CNC Machine Calibration Test & Machine Accuracy Adjustment

Power By :

Renishaw QC20-W wireless ballbar for machine tool performance diagnosis

Check machine positioning performance and diagnose machine errors automatically

Why do I need to perform a Ballbar test?

- A typical three-axis machine tool is subject to twenty-one degrees of freedom which include linear positioning, pitch, yaw, straightness, roll and squareness to the other axes.

- Each of these degrees of freedom can have a detrimental effect on the machine's overall positioning accuracy and the accuracy of machined parts. Furthermore, the potential for problems increases significantly with the additional dynamic effects of machine movement.

- The Ballbar final diagnosis result and data will help out end user to decide:
  - Weather to go for final Laser calibration and compensation of the error.
  - Recond or repair the machine accurately.

- In theory, if a CNC machine's positioning performance was perfect, a circle traced out by the machine would exactly match its programmed circular path.

However, in practice, any of the errors listed below can potentially cause the machine to deviate from the programmed circle path:

- backlash;
- reversal spikes;
- lateral play;
- cyclic error;
- straightness;
- scale error;
- servo mismatch;
- squareness.

Potential errors on an axis	
Backlash	Cyclic error
Reversal spikes	Straightness
Lateral play	Scale error

Potential errors between axes	
Servo mismatch	Squareness

By accurately measuring with Ballbar and comparing the circular path of the machine with the programmed circular path, it is possible to determine the machine's positional accuracy.

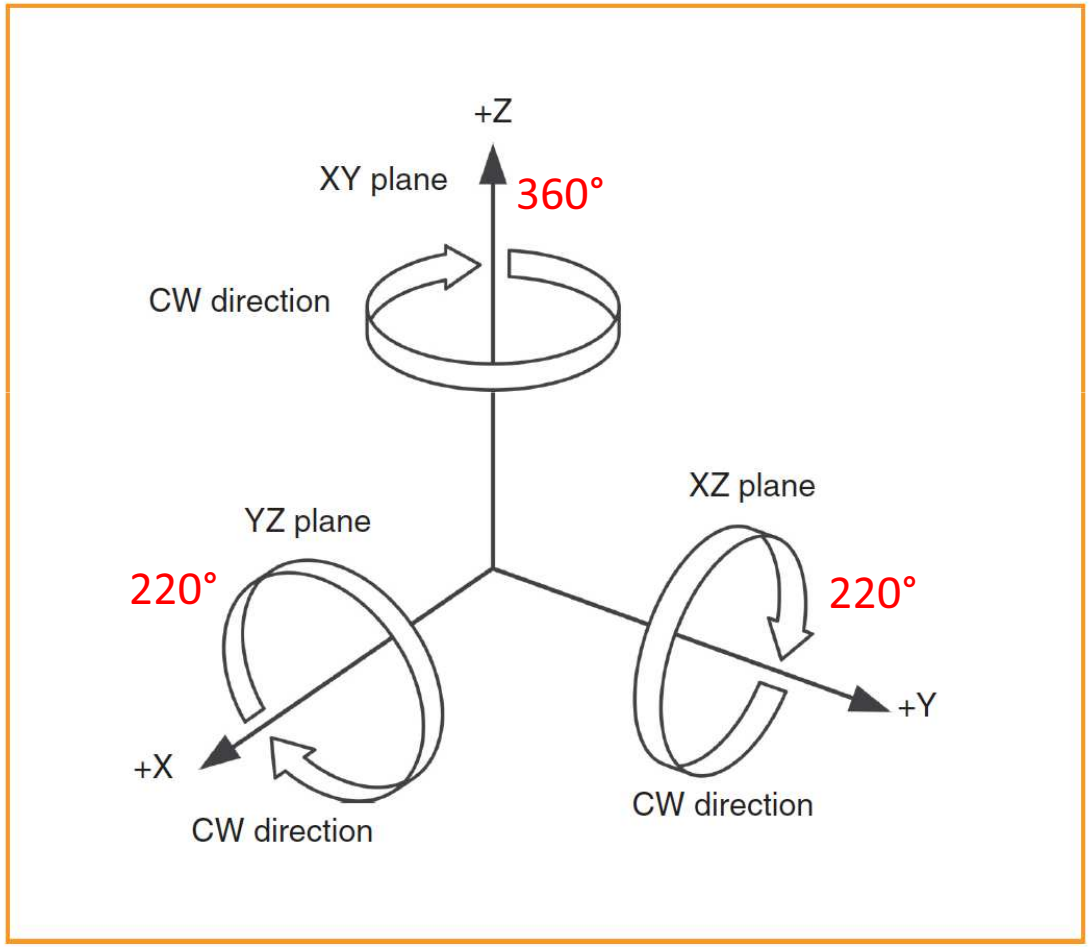
Testing Capacity

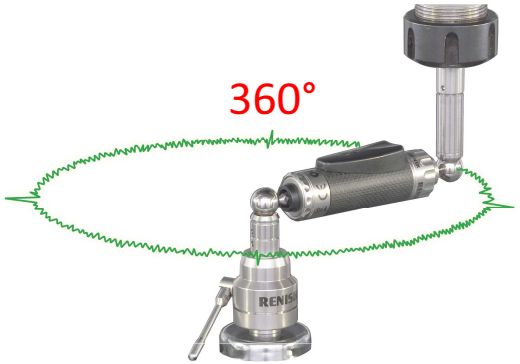
From 50, 100, 150, 250, 300, 400, 450, 550 or 600 mm radius. With additional extensions it is possible to perform tests up to 1350 mm.

