



**Development of Hard pellicle for 157 nm lithography**

**Asahi Glass Co; Ltd.**

**K.Okada, I.Ishikawa, K,Oota, K Ootsuka, M. litou, Y.Yoshikawa Y.Satou,  
H.kojima T.Kawahara, T.Minematsu, H.Mishiro, S. Kikugawa and Y.Sasuga  
[Kaname-okada@agc.co.jp](mailto:Kaname-okada@agc.co.jp)**



# Outline

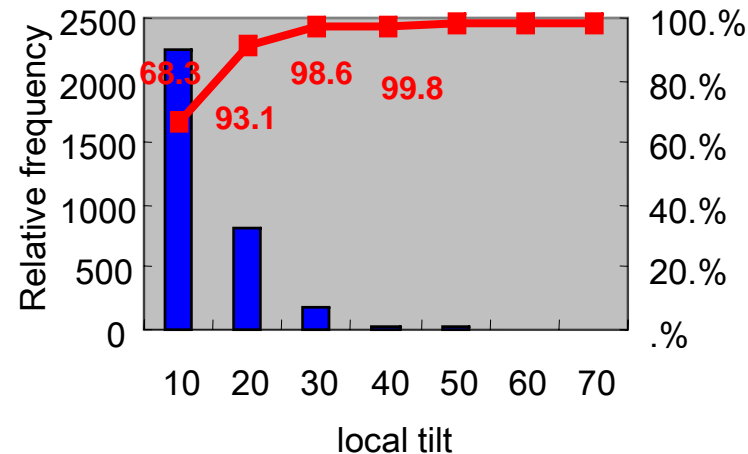
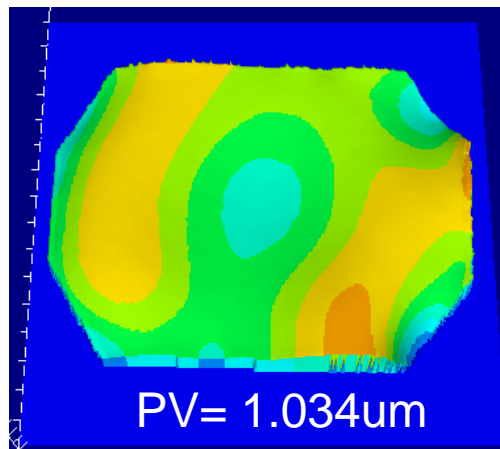
---

- **1) Local tilt data with conventional full flat pellicle**
- **2) Correctable error in the Stepper for new type pellicle shape**
- **3) Improved Attachment Machine ver.2.1 for cylindrical shape**
- **4) Making pellicle Process**
- **5) Local tilt of Cylindrical shape Pellicle**
- **6) Conclusion**
- **7) Development Schedule of Hard Pellicle**



## Local tilt data with conventional full flat pellicle

- Local tilt data of conventional pellicle is show below. We achieved 20urad of local tilt in 100mm square area and 99.8% area is less than 40urad in 150mm diameter.
- Even though the middle area is satisfied Spec, it is difficult to control local tilt less than 10urad in a entire area, because gravity induces pellicle sagging.





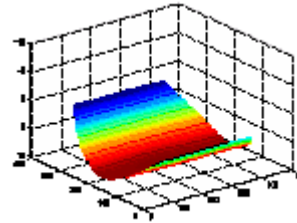
# Correctable error in the Stepper

➤ And we try not full flat pellicle but different type shape pellicle. One solution is cylindrical shape which can be adjusted as correctable error in scanner system. It is called “one-dimensional pellicle”.

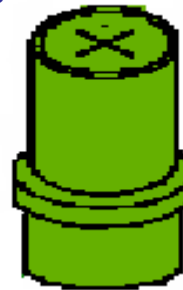
➤ In using one dimensional pellicle, quadratic and forth-order bow can be adjusted as correctable error in scanner system.

➤ By using cylindrical shape, we can achieve non distortion on the wafer.

