7.3 Complete experimental results

In the following pages we will present the complete set of results for the samples described in Table 7.1.2. As twelve microstepped topographic measurements and residuals are available for each of the samples, the amount of data involved is quite large and has as far as possible been organized in order to facilitate its interpretation.

This whole section has been arranged in order to closely follow the guidelines and structure of Section 6, from the contents of each sub-section to the order in which the presentation unfolds. In Section 7.3 we will follow the same pattern, as all topographic measurements and residuals have been grouped in pages with samples sharing a common orientation (G00, G30, G60 or G90), so each graphics page contains the topographies and residuals of one sample at one given orientation in three different positions (P1,P2 and P3), in the same way as the spherical samples in Section 6.3. For each plot page, a Table containing the numerical characteristics of the corresponding experiments, and the results for two-dimensional and three-dimensional fitting are provided. Results are arranged in the same pattern as the Tables in Section 6.3, with the obvious modifications introduced by the different geometry of the surface (two different radii of curvature are now being measured) and by removing the curvature values in two-dimensional fitting results, as these are simply the inverse of the measured radii. Standard deviations are only provided as three-dimensional fitting results, in the same way as was done in Section 6.3. As previously done with spherical samples, data has been distributed in order to simultaneously present to the reader both numerical results and their corresponding plots on consecutive pages, so it will be possible to see both the numerical results and the topographic and residual plots of the measured data at a glance.

In Section 7.3.2, experimental results will be analyzed and the tendencies observed in the measured data will be presented. As in Section 6.3, detailed comments on the characteristics of each plot or numerical result will not be given unless the measured result requires this.

7.3.1.- Measured data

Experimental measurements have been classified in coinciding Figure and Table numbers, so the numerical results of a given table describe the topographic and residual plots of the figure with the same number. Figure numbers have been

maintained for the same sample, naming each orientation as subplots (and table subdivisions) a, b, c and d for the G00, G30, G60 and G90 tilts, respectively.

- Figure and Table 7.3.1, a to d, depict topographic and residual plots for sample P30025A.

- Figure and Table 7.3.2, from a to d, depict the topographic and residual plots for sample P30025B.

- Figure and Table 7.3.3, from a to d, depict the topographic and residual plots for sample P30050A.

- Figure and Table 7.3.4, from a to d, depict the topographic and residual plots for sample P30050B.

- Figure and Table 7.3.5, from a to d, depict the topographic and residual plots for sample P45075A.

- Figure and Table 7.3.6, from a to d, depict the topographic and residual plots for sample P45075B.

In all Tables, the notation used in previous sections is preserved, so:

N stands for the number of available data points.

Δz stands for the total measured height range.

A stands for the measured area.

K_B (K_C) stands for the angular misalignment in the base (cross) curve direction.

r_B^2 (r_C^2) stands for the two-dimensional correlation coefficient of the linear fit along the direction of the base (cross) curve.

R_B (R_C) stands for the radius of curvature in the base (cross) curve direction.

x_0 (y_0) stands for the x (y) coordinate for the position of the vertex of the surface.

θ stands for the measured angular position of the principal meridian present in the first quadrant.

σ_α stands for the standard deviation for parameter α.

r stands for the correlation coefficient of the three-dimensional fitting procedure.

$\Delta z_{RESIDUAL}$ is the range of height residuals calculated.

Radioscope reference measurements (with uncertainties in the measurement range around 1mm) are provided at the foot of each Table in order to provide an independent radius of curvature measurement.

Table 7.3.1a: Measured results for sample P30025A, G00 tilt.

Sample P30025A G00 tilt	**Parameter**	**P1 d_R=186.7mm**	**P2 d_R=192.2mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6290	9594	10435
	Δz(mm)	0.468	0.383	0.380
	A(mm^2)	259.3	248.5	243.7
2D fitting	**K_B(rad)**	$-1.141\ 10^{-3}$	$-2.455\ 10^{-3}$	$-9.271\ 10^{-4}$
	r_B^2	0.9999978	0.9999901	0.9999963
	K_C(rad)	$-13.7\ 10^{-3}$	$-1.699\ 10^{-3}$	$-3.225\ 10^{-3}$
	r_C^2	0.9999963	0.9999949	0.9999949
	R_B(mm)	172.6	172.6	172.6
	R_C(mm)	160.8	160.7	160.7
3D fitting	**R_B(mm)**	172.7	172.7	172.3
	R_C(mm)	160.6	160.5	160.8
	σ_B(mm)	$2.4\ 10^{-3}$	$2.4\ 10^{-3}$	$2.1\ 10^{-3}$
	σ_C(mm)	$3.2\ 10^{-3}$	$3.2\ 10^{-3}$	$2.8\ 10^{-3}$
	x_0(mm)	0.210	0.277	0.159
	y_0(mm)	-0.199	-0.420	-0.518
	σ_{Xo}(mm)	$5.3\ 10^{-5}$	$5.9\ 10^{-5}$	$5.2\ 10^{-5}$
	σ_{Yo}(mm)	$2.2\ 10^{-4}$	$4.1\ 10^{-5}$	$3.5\ 10^{-5}$
	θ(°)	0.10	0.45	0.14
	σ_θ(°)	$6.0\ 10^{-3}$	$6.1\ 10^{-3}$	$5.3\ 10^{-3}$
	r^2	0.9999993	0.9999987	0.9999989
	$\Delta z_{RESIDUAL}$(mm)	$3.352\ 10^{-4}$	$2.586\ 10^{-4}$	$5.272\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.0±1.0mm**

R_C=159.7±1.0mm

Fig. 7.3.1a: Measured surface topographies and residuals: sample P30025A,G00 tilt.

