Brush Holder alignment not the best, but 1 or 2 degrees trailing is OK
Slip ring or Commutator
Rotation

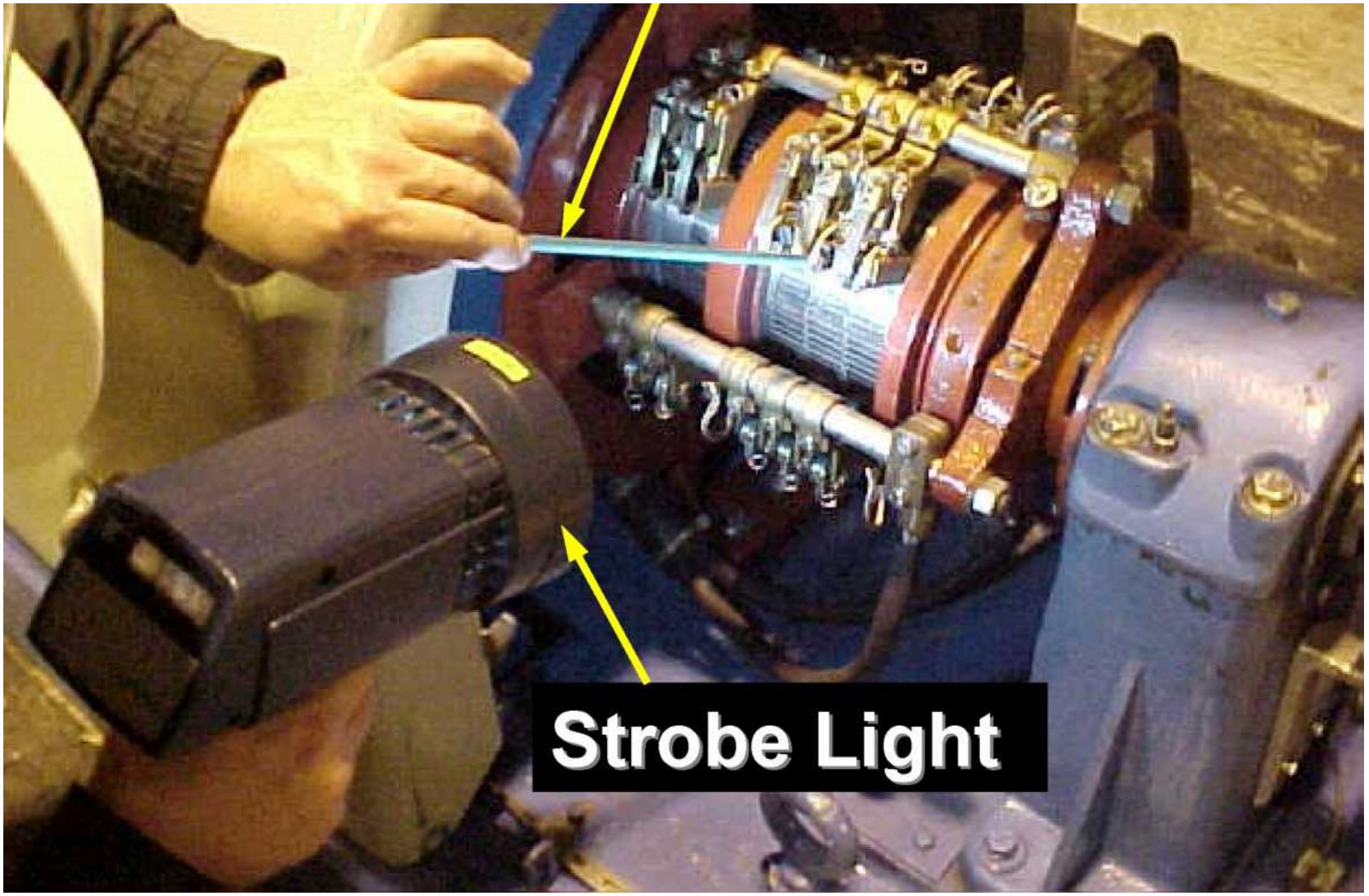
Brush Holder alignment needs adjustment. This is called leading or stubbing and can cause fast wear or friction chatter. Just 1 or 2 degrees makes a big difference.



