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Basic Performance for hard X-ray Polarimeter Using MAPMT

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Introduction

In X-ray astronomy, various information on stellar objects has been obtained through the energy spectrum, the time variability, and the image. Though the observation for the polarization is also very important, the observation has been rarely carried out. So we have been developing a hard X-ray polarimeters, applying new technology[1] and had several basic experiments in KEK PF BL14A to investigate the basic performance of the prototype polarimeter.

Design of Hard X-ray Polarimeter

We have applied Compton scattering as the principle of the polarimeter. Since the direction of the scattered hard X-ray depends on the polarization vector of incident hard X-ray, the information on the polarization can be obtained by measuring the direction of the scattered hard X-ray. Figure.1 shows the schematic view of the Compton scattering type polarimeter developed by us[1].

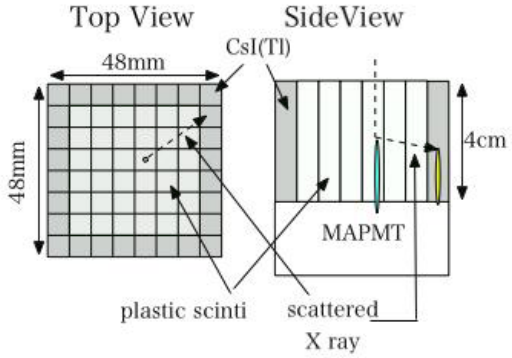

Figure 1: The design of the polarimeter.

This polarimeter consists of 36 plastic scintillators and 28 CsI(Tl) scintillators surrounding them. They are read out by one multianode photomultiplier (MAPMT) H8500, which is manufactured by Hamamatsu Photonics Inc. As the incident hard X ray is coming to any plastic scintillator, the hard X ray is scattered and the scattered hard X ray is absorbed by any CsI(Tl) scintillator. By detecting the scattering and absorption positions, the 2-dimensional scattering direction can be determined and hence the information on the polarization for incident hard X rays can be obtained.

Results

Figure. 2 shows the experimental setup and the results. The polarized hard X rays of 80 keV were injected to the center of the detector as shown in left figure. From acquired events, the events which satisfy the following two criteria were extracted and used for analysis.

1) The deposited energy in the plastic scintillator due to the Compton scattering of 80 keV hard X rays is around 11 keV. So we selected the events with the energy deposit which corresponds to ~11 keV in the plastic scintillator.
2) The energy deposit in the CsI(Tl) scintillator due to the Compton scattering corresponds to ~70 keV. So we selected the events with energy deposit around 70 keV in only one CsI(Tl) scintillator.

With the extracted events, we investigated the hit pattern for the CsI(Tl) scintillators. The x axis and y axis in the right figure correspond to the channel number for the CsI(Tl) scintillators and the number of events, respectively. The bars and the crosses are the results of the experiment and computer simulation, respectively. As shown in the right figure, the modulation can be clearly observed. We recognized that our polarimeter can obtain the good modulation factor of ~60% for 80 keV. Moreover, the detection efficiency was ~20%.

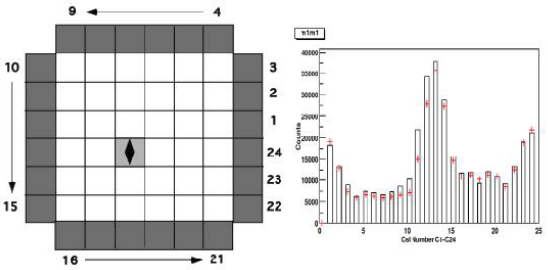

Figure.2; The left figure shows the notation for CsI(Tl) scintillators. The right figure shows the modulation of the counts for CsI(Tl) scintillators. The x axis and the y axis corresponds to the channel number for the CsI(Tl) scintillators and the number of events, respectively.

Conclusions

We have developed Compton scattering type polarimeter sensitive to hard X-ray band, using MAPMT (H8500). To investigate the performance, we have carried out basic experiments utilizing polarized X-ray beam of 80 keV in BL14A of KEK PF. From the results, we confirmed that it can obtain the modulation factor and the detection efficiency of ~60% and ~20% at 80 keV, respectively.

References

[1] S. Gunji etal. Adv. Space Res. Vol.33 (2004) pp1771-1776

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