§61. Development of Multi-channgel Ultraviolet Spectroscopic Component for Fine Resolution Computer Tomography

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The understanding of plasma turbulence has been largely advanced at present to provide a new concept that the plasma turbulence should be a system of microscale drift-waves and their generating meso- and macrostructures, such as zonal flows and streamers [1]. Therefore, further investigation needs new innovative diagnostics to be able to measure the plasma turbulence spreading over the whole plasma in a wide range of scales from micro- to macro. Computed tomography (CT) is one of the methods to present such measurement. The purpose of the proposal is to develop elements for such tomographic diagnostic ultra-violet light emission from the plasmas in QUEST experiment.

For measuring the turbulence structure with CT, a large number of spatial channels are necessary to resolve such fine structure in space and time, comparable to ion Lamor radius and drift wave frequency, respectively, of plasma turbulence. An invented diagnostic system should be necessary to increase the number of the detectors to perform the computed tomography of plasma turbulence with a sufficient spatio-temporal resolution. The system proposed here is s composed of collimator, ultra-violet filter, optical feed-through that transfers the filtered plasma light to the atmosphere side. The light passing through the optical feed-through is transferred through fibers to the photodiode detector array. The light signals are detected with detectors located sufficiently away from the plasma, therefore, the electric interference can be avoided, and this property is advantageous in improving the signal-to-noise ratio of the system. The optical feed-through is made of fluorescence glass to convert the plasma UV light to visible light for avoid the UV transmission decay due to fibers. The property of the fluorescence glass is shown in Fig. 1.

The conceptual view and pictures of the plasma interface system are shown in Fig. 2. The top view of the system is shown in Fig. 2, where the optical feed-through is made in ICF152 flange. The system has 45 channels aligned to observe the plasma in both poloidal and toroidal direction. The shape of the UV filter is chosen as an octagon. The bandwidth of the UV filter for the prototype system is selected to cover the range of light wavelength able to produce the fluorescence (see Fig. 1(upper)). The length of the fibers after the optical feed-through is 10 m. Interface components are made to connect the optical feed-through precisely to the transmission fibers. Each light signal transferred through a fiber is converted into voltage signal by using the photodiode amplifier. The gain and frequency bandwidth are 10^8 V/A and up to 50 kHz, respectively.

In the system, the replacement of optical filters allows us to detect plasma emission in any range of wavelength, or different regions of target plasmas. In other words, the core, edge and periphery of the target plasma can be observed with X-ray, UV and visible light like Hα respectively. In the case of X-ray, CsI scintillator, for instance, is replaced with the UV filter, the plasma X-ray emission can be detected. In fact, it was confirmed that the X-ray scintillator was able to detect the plasma X-ray emission in QUEST plasma in an equivalent detection system described here. The UV detection using the present system is waiting for the next fiscal year experiment.

[1] A. Fujisawa, Nuclear Fusion 49 013001(2009)

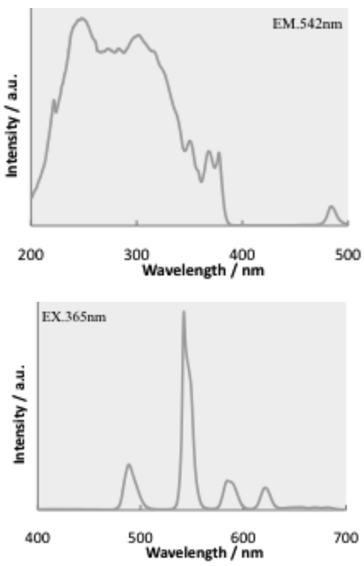

Fig.1 Properties of flourescence glass. (upper) Excitation efficient as a function of wavelength, and (lower) intensity of flourescence as a function of wavelength.

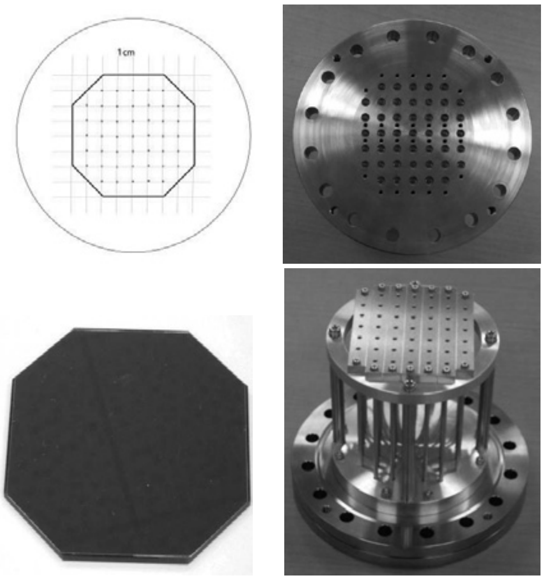

Fig. 2. (top-left) Conceptual view, and position of optical feedthrough and UV filter, (top-right) 152 flange with 45 optical feedthrough, (bottom-left) UV filter, and (right-bottom) the plasma interface system