

standard

机床精度检测新国家标准 GB/T17421.7 (ISO230-7)

2016.11.04
PRECISION



Lion Precision

- GB/T17421 (ISO230)&GB/T 17421.7 (ISO230-7)
- Lion Precision & Products
- Spindle Error Analyzer Basics

GB/T 17421 (ISO230)
&
GB/T 17421.7 (ISO230-7)



ISO230

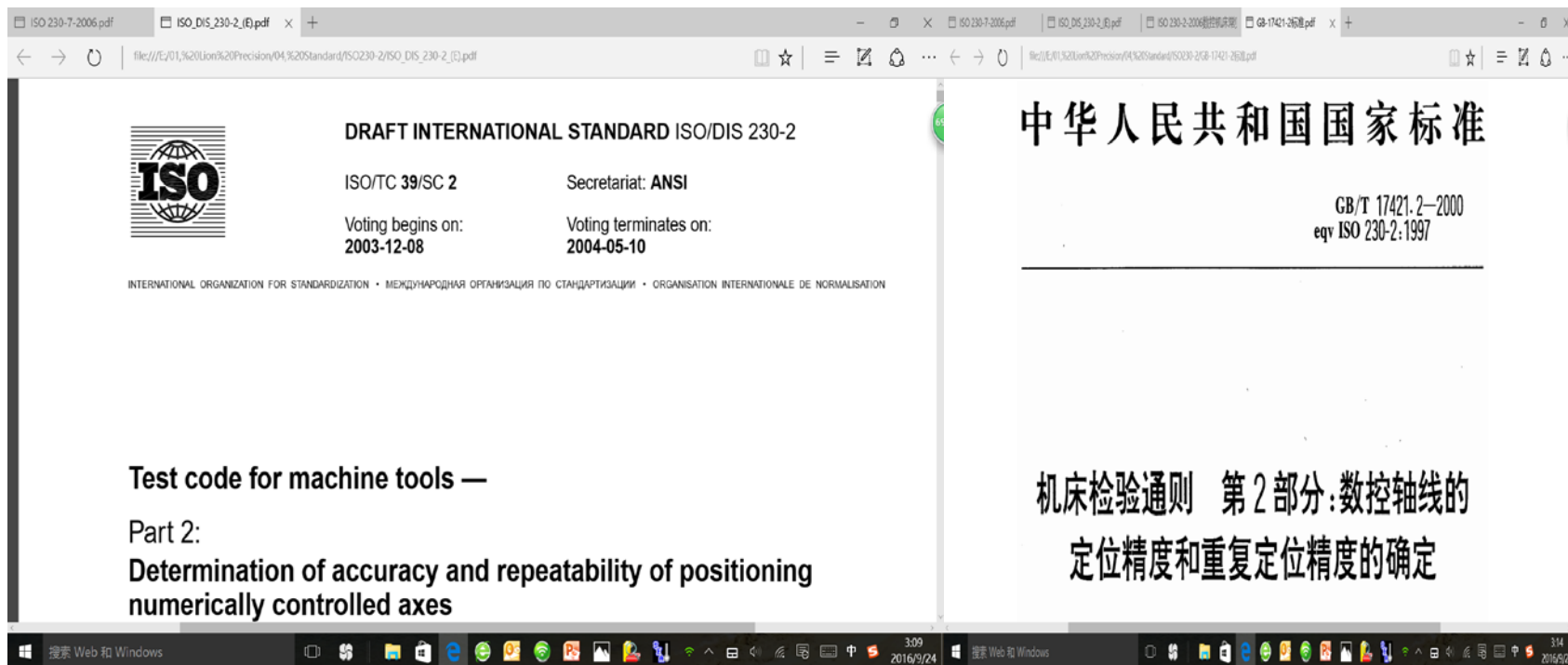
ISO 230 consists of the following parts, under the general title *Test code for machine tools*:

- *Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions*
- *Part 2: Determination of accuracy and repeatability of positioning numerically controlled axes*
- *Part 3: Determination of thermal effects*
- *Part 4: Circular tests for numerically controlled machine tools*
- *Part 5: Determination of the noise emission*
- *Part 6: Determination of positioning accuracy on body and face diagonals (Diagonal displacement tests)*
- *Part 7: Geometric accuracy of axes of rotation*
- *Part 9: Estimation of measurement uncertainty for machine tool tests according to series 230, basic equations [Technical Report]*

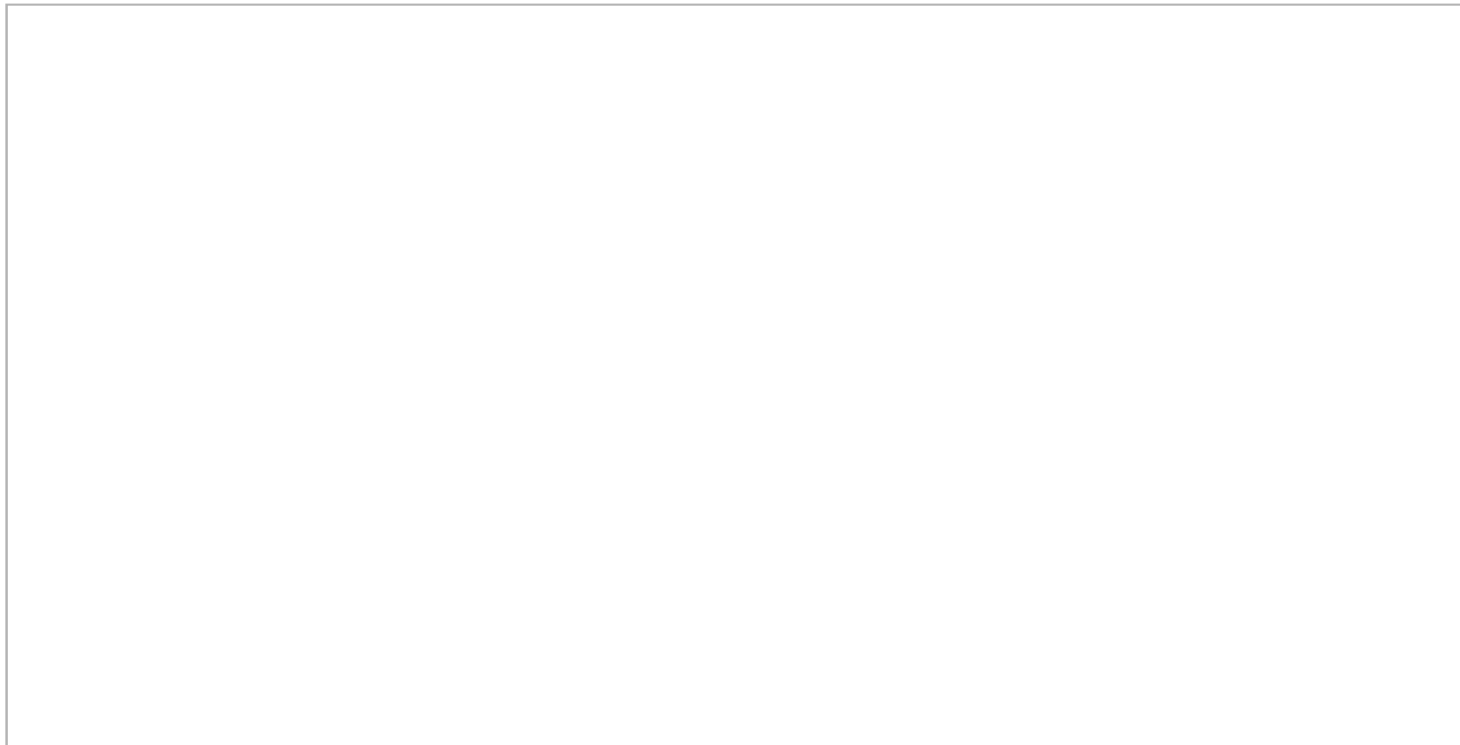
The following part is under preparation:

- *Part 8: Determination of vibration levels [Technical Report]*

GB/T 17421.2-2000 eqv ISO230-2:1997



GB/T 17421.2



GB/T 17421.4

国际标准

ISO 230-4: 1996

机床检验通则 第 4 部分: 数控机床的圆检验

1 范围

本标准规定了两线性轴线同时运动所产生的圆轨迹的圆滞后、圆偏差及半径偏差的检验和评定方法。有关的检验工具在 ISO 230-1: 1996 中的 6.63 说明。

本标准的目的是提供一种检验数控机床轮廓特性的方法。

2 引用标准

下列标准所包含的条文，通过在本标准中引用而构成本标准的条文。本标准出版时，所示版本均为有效。所有标准都会被修订，使用本标准的各方应探讨使用下列标准最新版本的可能性。IEC 和 ISO 各成员都保留有现行有效的国际标准。

ISO 230-1: 1996 机床检验通则 第 1 部分；在无负荷或精加工条件下

GB/T 17421.4



GB/T 17421.6-2016

国际标准

ISO / DIS 230-6

机床检验通则 第 6 部分：对角线位移检验

前 言

ISO（国际标准化组织）是世界范围内各国标准化组织（ISO 成员）的联合组织。国际标准的制定工作通常由 ISO 的技术委员会完成。对技术委员会设立的某一专题感兴趣的每个 ISO 成员都有权在该技术委员会表达自己的意见。与 ISO 有联系的国际组织、官方或非官方机构也可参与此项工作。ISO 在电工标准的所有问题上与国际电工委员会（IEC）合作密切。

国际标准的起草应符合 ISO / IEC 技术工作导则第 3 部分的规定。

经技术委员会接受的国际标准草案，在发往各成员征求意见后表决。国际标准的发布要求至少 75% 的成员投票通过。

国际标准 ISO 230-6 是由 ISO / TC 39 “机床”技术委员会的 SC 2 “金属切削机床检验条件”分委员会制定的。

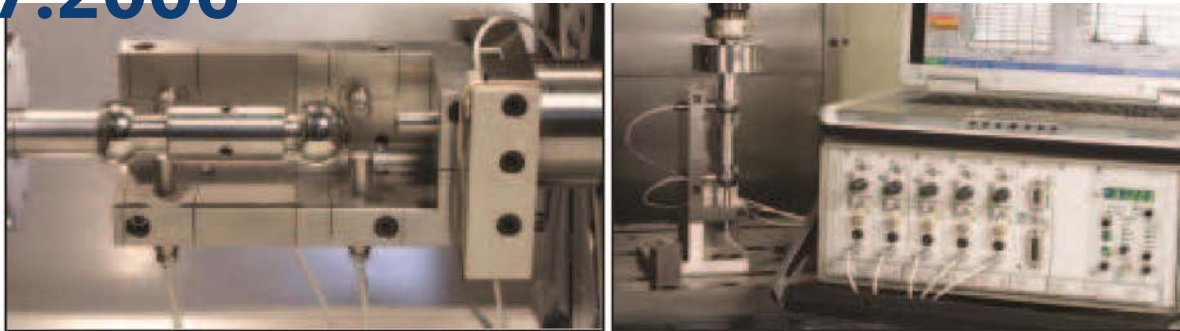


GB/T 17421.6



Spindle Error Analyzer (SEA)

GB/T17421.7-2016/ISO230-7:2006



The Spindle Error Analyzer performs tests in compliance with these standards:

ANSI/ASME Standard B5.54-2005: "Methods for Performance Evaluation of CNC Machining Centers"

ISO230: Test Code for Machine Tools, 3: "Determination of Thermal Effects" 7: "Geometric Accuracy of Axes of Rotation"

ANSI/ASME B5.57-1998: "Methods for Performance Evaluation of CNC Turning Centers"

ANSI/ASME B89.3.4: "Axes of Rotation, Methods for Specifying and Testing"

主轴回转误差分析仪



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GB/T 17421.1



DRAFT INTERNATIONAL STANDARD ISO/DIS 230-1

ISO/TC 39/SC 2

Secretariat: **ANSI**

Voting begins on:
2009-10-15

Voting terminates on:
2010-03-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Test code for machine tools —

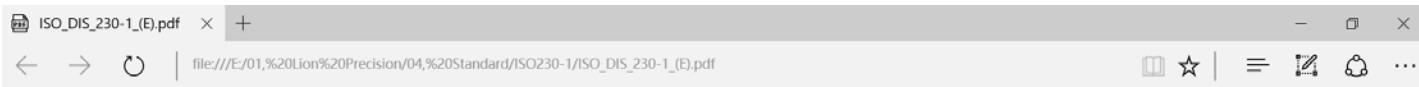
Part 1:

Geometric accuracy of machines operating under no-load or quasi-static conditions

Code d'essai des machines-outils —

Partie 1: Précision géométrique des machines fonctionnant à vide ou dans des conditions quasi-statiques

GB/T 17421.1



A check of the run-out of the spindle by machining and testing a cylindrical workpiece will take into account only defects in the bearings of the spindle.

