Gamma-ray Diagnostics for High-time Resolution Measurement in the Large Helical Device

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A high-time resolution gamma-ray spectrometer based on a $LaBr_3$(Ce) scintillation detector characterized by high-time resolution was installed in the Large Helical Device (LHD) as a complemental diagnostic for energic particle studies. The 1-inch diameter 1-inch height $LaBr_3$(Ce) scintillator coupled with a 1-inch photomultiplier tube is immersed into the radiation shield whose total weight is 500 kg. The radiation shield composed of 10 cm thick lead and more than 10 cm thick 10% borated polyethylene was designed using the Monte Carlo three-dimensional radiation transport code MCNP6 to suppress unwanted signals due to gamma-rays from the surrounding material as well as fast-neutron because a $LaBr_3$(Ce) detector has a sensitivity to fast-neutron. The pulse signal was transferred by a 60 m co-axial cable and fed into the 1 GHz sampling rate analog to digital converter equipped with a field programmable gate array implemented with an offline pulse height analysis function. The high voltage of the detector is applied by an externally controllable high voltage module having the logging function. After in-situ energy calibration of the $LaBr_3$(Ce) detector using a ^{137}Cs gamma-ray source was performed, we clarified that the unwanted pulse counts induced by neutrons created by thermal deuterium-deuterium fusion reactions do not inhibit gamma-ray spectroscopy measurement. The detailed design of the diagnostics and initial result of gamma-ray spectroscopy will be presented.