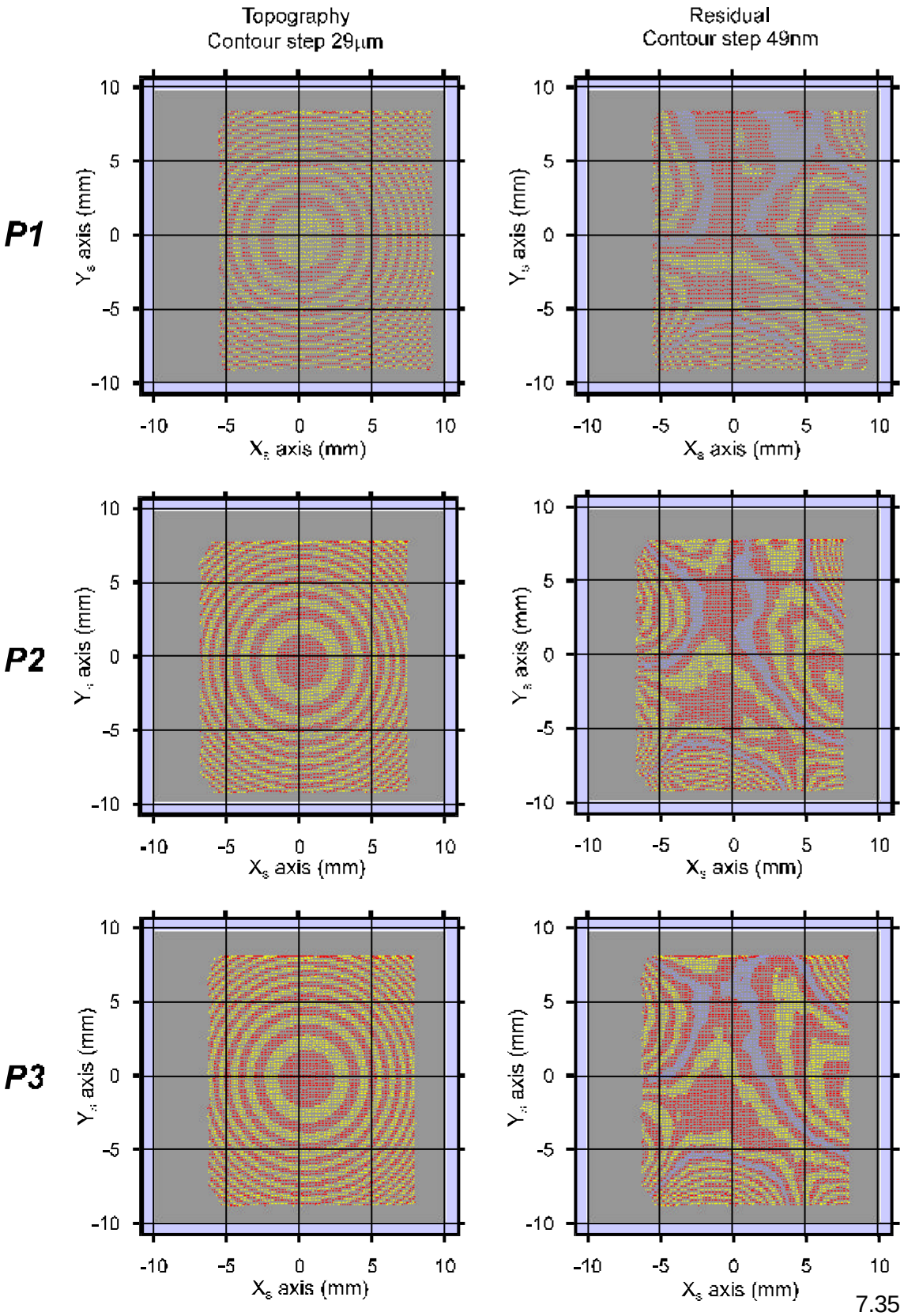

Table 7.3.1b: Measured results for sample P30025A, G30 tilt.

Sample P30025A G30 tilt	Parameter	P1 d_R=186.7mm	P2 d_R=192.2mm	P3 d_R=193.4mm
Experiment	N(points)	6418	9689	10372
	Δz(mm)	0.459	0.425	0.413
	A(mm^2)	286.9	270.7	266.3
2D fitting	K_B(rad)	$2.515\ 10^{-3}$	$3.003\ 10^{-3}$	$2.873\ 10^{-3}$
	r_B^2	0.999986	0.9999929	0.9999980
	K_C(rad)	$-3.396\ 10^{-3}$	$-3.226\ 10^{-3}$	$-3.324\ 10^{-3}$
	r_C^2	0.999942	0.9999824	0.999923
	R_B(mm)	172.5	172.5	172.5
	R_C(mm)	160.7	160.7	160.7
3D fitting	R_B(mm)	172.7	172.6	172.3
	R_C(mm)	160.6	160.7	160.9
	σ_B(mm)	$1.5\ 10^{-3}$	$2.1\ 10^{-3}$	$1.5\ 10^{-3}$
	σ_C(mm)	$2.1\ 10^{-3}$	$2.8\ 10^{-3}$	$2.0\ 10^{-3}$
	x_0(mm)	0.549	0.523	0.491
	y_0(mm)	0.432	0.515	0.540
	σ_{Xo}(mm)	$5.8\ 10^{-5}$	$9.2\ 10^{-5}$	$5.9\ 10^{-5}$
	σ_{Yo}(mm)	$6.0\ 10^{-5}$	$8.2\ 10^{-5}$	$6.2\ 10^{-5}$
	θ(°)	29.68	29.52	29.37
	σ_θ(°)	$6.1\ 10^{-3}$	$8.7\ 10^{-3}$	$6.1\ 10^{-3}$
	r^2	0.9999996	0.9999988	0.9999994
	$\Delta z_{RESIDUAL}$(mm)	$1.999\ 10^{-4}$	$6.704\ 10^{-4}$	$3.346\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.0±1.0mm**

R_C=159.7±1.0mm

Fig. 7.3.1b: Measured surface topographies and residuals: sample P30025A, G30 tilt.

