

## SP25M Scanning Performance Data



# SP25M Scanning Performance Summary

(Refer to data plots on following pages)

ISO 10360 Pt4									
Scanning Module	Stylus			ISO T <sub>ij</sub>		ISO Diff		Scan deflection	Time taken
	Length	Tip Ø	Stem Mat'l	Raw Data	Filtered Data	Raw Data	Filtered Data		
SM25-1	21 mm	Ø3 mm	SS	2.2 µm	1.2 µm	1.3 µm	0.9 µm	0.2 mm	0' 54"
SM25-1	50 mm	Ø5 mm	Cer	2.6 µm	1.3 µm	1.3 µm	0.7 µm	0.3 mm	0' 57"
SM25-2	100 mm	Ø6 mm	GF	2.5 µm	1.8 µm	1.9 µm	1.4 µm	0.3 mm	0' 58"
SM25-3	200 mm	Ø6 mm	GF	3.7 µm	2.3 µm	2.9 µm	2.3 µm	0.2 mm	0' 58"
SM25-4	221 mm	Ø5 mm	SS	2.8µm	1.7 µm	1.5 µm	0.9 µm	0.2 mm	1' 14"
SM25-4	400 mm	Ø8 mm	GF	6.4 µm	3.5 µm	3.7 µm	0.9 µm	0.2 mm	1' 17"
CMM Specification: $U^3 = 0.48 \mu\text{m} + L / 1000$						Scanning speed: 5 mm/s			
Filter used: Harmonic simple cut off order = 60 UPR (undulation per revolution)						Nom Ø of cal sphere used: Ø25 mm			

Bi-Directional Ring Gauge Scan									
Scanning Module	Stylus			RMS		Span		Scan deflection	Data points taken
	Length	Tip Ø	Stem Mat'l	Raw Data	Filtered Data	Raw Data	Filtered Data		
SM25-1	21 mm	Ø4 mm	SS	0.24 µm	0.19 µm	1.7 µm	1.0 µm	0.2 mm	945
SM25-1	50 mm	Ø5 mm	Cer	0.36 µm	0.29 µm	2.0 µm	1.4 µm	0.2 mm	924
SM25-2	100 mm	Ø6 mm	GF	0.41 µm	0.34 µm	2.7 µm	1.6 µm	0.3 mm	906
SM25-4	221 mm	Ø5 mm	SS	0.40 µm	0.30 µm	3.0 µm	1.7 µm	0.2 mm	2462
SM25-4	400 mm	Ø8 mm	GF	0.80 µm	0.50 µm	5.7 µm	2.7 µm	0.2 mm	2388
CMM Specification: $U^3 = 0.48 \mu\text{m} + L / 1000$						Scanning speed: 5 mm/s			
Filter used: Harmonic simple cut off order = 60 UPR (undulation per revolution)						Nom Ø of ring gauge: Ø50 mm			

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M1-w48146\ISO\_s20\_3def0.2.txt

Best Fitted Sphere	
x	579.7983 mm
y	200.4911 mm
z	259.1448 mm
Ø	28.0007 mm

Calibration Sphere Ø	
D	25.0008 mm

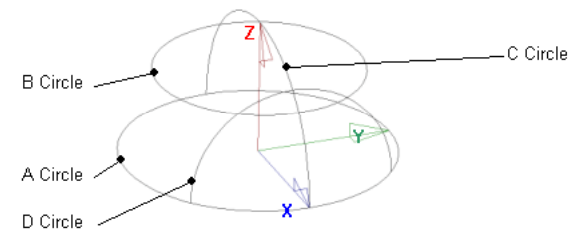
Calibrated Stylus Ø	
d	3.0006 mm

	Sphere	A circle	B circle	C ½ Circle	D ½ Circle
RMS (µm)	0.3	0.2	0.2	0.3	0.2
Max (µm)	1.2	0.6	0.6	1.1	0.4
Min (µm)	-1.0	-0.6	-0.6	-0.9	-0.6
ISO Diff	1.3 µm	0.9	1.0	1.3	0.9
ISO T <sub>ij</sub>	2.2 µm	1.2	1.2	2.0	1.0
ISO Time	0" 54"				

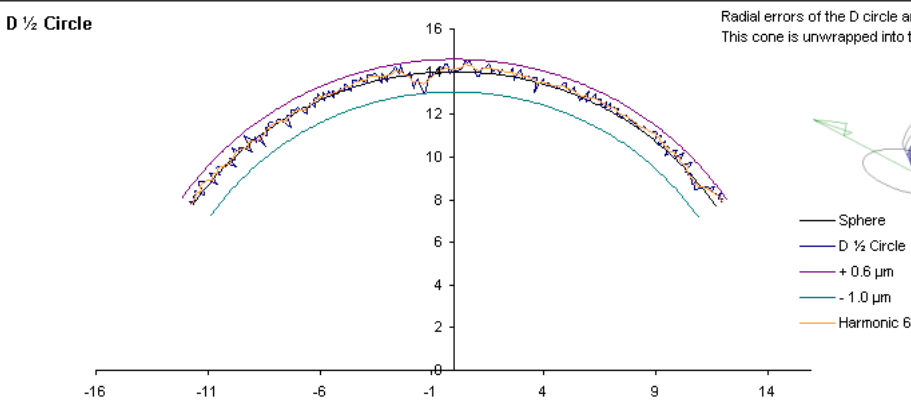
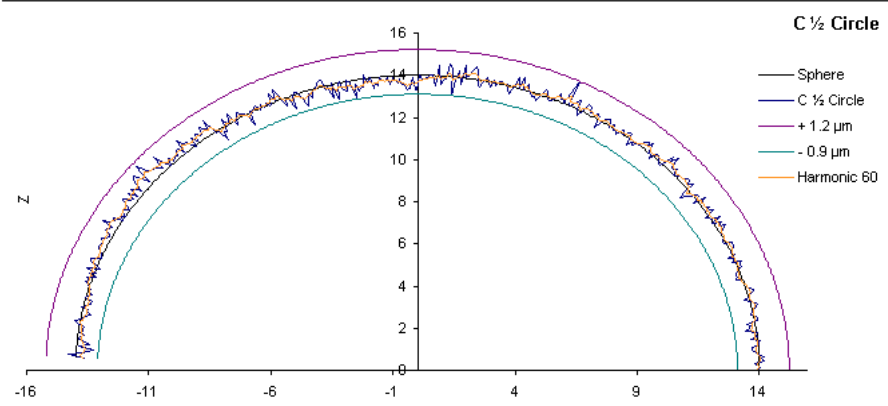
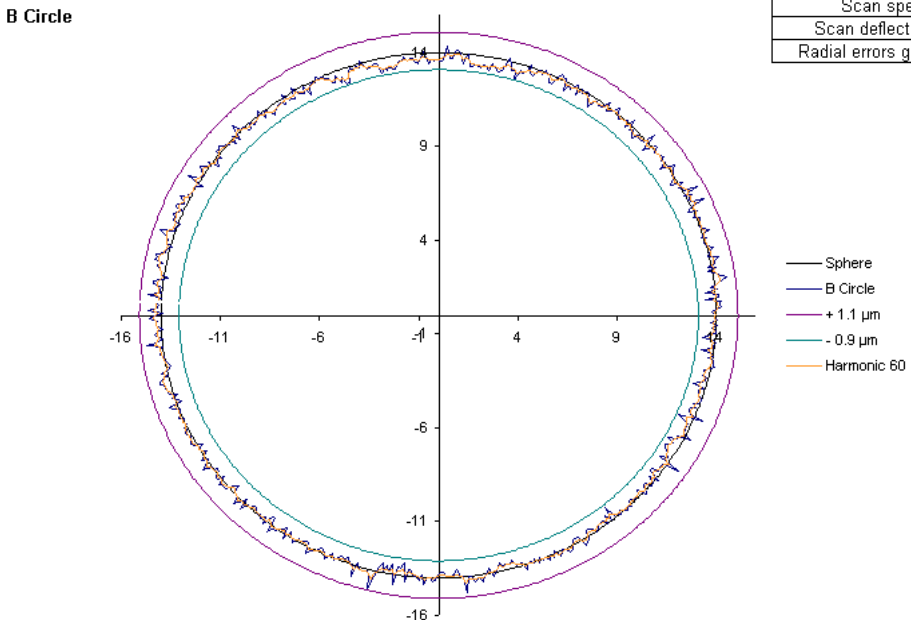
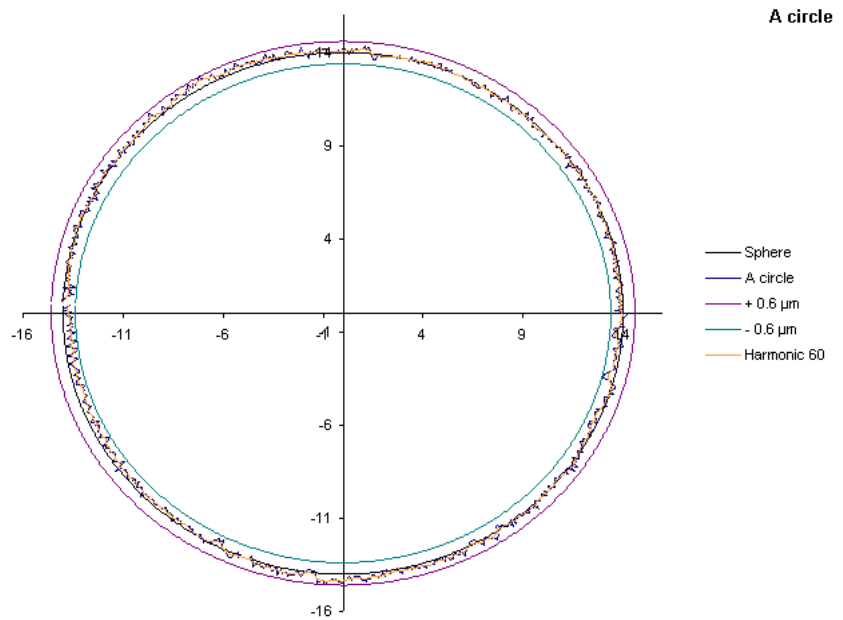
Harmonic filter simple cut off order : 60 upr  
= Undulation Per Revolution

