Capabilities and Pitfalls of Electric Field Measurements via the EFISH Diagnostic

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Electric field induced second harmonic generation, or EFISH, is a nonlinear optical phenomenon that has been recently exploited as a laser-based method for electric field strength measurements in plasmas. Given its excellent detection sensitivity and fast time response, this talk will review recent EFISH measurements across a variety of different non-equilibrium discharges, underscoring its advantages over traditional methods. These benefits include its non-resonant nature – which affords broad applicability to almost all gas types, its capacity to measure both the strength and orientation of the electric field, as well as the ability to sample one-dimensional field data [1,2]. At the same time, due to the coherent nature of the signal generation, recent studies have raised the possibility of measurement error when using EFISH, especially in discharges where the electric field profile shape and vector (along the direction of laser propagation) exhibit large variations in time [3,4]. Various strategies for addressing and avoiding these errors will be described, along with the benefits and limitations of each approach. These ensure that the EFISH method remains a viable, and thus powerful, tool for probing electric fields in pulsed plasmas. On this final note, the potential for EFISH to be used in tandem with other diagnostic approaches such as Rayleigh scattering, in which the signal generation is inherently non-coherent in nature, will also be presented (see figure 1 below). This paves the way for simultaneous measurements of temperature and electric fields.

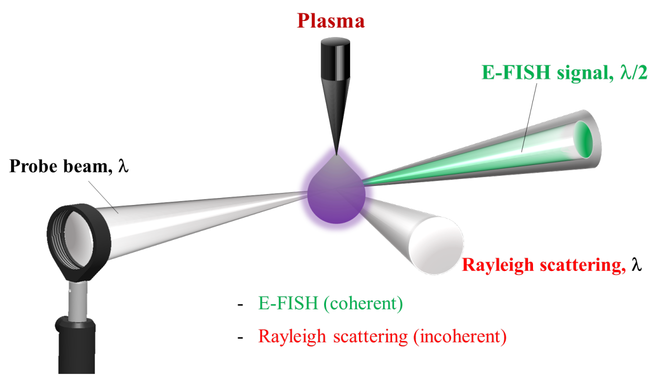

Figure 1. Schematic illustrating a combination of Rayleigh scattering (in which the signal is incoherent) and EFISH measurements (coherent signal).

[1] Dogariu, A, et al *Physical Review Applied* 7.2 (2017): 024024.

[2] Goldberg, BM., et al. *Optics letters* 44.15 (2019): 3853-3856.

[3] Chng, TL, et al. *Plasma Sources Science and Technology* 29.12 (2020): 125002.

[4] Zheng, X., et al. *Plasma Sources Science and Technology* 33.3 (2024): 035002.

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