Brush wear

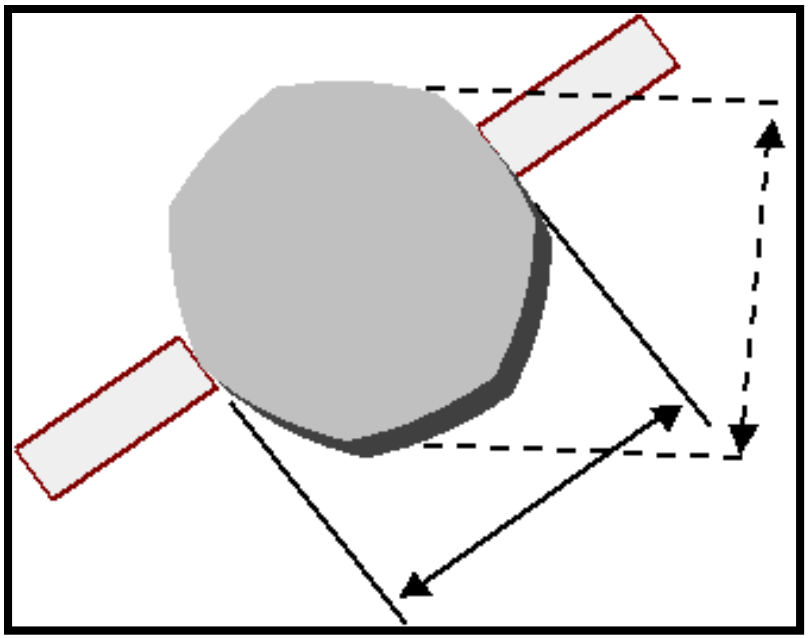


Brush wear



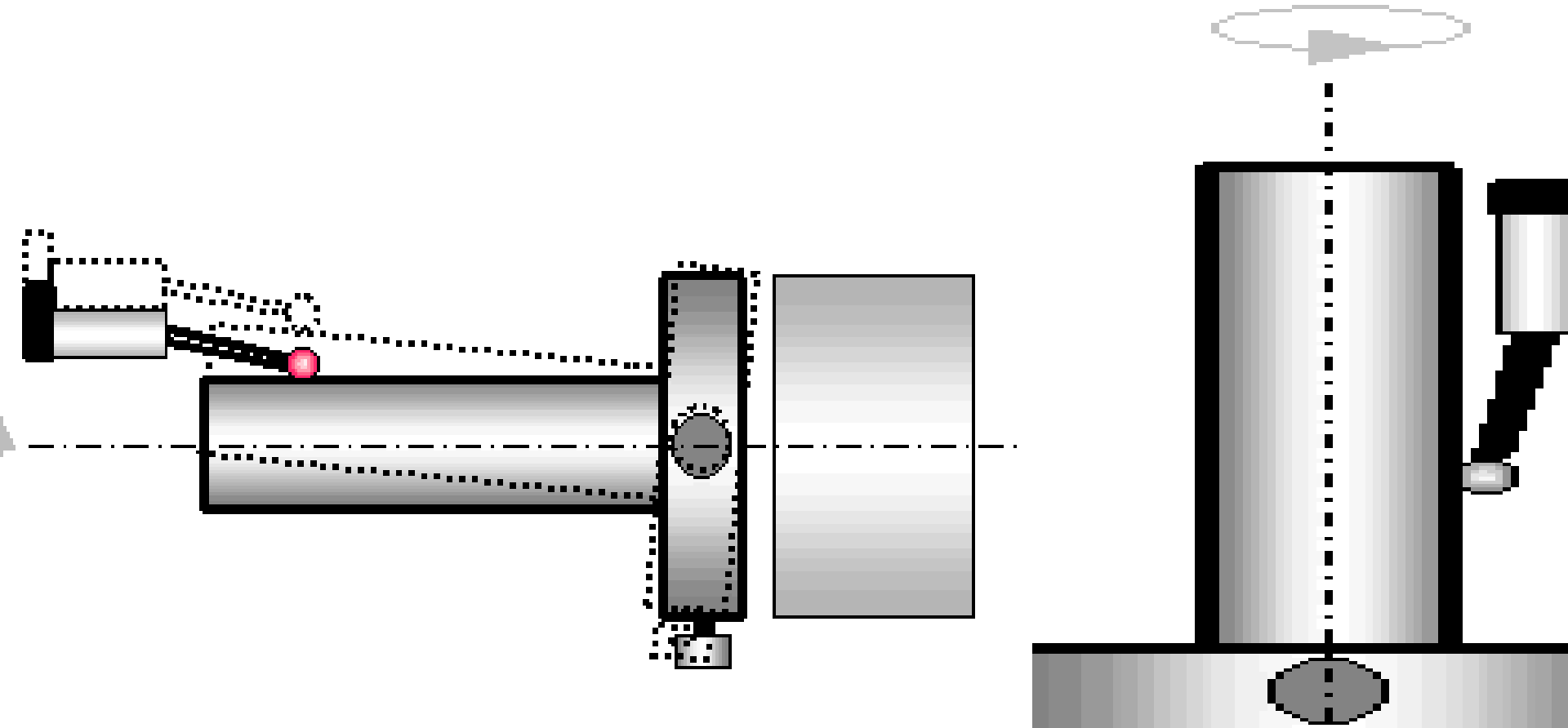
Roundness Measurements

- To measure out of roundness, Measuring differences in diameter by measuring radial deviations from a rotating datum axis; which is not sufficient and