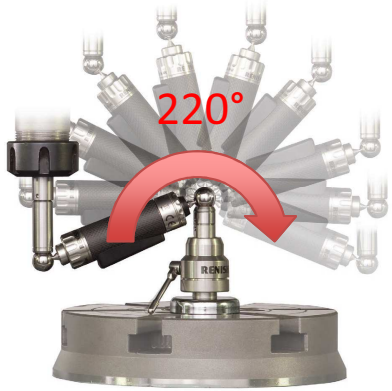
System specification

Sensor resolution	0.1 µm (4 µin)
Ballbar sensor accuracy	±0.5 µm (at 20 °C) / ±20 µin (at 68 °F)
Maximum sample rate	1000 values per second
Data transmission	Bluetooth, Class 2 (10 m typical)
Extension bars	50 mm, 150 mm, 300 mm
Operating range	0 °C - 40 °C (32 °F - 104 °F)
Calibrator accuracies (at 20 °C)	±1 µm (50 mm) ±1 µm (100 mm) ±1 µm (150 mm) ±1.5 µm (300 mm)

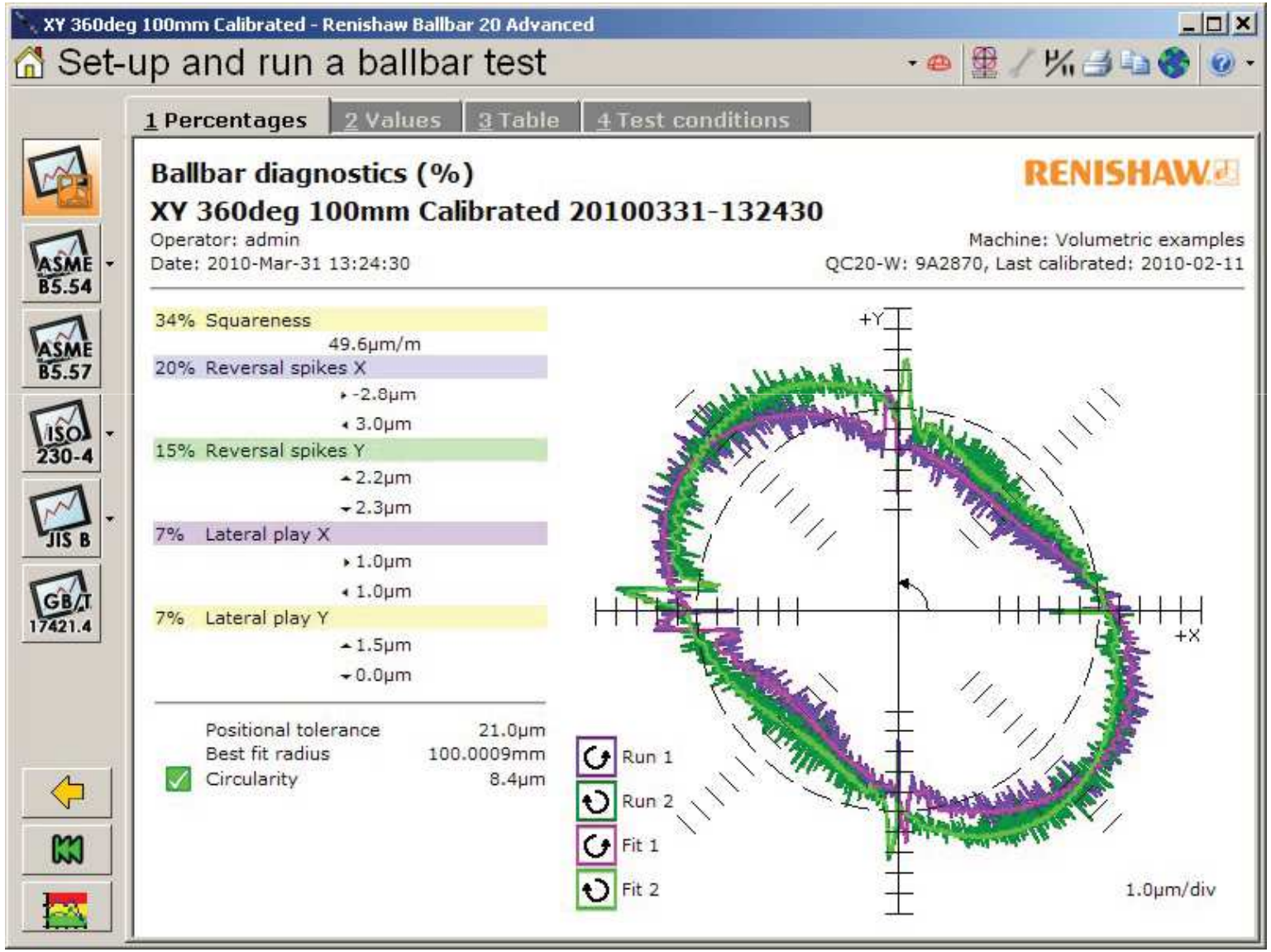
Axes Measurement