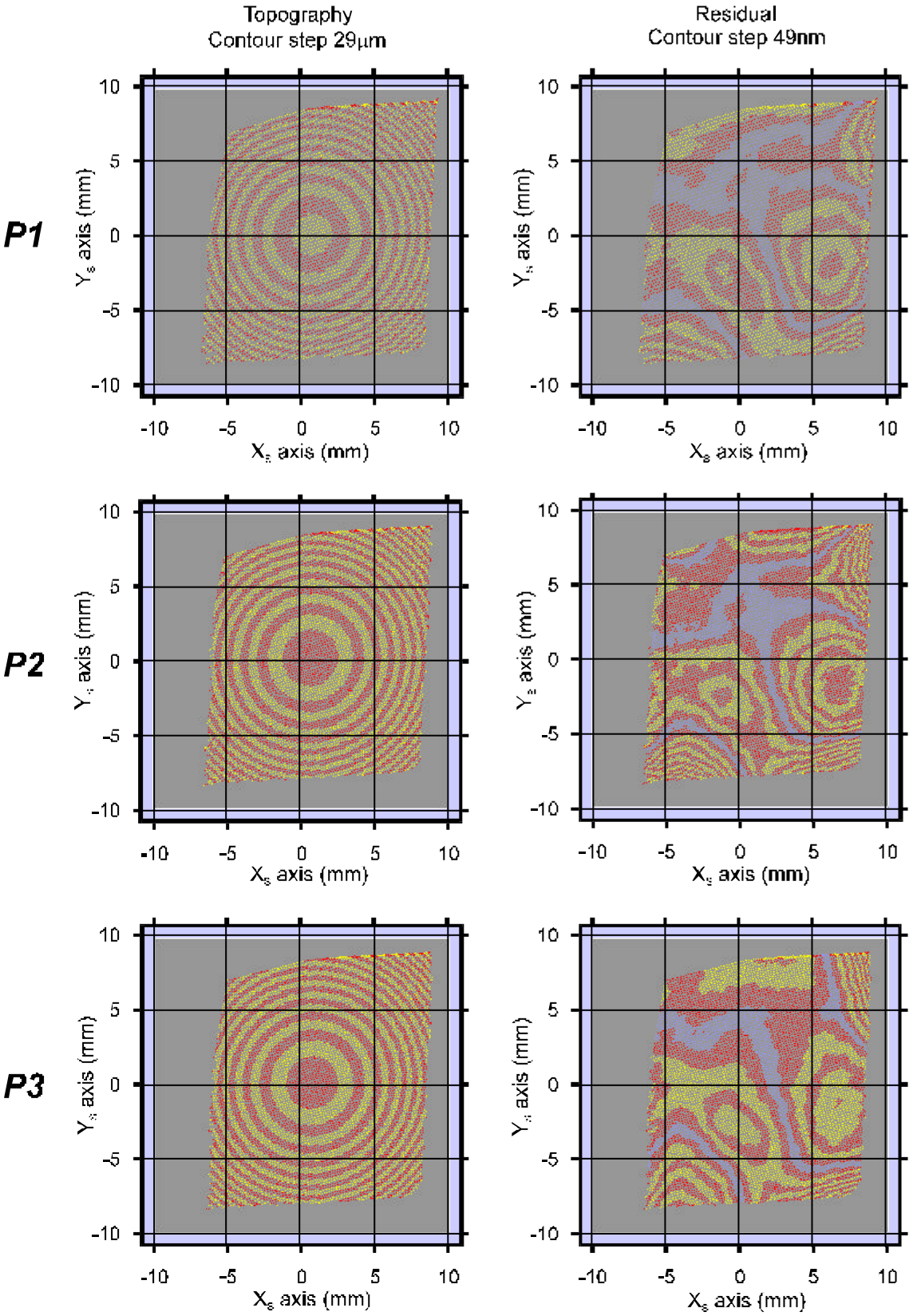

Table 7.3.1c: Measured results for sample P30025A, G60 tilt.

Sample P30025A G60 tilt	**Parameter**	**P1 d_R=186.7mm**	**P2 d_R=192.2mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6398	9607	10311
	Δz(mm)	0.452	0.417	0.409
	A(mm^2)	278.9	269.7	264.7
2D fitting	**K_B(rad)**	$2.662\ 10^{-3}$	$3.003\ 10^{-3}$	$6.305\ 10^{-3}$
	r_B^2	0.9999979	0.9999929	0.9999986
	K_C(rad)	$-5.952\ 10^{-4}$	$-1.628\ 10^{-3}$	$2.052\ 10^{-3}$
	r_C^2	0.9999943	0.9999943	0.9999897
	R_B(mm)	172.3	172.5	172.4
	R_C(mm)	160.7	160.7	160.9
3D fitting	**R_B(mm)**	172.4	173.1	172.6
	R_C(mm)	160.5	159.7	160.7
	σ_B(mm)	$1.7\ 10^{-3}$	$4.2\ 10^{-3}$	$1.5\ 10^{-3}$
	σ_C(mm)	$1.9\ 10^{-3}$	$4.9\ 10^{-3}$	$1.7\ 10^{-3}$
	x_0(mm)	0.895	0.928	1.094
	y_0(mm)	0.039	0.220	0.309
	σ_{Xo}(mm)	$1.1\ 10^{-4}$	$8.4\ 10^{-5}$	$1.2\ 10^{-4}$
	σ_{Yo}(mm)	$2.5\ 10^{-5}$	$2.5\ 10^{-4}$	$3.9\ 10^{-5}$
	θ(°)	59.32	59.22	59.02
	σ_θ(°)	$6.4\ 10^{-3}$	$1.4\ 10^{-2}$	$5.7\ 10^{-3}$
	r^2	0.9999996	0.9999961	0.9999995
	$\Delta z_{RESIDUAL}$(mm)	$2.022\ 10^{-4}$	$7.848\ 10^{-4}$	$2.394\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.0±1.0mm**

R_C=159.7±1.0mm

Fig. 7.3.1c: Measured surface topographies and residuals: sample P30025A, G60 tilt.