need to compare the part profile to an ideal circle or datum of individual circular cross sections of a surface



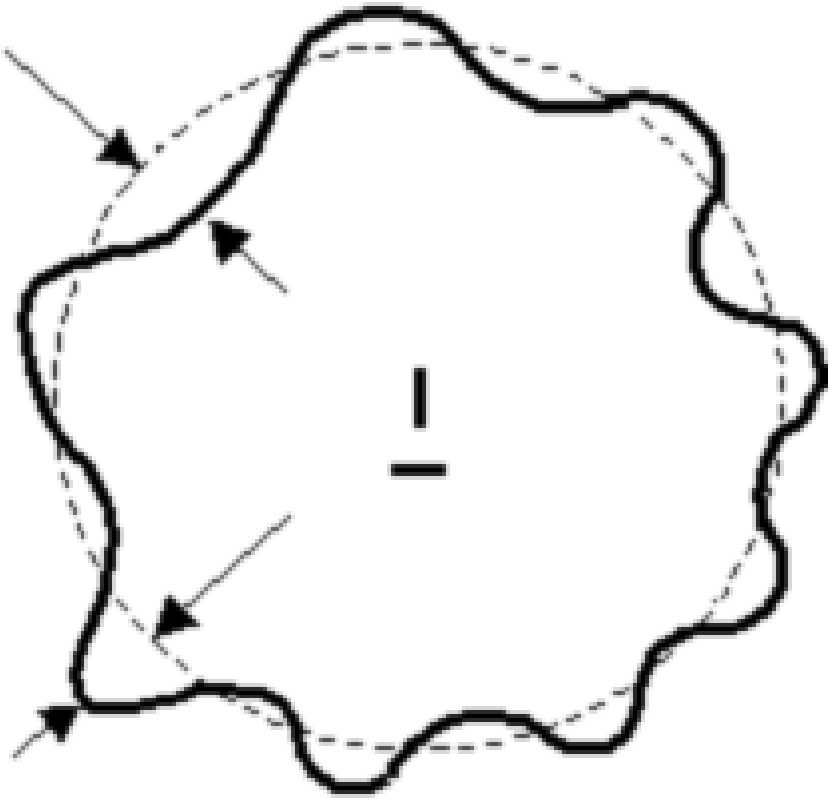
Roundness Measurement

- **Component rotation :** involves rotation of the part while keeping the measuring CD sensor fixed.



