Experimental EP Measurement for 300 and 450mm Actual Wafers using SEMI M73

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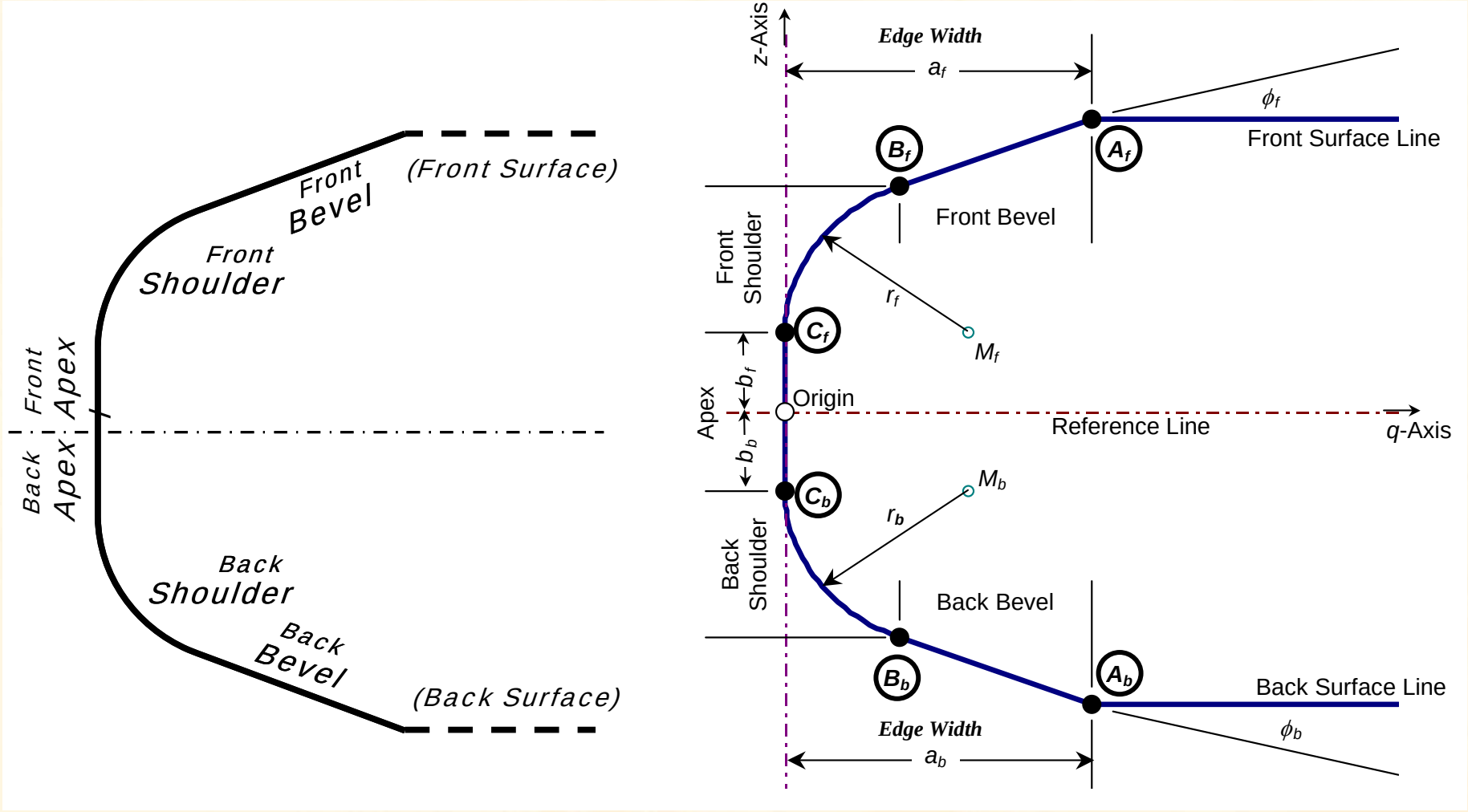
semi

Outline

- Definitions and Terminology of SEMI M73, Method 1 and Method 2
- Edge Profile Measuring Tool of KOBELCO
- Measurement of 300mm Wafer
- Measurement of 450mm Wafer

  (Under Development)
- Summary

SEMI M73 : Definitions & Terminology

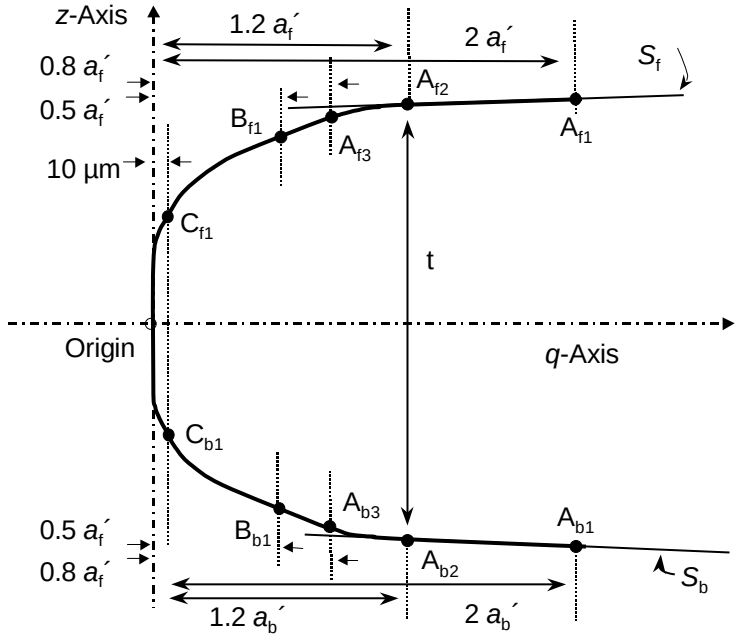


Segment Parameters

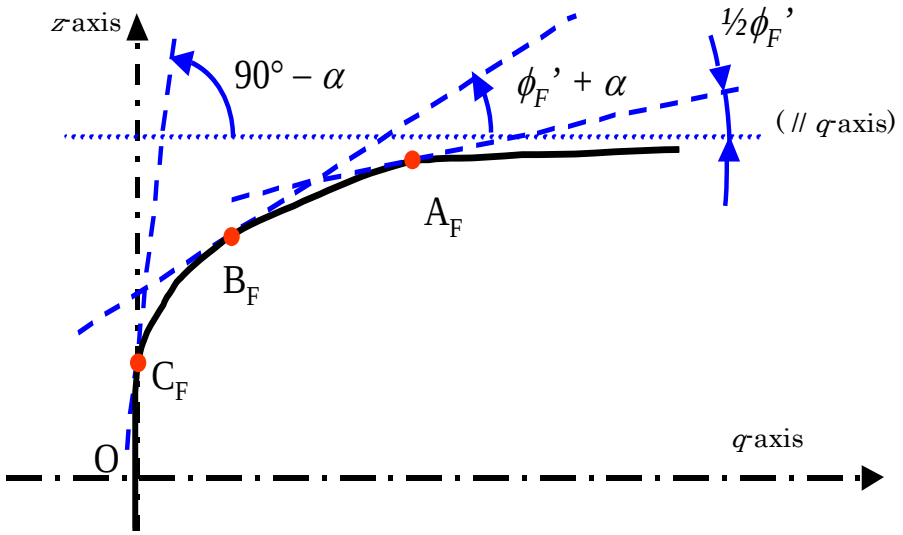
Method 1 and Method 2

Parameter Extraction using

- Specified Edge Width / Reconstruction of Ideal EP (Method 1)
- Specified Bevel Angle / Slope Change Point (Method 2)

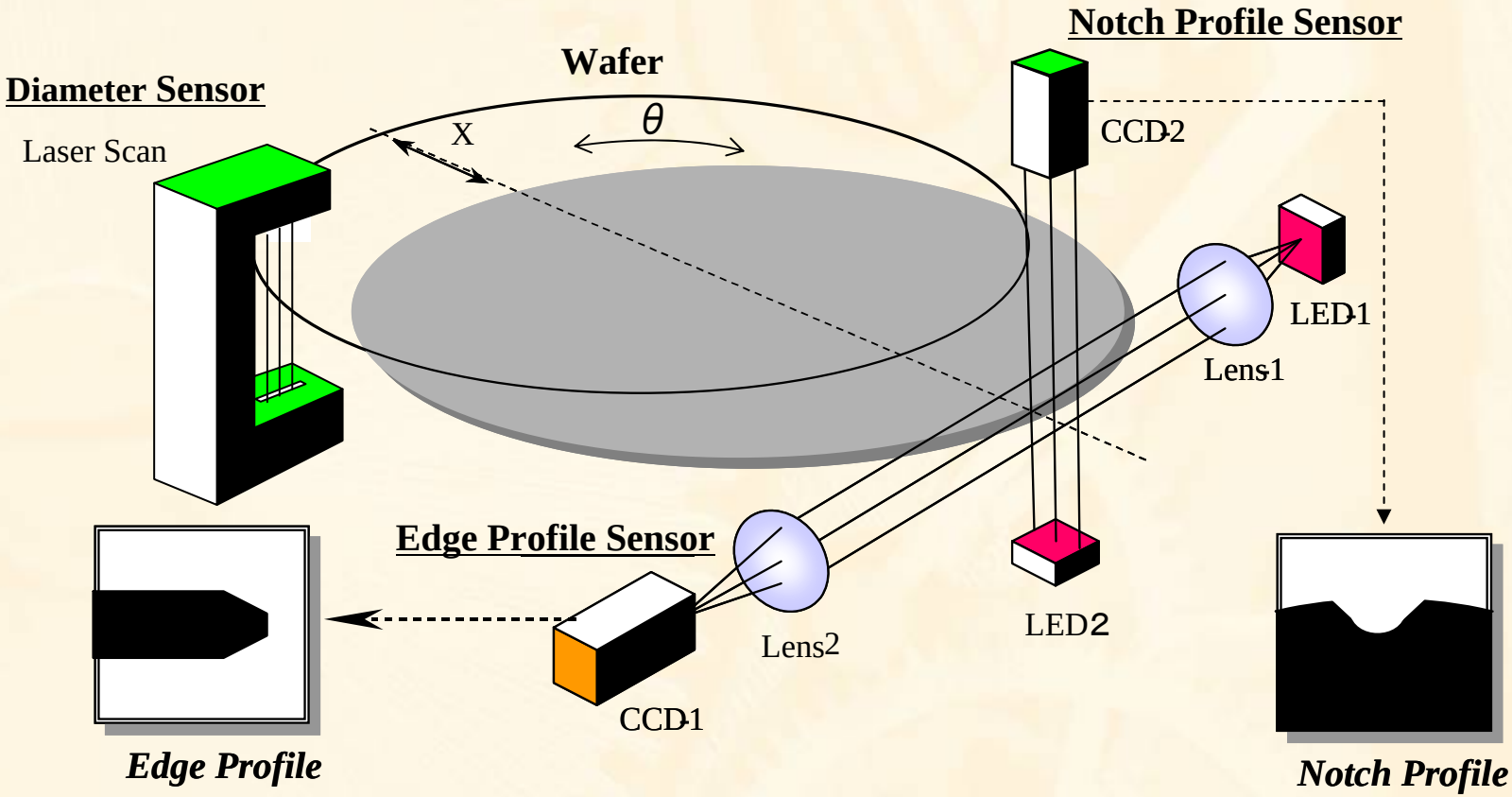


Test Method 1 — Edge-Width Method

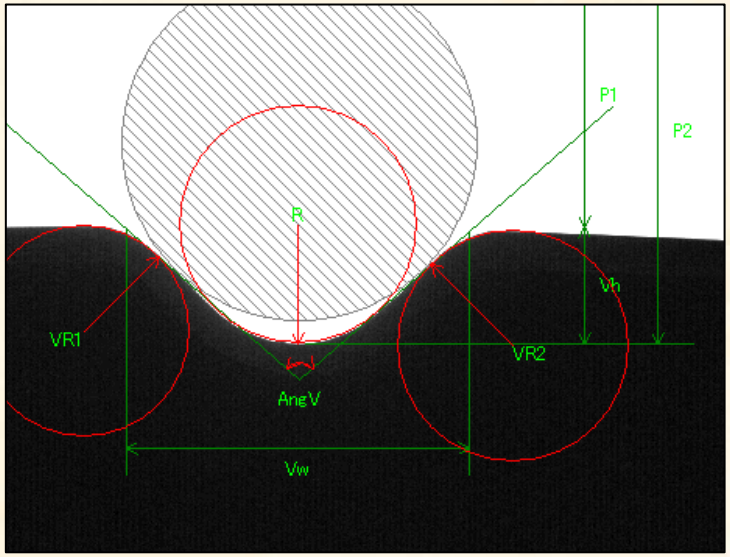


Test Method 2 — Slope-Change Method

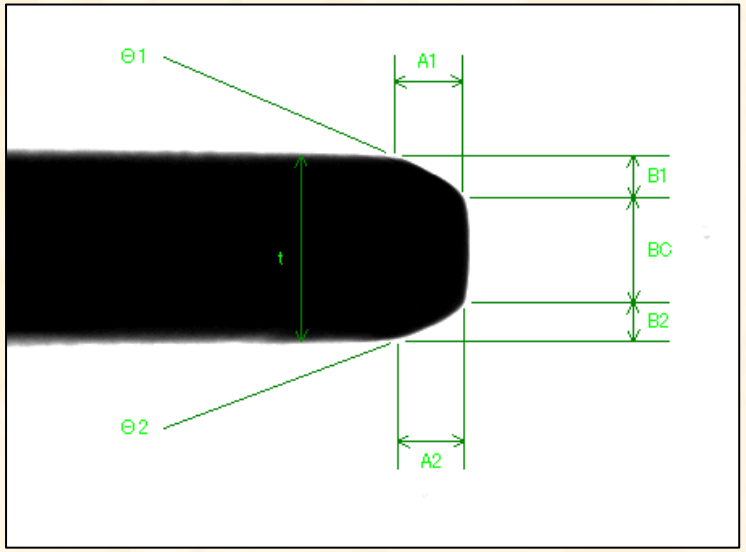
Configuration of Edge Profile Measuring System KOBELCO LEP-2200



