MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2016B0037 実験課題名 Title of experiment Feasibility test of micro-PIC detector for neutron reflectivity imaging 実験責任者名 Name of principal investigator Kenji Sakurai 所属 Affiliation National Institute for Materials Science	装置責任者 Name of responsible person K. Oikawa 装置名 Name of Instrument/（BL No.） BL10 実施日 Date of Experiment February 1-6 (total 4.5 days) March 3-6 (total 3 days)

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.

Patterned layered thin films (coated by Ni and Ti on Si wafer). Figure 1 shows a sketch of one of the samples used during the experiment.

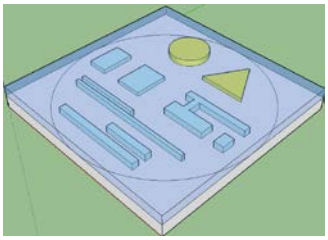

Figure 1 Schematic illustration of one of the sample used during the experiment. The patterns are buried under the top protection layer, which covers the whole area of the sample.

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.

The aim of the present work is testing feasibility of a micro-PIC detector for the neutron reflectivity imaging, which is a novel extension of conventional neutron reflectivity technique. In the previous beamtime (2016A0059), the experimental setup for neutron reflectivity has been carried from the NIMS X-ray laboratory to BL10 for the first time. This time basically almost the same setup was used. As is shown in Figure 2, some improvement such as addition of one more fine slit (a fixed thickness of aluminum foil sand-witched by a pair of B_4C rubber pieces). In the past research done at BL17 (2015A0011, 2014B0002, 2014A0002 and 2013A0227), it has been already confirmed that in-plane inhomogeneity of the buried layers and interfaces can be visualized by the present technique. However, the spatial resolution has been limited at around 1 mm, which is not very attractive for many scientific applications. Therefore our only interest in this program at BL10 is mainly the spatial resolution, as well as other feasibility to obtain reproducible and reliable

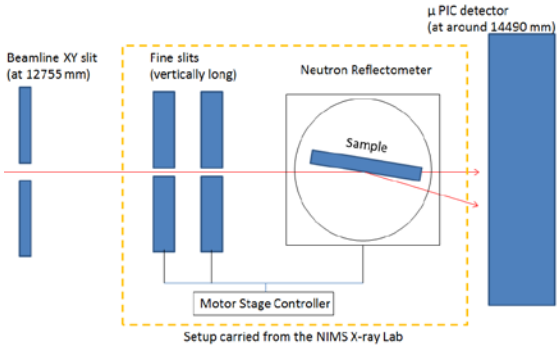

Figure 2
Schematic layout of neutron reflectivity imaging

images. Similar to the experiment at BL17, a series of reflection projection images have been collected as a function of in-plane angle of the sample. Figure 3 shows typical image of such reflection projection from a pattered sample. The central strong vertical line (around 58 mm length) indicates transmission (direct) neutron beam, while a shorter parallel line (around 37 mm length) in the right hand side is reflection from the sample. As is clearly seen, the reflection projection is not a uniform line, but has some intensity profile corresponding to the patterns (one example is shown in Figure 1). It has been confirmed that the data are quite close to that already obtained at BL17. On the other hand, unfortunately, the line image of the direct beam spreads and seems to have strong influence in low angle region. In the early stage of the commissioning, we have found some technical difficulties in the adjustment of the reflection condition for the sample. One can also see undesirable artificial line-like background in Figure 3. In the present research, we cut out a narrow strip (2.5mm×~50mm(V)) from the whole area (100mm(H)×100mm(V)). In other word, the detector is too large for our experiment, as we use smaller than 2 % of the area. Figure 4 shows typical sonogram, which is a collection of narrow strips taken at different in-plane angles. Because of the limitation of the length of the beamtime, this time the number was 36. One problem at BL10 is that the measuring time for each scan is constant, indicating that the data are not comparable before normalization by the number of primary neutron counts. Figure 5 shows an example of reconstruction. It has been found that the data is quite in good agreement with our previous results obtained at BL17. Though further analysis is still under way to estimate the spatial resolution of the present work, we may say this could be better than 1 mm (achieved at BL17), but is still not very far and the improvement is little. In conclusion, we were able to do successful neutron reflectivity imaging experiment at BL10, and the results seem similar each other. This means that the same experiments can be done without the use of BL17's reflectometer. When combined with the micro-PIC detector, the spatial resolution has become a little better. For further discussion, we need further analysis of the data, including the optimization of the image processing. The feasibility of micro-PIC detector in the neutron reflectivity imaging has been enough examined, and no further tests is necessary. However, to publish some data in the present work, it is extremely important to confirm the reproducibility.

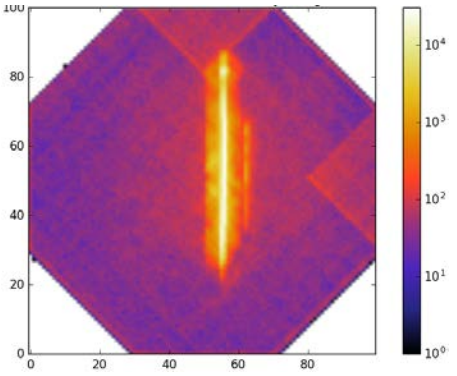

Figure 3
Typical reflection projection image from a patterned sample.

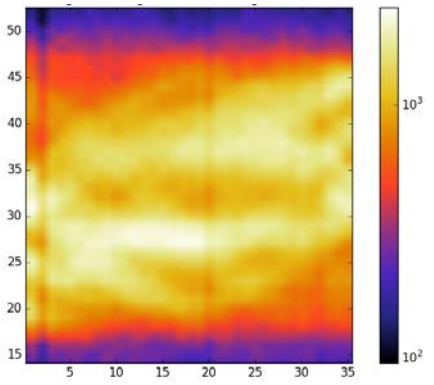

Figure 4 Typical sonogram from a patterned sample.

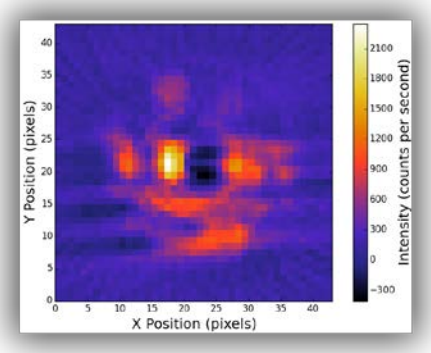

Figure 5 Typical reconstructed image.