This practical turning test gives no information on the exact shape of the cylindrical or conical bore, or of the actual position of the bore in relation to the axis of rotation.

Spindles which are automatically centred during rotation (e.g. by hydraulic pressure; hydrodynamic spindle) can be tested only when running at normal speed. In such a case, non-contact measuring instruments shall be used, e.g. a capacitive pickup, an inductive pickup or any other suitable instrument.

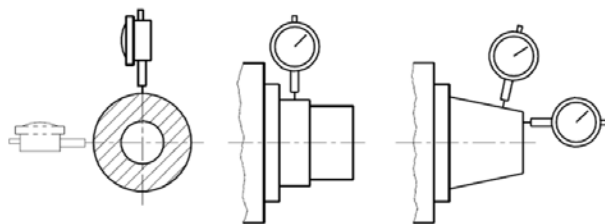


Figure 147 — Measurement of external run-out

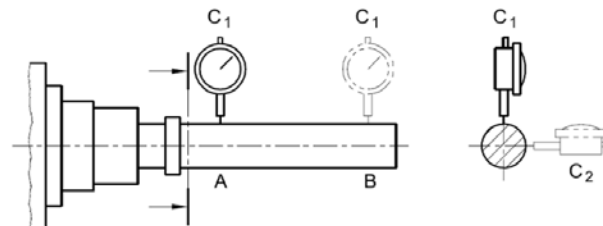
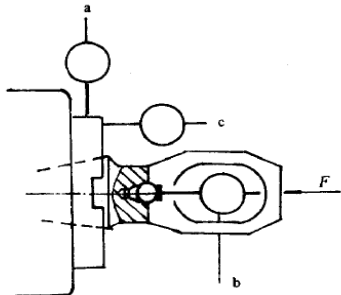
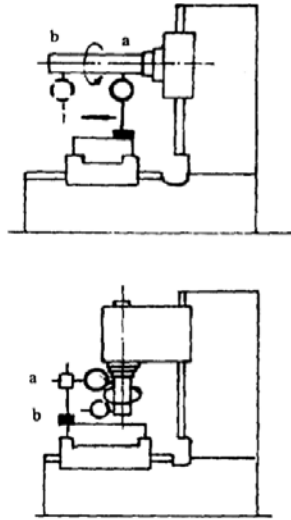
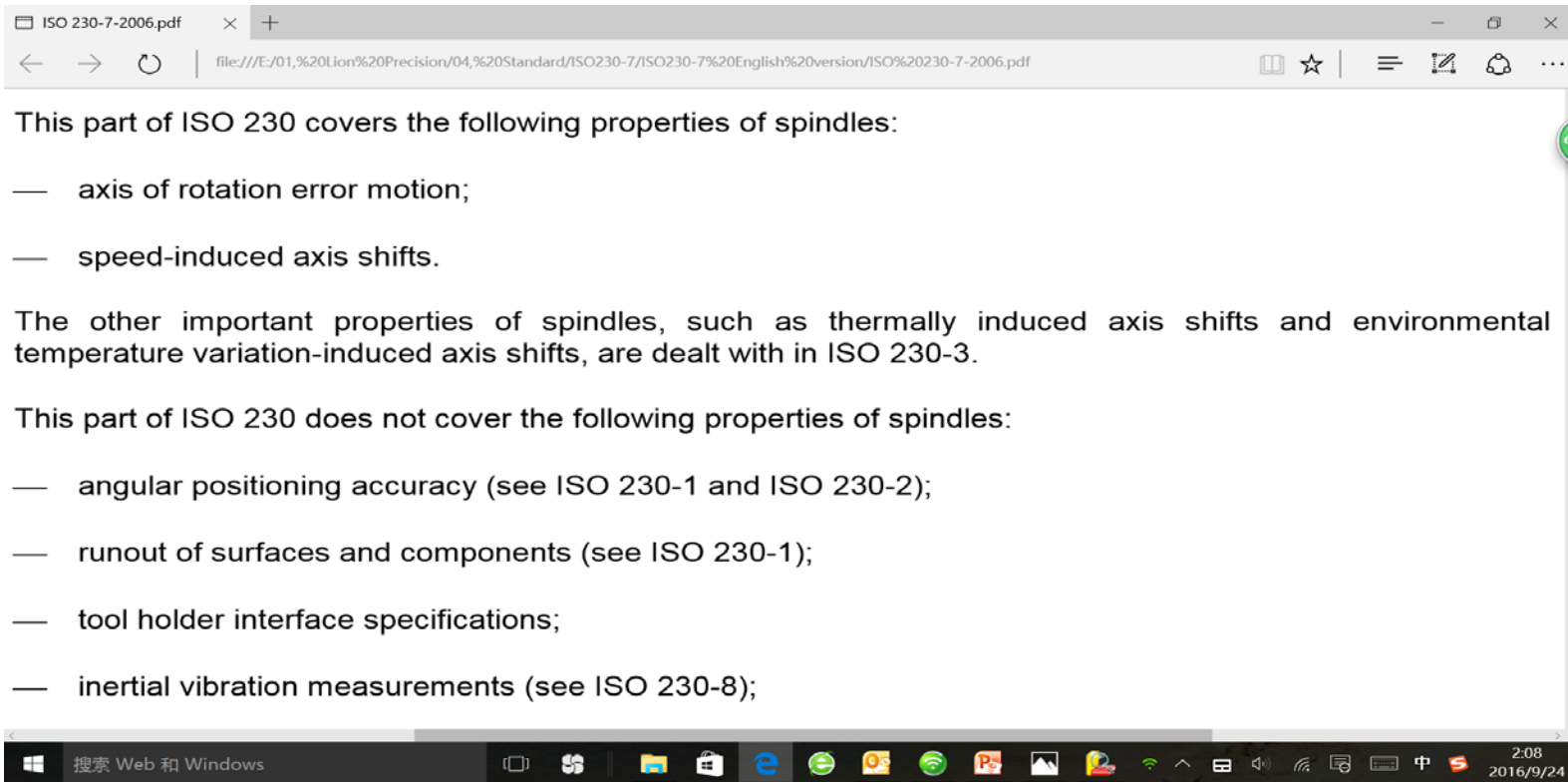


Figure 148 — Measurement of internal run-out

序号	简图	检验项目	允 差		检验工具	检 验 方 法
			mm		参照 GB/T 17421.1—1998 的有关条文	
G5		主轴端部的跳动:	普通级	精密级	指示器	a. 5.6.1.2.2
		a. 主轴定心轴颈的径向跳动(用于有定心轴颈的床身铣床);	a		专用检验棒	b. 5.6.2.2.1; 5.6.2.2.2
			0.010	0.006		c. 5.6.3.2
			b			固定指示器, 使其测头分别触及:
			0.010	0.006		a. 主轴定心轴颈表面; b. 插入主轴锥孔中的专用检验棒端面中心处; c. 主轴轴肩支承面靠近边缘处。旋转主轴进行检验。
			c			a、b、c 的误差分别计算。跳动或窜动误差以指示器读数的最大差值计。
			0.020	0.012		b、c 项检验时, 应通过主轴中心线加一个由制造厂规定的轴向力 F (对已消除轴向游隙的主轴, 可不加力)

序号	简图	检验项目	允 差 mm		检 验 方 法 检验工具 参照 GB/T 17421.1—1998 的有关
G6		主轴锥孔 轴线的径向 跳动: a. 靠近主 轴端面; b. 距主轴 端面 300 mm 处	普通级	精密级	指示器 5.6.1.2.3
			a		检验棒 在主轴锥孔中插入检验棒。固
			0.010	0.006	示器, 使其测头触及检验棒的表
			b		a. 靠近主轴端面; b. 距主轴端
			0.020	0.012	mm 处。旋转主轴进行检验。
			拔出检验棒, 相对主轴旋转 90		
			新插入主轴锥孔中, 依次重复检		
			次。		
			a、b 的误差分别计算。径向跳		
			差以四次测量结果的算术平均		

GB/T 17421.7 (ISO230-7)



GB/T 17421.7 (ISO230-7)

3.5.1 total error motion value scaled difference in radii of two concentric circles from a specified error motion centre just sufficient to contain the total error motion polar plot. ↵

NOTE Four total error motion values are defined: total radial error motion, total tilt error motion, total axial error motion and total face error motion. ↵

3.5.2 synchronous error motion value scaled difference in radii of two concentric circles from a specified error motion centre just sufficient to contain the synchronous error motion polar plot. ↵

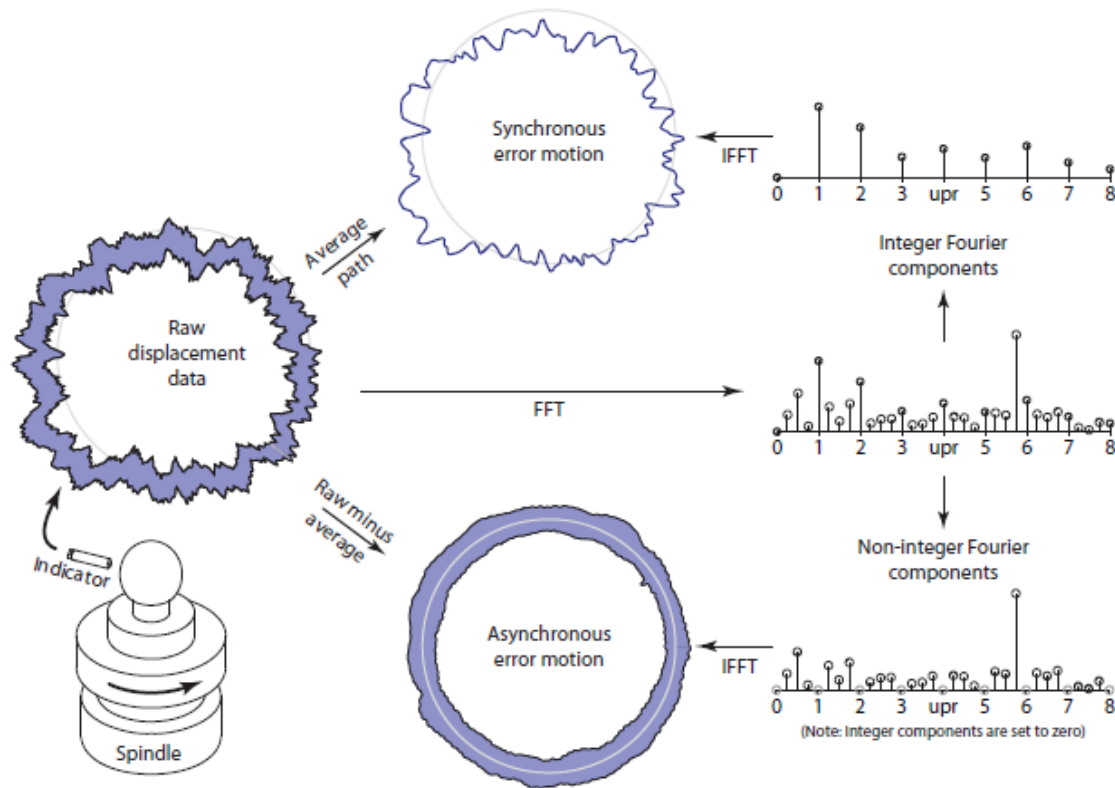
3.5.3 asynchronous error motion value maximum scaled width of the asynchronous error motion polar plot, measured along a radial line through a specified polar profile centre. ↵