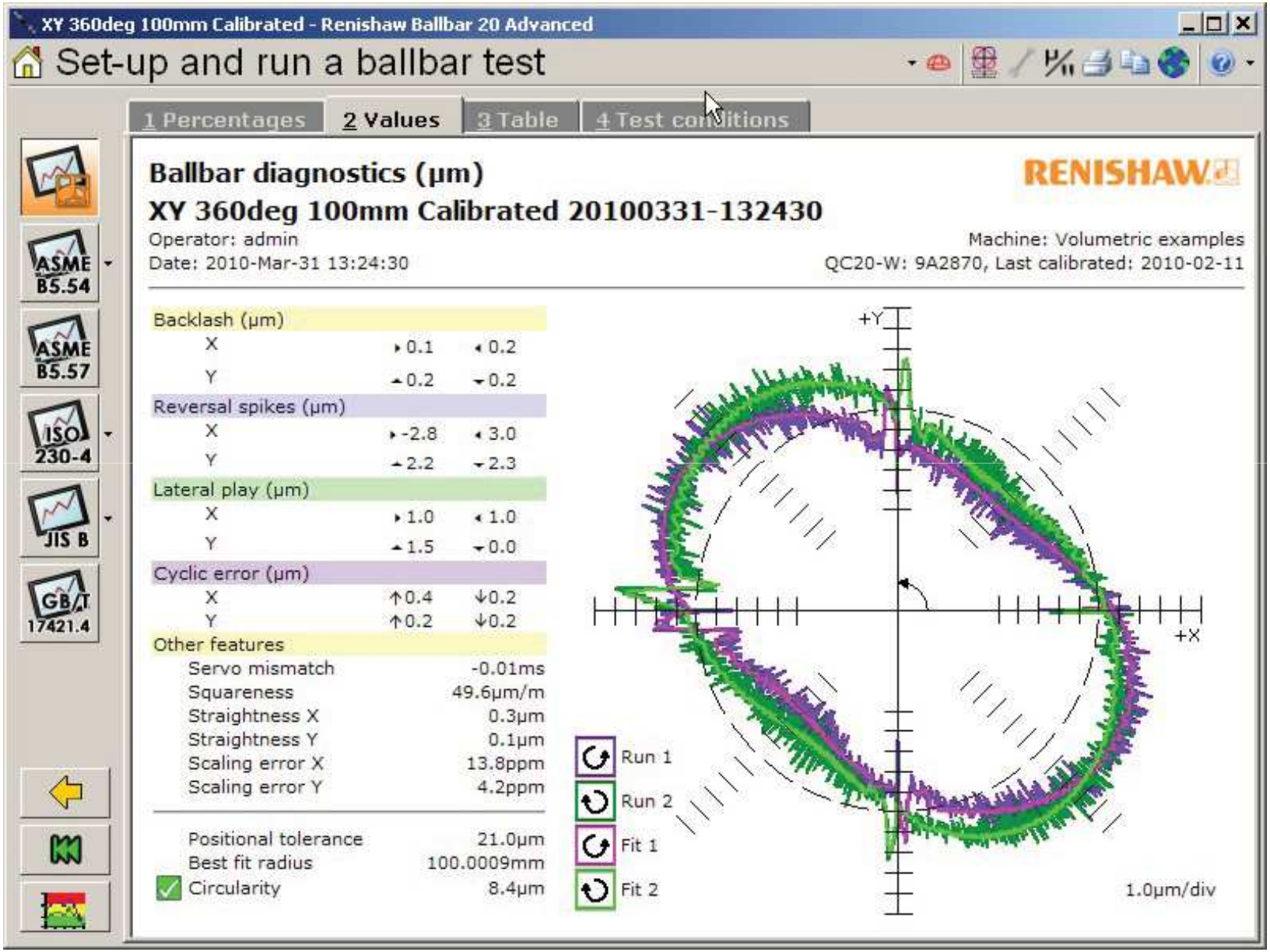




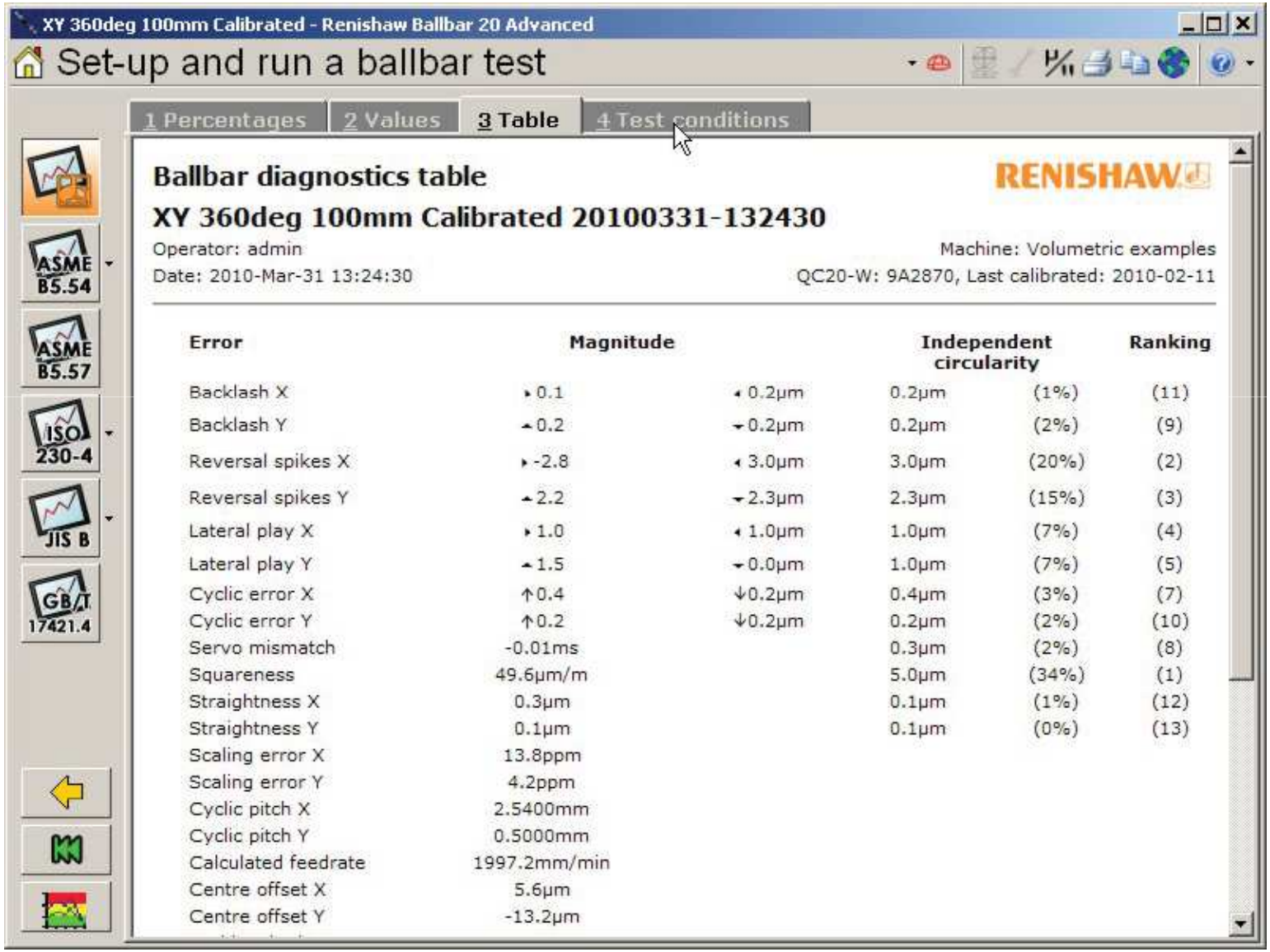


Sample of Analysing Results of The Ballbar Test

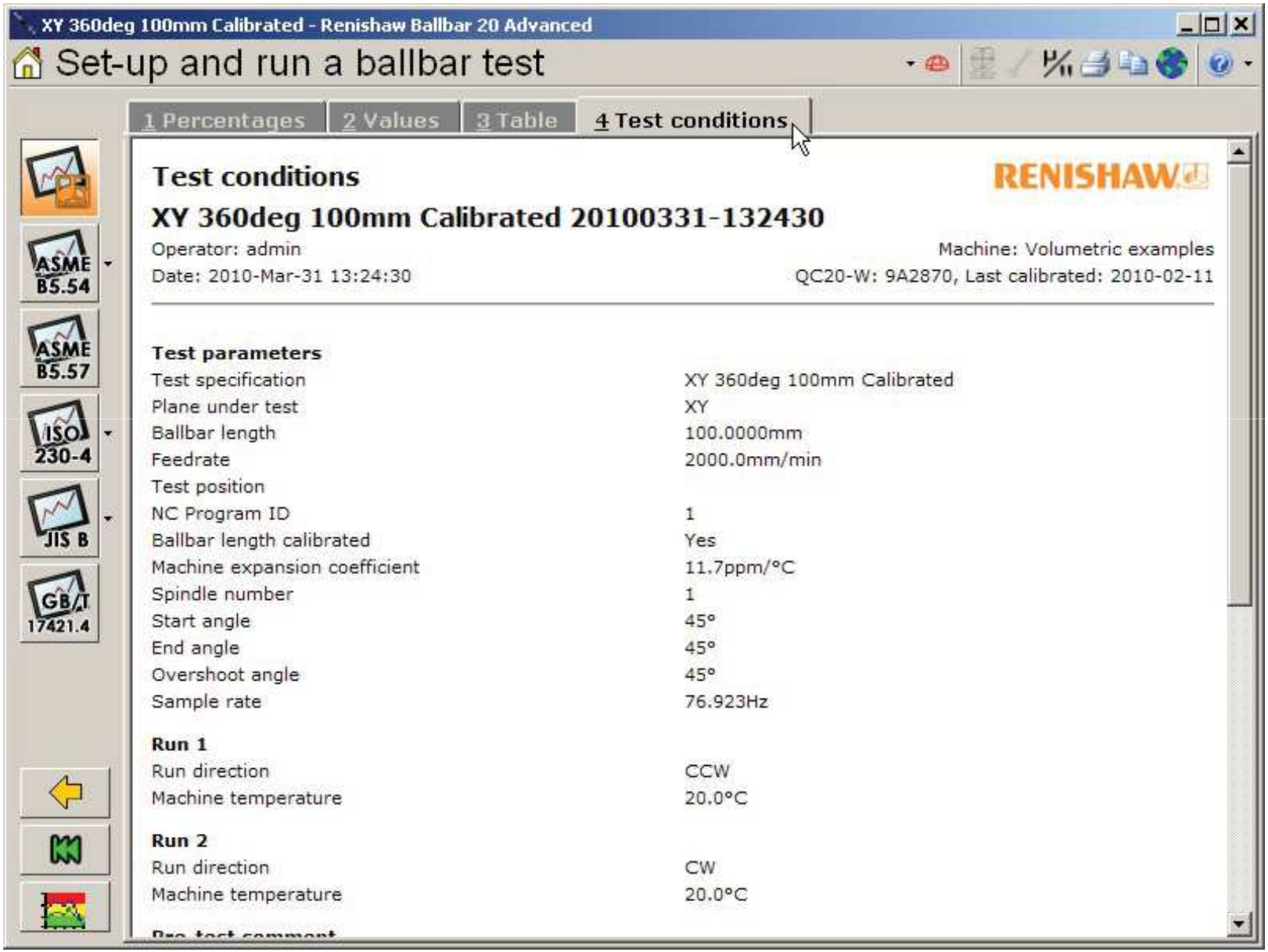



XY 360deg 100mm Calibrated - Renishaw Ballbar 20 Advanced
Set-up and run a ballbar test
1 Percentages
2 Values
3 Table
4 Test conditions
ASME B5.54
ASME B5.57
ISO 230-4
JIS B
GB/T 17421.4
Ballbar diagnostics (µm)
XY 360deg 100mm Calibrated 20100331-132430
RENISHAW
Operator: admin
Date: 2010-Mar-31 13:24:30
Machine: Volumetric examples
QC20-W: 9A2870, Last calibrated: 2010-02-11
Backlash (µm)
X ▸0.1 ◂0.2
Y ▴0.2 ▾0.2
Reversal spikes (µm)
X ▸-2.8 ◂3.0
Y ▴2.2 ▾2.3
Lateral play (µm)
X ▸1.0 ◂1.0
Y ▴1.5 ▾0.0
Cyclic error (µm)
X ↑0.4 ↓0.2
Y ↑0.2 ↓0.2
Other features
Servo mismatch -0.01ms
Squareness 49.6µm/m
Straightness X 0.3µm
Straightness Y 0.1µm
Scaling error X 13.8ppm
Scaling error Y 4.2ppm
Positional tolerance 21.0µm
Best fit radius 100.0009mm
Circularity 8.4µm
+Y
+X
Run 1
Run 2
Fit 1
Fit 2
1.0µm/div