<Pellicle>



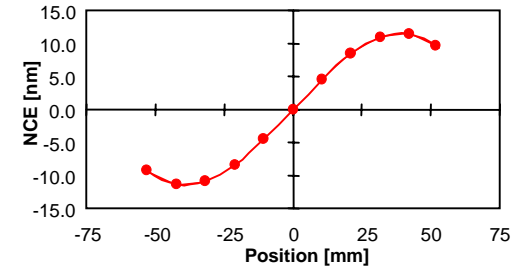
<Projection Lens>



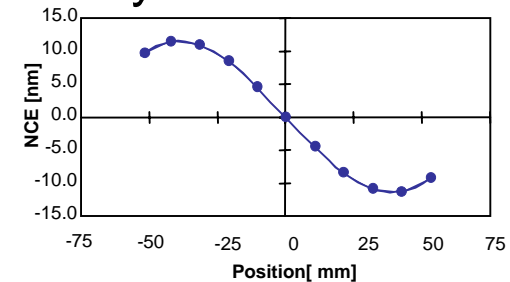
<Wafer>



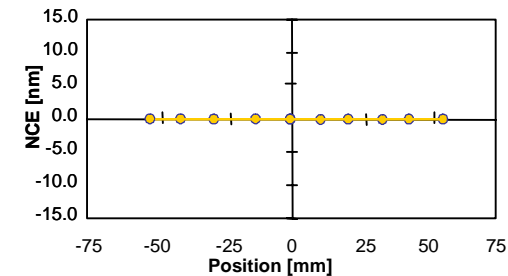
Pellicle induced distortion



System correction



Result of distortion

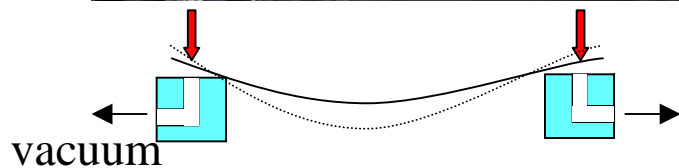
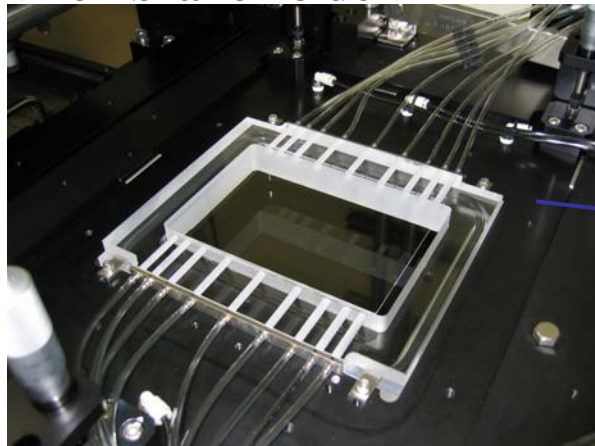




## Improved Attachment Machine ver.2.1 for cylindrical shape

- We improved attachment machine between pellicle and frame for cylindrical shape pellicle.
- The characteristic of membrane holder is 9 vacuum chucks for a long edge of membrane. In addition we can measure the vacuum pressure of each vacuum chuck to control membrane shape. Our machine is shown below.

