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Investigation on irradiation effects on highly integrated leading edge electronic components of diagnostics and control systems for the LHD deuterium operation

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High-temperature and high-density plasmas are achieved by means of real time control, fast diagnostic, and high power heating systems. Those systems are precisely controlled by means of transmission and highly integrated electronic components. However, the radiation damage due to neutron and gamma-ray may lead to serious impact on those systems. Therefore, effects due to irradiation on electronic components being used currently should be investigated for control and measurement of LHD deuterium plasmas. For precise estimation of the radiation field in the LHD torus hall, MCNP-6 Monte-Carlo neutronics code is used with the cross-section library of ENDF B-VI. The geometry is modeled based on the CAD drawing with some simplification. The dose on Silicon, which is a major ingredient of electronics components, during the nine years of the LHD deuterium operation shows that the gamma-ray contributions are dominant in dose. To investigate the irradiation effect on electronic components used in LHD, neutron irradiation tests are performed in the Fast Neutron Laboratory at Tohoku University and gamma-ray irradiation tests are performed in the Nagoya University Cobalt-60 irradiation facility. We found that most modules of the PLC are broken around the gamma-ray dose of 100 Gy. This is comparable with the dose in the LHD torus hall over nine years. Finally, if we consider the dose only, these components may survive more than nine years. However, the safety factor is low. For the safety of the LHD operation, electronic components placed on the torus hall have been rearranged.

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