Diagnostic Result With Data & Report



Error	Magnitude		Independent circularity		Ranking
Backlash X	▸0.1	◂0.2µm	0.2µm	(1%)	(11)
Backlash Y	▴0.2	▾0.2µm	0.2µm	(2%)	(9)
Reversal spikes X	▸-2.8	◂3.0µm	3.0µm	(20%)	(2)
Reversal spikes Y	▴2.2	▾2.3µm	2.3µm	(15%)	(3)
Lateral play X	▸1.0	◂1.0µm	1.0µm	(7%)	(4)
Lateral play Y	▴1.5	▾0.0µm	1.0µm	(7%)	(5)
Cyclic error X	↑0.4	↓0.2µm	0.4µm	(3%)	(7)
Cyclic error Y	↑0.2	↓0.2µm	0.2µm	(2%)	(10)
Servo mismatch	-0.01ms		0.3µm	(2%)	(8)
Squareness	49.6µm/m		5.0µm	(34%)	(1)
Straightness X	0.3µm		0.1µm	(1%)	(12)
Straightness Y	0.1µm		0.1µm	(0%)	(13)
Scaling error X	13.8ppm				
Scaling error Y	4.2ppm				
Cyclic pitch X	2.5400mm				
Cyclic pitch Y	0.5000mm				
Calculated feedrate	1997.2mm/min				
Centre offset X	5.6µm				
Centre offset Y	-13.2µm				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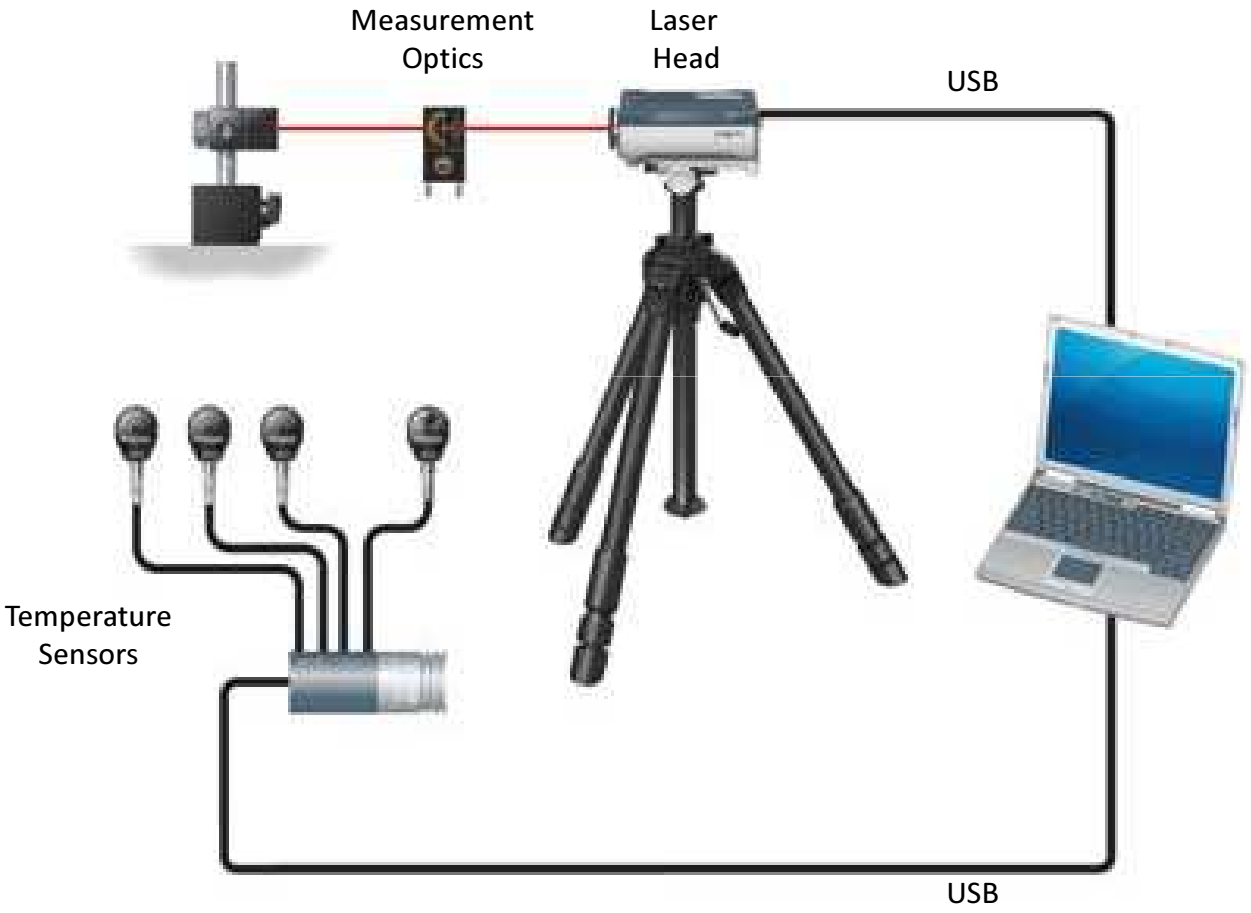
XY 360deg 100mm Calibrated 20100331-132430
Operator: admin
Machine: Volumetric examples
Date: 2010-Mar-31 13:24:30
QC20-W: 9A2870, Last calibrated: 2010-02-11
Test parameters
Test specification XY 360deg 100mm Calibrated
Plane under test XY
Ballbar length 100.0000mm
Feedrate 2000.0mm/min
Test position
NC Program ID 1
Ballbar length calibrated Yes
Machine expansion coefficient 11.7ppm/°C
Spindle number 1
Start angle 45°
End angle 45°
Overshoot angle 45°
Sample rate 76.923Hz
Run 1
Run direction CCW
Machine temperature 20.0°C
Run 2
Run direction CW
Machine temperature 20.0°C

Renishaw Laser Measurement and Calibration System

The ultimate metrology tool for traceable machine tool and motion system analysis

Laser Measurement & Calibration System Configuration



Equipment Specification

Sensor performance	Range	Accuracy
Material temperature	0 °C – 55 °C	±0.1 °C
Air temperature	0 °C – 40 °C	±0.2 °C
Air pressure	650 mbar – 1150 mbar	±1 mbar
Relative humidity (%)	0% - 95% Non-condensing	±6% RH

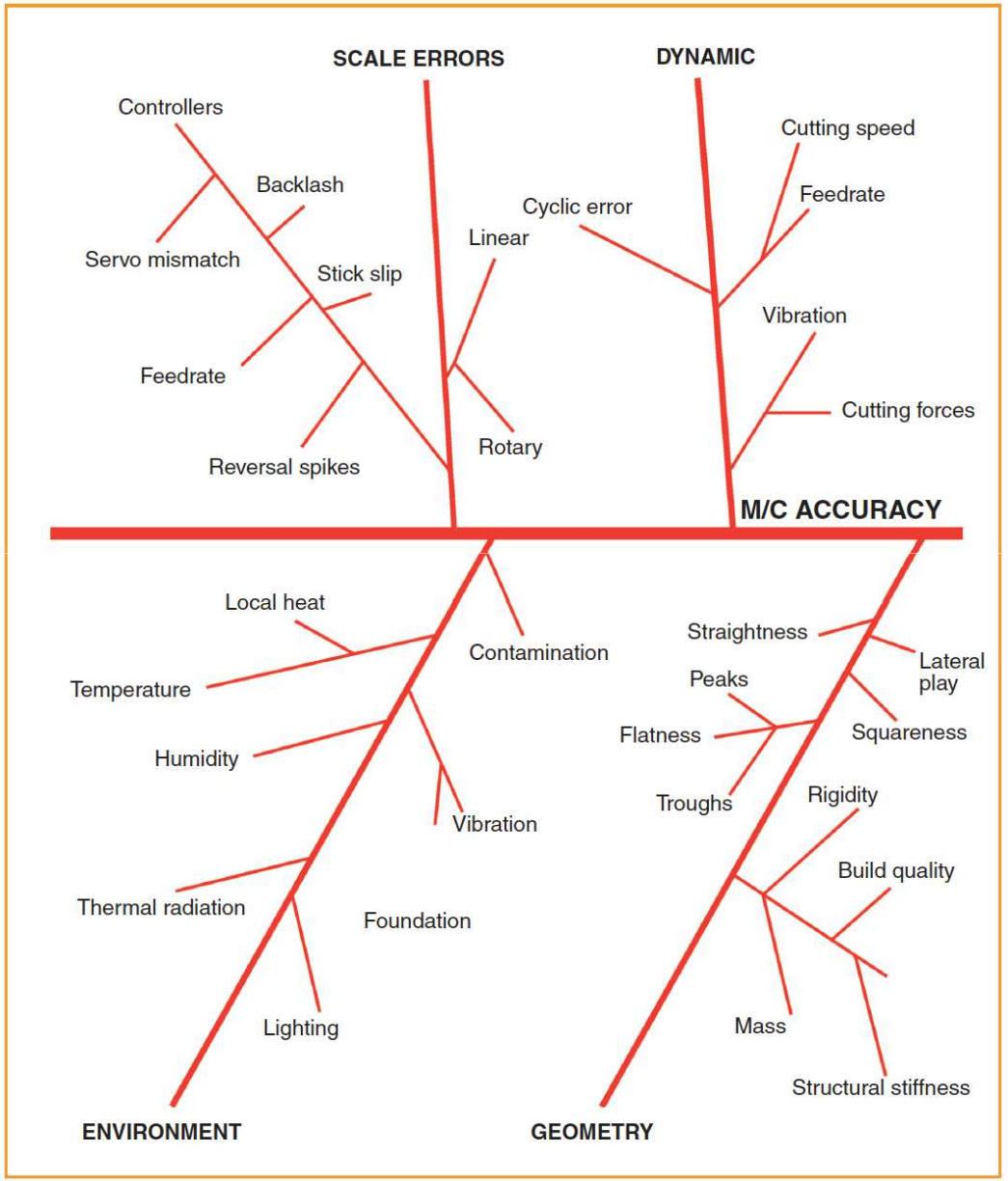
±0.5 ppm	certified linear measurement accuracy over the full range of environmental operating conditions 1 nm linear resolution (even at max. velocity)
4 m/s	maximum travel velocity
7 seconds	between each automatically updated environmental compensation
50 kHz	dynamic capture rate
80 m	linear range as standard