ISO T<sub>ij</sub> = max-min  
ISO Diff = MAX{ | Ø/2-(D+d)/2 + Max |, | Ø/2-(D+d)/2 + Min | }

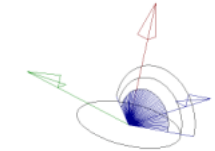
Iso Analysis Open File



2149 points
Scan speed = 5.00 mm/s
Scan deflection = 0.20 mm
Radial errors gain = 1000



Radial errors of the D circle are on a cone. This cone is unwrapped into this chart.



\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M1-w48146\iso1.txt

Best Fitted Sphere

x	579.8749	mm
y	200.1840	mm
z	288.5930	mm
Ø	30.0011	mm

Calibration Sphere Ø

D	25.0008	mm
---	---------	----

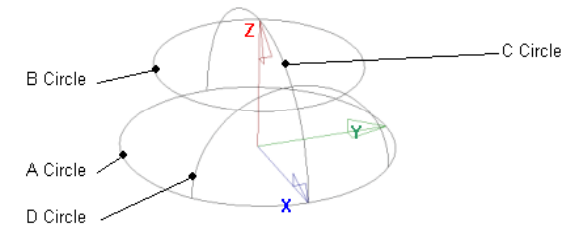
Calibrated Stylus Ø

d	5.0003	mm
---	--------	----

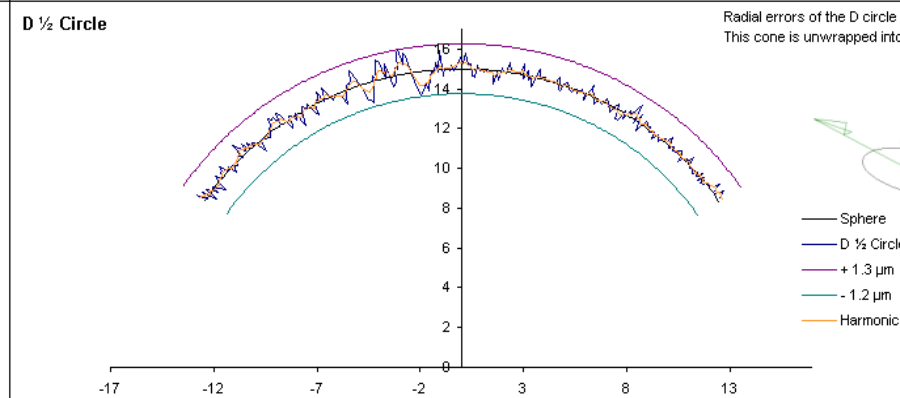
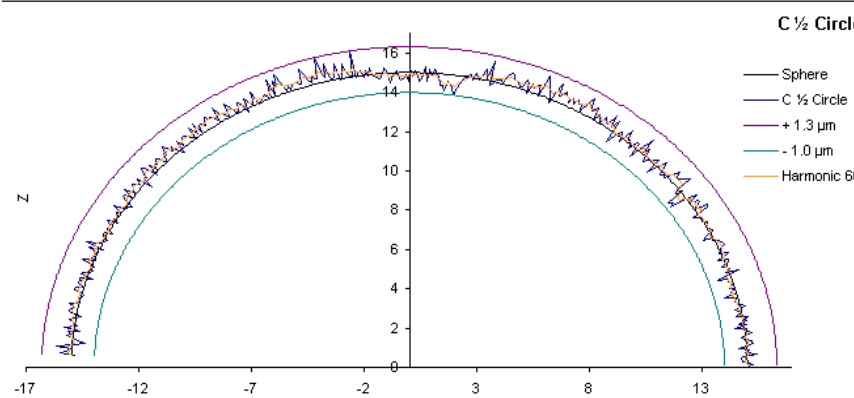
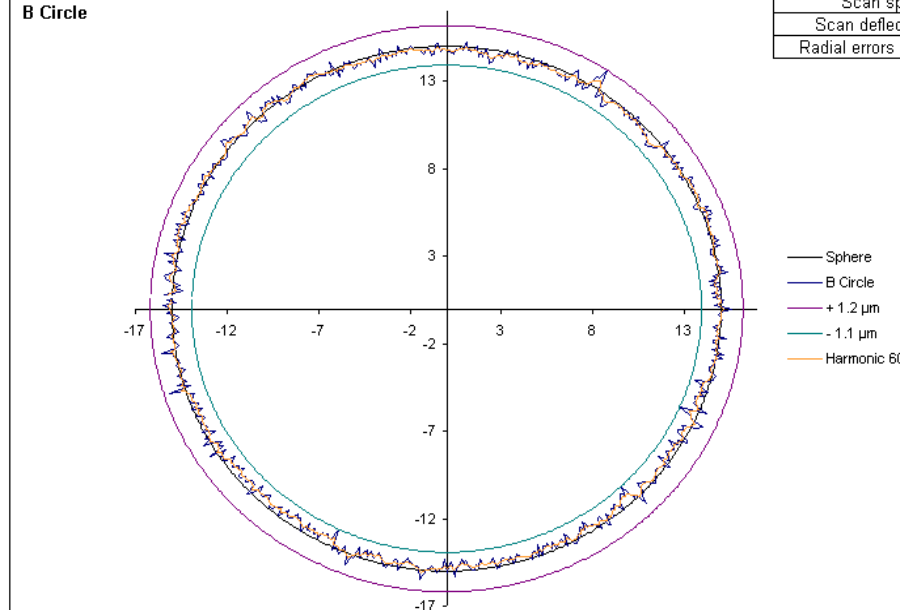
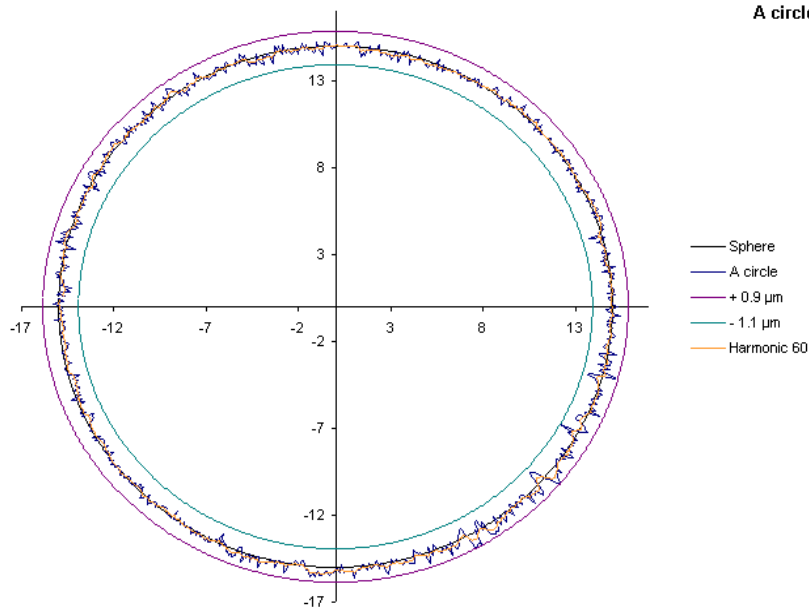
	Sphere	A circle	B circle	C ½ Circle	D ½ Circle
RMS (µm)	0.3	0.3	0.1	0.3	0.2
Max (µm)	1.3	0.6	0.9	0.5	1.2
Min (µm)	-1.2	-0.7	-1.1	-0.3	-1.1
ISO Diff	1.3 µm	0.7	1.1	0.5	1.2
ISO T <sub>ij</sub>	2.6 µm	1.3	1.9	0.8	2.3
ISO Time	0' 57"				

