TOKAI CROSS Experimental Report J-PARC	提出日 Date of Report 2013/3/11
課題番号 Project No.2012A0085 実験課題名 Title of experiment Development of high-performance focusing supermirror for GISANS and angular-divergent measurements 実験責任者名 Name of principal investigator Dai Yamazaki 所属 Affiliation J-PARC Center, JAEA	装置責任者 Name of responsible person Masayasu Takeda 装置名 Name of Instrument/(BL No.) SHARAKU/BL17 実施日 Date of Experiment 2012/6/27-2012/6/30, 2012/11/2-2012/11/5

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

No sample.

This experiment aimed performance tests of focusing supermirrors.

2. 実験方法及び結果 （実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

Performance tests of a vertically-focusing supermirror were carried out. The supermirror was developed as a component of a stacked supermirror and coated on a thin quartz substrate of 1 mm in thickness.

This experiment aimed at verifying the usefulness of the mirror in grazing-incidence small-angle scattering (GISANS) experiments. The focusing geometry is based on an ellipsoid whose parameters are as follows: a=5525 mm, b=81.15mm, $(x/a)^2 + (y/b)^2 = 1$. The first focal point of the ellipsoid was located at 6950 mm from the moderator surface, where the slit S1 is placed, while the second focal point was at 18000 mm (Detector Position). The focusing supermirror, whose surface shape also makes up a part of the ellipsoid, was placed at 14380 mm from the moderator. The beam line setup is illustrated in Fig.1. When the beam width was 1 mm at the slit S1 (at the first focal point), the focused beam width is supposed to be 0.49 mm at the detector.

The vertically-focused beam was observed with a scintillation area detector which uses a photomultiplier tube with dividing resisters (RPMT). Spatial profile of the focused beam is shown in the left panel of the Fig.2.

We subsequently collimated the focused beam transversally with the slits S1~S5 and observed the beam profile to obtain information on whether the focusing supermirror is useful in GISANS experiments. The transverse collimation was determined with S1 and S5 whose widths were both 1.0mm. The two-dimensional profile is shown in the right panel of Fig. 2. It can be seen that focused peak width is around 1.5mm in fill width

at half maximum which is larger than our expectation (0.5 mm). This could be attributed to spatial resolution of the area detector and subtle distortion of the thin focusing mirror. As for the detector resolution, we should have performed a measurement with an imaging plate whose resolution is 0.05 mm.

Figure3 shows the intensity of the beam in the right panel of Fig.2 as a function of distances from the beam center which correspond to scattering angle 2θ in SANS experiments. Beam intensity decreases rapidly by more than 3 digits within 2mrad of "scattering angle" but intensity level at ~ 10^{-1} exits for 2θ > 4mrad. The level could deteriorate the measurement data in SANS experiments, but it looks like backgrounds and could be removed by tuning the area detector and shielding the detector and beam line.

In conclusion, a vertically–focusing supermirror was developed and used to obtain a vertically–focused and transversally collimated beam. Background level was observed about 4 digits smaller than the peak height.

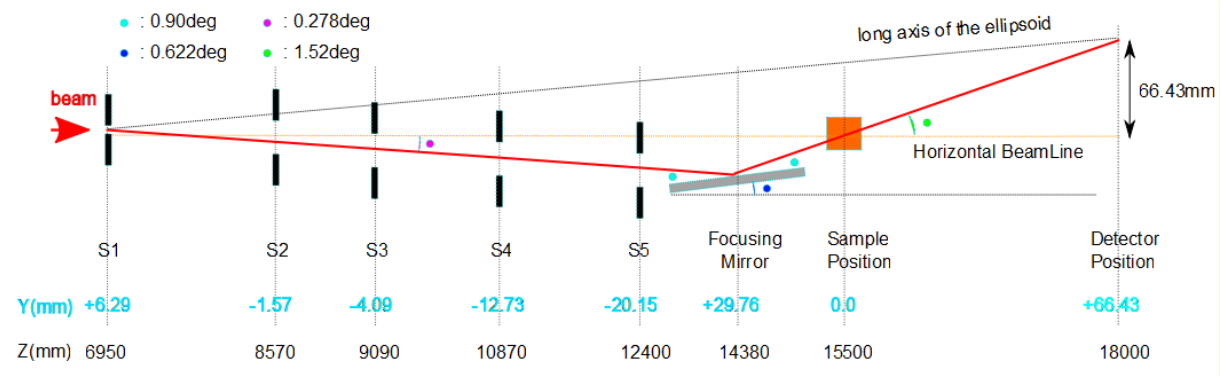

Figure 1. The beam line setup. 'Y' and 'Z' denote the vertical direction and the beam line direction, respectively. Blue and black digits at the bottom show the position of slits (S1–S5), the focusing mirror, sample stage or the detector surface.

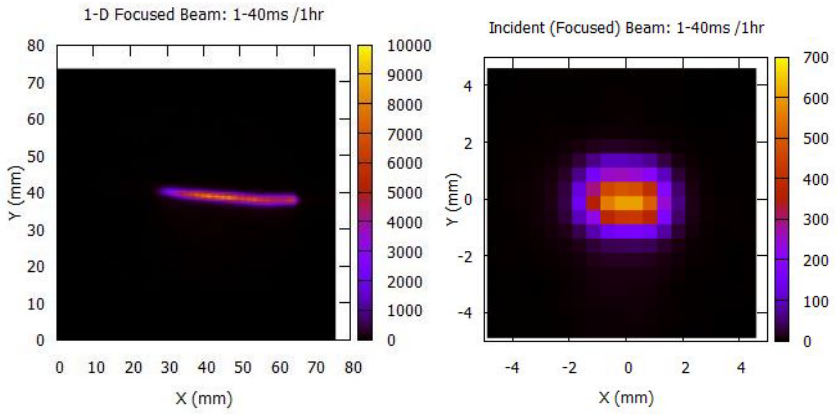

Figure 2. Beam profiles of a vertically focused beam (left) and a vertically–focused and transversally–collimated beam (right).

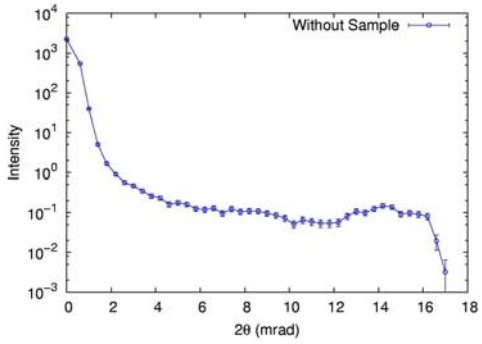

Figure 3. Intensity as a function of apparent "scattering angles" 2θ, which correspond to the distance from the beam center (deduced from the right panel of Fig.2). The rapid decrease at 2θ > 16 mrad shows the detector edge.