Circle References

- **Least Square Reference Circle (LSC):** is a circle where the sum of areas inside this circle is equal to the sum of the areas outside the circle and kept to a minimum separation.
- The out of roundness value is the difference between the maximum and minimum radial departure from the reference circle centre.



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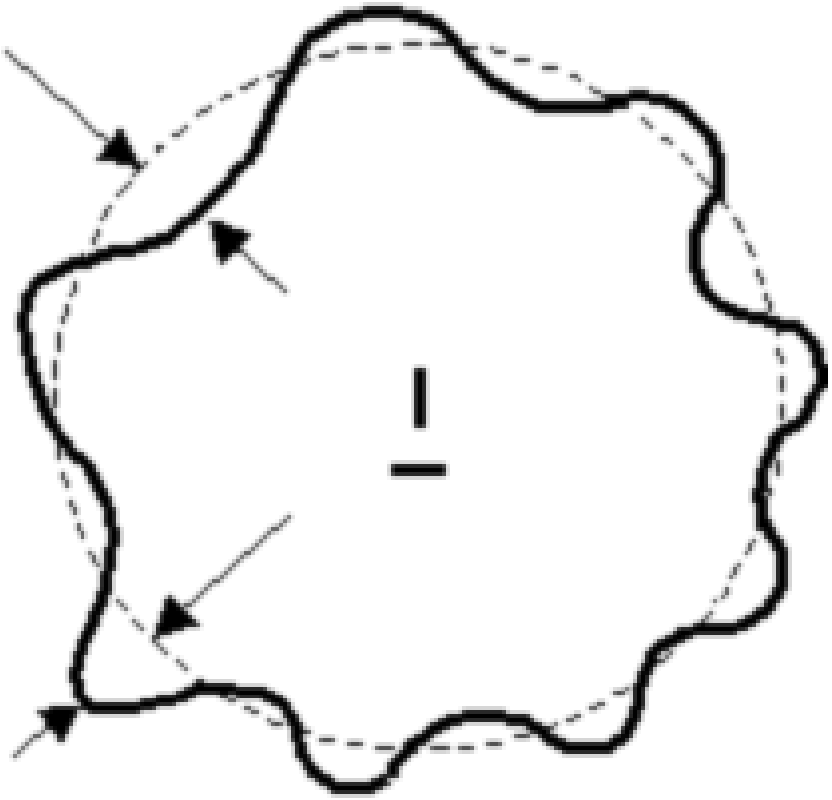

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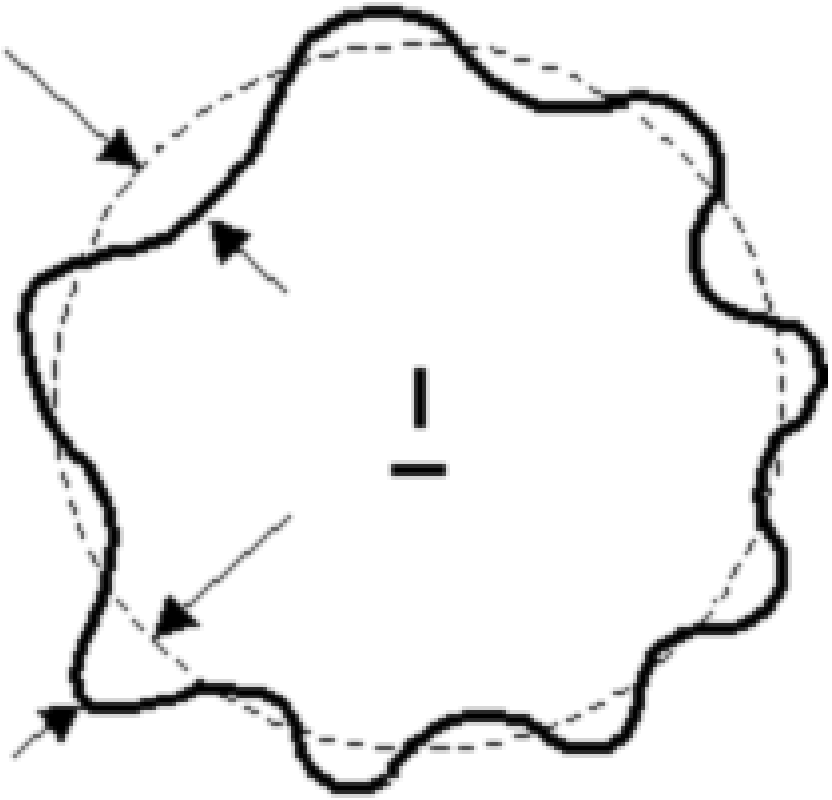