Harmonic filter simple cut off order: 60 upr  
 = Undulation Per Revolution  
 ISO T<sub>ij</sub> = max-min  
 ISO Diff = MAX(|Ø/2-(D+d)/2 + Max|, |Ø/2-(D+d)/2 + Min|)

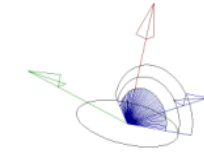
Iso Analysis Open File



2281 points
Scan speed = 5.00 mm/s
Scan deflection = 0.30 mm
Radial errors gain = 1000



Radial errors of the D circle are on a cone. This cone is unwrapped into this chart.



\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M2-w48157\iso\_st100\_6\_def0.3\_.txt

Best Fitted Sphere

x	580.2238	mm
y	655.3141	mm
z	349.8846	mm
Ø	31.0005	mm

Calibration Sphere Ø

D	25.0008	mm
---	---------	----

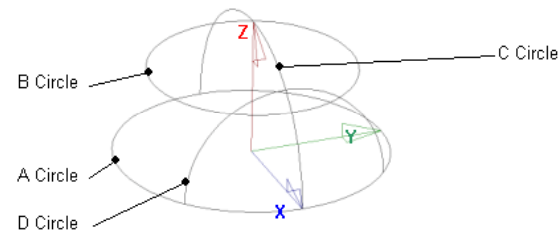
Calibrated Stylus Ø

d	6.0006	mm
---	--------	----

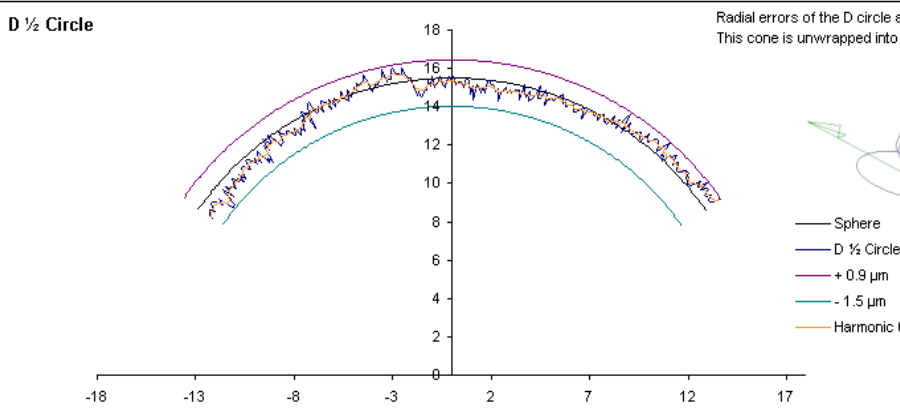
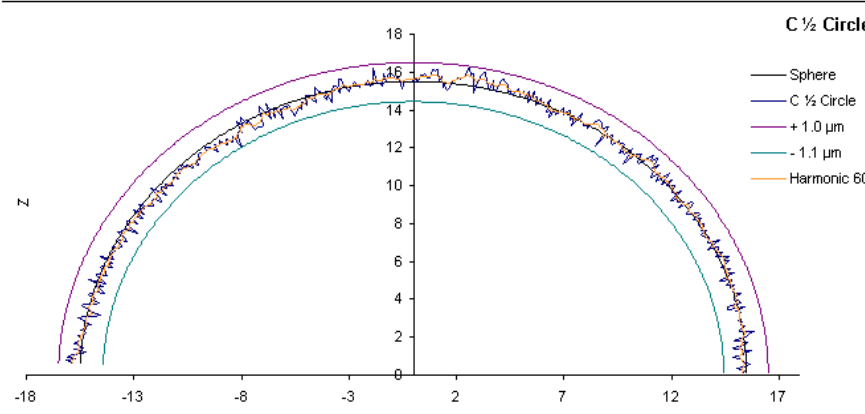
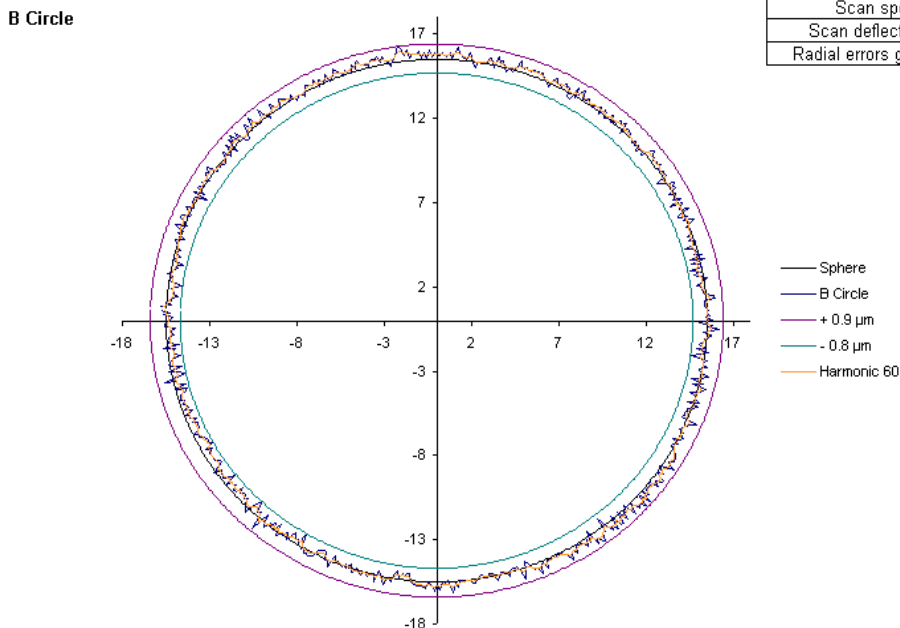
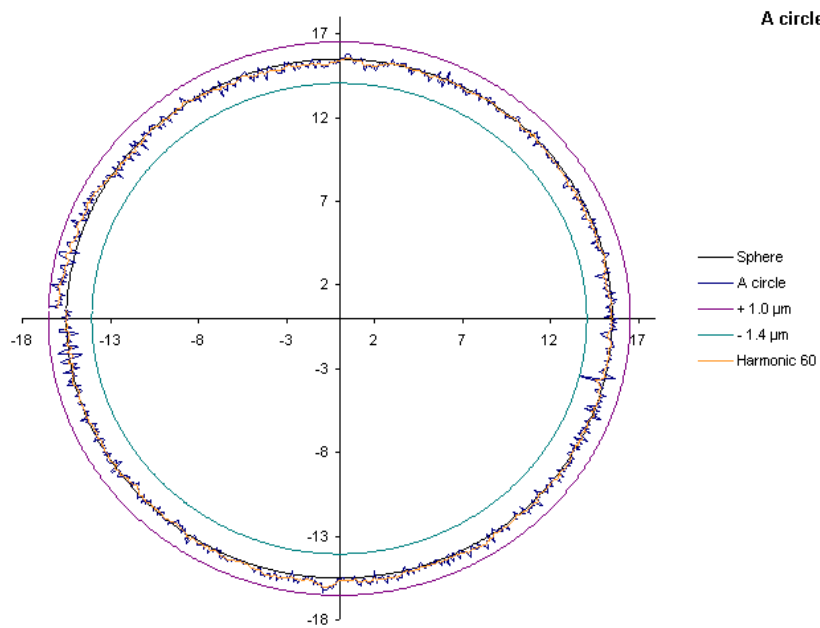
	Sphere	A circle	B circle	C ½ Circle	D ½ Circle
RMS (µm)	0.3	0.3	0.2	0.3	0.2
Max (µm)	1.0	0.8	1.0	0.6	0.9
Min (µm)	-1.5	-1.0	-1.4	-0.5	-0.8
ISO Diff	1.9 µm	1.4	1.9	0.9	1.3
ISO T <sub>ij</sub>	2.5 µm	1.8	2.5	1.1	1.7

