

# Development of K-B Mirror Manipulator for Hard X-ray Sub-50nm Focusing

Satoshi Matsuyama<sup>1</sup>, Hidekazu Mimura<sup>1</sup>, Hirokatsu Yumoto<sup>1</sup>, Soichiro Handa<sup>1</sup>,  
Keiko Katagishi<sup>1</sup>, Akihiko Shibatani<sup>1</sup>, Kazuya Yamamura<sup>2</sup>, Yasuhisa Sano<sup>2</sup>,  
Yoshinori Nishino<sup>3</sup>, Kenji Tamasaku<sup>3</sup>, Makina Yabashi<sup>4</sup>,  
Tetsuya Ishikawa<sup>3,4</sup> and Kazuto Yamauchi<sup>1</sup>

<sup>1</sup>*Department of Precision Science and Technology, Graduate School of Engineering, Osaka University, 2-1 Yamada-oka, Suita, Osaka 565-0871, Japan*

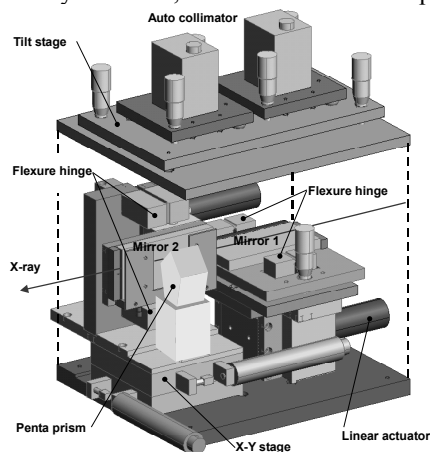
<sup>2</sup>*Research Center for Precision Science and Technology, Graduate School of Engineering, Osaka University, 2-1 Yamada-oka, Suita, Osaka 565-0871, Japan*

<sup>3</sup>*RIKEN / SPring-8, 1-1-1 Kouto, Mikazuki, Sayo, Hyogo 679-5198, Japan*

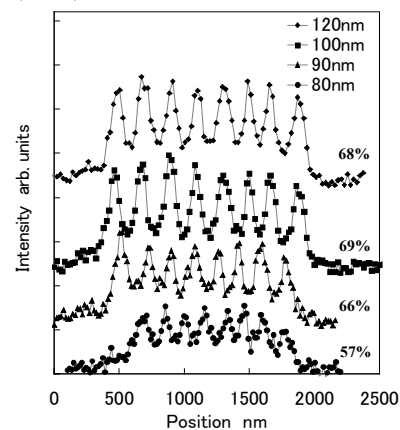
<sup>4</sup>*JASRI / SPring-8, 1-1-1 Kouto, Mikazuki, Sayo, Hyogo 679-5148, Japan*

X-ray focusing techniques using Kirkpatrick and Baez mirrors are promising due to their capability of highly efficient and energy-tunable focusing. We have been developing a hard-X-ray focusing system using K-B mirrors for an X-ray microscope<sup>[1]</sup>. Here, we report the development of a mirror manipulator (Fig. 1) and focusing tests using the manipulator. Mirror alignment tolerances were estimated using two types of simulators: a ray-trace simulator and a wave-optical simulator. On the basis of the simulation results, the mirror manipulator was developed achieving optimum K-B mirrors setup. The focal size was achieved to be 48 x 36nm<sup>2</sup> (V x H) in FWHM at 1km long beamline of SPring-8. The obtained spatial resolution test results indicate that a scanning microscope with the focused beam can resolve the line-and-space patterns of 80nm line width in a high visibility of 60% (Fig. 2).

[1] S. Matsuyama et al., Proc. SPIE Int. Soc. Opt. Eng. **5918**, 591804 (2005)



**Fig. 1** Schematic drawing of the developed mirror manipulator



**Fig. 2** Evaluation of spatial resolution in vertical direction using the patterns of various line widths