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Straightness & Parallelism

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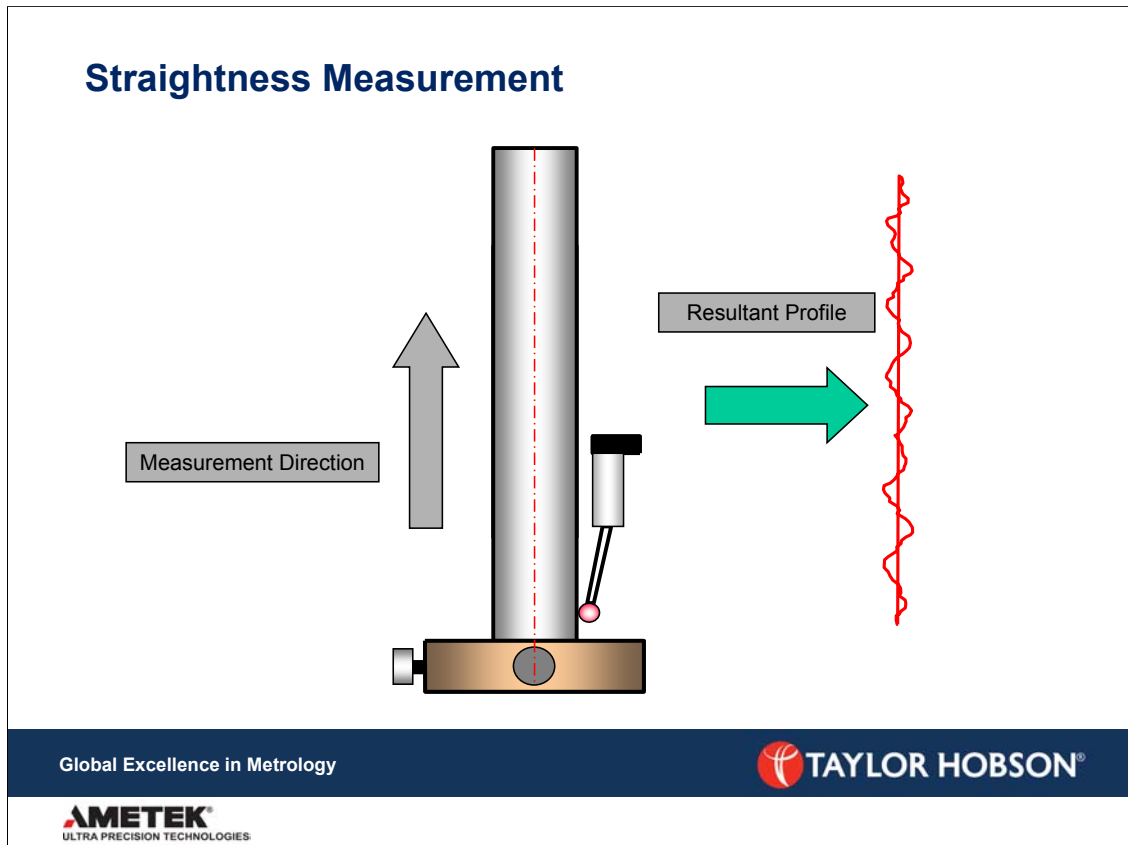
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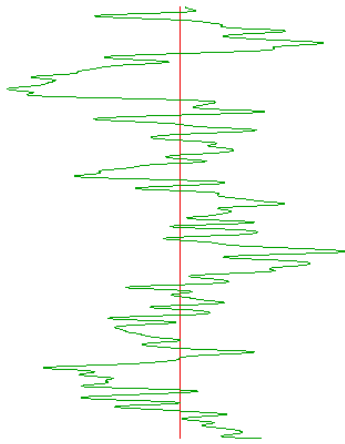
Instruments with vertical straightness units can be used to measure vertical straightness.

The movement of the stylus is controlled in a linear manner, the vertical and radial displacements can be recorded and analysed as a straightness measurement.

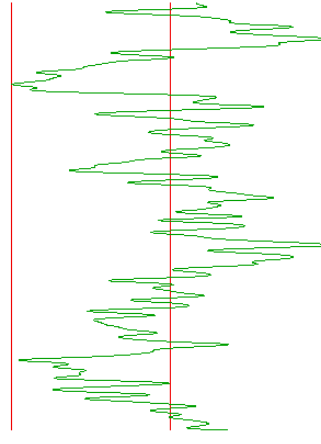
Prior to measurement the component should be centred and levelled with respect to the spindle axis to reduce any tilt errors which may affect the straightness result. This is of particular importance when measuring long, and/or small diameter components.

