Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

Development of Neutron Detectors for Four Circle Diffractometer at HANARO

Myungkook Moon*, Jongkyu Cheon, Younghyun Choi, Changhee Lee, Shinae Kim and Harkrho Kim
Korea Atomic Energy Research Institute, 150 Duckjindong, Yusung, Daejeon 305-353, moonmk@kaeri.re.kr

1. Introduction

Four Circle Diffractometer (FCD) at HANARO is a dedicated instrument for single crystal diffraction study and texture analysis. Since the neutron monochormator of FCD is single slab of mosaic Ge (331) crystal and the distance between monochromator and sample is 3.45 meters, the neutron flux at sample position is ~5×10^5 n/cm^2·s. Besides the typical sample volume is less than 0.1cm^3. This is caused by low neutron intensity at detector position. To improve the detection capability of the FCD we have completely upgraded the neutron detector and its signal process units. In this paper, development of the dedicated neutron detectors for FCD and their test results are presented.

2. Detector fabrication

In this section various types of the neutron detectors for the FCD are described. The types of the detector include a tube detector, position-sensitive detector, curved position-sensitive detector, and monitor-like position-sensitive detector.

2.1 Tube detector

The detection efficiency depends on neutron wavelength, detector thickness, and gas pressure. To increase the detection efficiency, one should use high pressure detector or increase detection thickness. Due to a small and single crystal sample of the FCD the shape of diffraction pattern represents as a small spot. Therefore small and effective detector is enough for the FCD. We have developed very effective detector for FCD. Compare to the conventional tube detector, the incident neutrons enter through the coaxial direction. Figure 1 shows the tube detector which has very thin window at left direction.

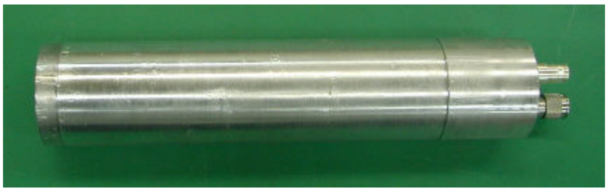

Figure 1. Tube detector for FCD.

2.2 Position sensitive detectors

We have developed two types of the position-sensitive 2 dimensional detector for FCD. The first detector has effective window of 19×19cm^2. The detector covers with 17^o×17^o. Figure 2 shows the shielding unit with position-sensitive detector. One of sample data from NaCl using a oscillating photo method shows in Figure 3.

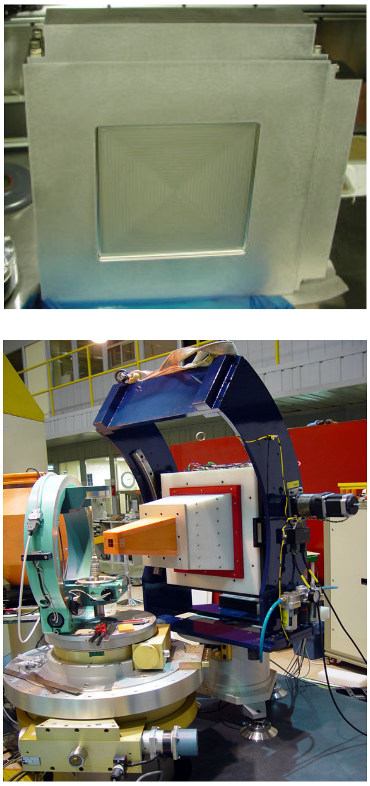

Figure 2. Two dimensional position-sensitive detector (upper photo) with shielding unit (lower photo).

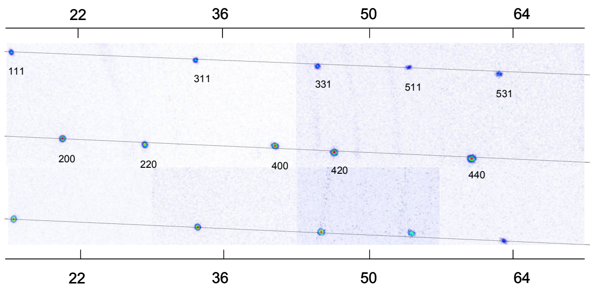

Figure 3. Diffraction pattern from NaCl crystal.