ISO Time 0' 58" Harmonic filter simple cut off order: 60 upr  
 ISO T<sub>ij</sub>=max-min = Undulation Per Revolution  
 ISO Diff = MAX(|Ø/2-(D+d)/2 + Max|, |Ø/2-(D+d)/2 + Min|)

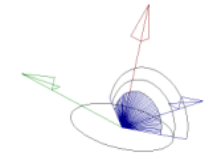
Iso Analysis Open File



2359 points
Scan speed = 5.00 mm/s
Scan deflection = 0.30 mm
Radial errors gain = 1000



Radial errors of the D circle are on a cone. This cone is unwrapped into this chart.



Sphere
D ½ Circle
+ 0.9 µm
- 1.5 µm
Harmonic 60

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M3-W48163\iso\_st200\_6\_def0.2e.txt

**Best Fitted Sphere**

x	333.8590	mm
y	426.6354	mm
z	343.3494	mm
Ø	31.0028	mm

**Calibration Sphere Ø**

D	25.0008	mm
---	---------	----

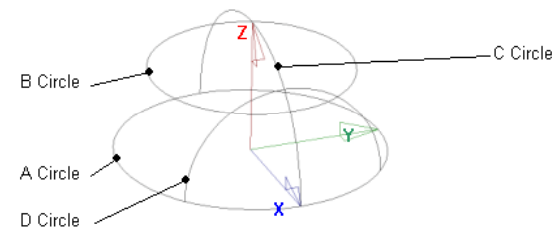
**Calibrated Stylus Ø**

d	6.0045	mm
---	--------	----

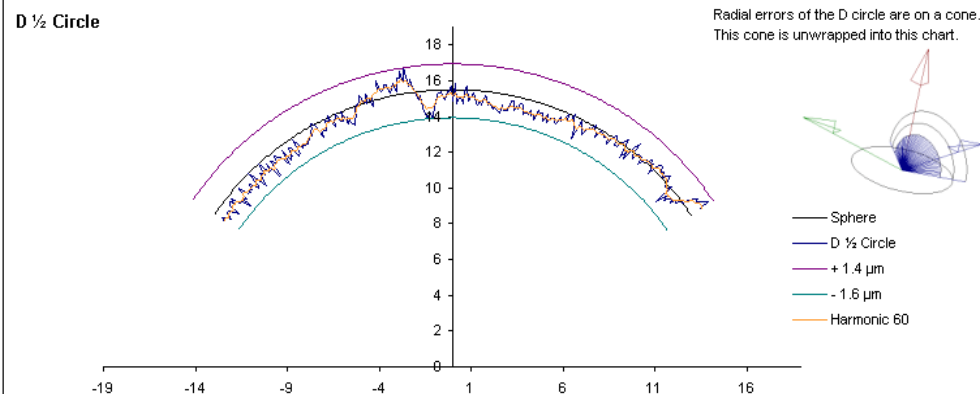
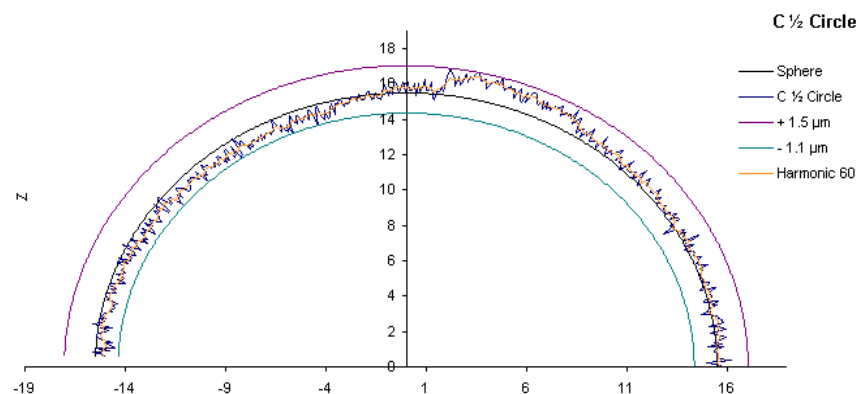
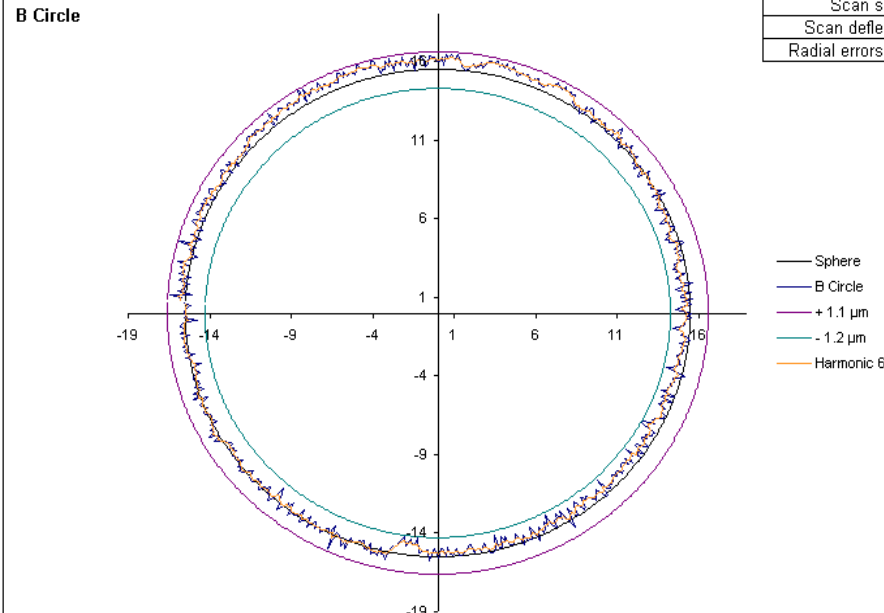
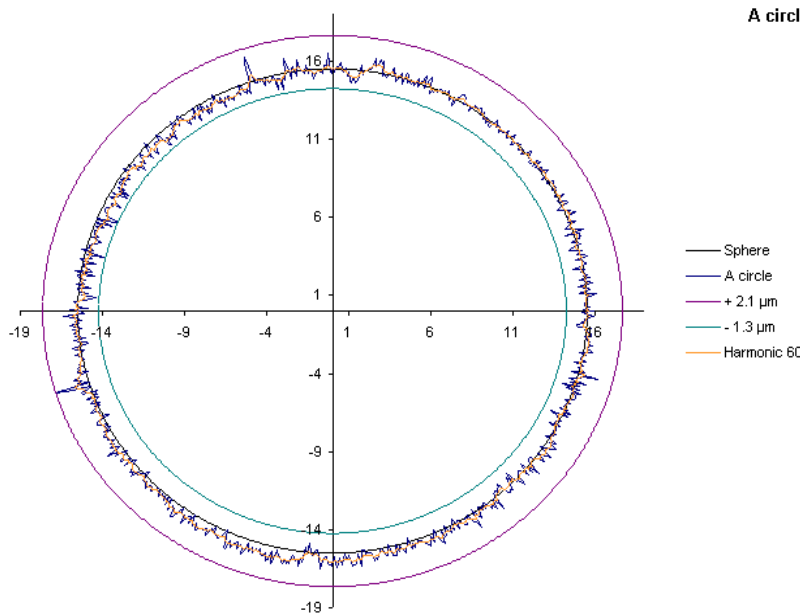
	Sphere	A circle	B circle	C ½ Circle	D ½ Circle
RMS (µm)	0.5	0.4	0.3	0.5	0.4
Max (µm)	2.1	1.3	2.1	0.9	1.1
Min (µm)	-1.6	-1.0	-1.3	-0.7	-1.2
ISO Diff	2.9 µm	2.3	2.6	2.0	2.5
ISO T <sub>ij</sub>	3.7 µm	2.3	3.4	1.6	2.3
ISO Time	0° 58"				