Examples of Notch and Edge Measurement

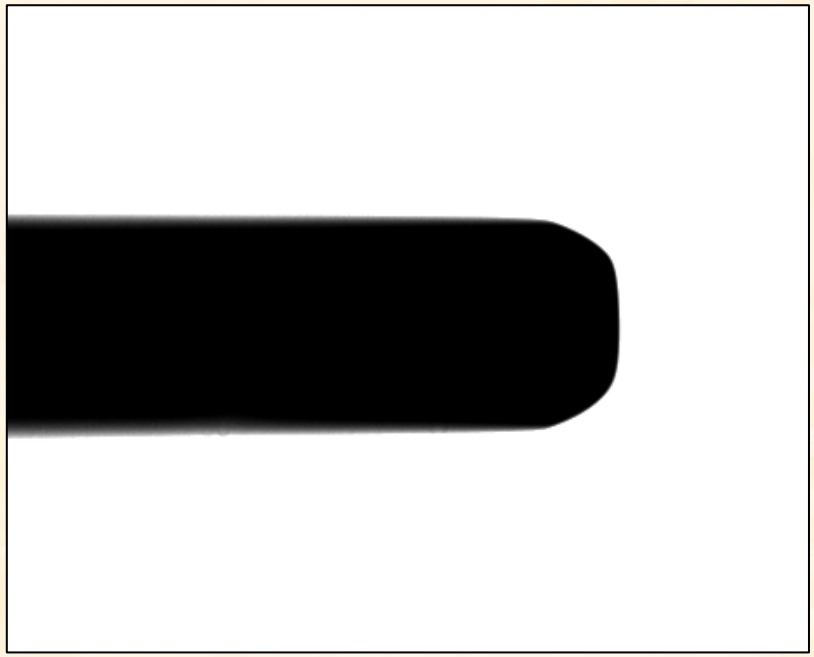


Notch

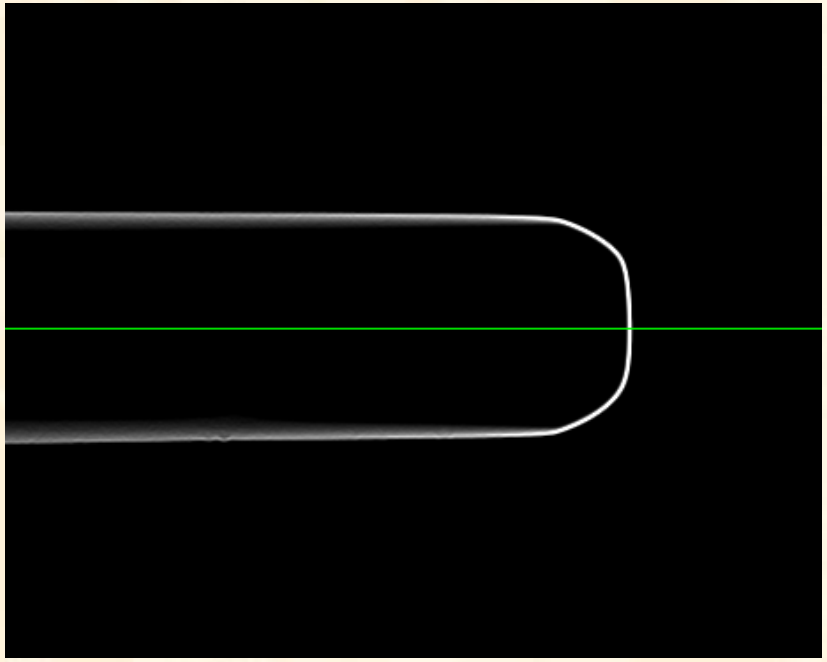


Edge

Image Data Processing



The Silhouette Image Captured by CCD Camera



Spatial Filtering Operations to emphasize the outline

Features of KOBELCO LEP-2200

From 1993 to 2005

Conventional System
LEP-1200 Series

Since 2005

New System
LEP-2200 Series

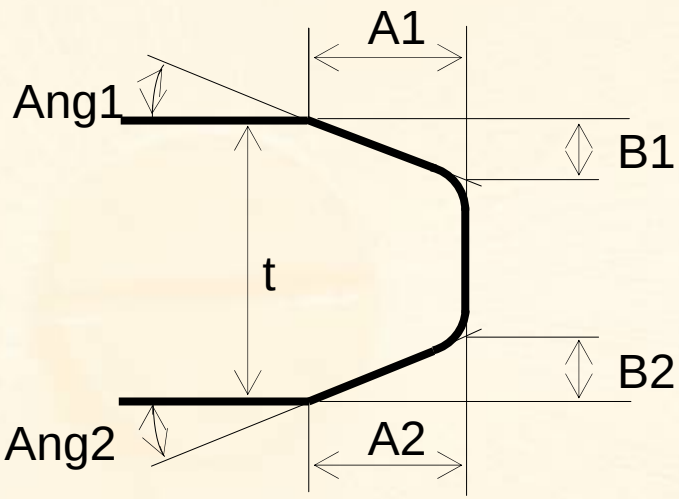
Fully Automatic System
for 300mm Wafer

LEP-2200

Edge Grip Wafer Handling
with FOUP Load Port

LEP-2200FE

Example of Measurements Repeatability



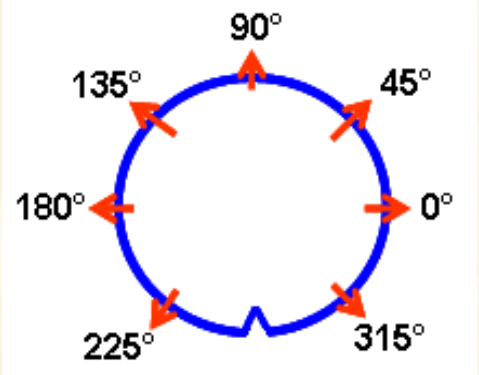
	σ
A1	1.6 um
A2	1.5 um
B1	5.3 um
B2	5.1 um
t	1.6 um
Ang1	0.1 °
Ang2	0.1 °

Conventional System

	σ
A1	0.3 um
A2	0.2 um
B1	0.2 um
B2	0.3 um
t	0.1 um
Ang1	0.03 °
Ang2	0.02 °

New System

Example of Measurement using SEMI M73 Method 1 and Method 2 - 300mm



- 300mm Wafer
- 3 Samples : Blunt, Blunter, Round
- Measurement Point :

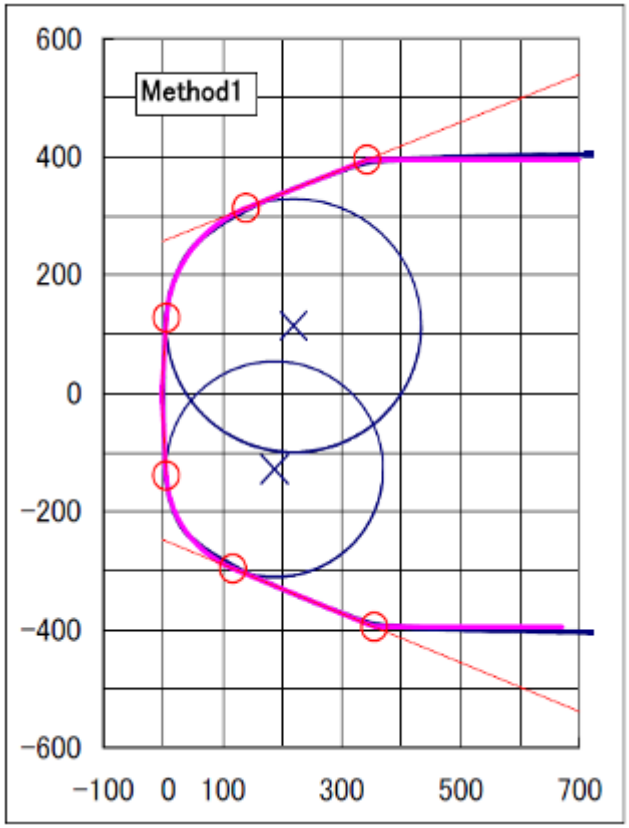
0, 45, 90, 135, 180, 225, 315 degree

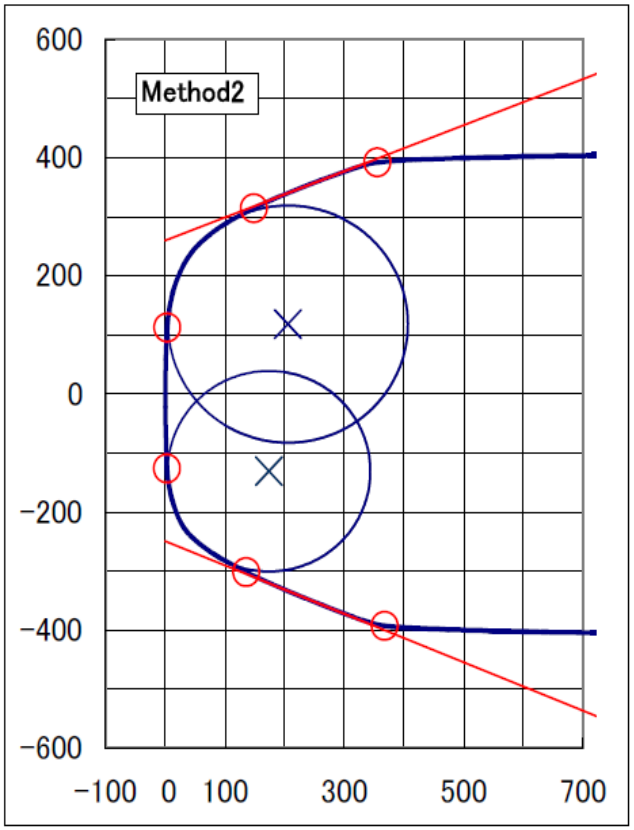
Blunt	Blunter	Round *)
Profile Type A	Profile Type B	Profile Type C

*)Note: Edge Width of Round is larger than that of the definition of M73.

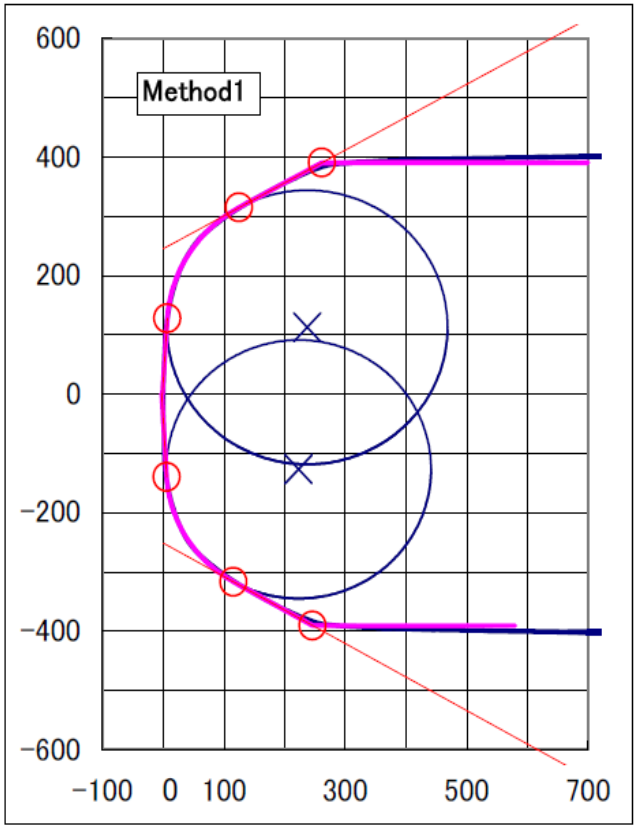
(around 380um) (240 to 310um)

