§32. Interlock System for 2.45 GHz ECR Plasma in LHD

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Electron Cyclotron Resonance Discharge Cleaning (ECR-DC) is arranged in LHD. By use of microwave (2.45 GHz, 20 kW), a hydrogen (Helium) plasma (n_e ~ 10^{16} m^{-3}, T_e = 3-7 eV) will be produced in standard magnetic configuration (R_{axis} = 3.75 m, B_0 = 0.0875 T). The daily cleaning is scheduled after the main discharge, the cleaning plasma will thereby be maintained over the night. Thus, we need some system monitoring plasma discharge automatically, because cleaning plasma may be vanished by some causes. When the microwave is kept turning on without plasma for long duration, some dangerous accidents, such as meltdown of O-ring, may happen because the microwave power is sufficiently high (20 kW). For this reason, it is necessary to interlock the monitor system and power supply of microwave.

A Schematic view of the interlock system for ECR-DC Plasma is shown in Fig. 1. We made simple spectroscopic detectors, which consist of interference filters, photodiodes and differential amplifiers. The SUS meshes are set in front of the apertures of the detectors to protect from the noise stemmed from microwave. The center wavelengths of these interference filters are selected to be able to measure the line intensity of H_α, OII and HeI. The details are shown in Table I. Sensitivities of photodiode with respect to the center wavelengths of these interference filters are also shown in Table I. The differential amplifier converts the current signal of photodiode to voltage signal with a gain of 10^7 and a cutoff frequency of 30 kHz. We can arrange these detector to measure the line intensity along a chord passing through the center of the LHD plasma or one passing through the edge region. These detectors can be used to monitor not only the ECR-DC plasma but also main discharge. It is very useful to evaluate the effect of the ECR-DC on the performance of main plasmas.

The H_α signal at 3-O port is used as a basis of the presence of hydrogen cleaning plasma. Consequently, the interlock system is so designed that, If the H_α signal is less than a certain level all certain time, the power supply of the microwave is automatically turned off to keep away from the dangerous accidents. We can set the critical level and time duration with the range of 0.1-10 V and 0.1-100 s, respectively. The H_α signal is naturally less than this critical level before breaking down, we must thus set the breakdown time (1-100 min). The H_α interlock system is available after a period of the breakdown time. If plasma does not break down within the period of the breakdown time, the power supply of the microwave is also turned off.

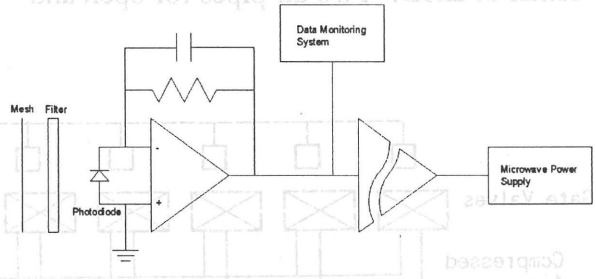

Fig. 1. Schematic view of the interlock system for ECR-DC Plasma.

Line	Wavelength nm	FWHM nm	sensitivity A/W
H_α	656.3	1.3	0.35
OII	441.5	1.0	0.23
HeI	587.6	1.1	0.32

Table I. Center wavelengths of the interference filters and the sensitivities of the photodiode.