<Membrane holder>



<Vacuum indicator>

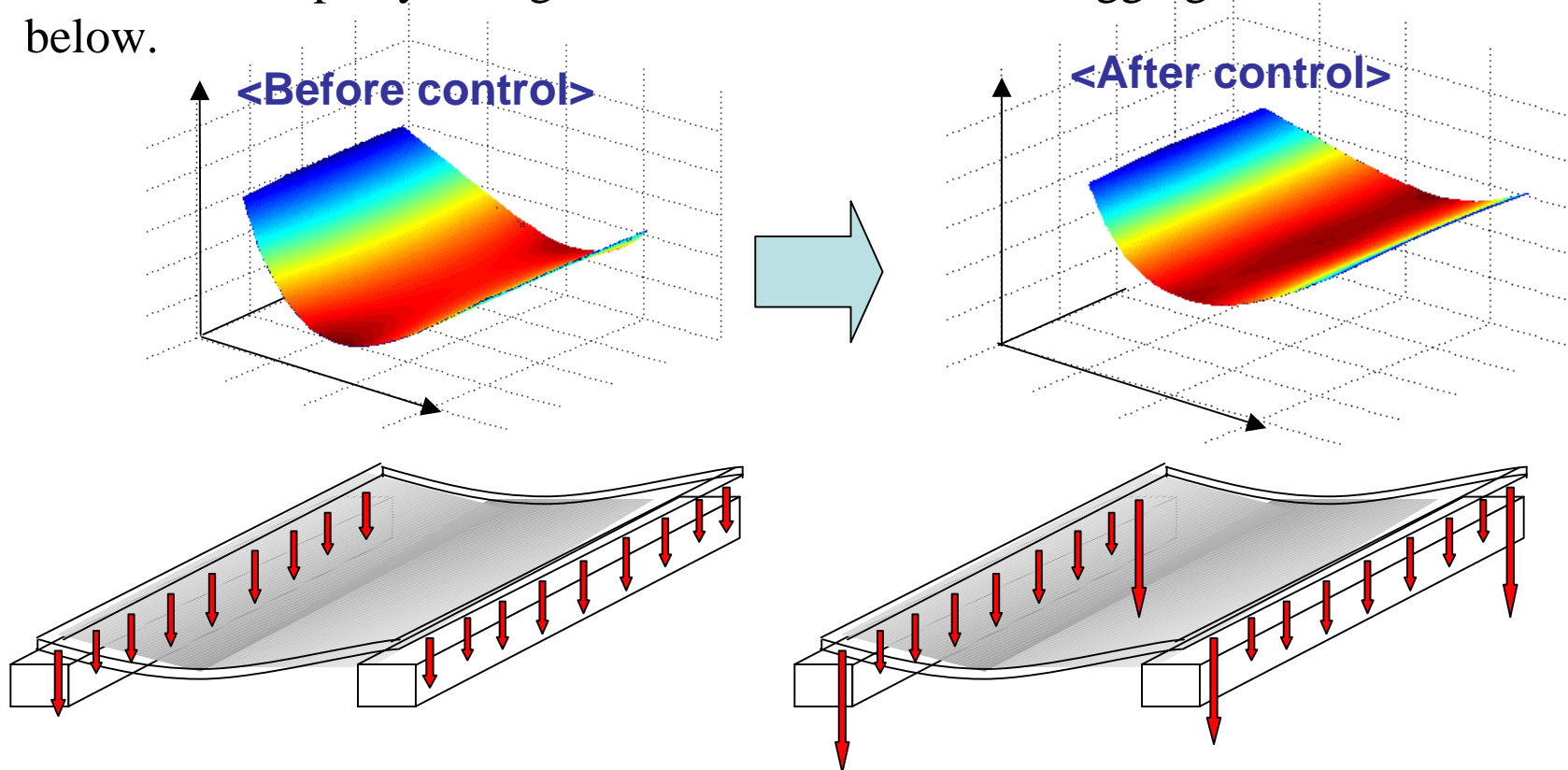


<Fizeau interferometer (FUJINON 102S)>



# How to Control Cylindrical Shape

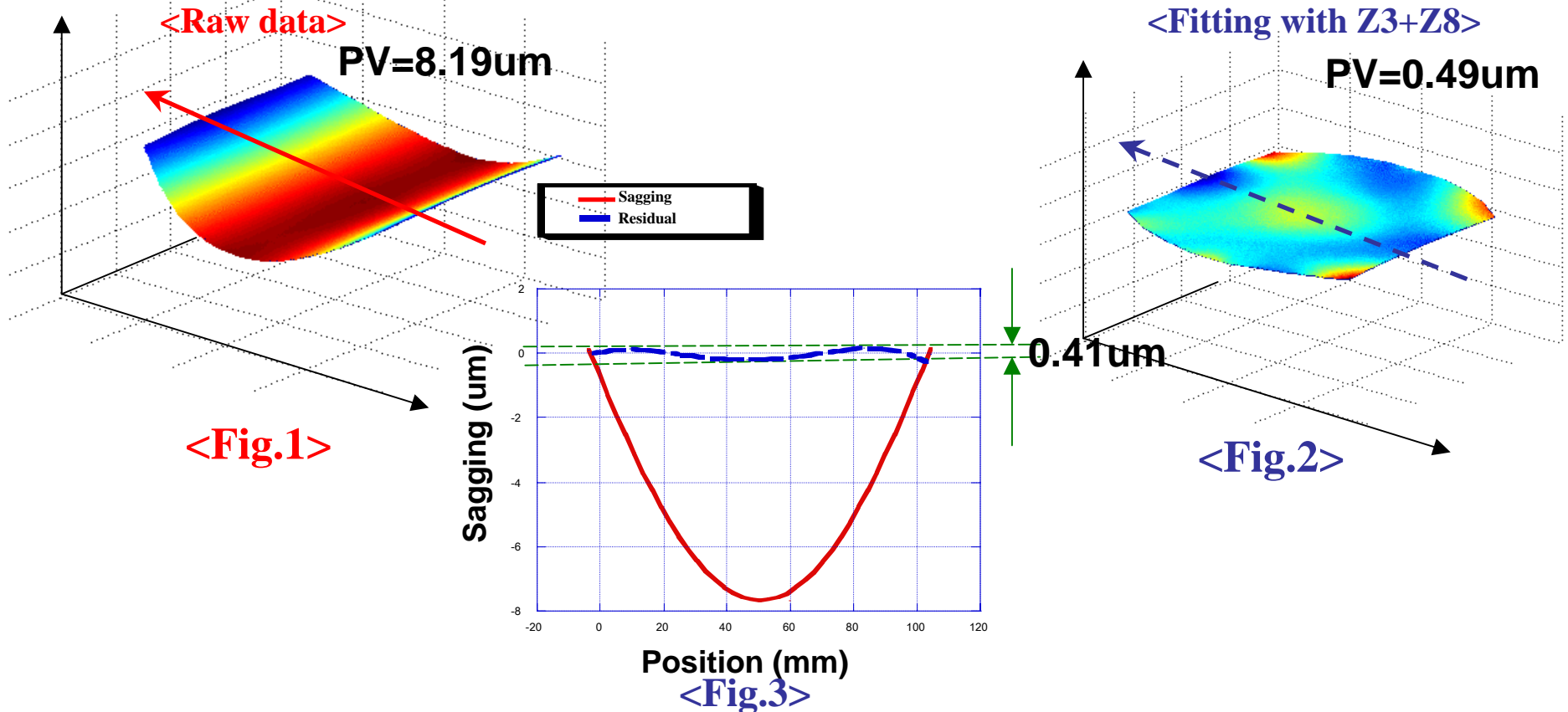
➤ We simulated the sagging of cylindrical shape pellicle and found the edge of sagging is larger than middle in the cross section. For reducing difference of sagging in the each cross section, we can adjust 9 vacuum chucks for desired membrane shape by fixing a membrane. Control of sagging results are shown below.