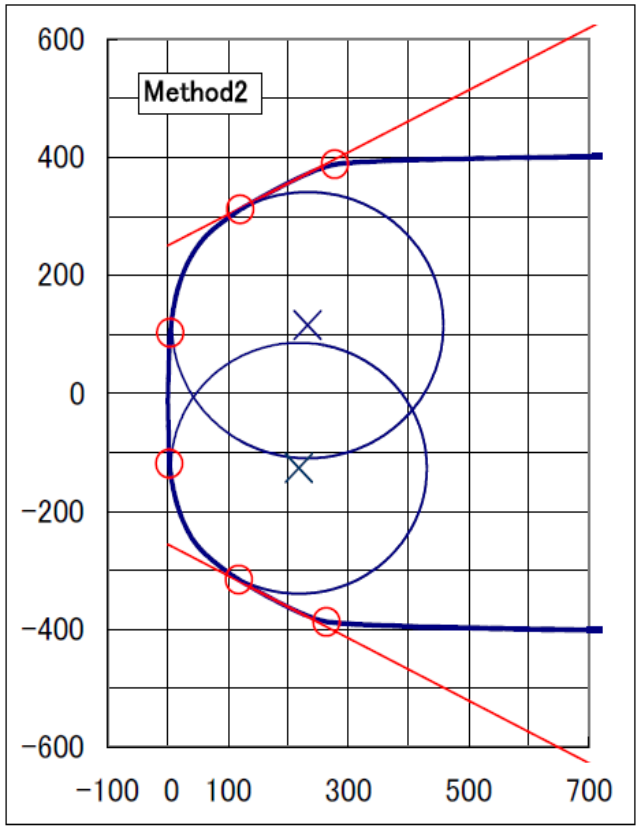
Blunt , 90 degree



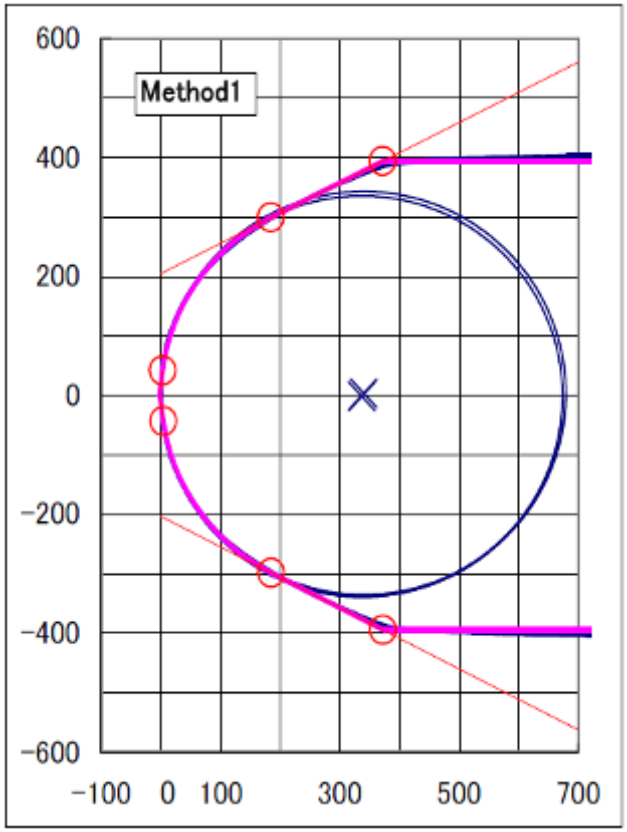


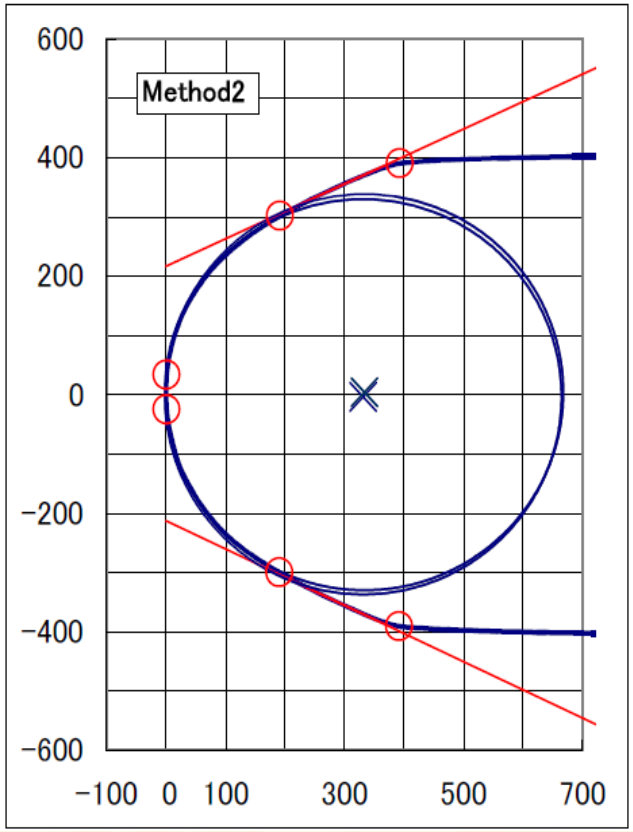
Blunter , 90 degree





Round , 90 degree



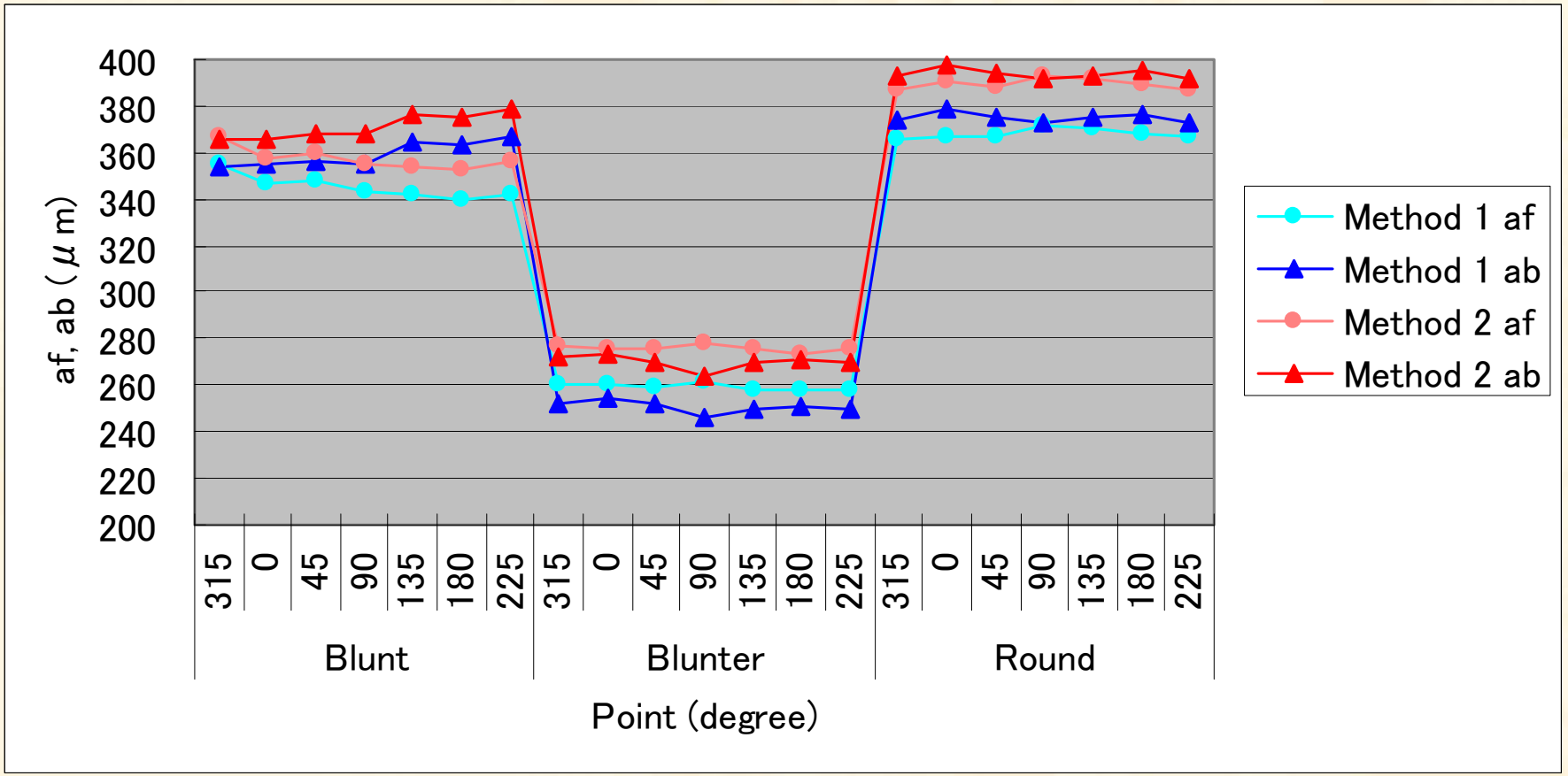


Comparison of Method 1 and Method 2 - 300mm -

Point °		Blunt 90		Blunter 90		Round 90	
Method		1	2	1	2	1	2
af	um	343	356	261	278	372	393
ϕ f	°	21.9	21.3	29.0	27.8	26.9	24.8
rf	um	214	201	231	226	337	334
β f	°	3.5	1.9	3.7	2.3	7.4	1.9
bf	um	126	109	127	99	41	33
bb	um	137	123	139	116	42	24
β b	°	3.3	1.4	3.4	1.3	7.9	2.3
rb	um	182	170	218	213	339	334
ϕ b	°	22.5	22.3	29.5	27.9	27.1	25.4
ab	um	355	368	246	264	373	392
t	um	781	781	775	775	778	778

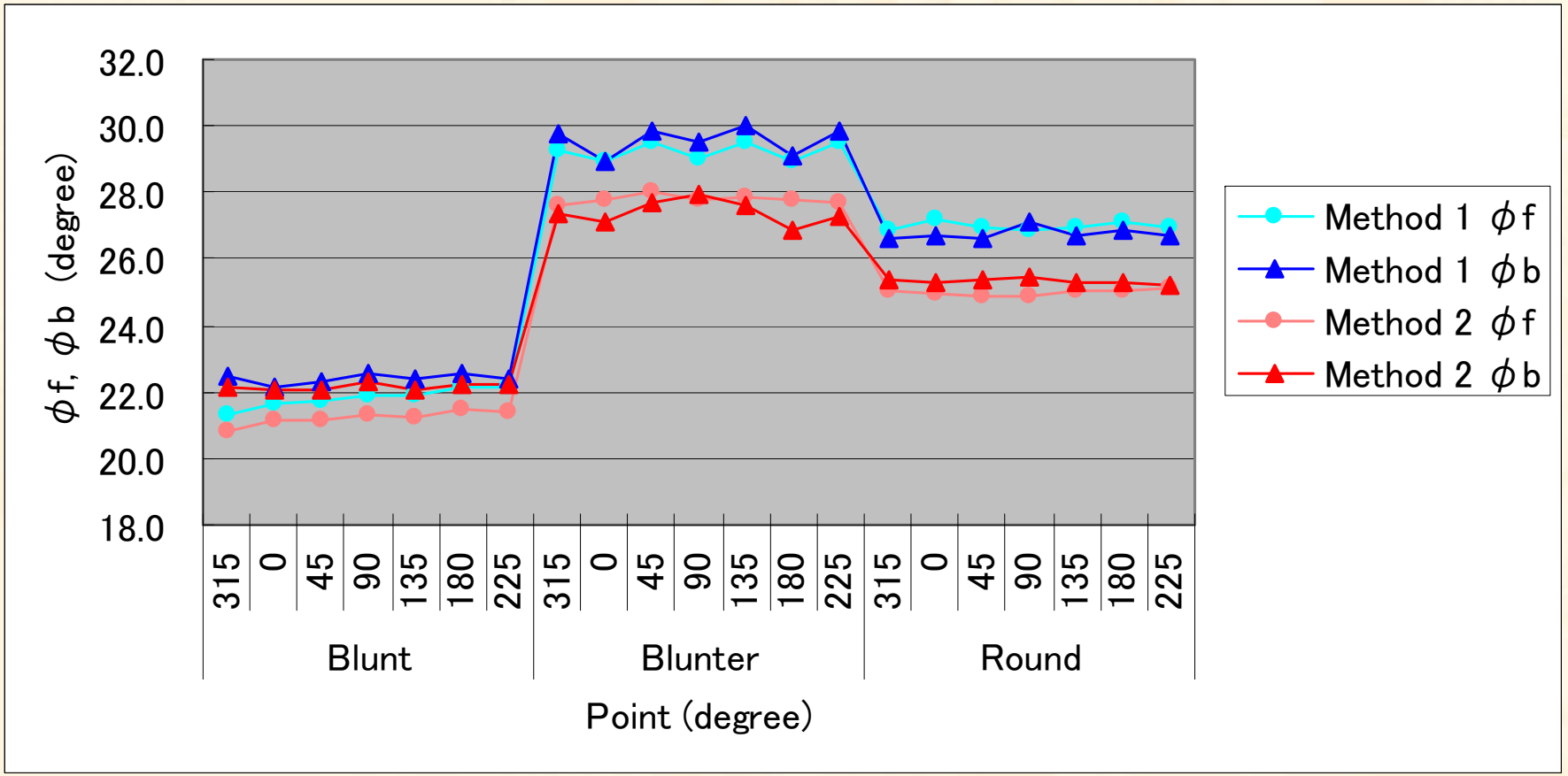
The difference between Method 1 and Method 2 appears remarkably in Apex part (β ,b).

