Abstract

Design and Simulation of Cu Target X-ray Source for ITER X-ray crystal spectrometers

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In ITER [1], X-ray Crystal Spectrometer diagnostic is required to provide accurate measurements of real time plasma behaviour and impurity characteristics. At IN-DA, two X-ray crystal spectrometer systems for Edge and Core plasmas respectively are being developed. The primary role of X-ray Survey [2] diagnostic is viewing the plasma core from an equatorial port for the identification and monitoring of impurities, because the X-ray spectral region (0.05 - 10 nm) contains important emission lines of light (Be, C, O) and metallic (Fe, Ni, Cu) impurities and strong emission features of likely plasma dopants (Ar, Ne, Kr). Edge spectrometer is to provide profiles of ion temperature (T_i) and plasma rotation at the plasma edge from emission measurements in the wavelength range of 0.2-0.5 nm.

A Fixed Cu target X-ray source is being designed at ITER-India. Later more targets like Ni, Cr, SS and W will be used to cover the entire required wavelength range. The source comprises a line filament as an electron source and Cu anode as a fixed target and allows X-ray beam output through a thin Be window. It will be operating at varying applied potentials up to 30 kV.

Monte Carlo simulations have been done to evaluate the performance of the X-ray source, to obtain information on output photon spectra, flux and dose rate at the detector location, 110 mm from the Cu target. The operational output dose rate was obtained as 6.7Sv/hr for a net photon flux of 3.3×10^{10} /s/cm^2. For safety purpose the leakage dose rate from the X-ray source was also calculated and the obtained value is around 0.26μSv/hr at a distance of 5cm from the steel chamber, which is in good agreement with the ALARA limits specified by AERB for radiation safety.

This presentation includes the description of the ITER X-ray crystal spectrometers, design requirements for the X-ray source needed for the testing and calibration of the spectrometer and the simulation results of the X-ray beam characteristics.

References

[1] www.iter.org

[2] S. Varshney, R. Barnsley et.al, Rev. Sci. Instrum. 83, 10E126 (2012)