If the instrument is fitted with a Radial Straightness Unit (RSU) horizontal straightness is also possible. Prior to measurement it is important, in this instance, to ensure that the component surface is levelled and square to the spindle axis.

Straightness Reference Types



Least Squares Reference



Minimum Zone Reference

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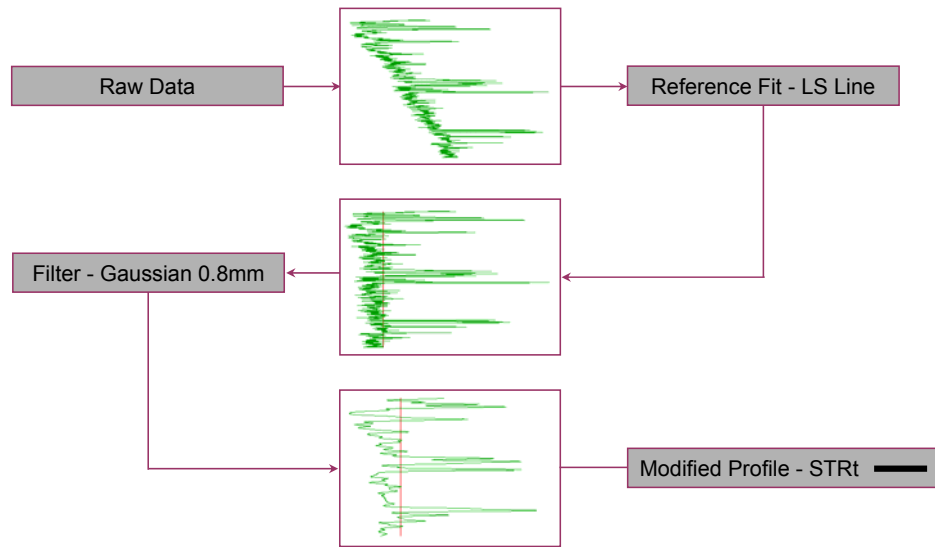
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The above slide shows the two reference types used for the analysis of Vertical and Horizontal straightness.

The least squares reference line is fitted to the raw measured data such that the sum of the squares of the deviations of the profile are minimised. The straightness value is the maximum peak to valley deviation perpendicular to the LS line.

The minimum zone reference is the minimum separation of two parallel lines which totally enclose the data and are of minimum separation. The straightness value is the separation of the two minimum zone lines.

Straightness Analysis



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The computerised method for the analysis straightness is as follows;

- The raw data is shown relative to the instrument vertical straightness unit (column). This data will have a certain amount of tilt, depending how well the component has been centred and levelled.
- An MZ or LS reference is fitted to the raw data to remove the tilt from the measured data.
- The resultant profile is then passed through a filter which attenuates wavelengths shorter than the selected cut-off value.
- From this modified profile the straightness parameters can be calculated.

Straightness Filter Selection

Measurement Length (mm)		Λ_c (cut-off)
From	Upto & Including	
0.4	1.25	0.08
1.25	4	0.25
4	-	0.8

***Default Filter Selection - Gaussian 0.8mm**

*Ref ISO 12780-2

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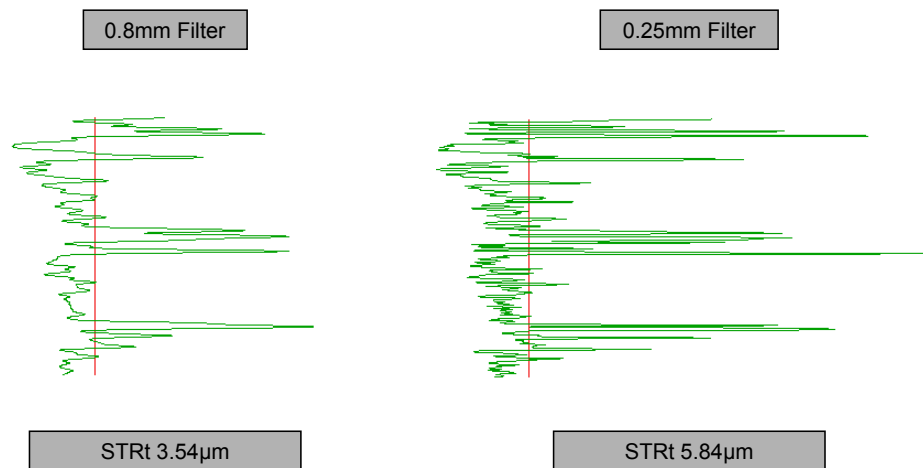
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The default cut-off selection for a straightness analysis as recommended in ISO 12781-2 is a Gaussian 0.8mm. This applies for measurement lengths greater than and including 4mm.

