The time spectrum of the K-shell conversion electrons is shown in Figure 2. The principal structure of the time spectrum is an exponential decay with the time constant of 131±17 ns, which coincides with the decay time of isolated ^{57}Fe nuclei, 141 ns. Compared with the time spectrum of the nuclear resonant photon emission for the same sample, neither the speed-up of decay process nor quantum beat structure is observed. The present results illustrate the incoherent nature and surface layer sensitivity of conversion electron emission.

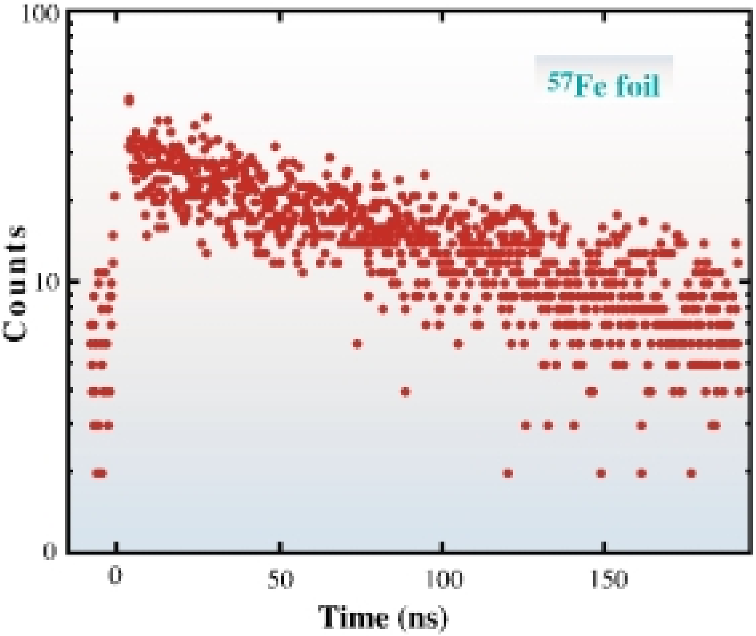

Fig. 2.: Time spectrum of K-shell conversion electrons from ^{57}Fe foil. Accumulation time of the spectrum was 7.8 hours.

Tatsuo Okano[a], Taizo Kawauchi[a] and Zhang Xiao-Wei[b]
(a) The University of Tokyo
(b) KEK

E-mail: okano@iis.u-tokyo.ac.jp

T.Okano, T.Kawauchi, X.-W. Zhang, K.Fukutani, Y.Yoda, U. Teerapongpipat and S.Kikuta, Submitted to *Japan J. Appl. Phys.*

X-RAY PARAMETRIC DOWN CONVERSION AT THE BREWSTER ANGLE

X-ray parametric down conversion originating from the property of free electrons is one of the nonlinear phenomena in the X-ray region. The phenomenon that one X-ray photon is converted to two photons was observed by Eisenberger *et al.* using an X-ray tube [1] and by Yoda *et al.* using synchrotron radiation [2]. The polarization dependence in X-ray parametric down conversion is different not only from that in Thomson scattering but also from that in optical parametric conversion. In the latter case, the spatial symmetry of a nonlinear optical medium restricts the form of the nonlinear optical susceptibility. The X-ray parametric down conversion was observed in such a geometry that the π -polarized X-rays are incident on the crystal at the Brewster angle where Thomson scattering is prohibited.

The experiment was performed at the beamline **BL09XU**. The linear polarized X-rays in the horizontal plane can be obtained by the in-vacuum horizontal undulator. The storage ring was operated in multi-bunch mode with 2 nsec pulse intervals and its typical current was 17 mA. X-rays from a Si (111) inclined double-crystal monochromator were incident on a diamond single crystal as shown in Figure 1.