Method 1 and Method 2 - 300mm, a

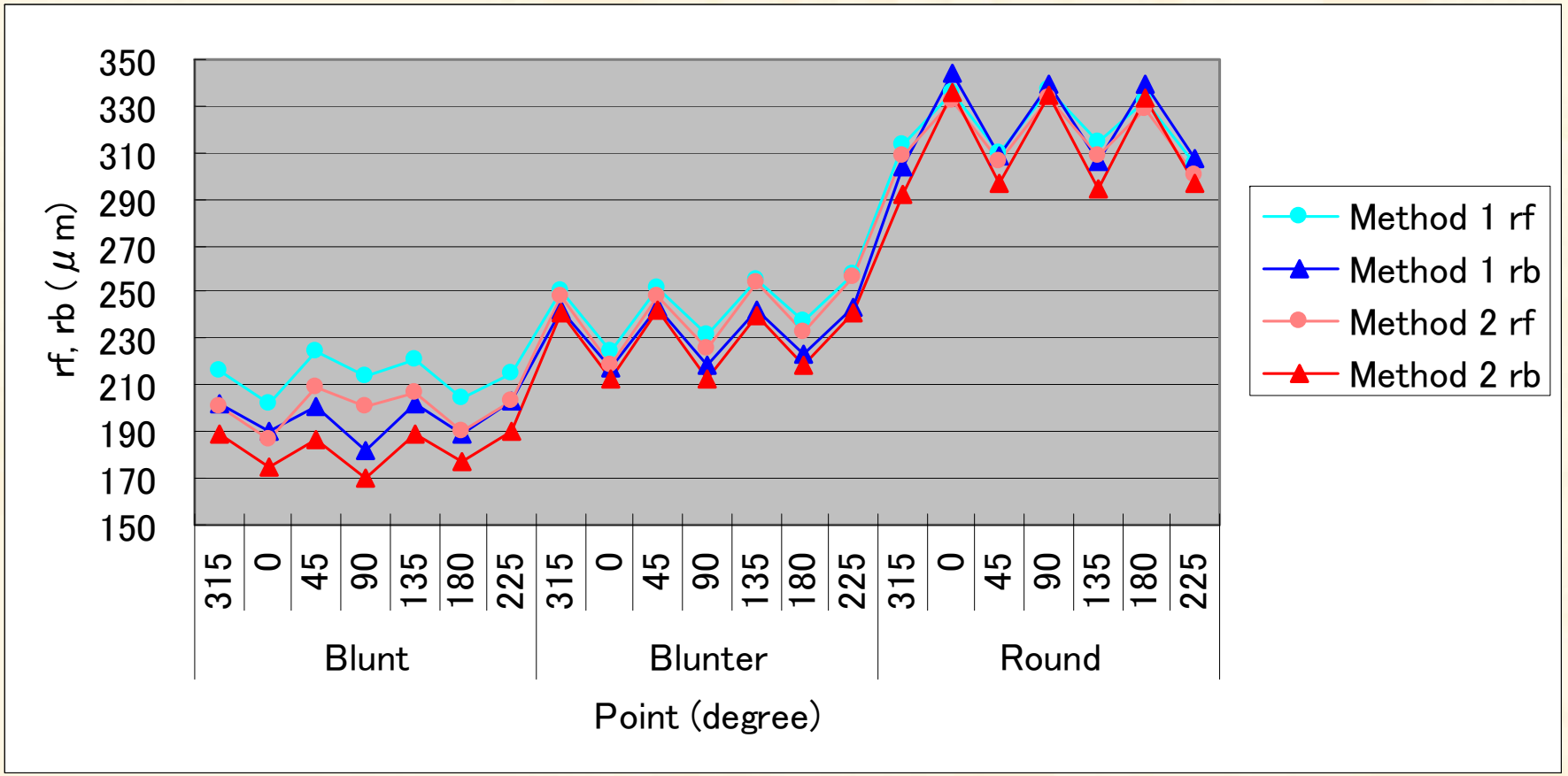


No large difference is exist between Method 1 and Method 2 regarding Edge Width.
However Edge Width of Method 2 is slightly larger than that of Method 1 in any shape.

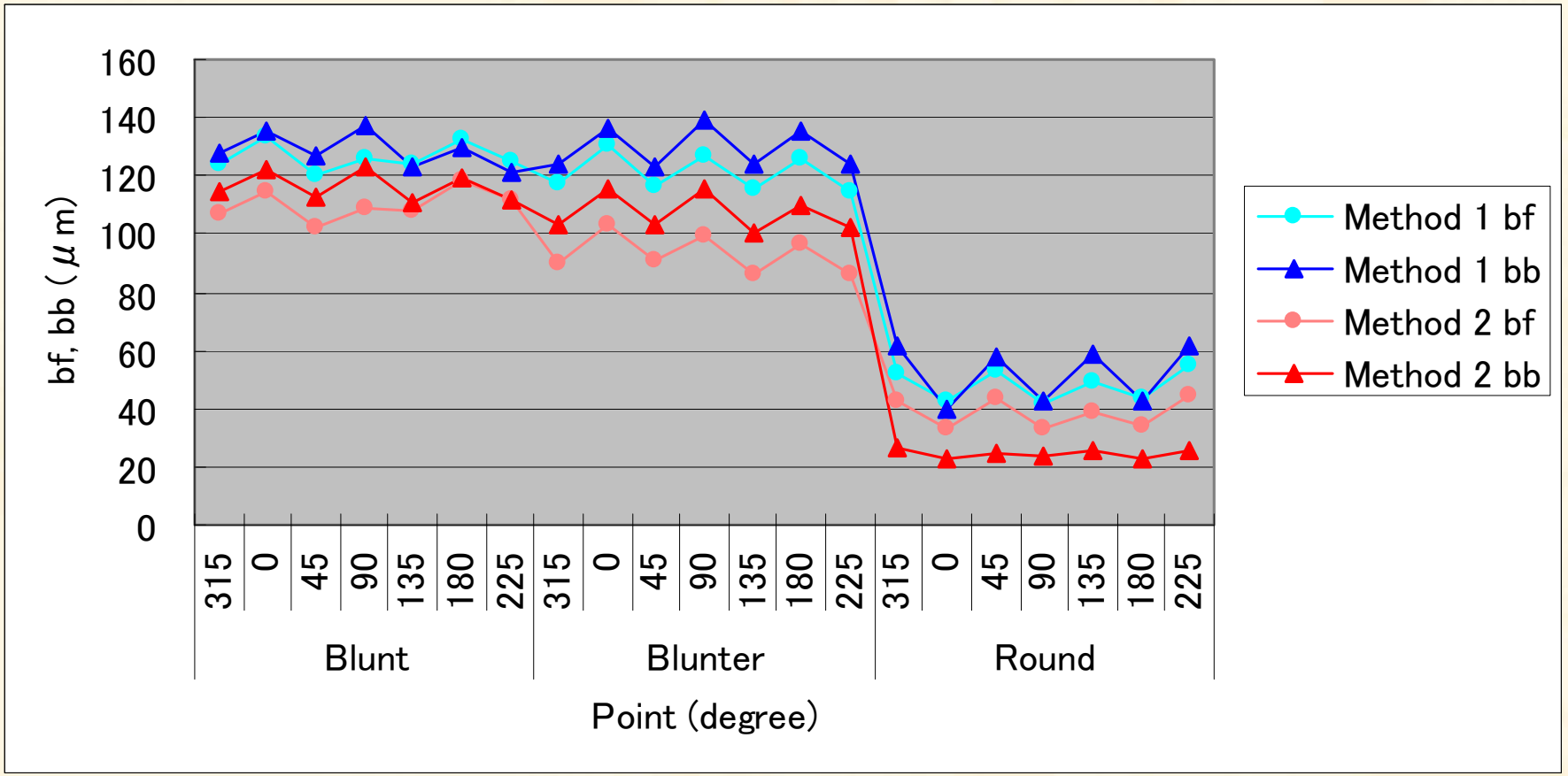
Method 1 and Method 2 - 300mm, ϕ



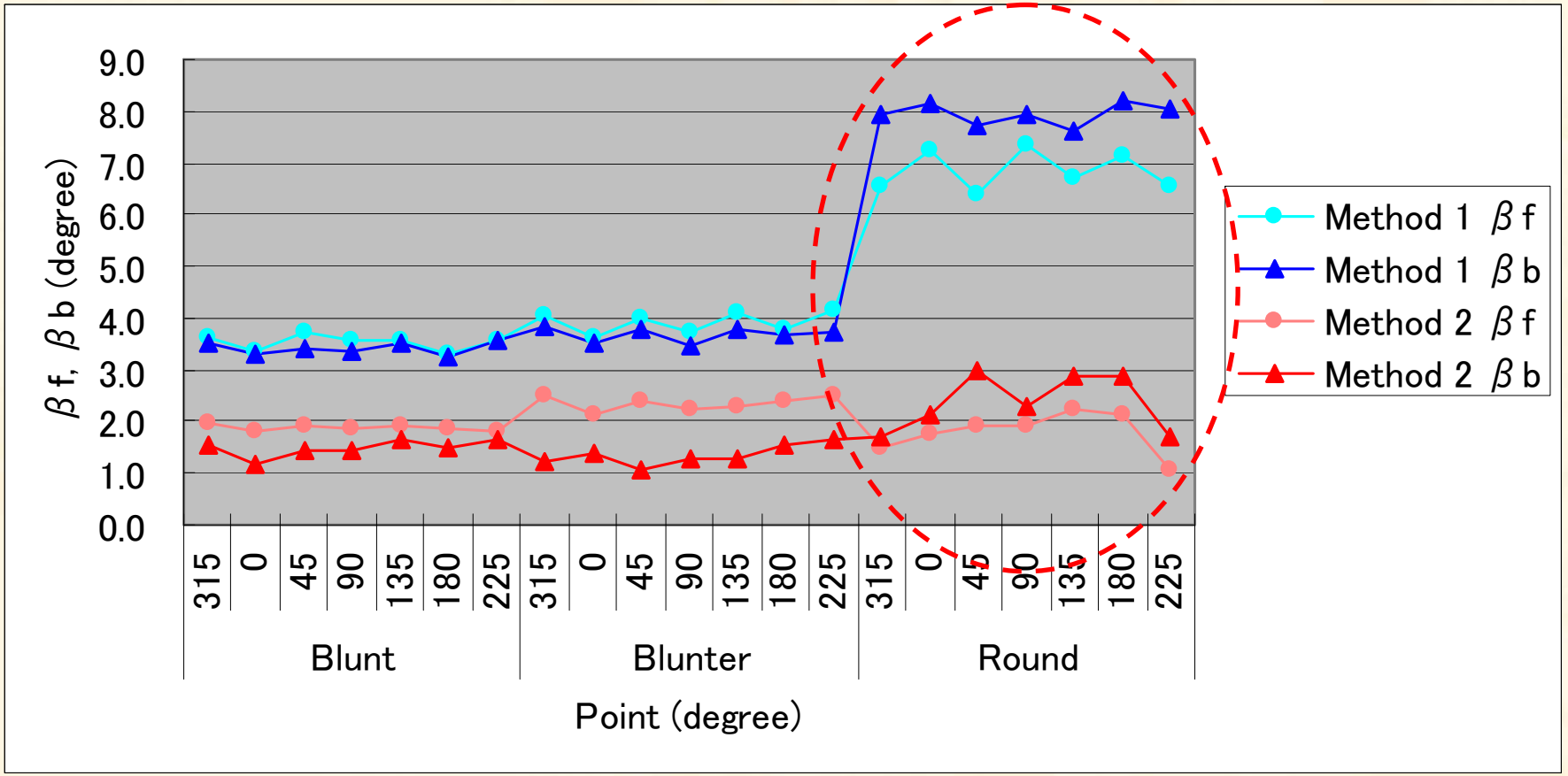
Method 1 and Method 2 - 300mm, r



Method 1 and Method 2 - 300mm, b



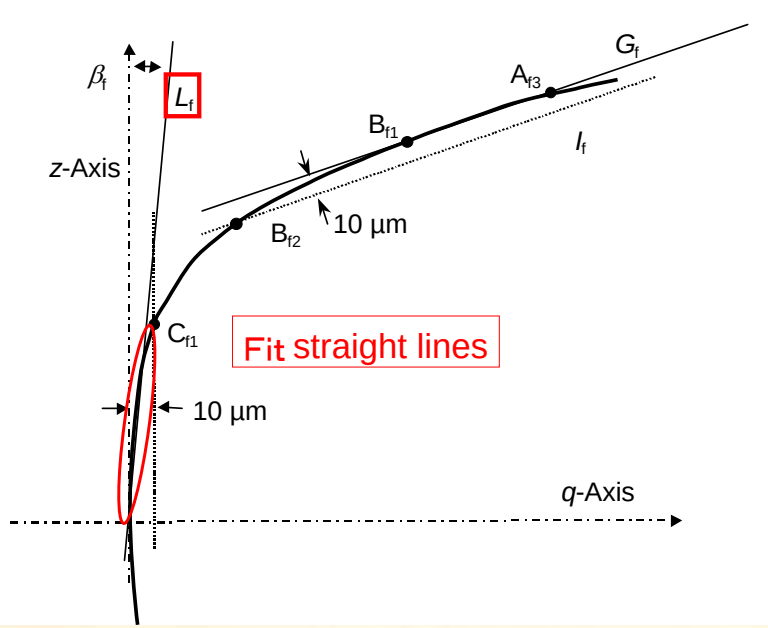
Method 1 and Method 2 - 300mm, β



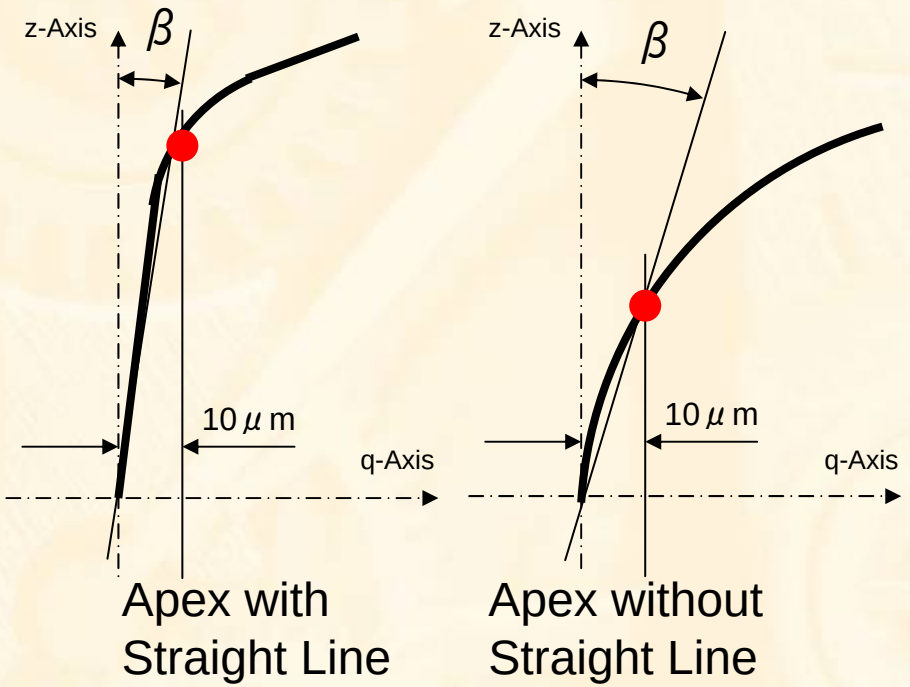
The difference between Method 1 and Method 2 is large in all wafers.
Especially, the difference in the Round is large.