Capability of Laser XL-80 Measure

- Linear
- Angular
- Straightness
- Squareness
- Flatness
- Rotary

At the moment, we can provide the Laser measuring service for Linear & Straightness range of 1m to 30m.

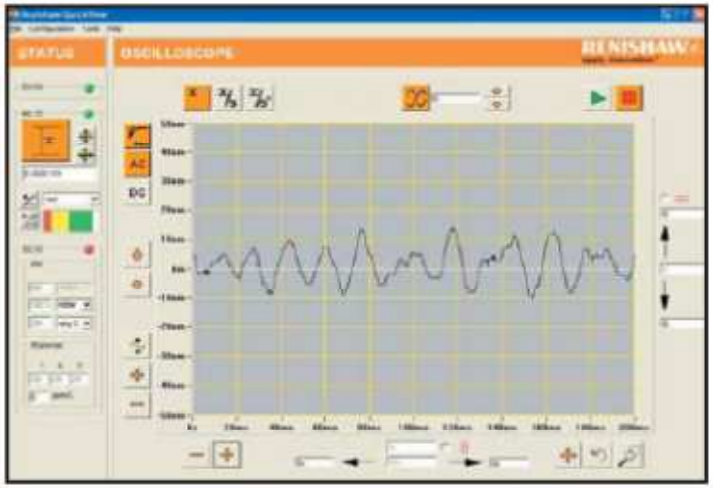
- **How a laser is used to check for machine tool errors.**
- **Factors effecting the accuracy of a machine tool.**



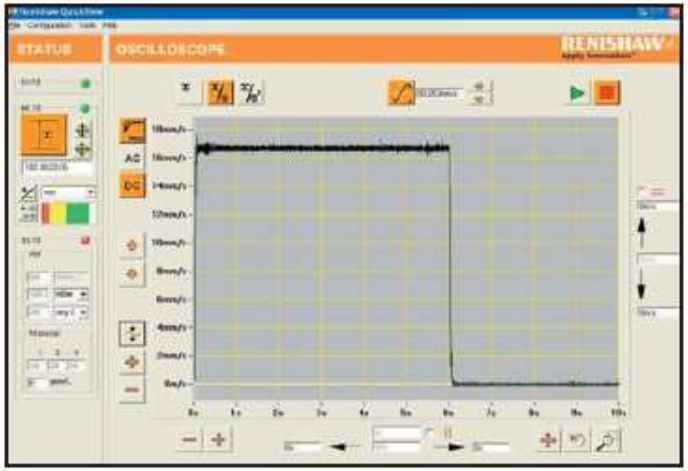
Dynamic Measurement - QuickViewXL software