See Figure 6. ↵

3.5.4 fundamental axial error motion value value equivalent to twice the scaled distance between the PC centre and a specified polar profile centre of the synchronous error motion polar plot. ↵

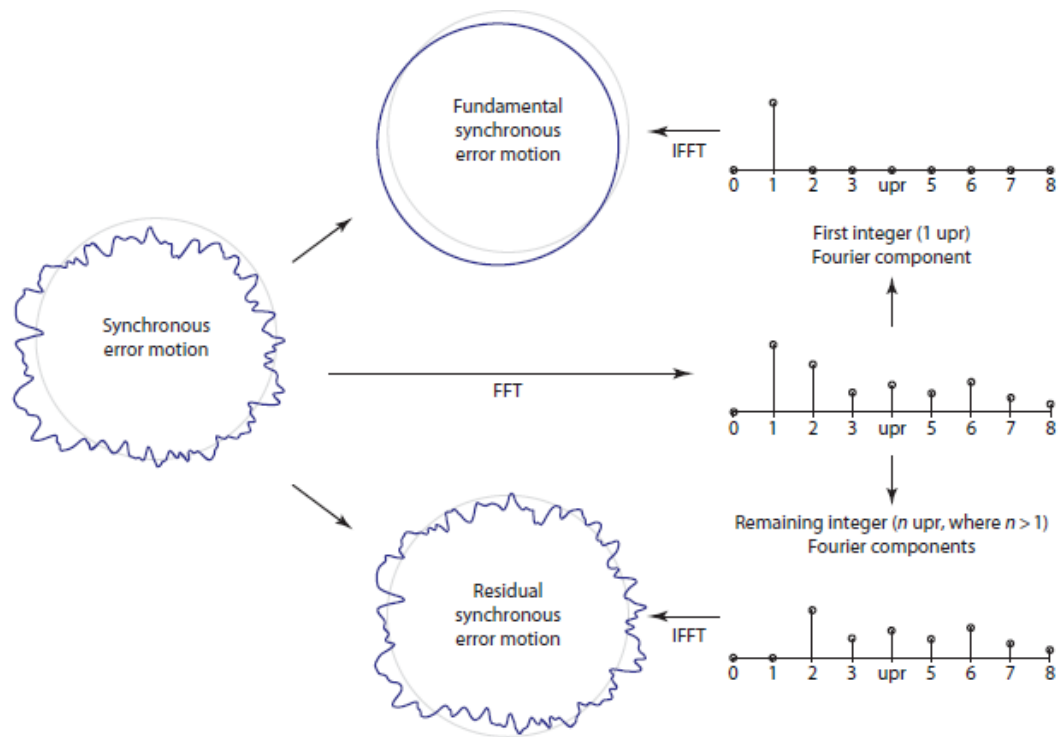
3.5.5 residual synchronous error motion value scaled difference in radii of two concentric circles from a specified error motion centre just sufficient to contain the residual synchronous error

GB/T 17421.7 (ISO230-7)

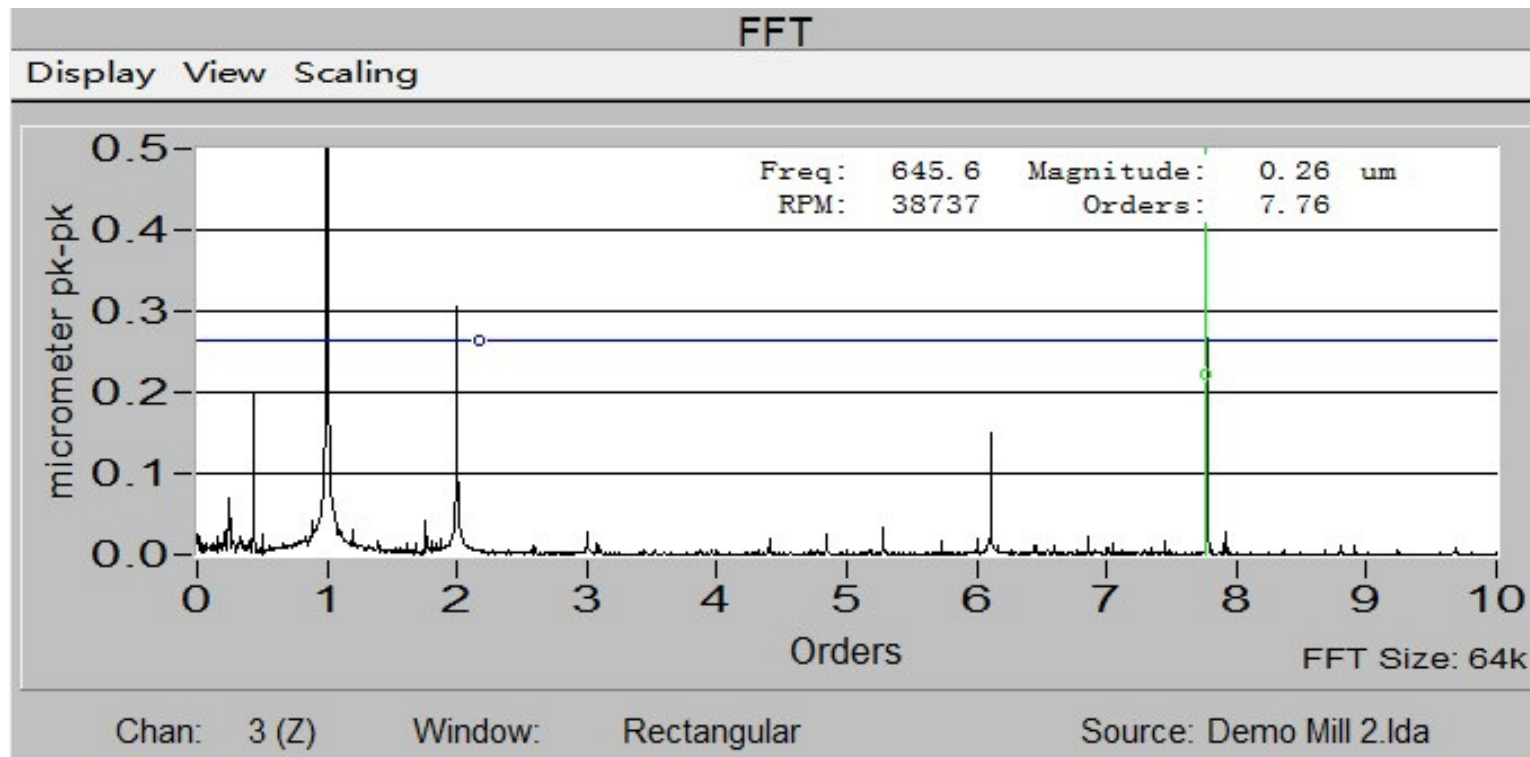


Decomposition of synchronous error motion into fundamental and residual components

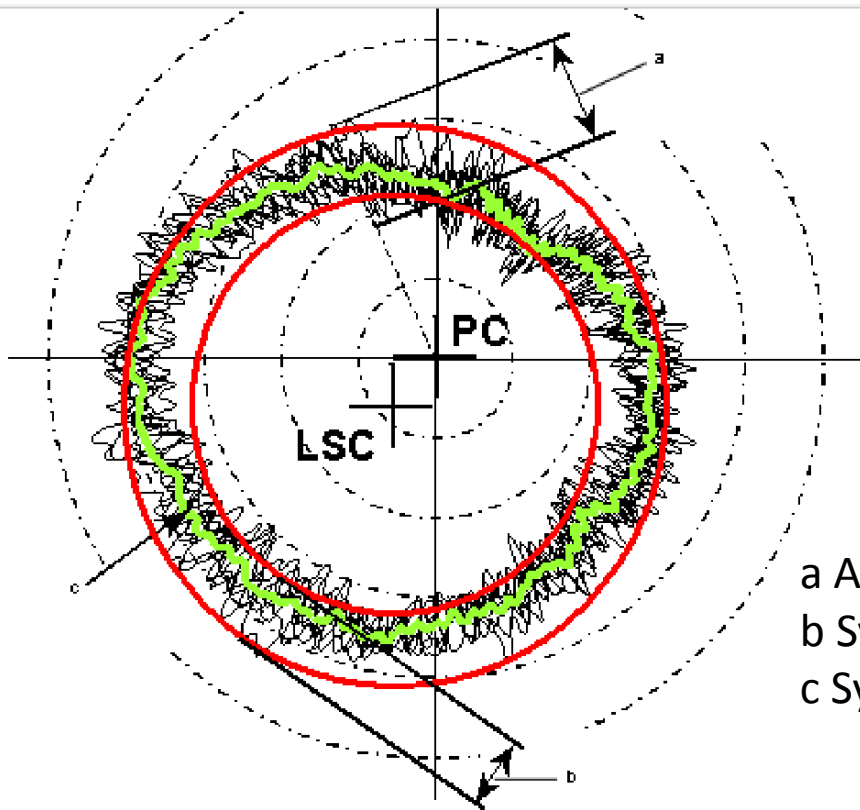
同步误差分解为基本和残余同步误差



GB/T 17421.7 (ISO230-7)



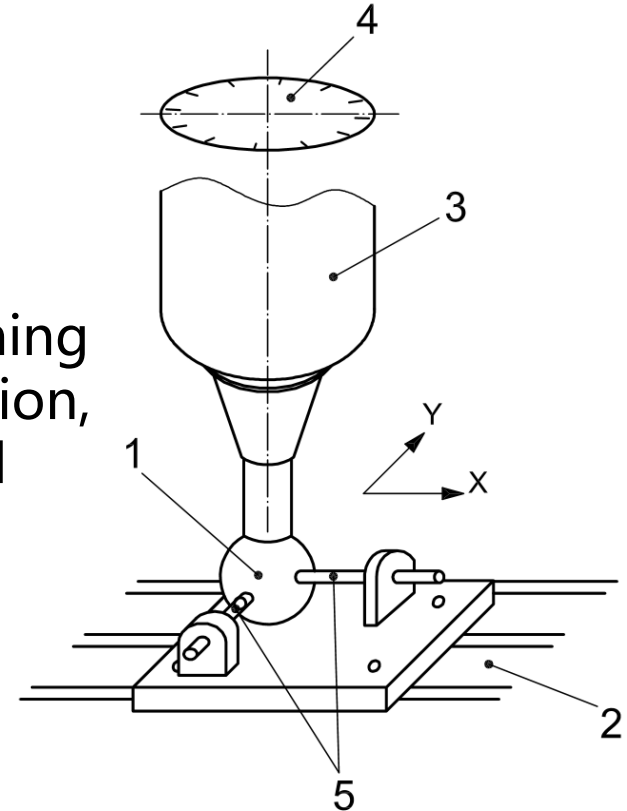
GB/T 17421.7 (ISO230-7)



- a Asynchronous error motion value.
- b Synchronous error motion value.
- c Synchronous error motion plot.