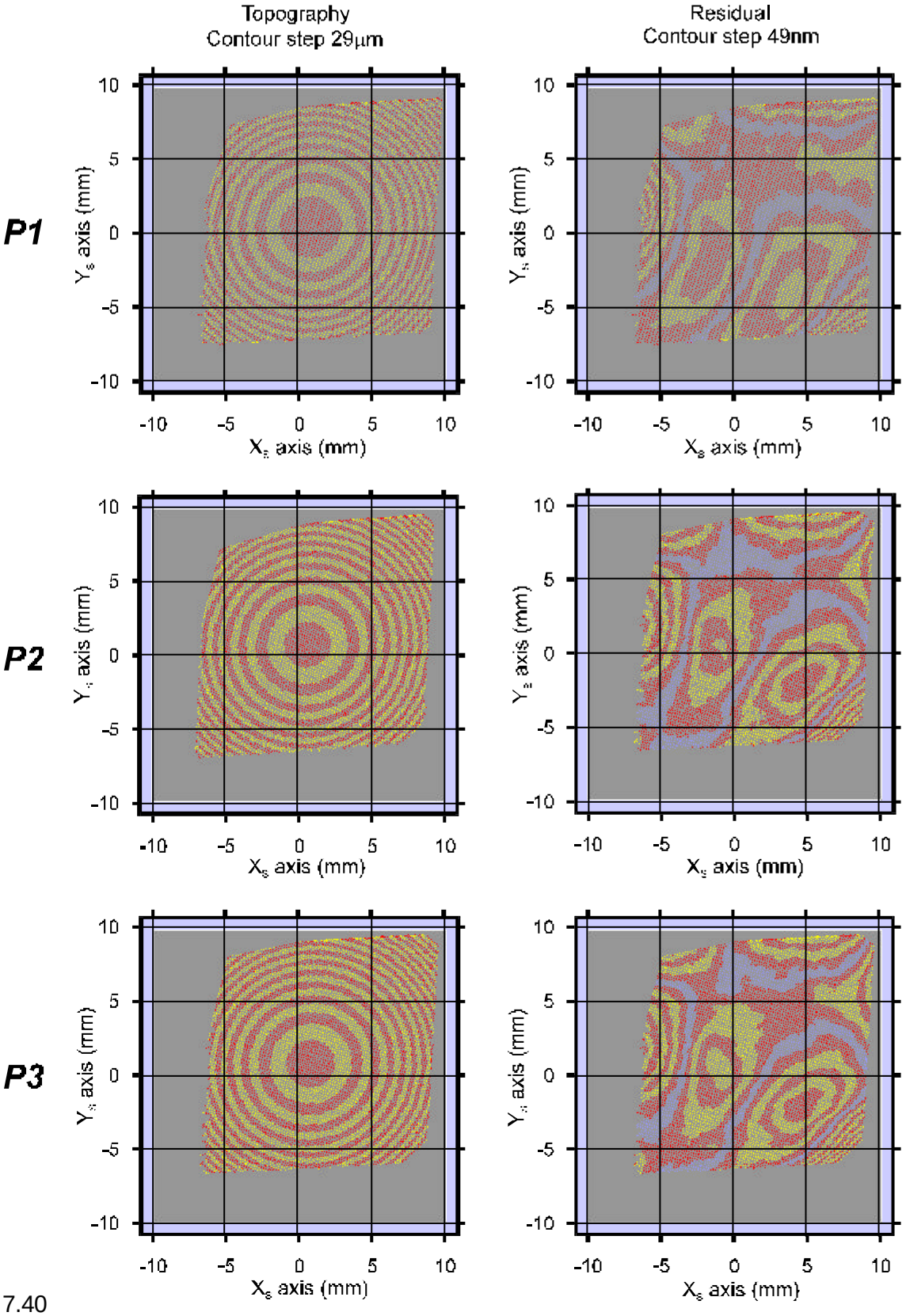

Table 7.3.1d: Measured results for **sample** P30025A, G90 tilt.

Sample P30025A G90 tilt	**Parameter**	**P1 d_R=186.7mm**	**P2 d_R=192.2mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6456	9644	10403
	Δz(mm)	0.421	0.399	0.373
	A(mm^2)	257.2	245.6	243.3
2D fitting	**K_B(rad)**	$-2.300\ 10^{-3}$	$-2.699\ 10^{-3}$	$-7.472\ 10^{-3}$
	r_B^2	0.9999975	0.9999968	0.9999963
	K_C(rad)	$7.176\ 10^{-3}$	$8.327\ 10^{-3}$	$4.698\ 10^{-3}$
	r_C^2	0.9999975	0.9999957	0.9999959
	R_B(mm)	172.1	172.3	172.3
	R_C(mm)	160.8	160.9	160.9
3D fitting	**R_B(mm)**	171.8	172.0	172.4
	R_C(mm)	160.9	161.1	160.8
	σ_B(mm)	$2.6\ 10^{-3}$	$2.5\ 10^{-3}$	$2.5\ 10^{-3}$
	σ_C(mm)	$2.5\ 10^{-3}$	$2.4\ 10^{-3}$	$2.4\ 10^{-3}$
	x_0(mm)	0.395	0.468	0.129
	y_0(mm)	1.155	1.339	0.756
	σ_{Xo}(mm)	$1.1\ 10^{-4}$	$1.3\ 10^{-4}$	$3.3\ 10^{-5}$
	σ_{Yo}(mm)	$5.4\ 10^{-5}$	$5.8\ 10^{-5}$	$7.6\ 10^{-5}$
	θ(°)	0.12	0.10	0.03
	σ_θ(°)	$5.7\ 10^{-3}$	$5.7\ 10^{-3}$	$5.6\ 10^{-3}$
	r^2	0.9999993	0.9999991	0.9999989
	$\Delta z_{RESIDUAL}$(mm)	$2.575\ 10^{-4}$	$2.439\ 10^{-4}$	$3.847\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.0±1.0mm**

R_C=159.7±1.0mm

Fig. 7.3.1d: Measured surface topographies and residuals: sample P30025A,G90 tilt.

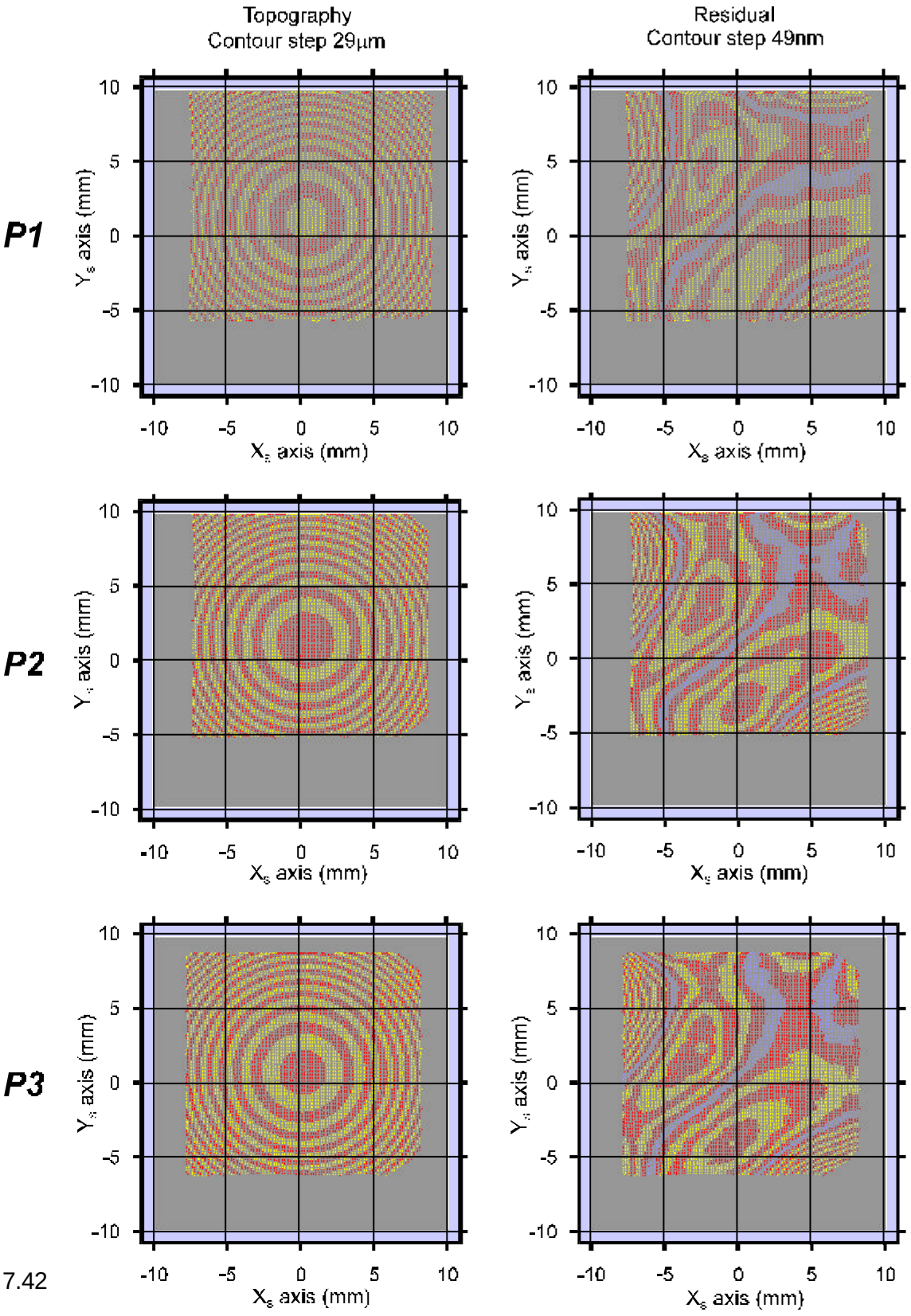

Table 7.3.2a: Measured results for **sample** P30025B, G00 tilt.

