§18. Hard X-Ray Diagnostic by Use of CdTe Detector in Heliotron J

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1. Introduction

The Heliotron J device is designed to provide quasi-ominigeneous (QO) property on magnetic field configuration. In a Heliotron J type configuration, the non-axisymmetric bumpy ripples play an important role to obtain good neoclassical confinement [1,2]. Because of this reason, the Heliotron J is flexible in changing the magnetic field configuration to explore optimized configuration experimentally. The primary purpose of this work is to study dependence of confinement property on magnetic field configuration through measuring pulse height spectra of X-rays, i.e. energy distribution of electrons in low-density ECRH plasmas.

2. Hard X-ray detector and electronics

Aiming at detection of X-rays originating from energetic electrons generated by ECRH, a hard X-ray detector based on a cadmium telluride (CdTe) diode (Amptek inc. /XR-100T-CdTe[3]) is chosen because a silicon (Si) semiconductor detector suitable for measuring relatively low energy X-rays is being employed in the Heliotron J. Because the atomic number Z of the CdTe detector is much higher than that of the Si detector, the CdTe detector is more suitable for high energy X-ray measurement. The detection volume of CdTe is 3x3x1 m^3. The thickness of beryllium (Be) window installed in front is 4 mil. The electronic circuit used in this system and a typical output pulse from a shaping amplifier due to X-ray irradiation are shown in Figure 1. This system is operated in pulse height analysis (PHA) mode. We employ a tungsten aperture system variable in its size (50 μm ~ 200 μm) from the outside of vacuum. This allows us to operate the system under appropriate counting rate.

3. Experimental setup

After the energy calibration of the system was carried out by use of γ-ray sources (^{133}Ba : 384 keV, 356 keV, 303 keV, 274 keV and ^{241}Am : 59.5 keV), we installed this detector on the Compact Helical System (CHS) to make sure whether the system can work well as a whole. In this test, X-rays up to 10 keV was successfully detected in a low density (n_e ~ 0.23x10^{19} m^{-3}) ECRH plasma at magnetic field strength B_t of 0.95 T. In a higher n_e plasma (n_e ~ 0.5x10^{19} m^{-3}), the maximum photon energy became lower than that in n_e ~ 0.23x10^{19} m^{-3} and was 6~7 keV. After we made sure that the system could work correctly in NIFS, the detector and electronics have been moved to the Heliotron J site. Figure 2 shows the location of Heliotron-J diagnostic port where the detector was installed. We have set the whole system in this fiscal year. In 2006,
dependence of confinement property on magnetic field configuration is going to be investigated through measuring pulse height spectra of X-rays in low-density ECRH plasmas.

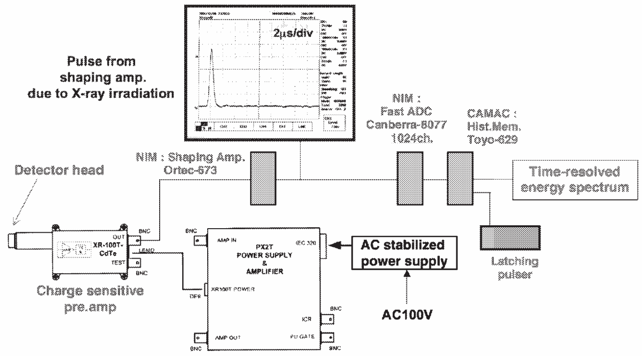

Figure 1 Electronic circuit for X-ray diagnostic by use of CdTe detector. Typical output pulse from shaping amplifier due to X-ray irradiation is also shown.

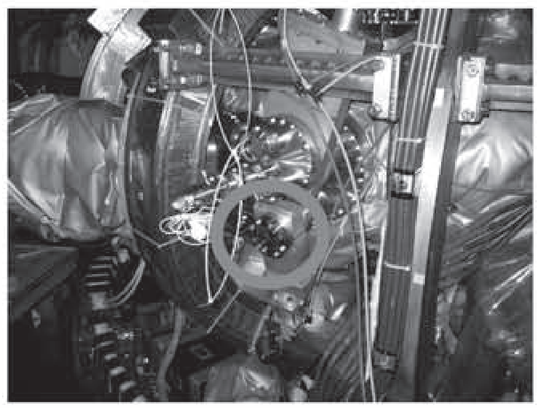

Figure 2 Diagnostic port on Heliotron-J where the CdTe X-ray detector was installed.

References
1) Obiki, T. *et al.*, Nuclear Fusion **41**, (2001)833.
2) Mizuuchi, T. *et al.*, Plasma Science & Technology **6**, (2004)2372.