Rotating Sensitive Direction

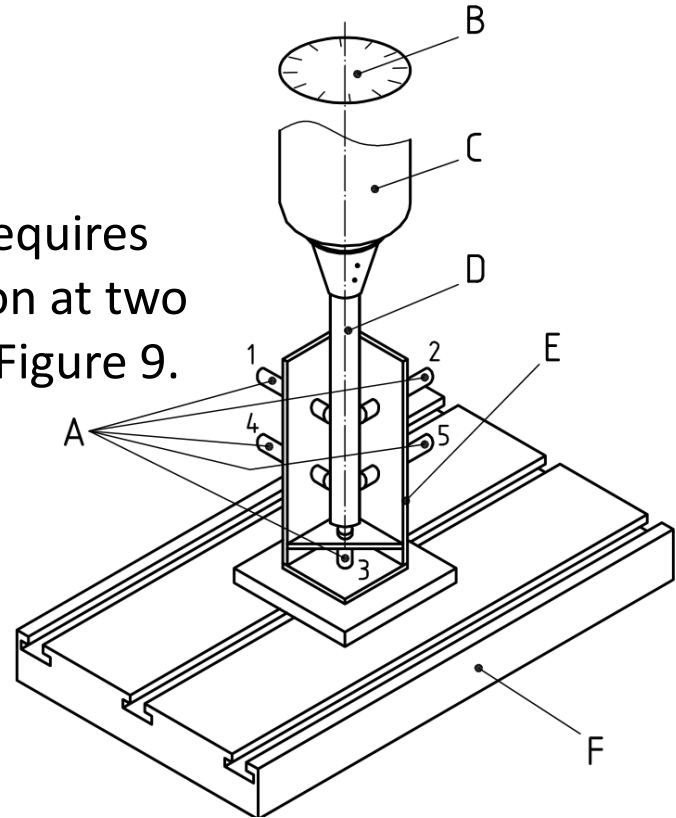
- 5.4 Spindle tests — Rotating sensitive direction
- 5.4.1 General
These tests are applicable to the machining operations with rotating sensitive direction, for example, boring, milling, drilling and contour grinding.



Tilt Error Motion

- 5.4.3 Tilt Error Motion

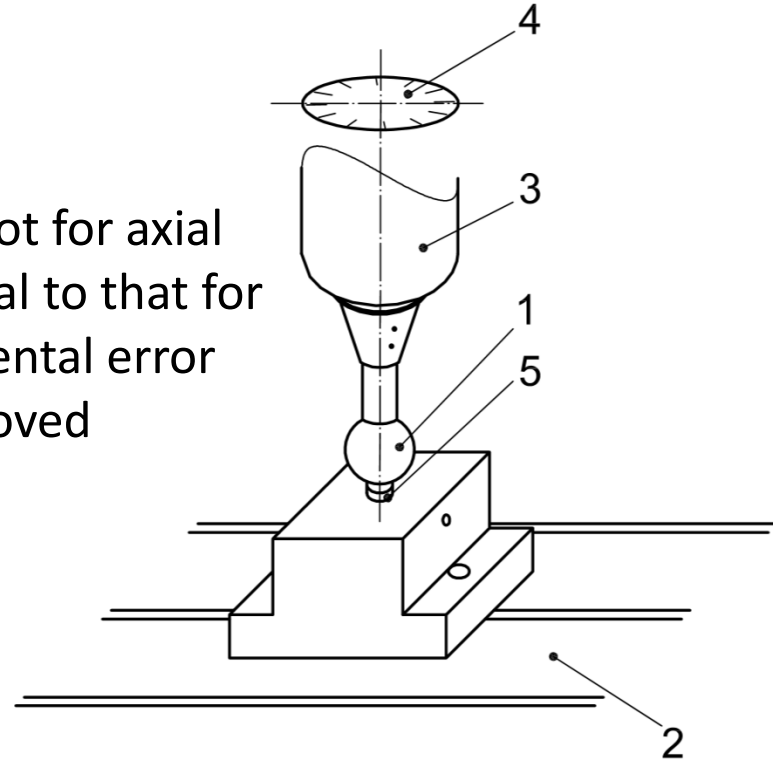
Measurement of the tilt error motion requires measurements of the radial error motion at two spatially separated points, as shown in Figure 9.



Axial Error Motion

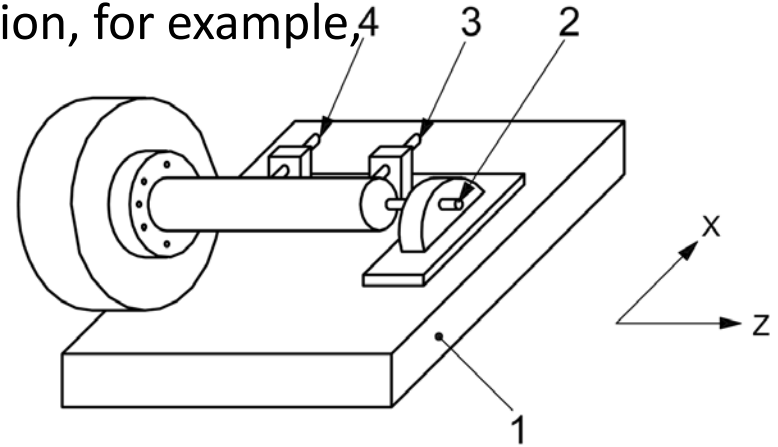
- 5.4.4 Axial Error Motion

The analysis of the error motion polar plot for axial error motion is also conceptually identical to that for radial error motion, except that fundamental error motion (eccentricity) should not be removed analytically.



Fixed Sensitive direction

- 5.5 Spindle tests — Fixed sensitive direction
These tests are applicable to the machining operations with fixed sensitive direction, for example, turning and cylindrical grinding.

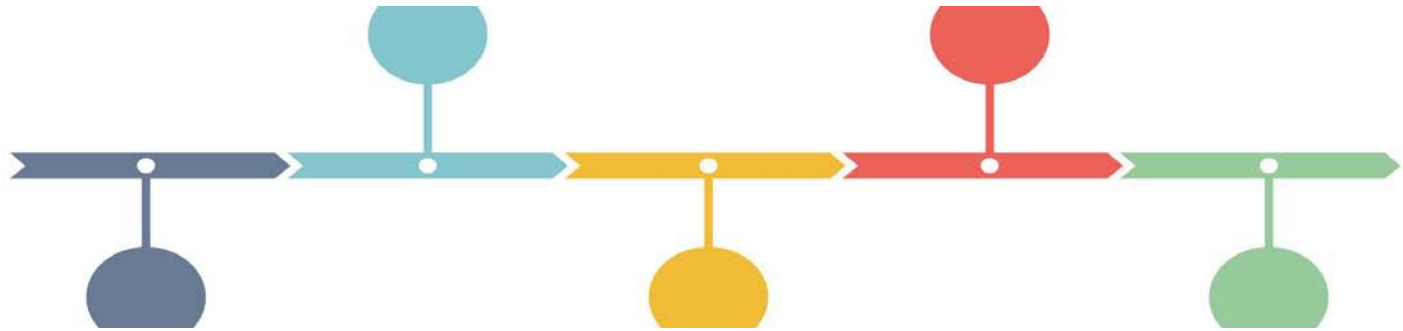


a)

Lion Precision & Products



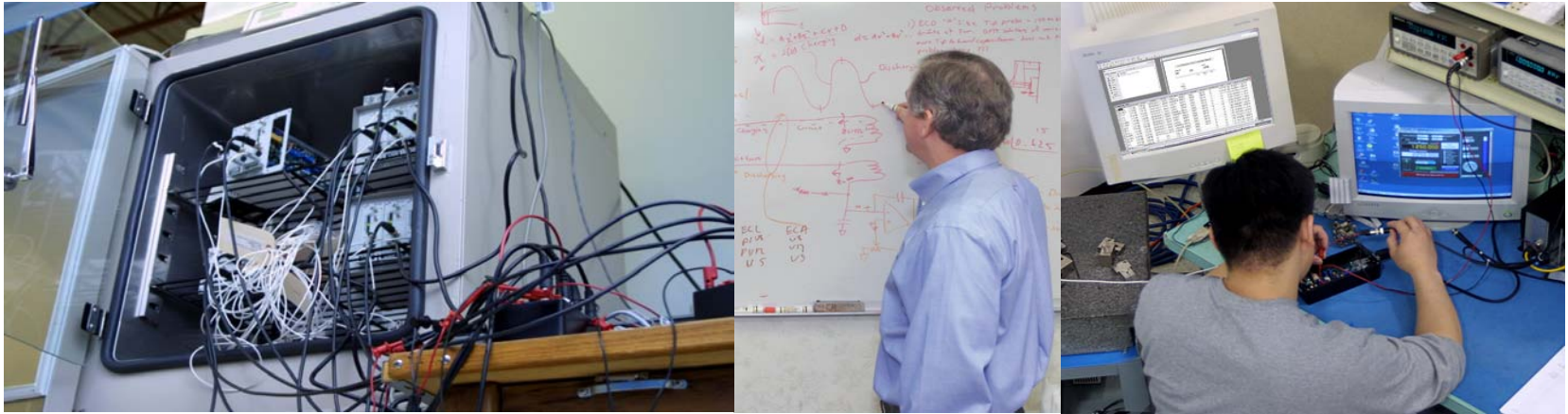
History



Ownership

- Established in 1958 by Dr. Kurt Lion, of MIT
- First manufacturer of commercial capacitive sensors
- Purchased in 1986 by Automated Quality Technologies (Don Martin and others)
- Purchased 2015 by Motion Tech Automation

Product Development



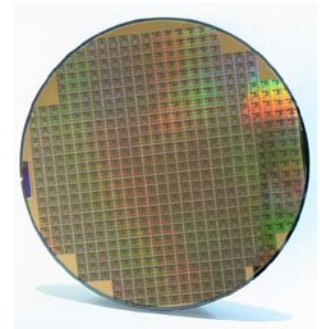
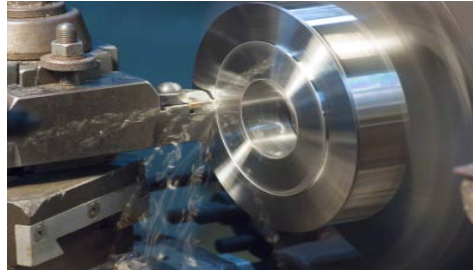
Product Families

- 1958 – Capacitive Products
- 1992 – Spindle Error Analyzer
- 1995 – Label Sensors
- 2001 – Eddy-Current Products
- 2015 - SpindleCheck



Industries Served

- Machine Tool
- Packaging
- Medical Device
- Semiconductor
- Disk Drive



美国雄狮精仪公司的主轴运动误差分析仪（SEA）和主轴检测仪SpindleCheck采用雄狮公司高分辨率无接触式的位移传感器，是世界领先的主轴误差运动测量系统和分析工具。

该系统采用软件分析和显示被测主轴在全速运动时X,Y和Z轴向的主轴性能。用户能够充分描述主轴的性能，包括受温度影响的主轴伸长和倾斜，FFTs分析的主轴轴承，及主轴性能相关特点的位置，圆度和表面粗糙度。测量分辨率可小于一个纳米。

SEA和SpindleCheck二个系统完全符合ANSI， ISO，和JIS主轴性能测量标准。

主轴回转误差分析仪





Main Products for Machine Tool

Dynamic Spindle Measurement

- Spindle Error Analyzer (SEA)
- SpindleCheck

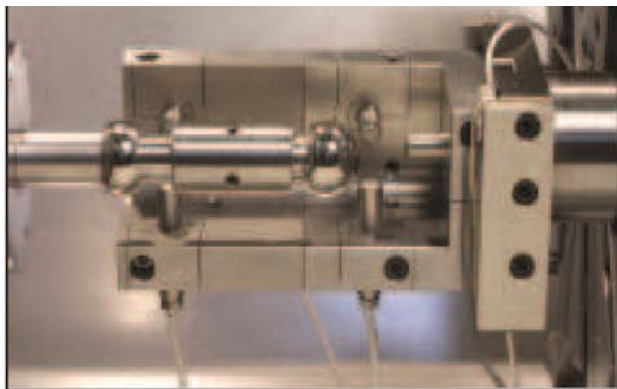
Spindle Error Analyzer (SEA)



SpindleCheck



Spindle Error Analyzer (SEA)



主轴回转误差分析仪



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ISO230: Test Code for Machine Tools, 3: "Determination of Thermal Effects" 7: "Geometric Accuracy of Axes of Rotation"

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ANSI/ASME B89.3.4: "Axes of Rotation, Methods for Specifying and Testing"

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PRECISION

Spindle Error Analyzer (SEA)

INTERNATIONAL
STANDARD

ISO
230-7

First edition
2006-11-15

Test code for machine tools —

Part 7:

Geometric accuracy of axes of rotation

Spindle Error Analyzer (SEA)

ASME B89.3.4-2010

[Revision of ANSI/ASME B89.3.4M-1985 (R1992)]

Axes of Rotation: Methods for Specifying and Testing

Spindle Error Analyzer (SEA)

GB/T17421.7-2016 / ISO230-7:2006

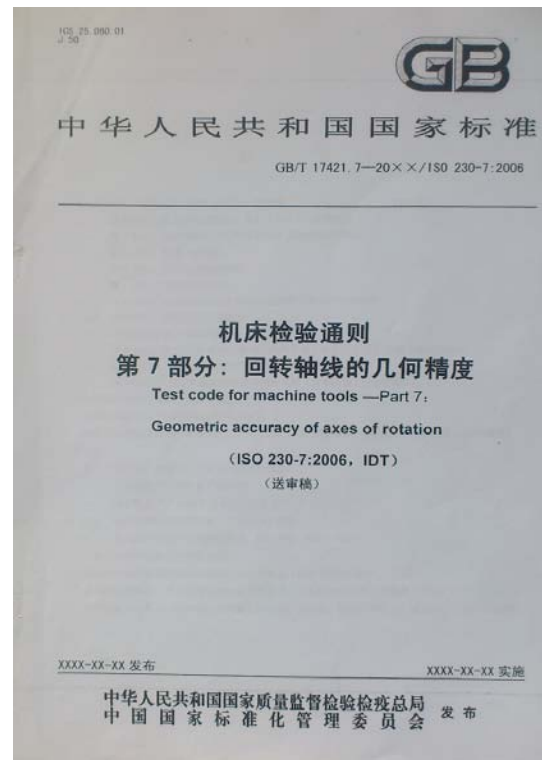
机床检验通则

第 7 部分：回转轴线的几何精度

Test code for machine tools —Part 7:

Geometric accuracy of axes of rotation

(ISO 230-7:2006, IDT)



A Few Well-Known Customers



A Few Well-Known Customers in China

国家机床质量监督检验中心

中国国家计量科学研究院

北京精密机床研究所

北京精密机床研究所

沈阳机床集团

沈阳机床集团

昆明机床集团

昆明机床集团

北京机电院

北京精雕机床集团

青海第一机床集团

上海机床厂集团

哈尔滨量具刃具集团

无锡机床集团

富士康科技集团

股份公司和民营企业

北京，上海，天津，广东，浙江，江苏，陕西，河南，湖北，辽宁等地大学

Spindle Error Analyzer Basics



Spindle Error Analyzer Basics

- Dynamic Spindle Analyzer
 - **Drift** (ISO230-3)
 - **Shift** (speed-induced axis shift)
 - Axis of rotation error motion
 - **Synchronous**
 - **Asynchronous**
 - **Total**



Spindle Error Analyzer Basics

Radial - Rotating Sensitive

Radial - Fixed Sensitive

Axial

Tilt - Fixed Sensitive

Thermal

Shift vs.RPM

Donaldson Reversal

Automated Measurements

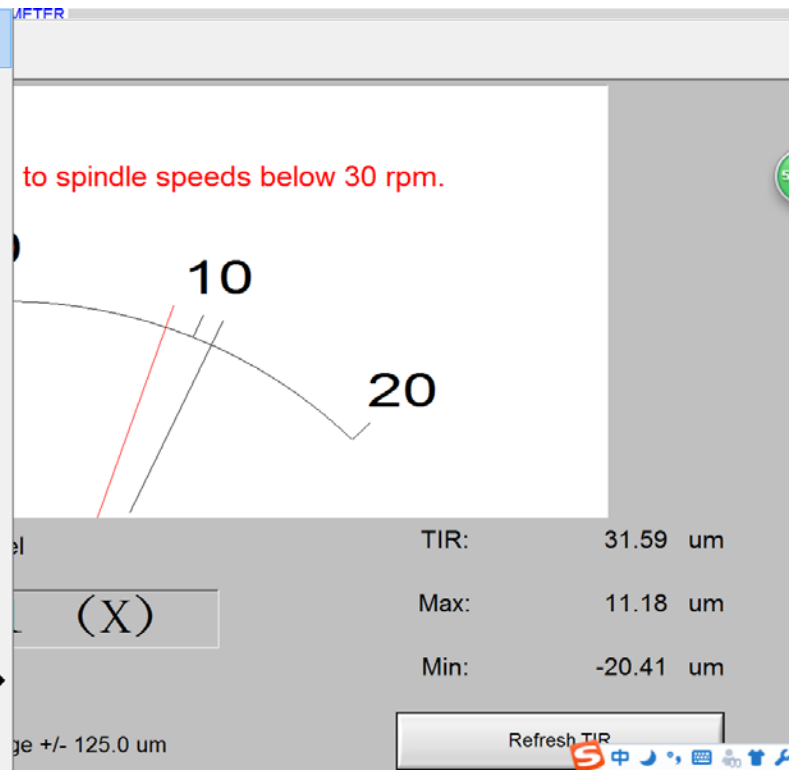
FFT

Oscilloscope

Probe Meter

Configuration Displays

Logo



LION PRECISION
Save Load Configuration DAQ Rate! Help Exit!

File Test Time: 16 Jun 2014 14:10:30 v.8.6.5

RADIAL - ROTATING SENSITIVE DIRECTION - POLAR PLOT

Display View Scaling

Source: 3000 -6 - 复件(1).lda

Config: From file

Chans: 1 & 2 (X & Y)

B89.3.4 Method

Synch:	0.47 um
Asynch:	0.50 um
Total:	0.82 um

TIRX:	61.62 um
TIRY:	61.69 um
RPM:	2992

micrometer

100 Points / Rev

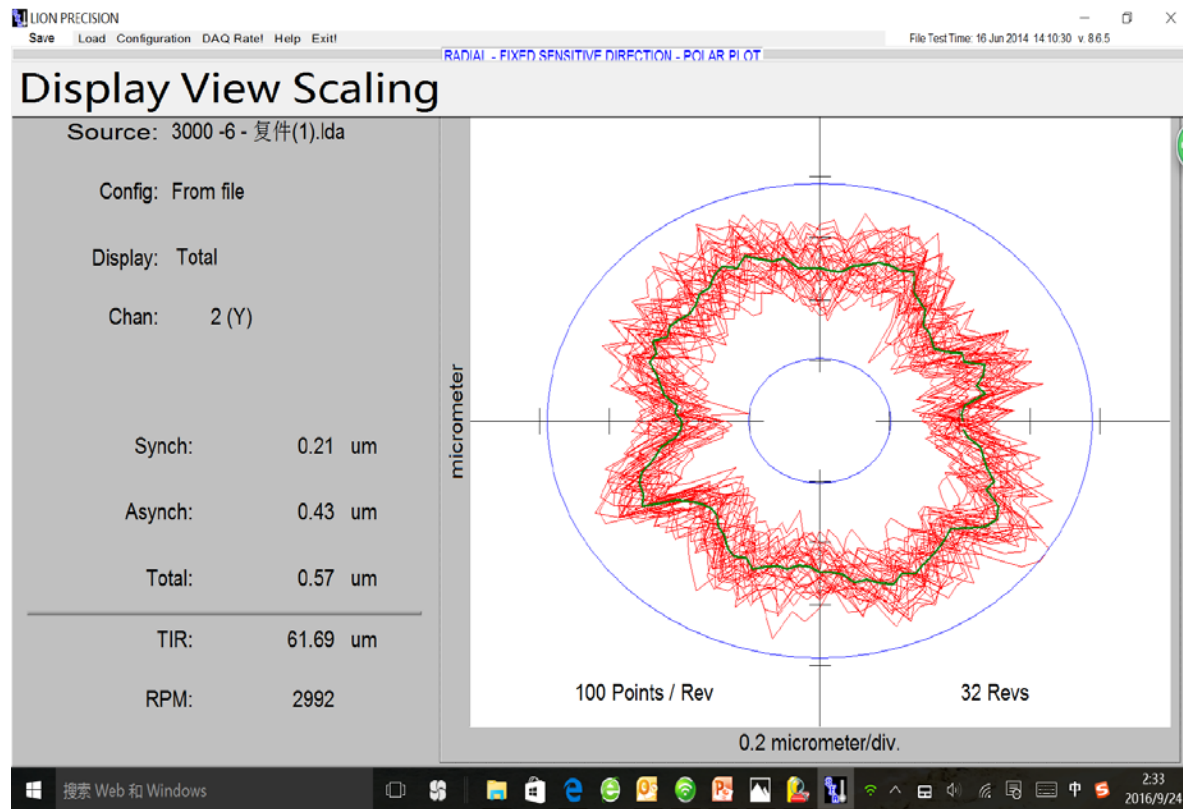
32 Revs

1 micrometer/div.