Harmonic filter simple cut off order : 60 upr  
 ISO T<sub>ij</sub> = max-min  
 ISO Diff = MAX( |Ø/2-(D+d)/2 + Max| , |Ø/2-(D+d)/2 + Min| ) = Undulation Per Revolution

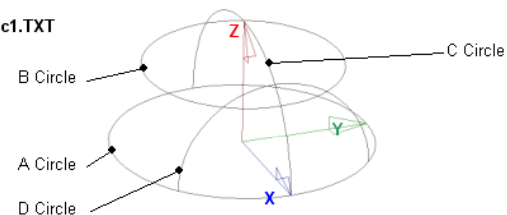
Iso Analysis Open File



2377 points
Scan speed = 5.00 mm/s
Scan deflection = 0.20 mm
Radial errors gain = 1000



\\Worcester\cmmwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\X35715\M4-0K2781\SM25-4\_400mm\_X35715\_0K2781\_3D\_ISO\_RG\_Inc1.TXT



**Best Fitted Sphere**

x	-0.0011 mm
y	0.0026 mm
z	-0.0016 mm
Ø	33.0057 mm

**Calibration Sphere Ø**

D	25.0002 mm
---	------------

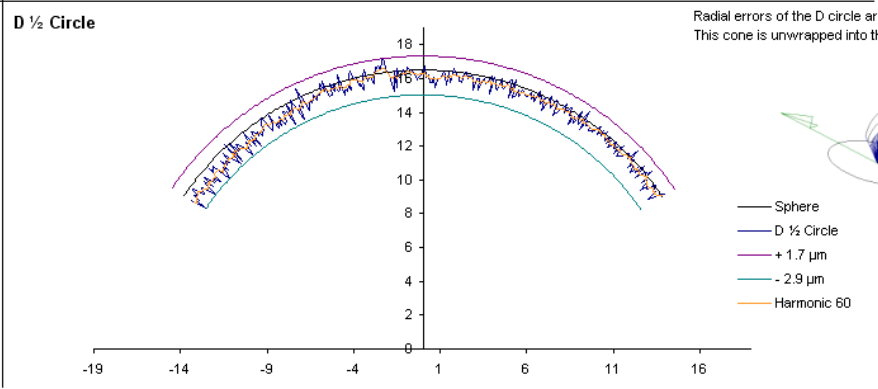
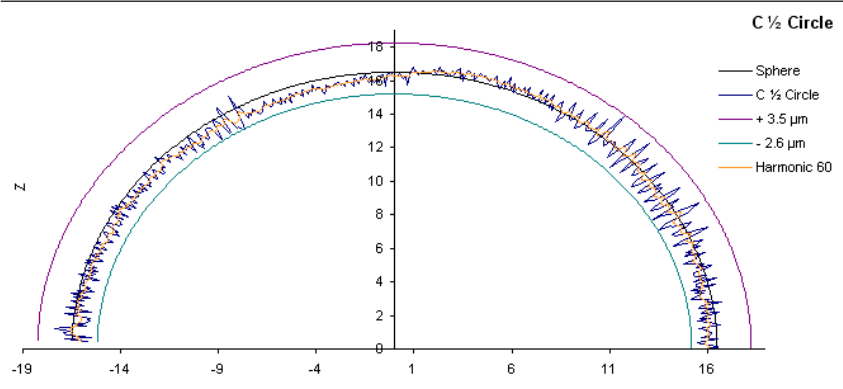
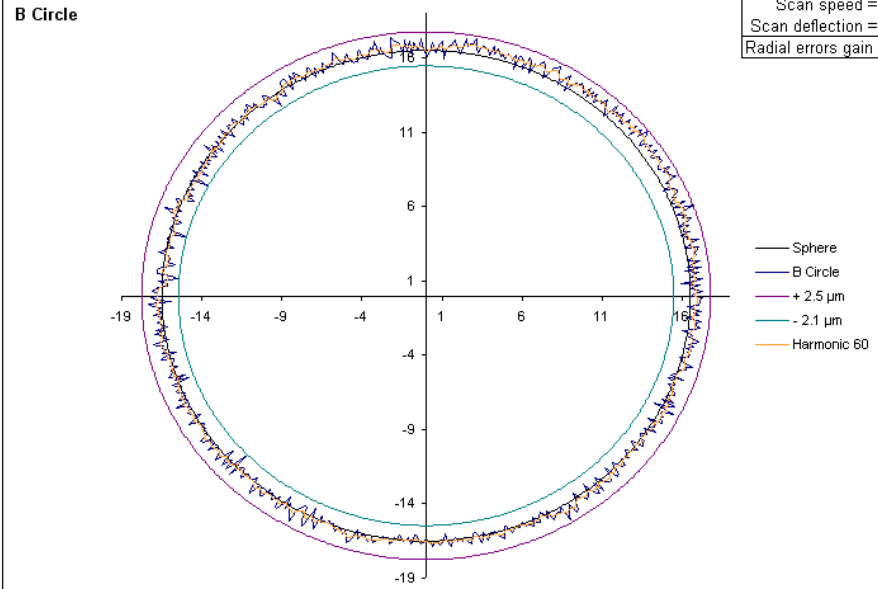
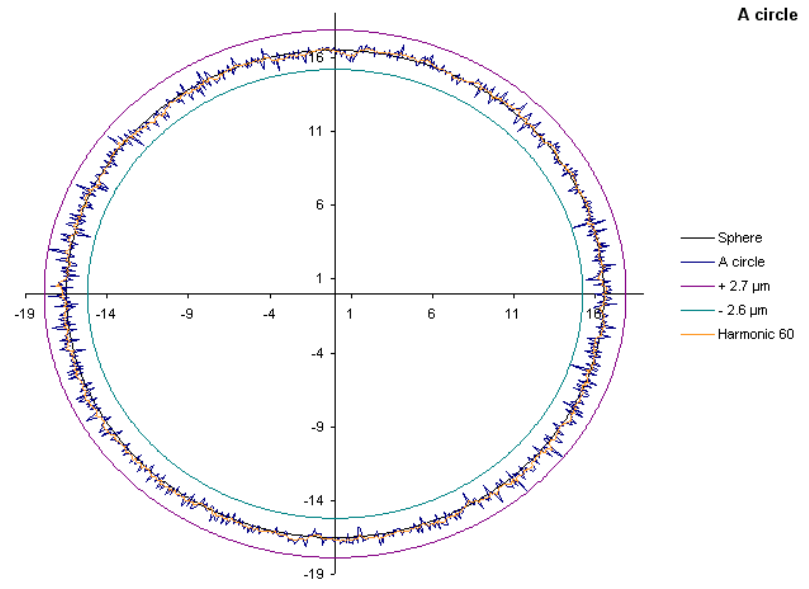
**Calibrated Stylus Ø**