Study 1 ~ Difference of β - Method 1 -

In Method 1, β is determined by the profile between the width of 10 μ m along q-Axis.



Method 1 in M73



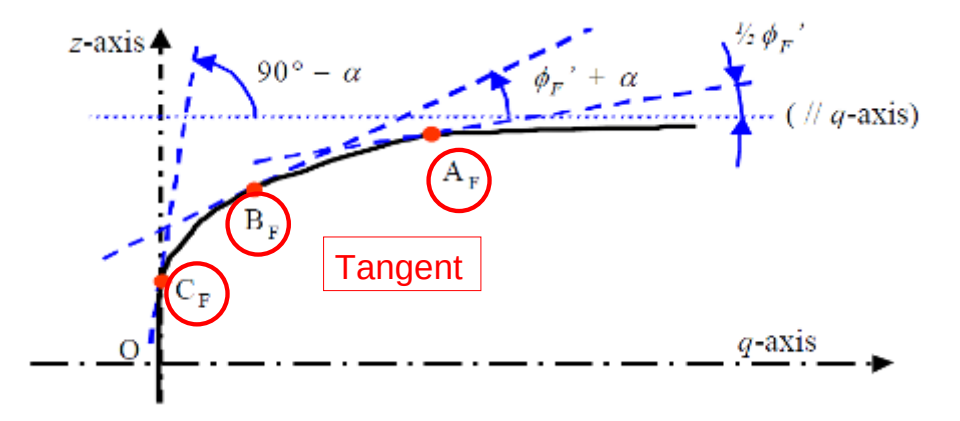
Apex with Straight Line

Apex without Straight Line

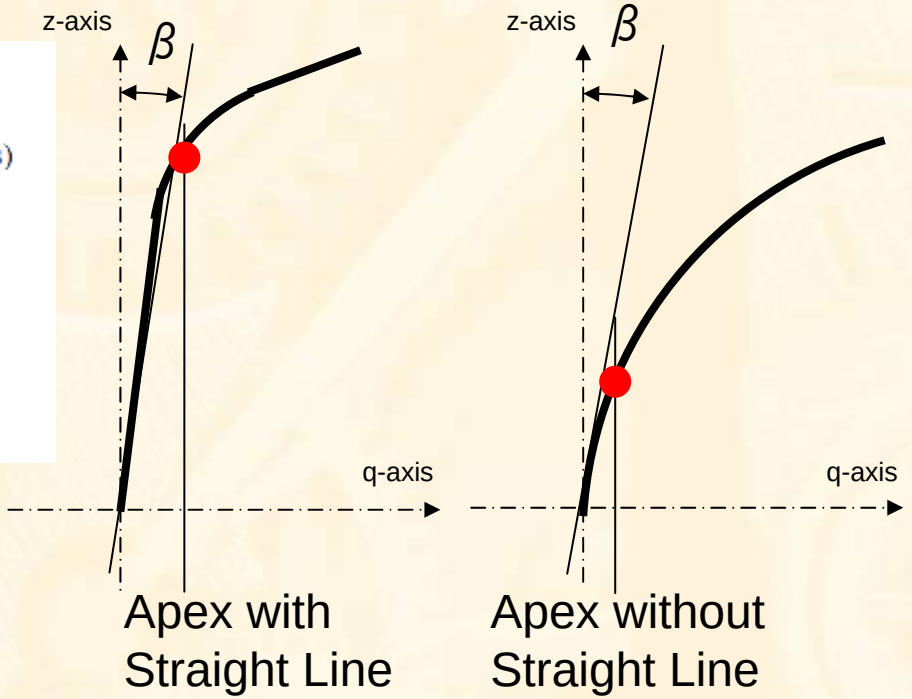
If Apex does not have clear straight line, β tends to grow.
And because Apex line does not exist in the profile of Round, β is determined by the value of r. That is, when r is large, β is small, and, when r is small, β is large.

Study 1 ~ Difference of β - Method 2 -

In Method 2, the fitting area of β is determined tangent to the edge profile at angle 90° - α, and α has a default value of 5° .



Method 2 in M73



Because the calculation area changes according to the shape of Apex, the value of β is steady. And the value of β is not exceed the value of α (=5 degree).

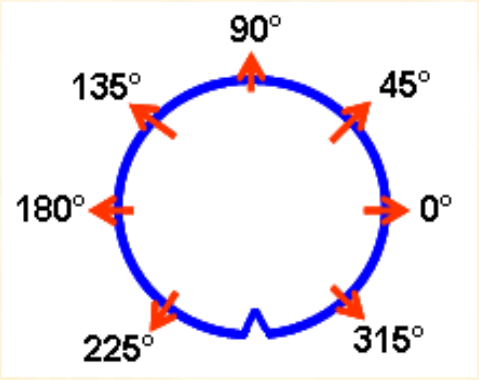
Summary of Study 1 ~ Difference of β

- The difference between Method 1 and Method 2 is remarkable in Apex, and there is especially a large difference in β in Round.
- In Method 1, because range of the calculation is a constant area regardless of presence in the straight line part of Apex, Method 1 is effective to judge presence in the straight line part.
- In Method 2, because range of the calculation is only the area of Apex almost parallel to z-axis, Method 2 is effective to judge an angle in the top of Apex even in the Round profile.
- Therefore, using Method by shape properly is preferable.

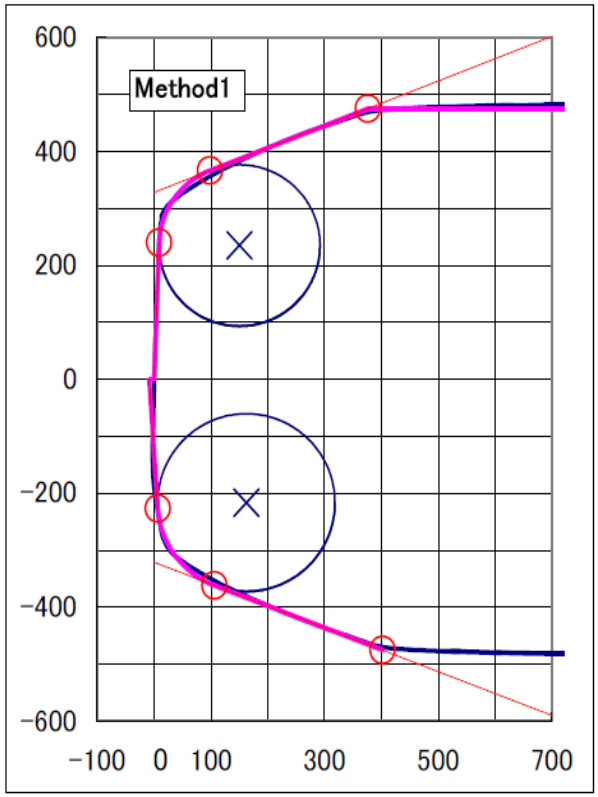
Example of Measurement using SEMI M73 Method 1 and Method 2 - 450mm

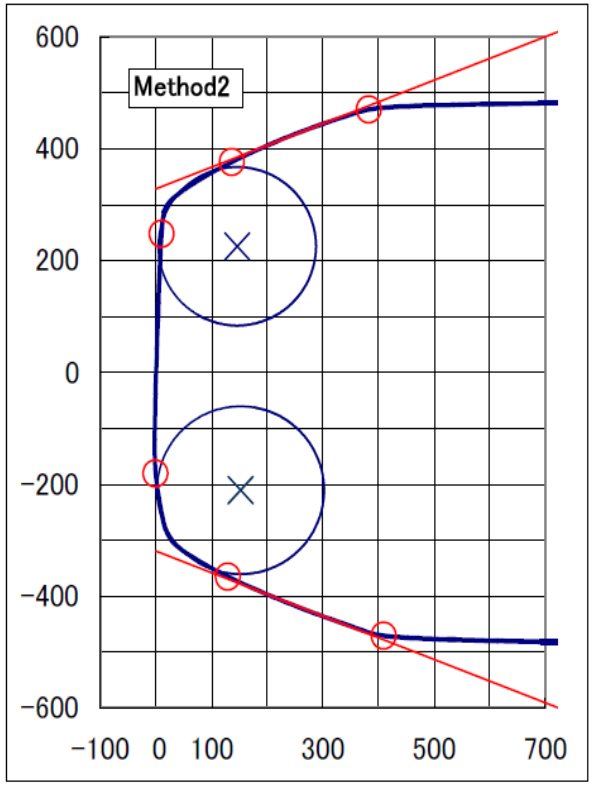
- 450mm Wafer (Under Development)
  - The wafer was offered by the cooperation of ISMI.
- 4 Samples : A, B, C, D
- Measurement Point :