The table shown above applies for lengths shorter than 4mm.

In reality the selected cut-off value would depend upon the information required from the surface and what influence certain wavelengths would have on the component's performance.

Gaussian Filter Characteristics



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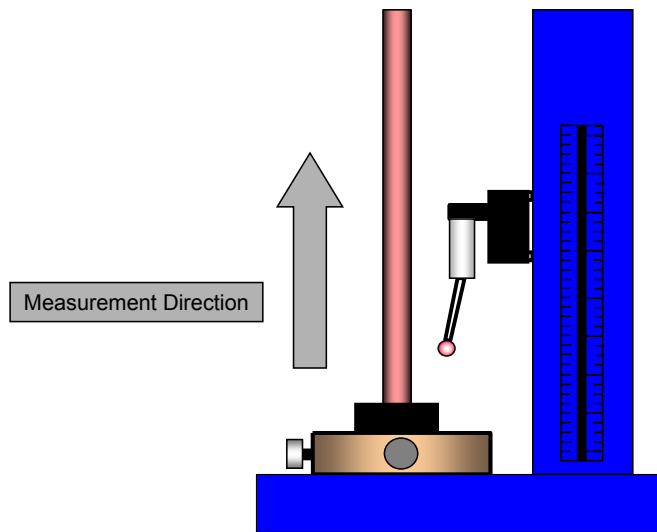
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As can be seen from the above slide the choice of filter value will have quite a significant effect on the STRt value.

This illustrates the importance of selecting a cut-off value which is suitable for the length and function of the part being measured. Also to prevent any misunderstanding between supply and customer in the interpretation of straightness results.

Straightness Measurement on Narrow Components



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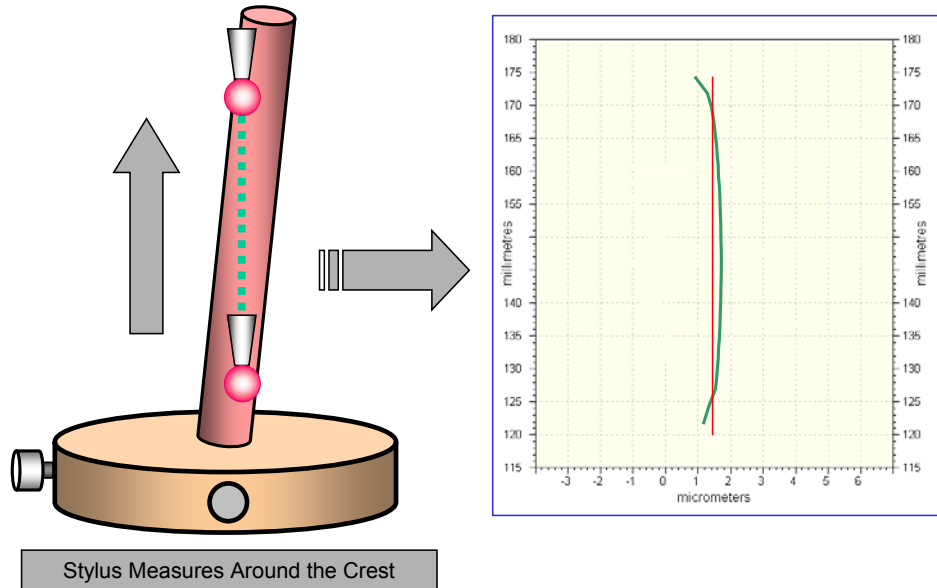
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When measuring straightness of narrow components it is difficult to keep the stylus on the crest of the part.

For example if straightness is required on the above part and the part is leaning problems will appear in the measurement.