# Local tilt of Cylindrical shape Pellicle in X-direction

- Typical sagging data of one-dimensional hard pellicle is shown below in Fig1.
- The system correction of  $AX^2 + BX^4$  ( Z3+Z8) is applied to compensate a membrane sagging in X direction, PV of residue after correction will be 0.41  $\mu\text{m}$  as can be seen in Fig.3.

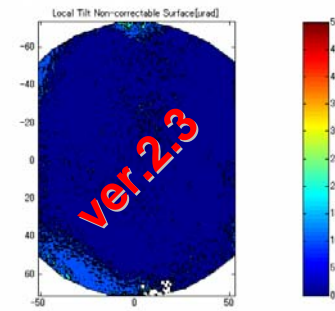
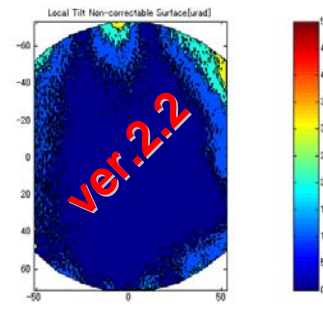
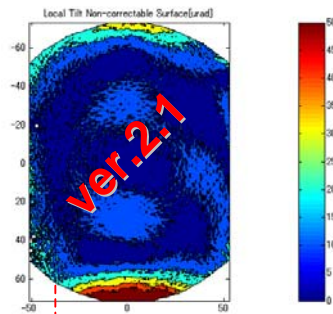




