


# XK20 alignment laser measurement specifications explained

## Introduction


In the examples that follow, we explain the factors that contribute to the published measurement specifications when using Renishaw's XK20 alignment laser system. A range of errors, including scale and residual, influence each measurement specification.

## Measurement specification explained

Straightness	
	<b>Range</b> ±5 mm
	<b>Accuracy</b> ±0.008A ±0.8 µm
	<b>Resolution</b> 0.1 µm

A = displayed straightness reading (µm)


- ±0.008A µm is the scale error of the position sensitive detector (PSD) in the M unit, where A is the displayed straightness reading.
- ±0.8 µm is the residual error associated with the PSD in the M unit, as well as the straightness of the beam emitted from the launch unit.

Squareness	
	<b>Range</b> ±5 mm
	<b>Accuracy*</b> ±0.008A/M ±1.4/M ±4 µm/m
	<b>Resolution</b> 0.1 µm

\* with squareness calibration factor

A = straightness reading of the furthest point (µm)  
 M = length of the (shortest) axis (m)

- ±0.008A/M µm/m is the scale error of the PSD in the M unit, where A is the displayed straightness reading, and the 1/M factor denotes that the uncertainty will decrease as the length of the (shortest) axis (M) increases.
- ±1.4/M µm/m is the residual error associated with the straightness of the beam emitted from the launch unit, where the 1/M factor denotes that the uncertainty will decrease as the length of the (shortest) axis (M) increases.
- ±4 µm/m is the residual error associated with the squareness of the pentaprism within the launch unit.

Flatness	
	<b>Range</b> ±5 mm
	<b>Accuracy*</b> ±0.01A ±1 ±(1 + 1.1M) µm
	<b>Resolution</b> 0.1 µm

\*over a 90° sweep

A = displayed straightness reading (µm)  
 M = distance to the furthest point (m)

- ±0.01A µm is the scale error of the PSD in the M unit, where A is the displayed straightness reading.
- ±1µm is the residual error associated with the PSD in the M unit, as well as the straightness of the beam emitted from the launch unit.
- ±(1 + 1.1M) µm is the laser plane flatness of the beam emitted from the launch unit, across a 90° sector.

Parallelism	
<b>Range</b>	±5 mm
<b>Accuracy (i)</b>	±0.008A/M ±1.4/M ±2 µm/m*
<b>Accuracy (ii)</b>	±0.008A ±1.4 ±2M µm*
<b>Resolution</b>	0.1 µm

\* laser to pentaprism distance >0.2 m

A = (largest) straightness reading (µm)

M = length of the axis (m)

(i) parallel angle

(ii) parallel straightness (point to point variation)

### Parallelism angle

- ±0.008A/M µm/m is the scale error of the PSD in the M unit, where A is the displayed straightness reading, and the 1/M factor denotes that the uncertainty will decrease as the length of the axis (M) increases.
- ±1.4/M µm/m is the residual error associated with the straightness of the beam emitted from the launch unit, where the 1/M factor denotes that the uncertainty will decrease as the length of the axis increases.
- ±2 µm/m is the residual error associated with the alignment of the launch beam to the pentaprism.

### Parallelism straightness

- ±0.008A µm is the scale error of the PSD in the M unit, where A is the displayed straightness reading.
- ±1.4 µm is the residual error associated with the straightness of the beam emitted from the launch unit.
- ±2M µm is the residual error associated with the alignment of the laser beam to the pentaprism, where M is the length of the axis.

## Example of different measurement specifications

The straightness specification when measuring a deviation of A=10 µm:

$$\pm 0.008 \times 10 \text{ µm} \pm 0.8 \text{ µm} = \pm 0.80 \text{ µm}$$

The parallelism angle specification between rails when measuring a deviation of A = 3 µm along a distance of M = 3 m, when pentaprism – launch separation is ≥0.2 m:

$$\pm 0.008 \times (3 \text{ µm}/3 \text{ m}) \pm 1.4/3 \text{ m} \pm 2 \text{ µm/m} = \pm 2.05 \text{ µm/m}$$

The squareness specification between rails when measuring a deviation of A = 8 µm deviation along a distance of M = 3 m:

$$\pm 0.008 \times (8 \text{ µm}/3 \text{ m}) \pm 1.4/3 \text{ m} \pm 4 \text{ µm/m} = \pm 4.03 \text{ µm/m}$$

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