

Development of VUV spectroscopy using modified Seya-Namioka monochromator and CEM detector in the HL-2A tokamak

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Abstract

Impurity study is one of the most important issues in fusion research since light and heavy impurities can cause fuel dilution and radiation loss in the plasma. Spectroscopy is commonly used to monitor impurity content and to study impurity transport in fusion devices. In the HL-2A, two EUV spectrometers and a VUV spectrometer have been utilized for monitoring the impurity lines in wavelength ranges of 40-400 Å and 400-3000 Å, respectively [1-3]. The radial profiles of impurity line emission and its spectrum can be measured with these spectrometers. However, the time resolution is limited to 6 ms for the spectral measurement and 100 ms for the profile measurement. In order to study the fast events in relation to impurity issues, such as impurity injection with laser blow-off (LBO) or supersonic molecular beam injection (SMBI) methods, a 20cm normal incidence vacuum ultraviolet (VUV) monochromator combined with a detector of the channel electron multiplier (CEM) has been developed in the wavelength range of 300-2000Å. A holographic 1200g/mm grating blazed at 1400Å is adopted which gives wavelength dispersion of 4 nm/mm. The effective aperture of the monochromator is f/4.5. The chamber of this system is evacuated by a 400l/s turbo molecular pump and the minimum vacuum pressure of 5.0×10^{-4} Pa can be obtained so far. The data is acquired with 1MHz sampling frequency.

The performance of the system has been examined by using a hollow cathode light source in the laboratory. The spectra of the helium and argon with strong intensity have been obtained. The stray light has been significantly reduced since the inner surface of the vacuum chamber of the monochromator is blackened. By scanning the width of the entrance and exit slits, and the working voltage applied to the CEM, the optical property of the system has been carefully checked. The results indicate that the system functions very well. The spectra of the HL-2A plasma have also been examined by installing the system in the HL-2A and the analysis of the spectra is carried out.

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