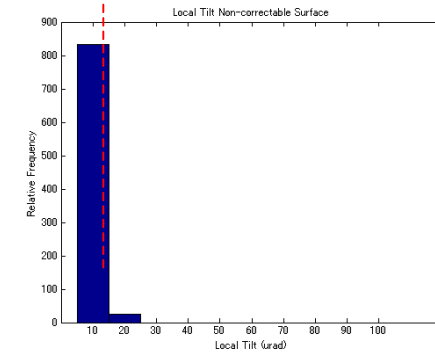
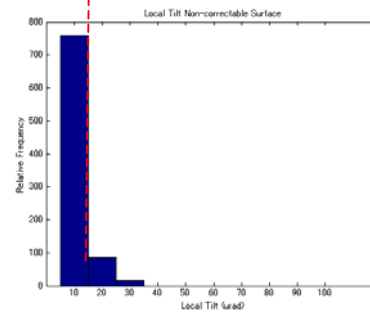
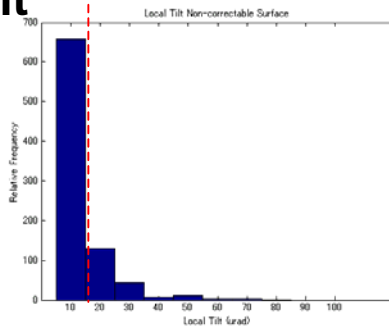
## Local tilt of Cylindrical shape Pellicle with improved attachment machine

➤ As you can see bottom figure, we can reduce local tilt with improved attachment machine between membrane and frame. As a result we will be able to control sagging of pellicle as you like.