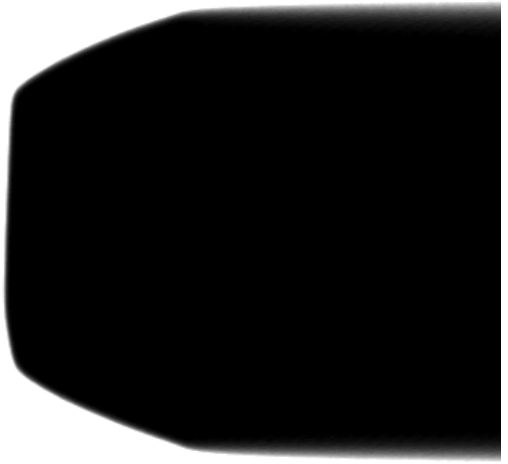
  0, 45, 90, 135, 180, 225, 315 degree



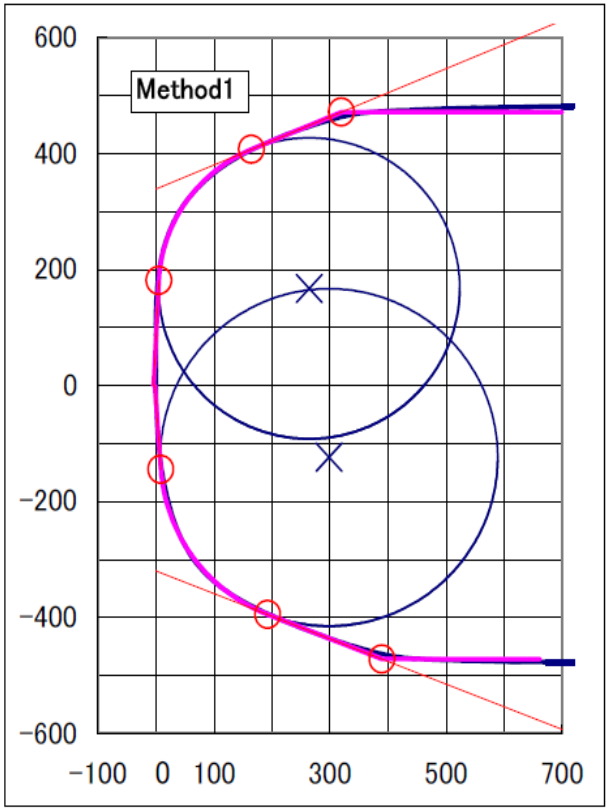
Sample A , 90 degree

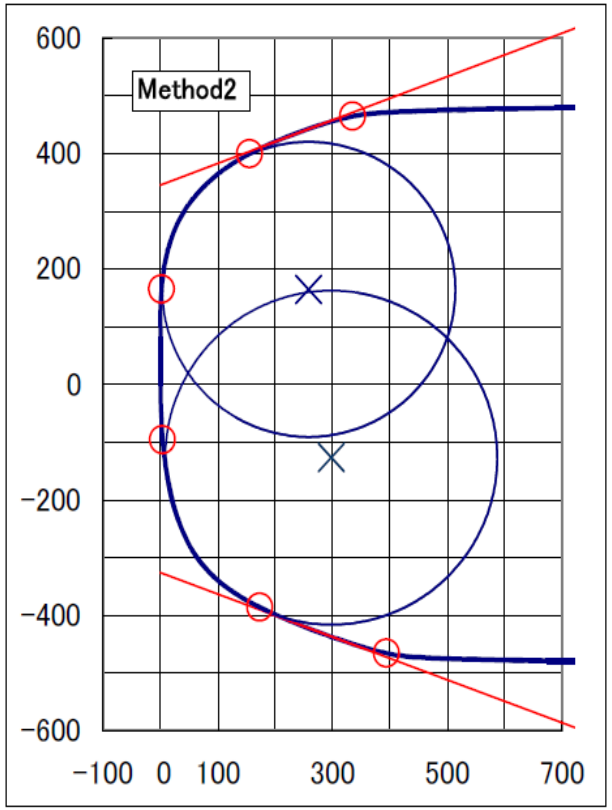




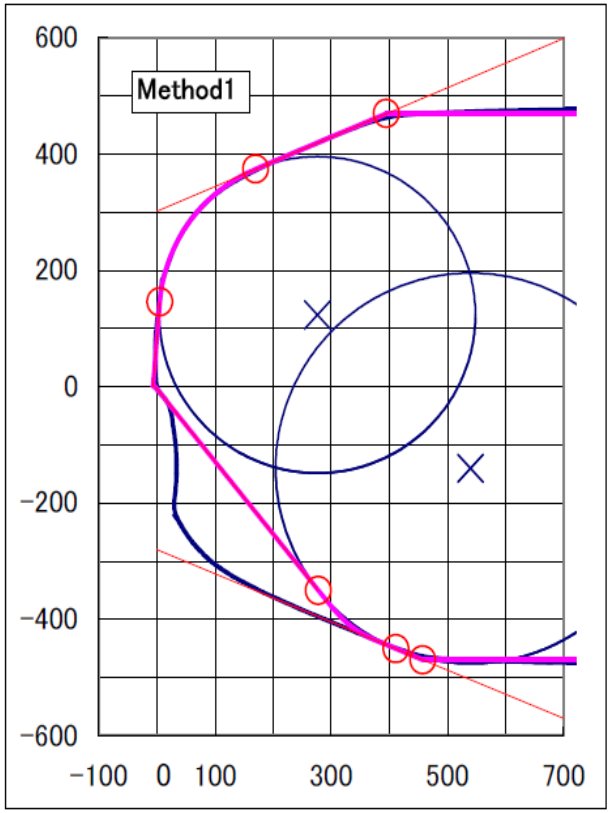


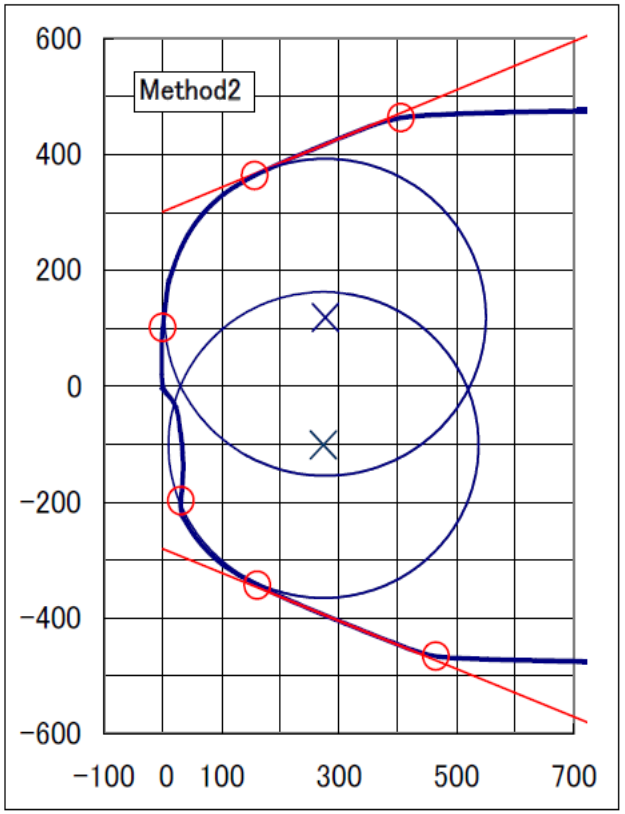
Sample B , 90 degree



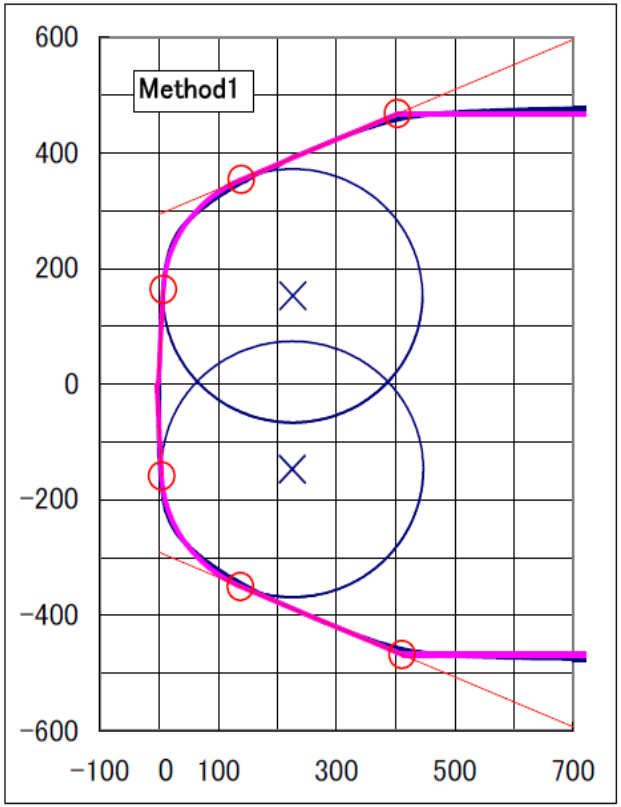


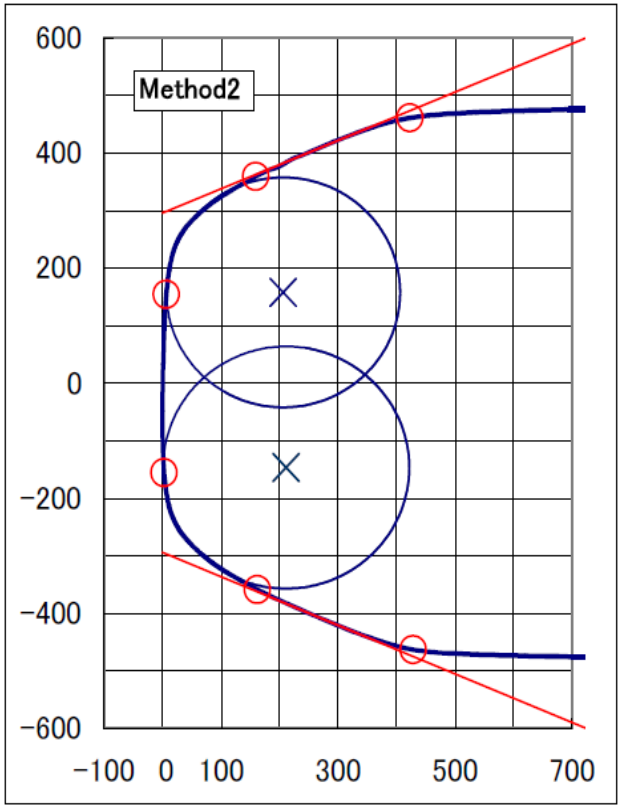
Sample C , 90 degree



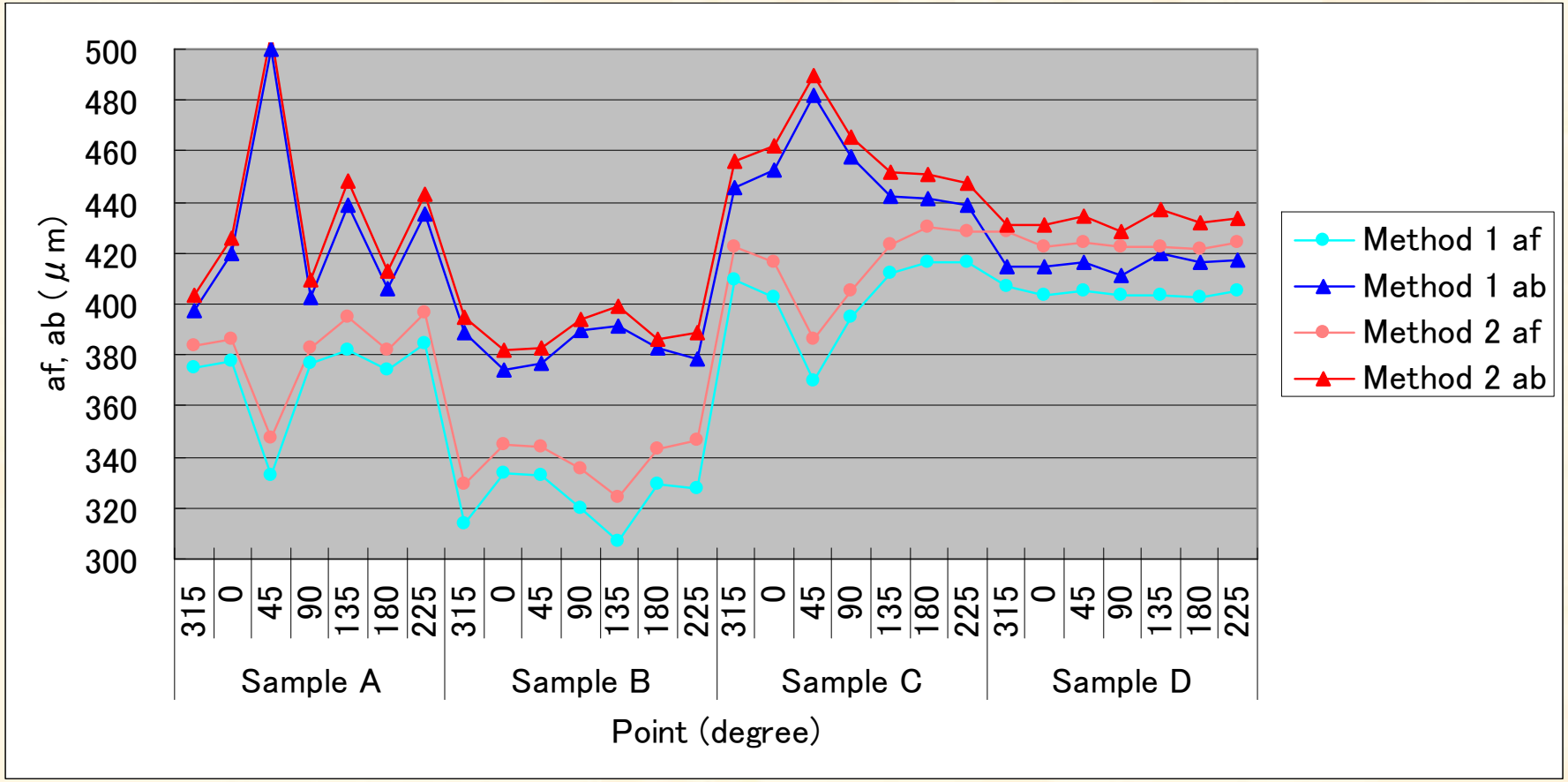


Sample D , 90 degree



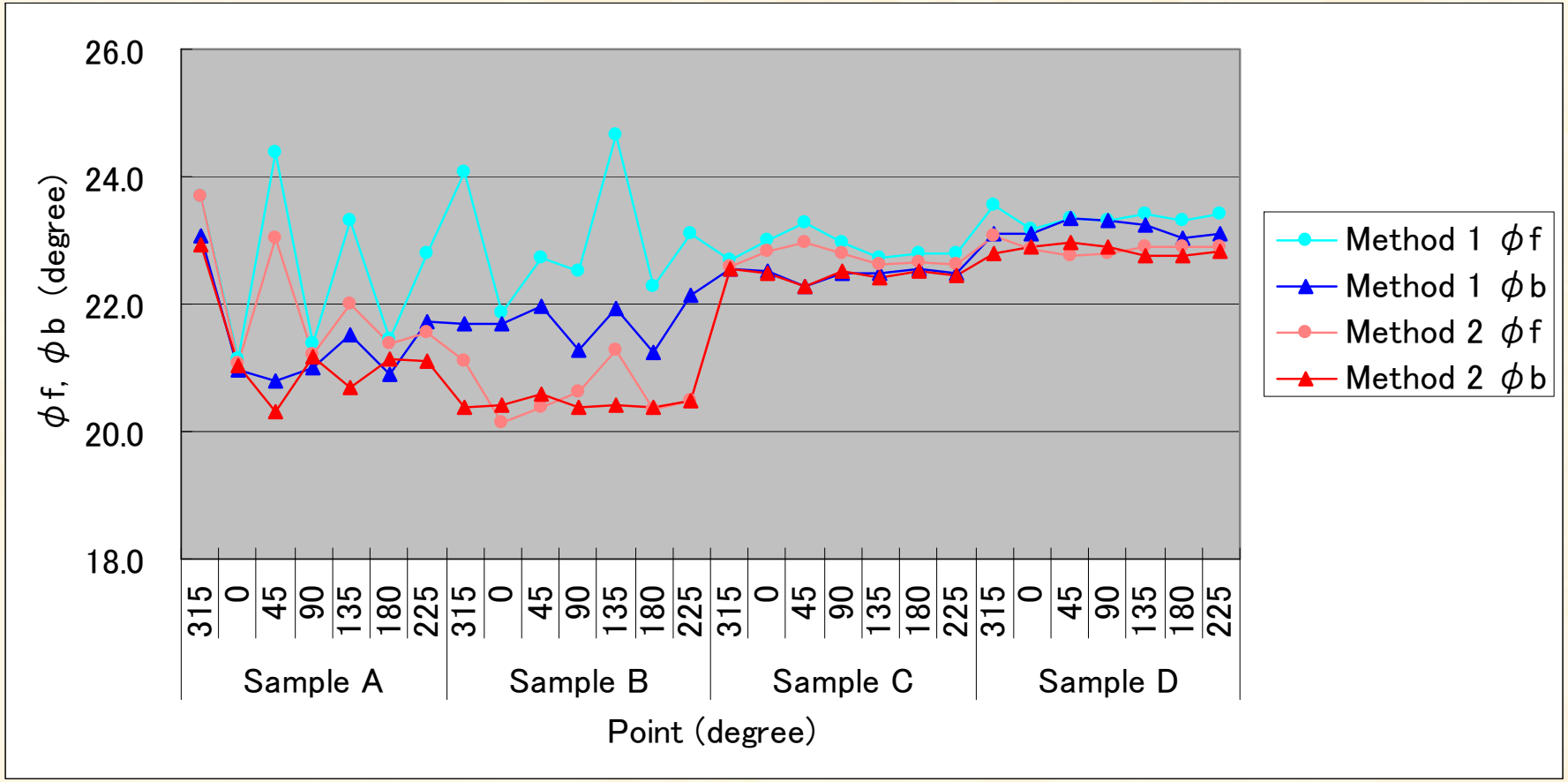


Method 1 and Method 2 - 450mm, a

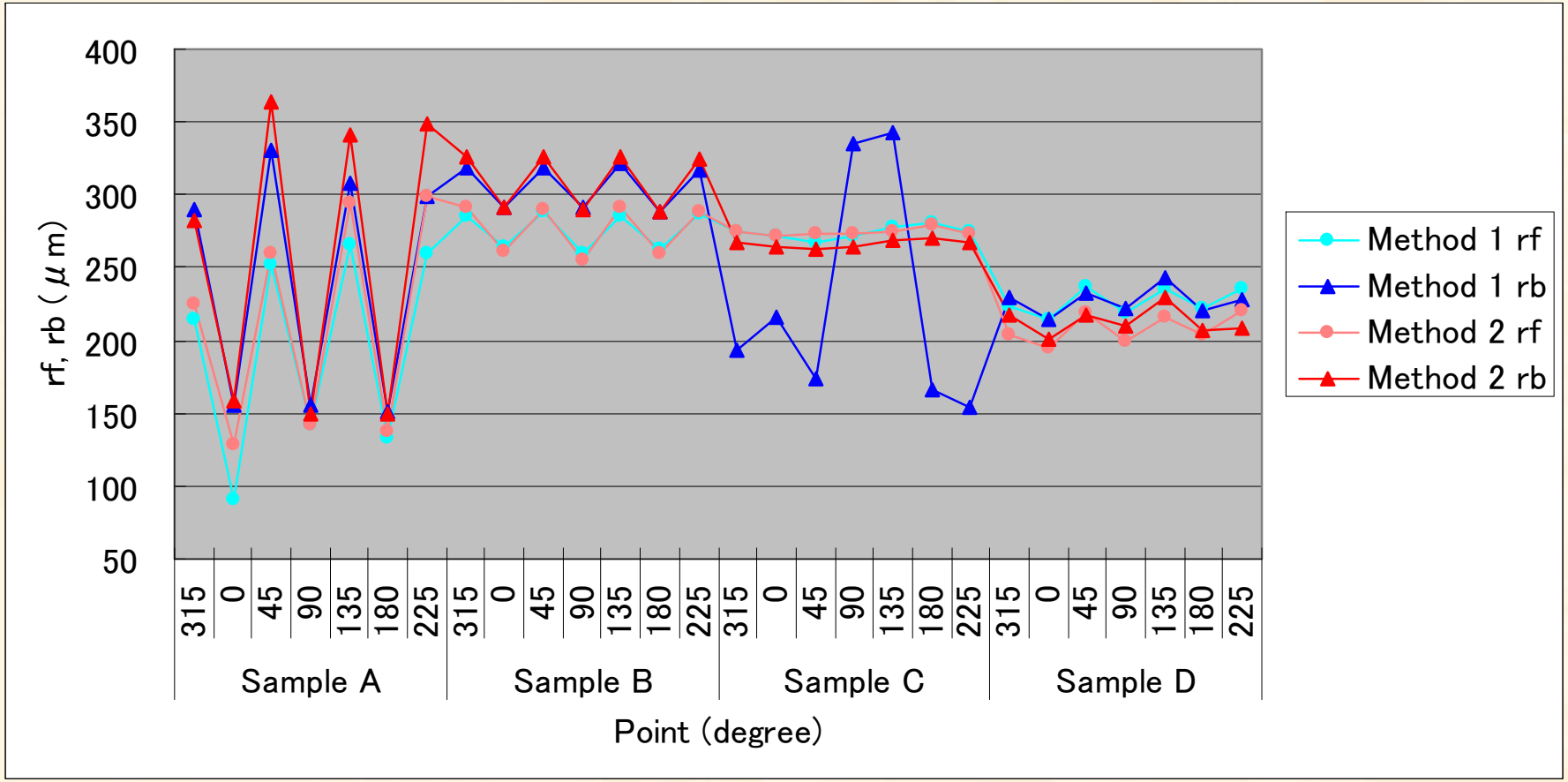


Because wafers are under development, shape is not steady in A, B, and C through all surroundings.