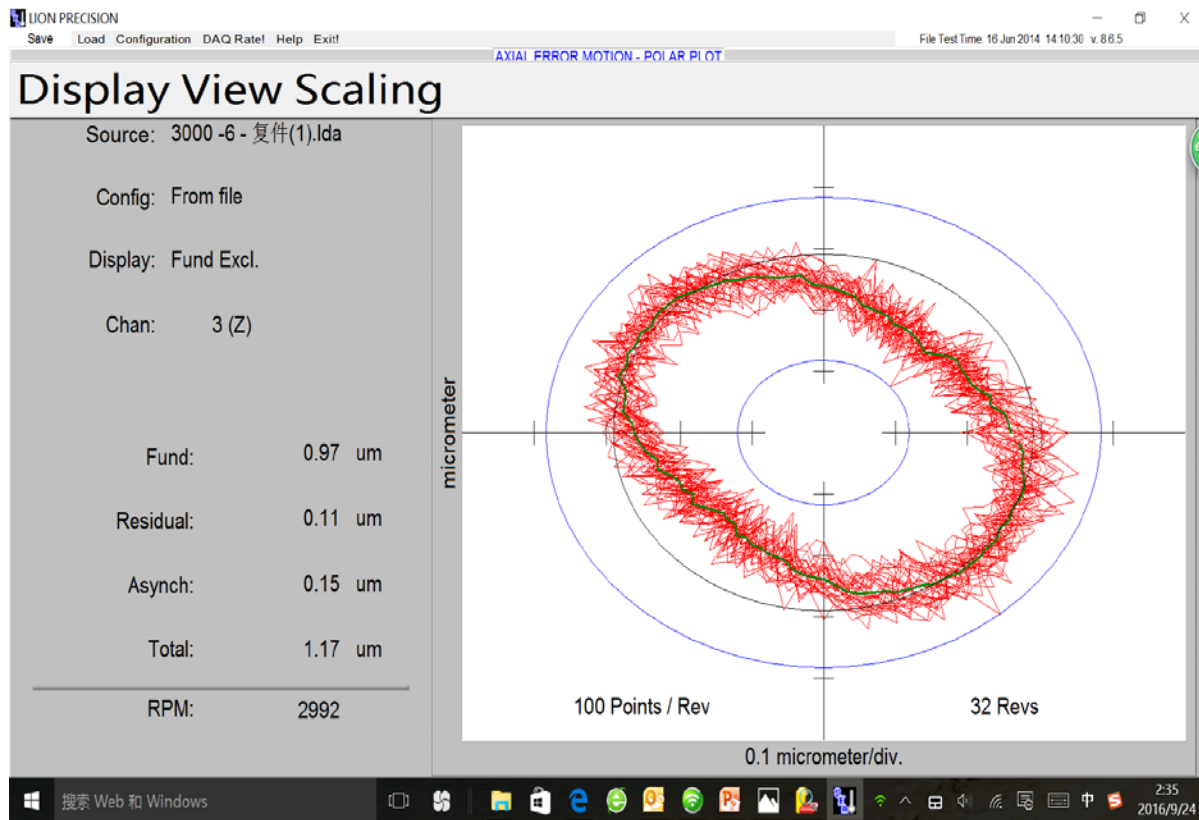
搜索 Web 和 Windows

2:30 2016/9/24

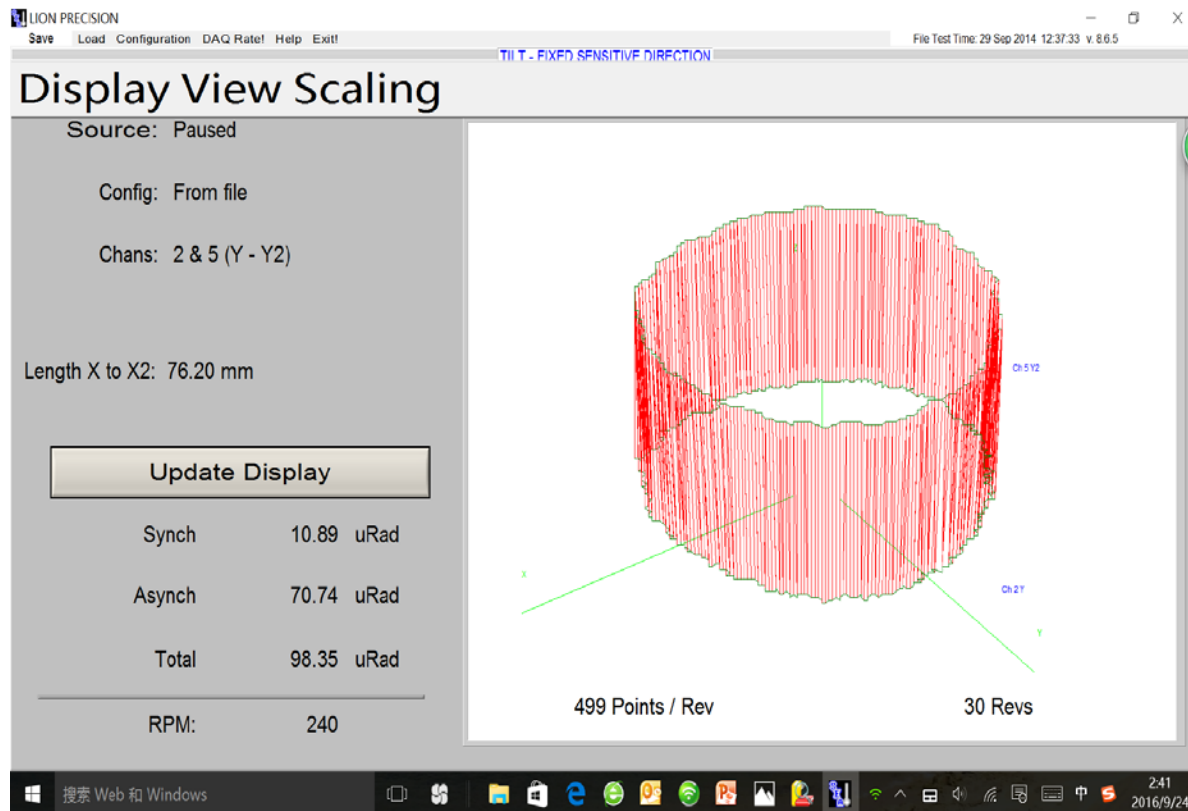
Fixed Sensitive direction



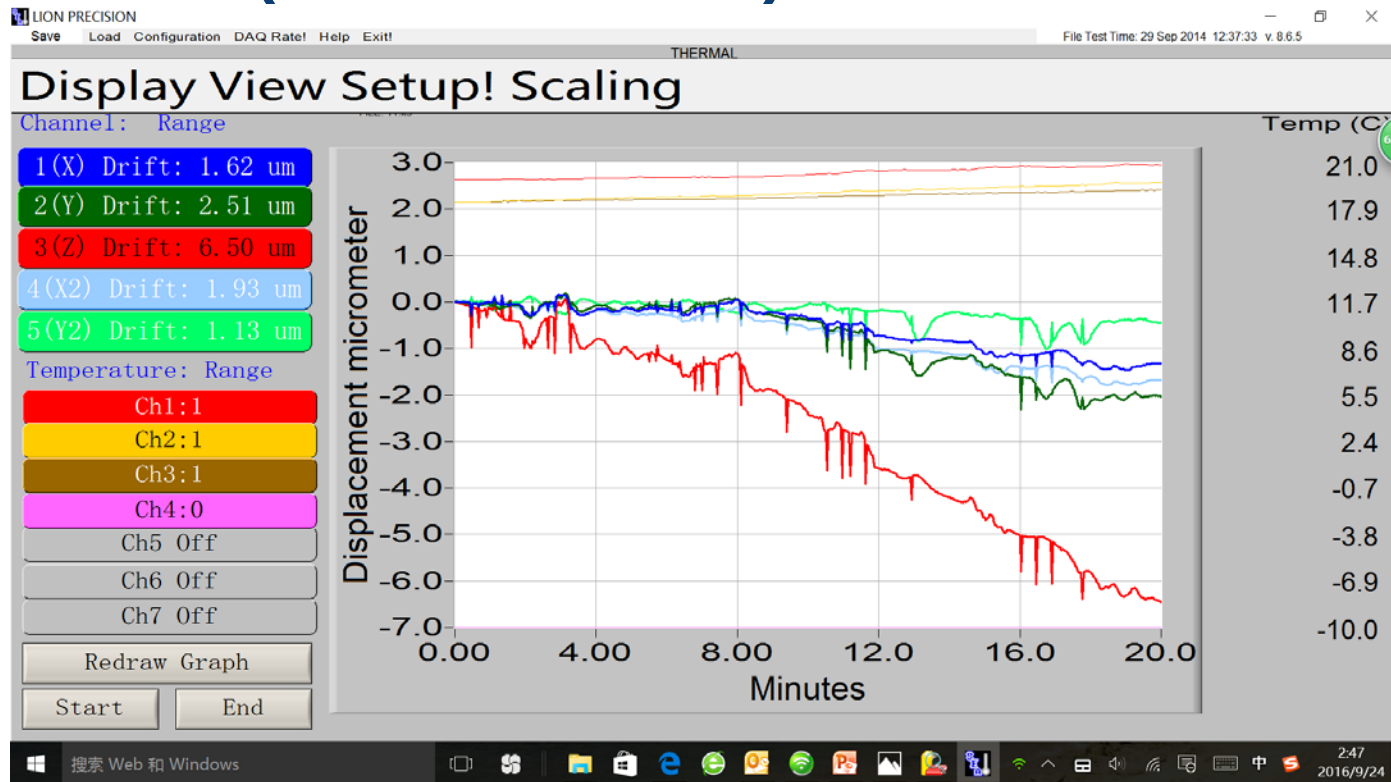
Axial Error Motion



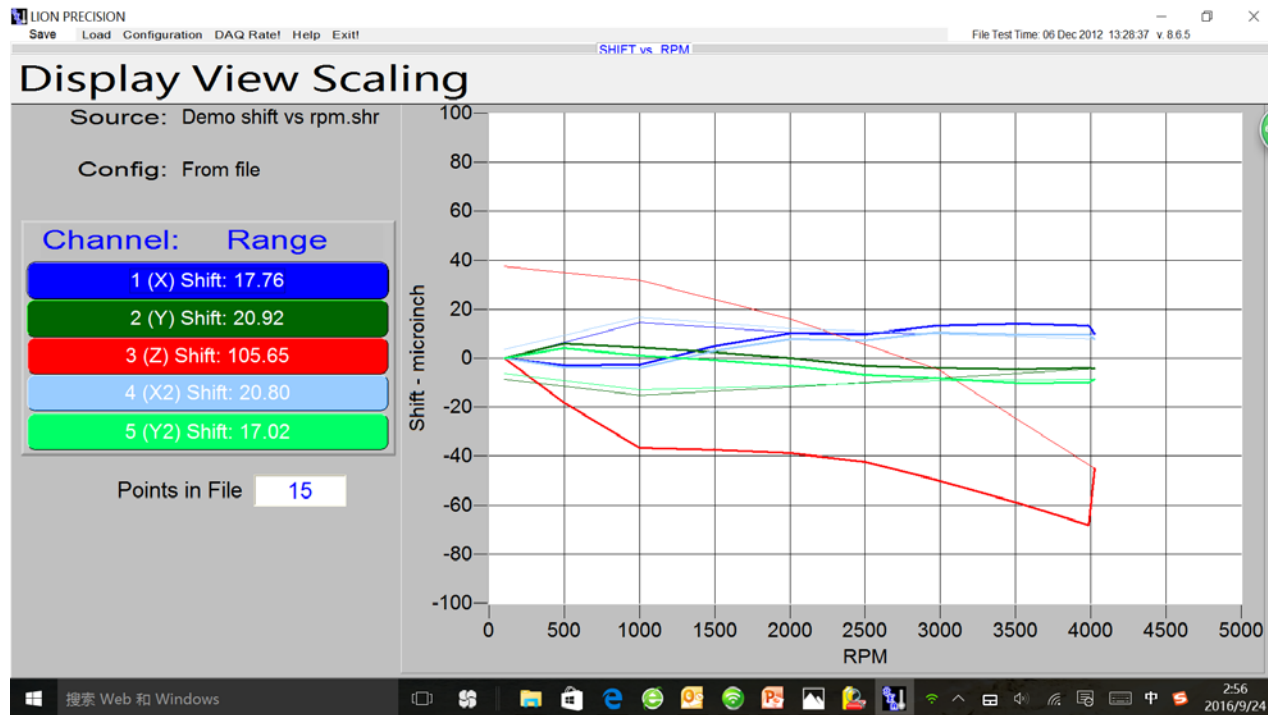
Tilt Error Motion



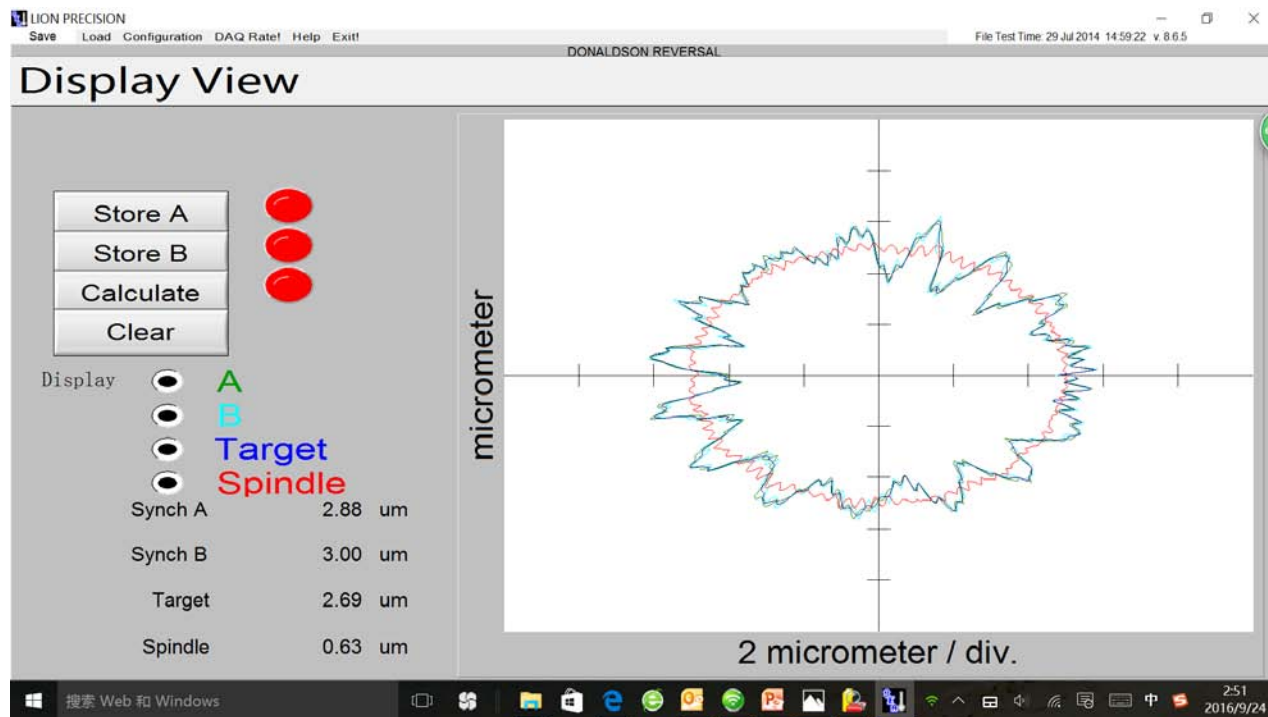
Thermal (ISO230-3)



Shift vs RPM



Donaldson Reversal



Automated Measurements

LION PRECISION

Save Load Configuration DAQ Rate! Help Exit!