Linear displacement

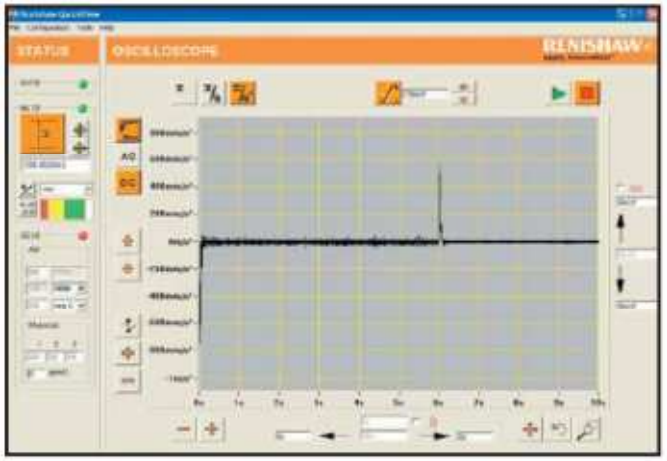
Machine vibration



Velocity versus time

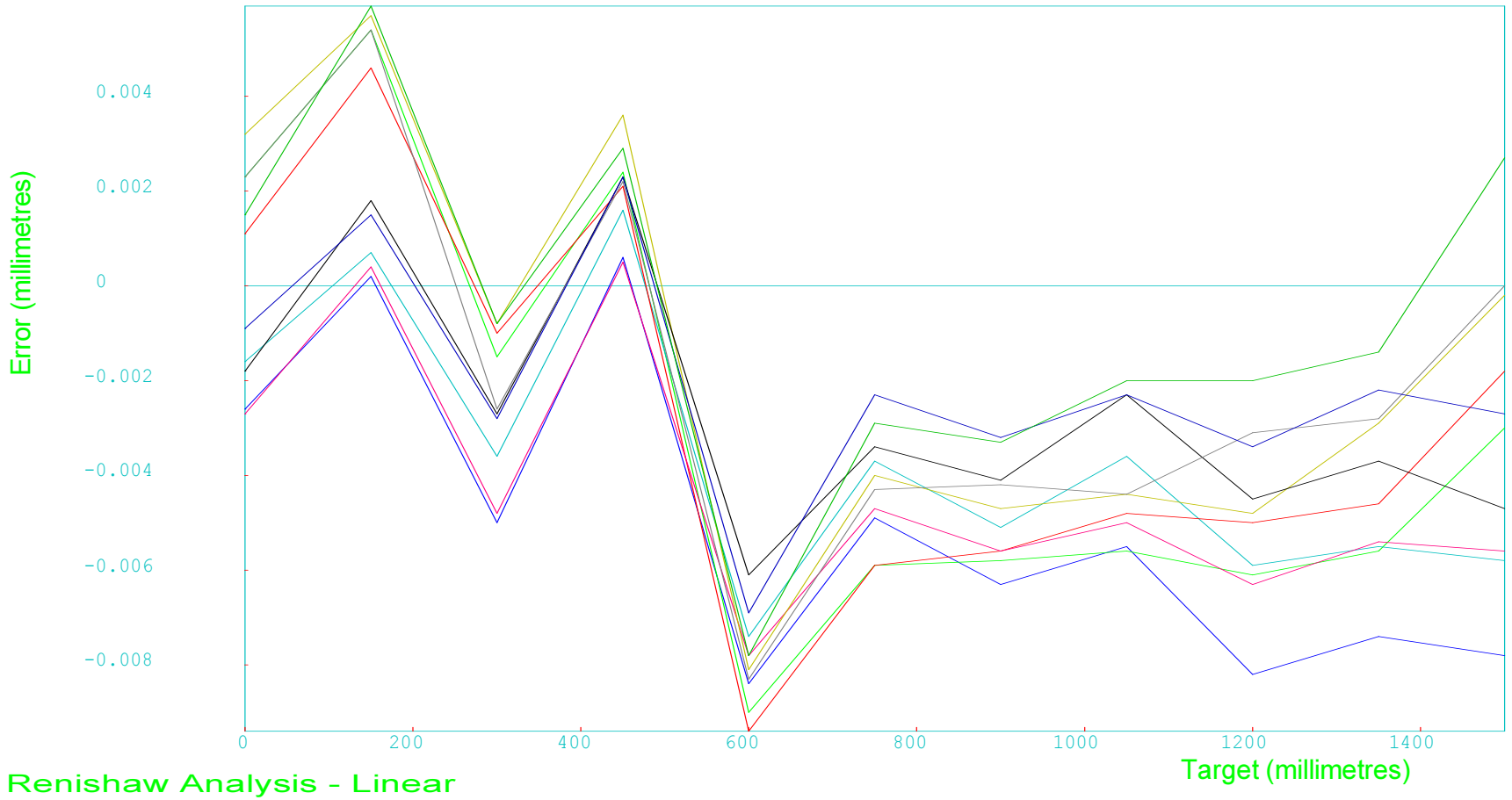


Acceleration versus time



Renishaw Analysis

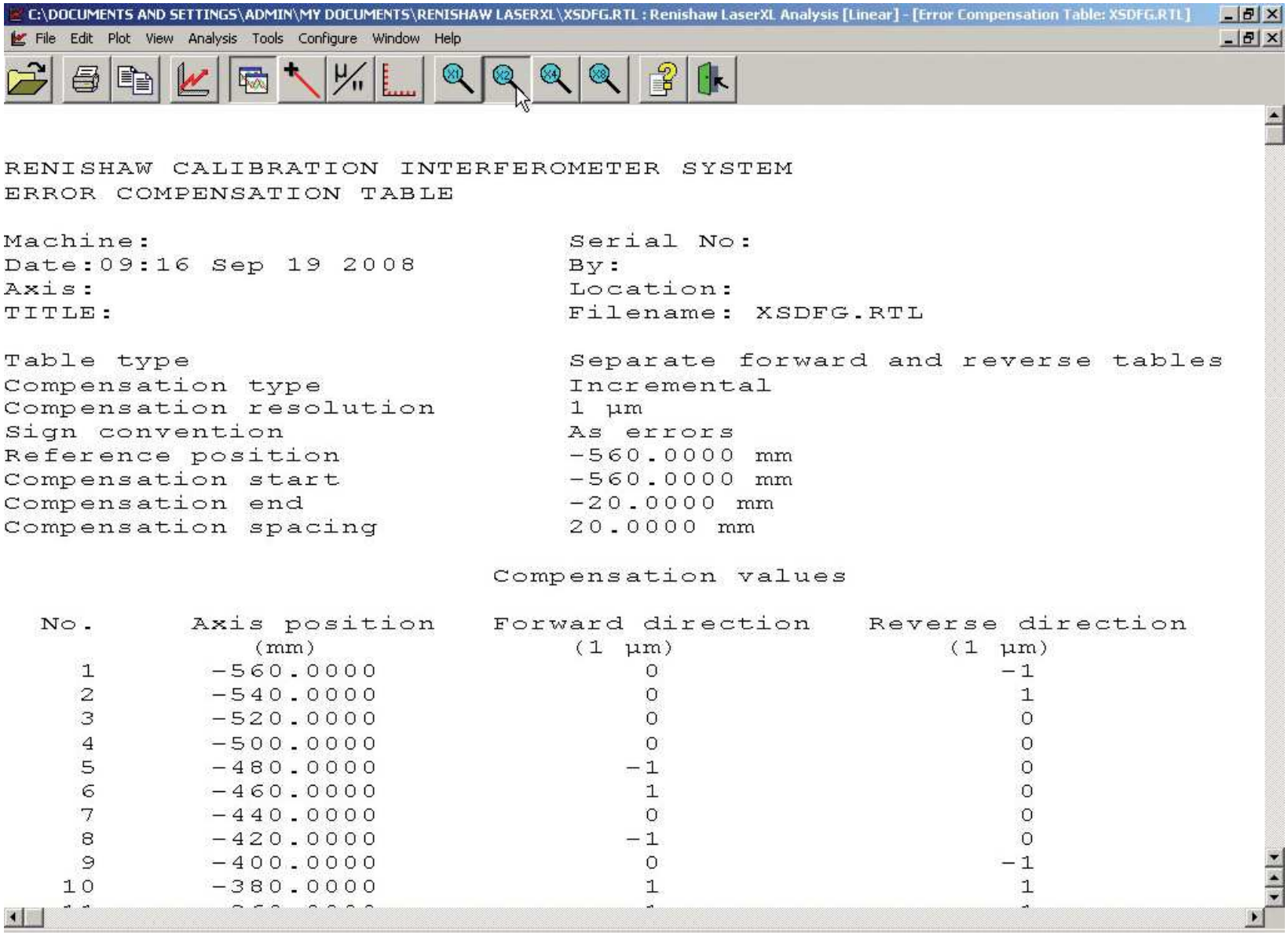
Error Comp Example



Renishaw Analysis - Linear

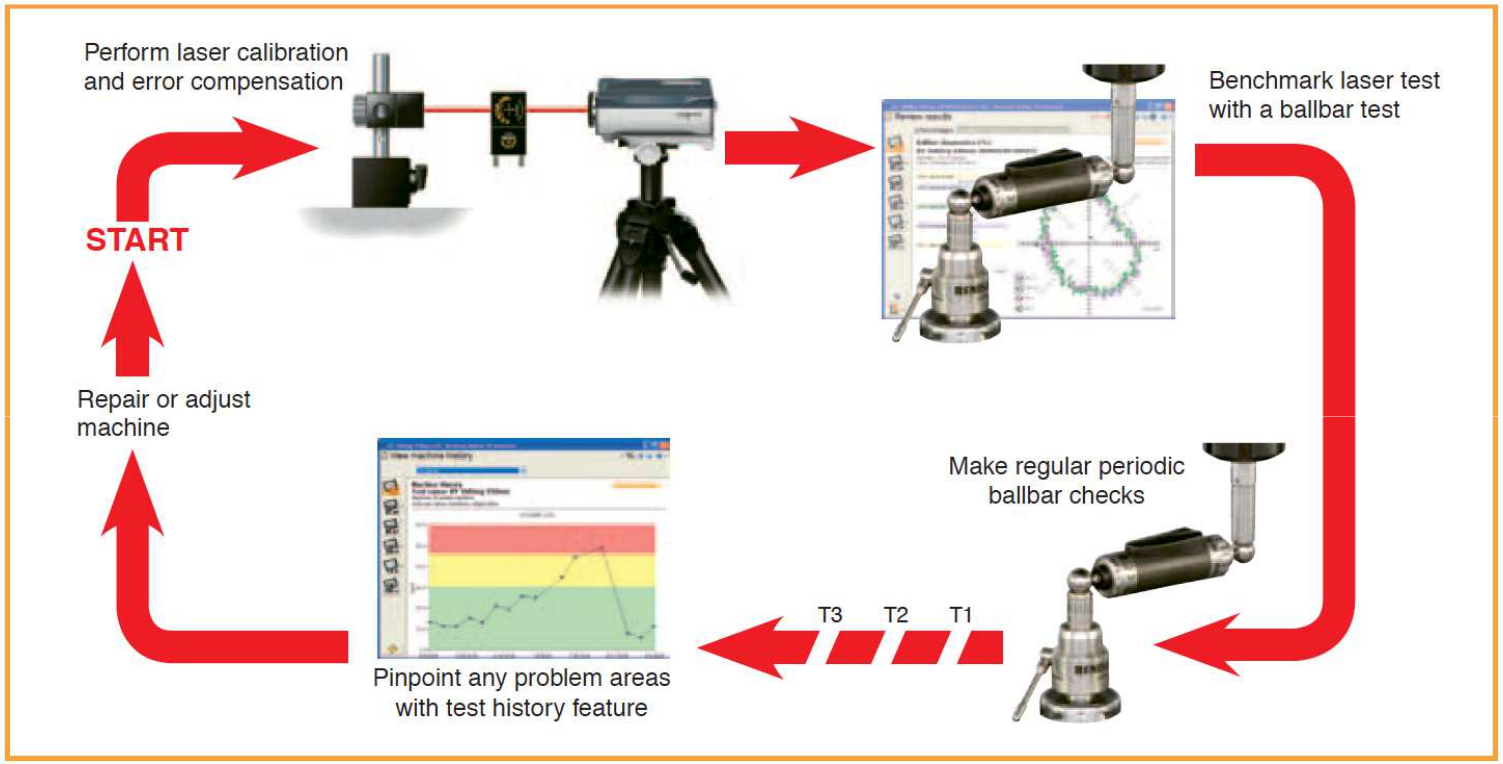
Machine:Linear Example	Axis:X	Accuracy : 0.0153
Serial No:15345/Lin	Location:Mid Position	Pos-Dir Rep.: 0.0052
Date:09:00 Sep 2 '97	Filename: errocomp.rtl	Rev-Dir Rep.: 0.0057