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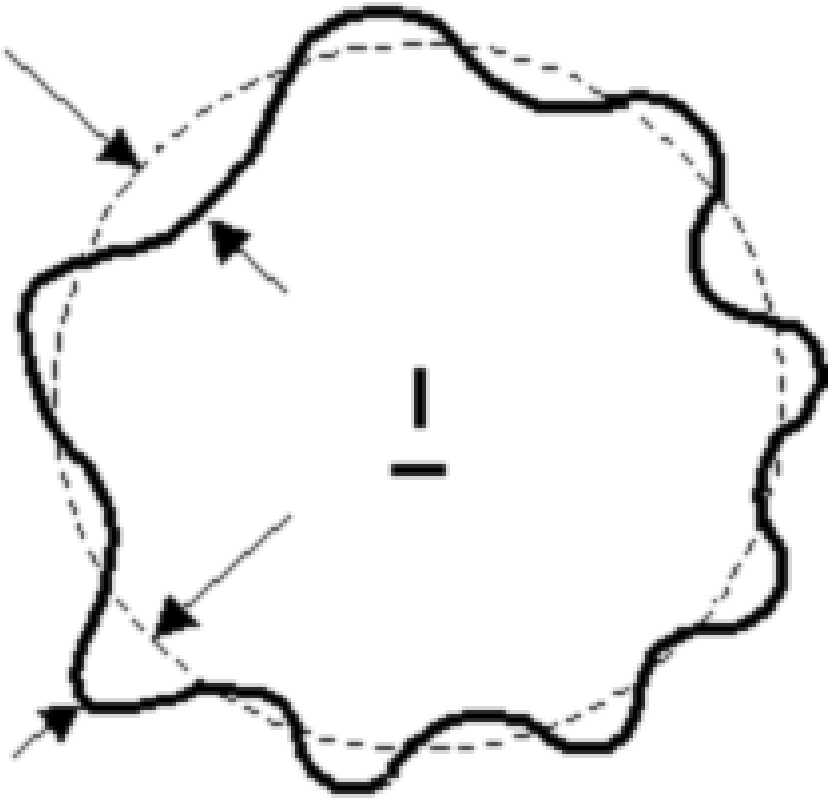
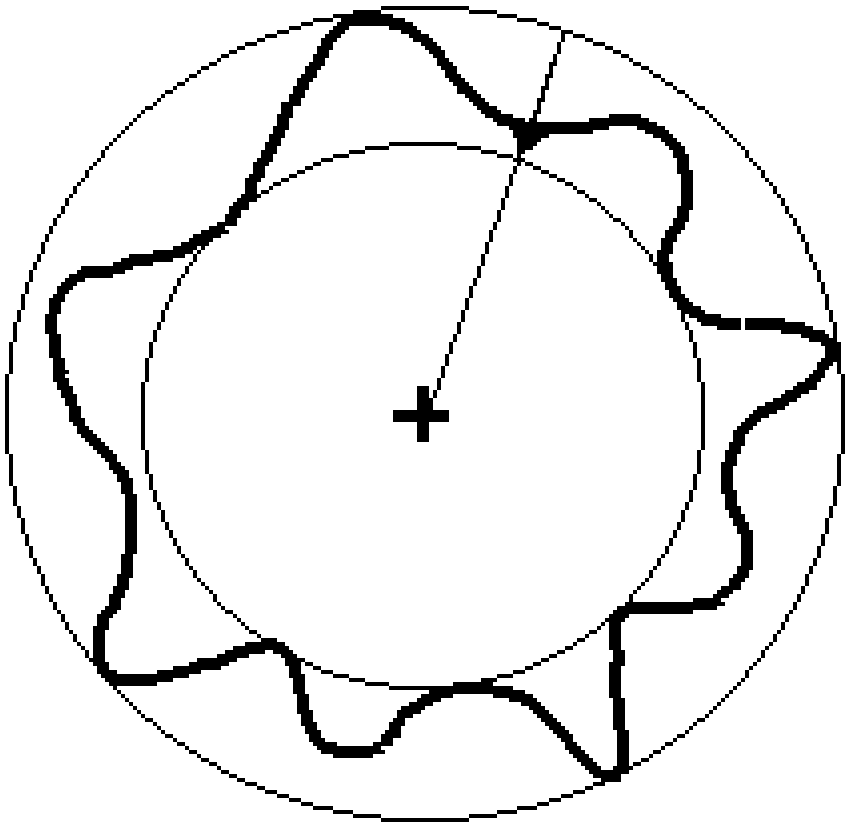