Sample P30025B G00 tilt	**Parameter**	**P1 d_R=186.8mm**	**P2 d_R=192.3mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6686	9939	10735
	Δz(mm)	0.382	0.358	0.353
	A(mm^2)	253.5	244.2	241.3
2D fitting	**K_B(rad)**	$-5.801\ 10^{-4}$	$-2.225\ 10^{-3}$	$-3.800\ 10^{-3}$
	r_B^2	0.9999981	0.9999989	0.9999989
	K_C(rad)	$2.313\ 10^{-4}$	$-1.060\ 10^{-3}$	$4.972\ 10^{-4}$
	r_C^2	0.9999973	0.9999979	0.9999974
	R_B(mm)	171.7	172.1	172.2
	R_C(mm)	159.9	160.2	160.3
3D fitting	**R_B(mm)**	171.4	171.9	171.9
	R_C(mm)	159.9	160.3	160.4
	σ_B(mm)	$1.8\ 10^{-3}$	$1.4\ 10^{-3}$	$1.4\ 10^{-3}$
	σ_C(mm)	$2.4\ 10^{-3}$	$1.9\ 10^{-3}$	$1.7\ 10^{-3}$
	x_0(mm)	0.100	-0.167	-0.081
	y_0(mm)	0.038	-0.384	-0.655
	σ_{Xo}(mm)	$2.4\ 10^{-5}$	$2.1\ 10^{-5}$	$1.8\ 10^{-5}$
	σ_{Yo}(mm)	$2.9\ 10^{-5}$	$3.2\ 10^{-5}$	$4.4\ 10^{-5}$
	θ(°)	0.02	0.22	0.02
	σ_θ(°)	$4.5\ 10^{-3}$	$3.5\ 10^{-3}$	$3.3\ 10^{-3}$
	r^2	0.9999995	0.9999995	0.9999995
	$\Delta z_{RESIDUAL}$(mm)	$1.998\ 10^{-4}$	$3.349\ 10^{-4}$	$1.986\ 10^{-4}$

Möller-Wedel radioscope measurement: $R_B = 172.6 \pm 1.0$mm

$R_C = 160.6 \pm 1.0$mm

Fig. 7.3.2a: Measured surface topographies and residuals: sample P30025B,G00 tilt.

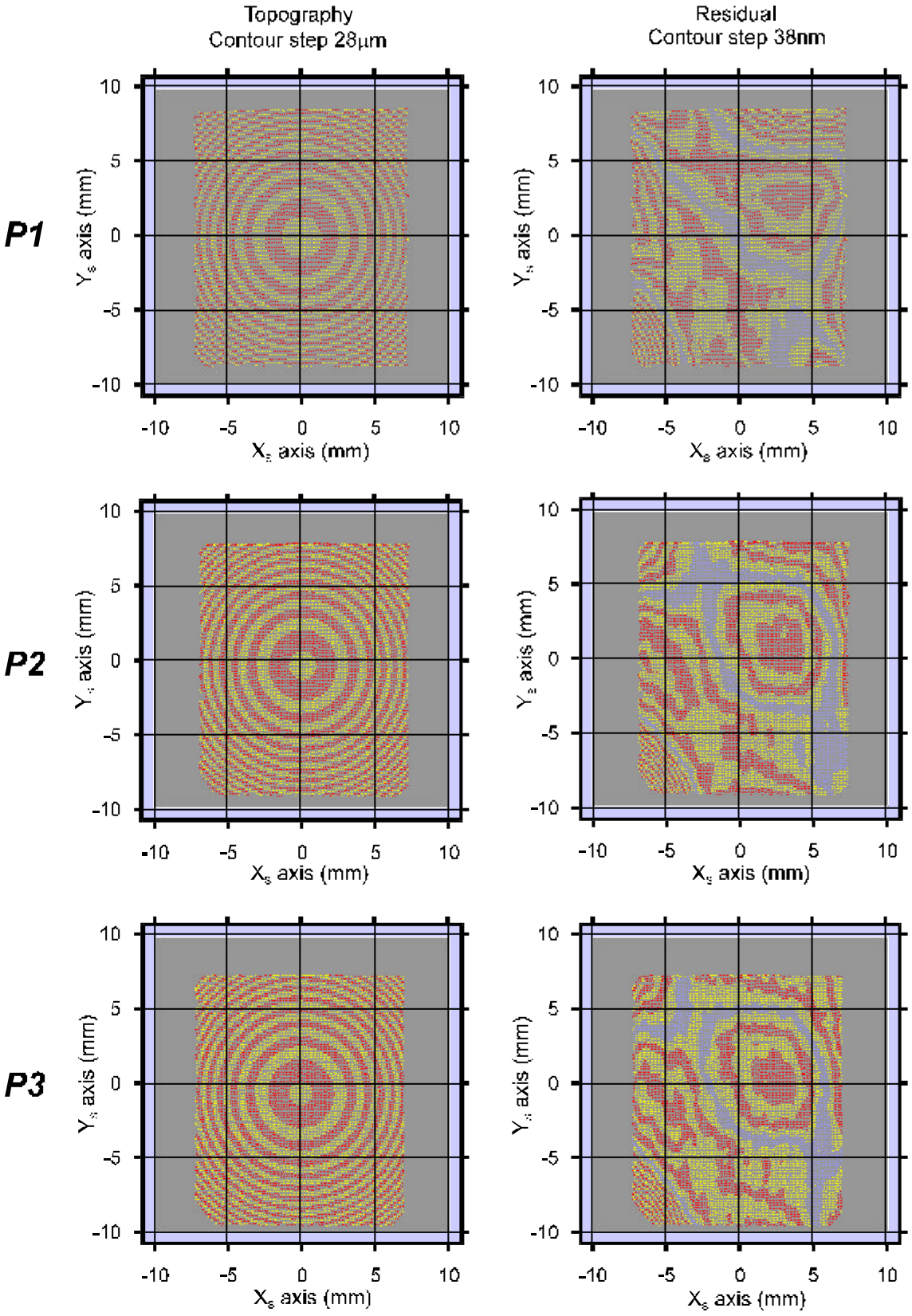
Topography
Contour step 28µm
Residual
Contour step 38nm
P1
P2
P3
Ys axis (mm)
Xs axis (mm)
10
5
0
-5
-10

Table 7.3.2b: Measured results for sample P30025B, G30 tilt.