However, the difference between Method 1 and Method 2 is small.

Method 1 and Method 2 - 450mm, ϕ

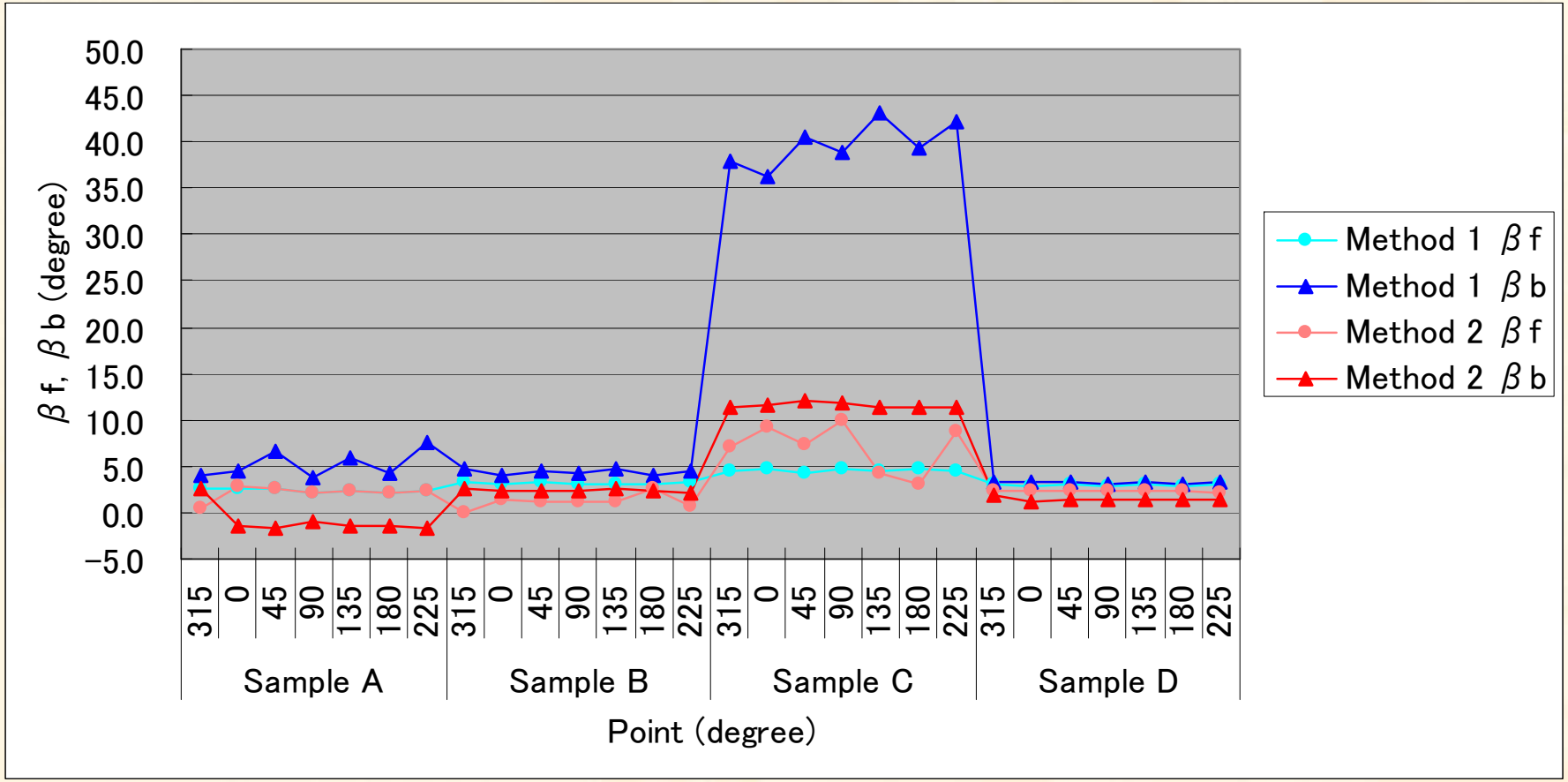


Method 1 and Method 2 - 450mm, r



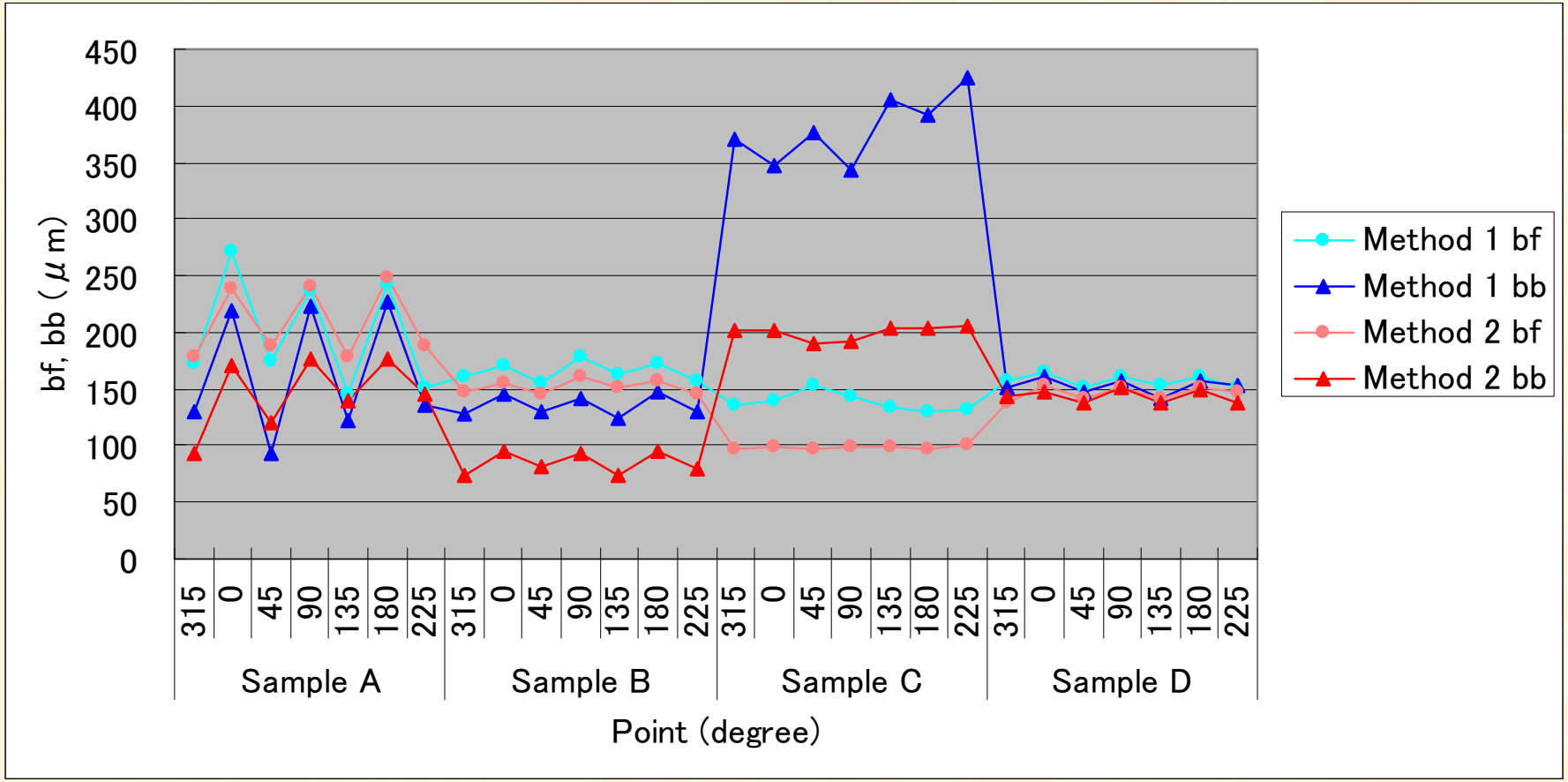
The change of every 45 degree of A is large. B also changes every 45 degree and there is a difference between the front and the back. The calculation fails by Method 1 because C has lack in Apex. D is comparatively steady.

Method 1 and Method 2 - 450mm, β



In A and C, the difference between Method 1 and Method 2 is large.

Method 1 and Method 2 - 450mm, b



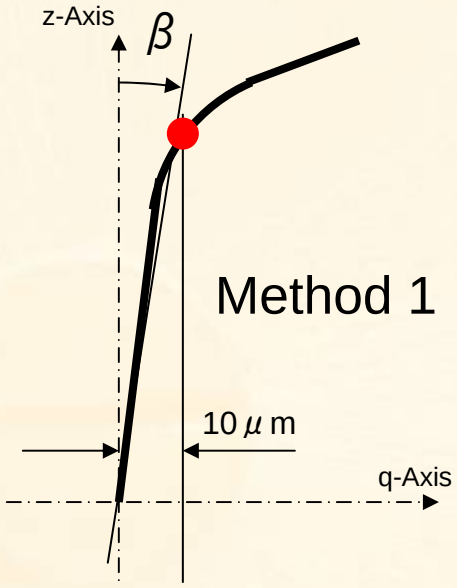
In A and C, the difference between Method 1 and Method 2 is large.