By:R.T.S.	Bidirectional, 5 Runs	Bi-Dir Rep. : 0.0105

Error Compensate Table



Complementary Products

Ballbar and laser, working together for maximum benefit

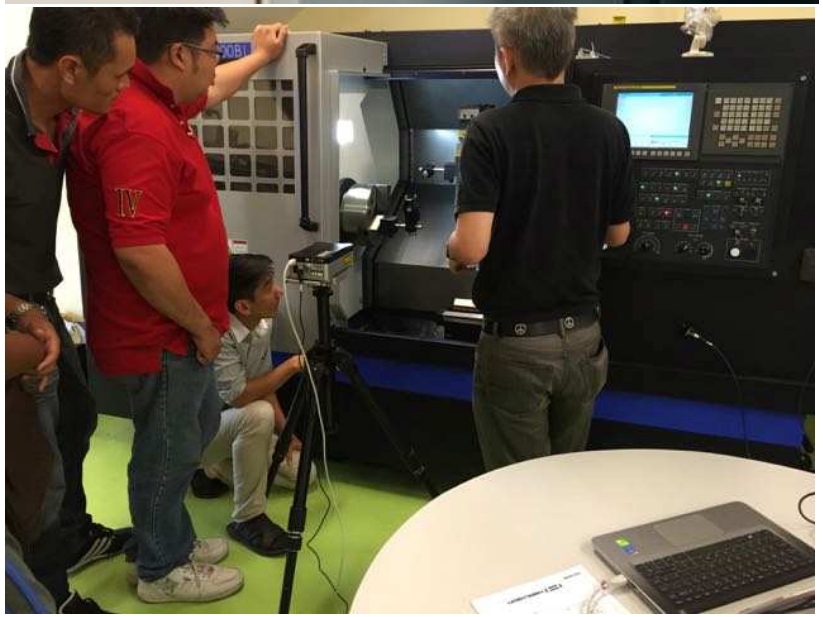


The Renishaw ballbar system is internationally recognised as the ideal solution to quickly check machine tool performance and benchmark in between scheduled laser calibrations.

RENISHAW

apply innovation™

XL-80 laser measurement system




Serial No H37762
CALIBRATION