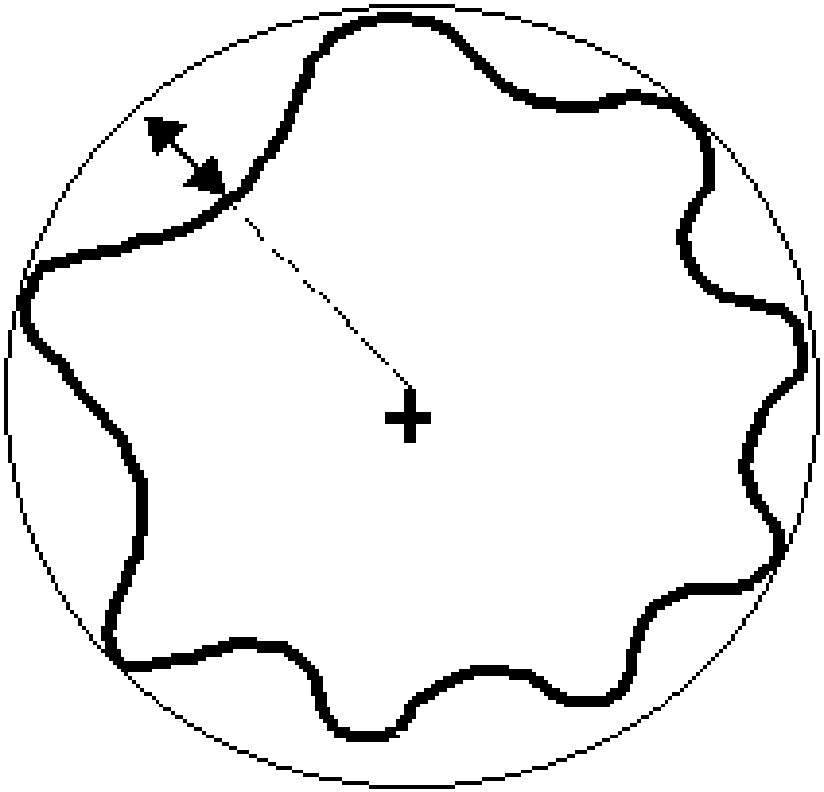
Circle References cont.