### < Residual Local Tilt >



### Local tilt

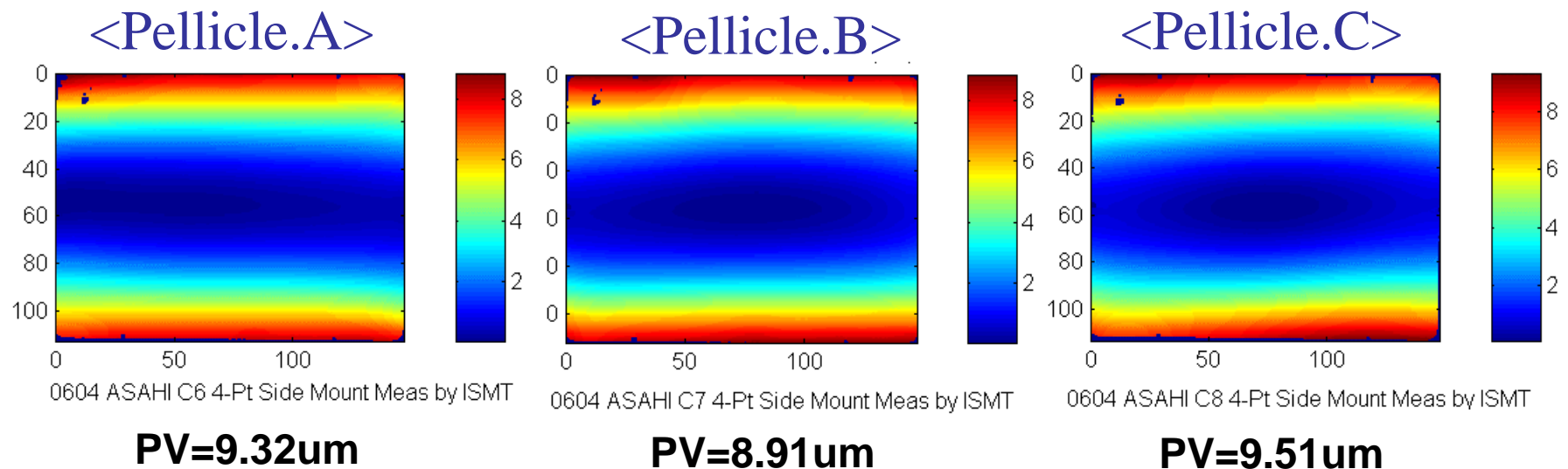


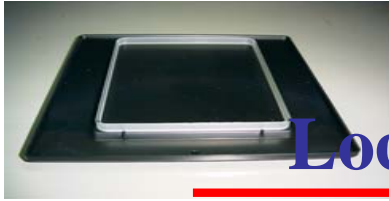
**Time**



## Reproduceability of Sagging

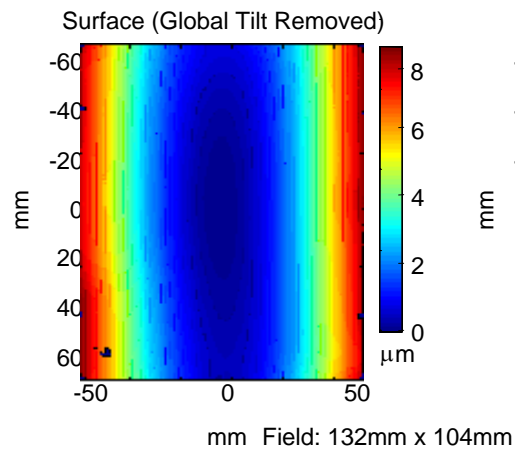
- Typical sagging data of hard pellicle made with new attachment machine Ver.2.3 is show below.
- As you can see in the bottom figure, cross section of sagging are almost same shape between pellicles. We will be able to control magnitude precisely with the improved attachment machine.



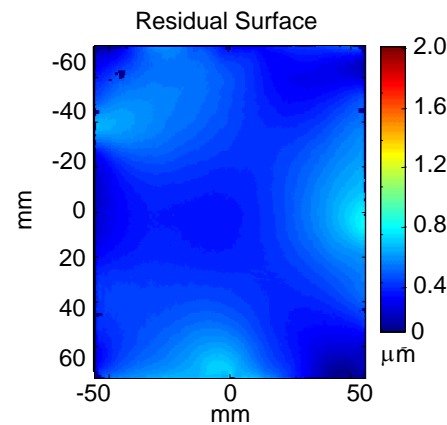


## Local tilt of Cylindrical shape Pellicle

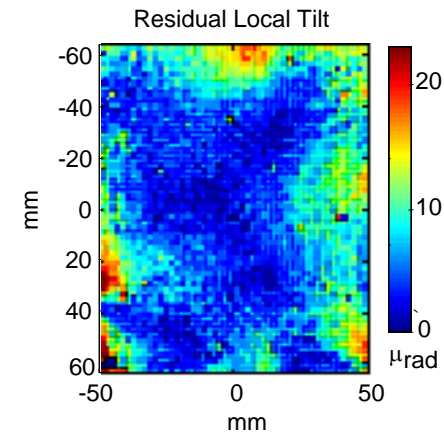
- The typical sagging data of cylindrical hard pellicle made with the improved attachment machine Ver.2.3 is show below in Fig.1.
- As you can see in Fig.3, points in 85% area are less than 10urad. It is thought to be able to reduce this local tilt with control of peripheral of frame .



<Fig.1>



<Fig.2>



<Fig.3>



## Conclusion

---

- **We installed Attachment Machine Ver.2.3 for cylindrical shape pellicle.**
  - With this attachment machine, we can control sagging during the fabrication process by calculating non correctable error of the stepper.
  - This machine can achieved the variation of local tilt less than 4urad range as standard deviation during the fabrication process.
  - We achieved that about 85% area is less than 10urad of local tilt in entire area without correctable error of stepper.
- **We will continue to make hard pellicle upon customer's request.**



# Development Schedule of Hard Pellicle

	2003	2004		2005
Time	3Q-4Q	1-2Q	3-4Q	1-2Q
Deformation (Bending)	<p><i>* improved attachment Machine for cylindrical shape</i></p> <p>→ Optimization of Production Technology →</p>			
Local tilt Target % (Less than 10urad Area)	70% <b>Clear</b>	80% <b>Clear</b>	90% <b>Almost Clear</b>	100% <b>Maybe possible</b>
Sample Delivery	<p>■ ■ ■ → <b>Upon customer's Request</b></p>			