Through the experiment by the prototype of the 2 dimension detector we finalized the specification of the large coverage angle detector. The detector should cover 45^o in vertical direction and 70^o degree in horizontal direction [1]. Because of parallax effect the shape of detector should be curved in horizontal direction. Figure 4 shows the prototype of curved detector. To fill high pressure of He-3 we analyze the mechanical deformation using FEM (finite element method). Some diffraction pattern measurement from NaCl crystal is shown in Figure 4.

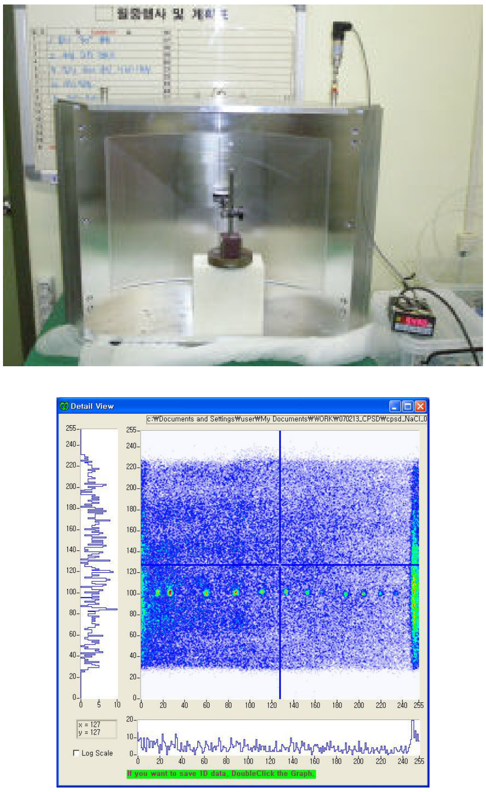

Figure 4. Curved position-sensitive detector (upper) and sample data from NaCl crystal.

2.3 Monitor like position-sensitive detector.

When the sample installs in cryostat or furnace user cannot see the position variation of sample cause to thermal expansion. We have developed very low efficiency but high resolution monitor-like position-sensitive detector to see the movement of the sample at cryostat [2].

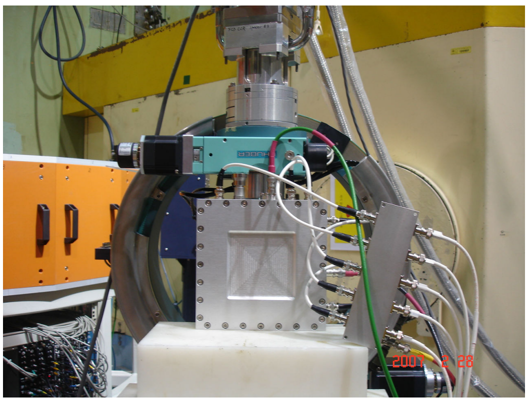

Figure 5. Monitor-like position-sensitive detector at direct beam position

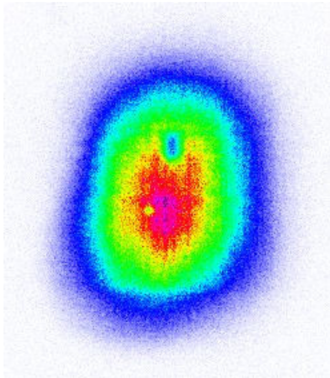

Figure 6. Direct beam measurement through cryostat sample.

3. Conclusion

Various types of detector were successfully developed and the initial performance results are promising. Those detectors can contribute to new scientific opportunity..

REFERENCES

[1] M.K. Moon *et al.*, 2007, Detailed specification will be presented at Spring Meeting of the Korean Physics Society in Pyungchang
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