Straightness Measurement on Narrow Components



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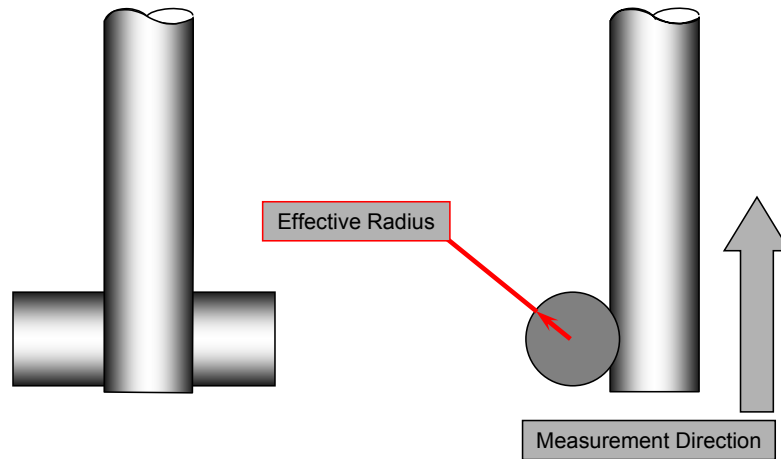
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Here is a view of a cylinder that is tilted in the none measuring direction. As the stylus is tracked up the cylinder it will pass around the crest of the part and produce a straightness track similar to that shown on the right hand side of the above picture.

This result will show a combination of both straightness error and the deflection of the stylus around the crest of the component.

Straightness Measurement on Narrow Components

- Bar Stylus



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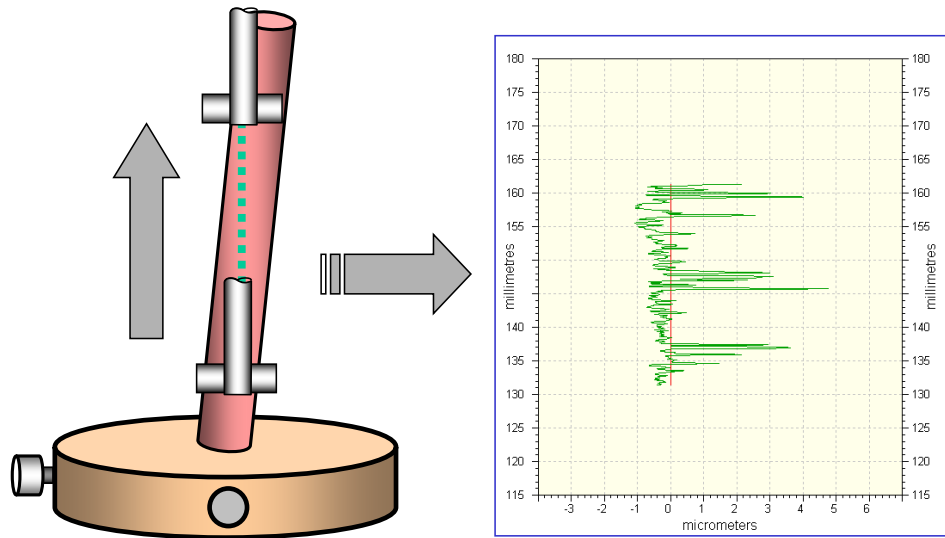
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To prevent this phenomena a bar stylus can be used.

This stylus consists of a cylinder fixed to a stylus arm and set perpendicular to the stylus arm.

A side view of the stylus shows it as a standard stylus with a standard radius when used in the measuring direction.

Straightness Measurement on Narrow Components



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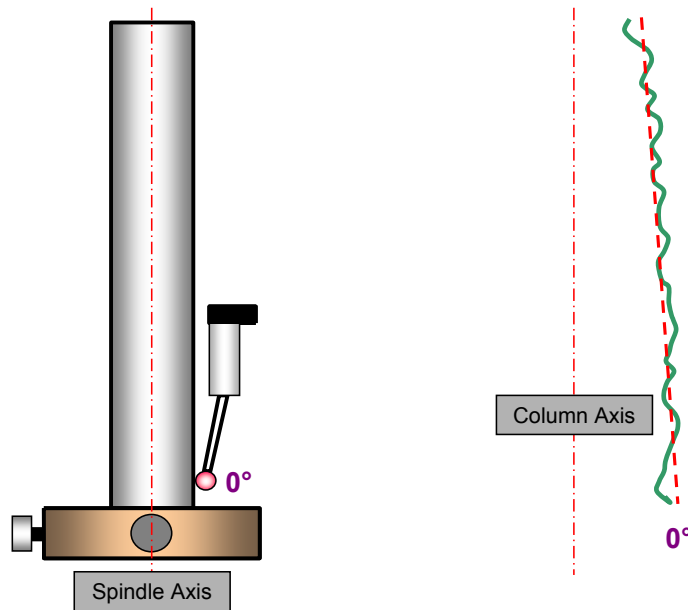
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Because of the width of this stylus, cresting errors will be reduced when measuring straightness.

This sort of stylus is also useful for [measuring straightness](#) of extremely thin edges such as rubber blades for screen printing.