- **Minimum Zone Circle (MZC)**
  The MZC is defined as two concentric circles positioned to just enclose the measured profile such that their radial departure is a minimum. The roundness value is then given as their radial separation. (RONt)



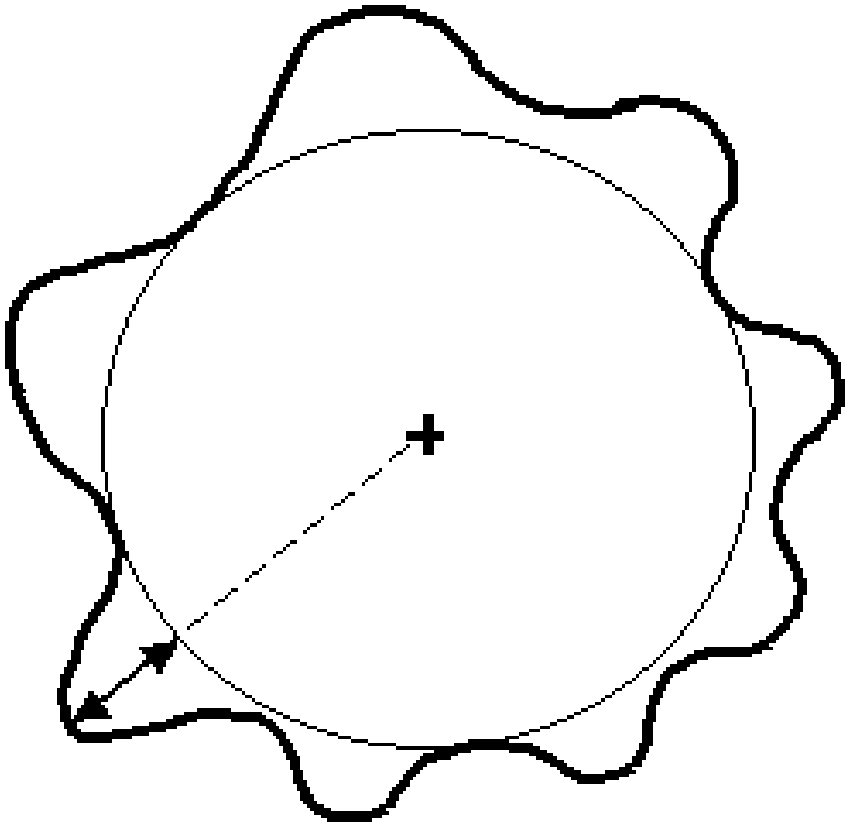
Circle References cont.

- **Minimum Circumscribed Circle (MCC):** This is also known as the ring gauge reference circle and is the smallest circle that totally encloses the profile. Out of roundness is quantified as the largest deviation from this circle (RONt).



Circle References cont.

- **Maximum Inscribed Circle (MIC) :**The maximum inscribed circle, sometimes referred to as the plug gauge circle, is the largest circle that is totally enclosed by the profile. Errors are quantified as the maximum radial deviation (RONt) away from this reference circle.



Accessories

Know more !

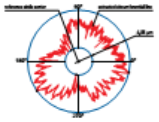
GEOPRO

Defining roundness

Deviation from perfect roundness is defined by the difference in radii of two coplanar and concentric reference circles whose sizes and center position are constructed by one of four methods (described below) after the circumferential line has been extracted. The diagrams show how the deviation value obtained is affected by the method used.

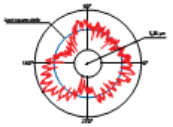
Minimum Zone Circle (MZC)

The size and position of two concentric circles that touch and together enclose the extracted circumferential line are adjusted until their radial difference is a minimum.



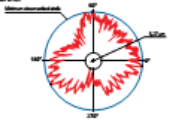
Least Squares Circle (LSC)

The size and position of a circle from which the sum of the squares of the radial deviations of the extracted circumferential line are a minimum is constructed. Two concentric circles coaxial with this circle are then constructed that touch and together enclose the extracted circumferential line.



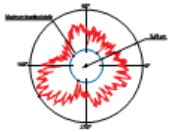
Minimum Circumscribed Circle (MCC)

A circumscribing circle of the minimum size to touch and enclose the extracted circumferential line is constructed. A second circle concentric with the first is then constructed to touch and, together with the first circle, enclose the extracted circumferential line.