Sample P30025B G30 tilt	**Parameter**	**P1 d_R=186.8mm**	**P2 d_R=192.3mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6731	9975	10713
	Δz(mm)	0.432	0.395	0.414
	A(mm^2)	276.9	269.4	264.1
2D fitting	**K_B(rad)**	$2.582\ 10^{-3}$	$-9.732\ 10^{-4}$	$1.887\ 10^{-3}$
	r_B^2	0.9999979	0.9999974	0.9999977
	K_C(rad)	$-1.929\ 10^{-3}$	$-2.733\ 10^{-3}$	$-3.553\ 10^{-3}$
	r_C^2	0.9999985	0.9999968	0.9999969
	R_B(mm)	171.7	172.1	172.1
	R_C(mm)	159.9	160.3	160.4
3D fitting	**R_B(mm)**	171.5	171.8	171.9
	R_C(mm)	160.0	160.5	160.5
	σ_B(mm)	$1.4\ 10^{-3}$	$1.1\ 10^{-3}$	$1.0\ 10^{-3}$
	σ_C(mm)	$1.9\ 10^{-3}$	$1.5\ 10^{-3}$	$1.4\ 10^{-3}$
	x_0(mm)	0.440	0.174	0.574
	y_0(mm)	0.313	-0.434	0.316
	σ_{Xo}(mm)	$3.7\ 10^{-5}$	$3.5\ 10^{-5}$	$4.2\ 10^{-5}$
	σ_{Yo}(mm)	$5.3\ 10^{-5}$	$2.4\ 10^{-5}$	$3.0\ 10^{-5}$
	θ(°)	29.33	29.02	29.07
	σ_θ(°)	$5.8\ 10^{-3}$	$4.4\ 10^{-3}$	$4.1\ 10^{-3}$
	r^2	0.9999996	0.9999996	0.9999996
	$\Delta z_{RESIDUAL}$(mm)	$2.008\ 10^{-4}$	$1.998\ 10^{-4}$	$1.934\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.6±1.0mm**

R_C=160.6±1.0mm

Fig. 7.3.2b: Measured surface topographies and residuals: sample P30025B, G30 tilt.

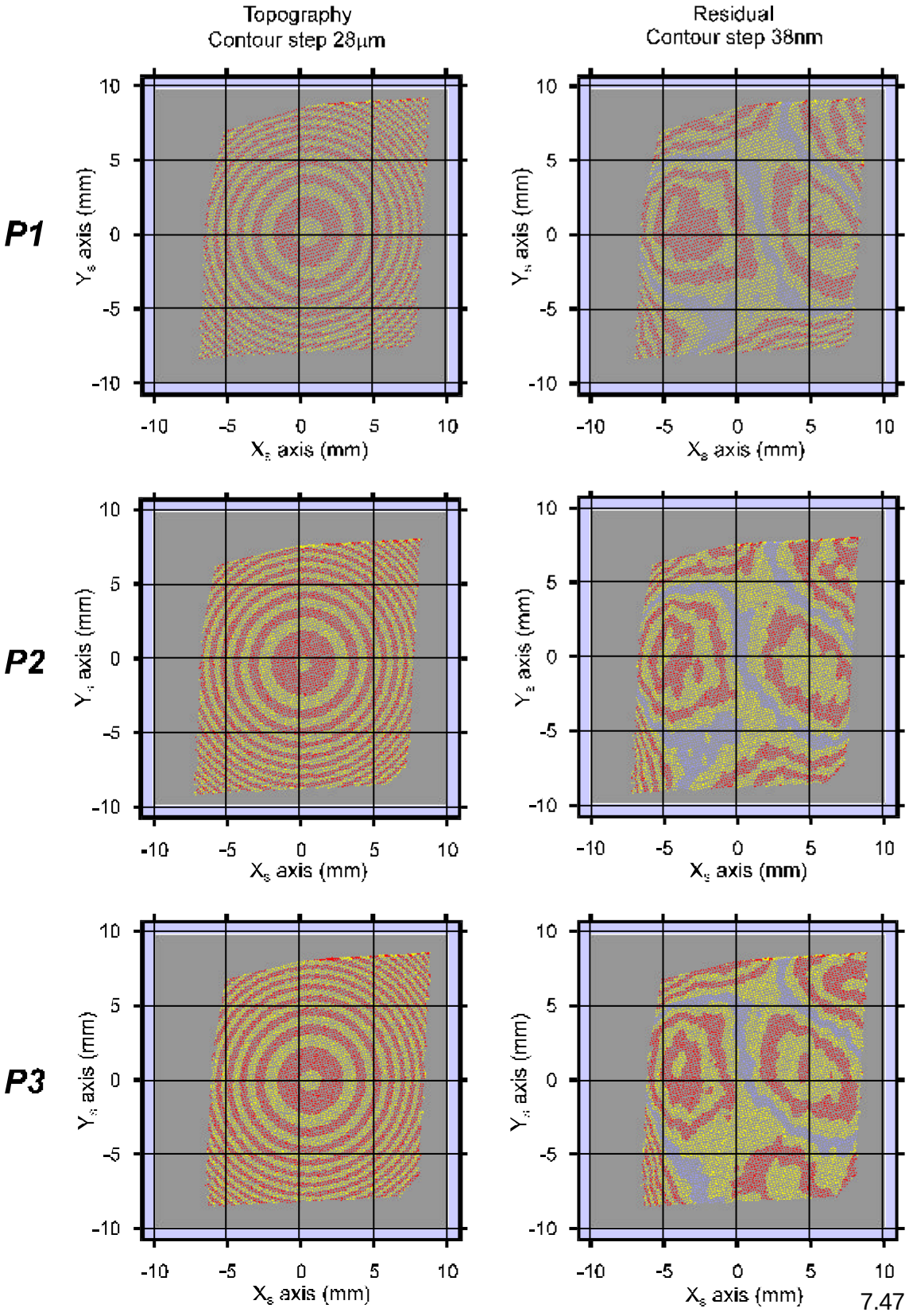

Table 7.3.2c: Measured results for **sample** P30025B, G60 tilt.