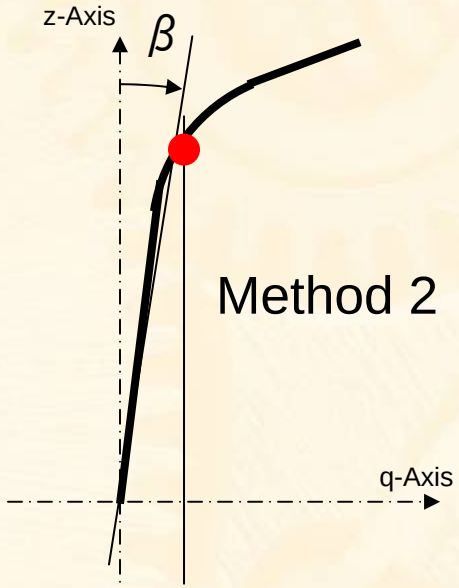
Comparison of Method 1 and Method 2
- 450mm -

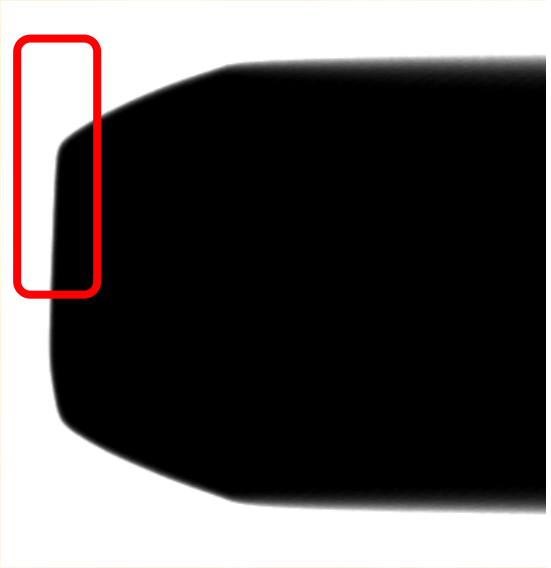
Point °		A		B		C		D	
		90		90		90		90	
Method		1	2	1	2	1	2	1	2
af	um	377	383	320	335	395	406	404	423
ϕf	°	21.4	21.2	22.5	20.6	23.0	22.8	23.3	22.8
rf	um	142	142	259	256	272	274	219	200
βf	°	2.2	2.2	3.0	1.2	4.7	9.9	2.9	2.3
bf	um	236	241	178	160	143	99	162	150
bb	um	223	176	142	93	373	192	157	152
βb	°	3.9	−1.1	4.1	2.3	38.7	11.9	3.1	1.4
rb	um	156	150	291	289	336	264	221	210
ϕb	°	21.0	21.2	21.3	20.4	22.5	22.5	23.3	22.9
ab	um	402	410	390	394	458	465	411	429
t	um	934	934	927	927	920	920	924	924

As for βb of A, the sign is different in Method 1 and Method 2.

Study 2 ~ Difference of the Sigh of β
- Sample A, Front Apex Angle -

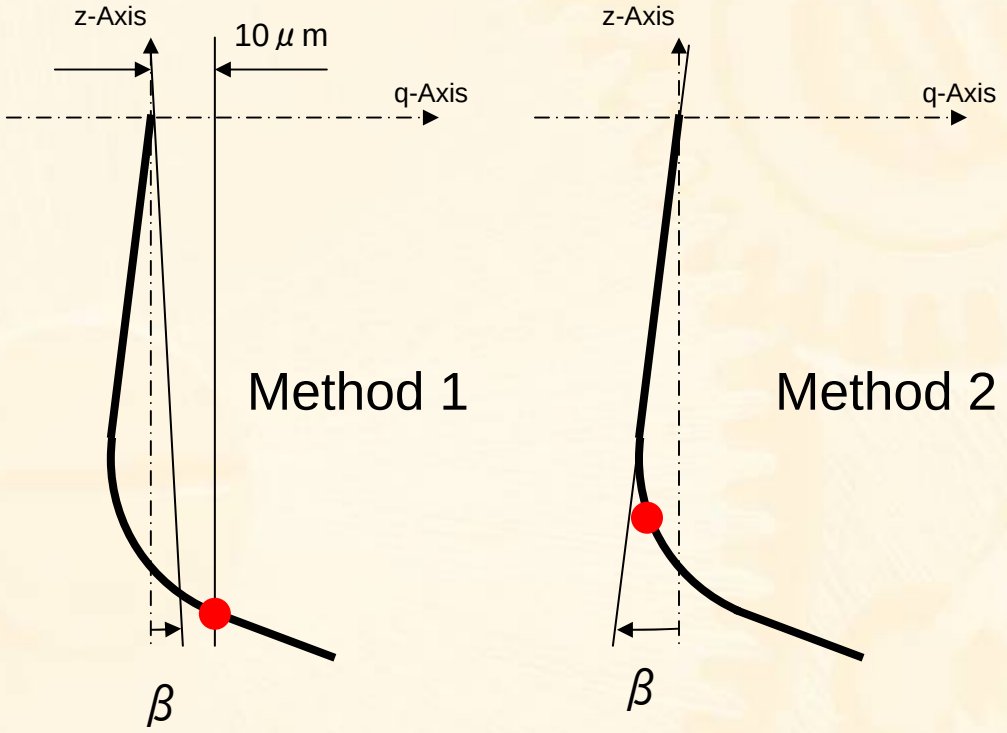


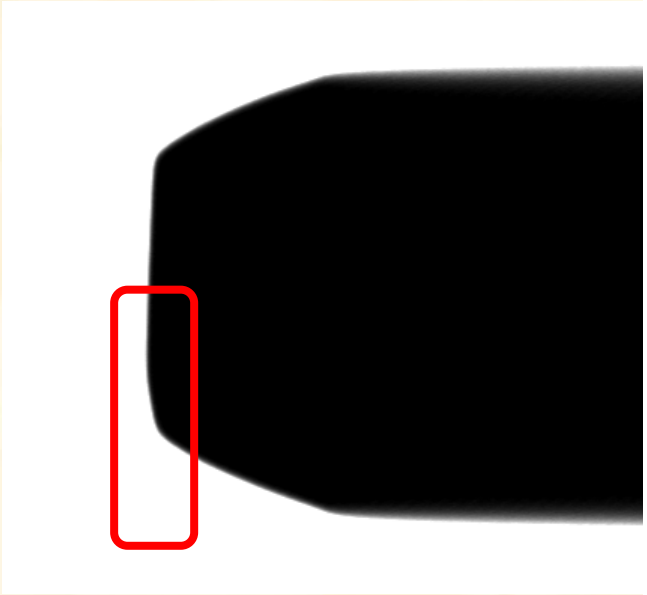




For Front Apex Angle, β calculated by Method 1 and β calculated by Method 2 are the same in the sign.

Study 2 ~ Difference of the Sigh of β
- Sample A, Back Apex Angle -



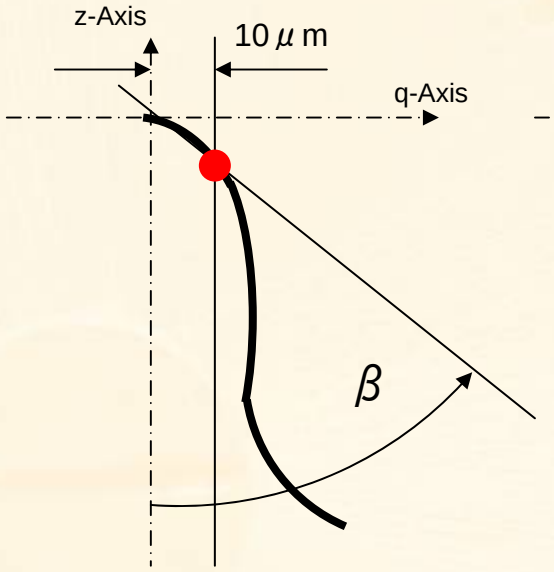


For Back Apex Angle, β calculated by Method 1 and β calculated by Method 2 are not the same in the sign.

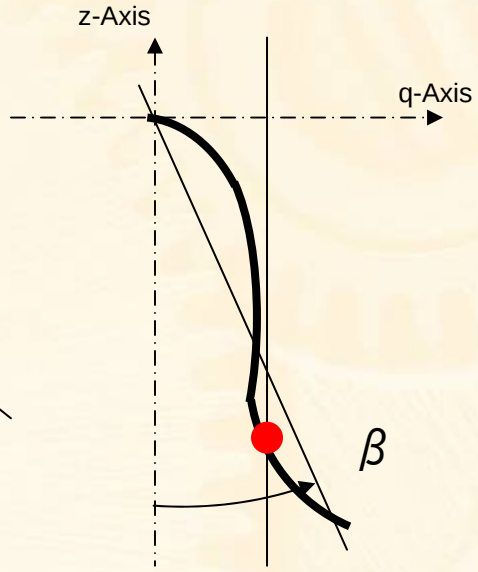
Summary of Study 2
~ Difference of the Sigh of β

- The sign of β might be different in Method 1 and Method 2 according to the shape of Apex.
- In Method 1, because range of the calculation is from origin to positive direction of q-axis, β almost becomes a positive value.
- In Method 2, because range of the calculation is not constant of q-axis, β can becomes a negative value reflecting a local inclination.

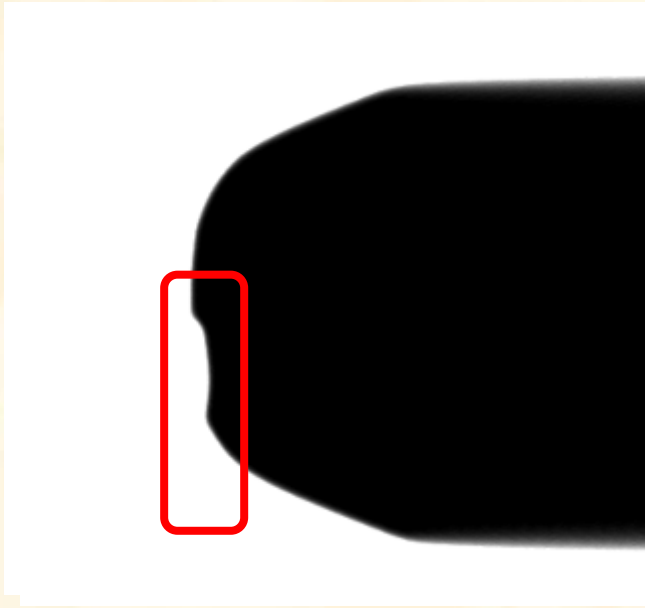
Study 3 ~ Effect of Lack in Apex
- Sample C, Back Apex Angle -



Method 1

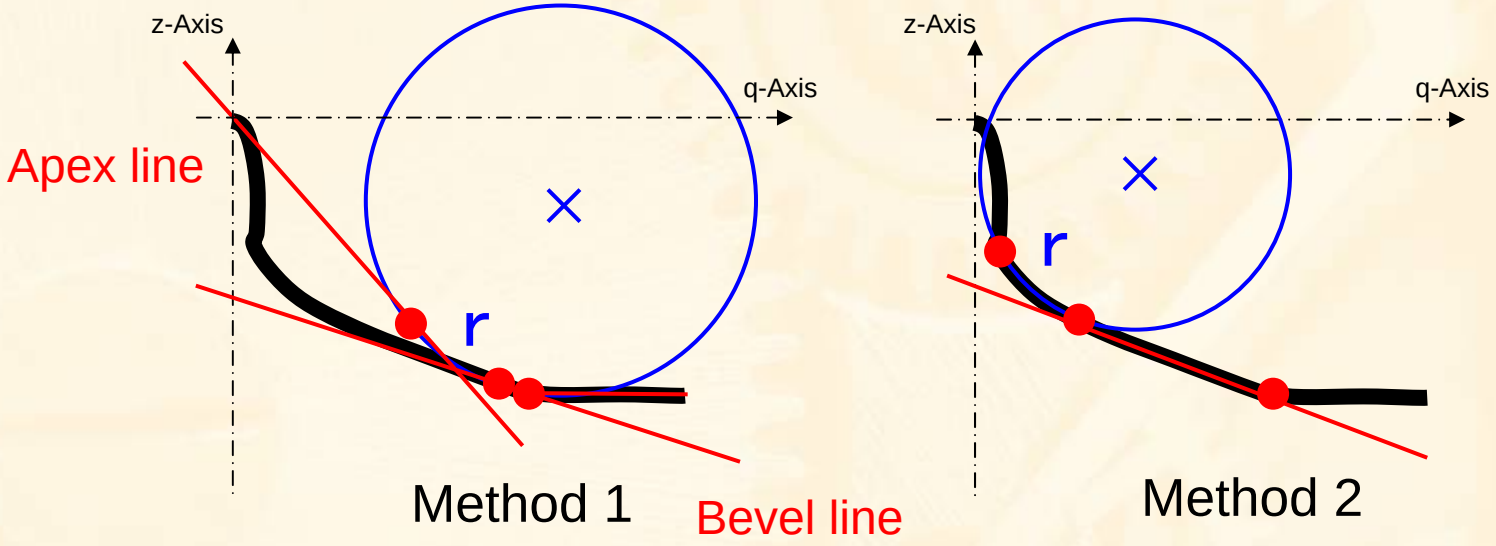


Method 2



If there is a lack in Apex, β becomes a large value in Method 1.
The reason is to use the area of the lack that inclines steep to calculate β.
In Method 2, the lack in such case does not influence β easily.

Study 3 ~ Effect of Lack in Apex
- Sample C, Back Shoulder Radius -



In Method 1, Circle of Shoulder R is tangent to both the Bevel line and the Apex line.
When β changes, r and center of Shoulder R is also changes.
And, the value of b also changes as the result.
On the other hand, in Method 2, the influence of the lack is not received easily.

Summary of Study 3
~ Effect of Lack in Apex

- As for sample C, there was a lack in Apex, and the result of Method 1 and Method 2 is greatly different.
- In Method 1, there is a possibility that the lack influences measurements.
- In Method 2, the lack does not influence measurements easily.
- Therefore, when irregular shape is measured, it is preferable to recognize the feature of Method.

Summary

- There are differences in the parameter of Method 1 and that of Method 2 even if it is 450mm wafer under development even if it is 300mm wafers produced in commerce. Especially, the difference is remarkable in Apex. Therefore, specifying Method used among users is to be necessary.
- M73 is a method of extracting the parameter from the edge profile. And the measuring method of the edge profile depends on the equipment. Therefore, the result may depend on the equipment.