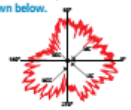


Maximum Inscribed Circle (MIC)

An inscribing circle of the maximum size to touch the extracted circumferential line is constructed. A second circle concentric with the first is then constructed to touch and, together with the first circle, enclose the extracted circumferential line.



The position of the center of the concentric circles defines the center of the extracted circumferential line and therefore the location of the circular feature measured. Each of the methods described above results in different center positions for the reference circles, as shown below.



Characteristic Symbol*	Definition	Geometrical Tolerancing*	Test Method	Result	Permissible Machine Movements
○	**Roundness** Roundness deviation is the difference in radii between two concentric circles constructed to touch and enclose the extracted circumferential line. A feature is toleranced by limiting the deviation to a value t.				
—	**Straightness** Straightness deviation is the distance between two parallel lines constructed to touch and enclose the extracted straight line with minimum separation. A feature is toleranced by limiting the deviation to a value t.				
▱	**Flatness** Flatness deviation is the distance between two parallel planes constructed to touch and enclose the extracted plane surface with minimum separation. A feature is toleranced by limiting the deviation to a value t.				
⌭	**Cylindricity** Cylindricity deviation is the difference in radii between two coaxial cylinders constructed to touch and enclose the extracted cylindrical surface with minimum separation. A feature is toleranced by limiting the deviation to a value t.				
◎	**Coaxiality** Coaxiality deviation is the maximum radial distance between the extracted cylindrical surface axis and the datum axis over the length of the evaluation range. A feature is toleranced by limiting the deviation to a value t/2.				
◎	**Concentricity** Concentricity deviation is the maximum radial distance between the extracted circumferential line center and the datum element center in a circular cross section. A feature is toleranced by limiting the deviation to a value t/2.				
//	**Parallelism (Plane to Plane)** Plane-to-Plane Parallelism deviation is the maximum difference in distance between the extracted plane surface and the datum plane. A feature is toleranced by limiting the deviation to a value t.				
⊥	**Perpendicularity (Plane to Axis)** Plane-to-Axis Perpendicularity deviation is the maximum difference in distance between the extracted plane surface and a plane perpendicular to the datum axis. A feature is toleranced by limiting the deviation to a value t.				
⊥	**Perpendicularity (Axis to Plane)** Axis-to-Plane Perpendicularity deviation is the maximum difference in distance between the extracted axial line and an axis perpendicular to the datum plane. A feature is toleranced by limiting the deviation to a value t.				
↗	**Run-out (Radial)** Radial Run-out deviation is the maximum difference in radii of an extracted circumferential line centered on the datum axis. A feature is toleranced by limiting the deviation to a value t.				
↗	**Run-out (Axial)** Axial Run-out deviation is the maximum difference in distance in the axial direction between an extracted circular line and a plane perpendicular to the axis. A feature is toleranced by limiting the deviation to a value t.				
⌰	**Total Run-out (Radial)** Radial Total Run-out deviation is the difference in radii between two concentric cylinders coaxial with the datum axis constructed to touch and enclose the extracted cylindrical surface with minimum separation. A feature is toleranced by limiting the deviation to a value t.				a b
⌰	**Total Run-out (Axial)** Total Axial Run-out deviation is the maximum difference in distance in the axial direction between an extracted flat surface and a plane perpendicular to the axis. A feature is toleranced by limiting the deviation to a value t.				a b

* Following ISO 1101:2012

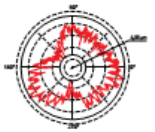
t = tolerance

Reference Element — Extracted Geometry

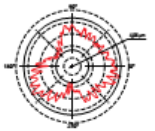
Filtering

Extracted lines can be low-pass filtered in various ways to reduce or eliminate unwanted detail, with a cut-off value set in terms of undulations per revolution (upr). The effect of different upr settings is shown in the diagrams below, for a phase-corrected 50% Gaussian filter, which illustrate how the measured roundness value decreases as lower upr settings progressively smooth out the extracted line.

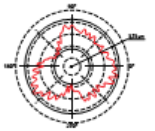
No filter



150 upr



50 upr



15 upr