AUTOMATED MEASUREMENTS

File Test Time: 29 Jul 2014 14:59:22 v. 8.6.5

Display View Setup!

Status: Viewing file:

Next Trial: NA

Next Sample: 0

File: Demo Auto Measure.lsq

RPM: NA

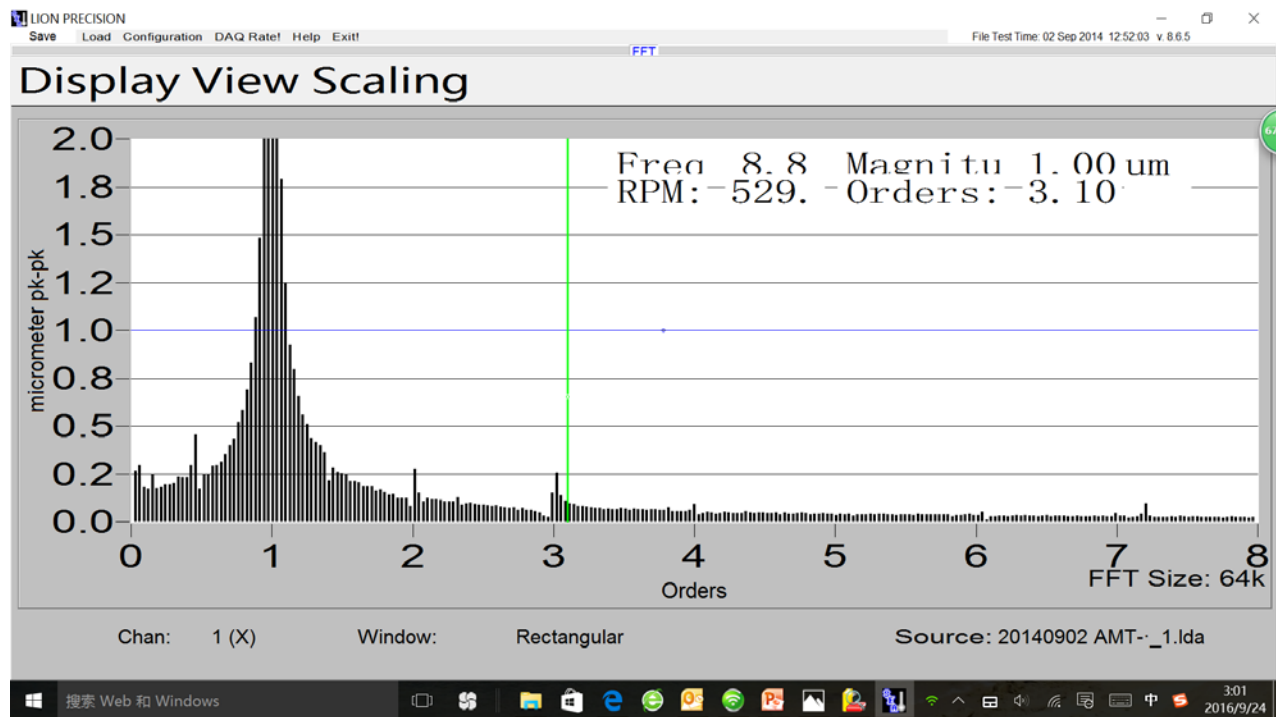
Test Type:
Radial - Fixed Sensitive

Units: um

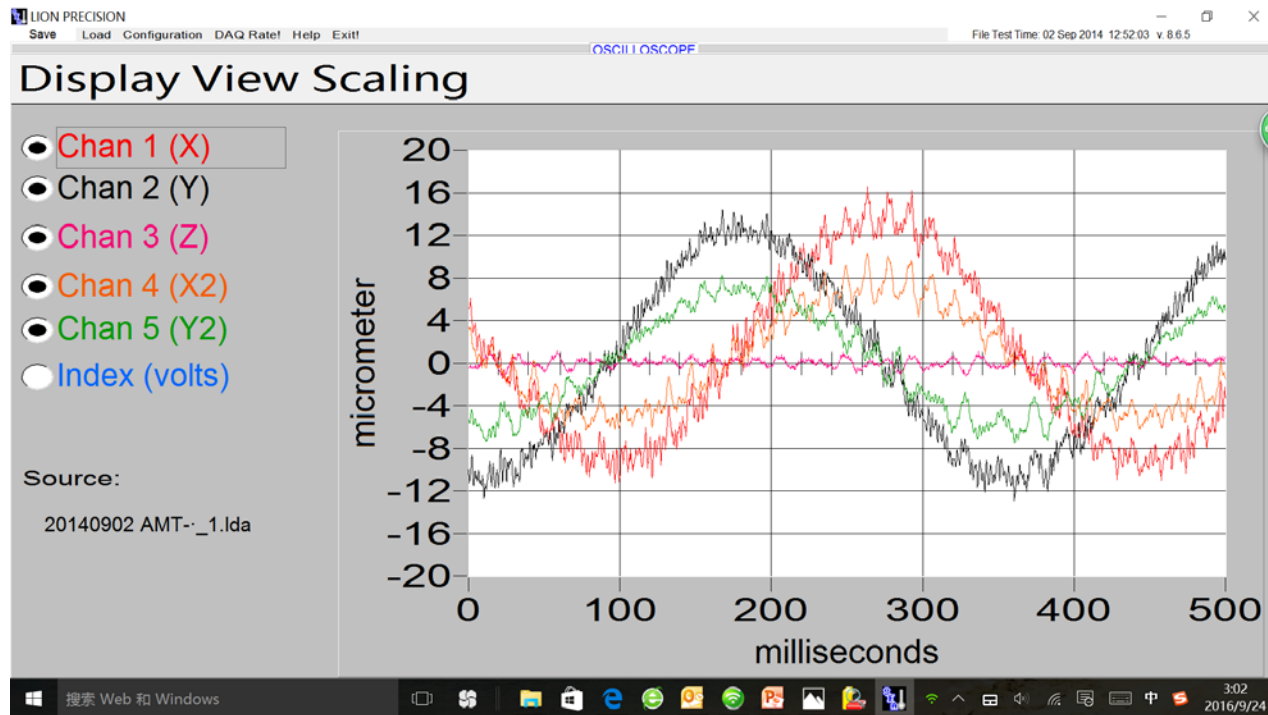
Trial	RPM	TIR	Total	Synch	Asynch with_comp	Std. Dev.
1	191	130.44	2.93	0.52	2.93	0.47
2	592	134.34	6.72	3.63	5.60	0.86
3	1009	135.95	7.25	3.55	5.59	1.06
Avg.		133.58	5.63	2.57	4.70	0.80
Std. Dev.		2.31	1.93	1.45	1.26	0.24

Windows 10 taskbar: 搜索 Web 和 Windows, 2:53 2016/9/24

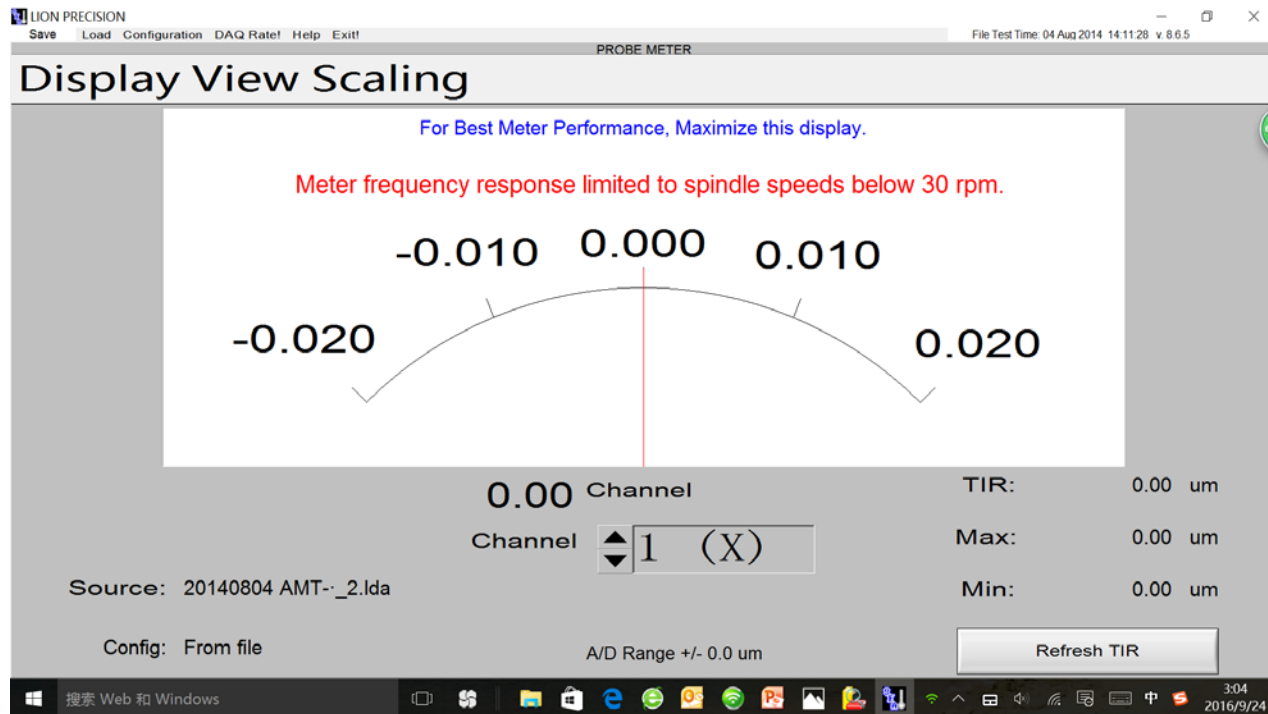
FFT



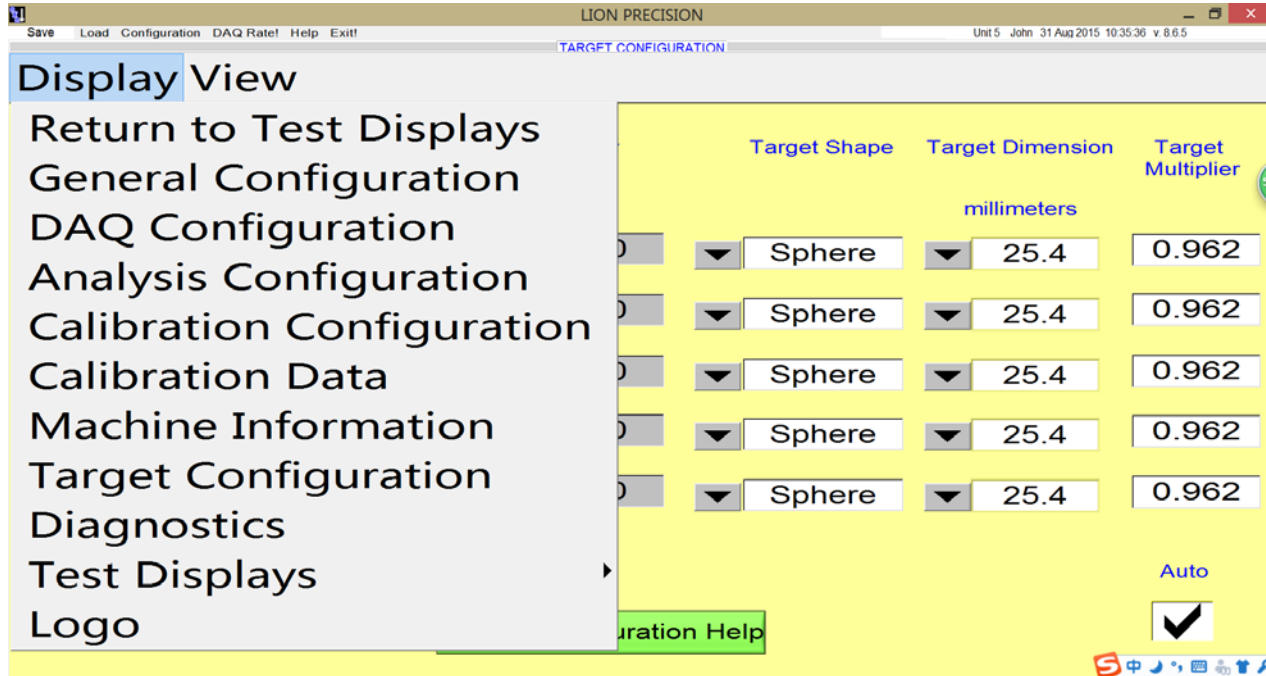
Oscilloscope



Probe Meter



Spindle Error Analyzer Basics



Spindle Error Analyzer Basics

LION PRECISION Unit 5 John 31 Aug 2015 10:31:02 v 8.6.5

Save Load Configuration DAQ Rate! Help Exit!