d	8.0050 mm
---	-----------

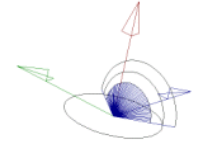
	Sphere	A circle	B circle	C ½ Circle	D ½ Circle
RMS (µm)	0.9	0.7	0.3	0.8	0.6
Max (µm)	3.5	1.7	2.7	1.3	2.5
Min (µm)	-2.9	-1.8	-2.6	-0.9	-2.1
ISO Diff	3.7 µm	1.9	3.0	1.6	2.8
ISO T <sub>ij</sub>	6.4 µm	3.5	5.3	2.2	4.6
ISO Time	1' 17"	HF noise RMS value		0.52	0.45
	ISO T <sub>ij</sub> =max-min		ISO Diff = MAX( Ø/2-(D+d)/2 + Max ,  Ø/2-(D+d)/2 + Min )		

ISO Analysis    Open File    Sample cut off order: 60 upr  
 (= Undulation Per Revolution)

2489 points  
 Scan speed = 5.00 mm/s  
 Scan deflection = 0.20 mm  
 Radial errors gain 500



Radial errors of the D circle are on a cone. This cone is unwrapped into this chart.



# Bi-Directional Ring Gauge Scan

Probe: SP25M + SM25-1

Stylus: 21 x Ø4 SS Stem

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M1-w48146\rg0.2.txt

Date Time : 08-Jul-02 #####  
Ring Gauge Ø 49.9982 mm  
Stylus ball Ø 4.0005 mm  
Theoretical Radius 22.9989 mm

Deflection 0.20 mm  
Speed 5.0 mm/s

Major unit = 2 µm  
Minor unit = 1 µm

## Best Fitted Circle

Open File	x	344.5031	mm
	y	268.8074	mm
Analysis	z	117.6682	mm
	Radius	22.9988	mm

## Radius Error

0.08 µm

## Normal errors (µm)

RMS	0.24	0.19
Max	0.8	0.5
Min	-0.9	-0.5
Span	1.7	1.0

Harmonic filter Order = 60 upr  
Cut off  $\omega_c = 376.99 \text{ rad}$   
(upr = Undulation Per Revolution)

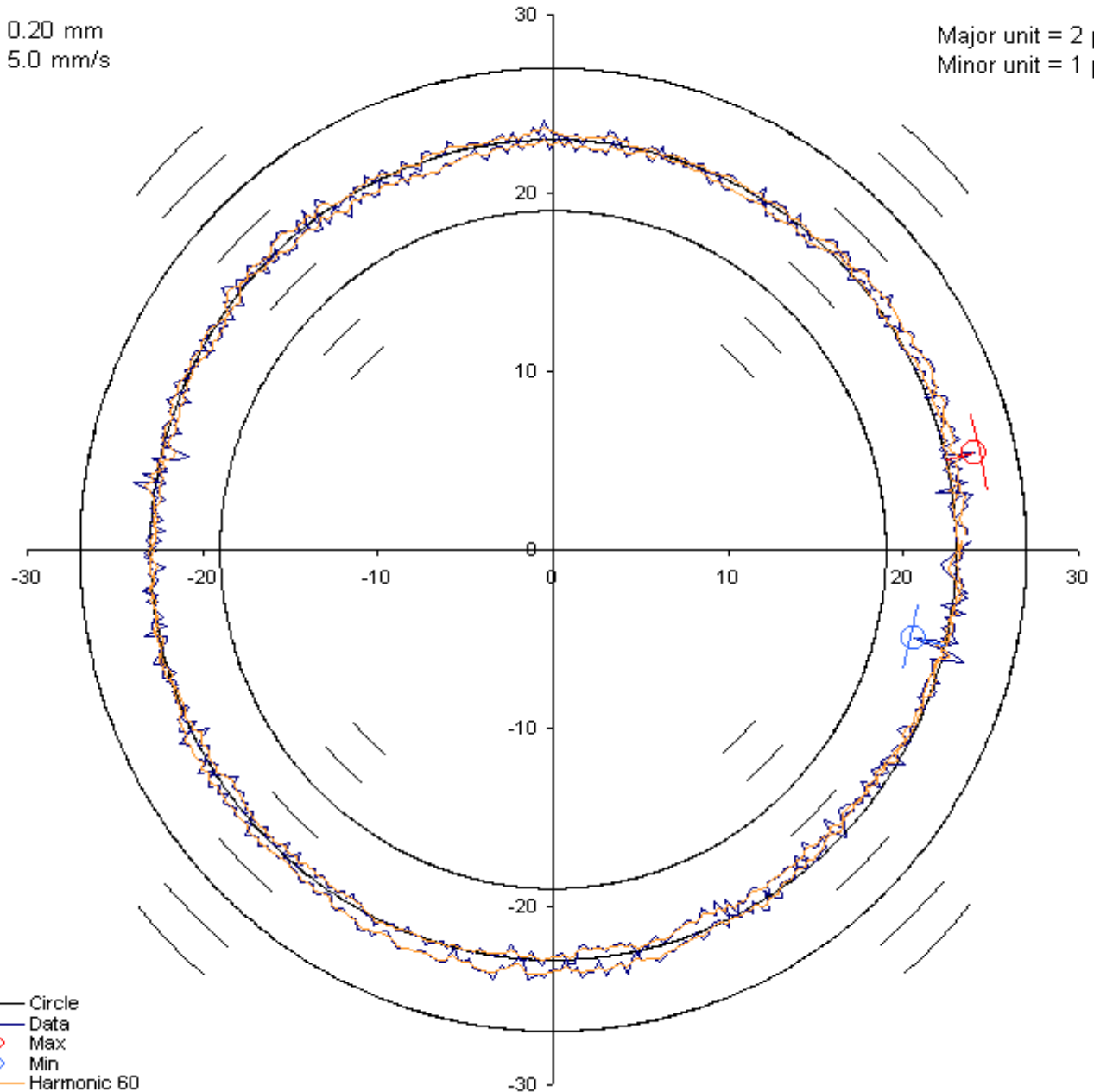
## Form identification

Ellipse	0.10 µm	2.91 °
Tri lobe	0.11 µm	37.41 °

## Circle Plane Normal

nx	0
ny	0
nz	1

Data collected with 945 points  
2 turns





# Bi-Directional Ring Gauge Scan

Probe: SP25M + SM25-1

Stylus: 50 x Ø5 Ceramic Stem

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M1-w48146\rg\_st50\_def0.2edit.txt

Date Time : 12-Jul-02 #####  
 Ring Gauge Ø 49.9982 mm  
 Stylus ball Ø 5.0003 mm  
 Theoretical Radius 22.4990 mm

Deflection 0.20 mm  
 Speed 5.0 mm/s

Major unit = 2 µm  
 Minor unit = 1 µm

## Best Fitted Circle

Open File	x	344.5727	mm
	y	268.5961	mm
Analysis	z	141.2672	mm
	Radius	22.4991	mm

## Radius Error

**-0.11** µm

## Normal errors (µm)

RMS	<b>0.36</b>	0.29
Max	<b>1.0</b>	0.7
Min	<b>-1.1</b>	-0.7
Span	<b>2.0</b>	1.4

Harmonic filter Order = 60 upr  
 Cut off  $\omega_c = 376.99 \text{ rad}$   
 ( upr = Undulation Per Revolution )