It can also be used for [roundness measurement](#) where high frequency elements of the surface are less critical, the bar will prevent cresting errors.

Parallelism



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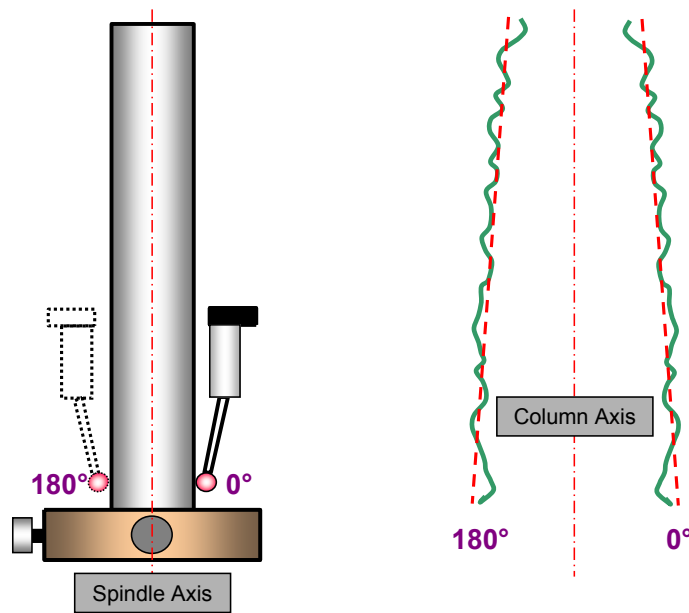
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If the column or vertical straightness unit of the measuring system is parallel to its spindle axis then other relationships can be established when analysing straightness.

In the case shown here it is possible to measure a cylinder and construct an axis, parallelism of the straightness track can then be analysed with respect to this axis.

Parallelism



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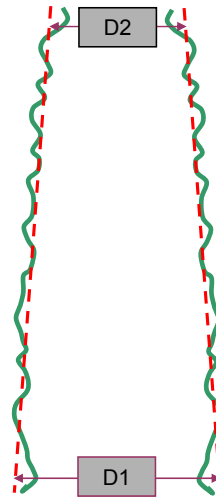
By measuring two sides of a cylinder it is possible to find the parallelism of the cylinder.

The bi-sector of the two straightness tracks can also be used for further analysis to other measured features.

Parallelism - Definition

PAR 

Parallelism = D1 - D2



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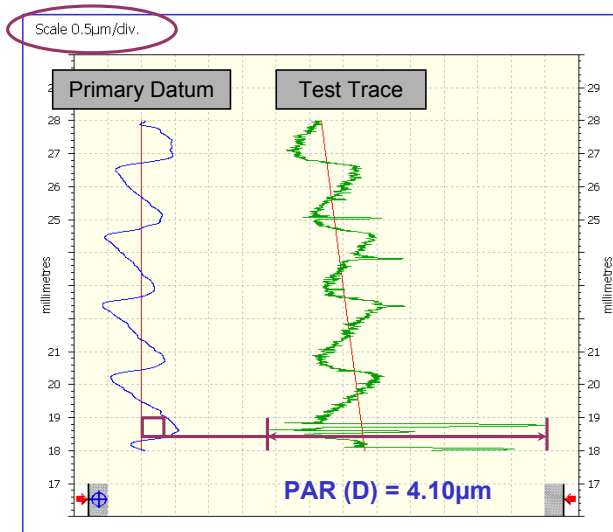
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A datum line is constructed using one straightness profile, by fitting a least squares line or minimum zone pair of straight lines. A least squares straight line is then constructed from the second straightness profile.

The parallelism value is the difference in the separation of the datum line and the second least squares line over the length of the straightness profiles.

Parallelism - PAR (D) Definition

- PAR (D)
- Peak to Valley of the Displacements of the Test Trace at a normal to the Primary Datum LS Line.



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PAR (D) is defined as the peak to valley of the displacements of the test trace from the primary datum. i.e. Displacement of furthest data point from the primary datum, minus the displacement of the nearest point from the primary datum.

Summary

- Instruments with vertical straightness units can be used to measure vertical straightness
 - If the instrument is fitted with a Radial Straightness Unit (RSU) horizontal straightness is also possible
- The choice of filter value will have quite a significant effect on the STRt value.
- When measuring straightness of narrow components it is difficult to keep the stylus on the crest of the part.
 - To prevent this phenomena a bar stylus can be used.
- By measuring two sides of a cylinder it is possible to find the parallelism of the cylinder.

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