Sample P30025B G60 tilt	**Parameter**	**P1 d_R=186.8mm**	**P2 d_R=192.3mm**	**P3 d_R=193.4mm**
Experiment	**N(points)**	6804	9918	10681
	Δz(mm)	0.448	0.411	0.387
	A(mm^2)	278.5	267.9	264.8
2D fitting	**K_B(rad)**	$4.418\ 10^{-3}$	$3.653\ 10^{-3}$	$1.473\ 10^{-3}$
	r_B^2	0.9999983	0.9999965	0.9999966
	K_C(rad)	$-1.531\ 10^{-3}$	$-6.691\ 10^{-4}$	$-1.338\ 10^{-3}$
	r_C^2	0.9999931	0.9999964	0.9999958
	R_B(mm)	171.9	171.9	172.0
	R_C(mm)	160.5	160.6	160.6
3D fitting	**R_B(mm)**	172.0	172.1	172.1
	R_C(mm)	160.2	160.4	160.4
	σ_B(mm)	$1.8\ 10^{-3}$	$1.2\ 10^{-3}$	$1.2\ 10^{-3}$
	σ_C(mm)	$1.5\ 10^{-3}$	$1.4\ 10^{-3}$	$1.1\ 10^{-3}$
	x_0(mm)	0.754	0.626	0.249
	y_0(mm)	0.261	0.122	-0.220
	σ_{Xo}(mm)	$8.6\ 10^{-5}$	$5.7\ 10^{-5}$	$2.6\ 10^{-5}$
	σ_{Yo}(mm)	$3.3\ 10^{-5}$	$1.9\ 10^{-5}$	$2.1\ 10^{-5}$
	θ(°)	58.74	58.63	58.61
	σ_θ(°)	$5.8\ 10^{-3}$	$4.5\ 10^{-3}$	$4.2\ 10^{-3}$
	r^2	0.9999996	0.9999997	0.9999996
	$\Delta z_{RESIDUAL}$(mm)	$2.055\ 10^{-4}$	$1.998\ 10^{-4}$	$2.499\ 10^{-4}$

Möller-Wedel radioscope measurement: $R_B = 172.6 \pm 1.0$mm

$R_C = 160.6 \pm 1.0$mm

Fig. 7.3.2c: Measured surface topographies and residuals: sample P30025B, G60 tilt.

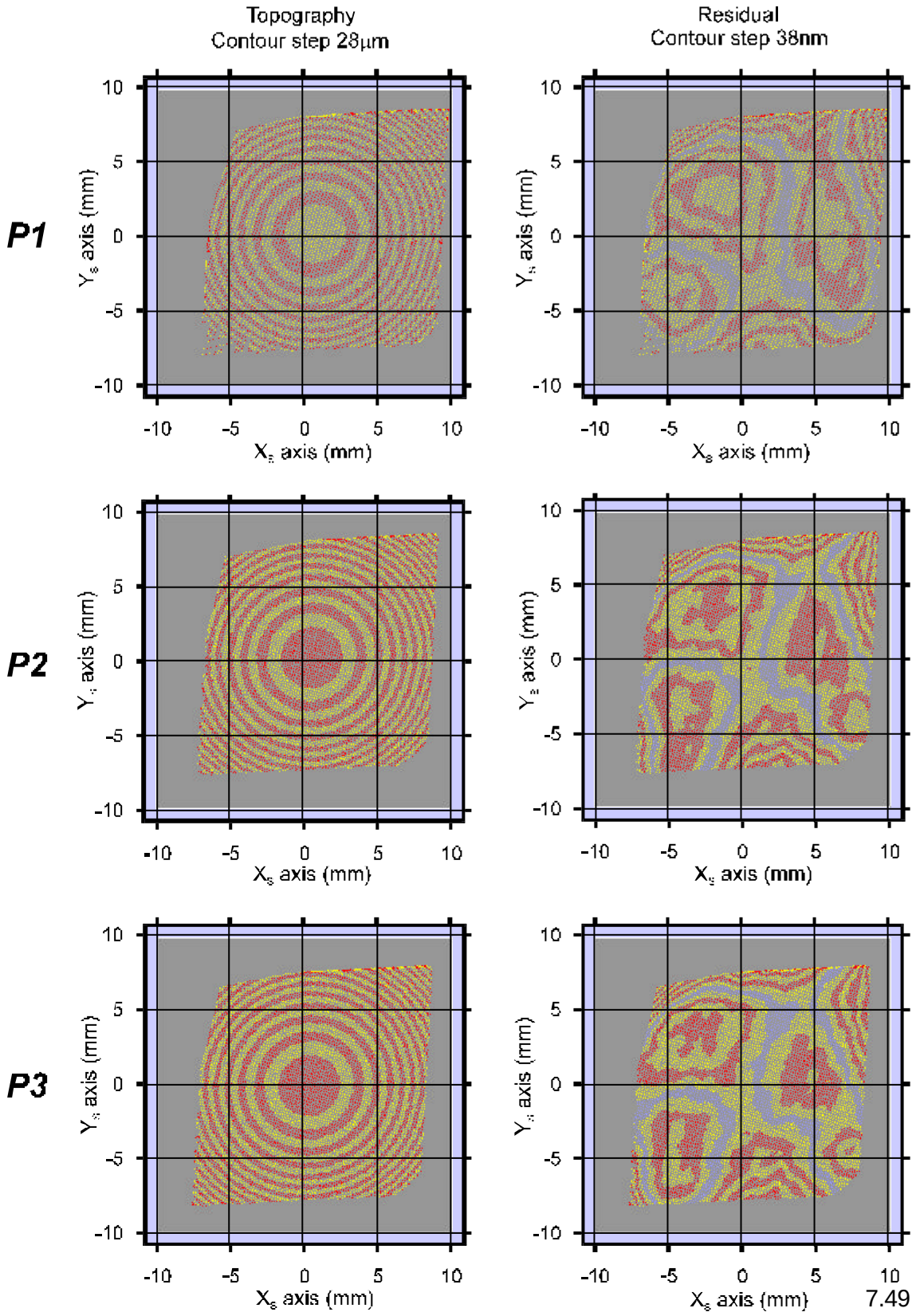

Table 7.3.2d: Measured results for **sample** P30025B, G90 tilt.

Sample P30025B G90 tilt	Parameter	P1 d_R=186.8mm	P2 d_R=192.3mm	P3 d_R=193.4mm
Experiment	N(points)	6667	9894	10678
	Dz(mm)	0.375	0.362	0.357
	A(mm^2)	256.8	244.2	243.9
2D fitting	K_B(rad)	$-6.208\ 10^{-4}$	$-1.898\ 10^{-3}$	$-2.141\ 10^{-3}$
	r_B^2	0.9999984	0.9999977	0.9999977
	K_C(rad)	$1.069\ 10^{-3}$	$2.153\ 10^{-3}$	$2.311\ 10^{-3}$
	r_C^2	0.9999681	0.9999975	0.9999978
	R_B(mm)	171.7	171.8	171.8
	R_C(mm)	160.7	160.8	160.8
3D fitting	R_B(mm)	171.8	171.9	171.9
	R_C(mm)	160.5	160.6	160.6
	s_B(mm)	$2.9\ 10^{-3}$	$1.7\ 10^{-3}$	$1.6\ 10^{-3}$
	s_C(mm)	$3.1\ 10^{-3}$	$1.6\ 10^{-3}$	$1.5\ 10^{-3}$
	x_0(mm)	0.170	0.344	0.369
	y_0(mm)	0.111	0.329	0.372
	s_{Xo}(mm)	$4.1\ 10^{-5}$	$3.1\ 10^{-5}$	$3.1\ 10^{-5}$
	s_{Yo}(mm)	$4.4\ 10^{-5}$	$2.9\ 10^{-5}$	$2.9\ 10^{-5}$
	q(°)	88.02	89.29	89.35
	s_q(°)	$7.2\ 10^{-3}$	$3.9\ 10^{-3}$	$3.6\ 10^{-3}$
	r^2	0.9999988	0.9999995	0.9999995
	$Dz_{RESIDUAL}$(mm)	$5.988\ 10^{-4}$	$2.565\ 10^{-4}$	$3.294\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=172.6±1.0mm**

R_C=160.6±1.0mm

Fig. 7.3.2d: Measured surface topographies and residuals: sample P30025B,G90 tilt.