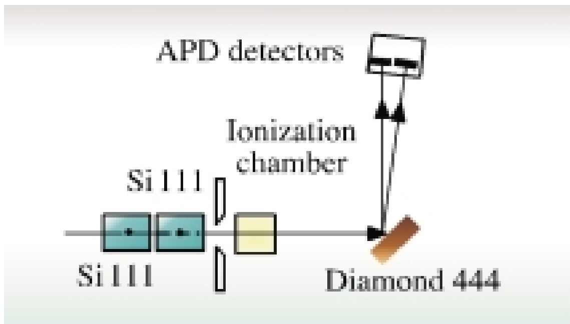

Fig.1: Experimental setup. Two APD detectors were arranged at scattering angles of nearly 90 degrees.

The combination of 0.72 Å wavelength of the monochromatized X-rays and the (444) reflection of diamond makes the Brewster angle. The symmetric Bragg-case was employed for the phase matching of parametric down conversion. Two avalanche photodiode (APD) detectors of 5 mm^2 were placed on the scattering plane with their centers 18 mm apart so as to be symmetric around the direction of the Bragg reflection. The coincidence technique with a time resolution of 1.5 nsec was used. The distance between the diamond crystal and the APD detectors was 290 mm.

The π-polarized X-ray beam was incident on the diamond crystal. The coincidence measurement was made by rotating the crystal step by step with a measuring time of 2850 sec at each point. The coincidence rate was obtained by subtracting the accidental coincidence, as plotted by solid circles in Figure 2. The Bragg reflection intensity is also plotted by open circles. The peak of Bragg reflection does not appear if the incident X-rays are 100% linear-polarized.

The coincidence peak is clearly seen at the higher angle side of the Bragg reflection peak, and its peak position agrees well with the estimated value 95 arcsec. The coincidence rate at the peak was 0.05 counts/sec and the accidental coincidence rate estimated from the counts at each detector was 0.001 counts/hour at most. At the peak position of the coincidence rate, the change in the coincidence rate was measured as a function of the time difference caused by two delay-cable lengths of the electronic circuits. No signal was counted in the region where the delay time was more than 1.5 nsec. This means that the peak of the coincidence rate in the angular scan is definitely formed owing to the simultaneous detection by the two detectors. The measured degree of linear polarization of the incident X-rays was 99.7%, and another measurement using σ-polarized incident X-rays at 90° showed that 0.3% σ-polarized incident X-rays did not contribute to the coincidence peak in Figure 2. Measurement at the Brewster angle will be effective to reduce the background noise in the experiment of X-ray parametric down conversion.

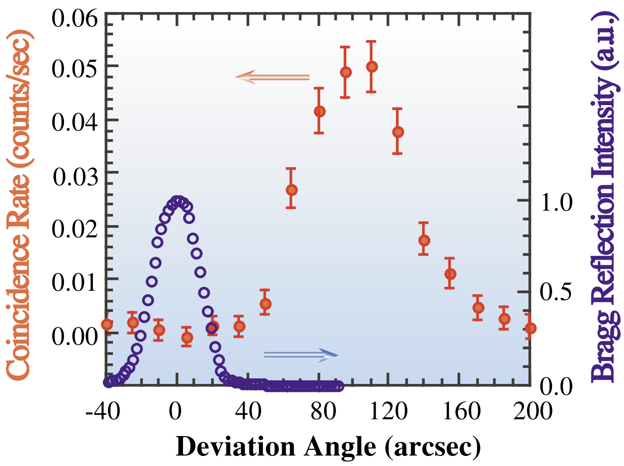

Fig. 2: Yield of X-ray parametric down conversion as a function of rotation angle of the diamond crystal. Red solid circles: coincidence rate of two APD detectors. Blue open circles: Bragg reflection intensity detected by one APD detector placed in the Bragg reflection direction.

Yoshitaka Yoda and Seishi Kikuta
SPring-8 / JASRI

E-mail: yoda@spring8.or.jp

References

[1] P. Eisenberger and S.L. McCall, *Phys. Rev. Lett.* **26** (1971) 684.
[2] Y. Yoda et al., *J. Synchrotron Rad.* **5** (1998) 980.