GENERAL CONFIGURATION

Display View

Version: 8.6.5
Lib Ver: 4.62
Calc Lib Ver: 1.06

Language: **English** Language File Rev: 18
File Date (only): 8/25/2012

PDF Viewer: **c:\Program Files (x86)\Adobe\Reader 11.0\ReaderAc** Select PDF Viewer

icromete Data Format: **D Mon Y**

DAQ CONFIGURATION

Display View

Dev1
USB-6251 (Mass Termination)

Active DAQ Channels:
Probe Channels: **All 5**
Other Channels: ☐ Temperature
☐ Index

DAQ Gain: **1** Gain Setting
+ 10.00 Voltage Range
DAQ Range and Resolution are shown on the Calibration Display

Shift Config and Restart DAQ

ANALYSIS CONFIGURATION

Display View

Enter RPM **Enter DAQ Rate** **Encoder**

Measured RPM: **243** Target RPM: **242** Revolutions for Display and Calculations: **30**

DAQ Card: **5** Channels: **50000** Test Temp: **720** Data Points Displayed per Revolution: **720**

Maximum RPM: **958** Minimum RPM: **60** Rotation Angle Detector: **Target Eccentricity Ch. 1 (X)**

File Size Selector: **Large - FFT and Decimation** Trigger & Sample Rate Insp. Shift Config and Restart DAQ

CALIBRATION CONFIGURATION

Display View

Sensitivity Selector Bandwidth: **Full**

High Sensitivity Low Sensitivity

Values and units from Calibration data source:

	mm	inch	volt
Near Gap	125.000E-3	4.921E-3	10.0
Far Gap	375.000E-3	14.764E-3	-10.00
Sensitivity	-80.00 V/mm	-2032.00 V/inch	

DAQ Card range and resolution in selected display units:

	Near Gap	Far Gap	DAQ Resolution	micrometer
	125.00	375.00	0.0038	

Calculation Details

Spindle Error Analyzer Basics

The screenshot displays the LION PRECISION Spindle Error Analyzer software interface, which is divided into four main sections:

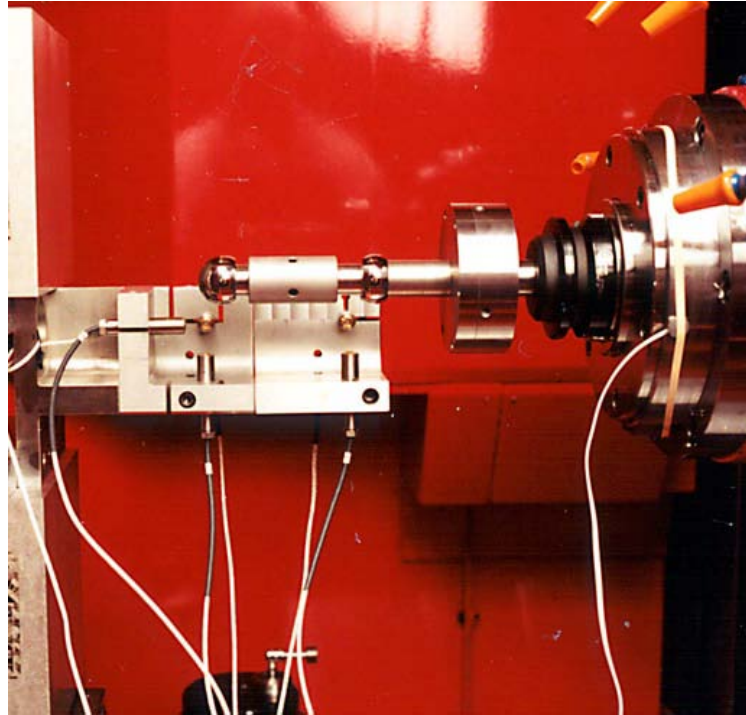
- Display View (Top Left):** This section allows for file management and data source selection. It includes a 'Re-Load' button, a 'Chassis' dropdown set to 'Elite', and a 'Click VTEDS filename to select a different file (select then cancel for none)' instruction. Below this, there are buttons for 'More Backplane Info' and a table of data sources (TEDS, C30-C, CFL590, TSP) with their respective last and next calibration dates.
- MACHINE INFORMATION (Top Right):** This section provides details about the machine being tested, including 'Machine ID' (Unit 5), 'Operator Name' (John), and a diagram of the spindle assembly with labels for Spindle, Test Mandrel, Sensor (S), and Fixture. It also includes a 'Normal Position During Measurements' section with input fields for X, Y, Z, A, B, and C coordinates in meters, inches, and degrees.
- TARGET CONFIGURATION (Bottom Left):** This section is used to configure the target for measurement. It includes a 'Target Model' dropdown set to 'Dual_Ball', a 'Target S/N' field set to '0000', and a 'Length X to X/2' field set to '76.20'. The 'Roundness Error' section shows a table of measurements for five points, each with a 'Roundness Error' of 0.00 and a 'Target Dimension' of 25.4 mm. The 'Target Shape' is set to 'Sphere' and the 'Target Multiplier' is 0.962.
- DIAGNOSTICS (Bottom Right):** This section displays the results of the security scan. It includes a 'Security' status indicator, a 'Re-Scan Security' button, and a table of diagnostic data. The table has columns for 'Disp. (um)', 'Volts', 'Sensitivity (V/um)', 'Target Corr.', and 'Scale Factor'. The data shows five points with displacement values ranging from -6.307 to 7.679 um. Below the table, there is a 'Temperature deg C' section with a table of temperatures for seven points, all showing '***' (likely indicating no data or error). At the bottom, there are fields for 'Encoder freq. PPS', 'Index freq. P/Min', and 'Entered/Observe' buttons.



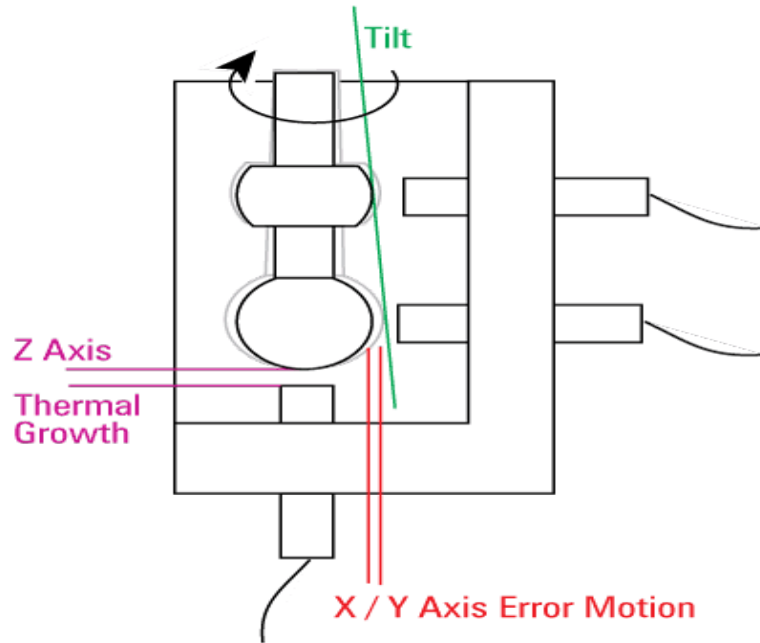
Spindle Error Analyzer Basics

- Development was Collaboration between UNCC (北卡罗来纳大学) and Lion Precision
- Now on Version 8.6.5 of software
- Supports Windows 8
- Supports ISO 230-3 and ISO 230-7

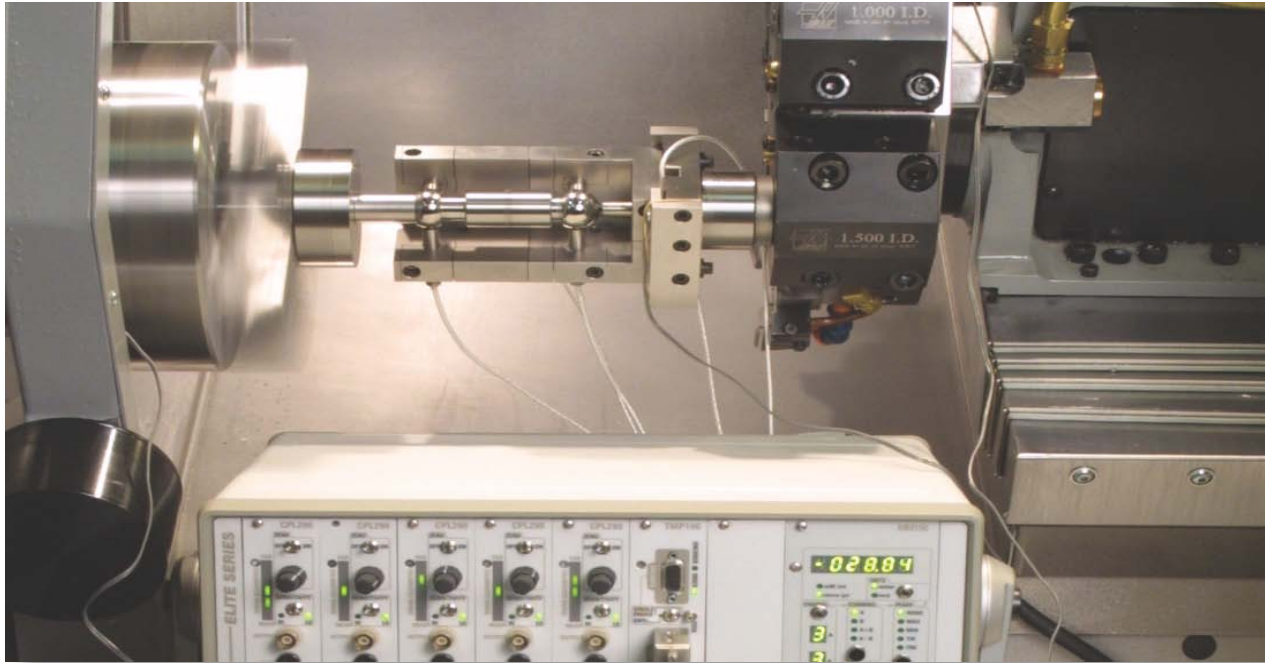
Spindle Error Analyzer (SEA) :HMC



Spindle Error Analyzer (SEA): VMC



Spindle Error Analyzer (SEA): CNC Lathe



Welcome to visit AMT Shanghai



Thank You

2016.11.04

