Fast Timescale Radiometry of DIII–D Disruptions*

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Plasma disruptions in medium-size tokamaks such as DIII–D are characterized by loss of the stored thermal energy on a time scale as short as 10^{-5} s, followed by a dissipation of the energy stored in the poloidal field on a 10^{-3} s time scale. In both the thermal quench phase and the current quench phase, radiation is thought to be an important energy loss channel, but little is known about this to date because of the absence of diagnostics to measure radiated power on these fast time scales. The standard diagnostic for measurement of radiant heat is the metal foil bolometer, whose temporal response is limited to $\sim 10^{-2}$ s. In order to better understand disruptions, and the role played in them by radiative energy loss, a faster sensor is needed for this measurement.

In this paper we report measurements of disruption thermal and current quenches using AXUV photodiodes in a disruption radiometer (“DISRAD”) in the DIII–D tokamak. The use of these devices, which are free of the “dead layer” that commonly desensitizes silcon photodiodes to ultraviolet radiation, for radiometry in high-temperature plasma experiments has been described previously [1].

A weakness of these detectors in such measurements, particularly from the relatively cool plasmas found during disruptions, is that the responsivity varies considerably with photon energy below 22 eV. To address this issue, the diagnostic described here uses UV filtering to provide spectral information, allowing the spectral response to be accounted for in deducing the radiant power from the measured photocurrent. In particular, we compensated for the photon energy dependence of the photodiode responsivity by use of transmission filters, and with the aid of absolutely calibrated UV spectrometry. The data described in this paper is from lines of sight through the central plasma. Disruption radiated power was measured with a 170 kHz bandwidth. Our measurements indicate that during the disruption current quench all but a few percent of the radiation power is from photons below 17 eV energy. The radiation observed by this diagnostic during the thermal quench decays on time scales as short as 0.13 ms, which is comparable with time resolved ECE temperature decay measurements.

[1] R.J. Maqueda, G.A. Wurden, and E.A. Crawford, Rev. Sci. Instrum. **63** (1992) 4717.

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