# §81. Development of Multi-channel Detectors for Turbulence Tomography

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For advancing modern understanding of plasma turbulence, development of a new diagnostic system becomes absolutely necessary to be able to observe the whole plasma turbulence in every scale, from micro- to macro-scale, simultaneously. Tomography is one of the candidates to satisfy the requirement. The tomography system needs to be equipped with sufficient number of detectors in order to resolve micro-scale fluctuations. Moreover, in magnetically confined plasma of high temperature, such tomography system needs to observe different lights of wavelengths, *i.e.,* X-ray, ultraviolet and visible lines for the core, intermediate, and edge region, respectively. Thus, we have developed such a tomography system with multi-channel and multi-wavelength detection.

A prototype detector system for ultraviolet light, using fluorescence glass to convert plasma UV to visible light, has been made for high temperature plasmas including QUEST and some other devices, as is shown in Fig. 1[1].The plasma facing component (hereafter referred to as the light-guide) of the prototype system consists of collimators, optical feed-throughs, an optical filter, and its housing. Fig. 1 presents (a) the light-guide system, (b) a flange with the optical feed-throughs, and (c) a conceptual view of the composition of the light-guide. The prototype system is made on a CF152 flange in which 45 optical feed-throughs made of fluorescent glass are implanted. The filter housing is located above the flange on the vacuum side but below the collimator, and the shape of the housing is an octagon covering the optical filter whose shape is also octagonal in order to make the opening large enough.
A bench test has been performed in a RELAX reversed field pinch plasma. The typical discharge duration is a few milliseconds. Figure 2(a) shows an example of a detected UV signal (orange line), while Fig. 2(b) presents the temporal evolution of the plasma current (thin solid line). It is found that the fluorescence signal still remains after the

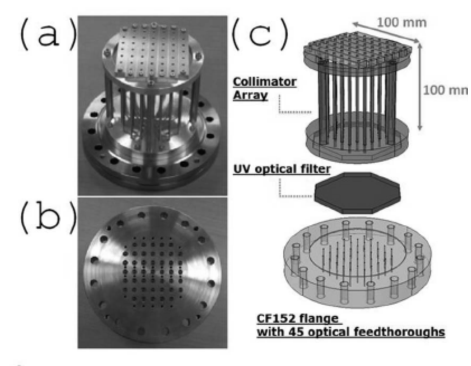


FIG. 1. (a) Light-guide system, (b) the flange with optical feed throughs, and (c) a conceptual view of the composition of the light-guide consisting of the collimators, filter housing, UV optical filter, and flange with optical feed-throughs.

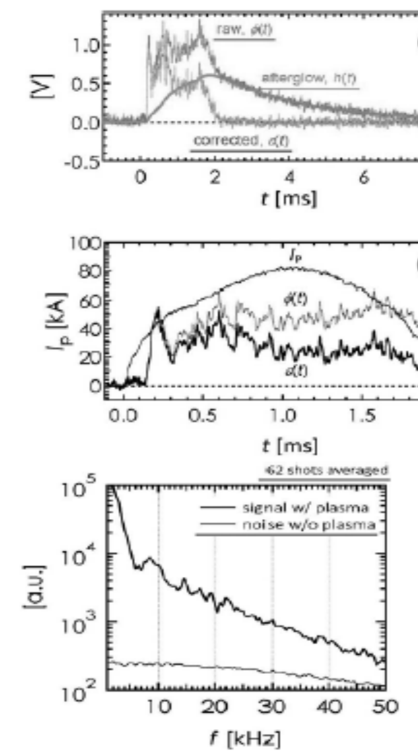


FIG. 2. (a) Temporal evolutions of ultraviolet emission using the prototype system; the orange line represents the raw signal, φ(t); the green line represents the afterglow component h(t); and the blue line represents the corrected signal _(t). (b) An example of waveforms of plasma current, φ(t) and _(t). .Fluctation spectrum observed in UV emission with the proposed system using fluorescence glass.

plasma is terminated, since fluorescent emission has an afterglow component with a several millisecond delay to the absorption. This afterglow effect of the fluorescent light is corrected, using the following formula

$$\varepsilon(t) = \frac{\phi(t)}{\beta} - \frac{\alpha}{\tau\beta^2}\int_0^t \phi(x)\exp\left[\frac{-(\alpha+\beta)(t-x)}{\tau\beta}\right]dx ,$$

where ε and ϕ represent the plasma emission and the detected signal, respectively, with α, β and τ being the rate coefficients of UV accumulation and immediate fluorescence, and the typical delay time of accumulated fluorescence, respectively.

Another purpose here is to study turbulence. As an initial step, the Fast Fourier Transformation (FFT) is performed on the signals. An example of the power spectra is successfully obtained as shown in Fig. 2(c). The calculation uses 930 ensembles for 62 shots, with a frequency resolution of 0.5 kHz. The noise level is sufficiently low to evaluate the power spectrum of the plasma UV emission. The peak around 8.5 kHz could reflect a characteristic magnetohydrodynamic activity which is often observed in a reversed field pinch plasma device.

Finally, the prototype diagnostics, a key of future application, is proven to work, and waits for further development of the new diagnostic system for plasma turbulence.

1) T. Onchi, A. Fujisawa, A. Sanpei, Rev. Sci. Instrum. **85**