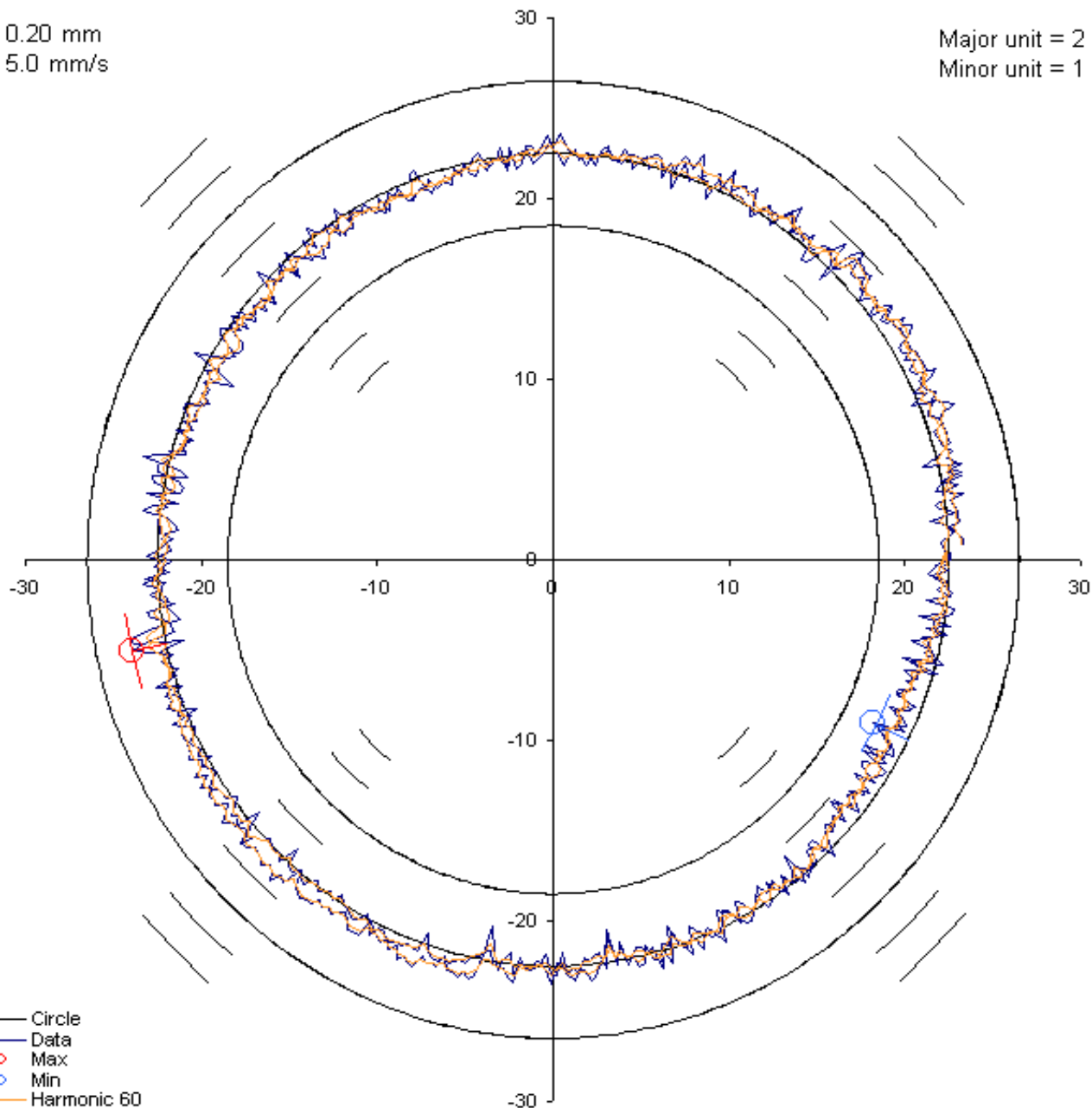
## Form identification

Ellipse	0.33 µm	353.87 °
Tri lobe	0.08 µm	350.37 °

## Circle Plane Normal

nx	0
ny	0
nz	1

Data collected with 924 points  
 2 turns



# Bi-Directional Ring Gauge Scan

Probe: SP25M + SM25-2

Stylus: 100 x Ø6 GF Stem

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M2-w48157\rg\_st100\_6\_def0.3.txt

Date Time : 09-Jul-02 #####  
Ring Gauge Ø 49.9982 mm  
Stylus ball Ø 6.0006 mm  
Theoretical Radius 21.9988 mm

Deflection 0.30 mm  
Speed 5.0 mm/s

Major unit = 2 µm  
Minor unit = 1 µm

## Best Fitted Circle

Open File	x	344.9174 mm
	y	723.7012 mm
Analysis	z	205.3037 mm
	Radius	21.9995 mm

## Radius Error

**-0.70** µm

## Normal errors (µm)

RMS	<b>0.41</b>	0.34
Max	<b>1.2</b>	0.7
Min	<b>-1.5</b>	-0.9
Span	<b>2.7</b>	1.6

Harmonic filter Order = 60 upr  
Cut off  $wc = 376.99 \text{ rad}$   
( upr = Undulation Per Revolution )