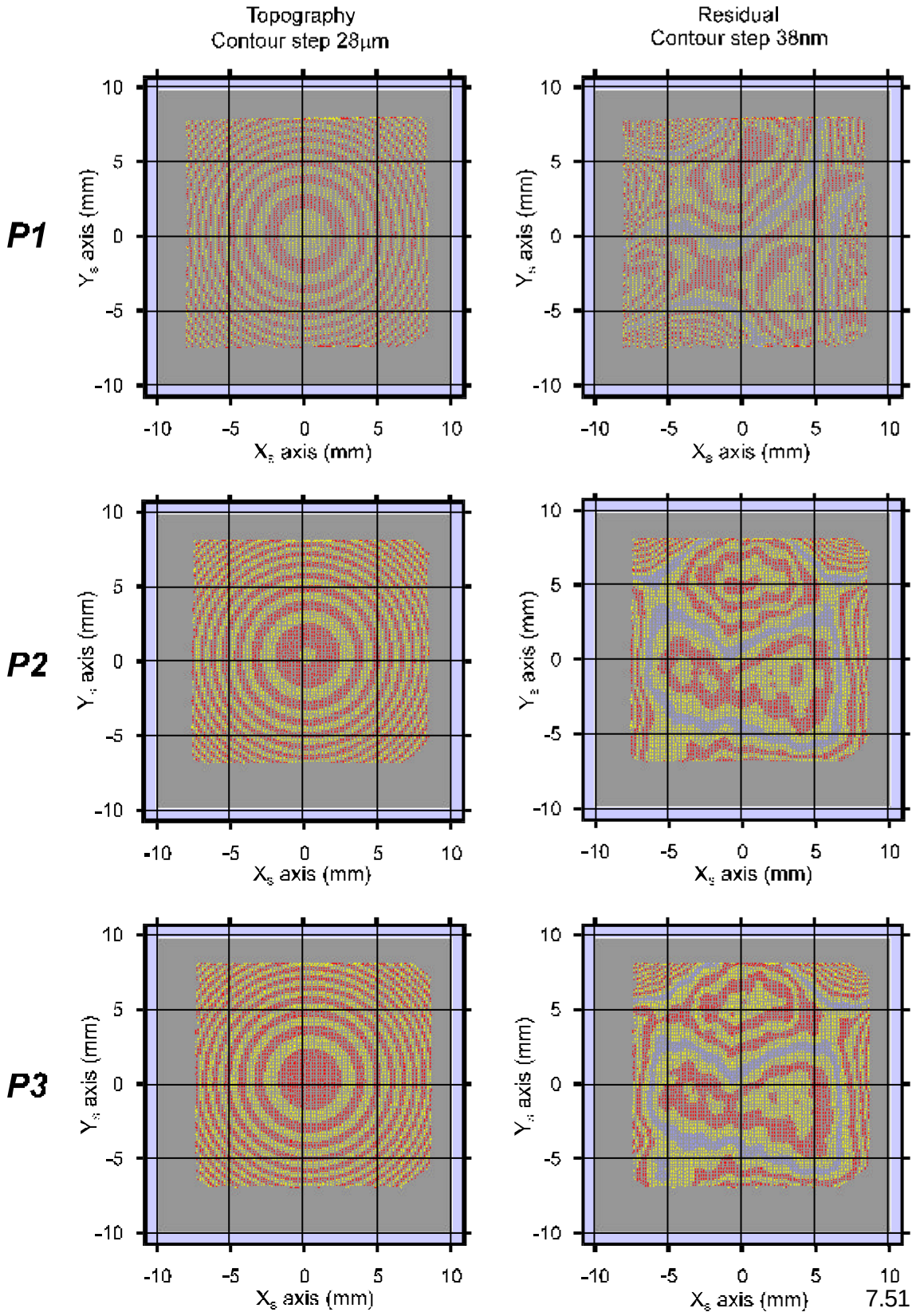

Table 7.3.3a: Measured results for sample P30050A, G00 tilt.

Sample P30050A G00 tilt	**Parameter**	**P1 d_R=180.1mm**	**P2 d_R=182.6mm**	**P3 d_R=188.4mm**
Experiment	**N(points)**	5237	6951	10669
	Δz(mm)	0.410	0.376	0.344
	A(mm^2)	226.8	224.9	218.4
2D fitting	**K_B(rad)**	$-2.761\ 10^{-3}$	$-3.130\ 10^{-3}$	$-4.303\ 10^{-5}$
	r_B^2	0.9999943	0.9999919	0.9999941
	K_C(rad)	$7.025\ 10^{-3}$	$-4.320\ 10^{-3}$	$-5.596\ 10^{-3}$
	r_C^2	0.9999920	0.9999911	0.9999912
	R_B(mm)	170.3	170.4	170.6
	R_C(mm)	148.9	148.9	149.0
3D fitting	**R_B(mm)**	170.5	170.2	170.3
	R_C(mm)	148.8	149.1	149.1
	σ_B(mm)	$3.8\ 10^{-3}$	$3.3\ 10^{-3}$	$2.9\ 10^{-3}$
	σ_C(mm)	$5.9\ 10^{-3}$	$5.1\ 10^{-3}$	$4.2\ 10^{-3}$
	x_0(mm)	0.485	0.641	0.832
	y_0(mm)	-1.037	0.062	0.021
	σ_{Xo}(mm)	$8.9\ 10^{-5}$	$6.6\ 10^{-5}$	$6.7\ 10^{-5}$
	σ_{Yo}(mm)	$1.1\ 10^{-4}$	$5.8\ 10^{-5}$	$4.8\ 10^{-5}$
	θ(°)	89.26	89.34	89.26
	σ_θ(°)	$5.6\ 10^{-3}$	$4.8\ 10^{-3}$	$4.2\ 10^{-3}$
	r^2	0.9999981	0.9999980	0.9999977
	$\Delta z_{RESIDUAL}$(mm)	$4.028\ 10^{-4}$	$5.613\ 10^{-4}$	$6.908\ 10^{-4}$

Möller-Wedel radioscope measurement: **R_B=170.9±1.0mm**

R_C=148.8±1.0mm