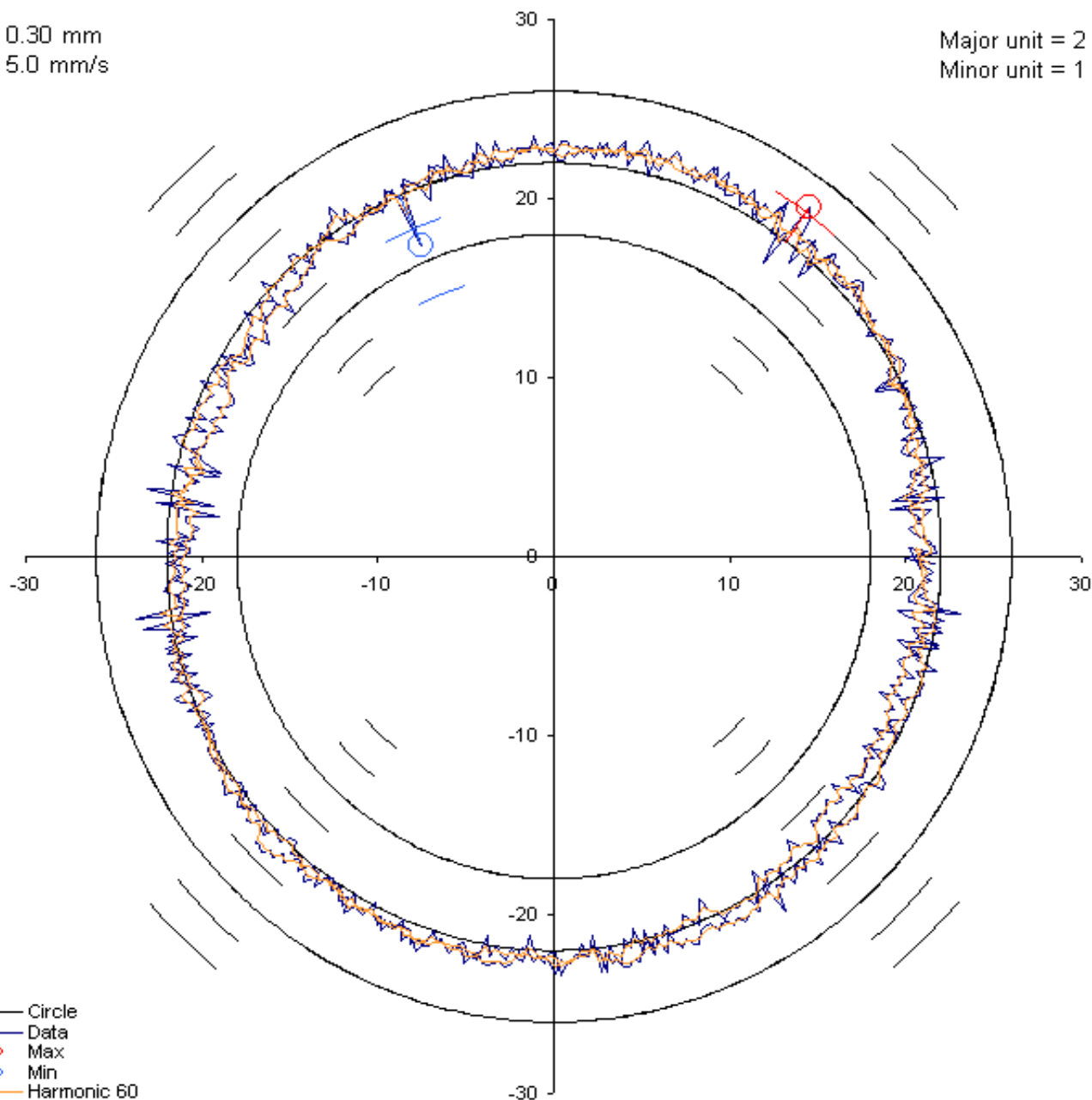
## Form identification

Ellipse	0.40 µm	300.45 °
Tri lobe	0.10 µm	226.29 °

## Circle Plane Normal

nx	0
ny	0
nz	1

Data collected with 906 points  
2 turns



# Bi-Directional Ring Gauge Scan

Probe: SP25M + SM25-3

Stylus: 200 x Ø6 GF Stem

\\Durham\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\w47867\M3-W48163\rg\_st200\_6\_def0.2.txt

Date Time : 11-Jul-02 #####  
Ring Gauge Ø 49.9982 mm  
Stylus ball Ø 6.0045 mm  
Theoretical Radius 21.9968 mm

Deflection 0.20 mm  
Speed 5.0 mm/s

Major unit = 2 µm  
Minor unit = 1 µm

## Best Fitted Circle

Open File	x	343.6923	mm
	y	267.6569	mm
Analysis	z	314.9965	mm
	Radius	21.9976	mm

## Radius Error

-0.80 µm

## Normal errors (µm)

RMS	0.43	0.30
Max	1.0	0.7
Min	-1.9	-1.3
Span	3.0	2.0

Harmonic filter Order = 60 upr  
Cut off  $wc = 376.99 \text{ rad}$   
( upr = Undulation Per Revolution )

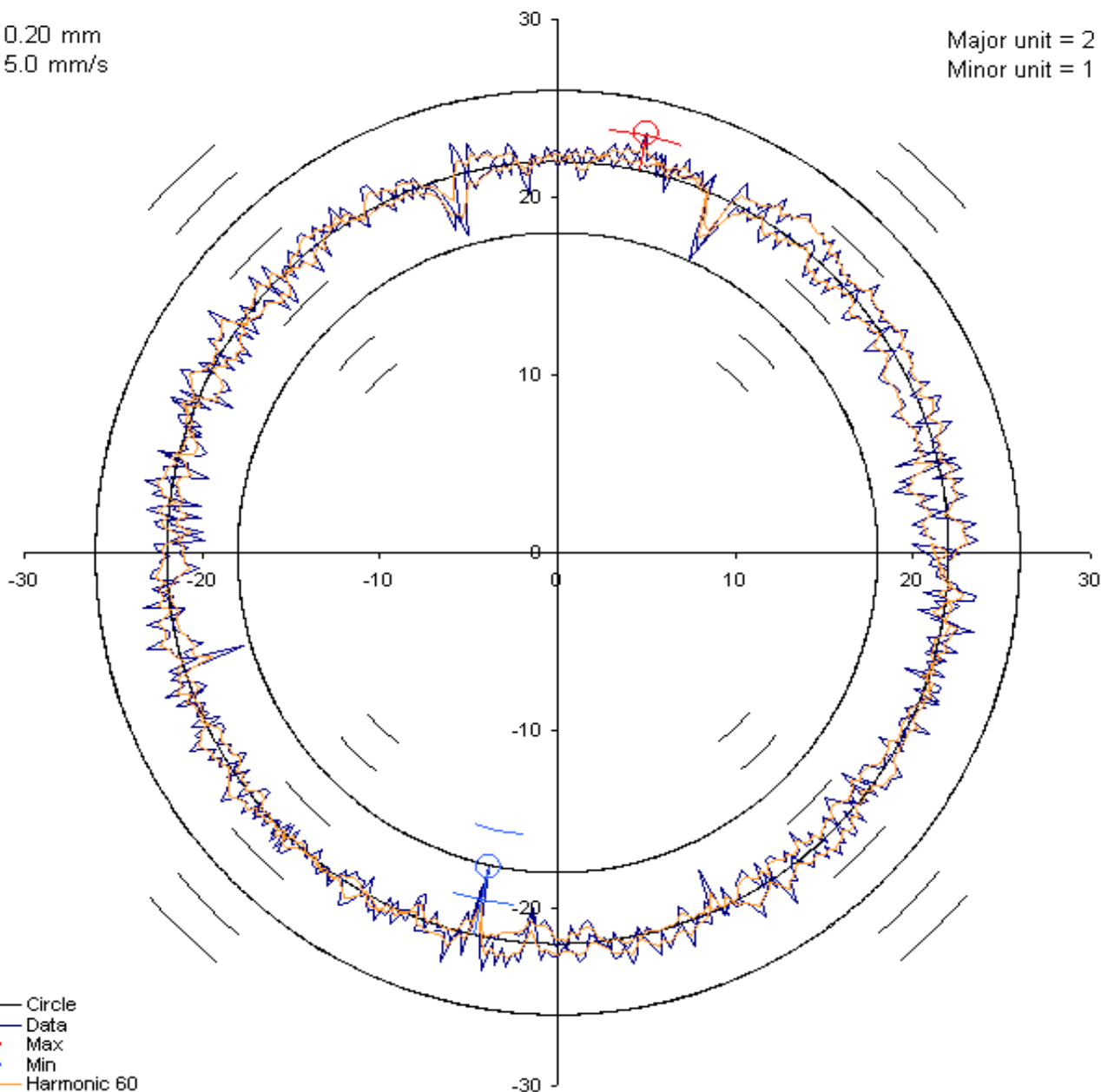
## Form identification

Ellipse	0.05 µm	305.43 °
Tri lobe	0.03 µm	200.71 °

## Circle Plane Normal

nx	0
ny	0
nz	1

Data collected with 904 points  
2 turns



# Bi-Directional Ring Gauge Scan

Probe: SP25M + SM25-4

Stylus: 200mm x Ø8 GF Stem

\\Worcester\cmmnwprodprb\Project Files\2237\Dev Test\Tests for Alpha\Metrology\X35715\M4-0K2781\SM25-4\_400mm\_X35715\_0K2781\_3D\_ISO\_RG\_Inc2.TXT

Ring Gauge Ø	39.9993	mm
Stylus ball Ø	8.0050	mm
Theoretical Radius	15.9971	mm

Deflection 0.200 mm  
Speed 5.0 mm/s

Major unit = 4 µm  
Minor unit = 2 µm

## Best Fitted Circle

Open File	x	-105.4381	mm
	y	54.5181	mm
Analysis	z	-59.7734	mm
	radius	15.9981	mm

## Ø Error

-2.00 µm

## Normal errors (µm)

RMS	0.83	0.50
Max	3.00	1.32
Min	-2.68	-1.36
Span	5.67	2.68
HF Noise Rms Value	0.53	

Harmonic filter Order = 60 upr  
Cut off  $\omega_c = 376.99 \text{ rad}$   
(upr = Undulation Per Revolution)

## Form identification

Ellipse	0.16 µm	129.08 °
Tri lobe	0.15 µm	347.89 °

## Circle Plane Normal

nx	0.0059
ny	1
nz	-0.0041

Data collected with 1881 points  
2 turns

## ISO 10360 error (µm)

ISO Tj	5.7	2.68
ISO Diff	3.7	2.36

Form minor scale unit 0.002  
form major scale unit 0.004

